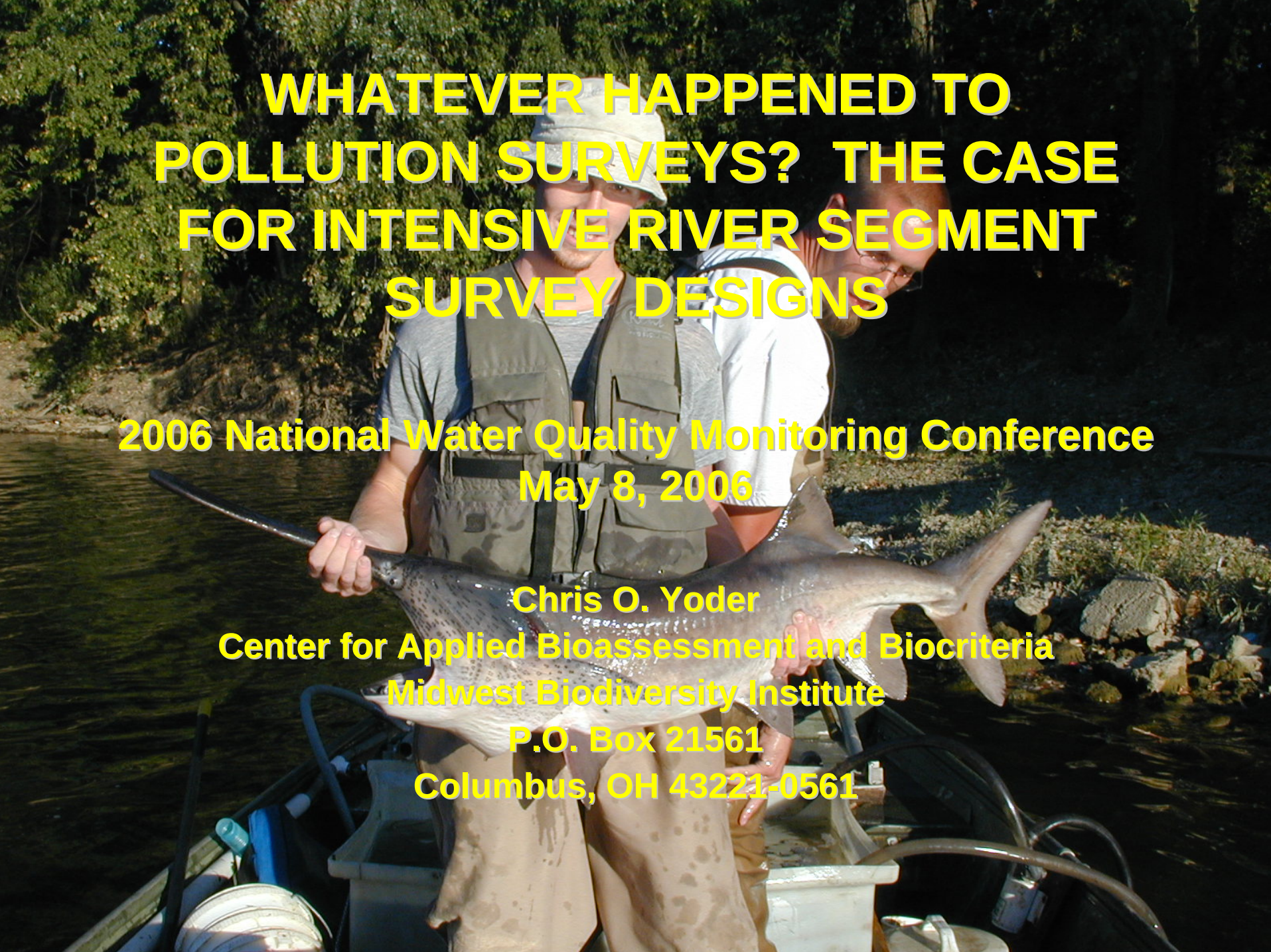


WHATEVER HAPPENED TO POLLUTION SURVEYS? THE CASE FOR INTENSIVE RIVER SEGMENT SURVEY DESIGNS

2006 National Water Quality Monitoring Conference
May 8, 2006

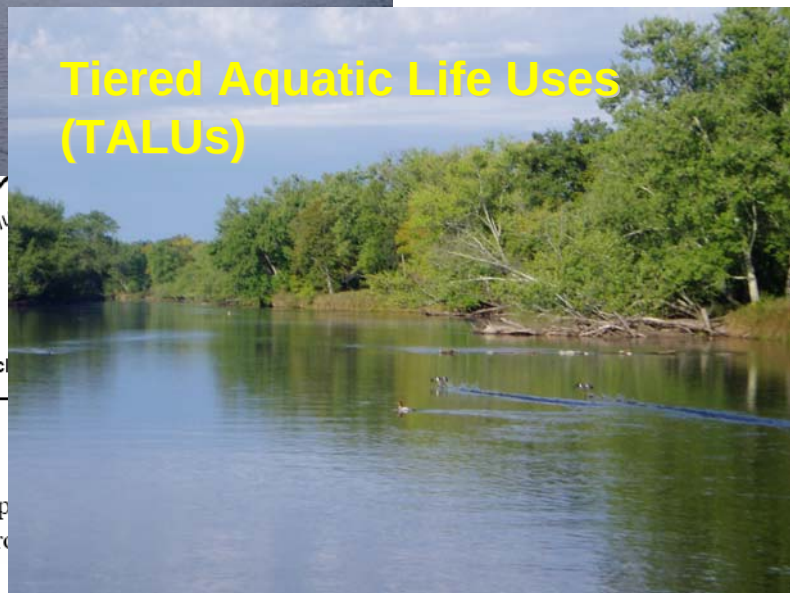
Chris O. Yoder
Center for Applied Bioassessment and Biocriteria
Midwest Biodiversity Institute
P.O. Box 21561
Columbus, OH 43221-0561

Background

- Concept applies to mainstem streams and rivers – many will be non-wadeable.
- Survey design – many choices, influenced by M&A objectives.
- States and regional entities – multiple management objectives are “inherent”.
- Also incorporates concepts of the EPA TALU approach – linkage of M&A with WQS.

What is a Pollution Survey?

- Targeted, stratified, & intensive site selection.
- Develop a “response profile” along a mainstem.
- Proximal analysis of biological response - determine ***severity and extent*** of impairments in spatial relation to sources & their make-up.
- Supports multiple water quality & resource management objectives – ***monitoring design matches the scale of management interest.***



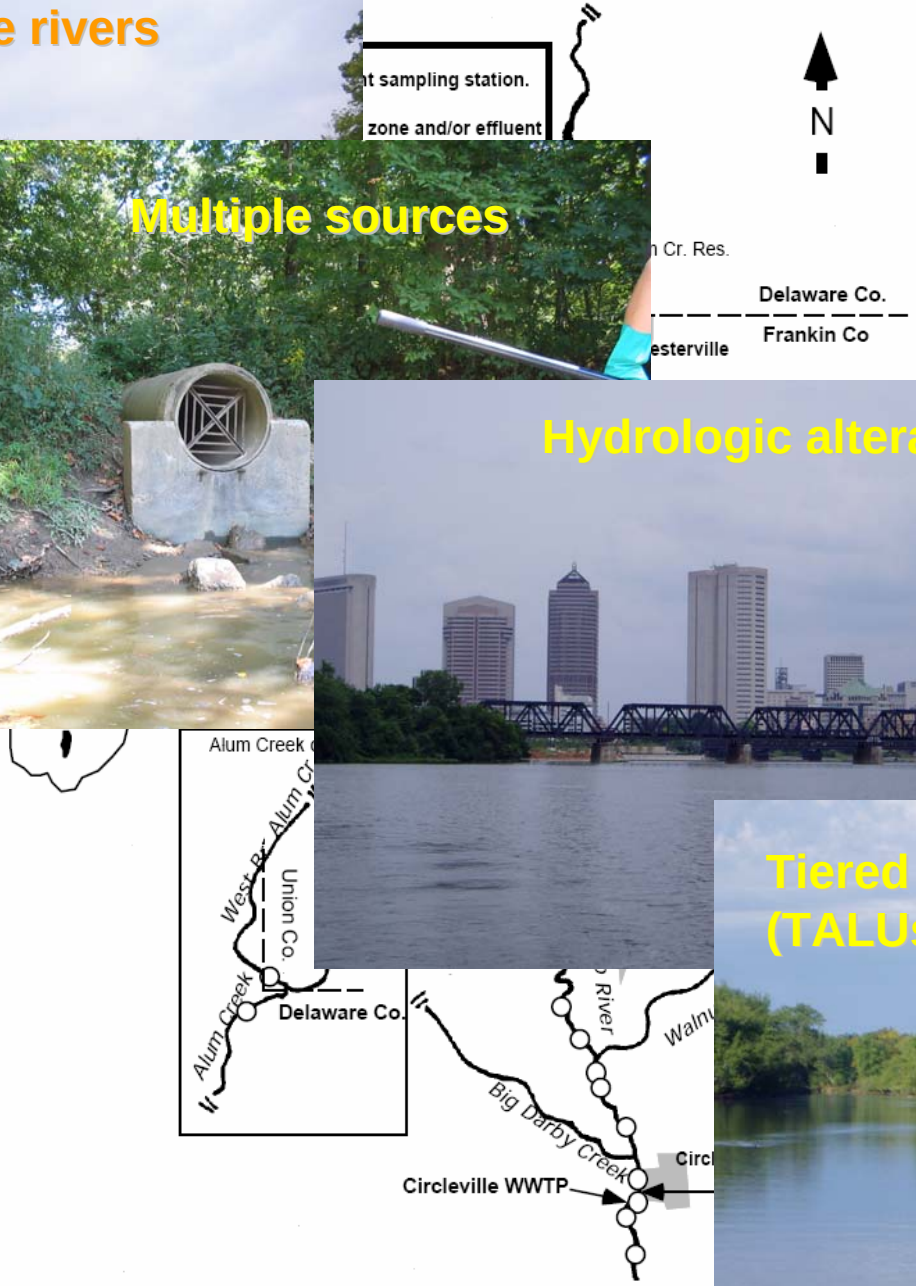
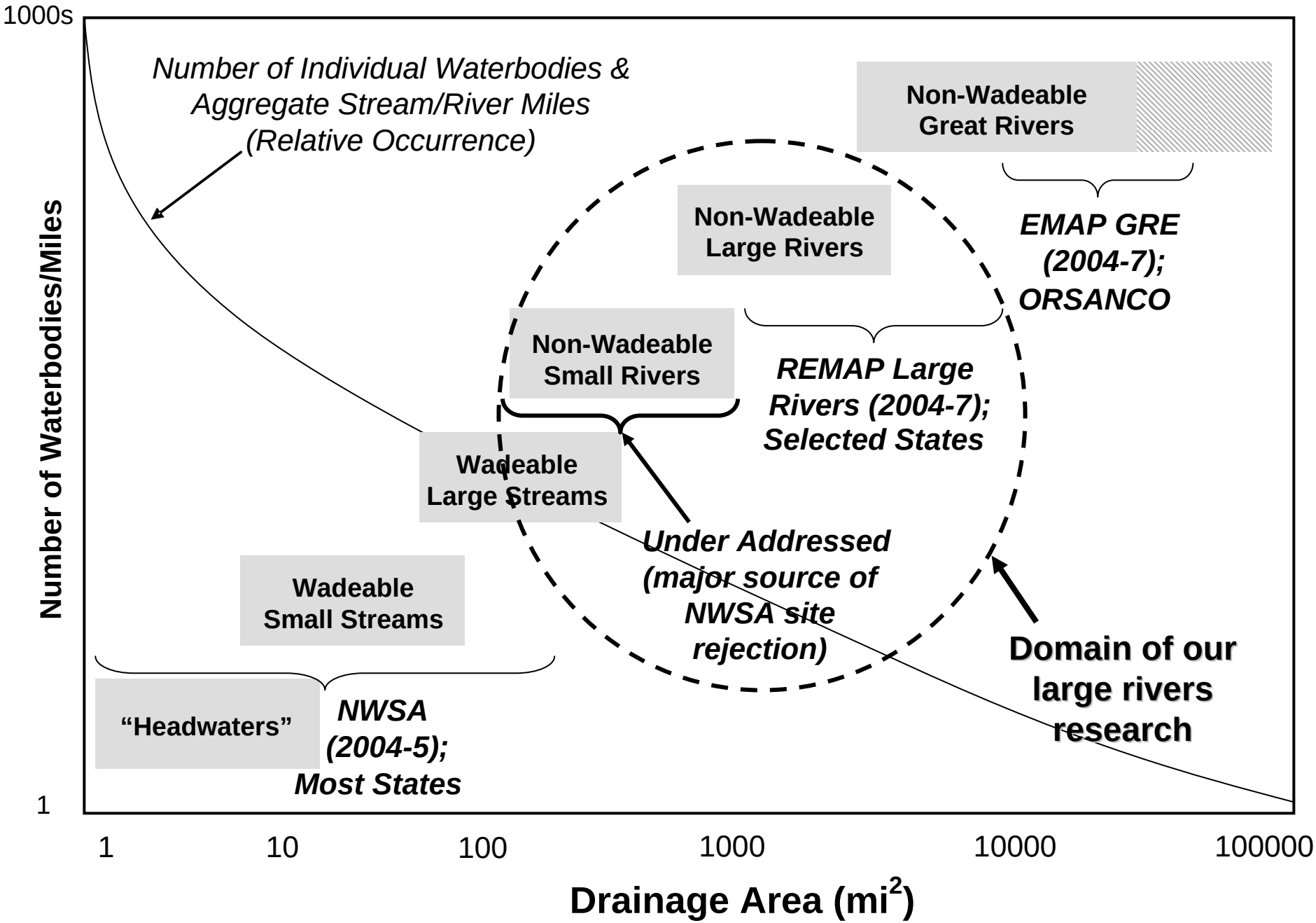


