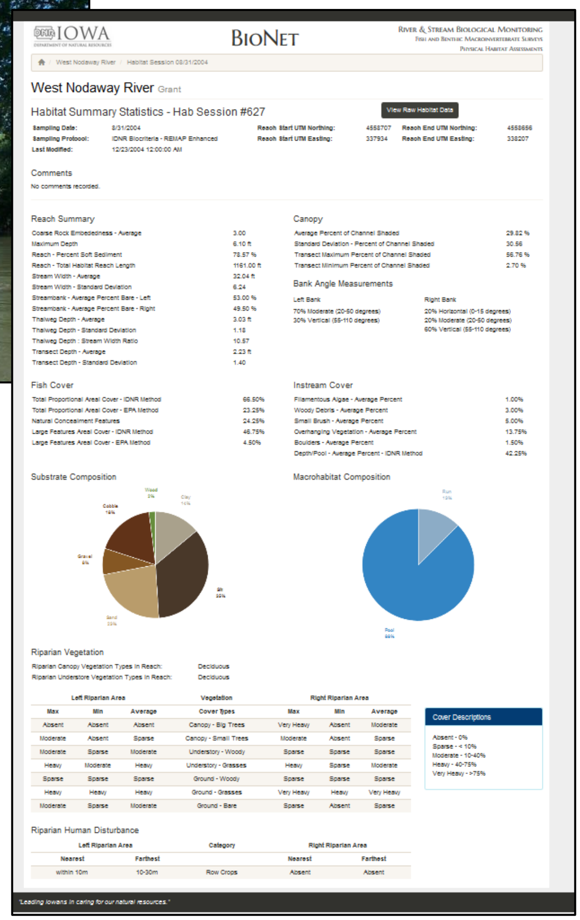
Fish Habitat Indicators for the Assessment of Wadeable, Warmwater Streams



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Summary

Physical habitat characteristics such as stream width and depth, instream cover, and substrate composition are important environmental factors that shape Iowa's stream fish species assemblages. Therefore, habitat data are often collected and used to help interpret stream fish sampling results. The Fish Index of Biotic Integrity (FIBI) is the primary tool used by the Iowa Department of Natural Resources (IDNR) stream biological assessment program to assess fish assemblage health condition and the attainment status of designated aquatic life uses. Until now, however, the bioassessment program lacked a quantitative habitat index that was correlated with the FIBI and could be calculated easily from habitat data generated by the sampling protocol.

To explore the possibility of a creating a new stream habitat index, a statistical analysis was performed using bioassessment sampling data collected between 1994 and 2011. The dataset included 522 matched sets of FIBI and physical sampling results from 311 stream sites across Iowa. The data were randomly subdivided to create calibration and validation datasets. Each dataset included sites representing least disturbed reference conditions and sites chosen for various other reasons, such as probabilistic (random) sampling or impaired stream investigation.

Relationships between the FIBI and sixty-two physical habitat metrics were examined by correlation analysis. The metrics represent several categories of habitat: bank condition, canopy coverage (shade), channel dimensions, macrohabitat (bedform), instream cover, and bottom substrate composition. Among the categories, substrate metrics were correlated most strongly with the FIBI; however, even the strongest correlations explained only about 25% of the variation in FIBI scores. A new composite metric, Percentage of Suboptimal Habitat Metrics (PctSubOpt), was among the most strongly correlated metrics. To calculate PctSubOpt, data for twenty-five individual habitat metrics are compared against suboptimal thresholds that were identified through graphical and quantitative analysis.

Multiple linear regression analysis was used to develop regression equations that serve as the basis for calculating the General Fish Habitat Index (GFHI) and the Ecoregion Fish Habitat Index (EFHI). The regression equations were chosen for their ability to maximize the amount of variability in FIBI scores predicted using the fewest habitat metrics. The GFHI includes five habitat metrics and can be considered a general index of fish habitat quality that applies to wadeable, warmwater streams throughout Iowa. It uses the same qualitative categories and scoring criteria as the FIBI (i.e., Poor, 0-25; Fair, 26-50, Good, 51-70, Excellent, 71-100).

The Ecoregion Fish Habitat Index (EFHI) includes seven habitat metrics and four categorical ecoregion variables. Ecoregions are defined by patterns in surficial geology, land use, hydrology, soils, and other environmental factors that shape the biological, chemical, and physical characteristics of streams. The inclusion of ecoregion variables in regression models increased the amount of explained variance in FIBI scores by an average of 13% over models that did not contain them.

Like the GFHI, the scoring range of the EFHI is also 0-100. Guidelines for interpreting the difference of the observed (sampled) FIBI score and the EFHI (predicted-FIBI) score are provided for the purpose of assessing the likelihood that stream factors besides physical habitat (e.g., water quality) have significantly impacted (either positively or negatively) the condition of the fish assemblage at a given site. The efficacy of these guidelines should be further evaluated using recent data collected after this study was completed.

Multiple linear regression analysis was conducted to examine relationships of habitat metrics and the FIBI within individual ecoregions. The results generally agreed with the statewide analysis results in that substrate metrics were found to be the best overall predictors of FIBI scores among sites located in the same ecoregion. The results also did not indicate that development of individual ecoregion-specific regression models would increase the

accuracy of FIBI predictions over that achieved by the EFHI model. Data availability for some of the ecoregions was fairly limited, so it might be worthwhile to repeat the analysis after additional sampling data become available.

Relationships between stream flow characteristics, habitat conditions, and the FIBI were also explored. Three readily-available flow metrics were used in the analysis: a) average current velocity; b) discharge (flow); c) watershed area: flow ratio. Stream flow metrics were correlated most strongly with habitat metrics representing channel dimensions and macrohabitat proportional abundance (i.e., % glide/pool, %riffle, %run). The metrics were weakly correlated with FIBI levels. Current velocity and discharge (Q) thresholds below which optimal levels of the FIBI are not likely to occur were identified. Preliminary guidelines for evaluating whether fish and habitat data were collected under unusually high or low stream flow conditions have been suggested.

The quantitative indexes and interpretative guidelines developed in this study should be useful in specific applications of the stream bioassessment program. These tools might also be useful for other management purposes such as stream habitat improvement prioritization and goal setting. For these other purposes, it would seem necessary to consider a broader suite of assessment indicators since local habitat conditions are known to be hierarchically related to a host of landscape and hydrological characteristics and processes.

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Introduction

Stream physical habitat characteristics play a key role in shaping fish species assemblages in Iowa's rivers and streams (Heitke et al. 2006; Pierce et al., 2013; Rowe et al. 2009a; Sindt et al. 2012; Wilton 2004). Within this report, the term "habitat" is used exclusively in reference to the physical aspects of stream habitat such as stream bank condition, channel dimension, instream cover, and substrate composition. In some studies, physico-chemical water quality parameters (e.g., dissolved oxygen and water temperature) have been described as habitat parameters, however, in this study they were not included as such.

The IDNR stream bioassessment sampling protocol (IDNR 2015) includes standardized methods for collecting habitat data from a designated stream sampling reach. The raw habitat data are entered into the BioNet database where a series of summary metrics are calculated. The habitat metrics are often used to provide insight for the interpretation of Fish Index of Biotic Integrity (FIBI) sampling results. The FIBI is a composite index comprised of eleven individual metrics that each quantify a different characteristic of the fish assemblage, such as the number of sensitive fish species or the proportional abundance of omnivorous fish. The IDNR biological assessment program uses the FIBI extensively to monitor stream biological condition and as a basis for determining the support status of designated aquatic life uses.

The goal of this project was to create a new quantitative habitat index from data routinely collected for stream bioassessment purposes. A habitat index that is correlated with the FIBI could be useful for assessing the degree to which stream fish assemblages reflect habitat conditions. More specifically, the index could be used to evaluate which if any habitat characteristics limit the FIBI score and attainment of designated aquatic life uses in a given segment of stream. Such a determination would be useful for appropriately assigning causes and sources of use impairment and establishing meaningful stream restoration goals.

Methods

Sampling Procedures

Fish and habitat sampling data used in the analysis were collected for the IDNR stream bioassessment project using standardized procedures (IDNR 2015). The habitat procedures were first implemented in 1994 and have largely remained constant since then. The method used to record instream cover observations was revised in 2003 to match the method used in the Environmental Monitoring and Assessment Program (EMAP) (USEPA 2007). Because this change had a significant impact on the quantification of instream cover parameters, the pre- and post-change instream habitat data were analyzed separately.

The IDNR habitat sampling procedures were developed to be used in wadeable streams. The protocol involves collecting habitat data at ten cross-sectional transects in the designated sampling reach. Additional measurements and observations are recorded along a longitudinal transect running the length of the sampling reach. The following general types of habitat parameters are measured or observed: stream dimensions, bottom substrate composition, instream cover, channel bedform features, bank condition, and riparian land use and vegetation. A series of habitat summary metrics representing the sampling reach as a whole are calculated from the individual habitat measurements and observations.

Bioassessment fish assemblage sampling methods have not changed significantly since 1994. Fish are sampled using direct current (DC) electrofishing gear. A single battery powered, backpack shocker is used in small streams of average width less than fifteen feet. In wide and shallow streams, two or three backpack shockers are operated side-by-side to obtain adequate coverage. A tow-barge electrofishing unit is used to sample large wadeable streams that require more power output to obtain a representative sample of fish. The electrofishing unit consists of a six-foot fiberglass tow-boat equipped with live well, generator, electrical control box, and two or three retractable, reel-mounted electrodes.

Block nets are set across the stream at the downstream and upstream reach boundaries to prevent large mobile fish such as suckers (Catostomidae) from escaping the sampling area. Block nets are not required in streams where shallow riffles serve as barriers to fish movement. Fish sampling is accomplished proceeding from downstream to upstream in a single pass through the designated sampling reach. All accessible types of fish habitat such as pools, riffles, woody debris snags, and undercut banks are methodically shocked in an effort to obtain a representative sample of fish. Stunned fish are collected using 3/16" mesh-diameter landing nets and transferred into plastic buckets or a live well for processing on-site. Fish are identified, counted, and examined for external physical abnormalities before being released back to the stream. Juvenile fish smaller than 25 mm in total length are excluded from the sample. Fish are identified to species whenever possible. Specimens that cannot be identified to species in the field are preserved in 10% formalin solution and subsequently identified in the laboratory using magnification and published taxonomic keys. For quality control purposes, voucher specimens of small-bodied fish species are collected at each sample site. Fish taxonomic experts are periodically used to identify and confirm specimens of rare or problematic species. A reference collection of Iowa stream fishes is maintained as a resource for the IDNR stream biological assessment project.

Data Organization

Habitat and FIBI data used in the analysis were downloaded from BioNet, the internet portal for sampling data and summary information collected using the protocols of the Stream Biological Monitoring and Assessment Program. The data were then imported into Microsoft Access where the habitat summary metric data were matched with FIBI metric data prior to performing statistical analysis.

Prior to the analysis, it was decided that only habitat data and FIBI data collected on the same date and from the same site would be analyzed in order to reduce the potential influences of spatial or temporal sampling variability. It was reasoned that fish and habitat data collected on the same date would more accurately portray relationships between habitat metrics and FIBI metrics than would data collected on different dates or averaged across multiple sampling dates. The IDNR bioassessment procedure of comparing individual FIBI results to the applicable biological assessment criterion (BIC) instead of a comparison using averaged FIBI results was an additional consideration.

At the time the project was initiated, quality verified data from 1994-2011 were available for model development and calibration. Data selection criteria were applied to limit the analysis to sample data collected during the July 15 - October 15 bioassessment index period from wadeable warmwater streams (watershed area 10-700 square miles). The number of date-matched fish and habitat samples collected per site ranged from 1–7. Approximately 40% of the sites had two or more matched samples.

The selection criteria resulted in a master dataset consisting of 522 matched samples collected from 311 sites (Figure 1). The master dataset was subdivided to create calibration and validation datasets. These datasets are referred to as the "all-site" calibration and validation datasets because they include both least disturbed reference sites and survey sites that are chosen for various purposes. A number was assigned randomly to each site using the random number generator in Excel. The sites were then sorted from lowest to highest number. The first 90% of the sites were assigned to the all-site calibration dataset and the last 10% of the sites were assigned to the all-site validation dataset. The all-site calibration dataset included 461 matched samples from 280 sites, and the all-site validation dataset included 61 matched samples from 31 sites.

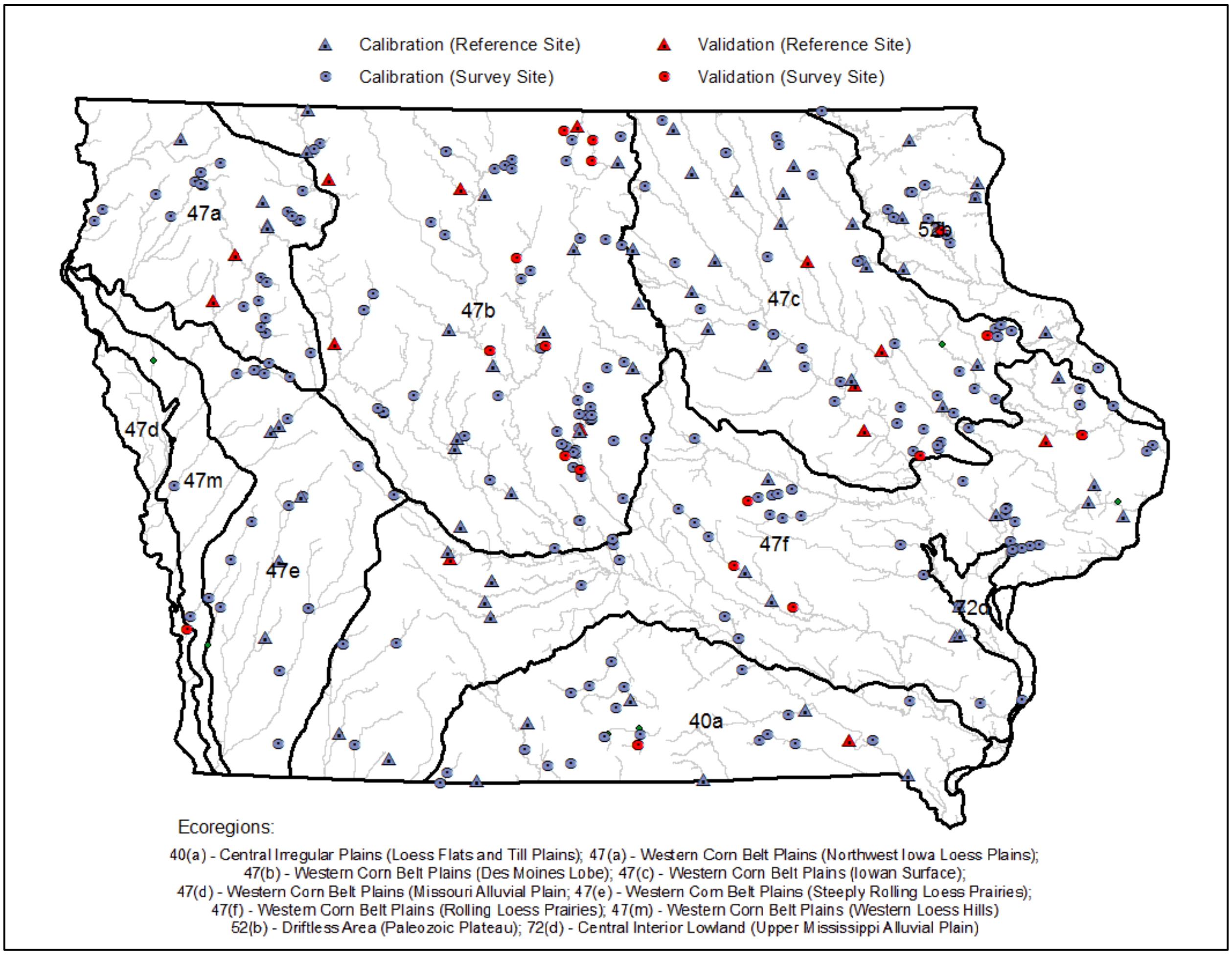


Figure 1. Locations of reference sites and survey sites included in the habitat index calibration and validation data sets.

The all-site calibration dataset was further subdivided into a reference site only calibration dataset to better explore FIBI and habitat relationships among sites representing stream habitats least disturbed by human influences. The reference calibration dataset included 218 samples from 83 sites. To examine relationships between instream cover metrics obtained using the current method implemented in 2003, the all-site calibration dataset was further subdivided to include only sampling data collected from 2003-2011.

Additional data from 24 sampling events in 2012 became available after the exploratory habitat model analysis was completed; these data were added to the validation dataset and used to evaluate the performance of alternative habitat models.

Data Analysis

Data analysis was performed in the statistical analysis software applications, Minitab® Release 16 (Minitab Inc. 2009) and *Statistix®* Version 1 (Analytical Software 1996). Fifty-one habitat summary metrics stored in BioNet plus ten additional metrics subsequently calculated in Excel (Table 1) were included in the analysis. One of the calculated metrics, percent suboptimal habitat metrics (PctSubOpt) is a composite habitat metric that is described in *Results and Discussion*.

Table 1. BioNet database habitat summary metrics and spreadsheet calculated habitat metrics included in the exploratory data analysis. (* indicates significant linear relationship with FIBI; p<0.05)

Category	BioNet Variable	Abbrv.		Category	Spreadsheet calculated variables	Abbrv.	
Bank	% Horizontal (0-15 degrees)	bnkahz%		Composite	Percent suboptimum habitat variables	pctsubopt	*
Bank	% Moderate (20-50 degrees)	bnkamd%		Dimension	Transect depth coefficient of variation	dpthcv	
Bank	% Undercut (115-180 degrees)	bnkauc%		Dimension	Transect depth + std.dev.	dpthsum	
Bank	% Vertical (55-110 degrees)	bnkavr%		Dimension	Stream Width coefficient of variation	strwdtcv	
Bank	Streambank - Average Percent Bare	bnkbare%	*	Dimension	Thalweg depth coefficient of variation	thwgdpcv	*
Canopy/Shade	Average Percent of Channel Shaded	chshdav%		Dimension	Thalweg depth + std.dev.	thwgdpsm	*
Canopy/Shade	Transect Minimum Percent of Channel Shaded	chshdmn%	*	Macrohabitat	Maximum macrohabitat type proportion	rchmxhb%	*
Canopy/Shade	Transect Maximum Percent of Channel Shaded	chshdmx%		Substrate	Clay+Silt+Sand	subfines%	*
Canopy/Shade	Standard Deviation - Percent of Channel Shaded	chshdsd%	*	Substrate	Cbbl+Bldr	sublgrk%	*
Dimension	Transect Depth - Average	dpthav		Substrate	Grvl+Cbbl+Bldr	subrock%	*
Dimension	Transect Depth - Standard Deviation	dpthsd		Substrate	Maximum substrate type proportion	substrmx%	*
Dimension	Maximum Depth	maxdep	*				
Dimension	Stream Width - Average	strwdtav	*				
Dimension	Stream Width - Standard Deviation	strwdtsd	*				
Dimension	Thalweg Depth - Average	thwgdpav	*				
Dimension	Thalweg Depth - Standard Deviation	thwgdpsd	*				
Dimension	Thalweg Depth : Stream Width Ratio	thwgwdr					
Instream Cover	Artificial Structure - Average Percent	cvrartf%					
Instream Cover	Boulders - Average Percent	cvrbldr%	*				
Instream Cover	Total Proportional Areal Cover - IDNR Method	cvrdnr%					
Instream Cover	Depth/Pool - Average Percent - IDNR Method	cvrdpl%					
Instream Cover	Total Proportional Areal Cover - EPA Method	cvrepa%	*				
Instream Cover	Filamentous Algae - Average Percent	cvrflma%					
Instream Cover	Large Features Areal Cover - IDNR Method	cvrlgdn%					
Instream Cover	Large Features Areal Cover - EPA Method	cvrlgep%					
Instream Cover	Macrophytes - Average Percent	cvrmacr%					
Instream Cover	Natural Concealment Features	cvrnatrl%	*				
Instream Cover	Overhanging Vegetation - Average Percent	cvrovhg%					
Instream Cover	Small Brush - Average Percent	cvrsbrsh%					
Instream Cover	Trees/Roots - Average Percent	cvrtrrt%					
Instream Cover	Undercut Banks - Average Percent	cvrucbk%					
Instream Cover	Woody Debris - Average Percent	cvrwdbrs%					
Instream Cover	Instream Cover - (Legacy) - Average Percent	lgcycvr%					
Instream Cover	Large Woody Debris - (Legacy) - Average Percent Occurrence	lrgwdy%					
Macrohabitat	Pool	rchpool%					
Macrohabitat	Riffle	rchrffl%	*				
Macrohabitat	Run	rchrun%					
Substrate	Coarse Rock Embededness - Average	embdrtg					
Substrate	Reach - Percent Soft Sediment	sfsdtwg%					
Substrate	Bedrock	subbdrk%					
Substrate	Boulder	subbldr%	*				
Substrate	Cobble	subcbbl%	*				
Substrate	Clay	subclay%	*				
Substrate	Detritus/Muck	subdemu%					
Substrate	Gravel	subgrvl%	*				
Substrate	Other	subothr%					
Substrate	Rip-Rap	subrrap%					
Substrate	Sand	subsand%	*				
Substrate	Silt	subsilt%	*				
Substrate	Soil	subsoil%					
Substrate	Wood	subwood%					

Exploratory data analysis was conducted in which relationships between physical habitat metrics and the Fish Index of Biotic Integrity (FIBI) were visually examined. Bivariate scatter plots comprised of a habitat variable on the x-axis and the FIBI or a component metric score on the y-axis were prepared and examined for relationship patterns. Particular attention was paid to whether a linear relationship pattern was evident, or whether some other type of pattern or trend was visually apparent. For example, Cade and Noun (2003) have described the occurrence of a linear trend formed by the upper edge of the plotted data (e.g., 95% percentile) as potentially representing the limiting effect of an independent variable (e.g., habitat metric value) over a dependent variable (e.g., FIBI score).

Correlation analysis was performed on all combinations of habitat metrics and the FIBI. In addition to the Pearson (parametric) correlation method, the Spearman (nonparametric) rank correlation method was used because most of the habitat metrics did not display a normal, symmetrical distribution. Many of the habitat metrics are expressed as a percentage and have truncated distributions at 0% or 100%. Additionally, the data distribution of several metrics was skewed in a positive direction. A square root transformation was performed, and for many metrics the transformed data was closer to being normally distributed. Habitat metrics (transformed or non-transformed) that were significantly correlated ($p \leq 0.05$) with the FIBI are noted in Table 1.

Stepwise multiple linear regression analysis was used to identify combinations of habitat metrics that explained significant amounts of variability in FIBI scores, and to evaluate whether or not regression modeling was a viable approach for creating a new habitat index. Stepwise (forward and backward) regression involves building alternative regression models by adding or subtracting variables in succession according to pre-specified criteria. to determine the specific combinations of habitat metrics that are best able to predict FIBI levels efficiently using the fewest variables.

Eleven habitat sampling events from 1994 had to be excluded from the stepwise regression analysis because data for several habitat metrics was unavailable. Stepwise regression analysis was conducted in 16 modeling runs determined by combinations of the following dichotomous data inclusion criteria:

1. Monitoring period (1995-2011 or 2003-2011)
2. Sample site type (all types or reference sites only)
3. Ecoregion effect (included or excluded)
4. Percent suboptimal habitat variable (included or excluded)

Stepwise regression is an effective analysis method of maximizing model predictive strength and efficiency. The regression algorithm sequentially builds increasingly more powerful models by adding or subtracting predictor variables according to specified variable selection criteria. For the initial exploratory regression analysis, a significance level of < 0.10 was required for a predictor variable to enter the model and to be retained in the model with the addition of successive variables. The significance level criterion is needed to exclude variables which have low predictive power and do not contribute significantly to the overall strength of the model. Only variables for which there is a reasonably high certainty (i.e., > 90%) that the predictor variable explains a significant amount of variation in the FIBI are retained in the model.

The regression analysis output lists the total amount of variability in FIBI scores explained by each alternative model (r^2) as well as the total adjusted for the number of predictor variables in the model (*adjusted* r^2). The output also lists the Mallows *Cp* statistic, which is an indicator of model precision and *s*, the standard deviation of the error term in the model. Stepwise regression analysis often produces several reasonable model alternatives. Generally, the preferred model will maximize r^2 and adjusted r^2, while minimizing Mallows *Cp* and *s*. Factors such as signal duplicity, co-correlation, and other practical considerations should also be weighed in the model selection process. For example, the percentage of fine substrates (clay, silt, sand) is highly (inversely) correlated with the percentage of coarse substrates (gravel, cobble, boulder). Both metrics represent the relative dominance of fine and coarse substrates at a sampling location. The fish assemblage response to both metrics is similar since both describe the same condition from opposite perspectives (i.e., high levels of fine sediments usually correspond with low levels of course substrates and vice versa). Therefore the metrics are duplicative and including both in the regression model is inefficient.

Output from each of the 16 modeling runs was examined using a variety of techniques to evaluate model performance and fitness. Model performance was evaluated using the approach described above. Final model selection was done using a significance level of < 0.05 to include only the variables that were most likely to contribute significantly to model strength. The "best" model was the one in which the *adjusted* r^2 value was as close to the maximum level and the model was comprised of only variables meeting the significance level criterion. Model fitness was further evaluated by examining the regression residuals to see if they were normally distributed and how the residuals were distributed in relation to fitted and observed FIBI values. Variance inflation statistics were obtained and evaluated for collinearity in model variables. The data subsetting lack of fit test in *Minitab* was used to examine for significant curvature in linear regression models of interest.

Results and Discussion

Exploratory Analysis

The initial visual examination of relationship patterns and subsequent correlation analysis revealed statistically significant, yet relatively weak linear relationships between several habitat metrics and the FIBI (e.g., Figure 2). A linear relationship pattern with the FIBI was not observed for most of the habitat metrics. Instead, more subtle patterns were observed involving the lower and/or upper ranges of several habitat metrics. For many habitat metrics, there appeared to be a broad (suitable) range in levels in which FIBI levels rated as "excellent" were observed and other (suboptimal) data regions where "excellent" FIBI ratings were not found (e.g., Figure 3).

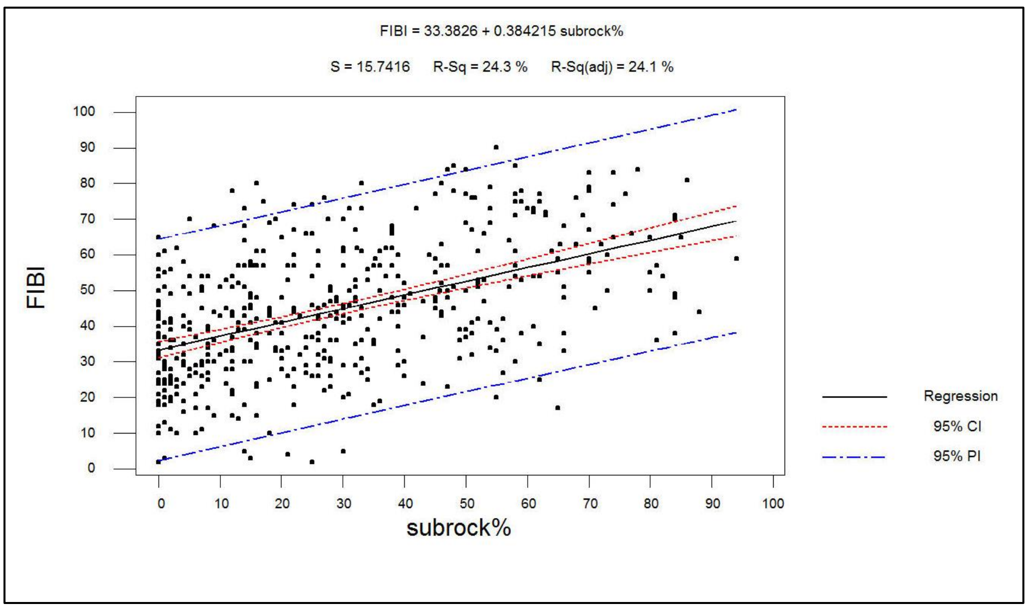


Figure 2. Least-square linear regression of total rock substrate (%gravel+%cobble+%boulder) and Fish Index of Biotic Integrity (FIBI). All site calibration dataset (1994-2011).

A new composite habitat metric, percent suboptimal habitat metrics (*pctsubopt*), was created to explore the usefulness of the apparent data patterns and thresholds. Each of the habitat metrics was examined graphically and the range of habitat metric data associated with the occurrence of FIBI scores > 71 (excellent) was identified (Figure 3). The data region(s) outside of the suitable range was defined as "suboptimal" provided each region was represented by at least 5% of the data points. Suboptimal thresholds for twenty-five habitat metrics were determined in this manner (Table 2).

Once the suitable and suboptimal ranges were obtained, habitat data from each sampling visit represented in the calibration dataset were compared to applicable thresholds. A value of one was assigned when the value fell outside of the suitable range (suboptimal) and zero if the value was in the suitable range. The assigned values were then summed and divided by the total number of metrics to obtain the percentage of habitat metrics rated as suboptimal. Pctsubopt ranged from 0% - 55% with an average of 11.6% among the 522 cases included in the calibration and validation datasets.

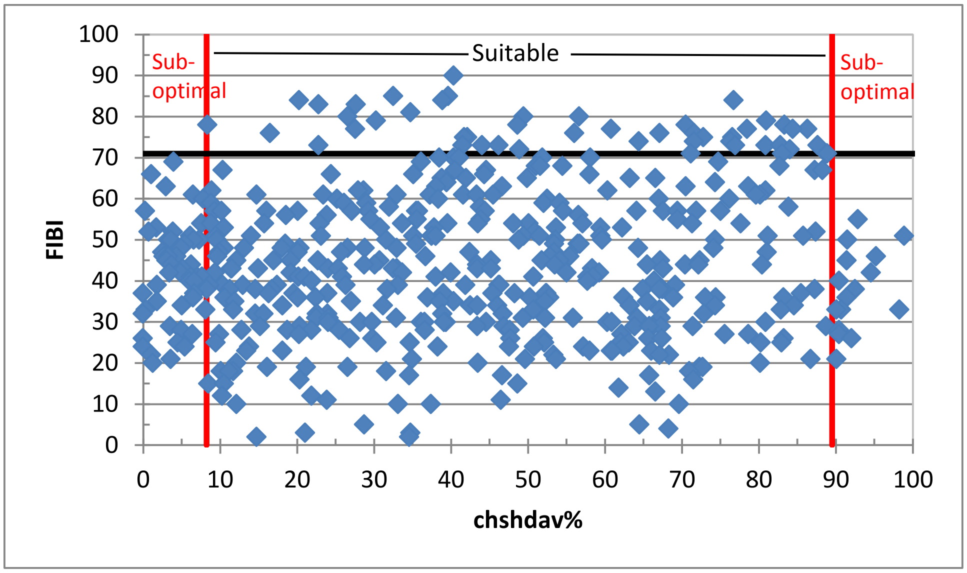


Figure 3. Average % stream channel shaded (chshdav%) vs. FIBI. All site calibration dataset (1994-2011). The black line indicates the lower boundary of FIBI scores considered as "excellent." The red lines indicate the lower and upper boundaries of chshdav% between which "excellent" FIBI scores were observed, thus defining the "suitable" and "suboptimal" data regions.

Table 2. Individual habitat metrics included in the composite metric, percentage of suboptimal habitat metrics (*PctSubOpt*), and the corresponding habitat ranges suitable for achieving "excellent" FIBI scores.

Category	Description	Abbrv.	Suitable Range
Bank	% Horizontal (0-15 degrees)	bnkahz%	<=65
Bank	% Moderate (20-50 degrees)	bnkamd%	>=20
Bank	% Vertical (55-110 degrees)	bnkavr%	<=40
Bank	Streambank - Average Percent Bare	bnkbare%	17.5-93.5
Canopy/Shade	Average Percent of Channel Shaded	chshdav%	8.8-88.9
Canopy/Shade	Standard Deviation - Percent of Channel Shaded	chshdsd%	>=10.4
Dimension	Transect Depth - Average	dpthav	<=1.4
Dimension	Transect Depth - Standard Deviation	dpthcv	>=0.46
Dimension	Maximum Depth	maxdep	>=1.65
Dimension	Stream Width - Average	strwdtav	>=13.7
Dimension	Stream Width - Standard Deviation	strwdtsd	>=3.41
Dimension	Thalweg Depth - Average	thwgdpav	>=0.56
Dimension	Thalweg Depth : Stream Width Ratio	thwgwdr	10.4-54.0
Instream Cover	Depth/Pool - Average Percent - IDNR Method	cvrdpl%	<=20.25
Instream Cover	Total Proportional Areal Cover - EPA Method	cvrepa%	>=13.5
Instream Cover	Overhanging Vegetation - Average Percent	cvrovhg%	<=10.5
Instream Cover	Woody Debris - Average Percent	cvrwdbrs%	<=13.5
Macrohabitat	Maximum macrohabitat type proportion	rchmxhb%	<89.3
Macrohabitat	Pool	rchpool%	5.4-83.9
Substrate	Coarse Rock Embededness - Average	embdrtg	<=3.33
Substrate	Clay	subclay%	<=16
Substrate	Clay+Silt+Sand	subfines%	<=84
Substrate	Grvl+Cbbl+Bldr	subrock%	>=12
Substrate	Silt	subsilt%	<=38
Substrate	Maximum substrate type proportion	substrmx	<=82

Simple linear regression analysis results show that the *pctsubopt* composite habitat metric explained 21% of the variation in FIBI scores (Figure 4). This was the highest level of variability explained by a habitat metric besides the percent rock substrate metric (24%). Based on this finding, it was decided that pctsubopt was a potentially useful predictor variable and should be included in the stepwise multiple regression analysis.

