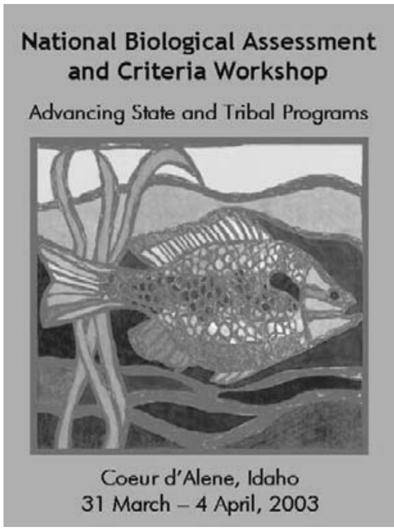
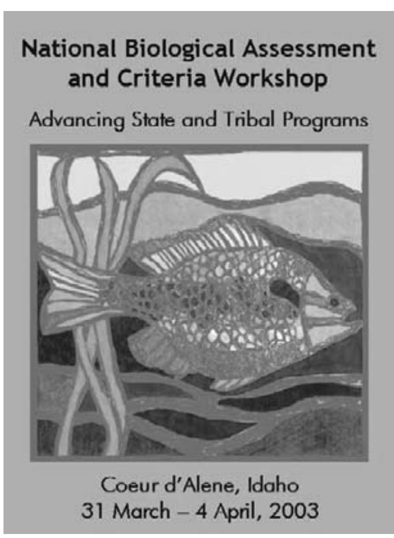


LR 101

LARGE RIVER BIOLOGICAL ASSESSMENT METHODS

Course Presenters and Contributors

Joseph E. Flotemersch, Chris Yoder, Robert Hughes, John Lyons, Kristen Pavlik, and Mike Paul



LR 101

Section 1: Introduction and Course Objectives

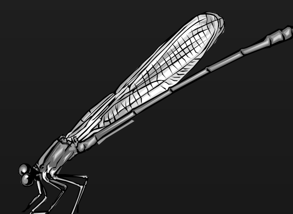
Presented by

Joseph E. Flotemersch, USEPA, Office of Research & Development

Historical Focus

Methods for wadeable streams and smaller rivers

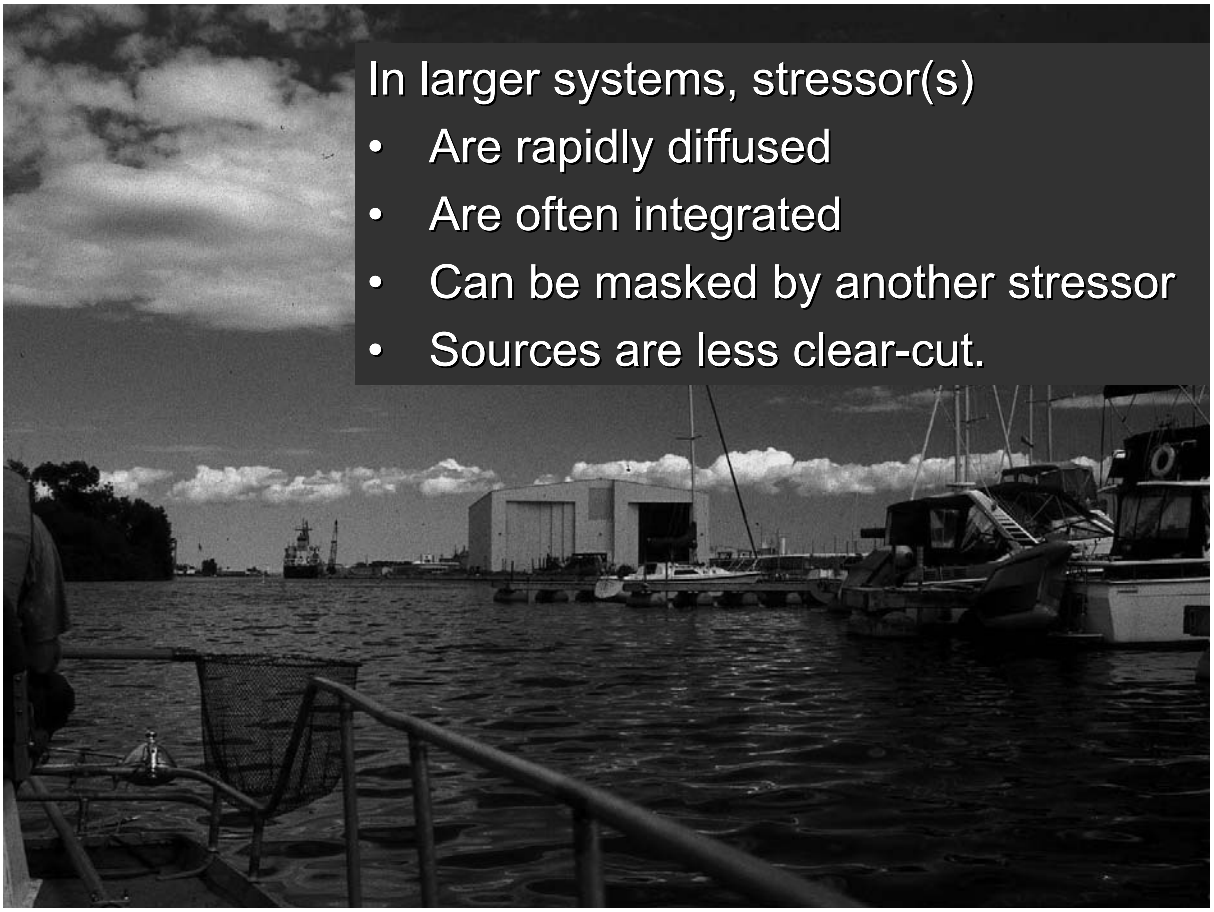
Taxonomically:

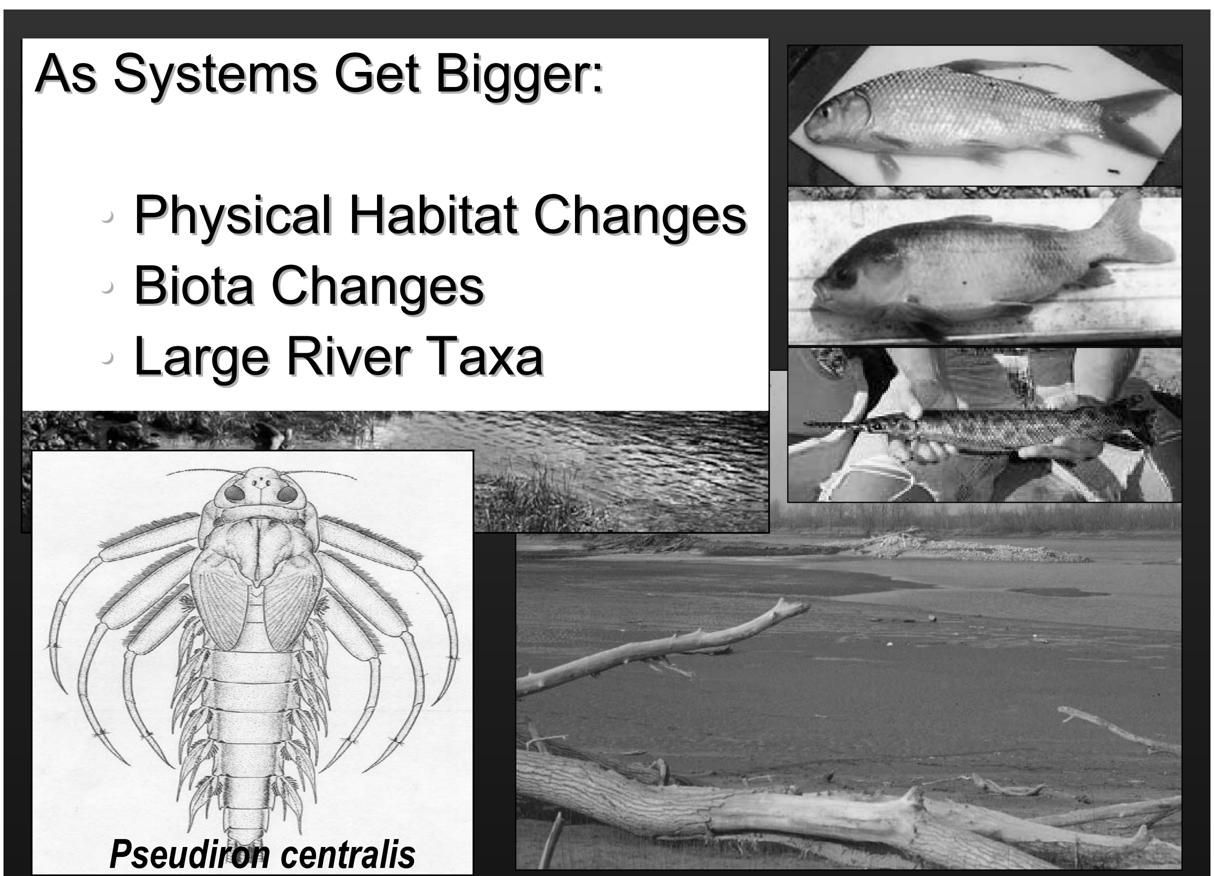


Focused largely on benthic macroinvertebrates

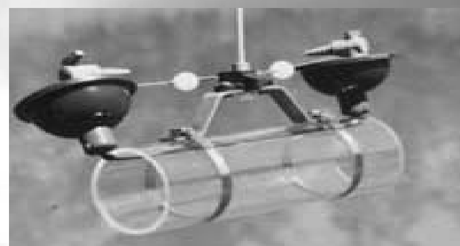
Increased awareness

- Non-point sources
- Diffuse sources of stressors
- Increased interest in larger rivers


In larger systems, stressor(s)
• Are rapidly diffused
• Are often integrated
• Can be masked by another stressor
• Sources are less clear-cut.


As Systems Get Bigger:
• Physical Habitat Changes
• Biota Changes
• Large River Taxa
Pseudiron centralis

As we move into these systems, methods will need to change.



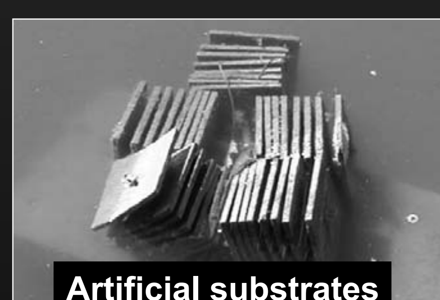
Non-Wadeable Methods

Many are slightly or unmodified wadeable method used in shallow areas

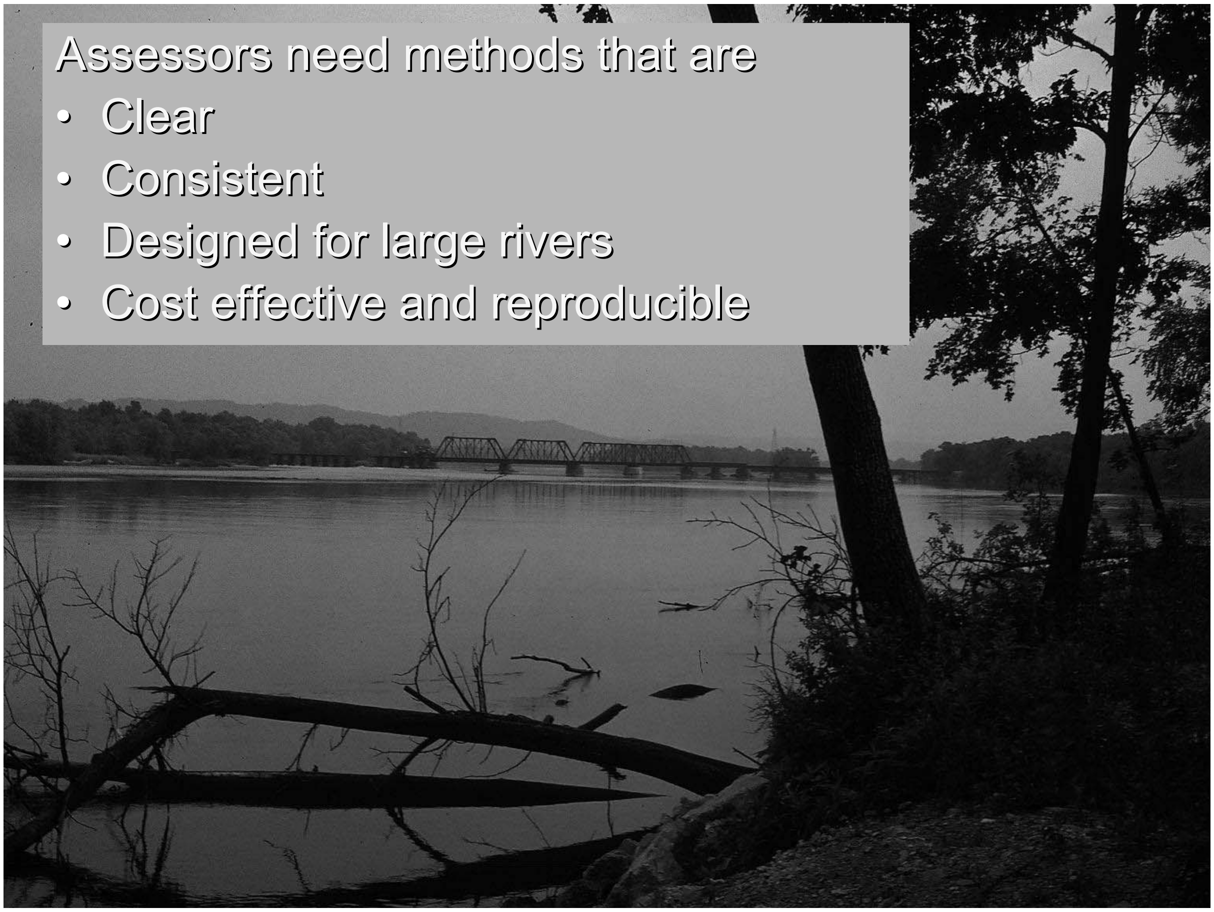
Wadeable net sampling

Net sampling near shore

Others, developed specifically for non-wadeable applications



Artificial substrates



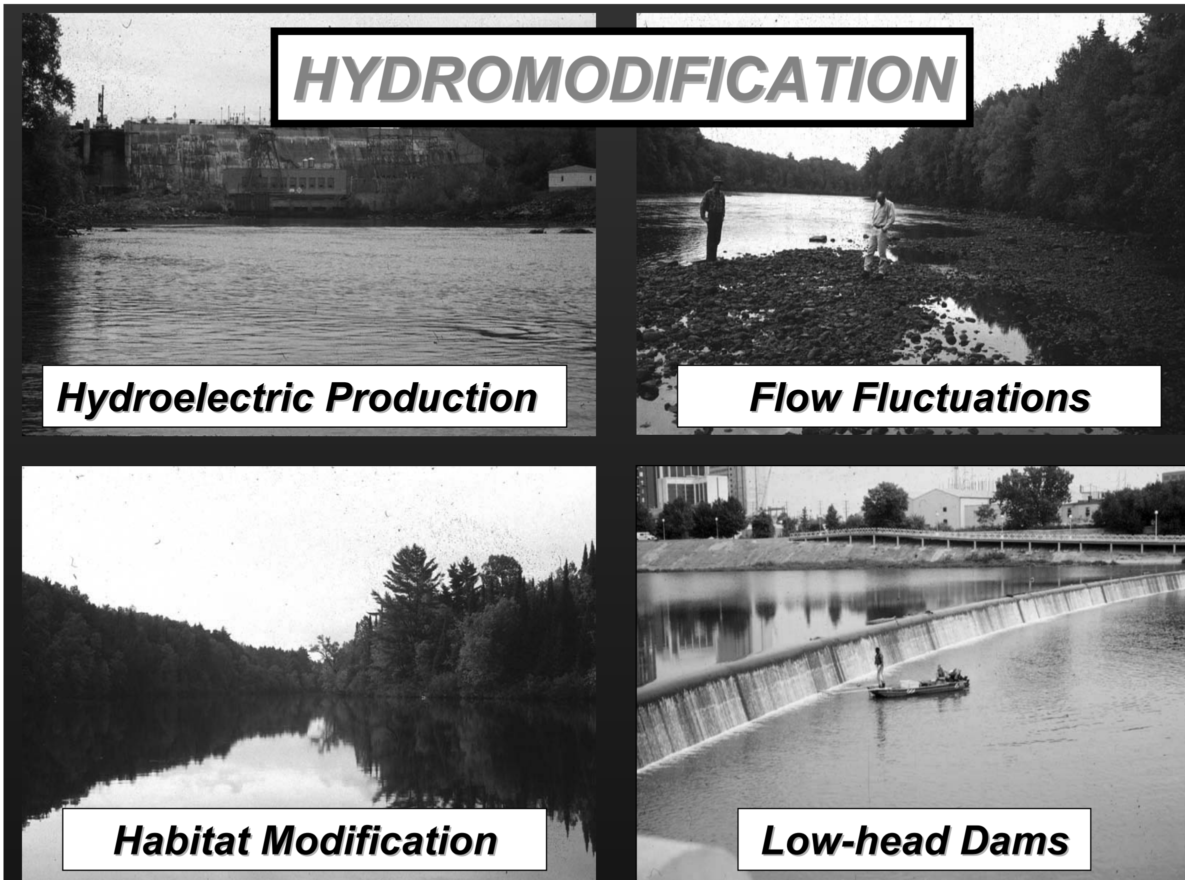
What makes large rivers different

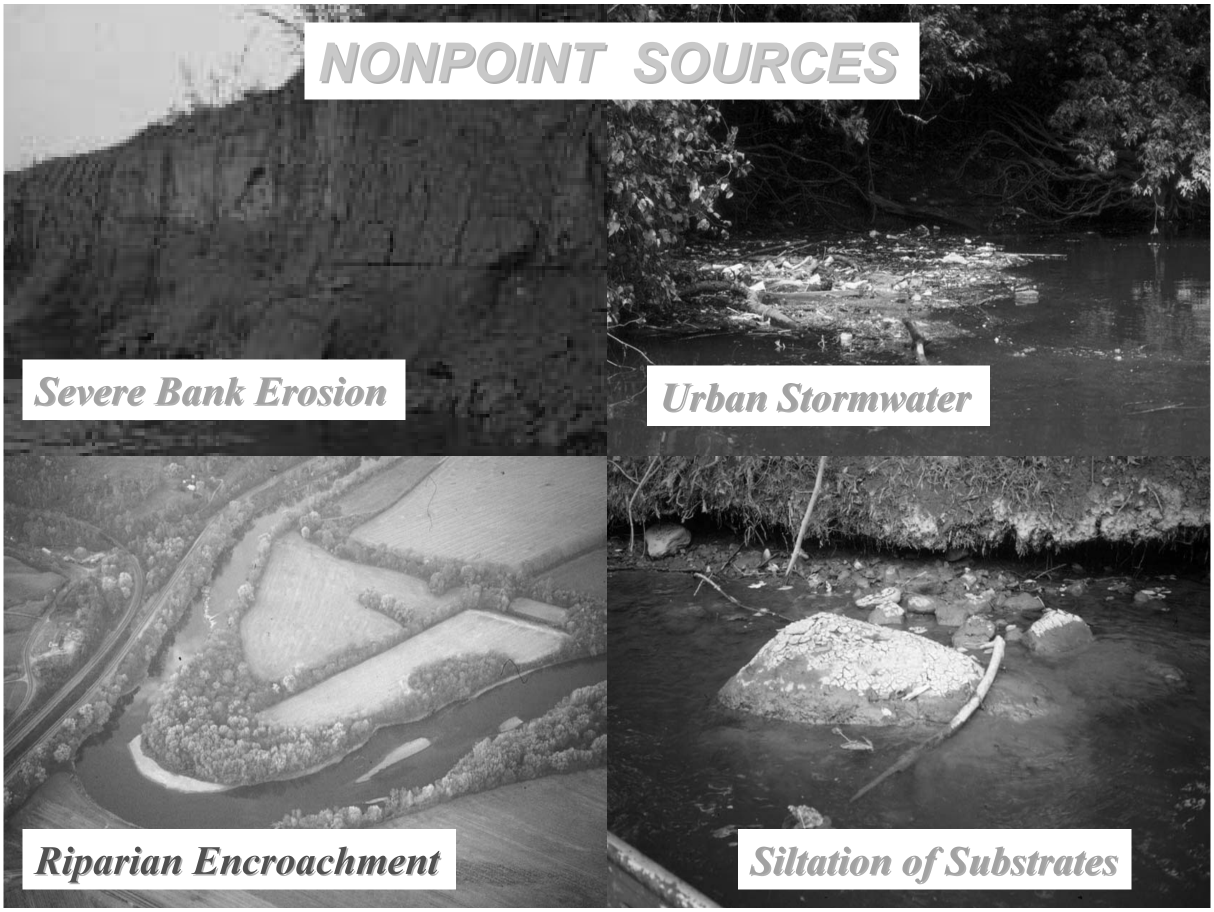
Issues unique and important to large river studies

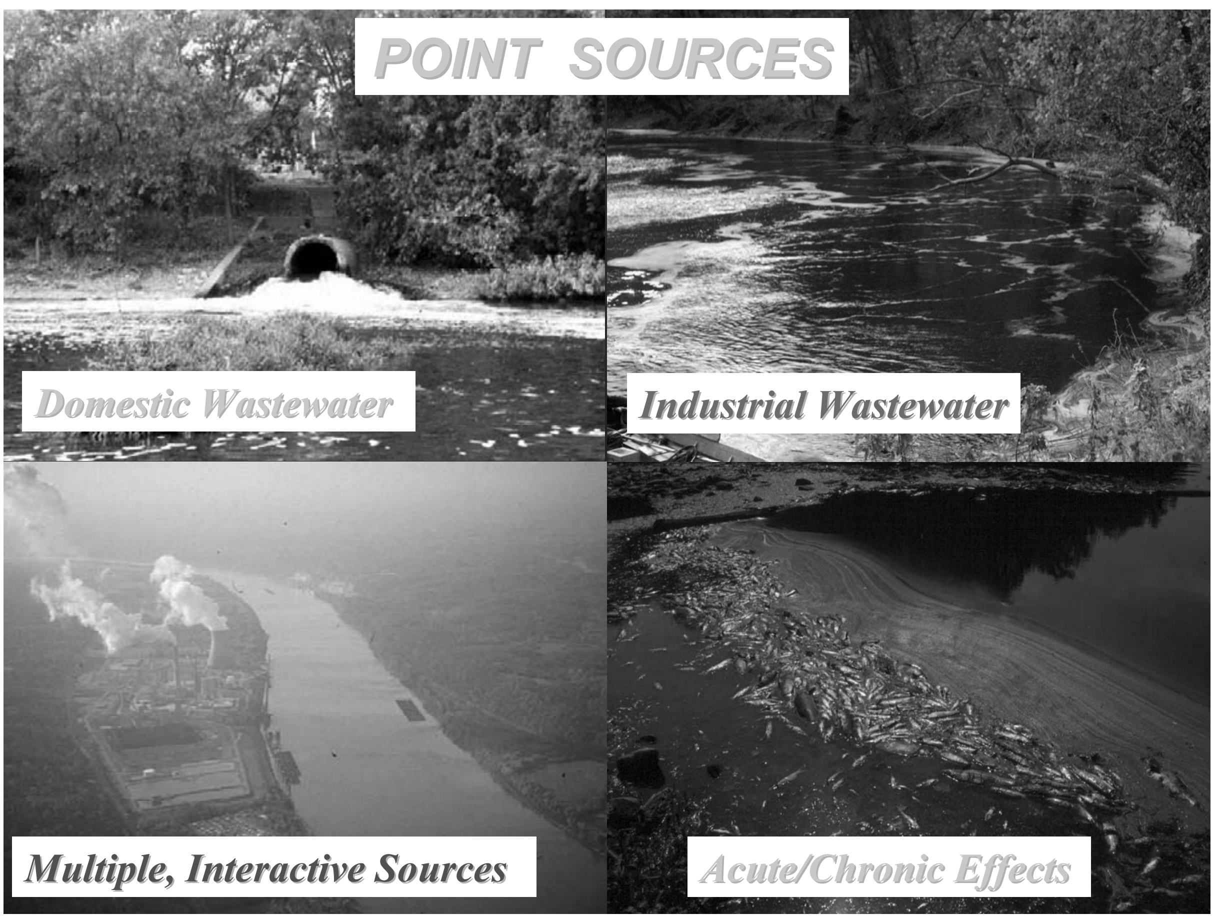
- Sample period
- Segment delineation
- Target assemblages
- Representative sampling
- Logistics

Other unique issues:

- Floodplain to channel ratio
- Presence / importance of adjacent habitats
- Volume of water to sample / represent
- Dams and impoundments
- Unique habitat characteristics
- Different faunas / floras
- Sampling methods



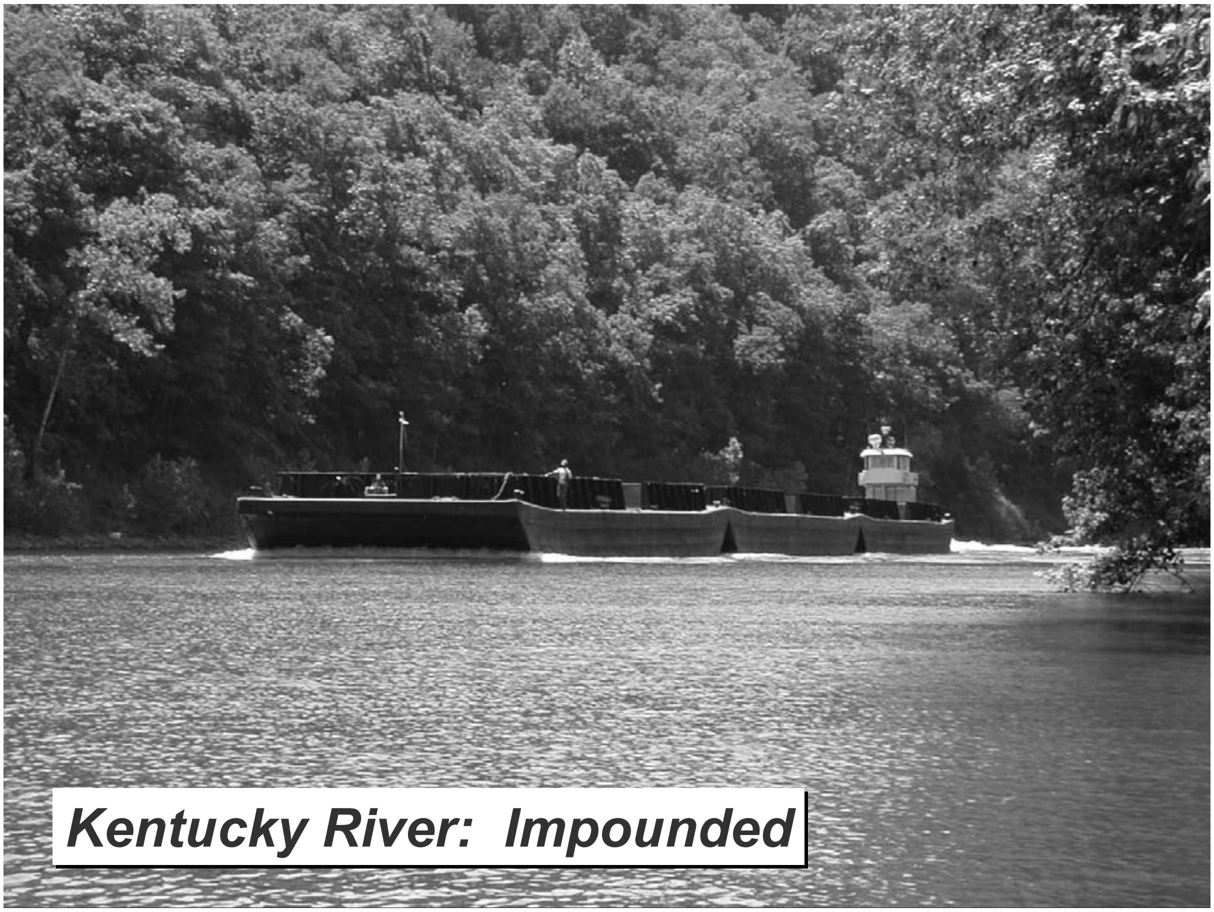

NONPOINT SOURCES
Severe Bank Erosion
Urban Stormwater
Riparian Encroachment
Siltation of Substrates

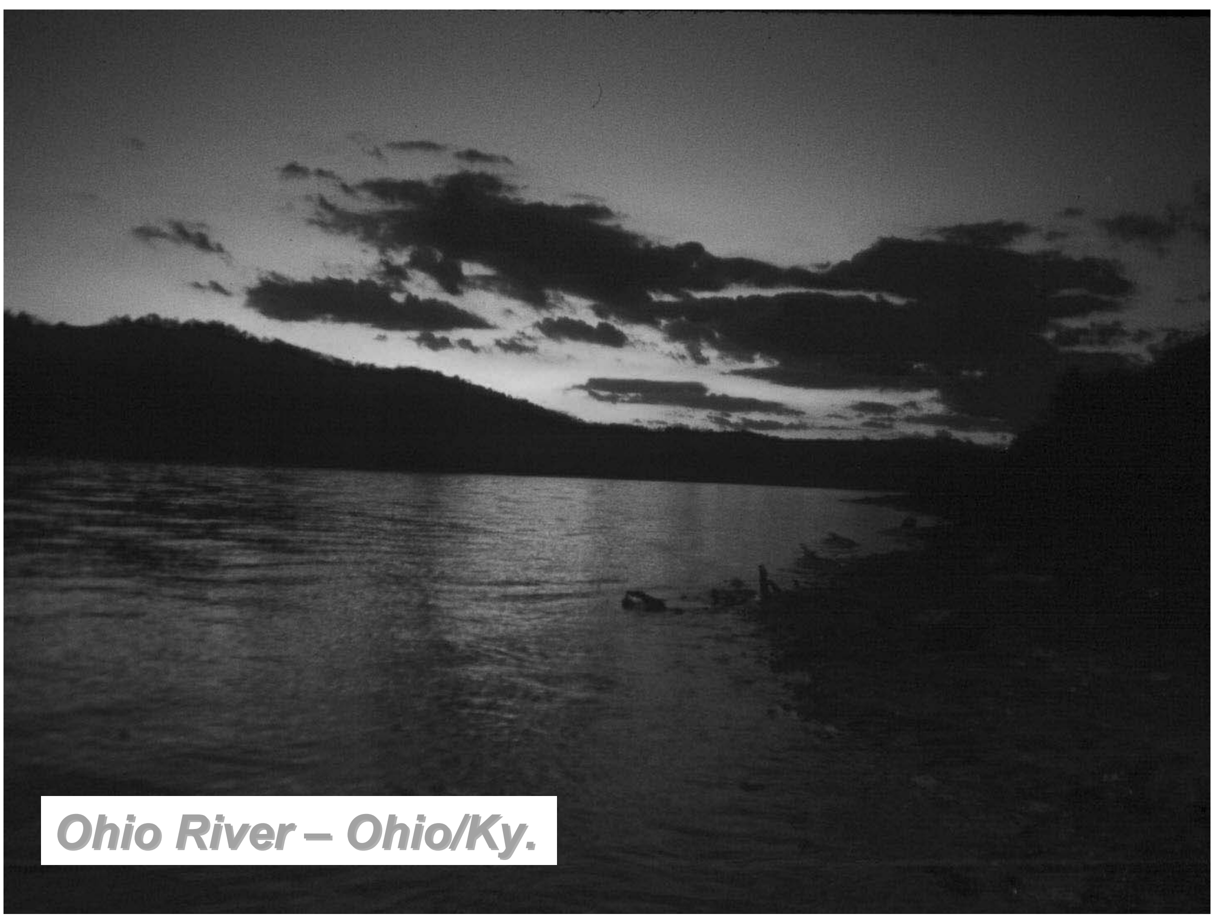

POINT SOURCES
Domestic Wastewater
Industrial Wastewater
Multiple, Interactive Sources
Acute/Chronic Effects

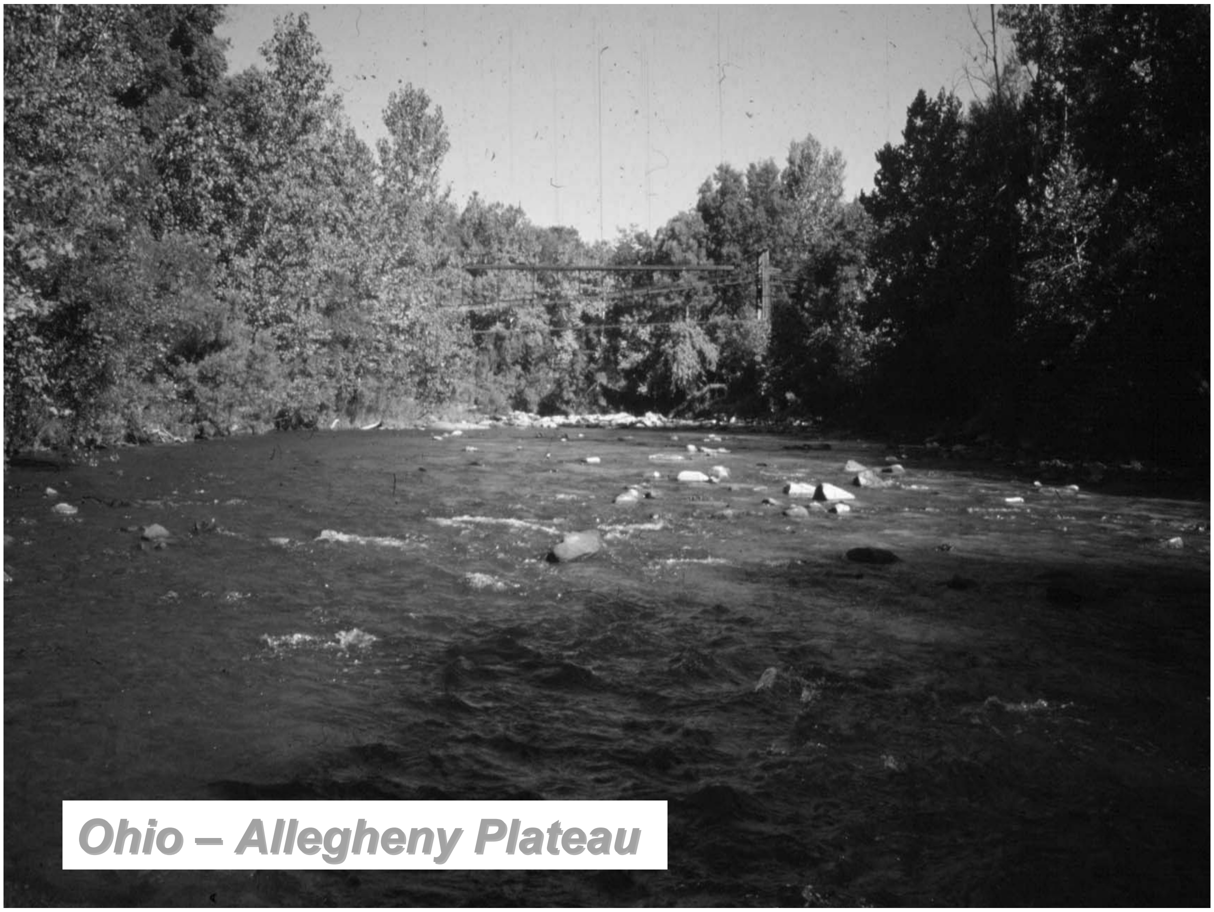
Course Objectives :

Increase familiarity with

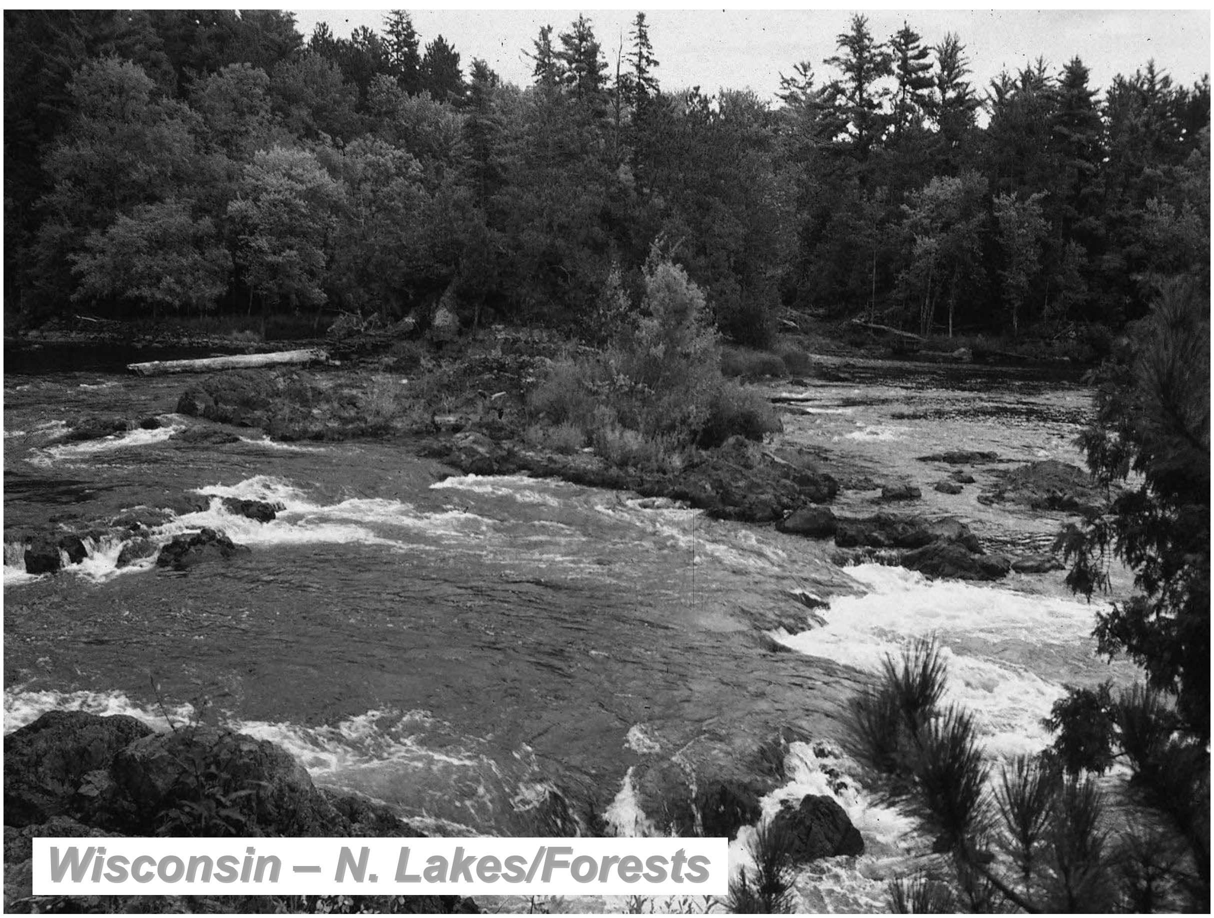
- an array of topics relevant to the development of an effective large river bioassessment program
- field methods for core biological indicator assemblages
- a diverse array and appropriate application of field methods currently being used or developed


Kentucky River: Impounded


Ohio River – Ohio/Ky.

