

Snohomish County Public Utility District No. 1
2005 Benthic Invertebrate Biomonitoring
Notes on the Benthic Index of Biological Integrity and other Metrics
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Data for each sample site consists of a spreadsheet with taxa abundances and a two page printout of a full spectrum of community composition metrics. This detailed site data has been summarized using the Karr Benthic Index of Biological Integrity (BIBI) and a selection of other community composition metrics that aid in tracking trends. BIBI total scores, BIBI individual metrics, and other selected metrics for the eight 2005 sites in the Sultan River basin are discussed briefly below.

BIBI Total Score: The BIBI Index consists of 10 community composition metrics. Site values for these metrics are given a score of 1, 3 or 5 (see scoring criteria table). The sum of the individual metric scores is the total BIBI score. Total scores can range from 10-50. Scores >40 translate in general to high biological integrity at a site, 25-39 to moderate biological integrity, and 10-24 to low. Note that BIBI scores usually drop naturally along a longitudinal profile from headwater streams to a river mouth.

Sites 1, 11, 2, 3 and 4 are spaced along a longitudinal profile of the lower Sultan River and total BIBI scores rise incrementally as in a normal longitudinal progression, from moderate biological integrity at the lower sites to high integrity at the upper sites. The three sites in the upper river basin (North Fork, South Fork and Williamson Creek) have relatively high total BIBI scores.

Total number of taxa: This is the total number of taxa identified at a site. West slope Cascades streams generally have greater total taxa richness than found in Puget Lowland streams where the BIBI was derived. The general rule is: >60 taxa is very high, 50-59 high, 40-49 moderate, 30-39 low, <30 very low. All of the Sultan River sites had moderate to high taxa richness.

Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies): EPT taxa are three insect orders that tend to dominate in streams with high biological integrity. Mayfly (E) richness at the Sultan River sites was moderate to high. Stonefly (P) richness was generally moderate and exceptionally high at Site 4 and Williamson Creek. Caddisfly (T) richness was lowest at sites near the mouth.

Number of long-lived taxa: These are aquatic invertebrate species that require >1 year to complete their life cycle. The number of long-lived taxa present increases with increasing habitat complexity and stability. There was a strong longitudinal trend in the number of long-lived taxa from Sites 1-4, going from 0 to 4 taxa present. Long-lived taxa richness was low at Site 11, and very high at the South Fork and Williamson Creek sites.

Number of intolerant taxa: These taxa are intolerant of warm water temperature, low dissolved oxygen, excessive fine sediment, and fouling of surfaces by filamentous algae.

Intolerant taxa in montane areas almost always increase in an upstream direction. Intolerant taxa display a strong longitudinal progression from Sites 1-4, they had low richness at Site 11, and high again at the South Fork and Williamson Creek sites (12 and 8 taxa).

% Tolerant taxa: These taxa tolerate warm water, lower dissolved oxygen levels, and usually excessive fine sediment and filamentous algae. Tolerant taxa naturally increase in a downstream direction. The Karr BIBI classifies the mayfly *Baetis tricaudatus* as a tolerant taxa. This mayfly species is ubiquitous in North American streams and is a classic “weed” taxa. It is not particularly tolerant of warm water, requires relatively high levels of dissolved oxygen, and does not tolerate fouling of surfaces upon which it feeds by fine sediment or filamentous algae. Though I don’t consider this species to be “tolerant”, it is a good indicator of disturbance, whether the disturbance be from scour and resorting of bottom substrates or from toxins. *Baetis tricaudatus* can rapidly recolonize disturbed habitats and reproduce rapidly.

The variation seen in the % tolerant taxa at the Sultan River sites and their increase in an upstream direction from Sites 1-4, comes primarily from *Baetis tricaudatus*. The %*Baetis tricaudatus* is listed near the bottom of the site summary tables. When *Baetis tricaudatus* is subtracted out, the contribution of tolerant taxa to benthic communities in the basin is generally low, and does increase in a downstream direction from Sites 4-1. Most west slope Cascade streams have low abundances of tolerant taxa except in lower gradient, more exposed (solar) reaches.

% Predator and predator taxa richness: Benthic communities with high biological integrity and habitat complexity generally have both an abundance (%) and richness of predator taxa (see BIBI scoring criteria). Montane streams usually have a trend of increasing predator abundance and richness from downstream to upstream. This is seen at Sites 1-4. Predator richness was exceptionally high at Site 4 (19 taxa).

Number of clinger taxa: These are invertebrate taxa that “cling” or attach to hard substrates rather than swim or burrow into soft substrates. Hard-bottomed streams of the west slope Cascades almost always have a high number of clinger taxa, higher than Puget Lowland streams. All the Sultan River sites, with the exception of Site 11 (B), had high clinger richness as defined by the Karr BIBI.

% Dominance (3 taxa): This metric calculates the % contribution of the three most common taxa at a site. Communities with high biological integrity and habitat complexity usually are not super-dominated by a few common taxa. Sultan River 2005 sites all had a relatively low dominance by the most common taxa, except Site 11 B, which had a moderate dominance.

