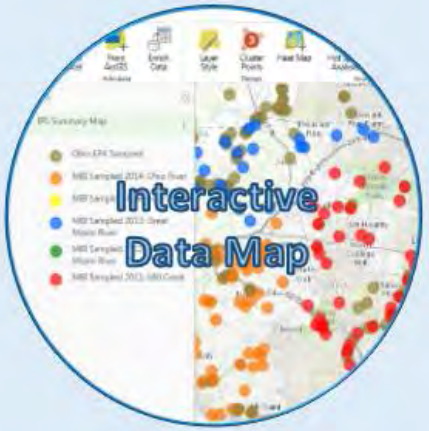
MSDGC Integrated Prioritization System (IPS)



MSDGC requested MBI to develop a tool for assessing biological & water quality conditions affected by multiple variables and stressors

Setting Priorities and Decision-Making: A Stronger Scientific Basis

- **MSDGC's service area:**
  - ✓ **11 sub-watersheds**
  - ✓ **3 major main stem rivers**

- Identify the most limiting stressors in the receiving streams
- Develop a database that can be queried at the site, reach, and sub-watershed levels
- Identify the "highest return" projects – both restoration and protection options.
- Address required regulatory actions (e.g., CSO controls) while cost-effectively improving conditions for aquatic life and attainment of Water Quality Standards.

History of Integrated Prioritization Systems

- **Ohio EPA**
  - Original IPS Concept Supports the Water Resource Restoration Sponsor Program (WRRSP)
    - Used to prioritize and qualify WRRSP funded projects.
    - Based on identified aquatic life use impairments related to habitat.
- **DuPage River Salt Creek Working Group IPS** (DuPage Co., IL)
  - Based on rotating basin surveys and includes consideration of:
    - Waterbody ecological potential;
    - "Restorability" of impairments revealed by monitoring and assessment;
    - Effectiveness of "doable" restoration options;
    - Being updated in 2016 based on lessons learned.

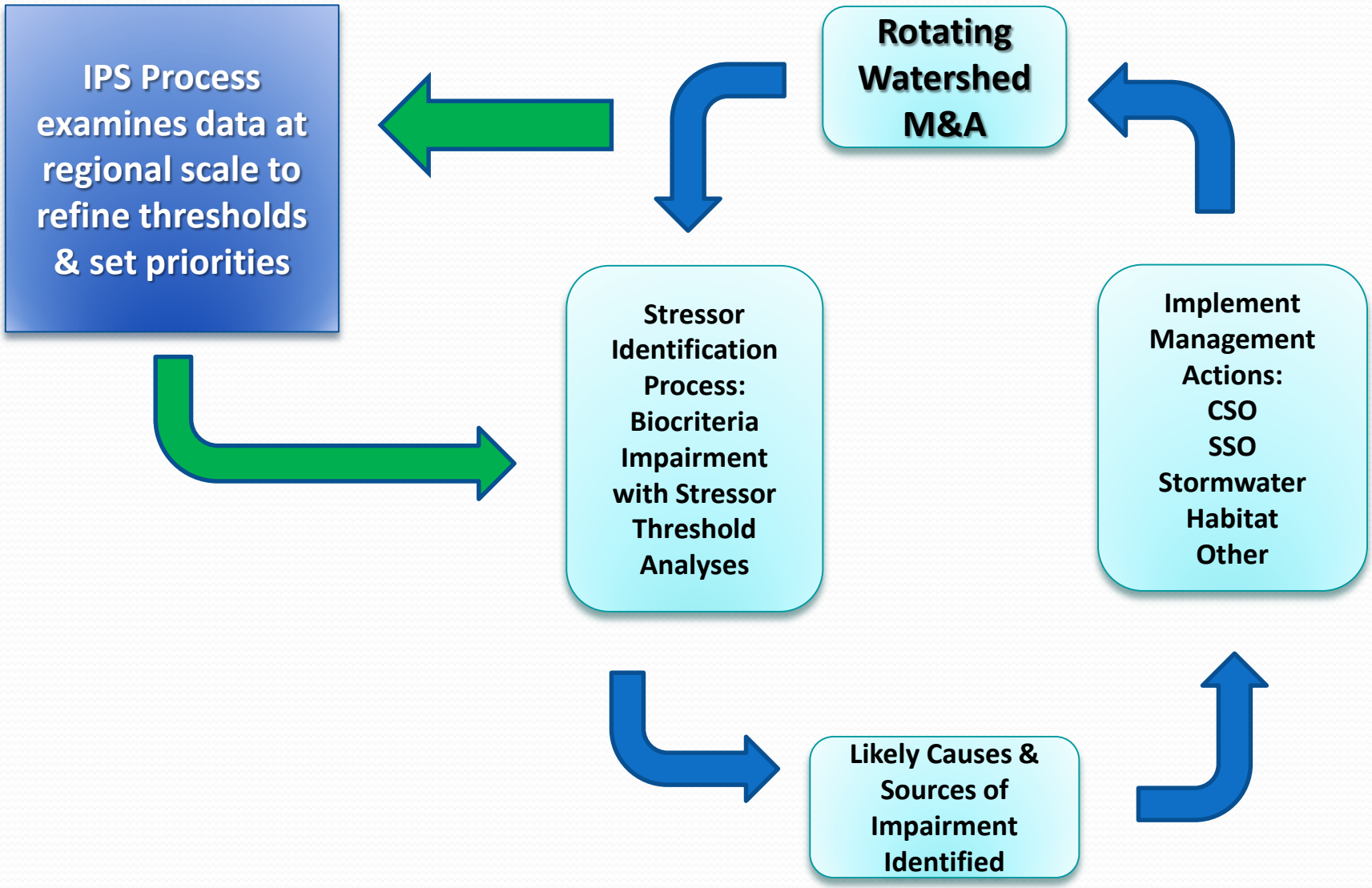
The IPS Regulatory Foundation:

CWA Section 101(a)(2) ". . . it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water . . . "

The IPS is focused on the attainment of Ohio Water Quality Standards

- Provides the basis for designated uses for aquatic life and recreation.
- Ohio WQS have tiered uses for aquatic life & recreation.
- Biocriteria are the arbiter of aquatic life use attainment.
- Bacterial indicators are the arbiter of recreation uses.
- Aquatic life is the focus of the IPS.

General Steps in a Stressor Identification Process for Aquatic Life



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TECHNICAL REPORTS

SURFACE WATER QUALITY

Measuring the Contribution of Agricultural Conservation Practices to Observed Trends and Recent Condition in Water Quality Indicators in Ohio, USA

Robert J. Miltner*

An example of the "value added" aspect of *consistent* monitoring & assessment.

Abstract

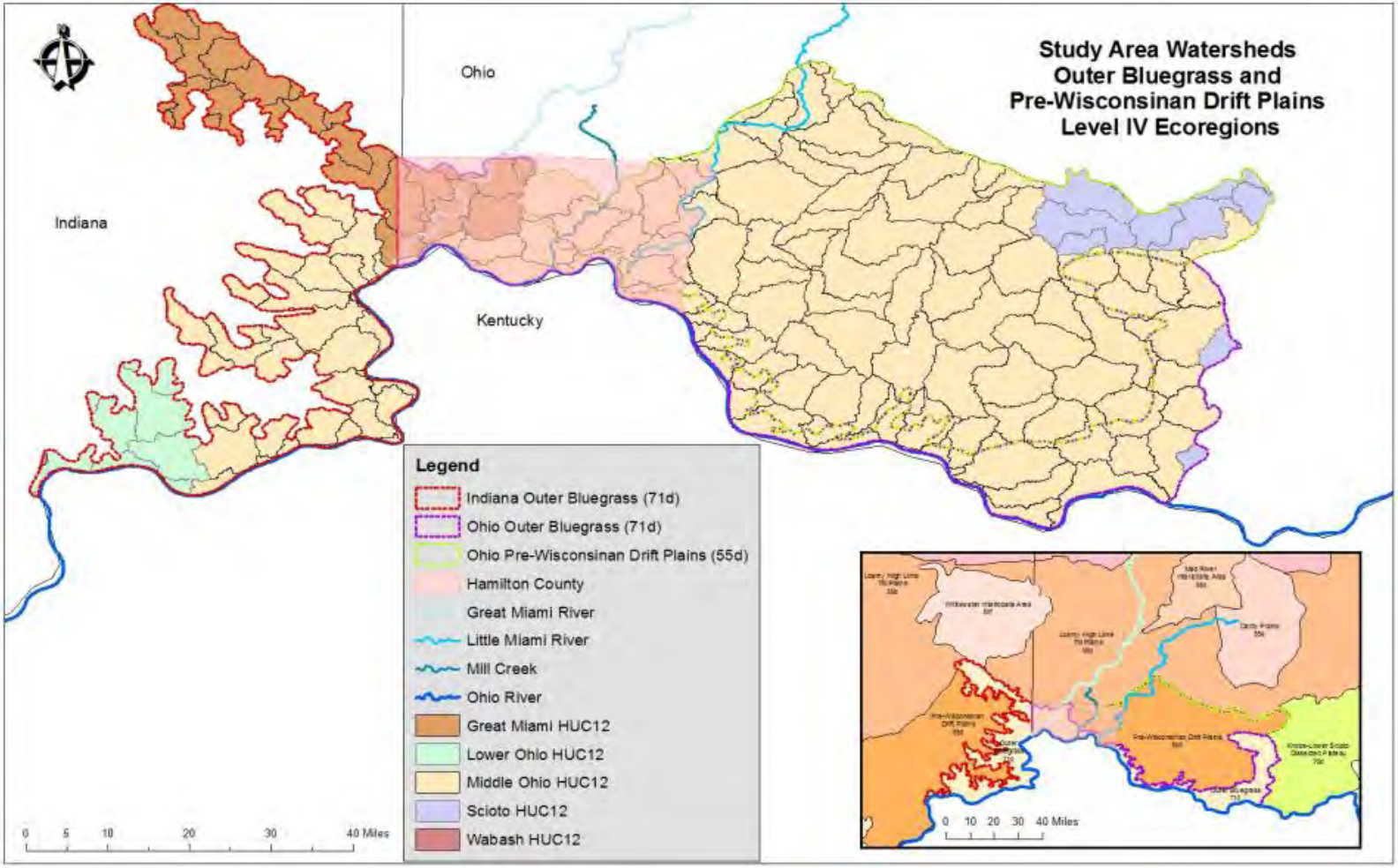
[illegible] to upgrade wastewater infrastructure and manage pollution from diffuse sources have resulted in measurably improved water quality and biological conditions [illegible] streams. Conservation measures to reduce [illegible] have contributed significantly to the improvement witnessed over the last two decades and should therefore be continued. Within the most recent timeframe examined, little difference was found in either total phosphorus or suspended sediment concentration in relation to conservation measures, indicating that the environmental benefits of measures targeting soil loss may be approaching an asymptote. Conservation measures targeting livestock and forage management, however, appear to have reduced nitrogen concentrations within the recent time frame. An examination of the interrelationships between habitat quality, conservation measures, and land use indicated