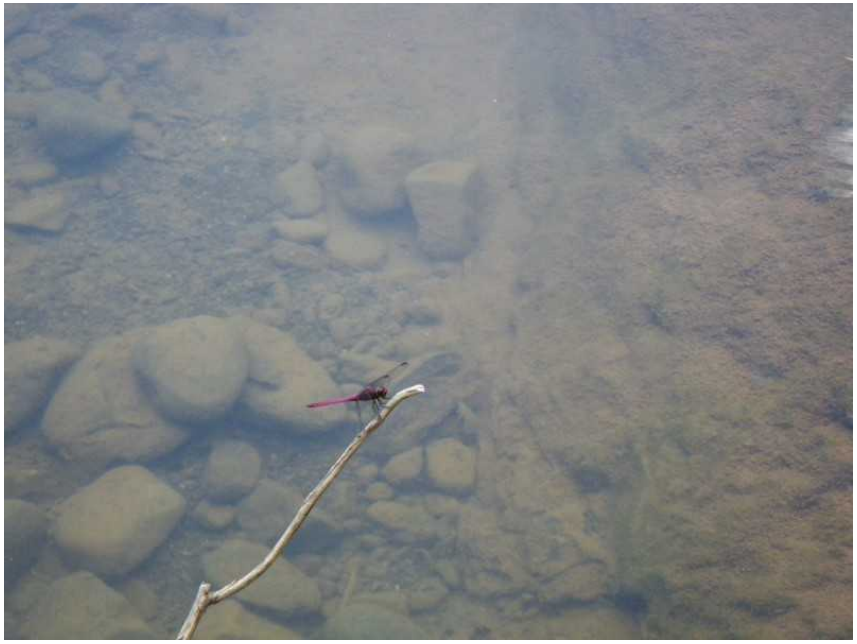
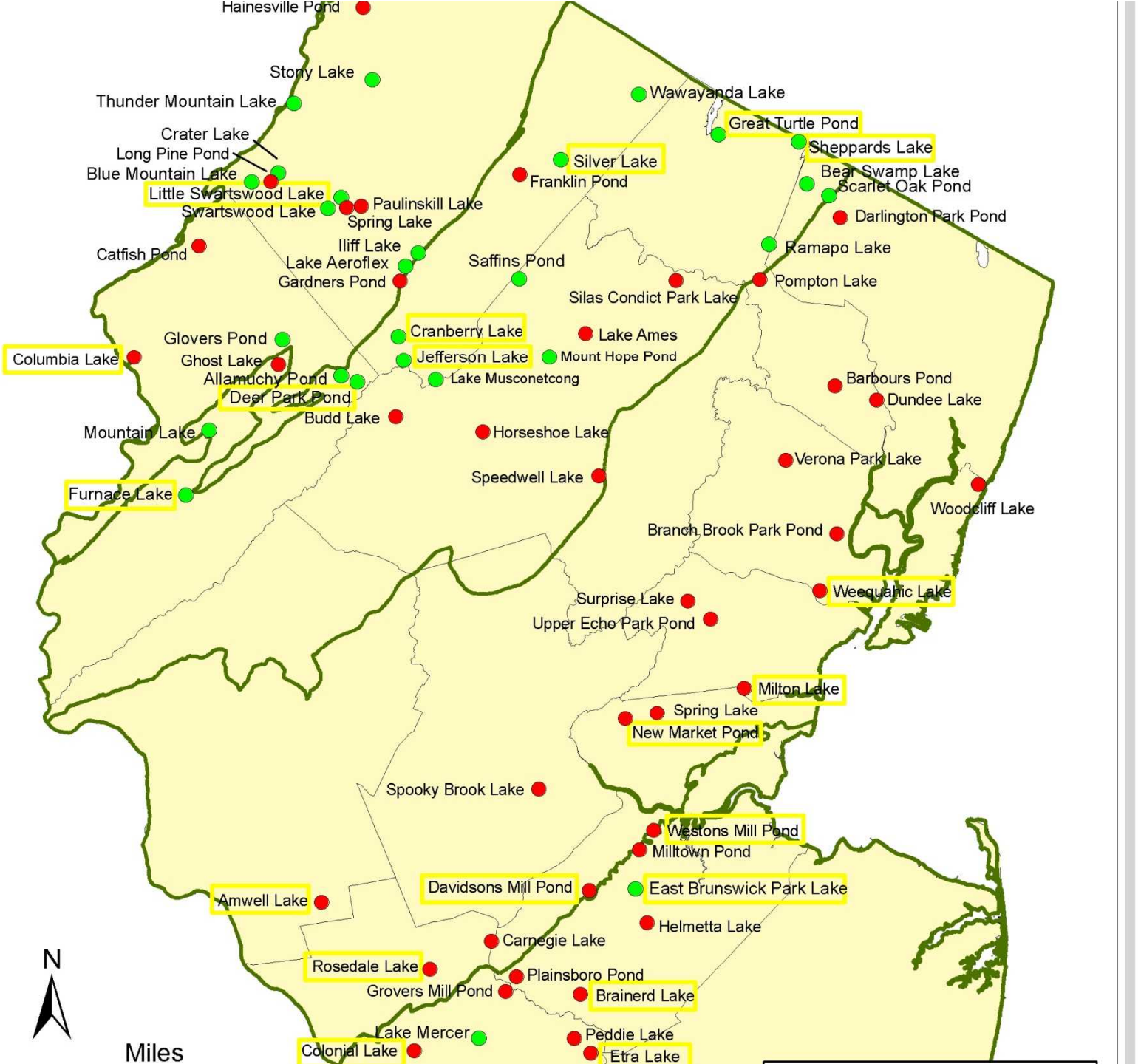
Evaluation of Sublittoral and Littoral Indexes of Macroinvertebrate Integrity for Southern New England and Mid-Atlantic Lakes - J. Kurtenbach, USEPA

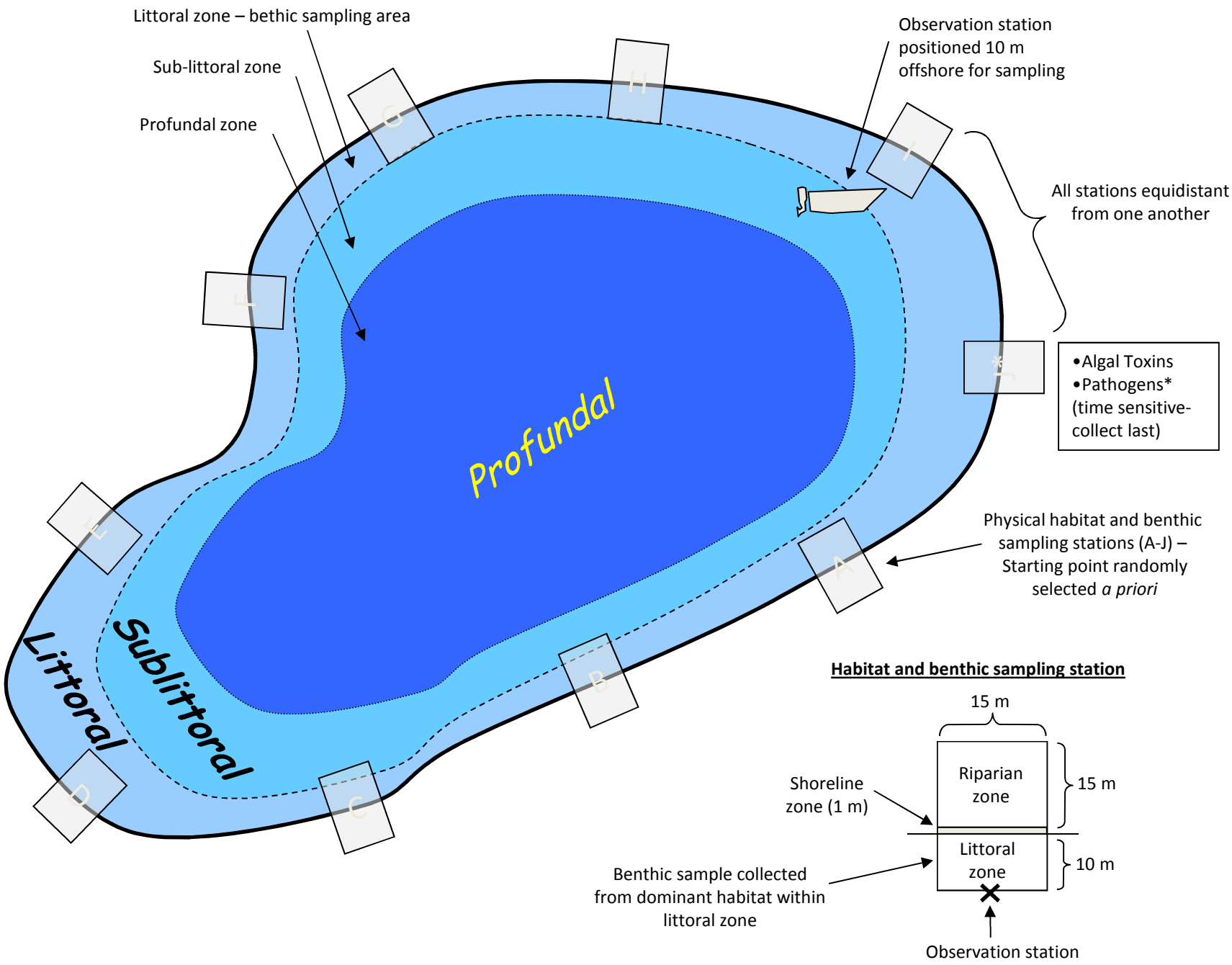
Objective: Compare recently developed sublittoral and littoral multimetric indexes for relationships with common lake stressors



