

Benthic Macroinvertebrate Biomonitoring of the Deer Creek Habitat Restoration Project, McKenzie River Basin, Oregon

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Introduction

Refer to Weybright 2019 (Attachment 1_Deer Creek Data Analysis.docx) for the restoration project overview. Restoration activities occurred in the summers of 2016-17, with the main earth moving disturbance in 2016. Basically, channel roughness was greatly increased with the addition of large woody debris, and extensive side channel habitat was created. This is a large stream that had been primarily an erosional mainstem chute with little pool and side channel development in the restoration area.

Post restoration benthic macroinvertebrate (BMI) monitoring occurred between the end of August and early November in 2018. Twenty samples were acquired from mainstem and newly created side channel habitats and from reaches that received and did not receive restoration treatment.

Objectives

- By late summer-early fall 2018 did BMI populations in the treated reaches of Deer Creek recover from the significant disturbance that occurred during project implementation in 2016? The primary comparison is between BMI communities sampled in various treated habitats in 2018 with an untreated reach also sampled in 2018.
- 2018 Untreated and Treated reaches will also be compared with historic data from the lower Deer Creek mainstem taken between 1998 and 2004 to help assess recovery in the Treated reaches.
- Are there notable differences in benthic macroinvertebrate community composition between the treated and untreated reaches after 2 years post-restoration?
- Are there any notable species present in lower Deer Creek?

Methods

Twenty BMI samples were taken in 2018 from the project area between August 30 and November 3. **Kate or Shannon Claeson can provide a synopsis of the methods.**

Habitat categories sampled in 2018 and the number of samples (n) were:

- Mainstem-erosional-untreated n=5
- Mainstem-erosional-treated n=4
- Mainstem-depositional-treated n=5
- Side channel-erosional-treated n=3
- Side channel-depositional-treated n=2
- Side channel-depositional-treated-hyporheic n=1

In the lab samples were subsampled to the 600+ individual organism level with a 95%+ sorting efficacy using dissecting scopes. Identification of BMI's was consistent with the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) level 2 standard taxonomic effort <https://www.pnamp.org/project/northwest-standard-taxonomic-effort>

The length of all invertebrates was measured using a stage micrometer to the nearest 0.5 mm if <5 mm long, and to the nearest 1 mm over 5 mm long. Sample data was entered and analyzed using Aquatic Biology Associates, Inc. (ABA) R metric program and taxa traits designations. The output file is attached here as an appendix and includes traits assigned to each taxon. Included in the analysis was calculation of biomass using established length-mass regression coefficients.

We re-analyzed historical data from BMI samples taken in lower Deer Creek from 1998-2000 by the McKenzie River Watershed Council, and in 2004 by the Eugene Water and Electric Board (EWEB) for dam relicensing requirements. These samples were collected in erosional habitats in the lower Deer Creek mainstem and were 8 square foot composite samples, subsampled to the 500+ individual organism level. Samples from both these studies were also analyzed by ABA. Data generated from these historic samples is relatively comparable to samples taken in 2018, except now the standard taxonomic effort for aquatic mites requires genus level identification (instead of lumping at subclass), and several Chironomidae midge genera are now identified to species group level. These differences in standard taxonomic effort will influence some of the taxa richness based metrics.

To provide a broader longitudinal context to the lower Deer Creek BMI communities we have included data from the McKenzie River mainstem taken in 2004 (n=3). These samples were taken in more shallow riffles upstream of the confluence of Deer Creek to just downstream of Trail Bridge Reservoir. We have also included a 2004 site from the Smith River just upstream of the Smith River Reservoir for comparison. Like Deer Creek, this is also a large tributary stream entering the McKenzie River from the NW, but at a higher elevation.

Results

See the Excel file **Tables Deer Creek restoration report 2018.xlsx**.

Excel file **2018 MMRRD Deer Creek BMI analysis.xlsx** provides the complete analysis of the 2018 lower Deer Creek BMI data, including a listing of all the traits used.

Excel file **1998-2004 Deer Creek & vicinity MRRD BMI analysis.xlsx** provides the complete analysis of the historical data and traits used.

Table 1 lists the 211 BMI taxa encountered in this study to date, including the McKenzie River and Smith River comparison sites. As expected for a mid-elevation western Cascades stream dominant taxonomic groups are the EPT insects (Ephemeroptera+Plecoptera+Trichoptera), and Diptera (true flies), especially Chironomidae (midges). **Cold water biota** that are restricted to cool-cold waters that support salmonids are well represented. There are much fewer **Warm water biota** represented.

