Food Base Enhancement Proposal for the biannual budget 2015-2016 and to start the discussion towards a more detailed plan:

Numerous published articles and presentations have referenced the importance of an adequate food base for the health and growth of native and non-native fish in the Colorado River. Colton Finch in his Thesis points out the importance of flow to the drift of invertebrate. ECOSYSTEM ECOLOGY MEETS ADAPTIVE MANAGEMENT: FOOD WEB RESPONSE TO A CONTROLLED FLOOD ON THE COLORADO RIVER, GLEN CANYON, points out Midges (Chironomidae), Black Flies (Simuliidae), and Scuds (Gammarus lacustris) represent most all of the insect food base. David Ward has pointed out the HBC’s over 60 – 70 mm have a greater chance of survival. A greater food base can improve their opportunity. Recently released in a preprint version the following article gives direct linkage to the food availability for the HBC and density limitations referenced by Carl Waters in past Knowledge Assessments. FOODWEB DYNAMICS IN A LARGE RIVER DISCONTINUUM, Cross et al Taxon-specific comparisons of the four most productive invertebrate taxa showed that fish consumed nearly all of the available Simulium, Chironomidae, Gammarus, and Potamopyrgus production at most site-year combinations downstream of the LCR.

Ted Kennedy has done extensive research on the drift of these insects. In his recent WebEx he suggested habitat improvements could be effective. This is supported by “Driftwood: an alternative habitat for macro invertebrates in a large desert river”, G. Allan Haden et all. Though the following article was in reference to salmonids it does demonstrate the impact of habitat augmentation on food base, “Do In-stream restoration structures enhance salmonid abundance? A meta-analysis”, Sarah L. Whiteway et all, the placement of large boulders and large woody debris is supported to restore and support high biomass of invertebrates in the rivers.

During the on river review by the Protocol Evaluation Panel, early last year, one member mentioned this very fact and suggested the key role that filter feeders play in the food base above the dam has been precluded from these canyons because the host colonies are above the dam and can no long support localized populations. Also mentioned was the dam not only is a barrier to sediment transportation but also that of drift wood, key to invertebrate production in rivers and streams. The specific insect mentioned was the Caddis (Trichoptera) which is found in many of the tributaries. During the January, 2013 Annual Report meeting Brian Healy reported that Caddis are present in lower tributaries. Those mentioned were Bright Angel and Havasu. Another insect found is the Mayfly (Baetidae).

The great work done by all of these scientists has established a large base of basic research on the food base types currently available, their densities, drift, impact of seasonal-light variations, aquatic vegetation variation, etc. It seems only timely and correct to move into an applied research mode to use this data to enhance food base in specific areas to benefit existing and planned aggregations, reduce possibilities for density limitations, and establish host colonies for speedier redevelopment of aquatic invertebrate production following detrimental events reducing available food. Such a program is consistent with the draft Performance Criteria for Glen Canyon Dam Long-Term Experimental and Management Plan Environmental Impact Statement in sections related to Natural Processes, Humpback Chub Recovery Goals, etc.
Thus as we move forward with the planning for the 2015-2016 budget we should include a project to Enhance Food Base in Specific areas of the River. The following is a very basic outline for such a program.

Food Base Enhancement to include:

a) A review/develop data on flows and Temperature to determine what flow regimes are most positive to higher densities of aquatic invertebrate,

b) Test stream habitat augmentation to improve colonization and establish host colonies of invertebrate. Such augmentation can include movement of rocks and boulders as well as introduction of wood and logs. Consideration should also be given to nutrient supplementation.

c) Translocation of native insect taxa to establish colonies in the main stream

Such a project should not be limited to the above considerations. During the 2015-2016 budgeting process the GCMRC could schedule a workshop to develop a project in coordination with responsible agencies. A good foundation may be data collected in the tail water synthesis project. By introducing a basic outline at this time the TWG, scientists of the GCMRC and constituents parties have the opportunity to utilize their understanding of the basic research at hand and organize a logical investigative approach for an applied application to address the issued discussed here.
Food Base Enhancement
It is well established that rainbow trout and native fish populations in Glen and Grand Canyon are limited by the availability of high quality invertebrate prey.

