AQUATIC INVERTEBRATE ASSEMBLAGES AND BIOLOGICAL ASSESSMENT OF STREAM SITES IN THE CITY OF BELLEVUE, WASHINGTON:

2013

Report to the City of Bellevue, Washington
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INTRODUCTION

This report summarizes and interprets aquatic macroinvertebrate data collected in August 2013 at stream sites in the City of Bellevue, King County, Washington. Similar to projects completed in prior years, the objectives of this study include using the invertebrate biota to detect impairment to biological health, using 2 assessment tools: the B-IBI (Benthic Index of Biological Integrity: Puget Sound Stream Benthos: http://pugetsoundstreambenthos.org, accessed May 2014), and a predictive model (RIVPACS – the River InVertebrate Prediction and Classification System) The B-IBI is a battery of 10 biological metrics calibrated for streams of the Pacific Northwest. In contrast to reports in previous years, B-IBI metric and index scores were derived in a different manner for this report: whereas previous years' scores were calculated using Rhithron's database applications and associated taxon attributes, all B-IBI scores reported here were obtained from the Puget Sound Stream Benthos website, using the revised version based on continuous scoring (0-100).

The RIVPACS model used in this report was developed by the Washington Department of Ecology (WDOE). RIVPACS compares the occurrence of taxa at a site with the taxa expected at a similar site with minimal human influence, and yields a score that summarizes the comparison.

These assessment tools provide a summary score of biological condition, and the B-IBI can be translated into biological health condition classes (i.e., excellent, good, fair, poor, and very poor) based on ranking criteria used by King County and other agencies and organizations in the Puget Sound region. In addition, this report identifies probable stressors which may account for diminished stream health, basing these observations on demonstrated and expected associations between patterns of response of B-IBI metrics and other metric expressions, as well as the taxonomic and functional composition of the benthic assemblages. The analysis examines common stressors associated with urbanization: water quality degradation, changes to natural thermal regimes, loss and impairment of instream habitats due to sediment deposition and altered flow regimes, and disturbance to reach scale habitat features such as streambanks, channel morphology, and riparian zone integrity.

METHODS

Sampling

The City of Bellevue provided oversight for the collection of 8 aquatic invertebrate samples from 6 sites. Replicate samples (3) were collected at one site (Kelsey Trestle): single collections were made at the other 5 sites. Samples were processed and invertebrates identified by Rhithron Associates, Missoula, Montana.

Sample processing

In the laboratory, standard sorting protocols were applied to achieve representative subsamples of aquatic organisms. 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 ethanol for subsequent identification. The final selected grid was completely sorted of all organisms. 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 protocols for Puget Sound Lowlands streams, using appropriate published taxonomic references and keys. Midges (Diptera: Chironomidae) were identified to genus/species group/species and Oligochaetes were identified to genus/species. Identification, counts, life stages, and information about the condition of specimens were recorded on bench sheets. 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 95% ethanol in labeled vials, and archived at the Rhithron laboratory.

Midges and worms 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 with Hoffman contrast. Slide mounted organisms were archived at the Rhithron laboratory.

Quality assurance (QA)/ quality control (QC) procedures

Quality control procedures for initial sample processing and subsampling involved checking sorting efficiency. These checks were conducted on all of the samples by independent observers who microscopically re-examined 100% of the sorted substrate from a randomly selected sample, representing 16.7% of total samples. 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 in the second sort. Target efficiency for these samples was 90%.

Quality assurance procedures for taxonomic determinations of invertebrates involved checking accuracy, precision and enumeration. Three samples were 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) for each selected sample. Internal data quality targets for these parameters are: PTD ≤5%, PDE ≤5%, and Bray-Curtis similarity ≥95%. 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

B-IBI metrics and scores were obtained from the Puget Sound Stream Benthos (PSSB) website, using the updated version (accessed in May 2014), scaled continuously between 0 and 100. This represents a change from past reporting for the City of Bellevue, in which B-IBI metrics and scores were calculated and scored using historic methods and Rhithron's database application, which is based on taxon attributes that differ in some cases from the PSSB database attributes.

