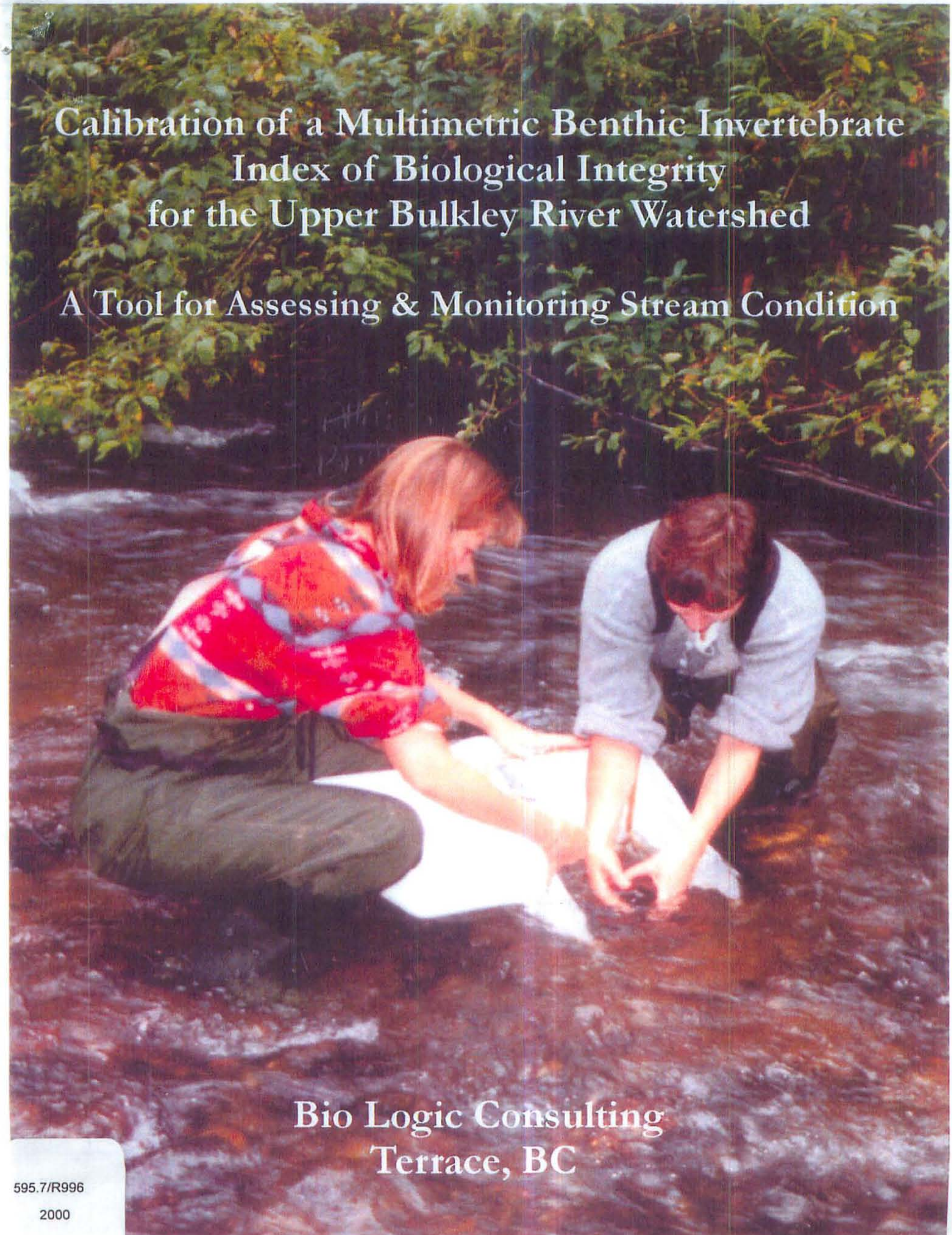
Calibration of a Multimetric Benthic Invertebrate Index of Biological Integrity for the Upper Bulkley River Watershed

A Tool for Assessing & Monitoring Stream Condition



Bio Logic Consulting
Terrace, BC

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April, 2000

Prepared by:

Shauna Rysavy, R.P. Bio
Bio Logic Consulting
Terrace, BC

Prepared for:

Community Futures Development Corporation of Nadina
Houston, BC
on behalf of the
Upper Bulkley River Roundtable

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Executive Summary

Degradation of fisheries resources and water quality are a top concern in Northwestern British Columbia. Many government and non-government programs have been initiated in the last ten years to inventory, assess and rehabilitate habitat for salmonids. Although hundreds of thousands of dollars have been spent on restoration of salmonid habitat, few of the restoration programs have a monitoring program in place to evaluate the short-term or long-term effectiveness of the project. In cases where monitoring programs may be in place, they often emphasize measuring physical habitat parameters (*e.g.* amount of large woody debris) or chemical water quality parameters (*e.g.* toxic substances or alkalinity) to estimate the capacity of the habitat to support salmonids. As there are many factors which can affect fish survival, some of which may not even be known yet, clearly there is a need for a monitoring tool which directly measures the condition of the aquatic life in a stream.

There are many factors to consider when choosing a biological monitoring tool. It must be inexpensive, easy to use, verifiable, and sensitive to changes in environmental conditions (Yoder, 1995). Decreasing financial and government human resources available for monitoring and assessment programs dictate that the monitoring program must be one which community members and volunteers have the ability to implement.

For years, benthic invertebrates have been used for monitoring and assessment of river ecosystems. Over the last twenty years, benthic invertebrate multimetric indices have gained recognition as sensitive and effective indicators of stream condition. A multimetric approach is one where a number of single community metrics (or attributes) are combined into a final index. Benthic invertebrates are ubiquitous, relatively sedentary, and can be easily sampled by community groups, making them a good choice for bio-monitoring. There have been many multimetric approaches to assessing stream condition using invertebrates, including the Alaska Stream Condition Index (Major et al., 1998), the Coast Plain Macroinvertebrate Index (Maxted et al., 1999), a biotic index for the southeastern USA (Lenat, 1993), the Invertebrate Community Index (DeShon, 1995) and the Index of Biological Integrity (Karr, 1981). The Index of Biological Integrity (IBI) is arguably the most widely used and effective multimetric index of stream condition (Simon and Lyons, 1995).

The purpose of this project was to calibrate the IBI, which has already been proven effective, for the upper Bulkley River watershed. The IBI was calibrated by testing the response of the individual metrics across a gradient of human influence, from uninfluenced to heavily influenced, and by establishing expectations for local streams based on reference (uninfluenced) streams.

Nine metrics which clearly distinguished lightly influenced from heavily influenced streams were chosen for incorporation into the multimetric index and included:

- Taxa richness,
- Ephemeroptera taxa richness,
- Plecoptera taxa richness,
- Trichoptera taxa richness,
- Long-lived taxa richness,
- Intolerant taxa richness,
- % Predators,
- Clinger taxa richness, and
- % Dominance (3 taxa).

Each stream which was sampled was given a score for each metric. The values for each metric were then summed to provide one final number or index. The index was compared against other local sites which were already scored, and the relative condition of the stream was determined.

This report provides a summary of the procedures and methods used to calibrate the IBI for the upper Bulkley River basin. Calibrating the IBI should be an iterative process, where metrics are re-evaluated as more data becomes available.

Acknowledgements

This project was completed through a partnership between the Community Futures Development Corporation (CFDC) of Nadina, the Office of the Wet'suwet'en Hereditary Chiefs, the Upper Bulkley River Roundtable, and the BC Environment Skeena Region Pollution Prevention Program. Funding was provided through Fisheries Renewal BC and BC Environment.

Many thanks to ***Scott Mackay****, CFDC Nadina Watershed Stewardship Coordinator,* ***Al McCracken****, Upper Bulkley River Roundtable Representative, and* ***Andy Witt****, Morice Forest District Forest Ecosystem Specialist for assisting with stream selection. Thanks to the BC Environment Skeena Region Pollution Prevention Program for funding a portion of the benthic invertebrate taxonomy and enumeration. Thanks to* ***Walter Joseph*** *and* ***Stefan Schug****, of the Office of the Wet'suwet'en Hereditary Chiefs for providing the project with two talented and knowledgeable interns, Annette Fuchs and Ingrid Gilly. Thanks to the Gitxsan Fisheries Council for contributing the invaluable services of Charlie Weget to the project. Thank you to* ***Annette Fuchs, Charlie Weget, Ian Sharpe, Ingrid Gilly, Lisa Westenhofer*** *and* ***Tanya Dykens*** *for persevering joyfully through bad weather and long field days to complete the field work.*

Most of all, thank you to ***James Karr****, for reviewing the proposal, and for invaluable help, advice and encouragement throughout the project.*

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1 Introduction

Degradation of fisheries resources and water quality are a top concern in Northwestern British Columbia. Many government and non-government programs have been initiated in the last ten years to inventory, assess and rehabilitate habitat for salmonids. Although hundreds of thousands of dollars have been spent on restoration of salmonid habitat, few of the restoration programs have a monitoring program in place to evaluate the short-term or long-term effectiveness of the project. In cases where monitoring programs may be in place, they often emphasize measuring physical habitat parameters (*e.g.* amount of large woody debris) or chemical water quality parameters (*e.g.* toxic substances or alkalinity) to estimate the capacity of the habitat to support salmonids. As there are many factors which can affect fish survival, some of which may not even be known yet, clearly there is a need for a monitoring tool which directly measures the condition of the aquatic life in a stream.

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The purpose of this project was to calibrate the IBI for the upper Bulkley River watershed. The IBI was calibrated by testing the response of the individual metrics across a gradient of human influence, from uninfluenced to heavily influenced, and by establishing expectations for local streams based on reference (uninfluenced) streams.

This report provides a summary of the procedures and methods used to calibrate the IBI for the upper Bulkley River basin. Calibrating the IBI should be an iterative process, where metrics are re-evaluated as more data becomes available.

2 Methods

Methods adopted for this project, and also for an IBI calibration project in the Kispiox River watershed (Rysavy, 2000), were kept as consistent as possible with work completed by James Karr (Karr and Chu, 1999).

2.1 Site Selection

The goal of site selection was to choose a set of streams within the Upper Bulkley River watershed with similar broad ecological and natural attributes including stream order, elevation, and gradient. Scott Mackay and Al McCraken of CFDC Nadina, Ian Sharpe of BC Environment, and a number of community members were consulted during the stream selection process to ensure the best local knowledge of streams was used. Local knowledge, combined with the results of completed assessments and past work (particularly Mackay *et al.*, 1998) were used to identify a group of streams with a diverse range of human influence, from little or no influence to highly influenced. The intention was to include the best and worst available streams within the upper Bulkley River watershed in the data set. All of the streams selected were non-glacial (clear) streams.

Selected streams were 2nd order or greater, 1950 to 3200 feet in elevation (determined from 1:50,000 NTS maps), relatively low gradient, and within the Sub-Boreal Spruce (SBS) biogeoclimatic zone (Banner *et al.*, 1993). Twenty-three potential assessment sites were chosen based on the easiest access. Three sites on the Bulkley River were assessed as well, although IBI calibration was not intended for this larger stream size. Assessment sites and locations are presented in Figure 1 and listed in Table 1.

Table 1: List of stream sites and locations within the upper Bulkley River basin.

Stream Site	Location
Ailport Creek	Upstream of the Highway 16 crossing
Barren Creek	Upstream of the Highway 16 crossing
Bob Creek	Upstream of the confluence with Buck Creek
Buck Creek @ 12 km	Upstream of the 12km bridge crossing
Buck Creek @ Bulkley Conf.	Upstream of the confluence with the Bulkley River
Buck Creek @ Mall	Adjacent to the Houston Shopping Mall
Bulkley River @ Craker	Upstream of the old Craker Rd. bridge
Bulkley River @ Knockholt	Downstream of the Knockholt bridge
Bulkley River @ Morice Confl.	Upstream of the Highway 16 bridge crossing
Byman Creek Downstream	Upstream of the Highway 16 crossing
Byman Creek Ref. or Upstream	Upstream of the North Road crossing
Cesford Creek Downstream	Upstream of the Highway 16 crossing
Cesford Creek Reference	Upstream of the transformer station, below the old bridge
Cesford Creek Upstream	Upstream of the Granisle Highway crossing
Crow Creek	Upstream of the Maxan Creek FSR Crossing
Foxy Creek @ Maxan	Upstream of the confluence with Maxan Creek
Foxy Creek below mine	Downstream of the mine, below confluence with Berzelius Creek
Johnny David Creek	Upstream of the Highway 16 crossing
McQuarrie Creek Downstream	Upstream of the Highway 16 crossing
McQuarrie Creek Ref. or Upstream	Upstream of the North Road crossing
Richfield Creek @ CN	Upstream of the CN Rail crossing
Richfield Creek Downstream	Upstream of the Highway 16 crossing
Richfield Creek Upstream	Upstream of the Granisle Highway crossing

In early August, potential assessment sites were visited to assess access and wadability. Those sites which were too large to wade, too low gradient, or too difficult to access were removed from the list.

2.2 Field Methods

Benthic invertebrate communities generally vary greatly from season to season and Karr and Chu (1999) recommend calibrating the IBI for one period in the year. Late summer, early fall was chosen as the sampling period for the Bulkley IBI which is consistent with the period used in the Pacific Northwestern United States (Karr and Chu, 1999). As flows are usually lower at the end of summer, and stream temperatures are high, this is an ideal period for impact assessment, and in terms of safety and stream wadability. Following a one day training workshop which provided participants with an introduction to sampling and habitat assessment techniques, sites were sampled during a five day period which began August 23rd, 1999. Each site was assessed and sampled by a team consisting of a biologist and a trainee or assistant biologist. Biologists for the project included Shauna Rysavy, Tanya Dykens, Lisa Westenhofer and Ian Sharpe. Assistant biologists included Charlie Weget, Annette Fuchs and Ingrid Gilly. It was intended to complete the sampling during a dry period, but a rainstorm occurred on the second day of sampling. Rainfall was not great enough to cause a noticeable increase in flows, and sampling was continued. To minimize year to year variability, sampling in future years should occur over a dry period between August 15th and September 15th. If weather allows, the last week of August should be ideal in terms of meeting requirements for low flow and avoiding spawning fish.

Field methods were adopted to meet Provincial sampling standards (Cavanagh *et al.*, 1997) and were consistent with methods used by Karr and Chu (1999). Three samples were collected in the best natural riffle at each site, starting at the downstream end of the riffle and moving upstream. All samples were collected in the main stream flow at depths between 10 and 25 cm. An exception to this rule was for samples collected from the Bulkley River, where depths were too great in the main flow, and sample collection was mainly from the edges of riffles. A modified 250 micron Surber sampler with a Dolphin Adaptor cod end was used for sampling (900 cm^2 sample area). Large rocks on top of the smaller substrate within the sampling area were gently removed and set aside in a wash basin. Invertebrates were carefully picked off the large rocks 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 labeled sample jar and 10% buffered formalin was added as a preservative. The three 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 B. 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 (Major and Barbour, 1997). Photographs were taken of the stream, riparian area, substrate size and any potential or actual land use impacts. A selection of site photos are included in Appendix F.

Benthic invertebrate samples were shipped to Fraser Environmental Services in Surrey, BC where invertebrates were identified to genus where possible, and enumerated by taxonomists Linda Curry and Jim Donkersly. Whole samples were analyzed and counted and electronic data was archived in the BC Environment EMS database. Raw benthic invertebrate data is included in Appendix A.

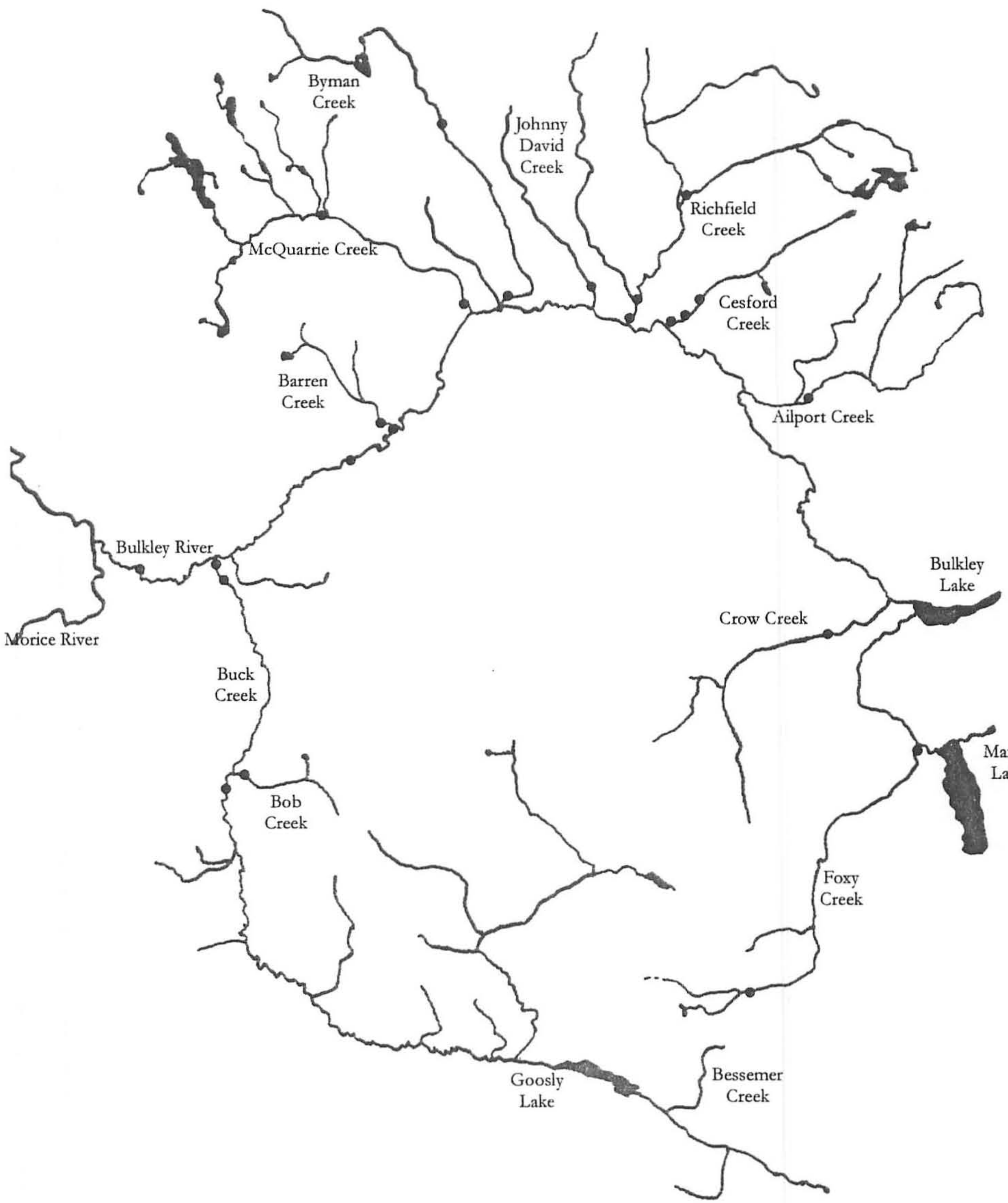


Figure 1: Location of stream sites within study area (not to scale). Streams and lakes not sampled were not included on map. Assessment sites are marked with red circles.

2.3 Metric Definitions & Calculations

Twelve metrics were chosen for testing based on Karr's B-IBI (Karr & Chu, 1999). Included were total taxa richness, Ephemeroptera taxa richness, Plecoptera taxa richness, Trichoptera taxa richness, long-lived taxa richness, intolerant taxa richness, percent tolerant individuals, clinger taxa richness, percent predator individuals, relative abundance of Oligochaetes, relative abundance of Chironomids and percent dominance. Metrics were calculated and defined as described on the Salmonweb internet site which hosts the Northwest Taxa Database (www.salmonweb.org). A brief summary of these definitions and calculations follows.

