Development of Macroinvertebrate and Diatom Biological Assessment Indices for Cook Inlet Basin Streams – Final Report

by

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Introduction

The central purpose of biological assessment is to determine how well a water body supports life. Biological assemblages integrate the effects of different pollutant stressors such as nutrient enrichment, toxic chemicals, increased temperature, and sedimentation, thus providing an overall measure of the aggregate impact of the stressors. Biological assemblages respond to stresses of all degrees over time and, therefore, offer information on perturbation not always obtained with "snap shot" water chemical measurements or discrete toxicity tests. Bioassessment allows direct measurement of biological integrity, a primary goal of the Clean Water Act (CWA). Biological data can be used by states to monitor long-term water quality trends, list and de-list waters (303d CWA), establish biological water quality criteria, prioritize sites for total maximum daily loads (TMDLs), test TMDL effectiveness, and diagnose sources of water quality impairment in addition to an array of other uses (Figure 1).

Biological monitoring in the state of Alaska is in its early stages. The University of Alaska Anchorage's Environment and Natural Resources Institute (ENRI) has developed standard operating procedures (SOPs) based on the U.S. Environmental Protection Agency's (USEPA) Rapid Bioassessment Protocols (RBPs) for macroinvertebrate and diatom biological assessment in wadeable Alaska streams (Barbour et al. 1999; Major and Barbour 2001; Major et al. 1998). The standard operating procedures include macroinvertebrate and diatom sampling, physicochemical water quality measurements, and visual assessment of instream and riparian habitat; our approach closely followed the concepts outlined by Barbour (1997). We have used these SOPs to guide the calibration of a macroinvertebrate biological assessment index for the Alexander Archipelago ecoregion (i.e., southeast Alaska; Rinella et al. 2005) and a preliminary macroinvertebrate index for the Cook Inlet Basin ecoregion (Major et al. 2001). In this report we describe the field data collection for and the calibration and testing of macroinvertebrate and diatom biological assessment indices for streams in the Cook Inlet basin ecoregion.

In our earlier work in the Alexander Archipelago ecoregion, we used macroinvertebrate data to test two competing biological assessment approaches: the multimetric approach, commonly used in the United States (see Barbour et al. 1999), and predictive modeling, the approach commonly used in Europe, Australia, and New Zealand (see Wright et al. 1993, Hawkins et al. 2000). Both approaches rely on data collected at Reference sites – streams that are minimally impacted by human impacts such as logging, mining, and residential or urban development – to represent the expected naturally-occurring conditions across the ecoregion. However, the two methods differ fundamentally in the way biological information is summarized. Multimetric indices are based on a suite of metric scores, quantifiable attributes of the macroinvertebrate assemblage that vary predictably with watershed disturbance. Predictive modeling estimates the expected taxonomic richness that would occur at a site in the absence of any watershed disturbance; this expected richness is then compared to the observed richness to quantify biological impairment. Both approaches resulted in comparable assessments of ecological condition. Since the multimetric approach is easier to use and is intuitively more straightforward, we continued with this approach for the calibration of Cook Inlet indices.

Biological assemblages integrate the effects of different pollutant stressors (e.g., nutrient enrichment, toxic chemicals, increased temperature, sedimentation) and provide an overall measure of the aggregate impact of the stressors. Because different assemblages operate on different spatial scales and are sensitive to different types of impacts (Hughes et al. 2000), the use of multiple biological assemblages (i.e., fish, macroinvertebrates, and/or algae) in aquatic monitoring programs can enhance the ability to detect and diagnose ecological impairment (Karr and Chu 1999). At least 40 states currently use multiple biological assemblages for water quality monitoring (USEPA 2002a). Due to Alaska's low diversity of resident fish and difficulties associated with distinguishing resident from juvenile anadromous fishes, fish assemblage data hold little or no promise for widespread monitoring in Alaska. Macroinvertebrates and diatoms are logical assemblages for Alaska biological monitoring: they are relatively quick and easy to sample and a large diversity of species occur in Alaska streams.

Generally speaking, the sensitivity of an assemblage is related to life cycle length, degree of mobility, and position in the food web (Barbour et al. 1999). Diatoms (single-celled algae with silica cell walls), being relatively sedentary primary producers with very short life cycles, respond quickly to physical and chemical impacts. The use of diatom tolerance values in water quality monitoring traces its history to Europe, where it has been used for almost a century (Kolkwitz and Marsson 1908). Algae (particularly diatoms) are gaining popularity as a biological monitoring assemblage and are currently used for water quality monitoring in at least 20 states (USEPA 2002a). A considerable body of research has established diatom species optima for nutrients and trophic status (Van Dam et al. 1994) as well as diatom tolerance to acidification (Van Dam et al. 1994), organic pollution (Lange-Bertalot 1979, Palmer 1969), and sedimentation (Stevenson and Bahls 1999). These attributes can be quantified and combined with other measures of assemblage attributes, such as diversity and biomass, to yield a multimetric index that is both responsive to general environmental degradation and diagnostic of specific causes (Karr 1993). Macroinvertebrates, the most commonly used assemblage in aquatic monitoring (USEPA 2002a), are relatively motile and have relatively long life cycles. Marcoinvertebrates have long been used for biological monitoring and a large number of studies have demonstrated their sensitivity to changes in ecological condition (Resh and Jackson 1993).

Biological index development is partitioned into ecoregions to minimize the amount of climatic, geologic, and biological variability within a large area like Alaska (Hughes et al. 1994, Stoddard 2005). Minimizing the among-site variation in physical, chemical, and biological attributes increases the ability to detect differences due to human impacts. This project's primary objective was to characterize regional reference conditions for the Cook Inlet Basin ecoregion and to develop benthic macroinvertebrate and diatom indices of ecological condition tailored to this region.

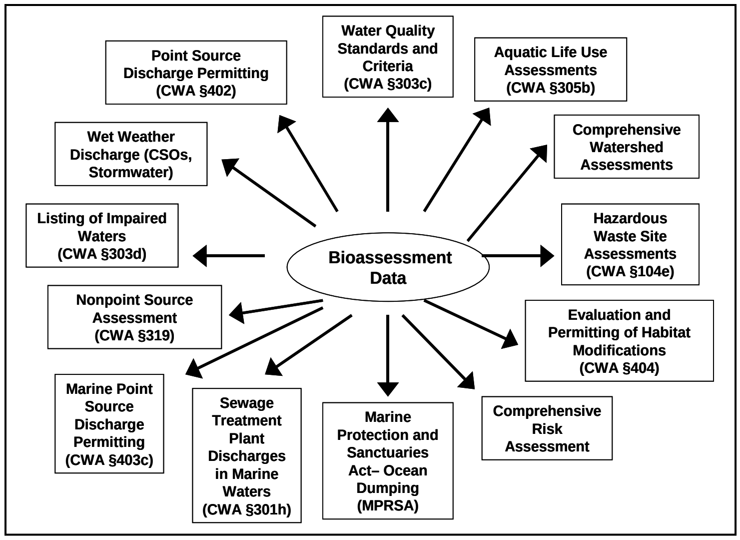

Figure 1. Use of bioassessment in water quality programs (from USEPA 2002b).

Study area

This study was conducted throughout the Cook Inlet Basin ecoregion (Nowacki et al. 2001), southcentral Alaska. This ecoregion consists of gently-sloped lowlands with abundant wetlands and lakes. The basin floor consists of fine-textured lacustrine deposits with wet, organic soils supporting extensive black spruce forests and ericaceous shrubs. Mixed forests (aspen, white birch, Sitka and white spruce) dominate the drier soils. The margins of the basin consist of glacial outwash and coarse-textured tills with associated willow and alder. Climate is intermediate between maritime and continental. This ecoregion is home to Anchorage, Alaska's largest city, and the rapidly expanding communities of Wasilla/Palmer in the Matanuska-Susitna Valley and Kenai/Soldotna on the Kenai Peninsula.

Overview of the multimetric index approach

The metrics comprising a multimetric index are quantifiable attributes of the benthic macroinvertebrate or diatom assemblages that reflect ecological conditions occurring at a particular site. For example, some metrics reflect the diversity or pollution tolerance of a given biological assemblage. Macroinvertebrate metrics are generally classified into 5 families based on the assemblage attributes quantified (sensu Barbour et al. 1999): taxonomic richness, taxonomic composition, tolerance/intolerance, feeding group, and habit. Diatom metrics generally fit into two functional categories: those designed to reflect the general biotic integrity of the diatom assemblage and those designed to diagnose ecological conditions (i.e., diagnostic metrics; sensu Stevenson and Bahls 1999). A suite of candidate metrics is tested and those that are precise (both spatially and temporally), not redundant with other metrics, representative of different metric families, and show predictable responses to watershed disturbance are selected for the final multimetric index (i.e., a mathematical combination of multiple metrics). Our approach was to calculate separate indices for macroinvertebrates and diatoms since these assemblages can convey different information regarding the ecological condition of water bodies.

Table 1. Summary of the steps required for developing a multimetric bioassessment index.

1. Data organization and metric calculation	The data were stored and manipulated for analysis in ENRI's Ecological Data Application System database. Data were generally transferred to other programs for analysis (Excel, PC-Ord, and Statistica).
2. Correlation Analysis	Correlation analysis was performed to identify metrics that may be redundant and therefore should not be included simultaneously in the index.
3. Precision Analysis	Metric precision was investigated using analysis of variance techniques with replicate samples.
4. Discrimination Efficiency	The degree to which metric values discriminate between Reference sites and those with expected ecological impairment was calculated and only those with the highest efficiency were considered for inclusion in the multimetric index.
5. Metric Combination	The best performing candidate metrics are mathematically combined to create an index that is responsive to ecological conditions in Cook Inlet Basin streams.

Data organization and metric calculation

We entered all biological and field data into ENRI's Ecological Data Application System, a relational database designed for aquatic biological assessment data. We then used EDAS to query data and to calculate biological metrics; we generally transferred data to other programs for analysis (Excel, SigmaPlot, and Statistica). We subjected all data to quality assurance checks prior to data analysis. Working with macroinvertebrate and diatom data separately, we calculated suites of standard bioassessment metrics that quantify different attributes of the assemblages and that were expected to reflect ecological condition.

Correlation analysis

We constructed a Pearson correlation matrix to check for correlations between each possible pair of metrics. If any two metrics were correlated at $\geq$ 0.85, one of the metrics would be eliminated from the final multimetric index. In such cases, the metric with the lowest discrimination efficiency and/or lowest precision was eliminated.

Discrimination efficiency

We calculated discrimination efficiencies for all metrics by comparing metric values from Reference sites to those from Class 2 sites (i.e., those with the highest watershed disturbance). We expressed discrimination efficiency as the percentage of Class 2 sites that fell below the lower quartile of the Reference sites (or above the upper quartile for metrics that increase with stress). Only metrics with discrimination efficiencies of >50% were considered for inclusion in the final multimetric index.

Metric combination

A multimetric index is composed of a suite of non-redundant metrics that show high precision, high discrimination efficiency, and that quantify different attributes of the macroinvertebrate assemblage. Although quantitative standards for precision and discrimination efficiency were used to screen potential metrics, we used professional judgment to ensure that metrics included in the index have understandable response mechanisms and have sufficient ranges of values to make scoring meaningful, and have a relatively small number of zero values.

Because the core metrics varied in scale, we standardized each to a unitless score (ranging from 0 to 100) prior to integration into a multimetric index. Scaling was based on the distribution of metric scores across all sites (eliminating values outside of the 5th and 95th percentiles as outliers), and unitless metric scores were calculated as a percentage of this percentile range. As such, we scored values ≤5th percentile as 0, ≥95th percentile as 100, and a value at the 50th percentile as 50. For each site, we averaged the unitless core metric scores to yield the final multimetric index score.

Site selection and *a priori* watershed disturbance gradient

We chose a large number of our sites due to ease of access and support offered by cooperating organizations. Since glaciers can dramatically influence the physical and chemical character of streams and accommodating these streams would require a much larger number of sites, we did not consider any streams with glacial influence. Figures 2 and 3 show locations of the study sites; Appendix 1 shows which biological assemblages (i.e., macroinvertebrates and/or diatoms) we sampled at each site.

We designated all streams *a priori* along a disturbance gradient that indexed the degree of human landscape disturbance within the watershed. We used Reference sites to establish the ecoregional reference condition (i.e., the expected “normal” conditions of unimpaired systems; Barbour et al. 1999) which is the benchmark for making comparisons and for detecting ecological impairment. To measure biological response to environmental degradation, we collected data at a number of streams in watersheds that were highly impacted by varying degrees of human watershed disturbance. We expect these streams to have altered biological assemblages due to these impacts and, as such, used them to test the sensitivity of biological metrics to detect ecological condition. We used non-biological criteria (i.e., land use, habitat quality, and water quality) for *a priori* designation to avoid the circularity inherent in using a biological classification system to predict a biological response. Furthermore, designation of sites based on non-biological criteria is essential to the interpretation of biological data. For example, sites affected by nutrient enrichment, which are often populated by an exceptionally abundant and diverse biota, may inaccurately be designated as reference sites if biological designations are used.

