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MEMORANDUM

To: Technical Work Group of the Glen Canyon Dam Adaptive Management Program

From: Jeff Lovich, Chief /s/

Subject: Recommended change of direction in food base monitoring

The purpose of this memo is to make recommendations to the TWG regarding the future of research and monitoring related to the aquatic food base in the Colorado River Ecosystem (CRE) below Glen Canyon Dam. The Grand Canyon Monitoring and Research Center (GCMRC) views this resource, and our understanding of it, as a very important part of our responsibilities to the Glen Canyon Dam Adaptive Management Program. As such we want to ensure that the effort invested into the program has maximum long-term value to the AMP.

While previous food basework has yielded several peer-reviewed publications, it has not produced a clear synthetic understanding of important trophic dynamics governing this system nor statistically reliable data that can be used to estimate conditions throughout the CRE. External peer reviewers of the ten-year summary report for food base monitoring concur with these conclusions. In addition, external advice from the Aquatic Protocol Evaluation Panel (PEP) report (dated November 28, 2001 and posted on the GCMRC website) strongly suggests that a new paradigm is needed to more fully understand the food base of the Grand Canyon Ecosystem.

The PEP report states:

> *The food base program needs to be critically reviewed because the current level of understanding about the linkages between lower trophic levels and food availability of native fishes is not adequate to interpret food base data in relation to the management goal. ... GCMRC needs to explicitly identify the goal of the food base program, determine what metrics to use to monitor the lower trophic levels, and decide what level of detection of change is required. Sufficient data and experience exists to design a program that meets the identified needs with appropriate power.*

The PEP report provides further evaluation and guidance:

" The PEP Panel was impressed with recent and ongoing research conducted on lower trophic levels in the Colorado River and some of its tributaries. While these studies were not often directly oriented toward answering specific monitoring questions, they will be important in determining possibilities for a meaningful and efficient monitoring program.

A long-term monitoring program for the food base does not presently exist. This is understandable because the research needed to ensure a successful monitoring program has not yet been completed. ...While increased primary and secondary production (food base) may relate to increased native fish production other consequences are also likely-the most important being that a maintaining or attaining a healthy food base may benefit non-native species which are possible competitors with, or predators on, native species. However, if the GCMRC deems this goal worthy, or might revisit it after suitable research, we offer the following suggestions.

Monitoring Primary Production (Community metabolism) - Estimating total stream metabolism is often used to evaluate production or the potential food base. Two methods have been tried on the Colorado River during the experimental flood of 1996 – an open stream method (Marzolf et al. 1999) and enclosed chambers method (Brock et al. 1999). Both were able to detect the effects of the experimental flood in P/R (the ratio of primary production to community respiration), gross and net primary production. Both approaches might be evaluated as endpoints for monitoring primary producers, as they are relatively easy and inexpensive to perform.

Monitoring Secondary Production:

Biomass (mass/area) is often used as a surrogate for production as it often has some relation to production, and is relatively easy to obtain. Algal biomass can be estimated by in-situ measurements of lengths of strands, harvesting and weighing, or indirectly by estimating chlorophyll content. Invertebrate biomass is estimated by quantitative sampling of the river bottom, removing invertebrates from associated debris and obtaining a dried weight. The problems associated with estimating biomass with any reasonable precision in a system as large and dynamic as the Colorado River are likely large. ..... One caution for directly relying on a biomass approach is the order of magnitude variation in the turnover rate of benthic organisms under different habitat conditions. For example, turnover rate (i.e. production/biomass ratio) of chironomids in lotic environments can vary between 10 to >250. ***Without knowledge of site specific estimates of spatial variation in turnover in CRE, as well as the impact of dam operations on habitat conditions that drive turnover***

rates, projections of benthic productivity [based on biomass estimates] are highly uncertain.

Monitoring Drift: Research on the river has indicated a shift in energy sources longitudinally along the Colorado River below Glen Canyon Dam (Shannon 2001), and from tributaries (Angradi 1994), some of which may be from outside the main channel. Significant allochthonous sources would complicate the use of primary production measurements as the sole measure of river productivity. A way to address this concern is by monitoring drift. Drift, composed of algae, detritus and invertebrates that have been either washed into the river or detached from the river substrate and are being carried by water currents, has been used as an indicator of river productivity. Because particulate organic matter is likely important to downstream filter-feeding invertebrates (e.g., Simuliidae and some Chironomidae) drift estimates of coarse particulate organic (CPOM) and fine particulate organic matter (FPOM) would seem prudent.

Advantages of drift as an indicator of system productivity are that the sample is relatively simple to collect, it integrates processes over a wide spatial area, and thus likely will have moderate intersample variation, allowing a reasonable number of collections. A drift program could be conducted at land-based access points that are currently used for physical science monitoring. Research questions to be addressed before knowing if this approach is feasible for the Colorado River include relating production to drift, and examining existing data on sample variability.

Finally, the interpretation of invertebrate biomass or drift density is contingent on an understanding of the degree to which the system is 'bottom-up' or 'top-down' controlled. That is, determining whether invertebrate abundance is limited by its food sources, or by grazing pressures from fish will influence how a management action might affect invertebrate abundance. Unfortunately, the response of intermediate trophic levels in tightly coupled systems is quite unpredictable (e.g., Power 1990)."

Based on the recommendations of the PEP report, GCMRC recommends a new approach for food base monitoring and research to further our understanding of this aspect of the ecosystem - we are by no means abandoning it. The first goal of this new research will be to identify the trophic pathways that are important for native and non-native fish in this system—that is, to determine the food base for fish. The second goal of this new approach will be to emphasize, to a much greater degree than past sampling and analysis, the 'bioenergetics' of the lower trophic levels rather than simply trying to estimate their abundance and composition. The intensity of future efforts (number of sites, sampling dates per year, etc.) will be guided by statistical power analysis so that we can accurately detect changes and long-term trends in the food base.

Assuming that this new direction, provided by the Aquatic PEP, is approved by the TWG, GCMRC proposes to implement pilot studies in FY04 to address some of the PEP concerns and provide preliminary results to help guide further research towards developing a robust food base monitoring program. The next step would be for GCMRC to release a Solicitation as early as FY04 to fully develop that monitoring program. Until we have a better understanding of the bioenergetics of this system and the trophic pathways that are important for native and non-native fishes we will not accomplish that objective. Continuing the kind of monitoring that has been conducted for the past 12 plus years will not accomplish the recommendations of the Aquatic PEP. GCMRC staff will more fully brief the TWG on this matter at the January, 2004 meeting and solicit input.