Report as of FY2007 for 2006UT72B: "Potential Impacts of Flow Augmentation on Stream Restoration Projects"

Publications

Project 2006UT72B has resulted in no reported publications as of FY2007.

Report Follows

Potential Impacts of Flow Augmentation on Stream Restoration Projects

Introduction and Purpose

As a method of helping the endangered June Sucker populations recover, the State of Utah has proposed restoring Hobble Creek in Springville to create spawning habitat (Stamp et al. 2003). This restoration area lies west of I-15 in Springville, Utah (see Figure 1). The restoration effort raises a few questions: 1) where is the optimum location for June Sucker fry to go after hatching upstream? 2) Can or will Hobble Creek deliver the fry to that location? 3) What are the sediment transport characteristics of Hobble Creek and how will they affect any created spawning habitat? This project answered the first two questions; work on the third question is ongoing through funding obtained as a result of this initial support.

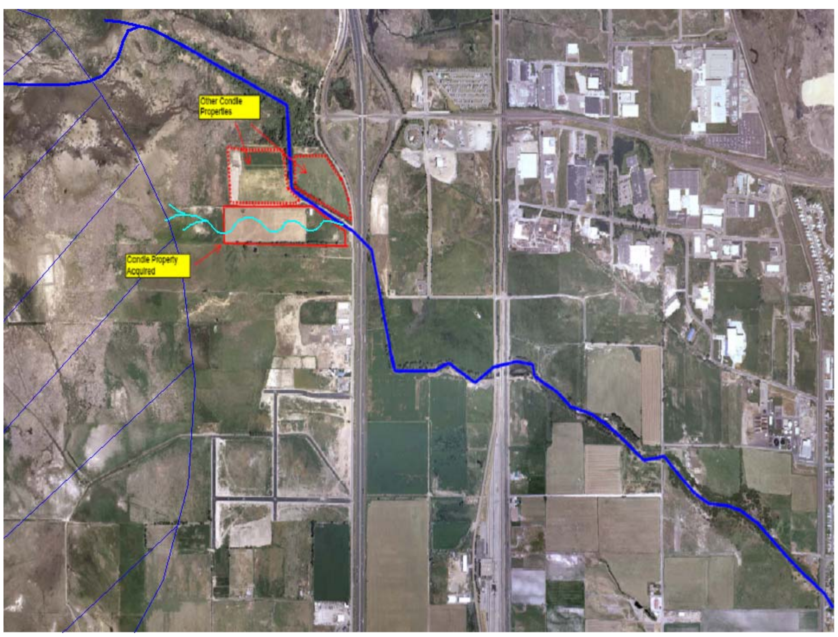

Figure 1. The proposed restoration area for lower Hobble Creek. Flow is from right to left.

June Sucker Fry Survival

In order to address the issue of identifying the optimum location for June Sucker fry survival, we investigated resource availability, areas for refuge from predation, temperature gradients in the lake/stream interface; and simulated larval drift rates of the stream to characterize where larvae will end up under the current creek flow regimes.

We set up a survey grid using geographic coordinates around the lake-stream interface of Hobble Creek and Utah Lake to sample for benthic invertebrates and zooplankton to find the areas of maximum resource potential. We sampled 4 different "zones": within the creek itself, in the dense emergent vegetation (>10 stems/ m^2) nearest the shore, in a defined zone of sparse vegetation (<10 stems/ m^2), and in the open lake where no emergent vegetation was present. In all cases, statistical analyses showed significant variation between sites, with the open lake being the area with highest counted zooplankton numbers per liter of water sampled. The creek, as expected, had very little zooplankton compared to the lake zones; for this reason we removed it from the analysis in order to see the differences between lake zones (see Figure 2).

