BIOLOGICAL ASSESSMENT OF STREAM SITES ON VASHON ISLAND, WASHINGTON: AQUATIC INVERTEBRATE ASSEMBLAGES

2013

Report to the Vashon Nature Center, Washington
Bianca Perla, Project Manager

Prepared by

Wease Bollman
Rhithron Associates, Inc.
Missoula, Montana
January 2014

INTRODUCTION

This report summarizes data compiled from the analysis of benthic macroinvertebrate samples collected from streams on Vashon Island, Washington in August and September 2013. Samples were collected at 2 sites named “Fisher” and 1 site on Judd Creek. Laboratory sample processing and identification methods were consistent with Washington Department of Ecology standard operating procedures (WADOE 2006). Bioassessment metrics were calculated to obtain parameters related to habitat and water quality. In addition, this report considers probable sources of stress that may cause biological impairment. These probable stressors are described in narratives, and their prediction is based on the patterns of assemblage composition and attributes of taxa. Linking these patterns and attributes to possible stressors is complex, since streams are typically subject to multiple sources of disturbance. This report makes no attempt to apply a formal process to stressor identification; the only data informing the observations made in this study are aquatic invertebrate taxa lists and counts. In composing the narratives, the author relies on demonstrated associations between assemblage components and habitat and water quality variables gleaned from the writer’s research, the published literature, and other expert sources.

METHODS

Sample processing

Three macroinvertebrate samples from the Vashon Nature Center (VNC) were delivered to Rhithron’s laboratory facility in Missoula, Montana. All samples arrived in good condition. An inventory containing sample identification information was provided by the VNC Project Manager. Upon arrival, samples were unpacked and examined, and checked against the VNC inventory. An inventory spreadsheet that included project code and internal laboratory identification numbers was created and uploaded into the Rhithron database.

Standard sorting protocols were applied to achieve representative subsamples of a minimum of 500 organisms, when possible. Caton sub-sampling devices (Caton 1991), divided into 30 grids, each approximately 5 cm by 6 cm were used. Each individual sample was thoroughly mixed in its jar(s), poured out and evenly spread into the Caton tray, and individual grids were randomly selected. The contents of each grid were examined under stereoscopic microscopes using 10x-30x magnification. All aquatic invertebrates from each selected grid were sorted from the substrate, and placed in 95% ethanol for subsequent identification. Grid selection, examination, and sorting continued until at least 500 organisms were sorted. The final selected grid was completely sorted of all organisms. When 500 organisms were not present, the entire sample was sorted. All unsorted sample fractions were retained and stored at the Rhithron laboratory.

Organisms were individually examined by certified taxonomists, using 10x – 80x stereoscopic dissecting scopes (Leica S8E and S6E) and identified to target taxonomic levels consistent with current requirements of the Washington Department of Ecology, using appropriate published taxonomic references and keys. Identification, counts, life stages, and information about the condition of specimens were recorded in the Rhithron database via an electronic data entry interface. To obtain accuracy in richness measures, organisms that could not be identified to the target level specified were designated as “not unique” if other specimens from the same group could be taken to target levels. Organisms designated as “unique” were those that could be definitively distinguished from other organisms in the sample. Identified organisms were preserved in 80% ethanol in labeled vials, and archived at the Rhithron laboratory.

Midges were carefully morphotyped using 10x – 80x stereoscopic dissecting microscopes (Leica S8E and S6E) and representative specimens were slide mounted and examined at 200x – 1000x magnification using an Olympus BX 51 compound microscope. Slide mounted organisms were archived at the Rhithron laboratory.

Quality control procedures

Quality control procedures for initial sample processing and subsampling involved checking sorting efficiency. These checks were conducted on a single randomly selected sample by independent observers who microscopically re-examined the sorted substrate. All organisms that were missed were counted and this number was added to the total number obtained in the original sort. Sorting efficiency was evaluated by applying the following calculation:

$$SE = \frac{n_1}{n_{1+2}} \times 100$$

where: SE is the sorting efficiency, expressed as a percentage, n_1 is the total number of specimens in the first sort, and n_2 is the total number of specimens expected in the second sort.

Quality assurance procedures for taxonomic determinations of invertebrates involved checking accuracy, precision and enumeration. A single sample was randomly selected and all organisms re-identified and counted by an independent taxonomist. Taxa lists and enumerations were compared by calculating the Percent Taxonomic Difference (PTD), the Percent Difference in Enumeration (PDE), and a Bray-Curtis similarity statistic (Bray and Curtis 1957). Routinely, discrepancies between the original identifications and the QC identifications are discussed among the taxonomists, and necessary rectifications to the data are made. Discrepancies that cannot be rectified by discussions are routinely sent out to taxonomic specialists for identification. However, taxonomic certainty for identifications in this project was high, and no external verifications were necessary.

Data analysis

A proprietary database application (RAILIS v. 1.2 – Rhithron Associates, Inc.) was used to calculate metrics used in the narrative interpretations.

Metric and taxonomic signals for sediment deposition, thermal stress, water quality (including the presence of possible metals contamination), and habitat indicators were investigated and described in narrative interpretations. These interpretations of the taxonomic and functional composition of invertebrate assemblages are based on demonstrated associations between assemblage components and habitat and water quality variables gleaned from the published literature, the writer's own research and professional judgment, and those of other expert sources (e.g. Wisseman 1998). These interpretations are not intended to replace canonical procedures for stressor identification, since such procedures require substantial surveys of habitat, historical and current data related to water quality, land use, point and non-point source influences, soils, hydrology, geology, and other resources that were not readily available for this study. Instead, attributes of invertebrate taxa that are well-substantiated in diverse literature, published and unpublished research, and that are generally accepted by regional aquatic ecologists, are combined into descriptions of probable water quality and instream and reach-scale habitat conditions. The approach to this analysis uses some assemblage attributes that are interpreted as evidence of water quality and other attributes that are interpreted as evidence of habitat integrity.

