The Use of a Habitat Assessment Method in the Derivation and Assessment of Tiered Aquatic Life Uses in Midwest Streams

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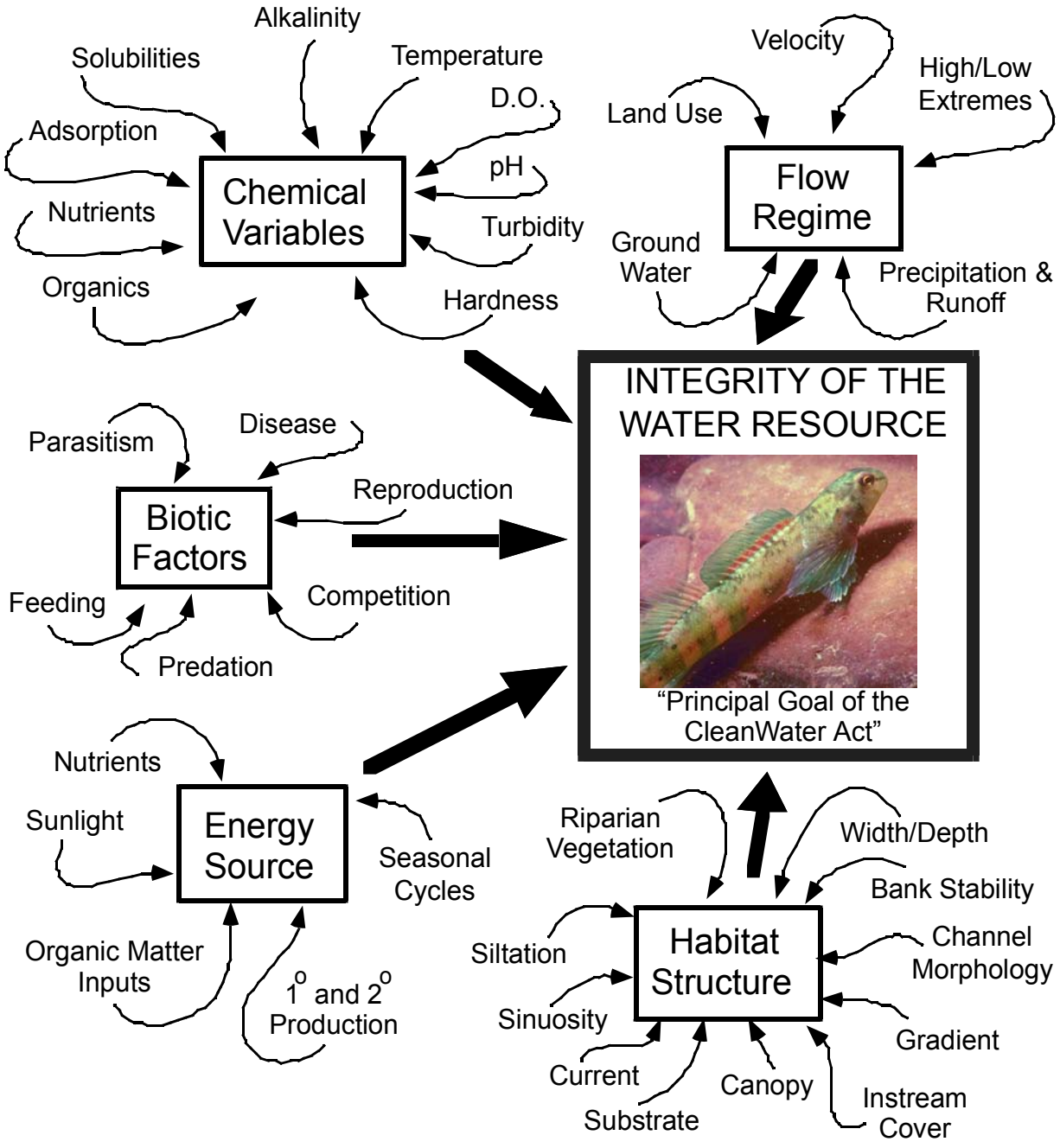
CABB

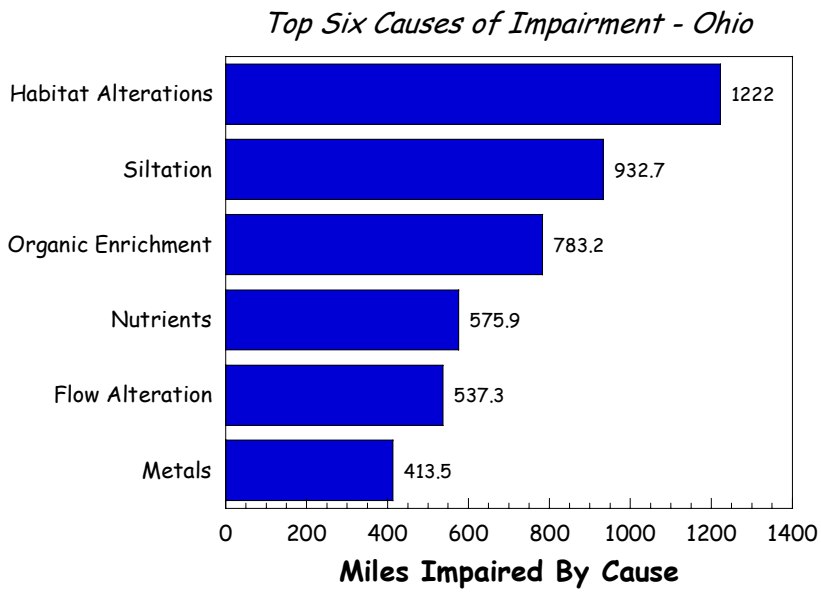

Alkalinity
Solubilities
Temperature
D.O.
Adsorption
pH
Chemical Variables
Nutrients
Turbidity
Organics
Hardness
Velocity
High/Low Extremes
Land Use
Flow Regime
Ground Water
Precipitation & Runoff
INTEGRITY OF THE WATER RESOURCE
"Principal Goal of the CleanWater Act"
Parasitism
Disease
Reproduction
Biotic Factors
Feeding
Competition
Predation
Nutrients
Sunlight
Energy Source
Seasonal Cycles
Organic Matter Inputs
1° and 2° Production
Riparian Vegetation
Width/Depth
Bank Stability
Siltation
Habitat Structure
Channel Morphology
Sinuosity
Gradient
Current
Canopy
Substrate
Instream Cover

How Important is Physical Habitat to Aquatic Life and Aquatic Life Uses?

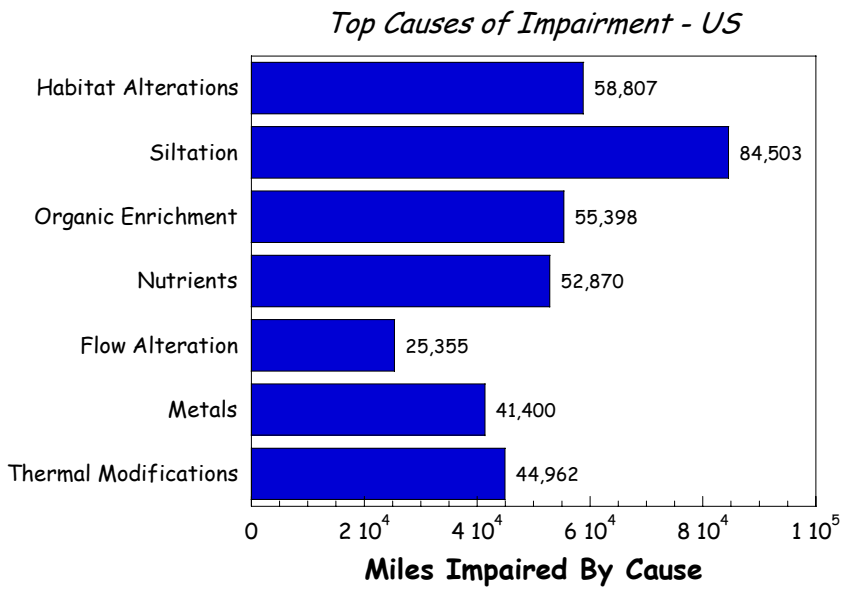
- General acknowledgement that habitat is a primary natural and anthropogenic factor explaining the condition and distribution of aquatic life
- Variation in natural classification factors (e.g., stream types, ecoregions) often expressed in local habitat changes
- Human alteration to the landscape and to streams directly has resulted in substantial changes to habitat

Top Stressors in Streams and Rivers

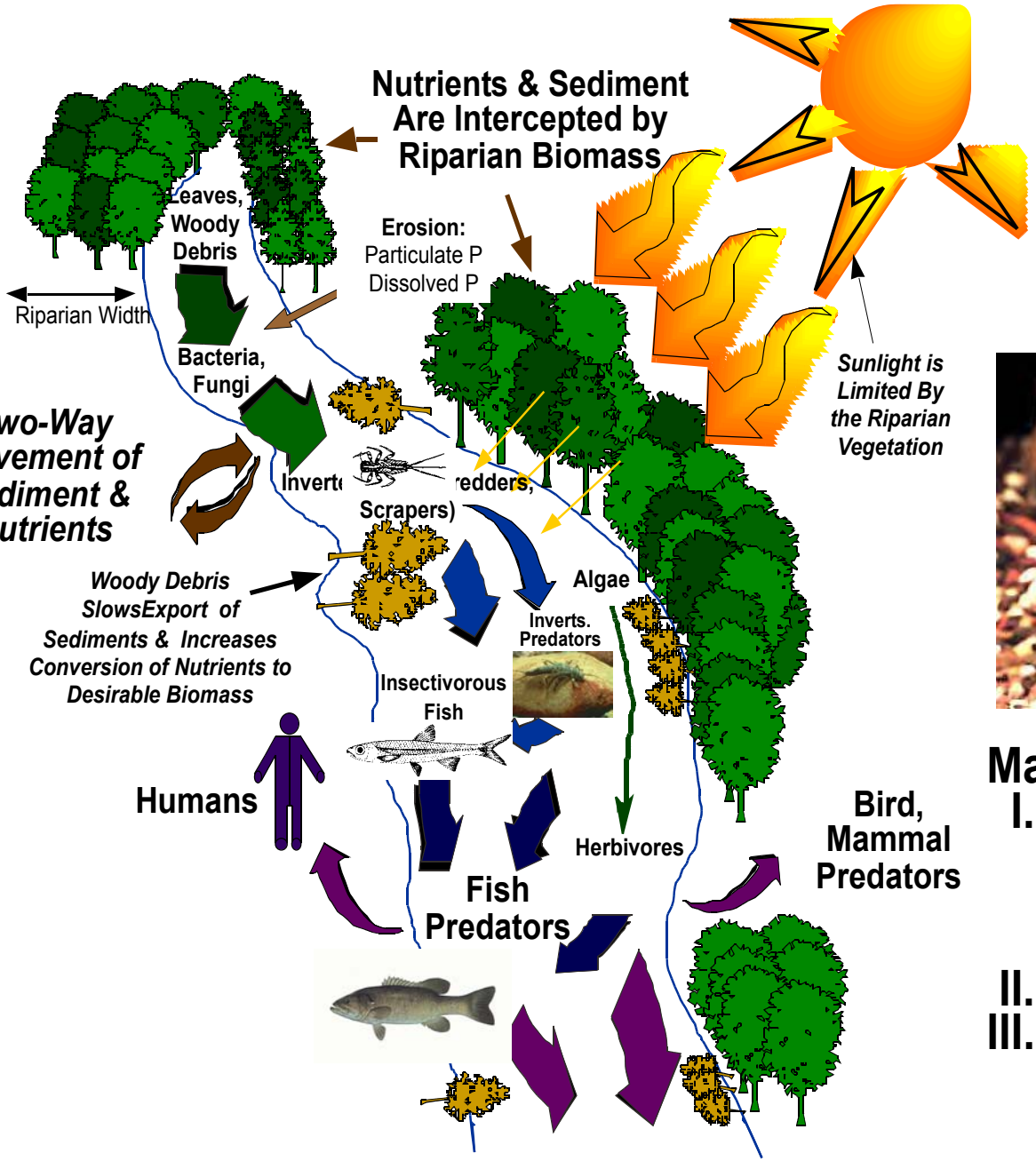
Ohio



U.S.



