Grand Canyon Monitoring and Research Center

Fiscal Year 2012 Annual Project Report

for the

Glen Canyon Dam
Adaptive Management Program

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INTRODUCTION

Following is the Grand Canyon Monitoring and Research Center's (GCMRC) Fiscal Year 2012 Annual Accomplishment Report. This report is prepared primarily for the Technical Work Group (TWG) of the Glen Canyon Dam Adaptive Management Program (GCDAMP). It includes a summary of accomplishments, shortcomings, and recommendations related to projects included in GCMRC's FY 2012 Work Plan for the GCDAMP.

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
1	**BIO 1.M1.12 Aquatic Food Base Monitoring**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	Theodore Kennedy, GCMRC Robert Hall, University of Wyoming Emma Rosi-Marshall, Cary Institute Colden Baxter, Idaho State University
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SUMMARY

The specific goals for FY12 identified in the work plan were:

- Produce a core monitoring report based on the recommendations of the PEP
- Continue monitoring at Lees Ferry and Diamond Creek with potential to modify monitoring based on PEP

Both of these goals were met.

I planned, organized, and then convened a Protocol Evaluation Panel (PEP) in late January. Proposed core monitoring was described in the summary report that was provided to the PEP (see publication #8, below). Based on critical feedback from the PEP, monitoring activities were revised and these modification are described in the FY13-14 work plan. Foodbase monitoring at Lees Ferry and Diamond Creek was conducted as described.

Additional accomplishments in FY12 include the launching of citizen science monitoring initiative, which was partially supported by funding from the USGS Southwest Biological Science Center ($10,000 in salary to hire a technician was provided by SBSC). The flux of emergent aquatic insects is highly correlated with river bottom insect production. The two taxa of aquatic insects that are common in the Colorado River (midges and black flies) are both attracted to light, so monitoring emergent aquatic insects using light traps might be a useful surrogate for more traditional river bottom invertebrate sampling. In collaboration with GCMRC's logistics manager (Carol Fritzinger) we contracted with eight professional river guides. Guides were supplied with simple light trap kits that were deployed each night in camp. Guides collected a total of 956 light trap samples from throughout Grand Canyon from April to October. 160 light trap samples have been processed so far and these preliminary data are very encouraging—catches of midges and blackflies in light traps peak in Marble Canyon and are much lower below the Little Colorado River confluence. These spatial patterns are consistent with earlier estimates of river bottom biomass and production for these taxa, however, the spatial and temporal resolution of light trap samples is far greater than for any previous estimates based on river bottom collections.

In FY12 we also collected invertebrate drift and rainbow trout diet samples from April, July, and September natal origins river trips (~100 drift and 100 diet samples per trip). Samples from April have been completely processed and samples from July are 90% processed.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Publication	Measuring air-water gas exchange and whole-system metabolism in a large, regulated river (Proof of Concept)		April 2012		Hall, R.O., **T.A. Kennedy**, and E.J. Rosi-Marshall, 2012. Air-water oxygen exchange in a large whitewater river. *Limnology and Oceanography: Fluids and Environments* **2**: 1-11. DOI: 10.1215/21573689-1572535
Publication	Assessing the seasonal and spatial variation in organic matter inputs to the Colorado River, Grand Canyon (Synthesis)			Summer 2013	
Publication	Determining spatial variation of secondary production of invertebrates in the Colorado River				Combined with #5, below.
Publication	Analyzing the spatial variation in the relative importance of basal resources to invertebrate and fish production in the Colorado River				In Press—Freshwater Science (expected publication date: April 2013)
Publication	Linking whole-river carbon flows with food webs in the Colorado River				November 2012—In Review at Ecological Monographs.
Publication	Effects of dam operations on rates of invertebrate drift			March 2013	
Report	Final report and peer-reviewed publications that summarize food base research project findings		January 2012		Kennedy, T.A., C.V. Baxter, R.O. Hall Jr., E.J. Rosi-Marshall, and W.F. Cross. 2012. A summary of research conducted in support of the Glen Canyon Dam Adaptive Management Program's Goal 1—Aquatic Foodbase—including draft monitoring protocols. Administrative Report Provided to Protocol Evaluation Panel (PEP) and Technical Work Group. January 12, 2012. 52 pp.
Report	Core Monitoring Report based on PEP recommendations				Core Monitoring Report is described in publication #8, above. Monitoring activities are also described in FY2013-2014 Work Plan.
Report	Brief trip reports				No river trips in 2012
Report	Draft final report summarizing major results and recommendations		January 2012		Combined with publication #8 above.
Report	Core Monitoring Report		Jan 2012		Combined with publication #8 above.

	OTHER				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
	Identification of key scientific uncertainties related to fish and aquatic resources in the Colorado River, Grand Canyon: summary and interpretation of an expert elicitation questionnaire.		Oct 2012		In press. USGS Scientific Investigations Report.

Gross Budget	$406,292				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$369,750	$39,559	$0	$409,309	($3,017)
Overhead	$38,204	$1,152	$0	$39,356	
Net Spent	$331,546	$38,407	$0	$369,953	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Publication #2 is delayed because I have focused my time on analyzing datasets that are more germane to management and long-term monitoring (i.e., publication #s 5 and 7)

Theodore Kennedy

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
2	**BIO 2.M1.12 Little Colorado River Humpback Chub Monitoring Lower 13.6 km (Population Estimates)**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	D.R. Van Haverbeke, USFWS W. Stewart, AZGFD
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SUMMARY

The Grand Canyon Monitoring and Research Center (GCMRC) determined that a rigorous stock assessment program for fishes in the Little Colorado River (LCR) was a priority in 2000. As a result, since 2000, the U.S. Fish and Wildlife Service have been contracted by GCMRC to conduct mark-recapture and monitoring activities in the lower 13.57 km of the LCR. The primary objective has been to monitor for annual changes in the spring and fall population abundances of humpback chub ≥150 mm, and ≥200 mm in the LCR. In spring 2009 researchers began PIT tagging humpback chub down to 100 mm, thus allowing estimates for this smaller size class to be generated. This protocol was continued through 2012. Also, in fall 2009 (and in cooperation with the Nearshore Ecology (NSE) Project), researchers initiated Visible Implant Elastomer (VIE) tagging of humpback chub <100 mm during the fall season in to obtain capture probability information and a population estimate for this size class of fish. This protocol was continued through fall 2012. Data from the above efforts are used to generate and update the Age Structured Mark-Recapture (ASMR) model developed at GCMRC. Finally, these trips provide opportunities to characterize the ecology of the LCR fish community.

During 2012, two mark-recapture trips were conducted in the lower 13.57 km of the LCR. Results indicated that during spring 2012 the estimated abundance of humpback chub ≥150 mm in the lower 13.57 km of the LCR was 7,958 (SE = 453). Of these fish, it was estimated that 5,327 (SE = 379) were ≥200 mm (Figure 1). These numbers indicate that the spring spawning abundances of humpback chub have remained relatively stable after experiencing significant post-2006 increases. In addition, bluehead and flannelmouth suckers underwent significant post-2006 increases in relative abundance during the spring. Catch per unit effort of bluehead suckers has since declined. The overall results suggest that sometime during the mid-2000s, conditions were favorable for all three large bodied native fishes in Grand Canyon. These favorable conditions are thought to be related to warmer water temperatures experienced in the Colorado River because of drought, and a system-wide decline of non-native salmonids in the Colorado River. In addition, some benefit may have accrued to humpback chub because of translocation efforts within the LCR, and because of hydrologic conditions within the LCR.

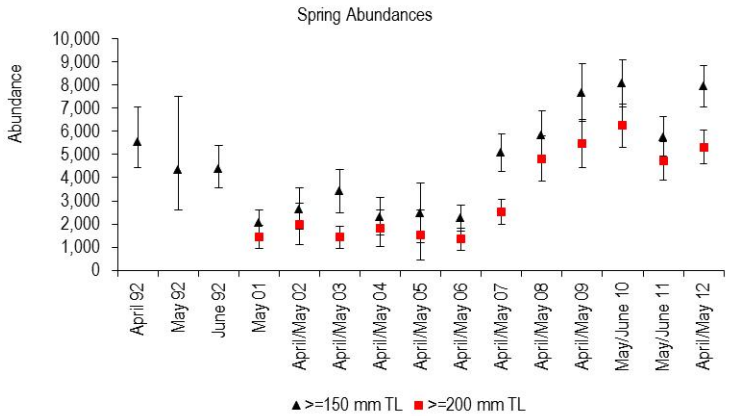

Figure 1. Spring abundances of humpback chub in the Little Colorado River since 2002. Comparative 1992 estimates are from Douglas and Marsh (1996).

Results also indicated that during fall 2012 the estimated abundance of humpback chub ≥150 mm in the lower 13.57 km of the LCR was 6,389 (SE = 613). Of these fish, it was estimated that 2,742 (SE = 522) were ≥200 mm (Figure 2). As with the spring results, the fall numbers indicate that the fall abundances of sub-adult and adult humpback chub have remained relatively stable after experiencing significant post-2006 increases. In addition, it was estimated that there were 6,952 (SE = 1,200) humpback chub <100 mm in the lower 13.57 km of the LCR during fall 2012. This indicates production of a relatively moderate cohort of age-0 humpback chub for 2012.

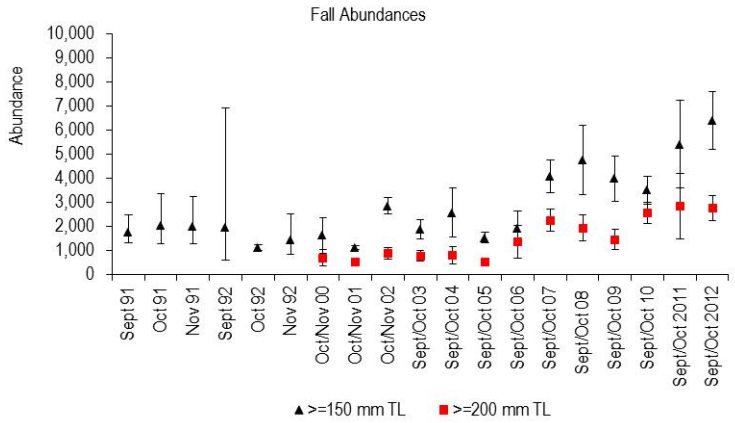

Figure 2. Abundances of humpback chub since fall 2001. Comparative 1991 and 1992 estimates are from Douglas and Marsh (1996).

USFWS has provided GCMRC with two trip reports covering these activities (see below). In addition, USFWS has submitted a manuscript to the Journal of Fish and Wildlife Management summarizing, among other topics, the mark-recapture activities conducted in the Little Colorado River of sub-adult and adult humpback chub. The manuscript has been accepted, pending minor revision and the abstract is provided below:

Abstract: The lower perennial corridor of the Little Colorado River in Grand Canyon, Arizona is numerically dominated by endemic desert fishes and therefore significant for conservation of these species. From 2000 to 2012, the U.S. Fish and Wildlife Service conducted monitoring of native fishes in the Little Colorado River near its confluence with the Colorado River. The primary focus of these efforts was to estimate the spring and fall abundance of native fishes including the federally endangered humpback chub *Gila cypha*. Because humpback chub in Grand Canyon are influenced by operations of Glen Canyon Dam, our efforts provide managers of the Glen Canyon Dam Adaptive Management Program with abundance estimates and trends of humpback chub in the Little Colorado River, the most important site in Grand Canyon for spawning and production of this species. From 2001 to 2006, the spring abundance estimates of chub ≥150 mm and ≥200 mm remained relatively low (≤3,419 and ≤2,002 fish, respectively); thereafter significantly increasing to highs of 8,083 and 6,250, respectively, by spring 2010. Also from 2000 to 2006, the fall abundance estimates of humpback chub were substantially below those abundances estimated after 2006. In addition, flannelmouth sucker *Catostomus latipinnis* and bluehead sucker *C. discobolus* showed post-2006 increases in relative abundance, suggesting a system wide event occurred that was beneficial to native fishes. Most of these increases occurred during the spring season in the reaches of the Little Colorado River between 5 and 13.57 km upstream from the confluence. Successful production of age 0 year classes of humpback chub may be partially driven by hydrograph dynamics of the Little Colorado River, while water temperatures and predation pressures in the mainstem Colorado River likely influence survivorship of native fishes into sub-adult and adult life stages.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Report	Two (2) Annual Trip reports		August 2012 Nov 2012	Pillow, M.E. 2012. Spring 2012 Monitoring of Humpback Chub (*Gila cypha*) and Other Fishes in the Lower 13.57 km of the Little Colorado River, Arizona: TRIP REPORT Little Colorado River 17 - 27 April 2012 and 16 - 26 May 2012 Stone, D.M. 2012. Fall 2012 Monitoring of Humpback Chub (*Gila cypha*) and other Fishes in the Lower 13.57 km of the Little Colorado River, Arizona: TRIP REPORT Little Colorado River September 11-21 and October 10-19, 2012
Report	Annual report delivered to GCMRC	February- March FY 2013	Submitted to Journal of Fish and Wildlife Management August 2012 Conditionally Accepted pending minor revision 9 November 2012	David R. Van Haverbeke, Dennis M. Stone, Lewis G. Coggins Jr., and Michael J. Pillow. In review. Long term monitoring of an endangered desert fish and factors influencing population dynamics
Report	Annual report prepared by USFWS in cooperation with GMRC		N/A	
Report	Annual report – monitoring results of the lower 1,200 m of the LCR		N/A	This is a Game and Fish Report
Report	Annual report prepared by AZGFD in cooperation with GMRC		N/A	This is a Game and Fish Report
Report	Core-monitoring – summarizing CM effort, 2009 PEP recommendations and results of analyses recommended by the 2009 PEP	FY 2011	N/A	This is a GCMRC report

Gross Budget	$534,763				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$240,781	$184,272	$0	$425,053	$109,710
Overhead	$24,878	$5,367	$0	$30,246	
Net Spent	$215,903	$178,905	$0	$394,807	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

D.R. Van Haverbeke, USFWS

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
2	**BIO 2.M3.12 Humpback Chub Translocation and Monitoring Above Chute Falls**

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SUMMARY

In December 2002 (and during Section 7 re-initiation in March 2003), a conservation action was identified by the U.S Bureau of Reclamation, the Grand Canyon Monitoring and Research Center (GCMRC) and the National Park Service to translocate 300 (50 to 100 mm) humpback chub (*Gila cypha*) from the lower reaches the Little Colorado River (LCR) to an upriver area of the LCR (16.1 km) above a travertine structure known as Chute Falls. This was intended as a voluntary conservation action to offset the potential impacts on humpback chub from experimental releases from Glen Canyon Dam and mechanical removal of nonnative fish. Since 2003, eight translocation efforts have occurred. To date, ~2,060 humpback chub (~80-130 mm) have been translocated to above Chute Falls. The primary objective of these translocations (as stated in the Biological Opinion) is a conservation action to attempt to diminish the loss of humpback chub in the 50 to 100 mm size class.

Additionally, in summer 2006 a mark-recapture effort was initiated in the LCR (between 13.57 and 18.1 km) in order to track the translocated humpback chub. These mark-recapture efforts were conducted again in the summers of 2007-2012. In 2010, unusual prolonged spring flooding occurred in the LCR. This flooding apparently resulted in displacement or downriver movement of nearly all humpback chub in the 13.57 to 18.1 reach of river. Because of this, in 2010 only one monitoring trip was conducted (i.e., it was not considered prudent to conduct a subsequent recapture trip in lieu of almost no fish being present). Rather, a population estimate was derived in this reach of the river using capture probability data. This tactic was used again in 2011 and 2012. The purposes of these annual population abundance estimation efforts above Lower Atomizer Falls are to: 1) track the abundance of translocated humpback chub above Chute Falls (14.1 to 18.1 km), and 2) to estimate the abundance of humpback chub in a small stretch of the LCR between 13.57 and 14.1 km. This small stretch of the LCR is of importance because it is where translocated humpback are generally detected if they vacate (i.e., move downriver) from above Chute Falls. This small stretch of the LCR is logistically impractical to sample during our primary LCR mark-recapture efforts conducted between 0 and 13.57 km. Thus, in addition to tracking the abundance of translocated humpback chub, the Chute Falls mark-recapture efforts compliment the primary mark-recapture efforts in the LCR. Finally, data collected during these mark-recapture efforts are used in the open Age Structured Mark Recapture model developed by GCMRC.

During 17-24 May 2012, a monitoring trip was conducted above Lower Atomizer Falls (13.57-18 km). Sampling effort mirrored those of the 2006-2011 monitoring trips. Biologists deployed 51 net sets for a total of 1,149 fishing hours in the Lower Atomizer to Chute Falls reach (13.58 to 14.1 km), and 99 net sets for a total of 2,382 fishing hours in the reach above Chute Falls (14.14 to 17.68 km). A total of 148 unique chub (TL range = 125-412 mm) were captured during the trip, which included 82 chub (125-338 mm) captured above Chute Falls, and 66 chub (130-412 mm) captured in the Lower Atomizer-Chute Falls reach. Using capture probability data, it was estimated that there were 40 (SE = 13) adult humpback chub ≥200 mm in the reach of river above Chute Falls (>14.14 km), and that there were 74 (SE = 11) adult humpback chub ≥200 mm in the reach of river immediately below Chute Falls (13.56-14.1 km). Length frequency analysis shows that there are additional humpback chub <200 mm in both of these reaches (Figure 1).

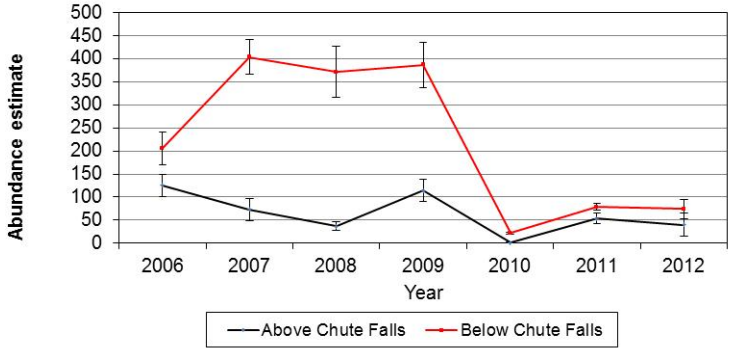

Figure 1. Abundance estimates of adult humpback chub (≥200 mm) since 2006 above Chute Falls (>14.14 km) and in the reach of river immediately below Chute Falls (13.57-14.1 km).

Note in Figure 1 the dramatic decrease in abundance of humpback chub both above and below Chute Falls in 2010. Again, this is thought to have been caused by the prolonged spring flooding during spring of 2009 that filled in much of the available deep pool habitat with sand. It is expected that as newly translocated fish since 2010 continue to grow into adulthood, these estimates will continue to rise again.

In addition, during 9-13 July 2012, USFWS and U.S. National Park Service biologists conducted a translocation trip. During this trip, 212 humpback chub (TL range 68-135 mm) were successfully PIT-tagged and translocated to above Chute Falls. In addition, another 702 humpback chub (<80 mm) were flown out of the LCR and transported to Dexter National Fish Hatchery and Technology Center, New Mexico. The 700 chub transported to Dexter included 200 chub to augment their existing captive broodstock, and 200 and 300 chub to be translocated into Shinumo and Havasu Creeks, respectively, within Grand Canyon National Park during 2013.

Key preliminary findings of the Chute Falls translocation and monitoring efforts to date are:

1) Since 2006, biologists have begun PIT tagging all humpback chub translocated to above Chute Falls in order to better track these fish.
2) Documented mortalities of humpback chub during actual translocation procedures have been very low (0-5%).
3) High growth rates for translocated humpback chub have been documented; nearly double or triple growth rates in the lower portions of the LCR (<13.57 km).
4) Based largely on length frequency analyses, there is some evidence that at least one spawning event likely occurred above Chute Falls.
5) There is evidence adult humpback chub are able to ascend Chute Falls on their own accord, although this appears to be rare (i.e., only a few individuals have been documented ascending Chute Falls on their own).
6) There is good evidence for retention of the translocated chub in the upper portions of the LCR , particularly in the reach above Chute Falls (>14.1 km), and in a small reach of river immediately below Chute Falls (Lower Atomizer to Chute Falls (13.58-14.1 km).
7) An exception to the above was seen during the Chute Falls monitoring of spring 2010, when it was estimated that nearly all humpback chub above Lower Atomizer (and in the upper portions of the Salt reach) vacated these portions of the river.
8) Based on preliminary mark-recapture and capture probability analyses, we estimate that at least half, and perhaps more of the humpback chub above Lower Atomizer in 2009 moved downriver into lower portions of the LCR, or into the mainstem during the 2009 spring flood event. However, the fate of the remaining portion of these fish is uncertain.
9) Since 2009, three more efforts to translocate humpback chub above Chute Falls have occurred (2010, 2011, and 2012). These fish again appear to be largely remaining in the reaches of the river above Lower Atomizer Falls, accompanied by attendant high growth rates.
10) Flows since spring 2010 have scoured and deepened many of the pools that were filled in with sand, likely providing suitable habitat for entering and future translocated fish.

Key uncertainties:

1) Can humpback chub translocated above Chute Falls successfully spawn on an annual basis?
2) How much are translocated humpback chub contributing to the recent increases in humpback chub abundance? Stated another way, are translocated chub experiencing higher survival than if they were not translocated? We know that humpback chub translocated to above Chute Falls experience extraordinarily high growth rates. This implies higher survival than if these fish were not translocated. However, exact contribution to the lower LCR population (that below Lower Atomizer Falls) has been difficult to ascertain, and is likely variable among years. However, it seems clear that at least several hundred adult humpback chub moved into the lower portions of the LCR sometime between 2009 and 2010, and contributed to the population at large.

USFWS provided GCMRC with a trip reports covering these activities (see below). In addition, USFWS is in preparation of a manuscript intended for submission to a peer reviewed journal covering aspects of the Chute Falls translocation and monitoring efforts. An abstract is not yet available.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Report	Two (2) annual trip reports		August 2012	Stone, D.M. 2012. Summer 2012 Monitoring and Translocation of Humpback Chub (*Gila cypha*) above Lower Atomizer Falls in the Little Colorado River, Arizona. Trip Report for May 17-24, 2012 Monitoring Trip and July 9-13, 2012 Note: This one trip report is inclusive of monitoring and translocation activities during 2012
Report	Annual report or manuscript prepared by USFWS	FY 2013		In progress for expected manuscript submission
Report	Annual report – monitoring results of the lower 1,200 m of the LCR		N/A	This is a AZ Game and Fish report
Report	Annual report prepared by AZGFD in cooperation with GMRC		N/A	This is a AZ Game and Fish report
Report	Core-monitoring – summarizing CM effort, 2009 PEP recommendations and results of analyses recommended by the 2009 PEP	FY 2011	N/A	This is a GCMRC report

Gross Budget	$132,248				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$47,903	$66,951	$0	$114,854	$17,394
Overhead	$4,950	$1,950	$0	$6,900	
Net Spent	$42,953	$65,001	$0	$107,954	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

D.R. Van Haverbeke, USFWS

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

Goal	Number and Title
2	**BIO 2.M4.12, Monitoring Mainstem Fish**

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SUMMARY

AZGDF:

Mainstem electrofishing surveys:

In 2012, we conducted electrofishing in the mainstem Colorado River between Lees Ferry and Lake Mead (RM 0 and RM 265). The river section between Lees Ferry and Diamond Creek was sampled from May 11–June 2, 2012, while the section between Diamond Creek and Pearce Ferry was sampled October 5-9, 2012. Daily flow discharge at GCD ranged from 14,900 to 23,300 ft^3/s, during the spring sampling event, while flows were stable at ~8,000 ft^3/s during the fall. We completed 479 standard transects and 48 additional transects to recapture fish during mark-recapture experiments. During the 23 nights of electrofishing, transects averaged 315 seconds. Average turbidity (6 NTUs) was low during spring sampling, but higher during fall sampling (average = 100 NTUs).