It should be noted that ecological attributes assigned to organisms in the Rhithron database application do not necessarily agree with attributes assigned by the Puget Sound Stream Benthos (PSSB) database. Thus, values of some bioassessment metrics may differ between the calculation made by the PSSB website and those reported here. For comparability with other Puget Sound Lowlands sites, users should refer to the PSSB website for B-IBI metric values and scores.

Water quality variables are estimated by examining mayfly taxa richness and the Hilsenhoff Biotic Index (HBI) value. Other indications of water quality include the richness and abundance of hemoglobin-bearing taxa and the richness of sensitive taxa. Mayfly taxa richness has been demonstrated to be significantly correlated with chemical measures of dissolved oxygen, pH, and conductivity (e.g. Bollman 1998, Fore et al. 1996, Wisseman 1998). The Hilsenhoff Biotic Index (HBI) (Hilsenhoff 1987) has a long history of use and validation (Cairns and Pratt 1993). The index uses the relative abundance of taxa and the tolerance values associated with them to calculate a score representative of the tolerance of a benthic invertebrate assemblage. Higher HBI scores indicate more tolerant assemblages. In one study, the HBI was demonstrated to be significantly associated with conductivity, pH, water temperature, sediment deposition, and the presence of filamentous algae (Bollman 1998). Crops of filamentous algae are also suspected when macroinvertebrates associated or dependent on it (e.g. LeSage and Harrison 1980, Anderson 1976) are abundant. Nutrient enrichment in streams often results in large crops of filamentous algae (Watson 1988). Hemoglobin-bearing taxa are very tolerant of environments with low oxygen concentrations, since the hemoglobin in their circulating fluids enables them to carry more oxygen than organisms without it. Low oxygen concentrations are often a result of nutrient enrichment in situations where enrichment has encouraged excessive plant growth; nocturnal respiration by these plants creates hypoxic conditions. Sensitive taxa exhibit intolerance to a wide range of stressors (e.g. Wisseman 1998, Hellawell 1986, Barbour et al. 1999), including nutrient enrichment, acidification, thermal stress, sediment deposition, habitat disruption, and other causes of degraded ecosystem health. These taxa are expected to be present in predictable numbers in functioning streams. Sensitive taxa encountered in Vashon Nature Center samples included the heptageniid mayflies *Cinygma* sp. and *Ironodes* sp., and a few other taxa that were more infrequently encountered.

Thermal characteristics of the sampled site are predicted by the richness and abundance of cold stenotherm taxa (Clark 1997) which require low water temperatures, and by calculation of the predicted temperature preference of the macroinvertebrate assemblage (Brandt 2001). Hemoglobin-bearing taxa are also indicators of warm water temperatures (Walshe 1947). Dissolved oxygen is associated with water temperature (colder water can hold more dissolved oxygen) and can also vary with the degree of nutrient enrichment. Increased temperatures and high nutrient concentrations can, alone or in concert, create conditions favorable to hypoxic sediments, habitats preferred by hemoglobin-bearers.

Metals sensitivity for some groups, especially the heptageniid mayflies, is well-known (e.g. Clements 1999, Clements 2004, Fore 2003). In the present approach, the absence of these groups in environs where they are typically expected to occur is considered a signal of possible metals contamination, especially when these signals are combined with a measure of overall assemblage tolerance of metals. The Metals Tolerance Index (MTI) (McGuire 1998) ranks taxa according to their sensitivity to metals. Weighting taxa by their abundance in a sample, assemblage tolerance is estimated by averaging the tolerance of all sampled individuals. Higher values for the MTI indicate assemblages with greater tolerance to metals contamination.

The condition of instream and streamside habitats is also estimated by characteristics of the macroinvertebrate assemblages. Stress from sediment deposition is evaluated by caddisfly richness and by clinger richness (Kleindl 1995, Bollman 1998, Karr and Chu 1999). A newer tool, the Fine Sediment Biotic Index (FSBI) (Relyea et al. 2000) is also used. Similar to the HBI, tolerance values are assigned to taxa based on the substrate particle sizes with which the taxa are most frequently associated. Scores are determined by weighting these tolerance values by the relative abundance of taxa in a sample. Higher values of the FSBI indicate assemblages with greater fine sediment sensitivity. However, it appears that FSBI values may be influenced by the presence of other deposited material, such as large organic material, including leaves and woody debris.

The functional characteristics of macroinvertebrate assemblages are based on the morphology and behaviors associated with feeding, and are interpreted in terms of the River Continuum Concept (Vannote et al. 1980) in the narratives. Alterations from predicted patterns may be interpreted as evidence of water quality or habitat disruption. For example, shredders and the microbes they depend on are sensitive to modifications of the riparian zone vegetation (Plafkin et al. 1989), and the abundance of invertebrate predators is likely to be related to the diversity of invertebrate prey species, and thus the complexity of instream habitats.

