Macroinvertebrate Index of Biotic Integrity for the Northern Glaciated Plains Ecoregion (46) of North Dakota

Final: March 2007

Prepared by:
Neil J. Haugerud
Environmental Scientist
and
Michael J. Ell
Environmental Administrator
North Dakota Department of Health
Division of Water Quality
918 East Divide Avenue
Bismarck, ND 58501-1947

North Dakota Department of Health
Division of Water Quality

Macroinvertebrate Index of Biotic Integrity for the Northern Glaciated Plains Ecoregion (46) of North Dakota

John Hoeven, Governor
Terry Dwelle, M.D., State Health Officer

North Dakota Department of Health
Division of Water Quality
918 East Divide Avenue
Bismarck, North Dakota 58501-1947

701.328.5210

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

Table Page

ACKNOWLEDGEMENTS

I would like to thank the many individuals and organizations who contributed to this report. Eric Pearson and Scott Elstad, formerly with the North Dakota Department of Health, Division of Water Quality were responsible for the field sampling, data entry and preliminary data analysis. Mike Ell provided project guidance and oversight. Joe Gross performed database management and assistance. Numerous staff members and temporary employees with the North Dakota Department of Health, Division of Water Quality provided assistance with field sampling. Funding for this project was provided by U. S. Environmental Protection Agency Region 8.

1.0 INTRODUCTION

The Northern Glaciated Plains ecoregion in North Dakota (Figure 1) is characterized by glacially formed topography and low to moderate annual precipitation. A relatively short growing (frost free) season promotes a land use emphasis on dry-farming and livestock production which in turn have the greatest large scale affect on stream water quality in the Northern Glaciated Plains. Trampling of stream banks and streambeds is particularly severe in this region because livestock tend to travel in dry water courses. Washing of manure from feedlots and stockyards into streams has a dramatic effect on stream water chemistry. Rain events tend to be intense and of short duration in this ecoregion. These rain events wash eroded cropland soil into streams, increasing turbidity and sedimentation. Fertilizers and herbicides applied to cropland are also carried to streams through runoff (Omernik and Gallant 1988).

The landscape is made up of glacial lake plains and nearly level to rolling glacial till plains that are punctuated by kettle holes, kames, and moraines. Elevations range from 1,000 to 1,800 feet above sea level. Watersheds of perennial rivers including the Sheyenne River, James River, and Souris River cover more than one thousand square miles each; however, most watersheds are 100 square miles or less. Excluding the large rivers, 85 to 90 percent of the streams in this ecoregion are intermittent or ephemeral (Omernik and Gallant 1988).

Aquatic life is a beneficial use that is assigned to all North Dakota streams by *State Water Quality Standards* (North Dakota Department of Health 2001). While an assessment of aquatic life use can be conducted indirectly with chemical data (e.g., dissolved oxygen and dissolved metals data), direct measures of the biological community are believed to be more accurate. Aquatic life use or biological integrity is defined by Karr and Dudley (1981) as the ability to support and maintain a balanced, integrated, adaptive community of organisms, having a species composition, diversity, and functional organization comparable to that of natural habitats of the region. Human disturbance of streams and landscapes alters key attributes of aquatic ecosystems (i.e., water quality, habitat structure, hydrological regime, energy flow, and biological interactions) which can result in decreased biotic integrity.

In order to develop biological indicators capable of assessing the biological conditions of state's rivers and streams, the North Dakota Department of Health (NDDoH) is developing a calibrated multi-metric index of biotic integrity (IBI) based on aquatic macroinvertebrate data for each ecoregion. Macroinvertebrates are common inhabitants of rivers and streams and vital links in the movement of energy through the food web. Advantages to using macroinvertebrates in IBI development include their high diversity, rapid colonization, and variability in tolerance to perturbation (Rosenberg and Resh 1993).

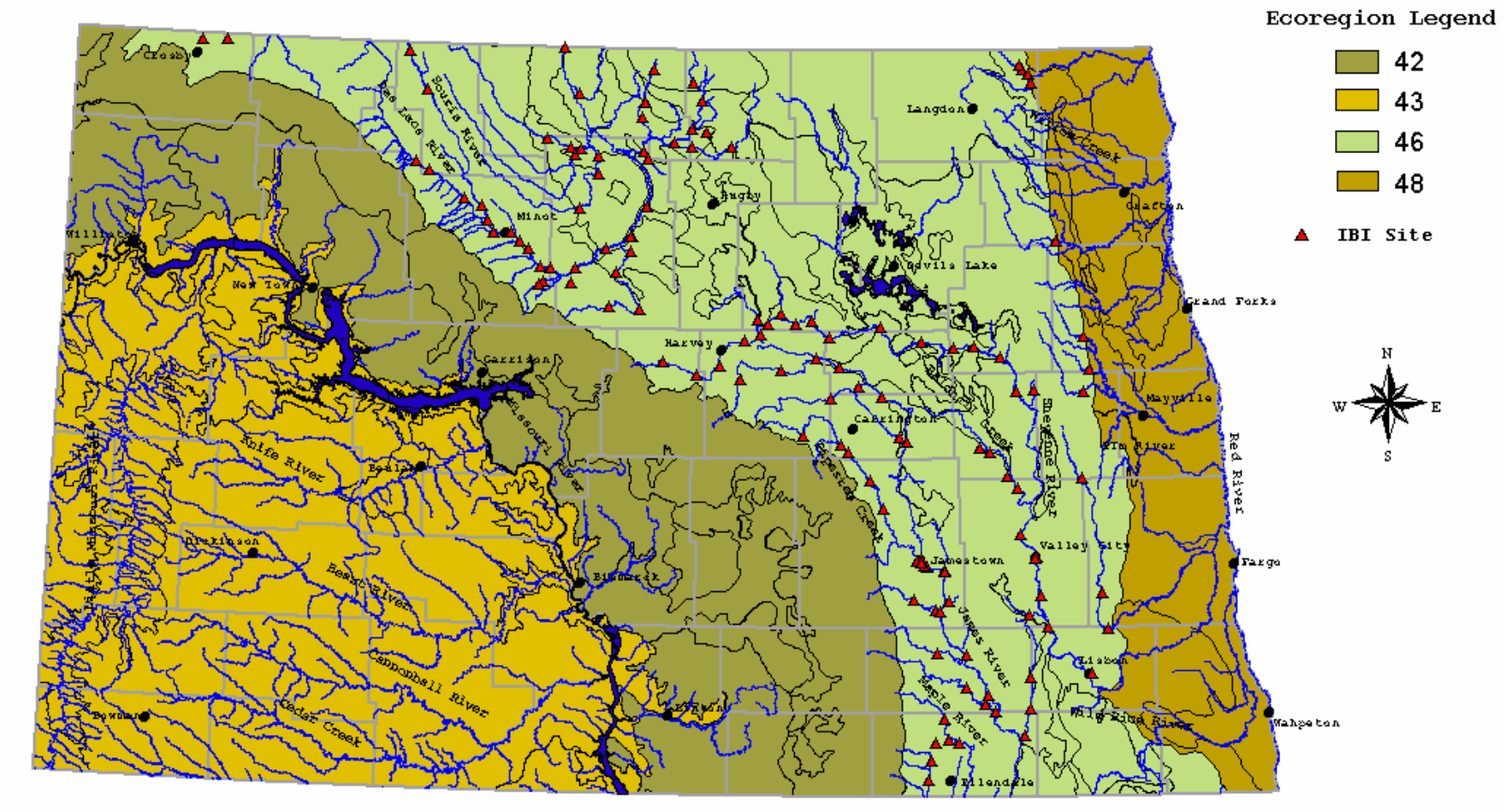


Figure 1. IBI Sampling Sites for the Northern Glaciated Plains Ecoregion (46) in North Dakota.

Once an IBI has been developed, it becomes a valuable assessment tool. A multi-metric IBI assumes that multiple measures of the biological community (i.e. metrics) (e.g., species richness, species composition, tolerance levels, trophic structure) will respond to increased pollution or habitat alterations. Metric development reduces the number of biological community attributes that need evaluation to only those that are sensitive to human disturbance or impairment. Metrics selected for the IBI are given a standardized score. Individual metric scores are then combined into an overall IBI score. These overall IBI scores can be matched with a qualitative rating such as those associated with aquatic life use support (e.g., fully supporting, fully supporting but threatened, and not supporting).

Benthic macroinvertebrate metrics generally fall into five distinct categories including richness metrics, composition metrics, tolerance/intolerance metrics, feeding measure metrics and habit metrics. Richness metrics, or the number of distinct taxa, represents the diversity within an aquatic assemblage (Resh *et al.* 1995). Richness is a key category of metrics in a macroinvertebrate IBI. Taxa richness is usually based on species level identification but can also be evaluated as groupings of higher taxonomic levels (e.g., genus, family, order). High levels of diversity suggest that niche space, habitat and food sources are adequate to support a diverse community of macroinvertebrates (Barbour *et al.* 1999).

Composition or relative abundance metrics provide information on the relative contribution of the various taxa to the total fauna. Although individual abundances may vary in magnitude, the proportional representations of taxa in a healthy and stable assemblage should remain consistent. A large percentage of a single dominant taxa can be equated with the dominance of a pollution tolerant organism and lowered diversity (Barbour *et al.* 1999).

Tolerance/intolerance metrics are intended to represent the sensitivity of the macroinvertebrate assemblage to disturbance. Measurements include numbers of pollution tolerant and intolerant taxa or their percent composition. High proportions or numerous taxa of tolerant macroinvertebrates can indicate possible stressors such as organic pollution or increased sedimentation (Barbour *et al.* 1999).

Feeding measures or trophic dynamics metrics provide information on the balance of feeding strategies by evaluating the number of taxa and percent composition of functional feeding groups. Functional feeding groups are not based on the type of food ingested, but rather on the morpho-behavioral mechanisms that a macroinvertebrate uses to acquire food (Merrit and Cummins 1996). Examples of functional feeding groups include predators, scrapers, shredders, filterers and gatherers. Stressors that cause instability in food dynamics will cause an alteration in the composition of functional feeding groups from the least disturbed or reference condition (Barbour *et al.* 1999).

Habit or modes of existence metrics evaluate the composition of morphological adaptations that allow macroinvertebrates to attach, move, and/or conceal themselves in their environment (Merritt and Cummins 1996). Habit metric categories include

swimmers, skaters, clingers, climbers and burrowers. Changes in the number of taxa or percent composition of habit metrics can indicate changes in available habitat niches.

The purpose of this report is to present a benthic macroinvertebrate IBI that has been developed for the Northern Glaciated Plains ecoregion in North Dakota. It is based on metrics from the above listed categories. IBI development is intended to be a dynamic process and additional refinement is likely as new sites and data are added.

2.0 METHODS

The data used to develop the macroinvertebrate IBI presented in this report are based on data collected from 1995 through 2003. A total of 333 sites were sampled statewide with 431 samples collected. Sites were divided into two distinct groups, riffle/run (RR) or glide/pool (GP).

2.1 Macroinvertebrate Field Sampling

Benthic macroinvertebrate field samples were collected by NDDoH Surface Water Quality Management Program personnel in 1995-1998, 2001-2003 within the Northern Glaciated Plains ecoregion. A total of 51 GP samples were collected from 43 sites and 75 RR samples were collected from 61 sites. Sampling was conducted by apportioning 20 jabs with a D-frame net among all habitat types present (Barbour *et al.* 1999). For a more complete description of the field sampling procedure, see Appendix A.

2.2 Macroinvertebrate Laboratory Analyses

Laboratory analysis of macroinvertebrate samples was conducted on a 300 count sub-sample (Appendix A). These sub-samples were obtained by spreading the sample evenly on a gridded pan and picking 300 individuals from randomly selected grids. Final organism identification was done at the lowest taxonomic level practical (genus/species preferred). Laboratory analysis of macroinvertebrate samples was contracted out to Dr. Andre Delorme, Valley City State University, and Larry Brooks, Western Aquatic Technology and Environmental Resource Specialists.

2.3 Data Management and Analysis

The biological, physical and chemical data collected were entered into the Ecological Data Application System (EDAS). EDAS is an Access based program developed by Tetra Tech, Inc. under contract with the U. S. Environmental Protection Agency (EPA). EDAS is designed to facilitate data analysis, particularly the calculation of biological metrics and indices. Pre-designed queries that calculate a wide variety of biological metrics are included with EDAS (Faulkner and Lepo 2000). EDAS was used to evaluate a total of 62 candidate metrics (Appendix C) in the five categories: taxa richness, percent composition,

tolerance values, feeding groups, and habit measures. Microsoft Excel 2002 and Analyse-It were also used to analyze the data (Microsoft Corporation 2002, Analyse-It Software, Ltd 2003).

2.4 Human Disturbance Scoring Analysis

A human disturbance score was developed to assess the level of degradation at each site. This process consisted of a field evaluation component and a remote sensing component. The field evaluation involved sampling personnel filling out a habitat assessment field data sheet. Each site was classified as a high gradient riffle/run (RR) or a low gradient glide/pool (GP) stream and the appropriate form was used. A sample of these forms can be found in Rapid Bioassessment Protocols (RBP) for Use in Wadeable Streams and Rivers (Barbour *et al.* 1999).

The remote sensing component involved the development of a Landscape Index (LSI) that evaluated landuse adjacent to and influencing each stream sample reach. Landuse for each sample reach was evaluated within a 3 km circular buffer by calculating landuse metrics with the Analytical Tool Interface for Landscape Assessment (ATtILA) (Ebert *et al.* 2001). A final set of landscape metrics were selected by evaluating their range of response, correlation to other metrics and through professional judgment (Appendix B).

The LSI and RBP habitat assessment score for each site were combined to form the final Human Disturbance Index (HDI) (Appendix E). Sites were assigned a value of good, fair or poor according to their HDI score. The boundaries for good, fair and poor sites were set at the 90^{th} percentile and above for good sites and the 10^{th} percentile and below for poor sites. When a sufficient number (at least 4 good and 4 poor) of sites were not available using this method, levels were determined by graphing the range of habitat scores and then looking for the natural breakpoints in the data (glide/pool sites: Table 1, Figure 2; riffle/run sites: Table 2, Figure 3).

2.5 Metric Selection

Candidate metrics underwent a series of data reduction steps to select the final metrics used to construct the IBI. First, “box and whisker” plots for each candidate metric were plotted to evaluate the range of data (Appendix D). Box and whisker plots were also evaluated based on the amount of overlap exhibited between sites with good and poor HDI scores. All metrics with complete overlap were eliminated due to the lack of response to disturbance. In addition, metrics with insufficient ranges were eliminated. All metrics with complete separation or minimal overlap were kept for further evaluation. Second, remaining candidate metrics were evaluated using the Mann-Whitney U test. This is a nonparametric test that evaluates the difference between the medians of two independent data sets. Metrics were eliminated if the P-value was less than 0.20. Third, metrics showing a significant relationship to human disturbance were selected. This was

Table 1. Northern Glaciated Plains Ecoregion (46) Glide/Pool Qualitative Human Disturbance Index (HDI) Score Rankings and Associated Scoring Ranges.

Habitat Rank	Human Disturbance Index Score Ranges
Good	≥135.0
Fair	95.6-134.9
Poor	≤95.5

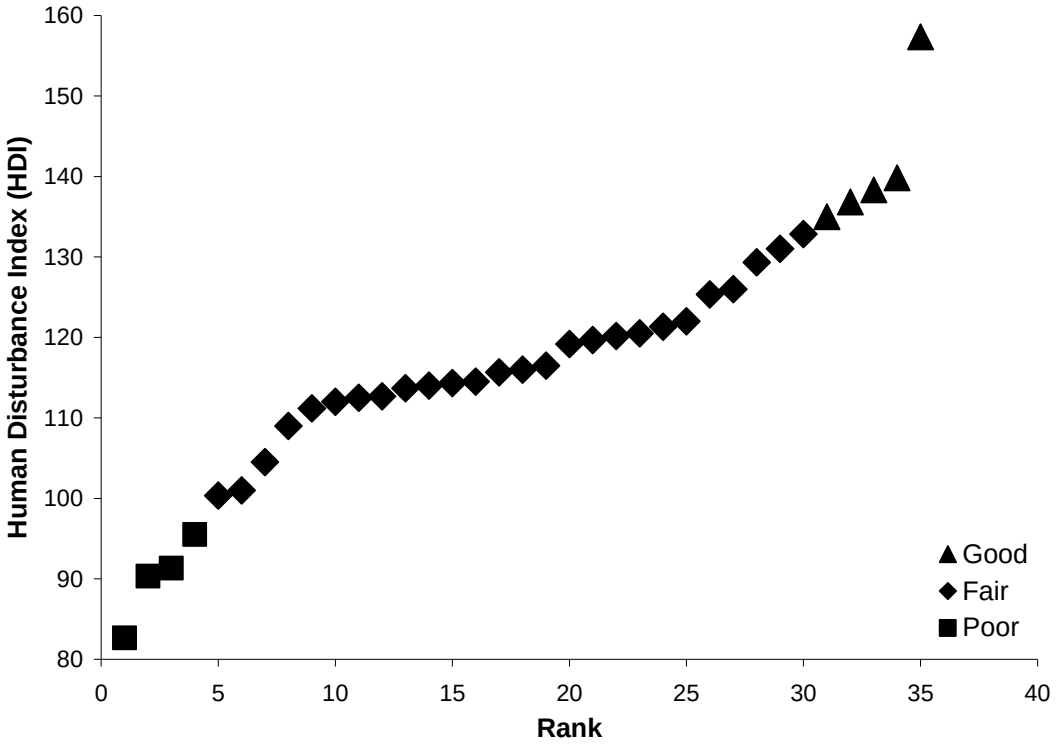


Figure 2. Distribution of the Human Disturbance Index Ranked from Lowest to Highest Score for Northern Glaciated Plains Ecoregion (46) Glide/Pool Sites.

Table 2. Northern Glaciated Plains Ecoregion (46) Riffle/Run Qualitative Human Disturbance Index (HDI) Score Rankings and Associated Scoring Ranges.

Habitat Rank	Human Disturbance Index Score Ranges
Good	≥132.6
Fair	87.0-132.5
Poor	≤86.9

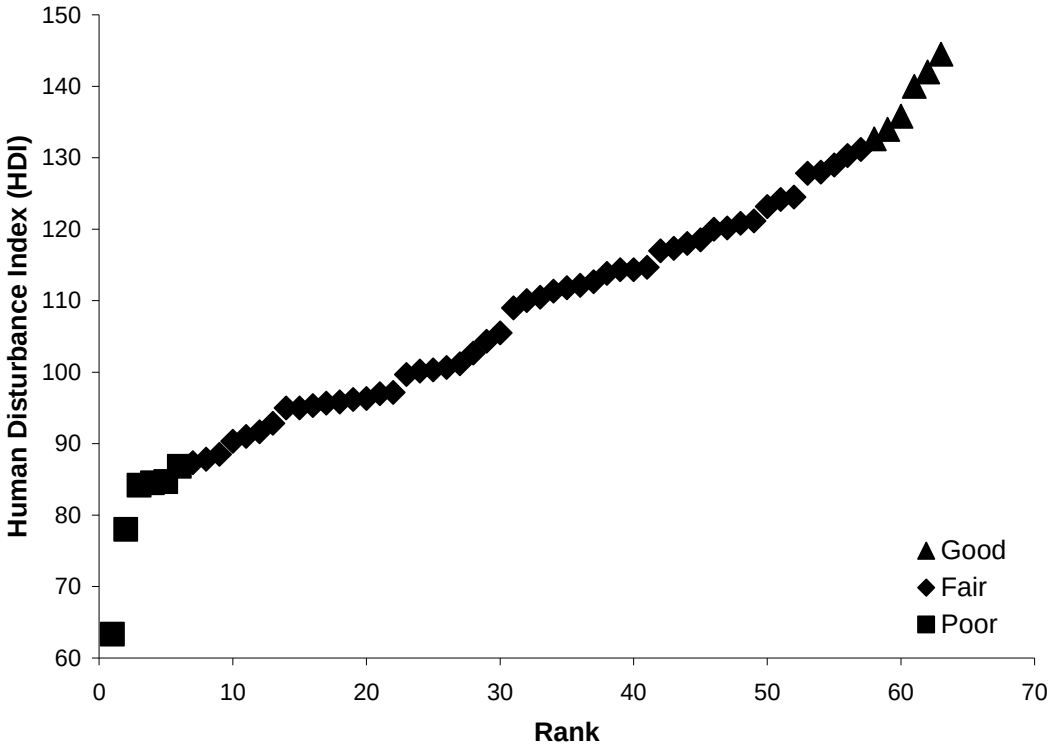


Figure 3. Distribution of the Human Disturbance Index Ranked from Lowest to Highest Score for Northern Glaciated Plains Ecoregion (46) Riffle/Run Sites.

evaluated by performing a Spearman Rank correlation with the HDI and the evaluated metric. Metrics with P-values greater than 0.05 were eliminated (Appendix E). Finally, a correlation matrix was completed on all metrics that were not eliminated due to low responsiveness or other poor predictive characteristics. When metrics pairs were highly correlated (r>0.80) one of the pair was eliminated to reduce redundancy within the final set of metrics.

Once the final metrics were determined, raw metric values were transformed into standardized metric scores. All metric scores were computed using the following equations developed by Minns *et al.* (1994). The equation result in a set of standardized metrics that are on a scale of 0 to 100.

Metrics that decrease with impairment:

$M_s = (M_R/M_{MAX}) \times 100$

Metrics that increase with impairment:

$M_s = (M_{MAX} - M_R) / (M_{MAX} - M_{MIN}) \times 100$

Where:

M_s = standardized metric value
M_R = the raw metric value
M_{MAX} = the maximum value
M_{MIN} = the minimum value

Maximum (M_{MAX}) and minimum (M_{MIN}) values were set at the 95^{th} and 5^{th} percentiles, respectively, of the entire data set. The overall IBI score was the mean of the standardized metric scores that comprise the final IBI.

If the data allowed, IBI scores for sites that had replicate data for consecutive years or within the same year were used to evaluate the variation in the IBI score. These comparisons allowed an evaluation of how the IBI performed between and within years. Also, at least one site with a good HDI score, one site with a poor HDI score and at least ten percent of sites with fair HDI scores were randomly selected to be left out of the IBI development process. These sites were considered validation sites and were used to evaluate performance of the final IBI.

3.0 RESULTS

3.1 Glide/Pool Sites

Glide/pool sites in the Northern Glaciated Plains ecoregion showed separation in box plots and had an adequate range of values for 23 potential metrics. Mann-Whitney tests yielded 23 metrics with P-values less than 0.20 (Table 3). Spearman rank correlations reduced the metrics to 13 candidate metrics. Evaluation of

correlation matrices left seven metrics (Table 4). Table 5 shows the metrics used to determine the final score and the maximum and minimum values used for scoring each metric. Results of individual IBI scores for glide/pool sites in the Northern Glaciated Plains Ecoregion are depicted in Appendix E.

The IBI scoring range for all glide/pool sites in the Northern Glaciated Plains ecoregion was 11.1 to 91.2 with a mean of 41.0 and a median of 34.5. The IBI scoring range for sites with good habitat scores was 48.6 to 78.5 with a mean of 64.3 and a median of 62.4. Sites with poor habitat scores ranged from 11.1 to 34.5 with a mean of 18.0 and a median of 13.2. Fair habitat scoring sites ranged from 14.2 to 91.2 with a mean of 40.0 and median of 33.4. A 1-way analysis of variance (AOV) showed a significant effect due to human disturbance ranks ($F=7.01$, $P=0.003$). A Tukey multiple comparison test ($\alpha=0.05$) was used to compare the mean IBI score of each habitat rank. Significant differences in mean IBI scores occurred between sites with good and poor habitat scores and between sites with good and fair habitat scores. There was no difference in IBI scores between sites with fair and poor habitat scores.

A plot of between-year variation showed little agreement between years in scoring (Figure 4). The considerable variation from the one to one relationship expected in this plot does raise concern on the performance of this IBI between years. It should be noted that this is a small sample and comparisons for each site were not available across the same years.

The validation sites' linear relationship ($y = 0.4054x + 0.4836$, $R^2=0.0891$, $p=0.4727$) between IBI and HDI scores that had a flatter slope than the relationship for IBI development sites($y = 0.7608x - 48.202$, $R^2=0.2918$, $p=0.0008$) (Figure 5). It should be noted that due to small sample size the best fit regression line is not significant and is shown only as a reference for comparison. Further study would be needed to validate the IBI for glide/pool streams.

IBI scores for glide/pool sites plotted by major drainage basin yielded a distinct pattern (Figure 6). Souris River basin sites made up the majority of the high IBI scores and Red River basin sites made up the majority of the low IBI scores. Since the IBI development hinges on differences between good and poor sites, this IBI may be responding to natural differences in these two basins rather than human disturbance. Future study designs in the Northern Glaciated Plains ecoregion may want to incorporate this information and consider development of separate macroinvertebrate IBIs for the two basins.

Table 3. Results of Mann-Whitney U Test and Spearman Rank Correlation to the Human Disturbance Index (HDI) for the Northern Glaciated Plains Ecoregion (46) Glide/Pool sites. (Asterisks denote P-values less than 0.05. Bold metrics indicate final IBI metrics.)

Metric Name	Metric Abbreviation	Mann-Whitney U Test (P-Value)	Spearman Rank Correlation	
			R-value	P-Value
Shannon- Weiner Index	Shan_e	0.0318	0.38	0.0253*
Margalef's Index	D-Mg	0.0080	0.43	0.0108*
Simpson's Index	D	0.0953	-0.28	0.1007
Evenness	Evenness	0.0318	0.34	0.0427*
Percent Amphipoda	AmphPct	0.0318	0.25	0.1537
Percent Chironomidae	ChiroPct	0.0953	0.26	0.1335
Percent Diptera	DipPct	0.0556	0.27	0.1099
Percent Odonata	OdonPct	0.0159	0.26	0.1342
Percent Collectors	CllctPct	0.0318	0.35	0.0379*
Percent Shredders	ShredPct	0.0080	0.38	0.0252*
Percent Climbers	ClmbrPct	0.0080	0.35	0.0402*
Coleoptera Taxa	ColeoTax	0.0159	0.30	0.0830
Diptera Taxa	DipTax	0.0159	0.35	0.0418*
Ephemeroptera, Plecoptera, and Trichoptera Taxa	EPTTax	0.0953	0.39	0.0200*
Collector Taxa	CllctTax	0.0159	0.42	0.0125*
Predator Taxa	PredTax	0.0080	0.32	0.0590
Shredder Taxa	ShredTax	0.0080	0.45	0.0073*
Climber Taxa	ClmbrTax	0.0159	0.38	0.0247*
Clinger Taxa	ClngrTax	0.0318	0.46	0.0053*
Sprawler Taxa	SprwlTax	0.0556	0.23	0.1889
Swimmer Taxa	SwmmrTax	0.0080	0.32	0.0588
Tolerant Taxa	TolerTax	0.0159	0.26	0.1265
Total Taxa	TotalTax	0.0080	0.36	0.0332*

Table 4. Northern Glaciated Plains Ecoregion (46) Glide/Pool Correlation Matrix. (Numbers in bold represent correlations with r>0.80. Abbreviations are defined in Table 3)

	Shan_e	D-Mg	Evenness	CllctPct	ShredPct	ClmbrPct	DipTax	EPTTax	CllctTax	ShredTax	ClmbrTax	ClngrTax	TotalTax
Shan_e	1.00												
D-Mg	0.78	1.00											
Evenness	**0.81**	0.47	1.00										
CllctPct	-0.10	0.28	-0.39	1.00									
ShredPct	0.31	0.27	0.51	-0.12	1.00								
ClmbrPct	0.32	0.20	0.29	-0.09	0.18	1.00							
DipTax	0.60	0.74	0.30	0.24	0.06	0.12	1.00						
EPTTax	0.42	0.57	0.26	0.18	0.03	-0.02	0.54	1.00					
CllctTax	0.59	**0.81**	0.18	0.49	0.02	0.11	0.76	0.66	1.00				
ShredTax	0.33	0.74	0.10	0.42	0.29	-0.02	0.43	0.57	0.68	1.00			
ClmbrTax	0.40	0.76	0.13	0.38	0.21	0.25	0.55	0.31	0.63	0.78	1.00		
ClngrTax	0.69	0.79	0.44	0.18	0.03	0.27	0.61	0.69	0.75	0.55	0.54	1.00	
TotalTax	0.66	**0.97**	0.27	0.39	0.13	0.15	0.71	0.58	**0.85**	0.78	0.78	0.78	1.00

Table 5. Northern Glaciated Plains Ecoregion (46) Glide/Pool Maximum and Minimum Values Used to Standardize Metrics.

Glide/Pool Metrics		Category	Reaction to Perturbation	Minimum value	Maximum value
1	Shannon Diversity Index	Richness	Decrease	0.58	2.54
2	Percent Collectors	Trophic	Decrease	0	88.03
3	Ephemeroptera, Plectoptera and Trichoptera Taxa	Composition	Decrease	0	6
4	Shredder Taxa	Trophic	Decrease	0	5
5	Climber Taxa	Habit	Decrease	0	6
6	Clinger Taxa	Habit	Decrease	0	7
7	Total Taxa	Richness	Decrease	6	32

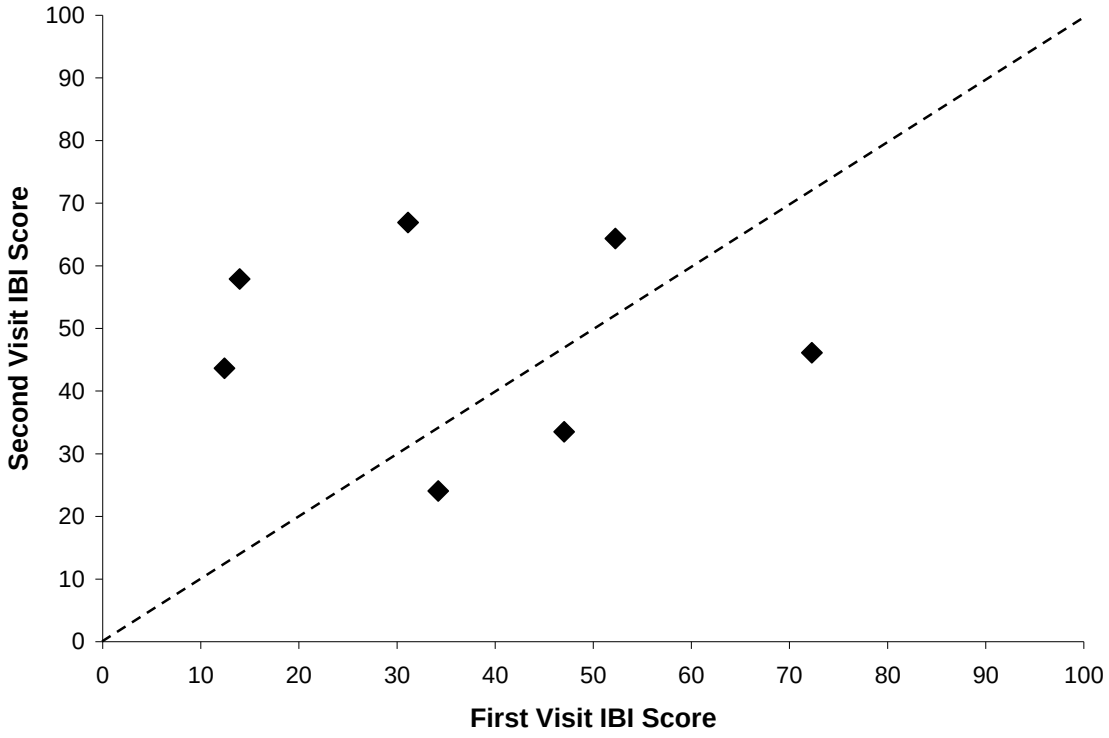


Figure 4. Between-year Variation of the IBI Developed for the Glide/Pool Stream Sections of Ecoregion 46 within North Dakota. (Dashed line indicates the expected 1 to 1 relationship. No significant regression existed for this set of points.)

