

Creation of a Multi-metric Macroinvertebrate Index: Implications for Annual Ohio River Assessments

D. Ryan Argo - ORSANCO



*National Monitoring Conference
Cincinnati, Ohio
April 30, 2014*



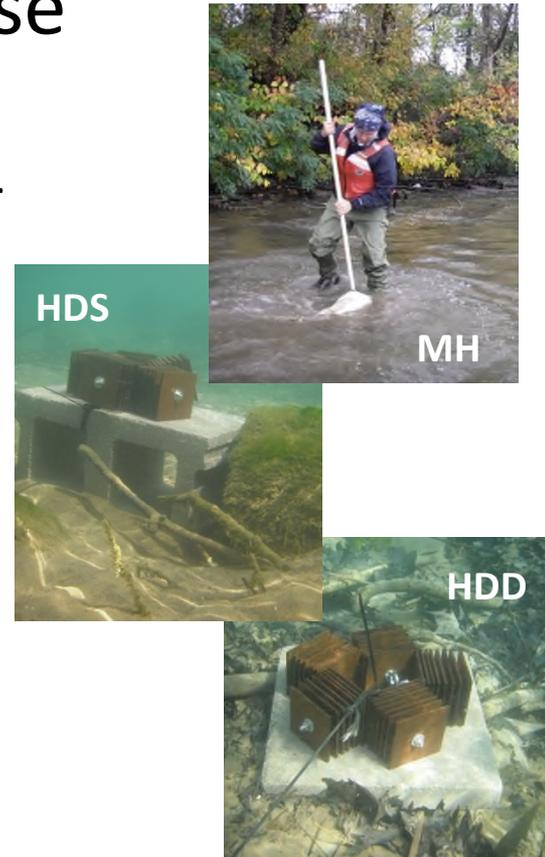
ORSANCO Biological Programs

- **Ohio River Valley Water Sanitation Commission (est. 1948)**
 - Interstate water pollution control agency
 - Compact signed by 8 states
 - IL, IN, KY, OH, PA, WV, NY, VA
- **Task :** Ensure the Ohio River is *capable of maintaining fish and other aquatic life*
- **Tools:** Biological Indices, Annual Surveys & Assessments
- **Products :** ORSANCO provides a Biennial Report to USEPA on behalf of states
 - Create standards for states to adopt & implement
 - Annual Pool Assessment Reports
 - Assess condition of 4 Designated Uses
 - Drinking Water
 - Contact Recreation
 - Fish Consumption
 - Aquatic Life