RESULTS

Quality Control Procedures

Sorting efficiency for the randomly-selected sample was 99.46%. Taxonomic precision for identification and enumeration was 99.18%. PTD was 0.91% and PDE was 0.09%. These statistics fall well within acceptable industry criteria (Stribling et al. 2003).

Ecological interpretation of aquatic invertebrate assemblages

- *Judd Creek*

Mayflies were poorly represented at this site: only 2 taxa were present, and only 12 individuals were counted. The biotic index value (5.38) was higher than expected for a Puget Sound Lowlands stream. Impaired water quality may be indicated by these findings. The dominant taxon was the blackfly *Simulium* sp., a filter-feeder, which accounted for 76% of sampled organisms. The abundance of these larvae suggests that suspended organic material was an important energy source at this site: nutrient enrichment is sometimes associated with large numbers of *Simulium* sp. The calculated thermal preference of the invertebrate assemblage was 13.7°C.

Seventeen "clinger" taxa and 7 caddisfly taxa were counted in the sample, suggesting that sediment deposition had limited influence on the benthic assemblage. The low FSBI value (3.15), however, indicated a sediment-tolerant assemblage. Overall taxa richness (39) was relatively high, suggesting diverse instream habitats. At least 6 stonefly taxa were supported here, including the perlodid *Kogotus* sp. Diversity among the stoneflies may be related to the condition of reach-scale habitat features. Stable streambanks, intact riparian function, and natural channel morphology may be indicated. Long-lived semivoltine invertebrates (4 taxa) were well-represented. These taxa could not complete their long life cycles if catastrophic events such as dewatering, scouring sediment pulses, or thermal extremes had been influential. The functional composition of the assemblage was overwhelmed by filterers, especially *Simulium* sp. Scrapers were notably rare, a finding that may be related to channel shading.

- *Fisher*

FishVNC2
The sample collected at this site contained only 163 organisms. Low abundance of invertebrates in benthic samples may be related to poor water quality or habitat integrity, or may be due to unfavorable sampling conditions. In spite of the low abundance, diversity was relatively high, and richness metrics appeared to perform well. As a result, the interpretation of the taxonomic and functional components of the assemblage is probably reliable.

This site supported at least 4 mayfly taxa, including the sensitive heptageniid *Ironodes* sp. The biotic index value (2.80) indicated a sensitive assemblage, characteristic of a stream without substantial water quality impairment. Although the metals tolerance index value (2.90) was slightly higher than the biotic index value, metals contamination seems unlikely here, since heptageniid mayflies (*Ironodes* sp. and *Cinygmula* sp.) were common in the sample. The thermal preference of the invertebrate assemblage was calculated at 12.9ºC.

“Clinger” taxa (19) and caddisfly taxa (9) were well-represented, suggesting that sediment deposition did not limit colonization of stony substrate habitats. The FSBI value (4.61) indicated a moderately sediment-tolerant assemblage. High overall taxa richness (39) may have been related to diverse instream habitats. Six stonefly taxa were counted: a rich stonefly fauna may indicate that reach-scale habitat features such as riparian vegetation, streambanks, and channel morphology were in good condition. Thermal stress, sediment scour, or dewatering probably were not influential, since 5 semivoltine taxa were present in the sample. All expected functional components were present, and the proportional representation of each group was consistent with a minimally-impaired Puget Sound Lowlands stream.

65B
The sample collected at this site contained only 104 organisms. Low abundance of invertebrates in benthic samples may be related to poor water quality or habitat integrity, or may be due to unfavorable sampling conditions. In this case, assemblage diversity was not as high as expected: interpretation of the taxonomic and functional composition may not be reliable.

Metric indicators of water quality gave conflicting results for this sample. Only 2 mayfly taxa were present, but the biotic index value (2.91) indicated a relatively sensitive benthic assemblage. The presence of relatively sensitive taxa, such as the caddisfly *Cryptochia* sp. and the elmid *Lara* sp. suggest good water quality. The calculated thermal preference was 12.9ºC.

Low diversity among the “clingers” (12 taxa) and the caddisflies (4 taxa) may be related to the low abundance of organisms in the collection. However, impaired instream habitats due to sediment deposition cannot be ruled out. The FSBI value (4.73) indicated a moderately sediment-tolerant assemblage. Overall taxa richness (28) was lower than expected. This may be a consequence of habitat disturbances, or of the low numbers of invertebrates in the sample. In contrast, the number of stonefly taxa (6) in the collection was high, suggesting stable streambanks, functioning riparian zones, and natural channel morphology. Five semivoltine taxa were counted, indicating that surface flow persisted year-round and that catastrophes such as dewatering or toxic pollutants did not influence the invertebrate assemblage. All expected functional groups were present. Predators, particularly among the stoneflies and dipterans, were notably abundant.

SUMMARY

Table 1 summarizes the stressors suggested by the analysis of taxonomic and functional composition of invertebrate assemblages and described in the site-by-site narratives.

Table 1. Possible stressors affecting sites on Vashon Island, suggested by the structure and function of the benthic invertebrate assemblages collected in 2013.

Station name	water quality degradation	metals	sediment deposition	thermal stress	habitat disruption
Judd Creek	+				
Fisher					
Fisher 65B	?		?		