that water quality was generally mediated by interactions with stream habitat quality. However, the positive effect of habitat quality was reduced in catchments draining fine-textured soils. The implication of these latter two findings suggest that proscriptively adding natural function to the large network of ditched and maintained conveyances draining agricultural lands would substantially improve water quality, but management at the field level is necessary to minimize phosphorus losses.

SIGNIFICANT EFFORTS to reduce sediment (and, in passing, phosphorus) pollution from agricultural sources were initiated [illegible] and early 2000s (Reimer, 2013). These efforts have led to significant reductions in suspended solids and total phosphorus (TP) in Ohio rivers [illegible] (2009), especially after 1990. Despite decreasing concentrations of TP, the fraction in dissolved form has been increasing (Ohio EPA, 2010; Baker et al., 2014; Obenour et al., 2014), contributing to a resurgence of algal blooms in Lake Erie. The return of eutrophic conditions in Lake Erie, along with the well-documented problem of hypoxia in the Gulf of Mexico due to agriculturally derived nutrient loads from the Mississippi River basin, have called into question the efficacy of conservation programs for water quality (Sohngen et al., 2013). Contributing to this view is the fact that because conservation measures (commonly referred to as best management practices [BMPs]) are widely distributed, broadly prescribed, and voluntarily adopted and because water quality monitoring programs tend to lack spatial and technical rigor (USEPA, 2002), documenting links between conservation measures and water quality improvement within specific catchments has been difficult (Meals et al., 2010; Tomer and Locke, 2011).

What is the IPS?

