State Agency Needs For Monitoring and Assessment in Support of 305[b] and 303[d]

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National Academy of Sciences Committee to Assess Science in TMDLs[1]

Two Major WQ Program Areas Identified as Needing Improvement:

- **Water Quality Standards**
- **Monitoring and Assessment**

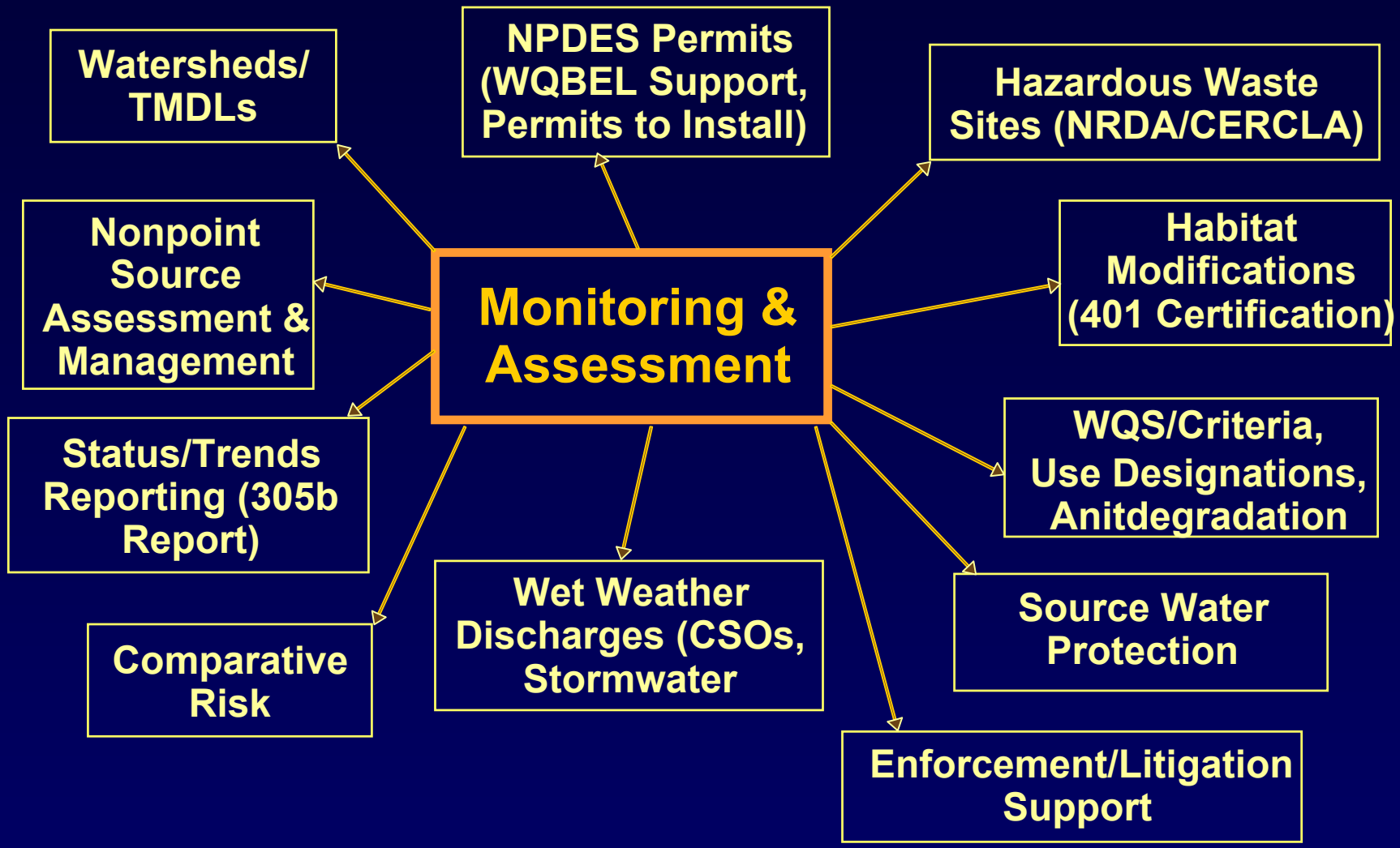
[1]NRC (2001). Assessing the TMDL Approach to Water Quality Management

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, *i.e.,* manage for environmental results.

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

Better Monitoring & Assessment Supports All Water Quality Management Programs



Fundamental Objectives of Adequate Monitoring and Assessment Approaches

Function: Surface Water Assessment

- Collect and analyze baseline information.
- Establish cause/effect (causal associations).
- Compare results to criteria and goals (use attainment).
- Publish results - statewide, regional, site-specific.

Function: WQ Mgmt./Pollution Abatement

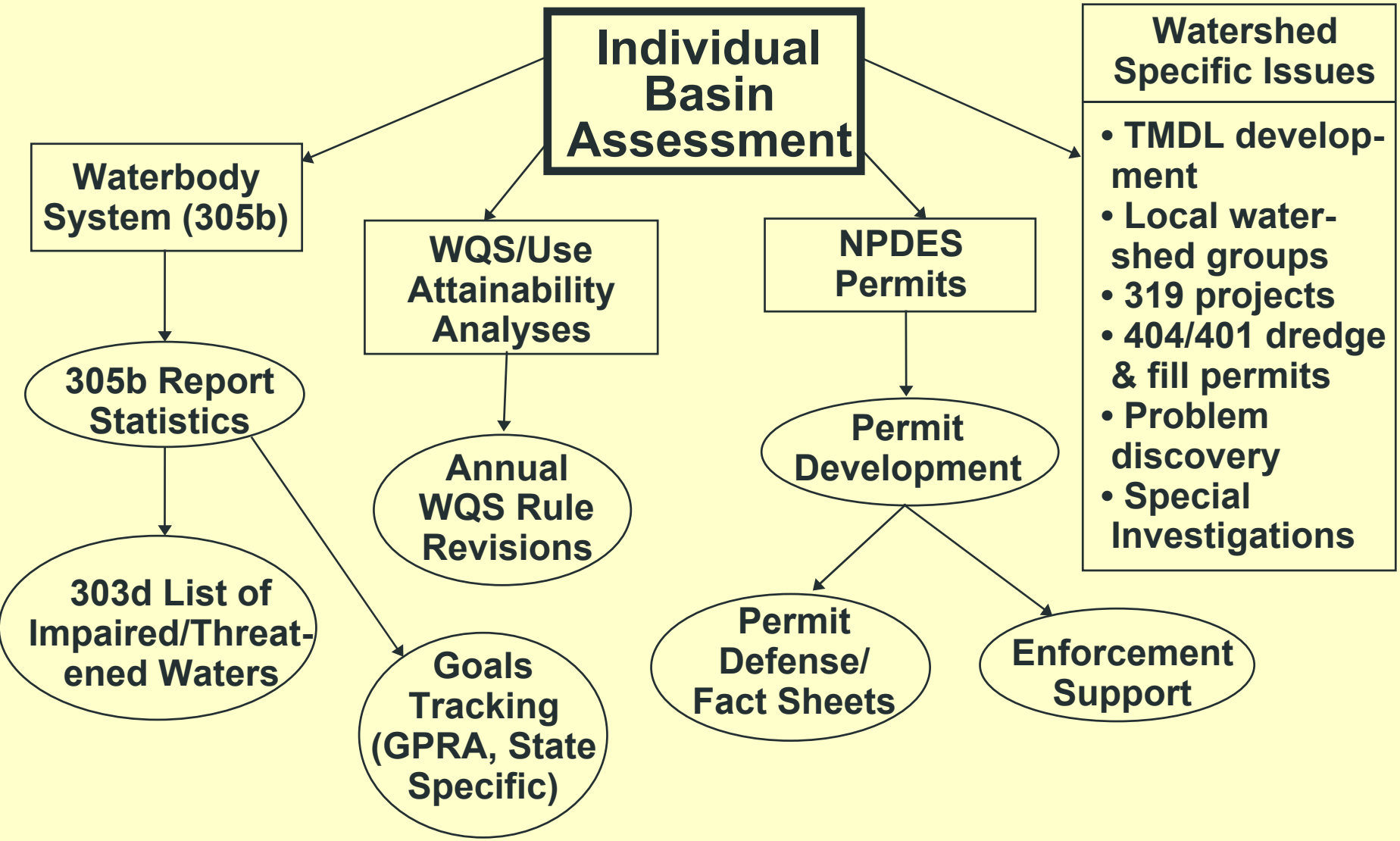
- Attainability analyses and criteria development (maintain WQS).
- Formulate and revise abatement strategies (TMDL development).
- Assess effectiveness of programs (WQ Management).