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APPENDIX

Taxa lists and metric summaries

Vashon Island: the Vashon Nature Center

2013

Taxa Listing

Project ID: VNC13BP
RAI No.: VNC13BP001

RAI No.: VNC13BP001 Sta. Name: JuddVNC1
Client ID: JuddVNC1
Date Coll.: 8/19/2013 No. Jars: 2 STORET ID: Judd Creek

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Other Non-Insect							
Oribatida	1	0.18%	Yes	Adult		11	PR
Crangonyctidae							
Crangonyx sp.	1	0.18%	Yes	Unknown		6	CG
Lebertiidae							
Lebertia sp.	1	0.18%	Yes	Adult		8	PR
Sphaeriidae							
Pisidium sp.	1	0.18%	Yes	Unknown		5	CF
Torrenticolidae							
Torrenticola sp.	1	0.18%	Yes	Adult		8	PR
Oligochaeta							
Lumbriculidae							
Lumbriculidae	6	1.09%	Yes	Unknown	Damaged	4	CG
Ephemeroptera							
Baetidae							
Baetis tricaudatus	10	1.81%	Yes	Larva		4	CG
Diphetor hageni	2	0.36%	Yes	Larva		5	CG
Plecoptera							
Chloroperlidae							
Suwallia sp.	7	1.27%	Yes	Larva		1	PR
Sweltsa sp.	8	1.45%	Yes	Larva		0	PR
Nemouridae							
Malenka sp.	1	0.18%	Yes	Larva		1	SH
Zapada cinctipes	10	1.81%	Yes	Larva		3	SH
Perlodidae							
Kogotus sp.	1	0.18%	Yes	Larva		1	PR
Skwala sp.	1	0.18%	Yes	Larva		3	PR
Trichoptera							
Glossosomatidae							
Glossosomatidae	1	0.18%	Yes	Pupa		0	SC
Hydropsychidae							
Hydropsyche sp.	10	1.81%	Yes	Larva		5	CF
Hydropsychidae	2	0.36%	No	Larva	Early Instar	4	CF
Limnephilidae							
Psychoglypha sp.	1	0.18%	Yes	Larva		0	SH
Rhyacophilidae							
Rhyacophila sp.	1	0.18%	No	Larva	Early Instar	1	PR
Rhyacophila atrata complex	2	0.36%	Yes	Larva		0	PR
Rhyacophila blarina	4	0.72%	Yes	Larva		1	PR
Rhyacophila Brunnea/Vemna Gr.	4	0.72%	Yes	Larva		2	PR
Rhyacophila narvae	3	0.54%	Yes	Larva		0	PR

Taxa Listing

Project ID: VNC13BP
RAI No.: VNC13BP001

RAI No.: VNC13BP001 Sta. Name: JuddVNC1
Client ID: JuddVNC1
Date Coll.: 8/19/2013 No. Jars: 2 STORET ID: Judd Creek

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Coleoptera							
Elmidae							
Cleptelmis addenda	1	0.18%	Yes	Adult		4	CG
Elmidae	2	0.36%	No	Larva	Early Instar	4	CG
Heterlimnius corpulentus	11	1.99%	Yes	Larva		3	CG
Lara sp.	5	0.91%	Yes	Larva		1	SH
Narpus concolor	2	0.36%	Yes	Larva		2	CG
Diptera							
Ceratopogonidae							
Ceratopogoninae	1	0.18%	Yes	Larva		6	PR
Pelecorhynchidae							
Glutops sp.	1	0.18%	Yes	Larva		1	PR
Simuliidae							
Simulium sp.	32	5.80%	No	Pupa		6	CF
Simulium sp.	385	69.75%	Yes	Larva		6	CF
Tipulidae							
Dicranota sp.	1	0.18%	Yes	Larva		3	PR
Tipula sp.	1	0.18%	Yes	Larva		4	SH
Chironomidae							
Chironomidae							
Brillia sp.	3	0.54%	Yes	Larva		4	SH
Cladotanytarsus sp.	1	0.18%	Yes	Larva		7	CG
Diplocladius cultriger	1	0.18%	Yes	Larva		8	CG
Eukiefferiella sp.	9	1.63%	Yes	Larva		8	CG
Micropsectra sp.	6	1.09%	Yes	Larva		4	CG
Orthocladiinae	2	0.36%	No	Larva	Early Instar	6	CG
Orthocladiinae sp. (RAI Taxon # 0001)	1	0.18%	Yes	Larva		11	UN
Parametriocnemus sp.	4	0.72%	Yes	Larva		5	CG
Rheotanytarsus sp.	1	0.18%	Yes	Larva		6	CF
Tvetenia Bavarica Gr.	3	0.54%	Yes	Larva		5	CG
Sample Count	552						

Taxa Listing

Project ID: VNC13BP
RAI No.: VNC13BP002

RAI No.: VNC13BP002 Sta. Name: FishVNC2
Client ID: FishVNC2
Date Coll.: 9/12/2013 No. Jars: 1 STORET ID: Fisher

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Other Non-Insect							
Hydrobiidae							
Hydrobiidae	1	0.61%	Yes	Immature		8	SC
Planorbidae							
Menetus sp.	1	0.61%	Yes	Unknown		6	SC
Sperchontidae							
Sperchonopsis sp.	1	0.61%	Yes	Adult		11	PR
Sphaeriidae							
Pisidium sp.	5	3.07%	Yes	Unknown		5	CF
Oligochaeta							
Lumbriculidae							
Lumbriculidae	2	1.23%	Yes	Unknown	Damaged	4	CG
Ephemeroptera							
Baetidae							
Baetis tricaudatus	21	12.88%	Yes	Larva		4	CG
Heptageniidae							
Cinygmula sp.	12	7.36%	Yes	Larva		0	SC
Ironodes sp.	3	1.84%	Yes	Larva		0	SC
Leptophlebiidae							
Paraleptophlebia sp.	1	0.61%	Yes	Larva		1	CG
Plecoptera							
Capniidae							
Capniidae	1	0.61%	Yes	Larva	Early Instar	1	SH
Chloroperlidae							
Sweltsa sp.	8	4.91%	Yes	Larva		0	PR
Nemouridae							
Zapada cinctipes	2	1.23%	Yes	Larva		3	SH
Zapada Oregonensis Gr.	2	1.23%	Yes	Larva		2	SH
Perlidae							
Hesperoperla pacifica	1	0.61%	Yes	Larva		1	PR
Perlodidae							
Kogotus sp.	4	2.45%	Yes	Larva		1	PR

