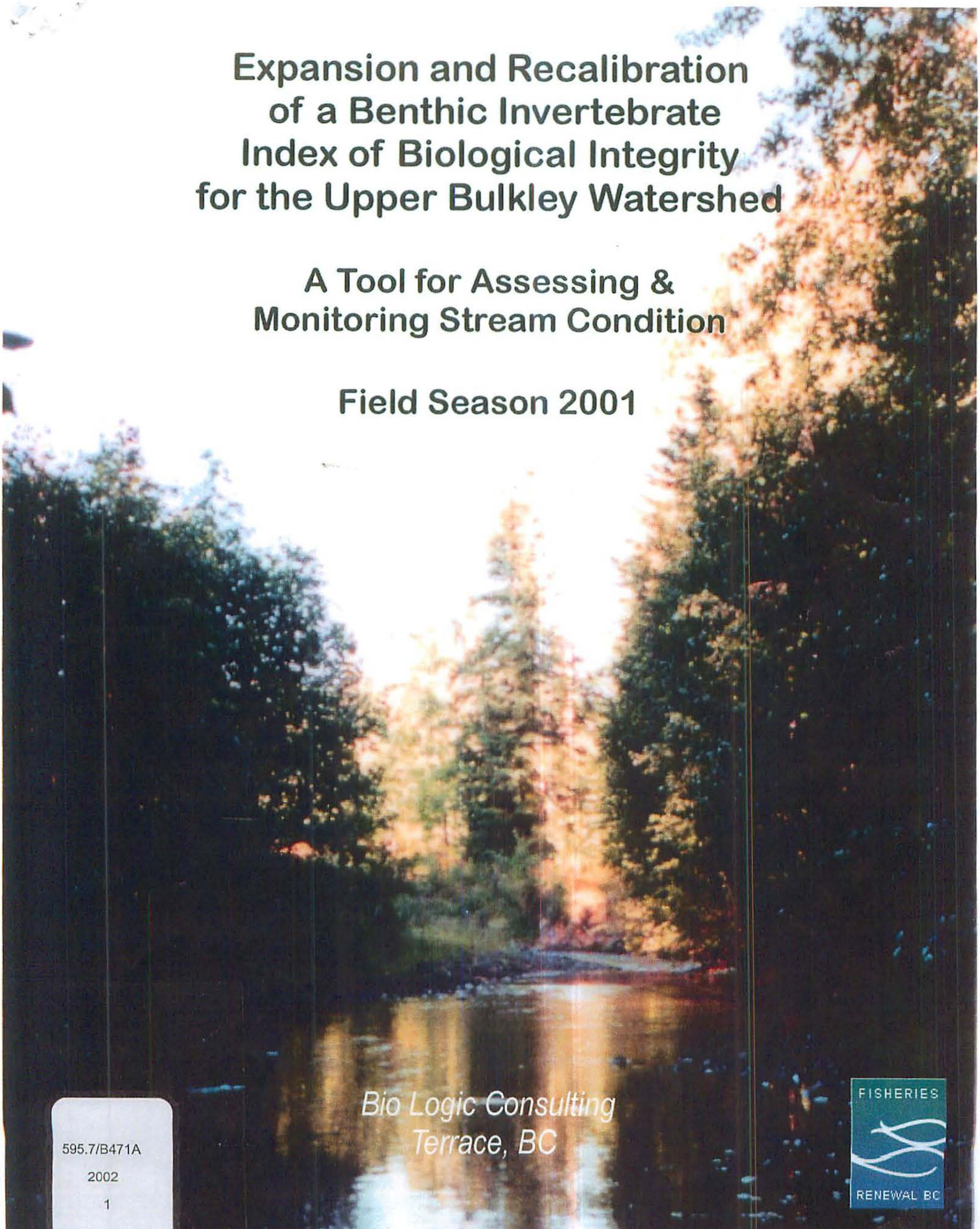
Expansion and Recalibration of a Benthic Invertebrate Index of Biological Integrity for the Upper Bulkley Watershed

A Tool for Assessing & Monitoring Stream Condition

Field Season 2001



Bio Logic Consulting
Terrace, BC

FISHERIES RENEWAL BC

Expansion & Recalibration of a Benthic Invertebrate Index of Biological Integrity for the Upper Bulkley Watershed

A Tool for Assessing & Monitoring Stream Condition

Field Season 2001

Prepared by:

Shauna Bennett, R.P. Bio
and
Kelli Ohland

Bio Logic Consulting
Terrace, BC

March 2002

Prepared for:

Community Futures Development Corporation of Nadina
Houston, BC

FUNDED BY FISHERIES RENEWAL BRITISH COLUMBIA

Executive Summary

Background

In 2001, the Community Futures Development Corporation of Nadina (CFDC Nadina) on behalf of the Bulkley-Morice Salmonid Preservation Group (BMSPG), drafted a strategic plan for the Bulkley River watershed *"to promote fish sustainability through education, stewardship, protection, restoration and enhancement of the aquatic ecosystem"* (Tamblyn and Donas 2001).

To ensure long-term conservation of fish and fish habitat, the strategic plan formulated a list of key watershed issues, objectives, and strategies to meet these objectives. One of the key watershed issues was water quality. To maintain or improve water quality and promote fish sustainability within the watershed, a recommendation was made to develop indicators that could track effectiveness of preservation and restoration efforts (Tamblyn and Donas 2001). The development and calibration of a Benthic Index of Biological Integrity (B-IBI) for the Bulkley River region was initiated in 1999, and continued in 2001 to help address this recommendation.

Fish populations and habitat depend not only on clean water, but also on functioning riparian and upland ecosystems in order to remain healthy. The benthic invertebrate index of biological integrity (B-IBI) is a multimetric approach that relies on biological data to assess the condition of a stream. Biological integrity is defined as '*the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of natural habitat of the region*' (Karr *et al.* 1987). Each attribute of a sampled benthic invertebrate community, such as the number of mayfly taxa in a sample, is termed a "metric" (Karr 1981). Metrics that are able to clearly distinguish streams uninfluenced by land use from streams that are heavily influenced by land use, and respond predictably over a gradient of land use are assigned a scale of numerical scores over the range of stream conditions. Benthic invertebrates are present in all streams, and are year-round residents, making them a good choice for bio-monitoring.

The B-IBI has been shown to be an effective tool for assessing and measuring stream condition in a number of states in the USA and Japan (Fore *et al.* 1996; Karr and Chu 1999).

Invertebrate Abundance and Sample Area

Calibration of an index of biological integrity for streams within the Upper Bulkley River watershed began in 1999. At that time, nine metrics were identified which successfully distinguished uninfluenced from heavily influenced sites and were included in the locally calibrated B-IBI. However, in other on-going B-IBI projects in the Bulkley and Kispiox forest districts, naturally low invertebrate abundance at some uninfluenced sites was found to be skewing metric results (Bennett and Hewgill 2001, Bennett 2001a; 2001b). As a solution to this problem, the sample area for each replicate was tripled from $0.09m^2$ to $0.27m^2$ in the 2001 field season. Increasing the sample area for each replicate successfully increased the average sample size at all Upper Bulkley sites assessed in 2001, and more than 500 individuals per replicate were collected from each site.

Metric Calculation

Several changes were made in 2001 with respect to how raw data was treated and how metrics were calculated. As a result, all the 1999 data was reworked, and the metrics were re-tested. For sites sampled in 2001, metrics were calculated and tested at two different levels of invertebrate identification, the family level and genus level. This was done to evaluate the effectiveness at the two levels in accurately identifying the biological condition of each sampled stream. Although genus-level identification may strengthen the ability to discriminate among sites of intermediate quality (Salmonweb 2001), family-level identification might make the sampling more affordable and less time consuming as volunteers rather than professionals could complete it.

Family-level Metrics

At the family-level, seven metrics were tested for variation across a gradient of human influence. The following five metrics were found to discriminate uninfluenced sites from heavily influenced sites and were included in the locally calibrated family-level B-IBI:

- Plecoptera (Stonefly) taxa richness
- Trichoptera (Caddisfly) taxa richness
- % Ephemeroptera (Mayfly) individuals
- % Dominance (1 taxon)
- Family Biotic Index (FBI)

Selected metrics were scored and combined to create an Upper Bulkley family-level B-IBI.

Genus-level Metrics

At the genus level, 21 metrics were tested for variation across a gradient of human influence. The following ten metrics were found to discriminate uninfluenced sites from heavily influenced sites and were included in the locally calibrated genus-level B-IBI:

- Plecoptera (Stonefly) taxa richness
- Trichoptera (Caddisfly) taxa richness
- % Diptera (True Flies) and non-insects
- % Ephemeroptera (Mayfly) individuals
- Number of intolerant taxa
- % Predators
- % Dominance (3 taxa)
- % Sediment tolerant individuals
- % Clingers
- Hilsenhoff Biotic Index (HBI)

Selected metrics were scored and combined to create an Upper Bulkley genus-level B-IBI.

Results

Metric value cut-off points were selected for scoring sites. A site scored 5 points if the metric value was similar to those at uninfluenced streams, 1 point if values were similar to heavily influenced streams, and 3 points if values were in-between the two extremes. Based on the metric value cut-off points, the possible maximum and minimum values for the 5-metric family-level B-IBI and the 10-metric genus-level B-IBI were 25 and 5, and 50 and 10 respectively. The family-level and genus-level B-IBI scores calculated for each of the sample sites were compared with each other. Based on pre-set metric value cut-offs, B-IBI scores were used to assign a relative stream condition (*e.g.* excellent, good, fair, poor, or very poor) to each assessment site. Family-level and genus-level B-IBI stream condition assignments were the same for 12 out of 18 sampling sites. The remaining six sites were classified higher using family-level metrics than they were using genus-level metrics.

Initial results suggest that both the family- and genus-level indices may be suitable monitoring tools. However, the family-level index may not be as sensitive to smaller changes in biological integrity, especially at the higher end of the scoring range (excellent sites). If the goal is to protect uninfluenced streams in the area, it might be more effective to use the genus-level index. However, these results should be re-evaluated with data from at least one more year of sampling. Calibration of the Upper Bulkley B-IBI remains an iterative process, and will benefit from further readjustment as more data becomes available.

Definitions

Benthic invertebrate: *A bottom-dwelling organism without a backbone. This includes mayfly, stonefly and caddisfly larvae, worms, beetles, snails, dragonfly larvae and others (Salmonweb 2001).*

Metric: *A measure of a single aspect of the sampled benthic invertebrate community.*

Taxon: *A single taxonomic group (i.e. genus, species, family).* ***Taxa*** *is the plural of taxon.*

Taxa richness: *A measure of the number of taxa in a sample (e.g. mayfly taxa richness is the number of unique mayfly taxa in a sample)*

Acknowledgements

*Many thanks to **Greg Tamblyn**, Nadina Watershed Stewardship Coordinator, for assisting with the project proposal, for assisting with stream selection for 2001 sampling, and for reviewing the draft report. Thanks also to **Ian Sharpe**, Environmental Quality Section Head in the Environmental Protection Division at BC Environment, for assisting with the project proposal, for sharing benthic invertebrate data with this project, for providing a portion of the invertebrate taxonomy funds, and for summarizing the value of the B-IBI to the BMSPG during proposal ranking. Thank you to **Kim Hewgill**, for supporting data analyses and for her invaluable assistance with the field work. Thanks to **Jeremy Burbee** and **Johanna Pfalz** (Ministry of Sustainable Resource Management) for creating and providing a composite Landsat satellite image of the study area. Also, thanks to the various landowners that granted us permission to access stream sites via their private properties.*

Most of all, thank you to Fisheries Renewal BC, and the members of the Bulkley-Morice Salmonid Preservation Group, for the opportunity to be involved with this project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. Introduction

In 2001, the Bulkley-Morice Salmonid Preservation Group (BMSPG) along with the Community Futures Development Corporation of Nadina (CFDC Nadina) created a draft strategic plan for the Bulkley River watershed, entitled Healthy Watersheds, Healthy Communities. The BMSPG came into being in 1998 to address declining salmonid stocks in the Bulkley River watershed, and is made up of representatives from First Nations and non-profit community organizations concerned about fish stocks and the health of the watershed (Tamblyn and Donas 2001). The Bulkley River watershed is known to support populations of approximately 23 species of economically and culturally important fish, including four species of salmon (FISS 2001). The primary goal of the strategic plan was "*to promote fish sustainability through education, stewardship, protection, restoration and enhancement of the aquatic ecosystem*" (Tamblyn and Donas 2001). Tamblyn and Donas identified the following steps in the plan to fulfill the goal:

1. Determine key watershed issues within the Bulkley-Morice watershed.
2. Determine goals, objectives and strategies to address each key issue.
3. Develop indicators to track effectiveness in reaching a desired end-state.

Ensuring water quality is optimal for fish production was identified as a key watershed issue in Goal 5-1 (Tamblyn and Donas 2001). An objective to "*maintain... or improve water quality in the Bulkley River and its tributaries*" was established, and two of the strategies suggested to help meet this objective were:

- to increase public involvement in Streamkeepers programs or other water quality monitoring programs such as an Index of Biological Integrity, and
- to improve public knowledge of local water quality through education (Tamblyn and Donas 2001).

The benthic invertebrate index of biological integrity (B-IBI) is a multimetric approach that relies on biological data to assess the condition of a stream. Biological Integrity is defined as '*the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of natural habitat of the region*' (Karr *et al.* 1987). Benthic invertebrates are ubiquitous, and relatively sedentary, making them a good choice for bio-monitoring.

The development and calibration of a Benthic Index of Biological Integrity (B-IBI) for the Bulkley River region, was initiated to begin the third task of developing indicators to track effectiveness of preservation and restoration efforts. Fish populations and habitat depend not only on clean water, but also on functioning riparian and upland ecosystems in order to remain healthy.

1.1 Background

The B-IBI has been shown to be an effective tool for assessing and measuring stream condition in many of the states in the USA (Fore *et al.* 1996, Kerans and Karr 1994, Karr and Chu 1999, Major *et al.* 2001, Maxted *et al.* 2000, Deshon 1995) including Ohio, where a benthic invertebrate multimetric community index has been adopted into biological water quality criteria in their water quality standards (USEPA 2000).

In 1999, with funding and support from Fisheries Renewal B.C., CFDC Nadina, the Wet'suwet'en and B.C. Environment, calibration of an index of biological integrity for 23 streams within the Upper Bulkley River watershed began. The B-IBI was calibrated by sampling a number of streams across a gradient of human influence; from uninfluenced, pristine watersheds, to watersheds with heavy human influence. Nine metrics were identified which successfully distinguished uninfluenced from heavily influenced sites and were included in the locally calibrated B-IBI (Rysavy 2000a). In the same year, development and calibration of a B-IBI specific to forest harvesting impacts was initiated in the Kispiox Forest District (Rysavy 2000b).

In 2000 and 2001, the B-IBI project in the Kispiox District continued (Bennett 2001a) and new projects began in the Bulkley Timber Supply Area (BTSA) and the Kalum Forest District (Bennett 2001b, Chaplin 2001, Bennett and Hewgill 2001). All projects were focussed on developing a B-IBI specific to monitoring the effects of forest harvesting on water quality and stream condition. In addition, site selection for a project focussed in the Morice and Lakes Forest Districts began in the fall of 2001, and sampling is scheduled to begin in the fall of 2002 (C. Croft, pers. comm. Sept 2001). The goal of the project is to develop and calibrate an indicator of stream quality specific to forest harvesting impacts for the Tweedsmuir Innovative Forest Practices Agreement.

1.2 Project Objectives

Development and calibration of a multi-metric index is an iterative process. Many changes have been made to the methods for field collection of invertebrates, laboratory processing of samples, and metric calculations since the Upper Bulkley B-IBI project began in 1999.

The purpose of this project is to further explore the use of a B-IBI as an effectiveness monitoring and stream condition assessment tool for long-term trend monitoring of water quality, specific to resources and land use influences within the Upper Bulkley watershed and nearby Nechako Plateau area. This included:

1. reworking of the 1999 data to incorporate changes to metric calculations,
2. sampling 11 new sites in 2001, and
3. calculating both Family and Genus level metrics, checking for trends with human influence, and comparing the effectiveness of B-IBI's developed for the two levels of taxonomic resolution.

2 Methods

2.1 Site Selection

Eleven sites were chosen for assessment in 2001 in collaboration with Greg Tamblyn (Watershed Stewardship Coordinator for Nadina). Sites were selected that balanced the need to maintain consistency with previous B-IBI sampling in 1999, and the need to monitor streams that are priorities for current or upcoming restoration activities. A group of clear, non-glacial stream sites with similar stream orders, elevations and gradients were selected.

Channel gradient was less than 3% at all eleven sites. Elevation of sampling sites ranged from 554 meters at the Deep Creek downstream site to 814 meters at the Foxy at Maxan site (as determined with a handheld Garmin® eTrex Venture GPS unit). Assessment sites at the streams were chosen based on easiest access. A list of sites sampled in 2001 and a brief description of the location are listed in Table 1, and relative location is shown in Figure 1.

Table 1: List of 2001 stream sites and approximate locations.

Stream Site	Location
Barren	immediately upstream of the Highway 16 crossing
Buck @ Mall	downstream of Highway 16 and CN bridge crossings
Byman	roughly 50 m upstream of Highway 16
Cesford (downstream)	roughly 100 m downstream of the Highway 16 crossing
Crow	50 m upstream of Maxan Lake FSR bridge crossing
Deep downstream	roughly 100 m downstream of the Farewell Rd. crossing
Deep upstream (Reference)	approx. 200 m upstream of irrigation system in Kerr's pasture
Foxy @ Maxan	100 m downstream of Foxy bridge crossing at 10km on Maxan Lake FSR
McQuarrie (downstream)	50 m upstream of Highway 16 crossing
Richfield @ CN	immediately upstream of the CN bridge crossing
Richfield downstream (above hwy)	Richfield Creek upstream of Nadina staff gauge, above the Highway 16 crossing

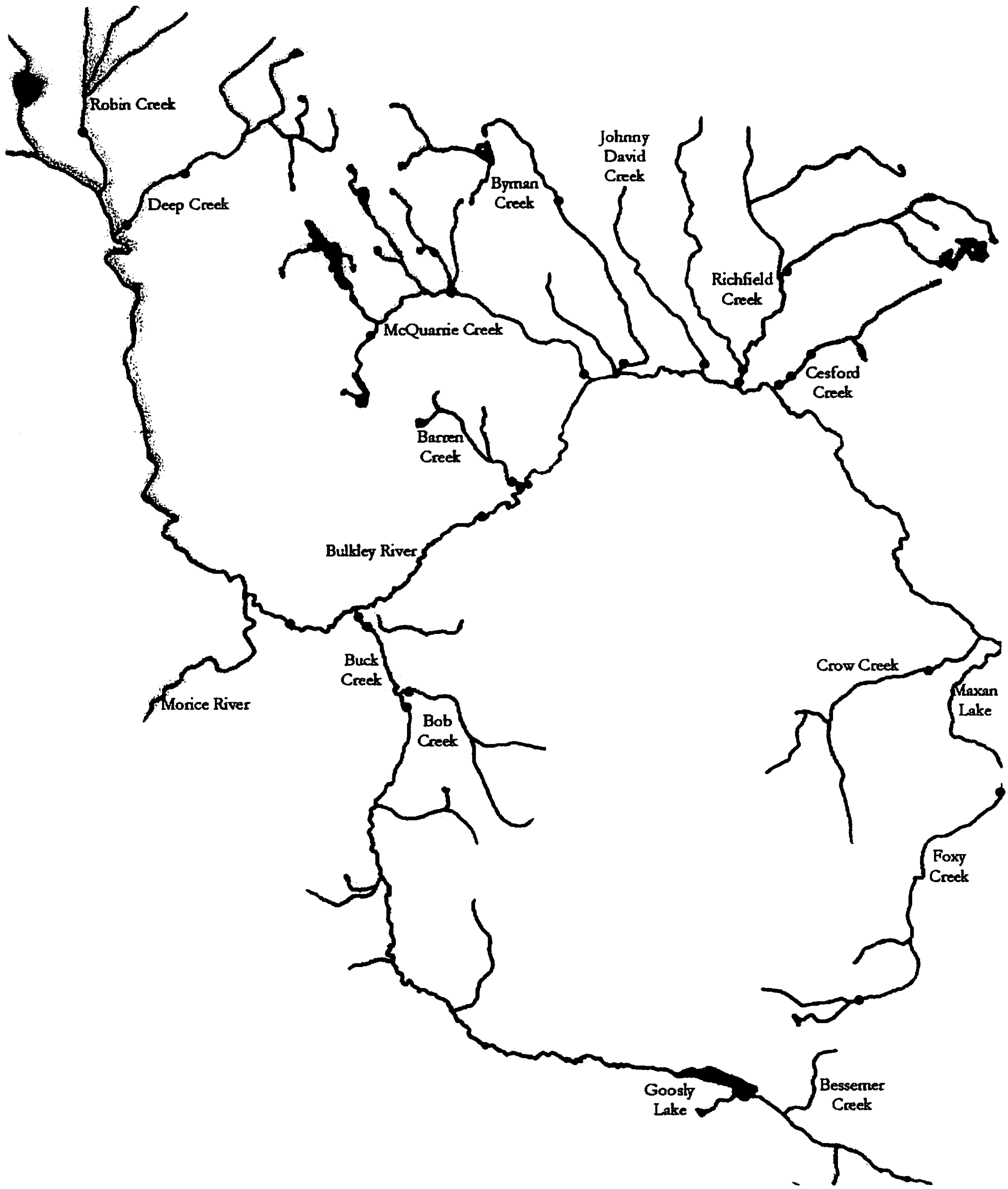


Figure 1: Location of stream assessment sites within the study area (not to scale). Streams not sampled were not included on the map. Stream sites assessed in 1999 are marked with *black circles*, while stream sites assessed in 2001 are marked with *red circles*.

2.2 Field Methods

In 1999, the late summer, early fall season was chosen for sampling as flows are usually lower at the end of the summer, and stream temperatures are high. This makes it an ideal period for temperature-related impact assessment, benthic invertebrate sampling, and in terms of safety and stream wadability. All sites were sampled during a three day period, which began on September 7th, 2001. Sites were assessed and sampled by Shauna Bennett and Kim Hewgill.

The sampling for benthic invertebrates was consistent with Provincial sampling standards as outlined in the Freshwater Biological Sampling Manual (Cavanagh *et al.* 1997), while maintaining B-IBI sampling standards as outlined in Karr and Chu (1999). The best natural riffles were selected at each site, and nine replicates (0.09 m^2 area each) were collected starting at the downstream end of the site. Every three replicates were composited together to form one sample, resulting in a total of three composite samples (0.27 m^2 area each) for each stream site.

All samples were collected in the main streamflow at depths between 10 and 25 cm. A 250-micron Surber sampler modified with a Dolphin Adaptor cod end was used for sampling. Larger cobbles were gently removed from within the sampling area and set aside in a washbasin. Invertebrates were later picked off the cobbles and added to the appropriate sample jar. Substrate within the sample area was disturbed to a 10 cm depth with a screwdriver for one minute. The sample was carefully transferred from the cod end to a labelled sample jar and 10% buffered formalin was added as a preservative. The three composite samples collected at each site were kept separate for identification and enumeration.

After benthic invertebrates were collected and preserved, in-stream and riparian conditions were assessed at each site. Four field forms were filled out at each site and are included in Appendix A. The first two forms summarized chosen key Fish Habitat Assessment Procedure parameters (Johnston and Slaney 1996). The second two forms were copied from the Standard Operating Procedures for the Alaska Stream Condition Index (ASCI) (Major and Barbour 1997). Completed field forms for each site are in Appendix B. Site position and information and elevation were collected using a handheld Garmin eTrex® Venture GPS unit.

Photographs were taken of the stream, riparian area, substrate size and any potential or actual land use impacts. One photo of each site has been included in Appendix C.

2.3 Laboratory Procedures

Benthic invertebrate samples were shipped to Fraser Environmental Services (FES) for sorting and identification to the lowest practical level (usually genus) by taxonomists Linda Currie, Jim Donkersley, and Sue Salter. Chironomids were identified only to the family level. As part of a large, on-going effort in the Skeena region, sampling methods were modified in the 2001 field season to ensure that a sufficient number of invertebrates were captured in each sample. Samples containing fewer than 300 individuals have been correlated with increased measurement error for some metrics (Fore *et al.* 2000). The total area sampled per replicate was increased in 2001 to 0.27 m^2 from 0.09 m^2 in the previous field seasons.

