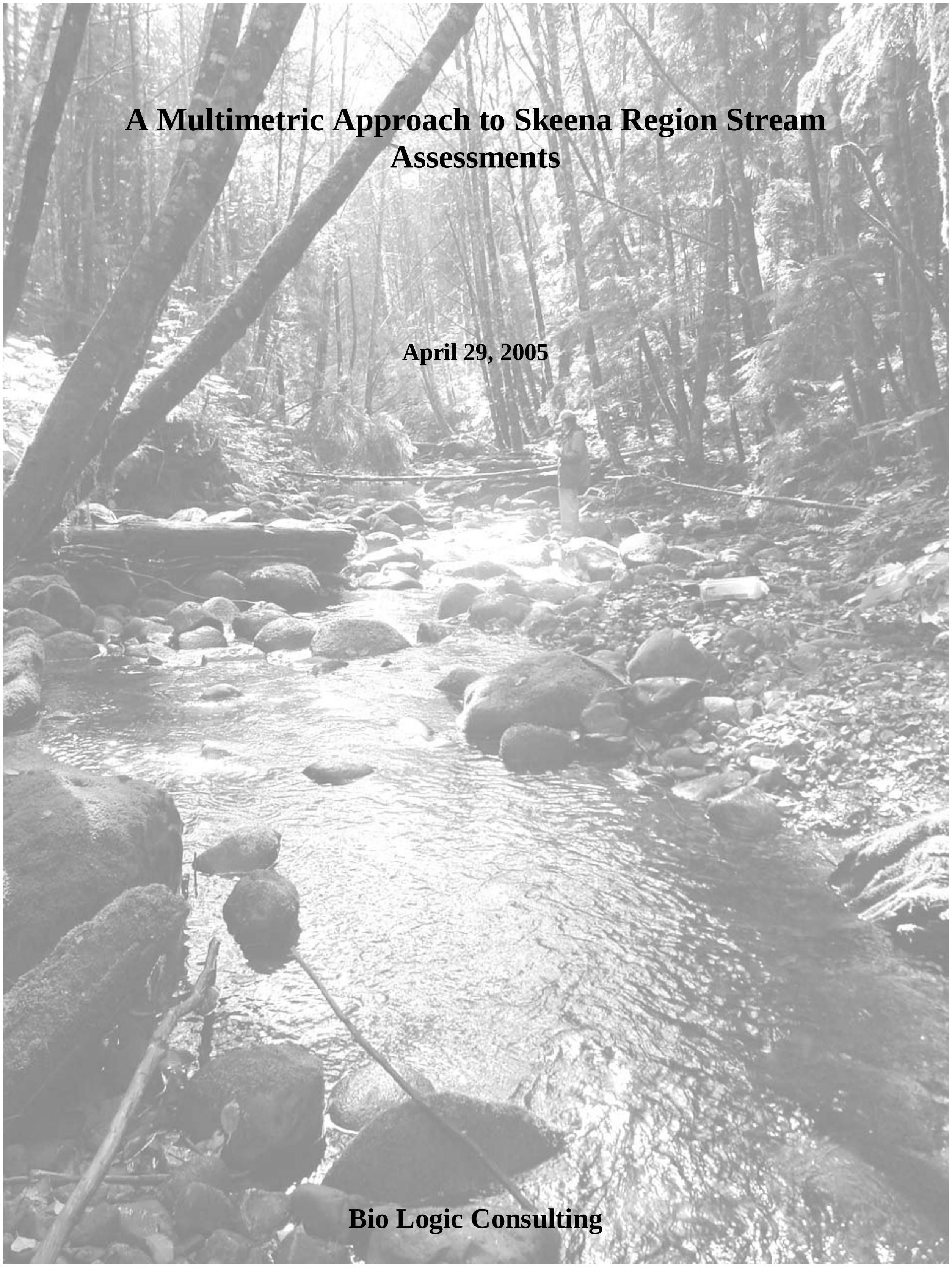

A Multimetric Approach to Skeena Region Stream Assessments

April 29, 2005

Bio Logic Consulting

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Prepared for

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Smithers, BC

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1 Introduction

The benthic invertebrate index of biological integrity (B-IBI) is a multimetric approach to interpreting biological data to assess the condition of a stream (Karr and Chu 1999). A metric is a descriptive statistic of the benthic invertebrate community. Metrics chosen for inclusion in the index must have a consistent and measurable response to increasing human influence at a stream station.

Development of a benthic invertebrate index of biological integrity (B-IBI) in the Kispiox Forest District and Upper Bulkley watershed began in 1999 (Bennett and Rysavy, 2003a, Bennett and Ohland 2002). In the following years, similar projects began in the Bulkley and Kalum Forest Districts Bennett and Rysavy 2003b) and the Lakes and Morice IFPA (Croft 2004). From the beginning, the objective was to develop a ‘results-based’ water quality assessment system to promote biological assessment in streams and the use of results in forest management decisions.

This work is part of a larger project to develop and test a benthic macroinvertebrate sustainability indicator system (Sharpe 2004). In this report, the metric results and B-IBI scores for the sites sampled in 2003 and 2004 are provided and compared with the RCA modeling results (Bailey, R.C. and S. Linke. In prep 2005 – refer to Section 8. Appendix 3 of “Benthic Macroinvertebrate Sustainability Indicator Development Project: Summary of Progress in Year 1” by Sharpe & Perrin, April 30, 2005).

