

## 2002 Progress Report: Testing Indicators of Coastal Ecosystem Integrity Using Fish and Macroinvertebrates

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**Center:** [Great Lakes Environmental Indicators Project](#)

**Center Director:** [Gerald J. Niemi](#)

**Title:** Testing Indicators of Coastal Ecosystem Integrity Using Fish and Macroinvertebrates

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**EPA Project Officer:** Barbara Levinson

**Project Period:** January 10, 2001 to January 9, 2005

**Research Category:** [Estuarine and Great Lakes Program \(EaGLE\)](#)

### Description:

**Objective:** To evaluate and integrate indicators across multiple spatial scales, we will employ a multi-tiered sampling and modeling strategy, integrating data collected at regional scales via satellite imagery, local scales, and site scales via field sampling. These data will be used to identify indicators at each scale that reflect critical ecosystem process or state variables related to the integrity and sustainability of those ecosystems. We will test indicators representing fundamental driving variables and processes at multiple spatial scales, and integrate them into a system for identifying positive or negative trends in the condition of ecosystems in coastal regions of the Great Lakes. The goals of our project are to:

1. Evaluate the applicability of SOLEC-derived and complementary indicators in the context of the ecosystem types found in the Great Lakes coastal region;
2. Rigorously test the efficacy of a suite of indicators across the range of habitats within the Great Lakes coastal system;
3. Recommend indicators of specific ecological conditions keyed to assessment endpoints and stressors in the Great Lakes coastal region.

**Progress Summary:** A total of 67 sites have been sampled across five geomorphic units (Table 1). During the 2002 season, a total of 59 sites were visited (areas ranging from 4 ha up to 20 km<sup>2</sup>); sites were rejected in the field due to low water levels, lack of access, and denial of access by landowners. Sampling protocols called for fish to be sampled using a combination of fyke nets (a maximum of 4 arrays set at 0.5 - 1 m depth for 48 hours) and trawls (open water habitats at 5 and 10 m depths). Invertebrates were sampled using D-frame nets and cores at 2 depths in shallow water, and via Ponar grab samplers and cores at the deepest point in wetlands and at 5 m and 10 m in open water sites (high energy and embayments). Over 35,000 fish were identified in

2002. Data have been entered and checked for quality control. Data analysis is in progress.

A total of 1,794 invertebrate samples were collected in 2002; sample processing is in progress and is approximately 50% complete. A large suite of physical water column and habitat variables was collected at fyke net and invertebrate sample points, as well as across the entire sampling unit. These data have been entered and are currently undergoing quality control checks.

Our review of preliminary information collected from pilot season efforts revealed that no data were being collected at the level of the entire sampling unit by any of the aquatic groups. Therefore, in 2002 we initiated a sampling protocol at the unit scale to assess: landscape context (surrounding land use and cover), morphometry, disturbances (hydrologic alterations, shoreline structures), human uses (recreation, other development), habitat diversity and structure, bathymetry, and macrophyte distributions. These observations were made in parallel to data collected at fyke net locations and invertebrate sample points.

Table 1. Total number of sites sampled to date.

|                         | 2001 | 2002 |
|-------------------------|------|------|
| High Energy (HE)        | 4    | 11   |
| Embayment (EB)          | 3    | 4    |
| Protected Wetland (PW)  | 1    | 8    |
| Riverine Wetland (RW)   | 3    | 17   |
| Lacustrine Wetland (LW) | 1    | 15   |
| Total                   | 12   | 55   |

### *Results to Date*

Comparison of 24 versus 48-hour fyke net protocol. V. Brady, J. Ciborowski, D. Breneman, T. Hrabik, J. Schuldt, L. Johnson, C. Richards.

One of the questions regarding the use of fyke nets for characterizing fish communities is whether an adequate representation can be obtained from a 24 hour fyke net set instead of a full 48 hours. Using our 2002 data, we have contrasted community structure metrics derived from 24 versus 48 hour fyke net sets, and quantified the possible effect of geomorphic types (wetland type, high energy or embayment) on the results. An important question is how similar the catches are to one other, not just in terms of total numbers or presence/absence of various species, but as representatives of the total site community. We have used a variety of approaches to assess this question. First we examined the number of additional fish species captured when nets were set for 48 hours. Overall, only 2-3 additional fish taxa were captured in 48 hour sets as compared to 24 hour net sets (Table 2).