Figure 4.. The 1996 middle Scioto River study area showing p
population centers, major pollution sources and envir

Four Projects beginning in 2004:

1. Fish assemblage methods comparison – direct field comparison with State, Municipal, and other orgs. – *bioassessment comparability.*
2. REMAP Large Rivers – eleven large river tribs. to Upper Miss. & Ohio R. (5 states) – *probability design.*
3. Application of EPA TALU concepts to non-wadeable rivers – *targeted sampling of specific reaches.*
4. Wadeable to non-wadeable transition highlighted by WSA – *mix of targeted & probabilitic designs.*


1000s
1
Number of Individual Waterbodies & Aggregate Stream/River Miles (Relative Occurrence)
Number of Waterbodies/Miles
Non-Wadeable Great Rivers
Non-Wadeable Large Rivers
EMAP GRE (2004-7); ORSANCO
Non-Wadeable Small Rivers
REMAP Large Rivers (2004-7); Selected States
Wadeable Large Streams
Under Addressed (major source of NWSA site rejection)
Wadeable Small Streams
Domain of our large rivers research
"Headwaters"
NWSA (2004-5); Most States
1
10
100
1000
10000
100000
Drainage Area (mi2)

Issues of Large River Bioassessment

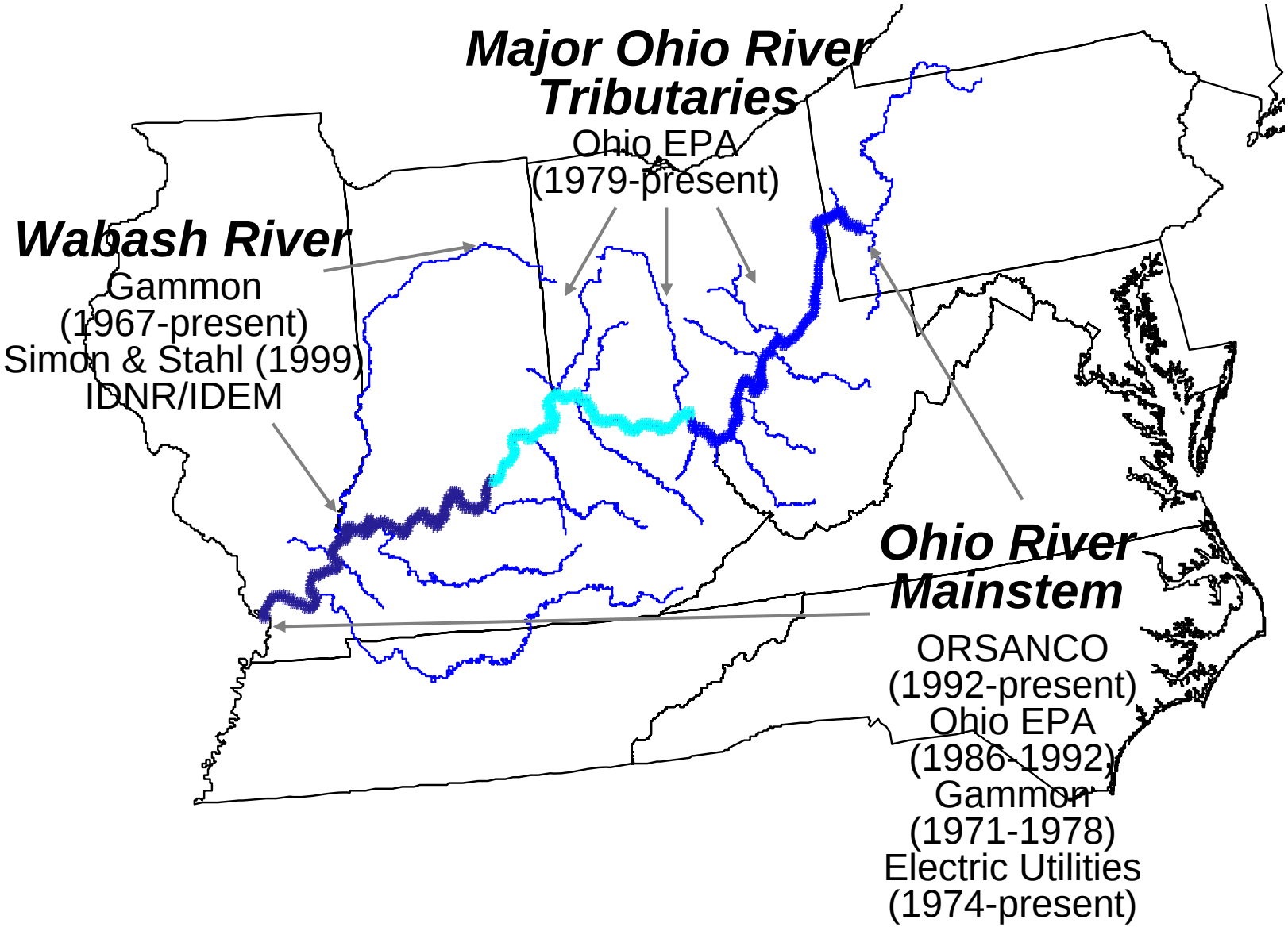
Common Perceptions:

- **Difficulties with sampling and assessment.**
- **Guidance is lacking or difficult to find.**
- **Logistical challenges are “daunting”.**

Current Status:

- **Methods and designs are available.**
- **Long-standing programs and approaches.**
- **Logistics are surmountable.**

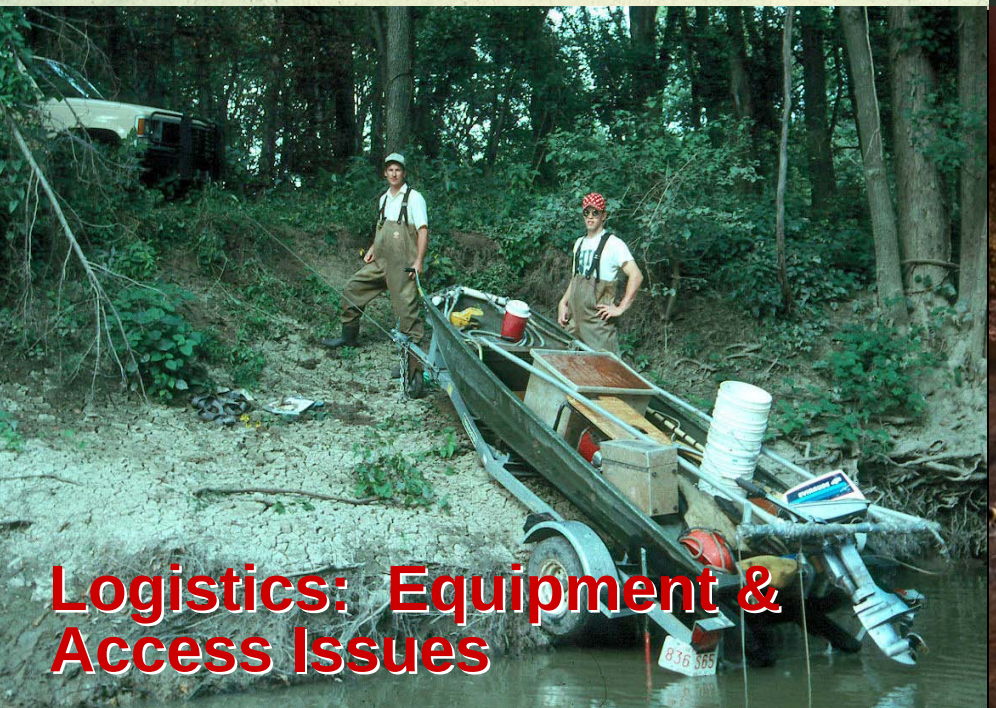
Fish Assemblage Assessments of Large and Great Rivers in the Upper Ohio Basin



Ohio EPA Non-Wadeable Methods

Electrofishing Gear Array: Wadeable to Non-Wadeable

Effort: Distance Sampled



Logistics: Equipment & Access Issues

Multiple Habitats Sampled

ELECTROFISHING METHODS

The concern is about the comparability *and* accuracy of the resulting assessment of environmental quality that are produced by the States and others – methods and the execution of the sampling is the genesis of some largely unrealized problems.

