LONG-TERM FRESHWATER WETLAND MONITORING IN ACADIA NATIONAL PARK

Kate Miller, Plant Ecologist
Outline

• Overview of NPS Inventory and Monitoring (I&M) Program
• Wetland monitoring approach in Acadia National Park
• Preliminary results from first monitoring cycle
• Example regional monitoring network
NPS Inventory and Monitoring Program

- 32 Networks covering more than 270 park units
  - Baseline inventories
  - Long-term monitoring
Northeast Temperate Network
10 Sentinel Sites (2011 & 2016)
  • Potential reference sites for EPA NWCA
  • Continuous water level monitoring

40 Rapid Assessment Sites (2012-2015)
  • USA-RAM developed by EPA
  • Timed plant species search
Wetland Monitoring Objectives: Sentinel Sites

Determine status and trends in:

• Vascular species composition, structure, and diversity
• Soil chemistry
• Water chemistry
• Water level mean and variability
Determine the status and trends in:

- Plant species composition and diversity
- Stressors, including adjacent land-use, altered hydrology and buffer condition
Water level monitoring in Sentinel Sites

• Hourly pressure recorded with HOBO loggers
• Visit wells in spring and fall to download data
• Convert pressure to cm of water relative to the surface of the wetland.
Rapid Assessment Sites

- USA-RAM Level 1 & 2 metrics
- 15 min. search for species per quarter in AA
Assessment Tools

• Sentinel Sites
  • Wetland MMIs: Vegetation, Soil, Water, Algae
  • Buffer plot stressors
  • Water Level Mean and Variability
• Rapid Assessment Sites (RAM)
  • USA-RAM stressors in buffer and AA
  • Adapted Vegetation MMI
<table>
<thead>
<tr>
<th>MMI</th>
<th>Indicator 1</th>
<th>Indicator 2</th>
<th>Indicator 3</th>
<th>Indicator 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation</td>
<td>Mean C</td>
<td>% Bryophyte</td>
<td>% Exotic Cover</td>
<td>% Cover Nat. Dist. Tolerant</td>
</tr>
<tr>
<td>Soil Chemistry</td>
<td>% Total Carbon</td>
<td>P (mg/kg)</td>
<td>pH in CaCl$_2$</td>
<td>Co (mg/kg)</td>
</tr>
<tr>
<td>Algae Taxa (# Individuals)</td>
<td>Eutonia</td>
<td>Fragilaria</td>
<td>Gomphononema</td>
<td>Nitzschia</td>
</tr>
<tr>
<td>Water Chemistry</td>
<td>Conductivity (µS/cm)</td>
<td>Total P (µg/L)</td>
<td>pH</td>
<td>---</td>
</tr>
</tbody>
</table>

+= higher for reference; -= lower for reference

Miller et al. 2016
Assessment Tools: MMIs
Results: Vegetation MMI

- NWCA Site Type
  - PROB
  - REF
- NETN Site Type
  - RAM
  - Sentinel
- ACAD Rest. Project
Results: Vegetation MMI

<table>
<thead>
<tr>
<th>Rating</th>
<th>RAM</th>
<th>Sent.</th>
<th>Rest.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>24</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Fair</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Poor</td>
<td>11</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

![Box plot showing vegetation MMI scores for different site types and projects]
Sentinel Results: Soil MMI

<table>
<thead>
<tr>
<th>Rating</th>
<th>Sent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>9</td>
</tr>
<tr>
<td>Fair</td>
<td>0</td>
</tr>
<tr>
<td>Poor</td>
<td>1</td>
</tr>
</tbody>
</table>

![Box plot showing Soil MMI scores for PROB, REF, and ACAD Sentinel categories. The green line indicates a threshold for good and poor ratings. The table on the right shows the ratings and their corresponding scores.]
Sentinel Results: Water MMI

<table>
<thead>
<tr>
<th>Rating</th>
<th>Sent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>4</td>
</tr>
<tr>
<td>Fair</td>
<td>1</td>
</tr>
<tr>
<td>Poor</td>
<td>1</td>
</tr>
</tbody>
</table>
Sentinel Results: Algae MMI

<table>
<thead>
<tr>
<th>Rating</th>
<th>Sent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>4</td>
</tr>
<tr>
<td>Fair</td>
<td>2</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
</tr>
</tbody>
</table>

![Box plots comparing Algae MMI scores for different conditions, with a table showing ratings and corresponding scores.](image-url)
Sentinel Results: Water Level

2013 Water Levels

- Riverine- Upper Perennial
- Organic Flats

Water Level (cm)

Surface

Hourly Precip (cm)
Sentinel Results: Water Level

Little Hunter’s Brook: 2013

Graph showing water level changes from June 1st to October 1st in 2013.
Sentinel Results: Water Level

Little Hunter’s Brook: 2013-2014

Water Level (cm)

Surface

2013
2014
Sentinel Results: Water Level

Little Hunter’s Brook: 2013-2015

Water Level (cm)

-20
-10
0
10
20
30

Jun-01
Jul-01
Aug-01
Sep-01
Oct-01

2013
2014
2015

Surface
Sentinel Results: Water Level

Little Hunter’s Brook: 2013-2016

Graph showing water level changes from 2013 to 2016 for Little Hunter’s Brook.
Sentinel Results: Water Level Summaries

Gilmore Meadow: 2015

**Monthly WL (cm)**
- Mean: 31.71
- sd: 4.68
- Min: 21.28
- Max: 55.79
- Max hr. inc: 11.53

**Growing Season WL (cm)**
- Mean: 20.98
- sd: 9.61
- Min: 3.10
- Max: 55.79
- Max hr. inc: 18.26
- WL change: -23.8
Next Steps

• Summarize stressor and buffer data
• Incorporate sites from Great Meadow restoration project
  • Water and Soil MMIs
  • Water Level Summaries
• Compare water level data across years and sites
• Long-term: Trend Analysis
Example Regional Monitoring Network

NPS Long-Term Forest Monitoring

- Adapted from the U.S. Forest Service- Forest Inventory and Analysis program (USFS-FIA)
- Implemented in 50 park units using compatible methods
- Largest network of plots in forests that are protected from logging
Example Reference Network
NPS Inventory and Monitoring (NPS I&M)
Methods: Paired comparisons

- PARK: NPS I&M forest plots in parks
- MATRIX: USFS FIA forest plots the same Ecological Subsection as the park
Methods: Forest structure metrics

- Density of Live and Dead trees per ha
  - All sizes
  - Trees ≥ 30 cm DBH
  - Trees ≥ 60 cm DBH
- Live and Dead Basal Area
- Coarse Woody Debris Volume
- Tree Growth & Mortality Rates
- Structural Stage: Pole, Mature, Late Successional
Live Basal Area (m²/ha)

*p ≤ 0.05
Density of Live Trees ≥ 30cm DBH/ha

* matrix Forest

*p ≤ 0.05
NPS Forest Structure Summary

• Results are consistent with parks having older, more complex structure than matrix forests
• Ecological thresholds suggest that differences are ecologically significant
• Regardless of park type, eastern parks protect regionally significant older forest
Reference Network Thoughts

- Compatible methods across programs
  - EPA NWCA
- Metrics in common
  - Water pH, Conductivity, Total P
- Sound data management
Northeast Temperate Network
54 Elm Street, Woodstock, VT 05091
Web: http://go.nps.gov/netn
Facebook: facebook.com/NPS.NETN

National Park Service
U.S. Department of the Interior

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