Taxa Listing

Project ID: VNC13BP
RAI No.: VNC13BP002

RAI No.: VNC13BP002
Sta. Name: FishVNC2
Client ID: FishVNC2
Date Coll.: 9/12/2013
No. Jars: 1
STORET ID: Fisher

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Trichoptera							
Glossosomatidae							
Glossosoma sp.	10	6.13%	Yes	Larva		0	SC
Glossosomatidae	1	0.61%	No	Pupa		0	SC
Hydropsychidae							
Arctopsychinae	1	0.61%	Yes	Larva	Early Instar	2	PR
Hydropsyche sp.	16	9.82%	Yes	Larva		5	CF
Limnephilidae							
Cryptochia sp.	1	0.61%	Yes	Larva		0	SH
Philopotamidae							
Wormaldia sp.	1	0.61%	Yes	Larva		0	CF
Rhyacophilidae							
Rhyacophila sp.	2	1.23%	No	Larva	Early Instar	1	PR
Rhyacophila atrata complex	1	0.61%	Yes	Larva		0	PR
Rhyacophila Betteni Gr.	2	1.23%	Yes	Larva		0	PR
Rhyacophila Brunnea/Vemna Gr.	4	2.45%	Yes	Larva		2	PR
Rhyacophila grandis	1	0.61%	Yes	Larva		1	PR
Coleoptera							
Elmidae							
Lara sp.	3	1.84%	Yes	Larva		1	SH
Narpus concolor	11	6.75%	Yes	Larva		2	CG
Diptera							
Ceratopogonidae							
Ceratopogoninae	10	6.13%	Yes	Larva		6	PR
Dixidae							
Dixa sp.	3	1.84%	Yes	Larva		1	CG
Meringodixa sp.	1	0.61%	Yes	Larva		2	CG
Pelecorhynchidae							
Glutops sp.	3	1.84%	Yes	Larva		1	PR
Psychodidae							
Pericoma / Telmatoscopus	2	1.23%	Yes	Larva		4	CG
Simuliidae							
Simulium sp.	2	1.23%	No	Pupa		6	CF
Simulium sp.	6	3.68%	Yes	Larva		6	CF
Tipulidae							
Dicranota sp.	2	1.23%	Yes	Larva		3	PR
Hexatoma sp.	5	3.07%	Yes	Larva		2	PR
Tipula sp.	1	0.61%	Yes	Larva		4	SH
Chironomidae							
Chironomidae							
Brillia sp.	1	0.61%	Yes	Larva		4	SH
Micropsectra sp.	2	1.23%	Yes	Larva		4	CG
Polypedilum sp.	1	0.61%	Yes	Larva		6	SH
Tvetenia Bavarica Gr.	5	3.07%	Yes	Larva		5	CG
Sample Count	163						

Taxa Listing

Project ID: VNC13BP
RAI No.: VNC13BP003

RAI No.:	VNC13BP003			Sta. Name:	65B
Client ID:	65B				
Date Coll.:	9/9/2013	No. Jars:	1	STORET ID:	Fisher

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Other Non-Insect							
Lebertiidae							
Lebertia sp.	1	0.96%	Yes	Adult		8	PR
Planorbidae							
Menetus sp.	1	0.96%	Yes	Unknown		6	SC
Ephemeroptera							
Baetidae							
Baetis tricaudatus	8	7.69%	Yes	Larva		4	CG
Heptageniidae							
Cinygmula sp.	18	17.31%	Yes	Larva		0	SC
Plecoptera							
Chloroperlidae							
Chloroperlidae	1	0.96%	No	Larva	Early Instar	1	PR
Suwallia sp.	3	2.88%	Yes	Larva		1	PR
Sweltsa sp.	4	3.85%	Yes	Larva		0	PR
Nemouridae							
Soyedina sp.	1	0.96%	Yes	Larva		2	SH
Zapada cinctipes	1	0.96%	Yes	Larva		3	SH
Perlidae							
Hesperoperla pacifica	3	2.88%	Yes	Larva		1	PR
Perlodidae							
Kogotus sp.	9	8.65%	Yes	Larva		1	PR
Trichoptera							
Glossosomatidae							
Glossosoma sp.	3	2.88%	Yes	Larva		0	SC
Hydropsychidae							
Hydropsyche sp.	1	0.96%	Yes	Larva		5	CF
Limnephilidae							
Cryptochia sp.	1	0.96%	Yes	Larva		0	SH
Rhyacophilidae							
Rhyacophila sp.	1	0.96%	No	Larva	Early Instar	1	PR
Rhyacophila Brunnea/Vemna Gr.	2	1.92%	Yes	Larva		2	PR
Coleoptera							
Elmidae							
Heterlimnius corpulentus	1	0.96%	Yes	Larva		3	CG
Lara sp.	2	1.92%	Yes	Larva		1	SH
Narpus concolor	2	1.92%	Yes	Larva		2	CG

