

Provo River Restoration Project Aquatic Invertebrate Sampling 1999-2002

The following is a technical summary of macroinvertebrate sampling from 1999 through 2002 of six stations along the middle Provo River, between Jordanelle Dam and Deer Creek Reservoir.

Stations listed in the proceeding tables refer to reaches within the Provo River Restoration Project (view “PRRP Area and Reaches map” on our web site at: www.mitigationcommission.gov/prrp/prrp_area.html). Station 8 is within Reach 8, which was the first reach reconstructed, in 1999. Station 6 is within Reach 6, which is yet to be reconstructed. Station 4 is within Reach 4, which will not be reconstructed as it was not historically altered and therefore retains more natural riverine conditions. Station 3 is within Reach 3, the upstream half of the 2003 project area. The Side Channel was constructed in 1999 as part of Reach 8 restoration. Station 7 is within Reach 7, which was constructed in 2000.

Monitoring was conducted through an agreement with Brigham Young University using intensive, semi-quantitative techniques to monitor changes in aquatic invertebrate (insect) populations over time.



*Middle Provo River macroinvertebrate sampling done in transects two meters apart
Photo courtesy of Dennis K. Shiozawa, Brigham Young University*

Listed below are the most common taxa (species) found in the river during monitoring, ranked by abundance. The numbers are relative indicators of abundance in the entire sample data set, including all sites and all dates, based on overall average occurrence per sample. A total of 117 taxa were collected in the study over the entire sampling period.

<u>Taxa</u>	<u>Common family name</u>	<u>Abundance Level</u>
<i>Chironomids</i>	Midge	20.08 most abundant
<i>Baetis</i>	Mayfly	18.89
<i>Oligochaeta</i>	Worm	14.72
<i>Simuliium</i>	Blackfly	12.75
<i>Ephemerella</i>	Mayfly	9.16
<i>Brachycentrus echo</i>	Caddisfly	8.98
<i>Chironomid pupae</i>	Midge	7.33
<i>Hydropsyche</i>	Caddisfly	7.23
<i>Ostracod</i>	Crustacean	7.17
<i>Optioservus</i>	Beetle	7.13 (both adults & larvae)
<i>Paraleptophlebia</i>	Mayfly	6.69
<i>Epeorus</i>	Mayfly	6.27
<i>Drunella grandis</i>	Mayfly	6.24
<i>Brachycentrus spp</i>	Caddisfly	4.68
<i>Asellus</i>	Crustacean	3.73
<i>Copepoda</i>	Zooplankton	3.24
<i>Isoperla</i>	Stonefly	2.98
<i>Hydrarcarina</i>	Water mite	2.96
<i>Plecops</i>	Stonefly	2.86
<i>Sphaerium</i>	Fingernail Clam	2.62
<i>Rhithrogena</i>	Mayfly	2.58
<i>Physella</i>	Snail	2.49
<i>Rhyacophila</i>	Caddisfly	1.98
<i>Cladocera</i>	Zooplankton	1.84
<i>Arctopsyche</i>	Caddisfly	1.32
<i>Lepidostomatidae</i>	Caddisfly	1.32
<i>Lymnaea</i>	Snail	1.17 least abundant listed

Note - Does not include species/taxa with less than a 1.0 for the abundance level (that is, not all 117 taxa are listed).

To view images of the above, visit Wilfrid Laurier University's "Illustrated Aquatic Invertebrate Field Guide" web site at:
<http://www.wlu.ca/~wwwbiol/bio305/Database/Categories.htm>

Summary Tables by Date and Location

The first two tables are for the total number of taxa collected at each station on a given date. These suggest the highest taxa diversity occurs in station 4, the unmodified site. Seasonality is not addressed as there is only one fall sample series, so results from Fall 1999 are not comparable to any other sampling period.

Note: Shaded cells contain results from stations after they were reconstructed.

