

GCMRC Updates

- **2009 Temperature and Sediment Conditions**

Mainstem river temperatures peaked at about 18° C at Diamond Creek in late July. Temperatures at this location have been similar for the past 4 years, which is lower than the peak temperatures of approximately 19° to 20° C reached in the 2000-2005 period. Mainstem temperature at Lees Ferry is currently about 11° C and will likely peak at approximately 13° C in October or November. This is also similar to the past 4 years and lower than the 2006 peak temperature at Lees Ferry of 16° C.

Mass-balance sand budgets have been computed for the period beginning immediately after the November 2004 high flow extending through April 2009 for 5 mainstem reaches: (1) Upper Marble Canyon (0-30 mile), (2) Lower Marble Canyon (30-61 mile), (3) Eastern Grand Canyon (61-87 mile), (4) Central Grand Canyon (87-166 mile), and (5) Western Grand Canyon (166-225 mile). These computations show that the sand budget leading up to the 2008 high flow was positive (net sand accumulation) in all five reaches and was still positive following the high flow. Thus, there was more sand in storage following the 2008 high flow than following the 2004 high flow. Between the 2008 high flow and April 2009, net sand export occurred in four out of the five mainstem reaches. Tributary sediment inputs were small in 2008 and, to date, have been negligible in 2009. Multiple moderate tributary input events or a single large input would be required to move the system to a condition of significant positive sand mass balance.

The high-resolution sediment-transport data used to construct these sediment budgets is posted on the GCMRC website: http://www.gcmrc.gov/products/other_data/gcmrc.aspx.

- **Integrated flow, temperature, and sediment modeling update**

Wright and others have completed a new “shifting rating curve” model for simulating the fate of tributary sand inputs in the mainstem Colorado River below Glen Canyon Dam. This model is described in a paper that was submitted to the journal *Water Resources Research* in July 2009. The modeling team is prepared to begin using this model to evaluate and compare predicted sand export and accumulation for alternative operating scenarios. This work will require cooperation with TWG members in selecting and providing hourly input hydrographs. The following generalized scenarios have been proposed for evaluation: (1) fluctuating daily flows with variable monthly release volume, (2) steady daily flows with variable monthly release volume, (3) fluctuating daily flows with steady monthly release volume, (4) steady daily flows with steady monthly release volume. We expect that each of these scenarios will be evaluated for a range of annual release volumes, e.g. the 2009 actual release volume, 2010 projected most probable release volume, etc.

- **HFE Reporting Update, Schedule for Completion**

Most of the 2008 HFE reports are currently being drafted by GCMRC scientists and cooperators. A handout will be distributed at the September TWG meeting that lists the working titles of the various reports along with the lead authors.

Several of the reports have already been completed and are through USGS peer review (eddy modeling and data related to Aeolian sand transport, as well as rainbow trout movements). Summaries of the HFE reports shall be included in the FY 2009 annual reports that the GCMRC intends to develop this fall for all of the 2009 monitoring and research projects. The final results of the 2008 HFE projects will be presented during the week of January 11, 2010 at the Annual reporting meeting.

Synthesis of all HFE results from the 1996, 2004 and 2008 testing is beginning in fall 2009 and is scheduled to be completed in 2010. The HFE synthesis team is being led by Schmidt and Valdez. The synthesis of HFE results will provide information intended to inform HFE planning in FY 2011 relative to longer term sediment and flow testing.

- **Senior Ecologist Update**

"AQUATIC SUB-MODEL – Under guidance of the senior ecologist (Walters), GCMRC scientists and science cooperators have developed a preliminary ecosystem model using Ecopath/Ecosim software, for evaluation of impacts of foodbase changes related to exotic invasions, changes in water quality and nutrient loading from Lake Powell, and control of exotic predators like rainbow trout. Many of the inputs for this model remain highly uncertain, and a workshop among cooperating scientists is scheduled for March 2010 to refine them. We will attempt to provide clear and testable alternative hypotheses for the recent rainbow trout decline in the Lees Ferry reach, and to incorporate data from NSE in assessment of food web changes in the CR reach near the LCR. A second workshop in April 2010 is proposed by GCMRC with the senior ecologist and interested stakeholders to review the outcome of the aquatics modeling meeting in March.

