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

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Penn State Cooperative Wetlands Center

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THANKS!

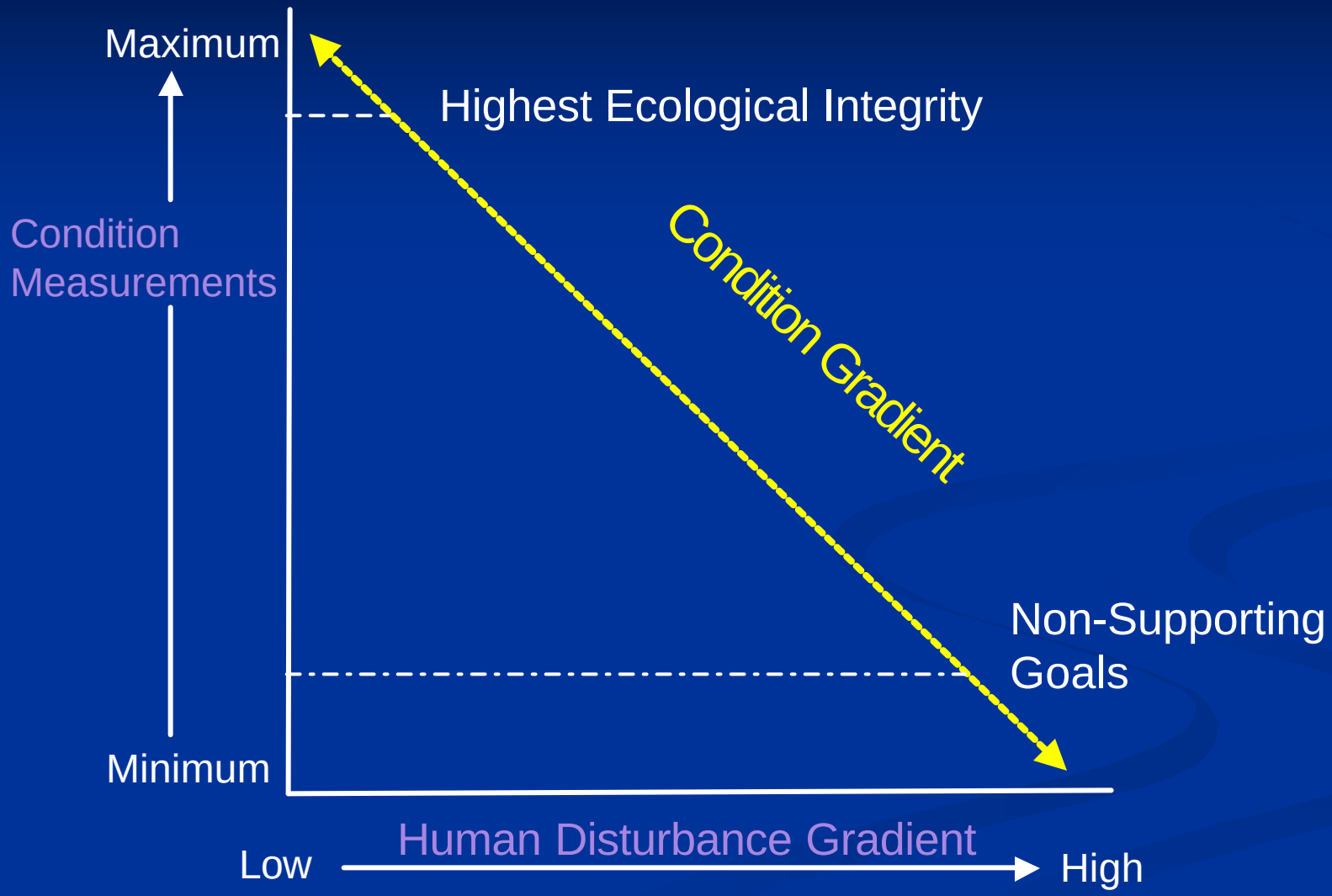
Questions

- 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

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

Conceptual Condition Gradient



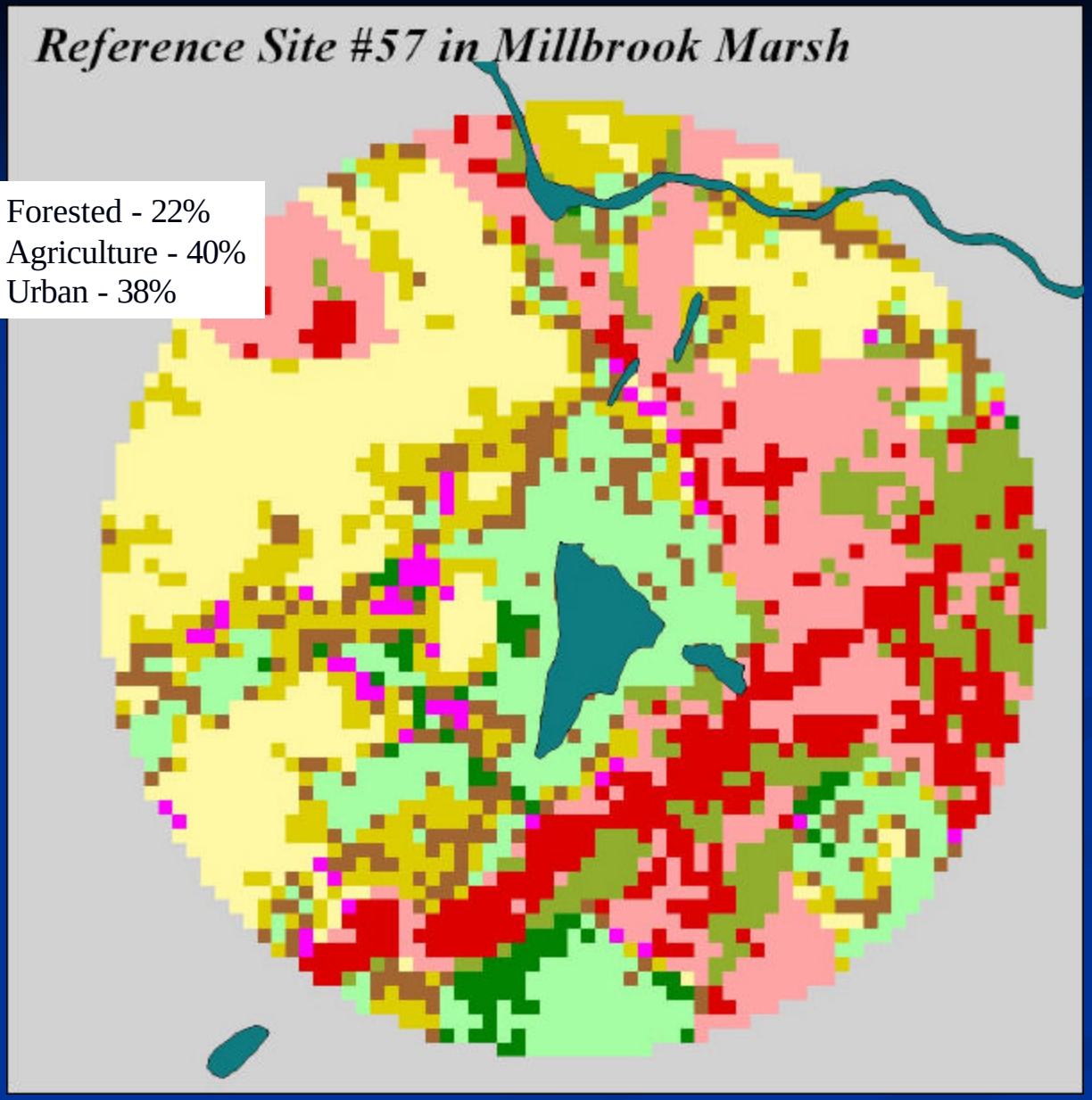
Reference

- 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.

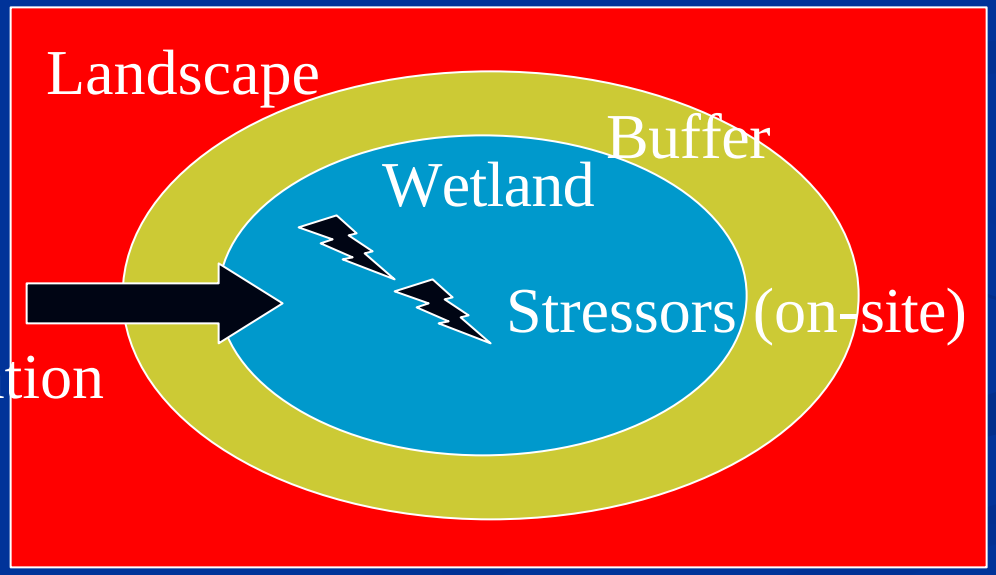
Wetland, Stream, and Riparian Assessment Protocols and Tools of the Penn State Cooperative Wetlands Center

- 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

STRESSOR CHECKLIST

Stressor Score: _____

Site Name: _____ Site Number: _____ Date: _____

Buffer Type*	Buffer Width: >100	30-100	10-30	3-10	0-3
Natural Forest	14	12	10	8	6
Shrub/Sapling	12	10	8	6	4
Perennial Herb	10	8	6	4	2
Other	0	0	0	0	0

*If exactly one-half of two buffer types, take half the sum

Buffer Width _____ (m) Buffer Score _____

Buffer Type

- ☐ Natural Forest
- ☐ Perennial Herb
- ☐ Shrub/Sapling
- ☐ Other (list) _____

Hydrologic Modification Score: _____

(Score = the number of checked boxes)

- ☐ Ditch
- ☐ Tile Drain
- ☐ Dike
- ☐ Weir/dam *Type:* _____
- ☐ Stormwater inputs/culvert
- ☐ Point source (non-stormwater)
- ☐ Filling, grading, dredging (of wetland/waterbody or immediate buffers)
- ☐ Road bed/railroad
- ☐ Dead/dying trees
- ☐ Other _____

Vegetation Alteration Score: _____

- ☐ Mowing
- ☐ Grazing
- ☐ Tree cutting (> 50 % canopy removal)
- ☐ Brush cutting (mechanized removal of shrubs/saplings)