Total taxa richness was the total number of distinct taxa (groups of like organisms) identified in each replicate sample. For one stream site, where three replicate samples were collected, there would be three counts for this metric. The three replicates were then averaged to give one number 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 total 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 Order Trichoptera respectively.

The number of long-lived taxa has been defined as the number of taxa living at least two to three years in the immature state (Karr and Chu, 1999; www.salmonweb.org). The best available information was used for this metric, summarized from the Northwest Taxa Database (www.salmonweb.org) and Merritt and Cummins (1996), and was not specific to this region. As there are very few taxa which are long-lived in each replicate, the cumulative number of unique long-lived taxa in all three replicates were counted (and not averaged over the three samples).

The number of intolerant taxa was calculated in the same way as the number of long-lived taxa. There are very few taxa which are intolerant, so the cumulative number of unique taxa in all three replicates were counted (and not averaged over the three samples). Intolerance refers to organic pollution and information on which taxa are intolerant was retrieved from the Northwest Taxa Database on the Salmonweb.

Percent tolerant individuals refers to the total number of tolerant individuals counted in each replicate, divided by the total number of individuals counted in that replicate, multiplied by 100. Both intolerant and tolerant taxa metrics refer to the response of benthic invertebrates to organic pollution and this information was retrieved from the Northwest Taxa Database.

The number of clinger taxa refers to the primary behavior exhibited by an invertebrate as documented by Merritt and Cummins (1996). The total number of clinger taxa were counted for each of three replicates, and then averaged to give one final metric score for the site.

Percent predator individuals is the total number of individuals in a replicate belonging to the predator functional feeding group, divided by the total number of individuals in that replicate and multiplied by 100. The percent predator individuals for each of the three replicates was then averaged to give one final metric score.

Relative abundance of Oligochaete individuals was calculated per replicate, as the total number of Oligochaete individuals divided by the total number of individuals, and multiplied by 100. The percent Oligochaete individuals for each of the three replicates was then averaged to give one final metric score. Relative abundance of Chironomids was calculated using the same method.

Percent dominance is the sum of individuals in the three most abundant taxa in that replicate, divided by the total number of individuals in that replicate and multiplied by 100. The percent dominance for each of the three replicates was then averaged to give one final metric score for the site.

A list of taxa, assigned functional feeding group, life history, and tolerance designations has been included in Appendix C. Sample calculations have been posted by the Salmonweb organization on their internet website. Metric scores for streams sampled in the upper Bulkley River watershed are summarized in Appendix D.

3 Selection of Metrics for Incorporation into the Index

3.1 Human Influence

Similar to Fore *et al.* (1996), sites were subjectively classified into three categories: little or no human influence, moderately influenced, or heavily influenced. Types of influence included residential development, agricultural land use, forest harvest (including road density), and range land use. Recreational land use and accessibility were also considered. Classification was based primarily on air photo interpretation, forest development plan interpretation, field notes on assessment of the local area surrounding the sampling site and in-stream condition, and local knowledge.

Only twelve of the twenty-three sites sampled were used for testing the responses of metrics over a gradient of human influence. The twelve sites were chosen based on a greater confidence that the level of human influence could be easily estimated within the watershed using maps and air photos, and that the stream was accurately classified. In some watersheds, there was local knowledge of potential impacts, where the magnitude of the impact was unknown or the source of the potential impact could not be confirmed. A buried mine concentrate discovered near Richfield Creek and an old garbage dump and / or forest fire tower battery dump thought to be within the upper Cesford Creek watershed are two examples of watersheds harbouring potential (unconfirmed in the case of Cesford Creek) impact sources with unknown magnitude. Sites on these streams were excluded from metric testing as it was too difficult to accurately assign a human influence classification to them.

Two uninfluenced sites were identified. The sites were not pristine, but had a greater percentage of forested area and less human influence in the watershed upstream of the site. Foxy Creek at the Maxan Creek confluence and Ailport Creek had the lowest relative human influence within the upstream catchment basin. Although a closed silver mine exists which was a source of acid drainage affecting Foxy Creek in the early 1980s, benthic invertebrate and periphyton monitoring in 1998 found diverse and abundant benthic invertebrate communities at two sites on downstream Foxy Creek, when compared with an upstream reference site (Perrin, 1999). Originally, based on forest development plan map interpretation, McQuarrie Creek upstream of North Road and Byman Creek upstream of North Road were classified as lightly influenced. However, field inspection found indicators of riparian and channel impacts, and the sites were re-classified as moderately influenced.

Moderately influenced sites included those with low to moderate land use within the upstream catchment basin. The majority of streams, except for a few which were identified as having low human influence or high human influence within the watershed, were placed in this category.

Heavily influenced sites included those with moderate to high recreation, agriculture, forest harvesting and / or residential land use within the watershed. McQuarrie Creek downstream, Byman Creek downstream, Buck Creek at the mall and at the Bulkley River Confluence were classified as heavily influenced.

In-stream state and riparian condition were assessed at the time of sampling using key Fish Habitat Assessment Procedure parameters (Johnston and Slaney, 1996) and assessment forms excerpted from the Standard Operating Procedures for the Alaska Stream Condition Index (ASCI) (Major and Barbour, 1997). Competed field forms for each site are in Appendix E. The ASCI in-stream and riparian condition values were calculated for each stream and values for the twelve streams ranged from 116 to 170, where the minimum possible score was 0 and the maximum possible score was 200. These values were plotted against the landscape-scale human influence category assigned to each stream site as shown in Figure 2, in an effort to identify any streams which may have been misclassified. Generally, the average ASCI value decreased with increasing human influence at the landscape scale. One exception was Ailport Creek. Ailport Creek scored a low ASCI value due to poor in-stream and riparian conditions at the assessment site.

However, the majority of the watershed upstream of the site is forested, and overall the watershed was thought to have a low human influence.

In summary, stream sites were classified as either high, moderate or low human influence using air photos and forest development plan maps. Following this rough classification, streams were moved up or down a category based on field assessment of instream and riparian condition, and on local knowledge. Stream sites and associated human influence classifications are listed in Table 2.

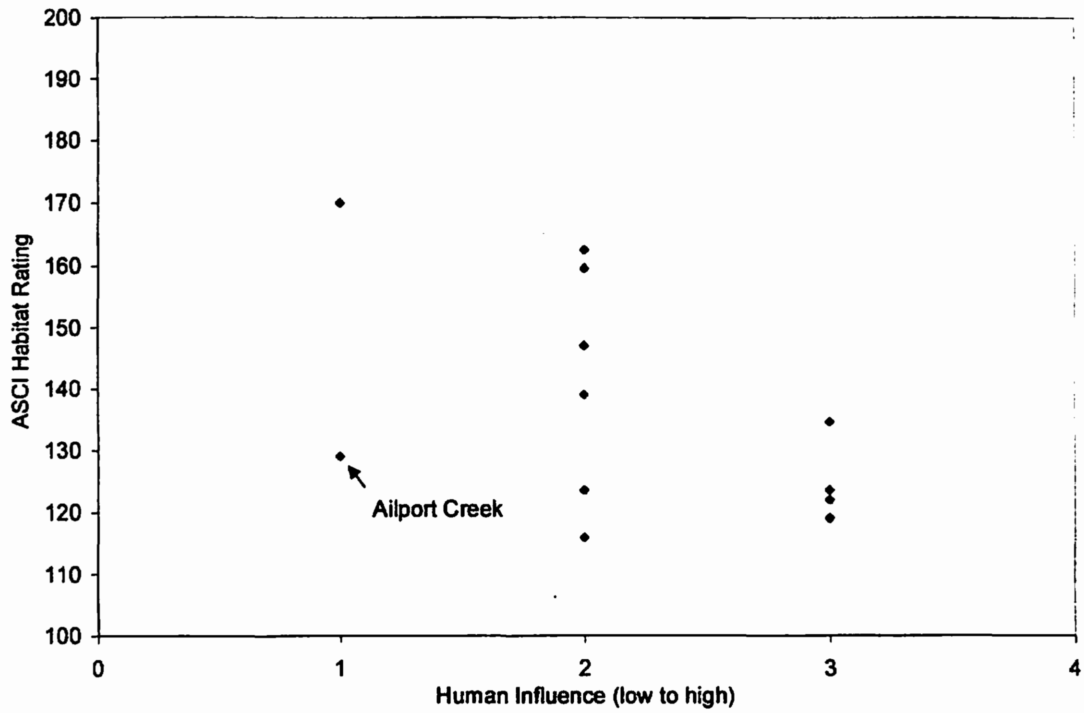


Figure 2: ASCI in-stream and riparian condition value (Major and Barbour, 1997) plotted against landscape scale human influence classification.

Table 2: List of stream sites used for metric testing, location and level of human influence within the upstream catchment basin of the watershed.

Stream	Site Location	Human Influence Classification
Foxy Creek @ Maxan	Foxy Creek above confluence with Maxan Creek	Low
Ailport Creek	Ailport Creek above Highway 16	Low
Crow Creek	Crow Creek upstream of FSR	Moderate
Barren Creek	Barren Creek upstream of Highway 16	Moderate
Byman Creek Upstream	Byman Creek upstream of North Road	Moderate
McQuarrie Creek Upstream	McQuarrie Creek upstream of North Road	Moderate
Buck Creek @ 12 km	Buck Creek upstream of 12km bridge	Moderate
Johnny David Creek	Johnny David Creek upstream of Highway 16	Moderate
Buck Creek @ Bulkley Confluence	Buck Creek upstream of confluence with Bulkley River	High
McQuarrie Creek Downstream	McQuarrie Creek upstream of Highway 16	High
Buck Creek @ Mall	Buck Creek adjacent to Houston Shopping Mall	High
Byman Creek Downstream	Byman Creek upstream of Highway 16	High

3.2 Metric Testing

A metric is one attribute of a sampled benthic invertebrate community (Karr, 1981). A multimetric index combines a number of individual metrics into one score or value, easing comparison of multiple sites. Examples of commonly presented metrics include, but are not limited to, abundance (*e.g.* mean number of individuals per sample or standard measurement unit), functional feeding group metrics (*e.g.* relative abundance of shredders) and richness indices.

The benthic index of biological integrity (B-IBI) is a multimetric index of stream condition developed by James Karr (1981). 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. Each metric is assigned a set of unitless values across the range of results, which indicate whether the results were similar to those expected of an uninfluenced stream, a moderately influenced stream or a highly influenced stream (Karr and Chu, 1999).

Twelve metrics were considered for inclusion in the multimetric index. Candidate metrics and their expected response to increased human influence within the watershed are included in Table 3. The twelve metrics considered have been successfully included in multi-metric IBI's for the Tennessee Valley, southwest Oregon, north coast Oregon, Puget Sound, Japan and northwest Wyoming (Karr & Chu, 1999). Each metric was tested to determine whether the metric varied uniformly across a gradient of human influence in the upper Bulkley Watershed, using simple graphical analysis. A multivariate approach was not employed to test for statistically significant differences between sites. Simple graphical analyses are recommended over complex multivariate statistics as the "*inherent statistical complexity of multivariate analyses distracts biologists from making clear, testable statements to each other and to non-scientists about how the biota responds to human influence*" (Fore *et al.*, 1996). Using simple graphical analyses promotes interpretation and comprehension of monitoring results by community members, volunteers, or other interested stakeholders.

Figure 3 illustrates each metric graphed as a function of human influence within the watershed sampled. Human influence was rated as either 1, 2 or 3 where 1 is uninfluenced, 2 is moderately influenced and 3 is highly influenced. Metrics which successfully differentiated between uninfluenced and highly influenced sites, included total number of taxa, number of Ephemeroptera taxa, number of Plecoptera taxa, number of Trichoptera taxa, number of long lived taxa, number of intolerant taxa, number of clinger taxa and dominance (3 taxa). Although a decreasing trend was discernable, uninfluenced sites were not clearly distinguished from heavily influenced sites using relative abundance of predator individuals. There was no clear pattern across a gradient of human influence for relative abundance of tolerant individuals, relative abundance of Oligochaetes, and relative abundance of Chironomids.

Total taxa richness (number of taxa) clearly declined across a gradient of human influence which was consistent with the expected response. Taxa richness is thought to be a good indicator for most types of pollution with the exception of organic pollution. In streams where organic pollution is present, alien taxa may artificially increase taxa richness at a site (Karr and Chu, 1999). Alien taxa are defined as those which were not originally present in the stream, but were introduced through human activities and land use.

Ephemeroptera taxa richness and Plecoptera taxa richness clearly distinguished uninfluenced sites from heavily influenced sites. Trichoptera taxa richness also distinguished uninfluenced from heavily influenced sites, but the difference was much smaller. Karr and Chu (1999) suggest that decreased taxa richness of these three orders occur due to different types of disturbance within the watershed. Ephemeroptera are generally sensitive to toxic chemical pollutants such as mine wastes, while Plecoptera are thought to be sensitive to sedimentation impacts and removal of riparian vegetation (Karr and Chu, 1999). Figure 3 illustrates that in the upper Bulkley River watershed, Plecoptera taxa richness was the most sensitive to human influence. Moderately and highly influenced streams have similarly low Plecoptera taxa richness scores. The Plecoptera taxa richness result is consistent with other research which has found the metric to be the most sensitive of the three (Karr and Chu, 1999). A similar calibration project conducted in the Kispiox River watershed which focused mainly on forest harvesting impacts, found that Plecoptera taxa richness and Trichoptera taxa richness were sensitive indicators of sedimentation impacts (Rysavy, 2000).

Table 3: Candidate metrics and their expected direction of metric response (from Karr & Chu, 1999)

Category	Metric	Definition	Expected Response to Increasing Human Influence within the Watershed
Taxa Richness & Composition	No. of Taxa	Total number of different taxa	Decrease
	No. of Ephemeroptera Taxa	Total number of different Ephemeroptera taxa	Decrease
	No. of Plecoptera Taxa	Total number of different Plecoptera taxa	Decrease
	No. of Trichoptera Taxa	Total number of different Trichoptera taxa	Decrease
	No. of Long-lived Taxa	Total number of long-lived taxa	Decrease
	% Oligochaetes	Relative abundance of Oligochaetes	Increase
	% Chironomids	Relative Abundance of Chironomids	Increase
Tolerants / Intolerants	No. of Intolerant Taxa	Total number of intolerant taxa	Decrease
	% Tolerants	Relative abundance of tolerant individuals	Increase
Feeding / Habit Metrics	% Predators	Relative abundance of predators	Decrease
	No. of Clinger Taxa	Total.number of clinger taxa	Decrease
Populations Attributes	% Dominance (3 taxa)	Measures the relative abundance of the three most abundant taxa	Increase

The number of long lived taxa and number of intolerant taxa (organic pollution) clearly distinguished between uninfluenced and heavily influenced sites although the range was not large for either metric. Presence of long-lived and intolerant taxa, even in small numbers, are strong indicators of good biological condition (Karr and Chu, 1999).

Relative abundance of tolerant individuals did not clearly discriminate uninfluenced sites from heavily influenced sites. All sites were found to have less than 3.5% tolerant individuals, which was lower than expected for heavily influenced sites. In Puget sound lowland streams and in the Clackamas River basin in Oregon, this metric was included in an IBI as a successful indicator of human influence (J. Karr, pers. comm., March 17, 2000). The expectation for sites with good biological condition in those regions, is for less than 27% tolerant individuals, with expectations of higher values at more degraded sites. This suggests that the metric has low sensitivity, as it has not responded to levels of human influence present in the upper Bulkley River basin streams. However, based on the success of this metric in other areas, it may become more useful if stream conditions decline in the upper Bulkley River basin. This metric should be re-evaluated after further data has been collected in the upper Bulkley River basin streams.

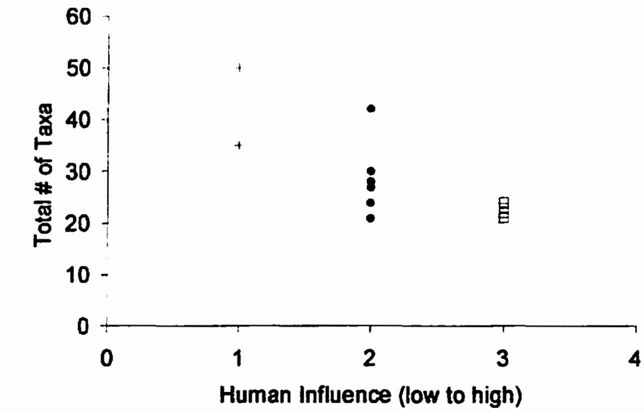
Two feeding and behavior metrics were included for testing: relative abundance of predators and the number of clinger taxa. Declining clinger taxa richness (and relative abundance of clingers) has been found to be an effective indicator of stream degradation and has been included in several benthic invertebrate multimetric indices (Karr and Chu, 1999; Maxted *et al.*, 1999). Clinger taxa richness clearly differentiated between uninfluenced and heavily influenced sites within the upper Bulkley River basin. The results for the heavily influenced streams were clumped together, suggesting high sensitivity to human influence and low variability.

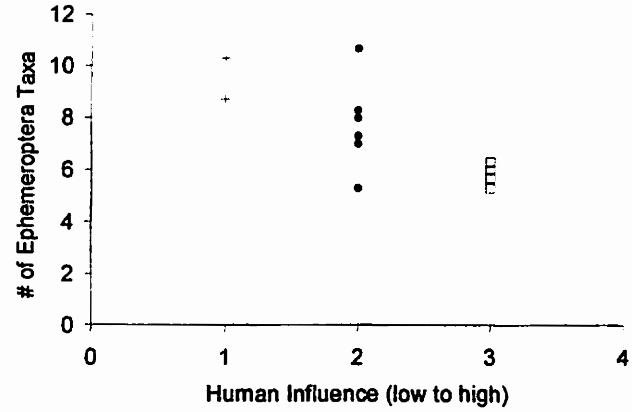
As predicted, relative abundance of predators decreased across the gradient of human influence. Although the metric did not clearly separate all uninfluenced sites from heavily influenced sites, it was included in the IBI based on past performance (Karr and Chu, 1999) as a successful indicator of biological integrity in the Tennessee Valley, Northcoast Oregon, and northwest Wyoming. When additional data has been collected, this metric should be re-evaluated.

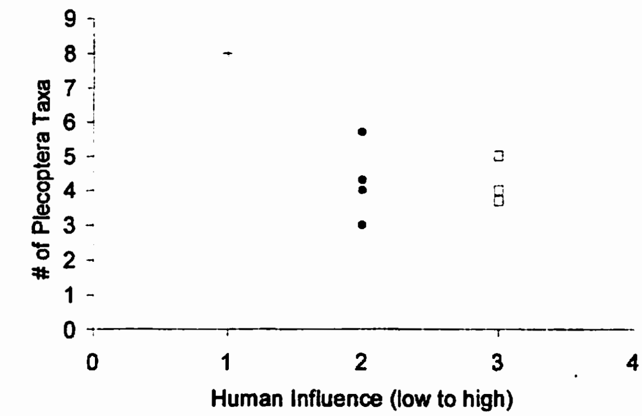
Feeding and behavior information for each taxon was found in Merritt and Cummins (1996). Other feeding metrics include relative abundance of scrapers, shredders, filter feeders, gatherers, and omnivores, and the number of taxa within a specific feeding group. Scrapers and other specialized feeders are thought to be sensitive to human influence and more abundant in uninfluenced streams (Major et al., 1998). However, many of these other metrics have been found to vary unpredictably with increasing human influence within a watershed, or to vary unpredictably year to year (Fore *et al.*, 1996).