In addition and also under the guidance of the senior ecologist, GCMRC has developed an Individual Based Model (IBM) for exploring population dynamics of humpback chub in more detail, particularly in relation to possible sample biases in the PIT tagging program and in relation to recent evidence of increasing HBC rearing in the CR mainstem downstream from the LCR. The IBM has shown that there is potentially a severe retrospective biases in ASMR reconstructions of HBC recruitment rates, and that the best estimate of annual recruitment comes from the ASMR estimation done one year after the recruitment occurs. Correcting this problem has demonstrated more clearly that there has been a relatively sudden and large increase in HBC recruitment since 2000, but probably beginning before the period of natural warming that started in 2003-04. In conjunction with estimates of HBC juvenile abundance in the NSE program, it now appears that a substantial proportion (up to 30%) of the net recruitment to the HBC adult population may soon be coming from mainstem rearing.

PHYSICAL SUB-MODEL - Progress on upgrading the physical submodel of the Grand Canyon ecosystem model has been made in FY 2009. Wright and others have completed a new “shifting rating curve” model for simulating the fate of tributary sand inputs in the mainstem Colorado River below Glen Canyon Dam. This model is described in a paper that was submitted to the journal Water Resources Research in July 2009. Korman and Wright are also collaborating, as part of the ecosystem and integrated modeling projects,

on updating the hydrology data for use as dam operations input that drive future simulations for sand transport using the new shifting rating curve model.”

- **FY2010 Planned Reports for GCMRC and USBR**

During FY 2010, the GCMRC proposes a large number of USGS reports on a wide variety of monitoring and research topics; including the several reports related to the 2008 High Flow Experiment.

Physical Science and Modeling Program - 15 technical reports (journal articles, Open File and Scientific Investigation Reports) and Fact Sheets related to quality of water (turbidity) and sediment sampling methods, as well as sediment transport data and fate of backwaters from the 2008 HFE. Synthesis of all physical results from the past three HFEs is also scheduled for 2010.

Sociocultural Program - Three USGS technical reports and a Fact Sheet are anticipated on topics related to cultural resources (including virtual shorelines).

DASA Program - Two USGS Data Series Reports related to digital remotely sensed imagery and one Open File Report on mapping of shoreline habitats from remotely sensed imagery are anticipated from the DASA Program.

Biology Program - Three USGS reports are planned. One on the Low Summer Steady Flow synthesis, another on the food web research project and a third on the effects of water temperature. A fourth report on vegetation synthesis may also be produced in FY 2010.

As many as 25 USGS reports are proposed during 2010, making it the most ambitious publication year to date. Owing to the large number of reports, the GCMRC management team is working with the editorial staff to prioritize the order in which the reports are processed through the USGS Fundamental Science Practices for peer review and delivery to the Enterprise Publishing Network within the western region of USGS during the year. Highest priority in the first quarter of the fiscal year will be on getting the 2008 HFE reports completed by January 2010

- **November Workshop: Economics and CMP Planning Discussion**

CMP Review

The draft General Core Monitoring Plan was reviewed by the Science Advisors during August 2009. The GCMRC staff is now preparing a revision of the draft plan and responses to the SA’s review comments for distribution to the TWG on October 16th. The comment period for TWG is proposed to be one month with comments being returned on the comment table by November 13th.

The CMP workshop will be convened on December 1st in Phoenix at the Arizona Water District Office in conjunction with the socioeconomic workshop on Dec.2-3. This will give GCMRC about 10 days to review TWG comments and come to the workshop with

preliminary responses and proposals for further revision of the general plan. The objectives of the CMP workshop include:

- 1) discuss the elements of the monitoring plan and development of the draft relative to the steps outlined in the MRP;
- 2) discuss the Science Advisors' review of the draft and the GCMRC responses;
- 3) review the current status of the various PEPs related to the proposed projects and timeline for implementation;
- 4) discuss the GCMRC's responses to TWG comments on the draft general plan; and
- 5) seek additional input from TWG on next steps toward implementation of core monitoring in future workplans/budgets (recommendation to AMWG for their consideration).

