Macroinvertebrate Monitoring of Redmond and Blakely Ridge Ephemeral Streams

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Introduction

Since the early 1980's biological monitoring has developed as a reliable tool for the assessment of stream and watershed health in an ecological context broader than traditional chemical and habitat assessment. In late May of 1991, macroinvertebrate samples were collected from 6 streams and 2 wetlands in the proposed Blakely and Redmond Ridge development projects (UPD) as a biological component of the project monitoring plan. The 1991 collections were intended to represent a pre-development, biological baseline upon which future monitoring efforts could be based. In an attempt to evaluate the streams using the benthic index of biological integrity (B-IBI), macroinvertebrates were again collected in late September 1997 from 5 streams sites and in late September 1998 from 1 stream in the development area. The researchers found the study streams were variably ephemeral and thus not appropriate for use in a standard Fall analysis using Puget Sound lowland B-IBI.

To address the ephemeral streams dilemma, a project was undertaken to determine a period of time during which the UPD streams could be sampled and evaluated using macroinvertebrates. Following the methods outlined in Karr and Chu (1999), samples were to be taken at two week intervals beginning in late May on 7 small streams draining the development area. Sampling would be halted when stream dewatering inhibited sampling efforts. The set of samples taken two weeks prior to the early drying of streams would then be analyzed to represent the macroinvertebrate fauna present during the latest appropriate time for sampling the ephemeral streams and the response of that fauna to varying levels of human impact on the watershed. The spring and summer 1999 macroinvertebrate assessment effort and lessons from the study will be described in the following report.

Methods and Site Selection

Site Selection

Sites sampled in 1991 and 1997 were purposely chosen for the 1999 study to allow comparison between years and between seasons. These seven stream sites (Table 1) represent the primary drainages of the UPD development area. As much as possible, sample sites were chosen where a cobble-gravel riffle was present upstream of any bridges, water control structures, or other permanent human influences. Where such riffles were not present, sample locations were selected in substrates and riparian conditions typical of the stream and where the gradient increased the flow enough to effectively use a surber sampler.

Sampling

A 500-µm mesh, 30 cm (12 in) x 30 cm frame, modified surber sampler was used to collect samples from near the downstream end, the middle, and near the upstream end of a riffle, in that order. The surber sampler was placed in the thalweg or main channel. Large cobble and other sizable debris is lifted from the substrate, rubbed off inside the net to remove any organisms, then placed into a bucket for final examination. A metal tool (an old chisel or screwdriver) was marked at 10cm and used to disturb the substrate within the frame to a depth of 10cm. Once loosened, hands and the tool were used to disturb the substrate from the upstream to downstream end of the frame to methodically direct the organisms with the current into the net.

Once collected, organisms are picked from inside the net and the cod end emptied into a pan. Large debris is picked from the pan before the remaining debris and organisms are washed into a 500-µm mesh sieve. Material in the sieve is washed with a squirt bottle into an 8-oz container; the complete sample should occupy about 1/3 of the container. The remainder of the container is then filled with 95-100% ethanol (EtOH) to fix macroinvertebrates with approximately 70% alcohol. Containers with a lot of sand and organic debris are marked for immediate sorting in the lab and preservation in 70% EtOH. If a large amount of sand and other heavy debris is present in the cod end, the cod end contents are decanted into the sieve a minimum of ten times, then remaining sand and gravel is examined for moving or dead organisms and replaced in the stream. The three samples are neither composited nor sub-sampled. The same person was involved in site selection and sample collection of all field samples, to ensure quality control in field procedures.

Field data was also collected during the sampling process. Water and air temperature, a qualitative description of vegetative cover, and current and recent weather conditions were recorded once at each stream. Substrate size and any difficulties or differences in sampling are noted after each replicate if necessary. Stream and replicate information are often useful when exploring differences between streams or explaining unexpected differences between replicates.