Total invertebrate abundance: This is the total number of invertebrates found at a site (standing crop) expressed on a one square meter basis. The general rule of thumb for invertebrate abundance in forested, montane streams in the PNW is, <500 very low standing crop, 500-1000 low, 1000-5000 moderate, 5000-10,000 high, >10,000 very

high. If a well shaded, hard-bottomed, montane stream in the PNW has >10,000 invertebrates per square meter then nutrient enrichment is strongly suspected, and 5000-10,000 is suspect.

Standing crops at the Sultan River sites were generally low. Only two sites had >1000 invertebrates per square meter. Though an instantaneous measurement of standing crop is not always correlated with total annual production of invertebrates, it usually is a good indicator of available fish food being produced by the habitat. The Sultan River basin does not appear to be a very productive system, probably due to low availability of nutrients.

Scraper and shredder richness: Scrapers are taxa that feed by scraping algae from hard surfaces. Shredders are detritivores that “shred” detritus such as leaves, needles or even wood. Forested, montane streams in the PNW with high biological integrity and habitat complexity usually have a high richness of in these two feeding groups. Both scrapers and shredders are found in greater abundance and richness in headwater streams, and decline going downstream.

% Intolerant taxa: West slope Cascade streams typically have >25% intolerant taxa (or cold water biota) at higher elevation, headwater reaches. The % contribution and richness of intolerant taxa typically decreases in a downstream direction. My rule of thumb is that if a site has >10% intolerant taxa, along with >8 intolerant taxa, then the stream reach is fully supportive of salmonids. Sites with 5-10% and 5-8 taxa probably support salmonids, but rearing conditions may be borderline. Sites with <5% and 5 intolerant taxa may not support salmonids in the long-term. However, factors other than elevated stream water temperature can depress intolerant taxa abundance and richness. The abundance of intolerant taxa was lowest at Site 1 and Site 11.

% Collector: This feeding group “collects” and feed on fine organic particles using a variety of methods. Collectors tend to dominate where fine sediments predominate or where there is an abundance of particles drifting in the water column. Collector dominance typically increases from upstream to downstream or in lower gradient reaches. They also tend to dominate stream reaches where hard substrates are fouled with filamentous algae. Site 1 and Site 11 had the highest collector dominance.

% Parasite: These are invertebrate parasites on other invertebrates. The % was highest in the lower basin.

% Oligochaeta (segmented worms): Many segmented worms are tolerant, though not all. Worm abundance increases where stable, fine sediments are found, or can be found in abundance at hard-bottomed sites where flow is more constant and there is little scouring and resorting of substrates from annual flooding. Worms are usually more common in downstream, riverine or low gradient reaches. Site 1 and Site 11 had moderate to high worm densities.

% Baetis tricaudatus plus % Simuliidae (black-flies): See the discussion above under % tolerant taxa about Baetis tricaudatus. Both Baetis tricaudatus and black-flies are classic weed taxa capable of rapidly colonizing disturbed substrates and reproducing rapidly. When the contribution of these two taxa exceeds 50% of the benthic community, significant, recent disturbance of substrates is strongly suspected. Disturbance may come from scour and resorting during floods, or could be from toxins or even wild fire. All of the Sultan River sites had <25% combined Baetis tricaudatus and Simuliidae. This is normal. Some annual disturbance of substrates in montane streams is normal and helps to regenerate habitat complexity. It is notable that Site 11 had exceptionally low abundances of these two taxa. I interpret this as there being very low levels of annual disturbance of stream substrates in these stream reaches.

% Chironomidae (midges): Midges are often dominant in impacted systems. This metric is quite variable, even in completely natural systems.

Macroinvertebrate Sampling Locations, Sultan River, 2005					
Site No.	Location	River Mile	Latitude	Longitude	Reach
1	Sultan River below Culmback Dam	0.2	47 51.695 N	121 49.352 W	Downstream of Powerhouse
11	Sultan River below Culmback Dam	2.7	47 53.367 N	121 50.026 W	Downstream of Powerhouse
2	Sultan River below Culmback Dam	5.1	47 54.824 N	121 48.696 W	Downstream of Diversion Dam
3	Sultan River below Culmback Dam	9.6	47 57.54 N	121 47.809 W	Downstream of Diversion Dam
4	Sultan River below Culmback Dam	14.3	47 58.203 N	121 43.365 W	Downstream of Culmback Dam
5	Williamson Creek		47 59.678 N	121 35.569 W	Upstream of Spada Reservoir
8	North Fork Sultan River		47 58.698 N	121 34.823 W	Upstream of Spada Reservoir
10	South Fork Sultan River		47 56.78 N	121 37.449 W	Upstream of Spada Reservoir

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

WA: Snohomish County Public Utility District No. 1. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Sampling protocol: erosional habitat, D-frame net, 500 micron mesh, 4 point composite, 8 square feet area total.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis.