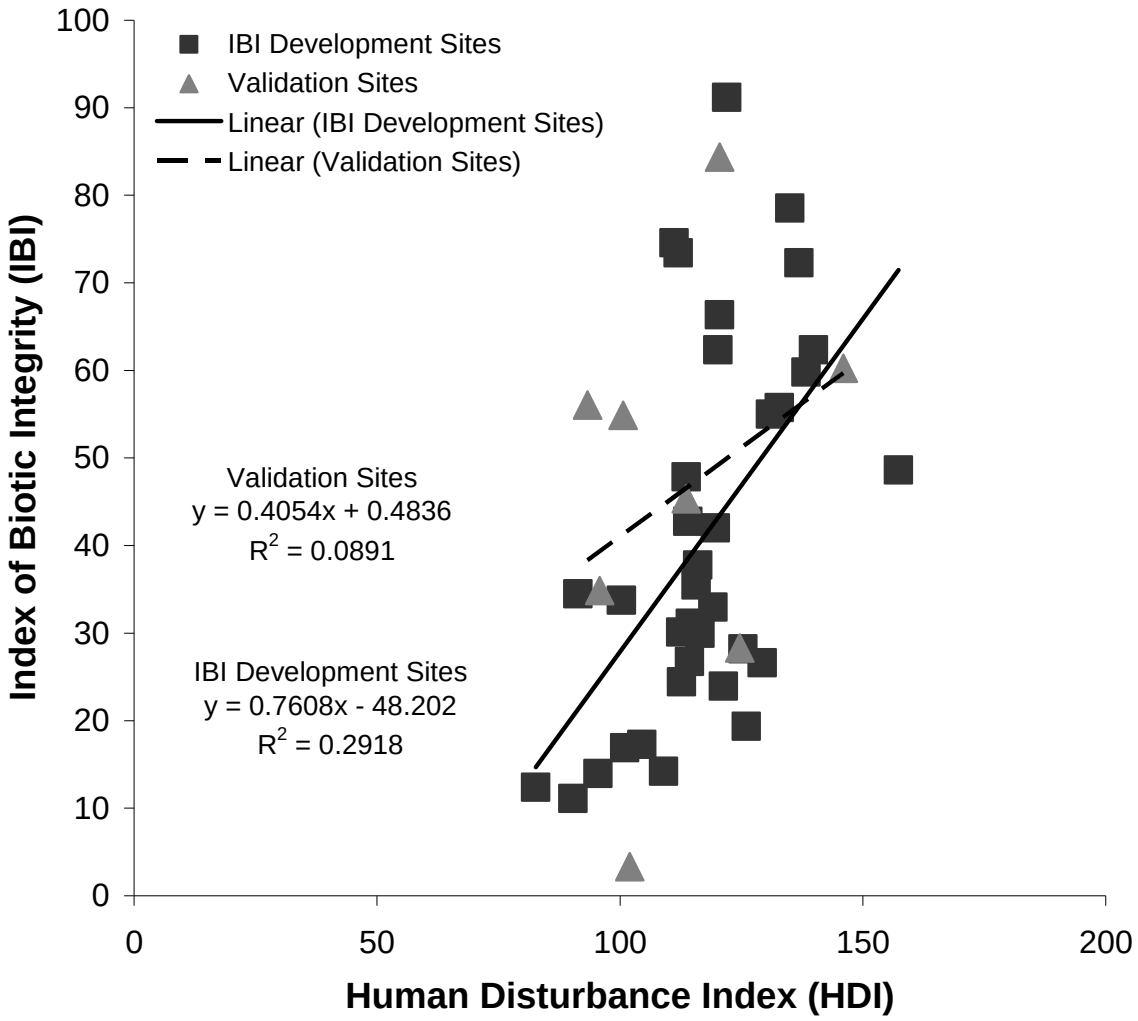


Figure 5. Comparison of IBI Development Sites to Validation Sites for Glide/Pool Stream Sections of Ecoregion 46 within North Dakota. (Lines indicate linear regressions. Results of each linear regression are reported above.)

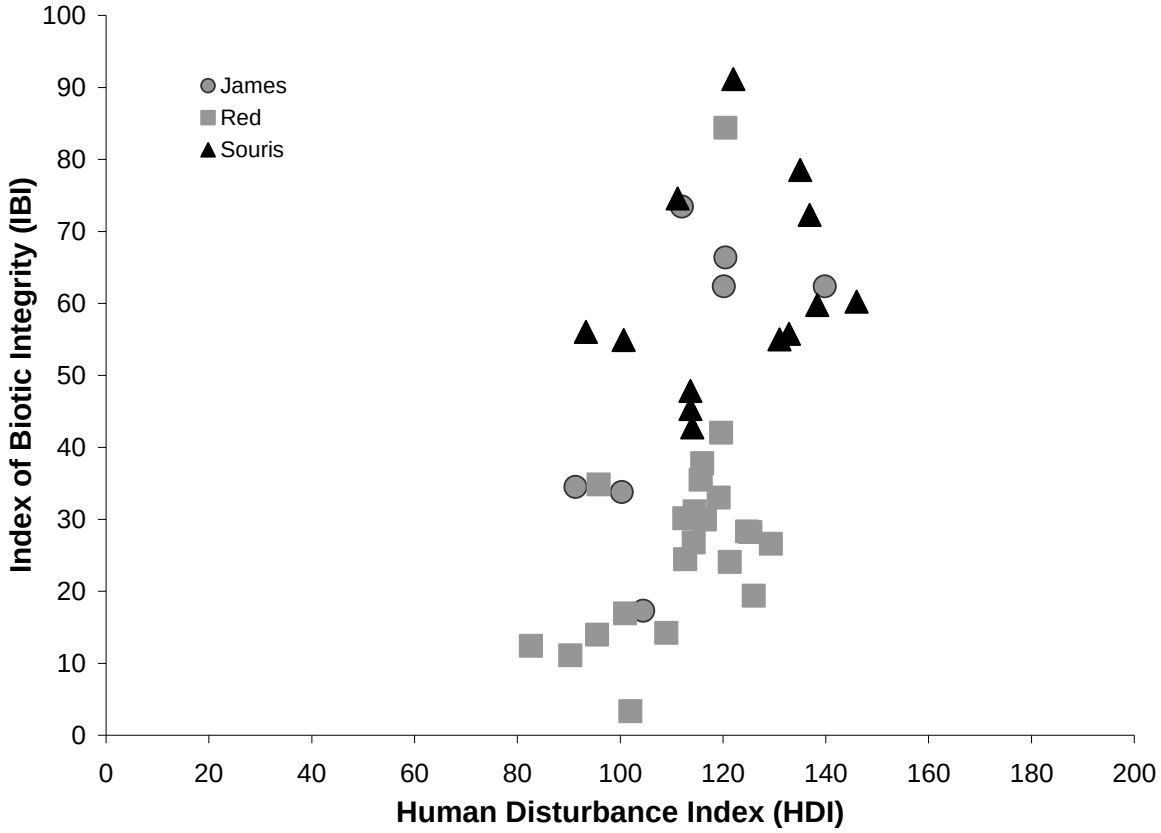


Figure 6. Scatterplot Showing Major Drainage Basin Membership for Glide/Pool Stream Sites in Ecoregion 46.

3.2 Riffle/Run Sites

Riffle/run sites in the Northern Glaciated Plains ecoregion showed separation in box plots and had an adequate range of values for 20 potential metrics. Mann-Whitney tests yielded 20 metrics with P-values less than 0.20 (Table 6). Spearman rank correlations reduced the metrics to 7 candidate metrics. Evaluation of correlation matrices left five metrics (Table 7). The intolerant taxa metric was added back to the IBI after it was determined that it caused the IBI score to have a better correlation with the HDI score after it was added back to the index. Table 8 shows the metrics used to determine the final score and the maximum and minimum values used for scoring each metric. Results of individual IBI scores for riffle/run sites in the Northern Glaciated Plains Ecoregion are depicted in Appendix E.

The IBI scoring range for all riffle/run sites in the Northern Glaciated Plains ecoregion was 1.7 to 89.0 with a mean of 36.8 and a median of 35.1. The IBI scoring range for sites with good habitat scores was 24.7 to 85.1 with a mean of 57.6 and a median of 55.8. Sites with poor habitat scores ranged from 13.6 to 26.7 with a mean of 19.7 and a median of 19.0. Fair habitat scoring sites ranged from

1.7 to 89.0 with a mean of 36.4 and median of 35.2. A 1-way analysis of variance (AOV) showed a significant effect due to human disturbance ranks ($F=5.71$, $P=0.006$). A Tukey multiple comparison test ($\alpha=0.05$) was used to compare the mean IBI score of each habitat rank. Significant differences in mean IBI scores occurred between sites with good and poor habitat scores and between sites with good and fair habitat scores. There was no difference in IBI scores between sites with fair and poor habitat scores.

Data for both within-year and between year comparisons were available for riffle/run sites. A plot of within-year variation had a slightly flatter slope from the expected slope of 1 (Figure 7). The small sample size (n=5) makes it unclear if the variation is enough to warrant a strict sampling window for these sites. A plot of between-year variation showed little agreement between years in scoring (Figure 8). The considerable variation from the one to one relationship expected in this plot does raise concern on the performance of this IBI between years. It should be noted that comparisons for each site were not available across the same years.

The validation sites' linear relationship ($y = 0.2771x + 7.2597$, $R^2=0.1044$, $p=0.4879$) between IBI and HDI scores that had a flatter slope than the relationship for IBI development sites($y = 0.4737x - 16.7470$, $R^2=0.2050$, $p=0.0007$) (Figure 9). It should be noted that due to small sample size the best fit regression line is not significant and is shown only as a reference for comparison. Further study would be needed to investigate whether the IBI is valid.

IBI scores for riffle/run sites plotted by major drainage basin did not yield a distinct pattern (Figure 10). Scores for the Souris basin and James basin were scattered throughout the distribution and the Red basin had too few sites to evaluate (n=3). Drainage basin differences within the ecoregion do not seem to affect IBI scores for riffle/run sites as strongly as they do for glide/pool sites (Figure 6).

Table 6. Results of Mann-Whitney U Test and Spearman Rank Correlation to the Human Disturbance Index (HDI) for the Northern Glaciated Plains Ecoregion (46) Riffle/Run sites. (Asterisks denote P-values less than 0.05. Bold metrics indicate final IBI metrics.)

Metric Name	Metric Abbreviation	Mann-Whitney U Test (P-Value)	Spearman Rank Correlation	
			R-value	P-Value
Shannon- Weiner Index	Shan_e	0.0476	0.08	0.5693
Margalef's Index	D-Mg	0.0754	0.08	0.5656
Hilsenhoff Biotic Index	HBI	0.0754	-0.18	0.1904
Beck Biotic Index	BeckBI	0.0080	0.37	0.0057*
Evenness	Evenness	0.0754	0.08	0.5864
Percent Amphipoda	AmphPct	0.0754	-0.02	0.9108
Percent Trichoptera	TrichPct	0.0278	0.36	0.0074*
Percent Filterer	FiltrPct	0.0476	0.19	0.1705
Percent Predator	PredPct	0.0754	-0.32	0.0182*
Percent Shredders	ShredPct	0.0278	0.23	0.1011
Percent Intolerant Taxa	IntolPct	0.0040	0.32	0.0190*
Percent Tolerant Taxa	TolerPct	0.0476	-0.13	0.3604
Percent Dominant Taxa	Dom01Pct	0.0754	-0.01	0.9470
Ephemeroptera, Plecoptera, and Trichoptera Taxa	EPTTax	0.0278	0.31	0.0260*
Trichoptera Taxa	TrichTax	0.0159	0.36	0.0090*
Shredder Taxa	ShredTax	0.0476	0.08	0.5574
Clinger Taxa	ClngrTax	0.0754	0.14	0.3278
Sprawler Taxa	SprwlTax	0.0278	0.16	0.2638
Intolerant Taxa	IntolTax	0.0040	0.30	0.0284*
Total Taxa	TotalTax	0.0476	0.07	0.6359

Table 7. Northern Glaciated Plains Ecoregion (46) Riffle/Run Correlation Matrix. (Numbers in bold represent correlations with r>0.80. Abbreviations are defined in Table 6)

	BeckBI	TrichPct	PredPct	IntolPct	EPTTax	TrichTax	IntolTax
BeckBI	1.00						
TrichPct	0.38	1.00					
PredPct	-0.09	-0.23	1.00				
IntolPct	0.42	0.38	0.10	1.00			
EPTTax	0.66	0.36	-0.24	0.30	1.00		
TrichTax	0.63	0.39	-0.26	0.17	**0.87**	1.00	
IntolTax	**0.83**	0.37	0.07	0.35	0.44	0.48	1.00

Table 8. Northern Glaciated Plains Ecoregion (46) Riffle/Run Maximum and Minimum Values Used to Standardize Metrics.

Glide/Pool Metrics		Category	Reaction to Perturbation	Minimum value	Maximum value
1	Beck Biotic Index	Tolerance/Intolerance	Decrease	0	6
2	Percent Trichoptera	Composition	Decrease	0	30.36
3	Percent Predators	Trophic	Increase	1.04	38.05
4	Percent Intolerant Taxa	Tolerance/Intolerance	Decrease	0	25.05
5	Ephemeroptera, Plecoptera and Trichoptera Taxa	Composition	Decrease	0	10
6	Intolerant Taxa	Tolerance/Intolerance	Decrease	0	3

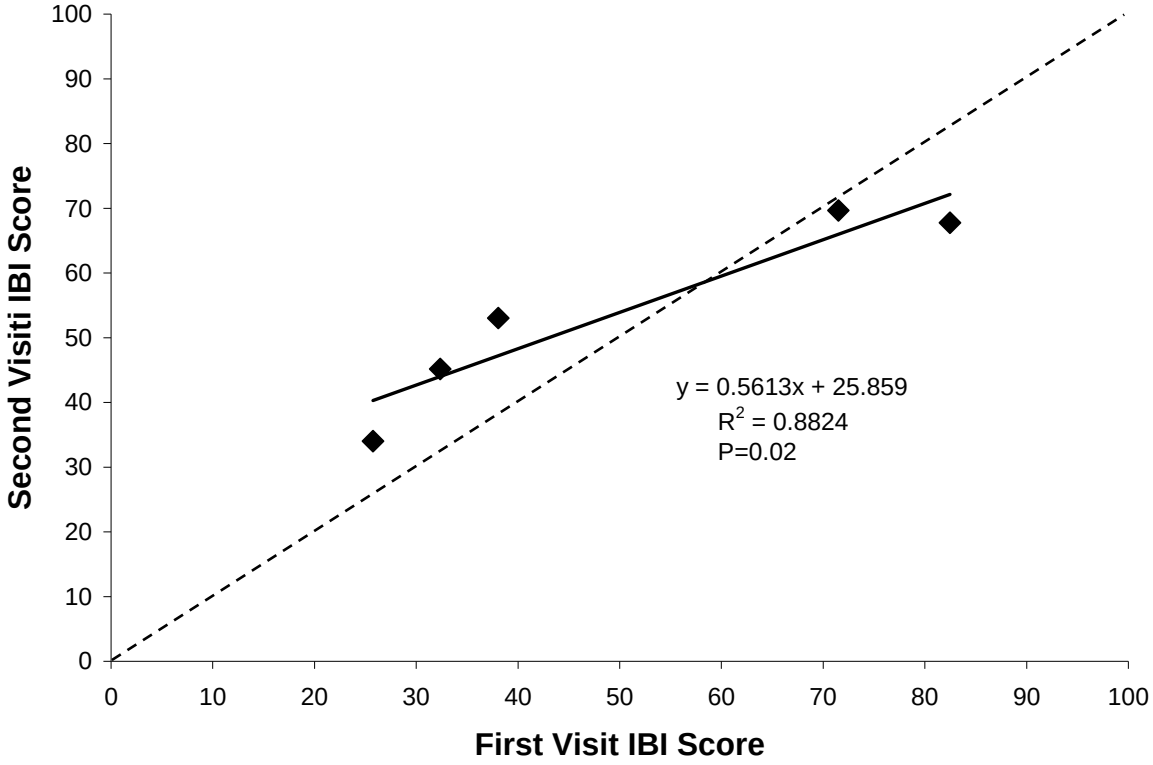


Figure 7. Within-year Variation of the IBI Developed for the Riffle/Run Stream Sections of Ecoregion 46 within North Dakota. (Dashed line indicates the expected 1 to 1 relationship. Solid line indicates the regression line. Results of the linear regession are reported above.)

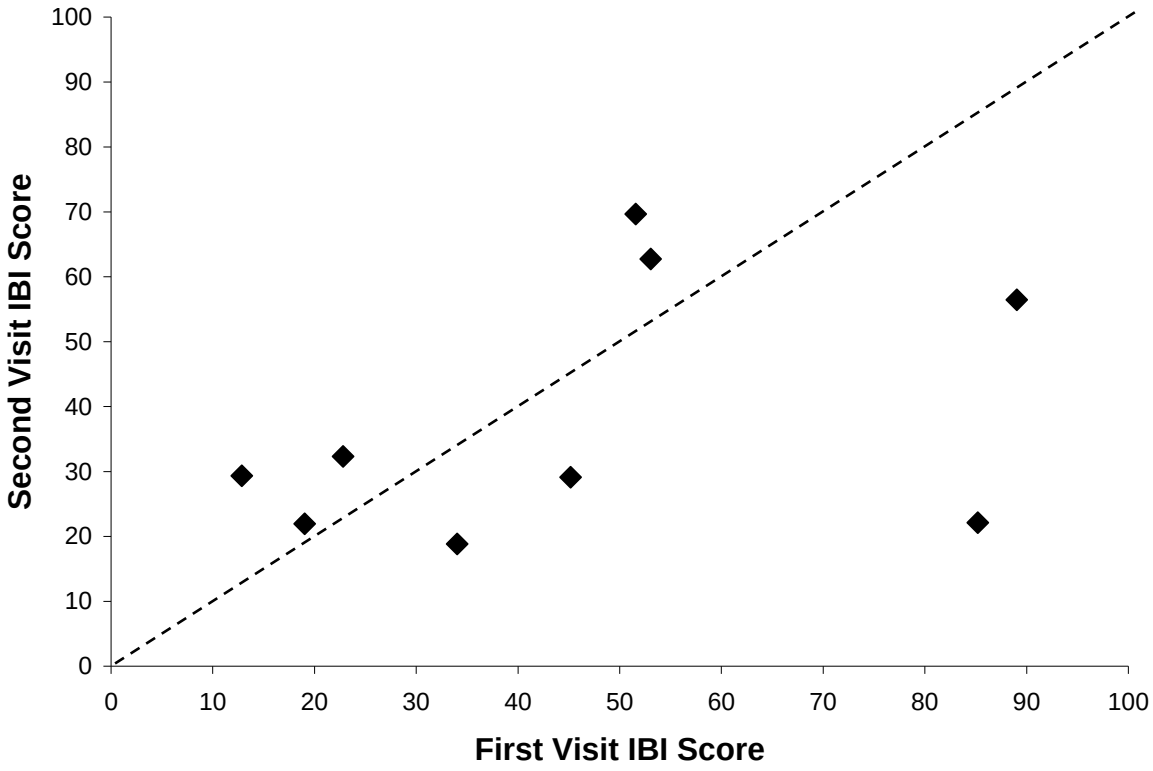


Figure 8. Between-year Variation of the IBI Developed for the Riffle/Run Stream Sections of Ecoregion 46 within North Dakota. (Dashed line indicates the expected 1 to 1 relationship. No significant regression existed for this set of points.)

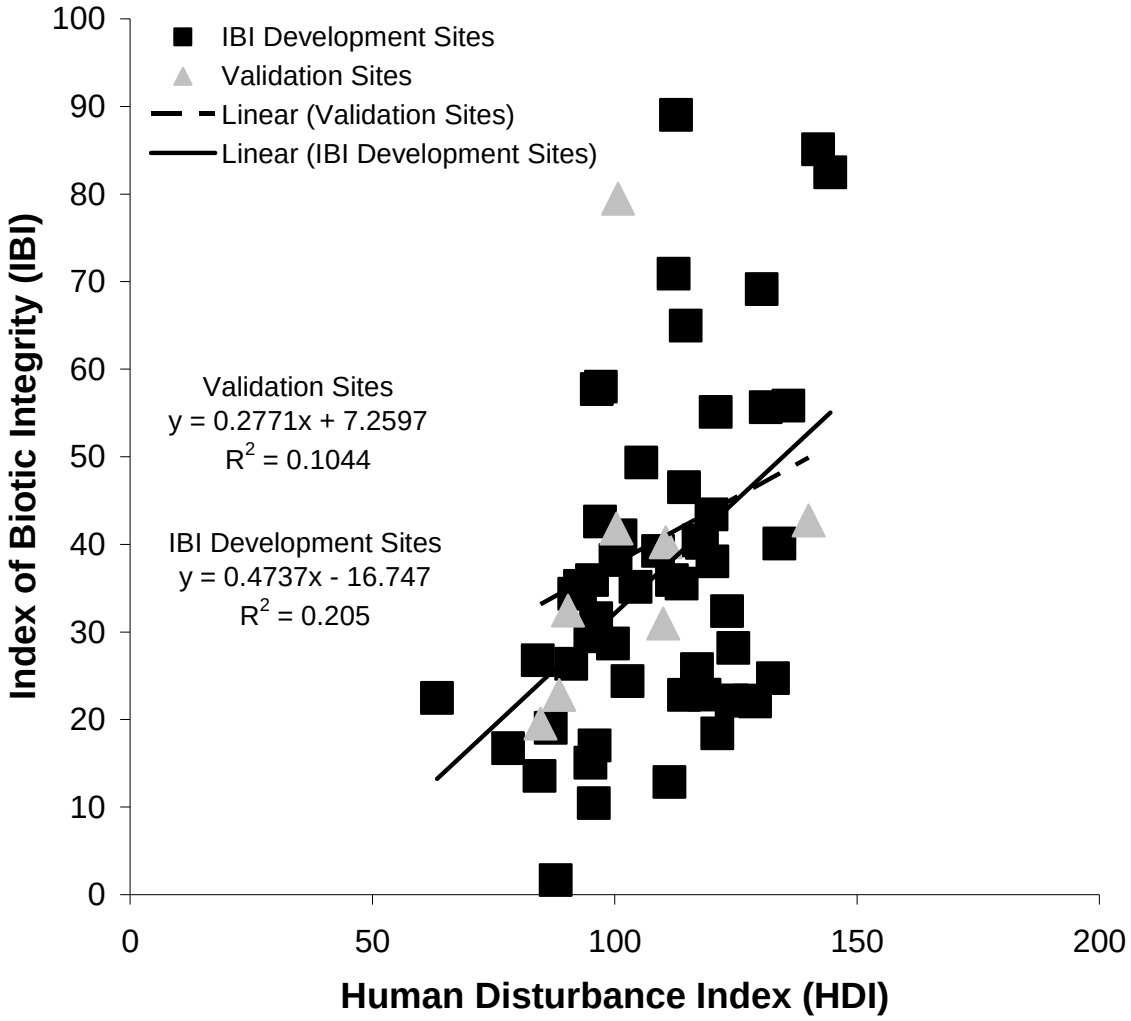


Figure 9. Comparison of IBI Development Sites to Validation Sites for Riffle/Run Stream Sections of Ecoregion 46 within North Dakota. (Lines indicate linear regressions. Results of each linear regression are reported above.)

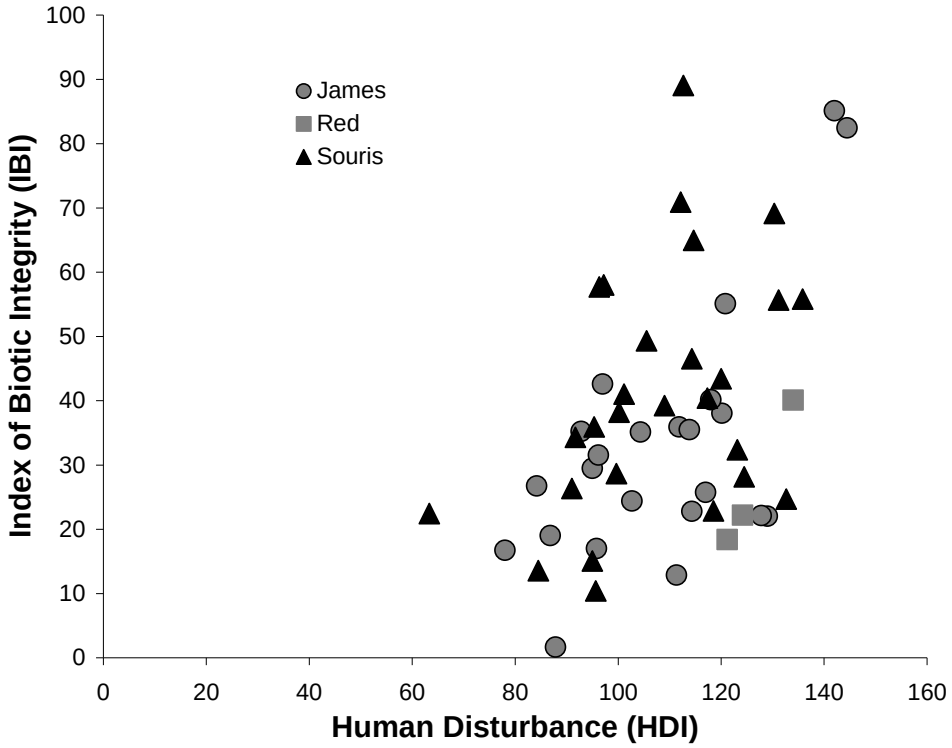


Figure 10. Scatterplot Showing Basin Groupings for Riffle/Run Stream Sites in Ecoregion 46.

4.0 SUMMARY

The purpose of this project is to develop a set of benthic macroinvertebrate multimetric IBIs that can be used to assess the biological condition of perennial rivers and streams in North Dakota. This report addresses those methods used and results found for the Northern Glaciated Plains ecoregion (46) within North Dakota. Exhaustive statistical analyses were not conducted on these data. Tests of significance are often overused by ecologists (Fore *et al.* 1996) and short-circuit the process of looking at and interpreting the data. Such tests address detection of impact rather than their magnitude or relevance (Stewart-Oaten 1986). This was considered when we incorporated visual assessments (box plots) in evaluating metrics and used less rigorous p-values when assessing the Mann-Whitney tests. More emphasis should be centered on understanding and evaluating the biological data and condition of the sampling sites and less on the statistical procedures used to analyze them.

Development of an IBI is a widely accepted practice throughout the United States. Biocriteria are useful tools in allowing managers to assess human disturbances to our aquatic environments. Because biological systems are dynamic, an IBI should be continually revised and updated as additional data becomes available. Efforts should also

focus on sampling sufficient numbers of "least disturbed" or "best available" reference sites as well as impaired sites with high levels of human disturbance. Efforts to resample reference and impaired sites between and within years should also be implemented to permit the evaluation of how IBI scores vary over time.

An IBI is a useful tool for evaluating and monitoring our lotic environments. It should, however, be used to complement and enhance other data (e.g., chemical data, habitat data, landscape data) to determine not only the biological condition of the aquatic resource, but to understand the cause and source of stressors on the biology of impaired rivers and streams. Other biological conformation (e.g., fish community data) can also be collected when performing stream surveys. By combining information from different biological communities, an integrated approach to examining aquatic life use can be developed.

The IBIs developed for Northern Glaciated Plains ecoregion showed some variability problems that warrant refinement before they are used in management decisions. Future studies of this ecoregion will need to be aware of the basin effects seen in glide/pool reaches and designs must address this issue. Also, the use of a stricter sampling window during sample collection may yield better performing IBIs.

5.0 LITERATURE CITED

Analyse-It Software, Ltd., Analyse-It, version 1.67. 2003.

Barbour, M.T., J.B. Stribling and J.R. Karr. 1995. Multimetric approach for establishing biocriteria and measuring biological condition. Pages 63-77 in W.S.

Barbour, M.T., J. Gerritsen, B.D. Snyder, J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers. EPA 841-B-99-002. A7-A10.

Davis and T.P. Simon (editors). Biological assessment and criteria. Tools for water resource planning and decision making. Lewis Publishers, Boca Raton, Florida.

Ebert, D. W., T. G. Wade, J. E. Harrison, and D. H. Yankee. 2001. Analytical Tools Interface for Landscape Assessment (ATtILA) Quick Start Guide Version 3.0. Draft. http://www.epa.gov/nerlesd1/land-sci/oregon/attila/user_guide.html

Faulkner, C. and E. Lepo. 2000. Ecological Data Application System (EDAS) A User's Guide. Tetra Tech, Inc. 10045 Red Run Blvd, Baltimore, MD. 21117.

Fore, L. S., J. R. Karr, and L.L. Conquest. 1994. Statistical properties of an index of biotic integrity used to evaluate water resources. Canadian Journal of Fisheries and Aquatic Sciences 51:1077-1087.

Fore, L.S., J.R. Karr, and R.W. Wisseman. 1996. Assessing invertebrate responses to human activities: evaluating alternative approaches. Journal of North American Benthological Society 15(2):212:231.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspectives on water quality goals. Environmental Management 5: 44-68.

North Dakota Department of Health. 2001. Standards of Water Quality for Waters of the State. North Dakota Century Code 33-16-02.1.

Merritt, R.W. and K.W. Cummins (eds.) 1996. An Introduction to the Aquatic Insects of North America. 3rd edition. Kendall/Hunt Publishing Company. Dubuque, IA. USA.

Microsoft Corporation, Excel 2002 SP-2, 2002.

Minns, C.K., V.W. Cairns, R.G. Randall, and J.E. Moore. 1994. An index of biotic integrity (IBI) for fish assemblages in the littoral zone of Great Lakes' areas of concern. Canadian J. Fish Aquat. Sci. 51:1804-1822.

Omernik, J.M. and A.L.Gallant 1988. Ecoregions of the Upper Midwest States. USEPA Research Laboratory, Corvallis, OR. EPA/600/3-88/037.

Resh, V.H., R.H. Norris, and M.T. Barbour. 1995. Design and implementation of rapid assessment approaches for water resource monitoring using benthic macroinvertebrates. Austrailian Journal of Ecology 20:108-121.

Rosenberg, D.M. and V.H. Resh (eds.). 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman and Hall. New York.

Stewart-Oaten, W.W. Murdoch, and K.R. Parker. 1986. Environmental impact assessment and "pseuoreplication" in time. Ecology 67:929-40.

Appendix A

Standard Operating Procedures for the Collection and Laboratory Analysis of Macroinvertebrate Samples Including Example Data Forms

7.19 STANDARD OPERATING PROCEDURES FOR THE COLLECTION OF A MACROINVERTEBRATE SAMPLE FROM WADABLE RIVERS AND STREAMS

Summary

Macroinvertebrates are excellent indicators of aquatic health. Additionally, due to the range of life spans and varying needs throughout their life span, macroinvertebrates are excellent indicators of chronic and acute pollution impacts.

In rivers and streams which naturally contain cobble (riffle/run) habitat, a single sample collected from this habitat is considered representative of the stream reach. Many rivers and streams in the state, however, do not naturally contain cobble substrate. These rivers and streams are typically low gradient streams with sandy or silty sediments. In cases where cobble substrate represents less than 30% of the sampling reach in reference streams (i.e., least impaired streams which represent the ecoregion or basin) the multi-habitat method for collecting macroinvertebrate samples should be used (Section 3.19.2). It is important to recognize that the appropriate sampling method (single or multi-habitat) should be selected based on the habitat availability of the reference condition and not of potentially impaired streams. For example, the multi-habitat method should not be used for stream reaches where the extent of cobble substrate was reduced due to anthropogenic sediment deposition. Conversely, the single-habitat method should not be used where the stream reach contains artificially introduced rock or cobble material.

The following methods have been developed, in part, based on the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition (Barbour *et al.* 1999).

7.19.1 Field Collection Procedures for Single-Habitat Macroinvertebrate Samples

Equipment list

__ D-Frame net, Kick net, Surber Bottom Sampler, or Hess Bottom Sampler (500-600 µm mesh opening)
__ Waders (chest-high or hip boots)
__ Sample containers (1 and 2 liter plastic jars)
__ Sample container labels (waterproof Nalgene Polypaper)
__ 95 % Ethanol
__ Sieve bucket (500 µm mesh opening)
__ Forceps
__ Permanent marker (black)
__ Pencils, clipboard
__ Field Recording and Log Forms
__ Camera
__ Global Positioning System (GPS) Unit (optional)

Procedures

1. Once the sampling reach has been selected (Note: The area should be at least 100 meters

upstream from any road or bridge crossing to minimize its effect on stream velocity, depth and overall habitat quality.), complete the Biological Monitoring Field Collection Data Form (Figure 7.19.1). To record the latitude and longitude, use a hand held Global Positioning System (GPS) and determine latitude and longitude at the furthest downstream point of the sampling reach. On the recording form, draw a site map of the sampling reach. The map should include in-stream attributes (e.g., riffles, fallen trees, pools, bends), important structures, attributes of the bank and near bank area, and the location of all areas sampled. The map should also include an arrow in the direction of flow and an arrow depicting north.

2. A composite sample is collected from a minimum of three "kicks" each located at various velocities, in the riffle or series of riffles. (Note: The composite sample should consist of a minimum of 300 organisms; therefore, additional kick samples may be required.) A "kick" is a stationary sampling accomplished by disturbing area in front of the full width of the net to a distance 1 meter upstream of the net. Using the toe or heel of the boot, dislodge the upper layer of cobble or gravel and scrape the underlying bed. Larger rocks should be picked up and rubbed by hand to remove attached organisms. This method presumes a D-frame net with a 454 cm^2 opening is used, however, other gear types (e.g., kick-net, Surber sample, Hess sampler, etc.) may be used depending on project specific Quality Assurance Project Plans.

3. The individual kicks collected for each area in the riffle or series of riffles is composited into a single homogeneous sample. After every kick, place the sample in a sieve bucket, or in the sample net, wash the collected material with clean stream water 2-3 times. Remove large debris after rinsing and inspecting it for organisms, placing all organisms found into the sample container.

4. Transfer the sample from the sieve bucket or net to the sample container. Once all the samples are composited in the sample container, decant excess water from the container and preserve in enough 95 % ethanol to cover the sample. (Note: Forceps may be needed to remove organisms from the net.)

5. Place a Nalgene Polypaper label in the sample container and label the outside of the container with black permanent marker. Both labels should contain the station identification number and description, the field number, date and time of collection, and the collector(s) name. The outside of the container should also contain the words: "preservative: 95% ethanol." If more than one container is used for a sample, each container should contain all the information for the sample and should be numbered 1 of 2, 2 of 2, etc.