Our watershed human disturbance gradient incorporated three basin-scale disturbance measures – road density (i.e., km of road per ha of watershed area), stream water specific conductance (i.e., a measure of dissolved ion concentration), and the USEPA's rapid habitat assessment protocol (Barbour et al. 1999). Reference sites, by definition, had zero or negligible human disturbance within the watershed. For non-reference sites, we ranked each of the above measures according to the range of values observed among non-Reference sites. We designated all sites whose road density and specific conductance were greater than the 50^{th} percentile and whose habitat assessment score was less than the 50^{th} percentile as Class 2 (i.e., most impaired). We designated all other sites as Class 1 (i.e., intermediate). Figure 4 graphically depicts the disturbance gradient's constituent indices for each of the 3 *a priori* disturbance classes.

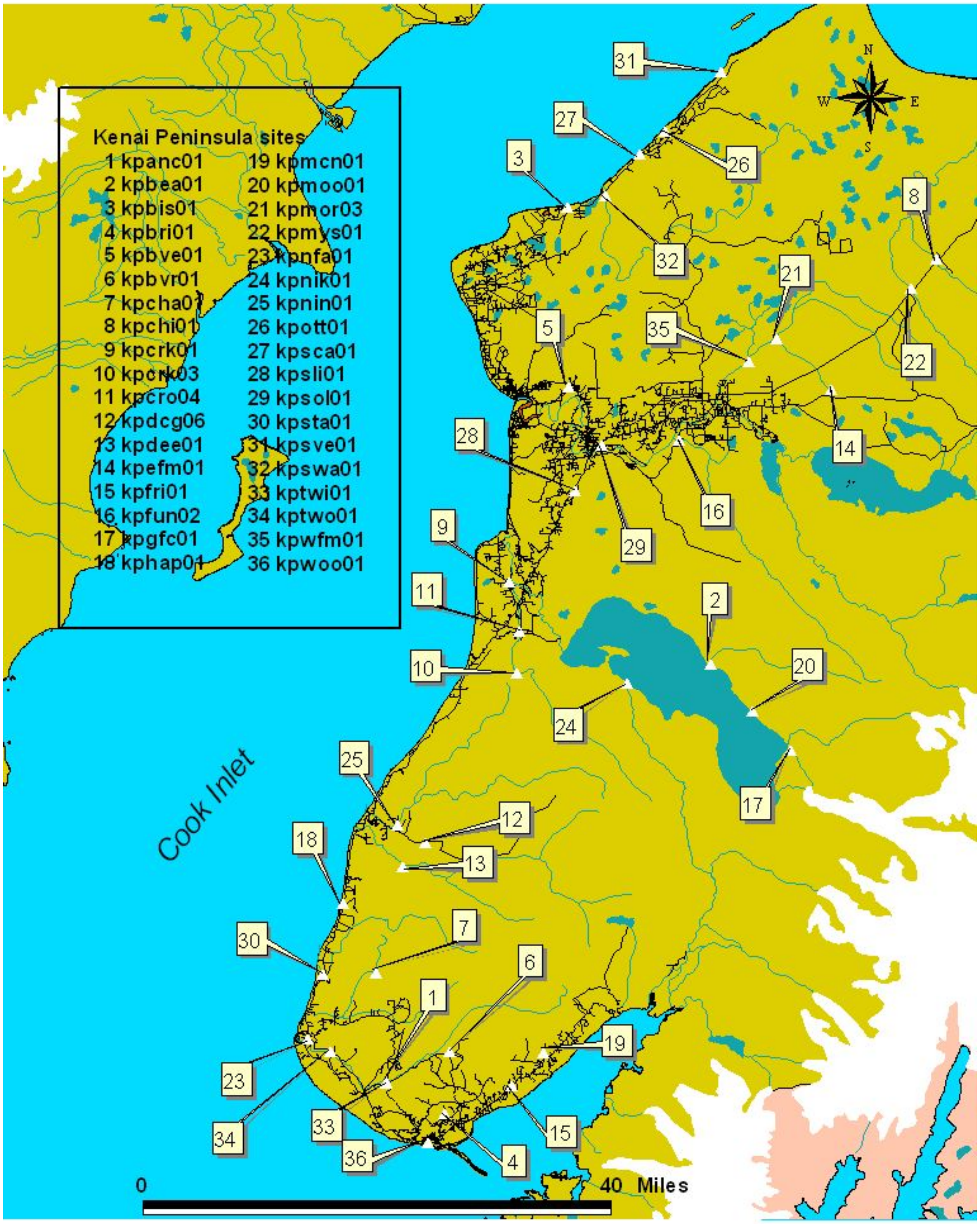

Figure 2. Kenai Peninsula stream sites used in the calibration of macroinvertebrate and/or diatom indices.

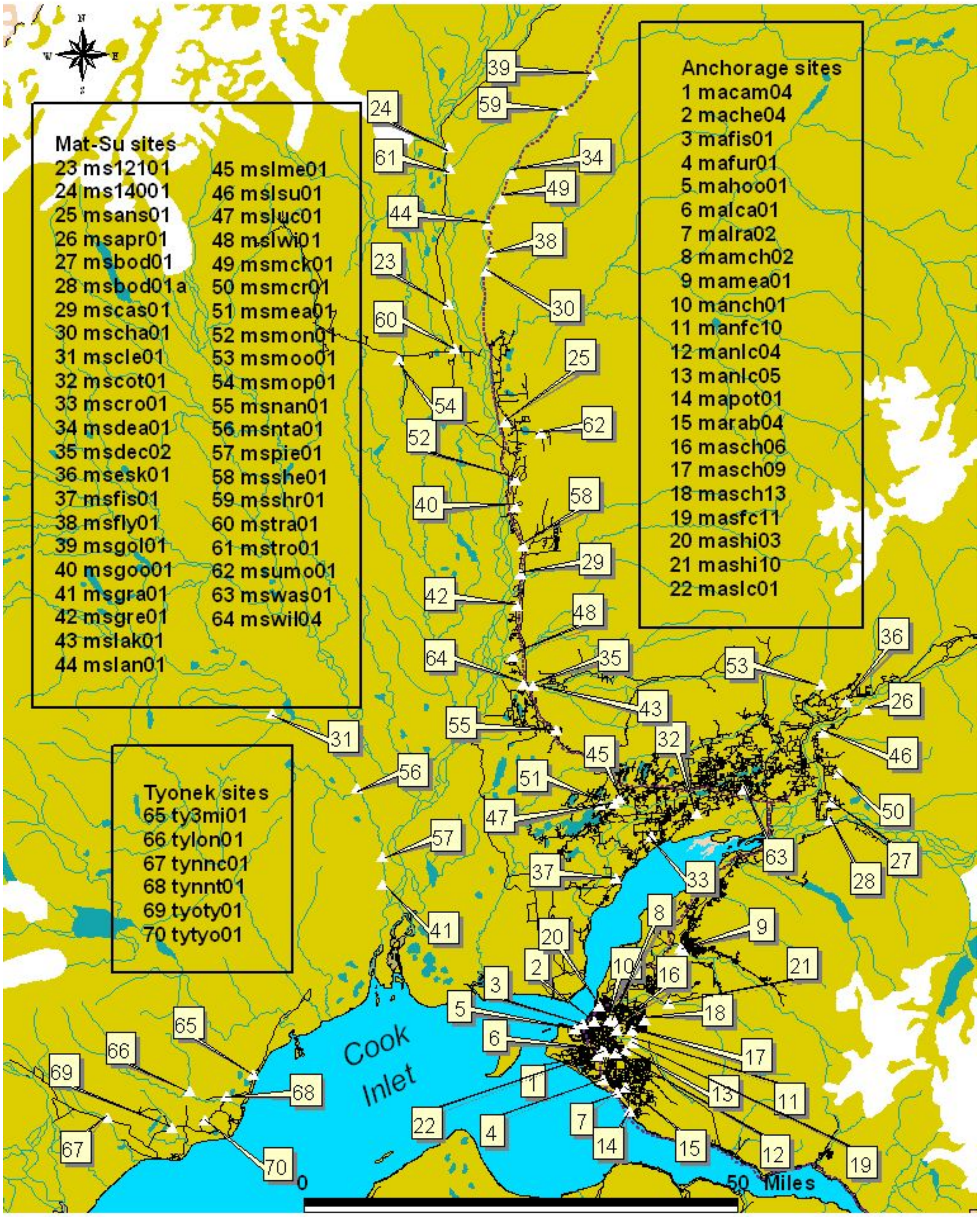

Figure 3. Anchorage Bowl, Mat-Su Valley, and Tyonek area stream sites used in the calibration of macroinvertebrate and/or diatom indices.

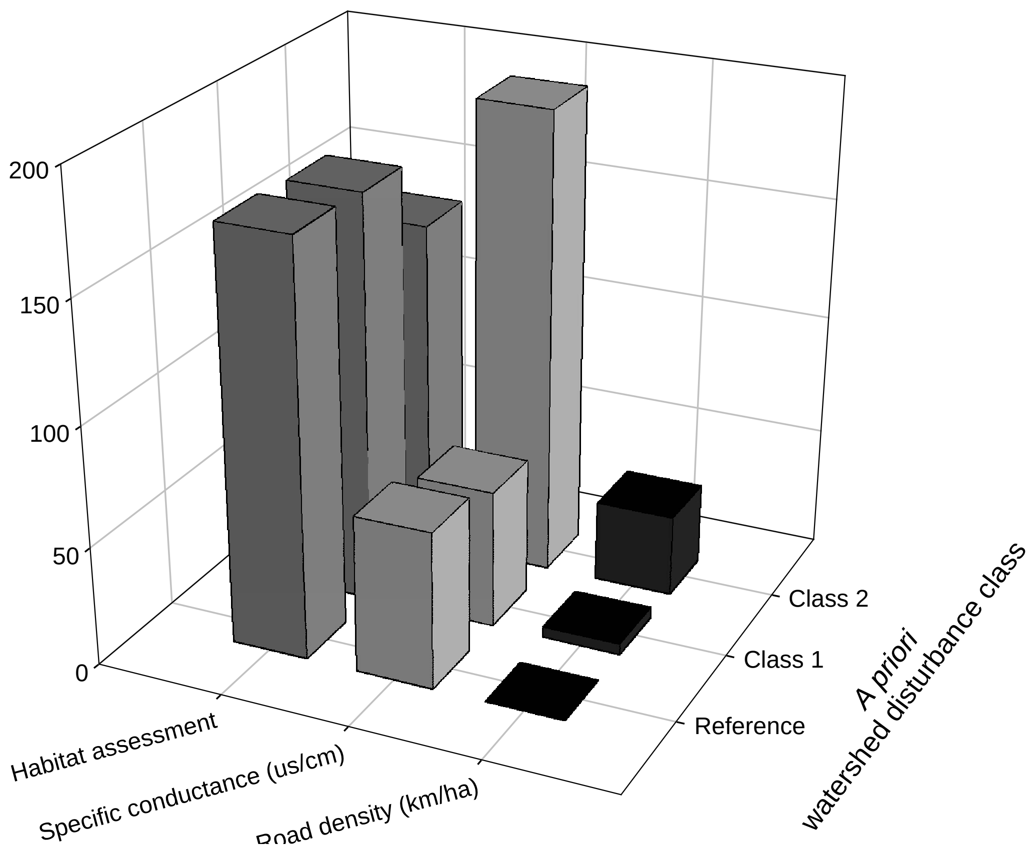

Figure 4. The habitat assessment index and the 2 watershed human disturbance measures constituting the watershed disturbance gradient displayed for each of the 3 *a priori* watershed disturbance classes. The habitat assessment is from Barbour et al. (1999).

Physicochemical sampling

We measured water physicochemical parameters (pH, specific conductance, temperature, total dissolved solids, and dissolved oxygen) in situ at each site using a Hydrolab Surveyor 4 and Minisonde that was calibrated daily. We also measured discharge by the incremental cross-sectional area method using an electronic flow meter (Marsh-McBirney model 2000) and we measured channel slope over the sample reach using a clinometer.

Macroinvertebrate index development

Macroinvertebrate field sampling and processing

We collected biological and associated environmental data from wadeable streams throughout the Cook Inlet Basin ecoregion during late April, May, and June of 1997–2001 and 2005–2006. This sampling period corresponded to seasonally low rainfall and stable weather and also allowed us to avoid the confounding influence of substrate disturbance and nutrient enrichment associated with spawning salmon, which are abundant during summer in most coastal Alaskan streams. While we sampled macroinvertebrates at approximately 182 different sites, we omitted many of these sites from the index development process for a variety of reasons, the main one being a lack of statistical independence (i.e., when multiple sites occurred in the same watershed, we omitted all but one). Of the sites used in the index calibration, 30 were Reference sites, 49 were Class 1 sites, and 19 were Class 2 sites.