Water Body	Sultan River Site 1		Sultan River Site 11-A,B,C,D		Sultan River Site 2		Sultan River Site 3		Sultan River Site 4	
Date	8/8/2005		8/8/2005		8/8/2005		8/8/2005		8/11/2005	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	44	5	45	5	55	5	49	5	52	5
D Number Ephemeroptera taxa	5	3	9	5	12	5	11	5	9	5
D Number Plecoptera taxa	5	3	5	3	6	3	5	3	11	5
D Number Trichoptera taxa	4	1	4	1	7	3	6	3	9	3
D Number of long-lived taxa	0	1	1	1	4	3	3	3	4	3
D Number of intolerant taxa	0	1	2	1	3	3	4	5	8	5
I % Tolerant taxa	10.35	5	5.56	5	11.23	5	16.55	5	17.93	5
D % Predator	6.56	1	4.82	1	7.78	1	19.41	3	17.25	3
D Number of clinger taxa	22	5	23	5	36	5	29	5	38	5
I % Dominance (3 taxa)	32.07	5	44.99	5	42.57	5	29.55	5	33.11	5
TOTAL SCORE	30		32		38		42		44	

BIOLOGICAL CONDITION CATEGORY

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Metric	Site 1	Site 11-A,B,C,D	Site 2	Site 3	Site 4
Total abundance (m2)	530	460	1491	568	581
D EPT taxa richness	14	17	25	22	29
D Predator richness	5	7	12	12	19
D Scraper richness	10	10	17	12	11
D Shredder richness	3	3	3	2	6
D %Intolerant taxa	0	0.44	5.25	5.68	8.97
I Hilsenhoff Biotic Index	5.5	5.5	4.51	4.59	4.86
I %Collector	63.65	64.5	33.13	53.93	50.36
I %Parasite	3.79	3.14	4.71	0.71	3.45
I %Oligochaeta	14.39	14.13	1.27	1.18	0.92
I Number tolerant taxa	8	5	6	4	2
I % <i>Baetis tricaudatus</i>	2.02	0.8	4.71	13.71	15.86
I %Simuliidae	5.05	0.64	8.88	10.41	5.06
I %Chironomidae	26.26	39.98	13.95	26	37.7

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity.

M= Moderate biological integrity.

H= High biological integrity.



BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

WA: Snohomish County Public Utility District No. 1. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Sampling protocol: erosional habitat, D-frame net, 500 micron mesh, 4 point composite, 8 square feet area total.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis.

Water Body	N. Fk. Sultan River mainstem		S. Fk. Sultan River		Williamson Creek	
Date	9/14/2005		9/14/2005		9/14/2005	
METRIC	Value	Score	Value	Score	Value	Score
D Total number of taxa	46	5	48	5	47	5
D Number Ephemeroptera taxa	12	5	10	5	8	3
D Number Plecoptera taxa	6	3	8	5	11	5
D Number Trichoptera taxa	6	3	8	3	6	3
D Number of long-lived taxa	3	3	6	5	6	5
D Number of intolerant taxa	4	5	12	5	8	5
I % Tolerant taxa	18.79	5	6.86	5	21.16	3
D % Predator	6.71	1	11.32	3	12.79	3
D Number of clinger taxa	29	5	31	5	32	5
I % Dominance (3 taxa)	43.63	5	45.66	5	39.52	5

TOTAL SCORE

	40		46		42
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BIOLOGICAL CONDITION CATEGORY

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	622	1450	672
D EPT taxa richness	24	26	25
D Predator richness	9	12	12
D Scraper richness	13	10	8
D Shredder richness	5	8	8
D %Intolerant taxa	2.16	13.37	12.78
I Hilsenhoff Biotic Index	5.04	4.86	4.82
I %Collector	36.45	31.35	55.31
I %Parasite	0.86	1.11	0.4
I %Oligochaeta	0.22	1.11	0.2
I Number tolerant taxa	2	1	2
I % <i>Baetis tricaudatus</i>	18.36	6.86	19.96
I %Simuliidae	2.16	0.19	2.4
I %Chironomidae	39.52	57.7	29.34

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Karr's Benthic Index of Biological Integrity (BIBI).
Scoring criteria modified from Fore, L.S., 1999.

Metric	Response	Scoring Criteria		
		1	3	5
Taxa richness and composition				
Total number of taxa	Decrease	0-19	20-40	>40
Number of Ephemeroptera taxa	Decrease	0-3	4-8	>8
Number of Plecoptera taxa	Decrease	0-3	4-7	>7
Number of Trichoptera taxa	Decrease	0-4	5-10	>10
Number of long-lived taxa	Decrease	0-2	3-4	>4
Tolerance				
Number of intolerant taxa	Decrease	0-1	2-3	>3
% of individuals in tolerant taxa	Increase	>49	20-49	0-19
Feeding ecology				
% of predator individuals	Decrease	0-9	10-19	>19
Number of clinger taxa	Decrease	0-9	10-20	>20
Population attributes				
% dominance (3 taxa)	Increase	>74	50-74	0-50