During standardized electrofishing a total of 2,688 fish were captured comprising 17 species. A total of 993 fish were marked this year with PIT tags. Recapture data were available for 68 PIT tagged fish and 5 Floy tagged fish. Three PIT tagged rainbow trout were recaptured, but did not appear in the database. Coefficients of variation of river-wide mean CPUEs for salmonids, carp, and catastomids were ≤ 16% during 2012 sampling (table 4).

In addition to our standardized sampling activities, we conducted three mark-recapture experiments during our 2012 sampling trip to estimate salmonid absolute abundance and capture probabilities at discrete locations. We estimated abundance and capture probability for rainbow trout within the Paria River to Badger Rapid reach (RM 4) and in a reach located slightly upstream from the Little Colorado River confluence area (RM 60.2-61.3). The mark-recapture experiment within the Little Colorado River reach was conducted in coordination with the Natal Origins Project. Brown trout estimates were attained near the Bright Angel Creek confluence (RM 87).

During our fall 2012 sampling trip, we seined backwater habitats to determine presence of juvenile razorback suckers (*Xyrauchen texanus*) downstream from Diamond Creek. A bag seine was spread across the backwater opening, and two netters moved in parallel towards the back shoreline. Fish were identified to species and a subsample of 30 fish was measured for TL. Remaining fish were separated by species and counted. Seining backwater habitats within the Diamond Creek to Pearce Ferry reach yielded 1,557 fish comprising 8 species. We seined five juvenile humpback chub near a large backwater located at RM 243.

Mean CPUE of rainbow trout in 2009 (63.0±9.8 fish/hr) and 2010 (58.3±9.2 fish/hr) was similar to 2011 (52.1±7.5 fish/hr; fig. 3*A*). However, in 2012 we found an overall decline primarily driven by substantial declines near the Little Colorado River confluence. Brown trout river-wide CPUE remained relatively consistent from 2008 (3.7±0.9 fish/hr) to 2010 (4.8±1.1 fish/hr), but showed a slightly significant increase in 2011 (7.2±1.6 fish/hr). In 2012, CPUE declined overall primarily driven by decreased CPUE in the Bright Angel Creek area. Common carp CPUE declined from 2003 (5.1±0.9 fish/hr) to 2007 (1.1±0.3 fish/hr) and has remained relatively low since that time. In 2012, no differences were found in common carp CPUE with the previous year in most reaches. In addition to the common nonnative fish, we captured green sunfish (*Lepomis cyanelles*), gizzard shad (*Dorosoma cepedianum*), mosquitofish (*Gambusia* spp.) red shiner (*Cyprinella lutrensis*), fathead minnow (*Pimephales promelas*), black bullhead (*Ameiurus melas*), channel catfish (*Ictalurus punctatus*), plains killifish (*Fundulus zebrinus*) and striped bass (*Morone saxatilis*). Eight adult striped bass measuring greater than 340 mm TL were captured just upstream from Diamond Creek (RM 218-222).

We captured a ripe adult male razorback sucker measuring 543 mm TL at Spencer Canyon (RM 246). The fish was tuberculate on the anal and caudal fins. This species is federally listed as endangered, and this was the first confirmed capture in Grand Canyon in 20 years. During 2009-2011, increased flannelmouth sucker CPUE in reaches 5 and 6 (Western Grand Canyon) drove an overall increase for the whole river. However, a large river-wide decline was evident in 2012 primarily caused by lower CPUE in the same reaches. The trend in CPUE has shown a staggered yet increasing pattern from 2006-2010, but has declined since 2010. Mean CPUE trends for speckled dace were very similar to flannelmouth

sucker. Humpback chub are sporadically observed during mainstem electrofishing surveys possibly due to their lessened vulnerability to electrofishing. However, flannelmouth and bluehead sucker appeared to be vulnerable to this gear.

Population estimates for rainbow trout (all sizes) within the Paria River to Badger Rapid area (RM 4-5) were 5,450±1,376 per mile. Rainbow trout capture probability was 0.12±0.03 under clear water conditions. In coordination with the Natal Origins Project, we estimated rainbow trout abundance in a reach just upstream from the Little Colorado River confluence (RM 60-61) to be 921±293 per mile, with a capture probability of 0.07±0.03. We could not attain an estimate for brown trout near the Bright Angel Creek confluence (RM 87) because too few fish were marked and recaptured.

FWS:

Native fish populations in Grand Canyon are key resources of concern influencing decisions on the operations of Glen Canyon Dam, including non-flow actions. To inform these decisions, it is important that timely information on the status of fish populations, particularly the endangered humpback chub (HBC), be available to managers. In response to goals identified by the Glen Canyon Dam Adaptive Management Program (GCDAMP), the 2009 Protocol Evaluation Panel (PEP) for Grand Canyon Fishes concluded that it is important to conduct mainstem fish monitoring with a variety of sampling designs and gears (Bradford et al. 2009). To this end, a three pronged approach was suggested by the PEP including: 1) mainstem stratified random electrofishing, 2) targeted monitoring to obtain relative abundance of HBC at aggregation sites, and 3) a targeted program for the detection of rare nonnative species. This study addresses the second element above. In addition, conducting mainstem fall HBC aggregation trips help to address conservation measures in a Biological Opinion (USFWS 2011) and help to address the following GCDAMP Core Monitoring Information Needs (CMIN):

> CMIN 2.1.2. Determine and track recruitment of all life stages, abundance, and distribution of HBC in the Colorado River.

Because other fishes are captured besides HBC, this study also helps to address these CMINs and Research Information Needs (RINs):

> CMIN 2.4.1. Determine and track the abundance and distribution of nonnative predatory fish species in the Colorado River.
>
> CMIN 2.6.1. Determine and track the abundance and distribution of flannelmouth sucker, bluehead sucker, and speckled dace populations in the Colorado River ecosystem.
>
> RIN 2.4.2. Determine if suppression of nonnative predators and competitors increases native fish populations.

Finally, data collected during aggregation trips can potentially be incorporated into other studies conducted by Grand Canyon Monitoring and Research Center (GCMRC) including: 1) collection of data that can be used for the Age Structured Mark-Recapture models, 2) contribution to a long-term data set to obtain information on movement, growth, etc., of native fishes, 3) examining movement and recruitment dynamics between the Little Colorado River (LCR) and mainstem Colorado River aggregations, and 4) to inform the fate of fish translocated to Shinumo and Havasu creeks.

Between September 7 and September 24, 2012, biologists from USFWS, GCMRC and AZGFD and volunteers sampled nine HBC aggregation sites. This was in continuation of mainstem aggregation trips conducted since 2002. Two important objectives of these trips are 1) to work toward obtaining population abundance estimates for these aggregations, and 2) to look for measureable effects of HBC being translocated into Shinumo and Havasu creeks.

Mainstem aggregation trips have historically relied heavily upon trammel netting. Although this gear type still appears to be necessary at several aggregations, increasingly more emphasis has been placed on using hoopnets as a gear type. Hoopnets catch a broader size class of HBC, and are much less stressful to the fish than trammel nets. During sampling in 2012, for example, trammel netting was ceased within the LCR and Shinumo aggregations, since the LCR aggregation is sufficiently well monitored with the use of hoopnets, and an effort was made to obtain a within year closed abundance estimate of the Shinumo aggregation with the exclusion of trammel nets.

Because of the difficulty in capturing HBC, either with hoopnets or trammel nets, obtaining population abundances of HBC within the distinct aggregations has been challenging. Even with monthly sampling, Valdez and Ryel (1995) were unable to obtain abundance estimates in all aggregations. Capture probability of HBC in the mainstem is low, and obtaining a sufficient number of recaptured fish to estimate abundance has been problematic. Because of this factor, biologists have relied upon pooled capture probability data in an effort to achieve their goal (i.e., to obtain abundance estimates). Data is too sparse to run open population models. Rather, a closed model approach has been used, yielding preliminary results. The mark event is year x and the recapture event is year x+1. An assumption is made that HBC have high site fidelity. Because of the sparseness of recaptured fish within any given aggregation, data is pooled across all aggregations, yielding a homogenous capture probability (p-cap). This p-cap is then applied to raw catch within each aggregation to derive annual abundance estimates for each aggregation. The p-cap estimate derives its mean and variance as annual trips are continued and as

across year mark-recapture efforts continue to derive new p-cap information. One alternative to this approach is to perform within year closed mark-recapture efforts at each aggregation. However, the recapture rate is so low in most aggregations, that his approach is likely not very realistic. Nevertheless, this approach was taken in 2012 at the Shinumo aggregation, yielding some results. The figures below show preliminary raw catch of HBC within the 8 aggregations outside of the LCR aggregation, and population estimates of HBC within those aggregations.

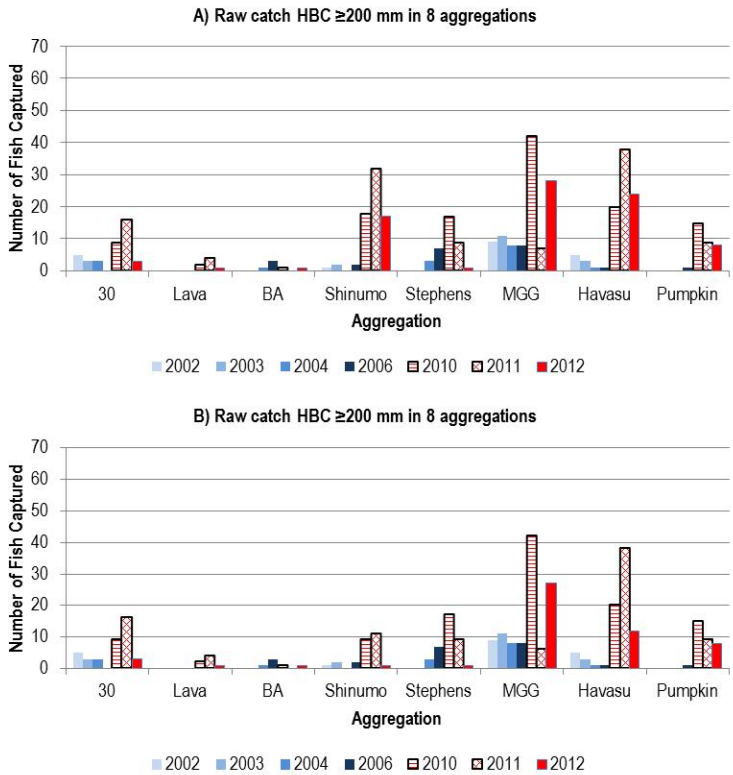

Figure 1. Raw catch of adult humpback chub (≥200 mm) in eight aggregations between 2002 and 2012 outside of the Little Colorado River aggregation. A) catch is inclusive of chub that were translocated into Shinumo and Havasu creeks and were then captured in the mainstem or immediate vicinity of the mainstem (i.e., the mouths of Shinumo or Havasu creeks), and B) catch is exclusive of chub that were translocated into Shinumo or Havasu creeks.

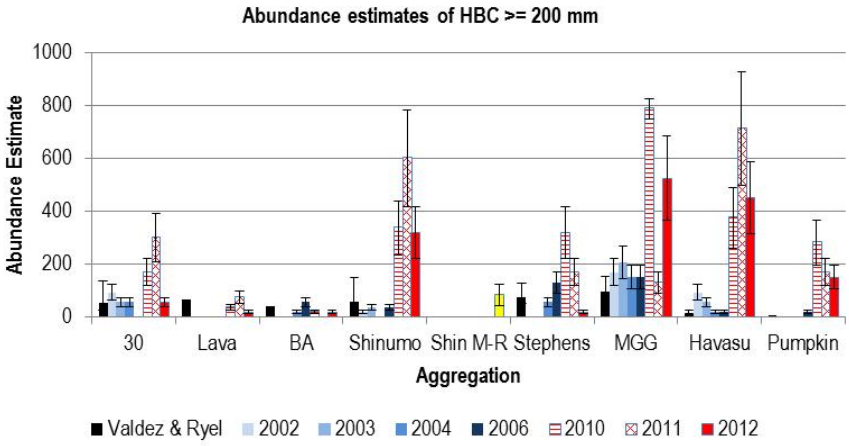

Figure 2. Abundance estimates of adult humpback chub (≥200 mm) in eight aggregations outside of the Little Colorado River aggregation. Shin M-R = 2012 abundance estimate for the Shinumo aggregation derived via a within year mark-recapture experiment.

Note in Figure 1 that there is a visible difference between including and excluding adult HBC that were translocated into either Shinumo or Havasu creeks and then captured in the mainstem, or the immediate vicinity of the mainstem (i.e., the

mouths of Shinumo or Havasu creeks). These differences are particularly visible in the Shinumo (Shin) aggregation during 2010, 2011, and 2012. The difference at the Havasu creek aggregation is only visible in 2012. This is because translocations into Havasu Creek did not begin until after translocation into Shinumo Creek. There is also a very small difference (~1 fish per year) in the Middle Granite Gorge (MMG) aggregation. These were HBC that were translocated into Shinumo Creek and swam downriver into the MGG aggregation. Note in Figure 2 that the abundance estimates for adult HBC follow the same pattern as raw catch in Figure 1. This is the result of applying a uniform p-cap to derive abundance estimate within each aggregation. Note also that Figure 2 shows the result of conducting a closed within-year mark-recapture experiment at the Shinumo aggregation (Shin M-R). This estimate is considerably lower than the method of applying uniform p-cap data to derive abundance. The result of the within-year closed mark-recapture effort could be real, or it may be an artifact of obtaining too few recaptures (only 6) in the within year mark-recapture study, or it could be an artifact of timing (the recapture trip was run almost immediately after the marking trip and fish may have been affected by this). Regardless, it does demonstrate the difficulties and uncertainties that should be expected if managers decide to investigate each aggregation more closely via within-year mark-recapture experiments. Again, the lack of sufficient recaptures during the within-year closed experiment at Shinumo (only 6) demonstrates the difficulties that may be encountered by taking such an approach. It is expected that within-year recaptures at the other 7 aggregations may be even fewer. A minimum of 7 recaptures is desirable for confidence in an estimate.

USFWS has submitted two trip reports to GCMRC covering the aggregation trips from 2010 to 2012 (see below). These trip reports also are inclusive of some data from the 2002-2006 aggregation monitoring trips (e.g., catch data). In addition, a manuscript is in progress for submission as an USGS Open File Report. This manuscript is being prepared by USGS and USFWS, and is expected to be finished this fiscal year. The preliminary abstract is included below.

ABSTRACT: Humpback chub, *Gila cypha*, is an endangered cyprinid species endemic to the Colorado River basin of western United States. The species was described in 1946 by R. Miller from a specimen taken near the mouth of Bright Angel Creek, Grand Canyon National Park, Arizona; and was listed as endangered in 1967. Long term fish monitoring in the Colorado River downstream of Glen Canyon Dam is a component of the Glen Canyon Dam Adaptive Management Program. Monitoring for humpback chub in the mainstem Colorado River in Grand Canyon has been conducted sporadically since the 1970's, and has improved since the introduction of small motorized watercraft and the use of hoopnets and trammel nets. Nine humpback chub aggregations were originally identified based on fish collected during 1990 -1993, and closed population model abundance estimates were generated for six of those aggregations. An aggregation was defined as "a consistent and disjunct group of fish with no significant exchange of individuals with other aggregations, as indicated by recapture of PIT-tagged juveniles and adults and movement of radio-tagged adults". An open population model has been developed to estimate the population size of the aggregation centered at the Little Colorado River and the adult humpback chub population is estimated between 9,000 and 12,000 fish. We estimated abundance of humpback chub at aggregations by applying a uniform set of capture probability estimates to annual catches within the aggregations to estimate humpback chub abundance. The adult humpback chub population at eight mainstem aggregations, exclusive of the Little Colorado River aggregation, is estimated between 1,000 and 1,800 fish. There appears to have been an increase in 2010 and 2011 in the 30-mile, Shinumo, Havasu, and Pumpkin Springs aggregations compared to previous years. Shinumo and Havasu aggregations appear to have benefited from an ongoing program of translocations of young humpback chub to those tributaries.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Report	Annual report on catch rates, species encountered, size class distributions an locations for captures for the fall HBC monitoring	FY 2011	July 2012	David R. Van Haverbeke and W. R. Persons. 2012. Monitoring of Humpback Chub (*Gila cypha*) Aggregations in the mainstem Colorado River in Grand Canyon during 2010 and 2011 Trip Report
Report	Annual report on catch rates, species encountered, size class distributions an locations for captures for the fall HBC monitoring	FY 2012	January 2013	Michael Pillow. 2013. Monitoring of Humpback Chub (*Gila cypha*) Aggregations in the Colorado River in Grand Canyon, 2012 TRIP REPORT: Colorado River Aggregations 7 - 24 September 2012
Report	Annual report on catch rates, species encountered, size class distributions and locations for captures for the spring electrofishing.			Bunch, A.J., R. Osterhoudt, M. Anderson, and W.T. Stewart. 2012. Colorado River Fish Monitoring in Grand Canyon, Arizona—2012 Annual Report. Submitted to: USGS/GCMRC. (in review)
Database	All fish data submitted to GCMRC for inclusion in fish database			These data are held by GCMRC and Reclamation can access there.
Journal Article				Bunch, A.J., C. Walters, and L. Coggins. *In review*. Measurement Error in Fish Lengths: Evaluation and Management Implications. Fisheries Accepted with minor revisions.

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Comments**
Monitoring	Mainstem Fall Humpback Chub Aggregation	FY 2011		Motorized; GCMRC, USFWS, AZGFD
Monitoring	Mainstem Fall Humpback Chub Aggregation	FY 2012		Motorized; GCMRC, USFWS, AZGFD
Monitoring	Mainstem Fall Fish	October 2012		AZGFD
Monitoring	Mainstem Spring Electrofishing	February FY 2012		Motorized; AZGFD
Monitoring	Mainstem Spring Electrofishing	March FY 2012		Motorized; AZGFD

Gross Budget	$457,529				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$260,190	$156,560	$0	$416,750	$40,779
Overhead	$26,884	$4,560	$0	$31,444	
Net Spent	$233,306	$152,000	$0	$385,306	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

W. R. Persons

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
2	**BIO 2.R7.12 Stock Assessment of Grand Canyon Native Fish**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	W.R. Persons, USGS/GCMRC
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

This project will provide annual updates of population size composition and capture rates of humpback chub and other Grand Canyon fish to the GCDAMP and other managers. The goals are to lead the analyses of existing fish capture information, seek to develop and implement methods for making the humpback chub database available electronically, and develop an annual reporting framework for native and nonnative fishes that includes results of current and historic fisheries monitoring.

Outcome:

Scott VanderKooi presented Dr. Steve Martel's latest ASMR findings at the April 2012 TWG meeting. A follow-up webex meeting with Dr. Martell, TWG members, and GCMRC staff was held in June 2012. Dr. Martell is now developing a length based mark-recapture model to estimate abundance of humpback chub. A Stock assessment report is being refined based on the 2011 Knowledge Assessment and Fish Cooperators Meeting.

Database with tag history information has been revised and is current through Spring 2012.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Report	Annual Stock Assessment report	Winter		

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Comments**
Analysis	Retrospective analysis of fish catch rate data	FY 2011	January, 2012 Knowledge Assessment	Supported by AZGFD & USFWS, presented to TWG
Update	ASMR model	Winter	April 2012	Delivered to GCDAMP at TWG meeting
Database	Pursue making the humpback chub database information available electronically		November 5, 2012	Capture history database delivered to fish cooperators.

Gross Budget	$70,051				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$65,946	$0	$0	$65,946	$4,105
Overhead	$6,814	$0	$0	$6,814	
Net Spent	$59,132	$0	$0	$59,132	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

W. R. Persons

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
2	**BIO 2.R13.12 Remote PIT Tag Reading**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	W.R. Persons, USGS/GCMRC Kristen Pearson and Dana Winkelman, Colorado State University
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

The major tasks for this project are to build, install, operate and maintain a PIT antennae interrogation system in the Little Colorado River (LCR) as well as to evaluate and learn to use the system. Since 2004, a few small (60 cm square) antennae have been used in the LCR with limited success. In 2009, in cooperation with the USGS Columbia River Research Laboratory, a larger system consisting of six 6 x 0.6 m rectangular antennae was built and installed near approximately river kilometer 2 in the LCR. The antennae array records date and time along with PIT tags to a single transceiver/reader. The system includes a solar power plant designed to keep the system operational year round. The system was upgraded in May 2012 to include a second solar power plant and an antenna array approximately 200 m downstream from the first array. A remote communication station was installed during spring 2012 and is operational. The remote station allows users to download data from the two readers and to check status of antennas and the solar power plants.

Kristen Pearson started her master's thesis research with Colorado State University and conducted range detection tests during May 2012. Her thesis will evaluate the efficiency of current hoop-net sampling efforts as compared to the remote PIT tag detection system in regards to estimating vital population parameters for the LCR aggregate populations of humpback chub.

Parts of the antenna arrays were dislodged by high flows in September 2012 and repairs were made in October 2012. The antenna arrays detected 3,147 unique humpback chub between January 1 and November 29, 2012, including a fish that was translocated to Shinumo Creek in 2009. The system also detected 1,376 unique bluehead suckers and 848 unique flannelmouth suckers during the year. Most fish were detected during March-May, and most fish were only detected one time, suggesting they were relatively transient fish on spring spawning runs. Detection records have been added to the GCMRC fish database and further analysis is ongoing.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Report	Installation and operation of the equipment and collected data	September 2012	September 2012	Delivered to GCMRC

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Comments**
Student	Introduce student to the data and field operations, provide data to student.	September 2012	September 2012	Kristen Pearson, Colorado State University is working with the data for a Master's Thesis.

Gross Budget	$124,274				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$43,425	$26,780	$33,995	$104,200	$20,074
Overhead	$4,487	$780	$8,639	$13,906	
Net Spent	$38,938	$26,000	$25,356	$90,294	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

W. R. Persons

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

Goal	Number and Title
2	**BIO 2.R15.12 Nearshore Ecology / Fall Steady Flows**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	W.E. Pine, University of Florida M.D. Yard, USGS/GCMRC C.J. Walters, University, BC
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

This document represents a summary of NSE project findings to date. Detailed information can be found in the previous provided annual report (presented in spring 2012) and in three University of Florida Master's Theses all available at this web page

(http://floridarivers.ifas.ufl.edu/NSE.htm)

Introduction- The "Nearshore Ecology" (NSE) project was designed to assess two key fundamental research questions related to our knowledge of humpback chub population ecology.

(1) Do steadier flows during late summer and early fall increase survival, abundance, and/or growth rates of juvenile native and non-native fish?
(2) Do juvenile humpback chub select specific habitat types and if so, does this selection change under different river flow regimes?

Background- Glen Canyon Dam is operated primarily as a load-following hydropower facility, increasing and decreasing dam discharge to match power demand. This periodic "flushing" of the river reduces the residence time of water as well as the availability of certain shoreline habitat types. In contrast, steady flows can increase the retention time of water in littoral areas such as backwaters and low-angle shorelines, and if discharge volume and ambient temperature are appropriate, can locally increase water temperatures. The NSE project evaluated experimental steady flows that occurred from 1 September- 31 October in each year 2009-2011. This study took place between river km 102-106 just downstream of the confluence of the mainstem Colorado and Little Colorado rivers, where most prior research on humpback chub in Grand Canyon has been completed. The timing and magnitude of the steady flow experiment was developed by resource managers independent of the NSE team and experimental flow regimes were about 10% of the unregulated (pre-Glen Canyon Dam) annual fluctuations.

