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MEMORANDUM

To: Glen Canyon Dam Adaptive Management Program Stakeholders
From: John Hamill, Chief, Grand Canyon Monitoring and Research Center *John Hamill*
Subject: Evaluation of the September-October Steady Flows

I. Introduction

One of the experimental actions described in the recent Environmental Assessment regarding operation of Glen Canyon Dam that was finalized in February 2008 is the release of steady flows in September and October from Glen Canyon Dam for five years beginning in 2008. This document was released after the FY 2008 Glen Canyon Dam Adaptive Management Program (GCDAMP) Annual Work Plan and the Science Plan for the March 2008 High Flow Experiment (HFE) were finalized. The Grand Canyon Monitoring and Research Center (GCMRC) seeks to be responsive to the Bureau of Reclamation, Fish and Wildlife Service, and other GCDAMP stakeholders who wish to see additional scientific monitoring and research conducted around the 5 years of September-October steady flows. Fortunately, we are relatively well-positioned to study the September-October steady flows with several existing projects, summarized below. In addition we are currently working on plans for additional studies associated with the September-October steady flows, which are also summarized below.

It is relevant to note that GCMRC has studied September-October steady flows in the recent past. The 2005 experimental flows in September and October contributed to our understanding of sediment transport in Grand Canyon. These flows helped demonstrate that steady flows transport less sand than fluctuating flows for a similar flow volume, consistent with basic sediment transport theory. We also know that lower magnitude steady flows will transport less sand, resulting in greater sand conservation, than higher magnitude steady flows. The work by Ralston and others (2007) reviewed what was learned about biotic responses to short duration experimental flows in September and October 2005. These workers concluded that the short-duration and timing of the flows in 2005 limited the magnitude of the biological response, and inferences were therefore weak. Another factor that made it difficult to see biological responses was that each 2 week experimental flow was preceded by a different flow pattern, further limiting their ability to draw robust conclusions. Although the proposed 2008-2012 fall steady flows are of longer duration than the 2005 flows (2 months of steady flows repeated over 5 years vs. 2

week blocks of steady and low fluctuating flows in only 1 year), we wish to caution GCDAMP stakeholders to not have unrealistic expectations regarding what can be learned, and how the biotic community will respond, to these experimental flows.

Our current and planned work associated with the 2008-2012 September-October steady flows generally falls into one of two broad categories: physical sciences and biology. In the physical science arena we will be collecting data regarding how these flows affect sediment transport and near-shore water temperatures. Our biological studies will investigate how aquatic organisms (including humpback chub) may or may not respond to late summer - fall steady flows. We are conducting one project, more fully described in the HFE Science Plan, which monitors formation and fate of sand-mediated backwater habitats and the use of these habitats by small-bodied fishes (Project 1.D.). Finally, we also discuss the approach we propose for studying biotic responses to September-October steady flows in conjunction with a new near shore ecology project. This is an approach that is described in, and supported by, the 2008 Biological Opinion (pg. 54).

II. Current Studies

A. Physical Sciences:

1) Mass balance project. HFE Science Plan question: Is the net mass balance of sediment following the experimental flow positive, negative, or neutral?

Sediment flux at each of the standard monitoring stations will be measured during the fall steady flows. Fluxes will be compared to expected fluxes for different operating regimes to estimate the effect of the steady flows on the quantity of sand export during the accumulation season. This work will be done for any operating regime and there is no added cost for the fall steady flows.

2) Near shore water temperatures. Primary study question: How do water temperatures in near shore environments vary, and can variation be correlated with flows?

As part of the High Flow Experiment we have been deploying thermistors to determine how near shore water temperatures do or do not respond to September-October steady flows. These data are being collected in support of near shore water temperature modeling to complement the mainstem water temperature model that has been completed. This work is already funded, so no additional funding is sought.

B. Biology:

1) Aquatic food base project. HFE Science Plan question: How is invertebrate flux affected by water quality and dam operations? Additional science questions: Does flow regime affect rates of primary production or organic and invertebrate drift? Does flow regime affect the residence time of water in backwater habitats?

The foodbase project is already collecting several streams of data that should address important questions related to the proposed fall steady flows. Primary production is being measured continuously in the Lees Ferry reach, once per month at Diamond Creek, and seasonally at four

sites that are accessed via river trips. Primary production data collected during September and October 2008 will be compared with the months before and after (Lees Ferry and Diamond Creek), and also from previous years (all sites), to determine whether steady flows affect rates of in-stream primary production. Organic and invertebrate drift is measured monthly at Lees Ferry. To determine whether steady flows affect drift rates, we will compare data collected in September and October 2008 with the months before and after.

As part of the HFE Project 1D funding, the aquatic foodbase project began intensive study of backwaters on their April 2008 river trip. Data being collected in backwaters includes primary and invertebrate production and dye-tracer studies to determine water residence time. Because data collection in backwaters began in April 2008, we do not have data on biological parameters from previous years to compare with 2008 fall steady flows data. However, water residence time will only be affected by the morphology of backwaters and the flow regime, but not season. Thus, we can determine whether steady flows affect water residence time in backwaters by comparing data collected during other flow regimes (i.e., April and June 2008 and January 2009). We are confident that we can determine the effects of 2 months of fall steady flows on primary production, organic and invertebrate drift, and water residence time in backwaters. We may also be able to determine the effects of fall steady flows on other important aspects of the foodbase (i.e., invertebrate production in mainstem and backwaters). Additionally, we are conducting experiments at the Artificial Stream Facility at Loyola University, Chicago, that should allow us to determine the effects of flow regime (steady flows, low fluctuating flows, and high fluctuating flows) on aspects of the foodbase (i.e., invertebrate growth and production) that cannot realistically be addressed in a field setting with short-duration flow treatments.