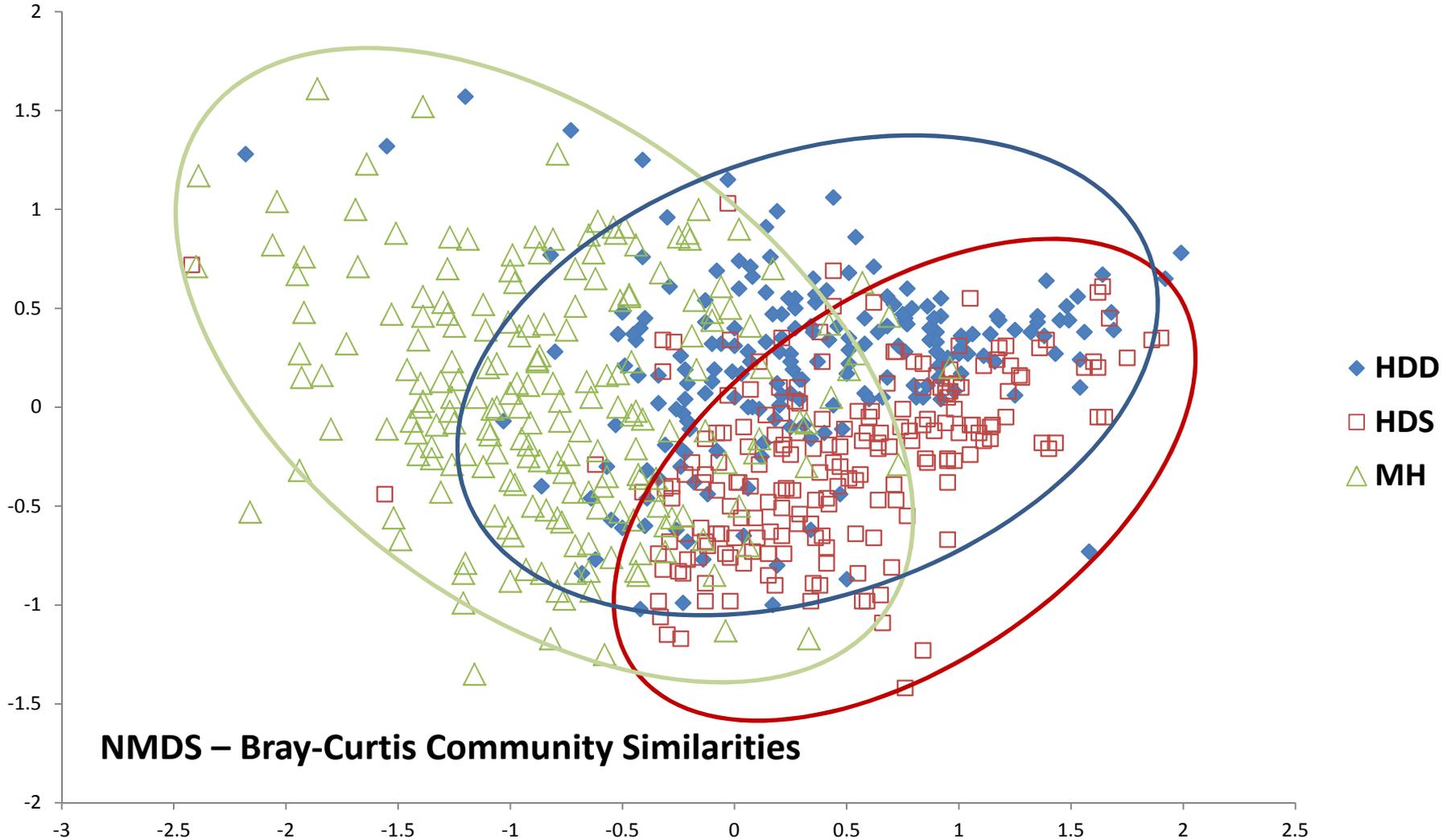
Macro Methods Comparison

Goal: Develop macroinvertebrates as an additional indicator for evaluating aquatic life use

- Collected macros via 3 methods since 2004
 - Multi-Habitat (MH), Hester-Dendy Shallow (HDS), HD Deep (HDD)
- Have paired EMAP abiotic data since 2007
 - Water & sediment chemistry and nutrients



Preliminary Comparison Results



Index Development

- **Approach**: Since each method provides different results, we will develop 7 separate indices
 - Single Method Indices
 - HDD, HDS, MH
 - Two Method Indices
 - HDDHDS, HDDMH, HDSMH
 - All Methods
- **Rationale**: Create the indices that are responsive to defined instream condition gradients
 - i.e. responsive to stress

