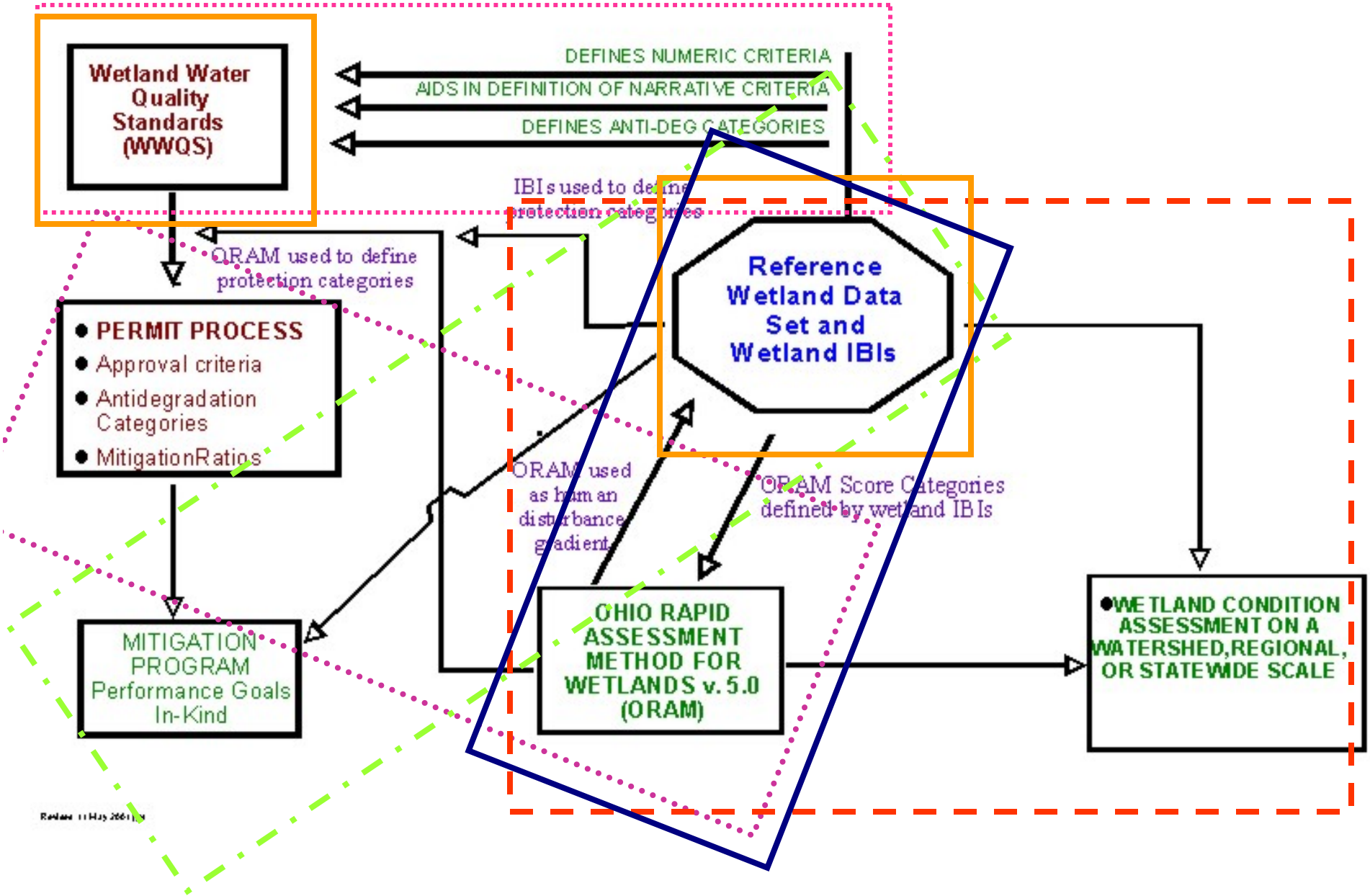
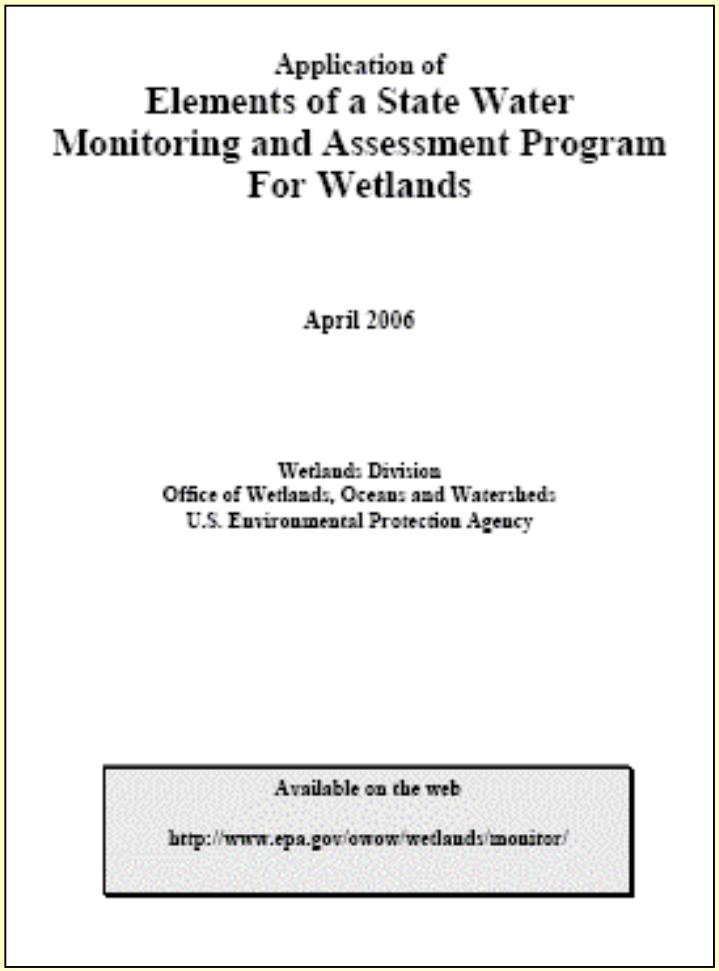
Integrated Wetland Assessment in Ohio



Elements of Adequate State Wetland Monitoring Program

- Recently released Elements of a State Wetland Monitoring Program
- Tiered approach to wetland monitoring
- Prerequisite elements
  - Reference wetland network
  - Classification system
  - Rapid assessment (RA) protocol
  - Intensive assessment protocols
- RA calibrated by comparison to reference data
- Mitigation monitoring and performance using intensive protocols