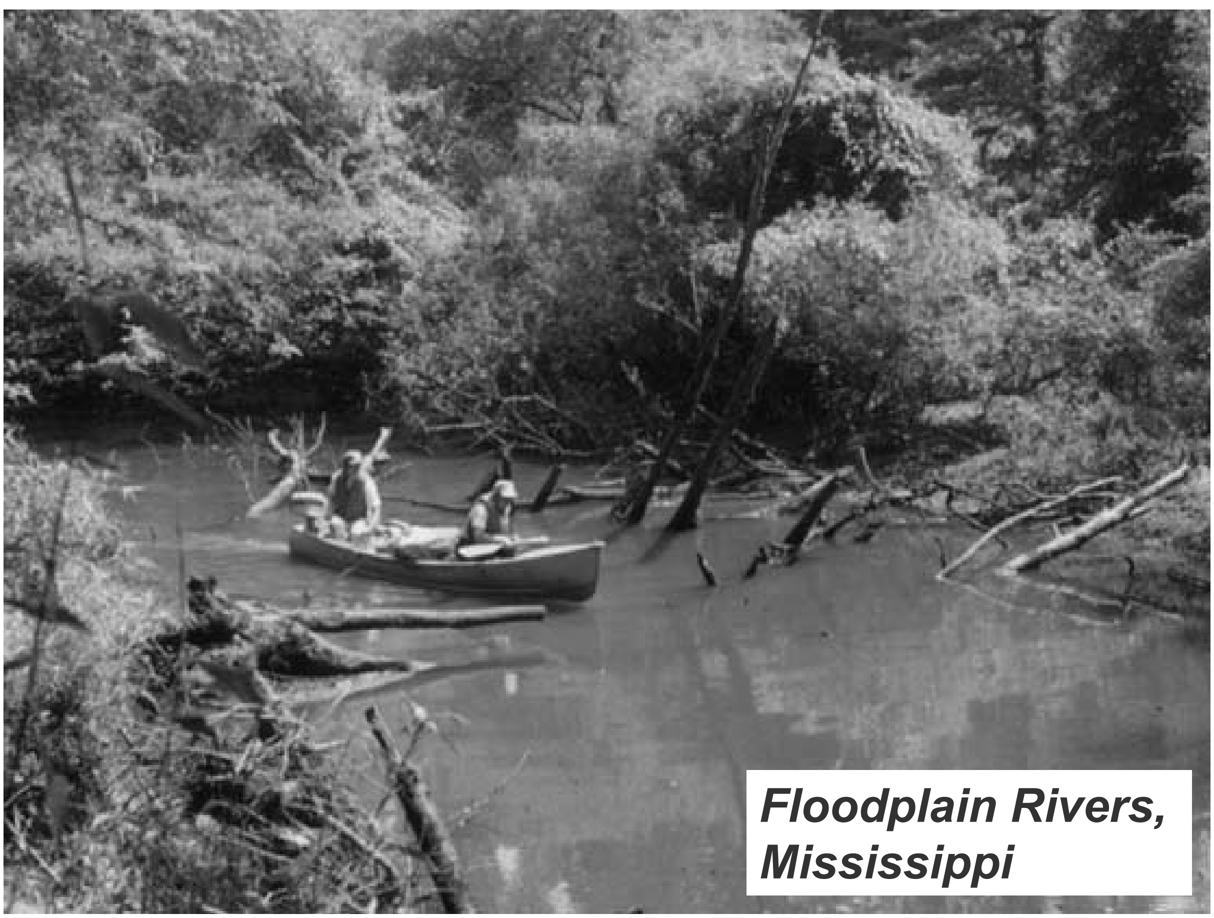


Ohio – Allegheny Plateau



Wisconsin – N. Lakes/Forests


Oregon – Cascades


Floodplain Rivers,
Mississippi

So, what is a Large River?

- Drainage area designations?
- Stream order designations?
- On-site call by field crew?

- Non-wadeable lotic stream ecosystems
  - General characteristics:
    - Boatable or raftable
    - Significant presence of riverine species
    - Does not include large reservoirs
    - May be impounded, yet retain generalized form and function of a flowing river ecosystem
  - *Bottom line: There is no Bright Line*

What is a Large River?

A lotic stream system that is better sampled with boat-based field methods rather than wadeable techniques.

- Fish perspective: Boat or raft-mounted methods
- Benthic Macroinvertebrates: Dip-net or artificial substrates in shoreline margins
- Algae: Periphyton to Phytoplankton

DESIRABLE TRAITS OF A LARGE RIVER BIOASSESSMENT PROGRAM

- **Cost-effective**
- **Transcends sub-habitat differences**
- **Reasonably rapid turn-around for data**
- **Readily obtained decisions or judgments**
- **Easily translated to management and public**
- **Complete multiple sites in a day**

DESIRABLE TRAITS OF A LARGE RIVER BIOASSESSMENT PROGRAM

- **Methods**
  - Adaptable to the multi-purpose sampling needs within a water quality organization.
    - Bioassessment
    - Trend analysis,
    - Point source
    - Non-point source
  - Accepted by participating scientist

TECHNICAL ISSUES FOR LARGE RIVER BIOLOGICAL PROGRAMS

- Designing study objectives
- Defining reference conditions
- Identifying an appropriate index period
- Taking a representative sample
- Understanding ecological relationships
- Diagnosing the source and cause of impairment

What is a Representative Sample?

- What it is:
  - An adequate sample for bioassessment
    - Representative of the system
    - Discrete
    - Reproducible (across segments)
    - Consistent (low variability within segment)
    - Diagnostic (desirable objective)
- What it is not:
  - Exhaustive survey of all taxa or targeted taxa

Logistical Issues…

- Equipment
- Facilities
- Experience
- Technical procedure
- Training

Constraining Issues…

- Typically monitored by a different agency (with different objectives)
- Common focus on wadeable streams
- Site specific approach to assessment
- Interstate and trans-boundary waters jurisdictions is unclear

Example → *Lack of Reference condition and accepted models…*

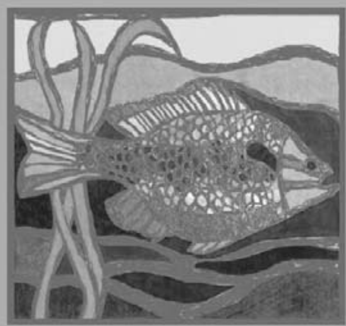
- "Natural" reaches are rare
- "Least Disturbed" often = highly disturbed
- Models exist but ecological theory hampered by loss of the resource

Exercise 1:

1) **Additional constraining issues**
2) **Options for overcoming constraining issues**
3) **Objectives and assessment questions of greatest interest to group**

National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs



Coeur d'Alene, Idaho
31 March – 4 April, 2003

LR 101

Section 2: Initial Decisions and Considerations

Presented by

Chris O. Yoder, Midwest Biodiversity Institute & Center for Applied Bioassessment and Biocriteria

Essential Principles of Adequate Monitoring and Assessment Approaches

- **Methods Development: cost-effective approaches that meet the needs of a bioassessment program.**
- **Data Quality Objectives:** produce data and information at a sufficient level of resolution so as to assure accuracy and precision.
- **Scale of Assessment:** essential to encompass the full gradient of response and exposure to multiple stressors and influences; scale of assessment = scale of management.
- **Comprehensive Assessments:** integrated and careful analysis of multiple indicators adhering to a disciplined approach (Hierarchy of Indicators).
- **Learn by Doing:** gain new knowledge and insights by interactive assessment and observing responses to management actions (determine what works).

Large River Fish Assemblage Assessment Attributes

- Standardized & Representative Sampling – pulsed D.C. electrofishing methods, summer – fall seasonal index period.
- Relative Abundance – numbers and weight (biomass) per unit distance (effort).
- Data Quality Objectives – species level I.D. based on regional ichthyology keys and AFS nomenclature.
- Key Component of Biocriteria – IBI, MIwb, and component metrics; development of tiered uses and numerical biocriteria.
- Longitudinal Sampling Design – longitudinal reach-scale sampling and interpretation of results along entire mainstems.
- Sampling Site Considerations – include complete cycles of riverine habitat types; may vary between constrained and floodplain rivers.
- Experienced Biologists – knowledge of regional fauna, natural history, response signatures, impact types.

Large River Macroinvertebrate Assemblage Assessment Attributes

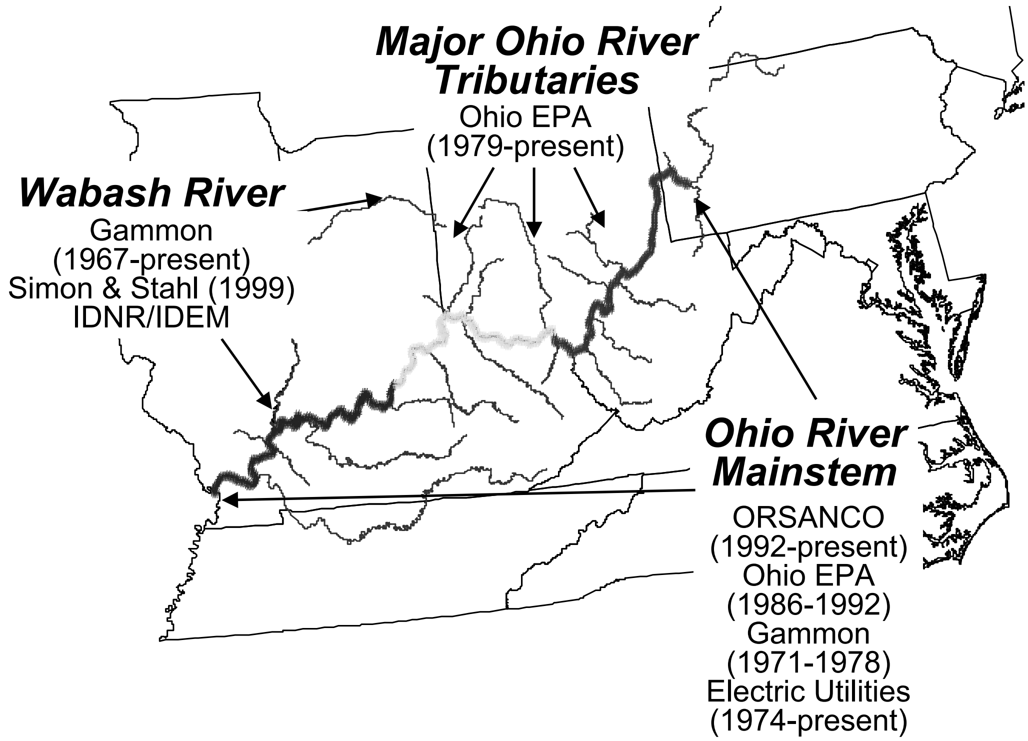
- Standardized & Representative Sampling – artificial substrates, summer – fall seasonal index period.
- Relative Abundance – organisms per unit surface area.
- Data Quality Objectives – lowest practicable level I.D. based on representative keys.
- Key Component of Biocriteria – ICI, BIBI, and component metrics, also RIVPACS, discriminant function model; development of tiered uses and numerical biocriteria.
- Longitudinal Sampling Design – longitudinal reach-scale sampling and interpretation of results along entire mainstems.
- Sampling Site Considerations – include complete cycles of riverine habitat types; may vary between constrained and floodplain rivers.
- Experienced Biologists – knowledge of regional fauna, natural history, response signatures, impact types.

Methods Development Issues: Fish Assemblage Example

History of Large River Fish Assemblage Assessment

- **Since Late 1960s** – improved electrofishing equipment & technology (pulsed DC, sophisticated electronics).
- **Early 1970s:** – Gammon's work on the Wabash River, Indiana; resulted in development of single-gear approach (shoreline electrofishing based on distance).
- **1980s/1990s** – Ohio EPA initiated statewide use of electrofishing to survey fish assemblages; followed by IBI development and biological criteria adoption.
- **Late 1980s** – Hughes & Gammon work on the Willamette River, Oregon; addressed challenges with depauperate fish faunas in bioassessment and IBI development.
- **1990s** – Western EMAP (Large Coldwater Rivers), ORSANCO (Ohio R. mainstem), and Wisconsin (Lyons, IBI), Idaho (IBI, Mebane et al.).

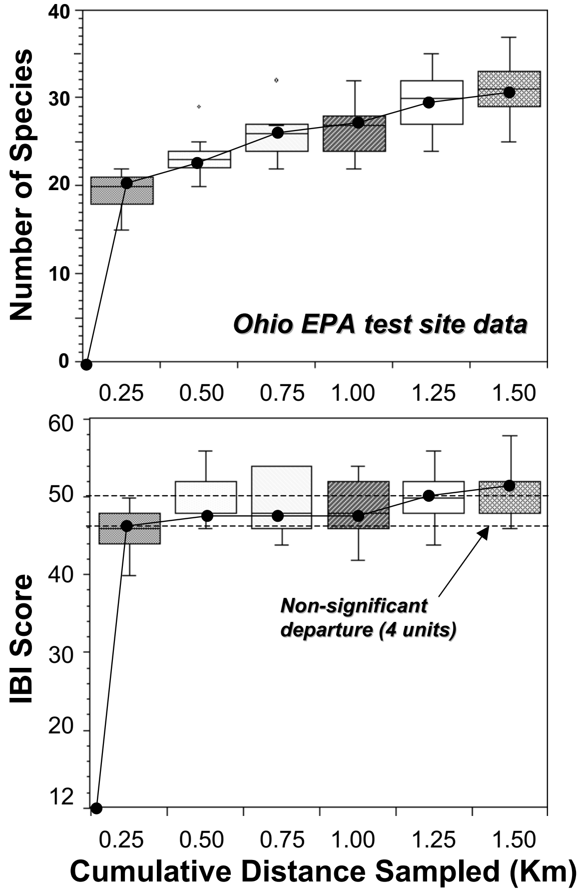
Fish Assemblage Assessments of Large and Great Rivers in the Upper Ohio Basin



Methods Development Issues:

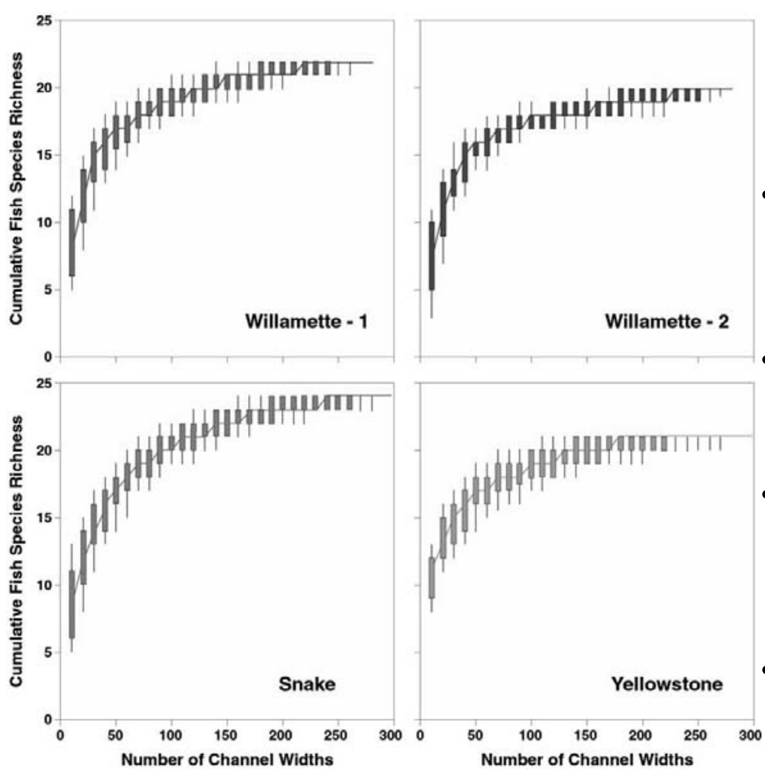
Sampling Effort:

- **How to measure sampling effort – time or distance or both?**
- **Pilot studies conducted in the Wabash R. (1973-76), Ohio rivers (1979-81), Wisconsin rivers (mid-1990s), Oregon rivers (late 1990s).**
- **Early studies derived fixed distance criteria (e.g., 500m); Ohio EPA added minimum time requirement.**
- **Later studies derived a river width formula (40-80x)**
- **Choice influenced by program objectives.**
- **Some protocols developed for source assessment – Ohio EPA mixing zone, ORSANCO T-zone.**



Methods Testing and Evaluation: Ohio

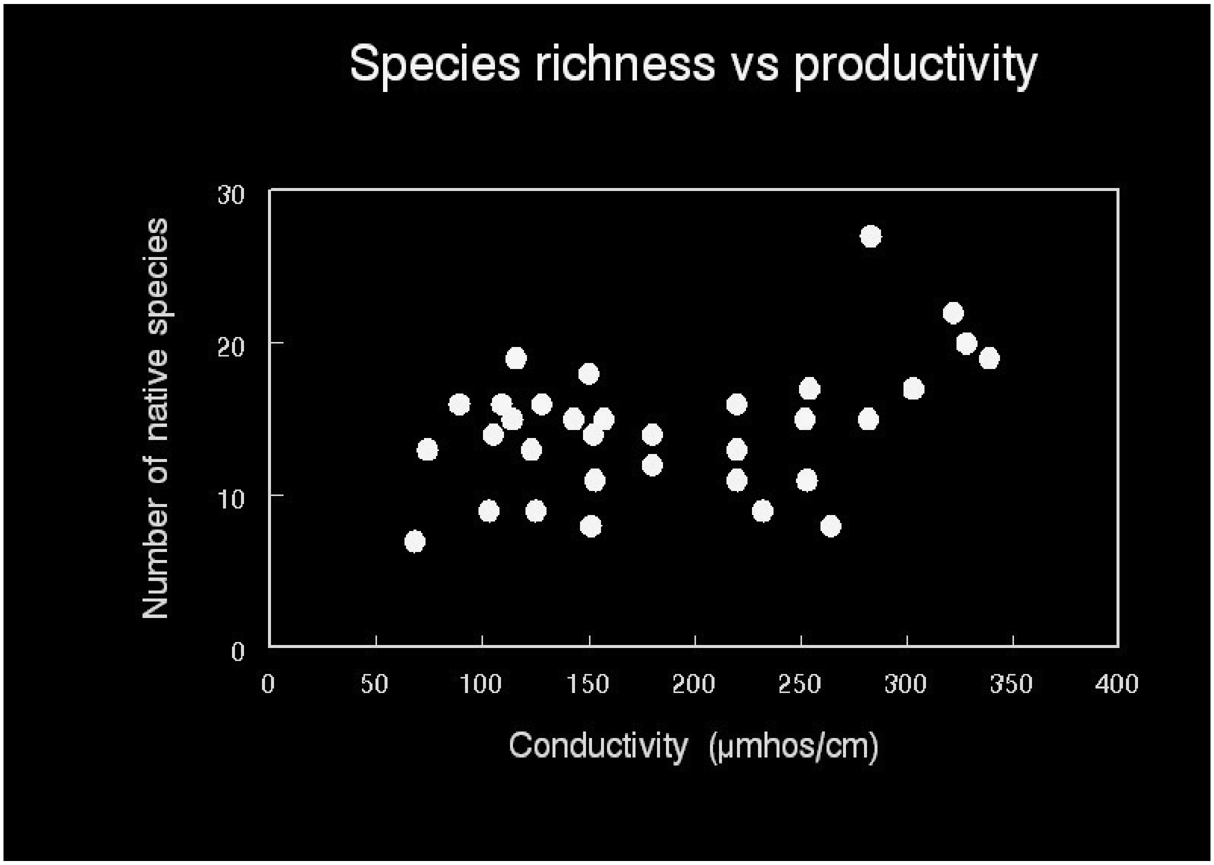
- Methods testing to determine effect of effort, variability, and reproducibility.
- Conduct repeated samplings under controlled circumstances.
- Species richness increases with distance; rate of increase stable >250 m.
- IBI increase diminishes at shorter distances; non-significant differences 500-1250 meters; >@ 1500 m.



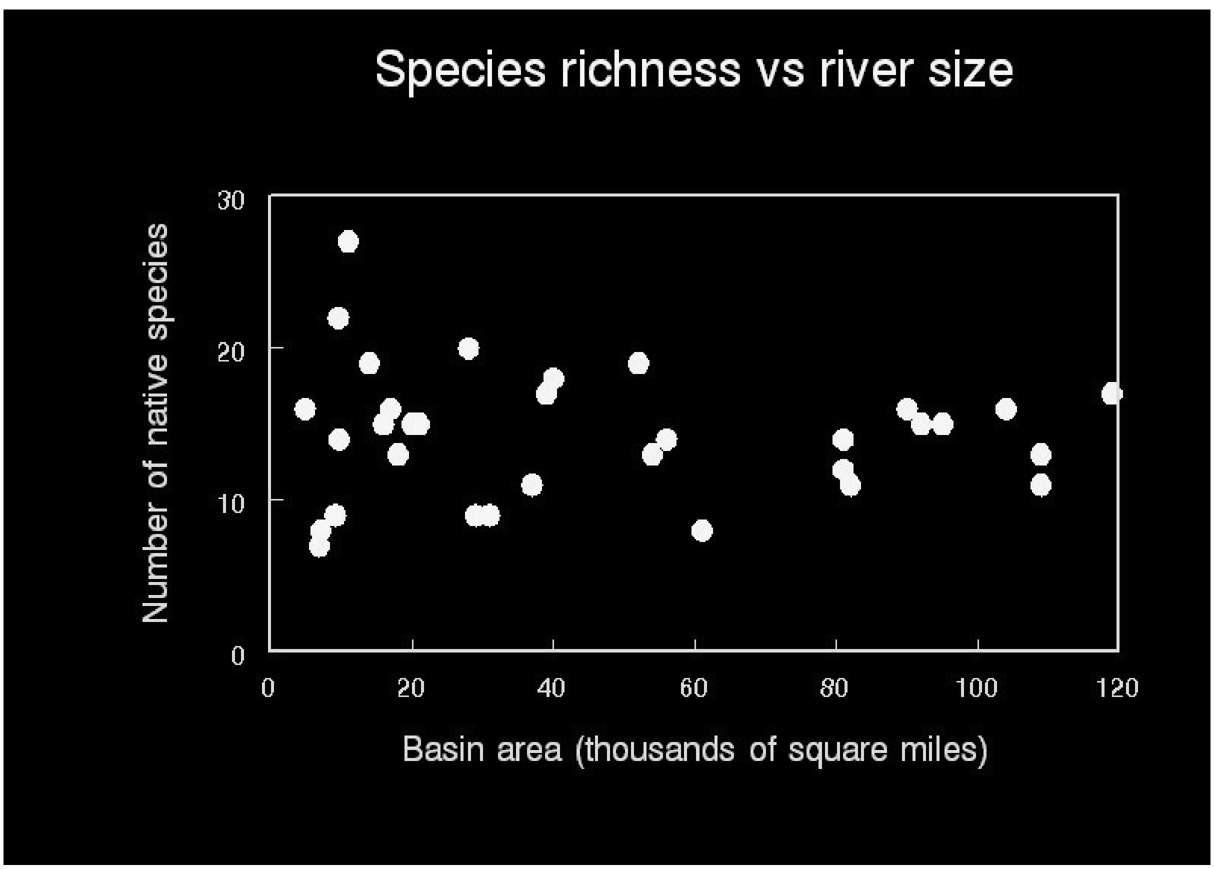
Methods Testing and Evaluation: Western EMAP

- Methods testing to determine effect of effort, variability, and reproducibility.
- Test sites to determine effect of sampling distance on species richness.
- Cumulative species richness increases sharply with increasing distance sampled.
- 186-240 widths required to accumulate 95% of true species richness.

after Hughes et al. 2002

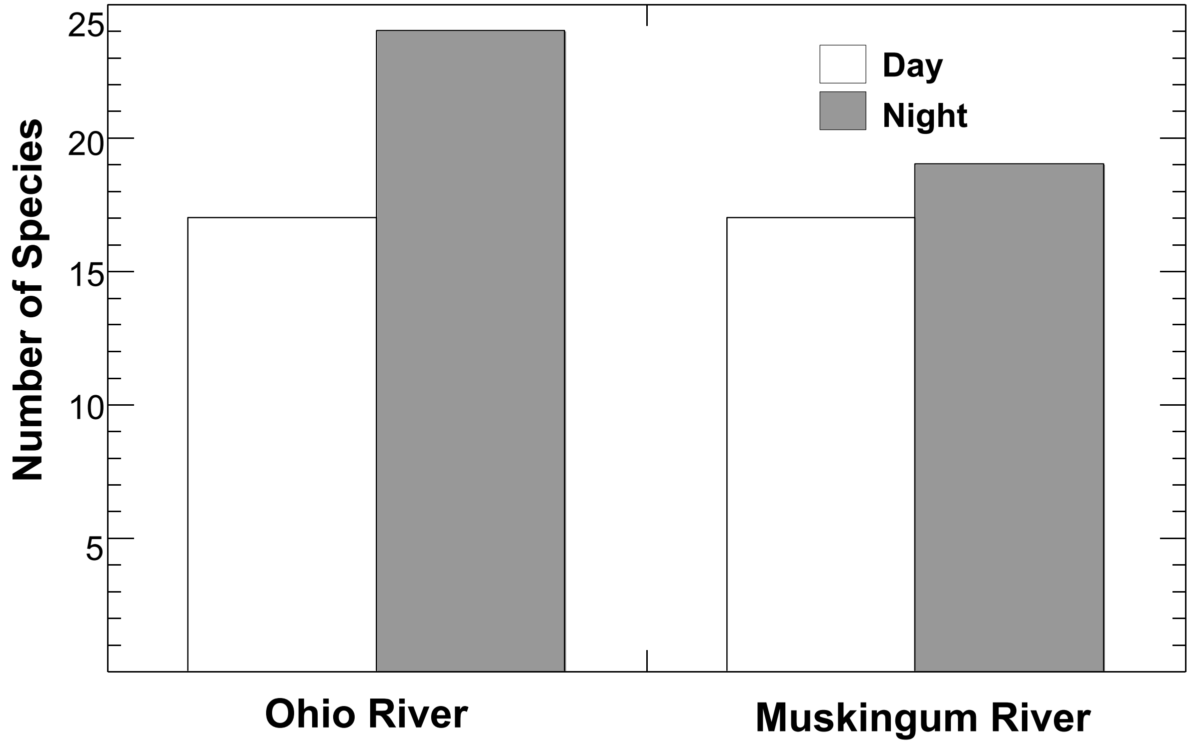


Slide Used Courtesy of John Lyons, Wisconsin DNR

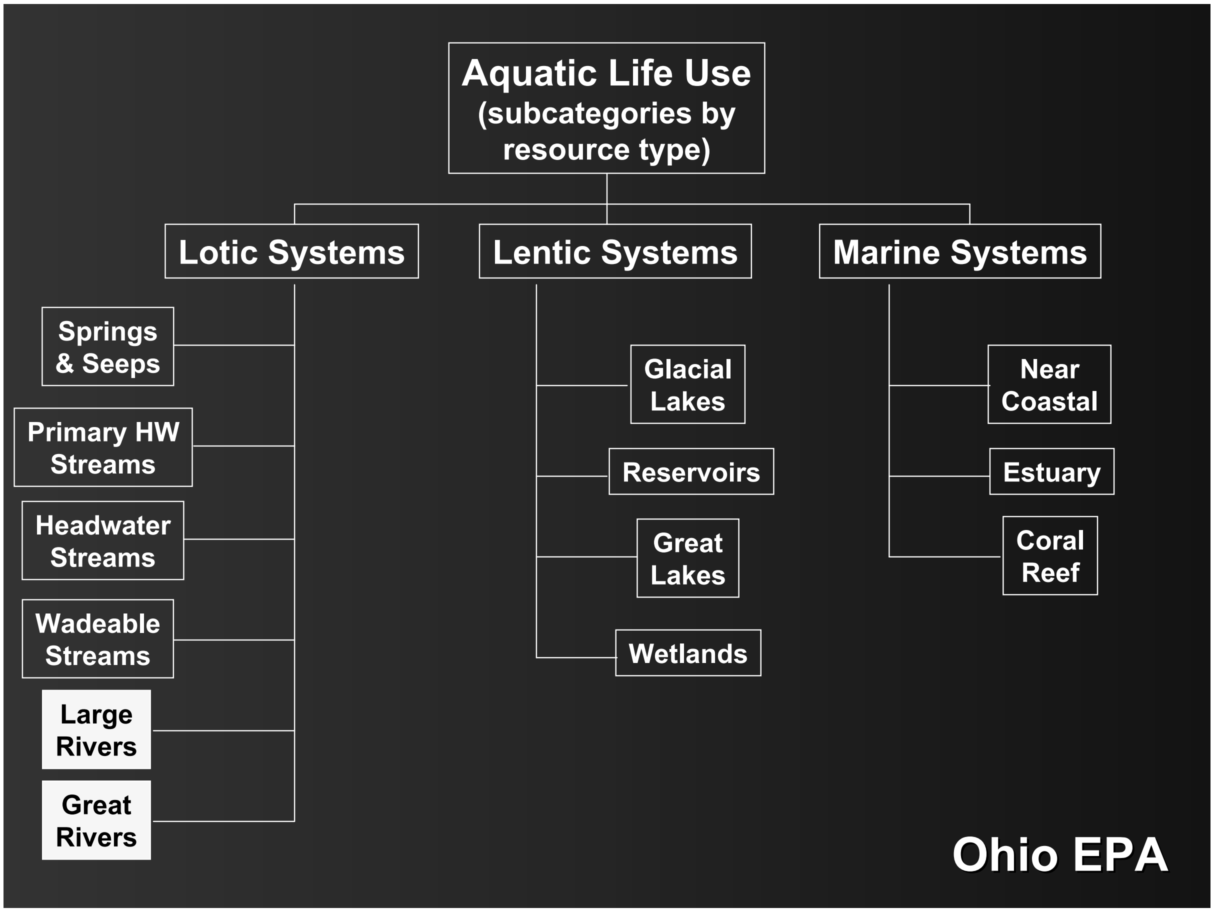


Slide Used Courtesy of John Lyons, Wisconsin DNR

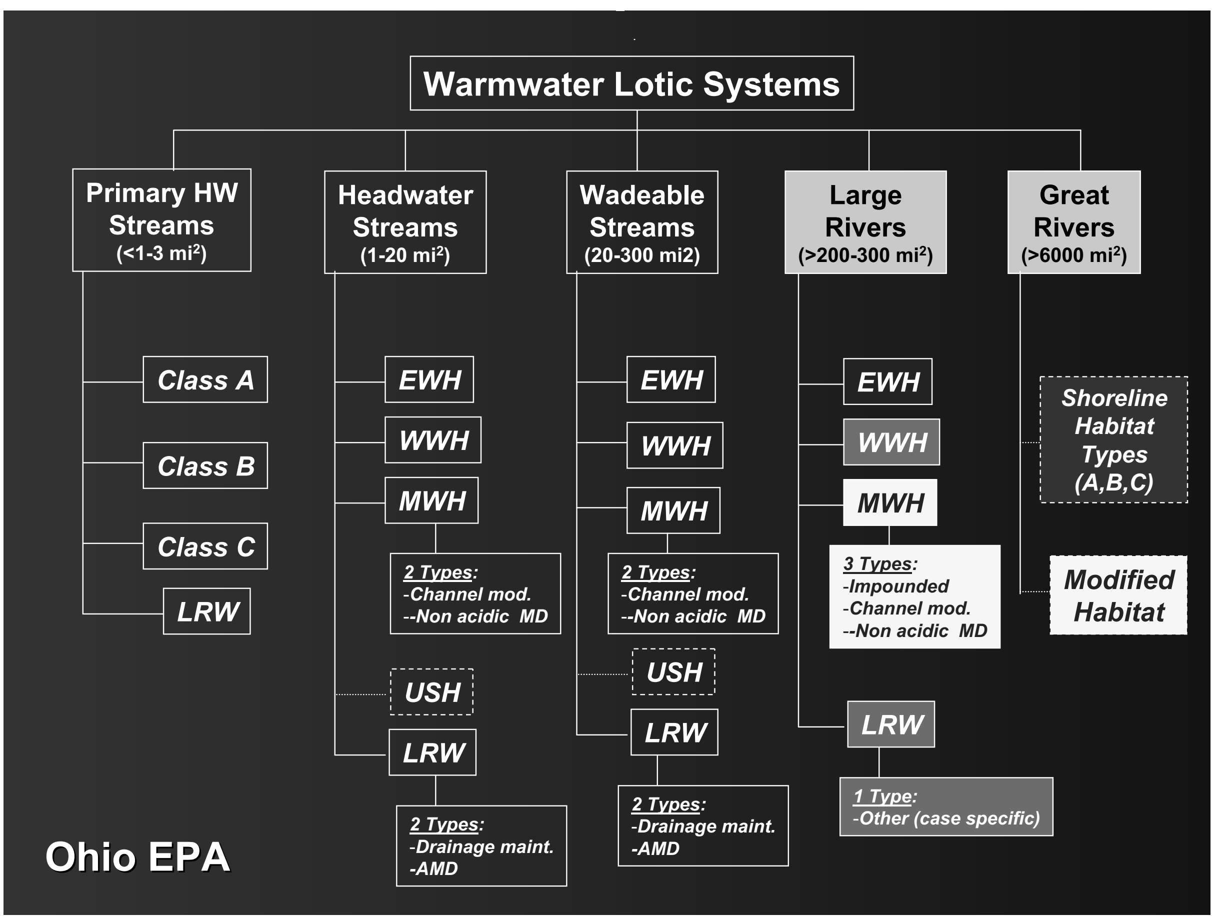
Effect of Time of Day on Electrofishing Efficiency: Impounded Rivers