However, for streams with abundant invertebrates, the new methods translated into greater than 1000 individuals in many samples. To lessen processing costs and workload, the taxonomist subsampled large samples (with greater than 1000 individuals). If the sample contained less than 1000 individuals, the entire sample was sorted. If the sample was estimated to contain more than 1000 individuals, the taxonomist screened the entire sample using a one millimetre and 212 micron nested sieve system. The entire contents of the one millimetre sieve were sorted and counted while the contents of the 212 micron sieve were sub-sampled using a Caton Tray. A minimum of 600 individuals were sorted and counted in split samples. The taxonomist marked any especially large individuals in a given sample with an asterix in the data report.

2.4 Metric Calculations & Definitions

Data for all sites was consolidated into an excel spreadsheet. All adults and pupae were eliminated from the raw data, and invertebrates that were not identified to the family level were ignored during metric calculation. Raw data has been included in Appendix D.

A number of community attributes, known as metrics, were calculated for each site. Metrics calculated and presented in this report were those that have been shown in other studies to vary predictably across a gradient of human influence (Karr and Chu 1999, Major et al. 2001, Zweig and Rabeni 2001, Maxted et al. 2000).

Metrics were calculated at two different taxonomic resolutions of the data, the family-level and genus-level, as described on the Salmonweb internet site (www.salmonweb.org). Metrics were tested at both taxonomic resolutions to evaluate the effectiveness at the two levels in accurately identifying the biological condition of each sampled stream. Generally, a genus-level index more accurately portrays stream condition as there are more metrics included in the index, and more information goes into the metrics at lower levels of identification (Salmonweb 2001). Although genus-level identification may strengthen the ability to discriminate among sites of intermediate quality, family level identification might make the sampling more affordable and less time consuming as volunteers rather than professionals could complete it (Salmonweb 2001). However, where volunteers are used, the cost savings of invertebrate identification may be outweighed by the costs associated with sample storage for data quality assurance, and reference sample verification that would be completed by a taxonomist (Lenat and Resh 2001).

2.4.1 Family-Level Metric Definitions

Seven family-level metrics were calculated for each site.

- Total taxa richness was the total number of unique taxa identified in each replicate sample. The three replicates were averaged to give a single number for total taxa richness.
- Ephemeroptera taxa richness was the total number of unique mayfly (Order Ephemeroptera) taxa identified in each replicate sample. The three replicates were averaged to give a single number for Ephemeroptera taxa richness. Plecoptera and Trichoptera taxa richness were calculated in the same way as Ephemeroptera taxa richness, except counting the number of taxa in the Order Plecoptera and the Order Trichoptera respectively. Ephemeroptera, Plecoptera, and Trichoptera taxa richness are correlated to water quality (Lenat and Resh 2001).
- % Ephemeroptera was the average percentage of Ephemeroptera individuals per site, including individuals identified to the order level.
- Percent dominance was calculated as the proportion of individuals in the single most abundant taxon, averaged for the three replicates.
- The Family Biotic Index (FBI) is a modified Hilsenhoff Biotic Index designed for family-level data, and was calculated by multiplying the number of individuals in each taxa by their assigned tolerance value (Resh *et al.* 1996), and then summing these values and dividing the resulting number by the total number of individuals in the sample. The FBI scores for the three replicates were averaged to give a final FBI score for the site.

Candidate metrics for the family level and their expected response to increased human influence within the watershed are included in Table 2.

Table 2: Expected family-level metric response to increasing human influence within a watershed (modified from Karr and Chu 1999).

Category	Metric	Definition	Expected Response to Increasing Human Influence within the watershed	Reference
Taxa Richness & Composition	No. of Taxa	Total number of different taxa	Decrease	Karr and Chu 1999
	No. of Ephemeroptera Taxa	Total number of different Ephemeroptera taxa	Decrease	Karr and Chu 1999
	% Ephemeroptera	Proportion of Ephemeroptera individuals	Variable	Maxted *et al* 2000
	No. of Plecoptera Taxa	Total number of different Plecoptera taxa	Decrease	Karr and Chu 1999
	No. of Trichoptera Taxa	Total number of different Trichoptera taxa	Decrease	Karr and Chu 1999
Population Attributes	% Dominant Taxon	Measures the relative abundance of the single most abundant taxon	Increase	Karr and Chu 1999
Tolerants / Intolerants	Family Biotic Index (FBI)	Weighted average based on the relative abundance and tolerance of organisms	Increase	Resh *et al* 1996

2.4.2 Genus-Level Metric Definitions

Twenty-one genus-level metrics were calculated for each stream site. Taxa classifications were found on the Salmonweb internet site (www.salmonweb.org) or were taken from Merritt and Cummins (1996).

- Total taxa richness was the total number of distinct taxa identified in each replicate sample. The three replicates were then averaged to give a single value for total taxa richness.
- Ephemeroptera taxa richness was the total number of distinct taxa in the Order Ephemeroptera, identified in each replicate sample. The three replicates were then averaged to give one number for Ephemeroptera taxa richness. Plecoptera and Trichoptera taxa richness were calculated in the same way as Ephemeroptera taxa richness, counting the number of taxa in the Order Plecoptera and the Order Trichoptera respectively.
- % Ephemeroptera was the average percentage of Ephemeroptera individuals per site, including individuals identified to the order level.
- Diptera taxa richness was the total number of distinct Diptera taxa in each sample. The three replicate samples were averaged to give one number for Diptera taxa richness for each site.
- % Dipterans was the average percentage of Diptera individuals per site, including individuals identified to the order level.
- % Non-insects was the average percentage of non-insect individuals per site, including individuals identified to the order level.
- Long-lived taxa richness was defined as the number of taxa that reproduce only once a year, or once every few years. The best available information was used for this metric, provided by Robert Wisseman on Salmonweb (NuWiss.Master98), and was not specific to this region. The cumulative number of unique long-lived taxa in all three replicates was counted (and not averaged over the three samples).
- % Long-lived individuals is the average proportion of long-lived individuals per site.
- Intolerant taxa richness was the cumulative number of unique intolerant taxa in all three replicates. Intolerance is relative to a broad array of disturbances (Fore *et al.* 1996) and information on which taxa are intolerant was provided by Robert Wisseman on the Salmonweb website (NuWiss.Master98.xls).
- % tolerant individuals is the total number of tolerant individuals in each replicate, divided by the total number of individuals in that replicate and multiplied by 100. The results for the three replicates were averaged to give one final metric score.
- Clinger taxa richness is the total number of clinger taxa counted for each replicate and averaged to give one score for each site. Clinger refers to the primary behaviour exhibited by an invertebrate as documented by Leska Fore (Salmonweb) or Merritt and Cummins (1996).
- % Clingers is the percentage of individuals that exhibit clinger behaviour, calculated for each replicate and averaged to give one score for each site.
- % predator individuals is the percentage of individuals that belong to the predator functional feeding group. The results for the three replicates were then averaged to give one final metric score.
- % dominance is the percentage of individuals that belong to the three most abundant taxa in that replicate. The results for each replicate were then averaged to give one final metric score for the site.
- % sediment tolerant individuals is the percentage of individuals classified as sediment tolerant. The results for each replicate were then averaged to give one final metric score for each site. Sediment tolerant taxa were defined by Zweig and Rabeni (2001) and Kleindl (1995).
- % sediment intolerant individuals is the percentage of individuals classified as sediment intolerant. The results for each replicate were averaged to give one final metric score for each site. Sediment intolerant taxa were defined by Zweig and Rabeni (2001) and Kleindl (1995).

- % Oligochaetes is the percentage of Oligochaete individuals per sample, including individuals identified to order. The results for each replicate were averaged to give one final metric score for each site.
- % Dipterans and Non-insects is the percentage of individuals that belong to the Order Diptera and those that were identified as non-insects. The percent dipterans and non-insects were averaged over the three replicates to give one final metric score for the site.
- The Hilsenhoff Biotic Index (HBI) was calculated by multiplying the average number of individuals in each taxa by their assigned tolerance value, and then summing these values and dividing the resulting number by the average number of individuals per sample. The HBI is a community index that uses a tolerance classification based on the effects of organic pollution (Barbour *et al.* 1995).

A list of taxa, assigned functional feeding group, life history and tolerance designations have been included in Appendix E. Sample calculations have been posted by the Salmonweb organization on their internet website. A summary of family- and genus-level metric scores for sites sampled in 1999 and 2001 has been provided in Appendix F and Appendix G, respectively.

The twenty-one metrics considered have been successfully included in multimetric IBI's in North America (Karr and Chu 1999, Maxted et al. 2000, DeShon 1995, Zweig and Rabeni 2001). Genus-level candidate metrics and their expected response to increased human influence within the watershed are included in Table 3.

Table 3: Expected genus-level metric response to increasing human influence within a watershed (modified from Karr and Chu 1999).

Category	Metric	Definition	Expected Response to Increasing Human Influence within the Watershed	Reference
Taxa richness & composition	No. of taxa	Total number of different taxa	Decrease	Karr and Chu 1999
	No. of Ephemeroptera taxa	Total number of different Ephemeroptera taxa	Decrease	Karr and Chu 1999
	% Ephemeroptera	Relative abundance of Ephemeroptera individuals	Variable	Maxted *et al* 2000
	No. of Plecoptera taxa	Total number of different Plecoptera taxa	Decrease	Karr and Chu 1999
	No. of Trichoptera taxa	Total number of different Trichoptera taxa	Decrease	Karr and Chu 1999
	No. of Long –lived taxa	Cumulative number of unique long-lived taxa	Decrease	Karr and Chu 1999
	% Long Lived	Relative abundance of long-lived individuals	Decrease	
	% Diptera & Non-insects	Relative abundance of all dipterans and non-insects.	Increase	DeShon 1995
	No. of Diptera Taxa	Total number of different Diptera taxa	Decrease	DeShon 1995
	% Dipterans	Relative abundance of Diptera individuals	Increase	Maxted *et al* 2000
	% Non-insects	Relative abundance of non-insect individuals	Increase	Maxted *et al* 2000
Tolerants/ Intolerants	# of Intolerant taxa	Cumulative number of unique intolerant taxa	Decrease	Karr and Chu 1999
	% Tolerants	Relative abundance of tolerant individuals	Increase	Karr and Chu 1999
	% Sediment Tolerants	Relative abundance of sediment tolerant individuals	Increase	Zweig and Rabeni 2001
	% Sediment Intolerants	Relative abundance of sediment intolerant individuals	Decrease	Zweig and Rabeni 2001
	% Oligochaetes	Relative abundance of Oligochaete individuals	Increase	Maxted *et al* 2000
	Hilsenhoff Biotic Index (HBI)	Weighted average based on abundance and tolerance of organisms	Increase	Maxted *et al* 2000
Feeding / Habit Metrics	% Predators	Relative abundance of predator individuals	Decrease	Karr and Chu 1999
	No. of clinger taxa	Total number of clinger taxa	Decrease	Karr and Chu 1999
	% Clingers	Relative abundance of clinger individuals	Decrease	Maxted *et al* 2000
Population Attributes	% Dominance (3 taxa)	The proportion of the three most abundant taxa relative to the sample size	Increase	Karr and Chu 1999

2.5 Land Use Classification

Classification of human influence was based primarily on interpretation of Landsat[1] satellite imagery from 1995, which was provided by the Ministry of Sustainable Resource Management, and review of habitat and riparian assessment reports where available.

Of the eleven sites sampled in 2001, only one was expected to be uninfluenced, and after review of the satellite image for the watershed, it appeared that there was some land clearing and possibly agriculture upstream of the monitoring site. For this reason, four uninfluenced sites from the nearby Bulkley District that were sampled for another project (Bennett and Hewgill 2002) were added to the dataset for metric testing. One heavily influenced stream site sampled for the same Bulkley District project (Robin) was also added to the dataset as it was in the immediate vicinity of the Deep Creek sites.

There was evidence of agricultural land use or livestock access to the stream at nearly all the stream sites assessed in 2001. Low levels of agriculture and livestock access can lead to increased taxa richness metrics through introduction of alien taxa and nutrient enrichment, making it difficult to interpret metric results (Karr and Chu 1999). Assessment of the local area surrounding the sampling site, and in-stream conditions were considered to try and further separate the similar levels of watershed influence.

Stream buffers are important for predicting sediment related impacts (Richards et al. 1996). Sites with partially disturbed or removed riparian vegetation were expected to have lower metric scores than streams with intact riparian buffers, and were classified as more highly influenced (*e.g.* Cesford, Robin, Buck).

Sites were classified into four categories: little or no human influence, low -moderate influence, moderate influence, and heavy influence. Stream sites and associated human influence classifications are listed in Table 4.

Table 4: Human influence, location and local site riparian condition for stream sites[2] sampled in 2001 and used for testing metrics (data for sites in italics from Bennett and Hewgill, 2002).

Stream	Site Location	Riparian Condition	Human Influence Classification
Arnett	*Bulkley Timber Supply Area (TSA) – see Bennett and Hewgill 2002*	*Mature coniferous forest*	*Uninfluenced*
Driftwood		*Mature coniferous forest*	*Uninfluenced*
Reiseter East		*Mature coniferous forest*	*Uninfluenced*
Reiseter West		*Mature coniferous forest*	*Uninfluenced*
Byman Downstream	upstream of Hwy 16	Deciduous forest (signs of grazing livestock)	Low-Moderate
Barren	upstream of Hwy 16	Young deciduous forest	Low-Moderate
Crow	upstream of Forest Service Road	Young, mixed forest	Low-Moderate
Deep Reference	upstream of Farm irrigation system	Mature mixed forest	Low-Moderate
Richfield above Hwy 16	upstream of Hwy 16	Mature mixed forest, partially disturbed	Low-Moderate
Richfield @ CN bridge	upstream of CN bridge crossing	Young deciduous forest, partially disturbed	Low-Moderate
Foxy @ Maxan	above confluence with Maxan Creek	Mature mixed forest	Moderate
Deep Downstream	downstream of Farewell Creek Rd crossing	Partially removed, disturbed in local area	Moderate
McQuarrie Downstream	upstream of Hwy 16	Partially removed, disturbed (narrow buffer)	Moderate
Buck @ Mall	downstream of Hwy 16 and railway crossing	Partially removed, disturbed	Moderate
Cesford @ Topley	downstream of Hwy 16	Removed	High
Robin	*Bulkley TSA – see Bennett and Hewgill 2002*	*Removed*	*High*

[1] Landsat data © 1995 provided by the Ministry of Sustainable Resource Management, Skeena Region, Government of BC.
[2] For consistency, site names are from Rysavy 2000a.

3 Results & Discussion

3.1 Invertebrate Abundance and Sample Area

Other B-IBI projects in the Skeena Region found that naturally low invertebrate abundance at some uninfluenced sites was skewing metric results (Bennett and Hewgill 2001, Bennett 2001a and Bennett 2001b). Samples containing fewer than 300 individuals have been correlated with increased measurement error for some metrics (J. Karr, pers. comm. Feb 2001). For sites with naturally low invertebrate densities, lower taxa richness can be more strongly linked to the size of the area sampled, than to the level of human influence in the watershed.

A review of the 1999 Upper Bulkley data found that 64% of sites sampled had fewer than 500 individuals per sample, and 16% had fewer than 300 invertebrates per sample. As a solution to this regional problem, the area sampled for each replicate was tripled from 0.09 m^2 to 0.27m^2 in the 2001 field season. As shown in Table 5, more than 500 individuals per replicate were collected from each site in 2001. Invertebrates were least abundant in Richfield Creek above Highway 16 (684 per sample), and most abundant in Foxy Creek upstream of the confluence with Maxan Creek (4551 per sample).

Table 5: Average number of individuals collected per replicate at stream sites assessed in 1999 and 2001. Sample area per replicate increased from 0.09 m2 in 1999 to 0.27 m2 in 2001.

Stream Site	Average number of invertebrates per replicate	
	1999 Sample area 0.09m^2	2001 Sample area 0.27 m^2
Ailport	670	
Barren	378	1376
Bessemer	1598	
Bob	587	
Bulkley @ Craker	301	
Bulkley @ Knockholt	440	
Bulkley @ Morice	340	
Buck @ Mall	380	3707
Buck @ 12km FSR crossing	290	
Buck Confluence	378	
Byman downstream	198	3279
Byman Reference	245	
Cesford above hwy 16	909	
Cesford below hwy 16		4152
Cesford Reference	1683	
Cesford upstream	482	
Crow	803	1849
Deep downstream		3789
Deep reference		1723
Foxy below mine	535	
Foxy @ Maxan	749	4551
Foxy upstream	263	
Johnny David	436	
McQuarrie downstream	351	3072
McQuarrie Reference	381	
Richfield @ CN	1269	1749
Richfield above Hwy 16	359	
Richfield upstream	454	684

Invertebrate abundance was plotted against family- and genus-level taxa richness for streams sampled in 1999 and 2001 as shown in Figure 2. In 1999, there was an increasing pattern of taxa richness with abundance at both the family- and genus-levels. Lower abundance was associated with lower taxa richness, although higher abundance did not always result in greater taxa richness. In 2001, there was no correlation between abundance and taxa richness at either the family- or genus-levels.

While sampling over a larger area ensured that richness metric scores were not determined by sample size at streams with naturally low invertebrate densities, abundance was not considered as a metric for the multimetric index. Although human influence in a watershed can affect invertebrate abundance (density), it is not expected to vary predictably with all types of increasing human influence, which makes it an unreliable community metric for inclusion in a multi-metric index. For example, abundance might increase with agricultural land use through nutrient enrichment, while it might decrease with increasing industrial land use and associated point source and non-point source discharges.

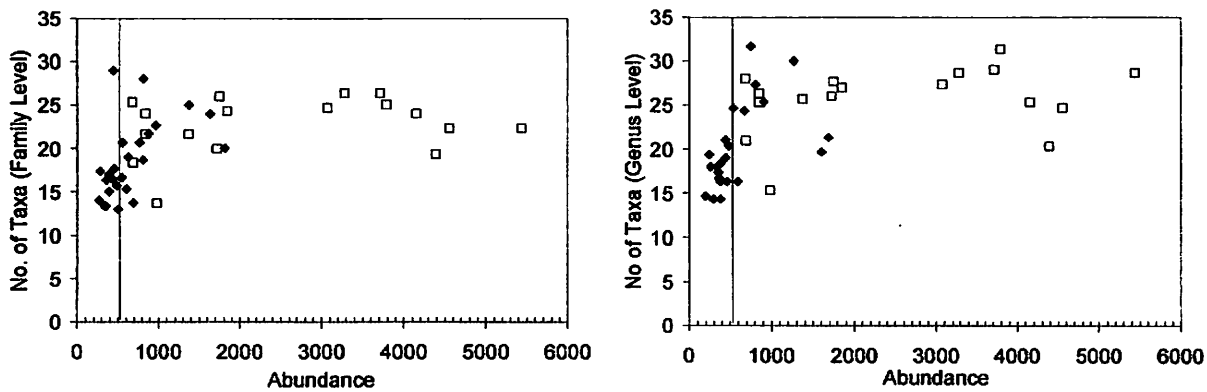


Figure 2: Invertebrate abundance plotted against taxa richness (family- and genus- level) for sites sampled in 1999 (black diamonds) and 2001 (open boxes).

3.2 Family-level Metrics

3.2.1 Trends with Human Influence

A multimetric index combines a number of individual metrics into one score or value, easing comparison of multiple sites. The index of biological integrity is the sum of scores for a set of core metrics that are known to respond in a predictable way across a gradient of human influence (Karr and Chu 1999). Each metric is assigned a set of unitless values across the range of results, which reflect whether the results were similar to those expected of an uninfluenced stream, a moderately influenced stream or a highly influenced stream.

Metrics can be calculated for various taxonomic resolutions of the invertebrate data including family-, genus- and species-level. In the Puget Sound area, Salmonweb is a community based monitoring program that uses a combination of a family-level B-IBI with genus- and species-level B-IBI's when data for the lower taxonomic resolutions is available.

As shown in Figure 3, two of the seven family-level metrics tested did not vary predictably with increasing human influence. There was not a clear trend across the gradient of human influence with either total taxa richness or Ephemeroptera taxa richness.

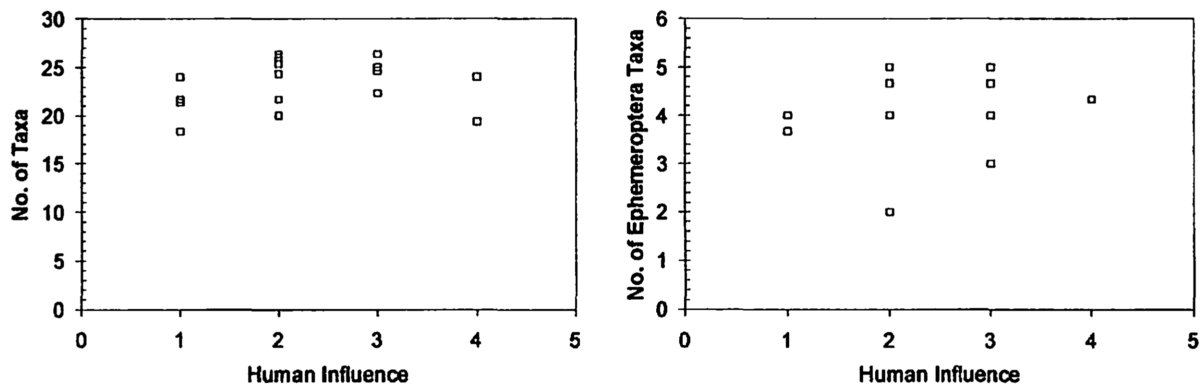
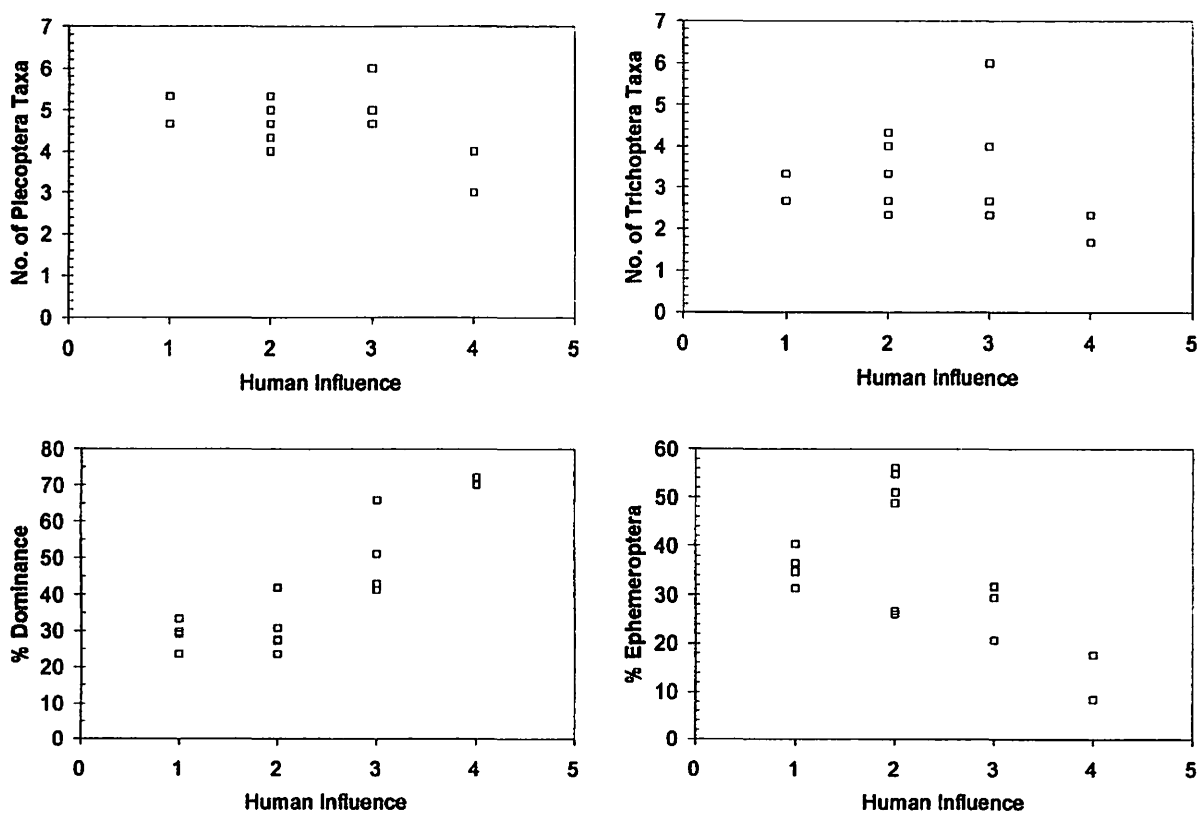


Figure 3: Family-level metrics that did not vary predictably with increasing land use influence for sites sampled in 2001. Human influence increases from uninfluenced on the far left (category 1) to heavily influenced on the far right (category 4).