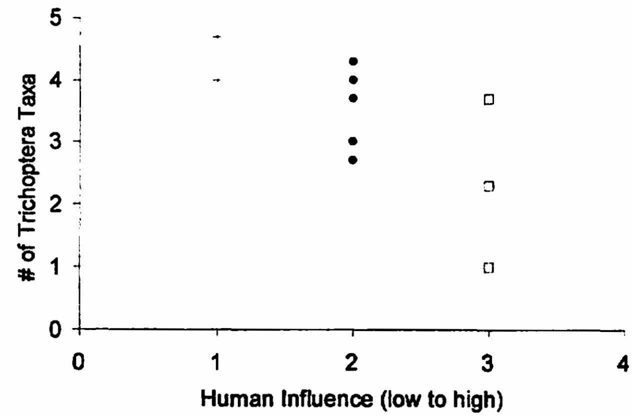
Dominance of three taxa increased over the gradient of human influence and distinguished uninfluenced sites from heavily influenced sites.

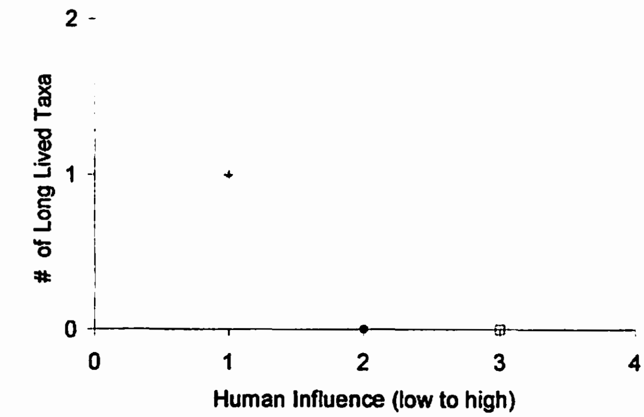
Neither relative abundance of Chironomids nor relative abundance of Oligochaetes differentiated between uninfluenced and heavily influenced sites. Neither metric was included in the upper Bulkley IBI.

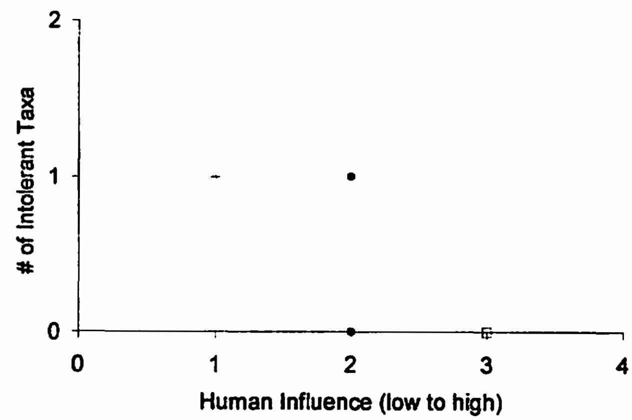

Total # of Taxa
60
50
40
30
20
10
0
0
1
2
3
4
Human Influence (low to high)

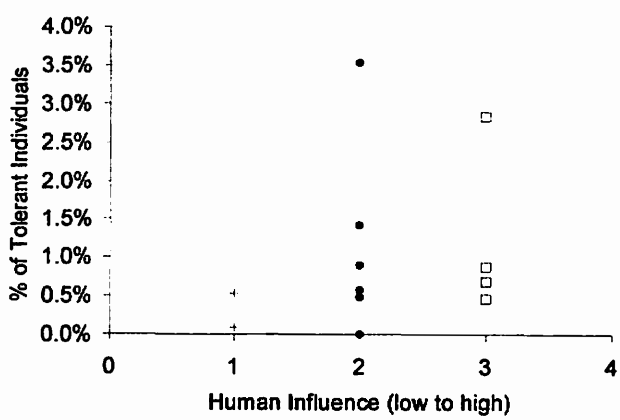

# of Ephemeroptera Taxa
12
10
8
6
4
2
0
0
1
2
3
4
Human Influence (low to high)

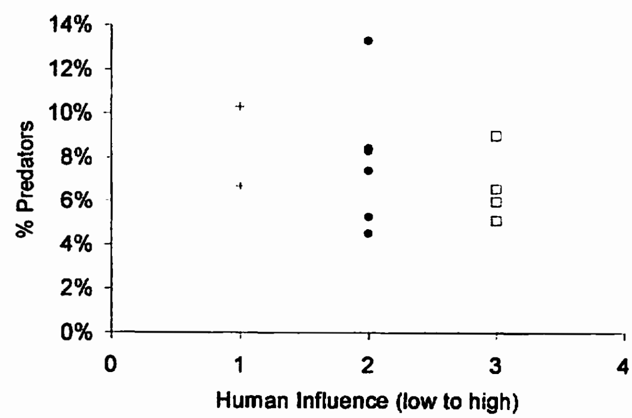

# of Plecoptera Taxa
9
8
7
6
5
4
3
2
1
0
0
1
2
3
4
Human Influence (low to high)


# of Trichoptera Taxa
5
4
3
2
1
0
0
1
2
3
4
Human Influence (low to high)


# of Long Lived Taxa
2
1
0
0
1
2
3
4
Human Influence (low to high)


# of Intolerant Taxa
2
1
0
0
1
2
3
4
Human Influence (low to high)


% of Tolerant Individuals
4.0%
3.5%
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
0
1
2
3
4
Human Influence (low to high)


% Predators
14%
12%
10%
8%
6%
4%
2%
0%
0
1
2
3
4
Human Influence (low to high)

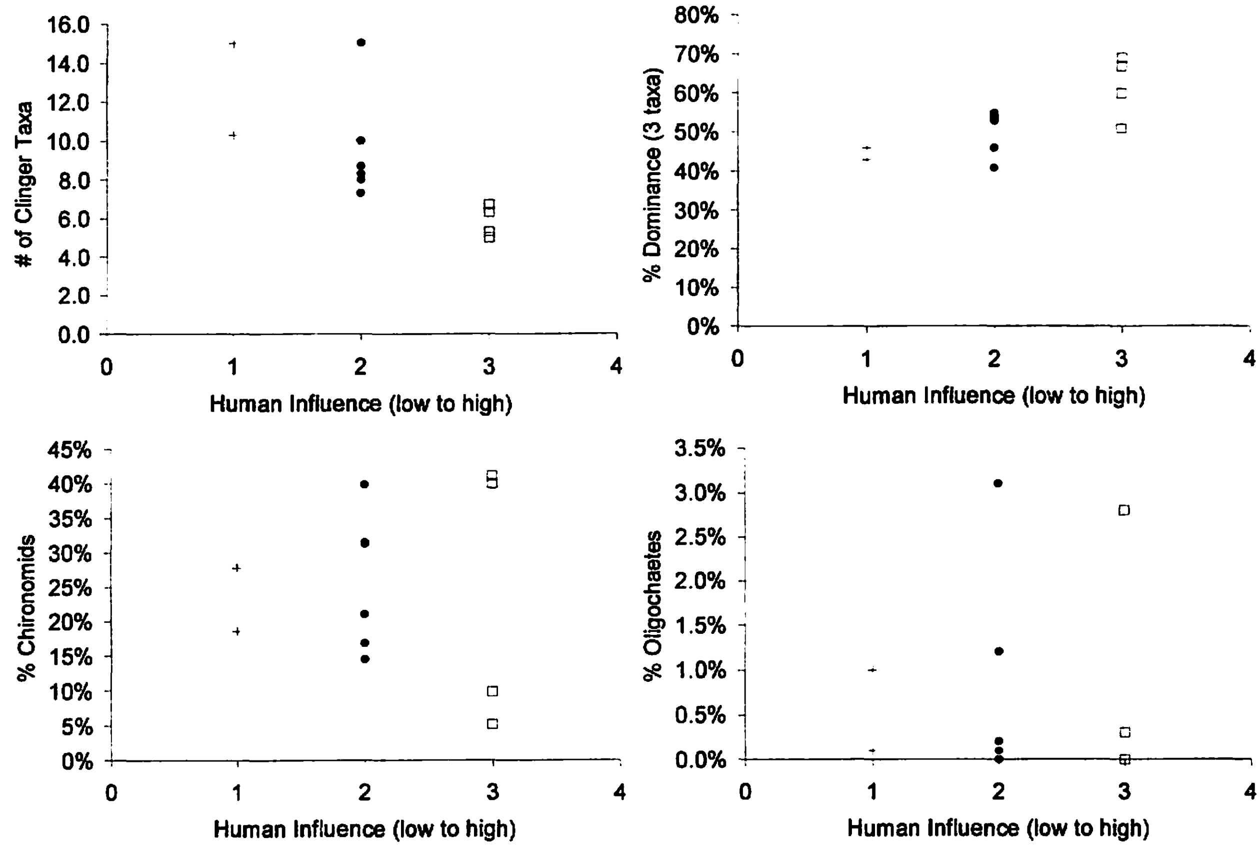


Figure 3: Benthic invertebrate metrics across a gradient of human influence. *Plus signs* represent lightly influenced sites. *Open boxes* represent the most severely degraded sites. *Solid circles* represent moderately influenced sites.

3.3 Core Metric Scoring

Nine out of twelve metrics were chosen for incorporation into the multimetric index based on the ability to clearly differentiate uninfluenced from heavily influenced sites. Pair-wise correlations between each of the metrics have found them to be non-redundant (Kerans & Karr, 1994), suggesting that each metric contributes different and valuable information to the end product. Data results from all twenty-three streams sampled in the upper Bulkley River watershed were ranked by metric value and graphed as illustrated in Figure 4.

Graphs were studied closely for natural breaks or patterns, and compared with cutoffs used in the Puget Sound lowland streams and Clackamas River basin streams in Oregon (J. Karr, pers. comm., March 17, 2000). Cutoff points were selected and metrics were scored 5 points if values were similar to uninfluenced streams, 3 points if values were similar to moderately influenced streams, and 1 point if values were similar to heavily influenced streams (Karr and Chu, 1999). All selected metrics and scoring cutoff points are summarized in Table 4.

Some other multimetric index projects have taken a more standardized approach by trisecting or quadrisecting the ranked metric values, depending on the number of human influence classifications (Maxted *et al.*, 1999; Major *et al.*, 1998). However, as there were lower numbers of uninfluenced streams sampled for this project compared with the number of moderately influenced and highly influenced streams sampled, an equal trisection of the data would have resulted in artificially low cutoff points for the uninfluenced condition, leading to higher overall stream condition scores for some moderately influenced streams.

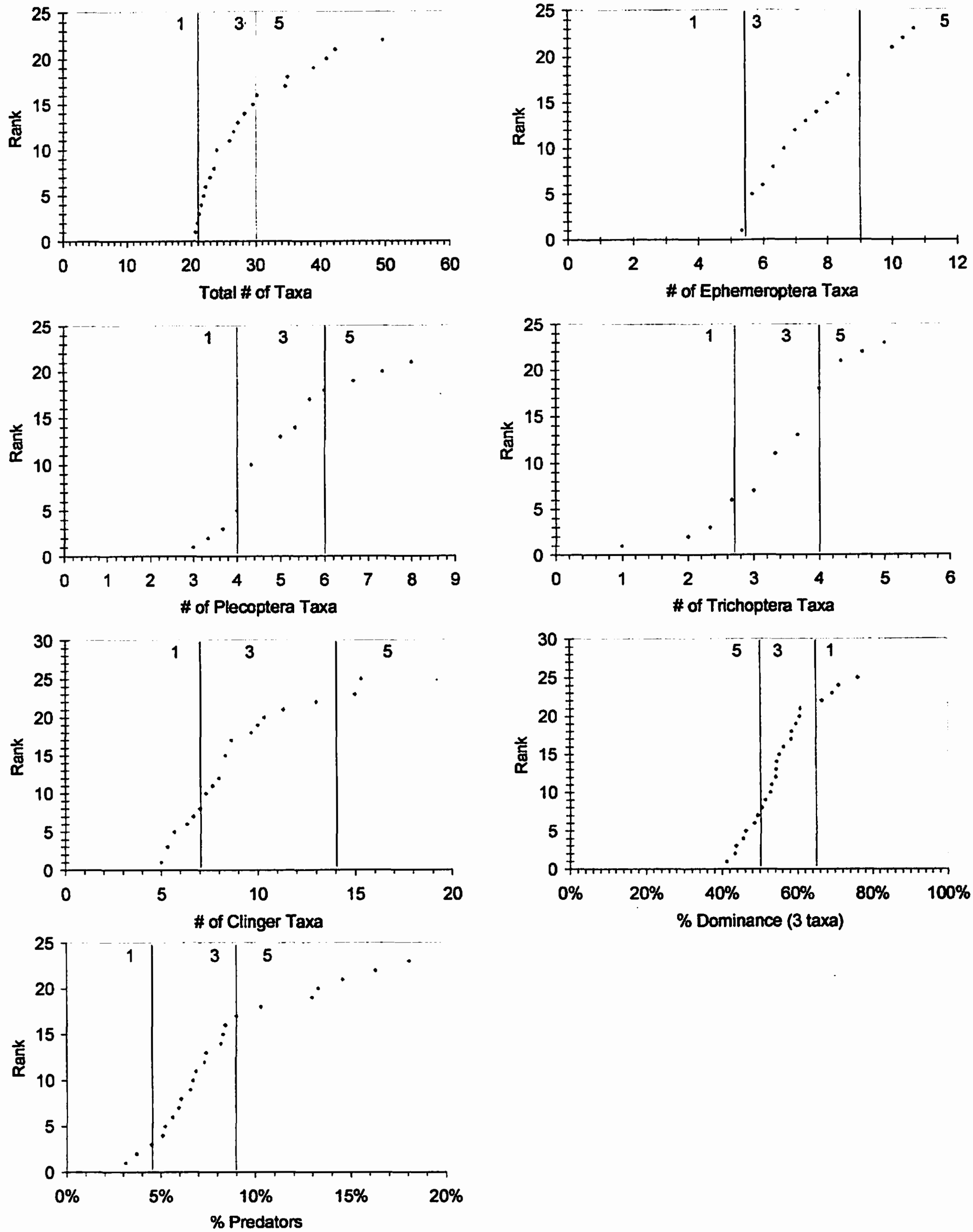


Figure 4: Cutoff scoring values for each metric based on rank distribution of scores for upper Bulkley River watershed streams.

Graphs for scoring intolerant taxa richness and long-lived taxa richness are not shown as there were only two or three possible results for these metrics. In these cases, the maximum value was scored as a 5, the minimum value was scored as a 1 and if there was an intermediate value, it was scored as a 3.

When more data is collected for similar streams in this region, all metrics and their associated scores should be re-evaluated to ensure that the maximum range of possible values have been included.

Table 4: Nine metrics and scoring cutoff points chosen for inclusion in the upper Bulkley River watershed multimetric index.

Metric	Metric Score		
	1	3	5
Total number of taxa	< 22	22 – 30	> 30
Number of Ephemeroptera taxa	< 5.5	5.5 – 9	> 9
Number of Plecoptera taxa	< 4	4.1 - 6	> 6
Number of Trichoptera taxa	< 2.7	2.7 – 3.9	≥ 4
Number of long-lived taxa	0	1	≥ 2
Number of intolerant taxa	0		≥ 1
Number of clinger taxa	< 7	7 – 13.9	≥ 14
% Predators	< 4.5	4.5 – 9	> 9
% Dominance (3 taxa)	≥ 65	50 – 64	< 50

4 Results

Benthic invertebrate metrics for all streams sampled within the upper Bulkley River watershed were summarized and scored using cutoff points identified in Table 4. The final score was converted to stream condition as shown in Table 5, using 10-metric IBI score cut-off points from the Salmonweb internet site (www.salmonweb.org) which were adjusted to reflect the 9-metric IBI calibrated for the upper Bulkley River watershed. Metric scores for each site were added up to provide one final index score, as presented in Table 6. There were nine metrics included in the index, each of which had a maximum possible score of 5 and a minimum possible score of 1. Therefore, the maximum possible index score was 45 and the minimum possible index score was 9. The actual maximum score for streams sampled was 41 for Foxy Creek at the Maxan Creek confluence, and the minimum score was 15 for McQuarrie Creek above the Highway 16 crossing. Many of the streams sampled were in poor or fair condition as illustrated in Figure 5. Very poor sites are marked in red, while poor sites were orange, fair sites were yellow, good sites were green and excellent sites were blue.

Table 5: Nine metric upper Bulkley - calibrated IBI scores and associated stream condition

9 Metric Kispiox-Calibrated IBI Score	Stream Condition
41 – 45	Excellent
34 – 40	Good
25 – 33	Fair
16 – 24	Poor
9 - 15	Very Poor

Table 6: Stream sites and condition within the upper Bulkley River watershed.

Stream Site	Index of Biological Integrity Score	Stream Condition
McQuarrie downstream	15	Very Poor
Buck @ Confluence	17	Poor
Byman downstream	17	Poor
Buck @ Mall	19	Poor
Bulkley @ Craker Road	19	Poor
Richfield upstream	19	Poor
Bob Creek	21	Poor
Buck Creek above 12km bridge	21	Poor
Cesford upstream	21	Poor
Barren Creek	23	Poor
Johnny David	23	Poor
McQuarrie Upstream	23	Poor
Richfield above Hwy 16	23	Poor
Cesford above Topley	25	Fair
Bulkley @ Morice Confluence	25	Fair
Byman Upstream	29	Fair
Bulkley @ Knockholt bridge	31	Fair
Crow Creek	31	Fair
Cesford @ Topley	33	Fair
Foxy Creek below mine	33	Fair
Ailport Creek	37	Good
Richfield Creek @ CN bridge	39	Good
Foxy Creek @ Maxan	41	Excellent

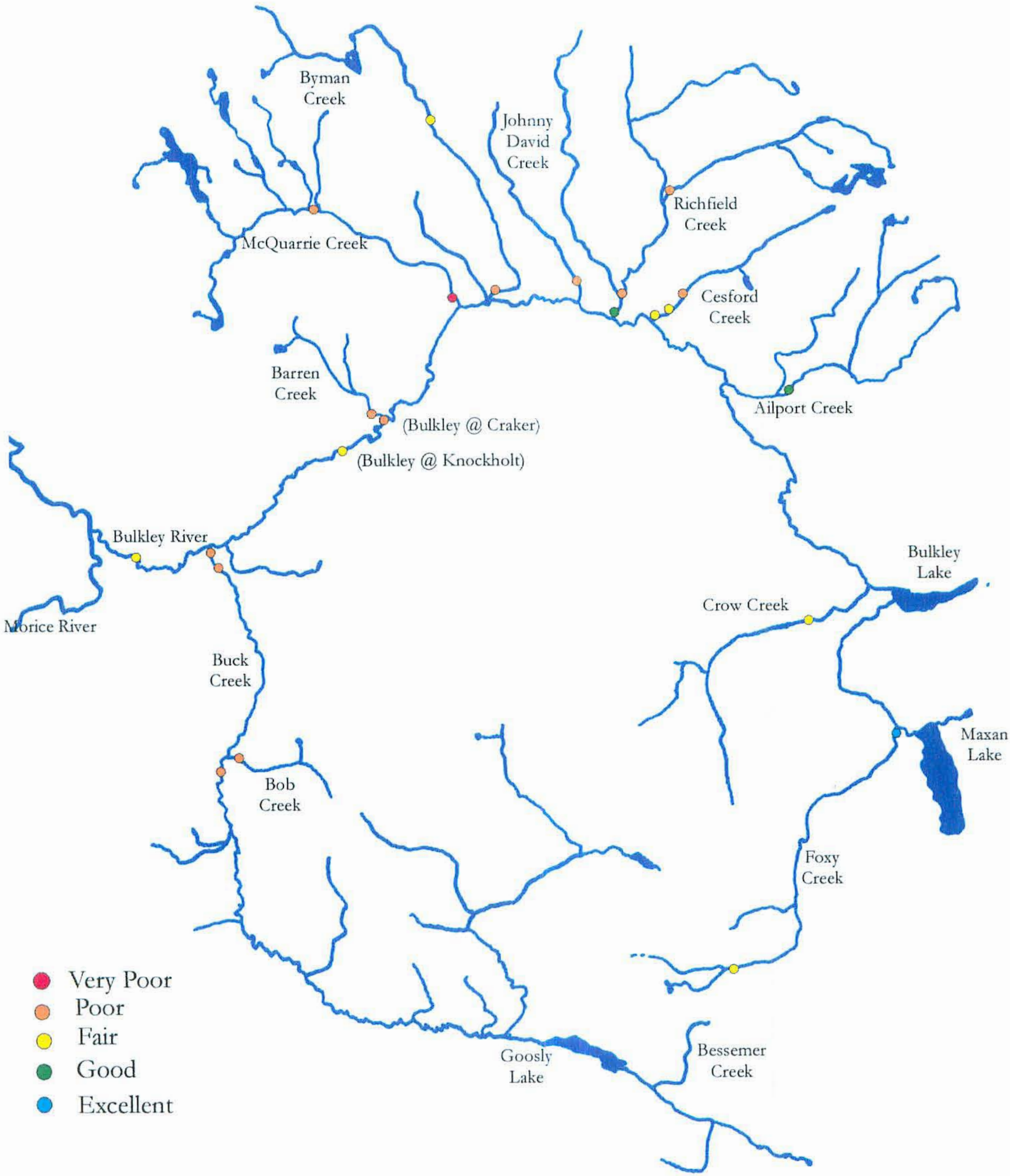


Figure 5: IBI Scores for each assessed site.

