

US EPA ARCHIVE DOCUMENT

Evaluation of the Lake
Macroinvertebrate Integrity Index
(LMII) and Alternate Indices for
Eastern US Lakes and
Reservoirs

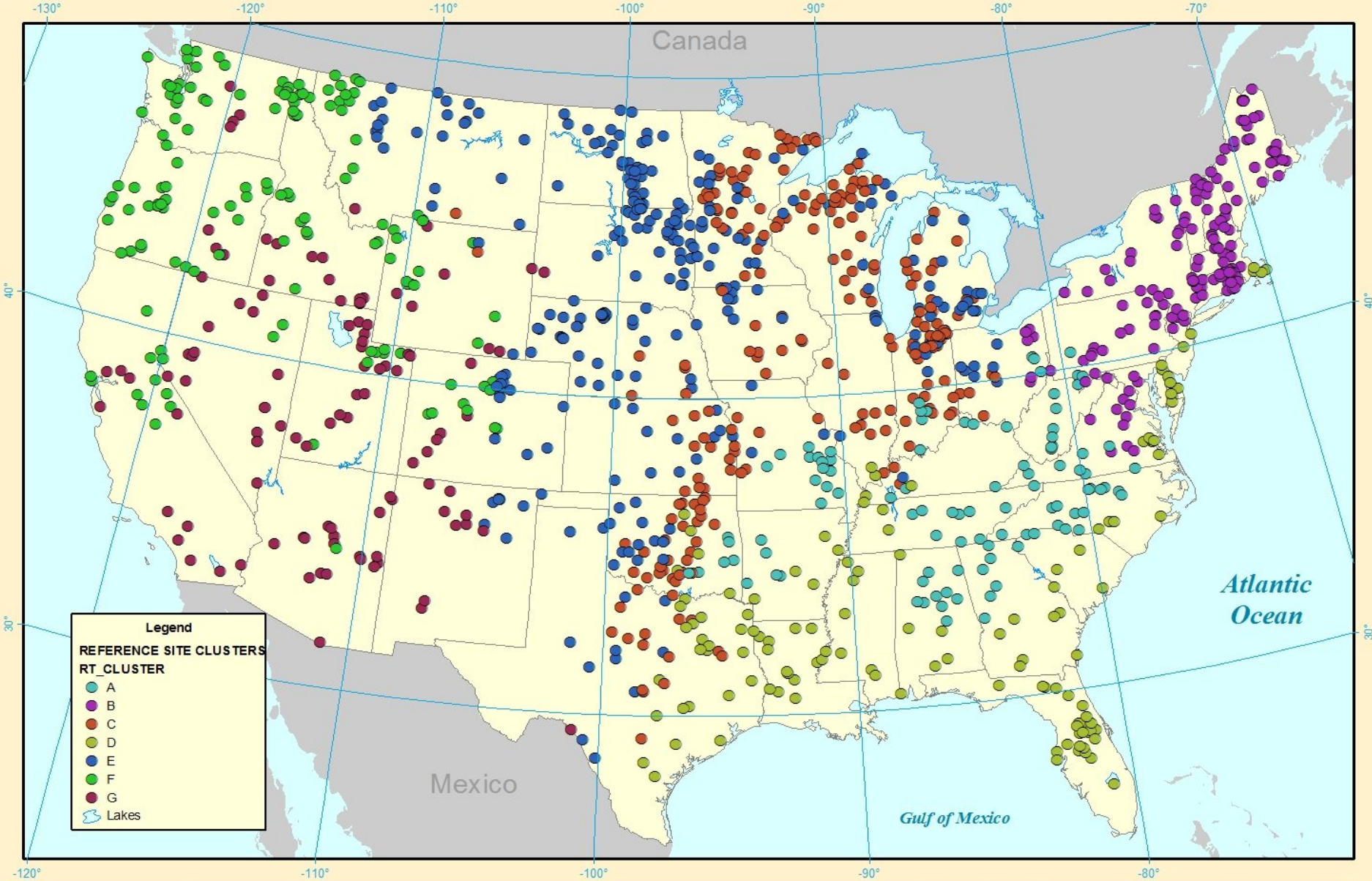
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USEPA, Region II; Karen
Blocksom, USEPA, NHEE,
Corvallis, OR; Frank Borsuk,
USEPA, Region III

Objectives

- Field validate a Lake Macroinvertebrate Integrity Index (LMII)
- Determine relationships between the LMII, water quality, and physical habitat
- Examine the regional applicability of the LMII
- Examine alternate indices using candidate metrics

Lake Sites for LMII





Legend

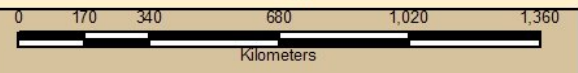
REFERENCE SITE CLUSTERS

RT_CLUSTER

- A
- B
- C
- D
- E
- F
- G

Lakes

NLA Reference Clusters



Albers Projection
 Central Meridian: -96
 1st Std Parallel: 20
 2nd Std Parallel: 60
 Latitude of Origin: 40