Five of the seven metrics tested varied predictably with increasing human influence and clearly differentiated between uninfluenced sites and heavily influenced sites as shown in Figure 4. The proportion of the dominant taxon, the family biotic index, Plecoptera taxa richness, Trichoptera taxa richness and the proportion of Ephemeroptera were all successful metrics. However, there was high variability at moderately influenced sites for both the Plecoptera and Trichoptera taxa richness metrics.

As expected, the proportion of the dominant taxon and the family biotic index increased with increasing human influence, while the other three metrics decreased with increasing human influence.



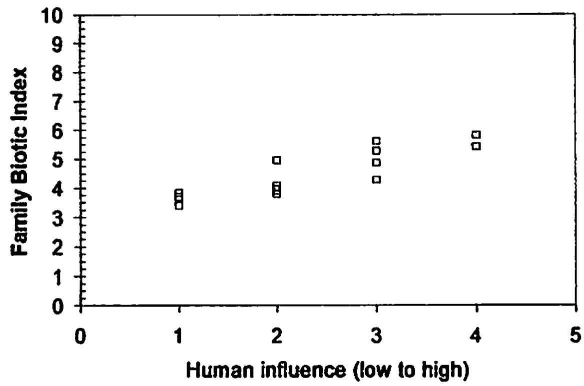


Figure 4: Family-level metrics that varied predictably with increasing land use influence for sites sampled in 2001. Human influence increases from uninfluenced on the far left (category 1) to heavily influenced on the far right (category 4).

Each of the graphs for the five successful metrics was studied closely, and cut-off points were selected for scoring sites. Similar to Karr and Chu (1999), a site scores 5 points if the metric value was similar to those at uninfluenced streams, 1 point if values were similar to heavily influenced streams, and 3 points if values were in-between the two extremes. All selected metrics and scoring cut-off points are summarized in Table 6.

Table 6: Five metrics and scoring cut-offs chosen for inclusion in a Bulkley River watershed family-level multimetric index.

Metric	Metric Score		
	1	3	5
No. of Plecoptera Taxa	< 3.5	≥ 3.5, < 4.6	≥ 4.6
No. of Trichoptera Taxa	< 1.8	1.8 – 2.3	≥ 2.4
% Ephemeroptera Individuals	< 22	22 - 34	> 34
% Dominant Taxon	> 50	30 - 50	< 30
Family Biotic Index (FBI)	> 5	4 - 5	< 4

3.2.2 Family-level site scores based on 1999 & 2001 data

Based on the metric value cut-offs presented in Table 6, family-level B-IBI scores were calculated for all sites sampled in 1999 and 2001. Since there are five metrics in the family-level B-IBI, the maximum possible score for a site is 25 and the minimum possible score is 5. A score close to 25 would be expected at uninfluenced sites. Using an approach similar to one on the Salmonweb (2001), stream conditions were assigned to sites sampled in 2001 based on the B-IBI score as summarized in Table 7. The family-level B-IBI score and the average sample size for each site are summarized in Table 8.

Table 7: Five metric Family-level B-IBI scores and associated stream condition

5-metric Family-level B-IBI Score	Stream Condition
23 - 25	Excellent
19 - 22	Good
14 - 18	Fair
9 - 13	Poor
5 - 8	Very Poor

For the 2001 field season, Crow, Arnett, Driftwood and Reiseter West creeks had the highest B-IBI scores (25), while Robin creek had the lowest (5). With one stream scoring the lowest possible score (5) during index calibration, this may potentially limit the effectiveness of the index for heavily influenced streams. If the conditions at that site deteriorate further, the index will not be able to reflect it. As expected, streams with low to moderate levels of agricultural influence and intact riparian buffers scored relatively high for taxa richness metrics, most likely due to nutrient enrichment.

There were three sites (Crow, Foxy at Maxan and Richfield CN) that had an average of more than 500 individuals per sample in both 1999 and 2001, despite the difference in sample collection area. At Crow and Richfield CN, there was an increase in family-level B-IBI scores from 1999 to 2001. At Richfield CN, scores in 1999 and 2001 both indicated good stream condition. However, at Crow the increase in scores from 1999 to 2001 translated to an increase from good to excellent stream condition. The higher scores in 2001 may have been due to the increase in area sampled. At the Foxy site, there was an unexpected decrease in family-level B-IBI scores from 1999 to 2001, and relative stream condition dropped from excellent to fair.

Table 8: Average number of invertebrates per sample and 5-metric family level B-IBI results for Upper Bulkley stream sites sampled in the 1999 and 2001 field seasons[3]. Samples with an average number of invertebrates less than 500 have been underlined.

	1999 Field Season		2001 Field Season		
Site	**Average # of Invertebrates per sample**	**Family-Level B-IBI Score**	**Average # of Invertebrates per sample**	**Family-Level B-IBI Score**	**Stream Condition**
Ailport	670	25			
Barren	378	15	1376	23	Excellent
Bessemer	1598	21			
Bob	587	9			
Buck @ Mall	380	5	3707	19	Good
Buck @ 12 km FSR crossing	290	13			
Buck @ Bulkley R. confluence	378	9			
Bulkley @ Morice	340	11			
Bulkley @ Craker	301	15			
Bulkley @ Knockholt	440	21			
Byman	198	13	3279	23	Excellent
Byman Reference	245	11			
Cesford downstream (above hwy 16)	909	9			
Cesford @ Topley (below hwy 16)			4152	9	Poor
Cesford Reference	1683	9			
Cesford upstream	482	17			
Crow	803	21	1849	25	Excellent
Deep downstream			3789	13	Poor
Deep upstream			1723	23	Excellent
Foxy @ Maxan	749	23	4551	17	Fair
Foxy below mine	535	21			
Foxy upstream (above mine)	263	25			
Johnny David	436	13			
McQuarrie Downstream	351	11	3072	15	Fair
McQuarrie Reference	381	19			
Richfield CN	1269	19	1749	21	Good
Richfield Downstream (above Hwy 16)	359	11	684	17	Fair
Richfield Upstream	454	15			
Arnett			*686*	*25*	*Excellent*
Driftwood Reference			*1135*	*25*	*Excellent*
Lemieux downstream (above Hwy 16)			*979*	*13*	*Poor*
Lemieux upstream			*5436*	*9*	*Poor*
Reiseter East			*844*	*23*	*Excellent*
Reiseter West			*846*	*25*	*Excellent*
Robin			*4390*	*5*	*Very Poor*

[3] Data for sites in italics from Bennett and Hewgill 2002.

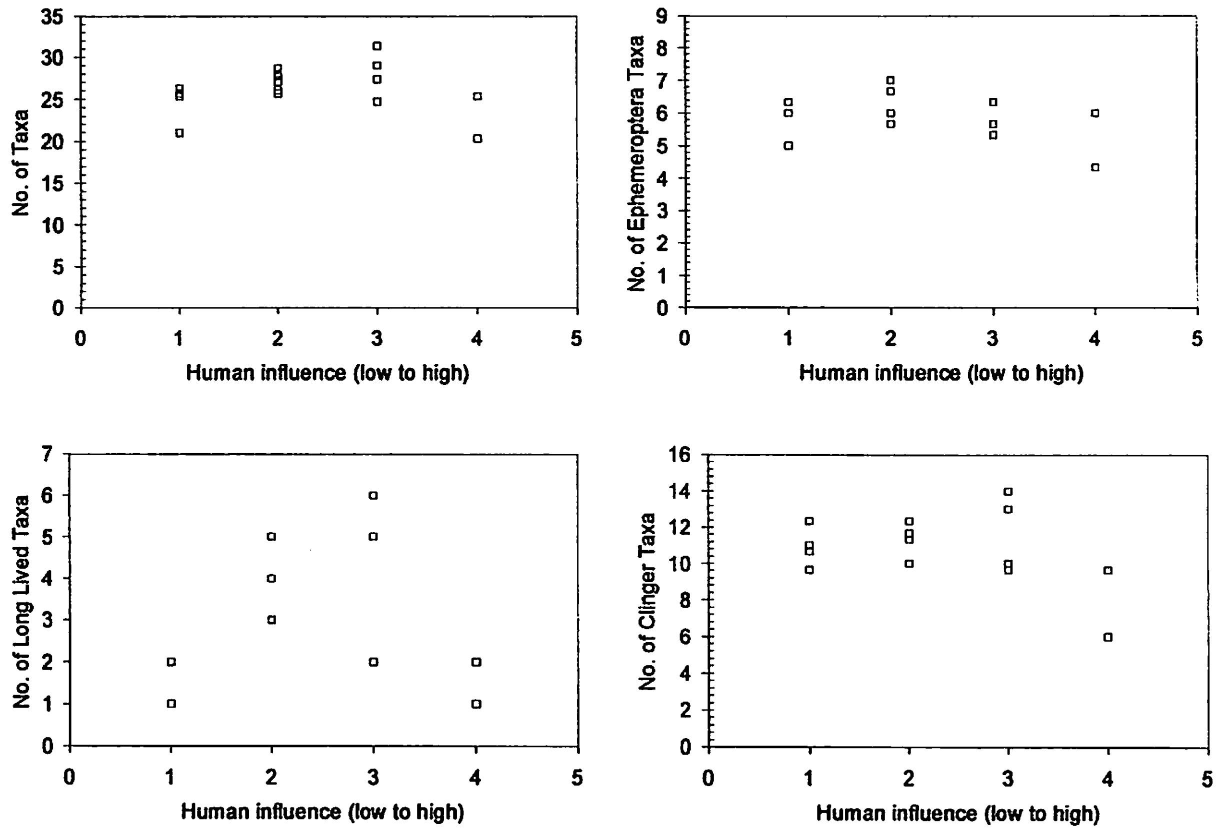
3.3 Genus Level Metrics

3.3.1 Trends with Human Influence

In 1999, twelve genus-level metrics were considered for inclusion in the multimetric index. Nine were found to vary systematically across a gradient of human influence. Several changes were made in 2001 with respect to how raw data was treated, how metrics were calculated, and how sites were classified. As a result, all the 1999 data was reworked, and the metrics were re-tested using the 2001 data.

Twenty-one metrics were considered for inclusion in the multimetric index. Each metric was tested to determine whether it varied systematically across a gradient of human influences specific to the Bulkley River watershed, and could discriminate uninfluenced sites from heavily influenced sites using simple graphical analysis.

As shown in Figure 6, eight of the twenty-one metrics tested did not vary predictably with increasing human influence. Similar to the family-level metrics, there was no decrease in either total taxa richness or Ephemeroptera taxa richness with increasing human influence. Other richness metrics that did not vary with human influence were clinger taxa richness and Diptera taxa richness.



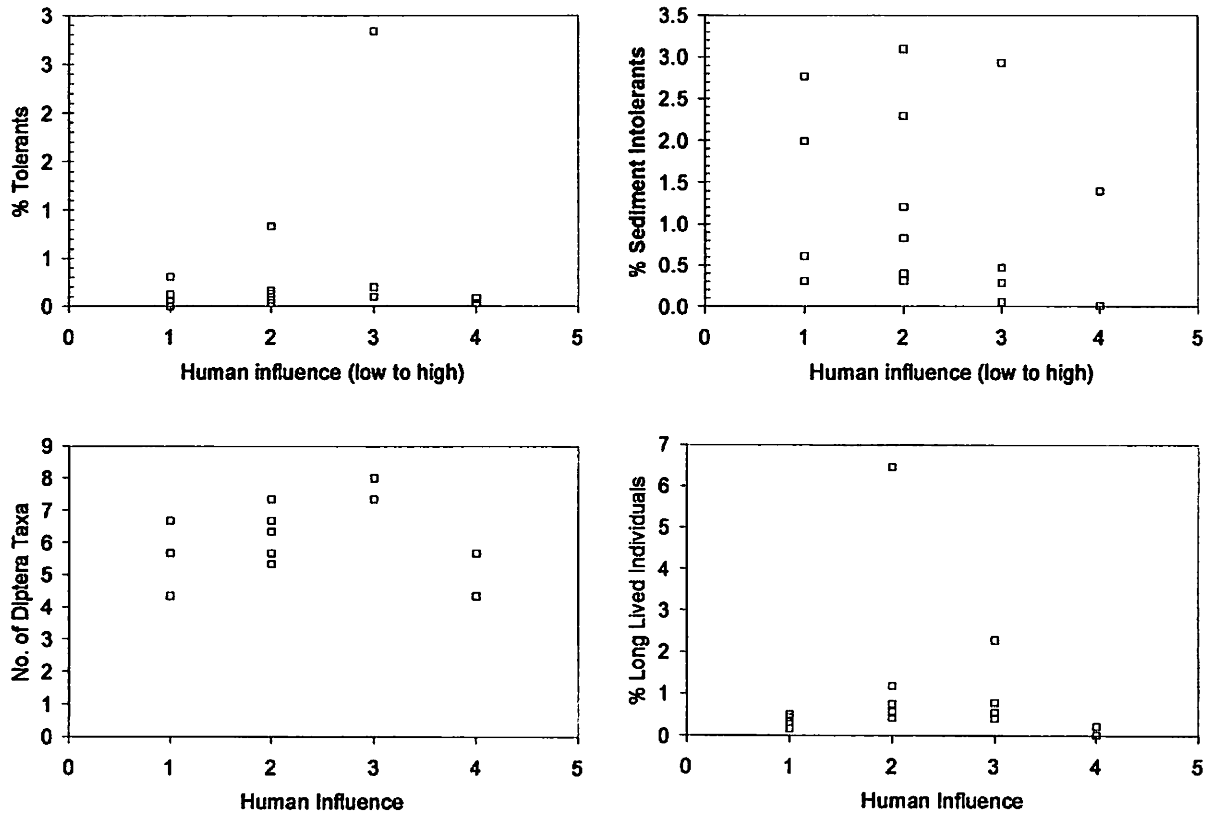
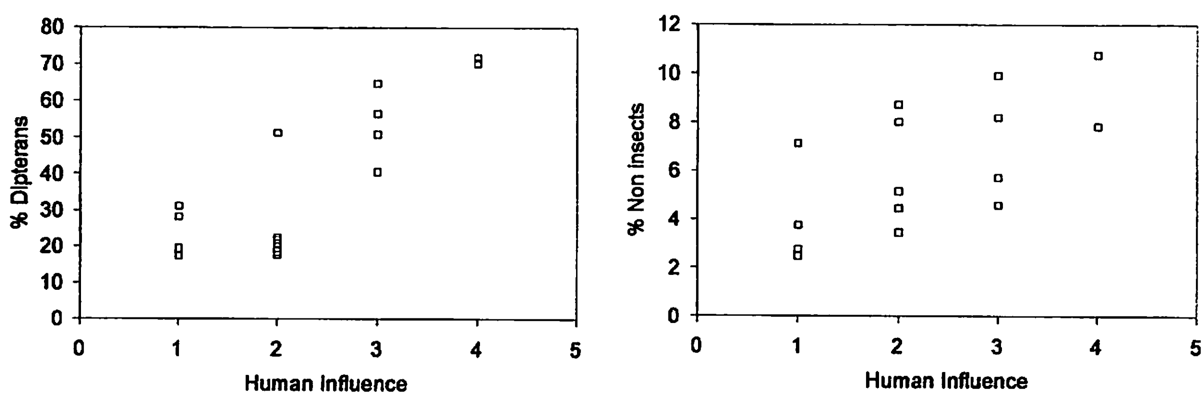


Figure 6: Genus-level metrics that did not vary predictably with increasing land use influence for sites sampled in 2001. Human influence increases from uninfluenced on the far left (category 1) to heavily influenced on the far right (category 4).

There were 13 metrics that did vary predictably with human influence, and clearly differentiated between the two human influence extremes as shown in Figure 7 and Figure 8. However, the three metrics shown in Figure 7 were redundant with metrics that ended up being selected for inclusion in the genus-level B-IBI for the Bulkley River watershed.



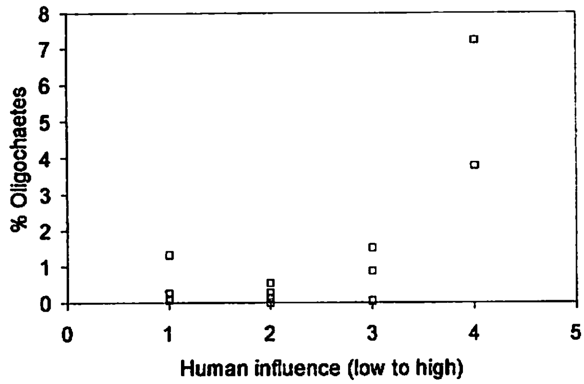
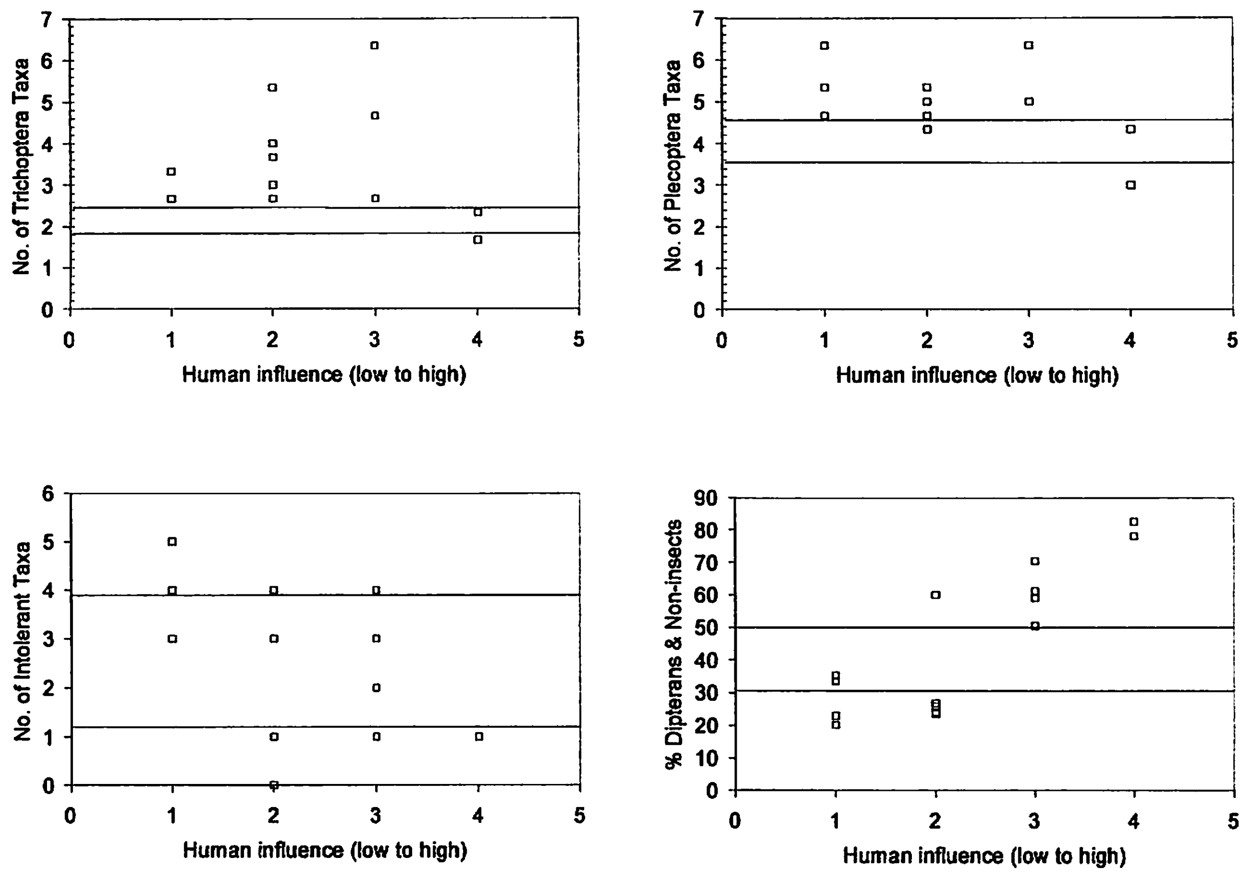


Figure 7: Genus-level metrics that varied predictably with increasing land use influence for sites sampled in 2001, but were redundant with other metrics selected for the index. Human influence increases from uninfluenced on the far left (category 1) to heavily influenced on the far right (category 4).



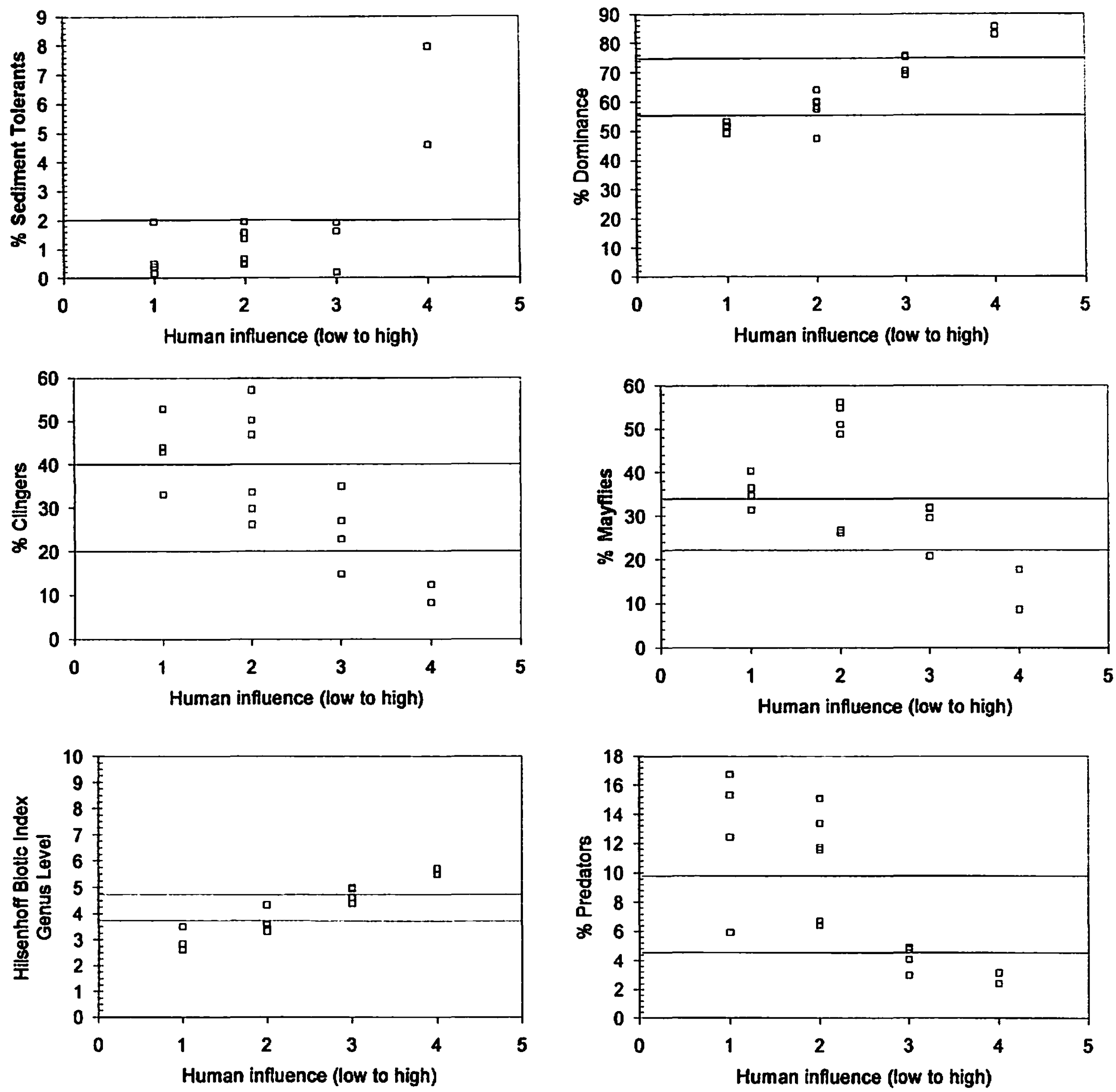


Figure 8: Genus-level metrics that varied predictably with increasing land use influence for sites sampled in 2001. Human influence increases from uninfluenced on the far left (category 1) to heavily influenced on the far right (category 4). Scoring cut-offs have been drawn in for reference.