Prior to the NSE project, our understanding of juvenile humpback chub ecology in the mainstem Colorado River was deficient compared with our knowledge of adult humpback chub primarily because of limited sampling of mainstem habitat for juvenile life stages. The NSE project developed a sampling and analytical framework to directly assess juvenile humpback chub survival, abundance, individual growth, and habitat use through spatially referenced mark-recapture experiments with multiple gear types. This direct assessment of key vital rates complements indirect approaches used to estimate survival through population modeling efforts. For example, age-structured-mark-recapture (ASMR, Coggins et al. 2006) reconstructs juvenile abundance and survival through time from adult population numbers (estimated from mark-recapture) and assumed survival relationships based on life-history characteristics and growth rates. In contrast, the NSE project directly estimates juvenile fish population metrics, in terms of abundance, survival, growth, or habitat use, which is useful for rapidly assessing how juvenile humpback chub respond to management actions such as experimental flows.

Results and Discussion- The NSE project found that annual apparent survival of juvenile humpback chub (size at tagging < 100-mm total length, "TL") did not differ significantly between the extant fluctuating flows and the experimental steady flow treatments. The NSE project also documented that juvenile humpback chub were able to survive and rear in the mainstem Colorado River even at small sizes of 40-100 mm TL. A somewhat surprising finding was that growth in juvenile humpback chub declined during these short-term steady flows versus fluctuating flows even though water temperatures were generally similar between the fluctuating and steady flow treatments (Finch 2012). Reasons for this counterintuitive growth response are not known, but Finch (2012) hypothesizes that food availability in the drift (primarily aquatic insects) may change between fluctuating and steady flows with higher food resources found in fluctuating flows.

In Grand Canyon the creation, maintenance, and persistence of specific habitat types considered critical for the persistence and recovery of native fish populations, including humpback chub. For example, backwaters are thought to be more similar to the Colorado River ecosystem prior to river modification because they are generally warmer and may be less influenced by river stage and dam operations than other mainstem habitat types. The NSE study compared abundance, density and habitat selection patterns between shoreline habitats (cliff, talus, debris fan, sand, backwater) and found that abundance of juvenile humpback chub was consistently highest in talus habitats and lowest in backwater habitats (Dodrill 2012). Juvenile humpback chub did show positive selection for backwater habitats, but in the NSE study reach, the spatial extent of

backwater habitats was small compared to other habitat types, so the overall abundance in backwater habitats was low compared to other habitat types. Additionally, ultrasonic telemetry of larger juvenile humpback chub (about 180-190-mm TL) found that habitat selection and daily movements did not change between fluctuating and the steady flow experiment (Gerig 2012). This suggests that, at least in this reach of the Colorado River, management actions directed at manipulating this habitat type will affect a small proportion the habitat, and the population, of humpback chub. Because the NSE study reach is a section of Grand Canyon with steep bank angle, the available habitat in this reach is robust to changes in river stage associated with the range of flows observed from 2009-2011. Future work could assess whether juvenile humpback chub are similarly robust to changes in a river reach where available habitats are more flow sensitive.

Conclusions- The NSE project provided a sampling and analytical framework to directly assess juvenile humpback chub (and other fish species) population responses to management actions at smaller fish sizes than were previously possible. This framework is important, as the key outcome from many different types of management actions in the Colorado River is to improve survival of juvenile humpback chub, increasing overall abundance and accelerating the population to recovery. The NSE project also documented that small juvenile humpback chub can survive and rear in the mainstem Colorado River. This is important because over the past decade adult humpback chub numbers (age 4+) have increased and one possible explanation for this increase is improved survival in the mainstem Colorado River (Coggins and Walters 2009).

The results of the NSE project suggest that juvenile humpback chub survival, growth, abundance, and habitat use are robust to the fall steady flows observed during 2009-2011. It is likely that more extreme flow treatments (higher or lower discharges, longer duration) are required before changes in these metrics would be observed. This data demonstrating the apparent flexibility of juvenile humpback chub in habitat selection regardless of flows as well as the growth, survival, and persistence of juveniles in the mainstem Colorado River are invaluable additions to the body of knowledge available for managing both the Colorado River and regulated rivers globally.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Theses	3 MS Theses				(http://floridarivers.ifas.ufl.edu/NSE.htm)

	OTHER				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Comments**

Gross Budget	$430,233				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$121,988	$249,867	$0	$371,855	$58,378
Overhead	$12,604	$7,278	$0	$19,882	
Net Spent	$109,384	$242,589	$0	$351,973	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

W. E. Pine, III

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
2	**BIO 2.R17.12 Nonnative Control Plan Science Support**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	David Ward, USGS/GCMRC
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Telephone	(928) 556-7376		

SUMMARY

USGS administrative Report entitled, "Summary of Nonnative Fish Control Options, Monitoring Strategies, and Research Needs for Grand Canyon, Arizona", By Kara D. Hilwig and Matthew E. Andersen was published as a USGS Administrative Report in August of 2011.

In Fiscal year 2012 USGS researchers conducted a small exploratory to evaluate liquid ammonia as a new tool for removal of invasive nonnative aquatic species. Results of that work are currently in review for publication in the North American Journal of Fisheries Management (see abstract below)

Attempts to remove nonnative fish from areas with native fish are common, but success is limited because very few tools are available for managing invasive aquatic species and invertebrates. This creates the need to evaluate new chemicals that could be used as management tools for native fish conservation. At high concentrations, ammonia is known to be toxic to a wide variety of organisms and yet ammonia is the natural product of fish metabolism and is naturally present in the environment at low levels. Natural bacteria in the environment rapidly convert ammonia nitrate. Our objective is to determine the feasibility of using liquid ammonia as a tool for removal of invasive aquatic species by evaluating its effectiveness at killing undesirable species and its persistence in the environment when applied to a natural pond setting. A suite of common nonnative fishes including smallmouth bass *Micropterus dolomieu*, largemouth bass *Micropterus salmoides*, common carp *Cyprinus carpio*, green sunfish *Lepomis cyanellus*, fathead minnow *Pimephales promelas*, red shiner *Cyprinella lutrensis*, mosquitofish *Gambusia affinis*, black bullhead *Ameiurus melas*, channel catfish *Ictalurus punctatus*, flathead catfish *Pylodictis olivaris*, American bullfrog tadpoles *Lithobates catesbeianus*, and northern crayfish *Orconectes virilis* were introduced into two experimental outdoor ponds located at the Rocky Mountain Research Station in Flagstaff, Arizona. Each pond was treated with ammonium hydroxide (29%) at 0.5 ml of ammonia per 3.78 L of water (38 ppm). Water quality was monitored for 49 days to determine how quickly the natural bacteria in the environment converted the ammonia to nitrate. After 49 days all water in both ponds was drained and no fish, crayfish or tadpoles were found to have survived the treatment, but red-eared slider turtles *Trachemys scripta elegans* and hatchling mud turtles *Kinosternon baurii* remained alive and appeared unaffected.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Report	Synthesis Report of nonnative fish information from monitoring and research data			
Report	Project Reports			
Report	Peer Reviewed Literature			OFR

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Comments**
Workshops	Will conduct nonnative fish workshops	Annually		

Gross Budget	$0				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$0	$0	$0	$0	$0
Overhead	$0	$0	$0	$0	
Net Spent	$0	$0	$0	$0	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

K.D. Hilwig

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

Goal	Number and Title
2	**BIO 2.E18.12 Detection of Rainbow Trout Movement from the Upper Reaches of the Colorado River below Glen Canyon Dam**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	Mike Yard, USGS/GCMRC J. Korman, Ecometric Research, Inc.
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

This project was initiated in October 2011. Approximately 12,000 age-0 rainbow trout (80-150 mm) were PIT-tagged in the Lees Ferry reach in November 2011, and approximately 10,000 age-0 trout were tagged in 2012 in trips conducted before (October) and after (December) the 2012 HFE. Three downstream recovery trips have been conducted to date (April, July, and September 2012). Approximately 8,000 rainbow trout of all ages (> 80 mm) were marked on these trips. Thus, a total of approximately 30,000 rainbow trout have been PIT tagged between Glen Canyon Dam to just below the Little Colorado River since this project was initiated.

Age-0 population abundance in the Lees Ferry reach was estimated during age-0 marking trips. Preliminary estimates for November 2011 and October 2012 are 208,000 and 110,000-170,000, respectively. Estimates of abundance for rainbow trout (>80 mm) in 5 reaches between Glen Canyon Dam to just below the LCR have also been obtained based on the release and recapture of marked fish within trips, and are generally quite precise. These estimates are approximately 8,000 fish/km in Lees Ferry, 7,500 fish/km at river mile 20, 3,000 fish/km at river mile 40, 600 fish/km just above the LCR, and 200 fish/km just below the LCR. Estimates for the reach below the LCR are below the trigger (315 fish/km).

A total of 881 PIT-tagged rainbow trout were recaptured on latter trips. These across-trip recaptures provide valuable information on growth, movement, and survival. The vast majority of fish are recaptured within a kilometer of their release location. Only 3 of approximately 12,000 rainbow trout tagged in Lees Ferry have been recaptured downstream of Lees Ferry (approximately at river mile 20). One fish was marked at river mile 20 and recaptured just above the LCR. Three fish marked above the LCR were recaptured below the LCR. Trends in growth rate through time and across reaches are providing interesting insights on the effects of fish density and food availability.

More detailed and quantitative results on survival, movement, and growth will be available next year when enough trips have been completed to apply open population models.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Report	Draft annual report with full analysis	Sep. 30, 2012			
Report	Annual Data Report	FY 2012			USGS format
Report	Final Report	Dec. 1, 2012			OFR

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Comments**

Gross Budget	$534,763				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$240,781	$184,272	$0	$425,053	$109,710
Overhead	$24,878	$5,367	$0	$30,246	
Net Spent	$215,903	$178,905	$0	$394,807	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

W.R. Persons

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
2	**BIO 2.R19.12 Biometrics and General Analysis**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	Statistician, USGS/GCMRC
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

Since joining GCMRC in December 2012, the statistician – Charles Yackulic – has: 1) helped design aspect of the Natal Origins sampling design, 2) worked with the NSE project to analyze data, and 3) worked with Ted Kennedy and cooperators to modify sampling protocols and analyze data concerning invertebrate drift and primary production. Products produced include 2 presentations at conferences (one given by the statistician, the other given by Bob Hall with the statistician contributing to the modeling work that was presented) and 3 manuscripts that are in preparation (1 of which the statistician was first author and the abstract is include below, the others of which have different first authors and are listed elsewhere).

Abstract: The federally endangered humpback chub (*Gila cypha*) persists in six populations distributed throughout the Colorado River Basin and its tributaries. The largest population is dispersed downstream of Glen Canyon Dam throughout Grand Canyon National Park, where most individuals are found either in the Little Colorado River (LCR) or in reaches of the mainstem Colorado River near the LCR confluence. While adults are known to migrate between spawning grounds in the LCR and return with remarkable site fidelity to locations within the mainstem, movements of juveniles have not been systematically studied. Understanding movement (adult and juvenile) is important both for designing and interpreting population surveys and for understanding how variation in the LCR and mainstem environments affects survival, growth and ultimately population size. More broadly, partial migratory systems suggest that there are life history tradeoffs that are dependent on fish size. Here, we use multistate models to analyze three years of batch and individual mark-recapture data collected within the LCR and in a nearby reach of the mainstem to gain a better understanding of movement rates and their dependency on individual size. These models also allow us to compare apparent survival and growth rates between sampling locations. Movement rates of juvenile fish from the LCR to the mainstem Colorado river are extremely high during the monsoonal portion of the year. Interestingly, although juveniles (>10 cm) and subadults (10-20 cm) have higher monthly survival rates in the mainstem, the actual rate of survival to adulthood for mainstem fish is lower than in the LCR because of lower growth rates in the mainstem. Furthermore, these results are based on data from 2009-2011, a period during which conditions have been relatively favorable.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Report	Unidentified			

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Comments**

Gross Budget	$176,748				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$97,670	$0	$0	$97,670	$79,078
Overhead	$10,092	$0	$0	$10,092	
Net Spent	$87,578	$0	$0	$87,578	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Principal Investigator	Signature	Date

Scott VanderKooi		
Program Manager	Signature	Date

Goal	Number and Title
4	**BIO 4.M2.12 Maintain a Naturally Reproducing Population of Rainbow Trout above the Paria River, to the Extent Practicable and Consistent with the Maintenance of Viable Populations of Native Fish.**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	A.J. Bunch, AZGFD USGS/GCMRC
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

Eight redd surveys were conducted for the 2012 season of the rainbow trout early life stage survey, with the first occurring on December 19, 2011 and the last occurring on May 8, 2012. The estimated number of redds created in 2012 was 1852, slightly above the mean of 1701.

Four larval and juvenile fish surveys were conducted in 2012 during July, August, September, and November. The November survey occurred on the 6th through the 8th, prior to the HFE. The July population estimate was 377,000 fish for the entire Lees Ferry reach, with lower and upper confidence intervals of 291,000 and 478,000, respectively. This is the second highest July estimate on record, following that of 2008. The November population estimate was 100,000 fish for the entire Lees Ferry reach, with lower and upper confidence intervals of 72,000 and 130,000, respectively. This is the highest November estimate on record.

A draft report for the 2011 rainbow trout early life stage survey was completed and submitted to various reviewers. Suggested edits required that that report to be put on hold until further data were received. Those data are expected by the end of January. It is expected that a report for 2011 and 2012 will be completed in the 2013 fiscal year.

Annual standardized random electrofishing surveys within the Lees Ferry reach occurred in the spring (Apr. 9-11), summer (Jul. 17-19), and fall (Oct. 15-17). Nonnative surveillance sampling was conducted on July 20, during summer electrofishing. During 2012 sampling, a total of 108 standard monitoring sites were sampled and an additional 9 sites were sampled during nonnative surveillance.

April 2012 electrofishing yielded catch rates which were similar to those observed during fall 2011 sampling. Estimated overall CPUE was 9.3±1.8 fish/minute, with over 80% of the total catch comprised of fish <200 mm. Mean total length of rainbow trout was 156±3.6 mm TL. Condition of rainbow trout >152 mm TL was similar to that observed during fall 2011 sampling 78.7±1.1. In addition to the 1,974 rainbow trout captured, 2 brown trout and 1 flannelmouth sucker were collected.

July 2012 electrofishing catch rates decreased slightly between April and July with overall CPUE estimated to be 7.3±1.8 fish/minute in July. Similar to findings in April, 80% of the fish captured were <200 mm TL. Mean total length increased to 167±3.4 mm, largely due to 2011 cohort fish growth during late spring and early summer. Condition factor improved for all size classes with overall condition increasing to 97.7±2.4. One brown trout was captured during standard monitoring in addition to the 1,898 rainbow trout.

Warm water nonnative fish surveillance occurred during the summer electrofishing trip (July 20). during which we sampled areas immediately downstream from Glen Canyon Dam spillways, spring inflows, and the large backwater at river mile -12. During this sampling we captured 49 common carp, 3 flannelmouth sucker, 3 walleye and 2 brown trout. Common carp relative abundance for the backwater near RM -12 was estimated at 2.18 fish/min, slightly higher than observed in 2010 and 2011. No new species were observed during this extra day of effort.

October 2012 electrofishing was the first capture period for the 2012 rainbow trout cohort. CPUE estimates for this year class (2.3±0.6 fish/min) were significantly lower than was observed for the 2011 cohort (11.1±2.5 fish/min). Overall CPUE also decreased between summer and fall sampling, with fall CPUE estimated at 5.4±1.1 fish/min. Mean total length increased to 185±4.8 mm TL, which again was in large part to growth among the smaller size classes. Condition decreased in comparison to summer sampling to 81.4±0.8, which has been a typical seasonal trend for the population. In addition to the 1,600 rainbow trout captured during this sampling, we also captured 2 common carp, 2 brown trout, 1 flannelmouth sucker, and 1 walleye. The walleye was an adult specimen that was collected in the upper section of the river.

Overall in 2012, standard monitoring collected 5,472 rainbow trout, 2 flannelmouth sucker, 2 common carp and 1 walleye

during standard monitoring Overall CPUE in 2012 was 7.3±0.94 fish/min a slight decline from 2011. Condition of all size classes.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Report	Annual Lees Ferry Monitoring Results report by AZGFD	Apr 30, 2013	Jan 1, 2013	
Report	Annual Warm Water Nonnative Fish Surveillance Trip Summary Report by GCMRC	FY 20112012	August 20112012	Trip summary included in: Bunch, A., Osterhoudt, R., Clark, B., and Pickett, J., 2011. Lees Ferry Rainbow Trout Monitoring—July 2011 Trip Report (LF20110725). Submitted to: USGS/GCMRC.

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Comments**
Survey	Three (3) Annual Standardized Random Electrofishing Surveys	FY 2012	April 12-15, July 17-20, and October 15-17, 2012	
Trip	One Annual Nonnative Surveillance trip	FY 2012	July 20, 2012	Trip may extend below Paria River / Motorized

Gross Budget	$218,058				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$66,834	$132,190	$0	$199,024	$19,034
Overhead	$6,906	$3,850	$0	$10,756	
Net Spent	$59,928	$128,340	$0	$188,268	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

A.J. Bunch, AZGFD

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
5	**BIO 5.R1.12 Monitor Kanab Ambersnail**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	J.A. Sorensen, AZGFD
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

Three monitoring surveys of the Kanab ambersnail population at Vaseys Paradise, Grand Canyon, were conducted in May, June, and September 2012. Overall, the snail counts and Catch Per Unit Effort estimates of abundance were down from previous years. The September 2012 survey had the lowest counts of live ambersnails (n=11) and lowest CPUE estimate (0.41 snails/10 min search) at Vaseys Paradise compared with all prior surveys (both by season and by year) since timed presence-absence sampling was started in 2006. To put the 2012 surveys in context with past years, the September 2010 survey had the highest autumn count of live ambersnails (n=139) and highest CPUE estimate (4.75 snails/10 min search), but the September 2006 survey also had a low count of live Kanab ambersnails (n=16) and low CPUE estimate (0.73 snails/10 min search).

The snail habitat at Vaseys Paradise generally was in good condition throughout the year, with the exception of the upstream half of Patch 6, all of Patch 7U and 7L, and most of Patch 8L which was predominately dry, dead vegetation during the June and September surveys. That area is typically kept wet with springflow from the upper waterfalls, but in 2012 most of the springflow drained along the base of the waterfall to the upper pool and lower waterfall on the downstream end of the site.

The translocation site, Upper Elves Chasm, was surveyed in May 2012. Like at Vaseys Paradise, counts of live ambersnails (n=7) and CPUE estimate (0.85 snails/10 min search) at Upper Elves Chasm were the lowest compared to past surveys (since 2009, when this sampling method was first used at this site). In contrast, the Niobrara ambersnail population at Indian Garden, on the South Rim of Grand Canyon, had relatively higher counts of live ambersnails (n=13) and a high CPUE estimate (6.50 snails/10 min search) when this site was surveyed in September 2012, but these counts and CPUE estimate were still lower than the previous year.

Based on the lower snail counts and CPUE estimates from our September survey at Vaseys Paradise, the Department did not advocate conducting any snail habitat mitigation for the planned November 2012 High Flow Experiment. If future high flows occur more regularly rather than once every 4-5 years, it is expected that the lower edge of high quality ambersnail habitat will remain at a higher elevation at Vaseys Paradise—and should result in less incidental take of Kanab ambersnails during high flows in the long term. The most current biological opinion on the operation of Glen Canyon Dam does not require ambersnail habitat mitigation at Vaseys Paradise due to high flow experiments planned under programmatic sediment trigger events.

Note: The project described in NGTR 272 KAS status report 2012 (specifically, Vaseys Paradise population monitoring and management) was supported by Grant/Cooperative Agreement Number G11AC20194 from the U.S. Geological Survey. All work described in this report was covered under NPS research permit GRCA-2012-SCI-0018, the Department's Section 6 Cooperative Agreement and E5 Segment 22 work plan, and Federal Fish and Wildlife Permit TE821577-2 (amendment).

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Report	Kanab Ambersnail 2012 Status Report. Nongame and Endangered Wildlife Program Technical Report 272.	Dec. 15 FY 2012	Dec. 28, 2012		Sorensen, J.A. 2012. Kanab Ambersnail 2012 Status Report. Nongame and Endangered Wildlife Program Technical Report 272. Arizona Game and Fish Department, Phoenix, Arizona.

	OTHER				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Comments**

Gross Budget	$20,865				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$7,110	$13,355	$0	$20,465	$400
Overhead	$735	$389	$0	$1,124	
Net Spent	$6,375	$12,966	$0	$19,341	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

J.A. Sorensen, AZGFD

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
6	**BIO 6.M1.12 Vegetation Mapping and BIO 6.M2.12 Vegetation Transects**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	B.E. Ralston, USGS/GCMRC Others - TBD
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

BIO 6.M1.11, 12 Vegetation Mapping – Progress on the vegetation mapping project included extracting a gross vegetation layer from the 2009 imagery. This layer forms the basis for vegetation classification. The accuracy of the gross vegetation extraction is being evaluated but preliminary analysis indicates an 85% accuracy value. Problematic areas of over classification are cliff and boulder areas where vegetation is sparse as well as cobble bars adjacent to the water's edge that may be submerged aquatic vegetation or algae and classified as terrestrial vegetation. The layer was provided to a Ph.D. graduate student to classify vegetation into the identified vegetation classes.

BIO 6.M2.11, 12 Vegetation Transects – A research and collecting permit was submitted to Grand Canyon National Park and Glen Canyon National Recreation Area. The proposed monitoring incorporated aspects of the National Park Service Big River Protocol that is being applied in Colorado River segments of the Upper Basin.

Date collection includes fixed sites that are associated with the sandbar monitoring program in Physical Sciences (Goal 8) and random sites that will survey plants that occur on other geomorphic features besides sandbars.

A pilot research and collecting permit was provided by GRCA and a sampling trip was conducted in October 2012 in association with the sandbar monitoring trip. The permit will require renewal or revision pending discussions with GRCA. Vegetation cover and species occurrence sampling was done using a 1 m square quadrate along a transect that ran perpendicular to the river. The center of each plot was flagged with a pin flag and the location of the pin flags surveyed in as a part of the sandbar surveys. The location of the flags will be used to determine relationships between stage elevation and plant associations.

The data from the trip are being entered and analysis of the data should take place in the first quarter of the 2013 calendar year.

A riparian vegetation post-doctoral position is begin advertised to take the lead in vegetation monitoring plan development and analysis. Other collaborators in this project include Patrick Shafroth (USGS), David Merritt (USFS), and from the NPS (Dustin Perkins, Lori Makarick, Todd Chaudhry, and Michael Kearsley). Carrie Cannon from the Hualapai Tribe assisted in the vegetation sampling and it is likely that there is potential to cross-walk these results with the Hualapai vegetation monitoring.

	PRODUCTS/REPORTS				
Type	Title	Date Due	Date Delivered	Date Expected	Citations/Comments
	FY 2012 Status report of vegetation mapping and transect sampling	January 2013	December 2012		Annual reporting form submitted here
	USGS Report on veg change 2002-2009 -	Sept 2012		Sept 2013	resampled 2002 imagery and 2009 gross vegetation available in Septeber 2012. Vegetation change analysis initiated in November 2012. Delayed report to fall 2013. Vegetation classification initiated after gross vegetation cover provided to graduate student.
	Core monitoring report -			April 2013	Monitoring approach is still under development in Cooperation w/Park Inventory and Monitoring Program and Grand Canyon National Park. Results of fixed sites to be provided as a report in first quarter of 2013 calendar year.

	OTHER				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Comments**
	4-boat oar or single snout and sport boat trip	September 2011	October 2012		Delayed in 2011. Became a pilot trip with two oar boats added to sandbar monitoring trip in October 2012.