Field Collection

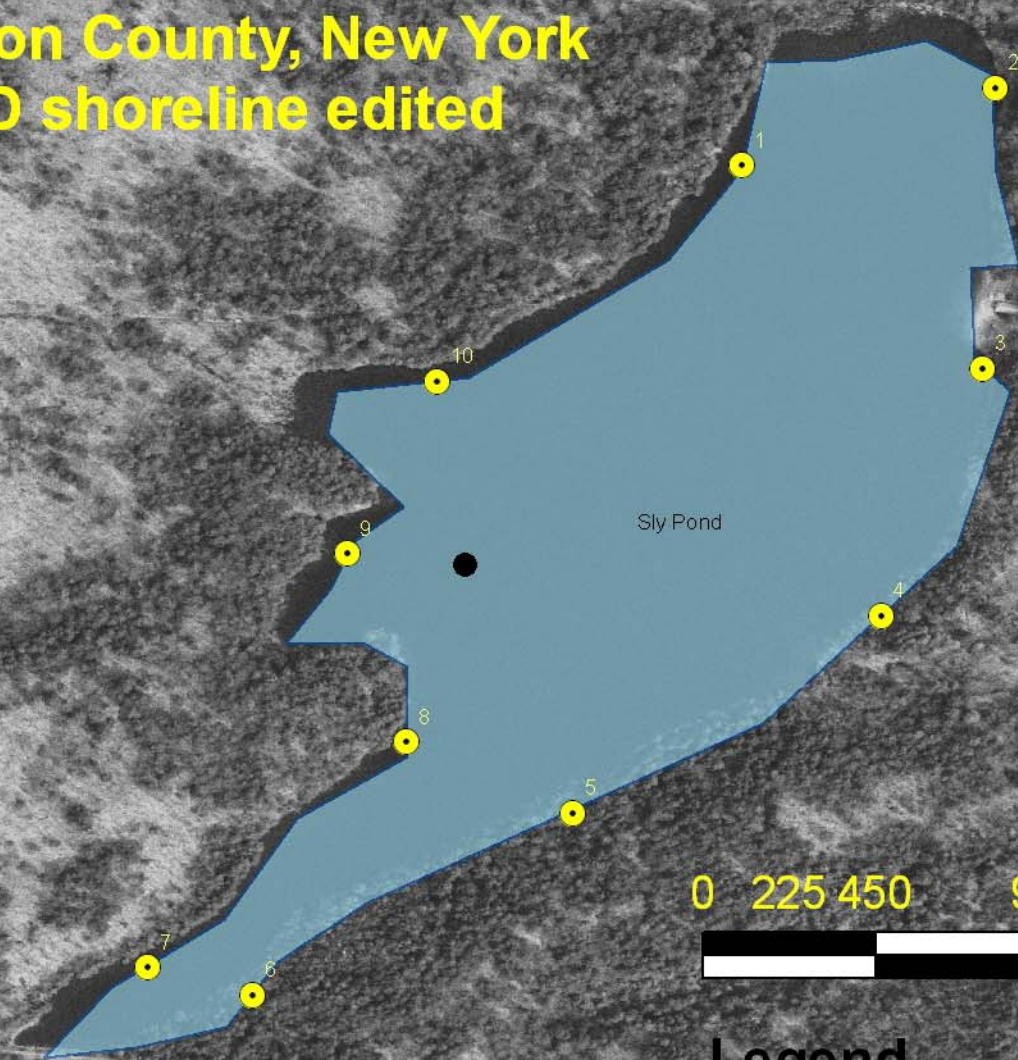
- Sublittoral benthic macroinvertebrate assemblage
- Petite ponar grab samples
- Ten randomly selected sites and composited into a single sample
- Samples wet sieved through wash bucket with 500 μ m screen
- Specimens preserved with 95% ethanol or 10% formalin

NLA06608-1333

Sly Pond

Washington County, New York

Note: NHD shoreline edited



Legend

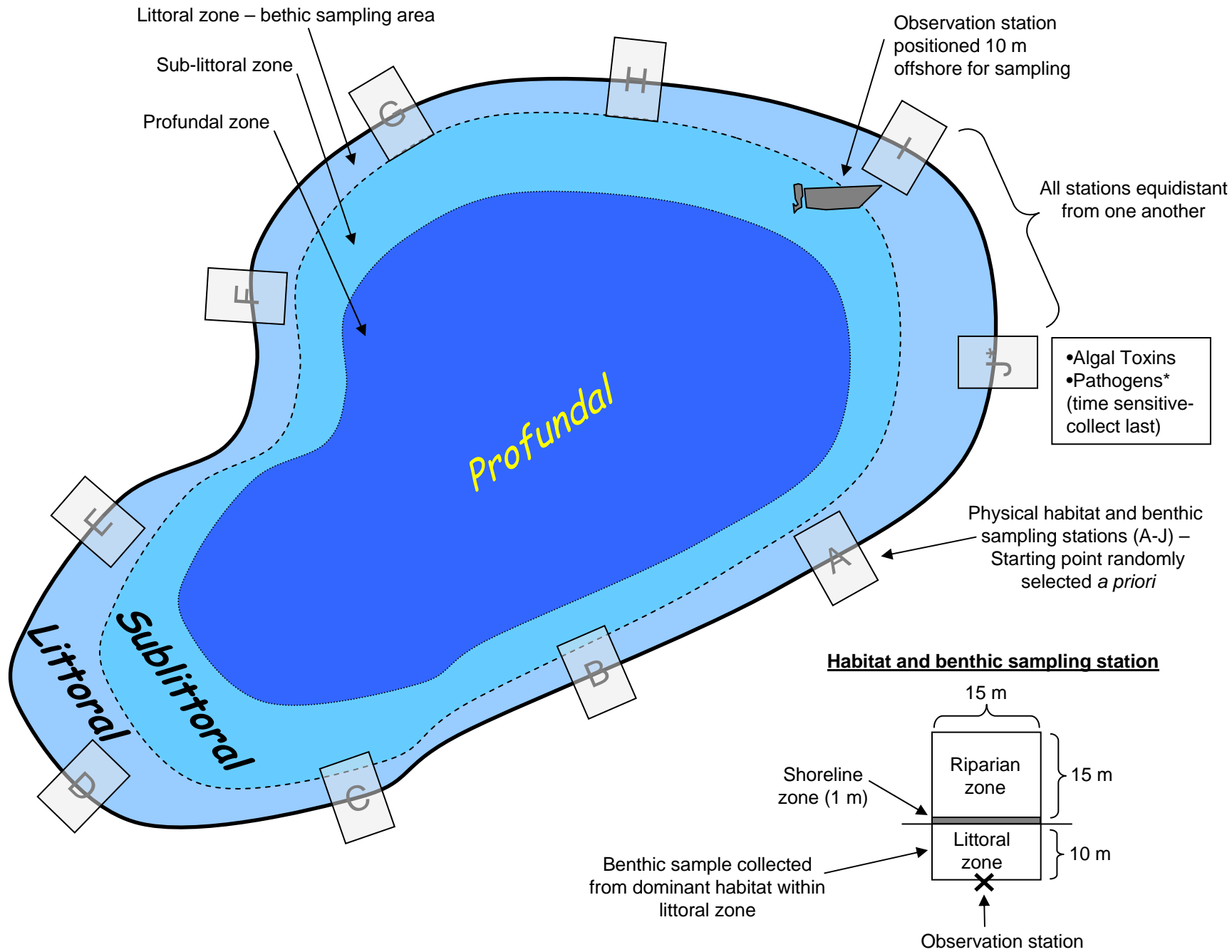


Proposed phab stations



Proposed Water Body with NHD shoreline





Littoral zone – benthic sampling area

Sub-littoral zone

Profundal zone

Observation station positioned 10 m offshore for sampling

All stations equidistant from one another

- Algal Toxins
- Pathogens* (time sensitive- collect last)