6. Record each sample on the Macroinvertebrate Sample Log Form (Figure 7.19.2). Include information such as field number, station identification and description, date and time, and number of containers.

North Dakota Department of Health
Division of Water Quality
Biological Monitoring Field Collection Data Form

Station ID: _____ Field Number: _____

Waterbody Name: _____

Station Description: _____

Latitude: _____ Longitude: _____

County: _____ Township: _____ Range: _____ Section: _____

River Basin: _____ Ecoregion: _____

Weather (air temp, wind, etc.): _____

Flow (cfs): _____ Water Temp: _____ pH: _____ Specific Cond.: _____Dissolved Oxygen: _____

Reach Length (m): _____ Average Reach Width (m): _____ Average Reach Depth (m): _____

Stream Habitat Type (%): Riffle: _____ Pool: _____ Snag: _____Aquatic Vegetation: _____

Undercut Bank: _____ Overhanging Vegetation: _____ Other: _____

Bottom Substrate Type (%): Boulder: ____ Cobble: ____ Gravel: ____ Sand: ____ Silt: ____ Clay: ____

Collection Method: _____Time Start: _____ Time Stop:_____ Total Time:_____

Habitat Assessment: Yes or No Macroinvertebrate Sample: Yes or No Water Chemistry: Yes or No

Sampler(s): _____

Comments: _____

Figure 7.19.1. Macroinvertebrate Field Collection Data Recording Form

North Dakota Department of Health
Division of Water Quality
Macroinvertebrate Field Sample Log

Field Number	Station ID and Description	Date/ Time	Collection Method	Comments

Figure 7.19.2. Macroinvertebrate Sample Log

7.19.2 Field Collection Procedures for Multi-Habitat Macroinvertebrate Samples

Equipment list

__ D-frame net (454 cm^2 opening and 600 µm mesh)
__ Waders (chest-high or hip boots)
__ Sample containers (1 and 2 liter plastic jars)
__ Sample container labels (water proof Nalgene Polypaper)
__ 95 % Ethanol
__ Sieve bucket (500 µm mesh opening)
__ Forceps
__ Permanent magic marker (black)
__ Pencils, clipboard
__ Field Recording and Log Forms
__ Camera
__ Global Positioning System (GPS) Unit (optional)

Procedures

1. Once the sampling reach has been selected (Note: The area should be at least 100 meters upstream from any road or bridge crossing to minimize its effect on stream velocity, depth and overall habitat quality.), complete the Macroinvertebrate Field Collection Data Recording Form (Figure 7.19.1). To record the latitude and longitude, use a hand held Global Positioning System (GPS) and determine latitude and longitude at the furthest downstream point of the sampling reach. On the recording form, draw a site map of the sampling reach. The map should include in-stream attributes (e.g., riffles, fallen trees, pools, bends), important structures, attributes of the bank and near bank area, and the location of all areas sampled. The map should also include an arrow in the direction of flow and an arrow depicting north.

2. A composite sample is collected from stable stream macroinvertebrate habitats in the sample reach (e.g., riffles, shoreline, aquatic vegetation, leaf pack, root wads, and snags). Each composite sample will consist of collecting 20 individual jab/kick samples apportioned among the stable stream habitats, with a minimum of 2 samples per habitat. Each available habitat is sampled in approximate proportion to their availability in the reach. For example, if a sampling reach is composed of 10 percent riffles, 40 percent pools with vegetation, and 50 percent runs with over hanging banks, 2 samples would be collected from the riffles, 8 from the pools and 10 from the runs. A minimum of two jabs or kicks should be collected from each available habitat type. Habitat types contributing less than 5 percent of stable habitat in the reach should not be sampled. In this case, allocate the remaining jabs proportionately among the predominant substrates. Record the number of jabs and kicks taken in each habitat type in the comments on the Field Data Recording Form (Figure 7.19.1).

3. Sampling begins at the downstream end of the reach and proceeds upstream. Each “jab” sample consists of forcefully thrusting the net into the productive habitat for a linear distance of 1 m. Kick samples should be collected from snag or riffle habitats. A “kick” is a stationary sample taken by positioning the net and disturbing the substrate for a distance of 1 m upstream of the net.

4. All 20 jabs/kicks which are collected from the multiple habitats will be composited into a single homogeneous sample. After every three individual jab/kick samples, more often if necessary, place the sample in a sieve bucket and wash the collected material by running

clean stream water through the net two to three times. Remove large debris after rinsing and inspecting it for organisms; place any organisms found into the sample container. Do not spend time inspecting small debris in the field.

5. Transfer the sample from the sieve bucket into the sample container. Once all the individual samples are composited in the sample container, decant excess water from the container and preserve in enough 95 % ethanol to cover the sample. (Note: Forceps may be needed to remove organisms from the net.)

6. Place a Nalgene Polypaper label in the sample container and label the outside of the container with black permanent marker. Both labels should contain the station identification number and description, the field number, date and time of collection, and the collector(s) name. The outside of the container should also contain the words: “preservative: 95% ethanol. ”If more than one container is used for a sample, each container should contain all the information for the sample and should be numbered 1 of 2, 2 of 2, etc.

7. Record each sample on the Macroinvertebrate Field Sample Log Form (Figure 7.19.2). Include information such as field number, station identification and description, date and time, and number of containers.

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

7.20 STANDARD OPERATING PROCEDURE FOR LABORATORY PROCESSING OF MACROINVERTEBRATE SAMPLES

Summary

Macroinvertebrate samples collected in the field by either the single or multi-habitat method are best processed in the laboratory under controlled conditions. Aspects of laboratory sample processing include washing, rinsing, sub-sampling, sorting, identification, and enumeration of organisms.

The following protocol describes a method to sub-sample macroinvertebrates collected from a site. In cases where the sample contains large numbers of organisms, sub-sampling reduces the effort required for sorting and identification. The following protocol is based on a 300 organism sub-sample, but it can be used for any size sub-sample (100, 200, 500, etc.).

Equipment list

___ Laboratory sample log in forms (Figure 7.20.1)
___ Laboratory bench sheets for sorting and identification (7.20.2)
___ Sorting Pans (surface area of pan should be divided into grids of equal size for picking)
___ Forceps (both fine tipped, medium tipped and curved)
___ Dissecting Probes and Needles
___ Watch Glasses
___ Dissecting Scope (9X to 110X for final IDs)
___ Dissecting Scope (7X to 30X to aid in sorting)
___ Compound Microscope (4X, l0X, 40X, and 100X oil objectives andphase contrast optics)
___ Specimen Vials (assorted sizes of 1, 2, and 4 drams and larger with screw cap vials for voucher specimens)
___ Squeeze bottles (1 liter for 70% ethanol)
___ Eyedroppers
___ Tally counter
___ Hot plate
___ Microscopes slides
___ Microscope coverslips 1 oz. Round
___ Magnifying lens with light source for picking samples
___ Taxonomic keys
___ 70% Ethanol
___ Euparol and/or CMC 10 mounting media
___ Potassium Hydroxide (KOH) 10% by volume
___ Illuminator compatible with dissecting scope
___ Deck of numbered cards

Procedures

1. Sample Custody/Login In

In order to ensure proper sample custody, upon transfer and receipt by laboratory personnel, record all samples on the laboratory sample log in form (Figure 7.20.1). Include the date received and all information from the sample container label. If more than one container was used, record the number of containers per sample. All samples should be sorted in the same laboratory to enhance quality control.

2. Washing and Preparing the Sample for Sorting

Thoroughly rinse the sample in a 500 µm-mesh sieve to remove preservative and fine sediment. Large organic material (whole leaves, twigs, algae, or macrophyte mats, etc.) not removed in the field should be rinsed, visually inspected, and discarded. If the samples have been preserved in alcohol, it will be necessary to soak the sample contents in water for about 15 minutes to hydrate the benthic organisms. This will prevent them from floating on the water surface during sorting. If the sample was stored in more than one container, the contents of all containers for a given sample should be combined at this time. Gently mix the sample by hand while rinsing to make the entire sample homogeneous.

After washing, spread the sample evenly across a pan marked with numbered grids approximately 6 cm x 6 cm. Along the sides and top of the gridded pan, line up numbered specimen vials, which will hold the sorted organisms. Start with vials 1-15 set up and have vials 16-30 available, if needed. If the sample is to be identified that day, these jars can contain water. If it is towards the end of the day and they will not be identified in the next twelve hours the jars should contain 70 percent ethanol.

3. Sample Sorting and Counting

Using a deck of cards that contains numbers corresponding to the numbered grids in the pan, draw a card to select a grid within the gridded pan. This is done to make sure a random sampling is carried out. Begin picking organisms from that square and placing them in the numbered vials. Any organism that is lying over a line separating two grids is considered to be on the grid containing its head. In those instances where it may not be possible to determine the location of the head (worms for instance), the organism is considered to be in the grid containing most of its body. Each numbered vial should contain one taxon of organisms. Use a tally counter to keep track of the total number of organisms. The tally counters can also be used to keep track of specific taxa (i.e., scuds or corixids) that may be in high abundance. When all organisms have been removed from the selected grid, draw another card and remove all the organisms from that grid in the same manner. If new taxa are found, place them in the next empty vial. Continue this process of drawing cards and picking grids. After 10 grids have been picked, determine the average number of organisms per grid and determine approximately how many total grids will be picked to reach 300 organisms. When approaching that number of grids, monitor the total count of organisms. A sample should not be stopped in the middle of picking a grid, so stop on a grid that will give a number of 300 organisms or more. This is done to eliminate any bias as to which organisms would be picked in the last grid. Rarely will the final count be exactly 300 organisms. Note on the bench data sheet how many

grids were picked to get the final count. Save the remaining unsorted sample debris residue in a separate container labeled “sample residue”; this container should include the original sample label.

On the laboratory bench data sheet (Figure 7.20.2) write down the tentative identifications and total numbers of organisms for each vial. Examine vials under a 10X dissecting scope to count organisms and ensure that all organisms in a jar are of the same taxon. Do not try and separate taxa that are hard to differentiate, this will be done under higher power during the final identification. Once all vials have been recorded on the bench sheet, place screw tops on the vials, place the vials and bench sheet in to a designated tray and bring it over to the final identification station.

After laboratory processing is complete for a given sample, all sieves, pans, trays, etc., that have come in contact with the sample will be rinsed thoroughly, examined carefully, and picked free of organisms or debris; organisms found will be added to the sample residue.

4. Sample Identification

Final organism identifications should be done to the lowest taxonomic level practicable (genus/species preferred). In order to provide accurate taxonomic identification, midge (Chironomidae) larvae and pupae will be mounted on slides in an appropriate medium (e.g., Euperal, CMC-10); slides will be labeled with the site identifier, date collected, and the first initial and last name of the collector. As with midges, worms (Oligochaeta) must also be mounted on slides and should be appropriately labeled. All slides should be archived so further levels of identification can be done at a later date. Each taxon found in a sample is recorded and enumerated on the laboratory bench sheet (Figure 7.20.2). Any difficulties encountered during identification (e.g., missing gills) are noted on these sheets.

Record the identity and number of organisms in each taxonomic group on the laboratory bench sheet. Also, record the life stage of the organisms and the taxonomist’s initials. After each taxon is identified, the organisms will be placed in a container. A label with the site number, location, date of the sample, and taxonomic identification should also be placed in the container.

5. Sample Vouchers and Storage

In order to ensure accuracy and precision it is recommended that a voucher collection be established for each set of samples which are enumerated and identified by a specific laboratory. A voucher collection is established by extracting individual specimens of each taxon from the sample collection. These individuals will be placed in specimen vials and tightly capped. A label that includes site, date, taxon, and identifying taxonomist will be place inside the vial. Slides that are to be included in the voucher collection must be initialed by the identifying taxonomist. A separate label may be added to slides to include the taxon (taxa) name(s) for use in a voucher or reference collection.

For archiving samples, specimen vials (grouped by voucher collection station and date) are placed in jars with a small amount of denatured 70 percent ethanol and tightly capped. The ethanol level in these jars must be examined periodically and replenished as needed, before ethanol loss from the specimen vials takes place. A stick-on label is placed on the

outside of the jar indicating sample identifier, date, and preservative (denatured 70 percent ethanol). Voucher collections will be cataloged and placed in the North Dakota River and Stream Macroinvertebrate Collection located at Valley City State University by Dr. Andre DeLorme, Ph.D.

North Dakota Department of Health
Division of Water Quality
Macroinvertebrate Laboratory Bench Data Sheet

Site: _____Sample #: _____ Date sampled:_____

No. of Squares picked; _____ Pickers: _____DateID:_____

Jar #	Phylum/ Order	Family	Genus Species	Final Count	Life Stage	Notes
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

Figure 7.20.2. Macroinvertebrate Laboratory Bench Data Sheet.

Appendix B

Landscape Index Development Procedure

Landscape Index Development

The Landscape Index (LSI) was developed to add a broader watershed landuse component to our estimate of human disturbance and refine our development of biological indicators. The habitat assessments from the Rapid Bioassessment Protocol (RBP) provided local, site specific disturbance, but did not encompass much beyond what was visible at a site. Combining these two indices allowed for a more holistic approach to determining human disturbance.

Methods

The LSI was developed using the Analytical Tools Interface for Landscape Assessments (ATtILA, Version 3.0) in ArcView 3.2. This ArcView extension required six specific datasets to provide data on potential landuse metrics (Ebert *et al.* 2001) (Table 1). Initial investigation evaluated whether delineating watershed boundaries within 3 km of a sample site or using 3 km circles centered at the site were different in determining landuse metrics. The sample area was all 12-digit hydrologic unit code (HUC) watersheds that had been delineated within the border of North Dakota as of 2004. Those 12-digit HUC watersheds that were only partially inside the border were not used in this analysis because the landuse coverage was available only for North Dakota. Each 12-digit HUC (n = 304) had a test site added at the outlet point. The results indicated both methods yielded similar information (Table 2). Since delineating watershed boundaries for site evaluation required more effort, 3 km circular buffers were used to analyze potential metrics for the LSI. A total of 46 metrics were considered for use in the LSI. Metrics were evaluated by the overall range of values, colinearity with other metrics (through a correlation matrix) and best professional judgment. Metrics were eliminated with narrow value ranges and those selected had moderate to low correlation.

Results and Discussion

A total of 6 metrics were selected for the final LSI (Table 3; abbreviations for metrics are listed in Table 2). They represented erosion potentials, landuse nearest to stream edge, road density (which also is a surrogate to population) and nutrient loading. Metrics had broad ranges (Table 3) and limited correlation (did not exceed r = 0.60) (Table 4).

Erosion potential metrics (AGPSL3 and AGCSL3) were included for both cropland and pastureland recognizing that the eastern part of North Dakota is dominated by row crop agriculture and western North Dakota is dominated by cattle grazing. A slope of 3% is the threshold determined at which soil erosion occurs (USDA 1951). Increased soil erosion could lead to higher total suspended solids and increased sedimentation. Metrics addressing cropland and grasslands nearest the stream (RAGC30 and RNG30) were used to determine runoff problems. Cropland provides little buffer to overland flow whereas grassland provides greater retention and absorption. Roadways could impact streams through increased runoff and sediment. Increased road density (RDDENS) also indicated areas of higher population. Runoff from these areas could carry lawn fertilizer, automobile fluids/oils and other harmful household chemicals to the stream. Nutrient

loading was addressed by the phosphorus loading metric (P_LOAD). This was an estimate of nonpoint source phosphorus coming off all the surrounding land within the 3 km buffer. Estimates were based on literature export coefficients (Reckhow *et al.* 1980). Increased levels of phosphorus could lead to eutrification of a stream and decreased oxygen levels. All of the metrics included in the LSI provided a broader look at human impacts that could potentially affect the biological community.

Literature Cited

Ebert, D. W., T. G. Wade, J. E. Harrison, and D. H. Yankee. 2001. Analytical Tools Interface for Landscape Assessment (ATtILA) Quick Start Guide Version 3.0. Draft. http://www.epa.gov/nerlesd1/land-sci/oregon/attila/user_guide.html

Reckhow, K.H., Beaulac, M. N., and Simpson, J. T. 1980. Modeling Phosphorus Loading and Lake Response Under Uncertainty: A Manual and Compilation of Export Coefficients. USEPA 440/5-80-011. Washington, DC: Office of Water Regulations and Standards, U.S. Environmental Protection Agency.

U.S. Department of Agriculture. 1951. Soil Survey Manual. Agricultural Handbook 18. Washington, DC: U.S. Department of Agriculture. 503pp.

Table 1. Data Input and Sources for the Analytical Tools Interface for Landscape Assessments (ATtILA) Used to Develop the Landscape Index (LSI).

	Dataset	Source
1	Landuse/Land cover	National Agricultural Statistic Services, 2003 data
2	Elevation/Slope	United States Geological Survey (USGS), Digital Elevation Map (DEM)
3	Streams	USGS, National Hydrography Dataset (NHD)
4	Roads	North Dakota Department of Transportation
5	Population	U.S. Census Bureau, 2000 data
6	Precipitation	North Dakota State Climatologist, North Dakota Agricultural Weather Network (NDAWN), Average precipitation 1971-2000

Table 2. Pearson Correlation Coefficient (r) of Landscape Index (LSI) Metrics Comparing Watershed Boundaries Within 3 km to 3 km Circular Buffers of Sample Sites. (All are significant at $p<0.0001$.)

Metrics	Abbreviation	r
Percentage of pasture land on a slope of > 3%	AGPSL3	0.95
Percentage of crop land on a slope of > 3%	AGCSL3	0.88
Percentage of crop land within 30M of the stream	RAGC30	0.95
Percentage of grasslands within 30M of the stream	RNG30	0.88
Road density	RDDENS	0.82
Phosphorus loading	P_LOAD	0.93

Table 3. Range of Values for the Landscape Index (LSI) Metrics.

Metrics	Human disturbance greatest at this level	Range	
AGPSL3	Higher	0%	89.4%
AGCSL3	Higher	0%	43.0%
RAGC30	Higher	0%	92.7%
RNG30	Lower	0%	63.3%
RDDENS	Higher	0 km/buffered area	11.3 km/buffered area
P_LOAD	Higher	0.4 kg/ha/yr	1.5 kg/ha/yr

Table 4. Pearson Correlation Matrix of the Landscape Index (LSI) Metrics.

	AGPSL3	AGCSL3	RAGC30	RNG30	RDDENS	P_LOAD
AGPSL3	1.00					
AGCSL3	0.02	1.00				
RAGC30	-0.60	0.18	1.00			
RNG30	-0.34	0.07	0.16	1.00		
RDDENS	-0.15	-0.08	-0.01	0.02	1.00	
P_LOAD	-0.12	-0.12	0.42	-0.35	-0.02	1.00

Appendix C

List of Metrics Evaluated

Percent Abundance
Amphipoda
Chironomidae
Coleoptera
CricotopusChironomus/-
Chironomidae
Diptera
Ephemeroptera
Plecoptera
Trichoptera
EPT
Gastropoda
Non-Insect
Odonata
Oligochaeta
Burrower
Climber
Clinger
Sprawler
Swimmer
Collector
Filterer
Predator
Scraper
Shredder
Univoltine
Multivoltine
Dominant taxa
Baetidae/Ephemeroptera
Hydropsychidae/EPT
Hydropsychidae/Trichoptera
Intolerant
Tolerant
Crustacea/Mollusca

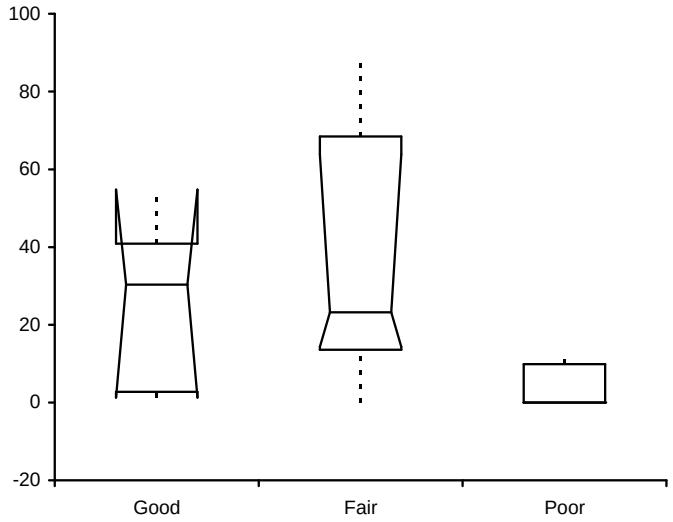
Number of Taxa
Burrower
Climber
Clinger
Sprawler
Swimmer
Collector
Filterer
Predator
Scraper
Collector
Filterer
Predator
Shredder
Chironomidae
Coleoptera
Crustacea/Mollusca
Diptera
Ephemeroptera
Plecoptera
Trichoptera
EPT
Oligochaeta
Total
Intolerant
Tolerant

Index
Shannon-Weiner_e
Shannon-Weiner_2
Shannon-Weiner_10
Hilsenhoff Biotic
Beck Biotic
Simpson's
Margalef's

Appendix D

Box-Whisker Plots

Test	**Comparative descriptives** Glide/Pool 46 Percent Amphipoda by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



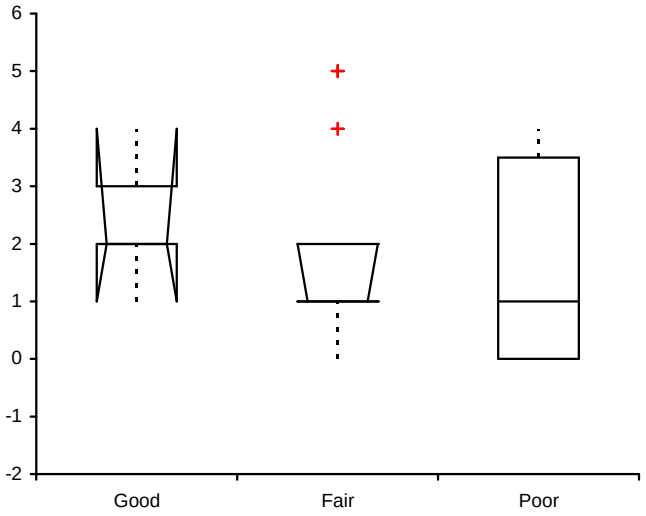
AmphPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	26.022	23.5682	10.5400	3.552 to 48.492	30.361	38.106	1.270 to 54.817
Fair	26	36.320	31.0868	6.0966	25.906 to 46.734	23.242	54.830	14.286 to 63.823
Poor	4	3.287	6.5744	3.2872	-4.449 to 11.023	0.000	9.862	- to -

Test **Comparative descriptives**
Glide/Pool 46
Percent Baetidae/Ephemeroptera by HDI rating

Performed by Neil Haugerud **Date** 20 October 2004

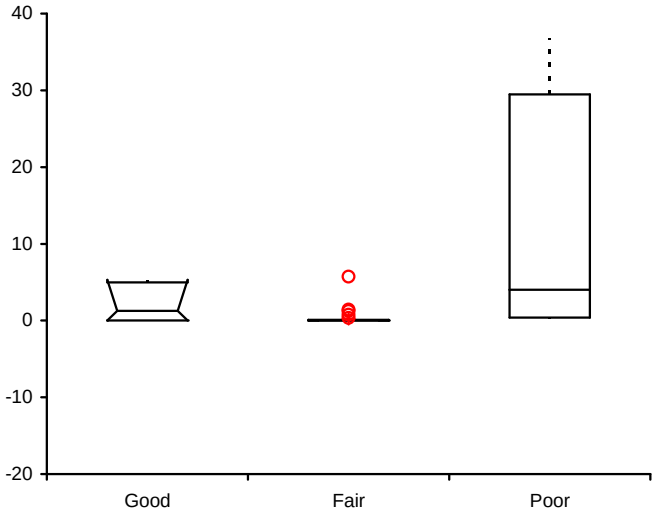
Baet2EphPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	64.127	41.7913	18.6896	24.283 to 103.970	87.179	45.650	0.000 to 100.000
Fair	44	23.161	35.2444	5.3133	14.228 to 32.093	0.000	46.154	0.000 to 11.111
Poor	5	4.007	6.6715	2.9836	-2.353 to 10.368	0.000	4.651	0.000 to 15.385

Test	**Comparative descriptives** Glide/Pool 46 Beck Biotic Index by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



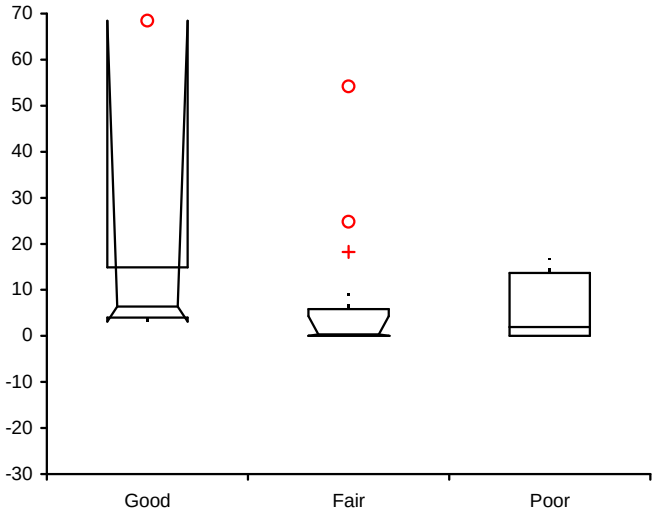
BeckBI by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.400	1.1402	0.5099	1.313 to 3.487	2.000	1.000	1.000 to 4.000
Fair	26	1.769	1.5571	0.3054	1.248 to 2.291	1.000	1.000	1.000 to 2.000
Poor	4	1.500	1.9149	0.9574	-0.753 to 3.753	1.000	3.500	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Bivalvia by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



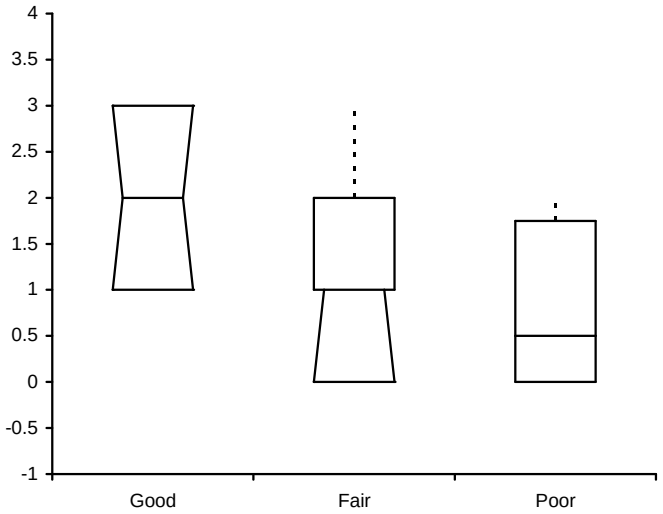
BivalPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.309	2.6358	1.1788	-0.204 to 4.822	1.270	4.972	0.000 to 5.301
Fair	26	0.384	1.1544	0.2264	-0.003 to 0.770	0.000	0.077	0.000 to 0
Poor	4	11.263	17.3440	8.6720	-9.146 to 31.671	4.007	29.108	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Burrowers by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



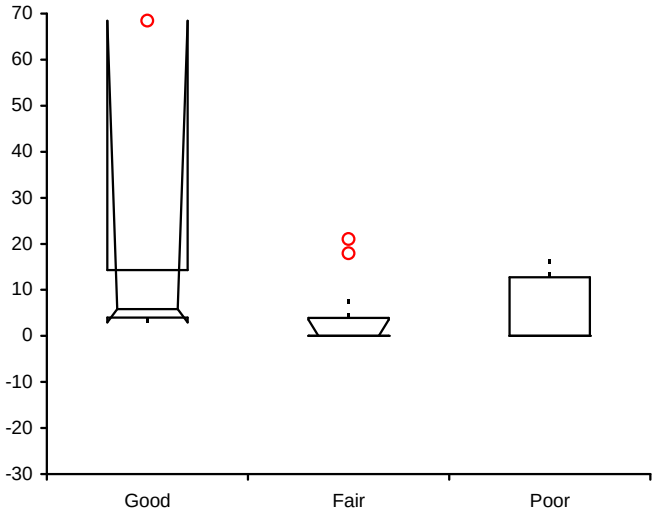
BrrwrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	19.366	27.8246	12.4435	-7.162 to 45.893	6.354	10.934	3.133 to 68.434
Fair	26	5.489	11.6311	2.2810	1.593 to 9.386	0.330	5.798	0.000 to 4.298
Poor	4	5.219	8.0393	4.0197	-4.241 to 14.679	1.961	13.697	- to -

Test	**Comparative descriptives** Glide/Pool 46 Burrower taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



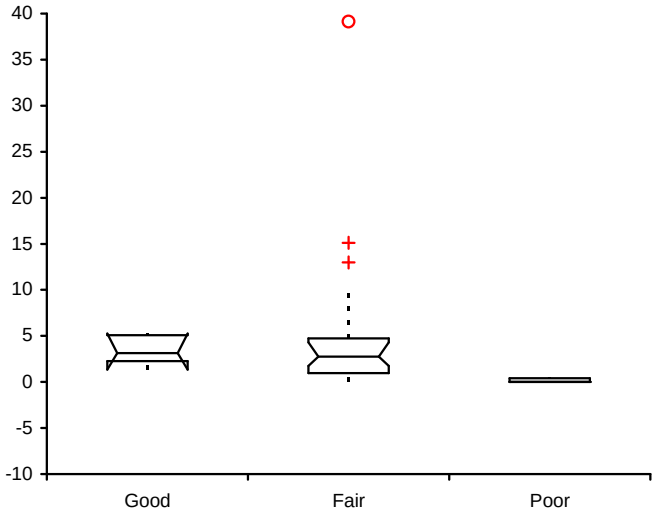
BrrwrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.000	1.0000	0.4472	1.047 to 2.953	2.000	2.000	1.000 to 3.000
Fair	26	0.962	1.0763	0.2111	0.601 to 1.322	1.000	2.000	0.000 to 1.000
Poor	4	0.750	0.9574	0.4787	-0.377 to 1.877	0.500	1.750	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Chironomidae by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



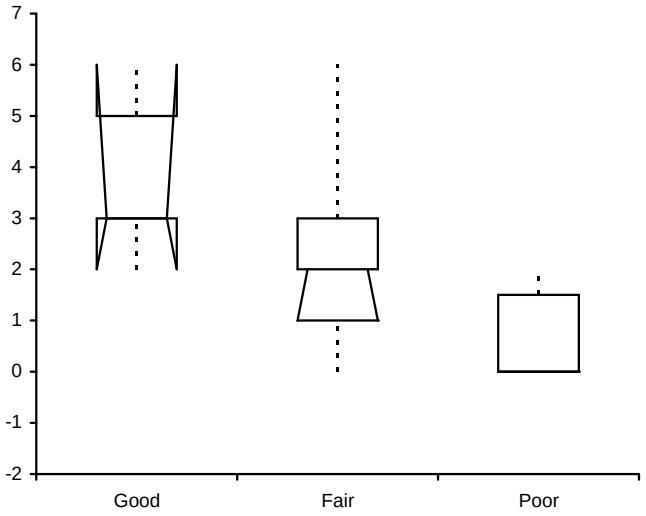
ChiroPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	19.080	27.9510	12.5001	-7.568 to 45.728	5.801	10.299	2.892 to 68.434
Fair	26	3.082	5.5149	1.0816	1.235 to 4.930	0.000	3.884	0.000 to 3.540
Poor	4	4.239	8.4775	4.2388	-5.737 to 14.214	0.000	12.716	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Climbers by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



ClmbrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.412	1.7225	0.7703	1.770 to 5.055	3.133	2.807	1.329 to 5.249
Fair	26	5.266	7.9854	1.5661	2.591 to 7.941	2.751	3.744	1.729 to 4.302
Poor	4	0.136	0.2717	0.1359	-0.184 to 0.456	0.000	0.408	- to -

Test	**Comparative descriptives** Glide/Pool 46 Climber taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



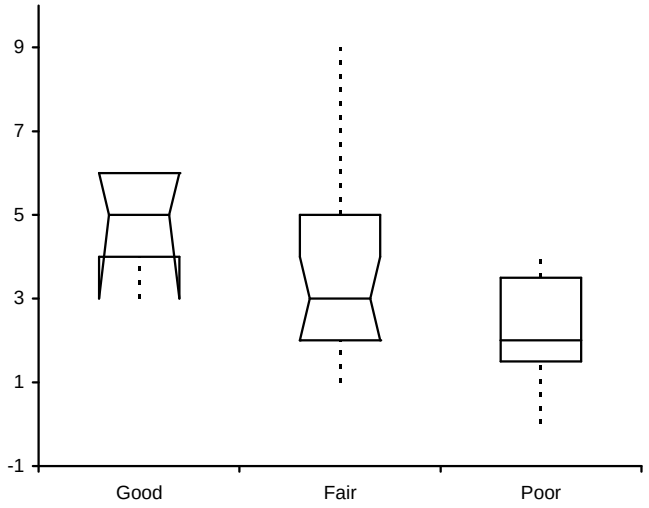
ClmbrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.800	1.6432	0.7348	2.233 to 5.367	3.000	2.000	2.000 to 6.000
Fair	26	2.077	1.4120	0.2769	1.604 to 2.550	2.000	2.000	1.000 to 2.000
Poor	4	0.500	1.0000	0.5000	-0.677 to 1.677	0.000	1.500	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Clingers by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

ClngrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	23.704	17.2820	7.7287	7.227 to 40.180	19.949	6.496	8.840 to 53.333
Fair	26	24.659	25.2979	4.9613	16.184 to 33.134	15.170	31.670	4.683 to 34.190
Poor	4	25.410	29.7783	14.8891	-9.630 to 60.449	21.163	54.264	- to -

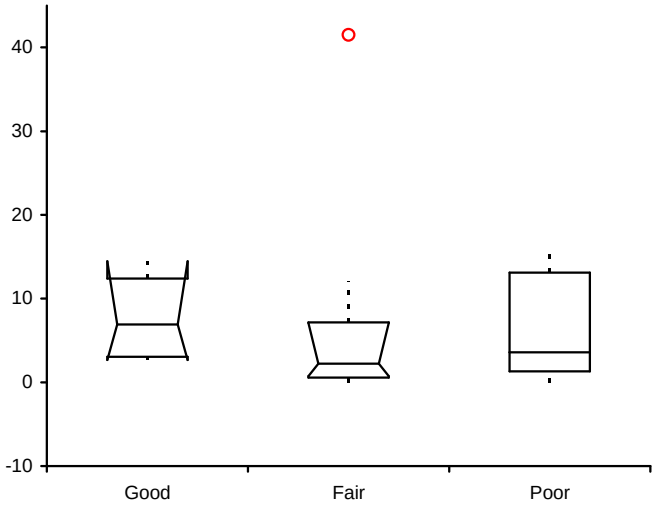
Test **Comparative descriptives**
Glide/Pool 46
Clinger taxa by HDI rating

Performed by Neil Haugerud **Date** 9 November 2004



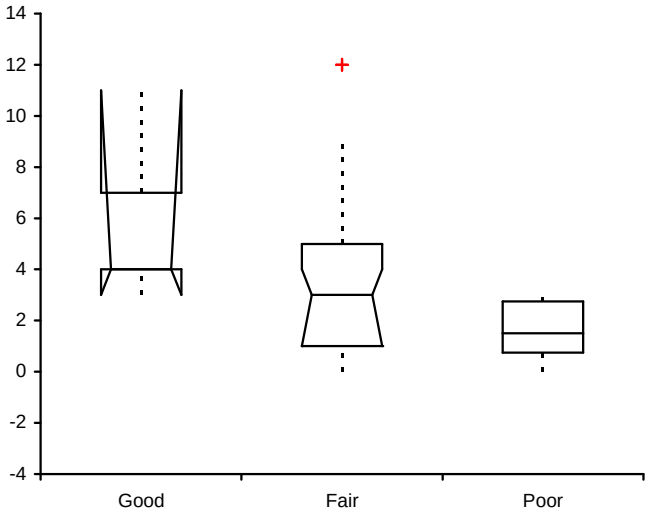
ClngrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	4.800	1.3038	0.5831	3.557 to 6.043	5.000	2.000	3.000 to 6.000
Fair	26	3.615	2.0991	0.4117	2.912 to 4.319	3.000	3.000	2.000 to 4.000
Poor	4	2.000	1.6330	0.8165	0.078 to 3.922	2.000	2.000	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Coleoptera by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



ColeoPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	7.887	5.3681	2.4007	2.769 to 13.004	6.906	9.351	2.658 to 14.458
Fair	26	5.401	8.3440	1.6364	2.605 to 8.196	2.225	6.586	0.744 to 7.075
Poor	4	5.707	7.0137	3.5068	-2.546 to 13.960	3.582	11.808	- to -

Test	**Comparative descriptives** Glide/Pool 46 Coleoptera taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



ColeoTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	5.800	3.2711	1.4629	2.681 to 8.919	4.000	3.000	3.000 to 11.000
Fair	26	3.846	3.6845	0.7226	2.612 to 5.080	3.000	4.000	1.000 to 4.000
Poor	4	1.500	1.2910	0.6455	-0.019 to 3.019	1.500	2.000	- to -

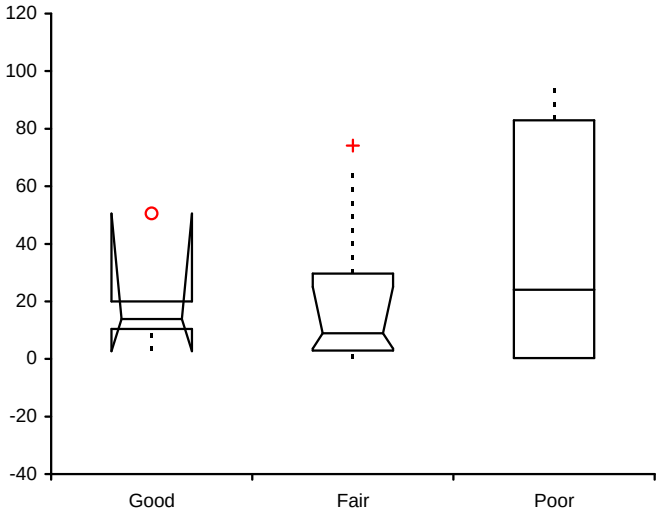
Test	**Comparative descriptives** Glide/Pool 46 Percent Collectors by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

CllctPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	60.132	20.8284	9.3147	40.274 to 79.989	60.241	16.769	29.206 to 85.050
Fair	26	43.786	30.7447	6.0295	33.487 to 54.086	43.452	49.149	23.034 to 63.823
Poor	4	14.014	28.0277	14.0138	-18.966 to 46.993	0.000	42.042	- to -

Test	**Comparative descriptives** Glide/Pool 46 Collector taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

CllctTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	6.400	2.0736	0.9274	4.423 to 8.377	7.000	2.000	3.000 to 8.000
Fair	26	3.615	2.6844	0.5265	2.716 to 4.515	3.000	3.250	2.000 to 5.000
Poor	4	1.250	2.5000	1.2500	-1.692 to 4.192	0.000	3.750	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Crustacea/Mollusca by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



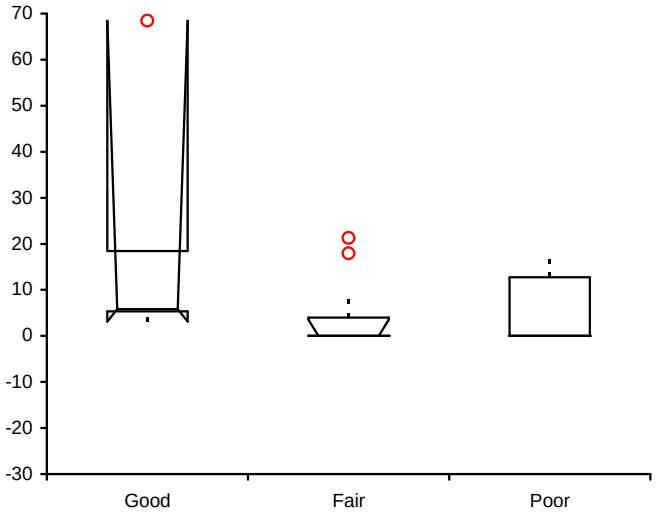
CrMolPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	19.451	18.4339	8.2439	1.877 to 37.026	13.812	9.588	2.658 to 50.476
Fair	26	21.802	24.5147	4.8077	13.590 to 30.014	8.928	26.843	3.540 to 25.000
Poor	4	35.758	45.1534	22.5767	-17.373 to 88.889	24.076	82.524	- to -

Test **Comparative descriptives**
Glide/Pool 46
Crustacea and Mollusca taxa by HDI rating

Performed by Neil Haugerud **Date** 9 November 2004

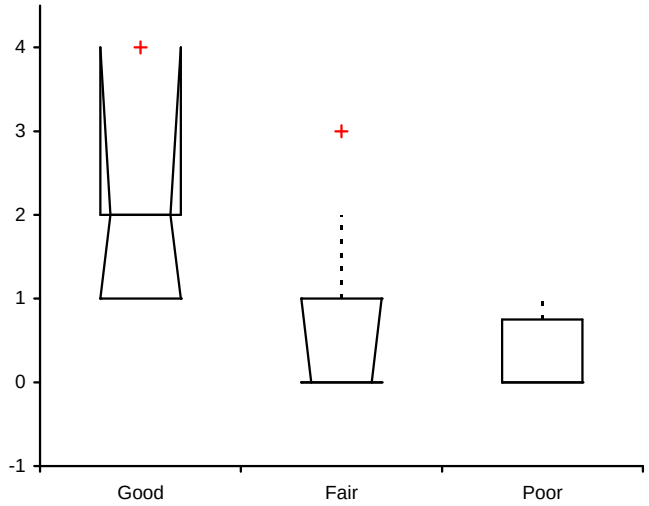
CrMolTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.400	1.5166	0.6782	1.954 to 4.846	4.000	1.000	1.000 to 5.000
Fair	26	2.923	1.7871	0.3505	2.324 to 3.522	3.000	3.250	2.000 to 3.000
Poor	4	2.000	1.4142	0.7071	0.336 to 3.664	1.500	2.500	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Diptera by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



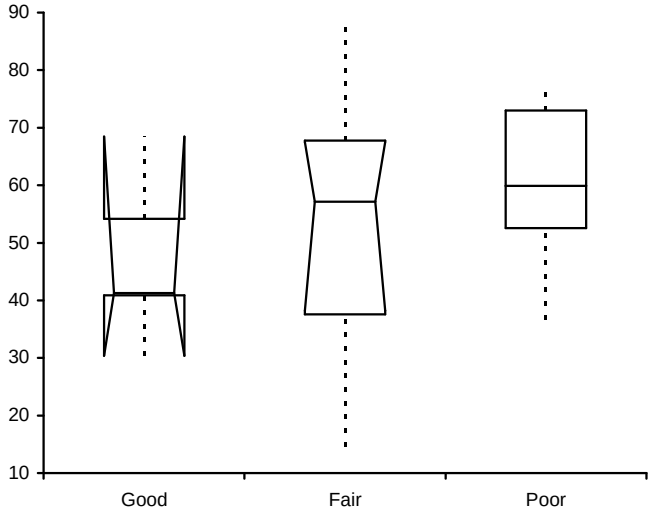
DipPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	20.219	27.6130	12.3489	-6.107 to 46.545	5.801	13.097	3.133 to 68.434
Fair	26	3.157	5.5914	1.0966	1.284 to 5.030	0.000	3.956	0.000 to 3.540
Poor	4	4.239	8.4775	4.2388	-5.737 to 14.214	0.000	12.716	- to -

Test	**Comparative descriptives** Glide/Pool 46 Diptera taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



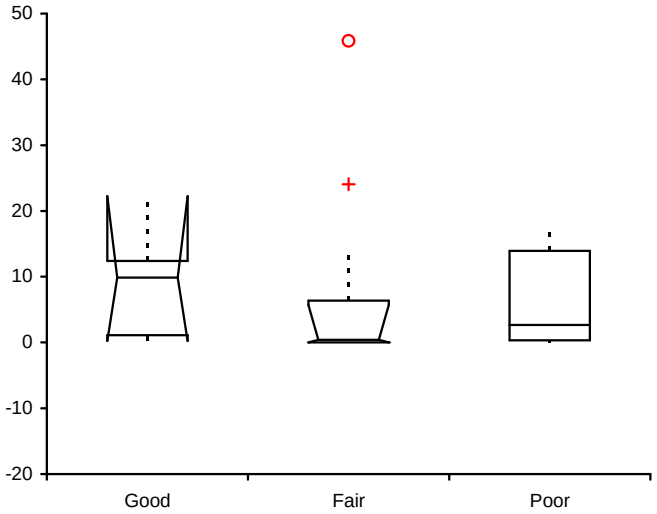
DipTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.000	1.2247	0.5477	0.832 to 3.168	2.000	1.000	1.000 to 4.000
Fair	26	0.615	0.8521	0.1671	0.330 to 0.901	0.000	1.000	0.000 to 1.000
Poor	4	0.250	0.5000	0.2500	-0.338 to 0.838	0.000	0.750	- to -

Test	**Comparative descriptives** Glide/Pool 46 Dominant taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



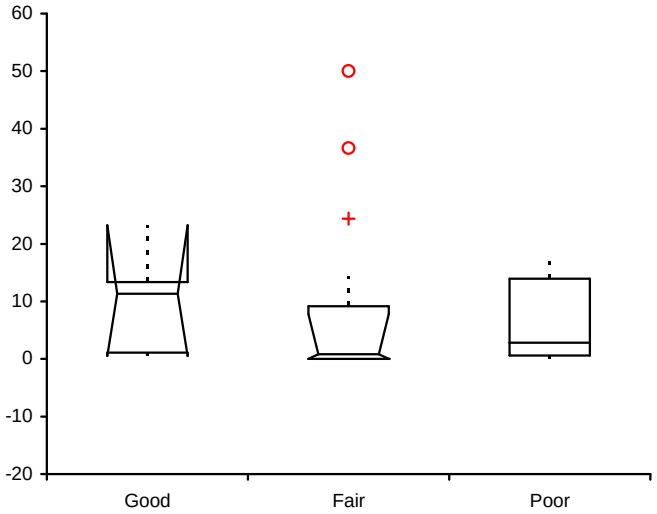
Dom01Pct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	47.020	14.6430	6.5486	33.060 to 60.981	41.270	13.269	30.361 to 68.434
Fair	26	52.823	20.1170	3.9453	46.084 to 59.562	57.143	30.192	38.199 to 67.495
Poor	4	58.296	16.5317	8.2659	38.844 to 77.749	59.900	20.467	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Ephemeroptera by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



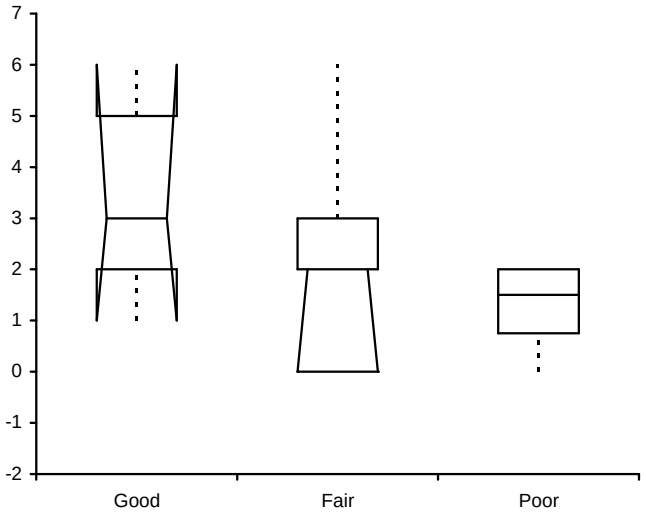
EphemPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	9.175	9.0375	4.0417	0.559 to 17.792	9.880	11.276	0.253 to 22.259
Fair	26	5.409	10.1445	1.9895	2.010 to 8.807	0.426	6.353	0.000 to 5.676
Poor	4	5.565	7.9121	3.9560	-3.745 to 14.875	2.652	13.641	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Ephemeroptera, Plecoptera and Trichoptera by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



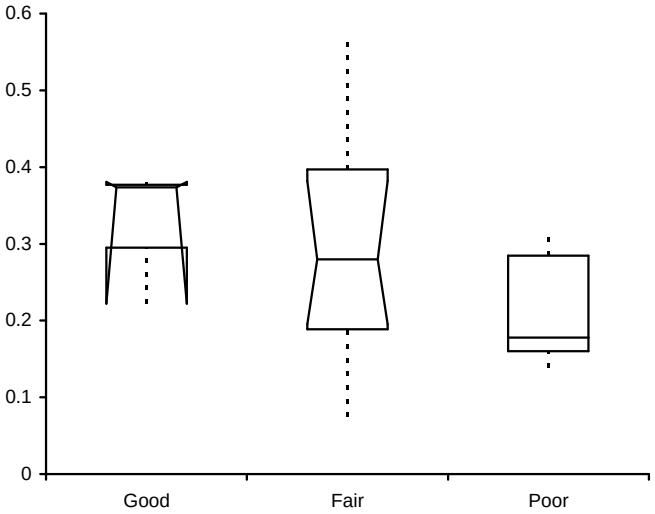
EPTPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	9.905	9.4580	4.2297	0.888 to 18.922	11.325	12.228	0.505 to 23.256
Fair	26	7.526	12.4135	2.4345	3.367 to 11.684	0.823	9.151	0.000 to 7.778
Poor	4	5.665	7.8268	3.9134	-3.545 to 14.875	2.853	13.339	- to -

Test	**Comparative descriptives** Glide/Pool 46 Ephemeroptera, Plecoptera and Trichoptera taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



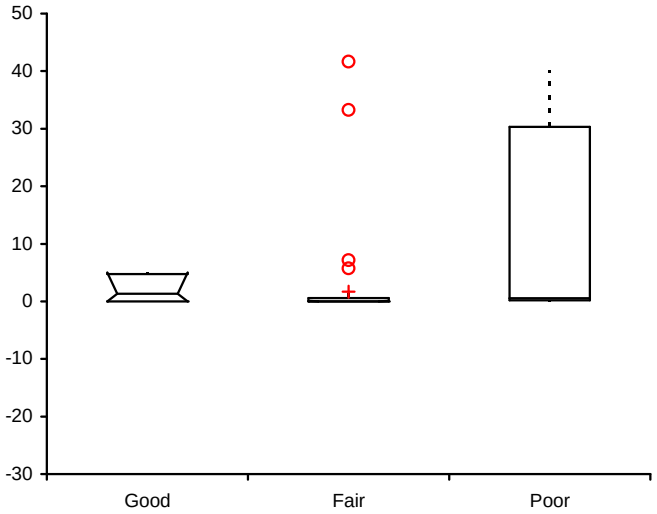
EPTTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.400	2.0736	0.9274	1.423 to 5.377	3.000	3.000	1.000 to 6.000
Fair	26	1.692	1.6436	0.3223	1.142 to 2.243	2.000	3.000	0.000 to 2.000
Poor	4	1.250	0.9574	0.4787	0.123 to 2.377	1.500	1.250	- to -

Test	**Comparative descriptives** Glide/Pool 46 Evenness by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



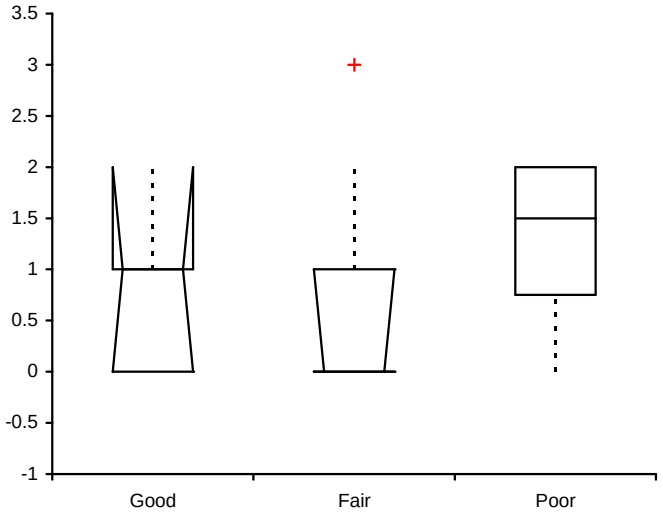
Evenness by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	0.330	0.0699	0.0313	0.263 to 0.396	0.374	0.082	0.222 to 0.381
Fair	26	0.295	0.1349	0.0264	0.249 to 0.340	0.280	0.208	0.195 to 0.382
Poor	4	0.203	0.0787	0.0394	0.110 to 0.295	0.178	0.125	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Filterers by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



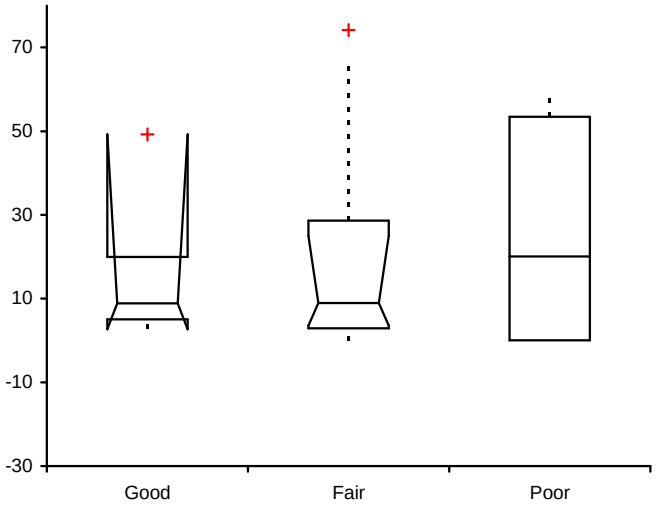
FiltrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.213	2.4843	1.1110	-0.156 to 4.581	1.329	4.762	0.000 to 4.972
Fair	26	3.548	10.2040	2.0012	0.129 to 6.966	0.000	0.601	0.000 to 0.070
Poor	4	10.318	19.9217	9.9608	-13.124 to 33.759	0.537	30.144	- to -

Test	**Comparative descriptives** Glide/Pool 46 Filterer taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



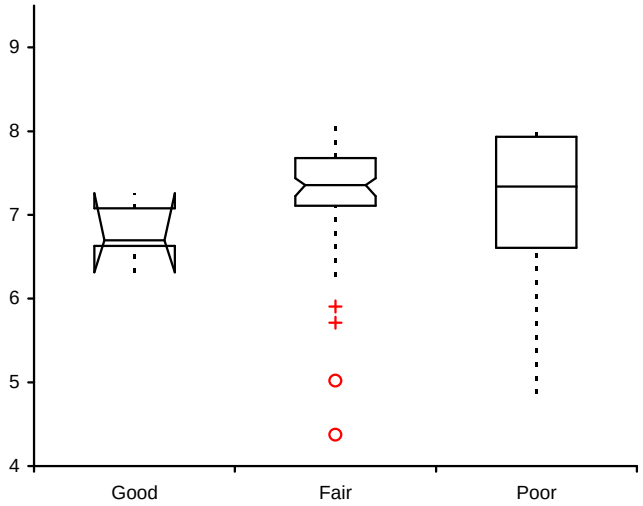
FiltrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	0.800	0.8367	0.3742	0.002 to 1.598	1.000	1.000	0.000 to 2.000
Fair	26	0.577	0.8566	0.1680	0.290 to 0.864	0.000	1.000	0.000 to 1.000
Poor	4	1.250	0.9574	0.4787	0.123 to 2.377	1.500	1.250	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Gastropoda by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



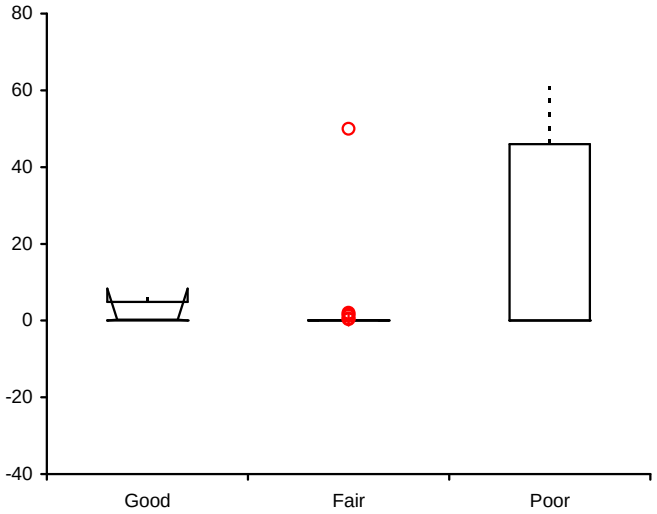
GastrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	17.143	19.1095	8.5460	-1.076 to 35.362	8.840	14.889	2.658 to 49.206
Fair	26	21.418	24.1820	4.7425	13.318 to 29.519	8.928	25.769	3.540 to 25.000
Poor	4	24.495	29.1937	14.5969	-9.856 to 58.847	20.069	53.417	- to -

Test	**Comparative descriptives** Glide/Pool 46 Hilsenhoff Biotic Index by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



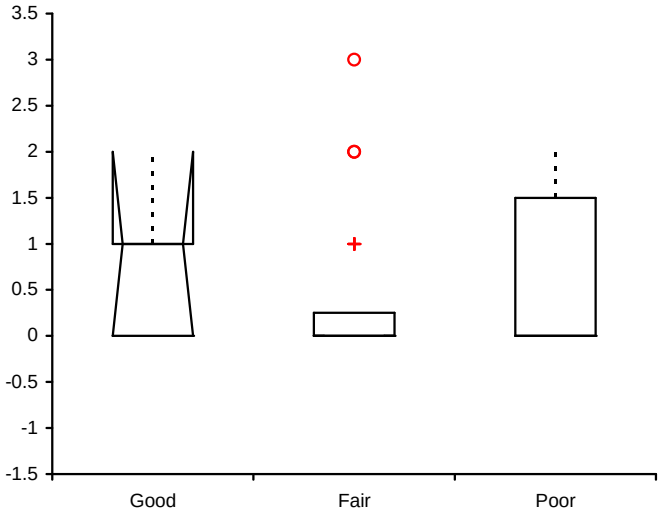
HBI by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	6.796	0.3754	0.1679	6.438 to 7.153	6.697	0.451	6.315 to 7.259
Fair	26	7.113	0.9443	0.1852	6.796 to 7.429	7.358	0.573	7.223 to 7.439
Poor	4	6.905	1.4141	0.7071	5.241 to 8.569	7.341	1.329	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Intolerant by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



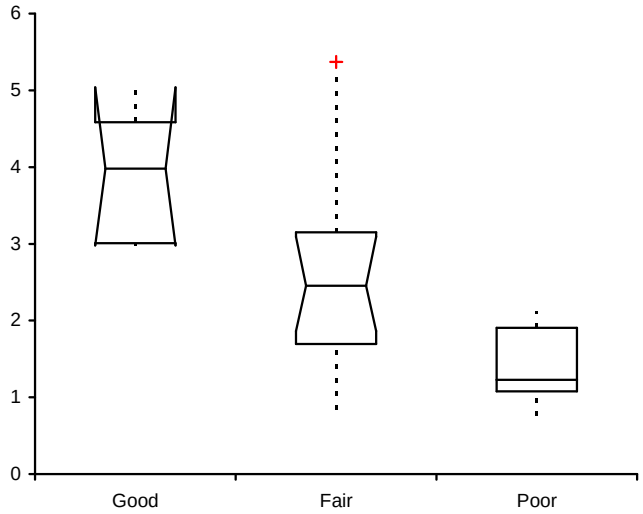
IntolPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.675	3.7577	1.6805	-0.907 to 6.258	0.253	4.819	0.000 to 8.306
Fair	26	2.155	9.7735	1.9167	-1.119 to 5.429	0.000	0.067	0.000 to 0
Poor	4	15.319	30.6373	15.3186	-20.732 to 51.369	0.000	45.956	- to -

Test	**Comparative descriptives** Glide/Pool 46 Intolerant taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



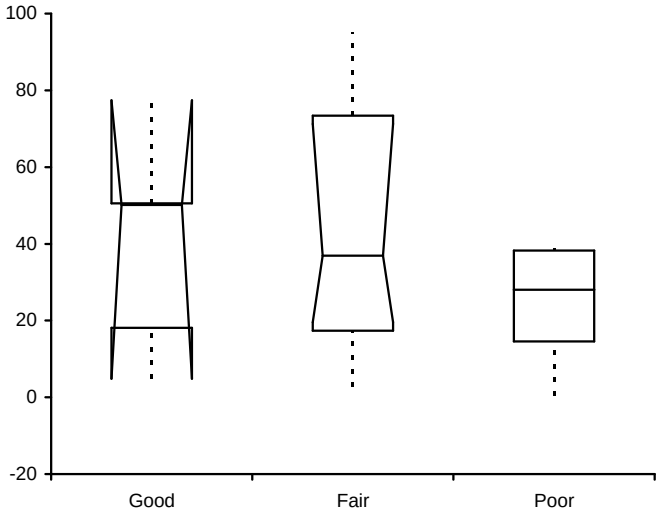
IntolTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	0.800	0.8367	0.3742	0.002 to 1.598	1.000	1.000	0.000 to 2.000
Fair	26	0.423	0.8086	0.1586	0.152 to 0.694	0.000	0.250	0.000 to 0
Poor	4	0.500	1.0000	0.5000	-0.677 to 1.677	0.000	1.500	- to -

Test	**Comparative descriptives** Glide/Pool 46 Margalef's Index by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



D_Mg by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.919	0.9240	0.4132	3.038 to 4.800	3.981	1.573	2.979 to 5.041
Fair	26	2.738	1.3810	0.2708	2.275 to 3.200	2.455	1.457	1.865 to 3.090
Poor	4	1.331	0.5713	0.2857	0.659 to 2.003	1.227	0.829	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Multivoltine taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

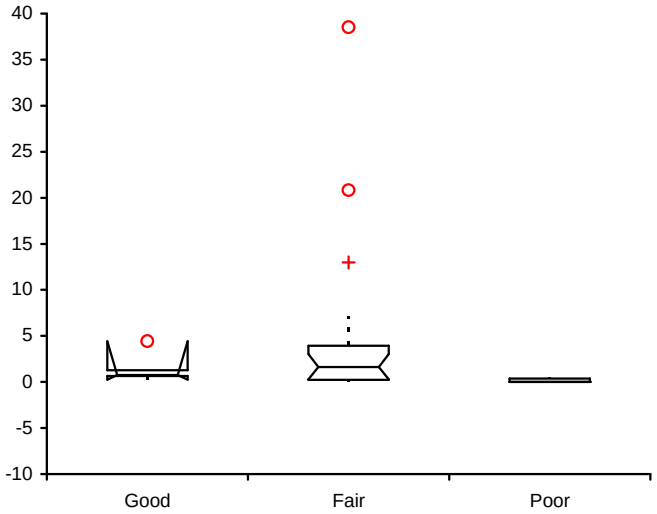


MltVolPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	40.195	28.8617	12.9074	12.678 to 67.711	50.120	32.457	4.798 to 77.409
Fair	26	44.050	31.5554	6.1885	33.480 to 54.621	36.901	56.016	19.597 to 71.212
Poor	4	23.804	17.8840	8.9420	2.760 to 44.847	28.029	23.686	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Non-Insect by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

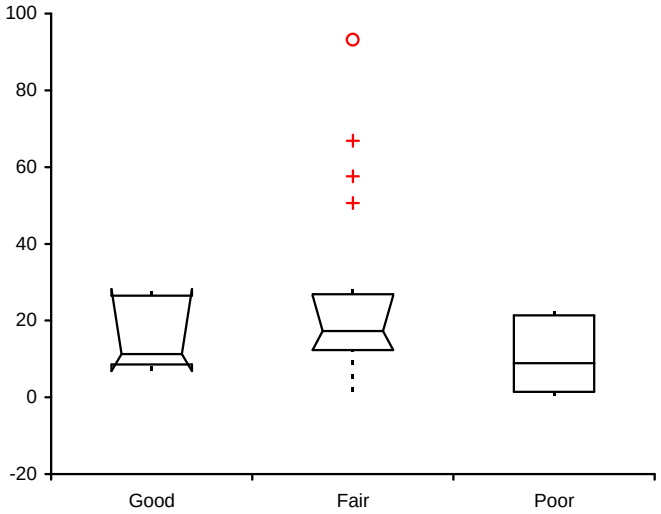
NonInPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	48.930	14.5467	6.5055	35.062 to 62.799	53.016	10.188	24.495 to 61.050
Fair	26	62.328	27.7392	5.4401	53.035 to 71.620	72.245	37.882	47.558 to 78.571
Poor	4	39.333	46.6012	23.3006	-15.502 to 94.167	31.225	85.296	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Odonata by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



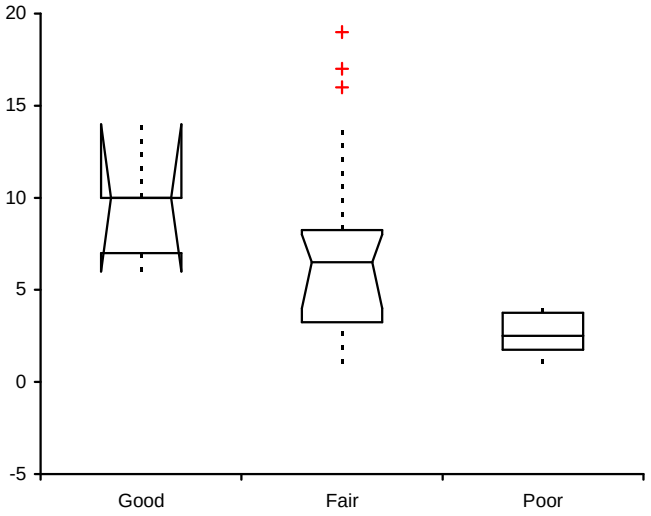
OdonPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	1.471	1.6889	0.7553	-0.140 to 3.081	0.758	0.605	0.241 to 4.420
Fair	26	4.343	8.3744	1.6424	1.537 to 7.148	1.614	3.686	0.295 to 3.030
Poor	4	0.123	0.2451	0.1225	-0.166 to 0.411	0.000	0.368	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Predators by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