RIVPACS scores were obtained by entering data into a web-based application maintained by the Utah State University's Western Center for Monitoring and Assessment of Freshwater Ecosystems. Related applications on this website produce a taxa list from each sample by a random re-sampling routine that standardizes sample sizes. Some taxa are excluded from the analysis. Output from the RIVPACS applications provide a RIVPACS score for each replicate.

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, and 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. To arrive at impairment hypotheses, attributes are considered individually, so information is maximized by not relying on a single cumulative score, which may mask stress on the biota. When replicate samples were collected, data was compiled for the narrative analyses.

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.

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). 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 quality control sample was 99.1%. PDE (0.18%), PTD (0.37%), and Bray-Curtis similarity was 99.45%. All QC parameters met Rhithron's internal quality criteria (Rhithron Associates 2013), and were all well within industry standards for sorting and taxonomic data quality (Stribling et al. 2003).

Data analysis

Taxa lists and counts, and values and scores for standard bioassessment metrics for composited replicate samples are given in the Appendix. Table 2 summarizes B-IBI and RIVPACS scores for sites and for sample replicates. B-IBI scores varied from 10.7 to 56.3 for City of Bellevue samples collected in 2013. These scores indicated "poor" or "very poor" conditions for 5 of the 6 sites. A single site, Lewis Creek above Lakemont, rated "fair". B-IBI site scores are graphed in Figure 1.

RIVPACS scores varied from 0.29 to 0.49. These scores indicated impaired biological conditions in 2013 for all 6 sites. RIVPACS scores for replicates collected at the Kelsey Trestle site were averaged to achieve a site score. Site scores are graphed in Figure 2.

B-IBI scores and RIVPACS results for the 6 sites in this study were not significantly correlated with each other ($r = 0.0864$, $p = 0.8707$). Figure 3 illustrates this relationship.

<table>
<tr><th>Station name</th><th>Bellevue site ID</th><th>PSSB site ID</th><th>B-IBI score</th><th colspan="2">RIVPACS score</th></tr>
<tr><td>Yarrow (Glory Hole) Rep 1</td><td>YarrowRM0.2_2013R1</td><td>YarrowWestTribBelRM0.2</td><td>35.8</td><td colspan="2">.49</td></tr>
<tr><td>Kelsey Trestle Rep 1</td><td>KelseyRM0.2_2013R1</td><td>KelBelRM0.2</td><td rowspan="3">30</td><td>.39</td><td rowspan="3">.373</td></tr>
<tr><td>Kelsey Trestle Rep 2</td><td>KelseyRM0.2_2013R2</td><td>KelBelRM0.2</td><td>.39</td></tr>
<tr><td>Kelsey Trestle Rep 3</td><td>KelseyRM0.2_2013R3</td><td>KelBelRM0.2</td><td>.34</td></tr>
<tr><td>NewPort (Bio-eng Site) Rep 1</td><td>NewportRM0.5_2013R1</td><td>NewpStabRM0.4</td><td>10.7</td><td colspan="2">.41</td></tr>
<tr><td>West Trib (Kelsey Farm, Restored Reach) Rep 1</td><td>WestTribRM0.5_2013R1</td><td>WestTribFarmRM0.4</td><td>17.9</td><td colspan="2">.45</td></tr>
<tr><td>Coal Anna's Pond Rep 1</td><td>CoalRM1.3_2013R1</td><td>CoalBelrm2.3</td><td>18.1</td><td colspan="2">.29</td></tr>
<tr><td>Lewis Creek above Lakemont Outfall Rep 1</td><td>LewisRM2.1_2013R1</td><td>LewisBelRM2.1</td><td>56.3</td><td colspan="2">.38</td></tr>
</table>

Table 1. B-IBI scores and RIVPACS scores for replicates and for sites. The RIVPACs site score for the Kelsey Trestle site, from which 3 replicates were collected, were obtained by averaging replicate scores. All B-IBI scores were calculated by the PSSB website database application. City of Bellevue, 2013.