- ☐ Removal of woody debris
- ☐ Aquatic weed control (mechanical or herbicide)
- ☐ Excessive herbivory (deer, muskrat, geese, carp, etc.)
- ☐ Dominant presence (>50% of the vegetation) of exotic or aggressive plant species (see list)
- ☐ Evidence of chemical defoliation
- ☐ Oth _____

Sedimentation Score: _____

- ☐ Active/recently active adjacent construction, plowing, heavy grazing, or forest harvesting
- ☐ Siltlines on ground or vegetation
- ☐ Urban/road stormwater input/culvert
- ☐ Dominant presence (>50% of vegetation) of sediment tolerant plants (see list)
- ☐ Other _____

Nutrient Enrichment

- ☐ Direct discharges from septic or sewage treatment systems
- ☐ Heavy or moderately heavy formation of algal mats
- ☐ Dominant presence (>50% of vegetation) of nutrient tolerant species (e.g., uniform stands of exotic/aggressive species - see list)
- ☐ Other (e.g., signs of excess nutrients - methane odor, dead fish, etc.) _____

Dissolved Oxygen Score: _____

- ☐ Excessive density of aquatic plants or algal mats in water column
- ☐ Excessive deposition or dumping of organic waste (e.g., leaves, grass clippings, woody debris, etc.)
- ☐ Direct discharges of organic wastewater or material (e.g., milkhouse waste, food-processing waste, other wastewater sources)

Acidification Score: _____

- ☐ AMD discharges
- ☐ Adjacent mined lands/spoil piles
- ☐ Excessively clear water
- ☐ Absence of expected biota
- ☐ Other (e.g., abnormally low pH measure) _____

Turbidity (if high conc, check both boxes) Score: _____

- ☐ High concentration of suspended solids in water column
- ☐ Moderate concentration of suspended solids in water column

