MIDDLE PROVO RIVER

2004
BENTHIC MACROINVERTEBRATE
SUMMARY REPORT

Photo by Tyler Allred. Shows recently restored Charleston (CA) monitoring site during high flows in 2004.

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*O*ne component of the ongoing effort to monitor the Provo River Restoration Project is the collection of aquatic insects and other invertebrates. Monitoring the macroinvertebrate community can provide information on changes in water quality and habitat, as well as provide an index for the quantity and quality of food available for the trout fishery. Such information can then be used to determine if and what types of activities are needed to maintain the middle Provo River in a desirable condition. Monitoring the health of the macroinvertebrate community will help ensure the project is achieving its objectives of restoring, improving and maintaining the biological integrity of the river.

Middle Provo River macroinvertebrates were sampled in 1999, from 2000 to 2002, and in 2004. In 1999 and 2004, samples were collected using quantitative techniques, which allow for a number of statistical analyses of the macroinvertebrates in a given area. Between 2000 and 2002, qualitative techniques, which primarily provide an index to the numbers and types of different macroinvertebrates in an area, were used.

In 1999 and 2004 quantitative samples were taken using a Hess sampler (shown left) in riffle areas at each site. In addition, one qualitative sample was taken from multiple habitats at each site using a D-frame kick net (shown right—aquatic insects stirred from disturbed sediments are collected in the net).

<u>Results of 2004 Sampling</u>

This summary describes results and comparisons of the 1999 and 2004 quantitative collections.

Sites sampled in 2004 were in restoration areas, listed upstream to downstream:
below Jordanelle Dam (**BJ**)……………………………………….2 years after restoration
near River Road (**RR**)…………………………………………..3 years after restoration
near Midway (upstream from the Legacy Bridge) (**NC**)……….no restoration, reach not historically channelized
near Casperville Road (**CA**)……………………………………….0 years after restoration

While some invertebrates were common throughout the study area, such as the mayfly *Baetis tricaudatus*, midges (Chironomidae), and worms (Oligochaeta), the two upstream sites (BJ and RR) had a distinctly different community from the most downstream (NC and CA) sites (see Tables 1-4 on the following pages). Caddisflies of the family Brachycentridae and mayflies in the family Ephemerellidae were both common at the BJ and RR sites. Conversely, riffle beetles (Coleoptera) were common at the NC and CA sites, but not the BJ and RR sites upstream.

The CA site was sampled a few days after restoration work finished there in the spring of 2004. At that time the site was dominated by tolerant and quickly-colonizing invertebrates, such as midges, worms, blackflies (*Simulium* sp.), and the mayfly, *Baetis tricaudatus*. During the autumn sampling, the invertebrate community found at the CA site was similar to the community found at the NC site, the closest site upstream. The density (number per square meter) and abundance (total number) of invertebrates was also similar to the NC site.

Table 1. Ten most abundant invertebrate taxa collected in the spring and autumn of 2004 at the restoration area below Jordanelle Dam (**BJ**), in descending order.

Spring 2004		**Fall 2004**	
Scientific name	**Fly/common name**	**Scientific name**	**Fly/common name**
Baetis tricaudatus	Blue-winged olive	*Baetis tricaudatus*	Blue-winged olive
Ephemerella inermis/infrequens	Pale morning dun	Chironomidae	Midge
Chironomidae	Midge	Oligochaeta	Worm
Brachycentrus americanus	American grammon	*Brachycentrus americanus*	American grammon
Oligochaeta	Worm	Nematoda	Pin worm or hook worm
Paraleptophlebia sp.	Mahogany dun/Blue Quill*	*Simulium sp.*	Blackfly
Ostracoda	Seed shrimp	*Caecidotea sp.*	Aquatic sowbug
Epeorus sp.	Mayfly*	*Hydropsyche sp.*	Cinnamon caddis/net building caddis*
Nematoda	Pin worm or hook worm	Acari	Mite
Hydropsyche sp.	Cinnamon caddis/net building caddis*	Ephemerellidae	Pale morning dun*

* These taxa have multiple common names depending on the exact species.

Table 2. Ten most abundant invertebrate taxa collected in the spring and autumn of 2004 at the restoration area near River Road (**RR**), in descending order.

