US EPA ARCHIVE DOCUMENT

An Overview of Fish Assemblage Assessments in Great and Large Rivers of the Upper Mississippi and Ohio River Basins

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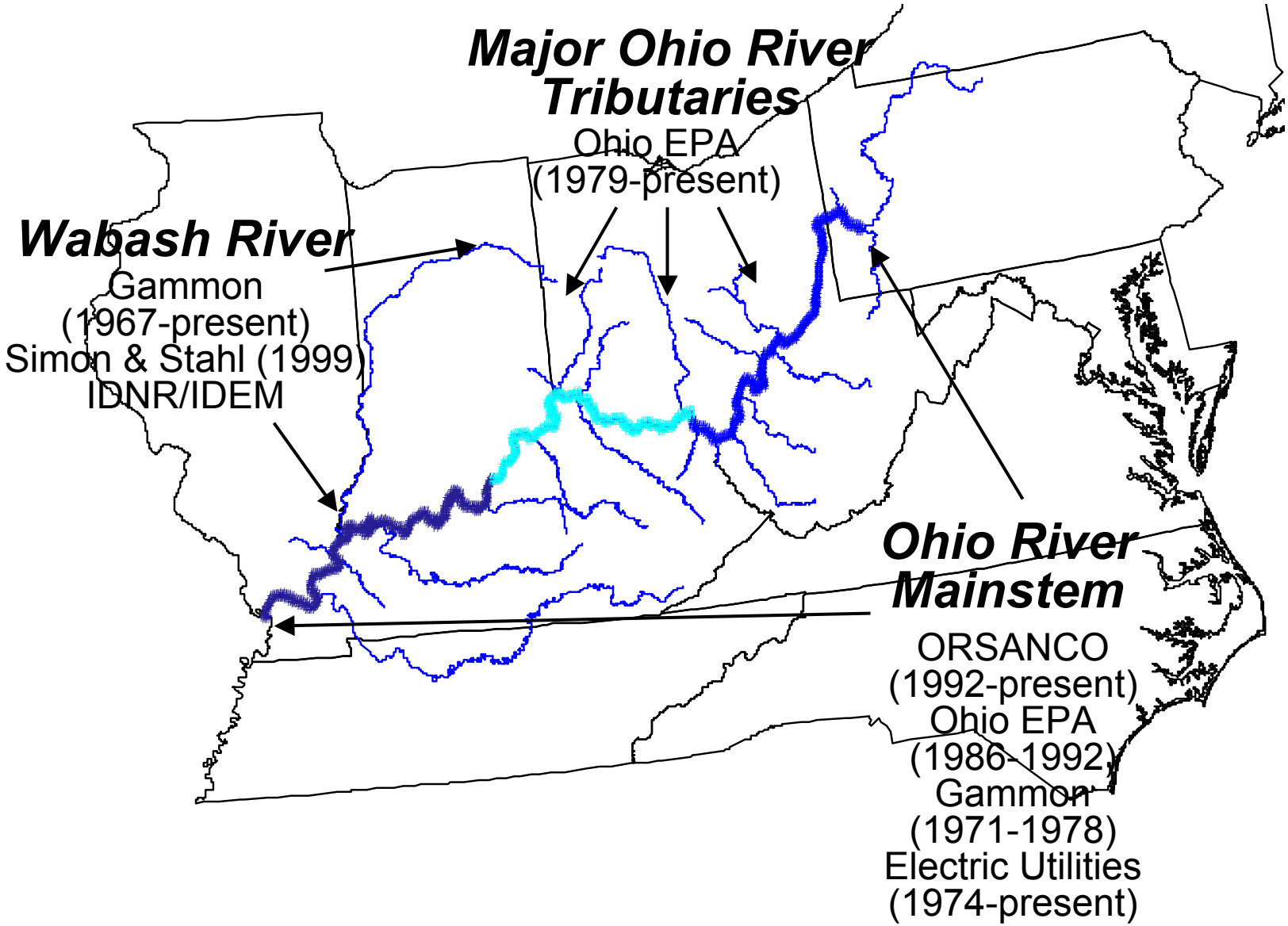
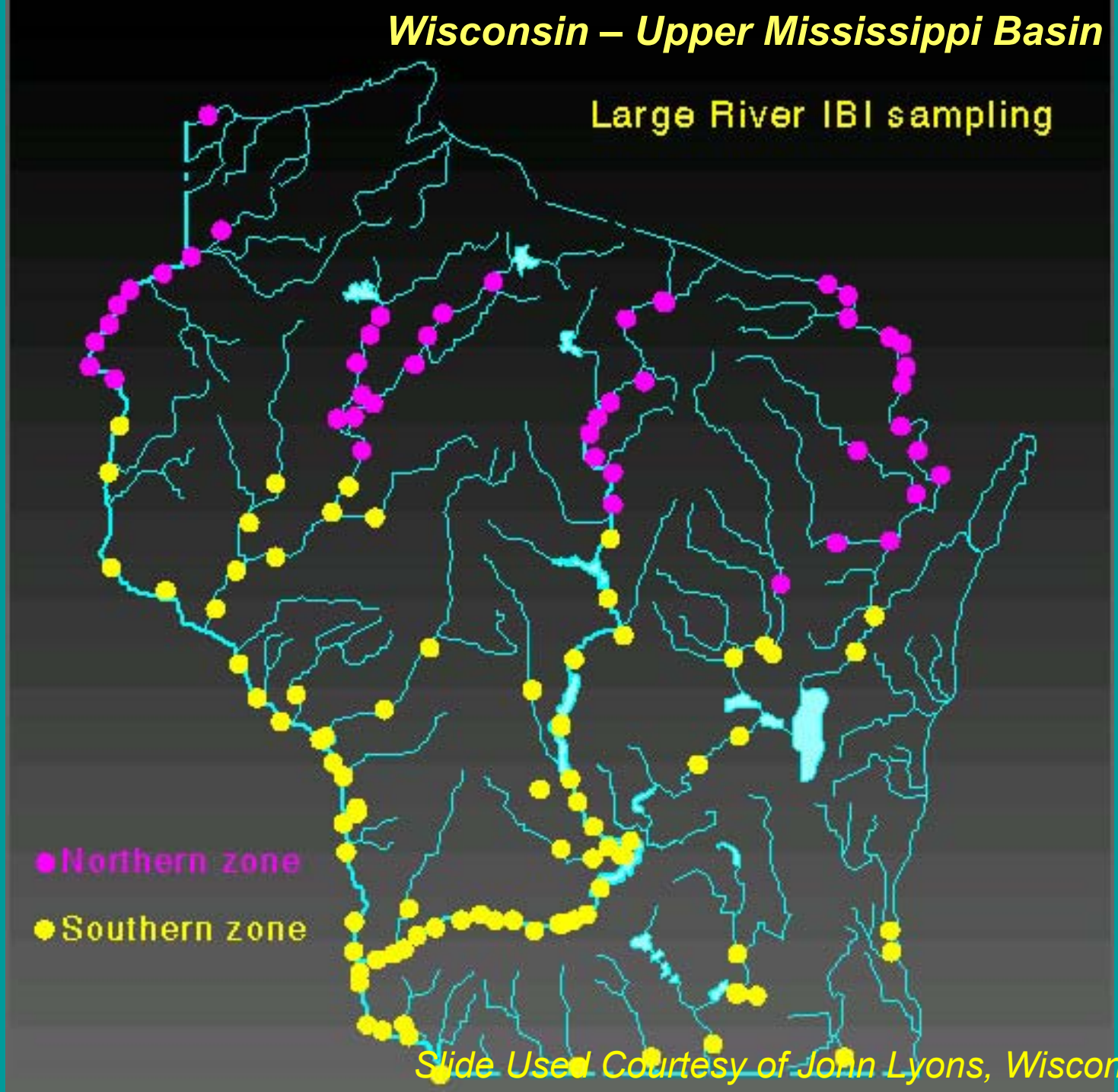
Fish Assemblage Assessments of Large and Great Rivers in the Upper Ohio Basin





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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 Statewide Large Rivers (Lyons, IBI), several others in midwest U.S.

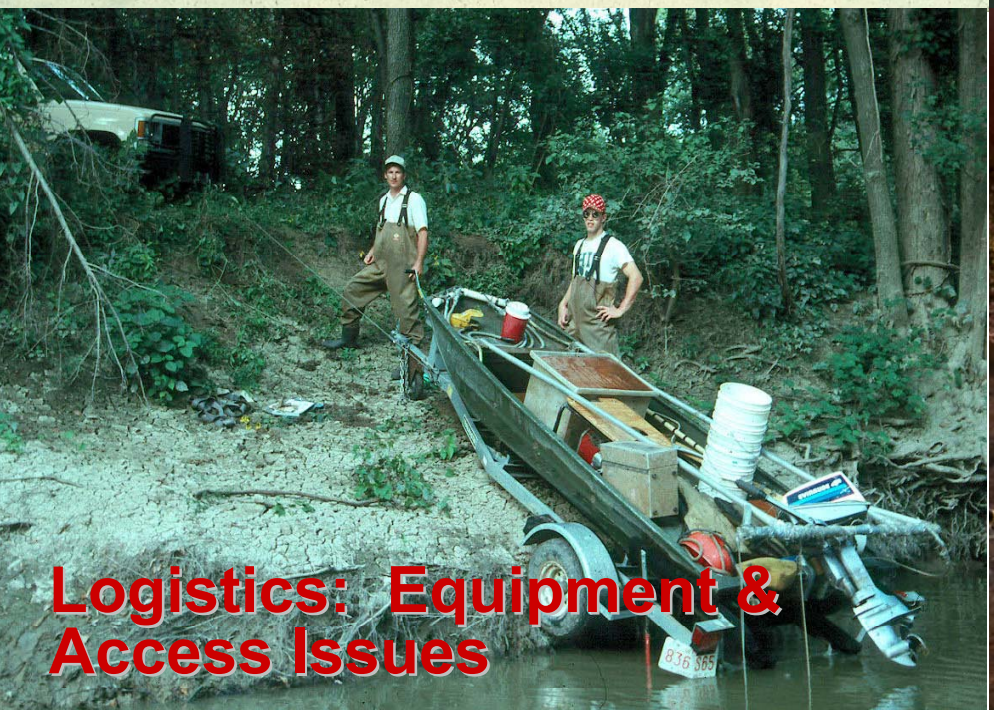
Large Rivers: Single-Gear Electrofishing Approach