Contaminant Toxicity Score: _____

- ☐ Severe vegetation stress
- ☐ Obvious spills, discharges, plumes, odors
- ☐ Wildlife impacts (e.g., tumors, abnormalities, etc.)
- ☐ Adjacent industrial sites, proximity of railroad
- ☐ Other _____

Thermal Alteration (if high temp, check both boxes) Score: _____

- ☐ Significant increase water temperture
- ☐ Moderate increase in water temperature

Salinity Score: _____

- ☐ Obvious increase in concentration of dissolved salts

Methods...Blah, blah, blah

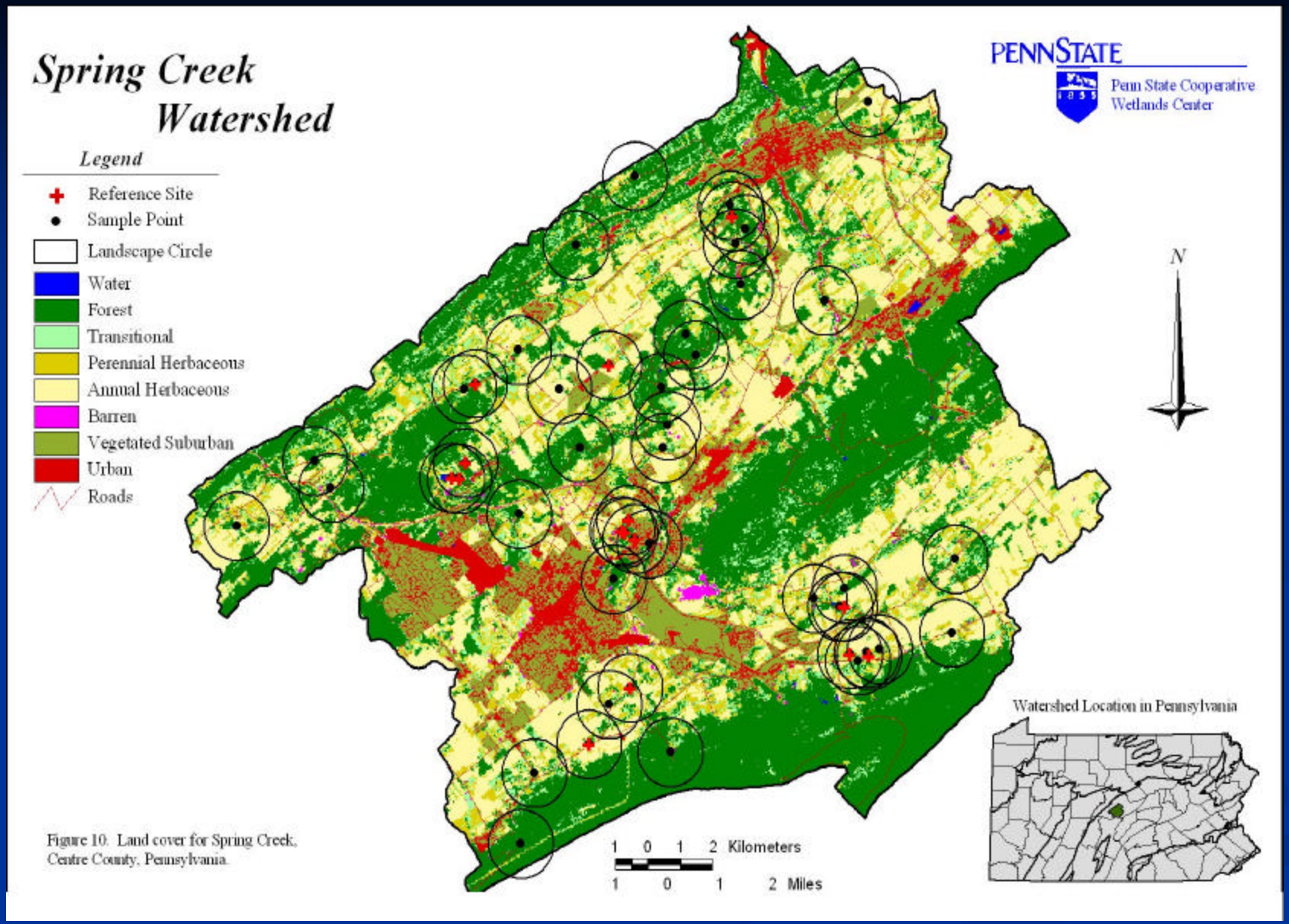
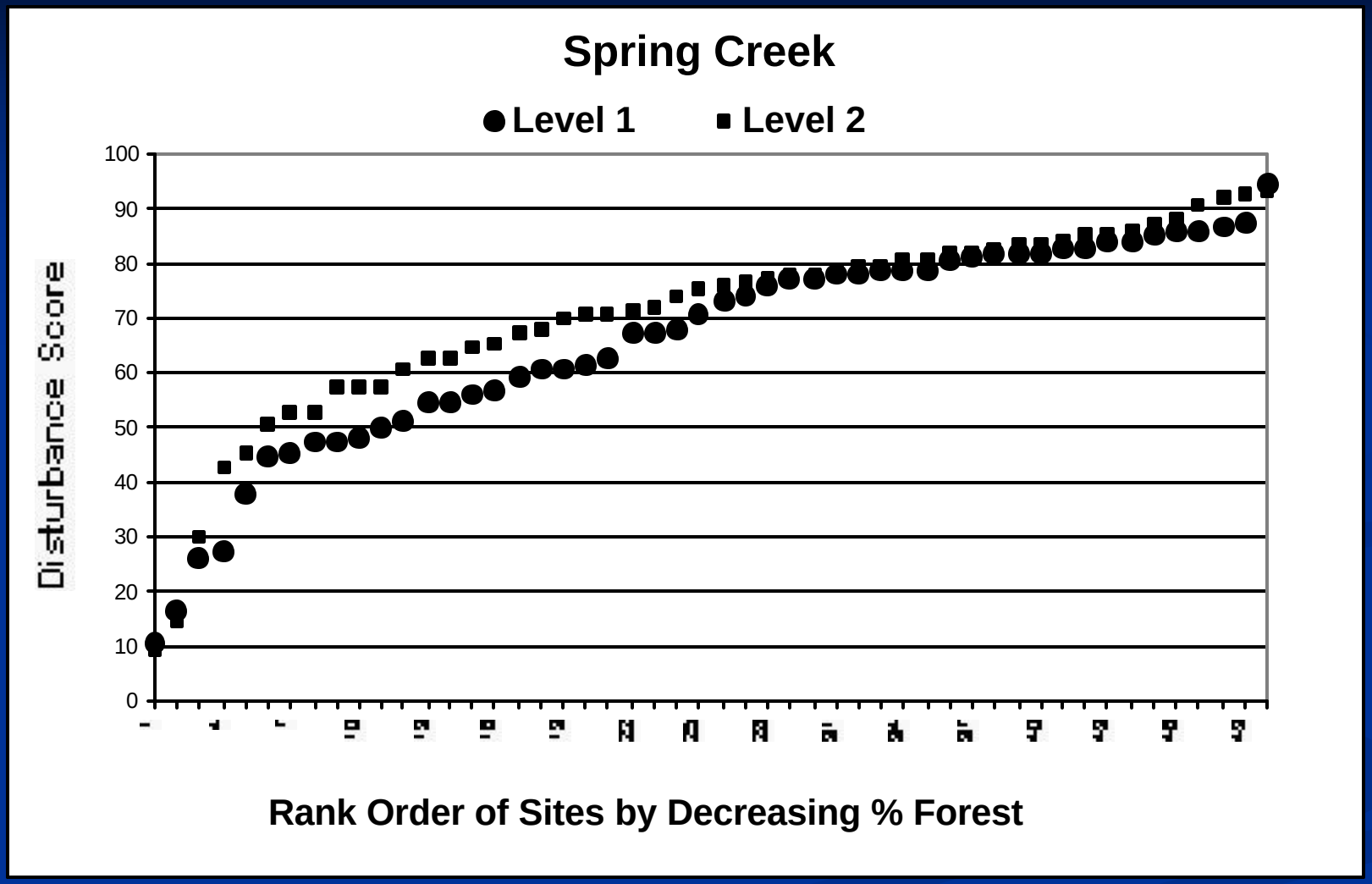
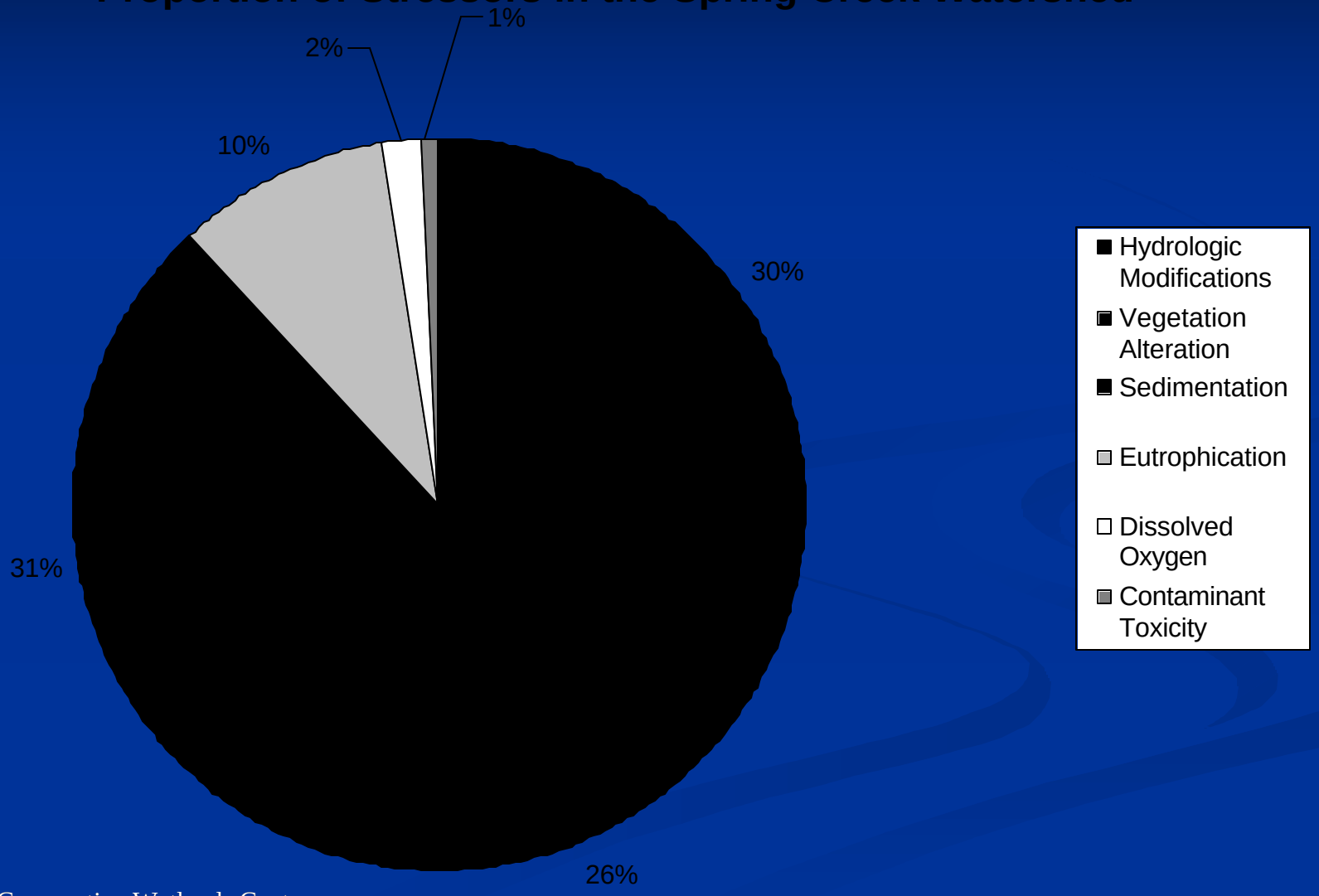


