Glen Canyon Dam Adaptive Management Work Group
Agenda Item Information
September 9-10, 2008

Agenda Item

Research Updates, Grand Canyon Monitoring and Research Center (GCMRC)

1. Is there enough sand?
2. Completion of the HEC-RAS Model and New Report on Suspended-Sand Transport
3. LSSF Workshop Update
4. Trout diet analysis 2003 and 2004
5. Short-term non-native fish control plan
6. Q&A

Action Requested

√ Information item only; we will answer questions but no action is requested.

Presenters

Matthew Andersen, Biological Program Manager, Grand Canyon Monitoring and Research Center
Paul Grams, Physical and Modeling Program Manager, Grand Canyon Monitoring and Research Center
Kara Hilwig, Fish Biologist, Grand Canyon Monitoring and Research Center
Scott Wright, Hydrologist, California Water Science Center, U.S. Geological Survey

Previous Action Taken

N/A

Relevant Science

N/A

Background Information

1. Is there enough sand? - Scott Wright, USGS

This new *GSA Today* article will be distributed at the AMWG meeting.

Abstract: Large dams have the potential to dramatically alter the flow regime, geomorphology, and aquatic ecosystem of downstream river reaches. Development of flow release regimes in order to meet multiple objectives is a challenge facing dam operators, resource managers, and scientists. Herein, we review previous work and present new analyses related to the effects of Glen Canyon Dam on the downstream reach of the Colorado River in Marble and Grand Canyons. The dam traps the entire incoming sediment load in Lake Powell and modulates the hydrologic regime by, for example, eliminating spring snowmelt floods, resulting in changes in the geomorphology of the river downstream. The primary geomorphic impact has been the erosion of sandbars along the banks of the river. Recognition of this impact has led to many scientific studies and a variety of experimental operations of Glen Canyon Dam with the goal of rebuilding the eroding sandbars. These efforts

have thus far been generally unsuccessful and the question remains as to whether or not the dam can be operated such that sandbars can be rebuilt and maintained over extended periods with the existing sediment supply. We attempt to answer this question by evaluating a dam operation that may be considered a "best-case scenario" for rebuilding and maintaining eroded sandbars. Our analysis suggests that this best-case scenario may indeed have viability for rebuilding sandbars, and that the initial rate at which sandbars could be rebuilt is comparable to the rate at which sandbars have been eroded since dam construction. The question remains open as to the viability of operations that deviate from the best-case scenario that we have defined.

2a. Completion of the HEC-RAS Model – Overview of results by Paul Grams
This article was distributed to AMWG members on May 19, 2008.

USGS Scientific Investigations Report 2008-5075, "Modeling Water-Surface Elevations and Virtual Shorelines for the Colorado River in Grand Canyon, Arizona"

Abstract: Using widely-available software intended for modeling rivers, a new one-dimensional hydraulic model was developed for the Colorado River through Grand Canyon from Lees Ferry to Diamond Creek. Solving one-dimensional equations of energy and continuity, the model predicts stage for a known steady-state discharge at specific locations, or cross sections, along the river corridor. This model uses 2,680 cross sections built with high-resolution digital topography of ground locations away from the river flowing at a discharge of 227 m^3/s; synthetic bathymetry was created for topography submerged below the 227 m^3/s water surface. The synthetic bathymetry was created by adjusting the water depth at each cross section up or down until the model's predicted water-surface elevation closely matched a known water surface. This approach is unorthodox and offers a technique to construct one-dimensional hydraulic models of bedrock-controlled rivers where bathymetric data have not been collected. An analysis of this modeling approach shows that while effective in enabling a useful model, the synthetic bathymetry can differ from the actual bathymetry. The known water-surface profile was measured using elevation data collected in 2000 and 2002, and the model can simulate discharges up to 5,900 m^3/s. In addition to the hydraulic model, GIS-based techniques were used to estimate virtual shorelines and construct inundation maps. The error of the hydraulic model in predicting stage is within 0.4 m for discharges less than 1,300 m^3/s. Between 1,300-2,500 m^3/s, the model accuracy is about 1.0 m, and for discharges between 2,500-5,900 m^3/s, the model accuracy is on the order of 1.5 m. In the absence of large floods on the flow-regulated Colorado River in Grand Canyon, the new hydraulic model and the accompanying inundation maps are a useful resource for researchers interested in water depths, shorelines, and stage-discharge curves for flows within the river corridor with 2002 topographic conditions.

2b - New Report on Suspended-Sand Transport – Overview of Results by Paul Grams
Notice of this new article was distributed to AMWG members in April 2008.

Sedimentary Geology article, "Coupled changes in sand grain size and sand transport driven bychanges in the upstream supply of sand in the Colorado River: Relative importance of changes in bed-sand grain size and bed-sand area" by D.J. Topping, D.M. Rubin and T.S. Melis.

Abstract: Sand transport in the Colorado River in Marble and Grand canyons was naturally limited by the upstream supply of sand. Prior to the 1963 closure of Glen Canyon Dam, the river exhibited the following four effects of sand supply limitation: (1) hysteresis in sediment concentration, (2)

hysteresis in sediment grain size coupled to the hysteresis in sediment concentration, (3) production of inversely graded flood deposits, and (4) development or modification of a lag between the time of a flood peak and the time of either maximum or minimum (depending on reach geometry) bed elevation. Construction and operation of the dam has enhanced the degree to which the first two of these four effects are evident, and has not affected the degree to which the last two effects of sand supply limitation are evident in the Colorado River in Marble and Grand canyons. The first three of the effects involve coupled changes in suspended-sand concentration and grain size that are controlled by changes in the upstream supply of sand.