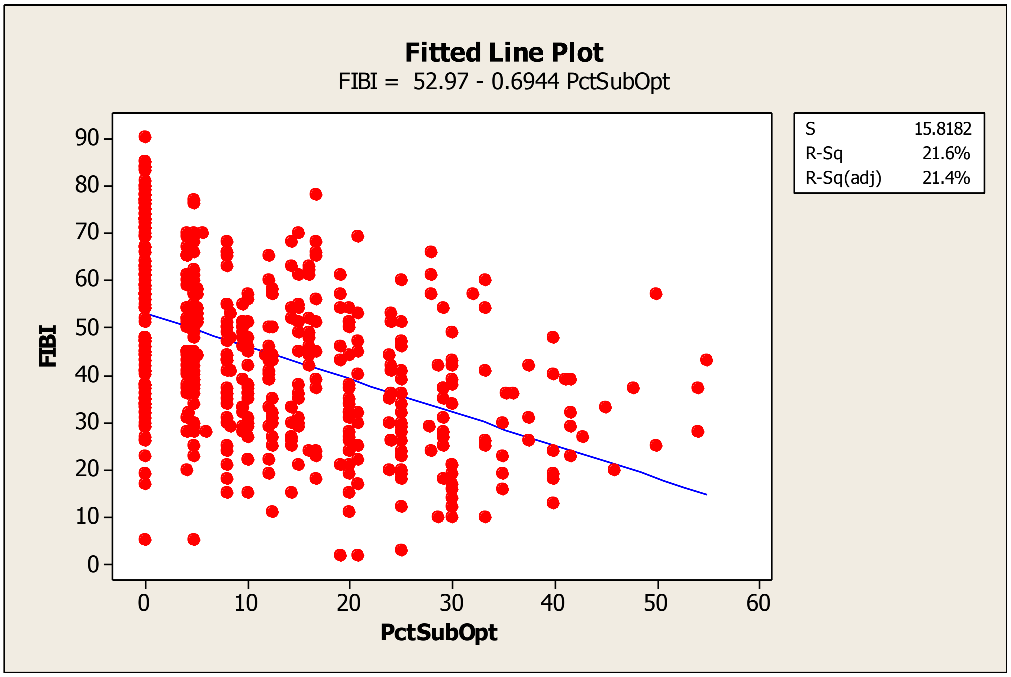


Figure 4. Least-square linear regression of percentage of suboptimal habitat metrics (PctSubOpt) versus Fish IBI. All site calibration and validation datasets (1994-2011).

Table 3 contains a summary of the preferred models selected from the 16 regression analysis runs that were described earlier. The models explained a substantial proportion of the variation in FIBI scores (34.8%–57.9%). A total of 23 habitat metrics and six ecoregion variables were included in at least one regression model. The number of variables included in any individual model ranged from 5-15.

The number of habitat metrics chosen by category was: bottom substrate (8 metrics), channel dimension (4), canopy/shade (3), streambank (3), instream cover (2), macrohabitat (2), and composite habitat metric (1). Similar results were reported by Rowe et al. (2009a) with respect to the prominence of substrate metrics. In that study of habitat and fish assemblage relationships in Iowa wadeable streams, 40% of the total number of habitat metrics included in regression models were substrate metrics compared with 35% (8 of 23) in this study.

Among individual metrics, the percentage rock substrate (subrock%) metric was included in 100% of the models. Other habitat metrics that were included in the majority of models were: strwdtav (88%), cvrdpl% (75%), chshdsd% (69%), and subclay% (56%) (*see Table 1 for abbreviations*).

Among the categorical ecoregion variables, ecoregion 47c was selected in 100% of the preferred models that included ecoregion variables in the stepwise regression analysis. Ecoregions 47(b) and 47(e) were also included in the majority of preferred models (75% and 63%, respectively).

The preferred models from the 16 regression analysis runs displayed differences in predictive ability as indicated by the amount of FIBI variation explained by the various regression models and the variables included in them. The largest difference is attributable to whether ecoregion variables were included in the model. Among the eight models that included ecoregion variables, the median percentage of FIBI variation explained was 52.1%, compared with a median of 39.2% among models including habitat metrics only. The Kruskal-Wallis nonparametric analysis of variance test (KWAOV) confirmed that models including ecoregion variables explained a significantly greater amount of variation in FIBI levels than models including habitat metrics only (p=0.001).

Table 3. Data included in each of 16 stepwise multiple linear regression analysis runs; % FIBI variation explained and habitat metrics (*see Table 1 for abbrev.*) included in each preferred regression model.

Model	No. Cases (n)	Total No. Vrbs.	Data	Pctsubopt?	Ecoregion Varbs?	Preferred Model, % FIBI Variance	No. Model Varbs.	Variables
1	206	56	Clbr '03-'11	N	N	38.2	5	subrock%, strwdtav, rchrffl%, subcbbl%, subclay%
2	206	63	Clbr '03-'11	N	Y	50.5	8	subrock%, e47c, e47e, e40a, strwdtav, subsoil%, cvrdpl%, rchrffl%
3	206	57	Clbr '03-'11	Y	N	41.1	6	subrock%, strwdtav, rchrffl%, pctsubopt, bnkbare%, sublgrk%
4	206	64	Clbr '03-'11	Y	Y	50.5	8	subrock%, e47c, e47e, e40a, strwdtav, subsoil%, cvrdpl%, rchrffl%
5	450	40	Clbr '95-'11	N	N	34.8	8	subrock%, subclay%, strwdtav, chshdsd%, bnkbare%, bnkahz%, thwgwdr, thwgdpav
6	450	47	Clbr '95-'11	N	Y	50.9	15	subrock%, e47c, e52b, e47b, strwdtav, e47f, bnkavr%, bnkbare%, subsilt%, bnkahz%, chshdsd%, chshdmx%, chshdav%, thwgwdr, thwgdpav
7	450	41	Clbr '95-'11	Y	N	36.2	6	subrock%, subclay%, pctsubopt, bnkbare%, strwdtav, chshdsd%
8	450	48	Clbr '95-'11	Y	Y	50.3	10	subrock%, e47c, pctsubopt, e52b, bnkbare%, e47e, strwdtav, e47b, bnkavr%, rchrun%
9	97	57	Ref '03-'11	N	N	44.2	7	subrock%, subclay%, cvrtrrt%, cvrdpl%, strwdtav, subcbbl%, chshdsd%
10	97	64	Ref '03-'11	N	Y	57.9	8	subrock%, e47c, e47b, e52b, cvrdpl%, subclay%, e47f, chshdsd%
11	97	58	Ref '03-'11	Y	N	44.2	7	subrock%, subclay%, cvrtrrt%, cvrdpl%, strwdtav, subcbbl%, chshdsd%
12	97	65	Ref '03-'11	Y	Y	57.9	8	subrock%, e47c, e47b, e52b, cvrdpl%, subclay%, e47f, chshdsd%
13	209	40	Ref '95-'11	N	N	39.2	6	subrock%, chshdsd%, subclay%, dpthav, subbdrk%, strwdtav
14	209	47	Ref '95-'11	N	Y	53.3	11	subrock%, e47c, e47b, chshdsd%, e47e, dpthav, strwdtav, subrrap%, subbdrk%, bnkbare%, bnkavr%
15	209	41	Ref '95-'11	Y	N	39.2	6	subrock%, chshdsd%, subclay%, dpthav, subbdrk%, strwdtav
16	209	48	Ref '95-'11	Y	Y	53.3	11	subrock%, e47c, e47b, chshdsd%, e47e, dpthav, strwdtav, subrrap%, subbdrk%, bnkbare%, bnkavr%

Besides ecoregion, no clear differences were observed in model performance. There was a tendency for reference dataset regression models to rank higher in FIBI variance explained compared with the all-site calibration dataset models; however the overall ranking was not statistically significant (KWAOV, p=0.14).

Habitat models developed using the entire dataset (i.e., 1995-2011) were fairly comparable in performance to models developed using only the more recent data from 2003-2011. As indicated earlier, the main difference between the more recent data from earlier data is methods for instream habitat evaluation. Instream habitat metrics were not strong predictor variables in any of the 16 preferred models. Overall, just two of fifteen current instream cover metrics were chosen for a model. The percentage instream cover as deep pools (cvrdpl%) was the most frequently selected metric, with 75% of the models including it. This metric only explained approximately 1-3% of the total variance in FIBI scores. The overall contribution of individual instream cover metrics was considered marginal and not worth restricting the data used to develop a new habitat index to only those data collected after 2002. The main advantage in using the entire 1995-2011 dataset is that index results going forward will be comparable to index results for the entire habitat sampling period of record dating back to 1995.

The synthetic habitat metric, pctsubopt, was selected in three of the sixteen exploratory models. Overall it had a relatively small positive impact, and it was decided to allow the metric to remain in the pool of metrics used in final model development. Pctsubopt is the incorporates thresholds for up to 25 habitat metrics (see Table 2) including four of the current instream habitat metrics. Because the metric is enumerated as a percentage of the total number of habitat metrics evaluated, it is compatible with habitat data collected in all sampling years.

Based on the initial considerations discussed above, four regression models were selected for further examination:

- All-site calibration data (1995-2011), habitat metrics only(Table 3, #7)

- All-site calibration data (1995-2011), habitat metrics and ecoregion variables (Table 3, #8)
- Reference site calibration data (1995-2011), habitat metrics only (Table 3, #15)
- Reference site calibration data (1995-2011), habitat metrics and ecoregion variables (Table 3, #16)

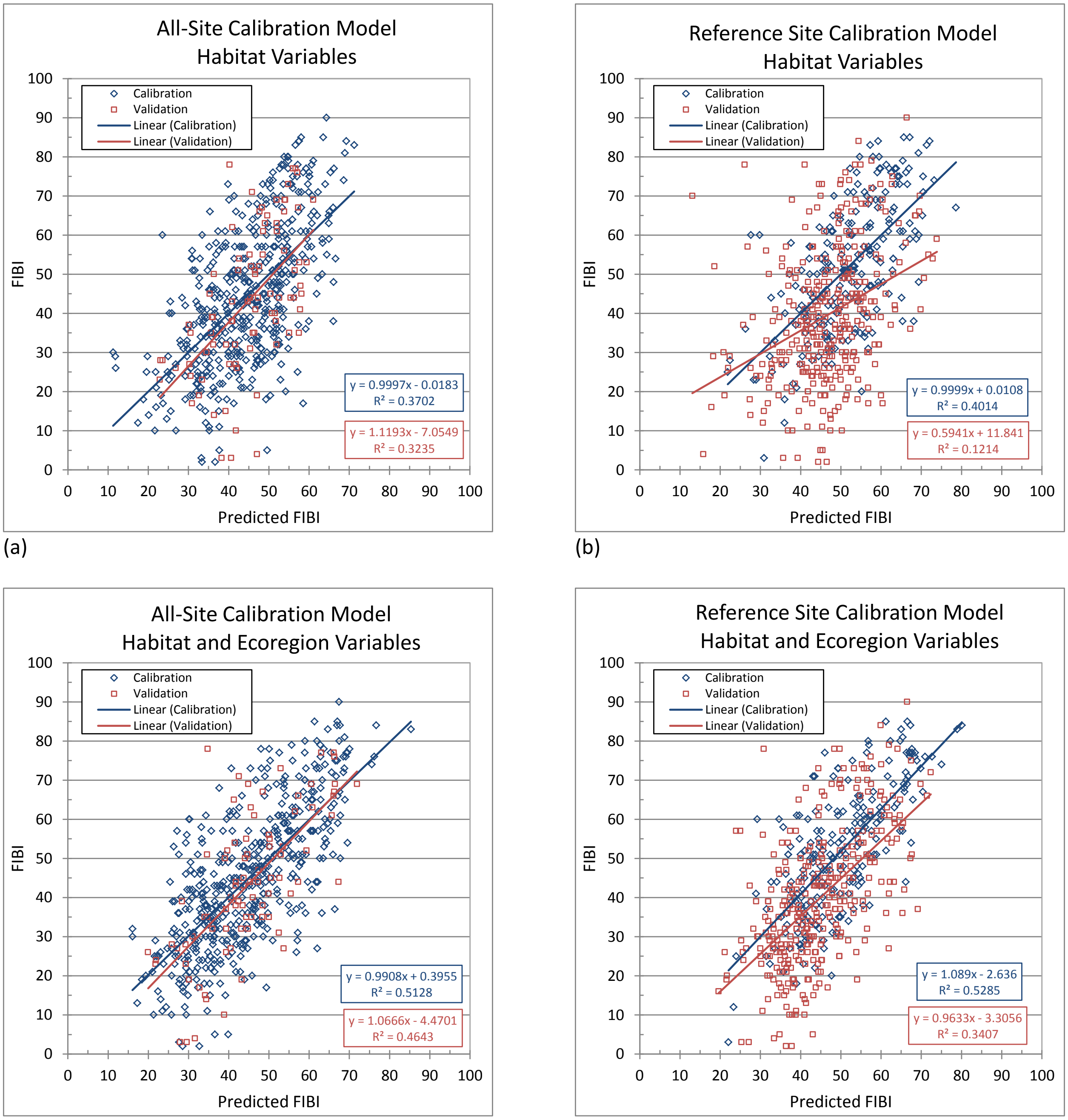
Regression modeling results for calibration and validation datasets were graphed to assist in evaluating the four models (Figures 5a-d). The respective regression model equations were applied to the calibration and validation datasets and the resulting model-fitted (predicted) FIBI scores were plotted on the x-axis against the observed (sampled) FIBI scores on the y-axis. While the all-site calibration and the reference calibration regression models performed similarly, the correspondence between the all-site calibration and validation dataset regression results was better than the correspondence of results from the reference calibration and non-reference validation datasets.

For the habitat only models (Figure 5a-b), the regression fitted lines for all-site calibration data (Figure 5a) and the reference site calibration data (Figure 5b) indicated overall good correspondence of predicted and observed FIBI scores. Both lines have a y-intercept value that is very close to zero and a slope coefficient of approximately one, indicating very little bias in the regression models. While the amount of variation in FIBI scores explained by the regression models was similar for the two calibration datasets (37%, all-site; 40%, reference only), the amount of explained FIBI variation within the all-site validation dataset (32%) (Figure 5a) was greater than the explained variation of the non-reference site validation dataset (12%) (Figure 5b).

Furthermore, the all-site calibration and validation datasets appear to correspond more closely with each other in terms of regression model slope coefficient and intercept (Figure 5a) compared with the respective slope coefficient and intercepts for the reference site calibration and non-reference validation datasets (Figure 5b). The reference calibration model when applied to the non-reference validation dataset tends to under-estimate FIBI score when observed FIBI scores are below 30 and over-estimate the score when observed scores are above 30. The all-site calibration model does a better overall job of predicting the observed FIBI, with a slight tendency to over-estimate the score up to about a score of 50.

Generally similar patterns and results were observed for the habitat/ ecoregion models (Figures 5c-d). The amount of FIBI score variation explained in the all-site validation dataset (46%) (Figure 5c) was greater than the FIBI variation in the non-reference validation dataset (34%) (Figure 5d). Likewise correspondence of slope and intercepts for the calibration and validation datasets were more similar for the all-site model compared to results for the reference site model, which again showed a greater tendency to over-estimate FIBI scores in the non-reference validation dataset.

The comparative analysis showed that models developed using the all-site data performed slightly better than the reference site only calibration models with respect to predicting FIBI levels in the corresponding validation dataset. Reference sites are selected to represent habitat and water quality characteristics that are least impacted by anthropogenic disturbances. For example, stream segments that are actively maintained as drainage ditches, lack riparian buffer strips, or actively managed for livestock grazing are not afforded consideration as reference sites. Given the selection bias toward least disturbed conditions , it might be understandable that a habitat index that is developed and calibrated from only reference site habitat data would not necessarily offer as much accuracy when applied to a broader cross-section of stream conditions including moderately or severely impacted habitat and/or water quality conditions.



(c) (d)

Figure 5. Least-square linear regression of observed and habitat model-predicted FIBI score. Results derived from (a) All-site habitat model; (b) Reference site habitat model; (c) All-site habitat + ecoregion model; (d) Reference site habitat + ecoregion model. (*Blue diamonds represent calibration site data used to develop model; Red squares represent validation site data.*)

Final Regression Analysis and Habitat Index Selection

For the reasons explained above, the all-site calibration dataset was chosen to be used in the final regression analysis instead of the reference site only dataset. Data from sampling years 1995-2011, including the new composite habitat metric, *pctsubopt*, were analyzed using stepwise linear regression. As previously noted, several habitat metrics showed a positive data skew; therefore, square root transformation was performed on certain metrics when it was shown this would increase the explained variation in FIBI scores.

Prior to conducting the final analysis, it was decided that two habitat models would be developed: a general habitat model and an ecoregion-adjusted habitat model (described below). The general model would be based on habitat metrics alone and would have statewide applicability, thus allowing habitat conditions among sampling sites throughout the state to be compared on the same scale.

By including both ecoregion variables and habitat metrics, the second model would provide better predictions of the expected FIBI score given the ecoregion location and habitat characteristics of a sampling site. Such a model would be useful for completing biological assessments to be included in the Clean Water Act Section 303(d) and Section 305(b) Integrated Report. For example, in cases where a stream site fails to achieve the FIBI ecoregion-based reference criterion, the ecoregion-adjusted habitat model would be useful for evaluating the likelihood that the stream fish assemblage is impaired due to habitat limitations or whether the cause of impairment might include other stressors, such as degraded water quality conditions. This distinction is an important one with respect to the development of the Section 303(d) list of impaired waters and development of plans to restore aquatic life uses to full attainment.

1) <u>General Fish Habitat Index</u>

The General Fish Habitat Index (GFHI) includes five habitat metrics (*see Table 1*) in the regression equation used to estimate Fish Index of Biotic Integrity (FIBI) score:

$$FIBI = 61.1163 - 3.3639\left(\sqrt{pctsubopt}\right) - 3.4212\left(\sqrt{subclay}\%\right) - 0.1458(bnkbare\%) + 1.0315\left(\sqrt{subcobbl}\%\right) + 1.0321(maxdep)$$

The amount of FIBI score variation explained by the GFHI was 39% for the combined calibration and validation data sets (Figure 6).

The habitat rating categories for the GFHI follow those already established for the FIBI and are meant to serve as general guidelines based on the average expectation of the FIBI score at the statewide scale. Note: the maximum GFHI-predicted FIBI score in the dataset used to calibrate and validate the index was 71 and the minimum was 12.

GFHI	Habitat Rating
≤25	Poor
26-50	Fair
51-70	Good
≥71	Excellent

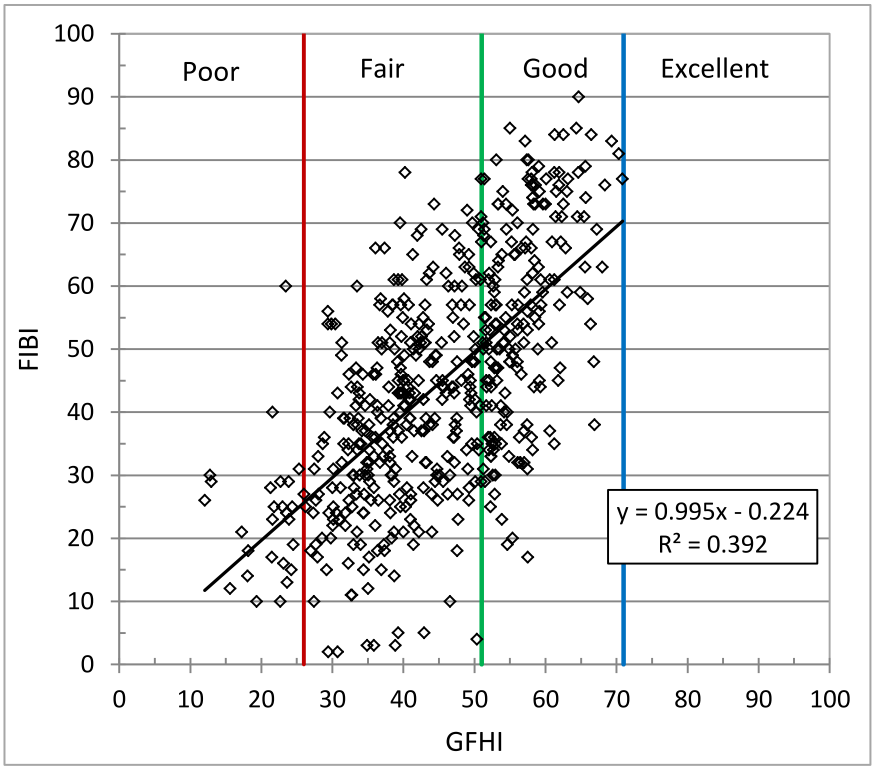


Figure 6. Results of least-square regression of the General Fish Habitat Index (GFHI) and observed FIBI score plotted in relation to proposed qualitative habitat rating boundaries. Results represent calibration and validation data 1995-2012.

2) <u>Ecoregional Fish Habitat Index</u>

The Ecoregional Fish Habitat Index (EFHI) includes seven habitat metrics and four ecoregion variables in the regression equation used to estimate Fish Index of Biotic Integrity (FIBI) score:

$$
\begin{aligned}
FIBI = 55.8404 &- 2.46942\left(\sqrt{pctsubopt}\right) + 16.4306(e47c) - 1.4323\left(\sqrt{subclay}\%\right) + 11.3392(e52b) \\
&- 0.1418(bnkbare\%) - 7.8094(e47e) + 0.0822(strwdtav) + 4.3049(e47b) \\
&- 0.1029(bnkavr\%) - 0.0545(rchpool\%) + 1.1628\left(\sqrt{subcbbl}\%\right)
\end{aligned}
$$

The amount of FIBI variation explained by the EFHI was 52% for the combined calibration and validation data sets (Figure 7). The amount of FIBI variation explained by the EFHI is similar to the amount explained by Rowe et al. (2009a) in research of relationships between physical habitat and wadeable stream fish assemblages in Iowa. In this study of randomly selected stream sites across Iowa, 50% of the variability in FIBI scores was explained by four habitat metrics: percent large rock substrate, mean residual stream reach width, percent fine gravel substrate, and mean channel incision height.

Stream physical habitat data analyzed by Rowe et al. (2009a) was collected according to the USEPA (2007) sampling procedures for the National River and Stream Assessment. This protocol is more labor intensive than the IDNR physical habitat sampling protocol, and it generates additional riparian and instream habitat metrics not calculated in this study. Two of the metrics, mean residual stream width and mean channel incision height were not available for use in this study.

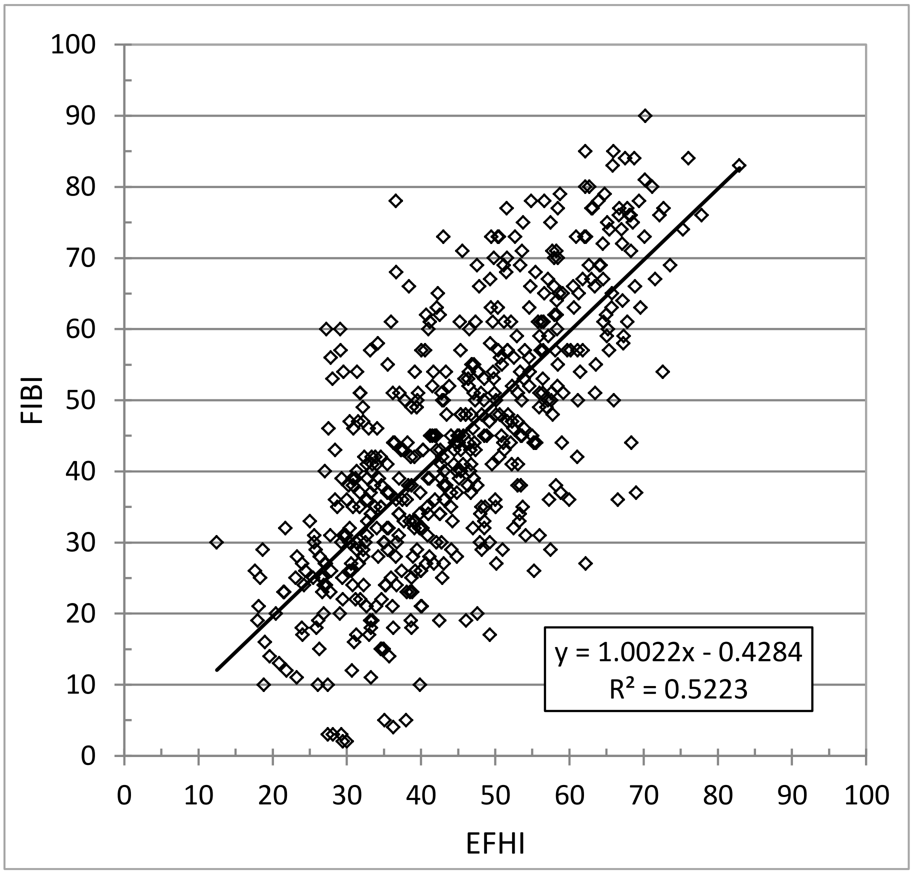


Figure 7. Least-square linear regression of the Ecoregional Fish Habitat Index (EFHI) and observed FIBI score. Results represent calibration and validation data 1995-2012.

Bioassessment interpretation of the EFHI

The difference of the observed (sampled) FIBI score (O) and the EFHI-predicted FIBI score (P) is a potentially useful diagnostic indicator for bioassessment purposes. For example, a scenario in which "O" is markedly lower than "P" suggests that habitat is not likely the limiting environmental factor causing the fish assemblage to not match the predicted FIBI level determined by ecoregion location and habitat characteristics. There is a greater likelihood that other factors (e.g., water quality) contribute to the stream site failing to attain the expected FIBI level. Alternatively, the scenario in which "O" is markedly higher than "P" suggests that water quality and/or other environmental characteristics are favorable and allow the observed FIBI level to "out-perform" the predicted level.

Guidelines for interpreting differences in the observed and predicted FIBI levels were developed using a statistical approach that is similar to the one already established by the stream bioassessment program. For example, the 25^{th} percentile of FIBI scores for least disturbed reference sites in a given ecoregion is used as a threshold for determination of attainment status of designated aquatic life uses that apply to other streams in the same ecoregion. FIBI levels falling below the 25^{th} percentile threshold are not considered to be consistent with the reference biological expectation and serve as evidence of aquatic life use impairment .

A similar conceptual approach was taken to develop O-P interpretation guidelines (Table 1). O-P values were obtained by subtracting the EFHI-modeled FIBI score (P) from the observed (sampled) FIBI score (O) for all sites

listed in Appendix 1. Statistical percentiles (10%, 25%, 75%, 90%) for O-P were then obtained using data from only the reference sites (site status = WD-REF).
Table 4 contains suggested guidelines for interpreting the O-P statistic. In general, when there is a large difference (negative or positive) in the observed and predicted FIBI scores it is more likely that other environmental factors besides or in addition to physical habitat are influencing the O-P outcome. A cursory review of the data collected from streams known to experience either good or poor water quality conditions has suggested that the guidelines will be useful for the intended purpose; however, additional "ground truthing" of the guidelines using data from Stressor Identification studies or other stream investigations would be beneficial.

Table 4. Suggested guidelines for interpreting Observed FIBI score, (O) – (P), EFHI-Predicted FIBI score.
O-P percentile ranges were obtained from the 1995-2011 reference site dataset.

FIBI O-P	Reference Percentile	Interpretation
< (-12)	<10	Adverse water quality and/or other environmental factors besides physical habitat are very likely to contribute to the predicted FIBI score exceeding the observed FIBI score.
(-12) - (-6)	10 - 24	Adverse water quality and/or other environmental factors besides physical habitat are somewhat likely to contribute to the predicted FIBI score exceeding the observed FIBI score.
(-5) - 8	25 - 75	The observed FIBI score is roughly equivalent to the predicted FIBI score and within expectations based on physical habitat characteristics and ecoregion.
9 - 18	76 - 90	Favorable water quality and/or other environmental factors besides physical habitat are somewhat likely to contribute to the observed FIBI score exceeding the predicted FIBI score.
> 18	>90	Favorable water quality and/or other environmental factors besides physical habitat are very likely to contribute to the observed FIBI score exceeding the predicted FIBI score.

Figure 8 shows a plot of observed (sampled) and predicted (modeled) FIBI scores from 534 matched fish and habitat stream bioassessment sampling events in relation to reference site O-P percentile boundaries. Using the interpretive guidelines in Table 4, data points falling between the 25th and 75th percentile lines represent cases where the fish assemblage condition reasonably closely matches the expected condition based on sampling site habitat characteristics.

Data points plotted above the 75th and 90th percentile lines represent cases where it is somewhat likely or very likely that good water quality and/or other favorable environmental factors besides physical habitat contribute to achieving a higher level of fish assemblage condition than expected. Besides good water quality, examples of other positive contributing factors include stability of base flow and direct connection to a stream segment that supports high fish diversity.

Conversely, data points falling below the 25th or 10th percentile lines are cases where it is somewhat likely or very likely that adverse water quality conditions or other environmental factors besides physical habitat limitations alone contribute a lower level of fish assemblage condition than expected. Besides poor water quality, examples of other negative contributing factors include instability of base flow or barriers to fish movement caused by dams.

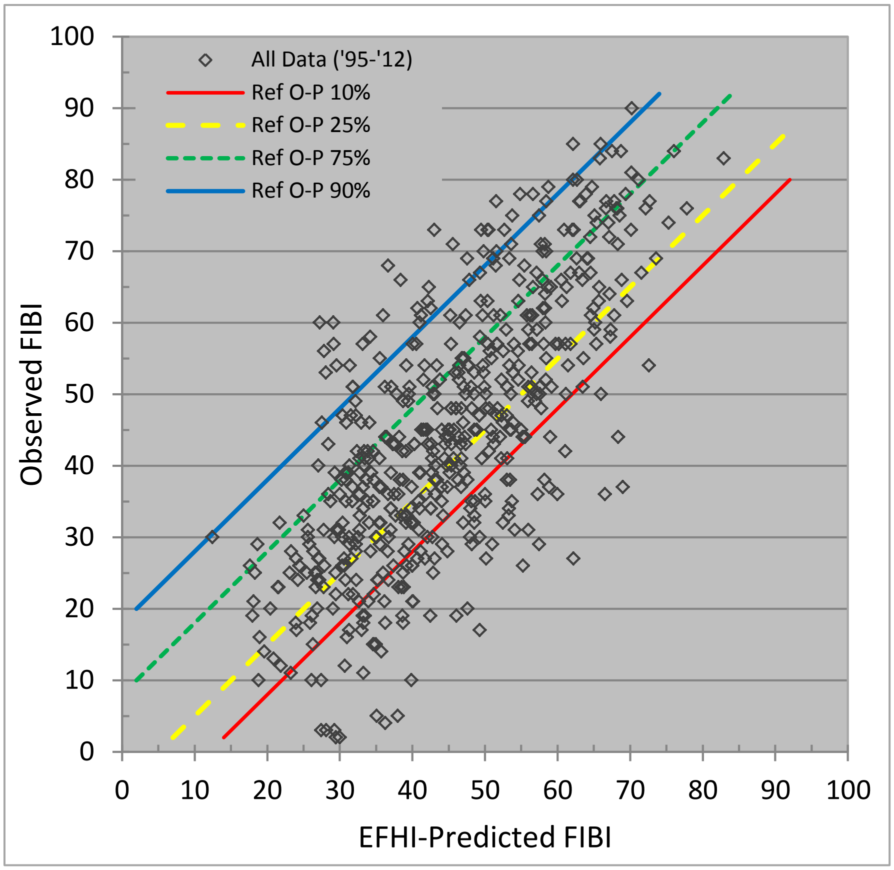


Figure 8. Observed FIBI score versus (EFHI) Predicted FIBI score. The various colored lines represent the 10th, 25th, 75th and 90th percentile O-P levels in Table 4. *Data points represent all calibration and validation BioNet data from wadeable warmwater streams used in the development of the EFHI (1995-2012).*

Ecoregion and Streamflow Relationships with Habitat

Ecoregion

Stream physical habitat characteristics vary significantly across Iowa's ecoregions (Heitke et al., 2006 Rowe et al. 2009a, 2009b; Wilton 2004). For referral purposes, the statistical ranges of habitat metric data collected from stream ecoregion reference sites are listed in Appendix 3.

The habitat and FIBI modeling analysis demonstrated that the ecoregion in which a stream is located matters. On average, FIBI prediction accuracy was improved about 13% among regression models that included ecoregions as predictor variables over models that did not include them. Subsequent data analysis was conducted to more closely examine habitat and FIBI relationships within individual ecoregions.

Spearman rank correlation analysis was again used to identify habitat metrics that were most strongly correlated with FIBI levels. Table 5 reports, by ecoregion, the metric having the largest (negative or positive) correlation coefficient within four habitat metric categories. The correlation analysis was performed on two sets of data: (a) 1994-2012 calibration and validation data combined (excluding instream cover metrics); (b) 2003-2012 calibration and validation data combined (including instream cover metrics).