5 Discussion

Assessment of twenty-three stream sites within the upper Bulkley River basin has provided a baseline for trend monitoring at those sites over time. For comparison of a number of sites on the same stream, we need to know what level of variability would be expected between two sites on the same stream with similar levels of human influence. Deshon (1995) has investigated this question for the Invertebrate Community Index (ICI), and found that an ICI difference of 4 points or less (out of a total of 60 for a 10 metric index) should be considered a significant departure. If we assume a similar 7% difference to be significant within the upper Bulkley River basin, this would work out to be a difference of 3 points or more. This definition of 'significant' difference between two sites on the same stream, combined with the condition rating (e.g. very poor to excellent), will aid in interpretation of results.

As expected, a decrease in biological integrity between the upstream and downstream sites was found at both Byman and McQuarrie Creeks. In both cases the difference in IBI scores between the upstream and downstream sites was 8 points or more. This suggests that land use increases in the lower watershed, which agrees with air photo analysis. Further analysis of differences between the upstream and downstream sites on these two creeks might allow identification of specific indicator metrics for forest harvesting impacts versus combined land use impacts, as forest harvesting was the main influence in the upper watersheds of both streams.

Concerns regarding the state of Cesford Creek and possible contamination from an old garbage dump, an old transformer station and a rumoured battery dump near the Cesford hill forestry look-out tower lead to three sampling stations on this creek. Two downstream sites, one within Topley and one just upstream of the Granisle Highway were found to be in fair condition. A site further upstream was rated as poor. The site furthest upstream was above the old transformer station, upstream of an old bridge and adjacent to old logging. Whether the poor condition rating was due to an old garbage dump or battery dump influence was not clear. It seems likely that if an old battery dump was affecting the upstream reference site, it would have had some impact on the site upstream of the Granisle Highway as well, which was not the case. In any case, the IBI scores for the three Cesford Creek sites provide a starting point for long term trend monitoring of stream condition.

Ailport Creek had one of the most highly influenced local sampling areas. Samples were collected in an area which was an obvious livestock trail. Despite this, the final IBI score for this stream was relatively high compared with other streams in the upper Bulkley watershed. However, although the in-stream and riparian condition was poor, the majority of the Ailport Creek watershed was forested with low human influence. This suggests that watershed influences play a larger role than local instream and riparian condition in predicting biological integrity of a stream site. Similar results were found for the Kispiox River IBI calibration project (Rysavy, 2000). During a study of landscape scale influences and stream buffers on stream habitats and biota, Richards et al, (1996) found that whole catchment variables were more predictive of biotic condition than local stream buffer data, even though riparian buffers had a modifying influence on sediment delivery from the catchment basin and reach-scale erosional processes.

One metric which is used as part of the ICI, is relative abundance of Tribe Tanytarsini midges. Tanytarsini midges are intermediate in pollution tolerance and often disappear or decline under moderate human influence (DeShon, 1995). Although this metric was not tested formally for this project, a review of the data found that Tanytarsini midges were found at all sites rated with the IBI as excellent or good condition, and at roughly half of the sites rated as fair condition. Tanytarsini midges were not present at any of the sites rated as poor or very poor condition by the upper Bulkley River calibrated IBI. Based on these preliminary findings, further study and sampling of streams within the upper Bulkley River watershed should include evaluation of this metric. Even without inclusion of the metric in the Bulkley River IBI, it has potential benefit as a tool for assessing stream condition.

Larger river sites, such as the upper Bulkley River, were expected to have slightly lower taxa richness and decreased diversity compared with mid-sized streams due to changes in organic inputs and substrate types (DeShon, 1995). Although samples were collected at three sites in each of Buck Creek and the Bulkley River, these aquatic ecosystems are much larger than the other streams sampled, and as such, should mainly be compared with other sites on the same stream. Although expectations may differ making comparison of a large stream with a small stream impractical, comparison of a number of sites on one stream or comparison of a single site to itself over time still allows monitoring of changes in biological condition. Concerns were raised by a community member at the start of the Bulkley IBI project regarding the immediate and long-term potential impacts of a garbage dump adjacent to the Bulkley River. Three sites on the Bulkley River were sampled, and results of assessment have created a baseline for comparison of future monitoring results.

Overall, the 9 metric benthic invertebrate Index of Biological Integrity appears to be an effective tool for assessing and monitoring streams within the upper Bulkley River watershed. The applications and expected benefits of this tool are many, and include:

- serving as a stream monitoring and assessment tool for LRMP or other strategic level plan,
- serving as an effectiveness monitoring tool for watershed restoration and stream rehabilitation projects,
- serving as an assessment tool for prioritizing streams for rehabilitation and/ or restoration,
- tracking stream recovery or degradation over the long term, and
- aiding in defensible resource management and planning decisions.

6 Recommendations

To successfully use the IBI for the applications as mentioned above, the following recommendations are made for implementation and further study:

- Sampling of additional reference sites within the upper Bulkley River watershed or from a similar biogeoclimatic zone would serve to strengthen the uninfluenced data range and metric scores.
- The calibrated IBI should be tested and validated with an independent data set.
- Data could be collected for different biogeoclimatic zones around the upper Bulkley. If scoring cutoffs for metrics were similar between ecoregions, perhaps the IBI could be applied over a broader area, without additional work to calibrate it for each region.
- A search for comparable historical benthic invertebrate data would allow calculation of IBI scores for streams in past years, and ultimately provide a historical trend of stream condition for those sites. For example, historical data for both the Bulkley River at the Morice confluence site, and the Foxy Creek at the Maxan confluence site are available, and although sampling techniques were slightly different, the period of collection (late August, early September) was the same (Remington et al., 1993, Remington, 1991 and Perrin, 1999).
- Local calibration of the IBI should be an iterative process. Any additional data collected should be used to re-check the metric trends over a gradient of human influence, and re-affirm the metric scoring cut-off points. Use of relative abundance of predators and Tanytarsini midges as metrics should be re-evaluated.

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Appendix A: Benthic Invertebrate Data

EMS Number		400296	400296	400296	E238800	E238800	E238800
FES Sample Number		990524	990525	990526	990527	990528	990529
Site Name		Bulkley @ Morice	Bulkley @ Morice	Bulkley @ Morice	Bulkley @ Craker	Bulkley @ Craker	Bulkley @ Craker
Replicate #		1	2	3	1	2	3
units	stage						
Phylum : Nematomorpha							
Class : Oligochaeta		3			5		
Family : Lumbricidae							
Family: Naididae							
Nais sp.							
Order : Ephemeroptera	adult						
Order : Ephemeroptera	nymph	17	20	13	21	7	26
Family : Ameletidae	nymph						
Ameletus sp.	nymph	20	7	1	5		
Family : Ephemerellidae	nymph	32	25	21	77	14	40
Drunella doddsi	nymph						
Drunella grandis	nymph						
Drunella sp.	nymph	2		1	4	15	26
Drunella ?	nymph						
Ephemerella	larvae						
Serratella sp.	nymph						
Family : Heptageniidae	nymph	3	16	17		16	49
Cinygmula sp.	nymph						
Epeorus sp.	nymph						
Rhithrogena sp.	nymph			2	3	16	20
Stenonema	larvae						
1st instar	larvae						
Family : Baetidae	nymph		1	2		1	
Baetis sp.	nymph						3
Baetis ?	nymph						
Family : Leptophlebiidae	nymph	3	2	3		1	1
Paraleptophlebia sp.	nymph				3		
Order : Plecoptera	juvenile						
Order : Plecoptera	nymph	5	28	27	3	13	14
Family : Capniidae	juvenile						
Family : Capniidae	nymph						
Family : Chloroperlidae	juvenile						
Family : Chloroperlidae	nymph	10	15	4	12	1	21
Kathroperla sp.							
Alloperla	larvae						
Paraperla	larvae						
Suwallia sp.	nymph						
Sweltsa sp.	nymph						
Sweltsa complex	nymph						
Sweltsa complex ?	nymph						
Family : Taeniopterygidae	juvenile						
Family : Taeniopterygidae	nymph	4					
Family : Nemouridae	nymph	1	6	2			
Amphinemura sp.	nymph						
Visoka	larvae						
Nemoura	larvae						
Zapada sp.	nymph						
Zapada ?	nymph						
Family : Perlodidae	nymph	6			2	3	3
Megarcys sp.	nymph						
Megarcys?	nymph						
Isoperla	larvae						
Acrynopteryx	larvae						
1st instar	larvae						
Skwala ?	nymph						
Skwala sp.	nymph		12	9			
Family : Pteronarcyidae	nymph						
Pteronarcella sp.	nymph	2	4	4	3	11	15
Pteronarcys sp.	nymph						
Family : Perlidae	nymph						
Doroneuria sp.	nymph						
Hesperoperla sp.	nymph						
Family : Leuctridae / Capniidae	nymph						
Phylum : Coelenterata							
Hydra sp.							
Order : Lepidoptera							

EMS Number		400296	400296	400296	E238800	E238800	E238800
FES Sample Number		990524	990525	990526	990527	990528	990529
Site Name		Bulkley @ Morice	Bulkley @ Morice	Bulkley @ Morice	Bulkley @ Craker	Bulkley @ Craker	Bulkley @ Craker
Replicate #		1	2	3	1	2	3
units	stage						
Order: Thysanoptera	adult						
Order: Hymenoptera							
Order : Hemiptera							
Family : Aphididae							
Sub-order : Homoptera	adult						
Sub-order : Homoptera	nymph						
Order : Trichoptera	larvae	12	23	7	15	11	11
Order : Trichoptera	juvenile						
Order : Trichoptera	pupae						
Family : Glossosomatidae	larvae						
Glossosoma sp.	larvae						
Family : Rhyacophilidae	pupae						
Family : Rhyacophilidae	larvae						
Rhyacophila sp.	larvae						
Rhyacophila ?	larvae						
Family : Hydropsychidae	juvenile						
Family : Hydropsychidae	larvae	7					6
Arctopsyche sp.	larvae						
Hydropsyche sp.	larvae						
Hydropsyche ?	larvae						
Ceratopsyche ?	larvae	3	34	52		9	4
Parapsyche sp.	larvae						
Family : Brachycentridae	larvae	7	3	2			
Brachycentrus sp.	larvae						
Family : Hydroptilidae	juvenile						
Family : Hydroptilidae ?	pupae						
Family : Hydroptilidae	larvae		1		1	1	1
Family : Hydroptilidae ?	larvae						
Family : Limnephilidae	juvenile						
Family : Limnephilidae	larvae						
Dicosmoecus sp.	larvae						
Order : Diptera	adult		6	10			1
Order : Diptera	pupae	9	7	5	2	3	5
Order : Diptera	larvae						
Family : Dixidae	larvae						
Family : Chironomidae	adult						
Family : Chironomidae	pupae						
Family : Chironomidae	larvae	230	165	127	49	84	188
Sub-family : Orthocladiinae	larvae	8	44	14	Present	11	28
Crictopus spp.	larvae						
Crictopus / Orthocladius sp.	larvae						
Orthocladius sp.	larvae						
Corynoneura sp.	larvae						
Eukiefferiella sp.	larvae						
Eukiefferiella sp. ?	larvae						
Rheocricotopus sp.	larvae						
Thienemanniella sp.	larvae						
Synorthocladuis sp.	larvae						
Sub-family : Prodiamesinae	larvae						
Sub-family : Diamesinae	larvae						
Boreoheptgyia sp.	larvae						
Diamesa sp.	larvae						
Diamesa ?	larvae						
Pagastia sp.	larvae						
Potthastia sp.	larvae						
Sub-family : Tanypodinae	larvae	16	Present				
Thienemannimyia group	larvae						
Sub-family : Tanytarsini	larvae						
Tribe : Tanytarsini	pupae						
Tribe : Tanytarsini	larvae						
Sub-family : Chironominae	larvae	16					
Micropsectra sp.	larvae						
Family : Empididae	larvae						
Chelifera sp.	larvae						
Oreogeton sp.	larvae						
Family : Ceratopogonidae	larvae						

EMS Number		400296	400296	400296	E238800	E238800	E238800
FES Sample Number		990524	990525	990526	990527	990528	990529
Site Name		Bulkley @ Morice	Bulkley @ Morice	Bulkley @ Morice	Bulkley @ Craker	Bulkley @ Craker	Bulkley @ Craker
Replicate #		1	2	3	1	2	3
units	stage						
Bezzia / Probezzia sp.	larvae	2	2				1
Family : Tipulidae	larvae	4	5	1	3		6
Tipula abdominalis	larvae						
Dicranota sp.	larvae						
Hexatoma sp.	larvae						
Rhabdomastix sp.	larvae						
Antocha sp.	larvae						
Family : Athericidae	larvae						
Atherix sp.	larvae				4	6	5
Family : Simuliidae	larvae		1	2			
Family : Simuliidae	pupae						
Cnephia sp.	larvae						
Simulium sp.	pupae						
Simulium sp.	larvae						
Simulium ?	larvae						
Family : Stratiomyidae	larvae						
Family : Tanyderidae	larvae						
Protoplasa fitchii	larvae						
Family : Psychodidae	larvae						
Pericoma sp.	larvae		1				
Order : Coleoptera	adult	1	1				
Family : Elmidae	adult						
Family : Elmidae	larvae		2	1	2	3	3
Lara sp.	larvae						
Narpus ?	larvae						
Optioservus sp.	larvae						
Family : Curculionidae ?							
Family : Dytiscidae	larvae						
Family : Gyrinidae ?	larvae						
Order : Collembola							
Family : Sminthuridae							
Sub-Class : Ostracoda							
Sub-class : Copepoda							
Order : Cyclopoida							
Order : Harpacticoida							
Phylum : Nematoda		3	2	1			
Class: Arachnoida							
Group : Hydracarina		8	12	3	33	23	60
Family : Protziidae							
Wandesia sp.							
Division : Oribatei							
Phylum : Mollusca							
Class : Gastropoda							
Family : Planorbidae							
Order : Pelecypoda							1
Phylum : Platyhelminthes							
Class : Turbellaria							
Polycelis coronata							
Total		434	445	331	247	249	538
# of Taxa		27	27	24	20	20	24
# of Ephemeroptera		6	6	8	6	7	7
# of Plecoptera		6	5	5	4	4	4
# of Tricoptera		4	4	3	2	3	4
# of Long- Lived Taxa (sv?)		1			1		
# of Intolerant Taxa		0			0		
% of Individuals in Tol. Taxa		0.69%	0.22%	0.00%	4.05%	2.81%	1.12%
% of Predator Individuals		7.83%	6.52%	3.93%	7.29%	4.02%	5.58%
# of Clinger taxa		7	6	8	4	6	7
% dominance (3 taxa)		65%	55%	62%	64%	49%	55%
% Oligochaetes		0.7%	0.0%	0.0%	2.0%	0.0%	0.0%
% Chironomids		62.2%	47.0%	42.6%	19.8%	38.2%	40.1%

EMS Number		E238643	E238643	E238643	E238636	E238636	E238636
FES Sample Number		990335	990336	990337	990320	990321	990322
Site Name		Bulkley Knockholt	Bulkley Knockholt	Bulkley Knockholt	Foxy Maxan	Foxy Maxan	Foxy Maxan
Replicate #		1	2	3	1	2	3
units	stage						
Phylum : Nematomorpha							
Class : Oligochaeta						1	4
Family : Lumbricidae							
Family: Naididae							
Nais sp.							
Order : Ephemeroptera	adult						
Order : Ephemeroptera	nymph	13	14	16		4	60
Family : Ameletidae	nymph						
Ameletus sp.	nymph	3		2	2	2	17
Family : Ephemerellidae	nymph	7	3	17	8	22	34
Drunella doddsi	nymph	1			66	48	98
Drunella grandis	nymph	3		4			
Drunella sp.	nymph				5	6	15
Drunella ?	nymph						
Ephemerella	larvae						
Serratella sp.	nymph					2	4
Family : Heptageniidae	nymph	45	39	92	2	11	48
Cinygmula sp.	nymph				4	9	9
Epeorus sp.	nymph	7	1	1	6	9	13
Rhithrogena sp.	nymph	81	79	128	6	26	14
Stenonema	larvae						
1st instar	larvae						
Family : Baetidae	nymph						
Baetis sp.	nymph	8	35	30	78	181	96
Baetis ?	nymph						
Family : Leptophlebiidae	nymph						
Paraleptophlebia sp.	nymph	6	8	46			
Order : Plecoptera	juvenile		1	6	2	7	5
Order : Plecoptera	nymph						
Family : Capniidae	juvenile						
Family : Capniidae	nymph		3	1	5	1	3
Family : Chloroperlidae	juvenile						
Family : Chloroperlidae	nymph	24	13	23	5	2	29
Kathroperla sp.							
Alloperla	larvae						
Paraperla	larvae						
Suwallia sp.	nymph						
Sweltsa sp.	nymph						
Sweltsa complex	nymph	23	32	24	6	40	20
Sweltsa complex ?	nymph						
Family : Taeniopterygidae	juvenile						
Family : Taeniopterygidae	nymph				2	1	
Family : Nemouridae	nymph						
Amphinemura sp.	nymph	1					
Visoka	larvae						
Nemoura	larvae						
Zapada sp.	nymph		1	2	22	34	42
Zapada ?	nymph						
Family : Perlodidae	nymph	2	2	3	2		5
Megarcys sp.	nymph						
Megarcys?	nymph						
Isoperla	larvae						
Acrynopteryx	larvae						
1st instar	larvae						
Skwala ?	nymph						
Skwala sp.	nymph	6	1	7		1	
Family : Pteronarcyidae	nymph						
Pteronarcella sp.	nymph	1	7	13		1	
Pteronarcys sp.	nymph						2
Family : Perlidae	nymph				2		5
Doroneuria sp.	nymph						
Hesperoperla sp.	nymph						
Family : Leuctridae / Capniidae	nymph						
Phylum : Coelenterata							
Hydra sp.						1	1
Order : Lepidoptera							