Physical habitat and benthic sampling stations (A-J) – Starting point randomly selected *a priori*

Habitat and benthic sampling station

15 m

Shoreline zone (1 m)

Riparian zone

15 m

Littoral zone

10 m

Benthic sample collected from dominant habitat within littoral zone

Observation station

Profundal

Littoral

Sublittoral



TRACKER

NJDEP LAKES UNIT NJ36206R



Evaluated in Littoral Shoreline Habitat Survey

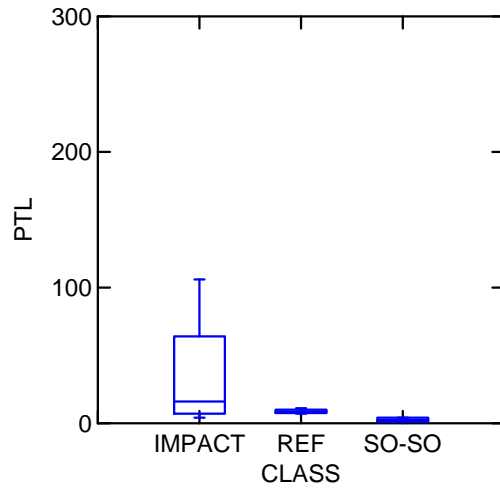
- Depth, Surface Characteristics
 - Substrate -- Bottom & Shoreline
 - Littoral Aquatic Macrophytes
 - Fish Cover
 - Riparian Vegetation Structure & Cover
 - Human Landuse & Disturbances
 - Bank Characteristics & Level Fluctuations
- 
- A person wearing a hat and a life vest is kayaking in a blue kayak on a calm blue lake. The background features a dense forest of evergreen trees covering a mountain range under a clear blue sky. A small island with several tall evergreen trees is visible in the middle ground.

Data Analysis (NLA Environmental Data): Step 1

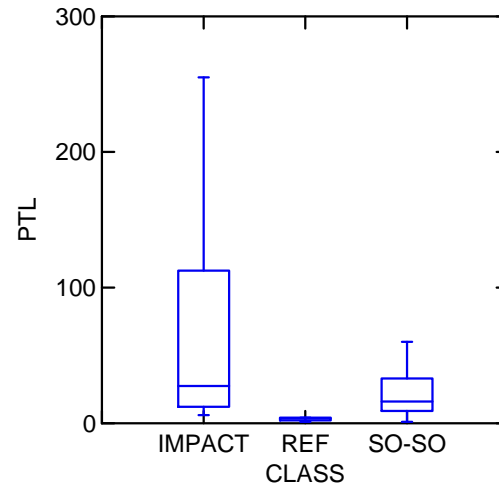
- Box plots of environmental variables (water chemistry and physical habitat) by NLA impairment class
- 22 parameters differed significantly between reference and impacted lakes

Total Phosphorus (ug/L)

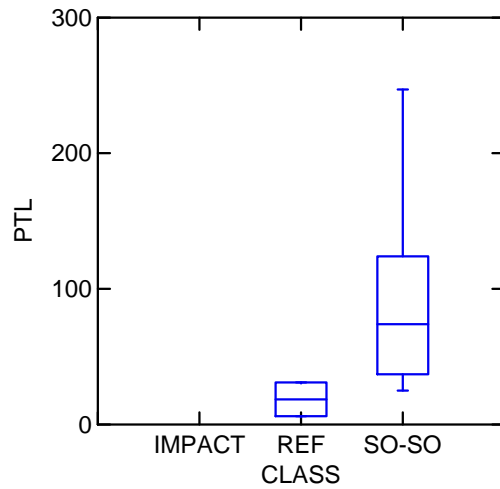
A



B

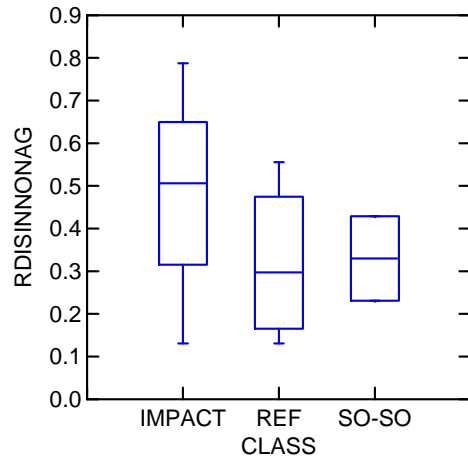


D

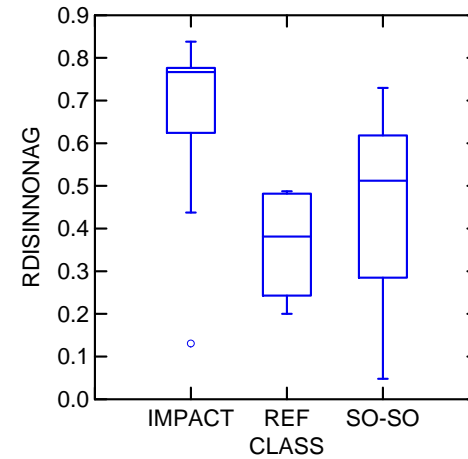


Riparian Non-Agricultural Disturbance Intensity Index

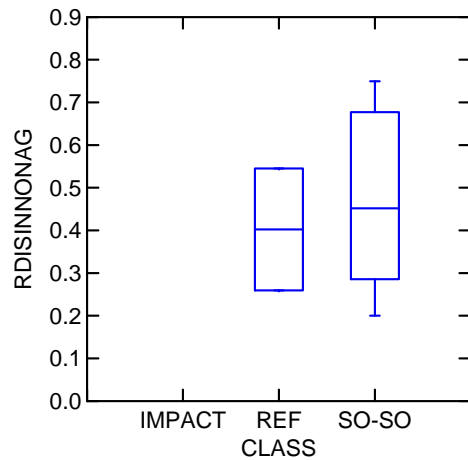
A



B



D



Original LMII Metrics

- Number of Diptera taxa
- Percent chironomid individuals
- Percent oligochaetes/leeches
- Percent collector-gatherer taxa
- HBI