2 Methods

2.1 Field and Laboratory Methods

Field and laboratory methods for this project have been described in other reports. Field methods are available in Perrin (in draft 2005). A complete description of the laboratory methods can be found in Perrin *et al* (2005).

2.2 Metric Definitions

Metrics were calculated and defined as described in Bennett (2004) and Croft (2004). A list of taxa, with assigned functional feeding groups, life history and tolerance designations have been included in an appendix (metricresults_appendix2005.xls).

2.3 Definition of ‘Reference Condition’ Sites

Before multivariate modeling or development of a multimetric index, sites were assigned *a priori* to either a reference condition or a test group. For B-IBI development, sites were defined as reference condition group if they met certain criteria (Bennett 2004).

- Less than 5% harvesting or cleared land in catchment,
- no mining in watershed,
- no channelization,
- no upstream impoundments,
- no known point or non-point source discharges (did not include natural slides),
- no urban land use in catchment, and
- an extensive riparian buffer on both river edges separating the stream from the adjacent land use.

Table 1 shows all sites that met the above criteria in the first column. Additionally, these were sites that had

- no adjacent agricultural non-point sources.

Twenty-four reference sites were sampled in 2004 and nine of those had also been sampled in 2003. All sites sampled for B-IBI development prior to 2004 were scrutinized by a group of local professionals to reclassify any reference condition sites that might be impacted by land use (Bennett 2004). Any sites that did not meet the criteria were potentially degraded or stressed by land use and were assigned to the test site group, as shown in Table 1. Sixteen sites were assigned to the test group, and five of those were sampled in both 2003 and 2004. Forty sites that were in areas not familiar to the group were categorized as ‘unknown’.

Several watershed-based land use information variables are being calculated from GIS coverage for the study area. Once this data is available, sites in Table 1 under the ‘test’ and ‘unknown’ *a priori* classification heading could be reclassified as either reference or test sites.

Usually, the reference sites would be used to test metric performance. The reference sites have been identified here so that the final B-IBI scores and projected condition can be compared with the *a priori* classification. This will not be useful for test and unknown sites, as both these groups may contain additional reference condition sites and the degree of human influence in the watersheds is not known in many cases.

Table 1: *A priori* classification of sites sampled in 2003 and 2004

Reference Condition Sites		Test Sites		Unknown	
BUL0104	Little Joe Ck	BUL0304	Deep Ck d/s	BUL2304	Caribou Ck.
BUL0704	Sinclair ck.	BUL1003	Jonas Creek	BUL3704	Gramophone u/s
BUL0903	Arnett Ck.	BUL1004	Jonas Creek	BUL4004	Causqua Ck.
BUL0904	Arnett Ck.	BUL1604	Goathorn Ck	BUL4104	Corya Creek
BUL1104	Howson Ck	BUL1903	Chicken Ck.	BUL4204	Kwun Ck
BUL2403	Driftwood Ref	BUL1904	Chicken Ck.	BUL5104	Coal Creek
BUL2404	Driftwood Ref	BUL3303	Toboggan d/s	BUL5204	Toboggan u/s
BUL2703	Reiseter above bridge	BUL3304	Toboggan d/s	KAL0504	Anweiler @ bridge
BUL2704	Reiseter above bridge	BUL5004	Sandstone Ck.	KAL1504	Luncheon D/S
BUL2803	Reiseter Trib West	KAL0404	Thornhill @ Skeena	KIS0404	McCutcheon
BUL2804	Reiseter Trib West	KIS1403	Steep Canyon D/S	KIS0504	Sterritt
BUL2903	Reiseter Trib. East	KIS1404	Steep Canyon D/S	KIS0604	Pinenut
BUL2904	Reiseter Trib. East	KIS2104	Murder Ck.	KIS0904	Shegunia Tributary 250m D/S
BUL4804	Serb Ck	KIS4303	Station d/s	KIS1803	Helen @ 19
KAL0104	Fiddler Ck	KIS4304	Station d/s	KIS1804	Helen @ 19
KAL1704	Deep @ intake	KTM0104	Tributary	KIS2803	Hevenor D/S
KIS0204	Cataline	LAK0504	Pinkut Crk.	KTM0204	Tributary
KIS0304	Gail #3	MOR1204	Nadina R	KTM0304	Tributary
KIS0704	Shegunia Tributary 150m U/S	MOR3704	Upper Bulkley @ Morice	KTM0404	Tributary
KIS1303	Hevenor @ 19	MOR4504	Lamprey Ck	KTM0504	Raley Creek
KIS1304	Hevenor @ 19	MOR5004	Owen Ck Lower	KTM0604	Tributary
KIS1503	Steep Canyon Reference			LAK0304	Coldwater Creek
KIS1504	Steep Canyon Reference			LAK0404	Four Mile Creek
KIS1603	Date 1200			LAK1104	Twain Creek
KIS1604	Date 1200			LAK1304	Rat Creek
KIS2204	Compass u/s			LAK1404	Roof Creek
KIS3104	Nichyeskwa @ 9km			LAK2104	Gerow Creek
KIS4003	Station Reference			LAK2304	Upper Ailport Ck U/S
KIS4004	Station Reference			MOR0604	Sibola Main R
KLP0104	Tributary 100m U/S Kitlope River			MOR0704	Glacier Main @ 18
KLP0304	Rediscovery Creek			MOR0804	Glacier Main @ 17 km
KLP0604	Hill-Amos Creek			MOR2004	Richfield U/S
MOR1304	Foxy Ck u/s			MOR2404	Byman Reference
				MOR2604	McQuarrie
				MOR3304	Buck Ck @ 12 km
				MOR3404	Bob Ck
				MOR3904	Shea Ck U/S
				MOR4004	Llojuh Ck
				MOR4104	Deny's Ck
				MOR4204	Raina Ck
				MOR5304	Guess Ck.

