

The Effects of Single vs. Tiered Aquatic Life Uses, Multiple vs. Single Assemblages, and Bioassessment-Based vs. Chemical Criteria-Based Methods on Estimation of Aquatic Life Use Attainment and Impairment

Edward T. Rankin

Center for Applied Bioassessment and Biocriteria

Rankin@Ilgard.ohiou.edu

QHEI@aol.com

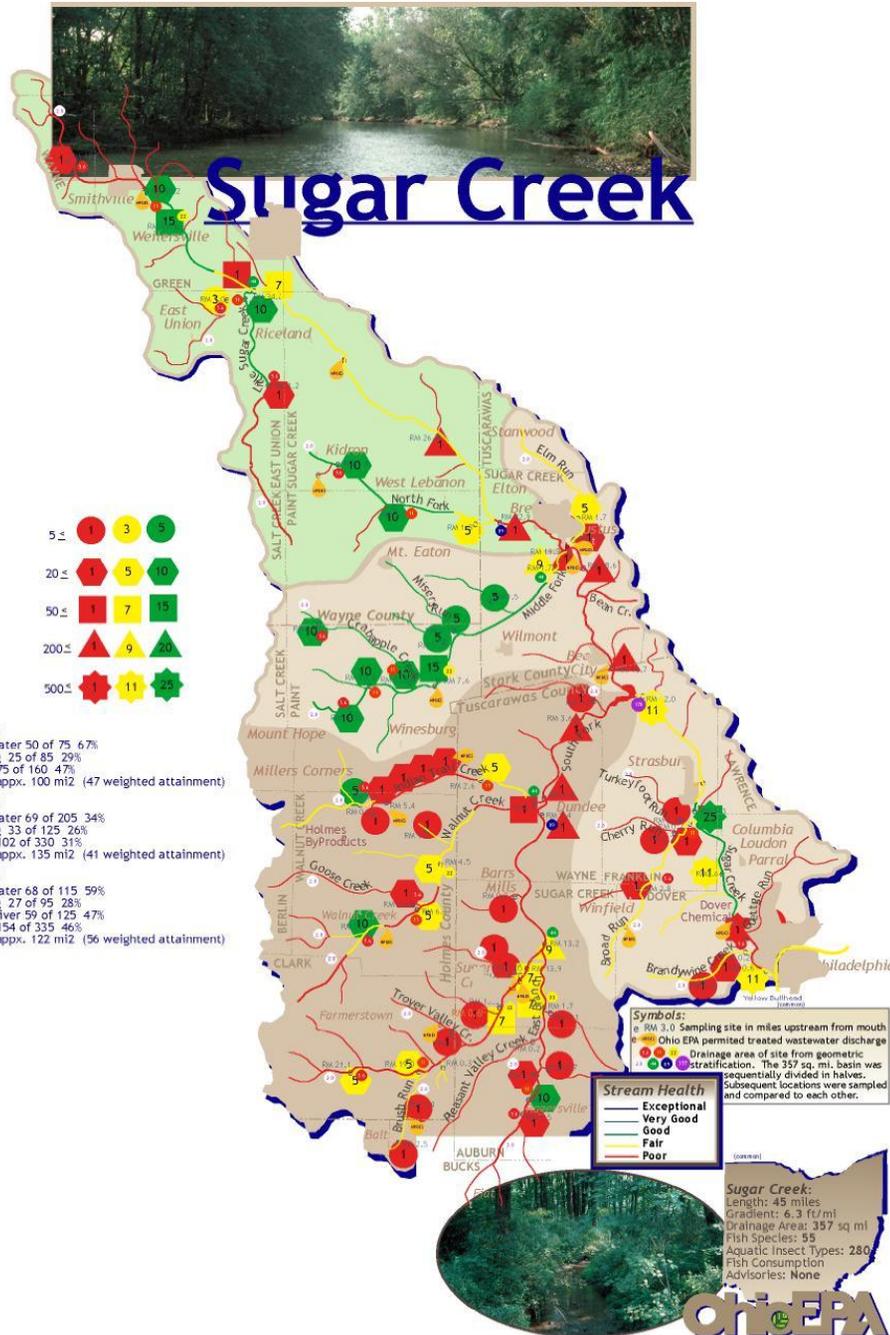
CABB

Importance of Adequate Monitoring and Water Quality Standards Program

- TMDL program and a myriad of other state water management programs are dependent on the structure of a state's water quality standards program including:
 - its aquatic life use structure, and
 - monitoring efforts performed to measure attainment or impairment of these aquatic life goals
- Therefore, there is a need to know consequences of monitoring choices including organism groups, goals for waters and use of indicators to identify impairment

Restrospective Examination Of Ohio EPA Ecological Database

- Ohio has:
 - Tiered aquatic life uses
 - Biocriteria based on two organism groups (fish and macroinvertebrates)
 - Weight of evidence approach to assessment of aquatic life use impairment
 - Watershed/Geometric site design approach to monitoring
 - Tight integration with WQS and multiple uses and purposes for monitoring information (detecting impairment, UAA, stressor identification, TMDLs, hazardous waste assessments etc.,)



Sugar Creek Subbasin: Results of Geometric Design Assessment

- TMDL development scale: 11 digit HUC units, 328 statewide
- Mainstem rivers <500 mi² treated separately
- Watershed assessment results initially support UAA process
- Degree and severity of impairment then determined with biocriteria
- Causal associations determined via integrated analysis process
- **Supports prioritization ranking**
- More focused targeting of restoration activities
- **Local stakeholder “buy in” enhanced by scale of design**

Case History: Development of Tiered Aquatic Life Uses in Ohio

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

- More Chemical Criteria

- Complex Chemical Criteria

- More Complex Chemical Criteria

- General Aquatic Life Use

- Tiered Aquatic Life Uses

- Tiered Aquatic Life Uses

- Tiered Aquatic Life Uses

(1974 - 1978)

(1978 - 1980)

- Narrative Biological Criteria

- Numerical Biological Criteria

(1980 - 1990)

- Whole Effluent Toxicity Tests

- Physical Habitat Evaluation

(1990 - Present)

LESS ACCURACY



MORE ACCURACY

("Natural" convergence of independently developed tools?)

