Mid-Atlantic Freshwater Wetlands: Using Science to inform Policy and Practice

MAWWG – Mid-Atlantic Wetlands Work Group
Regina Poeske, EPA – Region 3, Co-Director
www.mawwg.psu.edu

Riparia - a Center where science informs policy and practice in wetlands ecology, landscape hydrology, and watershed management
Robert P. Brooks, Ph.D., Director
www.riparia.psu.edu
Putting Tools into Practice

Presentation Outline

• MAWWG Background
• Scale of Assessment
• Level 1 – Landscape Assessment
• Level 2 – Rapid Assessments
• Level 3 – Intensive Assessments
Clean Water Act

- Under the Clean Water Act 305(b) States are required to monitor and report on the quality of waters within their states, which includes wetlands.
- Some data on quantity, but little on the quality or condition of wetlands.
- Wetland monitoring & assessment major priority for EPA’s National Wetlands Program.
- Goal to increase quantity and improve the quality of the nation’s wetlands.
Strategies for Capacity Building

• National Wetlands Monitoring Work Group
  – Build state/tribal capacity in wetland monitoring and assessment
  – Help guide a National Wetland Condition Assessment
  – Establish a baseline of ambient wetland condition across the nation
  – Build science behind wetland assessment in collaboration with ORD, academia and states

• EPA Office of Research and Development (ORD)
  – Advance the science of natural resource monitoring at regional and national scales
  – Provide EPA with national scientific leadership for wetland monitoring initiatives
  – Support method development, design and analysis for wetland monitoring programs

• Regional Wetland Monitoring Workgroups
Mid-Atlantic Wetland Work Group

- **Purpose:** Forum for states in the Mid-Atlantic to facilitate the development and implementation of wetland monitoring and assessment strategies and integration into wetland program management.

- **Goals:**
  - Development and implementation of state wetland monitoring strategies and methods for the Mid-Atlantic region
  - Integrate wetland monitoring activities into water assessment programs
  - More effectively manage waters on a watershed basis
  - Integrate best available science into wetland program decision-making
Academic Partners

- Pennsylvania State University
- Virginia Institute of Marine Science
- West Virginia University
- Virginia Tech
- Kenyon College (Ohio)
<table>
<thead>
<tr>
<th>Year</th>
<th>Milestones</th>
<th>State Products</th>
<th>Collaborative Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Identification of Existing Wetland Assessment Tools, Training Needs</td>
<td>Assessment of Existing WQ Tools and Methods (New Jersey)</td>
<td>Launched MAWWG Web site</td>
</tr>
<tr>
<td>2004</td>
<td>Introduction to Probabilistic Sampling Methods</td>
<td>Unveiling of Wetland Data-Viewer (Virginia)</td>
<td>Developed Training Strategy for Member States</td>
</tr>
<tr>
<td>2005</td>
<td>Introduction to Tiered Aquatic Life Uses for Wetlands</td>
<td>Conducted Rapid Assessment for Riverine Wetlands (Maryland)</td>
<td>Report on Status of Wetland Monitoring by States and Academic Partners</td>
</tr>
<tr>
<td>2006</td>
<td>First Deployment of Monitoring and Assessment Programs</td>
<td>Conducted Non-tidal Wetlands Assessment (Virginia) &amp; IBI for Headwater Wetlands (Pennsylvania)</td>
<td>Initiated Atlantic Slope Consortium</td>
</tr>
<tr>
<td>2007</td>
<td>Discussion on Regulatory and Non-Regulatory Use of Wetland Assessment Data</td>
<td>Evaluated Mitigation Wetlands (West Virginia)</td>
<td>Committed to and Initiated Mid-Atlantic Regional Wetland Assessment</td>
</tr>
<tr>
<td>2008</td>
<td>Introduction to Wetland Ecosystem Services</td>
<td>Developed Rapid Assessment Procedure (DERAP) (Delaware)</td>
<td>Introduction to EPA’s Coastal Wetland Initiative</td>
</tr>
<tr>
<td>2009</td>
<td>Examination of Climate Change in the Mid-Atlantic and Impacts to Aquatic Resources</td>
<td>Developed Comprehensive Assessment Procedure (DECAP) (Delaware)</td>
<td>Completed Regional Floristic Quality Index</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td>Conducted Rapid Wetland Assessment (WRRAP) and Floristic Quality Assessment (West Virginia)</td>
<td>Conducted National Wetland Condition Assessment</td>
</tr>
<tr>
<td>2011</td>
<td>Discussion of Mitigation Banking in the Mid-Atlantic</td>
<td>Conducted DECAP for Mitigation Wetlands (Delaware)</td>
<td>Demonstrated Mitigation Design and Performance Database and Floristic Quality Assessment Calculator</td>
</tr>
<tr>
<td>2012</td>
<td>Introduction to Outreach Tools and Strategies</td>
<td>Reported on Economic Valuation of Wetland Ecosystem Services (Delaware)</td>
<td></td>
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</tbody>
</table>
Bioassessment Tools
Search for bioassessment tools by state or physiographic province
Floristic Quality Assessment Index (FQAI)
General information and developments for the Mid-Atlantic region
Mid-Atlantic Regional Wetland Condition Assessment
On-going project to develop a regional rapid assessment protocol for wetland condition
Wetlands Mitigation Design and Performance Database
On-going project compiling reference wetland data to be interpreted and used to inform the design and performance evaluation of restored and mitigated wetlands
Riparia
A center where science informs policy & practice in wetlands ecology, landscape hydrology, and watershed management