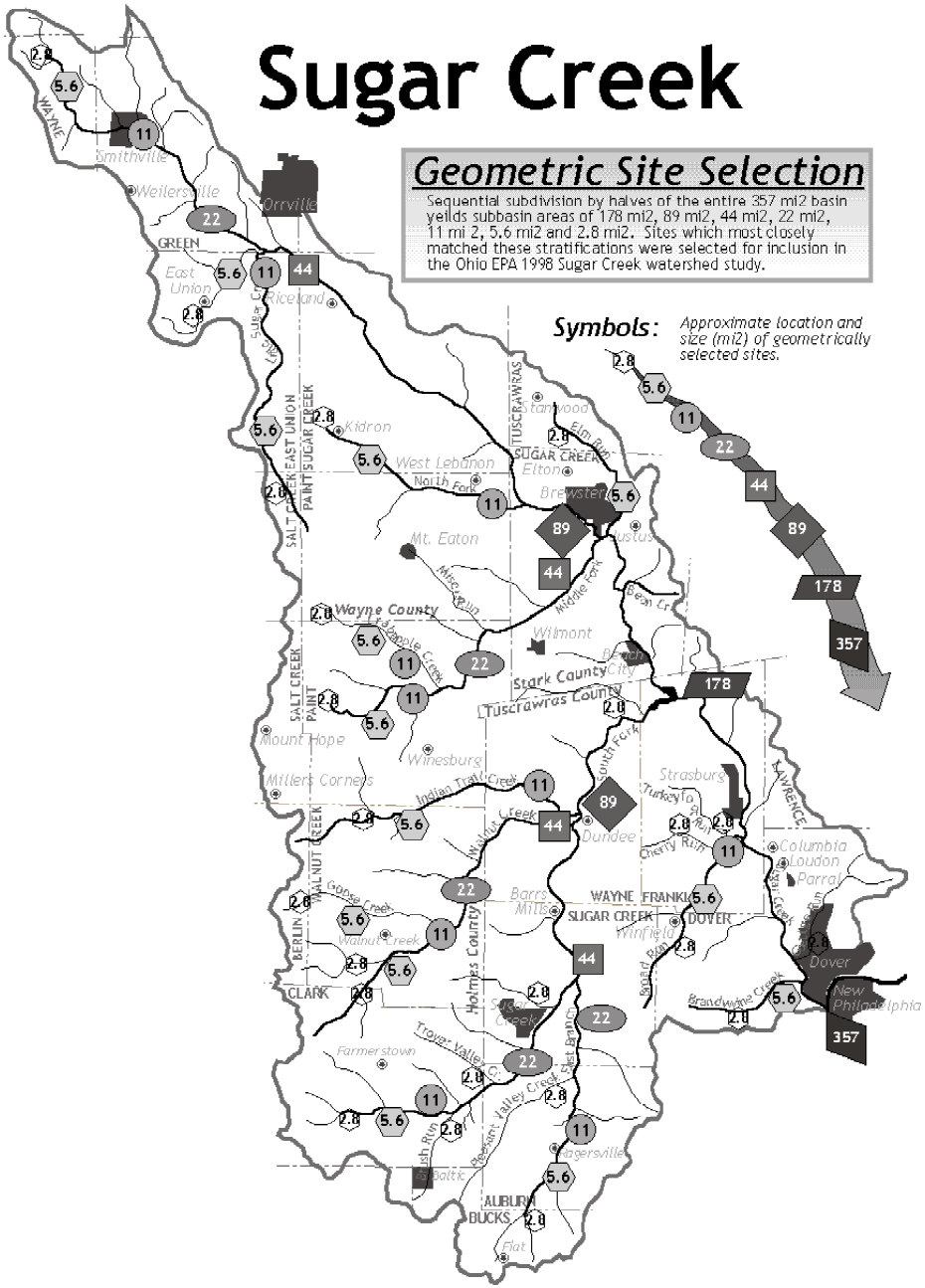
Function: Compliance Evaluation

- Monitor to determine compliance.
- Monitor to support enforcement.

after 40CFR Part 35 (deleted in 1990?)

Functional Support Provided by Annual Rotating Basin Assessments





Sugar Creek Subbasin: Example of Geometric Site Selection Process

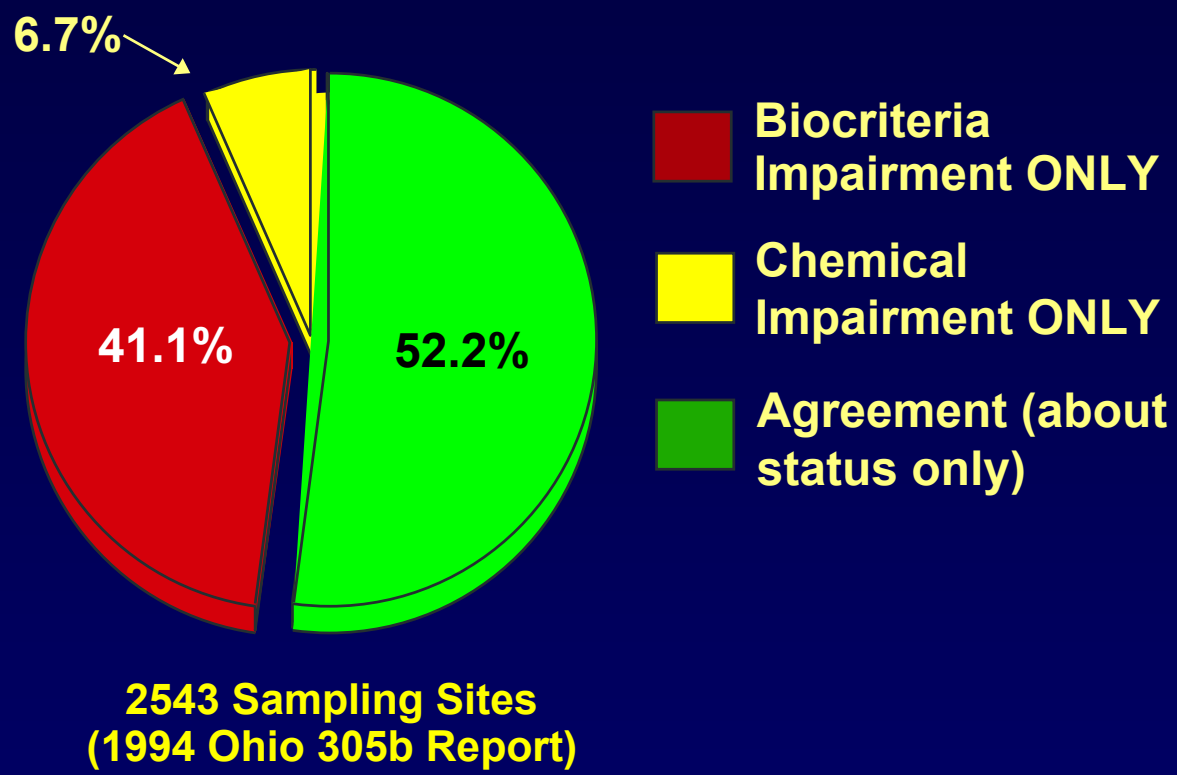
- Support 15 yr. TMDL development schedule beginning in 1998
- Augmented by 5-year basin approach database (1980-1997)
- Standardized biological, chemical, and physical tools and indicators
- Increased miles of assessed streams and rivers annually
- **Resolve undesignated streams**
- **Close 305b/303d listing gaps**
- **More comprehensive coverage of small streams (<5-10 mi^2**
- **Generate broader database for development of improved tools**