Table 5. Results of Spearman rank correlation analysis of Fish Index of Biotic Integrity (FIBI) and stream habitat metrics. Correlation coefficients (*rho*) are reported for the most strongly correlated habitat metrics within each category. *(see Table 1 for metric abbreviations)*

Ecoregion	N	Bank / Shade	*rho*	Channel Dimension / Macrohabitat	*rho*	Substrate	*rho*	Instream Cover	*rho*
1994-2012 (calibration and validation data)									
40a	46	BNKBARE	-0.25	RCHRFFL	0.51	SUBLGRK	0.60		
47a	40	BNKAVR	-0.36	STRWDTCV	0.48	SUBLGRK	0.45		
47b	136	CHSHDSD	0.28	MAXDEP	0.34	SUBROCK	0.44		
47c	103	BNKBARE	-0.18	THWGWDR	0.33	SUBROCK	0.47		
47e	33	CHSHDMN	-0.40	DPTHCV	0.39	SUBGRVL	0.41		
47f	107	BNKBARE	-0.36	RCHRFFL	0.33	SUBLGRK	0.43		
52	42	BNKAHZ	0.49	STRWDTSD	0.64	SUBLGRK	0.43		
2003-2012 (calibration and validation data)									
40a	27	CHSHDMN	0.18	STRWDTSD	0.45	SUBCLAY	-0.57	CVRBLDR	0.40
47a	14	CHSHDSD	-0.36	STRWDTCV	0.84	SUBFINES	-0.75	CVRDPL	-0.58
47b	71	CHSHDSD	0.30	MAXDEP	0.44	SUBFINES	-0.32	CVRDPL	0.36
47c	43	BNKBARE	-0.14	STRWDTCV	-0.38	SUBSILT	-0.60	CVRBLDR	0.51
47e	13	CHSHDSD	0.68	RCHRFFL	0.42	SUBGRVL	0.63	CVRTRRT	0.57
47f	50	BNKAUC	0.29	RCHRFFL	0.31	SUBROCK	0.58	CVRBLDR	0.53
52	24	BNKAHZ	0.45	THWGWDR	0.49	SUBSILT	-0.48	CVRARTF	-0.45

Similar to the analysis of habitat relationships at the statewide scale, correlations between substrate metrics and the FIBI in the “a” dataset tended to be the strongest in relation to metrics belonging to other categories. The percent of rock substrate (gravel+cobble+boulder) (SUBROCK) and percent large rock (cobble + boulder) (SUBLGRK) were most often the highest ranking metrics in the substrate category.

High ranking correlations among metrics in the (b) 2003-2012 data set were somewhat more evenly distributed among substrate, instream cover, and channel dimension. The smaller sample sizes of the “b” data set might be partly responsible for some of the differences in rankings compared to those from the “a” data set. Substrate metrics indicative of fine sediments (i.e., SUBFINES, SUBCLAY, SUBSILT) were most often identified as high ranking in the “b” data set compared with rock substrate metrics in the “a” data set.

In both datasets, stream bank and channel shade metrics tended to have the weakest correlations with FIBI. The metric found to be the highest ranking varied considerably across ecoregions and data sets. Likewise the highest ranking metrics within the channel dimension and macrohabitat category was a mixture with no individual metric chosen more than twice in either dataset. Among the instream cover category, the amount of boulder instream cover (CVRBLDR) was the most strongly correlated (positive direction) metric in three of seven ecoregions. Cover provided by deep pools (CVRDPL) was also identified as highest ranking in two ecoregions, one correlation in a positive direction and the other negative.

Using the same 1995-2011 calibration data set used in the statewide analysis, stepwise multiple regression analysis was again performed to identify the combination of habitat metrics that would best predict FIBI levels within individual ecoregions. The amount of variation in FIBI scores explained by habitat metrics ranged from 30.1 – 49.8% among ecoregions. This amount was similar to the amount explained by habitat metrics in the statewide analysis (see Table 3; models 5-8). This finding, although based on substantially less data for any given ecoregion, does suggest that greater accuracy would not necessarily be achieved through the development of ecoregion-specific regression models.

Substrate metrics were again found to be the most frequently included type of habitat metric among the individual ecoregion models. This finding provides evidence that differences in bottom substrate are biologically meaningful both at the statewide and regional scales in Iowa. It also corroborates previous statistical analysis findings documenting the importance of rock substrate and providing some of the justification for establishing habitat classifications within certain ecoregions for bioassessment purposes (Wilton 2004).

Table 6. Ecoregion results from stepwise regression analysis of stream habitat metrics and FIBI (1995-2011 calibration dataset).

Ecoregion	N	r^2 (%)	Habitat Variables				
40a	41	30.1	subcbbl%	subclay%			
47a	35	32.7	bnkavr%	subfines%			
47b	114	39.6	subrock%	strwdtav	chshdsd%		
47c	92	32.3	subsilt%	subrock%	strwdtav		
47e	32	31.5	dpthav	subgrvl%	subbdrk%		
47f	96	34.1	subfines%	bnkbare%	subsand%	bnkavr%	strwdtsd
52	41	49.8	strwdtcv	subrock%	subdemu%		

Streamflow itself can be considered a habitat variable. It was not included among the physical habitat metrics considered for developing a habitat index largely because it is a much more dynamic variable than other habitat characteristics. Typically, the only flow data collected at a wadeable stream bioassessment site is an instantaneous flow measurement that is taken once at the time of biological and habitat sampling. This was not thought to be sufficient

<u>Streamflow</u>

Variation in streamflow and alteration in watershed hydrologic response over short and long time scales have profound effects on stream channel morphometry and instream habitat characteristics (Allen 2004 and Poff et al., 2006). Streamflow was not included among the physical habitat characteristics included in this study primarily because of data limitations, but also because of the dynamic nature of streamflow and the complexity of its relationships with stream physical habitat structure. Other tools, such as the Index of Hydrologic Alteration (IHA) (Richter et al., 2004) are available for a comprehensive analysis of ecologically-relevant streamflow characteristics. The IHA requires a continuous record of daily flow values, like that obtained at a USGS flow gauging station. Almost all stream bioassessment sites included in this study are not located near a flow gaging station, thus adequate data to perform IHA analysis is not usually available.

An exploratory analysis of the limited data available from bioassessment sites was conducted to investigate relationships between streamflow, physical habitat, and the FIBI. As part of the bioassessment protocol, a discrete, instantaneous stream discharge (flow) measurement is taken in conjunction with collection of water samples, which often takes place on the same date as fish assemblage and habitat sampling .

A total of 363 instantaneous flow measurements from 1994-2011 dataset could be matched with fish and habitat samples on the same dates. These data were analyzed by correlation and least-square regression analysis. Three flow-related metrics that were easily calculated were included in the analysis:

- Average Current Velocity (CVAVG) in feet per second (calculated as Q /(Avg. Depth x Avg. Width))
- Discharge (FLOW) (*Q*) in cubic feet per second (*cfs*)
- Ratio of Surface Watershed Area (square miles) to Discharge (cfs) (WAREA:FLOW)

Results of Spearman rank correlation results for flow and habitat metrics are summarized in Table 7. Among the flow-related metrics, FLOW was positively correlated with average current velocity (CVAVG) and inversely correlated with watershed area: flow ratio (WAREA:FLOW). WAREA:FLOW was also inversely strongly correlated with CVAVG.

FLOW was most strongly correlated with channel dimension habitat metrics (e.g., STRWDTAV, THWGDPAV, DPTHAV) and with the amount of instream cover as deep pools (CVRDPL). It was weakly correlated with bank, channel shade, and substrate habitat metrics. It also was weakly correlated in a positive direction with observed and predicted FIBI scores.

Table 7. Spearman rank coefficients (rho) from correlations of stream discharge (FLOW), watershed area: flow ratio (WAREA:FLOW), and average current velocity (CVAVG) versus groupings of physical habitat metrics *(see Table 1 for abbreviations)*: (a) bank and shade metrics, %suboptimal habitat metrics (PCTSUBOPT), general model predicted FIBI (GHABMDL), ecoregion model predicted FIBI (EHABMDL), and FIBI score; (b) channel dimension and macrohabitat; (c) substrate; (d) instream cover. *(Bolded, italicized coefficient values represent strongest correlations within grouping).*

(a)

	FLOW	WAREA:FLOW	CVAVG
BNKAHZ	-0.17	***0.45***	-0.20
BNKAMD	0.12	-0.31	0.10
BNKAUC	0.01	-0.05	0.02
BNKAVR	0.11	-0.25	0.13
BNKBARE	0.02	0.23	0.02
CHSHDAV	-0.05	-0.08	-0.13
CHSHDMN	-0.01	-0.05	-0.09
CHSHDMX	-0.14	-0.06	-0.19
CHSHDSD	0.24	-0.20	0.12
PCTSUBOPT	-0.08	0.12	0.07
GHABMDL_FIBI	0.23	-0.27	0.04
EHABMDL_FIBI	0.20	-0.28	0.05
FIBI	0.13	-0.22	0.04

(b)

	FLOW	WAREA:FLOW	CVAVG
WAREA:FLOW	***-0.67***		
CVAVG	***0.79***	***-0.68***	
DPTHAV	***0.52***	***-0.41***	0.11
DPTHCV	-0.30	0.35	-0.41
DPTHSD	0.33	-0.17	-0.13
MAXDEP	0.38	-0.21	0.01
RCHMXHB	0.12	0.02	0.26
RCHPOOL	-0.31	0.31	***-0.66***
RCHRFFL	-0.08	-0.10	-0.10
RCHRUN	0.32	-0.27	***0.65***
STRWDTAV	***0.71***	-0.21	0.31
STRWDTCV	-0.39	0.31	-0.34
STRWDTSD	0.33	0.05	0.04
THWGDPAV	***0.61***	-0.39	0.16
THWGDPCV	-0.39	0.31	***-0.48***
THWGDPSD	0.18	-0.06	-0.20
THWGWDR	0.27	0.09	0.21

(c)

	FLOW	WAREA:FLOW	CVAVG
SUBBDRK	0.07	-0.06	-0.02
SUBBLDR	0.03	-0.14	-0.09
SUBCBBL	0.08	-0.21	-0.08
SUBCLAY	-0.18	0.09	-0.15
SUBDEMU	-0.05	0.09	-0.13
SUBFINES	-0.02	0.20	0.09
SUBGRVL	-0.06	-0.14	-0.04
SUBLGRK	0.09	-0.22	-0.08
SUBOTHR	0.07	-0.11	0.07
SUBROCK	0.04	-0.23	-0.05
SUBRRAP	-0.05	0.05	-0.06
SUBSAND	0.12	0.12	0.27
SUBSILT	-0.19	0.12	-0.27
SUBSOIL	-0.13	0.08	-0.08
SUBSTRMX	0.21	-0.03	0.32
SUBWOOD	0.00	0.09	-0.04

(d)

	FLOW	WAREA:FLOW	CVAVG
CVRARTF	-0.08	0.14	-0.15
CVRBLDR	-0.06	0.01	-0.16
CVRDNR	0.22	-0.11	-0.02
CVRDPL	***0.44***	-0.17	0.04
CVREPA	-0.03	0.08	-0.13
CVRFLMA	0.17	-0.12	0.13
CVRLGDN	0.24	-0.04	-0.11
CVRLGEP	-0.03	0.10	-0.18
CVRMACR	0.03	-0.21	0.05
CVRNATRL	0.04	-0.06	-0.04
CVROVHG	-0.02	-0.16	0.02
CVRSBRSH	0.03	0.09	-0.02
CVRTRRT	0.00	0.00	-0.05
CVRUCBK	0.07	-0.11	0.05
CVRWDBRS	0.06	0.05	0.01

CVAVG was most strongly correlated (inversely) with the amount of pool macrohabitat (RCHPOOL) and (positively) with the amount of run macrohabitat (RCHRUN). It was also relatively strongly correlated (inversely) with thalweg depth coefficient of variation (THWGDPCV).

WAREA:FLOW was most strongly correlated with the amount of horizontal bank (BNKAHZ), average water depth (DPTHAV), and thalweg average depth (THWGDPAV).

None of the flow-related metrics was strongly correlated with observed or predicted FIBI levels (Table 7). This finding suggested that including the flow metrics in the habitat – FIBI regression analysis would probably not cause model performance to improve significantly. This belief was confirmed through subsequent data analysis using the stepwise multiple linear regression procedures described earlier. In fourteen sequential models produced by stepwise regression, only CVAVG met the criteria for inclusion. It was the ninth of twelve habitat metrics sequentially added to the model, and its addition resulted in just a 0.5% increase in the amount of FIBI variability explained by the model.

Graphs of the flow-related variables plotted against the FIBI were examined for non-linear relationship patterns. Visually apparent thresholds in flow, current velocity, and watershed drainage area: flow ratio were observed during the examination of scatter plots (Figure 9a-c). Optimal levels of the FIBI (>71 "Excellent") were not observed at flow levels less than 2 cfs, current velocity less than 0.1 ft/s, or watershed area : flow ratio greater than 27 mi^2/cfs. The latter condition is not a flow characteristic per se, but can be an indicator of unusually dry climatic conditions and/or watershed characteristics (e.g., low soil permeability) that contribute to proportionately smaller amounts of groundwater contribution to stream flow and consequently less base flow stability.

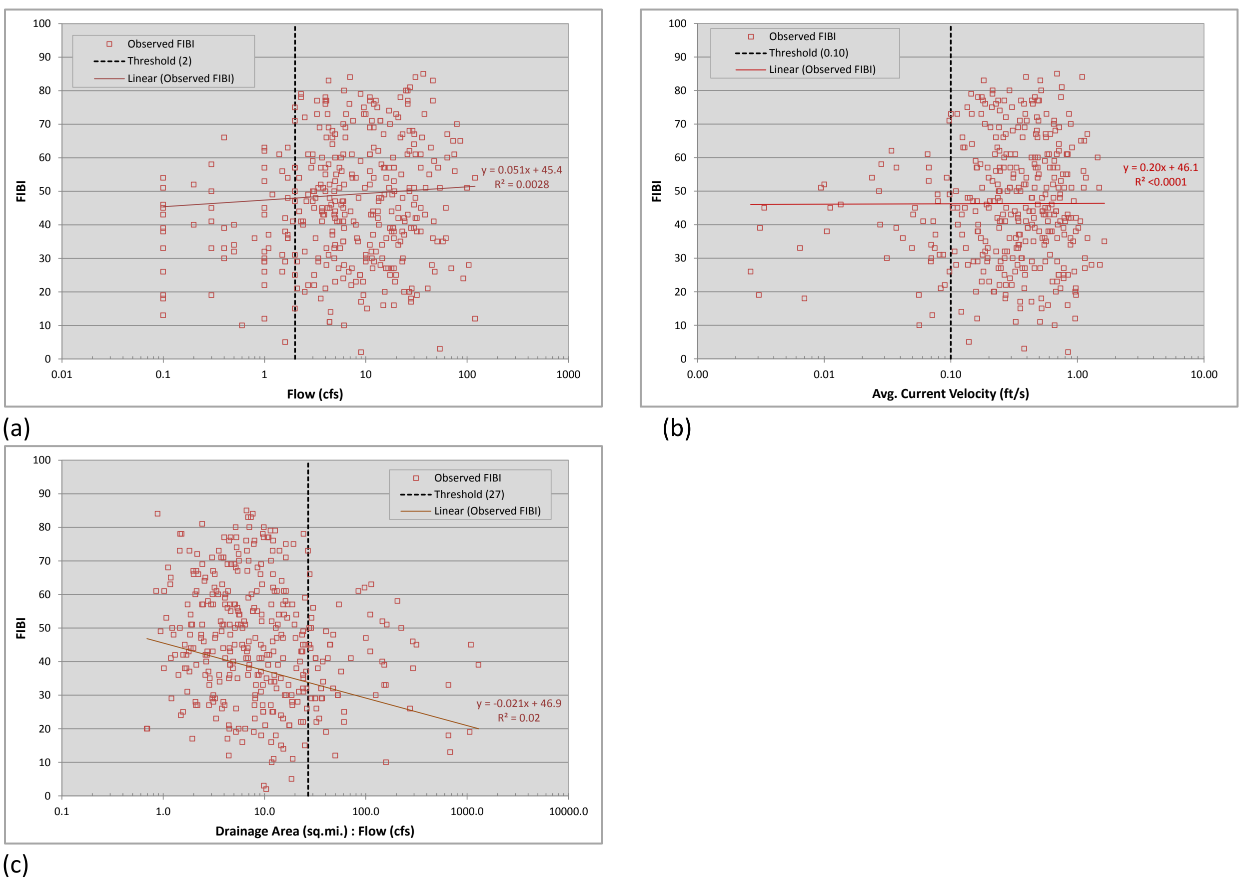


Figure 9. Fish Index of Biotic Integrity (FIBI) versus (a) instantaneous flow; (b) average current velocity; (c) watershed drainage area: flow ratio. Dashed vertical line indicates the visually apparent suboptimal threshold above or below which FIBI scores considered as "Excellent" (≥71) were not observed.

Flow and channel morphology characteristics are major determinants of the quality and quantity of physical habitat space available to sustain fish populations through dry periods. By influencing the amount of gas exchange with the atmosphere and water retention time, they can also impact water quality parameters such as dissolved oxygen and water temperature. For diagnostic purposes, it would be useful to have the ability to evaluate how unusual it would be for a stream site to exceed the suboptimal flow or current velocity thresholds in Figure 9 given the size of the watershed and the ecoregion location.

To explore this question, summary statistics of the flow metrics were prepared for seven of Iowa's largest ecoregions in which there was sufficient data (Table 8). The statistics illustrate some distinct ecoregional patterns in flow, current velocity, and watershed area: flow ratio. For example, ecoregion 40a stands out in comparison to the other ecoregions with respect to the frequency that threshold levels are exceeded. The thresholds for FLOW and AVGCV thresholds were exceeded more than 25% of the time, and the WAREA:FLOW threshold was exceeded more than 50% of the time. Each of these thresholds was exceeded less than 25% of the time in all of the other ecoregions.

As suggested above, the summary statistics might help to provide context for evaluating whether observed flow and current velocity were unusually low at the time of sampling. For example, suppose that flow, current velocity, and watershed area: flow ratio at a stream site are 1.5, 0.08, and 30, respectively. The flow and current velocity levels are suboptimal, that is below levels needed for optimal FIBI scores (i.e., flow $\geq$2 cfs; cv $\geq$ 0.1 fps). If the stream is located in the 40a ecoregion, according to Table 8, a WAREA:FLOW of 30 has been observed more than 50% of the time; therefore, the observed flow and current velocity levels can be considered a fairly common occurrence among streams of similar watershed size in the same ecoregion.

In contrast, the same flow and current velocity levels of 1.5 cfs and 0.08 fts, respectively, coupled with a WAREA:FLOW ratio of 30 has been observed less than 10% of the time in ecoregion 47c. In this case, the suboptimal flow and current velocity levels might be considered indicative of local or regional drought conditions. Another possible explanation is that the sampling site is located in a losing segment where surface flow is lost to groundwater due to fissures or sinkholes in the stream bottom. Such features are emblematic of karst geology in certain areas of Northeast Iowa.

Along with other statistical tools (e.g., USGS StreamStats), the statistical summary in Table 8 could be useful for bioassessment purposes. For example, when a stream sampling site fails to achieve the FIBI biological impairment criterion it becomes a candidate for impaired assessment of designated aquatic life uses and potential addition to the Section 303(d) list of impaired waters. Such a conclusion could misrepresent the true condition of the aquatic community if the reduction in FIBI score can be linked to the occurrence of stressfully low flow levels that are associated with drought conditions. In such cases, conducting additional sampling when flow levels return to more typical levels would be a prudent course of action.

Table 8. Summary statistics for flow, current velocity, and watershed area: flow ratio by ecoregion. Data mostly represent base streamflow conditions during the July – October biological index (n-371).

FLOW (cfs)							
	40a	47a	47b	47c	47e	47f	52b
N	32	24	95	90	29	78	23
MAX	100.0	104.0	75.8	79.5	70.0	120.0	120.0
90	12.5	43.8	20.2	44.2	45.6	35.3	36.7
75	7.8	21.0	11.0	23.5	24.0	23.1	22.8
50	2.8	8.3	4.2	8.6	14.6	11.0	12.6
25	0.6	2.7	2.3	3.9	8.8	3.0	5.1
10	0.1	1.6	0.9	2.0	4.8	1.0	4.3
MIN	0.1	0.4	0.1	0.1	0.5	0.1	3.2

Current Velocity (ft./sec.)							
	40a	47a	47b	47c	47e	47f	52b
N	32	24	95	90	29	78	23
MAX	1.49	1.51	1.12	1.20	1.64	1.45	1.17
90	0.53	1.08	0.65	0.73	1.15	0.81	0.89
75	0.31	0.84	0.42	0.60	0.95	0.59	0.62
50	0.16	0.44	0.24	0.38	0.78	0.39	0.33
25	0.07	0.25	0.13	0.23	0.61	0.21	0.24
10	0.01	0.12	0.07	0.13	0.32	0.09	0.23
MIN	0.00	0.03	0.00	0.02	0.20	0.00	0.18

WAREA:FLOW (mi^2/cfs)							
	40a	47a	47b	47c	47e	47f	52b
N	32	24	95	90	29	78	23
MAX	1061.9	125.5	1300.5	111.1	52.9	292.9	7.4
90	611.6	30.2	51.9	16.2	16.4	36.5	5.3
75	152.7	22.6	25.3	10.9	12.2	18.3	4.2
50	32.3	10.1	12.5	5.9	5.4	7.0	2.4
25	15.9	4.6	7.3	3.6	3.3	2.7	2.0
10	6.5	4.1	3.3	2.0	1.8	1.6	1.9
MIN	2.4	1.4	1.1	0.9	1.3	1.0	0.9

Habitat Indexes as Predictors of the BMIBI

At the onset of this study, it was presumed that physical habitat characteristics that are useful predictors of fish assemblage condition would not necessarily be the same as those that are useful for predicting benthic macroinvertebrate assemblage condition. To test this assumption, relationships between levels of the Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) and levels of the GFHI and EFHI were examined by simple linear regression analysis. The analysis included a total of 407 GFHI, EFHI, and FIBI sampling results from the 1995-2012 all-site calibration and validation datasets that could be matched by site and date with BMIBI sampling results.

Linear regression analysis found that BMIBI scores were not strongly related with either the GFHI or EFHI predicted FIBI scores (Figures 10a-b). The r-squared statistics from the regressions were 13% and 18%, for the GFHI and EFHI, respectively. In contrast, the relationship between the BMIBI and the observed (sampled) FIBI score was much stronger (52% - Figure 10c).

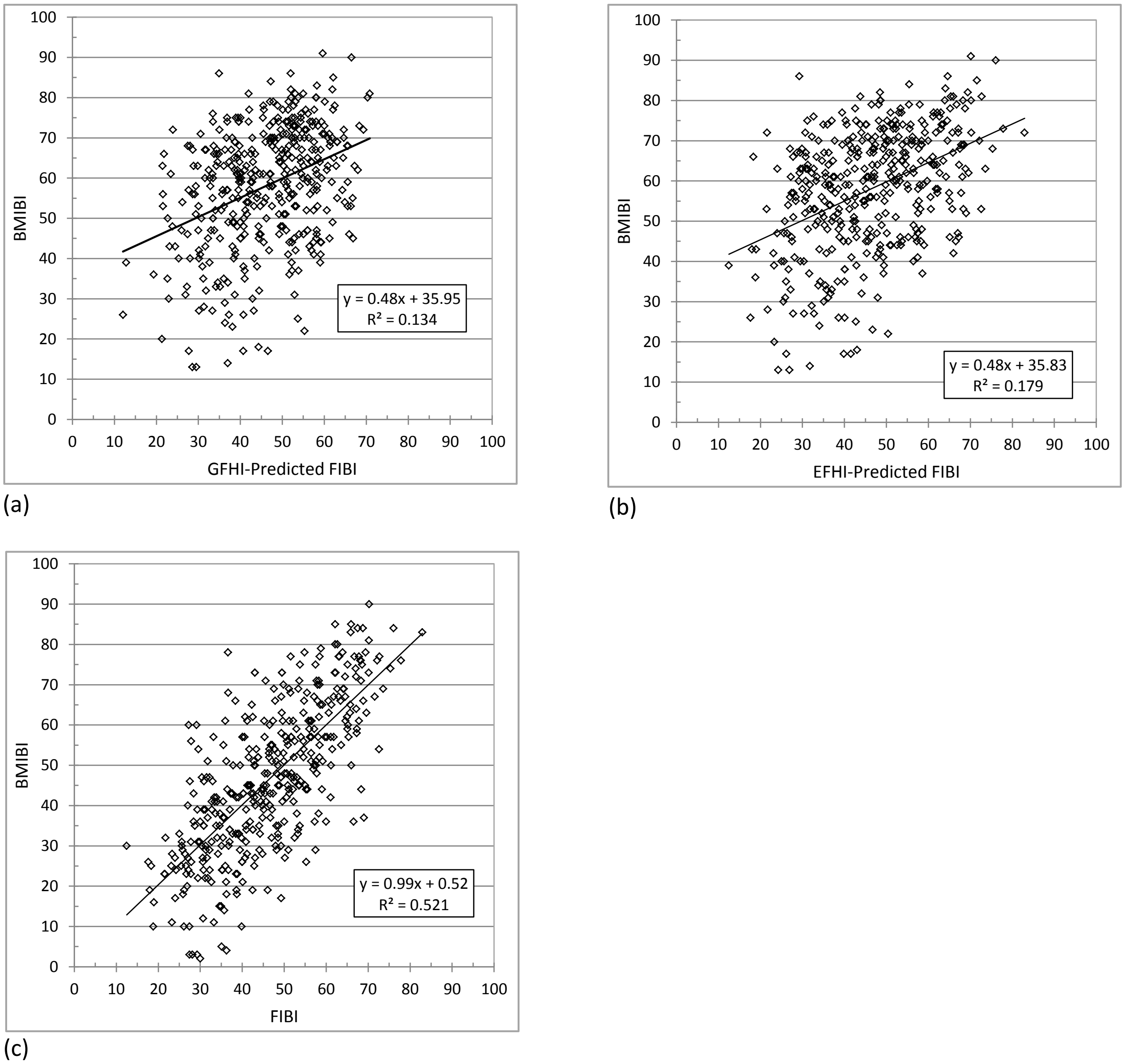


Figure 10. Simple linear regression of Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) versus (a) General Fish Habitat Index (GFHI); (b) Ecoregional Fish Habitat Index (EFHI); (c) Fish Index of Biotic Integrity (FIBI).

The lack of a strong relationship between the BMIBI and the GFHI or the EFHI suggests that the combination of habitat metrics included in these indexes does not adequately represent habitat characteristics that are important to structuring benthic macroinvertebrate assemblages in Iowa streams. In a previous analysis, reach-scale habitat metrics like those included in this study were found to be less strongly related with benthic macroinvertebrate assemblages than fish assemblages (Wilton 2004). The findings here suggest that a new analysis of BMIBI and habitat relationships, preferably representing both macro- and micro-scale habitat metrics, will be necessary in order to develop a quantitative habitat index that is useful for bioassessments involving benthic macroinvertebrate assemblages.

Conclusions

The quantitative habitat tools developed in this study should directly benefit the stream bioassessment program. The General Fish Habitat Index (GFHI) yields a normalized score between 0 and 100 that equates to qualitative categories (Excellent, Good, Fair, Poor) of fish assemblage health condition in Iowa's wadeable streams. It can be used to quickly compare and rank habitat conditions across multiple sampling sites throughout Iowa. It also identifies which of 25 individual habitat metrics are the most likely to limit the resident stream fish assemblage from attaining a higher condition level.

The Ecoregional Fish Habitat Index (EFHI) can be used more specifically in the stream bioassessment process. By adjusting for ecoregion effect, the EFHI provides a more accurate prediction of the Fish Index of Biotic Integrity (FIBI). Analysis of regression analysis residuals from least disturbed reference sites were used to establish guidelines for interpreting the difference between the observed (sampled) FIBI score and the EFHI-predicted FIBI score. These guidelines should be useful for distinguishing streams in which fish assemblage condition appears to match expectations based on physical habitat conditions from those in which fish assemblages are limited by other environmental factors such as water quality.

Guidelines for evaluating the likelihood that FIBI and habitat results are influenced by unusual flow conditions during sampling have been proposed. This consideration is important with respect to deciding whether or not the habitat data are representative of typical base flow conditions under which stream biological assessment indices have been calibrated. Unrepresentative data can lead to erroneous assessments based on inaccurate determinations of aquatic life use support status or impairment causes and sources.

The tools developed in this study might be useful for other stream management purposes, such as prioritizing and setting goals for stream habitat improvement projects. However, it is important to recognize the limitations of the tools, which represent local instream habitat characteristics only. Previous research in Iowa has demonstrated that stream fish assemblages and physical habitat conditions at the stream reach level are hierarchically related to landscape characteristics at the local riparian buffer and the watershed scales (Rowe et al., 2009b). As such, these habitat tools will be most useful when applied as part of a comprehensive assessment of watershed characteristics and processes that are shaping instream habitat conditions.

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Appendices

Appendix 1. Habitat Indexing Site Scores

General Fish Habitat Index (GFHI) and Ecoregion Fish Habitat Index (EFHI) results for stream sites included in the habitat modeling calibration (Clbr) and validation (Vld) data sets (1995-2013).

Abbreviations

Data group: Clbr, calibration; Vld, validation.

Ecoregion: (*see Figure 1)*

Site status: HW-CREF, headwater candidate reference; HW-SVY, headwater survey; WD-CREF, wadeable candidate reference sites; WD-REF, wadeable candidate reference site; WD-RJCT, rejected reference; WD-SVY, wadeable survey.

Suboptimal Habitat Metrics: (*see Table 2*)

FIBI – EFHI interpretation guidelines:

> 18, Beneficial environmental factors besides physical habitat characteristics are very likely to contribute to the observed FIBI score exceeding the predicted FIBI score;
9 – 18, Beneficial environmental factors besides physical habitat characteristics are somewhat likely to contribute to the observed FIBI score exceeding the predicted FIBI score;
(-5) – 8, The observed FIBI score is roughly equivalent to the predicted FIBI score and within expectations based on physical habitat characteristics and ecoregion;
(-12) - (-6), Adverse environmental factors besides physical habitat characteristics are somewhat likely to contribute to the predicted FIBI score exceeding the observed FIBI score;
< (-12), Adverse environmental factors besides physical habitat characteristics are very likely to contribute to the predicted FIBI score exceeding the observed FIBI score.