Resource Classification and Stratification Issues: Tiered Uses and Biocriteria



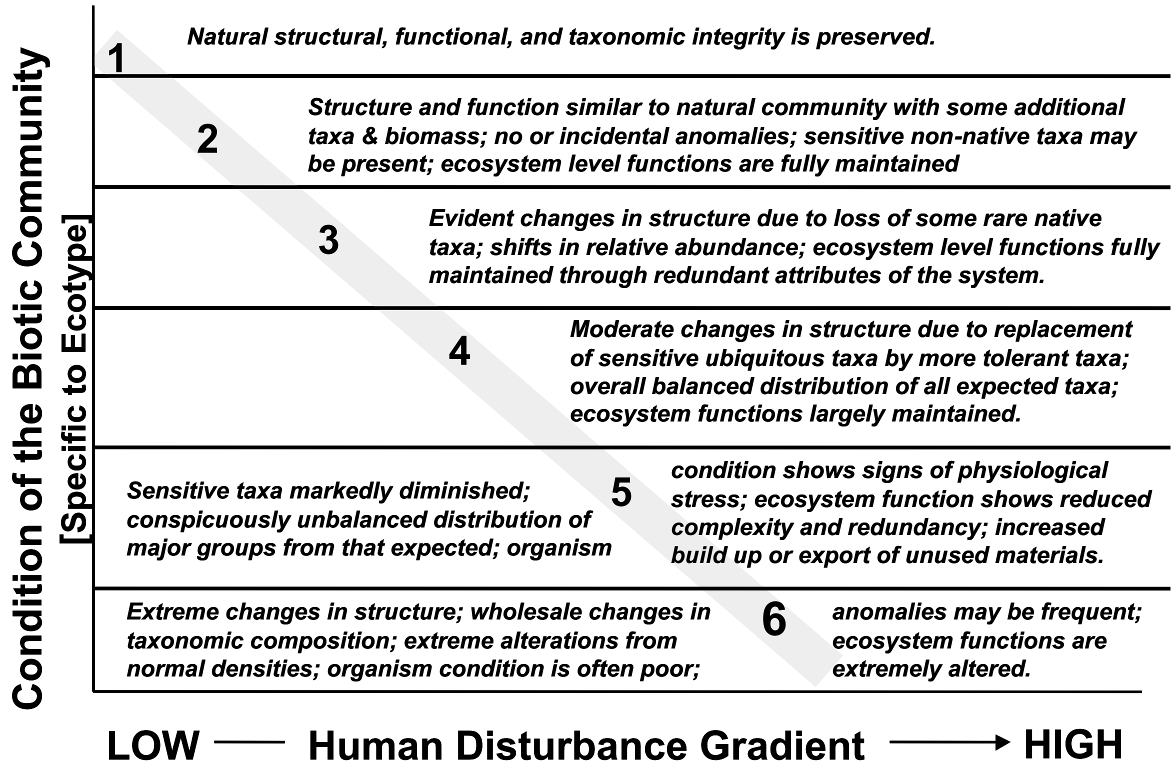
Aquatic Life Use (subcategories by resource type)
Lotic Systems
Lentic Systems
Marine Systems
Springs & Seeps
Primary HW Streams
Headwater Streams
Wadeable Streams
Large Rivers
Great Rivers
Glacial Lakes
Reservoirs
Great Lakes
Wetlands
Near Coastal
Estuary
Coral Reef
Ohio EPA



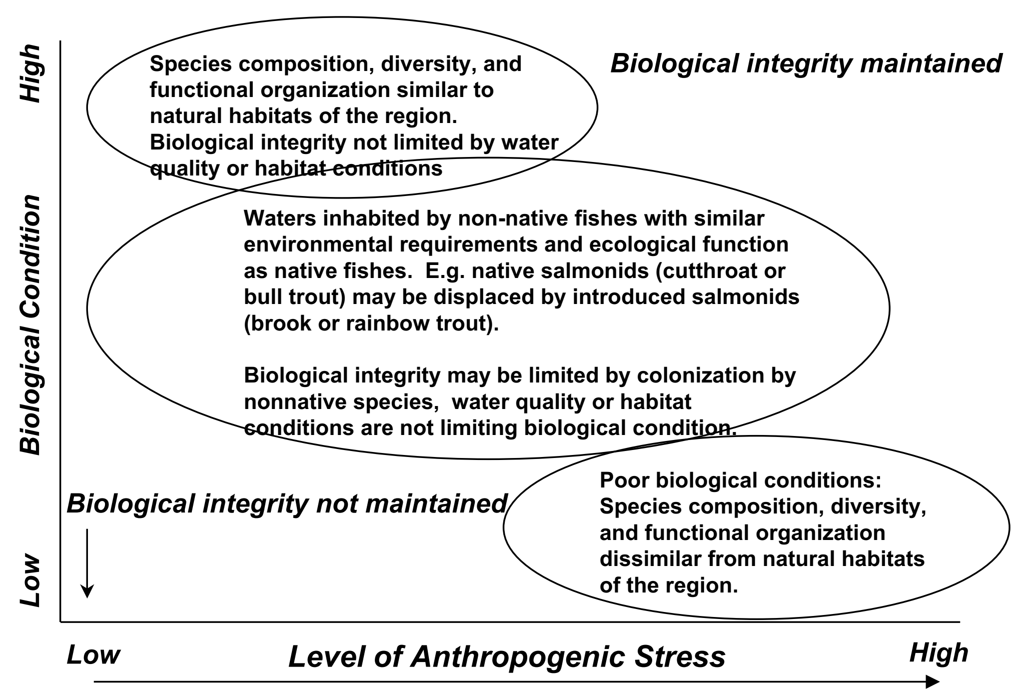
Warmwater Lotic Systems
Primary HW Streams (<1-3 mi²)
Headwater Streams (1-20 mi²)
Wadeable Streams (20-300 mi2)
Large Rivers (>200-300 mi²)
Great Rivers (>6000 mi²)
Class A
Class B
Class C
LRW
EWH
WWH
MWH
2 Types: -Channel mod. --Non acidic MD
USH
LRW
2 Types: -Drainage maint. -AMD
EWH
WWH
MWH
2 Types: -Channel mod. --Non acidic MD
USH
LRW
2 Types: -Drainage maint. -AMD
EWH
WWH
MWH
3 Types: -Impounded -Channel mod. --Non acidic MD
LRW
1 Type: -Other (case specific)
Shoreline Habitat Types (A,B,C)
Modified Habitat
Ohio EPA

Tiered Aquatic Life Use Conceptual Model: Draft Biological Tiers

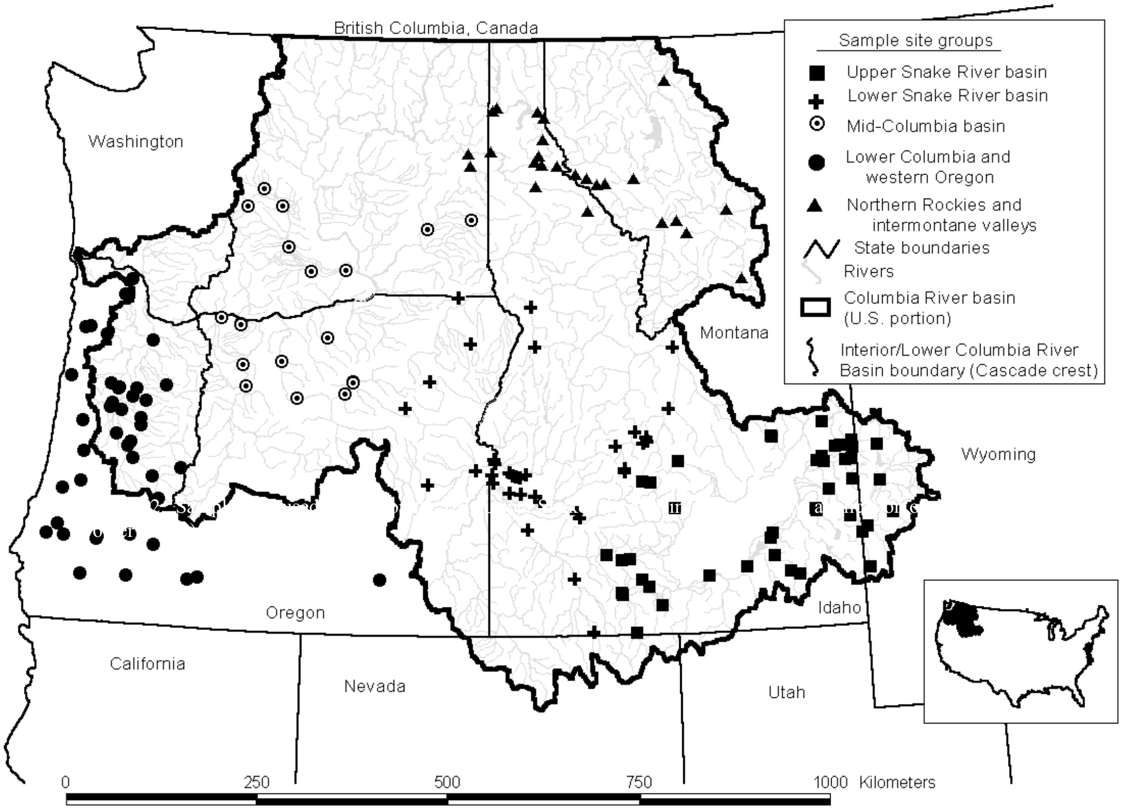
(10/22 draft)



Conceptual Response of a Large Cold Water Fish Assemblage to the Increased Effect of Stress



after Mebane et al. 2003



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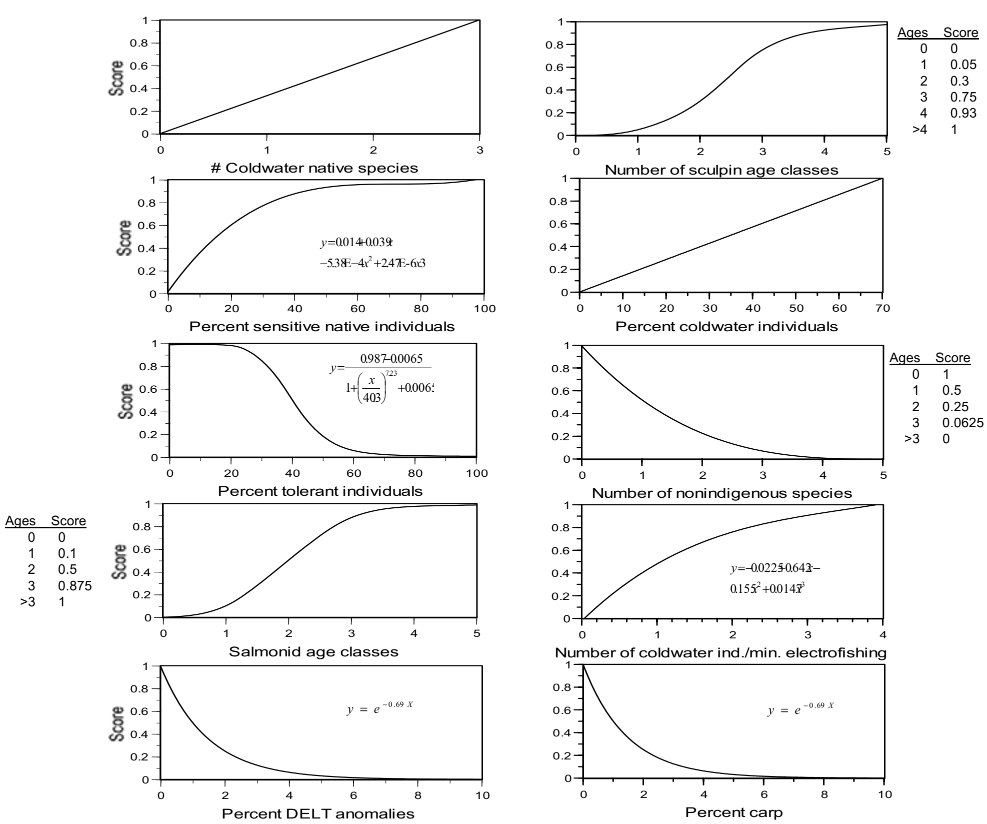
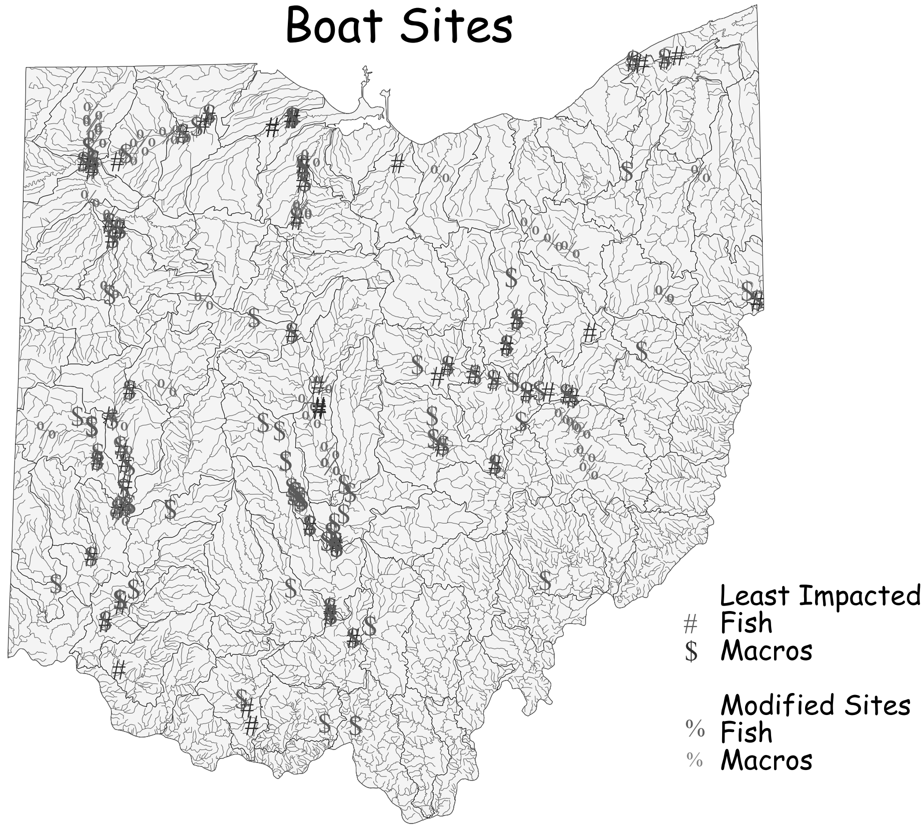


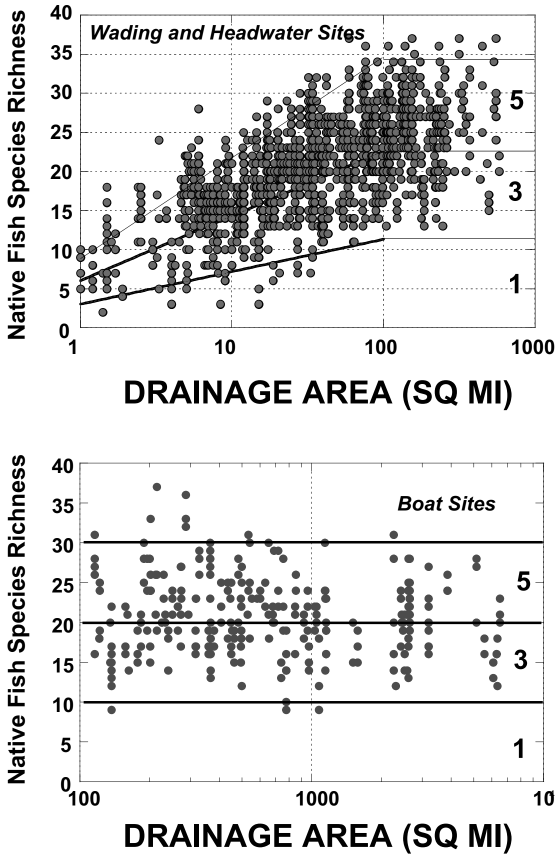
after Mebane et al. 2003

Ohio Biocriteria Reference Sites
Boat Sites



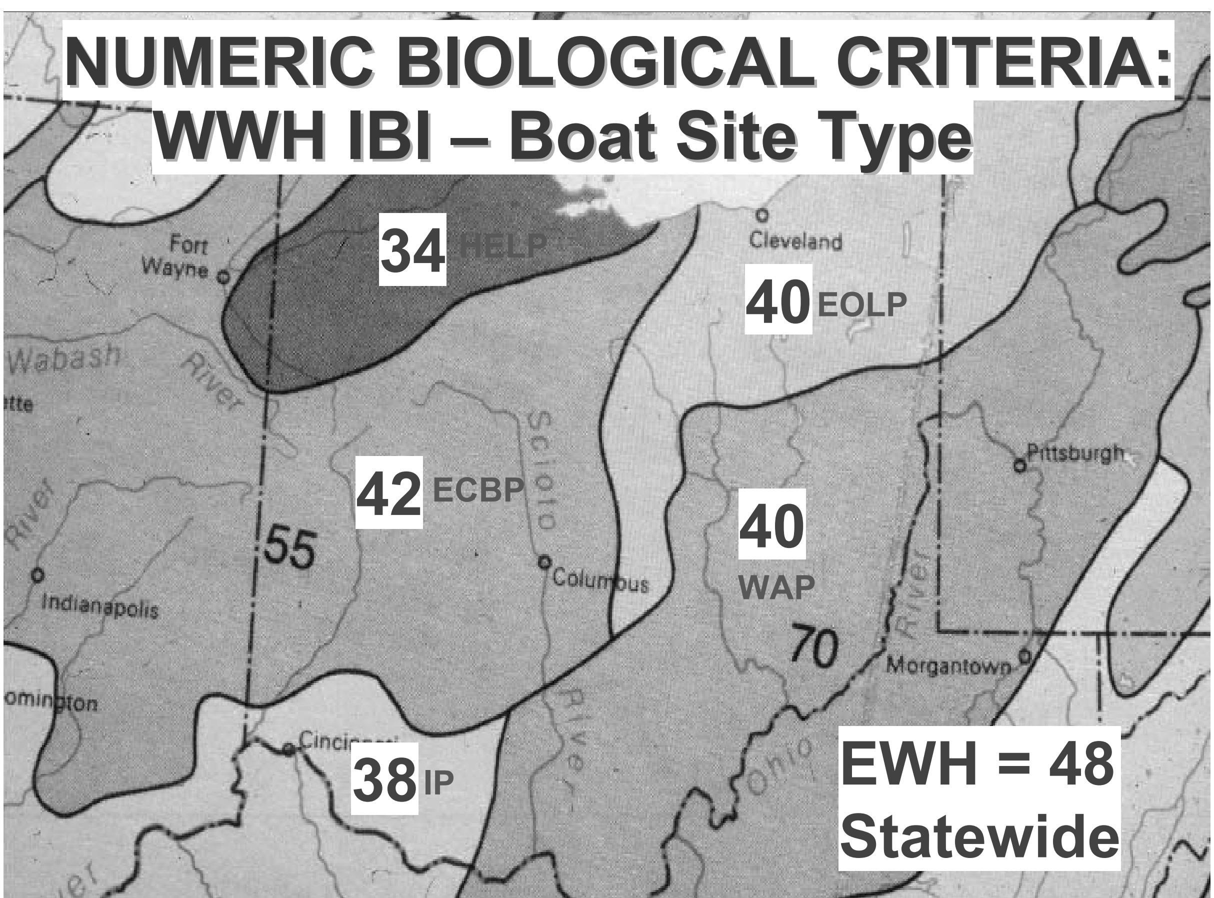
OHIO EPA MODIFIED IBI METRICs	HEADWATER SITE TYPE (<20 SQ. MI.)	WADEABLE SITE TYPE (20-300 MI²)	BOATABLE SITE TYPE (200-6000 MI²)
1. Total Native Species	X	X	X
2. #Darter Species		X	
#Darters + Sculpins	X*		
%Round-bodied Suckers			X*
3. #Sunfish Species		X	X
#Headwater Species	X*		
%Pioneering Species	X*		
4. #Sucker Species		X	X
#Minnow Species	X*		
5. #Intolerant Species		X	X
#Sensitive Species	X*		
6. %Tolerant Species	X	X	X
7. %Omnivores	X	X	X
8. %Insectivores	X	X	X
9. %Top Carnivores		X	X
10. %Simple Lithophils	X*	X*	X*
11. %DELT Anomalies	X	X	X
12. Number of Individuals	X	X	X

* - Substitute for original IBI metric described by Karr (1981) and Fausch et al. (1984)

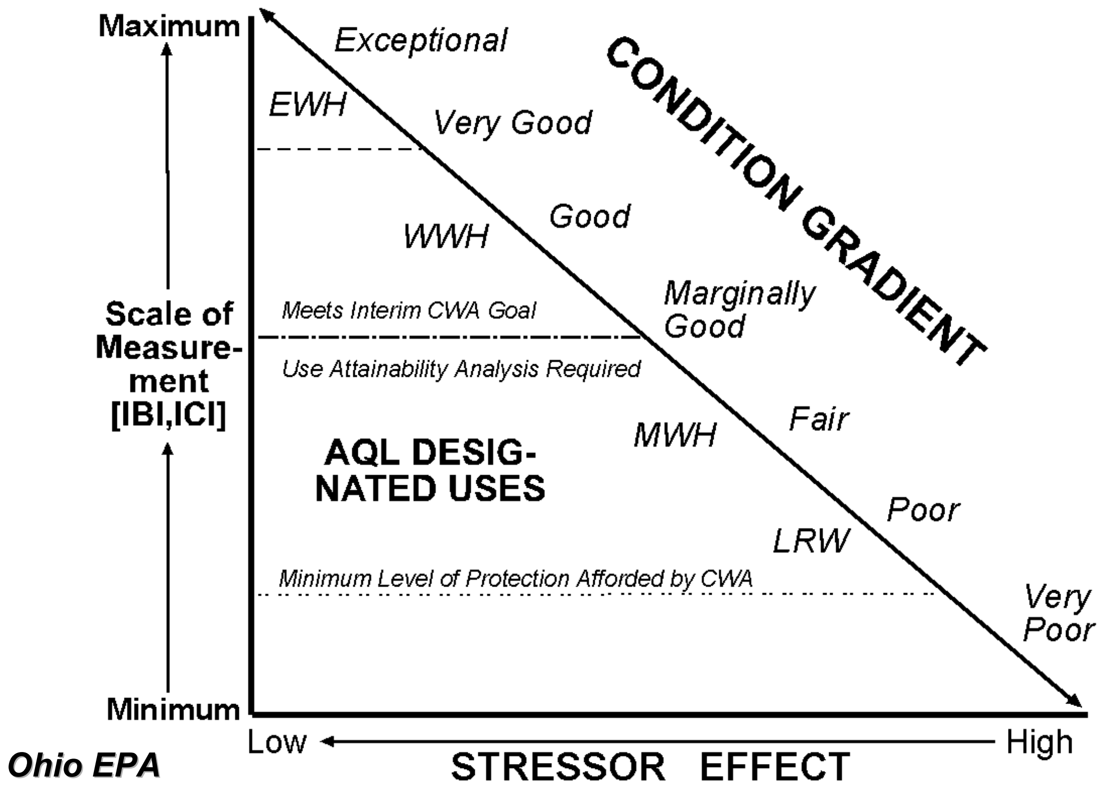


Calibration of Metrics Using Regional Reference Sites

- Scatter plot of metric value by appropriate calibration vector (e.g., watershed area).
- Determine 95% maximum line of best fit across surface of scatterplot; *driven by best reference sites.*
- Area beneath 95% line is subdivided (e.g., trisection) to determine metric scores - most data points should occur in upper ranges.
- This method reduces the influence of slightly degraded sites that may not biologically reflect the intent of reference condition.
- Slope of 95% line conservatively assumed to be zero for boat sites.



DESIGNATED USE OPTIONS ALONG THE BIOAXIS AND BIOLOGICAL CONDITION GRADIENT



Reference condition and how biological condition are measured form the basis for determining what is acceptable vs. unacceptable, both of which require some management action.

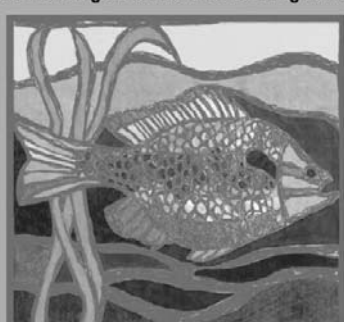
- ***Designated Use*** *– sets management goals and criteria for protection and restoration (Water Quality Standards).*
- ***Management Action*** *– protection or restoration activity or reconciling standards to attainable conditions (NPDES Permits, TMDLs, BMPs).*

Coping With Biological Data Variability

- **Compress Variability**: use multi-metric measures (e.g. IBI, ICI, etc.).
- **Stratify Variability**: use ecoregions (or subsets) and tiered aquatic life use classification system.
- **Control Variability**: select efficient sampling methods that yield informative and consistent results.

National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs



Coeur d'Alene, Idaho
31 March – 4 April, 2003

LR 101

Section 3: Large River Bioassessment Design and Data Interpretation

Presented by
Chris O. Yoder, Midwest Biodiversity Institute & Center for Applied Bioassessment and Biocriteria

Monitoring & Assessment Should Be a Determinant in How WQ is Managed

- Problem identification and characterization.
- Policy/program and legislation development.
- Criteria development and application.
- Demonstrate WQ management program effectiveness - *manage for environmental results*.

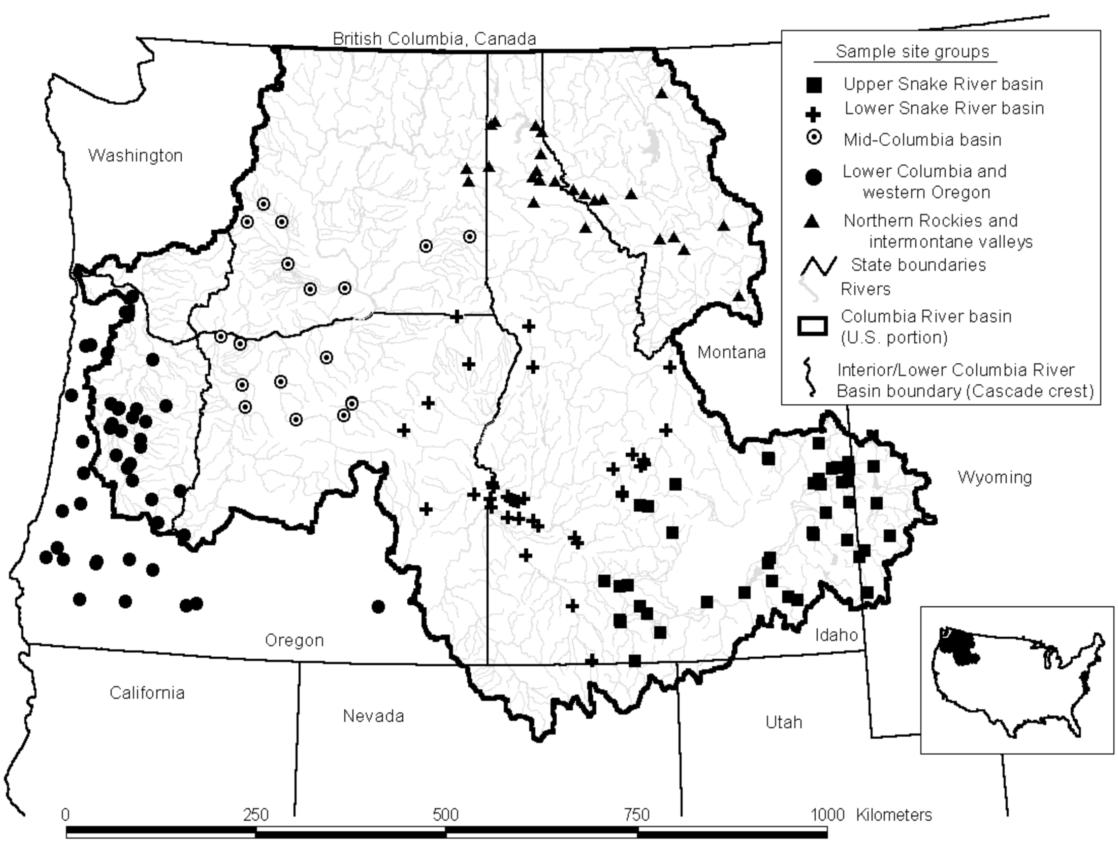
Develop monitoring & assessment as an overall function of WQ management, not on a piecemeal basis.

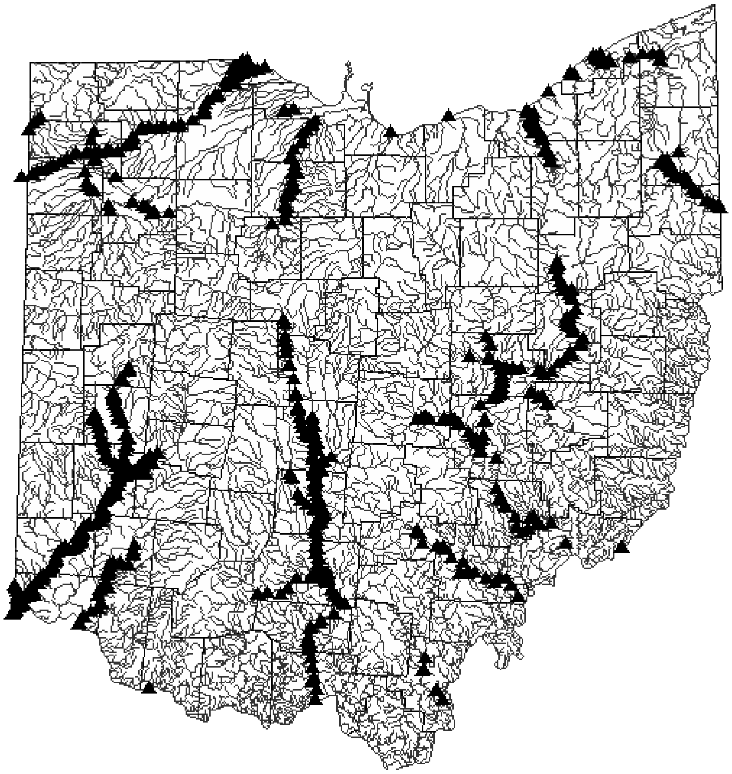
Recognizing the Strategic Role of Consistent and Systematic Monitoring and Assessment

- **Develop essential relationships between biological response and stressor variables**
- **Ensures that indicators are developed from data and case studies encompassing the full gradient of regional quality and response to stressors**
- **When performed as a baseline program function, the tools and indicators are available when they are needed.**

Issues of Large River Bioassessment

- Status and trends – sites, reaches, segments
- Scale issues – how much of a large river needs to be assessed?
- Local vs. reach scale issues.
- Support of different water quality management objectives – requires consideration of multiple designs.





Ohio Large Rivers Bioassessment: 1979 - present

- Multiple stressors (point & nonpoint sources, habitat, hydromodification)
- Intensive survey design
- Repeat samplings >1 to 5-10 years; supports before & after assessments
- Aggregate assessment for waterbody subclass (>500 mi.^{2})

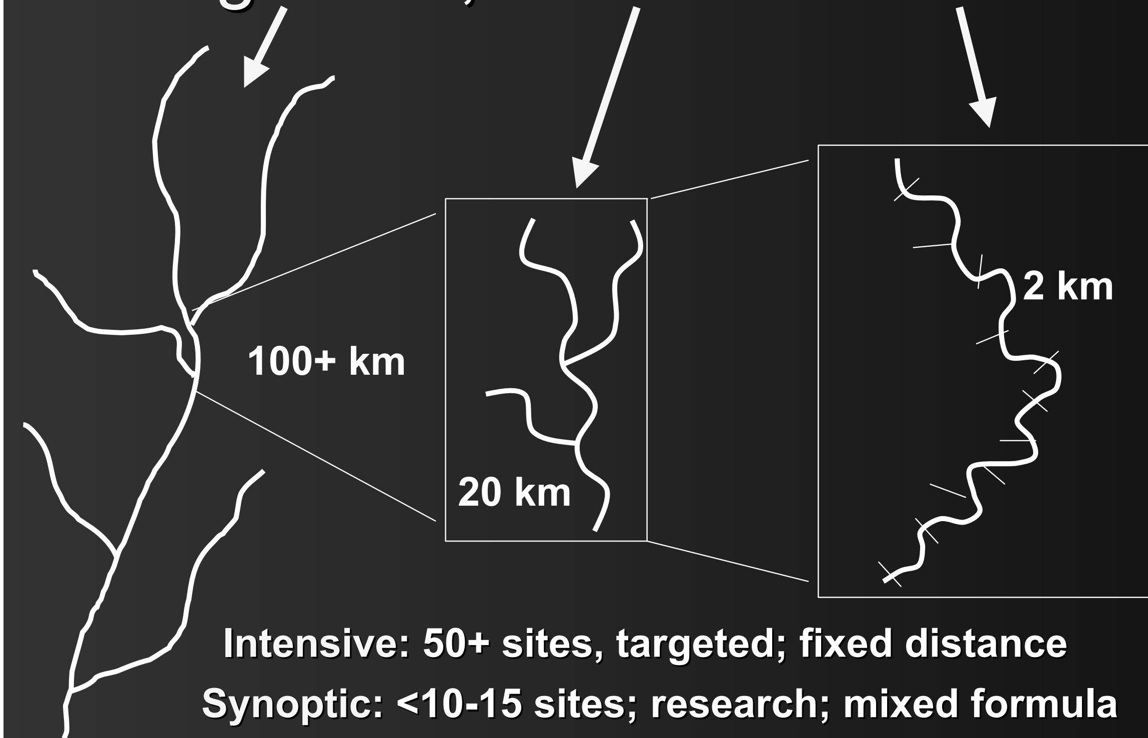
Segments, Reaches, and Sites

Segment – a major length of a riverine mainstem (hundreds of km); usually selected as part of a strategic M&A program.