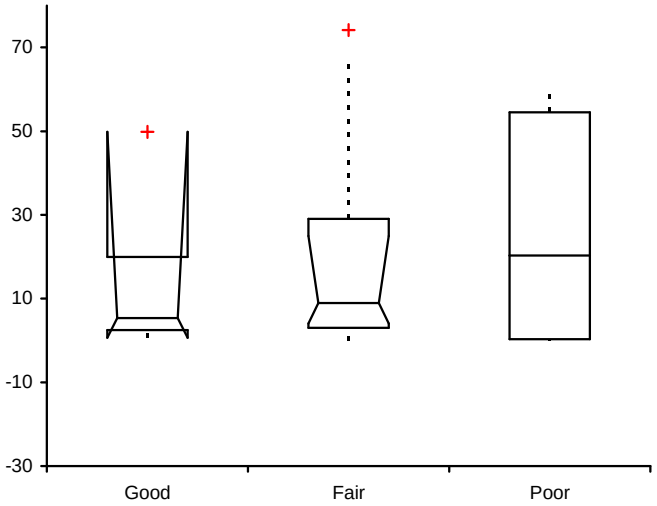
PredPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	16.274	10.2457	4.5820	6.505 to 26.042	11.296	17.935	6.818 to 28.177
Fair	26	23.692	21.5163	4.2197	16.484 to 30.900	17.315	14.533	12.399 to 26.415
Poor	4	10.346	11.0556	5.5278	-2.663 to 23.355	8.897	19.919	- to -

Test	**Comparative descriptives** Glide/Pool 46 Predator taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



PredTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	9.400	3.1305	1.4000	6.415 to 12.385	10.000	3.000	6.000 to 14.000
Fair	26	7.077	4.9309	0.9670	5.425 to 8.729	6.500	5.000	4.000 to 8.000
Poor	4	2.500	1.2910	0.6455	0.981 to 4.019	2.500	2.000	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Scrapers by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



ScrapPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	15.649	20.5699	9.1991	-3.963 to 35.260	5.301	17.463	0.664 to 49.841
Fair	26	21.670	24.6024	4.8249	13.428 to 29.912	8.928	26.045	4.012 to 25.000
Poor	4	24.963	29.6461	14.8231	-9.921 to 59.847	20.270	54.219	- to -

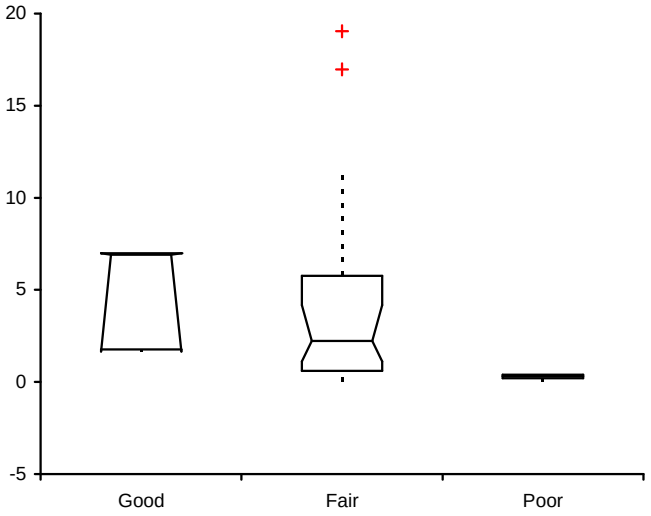
Test	**Comparative descriptives** Glide/Pool 46 Scraper taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

ScrapTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.000	1.5811	0.7071	1.493 to 4.507	3.000	2.000	1.000 to 5.000
Fair	26	2.577	1.4744	0.2892	2.083 to 3.071	2.000	2.250	2.000 to 3.000
Poor	4	1.500	1.2910	0.6455	-0.019 to 3.019	1.500	2.000	- to -

Test	**Comparative descriptives** Glide/Pool 46 Shannon-Weiner Index by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

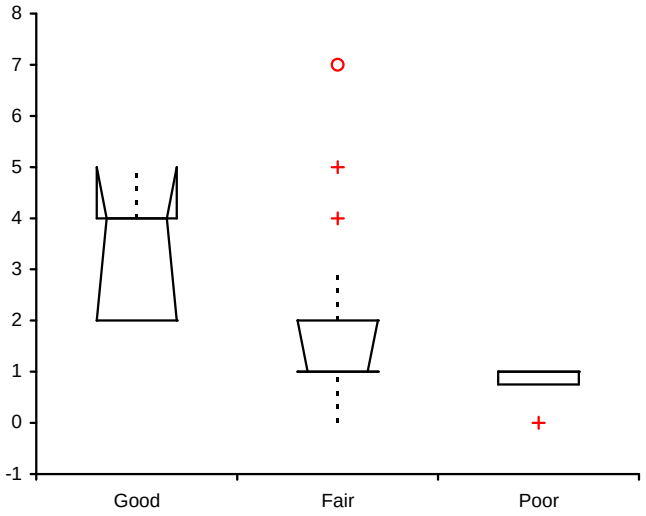
Shan_e by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	1.934	0.4127	0.1846	1.541 to 2.328	2.189	0.517	1.327 to 2.271
Fair	26	1.542	0.6046	0.1186	1.339 to 1.744	1.530	0.919	1.109 to 1.791
Poor	4	1.141	0.4596	0.2298	0.600 to 1.682	1.001	0.767	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Shredders by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



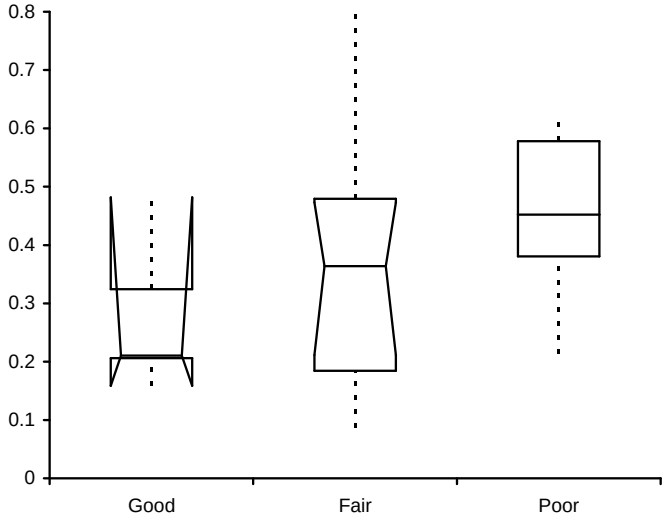
ShredPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	4.861	2.8732	1.2849	2.122 to 7.601	6.906	5.216	1.661 to 6.988
Fair	26	4.338	5.3374	1.0468	2.550 to 6.126	2.229	5.151	1.111 to 4.167
Poor	4	0.255	0.1780	0.0890	0.045 to 0.464	0.309	0.184	- to -

Test	**Comparative descriptives** Glide/Pool 46 Shredder taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



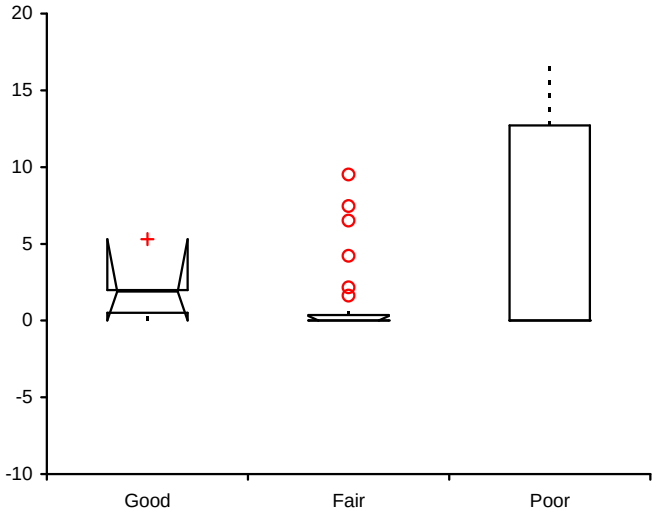
ShredTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.400	1.3416	0.6000	2.121 to 4.679	4.000	2.000	2.000 to 5.000
Fair	26	1.808	1.5753	0.3089	1.280 to 2.335	1.000	1.000	1.000 to 2.000
Poor	4	0.750	0.5000	0.2500	0.162 to 1.338	1.000	0.250	- to -

Test	**Comparative descriptives** Glide/Pool 46 Simpson's Index by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



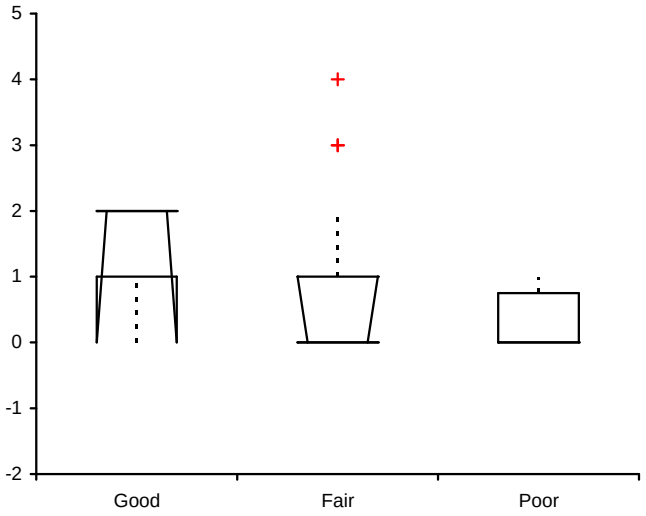
D by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	0.276	0.1301	0.0582	0.152 to 0.400	0.211	0.118	0.159 to 0.482
Fair	26	0.363	0.1937	0.0380	0.299 to 0.428	0.364	0.295	0.211 to 0.473
Poor	4	0.433	0.1655	0.0828	0.238 to 0.628	0.452	0.198	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Sprawlers by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



SprwlPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	1.941	2.0691	0.9253	-0.032 to 3.914	1.905	1.488	0.000 to 5.301
Fair	26	1.256	2.6280	0.5154	0.376 to 2.137	0.000	0.365	0.000 to 0.295
Poor	4	4.239	8.4775	4.2388	-5.737 to 14.214	0.000	12.716	- to -

Test	**Comparative descriptives** Glide/Pool 46 Sprawler taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

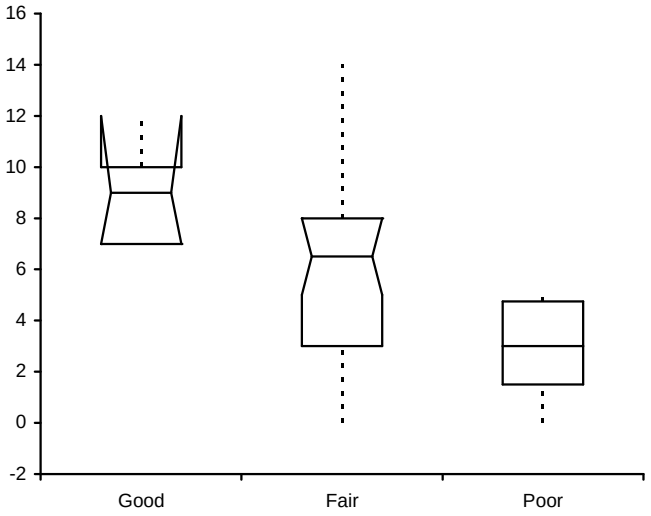


SprwlTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	1.400	0.8944	0.4000	0.547 to 2.253	2.000	1.000	0.000 to 2.000
Fair	26	0.731	1.1509	0.2257	0.345 to 1.116	0.000	1.000	0.000 to 1.000
Poor	4	0.250	0.5000	0.2500	-0.338 to 0.838	0.000	0.750	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Swimmers by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

SwmmrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	46.740	30.3003	13.5507	17.852 to 75.628	57.831	47.156	7.828 to 77.076
Fair	26	57.963	31.8771	6.2516	47.285 to 68.642	63.409	54.529	38.560 to 79.545
Poor	4	48.580	47.2986	23.6493	-7.076 to 104.235	49.469	79.661	- to -

Test	**Comparative descriptives** Glide/Pool 46 Swimmer taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



SwmmrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	9.000	2.1213	0.9487	6.978 to 11.022	9.000	3.000	7.000 to 12.000
Fair	26	6.538	4.2542	0.8343	5.113 to 7.964	6.500	5.000	5.000 to 8.000
Poor	4	2.750	2.2174	1.1087	0.141 to 5.359	3.000	3.250	- to -

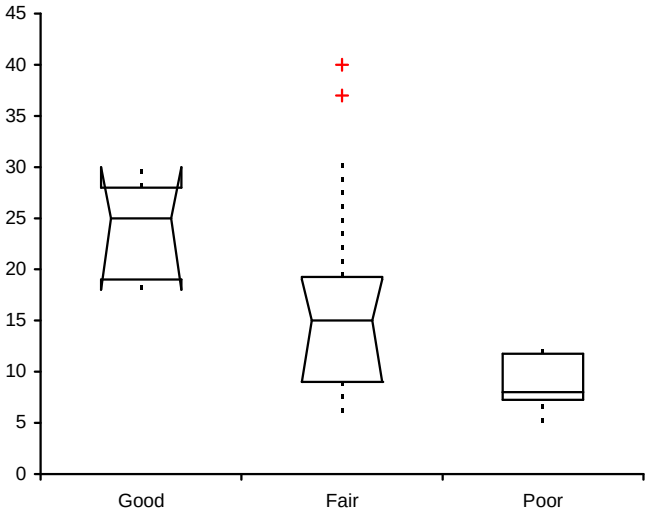
Test	**Comparative descriptives** Glide/Pool 46 Percent Tolerant by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

TolerPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	48.556	14.8354	6.6346	34.413 to 62.700	53.333	16.876	26.010 to 62.707
Fair	26	63.480	26.3609	5.1698	54.649 to 72.310	70.537	26.801	63.208 to 76.515
Poor	4	62.000	17.8699	8.9350	40.973 to 83.027	67.063	19.672	- to -

Test	**Comparative descriptives** Glide/Pool 46 Tolerant taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

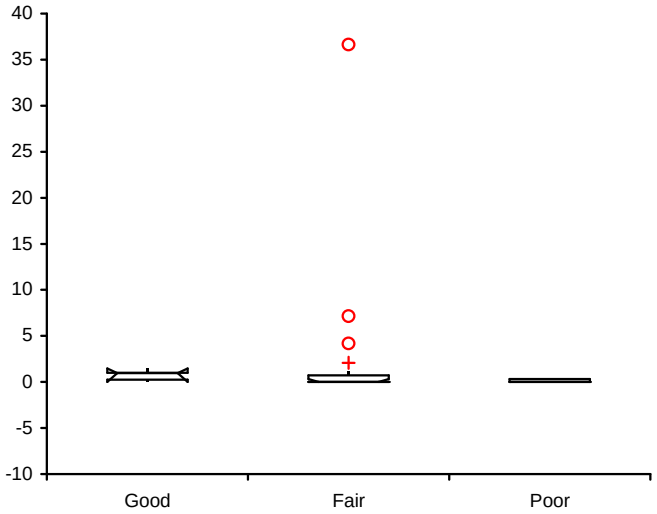
TolerTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	8.000	2.7386	1.2247	5.389 to 10.611	8.000	3.000	4.000 to 11.000
Fair	26	6.769	3.9730	0.7792	5.438 to 8.100	6.000	5.000	4.000 to 8.000
Poor	4	2.750	1.7078	0.8539	0.740 to 4.760	2.500	2.750	- to -

Test	**Comparative descriptives** Glide/Pool 46 Total taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



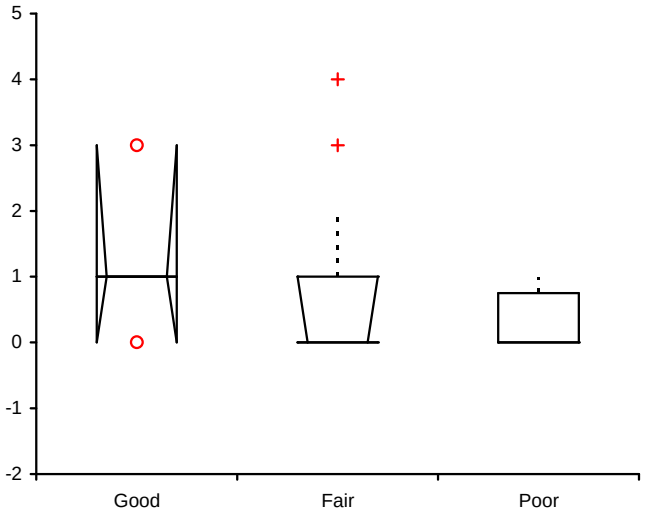
TotalTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	24.000	5.3385	2.3875	18.910 to 29.090	25.000	9.000	18.000 to 30.000
Fair	26	16.731	9.8043	1.9228	13.446 to 20.015	15.000	10.250	9.000 to 19.000
Poor	4	8.500	3.3166	1.6583	4.597 to 12.403	8.000	4.500	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Trichoptera by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



TrichPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	0.729	0.5903	0.2640	0.167 to 1.292	0.952	0.744	0.000 to 1.446
Fair	26	2.117	7.2190	1.4158	-0.301 to 4.535	0.000	0.729	0.000 to 0.309
Poor	4	0.100	0.2008	0.1004	-0.136 to 0.337	0.000	0.301	- to -

Test	**Comparative descriptives** Glide/Pool 46 Trichoptera taxa by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004



TrichTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	1.200	1.0954	0.4899	0.156 to 2.244	1.000	0.000	0.000 to 3.000
Fair	26	0.615	1.0228	0.2006	0.273 to 0.958	0.000	1.000	0.000 to 1.000
Poor	4	0.250	0.5000	0.2500	-0.338 to 0.838	0.000	0.750	- to -

Test	**Comparative descriptives** Glide/Pool 46 Percent Univoltine by HDI rating
Performed by	Neil Haugerud
Date	9 November 2004

UniVolPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	32.387	17.1971	7.6908	15.991 to 48.783	34.254	24.984	13.889 to 54.921
Fair	26	33.912	26.7495	5.2460	24.951 to 42.873	28.519	34.651	16.804 to 34.957
Poor	4	43.000	42.8219	21.4110	-7.387 to 93.388	41.738	75.296	- to -

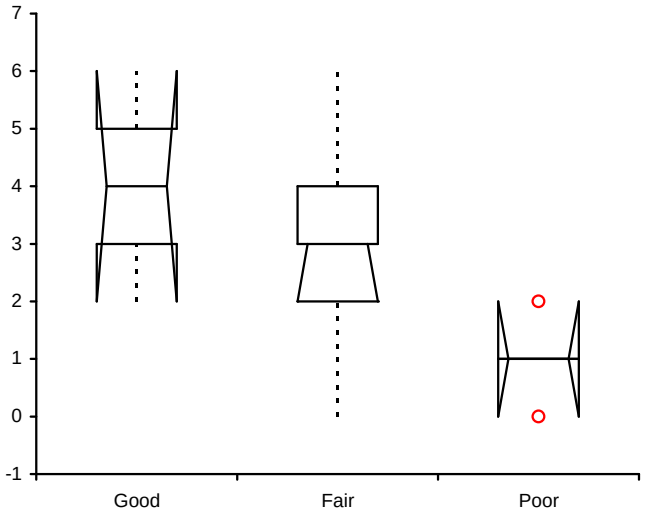
Test	**Comparative descriptives** Riffle/ Run 46 Percent Amphipoda by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

AmphPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	17.199	17.3274	7.7490	0.679 to 33.719	10.801	11.677	1.212 to 45.783
Fair	43	32.991	29.4828	4.4961	25.429 to 40.553	24.855	46.654	17.751 to 40.909
Poor	5	36.239	20.0038	8.9460	17.167 to 55.310	33.333	8.630	17.910 to 70.009

Test	**Comparative descriptives** Riffle/ Run 46 Percent Baetidae/Ephemeroptera by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

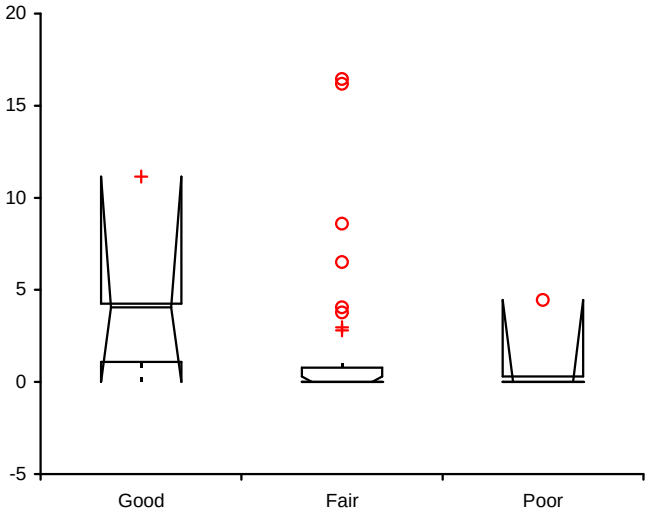
Baet2EphPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	32.357	31.2402	13.9711	2.573 to 62.141	38.462	56.410	0.000 to 66.912
Fair	43	31.452	36.4448	5.5578	22.104 to 40.800	9.677	65.716	2.326 to 33.721
Poor	5	2.409	3.3414	1.4943	-0.777 to 5.594	0.000	5.263	0.000 to 6.780

Test	**Comparative descriptives** Riffle/ Run 46 Beck Biotic Index by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



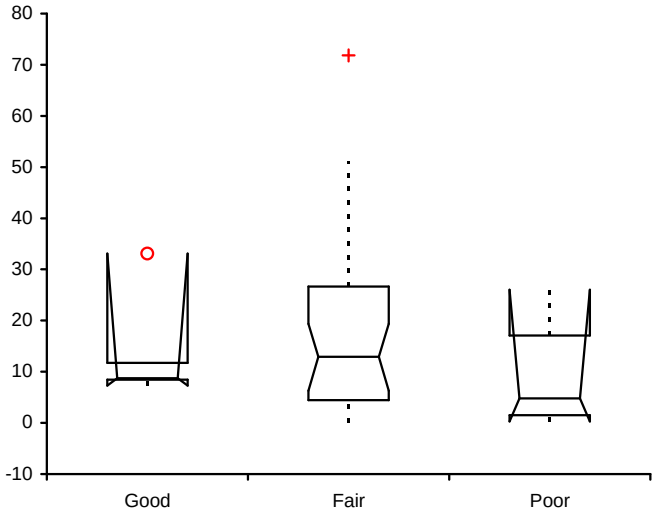
BeckBI by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	4.000	1.5811	0.7071	2.493 to 5.507	4.000	2.000	2.000 to 6.000
Fair	43	2.767	1.4612	0.2228	2.393 to 3.142	3.000	2.000	2.000 to 3.000
Poor	5	1.000	0.7071	0.3162	0.326 to 1.674	1.000	0.000	0.000 to 2.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Bivalvia by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



BivalPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	4.106	4.3477	1.9444	-0.039 to 8.251	4.050	3.155	0.000 to 11.150
Fair	43	1.558	3.7678	0.5746	0.592 to 2.525	0.000	0.773	0.000 to 0.295
Poor	5	0.947	1.9591	0.8761	-0.921 to 2.815	0.000	0.292	0.000 to 4.444

Test	**Comparative descriptives** Riffle/ Run 46 Percent Burrowers by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

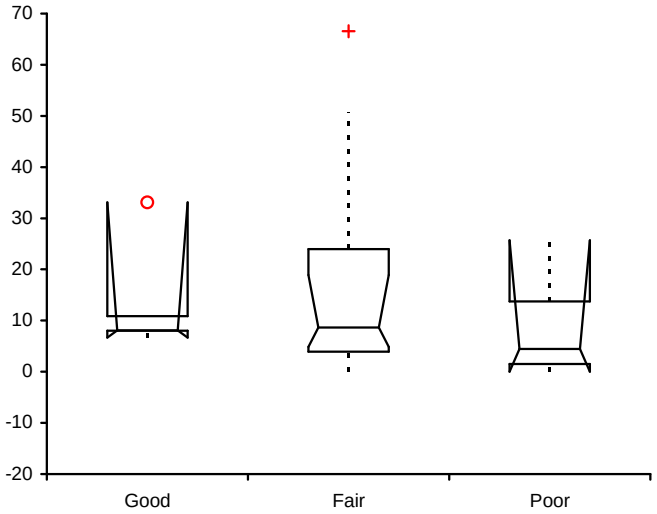


BrrwrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	13.864	10.8792	4.8653	3.492 to 24.236	8.723	3.269	7.273 to 33.101
Fair	43	17.546	16.7004	2.5468	13.263 to 21.830	12.895	22.139	6.309 to 19.329
Poor	5	9.930	11.1925	5.0055	-0.741 to 20.601	4.762	15.581	0.292 to 26.032

Test	**Comparative descriptives** Riffle/ Run 46 Burrower taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

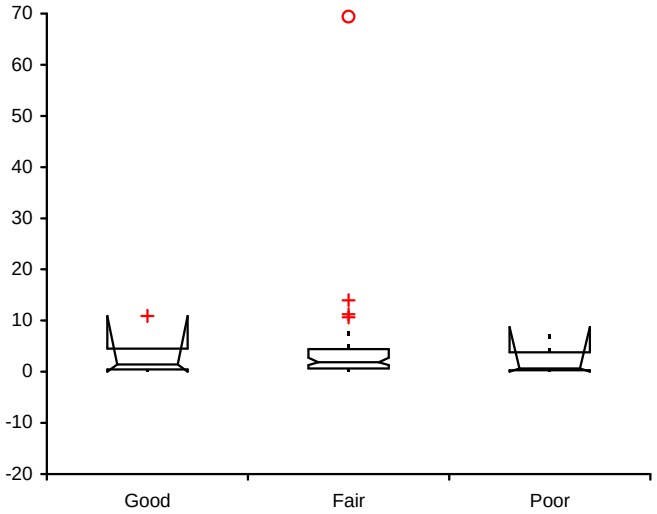
BrrwrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.200	0.8367	0.3742	1.402 to 2.998	2.000	1.000	1.000 to 3.000
Fair	43	2.605	1.3997	0.2134	2.246 to 2.964	2.000	1.000	2.000 to 3.000
Poor	5	2.400	1.6733	0.7483	0.805 to 3.995	2.000	2.000	1.000 to 5.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Chironomidae by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



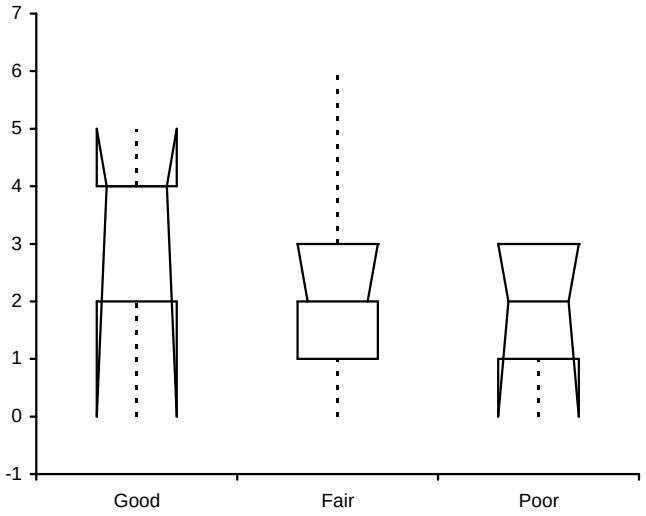
ChiroPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	13.351	11.1443	4.9839	2.726 to 23.976	8.100	2.800	6.667 to 33.101
Fair	43	15.832	15.8474	2.4167	11.767 to 19.897	8.625	20.099	4.843 to 18.932
Poor	5	9.076	10.7219	4.7950	-1.146 to 19.299	4.444	12.238	0.000 to 25.714

Test	**Comparative descriptives** Riffle/ Run 46 Percent Climbers by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



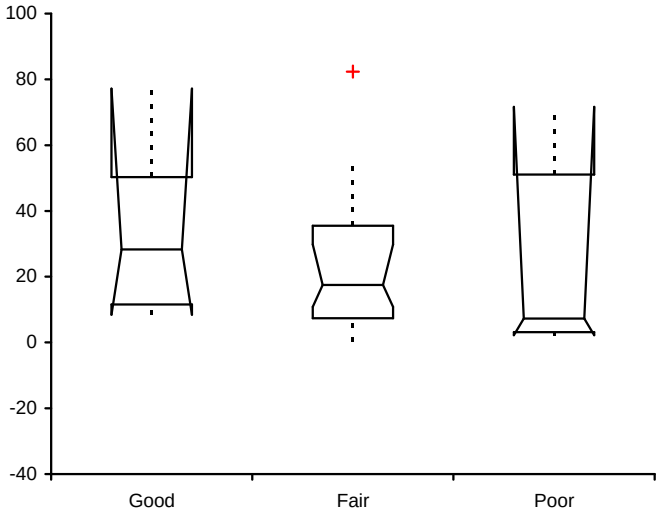
ClmbrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.451	4.5277	2.0249	-0.866 to 7.768	1.394	4.083	0.000 to 10.909
Fair	43	4.490	10.6413	1.6228	1.761 to 7.220	1.858	3.790	1.282 to 2.761
Poor	5	2.701	3.7091	1.6588	-0.835 to 6.237	0.632	3.492	0.000 to 8.746

Test	**Comparative descriptives** Riffle/ Run 46 Climber taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



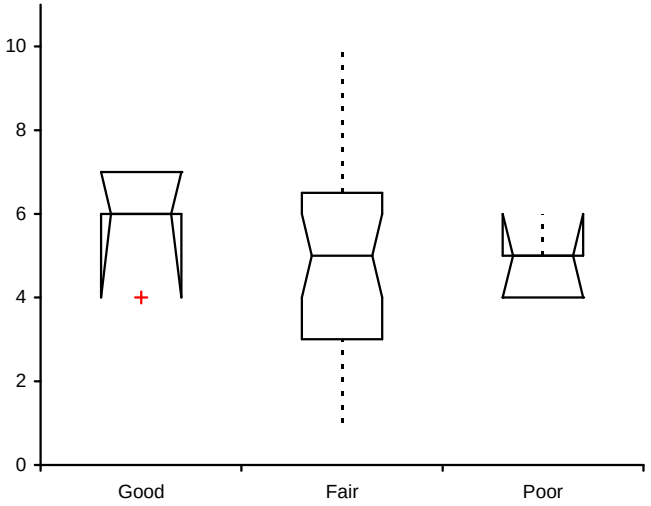
ClmbrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.000	2.0000	0.8944	1.093 to 4.907	4.000	2.000	0.000 to 5.000
Fair	43	2.302	1.6695	0.2546	1.874 to 2.731	2.000	2.000	2.000 to 3.000
Poor	5	1.800	1.3038	0.5831	0.557 to 3.043	2.000	2.000	0.000 to 3.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Clingers by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



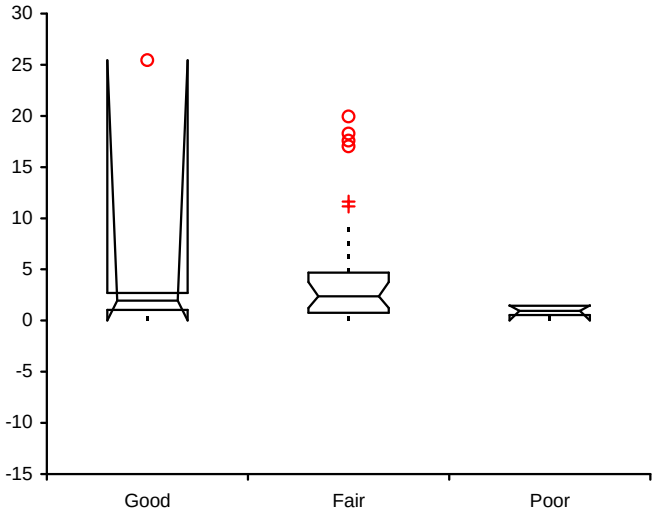
ClngrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	35.152	28.7882	12.8745	7.705 to 62.598	28.349	38.805	8.434 to 77.174
Fair	43	22.623	18.5606	2.8305	17.862 to 27.383	17.486	28.146	10.811 to 29.773
Poor	5	27.061	32.1798	14.3912	-3.619 to 57.741	7.302	47.846	2.168 to 71.642

Test	**Comparative descriptives** Riffle/ Run 46 Clinger taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



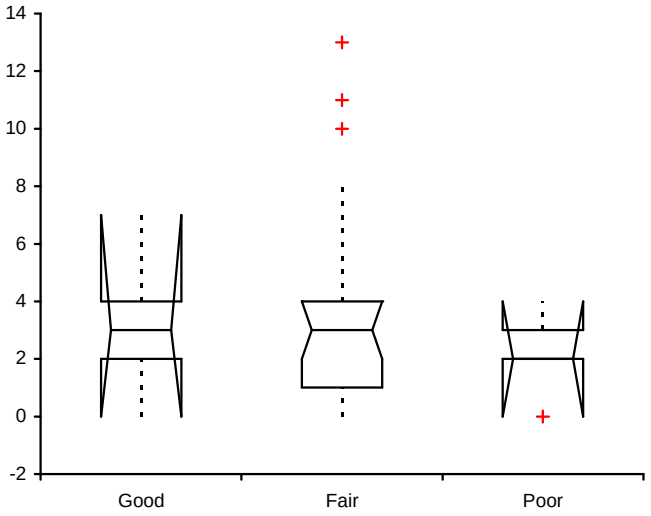
ClngrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	6.000	1.2247	0.5477	4.832 to 7.168	6.000	1.000	4.000 to 7.000
Fair	43	4.860	2.4357	0.3714	4.236 to 5.485	5.000	3.500	4.000 to 6.000
Poor	5	4.800	0.8367	0.3742	4.002 to 5.598	5.000	1.000	4.000 to 6.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Coleoptera by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