Spring 2004		**Autumn 2004**	
Scientific name	**Fly/common name**	**Scientific name**	**Fly/common name**
Chironomidae	Midge	Chironomidae	Midge
Baetis tricaudatus	Blue-winged olive	*Baetis tricaudatus*	Blue-winged olive
Ephemerella inermis/infrequens	Pale morning dun	*Brachycentrus sp.*	American grammon
Oligochaeta	Worm	Oligochaeta	Worm
Brachycentrus americanus	American grammon	*Brachycentrus echo*	American grammon
Antocha sp.	Cranefly	Acari	Mite
Ostracoda	Seed shrimp	*Diphetor hageni*	Dark brown dun
Hydropsyche sp.	Cinnamon caddis/net building caddis*	*Optioservus sp.*	Riffle beetle
Gyraulus sp.	Planorbid or flat snail	Nematoda	Pin worm or hook worm
Diphetor hageni	Dark brown dun	*Hydropsyche sp.*	Cinnamon caddis/net building caddis*

* These taxa have multiple common names depending on the exact species.

Table 3. Ten most abundant invertebrate taxa collected in the spring and autumn of 2004 at the restoration area near Casperville Road (**CA**), in descending order.

Spring 2004		Autumn 2004	
Scientific name	**Fly/common name**	**Scientific name**	**Fly/common name**
Oligochaeta	Worm	*Baetis tricaudatus*	Blue-winged olive
Baetis tricaudatus	Blue-winged olive	Chironomidae	Midge
Chironomidae	Midge	*Optioservus sp.*	Riffle beetle
Nematoda	Pin worm or hook worm	*Hydropsyche sp.*	Cinnamon caddis/net building caddis*
Simulium sp.	Blackfly	Perlodidae	Patterned stonefly*
Caecidotea sp.	Aquatic sowbug	*Caecidotea sp.*	Aquatic sowbug
Corixidae	Water boatmen	*Simulium sp.*	Blackfly
Optioservus sp.	Riffle beetle	Oligochaeta	Worm
Ostracoda	Seed shrimp	*Ephemerella sp.*	Pale morning dun*
Rhyacophila coloradensis gr.	Green sedge/green rock worm/green caddis	Acari	Mite

* These taxa have multiple common names depending on the exact species.

Table 4. Ten most abundant invertebrate taxa collected in the spring and autumn of 2004 at the never channelized area near Midway (**NC**), in descending order.

Spring 2004		Autumn 2004	
Scientific name	**Fly/common name**	**Scientific name**	**Fly/common name**
Oligochaeta	Worm	Chironomidae	Midge
Chironomidae	Midge	*Baetis tricaudatus*	Blue-winged olive
Baetis tricaudatus	Blue-winged olive	*Optioservus sp.*	Riffle beetle
Optioservus sp.	Riffle beetle	Oligochaeta	Worm
Nematoda	Pin worm or hook worm	*Hydropsyche sp.*	Cinnamon caddis/net building caddis*
Isoperla sp.	Medium brown stonefly	Perlodidae	Patterned stonefly*
Ephemerella inermis/infrequens	Pale morning dun	*Tricorythodes sp.*	Trico
Hydropsyche sp.	Cinnamon caddis/net building caddis*	Acari	Mite
Caecidotea sp.	Aquatic sowbug	*Caecidotea sp.*	Aquatic sowbug
Diphetor hageni	Dark brown dun	Nematoda	Pin worm or hook worm

* These taxa have multiple common names depending on the exact species.

Examining the number of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly), or EPT taxa, and the Hilsenhoff Biotic Index (HBI) also shows the differences between sites and the quick recovery of the CA site after restoration (see Figures 2 and 3 below). The number of EPT taxa at a site provides an index for community diversity among invertebrates that are generally considered intolerant to disturbance. The HBI can detect various impacts to the invertebrate community. Each invertebrate receives a score and all the scores are averaged into a rank. Samples with HBI scores of 0-2 are considered "clean", 2-4 "slightly enriched", 4-7 "enriched", and 7-10 "polluted".