Taxa Listing

Project ID: VNC13BP
RAI No.: VNC13BP003

RAI No.: VNC13BP003 Sta. Name: 65B
Client ID: 65B
Date Coll.: 9/9/2013 No. Jars: 1 STORET ID: Fisher

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Diptera							
Ceratopogonidae							
Ceratopogoninae	15	14.42%	Yes	Larva		6	PR
Empididae							
Chelifera sp.	2	1.92%	Yes	Larva		5	PR
Neoplasta sp.	1	0.96%	Yes	Larva		5	PR
Psychodidae							
Pericoma / Telmatoscopus	1	0.96%	Yes	Larva		4	CG
Simuliidae							
Simulium sp.	10	9.62%	Yes	Larva		6	CF
Tipulidae							
Dicranota sp.	1	0.96%	Yes	Larva		3	PR
Hexatoma sp.	1	0.96%	Yes	Larva		2	PR
Rhabdomastix Setigera Gr.	1	0.96%	Yes	Larva		3	CG
Chironomidae							
Chironomidae							
Brillia sp.	3	2.88%	Yes	Larva		4	SH
Micropsectra sp.	2	1.92%	Yes	Larva		4	CG
Parametriocnemus sp.	4	3.85%	Yes	Larva		5	CG
Sample Count	104						

Metrics Report

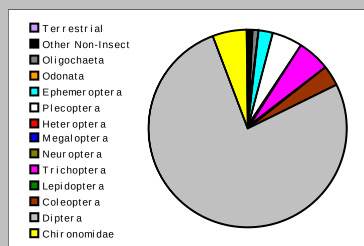
Project ID: VNC13BP
RAI No.: VNC13BP001
Sta. Name: JuddVNC1
Client ID: JuddVNC1
STORET ID Judd Creek
Coll. Date: 8/19/2013
Latitude: 47.41479 **Longitude:** -122.47598

Abundance Measures

Sample Count:	552	
Sample Abundance:	8,280.00	6.67% of sample used
Coll. Procedure:		
Sample Notes:	B.Perla, A.Eckhardt	

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	5	5	0.91%
Oligochaeta	1	6	1.09%
Odonata			
Ephemeroptera	2	12	2.17%
Plecoptera	6	28	5.07%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	7	28	5.07%
Lepidoptera			
Coleoptera	4	21	3.80%
Diptera	5	421	76.27%
Chironomidae	9	31	5.62%

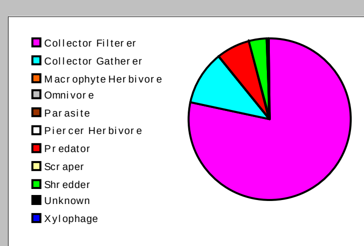


Dominant Taxa

Category	A	PRA
Simulium	417	75.54%
Heterlimnius corpulentus	11	1.99%
Zapada cinctipes	10	1.81%
Hydropsyche	10	1.81%
Baetis tricaudatus	10	1.81%
Eukiefferiella	9	1.63%
Sweltsa	8	1.45%
Suwallia	7	1.27%
Micropsectra	6	1.09%
Lumbriculidae	6	1.09%
Lara	5	0.91%
Rhyacophila Brunnea/Vemna Gr.	4	0.72%
Rhyacophila blarina	4	0.72%
Parametriocnemus	4	0.72%
Brillia	3	0.54%

Functional Composition

Category	R	A	PRA
Predator	14	37	6.70%
Parasite			
Collector Gatherer	13	61	11.05%
Collector Filterer	4	431	78.08%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	1	1	0.18%
Shredder	6	21	3.80%
Omnivore			
Unknown	1	1	0.18%

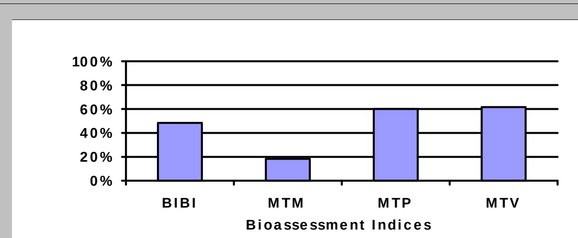


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	39
E Richness	2
P Richness	6
T Richness	7
EPT Richness	15
EPT Percent	12.32%
All Non-Insect Abundance	11
All Non-Insect Richness	6
All Non-Insect Percent	1.99%
Oligochaeta+Hirudinea Percent	1.09%
Baetidae/Ephemeroptera	1.000
Hydropsychidae/Trichoptera	0.429
Dominance	
Dominant Taxon Percent	75.54%
Dominant Taxa (2) Percent	77.54%
Dominant Taxa (3) Percent	79.35%
Dominant Taxa (10) Percent	89.49%
Diversity	
Shannon H (loge)	1.371
Shannon H (log2)	1.979
Margalef D	6.089
Simpson D	0.565
Evenness	0.048
Function	
Predator Richness	14
Predator Percent	6.70%
Filterer Richness	4
Filterer Percent	78.08%
Collector Percent	89.13%
Scraper+Shredder Percent	3.99%
Scraper/Filterer	0.002
Scraper/Scraper+Filterer	0.002
Habit	
Burrower Richness	3
Burrower Percent	1.81%
Swimmer Richness	2
Swimmer Percent	2.17%
Clinger Richness	17
Clinger Percent	88.22%
Characteristics	
Cold Stenotherm Richness	2
Cold Stenotherm Percent	0.36%
Hemoglobin Bearer Richness	
Hemoglobin Bearer Percent	
Air Breather Richness	2
Air Breather Percent	0.36%
Voltinism	
Univoltine Richness	19
Semivoltine Richness	4
Multivoltine Percent	7.97%
Tolerance	
Sediment Tolerant Richness	3
Sediment Tolerant Percent	1.45%
Sediment Sensitive Richness	0
Sediment Sensitive Percent	0.00%
Metals Tolerance Index	4.756
Pollution Sensitive Richness	1
Pollution Tolerant Percent	0.18%
Hilsenhoff Biotic Index	5.382
Intolerant Percent	7.43%
Supertolerant Percent	2.17%
CTQa	75.071