Application of
Elements of a State Water Monitoring and Assessment Program For Wetlands

April 2006

Wetlands Division
Office of Wetlands, Oceans and Watersheds
U.S. Environmental Protection Agency

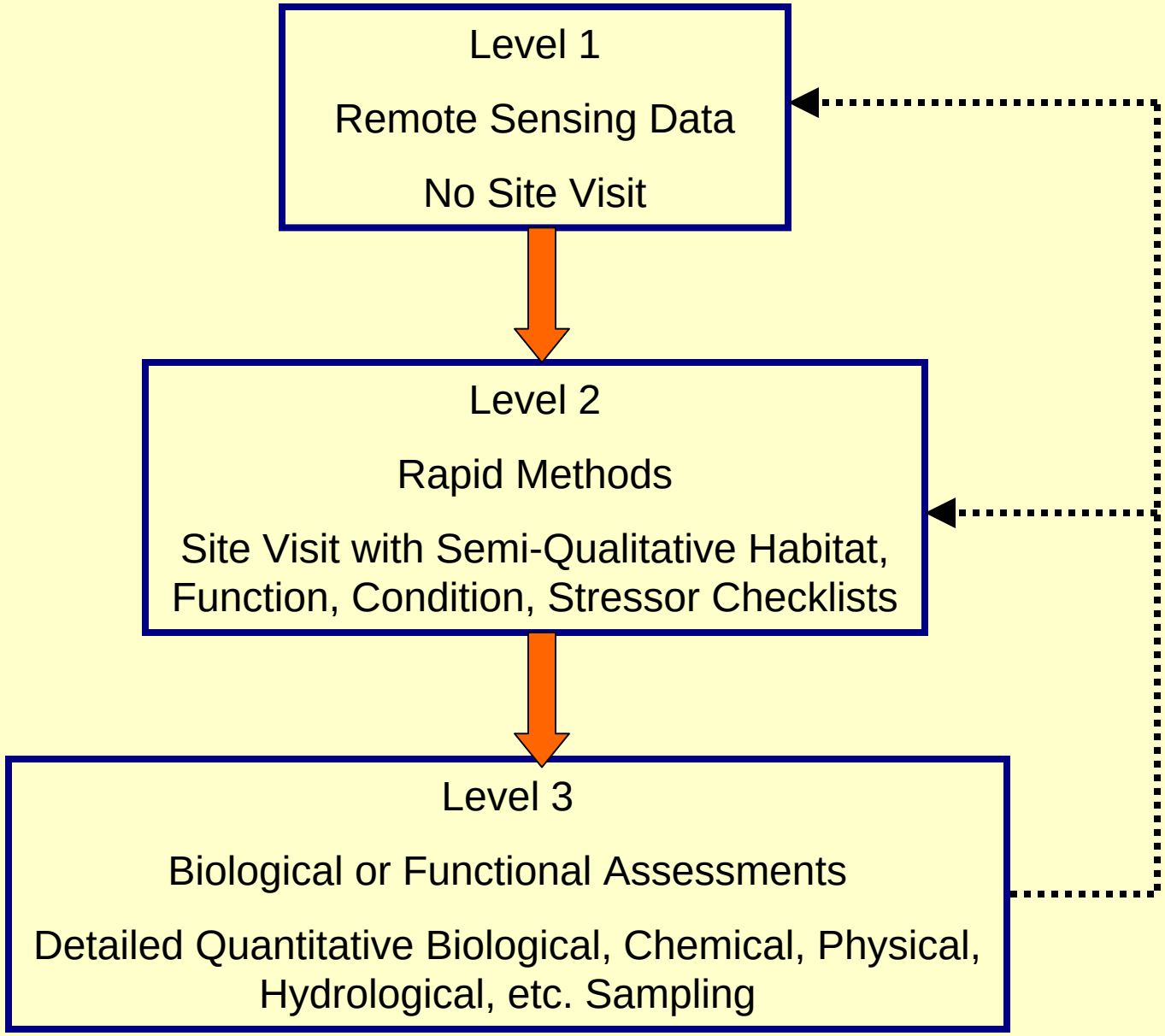
Available on the web

http://www.epa.gov/owow/wetlands/monitor/

Objectives of a State Monitoring Program

- Establish baseline wetland condition and report trends
- Evaluate effectiveness of compensatory mitigation
- Evaluate cumulative effects of wetland loss or restoration and develop watershed plans for impaired waters under 303(d)
- Develop wetland specific water quality standards based on wetland reference condition under 303(d)