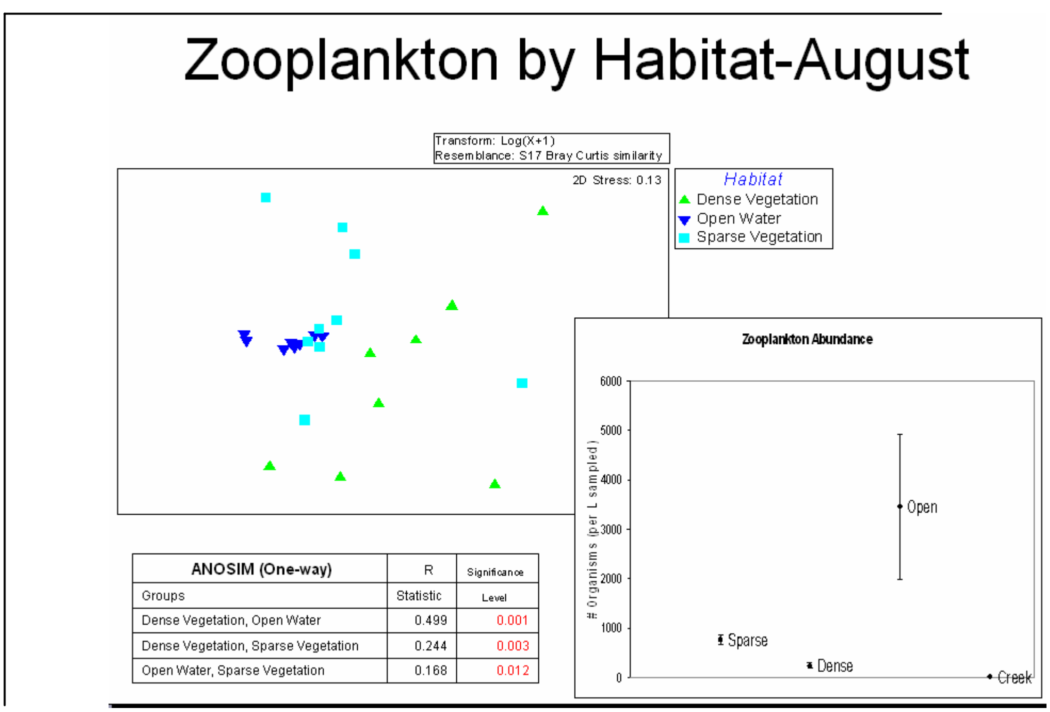

Figure 2. Zooplankton Statistical Analyses.

Areas of refuge were analyzed by setting up minnow traps along the same transects that were used for plankton sampling. Traps were left for 24 hours and minnow and small fish were identified by specie and counted. Analyses indicated that dense vegetation areas are the zones where small fish were congregating in greatest number and the difference between zones was highly significant (see Figure 3).

Finally, to further characterize habitat and the optimum location for June Sucker fry, we placed temperature probes in the three lake zones from June to November, 2007. Dense vegetation had significantly lower mean temperature than the open lake or sparsely vegetated zones (Figure 4).

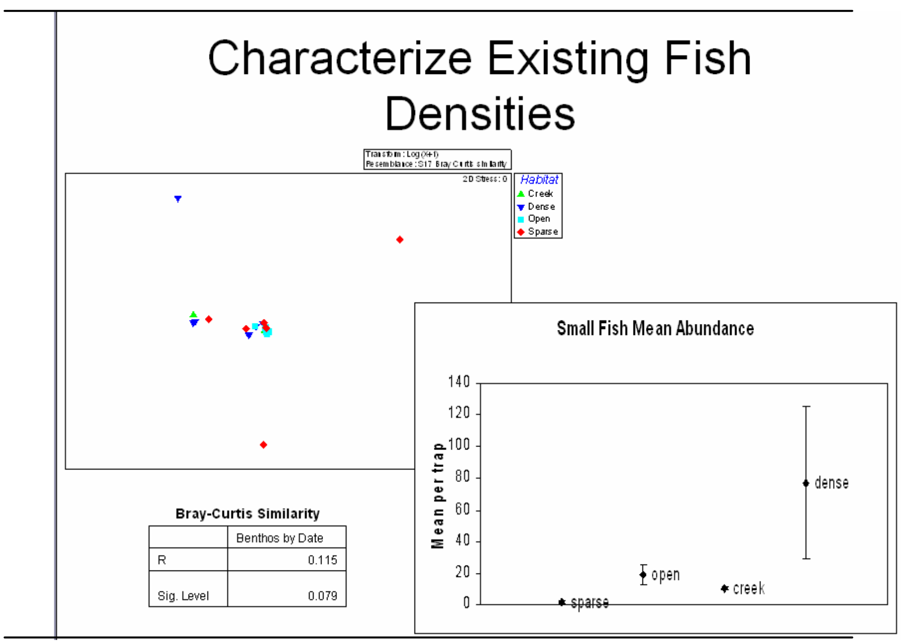

Figure 3. Minnow and small fish analysis.