Abiotic Gradients

- Step1: Understand abiotic condition/variation
- Classifying the condition of sites
 - Ohio River lacks true “reference” sites
 - Gradient from Least to Most disturbed
- Exploratory analyses supported development of



Site Abiotic Gradient Scoring Approach



POOR Abiotic Quality
Most Disturbed (MD)

GOOD Abiotic Quality
Least Disturbed (LD)

WATER_CHEM	SED_CHEM	TOT_NUTR	NUTR_INTXN*
CaCO ₃	LOI	TN_Sed	TN_WQ
Cl	pH_Dev	TP_Sed	TP_WQ
Cond	TOC	TN_WQ	NH ₃
SO ₄		TP_WQ	
TSS			
TOC			

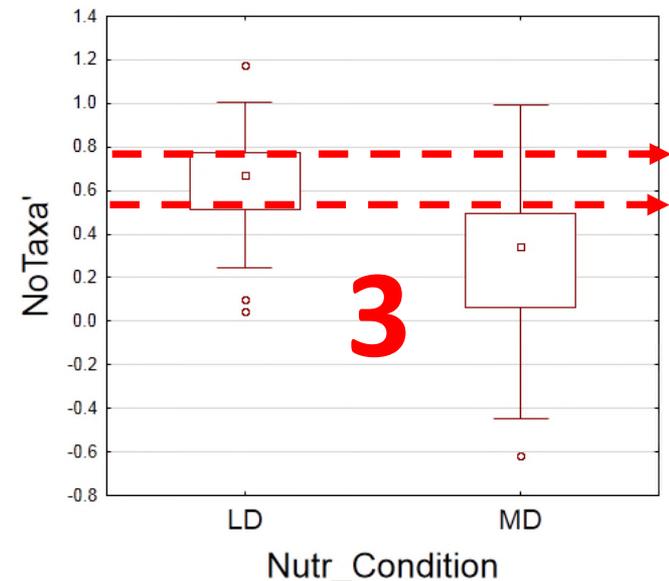
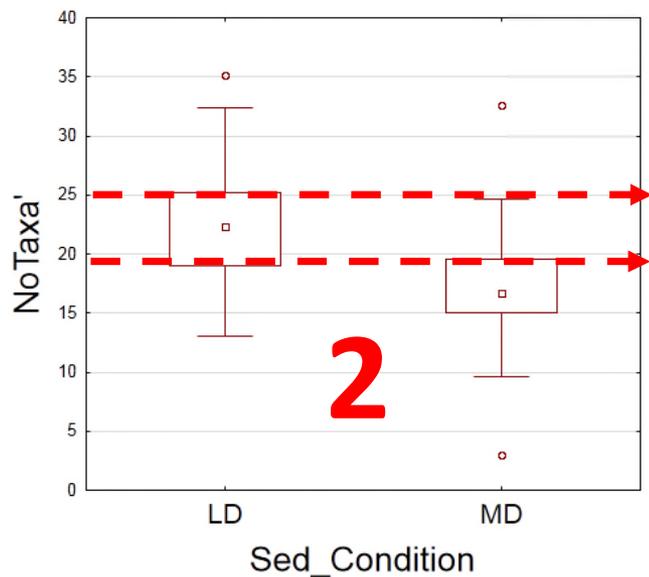
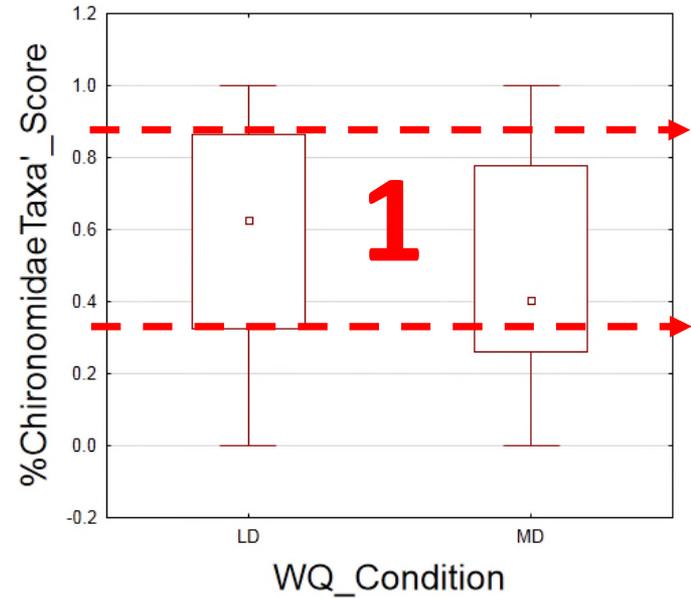
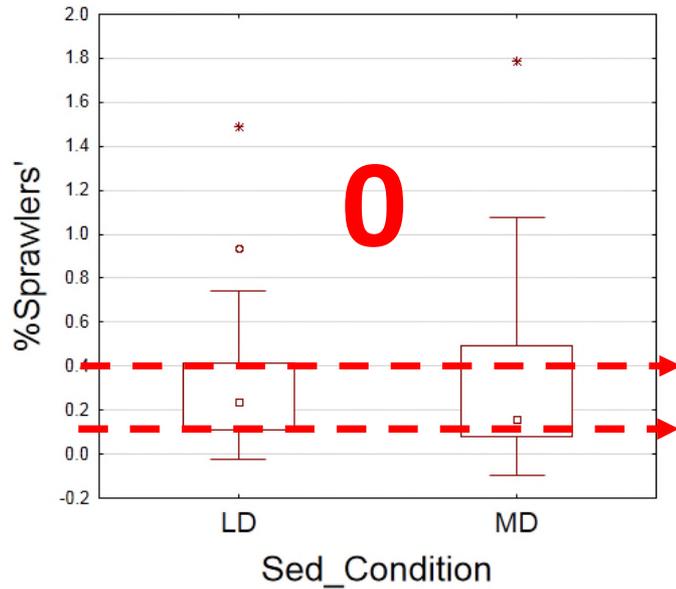
*Ohio EPA method - Miltner and Rankin 1998