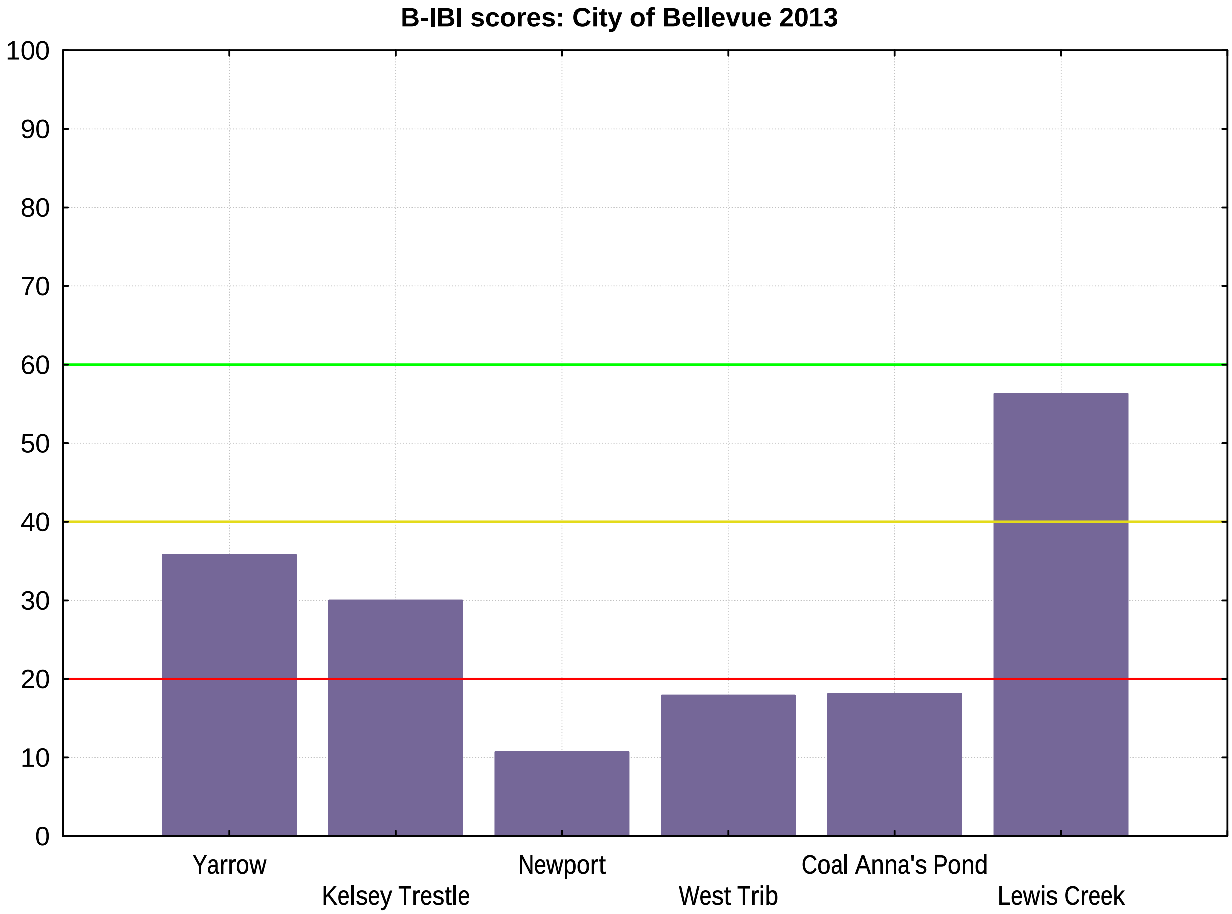

Figure 1. B-IBI site scores for stream sites in the City of Bellevue, 2013. The green line indicates the threshold (B-IBI = 60) for "good" conditions, as described on the Puget Sound Stream Benthos website (pugetsoundstreambenthos.org, accessed May 2014) for scoring using a 0-100 continuous scale. Scores below the threshold indicate impaired conditions. The yellow line is the threshold (B-IBI = 40) for "fair" conditions; scores falling below the threshold indicate "poor" conditions. Scores falling below the red line (B-IBI = 20) indicate "very poor" conditions.