(continued next page)

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	52	Bailey Cr.	Ingrebretsen	Franklin	47c	MS	WD-REF	7/22/1996	53	Good	57	65	-8	
Clbr	52	Bailey Cr.	Ingrebretsen	Franklin	47c	MS	WD-REF	7/24/2003	53	Good	60	65	-5	
Clbr	52	Bailey Cr.	Ingrebretsen	Franklin	47c	MS	WD-REF	7/20/2011	58	Good	64	67	-3	
Clbr	357	Bailey Cr.	Thornton	Cerro Gordo	47c	MS	WD-SVY	7/23/2003	45	Fair	49	57	-8	chshdav%, cvrepa%, cvrwdbrs%, embdrtg
Clbr	357	Bailey Cr.	Thornton	Cerro Gordo	47c	MS	WD-SVY	10/7/2003	53	Good	50	66	-16	chshdav%, cvrepa%, cvrwdbrs%
Clbr	659	Bailey Cr.	Thorton	Cerro Gordo	47b	MS	HW-CREF	8/30/2007	44	Fair	48	46	2	bnkahz%, bnkbare%, cvrovhg%, cvrwdbrs%, dpthcv, embdrtg, rchpool%, rchmxhb%, strwdtsd
Clbr	637	Ballard Cr.	Cambridge	Story	47b	MS	WD-SVY	7/18/2007	39	Fair	43	37	6	cvrepa%, strwdtav, strwdtsd
Clbr	136	Barber Cr.	Barber Creek	Clinton	47f	MS	WD-REF	9/9/1998	34	Fair	60	29	31	bnkavr%, bnkbare%, strwdtav, subrock%
Clbr	136	Barber Cr.	Barber Creek	Clinton	47f	MS	WD-REF	8/30/2004	23	Poor	60	27	33	bnkahz%, dpthcv, strwdtav, subclay%, subsilt%, subfines%, subrock%
Clbr	311	Battle Cr.	Battle Creek	Ida	47e	MO	WD-SVY	9/11/2002	40	Fair	43	28	15	chshdav%
Vld	26	Bear Cr.	Shellsburg	Benton	47c	MS	WD-REF	8/8/1995	51	Good	69	64	5	
Vld	26	Bear Cr.	Shellsburg	Benton	47c	MS	WD-REF	8/2/2001	47	Fair	44	56	-12	rchmxhb%
Vld	26	Bear Cr.	Shellsburg	Benton	47c	MS	WD-REF	10/1/2001	47	Fair	52	58	-6	subfines%
Vld	26	Bear Cr.	Shellsburg	Benton	47c	MS	WD-REF	8/20/2010	53	Good	63	61	2	
Vld	56	Bear Cr.	Buchanan Co	Buchanan	47c	MS	WD-REF	8/8/1996	51	Good	77	63	14	maxdep
Vld	56	Bear Cr.	Buchanan Co	Buchanan	47c	MS	WD-REF	8/7/2002	58	Good	77	63	14	
Vld	56	Bear Cr.	Buchanan Co	Buchanan	47c	MS	WD-REF	9/8/2009	48	Fair	66	58	8	cvrepa%, rchmxhb%
Vld	105	Bear Cr.	Eden Valley	Jackson	47f	MS	WD-REF	8/28/2003	50	Fair	52	42	10	subrock%
Vld	105	Bear Cr.	Eden Valley	Jackson	47f	MS	WD-REF	9/1/2011	53	Good	73	50	23	
Clbr	109	Bear Cr.	Roland WWTP	Story	47b	MS	HW-SVY	9/25/1997	39	Fair	36	37	-1	bnkavr%, chshdav%, maxdep
Clbr	109	Bear Cr.	Roland WWTP	Story	47b	MS	HW-SVY	9/10/2003	44	Fair	21	40	-19	chshdav%, chshdsd%
Clbr	110	Bear Cr.	Roland WWTP	Story	47b	MS	HW-SVY	9/26/1997	40	Fair	25	39	-14	maxdep, strwdtav, thwgdpav
Clbr	110	Bear Cr.	Roland WWTP	Story	47b	MS	HW-SVY	9/10/2003	38	Fair	26	37	-11	chshdav%, cvrepa%, cvrwdbrs%, maxdep, strwdtav, thwgdpav
Vld	114	Bear Cr.	Skunk River	Story	47b	MS	WD-REF	10/2/1997	47	Fair	38	43	-5	
Vld	114	Bear Cr.	Skunk River	Story	47b	MS	WD-REF	9/19/2007	51	Good	71	46	25	
Vld	114	Bear Cr.	Skunk River	Story	47b	MS	WD-REF	8/20/2008	52	Good	55	47	8	
Clbr	328	Bear Cr.	Brooklyn	Poweshiek	47f	MS	WD-SVY	9/25/2002	31	Fair	23	27	-4	bnkavr%, maxdep, rchpool%, rchmxhb%, strwdtav, strwdtsd, thwgdpav
Clbr	654	Bear Cr.	Roland	Story	47b	MS	HW-CREF	9/28/2007	47	Fair	36	43	-7	cvrdpl%, cvrovhg%, dpthav, dpthcv, subsilt%
Vld	853	Bear Cr.	Dyersville	Delaware	47c	MS	WD-SVY	7/27/2011	58	Good	44	68	-24	
Clbr	226	Beaver Cr.	Buffalo Grov	Boone	47b	MS	WD-CREF	10/16/2001	39	Fair	45	42	3	subfines%, subrock%
Clbr	226	Beaver Cr.	Buffalo Grov	Boone	47b	MS	WD-CREF	8/11/2011	48	Fair	54	43	11	bnkbare%
Vld	358	Beaver Cr.	Lake Mills	Winnebago	47b	MS	HW-SVY	7/22/2003	31	Fair	28	34	-6	bnkahz%, chshdav%, cvrepa%, cvrwdbrs%, dpthcv, rchpool%, rchmxhb%, strwdtsd, subsilt%, subfines%, subrock%, substrmx%
Clbr	373	Beaver Cr.	New Hartford	Butler	47c	MS	WD-SVY	8/14/2003	42	Fair	45	54	-9	cvrdpl%, dpthav, subfines%, subrock%
Vld	626	Beaver Cr.	Fisheries	Winnebago	47b	MS	WD-SVY	7/24/2006	51	Good	31	54	-23	bnkbare%, chshdav%, chshdsd%, cvrepa%, cvrwdbrs%
Clbr	201	Big Bear Cr.	Victor	Iowa	47f	MS	WD-SVY	9/21/1999	31	Fair	49	32	17	rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	194	Big Cedar Cr.	Gibson St Re	Henry	40a	MS	WD-SVY	9/12/2000	38	Fair	30	30	0	dpthav, embdrtg, subsilt%, subfines%, subrock%
Clbr	228	Big Cedar Cr.	Fonda	Pocahontas	47b	MS	WD-SVY	9/19/2001	56	Good	48	50	-2	strwdtsd
Clbr	228	Big Cedar Cr.	Fonda	Pocahontas	47b	MS	WD-SVY	9/27/2006	41	Fair	57	40	17	bnkahz%, bnkamd%, bnkavr%, bnkbare%, cvrepa%, cvrwdbrs%, strwdtsd, subsilt%
Clbr	128	Big Cr.	Denison	Crawford	47e	MO	WD-REF	8/12/1998	43	Fair	42	34	8	
Clbr	128	Big Cr.	Denison	Crawford	47e	MO	WD-REF	8/10/2004	53	Good	35	41	-6	
Clbr	128	Big Cr.	Denison	Crawford	47e	MO	WD-REF	10/12/2010	45	Fair	31	33	-2	cvrepa%
Clbr	248	Big Cr.	Marion- Secr	Linn	47c	MS	WD-SVY	7/19/2001	52	Good	57	62	-5	
Vld	34	Big Muddy Cr.	Spencer	Clay	47b	MO	WD-REF	9/6/1995	54	Good	35	49	-14	
Vld	34	Big Muddy Cr.	Spencer	Clay	47b	MO	WD-REF	9/5/2001	41	Fair	54	39	15	chshdav%
Vld	34	Big Muddy Cr.	Spencer	Clay	47b	MO	WD-REF	9/15/2009	52	Good	44	45	-1	
Vld	92	Black Cat Cr.	Algona	Kossuth	47b	MS	WD-REF	8/13/1997	45	Fair	51	43	8	bnkahz%, strwdtsd
Vld	92	Black Cat Cr.	Algona	Kossuth	47b	MS	WD-REF	8/25/2003	51	Good	50	43	7	cvrwdbrs%, subsilt%
Vld	92	Black Cat Cr.	Algona	Kossuth	47b	MS	WD-REF	8/15/2011	43	Fair	51	36	15	bnkavr%, cvrwdbrs%
Clbr	55	Black Hawk Cr.	Popp County	Black Hawk	47c	MS	WD-REF	7/31/1996	42	Fair	51	56	-5	subfines%, subrock%
Clbr	55	Black Hawk Cr.	Popp County	Black Hawk	47c	MS	WD-REF	8/8/2002	40	Fair	61	51	10	subsilt%, subfines%, subrock%
Clbr	55	Black Hawk Cr.	Popp County	Black Hawk	47c	MS	WD-REF	9/29/2004	33	Fair	44	47	-3	subsilt%, subfines%, subrock%
Vld	368	Boone Rvr.	Renwick	Wright	47b	MS	WD-SVY	8/20/2003	43	Fair	32	40	-8	cvrovhg%, subfines%, subrock%
Clbr	301	Boyer Rvr.	Deloit	Crawford	47e	MO	WD-SVY	8/1/2002	32	Fair	35	29	6	rchpool%, rchmxhb%
Clbr	369	Boyer Rvr.	Early	Sac	47a	MO	WD-SVY	8/19/2003	32	Fair	39	29	10	bnkahz%, bnkavr%, cvrovhg%, cvrwdbrs%
Clbr	333	Boylan Cr.	Aredale	Butler	47c	MS	HW-SVY	10/9/2002	33	Fair	38	46	-8	dpthav, dpthcv, subfines%, subrock%, substrmx%
Vld	413	Brophy Cr.	Mccausland	Clinton	47f	MS	WD-SVY	8/14/2012	37	Fair	50	38	12	chshdav%, chshdsd%, cvrepa%, subsilt%, subfines%, subrock%

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	165	Brush Cr.	Wadena	Fayette	52b	MS	WD-REF	10/3/2000	57	Good	83	66	17	
Clbr	165	Brush Cr.	Wadena	Fayette	52b	MS	WD-REF	9/27/2005	53	Good	80	63	17	
Clbr	711	Brushy Cr.	Dedham	Carroll	47e	MS	WD-SVY	9/16/2009	30	Fair	28	26	2	cvrwdbrs%, dpthcv, rchpool%, rchmxhb%, subfines%
Clbr	4	Buck Cr.	Barnes City	Mahaska	47f	MS	WD-REF	8/21/2000	33	Fair	21	33	-12	strwdtsd, subfines%, subrock%
Clbr	4	Buck Cr.	Barnes City	Mahaska	47f	MS	WD-REF	9/18/2007	23	Poor	25	25	0	dpthcv, rchmxhb%, strwdtav, strwdtsd, subfines%, subrock%
Clbr	239	Buck Cr.	Delhi	Delaware	47c	MS	WD-SVY	8/13/2001	48	Fair	60	58	2	chshdav%
Clbr	61	Buffalo Cr.	Central City	Linn	47c	MS	WD-REF	8/28/1996	57	Good	80	71	9	
Clbr	61	Buffalo Cr.	Central City	Linn	47c	MS	WD-REF	9/2/2008	58	Good	77	68	9	
Clbr	173	Buffalo Cr.	Titonka	Kossuth	47b	MS	WD-SVY	8/23/2000	36	Fair	18	36	-18	bnkavr%, dpthcv, maxdep, rchpool%, rchmxhb%, strwdtsd, subfines%, thwgdpav
Clbr	174	Buffalo Cr.	Michaelson M	Kossuth	47b	MS	WD-SVY	8/24/2000	29	Fair	15	35	-20	subfines%, subrock%
Clbr	257	Buffalo Cr.	Frozen Hill	Linn	47c	MS	WD-SVY	8/28/2001	51	Good	67	62	5	
Clbr	258	Buffalo Cr.	E-28 Bridge	Jones	47f	MS	WD-SVY	8/27/2001	42	Fair	68	37	31	subfines%, subrock%, substrmx%
Clbr	274	Buffalo Cr.	Red Ridge Ro	Linn	47c	MS	WD-SVY	8/30/2001	57	Good	67	63	4	
Clbr	565	Buffalo Cr.	155th	Winnebago	47b	MS	HW-SVY	9/19/2006	50	Fair	41	47	-6	strwdtav, strwdtsd
Clbr	754	Buffalo Cr.	Winthrop	Buchanan	47c	MS	WD-SVY	9/28/2010	43	Fair	53	56	-3	cvrdpl%, dpthav
Clbr	41	Buffington Cr.	Columbus Cit	Louisa	47f	MS	WD-REF	9/25/1995	55	Good	52	46	6	
Clbr	41	Buffington Cr.	Columbus Cit	Louisa	47f	MS	WD-REF	9/12/2001	56	Good	53	46	7	rchpool%
Clbr	41	Buffington Cr.	Columbus Cit	Louisa	47f	MS	WD-REF	8/23/2010	60	Good	73	49	24	
Clbr	182	Burnett Cr.	Marshalltown	Marshall	47f	MS	WD-SVY	8/22/2000	29	Fair	56	28	28	subfines%, subrock%
Clbr	230	Burr Oak Cr.	Osage (Downs	Mitchell	47c	MS	WD-SVY	8/8/2001	40	Fair	52	52	0	chshdav%, chshdsd%, strwdtsd
Clbr	230	Burr Oak Cr.	Osage (Downs	Mitchell	47c	MS	WD-SVY	8/3/2011	45	Fair	69	53	16	bnkahz%, chshdav%, chshdsd%, dpthcv, strwdtsd
Vld	230	Burr Oak Cr.	Osage (Downs	Mitchell	47c	MS	WD-SVY	7/30/2012	46	Fair	62	58	4	cvrwdbrs%, strwdtsd, subsilt%, subfines%, subrock%
Clbr	32	Buttrick Cr.	Waters Count	Greene	47b	MS	WD-REF	8/30/1995	53	Good	47	52	-5	
Clbr	32	Buttrick Cr.	Waters Count	Greene	47b	MS	WD-REF	7/24/2001	52	Good	36	50	-14	
Clbr	268	Calmus Cr.	Mason City	Cerro Gordo	47c	MS	WD-SVY	9/25/2001	52	Good	51	63	-12	chshdav%, chshdsd%
Clbr	245	Camp Cr.	Mitchellvill	Polk	47f	MS	WD-SVY	7/20/2005	40	Fair	25	36	-11	bnkavr%, strwdtsd
Clbr	529	Camp Cr.	Runnells	Polk	47f	MS	WD-SVY	7/19/2005	37	Fair	39	31	8	bnkahz%, bnkavr%, cvrovhg%, dpthcv, rchpool%, rchmxhb%, strwdtsd, subsilt%, subfines%, subrock%
Clbr	529	Camp Cr.	Runnells	Polk	47f	MS	WD-SVY	9/8/2009	27	Fair	31	30	1	cvrepa%, dpthcv, maxdep, rchpool%, rchmxhb%, strwdtsd, subfines%, subrock%, substrmx%
Clbr	530	Camp Cr.	Thomas Mitch	Polk	47b	MS	WD-SVY	7/12/1999	52	Good	29	48	-19	
Clbr	530	Camp Cr.	Thomas Mitch	Polk	47b	MS	WD-SVY	7/21/2005	53	Good	30	49	-19	
Clbr	530	Camp Cr.	Thomas Mitch	Polk	47b	MS	WD-SVY	9/9/2009	57	Good	32	52	-20	
Clbr	107	Canoe Cr.	Canoe Creek	Winneshiek	52b	MS	WD-REF	9/9/1997	70	Good	81	70	11	
Clbr	107	Canoe Cr.	Canoe Creek	Winneshiek	52b	MS	WD-REF	9/9/2003	71	Excellent	77	73	4	
Clbr	302	Cedar Cr.	Lohrville --	Calhoun	47b	MS	WD-SVY	7/31/2002	50	Fair	43	47	-4	
Vld	381	Cedar Cr.	Delta	Keokuk	47f	MS	HW-SVY	8/18/2003	32	Fair	26	24	2	chshdav%, dpthav, dpthcv, rchpool%, rchmxhb%, subsilt%, subfines%, subrock%
Clbr	334	Chariton Rvr.	Chariton	Lucas	40a	MS	WD-SVY	8/26/2002	28	Fair	19	26	-7	rchpool%, subsilt%, subfines%, subrock%
Vld	84	Chequest Cr.	Pittsburg	Van Buren	40a	MS	WD-REF	7/17/1997	62	Good	47	53	-6	
Vld	84	Chequest Cr.	Pittsburg	Van Buren	40a	MS	WD-REF	7/15/2003	62	Good	45	55	-10	
Vld	84	Chequest Cr.	Pittsburg	Van Buren	40a	MS	WD-REF	7/21/2011	61	Good	35	54	-19	
Clbr	251	Clear Cr.	Lisbon	Cedar	47f	MS	WD-SVY	7/26/2001	65	Good	78	55	23	
Clbr	53	Coldwater Cr.	Greene	Butler	47c	MS	WD-REF	7/23/1996	38	Fair	34	48	-14	bnkamd%, subfines%, subrock%, substrmx%
Clbr	53	Coldwater Cr.	Greene	Butler	47c	MS	WD-REF	8/12/2002	41	Fair	42	51	-9	chshdav%, chshdsd%
Clbr	53	Coldwater Cr.	Greene	Butler	47c	MS	WD-REF	10/13/2009	38	Fair	37	47	-10	bnkbare%, subsilt%, subfines%, subrock%
Clbr	720	Coppers Cr.	Keosauqua	Van Buren	40a	MS	HW-CREF	10/6/2009	40	Fair	43	38	5	cvrepa%, rchpool%, rchmxhb%
Clbr	720	Coppers Cr.	Keosauqua	Van Buren	40a	MS	HW-CREF	9/15/2010	29	Fair	36	30	6	cvrepa%, maxdep, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%, thwgdpav
Clbr	371	Cottonwood Drain	Burlington	Des Moines	72d	MS	WD-SVY	8/5/2003	29	Fair	20	27	-7	bnkahz%, cvrepa%, cvrwdbrs%, dpthav, dpthcv, rchpool%, rchmxhb%, subsilt%, subfines%, subrock%, substrmx%
Clbr	249	Crabapple Cr.	Springville-	Linn	47c	MS	HW-SVY	7/17/2001	48	Fair	57	56	1	strwdtsd
Clbr	3	Crane Cr.	Lourdes	Howard	47c	MS	WD-REF	10/11/2000	53	Good	64	58	6	
Clbr	3	Crane Cr.	Lourdes	Howard	47c	MS	WD-REF	9/28/2009	37	Fair	58	49	9	cvrepa%, subfines%, subrock%
Clbr	164	Crane Cr.	Saratoga	Howard	47c	MS	WD-SVY	10/10/2000	53	Good	57	58	-1	
Clbr	582	Crane Cr.	Riceville	Howard	47c	MS	WD-SVY	8/16/2010	50	Fair	70	58	12	
Clbr	29	Deer Cr.	Carpenter -	Mitchell	47c	MS	WD-REF	8/15/1995	66	Good	74	75	-1	
Clbr	29	Deer Cr.	Carpenter -	Mitchell	47c	MS	WD-REF	8/25/2008	60	Good	73	70	3	
Vld	126	Deer Cr.	Stuart	Guthrie	47f	MS	WD-REF	7/30/1998	50	Fair	61	47	14	
Vld	126	Deer Cr.	Stuart	Guthrie	47f	MS	WD-REF	7/29/2004	54	Good	40	47	-7	
Clbr	232	Deer Cr.	Carpenter- 3	Worth	47c	MS	WD-SVY	8/21/2001	37	Fair	57	52	5	bnkahz%, dpthcv, maxdep, strwdtsd

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	127	Dibble Cr.	Clermont	Fayette	52b	MS	WD-REF	8/4/1998	56	Good	57	61	-4	
Clbr	127	Dibble Cr.	Clermont	Fayette	52b	MS	WD-REF	8/5/2004	47	Fair	44	55	-11	cvrepa%, cvrwdbrs%
Clbr	690	Dick Cr.	Corydon	Wayne	40a	MS	WD-SVY	9/11/2008	12	Poor	26	18	8	maxdep, strwdtav, strwdtsd, subclay%, subrock%
Clbr	707	Dick Cr.	Corydon	Wayne	40a	MS	WD-SVY	8/13/2009	13	Poor	29	19	10	cvrepa%, cvrwdbrs%, strwdtav, subclay%, subfines%, subrock%
Clbr	653	Drainage Ditch 81	Nevada	Story	47b	MS	HW-CREF	8/29/2007	53	Good	30	48	-18	bnkavr%, cvrovhg%
Clbr	653	Drainage Ditch 81	Nevada	Story	47b	MS	HW-CREF	10/4/2007	46	Fair	43	45	-2	cvrwdbrs%, dpthcv
Clbr	215	Dry Run Cr.	Cedar Falls-	Black Hawk	47c	MS	WD-SVY	10/6/1999	50	Fair	50	57	-7	dpthav
Clbr	215	Dry Run Cr.	Cedar Falls-	Black Hawk	47c	MS	WD-SVY	10/3/2005	46	Fair	44	59	-15	cvrepa%, embdrtg, rchpool%, rchmxhb%
Clbr	215	Dry Run Cr.	Cedar Falls-	Black Hawk	47c	MS	WD-SVY	9/29/2009	59	Good	76	67	9	
Clbr	215	Dry Run Cr.	Cedar Falls-	Black Hawk	47c	MS	WD-SVY	9/14/2010	58	Good	74	67	7	
Clbr	215	Dry Run Cr.	Cedar Falls-	Black Hawk	47c	MS	WD-SVY	8/30/2011	58	Good	74	65	9	
Clbr	247	E. Big Cr.	Springville-	Linn	47c	MS	WD-SVY	7/18/2001	49	Fair	72	65	7	
Clbr	189	E. Br. Iowa Rvr.	Goodell	Hancock	47b	MS	WD-CREF	10/17/2000	44	Fair	29	44	-15	chshdav%, chshdsd%
Clbr	189	E. Br. Iowa Rvr.	Goodell	Hancock	47b	MS	WD-CREF	10/7/2010	40	Fair	57	41	16	bnkbare%, cvrepa%, cvrwdbrs%
Vld	189	E. Br. Iowa Rvr.	Goodell	Hancock	47b	MS	WD-CREF	7/24/2012	41	Fair	43	42	1	cvrwdbrs%, subsilt%, subfines%, subrock%
Clbr	190	E. Br. Iowa Rvr.	Belmond	Wright	47b	MS	WD-REF	10/18/2000	44	Fair	39	41	-2	dpthav
Clbr	190	E. Br. Iowa Rvr.	Belmond	Wright	47b	MS	WD-REF	8/25/2005	45	Fair	30	43	-13	cvrwdbrs%, subfines%, subrock%
Vld	190	E. Br. Iowa Rvr.	Belmond	Wright	47b	MS	WD-REF	7/23/2012	50	Fair	35	48	-13	subrock%
Clbr	16	E. Br. W. Nishna. R.	Avoca	Shelby	47e	MO	WD-REF	9/27/2011	41	Fair	27	32	-5	subfines%, subrock%, substrmx%
Clbr	225	E. Buttrick	Pound Pit Co	Greene	47b	MS	WD-CREF	7/18/2001	57	Good	46	52	-6	
Clbr	225	E. Buttrick	Pound Pit Co	Greene	47b	MS	WD-CREF	9/11/2009	53	Good	73	53	20	
Clbr	124	E. Frk. Des Moines R.	Seneca SWMA	Kossuth	47b	MS	WD-CREF	10/14/1997	35	Fair	29	36	-7	subsilt%, subfines%, subrock%
Clbr	124	E. Frk. Des Moines R.	Seneca SWMA	Kossuth	47b	MS	WD-CREF	8/21/2003	46	Fair	45	42	3	embdrtg
Clbr	124	E. Frk. Des Moines R.	Seneca SWMA	Kossuth	47b	MS	WD-CREF	9/9/2011	53	Good	54	50	4	
Vld	103	E. Frk. Wapsi. R.	Sweet Marsh	Bremer	47c	MS	WD-REF	8/27/1997	39	Fair	27	50	-23	dpthav, subrock%
Vld	103	E. Frk. Wapsi. R.	Sweet Marsh	Bremer	47c	MS	WD-REF	9/3/2003	40	Fair	45	45	0	cvrdpl%, dpthav, subsilt%, subfines%, subrock%
Clbr	44	E. Frk. Wapsi. Rvr.	New Hampton	Chickasaw	47c	MS	WD-REF	10/2/1995	34	Fair	43	45	-2	maxdep, strwdtav, strwdtsd, subfines%, subrock%, thwgdpav
Clbr	44	E. Frk. Wapsi. Rvr.	New Hampton	Chickasaw	47c	MS	WD-REF	10/3/2002	31	Fair	43	43	0	bnkahz%, bnkavr%, dpthcv, rchpool%, rchmxhb%, strwdtav, strwdtsd, subsilt%, subfines%, subrock%
Clbr	44	E. Frk. Wapsi. Rvr.	New Hampton	Chickasaw	47c	MS	WD-REF	9/20/2010	30	Fair	54	42	12	cvrepa%, rchpool%, rchmxhb%, strwdtav, strwdtsd, subsilt%, subfines%, subrock%
Clbr	150	E. Nodaway Rvr.	Hawleyville	Page	47f	MO	WD-REF	10/20/1998	43	Fair	28	41	-13	subrock%
Clbr	150	E. Nodaway Rvr.	Hawleyville	Page	47f	MO	WD-REF	10/13/2004	41	Fair	23	39	-16	cvrdpl%, cvrepa%, cvrwdbrs%, subrock%
Vld	150	E. Nodaway Rvr.	Hawleyville	Page	47f	MO	WD-REF	8/21/2012	32	Fair	39	37	2	bnkahz%, cvrepa%, cvrwdbrs%, subclay%
Clbr	101	Elk Cr.	Ida Grove	Ida	47e	MO	WD-SVY	8/21/1997	52	Good	36	37	-1	subsilt%
Clbr	170	Elk Cr.	Elk Creek Ma	Worth	47b	MS	WD-CREF	9/7/2000	39	Fair	21	36	-15	chshdav%, chshdsd%, rchpool%, rchmxhb%, subsilt%, subrock%
Clbr	170	Elk Cr.	Elk Creek Ma	Worth	47b	MS	WD-CREF	8/26/2008	33	Fair	47	30	17	cvrepa%, cvrwdbrs%, subsilt%, subfines%, subrock%
Vld	170	Elk Cr.	Elk Creek Ma	Worth	47b	MS	WD-CREF	9/26/2012	47	Fair	10	40	-30	bnkbare%, cvrepa%, dpthcv, rchpool%, rchmxhb%, subrock%
Clbr	198	Elk Run Cr.	Bunger Park	Black Hawk	47c	MS	WD-SVY	10/5/1999	54	Good	73	62	11	
Clbr	860	Elk Run Cr.	Lanesboro	Carroll	47b	MS	WD-SVY	8/4/2011	52	Good	45	51	-6	
Clbr	208	Elk Rvr.	Camp Mississ	Clinton	47f	MS	WD-SVY	8/17/1999	58	Good	17	49	-32	
Clbr	208	Elk Rvr.	Camp Mississ	Clinton	47f	MS	WD-SVY	8/6/2007	41	Fair	42	39	3	cvrdpl%, cvrepa%, dpthav, subsilt%
Vld	208	Elk Rvr.	Camp Mississ	Clinton	47f	MS	WD-SVY	8/13/2012	57	Good	53	50	3	cvrdpl%, dpthav
Clbr	640	Elk Rvr.	Andover	Clinton	47f	MS	WD-SVY	8/7/2007	23	Poor	29	26	3	cvrdpl%, cvrepa%, cvrwdbrs%, dpthav, rchmxhb%, subclay%, subsilt%, subfines%, subrock%
Clbr	287	English Rvr.	Riverside	Washington	72d	MS	WD-SVY	10/2/2001	32	Fair	34	33	1	bnkahz%, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	204	Farmers Cr.	Fulton	Jackson	47f	MS	WD-SVY	8/18/1999	46	Fair	27	42	-15	dpthav, subsilt%
Clbr	204	Farmers Cr.	Fulton	Jackson	47f	MS	WD-SVY	8/8/2007	45	Fair	42	39	3	bnkahz%, cvrdpl%, cvrepa%, cvrwdbrs%, dpthav, subsilt%
Clbr	204	Farmers Cr.	Fulton	Jackson	47f	MS	WD-SVY	10/20/2011	39	Fair	57	33	24	chshdav%, chshdsd%, cvrdpl%, cvrepa%, dpthav, subsilt%
Clbr	638	Farmers Cr.	LaMotte	Jackson	47f	MS	WD-SVY	8/8/2007	43	Fair	61	41	20	cvrovhg%, cvrwdbrs%, dpthcv, embdrtg, rchmxhb%, strwdtsd, subsilt%
Clbr	353	Flint Cr.	Danville	Des Moines	47f	MS	WD-SVY	7/15/2003	39	Fair	37	35	2	cvrepa%, embdrtg, subfines%, subrock%, substrmx%
Clbr	35	Floyd Rvr.	Sheldon Well	Obrien	47a	MO	WD-RJCT	9/7/1995	47	Fair	36	38	-2	chshdav%, rchmxhb%
Clbr	35	Floyd Rvr.	Sheldon Well	Obrien	47a	MO	WD-RJCT	9/14/1999	47	Fair	32	35	-3	dpthcv, rchpool%, rchmxhb%, subsilt%
Clbr	355	Floyd Rvr.	Sanborn	Obrien	47a	MO	WD-SVY	7/30/2003	43	Fair	37	40	-3	bnkbare%, cvrovhg%, cvrwdbrs%, dpthcv, subsilt%, subfines%, subrock%
Clbr	364	Floyd Rvr.	Alton	Sioux	47a	MO	WD-SVY	8/7/2003	37	Fair	18	33	-15	cvrdpl%, cvrwdbrs%, dpthav, rchpool%, subsilt%, subfines%, subrock%

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	213	Fourmile Cr.	Ankeny WWTP	Polk	47b	MS	WD-SVY	9/29/1999	47	Fair	37	44	-7	embdrtg
Clbr	214	Fourmile Cr.	Ankeny WWTP	Polk	47b	MS	WD-SVY	9/29/1999	45	Fair	30	42	-12	embdrtg
Clbr	300	Fox Rvr.	Bloomfield	Davis	40a	MS	WD-SVY	7/25/2002	42	Fair	22	35	-13	subfines%, subrock%
Clbr	756	Fox Rvr.	Drakesville	Davis	40a	MS	WD-SVY	10/5/2010	35	Fair	30	33	-3	bnkbare%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	757	Fox Rvr.	West Grove	Davis	40a	MS	WD-SVY	10/4/2010	38	Fair	24	35	-11	subfines%, subrock%
Clbr	88	Halfway Cr.	Galva WWTP	Ida	47a	MO	WD-SVY	8/7/1997	43	Fair	32	39	-7	subfines%, subrock%
Clbr	89	Halfway Cr.	Galva WWTP	Ida	47a	MO	WD-SVY	8/7/1997	35	Fair	32	36	-4	rchpool%, rchmxhb%, subfines%, subrock%
Clbr	203	Hickory Cr.	New Vienna	Dubuque	47c	MS	WD-SVY	8/11/1999	61	Good	37	69	-32	
Clbr	203	Hickory Cr.	New Vienna	Dubuque	47c	MS	WD-SVY	9/18/2008	50	Fair	42	61	-19	cvrepa%
Vld	655	Holiday Cr.	Coalville	Webster	47b	MS	HW-CREF	8/2/2007	40	Fair	41	44	-3	cvrwdbrs%, strwdtav
Vld	655	Holiday Cr.	Coalville	Webster	47b	MS	HW-CREF	8/19/2008	51	Good	41	52	-11	cvrwdbrs%
Clbr	130	Honey Cr.	Bedford	Taylor	47f	MO	WD-REF	8/18/1998	34	Fair	46	31	15	rchpool%, subsilt%
Clbr	130	Honey Cr.	Bedford	Taylor	47f	MO	WD-REF	8/18/2004	24	Poor	29	31	-2	strwdtav, strwdtsd, subclay%
Clbr	130	Honey Cr.	Bedford	Taylor	47f	MO	WD-REF	9/8/2010	22	Poor	40	27	13	bnkbare%, cvrepa%, subclay%
Clbr	135	Honey Cr.	Conesville	Louisa	72d	MS	WD-REF	9/2/1998	42	Fair	50	43	7	bnkahz%, bnkamd%, bnkbare%, subrock%
Clbr	252	Horton Cr.	Horton	Bremer	47c	MS	HW-SVY	7/24/2001	39	Fair	61	50	11	chshdav%, embdrtg, maxdep, thwgdpav
Clbr	17	Howerdon Cr.	Winterset	Madison	47f	MS	WD-REF	7/12/2001	52	Good	33	44	-11	chshdav%, chshdsd%
Clbr	17	Howerdon Cr.	Winterset	Madison	47f	MS	WD-REF	7/16/2009	53	Good	47	49	-2	
Clbr	82	Indian Cr.	Lewis	Cass	47e	MO	WD-CREF	10/15/1996	42	Fair	21	34	-13	embdrtg, rchpool%, rchmxhb%, subfines%
Clbr	82	Indian Cr.	Lewis	Cass	47e	MO	WD-CREF	7/23/2002	51	Good	34	41	-7	subfines%
Clbr	82	Indian Cr.	Lewis	Cass	47e	MO	WD-CREF	9/22/2011	35	Fair	26	31	-5	cvrepa%, cvrwdbrs%, dpthcv, embdrtg, rchpool%, rchmxhb%
Vld	186	Indian Cr.	Cedar Rapids	Linn	47c	MS	WD-SVY	9/18/2000	63	Good	66	69	-3	
Vld	186	Indian Cr.	Cedar Rapids	Linn	47c	MS	WD-SVY	8/28/2012	67	Good	69	74	-5	
Clbr	187	Indian Cr.	Cedar Rapids	Linn	47c	MS	WD-SVY	9/19/2000	58	Good	36	67	-31	
Clbr	188	Indian Cr.	Cedar Rapids	Linn	47c	MS	HW-SVY	9/25/2000	47	Fair	44	55	-11	embdrtg
Clbr	376	Indian Cr.	Mingo	Jasper	47b	MS	WD-SVY	9/30/2003	33	Fair	30	37	-7	rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	857	Jackson Cr.	Corydon	Wayne	40a	MO	WD-SVY	9/14/2011	30	Fair	31	30	1	subfines%, subrock%, substrmx%
Clbr	316	Johnson Cr.	Aplington	Butler	47c	MS	HW-SVY	9/11/2002	42	Fair	54	48	6	bnkavr%, embdrtg, strwdtav, strwdtsd
Clbr	15	Jordan Cr.	Macedonia	Pottawattamie	47e	MO	WD-REF	8/1/2001	24	Poor	23	22	1	rchmxhb%, subclay%, subsilt%, subfines%, subrock%
Clbr	15	Jordan Cr.	Macedonia	Pottawattamie	47e	MO	WD-REF	7/27/2009	22	Poor	25	18	7	strwdtsd, subclay%, subfines%, subrock%
Vld	907	Jordan Cr.	Millerton	Wayne	40a	MO	WD-SVY	9/12/2012	30	Fair	24	24	0	cvrepa%, rchpool%, rchmxhb%, strwdtav, subrock%, thwgdpav
Vld	86	Keg Cr.	Mineola	Mills	47e	MO	WD-RJCT	8/15/2012	36	Fair	3	27	-24	dpthcv, rchmxhb%, subfines%, subrock%
Clbr	308	Keg Cr.	McClelland	Pottawattamie	47e	MO	WD-SVY	9/4/2002	33	Fair	30	26	4	subfines%, subrock%
Vld	308	Keg Cr.	McClelland	Pottawattamie	47e	MO	WD-SVY	8/13/2012	39	Fair	3	28	-25	rchmxhb%
Clbr	112	Keigley Br.	Gilbert	Story	47b	MS	WD-SVY	9/29/1997	41	Fair	39	41	-2	maxdep
Clbr	83	Lick Cr.	Shimek State	Lee	40a	MS	WD-REF	7/16/1997	57	Good	51	48	3	bnkahz%
Clbr	83	Lick Cr.	Shimek State	Lee	40a	MS	WD-REF	7/14/2003	55	Good	20	48	-28	cvrepa%
Clbr	83	Lick Cr.	Shimek State	Lee	40a	MS	WD-REF	9/10/2010	59	Good	63	49	14	
Clbr	154	Lime Cr.	Lime Creek P	Buchanan	47c	MS	WD-REF	8/23/1995	63	Good	84	69	15	
Clbr	154	Lime Cr.	Lime Creek P	Buchanan	47c	MS	WD-REF	8/7/1996	61	Good	71	68	3	
Clbr	154	Lime Cr.	Lime Creek P	Buchanan	47c	MS	WD-REF	8/26/1997	63	Good	75	69	6	
Clbr	154	Lime Cr.	Lime Creek P	Buchanan	47c	MS	WD-REF	8/9/2000	60	Good	77	67	10	
Clbr	154	Lime Cr.	Lime Creek P	Buchanan	47c	MS	WD-REF	9/4/2007	62	Good	78	69	9	
Clbr	154	Lime Cr.	Lime Creek P	Buchanan	47c	MS	WD-REF	8/21/2008	58	Good	69	64	5	
Clbr	523	Little Bear Cr.	Brooklyn	Poweshiek	47f	MS	WD-SVY	8/24/2010	34	Fair	35	35	0	rchmxhb%, subfines%, subrock%
Clbr	2	Little Beaver Cr.	Woodward	Dallas	47b	MS	WD-REF	7/26/2000	38	Fair	33	38	-5	chshdav%, embdrtg
Clbr	2	Little Beaver Cr.	Woodward	Dallas	47b	MS	WD-REF	7/24/2007	42	Fair	52	44	8	cvrwdbrs%
Clbr	171	Little Buffalo Cr.	Titonka - R1	Kossuth	47b	MS	WD-SVY	8/22/2000	28	Fair	27	27	0	chshdav%, dpthcv, maxdep, rchpool%, rchmxhb%, strwdtsd, subfines%, subrock%, substrmx%
Clbr	172	Little Buffalo Cr.	Titonka - P6	Kossuth	47b	MS	WD-SVY	8/21/2000	34	Fair	24	35	-11	chshdav%, chshdsd%, subfines%, subrock%
Clbr	229	Little Cedar Cr.	Sunken Grove	Pocahontas	47b	MS	WD-SVY	9/20/2001	52	Good	53	46	7	bnkavr%
Clbr	229	Little Cedar Cr.	Sunken Grove	Pocahontas	47b	MS	WD-SVY	9/28/2006	38	Fair	57	29	28	bnkahz%, bnkavr%, bnkbare%, cvrdpl%, cvrepa%, cvrwdbrs%, dpthav, dpthcv, rchpool%, rchmxhb%, strwdtsd, subsilt%
Clbr	45	Little Cedar Rvr.	Colwell Co P	Floyd	47c	MS	WD-REF	10/3/1995	55	Good	85	66	19	
Clbr	45	Little Cedar Rvr.	Colwell Co P	Floyd	47c	MS	WD-REF	9/9/2009	58	Good	80	62	18	
Clbr	206	Little Floyd Rvr.	Sheldon	Obrien	47a	MO	WD-SVY	9/14/1999	33	Fair	28	32	-4	chshdav%, strwdtsd, subsilt%, subfines%, subrock%
Clbr	240	Little Floyd Rvr.	Sheldon	Obrien	47a	MO	WD-SVY	9/12/2001	39	Fair	38	35	3	strwdtav
Clbr	241	Little Floyd Rvr.	Sheldon	Obrien	47a	MO	WD-SVY	9/11/2001	35	Fair	41	36	5	chshdav%, maxdep, strwdtsd, subsilt%, subfines%
Clbr	304	Little Floyd Rvr.	Sheldon	Obrien	47a	MO	WD-SVY	8/22/2002	41	Fair	33	38	-5	bnkahz%, bnkbare%
Clbr	99	Little Maple Rvr.	Galva	Cherokee	47a	MO	WD-SVY	8/20/1997	40	Fair	38	38	0	embdrtg