Socioeconomic Workshop

The socioeconomic workshop will occur immediately following the CMP review on December 2 and the morning of December 3.

As described in the prospectus (attached), there will be three parts to the socioeconomic workshop: Part I on the morning of Dec. 2 will involve several presentations about past and recent socioeconomic studies by various individuals who were involved with those efforts. On the afternoon of Dec. 2 there will be a facilitated discussion with TWG members about their socioeconomic information needs and priorities. Several external economic experts have been invited to listen in and observe the proceedings on Dec. 2, and at the end of Part 2 they will try to clarify what they have heard. On the morning of Dec. 3 they will present to TWG some preliminary findings and recommendations on how the TWG can most effectively proceed with developing highest priority information needs for the program. We anticipate that the socioeconomic workshop will conclude by noon on Dec. 3.

- **Biological Update**

Fish PEP Implementation

Agency personnel will be reviewing their catch data this fall and winter to evaluate the change in monitoring focus recommended by the 2009 Protocol Evaluation Panel for Grand Canyon Fishes. The PEP's final report should be delivered in October. Based on the initial summary of recommendations, the following analyses are anticipated:

1. Mainstem fish monitoring results with one and two trips (AZGFD)
2. Closed population estimate of humpback chub using only spring and only fall capture data (USFWS)
3. ASMR model runs using only spring and only fall capture data (GCMRC)

The results of these analyses will be subjected to peer review. Peer-reviewed results will be distributed to TWG for discussion in a meeting to review the Grand Canyon fish sampling program for fiscal year 2011 (FY 2010 is similar to FY 09 in most cases). The 2010-11 work plan describes fish monitoring for these two years in greater detail. A meeting with TWG to review the implications of the analyses for FY 11 is anticipated for February 2010.

Trout Natal Origins

GCMRC personnel have drafted an outline of what a manuscript addressing this subject would include. The outline is being reviewed with outside reviewers and the Senior Ecologist. At this time we expect that the manuscript will include a literature review, documentation of known capture locations and spawning areas, any genetic information that may be available, and a discussion of the potential hypotheses regarding where these fish may be spawned and how those hypotheses can best be supported or refuted. We expect to determine if additional monitoring is needed to answer questions about rainbow and brown trout spawning areas based on analysis of possible alternative spawning locations.

Trout Removal Evaluation

AZGFD removed trout from the LCR reach in May 2009. Numbers of rainbow trout captured were: 1873 removed (2075 captured and released in control reach). Other non-native species were removed and their numbers were: 33 bullhead species, 20 brown trout, 1 channel catfish, 55 common carp, 566 fathead minnow, 1 plains killifish, 1 red shiner. These data have been used to support modeling conducted by Coggins that estimates levels of effort necessary to keep the LCR reach rainbow trout population at the target 10% level (LGC graph). These estimates of effort are being used in a revision of the Nonnative Control Plan. Amount of effort needed to keep the LCR population below 10% is dependent on the immigration rate into the reach.

LSSF Update

A summary report is being created that is intended to further our understanding about the relationships between physical habitat parameters and biological responses under steady flow releases from Glen Canyon Dam. From the period of April through September 2000, a complex hydrograph was executed to test hypotheses about the relationships between river volumes, water temperature and native fish spawning and recruitment requirements. The experimental hydrograph was developed in response to a recommended and prudent alternative issued by the Fish and Wildlife Service with the 1994 Biological Opinion associated with the operations of Glen Canyon Dam. The experimental flows were to be implemented during minimum delivery water years (WY). WY2000 was the first 8.23 m.a.f. year since the signing of the Record of Decision for Glen Canyon Dam (DOI, 1996). The decision to implement the experimental flows was made in February and March of 2000. It was the first experiment since the 1996 Beach Habitat Building Flow (Webb and others, 1999) that releases from Glen Canyon Dam were controlled for a period of time greater than a week for experimental purposes.