Our field methods followed the sampling methods of Major and Barbour (2001), a modification of the USEPA Rapid Bioassessment Protocols for use in Alaska. We collected macroinvertebrate samples throughout a 100-m reach at each site with a 350-μm-mesh D-frame net. Each sample was a composite of 20 subsamples collected from various instream habitats in proportion to each habitat's abundance. Riffles were the predominant substrate sampled, with large woody debris, submerged streambanks, and emergent vegetation, in turn, comprising increasingly smaller portions. For riffle samples we disturbed an area of streambed approximately 1.5 ft^2 (1350 cm^2) to a depth of 4 in (10 cm) and rubbed each cobble and boulder by hand to ensure all macroinvertebrates were dislodged and swept into the net by the stream's current. We sampled woody debris by manually scouring a 1.5 ft^2 (1350 cm^2) area of wood immediately upstream of the net. We sampled streambanks and emergent vegetation by making three successive sweeps of the net across a 1.5 ft^2 (1350 cm^2) area while rapidly jabbing the net into the substrate. We preserved all samples in the field with ethanol and returned them to ENRI's lab for processing. In the lab, we subsampled each macroinvertebrate sample to a fixed count of 300±20% organisms to standardize the taxonomic effort across all sites. In addition, we conducted a 5-minute search through the remaining sample to select any large and/or rare taxa that may have been missed during subsampling. We identified all insects to genus (or lowest taxon practical) and non-insects to higher taxa (usually family or order) using standard taxonomic keys (Weiderholm 1983, Pennak 1989, Merritt and Cummins 1996, Wiggins 1996, Thorpe and Covich 2001, Stewart and Stark 2002).

Macroinvertebrate index calibration

From the macroinvertebrate data, we calculated a suite of standard bioassessment metrics that quantify different attributes of the macroinvertebrate and diatom assemblages and that were expected to reflect ecological condition (Resh and Jackson 1993, Lenat and Barbour 1994, Barbour et al. 1999). Since we sampled macroinvertebrates over multiple years at many sites, we used average metric values to represent the best estimate of the true metric value. We tested a number of metrics from each of 5 metric categories (richness, composition, tolerance/intolerance, feeding group, and habit; Table 2).

We selected 6 metrics representing 3 metric categories (sensu Barbour et al. 1999) for inclusion in the final multimetric index (Table 3, Figure 5). The number of mayfly taxa and the number of EPT taxa (i.e., insects in the mayfly, stonefly, and caddisfly orders), which are generally held to decrease with environmental degradation, were lower at Class 2 sites relative to Reference sites. Likewise, the relative abundance of both mayflies and scrapers (i.e., macroinvertebrates that feed by scraping algae from rock surfaces) were also lower at Class 2 sites than at Reference sites. The above taxa require well-oxygenated, sediment-free substrates and, as such, can be indicative of organic pollution and/or excessive sedimentation (Fore et al. 1996, Barbour et al. 1999). Shannon's diversity, a metric that quantifies species richness and the equitability of each species' abundance, was lower at Class 2 sites. The non-insect proportion of the assemblage, considered to be relatively pollution tolerant (Deshon 1995), was greater at Class 2 sites. Appendix 2 presents the macroinvertebrate metric and multimetric index scores for all sampling events.

To apply the index to new sites, calculate the individual metric scores using the formulas in Table 3, reset any scores greater than 100 to 100 and any values less than 0 to 0, and average the scores. As a preliminary screening criteria, compare the index score to the 25th percentile of Reference scores (44); higher scores indicate samples similar to reference conditions and lower scores indicate possible impairment.

Macroinvertebrate index performance

Multimetric macroinvertebrate index scores ranged from 30 to 96 at reference sites (median = 58; Figure 6), from 17 to 88 at Class 1 sites (median = 51), and from 2 to 65 at Class 2 sites (median = 23). Discrimination efficiency for the index was 79% (i.e., 11 of 14 Class 2 sites scored lower than the 25th percentile of Reference sites).

We randomly selected 5 sites from each a priori watershed disturbance class and omitted these sites from the index calibration process; we then used these sites as an independent validation of index performance. For validation sites, the median score was 80 at Reference sites, 50 at Class 1 sites, and 27 at Class 2 sites (Figure 6). The validation data showed the same trends as the index data (i.e., Reference > Class 1 > Class 2), giving an independent confirmation of index reliability.

We measured sampling precision (i.e., between-replicate) from replicated macroinvertebrate samples (i.e., two samples collected from the same site on the same day). Sampling precision reflects the combined error from two main sources: variability in macroinvertebrate distribution within the stream and error in laboratory subsampling. Between-replicate differences ranged from 0.8 to 25 with a mean difference of 6 (based on 41 pairwise comparisons). We also measured the year-to-year index score precision based on the between-year difference in index scores for Reference sites that were sampled over multiple years. The between-year difference ranged from 0.5 to 32 with a median of 8 (based on 7 pairwise comparisons). It must be noted that, because between-year error combines the effects of both sampling error and temporal variation in macroinvertebrate communities, between-year variation is inherently greater than sampling error. These analyses show that, under most circumstances, precision is high. However, with observed sampling error as high as 25 index points, we suggest that multiple sampling events are required to draw strong conclusions about the ecological condition at any site.

Table 2. List of metrics tested for inclusion in the multimetric macroinvertebrate index.

Metric	Predicted response at disturbed sites
Richness/diversity metrics	
Total number of taxa	decrease
Number of EPT taxa	decrease
Number of mayfly taxa	decrease
Number of stonefly taxa	decrease
Number of caddisfly taxa	decrease
Shannon's diversity	decrease
Composition metrics	
%EPT	decrease
% Mayflies	decrease
% Midges	increase
% Non-insects	increase
Tolerance/intolerance metrics	
Number of intolerant taxa	decrease
% Tolerant organisms	increase
% Dominant taxon	increase
Feeding group metrics	
% Filterer	variable
% Scraper	decrease
Habit metrics	
Number of clinger taxa	decrease
% Clinger	decrease

Table 3. Metrics, discrimination efficiency, and scoring formulae for the final multimetric macroinvertebrate index.

Metric	**Discrimination efficiency (%)**	**Scoring formula**
Number of EPT taxa	79	(X - 2.1) / 0.109
Number of mayfly taxa	86	(X - 0.50) / 0.045
Shannon's diversity	64	(X - 0.72) / 0.014
% Mayflies	86	(X - 0.37) / 0.459
% Non-insects	79	100 - ((X - 0.71) / 0.311)
% Scraper	57	X / 0.137

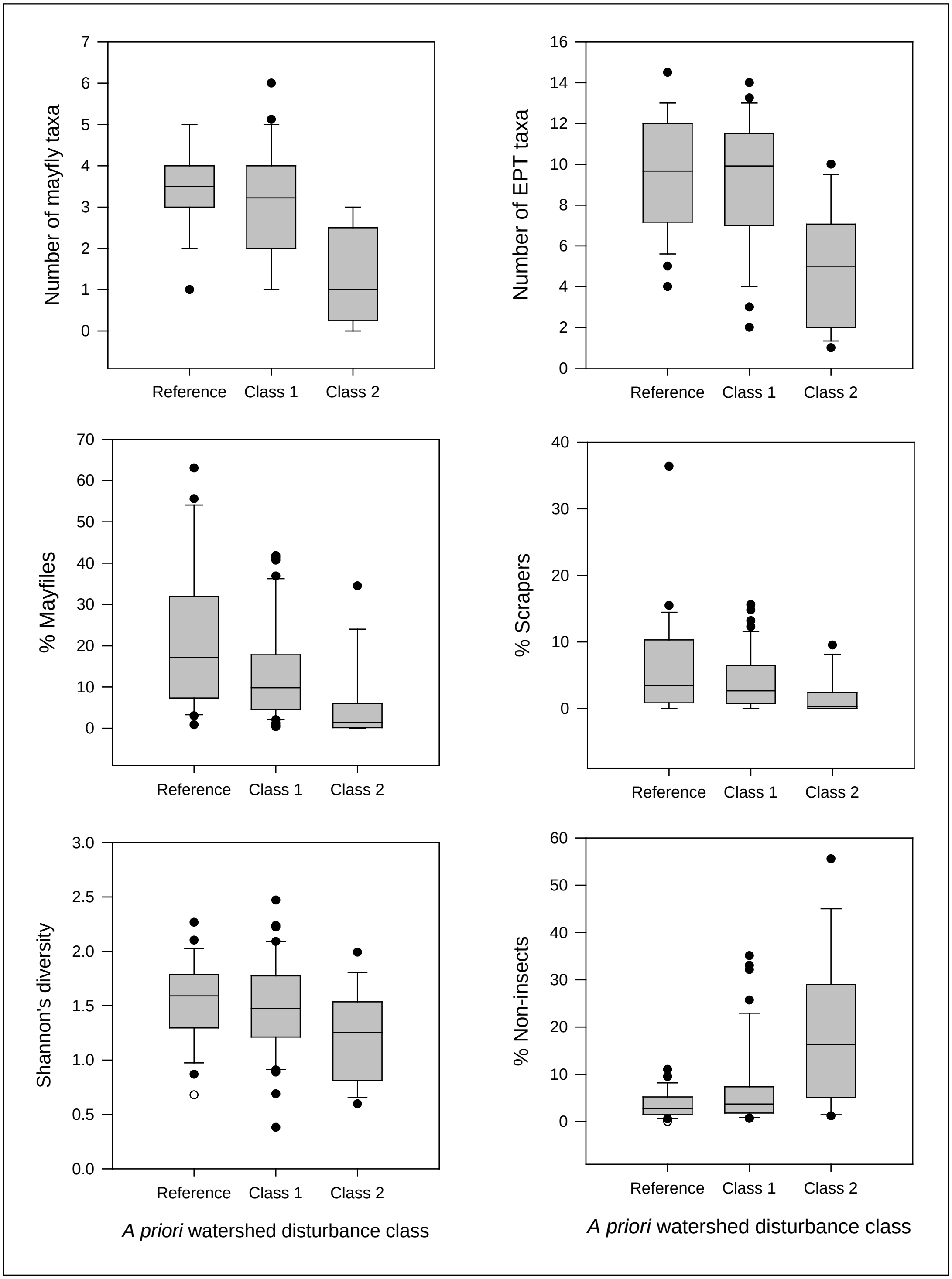

Figure 5. Distributions of macroinvertebrate metric values across the three *a priori* watershed disturbance classes for those metrics included in the final multimetric index. Horizontal lines represent median values, gray boxes represent 25th and 75th percentiles, and whiskers represent 5th and 95th percentiles.

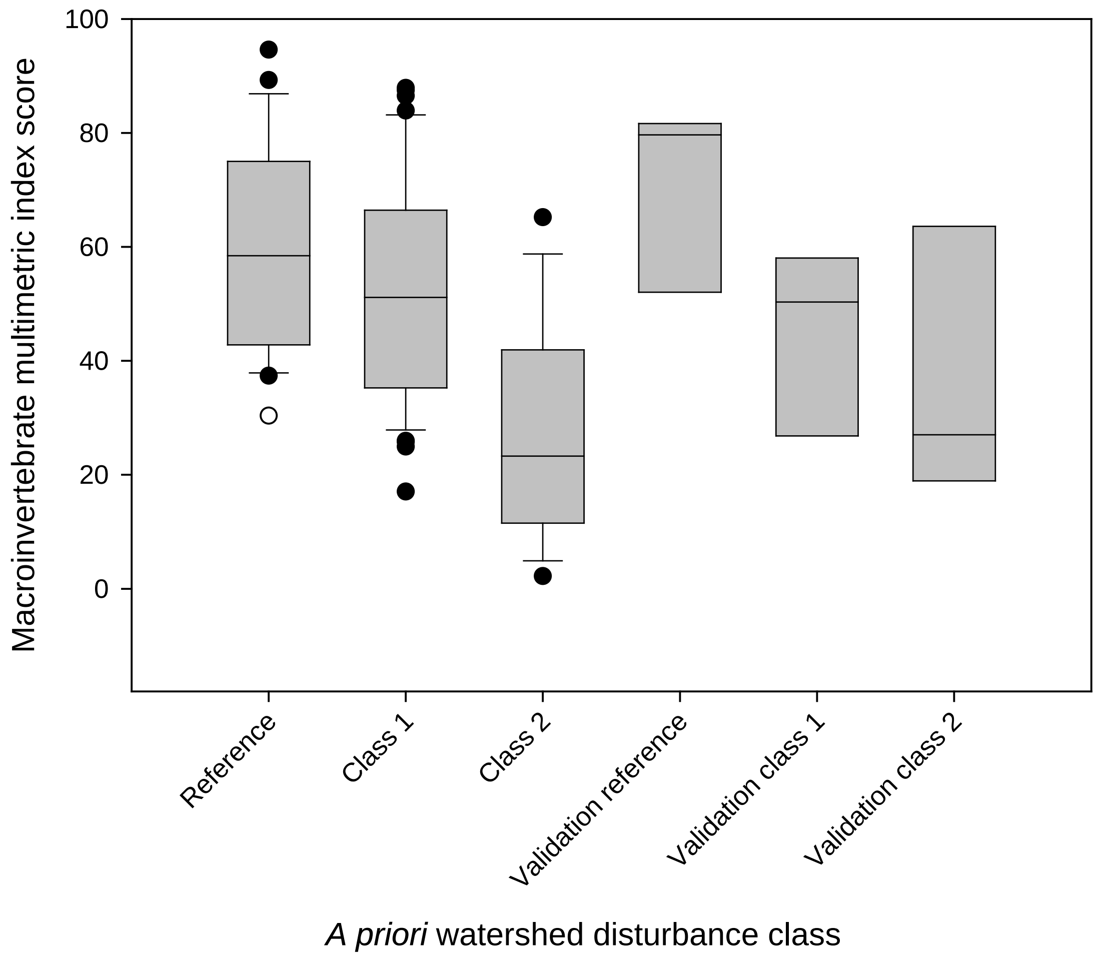

Figure 6. Distributions of final multimetric macroinvertebrate index scores for the *a priori* watershed disturbance classes and at the calibration sites and validation sites. Horizontal lines represent median values, gray boxes represent 25^{th} and 75^{th} percentiles, and whiskers represent 5^{th} and 95^{th} percentiles.