Level 1, 2, and 3 Assessments

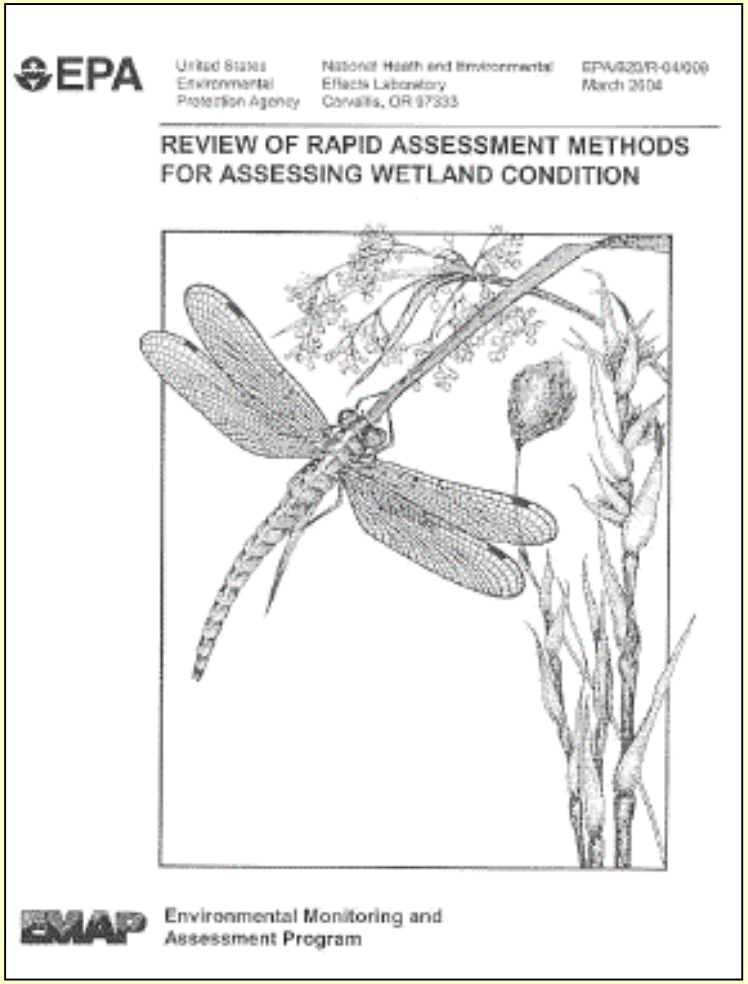


Overview: Level 2 Assessment

- *Application of Elements of a State Water Monitoring and Assessment Program for Wetlands*, April 2006
- "The development of wetland assessment methods, and in particular a rapid assessment method, is a prerequisite to accomplishing many [wetland] program objectives", p. 6.
- Key RA elements
  - Relatively simple metrics with single score that shows where wetland falls on a continuum from high to low condition
  - Takes two people no more than 4 hours of field time and ½ day of office time
  - Once verified with level 3 data can be used for regulatory decision-making, local land use decision-making and planning, and assessment of ambient wetland condition

Overview: Level 2 Assessment

- *Review of Rapid Assessment Methods for Assessing Wetland Condition* (Fennessy, Kentula and Jacobs 2004) EPA/620/R-04/009 March 2004
  - Reviewed 16 methods identified as potentially able to assess wetland condition (of a total of 40)
- Elements of condition-based Method
  - Method can be used to measure condition
  - Method should be “rapid” (<4 hrs for 2 people)
  - Method must be on-site assessment
  - Method can be verified using Level 3 data
- ORAM favorably rereviewed as one of only a few methods capable of performing wetland condition assessment


EPA

United States Environmental Protection Agency

National Health and Environmental Effects Laboratory Corvallis, OR 97333

EPA/620/R-04/009 March 2004

REVIEW OF RAPID ASSESSMENT METHODS FOR ASSESSING WETLAND CONDITION

EMAP Environmental Monitoring and Assessment Program

Overview: Level 3 Assessment

- *Application of Elements of a State Water Monitoring and Assessment Program for Wetlands*, April 2006
- "The development of wetland assessment methods is a prerequisite to accomplishing many [wetland] program objectives", p. 6.
- What is "Level 3" Assessment?
- Level 3 Assessment: "…rigorous, field-based method that provide higher resolution information on the condition of wetlands within an assessment area, often employing wetland bioassessment procedures…" p. 9.
- Key applications
  - Refinement and verification of Level 2 methods
  - Diagnosis of causes of wetland degradation
  - Performance standards for wetland mitigation
  - Development of Numeric Wetland Biocriteria (Wetland Tiered Aquatic Life Uses, WTALUs)

Assessing "function"

- A common misunderstanding is that wetland assessment methods actually measure wetland "functions" directly
- Instead, "structural" attributes (flora, fauna, physical features, etc.) of wetland are always measured
- "Functional capacity" inferred from the *condition* of these structural attributes in comparison to "reference standard" conditions

Defining Functions, Values

- Compare the "function by function" (value by value) approach in wetland assessment to the overall goal of the federal Clean Water Act:
  - to maintain and restore the physical, chemical and biological integrity of the nation's waters
- Redefinition of
  - "Functions": value-neutral ecosystem processes, like decomposition rates, or nutrient cycling
  - "Values": ecological services a wetland provides to human society
- Note difference between purpose in 401 program versus 404 program

Directly measuring functions

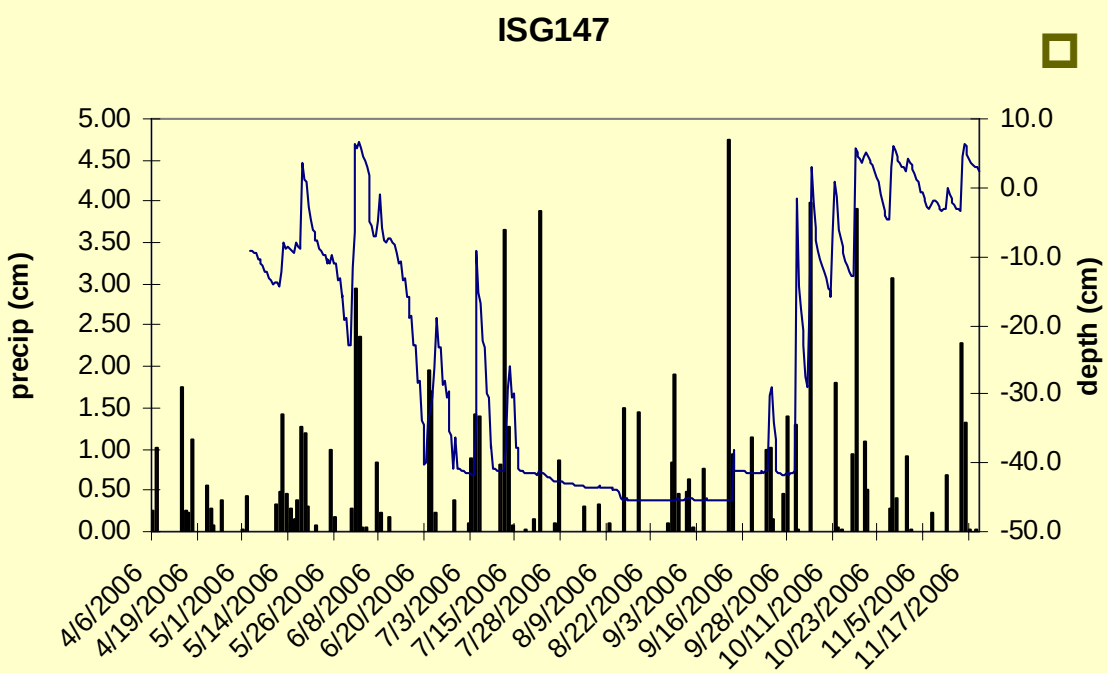
- It is difficult and time consuming to separately quantify ecosystem processes (functions)
- Very impractical to expect measurement of all functions for each wetland pre- and post-impact during the permitting process
- These difficulties may ultimately explain the limited extent that such approaches have been adopted nationwide in contrast to the numerous states with stream biomonitoring programs based on fish or macroinvertebrate IBIs

Example of directly measuring a function: wetland decomposition processes

- 15 sites
- 516 litter bags
- a minimum of 6 visits per site over 13 months (90 total site visits)
- 100s of hours of sample processing
- $1000s of dollars of lab costs

Example of directly measuring a function: FLOOD STORAGE OF URBAN WETLANDS

- 24 sites
- 26 automated monitoring wells ($795 each)
- 26 staff gauges
- 12 month hydrograph
- 2-4 days each site to map basin morphometry
- a minimum of 6 visits per site over 12 months



Assessment Approaches in U.S.