2) Backwater monitoring. HFE Science Plan question: To what extent are sand-mediated backwater habitats created by a HFE utilized by young-of-year humpback chub and other native and nonnative fishes? What are the relative proportions of each?

In association with the experimental high flow, we deployed a multiple trip project (Project 1.D.) to document and measure backwaters created by sand bars. The first two trips of this project were immediately before and after the experimental high flow. The third trip, conducted in May 2008, adds sampling of the backwaters with seines in order to monitor the use of these habitats by small-bodied, native and nonnative fishes. The fourth of the four trips will be deployed in September and October 2008 and will also include sampling backwaters for fish. With this schedule and protocol, this project not only documents how sandbar-mediated backwaters responded to summer fluctuating flows, it will also document the fish communities that are present in these habitats during the fall steady flows. Because similar methods will be employed on both the May and September-October trips, we anticipate being able to compare fish use of these habitats in two different seasons with different flow conditions. Used in conjunction with primary production, water residence time, and water temperature data (described above) this work provides important base information for helping to evaluate the relative value of these habitats for native and nonnative fishes. Work on other near shore habitats will begin in 2008 and is described below.

3) Lees Ferry rainbow trout monitoring. Primary study question: How do various flow release patterns affect the Lees Ferry rainbow trout population?

The Arizona Game and Fish Department continues to conduct at least three monitoring surveys of the Lees Ferry rainbow trout population annually; in 2008 they will conduct five such surveys. These observations, and comparisons with previous years, allow for the maintenance of a long-term trend line in the relative abundance and condition of this population in years with varying conditions and flows.

We believe that it will be difficult, if not impossible, to directly measure impacts of fall steady flows on the Lees Ferry rainbow trout population. The population spawns much earlier in the year, so steady flows in September and October may not have a direct impact on reproduction and growth of young fish. Young-of-year rainbow trout, particularly, may realize some benefits from fall steady flows that provide some increases in growth rates. We are developing pilot approaches to see if fall growth changes can be measured (see below).

Perhaps the most important effect of fall steady flows that might impact the rainbow trout would be any changes to the aquatic food base. The aquatic food base project described above will be taking regular, repeated observations to help evaluate the effects, if any, of fall steady flows on this basal resource.

As described in the HFE Science Plan the reproductive and early life history success of rainbow trout in the Lees Ferry reach are being evaluated in 2008 and 2009. These observations and comparisons to previous years' data will allow for comparative success in years with and without a HFE, and years with and without fall steady flows, though there are many confounding factors that will limit our ability to ascribe any changes to a single event, such as the fall steady flows.

III. Planned Studies

One of the historical emphases of study of native fishes in Grand Canyon has been backwater habitats. The relative value of backwaters and other habitats for humpback chub and other native fishes is not well understood. A more complete understanding of native and nonnative fish use of near shore habitats, especially those habitats other than backwaters, is needed to gain a more complete picture of fish life history in Grand Canyon, thereby informing additional research and management.

To address these information needs GCMRC has prepared a solicitation for cooperative agreement proposals for the Near Shore Ecology/Steady Flows project. We solicited, and received, suggestions for the solicitation from NPS, FWS, and BOR. Following review by the Science Advisors, we anticipate releasing this solicitation for open competition in the summer of 2008. We see this project as being very closely associated with the study of September-October steady flows, as well as studying habitats in other seasons under other flow regimes. We believe that the biological impacts of the September and October steady flows, especially on young humpback chub, can be best determined by putting long term biological data into the spatial and temporal contexts of the year-round flow regimes in different locations in Grand Canyon. While

collecting data in the September and October will help understand the condition of the biota during that time, it will be critical to collect data at other times of the year to understand what differences, if any, exist between this and other seasons, and between this and other flow regimes in a variety of near shoreline habitats.

To address the need to study near shore ecology and fall steady flows, GCMRC is completing a draft solicitation which will be released for open competition this summer. The competition will be conducted to identify one or more scientific cooperators who will be hired to bring new perspectives to the old problem of better understanding humpback chub life history and habitat use in the mainstem Colorado River in Grand Canyon. This cooperator is expected to be identified by the fall of 2008, at which time they will be included on the crew of one or more GCMRC river data collection projects during 2008.

In anticipation of the arrival of the cooperator(s) in the fall, GCMRC is developing a fall steady flows project that can be implemented in September 2008. Staff members are actively working on developing a study plan that will best address the following objectives:

- Evaluate methods to obtain density, abundance, and occupancy of near shore habitats by small, juvenile fishes
- Estimate relative piscivory risk among different habitat types and flow patterns
- Estimate use and movement of fish in backwater habitats
- Evaluate methods to assess flow impacts on growth of rainbow trout (e.g., otoliths, RNA/DNA ratios)

All of this work is dependent on continued and renewed fiscal support from the GCDAMP and the Bureau of Reclamation. It is also subject to permitting review and approval by Grand Canyon National Park.

We believe a great deal of important research and monitoring is being conducted during September and October 2008 which will support investigations of the planned fall steady flows. We will be making a presentation on this subject at the Adaptive Management Work Group meeting on May 22, 2008, in Phoenix. We look forward to discussing the subject further with you at that time.