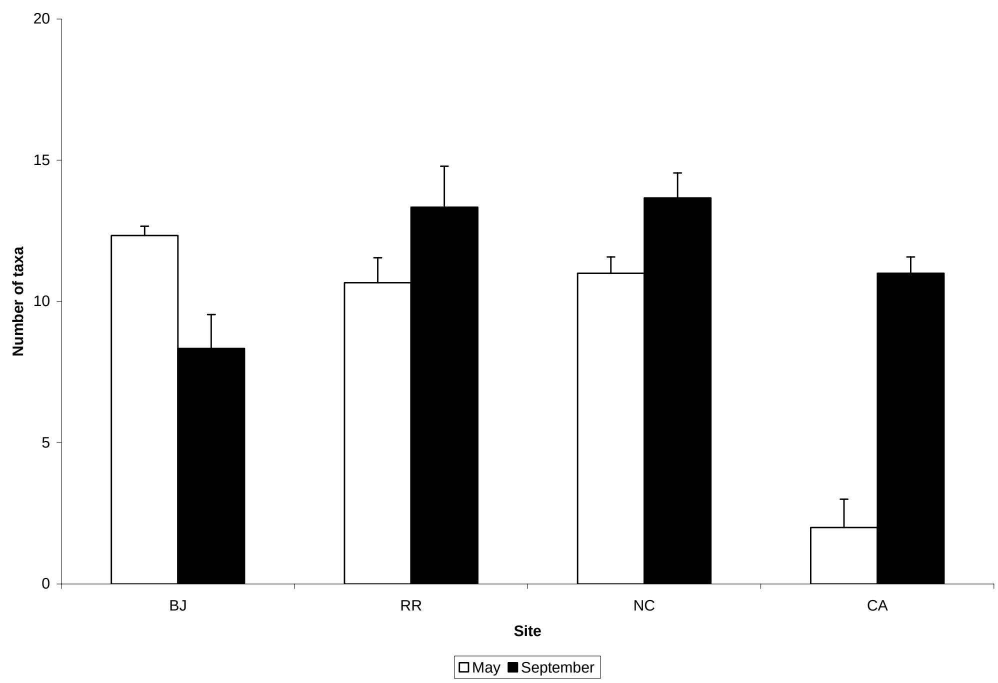

Figure 2. Average number of Ephemeroptera, Plecoptera and Trichoptera taxa found in quantitative (Hess) samples at the BJ, RR, NC, and CA sites in spring and autumn 2004. Error bars = 1 standard error.