Symptoms of An Incomplete Foundation in Water Quality Management

- General or "colloquial" uses and criteria
- Reliance on prescriptive approaches
- Reliance on anecdotal information
- Emphasis on administrative outcomes
- Point source focused and translation of concepts to NPS and TMDLs
- Inconsistent environmental statistics reported between States (305b, 304l, 303d, etc.)
- Lists that are too short
- Lists that are too long

Chemical vs. Biological Indicators of Aquatic Life Impairment:

Relative performance of chemical water quality criteria compared with biological criteria in detecting aquatic life impairments:



Major Classes and Types of Environmental Indicators: Problem Statement

1. **Stressor Indicators (e.g., loadings, land use, habitat)**
2. **Exposure Indicators (e.g., chemical-specific, biomarkers, toxicity)**
3. **Response Indicators (e.g., biological community condition)**

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

CORE INDICATORS

• Fish Assemblage • Macroinvertebrates • Periphyton
(Use Community Level Data From At Least Two)

Physical Habitat Indicators	Chemical Quality Indicators
• Channel morphology • Flow • Substrate Quality • Riparian	• pH • Temperature • Conductivity • Dissolved O_2

For Specific Designated Uses Add the Following:

AQUATIC LIFE
Base List:
- Ionic strength
- Nutrients, sediment

Supplemental List:
- Metals (water/sediment)
- Organics (water/sediment)

RECREATIONAL
Base List:
- Fecal bacteria
- Ionic strength

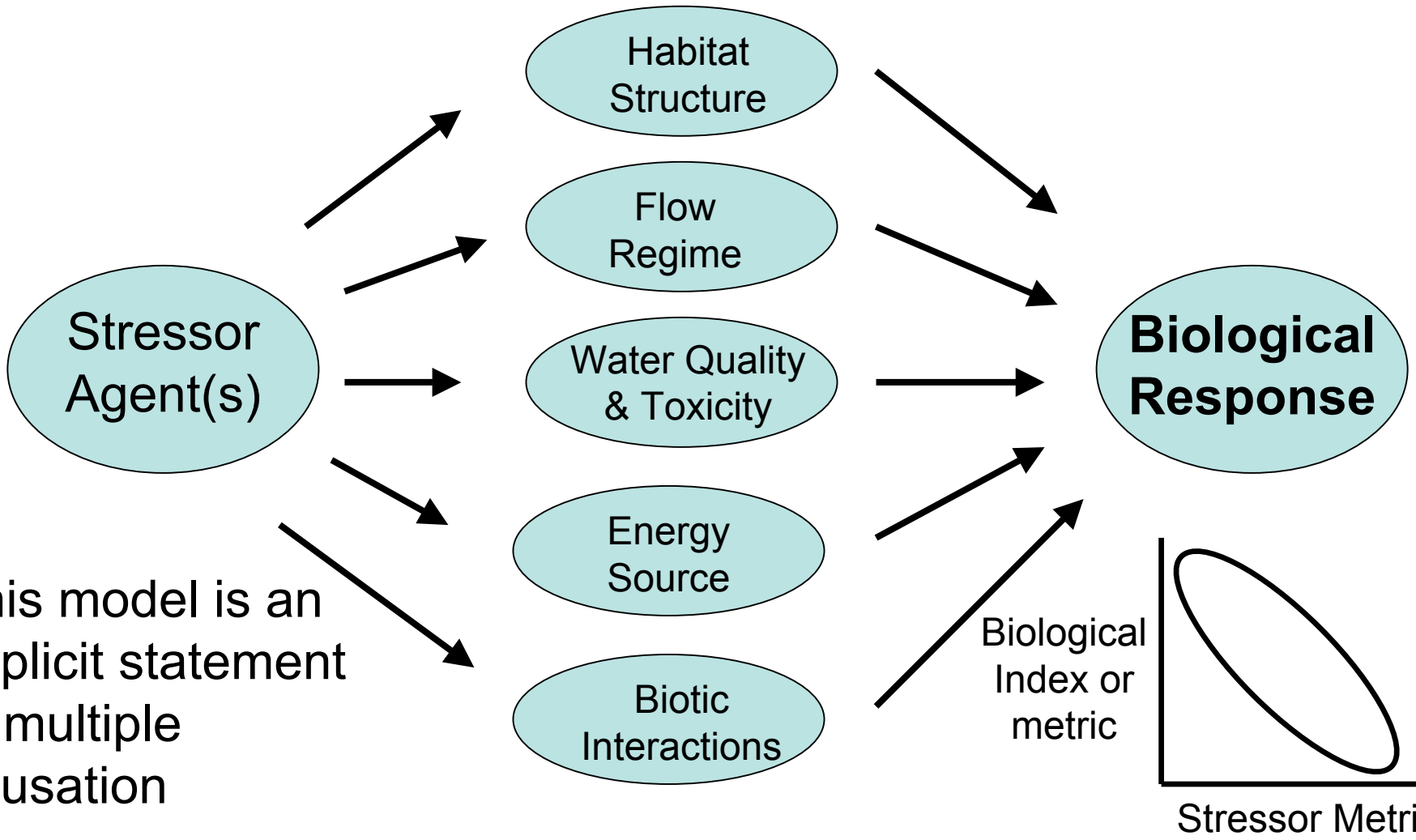
Supplemental List:
- Other pathogens
- Organics (water/sediment)

WATER SUPPLY
Base List:
- Fecal bacteria
- Ionic strength
- Nutrients, sediment

Supplemental List:
- Metals (water/sediment)
- Organics (water/sedimen
- Other pathogens

HUMAN/WILDLIFE CONSUMPTION
Base List:
- Metals (in tissues)
- Organics (in tissues)

The Linkage From Stressor Effects to Ecosystem Response



This model is an explicit statement of multiple causation

Water Quality Standards: The Basis for Water Quality Management

- Basis for implementing controls & management under CWA.
- Consist of uses and criteria.
- Focus of watershed planning and implementation.
- Benchmarks of evaluating effectiveness of controls, funding, permits, BMPs, TMDLs, etc.