Lakes Background

- Northern and Central New Jersey
- Natural lakes and impoundments
- Lake size (10 to 200 acres)
- Maximum depth (3 to 10 meters)


Hainesville Pond
Stony Lake
Thunder Mountain Lake
Crater Lake
Long Pine Pond
Blue Mountain Lake
Little Swartswood Lake
Swartswood Lake
Paulinskill Lake
Spring Lake
Catfish Pond
Iliff Lake
Lake Aeroflex
Gardners Pond
Saffins Pond
Silver Lake
Franklin Pond
Wawayanda Lake
Great Turtle Pond
Sheppards Lake
Bear Swamp Lake
Scarlet Oak Pond
Darlington Park Pond
Ramapo Lake
Pompton Lake
Silas Condict Park Lake
Glovers Pond
Columbia Lake
Ghost Lake
Allamuchy Pond
Deer Park Pond
Budd Lake
Mountain Lake
Furnace Lake
Cranberry Lake
Jefferson Lake
Lake Musconetcong
Lake Ames
Mount Hope Pond
Horseshoe Lake
Speedwell Lake
Barbours Pond
Dundee Lake
Verona Park Lake
Woodcliff Lake
Branch Brook Park Pond
Weequahic Lake
Surprise Lake
Upper Echo Park Pond
Milton Lake
Spring Lake
New Market Pond
Spooky Brook Lake
Westons Mill Pond
Milltown Pond
Davidsons Mill Pond
East Brunswick Park Lake
Helmetta Lake
Amwell Lake
Carnegie Lake
Rosedale Lake
Plainsboro Pond
Grovers Mill Pond
Brainerd Lake
Lake Mercer
Colonial Lake
Peddie Lake
Etra Lake
N
Miles


Littoral zone – bethic 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)
Profundal
Sublittoral
Littoral
Physical habitat and benthic sampling stations (A-J) – Starting point randomly selected *a priori*
Habitat and benthic sampling station
15 m
Riparian zone
15 m
Shoreline zone (1 m)
Littoral zone
10 m
Benthic sample collected from dominant habitat within littoral zone
Observation station

Benthic Macroinvertebrate Field Collection

- Sub-littoral macroinvertebrate assemblage
- Petite ponar grab samples
- Ten randomly-selected locations, composited into a single sample
- Samples wet sieved through wash bucket with 500-*u*m screen
- Specimens preserved with 10% buffered formalin
- 100 organism sub-count for lab identification

Benthic Macroinvertebrate Results

- Development of a lake macroinvertebrate integrity index (LMII) – Blocksom et al. (2002)
- Comprised of 5 metrics (# diptera taxa, % chironomid individuals, % oligochaetes/leeches, % collector-gatherer taxa, and Hilsenhoff biotic index

Development of a regional littoral benthic macroinvertebrate multi-metric index (MMI) for lakes from the National Lakes Assessment

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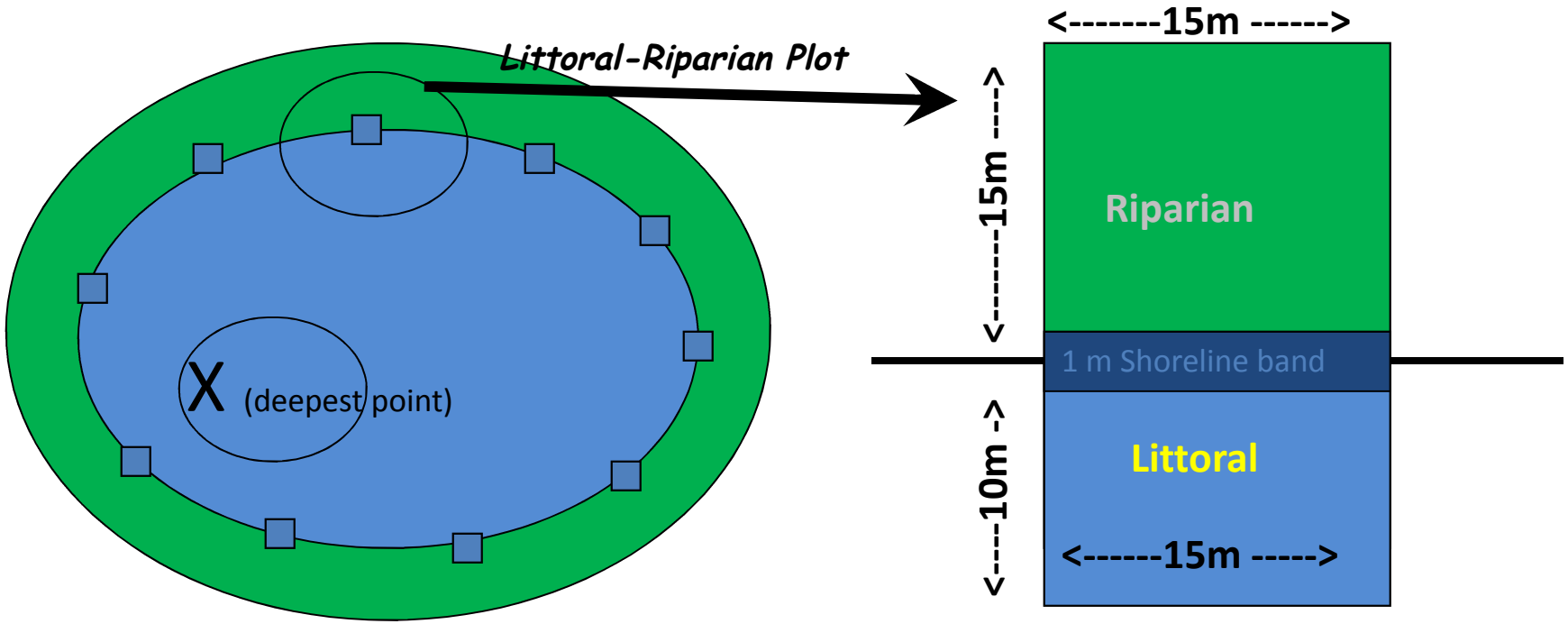
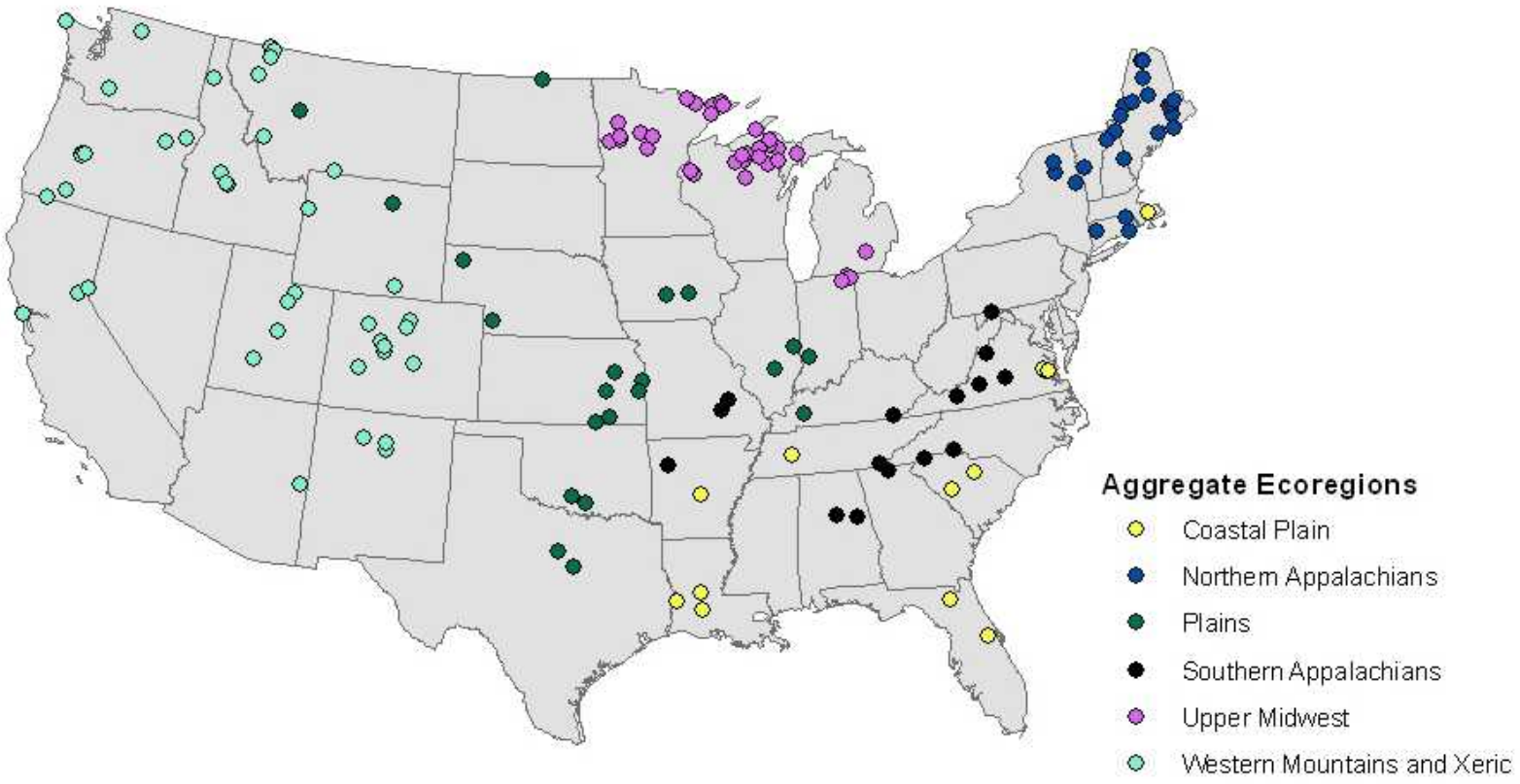
[1](USEPA, OWOW, Washington, DC), [2](Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR), [3](USEPA, ORD, Corvallis, OR)