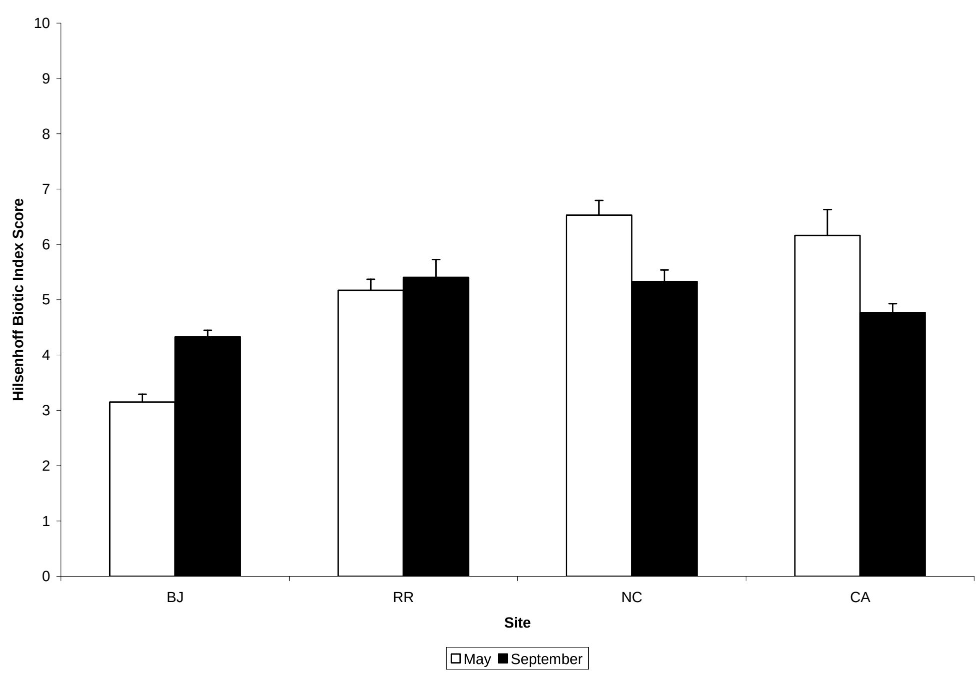

Figure 3. Average Hilsenhoff Biotic Index (HBI) scores calculated from quantitative (Hess) samples at the BJ, RR, NC, and CA sites in spring and autumn 2004. HBI scores of 0-2 are considered "clean", 2-4 "slightly enriched", 4-7 "enriched", and 7-10 "polluted". Error bars = 1 standard error.

The abundance and diversity of invertebrates at the CA site seemed to recover very quickly to a community similar to the NC site, which is the closest site upstream. The BJ site (restored in 2002) and RR site (restored in 2001) appear to have recovered to an invertebrate community different from that seen at the NC site and the CA site. We found that the BJ site had a significantly lower number of EPT taxa than the NC site in May 2004, and both the BJ site and the RR site had significantly lower HBI scores in May 2004 than the NC site. The BJ site would be characterized as slightly enriched by its average HBI score, whereas the remaining three sites would fall into the enriched category. Differences in the most abundant taxa present at the BJ and RR sites provide additional evidence that invertebrate communities at the BJ and RR sites are different from those at the NC and CA sites.

Recent studies of substrate and sediment transport at the four sites indicate that differences exist in the diversity of substrates found in the four sites. The BJ and RR sites have larger substrate (cobbles and boulders) and seem to be lacking sand and gravel, while the recently restored CA site has quite a bit of sand and silt from recent construction activities. The NC site has the most gravel of all four sites sampled, and has also received sand and silt during the construction phases of upstream restoration. Since substrate size and complexity is a key factor structuring aquatic invertebrate communities, substrate composition at the four sites may account for some of the differences in the invertebrate communities.

Comparisons to 1999

We were also able to compare quantitative samples taken in September 2004 with quantitative samples collected in the same areas in August 1999, prior to any restoration activities. In 2004, all sites showed a large (2-4 fold) increase in the density of invertebrates compared to the 1999 samples (see Figure 4 below), indicating that restoration activities have not caused a prolonged depression on the abundance of invertebrates the River. In fact, the abundance of invertebrates has increased potentially in response to restoration activities. The density of invertebrates at the four sites sampled on the middle Provo River in 2004 is comparable to or higher than that found in other Rocky Mountain trout streams, and should provide an adequate forage base for the trout fishery in this area. All sites except BJ showed increases in 2004 in taxa richness (the number of different invertebrates; see figures on the following page), compared to 1999. An increase in taxa richness is usually associated with reduced human-caused disturbance and the HBI score. However, all sites except BJ showed increases in the HBI score. An increase in the HBI score is generally evidence of increased disturbance.