States are the principal custodians of WQS and the associated designated uses and criteria.

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

WATER QUALITY ⟶ WATER RESOURCE

- Simple Chemical Criteria
- One Aquatic Life Use

(1974 - 1978)

- More Chemical Criteria
- Tiered Aquatic Life Uses

(1978 - 1980)

- Complex Chemical Criteria
- Tiered Aquatic Life Uses
- Narrative Biological Criteria

(1980 - 1987)

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

(1987 - Present)

LESS ACCURACY ⟶ MORE ACCURACY

Use Attainability Analysis II: Process and Information Requirements**

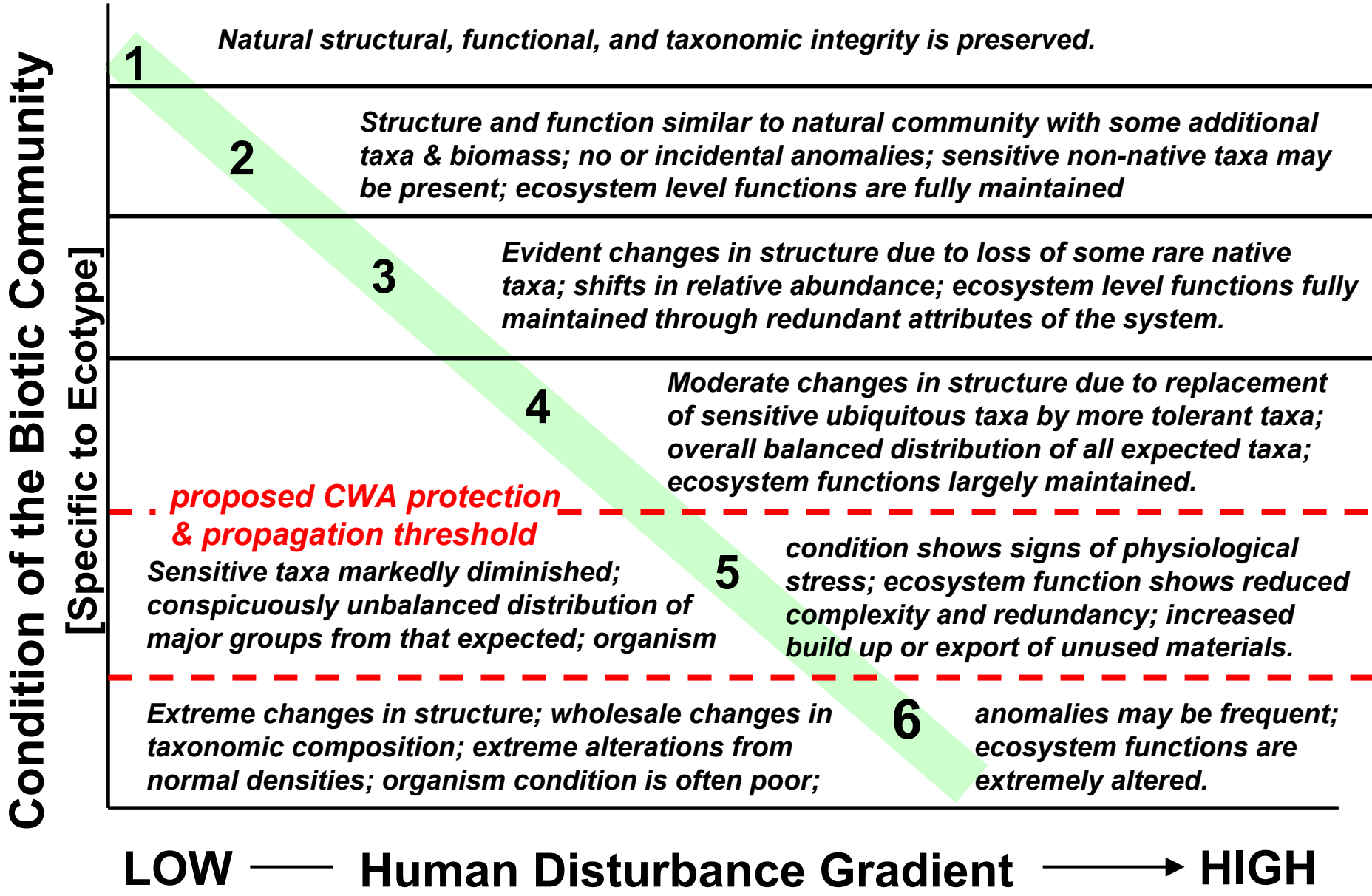
Use attainability analysis requires the following information and knowledge:

- 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
- reviewable every three years - a "temporary" designation.

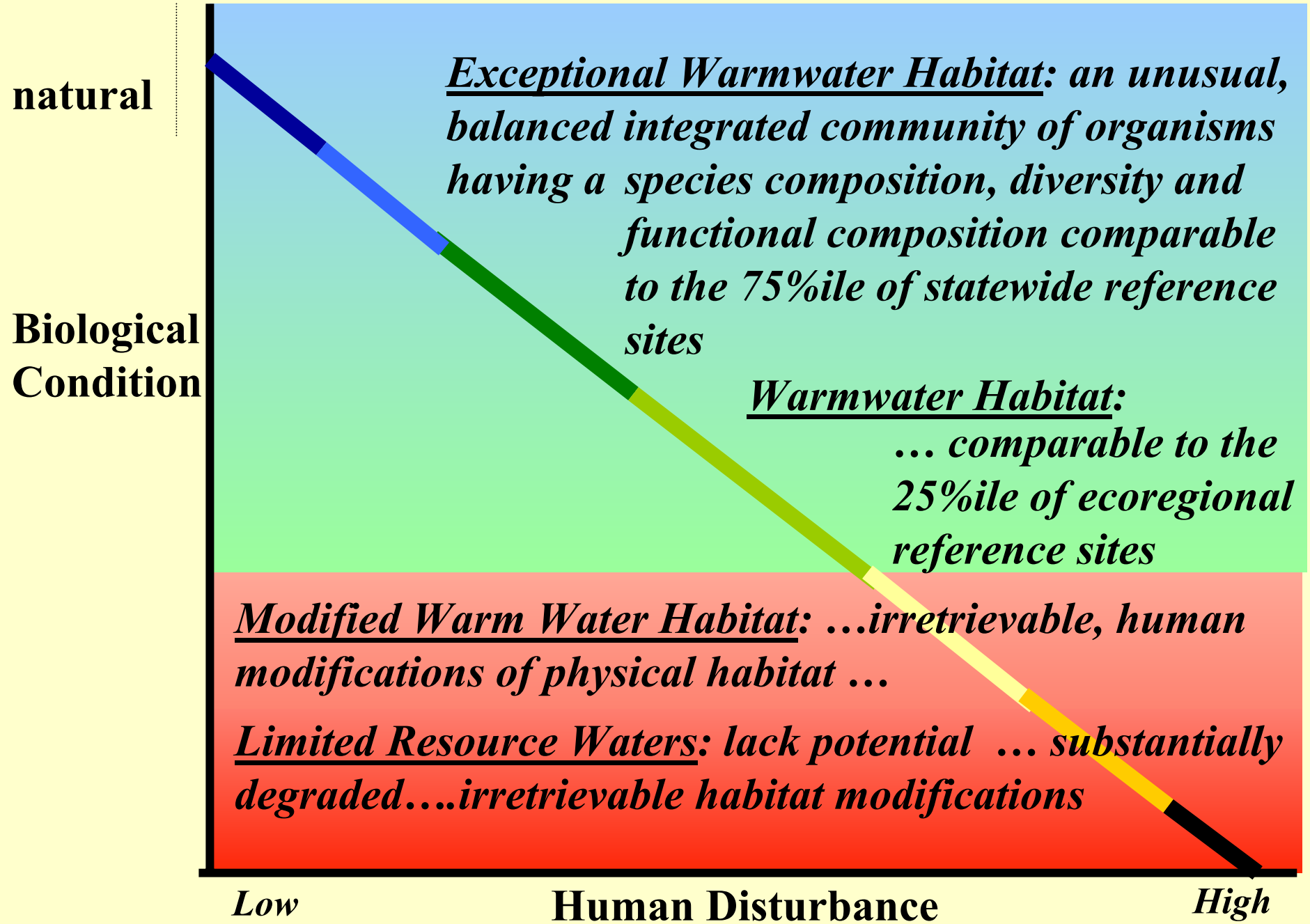
**** - All data collection and analysis must conform to Ohio WQS and Five-Year Monitoring Strategy data and design quality objectives.**