By taking resource availability, refuge areas, and temperature data into account, decision makers will be more able to make appropriate decisions on the stream restoration process. It appears that there is significant opportunity to formulate June Suck fry nursery areas on the border of Utah Lake at the mouth of Hobble Creek.

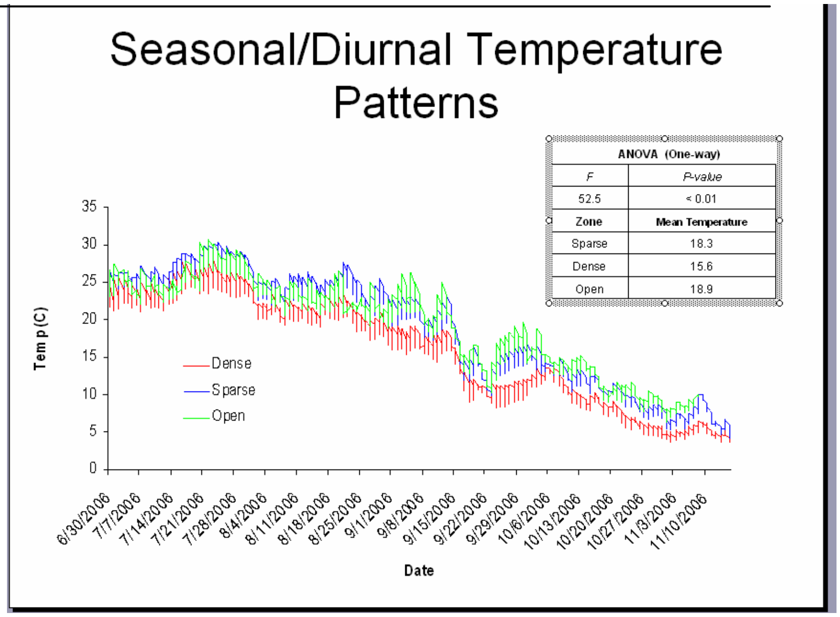

Figure 4. Temperature data from June to October.

Delivery of June Sucker Fry to Utah Lake via Hobble Creek

Knowing the target areas of development is one thing, whether the fry will make it to those locations or not is another. To help answer that question for the current creek flow regimes, we looked into where stream conditions will deliver the larvae.

Larval drift was simulated with the use of synthetic drift beads, small spheres designed to be neutrally buoyant that mimic larvae drifting with the currents. Beads were deployed in Hobble Creek at the 1600 W St Bridge and drift nets were set up west of I-15 in the levied section of the creek and beyond close to the lake-stream interface. The larval drift simulation was performed in late June when larvae are hatching in natural conditions. Figure 5 shows the starting location and drift net locations in the stream.

Beads began arriving in the most upstream sample site after 2.5 hours and arrived fairly constantly throughout the day with 30 minute sample times. Only 1 bead was collected at site 2 and no beads were found in sample site 3. From this experiment, we conclude that the stream flow characteristics are insufficient to deliver the larvae to the lake habitat under the present configuration of Hobble Creek.

Figure 5. Drift bead sampling locations.

Sediment Transport and Spawning in Hobble Creek

To address the issues of sediment transport capacities of Hobble Creek, we intend to model the stream using the Surface Model Software (SMS) system (SMS, 2006). In order to calibrate the sediment transport rate equations within the model, we have performed an extensive ongoing analysis of bedload transport rates, stream bed compositions and a detailed geometric survey of a 15.2 mile reach of Hobble Creek.

Bedload samples were taken during spring runoff event of 2006 using Bunte/Abt sampling traps. (Bunte and Abt, 2001) These were analyzed within sites to quantify lateral variations over time and between sites to determine the degree to which downstream fining occurs. Both dimensions of bedload are of interest to the restoration project, as incoming sediment that is too fine will prevent appropriate oxygenation of spawned eggs, and sediment that is too coarse will prevent redds from being built.

Several sites were selected based on a two fold criteria: proximity to roads and/or bridges, and uniform flow conditions that would facilitate discharge measurements. Bedload was measured over a 35 day period and was correlated with a simultaneously measured discharge (see figure 6). The flow rate peaked at 13.3 m^3/s (representing approximately a 5 year flood) and decreased daily down to 2.1 m^3/s, at which point bedload movement had ceased.

Figure 6. Students taking discharge measurements and bedload samples from a footbridge.