Director: Robert P. Brooks
Associate Director: Denice H. Wardrop

www.riparia.psu.edu
Mid-Atlantic Freshwater Wetlands: Advances in Wetlands Science, Management, Policy, and Practice

Robert P. Brooks
Denice Heller Wardrop Editors

Springer

February 2013
Figure 1. Diagram of Ecological and Socioeconomic Scales Relevant to Indicators for Coastal Ecosystems

Spatial/Temporal Scales:
- 1000 Km² - ECO-REGION
- 100 Km² - WATERSHED/LANDSCAPE
- Km² - SMALL WATERSHED
- ha - SITES

Human Scales:
- m² - GROUND PLOTS
- ha - FORESTED WETLAND/SALT MARSH
- ha - LAKE/RESERVOIR
- ha - STREAM/TIDAL CREEK
- person/family - FOREST STAND/MARSH COMMUNITY
- person/family - LAKE SHORE/DEEP WATER BENTHOS
- riparian block - RIFFLE-BRANCH/RIFFLE BENTHOS
How do we **inventory, assess ecological integrity, and restore** natural resources across geographic scales?

**Case Study – Level 1**
- Wetland classification, inventory, & landscape assessment
- **LEVEL 1 LANDSCAPE FROM GIS**
  - Condition assessment from office, reference

**Case Studies – Level 2**
- Mid-Atlantic Regional Wetlands Assessment
- **LEVEL 2 RAPID FIELD ASSESSMENT**
  - Refined condition assessment
  - Landscape profiles
  - Stressor profiles

**Case Studies – Level 3**
- Floristic Quality Assessment Index
- Reference Wetlands for Mitigation
- **LEVEL 3 INTENSIVE FIELD ASSESSMENT**
  - High quality condition assessment
  - FQAI, IBI, & HGM
  - Mitigation design & performance

(Rapanos vs. U.S.)
## Wetland Monitoring Matrix

<table>
<thead>
<tr>
<th>LEVEL 1</th>
<th>INVENTORY</th>
<th>ASSESSMENT</th>
<th>RESTORATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Use existing map resources (NWI) of wetlands</td>
<td>Map land uses in watershed; compute landscape metrics</td>
<td>Produce synoptic watershed map of restoration potential</td>
</tr>
<tr>
<td>LEVEL 2</td>
<td>Enhance inventory using landscape-based decision rules</td>
<td>Rapid site visit and stressor checklist; preliminary condition assessment</td>
<td>Select sites for restoration; examine levels of threat from surroundings</td>
</tr>
<tr>
<td>LEVEL 3</td>
<td>Map wetland zone abundance using verified inventory</td>
<td>Apply HGM and IBI models to selected sites for condition based on reference</td>
<td>Map specific sites for restoration; design projects with reference data sets</td>
</tr>
</tbody>
</table>
Typical Sample Sizes