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	40	Little Maquoketa R.	Twin Springs	Dubuque	52b	MS	WD-REF	9/21/1995	68	Good	63	70	-7	
Clbr	40	Little Maquoketa R.	Twin Springs	Dubuque	52b	MS	WD-REF	8/28/2001	59	Good	57	60	-3	dpthav
Clbr	40	Little Maquoketa R.	Twin Springs	Dubuque	52b	MS	WD-REF	8/19/2008	55	Good	67	65	2	
Clbr	64	Little Rock Rvr.	Little Rock	Lyon	47a	MO	WD-REF	9/5/1996	30	Fair	40	31	9	bnkahz%, chshdav%, maxdep, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	64	Little Rock Rvr.	Little Rock	Lyon	47a	MO	WD-REF	8/5/2003	48	Fair	45	41	4	cvrovhg%
Clbr	64	Little Rock Rvr.	Little Rock	Lyon	47a	MO	WD-REF	9/28/2011	39	Fair	61	36	25	bnkbare%, cvrwdbrs%, rchpool%, rchmxhb%
Clbr	329	Little Rvr.	Leon	Decatur	40a	MS	WD-SVY	9/23/2002	24	Poor	13	21	-8	maxdep, rchpool%, rchmxhb%, strwdtav, subfines%, subrock%, substrmx%, thwgdpav
Clbr	62	Little Sioux Rvr.	Lake Park- D	Dickinson	47b	MO	WD-REF	9/3/1996	47	Fair	57	45	12	subsilt%, subfines%
Clbr	62	Little Sioux Rvr.	Lake Park- D	Dickinson	47b	MO	WD-REF	7/23/2003	34	Fair	37	36	1	bnkahz%, bnkamd%, chshdav%, cvrepa%, cvrwdbrs%, subsilt%, subrock%
Clbr	62	Little Sioux Rvr.	Lake Park- D	Dickinson	47b	MO	WD-REF	9/29/2011	41	Fair	45	42	3	bnkahz%, chshdav%, cvrepa%, cvrwdbrs%
Clbr	63	Little Sioux Rvr.	Horseshoe Be	Dickinson	47b	MO	WD-REF	9/4/1996	59	Good	56	55	1	
Clbr	63	Little Sioux Rvr.	Horseshoe Be	Dickinson	47b	MO	WD-REF	7/22/2003	57	Good	31	56	-25	cvrdpl%, dpthav
Clbr	63	Little Sioux Rvr.	Horseshoe Be	Dickinson	47b	MO	WD-REF	9/30/2011	46	Fair	60	41	19	bnkamd%
Clbr	108	Little Turkey Rvr.	Gouldsburg C	Fayette	47c	MS	WD-REF	9/10/1997	69	Good	83	83	0	
Clbr	108	Little Turkey Rvr.	Gouldsburg C	Fayette	47c	MS	WD-REF	9/10/2003	68	Good	76	78	-2	
Clbr	335	Little Turkey Rvr.	Protivin	Howard	47c	MS	WD-SVY	8/19/2002	61	Good	84	68	16	
Clbr	50	Little Waterman Cr.	Waterman Cre	Obrien	47a	MO	WD-REF	8/27/2002	49	Fair	42	43	-1	bnkbare%, chshdav%, chshdsd%, strwdtav, strwdtsd
Clbr	50	Little Waterman Cr.	Waterman Cre	Obrien	47a	MO	WD-REF	8/25/2008	50	Fair	62	43	19	cvrovhg%, embdrtg, strwdtav
Clbr	66	Lizard Cr.	Clare	Webster	47b	MS	WD-REF	9/11/1996	53	Good	61	52	9	dpthcv
Clbr	66	Lizard Cr.	Clare	Webster	47b	MS	WD-REF	10/1/2002	64	Good	85	62	23	
Clbr	66	Lizard Cr.	Clare	Webster	47b	MS	WD-REF	8/22/2011	59	Good	75	57	18	
Clbr	37	Long Cr.	Decatur SWA-	Decatur	40a	MO	WD-REF	9/14/1995	44	Fair	62	41	21	bnkahz%
Clbr	37	Long Cr.	Decatur SWA-	Decatur	40a	MO	WD-REF	10/11/2001	44	Fair	38	39	-1	embdrtg
Clbr	37	Long Cr.	Decatur SWA-	Decatur	40a	MO	WD-REF	8/30/2010	33	Fair	41	33	8	bnkahz%, bnkbare%, cvrepa%
Clbr	42	Long Cr.	Columbus Jun	Louisa	47f	MS	WD-REF	9/26/1995	56	Good	54	48	6	
Clbr	42	Long Cr.	Columbus Jun	Louisa	47f	MS	WD-REF	9/9/2010	47	Fair	60	47	13	dpthcv, rchpool%, rchmxhb%
Clbr	115	Long Dick Cr.	Roland	Story	47b	MS	WD-SVY	10/2/1997	33	Fair	19	33	-14	bnkamd%, strwdtav, subfines%, subrock%, thwgdpav
Clbr	115	Long Dick Cr.	Roland	Story	47b	MS	WD-SVY	9/23/2003	35	Fair	34	37	-3	chshdav%, cvrepa%, maxdep, rchmxhb%, strwdtav, subsilt%
Clbr	116	Long Dick Cr.	Roland	Hamilton	47b	MS	WD-SVY	10/2/1997	54	Good	38	48	-10	chshdav%
Clbr	116	Long Dick Cr.	Roland	Hamilton	47b	MS	WD-SVY	9/24/2003	52	Good	33	49	-16	chshdav%, chshdsd%, cvrovhg%
Clbr	691	Long Dick Cr.	Ellsworth	Hamilton	47b	MS	HW-SVY	10/6/2008	31	Fair	24	32	-8	chshdav%, cvrepa%, cvrwdbrs%, maxdep, strwdtav, strwdtsd, subsilt%
Clbr	137	Lost Cr.	Princeton	Scott	47f	MS	WD-REF	9/10/1998	36	Fair	46	33	13	subfines%, subrock%
Clbr	137	Lost Cr.	Princeton	Scott	47f	MS	WD-REF	8/31/2004	38	Fair	53	28	25	rchpool%, rchmxhb%, subsilt%, subfines%, subrock%
Clbr	60	Lotts Cr.	Ringgold SWM	Ringgold	40a	MO	WD-REF	8/26/1996	46	Fair	33	39	-6	
Clbr	60	Lotts Cr.	Ringgold SWM	Ringgold	40a	MO	WD-REF	7/18/2003	30	Fair	22	32	-10	cvrwdbrs%, embdrtg, subclay%
Clbr	60	Lotts Cr.	Ringgold SWM	Ringgold	40a	MO	WD-REF	9/9/2010	32	Fair	39	31	8	embdrtg, subfines%, subrock%
Clbr	319	Lotts Cr.	West Bend	Kossuth	47b	MS	WD-SVY	9/25/2002	50	Fair	48	46	2	chshdav%, chshdsd%
Clbr	551	Lyons Cr.	Webster City	Webster	47b	MS	HW-SVY	8/22/2006	36	Fair	46	34	12	chshdav%, chshdsd%, strwdtav
Clbr	551	Lyons Cr.	Webster City	Webster	47b	MS	HW-SVY	9/15/2008	44	Fair	73	43	30	
Vld	552	Lyons Cr.	Webster City	Webster	47b	MS	HW-SVY	8/23/2006	37	Fair	35	34	1	cvrwdbrs%, embdrtg, strwdtav, subsilt%, subfines%
Vld	552	Lyons Cr.	Webster City	Webster	47b	MS	HW-SVY	9/16/2008	29	Fair	35	31	4	chshdav%, chshdsd%, cvrepa%, cvrwdbrs%, strwdtav, strwdtsd, subsilt%
Clbr	22	Lytle Cr.	Zwingle	Dubuque	47f	MS	WD-REF	7/27/1995	67	Good	48	58	-10	
Clbr	22	Lytle Cr.	Zwingle	Dubuque	47f	MS	WD-REF	8/16/1999	67	Good	38	58	-20	
Clbr	22	Lytle Cr.	Zwingle	Dubuque	47f	MS	WD-REF	7/31/2007	59	Good	45	53	-8	bnkahz%
Clbr	100	Maple Cr.	Aurelia	Cherokee	47a	MO	WD-SVY	8/20/1997	36	Fair	33	33	0	chshdav%, strwdtsd
Clbr	96	Maple Rvr.	Aurelia	Cherokee	47a	MO	WD-SVY	8/20/1997	38	Fair	44	36	8	chshdav%
Clbr	97	Maple Rvr.	Galva	Ida	47a	MO	WD-SVY	8/20/1997	34	Fair	35	35	0	chshdav%, chshdsd%, maxdep, rchpool%, rchmxhb%
Clbr	98	Maple Rvr.	Aurelia	Cherokee	47a	MO	WD-SVY	8/20/1997	40	Fair	28	39	-11	maxdep, strwdtsd
Clbr	102	Maple Rvr.	Ida Grove WW	Ida	47e	MO	WD-SVY	8/21/1997	35	Fair	38	31	7	rchpool%, rchmxhb%, substrmx%
Vld	323	Maquoketa Rvr.	Manchester	Delaware	47c	MS	WD-SVY	9/24/2012	57	Good	61	68	-7	
Clbr	537	Maquoketa Rvr.	Monticello	Jones	47c	MS	WD-SVY	9/6/2005	54	Good	75	65	10	
Clbr	312	Marrowbone Cr.	Lanesboro	Carroll	47b	MS	WD-SVY	9/12/2002	49	Fair	45	45	0	bnkbare%, rchpool%, rchmxhb%
Clbr	312	Marrowbone Cr.	Lanesboro	Carroll	47b	MS	WD-SVY	9/13/2007	36	Fair	66	38	28	cvrepa%, cvrwdbrs%, rchpool%, rchmxhb%
Clbr	553	Marrowbone Cr.	Lanesboro	Carroll	47b	MS	HW-SVY	9/12/2007	55	Good	57	50	7	
Clbr	20	Maynes Cr.	Mallory Co.	Franklin	47b	MS	WD-REF	8/23/2001	53	Good	54	46	8	bnkavr%
Clbr	20	Maynes Cr.	Mallory Co.	Franklin	47b	MS	WD-REF	8/18/2008	62	Good	71	58	13	
Clbr	332	Middle Avery Cr.	Chillicothe	Wapello	40a	MS	WD-SVY	8/27/2002	49	Fair	26	40	-14	

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	864	Middle Frk. Grand R.	Mount Ayr	Ringgold	40a	MO	WD-SVY	8/24/2011	34	Fair	15	35	-20	cvrwdbrs%, embdrtg
Clbr	865	Middle Frk. Grand R.	Mount Ayr	Ringgold	40a	MO	WD-SVY	8/24/2011	23	Poor	10	26	-16	cvrepa%, maxdep, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%, thwgdpav
Clbr	151	Middle Nodaway R.	Bridgewater	Adair	47f	MO	WD-CREF	10/12/2004	33	Fair	11	33	-22	cvrwdbrs%, subfines%, subrock%
Clbr	850	Middle Raccoon R.	Coon Rapids-	Guthrie	47e	MS	WD-SVY	10/6/2011	48	Fair	18	39	-21	cvrepa%, embdrtg
Clbr	138	Middle Rvr.	Pammel State	Madison	47f	MS	WD-REF	9/16/1998	55	Good	38	53	-15	
Vld	138	Middle Rvr.	Pammel State	Madison	47f	MS	WD-REF	7/16/2012	50	Fair	40	45	-5	bnkahz%, chshdav%
Clbr	292	Middle Rvr.	Indianola	Warren	47f	MS	WD-SVY	7/17/2002	40	Fair	21	40	-19	subfines%, subrock%, substrmx%
Clbr	243	Milford Cr.	Milford	Dickinson	47b	MO	WD-SVY	9/6/2001	41	Fair	39	43	-4	chshdav%, chshdsd%, maxdep, rchpool%, rchmxhb%
Clbr	244	Milford Cr.	Milford	Dickinson	47b	MO	WD-SVY	9/6/2001	55	Good	50	54	-4	chshdav%, chshdsd%
Vld	142	Mill Cr.	Larrabee	Cherokee	47a	MO	WD-REF	10/7/1998	40	Fair	43	40	3	embdrtg, rchmxhb%, subfines%, subrock%
Vld	142	Mill Cr.	Larrabee	Cherokee	47a	MO	WD-REF	10/12/2005	53	Good	35	50	-15	embdrtg, rchmxhb%
Vld	142	Mill Cr.	Larrabee	Cherokee	47a	MO	WD-REF	9/18/2012	59	Good	44	51	-7	
Clbr	199	Miller Cr.	Washburn	Black Hawk	47c	MS	WD-SVY	10/12/1999	43	Fair	51	53	-2	subrock%
Clbr	51	Mosquito Cr.	Panora	Dallas	47b	MS	WD-REF	7/15/1996	48	Fair	27	43	-16	bnkahz%, bnkavr%, chshdav%
Clbr	51	Mosquito Cr.	Panora	Dallas	47b	MS	WD-REF	8/8/2002	46	Fair	29	39	-10	rchpool%, rchmxhb%
Clbr	51	Mosquito Cr.	Panora	Dallas	47b	MS	WD-REF	9/18/2009	49	Fair	28	45	-17	chshdav%
Vld	166	Mosquito Cr.	Manawa	Pottawattamie	47e	MO	WD-SVY	10/10/2000	34	Fair	30	29	1	subclay%
Vld	166	Mosquito Cr.	Manawa	Pottawattamie	47e	MO	WD-SVY	9/24/2012	26	Fair	27	24	3	dpthcv, rchpool%, rchmxhb%, subrock%
Clbr	167	Mosquito Cr.	Council Bluf	Pottawattamie	47e	MO	WD-SVY	10/9/2000	52	Good	25	43	-18	maxdep
Vld	167	Mosquito Cr.	Council Bluf	Pottawattamie	47e	MO	WD-SVY	8/14/2012	50	Fair	4	36	-32	cvrwdbrs%, embdrtg
Clbr	168	Mosquito Cr.	Underwood	Pottawattamie	47e	MO	WD-SVY	10/11/2000	23	Poor	16	19	-3	dpthcv, subclay%, subsilt%, subfines%, subrock%
Clbr	169	Mosquito Cr.	Persia	Harrison	47e	MO	WD-SVY	10/12/2000	24	Poor	19	18	1	dpthav, dpthcv, strwdtsd, subclay%, subfines%, subrock%
Clbr	309	Mosquito Cr.	Panama	Shelby	47e	MO	WD-SVY	9/5/2002	33	Fair	11	23	-12	dpthcv, maxdep, subfines%, subrock%
Clbr	196	Muchakinock Cr.	Hull State G	Mahaska	47f	MS	WD-SVY	8/30/2000	39	Fair	5	38	-33	
Clbr	196	Muchakinock Cr.	Hull State G	Mahaska	47f	MS	WD-SVY	10/5/2011	31	Fair	2	29	-27	cvrepa%, subsilt%, subfines%, subrock%, substrmx%
Clbr	197	Muchakinock Cr.	Eddyville	Mahaska	47f	MS	WD-SVY	8/31/2000	18	Poor	14	20	-6	dpthav, rchpool%, rchmxhb%, strwdtsd, subclay%, subsilt%
Clbr	197	Muchakinock Cr.	Eddyville	Mahaska	47f	MS	WD-SVY	9/2/2011	34	Fair	38	34	4	subclay%
Clbr	67	Mud Cr.	Wilton - Nor	Muscatine	47f	MS	WD-SVY	9/16/1996	35	Fair	37	33	4	subfines%, subrock%
Clbr	68	Mud Cr.	Wilton - Nor	Muscatine	47f	MS	WD-SVY	9/16/1996	36	Fair	36	33	3	subfines%, subrock%
Clbr	70	Mud Cr.	Durant WWTP	Muscatine	47f	MS	WD-SVY	9/17/1996	24	Poor	15	26	-11	chshdsd%, strwdtav, strwdtsd, subsilt%
Clbr	71	Mud Cr.	Durant WWTP	Muscatine	47f	MS	WD-SVY	9/17/1996	16	Poor	12	22	-10	strwdtav, strwdtsd, subclay%, subsilt%, subfines%, subrock%
Clbr	384	Mud Cr.	Wilton	Muscatine	47f	MS	WD-SVY	9/16/2003	33	Fair	25	29	-4	subsilt%, subfines%, subrock%
Clbr	385	Mud Cr.	Wilton	Muscatine	47f	MS	WD-SVY	9/17/2003	34	Fair	27	27	0	cvrwdbrs%, dpthav, rchpool%, rchmxhb%, subsilt%, subrock%
Clbr	386	Mud Cr.	Wilton	Muscatine	47f	MS	WD-SVY	9/16/2003	36	Fair	40	33	7	rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	779	Mud Cr.	Brandon	Buchanan	47c	MS	HW-CREF	9/29/2011	38	Fair	56	51	5	maxdep, subfines%, subrock%, thwgdpav
Vld	8	No. Br. No. Rvr.	Goeldner Woo	Madison	47f	MS	WD-REF	7/18/2012	56	Good	32	47	-15	
Clbr	8	No. Br. North Rvr.	Goeldner Woo	Madison	47f	MS	WD-REF	8/25/1995	50	Fair	35	44	-9	
Clbr	8	No. Br. North Rvr.	Goeldner Woo	Madison	47f	MS	WD-REF	8/21/1996	49	Fair	34	43	-9	
Clbr	8	No. Br. North Rvr.	Goeldner Woo	Madison	47f	MS	WD-REF	7/28/1997	53	Good	47	52	-5	
Clbr	8	No. Br. North Rvr.	Goeldner Woo	Madison	47f	MS	WD-REF	7/27/2000	49	Fair	31	41	-10	
Clbr	8	No. Br. North Rvr.	Goeldner Woo	Madison	47f	MS	WD-REF	8/21/2007	56	Good	47	49	-2	
Clbr	264	No. Br. Volga Rvr.	Randalia	Fayette	47c	MS	WD-SVY	9/18/2001	47	Fair	68	55	13	subfines%
Clbr	202	No. Frk. Maquok. R.	New Wine Par	Dubuque	47c	MS	WD-SVY	8/10/1999	53	Good	27	62	-35	
Clbr	261	No. Frk. Maquok. R.	New Vienna	Dubuque	47c	MS	WD-SVY	8/21/2001	45	Fair	26	55	-29	chshdav%, chshdsd%, embdrtg
Clbr	262	No. Frk. Maquok. R.	Dyersville	Dubuque	47c	MS	WD-SVY	8/20/2001	51	Good	29	57	-28	subsilt%
Clbr	262	No. Frk. Maquok. R.	Dyersville	Dubuque	47c	MS	WD-SVY	7/27/2005	57	Good	37	59	-22	
Clbr	263	No. Frk. Maquok. R.	New Vienna	Dubuque	47c	MS	WD-SVY	7/28/2005	53	Good	36	57	-21	embdrtg, subsilt%
Vld	143	No. Raccoon Rvr.	Raccoon Rive	Sac	47b	MS	WD-REF	10/8/1998	47	Fair	55	47	8	embdrtg
Vld	143	No. Raccoon Rvr.	Raccoon Rive	Sac	47b	MS	WD-REF	9/30/2004	57	Good	56	53	3	
Clbr	78	No. Skunk Rvr.	Rose Hill	Mahaska	47f	MS	WD-REF	10/7/1996	32	Fair	35	32	3	bnkbare%, subfines%, subrock%
Clbr	78	No. Skunk Rvr.	Rose Hill	Mahaska	47f	MS	WD-REF	8/14/2002	35	Fair	12	31	-19	bnkbare%, dpthav, subsilt%, subfines%, subrock%
Clbr	78	No. Skunk Rvr.	Rose Hill	Mahaska	47f	MS	WD-REF	8/22/2011	35	Fair	3	29	-26	bnkbare%, cvrdpl%, dpthav, subsilt%, subfines%, subrock%
Vld	233	No. Skunk Rvr.	Millgrove Co	Poweshiek	47f	MS	WD-SVY	8/6/2001	37	Fair	15	35	-20	bnkbare%, subfines%, subrock%
Vld	233	No. Skunk Rvr.	Millgrove Co	Poweshiek	47f	MS	WD-SVY	7/26/2012	39	Fair	14	36	-22	bnkahz%, cvrwdbrs%, subfines%, subrock%
Clbr	234	No. Skunk Rvr.	Kellogg City	Jasper	47f	MS	WD-SVY	8/8/2001	34	Fair	19	33	-14	rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	235	No. Skunk Rvr.	Newton	Jasper	47f	MS	WD-SVY	8/9/2001	32	Fair	16	31	-15	dpthcv, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	236	No. Skunk Rvr.	Sully	Jasper	47f	MS	WD-SVY	8/7/2001	35	Fair	17	33	-16	rchpool%, rchmxhb%, subfines%, subrock%, substrmx%

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	216	Nutting Cr.	Ossian	Fayette	52b	MS	WD-SVY	9/1/1999	55	Good	49	56	-7	bnkavr%
Clbr	216	Nutting Cr.	Ossian	Fayette	52b	MS	WD-SVY	7/27/2006	51	Good	68	51	17	cvrepa%, subsilt%
Clbr	554	Nutting Cr.	Clermont	Fayette	52b	MS	WD-SVY	7/26/2006	56	Good	50	58	-8	bnkbare%, cvrepa%
Clbr	554	Nutting Cr.	Clermont	Fayette	52b	MS	WD-SVY	10/6/2008	54	Good	55	58	-3	cvrepa%, cvrwdbrs%
Clbr	554	Nutting Cr.	Clermont	Fayette	52b	MS	WD-SVY	9/21/2009	57	Good	66	63	3	bnkbare%, cvrepa%
Clbr	554	Nutting Cr.	Clermont	Fayette	52b	MS	WD-SVY	9/13/2010	56	Good	65	61	4	bnkbare%, cvrepa%, cvrwdbrs%
Clbr	354	Ocheyedan Rvr.	Spencer	Clay	47a	MO	WD-SVY	7/24/2003	36	Fair	28	37	-9	cvrovhg%, cvrwdbrs%, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	94	Odebolt Cr.	American Leg	Ida	47e	MO	WD-SVY	8/19/1997	43	Fair	42	35	7	rchpool%
Clbr	95	Odebolt Cr.	Ida Grove	Ida	47e	MO	WD-SVY	8/19/1997	52	Good	34	40	-6	
Clbr	374	Odebolt Cr.	Odebolt	Sac	47e	MO	HW-SVY	10/15/2003	31	Fair	32	22	10	cvrovhg%, cvrwdbrs%, maxdep, rchpool%, rchmxhb%, strwdtav, strwdtsd, subsilt%, subfines%, subrock%
Clbr	5	Old Mans Cr.	Williamstown	Johnson	47f	MS	WD-CREF	9/7/2000	33	Fair	27	31	-4	subfines%, subrock%
Clbr	5	Old Mans Cr.	Williamstown	Johnson	47f	MS	WD-CREF	10/11/2010	34	Fair	24	31	-7	cvrdpl%, dpthav, subfines%, subrock%
Clbr	650	Onion Cr.	Ames	Story	47b	MS	HW-CREF	7/25/2007	40	Fair	40	43	-3	chshdav%
Clbr	650	Onion Cr.	Ames	Story	47b	MS	HW-CREF	9/20/2007	39	Fair	50	40	10	chshdav%
Clbr	650	Onion Cr.	Ames	Story	47b	MS	HW-CREF	8/22/2008	45	Fair	45	46	-1	chshdav%
Clbr	129	Otter Cr.	Deloit	Crawford	47e	MO	WD-REF	8/11/2004	40	Fair	47	32	15	cvrepa%, rchpool%
Clbr	129	Otter Cr.	Deloit	Crawford	47e	MO	WD-REF	10/11/2010	43	Fair	37	32	5	embdrtg, subfines%
Clbr	191	Otter Cr.	Holmes	Wright	47b	MS	WD-SVY	8/31/2000	40	Fair	49	39	10	maxdep, subfines%
Clbr	192	Otter Cr.	Otter Creek	Wright	47b	MS	WD-SVY	8/10/2000	53	Good	45	44	1	
Clbr	13	Paint Cr.	Yellow River	Allamakee	52b	MS	WD-REF	8/13/2007	54	Good	51	59	-8	cvrovhg%
Clbr	13	Paint Cr.	Yellow River	Allamakee	52b	MS	WD-REF	8/13/2010	49	Fair	63	55	8	cvrdpl%, cvrovhg%, cvrwdbrs%, dpthav
Clbr	13	Paint Cr.	Yellow River	Allamakee	52b	MS	WD-REF	8/10/2011	53	Good	59	56	3	cvrepa%
Clbr	564	Pike Run	420th	Winnebago	47b	MS	WD-SVY	9/19/2006	32	Fair	24	37	-13	cvrovhg%, dpthcv, embdrtg, maxdep, rchpool%, rchmxhb%, strwdtsd, subsilt%, subfines%, subrock%
Vld	104	Pine Cr.	Quasqueton	Buchanan	47c	MS	WD-REF	8/28/1997	58	Good	76	68	8	subsilt%
Vld	104	Pine Cr.	Quasqueton	Buchanan	47c	MS	WD-REF	8/11/2003	55	Good	69	63	6	cvrwdbrs%
Vld	104	Pine Cr.	Quasqueton	Buchanan	47c	MS	WD-REF	8/9/2011	62	Good	67	72	-5	
Clbr	320	Pleasant Cr.	Springbrook	Jackson	52b	MS	WD-SVY	9/12/2002	43	Fair	69	51	18	embdrtg
Clbr	320	Pleasant Cr.	Springbrook	Jackson	52b	MS	WD-SVY	9/24/2002	57	Good	66	61	5	
Clbr	91	Plum Cr.	Algona	Kossuth	47b	MS	WD-REF	8/12/1997	39	Fair	31	37	-6	rchpool%, rchmxhb%, subsilt%
Clbr	91	Plum Cr.	Algona	Kossuth	47b	MS	WD-REF	8/24/2005	45	Fair	49	39	10	cvrwdbrs%, subsilt%
Clbr	106	Plum Cr.	Hopkinton	Delaware	47c	MS	WD-REF	9/4/1997	49	Fair	57	60	-3	rchmxhb%
Clbr	106	Plum Cr.	Hopkinton	Delaware	47c	MS	WD-REF	9/2/2003	58	Good	62	65	-3	
Clbr	106	Plum Cr.	Hopkinton	Delaware	47c	MS	WD-REF	8/29/2011	48	Fair	65	59	6	rchmxhb%
Clbr	59	Prairie Cr.	Dolliver Sta	Webster	47b	MS	WD-REF	8/22/1996	61	Good	67	57	10	
Clbr	59	Prairie Cr.	Dolliver Sta	Webster	47b	MS	WD-REF	9/3/2002	51	Good	55	51	4	chshdav%, chshdsd%
Clbr	59	Prairie Cr.	Dolliver Sta	Webster	47b	MS	WD-REF	8/2/2011	62	Good	57	56	1	
Clbr	227	Prairie Cr.	Whittemore	Palo Alto	47b	MS	WD-SVY	10/2/2001	37	Fair	33	39	-6	chshdav%, chshdsd%, dpthcv, maxdep, strwdtav, strwdtsd, subfines%, subrock%, substrmx%
Vld	250	Prairie Cr.	Maquoketa	Jackson	47f	MS	WD-SVY	8/14/2001	51	Good	69	48	21	
Vld	250	Prairie Cr.	Maquoketa	Jackson	47f	MS	WD-SVY	10/1/2008	49	Fair	65	42	23	subsilt%
Vld	250	Prairie Cr.	Maquoketa	Jackson	47f	MS	WD-SVY	8/26/2009	40	Fair	78	37	41	bnkahz%, dpthav, dpthcv, subrock%
Vld	250	Prairie Cr.	Maquoketa	Jackson	47f	MS	WD-SVY	9/8/2010	44	Fair	63	42	21	cvrdpl%, dpthav
Clbr	185	Pratt Cr.	Mt Auburn	Benton	47c	MS	WD-SVY	9/5/2000	44	Fair	54	55	-1	rchmxhb%, subfines%, subrock%
Clbr	36	Richland Cr.	Haven	Tama	47f	MS	WD-REF	9/8/1995	34	Fair	42	33	9	maxdep, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	36	Richland Cr.	Haven	Tama	47f	MS	WD-REF	9/22/1999	40	Fair	55	36	19	subsilt%, subfines%, subrock%
Clbr	36	Richland Cr.	Haven	Tama	47f	MS	WD-REF	10/6/2010	38	Fair	41	33	8	subfines%, subrock%
Clbr	177	Roberts Cr.	St Olaf	Clayton	52b	MS	WD-SVY	7/31/2000	59	Good	55	64	-9	dpthcv
Clbr	178	Roberts Cr.	Farmersburg	Clayton	52b	MS	WD-SVY	7/31/2000	34	Fair	39	47	-8	bnkavr%, subclay%
Clbr	179	Roberts Cr.	Postville	Clayton	52b	MS	WD-SVY	8/1/2000	54	Good	51	58	-7	dpthav, subsilt%
Clbr	179	Roberts Cr.	Postville	Clayton	52b	MS	WD-SVY	8/13/2008	43	Fair	52	55	-3	chshdav%, cvrepa%, cvrwdbrs%, dpthav
Clbr	310	Roberts Cr.	Gunder	Clayton	52b	MS	WD-SVY	7/31/2002	39	Fair	48	45	3	embdrtg, subsilt%
Clbr	310	Roberts Cr.	Gunder	Clayton	52b	MS	WD-SVY	8/11/2008	47	Fair	43	47	-4	bnkavr%, dpthav
Clbr	310	Roberts Cr.	Gunder	Clayton	52b	MS	WD-SVY	8/12/2009	43	Fair	55	47	8	cvrepa%, subsilt%
Vld	310	Roberts Cr.	Gunder	Clayton	52b	MS	WD-SVY	8/8/2012	40	Fair	45	49	-4	cvrovhg%, maxdep, subsilt%
Clbr	27	Rock Cr.	Tipton	Cedar	47f	MS	WD-REF	8/9/1995	65	Good	71	58	13	
Clbr	27	Rock Cr.	Tipton	Cedar	47f	MS	WD-REF	7/30/2001	64	Good	71	54	17	
Clbr	27	Rock Cr.	Tipton	Cedar	47f	MS	WD-REF	8/20/2008	51	Good	61	45	16	cvrepa%
Clbr	57	Rock Cr.	Rock Creek	Mitchell	47c	MS	WD-REF	8/15/1996	66	Good	54	73	-19	
Clbr	57	Rock Cr.	Rock Creek	Mitchell	47c	MS	WD-REF	8/21/2002	55	Good	72	67	5	
Clbr	57	Rock Cr.	Rock Creek	Mitchell	47c	MS	WD-REF	9/10/2009	58	Good	76	68	8	
Clbr	218	Shoal Cr.	Exline	Appanoose	40a	MO	WD-REF	8/23/1999	40	Fair	58	34	24	subfines%
Clbr	218	Shoal Cr.	Exline	Appanoose	40a	MO	WD-REF	10/3/2006	37	Fair	51	32	19	bnkahz%, cvrepa%, strwdtav, subsilt%, subfines%, subrock%