Sampling along shoreline
of main channel border

Ohio EPA Non-Wadeable Methods

Electrofishing Gear Array:
Wadeable to Non-Wadeable

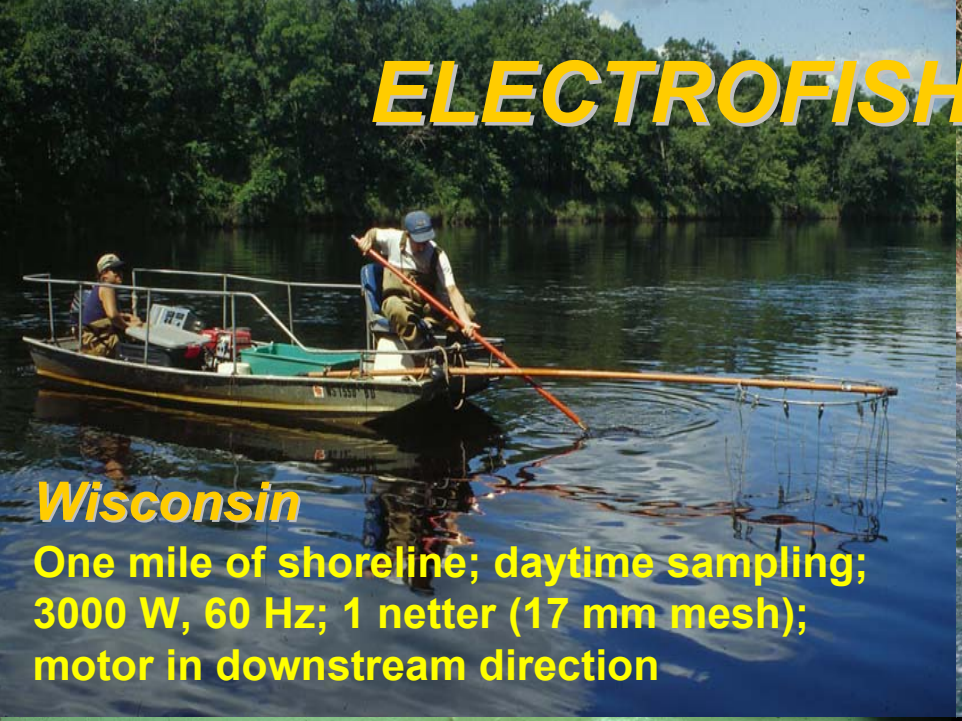
Effort: Distance Sampled



Logistics: Equipment &
Access Issues

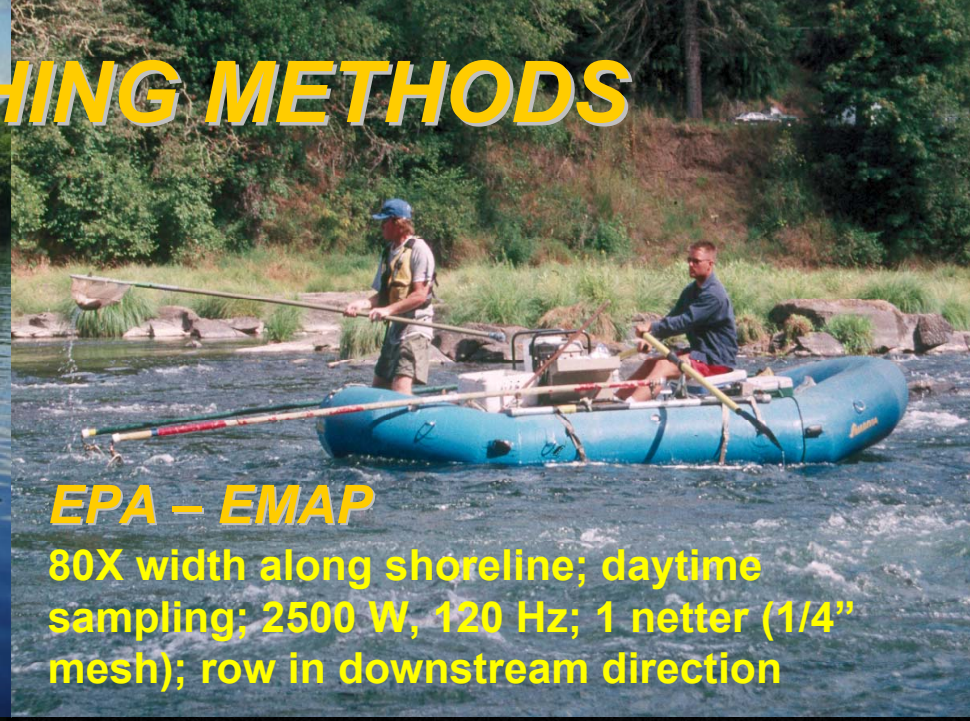
Multiple Habitats Sampled

ELECTROFISHING METHODS



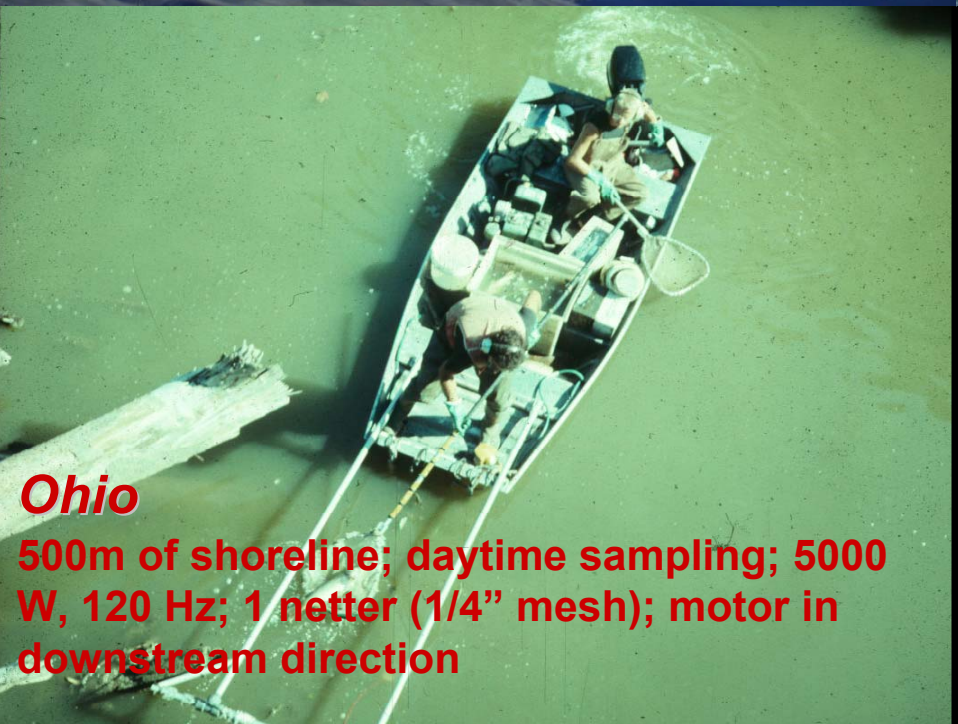
Wisconsin

One mile of shoreline; daytime sampling; 3000 W, 60 Hz; 1 netter (17 mm mesh); motor in downstream direction



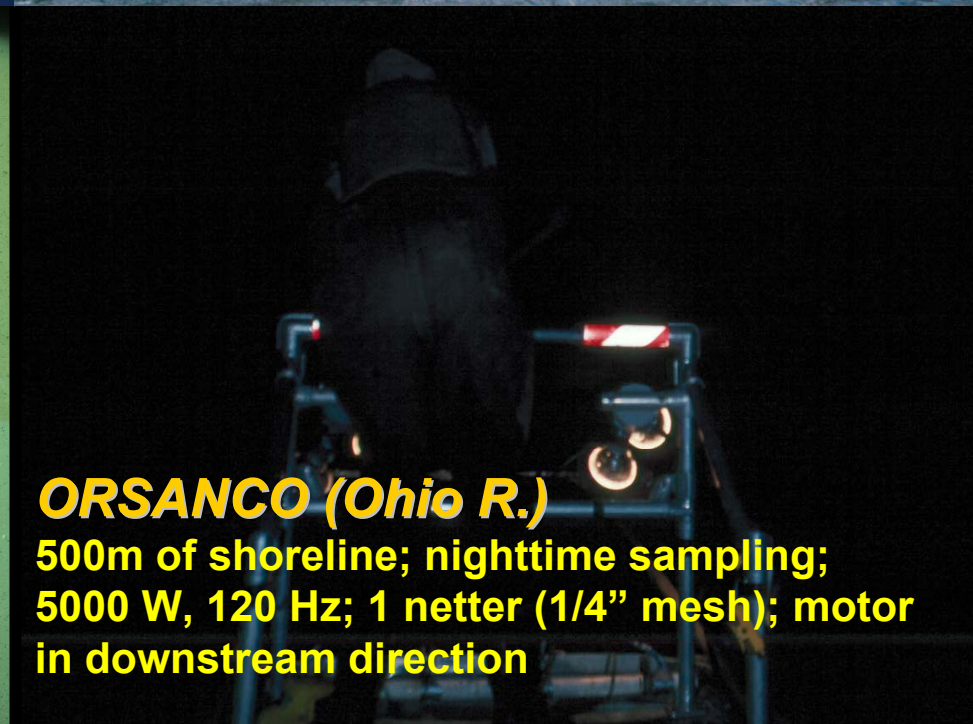
EPA – EMAP

80X width along shoreline; daytime sampling; 2500 W, 120 Hz; 1 netter (1/4" mesh); row in downstream direction



Ohio

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



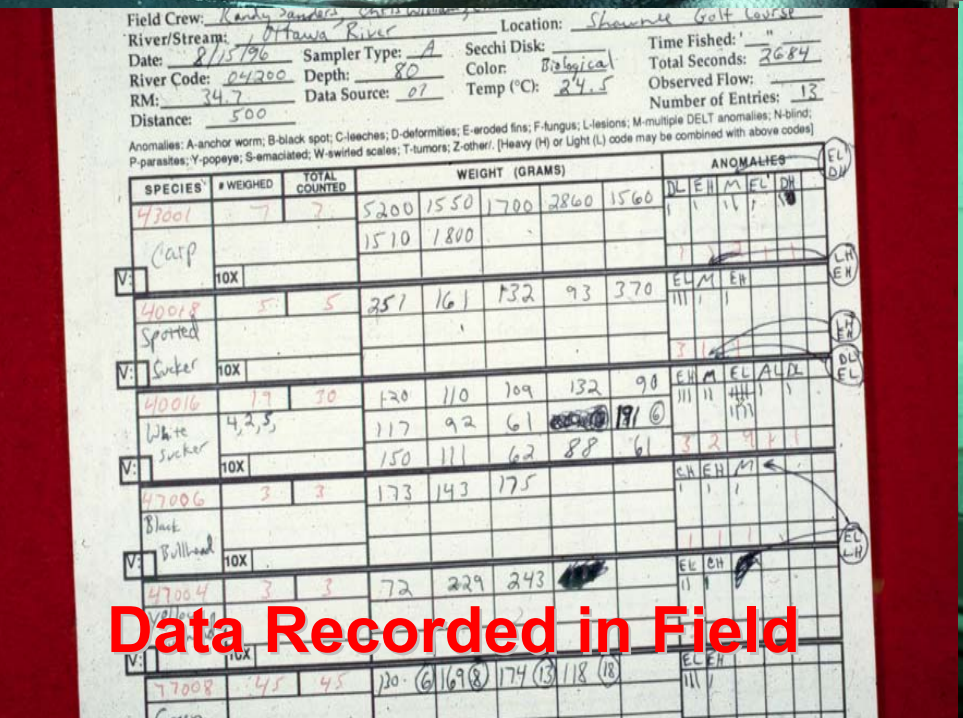
ORSANCO (Ohio R.)

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

Sample Processing & Data Management

Fish Are Placed On-Board

Individual or Batch Measurements (Weights, Anomalies, etc.)