Table 2. Comparison of fish species captured during 24 versus 48 hour fyke net sets.

| Type | # Sites | Mean # Taxa<br>24h | Mean # Taxa<br>48h | # Taxa<br>Added | % Taxa Added |
|------|---------|--------------------|--------------------|-----------------|--------------|
| LW   | 15      | 13.53              | 16.40              | 2.87            | 17.00        |
| EB   | 4       | 9.25               | 11.75              | 2.5             | 20.80        |
| HE   | 19      | 7.95               | 10.05              | 2.10            | 18.22        |
| PW   | 8       | 10.38              | 13.00              | 2.62            | 18.29        |
| RW   | 20      | 12.15              | 14.95              | 2.80            | 18.26        |

Using ordinations, we examined the community similarity in 24 versus 48 hour sets. Nonmetric multidimensional scaling (NMDS) ordinations were performed using PC-ORD software. To correct for differential fishing effort, ordinations were run on fish catches as proportions rather than as abundances. There were sufficient sites sampled to ordinate each geomorphic type except embayments. For each unit type we ran two ordinations: one that compared the 24 hour catch with the total 48 hour catch, and one that compared the Day 1 catch with the Day 2 catch (i.e. those fish caught only on the second day). In general, fyke net catches from the same site were similar to each other. As expected, the 24 hr vs. 48 hr catches were more similar to each other than were the Day 1 vs. Day 2 catches.

We then examined how differently the various catches plotted on the ordinations. First, we examined whether catch pairs plotted more closely to each other than to a different site. For all sites, the 24 vs 48 hr catch pairs plotted more closely to each other than to other sites. The Day 1 vs. Day 2 catch pairs were more likely to plot closer to another site than to each other only at some high energy (32%) and riverine (35%) wetland site types. We also examined whether vectors drawn between catch pairs (straight lines connecting the two data points) intersected vectors from other site pairs for each of the three graph orientations. There were very few vector intersections in most ordinations. Again, Day 1 vs. Day 2 catches at high energy and river-influenced wetland site types displayed the largest number of intersections, but represented 25% or fewer of the total data pairs.

Finally, Pearson correlations were run on the plot locations of site catch pairs for each of the first two ordination axes. Correlations were high, 0.95 and higher, for 24 vs. 48 hour catch pairs. Correlations for Day 1 vs. Day 2 catch pair ordinations were never lower than 0.77. Lacustrine wetland sites had the lowest catch pair correlations on the main axis.

From these results we have concluded that 24 hour net sets are adequate for characterizing the dominant species and relative community composition at a site. To ensure that these trends pertain to all geomorphic sites, we will sample additional protected wetlands and embayments in 2003 using the 48 hour protocol, and will rerun these analyses for those unit types. For other unit types, we will reduce our sampling effort to a 24 hour set, unless fewer than 100 fish are captured, at which time we will deploy nets for an additional 24 hours.

Relative influence of landscape characteristics and anthropogenic stress on fish communities in Great Lakes coastal wetlands: V. Brady, T.R. Hrabik, D. Breneman, L. Johnson, J. Ciborowski, J. Schuldt, and C. Richards.

We evaluated the fish communities in 43 wetlands ordinated along gradients of anthropogenic

stress from the US coastal margins of the 5 Great Lakes. To select sites, we used principal components analysis to summarize the influence of 214 GIS-based environmental and human disturbance variables for 731 segment sheds across the Great Lakes basin. Wetlands sampled spanned the resultant stress scales. Fish were sampled using 48-h fyke net sets during summer 2002. For analyses, sites were separated into northern and southern groupings due to latitudinal influences on fish community composition. Ordinations of fish relative abundances with the independent variables accounted for more than 60% of observed variation in the first three axes for both northern and southern sites. Different types of wetlands (lacustrine, protected, or river-influenced) did not appear to support distinctive fish communities. Both northern and southern wetlands supporting communities with high nonindigenous fish species richness were correlated with land uses and environmental variables characteristic of human disturbance and agricultural activities. We propose that the number of nonindigenous fish taxa is a robust indicator of the influence of anthropogenic stress that applies to a broad range of latitudes and geomorphic classes of wetlands.

The invasibility of stressed sites by exotic benthic macroinvertebrates in the great lakes: a test of hypotheses using *Echinogammarus ischnus*. M. Kang, J. Ciborowski, L. B. Johnson, T.R. Hrabik, C. Richards, and J. Schuldt.

