Ohio EPA Studies in Natural and Mitigation Wetlands

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Ohio EPA
Wetland Ecology Group
Wetland Assessment Methods
Developing Wetland Assessment Tools

- Used an Index of Biotic Integrity Approach
  - Worked well in stream program
  - Does a good job of integrating physical, biological and chemical factors
  - Provides an overall measurement of condition which directly relates to the ecological services being provided
- Also worked on having a rapid assessment method - lead to development of ORAM 5.0
Monitoring Ohio’s Wetlands

- Started monitoring Ohio’s natural and mitigation wetlands in 1995
- Monitor the plant, amphibian and macroinvertebrate communities, chemical and physical attributes, and hydroperiods
- Have monitored over 300 natural wetlands and more than 75 mitigation wetlands including wetland mitigation banks
- Sites have been from all of Ohio’s major ecoregions – have covered the entire state
What to Measure?
- Biological Condition
- Stressor Gradient
- [Effect of Human Activity]

How to Decide?
- Relative Abundance?
- Genetic Diversity?
- Trophic Structure?
- Biomass?
- Population Parameters?
- Taxa Richness?
- Feeding Groups?
- Biomarkers?
- Productivity?
Metric Behavior Along the Stressor Gradient

- **Highly Tolerant Taxa**
- **Intolerant Taxa**
- **Native Taxa**
- **Non-Native Taxa**

[Effect of Human Activity]
Two classification schemes used:

- Dominant plant community
  - based on Anderson (1982), Cowardin et al. (1979), Ohio EPA data
- Dominant landscape position
  - hydrogeomorphic (HGM) scheme (Brinson 1993)

Also classified by ecoregion
Ordination of Wetland Data

Axis 1

Axis 2

WOODY

INTERMEDIATE ZONE

OPEN MARESHES

SEDE-GRASS COMMUNITIES

BOGS

Bogs
Coastal marsh
Emergent marsh
Shrub swamps
Swamp forests
Open shrub swamps
Mitigation marshes
Prairies
Fens
Daughmer Savannah, Prairie Sedge Meadow, Crawford Co. Ohio
Slope (Hillside Fen), Miami Co. Ohio
Slope (Forest Seep), Mohican State Forest, Ashland, Ohio
Developing a Vegetation IBI

- Monitored over 250 natural wetlands using intensive vegetation survey methods
- Wetlands sampled
  - span the range of human disturbance
  - all over Ohio (all ecoregions)
  - all HGM and vegetation classes
  - includes a large mitigation wetland set
- Developed a Vegetation IBI that correlates strongly with human disturbance levels
Parameters Monitored

- presence/absence (~2900 vouchers collected 1996-2004, avg ~16 per plot)
- % cover herb and shrub stratum
- stem density and basal area shrub and tree stratum (shrub and forest only)
- standing biomass (emergent only)
- soil nutrients
- water chemistry
- physical parameters: water depth, depth to saturated soils, coarse woody debris, hummocks and tussocks, standing dead, etc.
<table>
<thead>
<tr>
<th>Metric</th>
<th>Type</th>
<th>E</th>
<th>F</th>
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<td>carex</td>
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<td>X</td>
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<td>richness</td>
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<tr>
<td>shrub</td>
<td>richness</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>hydrophyte</td>
<td>richness</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>shade species</td>
<td>richness</td>
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<td>richness</td>
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<td>FQAI</td>
<td>index</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>% tolerant</td>
<td>community</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>% intolerant</td>
<td>community</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>% invasive graminoids</td>
<td>community</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>% bryophyte</td>
<td>community</td>
<td>X</td>
<td>X</td>
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<tr>
<td>subcanopy IV</td>
<td>community/productivity</td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>canopy IV</td>
<td>index</td>
<td></td>
<td>X</td>
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<tr>
<td>std biomass</td>
<td>productivity</td>
<td>X</td>
<td></td>
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</table>
Vegetation IBI
Ohio EPA has been monitoring wetland amphibians since 1996:
- 1996-2005 monitored 172 natural wetlands
- 2001 - monitored 4 wetland mitigation banks and 10 individual wetland mitigation projects
- 2004 – monitored 8 wetland mitigation banks – 35 individual wetland subareas

Amphibian Index of Biotic Integrity (AmphIBI):
- 2002 – developed index
- 2004 – tested with additional sites
AmphIBI Metrics

- Amphibian Quality Assessment Index (AQAI)
- Number of species of pond breeding salamanders
- Relative abundance of sensitive species
- Relative abundance of tolerant species
- Presence of spotted salamanders or wood frogs
Amphibian IBI

