

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 al. 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 al, 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 longer 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.

A photograph of a field of tall, green grasses. The grasses are in the foreground and middle ground, with many small, white, star-shaped flowers or seed heads scattered throughout. The background is dark, making the white flowers stand out. The overall scene is a natural, agricultural setting.

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

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

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

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

Fish populations in the Colorado River downstream from Glen Canyon Dam appear to be limited by the availability of high-quality invertebrate prey. Midge and blackfly production is low and nonnative rainbow trout in Glen Canyon and native fishes in Grand Canyon consume virtually all of the midge and blackfly biomass that is produced annually. In Glen Canyon, the invertebrate assemblage is dominated by nonnative New Zealand mudsnails, the food web has a simple structure, and transfers of energy from the base of the web (algae) to the top of the web (rainbow trout) are inefficient. The food webs in Grand Canyon are more complex relative to Glen Canyon, because, on average, each species in the web is involved in more interactions and feeding connections. Based on theory and on studies from other ecosystems, the structure and organization of Grand Canyon food webs should make them more stable and less susceptible to large



As one of the most carefully managed river systems in the world, the aquatic ecosystem of the Colorado River in the Grand Canyon has been heavily influenced by Glen Canyon Dam and the decades of controlled release of water for power generation. Photo by Robert O. Hall, Jr., used with permission.

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Food-web dynamics in a large river discontinuum

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Slide 3

KT2

The foodbase project from 2006-2009 investigated sites throughout the CRE and came to basically the same conclusions that McKinney and Spears (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

Slide 4

KT8

modified and shortened text

Kennedy, Theodore, 1/8/2014

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.

Slide 5

KT6

shortened text. The points you were making were all
Kennedy, Theodore, 1/8/2014

A project of Food Base Enhancement would support a number of the Desired Future Conditions:

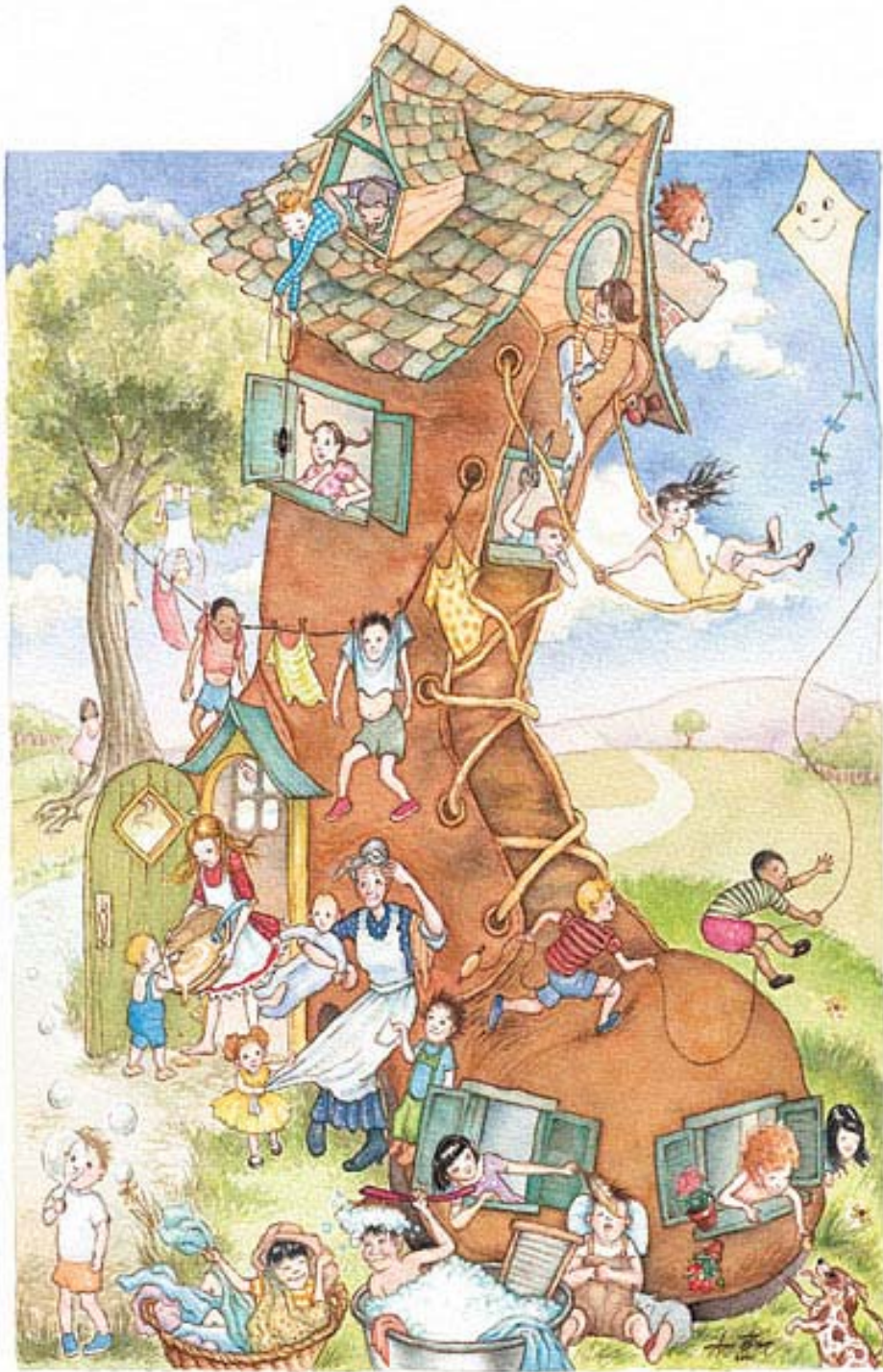
CRE Aquatic Domain

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, too many children (total fish of all species).



OLD MOTHER HUBBARD

Which has resulted in Mother Hubbard's cupboard being bare!

The answer is not to kill the children!