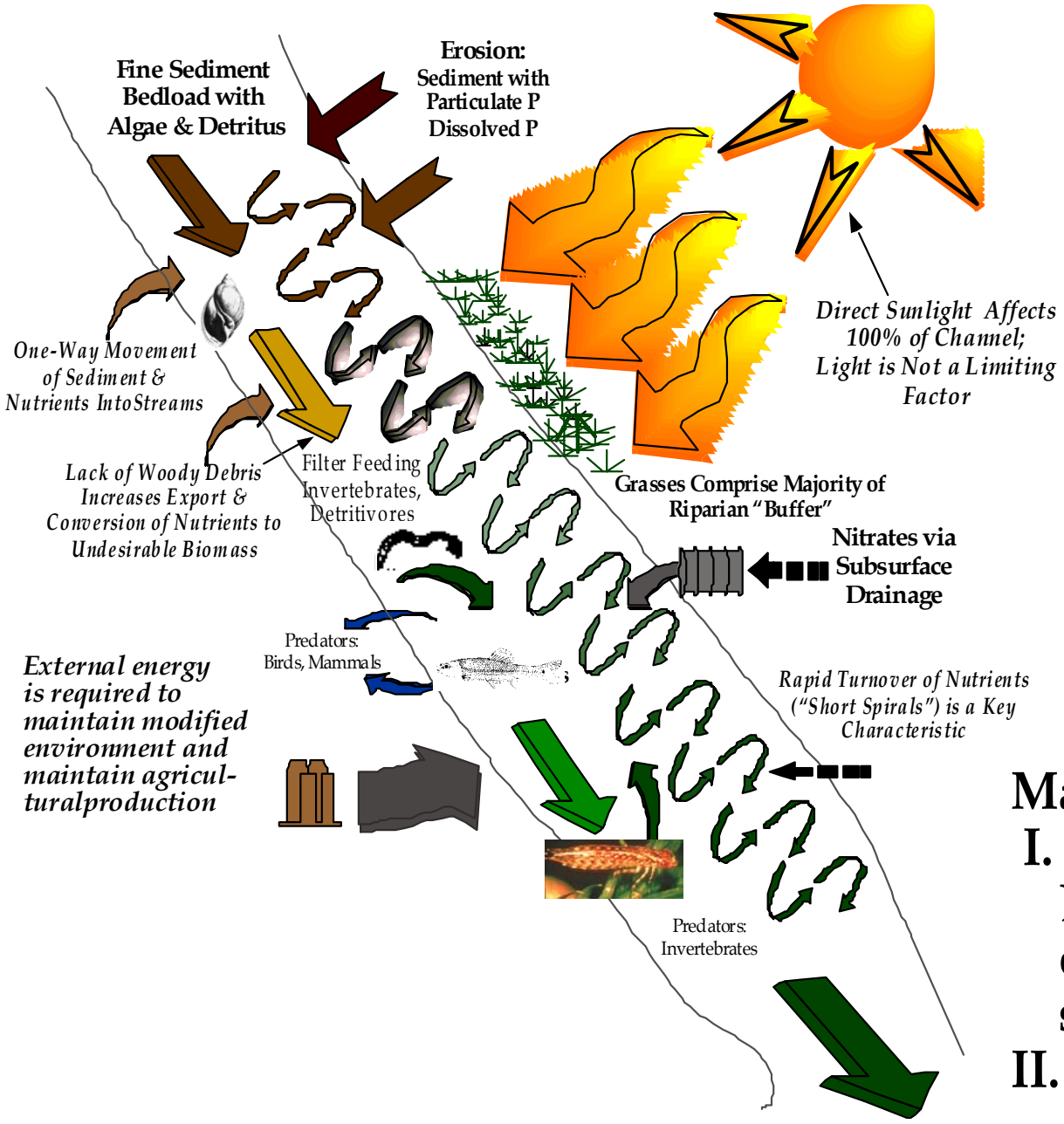
Good Stream Habitat



Major Downstream Exports:

I. Desirable Biomass (*e.g.*, fish, plants, birds, mammals, sensitive species)
II. Low Sediment Delivery
III. Water Quality Suitable for ALL Uses

Modified Stream Habitat



Major Downstream Exports:

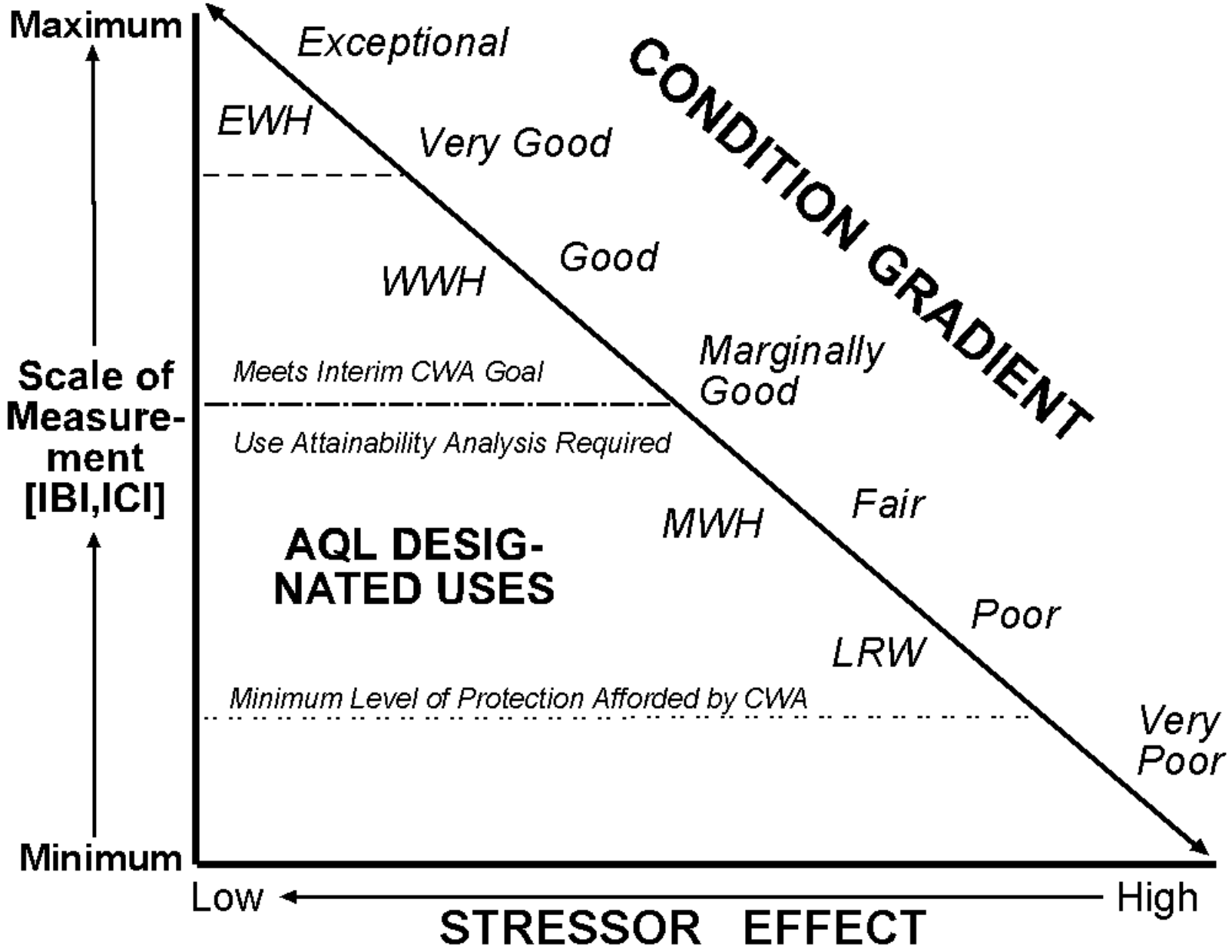
I. Nutrients & Undesirable Biomass (*e.g.*, algae, detritivores, tolerant species)

II. High Sediment Delivery

Importance of Habitat Monitoring

- States should have range of monitoring tools to assess habitat quality
- Need for sufficient precision and accuracy to explain patterns in aquatic life condition and predict results of management scenarios – i.e., need to be able to accurate describe "human disturbance gradient"
- Existing methodologies range from "Volunteer Methods" to qualitative professional methods to quantitative methods
- Opportunities for collaboration with geomorphologists, hydrologists, and engineers working on stream restoration, flood control, etc.

DESIGNATED USE OPTIONS ALONG THE BIOAXIS AND BIOLOGICAL CONDITION GRADIENT



Case History: Why Did Ohio Develop Tiered Uses?

Rationale for Ohio WQS in 1978

- Natural history - published texts convey a general knowledge of variable, yet distinguishable resource attributes (e.g., Trautman – Fishes of Ohio).
- One-size-fits-all did not "sell"
- Promised more customized water quality management outcomes (WQS, permits, etc.).

EVOLUTION OF ASSESSING SURFACE WATER INTEGRITY: ADDING NEW & BETTER TOOLS

WATER QUALITY → WATER RESOURCE

- Simple Chemical Criteria
- General Aquatic Life Use

(1974 - 1978)

- More Chemical Criteria
- Tiered Aquatic Life Uses

(1978 - 1980)

- Complex Chemi-Criteria
- Tiered Aquatic Life Uses
- Narrative Bio-logical Criteria

(1980 - 1990)

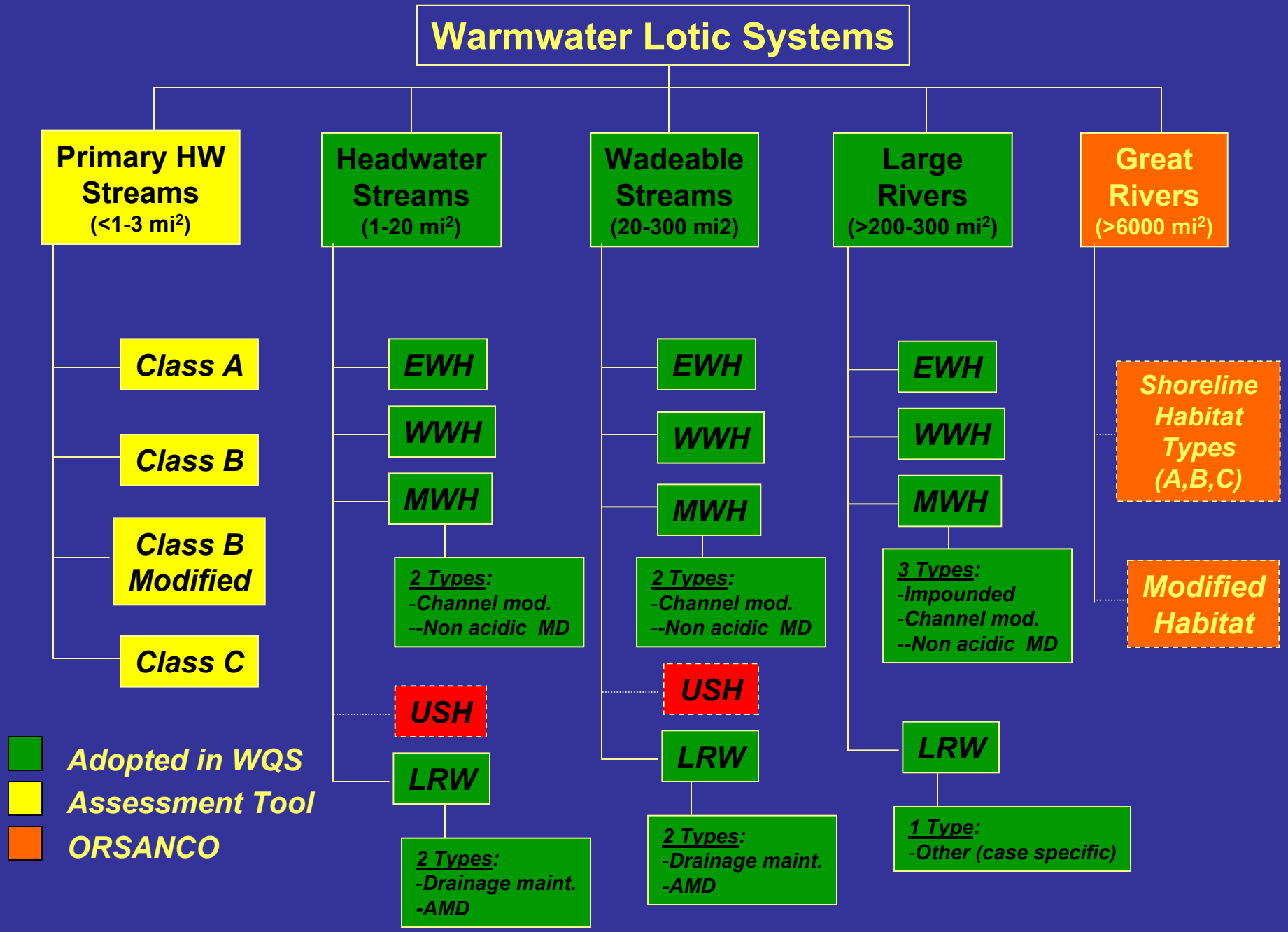
- More Complex Chemical Criteria
- Tiered Aquatic Life Uses
- Numerical Bio-logical Criteria
- Whole Effluent Toxicity Tests
- Physical Habitat Evaluation

(1990 - Present)

LESS ACCURACY → MORE ACCURACY

("Natural" convergence of independently developed tools?)