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	24	48.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	18	60.00%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	11	61.11%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	4	19.05%	Severe



Tuesday, January 28, 2014

Metrics Report

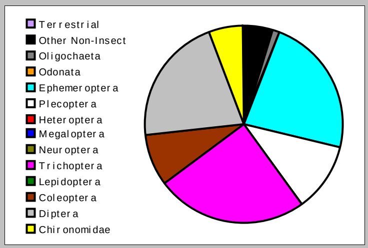
Project ID: VNC13BP
RAI No.: VNC13BP002
Sta. Name: FishVNC2
Client ID: FishVNC2
STORET ID Fisher
Coll. Date: 9/12/2013
Latitude: 47.38765 **Longitude:** -122.48467

Abundance Measures

Sample Count: 163
Sample Abundance: 163.00 100.00% of sample used
Coll. Procedure:
Sample Notes: BP, JR, MS, KF

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	4	8	4.91%
Oligochaeta	1	2	1.23%
Odonata			
Ephemeroptera	4	37	22.70%
Plecoptera	6	18	11.04%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	9	40	24.54%
Lepidoptera			
Coleoptera	2	14	8.59%
Diptera	9	35	21.47%
Chironomidae	4	9	5.52%

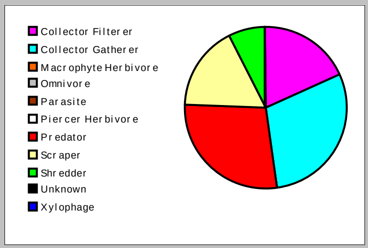


Dominant Taxa

Category	A	PRA
Baetis tricaudatus	21	12.88%
Hydropsyche	16	9.82%
Cinygmula	12	7.36%
Narpus concolor	11	6.75%
Glossosoma	10	6.13%
Ceratopogoninae	10	6.13%
Sweltsa	8	4.91%
Simulium	8	4.91%
Tvetenia Bavarica Gr.	5	3.07%
Pisidium	5	3.07%
Hexatoma	5	3.07%
Rhyacophila Brunnea/Vemna Gr.	4	2.45%
Kogotus	4	2.45%
Lara	3	1.84%
Ironodes	3	1.84%

Functional Composition

Category	R	A	PRA
Predator	13	45	27.61%
Parasite			
Collector Gatherer	9	48	29.45%
Collector Filterer	4	30	18.40%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	5	28	17.18%
Shredder	8	12	7.36%
Omnivore			
Unknown			

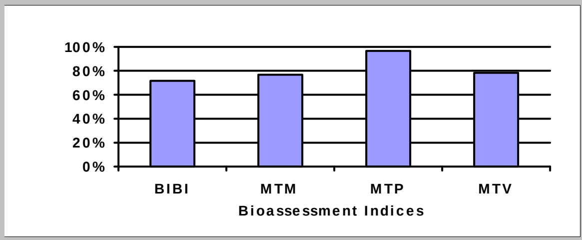


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	39
E Richness	4
P Richness	6
T Richness	9
EPT Richness	19
EPT Percent	58.28%
All Non-Insect Abundance	10
All Non-Insect Richness	5
All Non-Insect Percent	6.14%
Oligochaeta+Hirudinea Percent	1.23%
Baetidae/Ephemeroptera	0.568
Hydropsychidae/Trichoptera	0.425
Dominance	
Dominant Taxon Percent	12.88%
Dominant Taxa (2) Percent	22.70%
Dominant Taxa (3) Percent	30.06%
Dominant Taxa (10) Percent	65.03%
Diversity	
Shannon H (loge)	3.189
Shannon H (log2)	4.601
Margalef D	7.506
Simpson D	0.052
Evenness	0.041
Function	
Predator Richness	13
Predator Percent	27.61%
Filterer Richness	4
Filterer Percent	18.40%
Collector Percent	47.85%
Scraper+Shredder Percent	24.54%
Scraper/Filterer	0.933
Scraper/Scraper+Filterer	0.483
Habit	
Burrower Richness	5
Burrower Percent	6.75%
Swimmer Richness	4
Swimmer Percent	15.95%
Clinger Richness	19
Clinger Percent	57.67%
Characteristics	
Cold Stenotherm Richness	2
Cold Stenotherm Percent	2.45%
Hemoglobin Bearer Richness	2
Hemoglobin Bearer Percent	1.23%
Air Breather Richness	3
Air Breather Percent	4.91%
Voltinism	
Univoltine Richness	25
Semivoltine Richness	5
Multivoltine Percent	19.02%
Tolerance	
Sediment Tolerant Richness	4
Sediment Tolerant Percent	6.13%
Sediment Sensitive Richness	2
Sediment Sensitive Percent	6.75%
Metals Tolerance Index	2.896
Pollution Sensitive Richness	3
Pollution Tolerant Percent	0.00%
Hilsenhoff Biotic Index	2.796
Intolerant Percent	50.31%
Supertolerant Percent	0.61%
CTQa	64.607