Diatom index development

Diatom field sampling and processing

We collected biological and associated environmental data from wadeable streams throughout the Cook Inlet Basin ecoregion during July and early August of 2002 and during June of 2005 and 2006. This sampling period corresponded to seasonally low rainfall and stable weather and, to a large extent, allowed us to avoid the confounding influence of substrate disturbance and nutrient enrichment associated with spawning salmon. Spawning salmon were present at some sites during 2002 sampling, but we avoided streams with dense salmon concentrations. Of the sites used in the index calibration, 18 were Reference sites, 20 were Class 1 sites, and 17 were Class 2 sites.

Diatom sampling and processing followed ENRI's protocol adopted from U.S. EPA methods. Each stream sampling reach consisted of four consecutive riffles. From each riffle we selected four stones (cobble or large gravel), ensuring that algal coverage on the stones was visually representative of the riffle at large. From a standardized area (4.5 cm diameter circle) on each stone we scrubbed (with a small brush) and rinsed the algal layer into a washtub. For each stream we composited algae from all stones (4 stones x 4 riffles) into a single sample which we preserved with Lugol's solution. In the few reaches where cobbles or large gravels were not present, we collected samples by pressing an inverted Petri dish into the sediment and slid a spatula underneath to remove the top layer of sediment. We measured canopy closure (i.e., shade) at each riffle using a densiometer.

We also conducted a rapid index of algae biomass using the methodology in ENRI's protocol. We randomly selected 24 particles (i.e., sand, gravel, cobble, etc.) from each riffle (i.e., a total of 96 particles for each stream site). For each particle we recorded b-axis length and index values corresponding to the biomass of macroalgae and microalgae. Macroalgae biomass was ranked from 0 (none present) to 3 (>25% coverage); microalgae biomass was ranked from 0 (no apparent growth) to 5 (>2 cm thickness).

In the lab, we homogenized each sample then transferred an aliquot to a Palmer counting cell and estimated the proportion of diatoms that were alive at the time of sampling (i.e., those that contained protoplasm). To a second aliquot from each original sample we added nitric acid and heat to digest the diatom protoplasm and other organic material, thereby "clearing" the diatoms for easier identification. We then neutralized the acid digested aliquots by a succession of dilutions, concentrated the cleared diatom frustules by allowing them to settle, and slide mounted the frustules using NAPHRAX mounting medium. For each sample site, we identified a fixed count of 600 diatom valves to species or lowest practical taxon. The primary taxonomic references were Krammer and Lange-Bertalot (1986-1991) and Patrick and Reimer (1975).

Diatom index calibration

We quantified a suite of standard diatom metrics (i.e., quantifiable attributes of the diatom assemblage) drawn from the literature to test for possible inclusion in the multimetric biological monitoring index. We tested metrics that generally fit into two functional categories: those designed to reflect the general biotic integrity of the diatom assemblage and those designed to diagnose ecological conditions (i.e., diagnostic metrics; sensu Stevenson and Bahls 1999) (Table 4).

Biotic integrity metrics are sensitive to general ecological impairment but generally do not yield information regarding the source of impairment. We expressed diatom taxonomic richness as the number of species found in a sample. Richness has generally been shown to decline with ecological degradation (Stevenson and Bahls 1999), although slight nutrient enrichment in otherwise nutrient-poor streams (typical of the study area) can lead to increased richness (Patrick 1973; Stevenson 1984). Shannon diversity reflects the number of species in a sample as well as the equitability of their relative abundances and was predicted to be lower at stressed sites (see Stevenson and Bahls 1999; see Zar 1999 for formula). Dominance (expressed as the proportion of the commonest species in a sample) was predicted to be higher at stressed sites, as one or a few hearty species may proliferate under harsh conditions (Patrick 1973). We used the diatom pollution index of Lange-Bertalot (1979) where index values ranging from 1 (species tolerating the most pollution) to 3 (species intolerant of pollution) are averaged to reflect the overall pollution tolerance of the assemblage at large; pollution tolerance was predicted to be higher at stressed sites. *Achnanthes minutissima* is a cosmopolitan generalist diatom whose dominance has been associated with disturbances such as scouring flows and toxins (Stevenson and Bahls 1999). As such, we predicted a higher proportion of this species at stressed sites. The proportion of live diatoms in each sample was used to represent the physiological health of the assemblage (Hill et al. 2000) and was predicted to be lower at stressed sites.

Diagnostic metrics are those that infer ecological conditions based on diatom assemblage structure. Van Dam et al. (1994) derived diatom tolerance values for inorganic nutrients (nitrogen uptake metabolism and trophic state), oxygen concentration, and saprobity (biodegradable organic matter and low dissolved oxygen). Since water quality impairment is often associated with nutrient enrichment and low dissolved oxygen, we predicted that tolerance values for nitrogen uptake metabolism (i.e., nitrogen tolerance), oxygen requirements (i.e., hypoxia tolerance), saprobity (i.e., organic enrichment tolerance), and trophic state (i.e., nutrient enrichment tolerance) would be higher in stressed streams. We predicted tolerance to organic pollution, as indexed by Palmer (1969) based on an extensive literature review, to be higher at stressed sites. Since fine inorganic sedimentation is often associated with anthropogenic development (see Wood and Armitage 1997), we predicted the relative abundance of sediment-tolerant genera (i.e., motile: *Navicula*, *Nitzschia*, and *Surirella*) to be greater at stressed sites. In response to pollution, algal biomass can increase (e.g., nutrient enrichment) or decrease (e.g., sedimentation, scouring, toxicity; see Hill et al. 2000). As such, we predicted stressed sites to differ from reference sites in terms of algal biomass.

We selected 5 core metrics for inclusion in the diatom index. Percent motile diatoms (i.e., sediment tolerance), organic nitrogen tolerance, saprobity, diatom species richness, and trophic state were lower at Reference sites relative to Class 2 sites (Figure 7) and had discrimination efficiencies ranging from 53% to 100% (Table 5). Appendix 3 gives the diatom metric and multimetric index scores for all sampling events.

To apply the index to new sites, calculate the individual metric scores using the formulas in Table 5, reset any scores greater than 100 to 100 and any values less than 0 to 0, and average the scores. As a preliminary screening criteria, compare the index score to the 25th percentile of Reference scores (58); higher scores indicate samples similar to reference conditions and lower scores indicate possible impairment.

Diatom index performance

Diatom index scores ranged from 49 to 95 at Reference sites (median = 69; Figure 8), from 26 to 100 at Class 1 sites (median = 55), and from 15 to 59 at Class 2 sites (Median = 43) with discrimination efficiency of 100%.

We measured sampling precision (i.e., between-replicate) from two pairs of replicated diatom samples; these pairs of samples showed differences of 6 and 2 index units. Sampling precision reflects the combined error from two main sources: variability in diatom distribution within the stream and error in laboratory subsampling. We also measured the year-to-year index score precision based on the between-year difference in index scores for sites that were sampled over multiple years. The between-year difference ranged from 0.06 to 24 with a median of 9 (based on 9 pairwise comparisons). Ideally, the between-year precision would have been calculated with reference site data. Unfortunately, we did not collect these data and therefore the precision of this method is likely underestimated.

Relative to the number of sites sampled for macroinvertebrates, we sampled few sites for diatoms. As such we used all sites for index calibration, rather than excluding a subset for an independent validation. However we omitted three sites from index calibration that offered an interesting test of the index. Fossil Creek in Anchorage and Diamond Creek near Homer both have landfills within their watersheds. Fossil Creek scored 51 (6th percentile of Reference site scores) while Diamond Creek, sampled twice, scored 59 and 60 ($\leq$33rd percentile of Reference site scores). Nikoli Creek, a tributary to Tustamena Lake that at the time of sampling was receiving suspended sediment from an upstream landslide, scored 21, lower than any reference site.

Table 4. List of metrics tested for inclusion in the multimetric diatom index.

Metric	Reference	Predicted response at disturbed sites
Biotic integrity metrics		
Number of diatom species	Stevenson and Bahls 1999	variable
Shannon diversity	Stevenson and Bahls 1999	decrease
% Dominant species	Hill et al. 2000, Fore and Grafe 2002	increase
Pollution tolerance	Lange-Bertalot 1979	increase
% *Achnanthes minutissima*	Stevenson and Bahls 1999, Fore and Grafe 2002	increase
% Live diatoms	Stevenson and Bahls 1999, Hill et al. 2000	decrease
Diagnostic metrics		
Organic N tolerance	Van Dam et al. 1994	increase
Saprobity	Van Dam et al. 1994	increase
Trophic state	Van Dam et al. 1994	increase
Pollution class	Bahls 1993	decrease
% Motile (i.e., sediment tolerant)	Stevenson and Bahls 1999, Fore and Grafe 2002	increase
Microalgae biomass	Hill et al. 2000	variable
Macroalgae biomass	Hill et al. 2000	variable

Table 5. Metrics, discrimination efficiency, and scoring formulae for the final multimetric diatom index.

Metric	**Discrimination efficiency (%)**	**Scoring formula**
% Motile	65	100 - (X - 0.116) / 0.156
Organic nitrogen tolerance	94	100 - (X - 1.272) / 0.008
Saprobity	100	100 - (X - 1.592) / 0.011
Number of species	53	100 - (X - 18.4) / 0.443
Trophic state	82	100 - (X - 3.130) / 0.031

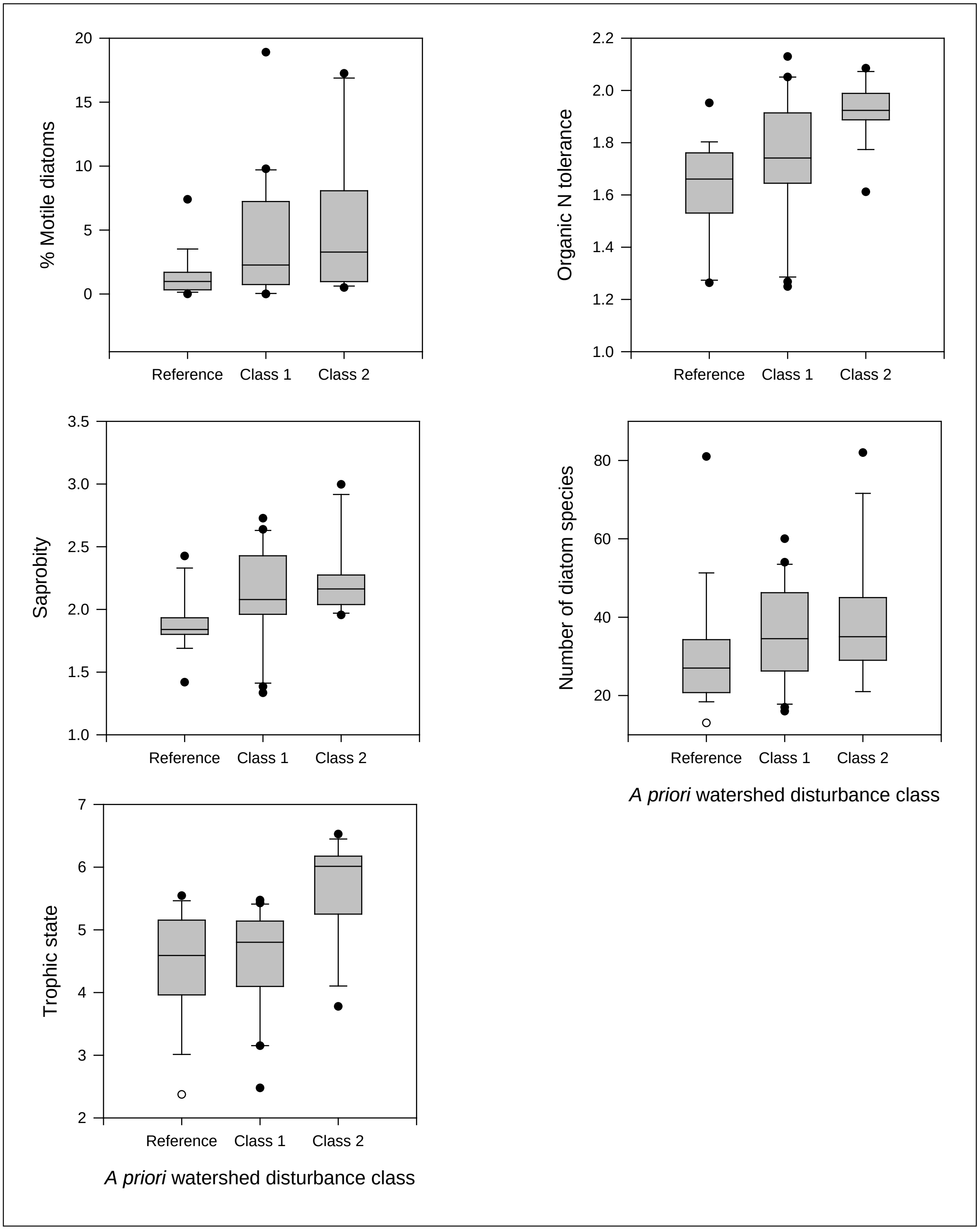

Figure 7. Distributions of diatom metric values across the three *a priori* watershed disturbance classes for those metrics included in the final multimetric index. Horizontal lines represent median values, gray boxes represent 25th and 75th percentiles, and whiskers represent 5th and 95th percentiles.

