



PROJECT SUMMARY

Ecosystem
 Management

Forest Productivity

Public Involvement

Adaptive
 Management

The ecosystem management component of the Morice & Lakes IFPA has embarked on several projects that assess biodiversity, ecological attributes, and fish and wildlife habitat. These projects will provide important ecological data that will be used in learning scenario development for the IFPA's Sustainable Forest Management Plan.

Evaluation of Aquatic Ecosystem Integrity through Biomonitoring

Introduction

The Morice and Lakes Timber Supply Areas (TSAs) are rich in fresh water aquatic resources. The integrity of these natural resources is increasingly being influenced by human actions, such as those associated with forest management practices, recreation, agriculture and urbanization. As these activities encroach further on our rivers, streams and riparian habitats, the integrity of these resources may be affected through physical habitat alteration, modified hydrologic flows, increased sedimentation and temperatures and altered or disrupted energy and nutrient inputs.

To further our understanding of the overall health of aquatic ecosystems in the Morice and Lakes Timber Supply Areas and the impacts specific human disturbances have on these ecosystems, a biological monitoring study is being implemented. Historically, stream condition and aquatic health have been assessed primarily through chemical analysis of the water or assessments of the physical structure of aquatic habitats as they relate to salmonids. However, our reliance on these measurements alone as indicators of stream condition assumes we have a complete understanding of exactly what aquatic life needs to maintain a healthy state (Karr and Chu 1999). It is also assumed that we are able to effectively correlate the results of these physical and chemical assessments to give us an accurate picture of what is happening over time in terms

of the cumulative effects associated with our actions. Since our collective knowledge with regards to these critical assumptions is limited, many of the management decisions regarding future development in and around a particular watershed or stream are made without a clear understanding of the true biological condition or integrity of the aquatic ecosystems present.

Biological integrity is defined as the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition diversity and functional organization comparable to that of the natural habitat in the region (Karr et al. 1987). Since the stream biota is known to reflect the quality and state of the habitat present, a biological monitoring approach to stream assessment can incorporate and integrate ecology, life history, physiology, and taxonomy into a management and assessment tool (Thorp and Covich 2001). As such, biomonitoring studies have been used in other geographic regions to measure the response and recovery of aquatic communities to disturbances and to protect biodiversity, evaluate compliance, and improve our understanding of the relationship between the physical, chemical and biological components in these environments (Gurtz 1994).

A benthic index of biological integrity (B-IBI) is one such biomonitoring approach. A B-IBI is a multimetric



