Vegetation Condition and Water Quality in Great Lakes Coastal Wetlands

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Understanding the Vegetation and Hydrology of Upper Midwest Wetlands
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Acknowledgments

Many collaborators, including:

Bad River Band of the Lake Superior Tribe of Chippewa Indians for permission to sample

Michael Bourdaghs

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develop a suite of new, integrative indicators of ecological condition, integrity, and/or sustainability that can be incorporated into long-term monitoring programs"
Research Questions

• What are the plant community types of northern Great Lakes coastal wetlands?
• How are they related to water chemistry?
Made 20,560 observations of cover class within 2051 sample plots in 90 wetlands
Northern Great Lakes wetland vegetation sample sites

Water chemistry measured on 26 northern sites (Trebitz et al. 2007, Morrice et al. 2008)
A Unifying Approach

1. sample wetlands representing the entire range of anthropogenic stress
2. sample a range of water depths within wetlands
3. use non-metric multidimensional scaling to determine a condition gradient
4. use hierarchical clustering to interpret MDS results
5. use GIS to map results
Step 1: Sample wetlands representing the entire range of anthropogenic stress

Step 2: sample a range of water depths within wetlands
Step 3: Use non-metric multidimensional scaling to determine a condition gradient

- MDS, NMS, NMDS
- computed Bray-Curtis similarities among 90 wetlands
- ordination based on ranked distances among vegetation species assemblages
- software packages PC-ORD, Primer
Step 4: Use hierarchical clustering to interpret MDS results

23% similarity
Step 5: Use GIS to map results

- ArcMap 9.2
- Identify geographic clusters of similar vegetation
- Identify geographic outliers
Plant Communities of Northern Great Lake Wetlands
burreed (*Sparganium eurycarpum*)
arrowhead (*Sagittaria latifolia*)
Northwest Territory sedge (*Carex utriculata*)
bladderwort (*Utricularia macrorhiza*)
bulrush (*Schoenoplectus tabernaemontani*)

Photo: C. Johnston

Photo: M. Bourdaghs
Wild rice (Zizania aquatica)
8 out of 90 sites, 7 on Lake Superior
Silt soil indicator
Plant Communities of Northern Great Lake Wetlands
Northern poor fen

*Sphagnum* moss
Wooly-fruit sedge (*Carex lasiocarpa*)
*Myrica gale*
leatherleaf (*Chamaedaphne calyculata*)
bog rosemary (*Andromeda polifolia*)
pitcher plant (*Sarracenia purpurea*)
bogbean (*Menyanthes trifoliata*)
Plant Communities of Northern Great Lake Wetlands
Bluejoint (Calamagrostis canadensis)
Tussock sedge (Carex stricta)
Softstem bulrush (Schoenoplectus tabernaemontani)
Jointed rush (Juncus nodosus)
Plant Communities of Northern Great Lake Wetlands

Point au Sable
Cattail marshes

cattail (*Typha angustifolia, Typha x glauca*)
bluejoint (*Calamagrostis canadensis*)
jewelweed (*Impatiens capensis*)
rice cutgrass (*Leersia oryzoides*)

Photos: C. Johnston
So much diversity...

What are plants telling us about wetland condition?
Non-metric multidimensional scaling – northern Great Lakes wetland vegetation
Non-metric multidimensional scaling – northern Great Lakes wetland vegetation
Chemical gradients among plant communities

log [Chloride]

log conductivity

pH

poor fen  burreed  bluejoint  cattail
Nutrient gradients among plant communities

**log [TP]**

- **poor fen**
- **burreed**
- **bluejoint**
- **cattail**

**log [TN]**

**log [Chlorophyll a]**
Turbidity gradients among plant communities

log Ttube

log [TSS]
Plant communities have different chemistry

<table>
<thead>
<tr>
<th>Parameter†</th>
<th>Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>specific conductance***</td>
<td>cattail &amp; bluejoint &gt; burreed &amp; fen</td>
</tr>
<tr>
<td>chloride***, pH**</td>
<td>cattail &gt; bluejoint ≥ burreed ≥ fen</td>
</tr>
<tr>
<td>total P***, total N***, chl_a***, turbidity***, TSS***</td>
<td>cattail &gt; bluejoint &amp; burreed &amp; fen</td>
</tr>
<tr>
<td>NO₃-N, NH₄-N, DOC, DO</td>
<td>not significant</td>
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** p < 0.01, *** p < 0.001
Non-metric multidimensional scaling – northern Great Lakes wetland vegetation

Diagram showing the relationships between different wetland vegetation types with respect to the Great Lakes Superior, Michigan, and Huron.
Lake Superior fluctuates less than Lakes Michigan/Huron

Superior lake level
Michigan/Huron lake level
Lakes have different chemistry

<table>
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<th>Parameter</th>
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</tr>
</thead>
<tbody>
<tr>
<td>specific conductance***, pH***</td>
<td>Huron &amp; Michigan &gt; Superior</td>
</tr>
<tr>
<td>chloride**</td>
<td>Michigan ≥ Huron ≥ Superior</td>
</tr>
<tr>
<td>total P**, total N***</td>
<td>Michigan &gt; Superior &amp; Huron</td>
</tr>
<tr>
<td>chlorophyll_a*</td>
<td>Michigan ≥ Superior ≥ Huron</td>
</tr>
<tr>
<td>NO₃-N*</td>
<td>no Tukey differences</td>
</tr>
<tr>
<td>NH₄-N, TSS, DOC, DO, turbidity</td>
<td>not significant</td>
</tr>
</tbody>
</table>

* p < 0.05, ** p < 0.01, *** p < 0.001
3 Geomorphic Types

Open-coast wetlands (Cw)

Protected wetlands (Pw)

Riverine wetlands (Rw)
Conclusions

- Plant species distinguish four major plant communities in northern Great Lakes
- Water quality varies by plant community and lake but not by geomorphology
- Based on chloride: cattail > bluejoint ≥ burreed ≥ fen
- Cattail wetlands (Lake Michigan) have poorest water quality (more total P, total N, chl_a, turbidity, TSS)
Future threats: invasive wetland plants
2004: common reed (Phragmites australis)
Monthly Water Level (MWL) at Green Bay, Lake Michigan, WI from 1999-2004
Source: NOAA
Take home messages

• A one-time “snapshot” sampling of multiple wetlands can advance understanding
• Take a GPS with you when you do the sampling!
• Keep looking at the data – it has many stories to tell
References