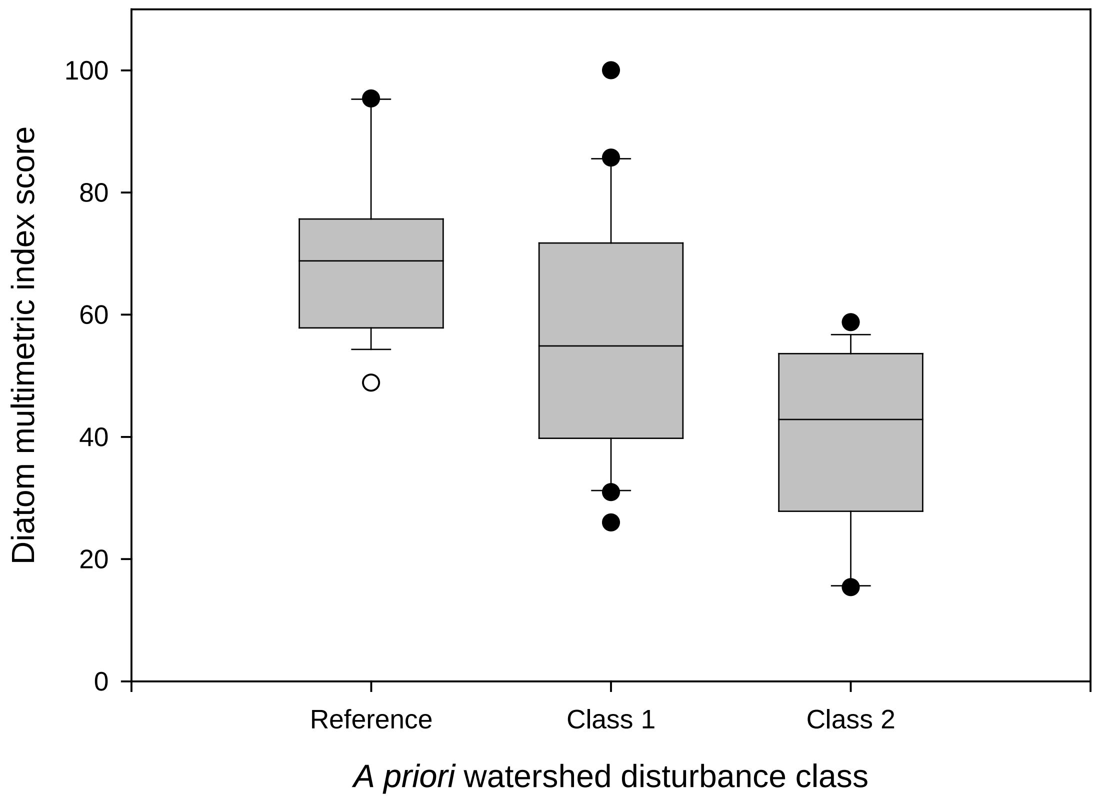

Figure 8. Distributions of final multimetric diatom index scores for the *a priori* watershed disturbance classes. Horizontal lines represent median values, gray boxes represent 25th and 75th percentiles, and whiskers represent 5th and 95th percentiles.

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Education and outreach activities (FY07)

ENRI provided extensive education and outreach opportunities during fiscal year 2007 (Table 6). We conducted training to increase the technical capacity of volunteer groups, educators, and agencies throughout Alaska. In total, we interfaced with 235 individuals for a total of 1920 education and outreach contact hours. Volunteers from a variety of agencies, tribes, and nonprofit groups assisted with field sampling for development of the Cook Inlet Basin ecoregion biological assessment indices.

Table 6. Education and outreach activities.

Event	Date	Number of Participants	Affiliation	Participant Hours	ENRI Hours
Recertification and technical systems review	8/16-18/2006	1	NAFWS Tribal Water Quality Training Program, Eagle	16	16
Aquatic Monitoring Workshop	8/28–9/1/ 2006	14	NAFWS Tribal Water Quality Training Program	560	48
Aquatic Monitoring Workshop	9/21-22/2006	12	NAFWS Tribal Water Quality Training Program	192	16
Recertification training	3/30/2007	9	Citizens Environmental Monitoring Program	36	8
Educational Outreach	4/20/2007	100	Teeland Middle School, Wasilla	83	6
Educational Outreach	4/23-25/2007	50	Unalaska School students and teachers	100	16
Volunteer Monitoring Training	5/1 & 3/2007	4	Anchorage Waterways Council	32	8
Recertification training	5/20-22/2007	14	Bristol Bay Native Association	224	24
Educational Outreach	5/24-26/2007	8	Lake & Peninsula School District Camp	128	16
Water Quality Monitoring Workshop	9/18-22/2007	12	Association of Village Council Presidents, Bethel	384	32
Alaska Stream Team Workshop	10/26-27/ 2007	11	Prince of Wales Island School Districts	165	16

Education and outreach materials, as well as project reports and methods manuals, are available from the ENRI Aquatic Ecology program website at www.aquatic.uaa.alaska.edu.

Appendix 1. Characteristics of sites sampled for the macroinvertebrate and diatom index calibration. Station IDs beginning with kp- are on the Kenai Peninsula, with ma- are in the Anchorage Bowl, with ms- are in the Mat-Su Valley, and with ty- are in the Tyonek area.

Station ID	Waterbody name	*A priori* class	Sampled for macro-invertebrates	Sampled for diatoms	Catchment area (mi2)	Elevation (ft)	Latitude (ºN)	Longitude (ºW)
kpanc01	Anchor River	Class 1	x		105	500	59.7177	151.6450
kpbea01	Bear Creek	Reference	x		33	145	60.2136	150.8043
kpbis01	Bishop Creek	Class 1	x		40	45	60.7803	151.1086
kpbri01	Bridge Creek	Class 1	x		1	1000	59.6765	151.5045
kpbve01	Beaver Creek, Soldotna	Class 1	x	x	30	125	68.5075	151.0247
kpbvr01	Beaver Creek	Class 1	x	x	16	650	59.7517	151.4857
kpcha01	Chakok River	Reference	x		23	300	59.8522	151.6584
kpchi01	Chickaloon River	Reference	x		67	375	60.6940	150.1864
kpcrk01	Crooked Creek	Class 1	x		63	50	60.3250	151.2936
kpcrk03	Crooked Creek	Reference	x		42	200	60.2128	151.2835
kpcro04	Crooked Creek	Reference		x	42	200	60.2639	151.2728
kpdcg06	Deep Creek (gamma branch)	Class 1	x	x	33	350	60.0093	151.5274
kpdee01	Deep Creek	Class 1	x		110	270	59.9800	151.5850
kpefm01	East Fork Moose River	Class 1	x	x	8	280	60.5284	150.4533
kpfri01	Fritz Creek	Class 1	x		9	170	59.9739	151.7892
kpfun02	Funny River	Class 1	x		130	150	60.4900	150.8600
kpgfc01	Glacier Creek	Reference	x		11	145	60.1030	150.6157
kphap01	Happy Creek	Class 1	x	x	11	120	59.9378	151.7340
kpmcn01	McNeil Creek	Class 1	x	x	2	1350	59.7465	151.2567
kpmoo01	Moose Creek	Reference	x	x	25	145	60.1529	150.7048
kpmor03	Moose River	Class 1	x		189	150	60.6067	150.5983
kpmys01	Mystery Creek	Reference	x		70	375	60.6597	150.2547
kpnfa01	North Fork Anchor River	Class 1	x		66	125	59.7733	151.8333
kpnik01	Nikolai Creek	Reference	x	x	80	135	60.1950	151.0117
kpnin01	Ninilchik River	Class 1	x		130	50	52.0988	129.2223
kpott01	Otter Creek	Reference	x		33	50	60.8678	150.8535
kpsca01	Scaup Lake Creek	Class 1	x	x	19	50	60.8418	150.9194
kpsli01	Slikok Creek	Class 2	x	x	16	125	60.4335	151.1217
kpsol01	Soldotna Creek	Class 2	x	x	13	85	60.4880	151.0449
kpsta01	Stariski Creek	Class 1	x	x	49	125	59.8517	151.7900
kpsve01	Seven Egg Creek	Reference	x		36	50	60.9348	160.6996

Station ID	Waterbody name	*A priori* class	Sampled for macro-invertebrates	Sampled for diatoms	Catchment area (mi2)	Elevation (ft)	Latitude (ºN)	Longitude (ºW)
kpswa01	Swanson River	Class 1	x		209	125	60.7919	151.0115
kptwi01	Twitter Creek	Class 1	x	x	17	350	59.7164	151.6428
kptwo01	Two Moose Creek	Class 1	x	x	11	170	59.7578	151.7794
kpwfm01	West Fork Moose River	Class 1	x		30	175	60.5817	150.6700
kpwoo01	Woodard Creek	Class 2	x	x	1	50	59.6414	151.5478
macam04	Campbell Creek	Class 2	x		61	60	61.1470	149.8888
mache04	Chester Creek	Class 2	x	x	29	30	63.3378	169.0042
mafis01	Fish Creek	Class 2	x	x	5	15	61.2000	149.9340
mafur01	Furrow Creek	Class 2	x	x	5	90	61.1066	149.8785
mahoo01	Hood Creek	Class 2	x	x	1	60	61.1939	149.9631
malca01	Little Campbell Creek	Class 2		x	13	85	61.1553	149.8735
malra02	Little Rabbit Creek	Class 1	x	x	6	150	61.0839	149.8311
mamch02	Middle Fork Chester Creek	Class 2	x		3	100	61.2017	149.8256
mamea01	Meadow Creek	Class 2	x	x	8	225	61.3112	149.5741
mamea02	Meadow Creek	Class 2	x	x	8	225	61.3164	149.5825
manch01	North Fork Chester Creek	Class 2	x	x	2	90	61.2046	149.8436
manfc10	North Fork Campbell Creek	Class 1	x	x	16	310	43.4386	158.3378
manlc04	North Fork Little Campbell Creek	Class 2	x		3	120	61.1497	149.8292
manlc05	North Fork Little Campbell Creek	Reference	x	x	2	230	61.1515	149.7924
mapot01	Potter Creek	Class 2	x	x	4	70	61.0521	149.7926
marab04	Rabbit Creek	Class 1	x		12	380	61.0911	149.8026
masch06	South Fork Chester Creek	Class 2		x	17	140	61.1854	149.8181
masch09	South Fork Chester Creek	Class 2	x		16	150	61.1856	149.7664
masch13	South Fork Chester Creek	Reference	x	x	10	1800	61.2014	149.7211
masfc11	South Fork Campbell Creek	Class 1	x	x	25	200	61.1630	149.7670
mashi03	Ship Creek	Class 2	x		123	250	61.2281	149.8750
mashi10	Ship Creek	Class 1	x		90	550	61.2240	149.6330
maslc01	South Fork Little Campbell Creek	Class 2	x		9	125	61.1522	149.8664
ms12101	Unnamed creek at Parks Hwy MP 121	Class 1	x		4	250	62.4027	150.2600
ms14001	Unnamed creek at Parks Hwy MP 140	Reference	x		4	400	62.6633	150.2267
msans01	Answer Creek	Class 1	x	x	19	300	62.2028	150.0792
msapr01	April Creek	Reference	x		6	465	61.6875	148.8759
msbod01	Bodenburg Creek	Class 2	x	x	16	75	61.5383	149.0217

Station ID	Waterbody name	*A priori* class	Sampled for macro-invertebrates	Sampled for diatoms	Catchment area (mi2)	Elevation (ft)	Latitude (ºN)	Longitude (ºW)
msbod01a	Bodenberg Creek	Class 2	x		18	50	61.5090	149.0299
mscas01	Caswell Creek	Class 1	x		19	100	61.9497	150.0592
mscha01	Chase Creek	Reference	x		4	450	62.4533	150.1177
mscle01	Clear Creek	Reference	x	x	21	140	61.7410	150.9570
mscot01	Cottonwood Creek	Class 1	x	x	35	150	61.5266	149.5258
mscro01	Crocker Creek	Class 2		x	6	125	61.5021	149.0215
msdea01	Deadhorse Creek	Reference	x	x	4	550	62.6125	150.0023
msdec02	Deception Creek	Class 1	x		58	200	61.7635	150.0368
mseska01	Eska Creek	Class 1	x		15	420	61.7015	148.9415
msfis01	Fish Creek	Class 2	x	x	123	50	61.4382	149.7880
msfly01	Flynn Creek	Reference	x	x	2	475	62.4856	150.0944
msgol01	Gold Creek	Reference	x	x	25	700	62.7673	149.6874
msgoo01	Goose Creek	Class 1	x		27	260	62.0607	150.0593
msgra01	Granite Creek	Reference	x		12	50	61.4500	150.6020
msgre01	Grey's Creek	Class 1	x	x	32	200	61.8970	150.0778
mslak01	Lake Creek	Class 1	x		20	250	61.7635	150.0368
mslan01	Lane Creek	Reference	x	x	12	621	62.5310	150.0991
mslme01	Little Meadow Creek	Class 1	x		36	100	61.5688	149.7599
mslsu01	Little Susitna River	Class 2	x		167	225	61.6552	149.0302
msluc01	Lucille Creek	Class 1	x		19	250	61.5608	149.7778
mslwi01	Little Willow Creek	Class 1	x		153	175	61.8153	150.0997
msmck01	McKenzie Creek	Reference	x	x	2	650	62.5665	150.5665
msmcr01	McRoberts Creek	Class 1	x		7	325	61.5856	148.9897
msmea01	Meadow Creek	Class 2	x		63	175	61.5617	149.8258
msmon01	Montana Creek	Class 1	x		157	280	62.1056	150.0549
msmoo01	Moose Creek	Reference	x		32	1000	61.7335	149.0290
msmop01	Moose Creek, Petersville	Class 1	x		52	500	62.3160	150.4458
msnan01	Nancy Creek	Class 1	x		7	600	61.6880	149.9644
msnta01	No name trib to Alexander Creek	Reference	x	x	10	90	61.6100	150.6720
mspie01	Pierce Creek	Reference	x	x	8	50	61.4950	150.5970
msshe01	Sheep Creek	Class 1	x		141	200	61.9950	150.0430
msshr01	Sherman Creek	Reference	x	x	7	620	62.7124	149.8052
mstra01	Trapper Creek	Class 1	x		19	350	62.3282	150.2438
mstro01	Troublesome Creek	Reference	x	x	38	454	62.6272	150.2252