Ability to do "Retrospective" Watershed Assessments

- Ohio database consists of over 10,000 potential stations
- Fish, macroinvertebrates, water chemistry, habitat (QHEI) collected in a consistent manner over the past 20-25 years
- Assessments done of tiered aquatic life uses since early 1990s

Retrospective Analyses in this Study:

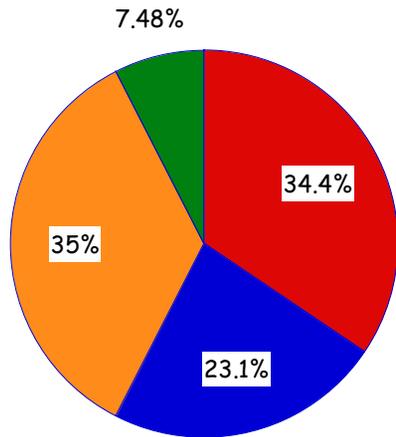
What are the consequences for assessment of condition??

- Chemical vs. biological indicators of aquatic life use attainment
- Fish vs. macroinvertebrates as indicators of aquatic life use attainment
- Tiered aquatic life uses vs. single aquatic life uses

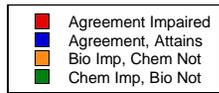
Chemical vs. Biological Measure of Aquatic Life Use Status: How Do They Differ?

- Biological data - fish/macroinvertebrate data based on tiered aquatic life uses in Ohio - Biocriteria based on ecoregion and stream size expectations
 - vs.
- Water chemistry indicators - conventional pollutants (D.O., pH, etc) and toxicants such as ammonia, metals, etc., and exceedences of water quality criteria

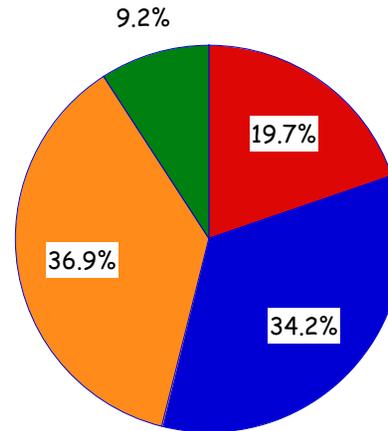
Chemical vs. Biological Indicators of Aquatic Life Use Attainment