Reach – a discrete length of a major river segment (tens of km); frequently the focus of stressor specific assessments.

Site – a sampling location (usually 100s or 1000s of meters) within which specific biological sampling methods are applied to produce relative abundance data.

Segments, Reaches & Sites



Intensive: 50+ sites, targeted; fixed distance

Synoptic: <10-15 sites; research; mixed formula

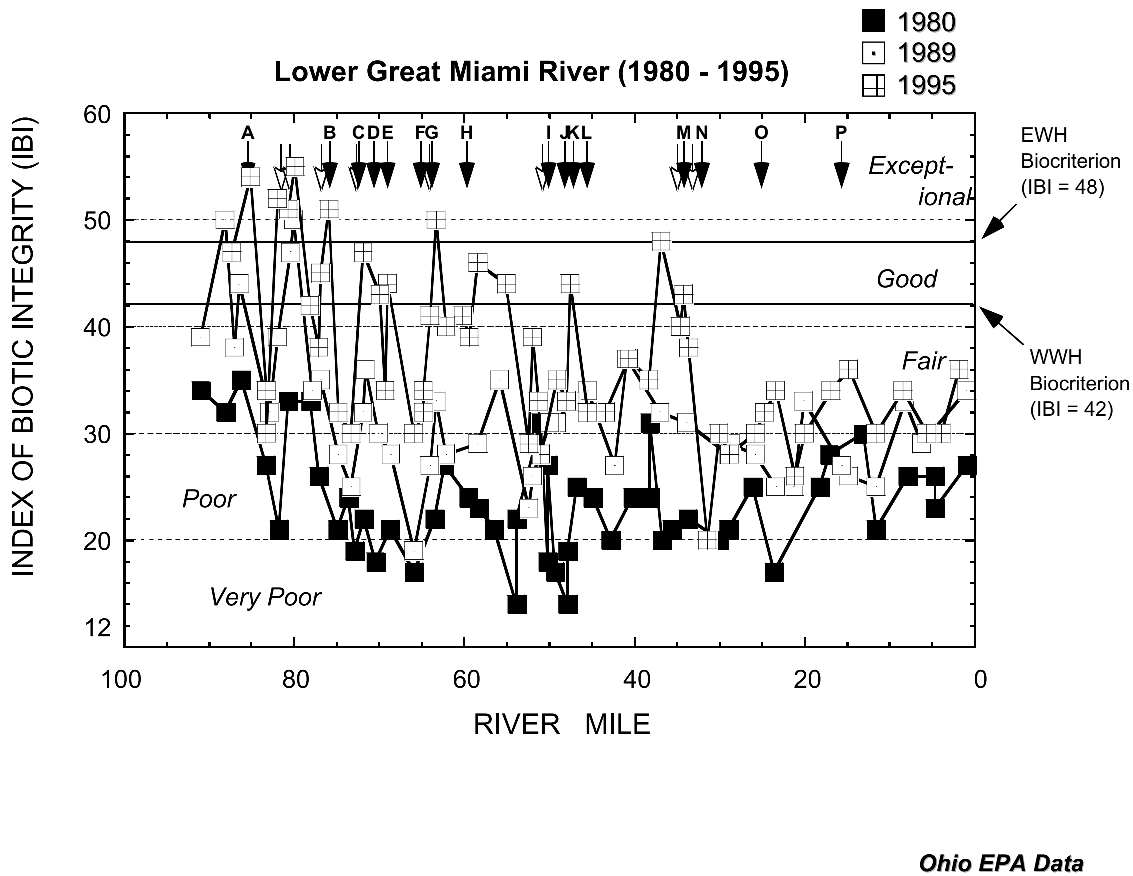
Probabilistic: <10 sites; probabilistic; width formula

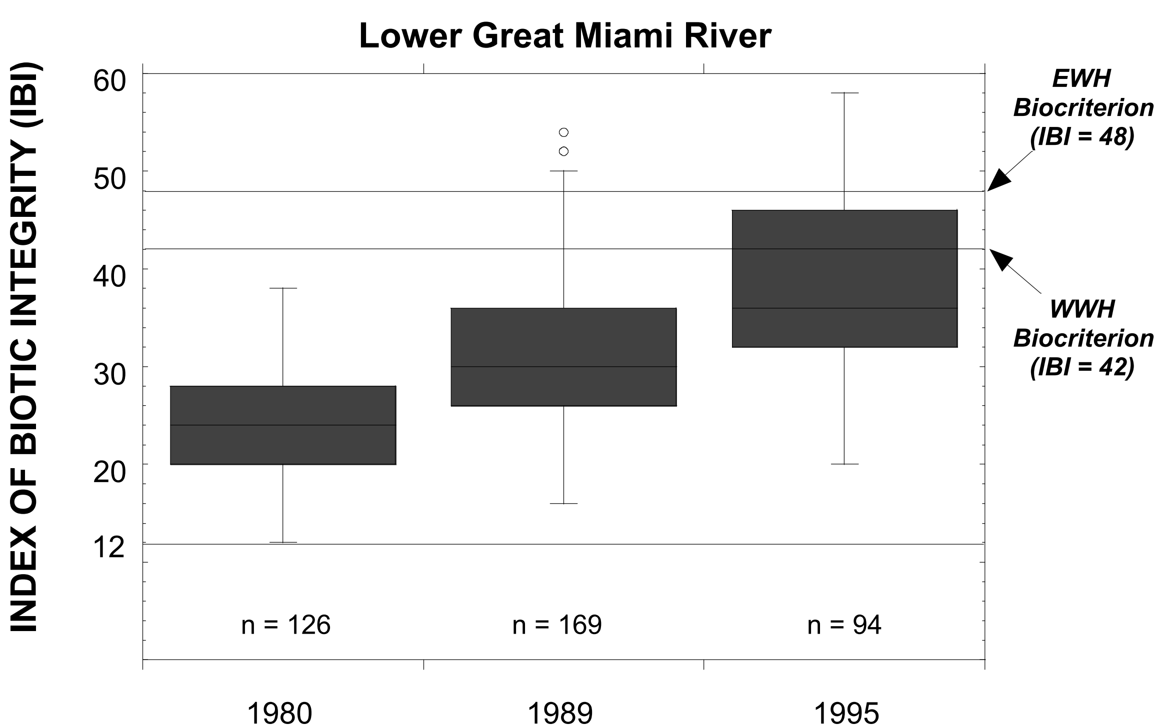
Segment, Reach, and Site Selection

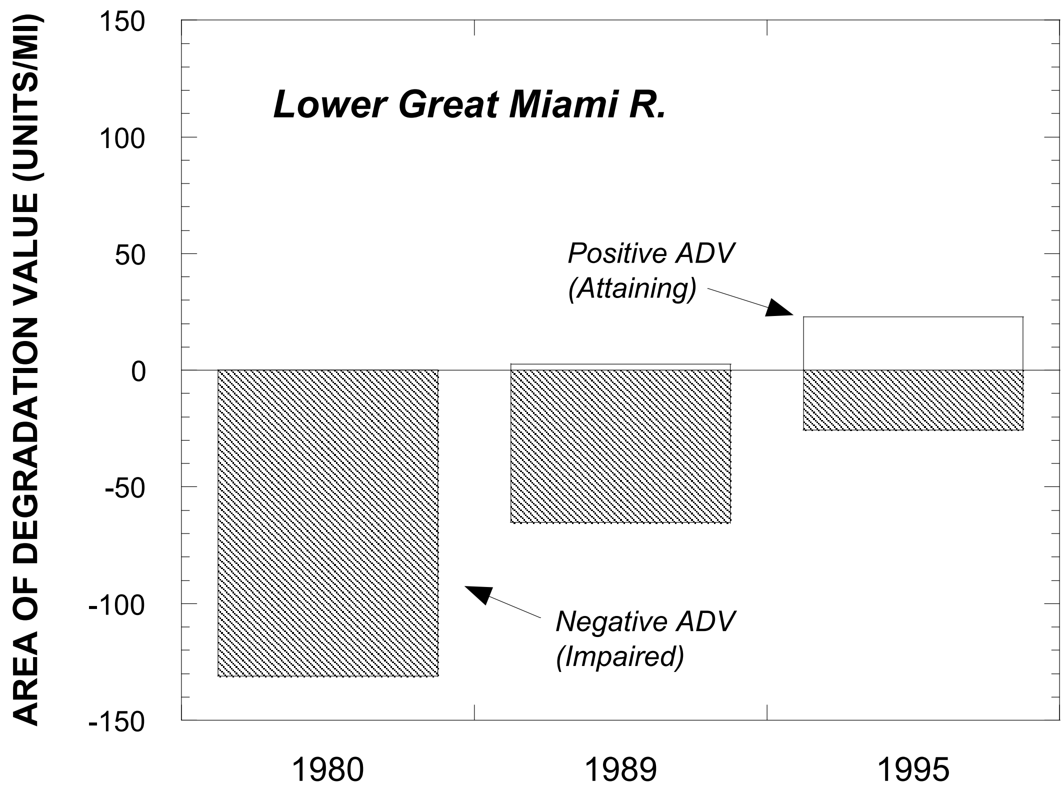
Segment Selection – governed by the overall objectives of the M&A program (e.g., statewide monitoring strategy); extent based on meeting multiple management and assessment objectives (e.g., full range of condition & response).

Reach Selection – dependent on extent and diversity of stressors, management needs and issues.

Site Selection – based on jurisdictional protocol developed to support assessment framework; density of sites reflects baseline design (probabilistic, targeted, census, etc.).


Lower Great Miami River (1980 - 1995)
1980
1989
1995
INDEX OF BIOTIC INTEGRITY (IBI)
A B C D E F G H I J K L M N O P
Except-
ional
Good
Fair
Poor
Very Poor
EWH
Biocriterion
(IBI = 48)
WWH
Biocriterion
(IBI = 42)
60 50 40 30 20 12
100 80 60 40 20 0
RIVER MILE
Ohio EPA Data


Lower Great Miami River
INDEX OF BIOTIC INTEGRITY (IBI)
60 50 40 30 20 12
EWH
Biocriterion
(IBI = 48)
WWH
Biocriterion
(IBI = 42)
n = 126
n = 169
n = 94
1980
1989
1995



Aquatic Life Use Attainment

Definition:

The condition when a waterbody has demonstrated, through use of ambient biological and/or chemical data, that it does not significantly violate biological or water quality criteria for that use.

Determining Use Attainment Status With Biocriteria

FULL ATTAINMENT

- ALL biological indices are at or within non-significant departure of the applicable biocriterion

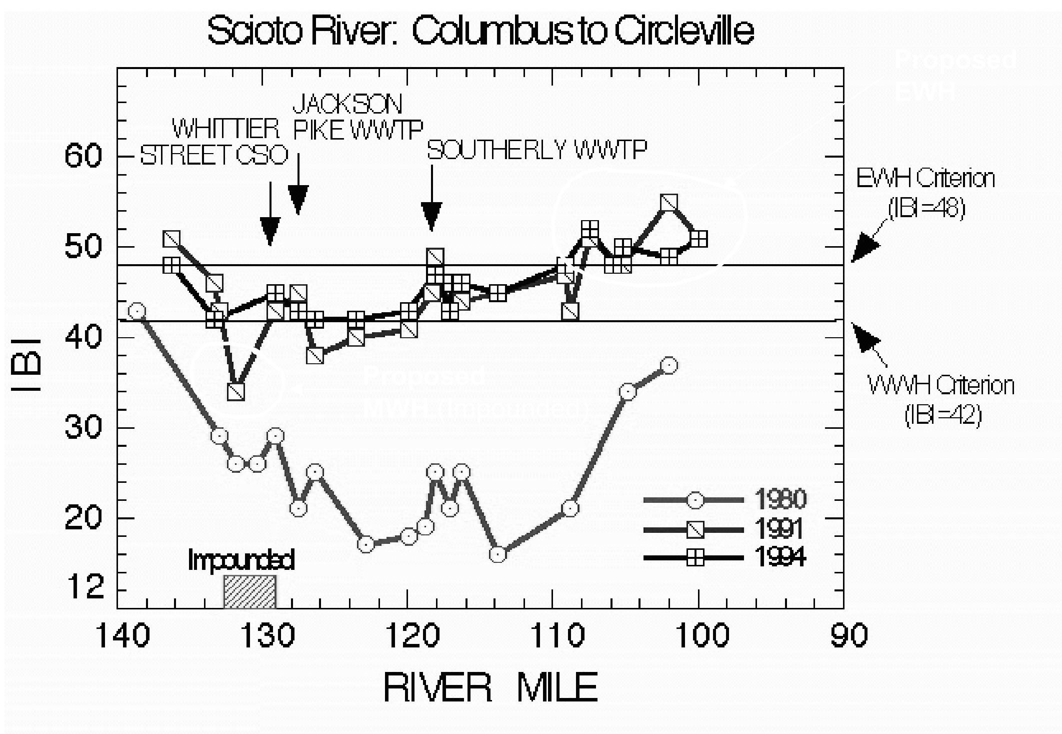
PARTIAL ATTAINMENT

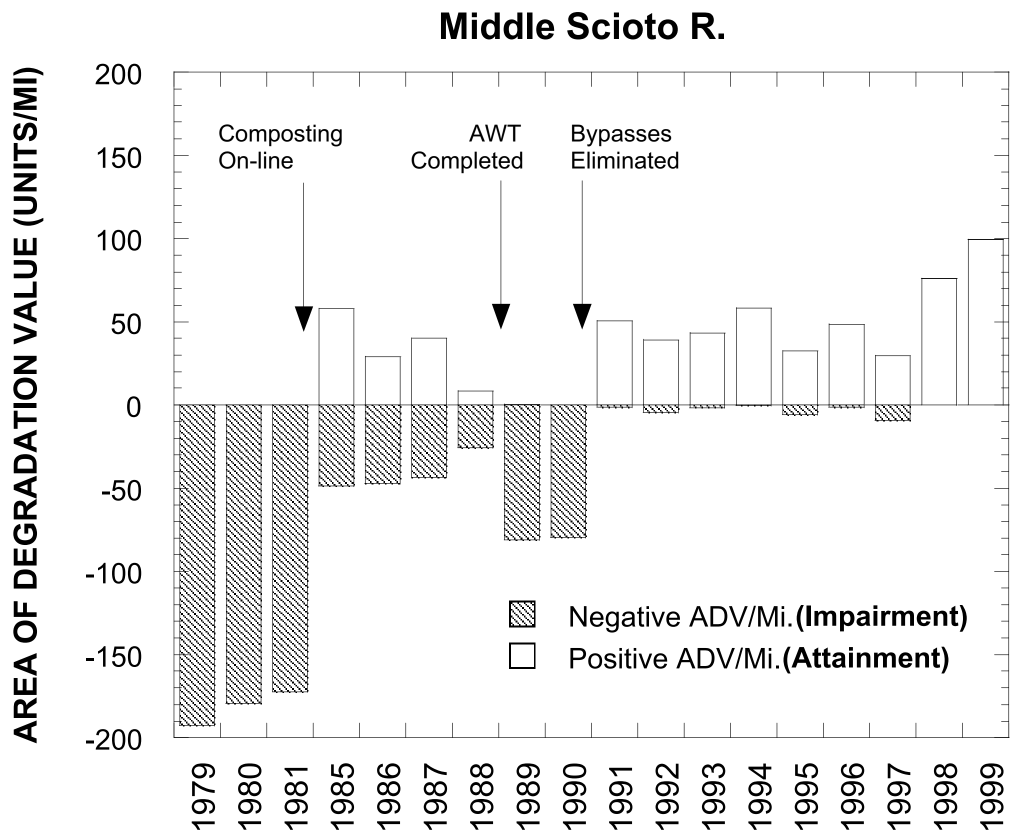
- A MIX of biological index scores at or within non-significant departure and below the applicable biocriterion

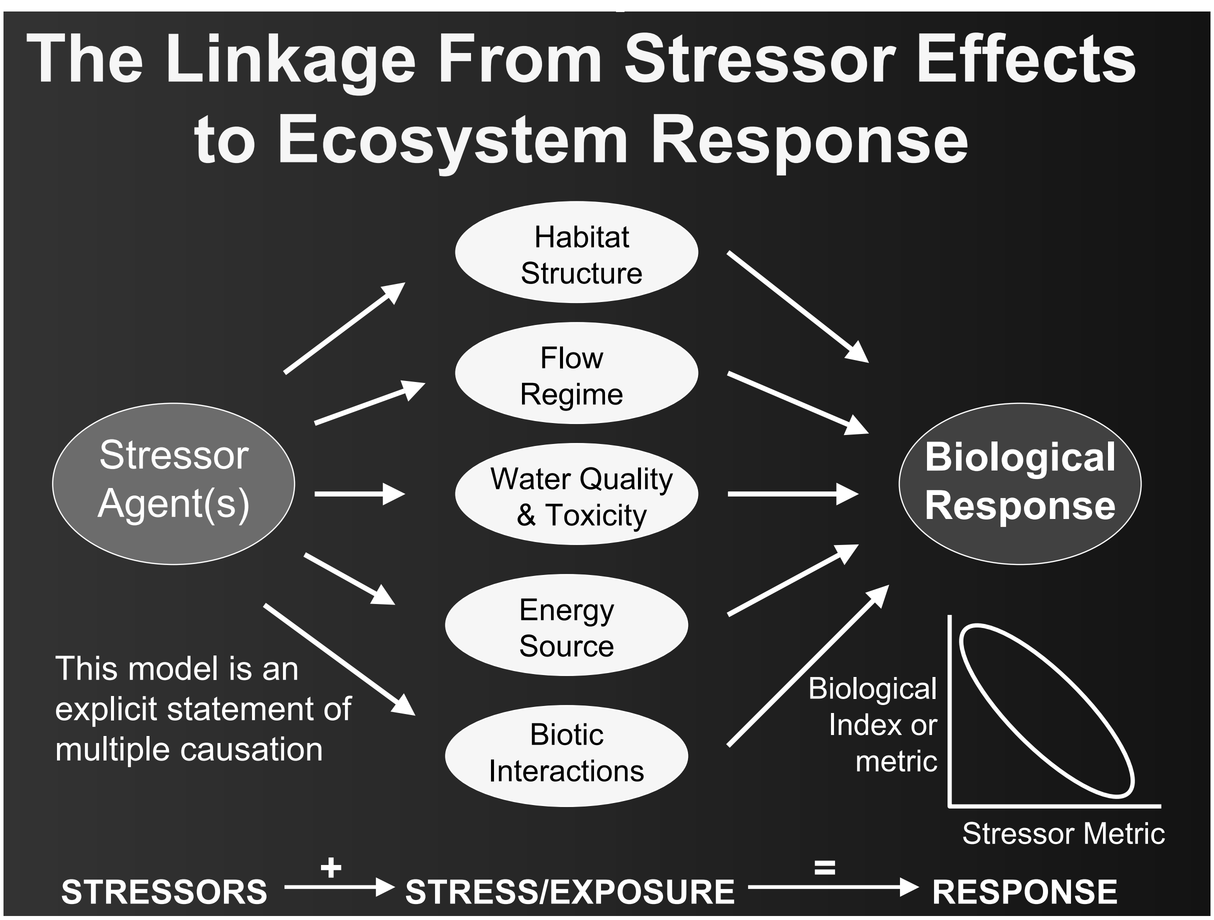
NON-ATTAINMENT

- NONE of the biological indices are at or within non-significant departure of the applicable biocriterion OR one organism group reflect poor or very poor quality.

Demonstrating Changes Through Time: Scioto River 1980 - 1994




Middle Scioto R.
AREA OF DEGRADATION VALUE (UNITS/MI)
200
150
100
50
0
-50
-100
-150
-200
Composting On-line
AWT Completed
Bypasses Eliminated
Negative ADV/Mi. (Impairment)
Positive ADV/Mi. (Attainment)
1979
1980
1981
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999


The Linkage From Stressor Effects to Ecosystem Response
Stressor Agent(s)
Habitat Structure
Flow Regime
Water Quality & Toxicity
Energy Source
Biotic Interactions
Biological Response
This model is an explicit statement of multiple causation
Biological Index or metric
Stressor Metric
STRESSORS
+
STRESS/EXPOSURE
=
RESPONSE

ADMINISTRATIVE INDICATORS

LEVEL 1:
Ohio EPA issues WQ based permits & awards funds for Columbus WWTPs

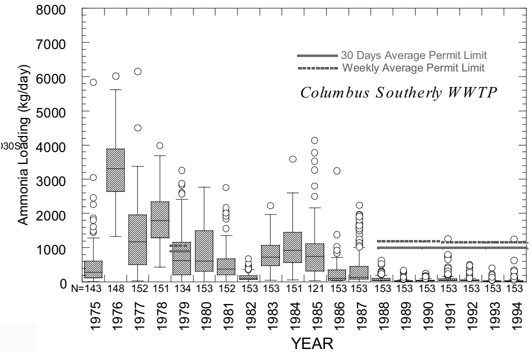
$$$$
NPDES

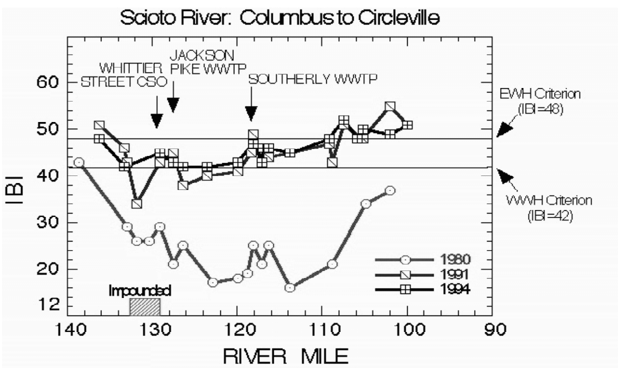
LEVEL 2:
Columbus constructs AWT by July 1, 1988; permit conditions attained

WWTP

STRESSORS

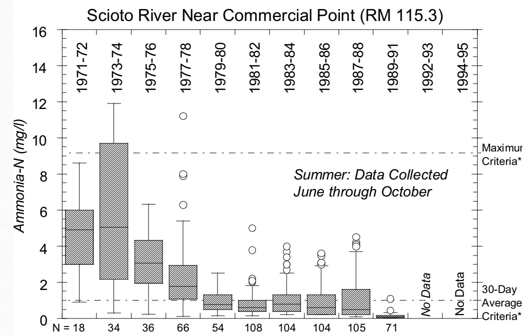
LEVEL 3: Loadings of ammonia, BOD, etc. are reduced





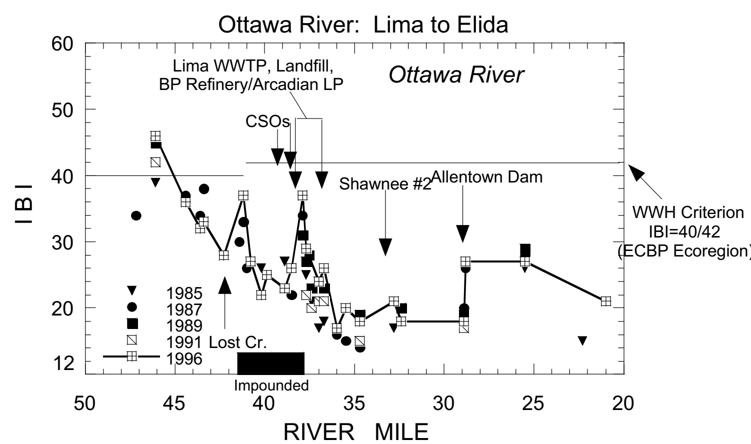
LEVEL 6: Biological recovery evidenced in biocriteria; 3 yrs. post AWT