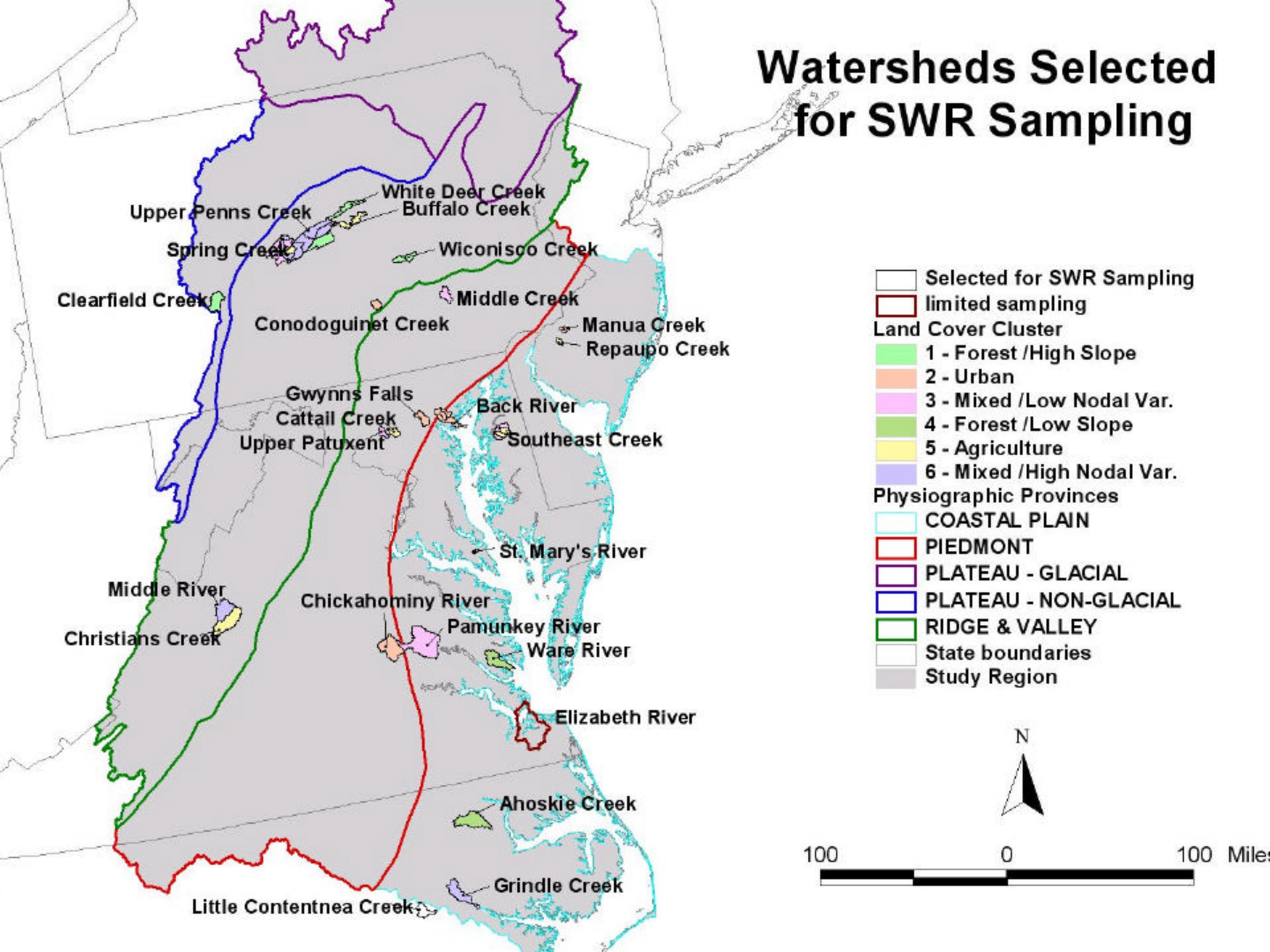
Figure 10. Land cover for Spring Creek, Centre County, Pennsylvania.