- **Level 1 - Landscape Assessment**
  - Unlimited number of sites
- **Level 2 - Rapid Assessment**
  - Approximately 20-50 sites per watershed; more watersheds
- **Level 3 - Intensive Assessment**
  - 2 to 3 sites/week, 10 weeks per year, 20 - 30 sites per watershed
Level 1 – Landscape Assessment

• Issues:
  – Wetland classification and inventory
  – Reference wetlands

• How? - Assess condition, ecosystem services, or restoration potential, using:
  – Existing synoptic land use
  – Enhanced inventory

• Policy Implications
  – Decisions made based on wetland classification and inventory
Riverine
  lower perennial (mainstem floodplain)
  floodplain complex
  upper perennial (headwater floodplain)
  headwater complex
  intermittent
    beaver impounded
    human impounded

Lacustrine (fringe)
  permanently inundated
  semipermanently inundated
  intermittently inundated
  artificially inundated
Hydrogeomorphic Classification for Mid-Atlantic Wetlands

Slope

Stratigraphic
Topographic
  mineral soil
  organic soil

Depression

perennial (riparian depression, emergent marsh)
seasonal
temporary (isolated depression, vernal pool)
  human impounded
  human excavated
Hydrogeomorphic Classification (Riparia - PA)

Stream Order

Headwater Floodplain

Riparian Depression

Mainstem Floodplain

Slope
Riverine Lower Perennial - Mainstem Floodplain (Forested) - Swamp
Depression temporary - Vernal pool
Riparia’s Reference Wetlands Collection (n = 222)
Reference Site #57 in Millbrook Marsh

- Forested: 22%
- Agriculture: 40%
- Urban: 38%
First approximation - Pennsylvania’s wetland condition (Level 1) based on landscape analyses for 424,000 NWI wetlands

- Low: 33%
- High: 16%
- Moderate: 51%

Brooks et al. 2004
Level 2 – Rapid Assessment Protocols (RAPs)

• Issue:
  – Implementing field-based, inexpensive assessments of wetlands

• How? Existing rapid assessment protocols (RAPs)
  – PA, DE, VA RAPs = Unified Mid-Atlantic RAP for Wetlands (MAWWG)
  – (also available) - Stream-Wetland-Riparian Index (SWR Index); Brooks et al. 2009 Env Monit Assmt

• Policy Implications
  – Determining condition of wetlands for states
Regional Wetland Assessment Sampling Locations
• Assessment Area (AA): 0.5 ha (40m-radius circle) can be altered in shape to fit site
• Buffer – 100 m concentric “ring” around AA
Landscape Profile for All Sites

# of Sites

Depression  Flat  Lacustrine  Riverine (High Order)  Riverine (Headwater)  Slope

Mid-Atlantic HGM Wetland Classification
Total Stressors for All Sites by Ecoregion
2008 & 2009

- RV: 25%
- AP: 17%
- PD: 30%
- CP: 18%
- GP: 10%
Mid-Atlantic ecosystem service score by watershed: Habitat (all NWI polygons)
Level 3 – Intensive Assessment Methods

• Issue: Using plant community to assess disturbance and/or mitigation performance
  – Mid-Atlantic Region plant list is finalized for use in FQAI

• How? - Floristic Quality Assessment Index
  – Enter plant species list into Calculator (MAWWG/Riparia), and compare scores
  – Testing efficacy with rapid (delineation) and intensive (reference and mitigation) data
2 Level 3 – Intensive Assessment Methods

• Riparia/MAWWG Database of Reference Wetlands
  – Assessing degradation
  – Designing mitigation and restoration projects
  – Evaluating performance of projects

• How? – Choose from relevant variables, and use summary data sorted by ecoregion, state, and HGM wetland type

• (also available: Macroinvertebrate & Amphibian IBIs)
Condition Gradient – Clean Water Act

- Maximum Condition Measurements
- Minimum Condition Measurements
- Highest Ecological Integrity
- Non-Supporting Goals
- Human Disturbance Gradient

Low Human Disturbance Gradient → High Human Disturbance Gradient
HGM Functional Assessment Models for Wetlands

- Energy dissipation/Short term SW detention
- Long term SW storage
- Interception of groundwater

- Cycling of redox-sensitive compounds
- Solute adsorption capacity
- Retention of inorganic particulates
- Export of organic particulates
- Export of dissolved organic matter