Data Analysis (Index Evaluation): Step 2

- LMII scores were analyzed for their ability to discriminate between lakes of differing NLA impairment status and by their relationships to known physical, chemical, and land use gradients
- LMII performance was poor
- There were generally few significant relationships

LMII

Score = 1

Metrics:

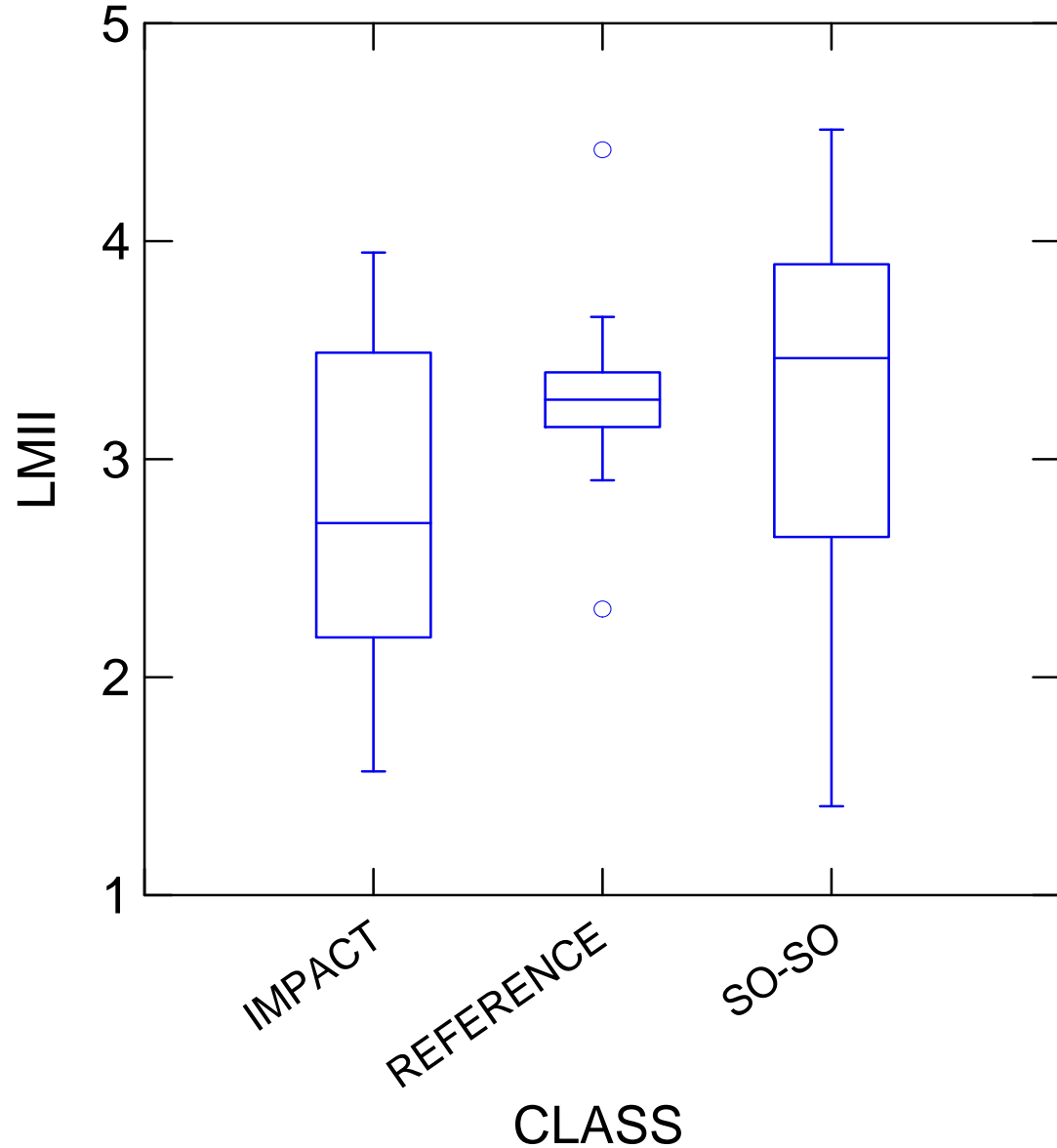
Diptera Taxa

% Chironomid
Individuals

HBI

% Oligochaetes &
Leeches

% Collector-Gatherer
Taxa

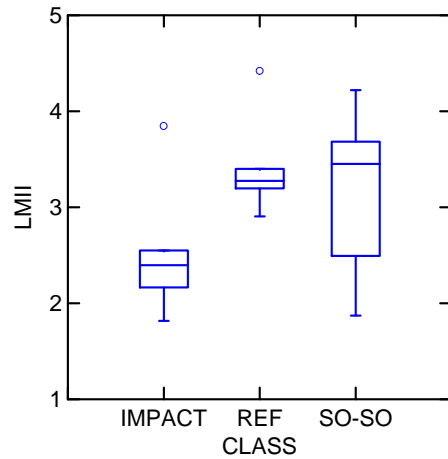


Data Analysis: Step 3

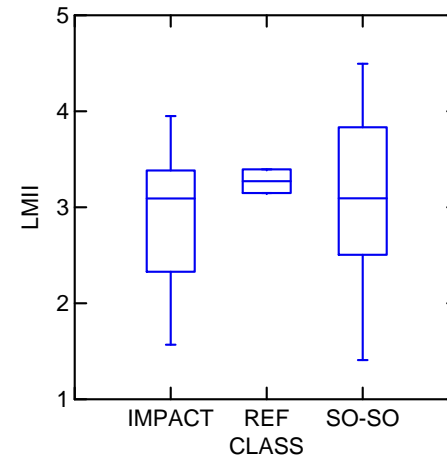
- LMII and sediment categories, lake conductivity, and lake origin
- LMII appeared to perform well for intermediate sediments and worse for muck and sand sediments
- LMII generally performed better on hard versus soft lakes
- Natural lakes had higher LMII scores than reservoirs