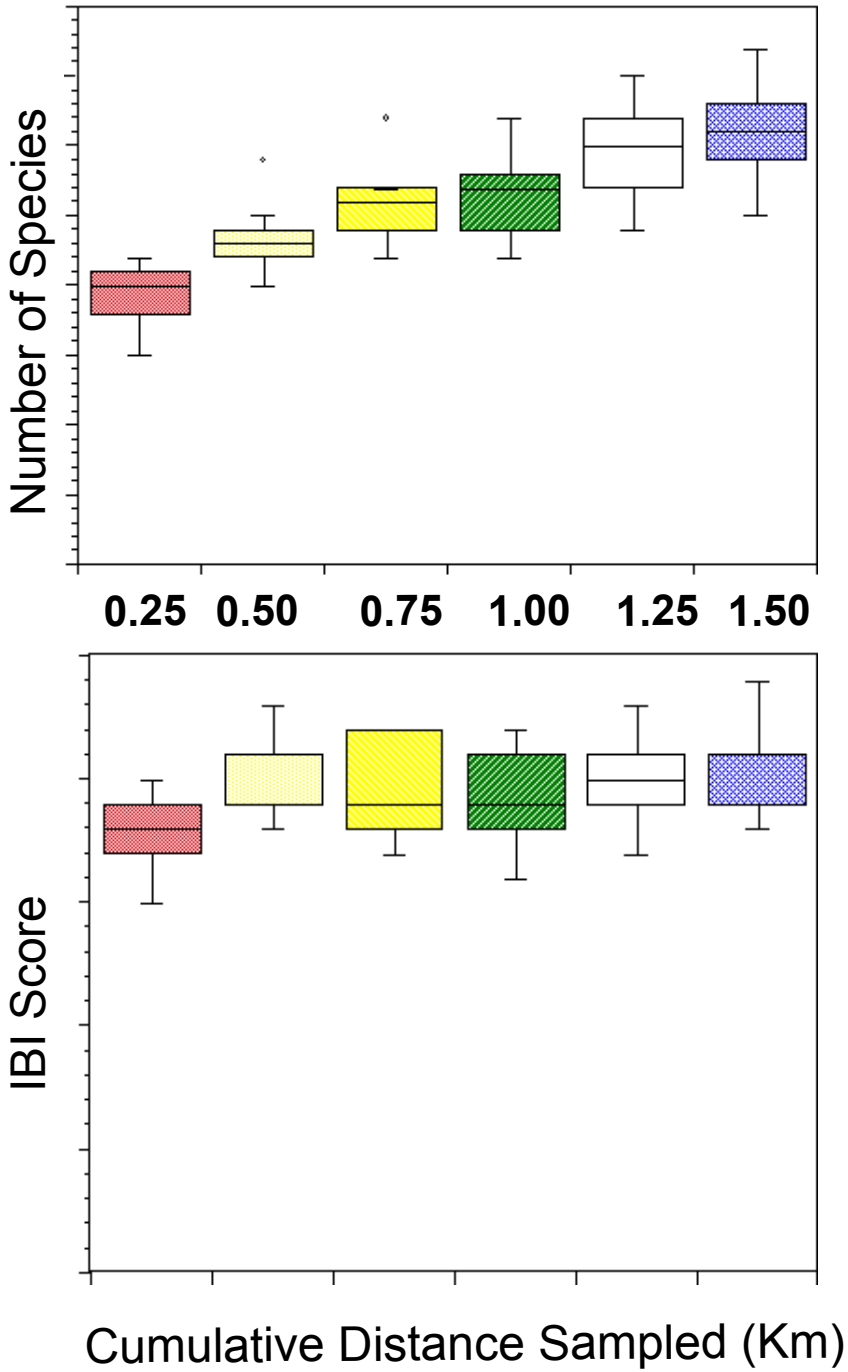
Field Crew: Randy Sanders, [illegible]
River/Stream: Ottawa River
Location: Shawnee Golf Course
Date: 8/15/96
Sampler Type: A
Secchi Disk:
Time Fished: "
Total Seconds: 2684
River Code: 04200
Depth: 80
Color: Biological
Observed Flow:
RM: 34.7
Data Source: 07
Temp (°C): 24.5
Number of Entries: 13
Distance: 500

Anomalies: A-anchor worm; B-black spot; C-leeches; D-deformities; E-eroded fins; F-fungus; L-lesions; M-multiple DELT anomalies; N-blind; P-parasites; Y-popeye; S-emaciated; W-swirled scales; T-tumors; Z-other/. [Heavy (H) or Light (L) code may be combined with above codes]

SPECIES	# WEIGHED	TOTAL COUNTED	WEIGHT (GRAMS)					ANOMALIES
43001	7	7	5200	1550	1700	2860	1560	DL EH M EL DH
Carp			1510	1800				
V:	10X							
40018	5	5	251	161	132	93	370	EL M EH
Spotted Sucker								
V:	10X							
40016	19	30	120	110	109	132	90	EH M EL AL DL
White Sucker	4,2,5,		117	92	61	[illegible]	191 (6)	
V:	10X		150	111	62	88	61	
47006	3	3	173	143	175			CH EH M
Black Bullhead								
V:	10X							
47004	3	3	72	229	243	[illegible]		EL CH
V:	10X							
77008	45	45	130 (6)	169 (8)	174 (13)	118 (18)		EL EH

Data Recorded in Field

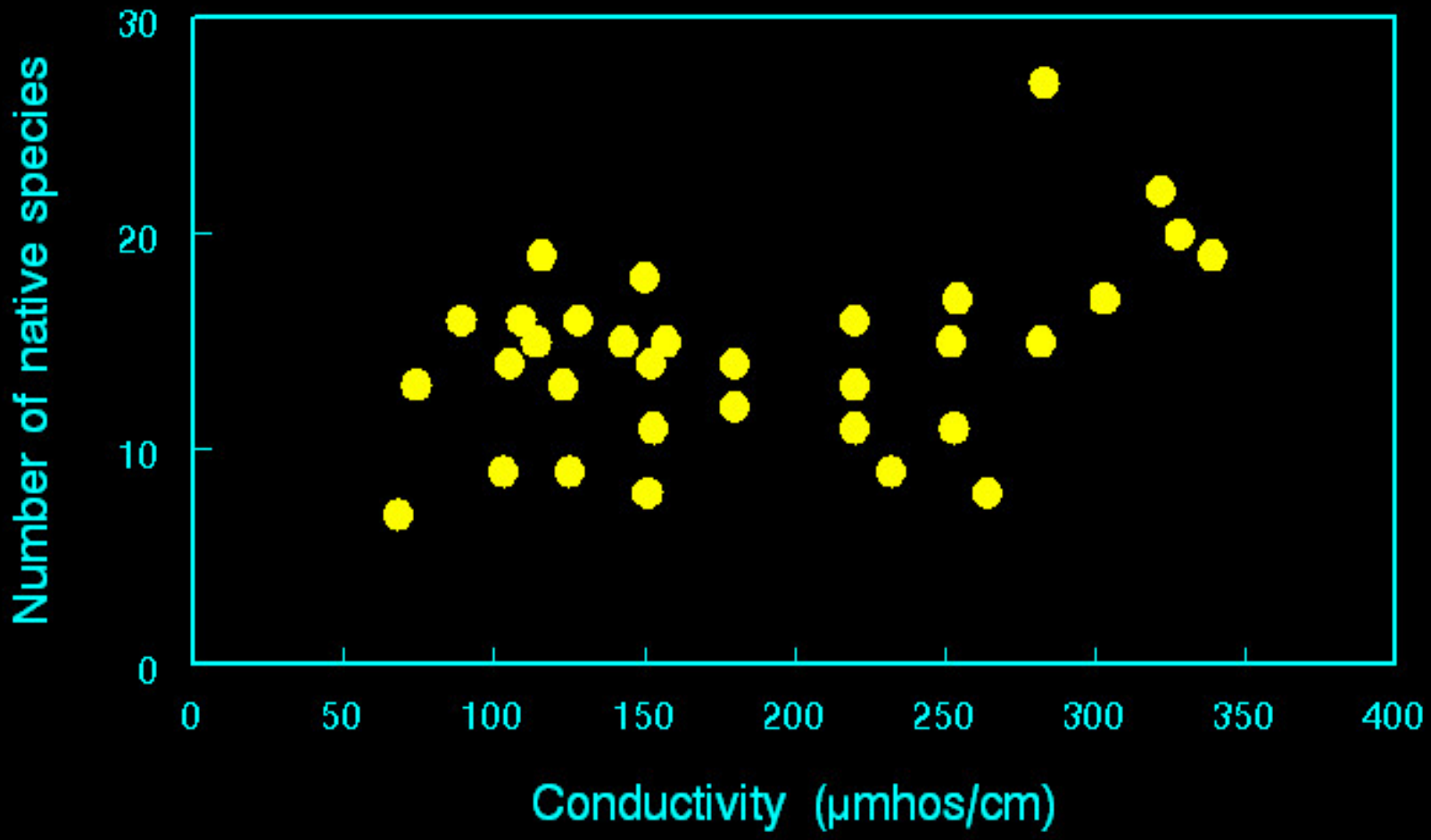
Data Stored Electronically



Methods Testing and Evaluation

- **Methods testing to determine effect of effort and effectiveness.**
- **Conduct repeated samplings under controlled circum-stances.**
- **Species richness increases with distance; rate of increase diminishes.**
- **IBI reaches asymptote at shorter distance.**

Species richness vs productivity



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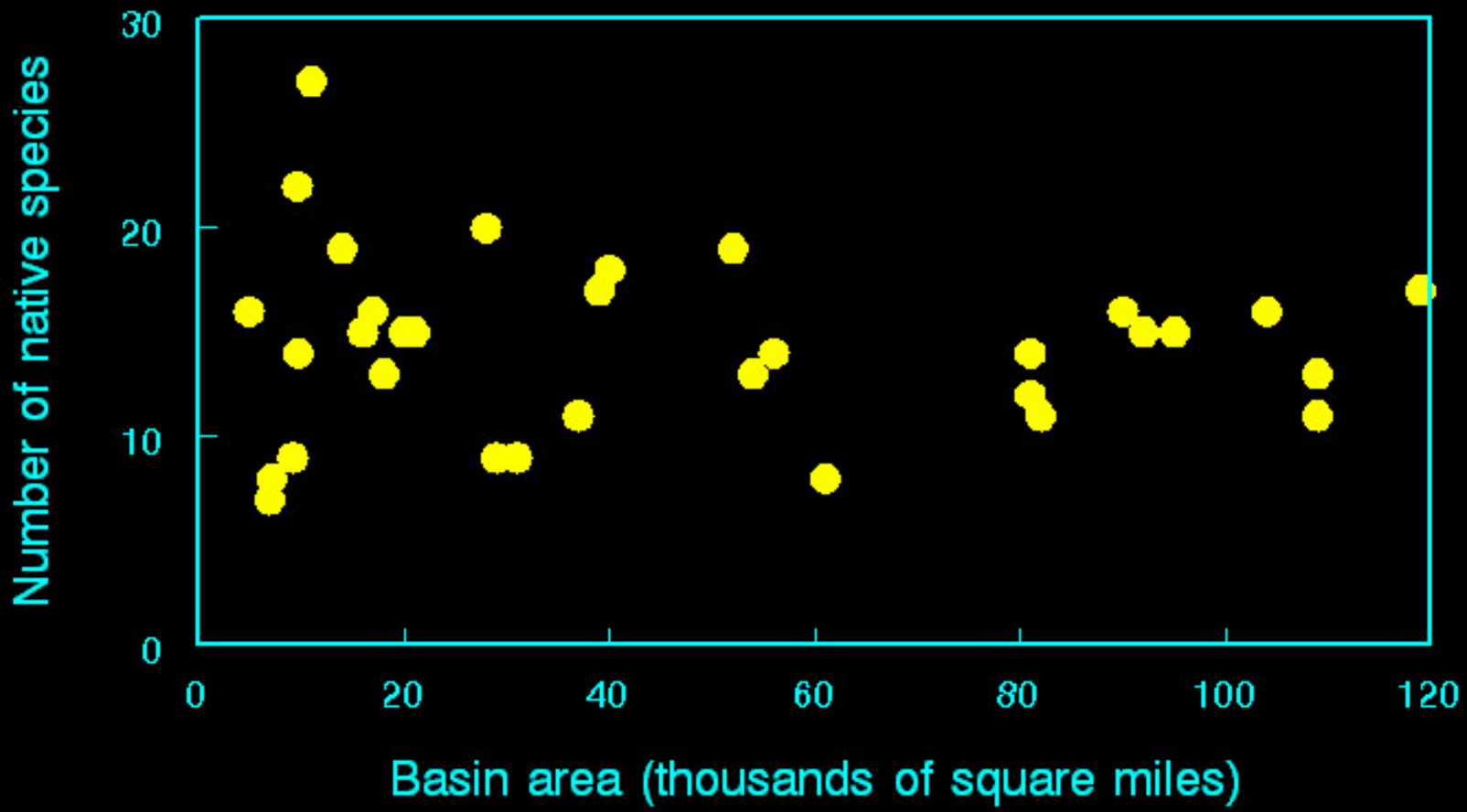
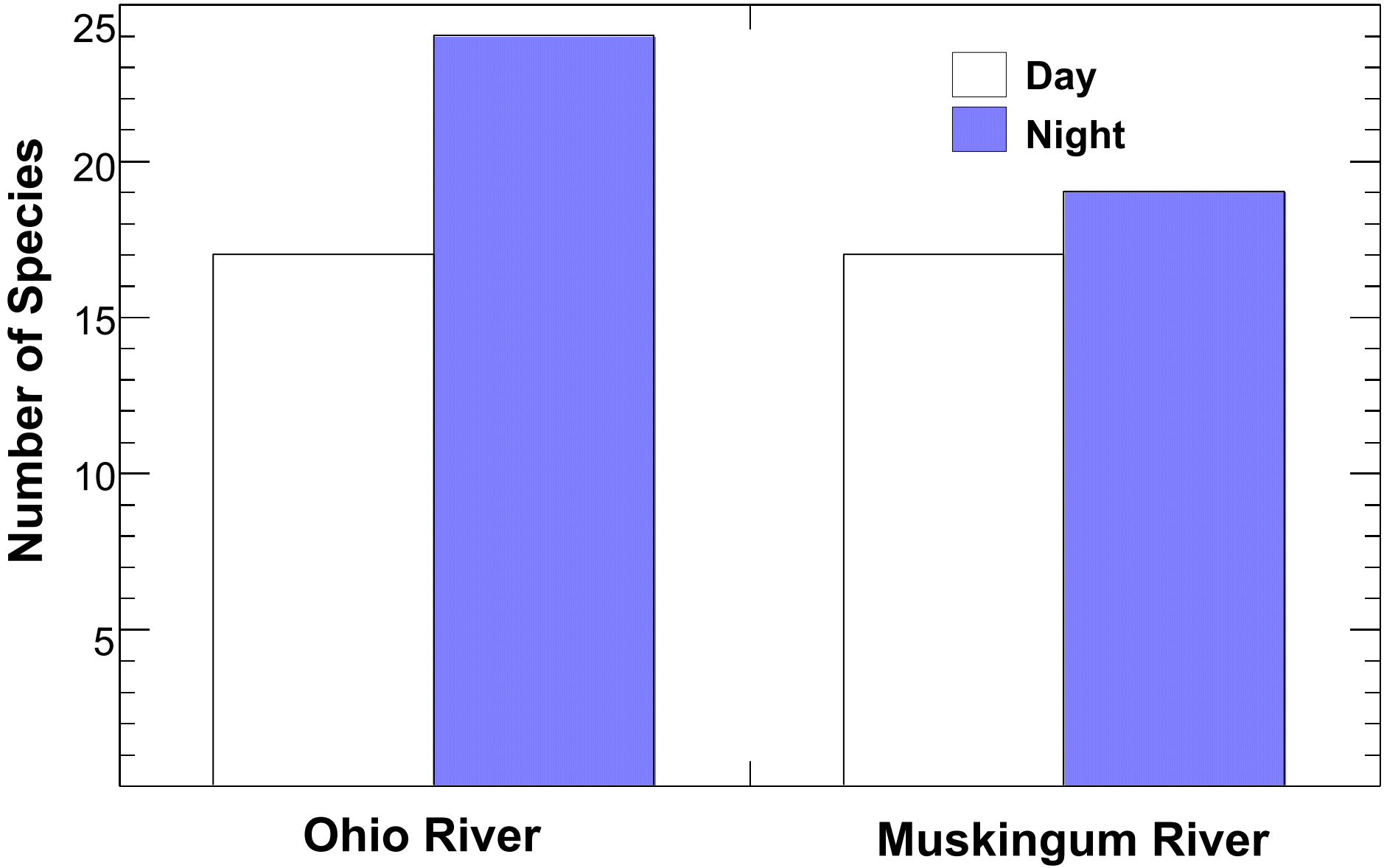
Species richness vs river size