Wiscon

One mile
3000 W,
motor in

e
r (1/4”
on

Ohio

500m of shoreline; daytime sampling; 5000 W, 120 Hz; 1 netter (1/4” mesh); motor in downstream direction

ORSANCO (Ohio R.)

500m of shoreline; nighttime sampling; 5000 W, 120 Hz; 1 netter (1/4” mesh); motor in downstream direction

Biological Criteria

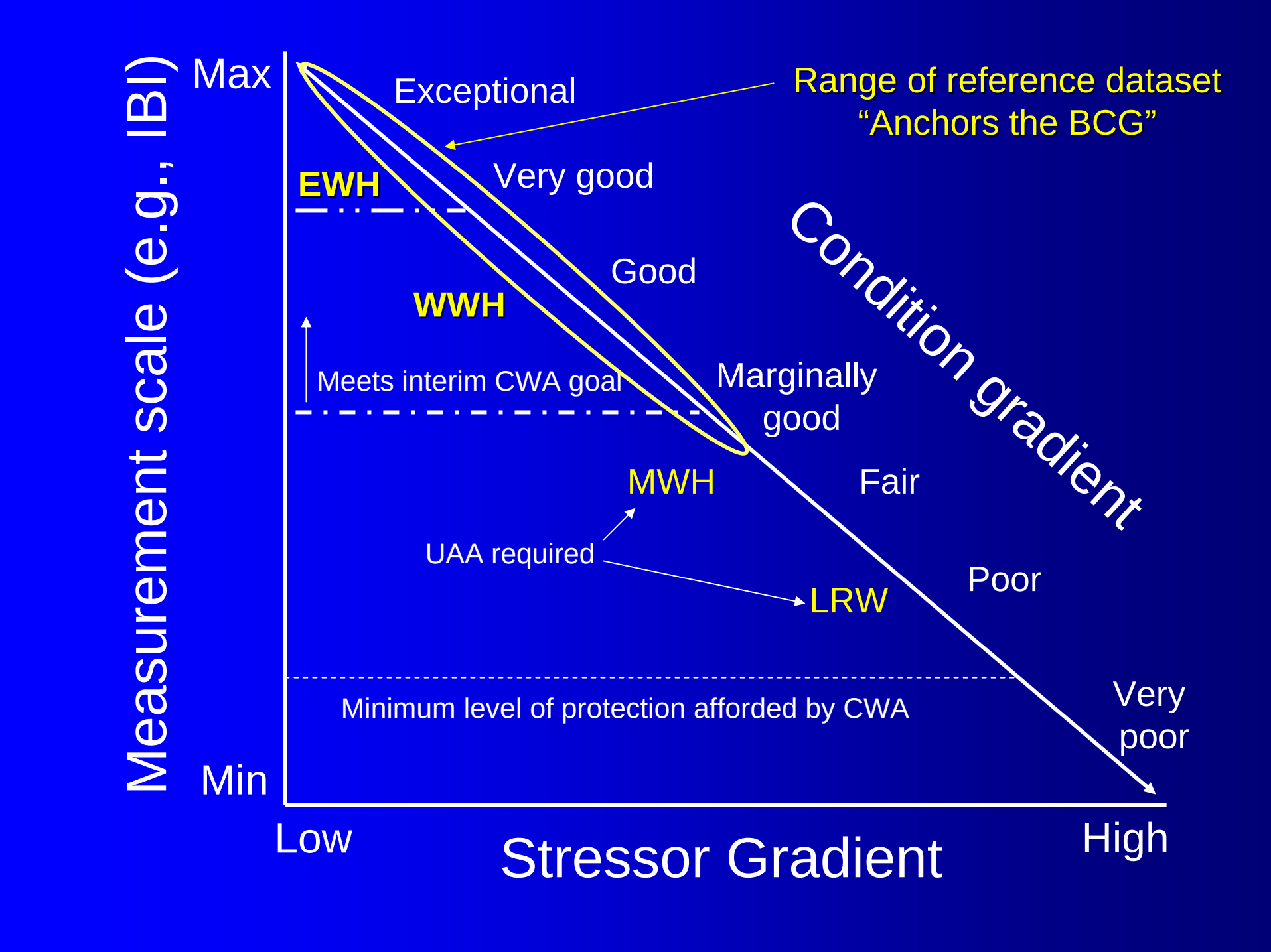
- **Numeric and narrative rating of a biological sample collected at a single site that supports assessment at multiple scales.**
- **Biocriteria are indexed to a reference assemblage within a geographical region and with respect to strata such as watershed size, temperature, ecotype, etc.**
- **Biocriteria represent a calibrated assessment tool that can foster an organized approach to goal setting in an effort to reconcile human impacts *and guide restoration efforts.***

United States
Environmental Protection
Agency

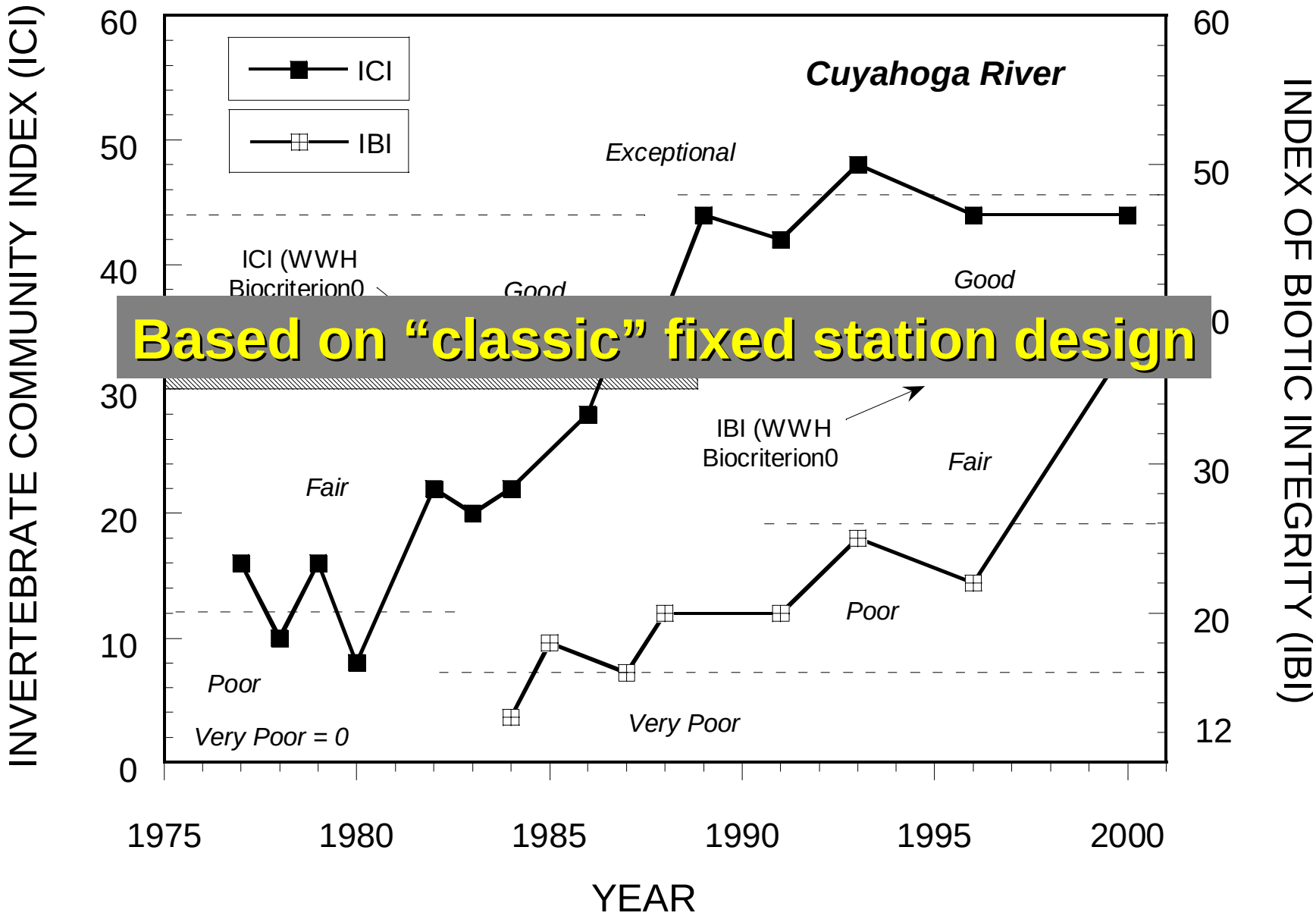
Use of Biological Information to Tier Designated Aquatic Life Uses in State and Tribal Water Quality Standards

August 2005

REVIEW DRAFT


Measurement scale (e.g., IBI)
Max
Min
Exceptional
Range of reference dataset
"Anchors the BCG"
Very good
EWH
Good
WWH
Condition gradient
Meets interim CWA goal
Marginally
good
MWH
Fair
UAA required
LRW
Poor
Minimum level of protection afforded by CWA
Very
poor
Low
Stressor Gradient
High

Hillside Road (RM 15.6) Fish and Macroinvertebrate Trends



Based on "classic" fixed station design

Mission Accomplished? Declarations of "total victory" – are they premature?