ORAM 5.0 Tertiles

AmphIBI
Reasons for Absence of Sensitive Species at Emergent Sites

- Originally 95% of Ohio was forested – sensitive species are adapted to this environment
- Many emergent wetlands have stream hydrology inputs and therefore predatory fish populations
- Often wetlands are predominately emergent due to past disturbances
Wetland Invertebrate Community Index

WICl Metric Values

- Mitigation: n = 21
- Nonreference: n = 68
- Reference: n = 60
Wetland Mitigation Studies
2002-2004 Mitigation Inventory Surveys – Deni Porej & Chad Kettlewell

- 101 projects (178 wetlands)
- 71.2% of required acreage constructed
- 425.3 ac wetland impacts, 697.8 ac required, 496.8 ac constructed (71.2%)
- Replacement ratio 1:1.17
- Approx. 95% emergent marshes
- 5% no mitigation constructed
“No net loss” in Ohio

less than permitted ratio

greater than permitted ratio
Types of Wetland Impacts and Replacement Occurring in Ohio

- Most impacts are to hydrologically isolated depressions
  - A large percentage of these are forested wetlands or shrub wetlands in a forested setting
  - Somewhere between 40-50% of impacts occur to forested and shrub depressions
- Replacement through mitigation projects has not resulted in replacing these systems
Where along the continuum do mitigation wetlands fall

Range of Natural Wetland Condition

Least impacted  Most disturbed

slide from Fennessy and Roksosh 2002
Ecosystem complexity: Measured components

- Aboveground biomass
- Plant community composition
- Soil composition
- Detritus
- Water Chemistry
- Soil
- Biogeochemical indicators
- Nutrient leaching rate
- Nutrient uptake rates
- Organic matter production

VIBI

slide from Fennessy and Rokosch 2002
Using wetland flora, decomposition rates, and soil chemistry to evaluate mitigation wetland success

A Comparison of the Similarity between Natural and Created Wetlands, Fennessy and Rokosch 2002

![Similarity Chart]

- Natural - blue
- Created - red
Using IBIs to evaluate mitigation wetland success
Vegetation IBI (1996-2002)

The graph shows a box plot of VIBI 2004 across different ORAM tertiles. The tertiles are labeled as 1st, 2nd, 3rd, and mitigation. The y-axis represents VIBI 2004 values ranging from 0 to 100.
Amphibian and Bird Dynamics – Deni Porej

Northern leopard frog, Rana pipiens
Wetlands with “Shallow”

Slope of 1:15 or less over a 15m transect, >50% emergent vegetation
Wetlands without “shallow”
Association of “shallows” & fish predation with amphibian $\alpha$ - diversity

Local species richness (-GB) = 2.35 - 1.41 Fish + 2.29 Shallows
R-Sq(adj) = 0.69

All coefficients significant at p< 0.05 level
Vegetation pattern in replacement wetlands

- Perimeter wetlands (<10% veg. cover): 37.7% (>1ha), 35.3% (<1ha)
- Low vegetation wetlands (10-40% veg. cover): 31.9% (>1ha), 29.4% (<1ha)
- High vegetation wetlands (>40% vegetation cover): 30.4% (>1ha), 35.3% (<1ha)
VEGETATION COVER

Slides from Deni Porej, TNC
## Changes in amphibian communities

<table>
<thead>
<tr>
<th>Species</th>
<th>Forested</th>
<th>Emergent</th>
<th>Mitigation</th>
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</thead>
<tbody>
<tr>
<td>Red spotted newt</td>
<td>27</td>
<td>0</td>
<td>5</td>
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<tr>
<td>Spotted salam.</td>
<td>55</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Jefferson salam.</td>
<td>45</td>
<td>12</td>
<td>0</td>
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<tr>
<td>Smallmouth salam.</td>
<td>86</td>
<td>31</td>
<td>20</td>
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<tr>
<td>Tiger salam.</td>
<td>64</td>
<td>38</td>
<td>5</td>
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<tr>
<td>Salamanders (sp/site)</td>
<td>3.00</td>
<td>0.92</td>
<td>0.26</td>
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<tr>
<td>Gray treefrog</td>
<td>27</td>
<td>33</td>
<td>31</td>
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<tr>
<td>N. spring peeper</td>
<td>64</td>
<td>92</td>
<td>53</td>
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<tr>
<td>Western chorus frog</td>
<td>42</td>
<td>41</td>
<td>22</td>
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<tr>
<td>Bullfrog</td>
<td>18</td>
<td>38</td>
<td>55</td>
</tr>
<tr>
<td>Green frog</td>
<td>64</td>
<td>54</td>
<td>68</td>
</tr>
<tr>
<td>N. leopard frog</td>
<td>45</td>
<td>85</td>
<td>65</td>
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<tr>
<td>Wood frog</td>
<td>27</td>
<td>0</td>
<td>0</td>
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<tr>
<td>American toad</td>
<td>0</td>
<td>8</td>
<td>48</td>
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<tr>
<td>Frogs &amp; toads (sp/site)</td>
<td>2.77</td>
<td>3.31</td>
<td>3.96</td>
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<tr>
<td>Total (sp./site)</td>
<td>5.77</td>
<td>4.23</td>
<td>4.32</td>
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# Wetland bird responses to wetland vegetation pattern