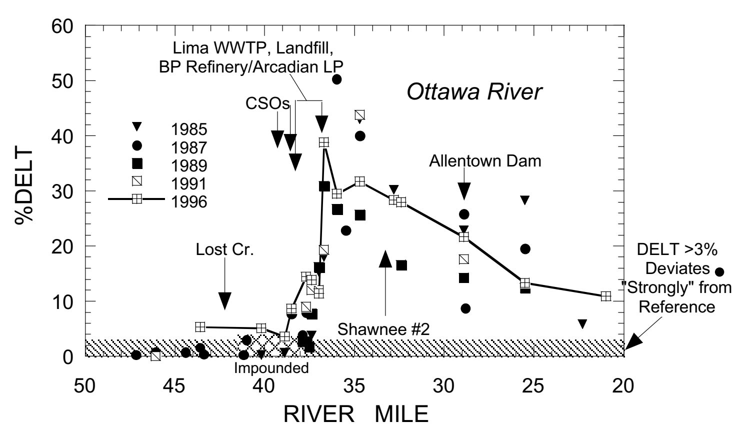
RESPONSE



LEVELS 4&5: Reduced instream pollutant levels; enhanced assimilation

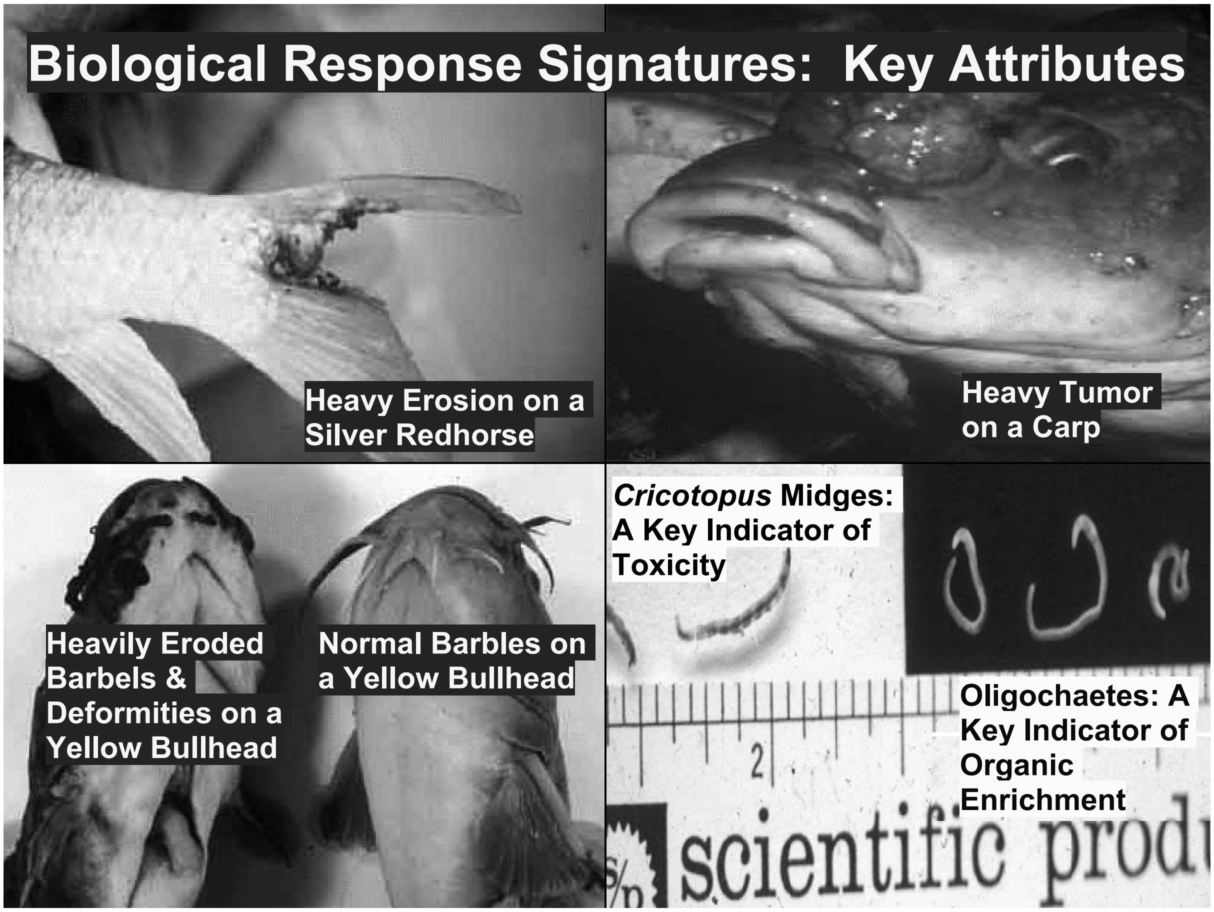
EXPOSURE

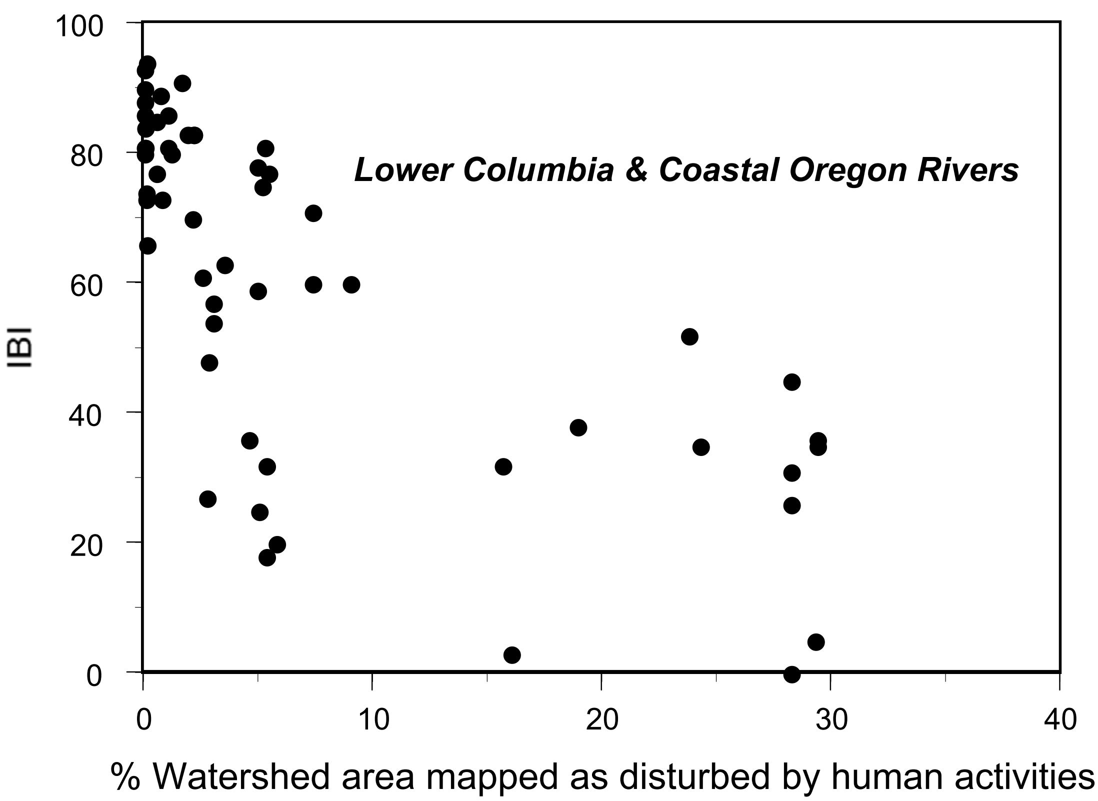


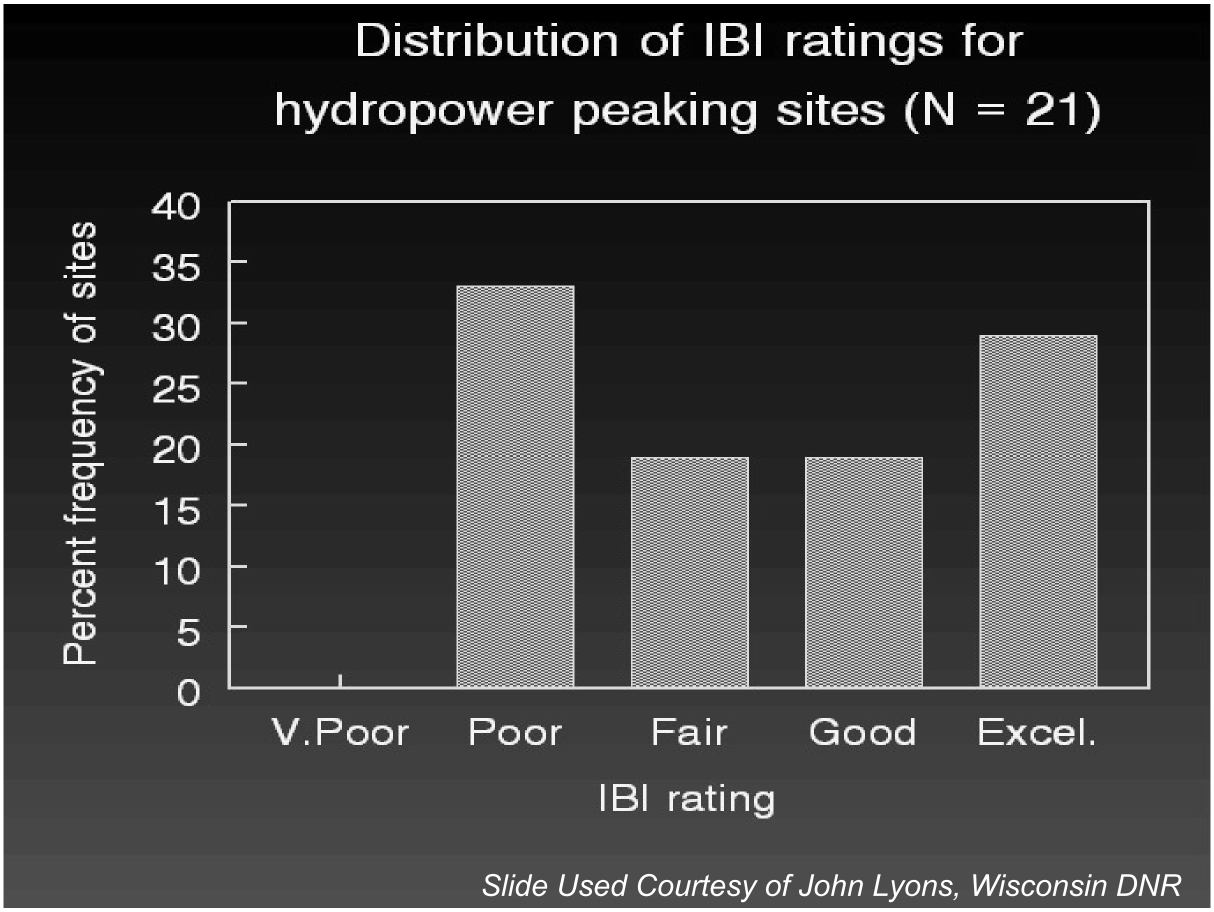


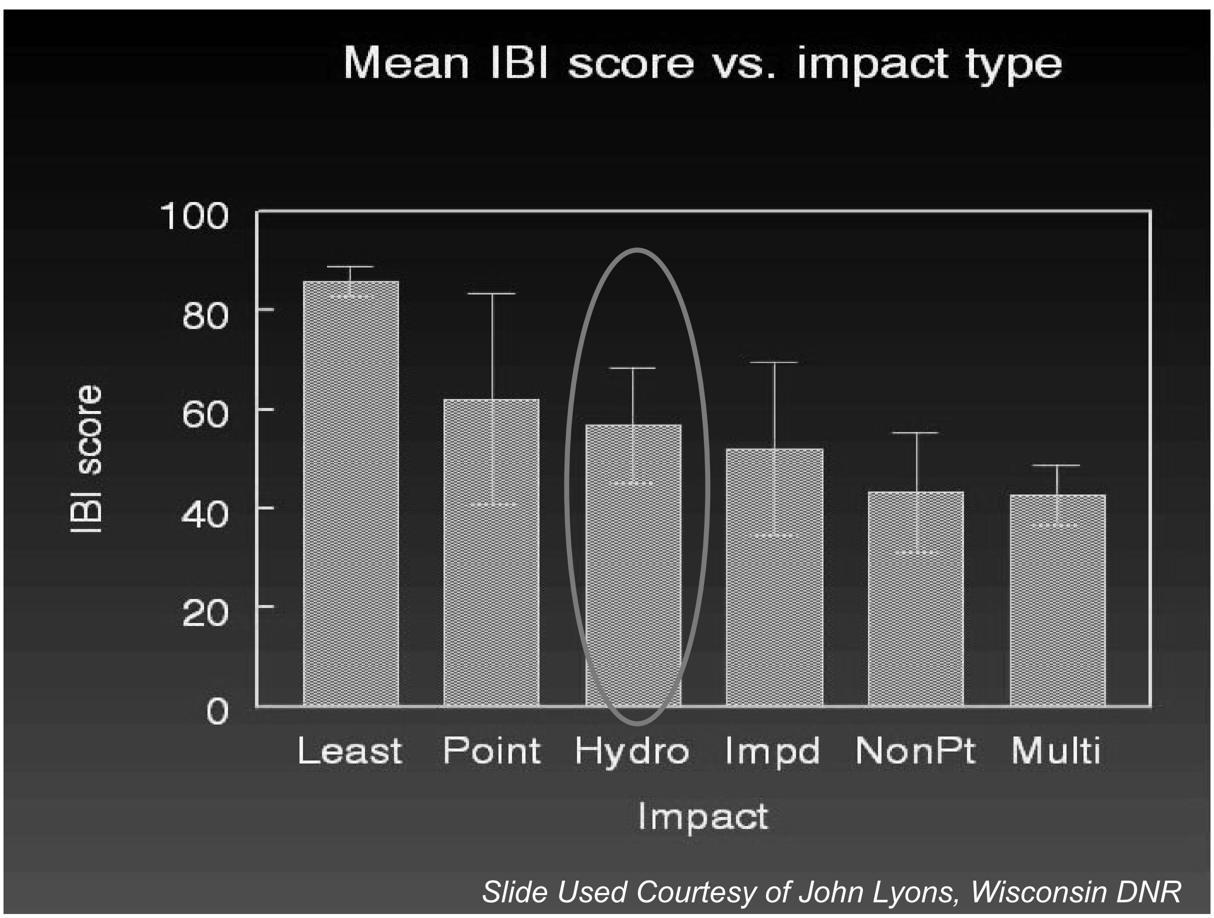
Ottawa River: Toxic Response Signatures

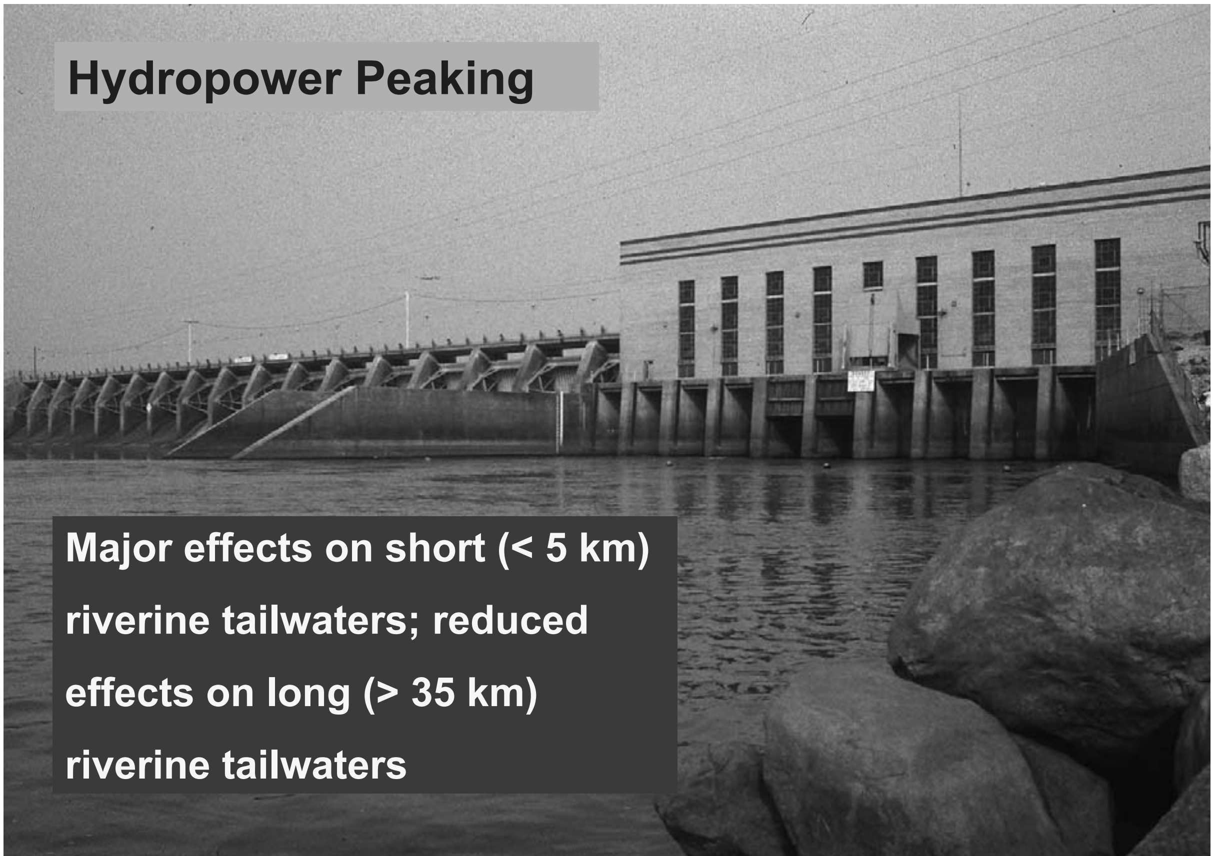
- **Extremely elevated DELT anomalies in combination with poor and very poor IBI scores is a signature of complex toxic conditions.**
- **Little change has taken place since 1985 despite reduced loadings of conventional pollutants.**
- **Far-field improvements were observed 25-30 miles downstream in 1996; lower 5 miles attain the WWH biocriteria.**


Biological Response Signatures: Key Attributes
Heavy Erosion on a Silver Redhorse
Heavy Tumor on a Carp
Heavily Eroded Barbels & Deformities on a Yellow Bullhead
Normal Barbles on a Yellow Bullhead
Cricotopus Midges: A Key Indicator of Toxicity
Oligochaetes: A Key Indicator of Organic Enrichment
scientific prod

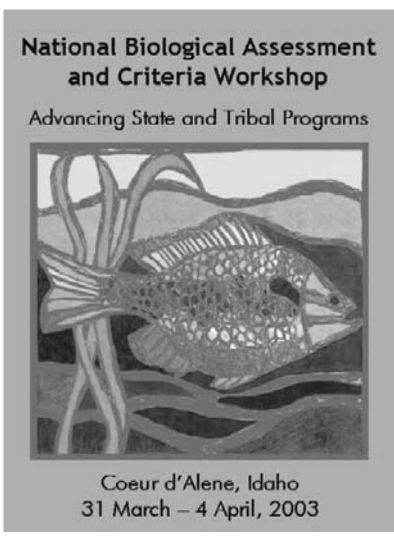

Lower Columbia & Coastal Oregon Rivers
IBI
100
80
60
40
20
0
0
10
20
30
40
% Watershed area mapped as disturbed by human activities


Distribution of IBI ratings for hydropower peaking sites (N = 21)
Percent frequency of sites
40
35
30
25
20
15
10
5
0
V.Poor
Poor
Fair
Good
Excel.
IBI rating
Slide Used Courtesy of John Lyons, Wisconsin DNR


Mean IBI score vs. impact type
IBI score
100
80
60
40
20
0
Least
Point
Hydro
Impd
NonPt
Multi
Impact
Slide Used Courtesy of John Lyons, Wisconsin DNR



Slide Used Courtesy of John Lyons, Wisconsin DNR

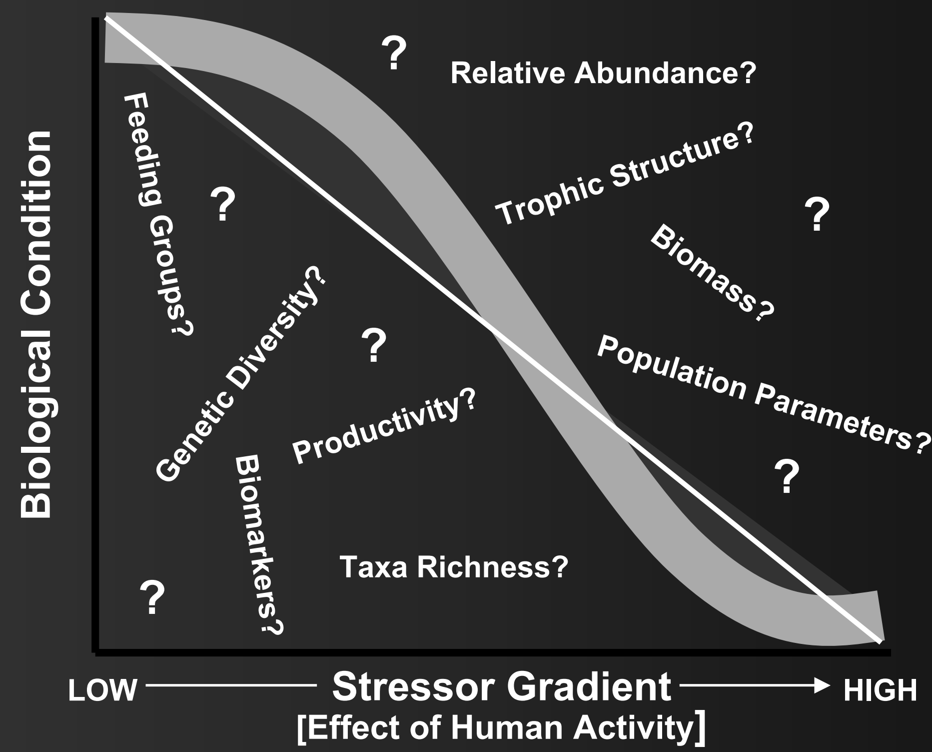


LR 101

Section 4a: Introduction to Environmental Indicators of Riverine Ecosystem Quality

Presented by
Chris O. Yoder, Midwest Biodiversity Institute & Center for Applied Bioassessment and Biocriteria

What to Measure? How to Decide?



What is an
"Environmental Indicator"

"…A measurable feature which singly or in combination provides managerially and scientifically useful evidence of ecosystem quality, or reliable evidence of trends in quality."

ITFM Indicators

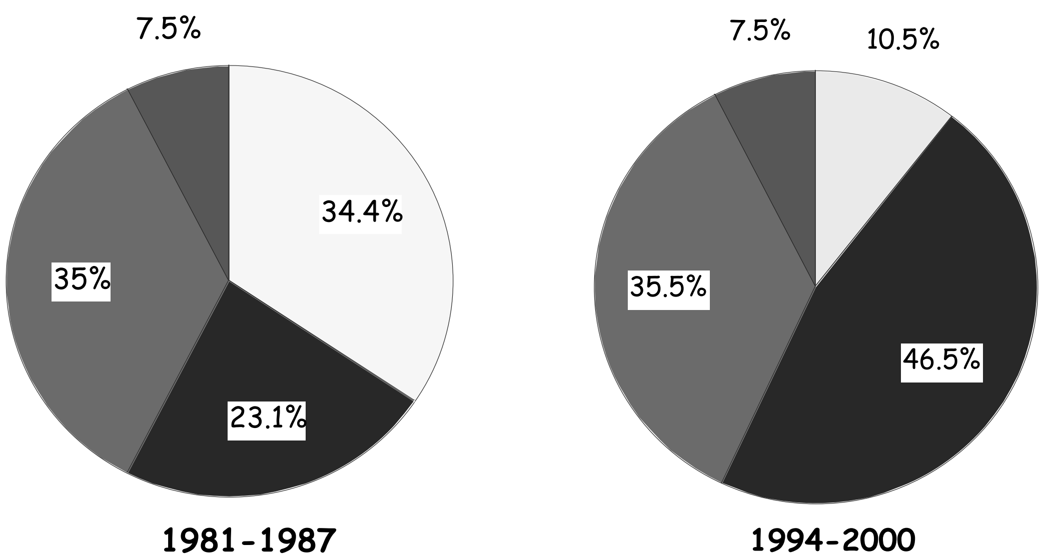
Ecological Indicators

Indicators linking organisms & environment

Problem Statement:

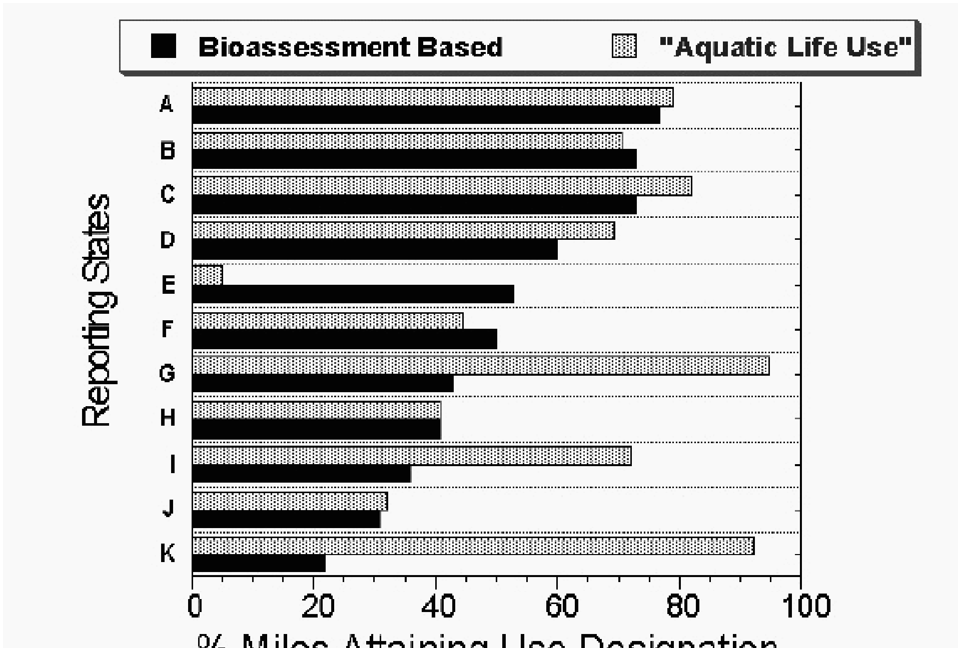
"The problem nationally has been with the inappropriate use of stressor and exposure indicators as response indicators"

COMPARATIVE ANALYSIS OF CHEMICAL & BIOLOGICAL ASSESSMENT FOR ALUS: OHIO RIVERS & STREAMS



- Agree about impairment } About STATUS Only
- Agree about attainment }
- Disagree about attainment (chemical impairment)
- <u>Disagree about impairment</u> (biological impairment)

Comparison of 305b Reporting Between States: Aquatic Life Use Attainment (1992 305b Report)



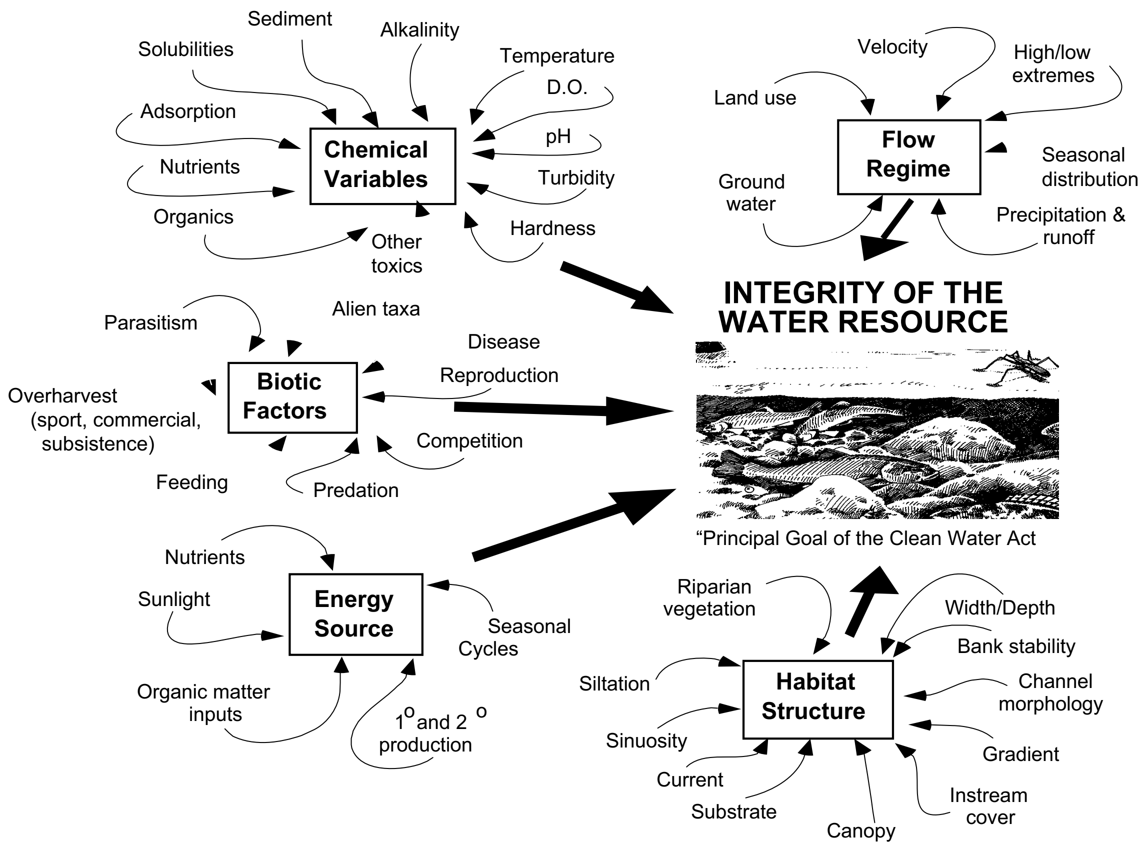
Source: U.S. EPA (1995)

Environmental Indicators

"Each is best used within their most appropriate role" (Yoder and Rankin 1998)

Roles/Categories:

- Stressor Indicators
  (e.g., loadings, land use, habitat)
- Exposure Indicators
  (e.g., chemical-specific, biomarkers, toxicity)
- Response Indicators
  (e.g., biological community condition, target species)



Stressor Indicators

- Loadings
- Land use
- Channel & flow modifications
- Physical habitat structure (can also function as a exposure)

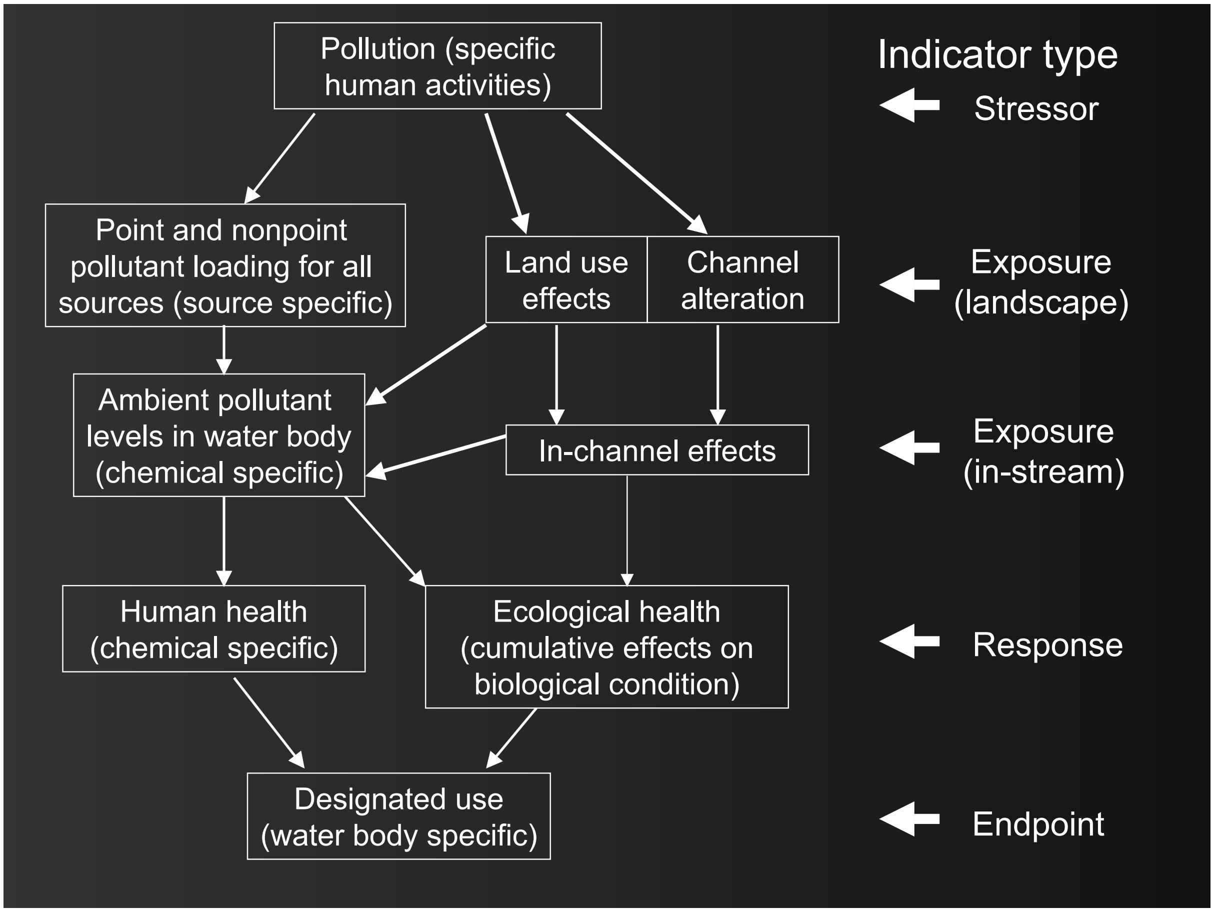
Exposure Indicators

- Chemical-specific
- Biomarkers
- Toxicity

Response Indicators

- **Biological community condition**
  - **Core indicator assemblages:**
    - algae, benthic macroinvertebrates, fish
  - **Other assemblages:**
    - zooplankton, macrophytes, bivalves, etc.

These are explored in more detail in next section



1. Management actions
2. Response to management

Administrative indicators
[permits, plans, grants, enforcement]
[technologies used, BMPs installed]

3. Stressor abatement

Stressor indicators
[effluent reduction, changes in land-use practices]

4. Ambient conditions
5. Direct exposure to effects of pollution

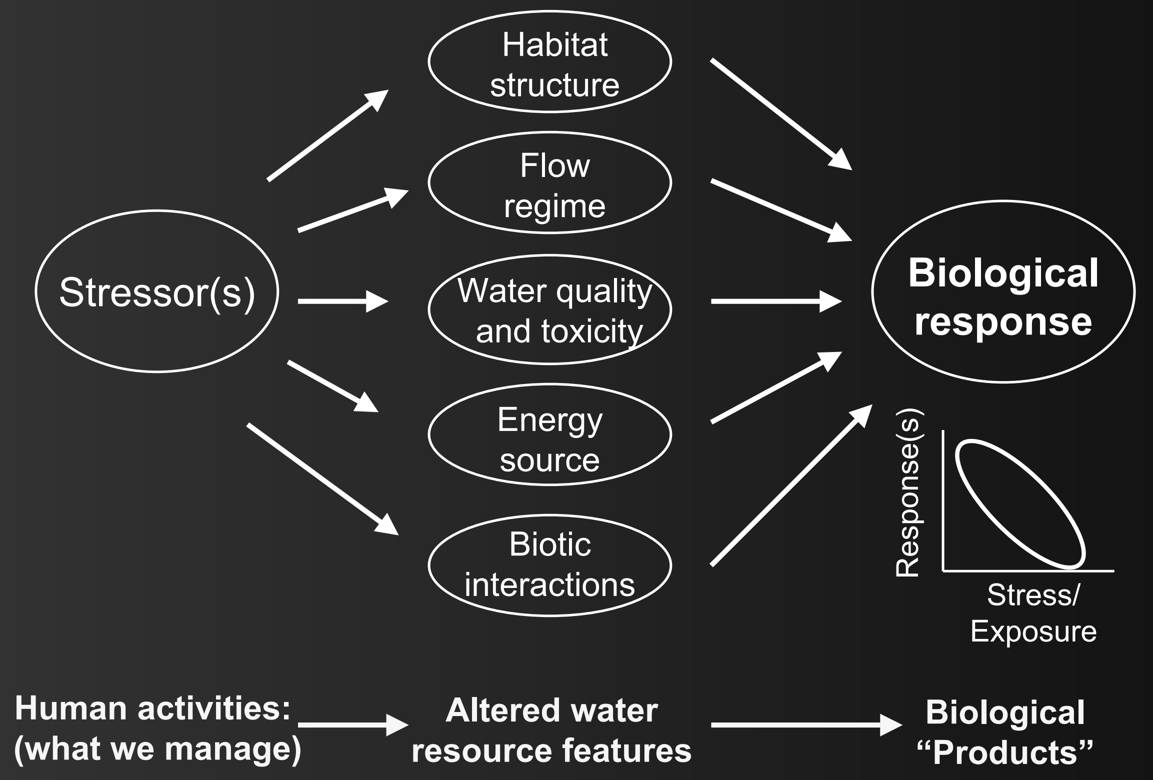
Exposure indicators
[pollutant conc., flow or physical habitat alteration]
[assimilation and uptake of pollutants, reduced spawning success, nutrient dynamics changed, sedimentation effects]

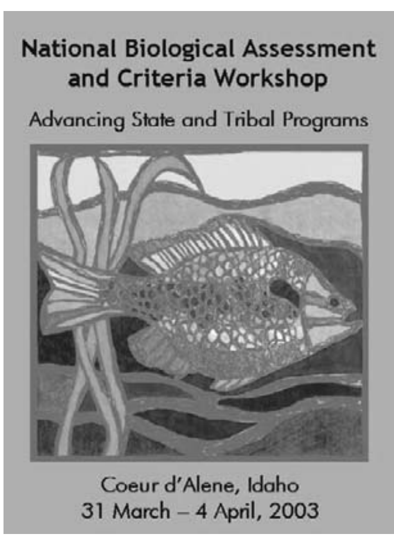
6. Biological response

Response indicators
[biological metrics, multimetric indexes, target species, other biological measures]

Endpoint: “ecological health” or biological condition

Linking Stress & Exposure to Response

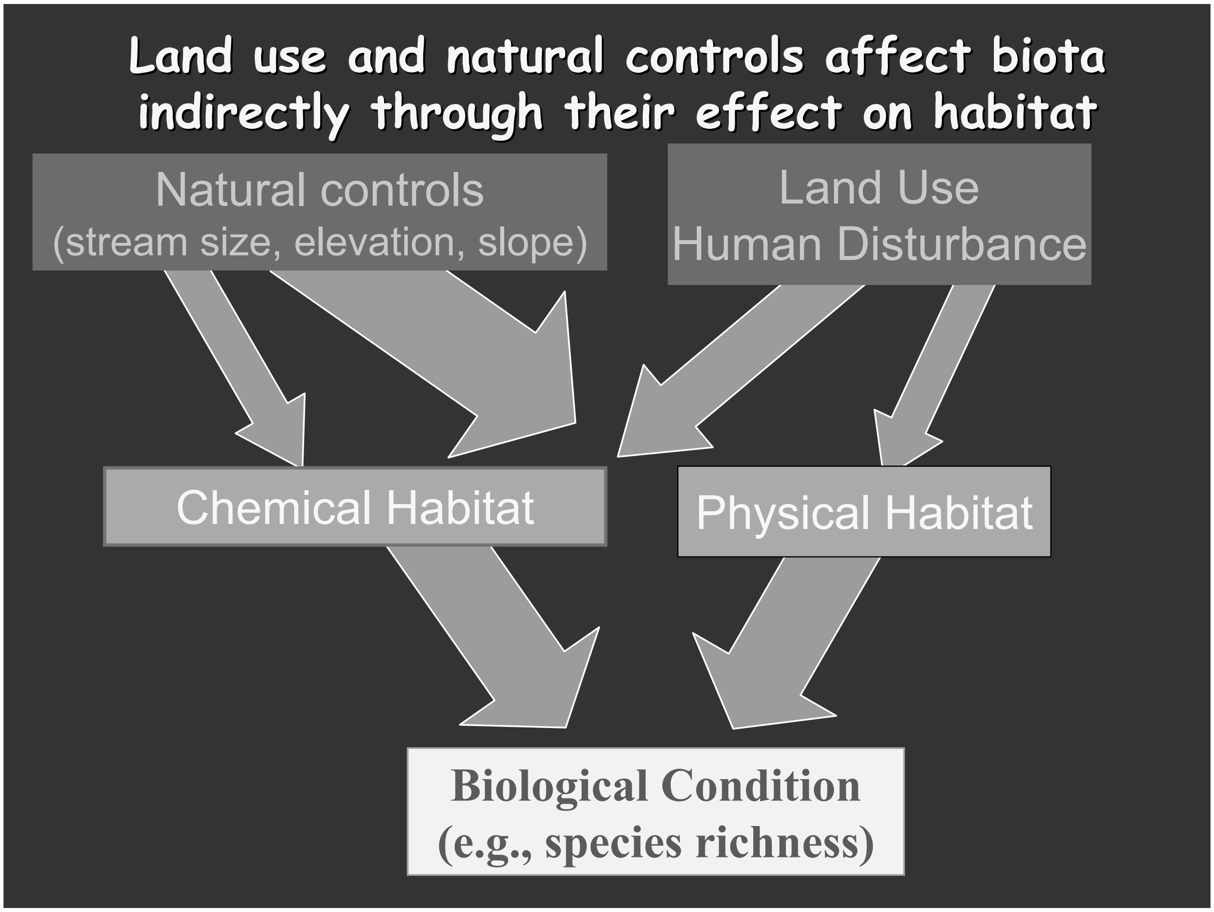




LR 101

Section 4b: W-EMAP Quantitative River Physical Habitat Assessment

Phil Kaufmann, USEPA - Corvallis, OR;
Bob Hughes, Dynamac - Corvallis, OR


Land use and natural controls affect biota indirectly through their effect on habitat
Natural controls
(stream size, elevation, slope)
Land Use
Human Disturbance
Chemical Habitat
Physical Habitat
Biological Condition
(e.g., species richness)

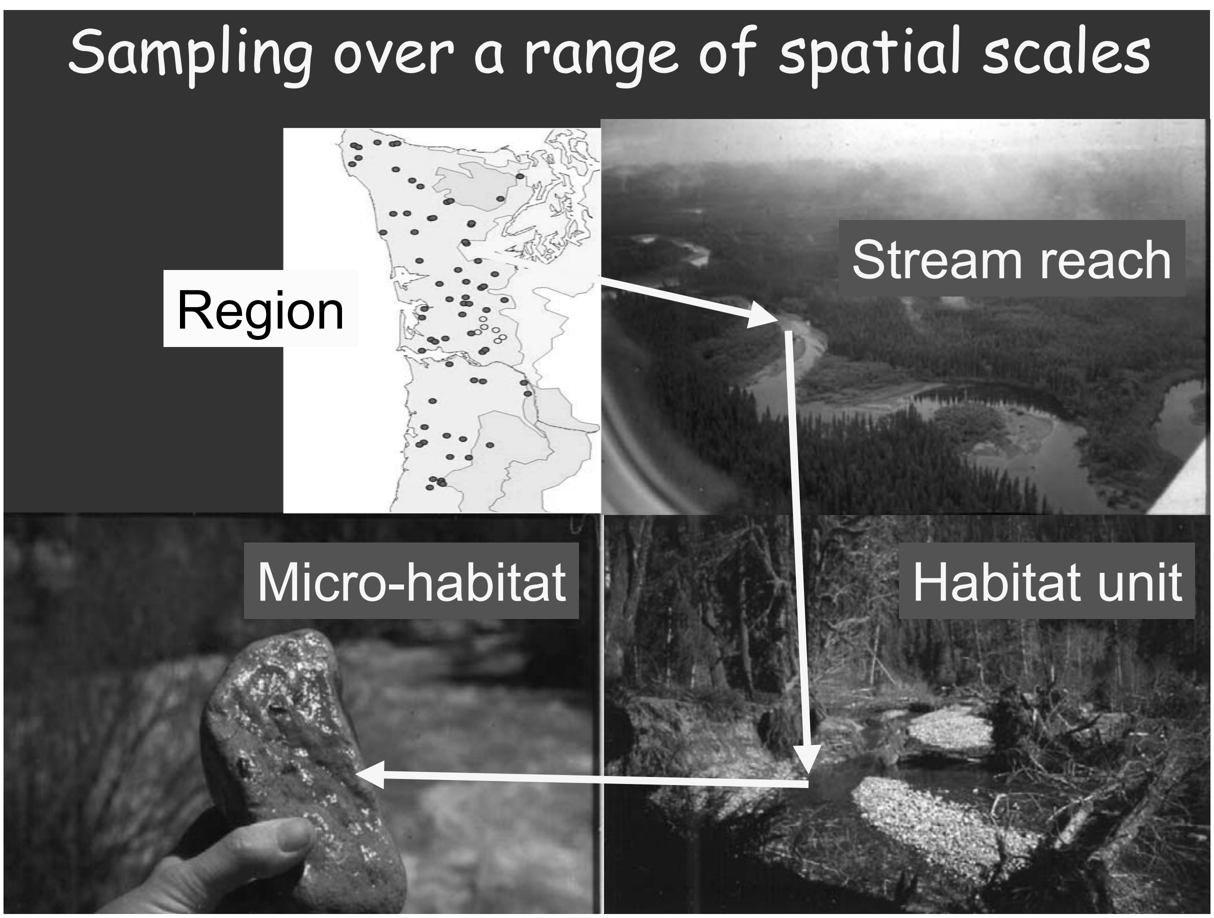

We alter habitat in many ways
Urbanization
Recreation
Logging
Agriculture, Irrigation
Dams
Road Building
Livestock Grazing, Feedlots
Channel "Improvement"

HABITAT... the set of conditions that support and control species distribution and abundance

- Physical : EMAP restricts consideration to physical habitat structure
  - Includes some “biological” elements like vegetation that affect structure
- Chemical
- Biological
- Consider Landscape and Historical Contexts
  - Measure at several spatial scales
  - Choose metrics that integrate conditions over time

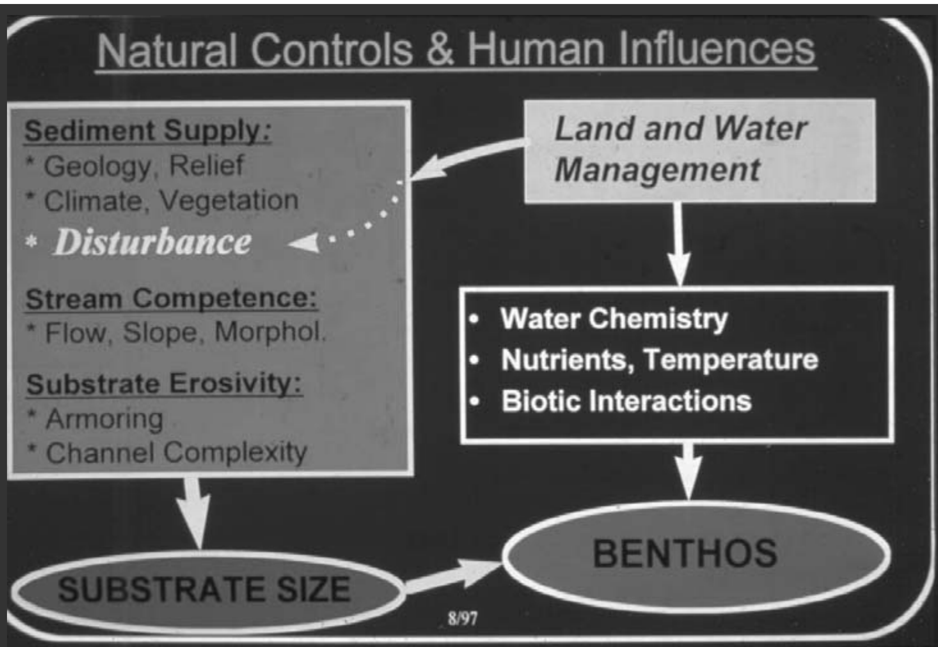
What Constitutes Good Physical Habitat?