Domestic Wastewater

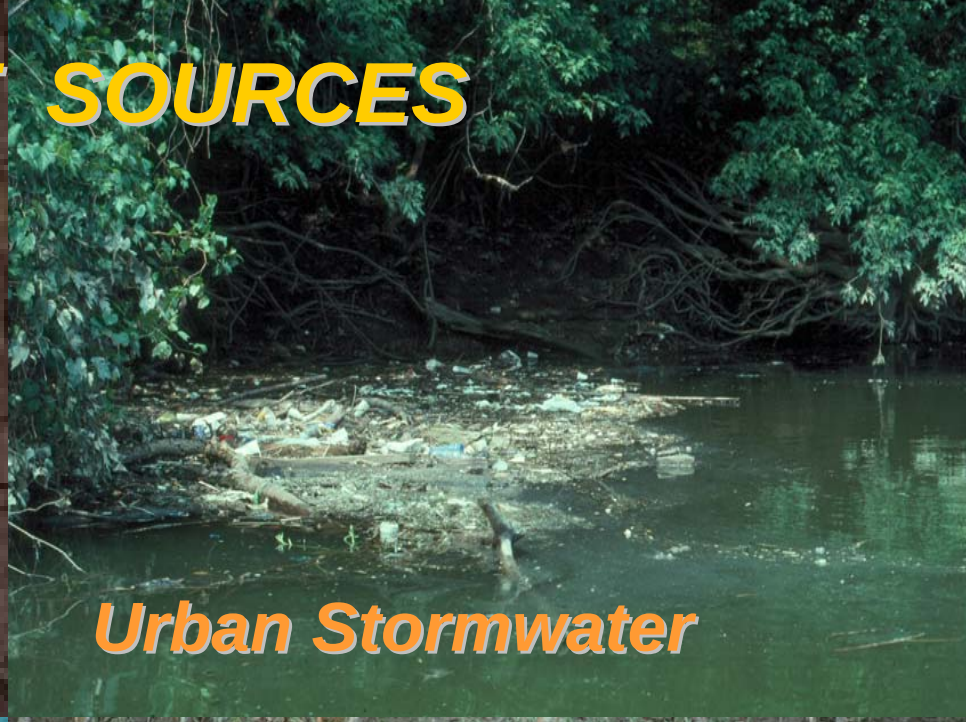
Industrial Wastewater

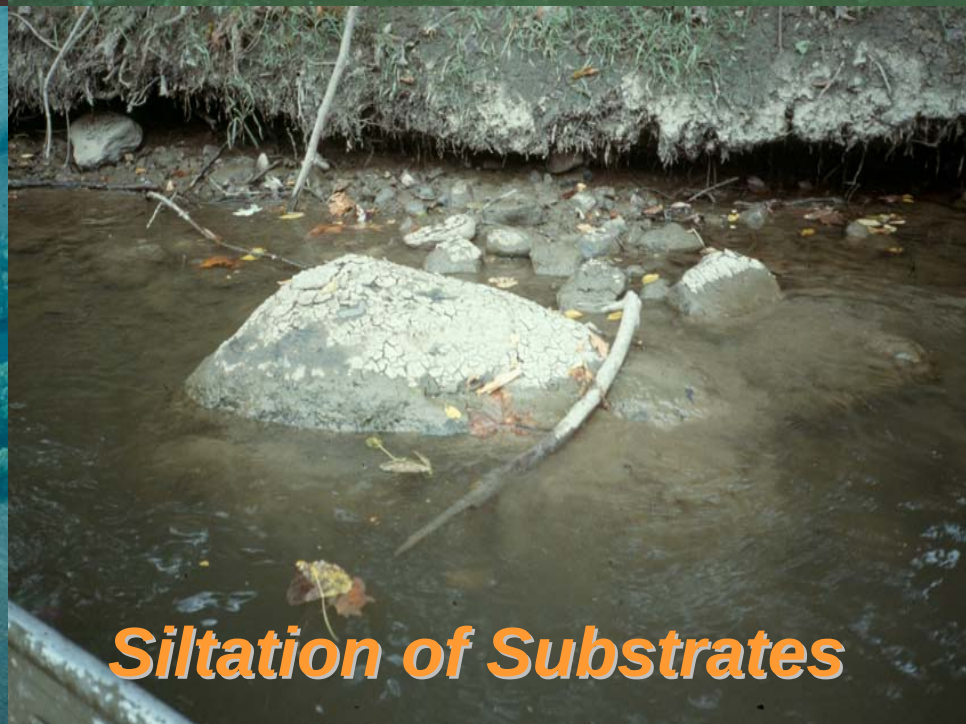
Many large rivers are effluent dominated by treated sewage flows – growth pressures are taxing existing infrastructure and assimilative capacity

Multiple, Interactive Sources

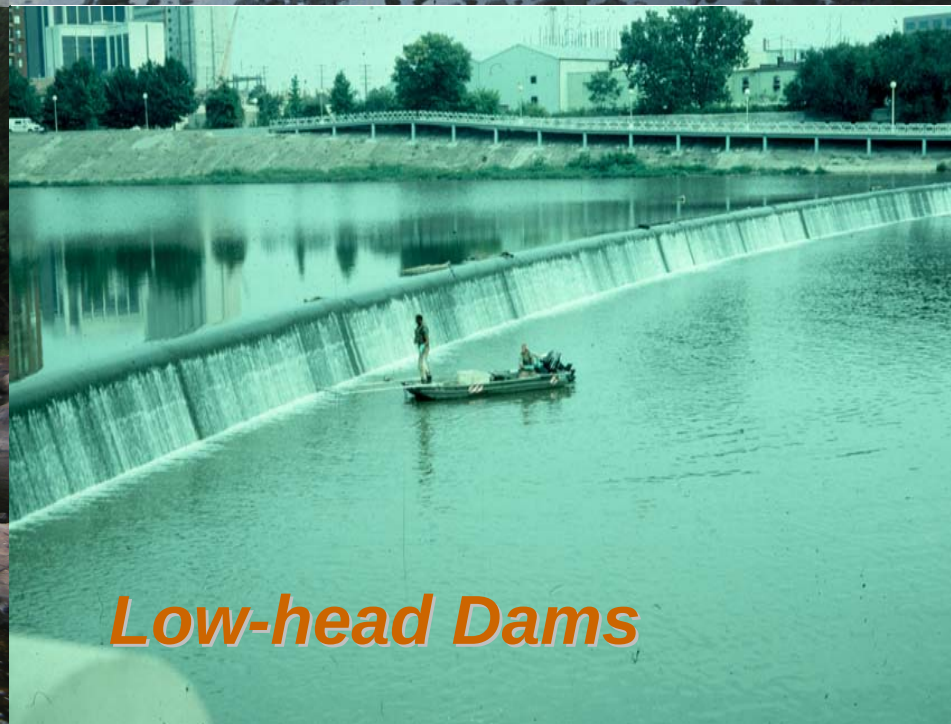
Acute/Chronic Effects

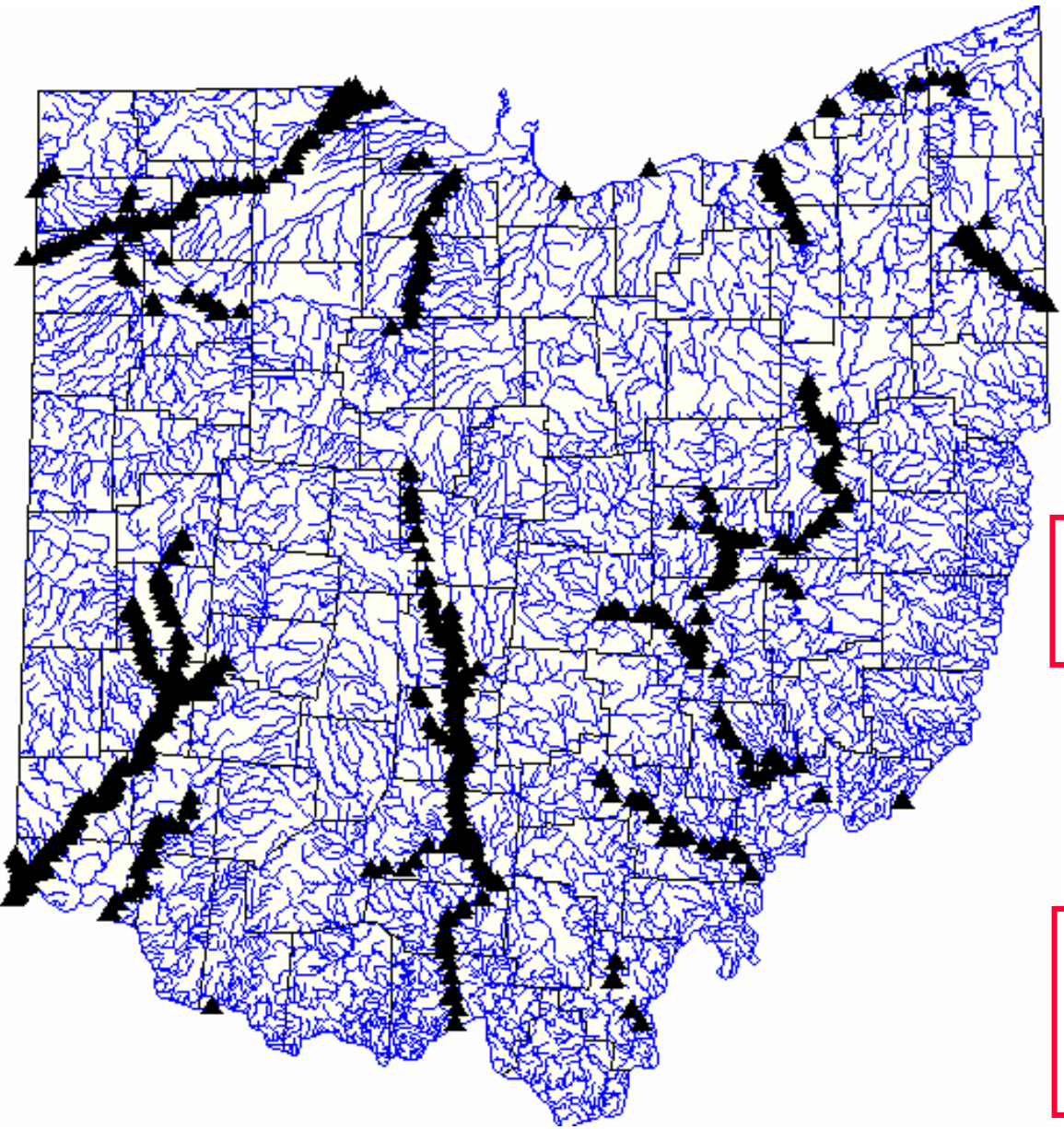
NONPOINT SOURCES





HYDROMODIFICATION





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 (>150-500 mi.^{2})

American Fisheries Society Symposium 45:000–000, 2005
© 2005 by the American Fisheries Society

Changes in Fish Assemblage Status in Ohio's Nonwadeable Rivers and Streams over Two Decades