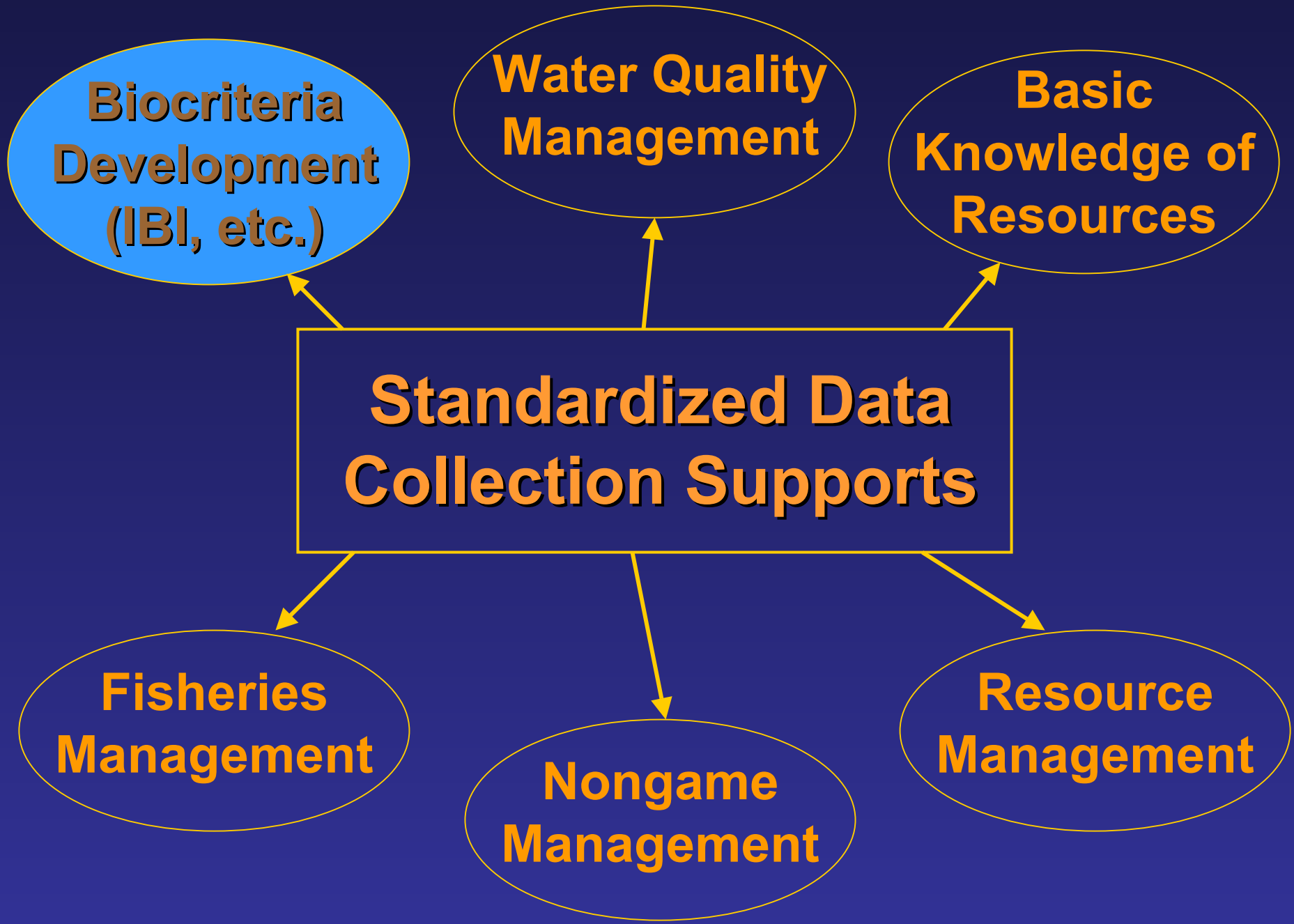


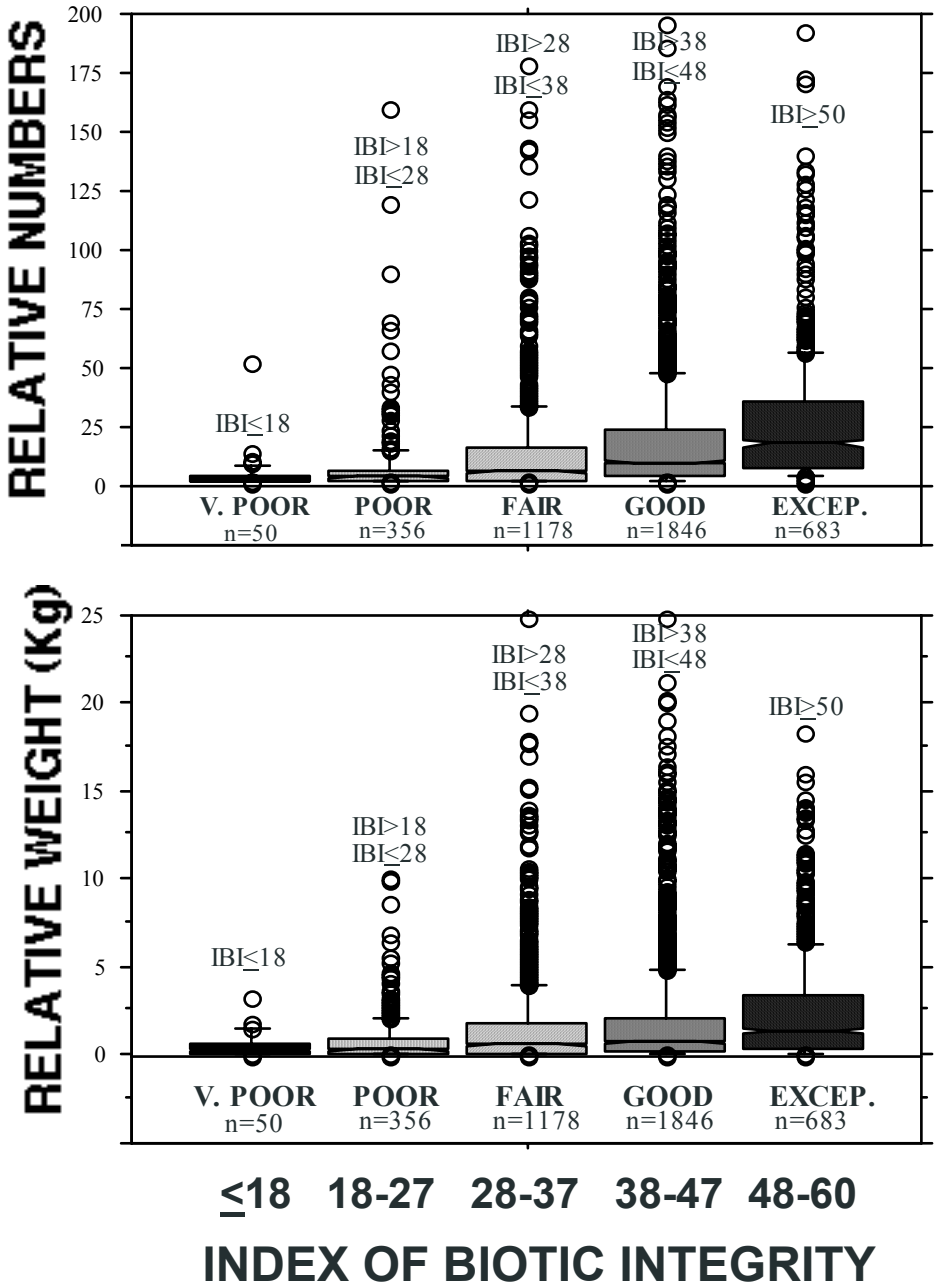
Effect of Time of Day on Electrofishing Efficiency: Impounded Rivers