----------Stream Size ------------>
LANDSCAPE & CHANNEL CONTEXT
strongly control habitat characteristics
------ Gradient ------>


Sampling over a range of spatial scales
Region
Stream reach
Micro-habitat
Habitat unit

PHYSICAL HABITAT INDICATOR DEVELOPMENT

- Determine Metrics of Interest
- Develop Field Monitoring Protocol
- Quantify Variability, Precision
- Demonstrate Ecological Relevance
  - Biological associations
  - Sensitivity to human disturbance



- Identify attributes of physical habitat that adequately describe the major natural and anthropogenic controls on biota
- Consider expected responses of habitat to various types of human disturbance

Essential River Physical Habitat Elements

- Channel Dimensions: Nothing may be more important than space
  - without it other elements do not matter
- Gradient: hydraulic "energy" of a river
  - used with size to determine power and shear stress
- Substrate Size and Type: important for biota - raw material for channel structure.
- Complexity & Cover: Niche diversity, protection from predation
  - one of the first elements to disappear

Essential River Physical Habitat Elements (continued):

- Riparian Vegetation Cover and Structure: Microclimates, organic inputs, channel morphology
- Alien Invasive Plants & Legacy Trees: Measures degree to which vegetation has changed
- Anthropogenic Alterations: River disturbance and "reference condition"
- Note: Chemistry, Nutrients, Temperature: Also need other physical and chemical data to interpret biological data

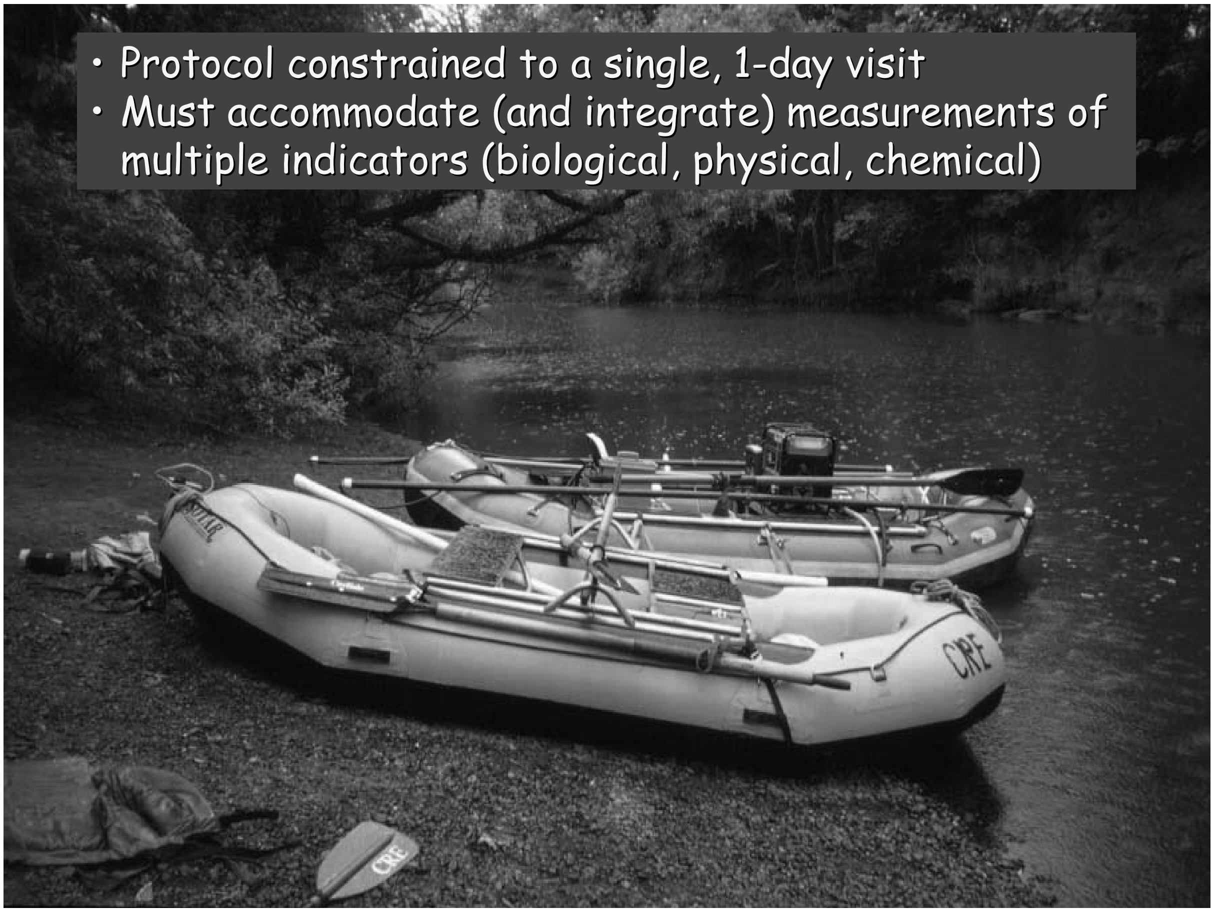
PHYSICAL HABITAT INDICATOR DEVELOPMENT

- Determine Metrics of Interest
- Develop Field Monitoring Protocol
- Quantify Variability, Precision
- Demonstrate Ecological Relevance
  - Biological associations
  - Sensitivity to human disturbance

Adequate Habitat Indicator?

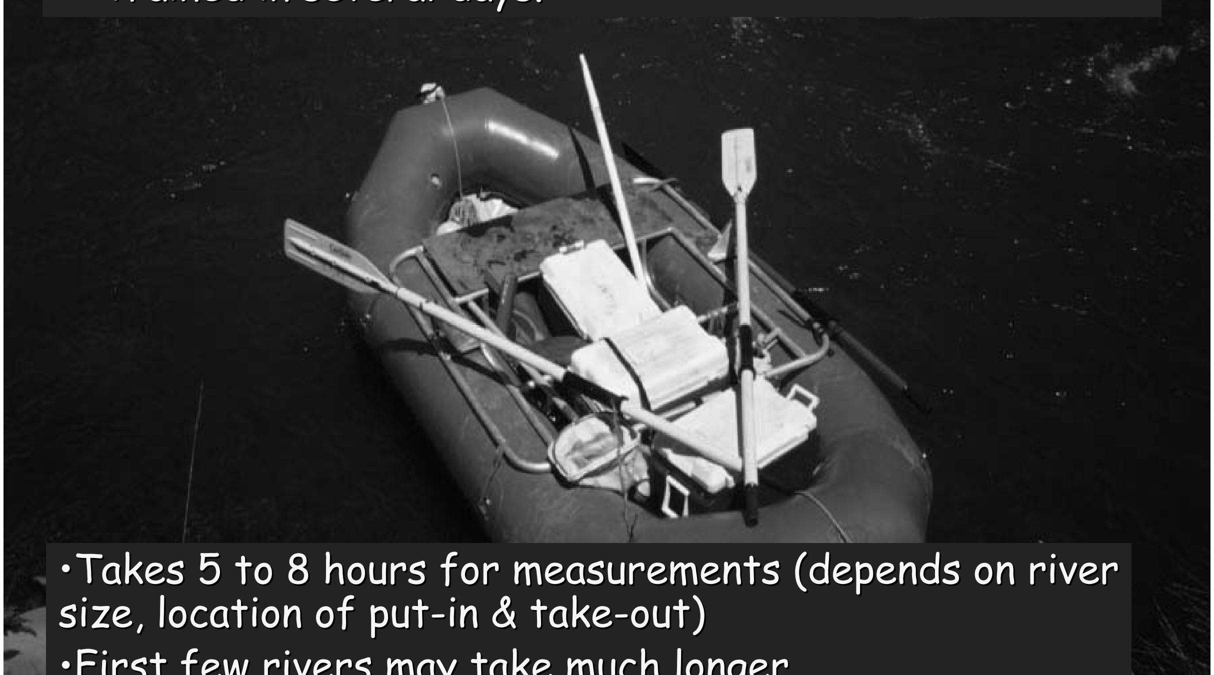
- Accurate & Responsive -- Does it measure what we intend ?
- Precise -- Can we separate changes or differences from measurement error?
- Relevant -- To Biological needs? Ecological processes? Social values?
- Practical -- Can we do it? ...afford it?

- Protocol constrained to a single, 1-day visit
- Must accommodate (and integrate) measurements of multiple indicators (biological, physical, chemical)



River P-Hab -- Can we do it? afford it?

- Best w/ crew of 2 on raft or inflatable kayak.
- Trained in several days.



- Takes 5 to 8 hours for measurements (depends on river size, location of put-in & take-out)
- First few rivers may take much longer.

EMAP P-Hab (Rivers):

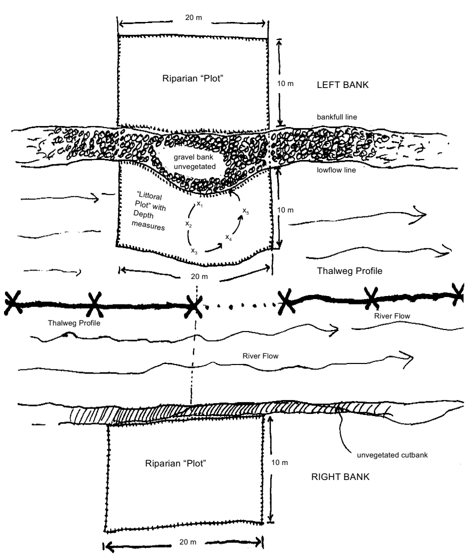
Quantitative Measurements:

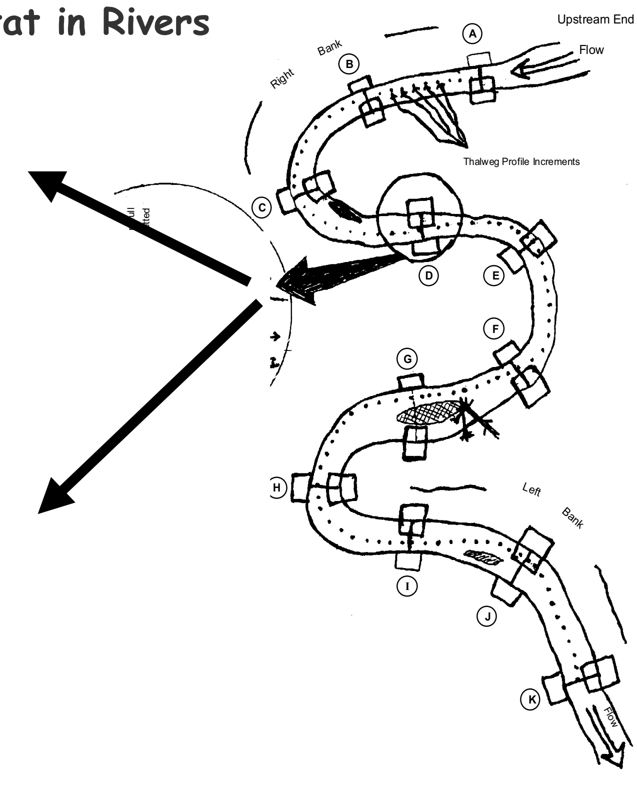
- Channel Dimensions
- Slope, Bearing, Bank Char.
- Near-Shore Canopy Density
- Thalweg/Littoral Depths

Visual Estimates/Tallys:

- Fish Concealment Features
- Woody Debris Tally
- Snags & Backwaters
- Rip. Veg. Cover/Structure
- Dom. Subdom. Substrate
- Human Disturbances
- Constraint

Plot Design: Physical Habitat in Rivers





EMAP River Physical Habitat Characterization

(on 100 Channel-Width Study Reach)

Long Profile at 100 equidistant points:
-- Dominant Substrate, Main Channel Habitat Class,

Long Profile at 200 equidistant points:
-- Thalweg depth, Presence of snags
-- Presence of Backwaters & Off-Channel Habitats

11 Equidistant Cross-Sections and Littoral/Riparian Plots:
Channel Measurements: Slope, Bearing, Main Channel Dimensions, Mid-Channel and Point bar widths, Littoral Depth, Dominant & Subdominant Littoral Substrate, Fish Cover, Large Woody Debris.
Riparian Measurements: Bank Character, Riparian Vegetation Cover & Structure, Presence of Alien Invasive Plant Species, Size/Type/Distance to Largest Tree, Human Disturbance, Dominant & Subdominant Substrate.

For the whole Reach:
Channel Constraint and Valley Width Assessment

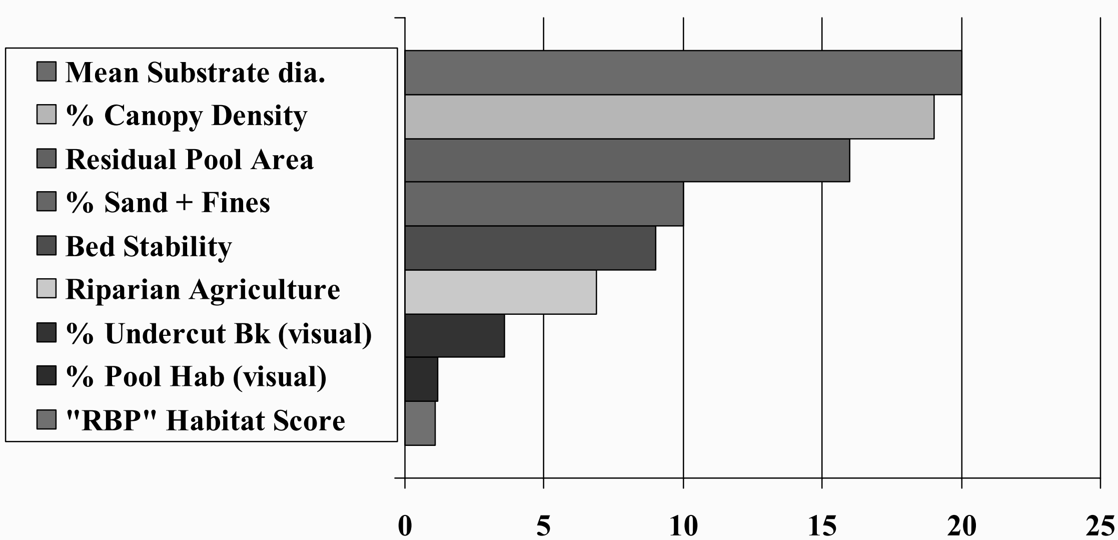
PHYSICAL HABITAT INDICATOR DEVELOPMENT

- Determine Metrics of Interest
- Develop Field Monitoring Protocol
- Quantify Variability, Precision
- Demonstrate Ecological Relevance
  - Biological associations
  - sensitivity to human disturbance

Precision:
Quantified through repeat sampling

- Within same day (measurement variance)
- Within same season
  - "index" variance – combines measurement and within-season
- Among Years (Year-to-year temporal variation)
  - Concordant: all sites vary together
  - Interaction: sites vary individually

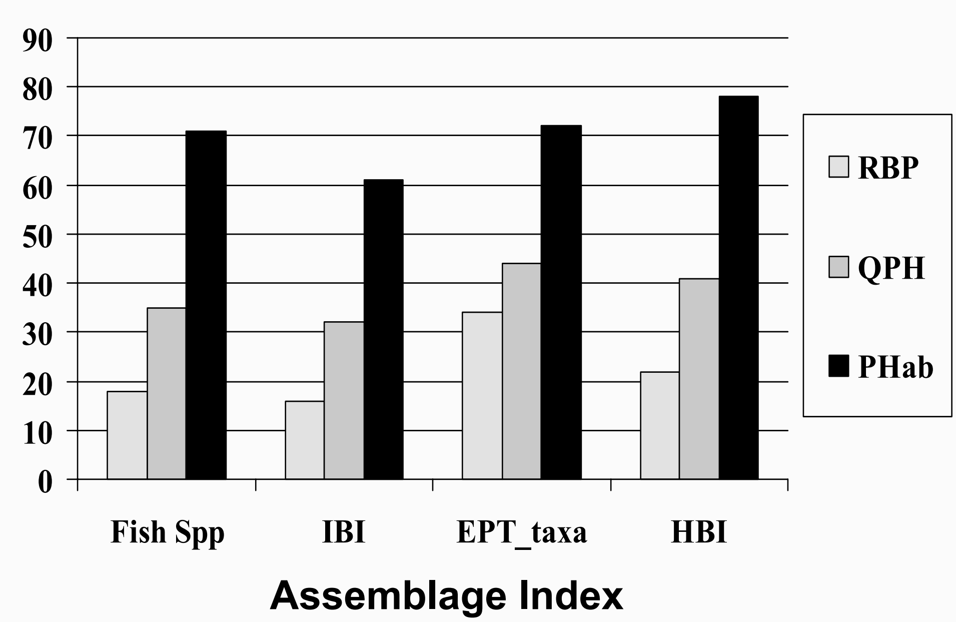
Signal to Noise Variance Ratio



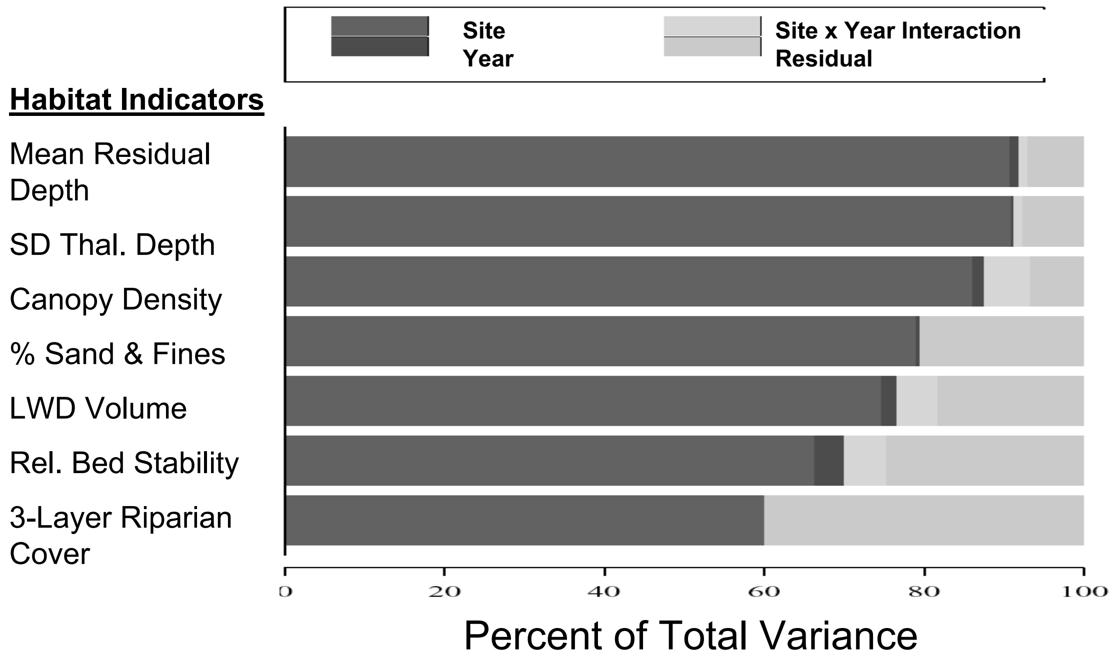
Effect of Measurement Precision on Maximum Observable Correlation (r) between Perfectly Correlated Variables.

$\sigma^2_{strm}/\sigma^2_{rep}$ (Variable 2)	Variable 1 $\sigma^2_{strm}/\sigma^2_{rep}$: 1	2	3	5	10	25	50	100
1	.50	-	-	-	-	-	-	-
2	.58	.67	-	-	-	-	-	-
3	.61	.70	.75	-	-	-	-	-
5	.65	.75	.79	.83	-	-	-	-
10	.67	.78	.83	.87	.91	-	-	-
25	.69	.80	.85	.90	.93	.96	-	-
50	.70	.81	.86	.90	.94	.97	.98	-
100	.70	.81	.86	.91	.95	.98	.99	.99

% Variance Explained Using Different Habitat Assessment Approaches



Partitioning Total Variance into Components



Trend Detection Potential

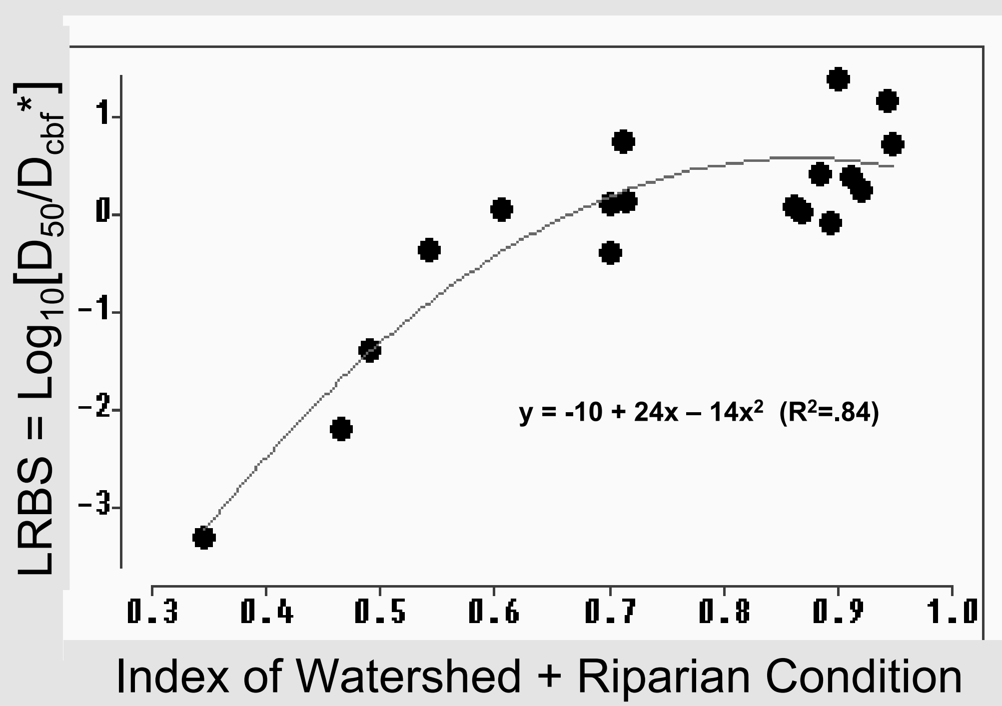
- **How long for 50 site network (sampled once/yr) to detect 2% and 1% per year trends?**

	2%	1%
- Std.Dev Thalweg Depth -----------	8 yr	13 yr
- Mean Residual Depth -------------	12	20
- % Sand & Fines --------------------	12	20
- % Embeddedness ------------------	12	20
- Relative Bed Stability -------------	8	12
- Large Woody Debris Volume ------	16	25
- 3-Layer Rip. Woody Veg. Cvr. ------	8	12
- Canopy Density ---------------------	8	14

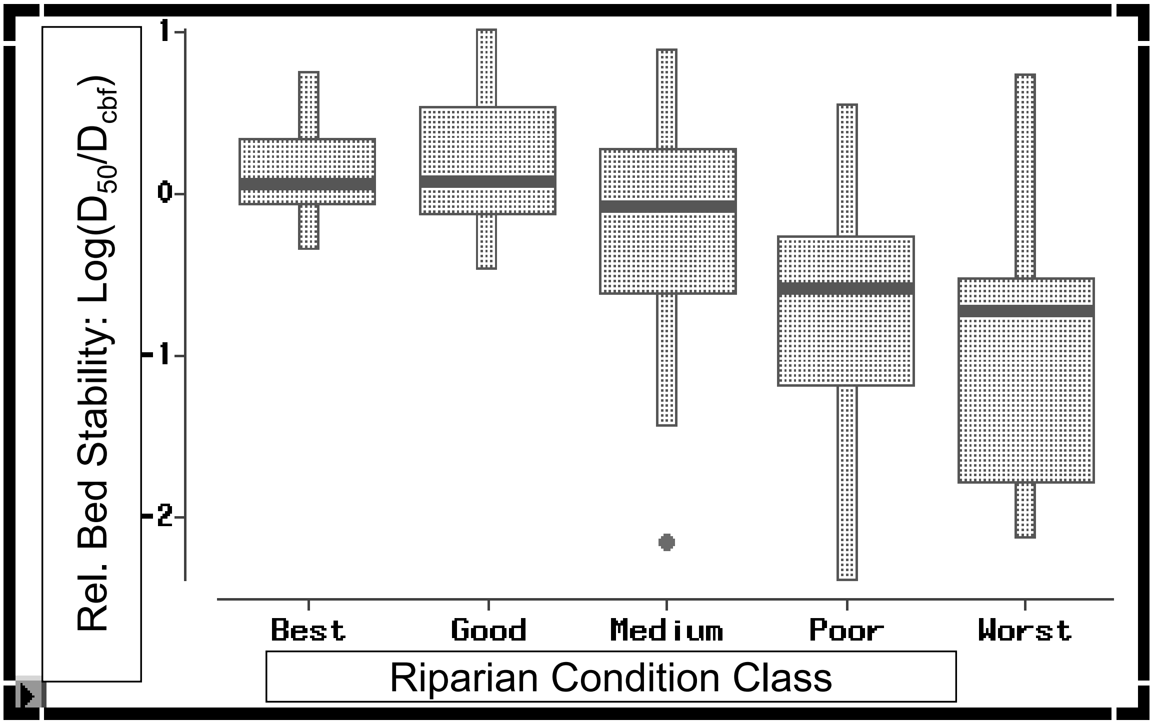
PHYSICAL HABITAT INDICATOR DEVELOPMENT

- Determine Metrics of Interest
- Develop Field Monitoring Protocol
- Quantify Variability, Precision
- Demonstrate Ecological Relevance
  - Biological associations
  - Sensitivity to human disturbance

Riverbed Stability vs. Landscape Condition

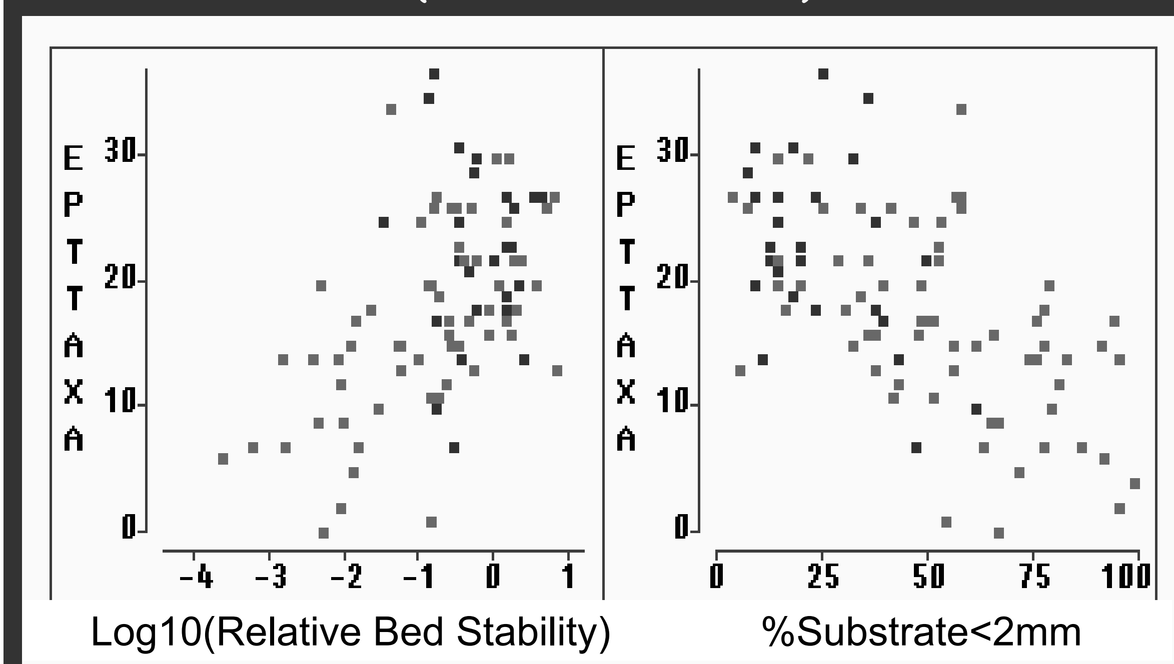


Substrate Stability vs. Riparian Condition



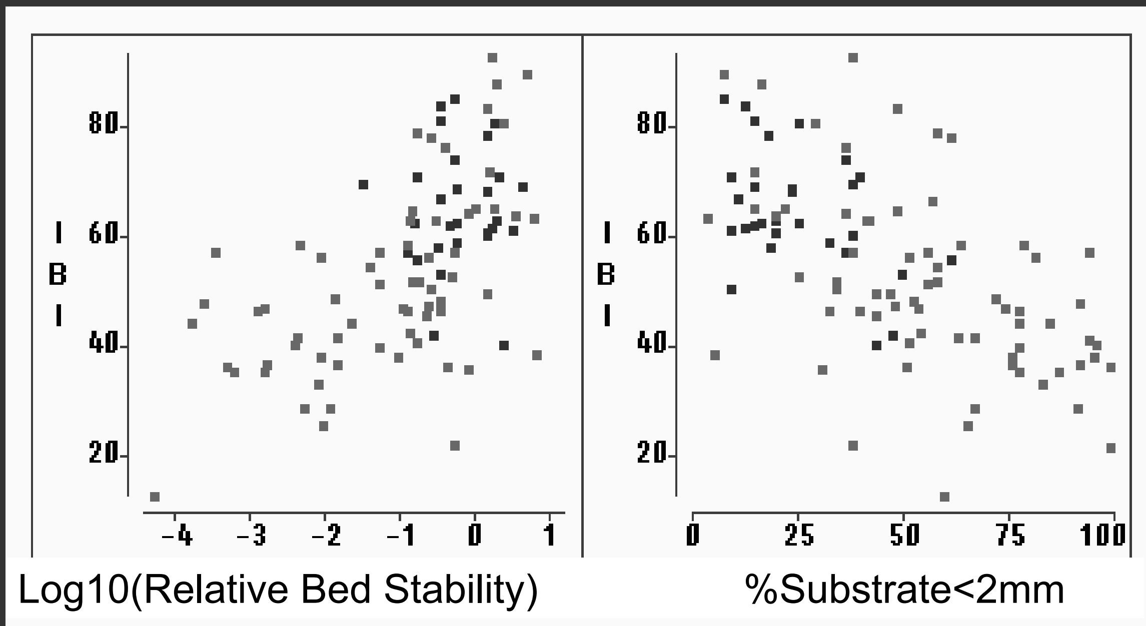
Aquatic Insects vs Channel Substrate

(blue=basalt red=sandstone)

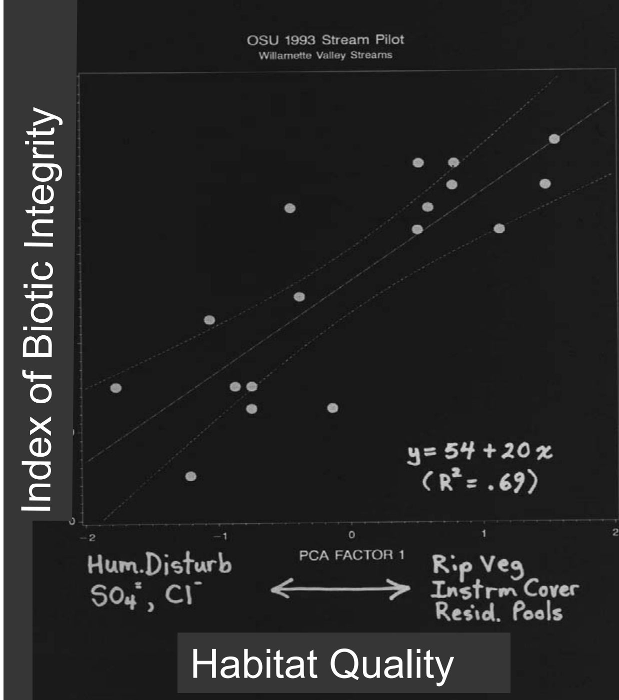


Fish vs Substrate

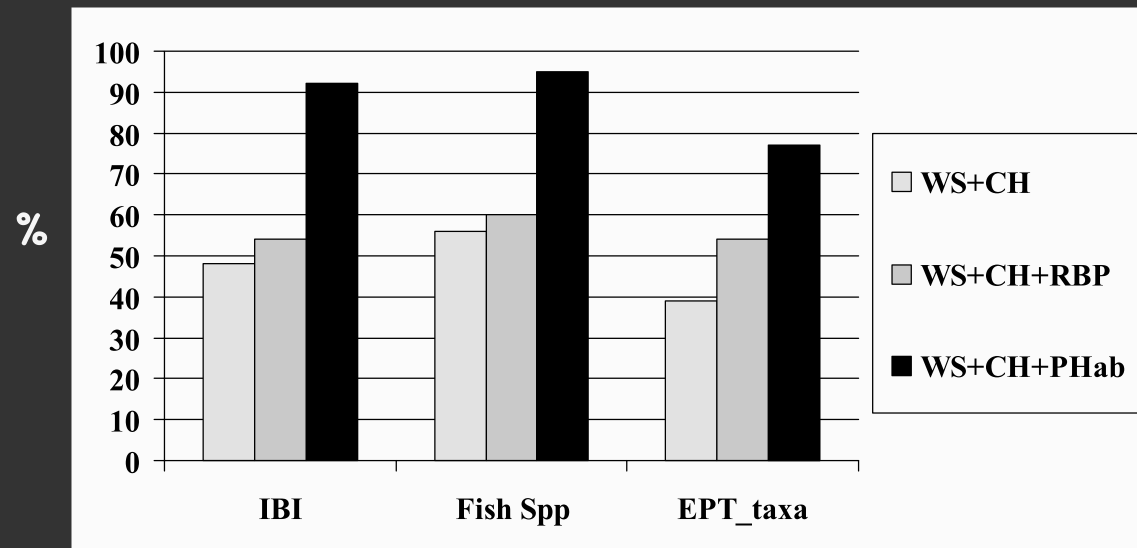
(blue=basalt red=sandstone)



Fish vs. Physical & Chemical Habitat



% Variance Explained Using Different Habitat Assessment Approaches



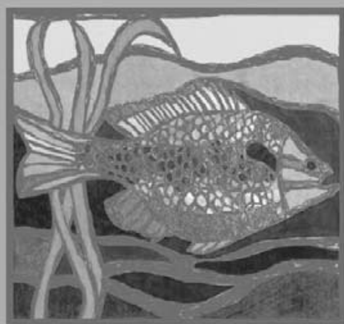
Assemblage Index

SUMMARY
EMAP Physical Habitat Field Protocol:

- Can be implemented in regional & local monitoring.
- Yields metrics with adequate precision for analysis of associations.
- Includes natural & anthropogenic metrics important to biota and diagnosis.