Fraser Lake Sawmills



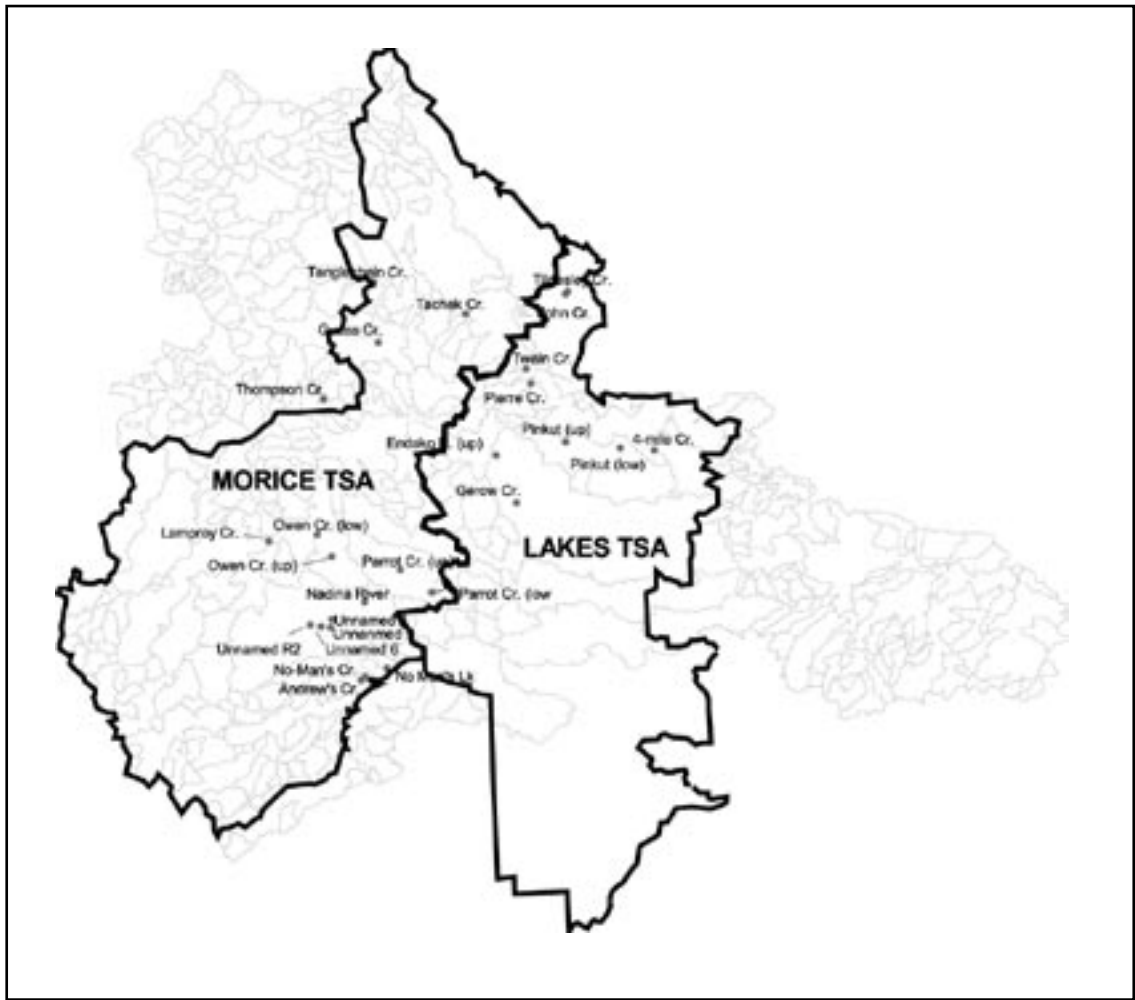


Figure 1. Sample Site Locations

assessment of stream condition based on biological data. A metric is described as a specific attribute of a community such as the number or diversity of benthic invertebrate taxa present. Benthic invertebrates were identified as effective organisms for biological monitoring because of their wide ecological amplitude, relatively sedentary behaviour and predictable responses of many taxa to different types of human disturbance (Resh et. al. 1996; Rysavy 2001).

Objective

The goal of this project is to develop and test a biomonitoring system that characterizes benthic invertebrate communities on a human disturbance gradient from highly disturbed to undisturbed aquatic ecosystems within the Morice and Lakes TSAs. It is hoped that this B-IBI can then be used as a long term monitoring tool to evaluate the impacts of forest practices on aquatic ecosystems within the Morice and Lakes TSAs. Long term monitoring capabilities are essential to the success of adaptive management initiatives and will provide a greater ability to maintain and protect the integrity of aquatic ecosystems, and the quality and quantity of water within the natural range of variability.

Methods

Site Selection

Within the Morice and Lakes TSAs, potential sample streams were selected based on their similar broad geographical, ecological and structural attributes including geographic location, stream order (3rd to 4th), elevation, biogeoclimatic classification (Sub-Boreal Spruce) and level of human influence. To clearly define the reference or control conditions for the Morice and Lakes TSAs, site selection focused on streams which were uninfluenced by human activities. To obtain adequate representation of the variability associated with the range of human influence within the Morice and Lakes TSAs, streams which were heavily influenced by forestry practices and non-forestry practices (eg: agriculture, range, urbanization etc) were also identified and selected for inclusion in the study (Figure 1).

Human Influence Gradient

With the use of a Geographic Data B.C. GIS database, entitled *Watersheds B.C.*, provided by the Ministry of Sustainable Resource Management, a quantitative index for the classification of human land use influence was developed. This province-wide database provides extensive summary information on many relevant land

use indicators (e.g., % forest land harvested) and is summarized on a watershed basis (3rd order or greater). All land use indicators or attributes are reported as a direct measurement of area, length, percentage or density which allow for a meaningful comparison between watersheds of different sizes.

Table 1. List of stream sites and level of human influence within the upstream catchment basin of the watershed.

