# DEVELOPMENT OF A BIOLOGICAL INDEX FOR WISCONSIN WETLANDS USING PLANTS AND MACROINVERTEBRATES

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(With financial support Provided by: USEPA & WDNR)

## OBJECTIVES

To Develop a multimetric biological index based on macroinvertebrates and plants for classifying wetlands as to:

1) biological purpose (i.e., biological function)
2) condition (i.e., health & ecological integrity)
3) relative rarity (i.e., systems and species)

## JUSTIFICATION

Wisconsin Administrative Code NR 103.03(1)(e-f) addresses biological function of wetlands, providing for the "protection of habitat for aquatic organisms and resident and transient wildlife".

NR103.03(2)(e) protects "the hydrological and ecological conditions" necessary to support these biota.

Due to the complexity of wetland types in Wisconsin, it was necessary to use narrative water quality criteria in the code. What is needed? – objective, numerical criteria to supplement narrative water quality criteria. The biological index is intended to provide the means to quantify biological condition, and as such can be used to monitor or evaluate wetland preservation, creation, and restoration efforts in a rapid and cost effective manner.

## METHODS

**Field Collections:**

Macroinvertebrates were collected by compositing 3 lipnet sweeps from the perimeter of each wetland. Samples were preserved in 95% Ethanol for delivery to lab.

Plant surveys were conducted on each wetland by wading and making visual estimations of percent cover at two scales; whole wetland and within 18 20x50 cm quadrats spaced equidistantly along 3 transects from shore to 60 cm water depth. Voucher specimens were collected of unknowns.

**Laboratory Procedures:**

Macroinvertebrate samples were distributed in a tray divided into 24 grids, and invertebrates were picked and classed (taxonomic levels varied among groups, but generally was at family level or coarser to provide a practical application) from randomly selected cells until a minimum of 100 organisms had been picked. These data represent the first stage of metrics. Picking continued until all organisms in a sample had been recovered (subsampling of dominant taxa was carried out to reduce processing time). The later set of data represented stage 2 metrics.

Plants generally were identified to a coarse taxonomic level to permit use of metrics by non-botanists.

**Other Field Attributes:**

Water chemistry samples (conductivity, pH, and alkalinity), color, temperature, and depth measurements were taken, and an estimate

## METRIC SELECTION PROCESS

**MACROINVERTEBRATE INDEX:**

- 51 Taxonomic groups (generally Family level, some order).
- 69 Community Attributes Tested (Abundance, richness, or percentage).
- 40 dropped due to insufficient numbers or low frequency of occurrence.
- Response of remaining 19 attributes compared between impacted and least-impacted wetlands.
- 15 Metrics chosen for Index (see Table attached).
- Metric scores assigned by trisection below the 5th percentile. Reference data used for metrics declining with impact; all data used for metrics increasing with impact.
- Adjustments made to compensate for habitat (water) duration.

**PLANT INDEX:**

- Taxonomy Generally at Genus level.
- 24 Community Attributes Tested (Richness, Importance Values, and Percent Cover).
- Removed attributes that occurred too infrequently, and compared the response of the remaining attributes between impacted and least-impacted wetlands.
- 9 Metrics chosen to represent Plant Index (see Table attached).
- Metric scores assigned by trisection method (described above)
- Includes 2 metrics that represent deep-water component to compensate for bias towards emergent community dominant in less persistent wetlands.

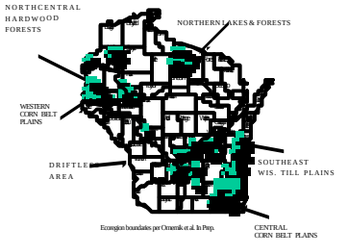
**Example of Data Manipulation**

Response based on UntransformedData

Tri-sectioning After Data Transformation

(N = 103)

## STUDY SITES




Ecoregion boundaries per Omernik et al. In Prep.

## WETLAND STUDY SITES

**Selection: Types – restricted to depressional palustrine wetlands with hydroperiods classed as "seasonally flooded" of different origin and vegetative class.**

**Distribution – 103 wetland basins statewide; 3 major ecoregions; 75% to represent "least-disturbed" natural reference conditions with the balance divided among a combination of restored wetlands and impacted wetlands (different degrees and causes of impact).**

**Study Site Criteria:**

(1) depressional, palustrine, not interconnected with permanent water basin.
(2) Majority unimpacted (or least-impacted").
(3) Temporary standing water (during spring): no fish!
(4) Available access.
(5) Different hydrologic types, hydroperiods, substrates, vegetation types represented.