Sampling Design within Lakes

- 10 Randomized, evenly-spaced shoreline plots
- 1m long sweep of littoral substrate using D-frame net
- Composite sample



Reference Sites for Benthic Macroinvertebrate MMI



MMI Development

- Each regional MMI contained one metric from each of the biotic integrity categories
  - Richness
  - Composition
  - Functional feeding Group
  - Habitat
  - Tolerance
  - Diversity (was not used in WMX, CPL, NAP, UMW)
- Metrics were selected on how well it performed
  - F-test
  - signal to noise ratio
  - Visually evaluate metrics with good F-test
  - Example metrics; total richness, burrower richness, climber richness, intolerant taxa, percent of top five dominate taxa

MMI Development

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  - F-test
  - signal to noise ratio
  - Visually evaluate metrics with good F-test
  - Example metrics; total richness, burrower richness, climber richness, intolerant taxa, percent of top five dominate taxa
- Metrics were scored on a scale of 0 to 10
- Metrics were combined/summed, final MMI scale ranges from 0 to 100

National Lakes Assessment is the latest National Aquatic Resource Survey

- First-ever nationally-consistent assessment of the nation's lakes, ponds and reservoirs
  - Biological and habitat condition
  - Recreational condition
  - Trophic state
- The 1,028 unique lakes sampled – plus 124 hand-selected reference lakes, and 100 resample visits – describe the condition of about 50,000 lakes nationwide

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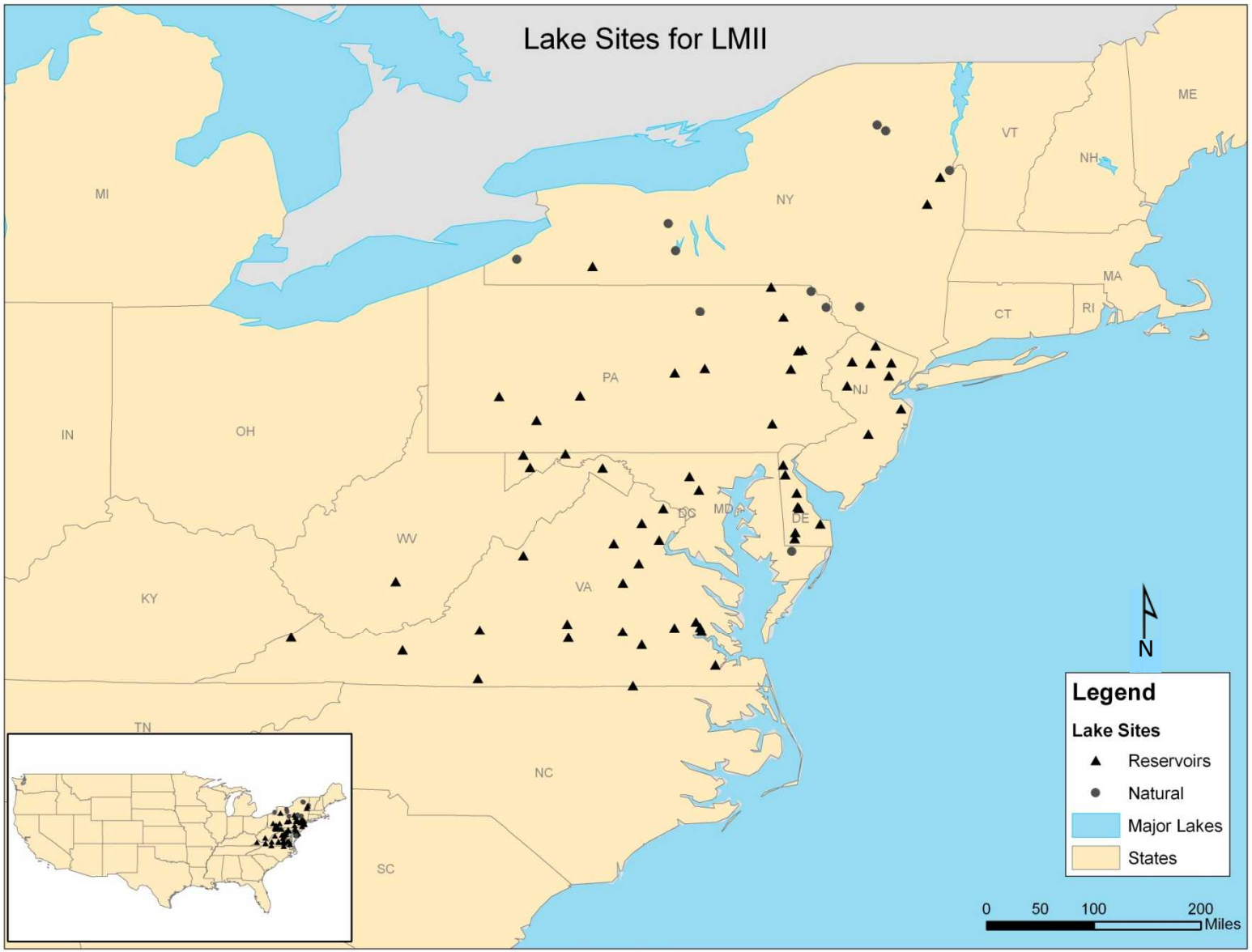

