BENTHIC INVERTEBRATE ASSESSMENT OF STREAMS IN THE GEORGIA BASIN USING THE REFERENCE CONDITION APPROACH: EXPANSION OF THE FRASER RIVER INVERTEBRATE MONITORING PROGRAM 1998-2002

Stephanie Sylvestre, Monique Fluegel and Taina Tuominen

Environment Canada
Environmental Conservation Branch
Aquatic and Atmospheric Sciences Division
#201-401 Burrard Street
Vancouver, BC V6S 3C5

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ABSTRACT

Intensive urban development and agricultural activity in the Georgia Basin of British Columbia, Canada, are a concern with regard to their effect on the stream quality. Benthic macroinvertebrates were used to assess the current biological quality of streams in the Georgia Basin. The assessment was based on a biomonitoring program developed for the Fraser River Basin which used the Reference Condition Approach and the BEAST (BEnthic Assessment of SedimenT) assessment method. The reference condition database developed for the Fraser River Basin was expanded to include 55 streams in the Georgia Basin, including areas in the Lower Fraser Valley, streams draining into the Strait of Georgia from Eastern Vancouver Island and watersheds adjacent to the Fraser River Basin. As a result, the Fraser River assessment model was modified and the new Fraser/Georgia Basin model was used to assess 46 streams exposed to urban and agricultural activities.

BEAST assessments were accompanied by other commonly used bioassessment tools such as observed to expected taxa ratios and bioassessment metrics, which are often part of a benthic index of biological integrity. Together, these tools provided a clear description of the benthic invertebrate community and how it was different from what was expected when compared to an appropriate reference condition. Ninety per cent of the streams sampled in urban and agricultural areas were *possibly stressed* or worse based on the BEAST assessments. Two thirds of the test sites fell outside of the 99% confidence ellipse indicating that they were *stressed* or *severely stressed*. Grab sample measurements of water quality were inadequate to identify causative stressors. The invertebrate communities may have been affected by a series of events or a single event not captured by grab samples since the communities reflect cumulative effects integrated over time. A detailed water chemistry study should be conducted at these sites.

With the development of the Canadian Aquatic Biomonitoring Network (CABIN) and online resources and a predictive model specific to the Georgia Basin, biomonitoring can be easily incorporated into water monitoring and assessment programs, possibly in cooperation with stewardship groups, in this region.

RESUMÉ

Le développement urbain et agricole intensifs dans le bassin de Georgia en Colombie-Britannique, Canada, est une source d'inquiétude en ce qui concerne son effet sur la qualité des cours d'eau. Des macro-invertébrés benthiques ont été utilisés pour évaluer la qualité biologique actuelle des cours d'eau du bassin de Georgia. L'approche suivie lors de cette évaluation était basée sur un programme de suivi biologique développé pour le bassin du fleuve Fraser qui utilisait l'approche de la condition de référence et la méthode d'évaluation BEAST (logiciel d'évaluation des sédiments benthiques). La base de données des conditions de référence développée pour le bassin du fleuve Fraser a été étendue pour inclure 55 cours d'eau du bassin de Georgia, y compris des zones dans la vallée du bas Fraser, des cours d'eau se jetant dans le détroit de Georgia depuis l'est de l'île de Vancouver ainsi que les bassins hydrographiques proches du bassin du fleuve Fraser. Le modèle d'évaluation du fleuve Fraser a ainsi été modifié et le nouveau modèle Fraser/bassin de Georgia a été utilisé pour évaluer 46 cours d'eau exposés aux activités agricoles et urbaines.

Les évaluations BEAST ont été accompagnées par d'autres outils d'évaluation biologique communément utilisés comme les rapports taxa observés/attendus et les mesures d'évaluation biologique, qui font souvent partie d'un indice benthique de l'intégrité biologique. Ensemble, ces outils ont fourni une description claire de la communauté des invertébrés benthiques et de la mesure dans laquelle elle était différente de celle attendue lorsque comparée à une condition de référence adéquate. 90 % des cours d'eau ayant fait l'objet d'échantillons dans les zones agricoles et urbaines indiquaient un *stress probable* ou pire, en se basant sur les évaluations BEAST. Deux tiers des sites testés étaient hors de l'ellipse de confiance à 99 %, indiquant ainsi qu'ils subissaient un *stress* ou un *stress sévère*. Les mesures de la qualité de l'eau par échantillon prélevé au hasard n'ont pas permis d'identifier les agresseurs en cause. Les communautés d'invertébrés peuvent avoir été affectées par une série d'événements ou par un seul événement non capturé(e) par les échantillons prélevés au hasard car ces communautés sont le reflet des effets cumulés qui ont été intégrés au fil du temps. Une étude chimique détaillée de l'eau devrait être menée sur ces sites.

Grâce au développement du Réseau canadien de biosurveillance aquatique (RCBA) et grâce aux ressources en ligne spécifiques au bassin de Georgia, la biosurveillance peut être facilement intégrée aux programmes d'évaluation et de surveillance de la qualité de l'eau, peut-être en collaboration avec les groupes de gérance environnementale présents dans cette région.

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1. Introduction

Nearly three million people are clustered in the Georgia Basin, representing 75% of the population of British Columbia. Population growth and urban development exert the greatest pressures on the basin. Urban development has substantially affected the hydrology, water quality and stream habitats of urban watersheds, causing deteriorating benthic invertebrate communities and salmon populations in the lower Fraser River Basin (Hall et al. 1999). Intensive agricultural practices and rapid development in the Lower Fraser Valley reflect the pressure from population growth in the lower mainland. Lower Fraser Valley streams are being affected by excessive nutrient inputs from application of manure and fertilizer and destruction of riparian areas by livestock (Schreier et al. 1999).

To assess impairment in stream ecosystems, a biomonitoring program based on the Reference Condition Approach (RCA; Bailey et al. 2004) was developed for the Fraser River Basin during the Fraser River Action Plan (FRAP) (Rosenberg et al. 1999, Reynoldson et al. 1997, Reynoldson et al. 2001). A large database of benthic macroinvertebrate assemblages was established from a wide range of habitats at minimally disturbed sites (reference sites) throughout the watershed. Using multivariate statistical techniques, empirical models were developed from this database that predicted the expected invertebrate assemblage (reference condition) using the habitat characteristics at a particular site. The assumption was that if the observed community was not what was expected then the stream must have experienced some anthropogenic stress. These models were used to assess sites within the Fraser River Basin thought to be impacted by various human activities. The RCA assessment method used in this program originated in the Great Lakes and was called the BEnthic Assessment of SedimenT (BEAST; Reynoldson et al. 1995). RCA predictive modelling approaches are also used in the United Kingdom (RIVPACS, Wright et al. 2000) and in Australia (AUSRIVAS, Parsons and Norris 1996). In these applications, the RIVPACS (River Invertebrate Prediction and Assessment Classification System, Wright 1995) assessment method is used rather than the BEAST method.

At the completion of the FRAP, it was intended that the established benthic invertebrate monitoring approach would be used for stream assessments for the Georgia

Basin Ecosystem Initiative (GBEI; 1998-2002). However, the Georgia Basin is a general drainage basin rather than a classical river basin. The Georgia Basin includes streams in the Lower Fraser River Valley, in eastern Vancouver Island, and in southwest British Columbia that drain into the Strait of Georgia (Figure 1), as well as streams in Washington that drain into Puget Sound. Unlike many of the sites sampled during FRAP, many streams exposed to human activities in the Georgia Basin are often slow moving, soft-bottom streams, in low-lying areas, often with very little riparian vegetation. Before stream assessments could be done, the reference conditions and predictive model developed for the Fraser River Basin needed to be expanded to include these additional habitat conditions in the Georgia Basin. The expansion required sampling reference sites in watersheds adjacent to the Fraser River Basin and in eastern Vancouver Island to capture environmental conditions outside the range of the original Fraser model. The ultimate objective of this study was to assess stream quality in the Georgia Basin based on benthic invertebrate communities in areas exposed to urban and agricultural activities.

Figure 1. Study area boundaries of the Georgia Basin and Fraser River Basin.

2. Methods

2.1 Study area and sampling sites

The Georgia Basin encompasses the southern coast of British Columbia (BC) and eastern Vancouver Island. This includes the Lower Fraser River Valley as well as watersheds adjacent to the Fraser River Basin flowing into the Strait of Georgia (Figure 1). In 1998-2002, 34 reference sites from the Lower Fraser Valley and 21 reference sites from eastern Vancouver Island were sampled and added to the existing Fraser reference database of 219 sites (Rosenberg et al. 1999) to ensure that the bioassessment model was appropriate to the expanded geographical area. In addition, 46 test sites were sampled from streams exposed to agricultural and or urban activities. Sites were initially classified as "reference" or "test" based on knowledge by local experts, and ground and air reconnaissance. Reference sites were sites determined to be minimally affected by human disturbance. Test sites were sites that have exposure to anthropogenic activities in adjacent or upstream land uses. Nine sites were sampled in multiple years (repeat sites) to assess temporal variation and seven sites were sampled in three riffles within the same reach to assess spatial variation (QA sites).

2.2 Sampling methods

During the fall (late September and early October), a single integrated sample of the invertebrate community was collected at each site with a travelling kick-net (400 μm mesh) for a timed period of three minutes. Samples were sub-sampled using a 100-cell Marchant box until a minimum of 300 organisms were obtained (Marchant 1989). The count was adjusted back to a whole sample count and recorded. On rare occasions where the flow was very slow and the substrate was very soft, resulting in an extremely large sample in the net, the sampling could not be practically or safely continued for three minutes. In such cases, the sample was sub-sampled and enumerated as described above and extrapolated to three minutes based on the sampling time of the actual collection. Thus, all biological data represent abundances based on a three minute integrated kick-net sample. Organisms were identified to the lowest possible taxon (usually genus or species level); however family-level data were used for the development of the

model based on Reynoldson et al. (2001) who showed that family-level models were more sensitive in detecting disturbed sites. At each site, approximately 40 environmental variables were measured representing landscape variables, reach, channel and water chemistry characteristics (Rosenberg et al. 1999). Detailed discussion of the sampling and processing methods and their calibration can be found in Rosenberg et al. (1999).

2.3 Data Analysis

All data were entered into the Canadian Aquatic Biomonitoring Network (CABIN) online database (http://CABIN.cciw.ca/cabin), maintained by the National Water Research Institute, Environment Canada, Burlington, Ontario. Fifty-five new reference sites were added to the Fraser River Basin database to include slow, soft-bottom streams as well as streams in the Eastern Vancouver Island Ecoregion (Figure 2). This provided a total of 274 sites from which an expanded bioassessment model was developed that would be applicable to the Georgia Basin as well as the Fraser Basin. Family-level invertebrate data were classified using cluster analysis and plotted in ordination space using non-metric multidimensional scaling in PATN (Belbin 1993) to describe and explain the variability among the sites. Biological groups were identified and each reference site was assigned to a biological group based on the classification.

Principal axis correlation (PCC procedure, Belbin 1993) was performed to examine the relationship between the habitat and invertebrate data. The correlation was done to determine which environmental variables were significantly correlated with the biological data and thereby reduce the number of potential habitat predictors. The best combination of predictor variables for the BEAST assessment model was chosen by an iterative process of discriminant function analysis (DFA) in SYSTAT 10 (SPSS Inc. 2000) beginning with stepwise DFA. Stepwise discriminant function analysis (DFA) identified the environmental variables that best separated the reference sites into their classified groups. From that point, environmental variables were added and removed iteratively.

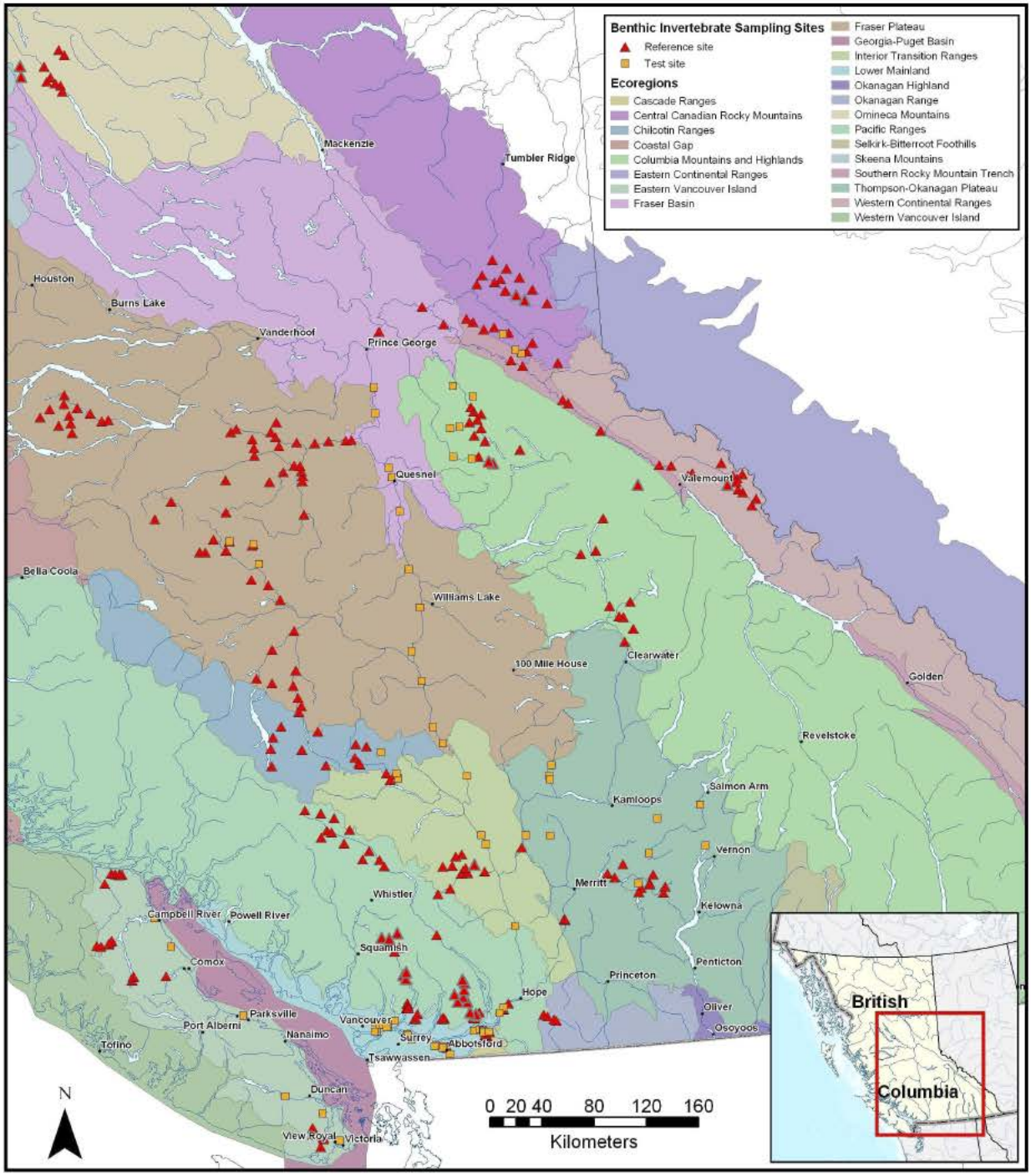


Figure 2. Reference and test sites sampled in the Fraser and Georgia basins across 13 ecoregions from 1994-2002.

The accuracy of the discriminant model was determined by examining how well the model predicted the sites into the correct biological group using two procedures in SYSTAT: resubstitution, where all sites were used in the development of the model and then resubstituted in the prediction to a reference group, and cross-validation, where all sites minus one were used to develop the model and the prediction was conducted on the site removed from the development. Cross-validation is the best check on the model since it does not use the reference site it is predicting to develop the model. The predicted classification and the actual classification were compared to determine the error rate. The optimal model was the model with the lowest error rates determined by both validation procedures. A detailed description of the analytical methods can be found in several publications by Rosenberg et al. (1999, 2000) and Reynoldson et al. (1997, 2001).

The new model developed to include the Georgia Basin was used to assess 46 test sites exposed to a variety of urban and or agricultural activities throughout the Georgia Basin, including Vancouver Island (Figure 2). These test sites were chosen based on interest or concern by local agencies or stewardship groups, intensity of land-use activities and sampling access. One sample was collected at each of the sites representing an integrated assessment of the biological quality of the stream.

2.4 Temporal variation (repeat sites)

Nine sites were selected as repeat sites: seven test sites and two reference sites. Two reference sites, ELK02 and HUN01, were sampled to examine the effect of annual variability on model performance. We also sampled seven test sites to examine the year-to-year variation of the stream assessment. The sites had no apparent changes in adjacent land-use between sampling years. One test site (CLB03) was sampled in three consecutive years, one reference site (HUN01) was sampled in two consecutive years, and six test sites (ELK06, BYR01, FRO01, BRU01, BRU02, and BRU03) and one reference site (ELK02) were sampled in two non-consecutive years (Table 1). To examine the variation in the community from year to year, the repeat sites were assessed together on the same ordination plot. Individual assessments are provided in Appendix C.

Table 1. Sampling summary of Georgia Basin repeat sites.

Repeat Site	1998	1999	2000	2001	2002
HUN01*	✓	✓			
ELK02*	✓		✓		
ELK06	✓		✓		
CLB03	✓	✓	✓		
BRU01			✓		✓
BRU02			✓		✓
BRU03			✓		✓
BYR01			✓		✓
FRO01			✓		✓

*denotes a reference site

2.5 Spatial variation (QA sites)

Three minute kick-net samples were collected from three riffles within a reach at seven sites, such that a sample was collected in downstream, mid-reach and upstream riffles. As well, the habitat variables were measured at each of the three riffles. Sampling was conducted to investigate the within-site variability of the benthic and habitat data and, ultimately, the BEAST assessment variability within a reach of stream or river. Four sites were sampled in 1998, one site was sampled in each of 1999 and 2000, and two sites were sampled in 2001 (Table 2).

Table 2. Sampling summary of Georgia Basin QA sites.

QA Site	Year
HUN0198	1998
CHH1298	1998
CLB0398*	1998
SUM0199	1999
BRU0200*	2000
BUT0101	2001
STR0301	2001

*denotes a test site

The variability in group prediction and BEAST assessment of quality assurance (QA) samples may also be a result of measurement variability of the operators. Quality assurance sites sampled during the Fraser River program (1994-1996) were sampled to address this source of variability. Unlike the QA habitat measurements described in the previous paragraph, the habitat measurements were measured in triplicate at the same downstream riffle location to examine measurement error by the operators. The habitat

measurements did not re-locate with the kick-net samples at the mid-reach and the upstream riffles as they did with QA samples during the GBEI sampling in 1998-2002.

2.6 Site Assessment

Test sites were assessed using the BEAST (Reynoldson et al. 1995) for the Fraser River Basin, as described in Reynoldson et al. (1997) and Rosenberg et al. (1999). The model assigns a probability of a test site belonging to a specific group of reference sites through discriminant analysis using the habitat data. The reference group to which the test site has the highest probability of belonging is deemed the most appropriate reference group for comparison. This reference group represents the range of expected communities. The predicted reference group represents the range of natural variation that would exist in benthic invertebrate communities from test sites if they were unaffected by human disturbance.

Invertebrate data from the test site and from the appropriate group of reference sites were merged and plotted together in a non-metric hybrid multidimensional scaling (HMDS) ordination plot using PATN (Belbin 1993) for the BEAST assessment. The ordination plot is a multivariate, three-dimensional summary of all taxa and their relative abundances using the Bray-Curtis dissimilarity coefficient. The BEAST site assessment uses a graphical display of the expected and observed communities (Figure 3). The graph uses three multivariate axes representing all benthic taxa. The closer two points are in ordination space, the more similar they are. The difference between the predicted community (reference sites) and the observed community (test site) indicates the degree of stress. Confidence ellipses surrounding the reference sites (90%, 99% and 99.9%) are drawn on the ordination in SYSTAT (SPSS 2000) to delineate four categories of stress (*not stressed, possibly stressed, stressed and severely stressed*) (Reynoldson et al. 2001, Rosenberg et al. 1999).

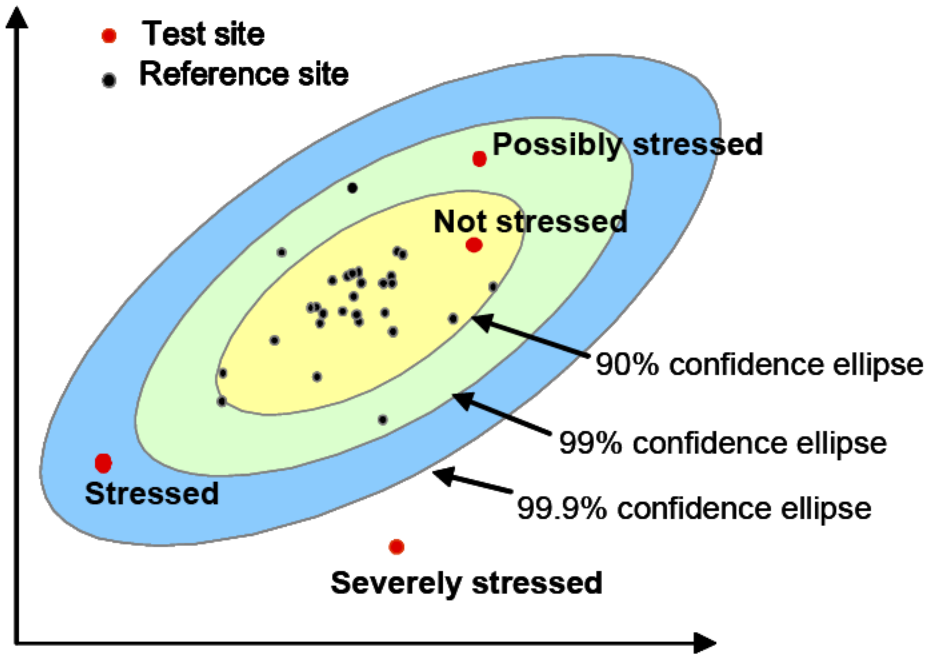


Figure 3. Ordination of invertebrate communities at reference sites and test sites. Different bands surrounding the cloud of reference sites represent the assessment criteria for a test site based on the distance the test site falls away from the cloud of reference sites. The closer two points are the more similar they are.

RIVPACS, an assessment method using presence and absence data (Wright et al. 2000), was also used to aid in interpretation of the BEAST assessment. Observed to expected taxa ratios (O:E ratios) were calculated. O:E ratios compare taxa expected to be present at a site with those taxa observed at the site. These ratios are therefore sensitive to taxa richness and taxa loss but not to changes in relative abundance (Reynoldson et al. 1997, Mazor et al. in prep).

RIVPACS calculation uses the probabilities of group membership for all reference groups and the frequency of taxa occurrence (percentage of sites where a particular taxon was found) in each reference group to predict the taxa that should be observed at a test site. The product of the probability of group membership and frequency of occurrence provides the contribution of a reference group to the overall probability of a taxon occurring. The sum of the contributions for all the reference groups provides the summed probability of any taxon being present. The likelihood of a taxon occurring at a test site is a sum of the products (Table 3).

Table 3. Calculation of the probability of *Baetidae* being present at test site FRA12. The probability of group membership for FRA12 is derived from discriminant function analysis and the frequency of *Baetidae* occurrence in each group is derived from the reference database.

Test Site FRA12	Grp1	Grp2	Grp3	Grp4	Grp5	Summed Prob. of taxon being present (%)
Probability of group membership	0.0018	0.9396	0.0003	0.0580	0.0001	
Frequency of occurrence in reference group (%)	94.51	75	88.75	63.16	92.65	
Combined probability (%)	0.17	70.47	0.027	3.66	0.0096	74.34

This calculation was conducted for every taxon to determine the expected community at a site. The expected taxa richness is calculated from the sum of all taxon probabilities of occurrence. O:E ratios were examined to investigate the loss of taxa that have more than a 50% chance of occurring ($O:E_{50}$), as well as the highly expected taxa with a 70% chance of occurrence ($O:E_{70}$). Ratios were calculated by summing up the total number of observed taxa (taxa present with probabilities of occurrence greater than 50% or 70%) and divided by the expected number of taxa (sum of probabilities greater than 50% or 70%). A low O:E score indicates taxa loss and represents a site exhibiting some form of anthropogenic stress. This assessment method provides a list of expected taxa but does not account for the expected relative abundance of taxa.

Selected U.S. Environmental Protection Agency bioassessment metrics were also calculated (Table 4) to examine correlations with multivariate descriptions of biological condition (Plafkin et al. 1989). Metrics are commonly combined into biological indices to summarize stream quality or biological integrity (Barbour et al. 1999, EVS Environmental Consultants 2003, Karr and Chu 1999, Kearns and Karr 1994). Metrics calculated in our report were not condensed into an index as they are in some biomonitoring studies (Barbour et al. 1999, GVRD 2004). Due to the wide range of benthic communities in each reference group, the central 90% range of reference metrics (5^{th} to 95^{th} percentile) was calculated to represent the range of central tendency rather than extreme minimum and maximum within each group. Calculated metrics at each test site were compared to the central 90% range of each metric calculated for the predicted reference group. Hundreds of community metrics exist that could have been chosen, however a subset of metrics was chosen that captured relevant ecological measures such as diversity and evenness. Pollution tolerance metrics such as EPT metrics (Ephemeroptera, Plecoptera and

Trichoptera) tend to be very sensitive to organic pollution (Table 4). Composition measures such as proportional abundance, as well as a statistical similarity coefficient such as Bray-Curtis were also calculated.

Table 4. Metric calculations and rationale for use in bioassessment studies.

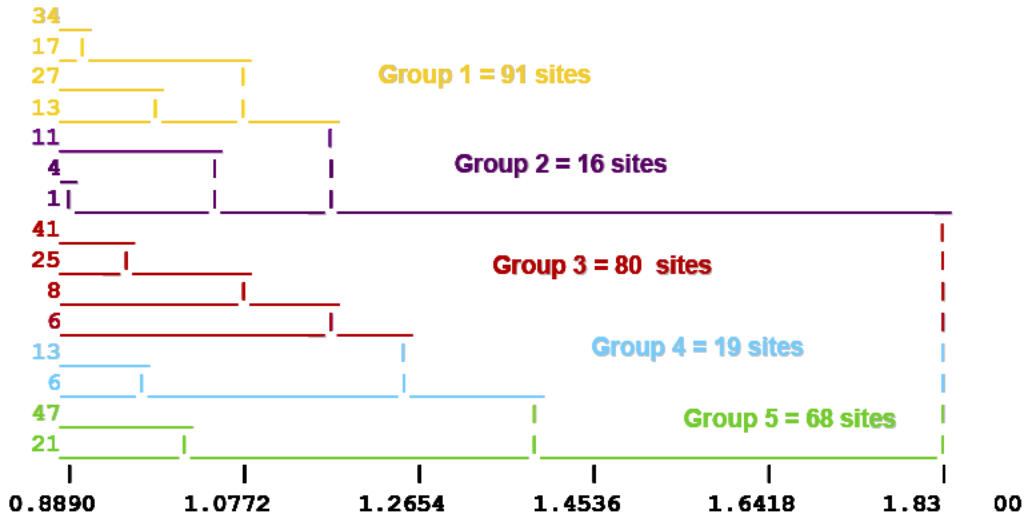
Metric	Calculation	Rationale	Reference
Abundance	N = number of individuals of all taxa in the community	Some environmental stresses may cause abundance to be reduced.	Resh and Jackson 1993
Total Richness	S = total number of taxa in the community	Reflects the health of a community by the variety of taxa present.	Plafkin *et al.* 1989
EPT richness (Ephemeroptera Plecoptera Trichoptera)	S_{EPT} = number of taxa in the Ephemeroptera, Plecoptera and Trichoptera orders	In general, the taxa from the orders Ephemeroptera, Plecoptera, and Trichoptera are pollution sensitive. Each one of these orders can be represented in their own richness metric as each has specific tolerances to oxygen, temperature and habitat complexity.	Lenat 1988, GVRD 2004
% EPT (Ephemeroptera Plecoptera Trichoptera)	% = sum of all individuals from EPT orders / total abundance	The decreased composition of these sensitive insect orders can be an indicator of toxic stress.	Plafkin *et al.* 1989
% Dominance (top 3 taxa)	$\%= \frac{n_i}{N} X\ 100$	Indicates balance in the community where the total of the 3 most abundant taxa are expressed in terms of total community contribution. A community dominated by relatively few taxa would indicate environmental stress.	Plafkin *et al.* 1989
% Chironomidae	% = number of Chironomidae individuals / Total abundance	The composition of Chironomidae tends to increase when disturbance increases as many genera are highly tolerant and opportunistic relative to the more sensitive insect groups.	Plafkin *et al.* 1989
Simpson's Diversity	$D= 1 / \sum_{i=1}^{S} P_i^2$	Accounts for both abundance and richness where P_i is the proportion of the *i*th taxon and S is the taxa richness. In some cases, a low diversity may be indicative of poor environmental quality.	Begon *et al.* 1990
Simpson's Evenness	$E= D / D_{max}$	Represents how evenly the taxa are distributed in the community where D_{max}=S, the maximum number than Simpson's diversity could be. An inequitable community (unbalanced) may be indicative of poor environmental quality.	Begon *et al.* 1990
Bray-Curtis dissimilarity measure	$BC = \frac{\sum \lvert P_{iJ} - P_{iM} \rvert}{\sum (P_{iJ} + P_{iM})}$	Where P_{iJ} is the proportion of taxon *i* in community J and P_{iM} is the proportion of taxon *i* in the median community M. A community with exactly the same structure as the median community will have a Bray-Curtis distance measure of 0 while a value of 1 indicates a totally different community.	Belbin 1993

3. Results and Discussion

3.1 Reference site classification

The expansion of the original Fraser database (219 sites and 74 taxa) with 55 new reference sites provided 19 new invertebrate families, a 25% increase in the reference taxa list. This reveals the importance of expanding the database as new habitats and communities were included. A total of 93 families at 274 reference sites were used for classification of the reference sites. Appendix A provides a taxonomic listing of the invertebrates in the expanded Fraser/Georgia Basin database and Appendix B summarises the family composition at each of the 55 reference sites sampled in the Georgia Basin.

The additional sites and expanded taxa list resulted in a classification of five groups (Figure 4) composed of 91, 16, 80, 19 and 68 sites. The premise of the predictive model is that a site is predicted to a group of reference sites that represents as much variability as you would expect to see in a site that is not affected by human perturbations. The reference groups each represent a range of invertebrate communities, which differ in the type and proportion of taxa. Figure 5 presents the proportion of major taxonomic groups for each of the reference groups. Groups 1 and 3 are dominated by Ephemeroptera (mayflies) and Plecoptera (stoneflies) but differ in the relative abundances of less dominant taxa. Group 2 is dominated by stoneflies, Group 4 by Diptera non-chironomids and Diptera Chironomidae (true flies and midges) and Annelida (worms). Group 5 is equally dominated by mayflies and chironomids and has a larger proportion of Coleoptera (beetles) than the other groups.



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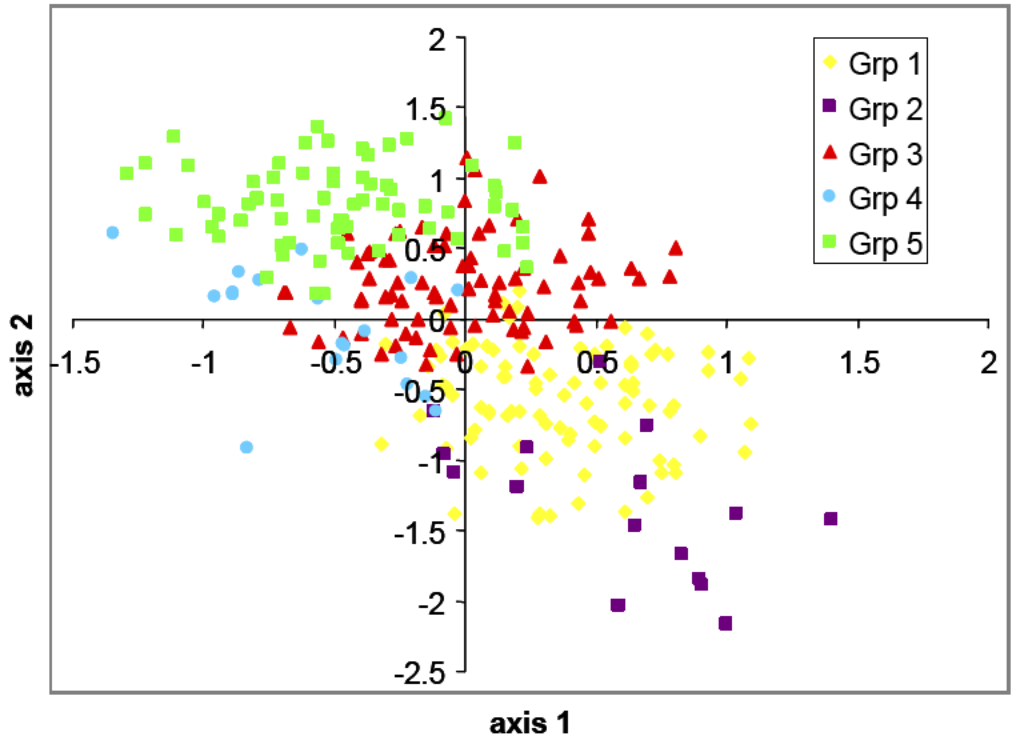


B.

Figure 4. Five groups of invertebrate communities as identified from classification (A) and ordination (B) of 93 families using Bray-Curtis dissimilarity measure from 274 reference sites for the Fraser River/Georgia Basin. The numbers on the dendrogram branches (A) represent the number of sites on each branch.

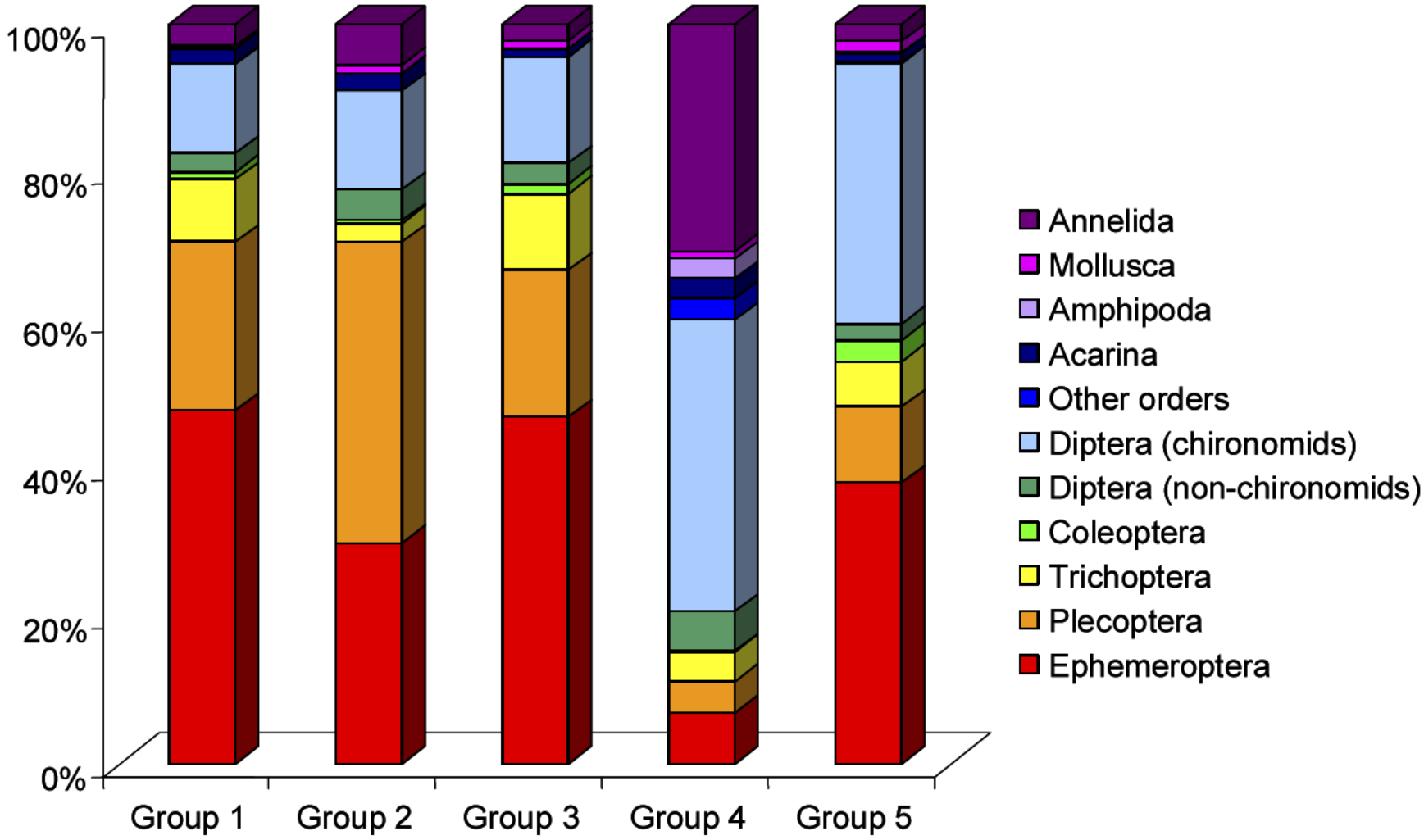


Figure 5. Proportion of the major invertebrates orders in each of the reference groups. Lower-level taxonomic identifications are listed in Appendix A.

The groups differed in composition of taxa and some groups also had higher abundance of organisms than others (Figure 6). Groups 1 and 2 had relatively low abundances of invertebrates compared with the other reference groups. The median abundance of each taxon in groups 1 and 2 was more evenly distributed than in the other groups. Group 3 had proportionately larger abundances of Chironomidae and three types of mayflies - Baetidae, Heptageniidae, Ephemerellidae. Group 2 had the lowest total numbers of invertebrates and lowest median abundances of different taxa than were found in the other groups. The median community of Group 4 had a very high proportion of Chironomidae and also included worms - Naididae, Tubificidae - that were not found in the median communities of other reference groups. The Group 5 median community had very high abundance and proportionately more stoneflies - Capniidae, Chloroperlidae, Nemouridae, Perlodidae - than other reference groups.

Reference groups were discriminated using environmental variables collected at each site (Table 5). Group 1 consisted of the largest number of sites and hence was widely distributed within the Fraser/Georgia Basin (Figure 7). These sites tended to be from headwater streams with steep slopes, fast velocities, and low alkalinities and are found in a variety of ecoregions with a large proportion from the Pacific Ranges ecoregion. Group 2 consists of a small number of sites from high order streams with large channel widths and a large proportion of sand substrate. Many of these sites were found in the north eastern part of the Fraser River Basin on the main-stem of the Fraser River. Many small streams with fast velocities from the Fraser Plateau with moderate alkalinity and conductivity concentrations were classified to Group 3. Sites in Group 4 were primarily from the Lower Mainland ecoregion at low altitudes having deep channels, slow velocities and a small proportion of gravel on the stream bottom. These sites also had the low values for alkalinity, conductivity and pH. In contrast, Group 5 sites were distinguished by high water chemistry measurements such as alkalinity, conductivity and pH as well as high altitudes, narrow channels and shallow depths. A large proportion of these sites were located in the Fraser Plateau ecoregion.

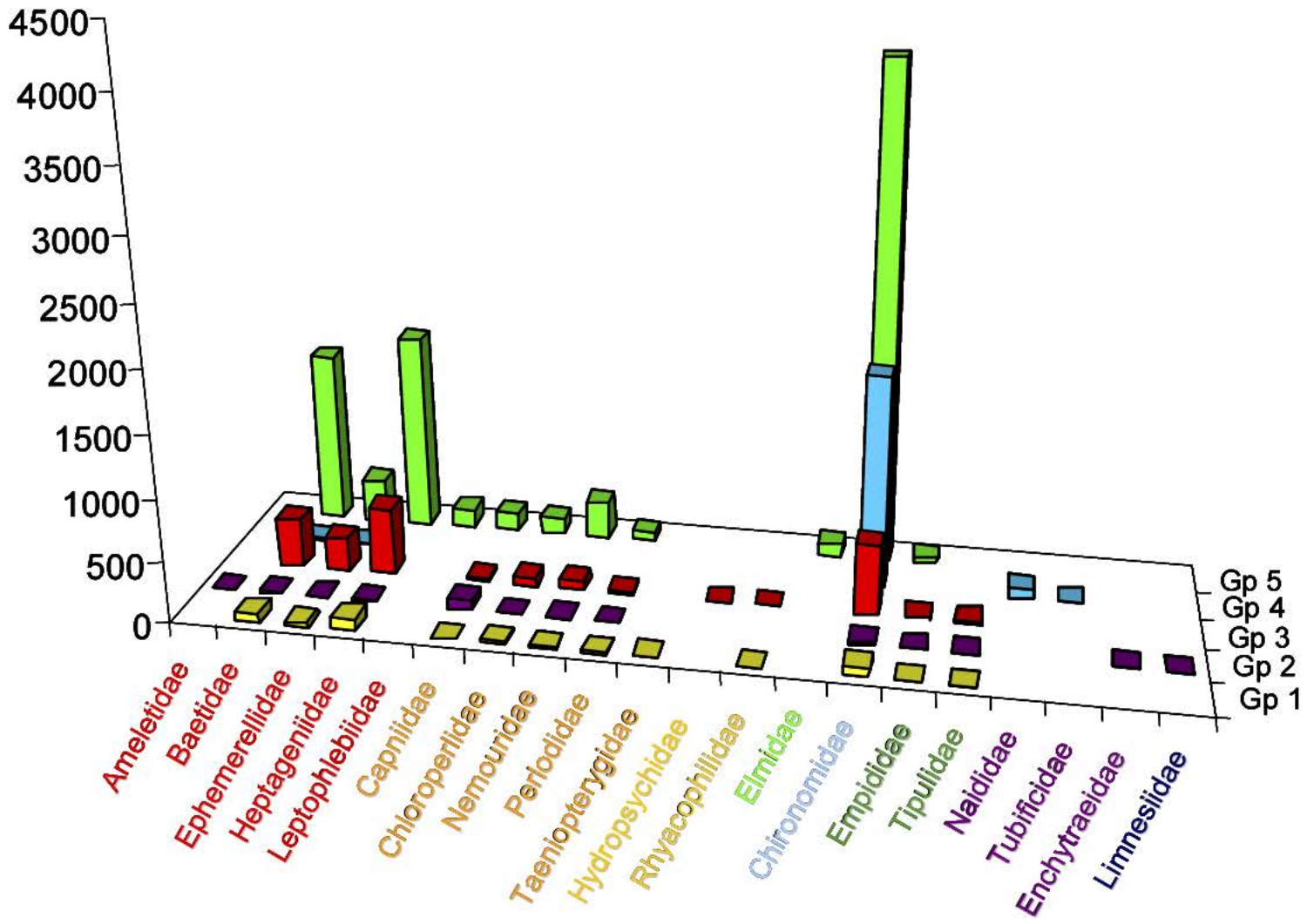


Figure 6. Median family abundances of the five reference groups. Median abundances are based on a 3 min kick-net sample. Family names are colour coded based on the invertebrate orders identified in Figure 5 while reference groups are colour coded based on Figure 4.

Table 5. Summary of median environmental variables of reference groups used in discriminant function analysis and principle axis correlation of the habitat with the invertebrate communities. (Stream order and ecoregion are represented by the mode, the category that appeared the most. Riparian vegetation variables are represented by the proportion of sites with vegetation present. R represents the correlation with the invertebrate data from principle axis correlation. N represents the number of sites in each group.)

	R	Group 1 N=91	Group 2 N=16	Group 3 N=80	Group 4 N=19	Group 5 N=68
Geographic Variables						
Stream order	0.19	2 (26 sites)	5 (5 sites)	3 (24 sites)	3 (7 sites)	3 (17 sites)
[1]Ecoregion	0.17	Pacific Ranges (28 sites)	Southern Rocky Mountain Trench (5 sites)	Fraser Plateau (22 sites)	Lower Mainland (6 sites)	Fraser Plateau (30 sites)
Latitude	0.13	50.342	53.339	51.789	49.367	52.623
Longitude	0.12	-122.637	-121.009	-122.802	-122.284	-122.265
Altitude (fasl)	0.31*	1830	2240	3300	292	3340
Channel Characteristics						
Bankfull width (m)	0.31*	30.33	63.37	19.00	37.11	15.74
Channel width (m)	0.37*	14.00	24.00	7.40	22.05	6.93
Slope	0.23*	0.016	0.001	0.012	0.001	0.007
Avg Channel depth (cm)	0.29*	29.4	26.4	22.0	30.0	18.6
Max Channel depth (cm)	0.27*	42.0	32.0	30.0	36.0	25.0
Avg Velocity (m/s)	0.44*	0.424	0.365	0.386	0.135	0.352
Max Velocity (m/s)	0.50*	0.718	0.486	0.556	0.250	0.532
Riparian Vegetation (presence)						
Coniferous trees %	0.21	90.1	93.7	82.3	42.1	79.7
Deciduous tress %	0.18	68.1	56.3	51.9	47.4	39.1
Grasses %	0.40*	33.0	12.5	46.8	63.2	68.1
Shrubs %	0.08	84.6	68.7	83.5	78.9	87.0
Substrate Characteristics						
[2]Macrophyte (1-5)	0.36*	0	0	0	1	0
[3]Embeddedness (1-5)	0.22*	4	3	4	4	4
[4]Dominant substrate (0-9)	0.47*	7	6	7	4	5
[5]Surrounding material (0-9)	0.21*	3	2	3	2	3
Gravel %	0.04	26.51	19.24	27.01	5.73	28.04
Sand %	0.10	70.98	75.80	72.06	73.93	67.78
Silt %	0.19	0	0	0	0	0
Clay %	0.16	0	0	0	0	0
Water Chemistry						
Alkalinity (mg/L)	0.25[6]*	26.4	55.5	39.1	25.2	54.45
Conductivity (uS/cm)	0.20	53.3	142.6	84.7	12.6	104.0
pH	0.22*	7.55	7.62	7.66	7.06	7.71

*Significant based on principle axis correlation with invertebrate data

[1]Ecoregion designated as the mode representing the category with the greatest number of sites: 13 categories were poss ble: 1, Eastern Vancouver Island; 2, Pacific Ranges; 3, Lower Mainland; 4, Chilcotin Ranges; 5, Fraser Plateau; 6, Central Canadian Rocky Mountains; 7, Fraser Basin; 8, Omineca Mountains; 9, Columbia Mountain Highlands; 10, Southern Rocky Mountain Trench; 11, Western Continental Ranges; 12, Interior Transition Ranges; 13, Thompson-Okanagan Plateau.

[2]Recorded as: 1, 0%; 2, 0-25%; 3, 25-50%; 4, 50-75%; 5, 75-100%.

[3]Estimated in sampling area: 1, completely embedded; 2, 75% embedded; 3, 50% embedded; 4, 25% embedded; 5, unembedded.

[4]Dominant particle size in sampling area: 0, organic material; 1, <0.1 cm; 2, 0.1-0.2cm; 3, 0.2-0.5cm; 4, 0.5-2.5 cm; 5, 2.5-5 cm; 6, 5-10 cm; 7, 10-25 cm; 8, >25 cm; 9, bedrock.

[5]Material surrounding dominant particles: 0, organic material; 1, <0.1 cm; 2, 0.1-0.2cm; 3, 0.2-0.5cm; 4, 0.5-2.5 cm; 5, 2.5-5 cm; 6, 5-10 cm; 7, 10-25 cm; 8, >25 cm; 9, bedrock.

[6]Correlation based on ordination with only 254 reference sites because 20 sites had missing values.

Despite some habitat generalities, there are limited large-scale geographic patterns of the classification of reference sites to groups (Figure 7). Benthic invertebrate communities are related to a combination of large-scale and small-scale habitat features. It is the combination of features determined in this report by discriminant function analysis that is used to develop an assessment model that predicts the benthic invertebrate community that should occur in streams with minimal human disturbance.

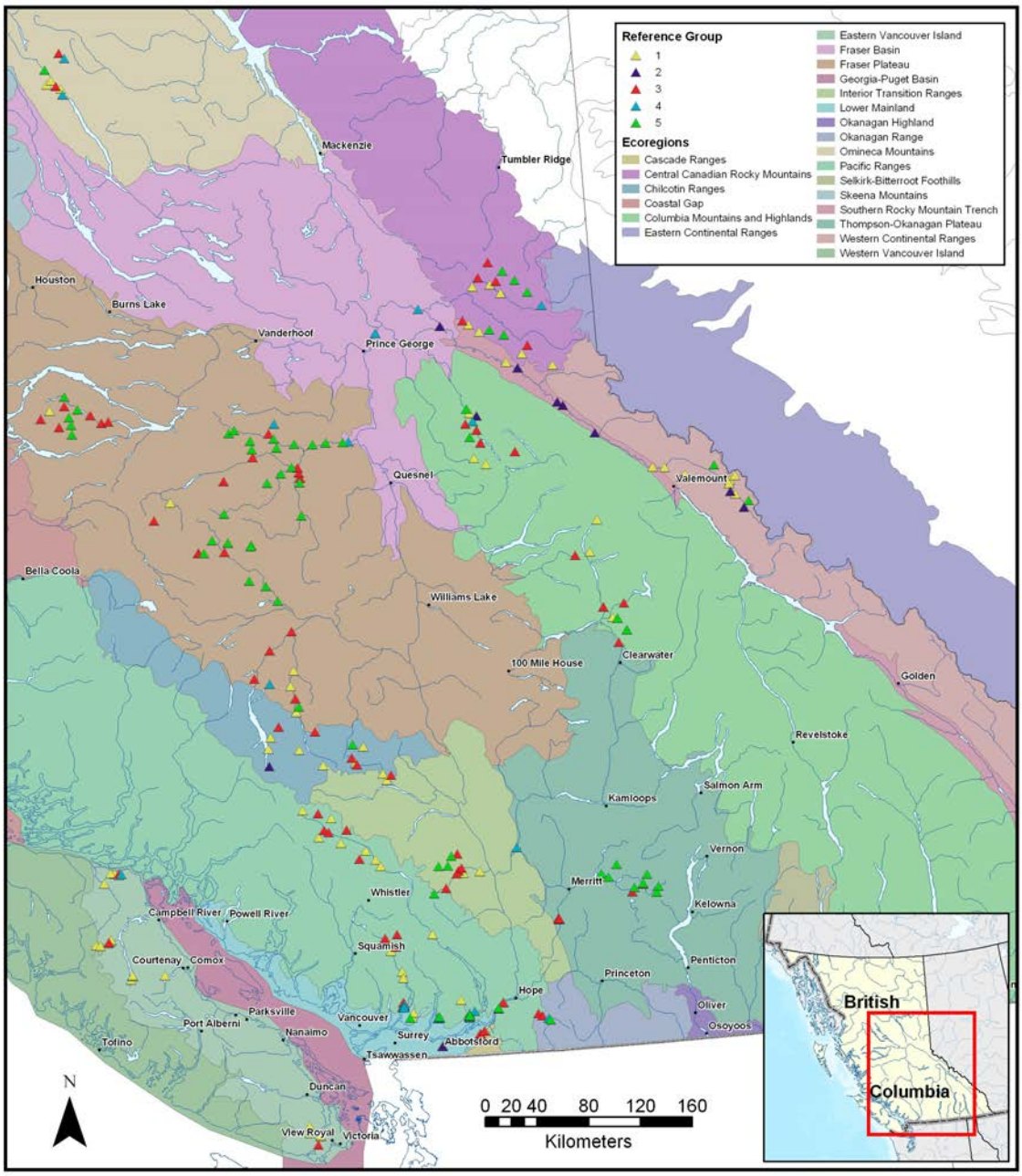


Figure 7. Distribution of reference groups across ecoregions in the Fraser/Georgia Basins.

3.2 Predicting appropriate reference groups

The 27 variables listed in Table 5 were considered to be appropriate predictor variables for the Fraser/Georgia Basin model. Many other environmental variables were measured such as dissolved oxygen, temperature, nutrients, ions, total suspended solids, chlorophyll-a, and biomass. These variables were either expected to be affected by human disturbance or were inappropriate for instantaneous measurement (e.g., temperature) and therefore were not considered in the development of the model. However, these measurements can be valuable in interpreting the BEAST assessment.

Nearly all of the environmental variables were significantly correlated with the invertebrate data based on principal axis correlation (Table 5). The model using all 27 habitat variables correctly predicted 57% of the reference sites to the pre-assigned classification by resubstitution procedure but only 46% by cross-validation procedure (Table 6). Any reference site missing data is excluded from the model, thus the model using 27 variables was based on 254 reference sites because 20 sites were missing alkalinity data. To include all sites in the model, we removed alkalinity as a potential predictor and 58% of the sites were correctly predicted to their classified group by resubstitution and 45% by cross-validation (Table 6). The stepwise DFA found that 14 variables in the model correctly predicted 56% of the sites to their classified group and 50% by cross-validation (Table 6). The decrease in variables improved the model error rate as determined by cross-validation. Variables were added and removed iteratively until the best combination of error rates by resubstitution and cross-validation was achieved.

Model performance is based on the ability of the model to discriminate between reference groups, but not its ability to determine whether the model correctly classified a reference site as “reference”. That performance evaluation is conducted on QA sites in section 3.5. The optimal model used for the assessment of streams in the Georgia Basin used 11 variables and predicted 58% of the reference sites correctly by resubstitution and 53% by cross-validation (Table 6).

Table 6. Model performance as measured by resubstitution and cross validation (in parentheses) of various discriminant models to predict reference sites.

# Variables	Model	Reference sites correctly classified by resubstitution (cross-validation)					% correct by Resubstitution (Cross-validation)
		Gp 1	Gp2	Gp 3	Gp 4	Gp 5	
27	**Complete 27 variable model**	46 (41)	9 (7)	36 (25)	12 (10)	40 (34)	57 (46)
26	**Complete 26 variable model:** (without alkalinity variable because 20 sites were missing an alkalinity value)	54 (48)	11 (8)	37 (26)	13 (10)	43 (31)	58 (45)
14	**Stepwise model:** altitude, latitude, longitude, ecoregion, avg depth, max depth, conif, dominant substrate, embeddedness, grass, pH, max velocity, width, slope	54 (52)	12 (8)	34 (28)	11 (10)	43 (38)	56 (50)
9	**Reduced model based on iteration**: latitude, ecoregion, stream order, avg depth, conif, dominant substrate, embeddedness, maximum velocity, wetted width	55 (54)	7 (7)	36 (34)	11 (10)	44 (40)	56 (53)
10	**Reduced model based on iteration**: latitude, ecoregion, stream order, avg depth, conif, dominant substrate, embeddedness, maximum velocity, wetted width, pH	57 (56)	7 (7)	36 (33)	11 (10)	44 (41)	57 (54)
11*	**Fraser/Georgia Basin model based on iteration**: latitude, ecoregion, stream order, avg depth, conif, dominant substrate, embeddedness, maximum velocity, wetted width, slope, pH	57 (53)	7 (7)	36 (32)	12 (10)	46 (42)	58 (53)

*Model used for assessment

The model was best able to discriminate sites in groups 1 and 5 as 63% and 68% of the reference sites were correctly classified by resubstitution and 58% and 62% correctly classified by cross-validation (Table 7). Fifty-seven of 91 sites were correctly predicted to Group 1 by resubstitution and 53 of 91 sites by cross-validation (Table 7). Of 68 sites in Group 5, 46 and 42 were correctly predicted to Group 5 by resubstitution and cross-validation respectively. There is very little overlap between Group 1 and 5 in ordination space (Figure 4B) and the communities are quite different (Figures 5 and 6).

The model has the most difficulty discriminating between groups 1 and 3 and between groups 3 and 5. Only 45% of Group 3 sites were correctly predicted by resubstitution and only 40% were correctly predicted by cross-validation. Misclassifications occur most commonly in regions of overlap (Figure 4B). Of 80 sites in Group 3, 18 were predicted to Group 1 by both validation procedures while19 and 21 sites were predicted to Group 5 by resubstitution and cross-validation, respectively. Based on the cross-validation method, 18 reference sites from Group 3 were misclassified to Group 1 and 23 sites from Group 1 were misclassified to Group 3 (Table 7). Similarly, 12 sites from Group 5 were misclassified to Group 3 and 21 sites from Group 3 were misclassified to Group 5 based on cross-validation (Table 7).

The taxonomic composition of groups 1 and 3 was very similar (Figure 5); however the relative median abundances of the taxa were different (Figure 6). The relative proportions of the most common taxa were similar between groups 3 and 5; however, the composition of the two groups differed with the less abundant taxa (Figure 5). Relative median abundance of Group 5 was greater than Group 3 (Figure 6). The sites that were misclassified were usually classified to a group that overlapped the correct group in ordination space (Figure 4B).

The potential for misclassifications of test sites does not imply that the BEAST assessments will be invalid or that the test sites will be misclassified as “reference”. The implication of a misclassification is simply that the test site would be compared to a different range of reference conditions.

Table 7. Detailed examination of the classification results of the new Fraser/Georgia Basin model by discriminant function analysis (DFA). The number of reference sites in each group is presented in parentheses. The first part of the table represents the number of reference sites classified by resubstitution and the second part represents the number of reference sites classified by cross-validation.

		DFA model classification by **resubstitution**					
		Group 1	Group 2	Group 3	Group 4	Group 5	% correct
Classification based on 93 taxa	Group 1 (91)	57	6	21	4	3	63
	Group 2 (16)	2	7	2	2	3	44
	Group 3 (80)	18	2	36	5	19	45
	Group 4 (19)	0	2	2	12	3	63
	Group 5 (68)	5	2	8	7	46	68
	Total	82	19	69	30	74	58
		DFA model classification by **cross-validation**					
		Group 1	Group 2	Group 3	Group 4	Group 5	% correct
Classification based on 93 taxa	Group 1 (91)	53	8	23	4	3	58
	Group 2 (16)	2	7	2	2	3	44
	Group 3 (80)	18	2	32	7	21	40
	Group 4 (19)	1	2	2	10	4	53
	Group 5 (68)	5	2	12	7	42	62
	Total	79	21	71	30	73	53

3.3 Assessment of Urban and Agricultural Activities

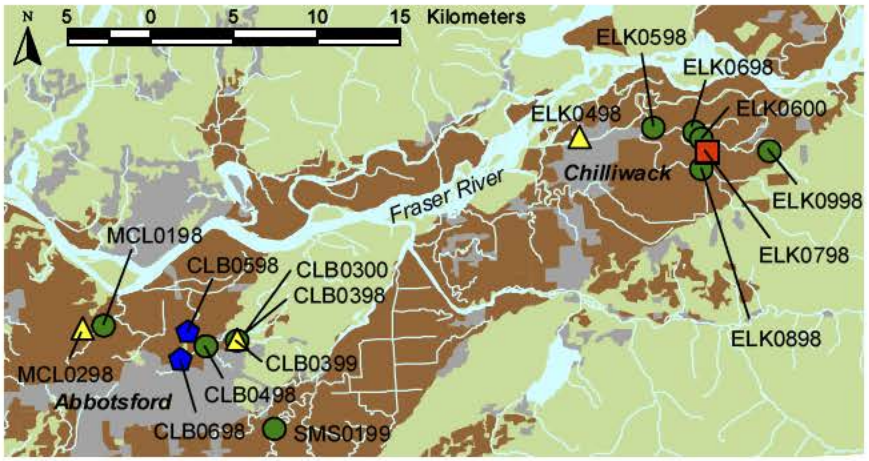
All test sites were assessed individually with the predicted reference group. Seventeen test sites were predicted to Group 4 (Table 8). This group of sites were primarily from the lower mainland ecoregion (Table 5). They had relatively wide channels with very small slopes and small substrates (Table 5). Only one test site was predicted to Group 2 and five sites were predicted to Group 3. Twelve and 11 sites were predicted to groups 1 and 5, respectively.

Test sites in the Lower Fraser Valley were primarily exposed to agricultural activities (Figure 8A). The Lower Mainland test sties were almost exclusively exposed to urban activities (Figure 8B). The Vancouver Island test sites are exposed to a variety of urban and agricultural activities (Figure 8C). One site (QUI0101) was also exposed to mining activities from upstream reaches.

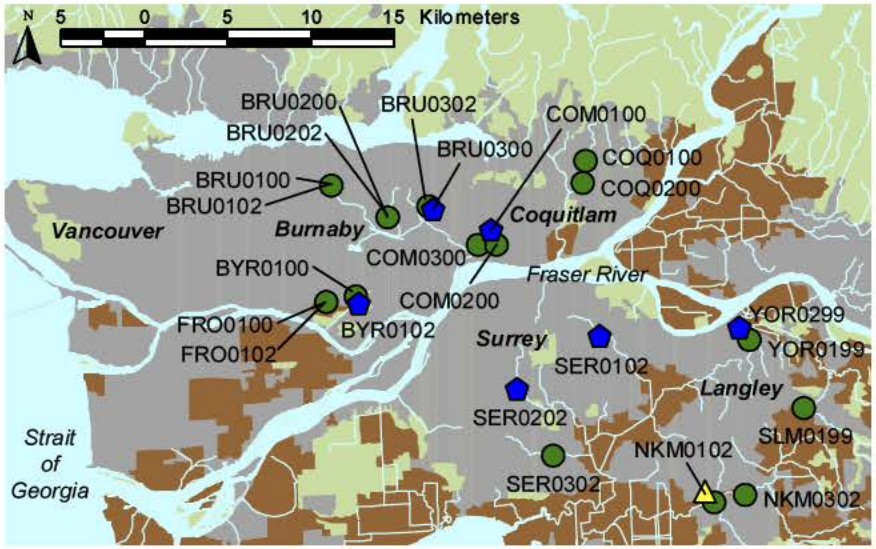
The biological condition of the stream varied among the agricultural and urban sites (Table 8). Most of the test sites, approximately 90%, indicated some level of stress and they were outside of the 90% confidence ellipse (Table 8). Ten sites exposed to urban activities (~29% of urban test sties) were *stressed* or *severely stressed* while three sites exposed to agriculture (~23% of agricultural test sites) were *stressed* or *severely stressed*. Detailed water quality studies should be conducted at these sites to investigate the causative stressors. Only five sites had invertebrate communities similar to reference sites. One of these sites was in an agricultural area exposed to cattle grazing and the other sites were found in urban or residential areas.

Table 8. BEAST assessment of test sites that were exposed to urban and agricultural activities in the Georgia Basin sampled between 1998-2002, their predicted reference group (i.e. their expected community) and the probability of group membership.

Site	Stream (Year)	Group	Probability	BEAST Assessment	Exposure
Lower Fraser Valley (Chilliwack, Abbostford)					
ELK0498	Hope Slough (98)	4	94.4%	not stressed	urban
ELK0598	Hope Slough (98)	4	89.3%	possibly stressed	agricultural
ELK0600	Elk Creek (00)	1	39.1%	possibly stressed	agricultural
ELK0698	Elk Creek (98)	4	93.4%	possibly stressed	agricultural
ELK0798	Elk Creek (98)	4	99.9%	severe stressed	agricultural
ELK0898	Elk Creek (98)	4	99.5%	possibly stressed	agricultural
ELK0998	Dunville Creek (98)	5	56.0%	possibly stressed	agricultural
CLB0398	Clayburn Creek (98)	1	43.3%	possibly stressed	residential/urban
CLB0399	Clayburn Creek (99)	1	43.4%	not stressed	residential/urban
CLB0300	Clayburn Creek (00)	1	55.1%	possibly stressed	residential/urban
CLB0498	Stoney Creek (98)	5	49.2%	possibly stressed	residential/urban
CLB0598	Clayburn Creek (98)	4	99.3%	stressed	agricultural
CLB0698	Wilband Creek (98)	4	98.5%	stressed	urban/agricultural
MCL0198	McLennan Creek (98)	4	98.7%	possibly stressed	agricultural
MCL0298	McLennan Creek (98)	5	46.4%	not stressed	agricultural
SMS0199	Sumas River (99)	4	99.0%	possibly stressed	agricultural
Lower Mainland (Langley, Surrey, Coquitlam, Burnaby)					
SLM0199	Salmon River (99)	4	71.0%	possibly stressed	agricultural
YOR0199	Mundy Creek (99)	4	89.9%	possibly stressed	urban
YOR0299	Yorkson Creek (99)	4	99.8%	stressed	urban
NKM0102	Nicomekl River (02)	4	91.7%	not stressed	urban
NKM0202	Anderson Creek (02)	5	50.0%	possibly stressed	urban
NKM0302	Nicomekl River (02)	4	64.4%	possibly stressed	urban
SER0102	Serpentine River (02)	1	54.6%	stressed	urban
SER0202	Bear Creek (02)	5	39.6%	stressed	urban
SER0302	Hyland Creek (02)	5	39.8%	possibly stressed	urban
COM0100	Como Creek (00)	5	52.6%	stressed	urban
COM0200	Booth Creek (00)	4	74.0%	possibly stressed	urban
COM0300	Nelson Creek (00)	5	60.5%	possibly stressed	urban
COQ0100	Coquitlam River (00)	1	51.2%	possibly stressed	urban
COQ0200	Coquitlam River (00)	2	22.8%	possibly stressed	urban
BRU0100	Beecher Creek (00)	4	48.1%	possibly stressed	urban
BRU0102	Beecher Creek (02)	3	42.2%	possibly stressed	urban
BRU0200	Eagle Creek (00)	3	37.7%	possibly stressed	urban
BRU0202	Eagle Creek (02)	1	41.3%	possibly stressed	urban
BRU0300	Stoney Creek (00)	5	42.3%	stressed	urban
BRU0302	Stoney Creek (02)	5	42.6%	possibly stressed	urban
BYR0100	Byrne Creek (00)	1	50.7%	possibly stressed	urban
BYR0102	Byrne Creek (02)	3	43.8%	stressed	urban
FRO0100	Froggers Creek (00)	3	36.2%	possibly stressed	urban
FRO0102	Froggers Creek (02)	3	44.2%	possibly stressed	urban
Vancouver Island					
BLA0101	Black Creek (01)	5	39.5%	stressed	urban
COL0101	Colquitz River (01)	4	97.2%	not stressed	urban
COW0101	Cowichan River (01)	1	95.5%	possibly stressed	urban/agricultural
FRE0101	French Creek (01)	1	35.5%	severe stressed	urban
QUI0101	Quinsam River (01)	1	80.1%	severe stressed	urban/mining
SHA0101	Shawnigan Creek (01)	1	63.7%	possibly stressed	residential/urban



A.