OHIO SPECIFIC TEMPLATE FOR STRATIFICATION



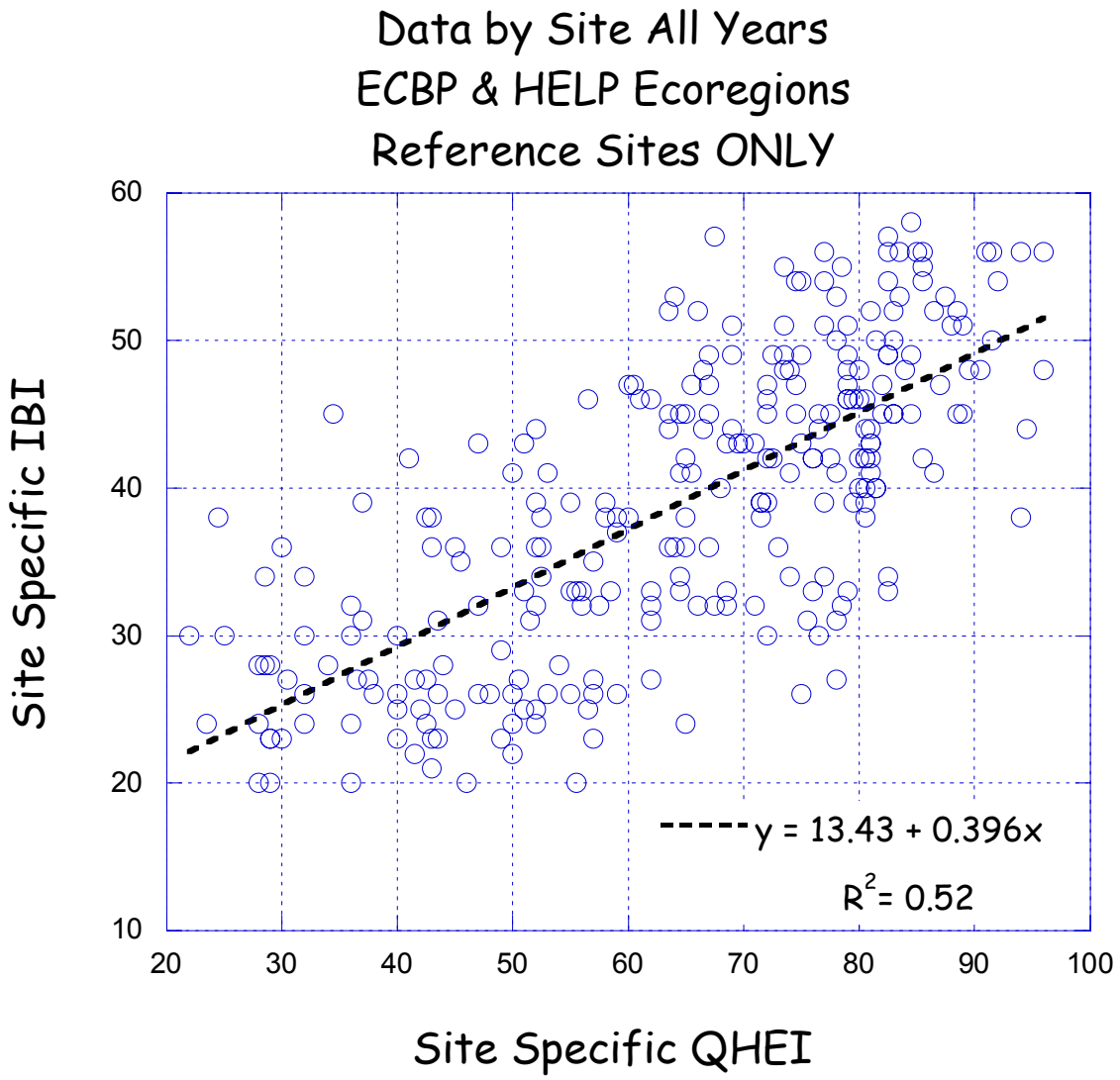
The Qualitative Habitat Evaluation Index (QHEI)

QHEI Includes Six Major Categories of Macrohabitat

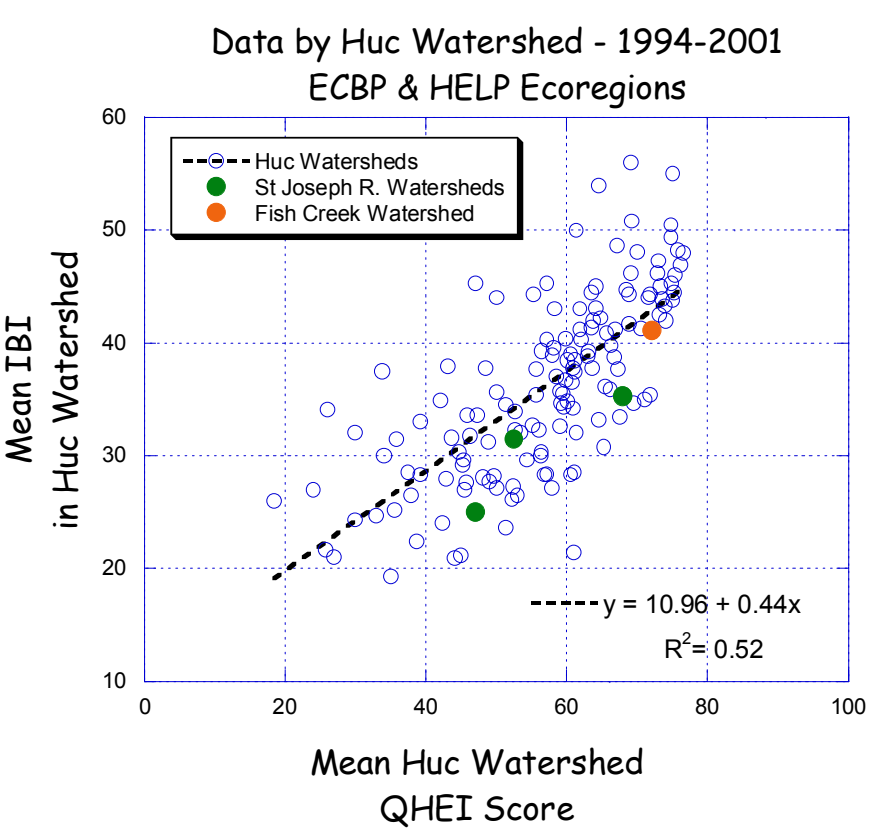
- Substrate - types, origin, quality, embeddedness
- Instream Cover - types and amounts
- Channel Quality - sinuosity, development, stability
- Riparian/Bank Stability - width, quality, bank erosion
- Pool/Riffle/Run - max. depth, current types, morphology, substrate embeddedness
- Gradient - local gradient (varies by drainage area)

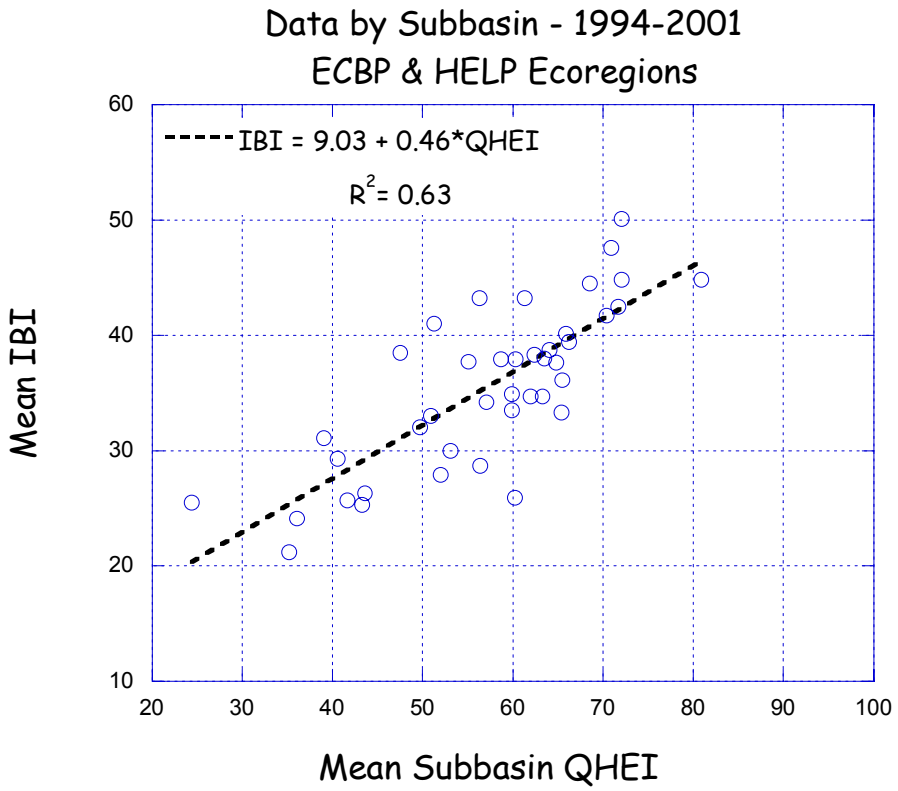
Source: The Qualitative Habitat Evaluation Index (Rankin 1989)

Spatial Correlations: Habitat features show strongest correlations

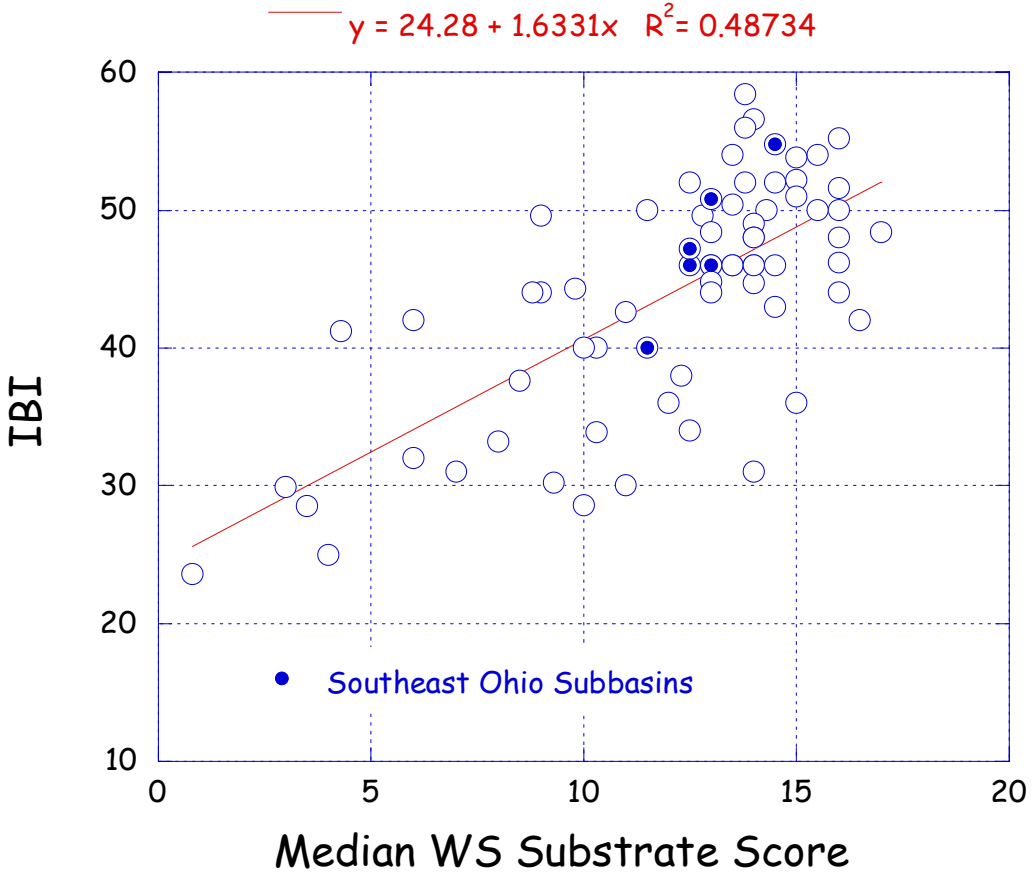


Spatial Correlation at Huc 11 Watershed and Subbasin Scales:

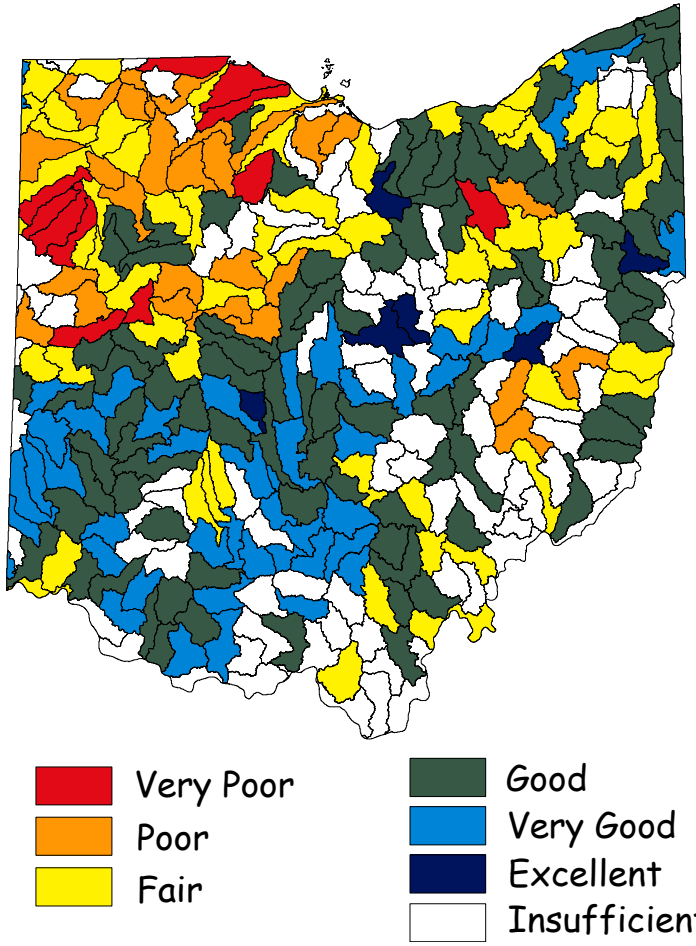


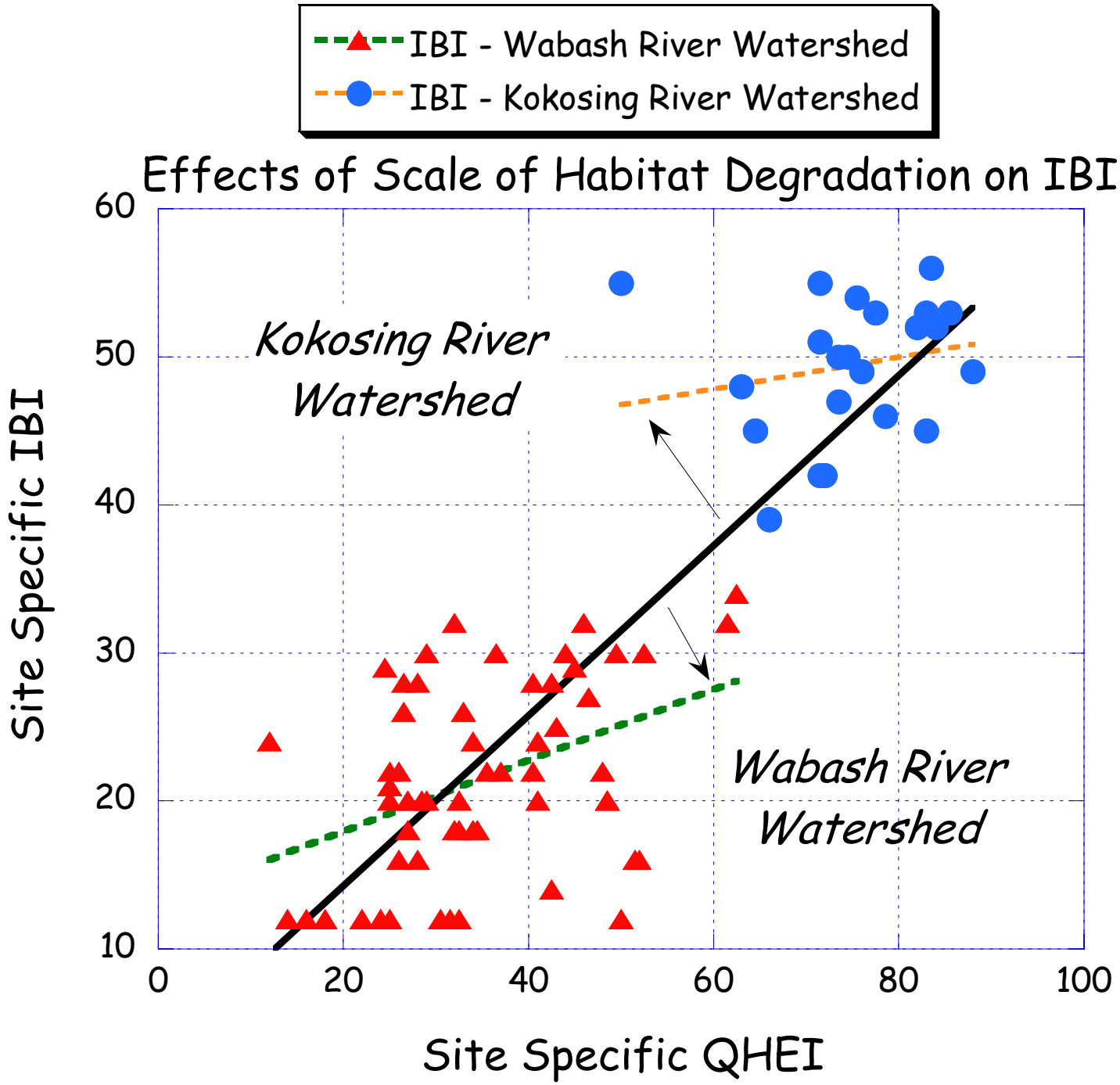


How Scale of Impacts Can Affect Development of Targets or Criteria



Average Habitat Quality by Watershed




IBI - Wabash River Watershed
IBI - Kokosing River Watershed
Effects of Scale of Habitat Degradation on IBI
Kokosing River Watershed
Wabash River Watershed
Site Specific IBI
Site Specific QHEI
60
50
40
30
20
10
0
20
40
60
80
100

Use Attainability Analysis I: Are CWA Goal Uses Attainable?

U.S. EPA regulations allow lower than CWA goal uses where precluded by:

- naturally occurring pollutant levels;
- natural flow conditions (i.e., ephemeral) **;
- human-induced conditions which cannot be remediated;
- hydrological modifications (dams, diversions, channel modifications) which cannot be operated in a manner consistent with the CWA goal use;
- natural physical features (substrate, flow, depth);
- controls to attain use would cause widespread, socioeconomic impacts.

** - does not apply when flow is augmented by an effluent discharge.

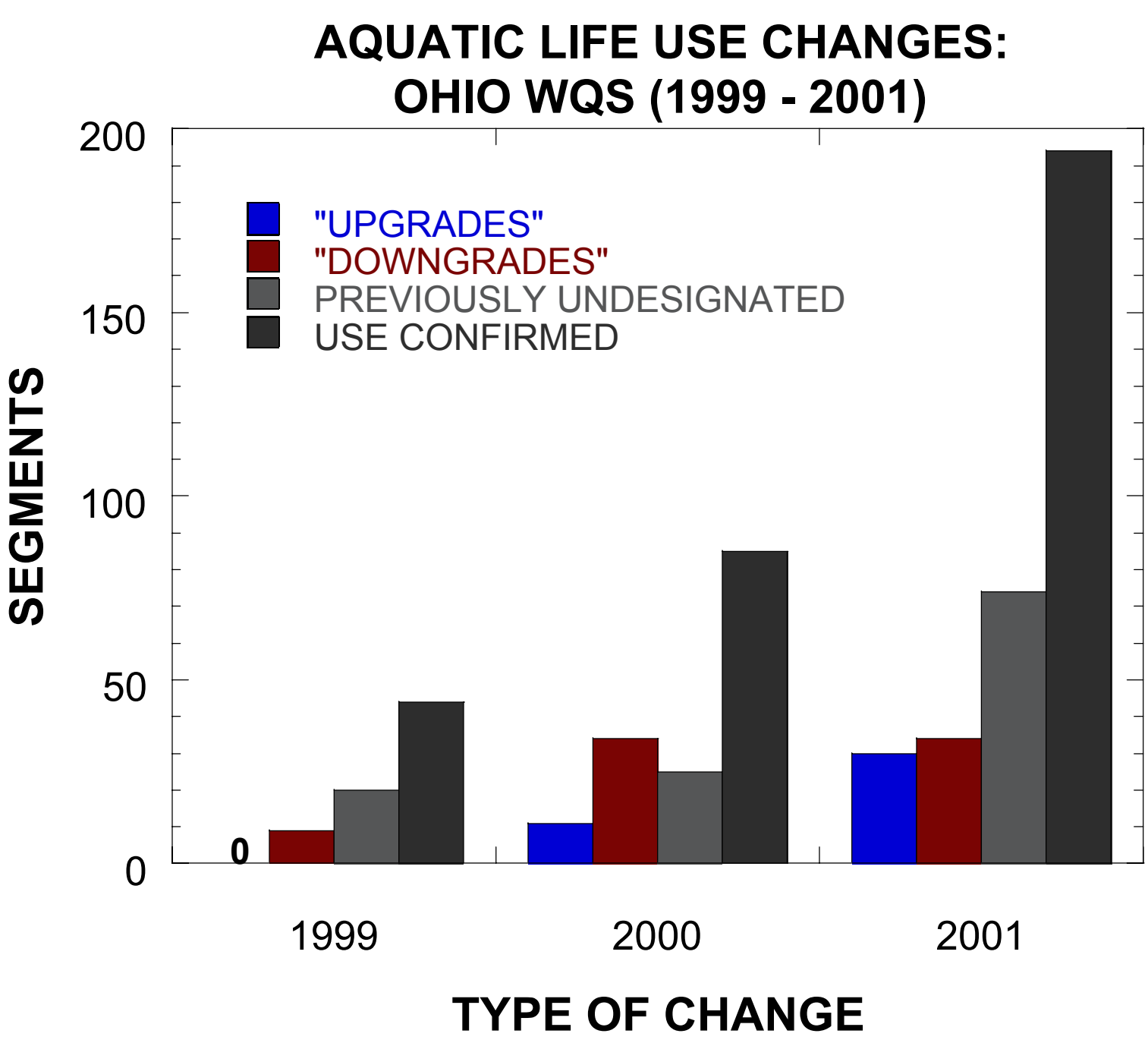
Source: 40 CFR Part 131.10 (g)(1-6)

Use Attainability Analysis in Ohio: Process and Information Requirements**

Use attainability analysis requires the following information and knowledge:

- existing status of waterbody based on biocriteria;
- habitat assessment to evaluate potential;
- reasonable relationship between impaired state and precluding activity based on assessment of multiple indicators used in appropriate roles;
- recommendation subject to WQS rulemaking process
- < CWA uses reviewable every three years - a "temporary" designation.