- Two dominant approaches to wetland assessment today
  - Hydrogeomorphic (HGM) Functional Assessment
  - Index of Biotic Integrity (IBI)
- As Stevenson and Hauer (2002) state, with regard to their fundamental assumptions, there is little difference between:
  - 1) an IBI approach which measures "structural" variables and assumes that if the structure deviates little from "reference" condition that the functions supporting that structure are also operating at reference levels; and
  - 2) an HGM approach, which measures structural variables and attempts to infer functional level directly by measuring the deviation of "structural" variables from "reference standard" condition

IBI (condition-based) approach

- The goal of an IBI is to assess the ecological integrity (condition) of the wetland
  - But foundational HGM documents (Smith et al. 1995) also state ecological integrity is the integrating super-function
- Resident biological communities inhabit wetlands continuously or for significant portions of their life cycles, and are integrators of the prevailing and past chemical, physical and biological history of the wetland
- The IBI approach has a proven, published record of being able to measure restoration and improvement of other aquatic resources like streams, lakes, and reservoirs

HGM versus IBIs

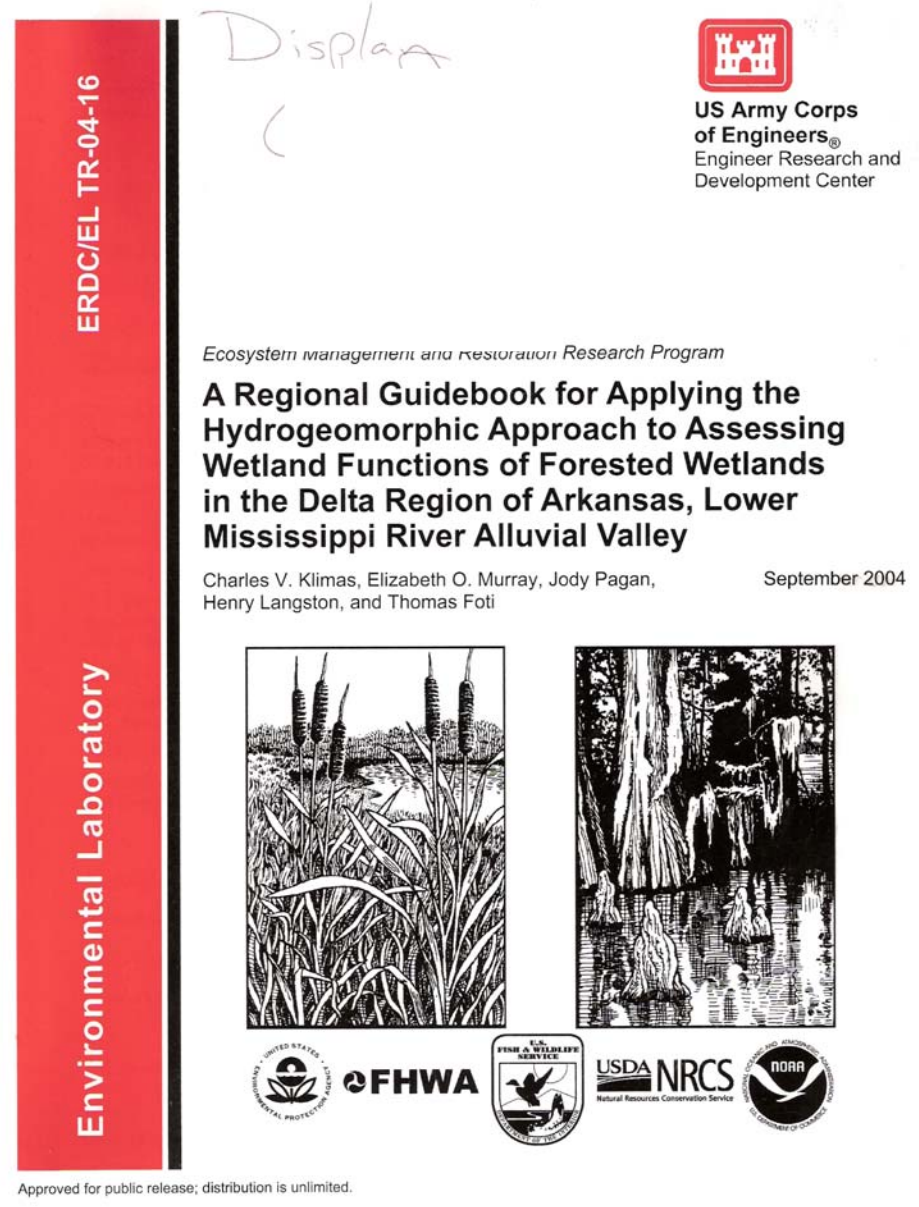
- Only biological attributes are included in the IBI as “metrics”
  - Other data (chemical, physical and landscape) are also collected and used
- HGM models often mix biotic, abiotic, and sometimes even landscape level attributes are often included in (usually) untested simple logic models
- It is very common for HGM models to include (mix up) data from Level 1, 2, and 3 type assessments in their equations and logic models
  - This is a logical flaw that controverts level 123 approach outlined in the Elements document

HGM v. IBI Approaches

- *Fundamental difference between HGM and IBI approaches is in their metric selection criteria and model development procedures*
- IBI metric selection criteria:
  - Evaluate attributes of community of interest for <u>interpretable</u> ecological relationships to human disturbance
  - By “interpretable” mean the relationship “makes sense” and is explainable and is not just a statistical artifact

Typical HGM Model

- Typical of other HGM models published by Corps
- Excellent HGM classification system
- Assesses forested wetlands in Delta Region of the Lower Mississippi Alluvial Valley in Arkansas



ERDC/EL TR-04-16

Environmental Laboratory

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US Army Corps of Engineers®
Engineer Research and Development Center

Ecosystem Management and Restoration Research Program

A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley

Charles V. Klimas, Elizabeth O. Murray, Jody Pagan, Henry Langston, and Thomas Foti

September 2004

Approved for public release; distribution is unlimited.

