Development of new high-gradient indices of biotic integrity for wadeable rivers and streams in New Jersey

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Introduction

The New Jersey Bureau of Freshwater and Biological Monitoring has been conducting Fish Index of Biotic Integrity (FIBI) monitoring on rivers and streams (>4 miles²) in the Northern part of the state since 2000 using Karr's original IBI format with several regional modifications. The NJ Fish IBI serves several purposes including identifying waters with aquatic life use impairments 303(d), assessing the waters of the state 305(b), nominating quality streams for special anti-degradation protection, and tracking streams with natural trout reproduction. In an effort to increase the overall performance of the IBI and to assess smaller headwater streams (<4 miles²), a new design and approach to metric development was evaluated on approximately 230 high gradient streams. This design, developed by Thomas Whittier and Robert Hughes, has been implemented for numerous Western U.S. studies, as well as the Connecticut multi-metric indices (MMI). Analysis resulted in two distinct stream classes; a coldwater community (Headwaters IBI) consisting of brook trout, sensitive salamanders, and native crayfish and cool/warmwater fish communities (Northern FIBI). Over 140 metrics from ten ecological classes were tested for signal to noise (S/N), range, responsiveness, and redundancy. A total of eight metrics were selected for the Northern FIBI and six were selected for the Headwaters IBI.

