Future CRE Foodbase Research and Management

Planning: Can we proceed from existing conditions and with Bug Flows and BF results move to more refined foodbase management? This set of projects and Bug Flows are not mutually exclusive, are not proposed as alternatives to Bug Flows, nor do they need to be ignored so long as Bug Flows are ongoing

What and How? Address specific questions by conducting basic field and some laboratory experiments at and near Lees Ferry and the Paria River confluence.

Why? Determine whether and how to scale potential CRE foodbase enhancement up to the ecosystem scale.

When? Over the course of the next several years, perhaps with the GCMRC 2020 budget revision, and in concert with the results of a foodbase PEP

Issues:
- Relationship of questions to Bug Flows results
- Integration into GCMRC schedule and budget planning
- Consider public visibility and safety issues
  - (e.g., flotsam and fixed CWD experimentation)
- Contingency planning
  - (e.g., anomalous flows, vandalism and replication levels)

Eight Questions and Issues That May Warrant More Attention in CRE Tailwaters Aquatic Foodbase Management

1. **Embeddedness:** How do it and flow variation affect foodbase productivity?
2. **Power-flushing the benthos:** Does flushing benthic substrata reduce BHA and enhance macroinvertebrate production?
3. **Coarse woody debris:** Can reintroduction of CWD improve foodbase production?
4. **Attractants:** Do specific microhabitats differentially attract and support selected BMI?
5. **Nutrient dynamics:** Whether and how strongly do Lake Powell Reservoir-to-downstream nutrient dynamics affect CRE aquatic foodbase productivity?
6. **EPT population enhancement:** Can mainstream EPT populations be enhanced?
7. **Epiphytic and macrophyte interactions:** Does epiphyton composition vary among the five common macrophyte taxa and can epiphyton production be enhanced?
8. **Desiccation and freezing:** What are the impacts and recovery rates of the foodbase from desiccation and freezing?

1) Embeddedness

Question: How do embeddedness and flow variation affect CRE tailwaters foodbase productivity?

Experiments: Use gravel/cobble basket treatments, floating (constant flow) vs below-low-flow anchored in springtime vs fall, and in the clearwater mainstream vs below the Paria River confluence

Replication: 30 reps of each treatment, deploy the baskets for two month intervals spring and fall, pulling 6 baskets bi-weekly

Year 2: Use results to test for interaction effects

Relation to Bug Flows: Determine how embeddedness interacts with reduced flow variation to affect benthic macroinvertebrates (BMI).

2) Power-flushing Benthic Sediments

Question: Can flushing benthic substrata reduce benthic and hyporheic anoxia and enhance macroinvertebrate production?

Experimental tests: Shallow submerged, 10 m X 5 m power- flushed rectangular plots, long axis perpendicular to channel

Replication: 12-15 replicates each in cobble vs sand, with controls, sampled bi-weekly for six months in springtime and in fall using submersible Hess samplers.

Year 2: Compare and contrast these results with pre- and post-autumn and springtime HFE scour

Relation to Bug Flows: Determine how Bug Flows influence embeddedness.

3) Coarse Woody Debris

Question: Cessation of coarse woody debris import and presence has been a major dam-related habitat alteration of the CRE. Can reintroduction of CWD improve foodbase production?

Experiment: Barked pine logs, floating with both ends anchored, each with numerous easily-extractable 0.1 m^2 sampling blocks, attached to shore, extending through the varial zone. Test branch baskets also?

Replication: Deploy 6 reps above vs 6 below the Paria River confluence, and monitor/sample bi-weekly; compare against other treatments. Test in the Paria River as well.

Year 2: a) ***Water- logging and decomposition*** rates of CWD of different tree species, if warranted;

b) CWD ***movement and deposition*** using citizen scientist tracking of labeled CWD through the river corridor.

Relation to Bug Flows: Determine whether CWD differs from rock.

4) Attractants

Question: Do other specific microhabitats differentially attract and support selected BMIs?

Test: a) Bubbling water: Establish floating shoreline basket samplers up on river left at the foot of the Paria Riffle where wave action is pronounced, and compare with another set of floating samplers placed downstream where wave action is minimal. Measure exposure and velocity relatively constant

Replication: 12 samplers in each setting, with pilot tests

Year 2: Is scaling up feasible with this question?

Relation to Bug Flows: Are specific microhabitats, such as wave-washed boulders preferred for nematoceran oviposition?

5) Nutrient Supplementation

Question: How strongly do Lake Powell Reservoir-to-downstream nutrient dynamics affect CRE aquatic foodbase productivity?

Test: a) Standard shallow-submerged clay pot experiment with N vs P vs control treatments. Scrape 100 cm^2/pot on upstream vs. downstream sites on bi-weekly intervals.

Replication: N=30 replicates of each treatment in springtime and in autumn, with deployment upstream, downstream, and in the Paria River.

Year 2: Use results to refine nutrient ratio data and test for interaction impacts of the two nutrients.

Relation to Bug Flows: Presently monitored and modeled by GCMRC, but not experimentally tested with Bug Flows.

6) EPT Population Enhancement

Question: Can CRE EPT populations be enhanced?

Test: Establish on-shore pool, onshore experimental flowing channel, and in-channel floating pool habitats. Pools are 1 m^2 X 0.25 m deep. Channels 0.5 m X 5m X 0.1 m deep, velocity of ca 0.1 m/sec.

Replication: 12 reps each, six shaded, the others in full sun, upstream, downstream, and in the Paria River. Monitor BMI colonization rates bi-weekly in springtime and fall.

Year Two: Attempt translocation of local *Cheumatopsyche osleri* from the Paria River into onshore and in stream channels and carefully monitor.

Relation to Bug Flows: Bug flows may demonstrate some EPT establishment; this experiment will indicate how the duration and timing of steady flows influences EPT colonization.

7) Macrophyte Ecology

Question: Epiphyton are the real source of the CRE aquatic food base, but are they distributed equally among five common macrophytes?

Measurements: a) Describe epiphyton and invertebrate composition and diet on *Chara*, *Zannichellia*, *Oscillatoria*, *Cladophora,* and moss. Use field surveys, laboratory, and *in situ* field experiments to determine comparative habitat preferences and competitive status of the five primary macrophyte taxa.

Replication: Measure ephiphytic and BMI presence across stage elevation on 6 transects above Lees Ferry and 6 below the Paria River confluence, and six transects in the Paria River.
Year Two: Experimental manipulation of nutrients and substrata to determine if it is possible to shift or enhance epiphyton-rich taxa (i.e., *Cladophora*) distribution.

Relation to Bug Flows: This topic has to do with larval BMI feeding, rather than egg desiccation, but may influence BF outcomes.

8) Desiccation and Freezing Impacts

Question: Desiccation and freezing may exert important impacts on near-shore habitats – what are macrophyte and BMI recovery rates from such disturbances?

Test: Opportunistically and experimentally test desiccation and freeze duration impacts on the five major macrophyte taxa, and BMI recolonization rate, using sterilized vs non-sterilized cobbles, upstream and downstream, and within the Paria River. Scrape 10 X 10 cm surface patches.

Replication: Test colonization rate and exposure impacts on 30 replicated cobbles of each in each setting.

Year Two: Use results if preliminary experiments to conduct scaled-up research.

Relation to Bug Flows: This experiment may augment BF examination of flow fluctuations affect epiphyton and macrophyte mortality.

Other Questions to be Addressed?

Discussion – Relevance of these ???

Moving forward – A Foodbase Ad Hoc?