Sorting and Identification

Whole samples were sorted, identified, and counted in the laboratory. First, alcohol was poured off the samples through a 500-μm sieve and saved for proper disposal. The contents of the sieve were washed into a small tray. The tray was decanted numerous times into the sieve until the organic debris had separated from the heavier sand. The material in the sieve was placed or washed into as many petri dishes as were necessary to facilitate thorough sorting. Macroinvertebrates were then removed from the debris with the aid of a dissecting microscope at 10x magnification. Although most organisms are in the petri dishes, a final search of the sand for heavy or sticky organisms (molluscs, turbellaria, some caddisflies) is critical to maintain data quality.

Insects were identified and counted primarily to the genus level (Appendix A) under a dissecting microscope. Exceptions to genus-level identification of insects include the orders Collembola and Odonata and the families and sub-families Blephariceridae, Ceratopogoninae, Forcypomyiinae, Chironomidae, Simuliidae, Stratiomyiidae, Dytiscidae, Capniidae, Taeniopterigidae, Corydalidae, and most Leuctridae (McAlpine et al. 1981, McCafferty 1983, Merritt and Cummins 1994, Stewart and Stark 1993, Wiggins 1998). Several genera, particularly *Epeorus*, *Drunella*, *Zapada*, and *Rhyacophila*, were identified to species but recombined to the genus level for analysis purposes. Non-insect macroinvertebrates were classified at higher taxonomic levels (Hydrazoa, Turbellaria, Nematoda, Oligochaeta, Branchiobdellida, Gastropoda, Bivalvia, Amphipoda, Copepoda, Deapoda, Ostracoda, and Hydrocarinae; McCafferty 1983, Thorp and Covich 1991). Once identified, samples were preserved in 70% ethanol or isopropanol.

Results and Biological Monitoring Recommendations

The number and types of streams surveyed in the Blakely and Redmond Ridge development during the early summer of 1999 was inadequate to evaluate metrics and develop scoring criteria for an ephemeral stream B-IBI. To properly develop metrics and scoring criteria, a gradient of streams that are similar in their natural condition but impacted by human activity, from highly affected to nearly pristine, is necessary (Karr and Chu 1999).

The 1999 samples suggest, however, that the last week of May and first week of June is an appropriate time during which to monitor the small and ephemeral streams of Blakely and Redmond Ridges. Furthermore, by comparing the 1991 and 1999 macroinvertebrate data, the samples collected during those years are similar and represent reasonable baseline conditions for the streams that could be used in a study monitoring changes in water quality over time and as heavier development occurs.

A properly designed study to determine appropriate B-IBI scoring criteria is dependent on having reference sites and several streams for which the primary difference between streams is not a natural condition but the level of human disturbance in the watershed. Of the seven streams sampled in this study, each had a different pattern of flow and a different period of dewatering. The two streams with the lowest level of human disturbance, Adair and South Colin Creeks, were of intermediate early June flow relative to Rutherford and Unnamed Creeks (Table 2). They are also frequently difficult or impossible to sample during the fall due to low or absent flow. Rutherford Creek has the highest late spring flow and is consistently sampleable in the fall. Unnamed Creek has a very low late spring flow, but often maintains that steady flow through the fall sampling season. Though the information is not available, the streams that dry up, likely do so for different intervals naturally, altering the macroinvertebrate community in different ways. Because all streams in this study are small to intermittent in the fall, the late spring sampling protocol should apply to all, but reference conditions will likely be different.

The natural state of the watersheds is also an important difference between streams. Adair and South Colin Creeks not only have different flow patterns but also have different types of watersheds. Both are well forested, but upstream of the South Colin Creek sample site is a substantial wetland that comprises the headwaters of the stream. Wetland influences may affect the chemical and physical properties of the water and make it unlivable for many macroinvertebrates while attracting others, thus altering the community structure. For example, the wetlands may trap and release sediment irregularly, alter temperature, change the pH, or increase the organic material available to downstream organisms. Examining stream with upstream wetlands and developed streams which are known to have lost the wetland component and drawing comparisons with South Colin Creek will permit greater understanding of how that particular type of intermittent stream responds to human disturbance.