EMS Number		E238643	E238643	E238643	E238636	E238636	E238636
FES Sample Number		990335	990336	990337	990320	990321	990322
Site Name		Bulkley Knockholt	Bulkley Knockholt	Bulkley Knockholt	Foxy Maxan	Foxy Maxan	Foxy Maxan
Replicate #		1	2	3	1	2	3
units	stage						
Order: Thysanoptera	adult		1		1		
Order: Hymenoptera							2
Order : Hemiptera							
Family : Aphididae							
Sub-order : Homoptera	adult						
Sub-order : Homoptera	nymph		1	1	2	1	2
Order : Trichoptera	larvae						
Order : Trichoptera	juvenile	3	3	1	2	8	110
Order : Trichoptera	pupae						1
Family : Glossosomatidae	larvae						
Glossosoma sp.	larvae				1	2	3
Family : Rhyacophilidae	pupae						
Family : Rhyacophilidae	larvae						
Rhyacophila sp.	larvae				6	6	13
Rhyacophila ?	larvae						
Family : Hydropsychidae	juvenile	3	23	30			4
Family : Hydropsychidae	larvae					2	
Arctopsyche sp.	larvae						
Hydropsyche sp.	larvae		5	2			
Hydropsyche ?	larvae						
Ceratopsyche ?	larvae						
Parapsyche sp.	larvae						
Family : Brachycentridae	larvae						
Brachycentrus sp.	larvae						
Family : Hydroptilidae	juvenile	1		2			
Family : Hydroptilidae ?	pupae						
Family : Hydroptilidae	larvae						
Family : Hydroptilidae ?	larvae						
Family : Limnephilidae	juvenile				3	2	5
Family : Limnephilidae	larvae						
Dicosmoecus sp.	larvae	1					
Order : Diptera	adult					4	4
Order : Diptera	pupae						
Order : Diptera	larvae						2
Family : Dixidae	larvae						
Family : Chironomidae	adult		1		3	1	1
Family : Chironomidae	pupae	2	4	5	2	3	4
Family : Chironomidae	larvae	8	15	13	23		260
Sub-family : Orthocladiinae	larvae	21	42	52	28	95	158
Crictopus spp.	larvae	45	17	29	10	8	
Crictopus / Orthocladius sp.	larvae					2	
Orthocladius sp.	larvae						
Corynoneura sp.	larvae		1			1	1
Eukiefferiella sp.	larvae	3	6	11			
Eukiefferiella sp. ?	larvae						
Rheocricotopus sp.	larvae						
Thienemanniella sp.	larvae	10	4	5	2	5	
Synorthocladuis sp.	larvae						
Sub-family : Prodiamesinae	larvae						
Sub-family : Diamesinae	larvae						19
Boreoheptagyia sp.	larvae				1		
Diamesa sp.	larvae						
Diamesa ?	larvae						
Pagastia sp.	larvae						
Potthastia sp.	larvae				8	6	
Sub-family : Tanypodinae	larvae		1		1	1	1
Thienemannimyia group	larvae						
Sub-family : Tanytarsini	larvae						
Tribe : Tanytarsini	pupae						
Tribe : Tanytarsini	larvae	2		5	11	43	58
Sub-family : Chironominae	larvae				1		
Micropsectra sp.	larvae						
Family : Empididae	larvae						
Chelifera sp.	larvae					1	
Oreogeton sp.	larvae						
Family : Ceratopogonidae	larvae						

EMS Number		E238643	E238643	E238643	E238636	E238636	E238636
FES Sample Number		990335	990336	990337	990320	990321	990322
Site Name		Bulkley Knockholt	Bulkley Knockholt	Bulkley Knockholt	Foxy Maxan	Foxy Maxan	Foxy Maxan
Replicate #		1	2	3	1	2	3
units	stage						
Bezzia / Probezzia sp.	larvae				1	3	5
Family : Tipulidae	larvae	1	1	1			
Tipula abdominalis	larvae				1		1
Dicranota sp.	larvae	1					
Hexatoma sp.	larvae		2	6	1		5
Rhabdomastix sp.	larvae						
Antocha sp.	larvae						
Family : Athericidae	larvae						
Atherix sp.	larvae	1		2			
Family : Simuliidae	larvae	2	41	23	1	8	2
Family : Simuliidae	pupae						
Cnephia sp.	larvae						
Simulium sp.	pupae						
Simulium sp.	larvae						
Simulium ?	larvae						
Family : Stratiomyidae	larvae				3		1
Family : Tanyderidae	larvae		1				
Protoplasa fitchii	larvae						
Family : Psychodidae	larvae						
Pericoma sp.	larvae				35	92	98
Order : Coleoptera	adult	2	1		2		
Family : Elmidae	adult						
Family : Elmidae	larvae	2			3	7	8
Lara sp.	larvae						
Narpus ?	larvae						2
Optioservus sp.	larvae						1
Family : Curculionidae ?							
Family : Dytiscidae	larvae						1
Family : Gyrinidae ?	larvae						
Order : Collembola			4		1	4	6
Family : Sminthuridae			1	1	1		6
Sub-Class : Ostracoda							4
Sub-class : Copepoda							
Order : Cyclopoida						1	2
Order : Harpacticoida							2
Phylum : Nematoda					1	2	3
Class: Arachnoida						1	1
Group : Hydracarina		8	5	20	1	4	39
Family : Protziidae							
Wandesia sp.						1	3
Division : Oribatei			2	1		1	6
Phylum : Mollusca							
Class : Gastropoda							
Family : Planorbidae							
Order : Pelecypoda							
Phylum : Platyhelminthes							
Class : Turbellaria							
Polycelis coronata							1
Total		347	421	625	379	724	1369
# of Taxa		33	36	35	44	49	56
# of Ephemeroptera		10	7	9	9	11	11
# of Plecoptera		6	8	8	8	8	8
# of Tricoptera		4	3	4	4	5	5
# of Long- Lived Taxa (sv?)		1			1		
# of Intolerant Taxa		0			1		
% of Individuals in Tol. Taxa		0.58%	1.19%	0.96%	0.79%	0.28%	0.51%
% of Predator Individuals		16.43%	12.11%	10.40%	6.33%	7.60%	6.21%
# of Clinger taxa		10	9	10	13	15	17
% dominance (3 taxa)		49%	38%	44%	47%	51%	39%
% Oligochaetes		0.0%	0.0%	0.0%	0.0%	0.1%	0.3%
% Chironomids		26.2%	21.6%	19.2%	23.7%	22.9%	36.7%

EMS Number		E238622	E238622	E238622	E238624	E238624	E238624	E238625	E238625	E238625
FES Sample Number		990278	990279	990280	990284	990285	990286	990287	990288	990289
Site Name		Buck 12km	Buck 12km	Buck 12km	Buck Mall	Buck Mall	Buck Mall	Buck Conf.	Buck Conf.	Buck Conf.
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Phylum : Nematomorpha										
Class : Oligochaeta				1						
Family : Lumbricidae										
Family: Naididae										
Nais sp.										
Order : Ephemeroptera	adult									
Order : Ephemeroptera	nymph	40		22	60		10	80	39	48
Family : Ameletidae	nymph									
Ameletus sp.	nymph	1							5	3
Family : Ephemerellidae	nymph	10	3					2	2	
Drunella doddsi	nymph									
Drunella grandis	nymph									
Drunella sp.	nymph	19	2	8	3			1		3
Drunella ?	nymph									
Ephemerella	larvae									
Serratella sp.	nymph									
Family : Heptageniidae	nymph	27	21		10		6		15	8
Cinygmula sp.	nymph									
Epeorus sp.	nymph				2					
Rhithrogena sp.	nymph	5	41	8	27	28	30	19	11	6
Stenonema	larvae									
1st instar	larvae									
Family : Baetidae	nymph			4		20		3	1	2
Baetis sp.	nymph	30	9		17	3	8			
Baetis ?	nymph									
Family : Leptophlebiidae	nymph				1	3	1	2		
Paraleptophlebia sp.	nymph									
Order : Plecoptera	juvenile									
Order : Plecoptera	nymph	40		6	32	10	13	10	23	8
Family : Capniidae	juvenile									
Family : Capniidae	nymph									
Family : Chloroperlidae	juvenile									
Family : Chloroperlidae	nymph		6		3	2				
Kathroperla sp.										
Alloperla	larvae									
Paraperla	larvae									
Suwallia sp.	nymph									
Sweltsa sp.	nymph									
Sweltsa complex	nymph	14	12	7	4	4	12	20	10	5
Sweltsa complex ?	nymph									
Family : Taeniopterygidae	juvenile				3					
Family : Taeniopterygidae	nymph									
Family : Nemouridae	nymph					6		3		1
Amphinemura sp.	nymph									
Visoka	larvae									
Nemoura	larvae									
Zapada sp.	nymph									
Zapada ?	nymph									
Family : Perlodidae	nymph	10	3		2					
Megarcys sp.	nymph									
Megarcys?	nymph									
Isoperla	larvae									
Acrynopteryx	larvae									
1st instar	larvae									
Skwala ?	nymph			8						2
Skwala sp.	nymph					3	4	9	5	
Family : Pteronarcyidae	nymph				1	2				
Pteronarcella sp.	nymph									
Pteronarcys sp.	nymph									
Family : Perlidae	nymph									
Doroneuria sp.	nymph									
Hesperoperla sp.	nymph									
Family : Leuctridae / Capniidae	nymph									
Phylum : Coelenterata										
Hydra sp.										
Order : Lepidoptera										

EMS Number		E238622	E238622	E238622	E238624	E238624	E238624	E238625	E238625	E238625
FES Sample Number		990278	990279	990280	990284	990285	990286	990287	990288	990289
Site Name		Buck 12km	Buck 12km	Buck 12km	Buck Mall	Buck Mall	Buck Mall	Buck Conf.	Buck Conf.	Buck Conf.
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Order: Thysanoptera	adult									
Order: Hymenoptera										
Order : Hemiptera										
Family : Aphididae					3	6	1		1	
Sub-order : Homoptera	adult									
Sub-order : Homoptera	nymph									
Order : Trichoptera	larvae	72	9	11	95	109	33	213	132	128
Order : Trichoptera	juvenile									
Order : Trichoptera	pupae	1				1				
Family : Glossosomatidae	larvae									
Glossosoma sp.	larvae	1	1					1		1
Family : Rhyacophilidae	pupae									
Family : Rhyacophilidae	larvae									
Rhyacophila sp.	larvae	1	1							
Rhyacophila ?	larvae									
Family : Hydropsychidae	juvenile									
Family : Hydropsychidae	larvae		8	3	43		15			
Arctopsyche sp.	larvae					33	7	26	18	11
Hydropsyche sp.	larvae									
Hydropsyche ?	larvae	19								
Ceratopsyche ?	larvae									
Parapsyche sp.	larvae									
Family : Brachycentridae	larvae									
Brachycentrus sp.	larvae							7		
Family : Hydroptilidae	juvenile									
Family : Hydroptilidae ?	pupae									
Family : Hydroptilidae	larvae							4		2
Family : Hydroptilidae ?	larvae									
Family : Limnephilidae	juvenile									
Family : Limnephilidae	larvae									
Dicosmoecus sp.	larvae									
Order : Diptera	adult		2	1 .	3	5	3	5	2	2
Order : Diptera	pupae	3	4	2	3	4	6	1	3	10
Order : Diptera	larvae									
Family : Dixidae	larvae									
Family : Chironomidae	adult									
Family : Chironomidae	pupae									
Family : Chironomidae	larvae	288	51	45	140	160	168	228	240	160
Sub-family : Orthocladiinae	larvae									
Crictopus spp.	larvae									
Crictopus / Orthocladius sp.	larvae	72		20	8	60	24	40	50	30
Orthocladius sp.	larvae									
Corynoneura sp.	larvae									
Eukiefferiella sp.	larvae			Present					Present	Present
Eukiefferiella sp. ?	larvae				24		6			
Rheocricotopus sp.	larvae									
Thienemanniella sp.	larvae									
Synorthocladuis sp.	larvae									
Sub-family : Prodiamesinae	larvae									
Sub-family : Diamesinae	larvae									
Boreoheptagyia sp.	larvae									
Diamesa sp.	larvae									
Diamesa ?	larvae									
Pagastia sp.	larvae									
Potthastia sp.	larvae									
Sub-family : Tanypodinae	larvae									
Thienemannimyia group	larvae									
Sub-family : Tanytarsini	larvae									
Tribe : Tanytarsini	pupae									
Tribe : Tanytarsini	larvae									
Sub-family : Chironominae	larvae									
Micropsectra sp.	larvae				8	present				
Family : Empididae	larvae							6		
Chelifera sp.	larvae									
Oreogeton sp.	larvae									
Family : Ceratopogonidae	larvae									2

EMS Number		E238622	E238622	E238622	E238624	E238624	E238624	E238625	E238625	E238625
FES Sample Number		990278	990279	990280	990284	990285	990286	990287	990288	990289
Site Name		Buck 12km	Buck 12km	Buck 12km	Buck Mall	Buck Mall	Buck Mall	Buck Conf.	Buck Conf.	Buck Conf.
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Bezzia / Probezzia sp.	larvae	4	4	3		1			1	
Family : Tipulidae	larvae	2	5	4	6		9	4	1	2
Tipula abdominalis	larvae									
Dicranota sp.	larvae									
Hexatoma sp.	larvae									
Rhabdomastix sp.	larvae									
Antocha sp.	larvae									
Family : Athericidae	larvae									
Atherix sp.	larvae									
Family : Simuliidae	larvae									
Family : Simuliidae	pupae									
Cnephia sp.	larvae									
Simulium sp.	pupae									
Simulium sp.	larvae	3		1	3	6	4		3	1
Simulium ?	larvae									
Family : Stratiomyidae	larvae									
Family : Tanyderidae	larvae									
Protoplasa fitchii	larvae									
Family : Psychodidae	larvae									
Pericoma sp.	larvae	2								1
Order : Coleoptera	adult		1			2	3	1	1	1
Family : Elmidae	adult									
Family : Elmidae	larvae			1		1	7	2	1	3
Lara sp.	larvae									
Narpus ?	larvae									
Optioservus sp.	larvae									
Family : Curculionidae ?										
Family : Dytiscidae	larvae									
Family : Gyrinidae ?	larvae									
Order : Collembola										
Family : Sminthuridae										
Sub-Class : Ostracoda								1		
Sub-class : Copepoda										
Order : Cyclopoida										
Order : Harpacticoida										
Phylum : Nematoda		2	1		2			1		
Class: Arachnoida										
Group : Hydracarina		49	16	12	93	44	51	57	44	48
Family : Protziidae										
Wandesia sp.										
Division : Oribatei										
Phylum : Mollusca										
Class : Gastropoda										
Family : Planorbidae										
Order : Pelecypoda		1								
Phylum : Platyhelminthes										
Class : Turbellaria						1				
Polycelis coronata										
Total		716	200	167	596	513	422	746	608	488
# of Taxa		24	19	19	25	22	22	25	22	25
# of Ephemeroptera		7	5	4	7	4	5	5	6	6
# of Plecoptera		3	3	3	6	6	3	4	3	4
# of Tricoptera		4	4	2	2	2	3	5	2	4
# of Long- Lived Taxa (sv?)		0			0			0		
# of Intolerant Taxa		1			0			0		
% of Individuals in Tol. Taxa		3.07%	0.00%	1.20%	0.50%	1.17%	0.95%	0.54%	0.49%	1.02%
% of Predator Individuals		4.05%	13.00%	10.78%	1.51%	8.38%	5.45%	8.18%	5.59%	4.10%
# of Clinger taxa		9	9	5	8	5	6	7	6	7
% dominance (3 taxa)		60%	57%	62%	55%	64%	60%	70%	69%	69%
% Oligochaetes		0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
% Chironomids		50.3%	25.5%	38.9%	30.2%	42.9%	46.9%	36.7%	47.7%	38.9%

EMS Number		E238623	E238623	E238623	E238639	E238639	E238639	E238629	E238629	E238629
FES Sample Number		990281	990282	990283	990326	990327	990328	990299	990300	990301
Site Name		Bob	Bob	Bob	Byman Ref.	Byman Ref.	Byman Ref.	Byman	Byman	Byman
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Phylum : Nematomorpha										
Class : Oligochaeta					7	8	11	2	14	10
Family : Lumbricidae										
Family: Naididae										
Nais sp.										
Order : Ephemeroptera	adult									
Order : Ephemeroptera	nymph	45	74	16		33	33	13	10	52
Family : Ameletidae	nymph									
Ameletus sp.	nymph		13	17	2	2	3	4	3	6
Family : Ephemerellidae	nymph	5		26	3	1	2		4	
Drunella doddsi	nymph				6	29	7			
Drunella grandis	nymph									
Drunella sp.	nymph		16						4	3
Drunella ?	nymph			15						
Ephemerella	larvae									
Serratella sp.	nymph									
Family : Heptageniidae	nymph	35	65	85	9	5	12	3	65	53
Cinygmula sp.	nymph						3			
Epeorus sp.	nymph	23	17	9	1					
Rhithrogena sp.	nymph	13	24	26	17	22	21	1	2	21
Stenonema	larvae									
1st instar	larvae									
Family : Baetidae	nymph									
Baetis sp.	nymph	26	44	22	10	31	8		1	2
Baetis ?	nymph									
Family : Leptophlebiidae	nymph	12		2				1		
Paraleptophlebia sp.	nymph				3	12	8			
Order : Plecoptera	juvenile				6	11	18			
Order : Plecoptera	nymph	42	82	54				2	7	17
Family : Capniidae	juvenile						2			
Family : Capniidae	nymph									
Family : Chloroperlidae	juvenile									
Family : Chloroperlidae	nymph	2			3	12	1			
Kathroperla sp.										
Alloperla	larvae									
Paraperla	larvae									
Suwallia sp.	nymph									
Sweltsa sp.	nymph									
Sweltsa complex	nymph	24	25	14	3	18	12	10	21	25
Sweltsa complex ?	nymph									
Family : Taeniopterygidae	juvenile									
Family : Taeniopterygidae	nymph						1			
Family : Nemouridae	nymph								13	5
Amphinemura sp.	nymph									
Visoka	larvae									
Nemoura	larvae									
Zapada sp.	nymph				14	11	1			
Zapada ?	nymph									
Family : Perlodidae	nymph		2					3	2	
Megarcys sp.	nymph									
Megarcys?	nymph									
Isoperla	larvae									
Acrynopteryx	larvae									
1st instar	larvae									
Skwala ?	nymph									
Skwala sp.	nymph									
Family : Pteronarcyidae	nymph									
Pteronarcella sp.	nymph									
Pteronarcys sp.	nymph									
Family : Perlidae	nymph				1					
Doroneuria sp.	nymph				1					
Hesperoperla sp.	nymph									
Family : Leuctridae / Capniidae	nymph		2	13				1	2	
Phylum : Coelenterata										
Hydra sp.					1					
Order : Lepidoptera										