Table 1 is arranged so the habitat affinity of each taxon can be tentatively assessed. The 2018 **Mainstem-erosional-untreated** (bordered column E) category represents the dominant habitat type in lower Deer Creek before restoration. Columns C & D provide additional information derived from the 1998-2000 and 2004 historical data as to the relative abundance of taxa in the **Mainstem-erosional-untreated** habitat category.

Note that given the less than robust nature of the data available thus far statistical testing on habitat affinity is not warranted. Columns O & P provide a best professional judgement on a comparison of the relative abundance of each taxon as follows:

- **Mainstem-erosional-untreated** (columns C-E, with emphasis on 2018)
- Versus **Treated-erosional-mainstem or side channel** (columns F-G all 2018)
- Versus **Treated-depositional-mainstem or side channel** (columns I-K all 2018)

Above comparisons were categorized as:

- N= none, neutral, not applicable, or insufficient information
- >= some increase over the untreated mainstem reaches
- >>= substantial increase over the untreated mainstem reaches
- <= some decrease over the untreated mainstem reaches
- <<= substantial decrease over the untreated mainstem reaches

The tentative evaluation of organism response to habitat restoration treatment in lower Deer Creek is:

Number of organisms		
Response	Erosional	Depositional
N	134	97
>	41	52
>>	10	18
<	22	38
<<	1	1

Restoration treatment appears to have dramatically increased the number of benthic taxa occurring in lower Deer Creek. Forty-three new taxa have appeared in the treated reaches of

lower creek that were not present in **Mainstem-erosional-untreated reaches** in 1998-2000, 2004 or 2018 (n=11 samples totaling about 6000 organisms identified). These taxa are noted in Table 1 (*). Most of these taxa are typically associated with depositional habitats or small streams. When only the **2018 Mainstem-erosional-untreated reach** (n= 5 samples) is compared with all the 2018 treated habitat categories (n= 15 samples), there were 65 taxa that occurred in the treated habitats that did not occur in the untreated mainstem reach (107 total taxa in the untreated reach versus 172 taxa in the treated habitats)(Table 2).

This phenomenal 62% increase in total BMI diversity in the treated habitats occurred in just 2 years, attesting to the dispersal power of most BMI taxa. Large woody debris in the mainstem and side channels undoubtedly stabilizes and protects microhabitats necessary for many of these new arrivals to persist. “Build it and they will come” is an appropriate metaphor here.

There are no taxa present in lower Deer Creek that are currently on the Interagency Special Status/Sensitive Species Program (ISSSSP Region 6 Forest Service) list
<https://www.fs.fed.us/r6/sfpnw/issssp/>

Species that are more rare and unusual that have newly appeared in lower Deer Creek are the snail *Pristinicola hemphilli* (previously listed by ISSSSP); the dragonfly *Cordulegaster dorsalis*; the mayflies *Caudatella edmundsi* (declining populations in the PNW) and *Siphonurus*; the stoneflies *Zapada frigida* and *Soliperla*; and the caddisflies *Lepidostoma hoodi group* (previously listed ISSSSP), *Pseudostenophylax edwardsi*, *Yphria californica* (previously listed ISSSSP), and *Rhyacophila grandis*. Species such as *Pseudostenophylax edwardsi* and *Rhyacophila grandis* are typically small stream taxa. Restoration treatment creates a mosaic of habitats and microhabitats, some of which appear to sufficiently mimic small stream habitat to attract these species.

In Treated erosional habitats (2018) there were substantial increases in abundance of 10 taxa when compared with the Untreated erosional reach: Ostracoda, *Cinygmula*, *Neoleptophlebia*, *Lepidostoma cascadense*, *Lepidostoma unicolor group*, *Ceratopogoninae*, *Eloeophila*, *Hesperoconopa*, *Paratanytarsus*, and *Stempellinella*. It is hypothesized that large woody debris and side channels create more refugia from scouring and resorting of substrates during high flows that would depress populations of these taxa.

In Treated depositional habitats (2018) there were substantial increases in abundance of 18 taxa. These 18 taxa are a mix of obligate depositional and facultative depositional-erosional affiliated taxa. Again, large woody debris and side channels provide refugia, but also serve to create special microhabitats conducive to certain species. E.g. *Hesperoconopa* and *Rhabdomastix* are crane fly larvae that prefer stable, clean sandy substrates to burrow in.

The only taxon that exhibited substantial decrease in abundance (2018) in Treated habitats was the blackfly *Simulium*. This is an r-selected, multivoltine, “weed” taxa that typically occurs in high abundance in stream habitats that are frequently disturbed by scouring and resorting of

substrates. They are able to rapidly recolonize substrates after physical disturbance and multiply rapidly before more long-lived predators recover populations.