Each of the graphs for the ten successful metrics was studied closely, and cut-off values were selected for scoring sites. Similar to Karr and Chu (1999), a site scores 5 points if the metric value was similar to those at uninfluenced streams, 1 point if values were similar to heavily influenced streams, and 3 points if values were in-between the two extremes. All selected metrics and scoring cut-off points are summarized in Table 9.

The relative proportion of Ephemeroptera individuals (% Ephemeroptera) does not require taxonomic resolution lower than the Order level. Therefore, the metric results and scoring cut-off values are the same at the family- and genus-levels.

Calculated taxa richness values for Plecopterans and Trichopterans increased only slightly at the genus-level compared with values calculated at the family-level. Cut-off thresholds for scoring the metrics were set at the same values for both levels of B-IBI. At the genus-level, overall taxa richness was greater in the

Bulkley River watershed than the Bulkley and Kispiox Forest District areas where the B-IBI is also being tested (Bennett and Hewgill 2002, Bennett et al. in prep.), and the cut-off values were set higher to reflect this.

Table 9: Ten metrics selected for inclusion in the genus-level B-IBI for the Bulkley River watershed, and associated scoring cut-off points.

Metric	Metric Score		
	1	3	5
No. of Plecoptera Taxa	< 3.5	3.6 - 4.5	≥ 4.6
No. of Trichoptera Taxa	< 1.8	1.8 – 2.3	≥ 2.4
% Diptera & Non-insects	> 50	30 – 50	< 30
% Ephemeroptera	< 22	22 - 34	> 34
No. of Intolerant Taxa	≤ 1	2 - 3	≥ 4
% Predators	< 4.5	4.5 - 10	> 10
% Dominance (3 taxa)	> 75	55 - 75	< 55
% Sediment Tolerants	> 10	2.1 - 10	≤ 2
% Clingers	< 20	20 - 40	> 40
Hilsenhoff Biotic Index (HBI)	> 4.75	3.75 - 4.75	< 3.75

3.3.2 Genus-level site scores based on 1999 & 2001 data

Based on the metric value cut-offs presented in Table 9, genus-level B-IBI scores were calculated for all sites sampled in 1999 and 2001. Since there are ten metrics in the genus-level B-IBI, the maximum possible score for a site is 50 and the minimum possible score is 10. A score close to 50 would be expected at uninfluenced sites. Using an approach similar to one on the Salmonweb (2001), stream conditions were assigned to sites sampled in 2001 based on the B-IBI score as summarized in Table 10. The genus-level B-IBI score and the average sample size for each site are summarized in Table 11.

Table 10: Ten metric genus-level B-IBI scores and relative stream condition.

10-metric Genus-level B-IBI Score	Stream Condition
46 - 50	Excellent
38 - 44	Good
28 - 36	Fair
18 - 26	Poor
10 - 16	Very Poor

For the 2001 field season, the uninfluenced Arnett, Driftwood and Reiseter West streams had the highest B-IBI scores (48), while Robin had the lowest (12). As expected, streams with low to moderate levels of agricultural influence and intact riparian buffers scored relatively high for taxa richness metrics, most likely due to nutrient enrichment.

Three sites (Crow, Foxy at Maxan and Richfield CN) had an average of more than 500 individuals per sample in both 1999 and 2001, despite the difference in sample collection area. Similar to the family-level B-IBI results, at Crow and Richfield CN there was an increase in genus-level B-IBI scores from 1999 to 2001, while at the Foxy site, there was a decrease. Relative stream condition was fair at both Crow and Richfield CN sites in 1999. At both sites, relative stream condition increased to good in 2001. At the Foxy site, the relative stream condition was fair in both years and the decrease in B-IBI score was not as great at the genus-level as it was at the family-level.

Table 11: Average number of invertebrates per sample and 10-metric genus level B-IBI results for Upper Bulkley stream sites sampled in the 1999 and 2001 field seasons[4]. Samples with an average number of invertebrates less than 500 have been underlined.

	1999 Field Season		2001 Field Season		
Site	Average # of Invertebrates per sample	Genus Level B-IBI Score	Average # of Invertebrates per sample	Genus Level B-IBI Score	Stream Condition
Ailport	670	44			
Barren	378	34	1376	44	Good
Bessemer	1598	32			
Bob	587	26			
Buck @ Mall	380	20	3707	32	Fair
Buck @ 12 km FSR crossing	290	28			
Buck @ Bulkley R. confluence	378	20			
Bulkley @ Morice	340	26			
Bulkley @ Craker	301	32			
Bulkley @ Knockholt	440	44			
Byman	198	30	3279	46	Excellent
Byman Reference	245	28			
Cesford downstream (above hwy 16)	909	28			
Cesford @ Topley (below hwy 16)			4152	16	Fair
Cesford Reference	1683	18			
Cesford upstream	482	36			
Crow	803	34	1849	44	Good
Deep downstream			3789	24	Poor
Deep upstream			1723	40	Good
Foxy @ Maxan	749	36	4551	32	Fair
Foxy below mine	535	46			
Foxy upstream (above mine)	263	36			
Johnny David	436	30			
McQuarrie Downstream	351	26	3072	32	Fair
McQuarrie Reference	381	38			
Richfield CN	1269	32	1749	44	Good
Richfield Downstream (ab. Hwy)	359	26	684	32	Fair
Richfield Upstream	454	28			
Arnett			*686*	*48*	*Excellent*
Driftwood Reference			*1135*	*48*	*Excellent*
Lemieux downstream (ab. Hwy)			*979*	*20*	*Poor*
Lemieux upstream			*5436*	*26*	*Poor*
Reiseter East			*844*	*42*	*Good*
Reiseter West			*846*	*48*	*Excellent*
Robin			*4390*	*12*	*Very Poor*

[4] Data for sites in italics from Bennett and Hewgill 2002.

3.4 Taxonomic Resolution and Metric Results

An initial stage family- and genus-level B-IBI were calibrated for the Bulkley River watershed based on sampling in the 2001 field season at 11 sites, and data for another four uninfluenced sites and one heavily influenced site from a nearby (BTSA) project (Bennett and Hewgill 2002). B-IBI results were calculated for the 16 sites, and for two sites on Lemieux Creek that were sampled for the BTSA project. Data from the Lemieux sites were not used for testing the metrics, as both sites had some degree of influence in the watershed and were difficult to classify using satellite photo interpretation.

The family-level B-IBI is composed of five metrics, while the genus-level B-IBI is composed of ten metrics. Other studies have looked at the differences in cost and effectiveness as a monitoring tool between family- and genus- level multimetric indices. Bailey et al. (2001) found that in areas that are taxonomically rich, data at the species-level index were more effective for differentiating between reference and stressed stream conditions than data at the family-level. To compare the effectiveness of family- and genus-level data in the Bulkley River watershed in assessing stream quality, we focussed on the biotic index metrics and the overall B-IBI scores and associated stream conditions.

3.4.1 Hilsenhoff Biotic Index

The premise behind the Hilsenhoff biotic index is that organic pollution tolerance differs among various benthic organisms, and assigning tolerance values to taxa in a sample allows calculation of a weighted average. Although it is generally calculated at a genus- or species-level, there is also a modified index that can be calculated for data at the family-level. In this study, both the genus-level Hilsenhoff Biotic Index (HBI) and a Family Biotic Index (FBI) were calculated for all stream sites. For both indices, scores range from 0 to 10, and a low score indicates better water quality, while a higher score indicates poorer water quality.

There are a couple of potential concerns when calculating the biotic index at the family-level. Within a benthic invertebrate family, there are usually many genera and species, and each of these can vary widely in pollution tolerance (Lenat and Resh 2001). One tolerance value must be assigned to a family to calculate the index, although even trying to assign a single pollution tolerance value to a genus can be difficult as the species within it may have different levels of pollution tolerance. Lenat and Resh (2001) compared a genus-level biotic index and a family-level biotic index for three regions and found that the family-level biotic index did not detect the finer differences in water quality, but it could consistently separate reference sites from stressed sites. The family-level biotic index was not as accurate at detecting water quality extremes, and missed 22 to 45% of the excellent sites and roughly 28% of the poor sites (Lenat and Resh 2001).

A second concern is that the tolerance values are derived from studies completed mostly in the Eastern United State, which likely differ substantially from the Pacific Northwest.

In the Kispiox Forest District, the FBI was tested as an indicator of forest harvesting impacts in 2000 (Bennett 2001a). As expected, while the FBI could detect changes in water quality between reference sites and sites with urban influences, it did not detect differences in water quality at any of the sites with forest harvesting in the watershed.

However, in the Bulkley watershed, the biotic index was selected as a metric for inclusion in the B-IBIs at both the family- and genus- levels. Biotic index values increased with increased human influence in a watershed, and clearly differentiated uninfluenced sites from heavily influenced sites at both taxonomic resolutions.

When the 2001 FBI results were plotted against the HBI results as shown in Figure 9, the two indices were correlated (r^2 0.88) suggesting that they supply similar information.

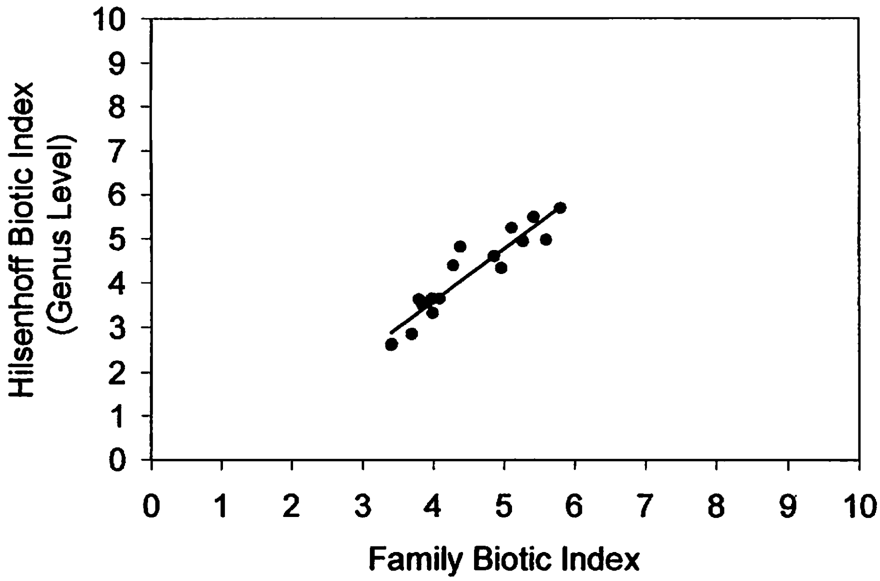


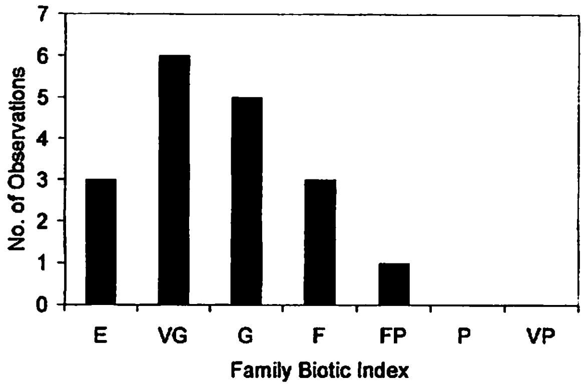
Figure 9: Modified Hilsenhoff Family Biotic index values for streams sampled in 2001, plotted against Genus-level Hilsenhoff Biotic index values (n=18, r^2 0.88).

For both the FBI and the HBI, the range of possible scores is from 0 to 10, with 0 representing the best water quality, and 10 representing the most degraded water quality as shown in Table 12. For the FBI, values for the 2001 sampled streams varied from 3.41 to 5.8, a total range of 2.39 points. For the HBI, values for the same sites ranged from 2.61 to 5.69, a total range of 3.08 points.

Table 12: Water Quality based on Hilsenhoff Genus- and Family- level Biotic Index Values (modified from Resh *et al.* 1996).

Hilsenhoff and Family Biotic Index Values	Water Quality
0.00 - 3.75	Excellent
3.76 - 4.25	Very Good
4.26 - 5.00	Good
5.01 - 5.75	Fair
5.76 - 6.50	Fairly Poor
6.51 - 7.25	Poor
7.26 - 10.00	Very Poor

The number of observations for each water quality rating based on the FBI and HBI values were plotted as shown in Figure 10. Similar to the results of Lenat and Resh (2001), it was found that more excellent water quality sites were identified with the genus-level biotic index than with the family-level biotic index. Although there were four uninfluenced sites in the group, the FBI classified only three sites as having excellent water quality, while the HBI classified nine sites as having excellent water quality.



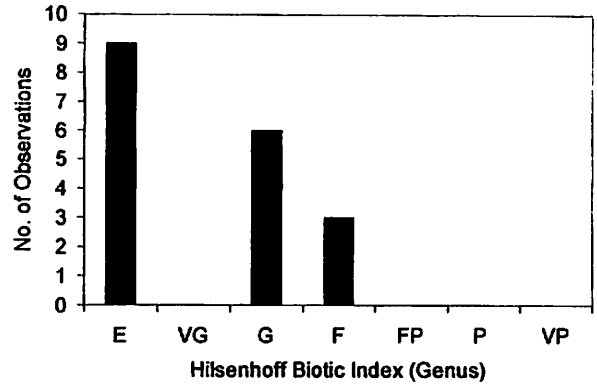


Figure 10: Frequency distribution of water quality rating as measured by the Family Biotic Index and Hilsenhoff Biotic Index (genus-level) for streams sampled in 2001.

Overall, it appears that the biotic index may under-rate water quality at the family-level compared with the genus-level. However, in this study scoring cut-offs were adjusted for the family-level metric to accommodate this (see Table 6 and Table 9).

3.4.2 Comparison of Family- and Genus- level B-IBIs

This study has focussed on initial development of two B-IBI's at different taxonomic resolutions of the same data for 16 stream sites. A five metric family-level B-IBI and a ten metric genus-level B-IBI were calibrated for human influence specific to the Bulkley watershed. B-IBI calibration was initiated at two taxonomic resolutions because the family-level B-IBI may be a less costly monitoring program to maintain on a regular basis, and may facilitate volunteer help with invertebrate identification compared to the genus-level B-IBI.

The final scores for the family- and genus-level B-IBI's were plotted against one another as shown in Figure 11. The scores for the two B-IBI's were highly correlated (r^2 0.91). Stream condition thresholds were drawn on the graph to help identify streams that were classified differently by the two indices.

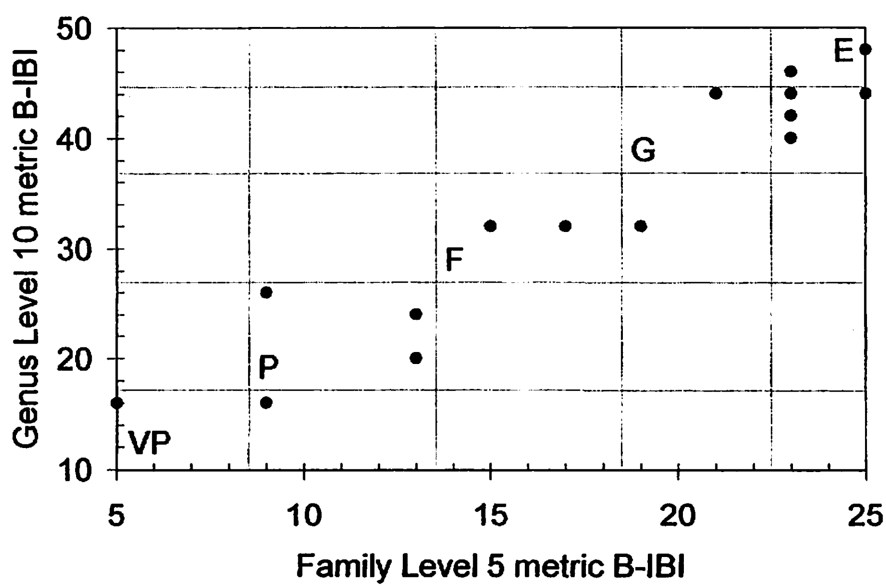


Figure 11: 5-metric family-level B-IBI scores plotted against 10-metric genus-level B-IBI scores for sites sampled in 2001. (n = 18, r^2 0.91)

In twelve out of eighteen streams sampled, the family-level B-IBI and genus-level B-IBI ranked the stream condition in the same category. In 6 cases (Barren, Buck @ Mall, Cesford, Crow, Deep upstream, and Reiseter East), stream sites were classified one level higher by the family-level B-IBI than the genus-level B-IBI.

Overall, the family-level B-IBI classified more streams as excellent stream condition than the genus-level B-IBI, as shown in Figure 12. Compared to the number of uninfluenced sites in the group (4), this number was relatively high. However, if the numbers of excellent and good streams are combined for each B-IBI, this added up to 9 streams for the genus-level index and 10 streams for the family-level index.

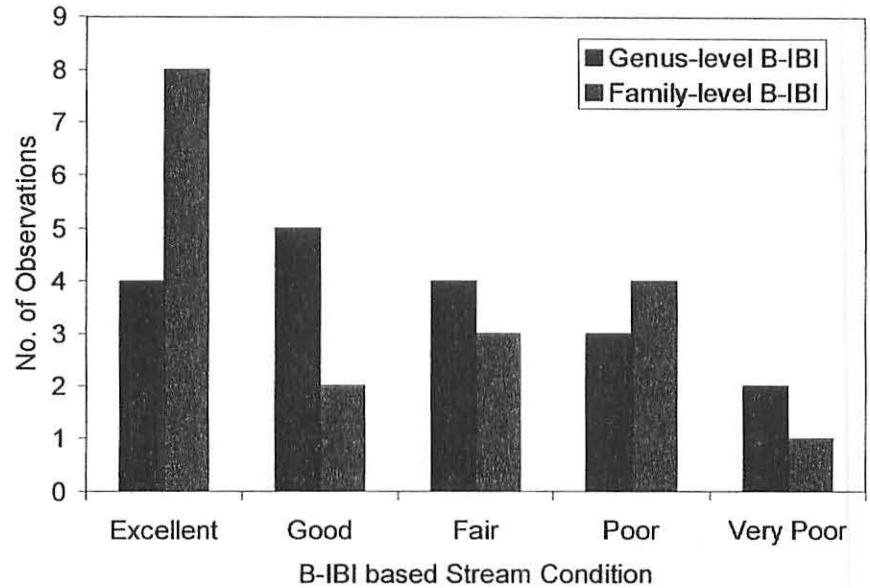


Figure 12: Frequency distribution of stream condition for genus- and family-level B-IBI for streams assessed in the 2001 field season.

3.5 B-IBI and Biotic Index Verification

Comparison of B-IBI results between sites on the same stream provides a preliminary means of verifying the indices, especially in cases where one site is uninfluenced. Two sites were sampled on each of three streams in 2001. Streams with two sites included Deep, Richfield and Lemieux. However, all stream sites had some degree of land use influence at both the upstream and downstream sites. All metric and index responses between the upstream and downstream sites for the three creeks are summarized in Table 13.

3.5.1 Deep Creek

On Deep Creek, an upstream site was sampled that was relatively uninfluenced compared to the downstream site. Both the family-level and genus-level multimetric indices described the downstream site as poor, while the upstream site was described as excellent and good, respectively. The results of family- and genus- level biotic indices described the upstream water quality as very good (family) and excellent (genus), while the water quality at the downstream site was described as fair (family) and good (genus).

At the family-level, Plecoptera and Trichoptera taxa richness were slightly lower at the upstream site. Nutrient enrichment at the downstream site was likely the cause of the slight increase in taxa richness at the downstream site. Percent dominant taxon, relative abundance of mayflies and biotic index results all responded as predicted with increasing human influence between the two sites.

At the genus-level, Plecoptera, Trichoptera and intolerant taxa richness were greater at the downstream site. Relative abundance of predators decreased from 11.7% to 3% at the downstream site. Ephemeroptera individuals and clingers decreased, and dominance and abundance of Diptera individuals and non-insects increased at the downstream site as expected. Relative abundance of sediment tolerant individuals did not change between the two sites.

Overall, the family- and genus-level multimetric indices decreased at the downstream site compared to the upstream site.

3.5.2 Lemieux Creek

On Lemieux Creek, two sites were chosen for monitoring as part of the Bulkley TSA B-IBI development project (Bennett and Hewgill 2002). Land use influence at the upstream site was mostly livestock access to the stream, with some forest harvesting further upstream. The downstream site was located upstream of Highway 16, near the Quick Elementary School. Influences at the downstream site included agriculture, rural residences, road crossings and disturbed riparian areas. Stream water levels and flow were very low at the downstream site, and habitat was mostly pools. Classification and assignment of a relative degree of human influence was difficult for both sites, and neither site was used to test metrics. Both the family-level and genus-level multimetric indices described the downstream and upstream sites as poor. With the family-level index, the upstream site scored lower, while with the genus-level index it scored higher. The results of family- and genus- level biotic indices found the downstream water quality to be better than the upstream water quality. The downstream water quality was described as good with both indices, while the water quality at the upstream site was described as fair with both indices.

At the family-level, Plecoptera and Trichoptera taxa richness were higher at the upstream site. Nutrient enrichment due to livestock access was likely the cause of the slight increase in taxa richness at the site. However, streamflow was also greater and the substrate was more suitable for invertebrate colonization at the upstream site. Percent dominant taxon was higher upstream than downstream, while relative abundance of mayflies was lower upstream than downstream.

At the genus-level, Plecoptera, Trichoptera and intolerant taxa richness were greater at the upstream site. Relative abundance of predators was low at both sites, and decreased from 5.4% to 2.6% at the downstream site. Results for percent dominance were similarly very high at both sites. Ephemeroptera individuals increased from 13% to 45% at the downstream site, while clingers decreased from 13% to 8%. Abundance of Diptera individuals and non-insects decreased at the downstream site (42%) from the upstream site (75%). Relative abundance of sediment tolerant individuals was slightly greater at the downstream site.

3.5.3 Richfield Creek

Two sites were assessed on Richfield Creek; a site upstream of the highway crossing, and a downstream site located upstream of the railway bridge. The sites were expected to have fairly similar index results after in-stream habitat assessment was completed and satellite images were reviewed. Surprisingly, the downstream site above the railway bridge was described as good by both indices, while the more upstream site above the highway was described as fair. It was not clear why the invertebrate community at the site above the highway was less taxonomically rich and diverse than the downstream site. However, the biotic index results agreed at both the family- and genus-levels. Water quality as measured by the FBI and HBI was very good (3.98) and excellent (3.64) at the site above the railway bridge, while water quality at the site upstream of the highway was good (4.96 and 4.33) with both indices. These results are very preliminary but may still provide support for re-assessment of the sites in coming years, and direction for investigating site-specific water quality issues.

At the family-level, Trichoptera taxa richness and relative abundance of Ephemeroptera individuals were higher at the downstream site, while Plecoptera taxa richness was lower. Percent dominant taxon did not change between the two sites.

At the genus-level, Plecoptera taxa richness was slightly higher upstream, while Trichoptera taxa richness was greater at the downstream site. There were no intolerant taxa at the downstream site, while three unique intolerant taxa were collected at the upstream site. The proportion of predator, clinger and Ephemeroptera individuals was twice as great at the downstream site, while the proportion of Diptera and non-insect individuals was greater at the upstream site. The proportion of sediment tolerant individuals did not change between the two sites. Percent dominance was slightly greater at the downstream site compared with the upstream site.

Table 13: Summary of metric response to family- and genus-level metrics between upstream and downstream monitoring sites on Deep, Lemieux[5] and Richfield Creeks. A plus sign represents an increase at the downstream site, while a minus sign represents a decrease.