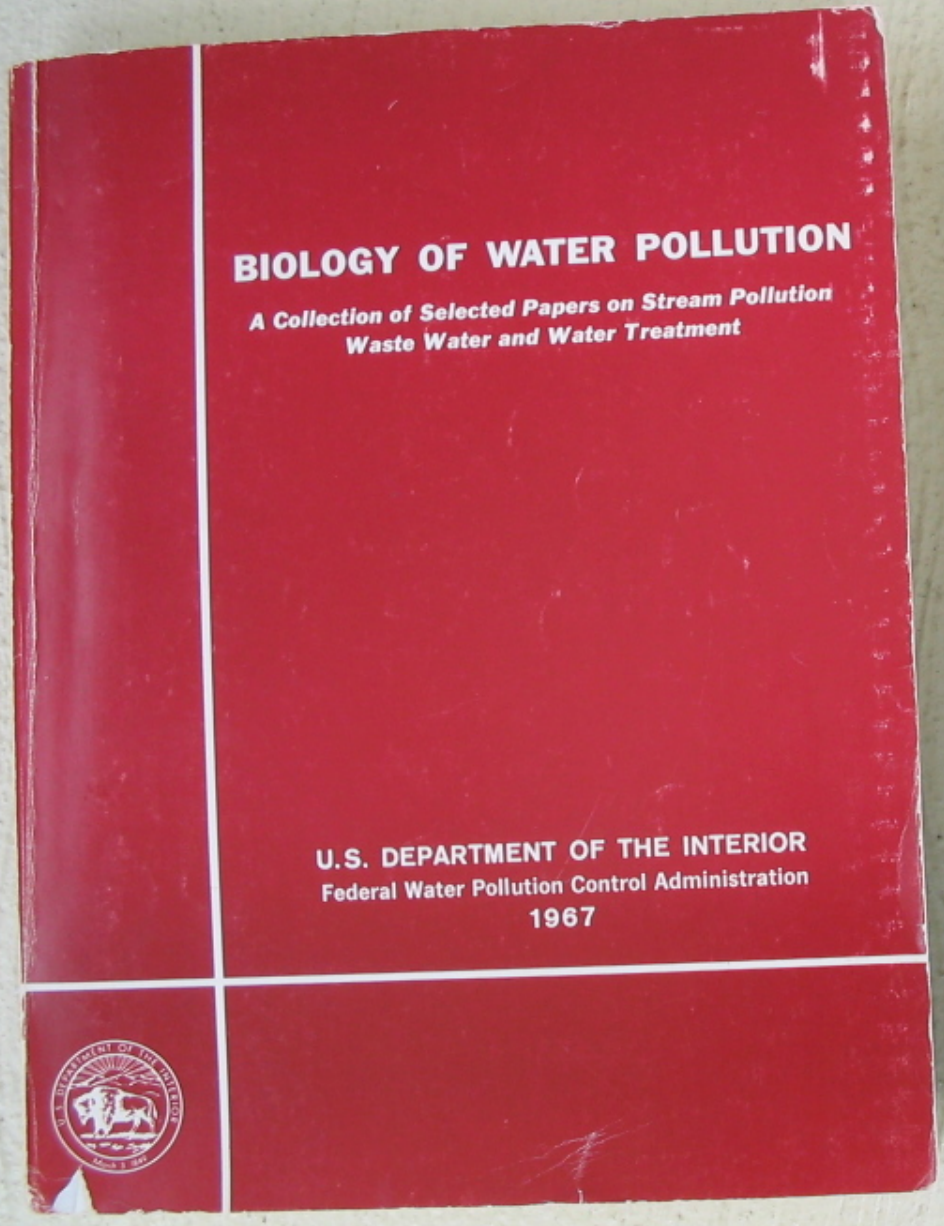
CHRIS O. YODER[1] AND EDWARD T. RANKIN

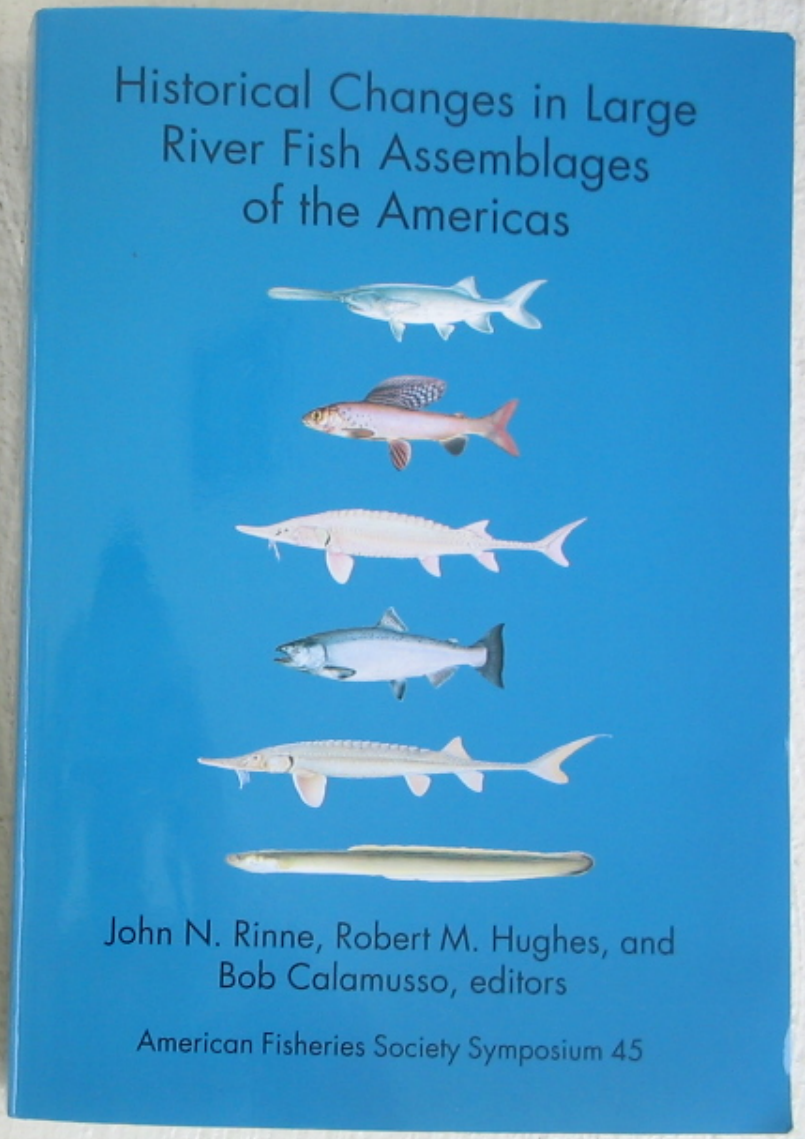
Midwest Biodiversity Institute and Center for Applied Bioassessment and Biocriteria
Post Office Box 21561, Columbus, Ohio 43221–0561, USA

MARC A. SMITH, BRIAN C. ALSDORF, DAVID J. ALTFATER, CHARLES E. BOUCHER, ROBERT J. MILTNER, DENNIS E. MISHNE, RANDALL E. SANDERS, AND ROGER F. THOMA

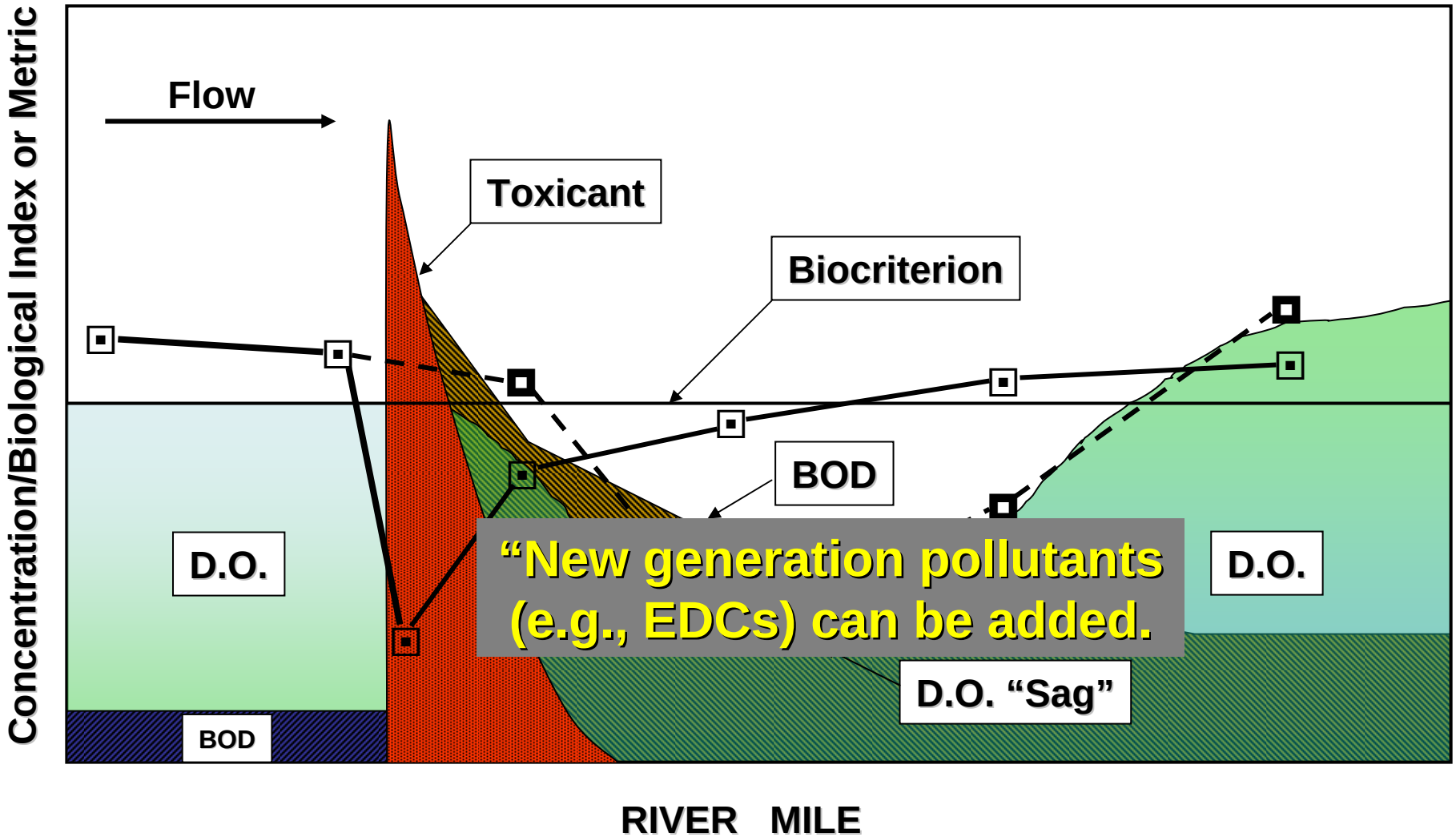
Ohio Environmental Protection Agency, 4675 Homer Ohio Lane, Groveport, Ohio 43125, USA

Abstract.—A systematic, standardized approach to monitor fish assemblages has been applied in Ohio's rivers since 1979. A primary objective is the assessment of changes in response to water pollution abatement and other water quality management programs. All major, nonwadeable rivers were intensively sampled using standardized electrofishing methods and a summer–early fall index period. Most rivers were sampled two or three times, before and after implementation of pollution controls at major point source discharges and best management practices for nonpoint sources. A modified and calibrated index of biotic integrity (IBI) was used to demonstrate and evaluate changes at multiple


BIOLOGY OF WATER POLLUTION
A Collection of Selected Papers on Stream Pollution
Waste Water and Water Treatment
U.S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
1967


Historical Changes in Large
River Fish Assemblages
of the Americas
John N. Rinne, Robert M. Hughes, and
Bob Calamusso, editors
American Fisheries Society Symposium 45

Recalling the Concept of the Pollution Impact Continuum in Rivers: It Still Exists



After Bartsch and Ingram (1967)