2.4 B-IBI Scoring Cutoffs and Calculations

Using the methods described in Bennett and Rysavy (2003a, 2003b), metrics were selected for inclusion in the Kispiox and Bulkley B-IBIs if they:

1. separated uninfluenced from heavily influenced stations using scatter plots and box plots,
2. had a coefficient of variation less than 1 between reference stations and between multiple replicates collected at a single reference station,
3. had a proportion of total variance between human influence groups that was greater than the proportion of total variance within human influence groups, and
4. were shown to contribute unique and biologically relevant information to the index through correlation analyses.

Using these criteria, the same six metrics were chosen for inclusion in B-IBI's for the Bulkley and Kispiox as shown in Table 2 and Table 3. In the Upper Bulkley (Bennett and Ohland 2002) and Lakes and Morice IFPA (Croft 2004), a similar process was used to select metrics. The Upper Bulkley B-IBI is based on 10 metrics as shown in Table 4, while the Lakes and Morice IFPA B-IBI is based on 9 metrics as shown in Table 5.

Table 2: Summary of scoring cutoff points for the six metrics included in the Bulkley TSA benthic invertebrate index of biological integrity.

Metric	Metric Score		
	1	**3**	**5**
# Plecoptera Taxa	≤ 3	3.1 - 5	≥ 5
# Trichoptera Taxa	≤ 1.5	1.6 – 3.4	≥ 3.5
# Intolerant Taxa	≤ 2	3 - 4	≥ 5
Hilsenhoff Biotic Index	≥ 4.75	3.76 – 4.74	≤ 3.75
# of Clingers	≤ 8	8.1 - 10.9	≥ 11
% Dominance	> 70	60-70	< 60

Table 3: Summary of scoring cutoff points for the six metrics included in the Kispiox TSA benthic invertebrate index of biological integrity.

Metric	Metric Score		
	1	**3**	**5**
# Plecoptera Taxa	≤ 3	3.1 - 4.69	≥ 4.7
# Trichoptera Taxa	< 2	2 – 2.99	≥ 3
# Intolerant Taxa	≤ 1	2 - 3	≥ 4
Hilsenhoff Biotic Index	≥ 5	3.76 – 4.99	≤ 3.75
# of Clingers	≤ 6	6.1 – 8.4	≥ 8.5
% Dominance	> 75	60-75	< 60

Table 4: Summary of scoring cutoff points for the ten metrics included in the Upper Bulkley benthic invertebrate index of biological integrity (Bennett and Ohland 2002)

Metric	Metric Score		
	1	**3**	**5**
# Plecoptera Taxa	≤ 3.5	3.6 - 4.5	≥ 4.6
# Trichoptera Taxa	< 1.8	1.8 – 2.3	≥ 2.4
% Diptera & Non-insects	> 50	30 – 50	< 30
% Ephemeroptera	< 22	22 - 34	> 34
# Intolerant Taxa	≤ 1	2 - 3	≥ 4
% Predators	< 4.5	4.5 - 10	> 10
% Dominance	> 75	55-75	< 55
% Sediment Tolerants	> 10	2.1 - 10	≤ 2
% Clingers	< 20	20 - 40	> 40
Hilsenhoff Biotic Index	> 4.75	3.75 – 4.75	< 3.75

Table 5: Summary of scoring cutoff points for the nine metrics included in the IFPA benthic invertebrate index of biological integrity (Croft 2004).

Metric	Metric Score		
	1	**3**	**5**
# Ephemeroptera Taxa	< 5	5 - 7	>7
# Plecoptera Taxa	< 5	5 – 7.5	> 7.5
% Non-insects	> 3	1.5 - 3	< 1.5
# Taxa	< 16	16 - 22	> 22
% Diperta individuals	> 4	1.5 - 4	< 1.5
# Intolerant Taxa	< 2	2 - 4	> 4
% Sediment Intolerant	< 0.5	0.5 – 1.5	> 1.5
% Predators	< 2.5	2.5 - 6	> 6
# of Clingers	< 7	7 – 11.5	> 11.5

For each of the selected metrics, scoring cutoffs were chosen from scatterplots, using natural slope breaks where possible, 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).