Data show that bedload D_{50} changed as a function of decreasing discharge and as a function of distance downstream. Also, bedload transport was positively correlated with stream discharge rates. Downstream fining was observed and quantified in streambed composition as well. When compared to bedload, we saw that streambed composition was coarser and more drastically affected by the I-15 culvert (see Figure 8). The I-15 culvert affect on particle size distributions can be seen clearly in Figure 9, where the curves on the left are particle size distributions from volumetric streambed samples taken immediately above and below the culvert.

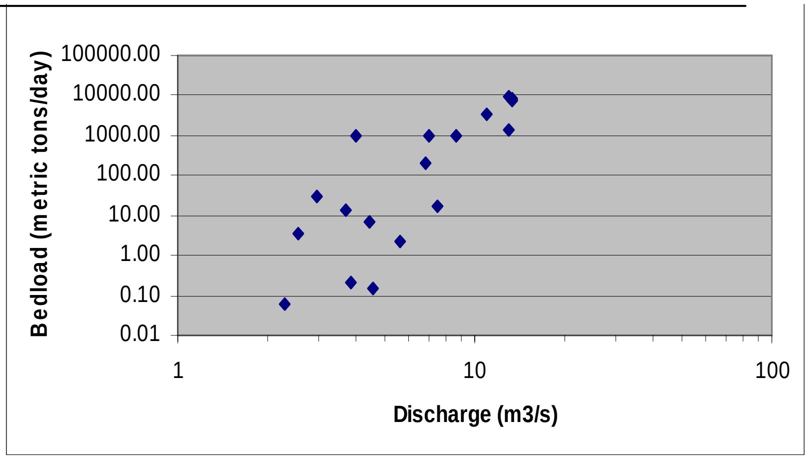

Figure 7. Bedload transport rates and flow rate on a log-log scale.

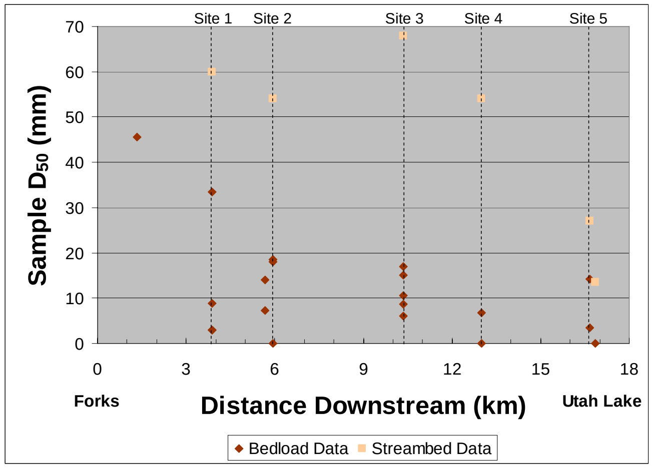

Figure 8. D50 sizes for bedload and streambed material.

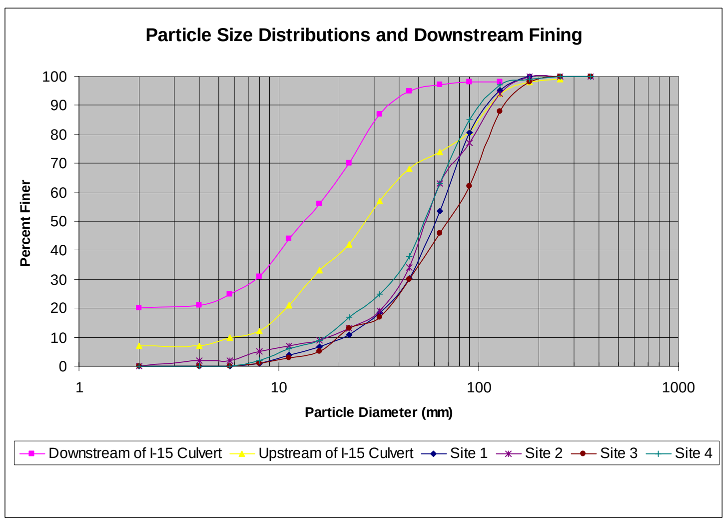

Figure 9. Particle size distributions for streambed material along Hobble Creek.

The difference between particle sizes around the culvert strongly indicates that the culvert causes a disconnect in the natural sediment transport capacity of the stream. It appears that appropriate spawning habitat for June Sucker based on sediment size is located upstream from the I-15 culvert.