Gross Budget	$94,417	BIO 6.M1.12 – Vegetation Mapping			
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$44,526	$38,565	$0	$83,091	$11,326
Overhead	$4,601	$1,123	$0	$5,724	
Net Spent	$39,925	$37,442	$0	$77,367	

Gross Budget	$24,402	BIO 6.M2.12 – Vegetation Transects			
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$0	$0	$0	$0	$24,402
Overhead	$0	$0	$0	$0	
Net Spent	$0	$0	$0	$0	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

B.E. Ralston

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

Goal	Number and Title
7	**BIO 7.R1.12 Water-quality Monitoring of Lake Powell and the Glen Canyon Dam Tailwater**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	William S. Vernieu, USGS/GCMRC
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

Lake Powell received 4.91 maf (45.3% of average) of unregulated inflow in WY2012, compared to 15.97 maf (147 % of average) in WY2011, placing WY2012 as the third driest year on record since the closing of Glen Canyon Dam in 1963. Reservoir levels reached a peak of 3,637ft in 2012, down from a peak of 3,661ft in 2011. Releases for WY2012 were 9.46 maf, which is 8.23 maf plus 1.23 maf (the Equalization release volume from 2011 that could not be achieved by September 30, 2011).

Glen Canyon Dam release temperatures from 2003-2010 have been above normal because of low reservoir elevations resulting from extended drought conditions in the Upper Colorado River Basin. Because of high inflows, the 2012 release volume was increased 12.5 maf to meet Equalization criteria, and resulted in the evacuation of cold water from the deeper portions of the reservoir. These unusual conditions resulted in the warmest release temperatures since 2005 (15.2^{0}C maximum), in spite of higher reservoir volumes. In 2012, with relatively higher reservoir elevations and more normal release volumes, release temperatures were much colder, and representative of average temperatures observed from 1990-2002, reaching a maximum value of 9.5^{0}C.

During WY2012, eleven reservoir forebay surveys were conducted at approximate monthly intervals. Four complete reservoir surveys were conducted in December 2011 and March, and March, June, and August 2012.The Seabird SBE-19plusV2 CTD instrument, acquired in 2010, has continued to perform well as the primary profiling instrument for the reservoir surveys. Seabird data processing techniques were further refined. A complete factory calibration on the instrument was performed at the end of WY2012.

Monitoring and sample collection in the Glen Canyon Dam forebay and tailwaters has been maintained. Water-quality data collection from the Glen Canyon Dam releases has been consistent and the remote telemetry system continues to provide current, reliable data. Continuous monitoring of Lees Ferry water quality was transferred to the downstream water-quality program in 2011. Maintenance has continued on the Uniflite limnology vessel. No major repairs were required in 2012.

An updated revision of Data Series Report DS-471 “Historical Physical and Chemical Data for Lake Powell and Glen Canyon Dam Releases, Utah-Arizona, 1964-2012” was completed and submitted for publication. In addition, a new Data Series report describing historic Lake Powell biological data was completed and is currently in review. With the assistance of a part-time student, significant progress was made in digitizing historical sonar strip charts representing longitudinal profiles of sediment deltas in three major tributary arms of Lake Powell.

Upcoming work in FY 2013 includes:

Publication of Lake Powell Biological Data Report and combing this report with the physical and chemical data report for future publication.

Transfer of Microsoft Access water-quality database to Oracle system for on-line data availability and reporting. Development of Lake Powell web page for data access and dissemination of reports and current conditions.

Developing interpretive synthesis of Lake Powell Data in collaboration with Dale Robertson (Wisconsin Science Center) and Nick Williams (BOR) for preliminary presentation at special North American Lake Management Society symposium session in November 2013 commemorating 50-year history of Lake Powell. Final report expected in FY 2014.

Continuing digitalization and analysis of Lake Powell delta profiles for eventual completion in FY 2014.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Reports	Periodic reports of water-quality conditions	FY 2012			Draft of Lake Powell historical biological dat report submitted for review, September 2012 Update of Lake Powell historical chemical and physical data review submitted for publication, September 2012
Reports	Written or oral (presentations) – Updates on water-quality conditions	FY 2012			Presentations made to: Aquatic Food Base Protocol Evaluation Panel January 2012 Museum of Northern Arizona, February 2012 Camp Colton Students, May 2012 Arizona Hydrological Society, September 2012

	OTHER				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Comments**
	Developed and refined procedures for digitization of historic sonar strip charts representing longitudinal profiles of Lake Powell sediment deltas. Completion of 37 delta profiles with assistance of part-time student hire. Completion of project expected in 2014.		In progress	FY 2012	Presentation of preliminary findings made to North American lake Management Society November 2012

Gross Budget	$250,565				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$200,145	$0	$0	$200,145	$50,420
Overhead	$20,680	$0	$0	$20,680	
Net Spent	$179,465	$0	$0	$179,465	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Reclamation continues to support the Lake Powell Water-Quality Monitoring Program with direct funding to GCMRC, field assistance from the UC Regional Office and National Park Service, and sample analysis through its Boulder City, NV lab. GCMRC continues to lead the field monitoring program and maintain the Uniflite limnology vessel.

William S. Vernieu

Principal Investigator | Signature | Date

Scott VanderKooi

Program Manager | Signature | Date

Goal	Number and Title
7	**PHY 7.M1.12 Integrated Quality of Water Monitoring (below Glen Canyon Dam)**

Project Chief	David Topping	**Principal Investigator(s)** (PI)	David Topping, USGS/GCMRC
Email	dtopping@usgs.gov		
Telephone	928-556-7396		

SUMMARY

The Downstream Integrated Quality-of-Water (DSQW) Core Monitoring Project is focused on high-resolution monitoring of stage, discharge, water temperature, specific conductance, dissolved oxygen, turbidity, and suspended-sediment concentration and particle size and a number of mainstem and tributary sites located throughout the Colorado River Ecosystem (CRE). These data are used to inform managers on the physical status of the Colorado River in the CRE and how this physical status is affected by dam operations in near realtime. The high-resolution suspended-sediment data collected under this project is used to construct the mass-balance sediment budgets used by managers to plan dam releases (including triggering controlled floods, ie., HFEs). Details of this project (including descriptions of the data-collection locations) are provided in the GCMRC Annual Work Plan under Goal 7. Note that during FY2013-2014, this ongoing Core Monitoring Project is renamed the "GOAL7: Streamflow, water quality, and sediment-transport project" to more accurately reflect the project scope.

Outcome:

In summary, this project coordinated the collection of stage, discharge, water-quality, and sediment-transport monitoring data at 7 mainstem locations and 8 major tributary locations and 8 lesser tributary locations during FY 2012 (suspended sediment is monitored at a subset of 5 mainstem and 16 tributary locations). Following the transition from research & development to core monitoring, instrument calibrations have been finalized and are being verified, with out-of-sample errors calculated. This work has resulted in the ability in FY 2012 to serve data at a new web site and update it on a monthly or more frequent basis.

Specifically, progress was made on many fronts within the DSIQW project:

1) All monitoring data required by this project were collected. Processing of all data is complete except for laboratory analyses of some of the lower-flow suspended-sediment data from the Paria River and Little Colorado River (this will be completed by the end of March 2013).

2) Discharge measurements and suspended-sediment samples were collected during the November 2012 HFE by personnel stationed at five sites on the Colorado River. Automatic suspended-sediment samples were collected during this controlled flood at one additional site on the Colorado River. The discharge measurements have been processed with stage-discharge ratings verified or adjusted as necessary; the suspended-sediment samples have begun to be processed through the GCMRC sediment laboratory (to be completed by late spring 2013).

3) 15-minute stage, discharge, and water temperature data (updated in realtime) and other QW data from the 9 gaging stations maintained by the USGS Arizona and Utah Water Science Centers under this project are available at http://waterdata.usgs.gov/nwis.

4) 15-minute stage, discharge, water temperature, specific-conductance, turbidity, dissolved oxygen and suspended-sediment-concentration and grain-size data from the stations maintained by GCMRC under this project have been processed and are starting to be served at our new web site at http://www.gcmrc.gov/discharge_qw_sediment/. These data are updated as frequently as every month, depending on data-collection location.

5) Two major peer-reviewed reports (a USGS Techniques and Methods Report and a USGS Scientific Investigations Report) were published on normal core-monitoring tasks. These reports are listed below.

6) One major peer-reviewed report (a USGS Open-File Report) on groundwater flow in a sandbar during and after the November 2004 HFE was reviewed, revised, and submitted for USGS approval (report to be published during 2013).

7) One major peer-reviewed report (a USGS Scientific Investigations Report) on turbidity was reviewed and revised (report to be published during 2013).

8) An abstract was published and a presentation made at the 2012 Fall Meeting of the American Geophysical Union.

9) Annual water-data reports for the data collected during 2011 were published by the Arizona and Utah Water Science Centers.

10) Work to develop user-interactive web tools to make the data collected by this project (including the mass-balance sediment budgets) more useful for stakeholders, managers, and the general public made a major leap forward during 2012. See progress at http://www.gcmrc.gov/discharge_qw_sediment/.

11) Substantial progress was also made on completing the delivery of the historical periods of record for unit-value stage and discharge for USGS gaging stations with QW and sediment data relevant to the CRE. As of December 2012, the following historical periods of record have been processed and are available either on request until they are all ported to our new web site or can be downloaded at http://www.gcmrc.gov/discharge_qw_sediment/.

09380000 Colorado River at Lees Ferry, AZ 1921-1986 Entire period of station record processed and online.
09381500 Paria River near Cannonville, UT 1951-1956 Entire period of station record processed and online.
09401000 Little Colorado River at Grand Falls 1926-1960, 1994-1995 Entire period of station record processed and online.
09401250 Moenkopi Wash near Moenkopi, AZ 1974-1976 Entire period of station record processed and available upon request.
09401260 Moenkopi Wash at Moenkopi, AZ 1976-1988 Entire period of station record processed and available upon request.
09401400 Moenkopi Wash near Tuba City, AZ 1949-1954, 1965-1977 Other years remaining to be processed.
09401500 Moenkopi Wash near Cameron, AZ 1954-1965 Entire period of station record processed and available upon request.
09402000 Little Colorado River near Cameron, AZ 1947-1990 Entire period of station record processed and online.
09402500 Colorado River near Grand Canyon, AZ 1923-1986 Entire period of station record processed and online.
09403000 Bright Angel Creek near Grand Canyon, AZ 1933-1936, 1943-1970, 1991-1993 Other years have been processed and are now being checked. 1933-1993 period of record available online.
09403780 Kanab Creek near Fredonia, AZ 1964-1970 Other years remaining to be processed.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
GCDAMP presentations	6-month updates made to TWG and AMWG on the state of sediment and QW in the CRE.				
Online database	Discharge and water-quality data collected at 9 gaging stations by the Utah and Arizona Water Science Centers under project are posted to the web in realtime	n/a	hourly	n/a	http://waterdata.usgs.gov/nwis
Online database and web-based applications	Discharge, sediment transport, water-quality, and sand-budget data are served through the GCMRC web page and a web-based application will be implemented to provide stakeholders and interested public with the ability to perform interactive online data visualization and analysis	ongoing	new versions released every motnh	completed FY 2014	http://www.gcmrc.gov/discharge_qw_sediment/
Abstracts	American Geophysical Union abstract for 2012 Fall Meeting entitled " Error and Uncertainty in High-resolution Quantitative Sediment Budgets." Presentation made at AGU on 12-5-2012.	FY 2012	August 2012	August 2012	Grams, P.E., Schmidt, J.C., Topping, D.J., and Yackulic, C.B., 2012, Error and Uncertainty in High-resolution Quantitative Sediment Budgets: EOS, Transactions, American Geophysical Union.
Journal articles and other major pubs.	USGS Techniques and Methods Report entitled "Design and maintenance of a network for collecting high-resolution suspended-sediment data at remote locations on rivers, with examples from the Colorado River"	FY 2012	June 25, 2012	FY 2012	Griffiths, R.E., Topping, D.J., Andrews, Timothy, Bennett, G.E., Sabol, T.A., and Melis, T.S., 2012, Design and maintenance of a network for collecting high-resolution suspended-sediment data at remote locations on rivers, with examples from the Colorado River: U.S. Geological Survey Techniques and Methods, book 8, chapter C2, 44 p. [http://pubs.usgs.gov/tm/tm8c2/]
	USGS Scientific Investigations Report entitled "Evaluation of intake efficiencies and associated sediment-concentration errors in US D-77 bag-type and US D-96-type depth-integrating suspended-sediment samplers"	FY 2012	received USGS approval in October 2012	online by end of February 2013	Sabol, T.A., and Topping, D.J., 2013, Evaluation of intake efficiencies and associated sediment-concentration errors in US D-77 bag-type and US D-96-type depth-integrating suspended-sediment samplers: U.S. Geological Survey Scientific Investigations Report 2012-5208.
Reports	2011 Annual USGS Water-Data Reports	2-28-2012	2-28-2012	2-28-2012	http://wdr.water.usgs.gov/wy2011pdfs/09380000.2011.pdf http://wdr.water.usgs.gov/wy2011/pdfs/09381800.2011.pdf http://wdr.water.usgs.gov/wy2011/pdfs/09382000.2011.pdf

	PRODUCTS/REPORTS				
Type	Title	Date Due	Date Delivered	Date Expected	Citations/Comments
					http://wdr.water.usgs.gov/wy2011/pdfs/09402000.2011.pdf http://wdr.water.usgs.gov/wy2011/pdfs/09402300.2011.pdf http://wdr.water.usgs.gov/wy2011/pdfs/09402500.2011.pdf http://wdr.water.usgs.gov/wy2011/pdfs/09404200.2011.pdf

Gross Budget	$1,014,745				
	GCMRC	**Cooperative Agreements**	**Sub-allocations to other USGS Centers**	**Total**	**Carryover**
Gross Spent	$577,245	$68,537	$338,814	$984,596	$30,149
Overhead	$59,643	$1,996	$199,853	$261,492	
Net Spent	$517,602	$66,541	$138,961	$723,104	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

David J. Topping		12-31-2012
Principal Investigator	Signature	Date

Goal	Number and Title
7	**PHY 7.R3.12 Modeling Support**

Program Manager (PM)	Paul Grams	**Principal Investigator(s)** (PI)	Scott Wright, USGS/CA Water Science Center Jonathan Nelson, USGS/National Research Program David Rubin, USGS/Coastal & Marine Geology David Topping, USGS/GCMRC Paul Grams, USGS/GCMRC
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SUMMARY

The objectives of the modeling project in FY 2012 were to continue work on multidimensional flow and sediment modeling and to provide support to GCMRC research projects and GCDAMP activities. In particular, this project provided modeling support to the implementation of the HFE protocol and the development of alternatives for the Long-term Experimental and Management Plan (LTEMP) EIS. This support was provided in the following ways:

- Development of CRFS GUI, a graphical user interface for the streamflow and sediment transport models. This model was developed to support decision making for implementing high flows and development of scenarios for the LTEMP. The model is currently in use by the Bureau of Reclamation in Salt Lake City and Denver.
- Development of a spreadsheet application for the monthly average temperature model. This product was developed to support development of scenarios for the LTEMP.
- Production of two-dimensional flow and temperature modeling results for the Near-shore ecology (NSE) study reach. This modeling was done to support analysis of results from the NSE project (see complete description of multidimensional modeling activities, below).
- Publication of report on near-shore water temperatures in the NSE study reach. This study and report was done in support of the NSE research project.
- Updated the sand routing model and compared to recent sand flux data and provided data used in HFE planning (May 2009 - Feb 2012).
- Collection of hydraulic data for the Glen Canyon "natal origins" reach in Aug 2012. Provided preliminary results to GCMRC (see attached)
- Participation in HFE planning discussion for design of the Nov 2012 artificial flood.

Multidimensional flow and sediment modeling

During 2012, work on modeling flow, sediment transport, morphologic evolution and temperature in the Colorado River in Grand Canyon was carried out at the USGS Geomorphology and Sediment Transport Laboratory. The GSTL researchers involved in the work were Brandy Logan, Richard McDonald, and Jonathan Nelson. Most efforts in 2012 were directed at developing and applying a temperature model for the Near-shore ecology study reach, but we also continued to work on certain aspects of the morphologic modeling, which is described first.

By the end of 2011, a Delft3d model of the Willie Taylor/Eminence eddy complex had been developed and compared to the field measurements taken by Wright and others in that area. In addition, several other models were developed at that site and others for comparison. The general conclusions were that all the models did a fairly good job of reproducing the flow patterns in the eddies and main river channel, with the largest uncertainties arising due to poor knowledge of the bed elevation in the hydraulic control area at the rapids and only crude estimates of spatial roughness patterns. However, sediment-transport computations proved much less reliable, requiring unrealistic calibration values to even get close to the observed suspended sediment concentrations. Similarly, morphodynamic calculations were poor relative to measured results and could only even be approximately simulated using calibration or other “fiddling” that seemed unrealistic. After comparing Delft3d to the measured values and also to other models, three principal issues were identified as potential causes of the poor predictive capability of the models:

(1) Potentially inaccurate treatment of the bottom boundary condition for suspended sediment concentrations.

(2) Neglect of potentially important gravitational failures of rapidly deposited sediment.

(3) Neglect of the interaction of large scale vortical structures with steep bed geometry in generating spatial patterns of sediment flux into and out of the eddies.

The first of these three was investigated by modifying Delft3d using other suspended sediment reference flux lower boundary conditions in lieu of the Van Rijn approach used in Delft3d. This work was reported on by Sloff et al. (River, Coastal, and Estuarine Morphodynamics, 2012). Although using different approaches did yield somewhat different results, the primary conclusion was that errors in this parameterization were not sufficient to produce the observed discrepancies in

the morphodynamic computations.

The second of these three is being addressed by adding simple gravitational failure algorithms to some of the existing models. As of this writing, the work is incomplete, but ongoing. The measurements clearly show that large gravitational failure do occur in eddy deposits so, at least to some degree, this effect must be important and should be included. However, it does not appear that this mechanism alone can explain the discrepancies between the modeled and measured morphodynamics, as even the initial deposition rates seen in the model predictions seem too large relative to observations. Nevertheless, the data set is sparse, so this mechanism may be of central importance for improving our predictive capabilities for eddy deposits.

The third mechanism cannot be addressed by any of the current models, as even the most sophisticated treatments are hydrostatic. Currently, we are working with two different fully 3-dimensional models to investigate the possibility that the interaction of vortices with the typical steep bed slopes are sufficient to alter predicted suspended sediment fluxes into and out of eddies. This is an intriguing idea and it would also potentially explain why certain eddies are ineffective at trapping sediment even when curvature and other externally imposed constraints suggest they should be fairly effective. In 2012, we developed our capabilities for using these three-d approaches and in the upcoming months we expect to carry out some simple, idealized lab experiments to test the models and more clearly ascertain the mechanics of this process.

As noted above, most of the modeling work in 2012 was directed at predicting spatial temperature patterns in the Colorado River in Grand Canyon using the temperature modeling capabilities of Delft3d. This work is described in detail in an attached memo and figures. Generally, the temperature model performed well compared to measurements, but more detailed near bank measurements are required for a more rigorous validation. The greatest shortcoming in the model appears to be the lack of bed conduction in Delft3d, as discussed in more detail in the attached material. The next step in this work should be to carry out a more detailed verification using additional field data and to modify Delft3d to include bed conduction. If we do not move forward in these areas, it would be appropriate to have the attached memo go through colleague review as a short report; if the work will continue, we would prefer to delay publication until that other work is complete, as the predictive power of the model would be better, especially with regard to bed heating in shallow areas.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Abstract	Laboratory and numerical modeling of sandbar bank erosion, application to diurnal stage variations in Grand Canyon	FY 2011 FY 2012	Dec. 2011	Alvarez, L.V. and Schmeeckle, M.W., 2011, presented at 2011 Fall Meeting, American Geophysical Union San Francisco, CA, 5-9 Dec. See attached Alvarez AGU abstract.
Abstract	Detached eddy simulation (DES) of turbulence and suspended sediment transport in lateral separation eddies in the Colorado River in Grand Canyon	FY 2011 FY 2012	Dec. 2011	Schmeeckle, M.W., 2011, presented at 2011 Fall Meeting, American Geophysical Union San Francisco, CA, 5-9 Dec. See attached Schmeeckle AGU abstract.
Abstract	Effect of sediment entrainment and avalanching on modeling of Grand Canyon eddy bars	FY 2012	FY 2012	Sloff, K.C.J., Nieuwboer, B.,Nelson, J., 2012, presented at River Coastal and Estuarine Morphodynamics.
Article	Erosion of river sandbars by diurnal stage fluctuations in the Colorado River in the Marble and Grand Canyons: full-scale laboratory experiments	FY 2011 FY 2012	Mar. 2012	Alvarez, L.V. and Schmeeckle, M.W., 2012, River Research and Applications, 16 p. DOI: 10.1002/rra.2576. *http://onlinelibrary.wiley.com/doi/10.1002/rra.2576/full*. See attached Alvarez&Schmeeckle,2012.pdf
Report	Near-shore Thermal Gradients of the Colorado River Near the Little Colorado River Confluence, Grand Canyon National Park, Arizona	FY 2011 FY 2012	Expected early 2013	Ross, R., and Grams, P.E., *in press*, U.S. Geological Survey Open-file Report (see attached Temp report abstract).
Presentations	Modeling presentation at Knowledge Assessment Workshop	FY 2011 FY 2012	Jan. 2012	Presentations by Scott Wright and David Topping

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Model	Colorado River Flow and Sediment User Interface. CRFS Ver. 1.0	FY 2012	Jun. 2012	See attached CRFS abstract.
Model	Excel Spreadsheet Tool for Monthly Average Temperature Model	FY 2012	Jan. 2012	See attached Temp model abstract.

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Model results	Model Development, Calibration and Results for the Near-shore Ecology Study Reach (FIST Reach 7)	FY 2012	Jan. 2012	See attached NSE modeling abstract and associated report.

Gross Budget	$172,496				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$117,579	$56,663	$0	$174,242	($1,746)
Overhead	$12,149	$1,650	$0	$13,799	
Net Spent	$105,430	$55,013	$0	$160,443	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Paul Grams

Principal Investigator | Signature | Date

Paul Grams

Program Manager | Signature | Date

Goal	Number and Title
8	**PHY 8.M2.12 Maintain or Attain Levels of Sediment Storage within the Main Channel and along Shorelines to Achieve the Adaptive Management Program Ecosystem Goals**

Program Manager (PM)	Paul Grams	**Principal Investigator(s)** (PI)	Matt Kaplinski, NAU, Geology Dept. Joseph Hazel, NAU, Geology Dept. Roderic Parnell, NAU, Geology Dept. David Topping, USGS/GCMRC Paul Grams, USGS/GCMRC
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SUMMARY

Long-term monitoring for changes in sediment storage:

The purpose of this project component is to track long-term trends in sediment storage in the Colorado River. Ultimately, this monitoring will help determine whether dam operations, including high-flow experiments, are resulting in net accumulation, depletion, or maintenance of sand storage in Marble Canyon and Grand Canyon. Because sandbars are built from sand in storage, declining storage will signal decreased capacity for building future sandbars. The monitoring follows a phased approach in which a 30 to 60-mile river segment is mapped each year. In May 2012, we mapped from river mile 30 to 62. The mapping utilized a combination of multibeam sonar, singlebeam sonar, and conventional total station survey. These data are currently being processed. Processing is expected to be completed on schedule in January 2013. Once complete, the maps will be compared with mapping of the same segment that was conducted in 2009 and analyzed for changes in storage. The data collected in 2009 have been processed and topographic surfaces have been created (see products, below).

