SWR in PA, MAHA, MAIA using
HGM: ID, RD, SL, HF, MF, FR
and
IBIs: ICI, AIBI, PIBI, BCI

RPB, DHW, JAB, JMR, SEL, AMC, MMF, SJM, and *TJO
from PSCWC

Thx: USEPA-OWOW, USEPA-STAR, USEPA-3, CORPS, PADEP
INTEGRATING BIOLOGICAL, PHYSICAL, AND LANDSCAPE INDICATORS FOR WETLANDS, STREAMS, AND RIPARIAN AREAS OF THE MID-ATLANTIC REGION

Penn State Cooperative Wetlands Center
*Acknowledgements*

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- USEPA OWOW, Washington, DC
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- PADEP, Div. Waterways, Wetlands & Erosion Control, Harrisburg, PA

THANKS!
Questions

- How do we find the wetlands? (Inventory)
- How do we assess their ecological integrity? (Condition)
- How do we use this information to improve condition? (Restoration)
## Wetland (Watershed) Monitoring Matrix

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>INVENTORY</th>
<th>ASSESSMENT</th>
<th>RESTORATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL 1</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-stressor checklist; based decision rules</td>
<td>Rapid site visit and 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>
Conceptual Condition Gradient

- **Highest Ecological Integrity**
- **Non-Supporting Goals**
- **Human Disturbance Gradient**

Condition Measurements:
- **Maximum**
- **Minimum**
Reference

- Streams:
  - reference = best attainable
  - disturbed = < reference
- Wetlands:
  - reference std. = best attainable
  - reference = < reference std.

Need a gradient of sites from high to low ecological integrity.
Wetland, Stream, and Riparian Assessment Protocols and Tools of the Penn State Cooperative Wetlands Center

- Reference wetlands (n=222) in PA
- Stream/Wetland/Riparian Protocol (Mid-Atlantic Region)
- Calibrated HGM Functional Models (n=6)(all PA ecoregions)
- Macroinvertebrate IBIs (multiple PA ecoregions)
- Amphibian IBI (Ridge and Valley Ecoregion)
- Wetland Plant Index of Biotic Integrity (IBI)(all PA sites)
- Bird Community Index (Landscape)(Mid-Atlantic Region)
- Streamside Salamander IBI (Mid-Atlantic Highlands-MAHA)
Reference Site #57 in Millbrook Marsh

- Forested: 22%
- Agriculture: 40%
- Urban: 38%
Rapid Assessment Score

- Combination of landscape, buffer, and site-specific stressors
- Score = Buffer + (%For*WF) - Buffer Hits
Stressor Checklist

- Hydrologic Modification
- Sedimentation
- Dissolved oxygen
- Contaminant toxicity
- Vegetation alteration
- Eutrophication
- Acidification
- Turbidity
- Thermal Alteration
- Salinity
**Methods...Blah, blah, blah**
Spring Creek
Watershed

Legend

- Reference Site
- Sample Point
- Landscape Circle
- Water
- Forest
- Transitional
- Perennial Herbaceous
- Annual Herbaceous
- Barren
- Vegetated Suburban
- Urban
- Roads

Figure 10: Land cover for Spring Creek, Centre County, Pennsylvania.
Spring Creek

Rank Order of Sites by Decreasing % Forest
Proportion of Stressors in the Spring Creek Watershed

- Hydrologic Modifications: 31%
- Vegetation Alteration: 26%
- Sedimentation: 2%
- Eutrophication: 10%
- Dissolved Oxygen: 2%
- Contaminant Toxicity: 1%

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Watersheds Selected for SWR Sampling
## Distribution of SWR-Sampled Watersheds Among Physiographic Provinces and Land Cover Clusters

<table>
<thead>
<tr>
<th>Province</th>
<th>1-Forest/Hi Slope</th>
<th>2-Urban</th>
<th>3-Mixed/Lo NV</th>
<th>4-Forest/Lo Slope</th>
<th>5-Agriculture</th>
<th>6-Mixed/Hi NV</th>
<th>Mixed Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Plain</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1*</td>
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<tr>
<td>Piedmont</td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ridge and Valley</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>2**</td>
</tr>
<tr>
<td>Plateau - NonGlacial</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Plateau - Glacial</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