Large Rivers Fish Assemblage Assessments

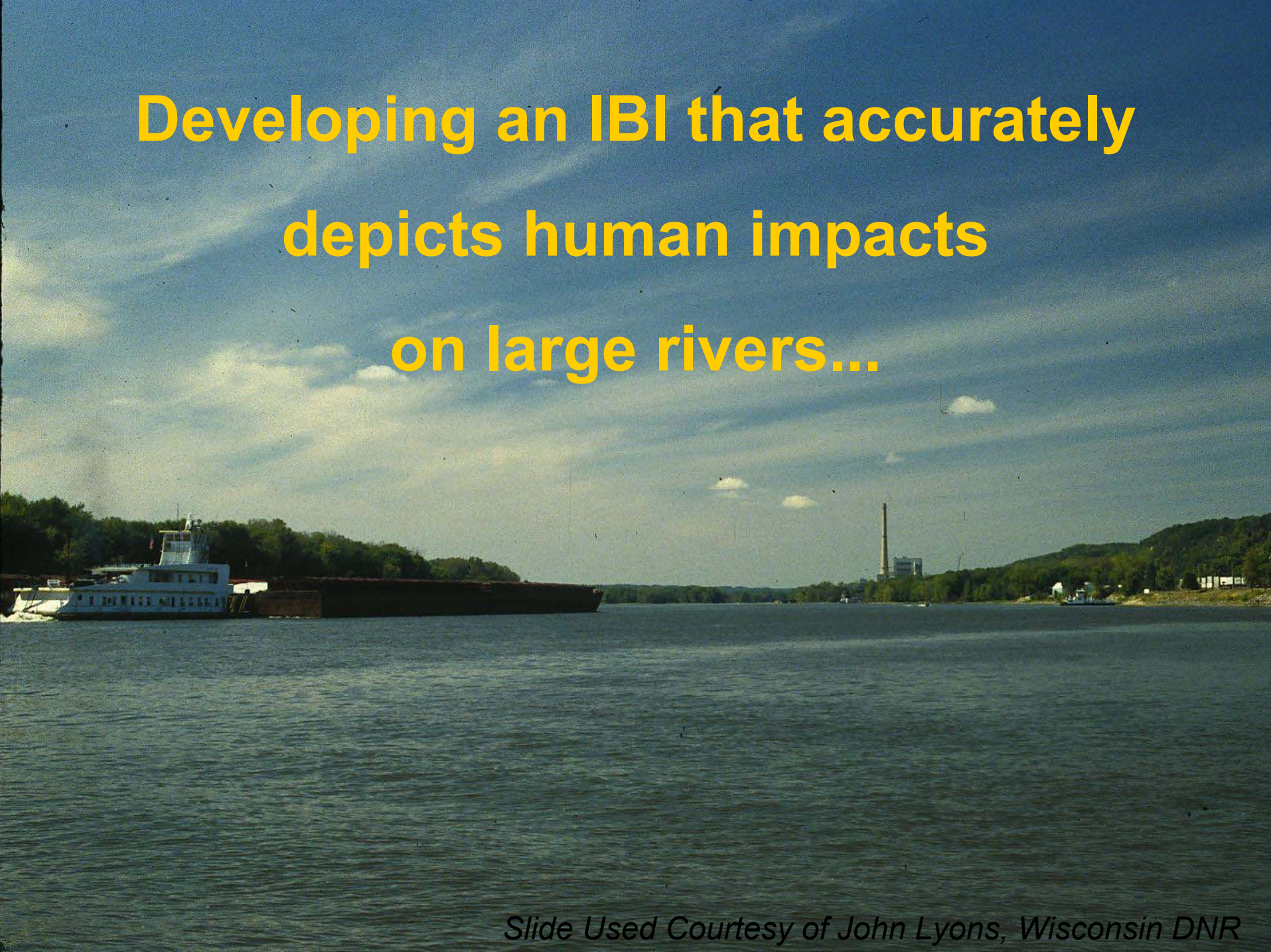
- Standardized & Representative Sampling - pulsed D.C. electrofishing methods, summer – fall seasonal index period.
- Relative Abundance - numbers and weight (biomass) per unit distance (effort).
- Data Quality Objectives - species level I.D. based on regional ichthyology keys and AFS nomenclature.
- Key Component of Biocriteria - IBI, MIwb, and component metrics; support development of tiered use classes.
- Longitudinal Sampling Design - longitudinal reach-scale Sampling and interpretation of results.
- Reach Scale Considerations - include entirety of mainstem and all habitat types; metric development considers each.
- Experienced Biologists - regional fauna, natural history, response signatures, impact types.


Biocriteria Development (IBI, etc.)
Water Quality Management
Basic Knowledge of Resources
Standardized Data Collection Supports
Fisheries Management
Nongame Management
Resource Management



The Abundance and Size of Smallmouth Bass Corresponds to the IBI in Ohio Streams & Rivers

- Smallmouth bass are one of the most popular and wide-spread game fish in Ohio and achieve their highest numbers and size in streams and rivers which attain WWH and EWH.
- As a top carnivore, small-mouth bass abundance and size decrease as overall aquatic community condition and health declines.



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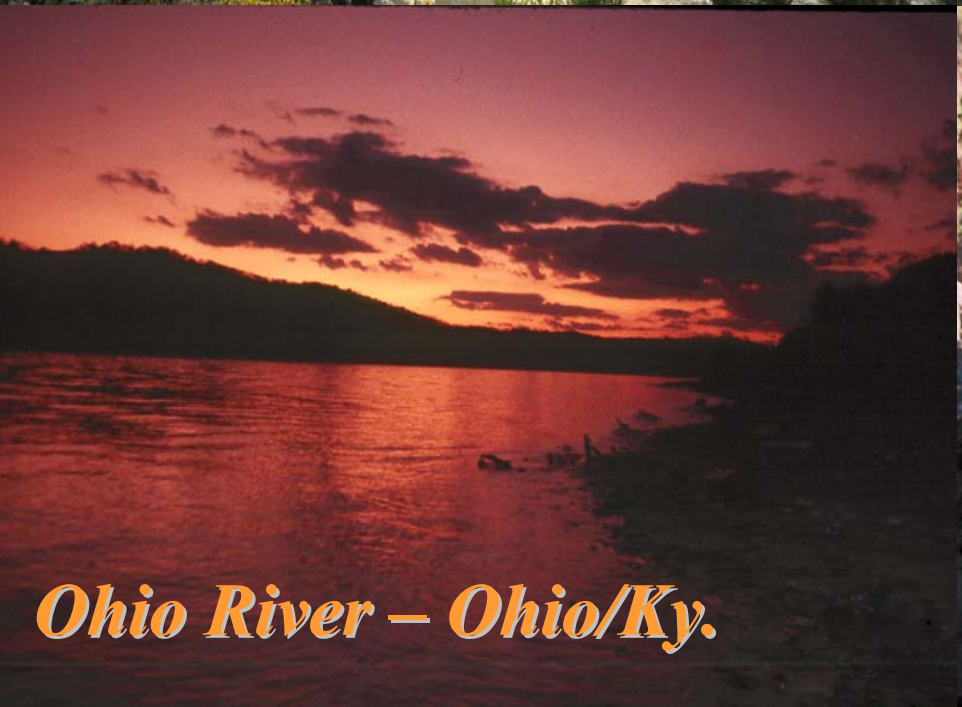
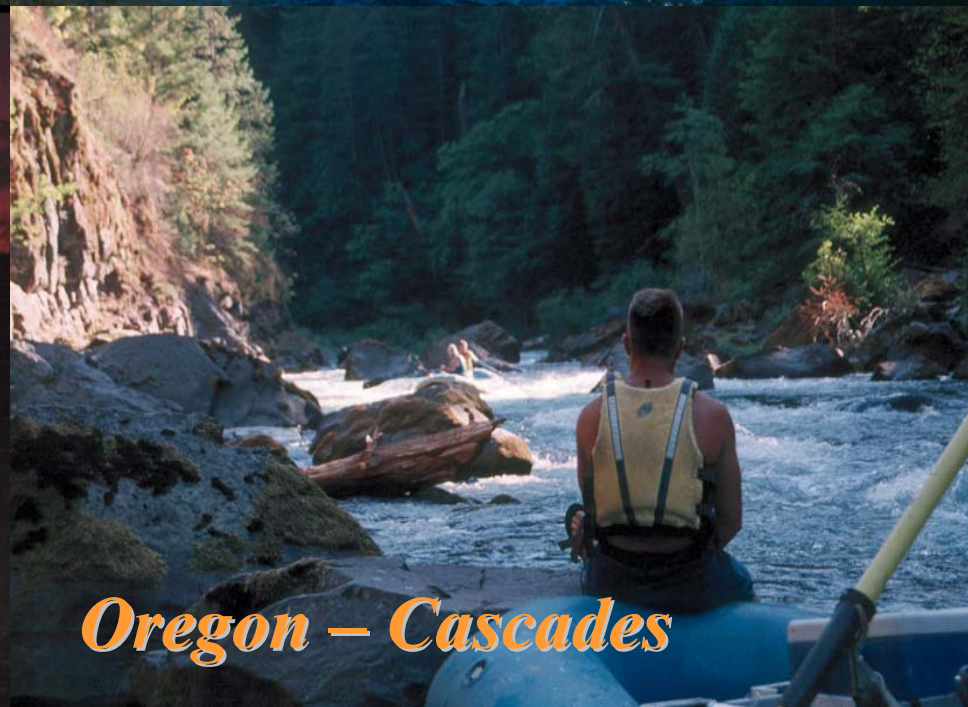
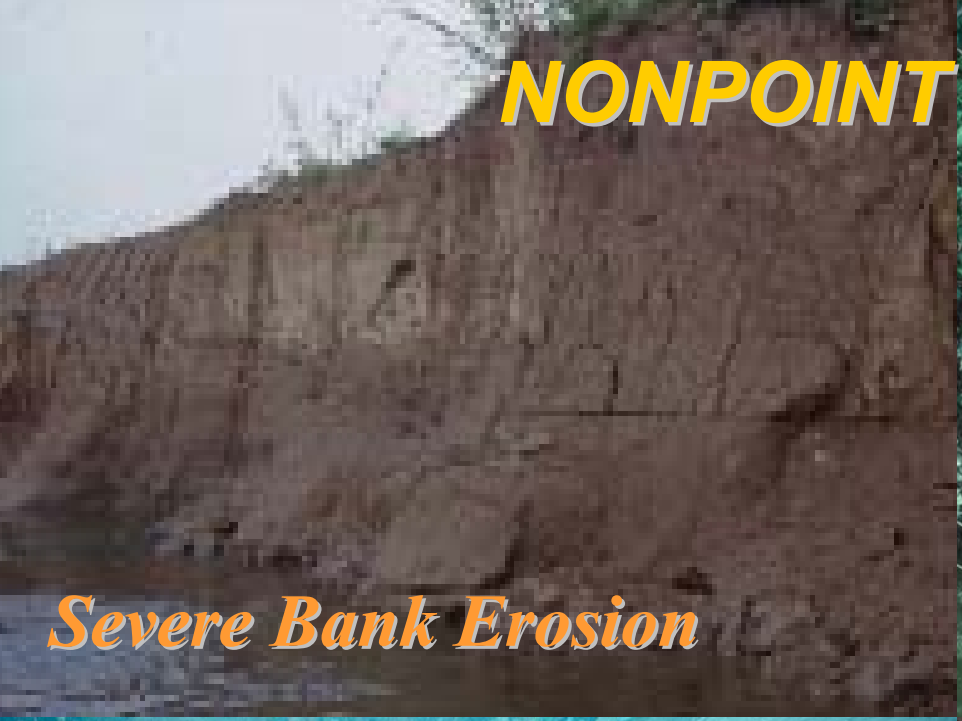
REFERENCE CONDITION