In FY 2012, we compared the channel mapping data collected between river mile 30 and 62 (lower Marble Canyon) in 2009 with portions of that reach (totaling about 20% of the 32-mile segment) that were mapped between 2000 and 2004 (see report "*Monitoring Fine-Sediment Volume…*", below). We found that the repeat maps of the short monitoring reaches (3 reaches each 1.5 to 3 miles in length) indicated increases in sand storage between 2002 and 2009, consistent with the trend of the flux-based sand budget for the same period. However, because of large spatial variability in sand storage locations those results cannot be extrapolated and the magnitude of sand storage change for all of lower Marble Canyon remains uncertain (see article "*Linking morphodynamic response…*", below). The comparison of the 2009 and 2012 maps that will occur in FY 2013 is expected to resolve this uncertainty.

Three "channel mapping" data sets have been collected between 2009 and 2012. As described above, lower Marble Canyon was mapped in 2009 and 2012. Eastern Grand Canyon (river mile 62 to 87) was mapped in 2011. Processing of the 2011 is not yet complete, because of positioning problems with the multibeam sonar data that required additional trouble-shooting and processing. Those issues have been resolved and we will complete processing the 2011 data after the 2012 data are processed. We prioritized the 2012 data, because of the strong interest in completing the comparison between the 2009 and 2012 data sets.

In FY 2012, USGS scientist Renee Takesue conducted preliminary work on the FY 2013 project A.5, (geochemical signatures of pre-dam sediment). It was determined that Paria River fine and very fine sand can be distinguished geochemically from similarly sized particles from the CO River based on their aluminum (Al), sodium (Na), potassium (K), and rubidium (Rb) contents. The average geochemical composition of mixed pre-dam fine and very fine sand was indistinguishable from that of the modern CO River. Pre-dam sediment probably consisted of 94% Colorado River sediment and 6% Paria River sediment, suggesting that this geochemical source-discrimination technique is not sensitive to such a small proportion of Paria River sediment. Modern sediment mixtures downstream from the Paria River confluence may consist of a greater proportion of Paria River sediment because the Colorado River sediment source has been eliminated; any Colorado River sand must be derived from pre-dam deposits. In FY13 we will determine geochemical compositions of sediment deposited and/or suspended during the 2012 or other high-flow events to explore how mixing proportions of Paria and Colorado River fine and very fine sand have changed.

Sandbar monitoring:

The purpose of this project component is to track the status of the sandbar resource on the Colorado River in Marble and Grand Canyons. Monitoring is designed to assess the effects of the Glen Canyon Dam operating regime, including high-flow experiments on sandbars. These objectives are met by annual and long-term monitoring of sandbars exposed above the stage of normal dam operations. Monitoring includes annual topographic surveys of a collection of 44 monitoring sites, daily photographs of a subset of those monitoring sites, and monitoring of sandbars throughout Grand Canyon (more than 1000 sites) by analysis of remote sensing imagery.

The FY 2012 topographic surveys of sandbars occurred in October 2011. Results from this monitoring trip were presented at the January 2012 reporting meeting and knowledge assessment workshop. A sandbar survey was also conducted in October

2012 and results from this survey will be presented at the January 2013 annual reporting meeting. Since 2011, we have been working to produce a comprehensive summary of the sandbar monitoring surveys spanning the period of data collection (1990 to present). This effort was scheduled for completion by the end of FY 2012, but is behind schedule and nearing completion. We expect this report to be in review within the next couple of months (see report and abstract "*Sand Storage Measured at Selected Sites…*", below).

We have enhanced the sandbar monitoring program by installation of digital cameras in the field at the long-term monitoring sites. In 2012, we installed an additional 8 remote cameras such that 32 of the 44 long-term monitoring sites are now equipped with cameras. In the next year, we plan to install another 8 to 10 additional cameras. Each camera records 5 images daily, which provides views for a range of flow and lighting conditions for each day. Each camera is equipped with an external battery, solar panel, and storage capacity that allows continuous operation for 1 year or longer between site visits. However, sites are typically visited about every 6 months to retrieve the images. We are using the images to (1) determine the precise timing of sandbar changes between the annual topographic surveys and (2) describe changes to sandbars that occur during flow treatments when it is not feasible to launch separate pre- and post-event topographic surveys. Results based on analysis of these images for the 2012 high-flow will be presented at the January 2013 reporting meeting.

We began installing the digital remote cameras in 2008. Prior to this, film cameras were used periodically at many of the same sandbar monitoring sites since about 1990. We have been loading digital versions of the old film images on the GCMRC server. Images from the old film record and the new digital record are available on the GCMRC website (see below).

Because the sandbar monitoring described above is limited to the selected study sites, we have been working to describe changes in sandbars for a much larger collection of sites based on the remote sensing imagery. In 2012, we created a database defining site boundaries for approximately 1200 sandbar locations between Lees Ferry and the Grand Wash Cliffs where we will measure sandbar area in existing and future imagery datasets. This analysis requires classification of bare sand areas within these regions of interest. This image classification process is in progress for the 2002, 2005, and 2009 datasets (see project report for DASA 12.D9).

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Report	A Generalized Classification of Bed Texture for the Colorado River in Grand Canyon, Arizona	FY 2012	Final expected in early 2013	Polino, M., Grams, P.E., and Kennedy, T.A., *in review*, U.S. Geological Survey Open-file Report, 24 p. (see Polino bed texture ofr abstract)
Article	Linking morphodynamic response with sediment mass balance on the Colorado River in Marble Canyon: Issues of scale, geomorphic setting, and sampling design	FY 2012	Final expected in early 2013	Grams, P.E., Topping, D.J., Schmidt, J.C., Hazel, J.E., and Kaplinski, M., *in review*, submitted to Journal of Geophysical Research Earth Surface. (see Grams JGRES abstract)
Report	Monitoring Fine-Sediment Volume in the Colorado River Ecosystem, Arizona: Digital Elevation Model Construction and Analysis	FY 2012	Final expected in early 2013	Matt Kaplinski, Joe Hazel, Paul Grams, Philip A. Davis, *in review*, U.S. Geological Survey Open-file Report. (see Kaplinski OFR abstract)
Report	Sand Storage Measured at Selected Sites, Colorado River in Glen, Marble and Grand Canyons, Arizona, 1990-2011	FY 2012	Final expected in mid 2013	Joseph E. Hazel, Jr., Matt Kaplinski, Rod Parnell, Paul Grams, Rob Ross, and Keith Kohl, *in preparation*, U.S. Geological Survey Open-file Report. (see Hazel sandbar data abstract)
Abstract	Linking Morphodynamic Response with Sediment Mass Balance: Issues of Scale, Geomorphic Setting, and Sampling Design	FY 2012	Dec. 2011	Grams, P.E., Topping, D.J., Schmidt, J.C., Kaplinski, M.A., Hazel, J.E., 2011, Abstract EP31F-04 presented at 2011 Fall Meeting, American Geophysical Union San Francisco, CA, 5-9 Dec. (see Grams_AGU_2011_abstract)
Abstract	Untangling Geomorphic Processes in the Grand Canyon with Topographic Time Series from Hybrid Surveys	FY 2012	Dec. 2011	Czarnomski, N., Wheaton, J.M., Grams, P.E., Hazel, J.E., Kaplinski, M.A., Schmidt, J.C., 2011, Abstract H51I-1322 presented at 2011 Fall Meeting, American Geophysical Union San Francisco, CA, 5-9 Dec. (see Czarnomski AGU 2011 abstract)

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Survey	Sandbar monitoring data (topographic surveys)	FY 2012	Jan. 2012	Presented 2011 sandbar monitoring results at annual reporting meeting. Data available on GCMRC website.
Maps	Topographic/bathymetric Maps of the monitoring reaches mapped between 2000 and 2004.	FY 2012	Jan. 2012	Data available on GCMRC website.

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
Maps	Topographic/bathymetric maps of the RM 29 to RM 61 segment mapped in 2009	FY 2012	Jan. 2013	Data available on GCMRC website.
Photos	Daily repeat photographs of sandbar monitoring sites	FY 2012	FY 2012	http://www.gcmrc.gov/gis/silverimage1.aspx
Photos	Paired photographs of sandbar monitoring sites for the 2012 high-flow.	FY 2012	FY 2012	https://docs.google.com/open?id=0B7IcByloNF0IbWlZV3MwM2x4RWc https://docs.google.com/open?id=0B7IcByloNF0IelhrSjNHWkI2RGM

Gross Budget	$504,651				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$344,523	$304,817	$0	$649,340	($144,689)
Overhead	$35,597	$8,878	$0	$44,476	
Net Spent	$308,926	$295,939	$0	$604,864	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Paul Grams

Principal Investigator | Signature | Date

Paul Grams

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
9	**REC 9.R1.12 Campsite Area Monitoring**

Program Manager (PM)	Helen Fairley	**Principal Investigator(s)** (PI)	R. Parnell, NAU, Geology Dept. M. Kaplinski, NAU, Geology Dept. J. Hazel, NAU, Geology Dept.
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SUMMARY

As in past years, this project involves monitoring the campable area at a sample of sand bar campsites in Grand Canyon. This campsite area monitoring occurs concurrently with the NAU sand bar monitoring project. In October 2011 (using FY2011 funding) and in October 2012 (using FY2012 funding), NAU geologists collected repeat surveys of the topography and campsite area at 36 of the 47 long-term NAU sandbar monitoring sites. These data are currently being processed and will be incorporated into a comprehensive report being prepared by NAU on the long-term NAU sandbar time series (Hazel and others, in prep.) These data are used to track trends in campsite area at the monitoring sites from 1998 to present. Results from these analyses have been reported at the stakeholder knowledge assessment workshops and professional meetings in past years.

In addition to the work described above, a small amount of funding ($8000) was provided to the Grand Canyon River Guides (GCRG) to continue the long-term citizen science initiative of GCRG known as the Adopt-A-Beach program. As in the past, GCRG used the funds to pay for digital cameras, paper, and other supplies to support the collection and compilation of repeat photographs by volunteer boatmen in 2012 and to pay for the analysis of these photographs and prepare a report on the results of the 2011 AAB effort (results of the 2012 effort will be analyzed and reported on in 2013).

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Report	Results of FY 2011 fieldwork will be reported in USGS Fact-Sheet or Open-File Report and served through the GCMRC website	FY 2012			Hazel, J.E., jr., Kaplinski, M., Schott, N., Parnell, R., Grams, P.E., Ross, R., in prep. Sand Storage Measured at Select Sites in the Colorado River in Marble and Grand Canyons, Ariz, 1990-2009: U.S. Geological Survey Scientific Investigations Report.

	OTHER				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Report	Lauck, P., Adopt – A – Beach: Long-Term Monitoring of Camping Beaches in Grand Canyon. *Summary of Monitoring Observations for Year 2011.*				

Gross Budget	$32,909				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$846	$32,000	$0	$32,846	$63
Overhead	$87	$932	$0	$1,019	
Net Spent	$759	$31,068	$0	$31,827	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

M. Kaplinski

Principal Investigator | Signature | Date

Helen Fairley

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
9	**REC 9.R3.12 Expand and Analyze Campsite Data in the GIS Atlas**

Program Manager (PM)	Helen Fairley	**Principal Investigator(s)** (PI)	Helen Fairley, USGS/GCMRC Tim Dealy, USGS/GCMRC
Email	*hfairley@usgs.gov*		
Telephone	(928) 556-77285		

SUMMARY

The campsite atlas has been under development since 2008 (see previous annual reports.) Although the basic GIS data, tabular data, and more than 5000 campsite photographs reflecting cumulative knowledge of 504 current and historical campsites were compiled and organized for this project more than two years ago, significant challenges with serving these data via GCMRC's GIS-based interactive map platform prevented completion of the atlas project on the original timeline. These challenges included the following: identification of a suitable Web-based GIS platform (Silverlight API); identification of the photo viewing and photo collection building tools necessary to serve thousands of campsite photos (PivotViewer); design of a relational photo collection database; development of in-house expertise for Silverlight Web programming; development and management of reliable spatial databases (Oracle and ESRI ArcSDE); migration from ArcIMS to ArcGIS Server software requiring new software installation, configuration, management, and maintenance; integration into the SBSC website, and into the umbrella USGS web security system; development of an extensive Help website.

In 2012, a major remodel of the GCMRC Silverlight Web Mapping application was undertaken. This remodel focused on creation of an interface where the user could easily navigate to a campsite polygon, select it, and view the photos and reports associated with that campsite. The selectable features were 504 digitized campsite polygons that had been previously segregated into two categories: primary campsites that are monitored or actively managed by the National Park Service (n=253) and legacy campsites (all remaining campsites, whether actively used or not; n=251.) The interface was modified to allow feature attributes to be viewed in a scrollable window, and if a photo or document collection was available, the photo/document viewer (PivotViewer) could be launched and populated with the appropriate collection. To integrate the rapid loading, filtering, and deep-zoom capabilities of the PivotViewer into the GCMRC Web Mapping application required innovative, custom in-house Silverlight programming. Considerable effort was invested in designing the photo collection database to allow easy switching between related photo collections. Photo collections were built, and as necessary rebuilt, with an Excel Add-in, and were organized and stored in locations required for serving on the Web. Individual photo names required development of a renaming protocol, and parsing formulas were developed for filename data extraction in Excel. The result of all these efforts can be experienced at: *http://www.gcmrc.gov/.*

Additional efforts in 2012 were also targeted at improving the reliability of GIS Web Services, building an extensive Web Mapping Help website, and documenting the collection building process. Once the website was tested and demonstrated to work with campsite features, generalized sandbar monitoring sites and their associated photos were integrated into the Web Mapping application. An additional product has been generated as a result of the work invested in the campsite atlas. A stand-alone Photo Viewer has been published on the GCMRC Website *http://www.gcmrc.gov/* that allows for photo viewing without the mapping component. Our intent is to continue improvements to the campsite atlas and web-based system into the foreseeable future.

In terms of the planned FY2012 project to utilize the campsite atlas data to conduct an analysis of vegetation change at a random sample of campsites throughout the river corridor, this project was originally delayed due to unanticipated complications with processing the imagery from the 2009 over flight (see 2011 Annual report for more detail) Basic processing of the 2009 imagery was finally completed during the first quarter of FY2012. Because the physical science program was planning to conduct various image analyses of sand bars throughout the river corridor using these same data, and because many of the locations proposed for analysis in the vegetation encroachment campsite study overlapped with those proposed for analysis in sand bar study, a decision was made in the winter 2012 to coordinate efforts for both projects. T. Dealy, the cultural program geographer, worked in collaboration with P.Grams, R. Ross and R.Tusso of GCMRC's physical science program to identify the areas targeted for change detection analysis. Dealy, Ross and Tusso then split the work load to create approximately 1300 GIS polygons to accommodate the needs of both studies. For both projects, the analysis requires classification of bare sand and vegetation areas within these areas of interest. This image classification process is in progress for the 2002, 2005, and 2009 datasets (see project report for DASA 12.D9).

Midway through 2012, Dealy left GCMRC and his position was not immediately refilled, stalling further progress on this project in 2012. The plan now is for a fully integrated analysis of campsite area, vegetation, and sand bar changes to be undertaken by a graduate student working under P. Grams in 2013, focusing initially on the long-term NAU

sandbar/campsite monitoring sites. (See last paragraph of PHYS 8.2 for more discussion about the sandbar analysis portion of this project in FY2012.)

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Report	Assessment of the role of vegetation in affecting campsite area	FY 2012			Study in progress but not completed. This study will be accomplished through a new integrated project (Project A.1.3) that is planned for FY2013-14.

	OTHER				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**

Gross Budget	$49,209				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$32,096	$0	$0	$32,096	$17,113
Overhead	$3,316	$0	$0	$3,316	
Net Spent	$28,780	$0	$0	$28,780	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

In May 2012, Tim Dealy left GCMRC and his position was not immediately refilled, stalling further progress on the vegetation encroachment analysis portion of this project in 2012. The plan in 2013 is to undertake a fully integrated analysis of campsite area, vegetation, and sand bar changes, focusing initially on the long-term NAU campsite/sandbar sites. This work will be undertaken by a graduate student working under P. Grams in 2013. (see last paragraph of PHYS 8.2 for more discussion about the sandbar analysis portion of this project in FY2012.)

Helen Fairley

Principal Investigator | Signature | Date

Helen Fairley

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
9	**REC 9.R4.12 Evaluate Recreation Values and visitor Experience Quality in the Glen Canyon Reach**

Program Manager (PM)	Helen Fairley	**Principal Investigator(s)** (PI)	TBD, in cooperation with AZGFD and NPS
Email	*hfairley@usgs.gov*		
Telephone	(928) 556-7285		

SUMMARY

This project, as originally defined in the 2011-2012 workplan, could not be implemented as planned in either 2011 or 2012, for several reasons. One main reason for the delay had to do with the evolving scope of the new EIS for Glen Canyon Dam operations and the need for NPS and Reclamation to come to agreement about what socioeconomic studies were needed and who would conduct them, in order to avoid duplication of efforts by NPS, Reclamation and GCMRC. Also, In 2011, GCMRC was initially informed that all social science survey instruments supported with federal funds required formal review and vetting through OMB's review process. This fact, plus the realization that the AZ Game and Fish creel survey instrument could not be significantly expanded to include a broad list of visitor use and financial expenditure questions, led to a decision in 2011 not to fund AZGF's creel survey as previously proposed. Instead, an agreement was established with researchers at the University of Montana to conduct a formal visitor use and expenditure survey focused on walk-in angler use of the river corridor. This focus was specifically chosen to complement and enhance a separate but related planned survey of visitor use that the National Park Service was proposing to undertake in 2012. However, midway through 2012, the National Park Service changed course and decided not to conduct the visitor use survey, but instead, to focus its limited financial resources on conducting a non-use value survey for the new EIS. This change in plans has created a major delay for the U of MT survey project proposed by GCMRC, because the walk-in angler use survey was planning was to use the same survey instrument being developed by NPS for the larger visitor use survey; however, because of the change in plan, the NPS survey instrument was never finalized or properly vetted through OMB. As a result, U of MT researchers have been granted a one year extension to allow sufficient time for the survey instrument to be finalized and reviewed by OMB. The current plan to have this process completed over the winter, with field work to commence in the spring, and a draft report developed by end of the 2013 calendar year. However, the contractor's ability to hold to this schedule will depend on the amount of time OMB requires to complete its review of the survey instrument.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Reports	Peer-reviewed products documenting the recreational values and the status and trends of visitor experience quality.	FY 2012			

	OTHER				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**

Gross Budget	$107,404				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$0	$0	$0	$0	$107,404
Overhead	$0	$0	$0	$0	
Net Spent	$0	$0	$0	$0	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Helen Fairley

Principal Investigator | Signature | Date

Helen Fairley

Program Manager | Signature | Date

Goal	Number and Title
10	**HYD 10.R2.12 Evaluate the suitability of the GTMax and other Models for Modeling Economic Implications of Power Generation under Current and Future Dam Operations**

Program Manager (PM)	Helen Fairley	**Principal Investigator(s)** (PI)	WAPA staff and cooperators with GCMRC staff
Email	*hfairley@usgs.gov*		
Telephone	(928) 556-7285		

SUMMARY

In August 2012, GCMRC hosted a series of "knowledge assessment" (KA) workshops, and in conjunction with this effort, GCMRC organized and hosted a review of the GTMax model. A panel of experts in hydropower modeling and energy economics was assembled by GCMRC to listen to a series of technical presentations provided by staff from WAPA and Argonne National Laboratories, in which the GT Max model -- its structure, underlying assumptions, capabilities and limitations – were described and discussed. Following the conclusion of the hydropower KA workshop on September 1, 2012, the review panel prepared a report. This final report was submitted to GCMRC in December 2012. Due to the highly technical nature of this report, GCMRC had numerous internal discussions on how to most effectively disseminate the results of the review to the GCD AMP. Ultimately, a decision was made to have the expert panel prepare an executive summary and a cover letter summarizing the key points of the review in laymen's language. This was accomplished during the summer of 2012. Because the review concerned a model that had been developed by the Department of Energy, the report was initially submitted to DOI for their review and concurrence in August 2012. Subsequent discussions then ensured between DOI and DOE on how best to address the issues raised in the review. These discussions are currently (Dec 2012) ongoing. It is anticipated that the report will be shared with the AMWG at their February 2013 meeting.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Reports	Detailed reports on methods, parameters and assumptions of its analysis of impacts to the base case that may result under different operating scenarios.	FY 2012			

OTHER				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**

Gross Budget	$17,866				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$5,682	$0	$0	$5,682	$12,184
Overhead	$587	$0	$0	$587	
Net Spent	$5,095	$0	$0	$5,095	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Principal Investigator | Signature | Date

Helen Fairley

Program Manager | Signature | Date

Goal	Number and Title
11	CUL 11.R1.12 Cultural Research and Development towards Core Monitoring, Phase II

Program Manager (PM)	Helen Fairley	**Principal Investigator(s)** (PI)	Brian Collins, USGS/GEMG Helen Fairley, USGS/GCMRC
Email	*hfairley@usgs.gov*		
Telephone	(928) 556-7285		

SUMMARY

In 2012, as a result of being unable to obtain a permit from Grand Canyon National Park to implement the Phase II field work that had been originally planned and described in the FY2011-2012 work plan, GCMRC redirected its cultural resource research and monitoring efforts towards wrapping up outstanding analysis and reporting from Phase I of the Cultural Monitoring Research and Development Project and initiating an assessment of the effects of Glen Canyon Dam operations on cultural sites in the Glen Canyon reach of Glen Canyon National Recreation Area (GLCA). This change in direction was discussed and approved by the Adaptive Management Working Group during their August 2011 meeting.

Grand Canyon

In July 2012, a final USGS Scientific Investigations report was published, summarizing the topographic changes measured at 11 archaeological sites between September 2007 and September 2010 (*http://pubs.usgs.gov/sir/2012/5133/*). The results indicate that significant erosion can be tied to specific geomorphic processes, namely precipitation-induced gullying and aeolian deposition and deflation. This work was presented at several professional scientific meetings and was well-received by the professional community, especially on the state-of-the-art error detection methodologies that came out of this work.

In the latter half of 2012, work was also initiated on a second report that will synthesize the results of the topographic changes that have been detected using repeat lidar surveys in relation to weather and flow data collected during the same period. Work completed to date on this second report includes the processing of all existing weather data collected at archaeological sites to date, in preparation for input to both an empirical climate-landscape change model and a numerical landscape evolution model. In 2012, PI Collins finished developing and laying out the analytical framework for how the project intends to couple weather observations with measured landscape change. Once implemented and completed, the results will form the bulk of the results for the report in preparation. These results will be coupled with detailed calibration analyses performed by PI Bedford using the previously referenced numerical model (see below).

In 2012 PI Bedford developed and implemented a high-resolution event-based rainfall-runoff numerical model using the topographic models that had been developed from repeat lidar surveys at several sites during the past five years. In some cases the existing ground-based lidar surface data sets previously required and used for high resolution change detection analysis was at an inappropriate resolution and of insufficient aerial extent for use in modeling, thus the ground-based lidar was reprocessed to include data over a wider area. In some cases aerial lidar data previously collected for all of Grand Canyon in 2000 was fused with the ground-based lidar to construct a meso-scale elevation model. These elevation models have been input into the landscape model and rainstorms over a threshold of 10 mm have been simulated for erosion-causing events. Preliminary results tend to show that erosion is predicted in areas where fluvial erosion was documented from lidar. In addition, the model results suggest that erosion tends to occur for rainfall events with greater than 30 mm cumulative precipitation with a coincident 20mm/15-minute intensity. Overall, our preliminary modeling shows that the input data and modeling approach are appropriate for predicting fluvial erosion of archeological sites. However, incorporation of wind erosion is still needed to fully calibrate the model(s) against landscape change metrics. Analysis is ongoing to determine how sensitive the model is to simulated perturbations that can help guide management decisions.

The synthesis work is taking longer than originally anticipated, due to the complexity of the analyses and modeling effort. As described above, significant additional work is required to get existing data sets ready for analytical modeling. This, combined with the fact that this type of modeling is research-intensive, with few existing guidelines to follow, has reduced the speed of progress towards a final report. However, significant intellectual strides have been made in 2012 on both the empirical and numerical approaches, and a review-ready report is now expected to ready for review by spring 2013.