Data Collected for Model

- HYDROLOGY VARIABLES
  - $V_{FLOOD\ FREQUENCY}$ – Surrogate data or BPJ
  - $V_{\%PONDED}$ – Visual estimate
- WOODY STEM AND PLANT COMMUNITY VARIABLES
  - Counts from at least four nested plots ($1m^2$, 0.04ha)
    - $V_{TOTAL\ BASAL\ AREA}$ $V_{SHRUB\ SAPLING\ DENSITY}$ $V_{WOODY\ DEBRIS}$ $V_{SNAG\ DENSITY}$ $V_{TREE\ DENSITY}$
  - %Cover from at least four nested plots ($1m^2$, 0.04ha)
    - $V_{GROUND\ VEGETATION\ COVER}$ V_{LITTER} $V_{TREE\ COMPOSITION}$ $V_{COMPOSITION}$
  - Two 50 foot transects - $V_{LOG\ DENSITY}$
  - Visual estimate - V_{STRATA}
- SOIL VARIABLES
  - From at least two 25 cm soil pits - V_{OHOR} V_{AHOR}
  - Visual estimates - $V_{\%SOIL\ INTEGRITY}$ V_{CEC},
- LANDSCAPE VARIABLES (GIS derived Level 1 info)
  - V_{TRACT} $V_{CONNECT}$ V_{CORE}

“Functions” purportedly “assessed”

- FUNCTION 1. Detain floodwater
- FUNCTION 2. Detain precipitation
- FUNCTION 3. Cycle nutrients
- FUNCTION 4. Export organic carbon
- FUNCTION 5. Remove elements and compounds
- FUNCTION 6. Maintain characteristic plant community
- FUNCTION 7. Provide habitat for fish and wildlife

Is the data collected able to "assess" these "functions"

- Using this data, are these functions actually being assessed?
  - BPJ hydrology evaluation
  - Quantitative plant community data
  - BPJ evaluation of soil integrity and litter depth
  - Some GIS landscape data
- Answer: No, except for maintain characteristic plant community
- Quantitative hydrologic, nutrient cycling, carbon, exportation, fish, wildlife data was not collected during model development or in subsequent assessments

General Critique of HGM Approach

- Claims it is “measuring” ecosystem processes but “functions” usually measured, if anything, are plant community characteristics
- Rarely actually measures key variables like hydrology, soil chemistry, decomposition, etc.
- Homogenizes disparate data types
- Variable selection and equation development “glossed over” but is actually critical step
- HGM models generally “pre-select” variables based on Data that can be easily collected, “Literature”, Professional judgment
- At best, disingenuous to claim functions measured when only structural data collected

Contrast "IBI" Approach

- Principled metric selection criterion: ecologically interpretable relationship to disturbance gradient
- An IBI "model"…
  - Is transparent without complicated equations and only 2 steps from IBI score to actual measured value
  - doesn't mix landscape (level 1), rapid (level 2 type visual estimates) and level 3 (quantitative information) in the same model
  - doesn't mix physical, chemical, and biological data in the same model
- When data on hydrology or ecosystem processes is needed it is directly measured as a type of "level 3" data, not inferred from poorly or uncorrelated surrogates

Consistency with Proposed Federal Compensatory Mitigation Rule

- IBI approach is consistent with brief federal guidelines provided in the proposed Compensatory Mitigation Rule which states at 33 CFR §332.5:
  - The mitigation plan must contain performance standards that will be used to assess whether the project is achieving its objectives.
  - Performance standards should relate to the objectives of the compensatory mitigation project, so that the project can be objectively evaluated to determine if it is developing into the desired resource type and providing the expected functions.
  - Performance standards should be based on attributes that are objective, verifiable, and can be measured with a reasonable amount of effort.

33 CFR §332.5 cont.

- Continued:
  - Performance standards may be based on variables or measures of functional assessment methodologies, measurements of hydrology or other aquatic resource characteristics, and/or comparisons to reference aquatic resources of similar types and landscape position.
  - Performance standards based on measurements of hydrology should take into consideration the hydrologic variability exhibited by reference aquatic resources, especially wetlands. Where practicable, performance standards should take into account the expected stages of the aquatic resource development process, in order to allow early identification of potential problems and appropriate adaptive management.

Developing the Vegetation Index of Biotic Integrity for Ohio Wetlands

Developing a vegetation-based biological assessment method

- Used well established index development approaches outlined in 3 decades of IBI literature
- Site selection
  - targeted selection of least to most impacted sites used
  - resource efficient, access issues
- “Reference” sites
  - sites lacking obvious or discernible human cultural influence or least-impacted systems available in a particular landscape

History of the VIBI

- 1996 FQAI Study
- 1996-1998 Initial Plant Community Reference Data Sets in Ohio
- 1998-99 Initial Plant IBI data analysis
- BAWWG 2000
  - Jim Karr x-axis “problem”
- 1999 Field Season
  - High end marshes, low end forests
- 1999 ORAM v. 5.0 disturbance gradient
- August 2000 Initial VIBI-E, -F, -SH
- November 2001 – 1st Evaluation

History of the VIBI cont.

- 2004 – 2nd Evaluation
  - Data from 2002
  - Revision and proposed WTALUs
- 2006 – 3rd Evaluation
  - Data from 2003-2004Finalization of metrics
  - WTALUs propose in Interested Party Draft of Wetland Rulemaking
  - Used case-by-case in individual and mitigation banking instruments as performance standards
- Peer-reviewed papers
  - Accepted (2)
  - Submitted (2)

VIBI Report Series

State of Ohio
Environmental Protection Agency

Wetland Ecology Group
Division of Surface Water

INTEGRATED WETLAND ASSESSMENT PROGRAM:
Part 9: Field Manual for the Vegetation Index of Biotic Integrity for Wetlands v. 1.3

Ohio EPA Technical Report WET/2004-9

Bob Taft, Governor
State of Ohio

Chris Jones, Director
Environmental Protection Agency

P.O. Box 1049, Lazarus Government Center, 122 S. Front Street, Columbus, Ohio 43216-1049

State of Ohio
Environmental Protection Agency

Wetland Ecology Group
Division of Surface Water

Addendum to:
INTEGRATED WETLAND ASSESSMENT PROGRAM.
Part 4: Vegetation Index of Biotic Integrity for Ohio Wetlands
Part 7: Amphibian Index of Biotic Integrity for Ohio Wetlands