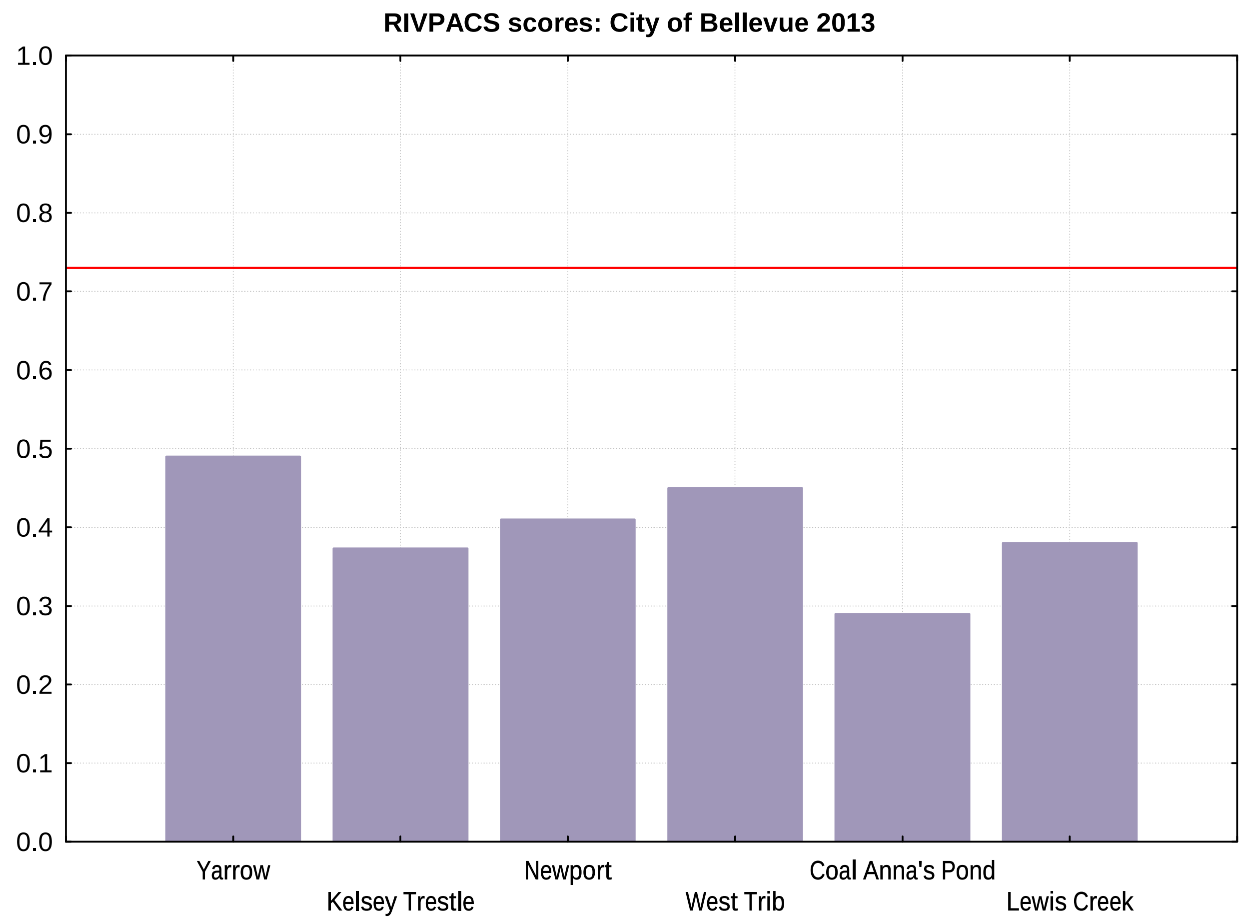

Figure 2. RIVPACS scores for stream sites in the City of Bellevue, 2013. The red line indicates the threshold (RIVPACS = 0.73) for “unimpaired” conditions, set by WDOE. Scores below the threshold indicate impaired conditions.