Two contrasting hypotheses regarding the invasibility of sites by exotic species have been proposed. Elton (1958) proposed that biotic resistance against exotic species establishment is greater in intact communities than in those disturbed by human activities. However, Baltz and Moyle (1993) suggest that if abiotic conditions are appropriate, invasion is likely, regardless of the biota already present. We tested these hypotheses by investigating the presence of *Echinogammarus ischnus*, an exotic amphipod, at sites influenced by varying degrees of anthropogenic stress. Thirty sites supporting *Gammarus fasciatus*, a common amphipod with habitat preferences similar to *E. ischnus*, were evaluated. The presence/absence of *E. ischnus* was ordinated across ranges of each of five different stressor variables: total nutrient input, N + P load, areas of agricultural land, human population density, and overall pollution loading. Runs tests were used to determine randomness of *E. ischnus*' occurrence at these sites ordinated from low to high stress. None of the five tests showed a significant association between the presence of *Echinogammarus ischnus* and the amount of stress. This is consistent with the expectations of Baltz and Moyle's hypothesis. This method can potentially be used to evaluate the amount and type of stress associated with invaders, as well as invader occurrence at stressed sites.

#### Graduate Student Participation:

MiSun Kang, M.S. Thesis topic: The invasibility of stressed sites by exotic benthic macroinvertebrates in the Great Lakes: a test of hypotheses using *Echinogammarus ischnus* (University of Windsor).

Cynthia Radix. M.S. Thesis topic: Effects of environmental stresses on zoobenthos of nearshore zones across the Great Lakes (University of Windsor).

#### Undergraduate Interns:

David Branstat, Darin Gossett, Robert Hell, Chris Palvere (University of Minnesota)  
Leanne Baker, Paige Short, Jennifer Stanley, Laura St. John, Rana Youseff (University of Windsor).

**Future Activities:** The 2003 field season will begin with "boot camp" in Green Bay, Wisconsin,

the first week of June. Following this training week, four crews will be in the field from June through September sampling 63 sites. Forty-three of these are new sites, including 14 embayments, 5 high energy shorelines, 5 lacustrine wetlands, 12 protected wetlands, and 7 river-influenced wetlands. These sites were selected to maximize both coverage of the stressor gradients and overlap with other subprojects. Twenty sites, four sites of each geomorphic type from among the 2002 sites, will be revisited to provide data on inter-annual variation. Laboratory work on invertebrate sample processing and identification will continue, as will data entry, data quality assessment, and data analyses. We will be giving several presentations on our preliminary results, including talks in the GLEI special session at the International Association of Great Lakes Research meeting, and a talk at the North American Benthological Society meeting.

**Publications and Presentations:** Total Count: 7

| <u>Type</u>  | <u>Citation</u>  |
|--------------|--|
| Presentation | <b>Johnson, L.B.</b> Testing indicators of coastal ecosystem integrity using fish and macroinvertebrates. Great Lakes Fisheries Commission. Duluth, MN, 25 Feb 2002.   |
| Presentation | <b>Johnson, L.B.</b> Quantifying stressors across shorelines of the Great Lakes Environmental Indicators project. MN DNR fisheries research staff. Duluth, MN, 17 Aug 2002.  |
| Presentation | <b>Hrabik, T.</b> L. Johnson, V. Brady, D. Breneman, J. Ciborowski, C. Richards. Quantifying the influence of landscape characteristics on fish communities in coastal riverine wetlands for use as indicators. EaGLE Symposium at ASLO Aquatic Sciences meeting. Salt Lake City, UT, 9-14 Feb 2002. |
| Presentation | <b>Sierszen, M.E.</b> , J.C. Brazner, J.M. Morrice, G.S. Peterson, A.S. Trebitz. Food web structure as a potential indicator of nutrient enrichment in Great Lakes coastal wetlands. EaGLE Symposium at ASLO Aquatic Sciences meeting. Salt Lake City, UT, 9-14 Feb 2002.                            |
| Presentation | <b>Yurista, P.M.</b> , J.R. Kelly, S.E. Miller. Zooplankton size-spectra as an indicator in Great Lakes coastal waters. EaGLE Symposium at ASLO Aquatic Sciences meeting. Salt Lake City, UT, 9-14 Feb 2002.   |

**Supplemental Keywords:** *Great Lakes, coastal wetlands, environmental indicators, community, fish, macroinvertebrate, high energy shorelines, embayment*

**Relevant Web Sites:** <http://glei.nrri.umn.edu>