National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs



Coeur d'Alene, Idaho
31 March – 4 April, 2003

LR 101

Section 4c: Water Chemistry

Presented by
Joseph E. Flotemersch, USEPA
Office of Research & Development

Water Chemistry Assessment

- *What is it?*
  - Measurements of chemical concentrations and physical properties of flowing waters.
- *Why collect?*
  - To characterize surface water quality and condition by measuring a suite of analytes.

Water Chemistry Assessment
Features from 5 existing programs

- Each program has unique objectives and suite of analytes
- Some have additional protocols to further assess surface water quality
  - ground water
  - bed sediment
  - tissue analyses

Water Chemistry Assessment
USEPA-EMAP-SW

- Why collect?
  - determine acidity/alkalinity
  - identify water chemistry type
  - characterize trophic condition
  - establish presence/absence of chemical stressors
- When?
  - Collected during biological sampling
    - Field determined: specific conductance, dissolved oxygen, temperature
    - Laboratory determined: major ions, nutrients, total iron, total manganese, turbidity, color, pH, dissolved inorganic carbon, and monomeric aluminum species.

(Herlihy 1998)

Water Chemistry Assessment
USGS-NAWQA

- Feature: Tiered sampling
  - basic fixed-site: temperature, specific conductance, suspended sediment, major ions and metals, nutrients, and organic carbon
  - intensive fixed-site: addition of dissolved-pesticide analyses

(Gilliom et al. 1995)

Water Chemistry Assessment
USEPA-RBP

- Feature: All measured parameters are field collected
  - estimated measurements: stream type, water odors, water surface oils, and turbidity(or measured directly)
  - quantitative measurements: temperature, dissolved oxygen, pH , and specific conductance
- Why?
  - to provide a brief and easily-obtained analysis of water chemistry

(Barbour et al. 1999)

Water Chemistry Assessment
MDNR-MBSS

- Feature: Split sampling design
  - Spring: samples are collected from each site for lab: *pH*, *ANC*, specific conductance, *sulfate*, *nitrate*, and *DOC*.
  - Summer, *in situ* measurements are made of *DO*, *pH*, *temperature*, and *conductivity*
- Why: Minimize equipment required per visit

(Roth et al. 1997b)

Water Chemistry Assessment
Idaho DEQ

- Feature: River Physiochemical Index (RPI)
  - Based on the Oregon Water Quality Index (OWQI)
    - 8 parameters scored 10-100 then average for index score
  - Data from U.S.G.S. (river chemistry network)
- Results:
  - Correlates with measures of human disturbance
    - Particularly agriculture and forest percentages within a watershed
  - Correlates with professional opinion regarding the status of river

Water Chemistry Assessment
Common Parameters

- Field determined
  - Dissolved oxygen
  - Temperature
  - Specific conductance
  - pH

- Laboratory determined
  - Nutrients: Nitrogen, Phosphorus
  - Alkalinity / Acid Neutralizing Capacity (ANC)
  - Turbidity
  - Chloride
  - Sulfate

Water Chemistry Assessment
Common Parameters: Dissolved Oxygen

- "***the most important of all chemical methods available for the investigation of the aquatic environment***" Wetzel and Likens 1979
- Why collect it?
  - Necessary for the survival of many aquatic organisms
  - Many chemical and biological reactions depend on the amount of D.O. present
  - Needed to support other water chemistry measures
- Why low D.O.?
  - decomposing organic material (high bacteria), e.g. algae, manure
  - wastewater discharges
  - high ammonia discharges
  - warmer temperatures
- D.O. cyclic (diel cycle), but a single data point has value

Water Chemistry Assessment

Common Parameters: Temperature

- Why Collect?
  - Needed to support other measures
    - Dissolved oxygen, conductivity, pH, rate and equilibria of chemical reactions, biological activity, fluid properties
  - Essential to document thermal alterations
    - natural phenomena
    - human activities
  - Useful for classifying streams
    - Coldwater vs. Warmwater

Water Chemistry Assessment

Common Parameters: Specific Conductance

- What is it?
  - Measure of capacity of water to conduct an electrical current
  - A function of the types and quantities of dissolved substances in water
- Why collect it?
  - Rough measure of ground water intrusion
  - Correlates with nutrients
  - Indicator of mine waste or waste water

Water Chemistry Assessment

Common Parameters: pH

- What is it?
  - A measure representing the hydrogen-ion activity of water
  - Can be natural
- Why collect it?
  - Useful for stream classification
    - Blackwater systems vs Other
  - Can increase with
    - agriculture (runoff from liming)
    - acid rain
      - can decrease pH
      - reduce buffering capacity

Water Chemistry Assessment

Common Parameter: Nutrients (Nitrogen and Phosphorus)

- Common sources:
  - Agricultural and urban uses of fertilizer
  - Agricultural use of manure
  - Combustion of fossil fuels
    - Increased levels of total nitrogen and total phosphorus

Note: Chlorophyll can serve as a surrogate for nutrients

Water Chemistry Assessment

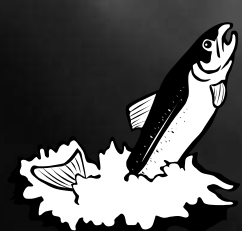
Common Parameter: Nutrients (Nitrogen and Phosphorus)

- Potential effects on systems:
  - can alter trophic dynamics
  - increase algal and macrophyte production
  - increase turbidity
  - decrease average D.O. concentrations
  - increase fluctuations in diel D.O. and pH.

Water Chemistry Assessment

Common Parameter: Nutrients (Nitrogen and Phosphorus)

- Specific effects
  - Nitrogen - Ammonia is toxic to fish
  - Phosphorus
    - High - excessive plant growth (eutrophication)
    - Low - can be culturally oligotrophic
      - Harvest of migrating salmon removes potential nutrient contributions of post-spawn salmon carcass'



Water Chemistry Assessment

Common Parameters: Alkalinity / ANC

- What is it?
  - measures of the ability of a sample to neutralize strong acid
- Why collect it?
  - Can provide information on
    - efficiency of wastewater processing
    - presence of contamination by anthropogenic wastes
    - maintaining ecosystem health
  - Useful for stream classification
    - geologic nature of stream
  - Determining susceptibility to acid deposition

Water Chemistry Assessment

Common Parameter: Chloride

- Source:
  - Water used by sewage treatment plants
    - Indicator of sewage input
    - Low-flow chloride concentration
      - Increase with population density
      - Decline with increase discharge
        - Good measure of discharge
  - Salt from roads (also adds sodium)
    - Urban and rural areas
  - Can be concentrated by irrigation
  - Impact: fish kills and changes in water chemistry

Water Chemistry Assessment

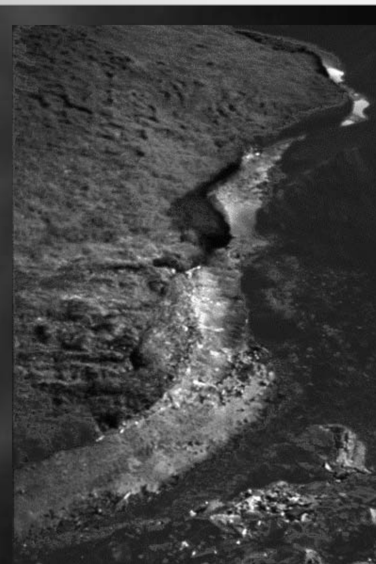
Common Parameters: Turbidity

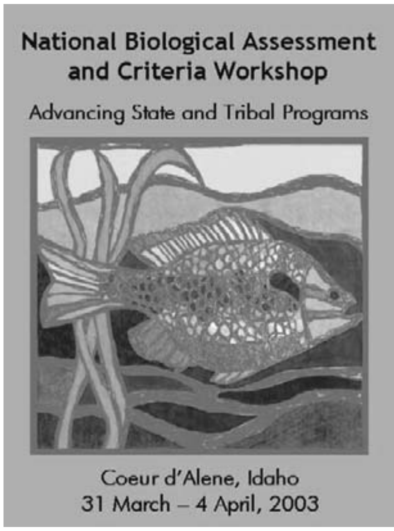
- What is it?
  - clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton, and microscopic organisms American Public Health Association 1992
- Why collect it?
  - Indicator of the condition and productivity of a system

Water Chemistry Assessment

Common Parameter: Sulfate

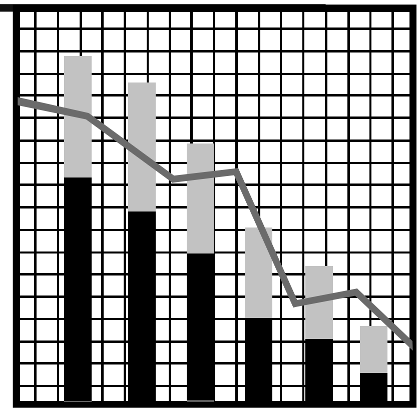
- Sources:
  - Mining activity
  - Naturally occurring
    - Coal seam
    - Sulfur containing rock or soils
  - Component of acid rain
  - Concentrated by irrigation practices
- Effects
  - Taste and odor
  - Changes in surface water, chemistry and aquatic biota





LR 101

Section 4d: Biological Response Indicators of Riverine Ecosystem Quality



Presented by
Joseph E. Flotemersch, USEPA, Office of Research & Development

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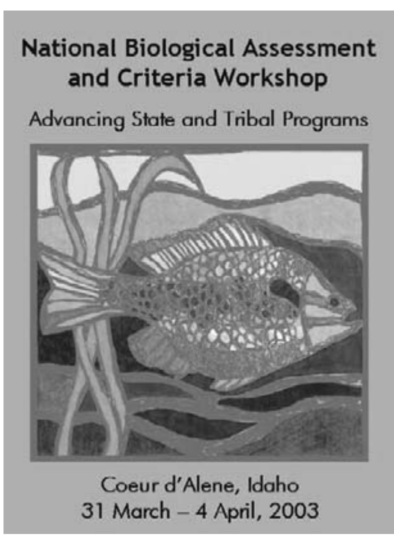


LR 101

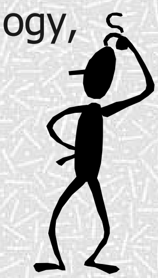
Index Period…

When to sample?

When to sample?
Selection of Index Period

- Index Period
  - To reduce variability, sample all sites in the same relative time period
  - Maximize gear efficiency
  - Maximize information gained
  - Depends on life history, meteorology, hydrology, etc.
  - Fits into logistical sequence of collection, processing, and write-up

Ref: U.S. EPA 1999

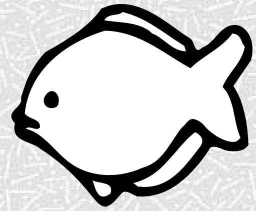
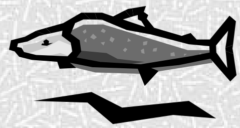
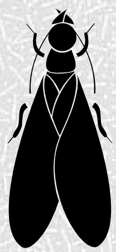
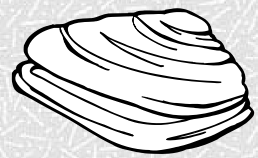


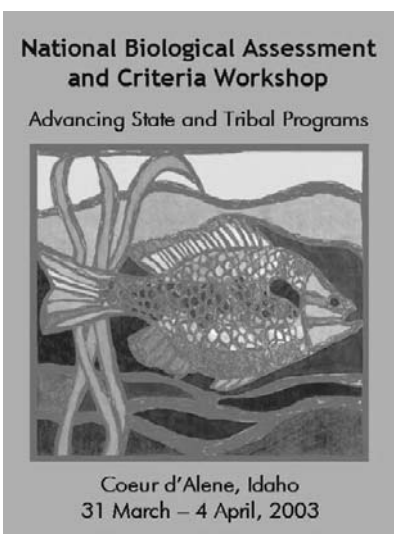
When?

- What time is good?
  - Fall and Winter?
  - Late Summer to Winter?
- Low and stable-flow index period
  - Mid-June to early October
- Widely accepted
  - Increases likelihood samples can be collected under similar flow conditions
- Probably safer

Core Assemblages Sampled…

- Algae
- Benthic Macroinvertebrates
- Fish
- Other Assemblages
  - Zooplankton
  - Macrophytes
  - Bivalves

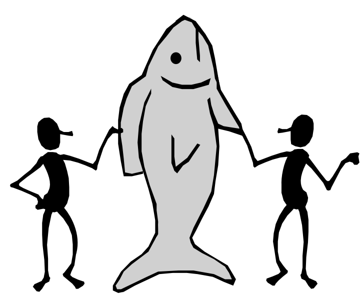







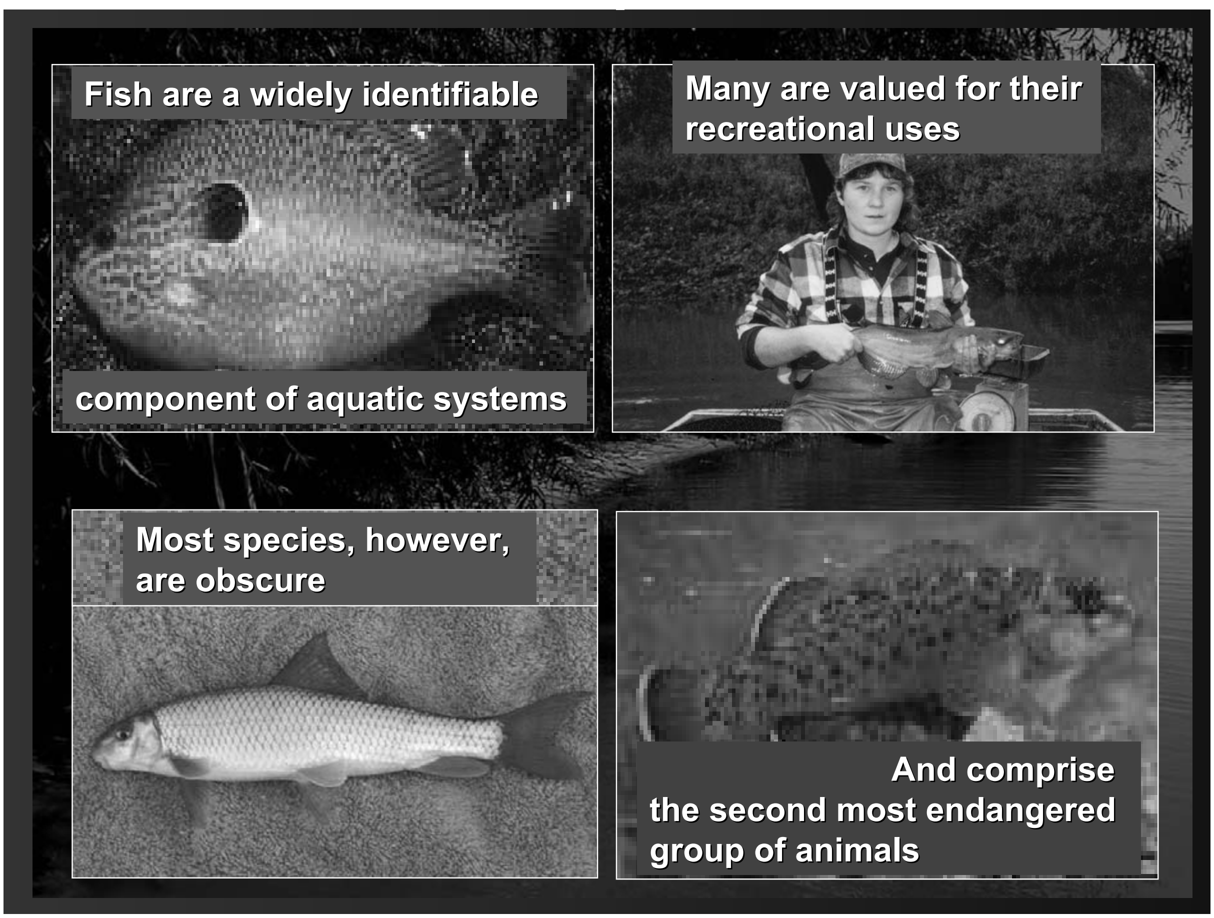
LR 101

Section 4e: Methods for Sampling Fish in Large Rivers

Presented by
**Joseph E. Flotemersch, USEPA,
Office of Research & Development**




I'm healthy,
I'm healthy,
let me go…


Fish are a widely identifiable
component of aquatic systems
Many are valued for their
recreational uses
Most species, however,
are obscure
And comprise
the second most endangered
group of animals

Characteristics of Vertebrates (e.g., Fish) that make them useful indicators

1) **Accurate environmental assessment of health**
2) **Visibility**
3) **Standardized use and interpretation**
4) **Extensively used in large river programs around the world**
5) **Long history of development and use in assessment; thus a strong body of literature from which to draw**

   Ref: Simon 1999
6) **Historical knowledge of distribution**

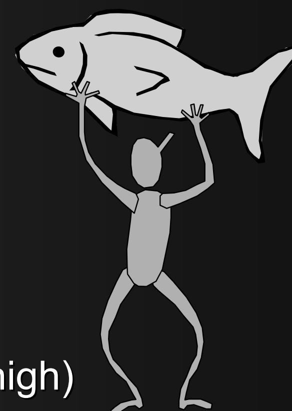
Fish (Vertebrates)

Important program development questions

- **Which sub-habitats**
- **What reach length**
- **What time of day**
- **Which methods (single vs. multiple gear)**
- **Field identification (knowing what to take back to the lab)**
- **What is the final indicator**

Fish (Vertebrates)
Common Sampling Approaches

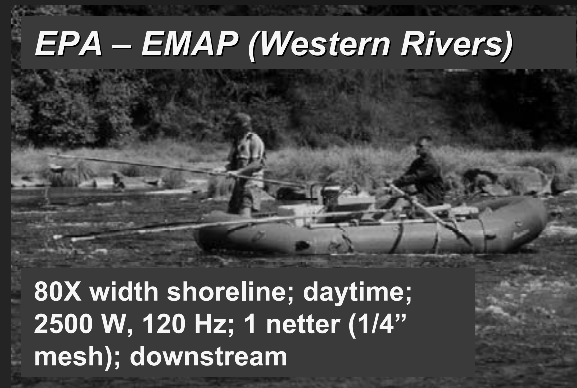
- **Active sampling methods**
  - Electrofishing
  - Seining
- **Passive sampling methods**
  - Nets (hoop, fyke, gill, trap, etc.)
    - Specific applications
      - Electrofishing prohibited
      - Target Species
      - Prohibitive conductivity (low and high)

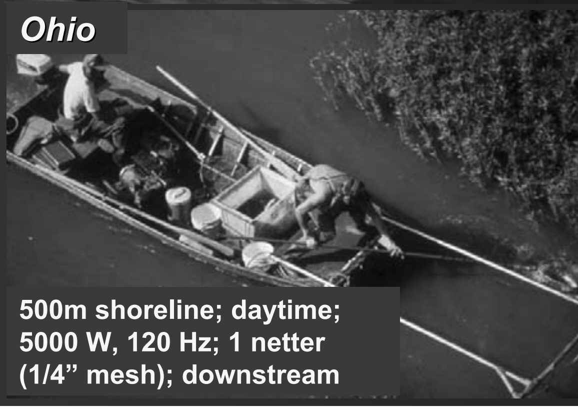


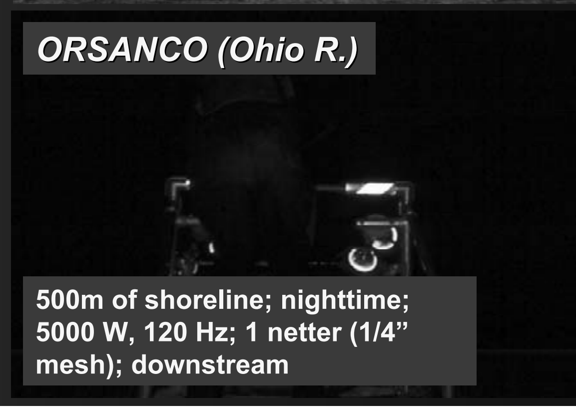
Fish (Vertebrates)
Active Sampling Methods

Electrofishing – Widely considered the most comprehensive and effective ***single*** method for collecting river fishes

Electrofishing Examples







May require an array of equipment to cover all encountered systems.

Human factors
influencing electrofishing performance

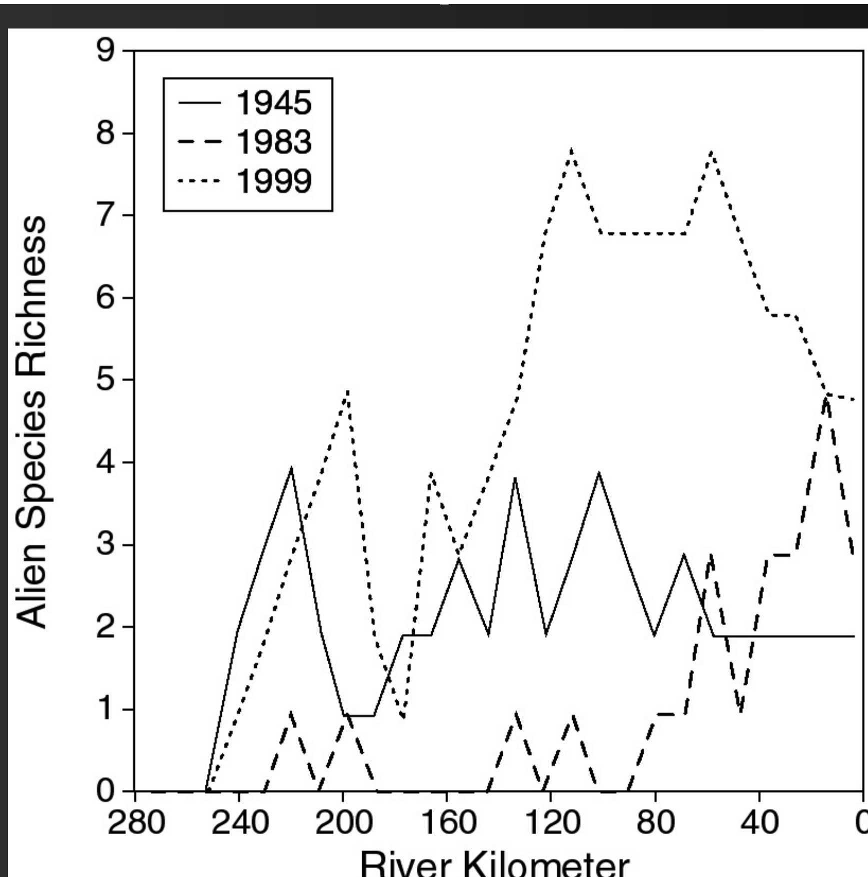
- ✓Equipment
  - ✓Configuration
    - ✓Boat size
    - ✓Electrode array
    - ✓Setting
    - ✓Equipment condition
- ✓Crew experience
  - ✓ Especially crew leader
  - ✓ Skill of boat driver
  - ✓ Historical focus
- ✓Physical skill and capacity
- ✓Attention to detail
- ✓Skill in fish identification
- ✓Training

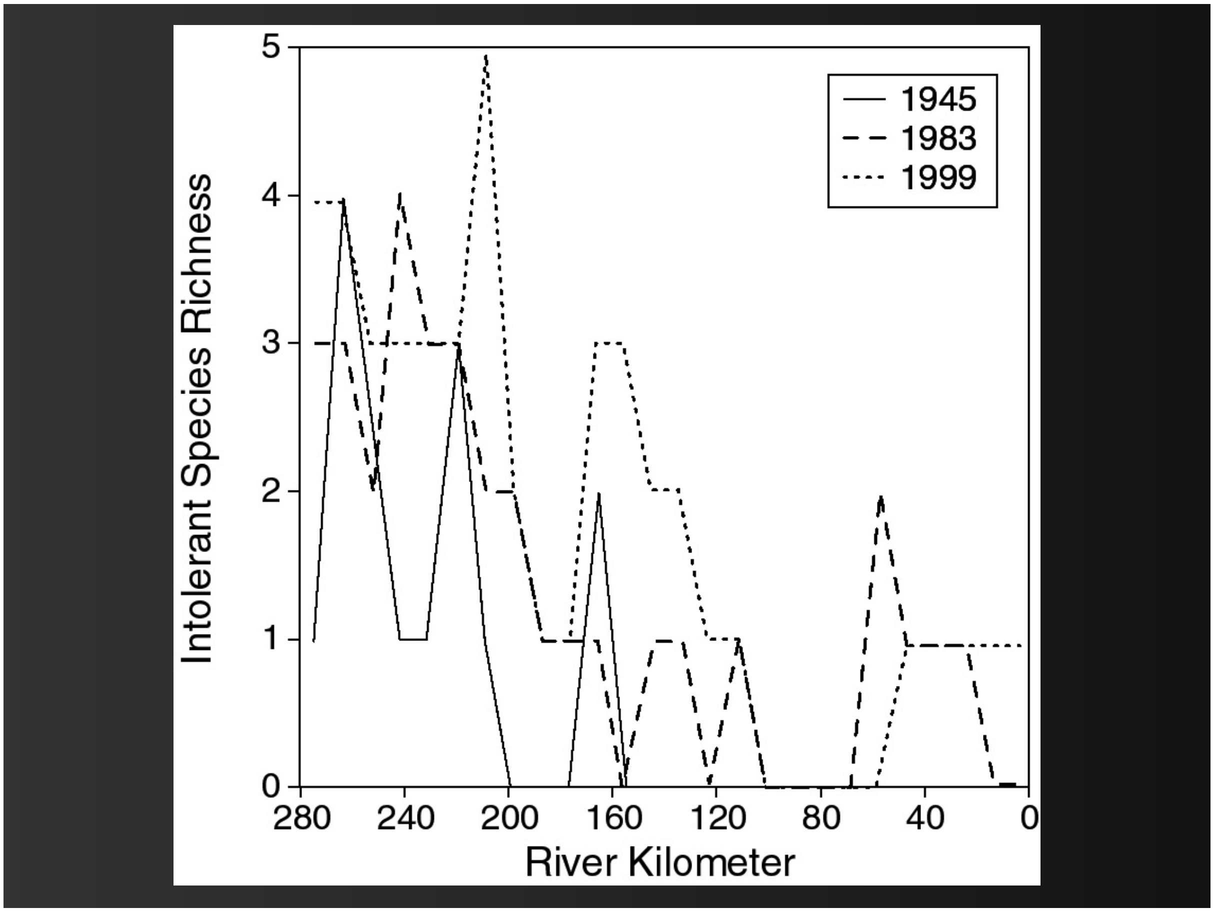
Environmental factors
influencing electrofishing performance

- ✓Recent weather patterns
- ✓Time of day
- ✓Wind
- ✓Departures from normal summer (low flow) water conditions
  - ✓Flow rate
  - ✓Water level
  - ✓Conductivity
  - ✓Clarity of water

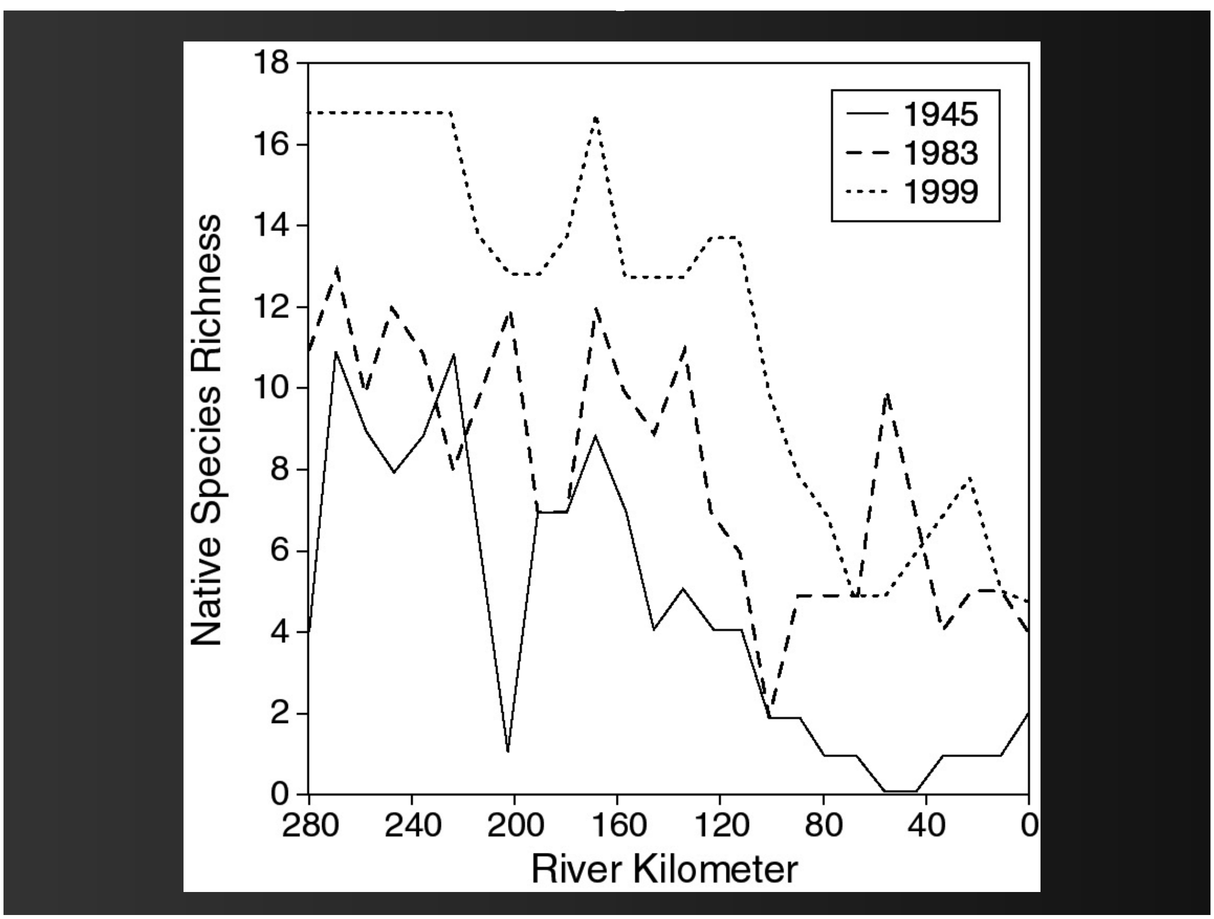
Recent Electrofishing Sample Design Research

Phil Kaufmann, USEPA, Corvallis, OR.
Bob Hughes, Dynamac, Corvallis, OR.