In addition to the synthesis report, a draft Open-file report compiling and summarizing weather data from 2010 was completed. This draft is currently undergoing peer review and is expect to be published by Spring 2013.

Finally, as an outgrowth of previous work conducted by this project as prior research on aeolian transport (but without funding from the current project), Draut completed and published a journal article comparing the ground cover conditions in Grand Canyon and Cataract Canyon (see Draut, A.E., 2012, Effects of river regulation on aeolian landscapes, Colorado River, southwestern USA: Journal of Geophysical Research – Earth Surface, V. 117, F2, doi:10.1029/2011JF002329). This study demonstrates how the sediment supply and flow regime of a relatively unconstrained Colorado River (in Cataract Canyon)

affects soil crust cover and vegetation density at elevations above the high flow stage, as compared to conditions in similar settings downstream of Glen Canyon Dam where sediment supply and flows are highly constrained. The implications of these differences in ground cover characteristics in terms of influencing types and degree of erosion in these different segments of the river system are also briefly discussed.

Glen Canyon

During the fall of 2011 and spring of 2012, GCMRC cultural program staff (Fairley) met with GLCA resource management staff on several occasions to discuss and plan the research and monitoring work proposed for the Glen Canyon reach and resolve potential resource concerns associated with installing stationary cameras and weather stations, as well as issues associated with conducting a future low-altitude helicopter flight to obtain airborne lidar data. In addition to communicating frequently via phone and email, GLCA and GCMRC staff met in the field on two separate occasions, once in October 2011 and a second time in May 2012. In June 2012, Fairley attended a meeting of the Glen Canyon NRA management team to seek formal approval for the next steps. As a result of these various field discussions and meetings, it was determined that the 2012 work would focus on collecting baseline lidar measurements using a terrestrial lidar system at four sites that are actively eroding and/or actively threatened by future flows from Glen Canyon Dam: AZ C:2:32, AZ C:2:35, AZ C:2:75, and AZ C:2:77. A permit was issued by GLCA for this work in September 2012.

Between September 17 and September 21, 2012, the planned field work was conducted in the Glen Canyon reach. The crew consisted of the following project personnel: Dr. Brian Collins, Dr. David Bedford, Dr. Joel Sankey, Mr. Skye Corbett, and Ms. Helen Fairley. Ms. Rosemary Sucec and Mr. Thann Baker from the GLCA Division of Resource Management accompanied the field crew during the first part of the week. Logistical support in the form of motorized boat support was provided by GCMRC logistics staff, Mr. Dave Foster and Mr. Seth Felder. Over the course of the week, the field crew collected detailed lidar and GPS measurements from the four archaeological sites, took field notes on the geomorphic settings of each site, and obtained numerous photographs. These data have been processed into high resolution topographic models and a report describing the data collection effort is in preparation. USGS staff (Collins, Corbett, and Fairley) intend to meet with GLCA personnel in the early part of 2013 to go over expected data products before finalizing the topographic models that will form the core section of the report for this first year's field effort. Additional mapping and soil infiltration work is planned for the first half of 2013 to begin to put the site specific data collection into geomorphic context within Glen Canyon.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Reports	Annual Descriptive Report during Phase II of the pilot monitoring program	FY 2012			Phase II work was not permitted by GRCA, so no report on this work could be written.
Report	Synthetic peer-reviewed report summarizing the entire project	FY 2012			Currently in progress – draft suitable for peer review is planned for spring 2013

Gross Budget	$172,267				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$38,807	$0	$0	$38,807	$133,460
Overhead	$4,010	$0	$0	$4,010	
Net Spent	$34,797	$0	$0	$34,797	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Helen Fairley

Principal Investigator | Signature | Date

Helen Fairley

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**DASA 12.D1.12 Quadrennial Remote-Sensing Overflight**

Program Manager (PM)	Phil Davis	**Principal Investigator(s)** (PI)	Philip A. Davis, USGS/GCMRC
Email	*pdavis@usgs.gov*		
Telephone	(928) 556-7084		

SUMMARY

This project is to collect airborne multispectral imagery and a digital surface model (DSM) for the entire river corridor. Nothing was done in FY12 except carry over the funds for the overflight collection and publishing the method used to produce the final 4-band image database. The DSM are currently being evaluated for accuracy and precision and registering to previous 2002 DSM data to allow change detection.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Data Sets	Data sets are proposed to be served through an instance of Environmental Systems Research Institute (ESRI) ArcGIS Server	FY 2012	FY2012		All final image data sets have been posted on GCMRC website, accessible to general public, and we have served this to a number of scientists who have requested the data.
Report	Annual progress report summarizing major results will be provided		FY2012		Davis, P.A., 2012, Airborne digital-image data for monitoring the Colorado River corridor below Glen Canyon Dam, Arizona, 2009—Image-mosaic production and comparison with 2002 and 2005 image mosaics, *U.S. Geological Survey Open File Report 2012-1139*, 82 p.

Gross Budget	$325,217				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$0	$0	$0	$0	$325,217
Overhead	$0	$0	$0	$0	
Net Spent	$0	$0	$0	$0	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

All of these funds were carried over to FY13 to fund May, 2013 overflight.

$325,217 Carryover ($240,483 from FY11).

Philip A. Davis	Philip A. Davis	12-06-2012
Principal Investigator	Signature	Date

Philip A. Davis	Philip A. Davis	12-06-2012
Program Manager	Signature	Date

Goal	Number and Title
12	**DASA 12.D2.12 Grand Canyon Integrated Oracle Database Management System**

Program Manager (PM)	Phil Davis	**Principal Investigator(s)** (PI)	Glenn Bennett, USGS/GCMRC
Email	*pdavis@usgs.gov*		
Telephone	(928) 556-7084		

SUMMARY

- Sediment Transport Model – Sandbox.exe
  - Sand loads and silt and clay loads are calculated using the method of Topping and others (2010) on the basis of Topping (1997) and Porterfield (1972). Model-predicted loads are adjusted to agree with measured loads using time-varying shifts calculated on the basis of physical suspended-sediment samples processed through the laboratory. Because of the time required to process samples through the laboratory, there is a lag of several weeks or more between the collection of suspended-sediment samples during a flood and the availability of these samples to adjust the model-predicted loads. As these samples become available, the loads calculated by this program will change and become more accurate. Uncertainties associated with "laboratory-adjusted" loads are approximately ±10%; uncertainties associated with raw model-predicted loads postdating the last laboratory-processed suspended-sediment sample (indicated at the right in the "Sed Lab Data" row in the interface) may exceed ±20 to 30%. Interface developed by Glenn Bennett and David Topping (USGS, Grand Canyon Monitoring and Research Center). References:
    - Porterfield, G., 1972, Computation of fluvial sediment discharge: Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 3, Chapter C3, 66 p., [http://pubs.er.usgs.gov/usgspubs/twri/twri03C3].
    - Topping, D.J., 1997, Physics of flow, sediment transport, hydraulic geometry, and channel geomorphic adjustment during flash floods in an ephemeral river, the Paria River, Utah and Arizona: University of Washington, unpublished Ph.D. dissertation, 406 p., [http://www.gcmrc.gov/library/reports/physical/Fine_Sed/Topping1997V1.pdf; and *http://www.gcmrc.gov/library/reports/physical/Fine_Sed/Topping1997V2.pdf*].
    - Topping, D.J., Rubin, D.M., Grams, P.E., Griffiths, R.E., Sabol, T.A., Voichick, N., Tusso, R.B., Vanaman, K.M., and McDonald, R.R., 2010, Sediment transport during three controlled-flood experiments on the Colorado River downstream from Glen Canyon Dam, with implications for eddy-sandbar deposition in Grand Canyon National Park: U.S. Geological Survey Open-File Report 2010-1128, 111 p., [http://pubs.usgs.gov/of/2010/1128/].
  - Self-updating program and GCMRC 30 mile data accessed from USGS FTP server
  - Accesses National Water Information System (NWIS) real time discharge data for Paria River
  - Program output:
    - Updated Sediment Loads for Paria River and River Mile 30 of the Colorado River (GCMRC-CR30); Mass Balance for Upper Marble Canyon
    - Onscreen zoom enabled graphics of model results and input discharge record
    - Tabular output files containing detailed model run results were used for input to the Scott Wright Sand Budget Model for the High Flow Experiment (HFE); other calculations for the LTEMP EIS. Model results will be used in future as input for light attenuation in FoodBase production models.

- Natal Origins (NO) & Juvenile Chub Monitoring (JCM) Field Data Entry – MarkRecap.exe
  - Fish monitoring efforts have traditionally relied on clipboards, hand written data entry sheets, and subsequent transcription into a database. These two projects are high volume 10,000 plus entries per trip that tend to overwhelm traditional methods. A field data entry program was written that electronically captures passive integrated transponder (PIT Tag) ID alphanumeric strings and allows input of various attributes: fork length, weight, species, etc. One of the main design goals is to insure data integrity – no data loss even in the event of computer hardware or software failure. The program achieves this by through real time multiple external storage device copies of data files that are opened, written in append mode, and immediately closed for all mirrored data files for each fish entered. Over eighty thousand fish were entered in FY2012 using the MarkRecap program.
  - Database
    - Transactional Comma Separated Values database
    - Real time backup to multiple storage devices – typically flash drives

        - Edits are stored as additional rows to maintain file integrity
        - All records contain unique key generated in real time which allows partial file merging and edit record matching
        - Corrections can be made while sampling events are fresh in researcher's mind
    - Hardware Interface
        - Reader / Data Storage Discovery mode as each laptop could use different ports and the reader could have issues with: timeout, cabling, power, and configuration
        - Supports two different models of PIT tag readers
        - PIT tag and date/time parsing
        - Duplicate tag rejection - PIT tag readers and their operators can easily make multiple reads of the same PIT tag.
        - Battery percent of charge indicator Comma Separated Values database
    - Graphical User Interface
        - Optimized user interface for data entry speed
        - Interface colors are user configurable – not all operators see color in the same way
        - Pull down menus and data field defaults are controlled by user configurable control file
        - Shortcut keys are available for all fields and functions – alternate to touch pad field selection
        - Multi-Mode for different effort (sampling) operations

- Fish Database
    - Completed upload of 53 trips containing 151,706 observations
    - New conversion program to accept MUX data from remote LCR pit antenna project
    - New program to detect and convert incompatible templates to upload older trips
    - Modified input template for NPS data
    - Produced combined dataset and Fish Tag History for Steve Martell Age Structured Mark Recapture
    - Produced year end combined dataset and Fish Tag History for FTP distribution to cooperators

- Dasa_CSV – Error checking and histogram
    - Major upgrades to program that finds duplicates and data errors

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Tracking System	Foodbase sample inventory and tracking system	FY 2012	Jul / 2012		
Application	Application to integrate power data, as provided by WAPA, into DASA data management system	FY 2012			Deferred
Application	Version 2 Refactor of DASA mSystem-Data-Sync-Web-Server application	FY 2012			Deferred
Application	Version 2 Refactor of Mark-recapture specimen tag synchronization	FY 2012	10/2/2011		Ongoing – Version 10 released 4/19/2012
Data	Online interactive data visualization and analysis tools on GCMRC website	FY 2012	Nov / 2012		First version online
Report	Annual progress report summarizing activities	Dec. 15, 2012			

Gross Budget	$161,203				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$127,994	$0	$0	$127,994	$33,209
Overhead	$13,225	$0	$0	$13,225	
Net Spent	$114,769	$0	$0	$114,769	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Glenn Bennett

Principal Investigator | Signature | Date

Philip A. Davis

Program Manager | Signature | Date

Goal	Number and Title
12	**DASA 12.D3.12 Library Operations**

Program Manager (PM)	Philip A. Davis Barbara Ralston	**Principal Investigator(s)** (PI)	Meredith Hartwell, USGS/GCMRC
Email	*pdavis@usgs.gov* *bralston@usgs.gov*		
Telephone	(928) 556-7084 (928) 556-7389		

SUMMARY

The purpose of this project is to provide a central repository for historic and current information such as books, reports, maps, photographs and videos generated by GCMRC scientists and others related to the Colorado River, Glen Canyon Dam, Grand Canyon and the Adaptive Management Program. The project supports the Department of the Interior's Resource Protection strategic goal to ensure the quality and relevance of science information and data to support decision making through accessibility of information.

Ongoing library activities:

- Convert hard copy materials to digital format and store the digital files for long-term preservation;
- Edit and maintain the online catalogue and databases of library materials to provide easy access for searches and retrieval of digital reports;
- Store original and duplicate copies of all digital remote-sensing data;
- Convert historic photography to digital format and store it using archival procedures;
- Ship appropriate materials to National Archives and Records Administration (NARA) after digitization;
- Contribute to the quality of scientific project success by providing assistance to GCMRC and other researchers in obtaining pertinent materials (imagery, reports, citations, etc.).

Projects finalized during FY2012:

- Digitization of helicopter overflight video of Grand Canyon from 1984 to 1997 onto Blu-ray media. The media is stored and the transfer process for accession at NARA is well underway.
- All VHS and Beta video media has been digitized to DVD, stored, inventoried in a database, and is accessible through library request.
- All unnecessary materials and equipment have been removed from the library and it has been reorganized for better functionality.
- Publication and data request response time has been improved from several weeks to same day delivery, in most cases.
- Best practice standards for digitizing and archiving of library materials for long-term preservation are now in development through collaboration with several other USGS libraries. These standards will now be followed to the greatest extent possible.

FY2012 projects continuing to FY2013:

1. During FY2012, the task to correct citation errors on the GCMRC library website was identified as high priority. That work is ongoing and will be completed by end of FY2013 with support from IT. In conjunction with the website editing task, the Endnote citation database on the GCMRC server will be updated so that by the end of the FY2013 it will contain all library website records.

2. The second priority task that started in FY2012 and continues through FY2013 is the comparison and reconciliation of existing hard copy library documents against scanned documents, the online website, and the Endnote citation database. The librarian will scan to PDF all documents that are not currently in our digital PDF archive; create a database of documents not already online for IT to add to the website; and enter any new records into the Endnote database. This will include all relevant documents, whether unpublished or published. With the exception of sensitive tribal reports, the digital collection will be available online to GCMRC; published documents will be available online to the general public, and unpublished will be available by request.

3. The third priority for FY2013 and likely into FY2014 is a review and reorganization of all digital remote sensing data that are on shelves, cabinets, or in boxes, and to copy the data on external hard drives to DVDs (2 sets), to be placed on GCMRC servers.

FY2013 projects continuing to FY2014:

1. A detailed review of all hard copy maps in the library has been reassigned to FY2014. They will be reorganized when necessary, inventoried in a database, scanned in order to be preserved, and placed on the GCMRC servers for online access. Additionally, a review of historic and current photographs including aerial imagery will be completed in FY2014. Like the maps, photographs will be reorganized, inventoried in a database, digitized, and placed on the GCMRC servers. The maps and photographs will be stored according to archival guidelines, in acid-free folders or boxes. As necessary after digitizing, photographs or their copies will be sent to NARA. If they already exist there (as is the case with some historic photographs in the library), they will be sent as necessary to the Denver Federal Center photographic lab for long-term cold-storage preservation.

	Products/Reports				
Type	**Title**	**Due Date**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Catalog	Up-to-date online library website catalog: corrections and additions	FY 2011		FY 2013	This project has been expanded due to the discovery of many website citation errors. The librarian is now providing IT with the corrections so that the website is updated and improved.
Catalog	Catalog records of all new materials (continually) received	On-going		On-going	This project is currently in progress
Access	Assist cooperators, stakeholders, media contact, and the public by providing access to reports, aerial photos, maps, slides, data and photographs in hard copy and digital form.	On-going		On-going	This project is currently in progress
Appraisal	Scientific appraisal of all available historical data – scanning and conversion of all products. Historical products include hard copy documents, maps, photographs, and aerial imagery of Grand Canyon.	FY 2013		On-going	This project is currently in progress
Access	Scan all library products currently housed in the library – make available in digital format via digital media such as the GCMRC library website, servers, and the Endnote citation database.	FY 2011		On-going	This project is currently in progress
Report	Annual progress report summarizing entire project	December 6, 2012		December 6, 2012	Completed

Gross Budget	$44,167				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$22,020	$0	$0	$22,020	$22,147
Overhead	$2,275	$0	$0	$2,275	
Net Spent	$19,745	$0	$0	$19,745	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Carryover of tasks from one fiscal year to the next is described in the summary. All carryover is due to a re-evaluation of the necessary time to complete each task as well as some slight changes in prioritization of tasks based on discussions with supervisors.

A review of the steps necessary to finalize the completion of digital scans of the 1984 B&W film and the 1988 CIR film. This project was on the FY2012 annual report and it is not a library operations task. It is integrated as part of another DASA project.

Meredith Hartwell		December 6, 2012
Principal Investigator	Signature	Date

Philip A. Davis		December 6, 2012
Barbara Ralston		December 6, 2012
Program Manager	Signature	Date

Goal	Number and Title
12	**DASA 12.D5.12 GIS Support for Integrated Analyses and Projects, GIS Lead**

Program Manager (PM)	Phil Davis	**Principal Investigator(s)** (PI)	Thomas Gushue, USGS/GCMRC
Email	*pdavis@usgs.gov*		
Telephone	(928) 556-7084		

SUMMARY

Goal(s):

- Development, management and dissemination of spatial data
- Creation of specialized maps and intuitive data retrieval specific to individual project needs
- Consultation and instruction related to GIS operation
- Spatial data analysis for the GCMRC staff
- Management and dissemination of spatial data

Outcome:

I. Improved web-based map application for Grand Canyon

The next version of GCMRC's web mapping application was released as beta in July of 2012. After live testing and some minor updates, it was re-released one month later in August. The design and implementation of the new web mapping application benefitted multiple projects by accomplishing several goals. The initial driver was to meet the requirements needed by the Campsite Atlas project.

What it does: The web map provides access to many of GCMRC's base data layers, including multiple dates of digital aerial photography in both True-Color and Color-Infrared formats. It also allows users to view, zoom and to, and query the NPS / GCMRC campsite atlas GIS layer. These two elements alone would allow anyone to view and detect changes to camping beaches at a sub-decadal time scale (2002 to 2005 to 2009). In addition to meeting this goal, the GIS team devised a method for querying collections of site photographs dating back to 1973. These photographs contain a wealth of historical significance, but actually reach their full potential when viewed in the context of other repeat photos taking at different times. The photo viewer application allows for searching and filtering of camping beach photographs collected as part of the Weeden and Weeden Repeat Photography projects, the Adopt-A-Beach program and other repeat photography efforts conducted by Grand Canyon National Park.

The design of this application allowed for expanding beyond the stated fy2012 goals to include other, large photographic data holdings at GCMRC. The GIS team was able to also serve photographs taken by remote cameras associated with the long-term sandbar monitoring sites. These photos date back to the early 1990's, and the latest version of website update now has photos for before, during and after the most recent High-Flow Event release from Glen Canyon Dam in November 2012. Additionally, the application allows a user to actually investigate relationships between site-based photographs collected as any part of any project along the Colorado River, thus in effect, functioning very similarly to a comprehensive site photograph database.

How to use it: Currently, campsite and remote camera (sandbar) photos are available through two different methods. A user can query campsite and sandbar sites interactively through the web mapping site. Alternatively, the user can also visit the stand-alone photo viewer web page and pick from a list of available photo site locations.

Where to find it:

Link to Web Mapping App: *http://www.gcmrc.gov/gis/silvermap1.aspx*

Link to Photo Viewer App: *http://www.gcmrc.gov/gis/silverimage1.aspx*

II. Creation of specialized maps and provide data according individual project needs

River Map Books

In support of the new Natal Origin project, the GIS team completely redesigned the look of its river map books for fisheries field work. A need existed to make the map books easier to use at night during electrofishing operations. Using the new version of ArcGIS (v10) and the updated Python scripting language, we updated mapping scripts to the use three data frames (a start frame, an end frame, and an overview frame). The Natal Origin fish sampling system (developed by GIS in FY2011) was used as the driver for automating the map outputs. Other improvements included changing the orientation from North always at the top of the page, to have the most downstream extent at the top of the page instead. Also, we added code that allows any user to produce maps with only basic knowledge of the GIS software needed. The final product is an ArcGIS mapping tool that met the needs of the fisheries researchers and was adaptable enough to benefit other GCMRC projects.

Other projects that were supported include mainstem fish monitoring, channel mapping, driftwood surveys, aeolian sand deposit mapping, aquatic food base monitoring, LCR native fish sampling (lower 15km), LCR native fish sampling (translocation reach), monitored campsites, and NAU sandbar survey. These map books were customized to meet the needs of each project, and supported GCMRC's physical, cultural, and biological programs as well as outside cooperators Arizona Game & Fish, Fish and Wildlife Service, Ecometrics (Josh Korman), and Amy Draut (USGS scientist).

Publication Maps & Data Requests

The GIS group also supported GCMRC staff and cooperators with publication maps in FY2012. There were six publications in which maps and/or spatial data were provided ranging in scope from specific site locations. Publication maps were mostly for publications about Humpback Chub in the Little Colorado River or in the mainstem of the Colorado River. In support of the LTEMP EIS, numerous data requests have been handled, usually within the same day as when the request was made. Additionally, several publication-quality maps have also been provided to the EIS team when requested.

III. Fish Cross Reference System

A fish cross reference system was created in GIS to assist researchers with comparing data collected by different monitoring projects. This effort required a considerable amount of time, beginning with analyzing and data clean-up / editing of the existing fish monitoring data sets used over the past 10 years. A relational scheme was designed in GIS that would allow for relating sampling units from different projects and compare spatial statistics of each. Additionally, this now serves as a catalyst for more easily comparing catch information between projects than was previously possible before.

This GIS cross reference system between Natal Origins and Glen Canyon AGF sampling units was completed in July and a resultant spreadsheet sent to Josh Korman at Ecometrics to be used for ecological research. In September, the cross reference between Natal Origins and Juvenile Chub Monitoring (JCM; formerly NSE) sampling units was completed and again sent to Ecometrics.

More work remains on completing a more encompassing, canyon-wide fish sampling cross reference system in FY2013, and is dependent on the cooperation of fisheries researchers in Grand Canyon and the timely delivery of data sets (i.e. sampling locations) to the GCMRC GIS team. Due to a lack of GIS technician support, no GIS fish data was entered during FY2012. Historically, this work was performed by a student worker at GCMRC, however, due to a lack of funds and an increase in more, higher-level data management and analysis assignments for GCMRC GIS staff, this data entry task was shifted to the cooperating agencies responsible for collecting the data. These data were not entered and we are now looking to find the appropriate level of GIS support through the Southwest Biological Science Center's GIS staff.

IV. GIS Database Development

The Oracle GIS database designed and implement in FY2011 was expanded during FY2012. New storage spaces were designed to allow for more base data information and new thematic layers relating to on-going GCMRC projects. New tablespaces were built for sandbar survey data, modeled shoreline data, and fisheries data sets. Additional layers were also added to existing tablespaces for GCMRC Base GIS data sets and topographic data sets including the Digital Surface Model elevation data associated with the 2002 and 2009 remote sensing overflights.

Database performance tools were better utilized to troubleshoot problems in SQL performance of specific data sets, particularly the digital imagery data sets collected as part of quadrennial overflight missions. These tools were used to monitor response times for individual data sets when accessed through both desktop applications and over the internet through web services hosted outside of GCMRC's internal firewall.

V. Development of spatial models and scripts for improved efficiency of GIS tasks

The GIS team continued to build upon its success from the previous year on updating existing python scripts to the new version as well as developing some new data processing scripts directly into the version that is compatible with ArcGIS v10. Most of these scripts were created to support on-going data processing with the sandbar studies or to generate maps in support of native and nonnative fish studies.