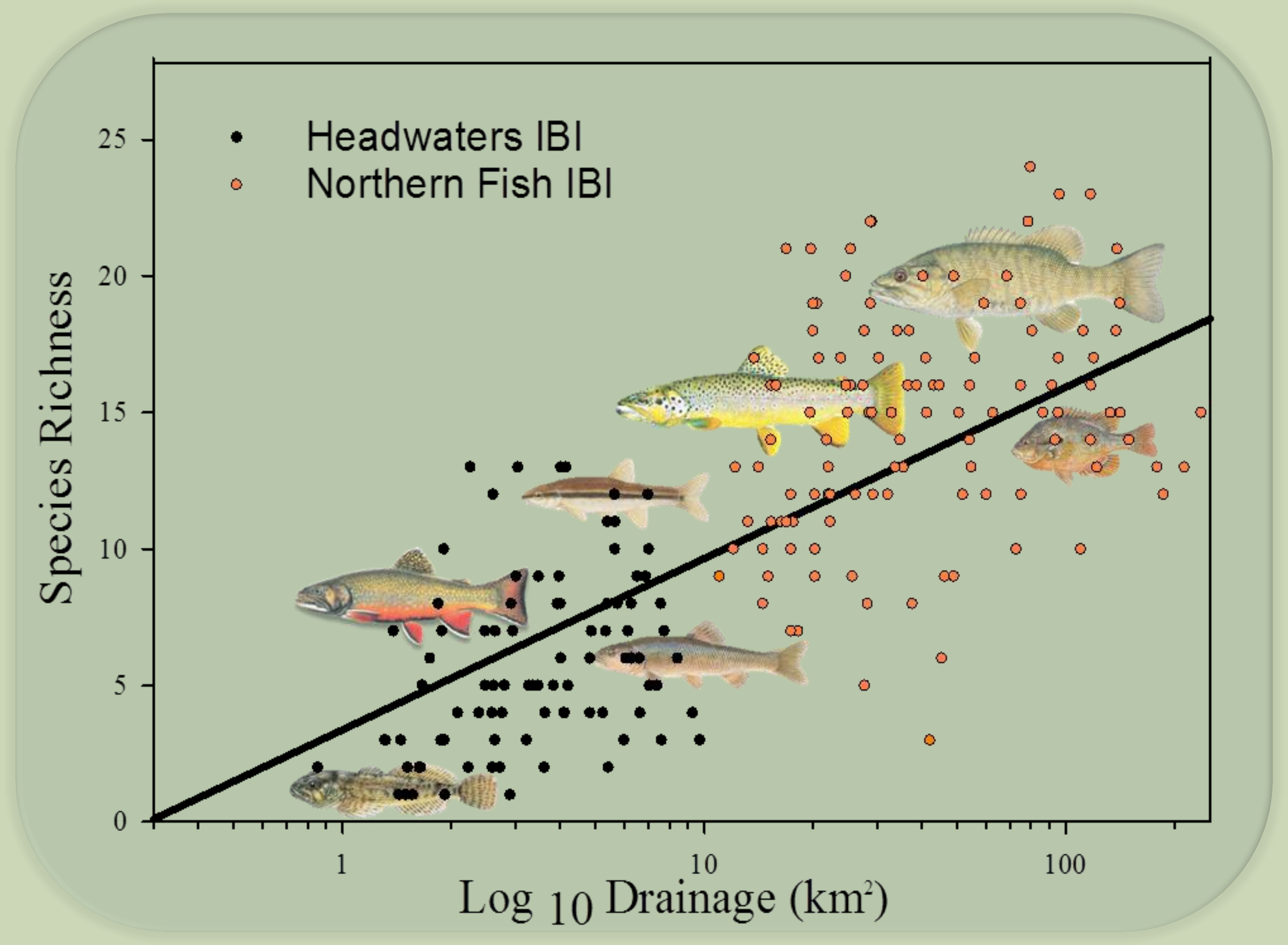
Methods

Sampling

- Fish, crayfish, and amphibian data were collected from 96 sites (< 10.4 km²)
- Fish assemblage data were collected from 137 sites (>10.4-km²)

Data Analysis

- Range - Metrics with greater than 75% zero values /identical values were eliminated
- Signal to Noise (S/N) – Metrics with S/N less than 3 were rejected
- Correlation with Stream Size - Metrics with r^2 values greater than 0.25 were adjusted using the linear regression model
- Responsiveness – ANOVA F-statistic used to select strongest metric in each ecological class
- Redundancy - A Pearson correlation coefficient of r = |0.75| used as a cut-off
- Metrics were scored using continuous scoring developed by TetraTech



Results

- 68 Headwaters and 80 Fish IBI metrics tested
- Final Fish IBI metrics, 3 corrected for watershed area and 2 have ubiquitous species excluded
- Total fish IBI and Headwater IBI scores indicated good discrimination efficiencies (96% and 100% respectively)
- Final redundancy analysis resulted in no significant correlation between metrics




Headwaters IBI

Metric	Ecological Class	Response to stress	S:N	F-value	% DE
Number of intolerant vertebrate species	Taxonomic Richness	Decrease	14.3	38.8	95
% vertebrate species as top carnivores	Trophic	Decrease	17.8	25.0	79
% Tolerant fish individuals	Tolerance	Increase	31.2	31.0	89
Proportion of total richness as native	Non-Native	Decrease	3.1	30.4	89
% Native crayfish	Composition	Decrease	3.2	43.1	100
Brook trout density (individuals/100m²)	Composition/Indicator Sp.	Decrease	1.6**	7.1	*