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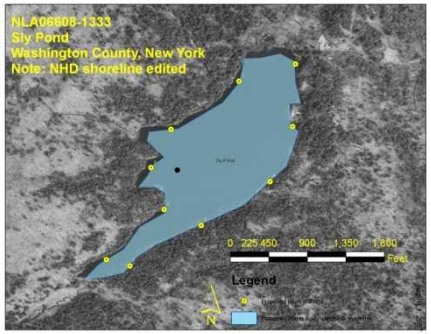
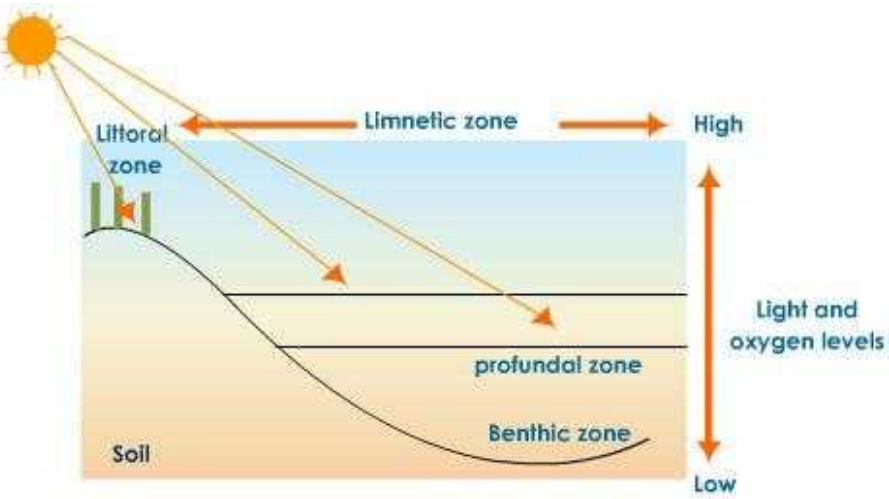


Lake Data Collected

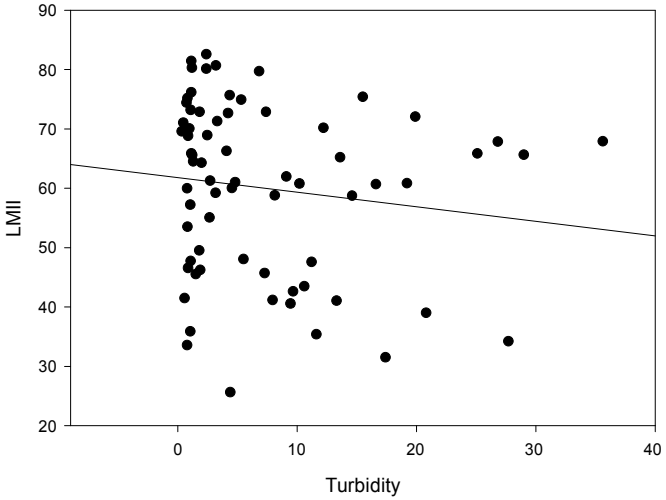
- *Riparian Zone:* Habitat, Substrate, Macrophytes
- *Littoral Zone:* Habitat, Substrate, Macrophytes, NLA Benthos Sampling
- *Sub-littoral Zone:* Region/State Benthos Sampling
- *Profundal Zone:* Water
- Land Use/Disturbance (
- Lake Level Fluctuations



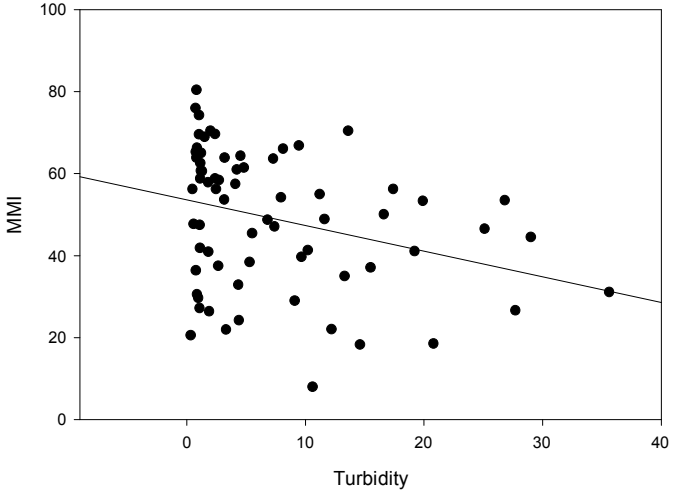
Results: LMII and MMI response to specific stressors

Turbidity

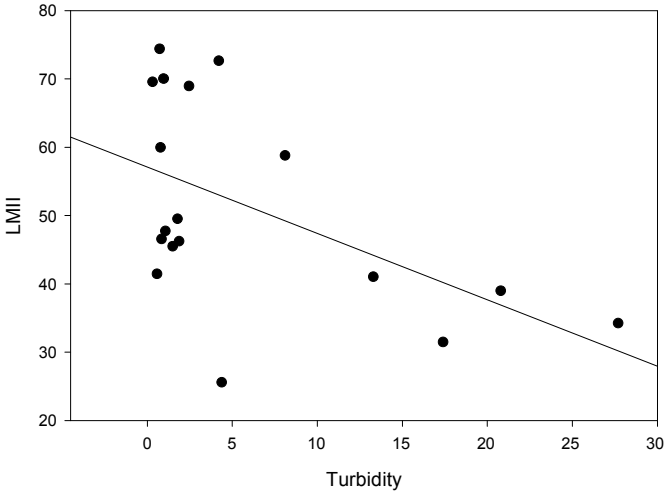
Turbidity vs LMII (r = -0.177; p = 0.146)



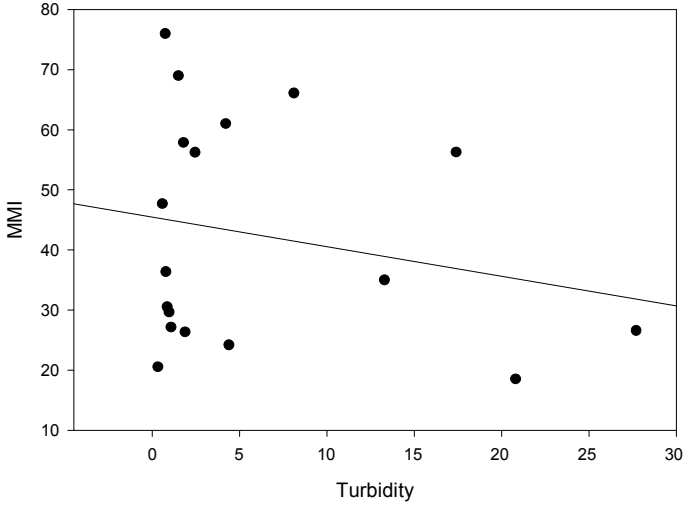
Turbidity vs MMI (r = -0.321; p = 0.00728)



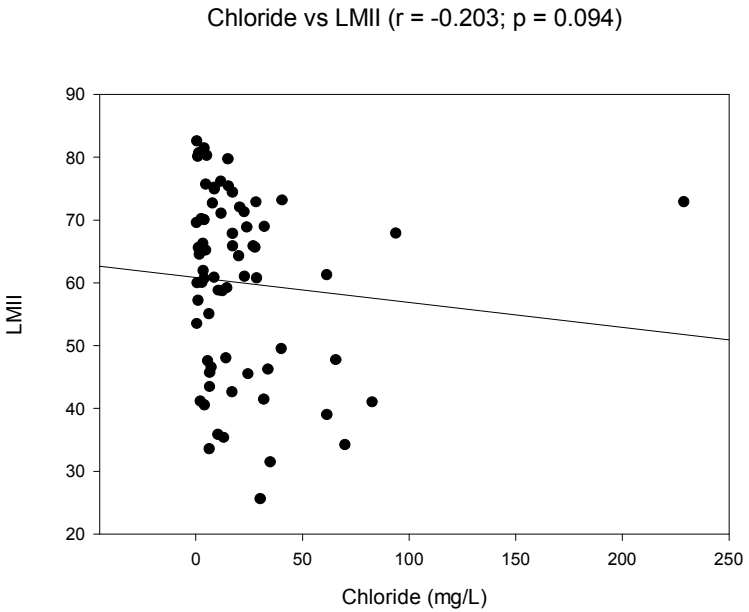
Region 2 Turbidity vs LMII (r = -0.524; p = 0.0129)