EMS Number		E238623	E238623	E238623	E238639	E238639	E238639	E238629	E238629	E238629
FES Sample Number		990281	990282	990283	990326	990327	990328	990299	990300	990301
Site Name		Bob	Bob	Bob	Byman Ref.	Byman Ref.	Byman Ref.	Byman	Byman	Byman
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Order: Thysanoptera	adult				1					
Order: Hymenoptera					1					
Order : Hemiptera										
Family : Aphididae				1						
Sub-order : Homoptera	adult									
Sub-order : Homoptera	nymph					2				
Order : Trichoptera	larvae	3	2	1				18	52	42
Order : Trichoptera	juvenile				16	3	1			
Order : Trichoptera	pupae	1	1	1				1		
Family : Glossosomatidae	larvae									
Glossosoma sp.	larvae				1	3				
Family : Rhyacophilidae	pupae									
Family : Rhyacophilidae	larvae									
Rhyacophila sp.	larvae	22	20	11						
Rhyacophila ?	larvae									
Family : Hydropsychidae	juvenile				1					
Family : Hydropsychidae	larvae							1	1	2
Arctopsyche sp.	larvae				1					
Hydropsyche sp.	larvae									
Hydropsyche ?	larvae									
Ceratopsyche ?	larvae									
Parapsyche sp.	larvae									
Family : Brachycentridae	larvae									
Brachycentrus sp.	larvae									2
Family : Hydroptilidae	juvenile									
Family : Hydroptilidae ?	pupae									
Family : Hydroptilidae	larvae				1					
Family : Hydroptilidae ?	larvae									
Family : Limnephilidae	juvenile									
Family : Limnephilidae	larvae						1			
Dicosmoecus sp.	larvae									
Order : Diptera	adult	17	8	4				5	1	6
Order : Diptera	pupae	9	2	6				1	1	2
Order : Diptera	larvae									
Family : Dixidae	larvae	1			1			1		
Family : Chironomidae	adult				1	1	1			
Family : Chironomidae	pupae					4	1			
Family : Chironomidae	larvae	94	264	588	54	57	16	9	37	41
Sub-family : Orthocladiinae	larvae			52	27	25	22			
Cricotopus spp.	larvae									
Cricotopus / Orthocladius sp.	larvae		30							
Orthocladius sp.	larvae									
Corynoneura sp.	larvae									
Eukiefferiella sp.	larvae									
Eukiefferiella sp. ?	larvae	17								
Rheocricotopus sp.	larvae									
Thienemanniella sp.	larvae									
Synorthocladuis sp.	larvae									
Sub-family : Prodiamesinae	larvae									
Sub-family : Diamesinae	larvae									
Boreoheptgyia sp.	larvae									
Diamesa sp.	larvae									
Diamesa ?	larvae									
Pagastia sp.	larvae									
Potthastia sp.	larvae									
Sub-family : Tanypodinae	larvae				1	3	3			
Thienemannimyia group	larvae									
Sub-family : Tanytarsini	larvae									
Tribe : Tanytarsini	pupae									
Tribe : Tanytarsini	larvae				18	48	56			
Sub-family : Chironominae	larvae									
Micropsectra sp.	larvae									
Family : Empididae	larvae					2				
Chelifera sp.	larvae									
Oreogeton sp.	larvae				2					
Family : Ceratopogonidae	larvae									

EMS Number		E238623	E238623	E238623	E238639	E238639	E238639	E238629	E238629	E238629
FES Sample Number		990281	990282	990283	990326	990327	990328	990299	990300	990301
Site Name		Bob	Bob	Bob	Byman Ref.	Byman Ref.	Byman Ref.	Byman	Byman	Byman
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Bezzia / Probezzia sp.	larvae	1				3		2	2	3
Family : Tipulidae	larvae							1	1	2
Tipula abdominalis	larvae									
Dicranota sp.	larvae									
Hexatoma sp.	larvae				1					
Rhabdomastix sp.	larvae									
Antocha sp.	larvae									
Family : Athericidae	larvae									
Atherix sp.	larvae									
Family : Simuliidae	larvae				2	1	1			
Family : Simuliidae	pupae									
Cnephia sp.	larvae									
Simulium sp.	pupae									
Simulium sp.	larvae	1								
Simulium ?	larvae									
Family : Stratiomyidae	larvae									
Family : Tanyderidae	larvae									
Protoplasa fitchii	larvae									
Family : Psychodidae	larvae									
Pericoma sp.	larvae			1		1		9	16	14
Order : Coleoptera	adult				1	1				
Family : Elmidae	adult								1	1
Family : Elmidae	larvae	11	1	5	2					
Lara sp.	larvae									
Narpus ?	larvae				1					
Optioservus sp.	larvae						1			
Family : Curculionidae ?										
Family : Dytiscidae	larvae									
Family : Gyrinidae ?	larvae									
Order : Collembola		1		3	1	2	1	2		
Family : Sminthuridae										
Sub-Class : Ostracoda				3			1			
Sub-class : Copepoda										
Order : Cyclopoida										
Order : Harpacticoida										
Phylum : Nematoda			1		1					
Class: Arachnoida										
Group : Hydracarina		9	6	11	16	22	8	35	79	54
Family : Protziidae										
Wandesia sp.										
Division : Oribatei							1			
Phylum : Mollusca										
Class : Gastropoda										
Family : Planorbidae										
Order : Pelecypoda										
Phylum : Platyhelminthes										
Class : Turbellaria		14	5	4						
Polycelis coronata										
Total		428	704	990	238	373	257	125	339	363
# of Taxa		22	20	24	37	27	27	20	22	20
# of Ephemeroptera		7	7	9	8	8	9	5	7	6
# of Plecoptera		3	4	3	6	4	6	4	5	3
# of Tricoptera		2	2	2	5	2	2	2	2	3
# of Long- Lived Taxa (sv?)		0			0			0		
# of Intolerant Taxa		0			1			0		
% of Individuals in Tol. Taxa		0.23%	0.00%	0.00%	3.78%	2.14%	4.67%	1.60%	4.13%	2.75%
% of Predator Individuals		11.45%	6.68%	2.53%	5.88%	10.19%	6.23%	12.00%	7.37%	7.71%
# of Clinger taxa		8	6	7	12	8	10	4	6	6
% dominance (3 taxa)		42%	60%	73%	42%	38%	43%	53%	58%	44%
% Oligochaetes		0.0%	0.0%	0.0%	2.9%	2.1%	4.3%	1.6%	4.1%	2.8%
% Chironomids		25.9%	41.8%	64.6%	43.3%	37.5%	38.5%	7.2%	10.9%	11.3%

EMS Number		E638640	E638640	E638640	E238631	E238631	E238631	E238632	E238632	E238632
FES Sample Number		990329	990330	990331	990305	990306	990307	990308	990309	990310
Site Name		Ailport	Ailport	Ailport	Richfield d/s	Richfield d/s	Richfield d/s	Richfield u/s	Richfield u/s	Richfield u/s
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Phylum : Nematomorpha										
Class : Oligochaeta		2			3					
Family : Lumbricidae										
Family: Naididae										
Nais sp.										
Order : Ephemeroptera	adult									
Order : Ephemeroptera	nymph	11	37	4	10	25		10	9	
Family : Ameletidae	nymph									
Ameletus sp.	nymph	20			2			11	18	16
Family : Ephemerellidae	nymph	4	9	2			1			
Drunella doddsi	nymph	8	14	2						
Drunella grandis	nymph									
Drunella sp.	nymph	1			17	17	9			9
Drunella ?	nymph									
Ephemerella	larvae									
Serratella sp.	nymph									
Family : Heptageniidae	nymph	32	24	16	17		13			
Cinygmula sp.	nymph	2								
Epeorus sp.	nymph		2	1		2	4		5	
Rhithrogena sp.	nymph	64	100	47	22	44	39	20	34	23
Stenonema	larvae									
1st instar	larvae									
Family : Baetidae	nymph									
Baetis sp.	nymph	60	210	118	7	12	24	83	23	79
Baetis ?	nymph									
Family : Leptophlebiidae	nymph					1		9		
Paraleptophlebia sp.	nymph	23	27	15					9	4
Order : Plecoptera	juvenile	20	85	20						
Order : Plecoptera	nymph				28	2	6	26	11	22
Family : Capniidae	juvenile									
Family : Capniidae	nymph	4	10	1						
Family : Chloroperlidae	juvenile									
Family : Chloroperlidae	nymph	3	8		1					
Kathroperla sp.										
Alloperla	larvae									
Paraperla	larvae									
Suwallia sp.	nymph									
Sweltsa sp.	nymph									
Sweltsa complex	nymph	52	84	52	21	29	13	6	5	9
Sweltsa complex ?	nymph									
Family : Taeniopterygidae	juvenile									
Family : Taeniopterygidae	nymph	3	6							
Family : Nemouridae	nymph				7		1			
Amphinemura sp.	nymph									
Visoka	larvae									
Nemoura	larvae									
Zapada sp.	nymph	67	101	23				29	16	49
Zapada ?	nymph									
Family : Perlodidae	nymph	1	5				1	1		4
Megarcys sp.	nymph									
Megarcys?	nymph									
Isoperla	larvae									
Acrynopteryx	larvae									
1st instar	larvae									
Skwala ?	nymph									
Skwala sp.	nymph									
Family : Pteronarcyidae	nymph		1							
Pteronarcella sp.	nymph	1	1							
Pteronarcys sp.	nymph									
Family : Perlidae	nymph	2	3			1	2			2
Doroneuria sp.	nymph								2	
Hesperoperla sp.	nymph			1						
Family : Leuctridae / Capniidae	nymph				1					
Phylum : Coelenterata										
Hydra sp.										
Order : Lepidoptera										

EMS Number		E638640	E638640	E638640	E238631	E238631	E238631	E238632	E238632	E238632
FES Sample Number		990329	990330	990331	990305	990306	990307	990308	990309	990310
Site Name		Ailport	Ailport	Ailport	Richfield d/s	Richfield d/s	Richfield d/s	Richfield u/s	Richfield u/s	Richfield u/s
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Order: Thysanoptera	adult									
Order: Hymenoptera		1								
Order : Hemiptera										
Family : Aphididae					1	9	4	1		
Sub-order : Homoptera	adult									
Sub-order : Homoptera	nymph	3								
Order : Trichoptera	larvae					18	11	28		11
Order : Trichoptera	juvenile	65	81	22						
Order : Trichoptera	pupae							1		
Family : Glossosomatidae	larvae									
Glossosoma sp.	larvae		1	2						
Family : Rhyacophilidae	pupae									
Family : Rhyacophilidae	larvae									
Rhyacophila sp.	larvae	1	1			1	5	1		2
Rhyacophila ?	larvae									
Family : Hydropsychidae	juvenile	37	206	8						
Family : Hydropsychidae	larvae					37		2	3	1
Arctopsyche sp.	larvae		2				20		1	
Hydropsyche sp.	larvae									
Hydropsyche ?	larvae									
Ceratopsyche ?	larvae									
Parapsyche sp.	larvae									
Family : Brachycentridae	larvae									
Brachycentrus sp.	larvae									
Family : Hydroptilidae	juvenile									
Family : Hydroptilidae ?	pupae									
Family : Hydroptilidae	larvae					2		7	5	16
Family : Hydroptilidae ?	larvae									43
Family : Limnephilidae	juvenile	7								
Family : Limnephilidae	larvae									
Dicosmoecus sp.	larvae									
Order : Diptera	adult				4	7		2	3	7
Order : Diptera	pupae				5	2		8	9	26
Order : Diptera	larvae									
Family : Dixidae	larvae									
Family : Chironomidae	adult	1	1	2						
Family : Chironomidae	pupae	13	14	3						
Family : Chironomidae	larvae	14	46	3	160	125	120	136	46	200
Sub-family : Orthocladiinae	larvae	115	131	34						
Cricotopus spp.	larvae									
Cricotopus / Orthocladius sp.	larvae				10	Present	70	53	240	
Orthocladius sp.	larvae									
Corynoneura sp.	larvae	6		1						
Eukiefferiella sp.	larvae						30	36	23	
Eukiefferiella sp. ?	larvae									
Rheocricotopus sp.	larvae									
Thienemanniella sp.	larvae									
Synorthocladuis sp.	larvae							Present		
Sub-family : Prodiamesinae	larvae									
Sub-family : Diamesinae	larvae						Present			
Boreoheptagyia sp.	larvae									
Diamesa sp.	larvae									
Diamesa ?	larvae									
Pagastia sp.	larvae									
Potthastia sp.	larvae									
Sub-family : Tanypodinae	larvae	3	4							
Thienemannimyia group	larvae									
Sub-family : Tanytarsini	larvae									
Tribe : Tanytarsini	pupae									
Tribe : Tanytarsini	larvae	28	49	5						
Sub-family : Chironominae	larvae									
Micropsectra sp.	larvae				6	Present				
Family : Empididae	larvae		2							
Chelifera sp.	larvae									
Oreogeton sp.	larvae									
Family : Ceratopogonidae	larvae									

EMS Number		E638840	E638840	E638840	E238631	E238631	E238631	E238632	E238632	E238632
FES Sample Number		990329	990330	990331	990305	990306	990307	990308	990309	990310
Site Name		Ailport	Ailport	Ailport	Richfield d/s	Richfield d/s	Richfield d/s	Richfield u/s	Richfield u/s	Richfield u/s
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Bezzia / Probezzia sp.	larvae		5	1	4	1		7		6
Family : Tipulidae	larvae		1			1		1		1
Tipula abdominalis	larvae									
Dicranota sp.	larvae									
Hexatoma sp.	larvae									
Rhabdomastix sp.	larvae									
Antocha sp.	larvae									
Family : Athericidae	larvae									
Atherix sp.	larvae									3
Family : Simuliidae	larvae		36							1
Family : Simuliidae	pupae						6			
Cnephia sp.	larvae									
Simulium sp.	pupae									
Simulium sp.	larvae				1	13				
Simulium ?	larvae						67			
Family : Stratiomyidae	larvae									
Family : Tanyderidae	larvae									
Protoplasa fitchii	larvae									
Family : Psychodidae	larvae						1			
Pericoma sp.	larvae	2	9	1	6	5		4	1	12
Order : Coleoptera	adult									
Family : Elmidae	adult				2					
Family : Elmidae	larvae				1					
Lara sp.	larvae									
Narpus ?	larvae									
Optioservus sp.	larvae									
Family : Curculionidae ?			1	1						
Family : Dytiscidae	larvae									
Family : Gyrinidae ?	larvae									
Order : Collembola		2			3	3				
Family : Sminthuridae										
Sub-Class : Ostracoda		1	2							1
Sub-class : Copepoda										
Order : Cyclopoida		3	2	1						
Order : Harpacticoida										
Phylum : Nematoda		1	1		1			1		3
Class: Arachnoida										
Group : Hydracarina		16	15	3	51	1	7	11	1	12
Family : Protziidae										
Wandesia sp.		2	22	5						
Division : Oribatei			1							
Phylum : Mollusca										
Class : Gastropoda										
Family : Planorbidae										
Order : Pelecypoda										
Phylum : Platyhelminthes										
Class : Turbellaria		1	1							
Polycelis coronata		1								
Total		703	1361	394	391	358	454	494	464	562
# of Taxa		39	40	26	24	24	23	24	19	24
# of Ephemeroptera		10	8	8	6	6	6	5	6	5
# of Plecoptera		9	10	5	5	3	5	4	4	5
# of Tricoptera		4	5	3	0	4	3	4	3	5
# of Long- Lived Taxa (sv?)		1			0			0		
# of Intolerant Taxa		1			0			0		
% of Individuals in Tol. Taxa		0.28%	0.00%	0.00%	1.02%	4.19%	14.76%	1.42%	1.08%	11.03%
% of Predator Individuals		8.82%	8.38%	13.71%	6.65%	8.94%	9.03%	3.04%	1.72%	4.63%
# of Clinger taxa		11	12	8	6	7	10	4	5	6
% dominance (3 taxa)		35%	40%	55%	61%	58%	57%	55%	69%	58%
% Oligochaetes		0.3%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%
% Chironomids		25.6%	18.1%	12.2%	45.0%	34.9%	48.5%	45.5%	66.6%	35.6%

EMS Number		E238645	E238645	E238645	E238627	E238627	E238627	E238628	E238628	E238628
FES Sample Number		990338	990339	990340	990293	990294	990295	990296	990297	990298
Site Name		Richfield CN	Richfield CN	Richfield CN	McQuarrie d/s	McQuarrie d/s	McQuarrie d/s	McQuarrie ref.	McQuarrie ref.	McQuarrie ref.
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Phylum : Nematomorpha										
Class : Oligochaeta		2	1	31		1	2	1	15	3
Family : Lumbricidae										
Family: Naididae										
Nais sp.										
Order : Ephemeroptera	adult									
Order : Ephemeroptera	nymph	68	21	14		10	1	15	24	40
Family : Ameletidae	nymph									
Ameletus sp.	nymph	3			3	1	6			8
Family : Ephemerellidae	nymph	6	7	11		1				
Drunella doddsi	nymph	16	16	17						
Drunella grandis	nymph	4	9	6						
Drunella sp.	nymph			3	5		5	27	42	33
Drunella ?	nymph									
Ephemerella	larvae									
Serratella sp.	nymph	3	1	1						
Family : Heptageniidae	nymph	65	13	19	60	48	99	7	23	17
Cinygmula sp.	nymph									
Epeorus sp.	nymph		11	10				12	22	1
Rhithrogena sp.	nymph	106	73	76	23	15	15	38	48	47
Stenonema	larvae									
1st instar	larvae									
Family : Baetidae	nymph									
Baetis sp.	nymph	10	63	62	17	5	6	46	92	9
Baetis ?	nymph									
Family : Leptophlebiidae	nymph				1		2	6	11	
Paraleptophlebia sp.	nymph	4	4							19
Order : Plecoptera	juvenile	45	19	19						
Order : Plecoptera	nymph				11				16	5
Family : Capniidae	juvenile									
Family : Capniidae	nymph	6	1							
Family : Chloroperlidae	juvenile									
Family : Chloroperlidae	nymph	3	1	3						
Kathroperla sp.										
Alloperla	larvae									
Paraperla	larvae									
Suwallia sp.	nymph									
Sweltsa sp.	nymph									
Sweltsa complex	nymph	117	40	47	25	18	17	19	29	12
Sweltsa complex ?	nymph									
Family : Taeniopterygidae	juvenile									
Family : Taeniopterygidae	nymph									
Family : Nemouridae	nymph						1	3	11	
Amphinemura sp.	nymph									
Visoka	larvae									
Nemoura	larvae									
Zapada sp.	nymph	19	19	40	10					
Zapada ?	nymph									
Family : Perlodidae	nymph				1	1	1			1
Megarcys sp.	nymph									
Megarcys?	nymph									
Isoperla	larvae									
Acrynopteryx	larvae									
1st instar	larvae									
Skwala ?	nymph									
Skwala sp.	nymph			7						
Family : Pteronarcyidae	nymph									
Pteronarcella sp.	nymph	2	2							
Pteronarcys sp.	nymph									
Family : Perlidae	nymph	3	4	4						
Doroneuria sp.	nymph									
Hesperoperla sp.	nymph									
Family : Leuctridae / Capniidae	nymph				6		3	1		
Phylum : Coelenterata										
Hydra sp.										
Order : Lepidoptera										