Total number of taxa collected

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	36	---	---	37	46	47
Fall 1999	49	---	---	48	70	58
Spr 2000	25	---	45	39	62	---
Spr 2001	39		48	44	55	---
Spr 2002	43	37	47	41	41	---

The “total numbers per station” table below shows trends with various treatments. Note that rehabilitation in station 8 in 1999-2000 reduced total numbers of invertebrates, but by spring 2002 the total numbers had recovered. However, this does not mean the system has fully recovered. And note the “natural” site, station 4, tends to have lower densities than stations 8 and 6; this could be an artifact of the sampling method. Because of the differences in substrate between station 4 and station 8, the sampling method is less effective in station 4.

Mean total numbers per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	302	---	---	246	86	81
Fall 1999	164	---	---	201	198	164
Spr 2000	113	---	291	165	119	---
Spr 2001	271		181	231	86	---
Spr 2002	357	189	84	211	94	---

More insight can be obtained from frequencies. These are the number of samples that contained at least one individual of a given taxon. Only some of the taxa are shown for illustrative purposes. *Baetis* (Mayflies - the blue winged olives) were abundant in the upper channelized stations. They are less abundant in the natural station (4), but still were quite frequent. The natural site may have been impacted by upstream construction - note the drop in frequency between 2000 and 2002. Construction in station 7 may have resulted in greater bedload, which would tend not to be retained in channelized sections, but which would fill interstitial spaces in station 4.

Frequency *Baetis* per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.98	---	---	1.00	0.94	0.72
Fall 1999	0.96	---	---	0.95	0.93	0.94
Spr 2000	0.87	---	0.86	1.00	0.86	---
Spr 2001	0.97	---	0.94	1.00	0.75	---
Spr 2002	0.99	0.88	0.74	1.00	0.65	---

Paraleptophlebia (a mayfly) shows a definite response to restoration (unlike *Baetis*, which is a vagrant species - prone to moving and recolonizing rapidly). This species also shows a depression in the later years in station 4, again possibly from the transport of sediments. Of course we don't have a good handle on how much annual variation to expect in these systems since we don't have much pre-upstream impact data. Clearly the presence of *Paraleptophlebia* has increased after restoration in the upper station (8).

Frequency *Paraleptophlebia* per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.18	---	---	0.41	0.60	0.28
Fall 1999	0.20	---	---	0.05	0.24	0.14
Spr 2000	0.01	---	0.35	0.54	0.51	---
Spr 2001	0.46	---	0.57	0.24	0.25	---
Spr 2002	0.45	0.36	0.23	0.39	0.26	---

Epeorus iron shows the impact of restoration construction, but it rebounds quickly (station 8). Again the natural site shows what may be upstream perturbation impacts in 2001, 2002.

Frequency *Epeorus iron* per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.53	---	---	0.57	0.56	0.10
Fall 1999	0.01	---	---	0.03	0.09	0.05
Spr 2000	0	---	0.15	0.60	0.62	---
Spr 2001	0.40	---	0.49	0.34	0.37	---
Spr 2002	0.64	0.18	0.10	0.30	0.15	---

As a group, *Plecoptera* (stoneflies) seem to be doing best in the natural site. Occurrences of *Plecoptera* in the rehabilitated site suggest the environment has been improved for stoneflies, although the increasing trend was seen at all stations.

Frequency immature *Plecoptera* per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0	---	---	0	0.05	0
Fall 1999	0.06	---	---	0.14	0.26	0.30
Spr 2000	0.01	---	0.02	0.22	0.41	---
Spr 2001	0.07	---	0.03	0.10	0.22	---
Spr 2002	0.19	0.08	0.08	0.33	0.33	---

A particular genus of stonefly, *Isoperla*, has generally decreased in frequency in all sites; however, it has not yet shown a recovery signature.