NAME	HUMAN LANDUSE INFLUENCE				TYPE	DEGREE	
	Site_ID#	Forestry	Non-Forestry	Mining			Total
4 MILE CREEK	R32	0	0	0	0	Reference	Low
ALLIN CREEK	BU	9	0	0	9	Forestry	Low
ANDREWS CREEK	8	33	0	0	33	Forestry	Moderate
BEACH CREEK	BU	12	0	0	12	Forestry	Low
DECKER CREEK	14	28	20	0	48	Non Forestry/Forestry	High
DUNGATE CREEK	BU	30	0	0	30	Forestry	Moderate
ENDAKO RIVER (LOWER)	15	17	30	3	50	Non Forestry/Forestry	High
GEROW CREEK	R3	7	0	0	7	Reference	Low
GUESS CREEK	35	12	0	0	12	Forestry	Low
HILL-TOUT LAKE	6	26	0	0	26	Forestry	Moderate
JOHN CREEK	30	Unk	0	0	N/A	Forestry	Moderate
KEW CREEK	BU	7	0	0	7	Forestry	Low
LAMPREY REC SITE	28	18	0	0	18	Forestry	Moderate
MAXAN CREEK (upper)	R-BU	18	3	0	21	Reference	Low
MOXLEY CREEK	BU	17	9	0	26	Forestry	Moderate
NADINA RIVER	27	19	7	0	26	Non Forestry/Forestry	Moderate
NO MANS CREEK	9	23	0	0	23	Forestry	Moderate
OUTLET NO-MANS LAKE	10	25	0	0	25	Forestry	Moderate
OWEN CREEK LOWER	2	14	24	1	39	Non Forestry/Forestry	High
OWEN CREEK UPPER	33	14	24	1	39	Non Forestry/Forestry	High
PARROTT CREEK @ FORD	12	16	11	1	28	Non Forestry/Forestry	Moderate
PARROTT CREEK LOWER	11	16	11	1	28	Non Forestry/Forestry	Moderate
PIERRE CREEK	18	5	0	0	5	Reference	Low
PINKUT CREEK LOWER	16	17	0	0	17	Forestry	Moderate
PINKUT CREEK UPPER	31	17	0	0	17	Forestry	Moderate
RAMSAY CREEK	13	17	4	0	21	Non Forestry/Forestry	Moderate
TACHEK CREEK	34	12	5	1	18	Forestry	Moderate
TANGELCHAIN CREEK	36	26	0	0	26	Forestry	Moderate
TATALROSE	BU	16	29	0	45	Non Forestry/Forestry	High
THOMPSON CREEK	BU	20	27	0	47	Non Forestry/Forestry	High
TILDESLEY CREEK	29	2	0	0	2	Forestry	Moderate
TWAIN CREEK	17	6	0	0	6	Forestry	Low
UNNAMED CREEK	R2	0	0	0	0	Reference	Low
UNNAMED CREEK	4	32	0	0	32	Forestry	Moderate
UNNAMED CREEK	3	38	0	0	38	Forestry	High
UNNAMED CREEK	5	27	0	0	27	Forestry	Moderate
VALLEE CREEK	1	25	25	0	50	Non Forestry/Forestry	High

Field Sampling

To ensure accurate, defensible and comparable sampling it was recommended that the calibration and use of an IBI be linked to one particular period in the year (Karr and Chu, 1999). Late summer to early fall was previously chosen as the sampling period for the Kispiox, Upper Bulkley and Bulkley TSA IBI's (Rysavy 2000a and 2000b; Rysavy 2001). Therefore, to ensure compatibility with these ongoing projects, this sampling period was also chosen for the Morice and Lakes TSA project. This period was chosen because stream flows and turbidity are usually lower at the end of the summer and stream temperatures are high, ensuring that sampling occurs during safe and effective conditions immediately after peak biomass production (Rysavy 2000a). Twenty-six sites, representing a range of human influence, were sampled within a two-week period beginning August 15th, 2002.