LMII

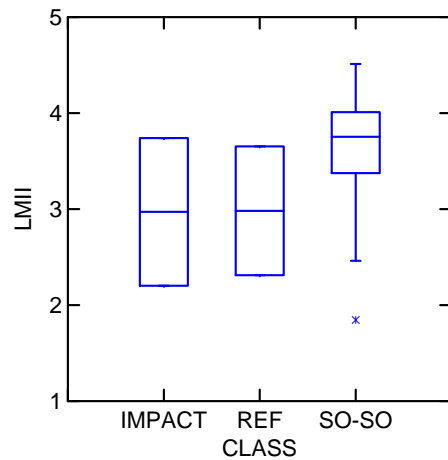
Intermediate



Muck



Sand



LMII Scores:

Intermediate = 3

Muck = 1

Sand = 0

July 2009:
LMII Analysis by Lake
Conductivity Type

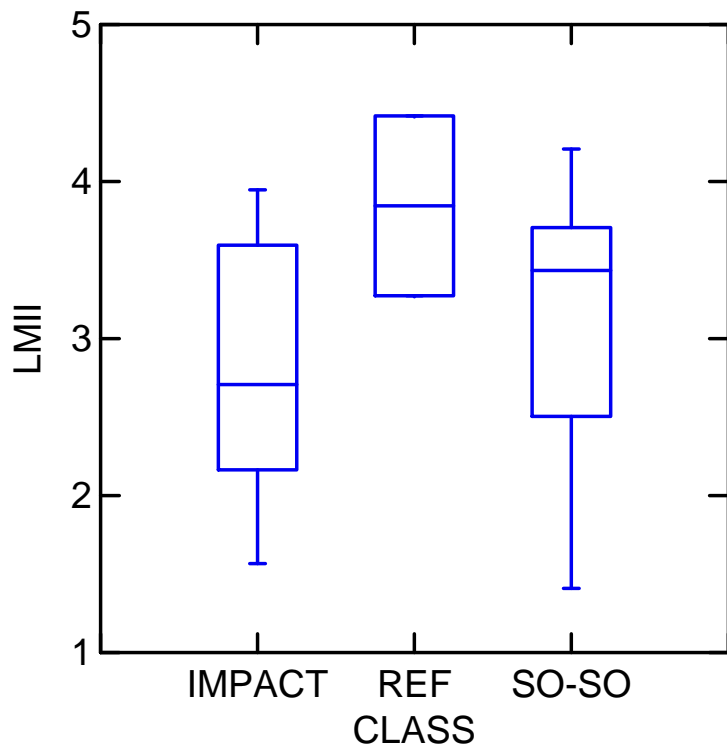
Hard Lakes ≤ 100

Soft Lakes < 100

(Units: $\mu\text{S}/\text{cm}$ @ 25 C)

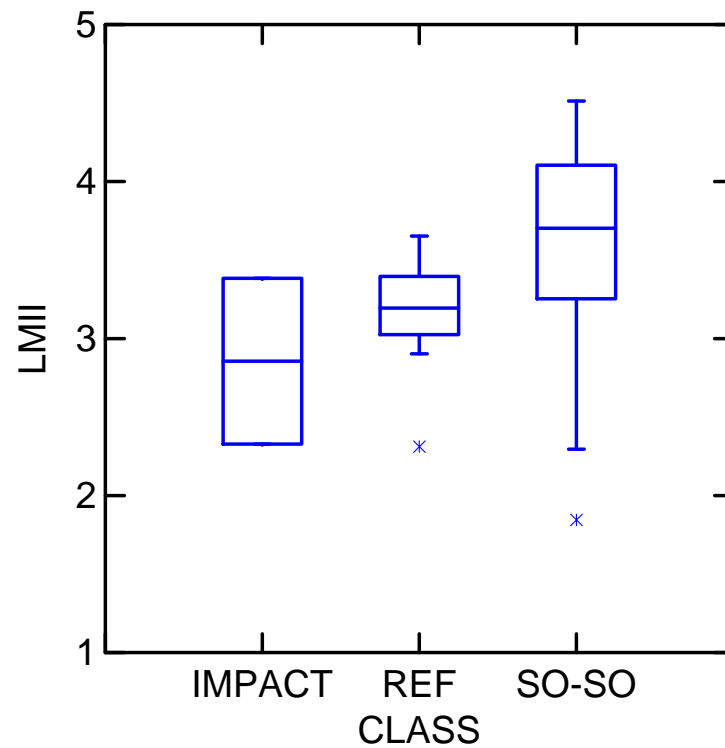
LMII

Hard

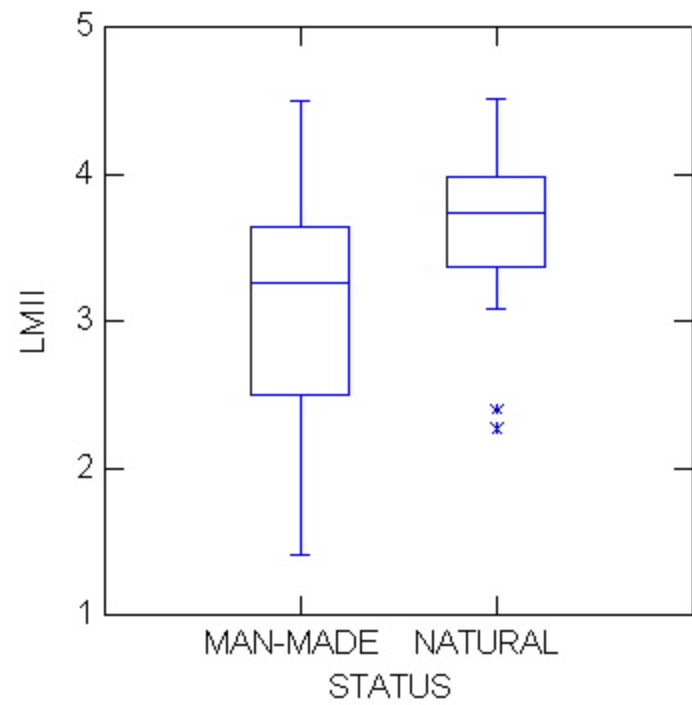


Score = 2

Soft



Score = 1



30 Additional Metrics Evaluated for Alternate Indices

- Richness measures (e.g., total number of taxa)
- Tolerance measures (e.g., % intolerant taxa)
- Composition measures (e.g., % non-insects)
- Trophic measures (e.g., % predator taxa)