Frequency *Isoperla* per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.34	---	---	0.41	0.57	0.32
Fall 1999	0	---	---	0	0.07	0.01
Spr 2000	0.01	---	0	0.10	0.25	---
Spr 2001	0.07	---	0.23	0.11	0.24	---
Spr 2002	0.05	0.03	0.03	0.11	0.04	---

The caddisfly *Brachycentrus echo* is increasing in the restored section, but has not yet reached levels similar to those in the natural site, pre-impact. It may not be able to recover to those levels since the restored site is still constrained by armored banks installed within the study area. This particular species builds cases of sand grains.

Frequency *Brachycentrus echo* per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.03	---	---	0.079	0.725	0.46
Fall 1999	0.17	---	---	0.83	0.74	0.80
Spr 2000	0.01	---	0.17	0.64	0.33	---
Spr 2001	0.20	---	0.40	0.69	0.34	---
Spr 2002	0.38	0.18	0.44	0.55	0.15	---

The caddisfly, *Hydropsyche*, appears to be recovering in the restoration site, but it is declining downstream. Again this is probably associated with downstream transport of sediments. This effect may persist until the fines are flushed from the system.

Frequency *Hydropsyche* per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.62	---	---	0.53	0.47	0.50
Fall 1999	0.49	---	---	0.49	0.27	0.66
Spr 2000	0.01	---	0.10	0.43	0.35	---
Spr 2001	0.37	---	0.36	0.17	0.24	---
Spr 2002	0.48	0.06	0.11	0.27	0.28	---

Simuliidae, blackflies, are filter feeders like the Hydropsychid caddisflies. They are also highly mobile - a sort of vagrant species that attaches to hard substrates. They drifted into the restoration site immediately and are doing well. However, the natural site again shows signs of perturbation. Note also the changing frequencies in the side channel. This likely reflects changes in the side channel habitat over time.

Frequency *Simuliidae* per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.91	---	---	0.61	0.52	0.29
Fall 1999	0.87	---	---	0.83	0.66	0.46
Spr 2000	0.84	---	0.57	0.69	0.50	---
Spr 2001	0.77	---	0.36	0.85	0.37	---
Spr 2002	0.80	0.54	0.10	0.84	0.38	---

Chironomids (midges) are ubiquitous—they seem to be everywhere. For that reason, identification of these to the family level as is done here, and as is typically done in most aquatic invertebrate studies, is not too useful. Taking them to the genus level would generate much more information, but is far too expensive for most studies.

Frequency Chironomids per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.94	---	---	0.86	0.97	0.97
Fall 1999	0.94	---	---	0.85	0.92	0.85
Spr 2000	0.99	---	1.00	1.00	0.98	---
Spr 2001	1.00	---	0.99	0.94	1.00	---
Spr 2002	1.00	1.00	0.99	1.00	0.91	---

Oligochaetes seem to have remained reasonably constant in frequency throughout the study. However, they do show immediate impact of the river reconstruction.

Frequency Oligochaeta per station

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.51	---	---	0.44	0.61	0.91
Fall 1999	0.64	---	---	0.37	0.83	0.69
Spr 2000	0.31	---	0.96	0.63	0.87	---
Spr 2001	0.85	---	0.90	0.98	0.80	---
Spr 2002	0.70	0.49	0.91	0.68	0.66	---

Mean numbers per net are given below. This information must be interpreted with caution since the sampling design was not geared to quantitative estimates. The numbers can only be interpreted as relative comparisons of different stations and dates. The numbers of *Baetis* show the impact of restoration (and seasonality). They also decline steadily in the side channel as the habitat changes. Other than that, they do not appear to give much information.

Mean number *Baetis* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	131	---	---	98	24	7
Fall 1999	96	---	---	61	74	27
Spr 2000	36	---	92	67	27	---
Spr 2001	98		58	96	28	---
Spr 2002	99	95	11	83	28	---

Paraleptophlebia responds positively to the restored section of stream; however, downstream numbers again appear to have declined.