VI. Continued Engineering Support and Development for SCADA Operations

Engineering support for SCADA operations linked to monitoring PIT tagged fish, sonar data acquisition, stream-flow, water quality, and sediment transport in the Colorado River and Little Colorado River Ecosystems. Perform communications design using cellular, satellite, and radio technologies. Perform solar power system design for autonomous remote operations. Tasks may also include communications systems control programming, computer setup and testing, electrical control wiring, system modification, troubleshooting, or maintenance, and system component recommendations.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Maps	Product maps for publications, posters outside of scheduled project work		FY 2012		Presented three posters at ESRI International GIS User Conference, San Diego, July 2012
Application	Improve web-based map application for Lake Powell and Grand Canyon		June 2012		Initial release was June 2012. Minor updates and edits made through August 2012.
Instruction	Provide instructional sessions for staff, cooperators and contractors on GIS layer development, integration and analysis		As needed		Hosted GIS Workshop for USGS Flagstaff campus. Presented first two workshop topics.
Models	Develop spatial models and scripts for improving overall efficiency of GIS tasks		FY 2012		
Report	Annual progress report summarizing major results		Dec. 15 FY 2012		Draft completed Dec. 14, 2012
Report	Annual progress report summarizing major results		Dec. 15 FY 2012		

Gross Budget	$476,197				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$271,863	$0	$38,500	$310,363	$165,834
Overhead	$28,090	$0	$11,398	$39,488	
Net Spent	$243,773	$0	$27,102	$270,875	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Tom Gushue

Principal Investigator | Signature | Date

Philip A. Davis

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**DASA 12.D9.12 Integrated Image Analysis and Change Detection**

Program Manager (PM)	Phil Davis	**Principal Investigator(s)** (PI)	Philip A. Davis, Paul Grams, Barbara Ralston, and Helen Fairley; USGS/GCMRC
Email	*pdavis@usgs.gov*		
Telephone	(928) 556-7084		

SUMMARY

This project is to analyze the 4-band image data and digital surface model (DSM) data to (1) map gross vegetation and vegetation alliances throughout the corridor using the 2009 image data and determine changes since 2002, and possibly 2005; (2) map the fine-grained sediment deposits using the 2002, 2005, and 2009 image data and determine areal changes between these periods; (3) determine the effects of vegetation encroachment on camp sites throughout the Canyon, using the data from items 1 and 2; and (4) determine the volumetric changes in fine-sediment deposits throughout the corridor using the 2002 and 2009 DSM data.

Here is the status of these tasks:

Task 1. The 2002 vegetation was mapped and published by 2008, however, I noticed that the vegetation was overclassified due to anomalous spectral signatures on some surfaces. We are currently eliminating non-vegetation from this database. We have completed the mapping of the 2009 gross vegetation and provided the database to the U of A PhD student who is identifying the alliances within that database. We are also improving the image registration for the 2005 imagery so we can map the gross vegetation (and fine sediment deposits) for 2005 and then perform change detection for gross vegetation throughout the corridor using the 2002, 2005, and 2009 databases. The revised 2002 and new 2005 gross vegetation databases should be completed within a few months.

Task 2. I am devising an image-processing algorithm to automatically map fine-grained sediment deposits within 1,250 sites throughout the Canyon, where there are sandbars and camp sites. Once the algorithm works with acceptable accuracy, it will be applied to the 2002 and 2009 image data and to the 2005 image data when its registration is fixed. Completion date estimated at February, 2013.

Task 3. This task requires the information produced from tasks 1 and 2 and will be a simple analysis, once those databases are produced. Completion date estimated to be shortly after completion of task 2.

Task 4. I am currently finalizing the 2002 and 2009 airborne DSM databases, which required minor co-registration and detailed vertical offset adjustments. The offsets do vary throughout the Canyon and their corrections need to be carefully performed. The databases will be completed before January, 2013 and then analyzed for volumetric change detection of fine- and coarse-grained sediment resources, and possibly vegetation canopies.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Report	USGS Digital Data Series – topographic maps produced from the 2009 image data (USGS Digital Data Series)	FY 2012		Dec., 2012	Finalizing the data sets now for publication; requires calibration between 2002 and 2009. Preliminary title of published report and databases: Davis, P.A., Sankey, J.B., Kohl, K.A., and Gushue, T.M., 2012, Evaluation of airborne ADS40 photogrammetric digital surface models for monitoring the Colorado River corridor below Glen Canyon Dam, Arizona: U.S. Geological Survey Open-File Report and Data Series XXX.
Report	Results from integrated, long-term topographic analysis for sandbars will be included in an annual report in coordination with project PHY8.M2	FY 2012			This will be accomplished as soon as DSM data calibrated between 2002 and 2009; there are vertical offsets between the two DSM data sets.
Report	Results from integrated, long-term topographic analyses for sandbars will be included in peer reviewed report or journal article in cooperation with project PHY 8.M2	FY 2012		Jan., 2013	This will be accomplished as soon as DSM data calibrated between 2002 and 2009; there are vertical offsets between the two DSM data sets.
Report	Report or journal article describing long-term surficial and volumetric changes within archaeological sites	FY 2012		No longer approached in this project.	This item is being approached by a newly formed scientific team who will use the image data, but not the DSM data because DSM data at 1-m cell size is too coarse for arch site studies.
Report	USGS Report on the observed effects of vegetation encroachment on campable area over time	FY 2012		Jan., 2013	We have mapped the gross vegetation in 2009, and previously in 2002, but we need to map the camp-site base ground before assessing vegetation encroachment – we are working on the algorithm to do this for all 1250 camp-site and sandbar locations all at once,
Data Sets	All data sets that have cleared USGS FSP review and approval are proposed to be served through an instance of Environmental Systems Research Institute (ESRI ArcGIS Server	FY 2012			

Gross Budget	$276,607				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$211,334	$0	$50,000	$261,334	$15,273
Overhead	$21,836	$0	$29,832	$51,668	
Net Spent	$189,498	$0	$20,168	$209,666	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Philip A. Davis	Philip A. Davis	12-06-2012
Principal Investigator	Signature	Date

Philip A. Davis	Philip A. Davis	12-06-2012
Program Manager	Signature	Date

Goal	Number and Title
12	**PLAN 12.P1.12 Continued Support and Enhancement of Ecosystem Modeling Efforts**

Program Manager (PM)	Scott VanderKooi	**Principal Investigator(s)** (PI)	Carl Walters, University of British Columbia
Email	*svanderkooi@usgs.gov*		
Telephone	(928) 556-7376		

SUMMARY

This project supports a range of activities by the Grand Canyon Senior Ecologist. These activities range from facilitation at scientific and stakeholder workshops to basic data analysis and mathematical modeling related to Grand Canyon aquatic resources, and provision of advice on analysis methods to cooperators in the aquatic program.

Work during the last fiscal year focused on six main topics.

1. Analysis of rainbow trout population dynamics, using a detailed stock synthesis model fitted to monitoring time series data to assist in reconstruction of historical recruitment rates and probable causes of recruitment variation. The senior ecologist's role in this work was to assist Josh Korman in model formulation and interpretation of recruitment patterns in relation to drivers of productivity including HFEs and interannual changes in total flow volume. A key goal has been to explain the period of low recruitment that occurred during the mid-2000s; the mechanism for this low period could be critical for future policy development aimed at preventing high rainbow and brown trout populations that threaten native fishes. Our best interpretation of the data remains that recruitment is highly sensitive to annual total CR flow volume.
2. Development of simple ecosystem models to explore predator-prey cycle hypotheses for rainbow trout population patterns. It has been hypothesized that rainbow trout may show a regular predator prey cycle with their invertebrate food base, involving periodic trout abundance peaks that severely deplete some key foodbase species such as gammarus. Using both the Grand Canyon Ecosim model developed last year and also a much simpler traditional Rosensweig-MacArthur predator-prey model, we conducted a workshop in April 2012 which showed that the predator-prey hypothesis is very likely not correct—if it were, the period of the cycle should be much shorter than observed, on order 6-8yr rather than the observed period of order 10-12 yr.
3. Development of an individual-based model (IBM) for population viability analysis of humpback chub. This modeling approach tracks recruitment and survival of humpback chub individuals so as to account for effect of demographic stochasticity (random mortality events) on probability of population persistence. The model has been used effectively to show that small tributary populations besides the LCR are unlikely to be persistent over long periods of time under current mainstem recruitment and survival conditions. Work in the past fiscal year has been mainly on expanding the model to account for effects of runs of warm and cold temperature years in the CR mainstem, where warm temperature years apparently result in doubling or tripling of potential recruitment while runs of cold years may result in much more severe population declines than expected from random environmental variation over time. We have shown that having such runs of good-bad conditions in the future will not substantially increase extinction risk for the LCR population of humpback chub.
4. Participation in the LTEMP advisory process. The senior ecologist attended two LTEMP planning workshops by telephone, and did background analyses related to hypotheses about causes of humpback chub recruitment failure in the CR mainstem and ways to mitigate these causes. More particularly, he developed a set of hypotheses about the relative roles of cold water and exotic trout predators in causing poor survival, and developed a proposal to experimentally warm the river using WEARS impeller systems to drive warm water down to the GCD penstocks. Development of that proposal involved contact and discussion with the WEARS system developers, development of simple heat budget models to predict temperature below the dam as a function of the expected WEARS flow volumes, and transmittal of those findings to Tracy Vermeeren (BOR engineer who will likely do further feasibility analysis). The senior ecologist also attempted to explain that the so-called LTEMP flow alternatives developed during the LTEMP workshops should not be considered adaptive management options at all, but rather represent particular flow treatment options for consideration in alternatives that are defined not by flow options but rather by alternative experimental designs (treatment patterns); this attempt was apparently unsuccessful.
5. Development of the Core Response Model (CRE) for use in LTEMP planning. In collaboration with Charles Yakulic, we have substantially improved the simple CRE for simulating alternative responses of trout and native fishes to policy actions ranging from HFEs to trout suppression flows. The model now (1) fits historical time series data much better; (2) can do parallel simulations of multiple hypotheses about responses to experimental policy options, and (3) use the results from those parallel simulations to calculate statistical likelihoods and probabilities of incorrect hypothesis choices (placing high odds on wrong hypothesis or being unable to discriminate between hypotheses) under alternative experimental treatment regimes over time. That is, CRE now allows us to examine the "power" of alternative experimental plans to distinguish between alternative hypotheses about what drives

changes in trout and native fish abundance, and to use that power as a criterion in deciding the best LTEMP experimental plan. This capability was requested by LTEMP workshop facilitators, but has so far not been used in the process, for reasons that are entirely unclear.

6. Analysis of foodbase drift dynamics and options for drift monitoring. Foodbase drift (entry of benthic invertebrates into the CR water column) is the main way for the CR foodbase to become available to fishes and other organisms like birds, so drift dynamics are critical to the CR aquatic and riparian animal ecosystem components. A workshop was conducted in September 2012 to evaluate a simple spreadsheet model for predicting downstream patterns of insect drift concentration in CR, under alternative assumptions about drift entry rates, predation removals, and settlement rates of drifting organisms back onto the river bottom. In order to explain observed downstream drift concentration patterns, this model indicated that drift times for typical invertebrates (midges, gammarus) need to be quite long, on order 6-18hr. Such long drift times are unexpected. Field sampling at Lees Ferry during the workshop indicated much shorter drift distances and durations for midges, on order minutes and 100-100m distances. We reviewed a number of possible methods for directly measuring drift entry and settlement rates, and for improving spatial sampling design to detect smaller-scale variation in drift concentrations.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Report	Annual report on various ongoing ecosystem modeling initiatives	January 2012	January 2012		Delivered to GCMRC staff
Report	Manuscript describing development and attributes of Lees Ferry rainbow trout production model, including various analyses of historical monitoring data used in developing the model.	FY 2012	August 2012		Manuscript accepted, Can. J. Fish. Aquat. Sci.: Josh Korman[1], Steven J.D. Martell[2], Carl J. Walters[2], Andrew S. Makinster[3], Lewis G. Coggins[4], Michael D. Yard[5], and William R. Persons. Estimating Recruitment Dynamics and Movement of Rainbow Trout in the Colorado River in Grand Canyon using an Integrated Assessment Model.
Report	Manuscript describing individual-based model (IBM) for humpback chub population viability, including effects of persistent cold-warm water mainstem rearing regimes	FY 2012	March 2012		Manuscript in review: Bill Pine, Brian Healy, Emily Omana Smith, Melissa Trammell, Dave Speas, Rich Valdez, Mike Yard, Carl Walters, Rob Ahrens, Randy Vanhaverbeke, Dennis Stone, Wade Wilson. An Individual Based Model for Population Viability Analysis of Humpback chub in Grand Canyon. North American Journal of Fisheries Management.
Workshop	Analysis of predator-prey cycle hypothesis for historical patterns in Lees Ferry rainbow trout/foodbase abundances, using Ecosim ecosystem model	April 2012	April 2012		Discussions with GCMRC ecology staff; fate of model results uncertain at this time, since model did not support hypothesis of predator-prey cycle
Workshops	Participation by phone in two LTEMP planning workshops for advice on major ecological uncertainties	Summer 2012	Summer 2012		Main recommendations were to evaluate WEARS impeller system for warming water from Powell, and to use Core Response Model for comparison of experimental design options
Workshop	Participation in workshop and preliminary field work on insect drift dynamics and downstream impact of Lees Ferry foodbase stock on drift available to native fishes downstream.	September 2012	September 2012		Discussions resulted in improved design for longitudinal monitoring of drift concentrations downstream from GCD as a means to estimate drift rates and drift distances
Software	Spreadsheet model for spatial drift dynamics and downstream patterns	September 2012	September 2012		Model used in insect drift workshop, may be used by T. Kennedy in further analysis of historical and planned drift data
Software	New spreadsheet implementation of Core Response Model to include alternative scenarios for Lake Powell Levels and downstream warming, better fit to historical data, and ability to estimate probabilities of drawing incorrect conclusions about main ecological drivers of trout, humpback chub (temperature vs predation, foodbase changes) under alternative experimental designs	August 2012	August 2012		Model development, use in experimental planning, and documentation will be taken over by Charles Yakulic, GCMRC

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Graduate theses	Assistance with data analysis and reporting for three students working on humpback chub in Grand Canyon	FY 2012	FY2012		3 theses as a committee member or special member: Gerig, B.S. 2012. Site occupancy and habitat selection of endangered humpback chub during experimental flow releases from Glen Canyon Dam in the Colorado River, Grand Canyon, Arizona. Master's Thesis. University of Florida. Dodrill, M. J. 2012. Habitat relationships of small bodied fish in the Grand Canyon reach of the Colorado River, Arizona, Emphasis on native fish and evaluation of backwater habitats. Master's Thesis. University of Florida. Finch. C. 2012. Manipulation of fish vital rates through ecosystem experimentation in a regulated river. Master's Thesis. University of Florida.

Gross Budget	$120,592				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$52,777	$15,000	$21,729	$89,506	$31,086
Overhead	$5,453	$437	$18,860	$24,750	
Net Spent	$47,324	$14,563	$2,869	$64,756	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$31,086 Carryover ($5,000 from FY11).

Sub-allocation to CA Water Science Center (overhead 86.795%).

Carl Walters

Principal Investigator | Signature | Date

Philip A. Davis

Program Manager | Signature | Date

Goal	Number and Title
12	**PLAN 12.P4.12 Update of Knowledge Assessment II and SCORE Report**

Program Manager (PM)	J.C. Schmidt	**Principal Investigator(s)** (PI)	T.S. Melis et al.
Email	*jcschmidt@usgs.gov*		
Telephone	(928) 556-7094		

SUMMARY

Two synthetic workshops were convened by the GCMRC during the 1st and 2nd quarters of FY 2012 to review outcomes of four expert knowledge assessment (II) workshops held during FY 2011. These workshops were attended by GCMRC staff, selected science cooperators and members of the TWG in October 2011 (aquatic resources) and January 2012 (physical and cultural resources). Both meetings were recorded and the PowerPoint presentations made by invited speakers, along with the digital recordings have been posted at the GCMRC web site since spring 2012.

During the fourth quarter of FY 2012, a draft report summarizing knowledge advances since 2005 (knowledge assessment I) and the persisting key uncertainties related to resources of interest to the GCDAMP. The report emphasizes three priority science areas identified by DOI in 2011: 1) Native Fish and humpback chub conservation, 2) sandbar conservation, and 3) control of exotic fishes and management of the Lees Ferry rainbow trout fishery. The report is proposed to be published as a book chapter during 2012 within an edited volume entitled "*National Parks: Strategies, Evaluation and Politics of Conservation*" sometime in 2013. Another journal manuscript has also been prepared during 2011-12 that will focus on the surprise nature of learning that has occurred in the GCDAMP over the last decade and a half entitled "*Surprise Learning Opportunities in the Glen Canyon Adaptive Management Program*" (see more below).

Major areas of uncertainty pertaining to the above priority areas may be summarized relative to several problem statements and related questions pertaining to select management goals:

1) SANDBARS - Sandbars in Grand Canyon (below River Mile 61) appear to have been increased incrementally between 1996 and 2008 by a combination of controlled flood experiments and MLFF dam operations (on basis of existing long-term sandbar measurements of volume above the 227 cubic meters per second stage elevation), but other sandbars have not responded in a similar manner on the basis of monitored sites in Marble Canyon – if true, then why is this so? A key point to consider is that recent analyses of the 1990 – 2011 sandbar measurement data has revealed that the subset of monitoring sites re-measured annually since 1990, are not deemed to be representative of sandbar responses system-wide and that these monitoring data are most representative of Upper Colorado River Basin hydrologic variability as reflected by annual volume releases from Glen Canyon Dam than MLFF operations specifically. Whether or not there is a long-term dam operation whereby rates of sandbar building from controlled flood experiments can exceed rates of sandbar erosion between experimental floods with the available sand input by tributaries below the dam is still indeterminate, but is being evaluated presently under the HFE Protocol adopted in 2012. Additionally, there is a high degree of uncertainty about whether or not the historically measured sand produced by tributaries below the dam is stationary. Finally, from sand transport and sandbar monitoring data collected in 2011-12, it is clear that annual dam releases that are 50% larger than previous minimum releases of 8.23 million acre feet (12.5 MAF were released in WY 2011 to meet obligations to equalize storage between Lakes Powell and Mead) can export 2-3 times the average sand input from tributaries and quickly erode Marble Canyon sandbars. However, sandbars further downstream in western Grand Canyon can also be increased in size when such operations as occurred in Water Year 2011, are released to meet water delivery requirements under the 2007 interim shortage guidelines. Achieving sandbar objectives (to date, still unstated by resource managers) is also tied to several other resource objectives, such as recreational campsite areas, maintenance of cultural sites, including archeological sites, and riparian vegetation.

2) CONSERVATION OF NATIVE FISH & ENDANGERED HUMPBACK CHUB - While humpback chub and other native fish populations within the Colorado River Ecosystem (CRE) below the dam have expanded substantially in the last decade, most all of the chub production has occurred in association with spawning habitat in the Little Colorado River – what factor(s) limit reproduction of chub in other settings below the dam, such as the main channel of the CRE or other tributaries, such as Havasu Creek? Preliminary modeling results suggest that the majority of chub recruitment in the last 9 years may have been mostly attributable to environmental factors in the main channel of the Colorado River below the Little Colorado River, but if true, it is still not clear which factor(s) are most responsible for juvenile survival to adulthood in the main channel. The weight of evidence suggests that the warmer thermal regime of the river resulting from decreased storage in Lake Powell is the most plausible explanation, but the role of predation/competition by exotic trout or other fish (including natives) cannot be ruled out on the basis of existing information. Results from the Nearshore Ecology of humpback chub (studies of experimental fall steady flows in SEP-OCT) indicate that chub survival was robust to experimental flow treatments implemented in 2009-11,

and that juvenile growth rates were higher during periods when typical summer MLFF operations occurred than during fall steady flows.

3a) MANAGEMENT OF LEES FERRY RAINBOW TROUT FISHERY - Increased production of rainbow trout has been related to dam operations that are more stable than operations that occurred before dam re-operation occurred and also is positively influenced by spring-timed controlled flood experiments; data collected since 1990 suggest a high degree of instability in the Lees Ferry population of rainbow trout – do fall-timed controlled floods have a similar influence on the Lees Ferry rainbow trout fishery? Can a combination of flow and non-flow treatments be identified that will achieve management's desired future condition for the tailwater recreational fishery?

3b) CONTROL OF EXOTIC FISHES - Exotic rainbow and brown trout are known predators of native humpback chub juveniles and monitoring data indicate that the abundance of trout in the vicinity of the Little Colorado River confluence area has fluctuated significantly over the past decade with the majority of rainbow trout found in Marble and Grand Canyons very likely derived from the tailwater spawning reach of Glen Canyon (brown trout coming mostly from Bright Angel Creek spawning habitat) – can these exotic coldwater fishes be co-managed using dam operations and other treatments to meet objectives for native fish and humpback chub in Grand Canyon National Park, while also achieving desired future conditions for the recreational rainbow trout fishery in Glen Canyon National Recreation Area? Finally, the influence of global warming and climate change on the water supply of the Colorado River (storage in both Lakes Powell and Mead) may play a large role in the future conditions of all of the above-mentioned resources, but it is uncertain whether climate-change induced influences on downstream resources of the CRE will be positive, neutral or negative. These and other uncertainties are currently being discussed as part of the ongoing Long Term Experimental and Management Plan EIS, being conducted jointly by the Department of the Interior's Bureau of Reclamation and the National Park Service.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Book Chapter	Monitoring Policy Experiments to Resolve Uncertainty for Adaptive Colorado River Management in Glen Canyon National Recreation Area and Grand Canyon National Park, AZ, Southwestern USA	FY 2012	Fall 2012	Mid-2013	Melis et al. draft (in preparation)
Journal Article	Surprise Learning Opportunities in the Glen Canyon Adaptive Management Program	FY 2012	Manuscript revised in preparation for submission to *Ecology & Society* in January 2013	2013	Walters, Korman and Melis (in preparation)
~~Circular~~	~~Multi-chapter USGS Circular that updates resources status and trends, following the 2005 SCORE report, but with additional content on modeling development and causes and effect relationships between various experimental treatments and resource responses.~~		cancelled	none	There are no current plans to publish a follow-up USGS circular to the 2005 SCORE report at this time.

Gross Budget	$186,796				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$8,869	$0	$0	$8,869	$177,927
Overhead	$916	$0	$0	$916	
Net Spent	$7,953	$0	$0	$7,953	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$177,927 Carryover ($107,462 from FY11).

SUGGESTED FUTURE ASSESSMENT EFFORTS: GCDAMP DOI stakeholders indicated a desire to participate with GCMRC more frequently in the process of knowledge assessment in the future; perhaps on an annual basis with quarterly meetings. With experimental actions now underway (HFE Protocol and NNFC), this seems to be needed and might be easily integrated into the normal schedule of Technical and Adaptive Management Workgroup meetings throughout the year. There was also desire on the part of Federal managers to have as much updated information as possible made available via the GCMRC website and this has already been increased during 2012, with efforts to provide near real-time updates of sand inputs from the Paria River to support planning for ongoing high flow experiments. Having similar updates for fisheries and food web related monitoring data sets would also be very useful to those involved in assessments of experimental actions, as well as to the various planning teams. A critical need in the near future is to ensure that the long-term monitoring activities of the GCMRC are appropriately aligned with whatever information and reporting needs arise from the proposed 20-year long experimental plan resulting from the LTEMP EIS outcome.