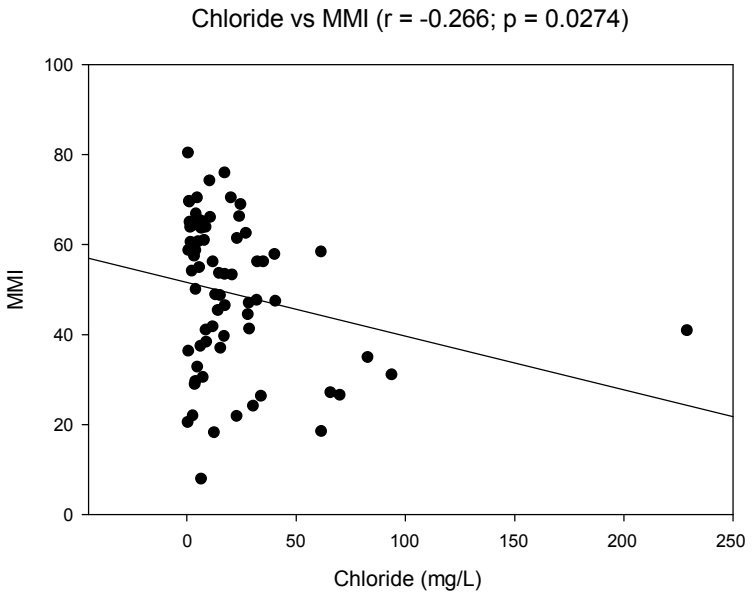


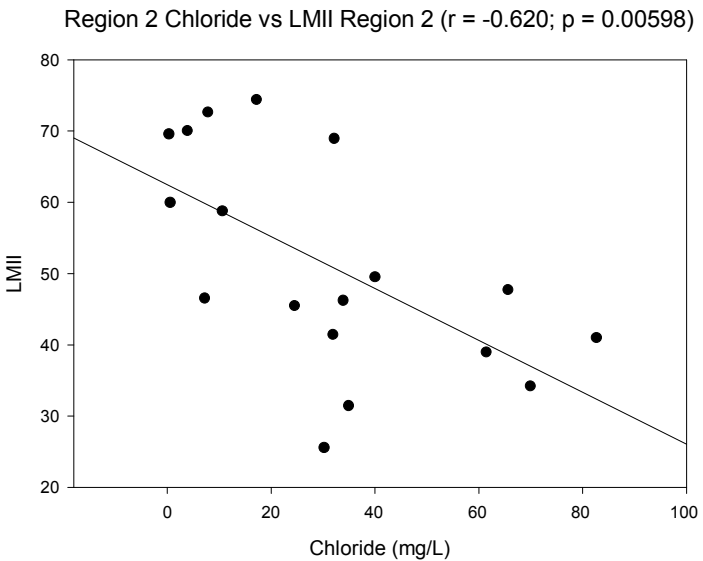
Region 2 Turbidity vs MMI (r = -0.115; p = 0.644)

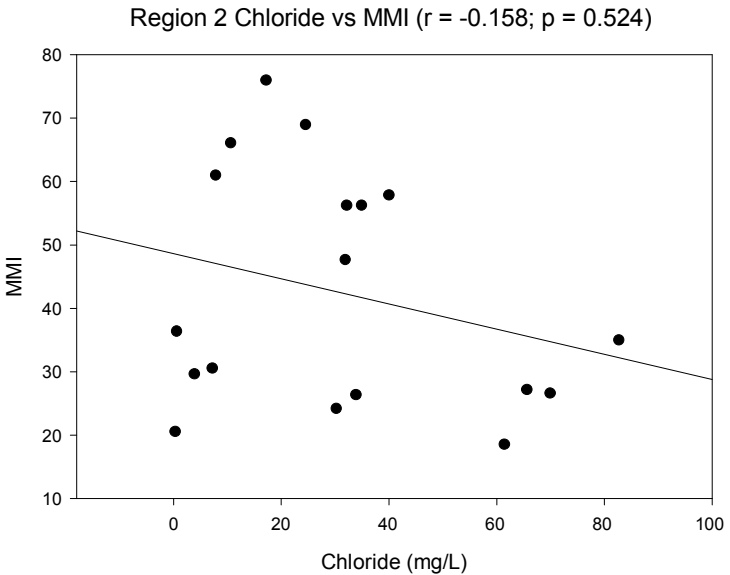


Chloride

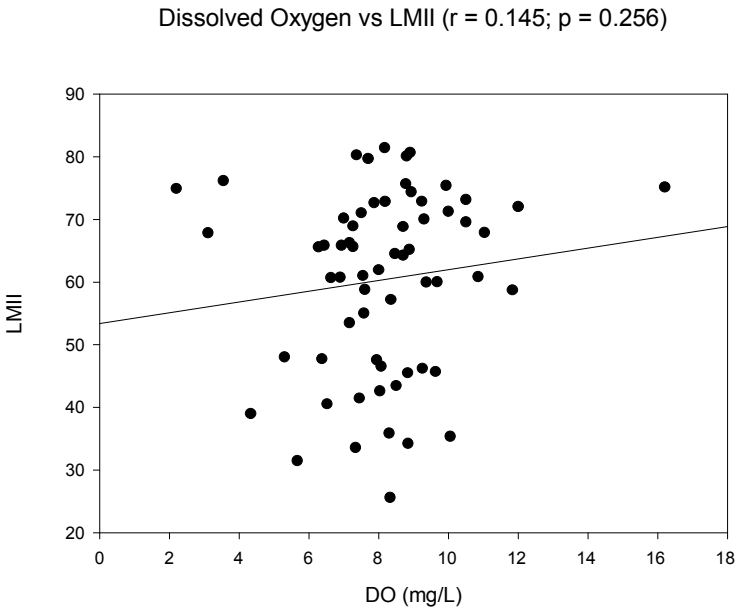

Chloride vs LMII (r = -0.203; p = 0.094)
LMII
Chloride (mg/L)
90
80
70
60
50
40
30
20
0
50
100
150
200
250

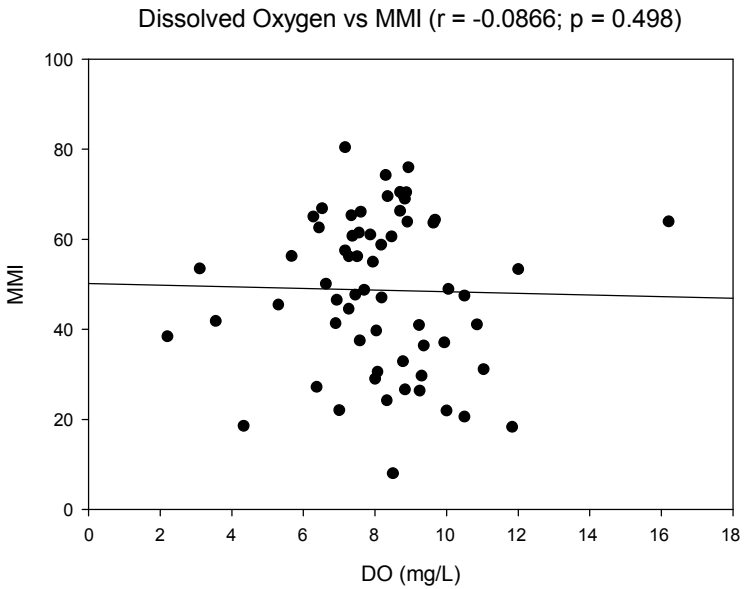

Chloride vs MMI (r = -0.266; p = 0.0274)
MMI
Chloride (mg/L)
100
80
60
40
20
0
0
50
100
150
200
250

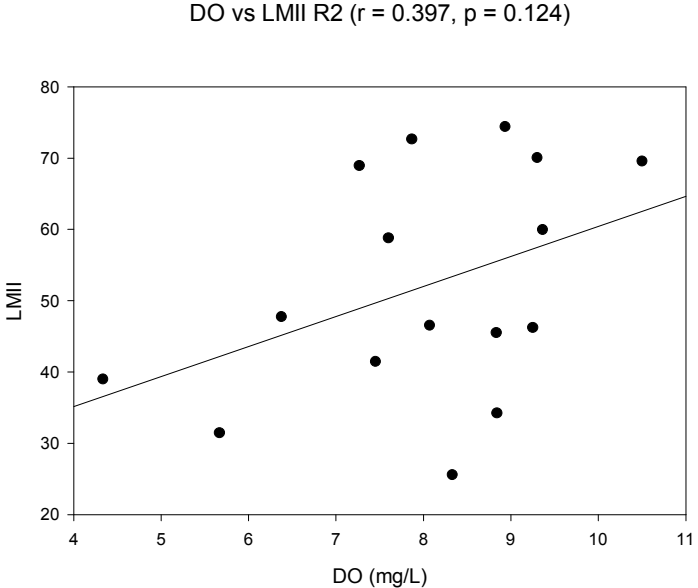

Region 2 Chloride vs LMII Region 2 (r = -0.620; p = 0.00598)
LMII
Chloride (mg/L)
80
70
60
50
40
30
20
0
20
40
60
80
100