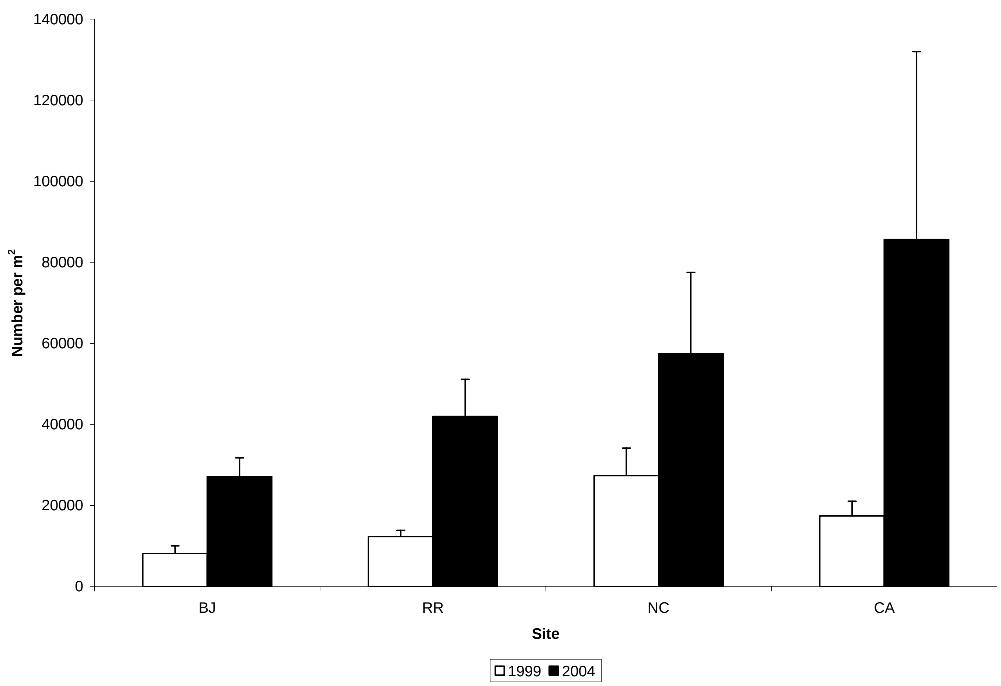

Figure 4. Average density (number per meter squared) of aquatic invertebrates collected in quantitative samples near the BJ, RR, NC, and CA sites in August 1999 and September 2004. Error bars = 1 standard error.

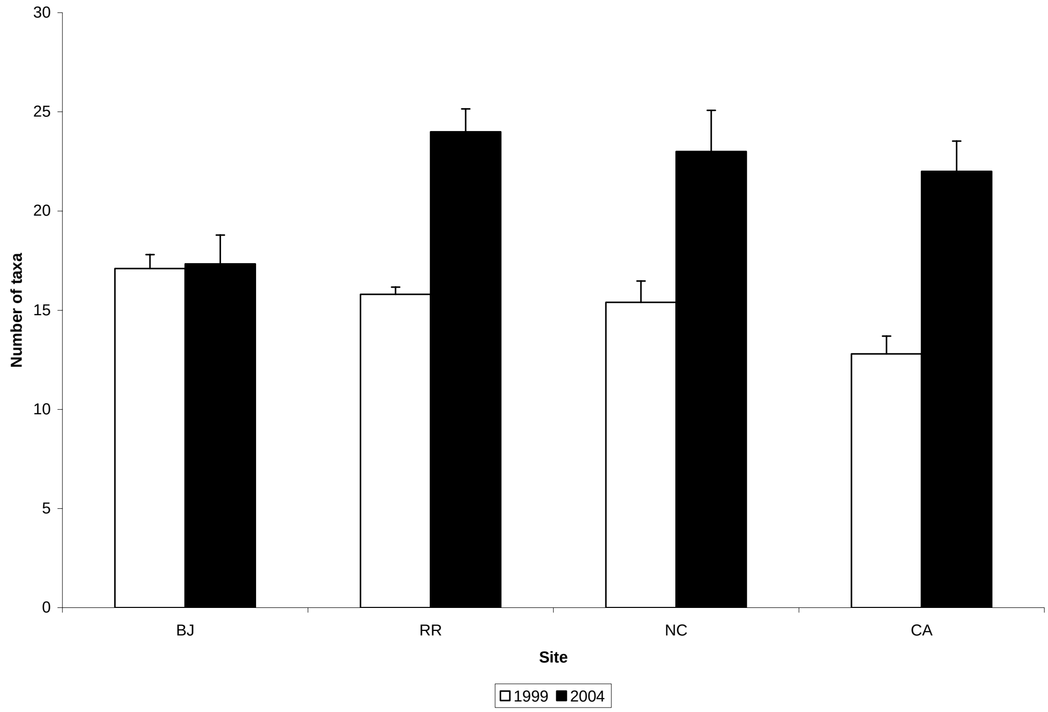

Figure 5. Average number of taxa collected in quantitative samples near the BJ, RR, NC, and CA sites in August 1999 and September 2004. Error bars = 1 standard error.