Mean number *Paraleptophlebia* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.36	---	---	1.77	2.18	0.66
Fall 1999	0.59	---	---	0.14	0.56	0.21
Spr 2000	0.01	---	1.58	1.44	3.06	---
Spr 2001	1.13	---	4.67	0.41	0.66	---
Spr 2002	1.20	1.11	0.24	0.66	0.66	---

Epeorus iron has been impacted in the downstream areas. Again it appears that sedimentation may be a factor. This species was definitely knocked back by the restoration work, but it recovered quickly.

Mean number *Epeorus iron* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	1.86	---	---	3.64	3.39	0.25
Fall 1999	0.01	---	---	0.05	0.12	0.09
Spr 2000	0	---	1.46	1.99	3.82	---
Spr 2001	1.50	---	3.16	1.00	1.40	---
Spr 2002	2.14	0.37	0.25	0.55	0.31	---

Stoneflies are doing well in the restored area and in the natural site as well. Note that these numbers are just unidentifiable immatures. Others were identified and placed in various other taxa.

Mean number immature *Plecoptera* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0	---	---	0	0.09	0
Fall 1999	0.09	---	---	0.16	0.76	0.59
Spr 2000	0.01	---	0.05	0.42	0.98	---
Spr 2001	0.11	---	0.03	0.16	0.42	---
Spr 2002	0.36	0.13	0.09	0.65	1.11	---

Isoperla was knocked back by river reconstruction and has not yet recovered. Other stations also show a depression.

Mean number *Isoperla* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.72	---	---	0.79	1.88	0.89
Fall 1999	0	---	---	0	0.22	0.01
Spr 2000	0.01	---	0	0.23	0.67	---
Spr 2001	0.07	---	0.27	0.16	0.48	---
Spr 2002	0.07	0.03	0.03	0.11	0.04	---

Brachycentrus echo and *Hydropsyche* show similar impacts in the frequency table. They do well in the restored stream and are impacted by upstream changes in the natural site.

Mean number *Brachycentrus echo* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	0.16	---	---	32.79	15.75	4.66
Fall 1999	1.62	---	---	85.22	38.99	91.49
Spr 2000	0.01	---	0.32	9.61	3.42	---
Spr 2001	0.65	---	4.83	10.68	2.70	---
Spr 2002	1.99	0.27	2.02	4.61	0.94	---

Mean number *Hydropsyche* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	2.07	---	---	1.97	1.94	4.58
Fall 1999	1.49	---	---	1.56	0.68	7.97
Spr 2000	0.01	---	0.30	0.90	1.06	---
Spr 2001	1.25	---	2.54	0.25	0.64	---
Spr 2002	1.42	0.07	0.26	0.49	0.84	---

Mean number *Simuliidae* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	61.79	---	---	66.05	5.27	1.30
Fall 1999	22.30	---	---	17.70	15.20	2.64
Spr 2000	31.25	---	57.97	14.26	5.89	---
Spr 2001	27.53		1.98	24.54	2.49	---
Spr 2002	17.13	6.71	0.31	28.15	3.62	---

Chironomids for some reason increased greatly in the restored site in 2002. Progressive decline in side channel probably reflect habitat changes. Cause of increase in station 6 is unclear.

Mean number *Chironomids* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	30.83	---	---	13.19	18.12	23.73
Fall 1999	22.09	---	---	11.06	21.96	4.84
Spr 2000	41.64	---	100.75	53.12	43.62	---
Spr 2001	89.36	---	64.68	65.32	21.38	---
Spr 2002	200.32	73.5	24.99	75.81	24.61	---

Oligochaetes are about back to normal in the restoration site. The increase in the natural site suggests increased fines in sediments.

Mean number *Oligochaeta* per sample

	Station 8	Station 7	Side Channel	Station 6	Station 4	Station 3
Spr 1999	4.60	---	---	2.67	5.23	29.32
Fall 1999	4.91	---	---	1.09	16.78	10.01
Spr 2000	1.04	---	28.19	5.25	13.94	---
Spr 2001	13.75	---	19.60	24.19	10.82	---
Spr 2002	3.39	2.26	12.86	2.35	18.88	---