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Memorandum

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Subject: Comments Regarding Experimental Flow Options for Glen Canyon Dam

Brief Perspective

An experimental flow regime or operation of Glen Canyon Dam is a fundamental element of the FY 07-11 Monitoring and Research Plan. As a result, several flow options are being presented to the Grand Canyon Monitoring and Research Center (GCMRC) for evaluation - to then be submitted to the Science Planning Group (SPG). The SPG will then submit their recommendations to the voting members of the Technical Workgroup (TWG) and ultimately to the Adaptive Management Workgroup (AMWG).

At present, four flow options are being evaluated:

1. Option 1 has been developed primarily by GCMRC. This option includes continued baseline monitoring of Modified Low-Fluctuating Flows (MLFF) under the 1996 Record of Decision (ROD) with testing of Beach Habitat Building Flows (BHBF) and winter ramping rate studies. Option 1 would also include winter power enhancement flows (Winter FF) similar to the experimental winter flows that have been in operation since 2003. These power enhancement flows are outside the boundaries of the ROD.

2. Option 2 is the same as Option 1, but adds stable flow operations in September and October. As with Option 1, Winter FF is included in the flow design.

3. Option 3 has been developed by Western Area Power Administration (Western), Arizona Game and Fish Department (AGFD) and the Federation of Flycasters. This option increases downramp rates from the ROD for several months out of the year, and decreases the daily minimum flow (compared to the ROD) by about 3,000 to 5,000 cfs in winter (December through March) and about 2,000 to 3,000 cfs in summer (June through August). This option will imply long-term riverine flow scenarios operating outside the boundaries of the ROD.

4. Option 4 is being developed by Grand Canyon Trust and the river guides, with GCMRC assisting to address some of their concerns in the option. Option 4's primary goal is to test the effects of a steady flow regime on humpback chub growth and survival in the mainstem and to "initiate a program of experimental dam releases" as called for in the 1994 Biological Opinion (USFWS 1994). As such, Option 4 calls for "naturalized" flows based in part on historic pre-dam data, but also fulfills the requirements for water delivery (8.25 maf). This option proposes a minimum year round steady flow of about 10,000 cfs, with increases up to ~13,000 to 14,000 during April through June. In addition, this option will include a BHBF strategy designed to test the effects of these flows on sediment and cultural resource protection, as well as non-native fish abundance and distribution, food base productivity and availability, and the recreational experience. Presently, this option is currently being proposed to run for 3-4 years to correspond to the life history of the humpback chub. Option 4 is within the boundaries of the ROD.

All options will assumedly be inclusive of three "nonflow" treatments or actions, including implementation of a selective withdrawal structure on GCD, implementation of some or all elements of the humpback chub comprehensive plan (refuge, translocations, etc.), and implementation of mechanical removal of non-native fishes.

Background

A major premise of the Biological Opinion (USFWS 1994) is that fluctuating flows have been instrumental in causing the jeopardy situation for the humpback chub. Element 1 A) of the Biological Opinion's RPA directs that: "A program of experimental flows will be carried out to include high steady flows in summer and fall during low water years (releases of approx. 8.23 maf) to verify an effective flow regime…a flow pattern that resembles the natural hydrograph as described for those seasons in the Seasonal Adjusted Steady Flow." Furthermore, the RPA directs that "When implemented, experimental flows will be conducted for a sufficient period of time to allow for experimental design, biological processes to function, and for variability inherent in riverine ecosystems to be expressed." To date, this RPA element has not been carried out, despite that Reclamation was instructed to do so by 1998. It has now been over a decade since completion of the Glen Canyon Dam Environmental Impact Statement (GCDEIS; USBR 1995).

Additionally, the first conservation recommendation in the Biological Opinion is clear: "Operate Glen Canyon Dam according to operating and other criteria of the Seasonally Adjusted Steady Flow alternative." The Biological Opinion provided ample citations to support this recommendation (Cushman 1985, Wydowski and Hammill 1991, Tyus 1992, USFWS 1992, Clarkson et al. 1994). These citations, and many others, support the premise that daily fluctuations are detrimental to native fish populations (e.g., Ward and Stanford 1983, Petts 1984, Benke 1990, Poff et al. 1997, Bain 2005, Gorman et al. 2005, Stone and Gorman 2006).