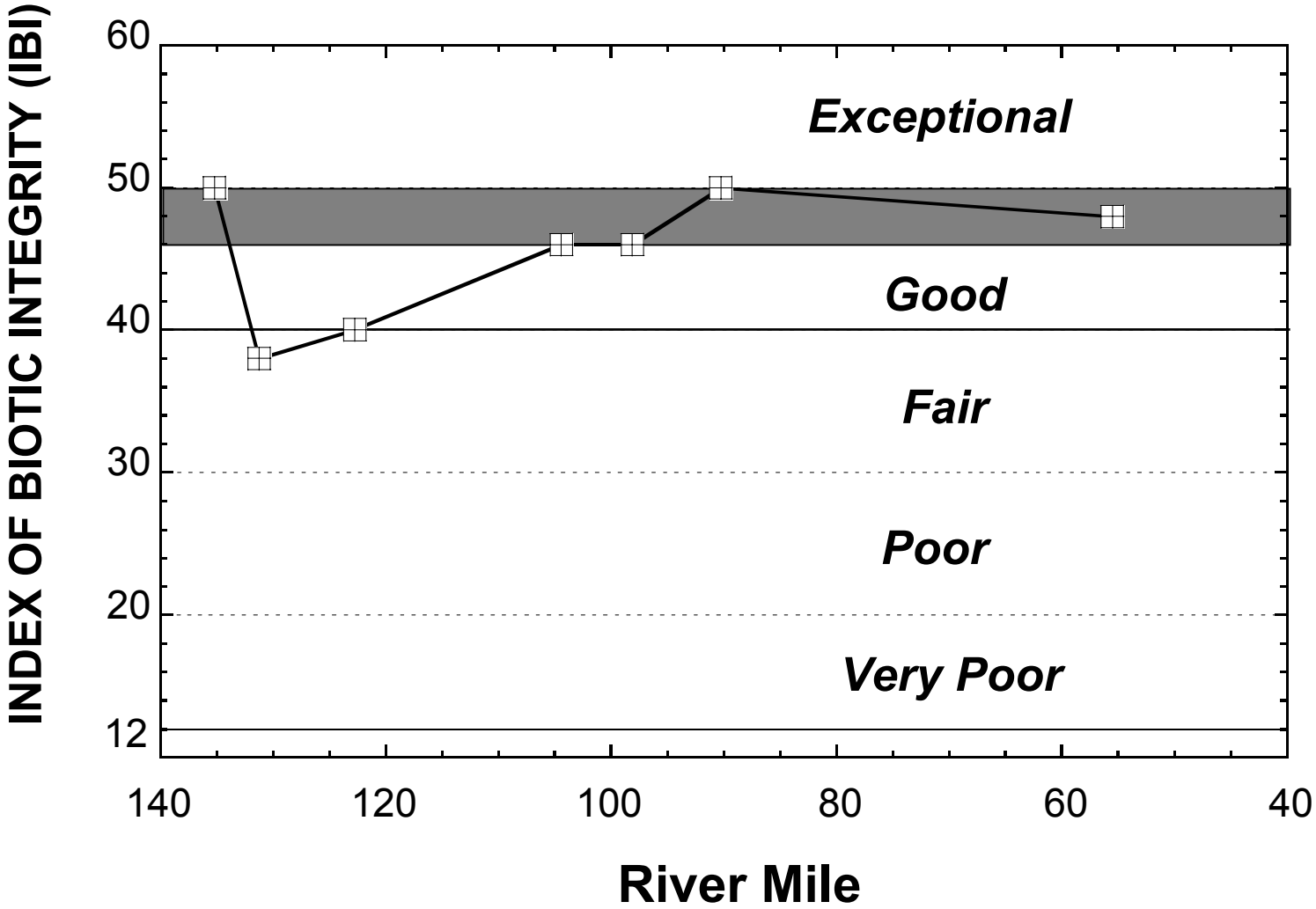
Tiered Aquatic Life Use Conceptual Model: Draft Biological Tiers

(10/22 draft)



Designated Aquatic Life Uses: Ohio/Streams & Rivers




INDEX OF BIOTIC INTEGRITY (IBI)
60
50
40
30
20
12
Exceptional
Good
Fair
Poor
Very Poor
140
120
100
80
60
40
River Mile

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).*

Resolution and Detail in WQS and Monitoring and Assessment Affect Overall WQ Management Program Effectiveness

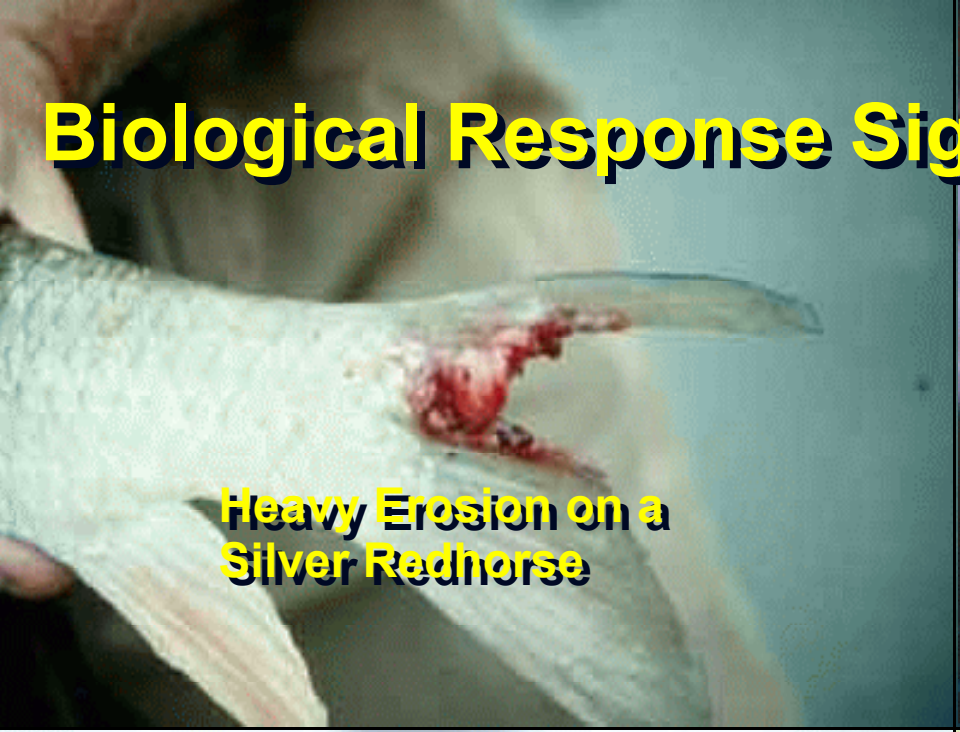
Program Attribute	Least Accurate → Most Accurate	
WQS/Des. Uses:	General Uses (Generic AQLU)	Refined Uses (Tiered AQLU)
WQ Criteria:	Simple, Chemical (Conventionals)	Chemical & Biological (Acute/Chronic, Biocriteria)
Monitoring:	Fixed Stations	Rotating Basins (Stratified, Probabilistic)
Indicators:	Chemical, Narrative	Chem., Phys., Biological (Numeric, Calibrated)
Detail:	Coarse (Low Signal)	Refined (Integrated Signal)
Resolution:	Pass/Fail (No Increments)	Incremental (Continuous Scale)