Deciding which metrics to include in a B-IBI and determining cut-off points for scoring each metric is an iterative process. Metric cutoffs for B-IBIs developed in the Kispiox and Bulkley have had the benefit of several years of data and many iterations. Only two seasons of data were collected in the Upper Bulkley and Lakes and Morice IFPA areas, so these B-IBI's may not be as robust as those developed for the Kispiox and Bulkley areas. Metric cutoffs for B-IBI's developed for the Bulkley TSA, Kispiox TSA, Upper Bulkley watershed and the Lakes and Morice IFPA are summarized in the following tables.

As shown in Table 6, the final metric scores were labeled with a stream condition (very poor, poor, fair, good or excellent) to aid interpretation of the results and provide a consistent approach for comparing stream conditions in areas with different B-IBIs.

Table 6: B-IBI scores and relative stream condition.

	Scoring Cutoffs		
Condition	**6 metric**	**9 metric**	**10 metric**
Very Poor	< 10	< 15	< 17
Poor	11 - 15	16 - 23	18 - 25
Fair	16 - 20	24 - 30	26 - 33
Good	21 - 25	31 - 38	34 - 42
Excellent	26 - 30	39 - 45	43 - 50

3 Results and Discussion

3.1 B-IBI Scores and Stream Assessment Results

Table 7 shows the station name, site code, *a priori* classification and the 2003 and 2004 B-IBI scores and stream condition for all sites sampled in the Bulkley Timber Supply Area. As expected, seven of the nine reference sites were good or excellent condition in 2004. Two sites, Howson and Arnett were fair and poor condition respectively. This result was surprisingly low for both sites. Arnett site had been sampled in 2003, and was assessed as good condition, scoring 24 points. In 2004, the sampling site was moved roughly 200 metres upstream. This should not have made a significant difference though, since there has been very little human disturbance in the watershed. It is interesting to note that both Arnett and Howson have a moderately embedded streambed compared with other sites sampled. This may be playing a role in the community composition, and further interpretation might be available from the multivariate modeling exercise.

Table 7: 6 metric genus-level B-IBI scores and estimated stream condition for Bulkley TSA sites sampled in 2003 and 2004. Some sites were *a priori* categorized as test sites, reference condition sites or unknown condition sites.

Station	Site Code	B-IBI Used	Type	2003 IBI		2004 IBI	
Little Joe	BUL01	6 metric Bulkley	Reference			**30**	**Excellent**
Reiseter above Brdge	BUL27	6 metric Bulkley	Reference	**24**	**Good**	**26**	**Excellent**
Reiseter West	BUL28	6 metric Bulkley	Reference	**26**	**Excellent**	**26**	**Excellent**
Serb	BUL48	6 metric Bulkley	Reference			**26**	**Excellent**
Sinclair Cr.	BUL07	6 metric Bulkley	Reference			**24**	**Good**
Reiseter East	BUL29	6 metric Bulkley	Reference	**24**	**Good**	**24**	**Good**
Driftwood Cr.	BUL24	6 metric Bulkley	Reference	**24**	**Good**	**22**	**Good**
Howson Cr.	BUL11	6 metric Bulkley	Reference			**20**	**fair**
Arnett Cr.	BUL09	6 metric Bulkley	Reference	**24**	**Good**	**14**	**poor**
Sandstone	BUL50	6 metric Bulkley	Test			**28**	**Excellent**
Toboggan d/s	BUL33	6 metric Bulkley	Test	**22**	**Good**	**20**	**fair**
Goathorn Cr.	BUL16	6 metric Bulkley	Test			**18**	**Fair**
Chicken Cr.	BUL19	6 metric Bulkley	Test	**10**	**very poor**	**18**	**fair**
Jonas Cr.	BUL10	6 metric Bulkley	Test	**24**	**good**	**14**	**poor**
Deep Cr D/S Bridge	BUL03	6 metric Bulkley	Test			**10**	**very poor**
Unamed Cr.	BUL31	6 metric Bulkley	Unknown			**28**	**Excellent**
Toboggan u/s	BUL52	6 metric Bulkley	Unknown			**28**	**Excellent**
Caribou	BUL23	6 metric Bulkley	Unknown			**26**	**Excellent**
Kwun	BUL42	6 metric Bulkley	Unknown			**26**	**Excellent**
Canyon d/s	BUL49	6 metric Bulkley	Unknown			**26**	**Excellent**
Coal Cr.	BUL51	6 metric Bulkley	Unknown			**26**	**Excellent**
Gramophone Cr.	BUL37	6 metric Bulkley	Unknown			**18**	**Fair**
Causqua Cr.	BUL40	6 metric Bulkley	Unknown			**14**	**poor**
Corya Cr.	BUL41	6 metric Bulkley	Unknown			**12**	**poor**

Of the eight sites sampled in both 2003 and 2004, three had very different scores in the two years including Arnett (discussed above), Chicken and Jonas. The B-IBI score at Jonas went from 24 (good) in 2003 to 14 (poor) in 2004. In 2003, this stream was sampled above the Telkwa 1000 FSR crossing in an area with a mature forest buffer on both sides. In 2004, the stream was sampled downstream of the road, adjacent to a recreational area in a part of the stream that had little or no riparian vegetation on either bank. It is likely that the 2004 score is specific to that 150 meter section of the stream located downstream of the Telkwa 1000 FSR. The B-IBI score at Chicken Creek, which increased from 10 in 2003 to 18 in 2004, indicates an improvement in stream condition. Since this is a test site with an urban influence, it would not be unusual for the condition to improve or decline in a given year depending on the circumstances of human disturbance contributing to the site.