Finally, the RPA directed that "Reclamation *shall* implement a selective withdrawal program for Lake Powell waters and determine feasibility using the following guidelines" (italics added).

Process Concerns

Decision timeframe

The decision being made will have long term consequences (i.e., 5-10 years). We believe that 1) not all long term flow scenario proposals have been considered, 2) at least some of the proposals under consideration are in the draft stage - apparently undergoing modification, and 3) a very short time frame is being proposed in which to make a decision that will have long lasting (and possibly irrevocable) consequences. While this expedited approach may be more appropriate for making minor annual flow alterations within the context of the ROD, it would not appear to be appropriate given the potential long term consequences of the decision to be made, particularly since at least one of the proposals (Western's) involves a flow proposal that is well outside the boundaries of the ROD and is not fully inclusive of the RPA.

Proposal Inclusions/Non-inclusions

As mentioned above, not all proposals are being considered. One is the 16 year experimental block design proposed at the onset of mechanical removal by GCMRC. This proposal had a valid experimental block design and had elements in it that were conducive to addressing the 1 A) of the RPA (e.g., steady flow treatment blocks).

We note that all options except Option 4 are inclusive of power enhancement flows during the winter months. As such, each option except option 4 is inclusive of flow operations outside of the ROD. Given the reluctance based on financial grounds to run a steady flow alternative in Grand Canyon, this would appear to potentially leave no choice but to operate outside the boundaries of the ROD in the future should Option 4 be rejected.

We support the inclusion of "non flow" treatments or actions common to all options. Furthermore, we earnestly recommend expeditious construction of a thermal control device (TCD) in Glen Canyon Dam since 1) this was a specific element in the RPA, 2) there is widespread support among the scientific community of fishery biologists in Grand Canyon, 3) many, if not all, of the specific guidelines for implementing the TCD have been addressed, and 4) it has been 11 years since completion of the Biological Opinion and the GCDEIS.

Other specific concerns

Option 1. (MLFF under ROD + winter FF, with BHBF and winter ramping rate studies) – This proposal contains no avenue for meeting 1 A) of the RPA. In addition, the BHBF is only inclusive of a non-biological trigger (i.e., sediment input). An additional trigger should include a decision based on the densities of age-0 and juvenile humpback chub inhabiting the mainstem Colorado River in the Little Colorado River (LCR) inflow area prior to running a BHBF. This is because results indicate that the age-0 humpback chub residing in the LCR inflow during fall 2005 underwent a substantial post flood decline in relative abundance that may have been prevented had such a trigger previously been in place.

Option 2. (MLFF under ROD + winter FF, with BHBF and winter ramping rate studies plus stable flow operations in September and October) – Although this proposal contains a provision for short term stable flows during the fall, we do not consider it fully inclusive of 1 A) of the RPA. The RPA directs that "When implemented, experimental flows will be conducted for a sufficient period of time to allow for experimental design, biological processes to function, and for variability inherent in riverine ecosystems to be expressed."

In order to achieve recruitment from age-0 humpback chub displaced into the mainstem LCR inflow, these fish must survive and grow to a size at which they are not susceptible to the detrimental effects of unstable shoreline habitat and predation. Stone and Gorman (2006) found that young of the year humpback chub between 30 to 90 mm were strongly associated with near shoreline habitat. Consider that a cohort of 30 mm humpback chub displaced out of the LCR, and exposed to < 10.9 ^{o}C, should not be expected to grow at all (Robinson and Childs 2004). Using Robinson and Childs (2004) linear regression describing the association between temperature and growth of humpback chub from hatching to age-1, these same fish exposed to a mainstem temperature of 17.5 ^{o}C should have a growth rate of 0.24 mm/day. Thus, for example, a cohort of 50 mm chub displaced out of the LCR and exposed to 17.5 ^{o}C may take ~164 days just to reach 90 mm, at which point they are less reliant on near shoreline habitat. To reach 150 mm, when they may begin to be considerably less prone to predation, would take another 245 days (Table 1).

Table 1. Growth rates of humpback chub (mm/day) based on temperature (°C; from Clarkson and Childs 2004). Using these calculations, the table shows number of days expected for humpback chub to grow from 50 to 90 mm and from 90 to 150 mm.