Should the reference condition and streams along a gradient of human disturbance not be available to properly develop a B-IBI for a particular stream type, an alternative study design for macroinvertebrate monitoring of the UPD streams is to monitor their biology on a stream by stream basis over time. Such a design does not represent the broader context of biological integrity and stream health that a B-IBI would provide, but it will identify streams that are affected by increased human disturbance and those for which the development has had little impact.

Regardless of the study design, evaluation of the 1999 late spring ephemeral streams study suggests the last week of May and first week of June are an appropriate sampling season. During that period, the streams still have a sampleable flow and constant rains have begun to subside, permitting breaks in the weather during which sampling can occur. However, flow in some of the streams is already at a low enough level that samples should be collected to ensure the sites are sampled before any of the streams dry. Furthermore, on such small streams sampleable riffles are not commonplace. By the third two-week period, sampling in consistently similar types of riffle habitat became very difficult. During late spring and early summer the recommended sampling period, based on sample collection in 1999, is late May and early June after a couple days of calm weather. Sampling of all seven streams will take 2-3 days with one crew or 1-2 days with two crews.

The 1999 UPD macroinvertebrate data provides baseline information for future monitoring. During the 1990's, few anthropogenic changes occurred in the watersheds of Blakely and Redmond Ridges. Similarly, the biological differences at the family level between streams sampled in 1991 and 1999 appear to be small for all four streams (Table 3). For the sake of comparison, 1999 macroinvertebrate genera were lumped into their respective families because the 1991 macroinvertebrates were only identified to family. In a family level comparison of spring 1999 and fall of 1997, Evans, Evens Trib. and Adair Creeks showed consistent and sometimes dramatic declines in richness metrics of fall samples (Table 4). The seasonal differences were small in Unnamed Creek since it maintains a low flow year round. Colin South, though typically dry in the fall, appears to be consistent when comparing between seasons. Due to its ephemeral nature, the similarity is unexpected and should be explored further. Because of natural instream variability, the 1999 baseline should still be viewed critically when used in analysis of future monitoring, but based on a rough, between-year comparison of 1991 and 1999, the data should serve as an appropriate baseline. If resources allow, taking a second sample from a nearby, upstream riffle in each stream will provide more information about instream variability and give more confidence to assessment of the stream's individual condition. Such a practice will also support a B-IBI score for the stream.

Blakely and Redmond Ridges are going to be developed heavily with the expectation that streams will be maintained at their current physical, chemical and biological condition. To support this expectation, a biological monitoring component should be included in the monitoring plan, whether in the form of protocols outlined above or by applying alternative protocols. Making inferences about biological condition based on physical and chemical properties alone, will inevitably perpetuate a century long decline in aquatic resources.

Literature Cited

Karr, J.R. and Ellen W. Chu. 1999. *Restoring Life in Running Waters: Better Biological Monitoring.* Island Press, Washington, DC.

McAlpine J.F., B.V. Peterson, G.E. Shewell, H.J. Teskey, J.R. Vockeroth, D.M. Wood. 1981. Manual of Neararctic Diptera, Volume 1. Canadian Government Publishing Center.

McCafferty P. W. 1983 Aquatic Entomology – The Fisherman's and Ecologists' Illustrated Guide to Insects and Their Relatives. Jones and Bartlett Publishers, Boston.

Merritt R.W. and K.W. Cummins. 1994. An Introduction to the Aquatic Insets of North America, second Edition. Kendall/Hunt Publishing Co. Dubuque, Iowa.

Stewart, K.W. and B.P. Stark. 1993. Nymphs of North American Stonefly Genera (Plecoptera). University of North Texas Press, Denton.

Thorp, J.H. and A.P. Covich. 1991. Ecology and Classification of North American Freshwater Invertebrates. Academic Press, Inc., San Diego.

Wiggins G.B. 1998. Larvae of the North American Caddisfly Genera (Trichoptera). University of Toronto Press.

Table 1: Late spring 1999 UPD macroinvertebrate collection sites and site information.