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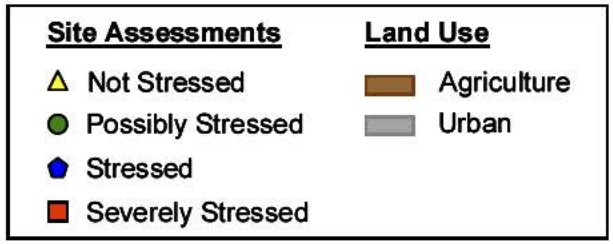

Figure 8. Summary of stream assessments from exposure to urban and agricultural activities in the Georgia Basin (A) in the Lower Fraser Valley (B) on the Lower Mainland and (C) on Eastern Vancouver Island.

The only bioassessment metric that appeared correlated with the categorical BEAST assessment was the Bray-Curtis dissimilarity measure (Figure 9). Bray-Curtis dissimilarity measure is the dissimilarity between the test site and the median reference community. A site indicates stress if the community is different than expected; a large Bray-Curtis measure indicates low similarity with the median reference community. Other metrics were not strongly correlated with the overall BEAST assessments (Figure 9).

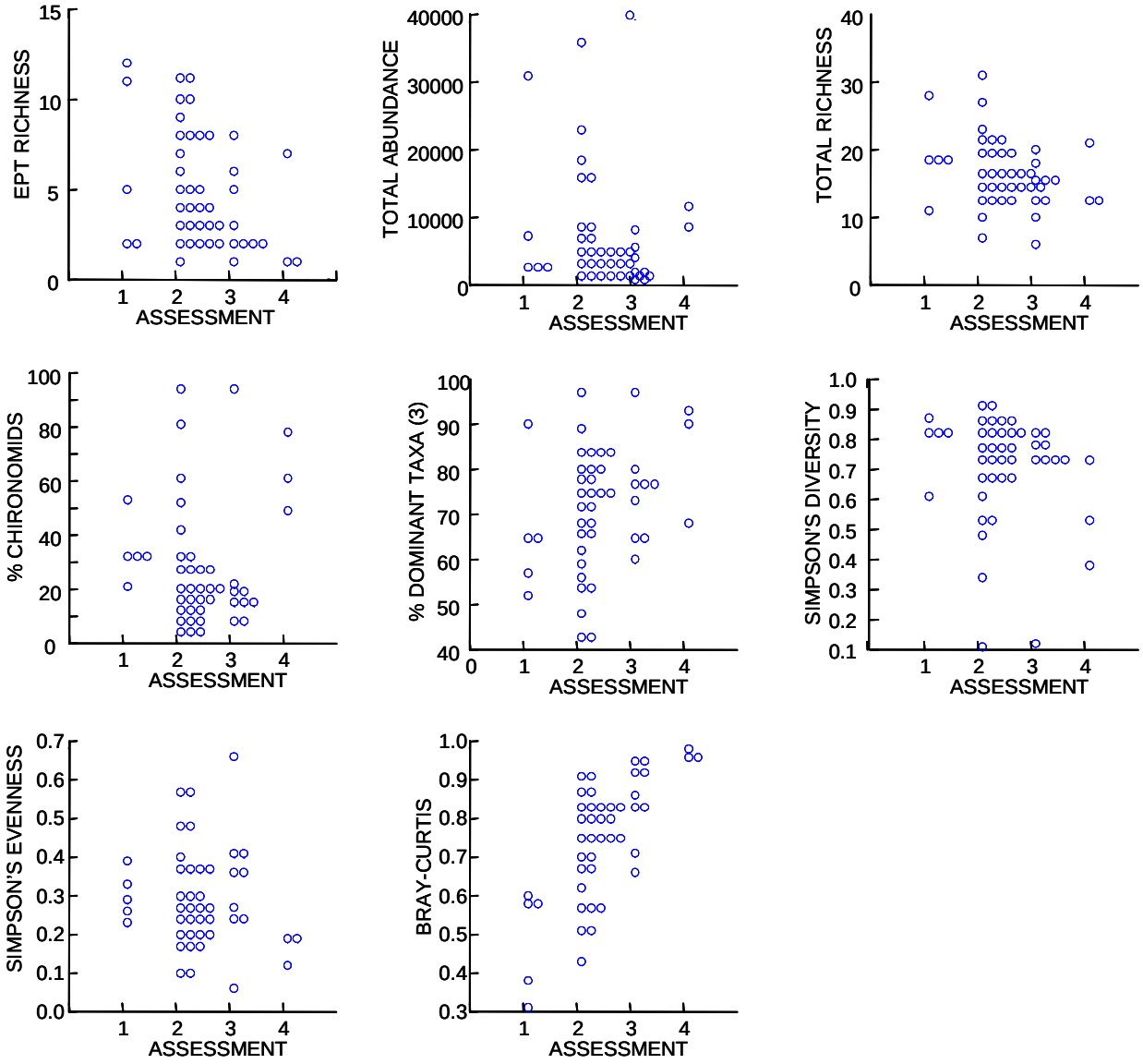

Figure 9. Density displays comparing commonly used bioassessment metrics with BEAST assessments of 46 test sites (1=not stressed, 2=possibly stressed, 3=stressed, 4=severely stressed). Detailed metrics are presented in the Appendix C with each site assessment.

Richness metrics (EPT and total) appeared to be weakly correlated with the assessment, where low scores are found in sites that are stressed (assessment = 4) and high scores in sites that are not stressed (assessment = 1). Abundance, compositional metrics (% Chironomidae and % Dominance) and Simpson's Diversity and Evenness showed no relationship with the BEAST assessments. Although these metrics were not correlated with the BEAST assessment they were useful descriptors of the invertebrate community. Some metrics were outside of the central 90% range of the reference sites and could be useful for speculating on possible stressors. A low EPT metric may indicate a toxic stress. A high % Dominance or % Chironomidae may indicate enrichment or some environmental stress that can only be tolerated by some invertebrates like extreme flow fluctuations.

Using ELK0798 as an example of a test site assessment, we have presented a step-by-step detailed explanation of the assessment (Box 3.3.1) that was done for each of 46 test sites (Appendix C). The invertebrate communities reflect cumulative effects and may have responded to a pulse of contaminant or a series of historical events. Thus, causative stressors could not always be identified with instantaneous water chemistry measurements. However, suggestions for possible causes were suggested in some assessments in Appendix C based on benthic invertebrate ecology. Enrichment from possible nutrient increases, possible disturbance from extreme flow fluctuations and possible contaminant stress from run off were suggested stressors.

Box 3.3.1 Example of test site assessment using BEAST and other assessment tools

BEAST Assessment

The Fraser/Georgia Basin model is used for the assessment of test site ELK0798. The predictor habitat variables for ELK0798 listed in Table 3.3.1 are used in a discriminant function analysis (DFA) with the reference habitat data employing SYSTAT (SPSS 2000).

Table 3.3.1. Habitat variables used in the Fraser/Georgia Basin model for BEAST site assessment of ELK0798 test site.

Variable	ELK0798
Latitude	49.1732 N
Ecoregion	Lower Mainland (196)
Stream order	2
Slope	0.002
Wetted width	6.8 m
Avg Depth	70.4 cm
Max Velocity	0.09 m/s
Dominant substrate	1 (silt)
Embeddedness	1 (completely embedded)
Coniferous present	0 (no)
pH	7.47

The DFA produces a table of the probabilities of ELK0798 belonging to each reference group (Table 3.3.2). Based on DFA, ELK0798 has a probability of 99.9% of being similar to reference Group 4 communities and <1% probability of belonging to any other group. The benthic invertebrate data of the test site are compared to those of the reference Group 4 in ordination space using PATN (Belbin 1993). Group 4 communities are dominated by Chironomidae and worms (Naididae, Tubificidae) and also have small abundances of mayflies (Baetidae, Ephemerellidae). Refer to Figures 4 and 5.

Table 3.3.2. Probability of group membership for test site ELK0798 determined by discriminant function analysis (DFA) using the Fraser/Georgia Basin model.

ELK0798	Probability of group membership
Group 1	0.0003
Group 2	0.0000
Group 3	0.0002
Group 4	0.9992
Group 5	0.0003

Figure 3.3.1 presents the ordination of the test site with Group 4 on three ordination axes, representing a three-dimensional space. ELK0798 falls outside of the 99.9% confidence ellipse on axis 1 versus axis 2 and on axis 2 versus axis 3. The site falls within the 90% confidence ellipse on axis 1 versus 3.

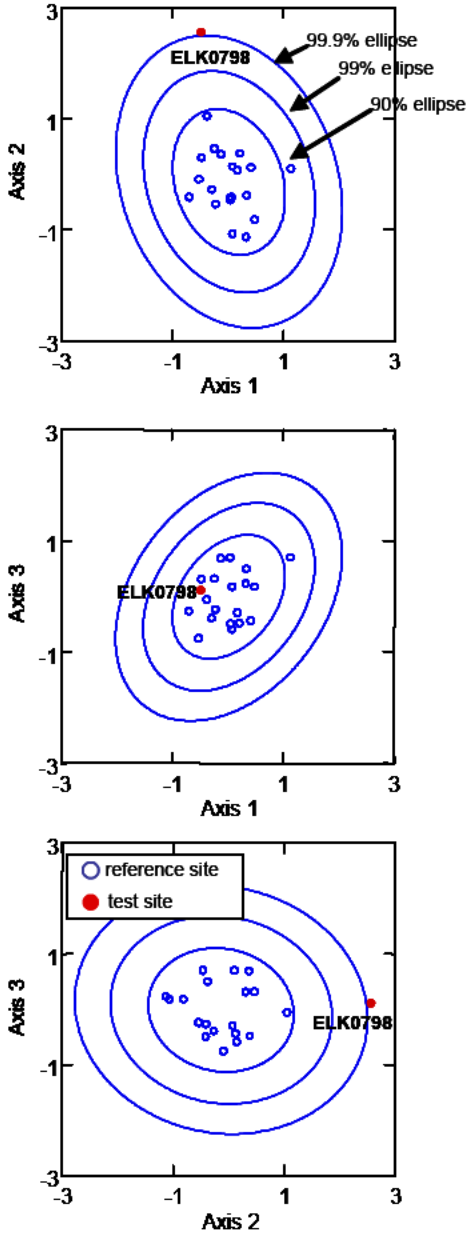

Figure 3.3.1. BEAST site assessment of ELK0798 with the predicted reference Group 4 on three ordination axes using non-metric multidimensional scaling ordination, plotted with 90%, 99% and 99.9% confidence ellipses of the reference sites.

It is the distance from the reference community in any one direction that is important for the assessment, not the average over three graphs or the number of graphs indicating stress, as the figure represents a three-dimensional space. The overall assessment is based on the most severe rating where the test site is most different from reference. ELK0798 is, therefore, considered ***severely stressed***.

NOTE: Three graphs are required in order to adequately display the relationships among the sites. The number of axes required is determined by the "ordination stress". This is a value calculated by PATN when the ordination is produced and is an indication of how well the ordination space represents the original similarity matrix from 0 (complete match) to 1 (random). Often two axes (two-dimensional space) are not adequate to illustrate the similarities of the sites to each other and a third axis (three-dimensional space) is required. The stress should not exceed 0.2 (Belbin 1993). For this report, all sites were assessed using three ordination axes.

Other Bioassessment Tools

Metrics can also be calculated to numerically examine specific components of the community. Table 3.3.3 provides a short list of some benthic invertebrate metrics that aid the interpretation of the BEAST assessment.

Table 3.3.3. Benthic invertebrate community metrics for ELK0798 and the range of metrics of the Group 4 reference communities.

	Test site	Reference Group 4
	ELK0798	Central 90% range (5^{th}-95^{th} percentiles)
Abundance	97500	820-8290
Total Richness	13	6-19
EPT Richness	1	1-10
% EPT	0.3	0-43
% Dominance (top 3 taxa)	90.5	39-83
% Chironomidae	77.8	18-82
# Ephemeroptera taxa	0	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	1	0-5
Diversity	0.38	0.31-0.77
Evenness	0.12	0.11-0.32
Bray-Curtis	0.96	0.27-0.73

ELK0798 has very high abundance of organisms relative to the central 90% range of reference communities in Group 4. Taxa richness is well within the central range of the reference group however, EPT richness, %EPT and individual EPT taxa are very low - at or below the 5^{th} percentile. Percent dominance is greater than the 95^{th} percentile of Group 4. Diversity and evenness are approaching the 5^{th} percentile of the reference range. The Bray-Curtis measure is very high indicating that ELK0798 is distant from the median reference community. With the exception of total richness, these metrics indicate a departure from the expected community.

The BEAST site assessment considers relative abundance of all the taxa present at all sites in the ordination. Taxa richness and taxa loss can also be examined through a RIVPACS assessment using observed to expected ratios. The probabilities from Table 3.3.2 are used to calculate the predicted taxa at ELK0798 in Table 3.3.4. The sum of the combined probabilities of a taxon occurring in each group represents the total probability of the taxon occurring at the site. These predictions can be combined with the observed taxa richness to calculate observed to expected ratios (O:E) for the entire community or at probabilities of 70% and 50% as in Table 3.3.5.

Table 3.3.4. RIVPACS calculation of the probability of occurrence (%) of some taxa at ELK0798 based on frequency of occurrence in each reference group and results from the DFA.

	Grp 1	Grp 2	Grp 3	Grp 4	Grp 5	
	Probability of group membership (DFA)					
$X10^{-2}$	**0.03**	**0.00**	**0.02**	**99.9**	**0.03**	
	Frequency of occurrence (%)					Prob. of occur. (%)
Chirono-midae	98.9	100	97.5	100	100	100
Naididae	20.9	31.2	31.6	78.9	34.8	79
Baetidae	94.5	68.8	88.6	63.2	91.3	63
Ephemer-ellidae	85.7	56.2	89.9	57.9	84.1	58
Tubifici-dae	6.6	12.5	8.9	52.6	15.9	53
Leberti-idae	42	31	31	47	40	47
Ceratopo-gonidae	22	6	21	47	18	47
Cont'd for all taxa	"	"	"	"	"	"

Table 3.3.5. Table of highly expected and observed taxa at ELK0798 and calculated O:E ratios.

Family	Observed Count	Probability
Chironomidae	75900	1
Naididae	1800	0.79
Baetidae	0	0.63
Ephemerellidae	0	0.58
Tubificidae	3000	0.53
Lebertiidae	600	0.47
Ceratopogonidae	600	0.47
Lumbriculidae	300	0.42
Hydropsychidae	300	0.26
Hydridae	1200	0.11
Glossiphoniidae	300	0.11
Crangonyctidae	3900	0.05
Asellidae	8400	0.05
Haliplidae	300	0
Physidae	900	0
	Observed	**Expected**
p>0.70	**2**	1 + 0.79 = **1.8**
O:E p>0.70		2 / 1.8 = **1.12**
p>0.50	**3**	1 + 0.79 + 0.63 + 0.58 + 0.53 = **3.5**
O:E p>0.50		3 / 3.5 = **0.85**

The observed community at ELK0798 had very high abundance, with Chironomidae, Asellidae and Crangonyctidae dominating the community. The mayflies with a high probability of occurrence (Baetidae, Ephemerellidae) were missing. This community had a high O:E_{50} taxa ratio indicating that the taxa that were expected to be there with a greater than 50% chance of occurring were found there.

Summary

ELK0798 is ***severely stressed***. This is indicated by the lack of similarity between the benthic invertebrate community observed at the site and the range of reference communities it was predicted to resemble based on the environmental characteristics. While the O:E_{50} ratio was high, the relative abundance of the taxa was not similar to the reference communities. This community had a very high Bray-Curtis distance (0.96), indicating that it was only 4% similar to the median reference community. There is an imbalance in the relative abundance of the expected taxa, as well as a high abundance of unexpected taxa.

Specifically, the absence of EPT taxa with a high probability of occurring, specifically Baetidae and Ephemerellidae, as well as the dominance of Chironomidae and two other nearly unexpected taxa, Asellidae and Crangonycitdae, suggest a shift in community composition from a pollution-sensitive to a pollution-tolerant community and possible enrichment. The mayfly taxa prefer clean water and an average oxygen supply, but some species can tolerate low dissolved-oxygen levels. Ephemerellidae are particularly pollution sensitive relative to Baetidae. Alternatively, the unexpected Amphipoda taxa (Asellidae and Crangonyctidae) are moderately pollution tolerant in comparison.

Water chemistry variables were collected at this site to aid in the interpretation of the findings. The instantaneous measurements of nutrients and dissolved oxygen are within the range of instantaneous measurements at reference sites (Appendix C). However, the invertebrates reflect cumulative and integrated effects and a detailed investigation of water chemistry should be conducted at this site to resolve possible contaminant pulses, nutrient peaks or periods of oxygen depletion.

3.4 Temporal Variation

Year-to-year habitat variation and the variation in the measurements of the habitat variables of reference sites HUN01 and ELK02, as well as test sites BRU03, CLB03 and FRO01, did not change model predictions to a reference group (Table 9). The probability of group membership was also similar among years. This suggests that the model performs well with year-to-year variation in habitat.

Table 9. Temporal variation in model prediction and combined BEAST assessments of repeat test sites.

Site	Year	Predicted Group	Probability of Group membership	BEAST Assessment (combined)
ELK02	1998	1	0.42	reference site
	2000	1	0.59	reference site
HUN01	1998	1	0.76	reference site
	1999	1	0.45	reference site
BRU01	2000	3	0.21	Possibly stressed
	2002	3	0.42	Possibly stressed
	2000	4	0.48	Possibly stressed
	2002	4	0.005	Possibly stressed
BRU02	2000	1	0.25	Possibly stressed
	2002	1	0.41	Possibly stressed
	2000	3	0.38	Possibly stressed
	2002	3	0.38	Possibly stressed
BRU03	2000	5	0.42	Stressed
	2002	5	0.43	Possibly stressed
BYR01	2000	1	0.51	Possibly stressed
	2002	1	0.29	Possibly stressed
	2000	3	0.37	Stressed
	2002	3	0.44	Severely stressed
CLB03	1998	1	0.43	Not stressed
	1999	1	0.44	Not stressed
	2000	1	0.55	Possibly stressed
ELK06	1998	4	0.93	Possibly stressed
	2000*	1	0.39	Possibly stressed
FRO01	2000	3	0.33	Possibly stressed
	2002	3	0.44	Possibly stressed

*2000 sampling location was moved slightly upstream of the confluence with Hope Slough where the sample was taken in 1998

Repeat samples from BRU03 were predicted to the same group but there was variability in the assessments, which suggests variability in the communities. BRU03 assessment improved in 2002 compared with 2000. Although the assessments differed for BRU03, the ordination plots indicate that the community did not differ greatly between years because the repeat samples are very close to each other relative to the reference sites (Figure 10). The different assessment is due to the imposed boundary of the confidence ellipse. Alternatively, repeat samples from FRO01 were predicted to the same

group and had the same assessment, however, FRO01 repeat samples are further apart from each other, indicating communities that are less similar and the community changed between years (Figure 10). The individual site assessments are provided in Appendix C. (It is important to know that the position of each site in an ordination is dependent on it's similarity to all other sites in the ordination, therefore the individual site assessments may differ from combined assessments. Combined assessments should only be conducted on samples collected from the same site if variation in the community at the site is the objective of the assessment. The rationale for this is discussed further in section 3.7)

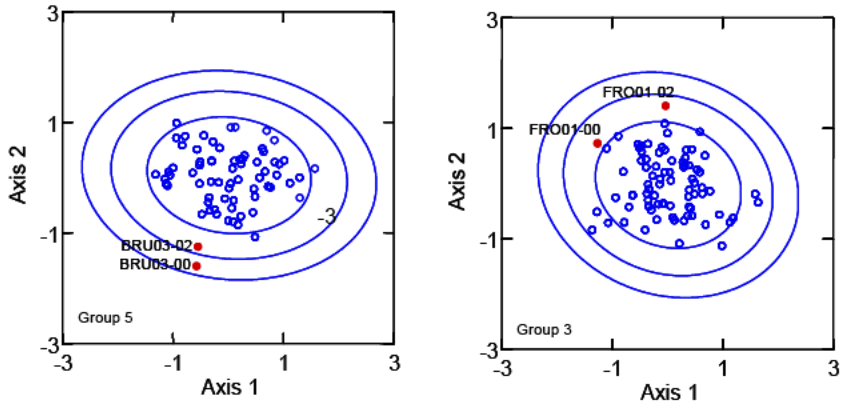

Figure 10. Temporal variation of BRU03 with Group 5 and FRO01 with Group 3 plotted in ordination space on one pair of axes with three confidence ellipses, 90%, 99%, and 99.9%. Open circles represent reference sites. Closed circles represent test sties.

CLB03 was sampled in three years and was predicted to the same group each year (Table 9). The communities were similar relative to the cloud of reference sites as they were located very close to each other (Figure 11). The sites were very close to the 90% confidence ellipse. In 1998 and 1999, the site fell within the ellipse indicating it was *not stressed*. The sample collected in 2000 suggested a *possibly stressed* condition as it fell just outside of the 90% confidence ellipse. CLB03 communities were quite similar from 1998 to 2000 and showed very little change in ordination space. Similar to BRU03, the assessments differed due to the imposed boundary by the 90% confidence ellipse. The individual site specific assessment summaries for these samples are provided in Appendix C.

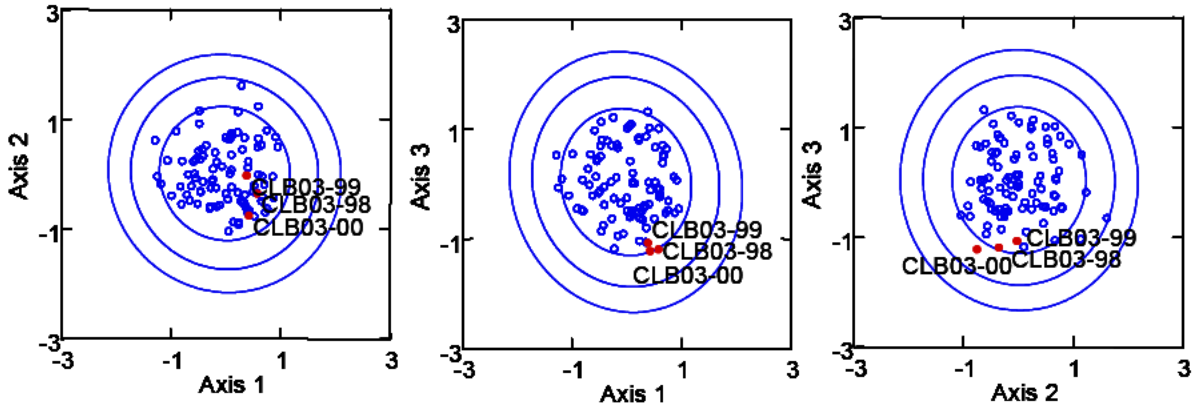

Figure 11. Temporal variation of CLB03 with Group 1 over three years (1998-2000) plotted in ordination space on three axes with three confidence ellipses, 90%, 99%, and 99.9%. Open circles represent reference sites. Closed circles represent test sties.

The year-to-year group predictions varied for four of the test sites suggesting that there was either natural variation in the habitat predictor variables or in measurement variability from year to year. ELK06 was predicted to different groups in 1998 and 2000 due to a change in location and a corresponding change in the habitat variables, yet the site assessments were the same. In 1998, the site was sampled just downstream of a confluence with a slough. After reviewing the 1998 data and a closer inspection of the stream, we felt that the merging watercourses were not well mixed at that location. In 2000, we moved the site slightly upstream of the confluence changing the habitat description of the site from a wide, deep channel to a narrower, shallower channel. This result illustrates the sensitivity of the reference condition approach to small geographical scale changes and the importance of correct reference site matching. The differences in habitat characteristics would not have been detected using a traditional upstream control site.

BRU01, BRU02 and BYR01 were predicted to different groups in different years due to slight differences measured in the channel characteristics (depth, width, velocity). Despite the differences in group prediction, BRU01 had the same BEAST assessment in both years (Table 9). Repeat samples for BRU01, BRU02, and BYR01 were assessed together with the different predicted reference groups (Figure 12) to examine the variation in communities relative to the two different groups. BRU01 and BRU02 had the same

assessments regardless of the predicted group. However, assessment of BYR01 differed depending on which reference group it was compared. The 2000 and 2002 samples had equivalent assessments with reference Group 1 but different assessments with reference Group 3 (Table 9). In addition, the 2000 and 2002 BYR01 samples diverged from each other in the ordination plots with both reference groups, indicating a change in the community. With Group 1, the 2000 sample appeared to diverge further from the reference communities than the 2002 sample but with Group 3, the reverse was true due to the community composition of the two reference groups. Reference sites in Group 3 had higher abundances of organisms than those in Group 1. In 2000, BYR01 had a high abundance of organisms which was more similar to Group 3, whereas in 2002, BYR01 had a low abundance of organisms which was more similar to Group 1 (Appendix C).

The model has the most difficulty in discriminating between Groups 1 and 3 (Table 7) because the taxonomic composition of the communities are so similar (refer to Figure 4B). Although abundances differ between the Group 1 and 3 (Figure 6), BYR01 is likely one of those sites that would fall into the range of overlap between these groups. There are 91 sites in Group 1 and 80 sites in Group 3; therefore, many sites are present within each reference group which would be a suitable comparison for BYR01. Nonetheless, BYR01 invertebrate community changed between 2000 and 2002. The decrease in the abundance of invertebrates at the site may be indicating a decline in biological condition, possibly caused by a toxic stress or extreme flow fluctuations from storm run off. This site should be visited again to determine if there is a trend toward a *stressed* community.

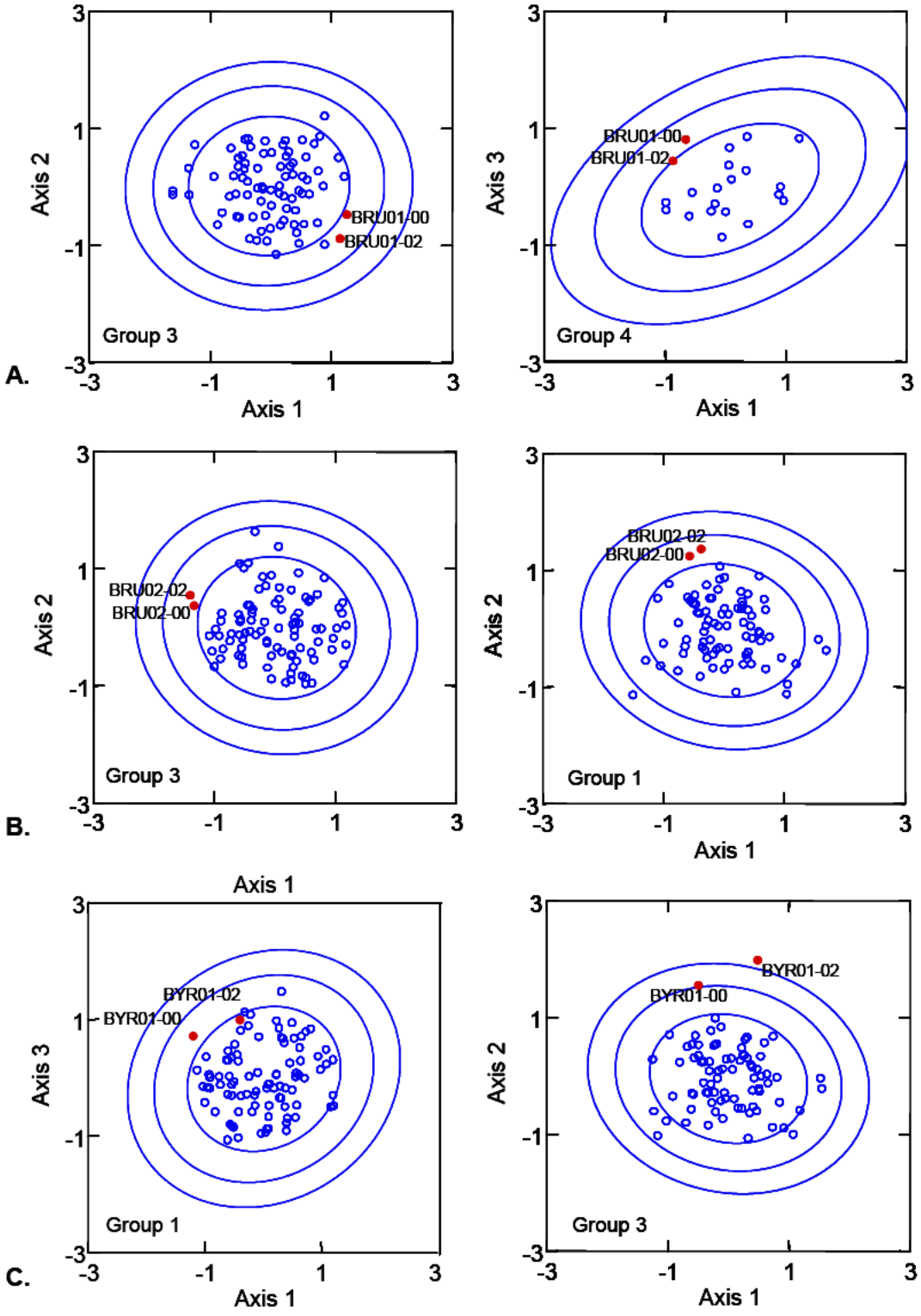

Figure 12. Temporal variation of (A) BRU01 with Group 3 and 4; (B) BRU02 with Group 3 and 1; and (C) BYR01 with Group 1 and 3 plotted in ordination space on one pair of axes with three confidence ellipses, 90%, 99%, and 99.9%. Open circles represent reference sites. Closed circles represent test sites. BYR01 falls within the *possibly stressed* band on axis 2 vs.3 with Group 1, not shown.

3.5 Spatial Variation

There was no spatial variation of the reference sites as indicated by the BEAST assessment. Samples 2 and 3 (QA samples) from five reference sites (BUT0101, CHH1298, HUN0198, SUM0199, and STR0301) were predicted to the same group to which the reference site sample (sample 1) was assigned (Table 10). For example, BUT0101 reference sample 1 was assigned to Group 1 by the model. Samples 2 and 3 from BUT0101 were also assigned to Group 1 by the model. Quality assurance samples at each reference site also had equivalent BEAST assessments. In one case, HUN0198, the QA samples were deemed *possibly stressed* because they fell outside of the 90% confidence ellipse. The basis of the BEAST assessment is that 10% of the reference sites will fall outside of the 90% confidence ellipse. Therefore, we are not concerned that the HUN0198 QA assessments of the reference sites are indicating a *possibly stressed* community.

Table 10. Spatial variation in model prediction and individual BEAST assessment of samples taken from three riffles at reference and test sites on the same sampling day. Data in parentheses indicate results when compared to another reference group.

Site	Sample	Predicted Group	Probability of Group membership	BEAST Assessment[1] (individual)
BRU0200	1	3	0.38	Possibly stressed
Test site	2	3	0.45	Possibly stressed
	3	3	0.42	Possibly stressed
BUT0101	1	1	0.83	Reference sample
	2	1	0.87	Not stressed
	3	1	0.64	Not stressed
CHH1298	1	4	0.68	Reference sample
	2	4	0.86	Not stressed
	3	4	0.91	Not stressed
CLB0398	1	3	0.35	Not stressed
Test site	2	3	0.40	Possibly stressed
	3	5 (3)	0.40 (0.35)	Possibly stressed (Not stressed)
HUN0198	1	1	0.76	Reference sample
	2	1	0.63	Possibly stressed
	3	1	0.63	Possibly Stressed
SUM0199	1	3	0.45	Reference sample
	2	3	0.44	Not stressed
	3	3	0.45	Not stressed
STR0301	1	1	0.75	Reference sample
	2	1	0.78	Not stressed
	3	1	0.66	Not stressed

[1] BEAST assessments are based on individual sample assessments as illustrated in Appendix D.

Individual sample assessments were important to capture the variability in the BEAST assessments of the sites (Appendix D), while a combined assessment of the QA samples in the same ordination plot was valuable to examine the variability of the communities (Figure 13). Test site BRU0200 indicated no spatial variation as the QA samples were predicted to the same group (Table 10) and had similar assessments (Appendix D). The samples were also very close to each other in the ordinations plots (Figure 13) indicating similar communities and the same assessments when plotted together.

However, CLB0398 QA samples indicated slightly variable results (Table 10). CLB0398 sample 1 and sample 2 were predicted to Group 3 with similar probabilities, 0.35 and 0.40, respectively. Sample 3 was predicted to Group 5 with a probability of 0.40 but also had a relatively high probability of belonging to Group 3 (probability=0.35), similar to samples 1 and 2 (Table 10). Two of three samples from CLB0398 had similar assessments when sample 3 was compared with Group 3 or Group 5 (Table 10). Sample 2 fell just outside of the 90% confidence ellipse while the other samples fell just within the ellipse (Appendix D). The difference in BEAST assessments again was a result of the imposed boundary of the 90% confidence ellipse as the QA samples (CLB0398-2 and CLB03-3) were very close to each other, indicating similarity (Figure 13). CLB0398 sample 1 (CLB03-1) had Empididae that was not found in the QA samples as well as a much smaller proportion of Chironomidae resulting in the departure from the other samples (Figure 13; Appendix D).

It is possible that sites exposed to anthropogenic activities may have more heterogeneous invertebrate communities. The value of collecting multiple invertebrate samples at test sites should be investigated for a precise assessment of stream quality.

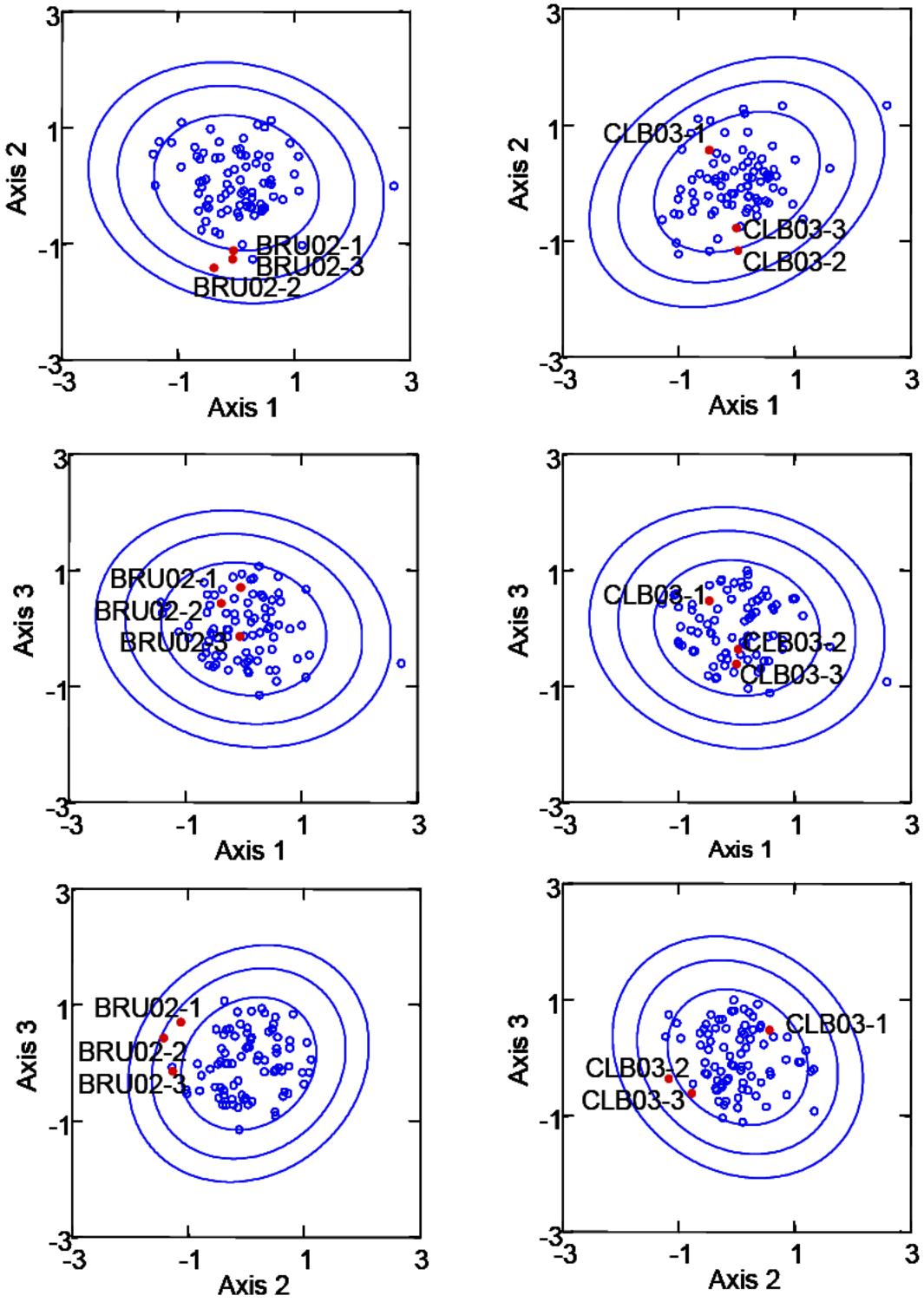

Figure 13. Spatial variation of invertebrate communities sampled at BRU0200 and CLB0398 exposed to urban and residential activities plotted with Group 3 reference sites in ordination space with three confidence ellipses, 90%, 99% and 99.9%. Open circles represent reference sites. Closed circles represent test sites.

3.6 Measurement error and model performance

We reanalysed the Fraser River QA samples with the new Fraser/Georgia Basin model. Quality assurance samples from 19 of 22 sites sampled in 1994-1996 were predicted to the same group with similar probabilities indicating that the model is robust and measurement variability is minimal (Table 11).

Only three sites indicated differences with relatively high probabilities in two reference groups. For example, HRK11295 was predicted to Group 3 and HRK11395 was predicted to Group 1 and the second highest probabilities were to Group 1 and Group 3, respectively (Table 11). Similarity, TOR01296 was predicted to Group 1 and TOR01396 was predicted to Group 3 and the second highest probabilities were to Group 3 and Group 1, respectively. Very low probabilities of group membership were assigned to Groups 2, 4 and 5 for each sample. Also, TAS04296 was predicted to Group 5 and TAS04396 was predicted to Group 3 with the second highest probabilities of group membership belonging to groups 3 and 5, respectively. Similar to the Georgia Basin QA sites, the predictions differed where the model had the most difficulty discriminating between overlapping groups.

The difference in group prediction for HRK11295 and HRK11395 was a result of the variability in the maximum velocity measurement (0.88 and 1.028 m/s). The differences in group prediction between TAS04296 and TAS04396 and between TOR01296 and TOR01396 were either due to changes in the location of the cross-section measurements or due to measurement error. Many predictor variable measurements were slightly different between samples for these two sets of data (i.e., depth: 10 cm versus 17 cm; velocity: 0.4 m/s versus 1.1 m/s; substrate size: sand versus boulders; embeddedness: 50% embedded versus unembedded; slope 0.03 m/m versus 0.006 m/m; and channel width: 2.5 m versus 3.1 m).

Table 11. Prediction variability of reference QA samples taken during the Fraser River program 1994-1996. Bold font indicates sites that differed in their reference group prediction.

Site	Predicted Group	Probability to Group 1	Probability to Group 2	Probability to Group 3	Probability to Group 4	Probability to Group 5
BOW03296	3	0.192794	0.014618	0.58195	0.002636	0.208003
BOW03396	3	0.036199	0.01274	0.535983	0.019461	0.395617
CHH04296	1	0.886799	0.002755	0.092012	0.006374	0.012059
CHH04396	1	0.943821	0.002505	0.047469	0.000441	0.005764
CHI05294	5	0.030272	0.007266	0.311547	0.04202	0.608894
CHI05394	5	0.028923	0.007113	0.308806	0.044601	0.610558
CKO03296	3	0.353828	0.092811	0.38907	0.000228	0.164062
CKO03396	3	0.216126	0.049412	0.529949	0.008017	0.196497
CLA07295	5	0.030743	0.180231	0.20409	0.021433	0.563503
CLA07395	5	0.025341	0.168085	0.198845	0.028673	0.579056
EUC03296	5	0.019235	0.014919	0.370163	0.007603	0.58808
EUC03396	5	0.017579	0.014141	0.367048	0.009119	0.592113
EUC06296	5	0.04367	0.019997	0.392884	0.005247	0.538201
EUC06396	5	0.043473	0.019402	0.395156	0.00558	0.536388
FRA06295	2	0.000702	0.994332	0.001738	0.0001	0.003128
FRA06395	2	0.000647	0.99402	0.001812	0.000131	0.00339
HRK11295	**3**	**0.254884**	0.06642	**0.341546**	0.009887	0.327262
HRK11395	**1**	**0.330225**	0.069372	**0.319308**	0.005038	0.276056
LIL06295	3	0.087896	0.095972	0.609014	0.003117	0.204001
LIL06395	3	0.089932	0.099003	0.606441	0.002987	0.201637
NIC10295	5	0.015768	0.024768	0.296933	0.062045	0.600486
NIC10395	5	0.021023	0.027059	0.316584	0.044061	0.591273
PIT06294	1	0.975919	0.001432	0.02005	0.001537	0.001062
PIT06394	1	0.978616	0.001345	0.017957	0.001173	0.000909
PIT07294	1	0.337063	0.000922	0.257861	0.295595	0.108559
PIT07394	1	0.367529	0.001038	0.265814	0.2527	0.112919
SAL03294	5	0.055774	0.072085	0.348171	0.017193	0.506778
SAL03394	5	0.059129	0.073786	0.35018	0.01569	0.501215
STN05295	5	0.025043	0.069883	0.372659	0.007886	0.524528
STN05395	5	0.022772	0.067157	0.368468	0.009113	0.53249
STU02294	3	0.022245	0.212416	0.454951	0.0009	0.309488
STU02394	3	0.019754	0.210499	0.450921	0.001119	0.317707
TAS04296	**5**	0.011869	0.010421	**0.245532**	0.130373	**0.601805**
TAS04396	**3**	0.051385	0.022754	**0.587106**	0.052696	**0.28606**
TOR01296	**1**	**0.561698**	0.006149	**0.384978**	3.37E-05	0.047142
TOR01396	**3**	**0.400779**	0.020048	**0.478454**	0.003006	0.097713
TOR02296	5	0.093496	0.174263	0.113596	0.105322	0.513323
TOR02396	5	0.092149	0.193733	0.11021	0.098201	0.505707
TYA08296	1	0.580961	0.025936	0.307359	0.000465	0.08528
TYA08396	1	0.595502	0.025663	0.297296	0.000401	0.081139
UFR06295	3	0.096716	0.049941	0.608864	0.011509	0.23297
UFR06395	3	0.094217	0.051142	0.6067	0.01139	0.236551
WRD12296	3	0.164102	0.017811	0.433263	0.000512	0.384313
WRD12396	3	0.26394	0.025026	0.414751	0.000577	0.295707

3.7 Comparison to Fraser River program results

The reference groups formed by adding 55 Georgia Basin reference sites to the database did not significantly alter the original reference groups defined in the Fraser program. Only 10.5% of the Fraser sites shifted from one group to another (Table 12). Most sites shifted from Group 1 to Group 3 as 14 Fraser sites shifted from Group 1 and 11 Fraser sites were added to Group 3. Seven Fraser sites were also added to a new reference group that was formed by the addition of the Georgia Basin sites; Group 4 (63% from the Georgia Basin). This suggests that classification of the reference groups is relatively robust and the additional Georgia Basin sites provided a new habitat type that only existed in seven Fraser sites.

Table 12. Number of site classification changes to original Fraser reference groups with additional George Basin reference sites.

	Grp 1	Grp 2	Grp 3	Grp 4	Grp 5	**Total**
Original Fraser sites	**80**	**15**	**63**	**0**	**61**	**219**
Fraser sites shifted from original group	-14	-4	-4	0	-1	-23
Fraser site added to new group	1	3	11	7	1	23
Georgia Basin sites added to new group	24	2	10	12	7	55
Fraser/Georgia Basin sites	**91**	**16**	**80**	**19**	**68**	**274**
Proportion of Georgia Basin sites	26%	13%	13%	63%	10%	20%

The inclusion of additional sites from the Georgia Basin increased the variability of the reference database. One new group was formed and the original groups became larger. Group 5 became more variable as a few Georgia Basin sites were located on the outer edges of the cluster of Group 5 sites (Figure 14), while the Georgia Basin sites added to Groups 1, 2, and 3 fell within the range of Fraser sites (Figure 14). Theoretically, the model becomes more refined as we more precisely characterize the description of reference condition (i.e., when new sites added are closer to the median), outliers become less important.

The model variables and the error rates were similar among the models after the addition of new reference sites from the Georgia Basin (Table 13). Alkalinity was an important variable in both Fraser River models (Rosenberg et al. 1999, Reynoldson and Rosenberg 1999, Reynoldson et al. 2001). Upon closer inspection of the Fraser data, 20

sites had suspiciously low alkalinity values (<1 mg/L). These sites had normal pH ranges of 7-8. Alkalinities measured in streams around the province are almost always above 10 mg/L based on the Ministry of Water Land and Air Protection water quality monitoring data (http://wlapwww.gov.bc.ca/wat/wq/wq_sediment.html). Two sites in 1994 were reported as having values of 0.05 and 0.5 mg/L. In 1995, three sites reported values of 0 mg/L, two sites had values of 0.05 mg/L and one site had a value of 0.1mg/L. In 1996, 12 sites were reported to have alkalinities of 0.15 mg/L. These data were not consistent with the conductivity and alkalinity correlations observed with the other reference sites nor were they consistent with other measurements taken by other water quality programs in British Columbia. After discussions with the analytical lab (National Laboratory for Environmental Testing, Burlington, Ontario) about analytical procedures, it was speculated that these values were likely analytical anomalies and the data were omitted from the database. As a result, 20 reference sites had incomplete habitat datasets and alkalinity was no longer used as a determining variable for the Fraser/Georgia Basin model.

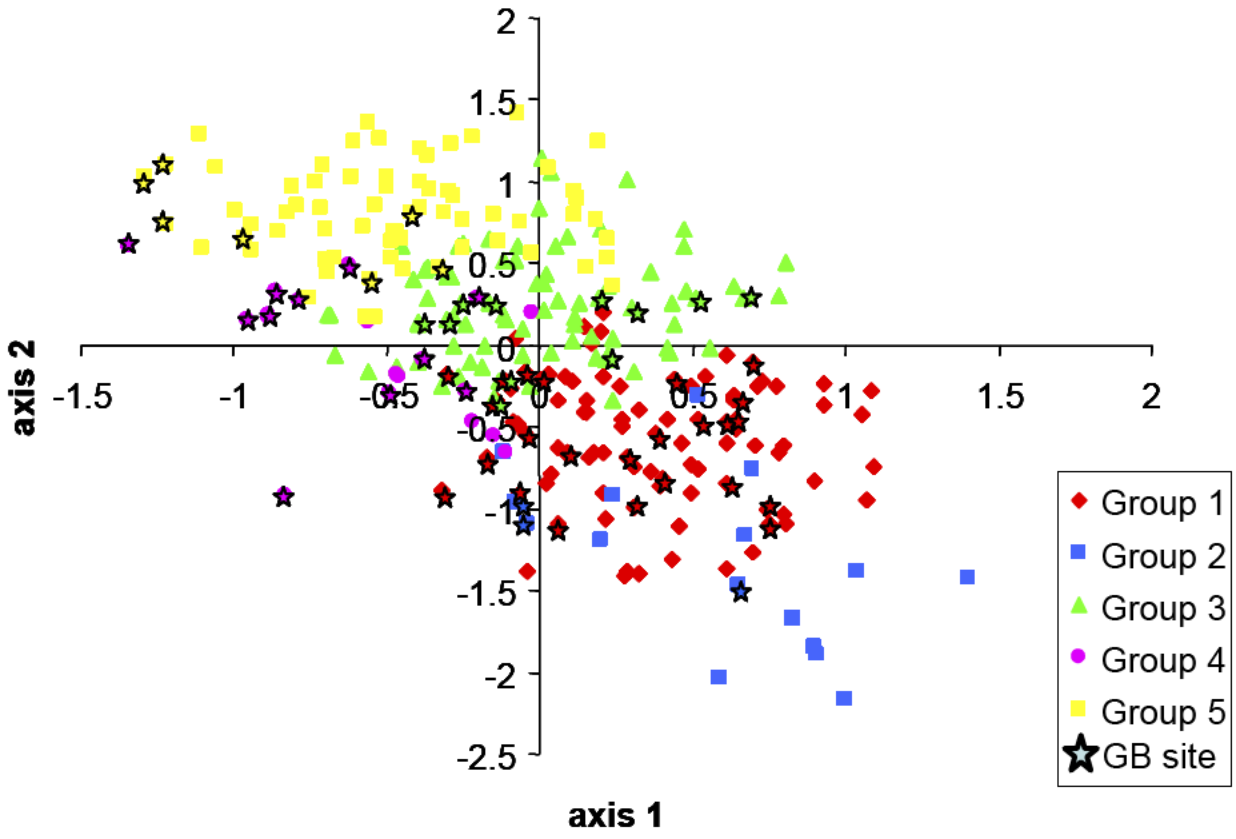

Figure 14. Ordination of five reference groups identifying new Georgia Basin (GB) sites within each group.

Channel width and depth were important in all models, as was the predominant substrate (Table 13). Riparian vegetation (i.e., the presence of grasses or coniferous trees) was important in all models. Map variables such as ecoregion and latitude were important in one of the Fraser models as well as the Fraser/Georgia Basin model, as was the water variable, pH and embeddedness of the substrate, a channel variable. The Fraser/Georgia Basin model incorporated variables such as stream order, slope and velocity which were not used in the Fraser models. This is partly due to the fact that the Fraser database was expanded to include smaller, slower moving streams that often occur in the lowlands of the Georgia Basin. The Fraser/Georgia Basin model had a slightly higher error rate in its ability to discriminate among the reference groups than the Fraser model reported in Rosenberg et al. (1999) and Reynoldson et al. (2001) but was similar to the error rate reported in Reynoldson and Rosenberg (1999).

Table 13. Model variables and error rates for Fraser models and the Fraser/Georgia Basin model.

Fraser Model (Reynoldson and Rosenberg 1999)	Fraser model (Rosenberg et al. 1999, Reynoldson et al. 2001)	Fraser/Georgia Basin model (this report)
Bankfull width	Ecoregion	Ecoregion
pH	Latitude	Latitude
Grasses present	Grasses present	Coniferous present
Wetted width	Wetted width	Wetted width
Max. Channel Depth	Max. Channel Depth	Avg. Channel Depth
Alkalinity	Alkalinity	pH
Embeddedness	Conductivity	Embeddedness
Dominant Substrate	Dominant Substrate	Dominant Substrate
	Longitude	Stream Order
		Slope
		Max. Velocity
Error rate = 42.9%	Error rate = 44%	Error rate = 42%

The effect of the refined model on test site assessment was examined by re-evaluating the Fraser River test sites using the Fraser/Georgia Basin model. Forty-five test sites were examined during the Fraser River Program in 1994-1996 (Reynoldson and Rosenberg 1999, Rosenberg et al. 1999). These test sites were assessed again using the Fraser/Georgia Basin model to examine changes in sensitivity of the model (Table 14). Both Fraser reports published in 1999 are used for comparison because different test sites were assessed in each report. The Fraser River main-stem test sites were only reported in Reynoldson and Rosenberg 1999. The other test site assessments were taken from

Rosenberg et al. 1999. All of the test sites were re-assessed using the Fraser/Georgia Basin model.

Twenty-six sites had the same assessment with both models. Nineteen test sites differed by one assessment band or more. Compared with 21 test site assessments reported in Rosenberg et al. (1999), the Fraser/Georgia Basin assessments found half of the test sites to be different from the Fraser assessments (Table 14). The Fraser/Georgia Basin model found only eight of 24 Fraser main-stem site assessments to be different that those reported in Reynoldson and Rosenberg (1999; Table 14). Six test sites were found to be more stressed (i.e. more different from reference) with the new model compared with the original Fraser reports. Most of those differences were for Fraser main-stem sites which were predicted to a different reference group than the other test sites. FRA2196 was found to be *severely stressed* using the Fraser/Georgia Basin model whereas the Fraser model assessed it as *possibly stressed.* Thus the Fraser/Georgia Basin model appears to be more sensitive than the Fraser model for this reference group due to the addition of new reference sites and the refinement of reference condition.

Table 14. Assessment differences between the FRAP model and the Fraser/Georgia Basin model. (Test sites with the same assessment are not listed in the table. Assessments in bold indicate a difference of more than one assessment band.

	Fraser model	Fraser/Georgia Basin model
BOW13[1]	**Severely stressed**	**Possibly stressed**
DEA02[1]	Possibly stressed	Not stressed
DEA03[1]	Possibly stressed	Not stressed
FRA1496[2]	Not stressed	Possibly stressed
FRA2196[2]	**Possibly stressed**	**Severely stressed**
FRA2596[2]	**Severely stressed**	**Possibly stressed**
FRA2695[2]	Not stressed	Possibly stressed
FRA2796[2]	Not stressed	Possibly stressed
FRA2894[2]	Not stressed	Possibly stressed
FRA2895[2]	Not stressed	Possibly stressed
FRA2896[2]	Not stressed	Possibly stressed
GUI01[1]	**Severely stressed**	**Possibly stressed**
GUI03[1]	**Severely stressed**	**Possibly stressed**
SAL02[1]	Not stressed	Possibly stressed
TOR10[1]	Possibly stressed	Not stressed
TOR11[1]	Possibly stressed	Not stressed
TYA05[1]	**Possibly stressed**	**Not stressed**
WIL02[1]	**Severely stressed**	**Not stressed**
WIL04[1]	**Stressed**	**Not stressed**

[1]Assessed in Rosenberg et al. 1999.
[2]Assessed in Reynoldson and Rosenberg 1999.

A difference of more than one assessment band was considered notable. Eight of the test sites assessed (indicated in bold in Table 14) by the Fraser/Georgia Basin model differed by more than one band compared with the Fraser model (Reynoldson and Rosenberg 1999). Four sites (BOW13, FRA2196, GUI01, and GUI03) were *severely stressed* by the Fraser model and *possibly stressed* by the Fraser/Georgia Basin model. Three sites, TYA05, WIL04 and WIL02 were *possibly stressed, stressed* and *severely stressed*, respectively, by the Fraser model and *not stressed* by the Fraser/Georgia Basin model.

The difference in assessment is due to the fact that, in the report by Rosenberg et al. (1999), these sites were assessed with other test sites in the ordination. Each test site should be assessed individually to get a true comparison of a test site to the reference sites because all sites in the ordination affect each other. For example, using the Fraser/Georgia Basin model GUI01, GUI03 and WIL01 were predicted to Group 3. When they are assessed together with Group 3 (Figure 15) GUI01 is *stressed*, GUI03 is *possibly stressed* and WIL01is *not stressed*. When these test sites are assessed individually with Group 3, GUI03 and WIL01 do not change but GUI01 becomes *possibly stressed* (Figure 15). The presence of the other test sites in the ordination affected the relationship with the reference sites. The ordination is produced from a matrix of similarity coefficients which includes the similarity of test sites with each other. Unless spatial or temporal change in the community at a test site is the purpose of the assessment, as in sections 3.4 and 3.5, test sites should always be analysed individually. The assessment should be based on the similarity of the test site to the range of reference sites and not on the similarity to other test sites.

FRA2596 was *possibly stressed* by the Fraser model and *severely stressed* by the Fraser/Georgia Basin model due to the difference in reference group prediction. Using the Fraser model, all Fraser River main-stem sites except FRA2596 were predicted to the same reference group (Reynoldson and Rosenberg 1999). FRA2596 was predicted to a different group by the Fraser model because one of the predictor variables, bankfull width, was much smaller for FRA2596 than any of the other Fraser River main-stem test sites. Bankfull width was not a predictor variable in the Fraser/Georgia Basin model.

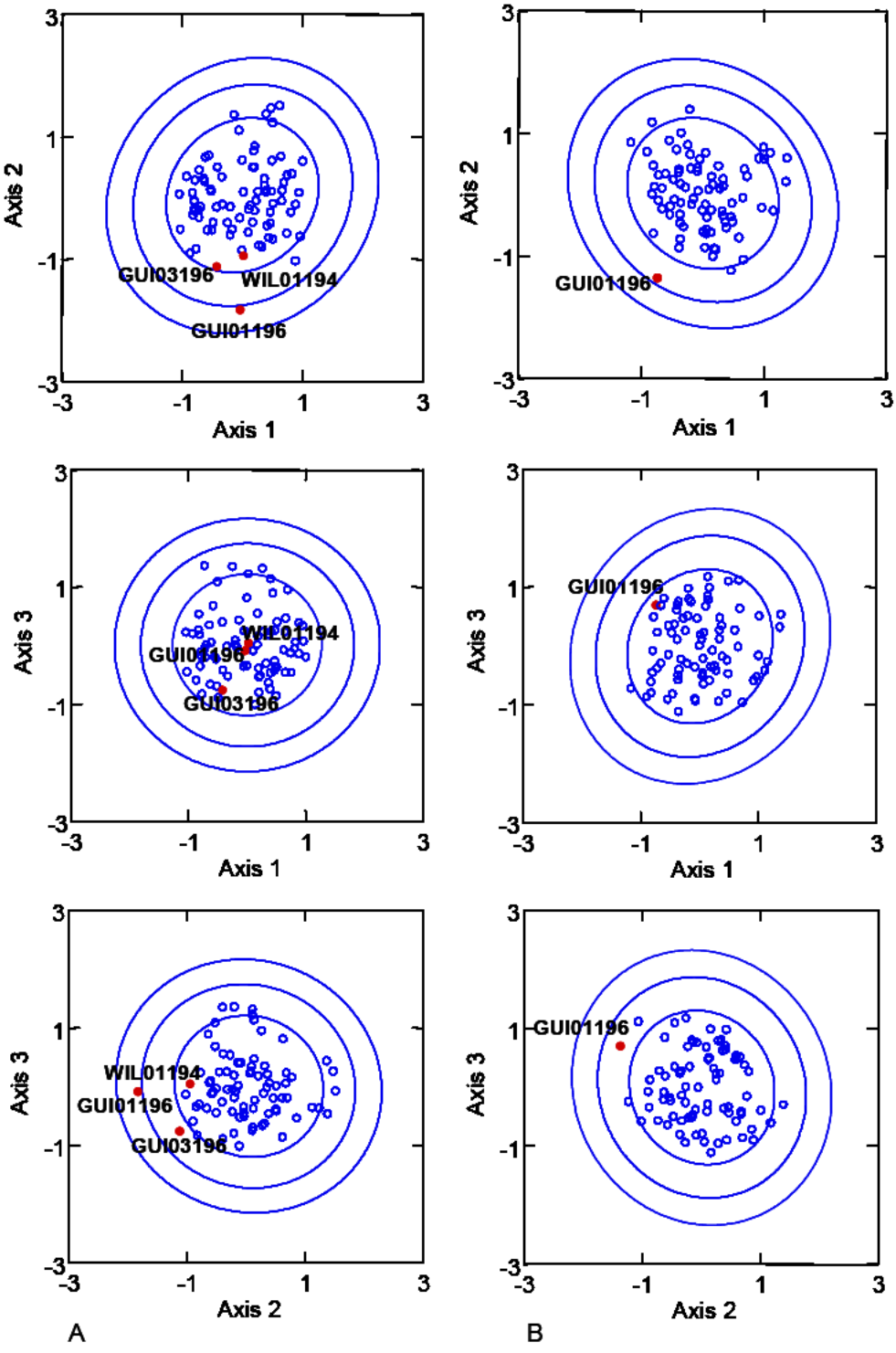

Figure 15. Ordinations of (A) multi-site assessments and (B) single test site assessments with Group 3 on three axes with three confidence ellipses, 90%, 99% and 99.9%. Open circles represent reference sites. Closed circles represent test sites.

However, wetted width was a predictor in the Fraser/Georgia Basin model. FRA2596 had a wetted width similar to other Fraser main-stem sites. Using the Fraser/Georgia Basin model, all of the main-stem sites, including FRA2596, were predicted to the same group. Consequently, the difference in assessments was a result of prediction to the incorrect reference group by the Fraser model due to imprecise habitat measurement (i.e., bankfull width estimate). Therefore, precise habitat measurement and stringent quality assurance procedures in the field are very important for appropriate matching of reference groups.

4. Summary and Recommendations

Expansion of Fraser model to Fraser/Georgia Basin model

- The reference condition database developed for the Fraser River was increased from 219 sites to 274 to include reference sites in the Georgia Basin.
- The number of invertebrate families in the reference database increased from 74 to 93.
- The number of reference groups increased from four to five. Addition of the Georgia Basin reference sites produced a new group of 19 sites characterised by low conductivity, fine-grained substrates, low velocities and low altitudes. All other sites sampled in the Georgia Basin fit into the four Fraser classifications, causing a classification shift of only 10% of Fraser River sites. The different reference group classifications represented ranges of invertebrate communities that differed in taxonomic composition and relative abundance.
- Most environment variables measured were significantly correlated with the invertebrate communities based on principal axis correlation. The pattern of reference group by ecoregion was significant, but was not readily apparent. Variables, in combination with ecoregion, were necessary to discriminate different types of communities; thus, comparisons between sites were not restricted to the same ecoregion.

- The Fraser/Georgia Basin model used similar variables as the Fraser model but included more variables to achieve a similar error rate, as determined by discriminant function analysis. The predictor variables were: latitude, ecoregion, stream order, average depth, presence of coniferous vegetation in the riparian zone, predominant substrate size, embeddedness of the substrate, maximum velocity, wetted width, slope and pH.

- The model had the most difficulty discriminating between groups 1 and 3 and groups 3 and 5. Groups are not discreet entities but rather partition a continuum of invertebrate communities at reference sites. Model prediction errors occur where the groups overlap. As more sites are added to the reference database, the gaps in the continuum will be filled and the variability of the reference condition may increase. This, as well as the formation of more groups, will make it more difficult for the model to correctly predict the appropriate expected community, and increase the model prediction error rate. Conversely, the improved description of the reference condition provides a more sensitive assessment.

Agricultural and Urban effects in the Georgia Basin

- Approximately 90% of the test sites fell outside of the 90% confidence ellipse indicating a departure from reference condition of the biological community. Two thirds of the test sites fell outside of the 99% confidence ellipse suggesting a *stressed* or *severely stressed* communities and a detailed investigation of water quality and potential causative stressors should be conducted at those sites.

- While six sites exposed to urban activities were similar to the predicted reference condition, over half of the urban test sites indicated *possible stress*. Several sites showed *stress* or *severe stress* (outside 99% confidence ellipse). This may be associated with extreme flow fluctuations occurring in urban streams, contaminants in urban runoff or other human population pressures on the aquatic ecosystem.

- Fourteen out of 15 sites exposed to agricultural activities showed at least *possible stress*, indicating that they fell outside of the 90% confidence ellipse. Only one site was similar to the predicted reference condition.

- Detailed water quality investigations should be conducted to determine if enrichment, depleted oxygen or contaminant pulses are contributing to the stressed benthic invertebrate community as they are reflecting cumulative impacts and instantaneous measurements of water quality are unlikely to identify causative stressors.

- Commonly used bioassessment metrics calculated at each site were weakly correlated with the overall BEAST assessment of stream health. Each metric describes a particular component of the community and can be useful in identifying components of the community that are experiencing stress.

- Temporal variation at reference sites was minimal. The model showed no variability in the yearly group predictions of reference sites. The temporal variation of test sites can be clearly tracked in the ordination plots to ascertain whether the site is departing from or getting closer to the expected invertebrate community. Test site assessments should be plotted individually, but when monitoring temporal variation of the same site, the annual samples should be analysed together on the same ordination plot to provide a graphical description of how the site is or is not changing over time.

- Spatial variation was minimal at reference sites. The model was robust in predicting samples from different riffles at the same site to the same reference group. There was spatial variation in some of the test site predictions and assessments.

Model Performance

- The Fraser/Georgia Basin model results closely matched the Fraser model results for 19 of the 22 QA sites. In fact, the Fraser/Georgia Basin model appeared to be more sensitive (e.g. detected greater difference from reference condition) for six

test sites than the Fraser model. At eight sites, the differences in assessments were substantial due to the assessment of multiple test sites in one ordination plot in the original Fraser reports.

- Test sites must be analysed individually. The inclusion of multiple test sites influences the calculation of the similarity matrix necessary for the ordination. The distance a test site falls from a reference site is relative to all other relationships in the ordination. If the relationship between two test sites is not relevant, they should not be assessed in the same plot.

- The precise measurement of habitat variables is very important. The assessment is dependent upon the environmental variables for an appropriately matched reference group. The expected community structure is determined by the habitat data.

Recommendations

- The potential for misclassification to the appropriately matched reference group increases as the number of reference groups increases. One solution to improve the misclassification error rate would be the possibility of predicting a test site to a region in the community continuum rather than to a group of communities that has been artificially defined by classification methods.

- The value of collecting replicates at test sites should be investigated for a precise assessment of stream quality.

- The cause of environmental stress indicated by the biological assessment cannot be determined without a detailed investigation of potential causative factors, e.g., chemical inputs or physical perturbations. The biological community reflects cumulative effects that may not be detected with instantaneous water chemistry measurements. Where a test site falls outside of the 99% confidence ellipse, a detailed investigation should be conducted. In addition, annual monitoring should be done to track changes from increasing urban or agricultural pressure in sites that

fall outside of the 90% confidence ellipse or in response to remediation or restoration.

- Benthic invertebrates provide an environmental warning signal regarding the health of streams. They are important components of the stream environment because they are a food source for most fish; they are sedentary; they are intimately linked with the bottom sediments; and they respond to a variety of stressors with various sensitivities. Invertebrate communities can be easily monitored, representing cumulative exposure to chemical and physical stressors over a period of time. Chemical and hydrologic water quality monitoring must be conducted at regular intervals to capture episodic pollution events. Together, water quality and biological monitoring can track the cumulative effects of anthropogenic activities on stream quality. Biological monitoring may pick up ecological signals that may be missed by the suite of water quality variables that are routinely monitored. The relatively small additional cost of biological monitoring provides significant value to a water quality monitoring program because it is the biological quality and stream function that we want to conserve and therefore should be incorporated into water quality monitoring programs.