Analysis of Candidate Metrics: Step 4

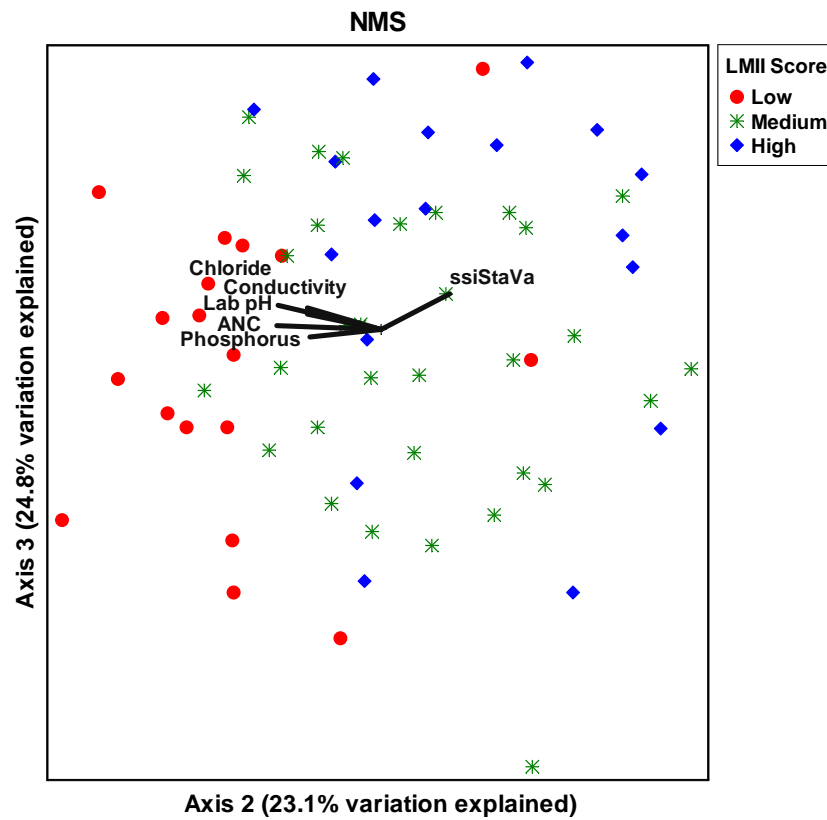
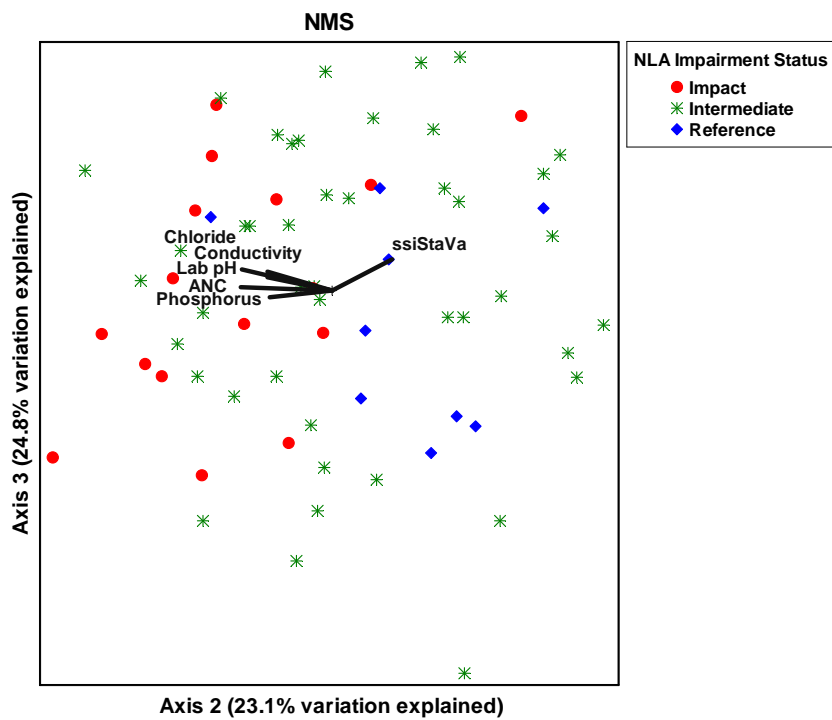
- Box plots used to link metric scores to NLA environmental variables, including sediment categories
- Principal components analysis used to detect major patterns of environmental variation
- Spearman Rank correlations used to determine strength of associations
- Non-metric multidimensional scaling (NMS) used to look at species gradient with environmental joint plot overlays

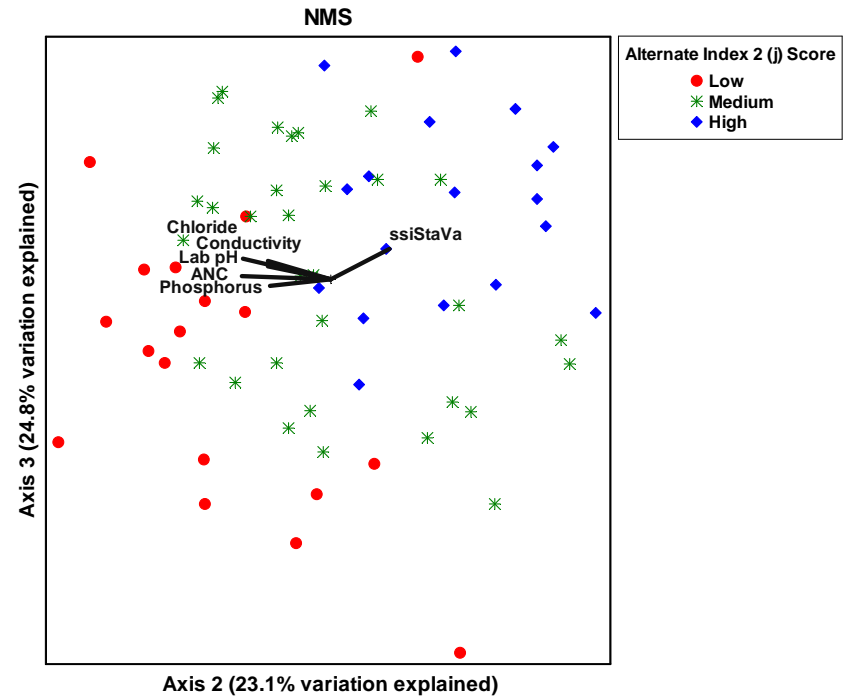
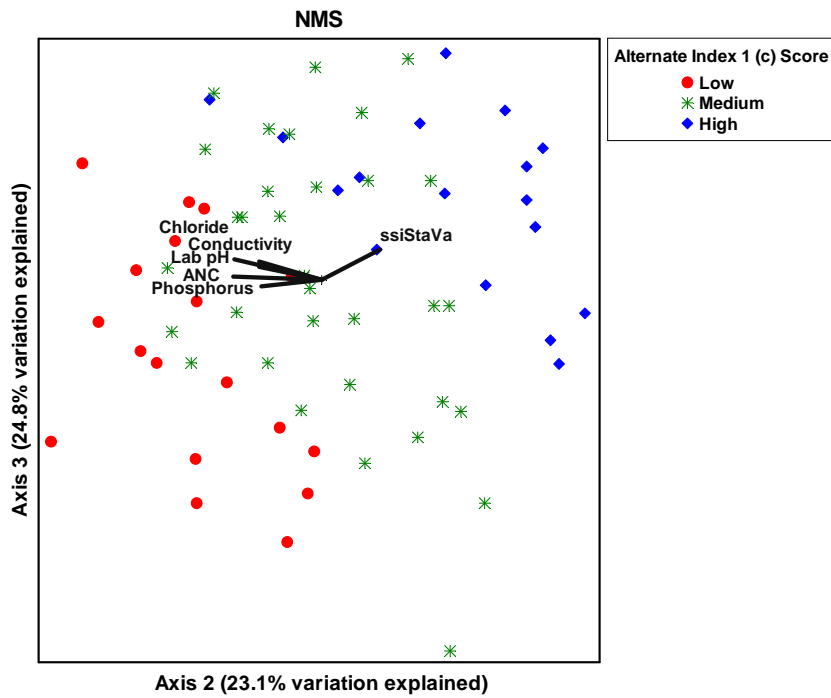
Criteria for the Selection of Metrics for Alternate Index Development