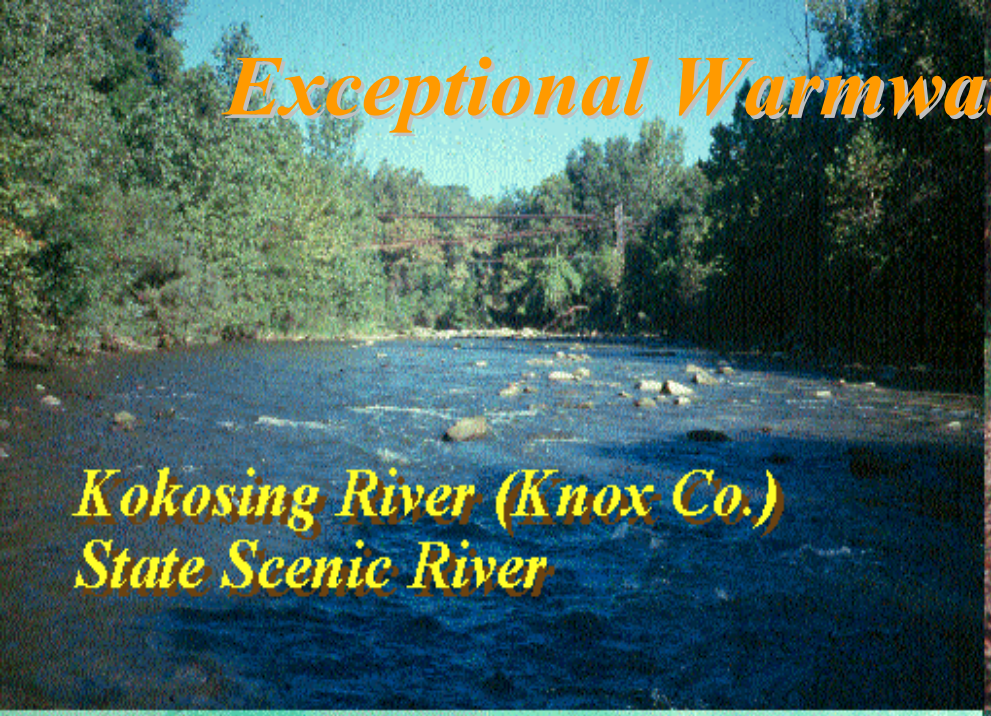
** -All data collection and analysis must conform to Ohio WQS and Five-Year Monitoring Strategy data and design quality objectives.


AQUATIC LIFE USE CHANGES:
OHIO WQS (1999 - 2001)
200
150
100
50
0
SEGMENTS
"UPGRADES"
"DOWNGRADES"
PREVIOUSLY UNDESIGNATED
USE CONFIRMED
0
1999
2000
2001
TYPE OF CHANGE

Adequate Monitoring & Assessment and Sufficiently Detailed WQS Are Essential to Sound UAA Practice

- UAAs are a routine outcome of adequate M&A
- Data & assessments to support UAA are produced in a consistent and timely manner
- Tiered uses and calibrated biocriteria anchor determinations of existing status & potential
- Focus is on outcome of assessment – terms "upgrade" and "downgrade" are not particularly relevant

Exceptional Warmwater Habitat (EWH)



Kokosing River (Knox Co.)
State Scenic River

Lost Creek (Miami Co.)

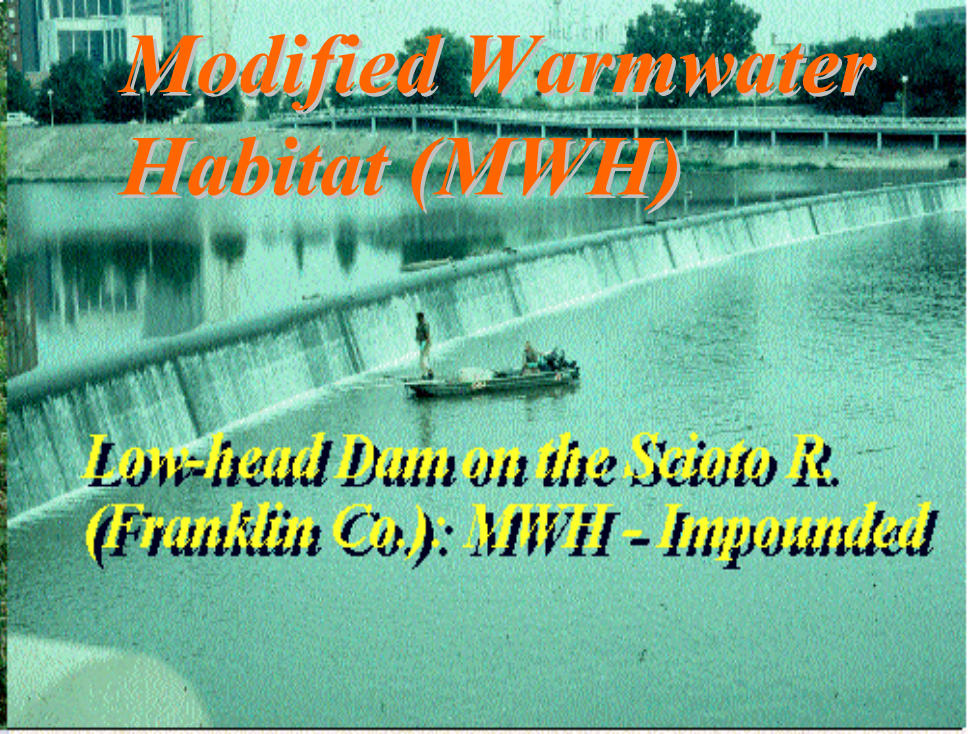
Big Darby Creek (Madison Co.
State and National Scenic River

Bluebreast darter
(Etheostoma camurum)
Ohio Threatened Species

Bokengehalas Cr. (Logan Co.)
E. Corn Belt Plain Ecoregion
Powell Creek (Definace Co.)
Huron/Erie Lake Plain
Warmwater Habitat (WWH)
Wolf Creek (Summit Co.)
Erie/Ontario Lake Plain Ecoregion
Duck Cr. Subbasin (Wash. Co.)
W. Allegheny Plateau Ecoregion

Modified Warmwater Habitat (MWH)

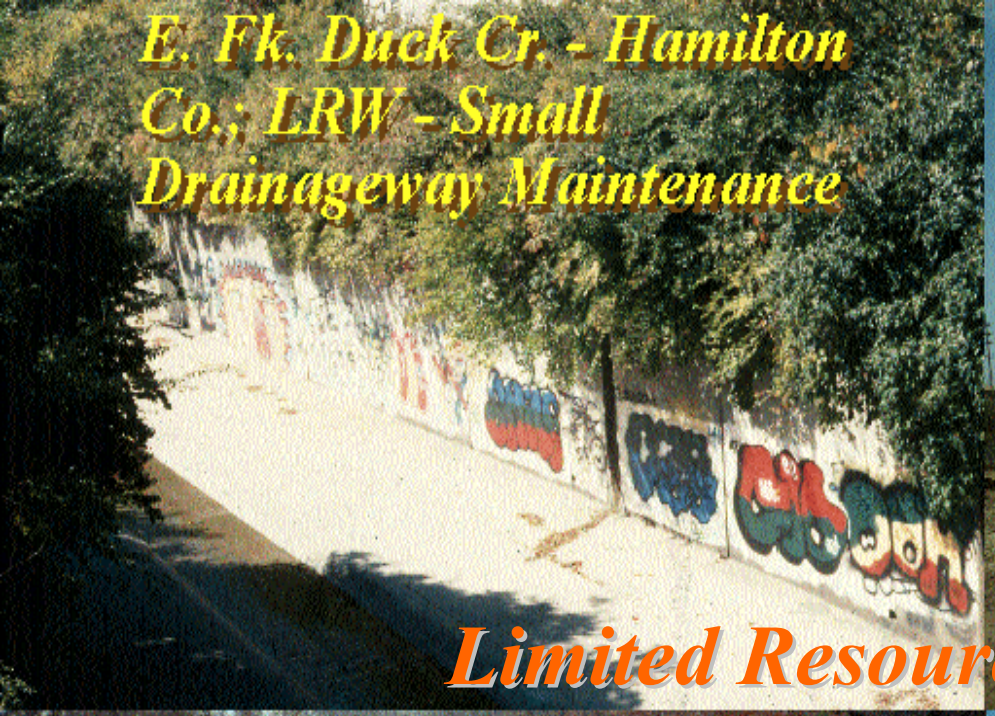
Drainage Maintenance is Common in Western and Northwest Ohio: MWH - Channelization



Low-head Dam on the Scioto R. (Franklin Co.): MWH - Impounded

Non-Acidic Runoff From Abandoned Mine Lands Results in Severe Sedimentation: MWH - Mine Drainage

Creek Chub With Blackspot: MWH Streams are Predominated by Tolerant Species

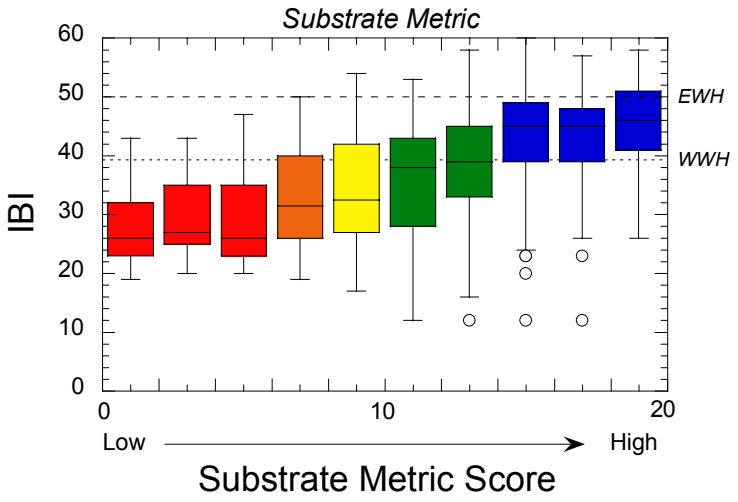


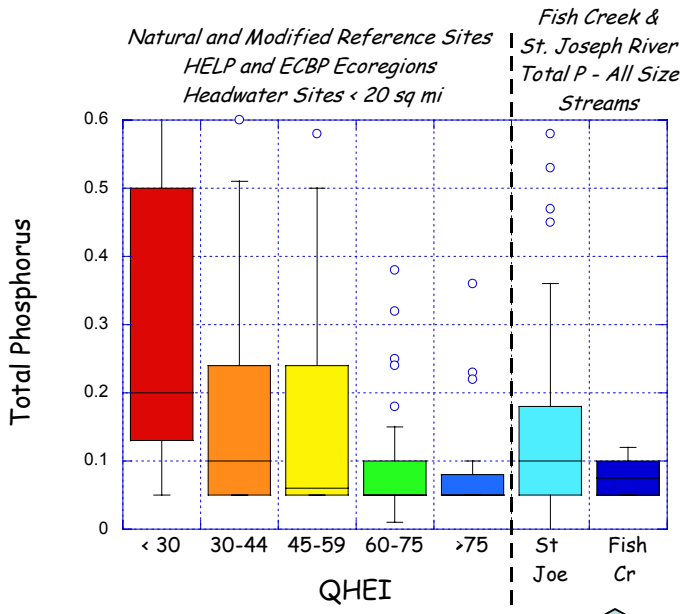
Limited Resource Waters (LRW)

In Addition to Derivation of Tiered Aquatic Life Uses and UAAs

- Habitat data appears to be critical influence on the delivery and effect of nutrients and sediments
- Use in stressor identification efforts
- Helps explain species-specific responses to land use changes, hydrological modification
- Direct tool for assessment of potential with 401/404 permitting