Taxonomic Groups	
Individuals	Coenagrionidae
No Taxa	Hemiptera
Ind-ZM	Coleoptera
Zebra Mussels	EPT
Corbicula	Ephemeroptera
Clitellata	Plecoptera
Oligocheata	Trichoptera
Diptera	Hydroptilidae
Chironomidae	Non-Insecta
Chrinominae	Polycentropodidae
Tanytarsini	Amphipoda
Orthoclaadiinae	Crustacea
Cricotopus	Gammaridae
Tanypodinae	Bivalvia (-C&D)
Megaloptera	Gastropoda
Odonata	Pleuroceridae
Tolerance & Diversity	Functional Feeding Guilds
Shannon Diversity	Collector-Filterers
Hilsenhoff Biotic Index	Collector-Gatherers
Intolerants	Piercer-Carnivores
Tolerants	Piercer-Herbivores
Habits	Predators
Burrowers	Scrapers
Climbers	Shredders
Clingers	
Sprawlers	
Swimmers	

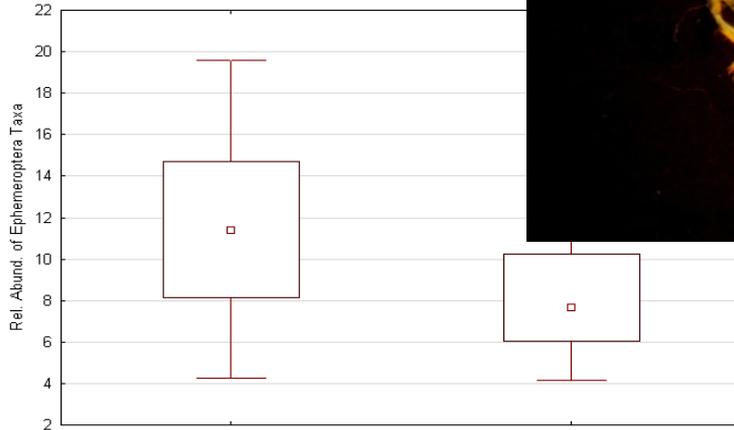
Metric Calculation

- From this base list calculated 160 candidate metrics
 - Including both individual and taxa abundance and relative abundance measures
- Evaluated metrics for responsiveness to environmental gradients