Completing the Cycle of Water Quality Management: Guiding the Results of Management Actions With Integrated Environmental Measures

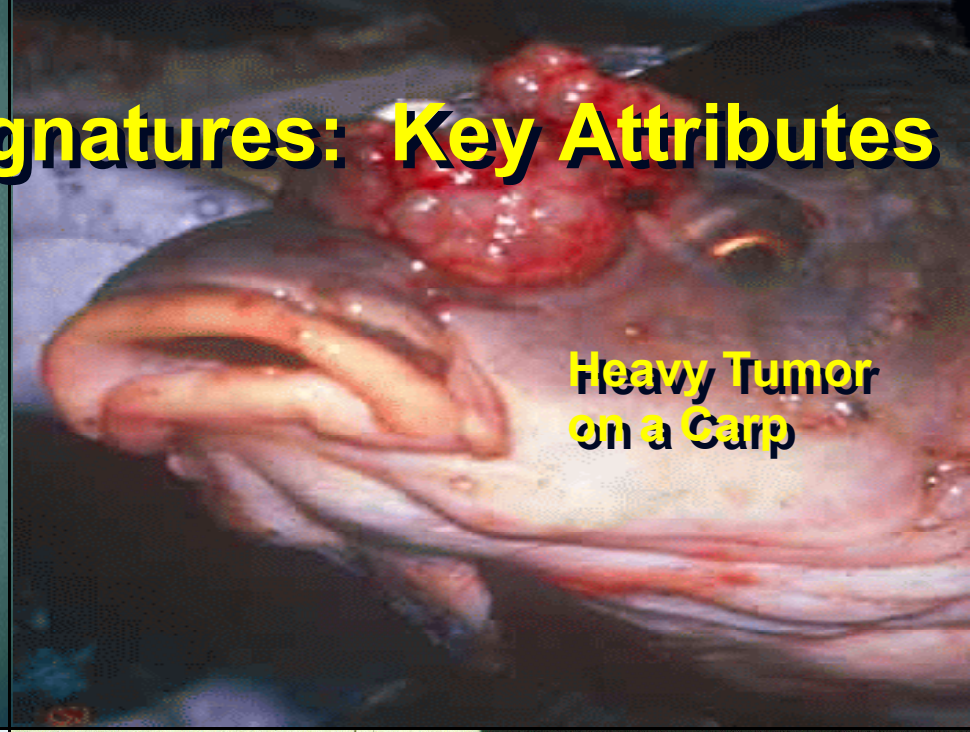
Multiple Indicators Matrix: Ottawa River

SEGMENT	DES. USE	RESPONSE INDICATORS				EXPOSURE INDICATORS						STRESSORS				
	Attain-ment Status	QHEI	IBI	MIwb	ICI	Water Chem.	Sedi-ment Chem.	Tox-icity	% DELT	Fish Tiss.	Bio-marker	# Dams/ Pools	Urban-Indust. Landuse	Cumulative Loads	Spills	CSO SSOs
Ottawa River mainstem - 1996																
Thayer Rd to Sugar St.	FULL-PART.	68	Fair-Good	Fair-Good	Good	Nitrates	Low	NA	Mod-High	Mer-cury	Low	Mod-e	Low	Low	Low	Low
Sugar St. to Lima WWTP	**NON**	47	**Poor** to Fair	**Poor** to Fair	**Poor** to M.G.	CBOD TSS D.O.	As,Cr Cd,Cu Ni,Zn	Mod-erate	**High**	Pesti-cides	BUN Naph B(a)p	**High**	**High**	Mod-erate	Mod-e	**High**
Lima WWTP Allentown dam	**NON**	72	**Poor**	**Poor** to Fair	Fair to Good	Amm. CBOD TSS D.O. Nitrates Phos Chrom. PAH Pesticid	As,Cr Cd,Cu Ni,Zn PAH	Mod-erate	**Very High**	Selen-ium Pest-icides	EROD Naph B(a)p BUN	Mod-e	**High**	**High**	**High**	**High**
Allentown dam to Kalida	PAR-TIAL	69	**Poor** -Fair	Fair-Good	Good -Exc.	TSS	Low	NA	**High**	Pesti-cides	Low	Low	Low	**High**	Low	Low
Kalida to mouth	FULL	69	Good	Good	Exc.	TSS	Low	NA	**Very High**	Pesti-cides	Low	Low	Low	**High**	Low	Low