- With the development of the Canadian Aquatic Biomonitoring Network (CABIN) website (http://CABIN.cciw.ca/cabin) and online nationally consistent resources (database, software, Fraser/Georgia Basin models, standardised protocols, and field sheets), biological monitoring is made convenient and easy in the Fraser River Basin and Georgia Basin and should be easily incorporated into biomonitoring and assessment programs.

- It would be advantageous for municipalities to work with watershed stewardship groups to monitor the streams in their communities and report to local government when impaired or declining conditions are detected.

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APPENDIX A

FRASER RIVER /GEORGIA BASIN TAXA LIST

Table A1. Taxa list for Fraser River and Georgia Basin sites 1998-2002.

Higher level classification	Order	*Family*
Taxa found in reference sites		
Acarina	Sarcoptiformes	*Hydrozetiidae*
	Trombidiformes	*Anisitsiellidae*
		Arrenuridae
		Aturidae
		Hydrodromidae
		Hydryphantidae
		Hygrobatidae
		Lebertiidae
		Limnesiidae
		Oxidae
		Pionidae
		Sperchontidae
		Stygothrombidiidae
		Torrenticolidae
		Trhypachthoniidae
		Unionicolidae
Bivalvia	Unionoida	*Margaritiferidae*
	Veneroida	*Sphaeriidae/Pisididiiae*
Demospongiae	Haplosclerida	*Spongillidae*
Gastropoda	Basommatophora	*Lymnaeidae*
		Physidae
		Planorbidae
	Heterostropha	*Valvatidae*
Hexapoda	Collembola	*Hypogasturidae*
		Isotomidae
		Sminthuridae
Hirudinea	Rhynchobdellida	*Glossiphoniidae*
		Piscicolidae
Hydrazoa	Hydroida	*Hydridae*
Insecta	Coleoptera	*Dytiscidae*
		Elmidae
		Haliplidae
		Hydrophilidae
		Staphylinidae
	Diptera	*Athericidae*
		Blephariceridae
		Ceratopogonidae
		Chironomidae
		Deuterophlebiidae
		Dixidae
		Empididae
		Muscidae
		Pelecorhynchidae
		Psychodidae
		Simuliidae
		Stratiomyidae
		Tabanidae
		Tanyderidae
		Thaumaleidae
	Diptera (cont'd)	*Tipulidae*
	Ephemeroptera	*Ameletidae*
		Ametropodidae
		Baetidae
		Baetiscidae
		Caenidae
		Ephemerellidae
		Ephemeridae
		Heptageniidae
		Leptohyphidae
		Leptophlebiidae
	Heteroptera	*Gerridae*
	Lepidoptera	*Pyralidae*
	Megaloptera	*Sialidae*
	Plecoptera	*Capniidae*
		Chloroperlidae
		Leuctridae
		Nemouridae
		Peltoperlidae
		Perlidae
		Perlodidae
		Pteronarcyidae
		Taeniopterygidae
	Trichoptera	*Apataniidae*
		Brachycentridae
		Glossosomatidae
		Hydropsychidae
		Hydroptilidae
		Lepidostomatidae
		Leptoceridae
		Limnephilidae
		Philopotamidae
		Polycentropodidae
		Rhyacophilidae
		Uenoidae
Malacostraca	Amphipoda	*Crangonyctidae*
		Gammaridae
		Hyalellidae
	Isopoda	*Asellidae*
Oligochaeta	Haplotaxida	*Enchytraeidae*
		Naididae
		Tubificidae
	Lumbriculida	*Lumbriculidae*
Turbellaria	Tricladida	*Planariidae*

Higher level classification	Order	*Family*
Taxa found in test sites only		
Gastropoda	Basommatophora	*Ancylidae*
	Neotaenioglossa	*Hydrobiidae*
Hexapoda	Collembola	*Entomobryidae*
		Poduridae
Hirudinea	Arhynchobdellida	*Erpobdellidae*
Insecta	Coleoptera	*Amphizoidae*
		Hydraenidae
		Tenebrionidae
	Diptera	*Dolichopodidae*
		Sciomyzidae
	Hemiptera	*Corixidae*
	Odonoata	*Coenagrionidae*
Malacostraca	Amphipoda	*Haustoriidae*
	Decapoda	*Astacidae*
	Mysida	*Mysidae*
Nemertea	Haplonemertea	*Tetrastemmatidae*
Polychaeta		*Aeolosomatidae*
Oligochaeta	Branchiobdellida	*Xironodrilidae*
Taxa found but not used in assessment		
Branchiopoda	Diplostraca	*Daphniidae*
		Macrothricidae
Copepoda	Cyclopoda	*Cyclopidae*
Ostracoda	Podocopa	*Candoniidae*
		Cyclocyprididae
		Cyprididae
		Cypridopsidae
		Limnocytheridae
Tardigrada	Eutardigrada	*Macrobiotidae*

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APPENDIX B

REFERENCE SITE TAXA SUMMARY

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	1	1	1	5	5
	BASIN	Buttle Lake	Buttle Lake	Buttle Lake	Buttle Lake	Chehalis River	Chehalis River
	STREAM	Henshaw Creek	Ralph River	Ralph River	Shepherd Creek	Chehalis River	Chehalis River
	SITECODE	BUT01101	BUT0201	BUT0301	BUT0401	CHH10198	CHH11198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Acarina	Anisitsiellidae	0	0	0	0	0	0
Acarina	Arrenuridae	0	0	0	0	0	0
Acarina	Aturidae	0	0	0	0	0	0
Acarina	Hydrodromidae	0	0	0	0	100	0
Acarina	Hydrozetiidae	0	0	0	0	0	0
Acarina	Hydryphantidae	0	0	0	0	0	0
Acarina	Hygrobatidae	0	0	0	0	0	0
Acarina	Lebertiidae	1.75	0	6.67	1.96	900	300
Acarina	Limnesiidae	0	0	0	0	0	0
Acarina	Oxidae	0	0	0	0	0	0
Acarina	Pionidae	0	0	0	0	0	100
Acarina	Sperchontidae	1.75	4.17	0	1.96	0	0
Acarina	Stygothrombidiidae	0	0	0	0	0	0
Acarina	Torrenticolidae	0	12.5	0	1.96	0	0
Acarina	Trhypachthoniidae	0	0	0	0	0	0
Acarina	Unionicolidae	0	0	0	0	0	0
Amphipoda	Crangonyctidae	0	0	0	0	0	0
Amphipoda	Gammaridae	0	0	0	0	0	0
Amphipoda	Hyalellidae	0	0	0	0	0	0
Bivalvia	Margaritiferidae	0	0	0	0	0	0
Bivalvia	Sphaeriidae	0	0	0	0	0	0
Coelentrata	Hydridae	0	0	0	0	0	0
Coleoptera	Dytiscidae	0	0	0	0	0	0
Coleoptera	Elmidae	0	0	0	0	0	0
Coleoptera	Haliplidae	0	0	0	0	0	100
Coleoptera	Hydrophilidae	0	4.17	0	0	0	0
Coleoptera	Staphylinidae	0	0	0	0	0	0
Collembola	Hypogasturidae	0	0	0	3.92	0	0
Collembola	Isotomidae	0	0	0	0	0	0
Collembola	Sminthuridae	0	0	0	0	0	0
Diptera	Athericidae	0	0	0	0	0	0
Diptera	Blephariceridae	0	0	0	0	0	0
Diptera	Ceratopogonidae	0	0	0	0	0	400
Diptera	Chironomidae	49.12	133.33	70	88.24	32600	18400
Diptera	Deuterophlebiidae	0	0	0	0	0	0
Diptera	Dixidae	1.75	0	0	0	0	0
Diptera	Empididae	0	4.17	0	5.88	300	0
Diptera	Muscidae	0	0	0	0	0	0
Diptera	Pelecorhnchidae	0	0	0	0	0	0
Diptera	Psychodidae	0	0	0	0	0	0
Diptera	Simuliidae	5.26	0	0	0	0	0
Diptera	Stratiomyidae	0	0	0	0	0	0
Diptera	Tabanidae	0	0	0	0	0	0
Diptera	Tanyderidae	0	0	0	0	0	0
Diptera	Thaumaleidae	0	0	0	0	0	0
Diptera	Tipulidae	0	12.5	0	3.92	0	0
Ephemeroptera	Ameletidae	0	0	3.33	1.96	0	0
Ephemeroptera	Ametropodidae	0	0	0	0	0	0
Ephemeroptera	Baetidae	36.84	20.83	53.33	23.53	1500	0
Ephemeroptera	Baetiscidae	0	0	0	0	0	0
Ephemeroptera	Caenidae	0	0	0	0	0	0
Ephemeroptera	Ephemerellidae	19.3	95.83	26.67	27.45	400	0
Ephemeroptera	Ephemeridae	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	96.49	195.83	206.67	58.82	200	0

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	1	1	1	5	5
	BASIN	Buttle Lake	Buttle Lake	Buttle Lake	Buttle Lake	Chehalis River	Chehalis River
	STREAM	Henshaw Creek	Ralph River	Ralph River	Shepherd Creek	Chehalis River	Chehalis River
	SITECODE	BUT01101	BUT0201	BUT0301	BUT0401	CHH10198	CHH11198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	0	25	20	7.84	100	0
Gastropoda	Lymnaeidae	0	0	0	0	0	0
Gastropoda	Physidae	0	0	0	0	0	0
Gastropoda	Planorbidae	0	0	0	0	100	0
Gastropoda	Valvatidae	0	0	0	0	0	0
Heteroptera	Gerridae	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	0	0	0	0	0	0
Hirudinea	Piscicolidae	0	0	0	0	0	0
Isopoda	Asellidae	0	0	0	0	0	0
Lepidoptera	Pyralidae	0	0	0	0	0	0
Megaloptera	Sialidae	0	0	0	0	0	0
Oligochaeta	Enchytraeidae	1.75	0	3.33	9.8	0	100
Oligochaeta	Lumbriculidae	5.26	12.5	0	0	0	0
Oligochaeta	Naididae	0	0	0	0	2400	1700
Oligochaeta	Tubificidae	0	0	0	0	100	0
Platyhelminthes	Planariidae	12.28	25	3.33	5.88	0	0
Plecoptera	Capniidae	0	4.17	6.67	3.92	0	0
Plecoptera	Chloroperlidae	5.26	20.83	23.33	3.92	100	0
Plecoptera	Leuctridae	3.51	0	13.33	1.96	0	0
Plecoptera	Nemouridae	3.51	79.17	30	56.86	0	0
Plecoptera	Peltoperlidae	0	0	0	0	0	0
Plecoptera	Perlidae	0	0	0	0	0	0
Plecoptera	Perlodidae	0	8.33	0	0	100	0
Plecoptera	Pteronarcyidae	0	0	0	0	0	0
Plecoptera	Taeniopterygidae	115.79	120.83	246.67	35.29	0	0
Porifera	Spongillidae	0	0	0	0	100	0
Trichoptera	Apataniidae	0	0	0	0	0	0
Trichoptera	Brachycentridae	0	0	0	0	0	0
Trichoptera	Glossosomatidae	10.53	70.83	13.33	3.92	0	0
Trichoptera	Hydropsychidae	0	0	3.33	0	200	0
Trichoptera	Hydroptilidae	0	0	0	0	0	0
Trichoptera	Lepidostomatidae	0	0	0	0	900	0
Trichoptera	Leptoceridae	0	0	0	0	0	0
Trichoptera	Limnephilidae	0	12.5	3.33	3.92	0	0
Trichoptera	Philopotamidae	0	0	0	0	0	0
Trichoptera	Polycentropodidae	0	0	0	1.96	0	0
Trichoptera	Rhyacophilidae	10.53	8.33	0	7.84	0	0
Trichoptera	Uenoidae	0	0	0	0	0	0
COMMUNITY DESCRIPTORS							
	Abundance	**380.68**	**870.82**	**733.32**	**362.71**	**40100**	**21100**
	Richness	**17**	**20**	**17**	**23**	**16**	**7**
	% Dominance	**0.3**	**0.2**	**0.3**	**0.2**	**0.8**	**0.9**
	% Dominance (top 3)	**0.7**	**0.5**	**0.7**	**0.6**	**0.9**	**1.0**
	# Ephemeroptera	**3**	**4**	**5**	**5**	**4**	**0**
	# Plecoptera	**4**	**5**	**5**	**5**	**2**	**0**
	# Trichoptera	**2**	**3**	**3**	**4**	**2**	**0**
	EPT Richness	**9**	**12**	**13**	**14**	**8**	**0**
	% EPT	**79.3**	**76.1**	**88.6**	**65.9**	**8.7**	**0.0**
	% Chironomidae	**12.9**	**15.3**	**9.5**	**24.3**	**81.3**	**87.2**
	Bray-Curtis	**0.35**	**0.54**	**0.44**	**0.37**	**0.74**	**0.73**
	Diversity	**0.81**	**0.88**	**0.79**	**0.87**	**0.33**	**0.23**
	Evenness	**0.31**	**0.40**	**0.28**	**0.33**	**0.09**	**0.19**

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	5	4	1	2	1	1
	BASIN	Chehalis River	Chehalis River	Clayburn Creek	Clayburn Creek	Salmon River (Van. Is.)	Lower Fraser River
	STREAM	Chehalis River	Chehalis River	Poignant Creek	Clayburn Creek	Dalrymple Creek	Elk Creek
	SITECODE	CHH12198	CHH13198	CLB01198	CLB02198	DAL0101	ELK01198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Acarina	Anisitsiellidae	0	0	0	0	0	0
Acarina	Arrenuridae	0	33.33	0	0	0	0
Acarina	Aturidae	0	0	0	0	0	0
Acarina	Hydrodromidae	0	0	0	0	0	0
Acarina	Hydrozetiidae	0	0	0	0	0	0
Acarina	Hydryphantidae	0	0	5	2	6.38	0
Acarina	Hygrobatidae	0	0	0	0	0	0
Acarina	Lebertiidae	100	0	1	0	4.26	23.08
Acarina	Limnesiidae	0	0	0	0	0	0
Acarina	Oxidae	0	0	0	0	0	0
Acarina	Pionidae	0	0	0	0	0	0
Acarina	Sperchontidae	533.33	0	1	0	4.26	0
Acarina	Stygothrombidiidae	0	0	0	0	0	0
Acarina	Torrenticolidae	33.33	0	39	19	0	0
Acarina	Trhypachthoniidae	0	0	0	0	0	0
Acarina	Unionicolidae	0	0	0	0	0	0
Amphipoda	Crangonyctidae	0	0	0	0	0	0
Amphipoda	Gammaridae	0	33.33	0	0	0	0
Amphipoda	Hyalellidae	0	233.33	0	0	0	0
Bivalvia	Margaritiferidae	0	0	0	0	0	0
Bivalvia	Sphaeriidae	0	66.67	0	2	0	0
Coelentrata	Hydridae	0	0	0	0	0	0
Coleoptera	Dytiscidae	0	0	0	1	0	0
Coleoptera	Elmidae	0	0	75	1	0	0
Coleoptera	Haliplidae	0	0	0	0	0	0
Coleoptera	Hydrophilidae	0	0	0	0	0	0
Coleoptera	Staphylinidae	0	0	0	3	0	0
Collembola	Hypogasturidae	0	0	0	0	0	0
Collembola	Isotomidae	0	0	0	0	0	0
Collembola	Sminthuridae	0	0	0	0	0	0
Diptera	Athericidae	0	0	0	0	0	0
Diptera	Blephariceridae	0	0	0	0	0	0
Diptera	Ceratopogonidae	0	66.67	0	4	0	30.77
Diptera	Chironomidae	6733.33	3433.33	111	104	25.53	123.08
Diptera	Deuterophlebiidae	0	0	0	0	0	0
Diptera	Dixidae	0	0	6	52	0	0
Diptera	Empididae	533.33	0	6	1	0	23.08
Diptera	Muscidae	0	0	0	0	0	0
Diptera	Pelecorhnchidae	0	0	0	0	0	0
Diptera	Psychodidae	0	0	4	0	0	0
Diptera	Simuliidae	0	0	11	2	4.26	7.69
Diptera	Stratiomyidae	0	0	0	4	0	0
Diptera	Tabanidae	0	0	0	0	0	0
Diptera	Tanyderidae	0	0	0	0	0	0
Diptera	Thaumaleidae	0	0	0	0	0	0
Diptera	Tipulidae	0	0	28	5	2.13	15.38
Ephemeroptera	Ameletidae	0	0	8	15	0	0
Ephemeroptera	Ametropodidae	0	0	0	0	0	0
Ephemeroptera	Baetidae	0	366.67	234	24	236.17	438.46
Ephemeroptera	Baetiscidae	0	0	0	0	0	0
Ephemeroptera	Caenidae	0	0	0	0	0	0
Ephemeroptera	Ephemerellidae	0	33.33	29	22	0	23.08
Ephemeroptera	Ephemeridae	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	0	0	119	14	46.81	269.23

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	5	4	1	2	1	1
	BASIN	Chehalis River	Chehalis River	Clayburn Creek	Clayburn Creek	Salmon River (Van. Is.)	Lower Fraser River
	STREAM	Chehalis River	Chehalis River	Poignant Creek	Clayburn Creek	Dalrymple Creek	Elk Creek
	SITECODE	CHH12198	CHH13198	CLB01198	CLB02198	DAL0101	ELK01198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	66.67	0	21	85	8.51	0
Gastropoda	Lymnaeidae	0	0	0	0	0	0
Gastropoda	Physidae	0	0	0	0	0	0
Gastropoda	Planorbidae	0	0	0	0	0	0
Gastropoda	Valvatidae	0	0	0	0	0	0
Heteroptera	Gerridae	0	0	0	2	0	0
Hirudinea	Glossiphoniidae	0	0	0	0	0	0
Hirudinea	Piscicolidae	0	0	0	0	0	0
Isopoda	Asellidae	0	233.33	0	0	0	0
Lepidoptera	Pyralidae	0	0	0	0	0	0
Megaloptera	Sialidae	0	0	0	0	0	0
Oligochaeta	Enchytraeidae	0	0	2	1	0	15.38
Oligochaeta	Lumbriculidae	0	33.33	0	3	2.13	0
Oligochaeta	Naididae	533.33	33.33	6	2	0	0
Oligochaeta	Tubificidae	0	33.33	0	0	0	0
Platyhelminthes	Planariidae	33.33	0	0	0	0	0
Plecoptera	Capniidae	0	0	3	81	2.13	0
Plecoptera	Chloroperlidae	33.33	0	32	5	12.77	100
Plecoptera	Leuctridae	0	0	0	2	0	0
Plecoptera	Nemouridae	0	0	31	11	36.17	115.38
Plecoptera	Peltoperlidae	0	0	0	0	0	7.69
Plecoptera	Perlidae	0	0	0	0	0	15.38
Plecoptera	Perlodidae	0	0	22	3	0	30.77
Plecoptera	Pteronarcyidae	0	0	0	0	0	7.69
Plecoptera	Taeniopterygidae	0	0	0	0	10.64	0
Porifera	Spongillidae	0	200	0	0	0	0
Trichoptera	Apataniidae	0	0	0	0	0	46.15
Trichoptera	Brachycentridae	0	0	0	0	0	15.38
Trichoptera	Glossosomatidae	0	0	3	1	0	0
Trichoptera	Hydropsychidae	300	0	45	5	2.13	38.46
Trichoptera	Hydroptilidae	0	0	0	0	2.13	0
Trichoptera	Lepidostomatidae	0	0	1	10	27.66	107.69
Trichoptera	Leptoceridae	0	33.33	0	0	0	0
Trichoptera	Limnephilidae	0	0	0	1	0	0
Trichoptera	Philopotamidae	0	0	0	0	0	0
Trichoptera	Polycentropodidae	0	0	0	0	4.26	0
Trichoptera	Rhyacophilidae	0	0	10	13	0	23.08
Trichoptera	Uenoidae	0	0	0	0	0	0
COMMUNITY DESCRIPTORS							
	Abundance	**8899.98**	**4833.31**	**853**	**500**	**438.33**	**1476.9**
	Richness	**10**	**14**	**26**	**32**	**18**	**21**
	% Dominance	**0.8**	**0.7**	**0.3**	**0.2**	**0.5**	**0.3**
	% Dominance (top 3)	**0.9**	**0.8**	**0.5**	**0.5**	**0.7**	**0.6**
	# Ephemeroptera	**1**	**2**	**5**	**5**	**3**	**3**
	# Plecoptera	**1**	**0**	**4**	**5**	**4**	**6**
	# Trichoptera	**1**	**1**	**4**	**5**	**4**	**5**
	EPT Richness	**3**	**3**	**13**	**15**	**11**	**14**
	% EPT	**4.5**	**9.0**	**65.4**	**58.4**	**88.8**	**83.9**
	% Chironomidae	**75.7**	**71.0**	**13.0**	**20.8**	**5.8**	**8.3**
	Bray-Curtis	**0.52**	**0.44**	**0.47**	**0.57**	**0.52**	**0.66**
	Diversity	**0.42**	**0.48**	**0.87**	**0.88**	**0.68**	**0.85**
	Evenness	**0.17**	**0.14**	**0.29**	**0.26**	**0.17**	**0.32**

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	3	3	1	3	1
	BASIN	Lower Fraser River	Lower Fraser River	Lower Fraser River	Lower Fraser River	Lower Fraser River	Goldstream River
	STREAM	Elk Creek	Elk Creek	Elk Creek	Dunville Creek	Nevin Creek	Niagara Creek
	SITECODE	ELK0200	ELK02198	ELK03198	ELK10199	ELK11199	GOL0101
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Acarina	Anisitsiellidae	0	0	0	0	0	0
Acarina	Arrenuridae	0	0	0	0	0	0
Acarina	Aturidae	0	0	0	0	0	2.22
Acarina	Hydrodromidae	0	0	0	0	0	0
Acarina	Hydrozetiidae	0	0	0	0	0	0
Acarina	Hydryphantidae	0	0	0	0	0	2.22
Acarina	Hygrobatidae	0	0	0	0	0	2.22
Acarina	Lebertiidae	0	0	0	0	14.29	0
Acarina	Limnesiidae	0	40	0	0	0	0
Acarina	Oxidae	0	0	0	0	0	0
Acarina	Pionidae	0	0	0	0	0	0
Acarina	Sperchontidae	12.5	0	0	0	0	0
Acarina	Stygothrombidiidae	0	0	0	0	0	0
Acarina	Torrenticolidae	25	20	0	0	0	33.33
Acarina	Trhypachthoniidae	0	0	0	0	0	0
Acarina	Unionicolidae	0	0	0	0	0	0
Amphipoda	Crangonyctidae	0	0	0	0	0	0
Amphipoda	Gammaridae	0	0	0	0	0	0
Amphipoda	Hyalellidae	0	0	0	0	0	0
Bivalvia	Margaritiferidae	0	0	0	0	0	0
Bivalvia	Sphaeriidae	0	20	0	0	0	0
Coelentrata	Hydridae	0	0	0	0	0	0
Coleoptera	Dytiscidae	0	0	0	0	0	0
Coleoptera	Elmidae	18.75	0	0	25	85.71	6.67
Coleoptera	Haliplidae	0	0	0	0	0	0
Coleoptera	Hydrophilidae	0	0	0	0	0	0
Coleoptera	Staphylinidae	0	0	0	0	0	0
Collembola	Hypogasturidae	0	0	0	0	0	0
Collembola	Isotomidae	0	0	0	0	0	4.44
Collembola	Sminthuridae	0	0	0	0	0	0
Diptera	Athericidae	0	0	0	0	0	0
Diptera	Blephariceridae	0	0	0	0	0	0
Diptera	Ceratopogonidae	6.25	20	14.29	16.67	0	0
Diptera	Chironomidae	62.5	120	71.43	175	414.29	108.89
Diptera	Deuterophlebiidae	0	0	0	0	0	0
Diptera	Dixidae	0	0	0	0	14.29	0
Diptera	Empididae	0	0	14.29	0	28.57	4.44
Diptera	Muscidae	0	0	0	0	0	0
Diptera	Pelecorhnchidae	0	0	0	0	14.29	0
Diptera	Psychodidae	31.25	0	0	0	0	0
Diptera	Simuliidae	0	40	28.57	8.33	0	4.44
Diptera	Stratiomyidae	0	0	0	0	0	0
Diptera	Tabanidae	0	0	0	0	0	0
Diptera	Tanyderidae	0	0	0	0	0	0
Diptera	Thaumaleidae	0	0	0	0	0	0
Diptera	Tipulidae	0	40	42.86	16.67	57.14	4.44
Ephemeroptera	Ameletidae	43.75	60	28.57	0	0	0
Ephemeroptera	Ametropodidae	0	0	0	0	0	0
Ephemeroptera	Baetidae	612.5	1700	1871.43	883.33	1542.86	42.22
Ephemeroptera	Baetiscidae	0	0	0	0	0	0
Ephemeroptera	Caenidae	0	0	0	0	0	0
Ephemeroptera	Ephemerellidae	18.75	320	228.57	75	0	26.67
Ephemeroptera	Ephemeridae	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	156.25	400	228.57	125	328.57	117.78

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	3	3	1	3	1
	BASIN	Lower Fraser River	Lower Fraser River	Lower Fraser River	Lower Fraser River	Lower Fraser River	Goldstream River
	STREAM	Elk Creek	Elk Creek	Elk Creek	Dunville Creek	Nevin Creek	Niagara Creek
	SITECODE	ELK0200	ELK02198	ELK03198	ELK10199	ELK11199	GOL0101
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	31.25	200	114.29	0	0	6.67
Gastropoda	Lymnaeidae	0	0	0	0	0	0
Gastropoda	Physidae	0	0	0	0	0	0
Gastropoda	Planorbidae	0	0	0	0	0	11.11
Gastropoda	Valvatidae	6.25	0	0	16.67	28.57	0
Heteroptera	Gerridae	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	0	0	0	0	0	0
Hirudinea	Piscicolidae	0	0	0	0	0	0
Isopoda	Asellidae	0	0	0	0	0	0
Lepidoptera	Pyralidae	0	0	0	0	0	0
Megaloptera	Sialidae	0	0	0	0	0	0
Oligochaeta	Enchytraeidae	12.5	20	0	16.67	42.86	4.44
Oligochaeta	Lumbriculidae	0	0	14.29	25	0	4.44
Oligochaeta	Naididae	81.25	360	71.43	0	0	0
Oligochaeta	Tubificidae	18.75	20	0	0	0	0
Platyhelminthes	Planariidae	0	0	71.43	58.33	185.71	37.78
Plecoptera	Capniidae	37.5	60	28.57	16.67	14.29	0
Plecoptera	Chloroperlidae	12.5	120	28.57	8.33	14.29	20
Plecoptera	Leuctridae	12.5	0	14.29	0	0	0
Plecoptera	Nemouridae	43.75	80	142.86	25	85.71	15.56
Plecoptera	Peltoperlidae	0	0	0	16.67	0	0
Plecoptera	Perlidae	0	20	0	16.67	71.43	2.22
Plecoptera	Perlodidae	0	0	0	0	0	2.22
Plecoptera	Pteronarcyidae	6.25	20	0	0	0	0
Plecoptera	Taeniopterygidae	0	0	0	0	0	0
Porifera	Spongillidae	0	0	0	0	0	0
Trichoptera	Apataniidae	0	0	0	0	0	0
Trichoptera	Brachycentridae	0	0	0	0	0	0
Trichoptera	Glossosomatidae	25	0	0	141.67	114.29	4.44
Trichoptera	Hydropsychidae	6.25	140	28.57	25	57.14	6.67
Trichoptera	Hydroptilidae	0	0	0	0	0	0
Trichoptera	Lepidostomatidae	25	40	14.29	8.33	57.14	13.33
Trichoptera	Leptoceridae	0	0	0	0	0	0
Trichoptera	Limnephilidae	0	0	0	0	0	0
Trichoptera	Philopotamidae	0	0	0	0	0	0
Trichoptera	Polycentropodidae	0	0	0	0	0	2.22
Trichoptera	Rhyacophilidae	0	0	0	8.33	0	2.22
Trichoptera	Uenoidae	0	0	0	0	0	0
COMMUNITY DESCRIPTORS							
	Abundance	**1306.25**	**3860**	**3057.17**	**1708.34**	**3171.44**	**493.3**
	Richness	**23**	**22**	**19**	**21**	**19**	**27**
	% Dominance	**0.5**	**0.4**	**0.6**	**0.5**	**0.5**	**0.2**
	% Dominance (top 3)	**0.7**	**0.6**	**0.8**	**0.7**	**0.7**	**0.5**
	# Ephemeroptera	**5**	**5**	**5**	**3**	**2**	**4**
	# Plecoptera	**5**	**5**	**4**	**5**	**4**	**4**
	# Trichoptera	**3**	**2**	**2**	**4**	**3**	**5**
	EPT Richness	**13**	**12**	**11**	**12**	**9**	**13**
	% EPT	**78.9**	**81.9**	**89.3**	**79.0**	**72.1**	**53.2**
	% Chironomidae	**4.8**	**3.1**	**2.3**	**10.2**	**13.1**	**22.1**
	Bray-Curtis	**0.65**	**0.53**	**0.57**	**0.71**	**0.51**	**0.33**
	Diversity	**0.75**	**0.77**	**0.61**	**0.71**	**0.73**	**0.87**
	Evenness	**0.18**	**0.20**	**0.13**	**0.16**	**0.19**	**0.28**

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	1	3	1	5	5
	BASIN	Goldstream River	Heber River	Lower Fraser River	Lower Fraser River	Lower Fraser River	Lower Fraser River
	STREAM	Niagara Creek	Crest Creek	Hunter Creek	Hunter Creek	Jones Creek	Jones Creek
	SITECODE	GOL0201	HEB0101	HUN01198	HUN01199	JON01198	JON02198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Acarina	Anisitsiellidae	0	0	0	0	0	0
Acarina	Arrenuridae	0	0	0	0	0	0
Acarina	Aturidae	20	0	0	0	0	0
Acarina	Hydrodromidae	0	0	0	0	0	0
Acarina	Hydrozetiidae	0	5.56	0	0	0	0
Acarina	Hydryphantidae	46.67	5.56	0	0	0	0
Acarina	Hygrobatidae	20	0	0	0	0	0
Acarina	Lebertiidae	20	8.33	0	0	66.67	0
Acarina	Limnesiidae	0	0	0	0	0	0
Acarina	Oxidae	0	0	0	0	0	0
Acarina	Pionidae	0	0	0	0	0	0
Acarina	Sperchontidae	13.33	8.33	33.33	0	66.67	0
Acarina	Stygothrombidiidae	0	0	0	0	0	0
Acarina	Torrenticolidae	106.67	2.78	0	5	0	0
Acarina	Trhypachthoniidae	0	0	0	0	0	0
Acarina	Unionicolidae	0	0	0	0	0	0
Amphipoda	Crangonyctidae	0	0	0	0	0	0
Amphipoda	Gammaridae	0	0	0	0	0	0
Amphipoda	Hyalellidae	0	0	0	0	0	0
Bivalvia	Margaritiferidae	0	0	0	0	0	0
Bivalvia	Sphaeriidae	0	0	0	0	0	0
Coelentrata	Hydridae	0	0	0	0	0	0
Coleoptera	Dytiscidae	0	0	0	0	0	0
Coleoptera	Elmidae	13.33	0	0	0	0	0
Coleoptera	Haliplidae	0	0	0	0	0	0
Coleoptera	Hydrophilidae	0	0	0	0	0	0
Coleoptera	Staphylinidae	0	0	0	0	0	0
Collembola	Hypogasturidae	0	0	0	0	0	0
Collembola	Isotomidae	0	0	0	0	0	0
Collembola	Sminthuridae	0	0	0	0	0	0
Diptera	Athericidae	0	0	0	0	0	0
Diptera	Blephariceridae	0	0	0	0	0	0
Diptera	Ceratopogonidae	20	0	0	0	0	0
Diptera	Chironomidae	406.67	50	1000	155	3066.67	3400
Diptera	Deuterophlebiidae	0	0	0	0	0	0
Diptera	Dixidae	20	2.78	0	0	0	0
Diptera	Empididae	6.67	2.78	50	10	166.67	0
Diptera	Muscidae	0	0	0	0	0	0
Diptera	Pelecorhnchidae	0	0	0	0	0	0
Diptera	Psychodidae	0	0	0	0	0	0
Diptera	Simuliidae	0	2.78	50	0	0	100
Diptera	Stratiomyidae	0	0	0	0	0	0
Diptera	Tabanidae	0	0	0	0	0	0
Diptera	Tanyderidae	0	0	0	0	0	0
Diptera	Thaumaleidae	0	0	0	0	0	0
Diptera	Tipulidae	6.67	0	133.33	0	0	0
Ephemeroptera	Ameletidae	13.33	0	0	0	0	0
Ephemeroptera	Ametropodidae	0	0	0	0	0	0
Ephemeroptera	Baetidae	6.67	61.11	933.33	585	2200	4250
Ephemeroptera	Baetiscidae	0	0	0	0	0	0
Ephemeroptera	Caenidae	0	0	0	0	0	0
Ephemeroptera	Ephemerellidae	73.33	97.22	400	0	233.33	400
Ephemeroptera	Ephemeridae	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	100	116.67	483.33	85	500	2150

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	1	3	1	5	5
	BASIN	Goldstream River	Heber River	Lower Fraser River	Lower Fraser River	Lower Fraser River	Lower Fraser River
	STREAM	Niagara Creek	Crest Creek	Hunter Creek	Hunter Creek	Jones Creek	Jones Creek
	SITECODE	GOL0201	HEB0101	HUN01198	HUN01199	JON01198	JON02198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	6.67	47.22	16.67	10	33.33	150
Gastropoda	Lymnaeidae	0	0	0	0	0	0
Gastropoda	Physidae	0	0	0	0	0	0
Gastropoda	Planorbidae	93.33	0	0	0	0	0
Gastropoda	Valvatidae	0	0	0	0	0	0
Heteroptera	Gerridae	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	0	0	0	0	0	0
Hirudinea	Piscicolidae	0	0	0	0	0	0
Isopoda	Asellidae	0	0	0	0	0	0
Lepidoptera	Pyralidae	0	0	0	0	0	0
Megaloptera	Sialidae	0	0	0	0	0	0
Oligochaeta	Enchytraeidae	0	0	0	0	0	50
Oligochaeta	Lumbriculidae	0	2.78	0	0	0	50
Oligochaeta	Naididae	0	2.78	333.33	0	266.67	1150
Oligochaeta	Tubificidae	0	0	0	0	0	50
Platyhelminthes	Planariidae	213.33	38.89	0	5	0	0
Plecoptera	Capniidae	0	0	0	15	133.33	550
Plecoptera	Chloroperlidae	60	8.33	0	25	0	0
Plecoptera	Leuctridae	0	0	0	0	0	0
Plecoptera	Nemouridae	173.33	55.56	33.33	5	66.67	0
Plecoptera	Peltoperlidae	0	0	0	0	0	0
Plecoptera	Perlidae	6.67	0	0	0	0	0
Plecoptera	Perlodidae	0	2.78	0	0	0	0
Plecoptera	Pteronarcyidae	0	0	0	0	0	0
Plecoptera	Taeniopterygidae	0	33.33	0	160	0	50
Porifera	Spongillidae	0	0	0	0	0	0
Trichoptera	Apataniidae	20	0	0	0	0	0
Trichoptera	Brachycentridae	6.67	0	0	0	0	0
Trichoptera	Glossosomatidae	13.33	30.56	0	0	0	0
Trichoptera	Hydropsychidae	0	8.33	83.33	5	66.67	0
Trichoptera	Hydroptilidae	0	0	0	0	0	0
Trichoptera	Lepidostomatidae	53.33	0	83.33	5	133.33	50
Trichoptera	Leptoceridae	0	0	0	0	0	0
Trichoptera	Limnephilidae	20	0	0	0	0	0
Trichoptera	Philopotamidae	0	0	0	0	0	0
Trichoptera	Polycentropodidae	26.67	0	0	0	0	0
Trichoptera	Rhyacophilidae	0	25	0	10	0	0
Trichoptera	Uenoidae	0	0	0	0	0	0
COMMUNITY DESCRIPTORS							
	Abundance	**1586.67**	**619.46**	**3633.31**	**1080**	**7000.01**	**12400**
	Richness	**28**	**23**	**13**	**14**	**13**	**13**
	% Dominance	**0.3**	**0.2**	**0.3**	**0.5**	**0.4**	**0.3**
	% Dominance (top 3)	**0.5**	**0.4**	**0.7**	**0.8**	**0.8**	**0.8**
	# Ephemeroptera	**5**	**4**	**4**	**3**	**4**	**4**
	# Plecoptera	**3**	**4**	**1**	**4**	**2**	**2**
	# Trichoptera	**6**	**3**	**2**	**3**	**2**	**1**
	EPT Richness	**14**	**11**	**7**	**10**	**8**	**7**
	% EPT	**36.6**	**78.5**	**56.0**	**83.8**	**48.1**	**61.3**
	% Chironomidae	**25.6**	**8.1**	**27.5**	**14.4**	**43.8**	**27.4**
	Bray-Curtis	**0.75**	**0.40**	**0.37**	**0.61**	**0.28**	**0.32**
	Diversity	**0.89**	**0.90**	**0.82**	**0.66**	**0.70**	**0.77**
	Evenness	**0.31**	**0.43**	**0.42**	**0.21**	**0.26**	**0.33**

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	4	3	1	1	1	4
	BASIN	Johnstone Strait	Johnstone Strait	Johnstone Strait	Johnstone Strait	Johnstone Strait	Morris Creek
	STREAM	Bear Creek	Amor de Cosmos	Tributary of Amor de Cosmos	Palmer Bay Creek?	Mt Milner West Creek?	Morris Creek
	SITECODE	JST0101	JST0201	JST0301	JST0401	JST0501	MOR01198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Acarina	Anisitsiellidae	0	0	0	0	0	0
Acarina	Arrenuridae	0	0	0	0	0	0
Acarina	Aturidae	0	0	0	0	0	0
Acarina	Hydrodromidae	0	0	0	0	0	0
Acarina	Hydrozetiidae	0	0	3	4.26	0	0
Acarina	Hydryphantidae	75	0	6	0	1	0
Acarina	Hygrobatidae	75	0	1	0	2	0
Acarina	Lebertiidae	25	0	1	0	0	0
Acarina	Limnesiidae	0	0	0	0	0	0
Acarina	Oxidae	0	0	0	0	0	0
Acarina	Pionidae	0	0	0	0	0	0
Acarina	Sperchontidae	0	0	0	2.13	0	0
Acarina	Stygothrombidiidae	0	0	0	0	0	0
Acarina	Torrenticolidae	50	137.5	1	0	0	0
Acarina	Trhypachthoniidae	0	0	0	0	0	0
Acarina	Unionicolidae	0	0	0	0	0	0
Amphipoda	Crangonyctidae	0	0	0	0	0	1900
Amphipoda	Gammaridae	0	0	0	0	0	0
Amphipoda	Hyalellidae	0	0	0	0	0	0
Bivalvia	Margaritiferidae	0	0	0	0	0	0
Bivalvia	Sphaeriidae	0	87.5	0	0	0	0
Coelentrata	Hydridae	0	0	0	0	0	1100
Coleoptera	Dytiscidae	0	0	0	0	0	0
Coleoptera	Elmidae	0	150	3	0	0	0
Coleoptera	Haliplidae	0	0	0	0	0	0
Coleoptera	Hydrophilidae	0	0	0	0	0	0
Coleoptera	Staphylinidae	0	0	0	0	0	0
Collembola	Hypogasturidae	0	0	0	2.13	0	0
Collembola	Isotomidae	0	0	0	0	0	0
Collembola	Sminthuridae	0	0	1	0	0	0
Diptera	Athericidae	0	0	0	0	0	0
Diptera	Blephariceridae	0	0	0	0	0	0
Diptera	Ceratopogonidae	25	0	0	0	0	500
Diptera	Chironomidae	2075	350	12	42.55	3	3500
Diptera	Deuterophlebiidae	0	0	0	0	0	0
Diptera	Dixidae	0	0	1	0	0	0
Diptera	Empididae	25	50	1	2.13	0	0
Diptera	Muscidae	0	0	0	0	0	0
Diptera	Pelecorhnchidae	0	0	0	0	0	0
Diptera	Psychodidae	125	0	0	0	0	0
Diptera	Simuliidae	0	0	1	0	0	0
Diptera	Stratiomyidae	0	0	0	0	0	0
Diptera	Tabanidae	0	0	0	0	0	0
Diptera	Tanyderidae	0	0	0	0	0	0
Diptera	Thaumaleidae	0	0	0	0	0	0
Diptera	Tipulidae	75	0	1	0	1	0
Ephemeroptera	Ameletidae	150	0	1	0	0	0
Ephemeroptera	Ametropodidae	0	0	0	0	0	0
Ephemeroptera	Baetidae	25	200	40	61.7	54	100
Ephemeroptera	Baetiscidae	0	0	0	0	0	0
Ephemeroptera	Caenidae	0	0	0	0	0	700
Ephemeroptera	Ephemerellidae	0	562.5	16	93.62	5	0
Ephemeroptera	Ephemeridae	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	900	37.5	48	225.53	36	0

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	4	3	1	1	1	4
	BASIN	Johnstone Strait	Johnstone Strait	Johnstone Strait	Johnstone Strait	Johnstone Strait	Morris Creek
	STREAM	Bear Creek	Amor de Cosmos	Tributary of Amor de Cosmos	Palmer Bay Creek?	Mt Milner West Creek?	Morris Creek
	SITECODE	JST0101	JST0201	JST0301	JST0401	JST0501	MOR01198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	0	75	12	0	0	0
Gastropoda	Lymnaeidae	0	0	0	0	0	0
Gastropoda	Physidae	0	0	0	0	0	0
Gastropoda	Planorbidae	0	250	0	0	0	200
Gastropoda	Valvatidae	0	0	0	0	0	100
Heteroptera	Gerridae	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	0	0	0	0	0	100
Hirudinea	Piscicolidae	0	0	0	0	0	0
Isopoda	Asellidae	0	0	0	0	0	0
Lepidoptera	Pyralidae	0	0	0	0	0	0
Megaloptera	Sialidae	0	0	0	0	0	0
Oligochaeta	Enchytraeidae	0	50	1	0	0	0
Oligochaeta	Lumbriculidae	0	75	2	0	0	0
Oligochaeta	Naididae	50	12.5	0	0	0	7600
Oligochaeta	Tubificidae	0	0	0	0	0	200
Platyhelminthes	Planariidae	25	0	1	8.51	9	0
Plecoptera	Capniidae	0	0	0	2.13	0	0
Plecoptera	Chloroperlidae	100	25	4	6.38	2	0
Plecoptera	Leuctridae	0	0	0	0	0	0
Plecoptera	Nemouridae	125	87.5	20	12.77	6	0
Plecoptera	Peltoperlidae	0	0	0	0	0	0
Plecoptera	Perlidae	0	12.5	0	0	0	0
Plecoptera	Perlodidae	0	12.5	0	0	0	0
Plecoptera	Pteronarcyidae	0	0	0	0	0	0
Plecoptera	Taeniopterygidae	0	0	1	2.13	45	0
Porifera	Spongillidae	0	0	0	0	0	900
Trichoptera	Apataniidae	0	0	0	0	0	0
Trichoptera	Brachycentridae	25	0	0	0	0	0
Trichoptera	Glossosomatidae	125	0	10	0	2	0
Trichoptera	Hydropsychidae	25	50	4	0	0	0
Trichoptera	Hydroptilidae	0	0	0	2.13	0	0
Trichoptera	Lepidostomatidae	1100	412.5	7	0	0	0
Trichoptera	Leptoceridae	0	0	0	0	0	300
Trichoptera	Limnephilidae	0	0	9	0	0	0
Trichoptera	Philopotamidae	0	0	0	0	0	0
Trichoptera	Polycentropodidae	25	0	6	12.77	1	0
Trichoptera	Rhyacophilidae	0	0	0	0	1	0
Trichoptera	Uenoidae	0	0	0	0	0	0
COMMUNITY DESCRIPTORS							
	Abundance	**5225**	**2637.5**	**214**	**480.87**	**168**	**17200**
	Richness	**21**	**19**	**28**	**15**	**14**	**13**
	% Dominance	**0.4**	**0.2**	**0.2**	**0.5**	**0.3**	**0.4**
	% Dominance (top 3)	**0.8**	**0.5**	**0.5**	**0.8**	**0.8**	**0.8**
	# Ephemeroptera	**3**	**4**	**5**	**3**	**3**	**2**
	# Plecoptera	**2**	**4**	**3**	**4**	**3**	**0**
	# Trichoptera	**5**	**2**	**5**	**2**	**3**	**1**
	EPT Richness	**10**	**10**	**13**	**9**	**9**	**3**
	% EPT	**49.8**	**55.9**	**83.2**	**87.2**	**90.5**	**6.4**
	% Chironomidae	**39.7**	**13.3**	**5.6**	**8.8**	**1.8**	**20.3**
	Bray-Curtis	**0.47**	**0.58**	**0.50**	**0.37**	**0.51**	**0.80**
	Diversity	**0.76**	**0.89**	**0.89**	**0.72**	**0.77**	**0.74**
	Evenness	**0.20**	**0.46**	**0.31**	**0.23**	**0.31**	**0.30**

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	4	1	1	3	1	1
	BASIN	Morris Creek	Sooke River	Sooke River	Sooke River	Elk River (Strathcona)	E k River (Strathcona)
	STREAM	Tr butary of Morris Creek	Jones Creek	Council Creek	Vietch Creek	Fi berg Creek	Cervus Creek
	SITECODE	MOR02198	SOO0101	SOO0201	SOO0301	STR0101	STR0201
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Acarina	Anisitsiellidae	0	0	0	0	0	0
Acarina	Arrenuridae	0	0	0	0	0	0
Acarina	Aturidae	0	22.22	0	0	0	0
Acarina	Hydrodromidae	0	0	0	0	0	0
Acarina	Hydrozetiidae	0	8.33	0	0	0	0
Acarina	Hydryphantidae	0	8.33	12.5	133.33	11.11	0
Acarina	Hygrobatidae	0	2.78	4.17	16.67	0	0
Acarina	Lebertiidae	0	0	0	50	0	5.56
Acarina	Limnesiidae	0	0	0	0	0	0
Acarina	Oxidae	0	0	0	0	0	0
Acarina	Pionidae	0	0	0	0	0	0
Acarina	Sperchontidae	0	2.78	0	0	5.56	11.11
Acarina	Stygothrombidiidae	0	0	0	0	0	0
Acarina	Torrenticolidae	0	63.89	16.67	466.67	11.11	0
Acarina	Trhypachthoniidae	0	0	0	100	0	0
Acarina	Unionicolidae	17.65	0	0	0	0	0
Amphipoda	Crangonyctidae	0	0	0	0	0	0
Amphipoda	Gammaridae	0	0	0	0	0	0
Amphipoda	Hyalellidae	0	0	0	0	0	0
Bivalvia	Margaritiferidae	0	0	0	0	0	0
Bivalvia	Sphaeriidae	17.65	0	0	0	0	0
Coelentrata	Hydridae	0	0	0	0	0	0
Coleoptera	Dytiscidae	0	0	0	0	0	0
Coleoptera	Elmidae	0	0	0	16.67	0	0
Coleoptera	Haliplidae	0	0	0	0	0	0
Coleoptera	Hydrophilidae	0	0	0	0	0	0
Coleoptera	Staphylinidae	0	0	0	0	0	0
Collembola	Hypogasturidae	0	11.11	0	0	0	0
Collembola	Isotomidae	0	0	20.83	0	0	0
Collembola	Sminthuridae	0	0	4.17	0	0	0
Diptera	Athericidae	0	0	0	0	0	0
Diptera	Blephariceridae	0	0	0	0	0	0
Diptera	Ceratopogonidae	35.29	0	4.17	66.67	0	0
Diptera	Chironomidae	211.76	155.56	229.17	616.67	105.56	66.67
Diptera	Deuterophlebiidae	0	0	0	0	0	0
Diptera	Dixidae	0	5.56	16.67	16.67	0	0
Diptera	Empididae	0	13.89	4.17	0	0	0
Diptera	Muscidae	0	0	0	0	0	0
Diptera	Pelecorhnchidae	0	0	0	0	0	0
Diptera	Psychodidae	0	0	0	16.67	0	0
Diptera	Simuliidae	0	2.78	0	0	0	5.56
Diptera	Stratiomyidae	0	0	0	0	0	0
Diptera	Tabanidae	0	0	0	0	0	0
Diptera	Tanyderidae	0	0	0	0	0	0
Diptera	Thaumaleidae	0	0	0	0	0	0
Diptera	Tipulidae	0	0	0	0	0	0
Ephemeroptera	Ameletidae	0	38.89	16.67	16.67	0	0
Ephemeroptera	Ametropodidae	0	0	0	0	0	0
Ephemeroptera	Baetidae	17.65	8.33	41.67	216.67	16.67	55.56
Ephemeroptera	Baetiscidae	0	0	0	0	0	0
Ephemeroptera	Caenidae	17.65	0	0	0	0	0
Ephemeroptera	Ephemerellidae	0	2.78	45.83	16.67	22.22	383.33
Ephemeroptera	Ephemeridae	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	0	16.67	166.67	1316.67	150	244.44

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	4	1	1	3	1	1
	BASIN	Morris Creek	Sooke River	Sooke River	Sooke River	Elk River (Strathcona)	E k River (Strathcona)
	STREAM	Tr butary of Morris Creek	Jones Creek	Council Creek	Vietch Creek	Fi berg Creek	Cervus Creek
	SITECODE	MOR02198	SOO0101	SOO0201	SOO0301	STR0101	STR0201
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	0	19.44	4.17	50	16.67	22.22
Gastropoda	Lymnaeidae	0	0	0	0	0	0
Gastropoda	Physidae	0	0	0	0	0	0
Gastropoda	Planorbidae	35.29	58.33	12.5	166.67	0	0
Gastropoda	Valvatidae	0	0	0	0	0	0
Heteroptera	Gerridae	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	0	0	0	0	0	0
Hirudinea	Piscicolidae	0	0	0	0	0	0
Isopoda	Asellidae	0	0	0	0	0	0
Lepidoptera	Pyralidae	0	0	4.17	0	0	0
Megaloptera	Sialidae	0	0	0	0	0	0
Oligochaeta	Enchytraeidae	52.94	0	4.17	83.33	5.56	11.11
Oligochaeta	Lumbriculidae	17.65	0	0	0	50	22.22
Oligochaeta	Naididae	388.24	0	0	100	0	0
Oligochaeta	Tubificidae	1164.71	0	4.17	33.33	0	0
Platyhelminthes	Planariidae	0	30.56	41.67	16.67	105.56	55.56
Plecoptera	Capniidae	0	0	0	33.33	0	0
Plecoptera	Chloroperlidae	0	0	45.83	150	5.56	22.22
Plecoptera	Leuctridae	0	0	0	0	5.56	5.56
Plecoptera	Nemouridae	0	25	20.83	716.67	0	33.33
Plecoptera	Peltoperlidae	0	0	0	0	0	0
Plecoptera	Perlidae	0	0	4.17	0	0	0
Plecoptera	Perlodidae	0	5.56	0	0	0	5.56
Plecoptera	Pteronarcyidae	0	0	0	0	0	0
Plecoptera	Taeniopterygidae	0	2.78	0	0	200	283.33
Porifera	Spongillidae	0	0	0	0	0	0
Trichoptera	Apataniidae	0	0	0	0	0	0
Trichoptera	Brachycentridae	0	2.78	20.83	0	0	0
Trichoptera	Glossosomatidae	0	11.11	8.33	0	538.89	100
Trichoptera	Hydropsychidae	0	0	0	0	0	0
Trichoptera	Hydroptilidae	0	0	0	0	0	0
Trichoptera	Lepidostomatidae	0	27.78	91.67	183.33	0	0
Trichoptera	Leptoceridae	0	0	0	0	0	0
Trichoptera	Limnephilidae	0	0	0	0	27.78	5.56
Trichoptera	Philopotamidae	0	0	0	0	0	0
Trichoptera	Polycentropodidae	0	41.67	8.33	50	0	11.11
Trichoptera	Rhyacophilidae	0	0	4.17	0	16.67	0
Trichoptera	Uenoidae	0	0	0	0	0	0
COMMUNITY DESCRIPTORS							
	Abundance	**1976.48**	**588.91**	**858.37**	**4650.03**	**1294.48**	**1350.01**
	Richness	**11**	**25**	**27**	**25**	**17**	**19**
	% Dominance	**0.6**	**0.3**	**0.3**	**0.3**	**0.4**	**0.3**
	% Dominance (top 3)	**0.9**	**0.5**	**0.6**	**0.6**	**0.7**	**0.7**
	# Ephemeroptera	**2**	**5**	**5**	**5**	**4**	**4**
	# Plecoptera	**0**	**3**	**3**	**3**	**3**	**5**
	# Trichoptera	**0**	**4**	**5**	**2**	**3**	**3**
	EPT Richness	**2**	**12**	**13**	**10**	**10**	**12**
	% EPT	**1.8**	**34.4**	**55.8**	**59.1**	**77.3**	**86.8**
	% Chironomidae	**10.7**	**26.4**	**26.7**	**13.3**	**8.2**	**4.9**
	Bray-Curtis	**0.83**	**0.74**	**0.54**	**0.54**	**0.71**	**0.64**
	Diversity	**0.60**	**0.89**	**0.87**	**0.86**	**0.77**	**0.83**
	Evenness	**0.23**	**0.35**	**0.28**	**0.28**	**0.26**	**0.31**

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	3	1	4	4	5
	BASIN	E k River (Strathcona)	Elk River (Strathcona)	Elk River (Strathcona)	Stave Lake	Stave Lake	Stave Lake
	STREAM	Tlools Creek	Elk River	Elk River	Cardinalis Creek	Stave River	Cascade Creek
	SITECODE	STR03101	STR0401	STR050	STV01198	STV02198	STV03198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Acarina	Anisitsiellidae	0	0	0	0	0	0
Acarina	Arrenuridae	0	0	0	0	0	0
Acarina	Aturidae	0	0	0	0	0	0
Acarina	Hydrodromidae	0	0	0	0	0	0
Acarina	Hydrozetiidae	0	0	0	0	0	0
Acarina	Hydryphantidae	0	0	0	0	0	0
Acarina	Hygrobatidae	5	0	0	0	0	0
Acarina	Lebertiidae	0	12.5	3.7	0	0	100
Acarina	Limnesiidae	0	0	0	187.5	20	100
Acarina	Oxidae	0	0	0	0	0	0
Acarina	Pionidae	0	0	0	0	0	0
Acarina	Sperchontidae	10	0	0	0	0	0
Acarina	Stygothrombidiidae	0	0	0	0	0	0
Acarina	Torrenticolidae	0	62.5	11.11	0	0	0
Acarina	Trhypachthoniidae	0	0	0	0	0	0
Acarina	Unionicolidae	0	0	0	0	0	0
Amphipoda	Crangonyctidae	0	0	0	0	0	900
Amphipoda	Gammaridae	0	0	0	0	0	0
Amphipoda	Hyalellidae	0	0	0	0	0	0
Bivalvia	Margaritiferidae	0	0	0	0	0	0
Bivalvia	Sphaeriidae	0	0	0	0	0	0
Coelentrata	Hydridae	0	0	0	0	0	0
Coleoptera	Dytiscidae	0	0	0	0	0	0
Coleoptera	Elmidae	0	0	0	0	0	0
Coleoptera	Haliplidae	0	0	0	0	0	0
Coleoptera	Hydrophilidae	0	0	0	0	0	0
Coleoptera	Staphylinidae	0	0	0	0	0	0
Collembola	Hypogasturidae	0	0	0	0	0	0
Collembola	Isotomidae	0	0	0	0	0	0
Collembola	Sminthuridae	0	0	0	0	0	0
Diptera	Athericidae	0	0	0	0	0	0
Diptera	Blephariceridae	0	0	0	0	0	0
Diptera	Ceratopogonidae	0	0	0	37.5	0	100
Diptera	Chironomidae	50	137.5	40.74	1912.5	2980	12600
Diptera	Deuterophlebiidae	0	0	0	0	0	0
Diptera	Dixidae	0	0	0	0	0	0
Diptera	Empididae	0	0	7.41	0	0	0
Diptera	Muscidae	0	0	0	0	0	0
Diptera	Pelecorhnchidae	0	0	0	0	0	0
Diptera	Psychodidae	0	0	0	0	0	0
Diptera	Simuliidae	10	150	0	0	760	200
Diptera	Stratiomyidae	0	0	0	0	0	0
Diptera	Tabanidae	0	0	0	0	0	0
Diptera	Tanyderidae	0	0	0	0	0	0
Diptera	Thaumaleidae	0	0	0	0	0	0
Diptera	Tipulidae	0	50	0	0	0	0
Ephemeroptera	Ameletidae	0	0	3.7	0	0	0
Ephemeroptera	Ametropodidae	0	0	0	0	0	0
Ephemeroptera	Baetidae	610	0	51.85	450	0	700
Ephemeroptera	Baetiscidae	0	287.5	0	0	0	0
Ephemeroptera	Caenidae	0	0	0	0	0	0
Ephemeroptera	Ephemerellidae	60	125	74.07	0	0	0
Ephemeroptera	Ephemeridae	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	100	1112.5	274.07	0	0	0

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	3	1	4	4	5
	BASIN	E k River (Strathcona)	Elk River (Strathcona)	Elk River (Strathcona)	Stave Lake	Stave Lake	Stave Lake
	STREAM	Tlools Creek	Elk River	Elk River	Cardinalis Creek	Stave River	Cascade Creek
	SITECODE	STR03101	STR0401	STR050	STV01198	STV02198	STV03198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	5	0	0	0	0	0
Gastropoda	Lymnaeidae	0	0	0	0	0	0
Gastropoda	Physidae	0	0	0	0	0	0
Gastropoda	Planorbidae	0	0	0	0	0	0
Gastropoda	Valvatidae	0	0	0	0	0	0
Heteroptera	Gerridae	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	0	0	0	0	0	0
Hirudinea	Piscicolidae	0	0	0	0	0	0
Isopoda	Asellidae	0	0	0	0	0	0
Lepidoptera	Pyralidae	0	0	0	0	0	0
Megaloptera	Sialidae	0	0	0	0	0	0
Oligochaeta	Enchytraeidae	0	0	0	0	0	100
Oligochaeta	Lumbriculidae	0	0	7.41	37.5	20	200
Oligochaeta	Naididae	0	12.5	0	3825	240	1700
Oligochaeta	Tubificidae	0	0	0	75	0	100
Platyhelminthes	Planariidae	45	0	11.11	0	0	0
Plecoptera	Capniidae	0	0	7.41	37.5	0	100
Plecoptera	Chloroperlidae	5	412.5	48.15	0	0	0
Plecoptera	Leuctridae	0	0	0	0	20	0
Plecoptera	Nemouridae	15	50	14.81	0	0	0
Plecoptera	Peltoperlidae	0	0	0	0	0	0
Plecoptera	Perlidae	0	0	0	0	0	0
Plecoptera	Perlodidae	0	25	0	0	0	0
Plecoptera	Pteronarcyidae	0	0	0	0	0	0
Plecoptera	Taeniopterygidae	145	150	151.85	0	0	0
Porifera	Spongillidae	0	0	0	0	0	0
Trichoptera	Apataniidae	0	0	0	0	0	0
Trichoptera	Brachycentridae	0	0	0	0	0	0
Trichoptera	Glossosomatidae	0	0	59.26	0	0	0
Trichoptera	Hydropsychidae	0	0	0	0	0	0
Trichoptera	Hydroptilidae	0	0	0	0	0	0
Trichoptera	Lepidostomatidae	0	12.5	11.11	0	0	0
Trichoptera	Leptoceridae	0	12.5	3.7	0	0	0
Trichoptera	Limnephilidae	0	0	3.7	0	0	0
Trichoptera	Philopotamidae	0	0	0	0	0	0
Trichoptera	Polycentropodidae	0	0	0	0	0	0
Trichoptera	Rhyacophilidae	5	0	22.22	0	0	0
Trichoptera	Uenoidae	0	0	0	0	0	0
COMMUNITY DESCRIPTORS							
	Abundance	**1065**	**2612.5**	**807.38**	**6562.5**	**4040**	**16900**
	Richness	**13**	**15**	**19**	**8**	**6**	**12**
	% Dominance	**0.6**	**0.4**	**0.3**	**0.6**	**0.7**	**0.7**
	% Dominance (top 3)	**0.8**	**0.7**	**0.6**	**0.9**	**1.0**	**0.9**
	# Ephemeroptera	**4**	**3**	**4**	**1**	**0**	**1**
	# Plecoptera	**3**	**4**	**4**	**1**	**1**	**1**
	# Trichoptera	**1**	**2**	**5**	**0**	**0**	**0**
	EPT Richness	**8**	**9**	**13**	**2**	**1**	**2**
	% EPT	**88.7**	**83.7**	**89.9**	**7.4**	**0.5**	**4.7**
	% Chironomidae	**4.7**	**5.3**	**5.0**	**29.1**	**73.8**	**74.6**
	Bray-Curtis	**0.59**	**0.58**	**0.51**	**0.54**	**0.36**	**0.62**
	Diversity	**0.64**	**0.77**	**0.82**	**0.57**	**0.42**	**0.43**
	Evenness	**0.21**	**0.29**	**0.30**	**0.29**	**0.29**	**0.15**

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	3	3	4	5	1	3
	BASIN	Sumallo River	Sumallo River	Sumallo River	Sumallo River	Pitt River	Pitt River
	STREAM	Sumallo River	Sumallo River	Sumallo River	Sumallo River	Widgeon Creek	Widgeon Creek
	SITECODE	SUM01199	SUM02199	SUM03199	SUM04199	WDG01198	WDG02198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Acarina	Anisitsiellidae	0	0	0	0	0	0
Acarina	Arrenuridae	0	0	0	0	0	0
Acarina	Aturidae	0	0	0	0	0	0
Acarina	Hydrodromidae	0	0	0	0	0	0
Acarina	Hydrozetiidae	0	0	0	0	0	0
Acarina	Hydryphantidae	0	0	15	0	0	0
Acarina	Hygrobatidae	0	0	0	0	0	0
Acarina	Lebertiidae	14.29	0	30	37.5	0	14.29
Acarina	Limnesiidae	0	34.62	0	0	3.33	21.43
Acarina	Oxidae	0	0	0	0	0	0
Acarina	Pionidae	0	0	0	0	0	0
Acarina	Sperchontidae	28.57	0	45	0	6.67	0
Acarina	Stygothrombidiidae	0	0	0	0	0	0
Acarina	Torrenticolidae	0	0	0	0	3.33	42.86
Acarina	Trhypachthoniidae	0	0	0	0	0	0
Acarina	Unionicolidae	0	0	0	0	0	0
Amphipoda	Crangonyctidae	0	0	0	0	0	0
Amphipoda	Gammaridae	0	0	0	0	0	0
Amphipoda	Hyalellidae	0	0	0	0	0	0
Bivalvia	Margaritiferidae	0	0	0	0	0	0
Bivalvia	Sphaeriidae	14.29	0	0	0	0	0
Coelentrata	Hydridae	0	0	0	0	0	0
Coleoptera	Dytiscidae	0	23.08	15	75	0	0
Coleoptera	Elmidae	0	0	0	0	0	0
Coleoptera	Haliplidae	0	0	0	0	0	0
Coleoptera	Hydrophilidae	0	0	0	0	0	0
Coleoptera	Staphylinidae	0	0	0	0	0	0
Collembola	Hypogasturidae	0	0	0	0	0	0
Collembola	Isotomidae	0	0	0	0	0	0
Collembola	Sminthuridae	0	0	0	0	0	0
Diptera	Athericidae	0	0	0	0	0	0
Diptera	Blephariceridae	0	0	0	0	0	0
Diptera	Ceratopogonidae	28.57	57.69	0	37.5	3.33	0
Diptera	Chironomidae	214.29	519.23	1905	3900	116.67	857.14
Diptera	Deuterophlebiidae	0	0	0	0	0	0
Diptera	Dixidae	0	0	0	0	0	0
Diptera	Empididae	0	0	0	0	6.67	0
Diptera	Muscidae	0	0	0	0	0	0
Diptera	Pelecorhnchidae	0	0	30	75	0	0
Diptera	Psychodidae	0	0	75	150	0	0
Diptera	Simuliidae	0	0	0	0	23.33	7.14
Diptera	Stratiomyidae	0	0	0	0	0	0
Diptera	Tabanidae	0	0	0	0	0	0
Diptera	Tanyderidae	0	0	0	0	0	0
Diptera	Thaumaleidae	0	0	0	0	0	0
Diptera	Tipulidae	28.57	0	15	0	0	7.14
Ephemeroptera	Ameletidae	100	80.77	90	0	0	0
Ephemeroptera	Ametropodidae	0	0	0	0	0	0
Ephemeroptera	Baetidae	471.43	265.38	90	225	223.33	28.57
Ephemeroptera	Baetiscidae	0	0	0	0	0	0
Ephemeroptera	Caenidae	0	0	0	0	0	0
Ephemeroptera	Ephemerellidae	314.29	265.38	120	1087.5	0	0
Ephemeroptera	Ephemeridae	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	757.14	253.85	60	1312.5	66.67	228.57