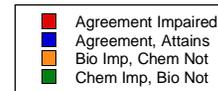
1981-1987



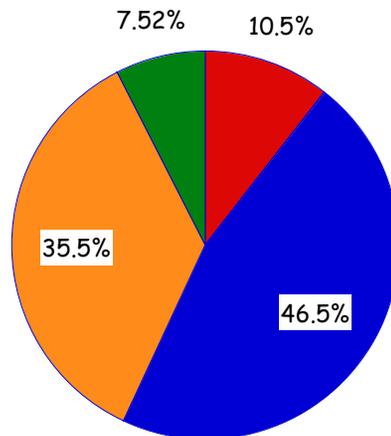
Time Period A



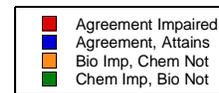
1988-1993



Time Period B

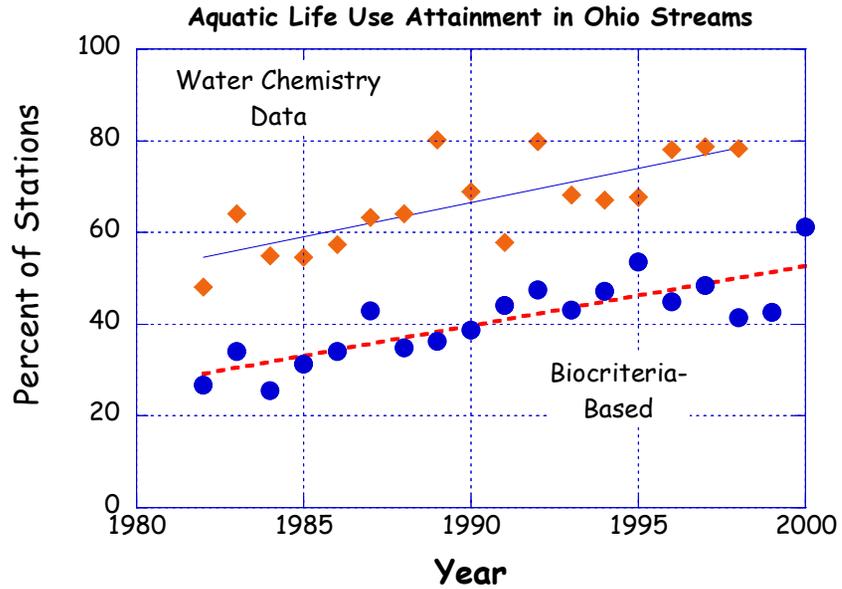


1994-2000

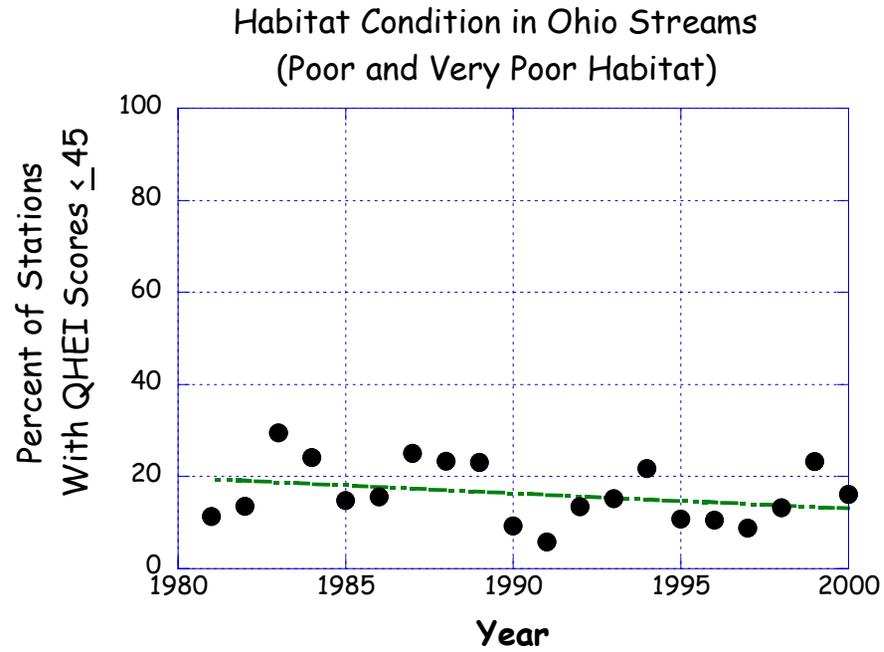


Time Period C

$y = -2912 + 1.497(\text{Year}) \quad R^2 = 0.58$
 $y = 2673 - 1.31(\text{Year}) \quad R^2 = 0.68$



$y = 678 - 0.33(\text{Year}) \quad R^2 = 0.10$

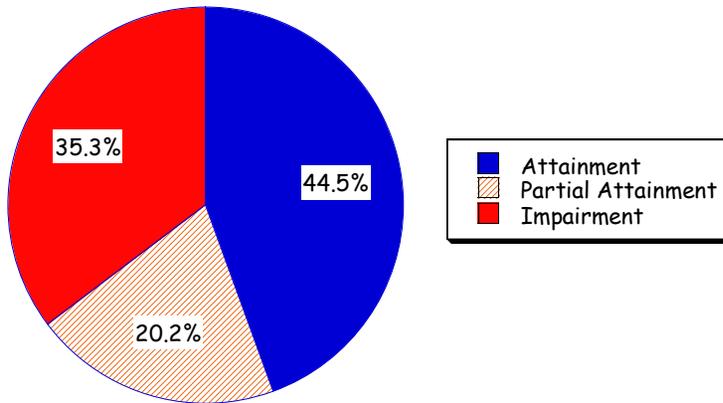


Fish vs. Macroinvertebrates

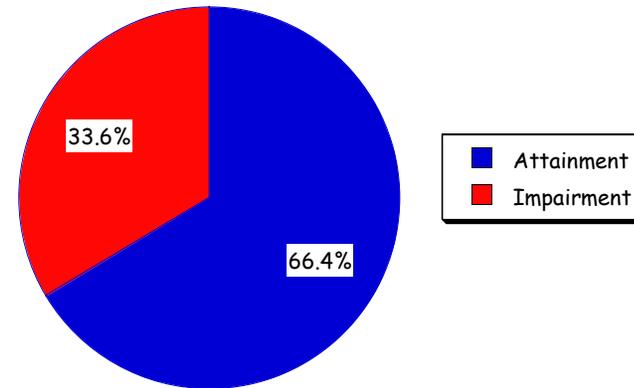
- Many stations in the Ohio database have both fish and macroinvertebrate data
- What would be the consequence of using a single organism group?

Aquatic Life Use Attainment: Fish vs. Macros

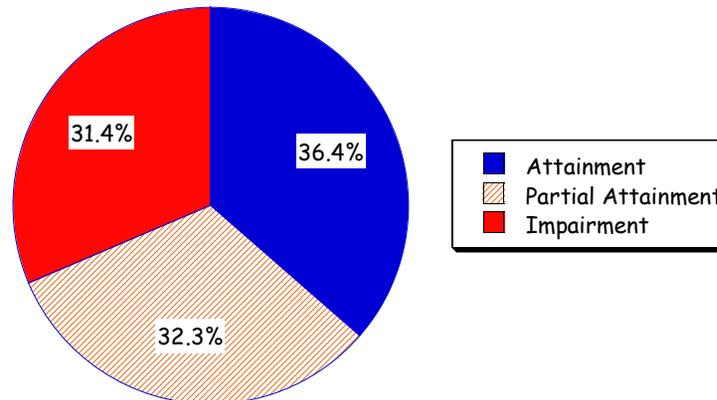
Aquatic Life Use Attainment
Based on Fish Communities Only