Benthic communities present in the McKenzie River mainstem upstream of Deer Creek are composed substantially of the same taxa as found in lower Deer Creek. There are some cold water taxa that are rare in lower Deer Creek but abundant in the McKenzie River, such as the stonefly *Yoraperla*. Another major difference is the net spinning caddisfly *Hydropsyche*, while common to abundant in lower Deer Creek is absent from the McKenzie River in this area.

Time trends in presence/absence and relative abundance of individual taxa in mainstem untreated erosional habitats from 1998-2000 to 2004 to present (2018-) will be made after 2019 and 2020 data become available. Preliminary indications are that **Warm water biota** have increased somewhat over the past 20 years in lower Deer Creek. Curiously, the **Cold water biota** seem to have also increased as a % of the BMI community (Table 3).

Table 2 lists the total number of taxa found in each habitat and treatment category, and also the numbers of taxa in the insect orders and non-insects. Again, in 2018, 107 taxa occurred in the Mainstem-erosional-untreated reach, while 172 (62% more) occurred in all of the Treated habitat categories.

In the lower Deer Creek mainstem, both the Treated erosional (129 taxa) and treated depositional (133 taxa) had significantly more taxa than the Untreated reach (107 taxa) in 2018 (Table 2). Erosional habitats in the newly created side channels had 108 taxa, comparable to the untreated reach, while the side channel depositional habitat had only 91 taxa present (only 2 samples could be averaged here). It is highly likely that the side channels will continue to rapidly accrue taxa before eventually plateauing off on species diversity in a few years time.

Table 3 lists salient community composition metrics. The Mainstem-erosional-untreated is highlighted for ready comparisons to treated habitats. Major findings are:

1. Total taxa richness was substantially higher in Mainstem-erosional-treated, Side channel-erosional-treated, and Mainstem-depositional-treated categories, and about the same in Side channel-depositional-treated habitats.
2. Total abundance was substantially higher in all the Treated habitat categories, except in Side channel-depositional-treated. However, this is comparing densities in riffles versus pools, and pools typically have sparser populations than riffles.
3. Total biomass was very substantially higher in all the treated habitat categories, except the Side channel-depositional-treated (again pools are not expected to be higher than riffles).
4. Total abundance varied from 1806 to 5336 invertebrates per square meter across all habitat categories, treatments and years in lower Deer Creek. Standing crops in this

range are on the low side for montane streams of this size in the western Cascades. Hopefully restoration will eventually boost standing crops into the 5-10k/m² range.

By the above community summary metrics, recovery in mainstem habitats after disturbance by restoration activities in 2016 is complete, and colonization and production in the side channel habitats is exceeding what is seen in the mainstem-erosional-untreated reach after 2 years. It is probable that taxa richness and standing crop abundance and biomass will continue on an upward trend over the next few years. Bear in mind that considerable annual variation is always expected depending primarily on discharge dynamics in any given year (Wagner & Schmidt 2004).

Further comparisons between treated and untreated habitat categories are:

1. Taxa that prefer warm water above the salmonid tolerance zone are present, but in low richness and abundance.
2. There is a relatively high richness and abundance of cold water taxa present in lower Deer Creek across all habitat categories, indicating water temperature regimes are supportive of salmonids, except for bull trout. Taxa that indicate year-round low water temperatures supportive of bull trout are rare or absent (e.f. *Megarcys*, *Yoraperla mariana*, *Parapsyche elsis*).
3. There is a high percentage of semivoltine taxa (long-lived) across all habitat types except in the 1 hyporheos sample taken, which is to be expected. Long-lived taxa indicate more habitat stability and maturity in the benthic community. They also tend to be larger taxa and favored food items for fish.
4. Most of the taxa present are small to medium size at maturity. The % larger taxa may increase in the treated reaches in the coming years as the community continues to change after the 2016 disturbance.
5. Insects are super-dominant in benthic communities across all habitat types, which is expected in a cooler, higher gradient, mid-elevation Cascades stream. Non-insects are more prevalent in the depositional habitats, which is again expected.
6. Feeding groups have an expected and balanced composition for a BMI community in a PNW montane stream in the treated habitats.
7. The 2018 Mainstem-erosional-untreated % composition of predators and shredders is substantially less than the treated habitats. Both of these groups contain many taxa sensitive to scouring and resorting of substrates during high flows, and require flow refugia to persist and thrive.

References

Wagner, R. and H.H. Schmidt 2004. Yearly discharge patterns determine species abundance and community diversity: Analysis of a 25 year record from the Breitenbach. Archives fur Hydrobiologia 161 (4): 511-544.