- Plant community structure and composition
- Detritus
- Vertebrate community structure and composition
- Invertebrate community structure and composition
- Maintenance of landscape-scale biodiversity
Wetlands Plants:

Floristic Quality Assessment Index (FQAI)

Plant Index of Biological Integrity

Sarah Chamberlain
### My Plant List

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Scientific Name</th>
<th>Family</th>
<th>C</th>
<th>Native</th>
</tr>
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<tbody>
<tr>
<td>CAST8</td>
<td>Carex stricta</td>
<td>Cyperaceae</td>
<td>6</td>
<td>Y</td>
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<tr>
<td>DRRO</td>
<td>Drosera rotundifolia</td>
<td>Droseraceae</td>
<td>10</td>
<td>Y</td>
</tr>
<tr>
<td>TYLA</td>
<td>Typha latifolia</td>
<td>Typhaceae</td>
<td>2</td>
<td>Y</td>
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### Results

<table>
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<th></th>
<th>Value</th>
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<tr>
<td>FQI</td>
<td>10.4</td>
</tr>
<tr>
<td>Adjusted FQI</td>
<td>60.0</td>
</tr>
<tr>
<td>Total mean C</td>
<td>6.0</td>
</tr>
<tr>
<td>Total N</td>
<td>3</td>
</tr>
<tr>
<td>Native mean C</td>
<td>6.0</td>
</tr>
<tr>
<td>Native N</td>
<td>3</td>
</tr>
</tbody>
</table>

### Tolerance

- **High**
- **Intermediate**
- **Poor**
- **Very Poor**
- **Not Applicable**
## FQAI Calculator Metrics:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>FQI</td>
<td>$I = \overline{C} \times \sqrt{N}$</td>
<td>Uses only native species</td>
</tr>
<tr>
<td>Adjusted FQI</td>
<td>$I' = \left( \frac{\overline{C} \times \sqrt{N}}{10 \times \sqrt{N} + A} \right) \times 100$</td>
<td>Includes non-native species (A)</td>
</tr>
<tr>
<td>Total Mean C</td>
<td>Average ($C_{\text{Native}}$ and $C_{\text{Non-Native}}$)</td>
<td>Mean coefficient value for native and non-native species</td>
</tr>
<tr>
<td>Total N</td>
<td>No. of Native species + No. of Non-native species</td>
<td>Total number of species present</td>
</tr>
<tr>
<td>Native Mean C</td>
<td>Average ($C_{\text{Native}}$)</td>
<td>Mean coefficient value for native species</td>
</tr>
<tr>
<td>Native N</td>
<td>No. of Native species</td>
<td>Total number of native species present</td>
</tr>
</tbody>
</table>
Wetland “Homogeneity” Model

Reference Population

Disturbed Population

Equivalence

Created Population

Goal for Restored and Created Populations

Degradation

Restoration

Brooks et al. 2005
Sample of landscape analysis for pair of headwater wetland complex sites in central Pennsylvania (Moon 2012, Moon & Wardrop 2013)
Using Reference Wetlands Data to Improve Design and Performance of Mitigation Projects

Gebo and Brooks 2012: Wetlands
We are learning to build better wetlands...

Overall, mitigation sites displayed lower potential to perform a characteristic wetland function than reference wetlands.
Landscape Disturbance

Landscape Index (1 km)

Mitigation

Reference

p=0.000
Comparison of Function in Reference and Mitigation Wetlands in Pennsylvania

Average of 10 HGM Functions

Fringing

Depression
Variables for mitigation design and performance

- Selected ground-based variables are used in design.
- All ground-based variables are used to assess performance.
- Landscape variables are relevant to site selection.
SLOPE DEPRESSION, SEASONAL

VREDOX, mottle and matrix chroma (n=14, n=6)

VORGMA, % organic content in top 5 cm of soil (n=14, n=6)

VSHRUB, estimated % cover of shrubs (n=14, n=6)

VSPPCOMP, adjusted FQAI scores (n=14, n=6)

VREDOX, mottle and matrix chroma (n=34, n=8)

VORGMA, % organic content in top 5 cm of soil (n=34, n=8)

VSHRUB, estimated % cover of shrubs (n=34, n=8)