EMS Number		E238645	E238645	E238645	E238627	E238627	E238627	E238628	E238628	E238628
FES Sample Number		990338	990339	990340	990293	990294	990295	990296	990297	990298
Site Name		Richfield CN	Richfield CN	Richfield CN	McQuarrie d/s	McQuarrie d/s	McQuarrie d/s	McQuarrie ref.	McQuarrie ref.	McQuarrie ref.
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Order: Thysanoptera	adult	1	1							
Order: Hymenoptera		3	1	2						
Order : Hemiptera										
Family : Aphididae					6	9	1			
Sub-order : Homoptera	adult									
Sub-order : Homoptera	nymph	1	12	8						
Order : Trichoptera	larvae				4		5	10	50	42
Order : Trichoptera	juvenile	58	61	10						
Order : Trichoptera	pupae									
Family : Glossosomatidae	larvae									
Glossosoma sp.	larvae							6		
Family : Rhyacophilidae	pupae									
Family : Rhyacophilidae	larvae							1		
Rhyacophila sp.	larvae	1	2	3					2	
Rhyacophila ?	larvae									
Family : Hydropsychidae	juvenile	37	181	201						
Family : Hydropsychidae	larvae							24		1
Arctopsyche sp.	larvae		2	4	2				41	
Hydropsyche sp.	larvae		69	51						
Hydropsyche ?	larvae									
Ceratopsyche ?	larvae									
Parapsyche sp.	larvae									
Family : Brachycentridae	larvae									
Brachycentrus sp.	larvae							1	1	
Family : Hydroptilidae	juvenile									
Family : Hydroptilidae ?	pupae									
Family : Hydroptilidae	larvae									
Family : Hydroptilidae ?	larvae									
Family : Limnephilidae	juvenile	56	10							
Family : Limnephilidae	larvae									
Dicosmoecus sp.	larvae									
Order : Diptera	adult		4	6	19	32	5	2	1	1
Order : Diptera	pupae		2	2		2	1			4
Order : Diptera	larvae		1							
Family : Dixidae	larvae			1	1		1			
Family : Chironomidae	adult	3	7	16						
Family : Chironomidae	pupae	11	10	20						
Family : Chironomidae	larvae	22	113	31	18	24	13	20	95	198
Sub-family : Orthocladiinae	larvae	187	338	318						
Cricotopus spp.	larvae	7	5	5						
Cricotopus / Orthocladius sp.	larvae									
Orthocladius sp.	larvae		2							
Corynoneura sp.	larvae	1	1	4						
Eukiefferiella sp.	larvae	6	4							
Eukiefferiella sp. ?	larvae									
Rheocricotopus sp.	larvae									
Thienemanniella sp.	larvae	2	1	3						
Synorthocladuis sp.	larvae									
Sub-family : Prodiamesinae	larvae									
Sub-family : Diamesinae	larvae									
Boreoheptgyia sp.	larvae									
Diamesa sp.	larvae									
Diamesa ?	larvae									
Pagastia sp.	larvae									
Potthastia sp.	larvae									
Sub-family : Tanypodinae	larvae									
Thienemannimyia group	larvae									
Sub-family : Tanytarsini	larvae	47	9	34						
Tribe : Tanytarsini	pupae									
Tribe : Tanytarsini	larvae									
Sub-family : Chironominae	larvae									
Micropsectra sp.	larvae									
Family : Empididae	larvae	1						1		
Chelifera sp.	larvae									
Oreogeton sp.	larvae									
Family : Ceratopogonidae	larvae									

EMS Number		E238645	E238645	E238645	E238627	E238627	E238627	E238628	E238628	E238628
FES Sample Number		990338	990339	990340	990293	990294	990295	990296	990297	990298
Site Name		Richfield CN	Richfield CN	Richfield CN	McQuarrie d/s	McQuarrie d/s	McQuarrie d/s	McQuarrie ref.	McQuarrie ref.	McQuarrie ref.
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Bezzia / Probezzia sp.	larvae	3	3	4	5	2	3	1	3	6
Family : Tipulidae	larvae	2	3	2			1	1		2
Tipula abdominalis	larvae									
Dicranota sp.	larvae	1	1	1						
Hexatoma sp.	larvae	9	2	3						
Rhabdomastix sp.	larvae									
Antocha sp.	larvae									
Family : Athericidae	larvae									
Atherix sp.	larvae	2								
Family : Simuliidae	larvae	5	652	127						
Family : Simuliidae	pupae	1	6	12						
Cnephia sp.	larvae									
Simulium sp.	pupae									
Simulium sp.	larvae				1		1		4	
Simulium ?	larvae									
Family : Stratiomyidae	larvae									
Family : Tanyderidae	larvae									
Protoplasa fitchii	larvae									
Family : Psychodidae	larvae									
Pericoma sp.	larvae		1	3	21	6	14	6	22	22
Order : Coleoptera	adult	21		2		1			3	1
Family : Elmidae	adult									
Family : Elmidae	larvae		1	3	7		4	2	8	12
Lara sp.	larvae	3	4	4						
Narpus ?	larvae									
Optioservus sp.	larvae	1								
Family : Curculionidae ?										
Family : Dytiscidae	larvae									
Family : Gyrinidae ?	larvae									
Order : Collembola		2	8	17	7	24				
Family : Sminthuridae		1								
Sub-Class : Ostracoda		1	6	13						
Sub-class : Copepoda										
Order : Cyclopoida			1	1						
Order : Harpacticoida										
Phylum : Nematoda				2				1		1
Class: Arachnoida										
Group : Hydracarina		59	18	51	234	92	155	12	18	28
Family : Protziidae										
Wandesia sp.		3	3	2						
Division : Oribatei		6	7	3						
Phylum : Mollusca										
Class : Gastropoda					1		1			
Family : Planorbidae										
Order : Pelecypoda										
Phylum : Platyhelminthes										
Class : Turbellaria										
Polycelis coronata		2	1	1						
Total		1048	1858	1340	488	292	363	263	581	513
# of Taxa		**49**	**61**	**49**	**24**	**17**	**24**	**25**	**23**	**23**
# of Ephemeroptera		**10**	**10**	**10**	**6**	**6**	**7**	**7**	**7**	**8**
# of Plecoptera		**7**	**7**	**6**	**5**	**2**	**4**	**3**	**3**	**3**
# of Tricoptera		**4**	**6**	**5**	**2**	**0**	**1**	**5**	**4**	**2**
# of Long- Lived Taxa (sv?)		**2**			**0**			**0**		
# of Intolerant Taxa		**1**			**0**			**0**		
% of Individuals in Tol. Taxa		**0.48%**	**3.77%**	**6.12%**	**0.20%**	**0.34%**	**0.83%**	**0.38%**	**3.27%**	**0.58%**
% of Predator Individuals		**13.38%**	**2.96%**	**5.67%**	**6.76%**	**7.19%**	**5.79%**	**8.37%**	**12.91%**	**3.70%**
# of Clinger taxa		**14**	**16**	**16**	**6**	**4**	**5**	**9**	**9**	**6**
% dominance (3 taxa)		**39%**	**63%**	**49%**	**65%**	**60%**	**75%**	**42%**	**41%**	**56%**
% Oligochaetes		**0.2%**	**0.1%**	**2.3%**	**0.0%**	**0.3%**	**0.6%**	**0.4%**	**2.6%**	**0.6%**
% Chironomids		**27.4%**	**26.4%**	**32.2%**	**3.7%**	**8.2%**	**3.6%**	**8.0%**	**16.4%**	**38.6%**

EMS Number		E238633	E238633	E238633	E238634	E238634	E238634	E238635	E238635	E238635
FES Sample Number		990311	990312	990313	990314	990315	990316	990317	990318	990319
Site Name		Cesford Ref	Cesford Ref	Cesford Ref	Cesford u/s	Cesford u/s	Cesford u/s	Cesford d/s	Cesford d/s	Cesford d/s
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Phylum : Nematomorpha										
Class : Oligochaeta		5	15	3		1	3	3	7	10
Family : Lumbricidae										
Family: Naididae										
Nais sp.										
Order : Ephemeroptera	adult	93	72							
Order : Ephemeroptera	nymph					95	303	60		
Family : Ameletidae	nymph									
Ameletus sp.	nymph		23	12	2		10	2	31	
Family : Ephemerellidae	nymph								5	11
Drunella doddsi	nymph								2	16
Drunella grandis	nymph									
Drunella sp.	nymph	23	26	46	39	22	12	20		
Drunella ?	nymph									
Ephemerella	larvae									
Serratella sp.	nymph									2
Family : Heptageniidae	nymph	5	15	42	34	24	33	44	24	26
Cinygmula sp.	nymph								18	6
Epeorus sp.	nymph	1			15	5	19	17		10
Rhithrogena sp.	nymph	1		4	8	13	7	3	1	8
Stenonema	larvae									
1st instar	larvae									
Family : Baetidae	nymph									1
Baetis sp.	nymph	10	11	16	14	38	16	22	17	30
Baetis ?	nymph									
Family : Leptophlebiidae	nymph								13	22
Paraleptophlebia sp.	nymph									
Order : Plecoptera	juvenile								35	48
Order : Plecoptera	nymph	81	91	44	42	109	315	12		
Family : Capniidae	juvenile									
Family : Capniidae	nymph									
Family : Chloroperlidae	juvenile									
Family : Chloroperlidae	nymph					55	59	60	31	31
Kathroperla sp.										
Alloperla	larvae									
Paraperla	larvae									
Suwallia sp.	nymph									
Sweltsa sp.	nymph									
Sweltsa complex	nymph	34	40	34	56	41	164	87	105	39
Sweltsa complex ?	nymph									
Family : Taeniopterygidae	juvenile									
Family : Taeniopterygidae	nymph									30
Family : Nemouridae	nymph		2	4		2	7			
Amphinemura sp.	nymph									
Visoka	larvae									
Nemoura	larvae									
Zapada sp.	nymph	22					5		9	34
Zapada ?	nymph							29		
Family : Perlodidae	nymph	4		5	1		2			1
Megarcys sp.	nymph								1	1
Megarcys?	nymph							2		
Isoperla	larvae									
Acrynopteryx	larvae									
1st instar	larvae									
Skwala ?	nymph									
Skwala sp.	nymph								2	
Family : Pteronarcyidae	nymph									
Pteronarcella sp.	nymph									
Pteronarcys sp.	nymph									
Family : Perlidae	nymph									
Doroneuria sp.	nymph									
Hesperoperla sp.	nymph									
Family : Leuctridae / Capniidae	nymph	3	3		1	5	7			
Phylum : Coelenterata										
Hydra sp.										
Order : Lepidoptera										

EMS Number		E238633	E238633	E238633	E238634	E238634	E238634	E238635	E238635	E238635
FES Sample Number		990311	990312	990313	990314	990315	990316	990317	990318	990319
Site Name		Cesford Ref	Cesford Ref	Cesford Ref	Cesford u/s	Cesford u/s	Cesford u/s	Cesford d/s	Cesford d/s	Cesford d/s
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Order: Thysanoptera	adult									
Order: Hymenoptera			1						2	2
Order : Hemiptera										
Family : Aphididae					3		3	16		
Sub-order : Homoptera	adult									
Sub-order : Homoptera	nymph								9	1
Order : Trichoptera	larvae	4	7	13	5	2	7	1		
Order : Trichoptera	juvenile								16	1
Order : Trichoptera	pupae	7	5		2	1	4	1		
Family : Glossosomatidae	larvae									
Glossosoma sp.	larvae	6	1		8	4	5	2	4	2
Family : Rhyacophilidae	pupae									
Family : Rhyacophilidae	larvae									
Rhyacophila sp.	larvae	21	35	18		25	27	14	10	5
Rhyacophila ?	larvae				14					
Family : Hydropsychidae	juvenile									
Family : Hydropsychidae	larvae									
Arctopsyche sp.	larvae									
Hydropsyche sp.	larvae									
Hydropsyche ?	larvae									
Ceratopsyche ?	larvae									
Parapsyche sp.	larvae									
Family : Brachycentridae	larvae									
Brachycentrus sp.	larvae									
Family : Hydroptilidae	juvenile									
Family : Hydroptilidae ?	pupae									
Family : Hydroptilidae	larvae									
Family : Hydroptilidae ?	larvae									
Family : Limnephilidae	juvenile									
Family : Limnephilidae	larvae	63	34	25					2	
Dicosmoecus sp.	larvae									
Order : Diptera	adult	5	1	2	1	20	5	27	2	
Order : Diptera	pupae	13	8	4	2	8	13	39		
Order : Diptera	larvae		1		112					
Family : Dixidae	larvae	1			1			1	1	1
Family : Chironomidae	adult								5	20
Family : Chironomidae	pupae								53	29
Family : Chironomidae	larvae	1200	1248	1040		120	240	420	307	85
Sub-family : Orthocladiinae	larvae	140	12	59			10	40	57	52
Cricotopus spp.	larvae								15	15
Cricotopus / Orthocladius sp.	larvae								145	
Orthocladius sp.	larvae									
Corynoneura sp.	larvae								9	6
Eukiefferiella sp.	larvae									
Eukiefferiella sp. ?	larvae									
Rheocricotopus sp.	larvae								9	4
Thienemanniella sp.	larvae		24						25	8
Synorthocladuis sp.	larvae									
Sub-family : Prodiamesinae	larvae									
Sub-family : Diamesinae	larvae									
Boreoheptagyia sp.	larvae									
Diamesa sp.	larvae		60	89			17			
Diamesa ?	larvae	140								
Pagastia sp.	larvae									
Potthastia sp.	larvae								1	1
Sub-family : Tanypodinae	larvae									
Thienemannimyia group	larvae								36	12
Sub-family : Tanytarsini	larvae									
Tribe : Tanytarsini	pupae									
Tribe : Tanytarsini	larvae								196	25
Sub-family : Chironominae	larvae									
Micropsectra sp.	larvae		12	Present			20	61		
Family : Empididae	larvae									
Chelifera sp.	larvae								1	
Oreogeton sp.	larvae									
Family : Ceratopogonidae	larvae									

EMS Number		E238633	E238633	E238633	E238634	E238634	E238634	E238635	E238635	E238635
FES Sample Number		990311	990312	990313	990314	990315	990316	990317	990318	990319
Site Name		Cesford Ref	Cesford Ref	Cesford Ref	Cesford u/s	Cesford u/s	Cesford u/s	Cesford d/s	Cesford d/s	Cesford d/s
Replicate #		1	2	3	1	2	3	1	2	3
units	stage									
Bezzia / Probezzia sp.	larvae	4	10		1		2	6	6	1
Family : Tipulidae	larvae	1	4	3		1	3	1		
Tipula abdominalis	larvae								2	1
Dicranota sp.	larvae								1	
Hexatoma sp.	larvae									
Rhabdomastix sp.	larvae									
Antocha sp.	larvae									
Family : Athericidae	larvae									
Atherix sp.	larvae									
Family : Simuliidae	larvae								1	5
Family : Simuliidae	pupae			1				32		
Cnephia sp.	larvae									
Simulium sp.	pupae									
Simulium sp.	larvae	4	2	4	1		7	132		
Simulium ?	larvae									
Family : Stratiomyidae	larvae									
Family : Tanyderidae	larvae									
Protoplasa fitchii	larvae									
Family : Psychodidae	larvae									
Pericoma sp.	larvae		1				1	8	12	4
Order : Coleoptera	adult			2			6	3		1
Family : Elmidae	adult									
Family : Elmidae	larvae	2	1	2	16	20	16	11	9	4
Lara sp.	larvae									
Narpus ?	larvae								3	
Optioservus sp.	larvae									
Family : Curculionidae ?										
Family : Dytiscidae	larvae								1	1
Family : Gyrinidae ?	larvae									
Order : Collembola				1		3	1	8	6	2
Family : Sminthuridae										1
Sub-Class : Ostracoda		2	4	2	2	1	2			
Sub-class : Copepoda										
Order : Cyclopoida										
Order : Harpacticoida										
Phylum : Nematoda			2	1	2	2	2		2	
Class: Arachnoida		2						2	1	1
Group : Hydracarina		87	151	87	10	29	96	18	22	5
Family : Protziidae										
Wandesia sp.										
Division : Oribatei										
Phylum : Mollusca										
Class : Gastropoda			4	2						
Family : Planorbidae										
Order : Pelecypoda										
Phylum : Platyhelminthes										
Class : Turbellaria		23	3	2	3	9	1	16		
Polycelis coronata										
Total		2007	1929	1567	395	653	1450	1220	1272	621
# of Taxa		29	31	29	23	24	35	33	48	44
# of Ephemeroptera		6	5	5	6	6	7	7	8	10
# of Plecoptera		5	4	4	4	5	7	5	6	7
# of Tricoptera		4	4	3	3	3	3	3	4	3
# of Long- Lived Taxa (sv?)		0			0			0		
# of Intolerant Taxa		1			0			1		
% of Individuals in Tol. Taxa		0.45%	0.88%	0.45%	0.25%	0.15%	0.69%	11.07%	0.55%	1.61%
% of Predator Individuals		3.14%	4.41%	3.64%	18.23%	18.53%	17.52%	13.85%	15.25%	14.65%
# of Clinger taxa		9	7	8	8	8	9	10	12	12
% dominance (3 taxa)		74%	77%	78%	54%	50%	59%	52%	58%	38%
% Oligochaetes		0.2%	0.8%	0.2%	0.0%	0.2%	0.2%	0.2%	0.6%	1.6%
% Chironomids		73.7%	70.3%	75.8%	0.0%	18.4%	19.8%	42.7%	67.5%	41.4%

EMS Number		E238626	E238626	E238626	E238630	E238630	E238630	E238636	E238636	E238636	400764	400764	400764
FES Sample Number		990290	990291	990292	990302	990303	990304	990323	990324	990325	990533	990534	990535
Site Name		Barren	Barren	Barren	Johnny David	Johnny David	Johnny David	Crow	Crow	Crow	Foxy b/m	Foxy b/m	Foxy b/m
Replicate #		1	2	3	1	2	3	1	2	3	1	2	3
units	stage												
Phylum : Nematomorpha													
Class : Oligochaeta					2			3		1			
Family : Lumbricidae													
Family: Naididae												1	
Nais sp.													1
Order : Ephemeroptera	adult											1	
Order : Ephemeroptera	nymph	20		32	40	8	133	79	78	19			
Family : Ameletidae	nymph												
Ameletus sp.	nymph	12		2	7		8	2	3		1		
Family : Ephemerellidae	nymph	4	4	6				6	9		31	13	27
Drunella doddsi	nymph							69	30	52	7	32	14
Drunella grandis	nymph												
Drunella sp.	nymph	2	1	8	7	9	22	1		1			
Drunella ?	nymph												
Ephemerella	larvae												
Serratella sp.	nymph							2	1	2			
Family : Heptagenidae	nymph	17	10	30	60	18	53	52	14	12	26	10	12
Cinygmula sp.	nymph							3	2		1	2	16
Epeorus sp.	nymph		24	24	2	1	8	32	9	38	21	34	18
Rhithrogena sp.	nymph	6	12	11	1	1		40	29	36	2	4	1
Stenonema	larvae												
1st instar	larvae												
Family : Baetidae	nymph												
Baetis sp.	nymph	19	39	46	20	26	76	304	97	370	192	333	81
Baetis ?	nymph												
Family : Leptophlebiidae	nymph	2	1	2	1		3					46	4
Paraleptophlebia sp.	nymph							4	1	2	67		
Order : Plecoptera	juvenile							24	17	14	20	40	11
Order : Plecoptera	nymph	169	174	49	92	42	184						
Family : Capniidae	juvenile												
Family : Capniidae	nymph							8	5	5	15	28	2
Family : Chloroperlidae	juvenile											16	
Family : Chloroperlidae	nymph		2					4	3	2	12		3
Kathroperla sp.													
Alloperla	larvae												
Paraperla	larvae												
Suwallia sp.	nymph												
Sweltsa sp.	nymph												
Sweltsa complex	nymph	60	27	72	23	8	51	23	16	15	21	19	2
Sweltsa complex ?	nymph												
Family : Taeniopterygidae	juvenile												
Family : Taeniopterygidae	nymph			165									
Family : Nemouridae	nymph				1	6							
Amphinemura sp.	nymph												
Visoka	larvae												
Nemoura	larvae												
Zapada sp.	nymph							50	13	34	13	25	9
Zapada ?	nymph	18		57			84						
Family : Perlodidae	nymph	3		3				4		2	48	17	21
Megarcys sp.	nymph												
Megarcys?	nymph												
Isoperla	larvae												
Acrynopteryx	larvae												
1st instar	larvae												
Skwala ?	nymph				5								
Skwala sp.	nymph					2	4				1		
Family : Pteronarcyidae	nymph												
Pteronarcella sp.	nymph												
Pteronarcys sp.	nymph												
Family : Perlidae	nymph										2	25	14
Doroneuria sp.	nymph										1		
Hesperoperla sp.	nymph											1	
Family : Leuctridae / Capniidae	nymph												
Phylum : Coelenterata													
Hydra sp.									1				
Order : Lepidoptera								1					