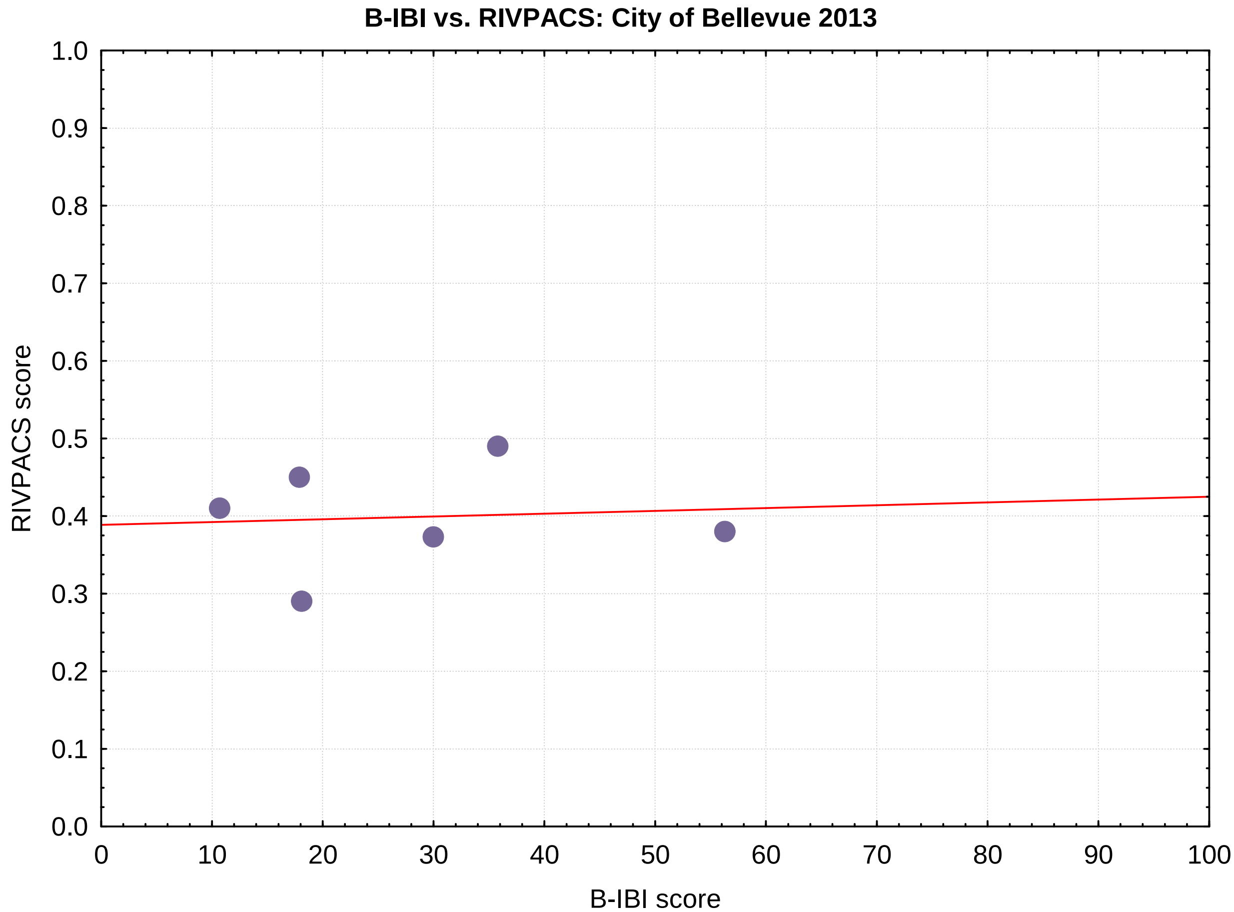

Figure 3. Correlation between B-IBI scores and RIVPACS scores for sites in the City of Bellevue, 2013. The relationship is not significant: r= 0.0864, p = 0.8707.

Aquatic invertebrate assemblage characteristics

Yarrow (Glory Hole)

- **Bioassessment scores: 2013**

The B-IBI site score (35.8) indicated "poor" biological conditions. The RIVPACS score (0.49) indicated impaired conditions, but was the highest RIVPACS score of any site in this study.