Stream	**Date 1999**	**Location**	**Water °C**	**Substrate**
Adair	5-30	~20m u/s of gauge 53A	12	Gravel cobble
Colin N	6-2	~30m u/s of gauge 02C	12	Cobble and fine roots
Colin S	6-2	Between footbridge and gauge 02D	10	Cobble gravel
Evans	5-31	~50m u/s of NE 75th St	12.5	Cobble with a lot of sand and gravel, some wood pieces
Evans trib	6-2	~20m d/s of culvert under 238th Ave NE	8.5	Gravel and fines with roots and wood pieces
Rutherford	5-31	~30m d/s of culvert under 225th Ave NE	14	Lot of wood and twigs in cobble gravel substrate
Unnamed	5-31	~50m u/s of gauge 53B	9	Gravel, organic debris and fines

Table 2: Late spring flow of UPD streams.

Stream	**Flow 6-1-99, cfs**	**Fall sample 97**	**Fall sample 98**	**Fall sample 99**
Rutherford	0.4	Yes	Yes	Yes
Adair	0.3	Yes	No	No
Colin South	0.2	Yes	No	No
Unnamed	0.1	Yes	No	Yes

Table 3: UPD stream metrics at family level identification for late spring of 1991 and 1999. (note: abundance is not an indicator of stream health, but was included only to potentially reflect differences in sampling and analysis procedures)

1991/1999 Spring	Abundance	Families	Mayfly taxa	Stonefly taxa	Caddisfly taxa
Unnamed 1991	140	20	3	3	4
Unnamed 1999 (ave)	888	26	3	4.7	5.3
Colin S 1991	810	15	3	2	2
Colin S 1999 (ave)	328	16.7	3	3	2.7
Colin N 1991	348	21	2	1	2
Colin N 1999 (ave)	2695.3	25	3	2.3	3.7
Adair 1991	84	17	4	3	3
Adair 1999 (ave)	236.7	24	2.7	4.7	4.3

Table 4: UPD stream metrics at family level identification for fall of 1997 and late spring 1999.

Fall 1997/Spring 1999	Abundance	Families	Mayfly taxa	Stonefly taxa	Caddisfly taxa
Evans 97 Fall	508.3	12.3	0	0.7	1.7
Evans 99 Spring	1491.7	24	3.7	2.7	2
Evans Trib 1997 Fall	374.3	18	3	2.7	3.7
Evans Trib 1999 Spring	1392.3	27.3	4	4.3	5
Unnamed 1997 Fall	202.3	21	3	4	3.7
Unnamed 1999 Spring	888	26	3	4.7	5.3
Colin S 1997 Fall	340	17	2.7	3	3.7
Colin S 1999 Spring	328	16.7	3	3	2.7
Adair 1997 Fall	701.7	18	2	3	3.3
Adair 1999 Spring	236.7	24	2.7	4.7	4.3

APPENDIX A: Macroinvertebrate lab datasheet.