Ohio EPA Technical Report WET/2006-2

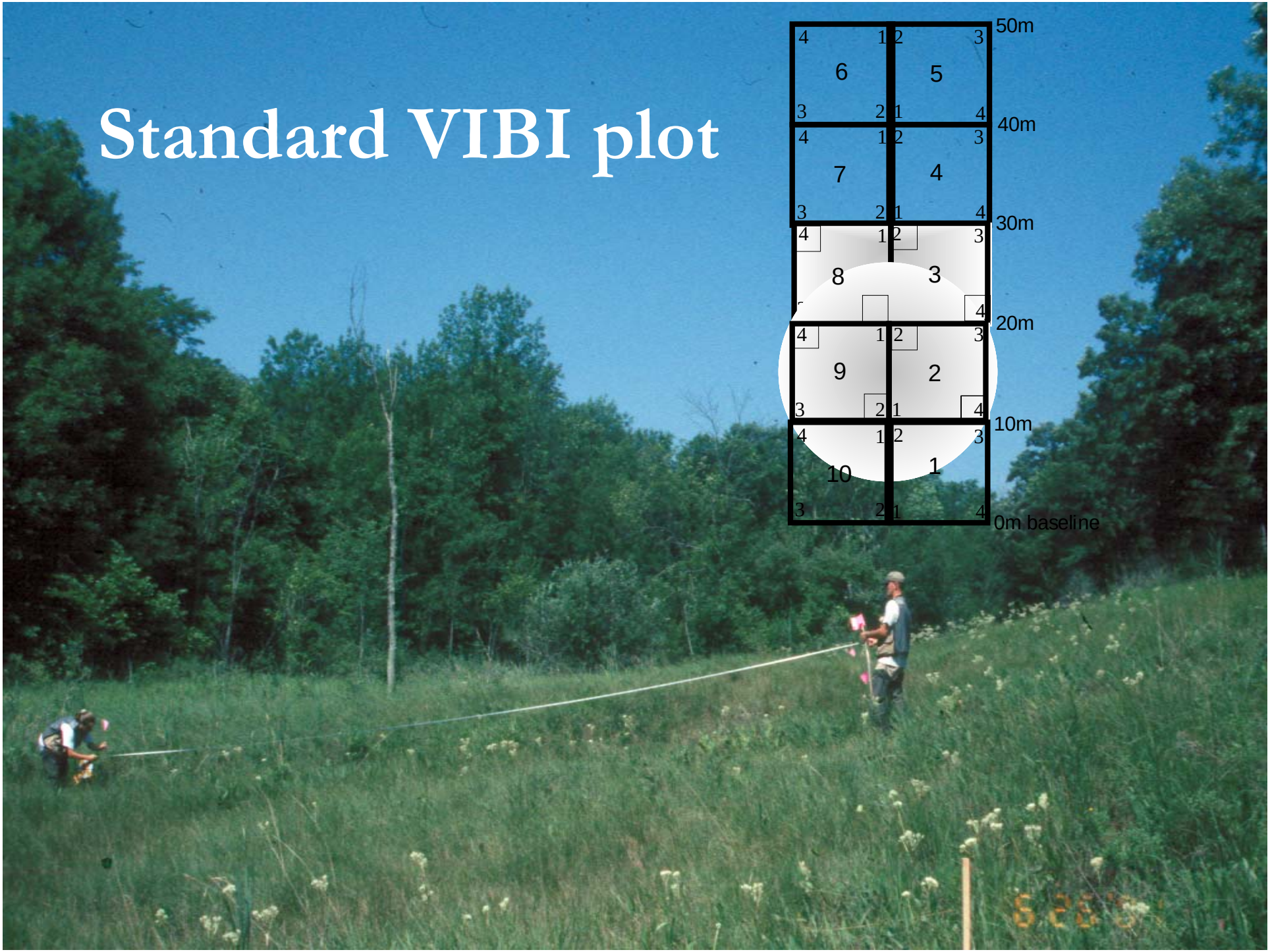
Bob Taft, Governor
State of Ohio

Joseph P. Koncelik, Director
Environmental Protection Agency

Overview of method

- Published by Robert Peet et al. (1998) for the North Carolina Vegetation Survey
- Combines releve concept of Braun-Blanquet methodology and transect-quadrat approach of “American” style sampling
- Well established methods equivalent to methods used in a century of plant community sampling
- Flexible multipurpose method for diverse plant communities
- “modular” approach with 10 x 10m “modules as building block for plot that locates plots in areas most representative of plant community of interest

Standard VIBI plot



Parameters -summary

- 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.

VIBI metrics	type	E	F	Sh
carex	richness	X		X
dicot	richness	X		X
shrub	richness	X	X	X
hydrophyte	richness	X	X	X
shade species	richness		X	
seedless vascular plants	richness		X	X
FQAI	index	X	X	X
%tolerant	community	X	X	X
%intolerant	community	X	X	X
%invasive graminoids	community	X		
%bryophyte	community		X	X
subcanopy IV	community/productivity		X	X
canopy IV	index		X	
std biomass	productivity	X		

Developing Wetland Tiered Aquatic Life Uses in Ohio

TALU Goals:

- 1) Develop meaningful (i.e. data driven and scientifically defensible) aquatic life use categories,
- 2) That reliably measure resource condition, and
- 3) That account for significant natural variation in aquatic ecosystems

- Ultimately, the variation that “matters” for the applied purposes of TALUs, is variation that results in significant differences in IBI scores

Purpose WTALU Rule

- Satisfy federal CWA obligations to assess all waters of the state
- Provide biocriteria framework equivalent to stream program for performing watershed based wetland assessments
- fully integrate wetland program into 106 funding structure
- provide ability to recognize ecological services provided by wetlands
- Other purposes: to quantitatively define wetland antidegradation categories

Who will use the rule?