- **Indicators of ecological condition: 2013**

a. Water quality

Three mayfly taxa were counted in the sample collected at this site: these included the ubiquitous *Baetis tricaudatus*, *Paraleptophlebia* sp., and several specimens of the sensitive cold stenotherm, *Cinygma* sp. The biotic index value (3.49) was within expectations for a Puget Sound Lowlands stream. It seems likely that water quality was good at this site. There was no evidence for metals contamination. The presence of several specimens of the turbellarian *Polycelis* sp. suggests that ground water contributed to surface flow at this site.

b. Thermal condition

One cold stenotherm taxon (*Cinygma* sp.) was collected, accounting for 2% of sampled animals. The thermal preference estimated for the invertebrate assemblage was 12.8°C.

c. Sediment deposition

Only 10 "clinger" taxa and 2 caddisfly taxa were present in the sample. These findings suggest that sediment deposition may have limited colonization of stony substrates. The FSBI value (3.60) indicated a moderately sediment-tolerant assemblage.

d. Habitat diversity and integrity

Overall taxa richness (41) was high at this site, suggesting diverse instream habitats. Four stonefly taxa were collected in 2013; two of these could be identified as members of the shredder family Nemouridae (*Malenka* sp., and *Zapada cinctipes*), representing 15% of collected animals. The relatively high numbers of nemourids suggests that stony benthic substrates may have been at least partly covered by large organic material such as leaves and woody debris. The samples yielded 2 semivoltine taxa. It seems likely that that this site was not subjected to thermal stress, toxic pollutants or other catastrophes that would interrupt long life cycles. All expected functional groups were represented in the sample. Gatherers dominated the functional mix.

Kelsey Trestle (replicates)

- **Bioassessment scores: 2013**

Three replicate samples were collected at this site in 2013: this analysis is based on a composite of all 3 replicates. Since a total of 1649 invertebrates were represented in the index calculations, the results of richness metrics cannot be compared directly to results from sites where only a single sample was collected. The B-IBI site score for this site was 30, indicating "poor" conditions. The mean RIVPACS result over the 2 replicates (0.373) also indicated impairment.

- **Indicators of ecological condition: 2013**

a. Water quality

A single mayfly taxon was collected at this site: this was the ubiquitous *Baetis tricaudatus*, which was very abundant in the sample. Low mayfly taxa richness, along with the elevated biotic index value (5.38) suggests that water quality was impaired here. No sensitive taxa were present in the sample, and relatively tolerant organisms, including the blackfly *Simulium* sp., the ancylid snail *Ferrissia* sp., and the isopod *Caecidotea* sp. were abundant. Evidence for metals contamination was not readily apparent. The functional composition of the assemblage was dominated by filterers (especially *Simulium* sp. and the midge *Rheotanytarsus* sp.) and gatherers: this pattern is sometimes interpreted as evidence of water quality impairment. The taxonomic composition of the assemblage suggests nutrient enrichment. The aggressively invasive New Zealand mudsnail, (*Potamopyrgus antipodarum)*, along with immature hydrobiids, accounted for nearly 10% of sampled organisms.

b. Thermal condition

The composition of the benthic fauna suggested relatively warm water temperatures: the calculated preference for the assemblage was 15.4°C. No cold stenotherm taxa were encountered in the samples.

c. Sediment deposition

Fifteen “clinger” taxa and 5 caddisfly taxa were present. Although results of these richness metrics are probably inflated by large sample size, it seems likely that colonization was not appreciably limited by sediment deposition. The FSBI value (3.39) indicated a moderately sediment-tolerant assemblage.

d. Habitat diversity and integrity

Taxa richness (36) was relatively high, suggesting diverse instream habitats. The samples contained 2 stonefly taxa; both were nemourids (*Malenka* sp. and *Zapada cinctipes*). Low richness among stoneflies may be related to unstable streambanks, altered channel morphology, or disrupted riparian zones. Five semivoltine taxa were counted, suggesting stable instream conditions. Scour, toxic inputs, and thermal extremes seem unlikely.

Newport (Bio-eng site)

- **Bioassessment scores: 2013**

The B-IBI score for Newport was 10.7, which was the lowest score for any site in this study, and indicated "very poor" biological conditions. The RIVPACS score was 0.41, indicating impaired biological conditions.