EMS Number		E238626	E238626	E238626	E238630	E238630	E238630	E238636	E238636	E238636	400764	400764	400764
FES Sample Number		990290	990291	990292	990302	990303	990304	990323	990324	990325	990533	990534	990535
Site Name		Barren	Barren	Barren	Johnny David	Johnny David	Johnny David	Crow	Crow	Crow	Foxy b/m	Foxy b/m	Foxy b/m
Replicate #		1	2	3	1	2	3	1	2	3	1	2	3
units	stage												
Order: Thysanoptera	adult									1			
Order: Hymenoptera										1			
Order : Hemiptera												2	
Family : Aphididae		1			3	1	1						
Sub-order : Homoptera	adult												
Sub-order : Homoptera	nymph							1					
Order : Trichoptera	larvae	14	13	33	23	16	39						
Order : Trichoptera	juvenile							3	2		1		
Order : Trichoptera	pupae	1	2							1		2	
Family : Glossosomatidae	larvae												
Glossosoma sp.	larvae	1			3	1	1	2	2	1		3	
Family : Rhyacophilidae	pupae										1		
Family : Rhyacophilidae	larvae												
Rhyacophila sp.	larvae	6	6	6		1	2	14	6	6	25	16	8
Rhyacophila ?	larvae												
Family : Hydropsychidae	juvenile							20	1	37			
Family : Hydropsychidae	larvae				2	6			2			1	
Arctopsyche sp.	larvae		16	17			2						
Hydropsyche sp.	larvae					3	5						
Hydropsyche ?	larvae												
Ceratopsyche ?	larvae												
Parapsyche sp.	larvae											1	
Family : Brachycentridae	larvae												
Brachycentrus sp.	larvae									1		1	
Family : Hydroptilidae	juvenile												
Family : Hydroptilidae ?	pupae												
Family : Hydroptilidae	larvae												
Family : Hydroptilidae ?	larvae												
Family : Limnephilidae	juvenile												
Family : Limnephilidae	larvae												
Dicosmoecus sp.	larvae												
Order : Diptera	adult	3	1	1	10	4	2	1			1	3	
Order : Diptera	pupae	5	3	8	8	3	16						
Order : Diptera	larvae												
Family : Dixidae	larvae												
Family : Chironomidae	adult							3	3	8	5	6	5
Family : Chironomidae	pupae							5	7	5	1	2	5
Family : Chironomidae	larvae	119	27		170	90	232	41	33	29	7	14	
Sub-family : Orthocladiinae	larvae		1	25				67	63	62	15	55	14
Cricotopus spp.	larvae										3		
Cricotopus / Orthocladius sp.	larvae	12			17	Present	26						
Orthocladius sp.	larvae												
Corynoneura sp.	larvae										2	1	
Eukiefferiella sp.	larvae												
Eukiefferiella sp. ?	larvae												
Rheocricotopus sp.	larvae												
Thienemanniella sp.	larvae										1	2	2
Synorthocladuis sp.	larvae												
Sub-family : Prodiamesinae	larvae		1										
Sub-family : Diamesinae	larvae								2	2			
Boreoheptagyia sp.	larvae												
Diamesa sp.	larvae												
Diamesa ?	larvae												
Pagastia sp.	larvae											1	
Potthastia sp.	larvae												1
Sub-family : Tanypodinae	larvae							2	2	1		1	
Thienemannimyia group	larvae												
Sub-family : Tanytarsini	larvae												
Tribe : Tanytarsini	pupae							2					
Tribe : Tanytarsini	larvae							32	27	1	3	7	
Sub-family : Chironominae	larvae												
Micropsectra sp.	larvae	Present	20	30	3	Present	38						
Family : Empididae	larvae												
Chelifera sp.	larvae											1	1
Oreogeton sp.	larvae												1
Family : Ceratopogonidae	larvae												

EMS Number		E238626	E238626	E238626	E238630	E238630	E238630	E238636	E238636	E238636	400764	400764	400764
FES Sample Number		990290	990291	990292	990302	990303	990304	990323	990324	990325	990533	990534	990535
Site Name		Barren	Barren	Barren	Johnny David	Johnny David	Johnny David	Crow	Crow	Crow	Foxy b/m	Foxy b/m	Foxy b/m
Replicate #		1	2	3	1	2	3	1	2	3	1	2	3
units	stage												
Bezzia / Probezzia sp.	larvae	3	1	2	4	1	3	3	1	1	5		
Family : Tipulidae	larvae		3	1		2	6		1	1		2	
Tipula abdominalis	larvae							1		1			
Dicranota sp.	larvae								1				1
Hexatoma sp.	larvae							1		5			
Rhabdomastix sp.	larvae									1			
Antocha sp.	larvae												
Family : Athericidae	larvae												
Atherix sp.	larvae												
Family : Simuliidae	larvae			1				7		359			
Family : Simuliidae	pupae									11		3	
Cnephia sp.	larvae									1			
Simulium sp.	pupae												
Simulium sp.	larvae					1	4				1	27	2
Simulium ?	larvae												
Family : Stratiomyidae	larvae												
Family : Tanyderidae	larvae												
Protoplasa fitchii	larvae												
Family : Psychodidae	larvae												
Pericoma sp.	larvae	31	9	18	40	13	44	11	19	16			
Order : Coleoptera	adult	3						5	6	2	1	1	
Family : Elmidae	adult												
Family : Elmidae	larvae	8	13	32	1	1	5	17	6	5	11	7	
Lara sp.	larvae												
Narpus ?	larvae							11	1	4	4	3	13
Optioservus sp.	larvae							7		2			
Family : Curculionidae ?													
Family : Dytiscidae	larvae										1		
Family : Gyrinidae ?	larvae												
Order : Collembola					1	1		2	4		4	1	2
Family : Sminthuridae													
Sub-Class : Ostracoda		1	2	6	22		28				5	3	
Sub-class : Copepoda												3	
Order : Cyclopoida									1				
Order : Harpacticoida													
Phylum : Nematoda				2	1		1	4	2		1	2	
Class: Arachnoida										1			1
Group : Hydracarina		9	4	8	4	3	5	16	3	9	3	8	1
Family : Protziidae													
Wandesia sp.								2				4	
Division : Oribatei								2	2	5			1
Phylum : Mollusca													
Class : Gastropoda		1		1									
Family : Planorbidae													
Order : Pelecypoda													
Phylum : Platyhelminthes													
Class : Turbellaria					1								
Polycelis coronata								2	1		2	2	2
Total		550	416	698	574	268	1086	995	526	1185	584	832	296
# of Taxa		27	24	29	29	27	29	45	39	43	39	47	31
# of Ephemeroptera		8	7	9	8	6	7	12	11	9	9	9	8
# of Plecoptera		4	3	5	4	4	4	6	5	6	9	8	7
# of Tricoptera		3	3	3	3	5	5	4	4	4	3	6	1
# of Long- Lived Taxa (sv?)		0			0			0			1		
# of Intolerant Taxa		0			0			0			0		
% of Individuals in Tol. Taxa		0.00%	0.00%	0.00%	0.35%	1.49%	0.83%	1.01%	0.19%	0.25%	0.17%	3.25%	0.68%
% of Predator Individuals		13.09%	12.50%	14.33%	5.57%	4.48%	5.71%	5.13%	5.70%	2.70%	20.03%	11.66%	17.23%
# of Clinger taxa		7	9	9	7	10	9	16	13	16	12	16	11
% dominance (3 taxa)		63%	58%	42%	56%	59%	51%	45%	45%	68%	53%	52%	44%
% Oligochaetes		0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.3%	0.0%	0.1%	0.0%	0.1%	0.3%
% Chironomids		23.8%	11.8%	7.9%	33.1%	33.6%	27.3%	15.3%	26.0%	9.1%	6.3%	10.8%	9.8%

Appendix B: Habitat Assessment Forms

Stream Name:	Site No.:	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
☐ 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 Wetted Depth: ____m ____m _____m
Stream Bankfull Width: _____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 Sinuosity	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 patterns 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**

Appendix C: Benthic Invertebrate Taxa & Classifications

FES Sample Number	LL	FFG	LH	CLINGER	SED TOL	SED INTOL	TOL	SENS	COLD	COMMENTS
Phylum : Nematomorpha										
Class : Oligochaeta		cg	uv		ST		T			
Family : Lumbricidae										
Family: Naididae										
Nais sp.										
Order : Ephemeroptera		un	uv							
Family : Ameletidae										
Ameletus sp.		cg	uv							
Family : Ephemerellidae		cg	uv	cl						
Drunella doddsi		cg	uv	cl				yes	yes	
Drunella grandis		cg	uv	cl						
Drunella sp.		cg	sv	cl						
Serratella sp.		cg	uv	cl						
Ephemerella sp.		cg		cl			I			
Family : Heptageniidae		sc	uv	cl						
Cinygmula sp.		sc	uv	cl						
Epeorus sp.		sc	uv	cl						
Rhithrogena sp.		sc	uv	cl						
Family : Baetidae		cg	mv							
Baetis sp.		cg	mv							
Family : Leptophlebiidae		cg	uv							
Paraleptophlebia sp.		cg	uv							
Order : Plecoptera		un	uv							
Family : Capniidae		sh	uv							sens. family
Family : Chloroperlidae		pr	uv	cl						
Isoperla sp. ?		pr	uv	cl						common
Kathroperla sp.		pr	uv	cl			I	yes		
Kathroperla / Paraperla sp.		pr	uv	cl			I	yes		
Neaviperla sp.?										
Suwallia sp.		pr	uv	cl						
Sweltsa sp.		pr	uv	cl						
Sweltsa complex		pr	uv	cl						
Family : Taeniopterygidae		om	uv					yes		
Taenionema sp.		sc	uv					yes		
Family : Nemouridae		sh	uv							
Amphinemura sp.		sh	uv							
Zapada sp.		sh	uv							
Family : Perlodidae		pr	uv							
Cultus ?										
Megarcys sp.		pr	uv					yes	yes	cold adapted, intolerant
Skwala sp.		pr	uv							*
Family : Pteronarcyidae		om	sv							
Pteronarcella sp.	LL	om	sv							
Pteronarcys sp.		om	sv							

FES Sample Number	LL	FFG	LH	CLINGER	SED TOL	SED INTOL	TOL	SENS	COLD	COMMENTS
Family : Perlidae		pr	sv							
Doroneuria sp.		pr	sv					yes	yes	
Hesperoperla sp.		pr	sv							
Family : Leuctridae		sh	uv					yes	yes	sens. family
Family : Leuctridae / Capniidae		sh	uv					yes	yes	sens. family
Order : Lepidoptera		un	uv							
Order: Thysanoptera										
Order: Hymenoptera										
Order : Hemiptera		un	uv							
Family : Aphididae										
Sub-order : Homoptera										
Order : Trichoptera		un	uv							
Family : Glossosomatidae		sc	uv							
Glossosoma sp.		sc	uv	cl		SIT				
Family : Rhyacophilidae		pr	sv	cl						
Rhyacophila sp.		pr	sv	cl						
Family : Hydropsychidae		cf	mv	cl						
Arctopsyche sp.		pr	sv	cl		SIT				cold, swift water
Hydropsyche sp.		cf	uv	cl			T			ubiquitous
Ceratopsyche ?				cl ?						
Cheumatopsyche sp.										
Parapsyche sp.	LL	pr	sv	. cl		SIT				
Family : Brachycentridae		om	uv	cl						
Micrasema sp.		om	uv	cl						
Brachycentrus sp.		om	sv	cl						
Family : Hydroptilidae		ph	mv				T			
Family : Limnephilidae		un	uv	cl?			I?			some sp. Intolerant
Dicosmoecus sp.		om	uv							
Ecclisiomyia ?										
Order : Diptera		un	uv							
Family : Dixidae		cg	uv							
Family : Chironomidae		un	mv							
Sub-family : Orthocladiinae		cg	mv							
Crictopus spp.		cg	mv							
Crictopus / Orthocladius sp.										
Orthocladius sp.										
Corynoneura sp.		cg	mv							
Eukiefferiella sp.		om	mv							
Rheocricotopus sp.		om	mv							
Thienemanniella sp.		cg	mv							
Synorthocladuis sp.		cg	mv					yes		
Sub-family : Prodiamesinae		cg	mv							
Sub-family : Diamesinae		cg	mv							
Boreoheptgyia sp.		cg	mv							
Diamesa sp.		cg	mv							
Pagastia sp.										

FES Sample Number	LL	FFG	LH	CLINGER	SED TOL	SED INTOL	TOL	SENS	COLD	COMMENTS
Potthastia gaedii type		cg	mv					yes		
Potthastia sp.		cg	mv					yes		
Sub-family : Tanypodinae		pr	mv							
Thienemannimyia group		pr	mv							
Sub-family : Tanytarsini		cg	mv							
Tribe : Tanytarsini		cg	mv							
Sub-family : Chironominae		cg	mv							
Tanytarsus sp.										
Micropsectra sp.		cg	mv							
Family : Empididae		pr	uv							
Chelifera sp.		pr	uv							
Hemerodromia sp.										
Oreogeton sp.		pr	uv					yes	yes	
Family : Ceratopogonidae		pr	uv				t			
Bezzia / Probezzia sp.		pr	uv							
Family : Tipulidae		sh	uv		ST					
Tipula abdominalis		sh	uv		ST					
Dicranota sp.		pr	uv		ST					
Ormosia sp.		pr	sv		ST					
Hexatoma sp.		pr	uv		ST					
Rhabdomastix sp.		pr	sv					yes		
Antocha sp.		cg	uv	cl	ST					
Family : Athericidae		pr					yes			
Atherix sp.		pr	uv				yes			
Family: Dixidae										
Family : Simuliidae		cf	uv	cl						
Cnephia sp.		cf		cl						
Simulium sp.		cf	uv	cl			T			
Family : Stratiomyidae		cg	uv				yes			
Family : Tanyderidae										
Protoplasa fitchii										
Family : Psychodidae		cg	uv							
Pericoma sp.		cg	uv							
Family: Tabanidae		pr	uv				T			
Tabanus sp.		pr					T			
Order : Coleoptera		un	uv							
Family : Carabidae ?										
Family : Elmidae		cg	sv							
Lara sp.	LL	sh	sv	cl						
Narpus ?		sc	sv	cl						
Optioservus sp.		sc	sv	cl			T			
Zautaevia sp.		cg	sv				yes			
Family: Haliplidae		sh					yes			
Haliplus sp.		sh					yes			
Family : Curculionidae ?										

FES Sample Number	LL	FFG	LH	CLINGER	SED TOL	SED INTOL	TOL	SENS	COLD	COMMENTS
Family : Dytiscidae		pr	sv				yes			
Family : Gyrinidae ?		pr	sv							
Order : Collembola		cg								
Family : Sminthuridae										
Class: Crustacea										
Sub-Class : Ostracoda										
Sub-class : Copepoda										
Order : Cyclopoida										
Order : Harpacticoida										
Order : Cladocera										
Bosmina sp.										
Phylum : Nematoda		om								
Class: Arachnoida										
Group : Hydracarina		pa	mv							
Family : Protziidae										
Wandesia sp.										
Division : Oribatei										
Phylum : Mollusca										
Class : Gastropoda		sc	uv		st					
Family : Planorbidae		sc	uv		yes		yes			
Order : Pelecypoda		cg	sv				I			
Family : Sphaeriidae										
Phylum : Platyhelminthes										
Class : Turbellaria										
Polycelis coronata										
Phylum : Coelenterata										
Hydra sp.		pr	mv				yes			

	Abbreviation	Classes
Long Lived	LL	
Functional Feeding Group	FFG	un = unknown cg = collector – gatherer sc = scraper pr = predator sh = shredder om = osmosis cf = collector – filterer pa = parasite
Life History	LH	uv = univoltine sv = semi-voltine mv = multiivoltine
Clinger	CL	Clinger behaviour
Sediment Tolerant	Sed Tol	
Sediment Intolerant	Sed Intol	
Sensitive	Sens.	
Cold water taxon	Cold	

Appendix D: Summary of Metrics Calculated from Raw Data

Stream	Team	ASCI Habitat Rating	Total # of taxa	Ephemeroptera Taxa	Plecoptera Taxa	Trichoptera Taxa	Long Lived Taxa	Intolerant Taxa	% Tolerants	% Predators	# Clinger Taxa	% dominance (3 taxa)	IBI Score
Allport	2	129	35	8.7	8.0	4.0	1	1	0.09%	10.30%	10.3	43%	37
Barren	3	123.5	27	8.0	4.0	3.0	0	0	0.00%	13.31%	8.3	54%	23
Bob	3	154	22	7.7	3.3	2.0	0	0	0.08%	6.88%	7.0	58%	21
Buck @ 12 km	3	159.5	21	5.3	4.0	2.7	0	1	0.57%	8.43%	7.3	55%	21
Buck @ Bulkley Conf.	3	134.5	24	5.7	3.7	3.7	0	0	0.68%	5.96%	6.7	69%	17
Buck @ Mall	3	123.5	23	5.3	5.0	2.3	0	0	0.87%	5.11%	6.3	60%	19
Bulkley @ Craker	1	131.5	21	6.7	4.0	3.0	1	0	2.66%	5.63%	5.7	56%	19
Bulkley @ Knockholt	1	157	35	8.7	7.3	3.7	1	0	0.91%	12.98%	9.7	44%	31
Bulkley @ Morice Confl.	1	141.5	26	6.7	5.3	3.7	1	0	0.31%	6.09%	7.0	61%	25
Byman	3	122	21	6.0	4.0	2.3	0	0	2.83%	9.03%	5.3	51%	17
Byman Reference	2	162.5	30	8.3	5.3	3.0	0	1	3.53%	7.43%	10.0	41%	29
Cesford @ Topley	2	111	41	8.3	6.0	3.3	0	1	4.41%	14.59%	11.3	49%	33
Cesford Reference	2	169	30	5.3	4.3	3.7	0	1	0.59%	3.73%	8.0	76%	21
Cesford above Topley	2	130	27	6.3	5.3	3.0	0	0	0.37%	18.09%	8.3	54%	25
Crow	1	139	42	10.7	5.7	4.0	0	0	0.48%	4.51%	15.0	53%	31
Foxy below mine	1	181	39	8.7	8.0	3.3	1	0	1.36%	16.31%	13.0	49%	33
Foxy @ Maxan	1	170	50	10.3	8.0	4.7	1	1	0.53%	6.71%	15.0	46%	41
Johnny David	3	116	28	7.0	4.0	4.3	0	0	0.89%	5.25%	8.7	55%	23
McQuarrie	3	119	22	6.3	3.7	1.0	0	0	0.46%	6.58%	5.0	67%	15
McQuarrie Reference	2	147	24	7.3	3.0	3.7	0	0	1.41%	8.33%	8.0	46%	23
Richfield @ CN	1	144.5	50	10.0	6.7	5.0	2	1	3.45%	7.33%	15.3	51%	39
Richfield @ hwy 16	2	131	24	6.0	4.3	2.3	0	0	6.66%	8.21%	7.7	58%	23
Richfield Upstream	2	154	22	5.3	4.3	4.0	0	0	4.51%	3.13%	5.0	61%	19