- Primarily Ohio EPA to fulfill its obligations under CWA to adopt wetland TALUs and assess wetlands in state
- IBI scoring ranges used to set mitigation performance goals
- 401 Certification process in Rule –54 and use of Wetland Categories remains completely intact
- Classification “uses” will not prohibit issuance of 401s for wetland fills just as current “wetland designated use” does not prohibit issuance
  - out-of-kind mitigation allowable under existing and proposed rules
- Rule also not replace ORAM with wetland IBIs

Dealing with variation in TALU development

- Natural variation in biological expectations can be addressed in several ways during IBI development:
  - 1) The data set can be partitioned from the outset by significant classes and separate IBIs developed
  - 2) Alternate metric scoring ranges can be set or metrics can be modified or substituted
  - 3) Different set points for tiered aquatic life categories can be established
- All three approaches were used in Ohio

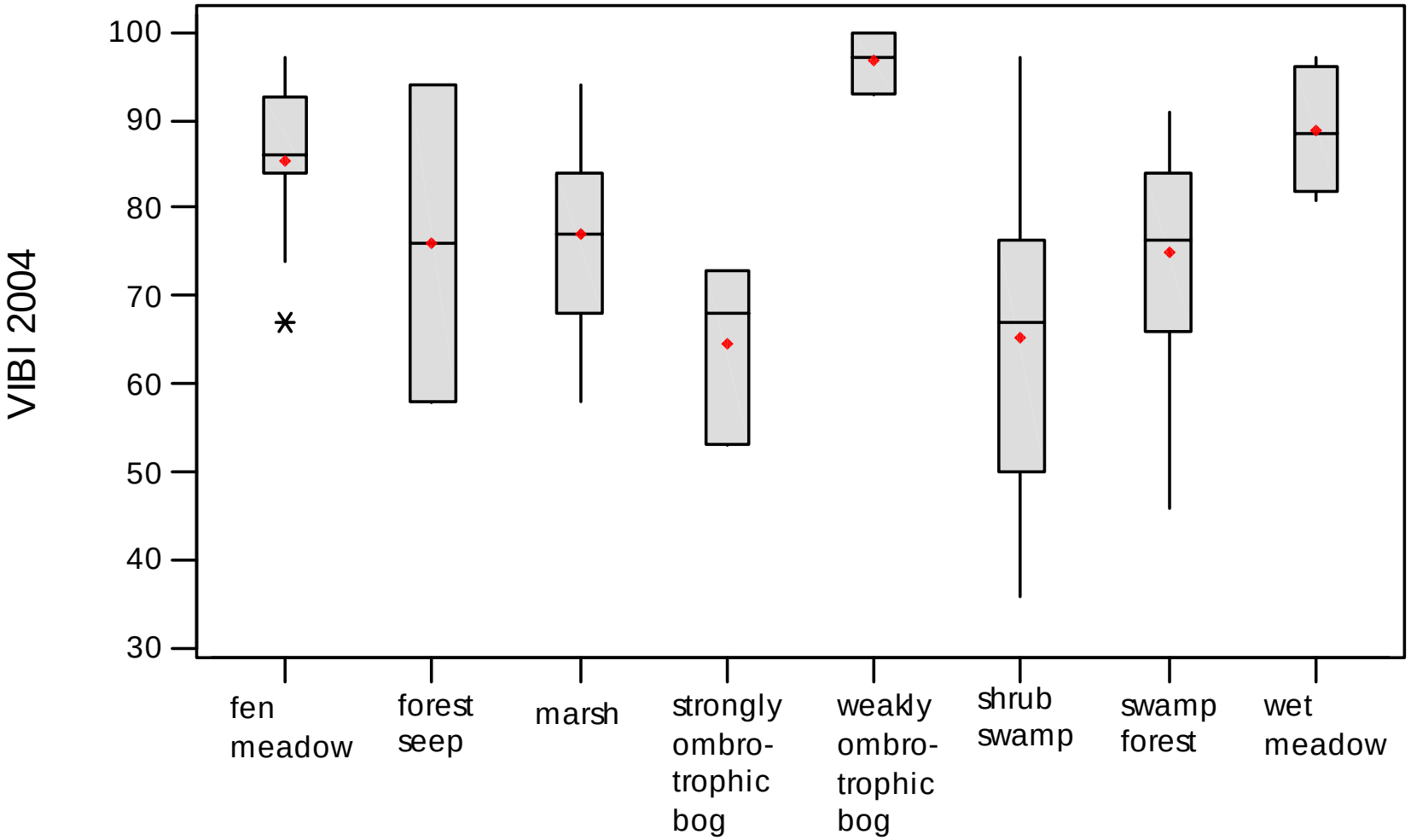
Accounting for differing (or similar) biological expectations

- Look for significant differences in mean, media, 95th percentile of IBI scores based on ecoregion, HGM class, and plant community
- Starting point of analysis previously developed and evaluated classification scheme
- Goal: fewest TALU categories as possible