- **Indicators of ecological condition: 2013**

a. Water quality

Low mayfly taxa richness (1) and elevated biotic index value (5.01) suggest that water quality was impaired in this reach. The sample was dominated by tolerant insects, especially the blackfly *Simulium* sp. The taxonomic and functional composition of the invertebrate assemblage is consistent with nutrient enrichment.

b. Thermal condition

No cold stenotherm taxa were encountered in the sample. The thermal preference of the assemblage was calculated at 14.2°C.

c. Sediment deposition

Only 5 “clinger” taxa and 2 caddisfly taxa were represented, in both cases, fewer than expected. These findings suggest that sediment deposition may have limited colonization of stony substrate habitats. The low FSBI value (3.09) indicated a sediment-tolerant assemblage.

d. Habitat diversity and integrity

Overall taxa richness (29) was lower than expected, suggesting disrupted or monotonous instream habitats. The 2 stonefly taxa counted in the sample were both nemourids (*Malenka* sp. and *Zapada cinctipes*), suggesting that appreciable amounts of leafy and woody material was present. Low stonefly diversity may be related to disturbed reach-scale habitat features. Long-lived taxa were poorly represented: only a single taxon was present. Periodic thermal extremes, dewatering, or toxic pollutants cannot be ruled out in this reach. The functional composition of the assemblage was dominated by gatherers in several taxa and by filterers (especially *Simulium* sp.), which may be an indication of water quality impairment. Their abundance suggests that fine organic particulates were an important energy source in the reach.

West Trib (Kelsey Farm restored reach)

- **Bioassessment scores: 2013**

The B-IBI score (17.9) calculated for the sample collected at this site indicated "very poor" conditions; the RIVPACS score (0.45) indicated impairment.

- **Indicators of ecological condition: 2013**

a. Water quality

A single mayfly taxon, the ubiquitous *Baetis tricaudatus*, was collected here. Low mayfly taxa richness, along with the moderately elevated biotic index value (4.18) suggests water quality impairment at this site. No sensitive taxa were counted. The functional composition of the invertebrate assemblage, which was dominated by gatherers and filterers, was also suggestive of potential nutrient enrichment.

b. Thermal condition

There were no cold stenotherms in the sample, and the thermal preference of the assemblage was estimated at 15.5°C.

c. Sediment deposition

Caddisflies were represented by only 2 taxa, and one of these was *Hydroptila* sp., which is typically associated with filamentous algae. Only 9 "clinger" taxa were counted. These findings suggest that sediment deposition may have limited colonization in this reach. The FSBI value (3.54) indicated a moderately sediment-tolerant assemblage.

d. Habitat diversity and integrity

Taxa richness (30) was moderate. Instream habitats may have been diverse and intact. Nemourid stoneflies (*Zapada cinctipes* and *Malenka* sp.) were abundant; suggesting that leaf litter and other large organic material may have been abundant. These were the only stonefly taxa present: low richness in this group may be related to loss of streambank stability, disturbed riparian zones, or altered channel morphology. Long-lived taxa were not well-represented: a single elmid beetle taxon (*Narpus concolor*) was collected, but only 2 individuals were counted. Catastrophes such as periodic dewatering, scouring sediment pulses, or intermittent inputs of toxic pollutants cannot be ruled out. The functional composition of the benthic assemblage was dominated by gatherers and filterers, and shredders were notably abundant, suggesting ample riparian inputs of large organic material.

Coal Anna's Pond

- **Bioassessment scores: 2013**

The B-IBI score (18.1) generated by this sample indicated "very poor" biological conditions, and the RIVPACS score (0.29) also indicated impairment. This sample had the lowest RIVPACS score of any sample in this study.

- **Indicators of ecological condition: 2013**

a. Water quality

One mayfly taxon (*Baetis tricaudatus*) was encountered in the sample collected here, and the biotic index value (5.09) was higher than expected for a Puget Sound Lowlands stream. Impaired water quality cannot be ruled out here. The functional composition of the sample, dominated by filterers (especially the blackfly *Simulium* sp. and the caddisfly *Hydropsyche* sp.) and gatherers, may be interpreted as evidence of nutrient enrichment.

b. Thermal condition

A single cold stenotherm taxon was present in the sample. The thermal preference calculated for this assemblage was 14.2°C.