Metrics and Indices	Expected Response with increasing human influence	Change from Upstream to Downstream		
		Deep	Lemieux	Richfield
Human Influence		*Increased*	*?*	*No change?*
Family-Level Results				
Plecoptera Taxa Richness	decrease	+	-	+
Trichoptera Taxa Richness	decrease	+	-	-
% Ephemeroptera	decrease	-	+	+
% Dominant Taxon	increase	+	-	≅
Family Biotic Index	increase	+	-	-
Family-level B-IBI	**decrease**	-	+	+
Genus-Level Results				
Plecoptera Taxa Richness	decrease	+	-	+
Trichoptera Taxa Richness	decrease	+	-	-
% Ephemeroptera	decrease	-	+	+
% Dipterans & Non-insects	increase	+	-	-
No. of Intolerant Taxa	decrease	+	-	-
% Predators	decrease	-	-	+
% Dominance	increase	+	≅	≅
% Sediment Tolerants	increase	≅	+	≅
% Clingers	decrease	-	-	+
Hilsenhoff Biotic Index	increase	+	-	-
Genus-level B-IBI	**decrease**	-	-	+

4 Recommendations

- Development and calibration of a B-IBI is an iterative process. Any additional benthic invertebrate or land use classification data collected should be used to re-check metric trends, and re-affirm the metric scoring cut-off points.
- Annual variation (temporal variability) of metrics and index results should be evaluated by re-sampling some of the 2001 sites. Re-sampling uninfluenced sites would be the most practical method for assessment of year-to-year variability. Particularly, annual variability of metrics that represent a proportion of the sample (e.g. % Clingers) should be evaluated.
- Both family- and genus-level indices should be validated by sampling several sites with varying degrees or types of human influence on one stream. Ideally, the sampling should include an uninfluenced reference site.
- Initial results suggest that both the family- and genus-level indices may be suitable monitoring tools. However, the family-level index may not be as sensitive to smaller changes in biological integrity, especially at the higher end of the scoring range (excellent sites). If the goal is to protect uninfluenced streams in the area, it might be more effective to use the genus-level index. However, these results should be re-evaluated with data from at least one more year of sampling.
- For effectiveness monitoring of restoration projects, a BACI (before-after-control-impact) design is recommended with either index. If before data is not available, efforts should still be made to find a

[5] Raw data for Lemieux Creek from Bennett and Hewgill 2002.

suitable upstream reference site. If a reference site is not available, before sampling becomes more important for establishing baseline information.

- The increase in area sampled per replicate from 0.09 m^2 in 1999 to 0.27 m^2 in 2001, appeared to lessen the taxa richness skewing error associated with naturally low invertebrate abundance in some streams. Any future sampling should maintain the larger area per replicate.
- In similar B-IBI projects, it has been recommended that a core set of streams be identified and monitored each year that sampling occurs. This core set of streams will be useful for assessing changes to B-IBI due to widespread, naturally occurring events (for example, a very low water year). Ideally, this core set of streams would be made up of uninfluenced reference sites.

5 Literature Cited

Bailey, R.C., R.H. Norris, and R.B. Reynoldson. 2001. Taxonomic resolution of benthic macroinvertebrate communities in bioassessments. *J. N. Am. Benthol. Soc.* **20**(2): 280-286.

Barbour, M.T., J.B. Stribling, and J.R. Karr. 1995. Multimetric Approach for Establishing Biocriteria and Measuring Biological Condition. Pages 63 – 77 in W.S. Davis and T.P. Simon, eds. *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis, Boca Raton, FL.

Bennett, S. 2001a. *Expansion and Recalibration of the Kispiox Benthic Invertebrate Index of Biological Integrity: Field Season 2000.* Prepared for the Small Business Forest Enterprise Program, Hazelton, BC.

Bennett, S. 2001b. *A Benthic Invertebrate Index of Biological Integrity for Streams in the Bulkley TSA. Field Season 2000*. Prepared for Pacific Inland Resources, the Bulkley Forest District Office and the BC Environment, Smithers, BC.

Bennett, S. and K. Hewgill. 2002. *The Development of a Benthic Invertebrate Index of Biological Integrity for Streams in the Bulkley Timber Supply Area. Field Season 2001.* Prepared for Pacific Inland Resources, the Bulkley Forest District Office and BC Environment, Smithers, BC.

Bennett, S. and K. Hewgill. 2001. *Assessment of Forest Harvesting Impacts on Aquatic Ecosystems in the Kispiox & Kalum Forest Districts. Field Season 2000.* Prepared for BC Environment, Smithers, BC.

Cavanagh, N., R.N. Nordin, and P.D. Warrington. 1997. *Freshwater Biological Sampling Manual.* BC Ministry of Environment, Lands and Parks. Water Management Branch.

Chaplin, J. 2001. *Operational Inventory of Water Quality and Quantity of Rivers Ecosystems in the Bulkley, Lakes and Morice Districts of the Skeena Region, Northwest British Columbia.* Prepared for BC Environment, Smithers, BC.

DeShon, J.E. 1995. Development and application of the Invertebrate Community Index (ICI). Pages 217-243 in W.S. Davis and T.P. Simon, eds. *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making.* Lewis, Boca Raton, FL.

Fish Inventory Stream Survey. 2001. *Provincial Fish Inventory Stream Survey Database.* BC Fisheries. (www.bcfisheries.gov.bc.ca/fishinv).

Fore, L.S., J.R. Karr and L.L. Conquest. 2000. The effect of fixed-count subsampling on macroinvertebrate biomonitoring in small streams. *Freshwater Biology* **44**: 355-371.

Fore, L.S., J.R. Karr, and R.W. Wisseman. 1996. Assessing invertebrate responses to human activities: evaluating alternative approaches. *J.N. Am. Benthol. Soc.*, **15**(2): 212 – 231.

Johnston, N.T., and P.A. Slaney. 1996. *Fish Habitat Assessment Procedures.* Watershed Restoration Technical Circular No. 8 (revised April 1996).

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

Karr, J.R. and P.R. Yant, K.D. Fausch, and I.J. Schlosser. 1987. Spatial and temporal variability of the index of biological integrity in three Midwestern streams. *Trans. Am. Fish. Soc.* **116**: 1-11.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. *Fisheries* 6(6): 21-27.

Kerans, B.L. and J.R. Karr. 1994. A benthic index of biotic integrity (B-IBI) for rivers of the Tennessee valley. *Ecological Applications* 4(4): 768 – 785.

Kleindl, W.J. 1995. *A benthic index of biotic integrity for Puget Sound lowland streams, Washington, USA.* M. Sc. Thesis, University of Washington, Seattle.

Lenat, D.R. and V.H. Resh. 2001. Taxonomy and stream ecology – The benefits of genus- and species-level identifications. *J. N. Am. Benthol. Soc.* **20**(2):287-298.

Major, E.B., B.K. Jessup, A Prussian, and D. Rinella. 2001. *Alaska Stream Condition Index: Biological Index Development for Cook Inlet 1997 – 2000 Summary.* Prepared for the Alaska Department of Environmental Conservation, Anchorage, AK.

Maxted, J.R., M.T. Barbour, J. Gerritsen, V. Poretti, N. Primrose, A. Silvia, D. Penrose, and R. Renfrow. 2000. Assessment framework for mid-Atlantic coastal plain streams using benthic macroinvertebrates. *J.N. Am. Benthol. Soc.*, **19**(1): 128-144.

Major, E.B. and M.T. Barbour. 1997. *Standard Operating Procedures for the Alaska Stream Condition Index: A Modification of the U.S. EPA Rapid Bioassessment Protocols.* Prepared for the Alaska Department of Environmental Conservation, Anchorage, Alaska.

Merritt, R.W. and K.W. Cummins. 1996. *An Introduction to the Aquatic Insects of North America, Third Edition.* Kendall Hunt Publishing Company, Iowa.

Resh *et al.* 1996. Macroinvertebrates as Biotic Indicators of Environmental Quality. Pages 647-667 in F.R. Hauer and G.A. Lamberti, eds. *Methods in Stream Ecology.* Academic Press, San Diego, California.

Richards, C., L. B. Johnson, and G. E. Host. 1996. Landscape-scale influences on stream habitats and biota. *Can. J. Fish. Aquat. Sci.* **53**(Suppl. 1): 295-311.

Rysavy, S. 2000a. *Calibration of a Multimetric Benthic Invertebrate Index of Biological Integrity for the Upper Bulkley Watershed: A Tool for Assessing & Monitoring Stream Condition.* Prepared for Community Futures Development Corporation of Nadina, Houston, BC.

Rysavy, S. 2000b. *Calibration of a Multimetric Benthic Invertebrate Index of Biological Integrity for the Kispiox River Watershed: A Tool for Assessing & Monitoring Stream Condition.* Prepared for the Kispiox Forest District Small Business Program, Hazelton, BC.

Salmonweb. 2001. Salmonweb Community Based Monitoring for Biological Integrity of Streams (www.salmonweb.org). Revised Jan. 2001.

Tamblyn, G. and B. Donas. 2001. *Healthy Watersheds, Healthy Communities: Bulkley-Morice Salmonid Preservation Group Draft Strategic Plan – Phase 1. Review Draft.* Houston, BC.

USEPA. 2000. *Bioassessment and Biocriteria: Steps in Developing a Bioassessment and Biocriteria Program.* (www.epa.gov/ost/biocriteri/programs/steps1.html). Revised July 30, 2000.

Wisseman, R. 1997. *BENTHOS Version 1.0.* Aquatic Biology Associates, Inc. Corvallis, OR.

Zweig, L.D. and C.F. Rabeni. 2001. Biomonitoring for deposited sediment using benthic invertebrates: a test on 4 Missouri streams. *J. N. Am. Benthol. Soc.* **20**(4): 643-657.

Stream Name:		EMS:
Site Description:		
Date:	Time:	Field Crew:
Comments:		
Air Temp: °C	Water Temp: °C	

Weather Conditions:

Now:
- ☐ storm (heavy rain)
- ☐ rain (steady rain)
- ☐ showers (intermittent)
- ☐ overcast
- ☐ clear/ sunny

Past 24 hours:
- ☐ storm (heavy rain)
- ☐ rain (steady rain)
- ☐ showers (intermittent)
- ☐ overcast
- ☐ clear/ sunny

Has there been a heavy rain in the past 7 days? ☐ Y ☐ N

Sample Site Location Map (Draw a diagram of the site and indicate the areas sampled, and estimate the length of channel assessed)

Record Time of Collection for each Benthic Sample:

Sample 1: Sample 2: Sample 3:

Disturbance Indicators: Check off the following disturbance indicators present at the site

Bed Characteristics
- ☐ Extensive areas of scour
- ☐ Large extensive sediment wedges
- ☐ Extensive riffle zones
- ☐ Extensive areas of (unvegetated) bar
- ☐ Elevated mid-channel bars
- ☐ Limited pool frequency and extent

Channel Pattern
- ☐ Multiple channels (braiding)

Banks
- ☐ Eroding banks
- ☐ Isolated sidechannels or backchannels

Large Woody Debris
- ☐ Most LWD parallel to banks
- ☐ Recently formed LWD jams

Riparian Vegetation
Check off the dominant vegetation type:
☐ Unvegetated (much bare mineral soil is visible) ☐ Shrub / Herb
☐ Coniferous Forest ☐ Deciduous Forest ☐ Mixed Conifer - Deciduous Forest

Record the dominant species present:

Record the Structural Stage of the dominant vegetation in the Riparian Area:
☐ Non-vegetated or initial stage following disturbance, with less than 5% cover
☐ shrub / herb stage, less than 10% tree cover
☐ pole-sapling stage, with trees overtopping the shrub layer, usually less than 15-20 years old
☐ young forest (30- 80 years) - forest canopy is differentiating into distinct layers
☐ mature forest - well developed understory

Canopy Closure (proportion of the surface area of the stream covered by the projecting riparian canopy)
☐ 0 - 20% covered ☐ 20 - 40% covered ☐ 40 - 70% covered
☐ 70 - 90% covered ☐ >90% covered

Stream Characterization
☐ Glacial
☐ Clear
☐ Stained
☐ Other

Gradient (please estimate % gradient beside box)
☐ Steep
☐ Moderate
☐ Low

Predominant Surrounding Land Use
☐ Forest ☐ Field / Pasture ☐ Agricultural ☐ Residential
☐ Logging ☐ Mining ☐ Commercial / Industrial ☐ Other

Local Watershed Erosion
☐ Heavy
☐ Moderate
☐ None

Local Watershed NPS Pollution
☐ Obvious sources Comments:____________
☐ Some potential Sources
☐ No evidence

Stream Parameters (Record 3 measurements)
Stream Wetted Width: ____m ____m ____m Stream Bankfull Width: _____m _____m _____m
Stream Wetted Depth: ____m ____m ____m Stream Bankfull Depth: _____m _____m _____m

Primary Habitat Units Present (check any habitats that occupy more than 50% of the wetted width of the main channel)
☐ Pools ☐ Glides ☐ Riffles ☐ Cascades ☐ Other

Sediment / Substrate
Odors
☐ Sewage ☐ Petroleum ☐ Anaerobic ☐ Chemical ☐ None ☐ Other
Oils
☐ Absent ☐ Slight ☐ Moderate ☐ Profuse

Bed Material

Substrate Type	Diameter	% composition in reach (=100%)
Sands, Silts, Clays & fine Organic materials	< 2mm	
Gravels	2 - 64 mm	
Cobbles	64 - 256 mm	
Boulder	> 256 mm	
Bedrock	> 4000 mm	

Cover = __________%
(% cover is the percent of the wetted surface area that is covered by woody debris, boulders, cutbanks, deep pools, overhanging vegetation (within 1 m of water surface) or instream vegetation)

Alaska Stream Condition Index (ASCI) Habitat Assessment Field Data Sheet

Major, E.B. and M.T. Barbour. 1997. *Standard Operating Procedures for the Alaska Stream Condition Index: A Modification of the U.S. EPA Rapid Bioassessment Protocols.* Prepared for Alaska Department of Environmental Conservation, Anchorage, Alaska.

Site Name:____________________ Date/Time:____________________

Sampling Team:____________________ Comments:____________________

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate / Available Cover	Greater than 70% of substrate favorable for epifaunal colonization, mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (ie, logs/snags that are not new fall and not transient	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale)	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides substantial niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity-Depth Combinations	All four velocity-depth combinations present (slow-deep, slow-shallow, fast-deep, fast-shallow)	Only 3 of the 4 combinations present (if fast-shallow is missing, score lower than if missing other combinations)	Only 2 of the 4 habitat combinations present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity-depth combination (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, ie, dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuousity	Occurrence of riffles (or bends) relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. All 4 velocity-depth patterns present.	Occurrence of riffles (or bends) infrequent; distance between riffles divided by the width of the stream is between 7 to 15. Only 3 of 4 velocity-depth pattens present (ie, slow-deep, slow-shallow, fast-deep, fast- shallow).	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles (or bends) divided by the width of the stream is between 15 to 25. Only 2 velocity-depth patterns present; usually lacking deep areas.	Generally all flat water or shallow riffles (or bends); poor habitat; distance between riffles divided by the width of the stream is a ratio of >25. Dominated by one velocity-depth pattern.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion, mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; 'raw' areas frequent along straight sections and bends; obvious bank sloughing; 60 – 100% of bank has erosional scars.
SCORE (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
SCORE (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
9. Bank Vegetative Protection (score each bank)	More than 90% of the streambank & immediate riparian zone surfaces covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the stream-bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
SCORE (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (ie parking, roadbeds, clearcuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
SCORE (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