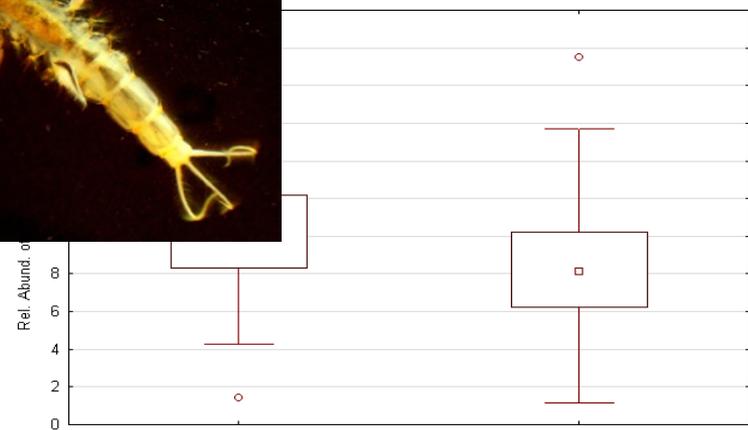
Metric Evaluation



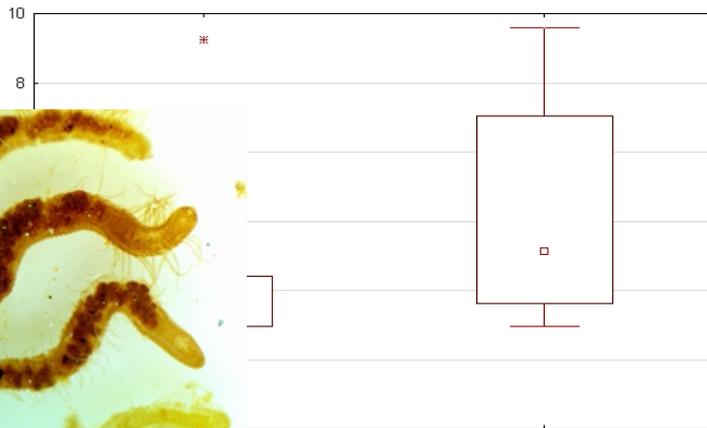
% Ephemeroptera Taxa



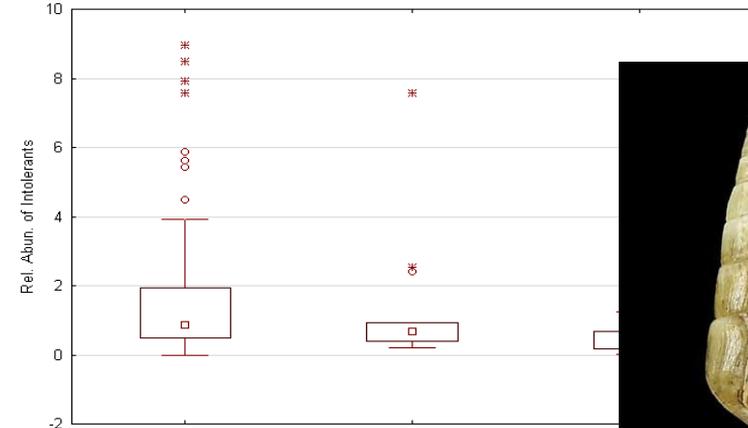
WATER_CHEM



TOT_NUTR



SED_CHEM



NUTR_INTxN

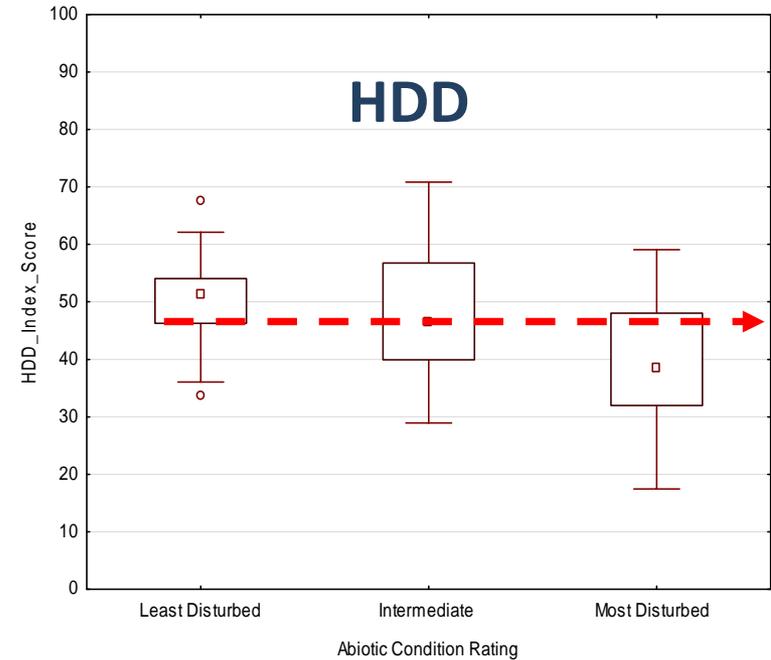
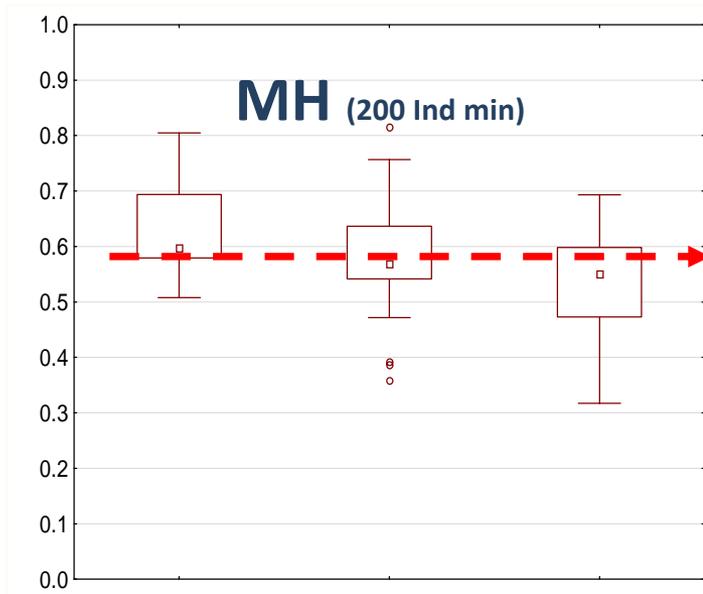
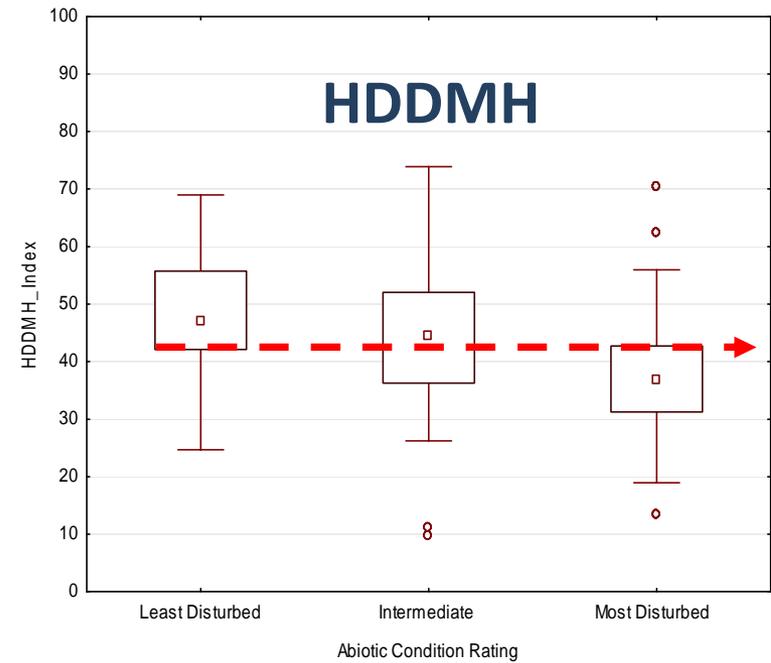