Aquatic Life Use Attainment
Based on Macroinvertebrate Communities Only



Aquatic Life Use Attainment
Based on Fish and Macroinvertebrate Communities



Tiered Aquatic Life Uses vs. Single Aquatic Life Uses

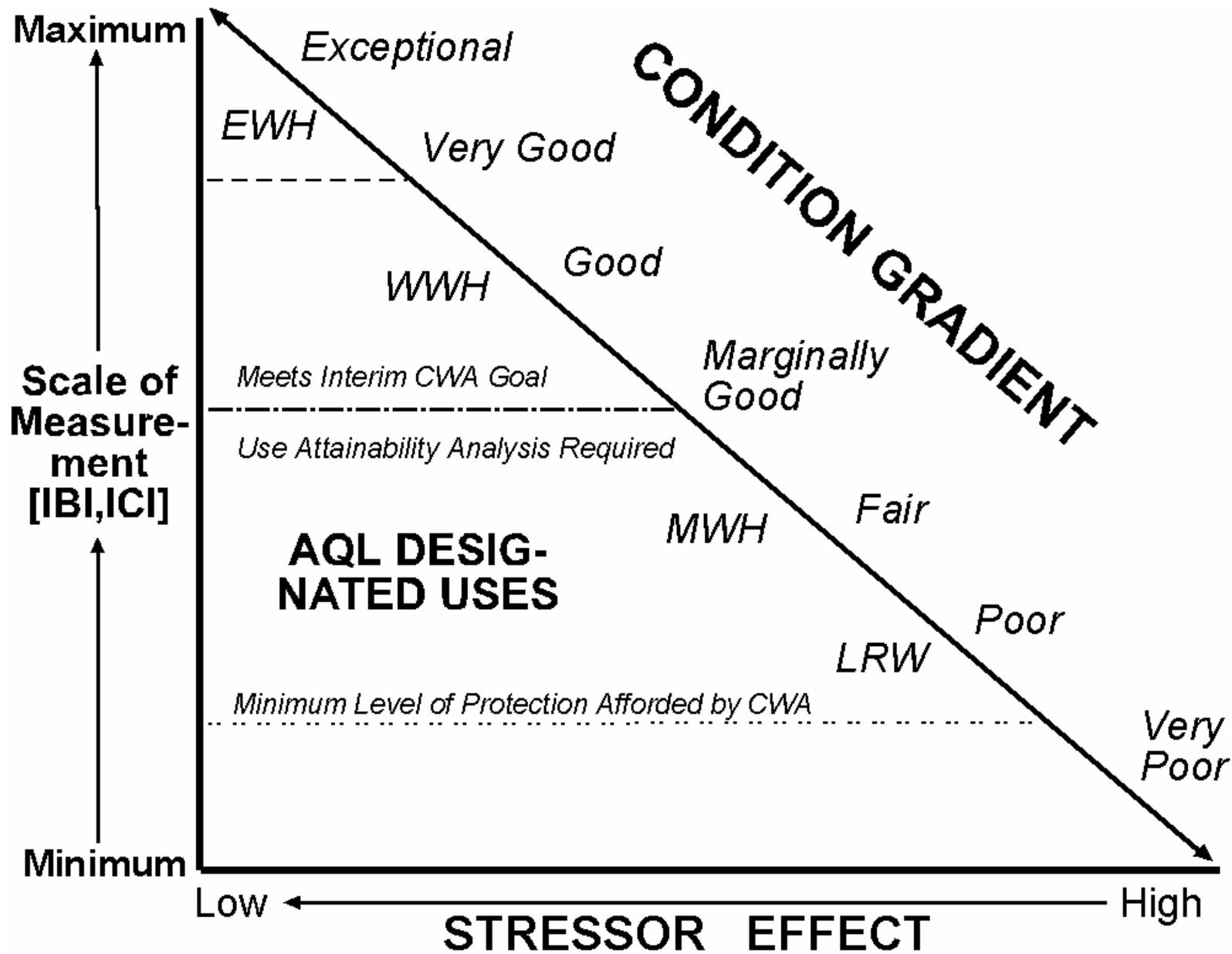
- Ohio has gradually developed a tiered aquatic life use system from the late 1970s to the early 1990s
- Biological expectations change largely along a anthropogenic physical gradient
- Four primary uses in the tiers: Exceptional Warmwater Habitat (EWH), Warmwater Habitat (WWH), Modified Warmwater Habitat (MWH) and Limited Resource Water (LRW)
- Biological data is ultimate arbiter of use, QHEI and habitat data are important sources of information