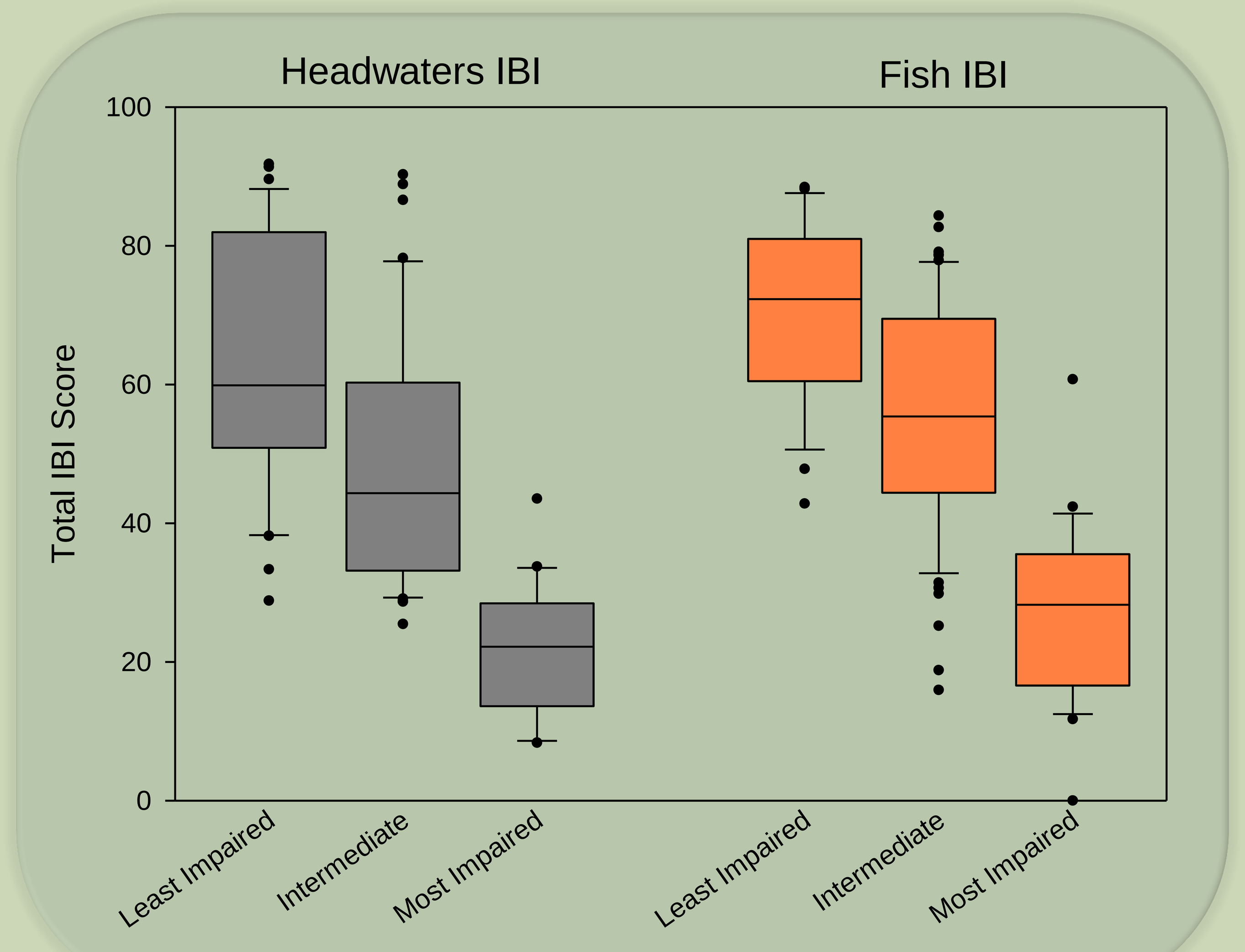
*The 25th percentile for least disturbed sites was 0.00 for metric
** Failed S/N test; however, passed all other screening procedures.