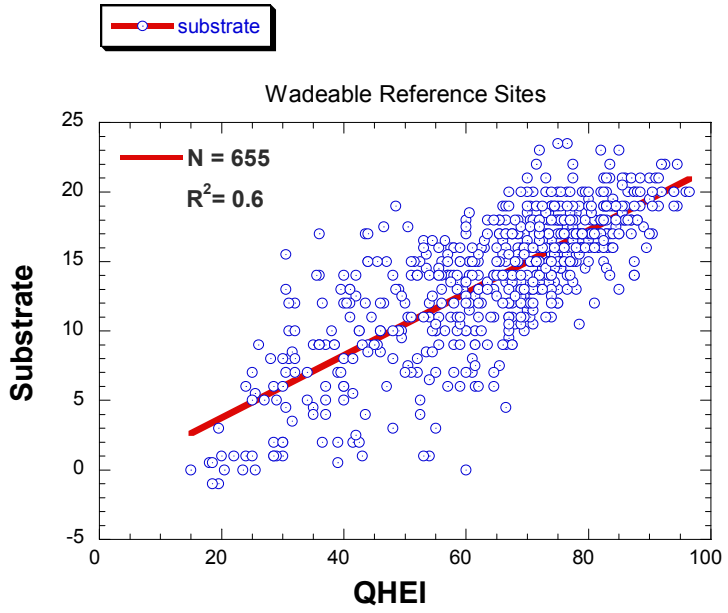
Substrate Strongly Related to IBI



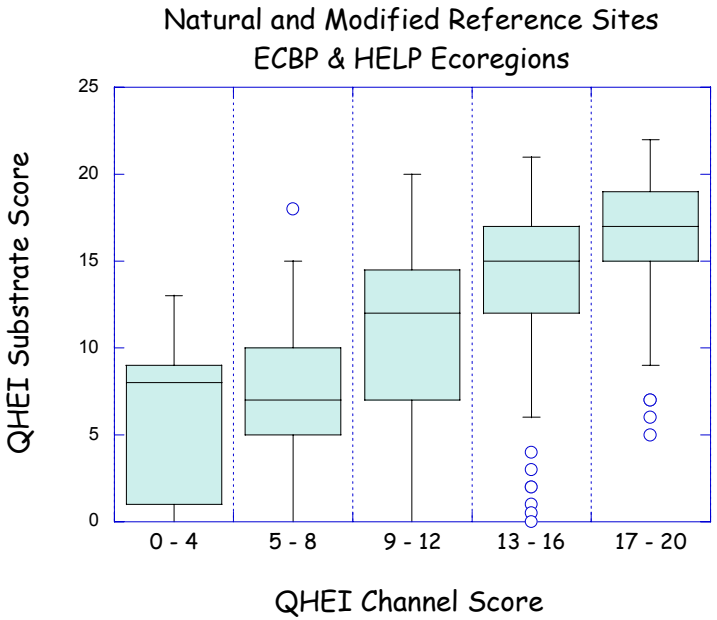


Substrate Major Component Of QHEI

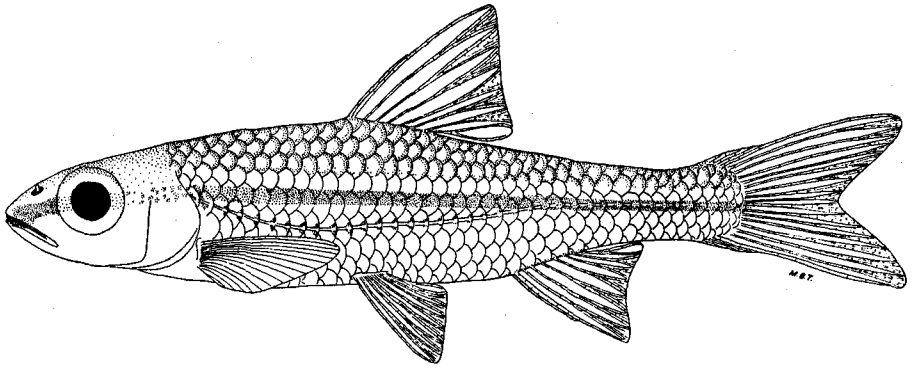
TP Influence by Habitat

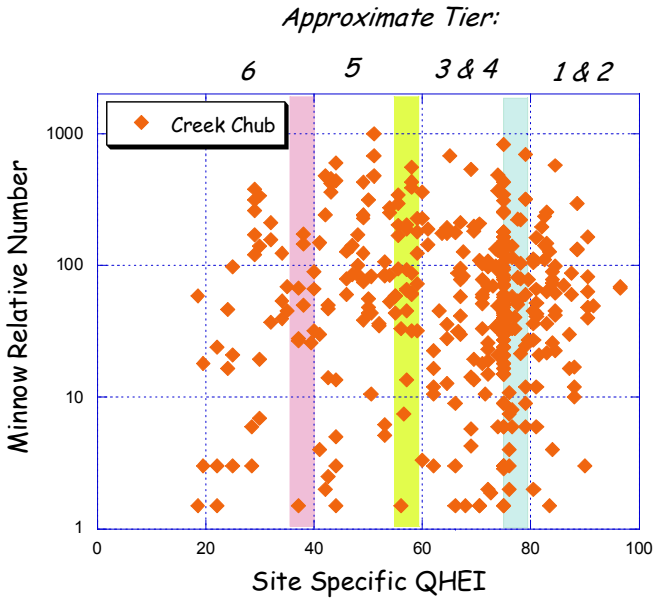


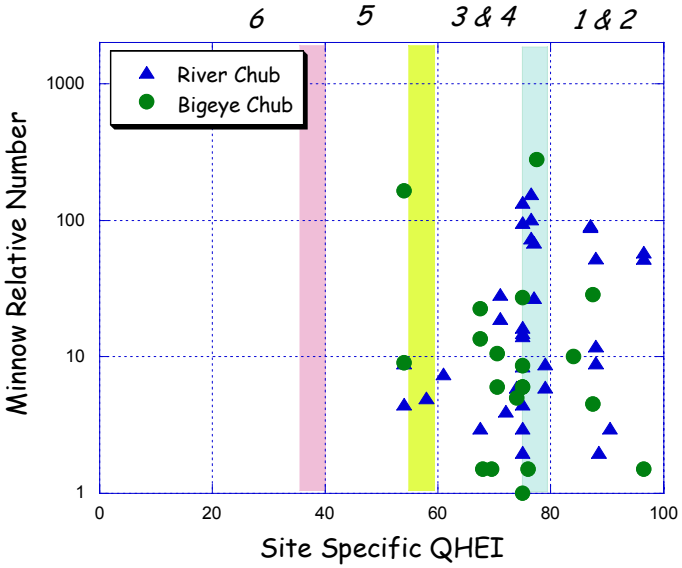
Substrate Strongly Linked to Channel Form

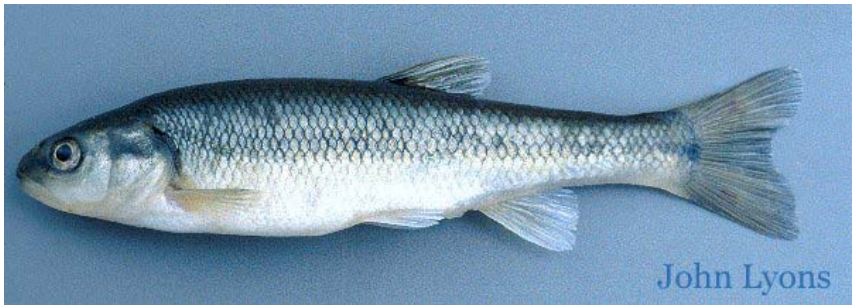


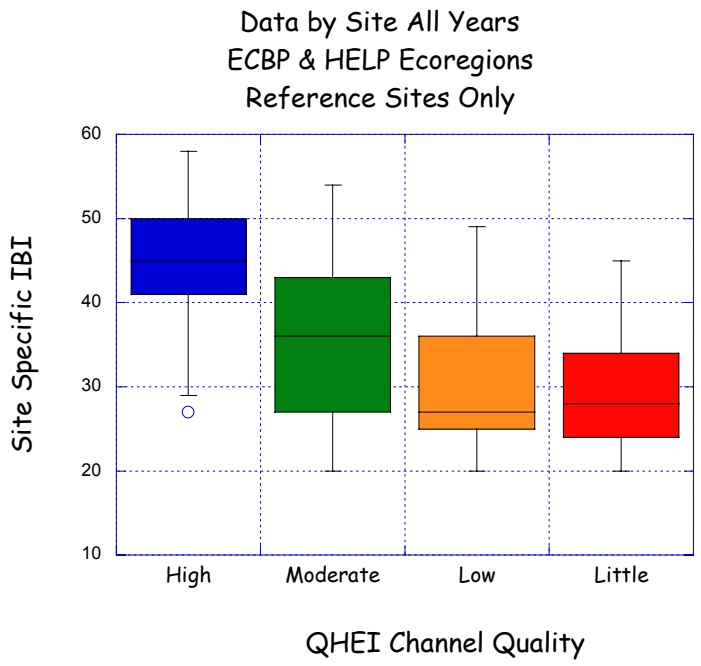
Association Between Habitat Quality and Species Relative Abundance, Tolerant & Sensitive Minnows