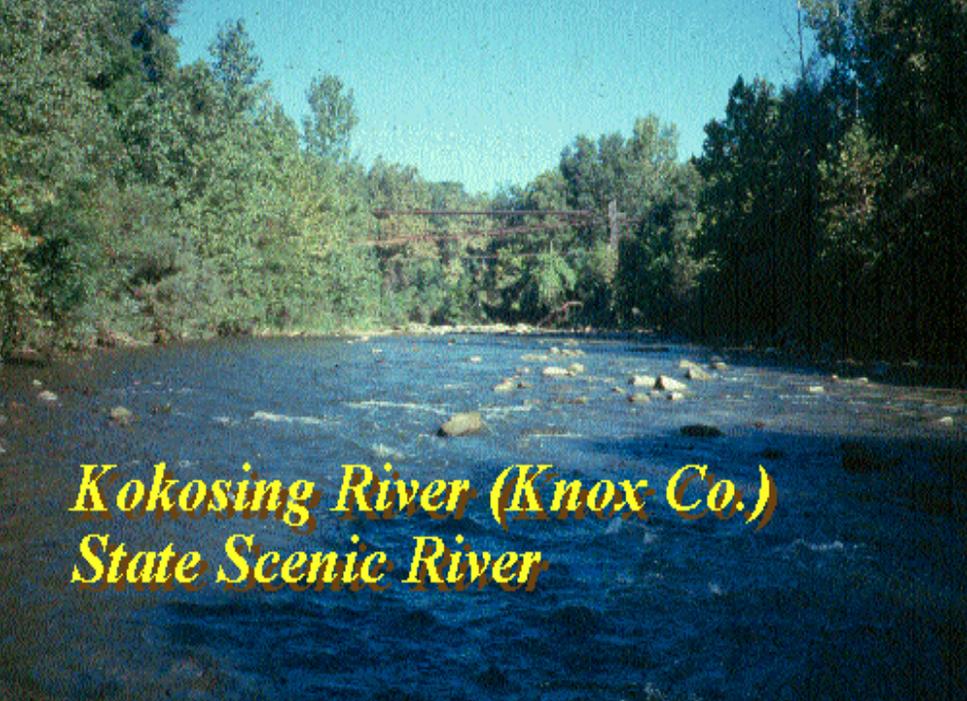
OHIO SPECIFIC TEMPLATE FOR STRATIFICATION

Warmwater Lotic Systems



DESIGNATED USE OPTIONS ALONG THE BIOAXIS AND BIOLOGICAL CONDITION GRADIENT





*Kokosing River (Knox Co.)
State Scenic River*



Lost Creek (Miami Co.)



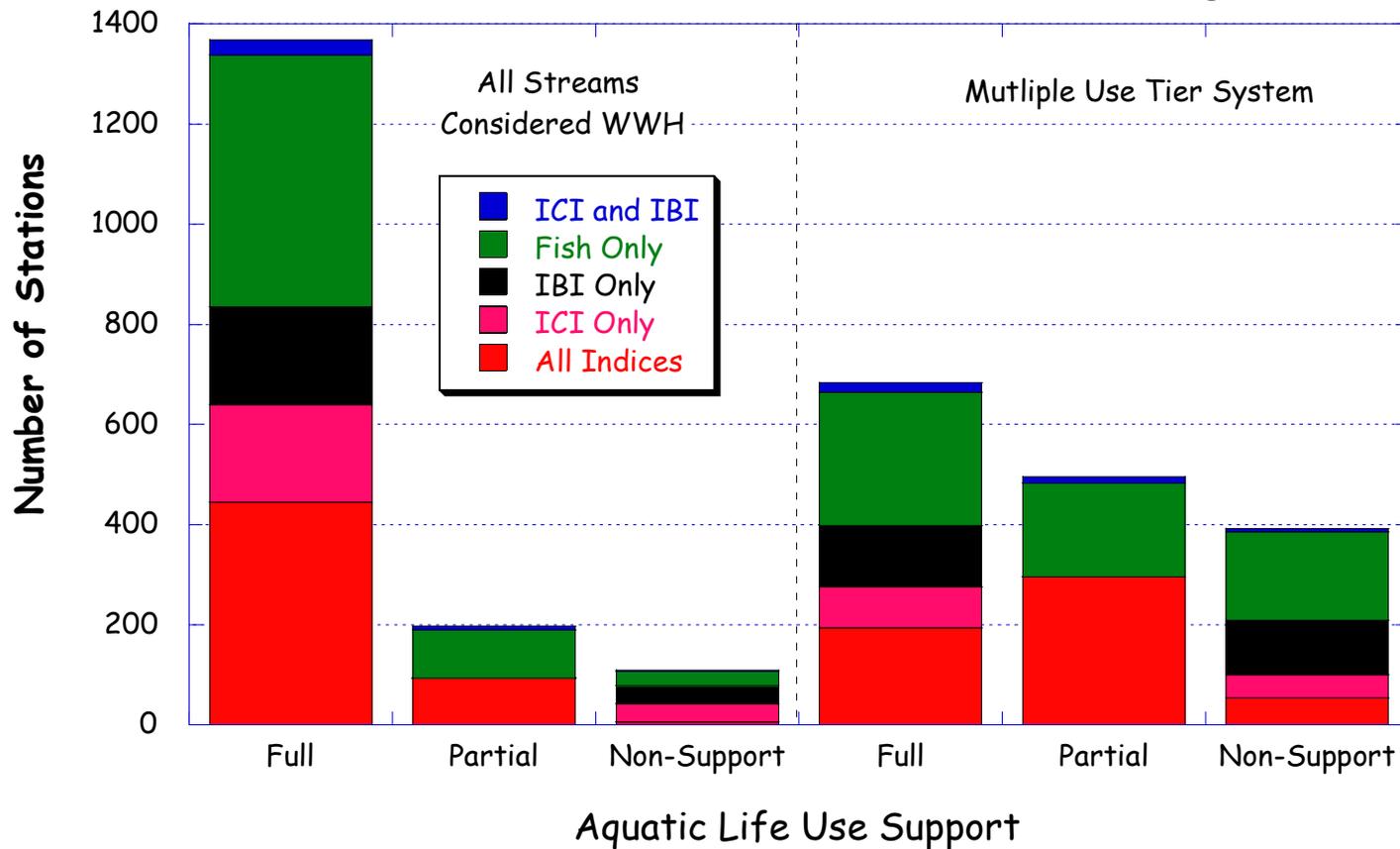
*Big Darby Creek (Madison Co.)
State and National Scenic River*