T.S. Melis		DEC 20, 2012
Principal Investigator	Signature	Date

J.C. Schmidt		
Program Manager	Signature	Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**PLAN 12.P6.12 Monitoring and Research Plan for Potential High Flow Experimental Protocol**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	Helen Fairley, Paul Grams, David Ward, Theodore Kennedy, Bill Persons, David Topping, Bill Vernieu and Scott VanderKooi, USGS/GCMRC
Email	*jcschmidt@usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

During FY2012, GCMRC participated in efforts to evaluate triggering conditions and plan for research, monitoring, and events associated with the High Flow Experiment (HFE) conducted in November 2012. GCMRC staff served on both the Glen Canyon Technical Team and Leadership Team. GCMRC scientists evaluated sediment inputs and used hydrologic and sediment models to determine the duration and magnitude of a potential HFE. GCMRC calculated Colorado River sediment input and loads by direct measurement of river stage at the Paria River gage, measurement of river sediment concentration using laser and acoustic instruments, collection of water samples for direct measurement of suspended sediment concentration, application of a previously developed predictive model of sand and mud load based on measured Paria River discharge, and calibration and adjustment of model results based on laboratory analysis of water samples, and calculation of loads. This information helped refine the model predictions and resolve uncertainty and led to an HFE release that best incorporated all of the available knowledge. GCMRC also coordinated with Reclamation and the National Park Service to ensure that natural and cultural resources issues were thoroughly addressed. In addition, GCMRC developed plans to evaluate the responses of key resources to the HFE including sandbars, the aquatic foodbase, native and nonnative fishes, and riparian vegetation.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
OFR / Fact Sheet	Summary of monitoring results an relevant findings specific to each individual HFE				
Analysis / Synthesis	Results of the multi-year experiment				

BUDGET				
HFE	**FY Planned Gross Budget**	**FY Net Available Balance**	**FY Expenditures / Obligations**	**End of FY Available Balance**
NO HFE	$447, 709			
With HFE	$447,709			

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

Theodore S. Melis

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**SUP 12.S1.12 Logistics Base Costs**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	Carol Fritzinger
Email	*jcschmidt@usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

Goal(s):

- Provide cost effective, efficient and complete logistical support for all the GCMRC funded projects.

Outcome:

GCMRC logistical support was provided for 13 different projects within the physical, biological, and cultural programs. This entailed providing complete logistical support of 19 river trips launching at Lees Ferry, including 4 river trips for the Pueblo of Zuni, Southern Paiute Consortium, Hualapai, and Navajo Tribes and two science trips that were conducted jointly with Grand Canyon Youth to promote educational outreach. Logistical support was also provided for external projects on Lake Powell and Dinosaur National Monument. River trips were coordinated and combined as feasible to minimize the number of trips and reduce costs. Logistical support was also provided for research projects in the Glen Canyon and Diamond Creek reaches of the Colorado River for aquatic food base, fisheries, and cultural resource projects. Helicopter supported trips were conducted on the Little Colorado River for humpback chub research and translocation projects.

PRODUCTS/REPORTS				
Type	**Title**	**Date Expected**	**Date Delivered**	**Citations/Comments**
	NONE			

Gross Budget	$211,291				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$204,401	$0	$0	$204,401	$6,890
Overhead	$21,120	$0	$0	$21,120	
Net Spent	$183,281	$0	$0	$183,281	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$6,890 Carryover.

Carol Fritzinger

Principal Investigator | Signature | Date

Carol Fritzinger

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**SUP 12.S2.12 Survey Operations**

Program Manager (PM)	Grams, Paul	**Principal Investigator(s)** (PI)	Keith Kohl, USGS/GCMRC
Email	*pgrams@usgs.gov*		
Telephone	(928) 556-7207		

SUMMARY

The survey program supported GCMRC research and monitoring efforts with 79 instrument setups for channel mapping, and 122 GPS (Global Positioning System) also known as GNSS (Global Navigation Satellite System) setups for control efforts. The program also supplied equipment and manpower for sandbar monitoring, post-flood November 2012 field surveys, and cultural surveys in Glen Canyon. Office efforts concentrated on creating a database infrastructure to monitor all adjustments and changes of coordinates over the 12 years of the data collection.

A process has been developed to bring all geodetic data (GNSS post-processed vector solutions, least squares adjustment results, and coordinate progression) into ESRI GIS file geodatabases. This will provide a long term archive of all calculations and assist in the transformation away from proprietary survey software and toward more transparent data sharing avenues. The file geodatabases can easily be shared with contractors and cooperators.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Report	Annual report summarizing all work conducted	January 2013		January 2013	

Gross Budget	$232,701	(combined with SUP 12.S3.12)			
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$225,357	$6,386	$0	$231,743	$958
Overhead	$23,285	$186	$0	$23,471	
Net Spent	$202,072	$6,200	$0	$208,272	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$958 Carryover ($35,665 from FY11).

Keith Kohl

Principal Investigator | Signature | Date

Paul Grams

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**SUP 12.S3.12 Control Network**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	Keith Kohl
Email	jcschmidt@*usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

The Grand Canyon Control Network now includes nearly 9000 GPS (Global Positioning System) also known as GNSS (Global Navigation Satellite System) vectors and over 2500 conventional (ground-based total station) measurements. In 2012, GNSS observations were made to support goal 8, and these measurements have been combined with those from 2009 and 2011 channel mapping and are included in the latest release. These efforts have also supported cultural program surveys in Glen Canyon under Goal 9, Quadrennial Remote-Sensing Overflight and GIS Support for Integrated Analyses and Projects under Goal 12, and Integrated Quality of Water Monitoring and Modeling under Goal 7.

Efforts this year focused on readjustment to the new NAD83 realization- NAD83 (2011) Epoch 2010.00. This national adjustment was not complete until July 2012. The results were used to constrain the network, which required readjustment of all levels (CORS, Rim, River Primary, River Secondary, and River Tertiary). Vertical changes from the NAD83 datum (NSRS2007) are at 3 cm and horizontal changes are at 2.5 cm. Regional accuracies and coordinate confidence have been improved to sub centimeter for rim control and sub decimeter for river control.

In Fy 2012, 18 NAVD88 benchmarks were observed with GNSS and published in 2012 to help constrain the Geoid 12a model. These efforts increase the elevation accuracy of all spatial data in the region by improving the accuracy of the NAVD88 vertical datum.

In addition, 1299 km of regional historical (up to 100 years old) leveling lines containing 770 benchmark disk stations were formatted into LOCUS for inclusion in the NGS leveling campaign. The Leveling Online Computations User Service (LOCUS) is a Web utility developed by the National Geodetic Survey (NGS). The purpose of LOCUS is to simplify the office processing and adjustment of geodetic leveling, including, as a long-term goal, the submission of leveling projects to NGS for publication. This work will benefit GCMRC by allowing for more accurate gravity-based elevations using GNSS technologies.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Meeting	Work with GCMRC staff to identify realistic and achievable accuracies using existing technologies and theory Meeting with GCMRC scientists to establish accuracy requirements that are appropriate for supporting CRE scientific investigations	FY 2012	March 23, May 1, July 30, September 1		
Report	Comprehensive Survey Control Network report including collection an d processing methodologies, analysis and discussion of results	FY 2012		May 2013	Delays due to NAD83 National Adjustment delay and software baseline processing failure
Report	Annual report summarizing all work conducted under the control network project for FY 2012	January 2013		January 2013	

Gross Budget	$232,701	(combined with SUP 12.S2.12)			
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$225,357	$6,386	$0	$231,743	$958
Overhead	$23,285	$186	$0	$23,471	
Net Spent	$202,072	$6,200	$0	$208,272	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$958 Carryover ($35,665 from FY11).

The delay in the completion of the NAD83(2011) Epoch 2010.00 until July of 2012 has delayed the readjustment process for subsequent levels of control. *http://www.ngs.noaa.gov/web/surveys/NA2011/*

Trimble Geomatics Office was the software used for baseline processing and least squares adjustment. A malfunction in the Wave Processing Module has prohibited the software from processing GPS observations. A suitable replacement has not yet been found. *http://www.trimble.com/support_trl.asp?Nav=Collection-3651&pt=Trimble%20Geomatics%20Office%E2%84%A2*

Keith Kohl

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**ADM 12.A1.12 (A) Administrative Operations**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	John C. Schmidt, USGS/GCMRC
Email	jcschmidt@*usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

The purpose of this project is to provide administrative suppose for aspects of the operations of GCMRC. In FY 2012, this project provided funds for:

1. Monetary awards for GCMRC staff for outstanding work
2. Travel and other costs associated with candidate interviews and recruiting and hiring the new Chief of GCMRC
3. Miscellaneous postage (specifically FedEx) costs
4. Staff cell phone charges
5. The salary costs of the publications and outreach coordinator (who was contracted through Northern Arizona University).

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Report	Projection Report by GCMRC Budget Analyst	Aug AMWG Meeting			
Report	Actual expenditures for previous fiscal year	March AMWG meeting			GCMRC Publications and Outreach Coordinator will assist as needed with publications and provide responses to media inquiries

Gross Budget	$292,759				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$89,922	$73,620	$0	$163,542	$129,217
Overhead	$9,291	$2,144	$0	$11,435	
Net Spent	$80,631	$71,476	$0	$152,107	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$129,217 Carryover ($100,588 from unfilled Economist position).

John C. Schmidt

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date

Goal	Number and Title
12	**ADM 12.A1.12 (B) Administrative Operation – GSA Vehicle Costs**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	John C. Schmidt, USGS/GCMRC
Email	jcschmidt@*usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

The GCMRC has a total of 10 vehicles that GCMRC staff gets priority of. These vehicles are:
Ford F-250 Crew-cab 4x4 (G63-2194H)
Ford F-250 Crew-cab 4x4 (G63-2725L)
2008 Suburban (G63-0146G)
2008 White Ford Escape (G-61-0030G)
2009 Black Chevy Trailblazer (G62-1261H)
Chevy 1-ton pick-up (G-63-2060K)
HHR (I-433308)
Chevy Cheyenne (I-53856)
Chevy truck with tool box (I-153648)
Chevy Tahoe (I-431524)

	PRODUCTS/REPORTS				
Type	Title	Date Due	Date Delivered	Date Expected	Citations/Comments
	NONE				

Gross Budget	$78,254				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$64,260	$0	$0	$64,260	$3,994
Overhead	$6,640	$0	$0	$6,640	
Net Spent	$57,620	$0	$0	$57,620	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$3,994 Carryover.
$10,000 to ADM 12.A1.12_C.

John C. Schmidt

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date

Goal	Number and Title
12	**ADM 12.A1.12 (C) Administrative Operations – Interior Vehicle Costs**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	John C. Schmidt, USGS/GCMRC
Email	jcschmidt@*usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

The GCMRC provides many vehicles to transport employees and equipment.

	PRODUCTS/REPORTS				
Type	Title	Date Due	Date Delivered	Date Expected	Citations/Comments
	NONE				

Gross Budget	$48,657				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$58,048	$0	$0	$58,048	($9,391)
Overhead	$5,998	$0	$0	$5,998	
Net Spent	$52,050	$0	$0	$52,050	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$10,000 from ADM 12.A1.12_B.

John C. Schmidt

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**ADM 12.A2.12 Program Planning and Management**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	John C. Schmidt, USGS/GCMRC
Email	jcschmidt@*usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

This project provides salary support for the GCMRC Chief, Deputy Chief, and Program Managers. There were program managers in: Physical Science and Modeling, Data Acquisition System Analysis, Biology, Cultural Resources/Socioeconomics, and Logistics/Survey Operations. Costs incurred in the project also include miscellaneous travel and meeting attendance and some administrative costs.

All products are described as other projects.

	PRODUCTS/REPORTS				
Type	Title	Date Due	Date Delivered	Date Expected	Citations/Comments
	NONE				

Gross Budget	$1,189,456				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$857,732	$0	$0	$857,732	$187,035
Overhead	$88,624	$0	$0	$88,624	
Net Spent	$769,108	$0	$0	$769,108	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

John C. Schmidt

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**ADM 12.A3.12 AMWG/TWG Meeting Travel Funds**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	John C. Schmidt, USGS/GCMRC
Email	jcschmidt@*usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

Vehicles are readily available for all GCMRC staff to attend AMWG and TWG meetings. If no vehicles are available, staff can use their personal vehicles and get reimbursed for mileage. All federal employees have a credit card to make reservations for hotels. For food, employees use their own money and get per diem back once they've returned from the meetings.

	PRODUCTS/REPORTS				
Type	Title	Date Due	Date Delivered	Date Expected	Citations/Comments
	NONE				

Gross Budget	$30,514				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$8,418	$0	$0	$8,418	$22,096
Overhead	$870	$0	$0	$870	
Net Spent	$7,548	$0	$0	$7,548	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$22,096 Carryover.

John C. Schmidt

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**ADM 12.A4.12 (A) Independent Reviews**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	John C. Schmidt, USGS/GCMRC
Email	jcschmidt@*usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

Paid for travel and stipends for PEP panel to come out and review Aquatic Biology proposals.

	PRODUCTS/REPORTS				
Type	Title	Date Due	Date Delivered	Date Expected	Citations/Comments
	NONE				

Gross Budget	$46,228				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$16,848	$0	$0	$16,848	$29,380
Overhead	$1,741	$0	$0	$1,741	
Net Spent	$15,107	$0	$0	$15,107	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$29,380 Carryover ($27,919 from FY11).

John C. Schmidt

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date

Goal	Number and Title
12	**ADM 12.A4.12 (B) Coordination and Review of Services Provided by Science Advisors**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	Lawrence D. Garrett, Principal M3 Research and Executive Coordinator of the Science Advisors
Email	jcschmidt@*usgs.gov*		
Telephone	(928) 556-7364		

SUMMARY

The GCDAMP Science Advisor Program is established to provide service to all AMP entities. Its focus is to conduct reviews and provide science service to GCMRC and technical and science service to the TWG, AMWG and Office of the Asst. Sec. of Interior. Review activities involve formal written reviews and related science/technical service as verbal reports at meetings, in conference calls, etc. Consulting service to TWG, AMWG and the Asst. Sec. can involve technical memos and/or reports, conference calls, meeting presentations, etc. In 2012 the SAs provided reviews on the 2012 MRP, Draft 2013/14 program budget, 2013/14 BWP and Knowledge Assessment. In service it provided support to the TWG, AMWG and Asst. Sec. on issues in adaptive management, core monitoring planning, recreation non-market valuation, hydropower market and non-market valuation, TWG Ad Hoc meeting management (SEAHG), TWG meeting contributions, CMP planning and EIS planning. Due to increased AMP focus on the EIS/LTEMP, planned reviews of several GCMRC reports are delayed to 2013/2014. Budget savings from these reviews in 2012 are proposed to be carried over to 2013 to accommodate the delayed reviews and service to the TWG and AMWG.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Participation	Participation in Annual Program Review meeting and HFE Synthesis to provide Science Advisor input on science direction	FY 2012	January, 2012		Attend Annual Program Review meeting and HFE Synthesis to provide Science Advisor Annual Report of 2011 activities and projected activities for 2012
Assessment	Work with GCMRC Chief, leadership team, and Senior Ecologist to assess opportunities for greater integration and improve overall system assessments of biology, sediment and socio-economic programs	FY 2012	Ongoing		Continued interactions with TWG, AMWG, GCMRC scientists in reviews, meetings and discussions regarding opportunities and approaches for science and science and management program integration
Participation	Provide input to TWG/Chair and members on GCMRC and TWG programs	January FY 2012	Ongoing		Provided updates on SA activities on DSS review, SEAHG programs and input on GCMRC programs from past reviews
Participation	Briefing information and documents to SAs on program efforts by GCMRC, AMWG and TWG in areas of biology, sediment and socio-economics	FY 2012	Ongoing		Continued interaction with SAs on proposed new programs utilizing DSS, market and non-market assessment approaches, ecosystem assessments, sediment assessments.
Reporting	Provide a draft report to TWG Chair on potential use of decision support systems by TWG	March 2012	November 2012		Complete TWG draft and final report evaluating potential decision support systems that could be utilized in evaluating differing monitoring alternatives for the AMP
Assessment	Provide outline to TWG members (CREDA, WAPA, Upper Colorado Water Users) regarding non-market valuation approaches	April 2012	April 2012		Responded to request for outline of potential approach for non-market valuation of energy resources
Participation	Attend BOR/NPS EIS/LTEMP meeting	April 2012	April 2012		Attended BOR/NPS GCD EIS meeting. Provided input from SAs reviews and perspectives on various proposals. Participated in workshops. Meeting with BOR/NPS to offer SA support to EIS/LTEMP process with reviews and technical assessments
Review	TWG request for SA review of MRP program overview and budget	April 2012	April 2012		Provided review of budget proposals for various GCMRC and AMP programs as well as assessment of suitability of proposed budgets. Recommended some shifts in budgets to provide greater efficiency and effectiveness. Clarified that proposed SA budget reduction of approximately 30% would severely limit capability of reviews and service.
Participation	Attend TWG spring meeting to present SA budget review and provide consultation	April 2012	April 2012		Presentation of preliminary review of draft 2013/14 budget and discussions. Met with

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
					members of TWG and GCMRC to discuss various activities, i.e. SEAHG, CMP, etc.
Assessment	Assess with SAs past reviews of proposed SE and fish programs and SA program proposals, and new AMP direction in DFCs	Ongoing	Ongoing		Briefing papers to SAs on new program and policy directions that are critical to the 2013/14 draft BWP
Reporting	GCMRC Chief request for SA budget report on expenditures over 2006-2012 and projected expenditures 2013/2014	June 2012	June 2012		Provided formal report evaluating past SA budget element funding, outcomes and projected funding needs for 2013/14.
Participation	Conference calls of TWG, AMWG and/or subcommittees, i.e. CMP, BAHG, SEAHG, etc.	Ongoing	Ongoing		Attend and participate in conference calls as requested by TWG Chair, AMWG, SAs etc. Broad range of CCDAMP topics discussed related to technical, science and policy areas.
Reporting	Requested draft prospectus on non-market valuation of water and hydropower resources by TWG members	June 2012	June 2012		Group of TWG members (Sponsors) including CREDA, Upper Colorado Water Users and WAPA request draft prospectus that evaluates potential approaches to non-market valuation of water and hydropower energy resources. Approach is to generally follow SA recommendation for SE research in review of 2010/11 MRP.
Participation	Attend summer TWG mtg. and present SA review of 2013/14 Biannual Program and Budget	June 2012	June 2012		Attend TWG mtg. and present SA review of 2013/14 GCDAMP Science Program and Budget. Also participate in various GCMRC and TWG discussions of SE, CMP,
SA Board	Interview and screening of potential candidates for systems ecology/aquatic ecology, cultural resources positions	July/August 2012	Ongoing		The AMWG has proposed that a cultural resources position be added to the SA group. In addition the SA EC is proposing a change in the systems ecology position. Several specialists will be screened.
Assessment	Work Tasks/Work Plan elements for conducting non-market valuation of water resources/hydropower	September 2012	September 2012		Provided review input to CREDA/WAPA/Upper Colorado River representatives on proposed general work plan elements for non-market valuation
Review	Review of elements of 2012 Knowledge Assessment	Oct./Nov. 2012	November 2012		Provided review report on sections of 2012 Knowledge Assessment and summary of SE information needs for hydropower and water resources

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Participation	Development of SEAHG Workshop for fall TWG mtg.	October 2012	October 2012		Participated in discussions of science and technical issues. Presented SEAHG workshop on socio-economic program planning
Participation	Attendance of AMWG meetings and conference calls	Ongoing	Ongoing		Participate in 2012 AMWG meetings and provide input on several program areas.
Participation	Attendance of DOI HFE program and TWG winter meeting	11/2012 1/2013	1/2013		Attend DOI program for HFE event and mtgs. with NPS. Participate in winter TWG meeting and GCMRC annual reporting mtg. Provide presentation on SEAHG activities.

Gross Budget	$216,598				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$216,598	$0	$0	$216,598	$0
Overhead	$22,380	$0	$0	$22,380	
Net Spent	$194,218	$0	$0	$194,218	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

The SA Exec. Coordinator and GCMRC projected several reviews of GCMRC reports by the SAs that were not completed in 2012. Therefore, expected review expenditures were lower than projected. In addition, the SA program anticipated assignments related to the LTEMP programs that were not directed to the SAs. Additional support was provided in consulting services to both AMWG and TWG members on several projects but the costs were lower than the costs of anticipated reviews. This will result in the SA program encumbering approximately $149,000.00 of its allocated $189,722 2012 annual budget. Due to shortfalls in budgets and expanded GCMRC programs, the original proposed $200,000 FY 2013 SA program budget has been reduced to $138,000.00. It is requested that the projected savings in the 2012 budget of approximately $40,000 be transferred to the 2013 budget to partially offset the shortfall and permit sufficient budget to accommodate delayed reviews from GCMRC and service needs from the TWG and AMWG.

Lawrence D. Garrett

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date

FY 2012 Project Report for the Glen Canyon Dam Adaptive Management Program

Goal	Number and Title
12	**ADM 12.A5.12 GCMRC Component of SBSC Computer Systems Support**

Program Manager (PM)	John C. Schmidt	**Principal Investigator(s)** (PI)	John C. Schmidt
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SUMMARY

SBSC Computer Systems Support maintained timeliness of installs for hardware and software as required by arrangement and/or customers and by following BWTST, BUTST, DOI, and USGS best practices and policies. >95% (support desk metric) of all Hardware and Software requests made were completed within three business days when software or hardware was available. If hardware or software was not available, purchases were set in motion to resolve request by deadline or as soon as feasible.

The GCMRC website is in full production capacity. Mapping, chart creation, and photo gallery are accessible to public. The GCMRC Library is available to the public with non-508 compliant materials available upon request or on the internally accessible site. Ensuring and updating the accuracy of each library record is ongoing.

All systems were backed up according to local policies with no incidences where customer's data was non-recoverable due to backup failures. No incidence of backup failure occurred.

SBSC Computer Systems Support team adhered to security requirements (managerial, operational, and technical) in accordance with the IT security plan and ensured adequate IT security funding was planned in support of the Department of the Interior's strategic goal to ensure management excellence in e-government and information technology management. Also, with regard to timeliness of remediation of vulnerabilities and quality of contingency planning. Implementation of IBM BigFix now allows for real time monitoring of system security vulnerabilities. The new Assessment and Authorization has started for this fiscal year. This includes the review of and quality of risk assessments and timeliness of implementing and correcting Plans of Action and Milestones.

Other accomplishments include the advisement, planning, documentation and execution of storage needs for future growth. As well as working closely with staff, identifying benefits of one system per user. Converting laptop and desktop users to one system—only a laptop with docking station. Thus, effectively reducing our overhead regarding purchasing and supporting unnecessary equipment which aligns SBSC with the DIET DOI strategy. Reviewed and reconfigured to ensure all data is being backed up to tape. Consolidated application servers to reduce costs attributed with End of Life Cycle replacements, energy consumption, maintenance, space and time needed to build and convert server.

	PRODUCTS/REPORTS				
Type	**Title**	**Date Due**	**Date Delivered**	**Date Expected**	**Citations/Comments**
Website	Develop and maintain a comprehensive and fully functional web site	FY 2012	FY 2012	Ongoing	
Library	Work with DASA program to ensure and support a comprehensive and fully functional library	FY 2012	FY 2012	Ongoing	
Computer	Full functional and integrated computing environment	FY 2012	FY 2012	Ongoing	

Gross Budget	$185,365				
	GCMRC	Cooperative Agreements	Sub-allocations to other USGS Centers	Total	Carryover
Gross Spent	$167,253	$0	$0	$167,253	$18,112
Overhead	$17,281	$0	$0	$17,281	
Net Spent	$149,972	$0	$0	$149,972	

COMMENTS *(Discuss anomalies in the budget; expected changes; anticipated carryover; etc.)*

$18,112 Carryover ($2,897 from FY11).

John C. Schmidt

Principal Investigator | Signature | Date

John C. Schmidt

Program Manager | Signature | Date