Ecosystem ecology meets adaptive management: food web response to a controlled flood on the Colorado River, Glen Canyon

Wyatt F. Cross,1,2,7 Colleen V. Baxter,3 Kevin C. Donner,2 Emma J. Ross-Marshall,3 Theodore A. Kennedy,5 Robert O. Hall, Jr.,7 Holly A. Wellard Kelly,2 and R. Scott Rogers6

1Department of Ecology, 319 Lewis Hall, Montana State University, Bozeman, Montana 59717 USA
2Department of Zoology and Physiology, University of Wyoming, Laramie, Wyoming 82071 USA
3Department of Biology, Idaho State University, Pocatello, Idaho 83209 USA
4Cary Institute of Ecosystem Studies, Millbrook, New York 12546 USA
5U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona 86001 USA
6Arizona Game and Fish Department, Flagstaff, Arizona 86001 USA

Observations of size-related asymmetries in diet and energy intake of rainbow trout in a regulated river

Ted McKinney* and David W. Spears
Arizona Game and Fish Department, Research Branch, 2221 West Greenway Road, Phoenix, AZ 85023, U.S.A.
(e-mail: tmcKinney@gf.state.az.us)
*Senior author

Received 27 November 2000 Accepted 24 April 2001

Key words: food habits, Colorado River, dam tailwater, Arizona, Oncorhynchus mykiss

Native and Nonnative Fish Populations of the Colorado River are Food Limited—Evidence from New Food Web Analyses

As one of the most carefully managed ecosystems in the world, the aquatic environments of the Colorado River in the Grand Canyon have been highly influenced by dam construction and the introduction of smallmouth bass, which have shaped the local fish community. Understanding the interactions between these species is critical for managing the ecosystem.

wyatt f. cross, 1, 2, 7 colleen v. baxter, 3 kevin c. donner, 2 emma j. ross-marshall, 3 theodore a. kennedy, 5 robert o. hall, jr., 7 holly a. wellard kelly, 2 sarah e. z. segrest, 5 katherine e. beaty, 6 and michael d. yardy 6

1department of ecology, montana state university, bozeman, montana 59717 usa
2department of zoology and physiology, university of wyoming, laramie, wyoming 82071 usa
3department of biology, idaho state university, pocatello, idaho 83209 usa
4cary institute of ecosystem studies, millbrook, new york 12546 usa
5department of biology, le Moyne college, syracuse, ny 13214 usa
6u.s. geological survey, southwest biological science center, grand canyon monitoring and research center, flagstaff, arizona 86001 usa

Food-web dynamics in a large river discontinuum

wyatt f. cross, 1, 2, 7 colleen v. baxter, 3 emma j. ross-marshall, 3 robert o. hall, jr., 2 theodore a. kennedy, 5 kevin c. donner, 2 holly a. wellard kelly, 2 sarah e. z. segrest, 5 katherine e. beaty, 6 and michael d. yardy 6

1department of ecology, montana state university, bozeman, montana 59717 usa
2department of zoology and physiology, university of wyoming, laramie, wyoming 82071 usa
3department of biology, idaho state university, pocatello, idaho 83209 usa
4cary institute of ecosystem studies, millbrook, new york 12546 usa
5department of biology, le moyne college, syracuse, ny 13214 usa
6u.s. geological survey, southwest biological science center, grand canyon monitoring and research center, flagstaff, arizona 86001 usa
The foodbase project from 2006-2009 investigated sites throughout the CRE and came to basically the same conclusions that McKinney and Speas (2001) arrived at for rainbow trout in Glen Canyon....fish populations are limited by the availability of high quality invertebrate prey.

Kennedy, Theodore, 1/8/2014
The scientists have provided us with a wealth of basic research on food base:

- Types currently available
- Their densities
- Drift
- Impact of seasonal light variations
- Aquatic vegetation, etc

It is **time** to move to an applied management mode to improve the health of the invertebrate assemblage.
A FY15-16 Food Base Enhancement project would include but not be limited to some of the following elements:

- A review of the data collected in the Tail Water Synthesis project

- Determine what flow regimes are most positive to higher densities of aquatic invertebrates

- Translocation of native insect taxa from other segments of the Colorado River

- Habitat augmentation to improve colonization and establishment of host colonies of invertebrates.
shortened text. The points you were making were all
A project of Food Base Enhancement would support a number of the Desired Future Conditions:

**CRE Aquatic Domain**

**Native Species**

**Rainbow trout**

**Nonfish Biotic Communities**

**Blue Ribbon Trout Fishery in Glen Canyon National Recreation Area**
The problem is that we have, in most all areas of the River, to many children (total fish of all species).
Which has resulted in Mother Hubbard’s cupboard being bare!

The answer is not to kill the children!