*Bluebreast darter
(*Etheostoma camurum*)
Ohio Threatened Species*

EWH Streams

Stations in Streams with an EWH Aquatic Life Use Designation



***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***

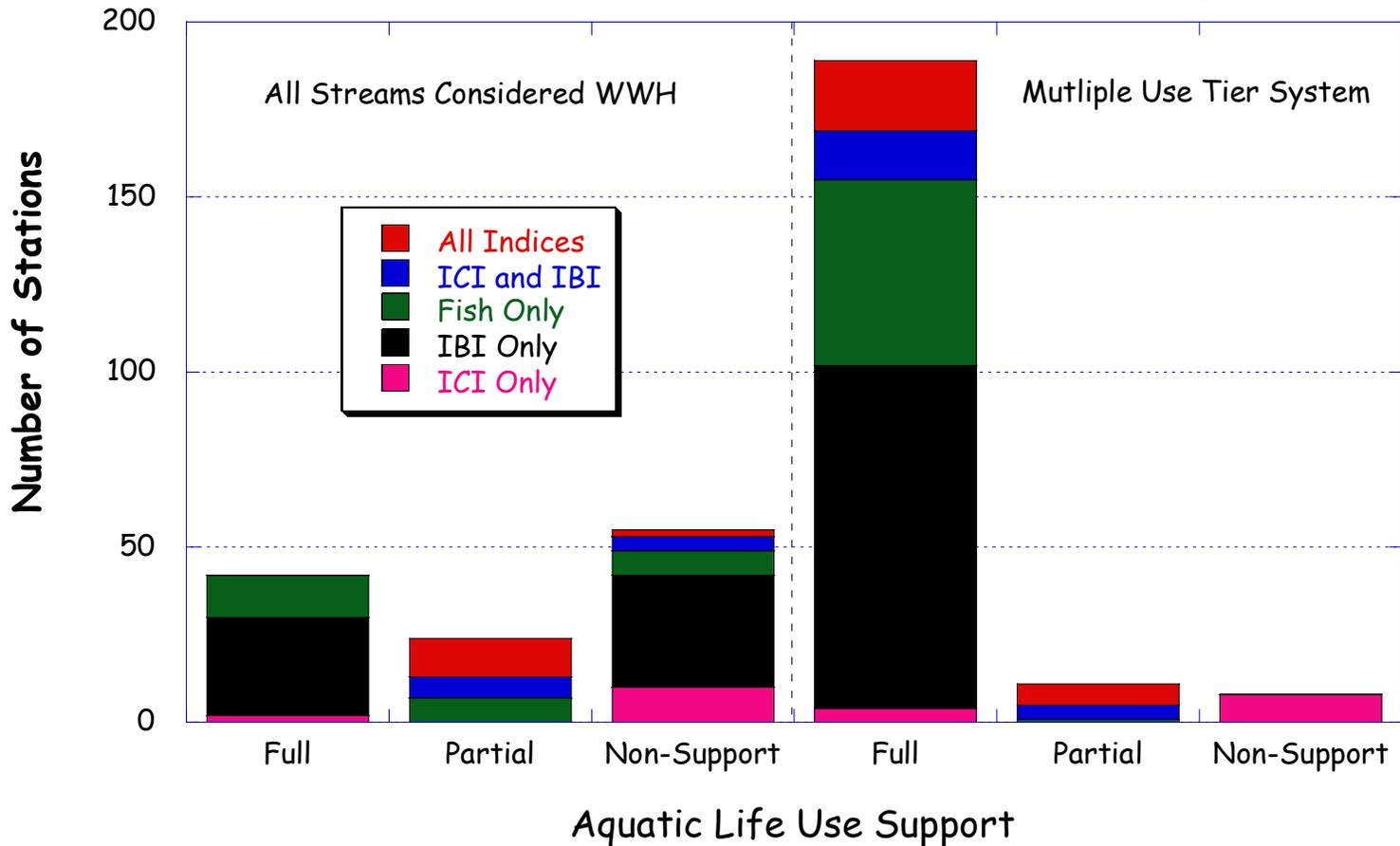


***Creek Chub With Blackspot:
MWH Streams are Predominated