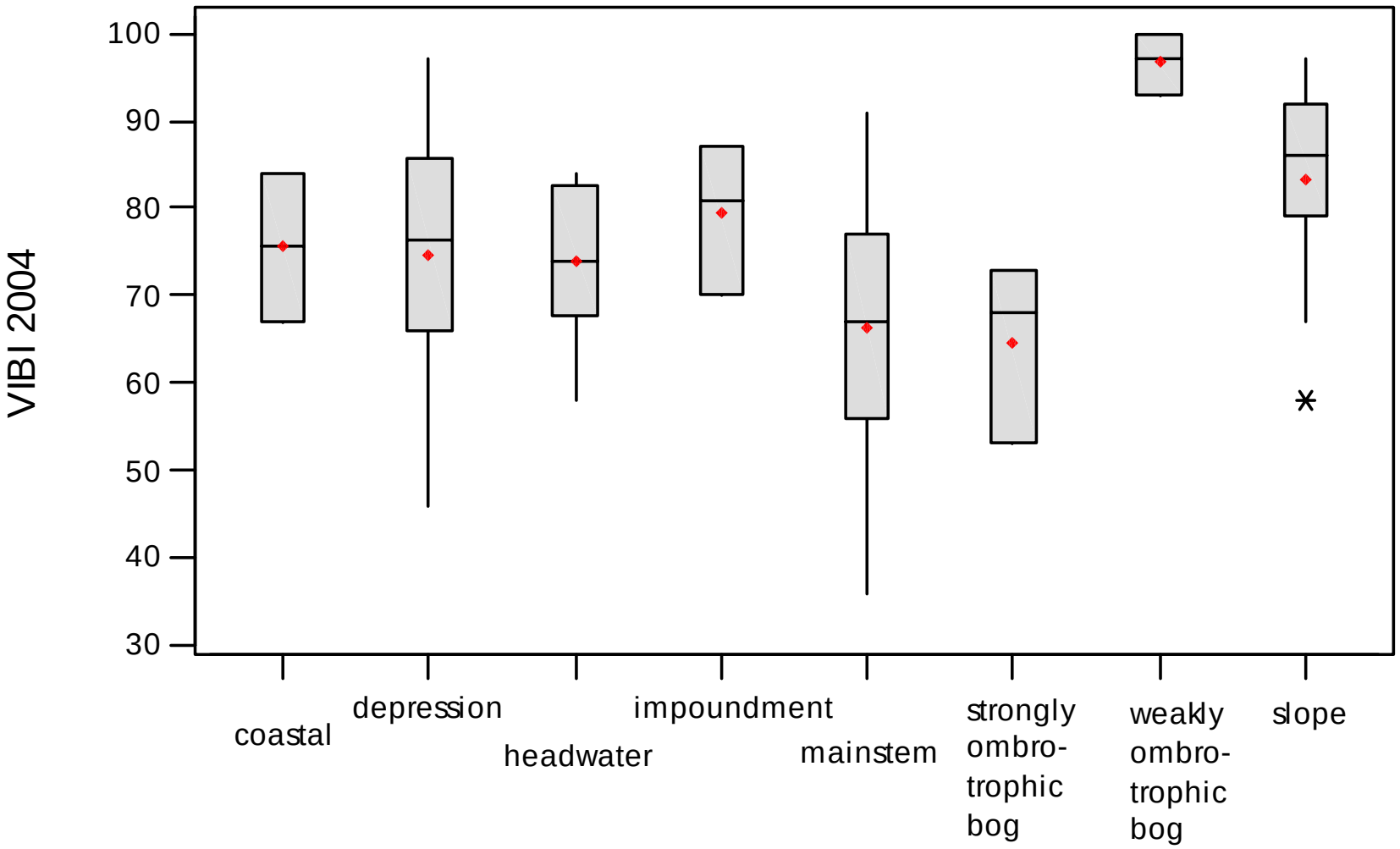
Ecoregional variation in VIBI scores

ecoregion	reference std wetlands	n	all sites	n
till plains (ECBP)	70.4 (14.2)a	22	43.1(26.2)a	64
glaciated Allegheny Plateau (EOLP)	80.4 (11.3)b	46	47.0 (27.6)b	72

Plant community variation



HGM class variation



Proposed Numeric Wetland Biocriteria for the State of Ohio

- Multiple "uses" proposed
  - 1) "classification" uses: HGM class use dominant plant community use
    - "in-kind" for purposes of mitigation equated to HGM and plant community class
    - "out-of-kind" allowed case by case
  - 2) tiered aquatic life uses
  - 3) special uses "ecological services," aka "values", e.g. flood storage

Special Wetland Uses

- Special wetland uses ~ Ecological Services
- Special uses equivalent to “public water supply” or “primary contact” designations in 3745-1-07
  - Recreation
  - Education
  - Fish reproduction habitat
  - T & E species habitat
  - Food Storage
  - Water Quality Improvement

Wetland TALU narrative categories

- Ohio's stream program has 4 aquatic life use categories:
  - "exceptional warmwater habitat," "warmwater habitat," "modified warmwater habitat," "limited quality waters"
- Narrative WTALU categories:
  - Superior Wetland Habitat (SWLH)
  - Wetland Habitat (WLH)
  - Restorable Wetland Habitat (RWLH)
  - Limited Quality Wetland Habitat (LQWLH)
- TALU categories equated to antidegradation protection categories already in rule
  - Category 1 (low), 2 (medium), 3 (high)
- Language for narrative WTALU adapted from existing stream TALUs in 3745-1-07

Narrative Definitions of TALU categories

- SUPERIOR WETLAND HABITAT
  - Wetlands that are capable of supporting and maintaining a high quality community with species composition, diversity, and functional organization comparable to the vegetation IBI score of at least 83% (five-sixths) of the 95th percentile for the appropriate wetland type and region as specified in Table 11.

Narrative Definitions of TALU categories

- WETLAND HABITAT
  - Wetlands that are capable of supporting and maintaining a balanced, integrated, adaptive community having a species composition, diversity, and functional organization comparable to the vegetation IBI score of at least 66% (two-thirds) of the 95th percentile for the appropriate wetland type and region as specified in TALU table.

Narrative Definitions of TALU categories

- RESTORABLE WETLAND HABITAT
  - Wetlands which are degraded but have a reasonable potential for regaining the capability of supporting and maintaining a balanced, integrated, adaptive community of vascular plants having a species composition, diversity, and functional organization comparable to the vegetation IBI score of at least 33% (one-third) of the 95th percentile distribution for the appropriate wetland type and region as specified in TALU table.

Narrative Definitions of TALU categories

- LIMITED QUALITY WETLAND HABITAT
  - Wetlands which are seriously degraded and which do not have a reasonable potential for regaining the capability of supporting and maintaining a balanced, integrated, adaptive community having a species composition, diversity, and functional organization comparable to the vegetation IBI score of <u>less 33% (one-third)</u> of the 95th percentile for the appropriate wetland type and region as specified in TALU table.

Developing numeric TALU categories, i.e. numeric biocriteria

- Use 95th percentile of score distribution for defined classes
- Evaluated tertile, quartile, quintile, and sextile sectioning of 95th percentile
- Sextiles worked best for defining narrative TALU categories
- Sextiles grouped:
  - 1st + 2nd = poor
  - 3rd + 4th = fair
  - 5th = good
  - 6th = superior

Numeric TALU table (excerpt)

HGM class	HGM sub-class	plant community	eco-regions	95th	LQWLH (Category 1)	RWLH (modified Cat 2)	WLH (Category 2)	SWLH (Category 3)
depression	all	sw. forest shrub sw. marsh	EOLP	91	0 -30	30-60	61-75	76-100
			all other regions	75	0-24	25-50	51-62	63-100
	all	wet meadow	all regions	91	0-29	30-59	60-75	76-100
bog	weakly ombro-trophic	tamarack-hardwood, tall shrub bog	all regions	100	0-32	33-65	66-82	83-100
	strongly ombro-trophic	tamarack, leatherleaf, sphagnum bog	all regions	72	0-23	24-47	48-59	60-100

Conclusions

- Tiered aquatic life uses and numeric biocriteria for wetlands can be developed
  - Procedures similar to stream efforts usable
  - Partitioning variation by classification very important
- Difficult part is collecting sufficient reference wetland data to characterize all wetland types or types selected for biocriteria development
- In addition to “traditional” ambient assessment applications, TALUs are equally useful in permit and mitigation programs to...
  - 1) define protection categories, 2) calibrate rapid assessment methods and 3) as quantitative mitigation performance goals