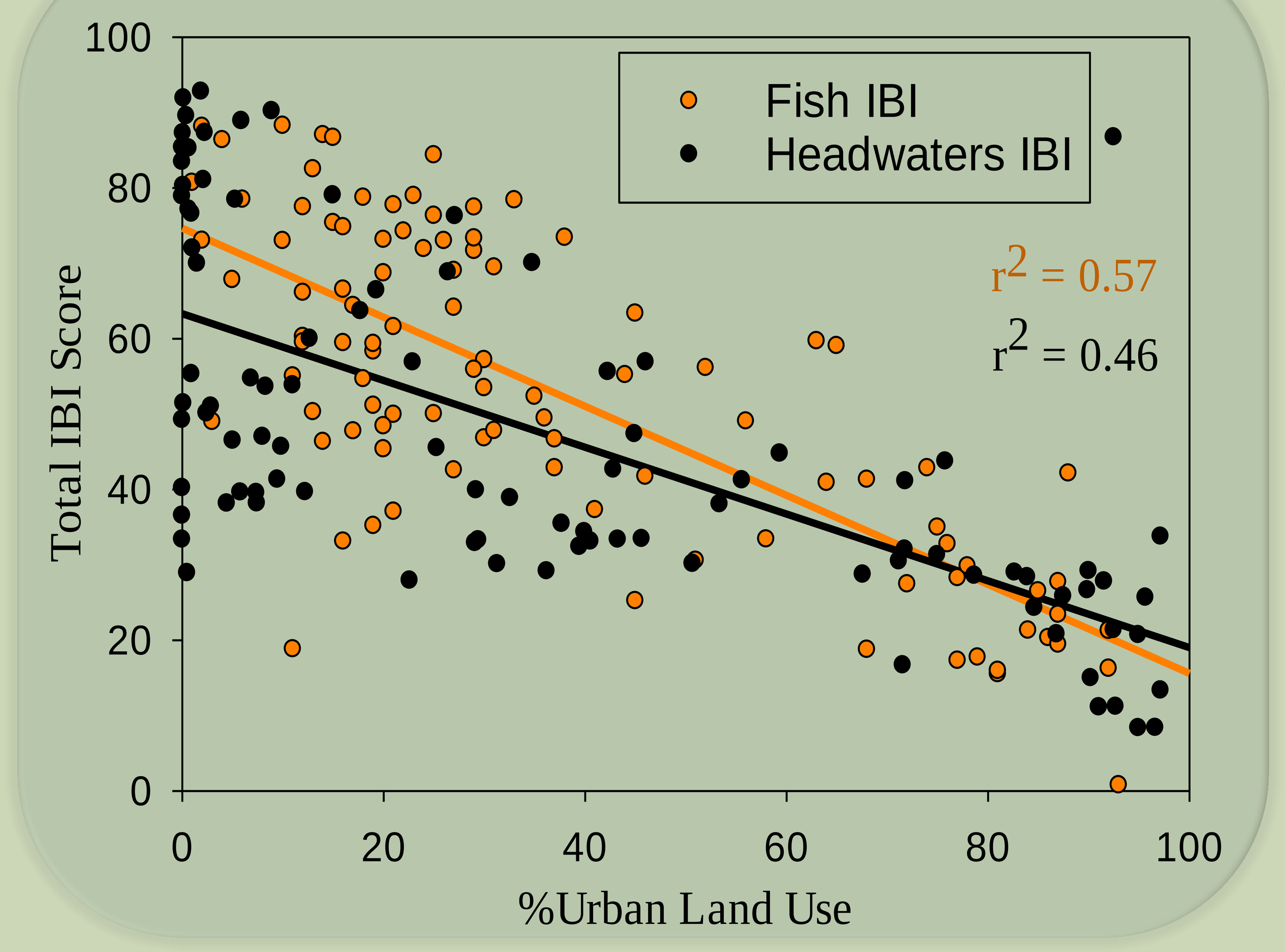


Fish IBI

Metric	Ecological Class	Response to stress	S:N	F-value	% DE
%Rheophilic Species[a]	Richness/Stream Flow	Decrease	12.5	99.5	100
%Coldwater & Nontolerant Coolwater Sp[b]	Thermal	Decrease	12.7	43.6	80
%Generalist Feeders[a]	Trophic	Increase	6.5	56.2	88
Tolerance Index	Tolerance	Increase	16.4	56.4	92
%Lithophilic Spawners[a]	Reproduction	Decrease	13.2	68.6	96
%Cyprinidae[b]	Composition	Decrease	11.3	62.0	88
%Dominant 3 Taxa[b]	Composition	Increase	7.5	33.7	88
%Benthic Insectivore Species[a]	Habitat	Decrease	16.0	50.3	96

[a]Proportion of Species
[b]Proportion of Individuals





Conclusions

- Metric testing procedures superior to traditional RBP methodology
- Final IBI's have greater sensitivity and precision than traditional Karr metrics