by Tolerant Species***



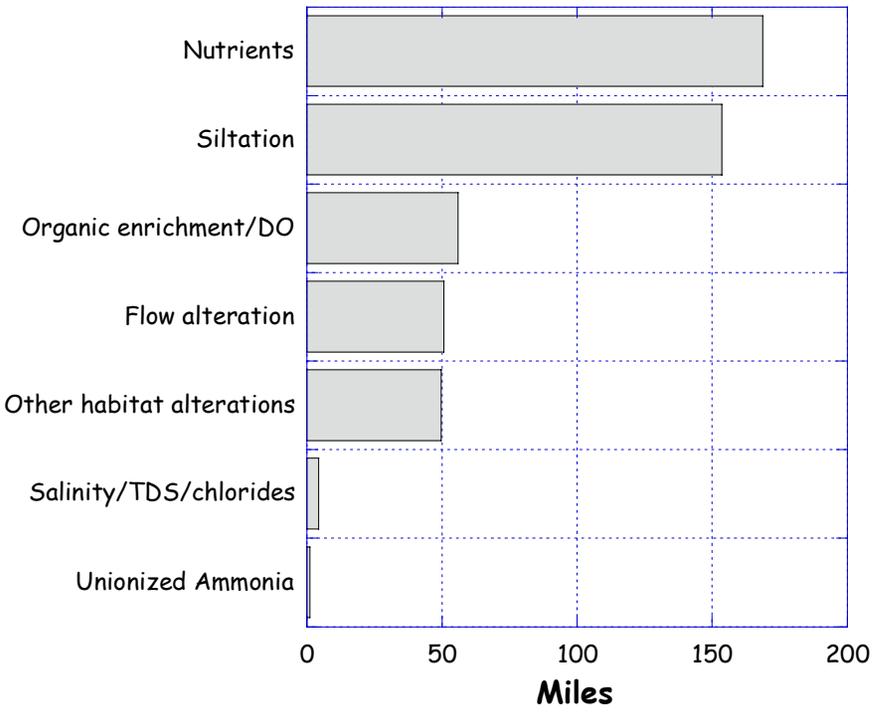
MWH Streams

Stations in Streams with a MWH Aquatic Life Use Designation

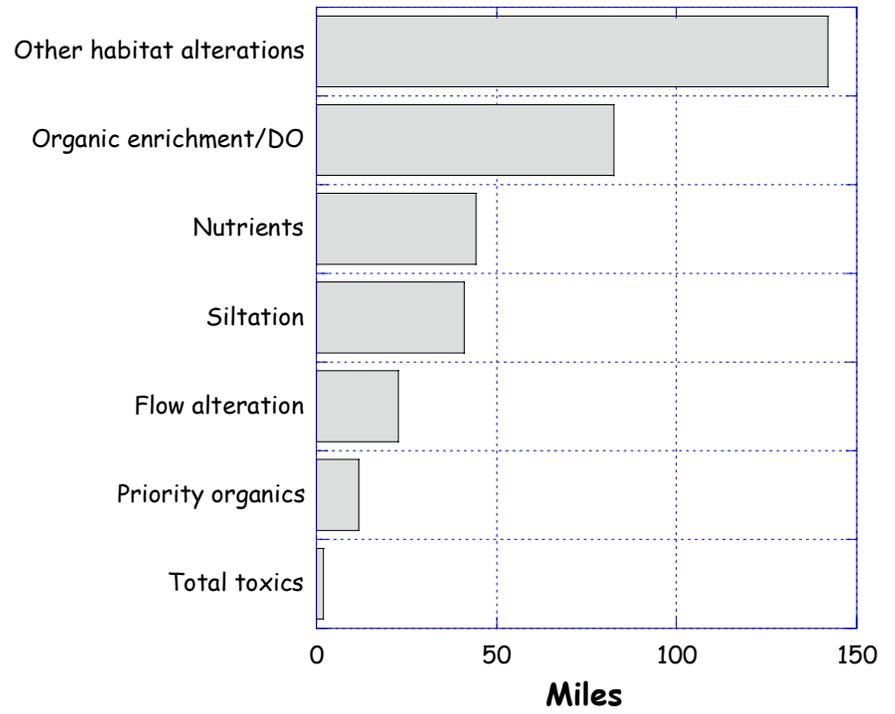


Causes of Impairment: EWH vs. MWH

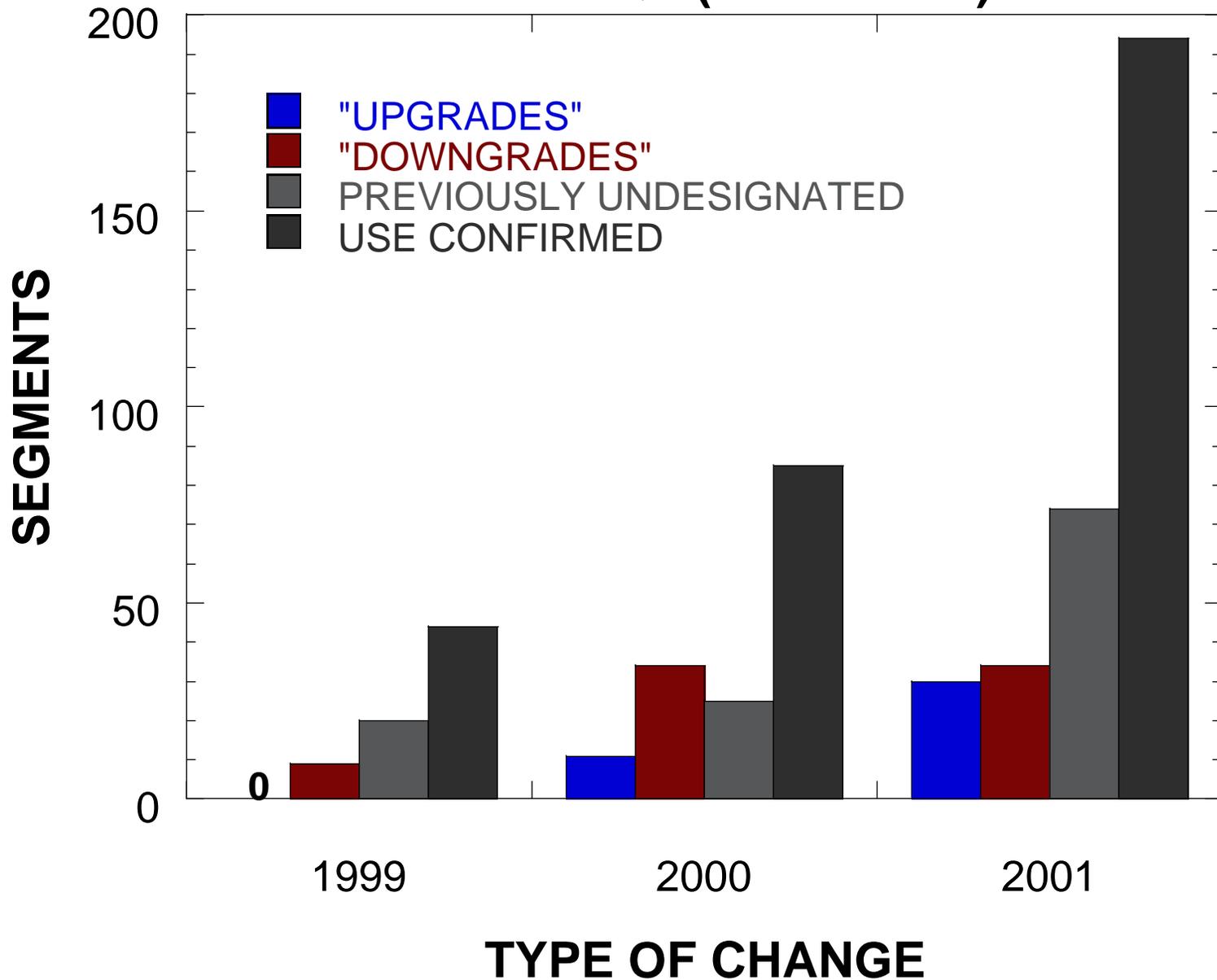
Causes of Impairment in Reaches Where the Aquatic Life Use is EWH