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	3	3	4	5	1	3
	BASIN	Sumallo River	Sumallo River	Sumallo River	Sumallo River	Pitt River	Pitt River
	STREAM	Sumallo River	Sumallo River	Sumallo River	Sumallo River	Widgeon Creek	Widgeon Creek
	SITECODE	SUM01199	SUM02199	SUM03199	SUM04199	WDG01198	WDG02198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	28.57	11.54	30	0	0	0
Gastropoda	Lymnaeidae	0	0	0	0	0	0
Gastropoda	Physidae	0	0	0	0	0	0
Gastropoda	Planorbidae	0	0	0	0	0	0
Gastropoda	Valvatidae	0	0	0	0	0	0
Heteroptera	Gerridae	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	0	0	0	0	0	0
Hirudinea	Piscicolidae	0	0	0	0	0	0
Isopoda	Asellidae	0	0	0	0	0	0
Lepidoptera	Pyralidae	0	0	0	0	0	0
Megaloptera	Sialidae	0	0	0	0	0	0
Oligochaeta	Enchytraeidae	471.43	530.77	0	0	0	0
Oligochaeta	Lumbriculidae	57.14	46.15	15	0	13.33	0
Oligochaeta	Naididae	0	0	0	0	13.33	128.57
Oligochaeta	Tubificidae	0	0	0	0	3.33	42.86
Platyhelminthes	Planariidae	28.57	23.08	0	37.5	0	0
Plecoptera	Capniidae	57.14	0	15	37.5	0	0
Plecoptera	Chloroperlidae	200	126.92	330	300	60	35.71
Plecoptera	Leuctridae	0	0	0	0	0	0
Plecoptera	Nemouridae	0	23.08	0	0	6.67	21.43
Plecoptera	Peltoperlidae	0	0	0	0	0	0
Plecoptera	Perlidae	0	0	0	0	0	0
Plecoptera	Perlodidae	14.29	11.54	0	0	0	0
Plecoptera	Pteronarcyidae	0	0	0	0	0	0
Plecoptera	Taeniopterygidae	228.57	69.23	0	0	0	0
Porifera	Spongillidae	0	0	0	0	0	0
Trichoptera	Apataniidae	0	11.54	0	0	0	0
Trichoptera	Brachycentridae	0	0	0	0	0	0
Trichoptera	Glossosomatidae	42.86	23.08	0	0	0	0
Trichoptera	Hydropsychidae	0	11.54	0	0	0	0
Trichoptera	Hydroptilidae	0	0	0	0	0	0
Trichoptera	Lepidostomatidae	0	0	15	0	6.67	0
Trichoptera	Leptoceridae	0	0	0	0	93.33	28.57
Trichoptera	Limnephilidae	0	0	0	0	0	0
Trichoptera	Philopotamidae	0	0	0	0	0	0
Trichoptera	Polycentropodidae	0	0	0	0	0	0
Trichoptera	Rhyacophilidae	42.86	11.54	0	0	0	0
Trichoptera	Uenoidae	0	0	0	0	0	0
COMMUNITY DESCRIPTORS							
	Abundance	**3142.87**	**2400.01**	**2895**	**7275**	**649.99**	**1464.28**
	Richness	**20**	**20**	**17**	**12**	**16**	**13**
	% Dominance	**0.2**	**0.2**	**0.7**	**0.5**	**0.3**	**0.6**
	% Dominance (top 3)	**0.5**	**0.5**	**0.8**	**0.9**	**0.7**	**0.8**
	# Ephemeroptera	**5**	**5**	**5**	**3**	**2**	**2**
	# Plecoptera	**4**	**4**	**2**	**2**	**2**	**2**
	# Trichoptera	**2**	**4**	**1**	**0**	**2**	**1**
	EPT Richness	**11**	**13**	**8**	**5**	**6**	**5**
	% EPT	**71.8**	**48.6**	**25.9**	**40.7**	**70.3**	**23.4**
	% Chironomidae	**6.8**	**21.6**	**65.8**	**53.6**	**17.9**	**58.5**
	Bray-Curtis	**0.39**	**0.36**	**0.24**	**0.24**	**0.52**	**0.49**
	Diversity	**0.87**	**0.86**	**0.55**	**0.65**	**0.81**	**0.62**
	Evenness	**0.39**	**0.36**	**0.13**	**0.24**	**0.32**	**0.20**

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	2	4	4	4	4
	BASIN	Pitt River	Pitt River	Pitt River	Pitt River	Pitt River
	STREAM	Widgeon Creek	Widgeon Creek	Widgeon Creek	Widgeon Creek	Widgeon Creek
	SITECODE	WDG03198	WDG04198	WDG05198	WDG06198	WDG07198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample
Acarina	Anisitsiellidae	0	0	0	0	0
Acarina	Arrenuridae	0	0	0	0	100
Acarina	Aturidae	0	0	0	0	0
Acarina	Hydrodromidae	0	0	0	0	0
Acarina	Hydrozetiidae	0	0	0	0	0
Acarina	Hydryphantidae	0	0	0	0	0
Acarina	Hygrobatidae	0	0	0	0	0
Acarina	Lebertiidae	2	37.5	44.44	0	0
Acarina	Limnesiidae	21	150	200	240	66.67
Acarina	Oxidae	0	0	11.11	0	0
Acarina	Pionidae	0	0	0	0	0
Acarina	Sperchontidae	1	0	0	0	0
Acarina	Stygothrombidiidae	0	0	0	0	0
Acarina	Torrenticolidae	2	0	11.11	0	0
Acarina	Trhypachthoniidae	0	0	0	0	0
Acarina	Unionicolidae	0	75	0	0	0
Amphipoda	Crangonyctidae	0	0	0	0	0
Amphipoda	Gammaridae	0	0	0	0	0
Amphipoda	Hyalellidae	0	0	0	0	0
Bivalvia	Margaritiferidae	0	0	0	0	0
Bivalvia	Sphaeriidae	0	37.5	0	120	100
Coelentrata	Hydridae	0	75	0	0	0
Coleoptera	Dytiscidae	4	0	0	0	0
Coleoptera	Elmidae	0	0	0	0	0
Coleoptera	Haliplidae	0	0	0	0	0
Coleoptera	Hydrophilidae	0	0	0	0	0
Coleoptera	Staphylinidae	0	0	0	0	0
Collembola	Hypogasturidae	0	0	0	0	0
Collembola	Isotomidae	0	0	0	0	0
Collembola	Sminthuridae	0	0	0	0	0
Diptera	Athericidae	0	0	0	0	0
Diptera	Blephariceridae	0	0	0	0	0
Diptera	Ceratopogonidae	0	337.5	0	120	1166.67
Diptera	Chironomidae	28	1012.5	611.11	2580	2033.33
Diptera	Deuterophlebiidae	0	0	0	0	0
Diptera	Dixidae	0	0	0	0	0
Diptera	Empididae	0	0	0	0	0
Diptera	Muscidae	0	0	0	0	0
Diptera	Pelecorhnchidae	0	0	0	0	0
Diptera	Psychodidae	0	0	0	0	0
Diptera	Simuliidae	0	0	0	0	0
Diptera	Stratiomyidae	0	0	0	0	0
Diptera	Tabanidae	0	0	0	0	0
Diptera	Tanyderidae	0	0	0	0	0
Diptera	Thaumaleidae	0	0	0	0	0
Diptera	Tipulidae	7	0	0	0	0
Ephemeroptera	Ameletidae	2	0	0	0	0
Ephemeroptera	Ametropodidae	0	0	0	0	0
Ephemeroptera	Baetidae	4	0	11.11	0	0
Ephemeroptera	Baetiscidae	0	0	0	0	0
Ephemeroptera	Caenidae	0	150	0	0	33.33
Ephemeroptera	Ephemerellidae	0	0	222.22	0	466.67
Ephemeroptera	Ephemeridae	0	0	0	0	0
Ephemeroptera	Heptageniidae	0	0	0	0	0

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	2	4	4	4	4
	BASIN	Pitt River	Pitt River	Pitt River	Pitt River	Pitt River
	STREAM	Widgeon Creek	Widgeon Creek	Widgeon Creek	Widgeon Creek	Widgeon Creek
	SITECODE	WDG03198	WDG04198	WDG05198	WDG06198	WDG07198
Class/Order	**Family**	count/sample	count/sample	count/sample	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	0	0	0	0	0
Gastropoda	Lymnaeidae	0	0	0	0	0
Gastropoda	Physidae	0	0	0	0	0
Gastropoda	Planorbidae	0	0	0	60	33.33
Gastropoda	Valvatidae	0	0	0	0	0
Heteroptera	Gerridae	0	0	0	0	0
Hirudinea	Glossiphoniidae	0	37.5	0	0	0
Hirudinea	Piscicolidae	0	0	0	0	0
Isopoda	Asellidae	0	0	0	0	0
Lepidoptera	Pyralidae	0	0	0	0	0
Megaloptera	Sialidae	0	0	0	0	0
Oligochaeta	Enchytraeidae	2	0	0	0	0
Oligochaeta	Lumbriculidae	50	225	0	0	66.67
Oligochaeta	Naididae	0	2550	555.56	0	2866.67
Oligochaeta	Tubificidae	3	375	11.11	60	266.67
Platyhelminthes	Planariidae	1	0	66.67	0	0
Plecoptera	Capniidae	4	0	66.67	0	0
Plecoptera	Chloroperlidae	79	0	0	0	0
Plecoptera	Leuctridae	1	0	0	0	0
Plecoptera	Nemouridae	3	0	0	0	0
Plecoptera	Peltoperlidae	0	0	0	0	0
Plecoptera	Perlidae	0	0	0	0	0
Plecoptera	Perlodidae	0	0	0	0	0
Plecoptera	Pteronarcyidae	0	0	0	0	0
Plecoptera	Taeniopterygidae	0	0	0	0	0
Porifera	Spongillidae	0	0	0	0	0
Trichoptera	Apataniidae	0	0	0	0	0
Trichoptera	Brachycentridae	0	0	0	0	0
Trichoptera	Glossosomatidae	0	0	0	0	0
Trichoptera	Hydropsychidae	0	0	0	0	0
Trichoptera	Hydroptilidae	0	75	0	0	0
Trichoptera	Lepidostomatidae	0	0	0	0	0
Trichoptera	Leptoceridae	3	112.5	66.67	0	100
Trichoptera	Limnephilidae	0	0	0	0	0
Trichoptera	Philopotamidae	0	0	0	0	0
Trichoptera	Polycentropodidae	0	0	0	0	0
Trichoptera	Rhyacophilidae	1	0	0	0	0
Trichoptera	Uenoidae	0	0	0	0	0
COMMUNITY DESCRIPTORS						
	Abundance	**218**	**5250**	**1877.78**	**3180**	**7300.01**
	Richness	**19**	**14**	**12**	**6**	**12**
	% Dominance	**0.4**	**0.5**	**0.3**	**0.8**	**0.4**
	% Dominance (top 3)	**0.7**	**0.8**	**0.7**	**0.9**	**0.8**
	# Ephemeroptera	**2**	**1**	**2**	**0**	**2**
	# Plecoptera	**4**	**0**	**1**	**0**	**0**
	# Trichoptera	**2**	**2**	**1**	**0**	**1**
	EPT Richness	**8**	**3**	**4**	**0**	**3**
	% EPT	**44.5**	**6.4**	**19.5**	**0.0**	**8.2**
	% Chironomidae	**12.8**	**19.3**	**32.5**	**81.1**	**27.9**
	Bray-Curtis	**0.75**	**0.69**	**0.62**	**0.28**	**0.58**
	Diversity	**0.79**	**0.71**	**0.78**	**0.33**	**0.74**
	Evenness	**0.25**	**0.25**	**0.37**	**0.25**	**0.32**

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	4
	BASIN	Pitt River	Pitt River
	STREAM	Widgeon Creek	Widgeon Creek
	SITECODE	WDG08198	WDG09198
Class/Order	**Family**	count/sample	count/sample
Acarina	Anisitsiellidae	0	0
Acarina	Arrenuridae	0	9
Acarina	Aturidae	0	0
Acarina	Hydrodromidae	0	0
Acarina	Hydrozetiidae	0	0
Acarina	Hydryphantidae	0	0
Acarina	Hygrobatidae	0	0
Acarina	Lebertiidae	3	30
Acarina	Limnesiidae	0	162
Acarina	Oxidae	0	27
Acarina	Pionidae	0	0
Acarina	Sperchontidae	0	0
Acarina	Stygothrombidiidae	0	0
Acarina	Torrenticolidae	0	0
Acarina	Trhypachthoniidae	0	0
Acarina	Unionicolidae	0	0
Amphipoda	Crangonyctidae	0	0
Amphipoda	Gammaridae	0	0
Amphipoda	Hyalellidae	0	0
Bivalvia	Margaritiferidae	0	0
Bivalvia	Sphaeriidae	3	15
Coelentrata	Hydridae	0	0
Coleoptera	Dytiscidae	0	0
Coleoptera	Elmidae	0	0
Coleoptera	Haliplidae	0	0
Coleoptera	Hydrophilidae	0	0
Coleoptera	Staphylinidae	0	0
Collembola	Hypogasturidae	0	0
Collembola	Isotomidae	0	0
Collembola	Sminthuridae	0	0
Diptera	Athericidae	0	0
Diptera	Blephariceridae	0	0
Diptera	Ceratopogonidae	27	45
Diptera	Chironomidae	222	798
Diptera	Deuterophlebiidae	0	0
Diptera	Dixidae	0	0
Diptera	Empididae	0	0
Diptera	Muscidae	0	0
Diptera	Pelecorhnchidae	0	0
Diptera	Psychodidae	0	0
Diptera	Simuliidae	0	0
Diptera	Stratiomyidae	3	0
Diptera	Tabanidae	0	0
Diptera	Tanyderidae	0	0
Diptera	Thaumaleidae	0	0
Diptera	Tipulidae	42	21
Ephemeroptera	Ameletidae	0	0
Ephemeroptera	Ametropodidae	0	0
Ephemeroptera	Baetidae	0	0
Ephemeroptera	Baetiscidae	0	0
Ephemeroptera	Caenidae	6	0
Ephemeroptera	Ephemerellidae	48	0
Ephemeroptera	Ephemeridae	0	0
Ephemeroptera	Heptageniidae	3	6

Appendix B. Inverterbate family counts and community descriptors for 55 reference sites sampled in the Georgia Basin 1998-2002

ASSIGNED	REFERENCE GROUP	1	4
	BASIN	Pitt River	Pitt River
	STREAM	Widgeon Creek	Widgeon Creek
	SITECODE	WDG08198	WDG09198
Class/Order	**Family**	count/sample	count/sample
Ephemeroptera	Leptohyphidae	0	0
Ephemeroptera	Leptophlebiidae	0	0
Gastropoda	Lymnaeidae	0	0
Gastropoda	Physidae	0	0
Gastropoda	Planorbidae	0	6
Gastropoda	Valvatidae	0	0
Heteroptera	Gerridae	0	0
Hirudinea	Glossiphoniidae	0	0
Hirudinea	Piscicolidae	0	0
Isopoda	Asellidae	0	0
Lepidoptera	Pyralidae	0	0
Megaloptera	Sialidae	0	0
Oligochaeta	Enchytraeidae	3	12
Oligochaeta	Lumbriculidae	0	30
Oligochaeta	Naididae	144	357
Oligochaeta	Tubificidae	3	9
Platyhelminthes	Planariidae	0	0
Plecoptera	Capniidae	0	0
Plecoptera	Chloroperlidae	3	3
Plecoptera	Leuctridae	0	0
Plecoptera	Nemouridae	0	0
Plecoptera	Peltoperlidae	0	0
Plecoptera	Perlidae	0	0
Plecoptera	Perlodidae	3	0
Plecoptera	Pteronarcyidae	0	0
Plecoptera	Taeniopterygidae	0	0
Porifera	Spongillidae	0	0
Trichoptera	Apataniidae	0	0
Trichoptera	Brachycentridae	0	0
Trichoptera	Glossosomatidae	0	0
Trichoptera	Hydropsychidae	0	0
Trichoptera	Hydroptilidae	0	0
Trichoptera	Lepidostomatidae	0	0
Trichoptera	Leptoceridae	21	93
Trichoptera	Limnephilidae	0	0
Trichoptera	Philopotamidae	0	0
Trichoptera	Polycentropodidae	0	0
Trichoptera	Rhyacophilidae	0	0
Trichoptera	Uenoidae	0	0
COMMUNITY DESCRIPTORS			
	Abundance	**534**	**1623**
	Richness	**15**	**16**
	% Dominance	**0.4**	**0.5**
	% Dominance (top 3)	**0.8**	**0.8**
	# Ephemeroptera	**3**	**1**
	# Plecoptera	**2**	**1**
	# Trichoptera	**1**	**1**
	EPT Richness	**6**	**3**
	% EPT	**15.7**	**6.3**
	% Chironomidae	**41.6**	**49.2**
	Bray-Curtis	**0.76**	**0.49**
	Diversity	**0.74**	**0.69**
	Evenness	**0.25**	**0.20**

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APPENDIX C

TEST SITE ASSESSMENT SUMMARIES

Lower Fraser Valley (Chilliwack, Abbostford)

Lower Mainland (Langley, Surrey, Coquitlam, Burnaby)

Vancouver Island

Summary of CABIN results

A. Test Site Information

Stream Name: Hope Slough
Site code: ELK04
Sampling Date: September 15, 1998
Latitude: 49.1818 N
Longitude: -121.9525 W
Ecoregion: Lower Mainland
Altitude: 49 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.020	0.0003	0.023	**0.944**	0.012

C. Selected habitat variables at the test site and median and central 90% range of reference sites

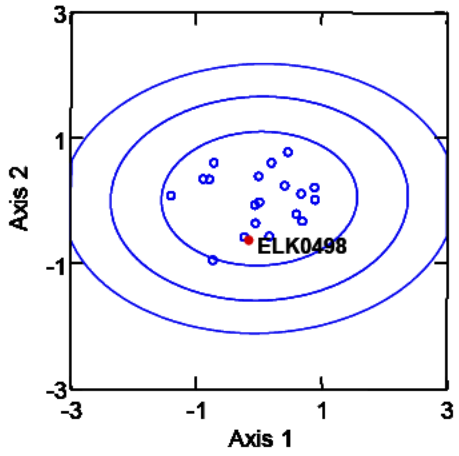
Variable	Test site ELK04	Reference Group 4 MEDIAN	RANGE
Altitude	49	292	20-4021
Stream order	2	3*	1-6
Slope ($x10^{-3}$)	1	1	0.1-29.9
Bankful width[1]	27.1	37.1	6.4-231.2
Wetted width[1]	18.8	22.1	3.7-83.0
Avg Depth[2]	57.1	30.0	12.6-87.4
Max Depth[2]	120	36	15-116.2
Avg Velocity[3]	0.16	0.14	0-0.59
Max Velocity[3]	0.33	0.25	0-0.68
Dominant substrate	5	5*	1-7
Surrounding material	4	2*	2-5
Embeddedness	4	5*	1-5
Alkalinity[4]	136.0	25.2	5.0-84.6
pH	7.40	7.06	5.50-8.24
Conductivity (µS/cm)	37.4	12.6	6.5-162.3
TKN[4]	0.212	0.120	0.037-0.387
Total Phosphorus[4]	0.033	0.011	0.004-0.038
Dissolved Oxygen[4]	7.94	10.21	6.84-12.11
TSS[4]	4.82	2.70	0.97-28.05
% Sand	1.5	72.9	0.1-99.0
% Gravel	98.4	5.7	0-62.8

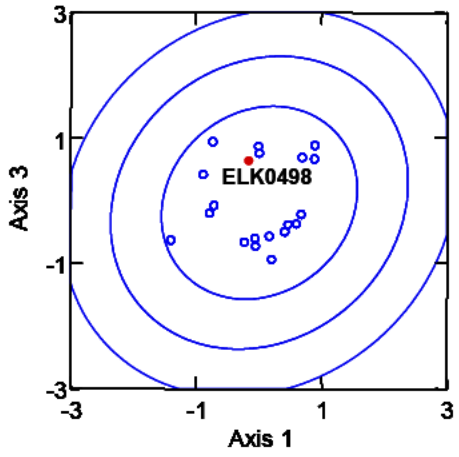
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

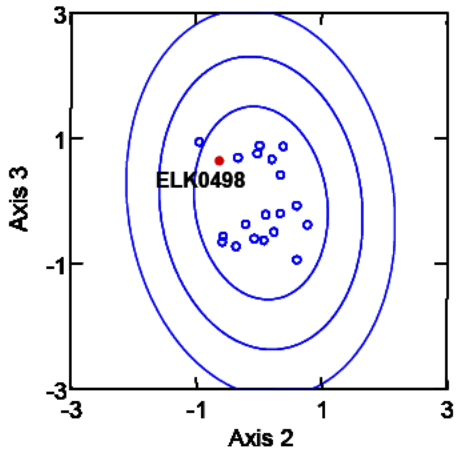
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	789	1
Naididae	267	0.76
Baetidae	22	0.65
Ephemerellidae	0	0.6
Tubificidae	333	0.5
Heptageniidae	0	0.5
Lebertiidae	33	0.47
Ceratopogonidae	11	0.46
Lumbriculidae	11	0.41
Leptoceridae	11	0.35
Sperchontidae	33	0.22
Caenidae	67	0.2
Ameletidae	11	0.17
Torrenticolidae	11	0.17
Planariidae	11	0.11
Apataniidae	11	0.1
Hydridae	11	0.1
Spongillidae	144	0.1
Crangonyctidae	378	0.05
Asellidae	122	0.05
Coenagrionidae	33	0
	Observed	**Expected**
p>0.70	2	1.8
p>0.50	4	4
O:E p>0.70		1.14
O:E p>0.50		1

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic Community Descriptors

	Test site **ELK04**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	2311	820-8290
Total Richness	19	6-19
EPT Richness	5	1-10
% EPT	5.8	0-43
% Dominance (top 3 taxa)	64.9	39-83
% Chironomidae	34.1	18-82
# Ephemeroptera taxa	3	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	2	0-5
Diversity	0.81	0.31-0.77
Evenness	0.28	0.11-0.32
Bray-Curtis	0.57	0.27-0.73

G. Discussion of Results

- ELK0498 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at ELK0498 was dominated by Chironomidae and worms but also had a large abundance of Crangonyctidae.
- This community had a very high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a moderate Bray-Curtis distance, indicating that it was 43% similar to the median reference community. Most metrics were well within the Central 80% range of the reference communities.
- This site falls within the 90% confidence ellipse, within the cloud of reference sites, indicating that it is similar to what was expected and, therefore, ***"not stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Hope Slough
Site code: ELK05
Sampling Date: September 15, 1998
Latitude: 49.1865 N
Longitude: -121.8918 W
Ecoregion: Lower Mainland
Altitude: 46 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)
Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.018	0.000	0.046	**0.892**	0.042

C. Selected habitat variables at the test site and median and central 90% range of reference sites

Variable	Test site ELK05	Reference Group 4 MEDIAN	RANGE
Altitude	46	292	20-4021
Stream order	2	3*	1-6
Slope ($x10^{-3}$)	1	1	0.1-29.9
Bankful width[1]	13.0	37.1	6.4-231.2
Wetted width[1]	8.3	22.1	3.7-83.0
Avg Depth[2]	42.6	30.0	12.6-87.4
Max Depth[2]	48	36	15-116.2
Avg Velocity[3]	0.16	0.14	0-0.59
Max Velocity[3]	0.24	0.25	0-0.68
Dominant substrate	5	5*	1-7
Surrounding material	3	2*	2-5
Embeddedness	4	5*	1-5
Alkalinity[4]	146.0	25.2	5.0-84.6
pH	7.47	7.06	5.50-8.24
Conductivity (µS/cm)	36.5	12.6	6.5-162.3
TKN[4]	0.116	0.120	0.037-0.387
Total Phosphorus[4]	0.019	0.011	0.004-0.038
Dissolved Oxygen[4]	8.90	10.21	6.84-12.11
TSS[4]	1.20	2.70	0.97-28.05
% Sand	30.0	72.9	0.1-99.0
% Gravel	66.7	5.7	0-62.8

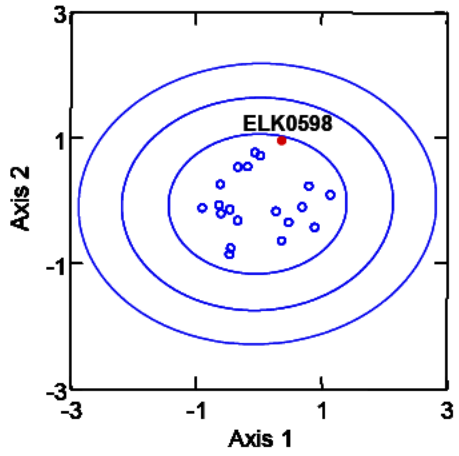
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

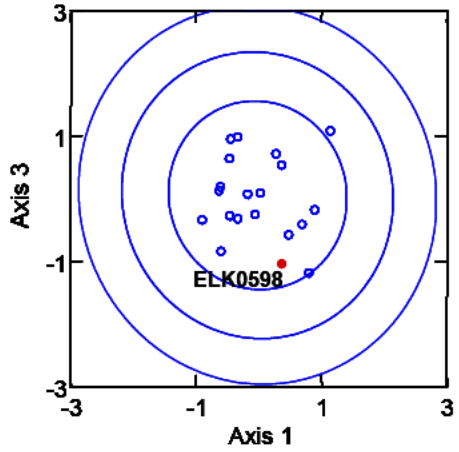
D. Invertebrate families predicted and occurring at test site

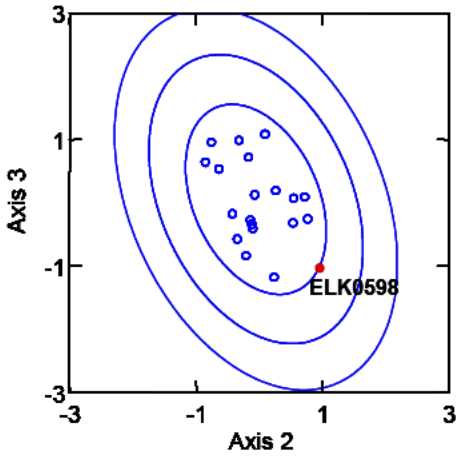
Family	Count	Probability
Chironomidae	3967	1
Naididae	831	0.74
Baetidae	1341	0.66
Ephemerellidae	0	0.61
Heptageniidae	0	0.53
Tubificidae	100	0.48
Lebertiidae	477	0.46
Limnesiidae	144	0.44
Sphaeriidae	1064	0.4
Tipulidae	11	0.39
Lumbriculidae	78	0.39
Leptoceridae	44	0.34
Hydropsychidae	1274	0.29
Lepidostomatidae	44	0.28
Enchytraeidae	11	0.27
Hydroptilidae	44	0.25
Planorbidae	953	0.24
Sperchontidae	366	0.22
Simuliidae	321	0.17
Torrenticolidae	78	0.17
Leptophlebiidae	33	0.14
Hydridae	188	0.1
Spongillidae	11	0.1
Elmidae	188	0.09
Crangonyctidae	2815	0.05
Asellidae	709	0.05
Leptohyphidae	22	0
Physidae	22	0
Hydrophilidae	11	0
Ancylidae	133	0
Coenagrionidae	11	0
Erpobdellidae	11	0

	Observed	Expected
p>0.70	2	1.7
p>0.50	3	3.5
O:E p>0.70		1.15
O:E p>0.50		0.85

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **ELK05**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	15304	820-8290
Total Richness	30	6-19
EPT Richness	7	1-10
% EPT	18.3	0-43
% Dominance (top 3 taxa)	53.1	39-83
% Chironomidae	25.9	18-82
# Ephemeroptera taxa	3	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	4	0-5
Diversity	0.87	0.31-0.77
Evenness	0.25	0.11-0.32
Bray-Curtis	0.78	0.27-0.73

G. Discussion of Results

- ELK0598 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at ELK0598 was very taxa rich, however many of the taxa that were found had low probabilities of occurring. These lesser expected taxa also comprised the largest proportion of the community.
- This community had a very high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a high Bray-Curtis distance, indicating that it was only 22% similar to the median reference community.
- ELK0598 exceeded the 90th percentile of the reference group for abundance, richness, diversity and Bray-Curtis.
- Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls just outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, ***"possibly stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Elk Creek
Site code: ELK06
Sampling Date: September 27, 2000
Latitude: 49.1769 N
Longitude: -121.8519 W
Ecoregion: Lower Mainland
Altitude: 46 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.391	0.0081	0.297	0.206	0.098

C. Selected habitat variables at the test site and median and central 90% range of reference sites

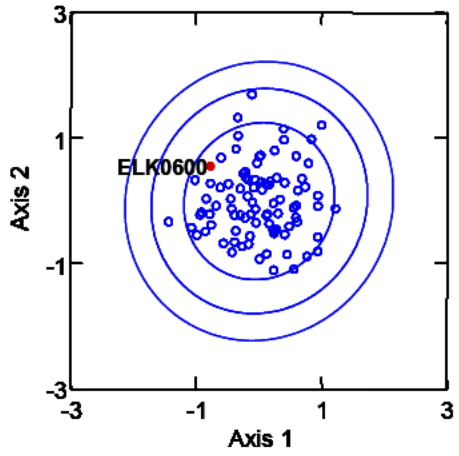
Variable	Test site ELK06	Reference Group 1 MEDIAN	RANGE
Altitude	46	1830	91-5115
Stream order	2	2*	1-4
Slope ($x10^{-3}$)	2	16	0.6-72.9
Bankful width[1]	6.7	30.3	4.2-149.4
Wetted width[1]	4.5	14.0	1.4-59.2
Avg Depth[2]	31.3	29.4	7.9-60.5
Max Depth[2]	41	42	10.0-83.5
Avg Velocity[3]	0.12	0.42	0.16-0.83
Max Velocity[3]	0.28	0.72	0.27-1.17
Dominant substrate	7	7*	5-8
Surrounding material	2	2*	2-6
Embeddedness	2	3*	1-5
Alkalinity[4]	117.0	26.4	4.2-88.5
pH	7.63	7.55	6.31-8.33
Conductivity (µS/cm)	198.0	53.3	8.0-211.5
TKN[4]	0.107	0.042	0.007-0.155
Total Phosphorus[4]	0.038	0.007	0.002-0.039
Dissolved Oxygen[4]	13.40	11.38	9.18-13.91
TSS[4]	4.04	2.98	0.23-36.71
% Sand	97.4	71.0	3.1-97.9
% Gravel	0	26.5	0.6-96.9

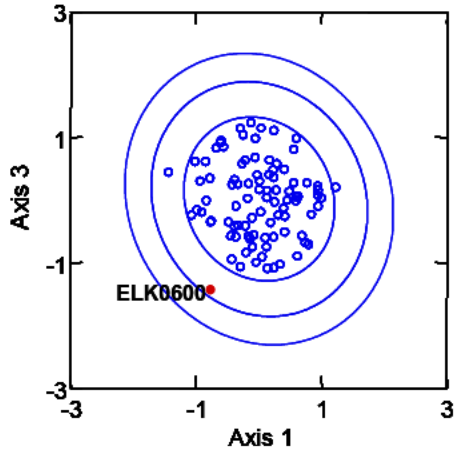
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

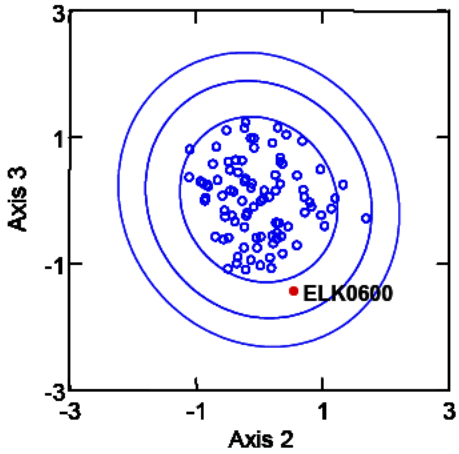
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	150	0.99
Heptageniidae	0	0.87
Baetidae	330	0.86
Ephemerellidae	0	0.83
Chloroperlidae	0	0.75
Nemouridae	10	0.67
Capniidae	10	0.59
Tipulidae	20	0.54
Perlodidae	0	0.54
Rhyacophilidae	10	0.49
Lebertiidae	100	0.4
Naididae	180	0.38
Enchytraeidae	10	0.32
Lumbriculidae	250	0.22
Sphaeriidae	130	0.2
Tubificidae	340	0.18
Planorbidae	50	0.09
Hygrobatidae	70	0.04
Hydridae	10	0.04
Crangonyctidae	160	0.02
Oxidae	10	0.02
Dytiscidae	10	0.02
Asellidae	90	0.01
Physidae	10	0
Haliplidae	10	0
Lymnaeidae	110	0
Ancylidae	10	0
	Observed	**Expected**
p>0.70	2	4.3
p>0.50	5	6.7
O:E p>0.70		0.47
O:E p>0.50		0.75

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Possibly stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **ELK06**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	2080	170-1777
Total Richness	23	9-26
EPT Richness	4	7-15
% EPT	16.8	47-97
% Dominance (top 3 taxa)	44.2	21-66
% Chironomidae	7.2	2-32
# Ephemeroptera taxa	1	2-5
# Plecoptera taxa	2	2-6
# Trichoptera taxa	1	0-6
Diversity	0.90	0.53-0.88
Evenness	0.44	0.17-0.43
Bray-Curtis	0.87	0.36-0.75

G. Discussion of Results

- ELK0600 is predicted to be similar to Group 1 reference sites. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at ELK0600 was dominated by worms and many lesser expected taxa. It was missing many of the expected mayfly and stonefly taxa.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- While the total taxa richness is high, the highly expected taxa were missing.
- This community had a very high Bray-Curtis distance, indicating that it was only 13% similar to the median reference community.
- ELK0600 fell below the 10th percentile of the reference groups for all EPT metrics and above the 90th percentile for abundance, diversity and Bray-Curtis.
- Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore ***"possibly stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Elk Creek
Site code: ELK06
Sampling Date: September 15, 1998
Latitude: 49.1810 N
Longitude: -121.8572 W
Ecoregion: Lower Mainland
Altitude: 49 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.006	0.002	0.007	**0.934**	0.051

C. Selected habitat variables at the test site and median and central 90% range of reference sites

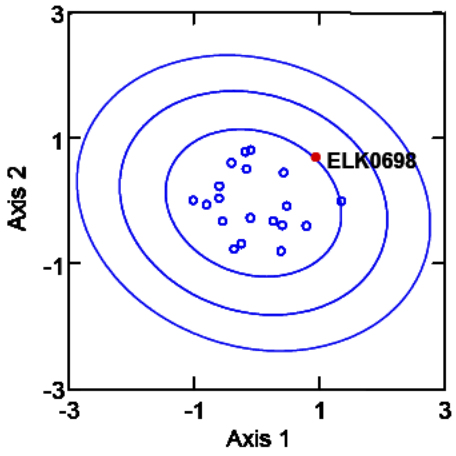
Variable	Test site ELK06	Reference Group 4 MEDIAN	RANGE
Altitude	49	292	20-4021
Stream order	2	3*	1-6
Slope ($x10^{-3}$)	6	1	0.1-29.9
Bankful width[1]	11.0	37.1	6.4-231.2
Wetted width[1]	9.4	22.1	3.7-83.0
Avg Depth[2]	25.3	30.0	12.6-87.4
Max Depth[2]	38	36	15-116.2
Avg Velocity[3]	0.24	0.14	0-0.59
Max Velocity[3]	0.36	0.25	0-0.68
Dominant substrate	1	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	1	5*	1-5
Alkalinity[4]	147.0	25.2	5.0-84.6
pH	7.40	7.06	5.50-8.24
Conductivity (µS/cm)	40.3	12.6	6.5-162.3
TKN[4]	0.163	0.120	0.037-0.387
Total Phosphorus[4]	0.021	0.011	0.004-0.038
Dissolved Oxygen[4]	9.05	10.21	6.84-12.11
TSS[4]	2.35	2.70	0.97-28.05
% Sand	86.1	72.9	0.1-99.0
% Gravel	0	5.7	0-62.8

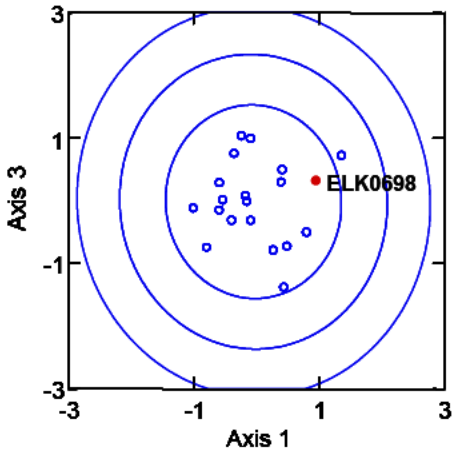
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

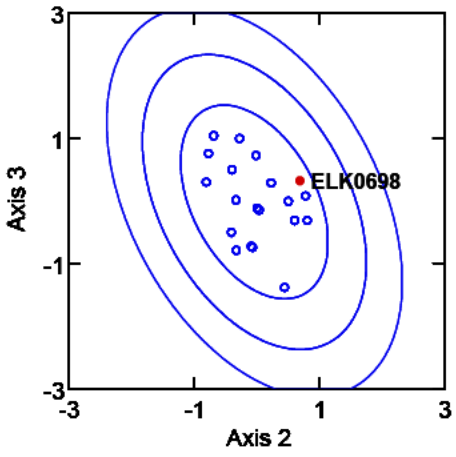
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	967	1
Naididae	200	0.76
Baetidae	267	0.65
Ephemerellidae	0	0.6
Heptageniidae	0	0.5
Tubificidae	2733	0.5
Lebertiidae	367	0.47
Limnesiidae	33	0.45
Sphaeriidae	233	0.41
Lumbriculidae	400	0.4
Leptoceridae	233	0.35
Hydropsychidae	33	0.28
Hydroptilidae	33	0.26
Simuliidae	100	0.17
Crangonyctidae	167	0.05
Asellidae	500	0.05
Haliplidae	33	0
Hydrobiidae	33	0
	Observed	**Expected**
p>0.70	2	1.8
p>0.50	4	4
O:E p>0.70		1.14
O:E p>0.50		1

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Not stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **ELK06**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	6333	820-8290
Total Richness	16	6-19
EPT Richness	4	1-10
% EPT	8.9	0-43
% Dominance (top 3 taxa)	66.3	39-83
% Chironomidae	15.3	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	3	0-5
Diversity	0.77	0.31-0.77
Evenness	0.27	0.11-0.32
Bray-Curtis	0.74	0.27-0.73

G. Discussion of Results

- ELK0698 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at ELK0698 was dominated by worms and Chironomidae but was missing two of the highly expected mayfly taxa.
- This community had a relatively high total richness. As a result, this site had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a high Bray-Curtis distance, indicating that it was only 26% similar to the median reference community.
- ELK0698 exceeded the 90th percentile of the reference communities for diversity and Bray-Curtis. It was very close to the 10th percentile for the EPT metrics.
- Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls just outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore ***"possibly stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Elk Creek - Big Ditch
Site code: ELK07
Sampling Date: September 15, 1998
Latitude: 49.1732 N
Longitude: -121.8520 W
Ecoregion: Lower Mainland
Altitude: 43 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.000	0.000	0.000	**0.999**	0.000

C. Selected habitat variables at the test site and median and central 90% range of reference sites

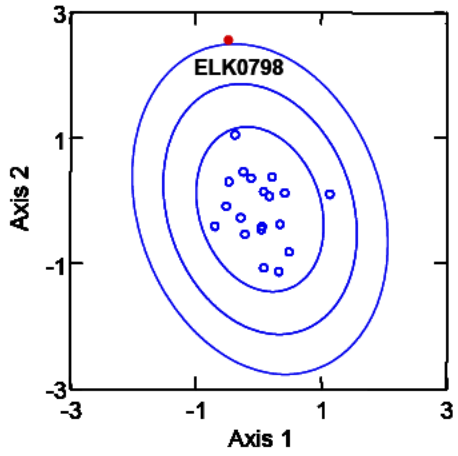
	Test site	Reference Group 4	
Variable	**ELK07**	**MEDIAN**	**RANGE**
Altitude	43	292	20-4021
Stream order	2	3*	1-6
Slope ($x10^{-3}$)	2	1	0.1-29.9
Bankful width[1]	8.0	37.1	6.4-231.2
Wetted width[1]	6.8	22.1	3.7-83.0
Avg Depth[2]	70.4	30.0	12.6-87.4
Max Depth[2]	78	36	15-116.2
Avg Velocity[3]	0.07	0.14	0-0.59
Max Velocity[3]	0.09	0.25	0-0.68
Dominant substrate	1	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	1	5*	1-5
Alkalinity[4]	141.0	25.2	5.0-84.6
pH	7.47	7.06	5.50-8.24
Conductivity (µS/cm)	40.6	12.6	6.5-162.3
TKN[4]	0.121	0.120	0.037-0.387
Total Phosphorus[4]	0.006	0.011	0.004-0.038
Dissolved Oxygen[4]	10.61	10.21	6.84-12.11
TSS[4]	1.93	2.70	0.97-28.05
% Sand	18.0	72.9	0.1-99.0
% Gravel	0	5.7	0-62.8

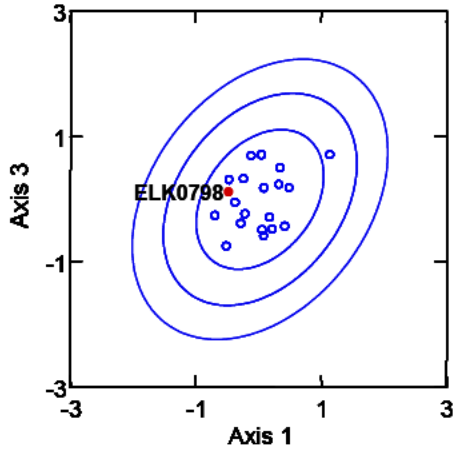
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

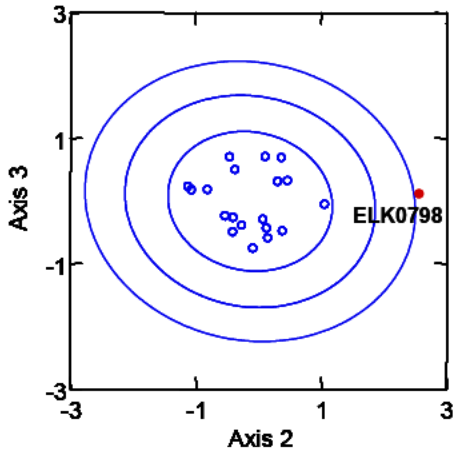
D. Invertebrate families predicted and occurring at test site

Family	**Count**	**Probability**
Chironomidae	75900	1
Naididae	1800	0.79
Baetidae	0	0.63
Ephemerellidae	0	0.58
Tubificidae	3000	0.53
Lebertiidae	600	0.47
Ceratopogonidae	600	0.47
Lumbriculidae	300	0.42
Hydropsychidae	300	0.26
Hydridae	1200	0.11
Glossiphoniidae	300	0.11
Crangonyctidae	3900	0.05
Asellidae	8400	0.05
Haliplidae	300	0
Physidae	900	0
	Observed	**Expected**
p>0.70	2	1.8
p>0.50	3	3.5
O:E p>0.70		1.12
O:E p>0.50		0.85

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Severely stressed	Not stressed	Severely stressed	**Severely stressed**

F. Benthic Community Descriptors

	Test site **ELK07**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	97500	820-8290
Total Richness	13	6-19
EPT Richness	1	1-10
% EPT	0.3	0-43
% Dominance (top 3 taxa)	90.5	39-83
% Chironomidae	77.8	18-82
# Ephemeroptera taxa	0	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	1	0-5
Diversity	0.38	0.31-0.77
Evenness	0.12	0.11-0.32
Bray-Curtis	0.96	0.27-0.73

G. Discussion of Results

- ELK0798 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at ELK0798 was extremely abundant with Chironomidae, Asellidae and Crangonyctidae. The mayflies with high probability of occurrence were missing. This suggests possible enrichment however, neither high phosphorus nor TKN were measured in the single samples taken. The dominance of these pollution tolerant organisms and the absence of the pollution sensitive mayflies may also suggest organic pollution from agricultural activities.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- While the O:E ratio was high, the relative abundance of the taxa was not similar to the reference communities.
- This community had a very high Bray-Curtis distance, indicating that it was only 4% similar to the median reference community.
- ELK0798 falls at the 5^{th} or 95^{th} percentile for many the metrics, and exceeds the range for %EPT, %dominance and Bray-Curtis.
- Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 99.9% confidence ellipse, very far from the cloud of reference sites, indicating that it is very different than what was expected and therefore ***"severely stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Elk Creek
Site code: ELK08
Sampling Date: September 15, 1998
Latitude: 49.1642 N
Longitude: -121.8530 W
Ecoregion: Lower Mainland
Altitude: 39 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.002	0.000	0.001	**0.995**	0.002

C. Selected habitat variables at the test site and median and central 90% range of reference sites

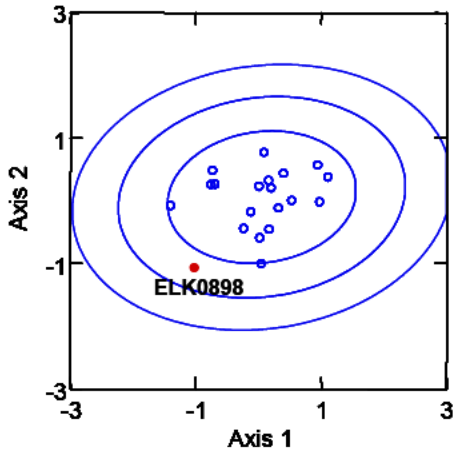
	Test site	Reference Group 4	
Variable	**ELK08**	**MEDIAN**	**RANGE**
Altitude	39	292	20-4021
Stream order	2	3*	1-6
Slope ($x10^{-3}$)	3	1	0.1-29.9
Bankful width[1]	4.8	37.1	6.4-231.2
Wetted width[1]	3.4	22.1	3.7-83.0
Avg Depth[2]	57.4	30.0	12.6-87.4
Max Depth[2]	75	36	15-116.2
Avg Velocity[3]	0	0.14	0-0.59
Max Velocity[3]	0	0.25	0-0.68
Dominant substrate	2	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	1	5*	1-5
Alkalinity[4]	106.0	25.2	5.0-84.6
pH	8.12	7.06	5.50-8.24
Conductivity (µS/cm)	31.1	12.6	6.5-162.3
TKN[4]	0.087	0.120	0.037-0.387
Total Phosphorus[4]	0.011	0.011	0.004-0.038
Dissolved Oxygen[4]	11.31	10.21	6.84-12.11
TSS[4]	6.76	2.70	0.97-28.05
% Sand	26.8	72.9	0.1-99.0
% Gravel	0	5.7	0-62.8

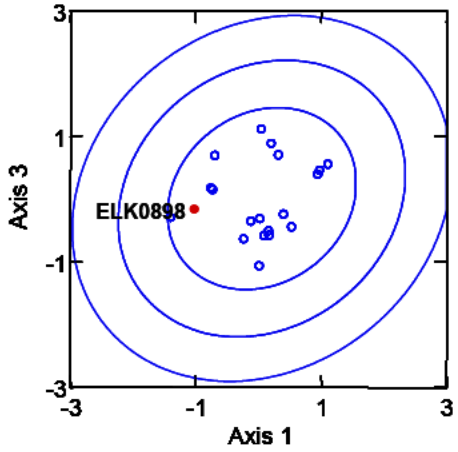
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

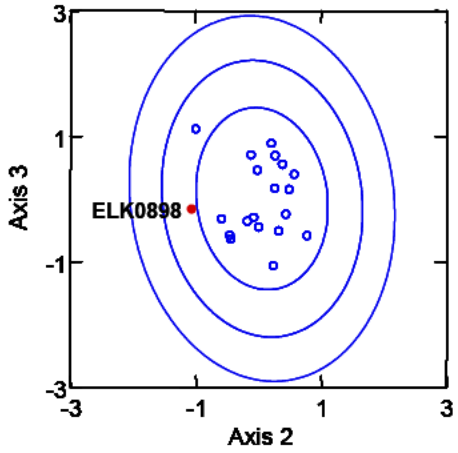
D. Invertebrate families predicted and occurring at test site

Family	**Count**	**Probability**
Chironomidae	9600	1
Naididae	600	0.79
Baetidae	0	0.63
Ephemerellidae	0	0.58
Tubificidae	1700	0.52
Lebertiidae	100	0.47
Ceratopogonidae	100	0.47
Sphaeriidae	100	0.42
Lumbriculidae	800	0.42
Empididae	100	0.26
Hydropsychidae	100	0.26
Hydroptilidae	300	0.26
Planorbidae	800	0.26
Torrenticolidae	100	0.16
Psychodidae	100	0.11
Planariidae	100	0.11
Hydridae	600	0.1
Crangonyctidae	2900	0.05
Haliplidae	100	0
Physidae	100	0
	Observed	**Expected**
p>0.70	2	1.8
p>0.50	3	3.5
O:E p>0.70		1.12
O:E p>0.50		0.85

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **ELK08**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	18300	820-8290
Total Richness	18	6-19
EPT Richness	2	1-10
% EPT	2.7	0-43
% Dominance (top 3 taxa)	77.6	39-83
% Chironomidae	52.5	18-82
# Ephemeroptera taxa	0	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	2	0-5
Diversity	0.68	0.31-0.77
Evenness	0.18	0.11-0.32
Bray-Curtis	0.81	0.27-0.73

G. Discussion of Results

- ELK0898 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at ELK0898 was dominated by Chironomidae, Crangonyctidae, and worms, and was missing the highly expected mayfly taxa.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a very high Bray-Curtis distance, indicating that it was only 19% similar to the median reference community.
- ELK0898 exceeded the 90th percentile for abundance and total richness while falling below and close to the 10th percentile for the EPT metrics.
- Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore ***"possibly stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Dunville Creek
Site code: ELK09
Sampling Date: September 16, 1998
Latitude: 49.1693 N
Longitude: -121.7977 W
Ecoregion: Lower Mainland
Altitude: 66 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.071	0.006	0.204	0.160	**0.559**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

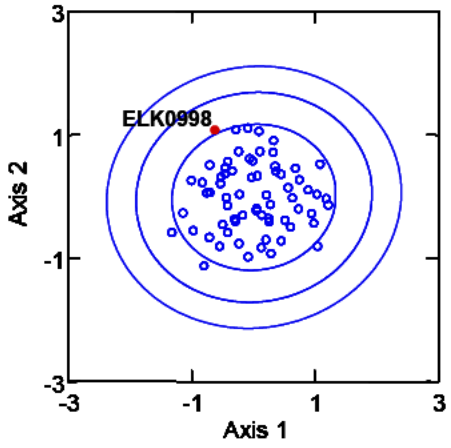
Variable	Test site ELK09	Reference Group 5 MEDIAN	RANGE
Altitude	66	3325	84-5293
Stream order	1	2*	1-6
Slope ($x10^{-3}$)	2	7	0.5-38.4
Bankful width[1]	3.2	16.0	2.7-73.0
Wetted width[1]	1.6	6.6	1.2-46.5
Avg Depth[2]	8.2	18.5	60-43.1
Max Depth[2]	10	26	6.0-38.0
Avg Velocity[3]	0.32	0.35	0.13-0.66
Max Velocity[3]	0.43	0.53	0.18-0.86
Dominant substrate	4	6*	1-8
Surrounding material	2	2*	1-5
Embeddedness	3	5*	1-5
Alkalinity[4]	127.0	55.0	8.9-111.0
pH	8.02	7.72	6.64-8.54
Conductivity (µS/cm)	35.7	109.5	12.0-237.4
TKN[4]	0.079	0.177	0.029-0.532
Total Phosphorus[4]	0.008	0.011	0.003-0.112
Dissolved Oxygen[4]	11.33	11.24	9.56-13.95
TSS[4]	4.31	4.09	1.07-13.41
% Sand	32.3	65.4	0-90.0
% Gravel	67.7	28.7	0-94.5

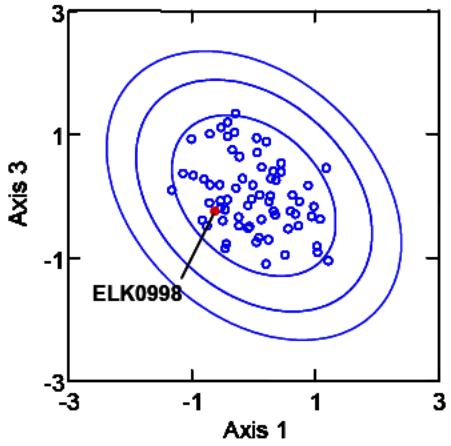
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

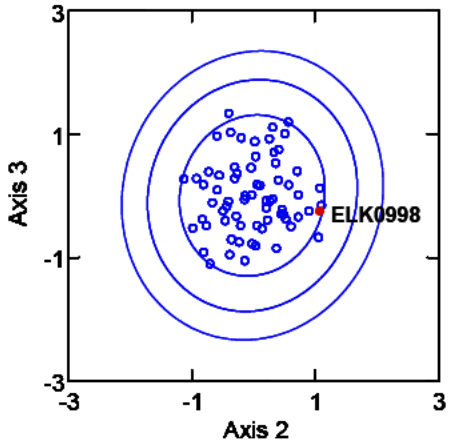
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	1560	0.99
Baetidae	1520	0.87
Heptageniidae	380	0.86
Ephemerellidae	100	0.82
Nemouridae	20	0.7
Chloroperlidae	0	0.69
Capniidae	80	0.63
Perlodidae	0	0.52
Tipulidae	40	0.5
Empididae	80	0.49
Leptophlebiidae	160	0.47
Hydropsychidae	20	0.44
Lebertiidae	20	0.39
Rhyacophilidae	20	0.36
Sphaeriidae	20	0.3
Torrenticolidae	20	0.29
Enchytraeidae	40	0.28
Simuliidae	280	0.27
Lumbriculidae	260	0.14
Planariidae	60	0.06
Apataniidae	40	0.05
Hydryphantidae	20	0.05
Hypogasturidae	40	0.01
Haliplidae	60	0.01
	Observed	**Expected**
p>0.70	4	3.5
p>0.50	6	6.1
O:E p>0.70		1.13
O:E p>0.50		0.98

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Not stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **ELK09**	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	4840	5414-32293
Total Richness	22	9-23
EPT Richness	9	5-13
% EPT	49.2	13-88
% Dominance (top 3 taxa)	71.5	24-73
% Chironomidae	32.2	4-73
# Ephemeroptera taxa	4	1-5
# Plecoptera taxa	2	1-6
# Trichoptera taxa	3	0-5
Diversity	0.78	0.46-0.87
Evenness	0.21	0.15-0.43
Bray-Curtis	0.43	0.24-0.71

G. Discussion of Results

- ELK0998 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abundances.
- The observed community at ELK0998 was equally dominated by Chironomidae and Baetidae followed by Simuliidae and worms. Two highly expected stoneflies were missing.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a moderately low Bray-Curtis distance, indicating that it was 57% similar to the median reference community.
- This site falls just outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Clayburn Creek
Site code: CLB03
Sampling Date: September 16, 1998
Latitude: 49.0794 N
Longitude: -122.2450 W
Ecoregion: Lower Mainland
Altitude: 133 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.433	0.008	0.368	0.004	0.187

C. Selected habitat variables at the test site and median and central 90% range of reference sites

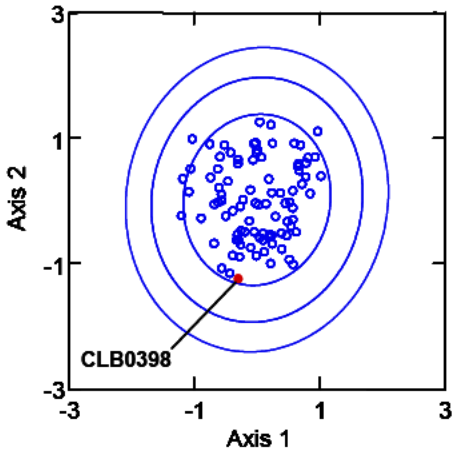
Variable	Test site CLB03	Reference Group 1 MEDIAN	RANGE
Altitude	133	1830	91-5115
Stream order	2	2*	1-4
Slope ($x10^{-3}$)	29	16	0.6-72.9
Bankful width[1]	9.4	30.3	4.2-149.4
Wetted width[1]	3.6	14.0	1.4-59.2
Avg Depth[2]	11.0	29.4	7.9-60.5
Max Depth[2]	18	42	10.0-83.5
Avg Velocity[3]	0.24	0.42	0.16-0.83
Max Velocity[3]	0.43	0.72	0.27-1.17
Dominant substrate	6	7*	5-8
Surrounding material	3	2*	2-6
Embeddedness	4	3*	1-5
Alkalinity[4]	72.0	26.4	4.2-88.5
pH	7.76	7.55	6.31-8.33
Conductivity (µS/cm)	16.8	053.3	8.0-211.5
TKN[4]	0.150	0.042	0.007-0.155
Total Phosphorus[4]	0.025	0.007	0.002-0.039
Dissolved Oxygen[4]	10.50	11.38	9.18-13.91
TSS[4]	1.43	2.98	0.23-36.71
% Sand	67.8	71.0	3.1-97.9
% Gravel	30.2	26.5	0.6-96.9

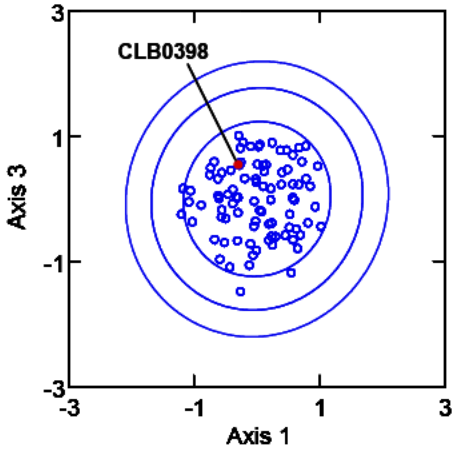
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

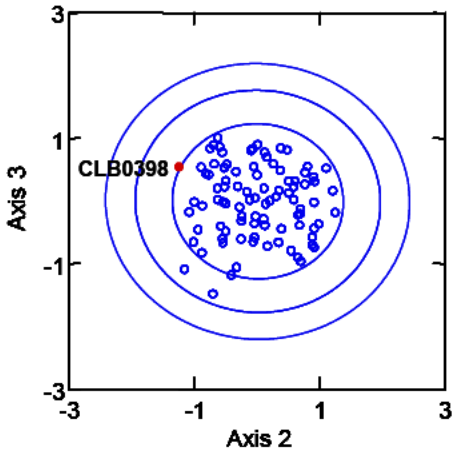
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	257	0.99
Heptageniidae	371	0.97
Baetidae	500	0.92
Ephemerellidae	14	0.89
Chloroperlidae	86	0.83
Nemouridae	143	0.79
Perlodidae	129	0.66
Capniidae	0	0.63
Tipulidae	86	0.58
Rhyacophilidae	43	0.56
Taeniopterygidae	0	0.54
Empididae	14	0.53
Hydropsychidae	400	0.49
Leptophlebiidae	186	0.39
Lebertiidae	14	0.37
Lepidostomatidae	14	0.37
Simuliidae	100	0.32
Elmidae	286	0.31
Glossosomatidae	14	0.29
Torrenticolidae	186	0.28
Lumbriculidae	29	0.16
Psychodidae	71	0.12
Limnesiidae	29	0.12
Hydryphantidae	14	0.1
Dixidae	57	0.05
	Observed	**Expected**
p>0.70	6	5.4
p>0.50	10	8.9
O:E p>0.70		1.11
O:E p>0.50		1.12

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **CLB03**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	3043	170-1777
Total Richness	23	9-26
EPT Richness	11	7-15
% EPT	61.0	47-97
% Dominance (top 3 taxa)	41.8	21-66
% Chironomidae	8.5	2-32
# Ephemeroptera taxa	4	2-5
# Plecoptera taxa	3	2-6
# Trichoptera taxa	4	0-6
Diversity	0.91	0.53-0.88
Evenness	0.48	0.17-0.43
Bray-Curtis	0.51	0.36-0.75

G. Discussion of Results

- CLB0398 is predicted to be similar to Group 1 reference sites. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at CLB0398 had slightly higher abundances of taxa than the range of reference communities and several taxa occurred in similar abundances. Chironomidae was the dominant taxon followed by Hydropsychidae.
- This community had a very high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a moderate Bray-Curtis distance, indicating that it was 49% similar to the median reference community.
- This site falls just outside of the 90% confidence ellipse, departing slightly from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Clayburn Creek
Site code: CLB03
Sampling Date: September 14, 1999
Latitude: 49.0794 N
Longitude: -122.2450 W
Ecoregion: Lower Mainland
Altitude: 131 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)
Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.439	0.006	0.374	0.005	0.176

C. Selected habitat variables at the test site and median and central 90% range of reference sites

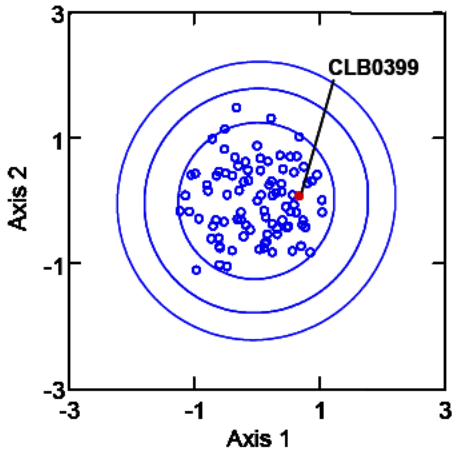
	Test site	Reference Group 1	
Variable	**CLB03**	**MEDIAN**	**RANGE**
Altitude	131	1830	91-5115
Stream order	2	2*	1-4
Slope ($x10^{-3}$)	20	16	0.6-72.9
Bankful width[1]	8.1	30.3	4.2-149.4
Wetted width[1]	3.2	14.0	1.4-59.2
Avg Depth[2]	16.0	29.4	7.9-60.5
Max Depth[2]	20	42	10.0-83.5
Avg Velocity[3]	0.21	0.42	0.16-0.83
Max Velocity[3]	0.37	0.72	0.27-1.17
Dominant substrate	7	7*	5-8
Surrounding material	3	2*	2-6
Embeddedness	4	3*	1-5
Alkalinity[4]	57.8	26.4	4.2-88.5
pH	7.87	7.55	6.31-8.33
Conductivity (µS/cm)	51.0	053.3	8.0-211.5
TKN[4]	0.563	0.042	0.007-0.155
Total Phosphorus[4]	0.023	0.007	0.002-0.039
Dissolved Oxygen[4]	10.24	11.38	9.18-13.91
TSS[4]	1.06	2.98	0.23-36.71
% Sand	46.2	71.0	3.1-97.9
% Gravel	53.3	26.5	0.6-96.9

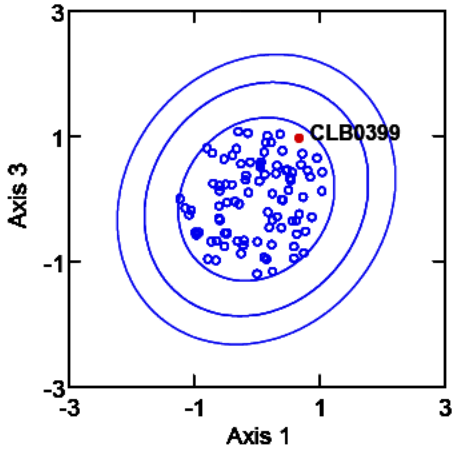
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

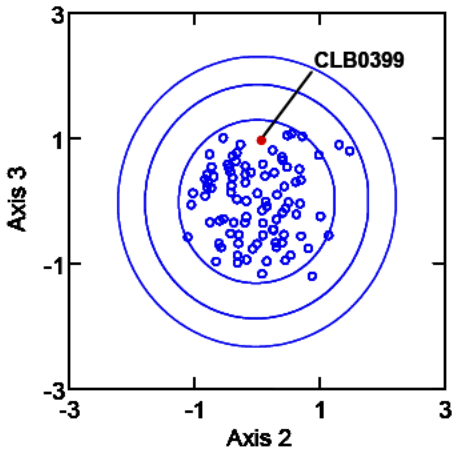
D. Invertebrate families predicted and occurring at test site

Family	**Count**	**Probability**
Chironomidae	700	0.99
Heptageniidae	300	0.97
Baetidae	230	0.92
Ephemerellidae	50	0.89
Chloroperlidae	10	0.83
Nemouridae	130	0.79
Perlodidae	40	0.66
Capniidae	30	0.63
Tipulidae	20	0.58
Rhyacophilidae	10	0.56
Taeniopterygidae	10	0.54
Empididae	10	0.53
Hydropsychidae	160	0.49
Leptophlebiidae	50	0.38
Sperchontidae	10	0.36
Simuliidae	10	0.32
Elmidae	190	0.3
Glossosomatidae	30	0.29
Naididae	20	0.29
Torrenticolidae	20	0.28
Ceratopogonidae	20	0.21
Sphaeriidae	20	0.16
Psychodidae	10	0.12
Tubificidae	10	0.1
Dixidae	50	0.05
Athericidae	10	0.03
Stratiomyidae	10	0.01
Hydraenidae	10	0
	Observed	**Expected**
p>0.70	6	5.4
p>0.50	12	8.9
O:E p>0.70		1.11
O:E p>0.50		1.35

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic Community Descriptors

	Test site **CLB03**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	2170	170-1777
Total Richness	28	9-26
EPT Richness	12	7-15
% EPT	47.9	47-97
% Dominance (top 3 taxa)	56.7	21-66
% Chironomidae	32.3	2-32
# Ephemeroptera taxa	4	2-5
# Plecoptera taxa	5	2-6
# Trichoptera taxa	3	0-6
Diversity	0.85	0.53-0.88
Evenness	0.23	0.17-0.43
Bray-Curtis	0.37	0.36-0.75

G. Discussion of Results

- CLB0399 is predicted to be similar to Group 1 reference sites. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at CLB0399 was dominated by Chironomidae followed by Heptageniidae and Baetidae.
- This community had a very high O:E taxa ratio, >1. All of the taxa that had a probability of occurring were found there.
- This community had a low Bray-Curtis distance, indicating that it was 63% similar to the median reference community.
- This site falls within the 90% confidence ellipse, within the cloud of reference sites, indicating that it is similar to what was expected and therefore "***not stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Clayburn Creek
Site code: CLB03
Sampling Date: September 27, 2000
Latitude: 49.0789 N
Longitude: -122.2456 W
Ecoregion: Lower Mainland
Altitude: 105 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.551	0.039	0.236	0.004	0.171