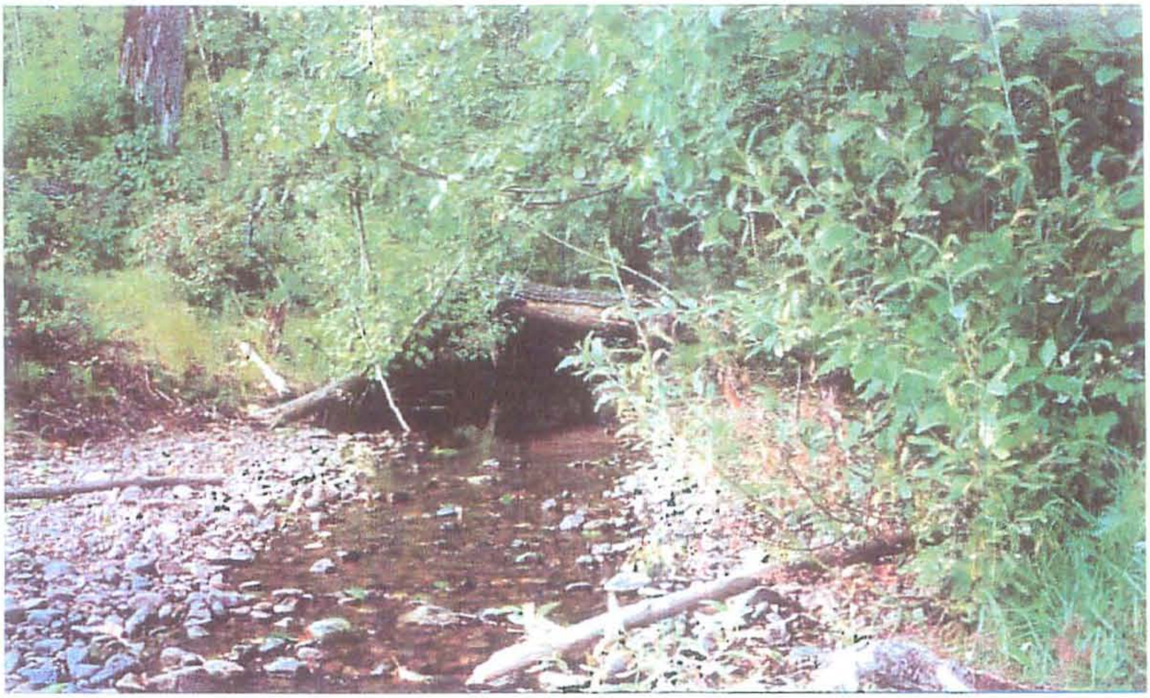


Figure 1: Barren Creek

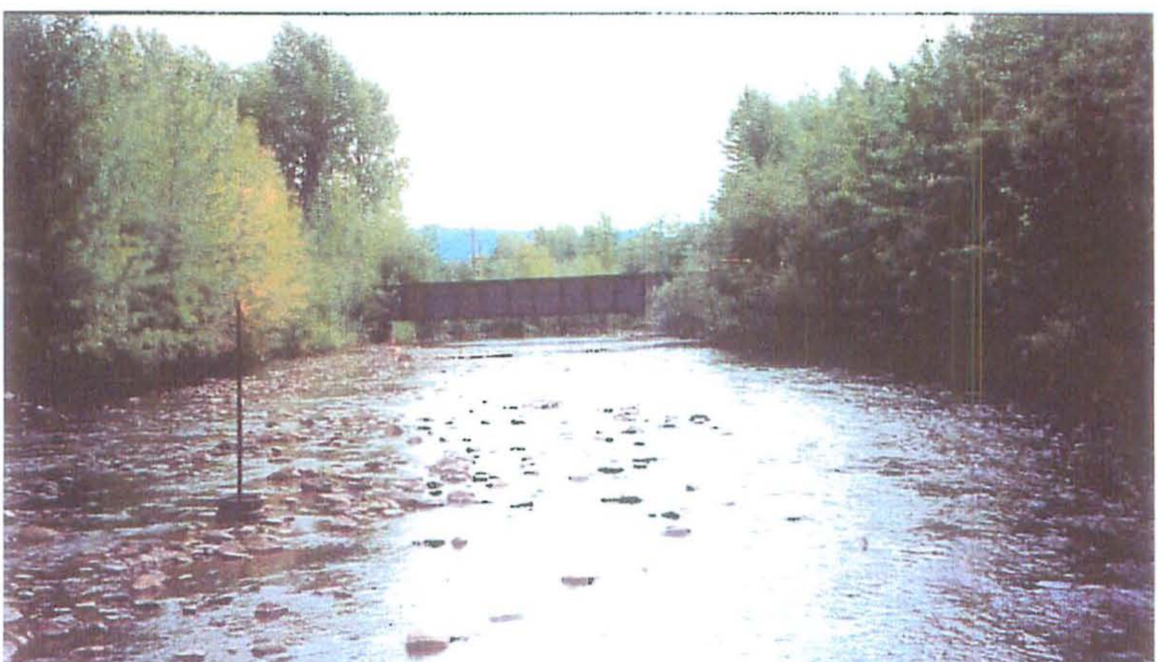


Figure 2: Buck Creek at Houston Mall

Figure 3: Byman Creek

Figure 4: Cesford Creek at Topley

Figure 5: Crow Creek

Figure 6: Deep Creek downstream

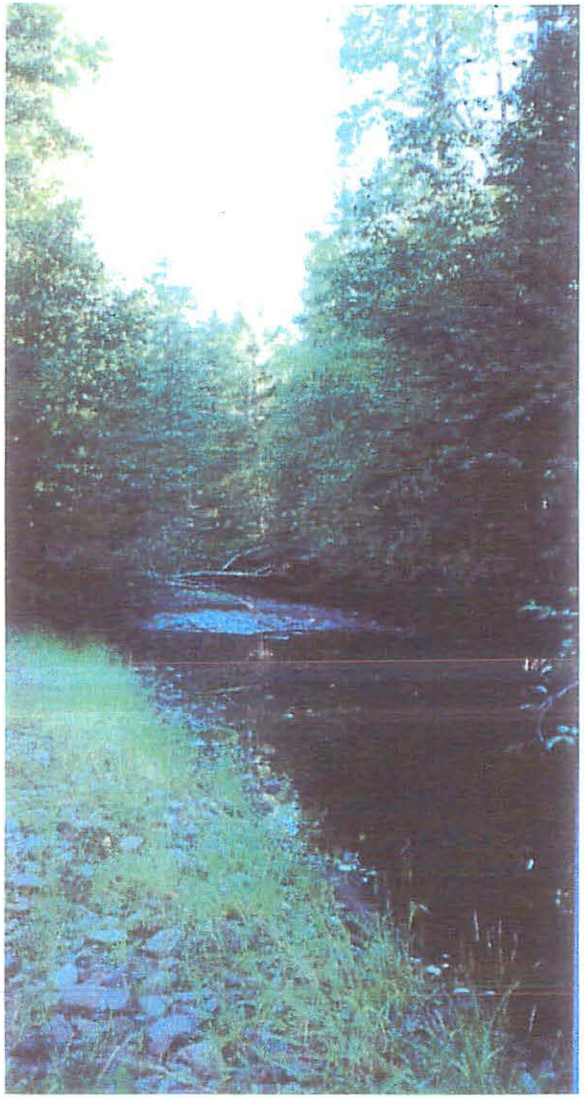


Figure 7: Foxy at Maxan

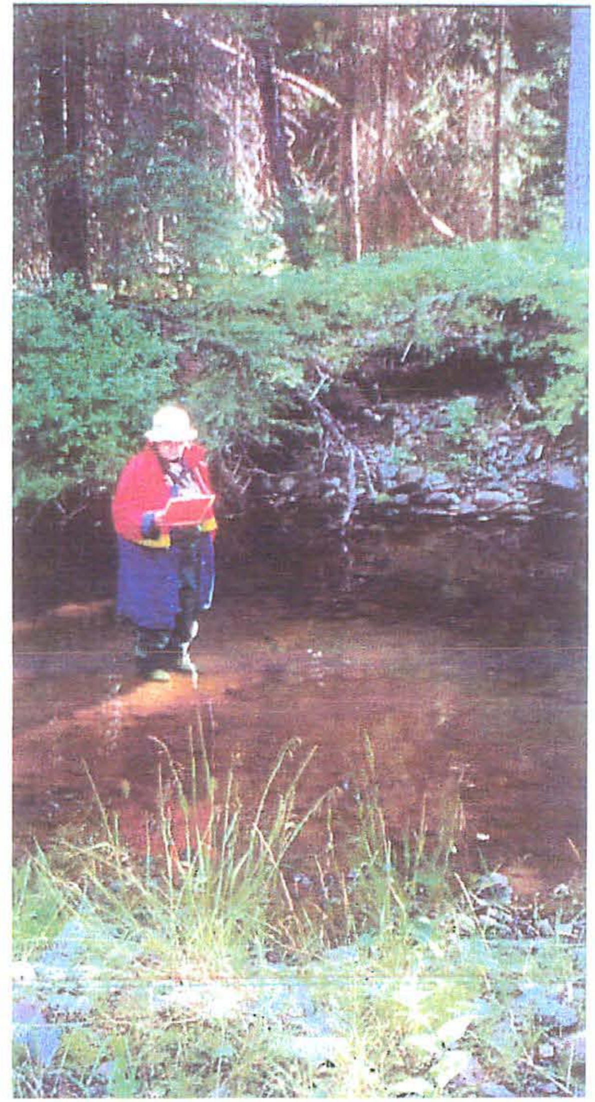


Figure 8: Foxy at Maxan, sediment deposition

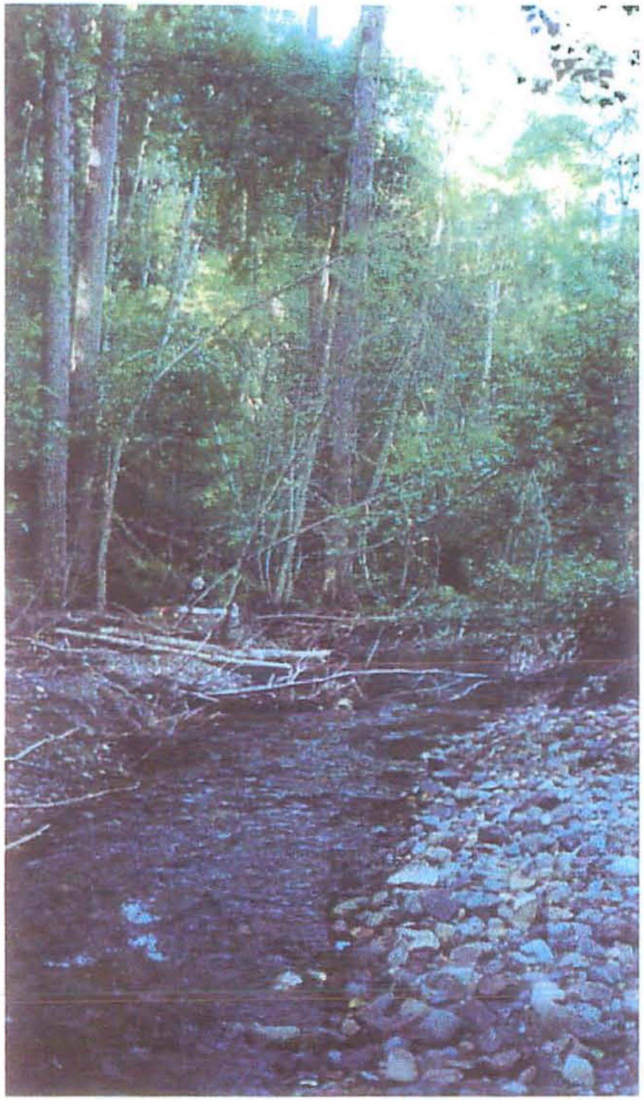


Figure 9: Deep Creek Reference

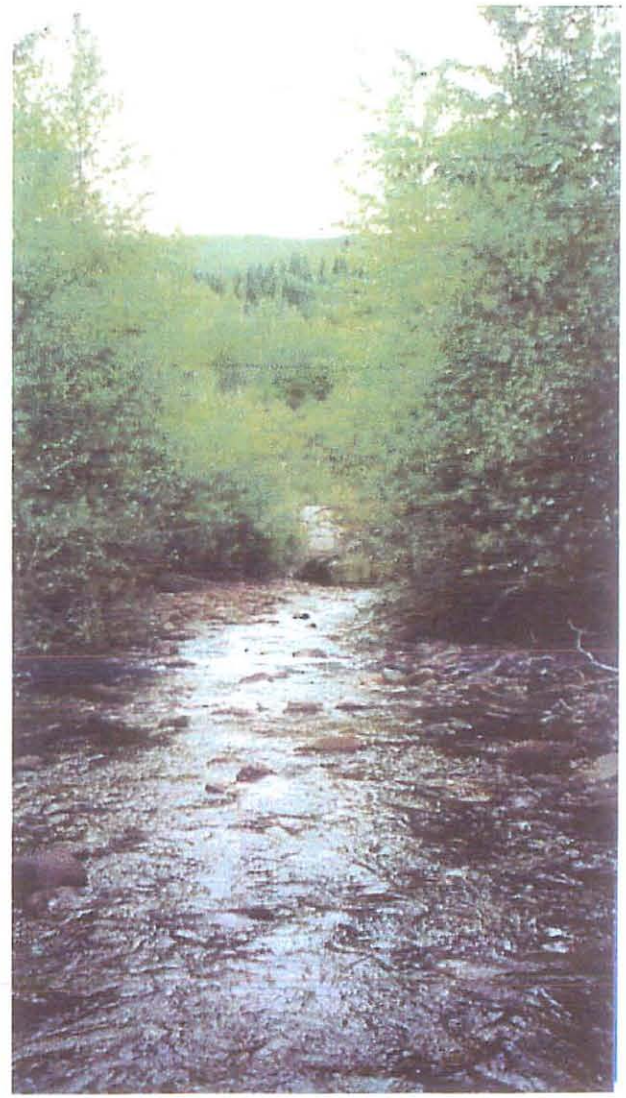


Figure 10: McQuarrie Creek

Figure 11: Richfield Creek at CN tracks

Figure 12: Richfield Creek above highway

				Deep Ustream			Deep ds			Richfield @ CN			Richfield ab hwy			Barren			Buck @ Mall		
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Class	Order	Family	Genus	E245201			E245200			E238645			E228631			E238626			E238624		
	Collembola	-	-					*7*	*4*	*4*	*2*	*2*	*2*	*2*	*6*	*10*	*17*				
	Collembola	*Sminthuridae*	-												*1*						
	Beetles																				
Insecta	Coleoptera	-	-																		
Insecta	*Coleoptera*	*Curculionidae*	-																		
Insecta	Coleoptera	Dytiscidiae	-																		
Insecta	Coleoptera	Dytiscidiae	Hydaticus?																		
Insecta	Coleoptera	Elmidae	-	6	2	6			15	4	2	5	2	1		12	5	9	70	17	26
Insecta	Coleoptera	Elmidae	Cleptelmis																		
Insecta	Coleoptera	Elmidae	Heterlimnius																		
Insecta	Coleoptera	Elmidae	Lara																		
Insecta	Coleoptera	Elmidae	Narpus					2										2			1
Insecta	Coleoptera	Elmidae	Optioservus																		
Insecta	Coleoptera	Elmidae	Zaitzevia						8					1				2			
Insecta	Coleoptera	Gyrinidae?																			
Insecta	Coleoptera	Haliplidae	Brychius																		
Insecta	Coleoptera	Haliplidae	Haliplus									5									
Insecta	Coleoptera	Hydrophilidae	-																		
Insecta	Coleoptera	Hydrophilidae	Lacobius																		
Insecta	*Coleoptera*	*Noteridae*	-																		
Insecta	*Coleoptera*	*Staphylinidae*	-																		
	True Flies																				
Insecta	Diptera	-	-										2								1
Insecta	Diptera	Athericidae	-																		
Insecta	Diptera	Athericidae	Atherix																11		14
Insecta	Diptera	Blephariceridae	-																		
Insecta	*Diptera*	*Ceratopogonidae*	-							*8*			*3*						*1*		
Insecta	*Diptera*	*Ceratopogonidae*	*Bezzia*	*4*	*2*	*12*	*1*	*1*	*5*		*4*	*5*		*4*	*4*		*2*	*9*		*2*	
Insecta	Diptera	Ceratopogonidae	Ceratopogoninae																		
Insecta	Diptera	Ceratopogonidae	Forcipomyiinae																		
Insecta	Diptera	Chironomidae	-	218	3	373	2893	1988	2024	666	391	318	239	340	282	42	59	678	1335	1363	2034
Insecta	Diptera	Culicidae	-																		
Insecta	Diptera	Dixidae	-																		
Insecta	Diptera	Dixidae	Dixa																		
Insecta	Diptera	Dixidae	Dixella																		
Insecta	Diptera	Dixidae	Meringodixa																		
Insecta	Diptera	Dolichopodidae																			
Insecta	Diptera	Deuterophlebiidae	Deuterophlebia																		
Insecta	Diptera	Empididae	-	7					8	1	12		3					37			8
Insecta	Diptera	Empididae	Chelifera				31	33	70			1							52	20	19
Insecta	Diptera	Empididae	Clinocera																		

				Deep Ustream			Deep ds			Richfield @ CN			Richfield ab hwy			Barren			Buck @ Mall		
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Class	Order	Family	Genus	E245201			E245200			E238645			E228631			E238626			E238624		
Insecta	Diptera	Empididae	Hemerodromia		2	8			1						1						2
Insecta	Diptera	Empididae	Oreogeton						1												
Insecta	Diptera	Empididae	Wiedemannia																		
Insecta	Diptera	Ephydridae	-																		
Insecta	Diptera	Muscidae	-																		
Insecta	Diptera	Pelecorhynchidae	Glutops																		
Insecta	*Diptera*	*Phoridae*	-																		
Insecta	Diptera	Psychodidae	-																4		
Insecta	Diptera	Psychodidae	Maruina																		
Insecta	Diptera	Psychodidae	Pericoma	175	72	213	363	127	196	6	6	21	47	24	53	60	91	398		1	.
Insecta	Diptera	Psychodidae	Psychoda																		
Insecta	*Diptera*	*Sciomyzidae*	-																		
Insecta	Diptera	Simuliidae	-		3			2		7			6						10		
Insecta	*Diptera*	*Simuliidae*	*Cnephia*																		
Insecta	Diptera	Simuliidae	Simulium	16		10	155		46		10	41		22	48			7			
Insecta	Diptera	Simuliidae	Prosimulium																		
Insecta	Diptera	Stratiomyidae	-																		
Insecta	Diptera	Tabanidae	-																		
Insecta	Diptera	Tabanidae	Tabanus																		
Insecta	Diptera	Tanyderidae	-																	1	
Insecta	Diptera	Tipulidae	-			4			17						4			33	13	6	
Insecta	Diptera	Tipulidae	Antocha						2											3	24
Insecta	Diptera	Tipulidae	Dicronata	5	2	8	3		3	14			7	13	3	13		34	12		
Insecta	Diptera	Tipulidae	Hexatoma	1	1		3		4	19	5	17		4	1	3	4	5	3	8	7
Insecta	*Diptera*	*Tipulidae*	*Limnophila*																		
Insecta	*Diptera*	*Tipulidae*	*Molophilus*																		
Insecta	Diptera	Tipulidae	Ormosia																		
Insecta	Diptera	Tipulidae	Rhabdomastix																		
Insecta	Diptera	Tipulidae	Tipula		2	11					1							5		2	
	Mayflies																				
Insecta	Ephemeroptera	-	-	122			1340			1181			36			8			542		
Insecta	*Ephemeroptera*	*Ameletidae*	-																		
Insecta	Ephemeroptera	Ameletidae	Ameletus				8	8	6	12		26	3		2	6	13	6	2	1	1
Insecta	Ephemeroptera	Baetidae	-																		
Insecta	Ephemeroptera	Baetidae	Acentrella																		
Insecta	Ephemeroptera	Baetidae	Baetis	650	335	772	159	89	278	47	60	133	38	73	66	21	117	209	80	356	88
Insecta	Ephemeroptera	Baetidae	Centroptilum																		
Insecta	Ephemeroptera	Baetidae	Diphetor																		
Insecta	Ephemeroptera	Ephemerellidae		18	35	53	11	61	126	8	69	27	3	7	3				186	519	1306
Insecta	Ephemeroptera	Ephemerellidae	Attenella																		
Insecta	Ephemeroptera	Ephemerellidae	Caudatella																		

				Deep Ustream			Deep ds			Richfield @ CN			Richfield ab hwy			Barren			Buck @ Mall		
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Class	Order	Family	Genus	E245201			E245200			E238645			E228631			E238626			E238624		
Insecta	Ephemeroptera	Ephemerellidae	Drunella	25	22	28	63	52	92	95	44	60	47	44	30	25	13	14	8	3	18
Insecta	Ephemeroptera	Ephemerellidae	Ephemerella												1						
Insecta	Ephemeroptera	Ephemerellidae	Serratella		1	2		1									1				
Insecta	Ephemeroptera	Ephemerellidae	Timpanoga																		
Insecta	Ephemeroptera	Heptageniidae	-	21	20	133	24	37	171	54	1002	457	6	52	46	44	112	275	20	404	172
Insecta	Ephemeroptera	Heptageniidae	Cinygmula	1									1	2		1	3				
Insecta	Ephemeroptera	Heptageniidae	Epeorus	49	27	45	22	4	3	4	10	15	1	3	3	8	10	15			2
Insecta	Ephemeroptera	Heptageniidae	Heptagenia																		
Insecta	Ephemeroptera	Heptageniidae	Ironodes																		
Insecta	Ephemeroptera	Heptageniidae	Nixe																		
Insecta	Ephemeroptera	Heptageniidae	Rhithrogena	11	81	112	314	30	84	110	71	122	35	35	36	31	44	205	19	17	1
Insecta	Ephemeroptera	Leptophlebiidae		5		4	30		20	8		1			4	1		69	5		8
Insecta	Ephemeroptera	Leptophlebiidae	Paraleptophlebia		44	22		14	47		7	47					12	7		122	2
Insecta	Ephemeroptera	Tricorythidae	Tricorythodes																		
	Alderflies																				
Insecta	*Megaloptera*	*Sialidae*	*Sialis*																		
	Stoneflies																				
Insecta	Plecoptera	-	-	67	24	129	58		30	18	37	28	22	24	5	51	88	653	152	44	83
Insecta	Plecoptera	Capniidae	-	14	17	46	29	10		9	11	14	8	53	3	4	4	50		1	
Insecta	Plecoptera	Chloroperlidae	-		4	14		3		1		7	12	4	11	64	96	30			4
Insecta	Plecoptera	Chloroperlidae	Kathroperla			19			1						1			3			
Insecta	*Plecoptera*	*Chloroperlidae*	*Isoperla*																		
Insecta	Plecoptera	Chloroperlidae	Paraperla																		
Insecta	*Plecoptera*	*Chloroperlidae*	*Neaviperla ?*																		
Insecta	*Plecoptera*	*Chloroperlidae*	*Plumiperla*																		
Insecta	Plecoptera	Chloroperlidae	Suwallia																		
Insecta	Plecoptera	Chloroperlidae	Sweltsa	408	22	6	81	15	28	206	209	142	19	12	16	11	62	107	29	33	12
Insecta	Plecoptera	Leuctridae	-																		
Insecta	Plecoptera	Nemouridae	-							2						14					
Insecta	Plecoptera	Nemouridae	Amphinemura																		
Insecta	Plecoptera	Nemouridae	Malenka																		
Insecta	Plecoptera	Nemouridae	Zapada	81	13	86	172	39	106	6	2	31		4	8	18	182	235	109	4	4
Insecta	Plecoptera	Perlidae	-									1							4		
Insecta	Plecoptera	Perlidae	Calineuria																		
Insecta	Plecoptera	Perlidae	Doroneuria												1						
Insecta	Plecoptera	Perlidae	Hesperoperla				5	1	1												
Insecta	Plecoptera	Perlodidae	-			8	4		1	1			1			1		1		56	
Insecta	Plecoptera	Perlodidae	Cultus					2						1			3				
Insecta	Plecoptera	Perlodidae	Isoperla																		
Insecta	Plecoptera	Perlodidae	Megarcys														2				
Insecta	Plecoptera	Perlodidae	Skwala						5										13	6	6

Class	Order	Family	Genus	Deep Ustream			Deep ds			Richfield @ CN			Richfield ab hwy			Barren			Buck @ Mall		
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
				E245201			E245200			E238645			E228631			E238626			E238624		
Insecta	Plecoptera	Pteronarcyidae	-				1		1												
Insecta	Plecoptera	Pteronarcyidae	Pteronarcella							1	3	3							12	10	5
Insecta	Plecoptera	Pteronarcyidae	Pteronarcys																		
Insecta	Plecoptera	Taeniopterygidae	-	188		36	86		1	34		1	4	1		169		42	5		
Insecta	Plecoptera	Taeniopterygidae	Taenionema																		
	Caddisflies																				
Insecta	Trichoptera	-	-	18		8	265		36	57	48	12	6	4	9		16	7	173		26
Insecta	*Trichoptera*	*Apataniinae*	*Apatania*																		2
Insecta	Trichoptera	Brachycentridae	-				1		4				1						6		
Insecta	Trichoptera	Brachycentridae	Brachycentrus			1		4							1					2	1
Insecta	Trichoptera	Brachycentridae	Micrasema																		
Insecta	Trichoptera	Glossosomatidae	-		36									1							
Insecta	Trichoptera	Glossosomatidae	Glossosoma	2	2	128	1	1	10		1						2	6	24	88	107
Insecta	Trichoptera	Glossosomatidae	Protoptila																		
Insecta	Trichoptera	Hydropsychidae	-	7		2	140	24	65	86	33	115	4		2	2			104	72	60
Insecta	Trichoptera	Hydropsychidae	Arctopsyche		3	14	9	5	11		3	13		2	4		2	6	37	26	5
Insecta	*Trichoptera*	*Hydropsychidae*	*Ceratopsyche*																		
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche																		
Insecta	Trichoptera	Hydropsychidae	Hydropsyche		1			1	16			49			3			1		24	19
Insecta	Trichoptera	Hydropsychidae	Parapsyche																		
Insecta	Trichoptera	Hydroptilidae	-										1						117		6
Insecta	Trichoptera	Hydroptilidae	Agraylea																	136	
Insecta	Trichoptera	Hydroptilidae	Hydroptila																		370
Insecta	Trichoptera	Lepidostomatidae	Lepidostoma																		
Insecta	Trichoptera	Limnephilidae	-								6								1	1	1
Insecta	Trichoptera	Limnephilidae	Dicosmoecus																		
Insecta	Trichoptera	Limnephilidae	Eccosmoecus																		
Insecta	Trichoptera	Limnephilidae	Ecclisocosmoecus																		
Insecta	Trichoptera	Limnephilidae	Ecclisomyia																		
Insecta	Trichoptera	Limnephilidae	Hydatophylax																		
Insecta	Trichoptera	Limnephilidae	Onocosmoecus																		
Insecta	Trichoptera	Limnephilidae	Psychoglypha																		
Insecta	Trichoptera	Philopotamidae	Wormaldia																		
Insecta	Trichoptera	Polycentropodidae	Polycentropus																		
Insecta	Trichoptera	Rhyacophilidae	-																		
Insecta	Trichoptera	Rhyacophilidae	Rhyacophila	23	17	61	3	2	4		1	5	2	2	4	3	9	22	9		2
Insecta	Trichoptera	Uenoidea	-																		
Insecta	Trichoptera	Uenoidea	Neophylax																		
Insecta	Trichoptera	Uenoidea	Neothremma																		
Insecta	*Thysanoptera*	-	-																		

				Deep Ustream			Deep ds			Richfield @ CN			Richfield ab hwy			Barren			Buck @ Mall		
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Class	**Order**	**Family**	**Genus**	E245201			E245200			E238645			E228631			E238626			E238624		
Insecta	*Hymenoptera*	-	-				2		1	8		2	2		6			4			
Insecta	*Hemiptera*	-	-																		
Insecta	*Hemiptera*	*Aphididae*	-	2			2			6	2		5	2		13					
Insecta	Hemiptera	Corixidae	-																		
Insecta	Lepidoptera	-	-																		1
Arachnoida	*Hydracarina*	-	-	13	43	73	68	70	402	42	87	98	28	3	84	2	80	126	303	343	363
Crustacea	Amphipoda	-	-																		
Crustacea	Cladocera	Chydoridae	-											1							
Crustacea	Decapoda	-	-																		
Crustacea	Copepoda	-	-																		
Crustacea	*Harpacticoida*	-	-																		
Crustacea	*Cyclopoida*											4		2	4						
Crustacea	Isopoda	-	-																		
Crustacea	*Mysis*	-	-																		
Crustacea	Ostracoda	-	-		36		24	8	72	4					8			49	16		4
Hirudinea	-	-	-																		
Oligochaeta	-	-	-	9			7		1	4		4	8	1	2			1	84		13
Hydrazoa	-	-	-						1												
Gastropoda	-	-	-																		
Pelecypoda	-	-	-																		
Pelecypoda	Veneroida	Sphaeriidae	-																		
Pelecypoda	Unionoida	Unionacea	-																		
-	-	-	-	18		18	23		19	5		2	42		1			1	17		45
Turbellaria	-	-	-	2	5	8	3		5	4	3	21	2					1		1	

Class	Order	Family	Genus	Crow			Foxy @ Maxan			Byman ds			Cesford @ Topley			McQuarrie d/s		
				1*	2	3	1	2	3	1	2	3	1	2	3	1	2	3
				E238638			E238636			E238629			E238635			E238627		
	Collembola	-	-			*1*			*4*	*1*		*2*	*19*	*1*	*5*	*2*		*11*
	Collembola	*Sminthuridae*	-		*4*	*1*									*4*			
	Beetles																	
Insecta	Coleoptera	-	-				50			2						4		
Insecta	*Coleoptera*	*Curculionidae*	-															
Insecta	Coleoptera	Dytiscidae	-															
Insecta	Coleoptera	Dytiscidae	Hydaticus?															
Insecta	Coleoptera	Elmidae	-	124		82		40	43		1	2	9	6	7			5
Insecta	Coleoptera	Elmidae	Cleptelmis															
Insecta	Coleoptera	Elmidae	Heterlimnius															
Insecta	Coleoptera	Elmidae	Lara															
Insecta	Coleoptera	Elmidae	Narpus			5									1			
Insecta	Coleoptera	Elmidae	Optioservus															
Insecta	Coleoptera	Elmidae	Zaitzevia		29	4			4								15	
Insecta	Coleoptera	Gyrinidae?																
Insecta	Coleoptera	Haliplidae	Brychius															
Insecta	Coleoptera	Haliplidae	Haliplus															
Insecta	Coleoptera	Hydrophilidae	-															
Insecta	Coleoptera	Hydrophilidae	Lacobius															
Insecta	*Coleoptera*	*Noteridae*	-															
Insecta	*Coleoptera*	*Staphylinidae*	-															
	True Flies																	
Insecta	Diptera	-	-									1						
Insecta	Diptera	Athericidae	-															
Insecta	Diptera	Athericidae	Atherix									2						
Insecta	Diptera	Blephariceridae	-															
Insecta	*Diptera*	*Ceratopogonidae*	-	*3*			*36*			*21*			*3*					
Insecta	*Diptera*	*Ceratopogonidae*	*Bezzia*		*8*	*3*		*62*	*32*		*32*	*11*				*15*	*15*	*11*
Insecta	Diptera	Ceratopogonidae	Ceratopogoninae															
Insecta	Diptera	Ceratopogonidae	Forcipomyiinae															
Insecta	Diptera	Chironomidae	-	212	172	583	2144	2560	1177	390	624	574	1462	5863	2316	1181	1544	1960
Insecta	Diptera	Culicidae	-															
Insecta	Diptera	Dixidae	-															1
Insecta	Diptera	Dixidae	Dixa															
Insecta	Diptera	Dixidae	Dixella															
Insecta	Diptera	Dixidae	Meringodixa															
Insecta	Diptera	Dolichopodidae																
Insecta	Diptera	Deuterophlebiidae	Deuterophlebia															
Insecta	Diptera	Empididae	-						1				1			1		12
Insecta	Diptera	Empididae	Chelifera			4	2	3	1			1					4	6
Insecta	Diptera	Empididae	Clinocera															