Spring Creek
Level 1
Level 2
Disturbance Score
100
90
80
70
60
50
40
30
20
10
0
Rank Order of Sites by Decreasing % Forest

Proportion of Stressors in the Spring Creek Watershed



Watersheds Selected for SWR Sampling



Distribution of SWR-Sampled Watersheds Among Physiographic Provinces and Land Cover Clusters

Province	Land Cover Cluster						
	1-Forest/Hi Slope	2-Urban	3-Mixed/Lo NV	4-Forest/Lo Slope	5-Agriculture	6-Mixed/Hi NV	Mixed Cluster
Coastal Plain		1	2	3	1	2	1*
Piedmont		2	2		1		
Ridge and Valley	3	1			2	1	2**
Plateau - NonGlacial							
Plateau - Glacial							

* 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

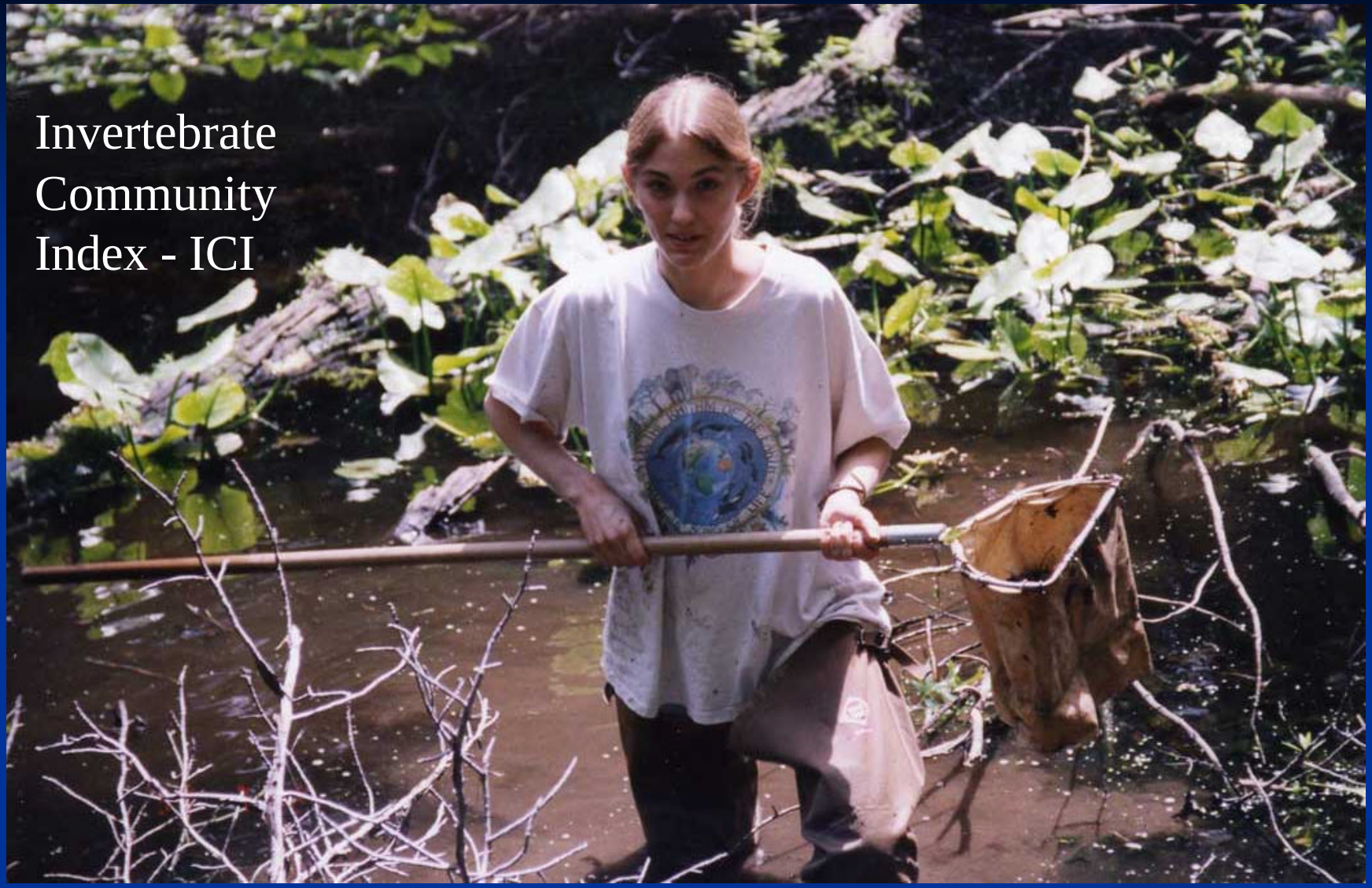
- Cycling of redox-sensitive compounds
- Solute adsorption capacity
- Retention of inorganic particulates
- Export of organic particulates
- Export of dissolved organic matter (Fx5)