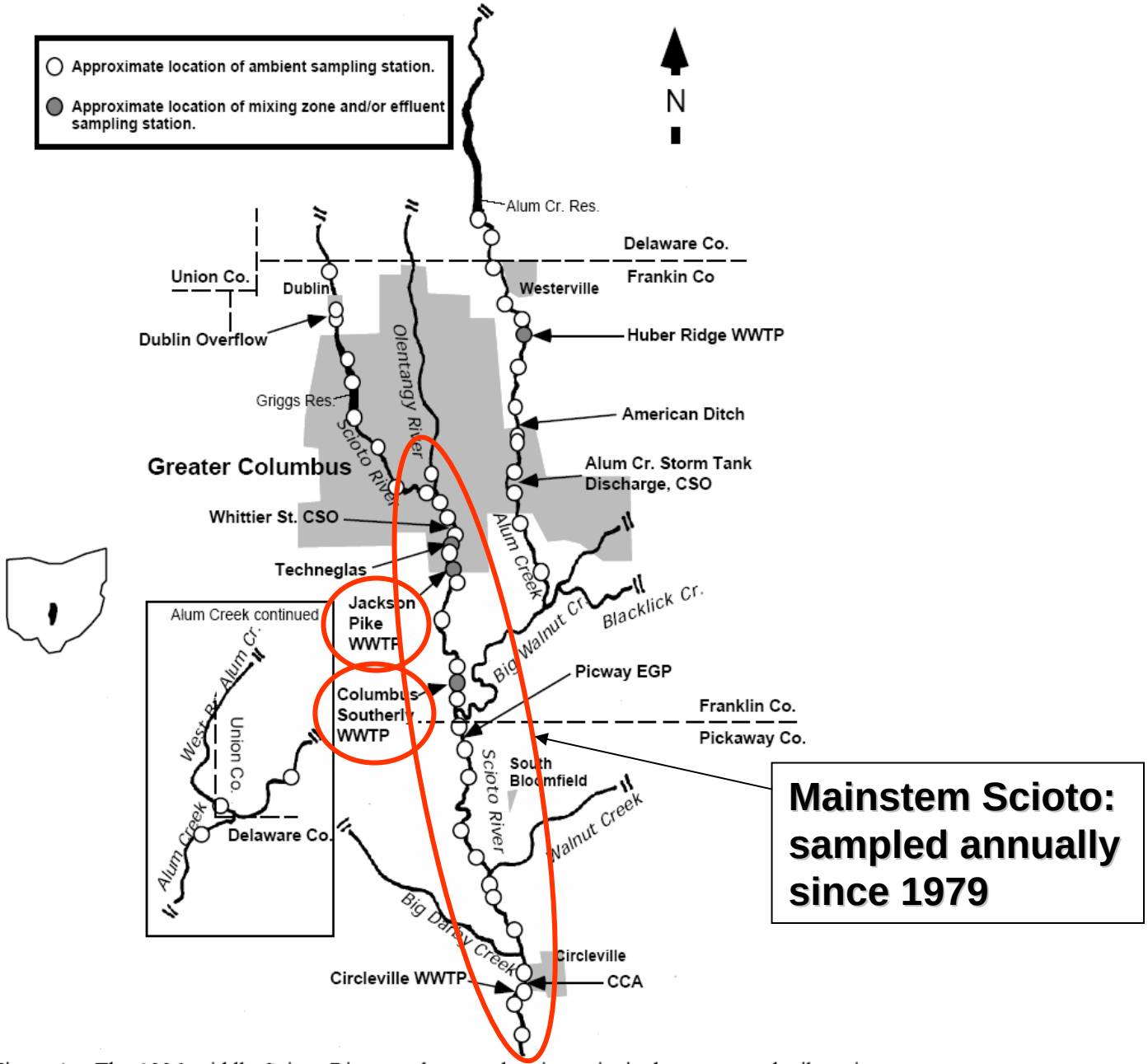
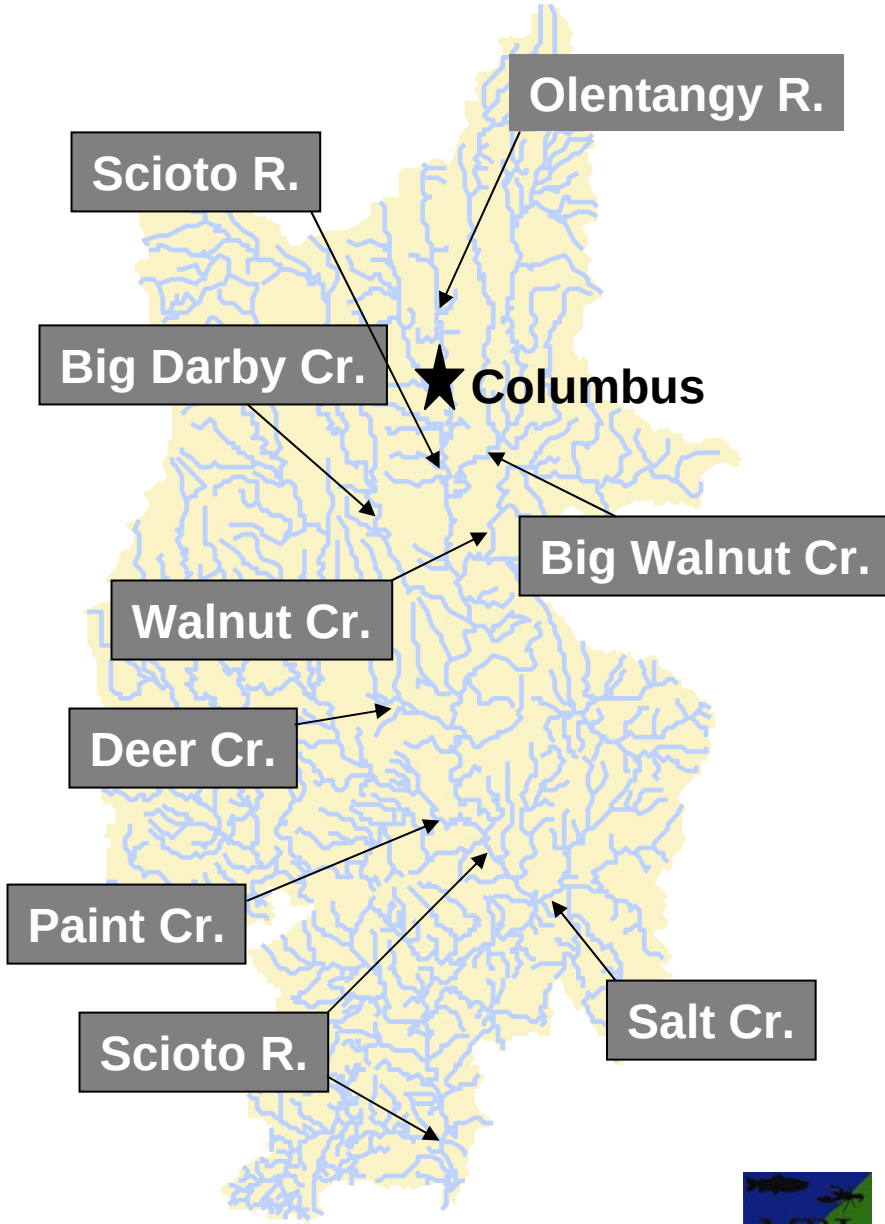


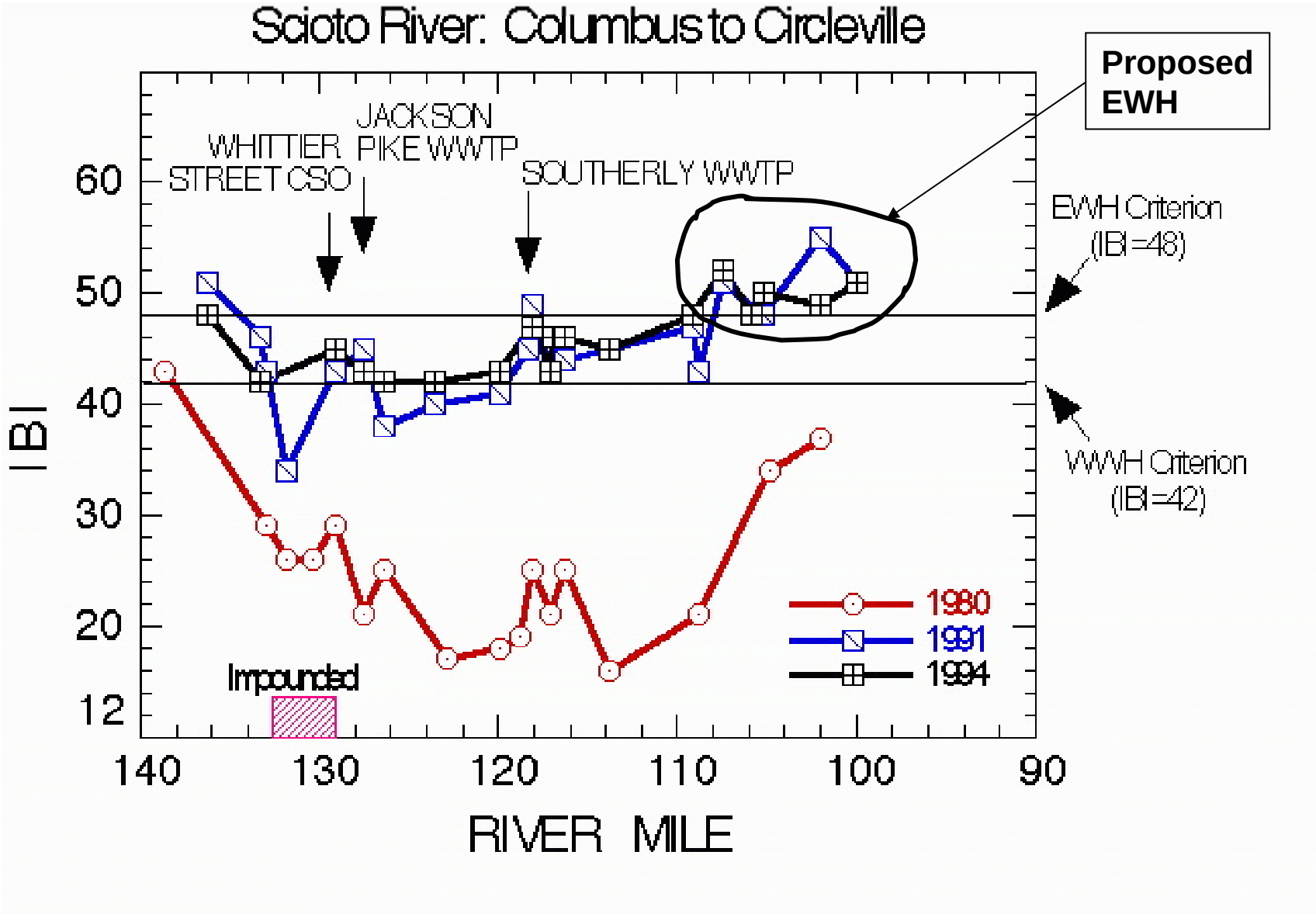
Figure 4.. The 1996 middle Scioto River study area showing principal streams and tributaries, population centers, major pollution sources and environmental monitoring stations.