Sampling at each site followed the protocols used by Karr and Chu (1999) and Rysavy (2000a, 2000b, 2001) in order to ensure

continuity between projects. At each site, the best and most accessible natural riffle within the thalweg was selected for sampling. Three replicates of three sub-samples were collected at each site starting at the downstream end of the riffle. All sampling was performed with a 250 micron Surber sampler with a Dolphin Adaptor cod end at water depths between 10 and 40 cm. Each set of three sub-samples was then combined into one sample in order to ensure an adequate sample size for each replicate (Figure 1). Samples containing less than 300 individuals have been correlated with increased sampling error for some metrics (Fore et al. 2000; Bennett 2001). To preserve the samples, 10% buffered Formalin solution was added to each sample jar.

Once the benthic invertebrate sampling was complete, each site was assessed for in-stream and riparian habitat conditions utilizing modified Fish Habitat Assessment Procedure parameters and the Standard Operating Procedures for the Alaska Stream Condition Index (ASCI).

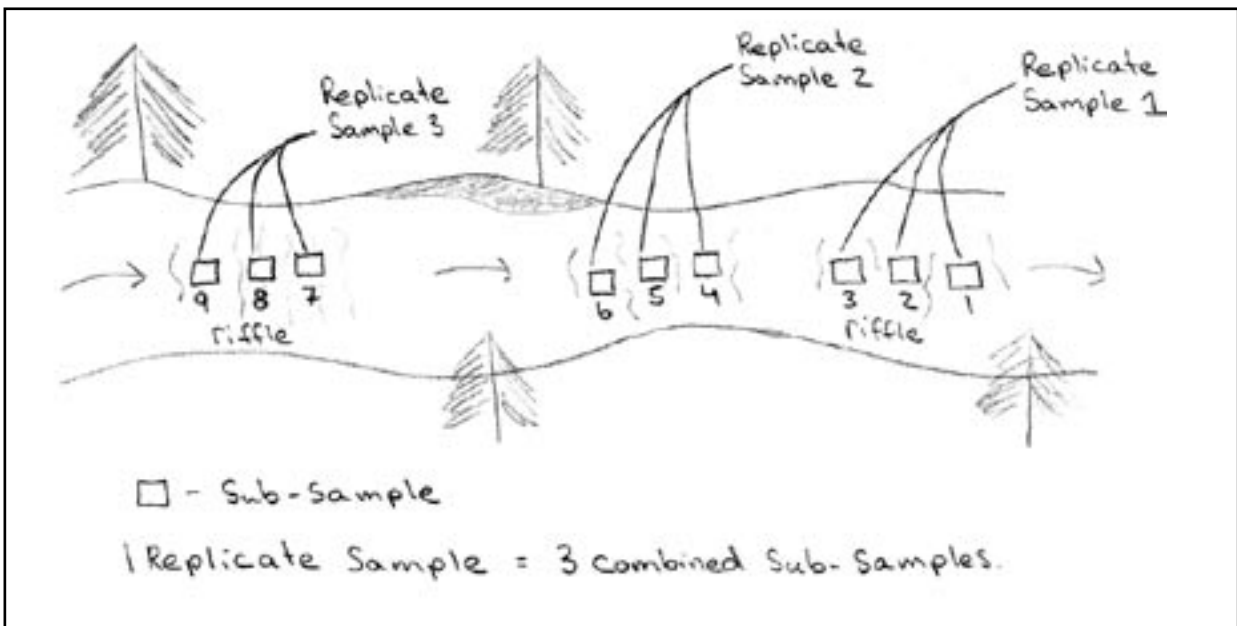


Figure 2. Field Sampling Methods

Taxonomic Classification

Each benthic invertebrate sample was shipped to Fraser Environmental Services in Surrey, B.C. for taxonomic classification. Whole samples were then sorted, analyzed, and identified to the lowest practical level (usually genus with the exception of chironomids which were sorted to family) by taxonomists.

Metric Calculation

All metrics were calculated at the genus level as described on the Salmonweb internet site (www.salmonweb.org). The genus level 10 Metric B-IBI method was chosen due to the increased level of precision that is expected to be achieved in portraying stream condition. This is because index development at the genus level allows for a greater number of metrics to be used with increased data per metric associated with lower levels of taxonomic classification (Salmonweb 2001). Functional group measures rely on functional rather than taxonomic information, and in this sense they bridge community and ecosystem level approaches to biomonitoring (Thorp and Covich 2001). Therefore, utilizing the Northwest Taxa Database from the Salmonweb, as well as Bennett (2001) and Merritt and Cummins (1996), behavioral, feeding and habitat characteristics of invertebrate taxa were identified and correlated with individual genera and families.