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	125	Silver Cr.	Dewitt	Clinton	47f	MS	WD-REF	7/22/1998	55	Good	40	45	-5	subrock%
Clbr	125	Silver Cr.	Dewitt	Clinton	47f	MS	WD-REF	7/14/2004	46	Fair	44	36	8	rchpool%
Clbr	180	Silver Cr.	Gunder	Clayton	52b	MS	WD-SVY	8/2/2000	40	Fair	41	46	-5	chshdav%, embdrtg, strwdtav, strwdtsd, subsilt%, subfines%, subrock%
Clbr	238	Silver Cr.	Monticello	Jones	47c	MS	WD-SVY	7/31/2001	57	Good	59	67	-8	
Clbr	314	Silver Cr.	Cherokee	Cherokee	47a	MO	WD-SVY	9/18/2002	41	Fair	44	38	6	chshdav%, chshdsd%, dpthcv, strwdtav, strwdtsd
Vld	571	Silver Cr.	Monona	Clayton	52b	MS	WD-SVY	8/7/2006	37	Fair	19	39	-20	bnkahz%, bnkavr%, cvrepa%, embdrtg, rchpool%, rchmxhb%, subsilt%, subfines%, subrock%, substrmx%
Clbr	175	Sixmile Cr.	Hawarden- Cl	Sioux	47a	MO	WD-SVY	8/3/2000	27	Fair	10	27	-17	bnkavr%, dpthcv, embdrtg, maxdep, rchpool%, rchmxhb%
Clbr	176	Sixmile Cr.	Hawarden- Ch	Sioux	47a	MO	WD-SVY	8/2/2000	29	Fair	2	30	-28	dpthcv, maxdep, rchpool%, rchmxhb%
Clbr	152	Skillet Cr.	Dayton WWTP	Webster	47b	MS	WD-SVY	8/1/2011	41	Fair	37	45	-8	cvrepa%
Clbr	54	So. Beaver Cr.	Parkersburg	Grundy	47c	MS	WD-REF	7/30/1996	41	Fair	51	50	1	bnkavr%, rchpool%, rchmxhb%
Clbr	54	So. Beaver Cr.	Parkersburg	Grundy	47c	MS	WD-REF	8/13/2001	34	Fair	44	45	-1	bnkamd%, subsilt%, subfines%, subrock%
Clbr	54	So. Beaver Cr.	Parkersburg	Grundy	47c	MS	WD-REF	9/3/2008	41	Fair	50	50	0	cvrwdbrs%, subfines%, subrock%
Vld	906	So. Frk. Chariton R.	Corydon	Wayne	40a	MO	WD-SVY	9/12/2012	21	Poor	28	23	5	bnkahz%, rchpool%, rchmxhb%, subclay%, subfines%, subrock%
Clbr	21	So. Frk. Iowa Rvr.	Logsdon Co P	Hardin	47b	MS	WD-REF	7/19/1995	51	Good	77	52	25	
Clbr	21	So. Frk. Iowa Rvr.	Logsdon Co P	Hardin	47b	MS	WD-REF	8/2/1999	63	Good	73	61	12	
Clbr	21	So. Frk. Iowa Rvr.	Logsdon Co P	Hardin	47b	MS	WD-REF	8/1/2007	63	Good	77	58	19	
Vld	21	So. Frk. Iowa Rvr.	Logsdon Co P	Hardin	47b	MS	WD-REF	8/2/2012	52	Good	67	49	18	
Clbr	380	So. Frk. Iowa Rvr.	Buckeye	Hardin	47b	MS	WD-SVY	8/19/2003	59	Good	73	51	22	
Clbr	652	So. Minerva Cr.	Clemons	Marshall	47b	MS	HW-CREF	8/8/2007	34	Fair	34	37	-3	bnkbare%, maxdep
Clbr	652	So. Minerva Cr.	Clemons	Marshall	47b	MS	HW-CREF	9/27/2007	55	Good	33	53	-20	
Clbr	181	So. Raccoon Rvr.	Nations Brid	Guthrie	47f	MS	WD-REF	9/13/2000	58	Good	66	55	11	subsilt%
Clbr	181	So. Raccoon Rvr.	Nations Brid	Guthrie	47f	MS	WD-REF	9/22/2005	65	Good	59	57	2	
Vld	181	So. Raccoon Rvr.	Nations Brid	Guthrie	47f	MS	WD-REF	7/25/2012	54	Good	53	54	-1	rchpool%
Clbr	38	So. Skunk Rvr.	Ames	Story	47b	MS	WD-REF	9/15/1995	61	Good	61	56	5	
Clbr	38	So. Skunk Rvr.	Ames	Story	47b	MS	WD-REF	9/16/2003	59	Good	54	53	1	rchpool%
Clbr	113	So. Skunk Rvr.	Ames - Squaw	Story	47b	MS	WD-SVY	9/29/1997	36	Fair	51	37	14	rchmxhb%, subfines%, subrock%, substrmx%
Clbr	117	So. Skunk Rvr.	Ames - Linco	Story	47b	MS	WD-SVY	10/6/1997	42	Fair	49	39	10	bnkamd%, subfines%, subrock%
Clbr	118	So. Skunk Rvr.	Randall	Hamilton	47b	MS	WD-SVY	9/17/2003	44	Fair	48	45	3	cvrepa%, cvrwdbrs%
Clbr	122	So. Skunk Rvr.	Story City	Story	47b	MS	WD-SVY	9/18/2003	52	Good	44	52	-8	
Clbr	43	So. White Breast Cr.	Weldon	Clarke	40a	MS	WD-CREF	9/28/1995	17	Poor	21	18	3	bnkbare%, rchpool%, rchmxhb%, subclay%, subfines%, subrock%
Clbr	43	So. White Breast Cr.	Weldon	Clarke	40a	MS	WD-CREF	9/29/2010	21	Poor	17	24	-7	bnkbare%, cvrepa%, subclay%, subfines%, subrock%
Clbr	79	Soap Cr.	Eldon SWMA -	Davis	40a	MS	WD-REF	10/8/1996	52	Good	41	50	-9	
Clbr	79	Soap Cr.	Eldon SWMA -	Davis	40a	MS	WD-REF	7/23/2002	58	Good	34	53	-19	
Clbr	79	Soap Cr.	Eldon SWMA -	Davis	40a	MS	WD-REF	10/4/2010	38	Fair	51	40	11	bnkbare%, cvrepa%, rchmxhb%, subfines%, substrmx%
Clbr	299	Soap Cr.	Floris	Davis	40a	MS	WD-SVY	7/24/2002	35	Fair	30	31	-1	bnkbare%, subfines%
Clbr	183	Soldier Rvr.	Pisgah	Harrison	47e	MO	WD-SVY	9/21/2000	39	Fair	39	34	5	rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	162	Squaw Cr.	Ames- South	Story	47b	MS	WD-SVY	7/13/2000	52	Good	41	53	-12	
Clbr	193	Squaw Cr.	Zenorsville	Boone	47b	MS	WD-SVY	7/14/2000	54	Good	43	51	-8	
Clbr	290	Squaw Cr.	Ames- Veenke	Story	47b	MS	WD-SVY	7/18/2002	52	Good	45	49	-4	dpthcv
Clbr	69	Sugar Cr.	Tipton - Pas	Cedar	47f	MS	WD-SVY	9/17/1996	37	Fair	32	30	2	chshdav%, chshdsd%, subsilt%, subfines%, subrock%
Clbr	72	Sugar Cr.	Tipton East	Cedar	47f	MS	WD-SVY	9/18/1996	41	Fair	26	39	-13	
Clbr	73	Sugar Cr.	Tipton East	Cedar	47f	MS	HW-SVY	9/18/1996	33	Fair	38	30	8	strwdtav
Clbr	76	Sugar Cr.	Wilton - Bed	Cedar	47f	MS	WD-SVY	9/25/1996	61	Good	78	57	21	
Clbr	76	Sugar Cr.	Wilton - Bed	Cedar	47f	MS	WD-SVY	8/23/2001	51	Good	70	50	20	
Clbr	77	Sugar Cr.	Moscow	Muscatine	47f	MS	WD-SVY	9/25/1996	29	Fair	54	31	23	bnkahz%, chshdav%, subfines%, subrock%
Clbr	253	Sugar Cr.	Tipton	Cedar	47f	MS	WD-SVY	8/22/2001	38	Fair	30	35	-5	rchpool%, rchmxhb%, subfines%
Clbr	254	Sugar Cr.	Tipton	Cedar	47f	MS	WD-SVY	8/23/2001	35	Fair	31	28	3	bnkavr%, subsilt%
Clbr	231	Tetes Des Morts Cr.	St Donatus (	Jackson	52b	MS	WD-SVY	8/29/2001	66	Good	58	67	-9	
Clbr	231	Tetes Des Morts Cr.	St Donatus (	Jackson	52b	MS	WD-SVY	8/27/2007	59	Good	50	61	-11	dpthav
Clbr	231	Tetes Des Morts Cr.	St Donatus (	Jackson	52b	MS	WD-SVY	9/4/2009	54	Good	65	59	6	cvrwdbrs%, dpthav
Clbr	231	Tetes Des Morts Cr.	St Donatus (	Jackson	52b	MS	WD-SVY	9/7/2010	63	Good	59	65	-6	
Clbr	231	Tetes Des Morts Cr.	St Donatus (	Jackson	52b	MS	WD-SVY	9/6/2011	56	Good	70	58	12	cvrwdbrs%
Clbr	266	Thompson Rvr.	Decatur City	Decatur	40a	MO	WD-CREF	10/17/2001	56	Good	32	49	-17	
Clbr	266	Thompson Rvr.	Decatur City	Decatur	40a	MO	WD-CREF	9/23/2011	40	Fair	43	40	3	bnkahz%, cvrepa%
Clbr	211	Tipton Cr.	Buckeye/Radc	Hardin	47b	MS	WD-SVY	8/3/1999	54	Good	50	47	3	bnkavr%
Clbr	549	Unn. Trib. Yellow R.	Postville	Allamakee	52b	MS	WD-SVY	7/31/2006	66	Good	63	66	-3	
Clbr	549	Unn. Trib. Yellow R.	Postville	Allamakee	52b	MS	WD-SVY	7/24/2007	56	Good	36	60	-24	cvrovhg%, strwdtsd
Clbr	330	Upper Iowa Rvr.	Florencevill	Howard	52b	MS	WD-SVY	10/1/2002	65	Good	90	70	20	
Clbr	39	Volga Rvr.	Maynard - Tw	Fayette	47c	MS	WD-REF	9/20/1995	66	Good	84	76	8	
Clbr	39	Volga Rvr.	Maynard - Tw	Fayette	47c	MS	WD-REF	8/30/2010	62	Good	76	72	4	

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	265	Volga Rvr.	Randalia	Fayette	47c	MS	WD-CREF	9/17/2001	58	Good	78	64	14	
Clbr	265	Volga Rvr.	Randalia	Fayette	47c	MS	WD-CREF	8/31/2010	58	Good	73	62	11	
Clbr	46	W. Br. 102 Rvr.	New Market	Taylor	47f	MO	WD-RJCT	10/11/1995	24	Poor	25	27	-2	bnkahz%, bnkamd%, bnkbare%, chshdav%, maxdep, rchpool%, rchmxhb%, subfines%, subrock%, thwgdpav
Clbr	256	W. Br. Floyd Rvr.	Hull	Sioux	47a	MO	WD-SVY	9/13/2001	36	Fair	22	31	-9	chshdav%, chshdsd%
Clbr	33	W. Buttrick Cr.	Spring Lake	Greene	47b	MS	WD-REF	8/31/1995	49	Fair	63	50	13	chshdav%, chshdsd%, maxdep
Clbr	33	W. Buttrick Cr.	Spring Lake	Greene	47b	MS	WD-REF	7/23/2001	59	Good	61	56	5	
Clbr	33	W. Buttrick Cr.	Spring Lake	Greene	47b	MS	WD-REF	9/4/2008	66	Good	79	59	20	
Clbr	209	W. Frk. Cedar Rvr.	Lake Considi	Butler	47c	MS	WD-REF	10/11/1999	40	Fair	70	52	18	bnkbare%, subfines%, subrock%
Clbr	209	W. Frk. Cedar Rvr.	Lake Considi	Butler	47c	MS	WD-REF	10/11/2006	41	Fair	65	57	8	cvrepa%, subfines%, subrock%, substrmx%
Vld	518	W. Frk. L. Sioux R.	Bronson	Woodbury	47m	MO	WD-SVY	9/17/2012	41	Fair	26	40	-14	cvrepa%, rchpool%, rchmxhb%, subfines%, subrock%
Vld	753	W. Jackson Cr.	Corydon	Wayne	40a	MS	WD-SVY	9/13/2010	38	Fair	32	34	-2	bnkbare%
Vld	753	W. Jackson Cr.	Corydon	Wayne	40a	MS	WD-SVY	9/15/2011	43	Fair	39	33	6	subsilt%, subfines%, subrock%
Clbr	6	W. Nishna. Rvr.	Shelby Co. U	Shelby	47e	MO	WD-REF	9/26/2011	36	Fair	36	28	8	dpthcv, embdrtg, rchpool%, rchmxhb%, subfines%, subrock%
Clbr	367	W. Nishnabotna R.	Irwin	Shelby	47e	MO	WD-SVY	8/25/2003	30	Fair	20	20	0	bnkavr%, cvrepa%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	367	W. Nishnabotna R.	Irwin	Shelby	47e	MO	WD-SVY	10/2/2003	30	Fair	25	23	2	cvrepa%, cvrwdbrs%, subfines%, subrock%, substrmx%
Clbr	131	W. Nodaway Rvr.	Grant	Cass	47f	MO	WD-CREF	8/19/1998	55	Good	19	46	-27	
Clbr	131	W. Nodaway Rvr.	Grant	Cass	47f	MO	WD-CREF	8/31/2004	36	Fair	26	30	-4	bnkavr%, cvrdpl%, cvrovhg%, dpthav, rchpool%
Clbr	270	W. Otter Cr.	Toddville	Linn	47c	MS	WD-CREF	10/11/2001	59	Good	79	65	14	
Clbr	270	W. Otter Cr.	Toddville	Linn	47c	MS	WD-CREF	8/19/2010	52	Good	61	65	-4	dpthcv
Clbr	882	W. Otter Cr.	Center Point	Linn	47c	MS	HW-CREF	8/25/2011	37	Fair	66	48	18	chshdav%, chshdsd%, cvrepa%, cvrwdbrs%, maxdep, strwdtav, strwdtsd
Clbr	47	W. Tarkio Cr.	Shenandoah	Page	47e	MO	WD-SVY	10/12/1995	13	Poor	30	12	18	strwdtav, strwdtsd, subclay%, subsilt%, subfines%, subrock%
Clbr	80	Walnut Cr.	Red Oak - Do	Montgomery	47e	MO	WD-SVY	10/14/1996	54	Good	23	38	-15	embdrtg
Clbr	81	Walnut Cr.	Red Oak- Ups	Montgomery	47e	MO	WD-SVY	10/14/1996	38	Fair	20	29	-9	chshdav%, chshdsd%, dpthcv, rchpool%, rchmxhb%
Clbr	133	Walnut Cr.	Windsor Heig	Polk	47f	MS	WD-SVY	8/26/1998	50	Fair	48	43	5	embdrtg, rchmxhb%
Clbr	200	Walnut Cr.	Holiday Lake	Poweshiek	47f	MS	WD-SVY	9/21/1999	24	Poor	24	27	-3	maxdep, subsilt%, subfines%, subrock%, thwgdpav
Clbr	200	Walnut Cr.	Holiday Lake	Poweshiek	47f	MS	WD-SVY	9/16/2008	25	Poor	31	26	5	cvrepa%, cvrwdbrs%, dpthcv, rchpool%, rchmxhb%, subfines%, subrock%
Clbr	200	Walnut Cr.	Holiday Lake	Poweshiek	47f	MS	WD-SVY	7/27/2009	28	Fair	26	28	-2	cvrepa%, dpthcv, rchpool%, rchmxhb%, strwdtsd, subfines%, subrock%, substrmx%
Clbr	200	Walnut Cr.	Holiday Lake	Poweshiek	47f	MS	WD-SVY	8/25/2010	26	Fair	25	27	-2	bnkahz%, cvrepa%, dpthcv, rchpool%, rchmxhb%, strwdtsd, subfines%, subrock%
Clbr	210	Walnut Cr.	Ames	Story	47b	MS	WD-SVY	7/15/1999	48	Fair	39	45	-6	strwdtsd
Clbr	210	Walnut Cr.	Ames	Story	47b	MS	WD-SVY	7/17/2007	50	Fair	29	51	-22	
Clbr	210	Walnut Cr.	Ames	Story	47b	MS	WD-SVY	7/19/2011	40	Fair	36	42	-6	strwdtsd
Clbr	359	Walnut Cr.	Belle Plaine	Poweshiek	47f	MS	WD-SVY	7/30/2003	35	Fair	42	32	10	chshdav%, chshdsd%, cvrepa%, dpthcv, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	359	Walnut Cr.	Belle Plaine	Poweshiek	47f	MS	WD-SVY	9/4/2003	36	Fair	41	34	7	chshdav%, cvrepa%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	359	Walnut Cr.	Belle Plaine	Poweshiek	47f	MS	WD-SVY	9/17/2008	31	Fair	51	32	19	cvrepa%, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Clbr	701	Walnut Cr.	Hartwick	Poweshiek	47f	MS	WD-SVY	7/27/2009	30	Fair	54	30	24	cvrepa%, dpthcv, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%
Vld	702	Walnut Cr.	Malcolm	Poweshiek	47f	MS	HW-SVY	7/28/2009	22	Poor	23	21	2	bnkahz%, bnkavr%, cvrovhg%, cvrwdbrs%, dpthcv, strwdtav, strwdtsd, subclay%, subrock%
Clbr	703	Walnut Cr.	Brooklyn	Poweshiek	47f	MS	WD-SVY	7/28/2009	39	Fair	29	32	-3	subfines%, subrock%
Vld	859	Walnut Cr.	Huxley	Story	47b	MS	WD-SVY	7/20/2011	28	Fair	17	31	-14	maxdep, rchpool%, rchmxhb%, subfines%, subrock%
Clbr	11	Wapsipinicon Rvr.	Twin Ponds P	Chickasaw	47c	MS	WD-REF	10/19/2000	52	Good	62	58	4	
Clbr	11	Wapsipinicon Rvr.	Twin Ponds P	Chickasaw	47c	MS	WD-REF	10/14/2010	43	Fair	57	52	5	cvrdpl%, cvrwdbrs%, dpthav
Clbr	24	Waterman Cr.	Whitrock Ind	Obrien	47a	MO	WD-REF	8/2/1995	51	Good	51	47	4	chshdav%
Clbr	255	Waterman Cr.	Sutherland	Obrien	47a	MO	WD-REF	9/14/2001	55	Good	48	47	1	
Clbr	255	Waterman Cr.	Sutherland	Obrien	47a	MO	WD-REF	8/26/2008	52	Good	48	48	0	
Clbr	372	Weldon Rvr.	Woodland	Decatur	40a	MS	WD-SVY	8/4/2003	18	Poor	18	24	-6	bnkahz%, cvrepa%, cvrwdbrs%, subclay%, subfines%, subrock%
Clbr	87	White Breast Cr.	Lacona	Lucas	40a	MS	WD-CREF	8/1/1997	48	Fair	23	39	-16	
Clbr	87	White Breast Cr.	Lacona	Lucas	40a	MS	WD-CREF	8/5/2009	32	Fair	22	29	-7	bnkahz%, bnkbare%, subfines%, subrock%, substrmx%
Clbr	327	White Breast Cr.	Woodburn	Lucas	40a	MS	WD-SVY	9/24/2002	19	Poor	10	19	-9	rchpool%, rchmxhb%, subclay%, subsilt%, subfines%, subrock%

Appendix 1 (continued).

Data Group	Bio Net ID	Stream	Landmark	County	Eco Region	Basin	Site Status	Sample Date	GFHI	GFHI Hab. Rtg.	FIBI	EFHI	FIBI - EFHI	Suboptimal Habitat Metrics
Clbr	1	White Fox Cr.	Webster City	Hamilton	47b	MS	WD-REF	8/22/1995	61	Good	61	57	4	
Clbr	1	White Fox Cr.	Webster City	Hamilton	47b	MS	WD-REF	9/10/1996	58	Good	57	54	3	
Clbr	1	White Fox Cr.	Webster City	Hamilton	47b	MS	WD-REF	8/25/1997	60	Good	59	53	6	
Clbr	1	White Fox Cr.	Webster City	Hamilton	47b	MS	WD-REF	8/30/2000	55	Good	48	52	-4	
Clbr	1	White Fox Cr.	Webster City	Hamilton	47b	MS	WD-REF	7/29/2009	62	Good	75	54	21	
Vld	25	Willow Cr.	Quimby	Cherokee	47a	MO	WD-REF	8/3/1995	57	Good	38	53	-15	
Vld	25	Willow Cr.	Quimby	Cherokee	47a	MO	WD-REF	8/14/2001	61	Good	51	56	-5	
Vld	25	Willow Cr.	Quimby	Cherokee	47a	MO	WD-REF	8/27/2008	49	Fair	44	46	-2	cvrepa%, cvrwdbrs%
Clbr	31	Willow Cr.	Willow Creek	Worth	47b	MS	WD-REF	8/17/1995	52	Good	50	49	1	bnkavr%, chshdav%
Clbr	31	Willow Cr.	Willow Creek	Worth	47b	MS	WD-REF	9/28/2010	52	Good	53	49	4	bnkbare%, chshdav%, chshdsd%, cvrepa%, cvrwdbrs%, dpthcv
Clbr	205	Willow Cr.	Royal	Clay	47a	MS	WD-SVY	9/15/1999	47	Fair	30	35	-5	embdrtg, rchpool%, rchmxhb%
Clbr	205	Willow Cr.	Royal	Clay	47a	MS	WD-SVY	9/14/2009	54	Good	41	43	-2	
Clbr	205	Willow Cr.	Royal	Clay	47a	MS	WD-SVY	9/19/2011	42	Fair	43	37	6	cvrwdbrs%
Clbr	306	Willow Cr.	Rossie	Clay	47a	MO	WD-SVY	8/26/2002	43	Fair	5	35	-30	bnkavr%
Clbr	854	Willow Cr.	Royal	Clay	47a	MO	WD-SVY	9/20/2011	32	Fair	46	28	18	chshdav%, cvrovhg%, cvrwdbrs%, strwdtav, strwdtsd, subsilt%
Clbr	868	Willow Cr.	Royal	Clay	47a	MO	WD-SVY	9/20/2011	36	Fair	47	32	15	chshdav%, chshdsd%, cvrepa%, cvrwdbrs%, rchpool%, subsilt%
Vld	30	Winnebago Rvr.	Lande Access	Winnebago	47b	MS	WD-REF	8/16/1995	44	Fair	38	43	-5	rchpool%, rchmxhb%, subrock%
Vld	30	Winnebago Rvr.	Lande Access	Winnebago	47b	MS	WD-REF	9/6/2000	44	Fair	27	41	-14	chshdav%, subsilt%, subfines%, subrock%
Vld	30	Winnebago Rvr.	Lande Access	Winnebago	47b	MS	WD-REF	9/19/2006	35	Fair	32	40	-8	bnkamd%, cvrepa%, subsilt%, subfines%, subrock%
Clbr	207	Wolf Cr.	Chariton	Lucas	40a	MO	WD-REF	8/24/1999	28	Fair	33	25	8	rchpool%, rchmxhb%, subrock%
Clbr	207	Wolf Cr.	Chariton	Lucas	40a	MO	WD-REF	8/10/2005	27	Fair	18	26	-8	cvrepa%, rchpool%, rchmxhb%, subclay%
Clbr	207	Wolf Cr.	Chariton	Lucas	40a	MO	WD-REF	8/26/2011	53	Good	34	43	-9	
Vld	207	Wolf Cr.	Chariton	Lucas	40a	MO	WD-REF	9/12/2012	30	Fair	23	28	-5	cvrepa%, rchpool%, rchmxhb%, strwdtav
Clbr	858	Wolf Cr.	Millerton	Lucas	40a	MO	WD-SVY	8/26/2011	27	Fair	24	27	-3	cvrepa%, rchpool%, rchmxhb%, subclay%
Vld	658	Worrell Cr.	Ames	Story	47b	MS	HW-CREF	7/25/2007	41	Fair	19	42	-23	cvrwdbrs%, strwdtav, strwdtsd
Clbr	141	Yellow Rvr.	Yellow River	Allamakee	52b	MS	WD-REF	9/14/2004	56	Good	65	66	-1	cvrepa%
Clbr	156	Yellow Rvr.	Most Upstrea	Winneshiek	52b	MS	WD-SVY	8/15/2000	40	Fair	46	47	-1	chshdav%, chshdsd%, embdrtg, subsilt%
Clbr	325	Yellow Rvr.	Ion	Allamakee	52b	MS	WD-SVY	8/29/2002	57	Good	54	61	-7	bnkahz%, dpthav, embdrtg
Clbr	568	Yellow Rvr.	Postville	Winneshiek	52b	MS	WD-SVY	8/1/2006	49	Fair	46	54	-8	chshdav%, chshdsd%, cvrepa%, subsilt%
Clbr	568	Yellow Rvr.	Postville	Winneshiek	52b	MS	WD-SVY	7/25/2007	48	Fair	48	51	-3	chshdav%, cvrepa%, strwdtsd, subsilt%

Appendix 2. Example Site Photographs and Habitat Modeling Results

a) West Buttrick Creek, Spring Lake (#33), 7/23/2001; GFHI=59 (Good); FIBI=56 (Good); EFHI=61 (Good); Suboptimal Habitat Metrics: (none); FIBI-EFHI = -5 (The observed FIBI score is roughly equivalent to the predicted FIBI score and within expectations based on physical habitat characteristics and ecoregion.)

b) North Fork Maquoketa River, New Vienna (#233), 7/28/2005; GFHI=53 (Good); FIBI=36 (Fair); EFHI=57 (Good); Suboptimal Habitat Metrics: embdrtg, subsilt%; FIBI-EFHI = -21 (Adverse environmental factors besides physical habitat characteristics are very likely to contribute to the predicted FIBI score exceeding the observed FIBI score.)

c) Little Rock River, Little Rock CWA, George (#64), 8/5/2003; GFHI=48 (Fair); FIBI=45 (Fair); EFHI=41 (Fair); Suboptimal Habitat Metrics: cvrovhg%; FIBI-EFHI = 4 (The observed FIBI score is roughly equivalent to the predicted FIBI score and within expectations based on physical habitat characteristics and ecoregion.)

d) Otter Creek, Deloit (#129), 8/11/2004; GFHI=40 (Fair); FIBI=47 (Fair); EFHI=32 (Fair); Suboptimal Habitat Metrics: cvrepa%, rchpool%; FIBI-EFHI = 15 (Beneficial environmental factors besides physical habitat characteristics are somewhat likely to contribute to the observed FIBI score exceeding the predicted FIBI score.)

e) English River, Riverside (#287), 10/2/2001; GFHI=32 (Fair); FIBI=34 (Fair); EFHI=33 (Fair); Suboptimal Habitat Metrics: bnkahz%, rchpool%, rchmxhb%, subfines%, subrock%, substrmx%; FIBI-EFHI = 1 (The observed FIBI score is roughly equivalent to the predicted FIBI score and within expectations based on physical habitat characteristics and ecoregion.)

f) Honey Creek, Bedford (#130), 8/18/2004; GFHI=24 (Poor); FIBI=29 (Fair); EFHI=31 (Fair); Suboptimal Habitat Metrics: strwdtav, strwdtsd, subclay%; FIBI-EFHI = -2 (The observed FIBI score is roughly equivalent to the predicted FIBI score and within expectations based on physical habitat characteristics and ecoregion.)