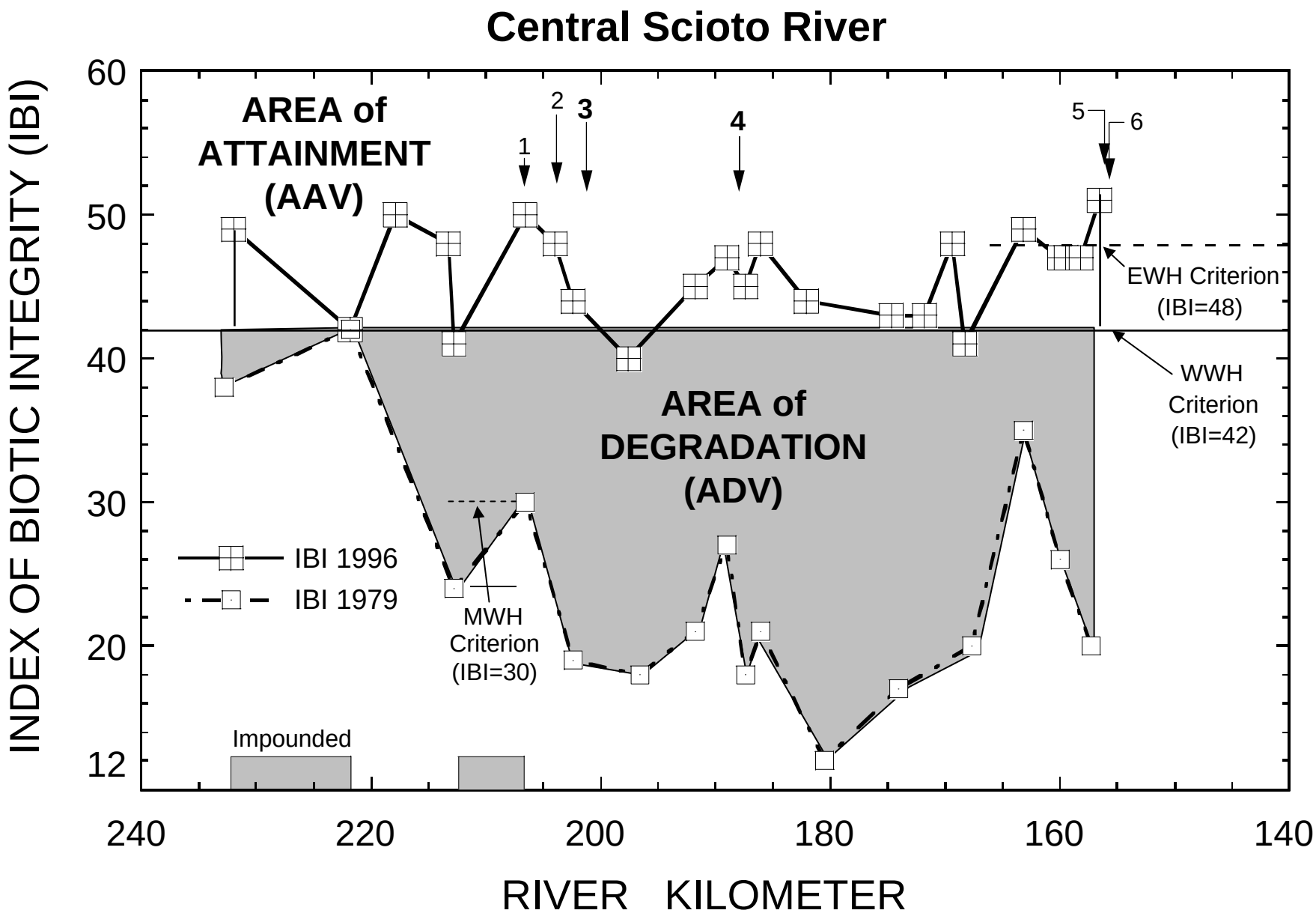
Scioto River History

- Historic occurrence of 115+ fish species in the mainstem and major tributaries.
- Major post-glacial route of ingress
- Free-flowing in lower 130 miles – unique for a Midwestern mainstem river
- Gross sewage pollution from cities and industries since late 19th century
- $Millions$ spent in 1970s and 1980s on point sources to meet CWA mandated goals – <u>serious doubts in 1970s about the attainability of these goals with effluent dominated sewage flows</u>
- Success of pollution controls documented by systematic biological monitoring (1979 – present).

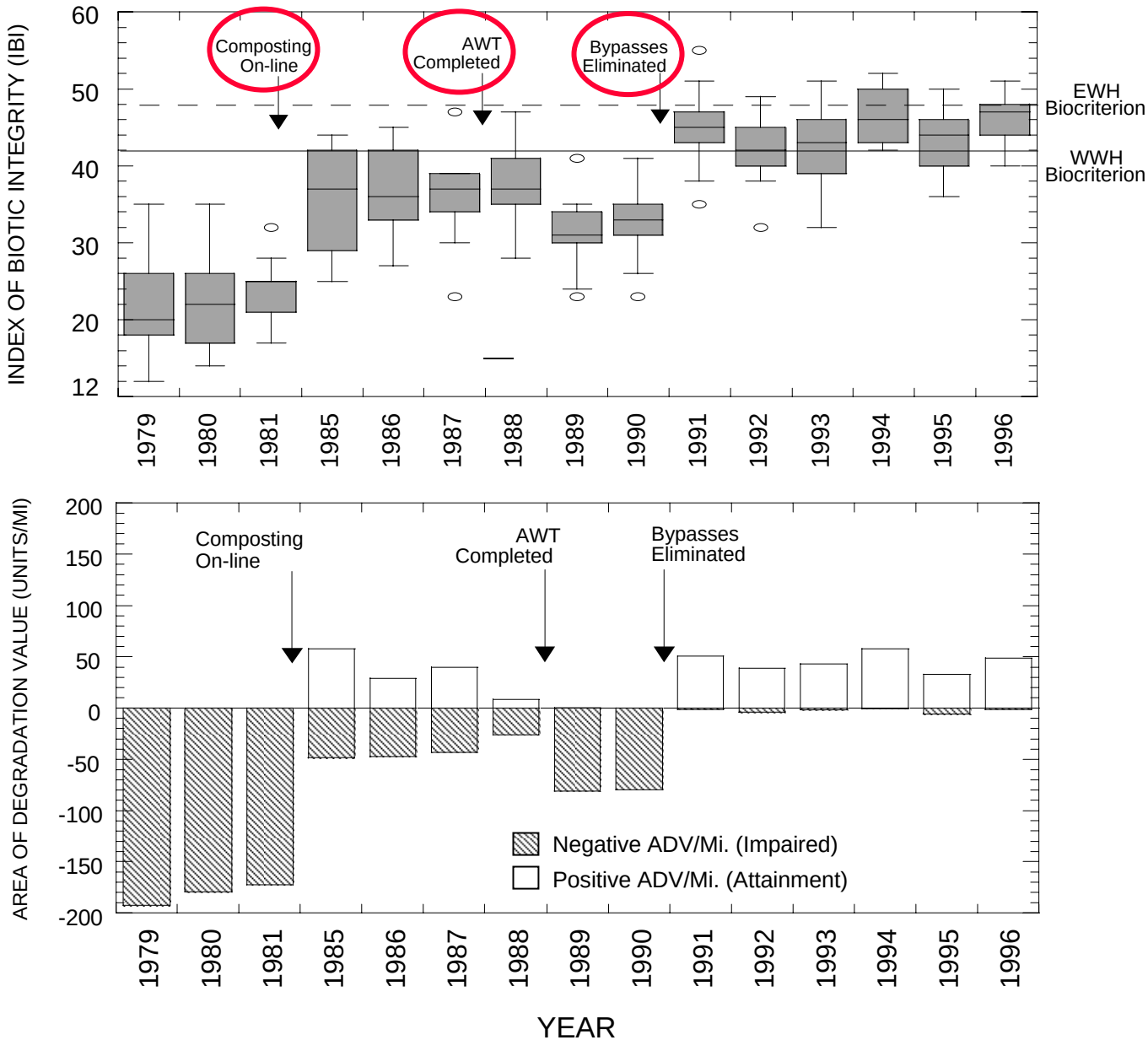


Demonstrating Changes Through Time: Scioto River 1980 - 1994

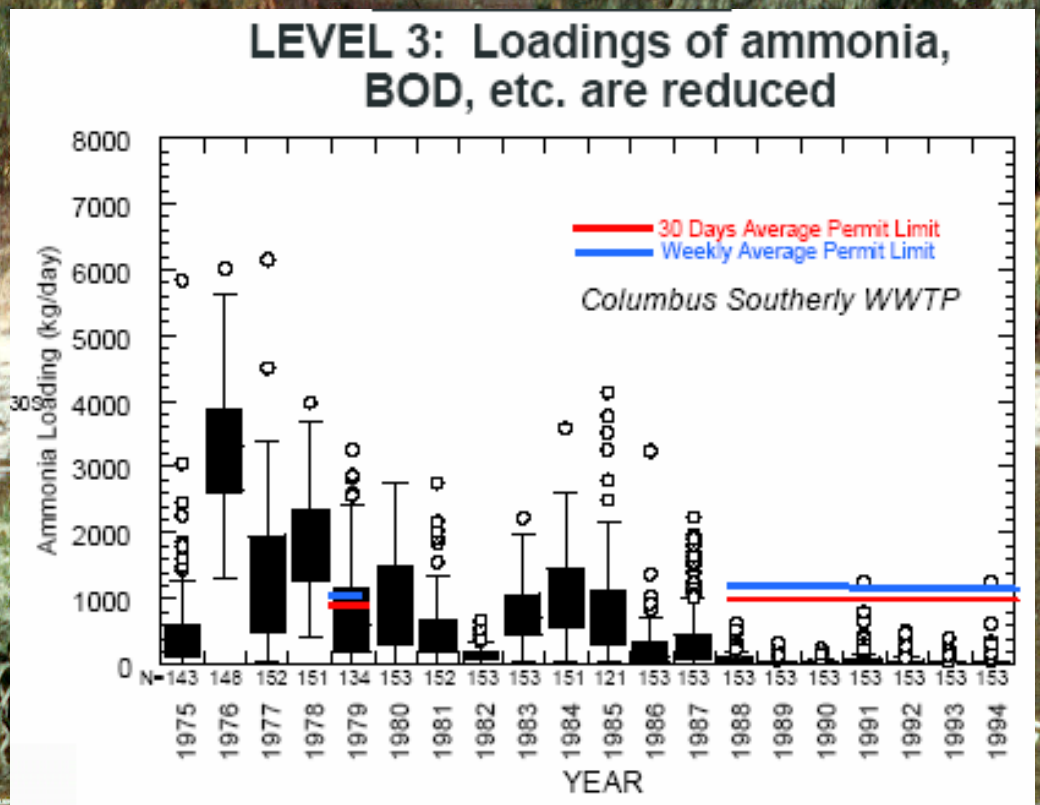



Central Scioto River
AREA of ATTAINMENT (AAV)
AREA of DEGRADATION (ADV)
1
2
3
4
5
6
EWH Criterion (IBI=48)
WWH Criterion (IBI=42)
MWH Criterion (IBI=30)
IBI 1996
IBI 1979
Impounded
INDEX OF BIOTIC INTEGRITY (IBI)
60
50
40
30
20
12
240
220
200
180
160
140
RIVER KILOMETER