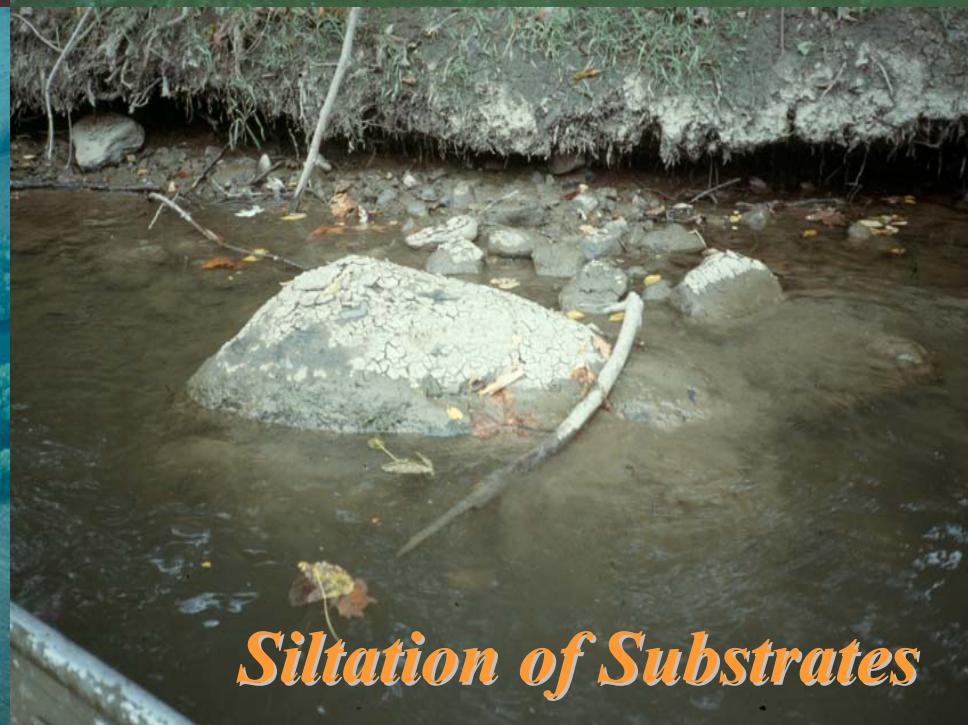




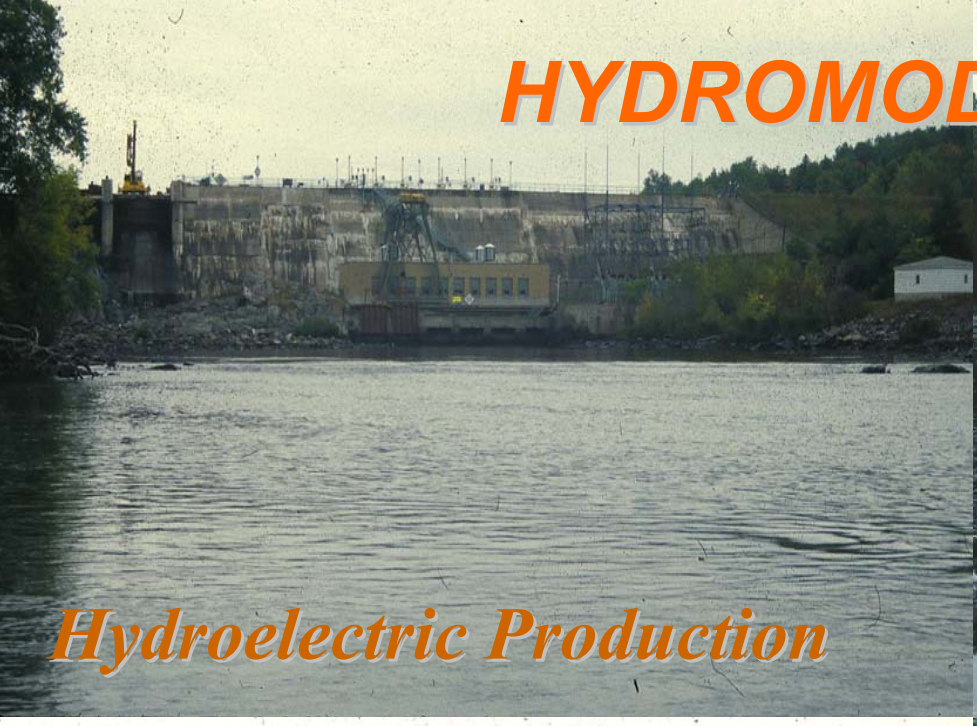
POINT SOURCES
Domestic Wastewater
Industrial Wastewater
Multiple, Interactive Sources
Acute/Chronic Effects

NONPOINT SOURCES





HYDROMODIFICATION



Hydroelectric Production

Flow Fluctuations

Habitat Modification

Low-head Dams

Characteristics of a good IBI:

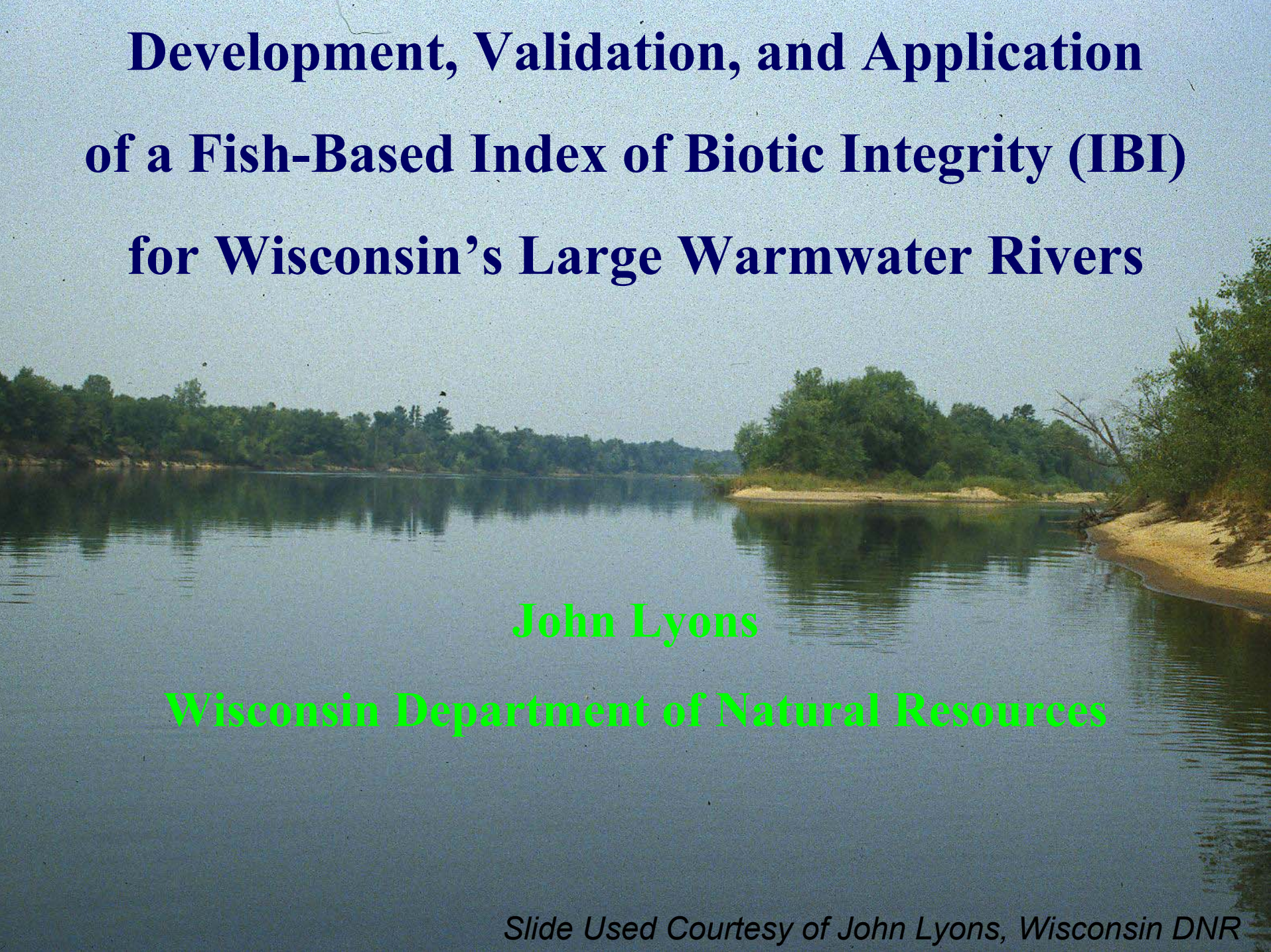
- Relatively fast, straightforward sampling and analysis
- Accurate depiction of human impacts on ecosystem
- Low variation when no change in human impacts
- Ability to disaggregate individual metrics and data attributes for other uses

Ohio EPA Modified IBIs for Streams and Rivers

	OHIO EPA MODIFIED IBI METRICs	HEADWATER SITE TYPE (<20 SQ. MI.)	WADEABLE SITE TYPE (20-300 MI.^{2})	BOATABLE SITE TYPE (200-6000 MI.^{2})
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)

Development, Validation, and Application of a Fish-Based Index of Biotic Integrity (IBI) for Wisconsin's Large Warmwater Rivers



John Lyons

Wisconsin Department of Natural Resources

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Large River IBI Metrics (Part 1)

Species richness and composition metrics:

-- Number of native species (N < S)

-- Number of sucker species

Indicator species metrics:

-- Number of intolerant species

-- Number of riverine species (N < S)

-- Percent of individuals as riverine spp (N > S)

-- Percent of biomass as "round" suckers (N > S)

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Large River IBI Metrics (Part 2)

Trophic function metrics:

-- Percent of biomass as insectivores (N > S)

Reproductive function metrics:

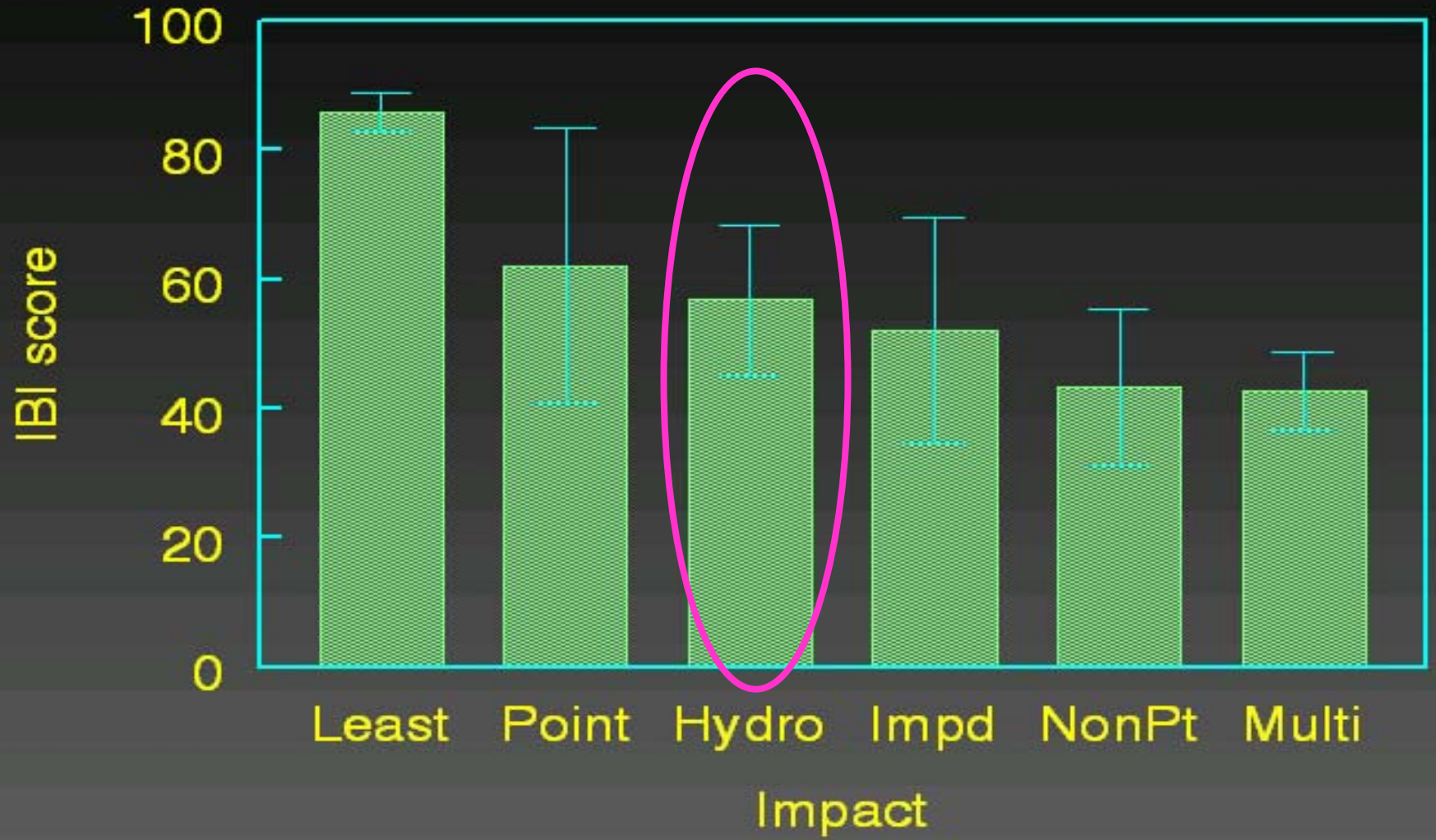
-- Percent of individuals as lithophils (N > S)

Abundance and condition metrics:

-- Total biomass (excluding tolerant species)

-- Percent of individuals w/ deformities or disease

Mean IBI score vs. impact type



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Distribution of IBI ratings for hydropower peaking sites (N = 21)