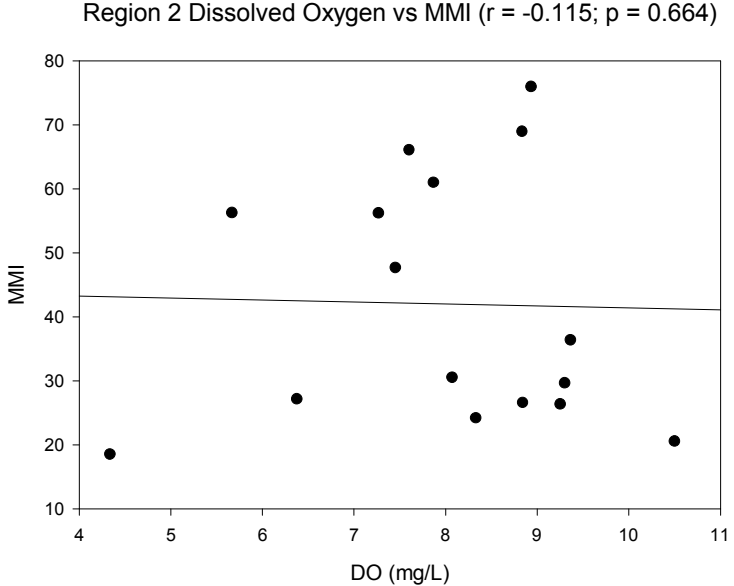

Region 2 Chloride vs MMI (r = -0.158; p = 0.524)
MMI
Chloride (mg/L)
80
70
60
50
40
30
20
10
0
20
40
60
80
100

Dissolved Oxygen



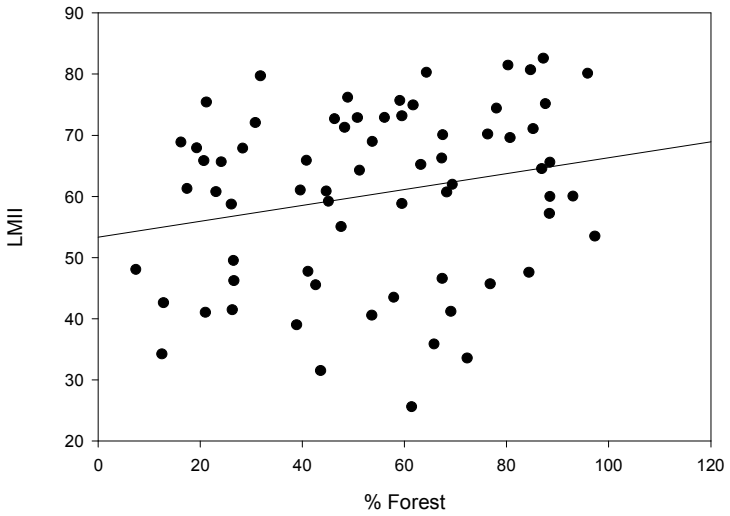




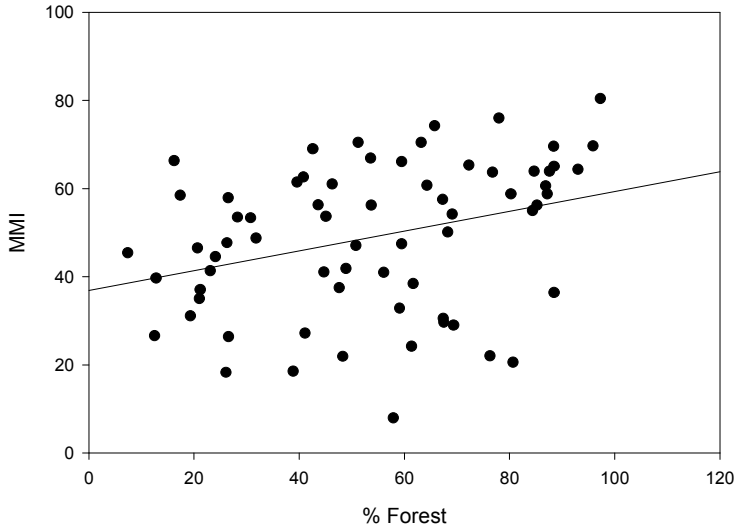


Percent Forest

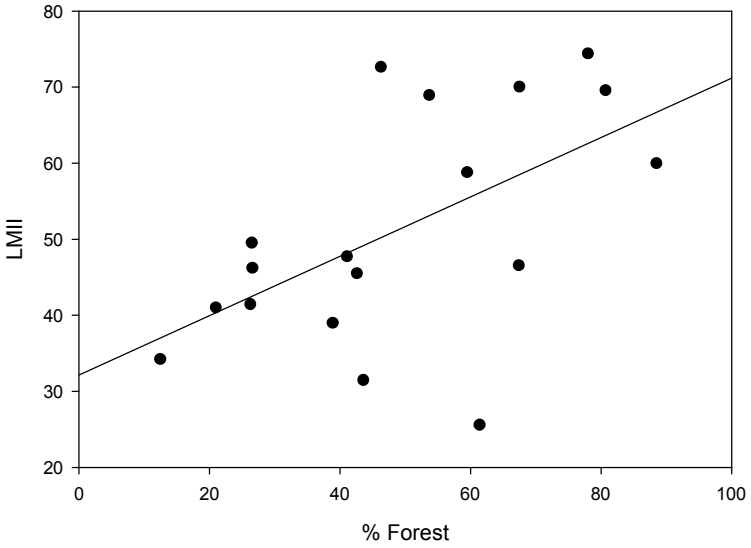
Percent Forest vs LMII (r = 0.216; p = 0.0773)



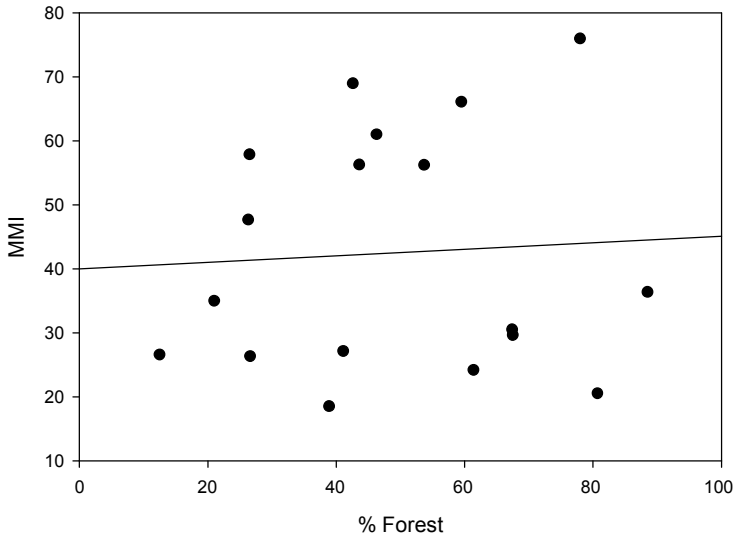
Percent Forest vs MMI (r = 0.355; p = 0.00311)



Region 2 Percent Forest vs LMII (r = 0.583; p = 0.0110)

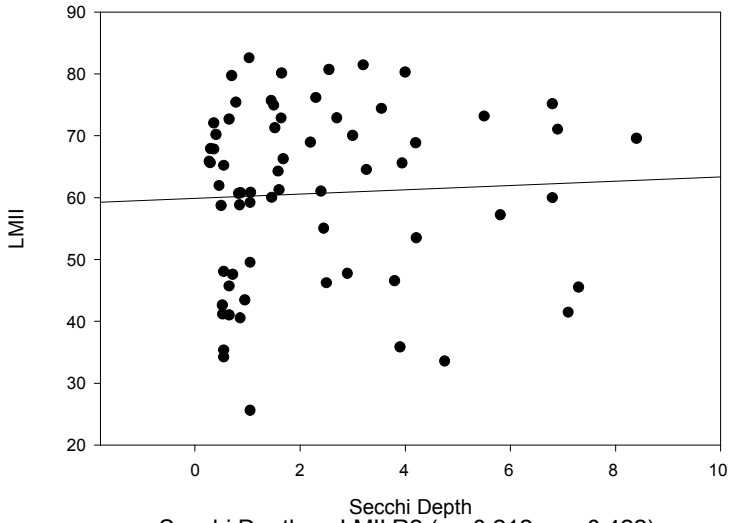


Region 2 Percent Forest vs MMI (r = 0.0836; p = 0.736)