G. & Ph. Poppe

% Oligochaeta

% Intolerants

Final Index score (0 – 100) = $\frac{\sum (\text{Metric Scores})}{\text{No. of Metrics}}$



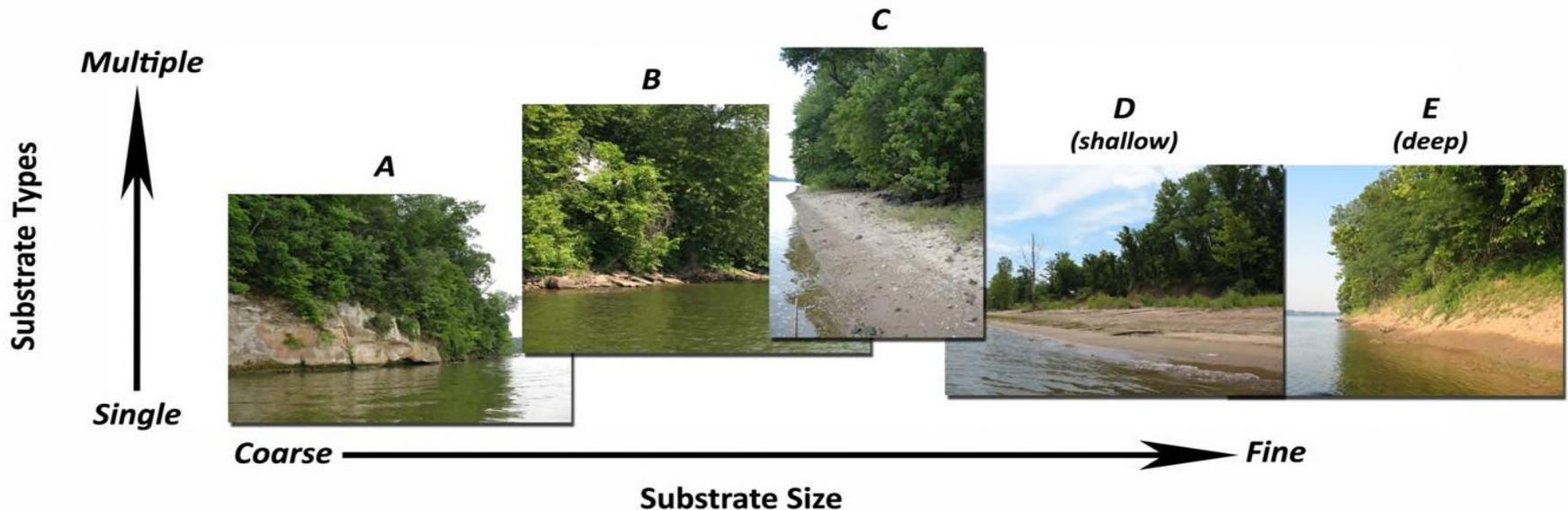
Index Selection

Method Subset/Combo	Index Sensitivity	Scoring Overlap Severity (b/w LD and MD)	Method Cost (per sample*)	Field Notes
HDDMH	2	0.58	Moderate	
MH (200 Ind)	2	1.42	Low	~ 50% of samples have 200 Ind
HDD	2	1.75	Low	~ 85% retrieval
HDSMH	2	1.91	Moderate	
All Methods	2	3.07	High	current approach
HDS	1	10.21	Low	~ 95% retrieval
HDDHDS	1	11.80	Moderate	

