New England Wetlands Webinar Series
New Tools to Assess Wetland Condition

March 10, 2016
Agenda

• Welcome and Introductions (10 min.)
• New Tools to Assess Wetland Condition (45 min.)
• Brief Q&A (5 min.)
• Discussion (30 min.)
• Wrap-Up
Webinar Moderator

Kimberly Roth,
Environmental Analyst,
Wetlands Program
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Since 2007, Kate has worked as a Plant Ecologist for the National Park Service Inventory and Monitoring Program, and is based out of Acadia National Park. Kate develops and implements long-term vegetation monitoring programs in northeastern parks, including for forests, freshwater wetlands and salt marshes. Kate has a BS in Natural Resources from Northland College and an MS in Ecology and Environmental Sciences from the University of Maine (2006). Kate is currently in a PhD program (started in 2014) at the University of Maine in the School of Biology and Ecology.
NEW TOOLS TO ASSESS CONDITION OF FRESHWATER WETLANDS IN THE NORTHEASTERN US: MULTIMETRIC INDICES FOR VEGETATION, SOIL CHEMISTRY, ALGAE TAXA, AND WATER CHEMISTRY

Kate Miller, Plant Ecologist
Webinar Outline

- NPS Inventory and Monitoring Program
- Need for regional wetland assessment tools
- Multimetric Indicator (MMI) Development
- MMI Results and Discussion
- Predicting MMIs with land use and RAM metrics
NPS Inventory and Monitoring Program

- 32 Networks covering more than 270 park units
- Baseline inventories
- Long-term monitoring
Northeast Temperate Network
Wetland Monitoring in Acadia NP

• 10 Sentinel Sites
  • EPA National Wetland Condition Assessment (NWCA)
  • Continuous water level monitoring

• 40 Rapid Assessment Sites
  • USA-RAM developed by EPA
  • Timed search to develop plant species list
Need for Regional Assessment Tools

Current assessment tools

• State level indicators
• Floristic Quality Assessment Index
• EPA Vegetation Multimetric Indicator (MMI)
EPA NWCA Plot Design

Overall Plot

Assessment Area
- Site, Water & Algae
- Soil Pit
- Vegetation

40m

100m
Objectives

- Develop MMIs using NWCA data (Stoddard et al. 2008)
  - Vegetation
  - Soil chemistry
  - Algae taxa
  - Water chemistry
- Determine if condition of the surrounding landscape can predict condition of the wetland
Wetland MMI Construction

Preliminary Step

• Determine which plots to include in MMI development
  • NMDS with % cover of plant species
  • Started with over 200 freshwater sites from eastern US
  • Removed plots until Lat/Long are not the first gradient
NMDS Results: 166 plots
NMDS Results: Disturbance Gradient

- Disturbance Type:
  - Reference
  - Intermediate
  - Most

- Variables:
  - Buff Width
  - Hummocks
  - Water Stress
  - Habitats Stress

- Axes:
  - NMDS1
  - NMDS2
  - Lat
  - Long
NWCA Sites by Wetland Type
Step 1: Determine least (REF) & most (MOST) disturbed sites

- Number of stressors in buffer plots, weighted by distance from center (same as EPA)
- REF: Handpicked using BPJ & no stressors in buffer plots
- MOST: Total of 2 or more stressors in buffer plots
Step 2: Find metrics that separate by disturbance type

- Compare box plots and t-statistics
- Metrics not strongly correlated ($r < 0.7$)
- Not correlated with natural gradients
- Signal:Noise $\geq 2$
Step 3: Combine metrics into MMI

- Convert metrics to 10-point scale and combine
- Convert combined index to 100-point scale
- Calculate thresholds between Good, Fair and Poor
- Rate each site using thresholds
Vegetation MMI
Metrics Tested
• Species Richness
  • Native
  • Invasive
• Index of Wetness
• % Cover by Life Form
  • Woody
  • Graminoid
  • Bryophytes
• Coefficients of Conservatism
  • FQAI, FQAI’ & Mean C
  • Weighted Mean C & FQAI
  • % Cover tolerant (C: 1-4)
  • % Cover sensitive (C: 7-10)
Vegetation MMI

Disturbance Class

Mean C

Mean C

% Exotic Cover

% Exotic Cover

% Bryophyte Cover

% Bryophyte Cover

% Cover Tolerant Spp.

% Cover Tolerant Spp.
Soil MMI

Metrics Tested

- % Total Carbon, Nitrogen & Sulfur
- Bulk Density
- pH in $\text{H}_2\text{O}$ and $\text{CaCl}_2$
- Cation Exchange Capacity
  - Ca, K, Mg, Na conc.
- Extractable acidity
- Phosphorous concentration
- Trace Elements (n=21)
- % Al, % Fe, % Mn
- % Clay and Silt
Algae MMI

Metrics Tested

- Microcystin
- Natural Units per mL
  - Genus (n=193)
  - Blue-green algae
  - Cryptophytes
  - Diatoms
  - Dinoflagellates
  - Green algae
Algae MMI

Disturbance Class

**Eunotia**
- REF
- INT
- MOST

**Gomphonema**
- REF
- INT
- MOST

**Fragilaria**
- REF
- INT
- MOST

**Nitzschia**
- REF
- INT
- MOST
Water MMI
Metrics Tested

- Conductivity
- Ammonia (NH$_3$)
- Nitrate + Nitrite conc.
- pH
- Total Nitrogen
- Total Phosphorus
- Chlorophyll A
Water MMI