<table>
<thead>
<tr>
<th>Breeders</th>
<th>Perimeter wetlands</th>
<th>Low vegetation cover</th>
<th>High vegetation cover</th>
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<tr>
<td></td>
<td>4.58 ± 0.60</td>
<td>7.26 ± 0.57</td>
<td>9.74 ± 0.62</td>
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<tr>
<td>Pie-billed grebe</td>
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<tr>
<td>Mallard</td>
<td>7.26 ± 0.57</td>
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<td></td>
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<tr>
<td>Canada goose</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Virginia rail</td>
<td>9.74 ± 0.62</td>
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<tr>
<td>Sora</td>
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<tr>
<td>Swamp sparrow</td>
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<tr>
<td>Marsh wren</td>
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<tr>
<td>Willow flycatcher</td>
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<tr>
<td>Wood duck</td>
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<td></td>
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<tr>
<td>All birds</td>
<td>11.02 ± 1.37</td>
<td>17.39 ± 1.31</td>
<td>21.83 ± 1.42</td>
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<tr>
<td>Migrating waterfowl</td>
<td>29.34 ± 3.44</td>
<td>34.75 ± 3.28</td>
<td>17.57 ± 3.57</td>
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<tr>
<td>Migrating shorebirds</td>
<td>6.66 ± 1.97</td>
<td>15.66 ± 1.87</td>
<td>5.72 ± 2.04</td>
</tr>
</tbody>
</table>
Recommendations - Deni Porej’s thesis

- Follow-up is necessary
- Hydrological equivalence
- Bank slopes 1:15 or less
- Restore forested and shrub wetlands with seasonal hydrology
- Avoid consolidation – several diverse pools rather than one big pool (maximize diversity)
- Require similarity in the landscape context, find creative ways to preserve terrestrial buffers
Mitigation Bank Study

- Monitored 33 subareas at 12 wetland mitigation banks
- Total = 999.2 acres (404.4 hectares)
- Data collected in 2003 and 2004
Bank Study Design

- Collected data on banks flora, fauna, soil and water chemistry and hydrology
- Monitored plants using 42 fixed and 331 random plots
- Monitored amphibians and invertebrates
  1040 funnel traps & 104 qual. samples
- Took grab water samples and used auger for soil samples
- Hydrology - used automated water recorders deployed for a year
Random plot sampling variation
Results of Bank Vegetation Surveys

- Open water – 0 to 82% - avg = 29%
- Unvegetated open water – 0 to 75.8% - avg = 19%
- Net loss of wetland acreage = 157.1 acres
- Net loss at sold out banks = 105.3 acres
- Plant communities present:
  - 46% emergent marsh
  - 17% wet meadow
  - 11% forest, 4% dead forest
  - no natural shrub communities
Ecological Quality of Ohio Banks
Species Composition of Wetland Mitigation Banks

- **Abundant**
  - Green frog, *Rana clamitans* 38%
  - Toads, *Bufo* sp. 21%
  - Leopard frog, *R. pipiens* 19%
  - Bullfrog, *R. catesbeiana* 12%
  - Spring peeper, *Pseudacris crucifer* 5%

- **Absent or extremely rare**
  - All ambystomatid salamander species
  - Red spotted newt, *Notophthalmus viridescens*
  - Wood frog, *R. sylvatica*
  - Spotted salamander, *Ambystoma maculatum*
Boxplots of AmphIBI by Wetland Type

(means are indicated by solid circles)

Score Cat

AmphIBI

Forest and Shrub Swamps
n=59

emergent
n=52

miti
n=10

miti bank
n=35
Bank Limitations to Amphibian Usage

- Presence of predatory fish – stream hydrology
- Permanent vs. seasonal hydrology
- Steep slopes and lack of vegetation – vegetation present is emergent class
- Narrow or no buffers and intensive surrounding land uses
- Large sizes minimizing edge habitats
Conclusions

- We have monitored wetlands
  - all ecoregions of Ohio
  - spanning the range of disturbance
  - all plant & HGM classes
  - including mitigation
- We have developed assessment tools (IBIs) that accurately measure wetland condition (quality)
- Wetland mitigation projects are not performing like the natural wetlands they are replacing
Thank You!