Table 8 shows the station name, site code, *a priori* classification and the 2003 and 2004 B-IBI scores and stream condition for all sites sampled in the Kispiox Timber Supply Area. There were fourteen reference sites sampled in the Kispiox area, and all but three were in good or excellent condition in 2004. The three sites that scored fair, poor and very poor were KLP01, Cataline and KLP06 respectively. Both KLP sites were Kitlope area streams located on the coast South of Kitimat. Since the B-IBI was not developed for that area, the low scores may indicate that the metrics and scoring cutoffs chosen for the Kispiox B-IBI are not suitable for the Kitlope streams. A poor B-IBI score at Cataline Creek was unexpected, although the stream morphology and other physical characteristics are quite different from other streams in the Kispiox area.

Table 8 6 metric genus-level B-IBI scores and estimated stream condition for Kispiox TSA sites sampled in 2003 and 2004. Sites were *a priori* categorized as test sites, reference condition sites or unknown condition sites.

Station	Site Code	B-IBI Used	Type	2003 IBI		2004 IBI	
Shegunia Trib 150m u/s	KIS07	6 metric Kispiox	Reference			**30**	**Excellent**
Hevenor	KIS13	6 metric Kispiox	Reference	**30**	**Excellent**	**30**	**Excellent**
Steep Canyon Ref. Rep 1	KIS15	6 metric Kispiox	Reference	**28**	**Excellent**	**30**	**Excellent**
Date 1200	KIS16	6 metric Kispiox	Reference	**24**	**Good**	**30**	**Excellent**
Nichyeskwa @ 9km	KIS31	6 metric Kispiox	Reference			**30**	**Excellent**
Station Reference	KIS40	6 metric Kispiox	Reference	**30**	**Excellent**	**30**	**Excellent**
Fiddler	KAL01	6 metric Kispiox	Reference			**28**	**Excellent**
Deep @ Intake	KAL17	6 metric Kispiox	Reference			**28**	**Excellent**
Compass Cr. #1	KIS22	6 metric Kispiox	Reference			**28**	**Excellent**
KPL0304	KLP03	assumed 6 metric Kispiox	Reference			**26**	**Excellent**
Gail Cr.	KIS03	6 metric Kispiox	Reference			**24**	**Good**
KPL0104	KLP01	assumed 6 metric Kispiox	Reference			**18**	**fair**
Cataline Cr.	KIS02	6 metric Kispiox	Reference			**12**	**poor**
KLP0604	KLP06	assumed 6 metric Kispiox	Reference			**10**	**very poor**
Station d/s	KIS43	6 metric Kispiox	Test	**20**	**fair**	**26**	**Excellent**
Murder Cr	KIS21	6 metric Kispiox	Test			**18**	**Fair**
Steep Canyon Cr.	KIS14	6 metric Kispiox	Test	**14**	**poor**	**16**	**fair**
Thornhill @ Skeena	KAL04	6 metric Kispiox	Test			**12**	**poor**
McKuthcheon Cr	KIS04	6 metric Kispiox	Unknown			**30**	**Excellent**
Shegunia Trib 250m d/s	KIS09	6 metric Kispiox	Unknown			**30**	**Excellent**
Helen @ 19 km	KIS18	6 metric Kispiox	Unknown	**24**	**Good**	**30**	**Excellent**
Anweiler @ bridge	KAL05	6 metric Kispiox	Unknown			**28**	**Excellent**
Pinenut Cr.	KIS06	6 metric Kispiox	Unknown			**28**	**Excellent**
Hevenor Dnstrm	KIS28	6 metric Kispiox	Unknown			**28**	**Excellent**
KTM06	KTM06	assumed 6 metric Kispiox	Unknown			**28**	**Excellent**
KTM03	KTM03	assumed 6 metric Kispiox	Unknown			**26**	**Excellent**
KTM04	KTM04	assumed 6 metric Kispiox	Unknown			**26**	**Excellent**
Luncheon d/s	KAL15	6 metric Kispiox	Unknown			**24**	**Good**
KTM01	KTM01	assumed 6 metric Kispiox	Unknown			**24**	**Good**
KTM02	KTM02	assumed 6 metric Kispiox	Unknown			**24**	**Good**
KTM05	KTM05	assumed 6 metric Kispiox	Unknown			**22**	**Good**
Sterrit Cr.	KIS05	6 metric Kispiox	Unknown			**18**	**Fair**

There were seven sites in the Kispiox area that were sampled in both 2003 and 2002. Three of the reference sites had no change (2 points or less) between the two years. At one reference site, Date 1200, there was an increase from 24 points in 2003 to 30 points in 2004. Similarly, at two of the test sites, there was a 6-point increase from 2003 to 2004. Perhaps this suggests an overall improvement at all sites due to a common factor such as higher water flows in August 2004 compared with August 2003. On the other hand, the increased scores at four of the seven sites and maximum scores at the remaining three might indicate a need to revisit the calibration and scoring of the metrics with the new sampling method. Further investigation would be required to support or eliminate theories as to why the scores might be higher at several of the sites in 2004 compared with 2003.