Station ID	Waterbody name	*A priori* class	Sampled for macro-invertebrates	Sampled for diatoms	Catchment area (mi2)	Elevation (ft)	Latitude (ºN)	Longitude (ºW)
msumo01	South Fork Montana Cr	Class 1	x		40	687	62.1803	149.9536
mswas01	Wasilla Creek	Class 2	x	x	42	125	61.5697	149.3231
mswil04	Willow Creek	Class 1	x		234	125	61.7684	150.0734
ty3mi01	3 Mile Creek	Class 1	x	x	20	80	61.1447	151.0810
tylon01	Lone Creek	Reference	x	x	20	220	61.1222	151.2996
tynnc01	No Name Tributary to Nikoli Creek	Reference	x	x	1	50	61.0841	151.5885
tynnt01	No Name Tributary	Reference	x	x	4	100	61.1110	151.1740
tyoty01	Old Tyonek Creek	Class 1	x	x	9	250	61.0632	151.3660
tytyo01	Tyonek Creek	Class 1	x	x	12	230	61.0736	151.2512

Appendix 2. Macroinvertebrate metric values and corresponding multimetric index scores for all Cook Inlet Basin ecoregion stream sites. Station IDs beginning with kp- are on the Kenai Peninsula, with ma- are in the Anchorage Bowl, with ms- are in the Mat-Su Valley, and with ty- are in the Tyonek area.

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
kpanc01	Anchor River	06-14-2000	0	10	3	7	1	1	3	49
kpanc01	Anchor River	07-09-1999	0	12	5	25	1	1	1	65
kpanc01	Anchor River	06-05-1997	0	14	4	6	0	1	1	53
kpanc01	Anchor River	07-09-1999	1	5	4	20	1	1	0	47
kpbea01	Bear Creek	06-06-1999	0	8	4	65	1	1	3	61
kpbea01	Bear Creek	06-20-2000	0	11	4	57	21	2	2	88
kpbea01	Bear Creek	06-05-1997	0	10	4	32	7	1	1	70
kpbis01	Bishop Creek	06-05-1999	0	2	1	1	14	2	29	31
kpbis01	Bishop Creek	06-15-2000	0	3	1	6	4	2	22	26
kpbis01	Bishop Creek	06-05-1999	1	5	1	7	7	2	19	35
kpbis01	Bishop Creek	06-04-1997	0	6	1	13	0	1	3	30
kpbri01	Bridge Creek	06-04-1999	0	11	3	11	1	1	3	52
kpbve01	Beaver Creek, Soldotna	06-14-2001	0	6	1	6	2	2	21	29
kpbve01	Beaver Creek, Soldotna	06-19-2000	0	3	1	42	0	1	12	38
kpbve01	Beaver Creek, Soldotna	06-02-1999	0	4	1	1	0	1	9	23
kpbvr01	Beaver Creek	06-18-2000	0	8	3	19	10	2	9	60
kpbvr01	Beaver Creek	06-03-1999	0	11	4	77	32	2	2	86
kpbvr01	Beaver Creek	06-04-1997	0	12	4	9	3	1	1	58
kpcha01	Chakok River	06-18-2000	0	11	4	5	2	1	1	51
kpcha01	Chakok River	06-05-1999	0	10	4	53	7	2	0	83
kpchi01	Chickaloon River	06-15-1999	0	12	6	11	2	2	3	66
kpchi01	Chickaloon River	06-05-1997	0	7	3	6	1	1	0	39
kpcre01	Creekside Cabin	06-02-1999	0	7	2	45	2	2	3	60
kpcrk01	Crooked Creek	06-04-1999	1	5	1	4	0	1	6	25
kpcrk01	Crooked Creek	06-13-2001	0	4	1	1	0	1	5	19
kpcrk01	Crooked Creek	06-06-1997	0	6	1	2	0	1	4	26
kpcrk01	Crooked Creek	06-04-1999	2	2	1	1	0	1	3	20
kpcrk01	Crooked Creek	06-04-1999	0	3	1	2	0	1	3	22
kpcrk02	Crooked Creek	06-04-1999	1	8	3	13	1	2	17	41
kpcrk02	Crooked Creek	06-04-1999	0	7	1	11	0	1	17	29

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
kpcrk02	Crooked Creek	06-06-1997	1	9	2	10	1	1	3	38
kpcrk02	Crooked Creek	06-06-1997	0	6	2	8	0	1	1	32
kpcrk03	Crooked Creek	06-16-1999	0	12	5	4	1	1	5	57
kpcrk03	Crooked Creek	06-16-1999	1	6	2	2	0	1	4	32
kpdcg06	Deep Creek (gamma branch)	06-17-2005	0	10	5	17	4	2	2	68
kpdee01	Deep Creek	06-16-2000	0	7	3	13	1	1	5	44
kpdee01	Deep Creek	06-13-2001	0	10	4	10	3	1	4	51
kpdee01	Deep Creek	06-06-1997	0	15	5	9	6	1	2	69
kpdee02	Deep Creek	06-16-2000	0	7	3	10	1	1	6	43
kpdee02	Deep Creek	06-07-1997	0	10	2	11	0	1	1	45
kpdee02	Deep Creek	07-08-1999	0	13	5	8	0	1	1	56
kpdia01	Diamond Creek	06-12-2001	0	9	3	21	8	1	6	57
kpdia02	Diamond Creek	06-16-2005	0	8	4	18	8	2	8	62
kpdia05	Diamond Creek	06-12-2001	0	3	1	1	0	1	17	20
kpdia05	Diamond Creek	06-04-1999	0	4	1	0	0	1	2	23
kpefb01	East Fork Beaver Creek	06-27-1999	0	5	1	2	8	2	49	28
kpefm01	East Fork Moose River	06-02-1999	0	5	1	1	29	2	62	36
kpefm01	East Fork Moose River	06-15-2005	0	6	1	1	27	2	45	35
kpefm01	East Fork Moose River	06-15-2000	0	5	1	2	6	1	31	24
kpefm01	East Fork Moose River	06-09-1997	0	11	1	1	0	1	3	32
kpfri01	Fritz Creek	06-02-1999	0	10	4	52	19	2	3	89
kpfri01	Fritz Creek	06-05-1997	0	10	3	22	8	1	0	64
kpfun01	Funny River	06-15-2000	0	7	2	1	1	1	7	30
kpfun02	Funny River	06-15-2000	0	8	2	3	0	1	5	33
kpfun02	Funny River	06-15-2000	1	7	2	2	0	1	2	31
kpgfc01	Glacier Creek	06-04-1997	0	7	2	1	0	2	2	40
kplin01	Little Indian Creek	06-15-1999	0	10	5	38	13	2	4	90
kplin01	Little Indian Creek	06-15-1999	1	9	4	33	4	2	1	71
kpmcn01	McNeil Creek	06-03-1999	0	6	1	5	0	2	18	28
kpmoo01	Moose Creek	06-06-1999	3	8	3	55	5	2	6	67
kpmoo01	Moose Creek	06-06-1999	4	8	3	56	11	2	4	77
kpmoo01	Moose Creek	06-06-1999	2	7	3	61	6	2	3	67

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
kpmoo01	Moose Creek	06-06-1999	5	7	3	51	9	2	2	74
kpmoo01	Moose Creek	06-06-1999	1	6	3	54	9	2	1	72
kpmoo01	Moose Creek	06-20-2000	1	8	3	66	7	1	1	68
kpmoo01	Moose Creek	06-20-2000	0	8	4	57	9	1	1	76
kpmoo01	Moose Creek	06-06-1999	0	7	3	48	6	2	1	68
kpmoo01	Moose Creek	06-04-1997	0	7	4	29	8	1	0	66
kpmor01	Moose River	07-02-1999	0	7	2	3	0	1	9	34
kpmor02	Moose River	07-02-1999	1	5	1	10	1	1	10	31
kpmor02	Moose River	07-02-1999	0	5	1	1	0	1	8	24
kpmor03	Moose River	07-01-1999	0	4	1	4	0	1	9	23
kpmys01	Mystery Creek	06-16-1999	0	12	5	23	17	2	5	88
kpmys01	Mystery Creek	06-05-1997	0	14	5	18	13	2	2	87
kpmys01	Mystery Creek	06-05-1997	1	9	3	27	17	2	1	75
kpnfa01	North Fork Anchor River	07-09-1999	0	12	6	17	11	2	12	75
kpnfa01	North Fork Anchor River	06-12-2001	1	9	2	41	7	2	9	64
kpnfa01	North Fork Anchor River	06-05-1997	0	5	1	2	0	1	3	25
kpnfa01	North Fork Anchor River	06-12-2001	0	6	2	39	4	1	3	55
kpnik01	Nikolai Creek	06-20-2000	0	10	4	12	4	1	3	59
kpnik01	Nikolai Creek	06-06-1999	0	11	5	29	7	2	3	81
kpnik01	Nikolai Creek	06-06-1999	1	10	4	24	2	2	1	69
kpnik01	Nikolai Creek	06-06-1997	0	9	3	2	1	1	0	40
kpnin01	Ninilchik River	06-13-2001	0	11	4	12	4	1	12	55
kpnin01	Ninilchik River	06-02-1999	0	8	3	27	3	2	9	55
kpnin01	Ninilchik River	06-06-1997	0	8	2	8	1	1	2	40
kpott01	Otter Creek	06-04-1997	0	10	3	11	4	2	0	58
kpsca01	Scaup Lake Creek	06-15-2006	0	2	2	11	4	1	6	32
kpsli01	Slikok Creek	06-15-2000	0	6	1	1	0	1	9	27
kpsli01	Slikok Creek	06-04-1999	1	3	1	1	0	1	6	20
kpsli01	Slikok Creek	06-03-1997	0	5	1	1	0	0	3	22
kpsli01	Slikok Creek	06-04-1999	0	3	1	1	0	1	2	22
kpsli01	Slikok Creek	06-14-2001	0	6	2	5	0	1	1	34
kpsol01	Soldotna Creek	06-19-2000	0	5	1	2	29	2	59	36
kpsol01	Soldotna Creek	06-02-1999	0	3	1	3	0	2	23	20

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
kpsol01	Soldotna Creek	06-18-2005	0	7	1	1	0	2	19	31
kpsol01	Soldotna Creek	06-14-2001	0	6	1	0	5	1	18	29
kpsol01	Soldotna Creek	06-03-1997	0	5	1	1	0	1	2	26
kpsol02	Soldotna Creek	06-19-2000	0	4	1	3	12	2	32	31
kpsol02	Soldotna Creek	06-02-1999	0	4	2	2	0	1	9	25
kpsol02	Soldotna Creek	06-03-1997	0	12	2	1	0	0	0	37
kpsta01	Stariski Creek	07-08-1999	0	11	4	3	1	2	6	53
kpsta01	Stariski Creek	06-12-2001	0	12	4	39	1	2	2	70
kpsta01	Stariski Creek	06-16-2000	0	12	4	13	1	1	2	59
kpsta01	Stariski Creek	06-06-1997	1	7	1	6	0	1	1	34
kpsta01	Stariski Creek	06-06-1997	0	13	3	10	2	2	1	58
kpsve01	Seven Egg Creek	06-04-1997	0	8	3	28	3	1	1	58
kpswa01	Swanson River	06-29-1999	0	6	2	2	1	2	15	34
kpswa01	Swanson River	06-26-2000	0	12	4	7	7	2	12	62
kpswa03	Swanson River	06-29-1999	0	7	1	5	0	1	20	26
kpswa04	Swanson River	06-26-2000	0	3	1	6	1	1	42	15
kpswa04	Swanson River	07-03-1999	0	7	2	3	2	2	18	34
kpswa05	Swanson River	06-26-2000	0	8	2	3	2	2	40	35
kpswa06	Swanson River	06-26-2000	0	5	1	2	2	2	24	23
kpswa06	Swanson River	06-29-1999	0	8	1	18	0	2	23	38
kpswa10	Swanson River	06-28-1999	0	3	1	3	28	2	62	32
kpswa10	Swanson River	06-26-2000	0	5	2	5	3	1	19	29
kptwi01	Twitter Creek	06-02-1999	1	8	3	31	10	2	12	67
kptwi01	Twitter Creek	06-02-1999	0	8	3	34	6	2	7	68
kptwi01	Twitter Creek	06-17-2005	0	9	5	19	3	2	1	68
kpwfm01	West Fork Moose River	07-02-1999	0	9	2	5	11	2	33	48
macal02	California Creek	05-30-2001	1	11	5	37	15	2	12	86
macam04	Campbell Creek	07-20-1999	0	10	4	8	1	2	7	52
macam04	Campbell Creek	05-14-1999	0	6	1	1	1	1	4	29
macam06	Campbell Creek	05-23-2000	0	6	0	0	0	1	23	19
macam06	Campbell Creek	05-24-2001	0	8	3	2	1	2	4	45
macam08	Campbell Creek	05-23-2000	0	7	3	4	1	1	13	37
macam08	Campbell Creek	05-24-2001	0	10	4	8	3	1	4	52