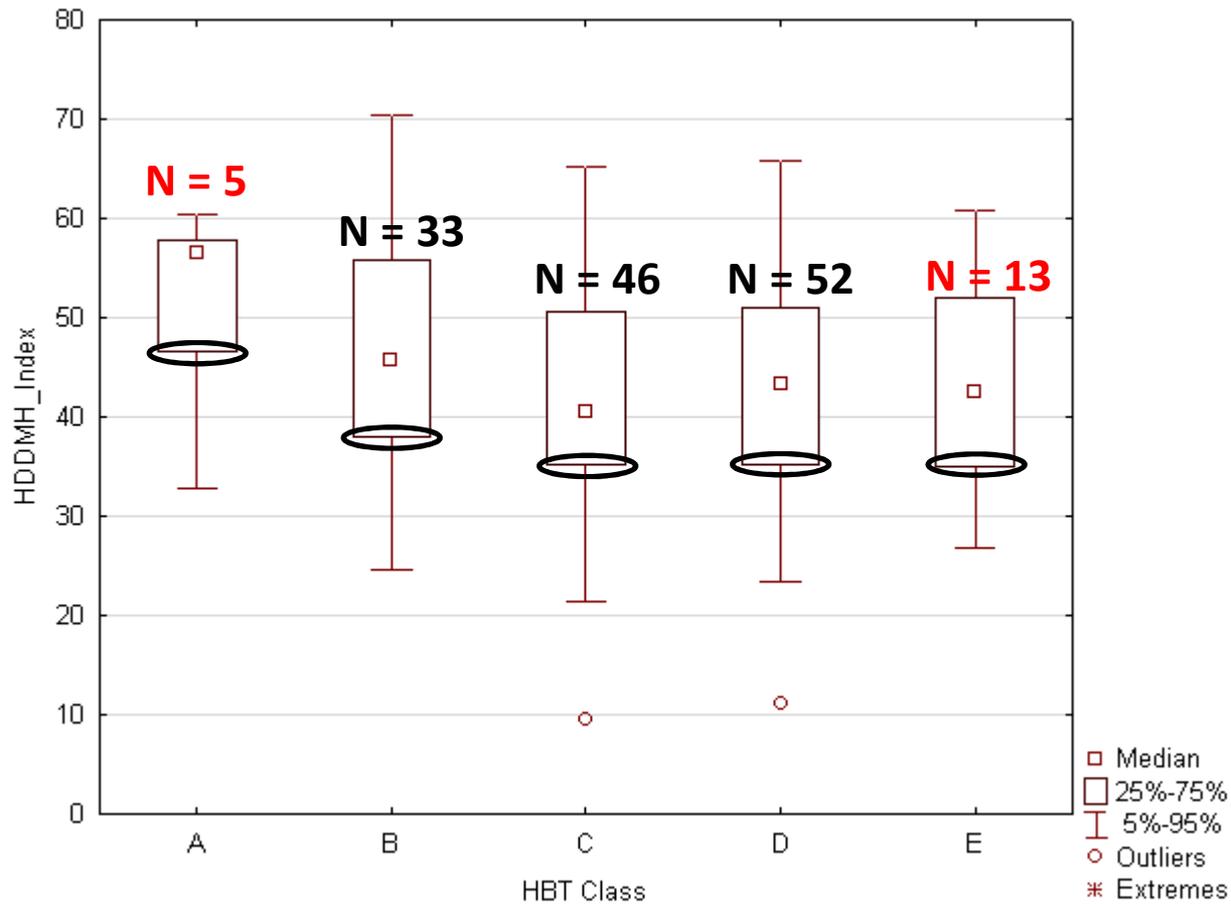
* Cost includes: supplies, analytical, and travel expenses

Index Application

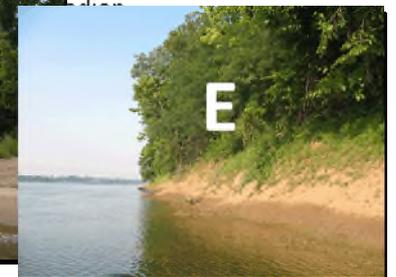
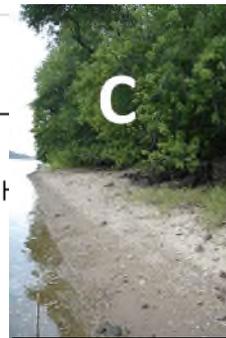
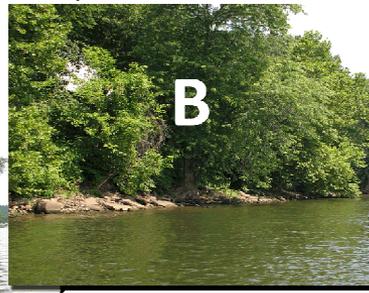
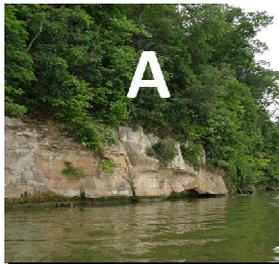
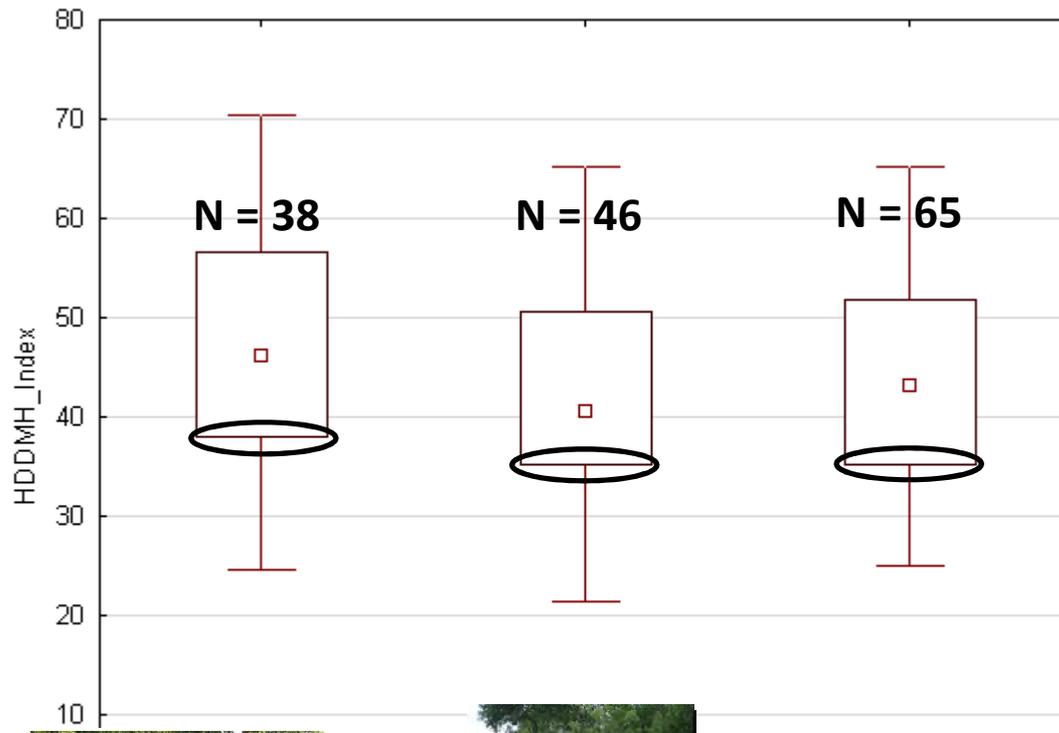
- What about instream habitat?
 - Affects sampling efficiency/community composition
 - Stratify index scoring expectations using existing habitat classes