There was only one site classified *a priori* as reference condition of the nine sites sampled in the Upper Bulkley River watershed. A score of 32 indicating fair stream condition was unexpected at the Foxy upstream site.

Table 9: 10 metric genus-level B-IBI scores and estimated stream condition for Upper Bulkley watershed sites sampled in 2004. Some sites were *a priori* categorized as test sites, reference condition sites or unknown condition sites.

Station	Site Code	B-IBI Used	Type	2004 IBI	
Foxy U/S	MOR13	10 metric Upper Bulkley	Reference	**32**	**fair**
Bulkley @ Morice (upper)	MOR37	10 metric Upper Bulkley	Test	**46**	**Excellent**
Shea Cr.U/S	MOR39	10 metric Upper Bulkley	Unknown	**48**	**Excellent**
Buck 12km	MOR33	10 metric Upper Bulkley	Unknown	**44**	**good**
Bob	MOR34	10 metric Upper Bulkley	Unknown	**40**	**good**
Richfield Cr.	MOR20	10 metric Upper Bulkley	Unknown	**34**	**fair**
McQuarrie	MOR26	10 metric Upper Bulkley	Unknown	**32**	**fair**
Upper Ailport Cr U/S	LAK23	10 metric Upper Bulkley	Unknown	**26**	**poor**
Byman Cr.	MOR24	10 metric Upper Bulkley	Unknown	**24**	**poor**

As shown in Table 10, the B-IBI scores in the Lakes and Morice area indicated stream conditions ranging from poor to good. Of the seventeen sites sampled, thirteen were in good condition, while two sites were in fair condition and two sites were in poor condition. For sites sampled in 2003 and 2004, B-IBI scores changed from 2 to 8 points. This may be in part due to the change in sampling methods between the two years. Croft (2004) used a three replicate Surber method in 2003, while a single kick net sample was collected in 2004. It is also possible that the IFPA B-IBI has a large annual variability. Annual variability has not been investigated for the IFPA B-IBI, which only began calibration in 2002.

Table 10: 9 metric genus-level B-IBI scores and estimated stream condition for Morice and Lakes IFPA sites sampled in 2003 and 2004. Some sites were *a priori* categorized as test sites, reference condition sites or unknown condition sites

Station	Site Code	B-IBI Used	Type	2003 IBI (Croft 2004)		2004 IBI	
Owen Cr Lower	MOR50	9 metric IFPA	Test	**29**	**fair**	**33**	**Good**
Pinkut	LAK05	9 metric IFPA	Test			**31**	**good**
Lamprey Rec Site	MOR45	9 metric IFPA	Test	**21**	**poor**	**29**	**fair**
Nadina R	MOR12	9 metric IFPA	Test			**23**	**poor**
Glacier Main @ 17 km	MOR08	assumed 9 metric IFPA	Unknown			**37**	**Good**
Roof Cr.	LAK14	9 metric IFPA	Unknown	**39**	**Good**	**37**	**good**
4 Mile Cr	LAK04	9 metric IFPA	Unknown	**27**	**fair**	**35**	**good**
Denys	MOR41	assumed 9 metric IFPA	Unknown			**35**	**good**
Gerow Cr.	LAK21	9 metric IFPA	Unknown	**39**	**good**	**35**	**good**
Rat Cr.	LAK13	9 metric IFPA	Unknown	**43**	**Excellent**	**35**	**good**
Glacier Main @ 18 km	MOR07	assumed 9 metric IFPA	Unknown			**33**	**Good**
Guess Cr	MOR53	9 metric IFPA	Unknown	**29**	**fair**	**31**	**Good**
Loljuh	MOR40	assumed 9 metric IFPA	Unknown			**31**	**Good**
Raina	MOR42	assumed 9 metric IFPA	Unknown			**31**	**Good**
Twain Cr	LAK11	9 metric IFPA	Unknown			**31**	**Good**
Coldwater Cr.	LAK03	9 metric IFPA	Unknown	**33**	**fair**	**27**	**fair**
Sibola 1.5 km	MOR06	assumed 9 metric IFPA	Unknown			**21**	**poor**

3.1.1 Quality Assurance

At four of the sites sampled in 2004, three kick net samples were collected. Two of the sites were reference condition sites, and two of the sites were test sites. Metric results were calculated individually for each sample and three B-IBI scores were generated for each site as shown in Table 11. There was less variability in B-IBI scores at the reference sites than at the test sites. The largest variation between the three scores was observed at the Toboggan upstream site, where one sample scored 28 out of a maximum 30 points indicating excellent condition and the other two samples scored 22 and 24 points indicating good condition. Overall, there was not a lot of variability at any of the four sites.

Table 11: Summary of quality assurance results for 4 sites sampled in 2004.