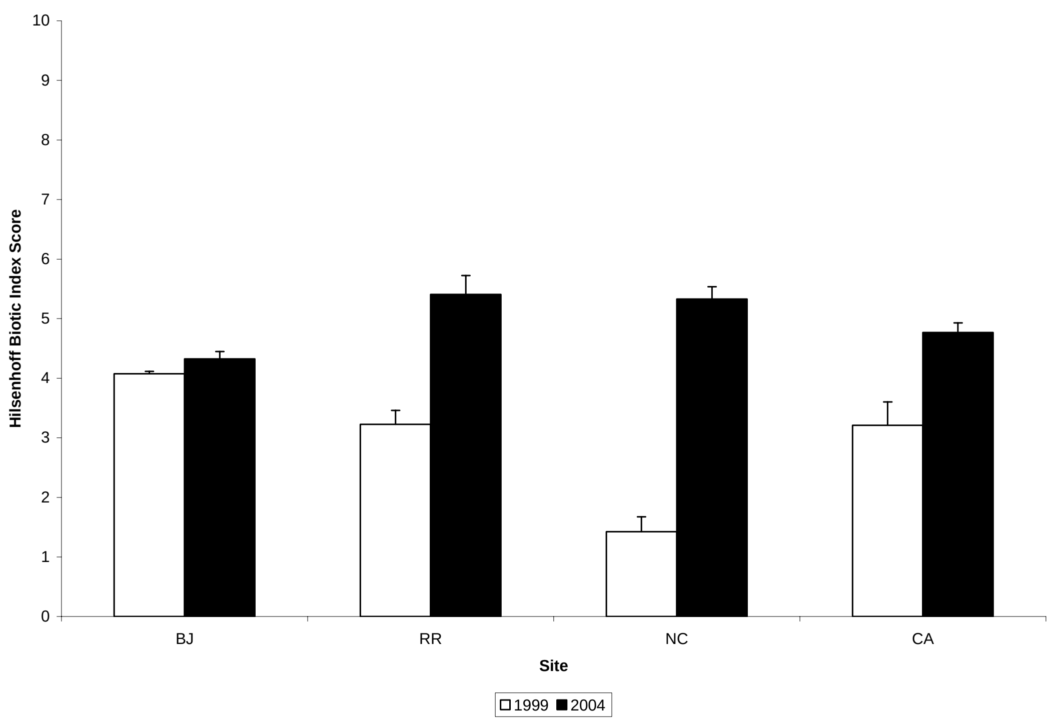

Figure 6. Average Hilsenhoff Biotic Index (HBI) scores for quantitative samples collected near the BJ, RR, NC, and CA sites in August 1999 and September 2004. HBI scores of 0-2 are considered clean, 2-4 slightly enriched, 4-7 enriched, and 7-10 polluted. Error bars = 1 standard error.

One explanation for the differences seen in the macroinvertebrate community between 1999 and 2004 is that the community has been influenced by restoration activities. Utah Division of Wildlife resources fish surveys have noted an increase in habitat quality and diversity resulting from restoration work. Since no restoration occurred in the NC reach, and it had never been channelized, we would have expected the benthic community to remain relatively constant in that reach. However, as with the RR and CA sites, we found increased invertebrate density, richness, and HBI scores at the NC site in 2004 compared to 1999. Therefore, we may be seeing results of multiple factors that have changed since the inception of Jordanelle Dam operations (altered flow regime, reduced sediment supply, and temperature changes) interacting with increased habitat complexity available in some areas after restoration. Additionally, while the NC site was never channelized, it still received impacts from upstream channelization, and also received deposition of fine sediments during upstream restoration activities.

In summary, the abundance of aquatic insects and other invertebrates seems to have recovered quickly (within 6-12 months) from restoration activities in the middle Provo River. In fact, it appears that the project has had a positive effect on the number of invertebrates present throughout the River. The current density of invertebrates should provide an adequate forage base for the trout fishery. The composition of the macroinvertebrate community in the middle Provo River has also changed since the onset of restoration activities in 1999. Some of this change is probably a function of construction activities related to the restoration, although the quick recovery of the CA site indicates these impacts are relatively short-lived. Changes in the amount and timing of flows, sand and gravel transport, and temperatures affiliated with the newly restored channel configuration and the operation of Jordanelle Dam may also be re-structuring the invertebrate community. Since invertebrate communities can exhibit relatively large changes from year to year based on weather and flow patterns, continued invertebrate monitoring over the next several years will help clarify how channel restoration and other factors may be influencing the invertebrate community in the middle Provo River.