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
mache04	Chester Creek	06-13-2005	0	3	0	0	0	1	62	4
mache04	Chester Creek	06-16-2001	0	5	1	1	0	1	56	14
mache04	Chester Creek	06-08-1999	1	9	2	2	0	2	28	33
mache04	Chester Creek	06-08-1999	0	7	1	0	0	2	19	32
mache04	Chester Creek	07-16-1999	0	7	2	32	0	2	18	47
mache04	Chester Creek	05-14-1999	0	6	1	2	0	1	3	24
mache08	Chester Creek	05-22-2000	0	6	1	0	0	1	35	17
mache08	Chester Creek	05-21-2001	0	4	1	0	0	1	4	20
macra02	Craig Creek	07-07-2006	0	5	1	1	0	2	34	24
maekl04	Eklutna River	05-16-2001	0	10	4	76	5	1	3	68
mafis01	Fish Creek	06-12-2005	0	2	0	0	0	0	6	14
mafos01	Fossil Creek	06-22-2006	0	6	1	7	0	2	7	37
mafur01	Furrow Creek	05-23-2001	0	2	0	0	0	1	13	10
mahoo01	Hood Creek	06-23-2006	0	1	0	0	1	2	29	18
malca01	Little Campbell Creek	05-23-2001	0	1	0	0	0	1	28	3
malca01	Little Campbell Creek	06-29-2006	0	4	1	4	3	1	21	24
malca01	Little Campbell Creek	05-24-2000	0	2	1	0	0	0	9	14
malca01	Little Campbell Creek	05-24-2000	1	1	0	0	0	0	7	13
malca01	Little Campbell Creek	05-24-2000	0	0	0	0	0	0	0	17
malra02	Little Rabbit Creek	05-25-2000	1	9	4	42	12	2	5	83
malra02	Little Rabbit Creek	06-22-2005	0	8	5	84	16	2	3	86
malra02	Little Rabbit Creek	05-25-2000	0	10	4	51	16	2	3	88
malra02	Little Rabbit Creek	06-08-1999	0	11	4	11	4	2	3	68
malra02	Little Rabbit Creek	05-23-2001	1	11	4	27	7	2	3	71
malra02	Little Rabbit Creek	05-23-2001	0	10	4	33	8	2	0	75
Malra10	Little Rabbit Creek	05-23-2001	0	10	4	33	6	2	2	72
mamch02	Middle Fork Chester Creek	05-22-2000	0	4	1	0	0	1	78	5
mamch02	Middle Fork Chester Creek	05-21-2001	0	0	0	0	0	1	34	4
mamea02	Meadow Creek	06-30-2005	0	9	4	58	7	2	13	76
mamea02	Meadow Creek	05-25-2001	0	9	4	46	4	2	11	67
mamea02	Meadow Creek	05-26-2000	0	7	2	51	6	2	3	63
mamea02	Meadow Creek	05-26-2000	1	7	2	65	9	1	2	65
mamea04	Meadow Creek	05-25-2001	0	9	4	49	6	2	19	68

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
mamea04	Meadow Creek	05-26-2000	0	10	3	37	8	2	6	72
mamea06	Meadow Creek	05-26-2000	0	8	3	58	16	2	5	79
mamea06	Meadow Creek	05-25-2001	0	11	4	38	6	2	2	73
manch01	North Fork Chester Creek	06-19-2006	0	3	0	0	0	1	20	8
manfc07	North Fork Campbell Creek	05-24-2000	0	6	2	3	1	1	9	31
manfc07	North Fork Campbell Creek	05-24-2000	1	8	3	2	2	1	7	39
manfc07	North Fork Campbell Creek	05-23-2001	0	10	4	28	19	2	3	80
manfc10	North Fork Campbell Creek	07-16-1999	1	13	5	14	2	2	7	70
manfc10	North Fork Campbell Creek	07-16-1999	0	12	5	13	4	2	6	71
manfc10	North Fork Campbell Creek	06-11-2005	0	9	3	18	4	2	3	62
manfc10	North Fork Campbell Creek	06-16-2001	0	10	4	9	4	1	2	50
manfc10	North Fork Campbell Creek	05-14-1999	0	10	3	6	2	2	2	54
manfc10	North Fork Campbell Creek	06-08-1999	0	7	2	1	1	1	2	34
manfc10	North Fork Campbell Creek	06-08-1999	1	10	3	4	1	1	1	49
manfc12	North Fork Campbell Creek	05-24-2001	0	9	4	50	6	2	2	75
manfc12	North Fork Campbell Creek	05-25-2000	0	8	4	30	15	1	2	74
manfc12	North Fork Campbell Creek	05-24-2001	1	11	5	22	4	1	1	65
manlc02	North Fork Little Campbell Creek	07-10-2006	0	2	1	8	3	2	46	23
manlc04	North Fork Little Campbell Creek	05-24-2001	0	5	1	1	0	1	6	22
manlc04	North Fork Little Campbell Creek	05-24-2000	0	1	0	0	0	0	5	14
manlc05	North Fork Little Campbell Creek	06-30-2006	0	7	3	10	1	2	3	48
mapot01	Potter Creek	06-11-2006	0	7	3	68	1	2	6	60
marab04	Rabbit Creek	07-20-1999	0	11	5	35	9	2	2	86
marab04	Rabbit Creek	06-08-1999	0	11	4	48	11	2	2	89
masch01	South Fork Chester Creek	05-22-2000	0	8	1	2	0	1	21	27
masch01	South Fork Chester Creek	05-21-2001	0	4	0	0	0	1	10	15
masch03	South Fork Chester Creek	05-22-2000	0	6	1	1	0	2	52	23
masch03	South Fork Chester Creek	05-21-2001	0	5	1	5	0	1	10	22
masch05	South Fork Chester Creek	05-22-2000	0	6	1	3	0	2	19	26
masch06	South Fork Chester Creek	05-22-2000	0	5	1	3	13	2	20	40

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
masch06	South Fork Chester Creek	05-23-2001	0	7	1	10	1	1	7	34
masch09	South Fork Chester Creek	05-23-2000	0	6	1	11	0	1	14	28
masch09	South Fork Chester Creek	05-22-2001	0	4	1	0	0	1	13	20
masch12	South Fork Chester Creek	05-08-2001	0	8	2	7	0	2	11	40
masch13	South Fork Chester Creek	05-08-2001	0	8	3	6	0	1	6	34
masch13	South Fork Chester Creek	05-23-2000	0	5	1	10	0	1	5	28
masch14	South Fork Chester Creek	06-08-1999	0	10	3	4	0	1	11	42
masch14	South Fork Chester Creek	07-16-1999	0	9	3	3	1	1	6	41
masch14	South Fork Chester Creek	05-14-1999	0	11	2	9	0	2	5	47
masfc11	South Fork Campbell Creek	07-19-1999	1	15	6	18	11	2	10	82
masfc11	South Fork Campbell Creek	06-08-1999	0	12	6	47	7	2	4	88
masfc11	South Fork Campbell Creek	05-23-2000	0	11	5	26	3	1	3	66
masfc11	South Fork Campbell Creek	06-14-2005	0	9	4	43	25	3	2	88
masfc11	South Fork Campbell Creek	06-08-1999	1	13	5	48	10	2	2	95
masfc11	South Fork Campbell Creek	07-19-1999	0	11	5	18	9	2	1	77
masfc11	South Fork Campbell Creek	05-22-2001	0	10	5	42	11	2	1	88
masfc11	South Fork Campbell Creek	05-13-1999	0	13	5	43	8	2	0	92
masfe01	South Fork Eagle River	06-26-1999	0	14	6	52	25	2	5	97
mashi03	Ship Creek	05-21-2001	0	3	1	0	0	1	37	4
mashi03	Ship Creek	05-23-2000	0	7	4	3	0	1	32	24
mashi10	Ship Creek	05-13-1999	0	13	5	41	12	2	1	90
maslc01	South Fork Little Campbell Creek	06-29-2006	0	2	1	2	1	2	32	21
maslc01	South Fork Little Campbell Creek	05-23-2001	0	1	0	0	0	1	18	7
maslc01	South Fork Little Campbell Creek	05-24-2000	0	2	0	0	0	0	7	13
maslc01.3	South Fork Little Campbell Creek	07-10-2006	0	5	1	4	3	2	43	28
maslc01.7	South Fork Little Campbell Creek	06-29-2006	0	8	1	14	0	2	3	41
maslc02	South Fork Little Campbell Creek	07-10-2006	0	11	1	5	2	2	19	43
maslc02	South Fork Little Campbell	05-24-2001	0	7	1	5	0	1	3	27

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
	Creek									
maslc02	South Fork Little Campbell Creek	05-24-2000	0	7	2	2	1	1	2	31
maslc04	South Fork Little Campbell Creek	07-06-2006	0	12	2	12	3	2	10	57
maslc04	South Fork Little Campbell Creek	05-24-2001	0	4	1	13	0	1	5	31
maslc04	South Fork Little Campbell Creek	05-25-2000	0	4	1	3	0	1	3	24
maslc05.5	South Fork Little Campbell Creek	07-14-2006	0	11	1	7	4	2	8	52
maslc07	South Fork Little Campbell Creek	07-07-2006	0	11	4	31	1	3	15	64
ms12101	Unnamed creek at Parks Hwy MP 121	05-14-1998	0	9	2	0	0	1	1	36
ms14001	Unnamed creek at Parks Hwy MP 140	05-14-1998	0	12	4	6	4	1	1	52
msans01	Answer Creek	05-15-1998	0	12	4	9	5	1	2	60
msapr01	April Creek	06-15-2004	0	9	3	63	14	2	2	80
msbod01	Bodenburg Creek	05-12-1998	0	8	2	31	3	2	2	56
msbod01	Bodenburg Creek	06-19-2000	0	6	2	14	4	1	2	38
msbod01	Bodenburg Creek	06-15-2001	1	5	2	42	14	1	1	64
msbod01	Bodenburg Creek	06-15-2001	0	8	3	51	17	1	0	76
mscas01	Caswell Creek	06-20-2000	0	6	1	5	7	2	45	33
mscas01	Caswell Creek	05-14-1998	0	11	3	7	3	2	19	52
mscha01	Chase Creek	05-23-1998	0	11	4	4	2	1	4	52
mscle01	Clear Creek	06-20-2006	0	12	3	5	3	2	25	49
mscot01	Cottonwood Creek	05-13-1998	0	13	4	6	1	2	4	59
mscot01	Cottonwood Creek	06-15-2001	0	12	2	5	0	1	4	46
mscot01	Cottonwood Creek	06-16-2000	0	15	3	6	1	2	3	61
mscot01	Cottonwood Creek	06-21-2005	0	13	4	14	4	2	1	72
mscot02	Cottonwood Creek	05-13-1998	1	6	2	8	8	2	8	47
mscot02	Cottonwood Creek	06-16-2000	0	4	1	5	0	1	2	24
mscot02	Cottonwood Creek	05-13-1998	0	7	1	9	1	1	2	37

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
mscot03	Cottonwood Creek	06-16-2000	0	6	3	10	1	1	5	39
mscot03	Cottonwood Creek	05-13-1998	0	9	3	10	1	2	4	49
msdea01	Deadhorse Creek	05-23-1998	0	9	3	22	11	1	5	63
msdec02	Deception Creek	06-14-2000	0	7	2	2	0	1	1	30
msdec05	Deception Creek	05-13-1998	0	9	3	19	6	2	3	59
msdec05	Deception Creek	06-20-2000	0	12	4	10	5	2	2	67
mseska01	Eska Creek	06-14-2004	0	9	4	5	2	1	8	43
msfis01	Fish Creek	06-16-2000	0	11	3	4	1	2	4	54
msfis01	Fish Creek	05-15-1998	0	9	4	6	1	1	1	49
msfis01	Fish Creek	06-20-2005	0	7	1	6	8	1	1	47
msfis01	Fish Creek	05-15-1998	1	13	4	8	2	2	1	62
msfis02	Fish Creek	06-18-2001	0	6	2	10	1	1	17	34
msfly01	Flynn Creek	05-24-1998	0	12	5	23	13	1	1	80
msgol01	Gold Creek	05-21-1998	0	11	5	56	6	2	1	82
msgoo01	Goose Creek	05-14-1998	0	10	2	4	0	1	8	40
msgoo01	Goose Creek	06-20-2000	0	11	4	4	1	1	4	50
msgoo01	Goose Creek	06-20-2000	1	10	4	4	5	1	2	53
msgra01	Granite Creek	06-24-2006	0	13	7	40	2	2	9	80
msgre01	Grey's Creek	06-20-2000	0	6	1	6	0	1	2	30
msgre01	Grey's Creek	05-15-1998	0	7	2	1	0	1	0	35
mslak01	Lake Creek	06-14-2000	0	3	2	5	1	1	26	20
mslan01	Lane Creek	05-21-1998	0	13	5	47	10	2	1	91
mslme01	Little Meadow Creek	05-15-1998	1	8	1	1	4	1	9	30
mslme01	Little Meadow Creek	06-15-2001	0	9	2	3	5	1	8	40
mslme01	Little Meadow Creek	06-15-2001	1	7	1	2	2	1	8	28
mslme01	Little Meadow Creek	06-15-2000	0	10	3	15	1	1	7	48
mslme01	Little Meadow Creek	05-15-1998	0	8	3	3	1	1	4	35
mslsu01	Little Susitna River	07-13-2000	0	12	6	20	11	2	5	83
mslsu01	Little Susitna River	05-12-1998	0	14	6	8	1	1	1	61
mslsu02	Little Susitna River	07-13-2000	0	10	5	56	31	2	2	95
mslsu02	Little Susitna River	05-12-1998	1	13	5	9	5	1	2	67
mslsu02	Little Susitna River	05-12-1998	0	14	6	14	6	2	0	71