Causes of Impairment in Reaches Where the Aquatic Life Use is MWH

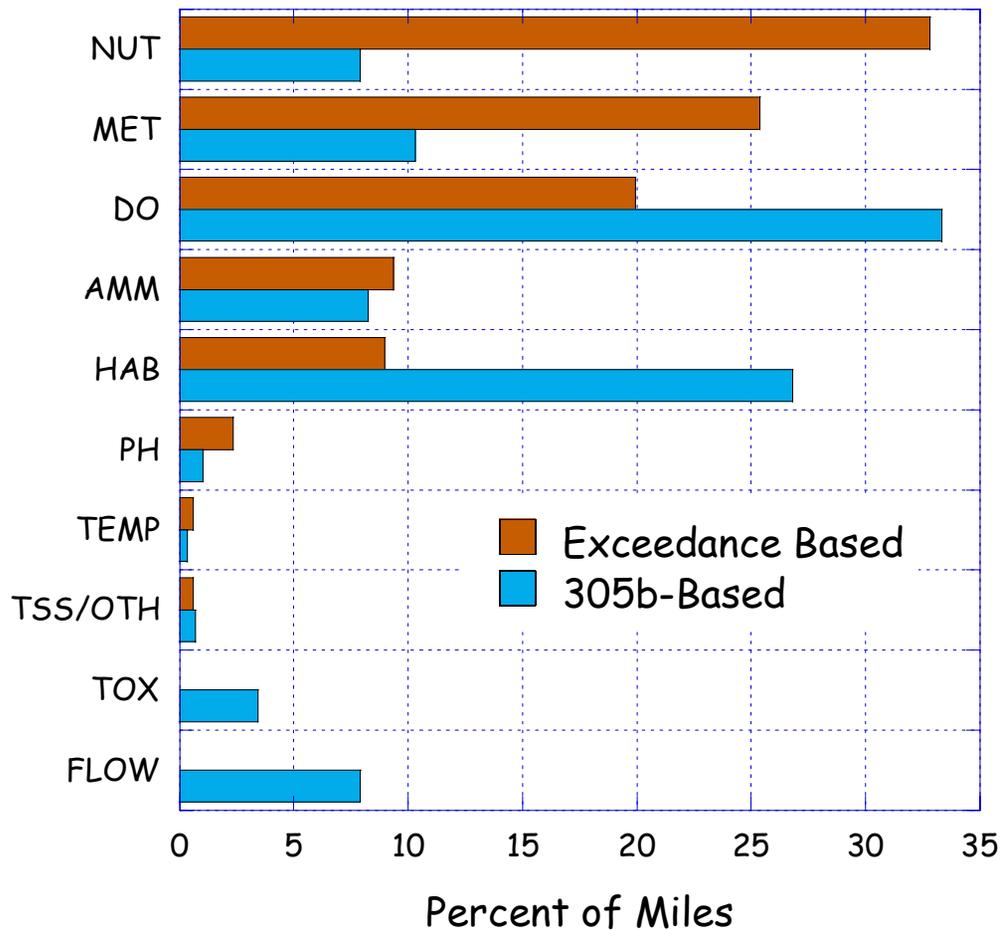


AQUATIC LIFE USE CHANGES: OHIO WQS (1999 - 2001)



Causes of Impairment

Sites With Chemical Exceedances
Biological Data Attaining
All Data



Conclusions

- Indicators
 - Tiered Aquatic Life Uses resulted in more protection for high quality waters; did not over-protect more limited waters - this could have strong affect on TMDL lists
 - Multiple organism groups detected more impaired waters, largely though better identification of physically modified reaches

Conclusions, cont'd

- Water chemistry changes responsible for improvements in biota in Ohio waters
- Biological data better able to detect physical stressors not measured by water chemistry
- Some agreement between biology and water chemistry could also be coincidental
- Only a small proportion of sites show "independent application" conflict and most of these explainable