Varying Index Expectation

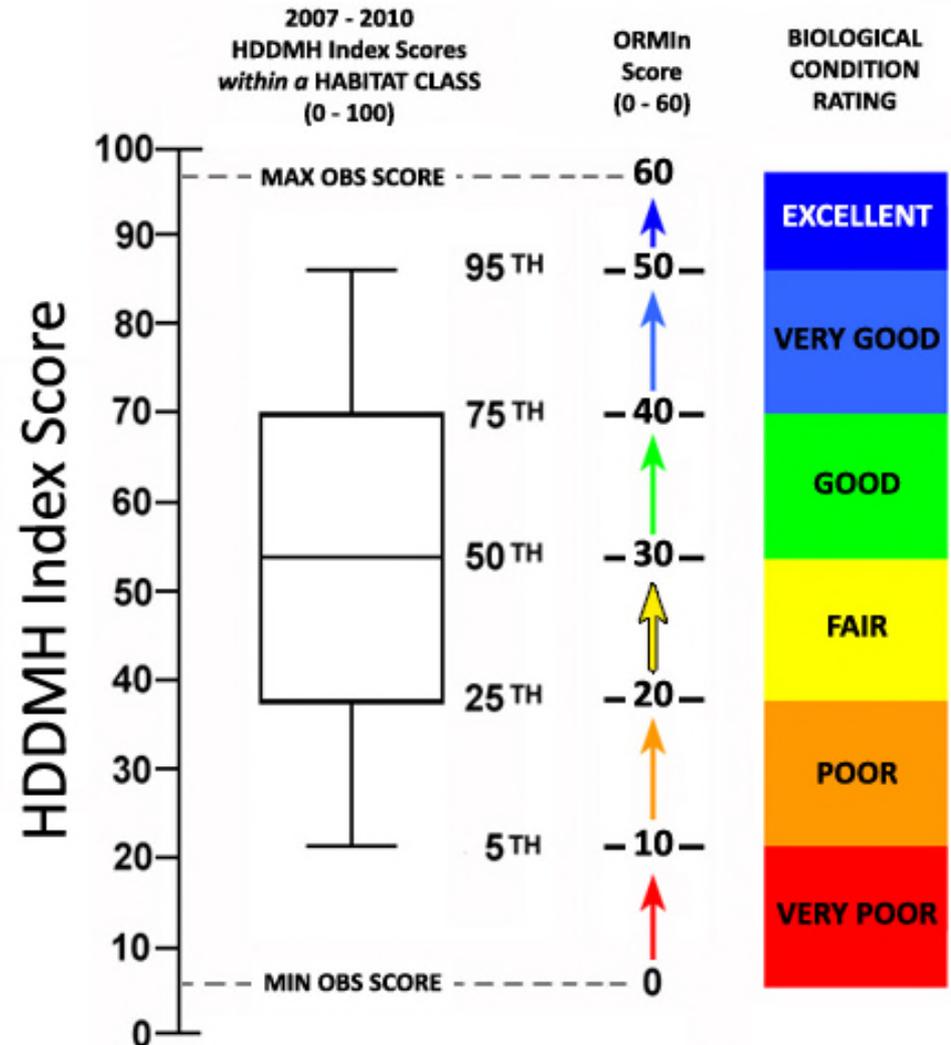


Combine Classes - Expectations

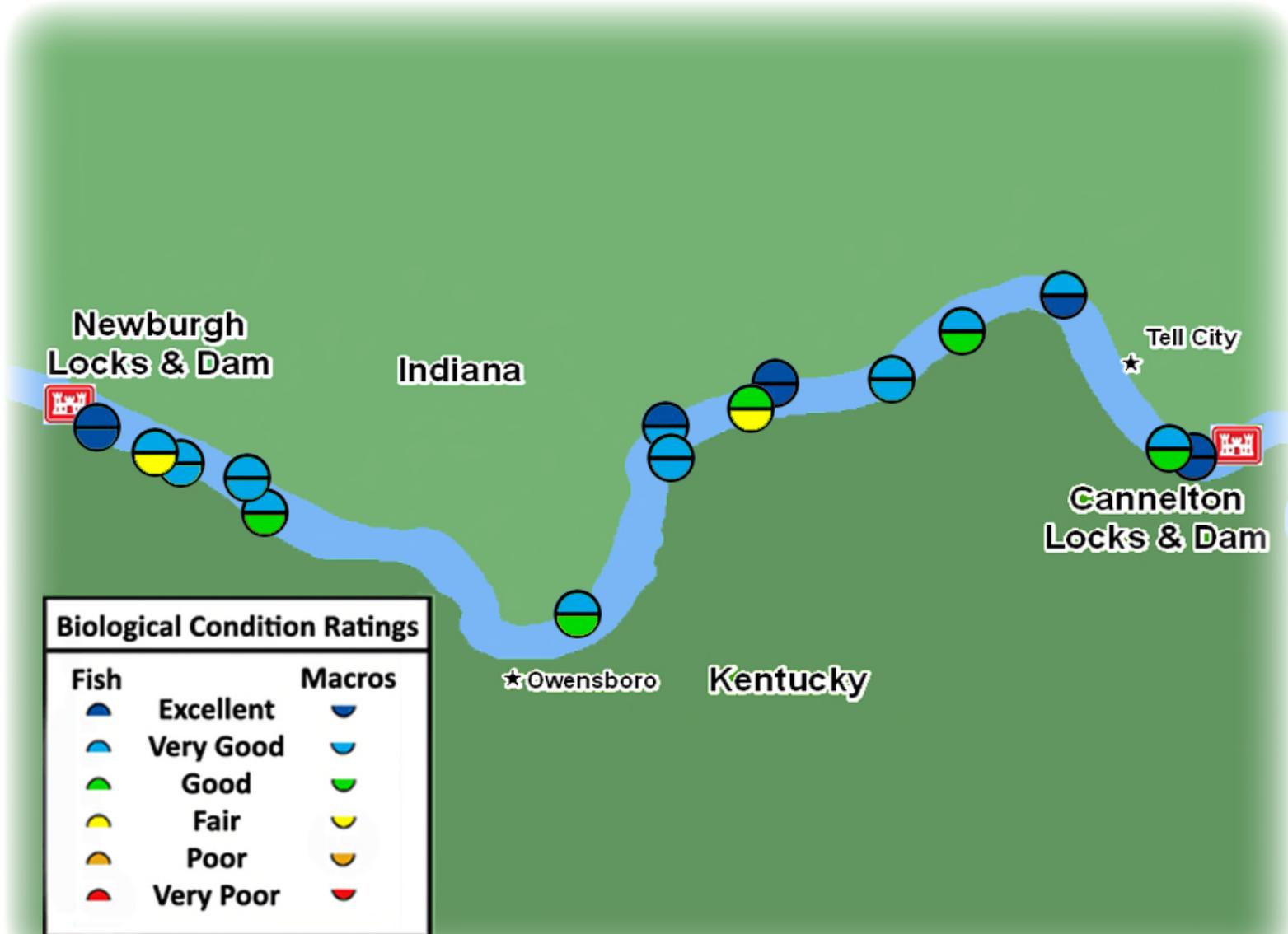


Ohio River Macroinvertebrate Index (ORMIn)

- Each site index score (i.e. HDDMH, HDD, or MH) is compared to past obs.
- Converts method index value to a relative performance measure
 - based upon habitat type
 - ORMIn score



Newburgh Fish vs. Macros



How should we treat multiple indicators?

Pool	Year	Fish Surveys		Macro Surveys	
		Score	Rating	Score	Rating
New Cumberland	2011	23.9	FAIR	35.5	GOOD
Willow Island	2011	27.7	FAIR	54.6	EXCELLENT
Greenup	2011	38.0	GOOD	39.2	GOOD
Cannelton	2011	43.6	VERY GOOD	25.8	FAIR
Emsworth	2012	26.6	FAIR	25.7	FAIR
Pike Island	2012	31.6	GOOD	41.6	VERY GOOD
Meldahl	2012	39.9	GOOD	<div style="border: 1px solid black; padding: 5px;"> What if... 9.8 VERY POOR </div>	
Newburgh	2012	46.0	VERY GOOD		

States use of Multiple Indicators

State	Fish IBI	Macro IBI	Consider Additional Info.	Process
PA		✓		Currently only one indicator
WV	✓	✓		On Hold, IBIs require additional refinement
OH	✓	✓	✓	One IBI Fails = Partial Attainment Still listed as impaired
KY	✓	✓	✓	One IBI Fails = Partial Attainment Still listed as impaired
IN	✓	✓		One IBI Fails = Impairment
IL	✓	✓	✓	One IBI Fails = Partial Attainment Still listed as impaired

**Overall, if one IBI says impaired then the unit is listed as impaired
Though some states will consider additional abiotic data before final listing**

Moving Forward

- Finalize our decision process for assessments
 - addressing multiple indicators
 - Potential for ORMI inclusion in 2015 305 (b) report
- Confirm the number of probabilistic macro sites required to assess a pool
 - Assumed it was 15 sites like fish, bootstrap analyses support
 - Conducted “oversampling” surveys in 2013
- Continued validation of the index
 - Test at least disturbed and most disturbed sites
 - Continuation of the EMAP abiotic data set

Questions?

Acknowledgments

This project was partially *funded by US EPA EMAP GRE* and benefitted from the efforts of countless interns assisting in field preparations and collections

The guidance and assistance of

Brent Johnson (USEPA)

Mark Joseph (IL EPA)

Greg Pond (USEPA)

Jeff DeShon (OH EPA)

Contact Info

D. Ryan Argo

ORSANCO

rargo@orsanco.org

513.231.7719