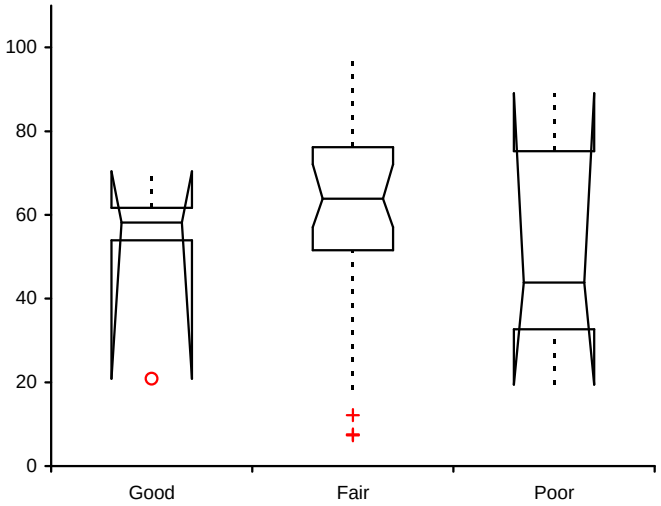
ColeoPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	6.233	10.7926	4.8266	-4.056 to 16.523	1.957	1.666	0.000 to 25.455
Fair	43	4.254	5.3376	0.8140	2.885 to 5.623	2.367	3.914	1.242 to 3.757
Poor	5	0.889	0.6329	0.2831	0.285 to 1.492	0.952	0.916	0.000 to 1.493

Test	**Comparative descriptives** Riffle/ Run 46 Coleoptera taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



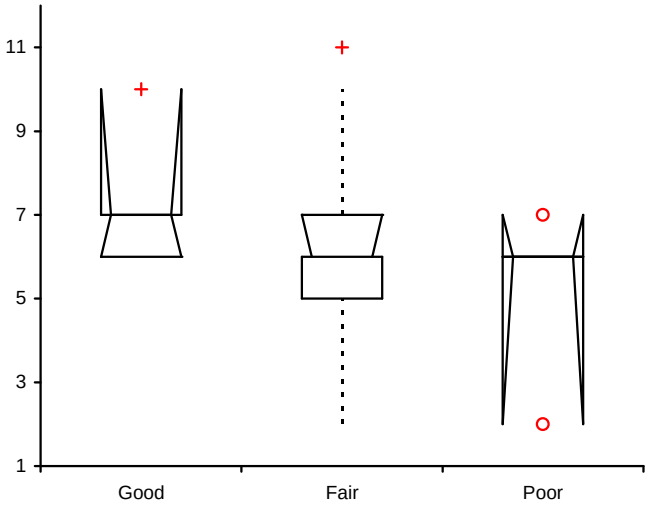
ColeoTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.200	2.5884	1.1576	0.732 to 5.668	3.000	2.000	0.000 to 7.000
Fair	43	3.419	2.9939	0.4566	2.651 to 4.187	3.000	3.000	2.000 to 4.000
Poor	5	2.200	1.4832	0.6633	0.786 to 3.614	2.000	1.000	0.000 to 4.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Collectors by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



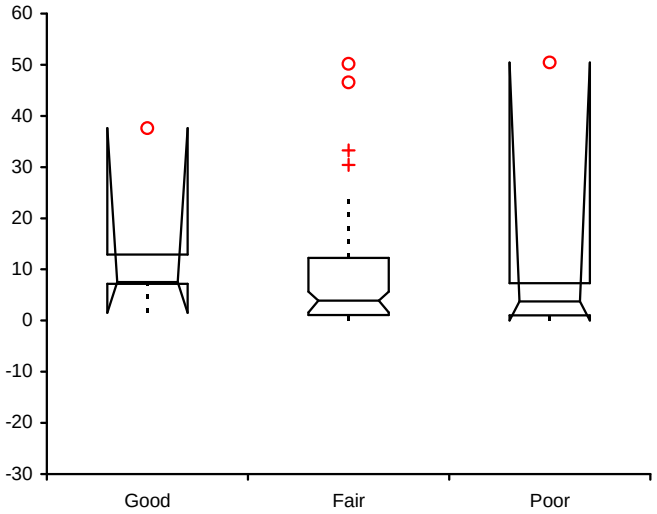
CllctPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	53.001	18.9549	8.4769	34.930 to 71.073	58.133	7.743	20.870 to 70.383
Fair	43	61.776	22.5113	3.4329	56.002 to 67.550	63.881	24.576	57.098 to 72.105
Poor	5	52.035	29.2323	13.0731	24.165 to 79.904	43.810	42.585	19.403 to 89.070

Test	**Comparative descriptives** Riffle/ Run 46 Collector taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



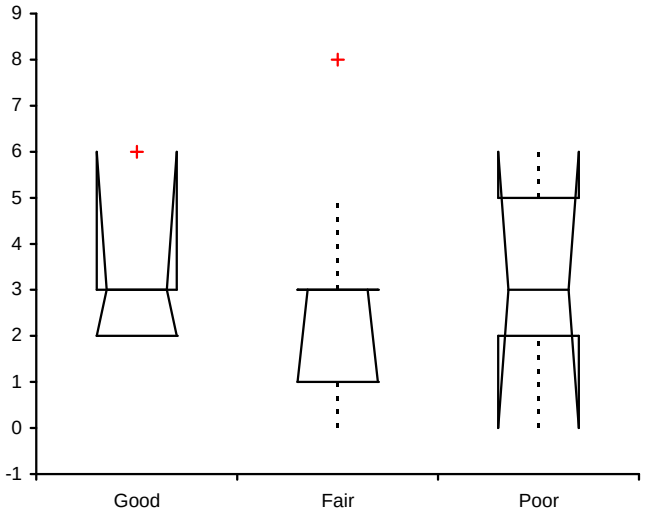
CllctTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	7.200	1.6432	0.7348	5.633 to 8.767	7.000	1.000	6.000 to 10.000
Fair	43	6.372	2.0357	0.3104	5.850 to 6.894	6.000	2.000	6.000 to 7.000
Poor	5	5.400	1.9494	0.8718	3.541 to 7.259	6.000	0.000	2.000 to 7.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Crustacea/Mollusca by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



CrMolPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	13.337	14.1344	6.3211	-0.139 to 26.813	7.530	5.727	1.522 to 37.576
Fair	43	8.867	12.3879	1.8891	5.689 to 12.044	3.896	11.173	1.579 to 5.611
Poor	5	12.493	21.3998	9.5703	-7.910 to 32.895	3.731	6.308	0.000 to 50.437

Test	**Comparative descriptives** Riffle/ Run 46 Crustacea and Mollusca taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

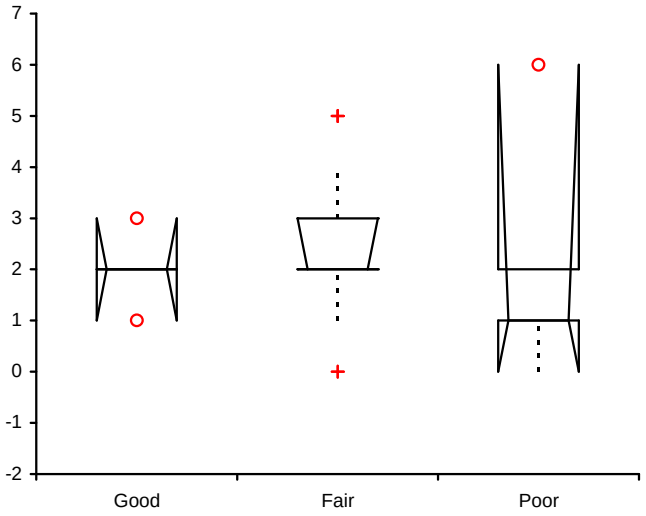


CrMolTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.200	1.6432	0.7348	1.633 to 4.767	3.000	1.000	2.000 to 6.000
Fair	43	2.419	1.7076	0.2604	1.981 to 2.857	3.000	2.000	1.000 to 3.000
Poor	5	3.200	2.3875	1.0677	0.924 to 5.476	3.000	3.000	0.000 to 6.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Diptera by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

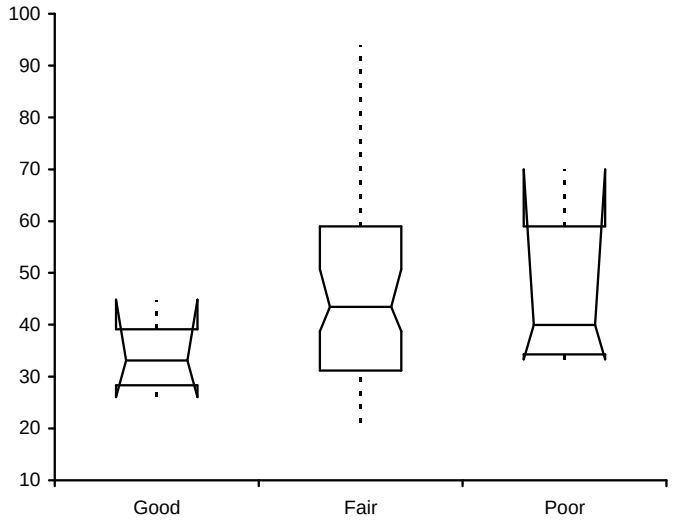
DipPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	21.746	17.8393	7.9780	4.738 to 38.754	11.747	24.452	6.667 to 47.174
Fair	43	23.639	22.8639	3.4867	17.775 to 29.504	15.805	26.760	9.827 to 24.927
Poor	5	9.656	11.5694	5.1740	-1.374 to 20.686	4.444	13.232	0.000 to 27.619

Test	**Comparative descriptives** Riffle/ Run 46 Diptera taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



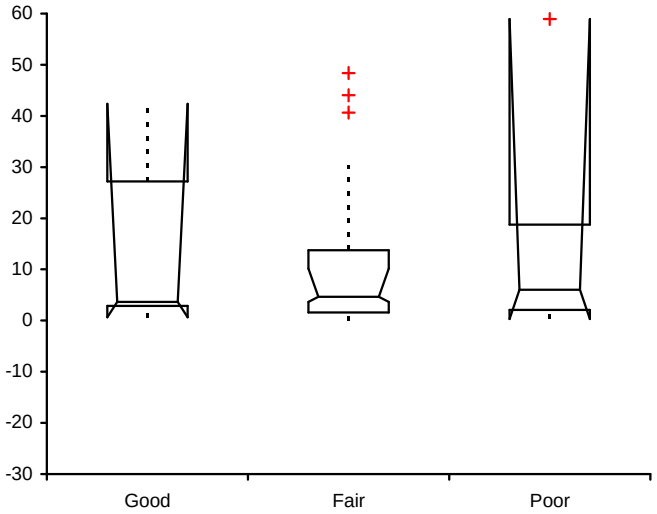
DipTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.000	0.7071	0.3162	1.326 to 2.674	2.000	0.000	1.000 to 3.000
Fair	43	2.512	1.2606	0.1922	2.188 to 2.835	2.000	1.000	2.000 to 3.000
Poor	5	2.000	2.3452	1.0488	-0.236 to 4.236	1.000	1.000	0.000 to 6.000

Test	**Comparative descriptives** Riffle/ Run 46 Dominant taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



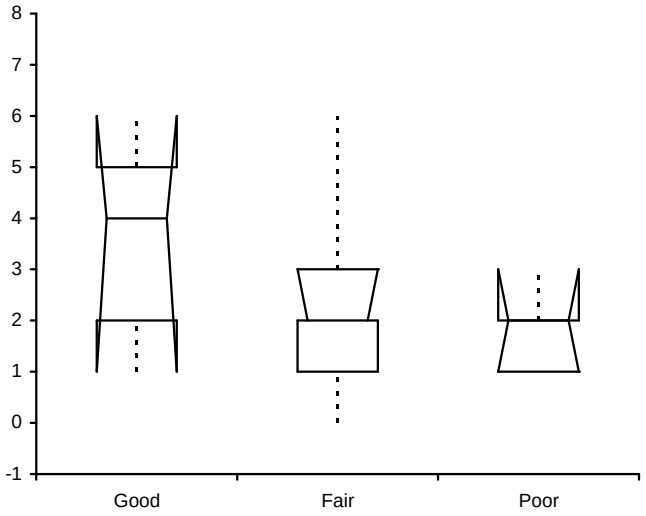
Dom01Pct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	34.304	7.7460	3.4641	26.919 to 41.689	33.101	10.782	26.061 to 44.880
Fair	43	47.625	19.6196	2.9920	42.593 to 52.658	43.443	27.826	38.718 to 50.751
Poor	5	47.305	16.3564	7.3148	31.711 to 62.899	39.942	24.670	33.333 to 70.009

Test	**Comparative descriptives** Riffle/ Run 46 Percent Ephemeroptera by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



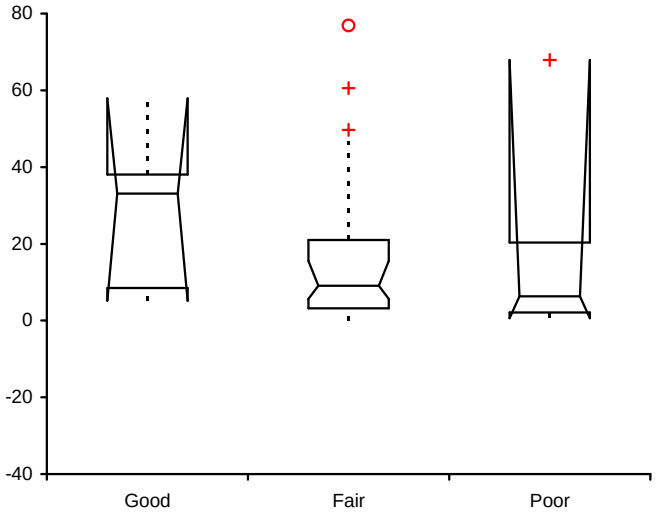
EphemPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	15.322	18.5835	8.3108	-2.395 to 33.039	3.636	24.352	0.602 to 42.368
Fair	43	10.711	12.4954	1.9055	7.506 to 13.916	4.607	12.157	3.625 to 10.116
Poor	5	17.217	24.4190	10.9205	-6.064 to 40.498	6.032	16.652	0.292 to 58.955

Test	**Comparative descriptives** Riffle/ Run 46 Ephemeroptera taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



EphemTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.600	2.0736	0.9274	1.623 to 5.577	4.000	3.000	1.000 to 6.000
Fair	43	2.233	1.3063	0.1992	1.897 to 2.568	2.000	2.000	2.000 to 3.000
Poor	5	1.800	0.8367	0.3742	1.002 to 2.598	2.000	1.000	1.000 to 3.000

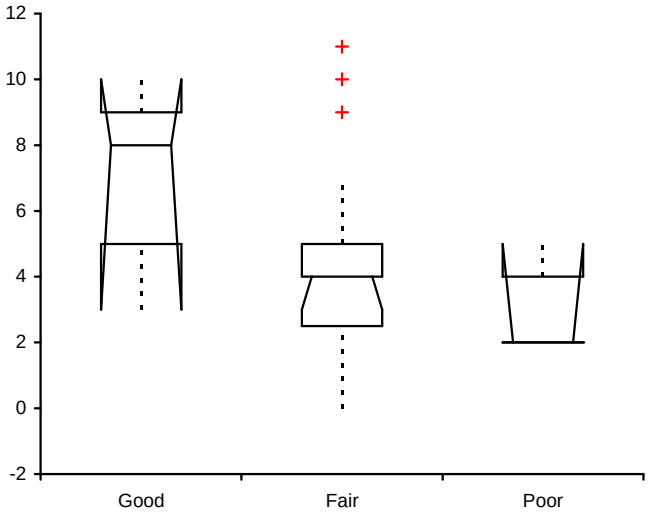
Test	**Comparative descriptives** Riffle/ Run 46 Percent Ephemeroptera, Plecoptera and Trichoptera by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



EPTPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	28.539	21.9453	9.8143	7.616 to 49.461	33.101	29.559	5.120 to 57.944
Fair	43	15.557	17.7628	2.7088	11.001 to 20.113	9.073	17.773	5.641 to 15.526
Poor	5	19.448	28.1893	12.6067	-7.428 to 46.323	6.349	18.240	0.583 to 67.910

Test **Comparative descriptives**
Riffle/ Run 46
Ephemeroptera, Plecoptera and Trichoptera taxa by HDI rating

Performed by Neil Haugerud **Date** 1 March 2006

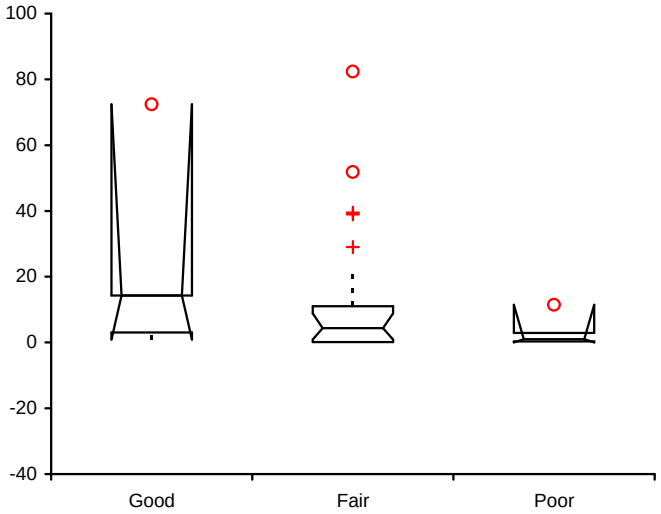


EPTTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	7.000	2.9155	1.3038	4.220 to 9.780	8.000	4.000	3.000 to 10.000
Fair	43	3.953	2.4098	0.3675	3.335 to 4.572	4.000	2.500	3.000 to 4.000
Poor	5	3.000	1.4142	0.6325	1.652 to 4.348	2.000	2.000	2.000 to 5.000

Test	**Comparative descriptives** Riffle/ Run 46 Evenness by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

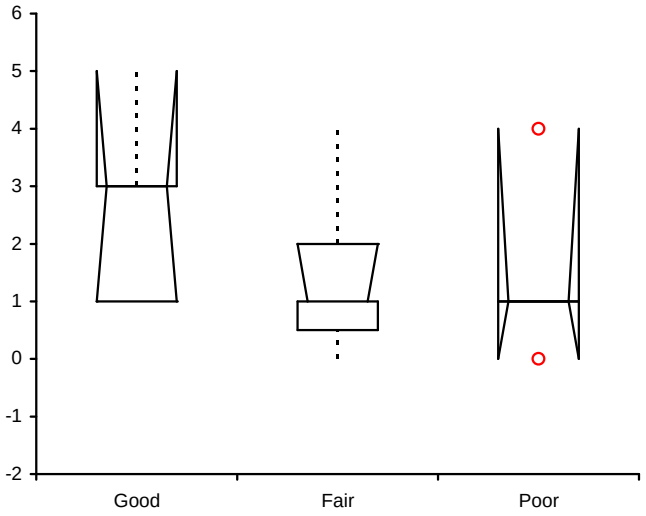
Evenness by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	0.382	0.0870	0.0389	0.299 to 0.465	0.380	0.080	0.295 to 0.518
Fair	43	0.304	0.1133	0.0173	0.275 to 0.333	0.306	0.147	0.280 to 0.354
Poor	5	0.299	0.0845	0.0378	0.218 to 0.379	0.304	0.080	0.164 to 0.374

Test	**Comparative descriptives** Riffle/ Run 46 Percent Filterers by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



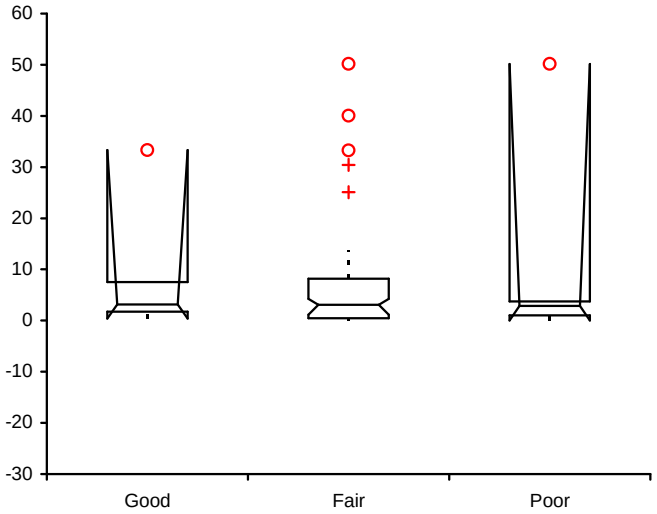
FiltrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	20.988	29.3999	13.1480	-7.041 to 49.018	14.286	11.300	0.904 to 72.391
Fair	43	10.153	16.2909	2.4843	5.975 to 14.332	4.348	10.895	0.929 to 8.832
Poor	5	3.114	4.7790	2.1373	-1.442 to 7.670	0.994	2.566	0.000 to 11.429

Test	**Comparative descriptives** Riffle/ Run 46 Filterer taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



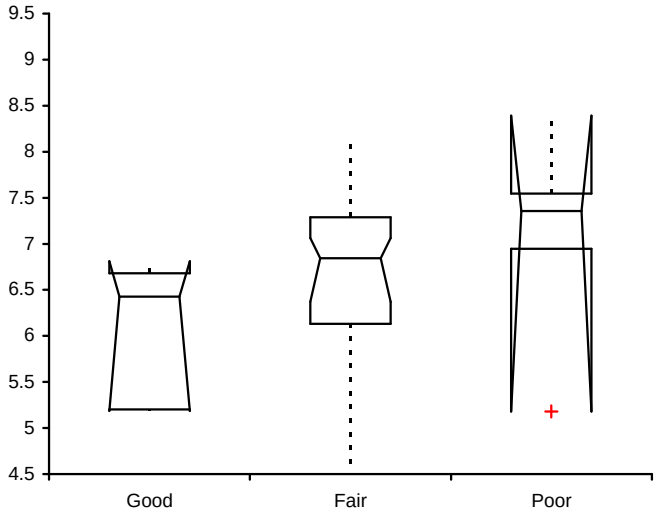
FiltrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.600	1.6733	0.7483	1.005 to 4.195	3.000	2.000	1.000 to 5.000
Fair	43	1.465	1.2218	0.1863	1.152 to 1.779	1.000	1.500	1.000 to 2.000
Poor	5	1.400	1.5166	0.6782	-0.046 to 2.846	1.000	0.000	0.000 to 4.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Gastropoda by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



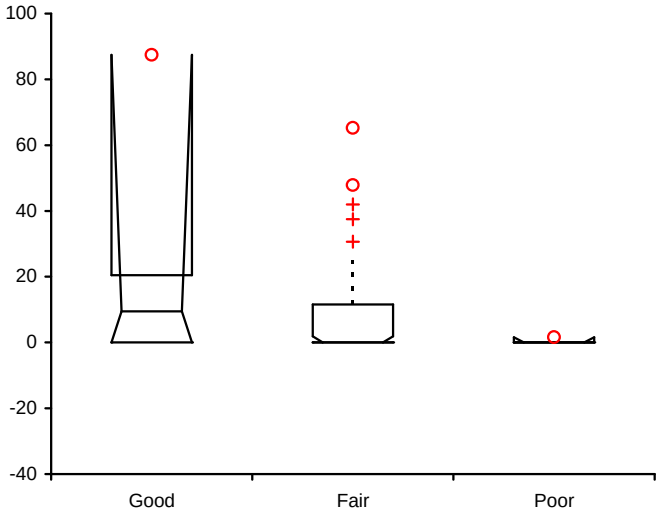
GastrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	9.231	13.7357	6.1428	-3.864 to 22.327	3.115	5.788	0.435 to 33.333
Fair	43	7.308	11.5040	1.7543	4.358 to 10.259	3.096	7.732	1.156 to 4.255
Poor	5	11.546	21.6285	9.6726	-9.075 to 32.166	2.857	2.738	0.000 to 50.146

Test	**Comparative descriptives** Riffle/ Run 46 Hilsenhoff Biotic Index by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



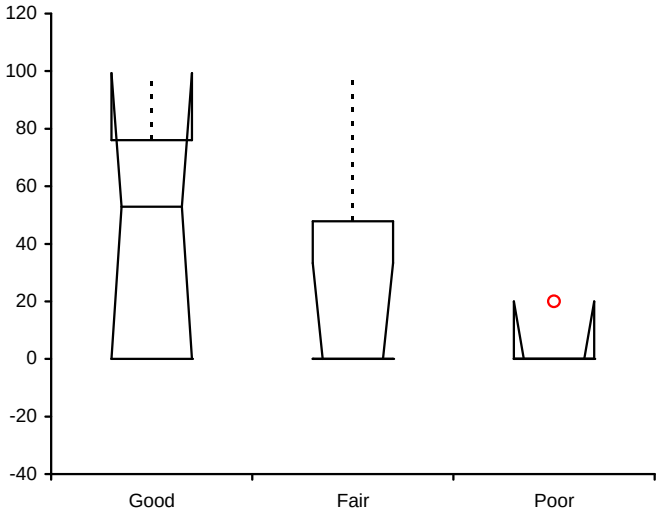
HBI by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	6.061	0.8030	0.3591	5.296 to 6.827	6.429	1.477	5.187 to 6.810
Fair	43	6.673	0.8251	0.1258	6.461 to 6.885	6.845	1.157	6.372 to 7.065
Poor	5	7.084	1.1878	0.5312	5.951 to 8.216	7.358	0.598	5.179 to 8.391

Test	**Comparative descriptives** Riffle/ Run 46 Percent Hydropsychidae/Ephemeroptera, Plecoptera and Trichoptera by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



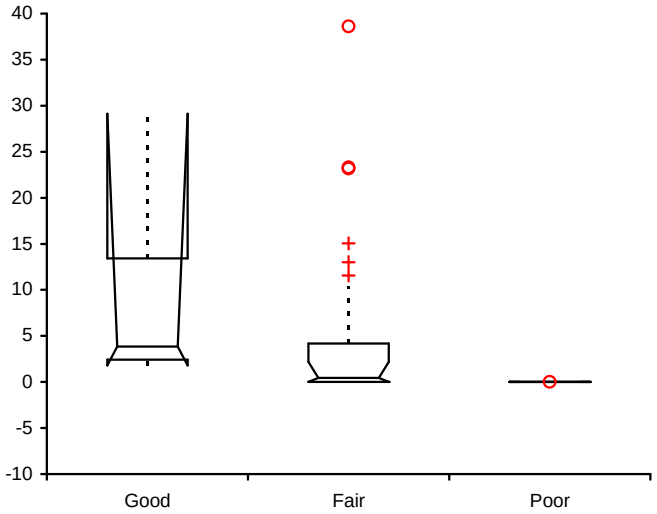
Hyd2EPTPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	23.466	36.7339	16.4279	-11.555 to 58.488	9.474	20.430	0.000 to 87.429
Fair	43	8.375	15.3370	2.3389	4.442 to 12.309	0.000	11.543	0.000 to 1.887
Poor	5	0.313	0.6988	0.3125	-0.354 to 0.979	0.000	0.000	0.000 to 1.563

Test	**Comparative descriptives** Riffle/ Run 46 Percent Hydropsychidae/Trichoptera by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



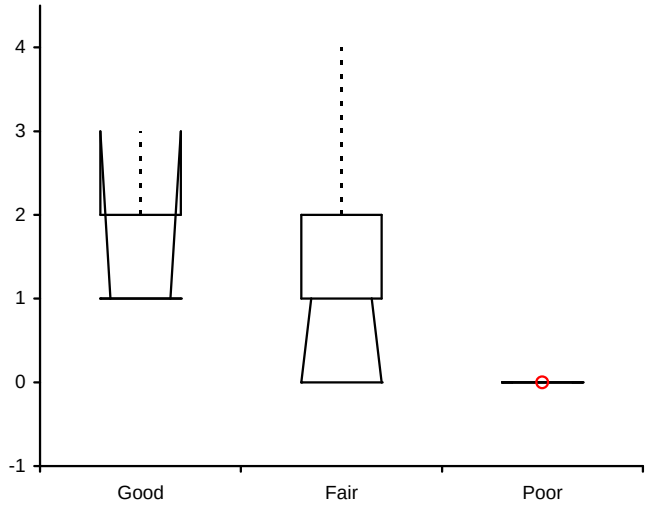
Hyd2TriPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	45.658	44.7937	20.0323	2.953 to 88.364	52.941	76.000	0.000 to 99.351
Fair	43	26.115	35.9326	5.4797	16.898 to 35.331	0.000	47.822	0.000 to 33.333
Poor	5	4.000	8.9443	4.0000	-4.527 to 12.527	0.000	0.000	0.000 to 20.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Intolerant by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



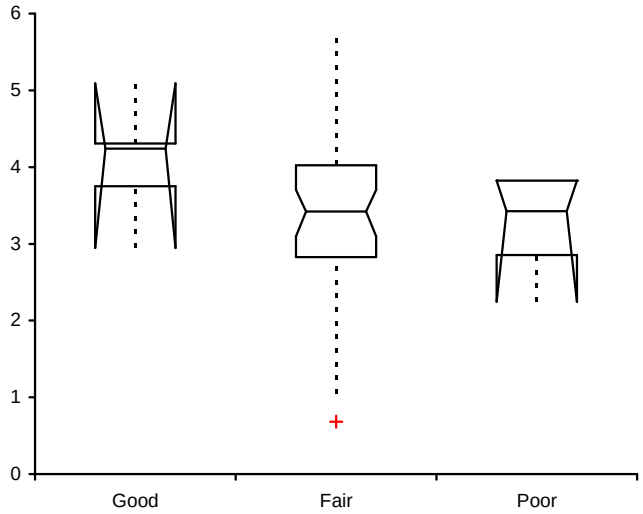
IntolPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	10.118	11.6188	5.1961	-0.959 to 21.195	3.833	10.971	1.807 to 29.130
Fair	43	4.185	7.9424	1.2112	2.148 to 6.222	0.450	4.167	0.000 to 2.168
Poor	5	0.000	0.0000	0.0000	0.000 to 0.000	0.000	0.000	0.000 to 0.000

Test	**Comparative descriptives** Riffle/ Run 46 Intolerant taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



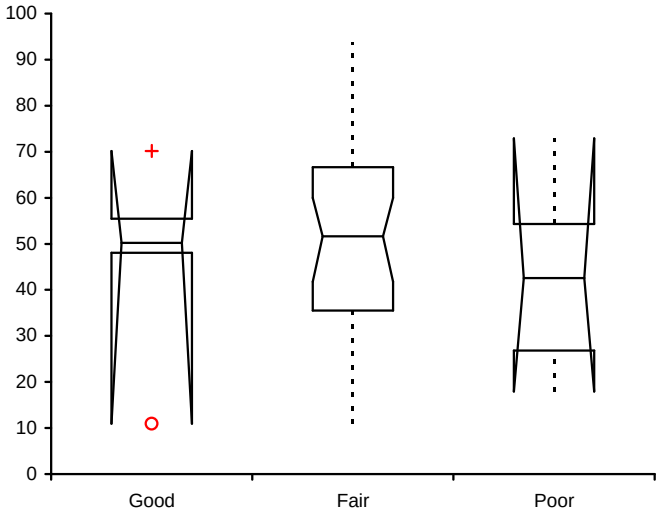
IntolTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	1.600	0.8944	0.4000	0.747 to 2.453	1.000	1.000	1.000 to 3.000
Fair	43	1.093	1.1915	0.1817	0.787 to 1.399	1.000	2.000	0.000 to 1.000
Poor	5	0.000	0.0000	0.0000	0.000 to 0.000	0.000	0.000	0.000 to 0.000

Test	**Comparative descriptives** Riffle/ Run 46 Margalef's Index by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



D_Mg by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	4.067	0.7899	0.3533	3.314 to 4.820	4.241	0.555	2.946 to 5.092
Fair	43	3.419	1.0648	0.1624	3.146 to 3.692	3.419	1.194	3.099 to 3.702
Poor	5	3.235	0.6810	0.3046	2.585 to 3.884	3.426	0.971	2.246 to 3.824

Test	**Comparative descriptives** Riffle/ Run 46 Percent Multivoltine taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