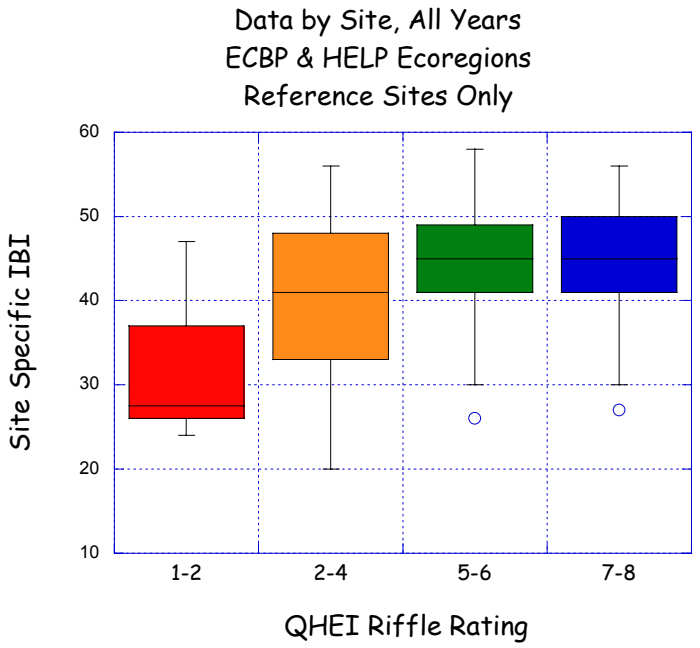


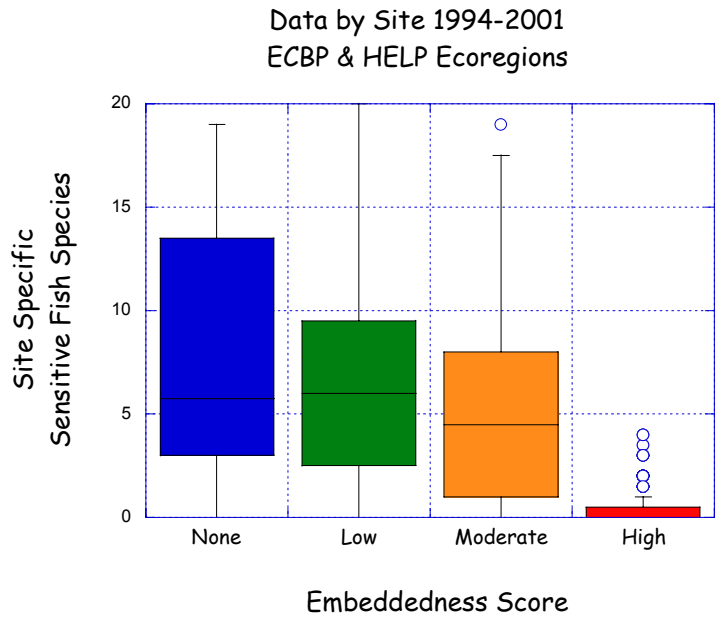


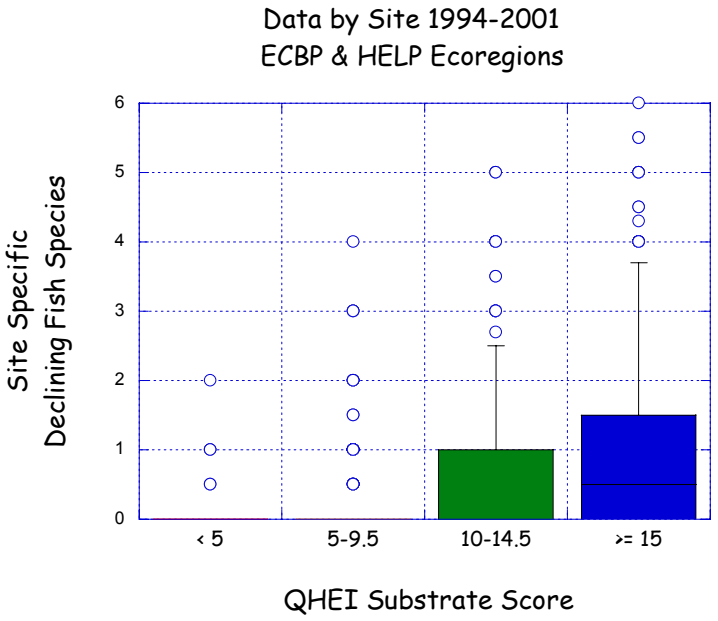




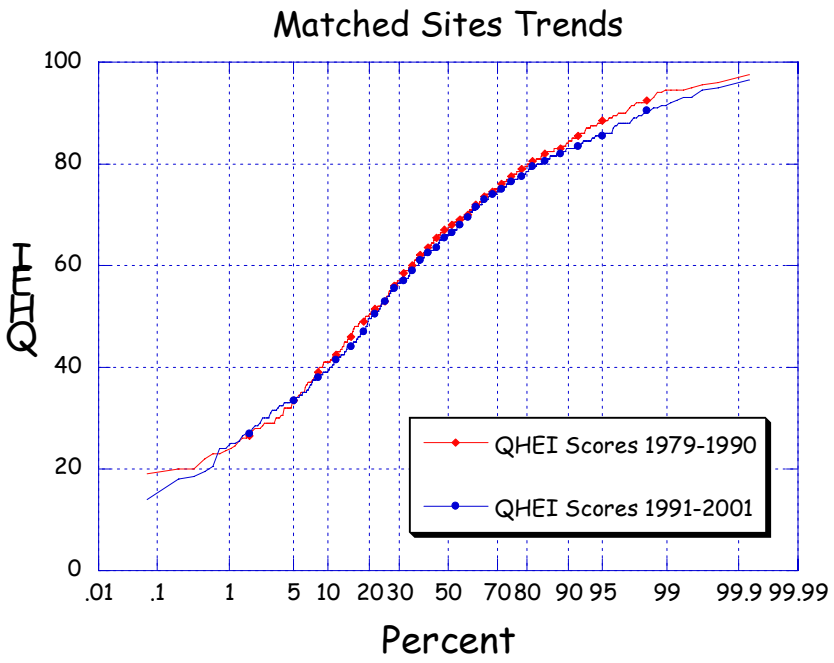

Data by Site All Years
ECBP & HELP Ecoregions
Reference Sites Only
Site Specific IBI
60
50
40
30
20
10
High
Moderate
Low
Little
QHEI Channel Quality

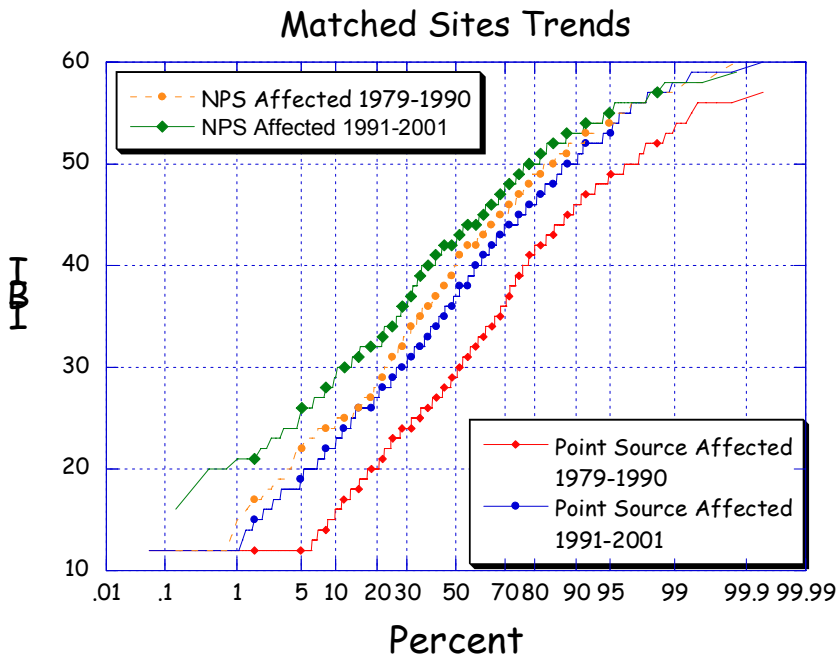

Data by Site, All Years
ECBP & HELP Ecoregions
Reference Sites Only
Site Specific IBI
60
50
40
30
20
10
1-2
2-4
5-6
7-8
QHEI Riffle Rating

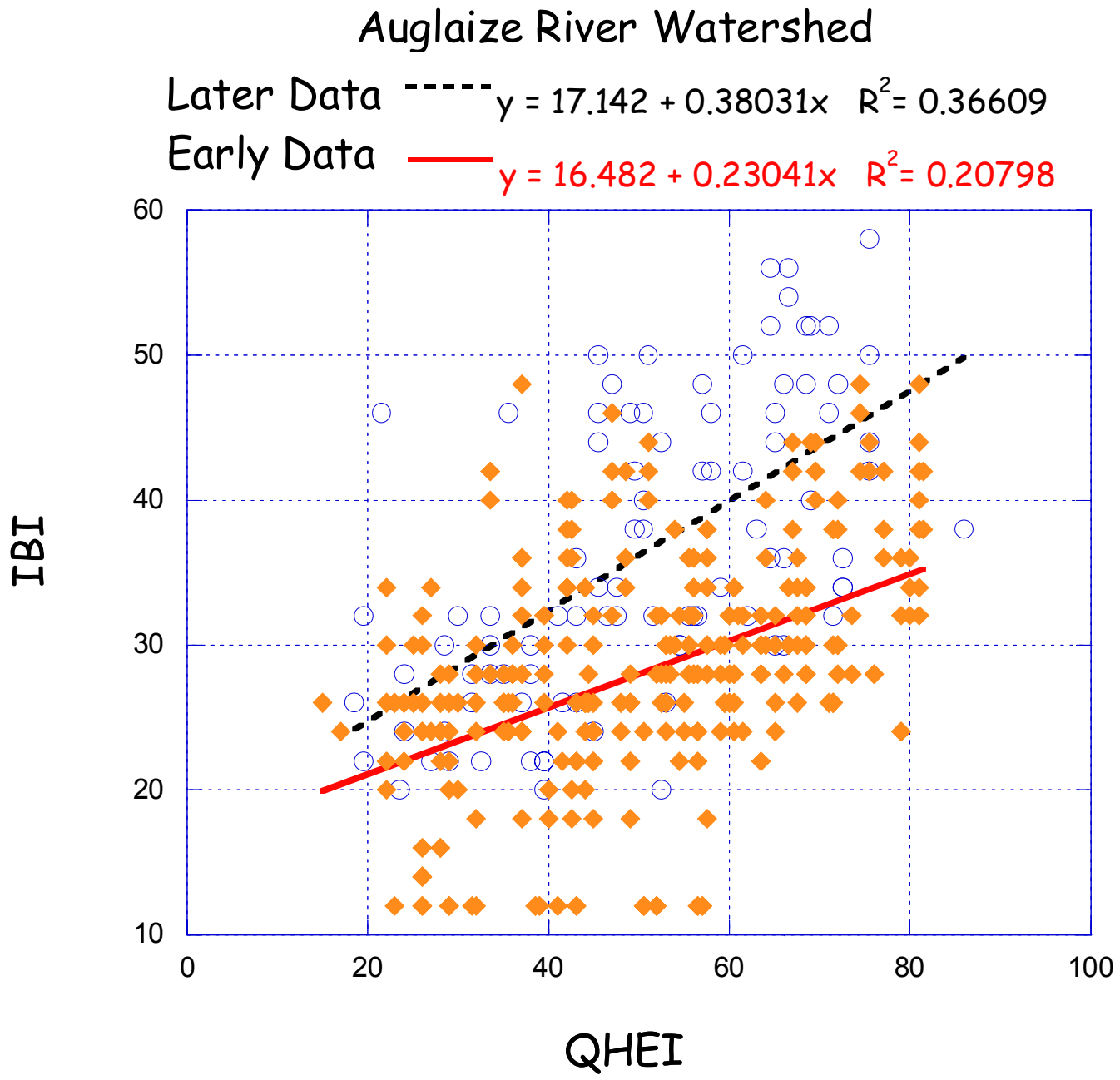

Data by Site 1994-2001
ECBP & HELP Ecoregions
Site Specific
Sensitive Fish Species
20
15
10
5
0
None
Low
Moderate
High
Embeddedness Score


Data by Site 1994-2001
ECBP & HELP Ecoregions
Site Specific
Declining Fish Species
6
5
4
3
2
1
0
< 5
5-9.5
10-14.5
>= 15
QHEI Substrate Score