Eighteen different invertebrate community attributes, or metrics, were calculated for each site. Metrics calculated for this study were chosen from four broad categories of metrics: community richness and composition; tolerance and intolerance; feeding and habit; and population attributes that have been identified as key components in a balanced multimetric index (Karr and Chu 1999; Barbour et al. 1999). The metrics calculated for the Morice and Lakes B-IBI were shown to vary predictably across a gradient of human influence in previous studies as well. The metrics calculated are shown in the table below.

Metric Testing

A multimetric index combines a number of individual metrics into one score or value to allow effective comparison of multiple sites. An overall index is then the sum of the scores for the group of identified core metrics (Karr and Chu 1999). Each calculated metric was tested for its response to increasing human influence by plotting metric values against human influence scores. Each correctly responding metric was then analysed by testing the significance of the regression with an analysis of variance (ANOVA) at a 95% confidence level.

Results

Although only three of the metrics tested showed a statistically significant response to increasing human influence, a total of ten were selected for incorporation into the final genus level 10 Metric B-IBI. The remaining seven were selected based on their ability to “reasonably”, although not statistically, discriminate between low and high influenced sites within the Morice and Lakes TSAs as well as provide adequate representation of the four broad categories identified as key components in a balanced multimetric index (Karr and Chu 1999; Barbour et al. 1999). Karr and Chu 1999 show that the use of statistical relationships alone for determining the effectiveness of a particular metric to distinguish between low influence and high influence is not recommended. Weak statistical correlation can miss important biological patterns when the distribution of data does not lend itself to tests based on standard correlation techniques that detect linear relationships (Karr and Chu 1999). The metrics selected include: total number of Ephemeroptera Taxa, Plecoptera Taxa, Trichoptera Taxa, number of Intolerant Taxa, number of Clinger Taxa, relative abundance of predators, relative abundance of shredders, relative abundance of Dipterans, total taxa richness, and relative abundance of Oligochaetes. Of these, the total number of intolerant taxa, % Diptera and number of Plecoptera taxa showed a statistically significant response to increasing human influence.

Table 2. Metrics Calculated for the Morice and Lakes B-IBI

Taxa Richness and Composition	Tolerance and Intolerance	Functional Feeding and Habits	Population Attributes
Total Number of Taxa	Number of Intolerant Taxa	# of Clinger Taxa	% Dominance
# of Ephemeroptera Taxa	% Tolerant Individuals	% Predator Individuals	
# of Plecoptera Taxa	% Oligochaetes	% Clingers	
# of Trichoptera Taxa		% Shredders	
# of Long-Lived Taxa			
# of Diptera Taxa			
% Non Insects			
% Non-Insects and Diptera			
% Dipterans			
% EPT			

Morice & Lakes IFPA Project Summary

As shown in Figure 3, the majority of the sites sampled scored within the range of fair to poor stream condition with no significant differentiation between low influenced sites and moderately influenced sites. These results indicate that either the land use gradient is inadequate and unable to accurately predict the level of human influence or that there is very little variation in benthic community structure and diversity between low influenced and moderately influenced streams in the Morice and Lakes TSAs.