## METRICS SCORES FOR THE WETLAND PLANT BIOTIC INDEX

| Taxon | Attribute | Response | Score=0 | Score=1 | Score=3 | Score=5 | Adjustments |
|---|---|---|---|---|---|---|---|
| Total Taxa | Abundance | Decrease | 0-1 | 2-8 | 9-16 | >16 | ? |
| Carex spp. | Importance Value (=IV) | Decrease | 0 | < 0.1 | 0.1 - 0.36 | > 0.36 | None |
| Reed Canary Grass | I V | Increase | > 0.5 | > 0.05 - 0.5 | > 0 - 0.05 | 0 | None |
| Cattail | I V | Increase | > 0.25 | 0.03 - 0.25 | > 0 – 0.03 | 0 | None |
| Duckweed | I V | Increase | > 0.6 | 0.2 – 0.6 | > 0 – 0.2 | 0 | None |
| Bluejoint Grass | I V | Decrease | - | 0 | > 0 – 0.05 | > 0.05 | None |
| Giant* Taxa | I V | Decrease | 0 | > 0 – 0.3 | 0.3 – 0.6 | > 0.6 | None |

**Deep Water Community Adjustments ( 1 to 5 maximum based on Pond IV & Floating-leaf / 2)**

| Taxon | Attribute | Response | Score=0 | Score=1 | Score=3 | Score=5 | Adjustments |
|---|---|---|---|---|---|---|---|
| Pondweeds | I V | Optimum | - | 0 | > 0 - 0.12 | 0.12 – 0.4 | None |
| Floating-leaf | Percent | Decrease | - | 0 | > and > 0.4 > 0 – 0.3 | > 0.3 | None |

* "Good" Includes all *Carex, Utricularia, Potamogeton, Leersia, Calamagrostis, Sagittaria, Polygonum,* and *Equisetum* species.

## METRICS SCORES FOR THE WETLAND MACROINVERTEBRATE INDEX

| Taxon | Attribute | Response | Score=0 | Score=1 | Score=3 | Score=5 | Adjustments |
|---|---|---|---|---|---|---|---|
| Mollusks | Abundance | Decrease | 0 | 1-10 | 11-99 | >99 | None |
| Annelids | Abundance | Decrease | - | 0-10 | 11-25 | >25 | None |
| Fairy Shrimp | Abundance | Decrease | - | 0-8 | 9-25 | >25 | Duration |
| Non-Insects | Richness | Decrease | 0 | 1-2 | 3-5 | >5 | Prairies? |
| Damselflies | Abundance | Decrease | 0 | 1-2 | 3-15 | > 15 | Kettles? |
| Pigmy B.S. | Abundance | Increase | 0 | 1-2&>100 | 3-5&11-99 | 6-10 | Duration |
| Boatmen | Abundance | Decrease | 0 | 1-4 | 5-10 | > 10 | None |
| Limnephilid | Abundance | Decrease | 0 | 1-10 | 11-50 | > 50 | ? |
| Caddisflies | Abundance | Decrease | 0 | 10 | 11-60 | > 60 | Duration? |
| Caddisflies | Percentage | Decrease | 0 | < 8% | 8-15% | > 15% | Redundant? |
| Phantom M. | Abundance | Decrease | 0 | 1-8 | 9-25 | > 25 | Duration |
| Mosquitoes | Abundance | Decrease | 0 | 1-10 | 11-99 | >100 | Duration? |
| Soldier Flies | Abundance | Increase | - | > 25 | 8-24 | < 7 | Duration |
| Total Invert | Abundance | Decrease | < 150 | 150-500 | 500-1500 | > 1500 | None |
| Total Taxa | Richness | Decrease | < 5 | 6-11 | 12-19 | > 19 | K vs. P? |

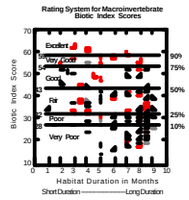
## METRIC RATING SYSTEM

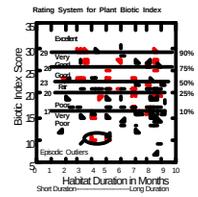
- Metric Rating lines were drawn based on the distribution of scores among the Least-disturbed Reference wetlands (designated by red stars).

  N=31 for Invert Biotic Index;
  N=29 for Plant Biotic Index.

- Six Ratings levels were assigned, ranging from "poor" to "excellent" using the 10, 25, 50, 75, and 90% percentiles (See Figures).

- Habitat Duration refers to the average number of months that a wetland holds surface water during the ice-free season (9.5 months represents permanent waterbodies).

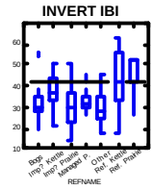


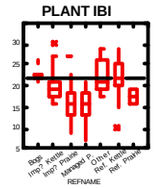




## METRIC PERFORMANCE

The **Macroinvertebrate Biotic Index** performed well in separating reference wetlands from wetlands suspected to have been impacted. Some 'impacted' wetlands were minimally influenced by nearby roads or agricultural runoff and therefore scored better than some 'reference' wetlands that may have been moderately impacted by unknown stressors. Bogs and other wetland types may require a different set of metrics based on their poor ratings using the current IBI.

The **Plant Biotic Index** demonstrated a clear separation between reference kettle wetlands and kettles suspected to have been impacted. The plant communities in the reference prairie type wetlands did not rate differently than counterpart impacted or managed wetlands. This may result from previous disturbance and lack of recovery (most reference prairie wetlands in the region have been disturbed historically). Bogs and 'other' wetland types had scores relatively similar to that of the reference wetlands.




## FUTURE DIRECTIONS & ONGOING STUDIES

- **Conduct Additional Testing & Refinement of Macroinvertebrate and Plant Biotic Indices.**
- **Develop a Training Program for agency staff to implement application of IBIs in wetland assessments.**
- **Development of tools/methods for assessment of wet soil wetlands.**
- **Expansion of communities to include:**

  DIATOMS
  ZOOPLANKTON
  AMPHIBIANS
  SMALL MAMMALS

Evening Frog & Toad Calling Surveys