Intolerant Species Richness
River Kilometer
1945
1983
1999
0
1
2
3
4
5
280
240
200
160
120
80
40
0



Native Species Richness
River Kilometer
1945
1983
1999
0
2
4
6
8
10
12
14
16
18
280
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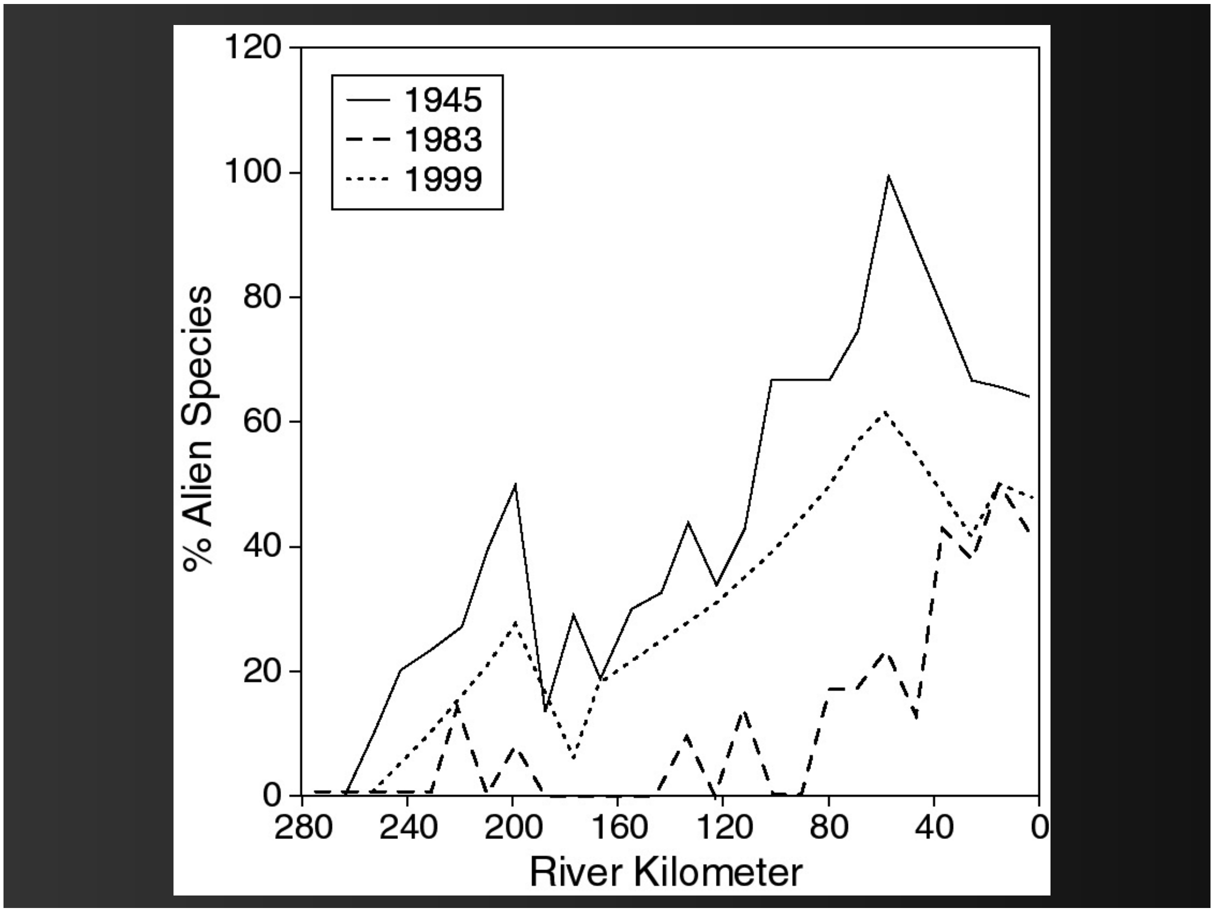
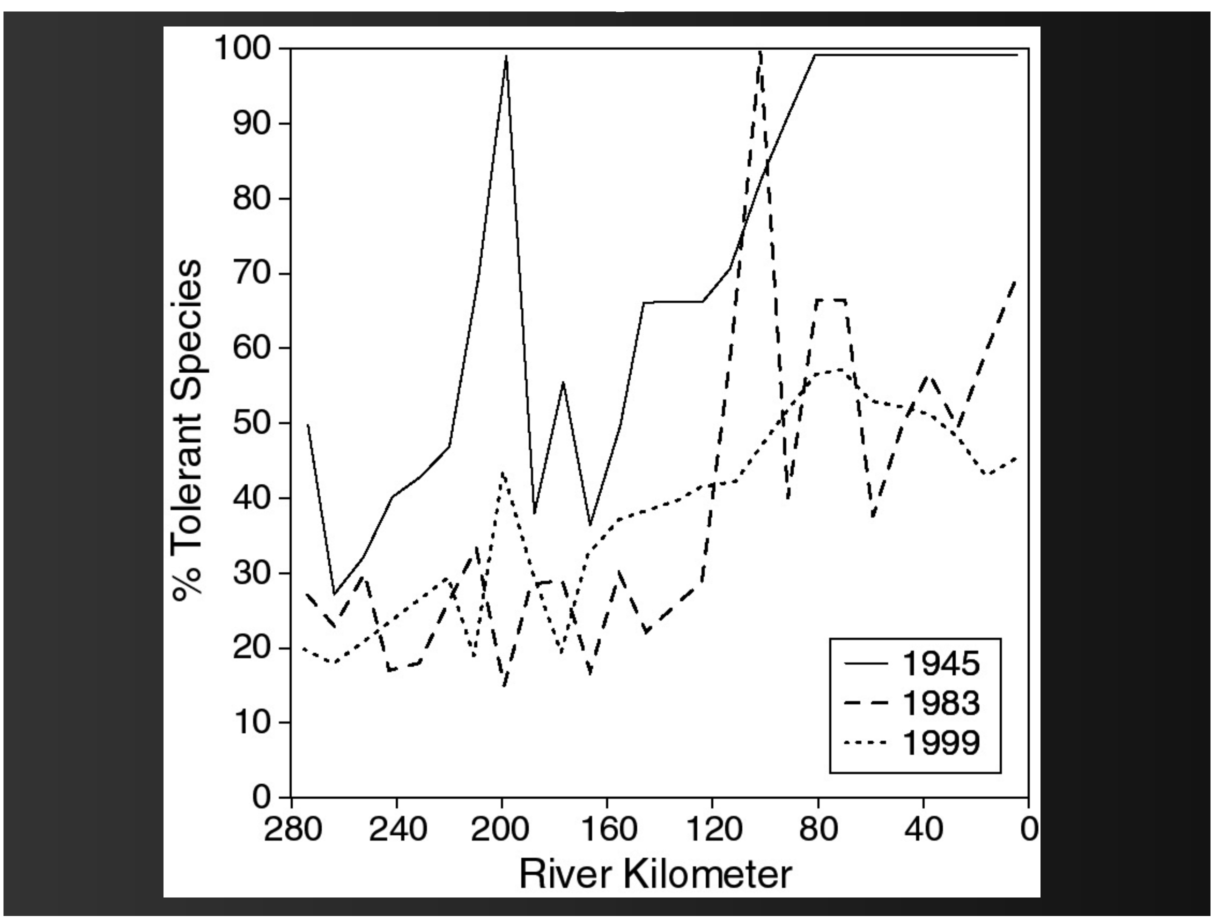
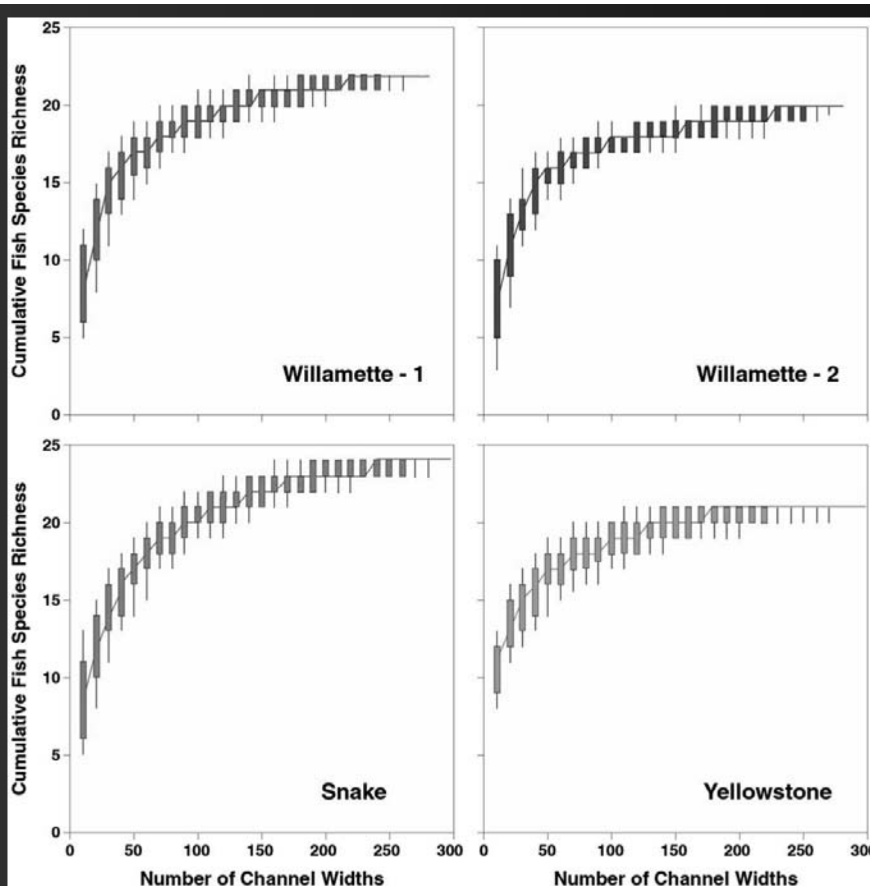
160
120
80
40
0



1945
1983
1999
% Alien Species
River Kilometer



1945
1983
1999
% Tolerant Species
River Kilometer



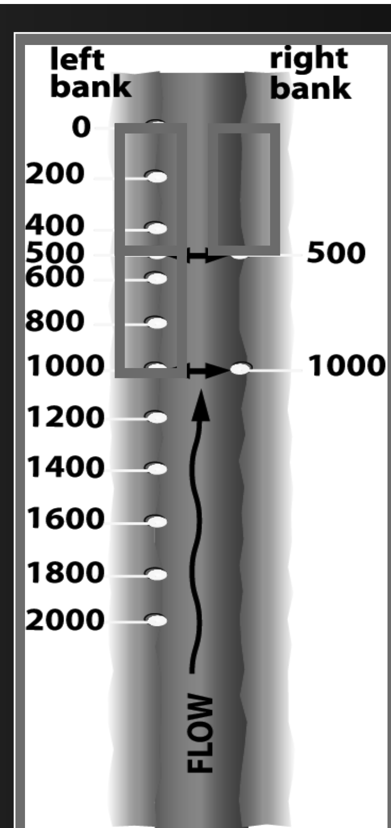
	Willamette-1	Willamette-2	Snake	Yellowstone
Species Observed	22	20	24	21
Number of Individuals	470	445	580	564
No. Species Occurring Once	2	2	2	2
No. Species Occurring Twice	2	2	2	1
True Species Richness (TSR)	23	23	25	22
Channel-widths for 80% TSR	92	77	105	79
Channel-widths for 90% TSR	164	138	182	166
Channel-widths for 95% TSR	220	186	240	240
Channel-widths for 100% TSR	294	250	316	348

Recent Electrofishing Sample Design Research

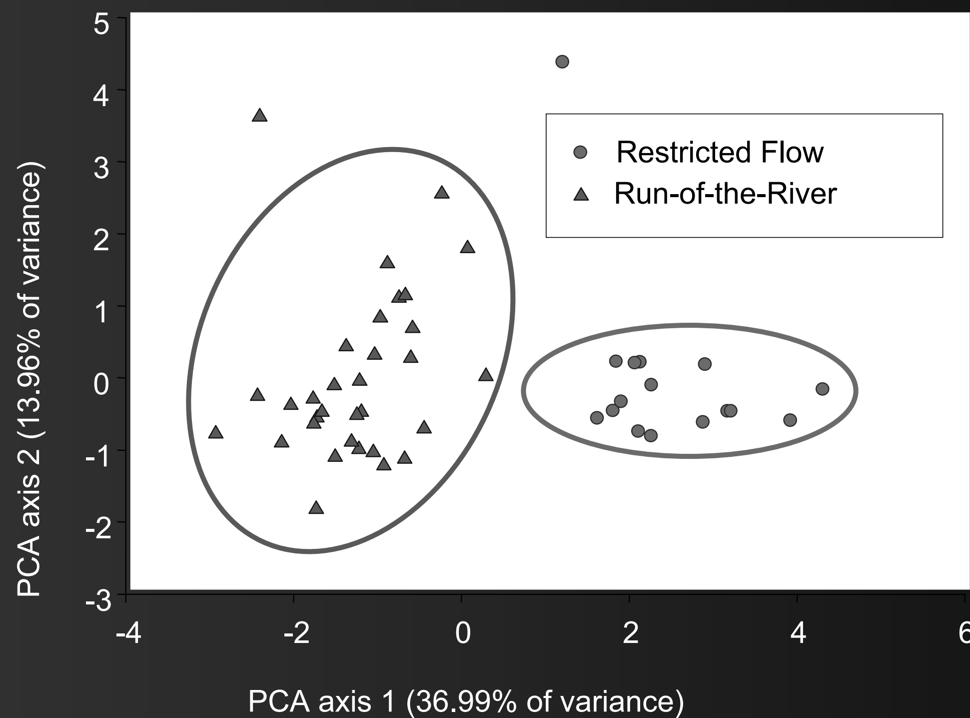
Field Sampling Methods Comparison Notes
(East-Central Rivers)

Joseph E. Flotemersch and Karen A. Blocksom,
USEPA, Office of Research & Development,
Cincinnati, OH.

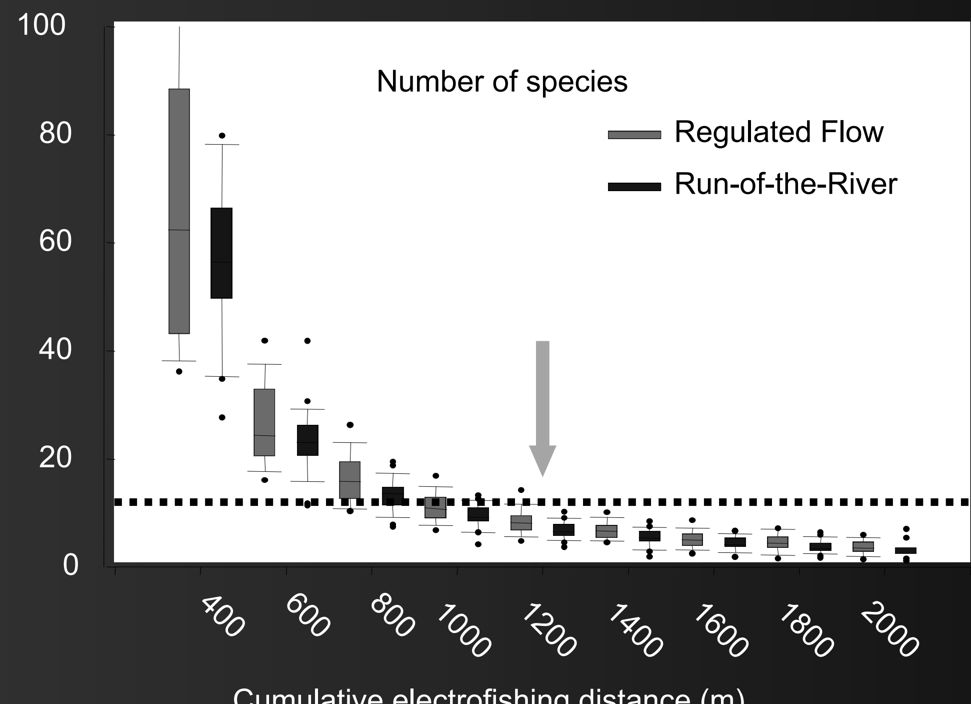
- Single experimental design
- Testing of multiple designs
- Testing of distance effects on metrics
- Collected >28,000
- Electrofished 180 km



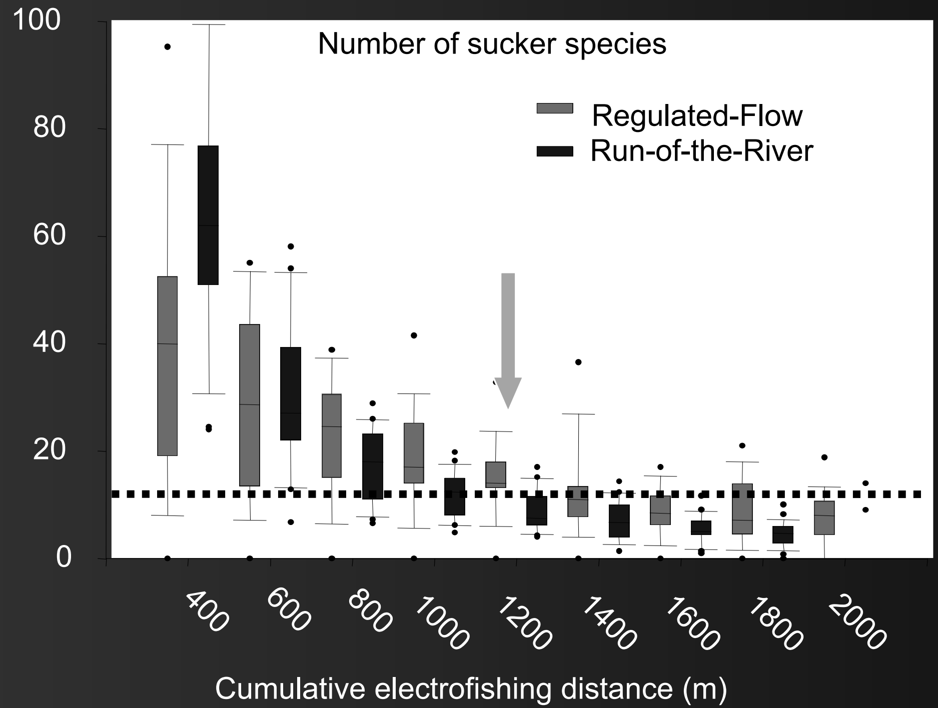
Principal Component Analysis



Monte Carlo Simulations



Monte Carlo Simulations



Overview of Conclusions…

- Degree of impoundment plays a critical role in characterizing sites.
  - Metrics did not perform the same across sites of differing impoundment status (e.g., free-flowing vs. impounded).
    - May categorize by degree of impoundment
  - Different designs may be required to adequately describe different categories of systems.
    - Shallow systems – daytime electrofishing
    - Deeper, impounded systems – night electrofishing
    - Distance required may also vary

Ref: Flotemersch & Blocksom, submitted

Active Sampling Methods: Seining

- ✓In places where electrofishing is prohibited
- ✓Difficult boat access
- ✓Low conductivity
- ✓Low equipment cost
- ✓ Per-capita cost may be higher

Active Sampling Methods: Seining

- Selective
  - Small (species and juveniles)
  - Schooling (normally inhabit shallow water areas)
  - Slower

Horse seining, Columbia River, Oregon

Passive Fish Sampling Methods
Nets: Hoop, Fyke, Trap, Gill, Etc.

- Advantages
  - Simple in design and construction
  - No electrical equipment to fail
  - Require little specialized training
  - Yield fairly precise data (relative abundance)
- Disadvantages
  - Selective (species, size, sex)
  - Require multiple trips to a site
  - Cannot pull fish out of cover
  - Spatial coverage is limited

(Ref: Hubert 1992)

Field and Laboratory Processing of Fish

- Be humane to collected specimens
- Be cognizant of who is watching
  - Public relations
- Identification
  - Vouchers
  - Length or size classes
  - Weight
  - * Recording anomalies
  - * Tissue samples
- Other issues

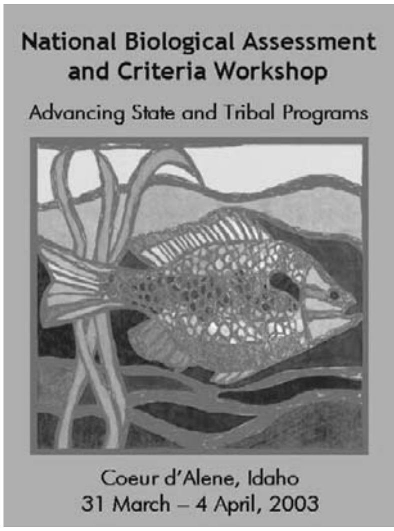
External Anomalies:

Deformities, Erosions, Lesions, Tumors (DELT) anomalies

- Effective communicator of degraded quality
- Useful in sites degraded by multiple and cumulative stresses
- Reliable indicator condition
- Occurrence may be part of the recovery
- Important diagnostic tool
- Includes parasites (Ref: Sanders et al. 1999)

Fish Tissue Sampling

- Fish Tissue
  - Commonly used indicator of contaminant risk
  - Strong connection to resource use and exposure
  - Standard methods exist
- Important questions
  - How to sample?
  - What to sample?
  - Which analytes to consider?



LR 101

Section 4f: Methods for Sampling Benthic Macroinvertebrates in Large Rivers

Presented by
Joseph E. Flotemersch, USEPA, Office of Research & Development

Benthic Macroinvertebrates

- Definition
  - *Benthic* - Inhabit the sediment or live on the bottom substrates
  - *Macroinvertebrate*s - retained by the Standard No. 30 sieve (0.595 mm opening) Klemm et al. 1990
- Includes insects, oligochetes, leeches, molluska, crustaceans, others
- Both active and passive collection methods are commonly employed
- Not as commonly employed in non-wadeable systems as in wadeable

Benthic Macroinvertebrates

- Life history characteristics that make them useful indicators:

  - Many have short life cycles and fast reproduction
  - Present in a variety of habitats
  - Standardized protocols are well developed
  - Sampling has limited impact on resident biota
  - Are relatively sedentary
  - Sensitive to a wide range of chemical stressors
  - Broad range of pollution tolerant species
  - Response to stressors widely described
  - Many states have background data

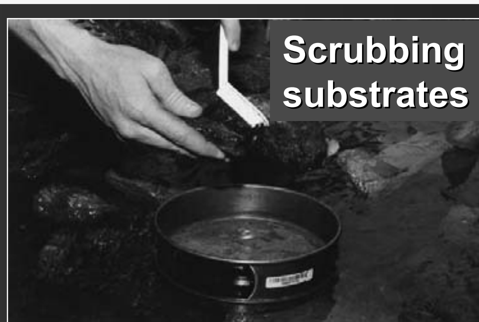
Benthic Macroinvertebrates Field Sampling

- Important questions to consider during program development.

  - Which methods?
  - Which habitats?(single vs. multi-habitat)
  - To composite or not to composite?
  - Which methods?
  - Allocation of samples?
  - How/where to process samples?
  - Identification
  - What is the final indicator?

Benthic Macroinvertebrates

Active Sampling Methods Examples



Picking

Net-based methods (including kicks, dips, jabs, sweeps, & picks)

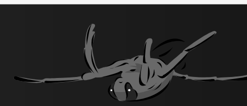
Benthic Macroinvertebrates

Active Sampling Methods Examples

- Net-based examples
  - Quantitative - USEPA-EMAP – timed kick net (595 µm) sampling conducted at assigned transects
  - Qualitative - USGS-NAWQA – kicking, dipping, or sweeping all available habitats (212 µm)
  - Semi-Quantitative Methods – Pilot SAM method – combines timed kicks and dipping (595 µm)
  - Timed sampling / approximate set area
- Ponar example
  - Quantitative – Lower Missouri, depositional areas. ? Grabs per habitat unit.

Benthic Macroinvertebrates

Passive Sampling Methods Examples

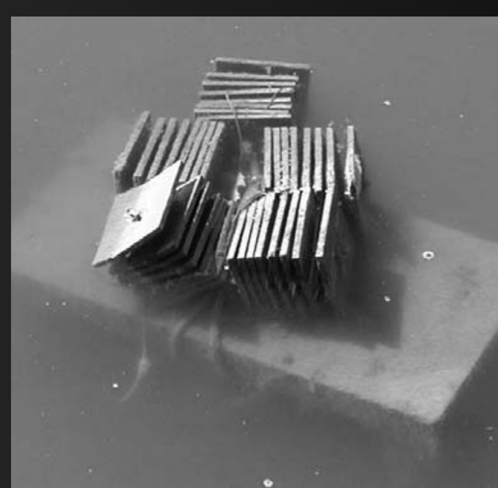


- Quantitative
  - Artificial substrates (Cairns 1982)
    - Containers with various substrates (e.g., Rock Baskets)
    - Multiplate samplers
      (e.g., Hester-Dendy (Ohio EPA, ORSANCO))
  - Drift-Nets
    - USEPA-EMAP – timed deployment
      - Used in large river pilot studies
        - Could not be deployed at sites with insufficient flow velocities

Benthic Macroinvertebrates

Passive Sampling Methods Examples

- Quantitative
  - Ohio-EPA – Hester-Dendy artificial substrate samplers. Five samplers exposed for six weeks



Benthic Macroinvertebrates
Typical Field Site Processing

- Sample materials are usually composited
- Sieved to reduce excess water and mud
- Large objects (e.g., rocks) are cleaned and removed **Sieving also controls for size of organisms
- Sample is transferred to jar
- Preserved with ethanol
- Some people still fix with formaldehyde, better for long term storage
- Sampling information recorded
- Sample is labeled
- Transported to laboratory

Benthic Macroinvertebrates
Typical Laboratory Processing

- Arrival of sample to lab is recorded
- Macroinvertebrates are picked from the sample following a predetermined protocol
- Organisms are identified to a predetermined taxonomic level
- Data entered in database
- QA/QC analysis is conducted
- Data ready for analysis

Laboratory processing questions/issues

- Pick in field or lab
- Sub-sample
- ID level
- QA/QC
- Cost of sample
- Sample sizes

Benthic Macroinvertebrates

Field Sampling Methods Comparison Notes

Study conducted comparing 6 sampling methods

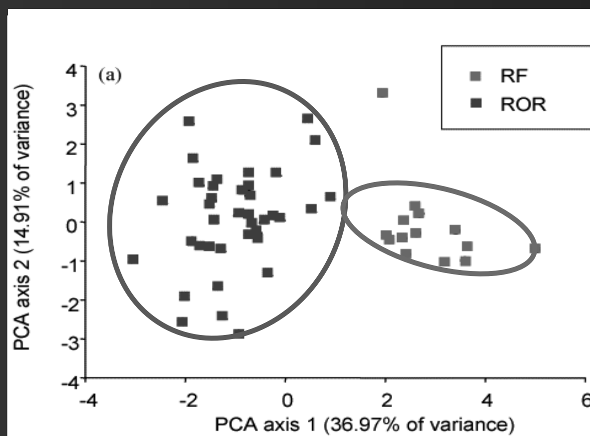
Conclusions: Methods matter

- Different field methods result in different metric values
- Performance of methods was not consistent between sites of differing impoundment status
- Even when metric values were similar, correlations with abiotic stressors differed across methods
- Merging data indiscriminately across field methods is not advised for bioassessment

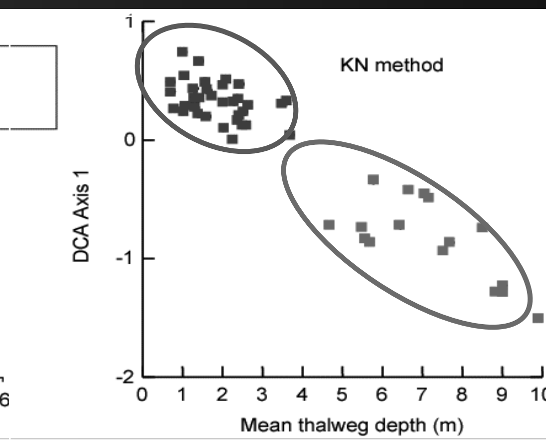
Ref: Blocksom & Flotemersch, submitted

Principal Component Analysis

Physical Habitat Data



Macroinvertebrate Data



Correlations With Stressors?

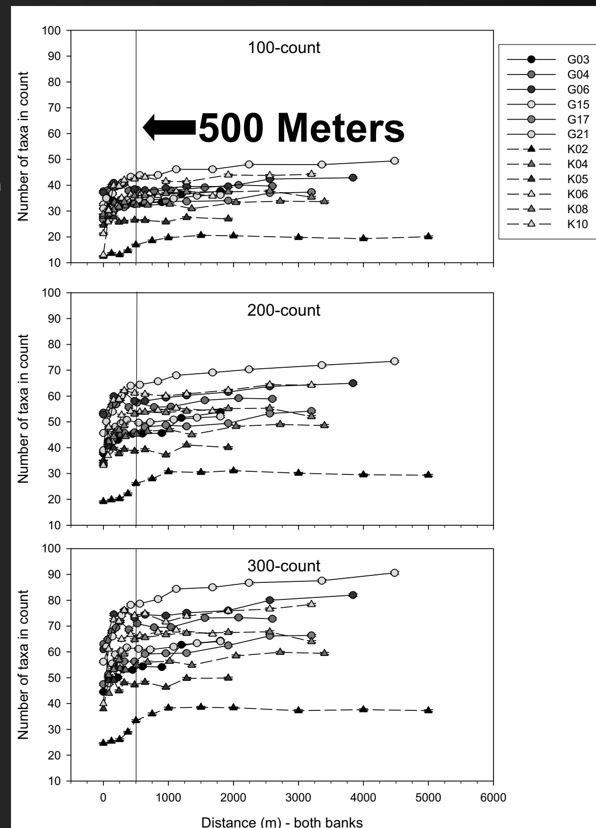
Metric	Riparian Disturbance All Types	Riparian Disturbance Non-Agriculture	Riparian Disturbance Trash/ Landfill	Natural Fish Cover	% Canopy Density	Cobble and Larger	Large Woody Debris Volume	Large Woody Debris Quantity
Number of taxa	00-00	00-00	00-00		+0+00		0000+	
Number Indiv. per taxon	+0+00	+0+00	0++00		---00		0000-	
% Chironomidae Individual	00+00	00+00	00+00		-0000		0000-	0000-
% Coleoptera Individual						+00+0	++0++	++0++
% Tolerant Individuals	00+0+	00+0+	00+00				--0--	-000-
% Scrapers					00+00	++0+0	+00++	000++

SAM Method: Number of Taxa

Metric level off after about 500m or 6 transects

⬆ Subsample size

⬆ Separation of sites



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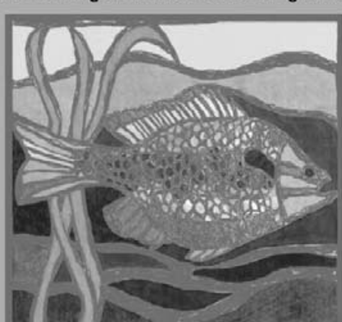


Coeur d'Alene, Idaho
31 March – 4 April, 2003

LR 101

Section 4g: Methods for Sampling Algae in Large Rivers

Presented by

Joseph E. Flotemersch, USEPA, Office of Research & Development

Algae (Microalgae)

- Freshwater dominated by:
  - Diatoms
  - Blue-green algae
  - Red algae
- Two major ecological categories
  - Benthic Algae (Periphyton)
  - Planktonic Algae (Phytoplankton)

Periphyton: Why are they useful indicators?

- Primary Producers: link nutrients to food web
- Sessile
- Relatively Diverse
- Short Life Cycle
- Spatially Compact
- Consistent sampling techniques
- Standard taxonomy
- Known Sensitivities

- Are generally receiving increased attention, especially for nutrient criteria

Important questions to consider during program development….

- When to sample?
- What type of samples?
  - Qualitative or Quantitative
- What methods?
- What substrates?
- Target indicator?
- Composite?
- Location of samples?
- Identification level of effort?

Active Sampling Method Examples

- Quantitative (single composite index sample)
  - USEPA-EMAP – from erosional and depositional habitats at 11 assigned transects
  - USGS-NAWQA (richest-targeted habitat) - at five locations, five representative substrates are sampled
- Qualitative (single composite index sample)
  - USGS-NAWQA – samples collected at all available habitats

How are actual samples collected

- **Erosional habitats:**
  - Substrate removed from stream
  - Attached periphyton are dislodged from upper surface
  - Dislodged periphyton washed into a sample bottle

- **Depositional habitats:**
  - Soft sediment is collected
  - Transferred to the sample bottle

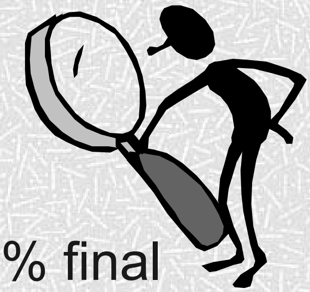
Passive Sampling Methods
(Artificial Substrates)

- Benthic Substrates - Rocks, bricks, clay tiles, glass or plastic rods, wood dowels

- Suspended substrates – styrofoam, periphytometers (with glass or plexiglas slides or coverslips)

Periphytometer with glass slides

Typical Field and Laboratory Processing of Samples



- ID/Enumeration samples
  - 50 ml subsample
  - Preserved w/ formalin (4-5% final concentration)
- Chlorophyll & Biomass samples
  - Filtered aliquot (volume varies)
  - Stored on dry ice or in portable freezer

Common Indicators of Condition
(and associated parameters)

Species composition - Species diversity, evenness, autecological indices

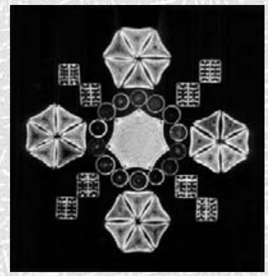
Cell density (cells/cm^2) – Abundance

Chlorophyll (μg/cm^2; surrogate for biomass) - standing stock, productivity, trophic status

Ash Free Dry Mass – Biomass, trophic status

Planktonic Algae (Phytoplankton)

- Poorly developed as large river indicator
  - Generally not very useful in smaller, more free-flowing rivers.
  - More useful in larger rivers
- Important questions to consider
  - When to take samples?
  - What type of sampler?
  - What is the target indicator?
  - Where are samples located?
  - To composite or not to composite



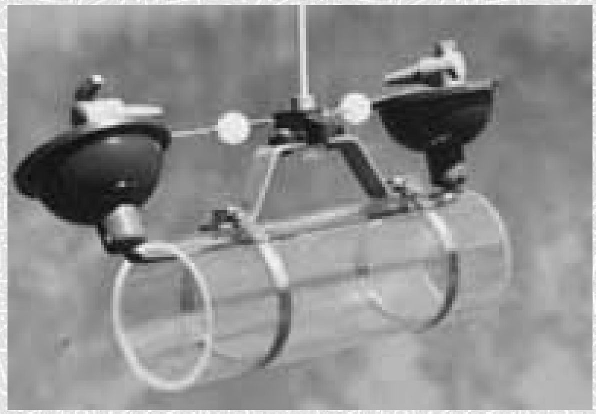
Phytoplankton: Why are they useful indicators?

- Reflect water quality conditions of the water mass in which they occur
  - However, may be dominated by dislodged benthic algae
- Substantial communities may develop in rivers during stable hydrologic conditions, particularly in large, impounded rivers.
- Sample is easy to collect, handle and curate

Phytoplankton collection method example…

- Quantitative
  - USGS-NAWQA – 1 liter depth and width integrated sample

Common indicators of condition parallel to those listed for benthic algae (periphyton)



Typical Field and Laboratory Processing of Samples…

- ID/Enumeration samples
  - 1000 ml subsample
  - Preserved w/ formalin (4-5% final concentration)
- Chlorophyll & Biomass samples
  - Filtered aliquot (volume varies)
  - Stored on dry ice or in portable freezer

The Top Eleven Worst Algae Jokes... *Ever*

#11. What do the mothers of blue-green algae hope for?

That their daughter cells will grow up and marry pond scum.

#10. What kind of algae most often joins the military?

Fighter-planktons.

#9. What is the most common form of algae transportation?

A nitrogyn cycle.

#8. Why did the algae fail math?

He divided when multiplying.

The Top Eleven Worst Algae Jokes... *Ever* (continued)

#7. Why did the algae get pulled over on his way to the pond?

He was chloro-plastered.

#6. What do they sell at the Red Tide lingerie shop?

Algae bloomers.

#5. What happened when the fungus met the algae?

He took a lichen to her.

#4. Why couldn't the algae keep a girlfriend?

He wasn't a fungi.

The Top Eleven Worst Algae Jokes... *Ever* (continued)

#3. What do you call a filamentous algae sandwich?

A spiro-gyro.

#2. What did they call the guy who beat Fred and Wilma's pet?

A dino-flagellate.

<u>And the absolute worst algae joke ever</u>

#1. Why do many algae couples drift apart?

They prefer planktonic relationships.

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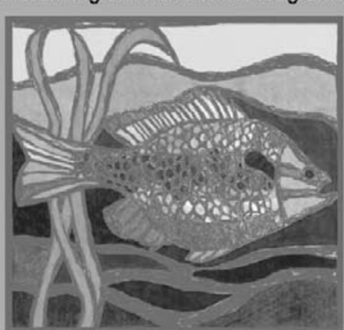


Coeur d'Alene, Idaho

31 March – 4 April, 2003

LR 101

Section 5: Logistics & Safety on Large Rivers

Presented by

Joseph E. Flotemersch, USEPA, Office of Research & Development

Logistics & Safety

General Field Safety

- Heavy equipment
  - Ask for help
  - Lift properly
  - Watch for others
  - Keep equipment balanced in the boat

Transportation of Equipment

to, in, and along the river

can present a substantial logistical challenge and safety hazard

General Field Safety

- Field attire
  - If hot
    - Protect from sun, dehydration, and heat exhaustion
    - No open-toed shoes
    - Choose long pants over shorts
    - If wading is required, consider waders
  - If cold
    - Protect from hypothermia and frost bite

General Field Safety

- Eye protection
  - UV rays, abrasions, chemical hazards, polarized
- Hearing protection
  - Chronic Exposure
    - Boat motors, generators
- Communication
  - 2-way among crew, cell phones
- Electrical Shock

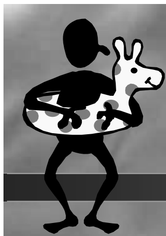
Electrofishing is inherently "dangerous"!
Secure proper training and <u>follow and enforce</u> safety precautions.

Chemical Safety

- Formalin
- Ethanol
- Gasoline
  - Explosion hazard
- Liquid nitrogen
- Material Safety Data Sheets

Safety on the Road

- Wear safety belts
- Consider defensive driving course
- Hauling equipment and towing a boat
  - Inspect hitch and trailer daily
  - Do not exceed capacity of truck or trailer
  - Reduce driving speeds
  - Check tie-downs



Safety on the Water

- Boating safety
  - rules and regulations
  - be familiar with hazards
  - redundant training
  - don't overload the boat
  - maintain equipment
  - required equipment
  - training, training, training

Safety on the Water - Training

- Operation of watercraft
- Maintenance of watrcraft
- Safety training
  - Drowning
  - Storms
  - Boat rescues
- CPR
  - Heimlich maneuver
- First Aid
  - Cuts and bleeding
  - Bruises
  - Puncture wounds
  - Heat emergencies
    - Heat cramps
    - Heat exhaustion
    - Heat stroke
  - Hypothermia
  - Frost bite