During tributary floods, sand on the bed of the Colorado River fines; this causes the suspended sand to fine and the suspended-sand concentration to increase, even when the discharge of water remains constant. Subsequently, the bed is winnowed of finer sand, the suspended sand coarsens, and the suspended-sand concentration decreases independently of discharge. Also associated with these changes in sand supply are changes in the fraction of the bed that is covered by sand. Thus, suspended-sand concentration in the Colorado River is likely regulated by both changes in the bed-sand grain size and changes in the bed-sand area. A physically based flow and suspended-sediment transport model is developed, tested, and applied to data from the Colorado River to evaluate the relative importance of changes in the bed-sand grain size and changes in the bed-sand area in regulating suspended-sand concentration. Although the model was developed using approximations for steady, uniform flow, and other simplifications that are not met in the Colorado River, the results nevertheless support the idea that changes in bed-sand grain size are much more important than changes in bed-sand area in regulating the concentration of suspended sand.

3. LSSF Workshop update – Matthew Andersen

In 2000, experimental flow volumes were released from Glen Canyon Dam. One of the features of these experimental releases was the low summer steady flows, so the experiment is usually called the LSSF. A number of scientific studies were conducted in association with these experimental flows, but those studies have not been compiled in one or a few volumes to date. At their August 2007 meeting, the AMWG asked GCMRC to proceed with a synthesis of the scientific experiments conducted in association with the 2000 LSSF. GCMRC has compiled the original study plan and the recommendations from associated studies into a synopsis document. This synopsis has been made available to participants in a workshop in Flagstaff held August 12-14, 2008, after this AIF is sent to the AMWG but before the AMWG meeting. AMWG members will be given a brief summary on the workshop, which was designed to bring together scientists and managers to discuss the results and recommendations, and how those might most usefully be synthesized to advise future work. Because of scheduling considerations, the August workshop focused on biological and physical sciences, and a second workshop will be conducted, likely in October, that will focus on social science studies and issues associated with the 2000 LSSF.

4. Trout diet analysis 2003 and 2004 – Matthew Andersen

During 2003 and 2004, GCMRC led an effort to remove nonnative fishes from the Little Colorado reach of the mainstem Colorado River. The gear used for this work, electroshocking, was most effective at removing trout species, so rainbow and brown trout dominated the catch of this project. The stomachs of the trout were removed and contents were analyzed. Analysis was stratified spatially and temporally. Results indicate that brown trout are more piscivorous (fish-eating) than are rainbow trout but rainbow trout were much more common, and so more humpback chub and other native fish were consumed by rainbow trout than by brown trout. Downstream of the Little Colorado River confluence, where turbidity increases, rainbow trout appeared to forage more

actively, eating more fish than they did upstream from the tributary mouth. The results support standard notions of the relative piscivory of rainbow and brown trout. The results also support the conclusion of the April 2007 workshop that, when present in large numbers, rainbow trout below the mouth of the Little Colorado River have a measureable negative impact on humpback chub through predation.

5. Short-term non-native fish control plan – Kara Hilwig

At its October 2004 meeting, the AMWG passed the following motion by consensus: "Authorize funds for workshops, and direct GCMRC to further develop warm water species plan with TWG. The workshops include GCMRC workshop as described in the prospectus for warm water species research, and participation in the Upper Basin Recovery Implementation Plan workshop on non-native fish control."

Recognizing that the Colorado River and its tributaries in Grand Canyon are an interconnected ecosystem that includes a variety of habitats and species, development of a short-term plan is the first of two steps in the preparation of a comprehensive approach to management of nonnative fish species in Grand Canyon. GCMRC scientists have determined that additional research and development was needed to address the potential expansion of nonnative fishes, but that a short-term plan was also required to address immediate needs in support of native fish conservation in Grand Canyon. The long-term plan will incorporate findings from projects proposed in this short-term plan and other pilot projects.

A review of nonnative fish related activities in Grand Canyon reveals the need for development of improved methods for monitoring nonnative fish, addressing information gaps, and facilitating communication and rapid responses regarding nonnative fish issues. Recommendations in the short-term plan to address nonnative fish issues in Grand Canyon include (1) developing studies to identify spawning areas through otolith, isotope and larval drift sampling, (2) developing studies to determine sources of nonnatives into Grand Canyon such as tributary inputs, dam passage, and illegal stocking, (3) developing a large scale sonic telemetry project in Grand Canyon, (4) development of flume studies to investigate negative interactions, (5) feasibility testing of catfish hoop nets in the Little Colorado River, (6) improving monitoring methods for small bodied nonnative fish and other warm water fish species, (7) increasing sampling intensity around Lees Ferry to attempt increased detection of newly invading nonnative fish species, (8) developing a formal reporting procedure for nonnative species observations or captures in Grand Canyon, (9) conducting an annual nonnative fish workshop, and (10) increasing public awareness.

GCMRC scientists are in the final stages of completing the short-term nonnative fish control plan, and will distribute it electronically in advance of the September 2008 AMWG meeting. Hard copies will be available at the meeting. The long-term plan is to be delivered in 2010.