Site Name	Site Code	B-IBI Used	Type	Maximum Possible Score	2004 IBI					
Toboggan Upstream	BUL52	6 metric Bulkley	Test	**30**	**28**	**Excellent**	**22**	**Good**	**24**	**Good**
Steep Canyon Reference	KIS15	6 metric Kispiox	Ref	**30**	**30**	**Excellent**	**30**	**Excellent**	**30**	**Excellent**
Compass Creek Upstream	KIS22	6 metric Kispiox	Ref	**30**	**28**	**Excellent**	**28**	**Excellent**	**28**	**Excellent**
Lamprey Rec Site	MOR45	9 metric IFPA	Test	**45**	**29**	**fair**	**29**	**fair**	**33**	**Good**

3.2 Comparison of B-IBI Scores and RCA Results

Linke and Bailey (2005) provided RCA modeling results for seventy-seven of the sites sampled in 2004. The results included the observed / expected (O/E) 50 scores and assessments for each of the sites. An O/E 50 score is a number that reflects the number of taxa observed at a test site compared with the number of taxa expected at a test site after it has been matched with a group of reference condition sites. An O/E 50 score greater than 0.84 reflects a test site that is not stressed and excellent condition (Linke, pers. comm.). An O/E 50 score between 0.52 and 0.83 indicates a stream in fair condition, while a score of 0.2 to 0.51 indicates a stressed stream and a score less than 0.19 indicates a stream in poor condition. Scores for Skeena Region streams ranged from 0.39 (stressed) to 1.23 (excellent).

The O/E scores were plotted against standardized B-IBI scores (each score was divided by the number of metrics in the IBI model) for each site as shown in Figure 1. There was a general positive linear trend of O/E score with B-IBI score.

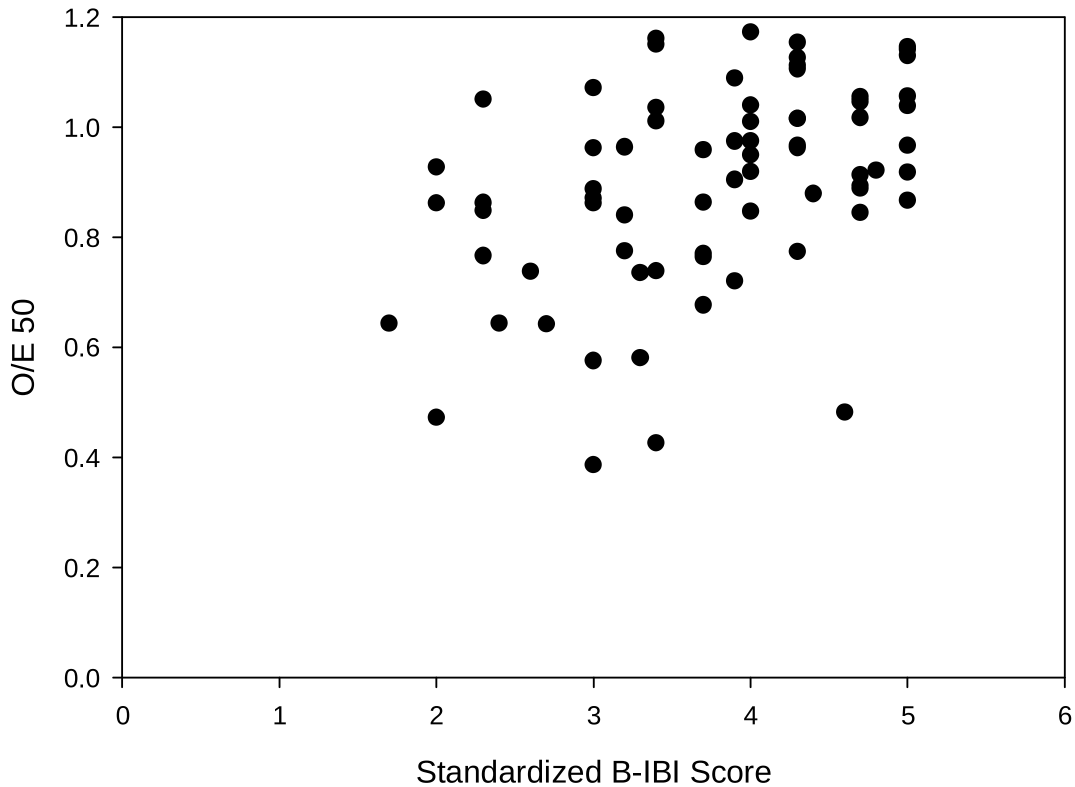

Figure 1: B-IBI scores plotted against RCA O/E 50 scores for sites sampled in 2004. B-IBI scores close to 5 indicate excellent stream condition while scores close to 1 indicate very poor stream condition. O/E 50 values greater than 0.84 indicate excellent stream condition, while scores less than 0.51 indicate a 'stressed' site and scores in between indicate a 'fair' stream condition.

O/E scores and condition and B-IBI condition were numerically coded and the difference between the two numeric scores is shown as the 'O/E – IBI' in Table 12. Where both assessment methods resulted in the same condition, the difference was zero, and these sites are not shown in the table. Fifty of the seventy-seven sites (65%) had O/E 50 RCA and B-IBI assessments that agreed. Twenty of the remaining twenty-seven sites (26%) had a difference of one class, while the final seven (9%) differed by two classes. Overall, there was substantial agreement between the two methods. The seven sites that differed by two classes had O/E scores that more accurately represented the original *a priori* condition. For example, Arnett and Cataline were two *a priori* defined reference condition sites that were classified as "Not Stressed" using the RCA method, but the B-IBI classified both sites as "poor" condition.