	Temperature										
	10	11	12	13	14	16	17	17.5	18	19	20
Growth rate (mm/day)	0	0.004	0.041	0.078	0.115	0.189	0.226	0.2445	0.263	0.3	0.337
50-90 mm (days)	N/A	10,000	976	513	348	212	177	164	152	133	119
90-150 mm (days)	N/A	15,000	1,463	769	522	317	265	245	228	200	178
Total days	N/A	25,000	2,439	1,282	870	529	442	409	380	333	297

This implies that to obtain a measurable increase in recruitment of age-0 humpback chub displaced from the LCR into the 150 mm size class may require a combination of prolonged steady flows, prolonged warming of mainstem waters, and mechanical removal of non-native fish. Even with the TCD in place, water temperatures may still only be warm enough for growth of humpback chub for a portion of the year, implying even longer periods of continued stabilized flows. The key to arresting further decline of humpback chub in Grand Canyon will likely ultimately be found in arresting and reversing the decay rate of age-0 humpback chub displaced out of the LCR. Thus far, this decay rate has not been completely arrested, even with mechanical removal of non-native fish in place, some natural warming of mainstem waters (from lower levels in Lake Powell), and short periods of somewhat stable flows in the fall months. For example, the high relative abundance of age-0 and juvenile humpback chub found in the LCR inflow during the fall of 2005 was apparently severely diminished (if not erased) by the ensuing BHBF and the onslaught of winter power enhancement flows. It should not be expected that displaced age-0 humpback chub have grown enough in three months of relatively stable flows (~6,000-9,000 cfs) during the fall to overcome mortality factors associated with ensuing destabilized habitat from fluctuating power flows.

Option 3. (Western/AFGD/Flycasters “Experimental Modification of the ROD MLFF) Western’s option would move significantly beyond the boundaries of the ROD a large percentage of time to increase daily power fluctuations, and with no element to address 1 A) of the RPA. Although some may view this option as a needed compromise, it should be recalled that the RPA was the compromise called for with the completion of the GCDEIS and that thus far little to no progress has been made in the stabilization of flows for the benefit of humpback chub.

Western suggests that increasing power fluctuations over the ROD (running Winter FF) may enhance control of the Lees Ferry population of rainbow trout, thereby providing an important benefit for humpback chub. However, Korman et al. (2005) pointed out that there was very likely little additional incubation mortality of rainbow trout associated with the higher experimental fluctuations in 2003 and 2004. Additionally, Korman et al. (2005) specifically stated that they made no claims regarding the linkage between modeled spawning habitat preference at different flows and the impacts on recruitment

of young trout. Although controlling rainbow trout abundance via dam operations may be possible, sufficient uncertainty would appear to exist to preclude warranting a full justification for the continuance of Winter FF flows based on this premise.

Option 4. Grand Canyon Trust experimental modification of the ROD MLFF.
We support this option for a number of reasons. First, this option makes an effort to address the spirit of element 1 A) in the RPA. Second, the designers of this option are making an effort to address and improve a number of additional critical resource issues in Grand Canyon, including enhanced sediment conservation, enhanced food base at Lees Ferry, providing for safe recreational boating, and providing potentially beneficial aspects for archaeological resources.

Conclusion
We support options that are fully and most adequately inclusive of the Biological Opinion's RPA, including element 1 A) in particular. We recommend other "non flow" actions common to all options, specifically that the TCD is expeditiously constructed as a management tool.

We also support maintaining a healthy rainbow trout fishery at Lees Ferry. If rainbow trout increase in abundance from striving to meet elements of the RPA, mechanical removal is already in place at the LCR inflow. At the discretion of the AMWG, consideration could be given to removing trout from the control reach where they are not currently removed, but only counted.

There has been a concern that a decision to continue Winter FF flows post 2004 will result in an inflexibility to return to MLFF or to run experimental flows for native fish (e.g., meet 1 A. of the RPA). This concern was expressed in a memorandum dated 11 February 2004 (see attachment).

Finally, we urge that BHBF be inclusive of a trigger taking into account the densities of age-0 and juvenile humpback chub inhabiting the mainstem Colorado River in LCR inflow.

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