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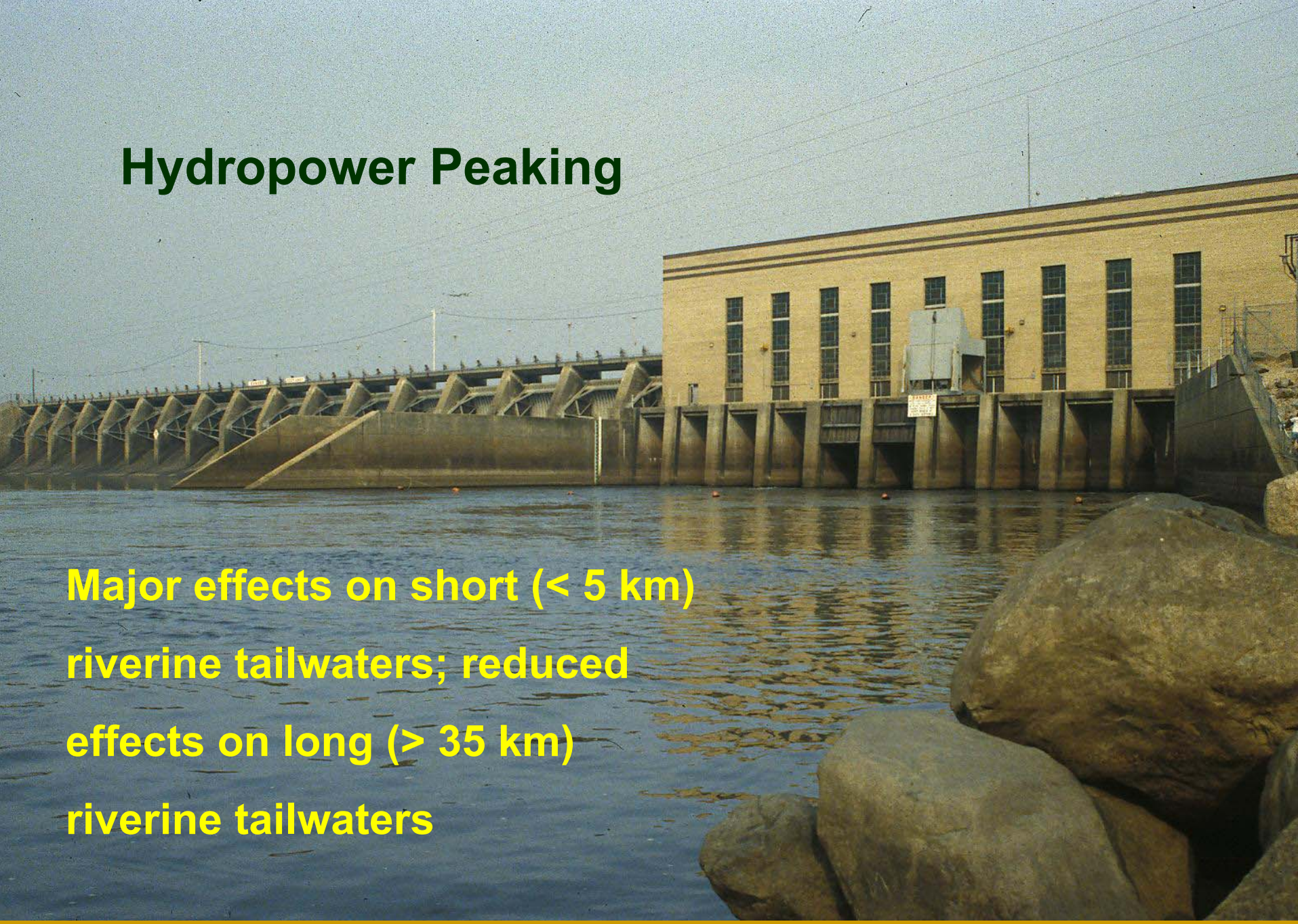
Hydropower Peaking



Major effects on short (< 5 km) riverine tailwaters; reduced effects on long (> 35 km) riverine tailwaters

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Biological Criteria: I

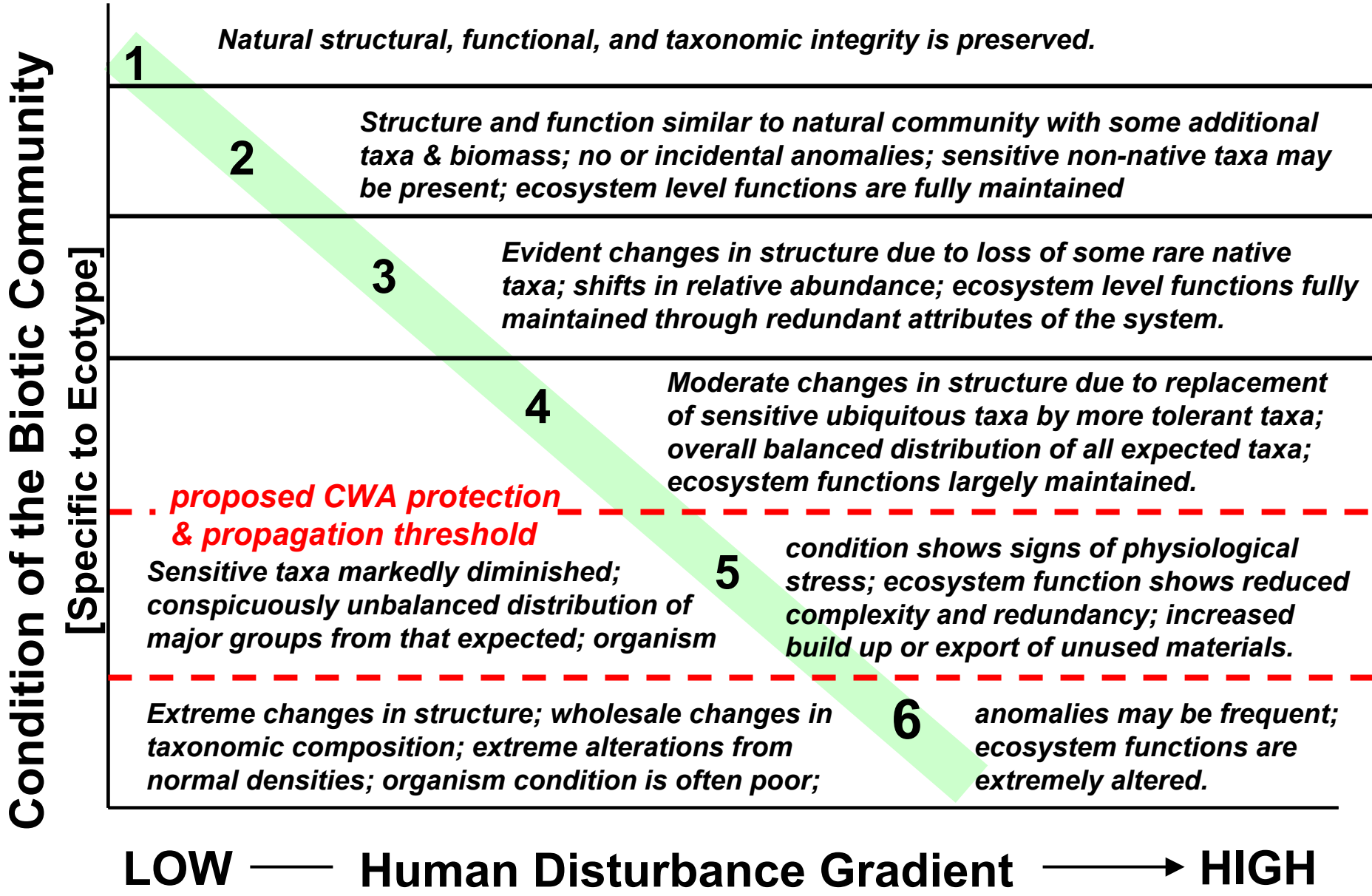
- Narrative ratings or numerical values which are based on the numbers and kinds of aquatic organisms (i.e., assemblage) which are found to inhabit a particular stream or river sampling location.

Biological Criteria: II

- Biological criteria are indexed to the reference assemblage of aquatic organisms within a particular geographical region (i.e., ecoregion) and with respect to stream and river size.

Tiered Aquatic Life Use Conceptual Model: Draft Biological Tiers

(10/22 draft)



Ohio Biological Criteria: Adopted May 1990 (OAC 3745-1-07; Table 7-14)

Huron Erie Lake Plain (HELP)

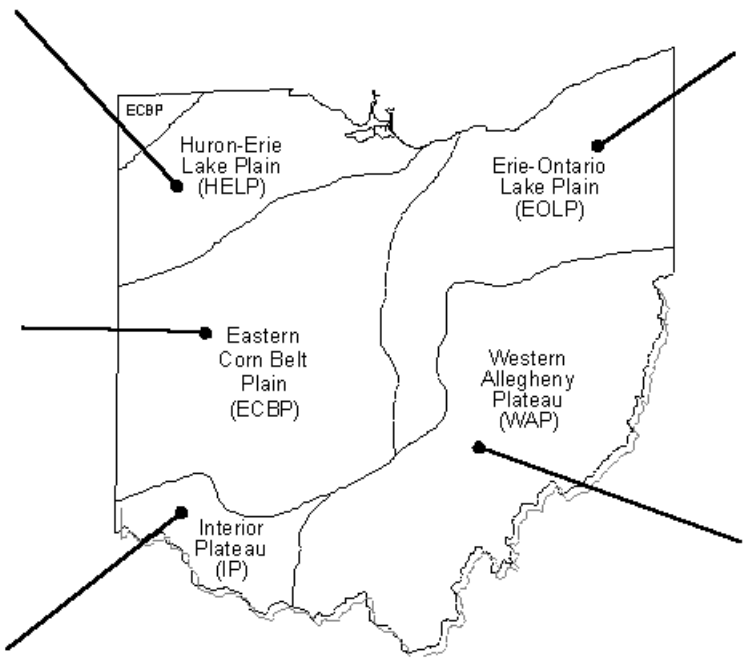
Use	Size	IBI	MIwb	ICI
WWH	H	28	NA	34
	W	32	7.3	34
	B	34	8.6	34
MWH-C	H	20	NA	22
	W	22	5.6	22
	B	20	5.7	22
MWH-I	B	30	5.7	NA

Eastern Corn Belt Plains (ECBP)

Use	Size	IBI	MIwb	ICI
WWH	H	40	NA	36
	W	40	8.3	36
	B	42	8.5	36
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-I	B	30	6.6	NA

Interior Plateau (IP)

Use	Size	IBI	MIwb	ICI
WWH	H	40	NA	30
	W	40	8.1	30
	B	38	8.7	30
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-I	B	30	6.6	NA