Class	Order	Family	Genus	Crow			Foxy @ Maxan			Byman ds			Cesford @ Topley			McQuarrie d/s		
				1*	2	3	1	2	3	1	2	3	1	2	3	1	2	3
				E238638			E238636			E238629			E238635			E238627		
Insecta	Diptera	Empididae	Hemerodromia									8			5			1
Insecta	Diptera	Empididae	Oreogeton						1	11								
Insecta	Diptera	Empididae	Wiedemannia															
Insecta	Diptera	Ephydridae	-															
Insecta	Diptera	Muscidae	-						1									
Insecta	Diptera	Pelecorhynchidae	Glutops															
Insecta	*Diptera*	*Phoridae*	-															
Insecta	Diptera	Psychodidae	-															
Insecta	Diptera	Psychodidae	Maruina															
Insecta	Diptera	Psychodidae	Pericoma	7	32	71	369	493	212	74	140	117	80	35	151	46	23	24
Insecta	Diptera	Psychodidae	Psychoda															
Insecta	*Diptera*	*Sciomyzidae*	-															
Insecta	Diptera	Simuliidae	-	2				64	2	2	16	5			4	10		12
Insecta	*Diptera*	*Simuliidae*	*Cnephia*															
Insecta	Diptera	Simuliidae	Simulium		92	78	1079	7	101		3						19	25
Insecta	Diptera	Simuliidae	Prosimulium															
Insecta	Diptera	Stratiomyidae	-															
Insecta	Diptera	Tabanidae	-															
Insecta	Diptera	Tabanidae	Tabanus															
Insecta	Diptera	Tanyderidae	-					1			1							
Insecta	Diptera	Tipulidae	-		12				7	14		1		4	3			57
Insecta	Diptera	Tipulidae	Antocha									12					4	9
Insecta	Diptera	Tipulidae	Dicranota	6		4	3	12				1	12		5	4	7	1
Insecta	Diptera	Tipulidae	Hexatoma	3			4			2	12	7				2		1
Insecta	*Diptera*	*Tipulidae*	*Limnophila*															
Insecta	*Diptera*	*Tipulidae*	*Molophilus*															
Insecta	Diptera	Tipulidae	Ormosia															
Insecta	Diptera	Tipulidae	Rhabdomastix															
Insecta	Diptera	Tipulidae	Tipula															
	Mayflies																	
Insecta	Ephemeroptera	-	-	245			245			1045			197	262		434		
Insecta	*Ephemeroptera*	*Ameletidae*	-															
Insecta	Ephemeroptera	Ameletidae	Ameletus	4		1	13	8		23	2	11	2	3	11	1		2
Insecta	Ephemeroptera	Baetidae	-															
Insecta	Ephemeroptera	Baetidae	Acentrella															
Insecta	Ephemeroptera	Baetidae	Baetis	166	679	496	409	1478	868	65	673	228	46	19	49	192	192	226
Insecta	Ephemeroptera	Baetidae	Centroptilum															
Insecta	Ephemeroptera	Baetidae	Diphetor															
Insecta	Ephemeroptera	Ephemerellidae			200	40	84	135	87		612	144	19	20	43	69	232	229
Insecta	Ephemeroptera	Ephemerellidae	Attenella															
Insecta	Ephemeroptera	Ephemerellidae	Caudatella															

Class	Order	Family	Genus	Crow 1*	Crow 2	Crow 3	Foxy @ Maxan 1	Foxy @ Maxan 2	Foxy @ Maxan 3	Byman ds 1	Byman ds 2	Byman ds 3	Cesford @ Topley 1	Cesford @ Topley 2	Cesford @ Topley 3	McQuarrie d/s 1	McQuarrie d/s 2	McQuarrie d/s 3
				E238638			E238636			E238629			E238635			E238627		
Insecta	Ephemeroptera	Ephemerellidae	Drunella	81	144	137	192	134	88	67	47	51	10	7	12	11	5	5
Insecta	Ephemeroptera	Ephemerellidae	Ephemerella															
Insecta	Ephemeroptera	Ephemerellidae	Serratella		4	2												
Insecta	Ephemeroptera	Ephemerellidae	Timpanoga															
Insecta	Ephemeroptera	Heptageniidae	-	2	246	575	8	82	231	44	1257	1130	20	4	137	88	208	661
Insecta	Ephemeroptera	Heptageniidae	Cinygmula			1	11	7	7				8	7	7		9	
Insecta	Ephemeroptera	Heptageniidae	Epeorus	31	85	55	8	15	8	3			22	12	34	1		
Insecta	Ephemeroptera	Heptageniidae	Heptagenia															
Insecta	Ephemeroptera	Heptageniidae	Ironodes															
Insecta	Ephemeroptera	Heptageniidae	Nixe															
Insecta	Ephemeroptera	Heptageniidae	Rhithrogena	59	70	76	17		25	108	218	171	7	2		236	174	118
Insecta	Ephemeroptera	Leptophlebiidae								2		5				3		2
Insecta	Ephemeroptera	Leptophlebiidae	Paraleptophlebia	2								23			1		27	16
Insecta	Ephemeroptera	Tricorythidae	Tricorythodes		11	8		12										
	Alderflies																	
Insecta	*Megaloptera*	*Sialidae*	*Sialis*															
	Stoneflies																	
Insecta	Plecoptera	-	-	40	48	37	61	132	48	50	247	56	32	36	50	16	26	39
Insecta	Plecoptera	Capniidae	-	11	16	7	2	8	9	28	10	17				39	48	69
Insecta	Plecoptera	Chloroperlidae	-	20	15	60	3	32	28	11		19			15	11	18	14
Insecta	Plecoptera	Chloroperlidae	Kathroperla															
Insecta	*Plecoptera*	*Chloroperlidae*	*Isoperla*															
Insecta	Plecoptera	Chloroperlidae	Paraperla															
Insecta	*Plecoptera*	*Chloroperlidae*	*Neaviperla ?*															
Insecta	*Plecoptera*	*Chloroperlidae*	*Plumiperla*															
Insecta	Plecoptera	Chloroperlidae	Suwallia															
Insecta	Plecoptera	Chloroperlidae	Sweltsa	116	95	35	39	54	49	92	256	59	74	102	51	110	86	48
Insecta	Plecoptera	Leuctridae	-															
Insecta	Plecoptera	Nemouridae	-											4				
Insecta	Plecoptera	Nemouridae	Amphinemura															
Insecta	Plecoptera	Nemouridae	Malenka															
Insecta	Plecoptera	Nemouridae	Zapada	1	12	8	10	39	60	22	168	91	21		14	24	50	40
Insecta	Plecoptera	Perlidae	-	1					2	9		1						
Insecta	Plecoptera	Perlidae	Calineuria															
Insecta	Plecoptera	Perlidae	Doroneuria								17	1						
Insecta	Plecoptera	Perlidae	Hesperoperla															
Insecta	Plecoptera	Perlodidae	-	2		7	1			1					6	1		
Insecta	Plecoptera	Perlodidae	Cultus					5			1							
Insecta	Plecoptera	Perlodidae	Isoperla															
Insecta	Plecoptera	Perlodidae	Megarcys		12	2			1						9			1
Insecta	Plecoptera	Perlodidae	Skwala									4	3	8	1			3

Class	Order	Family	Genus	Crow			Foxy @ Maxan			Byman ds			Cosford @ Topley			McQuarrie d/s		
				1*	2	3	1	2	3	1	2	3	1	2	3	1	2	3
				E238638			E238636			E238629			E238635			E238627		
Insecta	Plecoptera	Pteronarcyidae	-															
Insecta	Plecoptera	Pteronarcyidae	Pteronarcella				1											
Insecta	Plecoptera	Pteronarcyidae	Pteronarcys															
Insecta	Plecoptera	Taeniopterygidae	-	5	2		6			30			79	86	4	7	5	2
Insecta	Plecoptera	Taeniopterygidae	Taenionema															
	Caddisflies																	
Insecta	Trichoptera	-	-	24	16	17	100	166	21	72	212	424	14	2	18	11		15
Insecta	*Trichoptera*	*Apataniinae*	*Apatania*															
Insecta	Trichoptera	Brachycentridae	-															
Insecta	Trichoptera	Brachycentridae	Brachycentrus		2	2		3			10							
Insecta	Trichoptera	Brachycentridae	Micrasema								1							
Insecta	Trichoptera	Glossosomatidae	-					3			8							
Insecta	Trichoptera	Glossosomatidae	Glossosoma	3	6	23				30	5	46	58	25	48		6	
Insecta	Trichoptera	Glossosomatidae	Protoptila															
Insecta	Trichoptera	Hydropsychidae	-	4	3	8	26	5	15	83	264	42			5	35	57	27
Insecta	Trichoptera	Hydropsychidae	Arctopsyche		16	5			4		3	1				8	4	6
Insecta	*Trichoptera*	*Hydropsychidae*	*Ceratopsyche*															
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche															
Insecta	Trichoptera	Hydropsychidae	Hydropsyche								212	51						1
Insecta	Trichoptera	Hydropsychidae	Parapsyche				1	1										
Insecta	Trichoptera	Hydroptilidae	-	1														
Insecta	Trichoptera	Hydroptilidae	Agraylea															
Insecta	Trichoptera	Hydroptilidae	Hydroptila									2						
Insecta	Trichoptera	Lepidostomatidae	Lepidostoma															
Insecta	Trichoptera	Limnephilidae	-							370	6	1						
Insecta	Trichoptera	Limnephilidae	Dicosmoecus															
Insecta	Trichoptera	Limnephilidae	Eccosmoecus															
Insecta	Trichoptera	Limnephilidae	Ecclisocosmoecus															
Insecta	Trichoptera	Limnephilidae	Ecclisomyia															
Insecta	Trichoptera	Limnephilidae	Hydatophylax															
Insecta	Trichoptera	Limnephilidae	Onocosmoecus															
Insecta	Trichoptera	Limnephilidae	Psychoglypha															
Insecta	Trichoptera	Philopotamidae	Wormaldia															
Insecta	Trichoptera	Polycentropodidae	Polycentropus															
Insecta	Trichoptera	Rhyacophilidae	-															
Insecta	Trichoptera	Rhyacophilidae	Rhyacophila	18	51	64	32	44	166	16	3		15	12	12	2	4	7
Insecta	Trichoptera	Uenoidea	-															
Insecta	Trichoptera	Uenoidea	Neophylax															
Insecta	Trichoptera	Uenoidea	Neothremma															
Insecta	*Thysanoptera*	-	-															

				Crow			Foxy @ Maxan			Byman ds			Cesford @ Topley			McQuarrie d/s		
				1*	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Class	**Order**	**Family**	**Genus**	E238638			E238636			E238629			E238635			E238627		
Insecta	*Hymenoptera*	-	-									*3*	*19*	*13*	*21*			
Insecta	*Hemiptera*	-	-										*2*					
Insecta	*Hemiptera*	*Aphididae*	-	*1*						*1*			*37*	*23*		*1*	*5*	
Insecta	Hemiptera	Corixidae	-															
Insecta	Lepidoptera	-	-													1		
Arachnoida	*Hydracarina*	-	-	*47*	*26*	*82*	*97*	*203*	*247*	*261*	*111*	*406*	*38*	*49*	*151*	*102*	*174*	*391*
Crustacea	Amphipoda	-	-															
Crustacea	Cladocera	Chydoridae	-															
Crustacea	Decapoda	-	-															
Crustacea	Copepoda	-	-															
Crustacea	*Harpacticoida*	-	-															
Crustacea	*Cyclopoida*																	
Crustacea	Isopoda	-	-															
Crustacea	*Mysis*	-	-															
Crustacea	Ostracoda	-	-			4				1			13	80	20			
Hirudinea	-	-	-															
Oligochaeta	-	-	-	4				13		2	40	1	328	168	242	36	58	52
Hydrazoa	-	-	-															*1*
Gastropoda	-	-	-															
Pelecypoda	-	-	-															
Pelecypoda	Veneroida	Sphaeriidae	-															
Pelecypoda	Unionoida	Unionacea	-															
-	-	-	-	9		14	45		1	13		10		81		2		1
Turbellaria	-	-	-	2	3	7	6	4	6	9		17	15	6	3	5	14	4

Phylum	Class	Order	Family	Genus	CL	FFG	T/I	LL	%SV	HBI
		Collembola	-	-		*CG*				
		Collembola	*Sminthuridae*	-						
INSECTS		**Beetles**								
	Insecta	Coleoptera	-	-		UN				
Arthropoda	*Insecta*	*Coleoptera*	*Curculionidae*	-		*SH*				
Arthropoda	Insecta	Coleoptera	Dytiscidiae	-		PR	T	LL	100	5
	Insecta	Coleoptera	Dytiscidiae	Hydaticus?		PR	T			5
	Insecta	Coleoptera	Elmidae	-	CL	CG		LL	100	4
	Insecta	Coleoptera	Elmidae	Cleptelmis	CL	CG		LL	100	
Arthropoda	Insecta	Coleoptera	Elmidae	Heterlimnius	CL	CG		LL	100	4
Arthropoda	Insecta	Coleoptera	Elmidae	Lara	CL	SH		LL	100	4
Arthropoda	Insecta	Coleoptera	Elmidae	Narpus	CL	CG		LL	100	4
Arthropoda	Insecta	Coleoptera	Elmidae	Optioservus	CL	SC	T	LL	100	4
Arthropoda	Insecta	Coleoptera	Elmidae	Zaitzevia	CL	CG	T	LL	100	4
	Insecta	Coleoptera	Gyrinidae?			PR	T	LL	100	
Arthropoda	Insecta	Coleoptera	Haliplidae	Brychius	CL	MH	T	LL	100	5
Arthropoda	Insecta	Coleoptera	Haliplidae	Haliplus		MH	T	LL	100	5
Arthropoda	Insecta	Coleoptera	Hydrophilidae	-		PR		LL	100	5
Arthropoda	Insecta	Coleoptera	Hydrophilidae	Lacobius		PR		LL	100	5
	Insecta	*Coleoptera*	*Noteridae*	-		*PR*				
	Insecta	*Coleoptera*	*Staphylinidae*	-	*CL*	*PR*				
		True Flies								
Arthropoda	Insecta	Diptera	-	-		UN				
Arthropoda	Insecta	Diptera	Athericidae	-		PR	T			2
Arthropoda	Insecta	Diptera	Athericidae	Atherix		PR	T			4
Arthropoda	Insecta	Diptera	Blephariceridae	-	CL	SC	I			0
Arthropoda	*Insecta*	*Diptera*	*Ceratopogonidae*	-		*PR*				*6*
Arthropoda	*Insecta*	*Diptera*	*Ceratopogonidae*	*Bezzia*		*PR*				
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae		PR				6
Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae		PR				6
Arthropoda	Insecta	Diptera	Chironomidae	-		UN				6
	Insecta	Diptera	Culicidae	-		CG	T			8
Arthropoda	Insecta	Diptera	Dixidae	-		CG				2
Arthropoda	Insecta	Diptera	Dixidae	Dixa		CG				2
Arthropoda	Insecta	Diptera	Dixidae	Dixella		CG	T			2
Arthropoda	Insecta	Diptera	Dixidae	Meringodixa		CG				2
Arthropoda	Insecta	Diptera	Dolichopodidae			PR	T			8
Arthropoda	Insecta	Diptera	Deuterophlebiidae	Deuterophlebia	CL	SC	I			0
Arthropoda	Insecta	Diptera	Empididae	-		PR				6
Arthropoda	Insecta	Diptera	Empididae	Chelifera		PR				6
Arthropoda	Insecta	Diptera	Empididae	Clinocera	CL	PR				6
Arthropoda	Insecta	Diptera	Empididae	Hemerodromia		PR	T			6
Arthropoda	Insecta	Diptera	Empididae	Oreogeton		PR	I			6
Arthropoda	Insecta	Diptera	Empididae	Wiedemannia	CL	PR				6
	Insecta	Diptera	Ephydridae	-		CG	T			6
Arthropoda	Insecta	Diptera	Muscidae	-		PR	T			6
Arthropoda	Insecta	Diptera	Pelecorhynchidae	Glutops		PR	I			3
Arthropoda	*Insecta*	*Diptera*	*Phoridae*	-		*CG*				
	Insecta	Diptera	Psychodidae	-		CG				10
Arthropoda	Insecta	Diptera	Psychodidae	Maruina	CL	SC				2
Arthropoda	Insecta	Diptera	Psychodidae	Pericoma		CG				4
Arthropoda	Insecta	Diptera	Psychodidae	Psychoda		CG	T			10
Arthropoda	*Insecta*	*Diptera*	*Sciomyzidae*	-		*PR*				

Phylum	Class	Order	Family	Genus	CL	FFG	T/I	LL	%SV	HBI
	Insecta	Diptera	Simuliidae	-	CL	CF				6
Arthropoda	*Insecta*	*Diptera*	*Simuliidae*	*Cnephia*		*CF*				
Arthropoda	Insecta	Diptera	Simuliidae	Simulium	CL	CF				6
Arthropoda	Insecta	Diptera	Simuliidae	Prosimulium	CL	CF				3
	Insecta	Diptera	Stratiomyidae	-		CG	T			8
	Insecta	Diptera	Tabanidae	-		PR	T			8
	Insecta	Diptera	Tabanidae	Tabanus		PR	T			5
	Insecta	Diptera	Tanyderidae	-		UN	I			1
	Insecta	Diptera	Tipulidae	-		UN				3
Arthropoda	Insecta	Diptera	Tipulidae	Antocha	CL	CG	ST			3
Arthropoda	Insecta	Diptera	Tipulidae	Dicronata		PR	ST			3
Arthropoda	Insecta	Diptera	Tipulidae	Hexatoma		PR	ST			2
Arthropoda	*Insecta*	*Diptera*	*Tipulidae*	*Limnophila*		*PR*	*T*			
Arthropoda	*Insecta*	*Diptera*	*Tipulidae*	*Molophilus*		*UN*	*I*			
	Insecta	Diptera	Tipulidae	Ormosia		CG				3
	Insecta	Diptera	Tipulidae	Rhabdomastix		UN	I			3
Arthropoda	Insecta	Diptera	Tipulidae	Tipula		OM				4
		Mayflies								
	Insecta	Ephemeroptera	-	-		UN				
	Insecta	*Ephemeroptera*	*Ameletidae*	-		*CG*				
	Insecta	Ephemeroptera	Ameletidae	Ameletus		CG				0
Arthropoda	Insecta	Ephemeroptera	Baetidae	-		CG				4
Arthropoda	Insecta	Ephemeroptera	Baetidae	Acentrella		CG				4
Arthropoda	Insecta	Ephemeroptera	Baetidae	Baetis		CG				5
Arthropoda	Insecta	Ephemeroptera	Baetidae	Centroptilum		CG	T			2
Arthropoda	Insecta	Ephemeroptera	Baetidae	Diphetor		CG				4
	Insecta	Ephemeroptera	Ephemerellidae		CL	CG				1
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Attenella	CL	CG				2
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Caudatella	CL	CG	I			1
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Drunella	CL	CG				
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Ephemerella	CL	CG				1
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Serratella	CL	CG				2
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Timpanoga	CL	CG				7
	Insecta	Ephemeroptera	Heptageniidae	-	CL	SC				4
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Cinygmula	CL	SC				4
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Epeorus	CL	SC				0
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Heptagenia	CL	SC				4
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Ironodes	CL	SC				3
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Nixe	CL	SC				2
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Rhithrogena	CL	SC				0
	Insecta	Ephemeroptera	Leptophlebiidae			CG				2
Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	Paraleptophlebia		CG				4
Arthropoda	Insecta	Ephemeroptera	Tricorythidae	Tricorythodes		CG	T			4
		Alderflies								
Arthropoda	*Insecta*	*Megaloptera*	*Sialidae*	*Sialis*		*PR*				
		Stoneflies								
	Insecta	Plecoptera	-	-		UN				
Arthropoda	Insecta	Plecoptera	Capnidae	-		SH				1
	Insecta	Plecoptera	Chloroperlidae	-	CL	PR				1
Arthropoda	Insecta	Plecoptera	Chloroperlidae	Kathroperla	CL	PR	I			0
	Insecta	*Plecoptera*	*Chloroperlidae*	*Isoperla*	*CL*	*PR*				
	Insecta	Plecoptera	Chloroperlidae	Paraperla	CL	PR	I			0
	Insecta	*Plecoptera*	*Chloroperlidae*	*Neaviperla ?*	*CL*	*PR*				

Phylum	Class	Order	Family	Genus	CL	FFG	T/I	LL	%SV	HBI
Arthropoda	*Insecta*	*Plecoptera*	*Chloroperlidae*	*Plumiperla*	*CL*	*PR*				
Arthropoda	Insecta	Plecoptera	Chloroperlidae	Suwallia	CL	PR				0
Arthropoda	Insecta	Plecoptera	Chloroperlidae	Sweltsa	CL	PR				1
Arthropoda	Insecta	Plecoptera	Leuctridae	-		SH	I			0
	Insecta	Plecoptera	Nemouridae	-		SH				2
Arthropoda	Insecta	Plecoptera	Nemouridae	Amphinemura		SH				2
Arthropoda	Insecta	Plecoptera	Nemouridae	Malenka		SH				2
Arthropoda	Insecta	Plecoptera	Nemouridae	Zapada		SH				2
	Insecta	Plecoptera	Perlidae	-	CL	PR		LL	100	1
Arthropoda	Insecta	Plecoptera	Perlidae	Calineuria	CL	PR		LL	100	2
Arthropoda	Insecta	Plecoptera	Perlidae	Doroneuria	CL	PR	I	LL	100	1
Arthropoda	Insecta	Plecoptera	Perlidae	Hesperoperla	CL	PR		LL	100	2
	Insecta	Plecoptera	Perlodidae	-	CL	PR				2
Arthropoda	Insecta	Plecoptera	Perlodidae	Cultus	CL	PR	I			2
Arthropoda	Insecta	Plecoptera	Perlodidae	Isoperla	CL	PR				2
Arthropoda	Insecta	Plecoptera	Perlodidae	Megarcys	CL	PR	I			2
Arthropoda	Insecta	Plecoptera	Perlodidae	Skwala	CL	PR				2
Arthropoda	Insecta	Plecoptera	Pteronarcyidae	-	CL	OM		LL	100	0
Arthropoda	Insecta	Plecoptera	Pteronarcyidae	Pteronarcella	CL	OM		LL	100	0
Arthropoda	Insecta	Plecoptera	Pteronarcyidae	Pteronarcys	CL	OM		LL	100	0
	Insecta	Plecoptera	Taeniopterygidae	-		OM				2
	Insecta	Plecoptera	Taeniopterygidae	Taenionema		OM				2
		Caddisflies								
	Insecta	Trichoptera	-	-		UN				
Arthropoda	*Insecta*	*Trichoptera*	*Apataniinae*	*Apatania*	*CL*	*SC*	*I*			
Arthropoda	Insecta	Trichoptera	Brachycentridae	-	CL	UN				1
Arthropoda	Insecta	Trichoptera	Brachycentridae	Brachycentrus	CL	OM		LL	100	1
Arthropoda	Insecta	Trichoptera	Brachycentridae	Micrasema	CL	MH				1
Arthropoda	Insecta	Trichoptera	Glossosomatidae	-	CL	SC				0
Arthropoda	Insecta	Trichoptera	Glossosomatidae	Glossosoma	CL	SC	SIT			1
Arthropoda	Insecta	Trichoptera	Glossosomatidae	Protoptila	CL	SC				1
Arthropoda	Insecta	Trichoptera	Hydropsychidae	-	CL	CF				4
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsyche	CL	CF	SIT	LL	100	1
Arthropoda	*Insecta*	*Trichoptera*	*Hydropsychidae*	*Ceratopsyche*		*CF*				
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	CL	CF	SIT			8
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsyche	CL	CF	SIT			4
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Parapsyche	CL	CF	SIT	LL	100	0
Arthropoda	Insecta	Trichoptera	Hydroptilidae	-	CL	PH				4
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Agraylea		PH				8
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptila	CL	PH	T			6
Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostoma		SH				1
Arthropoda	Insecta	Trichoptera	Limnephilidae	-		UN				4
Arthropoda	Insecta	Trichoptera	Limnephilidae	Dicosmoecus		OM	I	LL	100	1
Arthropoda	Insecta	Trichoptera	Limnephilidae	Eccosmoecus		OM	I	LL	100	
Arthropoda	Insecta	Trichoptera	Limnephilidae	Ecclisocosmoecus		SH	I		50	0
Arthropoda	Insecta	Trichoptera	Limnephilidae	Ecclisomyia	CL	OM	I			2
Arthropoda	Insecta	Trichoptera	Limnephilidae	Hydatophylax		SH				1
Arthropoda	Insecta	Trichoptera	Limnephilidae	Onocosmoecus		OM				1
Arthropoda	Insecta	Trichoptera	Limnephilidae	Psychoglypha		OM				0
Arthropoda	Insecta	Trichoptera	Philopotamidae	Wormaldia	CL	CF	SIT			3
Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropus	CL	PR				6
Arthropoda	Insecta	Trichoptera	Rhyacophilidae	-	CL	PR			50	0
Arthropoda	Insecta	Trichoptera	Rhyacophilidae	Rhyacophila	CL	PR			50	0