c. Sediment deposition

Sediment deposition probably did not influence the invertebrate fauna at this site: fourteen "clinger" taxa and 6 caddisfly taxa were collected. The FSBI value (3.75) indicated a moderately sediment-tolerant assemblage.

d. Habitat diversity and integrity

Taxa richness (27) was lower than expected, which may indicate disturbed or monotonous instream habitats. At least 4 stonefly taxa were supported at this site, suggesting that reach-scale habitat features such as riparian zones, channel morphology, and streambanks were in relatively good condition. Three semivoltine taxa were counted: periodic dewatering, scouring sediment pulses, or other catastrophes that would interrupt long life cycles can probably be ruled out. Filterers accounted for 68% of collected animals, suggesting that fine organic particulates were an important energy source in the reach.

Lewis Creek above Lakemont outfall

- **Bioassessment scores: 2013**

The B-IBI score generated by this sample was 56.3: this was the highest B-IBI score attained by any sample in this study, and indicated “fair” biological conditions. The RIVPACS score was 0.38, indicating impaired conditions.

- **Indicators of ecological condition: 2013**

a. Water quality

Although 2 mayfly taxa were collected here, neither was well-represented. The mayfly fauna in the sample comprised a single individual of *Diphetor hageni*, and a single individual of *Cinygma* sp. Although low mayfly richness and abundance may signal water quality impairment, the biotic index value (3.19) calculated for the entire assemblage was within expectations for a Puget Sound Lowlands stream. The dominant taxon was the relatively sensitive chloroperlid stonefly *Sweltsa* sp., accounting for 21% of sampled animals. It seems likely that water quality was good in the reach. A few specimens of the turbellarian *Polycelis* sp. were present: groundwater may have augmented surface flow in the reach.

b. Thermal condition

A single cold stenotherm taxon was present in the sample. The thermal preference calculated for this assemblage was 13.5°C.

c. Sediment deposition

Eighteen “clinger” taxa and 6 caddisfly taxa were collected. These findings make it seem unlikely that colonization was limited by sediment deposition. A few early-instar representatives of the chloroperlid subfamily Paraperlinae were supported at this site: these hyporheic organisms strongly suggest that interstitial substrate spaces were free from sediment. The FSBI value (3.95) indicated a moderately sediment-tolerant assemblage.

d. Habitat diversity and integrity

High taxa richness (39) suggests that instream habitats were diverse and intact. No fewer than 6 stonefly taxa were supported here: reach-scale habitat features such as riparian zones, channel morphology, and streambanks may have been in relatively good condition. Seven long-lived taxa were present in the sample, making it seem unlikely that catastrophes such as periodic dewatering, scouring sediment pulses, or toxic pollutants that would interrupt long life cycles were influential. All expected functional groups were well-represented.

DISCUSSION

Impaired water quality was suggested by the aquatic fauna at 4 of the 6 sites studied in 2013 in the City of Bellevue. Multiple sources of stress were suggested by invertebrate assemblages at a minimum of 2 sites. Table 3 summarizes the stressors suggested by the analysis of the taxonomic and functional characteristics of the biotic assemblages. Evidence for metals contamination could not be readily identified from the components of the biota at any site.

B-IBI scores and, especially, RIVPACS scores may have overestimated impairment at Lewis above Lakemont, where Plecoptera and Trichoptera richness were relatively high, and where the fauna included several relatively taxa, some of which were abundant. These taxa included *Sweltsa* sp., *Kogotus* sp., pteronarcyid stoneflies, *Glossosoma* sp., and *Lara* sp. Bioassessment tools also may have overestimated impairment at the Yarrow site, which had a good representation of relatively sensitive taxa as well as high taxa richness.

Table 3. Summary of possible stressors, as suggested by the taxonomic and functional composition of invertebrate assemblages. City of Bellevue, 2013.

Site	water quality degradation	sediment deposition	metals	thermal stress	habitat disruption
Yarrow		?			
Kelsey Trestle	+				?
Newport	+	+		?	+
West Trib	+	+		?	+
Coal Anna's Pond	+				?
Lewis Creek					

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APPENDIX

Taxa lists and metric summaries

City of Bellevue, Washington

2013