Biological Response Signatures: Key Attributes



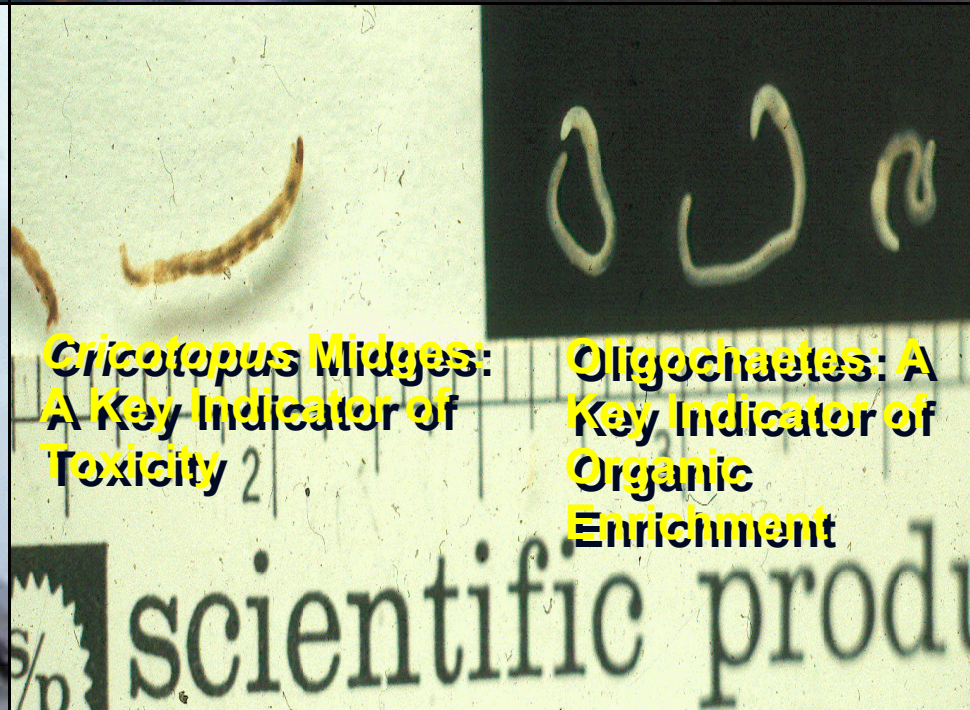
Heavy Erosion on a Silver Redhorse



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

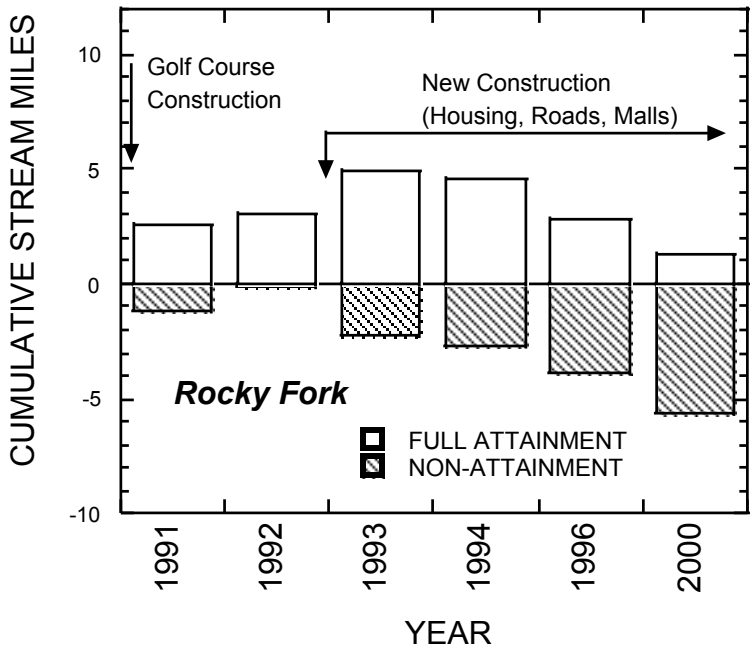
Rocky Fork: Impacts of Suburban Development in the 1990s

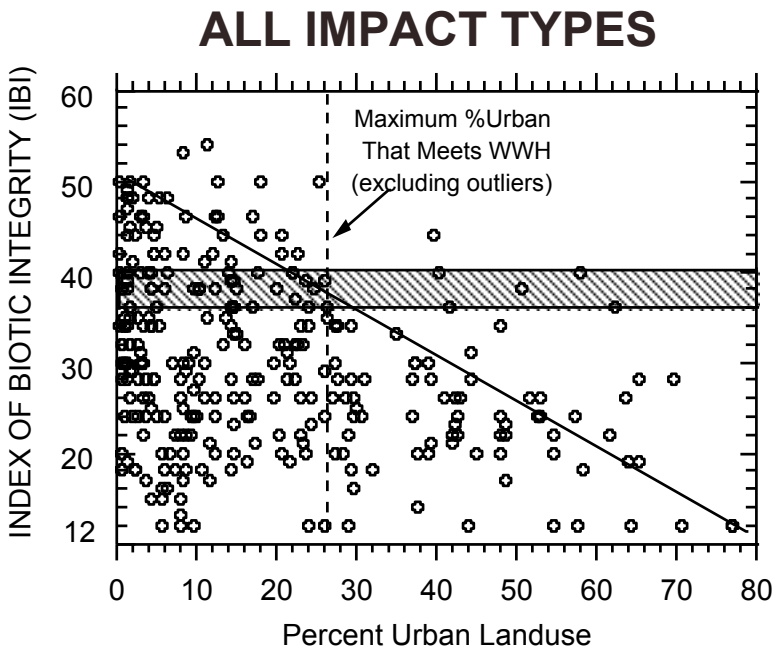
Rocky Fork Biological Assessment

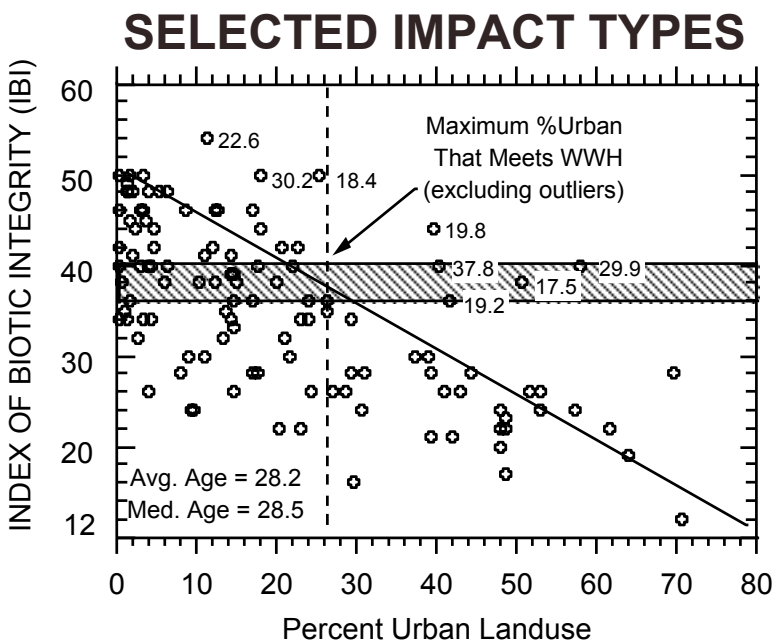
High Density Housing

Inconsistent success of BMPs

Aquatic Life Use Attainment Trend







IBI vs. % Urban Land Use

- **Typical threshold for WWH attainment at 25-30% urban land use.**
- **No attainment at >60% urban land use.**
- **Attainment "outliers" occur at 40-60% urban land use.**
- **Characteristics common to outliers are good riparian, sustained flow, or <20 years of urban development.**
- **Removal of habitat, sewer overflow, and legacy impacts helped clarify IBI/urban land use relationship.**

Strategic Support Provided Collectively by Rotating Basin Assessments

The ongoing accumulation of information across spatial and temporal scales

Policy Development

- TMDL Listing/De-listing
- Refined WQS Uses
- Antidegradation
- NPDES (WET, CSOs, Stormwater)
- 404/401 dredge & fill
- Stream Protection
- Nutrient management
- Overall program/policy effectiveness
- Environmental audits

Program Development

- Environmental Indicators
- Refined & Validated WQ Criteria
- Reference WQ & Sediment benchmarks
- Biological Criteria
- Biological Response Signatures
- Regional stratification (ecoregions, subreg.)