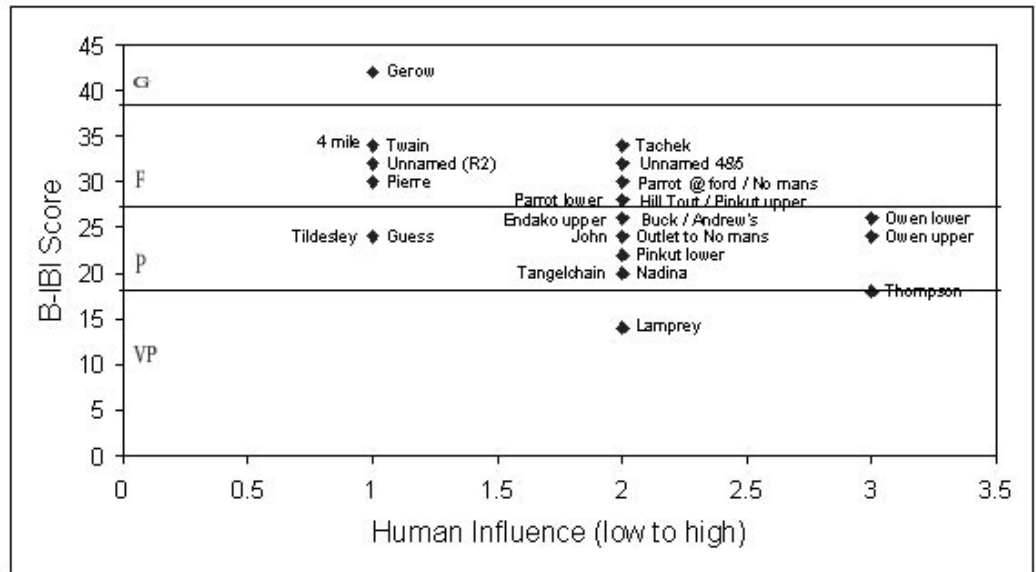


Figure 3: Final B-IBI Scores Plotted Against Degree of Human Influence in the Upstream Catchment Area

Discussion

The results of the 2002 sampling season and initial index development indicate that the natural uninfluenced stream condition in the area is not clearly defined.

Locating road accessible watersheds with suitable stream characteristics and a low level of human influence was difficult. However, seven low influence sites were identified and sampled in 2002.

The B-IBI scores associated with six of the sites (excluding Gerow Creek) scored within the range of fair to poor. The similarity between the scores associated with moderate influence sites and low influence sites indicates that the natural stream condition in the area is not clearly defined at this time. These conditions must be accurately defined in order to detect and understand change in biological systems that result from forest management activities. In order to understand change in biotic integrity we need to evaluate the change with respect to the natural condition. Accurate identification of reference conditions will also inform managers of the natural variability and allow for comparisons across watersheds.

The summer of 2002 was one of significantly lower rainfall levels than usual in both the Morice and Lakes TSAs. This resulted in several of the streams selected for sampling being completely dewatered. This sampling limitation was most notable in the streams identified as having the highest degree of human influence (Decker Creek, Tatalrose Creek, Vallee Creek and an unnamed tributary to Nadina River). The absence of significant water flow in these streams during late August may indicate that these streams are being extremely degraded. However, without the ability to sample sites of this nature, the capture of highly impacted conditions is limited.

Three streams were sampled at more than one site including Owen, Pinkut and Parrot creeks in order to validate the index and examine spatial variability. In the case of Pinkut and Parrot creeks the upstream site scored higher than the downstream site reflecting the cumulative effects associated with land use between the two sites. In Owen Creek the upstream and downstream sites scored 26 and 24 respectively. While both sites are influenced by land use the upstream site had a greater degree of influence at the reach scale due to the close proximity of the Morice Owen Road (approx 10m).

Recommendations

- Increase sample size of low impacted and high impacted sites.
- Adapt sampling plan to allow for sampling of high impact streams during adequate flow periods.
- Update land use information and validate current land use gradient.
- Local calibration of IBI should be an iterative process. Any additional data collected should be used to re-check the metric trends over a gradient of human influences and re-affirm the metric scoring cut-off points.
- Additional sampling should focus on isolation of indicator metrics for specific impacts associated with increased forest harvesting and road building within a watershed.

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Acknowledgments

The first stage of this multi-year project included the selection of potential sample sites and the development of a human influence gradient. The second stage consisted of field sampling twenty-six sites, taxonomically classifying the invertebrate samples and developing a preliminary index of biological integrity. The initiation, motivation and completion of these stages were greatly aided by several people. Many thanks to Ian Sharpe, Ministry of Water, Land and Air Protection for his enthusiasm, direction and provision of a portion of the funds for the taxonomic classification. Thank-you to Shauna Bennett for her expert advice and direction with regards to sampling protocols and index development. Thank-you to Malcolm Grey, Ministry of Sustainable Resource Management for providing the Geographic Information System (GIS) data utilized for the development and completion of a quantitative land use analysis.

Most of all thank-you to the members of the Morice and Lakes Innovative Forest Practices Agreement for their investment and the opportunity to be involved in a project such as this.

Layout and editing of this document completed by Ritchie Morrison of Tetrad Communications

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