- Distributional relevance
- Discriminatory power
- Relationships to stressors
- Lack of redundancy

Results

- High overlap in lake impairment designations
- Discrimination of high impacted lakes but little differentiation of reference and intermediate impacted lakes
- NMS output and Spearman correlations linked macroinvertebrate composition to water chemistry and substrate gradients, revealing stronger linkages to both alternate indices than to the original LMII
- LMII worked well in Region 2 but environmental linkages were limited; Region 3 performance was poor





Alt. Index 1

Score = 3

Metrics:

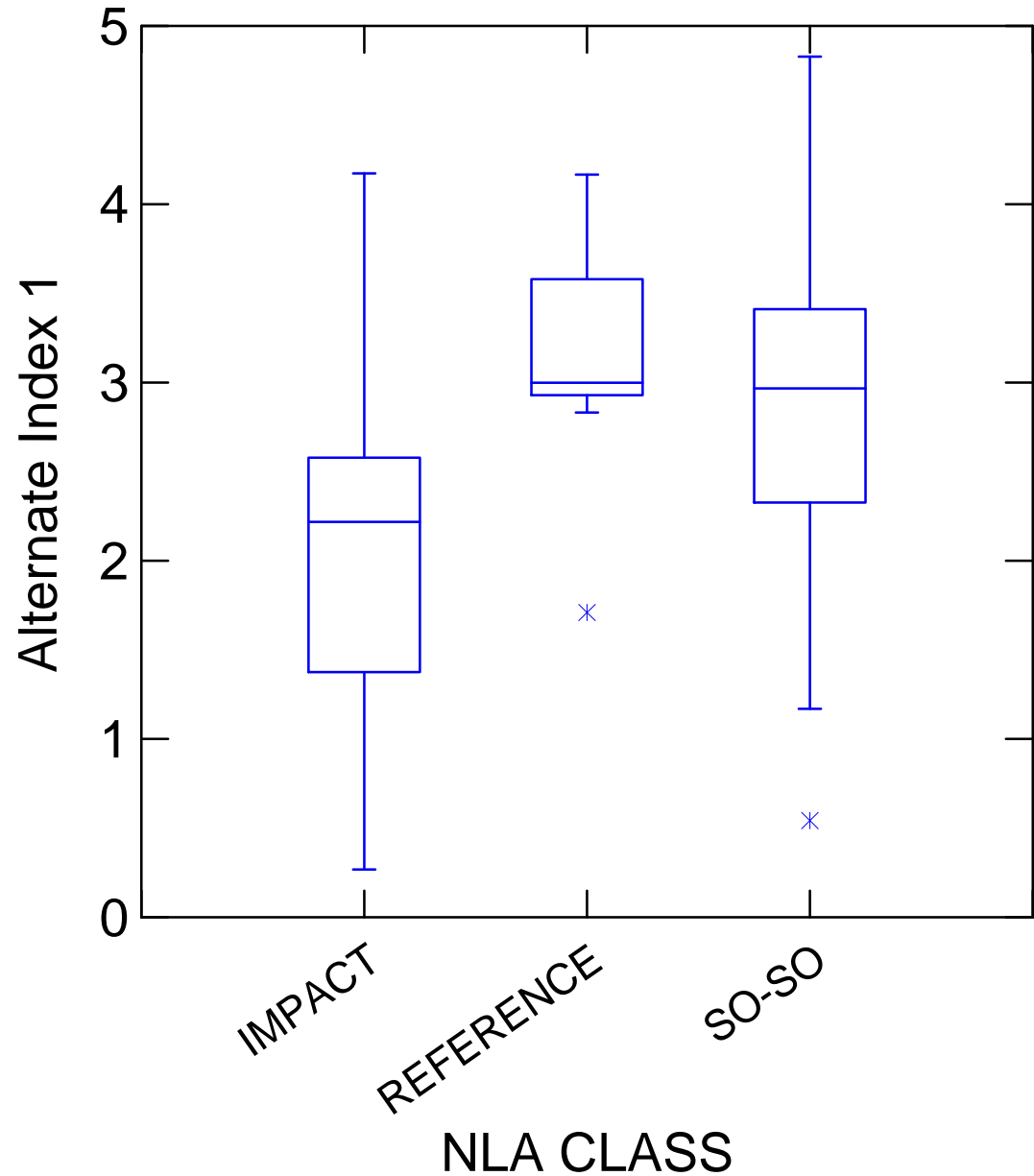
ASPT

HBI

Predator Taxa

Facultative Taxa

Tolerant Individuals



Alt. Index 2b

Score = 3

Metrics:

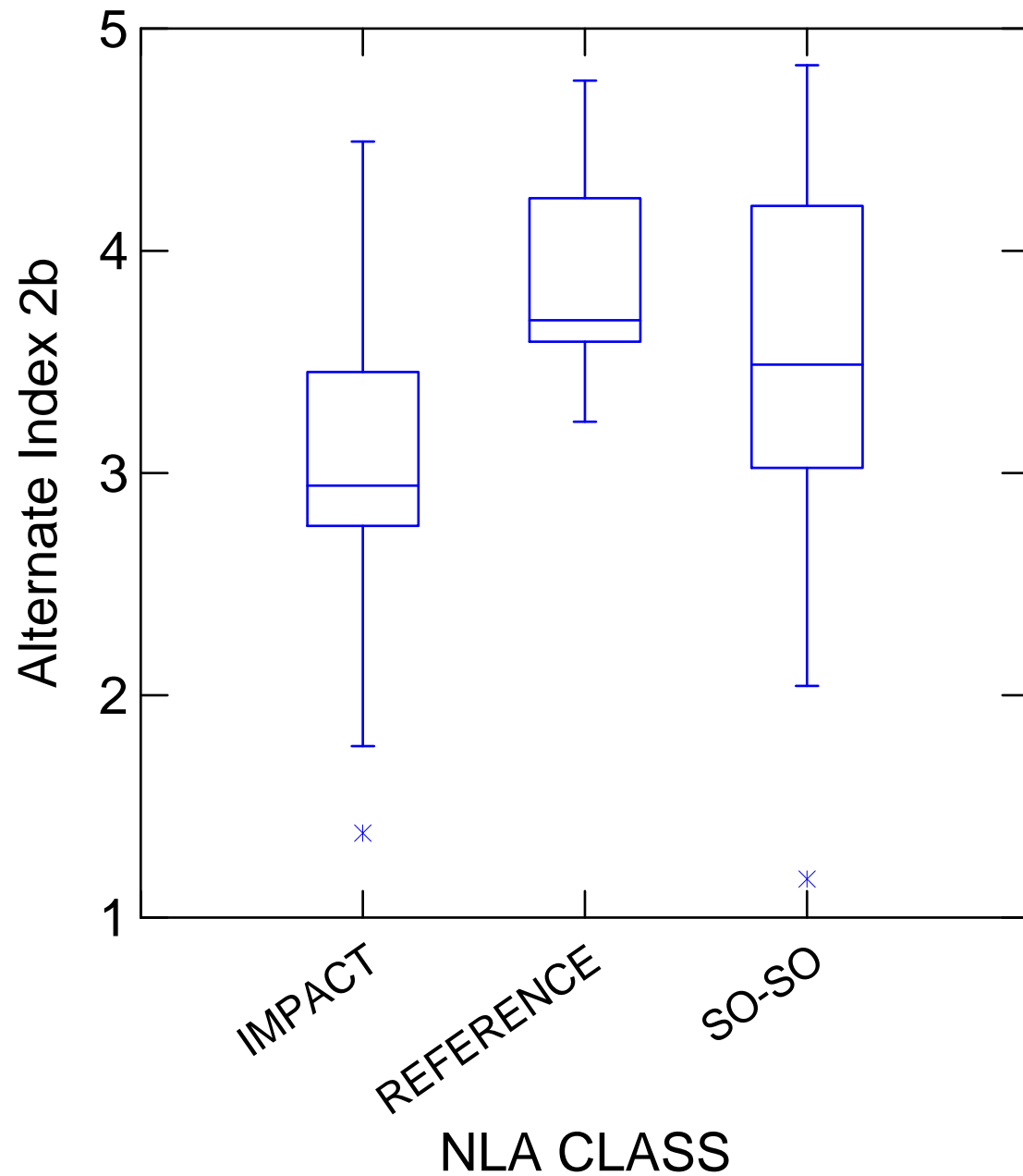
HBI

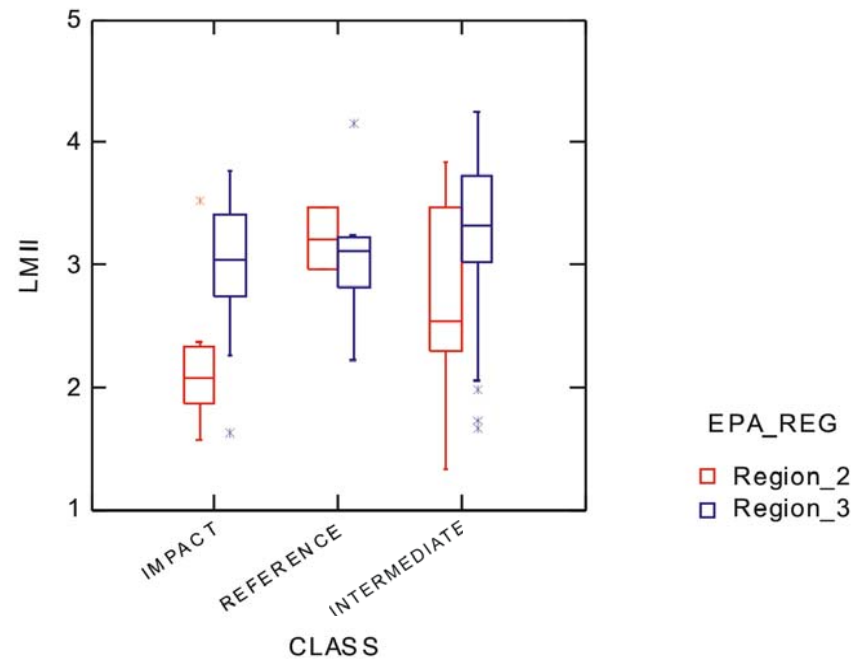
Chironomid Taxa

**# Individuals per
Taxon**

Predator Taxa

Simpson Diversity





Conclusions

- Original LMII performed poorly for lakes across the study area
- Alternate indices performed better for lakes across the study area
- Data variability could be attributed to the broad typology of lakes included in the NLA

Recommendation

- In conjunction with the development of an assessment system, we must develop a better understanding of the natural environmental variables lake benthic macroinvertebrates respond to (e.g., sediment type, water chemical and physical characteristics, morphometric factors and lake origin)