C. Selected habitat variables at the test site and median and central 90% range of reference sites

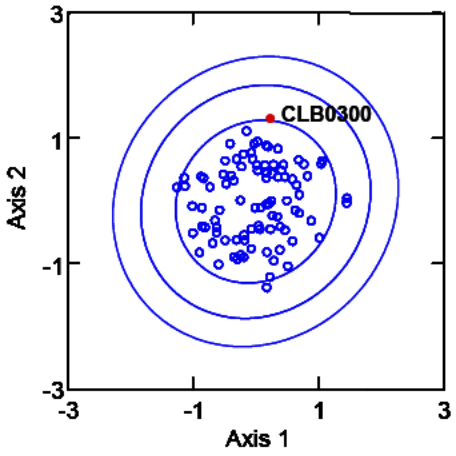
Variable	Test site CLB03	Reference Group 1 MEDIAN	RANGE
Altitude	105	1830	91-5115
Stream order	2	2*	1-4
Slope ($x10^{-3}$)	24	16	0.6-72.9
Bankful width[1]	10.4	30.3	4.2-149.4
Wetted width[1]	4.9	14.0	1.4-59.2
Avg Depth[2]	10	29.4	7.9-60.5
Max Depth[2]	14	42	10.0-83.5
Avg Velocity[3]	0.32	0.42	0.16-0.83
Max Velocity[3]	0.64	0.72	0.27-1.17
Dominant substrate	6	7*	5-8
Surrounding material	3	2*	2-6
Embeddedness	3	3*	1-5
Alkalinity[4]	61.2	26.4	4.2-88.5
pH	7.02	7.55	6.31-8.33
Conductivity (µS/cm)	106.0	53.3	8.0-211.5
TKN[4]	0.084	0.042	0.007-0.155
Total Phosphorus[4]	0.027	0.007	0.002-0.039
Dissolved Oxygen[4]	12.53	11.38	9.18-13.91
TSS[4]	0.66	2.98	0.23-36.71
% Sand	26.0	71.0	3.1-97.9
% Gravel	73.5	26.5	0.6-96.9

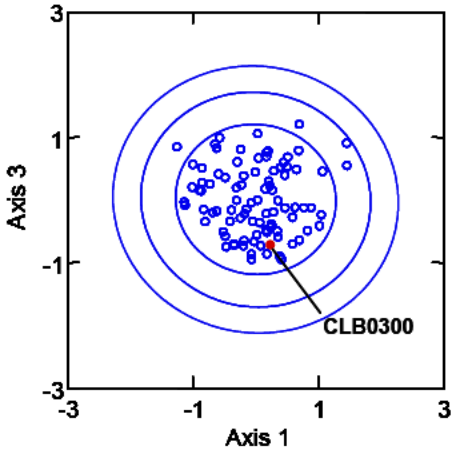
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

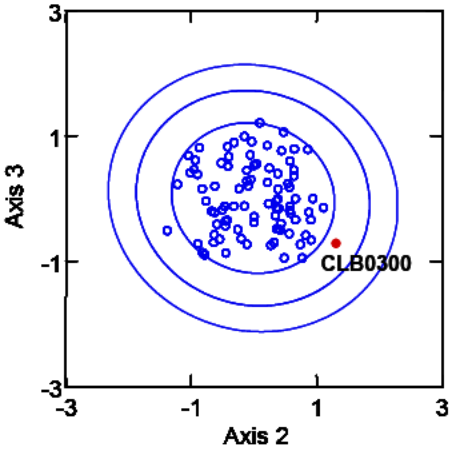
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	567	0.99
Heptageniidae	667	0.96
Baetidae	1433	0.92
Ephemerellidae	67	0.88
Chloroperlidae	117	0.84
Nemouridae	33	0.79
Perlodidae	0	0.66
Capniidae	67	0.64
Tipulidae	17	0.58
Taeniopterygidae	0	0.57
Rhyacophilidae	50	0.57
Empididae	0	0.53
Hydropsychidae	67	0.48
Leptophlebiidae	33	0.36
Simuliidae	33	0.31
Elmidae	283	0.3
Glossosomatidae	117	0.29
Torrenticolidae	33	0.26
Perlidae	17	0.16
	Observed	**Expected**
p>0.70	6	5.4
p>0.50	9	8.9
O:E p>0.70		1.11
O:E p>0.50		1.01

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **CLB03**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	3600	170-1777
Total Richness	16	9-26
EPT Richness	11	7-15
% EPT	72.7	47-97
% Dominance (top 3 taxa)	74.1	21-66
% Chironomidae	15.7	2-32
# Ephemeroptera taxa	4	2-5
# Plecoptera taxa	4	2-6
# Trichoptera taxa	3	0-6
Diversity	0.77	0.53-0.88
Evenness	0.27	0.17-0.43
Bray-Curtis	0.84	0.36-0.75

G. Discussion of Results

- CLB0300 is predicted to be similar to Group 1 reference sites. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at CLB0300 was dominated by the mayflies Baetidae and Heptageniidae followed by Chironomidae. However, this site also had a relatively large abundance of Elmidae beetles.
- This community had a very high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a very high Bray-Curtis distance, indicating that it was only 16% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Stoney Creek
Site code: CLB04
Sampling Date: September 16, 1998
Latitude: 49.0778 N
Longitude: -122.2703 W
Ecoregion: Lower Mainland
Altitude: 21 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.050	0.005	0.252	0.202	**0.491**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

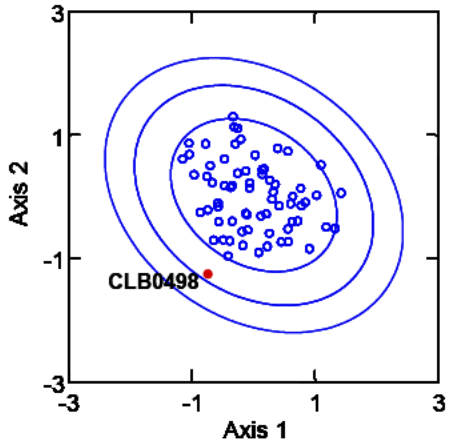
Variable	Test site CLB04	Reference Group 5 MEDIAN	RANGE
Altitude	21	3325	84-5293
Stream order	1	2*	1-6
Slope ($x10^{-3}$)	6	7	0.5-38.4
Bankful width[1]	8.0	16.0	2.7-73.0
Wetted width[1]	2.2	6.6	1.2-46.5
Avg Depth[2]	9.8	18.5	6.0-43.1
Max Depth[2]	12	26	6.0-68.0
Avg Velocity[3]	0.21	0.35	0.13-0.66
Max Velocity[3]	0.34	0.53	0.18-0.86
Dominant substrate	5	6*	1-8
Surrounding material	3	2*	1-5
Embeddedness	4	5*	1-5
Alkalinity[4]	76.1	55.0	8.9-111.0
pH	7.71	7.72	6.64-8.54
Conductivity (µS/cm)	21.1	109.5	12.0-237.4
TKN[4]	0.510	0.177	0.029-0.532
Total Phosphorus[4]	0.022	0.011	0.003-0.112
Dissolved Oxygen[4]	10.55	11.24	9.56-13.95
TSS[4]	2.48	4.09	1.07-13.41
% Sand	48.6	65.4	0-90.0
% Gravel	33.2	28.7	0-94.5

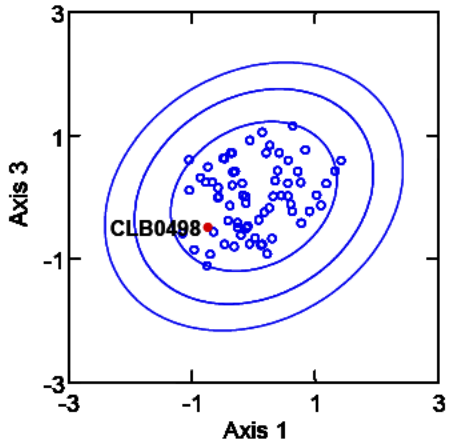
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

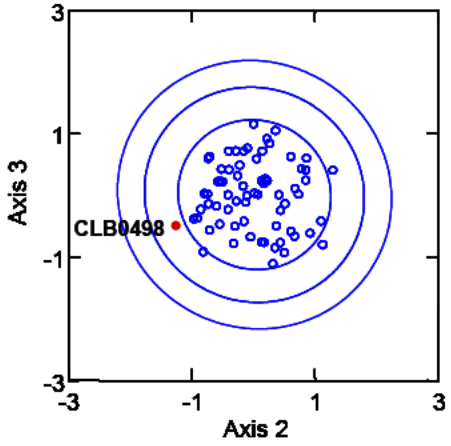
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	1786	0.99
Baetidae	143	0.86
Heptageniidae	43	0.85
Ephemerellidae	86	0.81
Chloroperlidae	0	0.68
Nemouridae	71	0.67
Capniidae	0	0.62
Perlodidae	14	0.5
Empididae	14	0.48
Leptophlebiidae	257	0.45
Naididae	129	0.43
Elmidae	100	0.37
Torrenticolidae	29	0.29
Glossosomatidae	86	0.24
Tubificidae	29	0.21
Limnesiidae	43	0.2
Lumbriculidae	100	0.15
	Observed	**Expected**
p>0.70	4	3.5
p>0.50	6	6
O:E p>0.70		1.14
O:E p>0.50		1

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **CLB04**	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	2929	5414-32293
Total Richness	15	9-23
EPT Richness	7	5-13
% EPT	23.9	13-88
% Dominance (top 3 taxa)	74.6	24-73
% Chironomidae	61.0	4-73
# Ephemeroptera taxa	4	1-5
# Plecoptera taxa	2	1-6
# Trichoptera taxa	1	0-5
Diversity	0.61	0.46-0.87
Evenness	0.17	0.15-0.43
Bray-Curtis	0.57	0.24-0.71

G. Discussion of Results

- CLB0498 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abdundances.
- The observed community at CLB0498 was dominated by Chironomidae as expected. However, Leptophelbiidae comprised a larger proportion of the community than the other expected mayflies.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a moderate Bray-Curtis distance value, indicating that it was 43% similar to the median reference community.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Clayburn Creek
Site code: CLB05
Sampling Date: September 16, 1998
Latitude: 49.0852 N
Longitude: -122.2842 W
Ecoregion: Lower Mainland
Altitude: 25 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.002	0.000	0.002	**0.993**	0.004

C. Selected habitat variables at the test site and median and central 90% range of reference sites

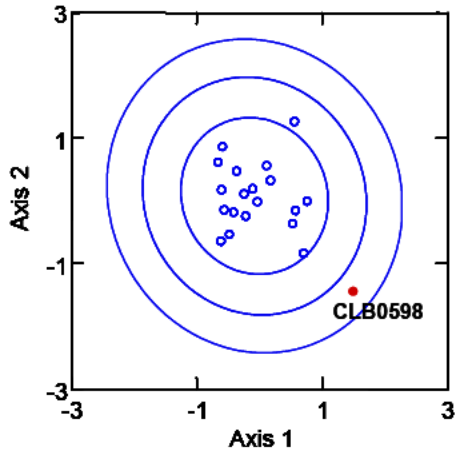
Variable	Test site CLB05	Reference Group 4 MEDIAN	RANGE
Altitude	25	292	20-4021
Stream order	2	3*	1-6
Slope ($x10^{-3}$)	0	1	0.1-29.9
Bankful width[1]	6.6	37.1	6.4-231.2
Wetted width[1]	4.3	22.1	3.7-83.0
Avg Depth[2]	47.5	30.0	12.6-87.4
Max Depth[2]	50	36	15-116.2
Avg Velocity[3]	0.02	0.14	0-0.59
Max Velocity[3]	0.05	0.25	0-0.68
Dominant substrate	2	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	1	5*	1-5
Alkalinity[4]	76.9	25.2	5.0-84.6
pH	7.41	7.06	5.50-8.24
Conductivity (µS/cm)	19.5	12.6	6.5-162.3
TKN[4]	0.480	0.120	0.037-0.387
Total Phosphorus[4]	0.028	0.011	0.004-0.038
Dissolved Oxygen[4]	10.64	10.21	6.84-12.11
TSS[4]	1.85	2.70	0.97-28.05
% Sand	85.1	72.9	0.1-99.0
% Gravel	12.5	5.7	0-62.8

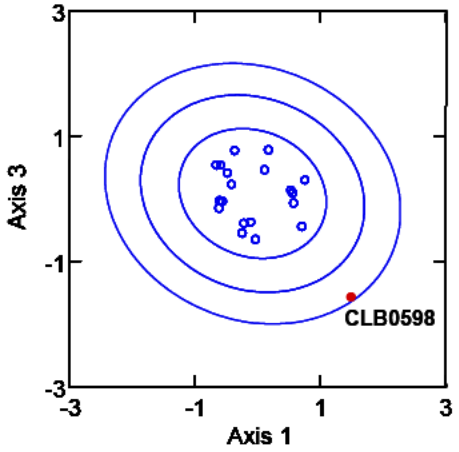
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

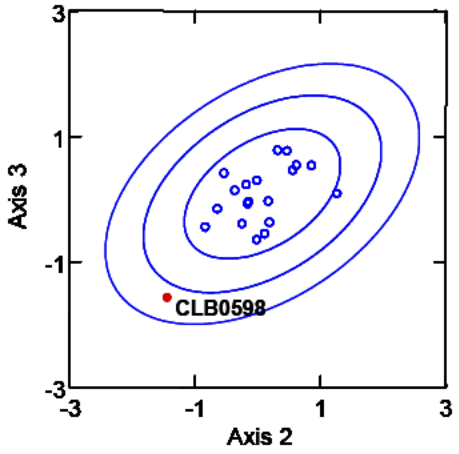
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	90845	1
Naididae	2057	0.79
Baetidae	1209	0.63
Ephemerellidae	0	0.58
Tubificidae	0	0.52
Lebertiidae	148	0.47
Ceratopogonidae	721	0.47
Limnesiidae	382	0.47
Sphaeriidae	276	0.42
Tipulidae	127	0.37
Empididae	21	0.27
Hydroptilidae	170	0.26
Torrenticolidae	21	0.16
Spongillidae	170	0.1
Dytiscidae	21	0.05
Asellidae	551	0.05
Haliplidae	148	0
Lymnaeidae	42	0
Tabanidae	64	0
Stratiomyidae	21	0
	Observed	**Expected**
p>0.70	2	1.8
p>0.50	3	3.5
O:E p>0.70		1.12
O:E p>0.50		0.85

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Stressed	Stressed	Stressed	**Stressed**

F. Benthic Community Descriptors

	Test site **CLB05**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	96996	820-8290
Total Richness	18	6-19
EPT Richness	2	1-10
% EPT	1.4	0-43
% Dominance (top 3 taxa)	97.0	39-83
% Chironomidae	93.7	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	1	0-5
Diversity	0.12	0.31-0.77
Evenness	0.06	0.11-0.32
Bray-Curtis	0.96	0.27-0.73

G. Discussion of Results

- CLB0598 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at CLB0598 had an extremely high abundance of Chironomidae followed by Naididae and Baetidae mayflies. This suggests enrichment from the agricultural activities. TKN concentration exceeds the 95th percentile of the reference data and the measured phosphorus concentration is approaching the 95th percentile.
- This community had a very high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- While the O:E ratio was high, the relative abundance of the taxa was not similar to the reference communities due to the extreme dominance of Chironomidae.
- This site had a very high Bray-Curtis distance, indicating that it was only 4% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 99% confidence ellipse, far from the cloud of reference sites, indicating that it is different than what was expected and therefore ***"stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Wilband Creek
Site code: CLB06
Sampling Date: September 21, 1998
Latitude: 49.0725 N
Longitude: -122.2932 W
Ecoregion: Lower Mainland
Altitude: 24 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.000	0.000	0.002	**0.985**	0.013

C. Selected habitat variables at the test site and median and central 90% range of reference sites

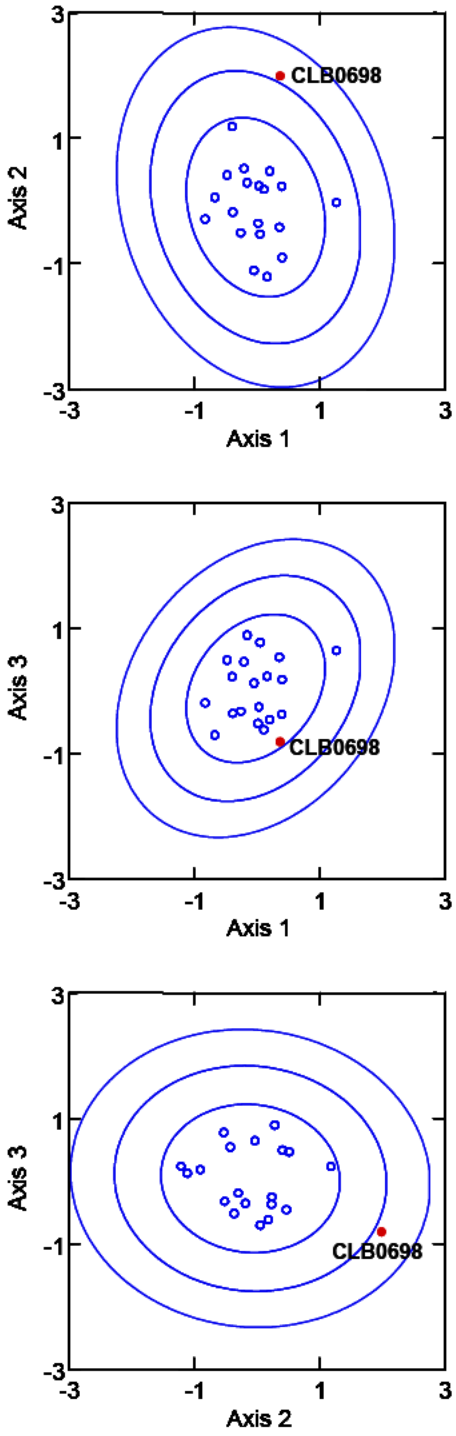
Variable	Test site CLB06	Reference Group 4 MEDIAN	RANGE
Altitude	24	292	20-4021
Stream order	1	3*	1-6
Slope ($x10^{-3}$)	2	1	0.1-29.9
Bankful width[1]	4.7	37.1	6.4-231.2
Wetted width[1]	3.9	22.1	3.7-83.0
Avg Depth[2]	36.8	30.0	12.6-87.4
Max Depth[2]	42	36	15-116.2
Avg Velocity[3]	0.16	0.14	0-0.59
Max Velocity[3]	0.19	0.25	0-0.68
Dominant substrate	1	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	4	5*	1-5
Alkalinity[4]	77.8	25.2	5.0-84.6
pH	7.36	7.06	5.50-8.24
Conductivity (µS/cm)	22.2	12.6	6.5-162.3
TKN[4]	0.198	0.120	0.037-0.387
Total Phosphorus[4]	0.045	0.011	0.004-0.038
Dissolved Oxygen[4]	11.21	10.21	6.84-12.11
TSS[4]	5.82	2.70	0.97-28.05
% Sand	97.0	72.9	0.1-99.0
% Gravel	0	5.7	0-62.8

* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	5550	1
Naididae	300	0.78
Baetidae	450	0.64
Ephemerellidae	0	0.58
Tubificidae	9600	0.52
Sphaeriidae	7200	0.42
Lumbriculidae	450	0.42
Planorbidae	450	0.26
Simuliidae	150	0.16
Spongillidae	15600	0.1
Asellidae	9600	0.05
Muscidae	150	0
Physidae	600	0
	Observed	**Expected**
p>0.70	2	1.8
p>0.50	4	3.5
O:E p>0.70		1.12
O:E p>0.50		1.14

E. Assessment of test site



Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Stressed	Not stressed	Stressed	**Stressed**

F. Benthic Community Descriptors

	Test site CLB06	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	50100	820-8290
Total Richness	12	6-19
EPT Richness	1	1-10
% EPT	0.9	0-43
% Dominance (top 3 taxa)	69.5	39-83
% Chironomidae	11.1	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	0	0-5
Diversity	0.80	0.31-0.77
Evenness	0.41	0.11-0.32
Bray-Curtis	0.93	0.27-0.73

G. Discussion of Results

- CLB0698 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at CLB0698 had an extremely high abundance of taxa that had low probabilities of occurring (<50%). Spongillidae dominated the community followed by Tubificidae and Isopoda.
- The high abundance of Spongillidae indicates that suspended sediment is not the environmental stress here since they feed by filtering mechanisms. They strive on silica and nutrients and enrichment may be a concern from the agricultural and industrial activities surrounding the site. The single total phosphorus concentration exceeds the 95th percentile of the reference range. Long term water chemistry data should be collected.
- This community had a very high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a very high Bray-Curtis distance, indicating that it was only 7% similar to the median reference community. Although the O:E ratio is high, the relative abundances are very different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 99% confidence ellipse, far from the cloud of reference sites, indicating that it is different than what was expected and therefore ***"stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: McLennan Creek
Site code: MCL01
Sampling Date: September 21, 1998
Latitude: 49.0935 N
Longitude: -122.3567 W
Ecoregion: Lower Mainland
Altitude: 66 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.000	0.000	0.001	**0.987**	0.011

C. Selected habitat variables at the test site and median and central 90% range of reference sites

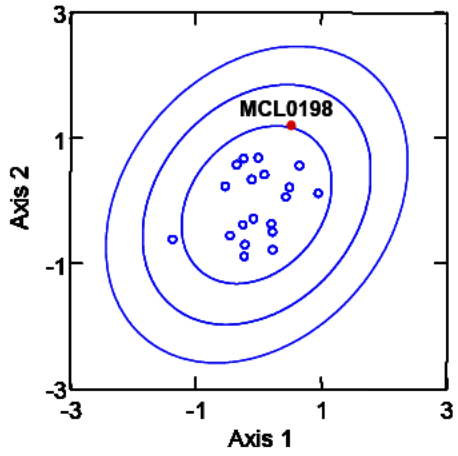
Variable	Test site MCL01	Reference Group 4 MEDIAN	RANGE
Altitude	66	292	20-4021
Stream order	2	3*	1-6
Slope ($x10^{-3}$)	8	1	0.1-29.9
Bankful width[1]	8.1	37.1	6.4-231.2
Wetted width[1]	6.5	22.1	3.7-83.0
Avg Depth[2]	32.6	30.0	12.6-87.4
Max Depth[2]	38	36	15-116.2
Avg Velocity[3]	0	0.14	0-0.59
Max Velocity[3]	0	0.25	0-0.68
Dominant substrate	1	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	2	5*	1-5
Alkalinity[4]	78.7	25.2	5.0-84.6
pH	7.80	7.06	5.50-8.24
Conductivity (µS/cm)	23.9	02.6	6.5-162.3
TKN[4]	0.430	0.120	0.037-0.387
Total Phosphorus[4]	0.005	0.011	0.004-0.038
Dissolved Oxygen[4]	11.15	10.21	6.84-12.11
TSS[4]	3.62	2.70	0.97-28.05
% Sand	10.5	72.9	0.1-99.0
% Gravel	0	5.7	0-62.8

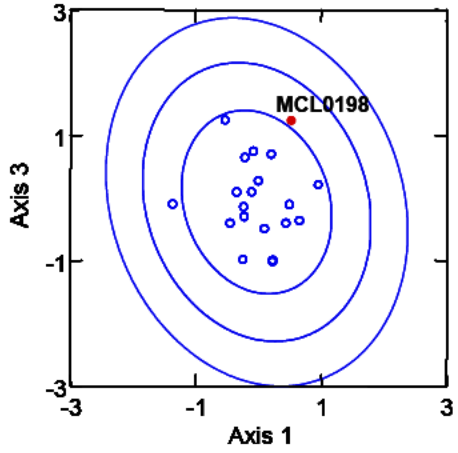
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

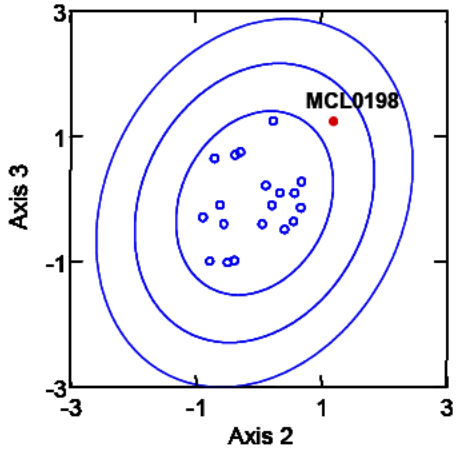
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	21600	1
Naididae	0	0.78
Baetidae	0	0.64
Ephemerellidae	0	0.58
Tubificidae	150	0.52
Ceratopogonidae	450	0.47
Limnesiidae	150	0.47
Hydropsychidae	300	0.27
Hydroptilidae	150	0.26
Crangonyctidae	150	0.05
	Observed	**Expected**
p>0.70	1	1.8
p>0.50	2	3.5
O:E p>0.70		0.56
O:E p>0.50		0.57

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Possibly stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **MCL01**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	22950	820-8290
Total Richness	7	6-19
EPT Richness	2	1-10
% EPT	2.0	0-43
% Dominance (top 3 taxa)	97.4	39-83
% Chironomidae	94.1	18-82
# Ephemeroptera taxa	0	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	2	0-5
Diversity	0.11	0.31-0.77
Evenness	0.16	0.11-0.32
Bray-Curtis	0.85	0.27-0.73

G. Discussion of Results

- MCL0198 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at MCL0198 was dominated by Chironomidae and the Ceratopogonidae; however it was missing the highly expected Naididae worm and mayfly taxa.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- This community had a very high Bray-Curtis distance, indicating that it was only 15% similar to the median reference community.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and. therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: McLennan Creek
Site code: MCL02
Sampling Date: September 21, 1998
Latitude: 49.0895 N
Longitude: -122.3710 W
Ecoregion: Lower Mainland
Altitude: 66 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.084	0.007	0.237	0.209	**0.463**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

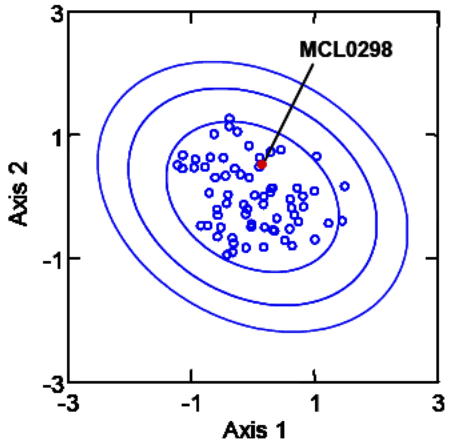
	Test site	Reference Group 5	
Variable	**MCL02**	**MEDIAN**	**RANGE**
Altitude	66	3325	84-5293
Stream order	2	2*	1-6
Slope ($x10^{-3}$)	11	7	0.5-38.4
Bankful width[1]	7.1	16.0	2.7-73.0
Wetted width[1]	2.9	6.6	1.2-46.5
Avg Depth[2]	10.4	18.5	6.0-43.1
Max Depth[2]	12	26	6.0-68.0
Avg Velocity[3]	0.26	0.35	0.13-0.66
Max Velocity[3]	0.36	0.53	0.18-0.86
Dominant substrate	5	6*	1-8
Surrounding material	2	2*	1-5
Embeddedness	3	5*	1-5
Alkalinity[4]	75.1	55.0	8.9-111.0
pH	7.89	7.72	6.64-8.54
Conductivity (µS/cm)	23.8	109.5	12.0-237.4
TKN[4]	0.370	0.177	0.029-0.532
Total Phosphorus[4]	0.054	0.011	0.003-0.112
Dissolved Oxygen[4]	11.01	11.24	9.56-13.95
TSS[4]	0.90	4.09	1.07-13.41
% Sand	19.3	65.4	0-90.0
% Gravel	79.7	28.7	0-94.5

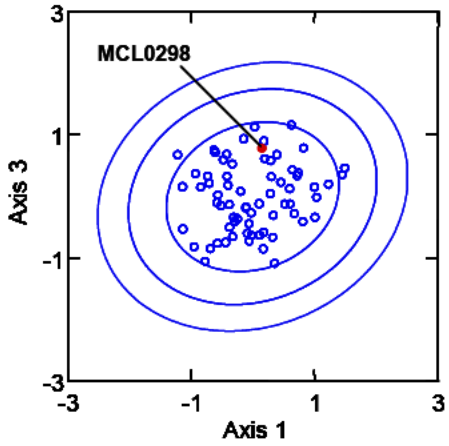
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

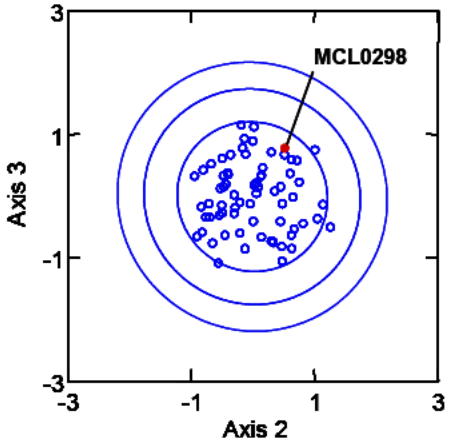
D. Invertebrate families predicted and occurring at test site

Family	**Count**	**Probability**
Chironomidae	6450	0.99
Baetidae	2700	0.86
Heptageniidae	3600	0.85
Ephemerellidae	300	0.81
Chloroperlidae	600	0.68
Nemouridae	4050	0.67
Capniidae	750	0.62
Perlodidae	150	0.5
Empididae	450	0.48
Hydropsychidae	600	0.43
Leptophlebiidae	4350	0.43
Naididae	300	0.42
Rhyacophilidae	150	0.37
Elmidae	5400	0.36
Sphaeriidae	150	0.3
Torrenticolidae	1050	0.28
Ceratopogonidae	150	0.25
Glossosomatidae	150	0.23
Perlidae	150	0.14
Physidae	150	0
	Observed	**Expected**
p>0.70	4	3.5
p>0.50	8	6
O:E p>0.70		1.14
O:E p>0.50		1.34

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic Community Descriptors

	Test site **MCL02**	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	31650	5414-32293
Total Richness	20	9-23
EPT Richness	12	5-13
% EPT	55.0	13-88
% Dominance (top 3 taxa)	51.2	24-73
% Chironomidae	20.4	4-73
# Ephemeroptera taxa	4	1-5
# Plecoptera taxa	5	1-6
# Trichoptera taxa	3	0-5
Diversity	0.87	0.46-0.87
Evenness	0.39	0.15-0.43
Bray-Curtis	0.59	0.24-0.71

G. Discussion of Results

- MCL0298 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abundances.
- The observed community at MCL0298 had all of the predicted taxa in proportions similar to the reference sites.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a moderate Bray-Curtis distance, indicating that it was 41% similar to the median reference community.
- This site falls within the 90% confidence ellipse, within the cloud of reference sites, indicating that it is similar to what was expected and therefore "***not stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Sumas River
Site code: SMS01
Sampling Date: September 14, 1999
Latitude: 49.0289 N
Longitude: -122.2189 W
Ecoregion: Lower Mainland
Altitude: 39 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.008	0.000	0.001	**0.990**	0.001

C. Selected habitat variables at the test site and median and central 90% range of reference sites

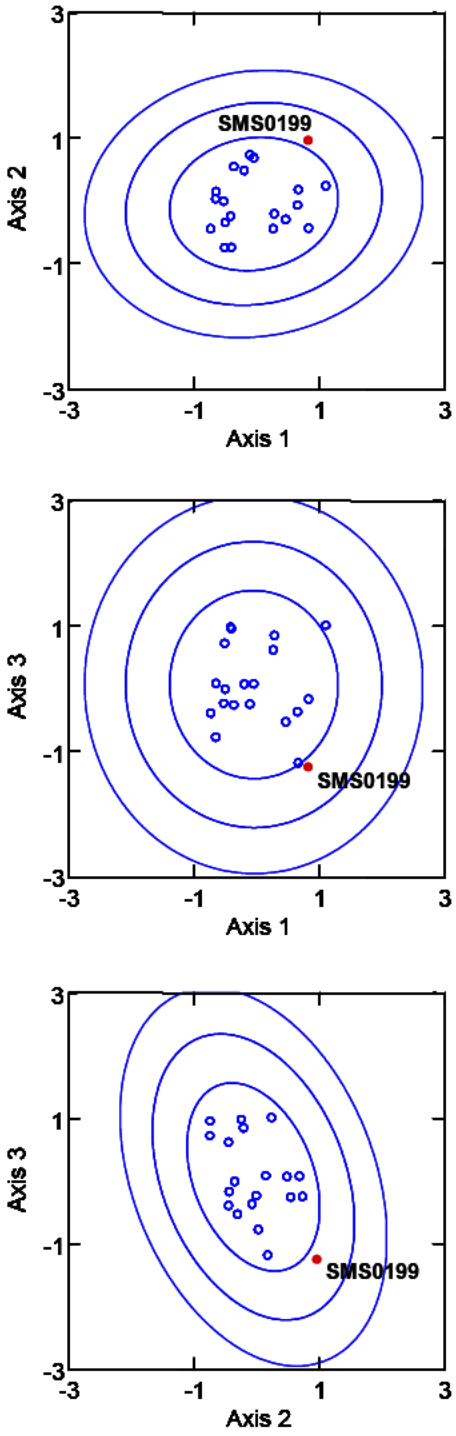
Variable	Test site SMS01	Reference Group 4 MEDIAN	RANGE
Altitude	39	292	20-4021
Stream order	1	3*	1-6
Slope ($x10^{-3}$)	1	1	0.1-29.9
Bankful width[1]	9.1	37.1	6.4-231.2
Wetted width[1]	8.4	22.1	3.7-83.0
Avg Depth[2]	84.0	30.0	12.6-87.4
Max Depth[2]	100	36	15-116.2
Avg Velocity[3]	0.15	0.14	0-0.59
Max Velocity[3]	0.25	0.25	0-0.68
Dominant substrate	2	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	1	5*	1-5
Alkalinity[4]	118.0	25.2	5.0-84.6
pH	8.42	7.06	5.50-8.24
Conductivity (µS/cm)	120.0	12.6	6.5-162.3
TKN[4]	2.949	0.120	0.037-0.387
Total Phosphorus[4]	0.051	0.011	0.004-0.038
Dissolved Oxygen[4]	9.18	10.21	6.84-12.11
TSS[4]	2.52	2.70	0.97-28.05
% Sand	80.6	72.9	0.1-99.0
% Gravel	18.6	5.7	0-62.8

* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	7800	1
Naididae	18150	0.78
Baetidae	450	0.63
Ephemerellidae	0	0.58
Tubificidae	4500	0.52
Sphaeriidae	150	0.42
Leptoceridae	150	0.37
Hydroptilidae	150	0.26
Planorbidae	1500	0.26
Sperchontidae	450	0.21
Hydridae	1050	0.1
Glossiphoniidae	150	0.1
Physidae	150	0
Ancylidae	300	0
Coenagrionidae	150	0
Haustoriidae	750	0
	Observed	**Expected**
p>0.70	2	1.8
p>0.50	4	3.5
O:E p>0.70		1.12
O:E p>0.50		1.14

E. Assessment of test site



Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Possibly stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **SMS01**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	35850	820-8290
Total Richness	15	6-19
EPT Richness	3	1-10
% EPT	2.1	0-43
% Dominance (top 3 taxa)	84.9	39-83
% Chironomidae	21.8	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	2	0-5
Diversity	0.68	0.31-0.77
Evenness	0.21	0.11-0.32
Bray-Curtis	0.90	0.27-0.73

G. Discussion of Results

- SMS0199 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at SMS0199 was dominated by Chironomidae and worms, as expected. However, it had a large proportion of unexpected taxa.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- While the O:E ratio was high, the relative abundance of the taxa was not similar to the reference communities.
- This community had a very high Bray-Curtis distance, indicating that it was only 10% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Salmon River
Site code: SLM01
Sampling Date: September 15, 1999
Latitude: 49.1397 N
Longitude: -122.6083 W
Ecoregion: Lower Mainland
Altitude: 10 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.041	0.013	0.052	**0.710**	0.184

C. Selected habitat variables at the test site and median and central 90% range of reference sites

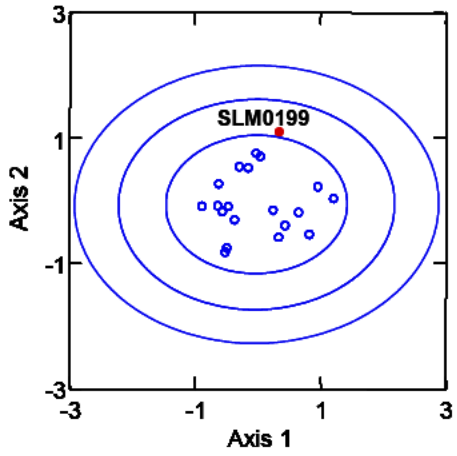
Variable	Test site SLM01	Reference Group 4 MEDIAN	RANGE
Altitude	10	292	20-4021
Stream order	2	3*	1-6
Slope ($x10^{-3}$)	2	1	0.1-29.9
Bankful width[1]	7.7	37.1	6.4-231.2
Wetted width[1]	4.7	22.1	3.7-83.0
Avg Depth[2]	18.0	30.0	12.6-87.4
Max Depth[2]	26	36	15-116.2
Avg Velocity[3]	0.28	0.14	0-0.59
Max Velocity[3]	0.33	0.25	0-0.68
Dominant substrate	3	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	1	5*	1-5
Alkalinity[4]	49.6	25.2	5.0-84.6
pH	7.27	7.06	5.50-8.24
Conductivity (µS/cm)	60.0	12.6	6.5-162.3
TKN[4]	4.579	0.120	0.037-0.387
Total Phosphorus[4]	0.033	0.011	0.004-0.038
Dissolved Oxygen[4]	9.07	10.21	6.84-12.11
TSS[4]	1.92	2.70	0.97-28.05
% Sand	96.8	72.9	0.1-99.0
% Gravel	1.8	5.7	0-62.8

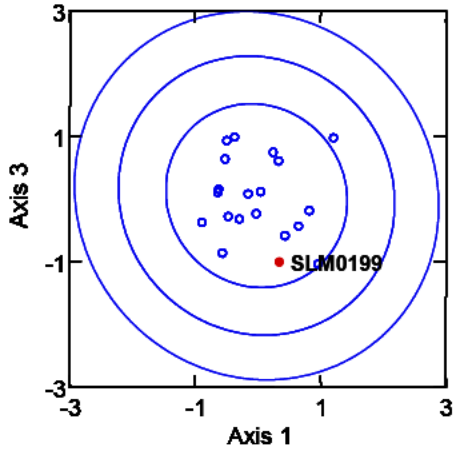
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

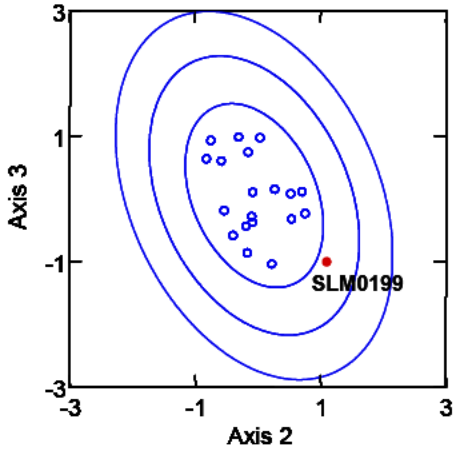
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	12975	1
Baetidae	825	0.71
Ephemerellidae	0	0.66
Naididae	450	0.66
Heptageniidae	0	0.61
Capniidae	0	0.53
Lebertiidae	150	0.45
Tubificidae	150	0.41
Tipulidae	225	0.41
Ceratopogonidae	225	0.39
Nemouridae	75	0.38
Empididae	75	0.34
Sperchontidae	225	0.23
Rhyacophilidae	75	0.23
Perlodidae	75	0.22
Torrenticolidae	75	0.2
Elmidae	300	0.17
Gammaridae	75	0.04
Asellidae	75	0.04
	Observed	**Expected**
p>0.70	2	1.7
p>0.50	3	4.2
O:E p>0.70		1.17
O:E p>0.50		0.72

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **SLM01**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	16050	820-8290
Total Richness	16	6-19
EPT Richness	4	1-10
% EPT	6.1	0-43
% Dominance (top 3 taxa)	88.8	39-83
% Chironomidae	80.8	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	2	0-2
# Trichoptera taxa	1	0-5
Diversity	0.34	0.31-0.77
Evenness	0.09	0.11-0.32
Bray-Curtis	0.78	0.27-0.73

G. Discussion of Results

- SLM0199 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at SLM0199 was dominated by Chironomidae and Baetidae with a smaller proportion of worms than expected and a large proportion of the lesser expected taxa.
- This community had a relatively high O:E taxa ratio indicating that most of the taxa that were expected to be there were found there.
- This community had a high Bray-Curtis distance value, indicating that it was only 22% similar to the median reference community.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Munday Creek
Site code: YOR01
Sampling Date: September 15, 1999
Latitude: 49.1756 N
Longitude: -122.6475 W
Ecoregion: Lower Mainland
Altitude: 49 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.010	0.003	0.021	**0.899**	0.067

C. Selected habitat variables at the test site and median and central 90% range of reference sites

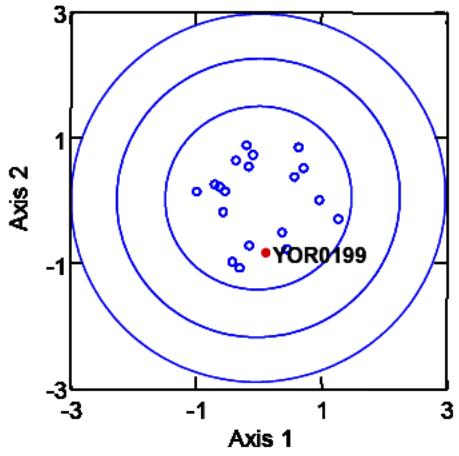
Variable	Test site YOR01	Reference Group 4 MEDIAN	RANGE
Altitude	49	292	20-4021
Stream order	1	3*	1-6
Slope ($x10^{-3}$)	0	1	0.1-29.9
Bankful width[1]	6.6	37.1	6.4-231.2
Wetted width[1]	3.2	22.1	3.7-83.0
Avg Depth[2]	21.0	30.0	12.6-87.4
Max Depth[2]	32	36	15-116.2
Avg Velocity[3]	0	0.14	0-0.59
Max Velocity[3]	0	0.25	0-0.68
Dominant substrate	3	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	1	5*	1-5
Alkalinity[4]	61.6	25.2	5.0-84.6
pH	7.23	7.06	5.50-8.24
Conductivity (µS/cm)	66.0	12.6	6.5-162.3
TKN[4]	1.583	0.120	0.037-0.387
Total Phosphorus[4]	0.044	0.011	0.004-0.038
Dissolved Oxygen[4]	9.25	10.21	6.84-12.11
TSS[4]	1.23	2.70	0.97-28.05
% Sand	68.3	72.9	0.1-99.0
% Gravel	29.8	5.7	0-62.8

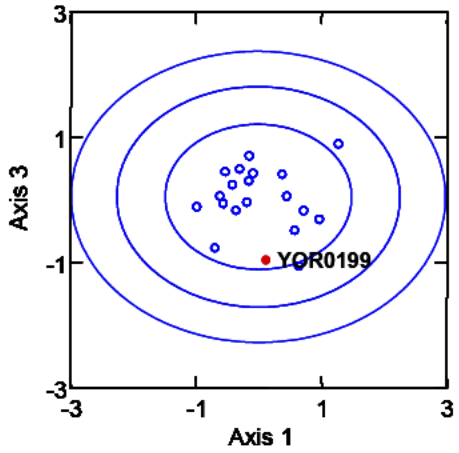
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

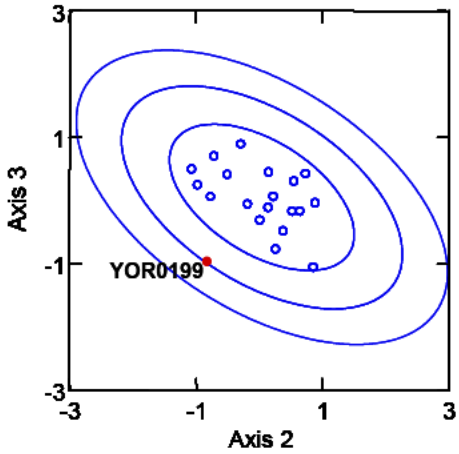
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	555	1
Naididae	105	0.74
Baetidae	0	0.66
Ephemerellidae	0	0.61
Heptageniidae	30	0.52
Tubificidae	45	0.49
Lebertiidae	15	0.46
Sphaeriidae	60	0.41
Lumbriculidae	165	0.39
Tipulidae	90	0.38
Leptoceridae	45	0.34
Lepidostomatidae	15	0.28
Nemouridae	30	0.27
Rhyacophilidae	15	0.18
Torrenticolidae	15	0.17
Crangonyctidae	1680	0.05
Asellidae	240	0.05
	Observed	**Expected**
p>0.70	2	1.7
p>0.50	3	3.5
O:E p>0.70		1.15
O:E p>0.50		0.85

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **YOR01**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	3105	820-8290
Total Richness	15	6-19
EPT Richness	5	1-10
% EPT	3.9	0-43
% Dominance (top 3 taxa)	79.7	39-83
% Chironomidae	17.9	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	1	0-2
# Trichoptera taxa	3	0-5
Diversity	0.66	0.31-0.77
Evenness	0.20	0.11-0.32
Bray-Curtis	0.74	0.27-0.73

G. Discussion of Results

- YOR0199 was strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at YOR0199 was dominated by amphipods followed by Chironomidae.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a high Bray-Curtis distance, indicating that it was only 26% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Yorkson Creek
Site code: YOR02
Sampling Date: September 15, 1999
Latitude: 49.1817 N
Longitude: -122.6547 W
Ecoregion: Lower Mainland
Altitude: 49 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.001	0.000	0.000	**0.998**	0.000

C. Selected habitat variables at the test site and median and central 90% range of reference sites

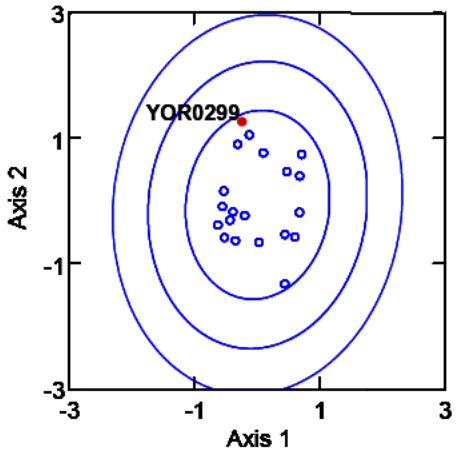
Variable	Test site YOR02	Reference Group 4 MEDIAN	RANGE
Altitude	49	292	20-4021
Stream order	2	3*	1-6
Slope ($x10^{-3}$)	0	1	0.1-29.9
Bankful width[1]	4.4	37.1	6.4-231.2
Wetted width[1]	3.8	22.1	3.7-83.0
Avg Depth[2]	73.0	30.0	12.6-87.4
Max Depth[2]	130	36	15-116.2
Avg Velocity[3]	0	0.14	0-0.59
Max Velocity[3]	0	0.25	0-0.68
Dominant substrate	3	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	1	5*	1-5
Alkalinity[4]	71.0	25.2	5.0-84.6
pH	6.95	7.06	5.50-8.24
Conductivity (µS/cm)	62.7	12.6	6.5-162.3
TKN[4]	0.628	0.120	0.037-0.387
Total Phosphorus[4]	0.051	0.011	0.004-0.038
Dissolved Oxygen[4]	6.40	10.21	6.84-12.11
TSS[4]	7.89	2.70	0.97-28.05
% Sand	32.7	72.9	0.1-99.0
% Gravel	66.1	5.7	0-62.8

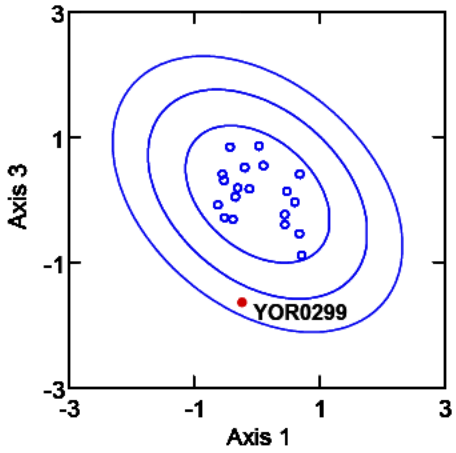
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

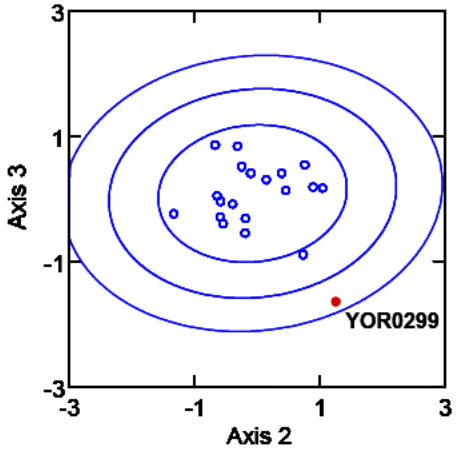
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	66	1
Naididae	0	0.79
Baetidae	0	0.63
Ephemerellidae	0	0.58
Tubificidae	189	0.53
Lumbriculidae	12	0.42
Sphaeriidae	87	0.42
Perlodidae	3	0.05
Hyalellidae	9	0.05
Asellidae	12	0.05
Muscidae	6	0
Stratiomyidae	75	0
Sialidae	3	0
	Observed	**Expected**
p>0.70	1	1.8
p>0.50	2	3.5
O:E p>0.70		0.56
O:E p>0.50		0.57

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Stressed	Stressed	**Stressed**

F. Benthic Community Descriptors

	Test site YOR02	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	462	820-8290
Total Richness	10	6-19
EPT Richness	1	1-10
% EPT	0.6	0-43
% Dominance (top 3 taxa)	76.0	39-83
% Chironomidae	14.3	18-82
# Ephemeroptera taxa	0	0-4
# Plecoptera taxa	1	0-2
# Trichoptera taxa	0	0-5
Diversity	0.75	0.31-0.77
Evenness	0.40	0.11-0.32
Bray-Curtis	0.94	0.27-0.73

G. Discussion of Results

- YOR0299 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at YOR0299 had a very low abundance of organisms and was dominated by Tubificidae worms.
- With the exception of Perlodidae stoneflies, this community is composed of only pollution tolerant invertebrates. This, with the fact that there is a low abundance of organisms, might suggest episodic pollution events from urban activities have affected this community, which is trying to recover. Water quality monitoring should be conducted at this site.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- This community had a very high Bray-Curtis distance, indicating that it was only 6% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 99% confidence ellipse, far from the cloud of reference sites, indicating that it is different than what was expected and therefore ***"stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Nicomekl River
Site code: NKM01
Sampling Date: September 26, 2002
Latitude: 49.0953 N
Longitude: -122.6910 W
Ecoregion: Lower Mainland
Altitude: 13 (fasl)
Stream Order: 3

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.026	0.002	0.017	**0.917**	0.038

C. Selected habitat variables at the test site and median and central 90% range of reference sites

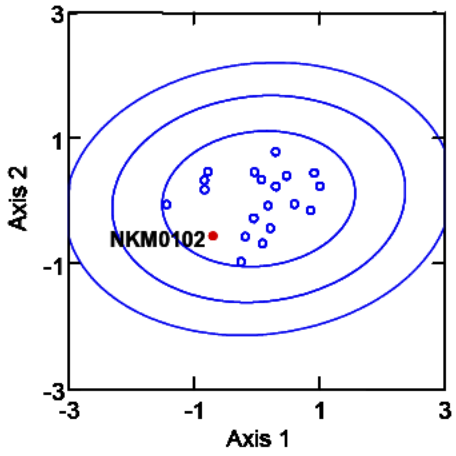
Variable	Test site NKM01	Reference Group 4 MEDIAN	RANGE
Altitude	13	292	20-4021
Stream order	3	3*	1-6
Slope ($x10^{-3}$)	4	1	0.1-29.9
Bankful width[1]	10.0	37.1	6.4-231.2
Wetted width[1]	6.5	22.1	3.7-83.0
Avg Depth[2]	37.5	30.0	12.6-87.4
Max Depth[2]	44	36	15-116.2
Avg Velocity[3]	0.24	0.14	0-0.59
Max Velocity[3]	0.35	0.25	0-0.68
Dominant substrate	3	5*	1-7
Surrounding material	2	2*	2-5
Embeddedness	1	5*	1-5
Alkalinity[4]	80.1	25.2	5.0-84.6
pH	7.54	7.06	5.50-8.24
Conductivity (µS/cm)	287.0	12.6	6.5-162.3
TKN[4]	0.140	0.120	0.037-0.387
Total Phosphorus[4]	0.146	0.011	0.004-0.038
Dissolved Oxygen[4]	8.94	10.21	6.84-12.11
TSS[4]	4.36	2.70	0.97-28.05
% Sand	76.2	72.9	0.1-99.0
% Gravel	23.4	5.7	0-62.8

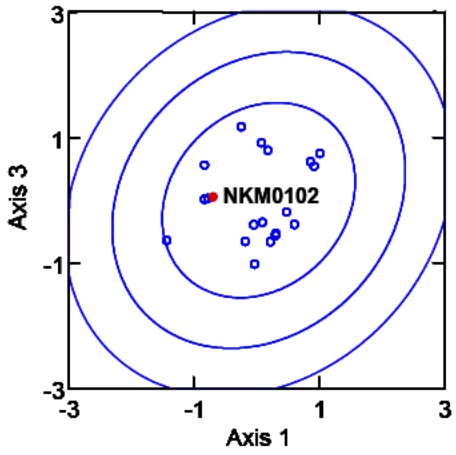
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

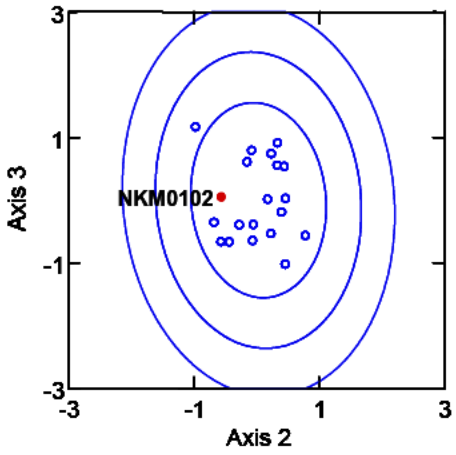
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	2271	1
Naididae	1371	0.75
Baetidae	557	0.66
Ephemerellidae	0	0.6
Heptageniidae	0	0.51
Tubificidae	686	0.49
Lebertiidae	193	0.47
Ceratopogonidae	21	0.45
Sphaeriidae	64	0.4
Lumbriculidae	64	0.4
Tipulidae	21	0.38
Empididae	107	0.29
Enchytraeidae	64	0.27
Planorbidae	86	0.24
Sperchontidae	21	0.22
Perlodidae	43	0.1
Hygrobatidae	64	0.05
Gammaridae	579	0.05
Asellidae	1029	0.05
Ancylidae	21	0
	Observed	**Expected**
p>0.70	2	1.7
p>0.50	3	3.5
O:E p>0.70		1.14
O:E p>0.50		0.85

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic Community Descriptors

	Test site **NKM01**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	7264	820-8290
Total Richness	18	6-19
EPT Richness	2	1-10
% EPT	8.3	0-43
% Dominance (top 3 taxa)	64.3	39-83
% Chironomidae	31.3	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	1	0-2
# Trichoptera taxa	0	0-5
Diversity	0.82	0.31-0.77
Evenness	0.32	0.11-0.32
Bray-Curtis	0.58	0.27-0.73

G. Discussion of Results

- NKM0102 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at NKM0102 was dominated by Chironomidae and worms, as expected, and also had small abundances of Baetidae.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a moderate Bray-Curtis distance, indicating that it was 42% similar to the median reference community.
- This site falls within the 90% confidence ellipse, within the cloud of reference sites, indicating that it is similar to what was expected and therefore "***not stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Anderson Creek
Site code: NKM02
Sampling Date: September 26, 2002
Latitude: 49.0921 N
Longitude: -122.6843 W
Ecoregion: Lower Mainland
Altitude: 16 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.109	0.004	0.257	0.133	**0.497**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

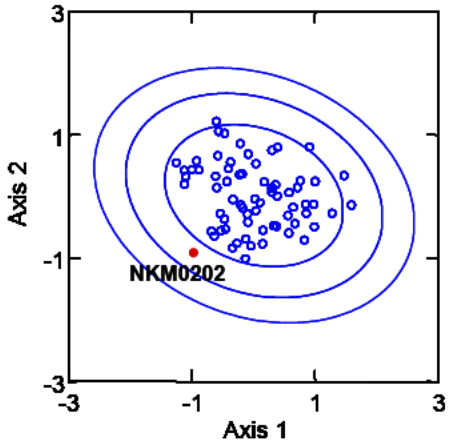
Variable	Test site NKM02	Reference Group 5 MEDIAN	RANGE
Altitude	16	3325	84-5293
Stream order	1	2*	1-6
Slope ($x10^{-3}$)	2	7	0.5-38.4
Bankful width[1]	7.0	16.0	2.7-73.0
Wetted width[1]	3.5	6.6	1.2-46.5
Avg Depth[2]	24.5	18.5	6.0-43.1
Max Depth[2]	35	26	6.0-68.0
Avg Velocity[3]	0.23	0.35	0.13-0.66
Max Velocity[3]	0.29	0.53	0.18-0.86
Dominant substrate	4	6*	1-8
Surrounding material	3	2*	1-5
Embeddedness	5	5*	1-5
Alkalinity[4]	68.2	55.0	8.9-111.0
pH	7.54	7.72	6.64-8.54
Conductivity (µS/cm)	224.0	109.5	12.0-237.4
TKN[4]	0.230	0.177	0.029-0.532
Total Phosphorus[4]	0.030	0.011	0.003-0.112
Dissolved Oxygen[4]	9.66	11.24	9.56-13.95
TSS[4]	1.16	4.09	1.07-13.41
% Sand	45.6	65.4	0-90.0
% Gravel	54.3	28.7	0-94.5

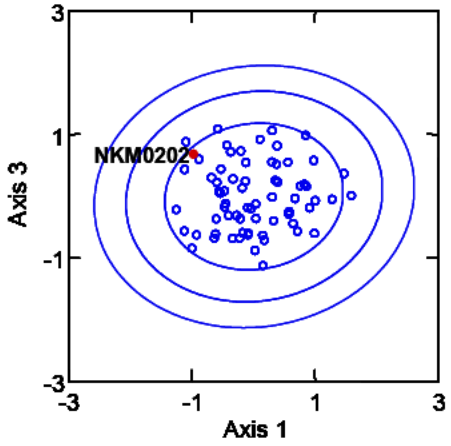
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

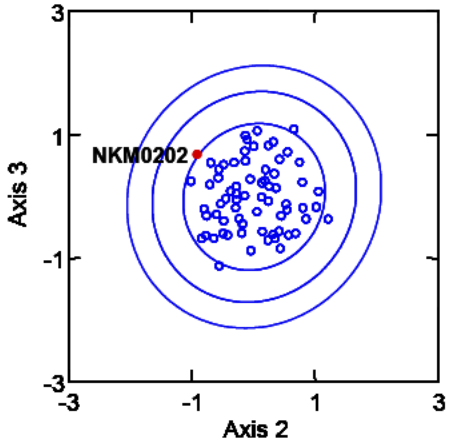
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	356	0.99
Heptageniidae	113	0.88
Baetidae	3938	0.88
Ephemerellidae	244	0.83
Chloroperlidae	38	0.71
Nemouridae	19	0.71
Capniidae	75	0.63
Perlodidae	188	0.55
Tipulidae	38	0.51
Empididae	38	0.5
Leptophlebiidae	19	0.46
Hydropsychidae	544	0.45
Rhyacophilidae	38	0.39
Lebertiidae	38	0.39
Elmidae	19	0.38
Torrenticolidae	19	0.29
Sperchontidae	38	0.28
Sphaeriidae	19	0.28
Tubificidae	38	0.18
Perlidae	19	0.15
Margaritiferidae	19	0.01
	Observed	**Expected**
p>0.70	6	5
p>0.50	9	6.7
O:E p>0.70		1.2
O:E p>0.50		1.34

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site NKM02	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	5850	5414-32293
Total Richness	21	9-23
EPT Richness	11	5-13
% EPT	88.8	13-88
% Dominance (top 3 taxa)	82.7	24-73
% Chironomidae	6.1	4-73
# Ephemeroptera taxa	4	1-5
# Plecoptera taxa	5	1-6
# Trichoptera taxa	2	0-5
Diversity	0.53	0.46-0.87
Evenness	0.10	0.15-0.43
Bray-Curtis	0.66	0.24-0.71

G. Discussion of Results

- NKM0202 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abundances.
- The observed community at NKM0202 was dominated by Baetidae and Hydropsychiidae, followed by Chironomidae. All taxa that had a high probability of occurring were found.
- This community had a very high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a moderately high Bray-Curtis distance value, indicating that it was 34% similar to the median reference community.
- This site falls just outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Nicomekl River
Site code: NKM03
Sampling Date: September 26, 2002
Latitude: 49.0954 N
Longitude: -122.6591 W
Ecoregion: Lower Mainland
Altitude: 20 (fasl)
Stream Order: 3

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.005	0.000	0.023	**0.645**	0.327

C. Selected habitat variables at the test site and median and central 90% range of reference sites

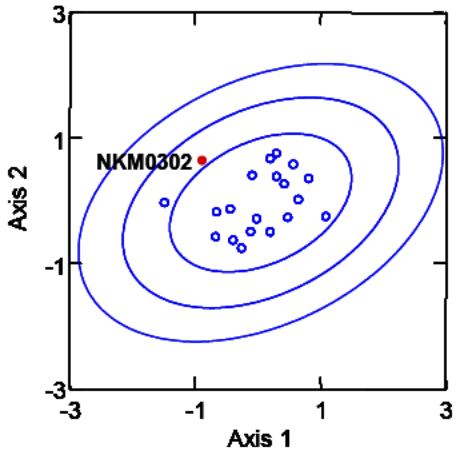
Variable	Test site NKM03	Reference Group 4 MEDIAN	RANGE
Altitude	20	292	20-4021
Stream order	3	3*	1-6
Slope ($x10^{-3}$)	2	1	0.1-29.9
Bankful width[1]	7.0	37.1	6.4-231.2
Wetted width[1]	4.5	22.1	3.7-83.0
Avg Depth[2]	28.6	30.0	12.6-87.4
Max Depth[2]	42	36	15-116.2
Avg Velocity[3]	0.13	0.14	0-0.59
Max Velocity[3]	0.25	0.25	0-0.68
Dominant substrate	1	5*	1-7
Surrounding material	3	2*	2-5
Embeddedness	5	5*	1-5
Alkalinity[4]	93.0	25.2	5.0-84.6
pH	7.67	7.06	5.50-8.24
Conductivity (µS/cm)	351.0	12.6	6.5-162.3
TKN[4]	0.160	0.120	0.037-0.387
Total Phosphorus[4]	0.260	0.011	0.004-0.038
Dissolved Oxygen[4]	7.58	10.21	6.84-12.11
TSS[4]	7.78	2.70	0.97-28.05
% Sand	48.1	72.9	0.1-99.0
% Gravel	51.3	5.7	0-62.8

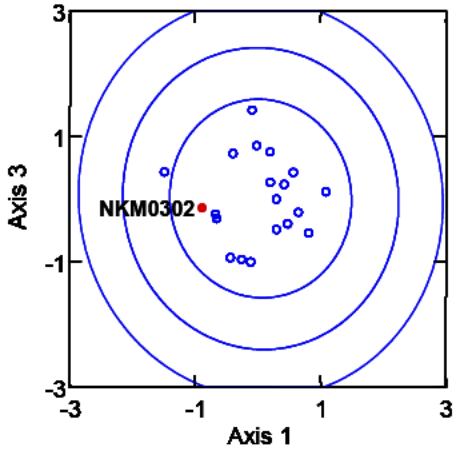
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

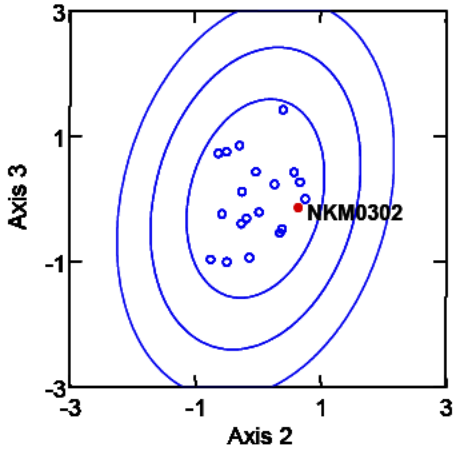
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	842	1
Baetidae	0	0.74
Ephemerellidae	0	0.68
Naididae	450	0.63
Heptageniidae	0	0.63
Capniidae	0	0.55
Lebertiidae	58	0.44
Tubificidae	185	0.39
Sphaeriidae	819	0.39
Ceratopogonidae	12	0.37
Hydropsychidae	12	0.34
Lumbriculidae	46	0.3
Leptophlebiidae	23	0.29
Enchytraeidae	35	0.27
Sperchontidae	127	0.22
Planorbidae	23	0.18
Crangonyctidae	185	0.05
Hygrobatidae	427	0.03
Asellidae	115	0.03
Anisitsiellidae	162	0.02
Margaritiferidae	12	0
Ancylidae	23	0
Mysidae	196	0
	Observed	**Expected**
p>0.70	1	1.7
p>0.50	2	4.2
O:E p>0.70		0.58
O:E p>0.50		0.47

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Not stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site NKM03	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	3750	820-8290
Total Richness	19	6-19
EPT Richness	2	1-10
% EPT	0.9	0-43
% Dominance (top 3 taxa)	56.3	39-83
% Chironomidae	22.5	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	1	0-5
Diversity	0.86	0.31-0.77
Evenness	0.38	0.11-0.32
Bray-Curtis	0.67	0.27-0.73

G. Discussion of Results

- NKM0302 is predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at NKM0302 was dominated by Chironomidae and Sphaeriidae and other lesser expected taxa. The highly expected mayfly taxa were not found.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- While the total taxa richness is high, the highly expected taxa were missing.
- This site had a moderately high Bray-Curtis distance value, indicating that it was 33% similar to the median reference community.
- This site falls just outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Serpentine River
Site code: SER01
Sampling Date: September 26, 2002
Latitude: 49.1831 N
Longitude: -122.7736 W
Ecoregion: Lower Mainland
Altitude: 102 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.546	0.015	0.314	0.002	0.123