- Conductivity (µS/cm)
  - REF
  - INT
  - MOST

- pH
  - REF
  - INT
  - MOST

- Total P (µg/L)
  - REF
  - INT
  - MOST

Disturbance Class
MMIs with Thresholds

**Veg. MMI**

- REF
- INT
- MOST
  
**Algae MMI**

- REF
- INT
- MOST

**Soil MMI**

- REF
- INT
- MOST

**Water MMI**

- REF
- INT
- MOST

**Disturbance Class**

- REF
- INT
- MOST
NMDS Results: MMIs
Vegetation MMI Ratings

Veg. MMI Ratings
- Good
- Fair
- Poor
- No Sample Taken
Soil MMI Ratings

Soil MMI Ratings
- Good
- Fair
- Poor
- No Sample Taken

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Algae MMI Ratings

- Good
- Fair
- Poor
- No Sample Taken
Water MMI Ratings

- Good
- Fair
- Poor
- No Sample Taken
**Freshwater Wetland Multimetric Index Calculator**

**Vegetation MMI**

<table>
<thead>
<tr>
<th>Vegetation MMI</th>
<th>Mean $C_{all}$</th>
<th>% Exotic Cover</th>
<th>% Bryophyte Cover</th>
<th>% Tolerant Cover</th>
<th>VMMI Score</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter Values</td>
<td>6.2</td>
<td>25</td>
<td>50</td>
<td>20</td>
<td>60.84</td>
<td>Fair</td>
</tr>
</tbody>
</table>

Metric 1: Mean $C_{all}$ is the average Coefficient of Conservatism (CofC) for all species on the plot, and ranges from 0-10.

Metric 2: % Exotic Cover is the cover of all exotic and cryptic (e.g., *Phalaris arundinacea*) species, and ranges from 0-100.

Metric 3: % Bryophyte Cover is the cover of all bryophyte species on the ground, and ranges from 0-100.

Metric 4: % Tolerant Cover is the cover of native species with a CofC ≤ 4, and ranges from 0-100.

For more information about the MMIs, refer to the following publication:


Available at go.nps.gov/MMI
MMI Results and Discussion

- MMIs included widely used metrics to assess wetland condition: % Exotic Cover, pH, Conductivity, P
- Vegetation MMI metrics may be applicable to sites sampled by non-NWCA protocols
- Algae was weakest MMI because of strong Lat/Long gradients in taxa
- Most applicable to depressional, flats or slope wetlands, with precip. and poorly buffered groundwater as main water inputs
Predicting MMIs with Land Use and RAM metrics
Random Forest Analysis- Phase 1

Objective

• Assess how well surrounding land use and USA-RAM metrics can predict each MMI

Predictor variables included

• % of land cover types within a 500 m and 1 km buffer around the center of the AA using 2011 NLCD

• USA-RAM metrics
Random Forest Analysis - Phase 2

Objective

• Assess how well surrounding land use, USA-RAM metrics and Vegetation MMI can predict other MMIs

Predictor variables included

• All metrics in previous analysis
• VMMI score, % Bryophyte Cover, Mean C, % Exotic Cover, and % Tolerant Cover
Random Forest Results - Vegetation MMI

Level 1 and 2 variables

Variable Importance Plot

43.61% of Var. Explained
Random Forest Results - Vegetation MMI
Level 1 and 2 variables
Observed vs. Predicted
$R^2=0.51$
slope=0.46
## Random Forest Results - Level 1 & 2 variables

<table>
<thead>
<tr>
<th>Variables with High Importance Values (strong predictors)</th>
<th>VMMI</th>
<th>SMMI</th>
<th>AMMI</th>
<th>WMMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Agriculture 1km buffer</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>% Agriculture 500m buffer</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>% Cultivated crops in 1km buffer</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>USA-RAM Metric 4: # Indicator</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>% Hayed/Pasture land 1km buffer</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>% Forest 1km buffer</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>% Wetland 1km buffer</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>% Emergent wetland 1km buffer</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>% Hayed/Pasture land 500m buffer</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>% Herbaceous upland 1km buffer</td>
<td>9</td>
<td>6</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>% Variance Explained</td>
<td>43.61</td>
<td>45.05</td>
<td>14.17</td>
<td>33.55</td>
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<tr>
<td>$R^2$ of pred. vs. obs.</td>
<td>0.51</td>
<td>0.50</td>
<td>0.06</td>
<td>0.42</td>
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</table>
## Random Forest Results - Level 1 & 2 + VMMI

### Variables with High Importance Values (strong predictors)

<table>
<thead>
<tr>
<th>Variables</th>
<th>SMMI</th>
<th>AMMI</th>
<th>WMMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMMI Score</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>VMMI: % Bryophyte Cover</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>VMMI: % Exotic Plant Cover</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>VMMI: Mean C</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>% Agriculture 500m buffer</td>
<td>1</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>% Hayed/Pasture land 1km buffer</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>% Forest 1km buffer</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>% Herbaceous upland 1km buffer</td>
<td>7</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>% Variance Explained</td>
<td>66.55</td>
<td>41.08</td>
<td>48.88</td>
</tr>
<tr>
<td>$R^2$ of pred. vs. obs.</td>
<td>0.71</td>
<td>0.29</td>
<td>0.53</td>
</tr>
</tbody>
</table>
Summary of Random Forest Results

- Land use metrics can provide a decent estimation of which wetlands are likely in the poorest condition.
- The addition of a site visit to collect vegetation data will improve assessment of soil and water condition.
- The results validate our monitoring approach in ACAD.
  - Intensive sampling in a few sites (10 sentinels).
  - USA-RAM and vegetation at many sites (40 sites).
Acknowledgements

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National Park Service
U.S. Department of the Interior

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Discussion
Thank you

Next Webinar

April 14, 2016
Featuring Lisa Rhodes, MassDEP
Chicopee Watershed Monitoring and Assessment: Summary and Findings

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Questions and Comments?
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