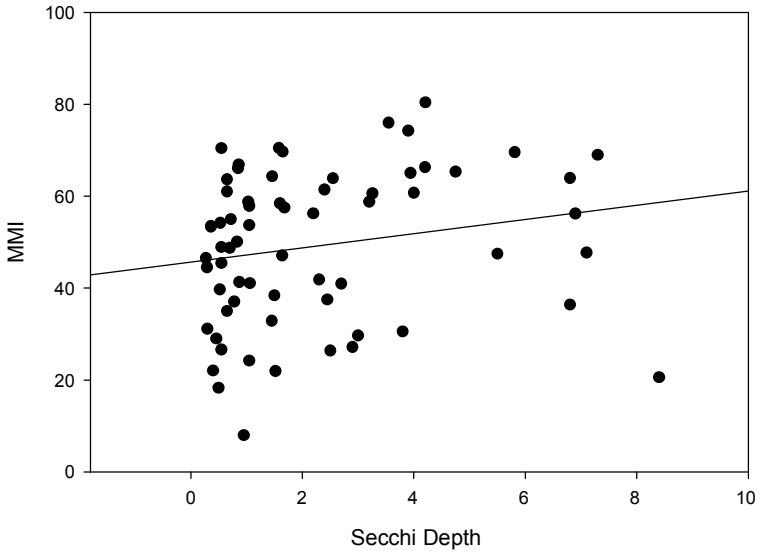


Secchi Depth

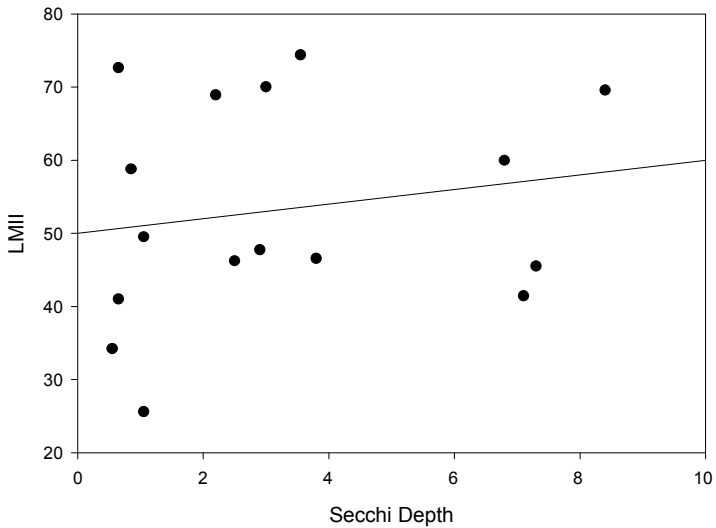
Secchi Depth vs LMII (r = 0.110; p = 0.377)



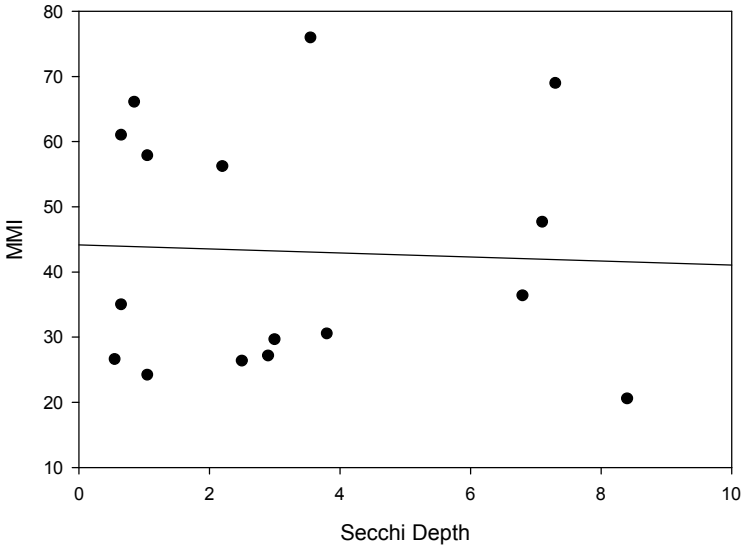
Secchi Depth vs MMI (r = 0.291; p = 0.0181)



Secchi Depth vs LMII R2 (r = 0.212; p = 0.422)

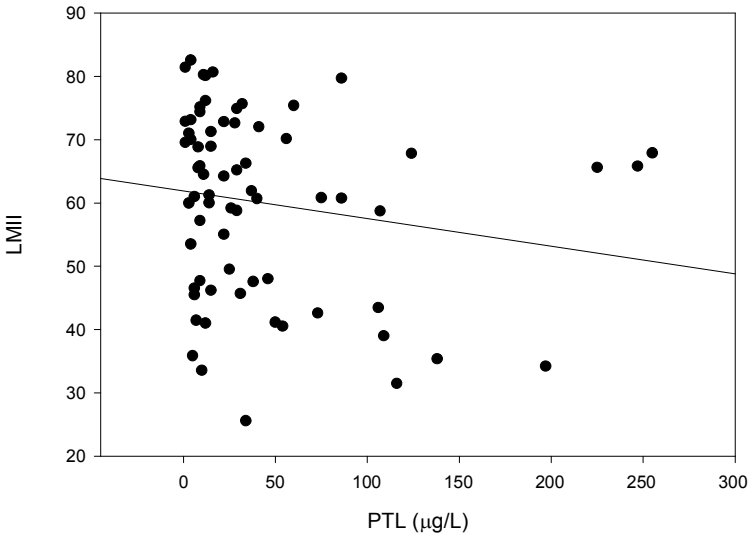


Region 2 Secchi Depth vs MMI (r = -0.00736; p = 0.969)

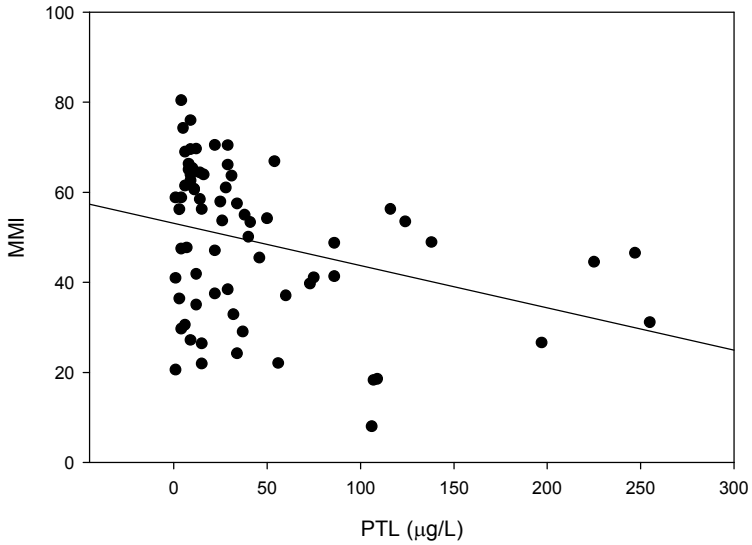


Total Phosphorus

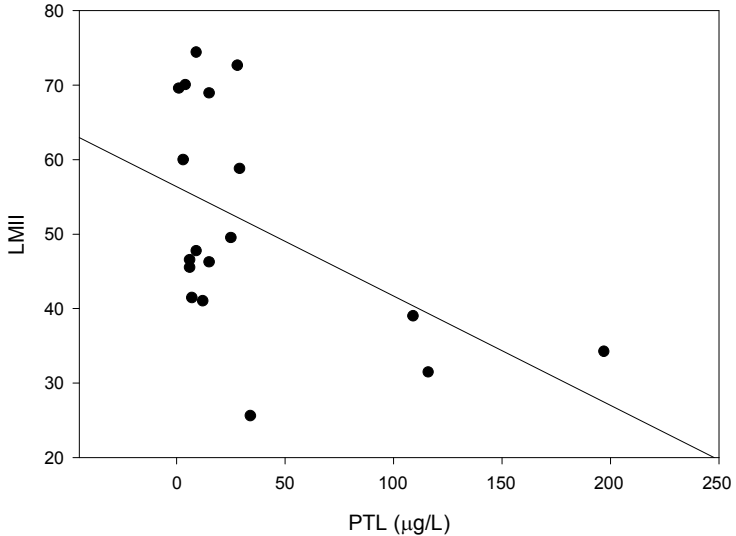
Total Phosphorus vs LMII (r = -0.245; p = 0.0423)