Phylum	Class	Order	Family	Genus	CL	FFG	T/I	LL	%SV	HBI
Arthropoda	Insecta	Trichoptera	Uenoidea	-	CL	SC				0
Arthropoda	Insecta	Trichoptera	Uenoidea	Neophylax	CL	SC				3
	Insecta	Trichoptera	Uenoidea	Neothremma	CL	SC	I			0
Arthropoda	*Insecta*	*Thysanoptera*	-	-		*UN*				
Arthropoda	*Insecta*	*Hymenoptera*	-	-		*PA*				
Arthropoda	*Insecta*	*Hemiptera*	-	-		*UN*				
Arthropoda	*Insecta*	*Hemiptera*	*Aphididae*	-		*UN*				
Arthropoda	Insecta	Hemiptera	Corixidae	-		UN				8
Arthropoda	Insecta	Lepidoptera	-	-		UN				5
NON-INSECTS										
Arthropoda	*Arachnoida*	*Hydracarina*	-	-		*PA*				
Arthropoda	Crustacea	Amphipoda	-	-		CG	ST			4
Arthropoda	Crustacea	Cladocera	Chydoridae	-		CF				8
Arthropoda	Crustacea	Decapoda	-	-		OM		LL	100	6
Arthropoda	Crustacea	Copepoda	-	-		CG				8
	Crustacea	*Harpacticoida*	-	-						
	Crustacea	*Cyclopoida*								
Arthropoda	Crustacea	Isopoda	-	-		CG				8
Arthropoda	*Crustacea*	*Mysis*	-	-						
Arthropoda	Crustacea	Ostracoda	-	-		CG				8
Annelida	Hirudinea	-	-	-		PR				10
Annelida	Oligochaeta	-	-	-		CG	ST		50	8
Coelenterata	*Hydrazoa*	-	-	-		*PR*	*T*			
Mollusca	Gastropoda	-	-	-		SC	ST			7
Mollusca	Pelecypoda	-	-	-		CF			75	
Mollusca	Pelecypoda	Veneroida	Sphaeriidae	-		CG			50	8
Mollusca	Pelecypoda	Unionoida	Unionacea	-		CF		LL	100	
Nematoda	-	-	-	-		PA				5
Platyhelminthes	Turbellaria	-	-	-		CG				4

Stream	Sampling Year	EMS #	Latitude** dd mm'ss.sssss	Longitude** dd mm'ss.sssss	Elevation** (m)	ASCI Habitat Rating	Average Bug Count	Total # of Taxa	E Taxa	P Taxa	T Taxa	% dom (1 taxa)	% Mayflies	IBI Score	FBI Score
Allport	1999	E238640				129	670.3	20.7	4.3	6	2.7	27.1%	40.0%	19	3.69
Barren	1999	E238626				123.5	377.7	16.7	4.7	2.7	2	29.9%	20.3%	16	3.92
Barren	2001*	E238626	54 27' 48.52101	126 31' 29.85348	622.33	138	1375.7	21.7	5	4.7	2.7	23.6%	26.1%	19	3.99
Bessemer	1999	E238642					1597.7	24	0	5	5	35.7%	35.3%	16	4.08
Bob	1999	E238623				154	587.3	13.7	4.3	2	1	53.4%	32.7%	14	4.65
Bulkley @ Craker	1999	E238800				131.5	300.7	13.3	4	3	1.7	42.8%	35.2%	14	3.79
Bulkley Knockholt	1999	E238643				157	439.7	17.7	4.7	4.7	2	36.0%	49.3%	17	3.95
Bulkley @ Morice	1999	E400296				141.5	339.7	17	4.7	4.3	2.3	59.9%	17.9%	17	4.77
Buck @ Mall	1999	E238624				123.5	379.7	13	3.3	3.3	1	52.7%	14.8%	14	5.13
Buck @ Mall	2001*	E238624	54 23' 58.09739	126 39' 16.05674	598.30	105	3707.3	26.3	5	5	6	43.0%	31.8%	21	4.28
Buck 12km	1999	E238622				159.5	289.7	13.3	3.3	2	2.3	50.0%	27.8%	14	4.66
Buck Confluence	1999	E238625				134.5	378.3	15.3	4	2.7	2.7	66.0%	13.8%	14	5.37
Byman d/s	1999	E238629				122	198.3	14	3.7	3	1.7	33.8%	27.9%	15	4.72
Byman d/s	2001*	E238629	54 31' 08.73688	126 25' 17.72062	653.58	133.5	3279	26.3	4.7	5.3	4.3	30.8%	48.8%	21	4.08
Byman Reference	1999	E238629				162.5	245	17.3	5	3	1.3	45.5%	32.2%	16	4.61
Cesford @ Topley	1999	E238635				111	908.7	22.7	4.3	3.3	2.3	52.9%	15.7%	17	4.61
Cesford @ Topley	2001*	E238635	54 30' 29.33003	126 18' 27.64964	674.25	100	4152	24	4.3	4	2.3	72.1%	8.6%	18	5.8
Cesford Reference	1999	E238633				169	1683	20	3.7	3.3	2.7	79.6%	7.4%	16	5.53
Cesford u/s	1999	E238634				130	482	18.7	3.7	3.3	2	29.8%	29.4%	16	3.06
Crow	1999	E238638				139	803.3	21.7	4.7	3.7	3.3	32.8%	53.4%	19	4.24
Crow	2001*	E238638	54 22' 18.76027	126 11' 55.22255	787.20	132	1849.3	24.3	4.7	5	4	27.7%	56.1%	20	3.79
Deep d/s	2001*	E245200	54 35' 29.80336	126 50' 15.88901	554.32	118	3789.3	25	3	6	4	65.9%	20.8%	17	5.6
Deep reference	2001*	E245201	54 36' 47.00813	126 47' 53.02075	673.04	174.5	1722.7	20	2	4	3.3	27.4%	51.0%	17	3.91
Foxy bm	1999	400764				181	534.7	20.7	4.3	5	2	35.7%	59.7%	18	3.17
Foxy @ Maxan	1999	E238636				170	748.7	28	4	6	3.7	30.4%	40.8%	19	4.47
Foxy @ Maxan	2001*	E238636	54 18' 51.70557	126 07' 36.97893	814.84	147	4551	22.3	4	5	2.7	41.3%	29.5%	17	5.27
Foxy u/s	1999	400763					262.7	29	5	5	5	31.3%	44.1%	21	3.71
Johnny David	1999	E238630				116	436	19	4.3	3	2.7	45.1%	25.8%	17	5.03
McQuarrie d/s	1999	E238627				119	350.7	16.3	4.7	3.3	0.3	44.3%	30.6%	16	4.24
McQuarrie d/s	2001*	E238627	54 30' 51.66878	126 27' 49.39270	641.56	116	3071.7	24.7	4.7	4.7	2.3	51.1%	31.7%	18	4.86
McQuarrie Reference	1999	E238628				147	381	16.3	4.3	2.3	2.7	30.3%	45.9%	17	4.26
Richfield @ CN	1999	E238645				144.5	1269.3	25	4	4.7	2.7	34.0%	19.1%	18	4.64
Richfield @ CN	2001*	E238645	54 30' 34.71685	126 20' 31.06647	660.31	153	1749.3	26	4.7	5.3	2.3	41.9%	54.8%	20	3.98
Richfield above Hwy 16	1999	E238631				131	369	15	3.7	3	1.7	47.9%	22.9%	14	4.89
Richfield above Hwy 16	2001*	E238631	54 30' 59.43397	126 20' 12.54213	686.02	144.5	683.7	25.3	4	4.3	3.3	41.8%	26.7%	19	4.96
Richfield u/s	1999	E238632				154	454.3	15.7	4.3	3.3	2.7	48.9%	30.3%	17	4.73
Arnett	2001*	E245188	54 35' 24.49620	127 25' 57.55784	734.81	188.5	686	18.3	4	4.7	2.7	29.7%	36.4%	17	3.69
Driftwood Reference	2001*	E245179	54 51' 16.09032	126 59' 28.39839	852.33	181	1135	21.3	3.7	4.7	2.7	29.1%	40.3%	18	3.41
Lemieux d/s	2001*	E245180	54 38' 40.92212	126 53' 05.75894	567.30	119	979	13.7	3	2.3	0.7	42.2%	44.8%	13	4.38
Lemieux u/s	2001*	E245781	54 39' 47.44288	126 50' 04.23005	715.10	169	5436	22.3	5	4.3	2.3	71.2%	13.4%	18	5.11
Reiseter East	2001*	E242682	54 56' 00.88811	127 06' 44.66126	702.84	185	844	21.7	3.7	5.3	3.3	33.4%	31.3%	18	3.84
Reiseter West	2001*	E242681	54 56' 02.62588	127 06' 47.79733	708.37	178	848	24	3.7	5.3	3.3	23.7%	34.7%	18	3.4
Robin	2001*	E245182	54 37' 31.12014	126 52' 01.46388	560.09	70	4390	19.3	4.3	3	1.7	70.0%	17.7%	15	5.42

* Stream sampling area tripled in 2001 compared to 1999.

**Latitude, Longitude, and elevation were determined using a handheld GPS unit (NAD 83).

KEY

E taxa = Ephemeroptera Taxa
P Taxa = Plecoptera Taxa
T Taxa = Trichoptera Taxa
LL Taxa = Long Lived Taxa

Stream	Sampling Year	EMS #	ASCI Habitat Rating	Ave. Bug Count (w/o order)	Ave. Bug Count (all)	Total # of Taxa	E Taxa	P Taxa	T Taxa	LL Taxa	Intol Taxa	% Tol	% Predators
Allport	1999	E238640	129	670.3	768	24.3	6	6	2.7	3	0	0.00%	11.90%
Barren	1999	E238626	123.5	377.7	545.7	18.3	5.3	2.7	2	2	0	0.00%	20.70%
Barren	2001*	E238626	138	1375.7	1650	25.7	7	5.3	3	3	3	0.00%	15.10%
Bessemer	1999	E238642		1597.7	1636	19.7	2.7	3.7	2	1	2	0.80%	1.10%
Bob	1999	E238623	154	587.3	693.7	16.3	5.3	2	1	1	0	0.00%	9.00%
Bulkley @ Craker	1999	E238800	131.5	300.7	341	14.3	4	3	1.7	2	0	1.90%	6.50%
Bulkley Knockholt	1999	E238643	157	439.7	458.7	19	5.7	5	2.7	3	2	0.20%	13.70%
Bulkley @ Morice	1999	E400296	141.5	339.7	390.3	18	4.7	4.3	2.3	2	0	0.00%	5.80%
Buck @ Mall	1999	E238624	123.5	379.7	500.3	14.3	3.7	3.3	1	3	0	0.00%	6.70%
Buck @ Mall	2001*	E238624	105	3707.3	4047.7	29	5.3	5	6.3	5	2	2.80%	4.10%
Buck 12km	1999	E238622	159.5	289.7	356.3	14.3	3.3	2	2.3	1	0	0.00%	11.20%
Buck Confluence	1999	E238625	134.5	378.3	605.3	16.3	4	2.7	2.7	3	0	0.00%	9.70%
Byman d/s	1999	E238629	122	198.3	269.3	14.7	4	3	1.3	0	0	0.00%	12.80%
Byman d/s	2001*	E238629	133.5	3279	3982	28.7	5.7	5.3	5.3	4	4	0.10%	6.40%
Byman Reference	1999	E238629	162.5	245	285.3	19.3	5.7	3	1.3	4	2	0.30%	7.80%
Cesford @ Topley	1999	E238635	111	908.7	966.3	25.3	6	3.7	2.3	1	1	0.09%	15.00%
Cesford @ Topley	2001*	E238635	100	4152	4355.7	25.3	6	4.3	2.3	1	1	0.00%	3.10%
Cesford Reference	1999	E238633	169	1683	1818.3	21.3	4	3.3	2.7	1	0	0.00%	4.10%
Cesford u/s	1999	E238634	130	482	812	20.3	4.7	3.3	2	1	0	0.00%	30.70%
Crow	1999	E238638	139	803.3	882	27.3	7.3	3.7	3.3	3	1	0.41%	5.10%
Crow	2001*	E238638	132	1849.3	1991.7	27	6.7	5	4	5	1	0.80%	11.60%
Deep d/s	2001*	E245200	118	3789.3	4365.7	31.3	6.3	6.3	4.7	6	3	0.10%	3.00%
Deep reference	2001*	E245201	174.5	1722.7	1845.3	26	6	4.3	3.7	3	1	0.20%	11.70%
Foxy bm	1999	400764	181	534.7	558.7	24.7	6.3	5	2	6	2	0.10%	17.30%
Foxy @ Maxan	1999	E238636	170	748.7	815.3	31.7	6.7	6	3.7	6	0	0.43%	7.00%
Foxy @ Maxan	2001*	E238636	147	4551	4825.3	24.7	5.7	5	2.7	6	4	0.10%	4.90%
Foxy u/s	1999	400763		262.7	444	18	5.3	3.7	1.7	2	0	0.00%	12.00%
Johnny David	1999	E238630	116	436	628.3	21	5	3	2.7	2	0	0.00%	7.60%
McQuarrie d/s	1999	E238627	119	350.7	361	17.3	4.7	3.3	0.3	2	0	0.00%	7.30%
McQuarrie d/s	2001*	E238627	116	3071.7	3253.3	27.3	5.3	5	2.7	2	1	0.20%	4.80%
McQuarrie Reference	1999	E238628	147	381	448.3	18.3	5.3	2.3	2.7	3	0	0.00%	9.70%
Richfield @ CN	1999	E238645	144.5	1269.3	1374.3	30	5.7	4.7	3.3	5	0	0.20%	8.70%
Richfield @ CN	2001*	E238645	153	1749.3	2209.7	27.7	5.7	5.3	2.7	5	0	0.10%	13.40%
Richfield above Hwy 16	1999	E238631	131	359	392.3	16.7	4.3	3	1.7	3	0	0.00%	9.20%
Richfield above Hwy 16	2001*	E238631	144.5	683.7	719.7	28	6	4.7	3.7	4	3	0.10%	6.70%
Richfield u/s	1999	E238632	154	454.3	487	16.3	4.3	3.3	2.7	2	1	0.00%	3.50%
Arnett	*2001**	*E245188*	*188.5*	*686*	*757.7*	*21*	*6.3*	*4.7*	*2.7*	*2*	*5*	*0.10%*	*9.70%*
Driftwood Reference	*2001**	*E245179*	*181*	*1135*	*1553.7*	*25.7*	*6*	*5.3*	*2.7*	*1*	*3*	*0.30%*	*15.30%*
Lemieux d/s	*2001**	*E245180*	*119*	*979*	*1149*	*15.3*	*3*	*2.3*	*0.7*	*2*	*1*	*0.00%*	*2.60%*
Lemieux u/s	*2001**	*E245781*	*169*	*5436*	*5549.3*	*28.7*	*8*	*5.3*	*2.3*	*3*	*4*	*0.10%*	*5.40%*
Reiseter East	*2001**	*E242682*	*185*	*844*	*945.3*	*25.3*	*6*	*6.3*	*3.3*	*2*	*4*	*0.00%*	*5.90%*
Reiseter West	*2001**	*E242681*	*178*	*848*	*975.7*	*26.3*	*5*	*5.3*	*3.3*	*2*	*3*	*0.10%*	*12.40%*
Robin	*2001**	*E245182*	*70*	*4390*	*4488*	*20.3*	*4.3*	*3*	*1.7*	*2*	*1*	*0.10%*	*2.40%*

* Stream sampling area tripled in 2001 compared to 1999.

KEY
E taxa = Ephemeroptera Taxa
P Taxa = Plecoptera Taxa
T Taxa = Trichoptera Taxa
LL Taxa = Long Lived Taxa

Stream	Sampling Year	EMS #	Clinger Taxa	% dom (3 taxa)	% Oligochaetes	% Mayflies	% Sediment Tolerant	% Sediment Intolerant	% Dipterans and non-insects	% Clingers	# Diptera taxa	% Dipterans
Allport	1999	E238640	9	54%	0.1%	40.0%	0.1%	0.3%	19.7%	39.7%		
Barren	1999	E238626	7.7	56%	0.0%	20.3%	0.2%	3.5%	21.0%	40.0%		
Barren	2001*	E238626	11.3	47%	0.0%	26.1%	1.6%	0.3%	26.9%	33.5%	5.3	22.4%
Bessemer	1999	E238642	5.3	80%	1.4%	35.3%	1.5%	10.3%	28.0%	12.7%		
Bob	1999	E238623	6.7	71%	0.0%	32.7%	0.0%	0.0%	48.8%	32.0%		
Bulkley @ Craker	1999	E238800	7.3	69%	0.7%	35.2%	0.8%	0.0%	47.7%	42.0%		
Bulkley Knockholt	1999	E238643	9	58%	0.0%	49.3%	0.6%	0.5%	30.1%	62.6%		
Bulkley @ Morice	1999	E400296	8	79%	0.2%	17.9%	0.3%	0.0%	56.4%	21.0%		
Buck @ Mall	1999	E238624	7	78%	0.0%	14.8%	0.0%	3.5%	55.5%	23.0%		
Buck @ Mall	2001*	E238624	13	69%	0.9%	31.8%	1.6%	2.9%	50.4%	35.0%	7.3	40.5%
Buck 12km	1999	E238622	7.3	69%	0.2%	27.8%	0.3%	1.4%	50.6%	33.8%		
Buck Confluence	1999	E238625	8.3	84%	0.0%	13.8%	0.0%	4.9%	51.1%	17.1%		
Byman d/s	1999	E238629	4.7	64%	2.9%	27.9%	3.9%	0.0%	43.1%	34.0%		
Byman d/s	2001*	E238629	11.3	58%	0.3%	48.8%	0.7%	3.1%	25.6%	46.9%	7.3	17.6%
Byman Reference	1999	E238629	6.7	62%	3.2%	32.2%	3.9%	0.6%	49.7%	27.5%		
Cesford @ Topley	1999	E238635	10	69%	0.9%	15.7%	1.0%	0.3%	58.4%	29.4%		
Cesford @ Topley	2001*	E238635	9.7	83%	7.2%	8.6%	7.9%	1.4%	82.5%	8.2%	4.3	71.7%
Cesford Reference	1999	E238633	7.7	89%	0.4%	7.4%	0.6%	0.1%	81.7%	7.6%		
Cesford u/s	1999	E238634	8.3	70%	0.1%	29.4%	0.2%	1.7%	29.5%	59.1%		
Crow	1999	E238638	12	65%	0.1%	53.4%	0.4%	0.3%	31.3%	39.6%		
Crow	2001*	E238638	12.3	58%	0.1%	56.1%	0.5%	0.8%	24.1%	50.2%	5.7	20.7%
Deep d/s	2001*	E245200	14	76%	0.0%	20.8%	0.2%	0.5%	70.4%	14.8%	7.3	64.7%
Deep reference	2001*	E245201	11.3	60%	0.1%	51.0%	0.5%	2.3%	23.6%	29.8%	7.3	18.4%
Foxy bm	1999	400764	11	54%	0.2%	59.7%	0.3%	0.2%	11.6%	41.1%		
Foxy @ Maxan	1999	E238636	13	62%	0.1%	40.8%	0.4%	0.3%	41.1%	30.1%		
Foxy @ Maxan	2001*	E238636	10	75%	0.1%	29.5%	0.2%	0.1%	61.0%	22.8%	7.3	56.4%
Foxy u/s	1999	400763	8.3	57%	0.2%	44.1%	0.4%	0.0%	22.4%	44.4%		
Johnny David	1999	E238630	9.3	68%	0.1%	25.8%	0.2%	1.3%	42.0%	24.9%		
McQuarrie d/s	1999	E238627	5.7	71%	0.3%	30.6%	0.5%	0.1%	54.0%	33.8%		
McQuarrie d/s	2001*	E238627	9.7	70%	1.5%	31.7%	1.9%	0.3%	59.0%	27.0%	8.0	50.8%
McQuarrie Reference	1999	E238628	8.3	54%	1.2%	45.9%	1.4%	3.7%	31.7%	44.2%		
Richfield @ CN	1999	E238645	11.7	64%	0.9%	19.1%	1.5%	2.8%	50.2%	51.8%		
Richfield @ CN	2001*	E238645	10	64%	0.1%	54.8%	1.4%	1.2%	26.1%	57.1%	6.7	21.7%
Richfield above Hwy 16	1999	E238631	7.7	72%	0.3%	22.9%	0.3%	1.5%	57.1%	37.3%		
Richfield above Hwy 16	2001*	E238631	11.7	60%	0.5%	26.7%	2.0%	0.4%	60.0%	26.2%	6.3	51.2%
Richfield u/s	1999	E238632	7.7	73%	0.0%	30.3%	0.0%	0.2%	49.1%	23.8%		
Arnett	*2001**	*E245188*	*16.7*	*49%*	*0.3%*	*36.4%*	*0.4%*	*0.6%*	*33.5%*	*52.8%*	*4.3*	*31.1%*
Driftwood Reference	*2001**	*E245179*	*10.7*	*51%*	*0.1%*	*40.3%*	*0.2%*	*0.3%*	*23.0%*	*43.9%*	*5.7*	*19.3%*
Lemieux d/s	*2001**	*E245180*	*3.3*	*82%*	*1.2%*	*44.8%*	*1.9%*	*0.0%*	*41.6%*	*7.5%*	*4.3*	*37.9%*
Lemieux u/s	*2001**	*E245781*	*12.3*	*83%*	*0.1%*	*13.4%*	*0.2%*	*1.4%*	*74.8%*	*13.2%*	*6.0*	*70.1%*
Reiseter East	*2001**	*E242682*	*12.3*	*53%*	*1.3%*	*31.3%*	*2.0%*	*2.8%*	*35.3%*	*33.1%*	*4.3*	*28.1%*
Reiseter West	*2001**	*E242681*	*11*	*52%*	*0.1%*	*34.7%*	*0.5%*	*2.0%*	*20.1%*	*42.9%*	*6.7*	*17.3%*
Robin	*2001**	*E245182*	*6*	*86%*	*3.8%*	*17.7%*	*4.6%*	*0.0%*	*78.0%*	*12.3%*	*5.7*	*70.2%*

* Stream sampling area tripled
in 2001 compared to 1999.

Stream	Sampling Year	EMS #	% Non-insects	% Long-lived	IBI Score	HBI Score
Allport	1999	E238640			44	3.45
Barren	1999	E238626			32	2.75
Barren	2001*	E238626	4.5%	1.2%	44	3.42
Bessemer	1999	E238642			32	4.44
Bob	1999	E238623			26	4.4
Bulkley @ Craker	1999	E238800			32	3.7
Bulkley Knockholt	1999	E238643			44	3.1
Bulkley @ Morice	1999	E400296			26	4.59
Buck @ Mall	1999	E238624			20	4.42
Buck @ Mall	2001*	E238624	9.9%	2.3%	32	4.55
Buck 12km	1999	E238622			28	4.39
Buck Confluence	1999	E238625			20	4.89
Byman d/s	1999	E238629			30	3.5
Byman d/s	2001*	E238629	8.0%	0.4%	46	3.53
Byman Reference	1999	E238629			28	4.19
Cesford @ Topley	1999	E238635			28	4.58
Cesford @ Topley	2001*	E238635	10.8%	0.2%	16	5.65
Cesford Reference	1999	E238633			18	5.41
Cesford u/s	1999	E238634			36	3.37
Crow	1999	E238638			34	4.22
Crow	2001*	E238638	3.5%	6.4%	44	3.63
Deep d/s	2001*	E245200	5.7%	0.6%	24	4.93
Deep reference	2001*	E245201	5.2%	0.6%	40	3.54
Foxy bm	1999	400764			46	3.5
Foxy @ Maxan	1999	E238636			36	3.86
Foxy @ Maxan	2001*	E238636	4.6%	0.8%	32	4.92
Foxy u/s	1999	400763			38	3.53
Johnny David	1999	E238630			30	4.3
McQuarrie d/s	1999	E238627			26	3.15
McQuarrie d/s	2001*	E238627	8.2%	0.4%	32	4.57
McQuarrie Reference	1999	E238628			38	3.17
Richfield @ CN	1999	E238645			32	4.46
Richfield @ CN	2001*	E238645	4.5%	0.7%	44	3.66
Richfield above Hwy 16	1999	E238631			26	4.14
Richfield above Hwy 16	2001*	E238631	8.7%	0.6%	32	4.35
Richfield u/s	1999	E238632			28	4.52
Arnett	*2001**	*E245188*	*2.5%*	*0.4%*	*48*	*2.79*
Driftwood Reference	*2001**	*E245179*	*3.8%*	*0.2%*	*48*	*2.43*
Lemieux d/s	*2001**	*E245180*	*3.8%*	*0.2%*	*22*	*4.13*
Lemieux u/s	*2001**	*E245781*	*4.6%*	*1.1%*	*26*	*5.22*
Reiseter East	*2001**	*E242682*	*7.1%*	*0.3%*	*42*	*3.41*
Reiseter West	*2001**	*E242681*	*2.8%*	*0.5%*	*48*	*2.85*
Robin	*2001**	*E245182*	*7.8%*	*0.0%*	*12*	*5.39*

* Stream sampling area tripled in 2001 compared to 1999.