Appendix 3. Physical Habitat Metric Data Summary: Stream Ecoregion Reference Sites (1995-2013)

(metric abbreviations from Table 1)

Category	BioNet Variable	Abbrv.		Category	Spreadsheet calculated variables	Abbrv.
Bank	% Horizontal (0-15 degrees)	bnkahz%		Composite	Percent suboptimum habitat variables	pctsubopt
Bank	% Moderate (20-50 degrees)	bnkamd%		Dimension	Transect depth coefficient of variation	dpthcv
Bank	% Undercut (115-180 degrees)	bnkauc%		Dimension	Transect depth + std.dev.	dpthsum
Bank	% Vertical (55-110 degrees)	bnkavr%		Dimension	Stream Width coefficient of variation	strwdtcv
Bank	Streambank - Average Percent Bare	bnkbare%	*	Dimension	Thalweg depth coefficient of variation	thwgdpcv
Canopy/Shade	Average Percent of Channel Shaded	chshdav%		Dimension	Thalweg depth + std.dev.	thwgdpsm
Canopy/Shade	Transect Minimum Percent of Channel Shaded	chshdmn%	*	Macrohabitat	Maximum macrohabitat type proportion	rchmxhb%
Canopy/Shade	Transect Maximum Percent of Channel Shaded	chshdmx%		Substrate	Clay+Silt+Sand	subfines%
Canopy/Shade	Standard Deviation - Percent of Channel Shaded	chshdsd%	*	Substrate	Cbbl+Bldr	sublgrk%
Dimension	Transect Depth - Average	dpthav		Substrate	Grvl+Cbbl+Bldr	subrock%
Dimension	Transect Depth - Standard Deviation	dpthsd		Substrate	Maximum substrate type proportion	substrmx%
Dimension	Maximum Depth	maxdep	*			
Dimension	Stream Width - Average	strwdtav	*			
Dimension	Stream Width - Standard Deviation	strwdtsd	*			
Dimension	Thalweg Depth - Average	thwgdpav	*			
Dimension	Thalweg Depth - Standard Deviation	thwgdpsd	*			
Dimension	Thalweg Depth : Stream Width Ratio	thwgwdr				
Instream Cover	Artificial Structure - Average Percent	cvrartf%				
Instream Cover	Boulders - Average Percent	cvrbldr%	*			
Instream Cover	Total Proportional Areal Cover - IDNR Method	cvrdnr%				
Instream Cover	Depth/Pool - Average Percent - IDNR Method	cvrdpl%				
Instream Cover	Total Proportional Areal Cover - EPA Method	cvrepa%	*			
Instream Cover	Filamentous Algae - Average Percent	cvrflma%				
Instream Cover	Large Features Areal Cover - IDNR Method	cvrlgdn%				
Instream Cover	Large Features Areal Cover - EPA Method	cvrlgep%				
Instream Cover	Macrophytes - Average Percent	cvrmacr%				
Instream Cover	Natural Concealment Features	cvrnatrl%	*			
Instream Cover	Overhanging Vegetation - Average Percent	cvrovhg%				
Instream Cover	Small Brush - Average Percent	cvrsbrsh%				
Instream Cover	Trees/Roots - Average Percent	cvrtrrt%				
Instream Cover	Undercut Banks - Average Percent	cvrucbk%				
Instream Cover	Woody Debris - Average Percent	cvrwdbrs%				
Instream Cover	Instream Cover - (Legacy) - Average Percent	lgcycvr%				
Instream Cover	Large Woody Debris - (Legacy) - Average Percent Occurrence	lrgwdy%				
Macrohabitat	Pool	rchpool%				
Macrohabitat	Riffle	rchrffl%	*			
Macrohabitat	Run	rchrun%				
Substrate	Coarse Rock Embededness - Average	embdrtg				
Substrate	Reach - Percent Soft Sediment	sfsdtwg%				
Substrate	Bedrock	subbdrk%				
Substrate	Boulder	subbldr%	*			
Substrate	Cobble	subcbbl%	*			
Substrate	Clay	subclay%	*			
Substrate	Detritus/Muck	subdemu%				
Substrate	Gravel	subgrvl%	*			
Substrate	Other	subothr%				
Substrate	Rip-Rap	subrrap%				
Substrate	Sand	subsand%	*			
Substrate	Silt	subsilt%	*			
Substrate	Soil	subsoil%				
Substrate	Wood	subwood%				

Appendix 3. Physical Habitat Metric Data Summary: Stream Ecoregion Reference Sites (1995-2013). *Ref Type: CW, Coldwater; WW, Warmwater. Ecoregion: (see Figure 1).*

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev	Minimum	Q25	Median	Q75	Maximum
Bank	bnkahz%	WW	40a	7	54.8	9.8	41.7	46.3	53.3	66.7	68.3
Bank	bnkahz%	WW	47a	6	39.1	18.3	21.3	22.8	37.5	53.8	65.0
Bank	bnkahz%	WW	47b	21	36.6	15.7	10.0	26.9	36.7	45.8	71.7
Bank	bnkahz%	WW	47c	20	36.2	9.4	20.0	32.7	34.3	39.3	60.0
Bank	bnkahz%	WW	47e	6	33.2	15.7	11.7	20.7	31.3	48.4	55.0
Bank	bnkahz%	WW	47f	19	37.5	14.4	8.3	28.3	38.3	50.0	56.7
Bank	bnkahz%	CW	52b	12	38.7	12.8	13.3	29.2	40.0	46.3	60.0
Bank	bnkahz%	WW	52b	7	35.0	14.3	16.3	21.7	33.3	41.7	60.0
Bank	bnkahz%	WW	72d	2	67.3	17.4	55.0	*	67.3	*	79.6
Bank	bnkamd%	WW	40a	7	38.5	8.8	26.7	30.0	37.5	48.3	50.0
Bank	bnkamd%	WW	47a	6	45.8	13.8	28.3	29.6	50.0	57.2	60.0
Bank	bnkamd%	WW	47b	21	42.8	9.3	25.0	37.5	42.4	50.0	61.3
Bank	bnkamd%	WW	47c	20	42.8	9.7	23.3	37.1	43.2	47.9	60.0
Bank	bnkamd%	WW	47e	6	50.3	11.2	38.8	39.7	48.1	61.7	66.7
Bank	bnkamd%	WW	47f	19	47.9	9.1	33.3	43.3	46.7	56.7	66.3
Bank	bnkamd%	CW	52b	12	42.0	13.0	25.0	30.0	45.0	48.3	70.0
Bank	bnkamd%	WW	52b	7	48.6	10.1	36.7	42.5	43.3	61.3	63.3
Bank	bnkamd%	WW	72d	2	30.2	13.9	20.4	*	30.2	*	40.0
Bank	bnkauc%	WW	40a	7	0.2	0.6	0.0	0.0	0.0	0.0	1.7
Bank	bnkauc%	WW	47a	6	0.3	0.7	0.0	0.0	0.0	0.4	1.7
Bank	bnkauc%	WW	47b	21	1.5	2.2	0.0	0.0	0.0	2.9	8.8
Bank	bnkauc%	WW	47c	20	1.3	1.3	0.0	0.0	1.3	2.3	5.0
Bank	bnkauc%	WW	47e	6	0.6	1.5	0.0	0.0	0.0	0.9	3.8
Bank	bnkauc%	WW	47f	19	0.7	1.4	0.0	0.0	0.0	1.7	3.8
Bank	bnkauc%	CW	52b	12	1.0	2.2	0.0	0.0	0.0	1.7	7.5
Bank	bnkauc%	WW	52b	7	0.7	1.3	0.0	0.0	0.0	1.3	3.3
Bank	bnkauc%	WW	72d	2	0.0	0.0	0.0	*	0.0	*	0.0
Bank	bnkavr%	WW	40a	7	6.6	3.8	1.7	3.3	6.7	10.0	11.7
Bank	bnkavr%	WW	47a	6	14.9	7.4	5.0	6.3	17.5	20.6	22.5
Bank	bnkavr%	WW	47b	21	19.1	8.4	3.3	12.5	18.3	25.6	35.0
Bank	bnkavr%	WW	47c	20	19.7	8.1	5.0	12.2	21.7	25.9	31.7
Bank	bnkavr%	WW	47e	6	15.9	6.5	5.0	10.6	17.5	21.4	21.7
Bank	bnkavr%	WW	47f	19	13.8	7.3	2.5	10.0	15.0	18.2	33.3
Bank	bnkavr%	CW	52b	12	18.3	12.7	5.0	7.1	15.0	30.6	41.7
Bank	bnkavr%	WW	52b	7	15.7	6.1	3.3	15.0	16.7	20.0	22.5
Bank	bnkavr%	WW	72d	2	2.5	3.5	0.0	*	2.5	*	5.0
Bank	bnkbare%	WW	40a	7	73.3	11.5	58.1	58.8	74.2	83.8	84.5
Bank	bnkbare%	WW	47a	6	54.7	21.2	33.7	35.8	48.2	79.4	83.8
Bank	bnkbare%	WW	47b	21	64.0	16.0	26.8	53.2	62.9	76.9	89.9
Bank	bnkbare%	WW	47c	20	67.4	17.2	29.2	58.1	66.2	84.8	88.6
Bank	bnkbare%	WW	47e	6	59.6	6.5	52.3	53.6	58.6	67.1	67.4
Bank	bnkbare%	WW	47f	19	63.5	15.4	30.9	52.4	63.6	76.1	97.3
Bank	bnkbare%	CW	52b	12	36.7	16.5	17.2	25.9	30.9	55.1	63.0
Bank	bnkbare%	WW	52b	7	42.9	13.2	19.5	36.5	43.9	50.8	60.9
Bank	bnkbare%	WW	72d	2	44.6	47.3	11.1	*	44.6	*	78.0
Canopy/Shade	chshdav%	WW	40a	7	56.2	22.3	28.7	28.9	58.1	81.5	82.6
Canopy/Shade	chshdav%	WW	47a	6	16.9	9.8	6.1	9.8	13.7	26.1	32.9
Canopy/Shade	chshdav%	WW	47b	21	42.9	28.6	6.3	19.9	37.0	73.6	89.1
Canopy/Shade	chshdav%	WW	47c	20	55.6	19.1	19.9	42.6	52.6	73.5	84.8
Canopy/Shade	chshdav%	WW	47e	6	34.1	12.1	17.6	20.2	37.3	45.4	46.2
Canopy/Shade	chshdav%	WW	47f	19	48.9	20.9	12.2	33.0	48.6	67.6	84.6
Canopy/Shade	chshdav%	CW	52b	12	60.9	25.9	1.2	44.7	62.4	82.6	90.5
Canopy/Shade	chshdav%	WW	52b	7	38.5	6.9	28.4	29.7	40.7	43.2	46.4
Canopy/Shade	chshdav%	WW	72d	3	32.9	45.0	0.2	*	14.4	*	84.2

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev	Minimum	Q25	Median	Q75	Maximum
Canopy/Shade	chshdmn%	WW	40a	7	27.9	24.0	3.4	4.8	28.8	53.8	63.7
Canopy/Shade	chshdmn%	WW	47a	6	3.2	3.8	0.0	0.7	2.2	5.3	10.5
Canopy/Shade	chshdmn%	WW	47b	21	19.3	24.3	0.0	0.6	6.6	43.2	66.7
Canopy/Shade	chshdmn%	WW	47c	20	24.4	19.4	0.9	3.6	22.0	40.5	58.6
Canopy/Shade	chshdmn%	WW	47e	6	5.4	5.8	0.0	0.0	3.7	11.4	14.4
Canopy/Shade	chshdmn%	WW	47f	19	17.9	17.9	0.0	3.3	11.3	27.0	66.7
Canopy/Shade	chshdmn%	CW	52b	12	29.8	27.6	0.0	3.6	22.3	50.4	77.5
Canopy/Shade	chshdmn%	WW	52b	7	10.2	3.9	2.7	8.6	11.4	13.3	14.7
Canopy/Shade	chshdmn%	WW	72d	3	15.9	27.6	0.0	*	0.0	*	47.8
Canopy/Shade	chshdmx%	WW	40a	7	82.4	16.7	57.0	62.5	85.6	96.1	98.5
Canopy/Shade	chshdmx%	WW	47a	6	36.7	12.2	24.9	25.8	33.8	47.8	57.1
Canopy/Shade	chshdmx%	WW	47b	21	68.4	25.4	21.9	48.1	64.9	96.1	100.0
Canopy/Shade	chshdmx%	WW	47c	20	83.3	13.4	57.4	69.4	89.1	93.6	99.1
Canopy/Shade	chshdmx%	WW	47e	6	68.0	21.0	36.0	48.5	70.9	86.5	93.5
Canopy/Shade	chshdmx%	WW	47f	19	80.0	15.7	48.7	65.8	84.7	90.7	98.4
Canopy/Shade	chshdmx%	CW	52b	12	85.9	26.0	5.4	91.8	94.4	96.6	97.8
Canopy/Shade	chshdmx%	WW	52b	7	70.0	12.8	55.9	56.2	67.1	77.7	91.6
Canopy/Shade	chshdmx%	WW	72d	3	54.7	49.2	1.8	*	63.1	*	99.1
Canopy/Shade	chshdsd%	WW	40a	7	24.5	7.1	12.3	17.4	28.3	29.8	30.9
Canopy/Shade	chshdsd%	WW	47a	6	21.7	6.1	16.9	18.4	19.9	24.1	33.8
Canopy/Shade	chshdsd%	WW	47b	21	26.1	7.9	14.1	18.4	27.0	33.2	38.4
Canopy/Shade	chshdsd%	WW	47c	20	31.0	6.6	17.6	26.2	32.5	34.3	43.3
Canopy/Shade	chshdsd%	WW	47e	6	28.4	5.7	20.9	24.4	27.8	32.2	37.9
Canopy/Shade	chshdsd%	WW	47f	19	27.3	5.3	14.3	23.9	27.3	29.7	36.9
Canopy/Shade	chshdsd%	CW	52b	12	22.7	10.6	3.7	14.5	24.2	32.3	34.6
Canopy/Shade	chshdsd%	WW	52b	7	32.5	3.0	28.8	29.1	31.9	35.6	36.0
Canopy/Shade	chshdsd%	WW	72d	3	16.5	13.5	1.0	*	24.1	*	24.5
Dimension	dpthav	WW	40a	7	0.7	0.2	0.5	0.5	0.7	0.9	1.0
Dimension	dpthav	WW	47a	6	0.7	0.1	0.6	0.6	0.7	0.8	0.9
Dimension	dpthav	WW	47b	21	0.9	0.2	0.5	0.8	0.9	1.0	1.2
Dimension	dpthav	WW	47c	20	0.9	0.3	0.6	0.8	0.9	1.0	1.8
Dimension	dpthav	WW	47e	6	0.7	0.2	0.5	0.5	0.7	0.9	1.1
Dimension	dpthav	WW	47f	19	0.9	0.4	0.4	0.6	0.9	1.0	2.1
Dimension	dpthav	CW	52b	12	0.7	0.1	0.5	0.6	0.8	0.9	0.9
Dimension	dpthav	WW	52b	7	1.0	0.3	0.7	0.8	0.9	1.4	1.4
Dimension	dpthav	WW	72d	3	0.7	0.4	0.4	*	0.9	*	1.0
Dimension	dpthcv	WW	40a	7	0.8	0.1	0.6	0.8	0.9	0.9	1.0
Dimension	dpthcv	WW	47a	6	0.6	0.1	0.5	0.6	0.6	0.7	0.7
Dimension	dpthcv	WW	47b	21	0.7	0.1	0.6	0.6	0.7	0.8	0.9
Dimension	dpthcv	WW	47c	20	0.7	0.1	0.5	0.6	0.7	0.7	0.8
Dimension	dpthcv	WW	47e	6	0.6	0.1	0.5	0.5	0.6	0.7	0.7
Dimension	dpthcv	WW	47f	19	0.7	0.1	0.6	0.6	0.7	0.8	1.0
Dimension	dpthcv	CW	52b	12	0.7	0.1	0.5	0.6	0.7	0.8	1.0
Dimension	dpthcv	WW	52b	7	0.8	0.2	0.5	0.6	0.8	0.9	1.2
Dimension	dpthcv	WW	72d	3	0.5	0.2	0.3	*	0.5	*	0.7
Dimension	dpthsd	WW	40a	7	0.6	0.2	0.4	0.4	0.6	0.8	0.8
Dimension	dpthsd	WW	47a	6	0.4	0.1	0.3	0.3	0.4	0.6	0.6
Dimension	dpthsd	WW	47b	21	0.6	0.1	0.3	0.5	0.6	0.7	0.9
Dimension	dpthsd	WW	47c	20	0.6	0.2	0.3	0.5	0.6	0.7	1.1
Dimension	dpthsd	WW	47e	6	0.4	0.1	0.3	0.4	0.5	0.5	0.6
Dimension	dpthsd	WW	47f	19	0.6	0.3	0.3	0.4	0.6	0.8	1.2
Dimension	dpthsd	CW	52b	12	0.5	0.1	0.4	0.5	0.5	0.6	0.8
Dimension	dpthsd	WW	52b	7	0.8	0.2	0.6	0.6	0.7	0.9	1.3
Dimension	dpthsd	WW	72d	3	0.3	0.1	0.2	*	0.3	*	0.4

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev	Minimum	Q25	Median	Q75	Maximum
Dimension	dpthsum	WW	40a	7	1.3	0.3	0.9	1.0	1.2	1.7	1.8
Dimension	dpthsum	WW	47a	6	1.2	0.2	0.9	1.0	1.2	1.3	1.4
Dimension	dpthsum	WW	47b	21	1.5	0.3	0.8	1.2	1.5	1.6	2.1
Dimension	dpthsum	WW	47c	20	1.6	0.5	0.9	1.3	1.4	1.7	2.8
Dimension	dpthsum	WW	47e	6	1.2	0.3	0.8	0.9	1.2	1.4	1.6
Dimension	dpthsum	WW	47f	19	1.5	0.6	0.7	1.0	1.4	1.8	3.3
Dimension	dpthsum	CW	52b	12	1.3	0.2	1.0	1.1	1.3	1.5	1.6
Dimension	dpthsum	WW	52b	7	1.8	0.5	1.3	1.5	1.6	2.3	2.6
Dimension	dpthsum	WW	72d	3	1.0	0.4	0.6	*	1.1	*	1.4
Dimension	maxdep	WW	40a	7	3.4	0.8	2.3	2.7	3.4	4.1	4.6
Dimension	maxdep	WW	47a	6	2.6	0.4	1.8	2.4	2.7	3.0	3.0
Dimension	maxdep	WW	47b	21	3.5	0.8	2.2	2.9	3.5	4.1	5.1
Dimension	maxdep	WW	47c	20	3.7	1.0	1.4	2.9	4.0	4.4	5.3
Dimension	maxdep	WW	47e	6	3.0	0.5	2.4	2.6	3.0	3.5	3.6
Dimension	maxdep	WW	47f	19	3.7	0.9	2.1	3.1	3.6	4.3	5.7
Dimension	maxdep	CW	52b	12	3.3	0.6	2.3	3.0	3.3	3.6	4.4
Dimension	maxdep	WW	52b	7	4.3	0.8	2.8	4.1	4.3	4.7	5.3
Dimension	maxdep	WW	72d	3	2.6	0.7	1.9	*	2.7	*	3.3
Dimension	strwdtav	WW	40a	7	29.9	17.8	14.5	16.4	22.9	46.5	61.4
Dimension	strwdtav	WW	47a	6	32.3	20.5	11.1	17.4	27.9	45.6	70.1
Dimension	strwdtav	WW	47b	21	39.3	21.0	19.3	23.1	32.2	50.8	102.8
Dimension	strwdtav	WW	47c	20	46.1	19.0	8.6	34.5	41.2	59.2	87.2
Dimension	strwdtav	WW	47e	6	28.1	15.5	15.2	17.3	23.9	37.1	57.5
Dimension	strwdtav	WW	47f	19	35.2	20.8	10.8	19.8	28.4	51.2	81.1
Dimension	strwdtav	CW	52b	12	16.8	6.7	7.0	11.9	15.7	20.8	29.2
Dimension	strwdtav	WW	52b	7	38.9	22.6	10.5	16.1	33.6	67.3	68.1
Dimension	strwdtav	WW	72d	3	29.5	3.1	26.7	*	28.9	*	32.9
Dimension	strwdtcv	WW	40a	7	0.4	0.1	0.2	0.3	0.4	0.5	0.5
Dimension	strwdtcv	WW	47a	6	0.3	0.1	0.2	0.2	0.3	0.3	0.3
Dimension	strwdtcv	WW	47b	21	0.3	0.1	0.2	0.2	0.3	0.3	0.6
Dimension	strwdtcv	WW	47c	20	0.3	0.1	0.2	0.2	0.2	0.3	0.4
Dimension	strwdtcv	WW	47e	6	0.3	0.1	0.2	0.2	0.2	0.3	0.4
Dimension	strwdtcv	WW	47f	19	0.3	0.1	0.2	0.2	0.3	0.3	0.4
Dimension	strwdtcv	CW	52b	12	0.3	0.1	0.2	0.3	0.3	0.4	0.4
Dimension	strwdtcv	WW	52b	7	0.4	0.1	0.2	0.3	0.3	0.4	0.6
Dimension	strwdtcv	WW	72d	3	0.3	0.1	0.2	*	0.4	*	0.4
Dimension	strwdtsd	WW	40a	7	10.2	3.8	7.4	7.6	9.3	10.6	18.2
Dimension	strwdtsd	WW	47a	6	8.0	3.1	3.5	5.0	8.6	9.9	12.3
Dimension	strwdtsd	WW	47b	21	11.7	10.5	3.1	6.1	7.6	11.9	43.7
Dimension	strwdtsd	WW	47c	20	12.0	6.0	1.4	8.6	11.3	13.5	31.8
Dimension	strwdtsd	WW	47e	6	6.7	3.2	4.2	4.5	5.2	9.8	12.1
Dimension	strwdtsd	WW	47f	19	9.8	7.1	2.7	4.7	7.5	12.5	27.0
Dimension	strwdtsd	CW	52b	12	4.9	2.0	1.6	3.4	5.2	6.3	8.6
Dimension	strwdtsd	WW	52b	7	13.2	7.8	4.0	4.5	13.0	17.9	25.6
Dimension	strwdtsd	WW	72d	3	9.5	3.0	6.5	*	9.7	*	12.4
Dimension	thwgdpav	WW	40a	7	1.3	0.3	0.8	1.0	1.3	1.5	1.8
Dimension	thwgdpav	WW	47a	6	1.3	0.2	1.1	1.1	1.3	1.5	1.7
Dimension	thwgdpav	WW	47b	21	1.6	0.4	0.9	1.3	1.6	1.8	2.2
Dimension	thwgdpav	WW	47c	20	1.7	0.6	0.9	1.3	1.7	2.0	2.8
Dimension	thwgdpav	WW	47e	6	1.3	0.3	1.0	1.0	1.4	1.6	1.6
Dimension	thwgdpav	WW	47f	19	1.6	0.7	0.6	1.2	1.5	1.9	3.5
Dimension	thwgdpav	CW	52b	12	1.3	0.2	1.0	1.1	1.2	1.5	1.6
Dimension	thwgdpav	WW	52b	7	1.8	0.6	1.0	1.4	1.6	2.4	2.6
Dimension	thwgdpav	WW	72d	3	1.2	0.3	0.8	*	1.2	*	1.5

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev	Minimum	Q25	Median	Q75	Maximum
Dimension	thwgdpcv	WW	40a	7	0.6	0.2	0.2	0.4	0.6	0.7	0.7
Dimension	thwgdpcv	WW	47a	6	0.3	0.1	0.2	0.2	0.3	0.4	0.5
Dimension	thwgdpcv	WW	47b	21	0.4	0.1	0.3	0.4	0.4	0.5	0.6
Dimension	thwgdpcv	WW	47c	20	0.4	0.1	0.3	0.4	0.4	0.4	0.5
Dimension	thwgdpcv	WW	47e	6	0.4	0.1	0.3	0.3	0.3	0.5	0.5
Dimension	thwgdpcv	WW	47f	19	0.5	0.1	0.3	0.4	0.5	0.6	1.0
Dimension	thwgdpcv	CW	52b	12	0.5	0.1	0.3	0.4	0.5	0.6	0.7
Dimension	thwgdpcv	WW	52b	7	0.5	0.1	0.3	0.4	0.5	0.6	0.7
Dimension	thwgdpcv	WW	72d	3	0.3	0.1	0.1	*	0.3	*	0.4
Dimension	thwgdpsd	WW	40a	7	0.7	0.3	0.3	0.5	0.7	1.0	1.0
Dimension	thwgdpsd	WW	47a	6	0.4	0.1	0.3	0.3	0.5	0.6	0.6
Dimension	thwgdpsd	WW	47b	21	0.7	0.2	0.4	0.5	0.7	0.8	1.3
Dimension	thwgdpsd	WW	47c	20	0.7	0.2	0.2	0.5	0.7	0.8	1.2
Dimension	thwgdpsd	WW	47e	6	0.5	0.1	0.3	0.4	0.5	0.6	0.6
Dimension	thwgdpsd	WW	47f	19	0.7	0.3	0.3	0.5	0.7	0.9	1.4
Dimension	thwgdpsd	CW	52b	12	0.6	0.1	0.4	0.5	0.6	0.7	0.9
Dimension	thwgdpsd	WW	52b	7	0.9	0.3	0.7	0.7	0.8	1.0	1.5
Dimension	thwgdpsd	WW	72d	3	0.3	0.1	0.2	*	0.3	*	0.4
Dimension	thwgdpsm	WW	40a	7	2.0	0.5	1.4	1.6	1.9	2.6	2.8
Dimension	thwgdpsm	WW	47a	6	1.8	0.3	1.4	1.5	1.7	2.0	2.3
Dimension	thwgdpsm	WW	47b	21	2.3	0.5	1.3	1.8	2.3	2.7	3.5
Dimension	thwgdpsm	WW	47c	20	2.4	0.8	1.1	1.8	2.4	2.7	3.9
Dimension	thwgdpsm	WW	47e	6	1.8	0.3	1.3	1.5	1.9	2.0	2.1
Dimension	thwgdpsm	WW	47f	19	2.3	0.9	1.0	1.6	2.4	2.7	4.5
Dimension	thwgdpsm	CW	52b	12	1.9	0.3	1.5	1.7	1.9	2.1	2.6
Dimension	thwgdpsm	WW	52b	7	2.8	0.8	1.8	2.1	2.4	3.4	4.1
Dimension	thwgdpsm	WW	72d	3	1.5	0.4	1.1	*	1.4	*	1.9
Dimension	thwgwdr	WW	40a	7	23.5	12.6	10.8	17.3	18.1	31.3	48.6
Dimension	thwgwdr	WW	47a	6	24.2	11.5	10.4	13.3	24.2	33.4	41.5
Dimension	thwgwdr	WW	47b	21	24.7	9.3	11.4	20.3	22.5	29.7	51.7
Dimension	thwgwdr	WW	47c	20	28.2	10.7	11.0	20.7	26.0	31.6	51.5
Dimension	thwgwdr	WW	47e	6	22.8	13.2	11.6	14.4	17.1	33.2	46.9
Dimension	thwgwdr	WW	47f	19	23.1	8.6	9.4	16.8	21.1	28.4	41.1
Dimension	thwgwdr	CW	52b	12	13.0	4.4	6.2	9.7	13.1	15.7	21.7
Dimension	thwgwdr	WW	52b	7	19.9	7.4	10.1	11.3	21.4	26.2	30.5
Dimension	thwgwdr	WW	72d	3	28.4	11.0	21.0	*	23.3	*	41.1
Instream Cover	cvrartf%	WW	40a	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Instream Cover	cvrartf%	WW	47a	5	0.9	1.2	0.0	0.0	0.3	2.0	2.8
Instream Cover	cvrartf%	WW	47b	21	1.2	2.1	0.0	0.0	0.3	1.0	7.4
Instream Cover	cvrartf%	WW	47c	20	0.3	0.8	0.0	0.0	0.0	0.0	3.0
Instream Cover	cvrartf%	WW	47e	6	0.2	0.3	0.0	0.0	0.0	0.5	0.5
Instream Cover	cvrartf%	WW	47f	19	1.0	2.8	0.0	0.0	0.0	0.3	11.3
Instream Cover	cvrartf%	CW	52b	12	0.7	1.3	0.0	0.0	0.0	0.9	4.0
Instream Cover	cvrartf%	WW	52b	7	0.5	1.1	0.0	0.0	0.0	0.7	3.0
Instream Cover	cvrartf%	WW	72d	3	0.0	0.0	0.0	*	0.0	*	0.0
Instream Cover	cvrbldr%	WW	40a	7	3.3	3.6	0.0	0.0	1.7	6.5	9.3
Instream Cover	cvrbldr%	WW	47a	5	5.1	3.7	1.5	2.3	4.5	8.3	11.1
Instream Cover	cvrbldr%	WW	47b	21	6.7	7.1	0.0	1.1	4.0	10.1	27.5
Instream Cover	cvrbldr%	WW	47c	20	4.0	7.2	0.0	0.0	0.9	6.3	30.0
Instream Cover	cvrbldr%	WW	47e	6	3.2	5.2	0.0	0.0	1.0	6.1	13.5
Instream Cover	cvrbldr%	WW	47f	19	3.3	5.6	0.0	0.0	1.5	3.6	23.6
Instream Cover	cvrbldr%	CW	52b	12	9.6	4.9	3.0	5.1	9.4	12.9	19.0
Instream Cover	cvrbldr%	WW	52b	7	5.7	3.8	1.2	3.3	3.8	9.5	11.8
Instream Cover	cvrbldr%	WW	72d	3	0.0	0.0	0.0	*	0.0	*	0.0

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev	Minimum	Q25	Median	Q75	Maximum
Instream Cover	cvrdnr%	WW	40a	7	19.3	4.6	14.8	16.3	17.3	23.2	27.8
Instream Cover	cvrdnr%	WW	47a	5	38.9	13.4	26.0	26.7	34.9	53.1	53.1
Instream Cover	cvrdnr%	WW	47b	21	39.8	23.1	14.8	29.8	34.8	42.5	128.8
Instream Cover	cvrdnr%	WW	47c	20	36.8	15.5	12.0	23.8	36.5	47.1	65.3
Instream Cover	cvrdnr%	WW	47e	6	31.0	11.5	16.0	23.7	29.6	37.9	51.1
Instream Cover	cvrdnr%	WW	47f	19	31.5	17.2	11.5	22.1	27.5	37.1	88.5
Instream Cover	cvrdnr%	CW	52b	12	60.4	19.8	37.0	48.9	55.1	70.1	109.0
Instream Cover	cvrdnr%	WW	52b	7	45.1	18.1	29.3	33.8	35.0	56.9	80.1
Instream Cover	cvrdnr%	WW	72d	3	64.7	34.5	26.0	*	75.5	*	92.5
Instream Cover	cvrdpl%	WW	40a	7	2.7	3.3	0.0	0.5	1.3	7.4	7.5
Instream Cover	cvrdpl%	WW	47a	5	2.9	3.1	0.0	0.1	3.3	5.4	7.6
Instream Cover	cvrdpl%	WW	47b	21	7.2	7.2	0.2	1.0	6.1	9.8	25.4
Instream Cover	cvrdpl%	WW	47c	20	6.9	7.5	0.0	2.5	4.3	7.9	25.3
Instream Cover	cvrdpl%	WW	47e	6	3.3	3.5	0.0	0.9	1.8	6.4	9.3
Instream Cover	cvrdpl%	WW	47f	19	6.9	12.5	0.0	0.5	1.8	6.0	53.5
Instream Cover	cvrdpl%	CW	52b	12	2.1	1.8	0.0	0.1	2.3	3.8	5.0
Instream Cover	cvrdpl%	WW	52b	7	7.9	7.3	1.3	2.3	3.1	17.3	18.1
Instream Cover	cvrdpl%	WW	72d	3	1.3	2.3	0.0	*	0.0	*	4.0
Instream Cover	cvrepa%	WW	40a	7	15.6	4.9	10.5	12.4	15.3	16.5	25.5
Instream Cover	cvrepa%	WW	47a	5	18.8	3.5	14.5	15.4	18.9	22.1	23.3
Instream Cover	cvrepa%	WW	47b	21	25.1	10.5	10.8	16.4	24.3	30.8	48.1
Instream Cover	cvrepa%	WW	47c	20	26.1	11.4	12.0	19.6	22.8	31.4	54.3
Instream Cover	cvrepa%	WW	47e	6	22.4	4.5	14.0	19.1	24.4	25.4	25.6
Instream Cover	cvrepa%	WW	47f	19	21.5	8.8	4.6	17.0	20.5	30.3	37.4
Instream Cover	cvrepa%	CW	52b	12	33.2	9.2	21.5	24.3	33.0	39.3	51.0
Instream Cover	cvrepa%	WW	52b	7	22.7	10.1	12.8	16.0	20.7	28.3	42.5
Instream Cover	cvrepa%	WW	72d	3	15.3	9.0	5.0	*	18.8	*	22.0
Instream Cover	cvrflma%	WW	40a	7	0.9	1.1	0.0	0.3	0.5	1.3	3.3
Instream Cover	cvrflma%	WW	47a	5	16.8	14.6	1.8	3.3	13.4	32.0	33.4
Instream Cover	cvrflma%	WW	47b	21	4.9	13.3	0.0	0.0	1.0	4.3	61.4
Instream Cover	cvrflma%	WW	47c	20	3.5	5.7	0.0	0.0	1.5	3.3	22.3
Instream Cover	cvrflma%	WW	47e	6	4.5	8.0	0.0	0.4	1.8	6.9	20.8
Instream Cover	cvrflma%	WW	47f	19	2.9	3.4	0.0	0.0	1.5	4.6	13.6
Instream Cover	cvrflma%	CW	52b	12	5.7	5.6	0.0	0.4	3.9	10.8	17.0
Instream Cover	cvrflma%	WW	52b	7	7.9	4.4	0.5	4.0	9.1	11.3	13.4
Instream Cover	cvrflma%	WW	72d	3	0.9	1.4	0.0	*	0.3	*	2.5
Instream Cover	cvrlgdn%	WW	40a	7	11.7	3.7	5.5	10.0	12.0	12.8	17.9
Instream Cover	cvrlgdn%	WW	47a	5	12.5	4.1	6.4	8.3	14.9	15.4	15.6
Instream Cover	cvrlgdn%	WW	47b	21	23.3	10.7	4.0	16.0	22.9	27.8	53.8
Instream Cover	cvrlgdn%	WW	47c	20	21.6	11.4	3.5	13.6	19.1	28.5	46.9
Instream Cover	cvrlgdn%	WW	47e	6	12.6	4.9	6.0	8.8	11.6	18.1	18.5
Instream Cover	cvrlgdn%	WW	47f	19	18.4	14.5	2.5	9.0	16.3	21.1	65.5
Instream Cover	cvrlgdn%	CW	52b	12	20.8	7.5	10.0	14.0	20.4	26.9	34.5
Instream Cover	cvrlgdn%	WW	52b	7	18.3	10.0	10.3	10.4	15.9	22.6	38.6
Instream Cover	cvrlgdn%	WW	72d	3	5.6	5.3	0.0	*	6.3	*	10.5
Instream Cover	cvrlgep%	WW	40a	7	9.0	4.3	4.5	5.3	8.8	11.5	16.4
Instream Cover	cvrlgep%	WW	47a	5	9.6	2.8	6.1	6.7	10.3	12.2	12.4
Instream Cover	cvrlgep%	WW	47b	21	16.1	8.6	3.0	10.4	15.0	21.6	33.6
Instream Cover	cvrlgep%	WW	47c	20	14.7	7.4	3.5	10.1	13.7	17.0	35.5
Instream Cover	cvrlgep%	WW	47e	6	9.3	4.5	5.0	5.8	8.0	13.0	17.3
Instream Cover	cvrlgep%	WW	47f	19	11.5	6.2	2.5	6.3	11.5	14.5	27.4
Instream Cover	cvrlgep%	CW	52b	12	18.7	7.2	7.5	13.2	19.3	24.3	32.0
Instream Cover	cvrlgep%	WW	52b	7	10.4	5.0	5.3	7.3	9.0	12.8	20.5
Instream Cover	cvrlgep%	WW	72d	3	4.3	5.5	0.0	*	2.3	*	10.5