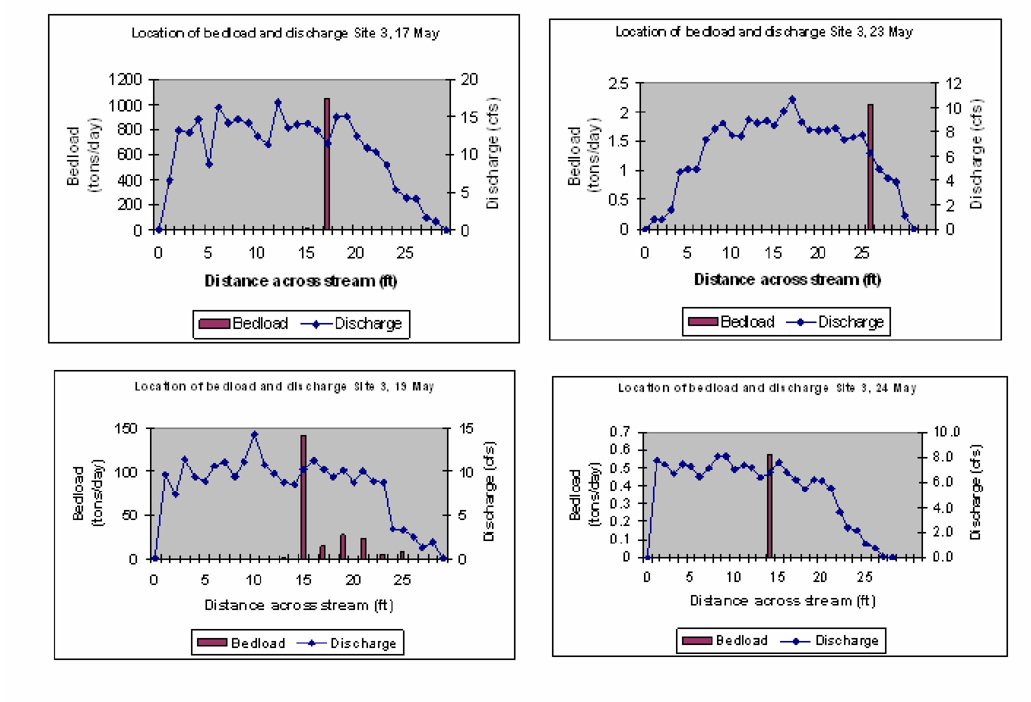

Figure 10. Lateral variation in bedload changing from day to day at a given site.

We also saw an interesting phenomenon in the bedload transport. The bedload was not necessarily located in the deepest or fastest moving water and was not uniformly distributed across the width of the stream. Furthermore, the locations across the stream where it was found would change from day to day. This lateral variation can be seen in the plots below. All four plots are from data from the same site; the red bar represents the bedload transport rate at a given location across the stream. The blue line is the unit width of discharge across the stream. The bedload does not necessarily line up with the peak unit discharge, and changes locations from anywhere between 14' and 26' from the right bank.

Since the restoration project intends to create spawning habitat, the affects of changing the stream geometries on sediment need to be known. Using the data acquired during this study, we will be able to accurately model both the present and future conditions of the stream for areas that may experience scour and deposition problems.

Summary of Conclusions from this Project

In summary, we have learned

1. It is likely that appropriate June Sucker Fry habitat can be created in the littoral zone of Utah Lake at the Hobble Creek outlet.
2. Current stream configuration is inadequate to deliver the June Sucker Fry to the mouth of Hobble Creek. A channel designed to do so will not meander, like one might presume of a 'natural' channel, but will take the straightest route to water as possible.
3. Adequate spawning gravels are located upstream from the I-15 culvert. We are analyzing the ability of adult June Sucker to traverse this culvert under spawning discharge conditions.

Literature Cited

Bunte, K. and S.R. Abt (2001). *Sampling Surface and Subsurface Particel-Size Distributions in Wadable Gravel- and Cobble-ben Streams for Analyses in Sediment Transport, Hydraulics, and Streambed Monitoring*. Gen. Tech. Rep. RMS-GTR-74. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 428 p.

Stamp, M.; D. Olsen, N. Norman, and S. Herstein (2003). *Hobble Creek Habitat Enhancement Concepts to Benefit the Endangered June Sucker*. Report Submitted to Reed Harris, Program Director for JSRIP. Utah Dept. of Natural Resources. 1594 W North Temple Box 146301, SLC, Utah, 84114.

Surface Modeling Software v. 9.0. 2006. Environmental Modeling Research Laboratory, BYU. Provo Utah 84602.