VSPPCOMP, adjusted FQAI scores (n=34, n=8)
<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Description</th>
<th>N</th>
<th>Min</th>
<th>Avg</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape</td>
<td>VURB</td>
<td>% urban development in 1 km radius</td>
<td>20</td>
<td>0</td>
<td>2.69</td>
<td>42.2</td>
</tr>
<tr>
<td>Landscape</td>
<td>VUNOBSTRUC</td>
<td>floodplain obstruction index</td>
<td>20</td>
<td>0.08</td>
<td>0.79</td>
<td>1</td>
</tr>
<tr>
<td>SoilTopo</td>
<td>VGRAD</td>
<td>elevation gradient based on topo maps</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>SoilTopo</td>
<td>VMACRO</td>
<td>% macrodepressions along transect</td>
<td>20</td>
<td>0</td>
<td>44.68</td>
<td>80</td>
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<tr>
<td>SoilTopo</td>
<td>VMICRO</td>
<td>microtopography</td>
<td>20</td>
<td>0.06</td>
<td>0.35</td>
<td>0.99</td>
</tr>
<tr>
<td>SoilTopo</td>
<td>VORGMA</td>
<td>% organic content in top 5 cm of soil</td>
<td>20</td>
<td>2.2</td>
<td>19.34</td>
<td>47.7</td>
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<tr>
<td>SoilTopo</td>
<td>VREDOX</td>
<td>mottle and matrix chroma</td>
<td>20</td>
<td>0.1</td>
<td>0.57</td>
<td>1</td>
</tr>
<tr>
<td>SoilTopo</td>
<td>VTEX</td>
<td>soil texture determined in field</td>
<td>20</td>
<td>0.03</td>
<td>0.58</td>
<td>0.99</td>
</tr>
<tr>
<td>Stressors</td>
<td>VHYDROSTRESS</td>
<td># of hydrologic modifications</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>3</td>
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<tr>
<td>Vegetation</td>
<td>VBIOMASS</td>
<td>estimated total biomass</td>
<td>20</td>
<td>74.92</td>
<td>245.72</td>
<td>1330.78</td>
</tr>
<tr>
<td>Vegetation</td>
<td>VTREE</td>
<td>estimated % cover of trees</td>
<td>20</td>
<td>0</td>
<td>0.17</td>
<td>1.16</td>
</tr>
<tr>
<td>Vegetation</td>
<td>VSHRUB</td>
<td>estimated % cover of shrubs</td>
<td>20</td>
<td>0</td>
<td>16.12</td>
<td>113.57</td>
</tr>
<tr>
<td>Vegetation</td>
<td>VHERB</td>
<td>estimated % cover of herbs</td>
<td>20</td>
<td>0</td>
<td>6.33</td>
<td>63.47</td>
</tr>
<tr>
<td>Vegetation</td>
<td>VCWD-BA</td>
<td>coarse woody debris est. basal area</td>
<td>20</td>
<td>17.7</td>
<td>218.63</td>
<td>996.16</td>
</tr>
<tr>
<td>Vegetation</td>
<td>VCWD-BA</td>
<td>CWD est. basal area, branches/saplings</td>
<td>20</td>
<td>0</td>
<td>78.12</td>
<td>360.59</td>
</tr>
<tr>
<td>Vegetation</td>
<td>VCWD-BA</td>
<td>CWD est. basal area, trees</td>
<td>20</td>
<td>0</td>
<td>79.71</td>
<td>227.54</td>
</tr>
<tr>
<td>Vegetation</td>
<td>VCWD-BA</td>
<td>CWD est. basal area, large trees</td>
<td>20</td>
<td>0</td>
<td>47.03</td>
<td>661.90</td>
</tr>
<tr>
<td>Vegetation</td>
<td>VCWD-SZ</td>
<td>coarse woody debris size class tally</td>
<td>20</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Vegetation</td>
<td>VEXOTIC</td>
<td>% of species that are non-native</td>
<td>20</td>
<td>0</td>
<td>12.71</td>
<td>46.4</td>
</tr>
</tbody>
</table>
How we inventory, assess the ecological integrity, and restore natural resources across geographic scales.

LEVEL 1 LANDSCAPE FROM GIS

LEVEL 2 RAPID FIELD ASSESSMENT

LEVEL 3 INTENSIVE FIELD ASSESSMENT
Thank you!

Q & A