* includes sub-watersheds in Clusters 3 & 5
** (1) sub-watersheds in Clusters 1 & 6; (2) sub-watersheds in Clusters 3, 5 & 6
Stream, Wetland, Riparian (SWR) Sampling with Brian & Jeremy

6 months + 16,000 miles + 13 motel chains + bed bugs + too many fast food meals + a couple of irate landowners =

17 watersheds + 360 sites + 1440 digital photographs + 6440 data sheets

(... and they are still smiling!!!
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 (Fx5)

- Plant community structure and composition
- Detritus (Fx10)
- Vertebrate community structure and composition
- Invertebrate community structure and composition
- Maintenance of landscape-scale biodiversity
Indices of Biological Integrity (IBIs)
Invertebrate Community Index - ICI

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Macroinvertebrate Index of Community Integrity metrics - Laubscher & Conklin

- **Isolated depressions (n=6)**
  - Class/Order richness
  - %OMT taxa
  - Relative abundance of Chaoboridae, Predator + Shredder
  - % Predator & % Shredder taxa

- **Riparian depressions (n=5)**
  - %TMP taxa
  - % Hydrophilidae
  - Relative abundance of Tipulidae
  - Collector taxa richness
  - Relative abundance of Predator & Shredders

...
Unglaciated Riparian Depressions

Final ICI Scores (A. Conklin, 2003)

- High Integrity
- Moderate to Low Integrity
- Very Low Integrity

$r = -0.733, P = 0.007$
Amphibian
Index of Biological Integrity
Amphibian IBI metrics - Farr

- Species richness
- Number of intolerant species
- Percent intolerant species
- Presence of spotted salamander or wood frog
- Presence of N. dusky salamander
Plant Index of
Biological Integrity
Plant IBI metrics - Miller & Wardrop

- Tested over 40 potential plant metrics
- Selected 8 to build IBI
  - Adjusted Floristic Quality Assessment Index
  - % Annuals
  - % Non-natives
  - % Invasives
  - % Trees
  - % Cryptogams (ferns and fern allies)
  - % Cover of tolerant plant species
  - % Cover of *Phalaris arundinacea*
LOUISIANA WATERTHRUSH (SEIURUS MOTACILLA)
BIOLOGICAL INDICATOR

Bird Community Index - BCI
Bird Community Index (BCI) metrics - O’Connell, Jackson & Brooks

- Guild (n=16) proportions for:
  - Structural
  - Compositional
  - Functional

Wetlands, riparian areas & landscape
Classification of Sites

Stream Order

Headwater Floodplain

Riparian Depression

Mainstem Floodplain

Slope

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IBI & HGM comparisons for isolated depressions

- **Invert IBI**
- **Amphibian IBI**
- **Plant IBI**
- **Bird BCI**
- **HGM Fx 5**
- **HGM Fx 10**

**Legend:**
- **Twin Ponds - PGC**
- **PSU Airport**
27-WDC GagingStn - Mainstem Floodplain
28-Millbrook Marsh - Mainstem Floodplain
IBI & HGM comparisons for mainstem floodplains

IBI/HGM Score (dimensionless)

- Invert IBI
- Amphibian IBI
- Plant IBI
- Bird BCI
- HGM Fx 5
- HGM Fx 10

WDC - Gaging Station  Millbrook Marsh
IBI & HGM scores for all sites (n=31) along disturbance gradient

Disturbance Score (dimensionless)

IBI/HGM Score (dimensionless)

- Invert IBI
- Amphibian IBI
- Plant IBI
- Bird BCI
- HGM Fx 5
- HGM Fx 10
Condition Assessments of Wetlands and other Waters

- “Dose-response” approach can be used for biological, chemical, physical indicators (e.g., IBIs, HGM models)
- Requires crafting a set of scientifically defensible benchmarks (tiers) that correspond to a degradation pattern or sequence of human activities
- Using multiple taxa and indicators, and stressor identification can help prioritize and focus management actions
- Approach can be adapted to all types of aquatic and terrestrial ecosystems, and multiple types of indicators
- This approach is useful for integrating waters under the Clean Water Act, USEPA research programs, and state water programs
Summary

Ask not what the wetland does for the watershed, but how the watershed (and its uplands) affects the wetland…and the stream, and the floodplain, and the riparian area, and the estuary…
“W” is for Wetlands and Waters