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	36	72.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	29	96.67%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	14	77.78%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	16	76.19%	Slight



Tuesday, January 28, 2014

Metrics Report

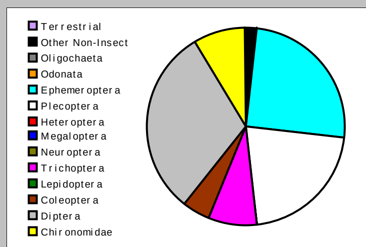
Project ID: VNC13BP
RAI No.: VNC13BP003
Sta. Name: 65B
Client ID: 65B
STORET ID Fisher
Coll. Date: 9/9/2013
Latitude: 47.383942 **Longitude:** -122.481469

Abundance Measures

Sample Count: 104
Sample Abundance: 104.00 100.00% of sample used
Coll. Procedure:
Sample Notes: Jeff Adams, B.Perla

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	2	2	1.92%
Oligochaeta			
Odonata			
Ephemeroptera	2	26	25.00%
Plecoptera	6	22	21.15%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	4	8	7.69%
Lepidoptera			
Coleoptera	3	5	4.81%
Diptera	8	32	30.77%
Chironomidae	3	9	8.65%

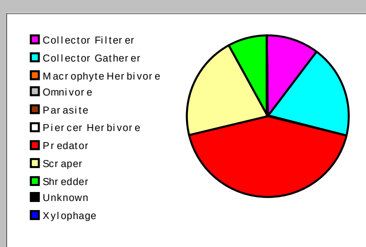


Dominant Taxa

Category	A	PRA
Cinygmula	18	17.31%
Ceratopogoninae	15	14.42%
Simulium	10	9.62%
Kogotus	9	8.65%
Baetis tricaudatus	8	7.69%
Sweltsa	4	3.85%
Parametriocnemus	4	3.85%
Suwallia	3	2.88%
Hesperoperla pacifica	3	2.88%
Glossosoma	3	2.88%
Brillia	3	2.88%
Rhyacophila Brunnea/Vemna Gr.	2	1.92%
Narpus concolor	2	1.92%
Micropsectra	2	1.92%
Lara	2	1.92%

Functional Composition

Category	R	A	PRA
Predator	11	44	42.31%
Parasite			
Collector Gatherer	7	19	18.27%
Collector Filterer	2	11	10.58%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	3	22	21.15%
Shredder	5	8	7.69%
Omnivore			
Unknown			

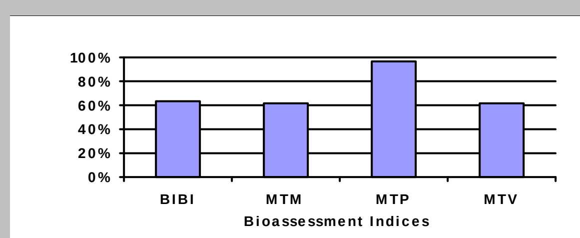


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	28
E Richness	2
P Richness	6
T Richness	4
EPT Richness	12
EPT Percent	53.85%
All Non-Insect Abundance	2
All Non-Insect Richness	2
All Non-Insect Percent	1.92%
Oligochaeta+Hirudinea Percent	0.00%
Baetidae/Ephemeroptera	0.308
Hydropsychidae/Trichoptera	0.125
Dominance	
Dominant Taxon Percent	17.31%
Dominant Taxa (2) Percent	31.73%
Dominant Taxa (3) Percent	41.35%
Dominant Taxa (10) Percent	74.04%
Diversity	
Shannon H (loge)	2.828
Shannon H (log2)	4.080
Margalef D	5.838
Simpson D	0.077
Evenness	0.056
Function	
Predator Richness	11
Predator Percent	42.31%
Filterer Richness	2
Filterer Percent	10.58%
Collector Percent	28.85%
Scraper+Shredder Percent	28.85%
Scraper/Filterer	2.000
Scraper/Scraper+Filterer	0.667
Habit	
Burrower Richness	5
Burrower Percent	6.73%
Swimmer Richness	1
Swimmer Percent	7.69%
Clinger Richness	12
Clinger Percent	55.77%
Characteristics	
Cold Stenotherm Richness	1
Cold Stenotherm Percent	0.96%
Hemoglobin Bearer Richness	1
Hemoglobin Bearer Percent	0.96%
Air Breather Richness	2
Air Breather Percent	1.92%
Voltinism	
Univoltine Richness	15
Semivoltine Richness	5
Multivoltine Percent	17.31%
Tolerance	
Sediment Tolerant Richness	2
Sediment Tolerant Percent	1.92%
Sediment Sensitive Richness	1
Sediment Sensitive Percent	2.88%
Metals Tolerance Index	2.818
Pollution Sensitive Richness	1
Pollution Tolerant Percent	0.00%
Hilsenhoff Biotic Index	2.913
Intolerant Percent	49.04%
Supertolerant Percent	0.96%
CTQa	66.611

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	32	64.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	29	96.67%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	11	61.11%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	13	61.90%	Slight



Tuesday, January 28, 2014