Demonstrating Changes Through Time: Scioto River (1979 – 1996)



Jackson Pike WWTP – 75 MGD
Columbus Southerly WWTP – 125 MGD
Combined 200 MGD = 90-95% of summer base flow



Application of Biocriteria in Complex Settings

1. Free-flowing river (**WWH** use designation):
Upstream from urban area ECBP Ecoregion - Wading site type:

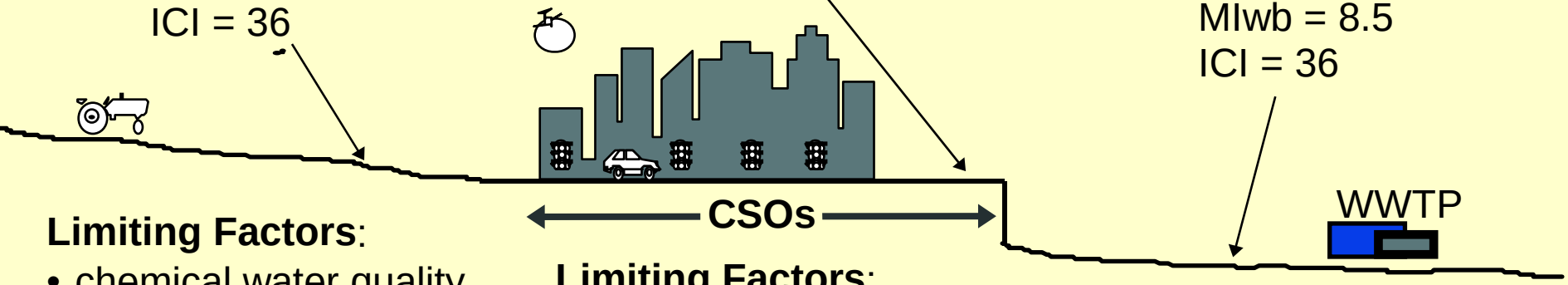
IBI = 40
MIwb = 8.3
ICI = 36

2. Impounded river (**MWH** use designation):
Within urban area ECBP Ecoregion - Boat site type:

IBI = 30
MIwb = 6.6
ICI = N/A

3. Free-flowing river (**WWH** use designation):
Downstream from urban area
ECBP Ecoregion - Boat site type:

IBI = 42
MIwb = 8.5
ICI = 36



Limiting Factors:
- chemical water quality
- physical habitat
- flow/energy dynamics

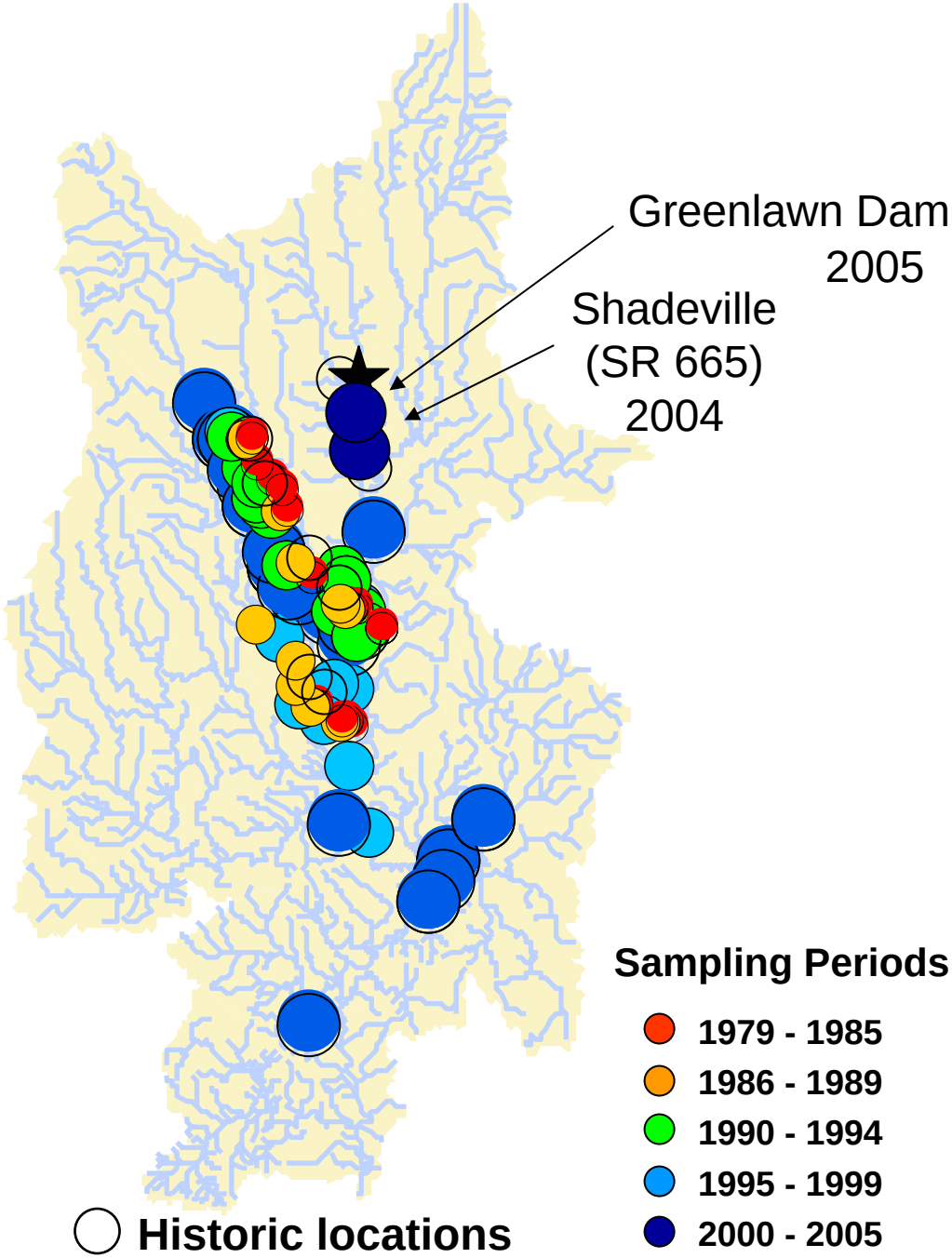
Limiting Factors:
- physical habitat
- energy/flow dynamics
- chemical water quality

Limiting Factors:
- chemical water quality
- energy/flow dynamics
- physical habitat

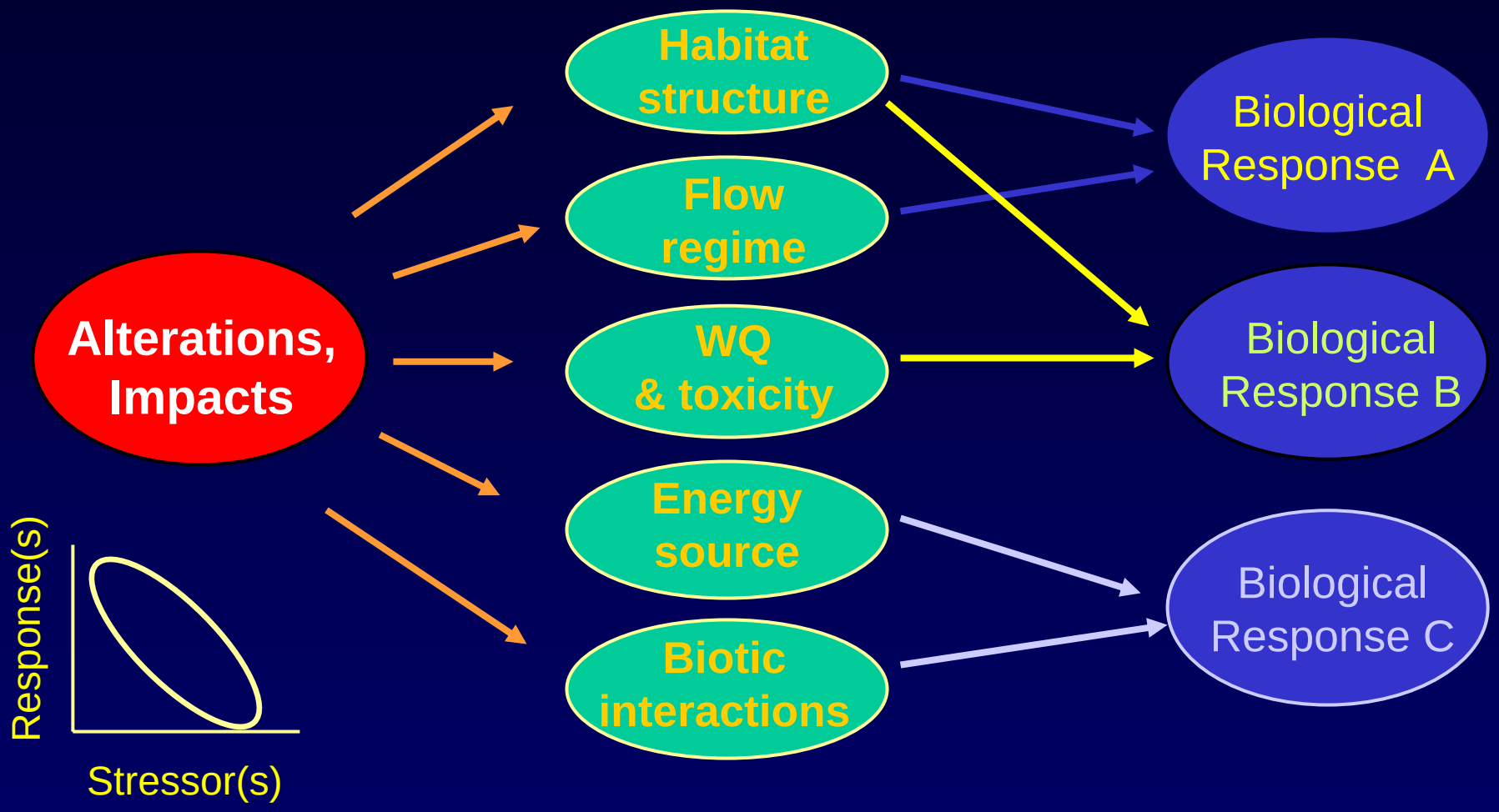
Flow Direction →

Tippecanoe darter
(Etheostoma tippecanoe)

- Ohio threatened species (ODOW)
- Ohio declining species (OEPA)
- Highly intolerant (OEPA)
- Found mostly in Big Darby and Deer Creek pre-1990s



Linking Biological Responses to Stressors



Human activity: "the drivers" → **Altered water resource features "stress & exposure"** → **Biological endpoint**

Measuring and Managing Environmental Progress: Hierarchy of Indicators

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 habitat, nutrient dynamics changes, sedimentation effects, etc.]

6. Biological response

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

Endpoint of Concern: "ecological health"

Good quality biological data *and a process for using it* is essential for improving the management of aquatic resources and bringing policy and legislation into the 21st Century