It is too early to say whether one model (RCA or B-IBI) is working better than the other. Although it appears that the RCA model is more reliably predicting *a priori* condition, more data is needed to further investigate this observation.

Table 12: Assessment differences between the RCA model and the B-IBI. O/E scores and condition and B-IBI condition were numerically coded and the difference between the two numeric scores is shown as the 'O/E – IBI'.

Site Name	Site Code	OE50	O/E Band	O/E Numeric Code	B-IBI Condition	B-IBI Numeric Code	O/E - IBI
Deep Creek d/s bridge	**BUL03**	**0.6431**	**B - Fair**	**2**	**very poor**	**4**	**-2**
Arnett	**BUL09**	**0.8624**	**A - Not Stressed**	**1**	**poor**	**3**	**-2**
Jonas	**BUL10**	**1.0508**	**A - Not Stressed**	**1**	**poor**	**3**	**-2**
Goathorn	BUL16	0.8705	A - Not Stressed	1	Fair	2	-1
Chicken	BUL19	0.3862	C - Stressed	3	fair	2	1
Driftwood	BUL24	0.7643	B - Fair	2	Good	1	1
Gramaphone	BUL37	1.0713	A - Not Stressed	1	Fair	2	-1
Causqua	BUL40	0.8483	B - Fair	2	poor	3	-1
Corya	**BUL41**	**0.8617**	**A - Not Stressed**	**1**	**poor**	**3**	**-2**
Fiddler	KAL01	0.8447	B - Fair	2	Excellent	1	1
Cataline	**KIS02**	**0.9274**	**A - Not Stressed**	**1**	**poor**	**3**	**-2**
Sterrit	KIS05	0.9621	A - Not Stressed	1	Fair	2	-1
Station d/s	KIS43	0.7741	B - Fair	2	Excellent	1	1
KLP01	KLP01	0.8617	A - Not Stressed	1	fair	2	-1
KTM02	KTM02	0.8471	B - Fair	2	Good	1	1
Coldwater	LAK03	0.8874	A - Not Stressed	1	fair	2	-1
Pinkut	**LAK05**	**0.4263**	**C - Stressed**	**3**	**good**	**1**	**2**
Rat	LAK13	0.7206	B - Fair	2	good	1	1
Sibola 1.5km	MOR06	0.7662	B - Fair	2	poor	3	-1
Glacier Main @18km	MOR07	0.7697	B - Fair	2	Good	1	1
Nadina R	MOR12	0.7382	B - Fair	2	poor	3	-1
Richfield	MOR20	1.1498	A - Not Stressed	1	fair	2	-1
Byman	MOR24	0.6437	B - Fair	2	poor	3	-1
McQuarrie	MOR26	0.9636	A - Not Stressed	1	fair	2	-1
Bulkley @ Morice	**MOR37**	**0.4822**	**C - Stressed**	**3**	**Excellent**	**1**	**2**
Owen Cr Lower	MOR50	0.6767	B - Fair	2	Good	1	1
Guess	MOR53	0.7385	B - Fair	2	Good	1	1

4 Conclusions and Recommendations

Proper classification of reference condition sites is critical for both B-IBI development and reference condition approach modeling (Bailey et al 2004). However, the purpose of *a priori* defined reference sites is different for each approach. For both methods, it is critical to begin with a set of sites that are minimally impacted by human land influence. However, with the reference condition approach, the original group of reference sites can vary widely in terms of stream size, geography and other environmental factors that are likely driving invertebrate community composition. The reference condition approach aims to capture a large variation in community variance at reference sites, and then uses statistical methods to place reference sites into groups based on similar community composition. In this method, there are no 'artificial' geographic boundaries created, and one model can be used over a large geographic area such as the Skeena Region, or perhaps even the Province of British Columbia.

With the B-IBI approach, the idea is to limit the variation by setting environmental criteria for choosing both reference and test sites. In the Kispiox B-IBI for example, all reference and test sites were clear, non-glacial streams, low or moderate channel gradient, 1st to 4th order with a defined channel and a site elevation between 393 to 1011 meters.

One advantage of the RCA is that a single model can be used over a very large geographic area, rather than having multiple B-IBI models each with a fairly small geographic area. This makes the RCA easier to implement if there is a diverse group of users wanting access to the assessment tool.

However, since the B-IBI is well established in some areas of the Skeena Region, and is extremely user-friendly, it may be worthwhile to continue to calculate the metrics and B-IBI scores for all sites. Further comparison of the B-IBI scores and the RCA results is warranted, along with comparison to the stressor gradient work that is forthcoming (Bailey and Linke in prep). If the B-IBI can accurately assess stream conditions, it would be worthwhile to explore methods for using the metrics in conjunction with the RCA.

Since there is now a large database of GIS-derived environmental variables for sites sampled in 2003 and 2004, it would be worthwhile to confirm that the metrics are responding predictably to a gradient of human influence, and to identify metrics that may be specific to certain types of human influence (termed *biological response signatures* Yoder and Rankin 1995).

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