C. Selected habitat variables at the test site and median and central 90% range of reference sites

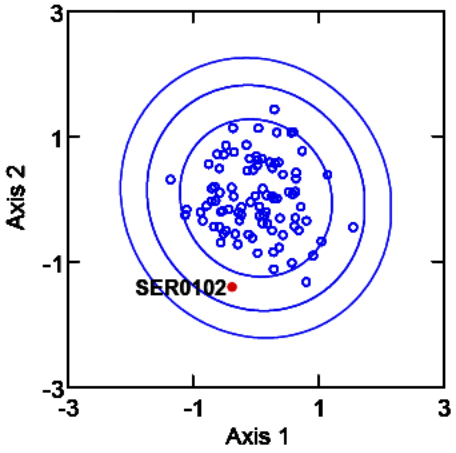
Variable	Test site SER01	Reference Group 1 MEDIAN	RANGE
Altitude	102	1830	91-5115
Stream order	1	2*	1-4
Slope ($x10^{-3}$)	21	16	0.6-72.9
Bankful width[1]	6.2	30.3	4.2-149.4
Wetted width[1]	4.8	14.0	1.4-59.2
Avg Depth[2]	9.1	29.4	7.9-60.5
Max Depth[2]	15	42	10.0-83.5
Avg Velocity[3]	0.24	0.42	0.16-0.83
Max Velocity[3]	0.34	0.72	0.27-1.17
Dominant substrate	7	7*	5-8
Surrounding material	5	2*	2-6
Embeddedness	3	3*	1-5
Alkalinity[4]	82.4	26.4	4.2-88.5
pH	7.74	7.55	6.31-8.33
Conductivity (µS/cm)	21.0	53.3	8.0-211.5
TKN[4]	0.055	0.042	0.007-0.155
Total Phosphorus[4]	0.054	0.007	0.002-0.039
Dissolved Oxygen[4]	9.79	11.38	9.18-13.91
TSS[4]	0.94	2.98	0.23-36.71
% Sand	9.1	71.0	3.1-97.9
% Gravel	90.9	26.5	0.6-96.9

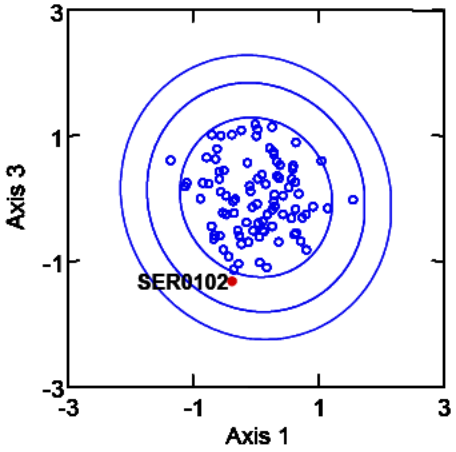
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

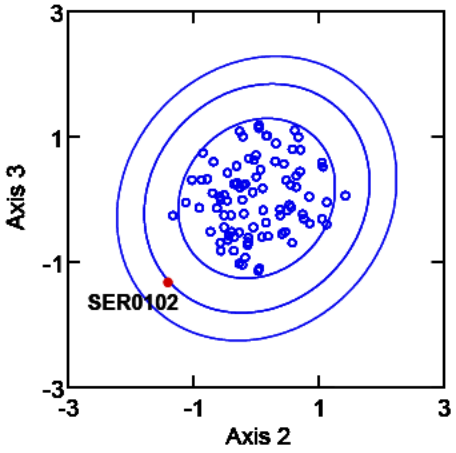
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	750	0.99
Heptageniidae	0	0.97
Baetidae	1700	0.92
Ephemerellidae	0	0.89
Chloroperlidae	0	0.85
Nemouridae	63	0.79
Perlodidae	25	0.67
Capniidae	0	0.63
Tipulidae	13	0.59
Rhyacophilidae	50	0.59
Taeniopterygidae	0	0.58
Empididae	25	0.53
Hydropsychidae	38	0.49
Leptophlebiidae	25	0.36
Enchytraeidae	25	0.34
Naididae	600	0.27
Lumbriculidae	200	0.18
Planariidae	88	0.13
Planorbidae	50	0.04
Crangonyctidae	363	0.01
	Observed	**Expected**
p>0.70	3	5.4
p>0.50	7	9
O:E p>0.70		0.55
O:E p>0.50		0.78

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Possibly stressed	Stressed	**Stressed**

F. Benthic Community Descriptors

	Test site **SER01**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	4013	170-1777
Total Richness	15	9-26
EPT Richness	6	7-15
% EPT	48.3	47-97
% Dominance (top 3 taxa)	76.0	21-66
% Chironomidae	18.7	2-32
# Ephemeroptera taxa	2	2-5
# Plecoptera taxa	2	2-6
# Trichoptera taxa	2	0-6
Diversity	0.75	0.53-0.88
Evenness	0.27	0.17-0.43
Bray-Curtis	0.92	0.36-0.75

G. Discussion of Results

- SER0102 is predicted to be similar to Group 1 reference sites. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at SER0102 was dominated by Baetidae and Chironomidae but also had a very large proportion of worms.
- This suggests that this site may be experiencing enrichment from urban activities. Total phosphorus concentration measured in a single sample exceeded the 95th percentile of the reference sites. Long term monitoring should be conducted.
- This community had a moderate O:E taxa ratio indicating that several of the highly expected taxa were not found at this site.
- This community had a very high Bray-Curtis distance, indicating that it was only 8% similar to the median reference community.
- Although the O:E ratio is moderate, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls just outside of the 99% confidence ellipse, far from the cloud of reference sites, indicating that it is different than what was expected and, therefore, ***"stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Bear Creek
Site code: SER02
Sampling Date: September 26, 2002
Latitude: 49.1560 N
Longitude: -122.8433 W
Ecoregion: Lower Mainland
Altitude: 82 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.042	0.007	0.253	0.302	**0.396**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

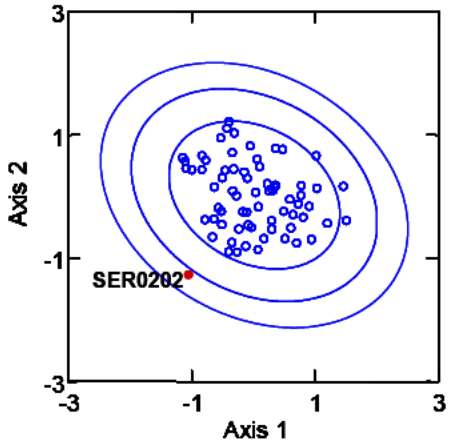
Variable	Test site SER02	Reference Group 5 MEDIAN	RANGE
Altitude	82	3325	84-5293
Stream order	2	2*	1-6
Slope ($x10^{-3}$)	12	7	0.5-38.4
Bankful width[1]	9.0	16.0	2.7-73.0
Wetted width[1]	4.5	6.6	1.2-46.5
Avg Depth[2]	10.7	18.5	6.0-43.1
Max Depth[2]	18	26	6.0-68.0
Avg Velocity[3]	0.18	0.35	0.13-0.66
Max Velocity[3]	0.24	0.53	0.18-0.86
Dominant substrate	6	6*	1-8
Surrounding material	4	2*	1-5
Embeddedness	4	5*	1-5
Alkalinity[4]	57.5	55.0	8.9-111.0
pH	7.30	7.72	6.64-8.54
Conductivity (µS/cm)	141.0	109.5	12.0-237.4
TKN[4]	0.176	0.177	0.029-0.532
Total Phosphorus[4]	0.032	0.011	0.003-0.112
Dissolved Oxygen[4]	9.39	11.24	9.56-13.95
TSS[4]	1.29	4.09	1.07-13.41
% Sand	10.8	65.4	0-90.0
% Gravel	89.1	28.7	0-94.5

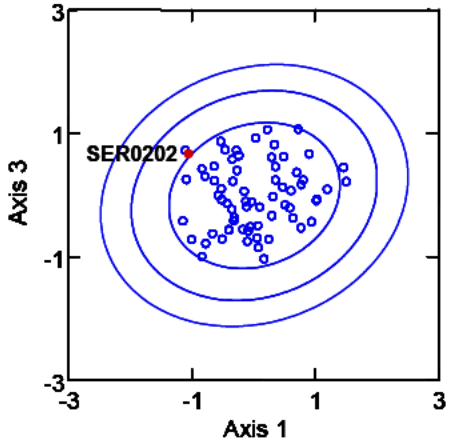
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

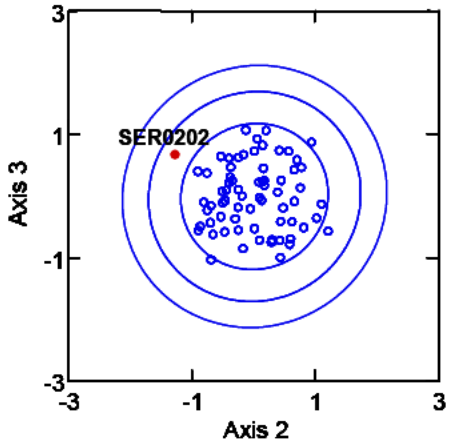
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	583	0.99
Baetidae	2233	0.83
Heptageniidae	0	0.8
Ephemerellidae	0	0.78
Chloroperlidae	0	0.65
Nemouridae	0	0.61
Capniidae	0	0.6
Naididae	967	0.47
Empididae	17	0.45
Sphaeriidae	17	0.31
Tubificidae	167	0.25
Hydroptilidae	17	0.23
Lumbriculidae	33	0.19
Planorbidae	17	0.1
Planariidae	150	0.07
Crangonyctidae	533	0.04
Asellidae	867	0.02
	Observed	**Expected**
p>0.70	2	3.4
p>0.50	2	5.3
O:E p>0.70		0.59
O:E p>0.50		0.38

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Stressed	Possibly stressed	Possibly stressed	**Stressed**

F. Benthic Community Descriptors

	Test site SER02	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	5600	5414-32293
Total Richness	12	9-23
EPT Richness	2	5-13
% EPT	42.9	13-88
% Dominance (top 3 taxa)	72.6	24-73
% Chironomidae	10.4	4-73
# Ephemeroptera taxa	1	1-5
# Plecoptera taxa	0	1-6
# Trichoptera taxa	1	0-5
Diversity	0.77	0.46-0.87
Evenness	0.36	0.15-0.43
Bray-Curtis	0.71	0.24-0.71

G. Discussion of Results

- SER0202 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abundances.
- The observed community at SER0202 had a very high proportion of Baetidae and less common taxa such as Asellidae and Crangonyctidae, which may suggest enrichment.
- Many pollution sensitive mayflies and stoneflies had a high probability of occurring yet they were not found.
- The oxygen concentration measured at the time of sampling was below the 5th percentile of the reference group suggesting that perhaps depressed oxygen from urban activities caused the departure from reference condition.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- This community had a high Bray-Curtis distance value, indicating that it was only 29% similar to the median reference community.
- This site falls outside of the 99% confidence ellipse, far from the cloud of reference sites, indicating that it is different than what was expected and, therefore, ***"stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Hyland Creek
Site code: SER03
Sampling Date: September 26, 2002
Latitude: 49.1208 N
Longitude: -122.8129 W
Ecoregion: Lower Mainland
Altitude: 30 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.019	0.002	0.187	0.394	**0.398**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

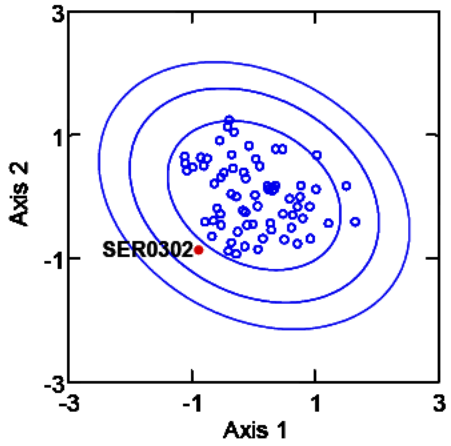
Variable	Test site SER03	Reference Group 5 MEDIAN	RANGE
Altitude	30	3325	84-5293
Stream order	1	2*	1-6
Slope ($x10^{-3}$)	25	7	0.5-38.4
Bankful width[1]	9.0	16.0	2.7-73.0
Wetted width[1]	1.5	6.6	1.2-46.5
Avg Depth[2]	10.0	18.5	6.0-43.1
Max Depth[2]	13	26	6.0-68.0
Avg Velocity[3]	0.14	0.35	0.13-0.66
Max Velocity[3]	0.28	0.53	0.18-0.86
Dominant substrate	5	6*	1-8
Surrounding material	4	2*	1-5
Embeddedness	5	5*	1-5
Alkalinity[4]	63.8	55.0	8.9-111.0
pH	7.39	7.72	6.64-8.54
Conductivity (µS/cm)	206.0	109.5	12.0-237.4
TKN[4]	0.181	0.177	0.029-0.532
Total Phosphorus[4]	0.058	0.011	0.003-0.112
Dissolved Oxygen[4]	7.34	11.24	9.56-13.95
TSS[4]	1.78	4.09	1.07-13.41
% Sand	10.8	65.4	0-90.0
% Gravel	66.6	28.7	0-94.5

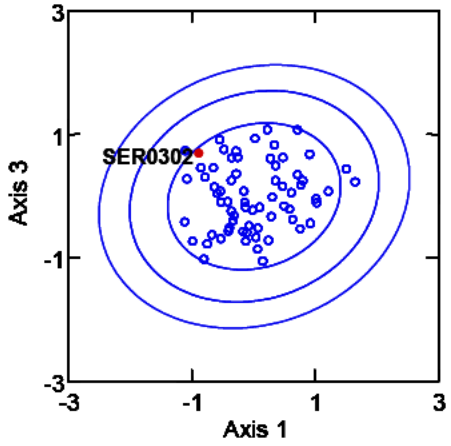
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

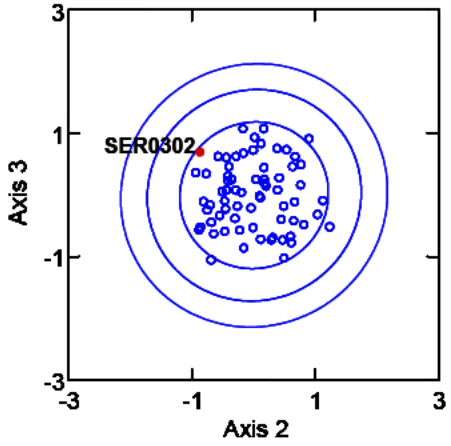
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	1375	1
Baetidae	4125	0.8
Heptageniidae	0	0.76
Ephemerellidae	0	0.75
Chloroperlidae	0	0.6
Capniidae	0	0.59
Nemouridae	0	0.56
Naididae	250	0.52
Empididae	25	0.43
Sphaeriidae	225	0.34
Tubificidae	25	0.29
Simuliidae	225	0.24
Lumbriculidae	550	0.21
Planorbidae	525	0.12
Planariidae	50	0.07
Crangonyctidae	225	0.04
Asellidae	200	0.02
Physidae	100	0
Ancylidae	175	0
	Observed	**Expected**
p>0.70	2	3.3
p>0.50	3	5.6
O:E p>0.70		0.61
O:E p>0.50		0.54

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Not stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **SER03**	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	8075	5414-32293
Total Richness	14	9-23
EPT Richness	1	5-13
% EPT	51.7	13-88
% Dominance (top 3 taxa)	74.9	24-73
% Chironomidae	17.0	4-73
# Ephemeroptera taxa	1	1-5
# Plecoptera taxa	0	1-6
# Trichoptera taxa	0	0-5
Diversity	0.70	0.46-0.87
Evenness	0.24	0.15-0.43
Bray-Curtis	0.66	0.24-0.71

G. Discussion of Results

- SER0302 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abundances.
- The observed community at SER0302 was dominated by Baetidae and Chironomidae. Many of the highly expected mayfly and stonefly taxa were not found.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- This community had a moderately high Bray-Curtis distance, indicating that it was 34% similar to the median reference community. Although the O:E ratio was low, the relative abundances of some of the less common taxa were similar to the median reference community.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Como Creek
Site code: COM01
Sampling Date: September 28, 2000
Latitude: 49.2397 N
Longitude: -122.8550 W
Ecoregion: Lower Mainland
Altitude: 36 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.039	0.016	0.221	0.197	**0.526**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

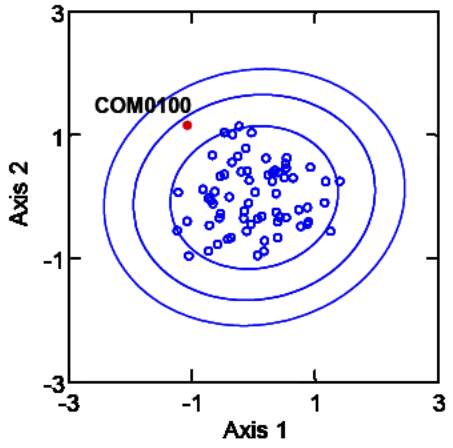
	Test site	Reference Group 5	
Variable	**COM01**	**MEDIAN**	**RANGE**
Altitude	36	3325	84-5293
Stream order	1	2*	1-6
Slope ($x10^{-3}$)	1	7	0.5-38.4
Bankful width[1]	13.5	16.0	2.7-73.0
Wetted width[1]	3.5	06.6	1.2-46.5
Avg Depth[2]	6	18.5	6.0-43.1
Max Depth[2]	9	26	6.0-68.0
Avg Velocity[3]	0.23	0.35	0.13-0.66
Max Velocity[3]	0.44	0.53	0.18-0.86
Dominant substrate	5	6*	1-8
Surrounding material	3	2*	1-5
Embeddedness	4	5*	1-5
Alkalinity[4]	60.9	55.0	8.9-111.0
pH	6.87	7.72	6.64-8.54
Conductivity (µS/cm)	147.0	109.5	12.0-237.4
TKN[4]	0.050	0.177	0.029-0.532
Total Phosphorus[4]	0.042	0.011	0.003-0.112
Dissolved Oxygen[4]	12.99	11.24	9.56-13.95
TSS[4]	0.61	4.09	1.07-13.41
% Sand	29.4	65.4	0-90.0
% Gravel	69.9	28.7	0-94.5

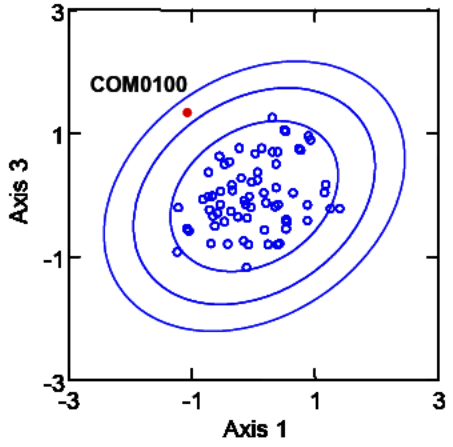
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

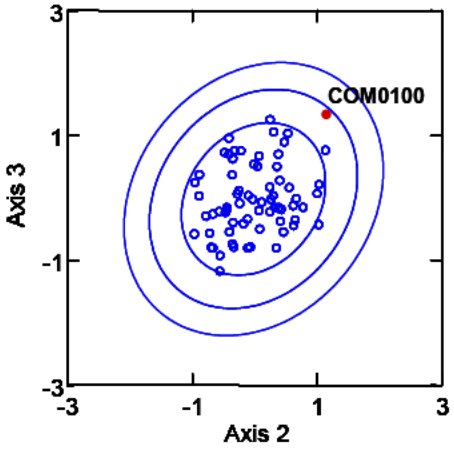
D. Invertebrate families predicted and occurring at test site

Family	**Count**	**Probability**
Chironomidae	288	0.99
Baetidae	513	0.86
Heptageniidae	0	0.84
Ephemerellidae	0	0.81
Chloroperlidae	0	0.68
Nemouridae	13	0.67
Capniidae	0	0.63
Perlodidae	0	0.5
Empididae	13	0.48
Naididae	413	0.43
Lumbriculidae	350	0.15
	Observed	**Expected**
p>0.70	2	3.5
p>0.50	3	6
O:E p>0.70		0.57
O:E p>0.50		0.5

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Stressed	Possibly stressed	**Stressed**

F. Benthic Community Descriptors

	Test site **COM01**	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	1588	5414-32293
Total Richness	6	9-23
EPT Richness	2	5-13
% EPT	33.1	13-88
% Dominance (top 3 taxa)	80.3	24-73
% Chironomidae	18.1	4-73
# Ephemeroptera taxa	1	1-5
# Plecoptera taxa	1	1-6
# Trichoptera taxa	0	0-5
Diversity	0.75	0.46-0.87
Evenness	0.66	0.15-0.43
Bray-Curtis	0.83	0.24-0.71

G. Discussion of Results

- COM0100 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abundances.
- While the observed community at COM0100 was dominated by Baetidae mayflies, it also had a very large abundance of worms (Naididae, Lumbriculidae). Many pollution sensitive mayflies and stoneflies with high probabilities of occurrence were not found at this site.
- The presence of the pollution sensitive stonefly, Nemouridae, with several pollution tolerant invertebrates suggests that this site may be recovering from episodic organic pollution events from urban activities.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- This community had a very high Bray-Curtis distance, indicating that it was only 17% similar to the median reference community.
- This site falls outside of the 99% confidence ellipse, far from the cloud of reference sites, indicating that it is different than what was expected and therefore ***"stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Booth Creek
Site code: COM02
Sampling Date: September 28, 2000
Latitude: 49.2350 N
Longitude: -122.8522 W
Ecoregion: Lower Mainland
Altitude: 20 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.006	0.001	0.080	**0.740**	0.173

C. Selected habitat variables at the test site and median and central 90% range of reference sites

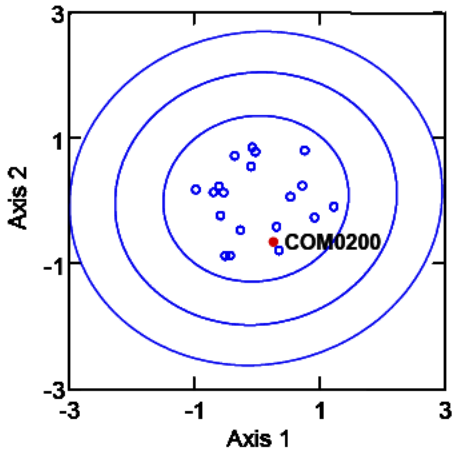
Variable	Test site COM02	Reference Group 4 MEDIAN	RANGE
Altitude	20	292	20-4021
Stream order	1	3*	1-6
Slope ($x10^{-3}$)	7	1	0.1-29.9
Bankful width[1]	5.0	37.1	6.4-231.2
Wetted width[1]	2.0	22.1	3.7-83.0
Avg Depth[2]	19	30.0	12.6-87.4
Max Depth[2]	22	36	15-116.2
Avg Velocity[3]	0.04	0.14	0-0.59
Max Velocity[3]	0.08	0.25	0-0.68
Dominant substrate	5	5*	1-7
Surrounding material	3	2*	2-5
Embeddedness	5	5*	1-5
Alkalinity[4]	70.9	25.2	5.0-84.6
pH	7.04	7.06	5.50-8.24
Conductivity (µS/cm)	156.0	12.6	6.5-162.3
TKN[4]	0.270	0.120	0.037-0.387
Total Phosphorus[4]	0.054	0.011	0.004-0.038
Dissolved Oxygen[4]	12.63	10.21	6.84-12.11
TSS[4]	5.34	2.7	0.97-28.05
% Sand	27.3	72.9	0.1-99.0
% Gravel	71.6	5.7	0-62.8

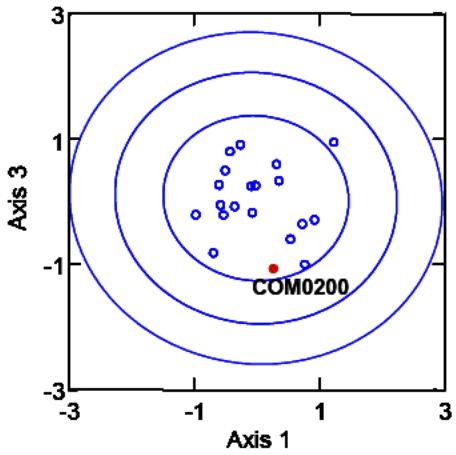
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

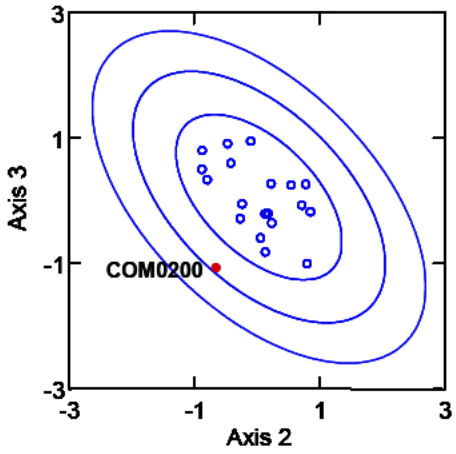
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	1333	1
Baetidae	800	0.71
Naididae	967	0.67
Ephemerellidae	0	0.65
Heptageniidae	0	0.59
Capniidae	0	0.52
Tubificidae	233	0.43
Nemouridae	33	0.36
Lumbriculidae	1267	0.33
Enchytraeidae	33	0.27
Planorbidae	567	0.2
Crangonyctidae	1200	0.05
Dytiscidae	33	0.04
Asellidae	2400	0.04
Physidae	400	0
	Observed	**Expected**
p>0.70	2	1.7
p>0.50	3	4.1
O:E p>0.70		1.17
O:E p>0.50		0.72

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **COM02**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	9267	820-8290
Total Richness	12	6-19
EPT Richness	2	1-10
% EPT	9.0	0-43
% Dominance (top 3 taxa)	54.0	39-83
% Chironomidae	14.4	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	1	0-2
# Trichoptera taxa	0	0-5
Diversity	0.85	0.31-0.77
Evenness	0.56	0.11-0.32
Bray-Curtis	0.74	0.27-0.73

G. Discussion of Results

- COM0200 is predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at COM0200 was dominated by Isopods, although they had only a 4% chance of occurring at the site, assuming it was unimpaired. This site is missing some mayflies that were expected to occur with probabilities >50%.
- This community had a relatively high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community also had a high Bray-Curtis distance, indicating that it was only 26% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Nelson Creek
Site code: COM03
Sampling Date: September 28, 2000
Latitude: 49.2347 N
Longitude: -122.8664 W
Ecoregion: Lower Mainland
Altitude: 26 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.029	0.009	0.228	0.129	**0.605**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

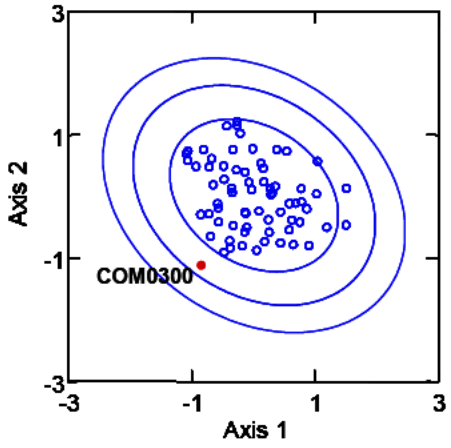
Variable	Test site COM03	Reference Group 5 MEDIAN	RANGE
Altitude	26	3325	84-5293
Stream order	1	2*	1-6
Slope ($x10^{-3}$)	8	7	0.5-38.4
Bankful width[1]	4.0	16.0	2.7-73.0
Wetted width[1]	1.8	06.6	1.2-46.5
Avg Depth[2]	3.8	18.5	6.0-43.1
Max Depth[2]	6	26	6.0-68.0
Avg Velocity[3]	0.30	0.35	0.13-0.66
Max Velocity[3]	0.57	0.53	0.18-0.86
Dominant substrate	5	6*	1-8
Surrounding material	3	2*	1-5
Embeddedness	5	5*	1-5
Alkalinity[4]	64.8	55.0	8.7-111.0
pH	6.88	7.72	6.64-8.54
Conductivity (µS/cm)	148.0	109.5	12.0-237.4
TKN[4]	0.370	0.177	0.029-0.532
Total Phosphorus[4]	0.106	0.011	0.003-0.112
Dissolved Oxygen[4]	11.62	11.24	9.56-13.95
TSS[4]	54.02	4.09	1.07-13.41
% Sand	36.2	65.4	0-90.0
% Gravel	63.2	28.7	0-94.5

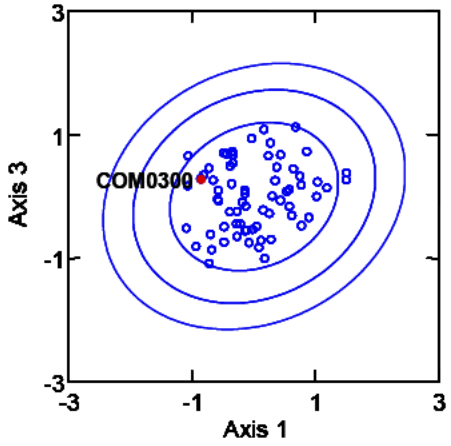
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

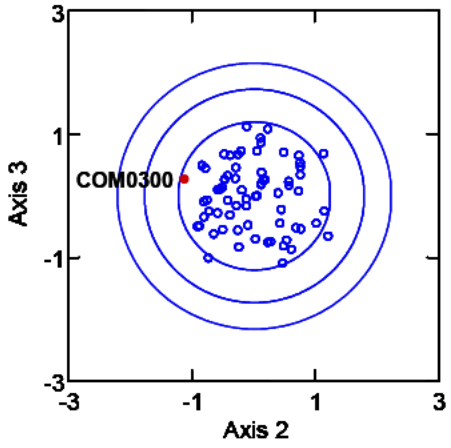
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	2033	0.99
Baetidae	1967	0.88
Heptageniidae	0	0.88
Ephemerellidae	0	0.83
Nemouridae	0	0.71
Chloroperlidae	0	0.7
Capniidae	0	0.64
Perlodidae	0	0.54
Empididae	0	0.5
Tipulidae	0	0.5
Hydropsychidae	67	0.45
Naididae	67	0.4
Simuliidae	33	0.27
Tubificidae	933	0.19
Lumbriculidae	1133	0.12
Crangonyctidae	600	0.04
Asellidae	767	0.01
Hydrobiidae	133	0
	Observed	**Expected**
p>0.70	2	4.3
p>0.50	2	7.2
O:E p>0.70		0.47
O:E p>0.50		0.28

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Not stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site COM03	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	7733	5414-32293
Total Richness	10	9-23
EPT Richness	2	5-13
% EPT	26.3	13-88
% Dominance (top 3 taxa)	66.4	24-73
% Chironomidae	26.3	4-73
# Ephemeroptera taxa	1	1-5
# Plecoptera taxa	0	1-6
# Trichoptera taxa	1	0-5
Diversity	0.81	0.46-0.87
Evenness	0.54	0.15-0.43
Bray-Curtis	0.61	0.24-0.71

G. Discussion of Results

- COM0300 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abundances.
- The observed community at COM0300 was dominated by Chironomidae and Baetidae as expected but also had high abundances of worms.
- This community was missing many of the highly expected mayflies and stoneflies as well as some of the Dipteran taxa.
- This community had a very low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- This site had a moderately high Bray-Curtis distance value, indicating that it was 39% similar to the median reference community. Although the O:E ratio was low, the relative abundances of some of the taxa were similar to the median reference community.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Coquitlam River
Site code: COQ01
Sampling Date: September 28, 2000
Latitude: 49.2767 N
Longitude: -122.7767 W
Ecoregion: Lower Mainland
Altitude: 49 (fasl)
Stream Order: 3

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.517	0.182	0.217	0.018	0.066

C. Selected habitat variables at the test site and median and central 90% range of reference sites

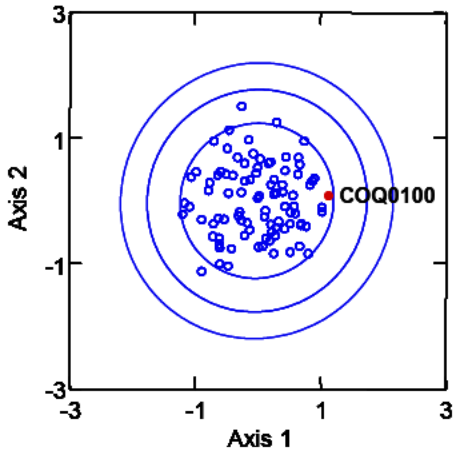
Variable	Test site COQ01	Reference Group 1 MEDIAN	RANGE
Altitude	49	1830	91-5115
Stream order	3	2*	1-4
Slope ($x10^{-3}$)	3	16	0.6-72.9
Bankful width[1]	37.6	30.3	4.2-149.4
Wetted width[1]	32.0	14.0	1.4-59.2
Avg Depth[2]	24.4	29.4	7.9-60.5
Max Depth[2]	32	42	10.0-83.5
Avg Velocity[3]	0.20	0.42	0.16-0.83
Max Velocity[3]	0.29	0.72	0.27-1.17
Dominant substrate	8	7*	5-8
Surrounding material	3	2*	2-6
Embeddedness	3	3*	1-5
Alkalinity[4]	5.9	26.4	4.2-88.5
pH	6.35	7.55	6.31-8.33
Conductivity (µS/cm)	18.0	53.3	8.0-211.5
TKN[4]	0.074	0.042	0.007-0.155
Total Phosphorus[4]	0.130	0.007	0.002-0.039
Dissolved Oxygen[4]	12.05	11.38	9.18-13.91
TSS[4]	2.99	2.98	0.23-36.71
% Sand	95.9	71.0	3.1-97.9
% Gravel	3.6	26.5	0.6-96.9

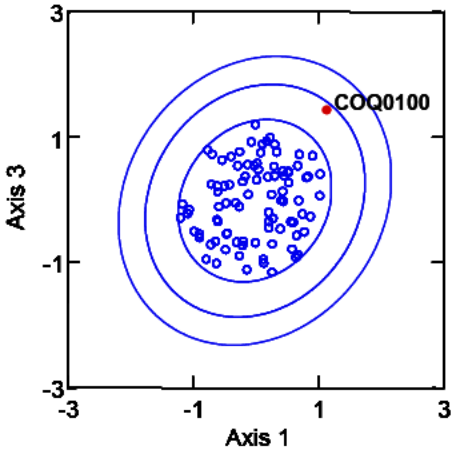
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

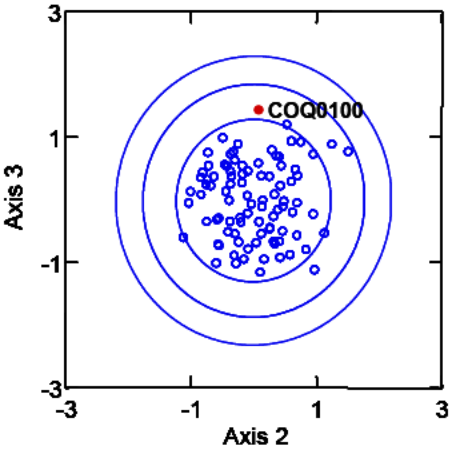
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	971	0.99
Heptageniidae	29	0.93
Baetidae	300	0.89
Ephemerellidae	200	0.84
Chloroperlidae	0	0.84
Nemouridae	0	0.76
Capniidae	14	0.64
Perlodidae	0	0.64
Tipulidae	114	0.59
Taeniopterygidae	0	0.57
Rhyacophilidae	0	0.57
Empididae	14	0.55
Sperchontidae	57	0.38
Lebertiidae	57	0.38
Lepidostomatidae	14	0.32
Leptophlebiidae	43	0.3
Naididae	1543	0.29
Torrenticolidae	86	0.23
Lumbriculidae	71	0.23
Hygrobatidae	14	0.04
Crangonyctidae	14	0.01
	Observed	**Expected**
p>0.70	4	5.3
p>0.50	7	8.8
O:E p>0.70		0.76
O:E p>0.50		0.79

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Possibly stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site COQ01	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	3543	170-1777
Total Richness	16	9-26
EPT Richness	6	7-15
% EPT	16.9	47-97
% Dominance (top 3 taxa)	79.4	21-66
% Chironomidae	27.4	2-32
# Ephemeroptera taxa	4	2-5
# Plecoptera taxa	1	2-6
# Trichoptera taxa	1	0-6
Diversity	0.72	0.53-0.88
Evenness	0.22	0.17-0.43
Bray-Curtis	0.90	0.36-0.75

G. Discussion of Results

- COQ0100 is predicted to be similar to Group 1 reference sites. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at COQ0100 was dominated by worms followed by Chironomidae.
- This community had a moderate O:E taxa ratio indicating that many of the several of the expected taxa, primarily stoneflies, were not found at this site.
- This community had a very high Bray-Curtis distance, indicating that it was only 10% similar to the median reference community. Although the O:E ratio is moderately high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Coquitlam River
Site code: COQ02
Sampling Date: September 28, 2000
Latitude: 49.2347 N
Longitude: -122.8664 W
Ecoregion: Lower Mainland
Altitude: 26 (fasl)
Stream Order: 3

B. Results of BEAST prediction

Test Site was predicted to: **Group 2**
(n= 16 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.179	**0.228**	0.216	0.219	0.159

C. Selected habitat variables at the test site and median and central 90% range of reference sites

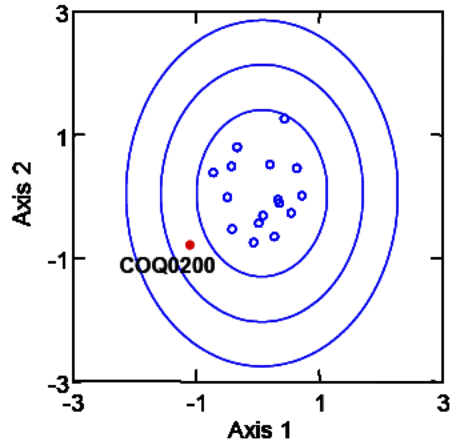
Variable	Test site COQ02	Reference Group 2 MEDIAN	RANGE
Altitude	26	2240	242-5020
Stream order	3	5*	1-6
Slope ($x10^{-3}$)	4	1	0.2-43.2
Bankful width[1]	38.7	63.4	5.1-263.6
Wetted width[1]	36.0	24.0	3.6-162.5
Avg Depth[2]	16.8	26.4	11.1-44.1
Max Depth[2]	24	32	13.5-64.0
Avg Velocity[3]	0.41	0.36	0.07-0.72
Max Velocity[3]	0.51	0.49	0.09-1.13
Dominant substrate	7	6*	4-7
Surrounding material	3	2*	0-5
Embeddedness	3	3*	2-4
Alkalinity[4]	5.9	55.5	4.2-80.6
pH	6.33	7.62	6.18-8.76
Conductivity (µS/cm)	17.0	142.6	11.5-169.8
TKN[4]	0.068	0.062	0.011-0.146
Total Phosphorus[4]	0.015	0.008	0.003-0.043
Dissolved Oxygen[4]	12.61	11.84	8.72-13.40
TSS[4]	4.00	18.58	3.61-55.49
% Sand	2.2	75.8	52.6-98.0
% Gravel	97.8	19.2	0-47.0

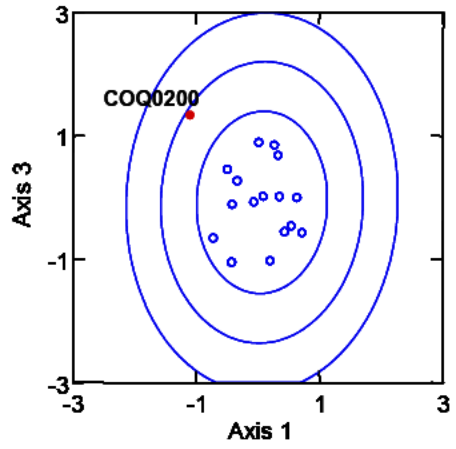
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

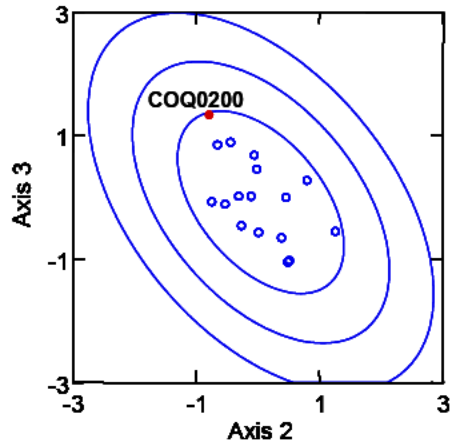
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	540	0.99
Baetidae	1600	0.82
Heptageniidae	540	0.81
Ephemerellidae	460	0.76
Chloroperlidae	40	0.72
Nemouridae	120	0.63
Capniidae	0	0.63
Tipulidae	60	0.54
Empididae	20	0.51
Perlodidae	60	0.5
Naididae	720	0.42
Sperchontidae	100	0.31
Leptophlebiidae	180	0.29
Lumbriculidae	220	0.25
Torrenticolidae	100	0.23
Glossosomatidae	40	0.19
Crangonyctidae	20	0.02
	Observed	**Expected**
p>0.70	5	4.1
p>0.50	8	6.4
O:E p>0.70		1.22
O:E p>0.50		1.25

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Possibly stressed	Not stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site COQ02	**Reference Group 2** Central 90% range (5th-95th percentiles)
Abundance	4820	32-1014
Total Richness	16	8-20
EPT Richness	8	4-12
% EPT	63.1	43-83
% Dominance (top 3 taxa)	59.3	21-60
% Chironomidae	11.2	7-32
# Ephemeroptera taxa	4	2-5
# Plecoptera taxa	3	2-4
# Trichoptera taxa	1	0-4
Diversity	0.83	0.57-0.90
Evenness	0.36	0.21-0.58
Bray-Curtis	0.81	0.31-0.80

G. Discussion of Results

- COQ0200 is predicted to be similar to Group 2 reference sites. These communities tend to have small abundances of many taxa including worms as well as stoneflies.
- The model had some difficulty in predicting this site. While it was predicted to be similar to Group 2 with a probability of 23%, it was also predicted to be similar to groups 3 and 4 with probabilities of 22% for both groups. The results were “not stressed” and “possibly stressed”, respectively.
- This community had a very high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a very high Bray-Curtis distance, indicating that it was only 19% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore “***possibly stressed***”.

Summary of CABIN results

A. Test Site Information

Stream Name: Beecher Creek
Site code: BRU01
Sampling Date: September 26, 2000
Latitude: 49.2705 N
Longitude: -122.9856 W
Ecoregion: Lower Mainland
Altitude: 128 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.017	0.004	0.208	**0.481**	0.289

C. Selected habitat variables at the test site and median and central 90% range of reference sites

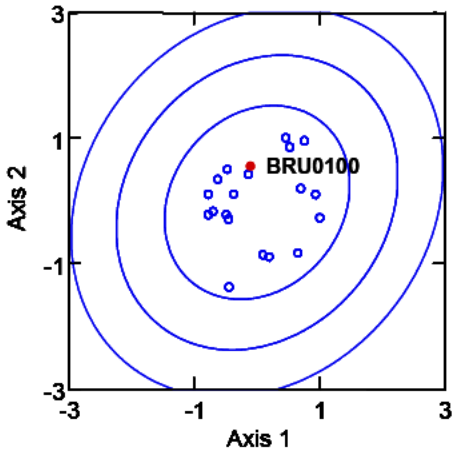
Variable	Test site BRU01	Reference Group 4 MEDIAN	RANGE
Altitude	128	292	20-4021
Stream order	1	3*	1-6
Slope ($x10^{-3}$)	51	1	0.1-29.9
Bankful width[1]	3.8	37.1	6.4-231.2
Wetted width[1]	1.3	22.1	3.7-83.0
Avg Depth[2]	5.25	30.0	12.6-87.4
Max Depth[2]	8	36	15-116.2
Avg Velocity[3]	0.13	0.14	0-0.59
Max Velocity[3]	0.192	0.25	0-0.68
Dominant substrate	6	5*	1-7
Surrounding material	4	2*	2-5
Embeddedness	5	5*	1-5
Alkalinity[4]	53.3	25.2	5.0-84.6
pH	6.70	7.06	5.50-8.24
Conductivity (µS/cm)	135.0	012.6	6.5-162.3
TKN[4]	0.070	0.120	0.037-0.387
Total Phosphorus[4]	0.026	0.011	0.004-0.038
Dissolved Oxygen[4]	9.79	10.21	6.84-12.11
TSS[4]	11.61	2.7	0.97-28.05
% Sand	3.1	72.9	0.1-99.0
% Gravel	96.4	05.7	0-62.8

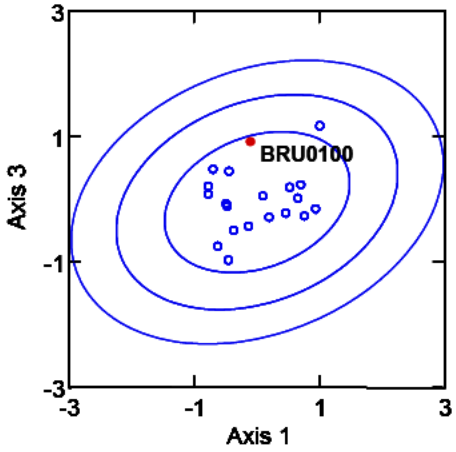
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

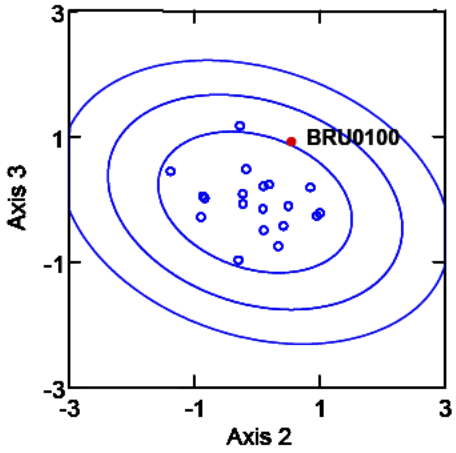
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	878	0.99
Baetidae	456	0.78
Ephemerellidae	0	0.73
Heptageniidae	0	0.72
Chloroperlidae	0	0.57
Capniidae	0	0.57
Naididae	44	0.55
Nemouridae	0	0.51
Empididae	67	0.41
Hydropsychidae	11	0.38
Lepidostomatidae	56	0.35
Rhyacophilidae	11	0.3
Enchytraeidae	22	0.28
Lumbriculidae	89	0.24
Simuliidae	11	0.23
Crangonyctidae	689	0.04
Asellidae	311	0.03
Ancylidae	44	0
	Observed	**Expected**
p>0.70	2	3.2
p>0.50	3	5.4
O:E p>0.70		0.62
O:E p>0.50		0.55

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **BRU01**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	2689	820-8290
Total Richness	13	6-19
EPT Richness	4	1-10
% EPT	19.4	0-43
% Dominance (top 3 taxa)	75.2	39-83
% Chironomidae	32.6	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	3	0-5
Diversity	0.78	0.31-0.77
Evenness	0.35	0.11-0.32
Bray-Curtis	0.57	0.27-0.73

G. Discussion of Results

- BRU0100 is predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at BRU0100 had a very low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- Ephemerellidae, Heptageniidae, Chloroperlidae, and Capniidae were expected to occur with probabilities >50% but were not found. Taxa such as Asellidae and Crangonyctidae were expected to occur with very low probabilities but were found in large abundances.
- This community had a moderate Bray-Curtis distance, indicating that it was 43% similar to the median reference community. Although the O:E ratio was low, the relative abundances of many of the taxa were similar to the median reference community.
- This site fell just outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and therefore "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Beecher Creek
Site code: BRU01
Sampling Date: September 23, 2002
Latitude: 49.2708 N
Longitude: -122.9858 W
Ecoregion: Lower Mainland
Altitude: 134 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 3**
(n= 80 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.328	0.019	**0.422**	0.005	0.225

C. Selected habitat variables at the test site and median and central 90% range of reference sites

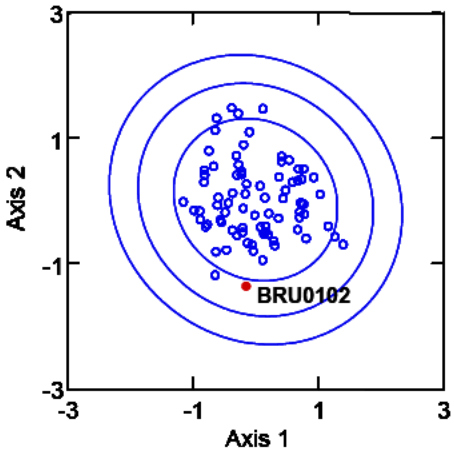
Variable	Test site BRU01	Reference Group 3 MEDIAN	RANGE
Altitude	134	3312	95-5584
Stream order	1	3*	1-4
Slope ($x10^{-3}$)	27	12	0.4-89.4
Bankful width[1]	3.6	18.0	3.1-92.9
Wetted width[1]	2.0	7.4	1.4-40.3
Avg Depth[2]	6.0	21.9	7.0-56.3
Max Depth[2]	8	30	8.0-78.3
Avg Velocity[3]	0.24	0.39	0.16-0.67
Max Velocity[3]	0.33	0.56	0.25-0.95
Dominant substrate	7	7*	4-8
Surrounding material	4	3*	2-5
Embeddedness	4	5*	2-5
Alkalinity[4]	47.8	39.5	7.4-112.2
pH	7.22	7.64	6.56-8.55
Conductivity (µS/cm)	152.0	83.5	15.2-187.4
TKN[4]	0.170	0.073	0.014-0.363
Total Phosphorus[4]	0.028	0.007	0.002-0.084
Dissolved Oxygen[4]	9.68	11.75	9.49-14.12
TSS[4]	2.88	3.62	0.95-20.69
% Sand	15.9	72.5	9.8-88.8
% Gravel	83.8	25.8	7.0-84.1

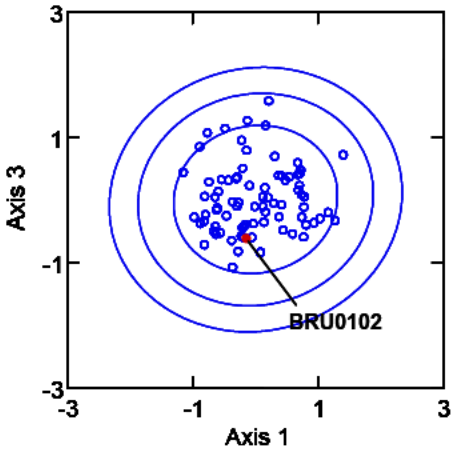
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

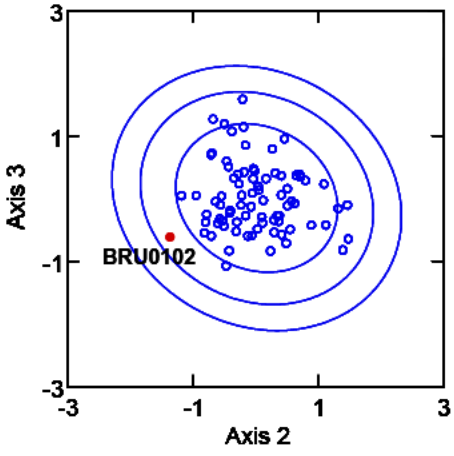
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	618	0.99
Heptageniidae	0	0.97
Baetidae	191	0.91
Ephemerellidae	0	0.88
Chloroperlidae	0	0.82
Nemouridae	0	0.79
Perlodidae	0	0.65
Capniidae	0	0.63
Tipulidae	0	0.58
Rhyacophilidae	0	0.54
Empididae	9	0.54
Taeniopterygidae	0	0.51
Hydropsychidae	23	0.49
Lepidostomatidae	14	0.38
Enchytraeidae	14	0.32
Simuliidae	4	0.32
Naididae	36	0.3
Sphaeriidae	4	0.18
Lumbriculidae	27	0.14
Planorbidae	9	0.04
Crangonyctidae	368	0.02
Physidae	4	0.01
Asellidae	114	0
Ancylidae	4	0
	Observed	**Expected**
p>0.70	2	5.4
p>0.50	3	8.8
O:E p>0.70		0.37
O:E p>0.50		0.34

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **BRU01**	**Reference Group 3** Central 90% range (5th-95th percentiles)
Abundance	1441	1659-12885
Total Richness	15	10-20
EPT Richness	3	5-13
% EPT	15.8	39-97
% Dominance (top 3 taxa)	81.7	22-65
% Chironomidae	42.9	2-43
# Ephemeroptera taxa	1	2-5
# Plecoptera taxa	0	2-6
# Trichoptera taxa	2	1-5
Diversity	0.73	0.57-0.87
Evenness	0.24	0.20-0.48
Bray-Curtis	0.55	0.32-0.75

G. Discussion of Results

- BRU0102 is predicted to be similar to Group 3 reference communities. These communities tend to have moderate abundances of many taxa but are generally dominated by Chironomidae, and the mayflies, Baetidae, Heptageniidae and Ephemerellidae.
- The observed community at BRU0102 had a very low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- While this community was dominated by Chironomidae and Baetidae, many of the mayflies, stoneflies and caddisflies that were expected to occur with probabilities >50% were not found. Taxa such as Asellidae and Crangonyctidae were expected to occur with very low probabilities but were found in large abundances.
- This community had a moderate Bray-Curtis distance, indicating that it was 45% similar to the median reference community. Although the O:E ratio was low, the relative abundances of many of the taxa were similar to the median reference community.
- The site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Eagle Creek
Site code: BRU02
Sampling Date: September 26, 2000
Latitude: 49.2522 N
Longitude: -122.9426 W
Ecoregion: Lower Mainland
Altitude: 125 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 3**
(n= 80 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.250	0.022	**0.377**	0.015	0.335

C. Selected habitat variables at the test site and median and central 90% range of reference sites

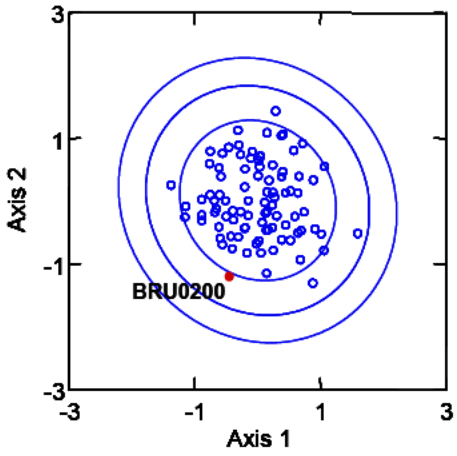
Variable	Test site BRU02	Reference Group 3 MEDIAN	RANGE
Altitude	125	3312	95-5584
Stream order	1	3*	1-4
Slope ($x10^{-3}$)	13	12	0.4-89.4
Bankful width[1]	5.0	18.0	3.1-92.9
Wetted width[1]	2.9	07.4	1.4-40.3
Avg Depth[2]	10.3	21.9	7.0-56.3
Max Depth[2]	16	30	8.0-78.3
Avg Velocity[3]	0.198	0.39	0.16-0.67
Max Velocity[3]	0.314	0.56	0.25-0.95
Dominant substrate	6	7*	4-8
Surrounding material	3	3*	2-5
Embeddedness	4	5*	2-5
Alkalinity[4]	73.5	39.5	7.4-112.2
pH	7.11	7.64	6.56-8.55
Conductivity (µS/cm)	138.0	083.5	15.2-187.4
TKN[4]	0.133	0.073	0.014-0.363
Total Phosphorus[4]	0.074	0.007	0.002-0.084
Dissolved Oxygen[4]	10.80	11.75	9.49-14.12
TSS[4]	3.39	3.62	0.95-20.69
% Sand	28.9	72.5	9.8-88.8
% Gravel	69.9	25.8	7.0-84.1

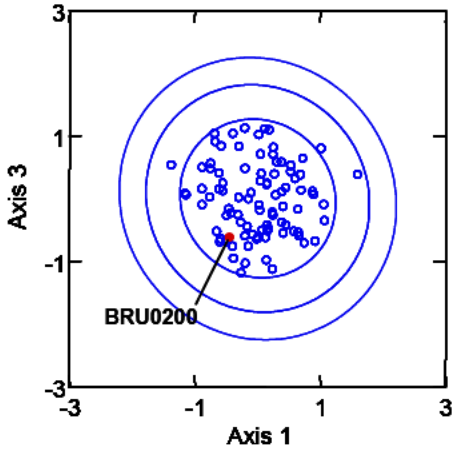
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

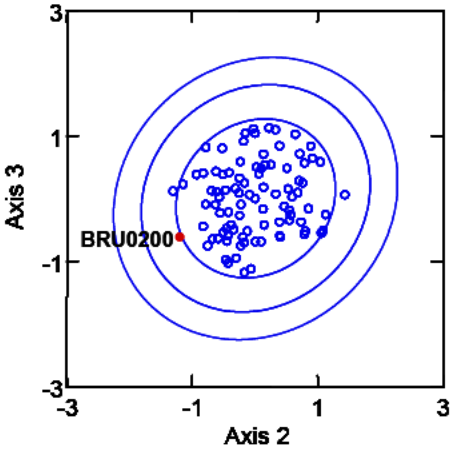
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	280	0.99
Heptageniidae	0	0.95
Baetidae	587	0.91
Ephemerellidae	0	0.87
Chloroperlidae	0	0.8
Nemouridae	53	0.78
Capniidae	0	0.64
Perlodidae	0	0.63
Tipulidae	0	0.56
Empididae	7	0.53
Rhyacophilidae	33	0.5
Hydropsychidae	40	0.48
Naididae	147	0.31
Simuliidae	13	0.31
Lumbriculidae	47	0.13
Crangonyctidae	107	0.03
Asellidae	60	0
	Observed	**Expected**
p>0.70	3	5.3
p>0.50	4	7.7
O:E p>0.70		0.57
O:E p>0.50		0.52

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **BRU02**	**Reference Group 3** Central 90% range (5th-95th percentiles)
Abundance	1373	1659-12885
Total Richness	11	10-20
EPT Richness	4	5-13
% EPT	49.5	39-97
% Dominance (top 3 taxa)	73.8	22-65
% Chironomidae	20.4	2-43
# Ephemeroptera taxa	1	2-5
# Plecoptera taxa	1	2-6
# Trichoptera taxa	2	1-5
Diversity	0.75	0.57-0.87
Evenness	0.37	0.20-0.48
Bray-Curtis	0.81	0.32-0.75

G. Discussion of Results

- BRU0200 is predicted to be similar to Group 3 reference communities. These communities tend to have moderate abundances of many taxa but are generally dominated by Chironomidae, and the mayflies, Baetidae, Heptageniidae and Ephemerellidae.
- The observed community at BRU0200 had a very low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- While this community was dominated by Chironomidae and Baetidae, many of the mayflies and stoneflies that were expected to occur with probabilities >50% were not found. Taxa such as Asellidae and Crangonyctidae were expected to occur with very low probabilities but were found in large abundances.
- This community had a very high Bray-Curtis distance, indicating that it was only 19% similar to the median reference community.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Eagle Creek
Site code: BRU02
Sampling Date: September 23, 2002
Latitude: 49.2520 N
Longitude: -122.9407 W
Ecoregion: Lower Mainland
Altitude: 102 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.413	0.017	0.385	0.005	0.180

C. Selected habitat variables at the test site and median and central 90% range of reference sites

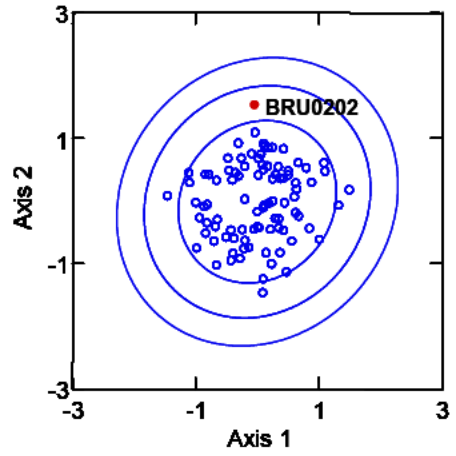
Variable	Test site BRU02	Reference Group 1 MEDIAN	RANGE
Altitude	102	1830	91-5115
Stream order	1	2*	1-4
Slope ($x10^{-3}$)	31	16	0.6-72.9
Bankful width[1]	10.5	30.3	4.2-149.4
Wetted width[1]	6.0	14.0	1.4-59.2
Avg Depth[2]	5.0	29.4	7.9-60.5
Max Depth[2]	8	42	10.0-83.5
Avg Velocity[3]	0.08	0.42	0.16-0.83
Max Velocity[3]	0.15	0.72	0.27-1.17
Dominant substrate	7	7*	5-8
Surrounding material	4	2*	2-6
Embeddedness	3	3*	1-5
Alkalinity[4]	103.0	26.4	4.2-88.5
pH	7.83	7.55	6.31-8.33
Conductivity (µS/cm)	243.0	53.3	8.0-211.5
TKN[4]	0.153	0.042	0.007-0.155
Total Phosphorus[4]	0.036	0.007	0.002-0.039
Dissolved Oxygen[4]	9.48	11.38	9.18-13.91
TSS[4]	2.51	2.98	0.23-36.71
% Sand	30.9	71.0	3.1-97.9
% Gravel	68.7	26.5	0.6-96.9

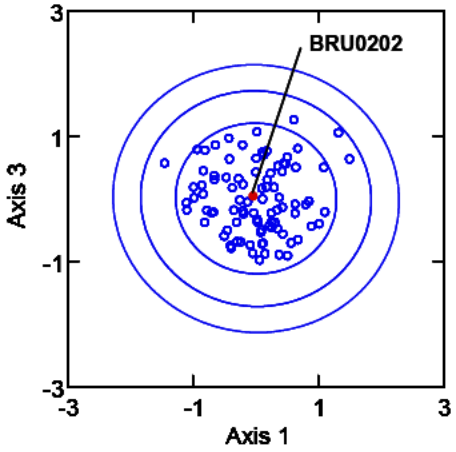
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

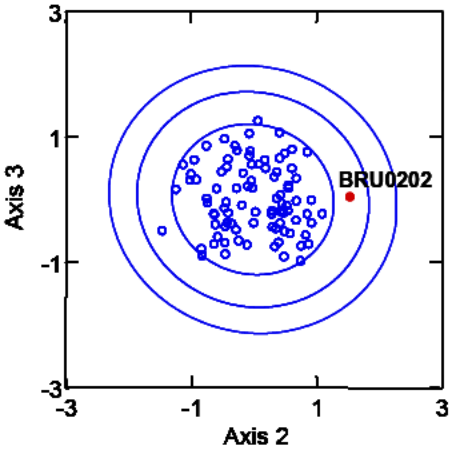
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	300	0.99
Heptageniidae	0	0.97
Baetidae	515	0.91
Ephemerellidae	0	0.89
Chloroperlidae	0	0.83
Nemouridae	35	0.79
Perlodidae	0	0.66
Capniidae	0	0.63
Tipulidae	5	0.58
Rhyacophilidae	0	0.56
Taeniopterygidae	0	0.54
Empididae	10	0.53
Hydropsychidae	100	0.49
Enchytraeidae	10	0.33
Simuliidae	25	0.32
Sphaeriidae	5	0.16
Lumbriculidae	180	0.15
Planorbidae	5	0.04
Hygrobatidae	5	0.04
Hydrozetiidae	5	0.02
Crangonyctidae	270	0.02
Physidae	20	0
Lymnaeidae	5	0
Asellidae	100	0
Tetrastemmatidae	40	0
	Observed	**Expected**
p>0.70	3	5.4
p>0.50	5	8.9
O:E p>0.70		0.56
O:E p>0.50		0.56

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **BRU02**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	1635	170-1777
Total Richness	18	9-26
EPT Richness	3	7-15
% EPT	39.8	47-97
% Dominance (top 3 taxa)	66.4	21-66
% Chironomidae	18.3	2-32
# Ephemeroptera taxa	1	2-5
# Plecoptera taxa	1	2-6
# Trichoptera taxa	1	0-6
Diversity	0.82	0.53-0.88
Evenness	0.31	0.17-0.43
Bray-Curtis	0.84	0.36-0.75

G. Discussion of Results

- BRU0202 is predicted to be similar to Group 1 reference communities. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at BRU0202 had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- Several of the mayflies and stoneflies that were expected to occur with probabilities >50% were not found.
- This community had a very high Bray-Curtis distance, indicating that it was only 16% similar to the median reference community.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Stoney Creek
Site code: BRU03
Sampling Date: September 26, 2000
Latitude: 49.2568 N
Longitude: -122.9043 W
Ecoregion: Lower Mainland
Altitude: 125 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.119	0.010	0.323	0.124	**0.423**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

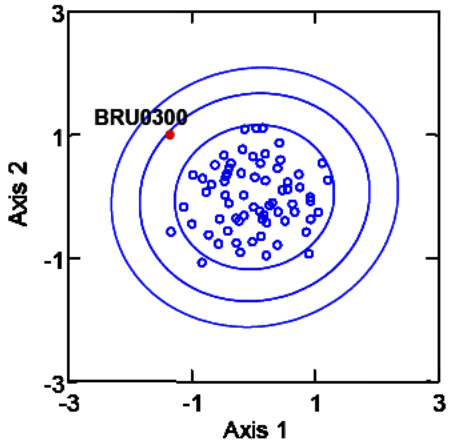
Variable	Test site BRU03	Reference Group 5 MEDIAN	RANGE
Altitude	125	3325	84-5293
Stream order	1	2*	1-6
Slope ($x10^{-3}$)	26	7	0.5-38.4
Bankful width[1]	11.6	16.0	2.7-73.0
Wetted width[1]	1.9	6.6	1.2-46.5
Avg Depth[2]	18.2	18.5	6.0-43.1
Max Depth[2]	22	26	6.0-68.0
Avg Velocity[3]	0.118	0.35	0.13-0.66
Max Velocity[3]	0.270	0.53	0.18-0.86
Dominant substrate	5	6*	1-8
Surrounding material	3	2*	1-5
Embeddedness	5	5*	1-5
Alkalinity[4]	61.0	55.0	8.9-111.0
pH	6.80	7.72	6.64-8.54
Conductivity (µS/cm)	152.0	109.5	12.0-237.4
TKN[4]	0.060	0.177	0.029-0.532
Total Phosphorus[4]	0.034	0.011	0.003-0.112
Dissolved Oxygen[4]	10.49	11.24	9.56-13.95
TSS[4]	1.22	4.09	1.07-13.41
% Sand	17.7	65.4	0-90.0
% Gravel	82.0	28.7	0-94.5