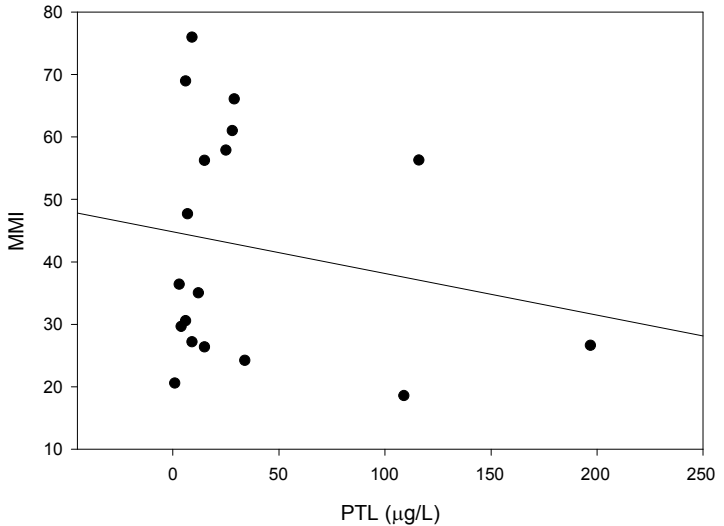
Total Phosphorus vs MMI (r = -0.327; p = 0.00621)



Region 2 Total Phosphorus vs LMII (r = -0.524; p = 0.0255)

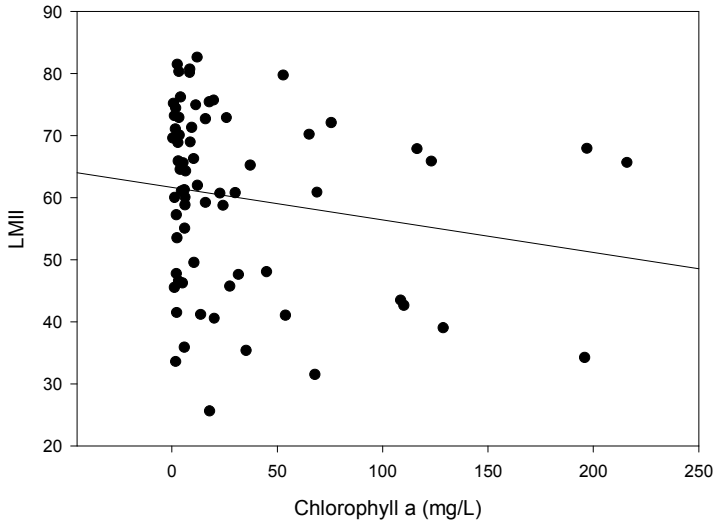


Region 2 Total Phosphorus vs MMI (r = -0.0310; p = 0.895)

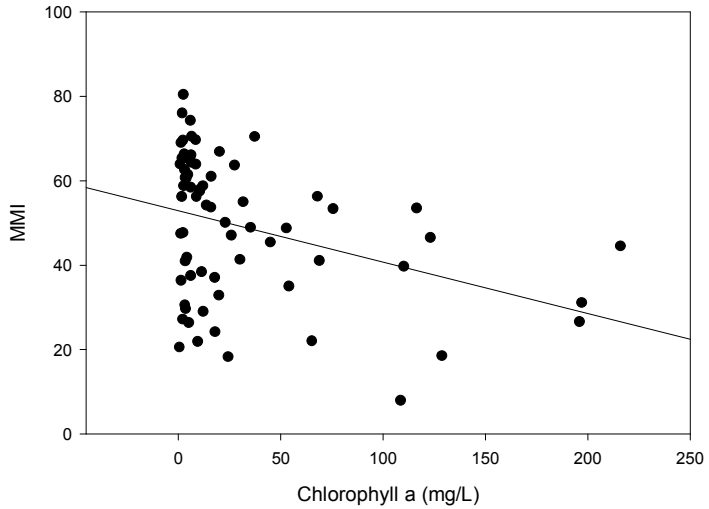


Chlorophyll a

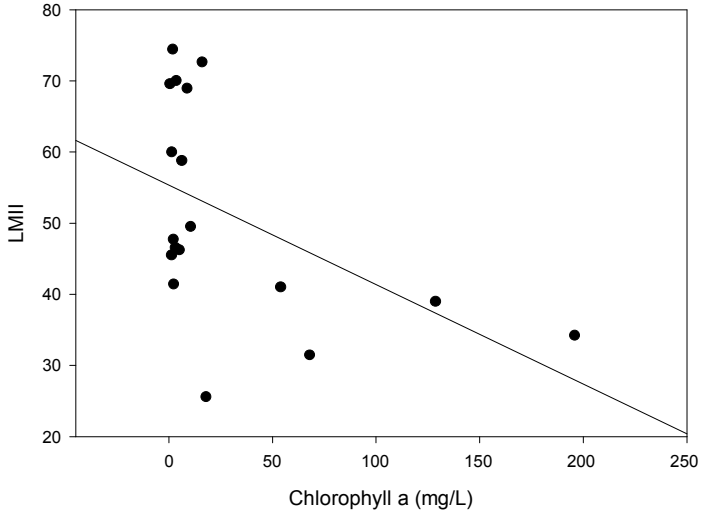
Chlorophyll a vs LMII (r = -0.188; p = 0.121)



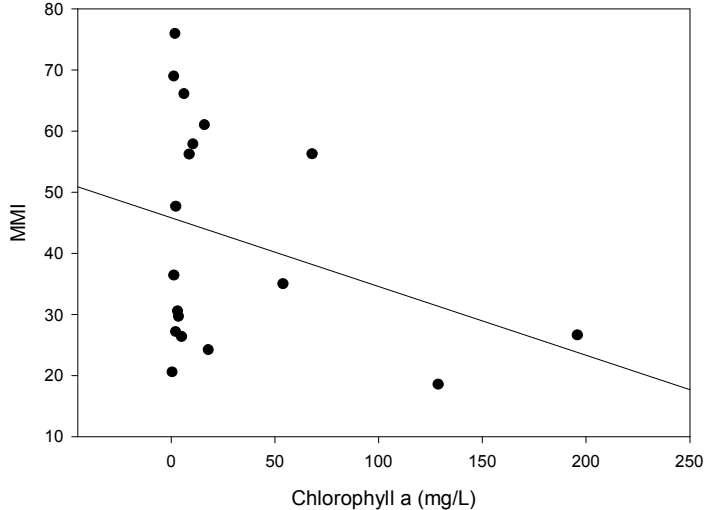
Clorophyll a vs MMI (r = -0.345; p = 0.00385)



Region 2 Chlorophyll a vs LMII (r = -0.548; p = 0.0184)



Region 2 Chlorophyll a vs MMI (r = -0.197; p = 0.426)



Summary of Results

- Across regions the MMI outperformed the LMII, except for dissolved oxygen
- However, neither index showed strong relationships with the stressors examined
- For Region 2 lakes the LMII outperformed the MMI and corresponded strongly with the stressors examined, except for secchi depth and dissolved oxygen

Conclusion

- Despite the risk of spurious correlation with other underlying causes, these analysis help to provide some insight on which macroinvertebrate assemblage can be used to assess lake condition

Future Direction

- NY State: 2008-2011 macroinvertebrate pilot lakes study; 12 lakes per year; sublittoral and littoral zone sampling; supplemental 106 funds
- NJ: proposed 2012-2013 pilot study; 2 panels of NJ's probabilistic lakes; 40 lakes per year; sublittoral benthos, littoral fish, and sediment diatoms; funding and/or resources?

Acknowledgements

- Dynamac Corporation (Sheila North)
- USEPA Region 3 (Frank Borsuk)
- USEPA, OWOW, Washington, DC (Richard Mitchell)
- USEPA Region 3 States (PA, DE, MD, WV, VA)
- USEPA Region 2 States (NJDEP and NYSDEC)
- 2007 National Lakes Assessment (numerous participants)