- 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

Invertebrate Community Index - ICI



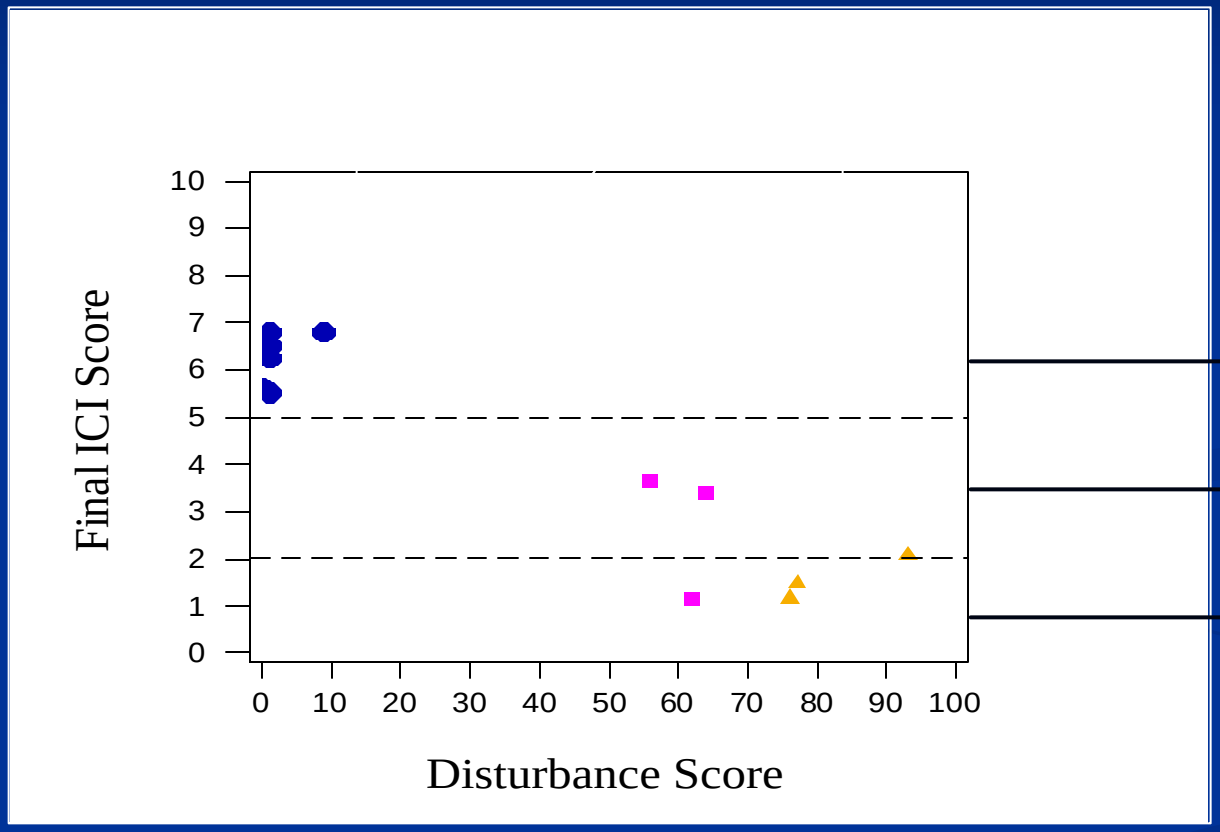
Macroinvertebrate Index of Community Integrity metrics - Laubscher & Conklin

- 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

Reference Moderate Severe

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*

Bird Community Index - BCI

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

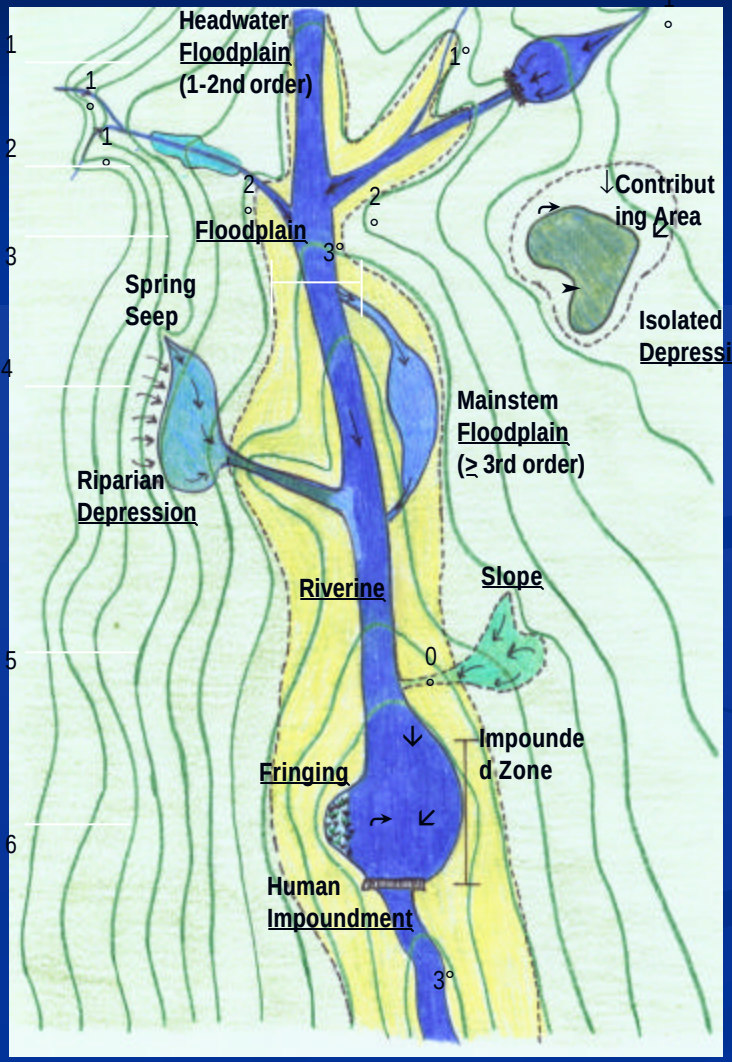
- Guild (n=16) proportions for:
  - Structural
  - Compositional
  - Functional