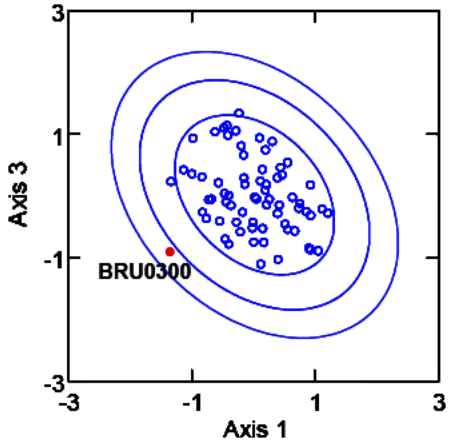
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

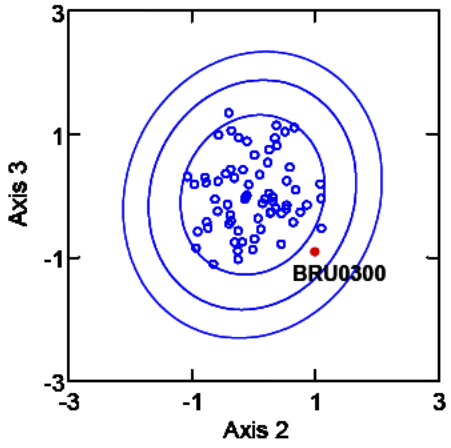
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	257	0.99
Heptageniidae	0	0.89
Baetidae	2300	0.88
Ephemerellidae	43	0.83
Chloroperlidae	0	0.73
Nemouridae	0	0.72
Capniidae	0	0.63
Perlodidae	0	0.56
Tipulidae	0	0.53
Empididae	0	0.5
Rhyacophilidae	29	0.42
Naididae	271	0.38
Simuliidae	14	0.29
Tubificidae	14	0.17
Lumbriculidae	186	0.14
Crangonyctidae	114	0.03
Asellidae	29	0.01
	Observed	**Expected**
p>0.70	3	5
p>0.50	3	7.3
O:E p>0.70		0.59
O:E p>0.50		0.41

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Stressed	Possibly stressed	**Stressed**

F. Benthic Community Descriptors

	Test site **BRU03**	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	3257	5414-32293
Total Richness	10	9-23
EPT Richness	3	5-13
% EPT	71.9	13-88
% Dominance (top 3 taxa)	86.8	24-73
% Chironomidae	7.9	4-73
# Ephemeroptera taxa	2	1-5
# Plecoptera taxa	0	1-6
# Trichoptera taxa	1	0-5
Diversity	0.48	0.46-0.87
Evenness	0.19	0.15-0.43
Bray-Curtis	0.71	0.24-0.71

G. Discussion of Results

- BRU0300 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abundances.
- The observed community at BRU0300 had a very low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- Many of the metrics exceeded or approached the 5^{th} or 95^{th} percentiles of the reference sites.
- This community was primarily composed of Baetidae mayflies and worms which generally indicate enrichment. Pollution sensitive taxa such as Ephemerellidae and Rhyacophilidae were present.
- The taxa that were absent tended to be sprawling taxa while clinging and burrowing taxa were present. This may suggest an adaptation to flow fluctuations from urban runoff.
- This community had a high Bray-Curtis distance, indicating that it was only 29% similar to the median reference community.
- This site falls outside of the 99% confidence ellipse, far from the cloud of reference sites, indicating that it is different than what was expected and, therefore, ***"stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Stoney Creek
Site code: BRU03
Sampling Date: September 23, 2002
Latitude: 49.2568 N
Longitude: -122.9042 W
Ecoregion: Lower Mainland
Altitude: 125 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.135	0.008	0.411	0.020	**0.426**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

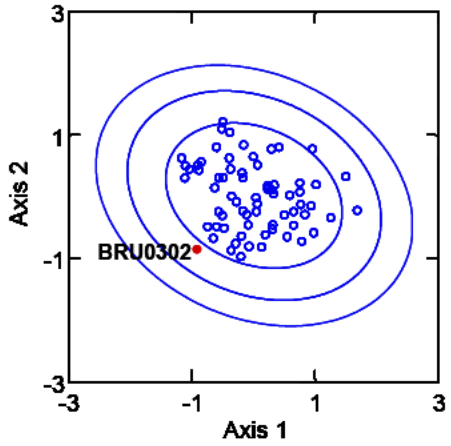
Variable	Test site BRU03	Reference Group 5 MEDIAN	RANGE
Altitude	125	3325	84-5293
Stream order	1	2*	1-6
Slope ($x10^{-3}$)	41	7	0.5-38.4
Bankful width[1]	11.5	16.0	2.7-73.0
Wetted width[1]	1.5	6.6	1.2-46.5
Avg Depth[2]	4.8	18.5	6.0-43.1
Max Depth[2]	10	26	6.0-68.0
Avg Velocity[3]	0.13	0.35	0.13-0.66
Max Velocity[3]	0.25	0.53	0.18-0.86
Dominant substrate	6	6*	1-8
Surrounding material	4	2*	1-5
Embeddedness	5	5*	1-5
Alkalinity[4]	65.1	55.0	8.9-111.0
pH	7.33	7.72	6.64-8.54
Conductivity (µS/cm)	226.0	109.5	12.0-237.4
TKN[4]	0.130	0.177	0.029-0.532
Total Phosphorus[4]	0.022	0.011	0.003-0.112
Dissolved Oxygen[4]	9.91	11.24	9.56-13.95
TSS[4]	1.06	4.09	1.07-13.41
% Sand	6.6	65.4	0-90.0
% Gravel	93.4	28.7	0-94.5

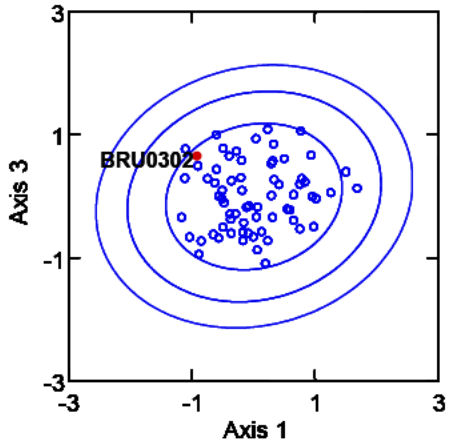
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

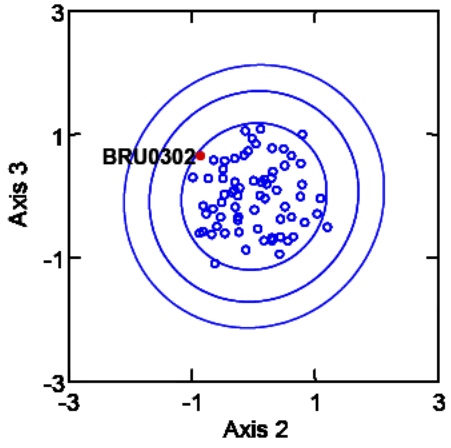
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	600	0.99
Heptageniidae	25	0.95
Baetidae	3400	0.91
Ephemerellidae	575	0.87
Chloroperlidae	0	0.78
Nemouridae	150	0.78
Capniidae	0	0.64
Perlodidae	50	0.62
Tipulidae	0	0.55
Empididae	100	0.53
Hydropsychidae	100	0.48
Leptophlebiidae	125	0.47
Elmidae	25	0.38
Naididae	325	0.33
Torrenticolidae	50	0.31
Simuliidae	525	0.31
Enchytraeidae	25	0.3
Lumbriculidae	775	0.1
Pteronarcyidae	50	0.06
Planorbidae	100	0.04
Crangonyctidae	425	0.03
Lymnaeidae	25	0.01
Asellidae	675	0
Ancylidae	25	0
Entomobryidae	25	0
Sciomyzidae	25	0
Tetrastemmatidae	50	0
	Observed	**Expected**
p>0.70	5	5.3
p>0.50	7	7.6
O:E p>0.70		0.95
O:E p>0.50		0.92

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Not stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **BRU03**	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	8250	5414-32293
Total Richness	24	9-23
EPT Richness	8	5-13
% EPT	54.2	13-88
% Dominance (top 3 taxa)	58.8	24-73
% Chironomidae	7.3	4-73
# Ephemeroptera taxa	4	1-5
# Plecoptera taxa	3	1-6
# Trichoptera taxa	1	0-5
Diversity	0.80	0.46-0.87
Evenness	0.20	0.15-0.43
Bray-Curtis	0.67	0.24-0.71

G. Discussion of Results

- BRU0302 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also found in high abdundances.
- The observed community at BRU0302 was strongly dominated by Baetidae mayflies, not by Chironomidae
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a high total richness with many unexpected taxa as well as expected taxa.
- This community had a moderately high Bray-Curtis distance value, indicating that it was 33% similar to the median reference community.
- The site falls just outside of the 90% confidence ellipse, slightly departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Byrne Creek
Site code: BYR01
Sampling Date: September 26, 2000
Latitude: 49.2070 N
Longitude: -122.9716 W
Ecoregion: Lower Mainland
Altitude: 138 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.507	0.009	0.370	0.007	0.108

C. Selected habitat variables at the test site and median and central 90% range of reference sites

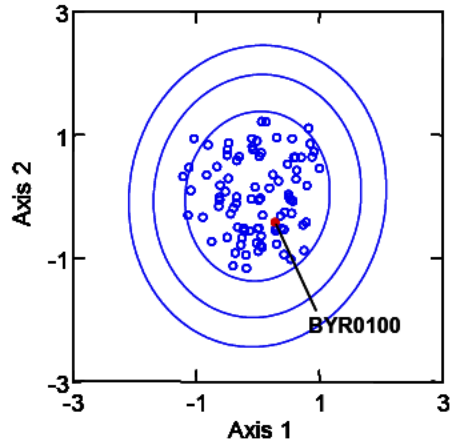
Variable	Test site BYR01	Reference Group 1 MEDIAN	RANGE
Altitude	138	1830	91-5115
Stream order	1	2*	1-4
Slope ($x10^{-3}$)	94	16	0.6-72.9
Bankful width[1]	6.0	30.3	4.2-149.4
Wetted width[1]	1.1	14.0	1.4-59.2
Avg Depth[2]	5.8	29.4	7.9-60.5
Max Depth[2]	12	42	10.0-83.5
Avg Velocity[3]	0.25	0.42	0.16-0.83
Max Velocity[3]	0.42	0.72	0.27-1.17
Dominant substrate	7	7*	5-8
Surrounding material	3	2*	2-6
Embeddedness	4	3*	1-5
Alkalinity[4]	73.2	26.4	4.2-88.5
pH	7.25	7.55	6.31-8.33
Conductivity (µS/cm)	169.0	53.3	8.0-211.5
TKN[4]	0.040	0.042	0.007-0.155
Total Phosphorus[4]	0.056	0.007	0.002-0.039
Dissolved Oxygen[4]	10.95	11.38	9.18-13.91
TSS[4]	10.34	2.98	0.23-36.71
% Sand	4.7	71.0	3.1-97.9
% Gravel	94.6	26.5	0.6-96.9

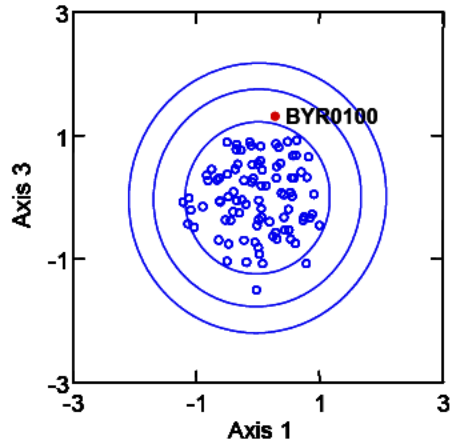
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

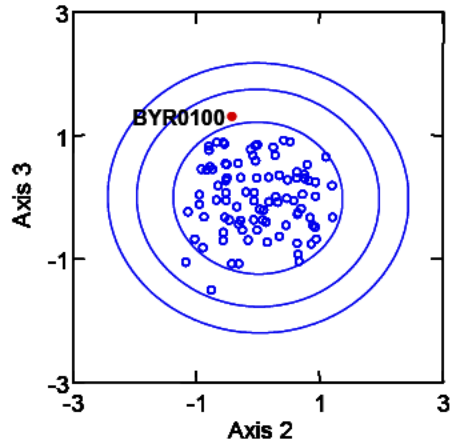
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	76	0.99
Heptageniidae	0	0.97
Baetidae	536	0.92
Ephemerellidae	0	0.89
Chloroperlidae	0	0.85
Nemouridae	0	0.79
Perlodidae	0	0.66
Capniidae	0	0.62
Tipulidae	0	0.59
Rhyacophilidae	0	0.58
Taeniopterygidae	0	0.57
Empididae	0	0.53
Hydropsychidae	4	0.49
Lebertiidae	4	0.38
Enchytraeidae	24	0.33
Naididae	80	0.28
Lumbriculidae	32	0.17
Planorbidae	12	0.04
Hydridae	4	0.02
Tabanidae	8	0.02
Crangonyctidae	8	0.01
Physidae	36	0
Hydrobiidae	8	0
	Observed	**Expected**
p>0.70	2	5.4
p>0.50	2	9
O:E p>0.70		0.37
O:E p>0.50		0.22

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Possibly stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site BYR01	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	832	170-1777
Total Richness	13	9-26
EPT Richness	2	7-15
% EPT	64.9	47-97
% Dominance (top 3 taxa)	83.2	21-66
% Chironomidae	9.1	2-32
# Ephemeroptera taxa	1	2-5
# Plecoptera taxa	0	2-6
# Trichoptera taxa	1	0-6
Diversity	0.56	0.53-0.88
Evenness	0.18	0.17-0.43
Bray-Curtis	0.76	0.36-0.75

G. Discussion of Results

- BYR0100 is predicted to be similar to Group 1 reference communities. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at BYR0100 was dominated by Baetidae followed by Chironomidae.
- This community had a very low O:E taxa ratio indicating that many of the highly expected taxa, primarily mayflies, stoneflies and caddisflies, were not found at this site.
- This community had a high Bray-Curtis distance value, indicating that it was 24% similar to the median reference community.
- Despite the decrease in many of the expected taxa, the relative abundance of the dominant taxa and the occurrence of the lesser expected taxa illustrated some similarity to the reference median.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Byrne Creek
Site code: BYR01
Sampling Date: September 23, 2002
Latitude: 49.2065 N
Longitude: -122.9712 W
Ecoregion: Lower Mainland
Altitude: 105 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 3**
(n= 80 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.288	0.009	**0.438**	0.004	0.260

C. Selected habitat variables at the test site and median and central 90% range of reference sites

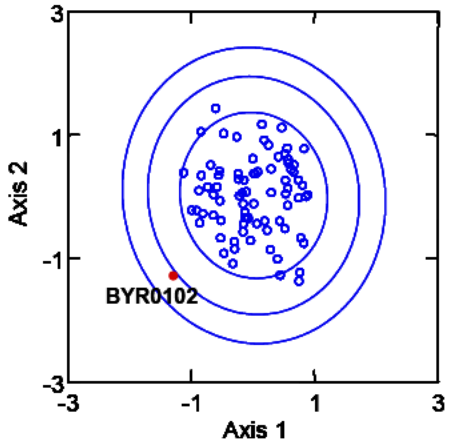
Variable	Test site BYR01	Reference Group 3 MEDIAN	RANGE
Altitude	105	3312	95-5584
Stream order	1	3*	1-4
Slope ($x10^{-3}$)	4	12	0.4-89.4
Bankful width[1]	5.6	18.0	3.1-92.9
Wetted width[1]	3.0	7.4	1.4-40.3
Avg Depth[2]	8.5	21.9	7.0-56.3
Max Depth[2]	10	30	8.0-78.3
Avg Velocity[3]	0.13	0.39	0.16-0.67
Max Velocity[3]	0.21	0.56	0.25-0.95
Dominant substrate	7	7*	4-8
Surrounding material	5	3*	2-5
Embeddedness	4	5*	2-5
Alkalinity[4]	64.9	39.5	7.4-112.2
pH	7.87	7.64	6.56-8.55
Conductivity (µS/cm)	179.0	83.5	15.2-187.4
TKN[4]	0.120	0.073	0.014-0.363
Total Phosphorus[4]	0.037	0.007	0.002-0.084
Dissolved Oxygen[4]	9.87	11.75	9.49-14.12
TSS[4]	0.49	3.62	0.95-20.69
% Sand	1.7	72.5	9.8-88.8
% Gravel	98.3	25.8	7.0-84.1

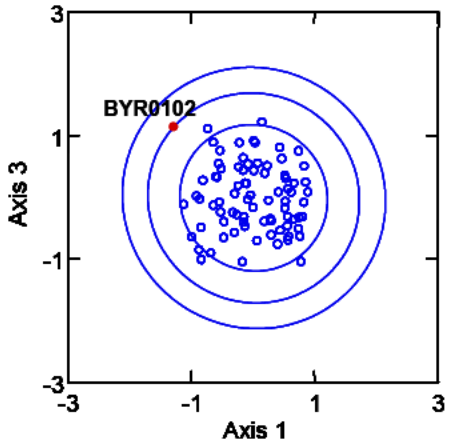
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

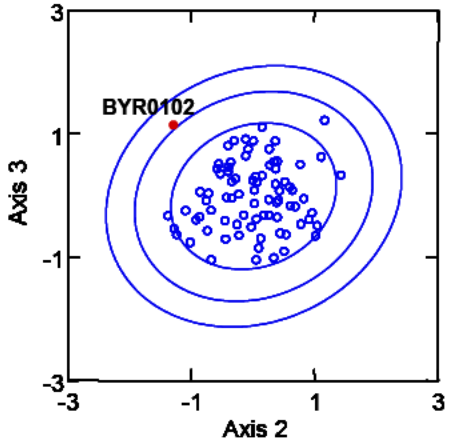
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	63	0.99
Heptageniidae	0	0.97
Baetidae	137	0.91
Ephemerellidae	0	0.88
Chloroperlidae	0	0.82
Nemouridae	2	0.79
Perlodidae	0	0.65
Capniidae	0	0.63
Tipulidae	1	0.58
Empididae	0	0.54
Rhyacophilidae	0	0.53
Hydropsychidae	1	0.49
Sperchontidae	2	0.34
Enchytraeidae	27	0.32
Naididae	12	0.3
Sphaeriidae	3	0.19
Lumbriculidae	16	0.13
Tubificidae	3	0.11
Planorbidae	7	0.04
Crangonyctidae	5	0.02
Physidae	12	0.01
Lymnaeidae	1	0
Sciomyzidae	1	0
	Observed	**Expected**
p>0.70	3	5.4
p>0.50	4	8.3
O:E p>0.70		0.56
O:E p>0.50		0.48

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Stressed	Possibly stressed	Stressed	**Stressed**

F. Benthic Community Descriptors

	Test site **BYR01**	**Reference Group 3** Central 90% range (5th-95th percentiles)
Abundance	293	1659-12885
Total Richness	16	10-20
EPT Richness	3	5-13
% EPT	47.8	39-97
% Dominance (top 3 taxa)	77.5	22-65
% Chironomidae	21.5	2-43
# Ephemeroptera taxa	1	2-5
# Plecoptera taxa	1	2-6
# Trichoptera taxa	1	1-5
Diversity	0.72	0.57-0.87
Evenness	0.22	0.20-0.48
Bray-Curtis	0.82	0.32-0.75

G. Discussion of Results

- BYR0102 is predicted to be similar to Group 3 reference communities. These communities tend to have moderate abundances of many taxa but are generally dominated by Chironomidae, and the mayflies, Baetidae, Heptageniidae and Ephemerellidae.
- The observed community at BYR0102 had a very low abundance of organisms compared with the range of reference communities; however it was dominated by Baetidae and Chironomidae as expected.
- The metrics fell outside of the central 90% range of reference sites for many of the metrics.
- The community was primarily composed of pollution tolerant invertebrates with a few individuals that are pollution sensitive. This combined with the fact that the community had a very low abundance of organisms might suggest possible episodic organic pollution events from urban activities. Ongoing invertebrate and water quality monitoring should be conducted.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- This community had a very high Bray-Curtis distance, indicating that it was only 18% similar to the median reference community.
- This site falls outside of the 99% confidence ellipse, far from the cloud of reference sites, indicating that it is different than what was expected and therefore ***"stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Frogger's Creek
Site code: FRO01
Sampling Date: September 26, 2000
Latitude: 49.2093 N
Longitude: -122.9934 W
Ecoregion: Lower Mainland
Altitude: 131 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 3**
(n= 80 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.314	0.013	**0.362**	0.116	0.194

C. Selected habitat variables at the test site and median and central 90% range of reference sites

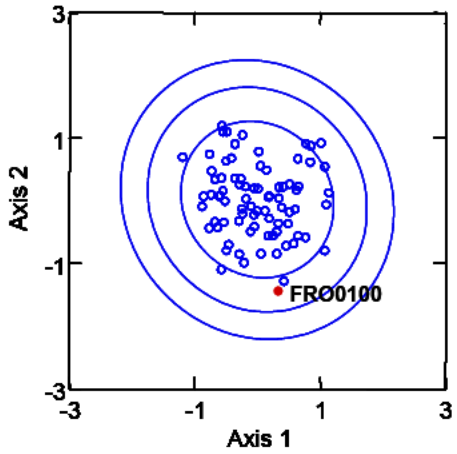
Variable	Test site FRO01	Reference Group 3 MEDIAN	RANGE
Altitude	131	3312	95-5584
Stream order	1	3*	1-4
Slope ($x10^{-3}$)	71	12	0.4-89.4
Bankful width[1]	6.3	18.0	3.1-92.9
Wetted width[1]	2.0	7.4	1.4-40.3
Avg Depth[2]	8.2	21.9	7.0-56.3
Max Depth[2]	12	30	8.0-78.3
Avg Velocity[3]	0.45	0.39	0.16-0.67
Max Velocity[3]	0.58	0.56	0.25-0.95
Dominant substrate	6	7*	4-8
Surrounding material	4	3*	2-5
Embeddedness	3	5*	2-5
Alkalinity[4]	74.6	39.5	7.4-112.2
pH	7.28	7.64	6.56-8.55
Conductivity (µS/cm)	177.0	83.5	15.2-187.4
TKN[4]	0.030	0.073	0.014-0.363
Total Phosphorus[4]	0.080	0.007	0.002-0.084
Dissolved Oxygen[4]	11.14	11.75	9.49-14.12
TSS[4]	0.60	3.62	0.95-20.69
% Sand	30.3	72.5	9.8-88.8
% Gravel	69.3	25.8	7.0-84.1

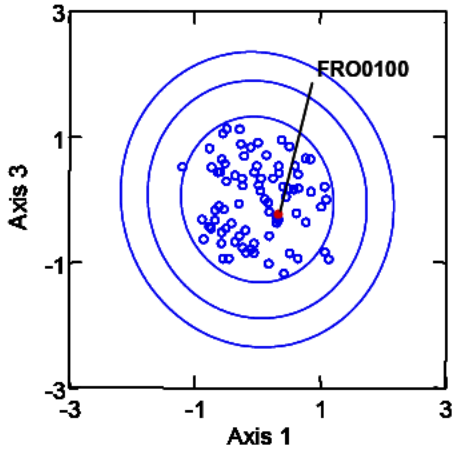
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

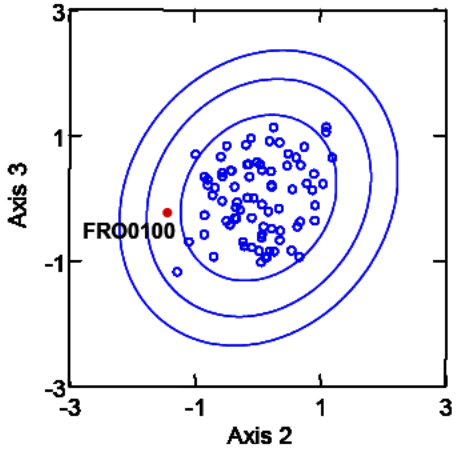
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	660	0.99
Heptageniidae	0	0.91
Baetidae	280	0.88
Ephemerellidae	0	0.85
Chloroperlidae	0	0.77
Nemouridae	240	0.72
Capniidae	0	0.61
Perlodidae	0	0.59
Tipulidae	100	0.56
Empididae	40	0.5
Rhyacophilidae	20	0.5
Hydropsychidae	1320	0.46
Lebertiidae	20	0.38
Lepidostomatidae	80	0.37
Naididae	60	0.35
Enchytraeidae	40	0.32
Simuliidae	40	0.3
Elmidae	20	0.29
Glossosomatidae	1180	0.26
Sphaeriidae	20	0.2
Lumbriculidae	20	0.17
Poduridae	40	0
	Observed	**Expected**
p>0.70	3	5.1
p>0.50	5	7.4
O:E p>0.70		0.58
O:E p>0.50		0.68

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **FRO01**	**Reference Group 3** Central 90% range (5th-95th percentiles)
Abundance	4180	1659-12885
Total Richness	17	10-20
EPT Richness	6	5-13
% EPT	74.2	39-97
% Dominance (top 3 taxa)	75.6	22-65
% Chironomidae	15.8	2-43
# Ephemeroptera taxa	1	2-5
# Plecoptera taxa	1	2-6
# Trichoptera taxa	4	1-5
Diversity	0.79	0.57-0.87
Evenness	0.28	0.20-0.48
Bray-Curtis	0.69	0.32-0.75

G. Discussion of Results

- FRO0100 is predicted to be similar to Group 3 reference communities. These communities tend to have moderate abundances of many taxa but are generally dominated by Chironomidae, and the mayflies, Baetidae, Heptageniidae and Ephemerellidae.
- The observed community at FRO0100 was dominated by two caddisfly taxa followed by Chironomidae.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- This community had a moderately high Bray-Curtis distance value, indicating that it was only 31% similar to the median reference community.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Frogger's Creek
Site code: FRO01
Sampling Date: September 23, 2002
Latitude: 49.2090 N
Longitude: -122.9935 W
Ecoregion: Lower Mainland
Altitude: 128 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 3**
(n= 80 reference sites)
Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.357	0.008	**0.442**	0.008	0.186

C. Selected habitat variables at the test site and median and central 90% range of reference sites

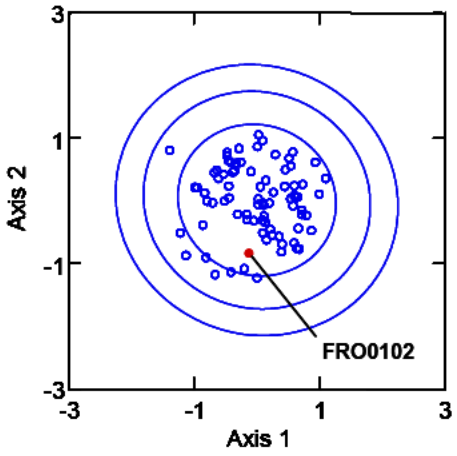
Variable	Test site FRO01	Reference Group 3 MEDIAN	RANGE
Altitude	128	3312	95-5584
Stream order	1	3*	1-4
Slope ($x10^{-3}$)	59	12	0.4-89.4
Bankful width[1]	8.0	18.0	3.1-92.9
Wetted width[1]	2.0	7.4	1.4-40.3
Avg Depth[2]	5.8	21.9	7.0-56.3
Max Depth[2]	12	30	8.0-78.3
Avg Velocity[3]	0.12	0.39	0.16-0.67
Max Velocity[3]	0.23	0.56	0.25-0.95
Dominant substrate	7	7*	4-8
Surrounding material	5	3*	2-5
Embeddedness	4	5*	2-5
Alkalinity[4]	70.3	39.5	7.4-112.2
pH	7.66	7.64	6.56-8.55
Conductivity (µS/cm)	212.0	83.5	15.2-187.4
TKN[4]	0.170	0.073	0.014-0.363
Total Phosphorus[4]	0.057	0.007	0.002-0.084
Dissolved Oxygen[4]	9.95	11.75	9.49-14.12
TSS[4]	2.91	3.62	0.95-20.69
% Sand	4.9	72.5	9.8-88.8
% Gravel	95.0	25.8	7.0-84.1

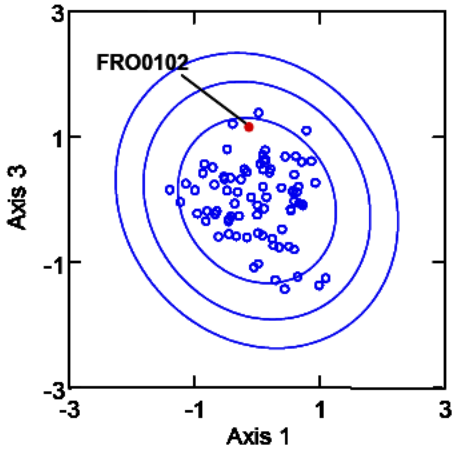
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

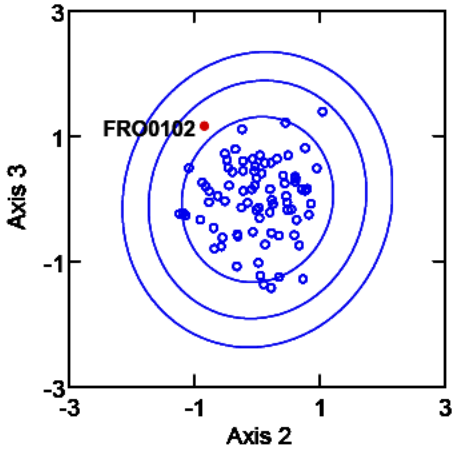
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	310	0.99
Heptageniidae	0	0.97
Baetidae	325	0.91
Ephemerellidae	0	0.89
Chloroperlidae	0	0.83
Nemouridae	55	0.79
Perlodidae	0	0.65
Capniidae	0	0.63
Tipulidae	5	0.58
Rhyacophilidae	0	0.55
Empididae	30	0.53
Taeniopterygidae	0	0.52
Hydropsychidae	90	0.49
Lepidostomatidae	15	0.38
Lebertiidae	15	0.37
Sperchontidae	50	0.35
Simuliidae	20	0.32
Enchytraeidae	25	0.32
Elmidae	15	0.3
Naididae	70	0.3
Glossosomatidae	225	0.29
Ceratopogonidae	5	0.21
Sphaeriidae	45	0.17
Lumbriculidae	45	0.14
Planariidae	5	0.1
Dixidae	5	0.04
Planorbidae	20	0.04
Hydridae	15	0.03
Crangonyctidae	30	0.02
Physidae	20	0.01
Tetrastemmatidae	5	0
	Observed	**Expected**
p>0.70	3	5.4
p>0.50	5	8.8
O:E p>0.70		0.56
O:E p>0.50		0.57

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **FRO01**	**Reference Group 3** Central 90% range (5th-95th percentiles)
Abundance	1445	1659-12885
Total Richness	24	10-20
EPT Richness	5	5-13
% EPT	49.5	39-97
% Dominance (top 3 taxa)	59.5	22-65
% Chironomidae	21.5	2-43
# Ephemeroptera taxa	1	2-5
# Plecoptera taxa	1	2-6
# Trichoptera taxa	3	1-5
Diversity	0.87	0.57-0.87
Evenness	0.31	0.20-0.48
Bray-Curtis	0.59	0.32-0.75

G. Discussion of Results

- FRO0102 is predicted to be similar to Group 3 reference communities. These communities tend to have moderate abundances of many taxa but are generally dominated by Chironomidae, and the mayflies, Baetidae, Heptageniidae and Ephemerellidae.
- The observed community at FRO0102 had a large abundance of Chironomidae and Baetidae but was missing Heptageniidae and Ephemerellidae and many highly expected stonefly taxa.
- This community had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site although the total taxa richness is high.
- This community had a moderate Bray-Curtis distance value, indicating that it was 41% similar to the median reference community. Although the O:E ratio was low, the relative abundances of many of the taxa were similar to the median reference community.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Black Creek
Site code: BLA01
Sampling Date: September 21, 2001
Latitude: 49.8319 N
Longitude: -125.1253 W
Ecoregion: Eastern Vancouver Island
Altitude: 167 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 5**
(n= 68 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.119	0.014	0.298	0.174	**0.395**

C. Selected habitat variables at the test site and median and central 90% range of reference sites

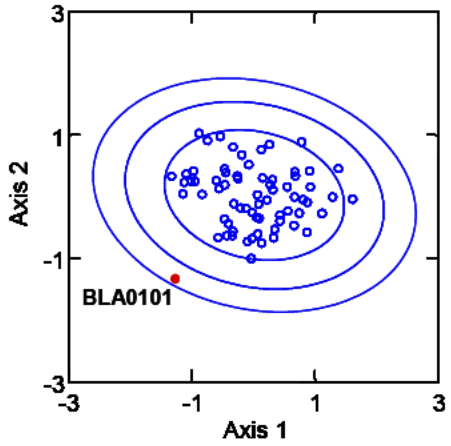
	Test site	Reference Group 5	
Variable	**BLA01**	**MEDIAN**	**RANGE**
Altitude	167	3325	84-5293
Stream order	2	2*	1-6
Slope ($x10^{-3}$)	10	7	0.5-38.4
Bankful width[1]	18.0	16.0	2.7-73.0
Wetted width[1]	5.6	6.6	1.2-46.5
Avg Depth[2]	7.6	18.5	6.0-43.1
Max Depth[2]	13	26	6.0-68.0
Avg Velocity[3]	0.13	0.35	0.13-0.66
Max Velocity[3]	0.31	0.53	0.18-0.86
Dominant substrate	6	6*	1-8
Surrounding material	3	2*	1-5
Embeddedness	3	5*	1-5
Alkalinity[4]	34.0	55.0	8.9-111.0
pH	7.53	7.72	6.64-8.54
Conductivity (µS/cm)	64.0	109.5	12.0-237.4
TKN[4]	0.467	0.177	0.029-0.532
Total Phosphorus[4]	0.050	0.011	0.003-0.112
Dissolved Oxygen[4]	8.79	11.24	9.56-13.95
TSS[4]	1.35	4.09	1.07-13.41
% Sand	25.0	65.4	0-90.0
% Gravel	75.0	28.7	0-94.5

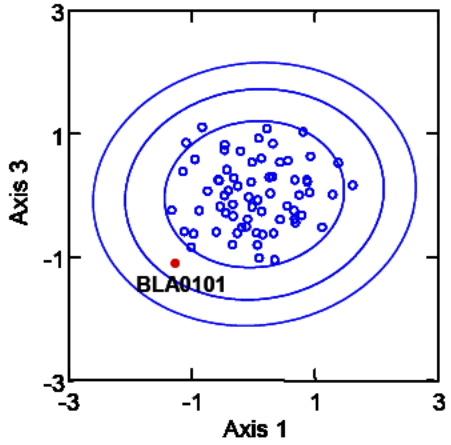
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

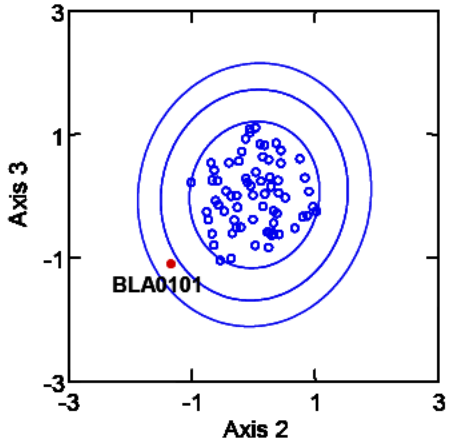
D. Invertebrate families predicted and occurring at test site

Family	**Count**	**Probability**
Chironomidae	330	0.99
Heptageniidae	70	0.87
Baetidae	80	0.86
Ephemerellidae	0	0.82
Chloroperlidae	0	0.71
Nemouridae	200	0.69
Capniidae	0	0.62
Perlodidae	0	0.53
Tipulidae	0	0.52
Empididae	30	0.49
Hydropsychidae	10	0.44
Naididae	90	0.4
Lepidostomatidae	640	0.39
Elmidae	20	0.34
Simuliidae	10	0.28
Tubificidae	20	0.19
Lumbriculidae	100	0.16
Planorbidae	10	0.07
Gammaridae	240	0.01
Physidae	10	0
Ancylidae	40	0
	Observed	**Expected**
p>0.70	3	4.3
p>0.50	4	6.6
O:E p>0.70		0.71
O:E p>0.50		0.61

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Stressed	Possibly stressed	Stressed	**Stressed**

F. Benthic Community Descriptors

	Test site **BLA01**	**Reference Group 5** Central 90% range (5th-95th percentiles)
Abundance	1900	5414-32293
Total Richness	16	9-23
EPT Richness	5	5-13
% EPT	52.6	13-88
% Dominance (top 3 taxa)	63.7	24-73
% Chironomidae	17.4	4-73
# Ephemeroptera taxa	2	1-5
# Plecoptera taxa	1	1-6
# Trichoptera taxa	2	0-5
Diversity	0.82	0.46-0.87
Evenness	0.35	0.15-0.43
Bray-Curtis	0.86	0.24-0.71

G. Discussion of Results

- BLA0101 is predicted to be similar to Group 5 reference communities. These communities have very large abundances of organisms primarily dominated by Chironomidae. Baetidae and Heptageniidae mayflies are also common.
- The total abundance is below the 5th percentile of the reference communities. Only one of four predicted stoneflies were found and this site had a low EPT richness (at 5th percentile of reference sites).
- The observed community at BLA0101 had a low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- Ephemerellidae and Chloroperlidae were expected to occur with probabilities >70% and Perlodidae, Capniidae and Tipulidae were expected to occur with probabilities >50%. However, none of these pollution sensitive taxa were observed.
- TKN concentration measured at the time of sampling was approaching the 95th percentile of the reference range and dissolved oxygen concentration was below the 5th percentile, suggesting possible enrichment. Water quality monitoring should be conducted.
- This community had a very high Bray-Curtis distance, indicating that it was only 14% similar to the median reference community.
- This site falls outside of the 99% confidence ellipse, far from the cloud of reference sites, indicating that it is different than what was expected and, therefore, ***"stressed".***

Summary of CABIN results

A. Test Site Information

Stream Name: Colquitz River
Site code: COL01
Sampling Date: September 27, 2001
Latitude: 48.4677 N
Longitude: -123.4012 W
Ecoregion: Eastern Vancouver Island
Altitude: 39 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 4**
(n= 19 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.001	0.000	0.005	**0.972**	0.022

C. Selected habitat variables at the test site and median and central 90% range of reference sites

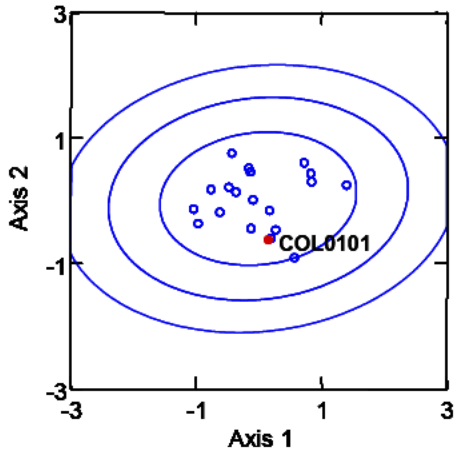
Variable	Test site COL01	Reference Group 4 MEDIAN	RANGE
Altitude	39	292	20-4021
Stream order	1	3*	1-6
Slope ($x10^{-3}$)	1	1	0.1-29.9
Bankful width[1]	4.9	37.1	6.4-231.2
Wetted width[1]	2.4	22.1	3.7-83.0
Avg Depth[2]	30.0	30.0	12.6-87.4
Max Depth[2]	45	36	15-116.2
Avg Velocity[3]	0	0.14	0-0.59
Max Velocity[3]	0	0.25	0-0.68
Dominant substrate	3	5*	1-7
Surrounding material	1	2*	2-5
Embeddedness	5	5*	1-5
Alkalinity[4]	54.3	25.2	5.0-84.6
pH	7.15	7.06	5.50-8.24
Conductivity (µS/cm)	121.8	12.6	6.5-162.3
TKN[4]	0.436	0.120	0.037-0.387
Total Phosphorus[4]	0.123	0.011	0.004-0.038
Dissolved Oxygen[4]	6.25	10.21	6.84-12.11
TSS[4]	7.28	3.62	0.97-28.05
% Sand	6.3	72.9	0.1-99.0
% Gravel	0	5.7	0-62.8

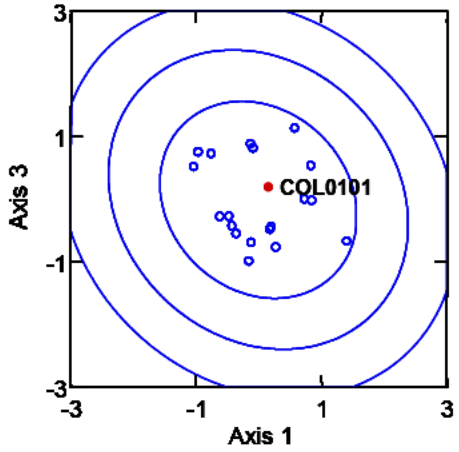
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

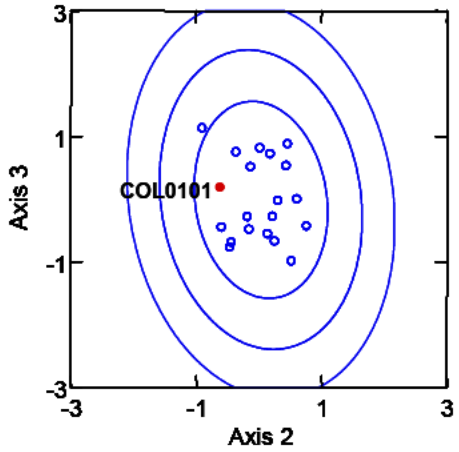
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	1586	1
Naididae	157	0.78
Baetidae	0	0.64
Ephemerellidae	0	0.59
Tubificidae	943	0.52
Heptageniidae	14	0.49
Rhyacophilidae	29	0.16
Spongillidae	143	0.1
Hydridae	14	0.1
Crangonyctidae	29	0.05
Hygrobatidae	29	0.05
Sialidae	29	0
Astacidae	14	0
	Observed	**Expected**
p>0.70	2	1.8
p>0.50	3	3.5
O:E p>0.70		1.13
O:E p>0.50		0.85

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic Community Descriptors

	Test site **COL01**	**Reference Group 4** Central 90% range (5th-95th percentiles)
Abundance	2986	820-8290
Total Richness	11	6-19
EPT Richness	2	1-10
% EPT	0.5	0-43
% Dominance (top 3 taxa)	90.0	39-83
% Chironomidae	53.1	18-82
# Ephemeroptera taxa	1	0-4
# Plecoptera taxa	0	0-2
# Trichoptera taxa	1	0-5
Diversity	0.61	0.31-0.77
Evenness	0.23	0.11-0.32
Bray-Curtis	0.32	0.27-0.73

G. Discussion of Results

- COL0101 is strongly predicted to be similar to Group 4 reference communities. These communities are dominated by Chironomidae and worms and also have small abundances of mayflies.
- The observed community at COL0101 was dominated by Chrionomidae and worms as expected. However, two highly expected mayfly taxa were not found.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a low Bray-Curtis distance, indicating that it was 64% similar to the median reference community.
- This site falls within the 90% confidence ellipse, within the cloud of reference sites, indicating that it is similar to what was expected and, therefore, "***not stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Cowichan River
Site code: COW01
Sampling Date: September 25, 2001
Latitude: 48.7841 N
Longitude: -123.9559 W
Ecoregion: Eastern Vancouver Island
Altitude: 417 (fasl)
Stream Order: 3

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.955	0.006	0.035	0.000	0.005

C. Selected habitat variables at the test site and median and central 90% range of reference sites

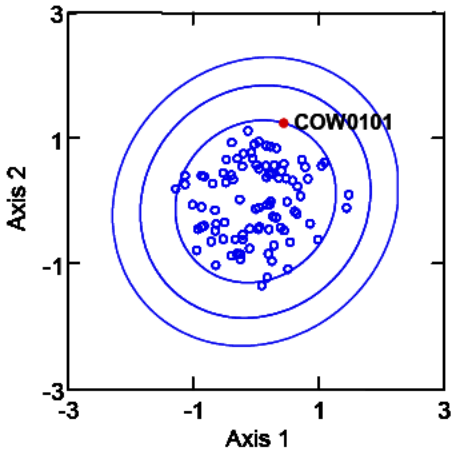
Variable	Test site COW01	Reference Group 1 MEDIAN	RANGE
Altitude	417	1830	91-5115
Stream order	3	2*	1-4
Slope ($x10^{-3}$)	4	16	0.6-72.9
Bankful width[1]	46.2	30.3	4.2-149.4
Wetted width[1]	38.0	14.0	1.4-59.2
Avg Depth[2]	25.8	29.4	7.9-60.5
Max Depth[2]	41	42	10.0-83.5
Avg Velocity[3]	0.51	0.42	0.16-0.83
Max Velocity[3]	1.00	0.72	0.27-1.17
Dominant substrate	8	7*	5-8
Surrounding material	5	2*	2-6
Embeddedness	3	3*	1-5
Alkalinity[4]	25.6	26.4	4.2-88.5
pH	8.10	7.55	6.31-8.33
Conductivity (µS/cm)	51.0	53.3	8.0-211.5
TKN[4]	0.002	0.042	0.007-0.155
Total Phosphorus[4]	0.007	0.007	0.002-0.039
Dissolved Oxygen[4]	8.44	11.38	9.18-13.91
TSS[4]	0.93	2.98	0.23-36.71
% Sand	5.9	71.0	3.1-97.9
% Gravel	92.3	26.5	0.6-96.9

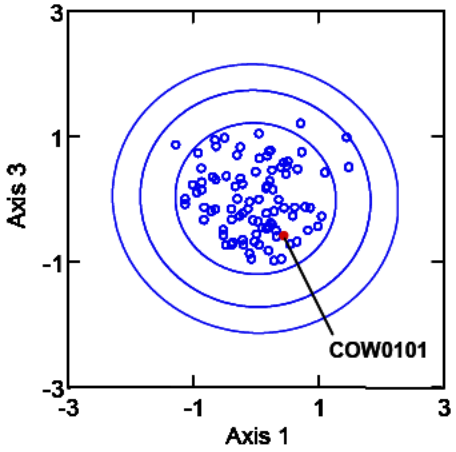
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

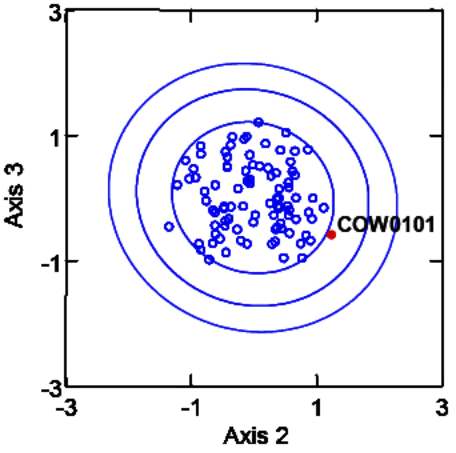
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	467	1
Heptageniidae	383	0.98
Baetidae	783	0.94
Ephemerellidae	517	0.91
Chloroperlidae	17	0.89
Nemouridae	33	0.81
Taeniopterygidae	0	0.69
Perlodidae	50	0.69
Rhyacophilidae	17	0.65
Capniidae	0	0.63
Tipulidae	50	0.58
Empididae	17	0.52
Hydropsychidae	417	0.48
Sperchontidae	50	0.43
Lebertiidae	17	0.41
Simuliidae	133	0.32
Lepidostomatidae	317	0.31
Glossosomatidae	33	0.31
Leptophlebiidae	17	0.28
Elmidae	183	0.24
Naididae	117	0.24
Torrenticolidae	17	0.22
Planariidae	17	0.19
	Observed	**Expected**
p>0.70	6	5.5
p>0.50	10	9.3
O:E p>0.70		1.09
O:E p>0.50		1.08

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **COW01**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	3650	170-1777
Total Richness	21	9-26
EPT Richness	11	7-15
% EPT	70.8	47-97
% Dominance (top 3 taxa)	48.4	21-66
% Chironomidae	12.8	2-32
# Ephemeroptera taxa	4	2-5
# Plecoptera taxa	3	2-6
# Trichoptera taxa	4	0-6
Diversity	0.88	0.53-0.88
Evenness	0.40	0.17-0.43
Bray-Curtis	0.84	0.36-0.75

G. Discussion of Results

- COW0101 is strongly predicted to be similar to Group 1 reference communities. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at COW0101 had a high abundance of organisms compared with the range of references sites. It was dominated by three mayfly taxa as well as Chironomidae.
- This community had a very high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- This community had a very high Bray-Curtis distance, indicating that it was only 16% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls just outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: French Creek
Site code: FRE01
Sampling Date: September 25, 2001
Latitude: 49.3473 N
Longitude: -124.3680 W
Ecoregion: Eastern Vancouver Island
Altitude: 16 (fasl)
Stream Order: 2

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.359	0.007	0.332	0.123	0.179

C. Selected habitat variables at the test site and median and central 90% range of reference sites

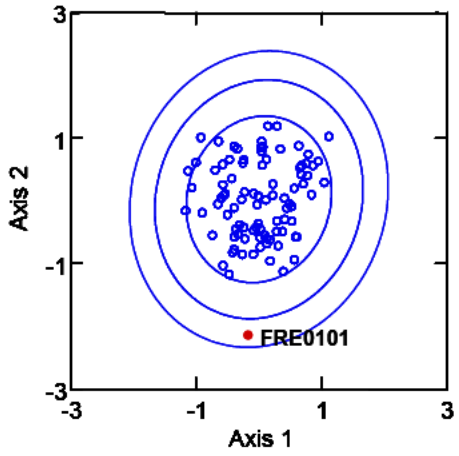
Variable	Test site FRE01	Reference Group 1 MEDIAN	RANGE
Altitude	16	1830	91-5115
Stream order	2	2*	1-4
Slope ($x10^{-3}$)	127	16	0.6-72.9
Bankful width[1]	17.5	30.3	4.2-149.4
Wetted width[1]	3.0	14.0	1.4-59.2
Avg Depth[2]	6.2	29.4	7.9-60.5
Max Depth[2]	9	42	10.0-83.5
Avg Velocity[3]	0.13	0.42	0.16-0.83
Max Velocity[3]	0.23	0.72	0.27-1.17
Dominant substrate	6	7*	5-8
Surrounding material	3	2*	2-6
Embeddedness	4	3*	1-5
Alkalinity[4]	64.4	26.4	4.2-88.5
pH	7.07	7.55	6.31-8.33
Conductivity (µS/cm)	119.0	53.3	8.0-211.5
TKN[4]	0.120	0.042	0.007-0.155
Total Phosphorus[4]	0.008	0.007	0.002-0.039
Dissolved Oxygen[4]	8.20	11.38	9.18-13.91
TSS[4]	0.67	2.98	0.23-36.71
% Sand	4.6	71.0	3.1-97.9
% Gravel	95.4	26.5	0.6-96.9

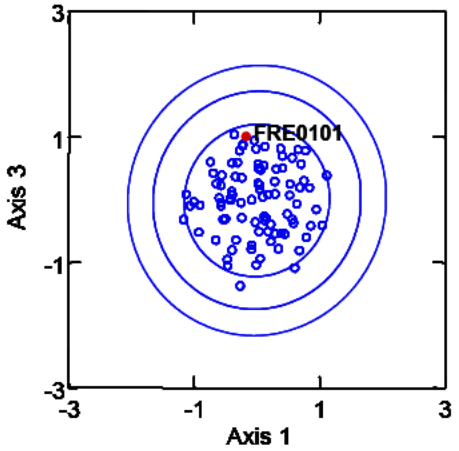
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

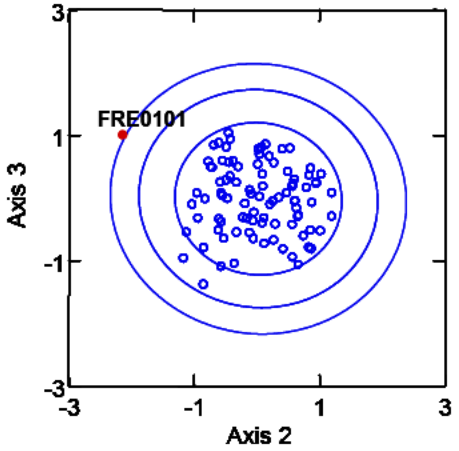
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	5700	0.99
Heptageniidae	567	0.91
Baetidae	267	0.88
Ephemerellidae	0	0.85
Chloroperlidae	67	0.77
Nemouridae	67	0.72
Capniidae	33	0.61
Perlodidae	0	0.58
Tipulidae	567	0.55
Rhyacophilidae	0	0.5
Empididae	33	0.5
Hydropsychidae	267	0.46
Lebertiidae	167	0.39
Lepidostomatidae	333	0.36
Leptophlebiidae	600	0.36
Naididae	1467	0.35
Sperchontidae	67	0.34
Elmidae	233	0.28
Torrenticolidae	800	0.27
Tubificidae	67	0.15
Psychodidae	33	0.13
Hydryphantidae	33	0.1
Planorbidae	33	0.07
Hygrobatidae	67	0.04
Aturidae	200	0.02
	Observed	**Expected**
p>0.70	5	5.1
p>0.50	7	7.4
O:E p>0.70		0.98
O:E p>0.50		0.95

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Stressed	Not stressed	Severely stressed	**Severely stressed**

F. Benthic Community Descriptors

	Test site **FRE01**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	11667	170-1777
Total Richness	22	9-26
EPT Richness	8	7-15
% EPT	18.9	47-97
% Dominance (top 3 taxa)	68.3	21-66
% Chironomidae	48.9	2-32
# Ephemeroptera taxa	3	2-5
# Plecoptera taxa	3	2-6
# Trichoptera taxa	2	0-6
Diversity	0.73	0.53-0.88
Evenness	0.17	0.17-0.43
Bray-Curtis	0.95	0.36-0.75

G. Discussion of Results

- FRE0101 is predicted to be similar to Group 1 reference communities. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- FRE0101 is also predicted to be similar to Group 3 with a slightly smaller probability than Group 1. When compared with Group 3, this community was deemed "possibly stressed" likely due to the fact that Group 3 reference sites tend to have larger abundances of organisms than Group 1.
- The observed community at FRE0101 had a very large abundance of Chironomidae, worms and mites and other less common taxa. This could be a sign of enrichment. Dissolved oxygen was below the 5th percentile of the reference sites suggesting possible short-term stress from oxygen depletion because oxygen sensitive organisms such as stoneflies were present.
- This community had a high O:E taxa ratio indicating that the taxa that were expected to be there were found there.
- While the O:E ratio was high, the relative abundance of the taxa was not similar to the reference communities.
- This site had a very high Bray-Curtis distance, indicating that it was only 5% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 99.9% confidence ellipse, very far from the cloud of reference sites, indicating that it is very different than what was expected and, therefore, "***severely stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Quinsam River
Site code: QUI01
Sampling Date: September 21, 2001
Latitude: 50.0314 N
Longitude: -125.2985 W
Ecoregion: Eastern Vancouver Island
Altitude: 27 (fasl)
Stream Order: 3

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.800	0.006	0.161	0.001	0.032

C. Selected habitat variables at the test site and median and central 90% range of reference sites

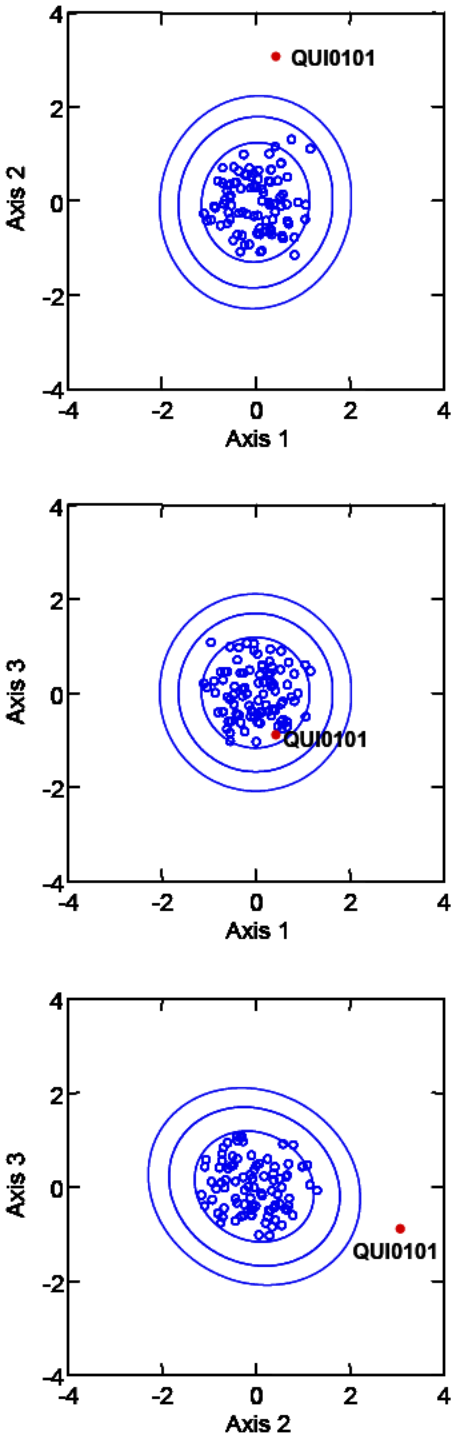
Variable	Test site QUI01	Reference Group 1 MEDIAN	RANGE
Altitude	27	1830	91-5115
Stream order	3	2*	1-4
Slope ($x10^{-3}$)	9	16	0.6-72.9
Bankful width[1]	21.3	30.3	4.2-149.4
Wetted width[1]	19.0	14.0	1.4-59.2
Avg Depth[2]	28.0	29.4	7.9-60.5
Max Depth[2]	50	42	10.0-83.5
Avg Velocity[3]	0.46	0.42	0.16-0.83
Max Velocity[3]	0.70	0.72	0.27-1.17
Dominant substrate	8	7*	5-8
Surrounding material	4	2*	2-6
Embeddedness	4	3*	1-5
Alkalinity[4]	42.7	26.4	4.2-88.5
pH	7.73	7.55	6.31-8.33
Conductivity (µS/cm)	84.3	53.3	8.0-211.5
TKN[4]	0.310	0.042	0.007-0.155
Total Phosphorus[4]	0.039	0.007	0.002-0.039
Dissolved Oxygen[4]	9.44	11.38	9.18-13.91
TSS[4]	4.64	2.98	0.23-36.71
% Sand	20.9	71.0	3.1-97.9
% Gravel	79.2	26.5	0.6-96.9

* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	5167	1
Heptageniidae	0	0.98
Baetidae	0	0.93
Ephemerellidae	33	0.9
Chloroperlidae	0	0.87
Nemouridae	0	0.8
Perlodidae	0	0.68
Taeniopterygidae	0	0.65
Rhyacophilidae	0	0.63
Capniidae	0	0.62
Tipulidae	33	0.59
Empididae	67	0.52
Sperchontidae	100	0.42
Lebertiidae	100	0.4
Naididae	2633	0.25
Torrenticolidae	67	0.24
Hydryphantidae	33	0.14
Tubificidae	33	0.08
Hygrobatidae	167	0.06
Xironodrilidae	100	0
	Observed	**Expected**
p>0.70	2	5.5
p>0.50	4	9.2
O:E p>0.70		0.36
O:E p>0.50		0.44

E. Assessment of test site



Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Severely stressed	Not stressed	Severely stressed	**Severely stressed**

F. Benthic Community Descriptors

	Test site **QUI01**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	8533	170-1777
Total Richness	12	9-26
EPT Richness	1	7-15
% EPT	1.6	47-97
% Dominance (top 3 taxa)	93.4	21-66
% Chironomidae	60.5	2-32
# Ephemeroptera taxa	1	2-5
# Plecoptera taxa	0	2-6
# Trichoptera taxa	0	0-6
Diversity	0.54	0.53-0.88
Evenness	0.18	0.17-0.43
Bray-Curtis	0.98	0.36-0.75

G. Discussion of Results

- QUI0101 is strongly predicted to be similar to Group 1 reference communities. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at QUI0101 was dominated by Chironomidae and worms. It was missing the highly expected mayfly, stonefly and caddisfly taxa.
- This community had a very low O:E taxa ratio indicating that many of the highly expected taxa were not found at this site.
- TKN is quite high relative to the range of reference sites and total phosphorus is at the 95th percentile. This site may be experiencing nutrient enrichment as it was heavily dominated by nutrient tolerant organisms, Chironomidae and worms.
- This community had a very high Bray-Curtis distance, indicating that it was only 2% similar to the median reference community.
- This site falls outside of the 99.9% confidence ellipse, very far from the cloud of reference sites, indicating that it is very different than what was expected and, therefore, "***severely stressed***".

Summary of CABIN results

A. Test Site Information

Stream Name: Shawnigan Creek
Site code: SHA01
Sampling Date: September 27, 2001
Latitude: 48.6579 N
Longitude: -123.5695 W
Ecoregion: Eastern Vancouver Island
Altitude: 151 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 1**
(n= 91 reference sites)

Probability of group membership from DFA

Group 1	Group 2	Group 3	Group 4	Group 5
0.637	0.002	0.304	0.001	0.057

C. Selected habitat variables at the test site and median and central 90% range of reference sites

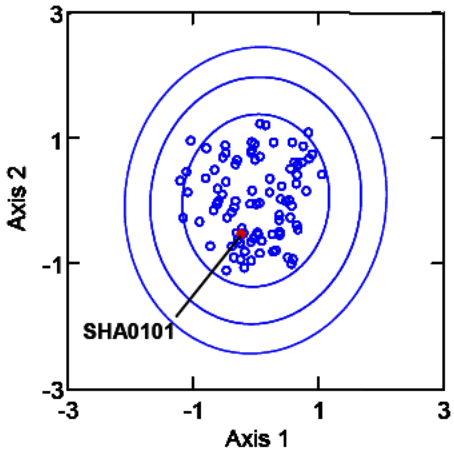
Variable	Test site SHA01	Reference Group 1 MEDIAN	RANGE
Altitude	151	1830	91-5115
Stream order	1	2*	1-4
Slope ($x10^{-3}$)	53	16	0.6-72.9
Bankful width[1]	13.0	30.3	4.2-149.4
Wetted width[1]	2.0	14.0	1.4-59.2
Avg Depth[2]	11.7	29.4	7.9-60.5
Max Depth[2]	20	42	10.0-83.5
Avg Velocity[3]	0.35	0.42	0.16-0.83
Max Velocity[3]	0.56	0.72	0.27-1.17
Dominant substrate	8	7*	5-8
Surrounding material	3	2*	2-6
Embeddedness	5	3*	1-5
Alkalinity[4]	31.2	26.4	4.2-88.5
pH	7.81	7.55	6.31-8.33
Conductivity (µS/cm)	67.8	53.3	8.0-211.5
TKN[4]	0.209	0.042	0.007-0.155
Total Phosphorus[4]	0.020	0.007	0.002-0.039
Dissolved Oxygen[4]	9.27	11.38	9.18-13.91
TSS[4]	0.73	2.98	0.23-36.71
% Sand	5.8	71.0	3.1-97.9
% Gravel	94.2	26.5	0.6-96.9

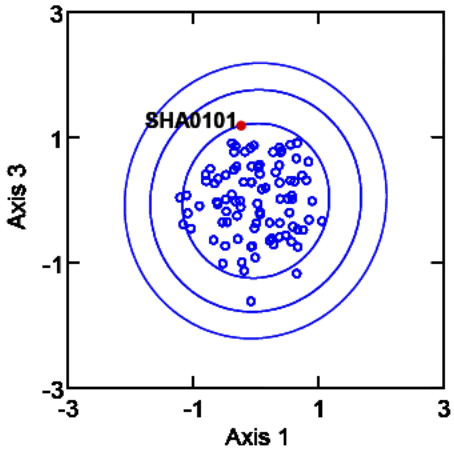
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

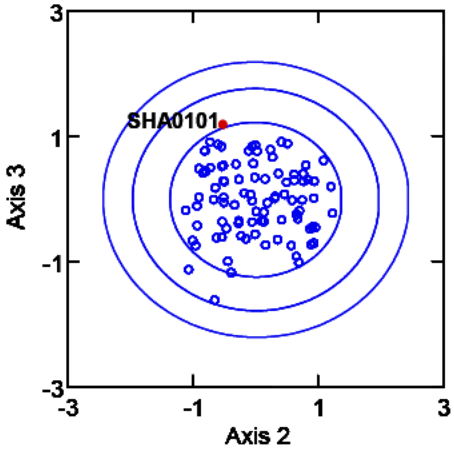
D. Invertebrate families predicted and occurring at test site

Family	Count	Probability
Chironomidae	50	0.99
Heptageniidae	50	0.98
Baetidae	542	0.93
Ephemerellidae	258	0.9
Chloroperlidae	8	0.86
Nemouridae	208	0.8
Perlodidae	417	0.68
Capniidae	0	0.62
Rhyacophilidae	0	0.61
Taeniopterygidae	0	0.61
Tipulidae	0	0.59
Empididae	8	0.53
Sperchontidae	17	0.4
Lebertiidae	17	0.38
Leptophlebiidae	100	0.33
Simuliidae	17	0.33
Glossosomatidae	8	0.3
Naididae	8	0.26
Elmidae	50	0.26
Torrenticolidae	8	0.26
Dixidae	8	0.06
Hydrozetiidae	8	0.03
Gammaridae	17	0
	Observed	**Expected**
p>0.70	6	5.5
p>0.50	8	9.1
O:E p>0.70		1.1
O:E p>0.50		0.88

E. Assessment of test site







Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
Not stressed	Not stressed	Possibly stressed	**Possibly stressed**

F. Benthic Community Descriptors

	Test site **SHA01**	**Reference Group 1** Central 90% range (5th-95th percentiles)
Abundance	1800	170-1777
Total Richness	19	9-26
EPT Richness	8	7-15
% EPT	88.4	47-97
% Dominance (top 3 taxa)	67.6	21-66
% Chironomidae	2.8	2-32
# Ephemeroptera taxa	4	2-5
# Plecoptera taxa	3	2-6
# Trichoptera taxa	1	0-6
Diversity	0.82	0.53-0.88
Evenness	0.29	0.17-0.43
Bray-Curtis	0.79	0.36-0.75

G. Discussion of Results

- SHA0101 is predicted to be similar to Group 1 reference communities. These communities have generally low and similar abundances of many taxa including Chironomidae and Baetidae.
- The observed community at SHA0101 was dominated by mayflies and stoneflies and had a very small proportion of Chironomidae. It was missing several of the highly expected stonefly and caddisfly taxa.
- This community had a high O:E taxa ratio indicating that most of the taxa that were expected to be there were found there.
- This community had a high Bray-Curtis distance, indicating that it was only 21% similar to the median reference community. Although the O:E ratio is high, the relative abundances are different suggesting a departure from reference condition due to anthropogenic stress.
- This site falls outside of the 90% confidence ellipse, departing from the cloud of reference sites, indicating that it is possibly different than what was expected and, therefore, "***possibly stressed***".