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
mslsu03	Little Susitna River	07-12-2000	0	13	5	25	9	2	11	81
mslsu03	Little Susitna River	05-12-1998	0	14	4	9	9	1	3	64
msluc01	Lucille Creek	06-15-2000	0	5	1	4	0	1	6	27
msluc01	Lucille Creek	05-16-1998	0	9	4	29	1	1	2	60
msluc03	Lucille Creek	06-15-2000	0	4	1	12	1	1	4	28
mslwi01	Little Willow Creek	05-13-1998	1	10	4	6	1	2	17	53
mslwi01	Little Willow Creek	07-13-2000	0	13	5	14	3	1	3	65
mslwi01	Little Willow Creek	05-13-1998	0	8	2	6	0	2	3	48
msmck01	McKenzie Creek	05-24-1998	0	10	4	26	11	1	4	71
msmcr01	McRoberts Creek	06-19-2000	0	9	4	16	10	2	2	68
msmcr01	McRoberts Creek	05-12-1998	0	11	4	32	11	2	1	84
msmea01	Meadow Creek	06-15-2000	1	5	2	2	8	1	20	34
msmea01	Meadow Creek	06-15-2000	0	6	2	3	0	1	12	27
msmea01	Meadow Creek	05-15-1998	0	6	1	1	2	1	6	24
msmea01	Meadow Creek	06-15-2001	0	4	2	2	1	1	2	26
msmon01	Montana Creek	07-16-2001	1	10	4	13	6	1	3	62
msmon01	Montana Creek	05-14-1998	0	12	4	13	1	1	3	56
msmon01	Montana Creek	07-16-2001	0	13	4	20	6	1	2	68
msmoo01	Moose Creek	06-14-2004	0	12	5	56	36	2	6	95
msmop01	Moose Creek, Petersville	05-15-1998	0	13	4	5	2	1	5	55
msnan01	Nancy Creek	06-15-2001	0	10	3	1	1	1	1	39
msnan01	Nancy Creek	05-15-1998	0	0	0	0	0	0	0	17
msnta01	No name trib - Alexander Creek	06-22-2006	0	5	2	8	2	1	3	37
mspie01	Pierce Creek	06-23-2006	0	13	4	35	2	2	9	73
msshe01	Sheep Creek	05-14-1998	0	13	3	18	2	2	10	63
msshr01	Sherman Creek	05-23-1998	0	9	2	4	1	1	4	37
mstra01	Trapper Creek	05-14-1998	0	13	4	9	2	2	5	60
mstro01	Troublesome Creek	05-14-1998	0	16	4	17	21	2	1	81
msumo01	South Fork Montana Cr	05-15-1998	0	14	4	15	5	2	2	68
mswas01	Wasilla Creek	06-23-2005	0	11	4	3	1	1	11	49
mswas01	Wasilla Creek	06-13-2000	0	6	2	12	3	1	3	39
mswas01	Wasilla Creek	05-11-1998	0	9	3	10	3	1	2	49

Station ID	Waterbody name	Date	Replicate number	Number of EPT taxa	Number of mayfly taxa	% Mayflies	% Scrapers	Shannon's diversity	% Non-insects	Multimetric index score
mswas01	Wasilla Creek	06-18-2001	0	10	3	33	3	2	2	66
mswas01	Wasilla Creek	05-11-1998	1	9	3	10	2	1	1	47
mswas02	Wasilla Creek	06-13-2000	0	11	5	29	6	2	5	75
mswas04	Wasilla Creek	06-13-2000	0	11	4	12	0	2	13	57
mswas05	Wasilla Creek	06-13-2000	0	10	4	9	1	2	10	53
mswas05	Wasilla Creek	06-13-2000	1	9	3	10	2	1	8	48
mswas10	Wasilla Creek	06-14-2000	0	12	4	9	1	2	18	53
mswas10	Wasilla Creek	05-11-1998	0	11	3	15	5	1	1	59
mswil01	Willow Creek	07-13-2000	0	6	3	9	0	1	12	31
mswil04	Willow Creek	05-13-1998	0	11	4	9	0	2	3	55
mswil04	Willow Creek	07-13-2000	0	14	6	32	15	2	0	89
mswol01	Wolverine Creek	06-19-2000	0	12	4	29	7	2	1	80
mswol01	Wolverine Creek	06-14-2004	0	9	5	66	5	2	1	77
mswol01	Wolverine Creek	06-14-2004	1	7	2	60	1	1	0	54
mswol02	Wolverine Creek	06-19-2000	0	7	2	9	0	1	4	37
msyel01	Yellow Creek	06-15-2004	0	6	2	40	0	1	4	50
ty3mi01	3 Mile Creek	06-13-2006	0	3	1	2	0	1	3	23
tylon01	Lone Creek	06-14-2006	0	6	3	14	0	2	7	46
tynnc01	No Name Tributary-to Nikoli Creek	06-15-2006	0	12	4	7	2	2	6	59
tynnt01	No Name Tributary	06-15-2006	0	4	1	17	0	2	11	36
tyoty01	Old Tyonek	06-12-2006	0	12	4	15	1	2	7	62
tytyo01	Tyonek Creek	06-16-2006	0	5	1	4	0	1	7	27

Appendix 3. Diatom metric values and corresponding multimetric index scores for all Cook Inlet Basin ecoregion stream sites. Station IDs beginning with kp- are on the Kenai Peninsula, with ma- are in the Anchorage Bowl, with ms- are in the Mat-Su Valley, and with ty- are in the Tyonek area.

Station ID and date	Waterbody name	Percent motile	Organic N tolerance	Saprobity	Species richness	Trophic state	Final index score
kpbve01_6/16/06	Beaver Creek, Soldotna	7	2.1	2.3	34	4.5	42
kpbvr01_7/22/02	Beaver Creek	10	1.9	2.6	25	5.1	37
kpcro04_6/16/06	Crooked Creek	3	1.7	2.3	33	4.8	55
kpdcg06_6/17/05	Deep Creek (gamma branch)	19	2.0	2.5	44	4.1	26
kpdia02_6/16/05	Diamond Creek	9	1.7	2.0	40	3.4	60
kpdia02_7/20/02	Diamond Creek	14	1.6	1.9	35	3.5	59
kpefm01_6/12/06	East Fork Moose River	3	1.5	1.9	79	4.8	53
kpefm01_6/15/05	East Fork Moose River	2	1.8	1.9	42	4.6	58
kpefm01_7/19/02	East Fork Moose River	2	1.2	2.0	34	4.2	76
kphap01_6/14/06	Happy Creek	4	2.1	2.5	49	4.8	34
kpmcn01_7/20/02	McNeil Creek	3	1.5	1.3	32	3.1	84
kpmoo01_7/24/02	Moose Creek	0	1.6	1.7	13	5.0	76
kpnik01_7/24/02	Nikolai Creek	16	1.9	2.8	35	5.6	21
kpsca01_6/15/06	Scaup Lake Creek	4	1.8	2.3	47	5.3	40
kpsli01_6/13/06	Slikok Creek	4	1.6	2.0	82	3.8	54
kpsol01_6/13/06	Soldotna Creek	9	2.2	3.2	60	5.8	13
kpsol01_6/18/05	Soldotna Creek	16	1.9	2.5	61	4.8	17
kpsol01_7/23/02	Soldotna Creek	3	2.1	2.9	56	5.1	26
kpsta01_6/14/06	Stariski Creek	6	1.9	2.6	37	4.8	40
kptwi01_6/17/05	Twitter Creek	3	2.0	2.8	32	6.0	33
kptwi01_7/20/02	Twitter Creek	9	1.7	2.2	25	4.2	57
kptwo01_6/18/06	Two Moose Creek	4	2.1	2.7	36	5.5	31
kpwoo01_6/16/06	Woodard Creek	15	2.1	3.0	39	5.5	16
mache04_6/13/05	Chester Creek	4	2.0	2.2	30	6.0	42
mafis01_6/12/05	Fish Creek	1	1.9	2.2	31	4.2	59
mafos01_6/22/06	Fossil Creek	2	1.9	2.1	33	5.5	51
mafur01_8/6/02	Furrow Creek	17	2.0	2.4	45	6.1	15
mahoo01_6/23/06	Hood Creek	0	1.9	2.0	45	6.2	43
malca01_6/20/06	Little Campbell Creek	6	1.9	2.1	33	6.0	42

malca01_8/6/02	Little Campbell Creek	10	2.0	2.2	33	5.9	34
malra02_6/22/05	Little Rabbit Creek	1	1.9	2.1	25	5.4	56
mamea01a_6/25/06	Meadow Creek	1	1.8	1.8	34	4.9	62
mamea01b_6/25/06	Meadow Creek	3	1.9	2.0	21	5.4	56
mamea02_6/30/05	Meadow Creek	1	1.9	2.2	35	5.7	48
manch01_6/17/06	North Fork Chester Creek	10	2.0	2.2	28	6.2	32
manfc10_6/11/05	North Fork Campbell Creek	1	1.7	2.0	54	4.8	53
manfc10_6/24/06	North Fork Campbell Creek	1	1.9	2.0	35	5.0	57
manfc10_7/29/02	North Fork Campbell Creek	2	1.7	2.1	35	4.2	63
manlc05_06	North Fork Little Campbell Creek	0	2.0	2.0	27	5.4	55
mapot01_6/11/06	Potter Creek	1	2.0	2.0	21	6.4	53
masch06_7/29/02	South Fork Chester Creek	17	2.0	2.3	40	5.3	25
masch13_8/6/02	South Fork Chester Creek	1	1.8	1.9	34	5.5	57
masfc11_7/30/02	South Fork Campbell Creek	0	1.7	2.0	17	4.8	72
masfc11a_6/14/05	South Fork Campbell Creek	0	1.9	2.0	30	5.2	58
masfc11b_6/14/05	South Fork Campbell Creek	0	1.9	1.9	25	5.4	60
msans01_6/13/06	Answer Creek	1	1.7	2.1	60	4.9	48
msbod01_6/21/06	Bodenberg Creek	1	1.9	2.0	25	6.0	54
mscle01_6/20/06	Clear Creek	3	1.7	1.8	81	4.9	49
mscot01_6/21/05	Cottonwood Creek	9	1.7	2.0	48	5.1	43
mscro01_6/21/06	mscro01	4	1.9	2.1	69	6.3	30
msdea01_6/18/06	Deadhorse Creek	0	1.3	1.8	20	3.1	95
msfis01_6/12/05	Fish Creek	3	1.8	2.0	44	5.2	49
msfly01_6/18/06	Flynn Creek	1	1.8	1.9	34	5.5	58
msgol01_6/15/06	Gold Creek	7	1.7	1.8	35	4.5	59
msgra01_6/24/06	Granite Creek	1	1.8	2.0	24	4.4	69
mslan01_6/15/06	Lane Creek	1	1.7	1.8	21	5.2	69
msmck01_6/17/06	McKenzie Creek	0	1.8	1.8	21	5.2	69
msnta01_6/22/06	No name trib - Alexander Creek	1	1.6	1.9	48	4.1	65
mspie01_6/23/06	Pierce Creek	1	1.6	1.7	45	4.0	72
msshr01_6/16/06	Sherman Creek	1	1.5	1.9	23	3.8	80

mstro01_6/14/06	Troublesome Creek	0	1.6	1.9	19	4.7	76
mswas01_2005	Wasilla Creek	1	2.0	2.2	34	6.5	44
ty3mi01_6/13/06	3 Mile Creek	0	1.3	1.4	16	2.5	100
tylon01_6/14/06	Lone Creek	1	1.3	1.4	27	2.4	95
tynnc01_6/15/06	No Name Tributary-to Nikoli Creek	2	1.5	1.8	27	4.4	74
tynnt01_6/14/06	No Name Tributary	1	1.4	2.4	19	3.9	74
tyoty01_6/16/06	Old Tyonek	1	1.5	1.7	34	3.2	86
tytyo01_6/16/06	Tyonek Creek	1	1.6	2.1	35	3.6	70