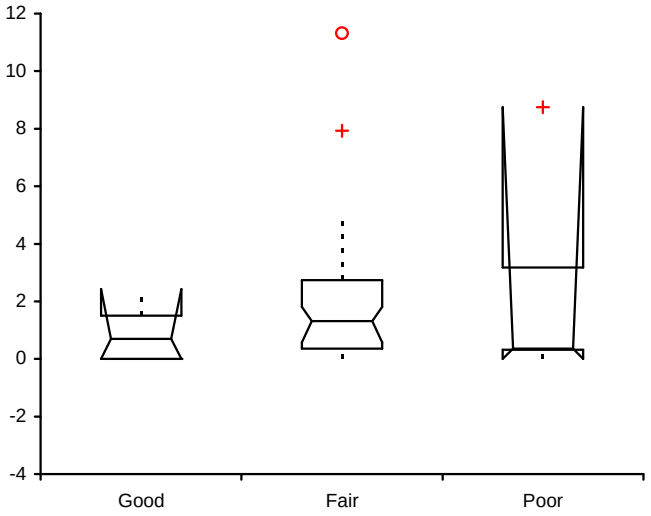


MltVolPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	46.969	21.9252	9.8052	26.065 to 67.872	50.217	7.368	10.909 to 70.181
Fair	43	52.024	24.1040	3.6758	45.841 to 58.207	51.645	31.142	41.775 to 60.000
Poor	5	42.892	21.8673	9.7794	22.043 to 63.740	42.540	27.464	17.910 to 72.900

Test	**Comparative descriptives** Riffle/ Run 46 Percent Non-Insect by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

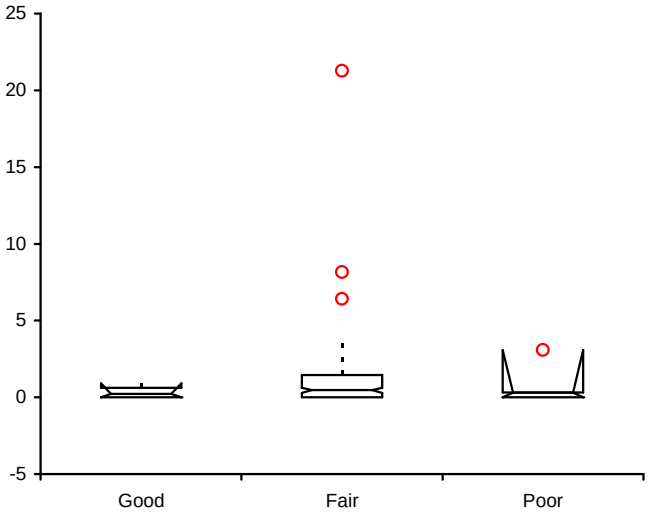
NonInPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	36.415	17.7760	7.9497	19.467 to 53.362	32.399	20.944	12.174 to 56.627
Fair	43	46.600	27.7518	4.2321	39.482 to 53.718	48.701	42.822	29.787 to 59.538
Poor	5	54.254	22.5078	10.0658	32.795 to 75.713	52.381	31.168	23.134 to 76.968

Test	**Comparative descriptives** Riffle/ Run 46 Percent Odonata by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



OdonPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	0.925	1.0427	0.4663	-0.069 to 1.919	0.697	1.506	0.000 to 2.424
Fair	43	1.898	2.2783	0.3474	1.313 to 2.482	1.316	2.374	0.578 to 1.813
Poor	5	2.520	3.7100	1.6592	-1.017 to 6.057	0.361	2.857	0.000 to 8.746

Test	**Comparative descriptives** Riffle/ Run 46 Percent Oligocheata by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



OligoPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	0.349	0.4011	0.1794	-0.034 to 0.731	0.217	0.623	0.000 to 0.904
Fair	43	1.494	3.5008	0.5339	0.596 to 2.392	0.473	1.456	0.279 to 0.619
Poor	5	0.736	1.3143	0.5878	-0.517 to 1.989	0.292	0.317	0.000 to 3.071

Test	**Comparative descriptives** Riffle/ Run 46 Percent Predators by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

PredPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	8.834	10.6353	4.7563	-1.305 to 18.974	5.923	4.618	0.000 to 27.108
Fair	43	13.089	13.0786	1.9945	9.734 to 16.443	9.910	15.654	5.397 to 12.384
Poor	5	14.287	5.2925	2.3669	9.241 to 19.333	12.687	5.714	8.311 to 21.866

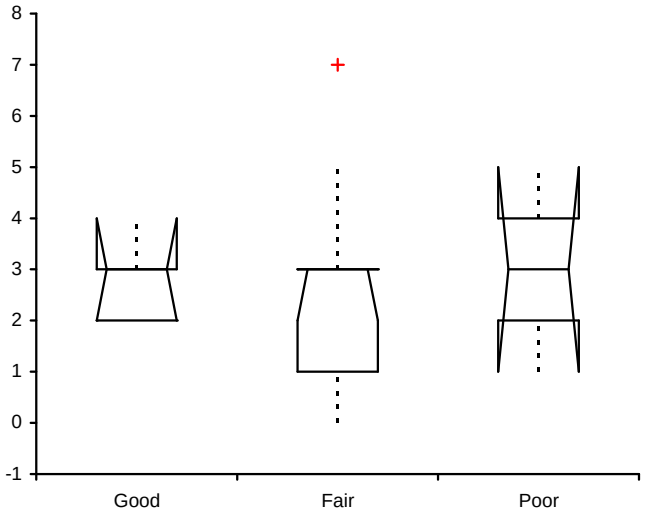
Test	**Comparative descriptives** Riffle/ Run 46 Predator taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

PredTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	6.600	4.3932	1.9647	2.412 to 10.788	7.000	5.000	0.000 to 11.000
Fair	43	7.256	4.0947	0.6244	6.206 to 8.306	6.000	5.000	5.000 to 8.000
Poor	5	7.800	3.3466	1.4967	4.609 to 10.991	9.000	2.000	2.000 to 10.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Scrapers by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

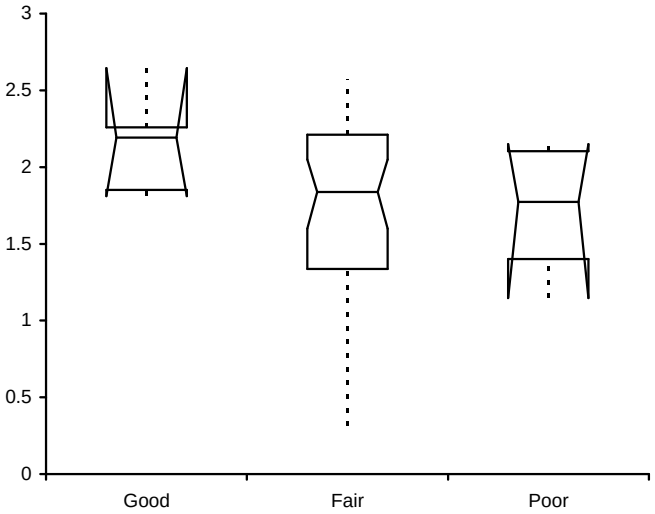
ScrapPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	7.415	5.0748	2.2695	2.576 to 12.253	7.530	3.001	1.522 to 15.265
Fair	43	8.886	12.2390	1.8664	5.747 to 12.025	3.779	9.341	2.244 to 6.294
Poor	5	23.112	28.7784	12.8701	-4.325 to 50.549	6.032	43.904	0.952 to 62.687

Test	**Comparative descriptives** Riffle/ Run 46 Scraper taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



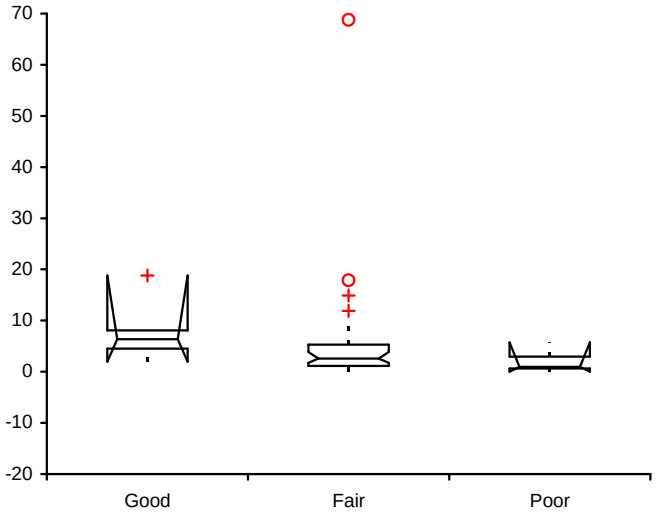
ScrapTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.800	0.8367	0.3742	2.002 to 3.598	3.000	1.000	2.000 to 4.000
Fair	43	2.372	1.5279	0.2330	1.980 to 2.764	3.000	2.000	2.000 to 3.000
Poor	5	3.000	1.5811	0.7071	1.493 to 4.507	3.000	2.000	1.000 to 5.000

Test	**Comparative descriptives** Riffle/ Run 46 Shannon-Weiner Index by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



Shan_e by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.151	0.3400	0.1521	1.827 to 2.476	2.193	0.408	1.810 to 2.644
Fair	43	1.738	0.5780	0.0881	1.590 to 1.886	1.838	0.874	1.599 to 2.049
Poor	5	1.715	0.4372	0.1955	1.298 to 2.132	1.774	0.702	1.147 to 2.150

Test	**Comparative descriptives** Riffle/ Run 46 Percent Shredders by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

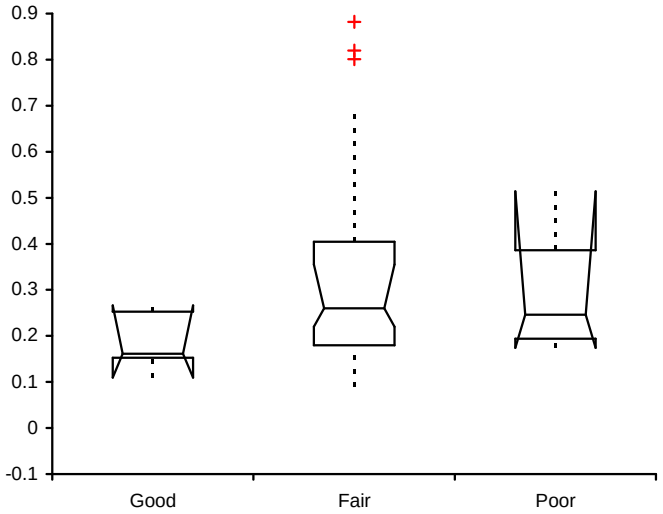


ShredPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	7.940	6.4758	2.8960	1.766 to 14.114	6.325	3.570	1.957 to 18.788
Fair	43	5.308	10.6711	1.6273	2.571 to 8.045	2.564	4.184	1.724 to 3.825
Poor	5	2.057	2.3301	1.0421	-0.165 to 4.278	0.952	2.353	0.000 to 5.714

Test	**Comparative descriptives** Riffle/ Run 46 Shredder taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

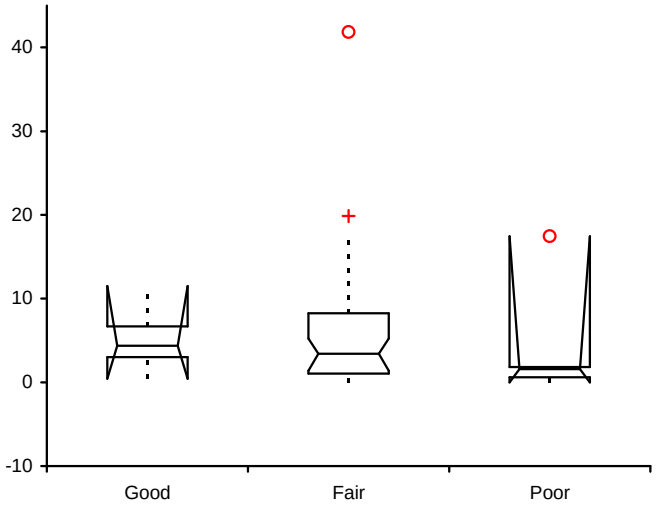
ShredTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	4.000	1.5811	0.7071	2.493 to 5.507	4.000	2.000	2.000 to 6.000
Fair	43	2.628	1.4804	0.2258	2.248 to 3.008	2.000	1.000	2.000 to 3.000
Poor	5	1.800	1.3038	0.5831	0.557 to 3.043	2.000	2.000	0.000 to 3.000

Test	**Comparative descriptives** Riffle/ Run 46 Simpson's Index by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



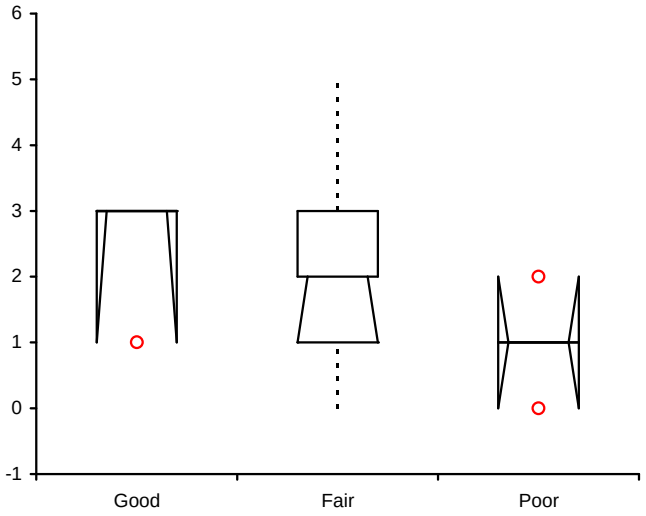
D by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	0.188	0.0678	0.0303	0.124 to 0.253	0.161	0.100	0.109 to 0.266
Fair	43	0.322	0.1967	0.0300	0.272 to 0.372	0.260	0.225	0.220 to 0.356
Poor	5	0.303	0.1442	0.0645	0.166 to 0.440	0.246	0.192	0.174 to 0.514

Test	**Comparative descriptives** Riffle/ Run 46 Percent Sprawlers by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



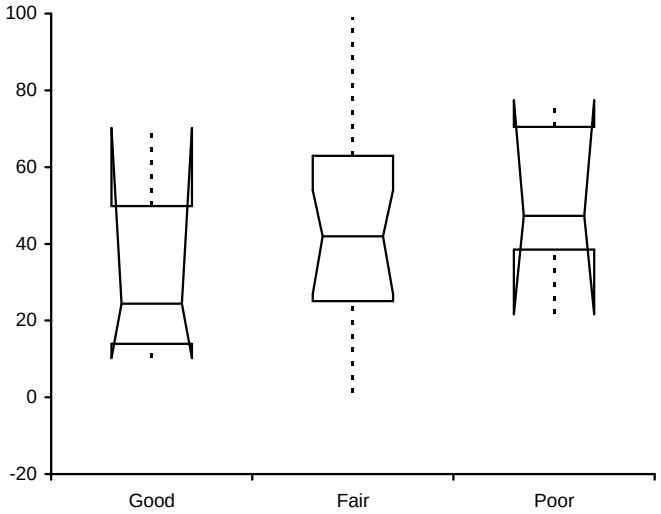
SprwlPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	5.195	4.1838	1.8711	1.206 to 9.183	4.361	3.655	0.435 to 11.498
Fair	43	5.732	7.6189	1.1619	3.778 to 7.686	3.419	7.186	1.397 to 5.202
Poor	5	4.287	7.4006	3.3096	-2.768 to 11.343	1.587	1.224	0.000 to 17.460

Test	**Comparative descriptives** Riffle/ Run 46 Sprawler taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



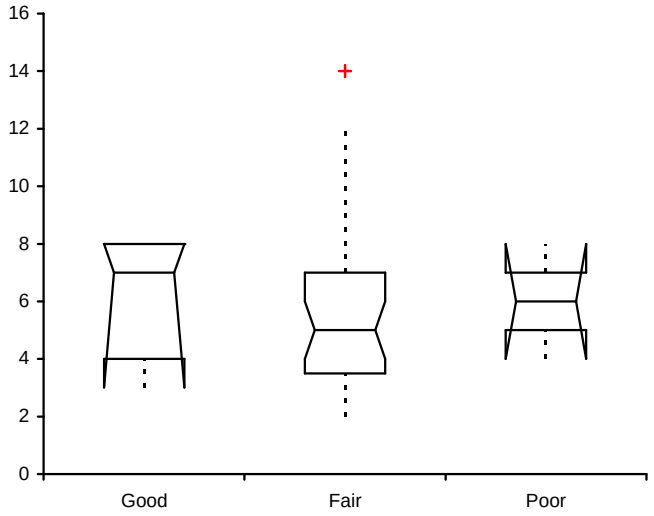
SprwlTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	2.600	0.8944	0.4000	1.747 to 3.453	3.000	0.000	1.000 to 3.000
Fair	43	1.860	1.3378	0.2040	1.517 to 2.204	2.000	2.000	1.000 to 2.000
Poor	5	1.000	0.7071	0.3162	0.326 to 1.674	1.000	0.000	0.000 to 2.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Swimmers by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



SwmmrPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	33.714	25.5933	11.4457	9.314 to 58.115	24.390	35.905	10.217 to 70.181
Fair	43	44.604	27.0951	4.1320	37.654 to 51.554	41.991	37.890	26.923 to 53.968
Poor	5	51.064	22.9639	10.2698	29.170 to 72.958	47.302	31.992	21.642 to 77.416

Test	**Comparative descriptives** Riffle/ Run 46 Swimmer taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



SwmmrTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	6.000	2.3452	1.0488	3.764 to 8.236	7.000	4.000	3.000 to 8.000
Fair	43	5.698	2.9644	0.4521	4.937 to 6.458	5.000	3.500	4.000 to 6.000
Poor	5	6.000	1.5811	0.7071	4.493 to 7.507	6.000	2.000	4.000 to 8.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Tolerant by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006

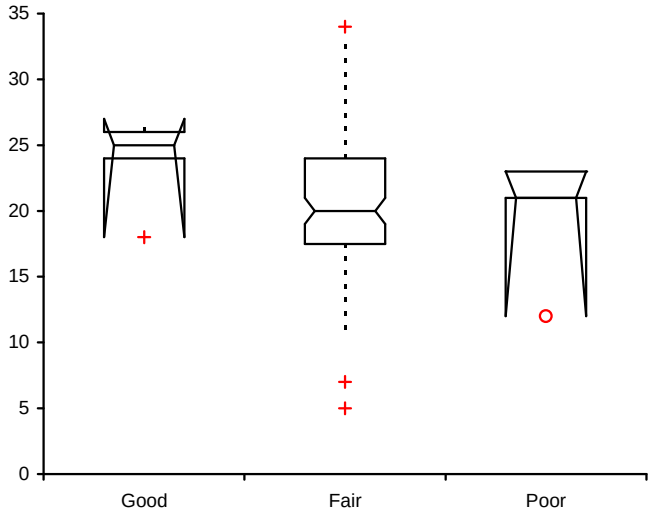
TolerPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	35.092	18.3590	8.2104	17.588 to 52.595	37.979	21.745	9.565 to 56.325
Fair	43	49.046	27.3707	4.1740	42.026 to 56.067	53.943	49.648	33.437 to 60.694
Poor	5	64.077	23.9801	10.7242	41.214 to 86.939	66.349	11.158	23.881 to 86.297

Test **Comparative descriptives**
Riffle/ Run 46
Tolerant taxa by HDI rating

Performed by Neil Haugerud **Date** 1 March 2006

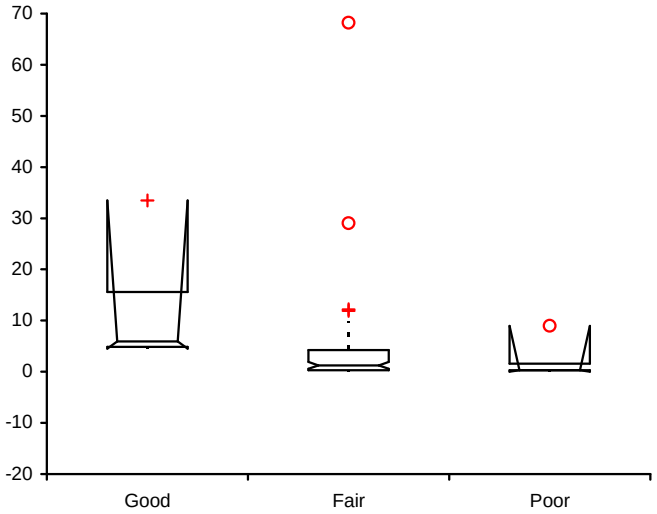
TolerTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	9.400	3.3615	1.5033	6.195 to 12.605	10.000	5.000	5.000 to 13.000
Fair	43	7.628	2.5074	0.3824	6.985 to 8.271	7.000	3.000	6.000 to 9.000
Poor	5	8.800	2.8636	1.2806	6.070 to 11.530	9.000	1.000	5.000 to 13.000

Test	**Comparative descriptives** Riffle/ Run 46 Total taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



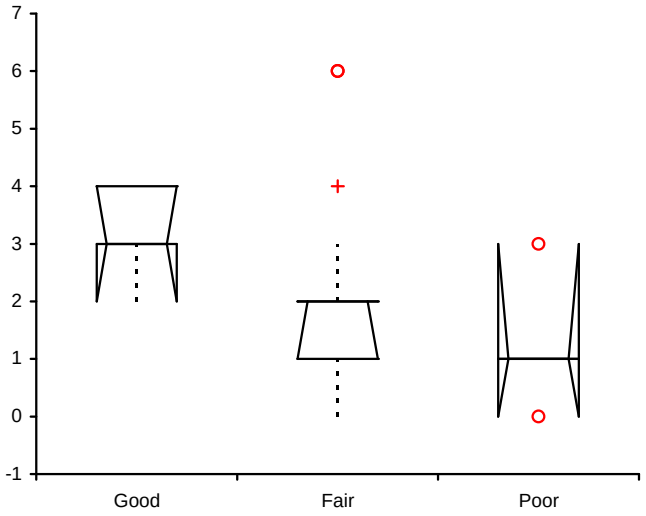
TotalTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	24.000	3.5355	1.5811	20.629 to 27.371	25.000	2.000	18.000 to 27.000
Fair	43	20.674	6.0856	0.9280	19.113 to 22.235	20.000	6.500	19.000 to 21.000
Poor	5	20.000	4.5826	2.0494	15.631 to 24.369	21.000	2.000	12.000 to 23.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Trichoptera by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



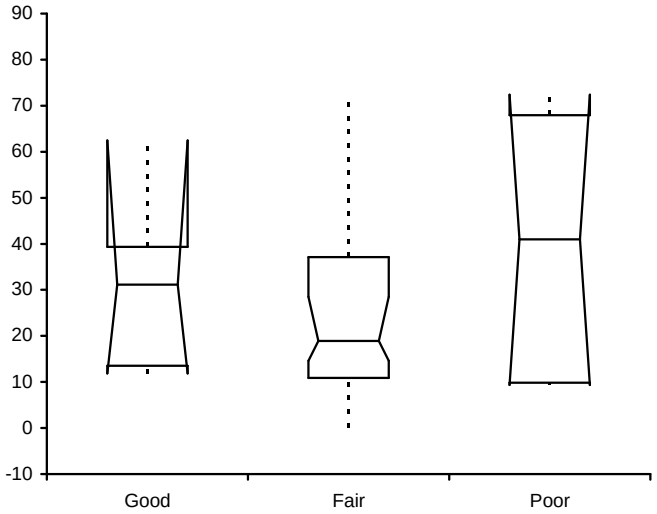
TrichPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	12.869	12.3933	5.5425	1.053 to 24.685	5.923	10.728	4.518 to 33.478
Fair	43	4.703	11.2329	1.7130	1.822 to 7.585	1.212	3.941	0.590 to 1.913
Poor	5	2.230	3.8089	1.7034	-1.401 to 5.862	0.317	1.296	0.000 to 8.955

Test	**Comparative descriptives** Riffle/ Run 46 Trichoptera taxa by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



TrichTax by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	3.200	0.8367	0.3742	2.402 to 3.998	3.000	1.000	2.000 to 4.000
Fair	43	1.674	1.4095	0.2149	1.313 to 2.036	2.000	1.000	1.000 to 2.000
Poor	5	1.200	1.0954	0.4899	0.156 to 2.244	1.000	0.000	0.000 to 3.000

Test	**Comparative descriptives** Riffle/ Run 46 Percent Univoltine by HDI rating
Performed by	Neil Haugerud
Date	1 March 2006



UniVolPct by Index rating	n	Mean	SD	SE	90% CI of Mean	Median	IQR	90% CI of Median
Good	5	31.665	20.7737	9.2903	11.860 to 51.471	31.153	25.794	11.847 to 62.424
Fair	43	23.841	17.1648	2.6176	19.438 to 28.244	18.879	26.254	14.563 to 28.479
Poor	5	40.083	30.3386	13.5678	11.159 to 69.008	40.952	58.089	9.304 to 72.388

Appendix E

Landscape Index Scores, Habitat Rankings, Habitat Scores and Raw Metric Scores

Table E-1. Landscape Index Scores Calculated Using the Analytical Tools Interface for Landscape Assessments (ATtILA, Version 3.0) for Glide/Pool Stream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Sites used in Metric Development.

Storet Number	Stream Name	HDI Rank	AGPSL3	AGCSL3	RAGC30	RNG30	RDDENS	P_LOAD	Landscape Index Score	HDI Score
552007	Wintering River	Good	5	1	1	20	5	3	35	138.3
552021	Willow Creek	Good	3	2	4	16	11	6	42	135.0
552029	Snake Creek	Good	5	2	1	16	7	4	35	157.3
552031	Unnamed Tributary of Souris R.	Good	7	1	1	20	3	9	41	136.8
554005	Pipestem Creek	Good	5	1	1	20	5	3	35	138.3
551207	Sheyenne River	Poor	8	12	18	7	18	17	80	90.33
551215	Sheyenne River	Poor	16	11	10	3	20	7	67	82.67
551216	Sheyenne River	Poor	16	13	7	3	20	7	66	95.50
554026	Bear Creek	Poor	7	9	13	6	12	18	65	91.33
551167	Maple River	Fair	3	8	17	7	17	14	66	101.0
551168	Maple River	Fair	2	4	16	2	11	8	43	119.1
551193	Sheyenne River	Fair	13	6	10	9	4	13	55	115.6
551194	Sheyenne River	Fair	11	3	2	17	16	8	57	109.0
551195	Sheyenne River	Fair	11	7	1	8	17	16	60	112.5
551197	Sheyenne River	Fair	9	19	9	3	7	16	63	116.5
551198	North Fork Sheyenne River	Fair	13	12	9	6	5	16	61	112.6
551200	Big Coulee	Fair	8	7	6	8	5	17	51	116.0
551201	Sheyenne River	Fair	11	7	5	3	7	8	41	129.3
551202	Sheyenne River	Fair	10	16	10	3	3	4	46	119.6
551203	Sheyenne River	Fair	10	11	3	5	5	4	38	114.3
551206	Sheyenne River	Fair	11	12	10	1	9	1	44	125.3
551210	Baldhill Creek	Fair	10	9	11	1	5	3	39	134.0
551212	Baldhill Creek	Fair	5	8	15	3	14	14	59	121.3
551214	Sheyenne River	Fair	13	12	13	4	12	6	60	114.5
552010	Deep Creek Little	Fair	3	3	11	15	16	7	55	111.1
552011	Deep River	Fair	4	4	9	11	17	3	48	122.0
552032	Souris River	Fair	7	1	1	20	3	10	42	131.0
552044	Souris River	Fair	13	10	1	17	15	5	61	113.6
552046	Souris River	Fair	7	10	10	2	5	4	38	132.8

Table E-1. Continued

Storet Number	Stream Name	HDI Rank	AGPSL3	AGCSL3	RAGC30	RNG30	RDDENS	P_LOAD	Landscape Index Score	HDI Score
552011	Souris River	Fair	5	2	1	20	19	13	60	114.00
551206	Pipestem Creek	Fair	6	19	13	1	9	9	57	112.00
551210	James River	Fair	2	8	15	3	14	17	59	100.33
551201	Elm River	Fair	3	2	13	4	8	18	48	120.50
552032	South Fork Maple River	Fair	4	4	15	6	8	18	55	120.17
552046	James River	Fair	7	7	7	7	20	3	51	104.50

Table E-2. Landscape Index Scores Calculated Using the Analytical Tools Interface for Landscape Assessments (ATtILA, Version 3.0) for Glide/Pool Stream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Validation and Between-Year Revisit Sites.

Storet Number	Stream Name	Site Type	HDI Rank	AGPSL3	AGCSL3	RAGC30	RNG30	RDDENS	P_LOAD	Landscape Index Score	HDI Score
552041	Souris River	Validation	Poor	16	13	3	18	19	8	77	93.33
552022	Willow Creek	Validation	Good	1	1	4	9	11	4	30	146.00
551240	Sheyenne River	Validation	Fair	17	9	3	3	20	8	60	120.50
551211	Silver Creek	Validation	Fair	7	2	11	2	9	15	46	124.67
551208	Sheyenne River	Validation	Fair	12	17	16	6	6	12	69	102.00
552042	Souris River	Validation	Fair	12	14	4	20	10	10	70.00	100.67
551199	Sheyenne River	Validation	Fair	12	16	14	7	14	17	80.00	95.83
552005	Wintering River	Validation	Fair	10	6	1	20	13	11	61.00	113.67
551197	Sheyenne River	Revisit	Fair	9	19	9	3	7	16	63	116.50
551198	North Fork Sheyenne River	Revisit	Fair	13	12	9	6	5	16	61	112.67
551201	Sheyenne River	Revisit	Fair	11	7	5	3	7	8	41	129.33
551214	Sheyenne River	Revisit	Fair	13	12	13	4	12	6	60	114.50
551216	Sheyenne River	Revisit	Poor	16	13	7	3	20	7	66	95.50
552031	Unnamed Tributary of Souris R.	Revisit	Good	7	1	1	20	3	9	41	156.33
551215	Sheyenne River	Revisit	Poor	16	11	10	3	20	7	67	82.67

Table E-3.Landscape Index Scores Calculated Using the Analytical Tools Interface for Landscape Assessments (ATtILA, Version 3.0) for Riffle/Run Stream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Sites used in Metric Development.

Storet Number	Stream Name	HDI Rank	AGPSL3	AGCSL3	RAGC30	RNG30	RDDENS	P_LOAD	Landscape Index Score	HDI Score
551210	Baldhill Creek	Good	10	9	11	1	5	3	39.00	134.00
552016	Long Creek	Good	5	1	7	20	8	11	52.00	132.67
552026	Willow Creek	Good	19	4	1	20	3	9	56.00	135.83
554003	Pipestem Creek	Good	6	7	12	1	11	2	39.00	142.00
554031	James River	Good	9	4	11	1	7	1	33.00	144.50
552037	Souris River	Poor	16	13	3	17	8	12	69.00	84.50
552038	Souris River	Poor	17	12	4	16	19	12	80.00	63.33
554023	Cottonwood Creek	Poor	4	11	20	15	16	20	86.00	81.33
554024	Cottonwood Creek	Poor	7	20	19	9	9	20	84.00	78.00
554046	Bear Creek	Poor	9	13	15	14	14	20	85.00	84.17
551209	Pickeral Creek	Fair	5	11	16	5	12	15	64.00	121.17
551213	Baldhill Creek Tributary	Fair	4	6	15	4	13	13	55.00	124.17
552001	Oak Creek	Fair	7	8	14	11	14	13	67.00	112.17
552002	Oak Creek	Fair	6	6	13	18	12	13	68.00	114.33
552003	Gassman/South Branch Coulee	Fair	18	5	2	17	12	13	67.00	101.17
552004	Wintering River	Fair	8	5	2	17	10	7	49.00	118.17
552006	Wintering River	Fair	6	3	3	19	18	10	59.00	95.33
552008	Cutbank Creek	Fair	2	1	6	12	16	1	38.00	117.33
552009	Cutbank Creek	Fair	3	2	10	12	15	3	45.00	118.50
552012	Cutbank Creek	Fair	4	6	4	13	18	9	54.00	95.00
552014	Egg Creek	Fair	2	1	2	13	15	3	36.00	120.00
552015	Spring Creek	Fair	10	9	5	17	16	7	64.00	107.67
552017	Long Creek	Fair	7	2	4	19	6	13	51.00	124.50
552020	Oak Creek	Fair	2	2	13	15	17	6	55.00	91.67
552023	Ox Creek	Fair	3	3	12	10	11	4	43.00	99.67
552024	Willow Creek	Fair	4	6	7	9	19	6	51.00	109.00
552025	Willow Creek	Fair	4	1	3	6	18	2	34.00	100.17
552027	Ox Creek	Fair	9	6	6	2	16	3	42.00	91.00
552028	Wolf Creek	Fair	6	7	4	9	18	4	48.00	105.50
552030	Boundary Creek	Fair	7	4	10	8	8	6	43.00	131.17

Table E-3. Continued

Storet Number	Stream Name	HDI Rank	AGPSL3	AGCSL3	RAGC30	RNG30	RDDENS	P_LOAD	Landscape Index Score	HDI Score
552033	Souris River	Fair	13	9	2	20	13	7	64.00	114.67
552034	Des Lacs River	Fair	16	10	8	16	10	10	70.00	95.67
552036	Souris River	Fair	13	14	6	18	15	8	74.00	87.33
552040	Souris River	Fair	14	15	2	19	17	9	76.00	100.67
552043	Souris River	Fair	7	1	5	16	5	4	38.00	130.33
554001	James River	Fair	12	17	14	2	3	5	53.00	120.83
554007	Pipestem Creek	Fair	7	15	12	2	11	3	50.00	113.83
554008	James River	Fair	5	10	15	2	13	11	56.00	111.83
554010	James River	Fair	5	16	14	6	13	17	71.00	87.83
554012	James River	Fair	4	3	8	6	15	6	42.00	129.00
554013	Beaver Creek	Fair	6	13	13	4	6	6	48.00	116.50
554015	Bone Hill Creek	Fair	4	15	19	11	17	20	86.00	95.83
554016	Streaman Coulee	Fair	10	13	14	3	13	18	71.00	113.83
554017	Elm River	Fair	6	3	7	4	13	17	50.00	127.83
554020	South Fork Maple River	Fair	5	14	18	5	8	18	68.00	99.83
554021	Maple River	Fair	3	8	15	4	11	20	61.00	113.67
554022	Maple River	Fair	4	15	19	11	10	20	79.00	102.67
554025	Cottonwood Creek	Fair	6	17	19	15	3	20	80.00	104.33
554027	Bear Creek	Fair	9	15	15	14	14	20	87.00	95.00
554028	Bear Creek	Fair	6	7	18	12	14	19	76.00	96.17
554029	Sevenmile Coulee	Fair	10	5	12	2	15	1	45.00	97.00
554030	Sevenmile Coulee	Fair	10	5	12	2	15	1	45.00	118.00
554042	Bone Hill Creek	Fair	10	16	14	13	8	19	80.00	92.83

Table E-4. Landscape Index Scores Calculated Using the Analytical Tools Interface for Landscape Assessments (ATtILA, Version 3.0) for Riffle/Run Stream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Validation, Between-Year Revisit (BY-Revisit) Sites and Within-Year Revisit (WY-Revisit) Sites.