Statewide Exceptional Criteria

Use	Size	IBI	MIwb	ICI
EWH	H	50	NA	46
	W	50	9.4	46
	B	48	9.6	46

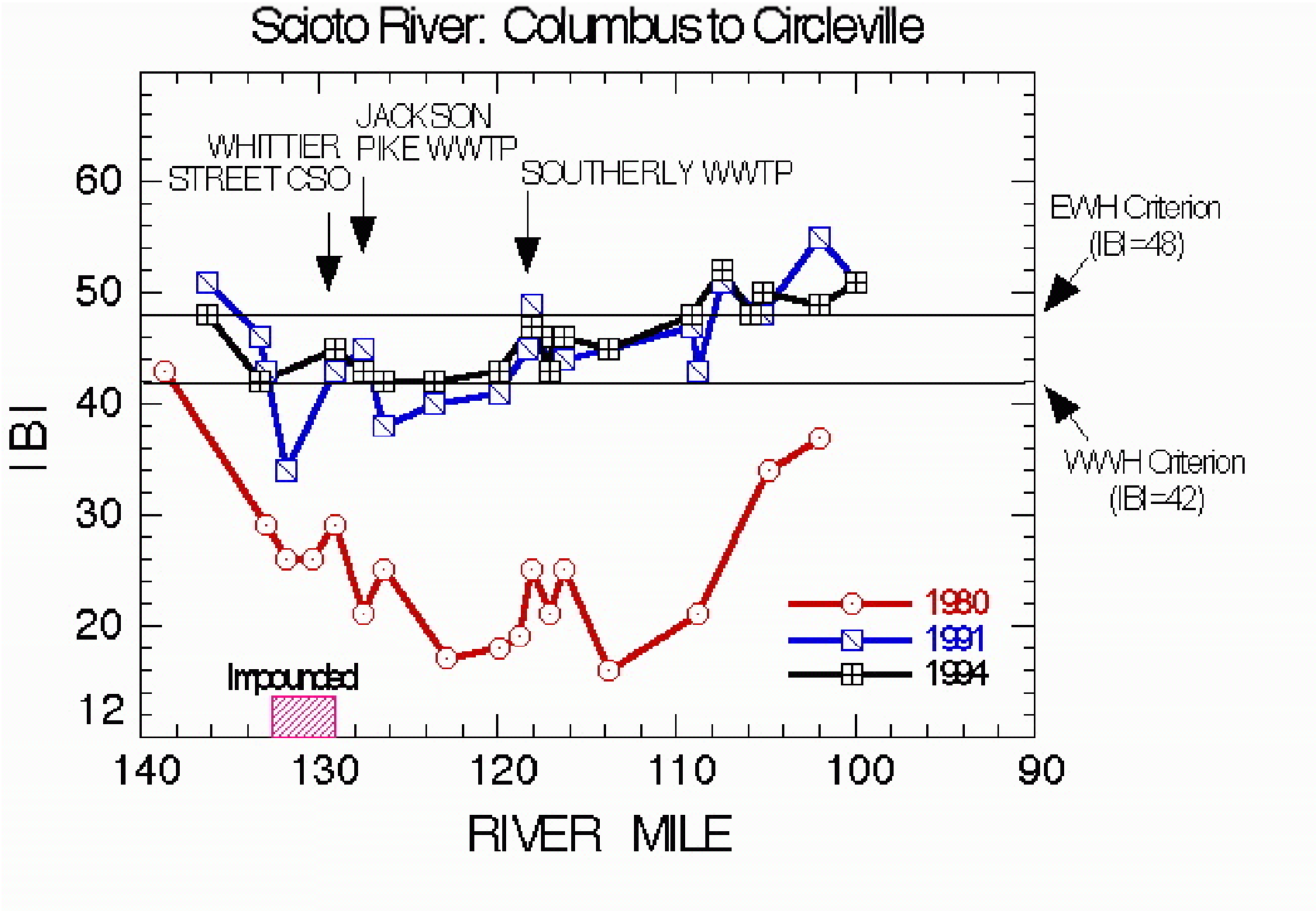
Erie Ontario Lake Plain (EOLP)

Use	Size	IBI	MIwb	ICI
WWH	H	40	NA	34
	W	38	7.9	34
	B	40	8.7	34
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-I	B	30	6.6	NA

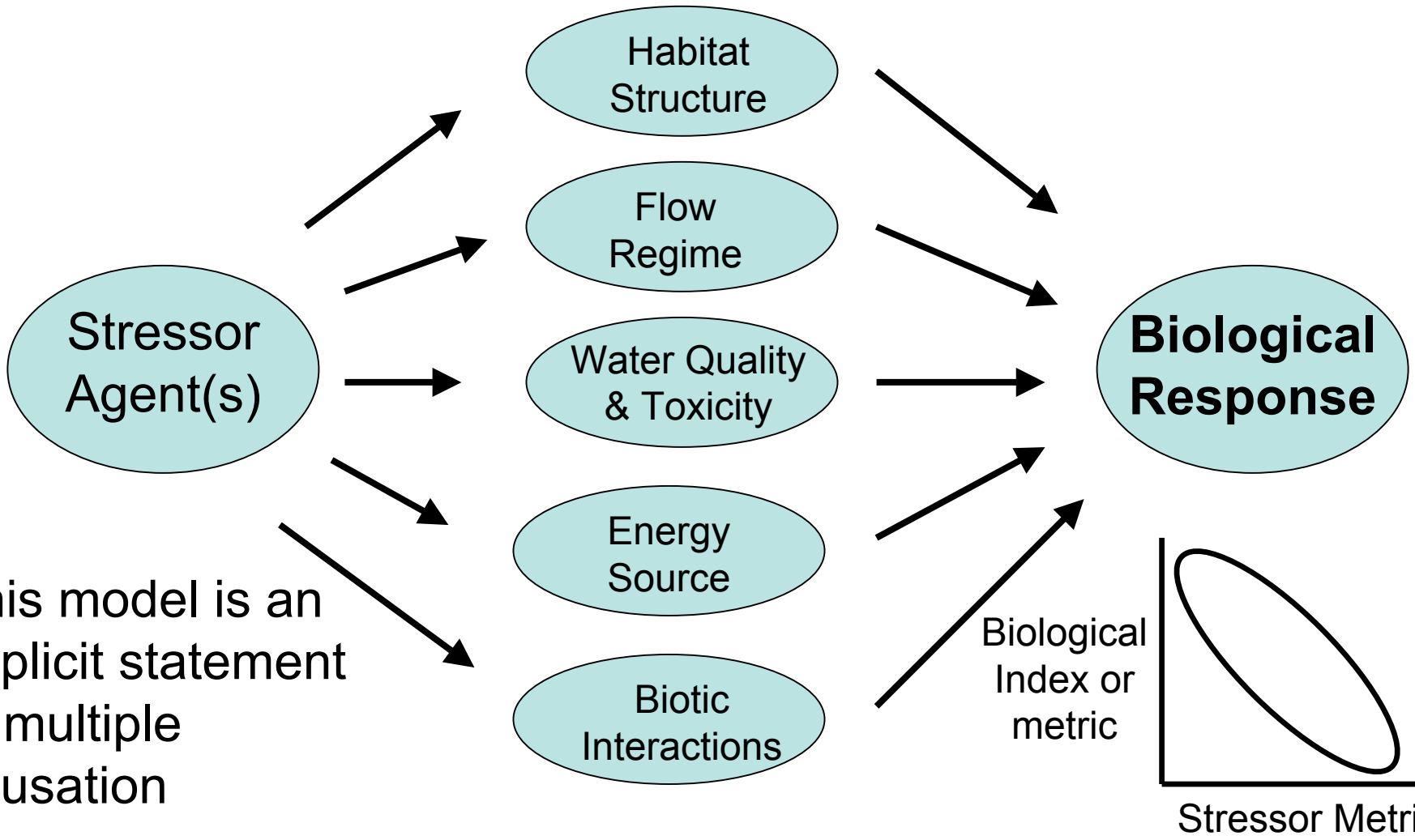
Western Allegheny Plateau (WAP)

Use	Size	IBI	MIwb	ICI
WWH	H	44	NA	34
	W	44	8.4	34
	B	40	8.6	34
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-A	H	24	NA	30
	W	24	5.5	30
	B	24	5.5	30
MWH-I	B	30	6.6	NA

Demonstrating Changes Through Time: Scioto River 1980 - 1994



The Linkage From Stressor Effects to Ecosystem Response



This model is an explicit statement of multiple causation

ADMINISTRATIVE INDICATORS

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

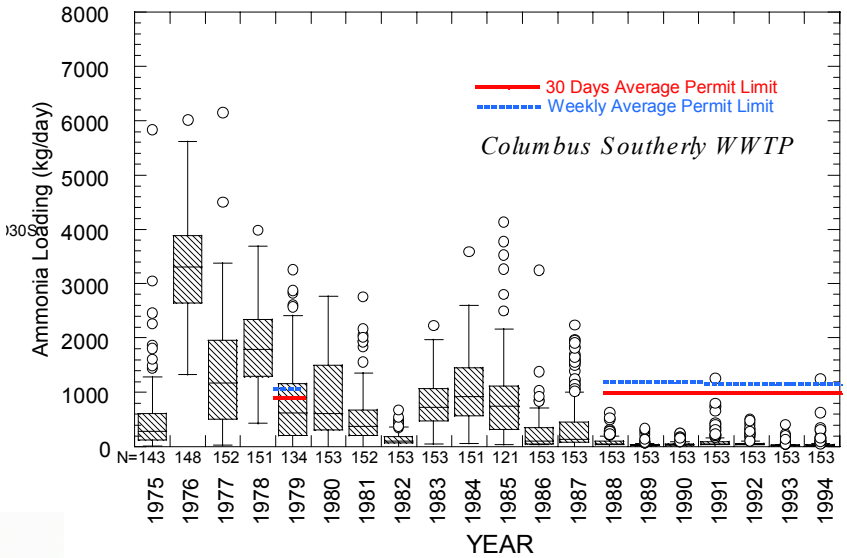
$$$$
NPDES

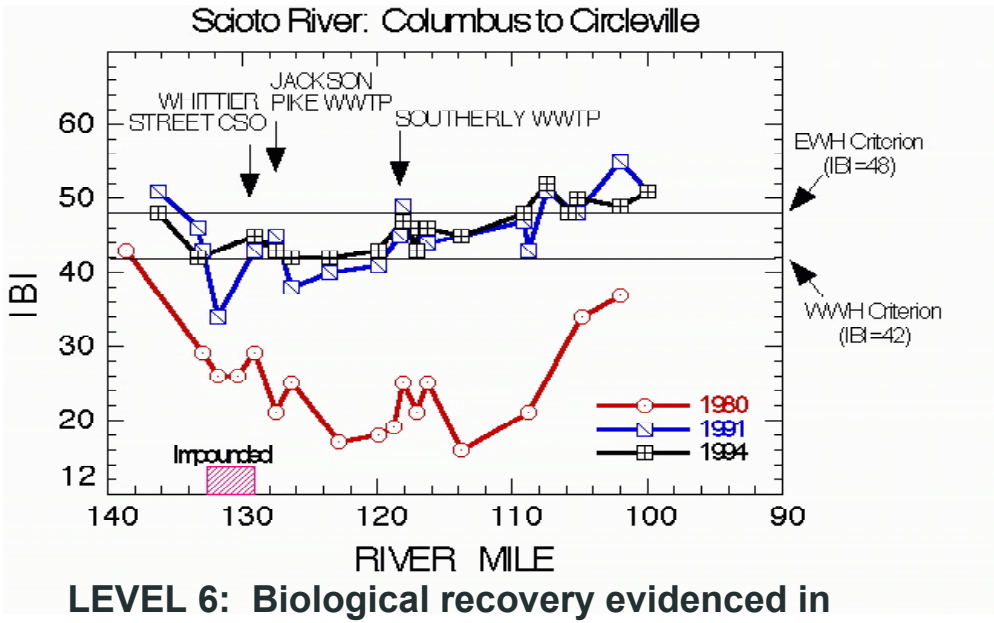
LEVEL 2:
Columbus constructs AWT by July 1, 1988; permit conditions attained

WWTP

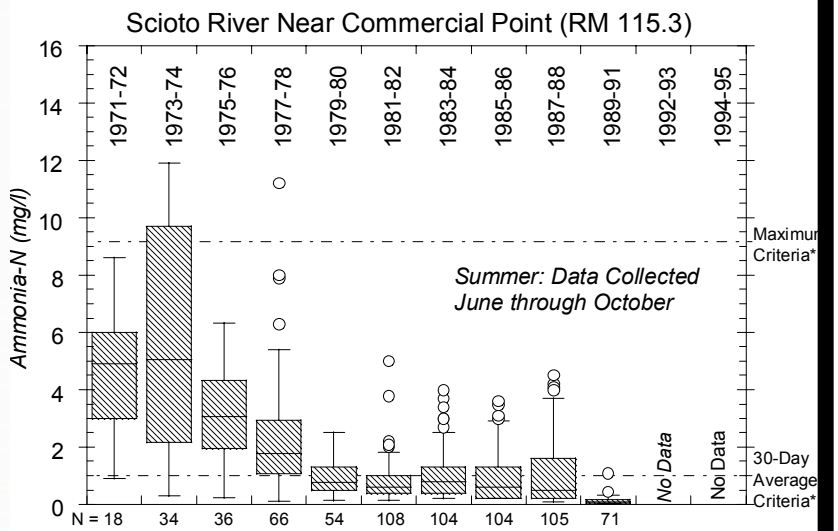
STRESSORS

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





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



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

RESPONSE

EXPOSURE

Implications - Wisconsin large river IBI

-- Rapid bioassessment practical in large rivers

-- Best uses:

- Compare environmental quality among different reaches
- Track EQ trends over time
- Communicate EQ conditions with the public

-- Not a substitute for:

- Detailed fishery survey
- Comprehensive faunal or T/E survey