The extended time frame for the experiment was designed to illicit a biological response from long-lived native fishes by spanning timeframes of spawning, emergence and growth of young of year fishes. Data collection with respect to native and nonnative fish response was focused on the steady flow period (June – September) to measure the growth and distribution of the rainbow trout in Glen Canyon and the fish community downstream of Lees Ferry. The steady flow period with discharges of 8,000 cfs was hypothesized to provide warmer mainstem and shoreline water as well as stabilize habitat. Colder temperatures and destabilized shoreline habitats associated with operations are identified as factors contributing to recruitment decline in humpback chub and other native fishes (Minckley, 1991).

Mainstem water temperatures near the Little Colorado River in 2000 were not significantly different from previous fluctuating flow years releasing similar volumes, while water temperatures in Western Grand Canyon were warmer than in previous years. Wright and others (2008) demonstrated that initial release temperatures influence the amount of possible warming in the upper portion of the Colorado River, while volume and ambient temperatures affect warming in the western portions of Grand Canyon. Measurement of shoreline temperatures near the confluence of the Little Colorado River indicate surface temperature reached optimum temperatures for young of year fish growth, but the depth of warming along the shoreline is unknown. Temperature probes in shoreline habitats indicate that surface temperatures quickly returned to mainstem temperature values when the sun was obscured or following sunset.

Fish growth data from 2000 seining efforts did not show that the combination of steady shorelines and warm water resulted in changes in length frequencies compared with previous years. The lack of an observable growth response in fish even in the western portions of Grand Canyon, where waters were warmer longer, may be attributable to three alternative hypotheses: a. Multiple spawning events adding new recruits to sampling sites (Trammell and others, 2002) and kept length frequencies stagnant, b. An ontogenetic shift by larger fishes out of backwater-type environments and into other environments that are less susceptible to seining nets or other gear types (Trammell and others, 2002) resulted in no changes in length frequencies, or c. Predation of young fish by non-natives resulted in little changes in length frequency. An updated abundance estimates for humpback chub (Coggins and Walters, 2009) suggests that recruitment strength began increasing in the mid to late 1990s, and that 1998-2000 year cohort may have benefited from the steady flow experiment which may support the first two hypotheses. However the authors caution against such a post-hoc evaluation. They indicate a lack of confidence that the recruitment time-series are completely uncontaminated by ageing error and subsequent retrospective bias as reasons for having only limited confidence in this explanation. Alternatively, evaluation of 2000 data with historic data and data collected since 2000 for native and nonnative fishes around the LCR confluence may lend support the third hypotheses, fish predation, regarding a lack of growth response by young fishes.

Other resource responses to the hydrograph and the interactions of resources are included in the summary report. Notable among these are the response of tamarisk to newly available open habitats associated with the steady flow period and following a habitat maintenance flow that redistributed sediment (Porter and Kearsley, 2002, Schmidt and others, 2007), the tradeoff responses the reduced flows had on camping and rafting experiences (Roberts and Bieri, 2001, Jonas and Stewart, 2002), and the economic effect of the experiment on the local economy and the broader electrical user group (Hjerpe and Kim, 2002, Palmer and others, 2004). A timeline for completion of the report is outlined in the attached table. In general, stronger conclusions regarding the experiment on fishes and other resources could have been made if more time had been available in the planning effort, and if long-term monitoring of resources had been in place prior to the experiment to provide more baseline information.

Schedule of LSSF Reporting	
Draft completion	November 1, 2009
Draft review (USGS review process)	November – January 2010
Report to TWG during Annual Reporting Mtg	January 2010
Revision and submit for policy review USGS	February 2010
Submit to USGS publishing OFR	March 2010
Dissemination to AMP	June/July 2010

Literature Cited (LSSF report)

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Wright, S.A., Anderson, C.R. and Voichick, N. 2008. A simplified water temperature model for the Colorado River below Glen Canyon Dam. River Research and Applications. DOI: 10.1002/rra.1179.