Storet Number	Stream Name	Site Type	HDI Rank	AGPSL3	AGCSL3	RAGC30	RNG30	RDDENS	P_LOAD	Landscape Index Score	HDI Score
554002	Kelly Creek	Validation	Good	11	17	3	1	6	4	42.00	140.00
554014	Beaver Creek	Validation	Poor	10	18	16	13	3	19	79.00	84.67
552018	Oak Creek	Validation	Fair	15	12	1	20	4	5	57.00	110.00
552045	Des Lacs River	Validation	Fair	16	6	7	19	16	11	75.00	88.50
552035	Des Lacs River	Validation	Fair	17	10	12	19	8	11	77.00	90.33
552019	Oak Creek	Validation	Fair	3	2	13	17	10	12	57.00	110.50
552013	Cutbank Creek	Validation	Fair	4	1	3	3	14	4	29.00	100.33
552039	Souris River	Validation	Fair	14	15	2	19	17	9	76.00	100.67
551185	Sheyenne River	BY-Revisit	Fair	9	9	11	5	20	6	60.00	128.00
552001	Oak Creek	BY-Revisit	Fair	7	8	14	11	14	13	67.00	112.17
552004	Wintering River	BY-Revisit	Fair	8	5	2	17	10	7	49.00	118.17
552040	Souris River	BY-Revisit	Fair	15	8	2	16	17	9	67.00	105.67
554007	Pipestem Creek	BY-Revisit	Fair	7	15	12	2	11	3	50.00	113.83
554013	Beaver Creek	BY-Revisit	Fair	6	13	13	4	6	6	48.00	116.50
554020	S. Fork Maple River	BY-Revisit	Fair	5	14	18	5	8	18	68.00	99.83
554021	Maple River	BY-Revisit	Fair	3	8	15	4	11	20	61.00	113.67
554023	Cottonwood Creek	BY-Revisit	Poor	4	11	20	15	16	20	86.00	81.33
551185	Sheyenne River	WY-Revisit	Fair	9	9	11	5	20	6	60.00	128.00
552004	Wintering River	WY-Revisit	Fair	8	5	2	17	10	7	49.00	118.17
554013	Beaver Creek	WY-Revisit	Fair	6	13	13	4	6	6	48.00	116.50
554021	Maple River	WY-Revisit	Fair	3	8	15	4	11	20	61.00	113.67
554031	James River	WY-Revisit	Good	9	4	11	1	7	1	33.00	144.50

Table E-5.Human Disturbance Rankings, Human Disturbance Index Scores and Raw Metrics Used to Calculate the Macroinvertebrate IBI for Glide/Pool Stream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Sites Used in the Metric Development.

Storet Number	Date Collected	HDI Rank	HDI Score	Shan_e	CllctPct	EPTTax	ShredTax	ClmbrTax	ClngrTax	TotalTax
552007	06/10/1997	Good	138.33	1.68	85.05	5.00	2.00	2.00	5.00	18.00
552021	06/24/1997	Good	135.00	2.27	60.24	6.00	5.00	3.00	6.00	25.00
552029	06/25/1997	Good	157.33	1.33	71.46	2.00	2.00	3.00	4.00	19.00
552031	06/26/1997	Good	136.83	2.19	29.21	3.00	4.00	6.00	6.00	30.00
554005	06/24/1998	Good	138.33	2.20	54.70	1.00	4.00	5.00	3.00	28.00
551207	08/30/1995	Poor	90.33	0.89	0.00	2.00	0.00	0.00	2.00	5.00
551215	10/12/1995	Poor	82.67	1.11	0.00	0.00	1.00	2.00	0.00	8.00
551216	10/12/1995	Poor	95.50	0.77	0.00	2.00	1.00	0.00	2.00	8.00
554026	07/28/1998	Poor	91.33	1.80	56.06	1.00	1.00	0.00	4.00	13.00
551167	08/23/1995	Fair	101.00	1.29	0.00	0.00	1.00	2.00	2.00	6.00
551168	08/24/1995	Fair	119.17	2.11	7.55	0.00	2.00	2.00	3.00	15.00
551193	08/15/1995	Fair	115.67	2.17	19.88	0.00	1.00	2.00	4.00	17.00
551194	08/15/1995	Fair	109.00	1.17	40.20	0.00	0.00	0.00	1.00	9.00
551195	08/15/1995	Fair	112.50	1.09	79.55	0.00	1.00	2.00	2.00	10.00
551197	08/16/1995	Fair	116.50	0.61	87.84	0.00	2.00	2.00	2.00	8.00
551198	08/16/1995	Fair	112.67	1.11	68.41	1.00	0.00	1.00	1.00	12.00
551200	08/28/1995	Fair	116.00	1.05	79.34	0.00	2.00	2.00	3.00	17.00
551201	08/28/1995	Fair	129.33	1.08	63.82	1.00	1.00	1.00	2.00	8.00
551202	08/28/1995	Fair	119.67	1.98	19.44	2.00	1.00	2.00	6.00	15.00
551203	08/28/1995	Fair	114.33	0.95	23.03	0.00	2.00	3.00	3.00	9.00
551206	08/30/1995	Fair	125.33	1.79	0.00	3.00	1.00	1.00	3.00	8.00
551210	09/12/1995	Fair	134.00	1.35	0.00	2.00	1.00	0.00	3.00	6.00
551212	09/12/1995	Fair	121.33	0.44	88.80	0.00	1.00	2.00	1.00	6.00
551214	10/12/1995	Fair	114.50	1.73	11.27	3.00	0.00	0.00	5.00	14.00
552010	06/11/1997	Fair	111.17	1.56	81.64	3.00	4.00	4.00	6.00	37.00
552011	06/11/1997	Fair	122.00	1.51	79.89	6.00	7.00	6.00	9.00	40.00
552032	06/26/1997	Fair	131.00	1.75	59.29	5.00	3.00	1.00	4.00	19.00
552044	08/19/1997	Fair	113.67	2.06	26.09	2.00	1.00	3.00	6.00	19.00
552046	08/20/1997	Fair	132.83	2.38	46.70	2.00	2.00	2.00	6.00	23.00

Table E-5. Continued

Storet Number	Date Collected	HDI Rank	HDI Score	Shan_e	CllctPct	EPTTax	ShredTax	ClmbrTax	ClngrTax	TotalTax
552011	08/20/1997	Fair	114.00	0.86	69.59	2.00	3.00	3.00	2.00	17.00
551206	06/24/1998	Fair	112.00	2.51	56.17	3.00	5.00	4.00	4.00	31.00
551210	07/01/1998	Fair	100.33	1.55	23.63	1.00	2.00	1.00	3.00	20.00
551201	07/15/1998	Fair	120.50	2.33	63.61	3.00	2.00	4.00	5.00	30.00
552032	07/15/1998	Fair	120.17	2.67	36.50	3.00	1.00	3.00	7.00	30.00
552046	08/17/1998	Fair	104.50	0.98	6.19	2.00	1.00	1.00	1.00	9.00

Table E-6. Human Disturbance Rankings, Human Disturbance Index Scores and Raw Metrics Used to Calculate the Macroinvertebrate IBI for Glide/Pool Stream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Validation and Between-Year Revisit Sites.

Storet Number	Date Collected	Site Type	HDI Rank	HDI Score	Shan_e	CllctPct	EPTTax	ShredTax	ClmbrTax	ClngrTax	TotalTax
552041	08/18/1997	Validation	Poor	93.33	1.19	75.80	1.00	3.00	3.00	6.00	26.00
552022	06/24/1997	Validation	Good	146.0	1.96	71.11	4.00	4.00	3.00	1.00	25.00
551240	08/21/2002	Validation	Fair	120.5	2.22	68.47	6.00	3.00	3.00	9.00	35.00
551211	09/12/1995	Validation	Fair	124.6	1.81	15.96	0.00	1.00	3.00	2.00	12.00
551208	08/30/1995	Validation	Fair	102.0	0.65	0.00	0.00	1.00	0.00	0.00	2.00
552042	08/18/1997	Validation	Fair	100.6	2.02	29.17	8.00	2.00	0.00	7.00	18.00
551199	08/16/1995	Validation	Fair	95.83	1.22	71.68	0.00	1.00	1.00	5.00	13.00
552005	06/10/1997	Validation	Fair	113.6	1.95	54.44	1.00	0.00	2.00	6.00	22.00
551197	08/16/1995	Revisit	Fair	116.5	1.64	93.71	3.00	1.00	3.00	1.00	19.00
551197	08/16/1995	Revisit	Fair	116.5	0.97	95.07	2.00	0.00	1.00	3.00	13.00
551198	08/16/1995	Revisit	Fair	112.6	0.99	92.57	2.00	0.00	2.00	1.00	18.00
551198	08/16/1995	Revisit	Fair	112.6	1.02	96.74	2.00	0.00	0.00	0.00	10.00
551201	08/28/1995	Revisit	Fair	129.3	1.51	86.44	5.00	0.00	1.00	6.00	17.00
551201	08/28/1995	Revisit	Fair	129.3	2.39	69.41	10.00	1.00	0.00	12.00	25.00
551214	10/12/1995	Revisit	Fair	114.5	1.73	11.27	3.00	0.00	0.00	5.00	14.00
551214	09/17/1996	Revisit	Fair	114.5	2.45	58.87	10.00	0.00	3.00	11.00	24.00
551216	09/18/1996	Revisit	Poor	95.5	0.77	0.00	2.00	1.00	0.00	2.00	8.00
551216	10/23/1995	Revisit	Poor	95.5	2.54	31.00	8.00	0.00	1.00	7.00	23.00
552031	08/12/1998	Revisit	Good	136.8	2.19	29.21	3.00	4.00	6.00	6.00	30.00
552031	10/27/1997	Revisit	Good	156.3	1.25	74.80	1.00	2.00	4.00	3.00	18.00
551215	10/17/1995	Revisit	Poor	82.67	1.11	0.00	0.00	1.00	2.00	0.00	8.00
551215	10/17/1995	Revisit	Poor	82.67	2.33	24.49	3.00	0.00	3.00	4.00	16.00

Table E-7. Human Disturbance Rankings, Human Disturbance Index Scores and Raw Metrics Used to Calculate the Macroinvertebrate IBI for Riffle/Run Stream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Sites Used in the Metric Development.

Storet Number	Date Collected	HDI Rank	HDI Score	BeckBI	TrichPct	PredPct	IntolPct	EPTTax	IntolTax
551210	08/06/1998	Good	134.00	3.00	4.85	7.88	2.42	5.00	1.00
552016	06/23/1997	Good	132.67	2.00	4.52	27.11	1.81	3.00	1.00
552026	06/25/1997	Good	135.83	4.00	5.92	5.92	3.83	8.00	2.00
554003	06/16/1998	Good	142.00	5.00	33.48	3.26	29.13	10.00	1.00
554031	07/29/1998	Good	144.50	6.00	15.58	0.00	13.40	9.00	3.00
552037	07/23/1997	Poor	84.50	1.00	0.29	21.87	0.00	2.00	0.00
552038	07/23/1997	Poor	63.33	1.00	8.96	12.69	0.00	2.00	0.00
554023	07/16/1998	Poor	81.33	1.00	0.32	17.14	0.00	4.00	0.00
554024	07/16/1998	Poor	78.00	0.00	0.00	8.31	0.00	2.00	0.00
554046	07/30/2003	Poor	84.17	2.00	1.59	11.43	0.00	5.00	0.00
551209	08/30/1995	Fair	121.17	0.00	0.32	1.29	0.00	1.00	0.00
551213	09/12/1995	Fair	124.17	2.00	0.00	1.12	0.00	0.00	0.00
552001	06/09/1997	Fair	112.17	4.00	68.21	5.78	10.40	3.00	3.00
552002	06/09/1997	Fair	114.33	3.00	6.05	24.78	38.62	4.00	1.00
552003	06/09/1997	Fair	101.17	2.00	0.29	17.30	23.17	3.00	1.00
552004	06/10/1997	Fair	118.17	2.00	0.00	2.21	0.16	3.00	1.00
552006	06/10/1997	Fair	95.33	3.00	2.71	6.78	2.17	3.00	1.00
552008	06/11/1997	Fair	117.33	4.00	4.21	22.63	3.42	4.00	2.00
552009	06/11/1997	Fair	118.50	1.00	0.32	1.28	0.00	2.00	0.00
552012	06/11/1997	Fair	95.00	1.00	0.00	10.76	0.00	0.00	0.00
552014	06/11/1997	Fair	120.00	3.00	9.84	5.40	4.13	4.00	1.00
552015	06/12/1997	Fair	107.67	6.00	1.28	10.51	4.87	5.00	4.00
552017	06/23/1997	Fair	124.50	2.00	1.35	9.91	0.45	2.00	1.00
552020	06/24/1997	Fair	91.67	4.00	1.91	63.93	4.10	5.00	2.00
552023	06/24/1997	Fair	99.67	3.00	0.60	36.25	2.11	4.00	2.00
552024	06/24/1997	Fair	109.00	3.00	0.59	28.02	23.30	3.00	1.00
552025	06/24/1997	Fair	100.17	3.00	0.00	25.53	6.38	2.00	3.00
552027	06/25/1997	Fair	91.00	2.00	0.96	4.17	0.00	3.00	0.00
552028	06/25/1997	Fair	105.50	5.00	1.62	9.06	2.27	2.00	3.00
552030	06/25/1997	Fair	131.17	6.00	2.02	22.83	11.56	4.00	3.00

Table E-7. Continued

Storet Number	Date Collected	HDI Rank	HDI Score	BeckBI	TrichPct	PredPct	IntolPct	EPTTax	IntolTax
552033	07/22/1997	Fair	114.67	4.00	6.47	2.91	4.21	9.00	3.00
552034	07/24/1997	Fair	95.67	1.00	0.00	24.74	0.00	1.00	0.00
552036	07/23/1997	Fair	87.33	4.00	9.60	12.38	13.00	6.00	2.00
552040	07/24/1997	Fair	100.67	5.00	29.02	2.80	15.03	10.00	3.00
552043	08/18/1997	Fair	130.33	5.00	12.18	3.53	7.05	7.00	3.00
554001	06/15/1998	Fair	120.83	4.00	6.55	11.03	0.69	11.00	2.00
554007	06/24/1998	Fair	113.83	2.00	0.29	11.21	0.00	3.00	0.00
554008	06/25/1998	Fair	111.83	2.00	11.90	3.68	0.00	5.00	0.00
554010	06/30/1998	Fair	87.83	0.00	0.00	42.23	0.00	1.00	0.00
554012	07/01/1998	Fair	129.00	3.00	0.31	31.89	0.31	3.00	1.00
554013	07/14/1998	Fair	116.50	2.00	0.00	4.34	0.00	3.00	0.00
554015	07/14/1998	Fair	95.83	1.00	0.00	13.82	0.00	2.00	0.00
554016	07/14/1998	Fair	113.83	3.00	4.27	5.13	0.00	6.00	0.00
554017	07/15/1998	Fair	127.83	2.00	1.21	21.21	0.00	5.00	0.00
554020	07/15/1998	Fair	99.83	0.00	0.00	13.20	0.00	1.00	0.00
554021	07/15/1998	Fair	113.67	2.00	8.71	2.40	0.00	7.00	0.00
554022	07/16/1998	Fair	102.67	2.00	0.62	11.80	0.00	4.00	0.00
554025	07/16/1998	Fair	104.33	3.00	3.41	1.20	0.00	5.00	0.00
554027	07/28/1998	Fair	95.00	2.00	1.62	14.82	0.54	4.00	1.00
554028	07/28/1998	Fair	96.17	3.00	0.92	9.82	0.00	6.00	0.00
554029	07/29/1998	Fair	97.00	4.00	0.87	0.87	0.58	5.00	1.00
554030	07/29/1998	Fair	118.00	3.00	1.68	1.96	1.12	5.00	1.00
554042	07/29/2003	Fair	92.83	3.00	0.31	6.29	0.31	4.00	1.00

Table E-8. Human Disturbance Rankings, Human Disturbance Index Scores and Raw Metrics Used to Calculate the Macroinvertebrate IBI for Riffle/RunStream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Validation, Between-Year (BY) and Within-Year (WY) Revisit Sites

Storet Number	Date Collected	Site Type	HDI Rank	HDI Score	BeckBI	TrichPct	PredPct	IntolPct	EPTTax	IntolTax
554002	06/15/1998	Validation	Good	140.00	4.00	2.56	13.33	0.26	8.00	1.00
554014	07/14/1998	Validation	Poor	84.67	2.00	0.57	22.51	0.00	4.00	0.00
552018	06/24/1997	Validation	Fair	110.00	3.00	0.65	8.79	0.33	2.00	1.00
552045	08/19/1997	Validation	Fair	88.50	1.00	0.03	0.47	0.00	2.00	0.00
552035	07/23/1997	Validation	Fair	90.33	3.00	1.65	14.88	0.83	4.00	1.00
552019	06/24/1997	Validation	Fair	110.50	3.00	1.18	16.57	2.37	2.00	3.00
552013	06/11/1997	Validation	Fair	100.33	2.00	0.14	0.53	0.11	5.00	2.00
552039	07/24/1997	Validation	Fair	100.67	3.00	33.55	0.66	29.28	6.00	2.00
551185	10/23/1995	BY-Revisit	Fair	128.00	4.00	5.31	3.71	3.98	5.00	2.00
551185	09/16/1996	BY-Revisit	Fair	128.00	12.00	4.76	22.79	15.31	14.00	4.00
552001	08/12/1998	BY-Revisit	Fair	111.67	0.00	3.82	0.64	0.00	2.00	0.00
552001	06/12/1997	BY-Revisit	Fair	112.17	6.00	21.25	8.01	26.48	6.00	3.00
552004	08/12/1998	BY-Revisit	Fair	118.17	2.00	4.69	9.97	0.00	5.00	0.00
552004	06/12/1997	BY-Revisit	Fair	123.17	3.00	1.89	3.15	0.95	5.00	2.00
552040	08/13/1998	BY-Revisit	Fair	105.67	4.00	3.00	4.20	6.01	8.00	2.00
552040	07/24/1997	BY-Revisit	Fair	112.67	5.00	29.02	2.80	15.03	10.00	3.00
554007	08/21/2003	BY-Revisit	Fair	113.83	2.00	0.32	12.99	7.14	3.00	1.00
554007	06/24/1998	BY-Revisit	Fair	114.33	2.00	0.29	11.21	0.00	3.00	0.00
554013	08/11/1999	BY-Revisit	Fair	116.50	1.00	1.31	15.08	0.00	3.00	0.00
554013	07/29/1998	BY-Revisit	Fair	118.50	3.00	6.58	14.94	0.00	7.00	0.00
554020	08/11/1999	BY-Revisit	Fair	99.83	2.00	5.36	17.67	0.00	7.00	0.00
554020	07/15/1998	BY-Revisit	Fair	111.33	0.00	0.00	13.20	0.00	1.00	0.00
554021	08/11/1999	BY-Revisit	Fair	113.67	2.00	27.60	4.22	16.88	6.00	1.00
554021	09/17/1998	BY-Revisit	Fair	120.17	3.00	19.53	6.41	3.79	7.00	1.00
554023	08/11/1999	BY-Revisit	Poor	81.33	3.00	0.64	23.40	0.00	4.00	0.00
554023	07/16/1998	BY-Revisit	Poor	86.83	1.00	0.32	17.14	0.00	4.00	0.00

Table E-8. Continued

Storet Number	Date Collected	Site Type	HDI Rank	HDI Score	BeckBI	TrichPct	PredPct	IntolPct	EPTTax	IntolTax
551185	09/16/1996	WY-Revisit	Fair	128.00	12.00	4.76	22.79	15.31	14.00	4.00
551185	08/26/1996	WY-Revisit	Fair	128.00	14.00	3.94	15.77	13.98	18.00	6.00
552004	06/10/1997	WY-Revisit	Fair	123.17	2.00	0.00	2.21	0.16	3.00	1.00
552004	06/12/1997	WY-Revisit	Fair	123.17	3.00	1.89	3.15	0.95	5.00	2.00
554013	07/14/1998	WY-Revisit	Fair	117.00	2.00	0.00	4.34	0.00	3.00	0.00
554013	07/29/1998	WY-Revisit	Fair	118.50	3.00	6.58	14.94	0.00	7.00	0.00
554021	07/15/1998	WY-Revisit	Fair	120.17	2.00	8.71	2.40	0.00	7.00	0.00
554021	09/17/1998	WY-Revisit	Fair	120.17	3.00	19.53	6.41	3.79	7.00	1.00
554031	07/29/1998	WY-Revisit	Good	144.50	6.00	15.58	0.00	13.40	9.00	3.00
554031	09/16/1998	WY-Revisit	Good	144.50	5.00	22.80	4.74	16.25	6.00	1.00

Table E-9. Individual Metric Scores and IBI Score for the Macroinvertebrate IBI Developed for Glide/Pool Stream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Sites Used in the Metric Development.

Storet Number	HDI Rank	Shan_e	CllctPct	EPTTax	ShredTax	ClmbrTax	ClngrTax	TotalTax	IBI Score
552007	Good	56	97	83	40	33	71	38	60
552021	Good	86	68	100	100	50	86	59	79
552029	Good	38	81	33	40	50	57	41	49
552031	Good	82	33	50	80	100	86	75	72
554005	Good	83	62	17	80	83	43	69	62
551207	Poor	16	0	33	0	0	29	0	11
551215	Poor	27	0	0	20	33	0	6	12
551216	Poor	10	0	33	20	0	29	6	14
554026	Poor	62	64	17	20	0	57	22	34
551167	Fair	36	0	0	20	33	29	0	17
551168	Fair	78	9	0	40	33	43	28	33
551193	Fair	81	23	0	20	33	57	34	35
551194	Fair	30	46	0	0	0	14	9	14
551195	Fair	26	90	0	20	33	29	13	30
551197	Fair	2	100	0	40	33	29	6	30
551198	Fair	27	78	17	0	17	14	19	24
551200	Fair	24	90	0	40	33	43	34	38
551201	Fair	26	72	17	20	17	29	6	27
551202	Fair	72	22	33	20	33	86	28	42
551203	Fair	19	26	0	40	50	43	9	27
551206	Fair	62	0	50	20	17	43	6	28
551210	Fair	39	0	33	20	0	43	0	19
551212	Fair	0	100	0	20	33	14	0	24
551214	Fair	59	13	50	0	0	71	25	31
552010	Fair	50	93	50	80	67	86	97	75
552011	Fair	47	91	100	100	100	100	100	91
552032	Fair	60	67	83	60	17	57	41	55
552044	Fair	76	30	33	20	50	86	41	48
552046	Fair	92	53	33	40	33	86	53	56

Table E-9. Continued

Storet Number	HDI Rank	Shan_e	CllctPct	EPTTax	ShredTax	ClmbrTax	ClngrTax	TotalTax	IBI Score
552011	Fair	14	79	33	60	50	29	34	43
551206	Fair	98	64	50	100	67	57	78	73
551210	Fair	50	27	17	40	17	43	44	34
551201	Fair	89	72	50	40	67	71	75	66
552032	Fair	100	41	50	20	50	100	75	62
552046	Fair	20	7	33	20	17	14	9	17

Table E-10. Individual Metric Scores and IBI Score for the Macroinvertebrate IBI Developed for Glide/Pool Stream Reaches of the Northern Glaciated Plains Ecoregion (46) Within North Dakota for the Validation and Between-Year Revisit Sites.

Storet Number	Date Collected	Site Type	HDI Rank	Shan_e	CllctPct	EPTTax	ShredTax	ClmbrTax	ClngrTax	TotalTax	IBI Score
552041	08/18/1997	Validation	Poor	31	86	17	60	50	86	63	56
552022	06/24/1997	Validation	Good	71	81	67	80	50	14	59	60
551240	08/21/2002	Validation	Fair	84	78	100	60	50	100	91	80
551211	09/12/1995	Validation	Fair	63	18	0	20	50	29	19	28
551208	08/30/1995	Validation	Fair	3	0	0	20	0	0	0	3
552042	08/18/1997	Validation	Fair	74	33	100	40	0	100	38	55
551199	08/16/1995	Validation	Fair	33	81	0	20	17	71	22	35
552005	06/10/1997	Validation	Fair	70	62	17	0	33	86	50	45
551197	08/16/1995	Revisit	Fair	54	100	50	20	50	14	41	47
551197	08/16/1995	Revisit	Fair	20	100	33	0	17	43	22	34
551198	08/16/1995	Revisit	Fair	21	100	33	0	33	14	38	34
551198	08/16/1995	Revisit	Fair	23	100	33	0	0	0	13	24
551201	08/28/1995	Revisit	Fair	47	98	83	0	17	86	34	52
551201	08/28/1995	Revisit	Fair	92	79	100	20	0	100	59	64
551214	10/12/1995	Revisit	Fair	59	13	50	0	0	71	25	31
551214	09/17/1996	Revisit	Fair	95	67	100	0	50	100	56	67
551216	09/18/1996	Revisit	Poor	10	0	33	20	0	29	6	14
551216	10/23/1995	Revisit	Poor	100	35	100	0	17	100	53	58
552031	08/12/1998	Revisit	Good	82	33	50	80	100	86	75	72
552031	10/27/1997	Revisit	Good	34	85	17	40	67	43	38	46
551215	10/17/1995	Revisit	Poor	27	0	0	20	33	0	6	12
551215	10/17/1995	Revisit	Poor	89	28	50	0	50	57	31	44

Table E-11.

Storet Number	HDI Rank	BeckBI	TrichPct	PredPct	IntolPct	EPTTax	IntolTax	IBI Score
551210	Good	50	16	82	10	50	33	40
552016	Good	33	15	30	7	30	33	25
552026	Good	67	20	87	15	80	67	56
554003	Good	83	100	94	100	100	33	85
554031	Good	100	51	100	53	90	100	82
552037	Poor	17	1	44	0	20	0	14
552038	Poor	17	29	69	0	20	0	22
554023	Poor	17	1	56	0	40	0	19
554024	Poor	0	0	80	0	20	0	17
554046	Poor	33	5	72	0	50	0	27
551209	Fair	0	1	99	0	10	0	18
551213	Fair	33	0	100	0	0	0	22
552001	Fair	67	100	87	42	30	100	71
552002	Fair	50	20	36	100	40	33	47
552003	Fair	33	1	56	92	30	33	41
552004	Fair	33	0	97	1	30	33	32
552006	Fair	50	9	85	9	30	33	36
552008	Fair	67	14	42	14	40	67	40
552009	Fair	17	1	99	0	20	0	23
552012	Fair	17	0	74	0	0	0	15
552014	Fair	50	32	88	16	40	33	43
552015	Fair	100	4	74	19	50	100	58
552017	Fair	33	4	76	2	20	33	28
552020	Fair	67	6	0	16	50	67	34
552023	Fair	50	2	5	8	40	67	29
552024	Fair	50	2	27	93	30	33	39
552025	Fair	50	0	34	25	20	100	38
552027	Fair	33	3	92	0	30	0	26
552028	Fair	83	5	78	9	20	100	49
552030	Fair	100	7	41	46	40	100	56

Table E-11. Continued

Storet Number	HDI Rank	BeckBI	TrichPct	PredPct	IntolPct	EPTTax	IntolTax	IBI Score
552033	Fair	67	21	95	17	90	100	65
552034	Fair	17	0	36	0	10	0	10
552036	Fair	67	32	69	52	60	67	58
552040	Fair	83	96	95	60	100	100	89
552043	Fair	83	40	93	28	70	100	69
554001	Fair	67	22	73	3	100	67	55
554007	Fair	33	1	73	0	30	0	23
554008	Fair	33	39	93	0	50	0	36
554010	Fair	0	0	0	0	10	0	2
554012	Fair	50	1	17	1	30	33	22
554013	Fair	33	0	91	0	30	0	26
554015	Fair	17	0	65	0	20	0	17
554016	Fair	50	14	89	0	60	0	36
554017	Fair	33	4	45	0	50	0	22
554020	Fair	0	0	67	0	10	0	13
554021	Fair	33	29	96	0	70	0	38
554022	Fair	33	2	71	0	40	0	24
554025	Fair	50	11	100	0	50	0	35
554027	Fair	33	5	63	2	40	33	29
554028	Fair	50	3	76	0	60	0	32
554029	Fair	67	3	100	2	50	33	43
554030	Fair	50	6	98	4	50	33	40
554042	Fair	50	1	86	1	40	33	35

Table E-12.

Storet Number	Date Collected	Site Type	HDI Rank	BeckBI	TrichPct	PredPct	IntolPct	EPTTax	IntolTax	IBI Score
554002	06/15/1998	Validation	Good	67	8	67	1	80	33	43
554014	07/14/1998	Validation	Poor	33	2	42	0	40	0	20
552018	06/24/1997	Validation	Fair	50	2	79	1	20	33	31
552045	08/19/1997	Validation	Fair	17	0	100	0	20	0	23
552035	07/23/1997	Validation	Fair	50	5	63	3	40	33	32
552019	06/24/1997	Validation	Fair	50	4	58	9	20	100	40
552013	06/11/1997	Validation	Fair	33	0	100	0	50	67	42
552039	07/24/1997	Validation	Fair	50	100	100	100	60	67	79
551185	10/23/1995	BY-Revisit	Fair	67	17	93	16	50	67	52
551185	09/16/1996	BY-Revisit	Fair	100	16	41	61	100	100	70
552001	08/12/1998	BY-Revisit	Fair	0	13	100	0	20	0	22
552001	06/12/1997	BY-Revisit	Fair	100	70	81	100	60	100	85
552004	08/12/1998	BY-Revisit	Fair	33	15	76	0	50	0	29
552004	06/12/1997	BY-Revisit	Fair	50	6	94	4	50	67	45
552040	08/13/1998	BY-Revisit	Fair	67	10	91	24	80	67	56
552040	07/24/1997	BY-Revisit	Fair	83	96	95	60	100	100	89
554007	08/21/2003	BY-Revisit	Fair	33	1	68	29	30	33	32
554007	06/24/1998	BY-Revisit	Fair	33	1	73	0	30	0	23
554013	08/11/1999	BY-Revisit	Fair	17	4	62	0	30	0	19
554013	07/29/1998	BY-Revisit	Fair	50	22	62	0	70	0	34
554020	08/11/1999	BY-Revisit	Fair	33	18	55	0	70	0	29
554020	07/15/1998	BY-Revisit	Fair	0	0	67	0	10	0	13
554021	08/11/1999	BY-Revisit	Fair	33	91	91	67	60	33	63
554021	09/17/1998	BY-Revisit	Fair	50	64	85	15	70	33	53
554023	08/11/1999	BY-Revisit	Poor	50	2	40	0	40	0	22
554023	07/16/1998	BY-Revisit	Poor	17	1	56	0	40	0	19

Table E-8. Continued

Storet Number	Date Collected	Site Type	HDI Rank	BeckBI	TrichPct	PredPct	IntolPct	EPTTax	IntolTax	IBI Score
551185	09/16/1996	WY-Revisit	Fair	100	16	41	61	100	100	70
551185	08/26/1996	WY-Revisit	Fair	100	13	60	56	100	100	71
552004	06/10/1997	WY-Revisit	Fair	33	0	97	1	30	33	32
552004	06/12/1997	WY-Revisit	Fair	50	6	94	4	50	67	45
554013	07/14/1998	WY-Revisit	Fair	33	0	91	0	30	0	26
554013	07/29/1998	WY-Revisit	Fair	50	22	62	0	70	0	34
554021	07/15/1998	WY-Revisit	Fair	33	29	96	0	70	0	38
554021	09/17/1998	WY-Revisit	Fair	50	64	85	15	70	33	53
554031	07/29/1998	WY-Revisit	Good	100	51	100	53	90	100	82
554031	09/16/1998	WY-Revisit	Good	83	75	90	65	60	33	68