APPENDIX D

SPATIAL VARIATION ASSESSMENT SUMMARIES

Spatial Variation Assessments

Summary of CABIN QA Results

A. QA site information

Stream Name: Henshaw Creek
Site code: BUT01 (QA site)
Sampling Date: September 21, 2001
Latitude: 49.60197 N Longitude: -125.53995 W
Ecoregion: Eastern Vancouver Island
Altitude: 761 (fasl)
Stream Order: 2

C. Selected habitat variables at the QA sites and median and central 90% range of reference group

	QA sites		Reference group 1	
Variable	**BUT01-2**	**BUT01-3**	**MEDIAN**	**RANGE**
Altitude	762	761	1830	91-5115
Stream order	2	2	2*	1-4
Slope ($x10^{-3}$)	18	16	16	0.6-72.9
Bankful width[1]	15.6	17.8	30.3	4.2-149.4
Wetted width[1]	14.0	15.0	14.0	1.4-59.2
Avg Depth[2]	28.2	24.7	29.4	7.9-60.5
Max Depth[2]	36.0	44.0	42	10.0-83.5
Avg Velocity[3]	0.30	0.32	0.42	0.16-0.83
Max Velocity[3]	0.66	0.54	0.72	0.27-1.17
Dominant substrate	7	6	7*	5-8
Surrounding material	3	3	2*	2-6
Embeddedness	3	4	3*	1-5
Alkalinity[4]	35.7	37.0	26.4	4.2-88.5
pH	7.86	7.86	7.55	6.31-8.33
Conductivity (µS/cm)	49.4	49.4	53.3	8.0-211.5
TKN[4]	0.008	0.011	0.042	0.007-0.155
Total Phosphorus[4]	0	0.002	0.007	0.002-0.039
Dissolved Oxygen[4]	11.14	11.00	11.38	9.18-13.91
TSS[4]	1.00	0.25	2.98	0.23-36.71
% Sand	24.2	8.2	71.0	3.1-97.9
% Gravel	75.8	90.0	26.5	0.6-96.9

* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

B. Results of BEAST prediction

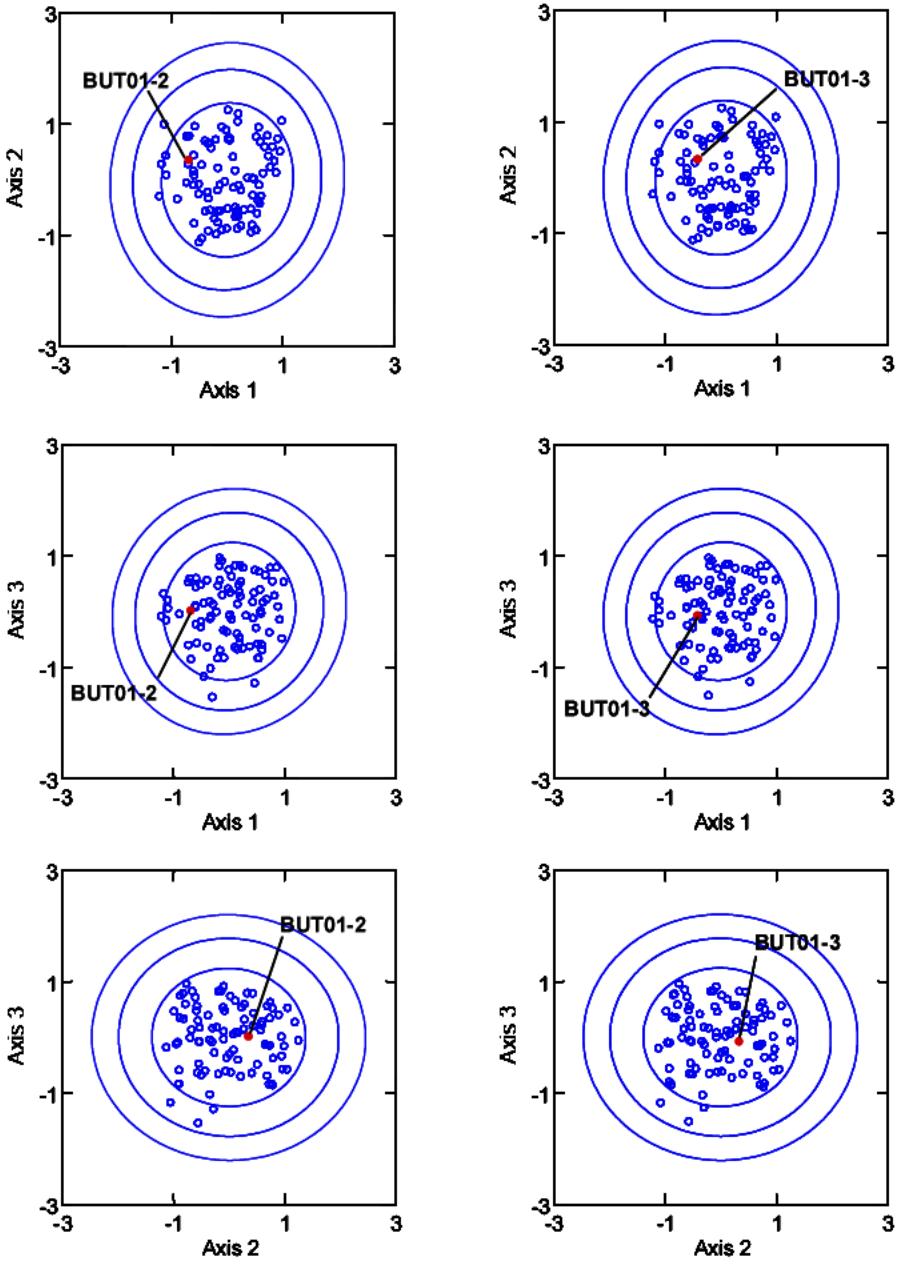
Test Site was predicted to: **Group 1** (n= 91 reference sites)
Probability of group membership from DFA

Sample	Group 1	Group 2	Group 3	Group 4	Group 5
2	**0.873**	0.004	0.102	0.001	0.020
3	**0.639**	0.007	0.230	0.010	0.115

D. Invertebrate families predicted and occurring at QA sites

Family	**BUT01-2**		**BUT01-3**	
	Count	**Prob**	**Count**	**Prob**
Chironomidae	38	1	73	0.99
Heptageniidae	145	0.98	121	0.97
Baetidae	50	0.94	39	0.93
Ephemerellidae	50	0.91	30	0.89
Chloroperlidae	29	0.88	12	0.85
Nemouridae	12	0.81	3	0 8
Perlodidae	5	0.69	0	0.67
Taeniopterygidae	148	0.67	270	0.6
Rhyacophilidae	19	0.64	12	0.59
Capniidae	7	0.63	15	0.63
Tipulidae	5	0.59	0	0.58
Empididae	2	0.52	0	0.52
Hydropsychidae	2	0.48	0	0.48
Ameletidae	2	0.43	0	0.4
Sperchontidae	17	0.42	6	0.39
Limnephilidae	2	0.37	6	0.34
Enchytraeidae	2	0.36	3	0.34
Simuliidae	2	0.32	0	0.32
Leuctridae	5	0.31	0	0.31
Glossosomatidae	21	0 3	30	0 3
Leptophlebiidae	7	0.29	6	0.34
Lumbriculidae	19	0.24	3	0.2
Torrenticolidae	0	0.23	3	0.26
Planariidae	19	0.18	24	0.15
Hygrobatidae	2	0.07	0	0.05
Aturidae	2	0.03	0	0.02
Hydrophilidae	0	0.01	3	0.01
	Obs	**Exp**	**Obs**	**Exp**
p>0.70	6	5 5	6	5.4
p>0.50	12	9 3	9	9.0
O:E p>0.70		1.09		1.10
O:E p>0.50		1.30		1.00

E. Assessment of QA sites



	Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
BUT01-2	Not stressed	Not stressed	Not stressed	**Not stressed**
BUT01-3	Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic community descriptors

	QA sites		**Reference group 1** Central 90% range (5th-95th percentiles)
	BUT01-2	**BUT01-3**	
Abundance	614	661	170-1777
Total Richness	25	18	9-26
EPT Richness	15	11	7-15
% EPT	82.2	82.6	47-97
% Dominance (top 3 taxa)	55.8	70.2	21-66
% Chironomidae	6.2	11.0	2-32
# Ephemeroptera taxa	5	4	2-5
# Plecoptera taxa	6	4	2-6
# Trichoptera taxa	4	3	0-6
Diversity	0.86	0.78	0.53-0.88
Evenness	0.29	0.25	0.17-0.43
Bray-Curtis	0.41	0.45	0.36-0.75

G. Discussion of results

- The QA samples taken at this reference site were predicted to be similar to Group 1 with high probabilities.
- The QA samples had similar taxonomic compositions.
- The samples also had similar O:E ratios and similar Bray-Curtis values.
- The ordination plots indicate that these samples are equivalent to reference.

Summary of CABIN QA Results

A. QA site information

Stream Name: Chehalis River
Site code: CHH12 (QA site)
Sampling Date: September 18, 1998
Latitude: 49.27817 N Longitude: -121.936 W
Ecoregion: Pacific Ranges
Altitude: 52 (fasl)
Stream Order: 3

C. Selected habitat variables at the QA sites and median and central 90% range of reference group

	QA sites		Reference group 4	
Variable	**CHH12-2**	**CHH12-3**	**MEDIAN**	**RANGE**
Altitude	52	52	292	20-4021
Stream order	3	3	3*	1-6
Slope ($x10^{-3}$)	2	6	1	0.1-29.9
Bankful width[1]	69.0	88.9	37.1	6.4-231.2
Wetted width[1]	24.0	26.0	22.1	3.7-83.0
Avg Depth[2]	14.6	20.4	30.0	12.6-87.4
Max Depth[2]	17.0	25.0	36	15-116.2
Avg Velocity[3]	0.11	0.08	0.14	0-0.59
Max Velocity[3]	0.12	0.12	0.25	0-0.68
Dominant substrate	6	6	5*	1-7
Surrounding material	3	3	2*	2-5
Embeddedness	4	4	5*	1-5
Alkalinity[4]	6.9	8.8	25.2	5.0-84.6
pH	5.95	5.98	7.06	5.50-8.24
Conductivity (µS/cm)	4.8	4.7	12.6	6.5-162.3
TKN[4]	0.022	0.022	0.120	0.037-0.387
Total Phosphorus[4]	0.005	0.005	0.011	0.004-0.038
Dissolved Oxygen[4]	8.28	8.12	10.21	6.84-12.11
TSS[4]	0.33	0.29	2.70	0.97-28.05
% Sand	66.2	67.6	72.9	0.1-99.0
% Gravel	32.8	32.4	5.7	0-62.8

* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

B. Results of BEAST prediction

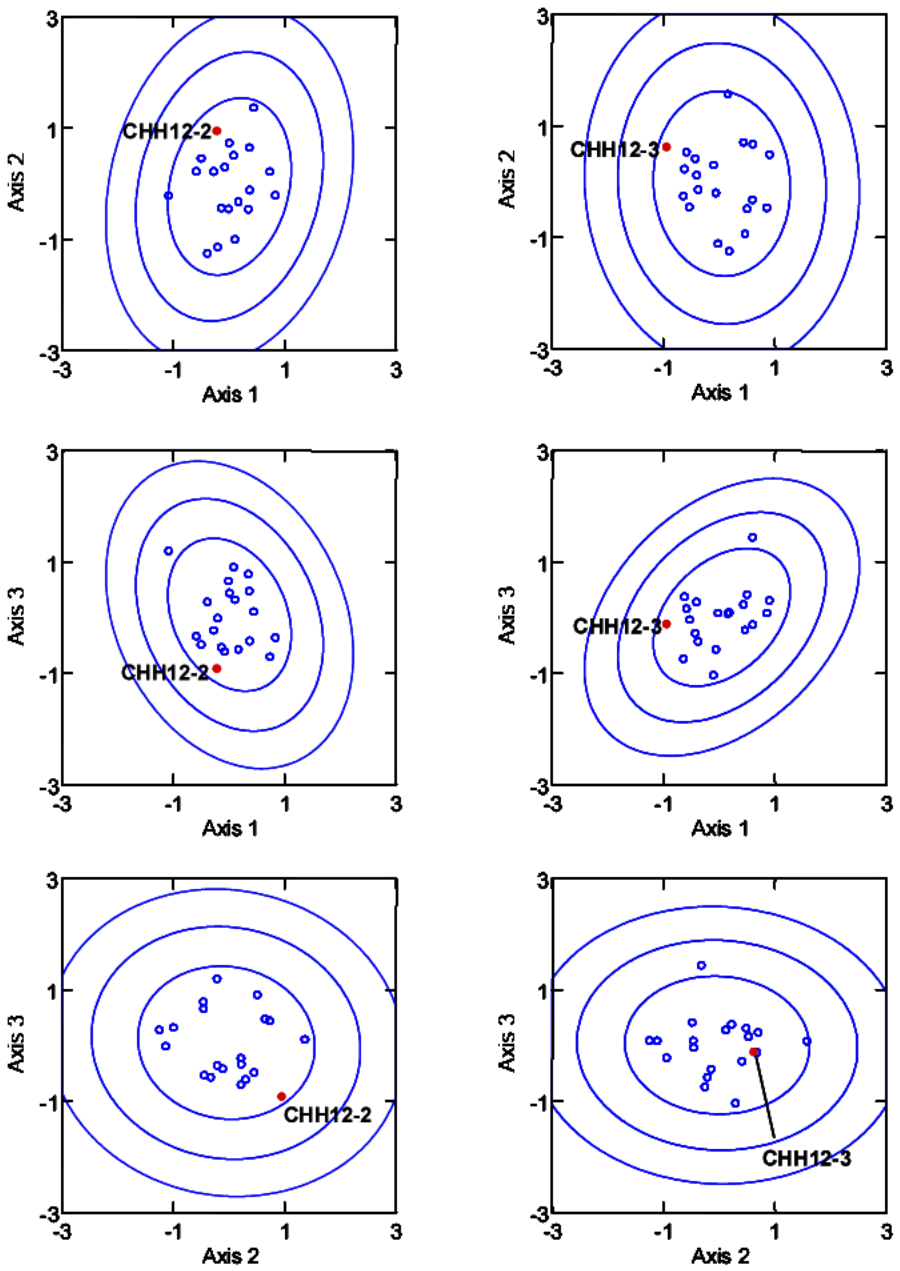
QA sites were predicted to: **Group 4** (n= 19 reference sites)
Probability of group membership from DFA

Sample	Group 1	Group 2	Group 3	Group 4	Group 5
2	0.009	0.011	0.040	**0.857**	0.083
3	0.008	0.006	0.027	**0.914**	0.044

D. Invertebrate families predicted and occurring at QA sites

Family	**CHH12-2**		**CHH12-3**	
	Count	**Prob**	**Count**	**Prob**
Chironomidae	8633	1	5067	1
Naididae	233	0.72	100	0.75
Baetidae	0	0.67	0	0.65
Ephemerellidae	0	0.62	33	0.6
Heptageniidae	0	0.54	0	0.51
Capniidae	0	0.5	0	0.49
Lebertiidae	33	0.46	100	0.46
Leptoceridae	33	0.33	33	0.34
Lumbriculidae	0	0.38	33	0.39
Leptophlebiidae	33	0.16	33	0.14
Empididae	533	0.3	500	0.29
Hydropsychidae	133	0.29	100	0.28
Sperchontidae	633	0.22	533	0.22
Torrenticolidae	0	0.18	100	0.17
Planariidae	0	0.1	33	0.1
Tubificidea	0	0.47	33	0.49
	Obs	**Exp**	**Obs**	**Exp**
p>0.70	2	1.7	2	1.8
p>0.50	2	4.1	3	4.0
O:E p>0.70		1.16		1.14
O:E p>0.50		0.49		0.75

E. Assessment of QA sites



	Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
CHH12-2	Not stressed	Not stressed	Not stressed	**Not stressed**
CHH12-3	Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic community descriptors

	QA sites		**Reference group 4** Central 90% range (5th-95th percentiles)
	CHH12-2	**CHH12-3**	
Abundance	10267	6700	820-8290
Total Richness	8	13	6-19
EPT Richness	3	4	1-10
% EPT	1.9	3.0	0-43
% Dominance (top 3 taxa)	95.5	91.0	39-83
% Chironomidae	84.1	75.6	18-82
# Ephemeroptera taxa	1	2	0-4
# Plecoptera taxa	0	0	0-2
# Trichoptera taxa	2	2	0-5
Diversity	0.29	0.42	0.31-0.77
Evenness	0.17	0.13	0.11-0.32
Bray-Curtis	0.69	0.56	0.27-0.73

G. Discussion of results

- The QA samples taken at this reference site were predicted to be similar to Group 4 with high probabilities.
- The QA samples had similar taxonomic compositions.
- The samples also had similar O:E ratios and similar Bray-Curtis values.
- The ordination plots indicate that these samples are equivalent to reference.

Summary of CABIN QA Results

A. QA site information

Stream Name: Hunter Creek
Site code: HUN01 (QA site)
Sampling Date: September 16, 1998
Latitude: 49.35683 N Longitude: -121.5745 W
Ecoregion: Pacific Ranges
Altitude: 100 (fasl)
Stream Order: 2

C. Selected habitat variables at the QA sites and median and central 90% range of reference group

	QA sites		Reference group 1	
Variable	**HUN01-2**	**HUN01-3**	**MEDIAN**	**RANGE**
Altitude	100	100	1830	91-5115
Stream order	2	2	2*	1-4
Slope ($x10^{-3}$)	17	16	16	0.6-72.9
Bankful width[1]	15.0	14.1	30.3	4.2-149.4
Wetted width[1]	5.7	6.1	14.0	1.4-59.2
Avg Depth[2]	22.8	15.6	29.4	7.9-60.5
Max Depth[2]	32.0	24.0	42	10.0-83.5
Avg Velocity[3]	0.16	0.19	0.42	0.16-0.83
Max Velocity[3]	0.26	0.37	0.72	0.27-1.17
Dominant substrate	8	8	7*	5-8
Surrounding material	5	5	2*	2-6
Embeddedness	4	4	3*	1-5
Alkalinity[4]	22.9	23.0	26.4	4.2-88.5
pH	7.09	7.09	7.55	6.31-8.33
Conductivity (µS/cm)	11.7	11.8	53.3	8.0-211.5
TKN[4]	0.074	0.019	0.042	0.007-0.155
Total Phosphorus[4]	0.007	0.008	0.007	0.002-0.039
Dissolved Oxygen[4]	11.01	10.74	11.38	9.18-13.91
TSS[4]	0.60	0.52	2.98	0.23-36.71
% Sand	35.9	53.2	71.0	3.1-97.9
% Gravel	50.0	46.3	26.5	0.6-96.9

* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

B. Results of BEAST prediction

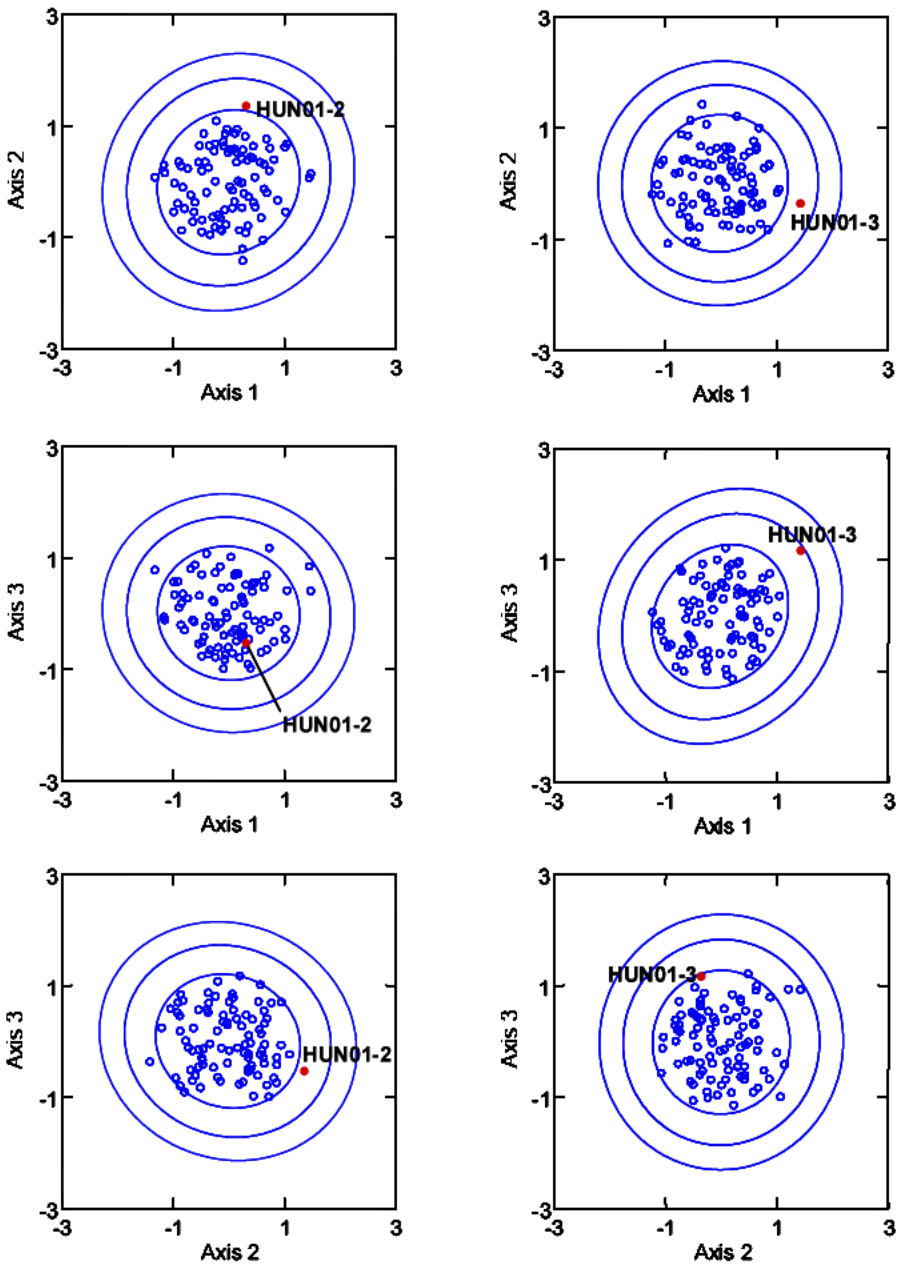
Test Site was predicted to: **Group 1** (n= 91 reference sites)
Probability of group membership from DFA

Sample	Group 1	Group 2	Group 3	Group 4	Group 5
2	**0.633**	0.006	0.282	0.011	0.067
3	**0.625**	0.009	0.280	0.004	0.081

D. Invertebrate families predicted and occurring at QA sites

Family	**HUN01-2**		**HUN01-3**	
	Count	**Prob**	**Count**	**Prob**
Chironomidae	483	0.99	950	0.99
Heptageniidae	400	0.97	800	0.97
Baetidae	783	0.92	2575	0.92
Ephemerellidae	467	0.9	675	0.9
Chloroperlidae	17	0.86	25	0.86
Nemouridae	50	0.79	200	0.8
Perlodidae	0	0.67	25	0.67
Capniidae	17	0.62	25	0.62
Rhyacophilidae	0	0.61	0	0.6
Taeniopterygidae	0	0.6	0	0.6
Tipulidae	17	0.59	0	0.59
Empididae	17	0.53	25	0.53
Hydropsychidae	133	0.48	325	0.49
Lebertiidae	67	0.39	25	0.39
Lepidostomatidae	100	0.34	150	0.35
Enchytraeidae	17	0.34	25	0.34
Leptophlebiidae	33	0.33	25	0.34
Simuliidae	33	0.32	50	0.32
Naididae	617	0.27	600	0.27
Torrenticolidae	17	0.26	0	0.26
Ceratopogonidae	17	0.22	25	0.21
Limnesiidae	33	0.12	0	0.12
Elmidae	0	0.26	0	0.27
Sperchontidae	0	0.39	25	0.39
	Obs	**Exp**	**Obs**	**Exp**
p>0.70	6	5.4	6	5.4
p>0.50	9	9.1	9	9.1
O:E p>0.70		1.10		1.10
O:E p>0.50		0.99		0.99

E. Assessment of QA sites



	Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
HUN01-2	Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**
HUN01-3	Possibly stressed	Possibly stressed	Not stressed	**Possibly stressed**

F. Benthic community descriptors

	QA sites		Reference group 1 Central 90% range (5th-95th percentiles)
	HUN01-2	**HUN01-3**	
Abundance	3317	6550	170-1777
Total Richness	19	18	9-26
EPT Richness	9	10	7-15
% EPT	60.3	73.7	47-97
% Dominance (top 3 taxa)	56.8	66.0	21-66
% Chironomidae	14.6	14.5	2-32
# Ephemeroptera taxa	4	4	2-5
# Plecoptera taxa	3	4	2-6
# Trichoptera taxa	2	2	0-6
Diversity	0.85	0.79	0.53-0.88
Evenness	0.35	0.26	0.17-0.43
Bray-Curtis	0.83	0.91	0.36-0.75

G. Discussion of results

- The QA samples taken at this reference site were predicted to be similar to Group1 with high probabilities.
- The QA samples had similar taxonomic compositions.
- The samples also had similar O:E ratios and similar Bray-Curtis values.
- The ordination plots resulted in similar assessments. They indicate that these samples are outside of the 90% confidence ellipse. These samples are not likely stressed rather they are the 10% of reference sites that will be plotted outside of the 90% confidence ellipse.

Summary of CABIN QA Results

A. QA site information

Stream Name: Elk River
Site code: STR03 (QA site)
Sampling Date: September 20, 2001
Latitude: 49.87855 N Longitude: -125.75385 W
Ecoregion: Eastern Vancouver Island
Altitude: 784 (fasl)
Stream Order: 2

C. Selected habitat variables at the QA sites and median and central 90% range of reference group

	QA sites		Reference group 1	
Variable	**STR03-2**	**STR03-3**	**MEDIAN**	**RANGE**
Altitude	784	784	1830	91-5115
Stream order	2	2	2*	1-4
Slope ($x10^{-3}$)	55	13	16	0.6-72.9
Bankful width[1]	9.7	11.2	30.3	4.2-149.4
Wetted width[1]	6.5	8.0	14.0	1.4-59.2
Avg Depth[2]	30.0	25.6	29.4	7.9-60.5
Max Depth[2]	50	42	42	10.0-83.5
Avg Velocity[3]	0.27	0.33	0.42	0.16-0.83
Max Velocity[3]	0.72	0.64	0.72	0.27-1.17
Dominant substrate	8	8	7*	5-8
Surrounding material	6	6	2*	2-6
Embeddedness	5	5	3*	1-5
Alkalinity[4]	25.8	25.8	26.4	4.2-88.5
pH	7.70	7.70	7.55	6.31-8.33
Conductivity (µS/cm)	35.3	35.0	53.3	8.0-211.5
TKN[4]	0.028	0.132	0.042	0.007-0.155
Total Phosphorus[4]	0.004	0.003	0.007	0.002-0.039
Dissolved Oxygen[4]	12.46	12.32	11.38	9.18-13.91
TSS[4]	0.49	0.36	2.98	0.23-36.71
% Sand	11.1	6.8	71.0	3.1-97.9
% Gravel	88.9	91.4	26.5	0.6-96.9

* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

B. Results of BEAST prediction

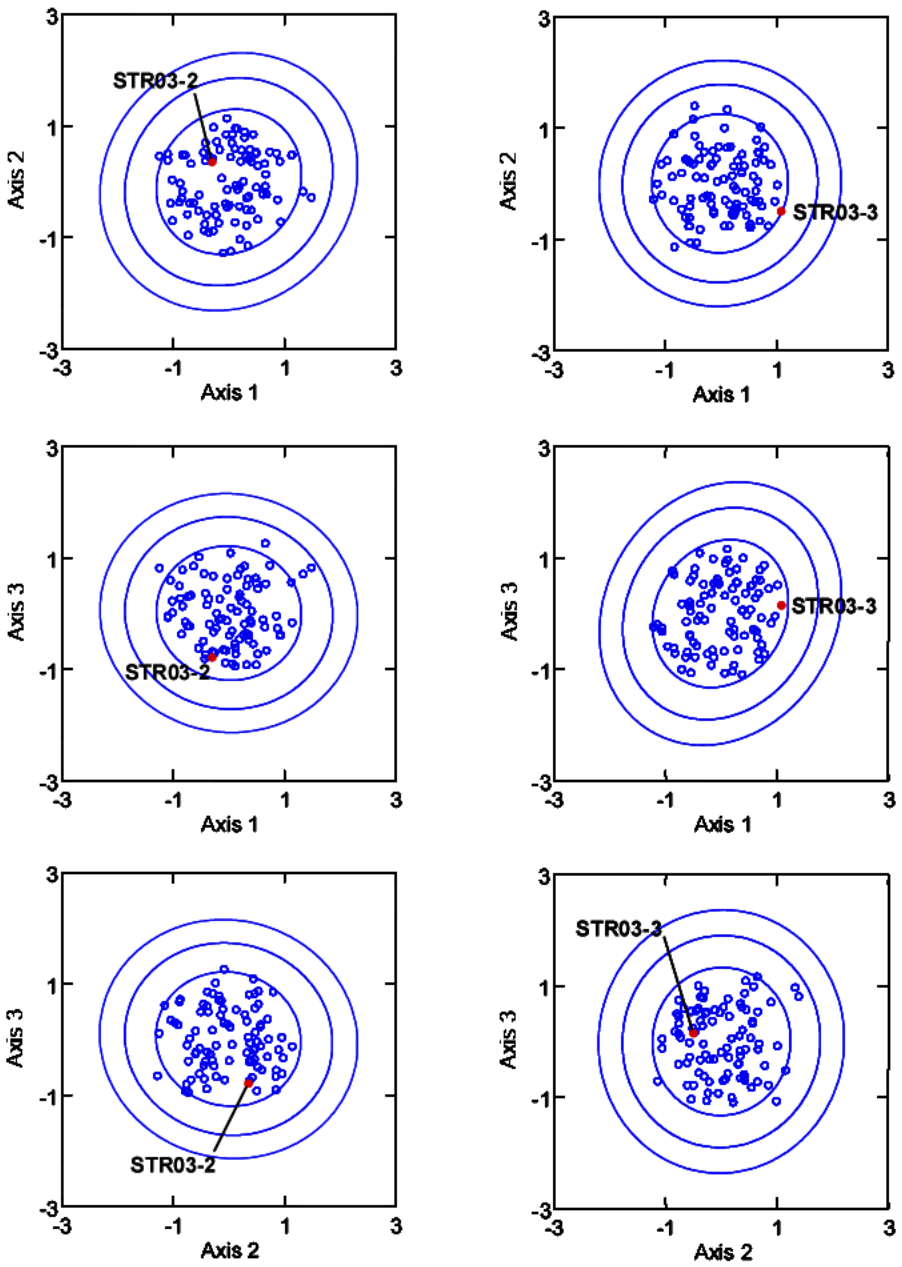
Test Site was predicted to: **Group 1** (n= 91 reference sites)
Probability of group membership from DFA

Sample	Group 1	Group 2	Group 3	Group 4	Group 5
2	**0.779**	0.001	0.195	0.002	0.023
3	**0.658**	0.003	0.280	0.001	0.057

D. Invertebrate families predicted and occurring at QA sites

Family	**STR03-2**		**STR03-3**	
	Count	**Prob**	**Count**	**Prob**
Chironomidae	17	1	72	0.99
Heptageniidae	208	0.98	72	0.98
Baetidae	1067	0.93	644	0.93
Ephemerellidae	142	0.91	94	0.9
Chloroperlidae	17	0.87	17	0.86
Nemouridae	8	0.8	28	0.8
Perlodidae	8	0.68	6	0.68
Taeniopterygidae	208	0.65	194	0.61
Rhyacophilidae	0	0.63	6	0.61
Capniidae	0	0.62	0	0.62
Tipulidae	17	0.59	0	0.59
Empididae	0	0.52	0	0.53
Sperchontidae	8	0.41	6	0.4
Lebertiidae	8	0.4	0	0.39
Simuliidae	17	0.33	17	0.33
Leuctridae	8	0.31	0	0.31
Leptophlebiidae	8	0.31	6	0.33
Glossosomatidae	83	0.3	33	0.3
Naididae	17	0.25	0	0.26
Planariidae	0	0.17	6	0.15
Hygrobatidae	17	0.06	11	0.05
Leptoceridae	17	0.04	6	0.04
Deuterophlebiidae	8	0.01	0	0.01
Sciomyzidae	8	0	0	0
Xironodrilidae	1875	0	1217	0
	Obs	**Exp**	**Obs**	**Exp**
p>0.70	6	5.5	6	5.5
p>0.50	9	9.2	9	9.1
O:E p>0.70		1.09		1.10
O:E p>0.50		0.98		0.99

E. Assessment of QA sites



	Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
STR03-2	Not stressed	Not stressed	Not stressed	**Not stressed**
STR03-3	Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic community descriptors

	QA sites		**Reference group 1** Central 90% range (5th-95th percentiles)
	STR03-2	**STR03-3**	
Abundance	1892	1217	170-1777
Total Richness	20	16	9-26
EPT Richness	11	11	7-15
% EPT	93.8	90.9	47-97
% Dominance (top 3 taxa)	78.4	76.7	21-66
% Chironomidae	0.9	5.9	2-32
# Ephemeroptera taxa	4	4	2-5
# Plecoptera taxa	5	4	2-6
# Trichoptera taxa	2	3	0-6
Diversity	0.65	0.68	0.53-0.88
Evenness	0.14	0.19	0.17-0.43
Bray-Curtis	0.76	0.62	0.36-0.75

G. Discussion of results

- The QA samples taken at this reference site were predicted to be similar to Group 1 with high probabilities.
- The QA samples had similar taxonomic compositions.
- The samples also had similar O:E ratios and similar Bray-Curtis values.
- The ordination plots indicate that these samples are equivalent to reference.

Summary of CABIN QA Results

A. QA site information

Stream Name: Sumallo River
Site code: SUM01 (QA site)
Sampling Date: September 13, 1999
Latitude: 49.26389 N Longitude: -121.20806 W
Ecoregion: Thompson-Okanagan Plateau
Altitude: 2044 (fasl)
Stream Order: 3

C. Selected habitat variables at the QA sites and median and central 90% range of reference group

	QA sites		Reference group 3	
Variable	**SUM01-2**	**SUM01-3**	**MEDIAN**	**RANGE**
Altitude	2044	2044	3312	95-5584
Stream order	3	3	3*	1-4
Slope ($x10^{-3}$)	2	1	12	0.4-89.4
Bankful width[1]	16.3	17.7	18.0	3.1-92.9
Wetted width[1]	11.8	11.8	7.4	1.4-40.3
Avg Depth[2]	33.0	34.0	21.9	7.0-56.3
Max Depth[2]	50	46	30	8.0-78.3
Avg Velocity[3]	0.41	0.51	0.39	0.16-0.67
Max Velocity[3]	0.74	0.65	0.56	0.25-0.95
Dominant substrate	6	6	7*	4-8
Surrounding material	4	4	3*	2-5
Embeddedness	4	4	5*	2-5
Alkalinity[4]	41.6	41.5	39.5	7.4-112.2
pH	7.54	7.52	7.64	6.56-8.55
Conductivity (µS/cm)	30.0	30.0	83.5	15.2-187.4
TKN[4]	0.148	0.148	0.073	0.014-0.363
Total Phosphorus[4]	0.005	0.007	0.007	0.002-0.084
Dissolved Oxygen[4]	10.43	10.39	11.75	9.49-14.12
TSS[4]	0.87	0.91	3.62	0.95-20.69
% Sand	50.8	51.3	72.5	9.8-88.8
% Gravel	48.8	48.2	25.8	7.0-84.1

* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

B. Results of BEAST prediction

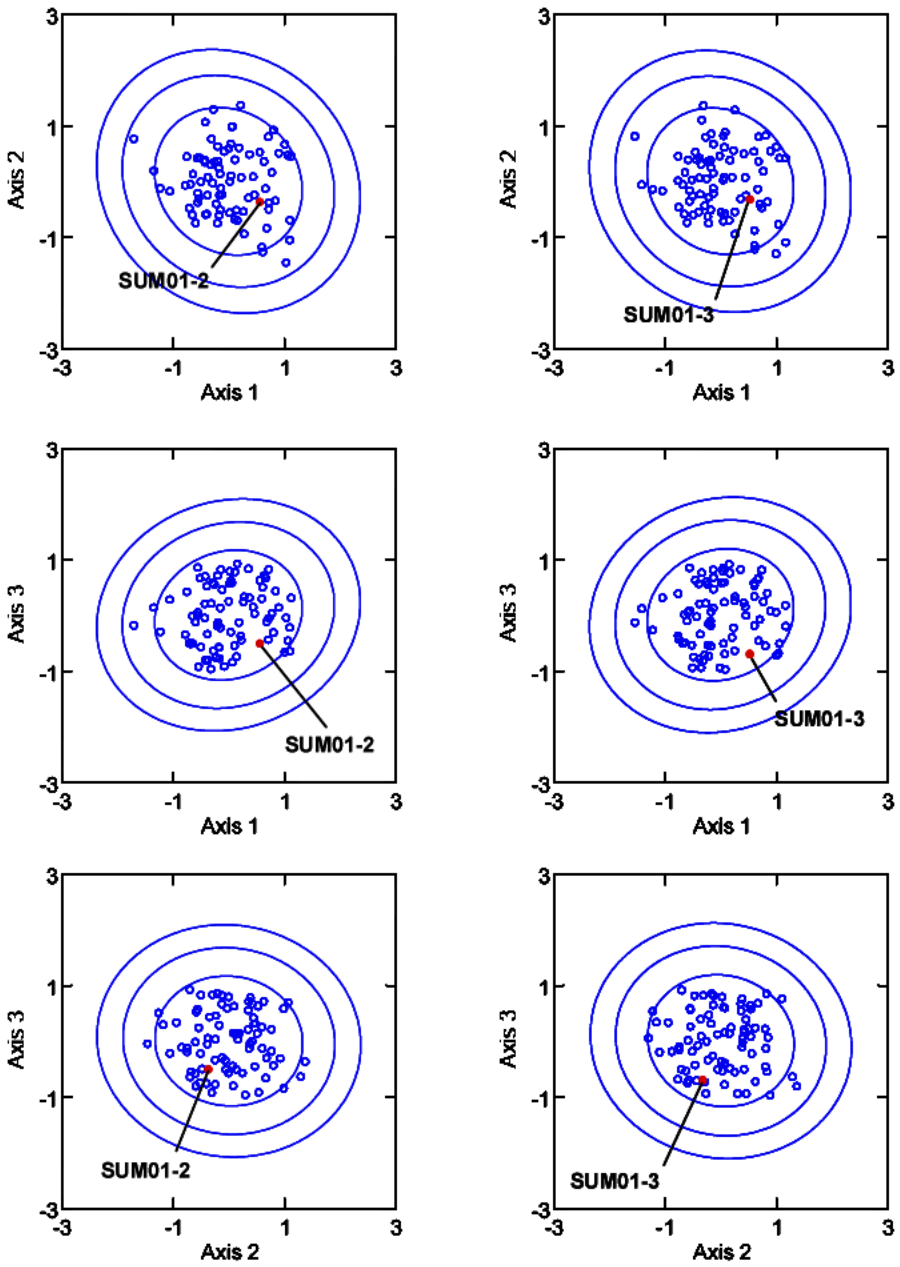
QA Sites were predicted to **Group 3** (n= 80 reference sites)
Probability of group membership from DFA

Sample	Group 1	Group 2	Group 3	Group 4	Group 5
2	0.160	0.065	**0.441**	0.006	0.328
3	0.138	0.061	**0.447**	0.010	0.344

D. Invertebrate families predicted and occurring at QA sites

Family	**SUM01-2**		**SUM01-3**	
	Count	**Prob**	**Count**	**Prob**
Chironomidae	360	0.99	1157	0.99
Heptageniidae	1020	0.95	1329	0.95
Baetidae	630	0.9	557	0.9
Ephemerellidae	900	0.86	429	0.86
Chloroperlidae	240	0.8	257	0.79
Nemouridae	120	0.77	86	0.77
Capniidae	120	0.64	514	0.64
Perlodidae	60	0.63	43	0.63
Tipulidae	90	0.57	43	0.57
Empididae	30	0.54	0	0.54
Rhyacophilidae	30	0.49	0	0.48
Taeniopterygidae	930	0.45	1971	0.44
Leptophlebiidae	60	0.44	129	0.44
Ameletidae	30	0.37	0	0.37
Enchytraeidae	1170	0.32	1971	0.32
Lumbriculidae	330	0.12	86	0.12
Tubificidae	60	0.12	0	0.12
Apataniidae	30	0.07	0	0.07
Hydryphantidae	60	0.07	43	0.48
Crangonyctidae	60	0.03	0	0.03
Glossosomatidae	0	0.27	43	0.27
Planariidae	0	0.07	43	0.07
Sphaeriidae	0	0.22	43	0.22
	Obs	**Exp**	**Obs**	**Exp**
p>0.70	6	5.3	6	5.3
p>0.50	10	7.7	9	7.6
O:E p>0.70		1.14		1.14
O:E p>0.50		1.31		1.18

E. Assessment of QA sites



	Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
SUM01-2	Not stressed	Not stressed	Not stressed	**Not stressed**
SUM01-3	Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic community descriptors

	QA sites		**Reference group 3** Central 90% range (5th-95th percentiles)
	SUM01-2	**SUM01-3**	
Abundance	6330	8743	1659-12885
Total Richness	20	17	10-20
EPT Richness	12	11	5-13
% EPT	65.9	61.8	39-97
% Dominance (top 3 taxa)	49.3	60.3	22-65
% Chironomidae	5.7	13.2	2-43
# Ephemeroptera taxa	5	4	2-5
# Plecoptera taxa	5	5	2-6
# Trichoptera taxa	2	2	1-5
Diversity	0.88	0.85	0.57-0.87
Evenness	0.41	0.38	0.20-0.48
Bray-Curtis	0.57	0.63	0.32-0.75

G. Discussion of results

- The QA samples taken at this reference site were predicted to be similar to Group 3 with similar probabilities.
- The QA samples had similar taxonomic compositions.
- The samples also had similar O:E ratios and similar Bray-Curtis values.
- The ordination plots indicate that these samples are equivalent to reference.

Summary of CABIN QA Results

A. QA site information

Stream Name: Eagle Creek
Site code: BRU02 (QA site)
Sampling Date: September 26, 2000
Latitude: 49.2522 N Longitude: -122.9426 W
Ecoregion: Lower Mainland
Altitude: 125 (fasl)
Stream Order: 1

B. Results of BEAST prediction

Test Site was predicted to: **Group 3** (n= 80 reference sites)

Probability of group membership from DFA

Sample	Group 1	Group 2	Group 3	Group 4	Group 5
1	0.250	0.022	**0.377**	0.015	0.335
2	0.102	0.018	**0.446**	0.063	0.371
3	0.078	0.012	**0.423**	0.162	0.324

C. Selected habitat variables at the QA sites and median and central 90% range of reference group

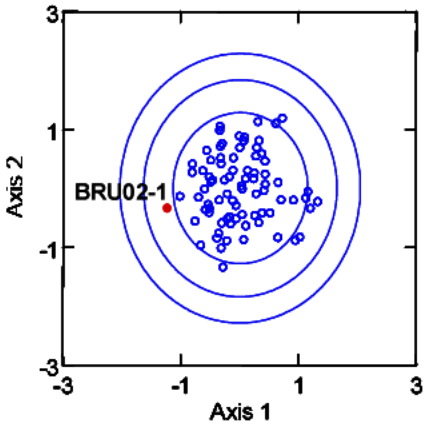
	QA sites			Reference group 3	
Variable	**BRU02-1**	**BRU02-2**	**BRU02-3**	**MEDIAN**	**RANGE**
Altitude	125	125	125	3312	95-5584
Stream order	1	1	1	3*	1-4
Slope ($x10^{-3}$)	13	13	25	12	0.4-89.4
Bankful width[1]	5.0	8.6	8.3	18.0	3.1-92.9
Wetted width[1]	2.9	4.3	3.5	7.4	1.4-40.3
Avg Depth[2]	10.3	8	9.4	21.9	7.0-56.3
Max Depth[2]	16	10	16	30	8.0-78.3
Avg Velocity[3]	0.198	0.232	0.085	0.39	0.16-0.67
Max Velocity[3]	0.314	0.372	0.206	0.56	0.25-0.95
Dominant substrate	6	7	7	7*	4-8
Surrounding material	3	3	3	3*	2-5
Embeddedness	4	4	4	5*	2-5
Alkalinity[4]	73.5	74.0	73.8	39.5	7.4-112.2
pH	7.11	7.10	7.09	7.64	6.56-8.55
Conductivity (µS/cm)	138.0	143.0	142.0	83.5	15.2-187.4
TKN[4]	0.133	0.122	0.124	0.073	0.014-0.363
Total Phosphorus[4]	0.074	0.050	0.047	0.007	0.002-0.084
Dissolved Oxygen[4]	10.80	10.76	10.66	11.75	9.49-14.12
TSS[4]	3.39	3.53	1.88	3.62	0.95-20.69
% Sand	28.9	15.2	8.2	72.5	9.8-88.8
% Gravel	69.9	84.6	91.6	25.8	7.0-84.1

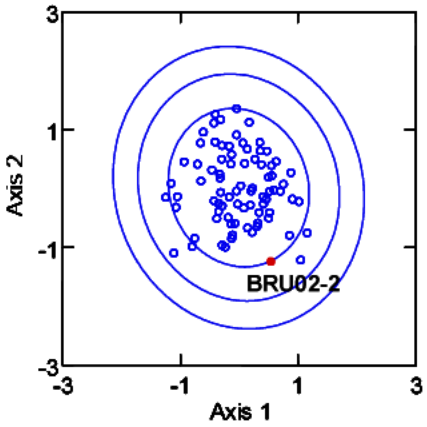
* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

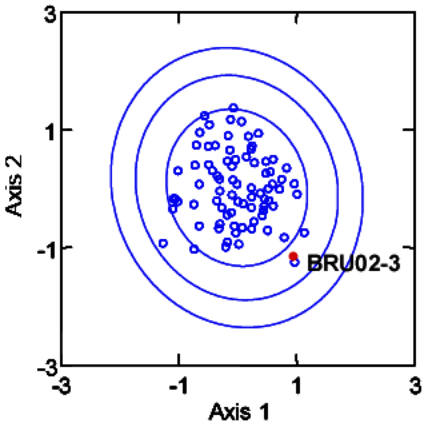
D. Invertebrate families predicted and occurring at QA sites

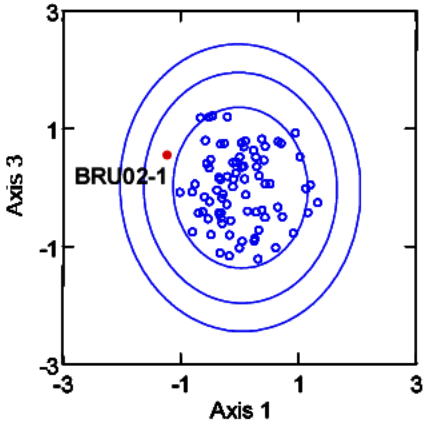
Family	**BRU02-1**		**BRU02-2**		**BRU02-3**	
	Count	**Prob**	**Count**	**Prob**	**Count**	**Prob**
Chironomidae	280	0.99	106	0.99	363	0.99
Heptageniidae	0	0.95	0	0.93	0	0.88
Baetidae	587	0.91	863	0.89	1484	0.86
Ephemerellidae	0	0.87	0	0.85	0	0.83
Chloroperlidae	0	0.8	0	0.76	0	0.72
Nemouridae	53	0.78	38	0.75	426	0.69
Capniidae	0	0.64	0	0.63	0	0.61
Perlodidae	0	0.63	0	0.6	0	0.54
Tipulidae	0	0.56	6	0.55	16	0.54
Empididae	7	0.53	0	0.52	32	0.5
Rhyacophilidae	33	0.5	13	0.46	16	0.43
Hydropsychidae	40	0.48	0	0.47	32	0.45
Naididae	147	0.31	19	0.35	32	0.4
Simuliidae	13	0.31	0	0.3	16	0.29
Lumbriculidae	47	0.13	44	0.12	126	0.14
Crangonyctidae	107	0.03	119	0.03	411	0.03
Asellidae	60	0	63	0	489	0.01
Sperchontidae	0	0.33	0	0.3	16	0.29
Leptophlebiidae	0	0.44	13	0.45	16	0.41
Polycentropodidae	0	0.04	6	0.02	0	0.02
	Obs	**Exp**	**Obs**	**Exp**	**Obs**	**Exp**
p>0.70	3	5.3	3	5.2	2	4.3
p>0.50	4	7.7	4	7.5	4	6.7
O:E p>0.70		0.57		0.58		0.47
O:E p>0.50		0.52		0.53		0.60

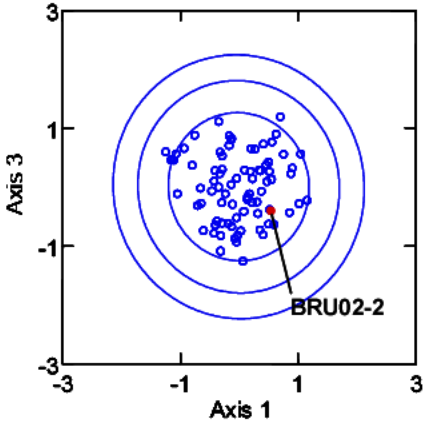
E. Assessment of QA sites

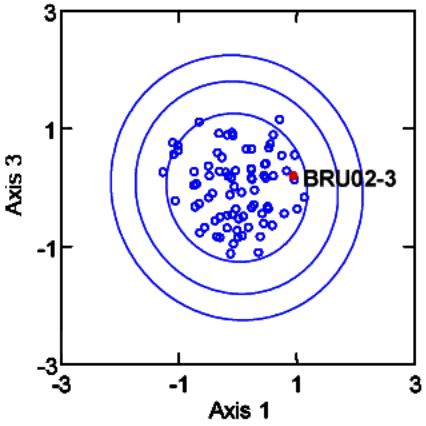


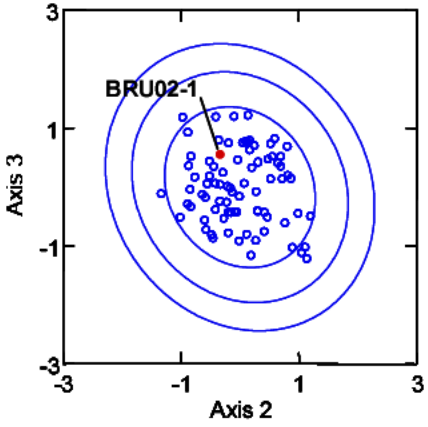


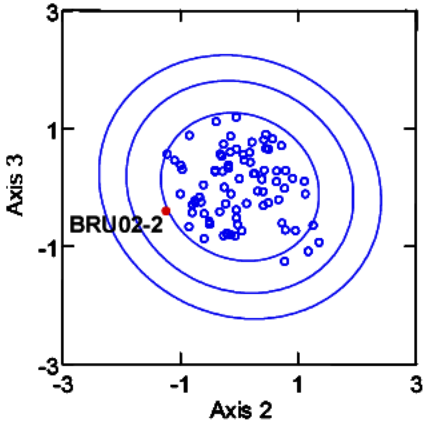


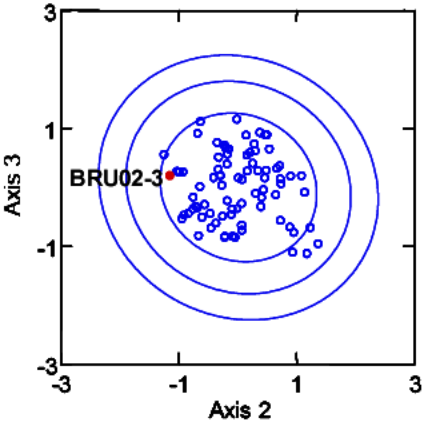












	Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
BRU02-1	Possibly stressed	Possibly stressed	Not stressed	**Possibly stressed**
BRU02-2	Possibly stressed	Not stressed	Possibly stressed	**Possibly stressed**
BRU02-3	Possibly stressed	Not stressed	Not stressed	**Possibly stressed**

F. Benthic community descriptors

	QA sites			**Reference group 3** Central 90% range (5th-95th percentiles)
	BRU02-1	**BRU02-2**	**BRU02-3**	
Abundance	1373	1288	3474	1659-12885
Total Richness	11	11	14	10-20
EPT Richness	4	5	5	5-13
% EPT	49.5	72.3	56.8	39-97
% Dominance (top 3 taxa)	73.8	84.5	69.1	22-65
% Chironomidae	20.4	8.3	10.5	2-43
# Ephemeroptera taxa	1	2	2	2-5
# Plecoptera taxa	1	1	1	2-6
# Trichoptera taxa	2	2	2	1-5
Diversity	0.75	0.53	0.76	0.57-0.87
Evenness	0.37	0.19	0.29	0.20-0.48
Bray-Curtis	0.81	0.66	0.68	0.32-0.75

G. Discussion of results

- These QA samples were predicted to be similar to Group 3 reference sites with similar probabilities.
- These QA samples had similar taxonomic compositions.
- Each sample had a low O:E taxa ratio indicating that they were missing many of the expected taxa.
- The first QA sample had a slightly higher Bray-Curtis value than the other two suggesting that it is more different from the reference sites than the other two QA samples.
- Each sample was deemed "***possibly stressed***" in the ordination plot with Group 3 reference sites although the samples were quite close to the 90% ellipse.

Summary of CABIN QA Results

A. QA site information

Stream Name: Clayburn Creek
Site code: CLB03 (QA site)
Sampling Date: September 16, 1998
Latitude: 49.0794 N Longitude: -122.2450 W
Ecoregion: Lower Mainland
Altitude: 133 (fasl)
Stream Order: 2

C. Selected habitat variables at the QA sites and median and central 90% range of reference group

	QA sites			Reference group 3	
Variable	**CLB03-1**	**CLB03-2**	**CLB03-3**	**MEDIAN**	**RANGE**
Altitude	133	133	133	3312	95-5584
Stream order	2	2	2	3*	1-4
Slope ($x10^{-3}$)	29	22	14	11.6	0.4-89.4
Bankful width[1]	9.4	6.3	5.7	18.03	3.1-92.9
Wetted width[1]	3.6	4.5	2.0	7.4	1.4-40.3
Avg Depth[2]	11.0	24.2	8.8	21.9	7.0-56.3
Max Depth[2]	18	35	12	30	8.0-78.3
Avg Velocity[3]	0.24	0.10	0.16	0.39	0.16-0.67
Max Velocity[3]	0.43	0.18	0.32	0.56	0.25-0.95
Dominant substrate	6	6	6	7*	4-8
Surrounding material	3	3	3	3*	2-5
Embeddedness	4	5	4	5*	2-5
Alkalinity[4]	72.0	73	72.6	39.5	7.4-112.2
pH	7.76	7.77	7.76	7.64	6.56-8.55
Conductivity (µS/cm)	16.8	17	17	83.5	15.2-187.4
TKN[4]	0.150	0.14	0.16	0.073	0.014-0.363
Total Phosphorus[4]	0.025	0.019	0.019	0.007	0.002-0.084
Dissolved Oxygen[4]	10.50	10.41	10.45	11.75	9.49-14.12
TSS[4]	1.43	3.46	31.07	3.62	0.95-20.69
% Sand	67.8	94.0	56.4	72.52	9.8-88.8
% Gravel	30.2	3.7	42.8	5.73	7.0-84.1

* Represented as mode not median.
[1] Width measured in meters (m).
[2] Depth measured in centimeters (cm).
[3] Velocity measured in m/s.
[4] Measurements in mg/L.

B. Results of BEAST prediction

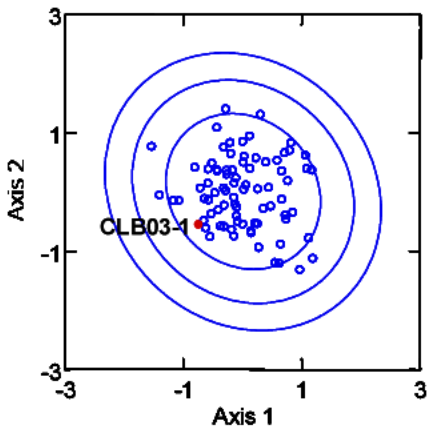
Test Site was predicted to: **Group 3** (n= 80 reference sites)
Probability of group membership from DFA

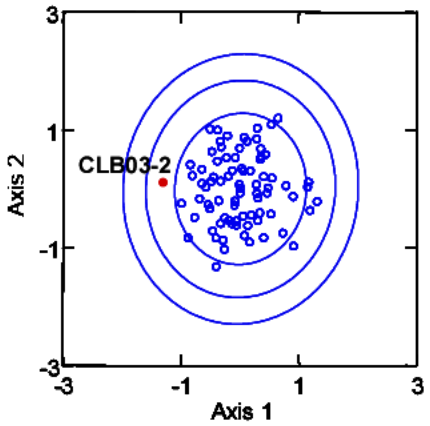
Sample	Group 1	Group 2	Group 3	Group 4	Group 5
1	0.433	0.008	**0.368**	0.004	0.187
2	0.194	0.003	**0.403**	0.076	0.324
3	0.229	0.009	**0.352**	0.010	0.399

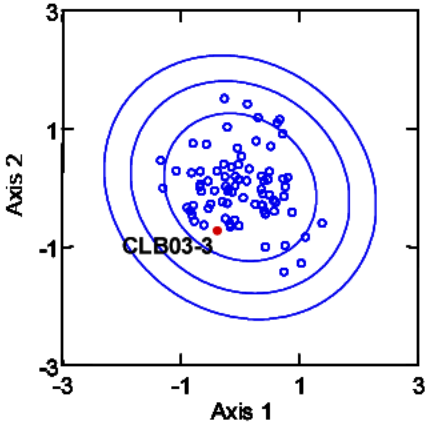
D. Invertebrate families predicted and occurring at QA sites

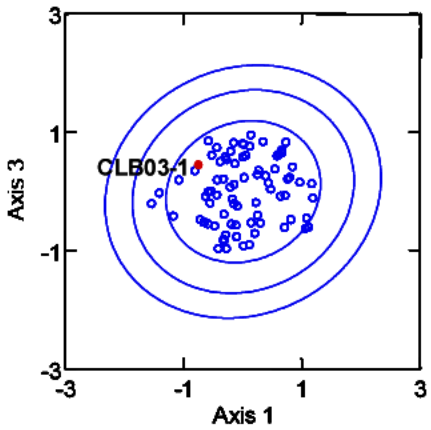
Family	**CLB03-1**		**CLB03-2**		**CLB03-3**	
	Count	**Prob**	**Count**	**Prob**	**Count**	**Prob**
Chironomidae	257	0.99	153	0.99	382	0.99
Heptageniidae	371	0.97	165	0.93	282	0.95
Baetidae	500	0.92	271	0.89	264	0.91
Ephemerellidae	14	0.89	29	0.86	18	0.87
Chloroperlidae	86	0.83	18	0.77	136	0.79
Nemouridae	143	0.79	12	0.75	0	0.78
Perlodidae	129	0.66	53	0.6	55	0.63
Capniidae	0	0.63	0	0.63	27	0.64
Tipulidae	86	0.58	41	0.55	182	0.56
Rhyacophilidae	43	0.56	24	0.47	9	0.48
Taeniopterygidae	0	0.54	0	0.45	0	0.46
Empididae	14	0.53	0	0.52	0	0.53
Hydropsychidae	400	0.49	35	0.47	27	0.48
Leptophlebiidae	186	0.39	29	0.43	0	0.46
Ameletidae	0	0.38	0	0.33	9	0.34
Lepidostomatidae	14	0.37	0	0.39	0	0.4
Lebertiidae	14	0.37	6	0.37	0	0.37
Enchytraeidae	0	0.33	0	0.3	18	0.31
Simuliidae	100	0.32	41	0.31	36	0.31
Elmidae	286	0.31	88	0.34	127	0.37
Naididae	0	0.29	0	0.35	9	0.32
Glossosomatidae	14	0.29	94	0.27	136	0.28
Torrenticolidae	186	0.28	65	0.3	55	0.3
Ceratopogonidae	0	0.21	12	0.22	0	0 2
Sphaeriidae	0	0.16	6	0.23	0	0.22
Lumbriculidae	29	0.16	6	0.13	9	0.12
Psychodidae	71	0.12	6	0.15	9	0.15
Limnesiidae	29	0.12	12	0.15	0	0.13
Hydryphantidae	14	0.1	6	0.07	9	0.07
Dixidae	57	0.05	0	0.03	18	0.04
	Obs	**Exp**	**Obs**	**Exp**	**Obs**	**Exp**
p>0.70	6	5.4	6	5.2	5	5.3
p>0.50	10	8.9	8	7.5	8	7.7
O:E p>0.70		1.11		1.16		0.95
O:E p>0.50		1.12		1.07		1.05

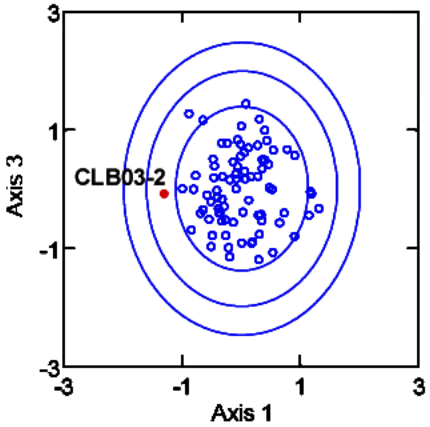
E. Assessment of QA sites

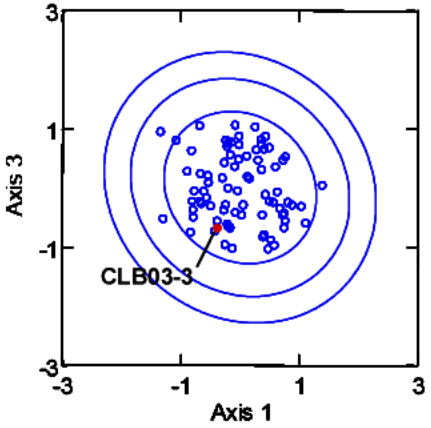


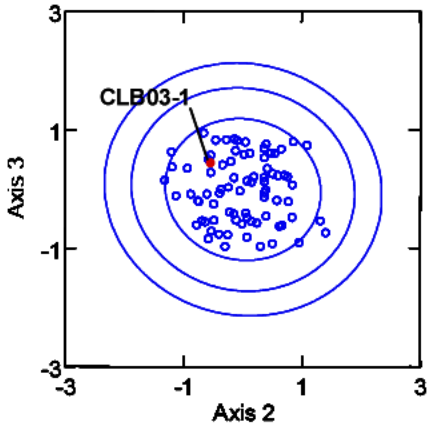


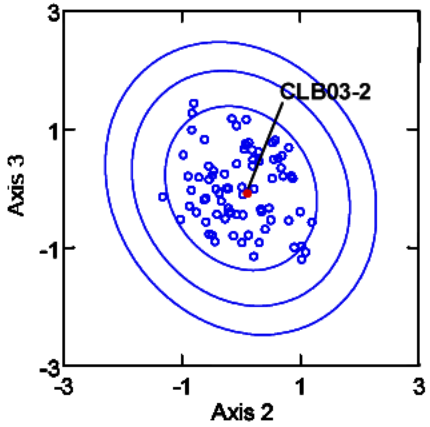


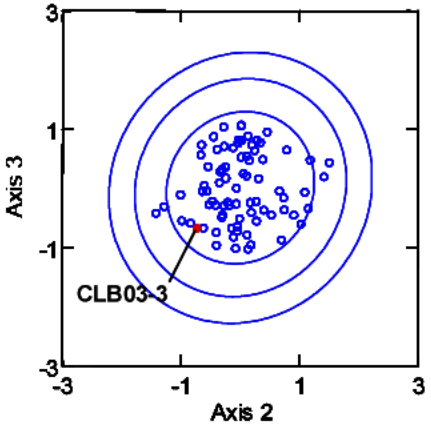












	Axis 1 vs 2	Axis 1 vs 3	Axis 2 vs 3	**Overall Assessment**
CLB03-1	Not stressed	Not stressed	Not stressed	**Not stressed**
CLB03-2	Possibly stressed	Possibly stressed	Not stressed	**Possibly stressed**
CLB03-3	Not stressed	Not stressed	Not stressed	**Not stressed**

F. Benthic community descriptors

	QA sites			**Reference group 3** Central 90% range (5th-95th percentiles)
	CLB03-1	**CLB03-2**	**CLB03-3**	
Abundance	3043	1171	1818	1659-12885
Total Richness	23	22	21	10-20
EPT Richness	11	10	10	5-13
% EPT	61.0	62.3	53.0	39-97
% Dominance (top 3 taxa)	41.8	50.3	51.0	22-65
% Chironomidae	8.5	13.1	21.0	2-43
# Ephemeroptera taxa	4	4	4	2-5
# Plecoptera taxa	3	3	3	2-6
# Trichoptera taxa	4	3	3	1-5
Diversity	0.91	0.89	0.88	0.57-0.87
Evenness	0.48	0.40	0.40	0.20-0.48
Bray-Curtis	0.51	0.56	0.43	0.32-0.75

G. Discussion of results

- These QA samples were predicted to be similar to Group 3 reference sites with similar probabilities.
- These QA samples had similar taxonomic compositions however the first QA sample had a higher abundance of organisms.
- The second QA sample had more of the less common taxa.
- Each sample had a low O:E taxa ratio indicating that they were missing many of the expected taxa.
- The samples had similar Bray-Curtis distance values that indicate that they are 49-57% similar to the reference communities.
- Two samples were deemed "***not stressed***" while one sample was "***possibly stressed***" as it fell just outside of the 90% confidence ellipse.