Project: ____

Sampling Date: __________Site: ___________________________Replicate: __________

Taxon	raw #	Taxon	raw #	Taxon	raw #
Hydrazoa		**Plecoptera:**		**Trichoptera:**	
Turbellaria		Capniidae		*Apatania*	
Nematoda		Chloroperlidae		Amiocentrus	
Oligochaeta		Katheroperla		Brachycentrus americanus	
Branchiobdellida		*Neaviperla/Suwallia*		*Brachycentrus occidentalis*	
Gastropoda		*Paraperla*		*Micrasema*	
Bivalvia		*Sweltsa*		*Agapetus*	
Amphipoda		Leuctridae		*Anagapetus*	
Copepoda		Despaxia		*Glossosoma*	
Decapoda		*Moselia*		*Glossosoma* (pupae)	
Ostracoda		*Malenka*		*Arctopsyche grandis*	
Hydrocarinae		*Soyedina*		*Cheumatopsyche*	
Collembola		*Visoka*		*Hydropsyche*	
Odonata		*Zapada cinctipes*		*Parapsyche elsis*	
		Zapada frigida		Hydroptilidae	
		Zapada columbiana		Agraylea	
		Zapada Oregonensis Gr.		*Hydroptila*	
		Soliperla		*Ochrotricia*	
		Yoraperla brevis		*Lepidostoma*	
Diptera:		Perlidae E.I.		*Lepidostoma (panel case)*	
Ahterix		Calineuria californica		*Lepidostoma (sand case)*	
Blephariceridae		*Claassenia sabulosa*		*Lepidostoma (turret case)*	
Brachycera		*Doroneuria*		Limnophilidae E.I.	
Ceratopogoninae		*Hesperoperla pacifica*		*Cryptochia*	
Forcipomyiinae		Perlodidae E.I.		*Ecclisomyia*	
Chironomidae		Frisonia		*Dolophilodes*	
Chironomidae (pupae)		Isoperla		*Wormaldia*	
Dixa		*Megarcys*		*Polycentropus*	
Meringodixa		*Rickera / Kogotus*		*Psychomyia*	
Chelifera		*Skwala*		Rhyacophilidae E.I.	
Clinocera		*Setvena*		Rhyacophila *Angelita Gr.*	
Hermerodromia		*Pteronarcella*		Rhyacophila *Betteni Gr.*	
Oregoton		*Pteronarcys*		Rhyacophila *Brunnea / Vemna Gr.*	
Wiedemannia		Taeniopterigidae		Rhyacophila *Coloradensis Gr.*	

Empididae (pupae)				Rhyacophila *Grandis Gr.*
Glutops				Rhyacophila *Hyalinata Gr.*
Maruina				Rhyacophila *Iranda Gr.*
Pericoma				Rhyacophila *Lieftincki Gr.* arnaudi
Prosimulium		**Ephemeroptera:**		Rhyacophila *Rotunda Gr.*
Simulium		Ameletus		Rhyacophila *Sibirica Gr.*
Simulidae (pupae)		Acentrella		Rhyacophila blarina
Stratiomyiidae		*Baetis bi / tricaudatus*		Rhyacophila narvae
Tabanidae		*Callibaetis*		Rhyacophila pellisa / valuma
Tipulidae		*Centroptilum / Procloeon*		Rhyacophila *Vagrita Gr.*
Antocha		*Diphetor hageni*		Rhyacophila *Verrula Gr.* verrula
Dicranota		*Attenella*		Rhyacophila *(pupae)*
Hesperoocanopa		*Caudatella*		Neophylax
Hexatoma		*Caudatella hystrix*		Neophylax rickeri / splendens
Limnophila		*Drunella coloradensis / flavensis*		*Neothremma*
Limonia		*Drunella doddsi*		*Oligophlebodes*
Tipula		*Drunella grandis / spinifera*		
		Ephemerella inermis / infrequens		
		Serratella tibialis		
		Timpanoga hecuba		
Coleoptera:		*Cinygma*		
Dytiscidae		*Cinygmula*		
Ampumixis dispar (L)		*Epeorus* E.I.		
Cleptelmis (L)		*Epeorus albertae*		
Cleptelmis (A)		*Epeorus deceptivus*		
Heterlimnus (L)		*Epeorus longimanus*		
Heterlimnus (A)		*Epeorus grandis*		
Lara avara (L)		*Heptagenia/Nixe*		
Narpus (L)		*Ironodes*		
Optioservus (L)		Rhithrogena		
Optioservus (A)		*Paraleptophlebia*		**Megaloptera:**
Ordobrevia nubifera (L)		*Paraleptophlebia bicornuta*		Corydalidae
Zaitzevia (L)		*Trichorythodes minutus*		Sialis
Zaitzevia (A)				
Acneus				

January 2000: Jeff Adams (adapted from ABA, Inc., 1997)

APPENDIX B: Field collection datasheet.

Clackamas River Biological Assessment Field Data Sheets

Creek	Date	Time	Air Temp.	Water Temp.	Stream Width	Pictures
			° C	° C	m	rl :

Weather:

Previous -

Current -

Location:

Upstream:

Downstream:

Notes:

Rep #1:

Rep #2:

Rep #3:

Other notes: Disturbances? Flow? Impressions? Etc.