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev	Minimum	Q25	Median	Q75	Maximum
Instream Cover	cvrmacr%	WW	40a	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Instream Cover	cvrmacr%	WW	47a	5	0.5	0.3	0.3	0.3	0.3	0.8	1.0
Instream Cover	cvrmacr%	WW	47b	21	2.6	11.0	0.0	0.0	0.0	0.0	50.4
Instream Cover	cvrmacr%	WW	47c	20	0.2	0.6	0.0	0.0	0.0	0.2	2.0
Instream Cover	cvrmacr%	WW	47e	6	0.8	1.7	0.0	0.0	0.0	1.5	4.1
Instream Cover	cvrmacr%	WW	47f	19	0.2	0.7	0.0	0.0	0.0	0.0	3.3
Instream Cover	cvrmacr%	CW	52b	12	19.4	21.8	0.0	0.6	11.0	35.9	67.6
Instream Cover	cvrmacr%	WW	52b	7	6.6	14.0	0.0	0.5	1.3	4.8	38.2
Instream Cover	cvrmacr%	WW	72d	3	47.2	43.2	1.5	*	52.5	*	87.5
Instream Cover	cvrnatrl%	WW	40a	7	16.6	4.7	11.0	13.5	16.3	16.8	26.3
Instream Cover	cvrnatrl%	WW	47a	5	35.2	14.6	18.5	20.9	34.4	49.8	49.9
Instream Cover	cvrnatrl%	WW	47b	21	31.4	23.0	12.3	17.5	28.9	34.9	123.0
Instream Cover	cvrnatrl%	WW	47c	20	29.6	12.1	12.0	22.0	27.0	40.9	54.3
Instream Cover	cvrnatrl%	WW	47e	6	27.6	11.8	16.0	19.2	25.7	33.4	49.9
Instream Cover	cvrnatrl%	WW	47f	19	23.6	8.7	9.4	18.5	22.0	29.4	42.1
Instream Cover	cvrnatrl%	CW	52b	12	57.6	20.0	33.5	45.4	53.1	66.9	108.8
Instream Cover	cvrnatrl%	WW	52b	7	36.7	13.0	24.3	26.1	32.5	44.3	62.2
Instream Cover	cvrnatrl%	WW	72d	3	63.3	34.0	26.0	*	71.5	*	92.5
Instream Cover	cvrovhg%	WW	40a	7	1.7	1.4	0.0	0.7	1.5	2.3	4.3
Instream Cover	cvrovhg%	WW	47a	5	7.1	4.0	2.8	4.0	6.5	10.6	13.6
Instream Cover	cvrovhg%	WW	47b	21	2.4	1.9	0.0	0.8	1.8	4.4	6.0
Instream Cover	cvrovhg%	WW	47c	20	2.6	2.1	0.0	0.7	2.4	3.8	8.5
Instream Cover	cvrovhg%	WW	47e	6	5.8	5.2	1.5	1.9	4.6	8.5	15.7
Instream Cover	cvrovhg%	WW	47f	19	2.6	2.0	0.0	1.0	2.5	4.8	5.5
Instream Cover	cvrovhg%	CW	52b	12	8.1	4.8	1.5	3.9	7.5	12.7	14.3
Instream Cover	cvrovhg%	WW	52b	7	9.2	9.8	2.8	4.8	5.0	11.7	30.5
Instream Cover	cvrovhg%	WW	72d	3	6.2	6.3	0.5	*	5.0	*	13.0
Instream Cover	cvrsbrsh%	WW	40a	7	4.9	2.4	2.0	2.8	6.0	6.5	8.1
Instream Cover	cvrsbrsh%	WW	47a	5	2.1	2.1	0.0	0.6	1.5	3.8	5.5
Instream Cover	cvrsbrsh%	WW	47b	21	6.5	4.3	0.0	3.4	5.3	8.8	15.2
Instream Cover	cvrsbrsh%	WW	47c	20	8.9	6.6	0.0	4.3	7.2	9.4	27.5
Instream Cover	cvrsbrsh%	WW	47e	6	7.3	4.4	2.3	3.2	6.9	11.1	14.3
Instream Cover	cvrsbrsh%	WW	47f	19	7.4	4.7	0.8	4.0	6.5	9.5	23.0
Instream Cover	cvrsbrsh%	CW	52b	12	6.4	5.2	0.0	2.8	4.9	10.9	15.5
Instream Cover	cvrsbrsh%	WW	52b	7	3.1	0.9	1.5	2.8	3.0	3.7	4.5
Instream Cover	cvrsbrsh%	WW	72d	3	4.8	5.6	0.0	*	3.5	*	11.0
Instream Cover	cvrtrrt%	WW	40a	7	1.2	0.6	0.3	1.0	1.2	1.3	2.3
Instream Cover	cvrtrrt%	WW	47a	5	1.7	1.4	0.0	0.6	1.3	2.9	3.8
Instream Cover	cvrtrrt%	WW	47b	21	2.7	2.0	0.0	1.0	2.0	4.3	7.8
Instream Cover	cvrtrrt%	WW	47c	20	3.1	1.3	0.0	2.0	3.5	4.2	4.8
Instream Cover	cvrtrrt%	WW	47e	6	1.9	1.3	0.0	1.1	1.7	2.9	4.1
Instream Cover	cvrtrrt%	WW	47f	19	2.0	2.2	0.0	0.5	1.0	3.3	8.4
Instream Cover	cvrtrrt%	CW	52b	12	2.5	3.0	0.0	0.5	1.0	4.9	9.4
Instream Cover	cvrtrrt%	WW	52b	7	1.6	1.2	0.0	0.5	1.5	2.8	3.5
Instream Cover	cvrtrrt%	WW	72d	3	0.7	0.6	0.0	*	1.0	*	1.0
Instream Cover	cvrucbk%	WW	40a	7	0.2	0.3	0.0	0.0	0.3	0.3	0.8
Instream Cover	cvrucbk%	WW	47a	5	0.9	0.8	0.0	0.1	1.0	1.5	2.0
Instream Cover	cvrucbk%	WW	47b	21	0.9	0.9	0.0	0.1	0.5	1.6	2.8
Instream Cover	cvrucbk%	WW	47c	20	1.7	1.1	0.3	0.8	1.4	2.5	4.3
Instream Cover	cvrucbk%	WW	47e	6	0.6	0.8	0.0	0.0	0.3	1.3	2.0
Instream Cover	cvrucbk%	WW	47f	19	1.0	1.3	0.0	0.0	0.5	1.5	4.8
Instream Cover	cvrucbk%	CW	52b	12	2.6	2.1	0.0	1.1	2.3	3.8	8.0
Instream Cover	cvrucbk%	WW	52b	7	1.4	1.3	0.0	0.3	1.0	3.0	3.5
Instream Cover	cvrucbk%	WW	72d	3	0.0	0.0	0.0	*	0.0	*	0.0

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev	Minimum	Q25	Median	Q75	Maximum
Instream Cover	cvrwdbrs%	WW	40a	7	4.3	4.6	0.8	1.5	2.8	5.0	14.4
Instream Cover	cvrwdbrs%	WW	47a	5	1.2	1.9	0.0	0.1	0.3	2.6	4.5
Instream Cover	cvrwdbrs%	WW	47b	21	4.7	5.6	0.0	0.5	2.3	7.6	17.5
Instream Cover	cvrwdbrs%	WW	47c	20	5.6	5.6	0.5	1.1	4.6	8.1	21.3
Instream Cover	cvrwdbrs%	WW	47e	6	3.4	1.7	1.3	1.9	3.3	4.9	6.0
Instream Cover	cvrwdbrs%	WW	47f	19	4.1	3.5	0.0	1.3	2.8	7.5	11.0
Instream Cover	cvrwdbrs%	CW	52b	12	3.2	4.1	0.0	0.0	1.6	5.2	12.0
Instream Cover	cvrwdbrs%	WW	52b	7	1.2	0.8	0.5	0.5	1.0	2.0	2.5
Instream Cover	cvrwdbrs%	WW	72d	3	3.6	5.2	0.0	*	1.3	*	9.5
Instream Cover	lgcycvr%	WW	40a	7	9.9	6.4	1.8	5.0	7.0	17.5	17.5
Instream Cover	lgcycvr%	WW	47a	6	4.1	6.3	0.0	0.4	1.5	7.4	16.5
Instream Cover	lgcycvr%	WW	47b	21	8.9	7.5	1.0	3.5	7.0	12.3	30.6
Instream Cover	lgcycvr%	WW	47c	20	7.6	9.3	0.5	1.8	3.5	10.4	38.5
Instream Cover	lgcycvr%	WW	47e	6	3.2	4.2	0.0	0.0	1.4	7.4	10.0
Instream Cover	lgcycvr%	WW	47f	19	8.1	7.9	0.0	2.0	7.0	11.3	26.0
Instream Cover	lgcycvr%	CW	52b	3	2.1	2.0	0.0	0.0	2.3	3.9	3.9
Instream Cover	lgcycvr%	WW	52b	7	10.5	8.9	1.2	3.5	8.5	18.5	26.5
Instream Cover	lgcycvr%	WW	72d	1	11.0	*	11.0	*	11.0	*	11.0
Instream Cover	lrgwdy%	WW	40a	7	17.9	13.5	1.8	7.1	16.1	32.1	39.3
Instream Cover	lrgwdy%	WW	47a	6	11.9	11.2	0.0	2.7	10.7	20.5	28.6
Instream Cover	lrgwdy%	WW	47b	21	22.0	13.7	0.0	11.6	23.2	31.3	50.0
Instream Cover	lrgwdy%	WW	47c	20	34.3	23.7	1.8	14.3	34.8	56.3	82.1
Instream Cover	lrgwdy%	WW	47e	6	25.3	14.7	7.1	11.2	25.0	38.4	46.4
Instream Cover	lrgwdy%	WW	47f	19	23.0	13.2	0.0	10.7	25.0	32.1	48.2
Instream Cover	lrgwdy%	CW	52b	3	8.3	7.2	1.8	1.8	7.1	16.1	16.1
Instream Cover	lrgwdy%	WW	52b	7	14.5	6.6	7.1	7.1	14.3	21.4	23.2
Instream Cover	lrgwdy%	WW	72d	1	46.4	*	46.4	*	46.4	*	46.4
Macrohabitat	rchmxhb%	WW	40a	7	68.6	13.7	52.4	54.7	67.1	78.1	90.6
Macrohabitat	rchmxhb%	WW	47a	6	67.6	13.9	52.7	55.1	66.1	82.3	82.8
Macrohabitat	rchmxhb%	WW	47b	21	67.5	9.5	53.6	58.7	64.3	75.5	83.9
Macrohabitat	rchmxhb%	WW	47c	20	67.4	11.1	46.9	60.0	65.8	76.8	88.1
Macrohabitat	rchmxhb%	WW	47e	6	74.5	21.2	47.3	51.4	78.5	94.9	95.5
Macrohabitat	rchmxhb%	WW	47f	19	67.6	11.4	45.2	59.0	69.6	76.2	87.5
Macrohabitat	rchmxhb%	CW	52b	12	52.9	10.5	41.1	46.0	48.8	60.1	78.6
Macrohabitat	rchmxhb%	WW	52b	7	55.4	5.5	47.6	50.9	57.1	61.0	61.3
Macrohabitat	rchmxhb%	WW	72d	3	85.7	12.4	78.6	*	78.6	*	100.0
Macrohabitat	rchpool%	WW	40a	7	60.9	19.2	33.5	45.2	61.9	75.6	90.6
Macrohabitat	rchpool%	WW	47a	6	26.6	14.6	7.1	12.5	26.2	42.0	44.6
Macrohabitat	rchpool%	WW	47b	21	40.8	17.5	14.3	27.5	41.7	51.5	81.0
Macrohabitat	rchpool%	WW	47c	20	37.7	14.1	13.7	25.3	35.1	44.9	66.1
Macrohabitat	rchpool%	WW	47e	6	18.5	15.0	0.9	4.2	16.6	34.8	37.5
Macrohabitat	rchpool%	WW	47f	19	43.5	16.2	12.5	35.7	42.3	51.3	70.2
Macrohabitat	rchpool%	CW	52b	12	28.8	9.6	10.7	21.7	28.6	37.0	43.3
Macrohabitat	rchpool%	WW	52b	7	40.5	13.8	17.9	29.8	41.1	47.6	61.0
Macrohabitat	rchpool%	WW	72d	3	77.8	22.6	54.8	*	78.6	*	100.0
Macrohabitat	rchrffl%	WW	40a	7	9.8	7.0	0.0	5.4	8.3	16.7	20.9
Macrohabitat	rchrffl%	WW	47a	6	10.7	7.6	1.2	3.0	10.4	18.6	20.6
Macrohabitat	rchrffl%	WW	47b	21	9.0	7.8	0.0	2.5	7.1	16.5	23.2
Macrohabitat	rchrffl%	WW	47c	20	6.0	7.4	0.0	0.0	3.4	10.1	25.5
Macrohabitat	rchrffl%	WW	47e	6	9.4	10.2	0.0	0.5	6.5	19.6	25.0
Macrohabitat	rchrffl%	WW	47f	19	8.4	7.0	0.0	1.2	8.9	14.9	21.4
Macrohabitat	rchrffl%	CW	52b	12	23.6	9.9	10.7	17.2	19.7	29.8	46.4
Macrohabitat	rchrffl%	WW	52b	7	18.5	6.9	11.3	12.8	16.7	25.0	29.8
Macrohabitat	rchrffl%	WW	72d	3	0.0	0.0	0.0	*	0.0	*	0.0

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev	Minimum	Q25	Median	Q75	Maximum
Macrohabitat	rchrun%	WW	40a	7	29.3	18.3	4.0	21.4	24.4	46.4	59.8
Macrohabitat	rchrun%	WW	47a	6	62.8	15.9	44.2	48.1	63.0	76.8	82.1
Macrohabitat	rchrun%	WW	47b	21	50.2	16.4	15.8	40.1	49.1	58.7	82.1
Macrohabitat	rchrun%	WW	47c	20	56.3	15.7	22.6	46.2	55.4	63.8	86.3
Macrohabitat	rchrun%	WW	47e	6	72.1	24.7	37.5	45.5	78.5	94.9	95.5
Macrohabitat	rchrun%	WW	47f	19	48.1	18.9	20.2	30.9	45.2	59.0	87.5
Macrohabitat	rchrun%	CW	52b	12	47.6	14.1	23.2	38.4	46.0	55.1	78.6
Macrohabitat	rchrun%	WW	52b	7	40.9	15.8	23.2	26.2	42.3	58.9	61.3
Macrohabitat	rchrun%	WW	72d	3	22.2	22.6	0.0	*	21.4	*	45.2
Substrate	subbdrk%	WW	40a	7	4.0	5.7	0.0	0.0	0.0	9.3	14.0
Substrate	subbdrk%	WW	47a	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Substrate	subbdrk%	WW	47b	21	0.3	1.1	0.0	0.0	0.0	0.0	4.7
Substrate	subbdrk%	WW	47c	20	1.0	3.7	0.0	0.0	0.0	0.4	16.5
Substrate	subbdrk%	WW	47e	6	0.2	0.4	0.0	0.0	0.0	0.3	1.0
Substrate	subbdrk%	WW	47f	19	2.6	6.7	0.0	0.0	0.0	1.0	24.7
Substrate	subbdrk%	CW	52b	12	4.3	9.8	0.0	0.0	0.3	4.0	34.7
Substrate	subbdrk%	WW	52b	7	0.4	0.7	0.0	0.0	0.0	0.5	2.0
Substrate	subbdrk%	WW	72d	3	0.0	0.0	0.0	*	0.0	*	0.0
Substrate	subbldr%	WW	40a	7	1.9	2.4	0.0	0.0	1.0	4.0	6.0
Substrate	subbldr%	WW	47a	6	2.4	2.6	0.0	0.0	1.7	5.3	6.0
Substrate	subbldr%	WW	47b	21	2.5	2.8	0.0	0.5	1.5	3.5	9.0
Substrate	subbldr%	WW	47c	20	2.4	4.3	0.0	0.0	0.0	3.8	17.5
Substrate	subbldr%	WW	47e	6	1.4	2.5	0.0	0.0	0.5	2.4	6.5
Substrate	subbldr%	WW	47f	19	2.6	4.6	0.0	0.0	0.7	3.3	17.5
Substrate	subbldr%	CW	52b	12	7.9	5.2	0.0	2.7	9.0	11.8	16.0
Substrate	subbldr%	WW	52b	7	4.2	3.2	0.7	1.0	3.3	7.0	8.7
Substrate	subbldr%	WW	72d	3	0.0	0.0	0.0	*	0.0	*	0.0
Substrate	subcbbl%	WW	40a	7	15.1	13.7	2.0	4.7	7.0	31.3	35.3
Substrate	subcbbl%	WW	47a	6	11.2	10.5	0.7	2.9	9.4	18.2	29.8
Substrate	subcbbl%	WW	47b	21	12.9	11.8	0.0	2.1	11.0	23.7	37.8
Substrate	subcbbl%	WW	47c	20	13.2	15.9	0.0	0.0	5.8	26.8	44.1
Substrate	subcbbl%	WW	47e	6	8.7	10.1	0.0	0.0	5.4	19.6	23.0
Substrate	subcbbl%	WW	47f	19	15.3	15.8	0.0	0.0	10.0	30.0	46.0
Substrate	subcbbl%	CW	52b	12	43.3	9.7	27.0	34.8	44.0	49.9	61.5
Substrate	subcbbl%	WW	52b	7	32.9	8.1	16.6	30.0	35.3	38.7	41.3
Substrate	subcbbl%	WW	72d	3	0.0	0.0	0.0	*	0.0	*	0.0
Substrate	subclay%	WW	40a	7	4.4	5.2	0.0	0.0	2.0	10.3	12.3
Substrate	subclay%	WW	47a	6	0.8	1.6	0.0	0.0	0.0	1.5	4.0
Substrate	subclay%	WW	47b	21	0.6	0.9	0.0	0.0	0.3	1.2	3.0
Substrate	subclay%	WW	47c	20	0.7	1.1	0.0	0.0	0.1	1.2	4.5
Substrate	subclay%	WW	47e	6	7.2	8.1	0.0	1.9	5.1	11.7	22.7
Substrate	subclay%	WW	47f	19	4.7	6.3	0.0	0.8	2.0	5.3	25.0
Substrate	subclay%	CW	52b	12	0.4	0.9	0.0	0.0	0.0	0.0	2.7
Substrate	subclay%	WW	52b	7	2.1	3.4	0.0	0.0	0.3	5.3	8.3
Substrate	subclay%	WW	72d	3	0.4	0.8	0.0	*	0.0	*	1.3
Substrate	subdemu%	WW	40a	7	1.7	2.4	0.0	0.0	0.7	2.0	6.8
Substrate	subdemu%	WW	47a	6	1.5	1.2	0.0	0.0	2.0	2.4	2.7
Substrate	subdemu%	WW	47b	21	3.2	4.8	0.0	0.7	1.3	4.5	21.0
Substrate	subdemu%	WW	47c	20	1.4	2.0	0.0	0.0	0.8	1.9	9.0
Substrate	subdemu%	WW	47e	6	1.1	2.1	0.0	0.0	0.3	1.7	5.3
Substrate	subdemu%	WW	47f	19	1.1	1.6	0.0	0.0	0.7	1.3	5.3
Substrate	subdemu%	CW	52b	12	0.3	0.6	0.0	0.0	0.0	0.5	2.0
Substrate	subdemu%	WW	52b	7	0.6	0.9	0.0	0.0	0.0	1.3	2.4
Substrate	subdemu%	WW	72d	3	34.3	23.8	7.0	*	46.0	*	50.0

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev		Minimum	Q25	Median	Q75	Maximum
Substrate	subfines%	WW	40a	7	64.7	18.5		38.3	44.3	68.3	85.7	86.0
Substrate	subfines%	WW	47a	6	61.6	19.4		39.8	45.7	57.0	84.0	84.0
Substrate	subfines%	WW	47b	21	56.7	18.1		22.5	41.3	60.0	70.0	88.5
Substrate	subfines%	WW	47c	20	65.7	22.8		22.5	43.9	67.4	86.9	95.8
Substrate	subfines%	WW	47e	6	76.2	17.9		54.8	56.8	79.4	92.5	94.0
Substrate	subfines%	WW	47f	19	63.1	25.4		18.0	39.3	63.3	87.0	98.7
Substrate	subfines%	CW	52b	12	21.3	14.2		6.0	7.7	18.3	32.3	49.0
Substrate	subfines%	WW	52b	7	30.4	12.5		13.0	17.3	28.0	44.0	45.2
Substrate	subfines%	WW	72d	3	64.1	21.1		50.0	*	54.0	*	88.3
Substrate	subgrvl%	WW	40a	7	10.2	3.4		5.7	8.3	8.8	13.3	15.7
Substrate	subgrvl%	WW	47a	6	20.5	12.0		8.3	10.1	18.4	33.0	34.7
Substrate	subgrvl%	WW	47b	21	20.9	11.1		2.0	13.0	21.3	29.1	42.3
Substrate	subgrvl%	WW	47c	20	14.3	9.3		1.3	6.3	10.3	22.7	29.7
Substrate	subgrvl%	WW	47e	6	9.7	5.7		3.5	3.6	9.8	14.3	18.3
Substrate	subgrvl%	WW	47f	19	13.3	12.4		0.0	1.3	10.7	24.7	37.5
Substrate	subgrvl%	CW	52b	12	21.9	9.9		5.0	13.9	24.0	28.5	40.0
Substrate	subgrvl%	WW	52b	7	30.9	11.2		15.3	18.5	31.3	36.7	48.7
Substrate	subgrvl%	WW	72d	3	0.0	0.0		0.0	*	0.0	*	0.0
Substrate	sublgrk%	WW	40a	7	17.1	15.6		2.0	4.7	8.5	35.3	41.3
Substrate	sublgrk%	WW	47a	6	13.6	12.4		0.7	4.4	10.8	22.8	34.8
Substrate	sublgrk%	WW	47b	21	15.3	13.6		0.0	2.4	11.5	25.5	46.8
Substrate	sublgrk%	WW	47c	20	15.6	18.7		0.0	0.0	7.8	28.3	54.8
Substrate	sublgrk%	WW	47e	6	10.1	11.9		0.0	0.0	5.9	24.3	25.0
Substrate	sublgrk%	WW	47f	19	17.9	19.3		0.0	0.0	10.7	39.0	63.5
Substrate	sublgrk%	CW	52b	12	51.2	12.8		28.0	43.0	49.7	62.0	71.5
Substrate	sublgrk%	WW	52b	7	37.1	9.7		17.6	33.3	40.7	42.3	48.0
Substrate	sublgrk%	WW	72d	3	0.0	0.0		0.0	*	0.0	*	0.0
Substrate	subothr%	WW	40a	7	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Substrate	subothr%	WW	47a	6	0.2	0.4		0.0	0.0	0.0	0.3	1.0
Substrate	subothr%	WW	47b	21	0.3	0.7		0.0	0.0	0.0	0.0	3.0
Substrate	subothr%	WW	47c	20	0.1	0.2		0.0	0.0	0.0	0.0	0.5
Substrate	subothr%	WW	47e	6	0.0	0.1		0.0	0.0	0.0	0.1	0.3
Substrate	subothr%	WW	47f	19	0.0	0.1		0.0	0.0	0.0	0.0	0.3
Substrate	subothr%	CW	52b	12	0.4	0.7		0.0	0.0	0.0	0.9	2.0
Substrate	subothr%	WW	52b	7	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Substrate	subothr%	WW	72d	3	0.0	0.0		0.0	*	0.0	*	0.0
Substrate	subrock%	WW	40a	7	27.3	17.8		10.3	10.7	21.3	51.0	52.3
Substrate	subrock%	WW	47a	6	34.1	18.0		11.3	13.3	38.8	50.6	51.3
Substrate	subrock%	WW	47b	21	36.3	20.0		2.0	17.6	35.3	52.0	72.0
Substrate	subrock%	WW	47c	20	29.9	22.1		1.3	10.0	25.6	52.2	63.5
Substrate	subrock%	WW	47e	6	19.8	16.0		3.5	3.6	19.3	36.3	37.0
Substrate	subrock%	WW	47f	19	31.2	25.9		0.0	3.7	28.7	52.0	78.8
Substrate	subrock%	CW	52b	12	73.1	15.1		51.0	57.4	75.3	87.5	93.0
Substrate	subrock%	WW	52b	7	68.0	11.6		54.3	56.0	68.3	82.0	82.3
Substrate	subrock%	WW	72d	3	0.0	0.0		0.0	*	0.0	*	0.0
Substrate	subrrap%	WW	40a	7	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Substrate	subrrap%	WW	47a	6	0.1	0.3		0.0	0.0	0.0	0.2	0.7
Substrate	subrrap%	WW	47b	21	0.7	1.4		0.0	0.0	0.0	1.0	5.5
Substrate	subrrap%	WW	47c	20	0.1	0.2		0.0	0.0	0.0	0.0	0.7
Substrate	subrrap%	WW	47e	6	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Substrate	subrrap%	WW	47f	19	0.5	1.3		0.0	0.0	0.0	0.0	5.0
Substrate	subrrap%	CW	52b	12	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Substrate	subrrap%	WW	52b	7	0.1	0.2		0.0	0.0	0.0	0.0	0.5
Substrate	subrrap%	WW	72d	3	0.0	0.0		0.0	*	0.0	*	0.0

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev		Minimum	Q25	Median	Q75	Maximum
Substrate	subsand%	WW	40a	7	47.0	12.5		30.7	32.8	50.3	57.7	64.5
Substrate	subsand%	WW	47a	6	46.8	20.0		21.8	29.6	44.0	68.3	71.3
Substrate	subsand%	WW	47b	21	40.3	14.0		17.3	26.3	45.3	51.8	60.5
Substrate	subsand%	WW	47c	20	46.4	17.2		15.8	34.3	49.6	58.6	78.7
Substrate	subsand%	WW	47e	6	45.9	27.0		13.5	23.6	40.1	75.1	81.5
Substrate	subsand%	WW	47f	19	35.0	17.4		1.5	23.3	30.5	48.7	70.3
Substrate	subsand%	CW	52b	12	2.3	2.8		0.0	0.1	1.8	2.8	10.0
Substrate	subsand%	WW	52b	7	10.9	7.6		2.3	3.2	11.7	19.3	19.8
Substrate	subsand%	WW	72d	3	24.8	23.3		0.0	*	28.0	*	46.3
Substrate	subsilt%	WW	40a	7	13.3	12.1		1.7	3.8	7.7	25.0	33.3
Substrate	subsilt%	WW	47a	6	14.0	2.8		11.0	11.6	13.3	17.0	18.0
Substrate	subsilt%	WW	47b	21	15.7	14.2		2.0	6.5	10.5	20.0	53.3
Substrate	subsilt%	WW	47c	20	18.6	10.8		2.7	10.6	17.5	26.7	42.0
Substrate	subsilt%	WW	47e	6	23.1	14.2		10.5	12.0	16.6	40.4	42.3
Substrate	subsilt%	WW	47f	19	23.4	13.3		5.0	15.0	21.5	34.3	53.7
Substrate	subsilt%	CW	52b	12	18.6	12.3		5.5	6.9	15.7	29.1	45.0
Substrate	subsilt%	WW	52b	7	17.3	7.6		8.3	9.7	16.3	24.4	29.6
Substrate	subsilt%	WW	72d	3	38.9	12.1		26.0	*	40.7	*	50.0
Substrate	subsoil%	WW	40a	7	1.2	2.2		0.0	0.0	0.0	2.0	6.0
Substrate	subsoil%	WW	47a	6	2.5	3.5		0.0	0.0	1.2	4.9	9.0
Substrate	subsoil%	WW	47b	21	1.9	2.5		0.0	0.0	0.7	3.3	7.3
Substrate	subsoil%	WW	47c	20	0.7	0.9		0.0	0.0	0.0	1.3	2.7
Substrate	subsoil%	WW	47e	6	1.7	3.1		0.0	0.0	0.5	3.0	8.0
Substrate	subsoil%	WW	47f	19	0.7	1.3		0.0	0.0	0.0	0.9	5.3
Substrate	subsoil%	CW	52b	12	0.3	0.6		0.0	0.0	0.0	0.0	2.0
Substrate	subsoil%	WW	52b	7	0.4	0.5		0.0	0.0	0.0	0.7	1.3
Substrate	subsoil%	WW	72d	3	0.4	0.8		0.0	*	0.0	*	1.3
Substrate	substrmx%	WW	40a	7	48.6	11.2		33.5	37.3	50.7	57.7	64.5
Substrate	substrmx%	WW	47a	6	50.5	15.7		36.3	36.6	45.7	68.3	71.3
Substrate	substrmx%	WW	47b	21	48.9	7.4		33.8	43.1	51.0	53.2	60.5
Substrate	substrmx%	WW	47c	20	51.5	12.1		30.3	41.3	49.8	58.8	78.7
Substrate	substrmx%	WW	47e	6	56.3	16.8		40.8	42.6	49.7	75.1	81.5
Substrate	substrmx%	WW	47f	19	47.7	12.0		33.3	36.3	45.7	59.0	70.3
Substrate	substrmx%	CW	52b	12	47.0	6.6		39.0	41.0	46.0	51.5	61.5
Substrate	substrmx%	WW	52b	7	44.2	4.3		37.2	40.8	44.7	48.7	49.3
Substrate	substrmx%	WW	72d	3	51.2	5.9		46.0	*	50.0	*	57.7
Substrate	subwood%	WW	40a	7	1.1	1.7		0.0	0.0	0.7	2.0	4.5
Substrate	subwood%	WW	47a	6	0.1	0.3		0.0	0.0	0.0	0.2	0.8
Substrate	subwood%	WW	47b	21	0.7	0.7		0.0	0.0	0.5	1.3	2.3
Substrate	subwood%	WW	47c	20	1.2	1.6		0.0	0.0	0.6	2.1	5.3
Substrate	subwood%	WW	47e	6	1.1	1.1		0.0	0.0	0.9	2.2	2.7
Substrate	subwood%	WW	47f	19	0.9	1.1		0.0	0.0	0.7	1.3	3.3
Substrate	subwood%	CW	52b	12	0.4	0.5		0.0	0.0	0.3	0.9	1.0
Substrate	subwood%	WW	52b	7	0.3	0.5		0.0	0.0	0.0	0.5	1.3
Substrate	subwood%	WW	72d	3	1.1	1.9		0.0	*	0.0	*	3.3
Substrate	embdrtg	WW	40a	7	2.4	0.5		1.8	2.0	2.5	2.7	3.2
Substrate	embdrtg	WW	47a	6	2.8	0.9		1.0	2.3	3.0	3.4	3.6
Substrate	embdrtg	WW	47b	20	2.2	0.6		1.0	1.9	2.2	2.5	3.2
Substrate	embdrtg	WW	47c	13	2.1	0.4		1.4	1.8	2.0	2.4	3.0
Substrate	embdrtg	WW	47e	4	2.8	1.0		1.9	1.9	2.6	3.8	4.0
Substrate	embdrtg	WW	47f	14	2.1	0.3		1.7	1.9	2.1	2.4	2.9
Substrate	embdrtg	CW	52b	12	1.6	0.5		1.1	1.2	1.5	1.9	2.9
Substrate	embdrtg	WW	52b	7	2.1	0.3		1.7	1.8	2.0	2.2	2.7
Substrate	embdrtg	WW	72d	3	*	*		*	*	*	*	*

Appendix 3 (continued).

Category	Variable	Ref Type	Ecoregion	Site Count	Mean	StDev	Minimum	Q25	Median	Q75	Maximum
Substrate	sfsdtwg%	WW	40a	7	67.2	22.7	26.8	48.2	71.4	87.5	89.3
Substrate	sfsdtwg%	WW	47a	5	65.0	20.5	37.5	45.5	64.3	84.8	87.5
Substrate	sfsdtwg%	WW	47b	21	61.5	26.3	7.1	47.3	62.5	82.1	98.2
Substrate	sfsdtwg%	WW	47c	20	73.2	25.6	23.2	48.7	79.5	98.7	100.0
Substrate	sfsdtwg%	WW	47e	6	75.6	21.5	44.1	53.9	79.8	96.4	96.4
Substrate	sfsdtwg%	WW	47f	19	64.9	31.8	7.1	42.9	62.5	96.4	100.0
Substrate	sfsdtwg%	CW	52b	12	17.4	13.8	3.6	7.1	14.3	31.7	41.1
Substrate	sfsdtwg%	WW	52b	7	36.1	15.8	10.7	26.8	32.1	48.2	58.9
Substrate	sfsdtwg%	WW	72d	3	100.0	0.0	100.0	*	100.0	*	100.0
Composite Metric	PctSubOpt	WW	40a	7	8.0	5.6	0.0	2.9	8.0	13.0	16.6
Composite Metric	PctSubOpt	WW	47a	6	9.6	7.4	2.7	3.7	6.9	18.0	20.1
Composite Metric	PctSubOpt	WW	47b	21	6.3	5.5	0.0	1.8	4.2	10.0	18.4
Composite Metric	PctSubOpt	WW	47c	20	7.4	9.6	0.0	1.5	3.1	14.5	39.4
Composite Metric	PctSubOpt	WW	47e	6	13.6	9.4	3.0	3.8	14.8	21.9	23.9
Composite Metric	PctSubOpt	WW	47f	19	9.1	8.7	0.0	2.0	4.5	17.2	26.4
Composite Metric	PctSubOpt	CW	52b	12	9.4	8.5	2.7	4.0	6.1	11.1	32.0
Composite Metric	PctSubOpt	WW	52b	7	4.4	3.5	0.0	1.3	4.2	7.2	9.8
Composite Metric	PctSubOpt	WW	72d	3	27.0	21.9	4.2	*	28.9	*	47.8
Habitat Index	GFHI	WW	40a	7	45.2	10.6	34.5	36.0	40.4	57.1	61.7
Habitat Index	GFHI	WW	47a	6	48.9	5.1	39.0	46.3	50.8	51.7	53.1
Habitat Index	GFHI	WW	47b	21	51.0	6.4	40.0	46.6	53.7	56.7	58.8
Habitat Index	GFHI	WW	47c	20	50.2	9.6	31.7	39.7	51.3	58.6	66.1
Habitat Index	GFHI	WW	47e	6	39.4	9.2	25.8	30.0	41.4	48.1	48.6
Habitat Index	GFHI	WW	47f	19	45.8	11.4	26.6	35.7	49.9	54.4	63.6
Habitat Index	GFHI	CW	52b	12	56.2	5.3	43.6	52.8	57.4	59.5	63.0
Habitat Index	GFHI	WW	52b	7	56.7	6.3	52.6	52.8	53.8	60.2	69.7
Habitat Index	GFHI	WW	72d	3	42.8	3.3	39.8	*	42.3	*	46.3
Habitat Index	EFHI	WW	40a	7	40.3	8.8	30.3	33.4	37.6	48.4	53.9
Habitat Index	EFHI	WW	47a	6	44.3	4.9	36.2	39.9	45.8	47.8	49.7
Habitat Index	EFHI	WW	47b	21	48.5	6.4	38.2	41.8	50.9	54.5	57.3
Habitat Index	EFHI	WW	47c	20	60.3	9.6	43.2	52.6	60.6	67.8	78.7
Habitat Index	EFHI	WW	47e	6	30.6	5.9	21.2	24.8	32.1	35.9	36.5
Habitat Index	EFHI	WW	47f	19	41.4	9.1	29.0	30.6	44.7	48.0	55.3
Habitat Index	EFHI	CW	52b	12	60.6	4.2	53.4	57.9	60.9	63.2	68.7
Habitat Index	EFHI	WW	52b	7	61.7	5.5	56.0	56.6	62.4	63.8	72.1
Habitat Index	EFHI	WW	72d	3	37.6	1.9	35.7	*	37.6	*	39.5