Statewide/Regional Applications

- TMDLs (303d)
- Status/Trends (305b)
- Local projects
- NPS/BMP effectiveness evaluations
- NAWQA/REMAP
- Watershed mgmt.
- SWAP
- UWA
- IWI "ground truthing"

Overview of the Ohio TMDL Project Process

Numbers on chart correspond to detailed task lists contained in Appendix B

ASSESSMENT PHASE
18 months

DEVELOPMENT PHASE
12 months

IMPLEMENTATION PHASE
18 months

VALIDATION PHASE
Ongoing

1	2	3	4	5	6	7	8	9	10	11	12
Design Watershed Survey	Collect Water Quality Data	Assess Waterbodies	Identify Target Conditions	Develop Restoration Targets	Select Restoration Scenario	Prepare Implement-ation Plan	Submit TMDL Report	Implement TMDL (inside OEPA)	Implement TMDL (outside OEPA)	Annual Validation Activities	Have WQS Been Achieved?
Examine internal information Examine external information Complete study plan design	Collect and compile ambient data (internal) for waterbody assessment Evaluate ambient data (external)	Determine impairments by designated use Determine causes and sources of impairments or threats Complete TMDL support documents	Examine readily available data Gather additional data as needed Analyze data Define goals Select causes of concern Identify and locate sources of causes Determine geographic scope Identify stakeholder involvement	Decide on calculation method Determine existing load Determine desired load Identify needed reduction Generate example restoration scenarios Decide how Ohio EPA authority will be used	Discuss scenarios w/ stakeholders; generate other options Develop decision criteria Screen scenarios to select best option Verify that scenario achieves reduction Finalize allocations	Describe actions Develop schedule Identify legal authorities Develop list of reasonable assurances Estimate time to attain WQS Develop monitoring plan Establish measurable milestones Decide re-open process	Prepare TMDL report Ohio EPA legal and management review Public notice, meeting(s), respond to comments Revise report as needed Ohio EPA management review and signoff Submit report to U.S. EPA	Provide info for WQMP revision Incorporate actions into priorities Identify resources for actions Identify resources for tracking Adjust work plans Do the work Incorporate implementation plans into other agency priorities	Identify implementing parties Verify implementing parties willingness to proceed	Verify monitoring plan Validate control actions implemented Validate stressor reduction	Validate water quality status or re-open TMDL De-list or re-list Input assessment results to 303(d) listing process

Continuously evaluate process

Quality Improvement Process

Evaluate effectiveness of technical decisions made on project

http://www.epa.state.oh.us/dsw/tmdl/index.html

IMPROVING THE TMDL PROCESS: PROGRESS TOWARDS A RESOURCE BASED APPROACH

Pollutant Focused

TMDL = WLA + LA + MOS
(Lbs./day) (1 of Karr's Five Factors)

TMDL = *f*(WQ + Physical + Biota)
(Lbs./day) (3 of Karr's Five Factors)

Use Attainment = *f*(WQ + Hydrological + Energy + Physical + Biota)
(Miles, Acres, Condition) (5 of Karr's Five Factors)

Resource Focused

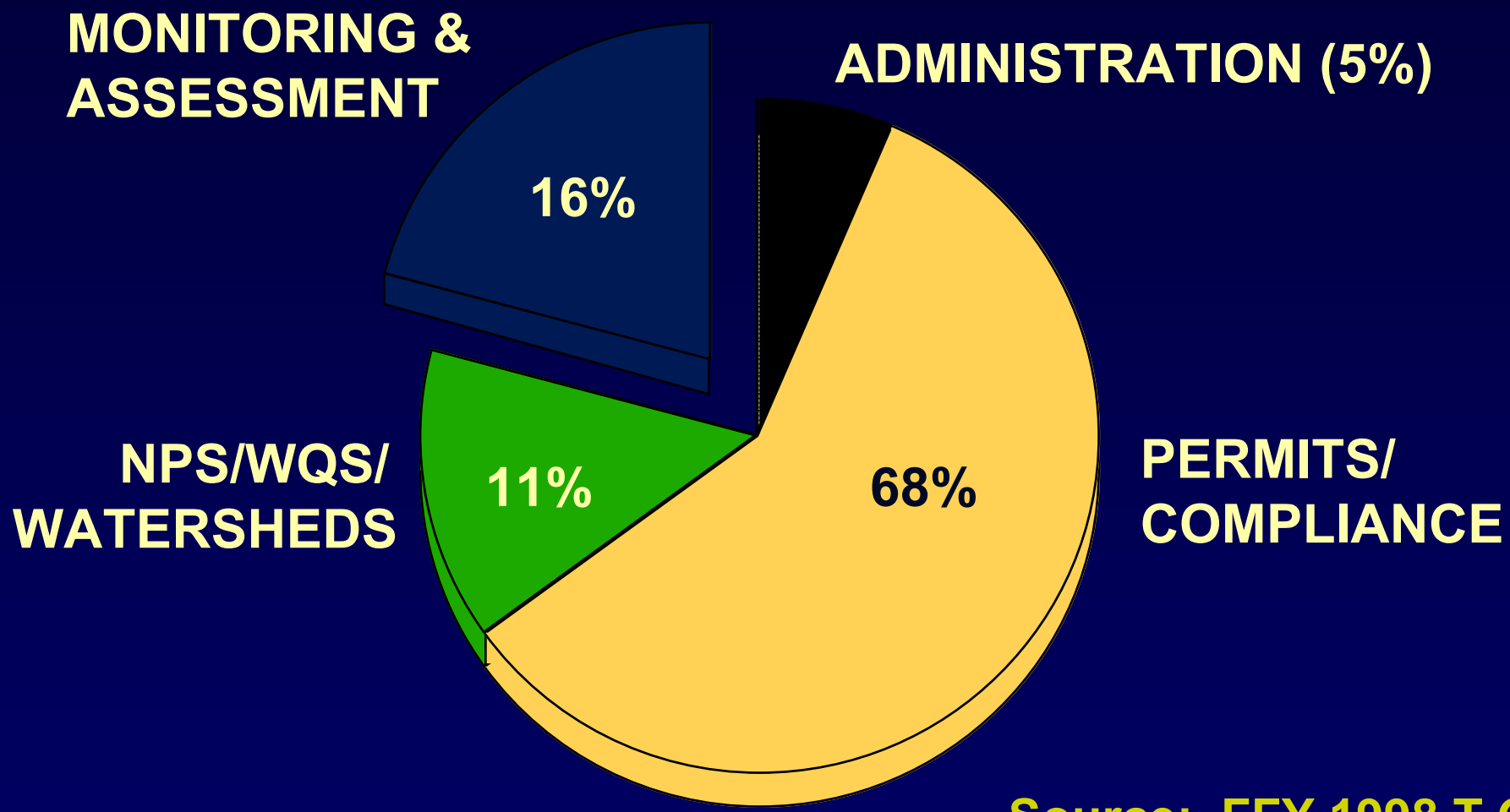
Essential Principles of Adequate Monitoring and Assessment Approaches

- **Data Quality Objectives**: need to produce data and information at a sufficient level of resolution so as to assure accuracy and precision.
- **Watershed Scale Assessment**: essential to encompass the full gradient of response and exposure to multiple stressors and influences.
- **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 iterative assessment and observing responses to management actions (what works?).

Increasing the Capacity of State Monitoring and Assessment Programs is an Urgent National Priority

- **Tiered uses and refined criteria, including numeric biological criteria**
- **Adequate M&A implemented by skilled and trained professionals, *consistent custody of assessment***
- **Integrated assessment process at the same scale at which management is being applied**

Ohio EPA Surface Water Program Resource Allocation by Functional Category



Source: FFY 1998 T.O.

The challenge for water quality management in the 21st century will be to incorporate the concepts of aquatic ecosystem functioning and health into water quality standards, monitoring and assessment, and regulation so as to stem the current declines in watershed health and the declining delivery of essential goods and services.