Wetlands, riparian areas & landscape

Classification of Sites

Headwater Floodplain

Riparian Depression



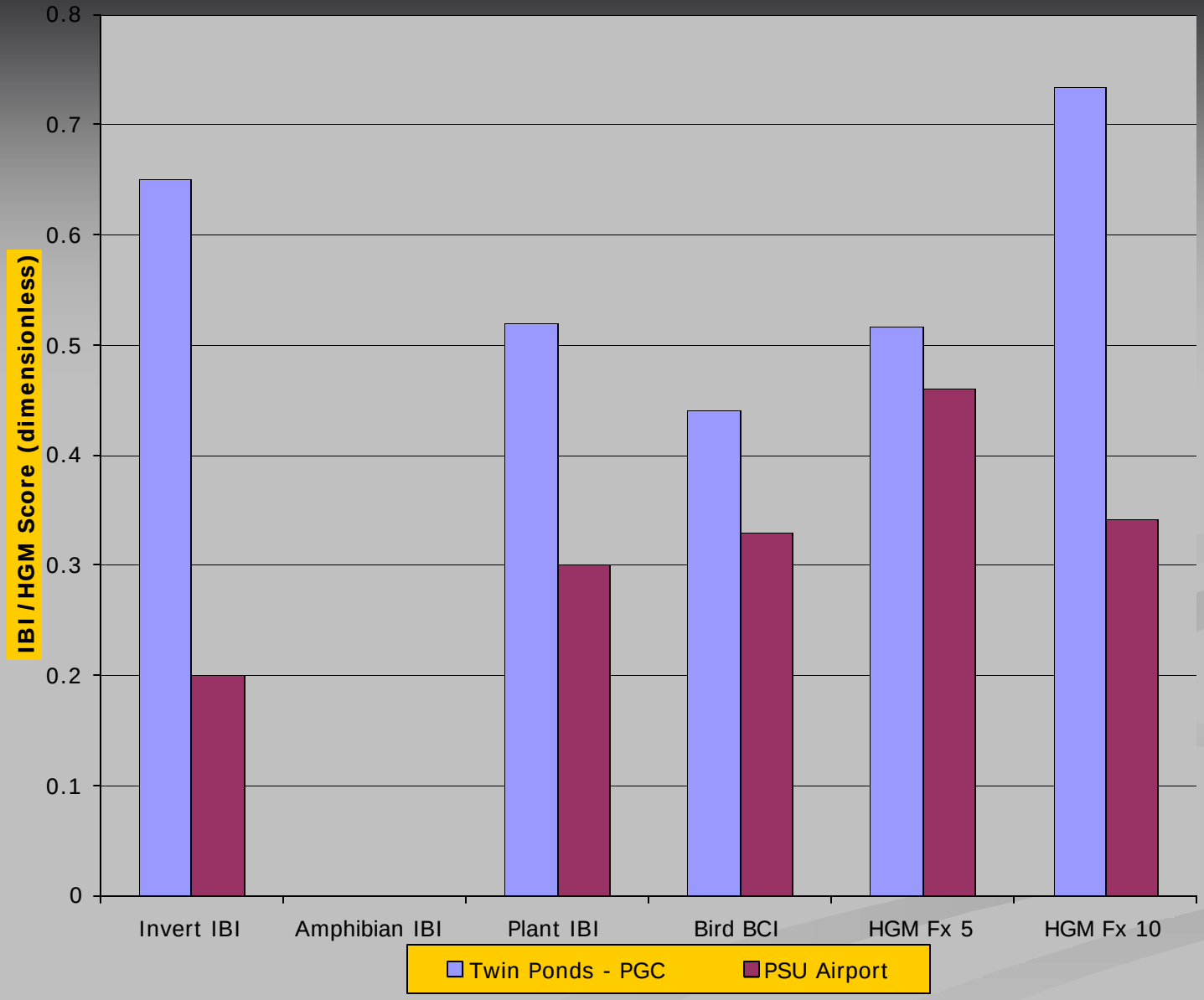
Mainstem Floodplain

Slope

38-TwinPonds-Isolated Depression

9-PSU Airport - Isolated Depression

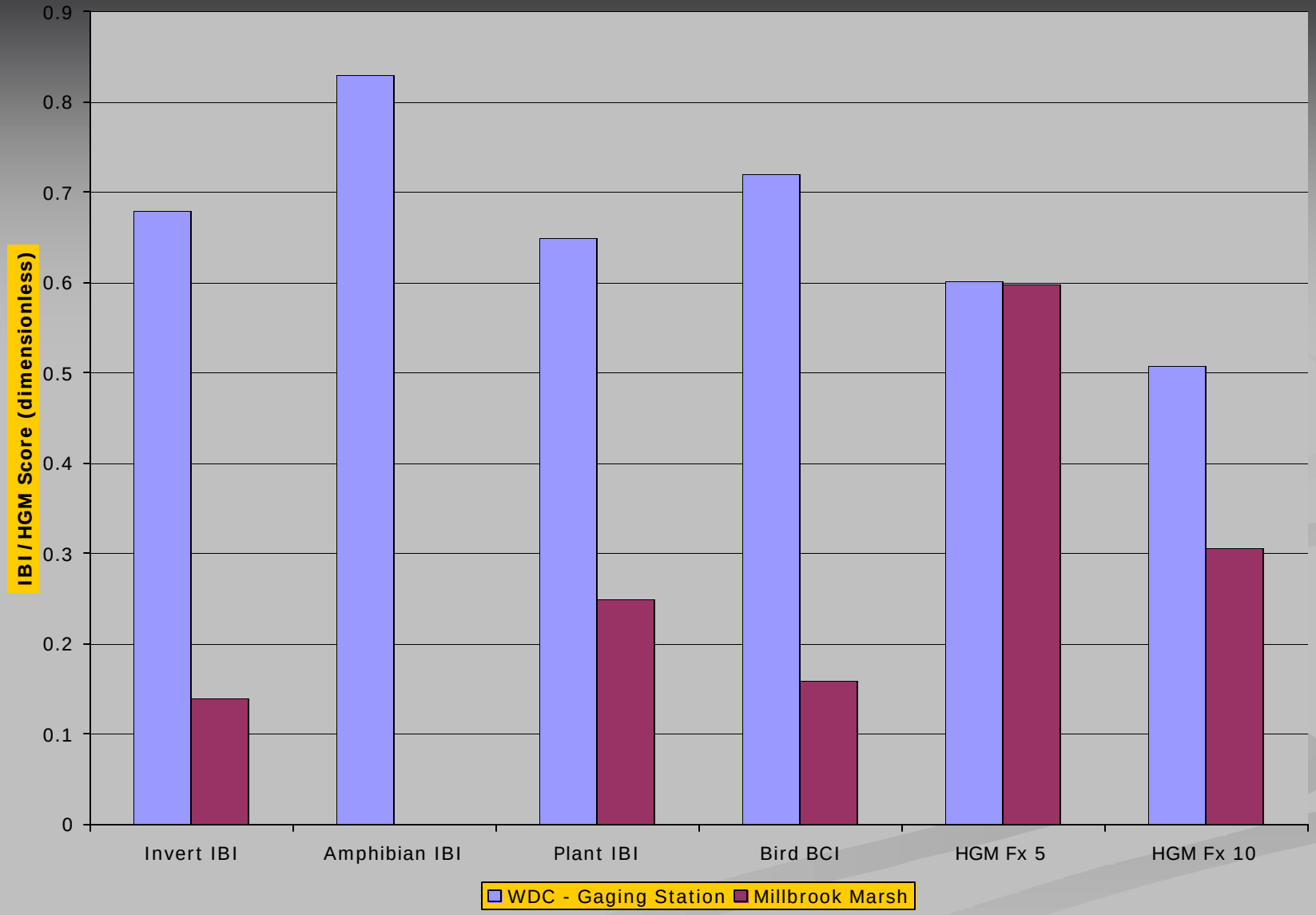
IBI & HGM comparisons for isolated depressions



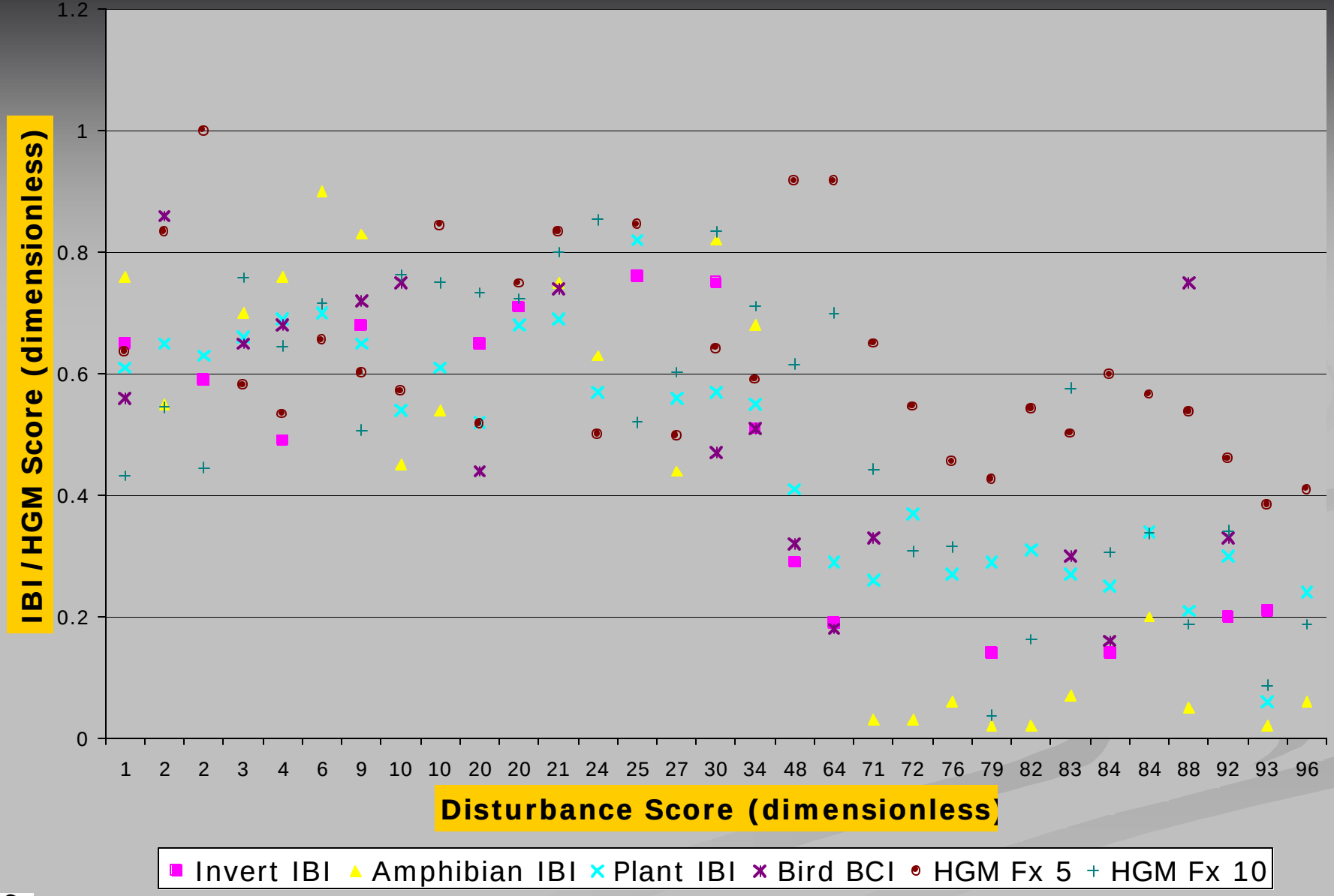

27-WDC GagingStn -
Mainstem Floodplain


28-Millbrook Marsh - Mainstem Floodplain

IBI & HGM comparisons for mainstem floodplains



IBI & HGM scores for all sites (n=31) along disturbance gradient



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