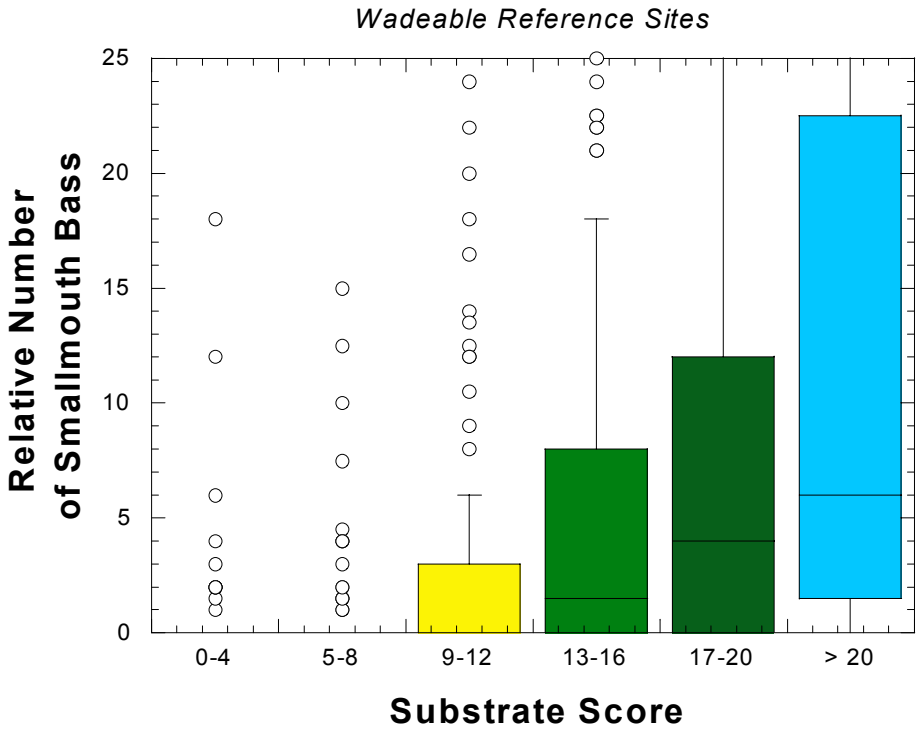
Trend Analyses - NPS



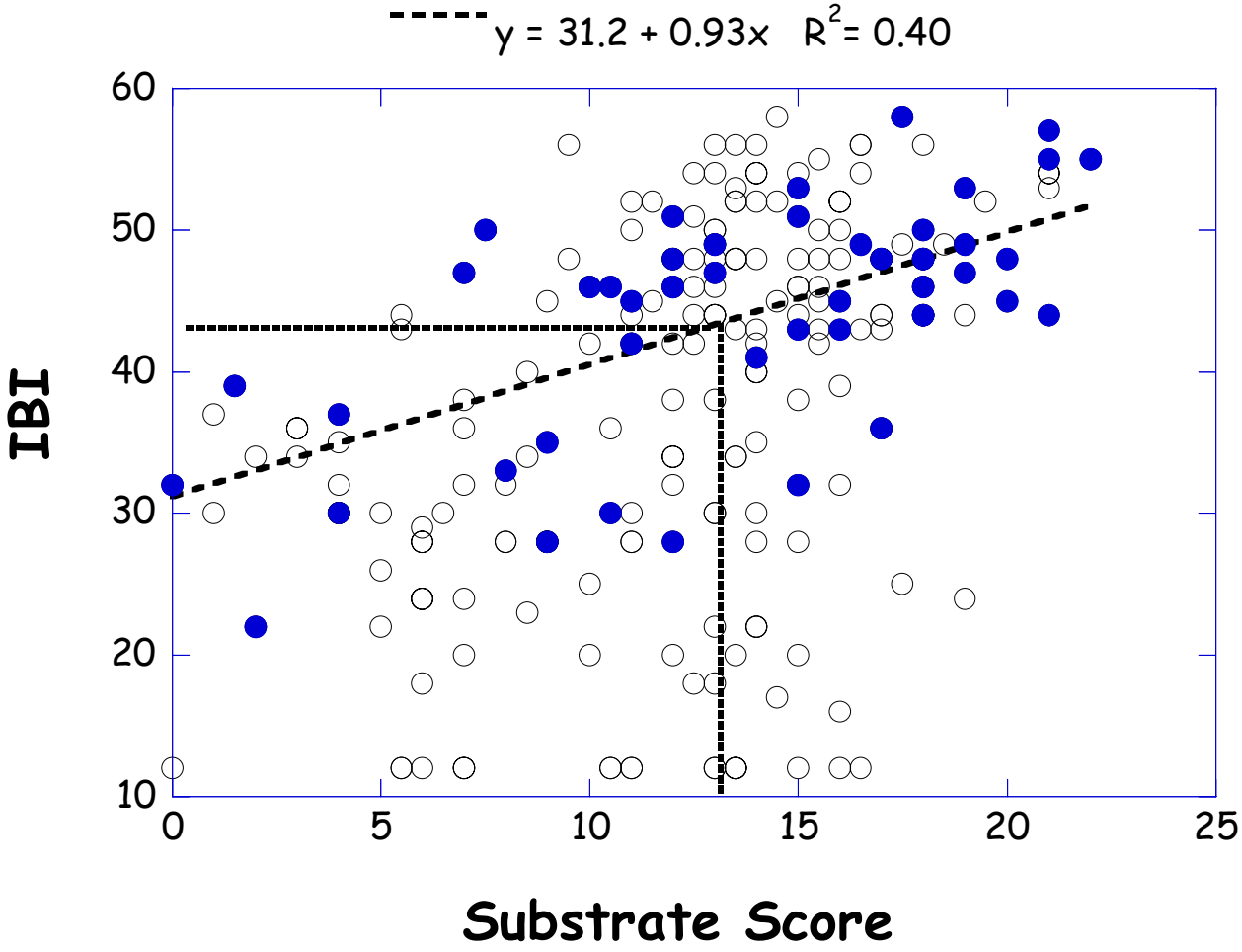



Auglaize River Watershed
Later Data
y = 17.142 + 0.38031x R2= 0.36609
Early Data
y = 16.482 + 0.23041x R2= 0.20798
IBI
QHEI
60
50
40
30
20
10
0
20
40
60
80
100

Smallmouth Bass vs QHEI Substrate



TMDL Development



Substrate Endpoints for Warmwater Streams:

QHEI Substrate Metric Endpoint for WWH streams:

13-14

QHEI Embeddedness Measure:

Low-None

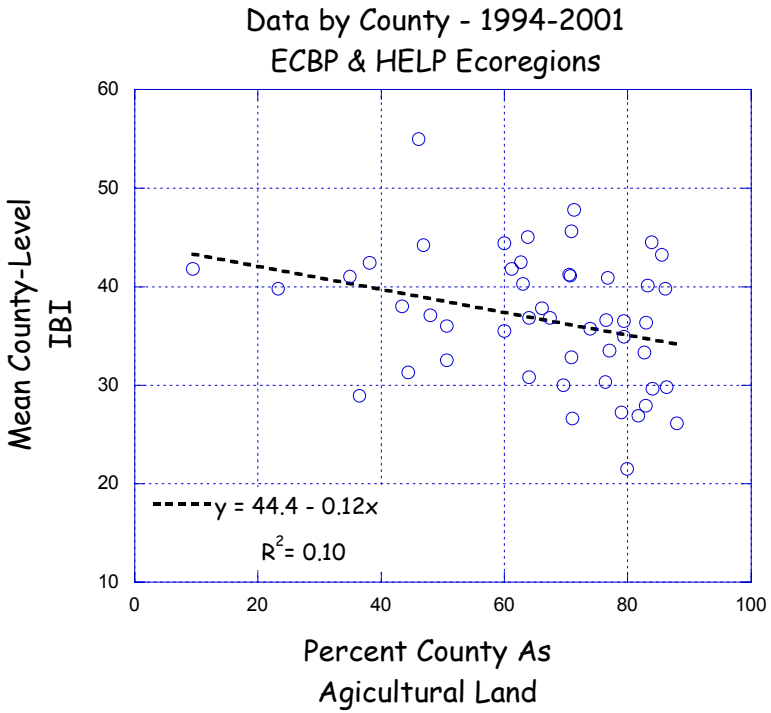
Mean Watershed Substrate Endpoint:

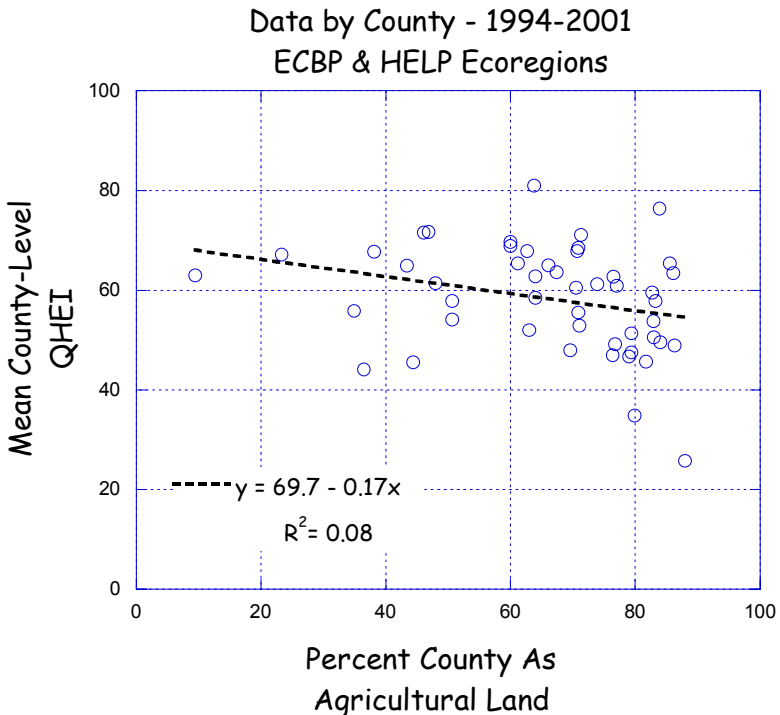
13-14

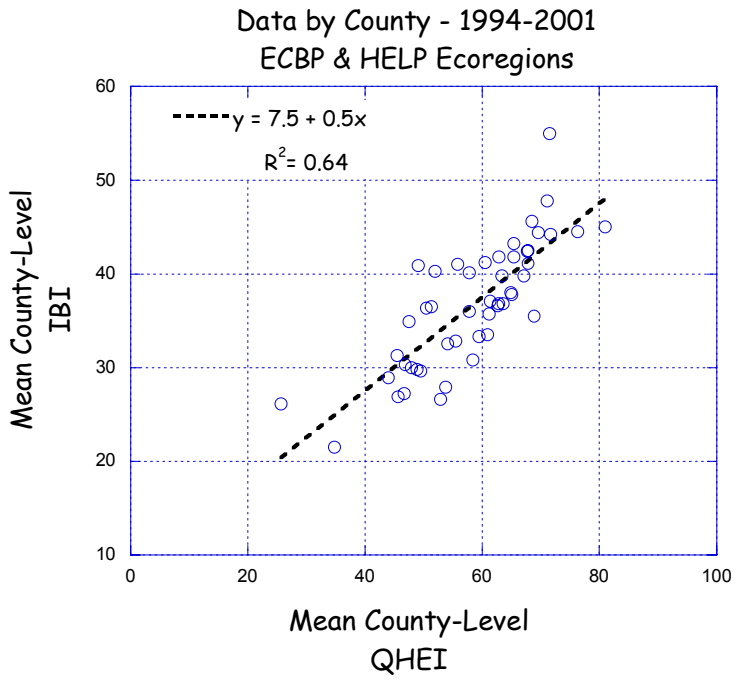
What is Missing from Most Habitat Assessments?

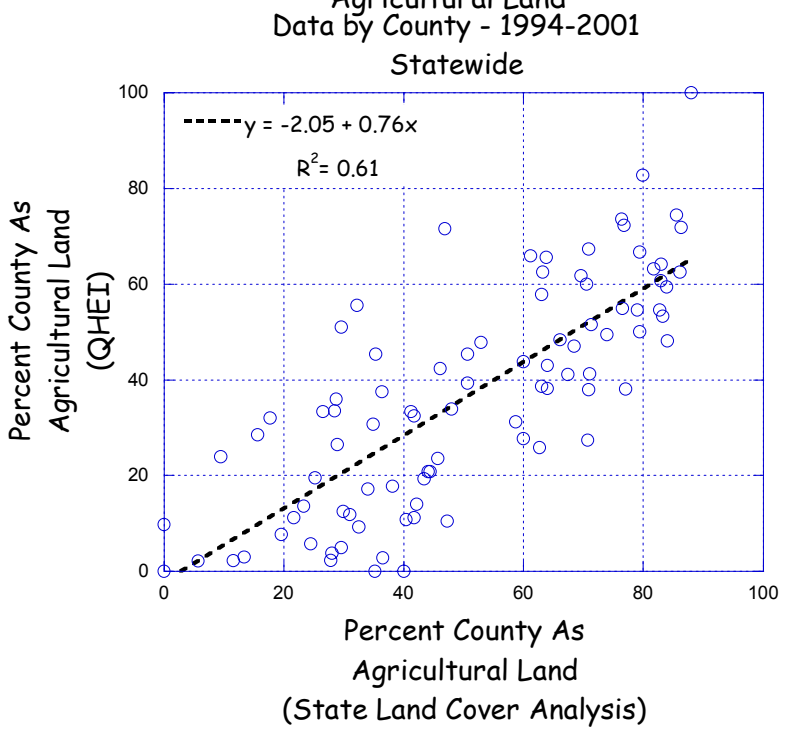
- Habitat data provides a great explanatory variable to explain biological condition in streams, but:
  - Need to understand mechanisms underlying changes in habitat features
  - Need to understand links between hydrology and habitat condition
  - This will allow more consistent approach to development and assessment of correct BMPs (e.g., natural streams design methods)

END


Data by County - 1994-2001
ECBP & HELP Ecoregions
Mean County-Level IBI
y = 44.4 - 0.12x
R2= 0.10
Percent County As Agicultural Land


Data by County - 1994-2001
ECBP & HELP Ecoregions
Mean County-Level QHEI
y = 69.7 - 0.17x
R2= 0.08
Percent County As Agricultural Land


Data by County - 1994-2001
ECBP & HELP Ecoregions
Mean County-Level IBI
y = 7.5 + 0.5x
R2= 0.64
Mean County-Level QHEI


Data by County - 1994-2001
Statewide
Percent County As Agricultural Land (QHEI)
y = -2.05 + 0.76x
R2= 0.61
Percent County As Agricultural Land (State Land Cover Analysis)

Key Discussion Questions

- What are the best indicators to measure for suspended and bedded sediments that would provide the most protection for aquatic life? Should these vary with water body type?
- How can suspended and bedded sediment indicators or measurements be adjusted for different aquatic life designated uses?
- What types of practical, reasonable cost quantified habitat indicators can be measured by States and Tribes to help improve protection of habitat and thereby aquatic life?
- Can quantified habitat indicators be used to set aquatic life designated uses or other aquatic life protection standards?
- Do you have a case study of where habitat indicators have been measured and used in water quality standards (designated uses or criteria) to better protect aquatic life in water bodies?
- Do you have a case study of where suspended and bedded sediment indicators have been measured and used in water quality standards (designated uses or criteria) to better protect aquatic life in water bodies?