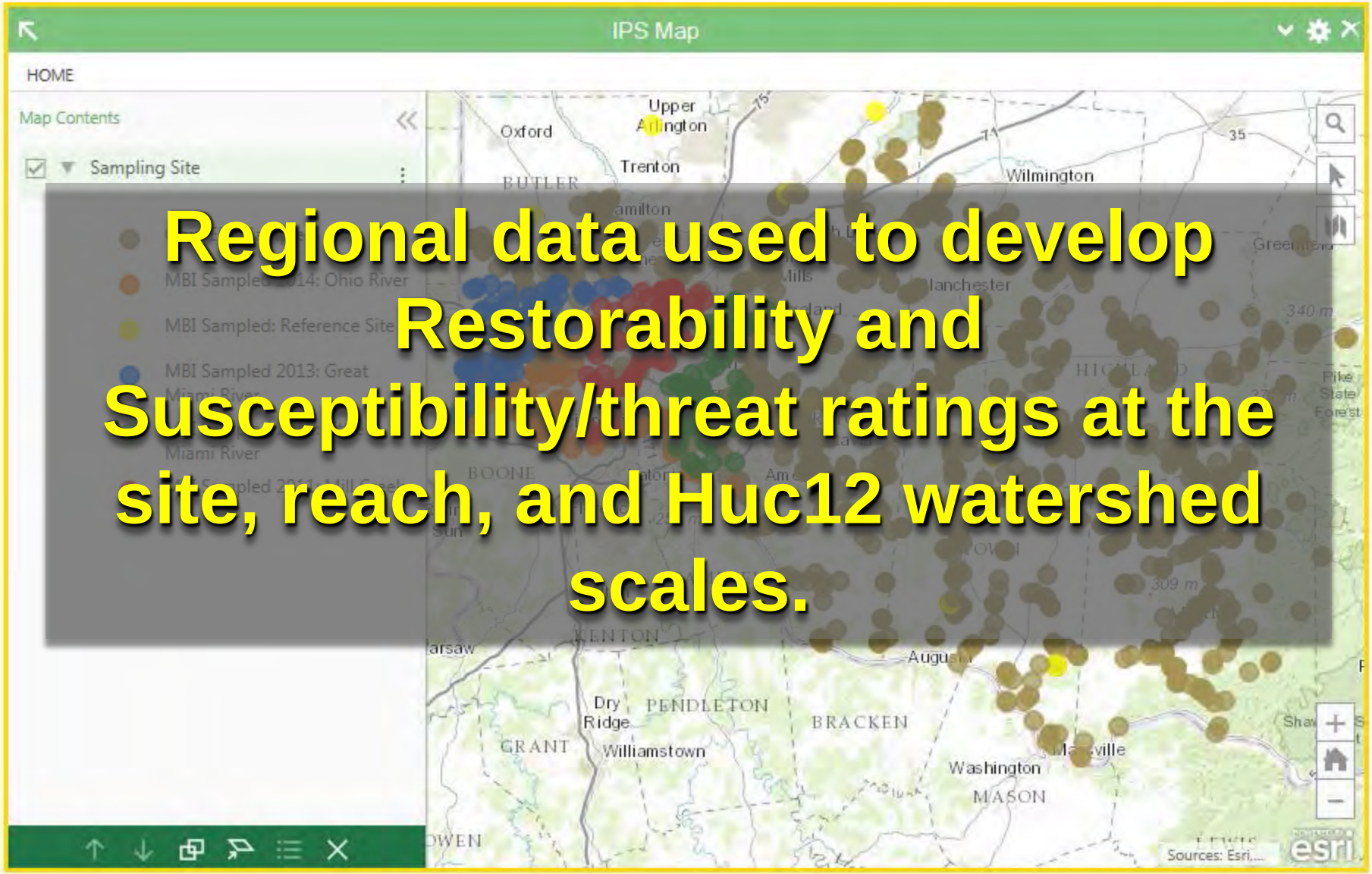
- Allows user to ***visualize and rank*** aquatic life use aspects of CWA water quality issues:
  - Identifies designated aquatic life uses (goals) for streams and rivers.
  - Identifies aquatic life impaired reaches including severity and extent.
  - Identifies probable causes of impairment.
  - *Standardized* approach to viewing data linked to attainment of aquatic life uses.
  - Sites, reaches, and watersheds ranked by ***Restorability*** (for impaired waters) and ***Susceptibility*** & ***Threat*** (for attaining waters).

The IPS study area is necessarily regional in scope and focuses on common sub-regions at Huc 12 scale

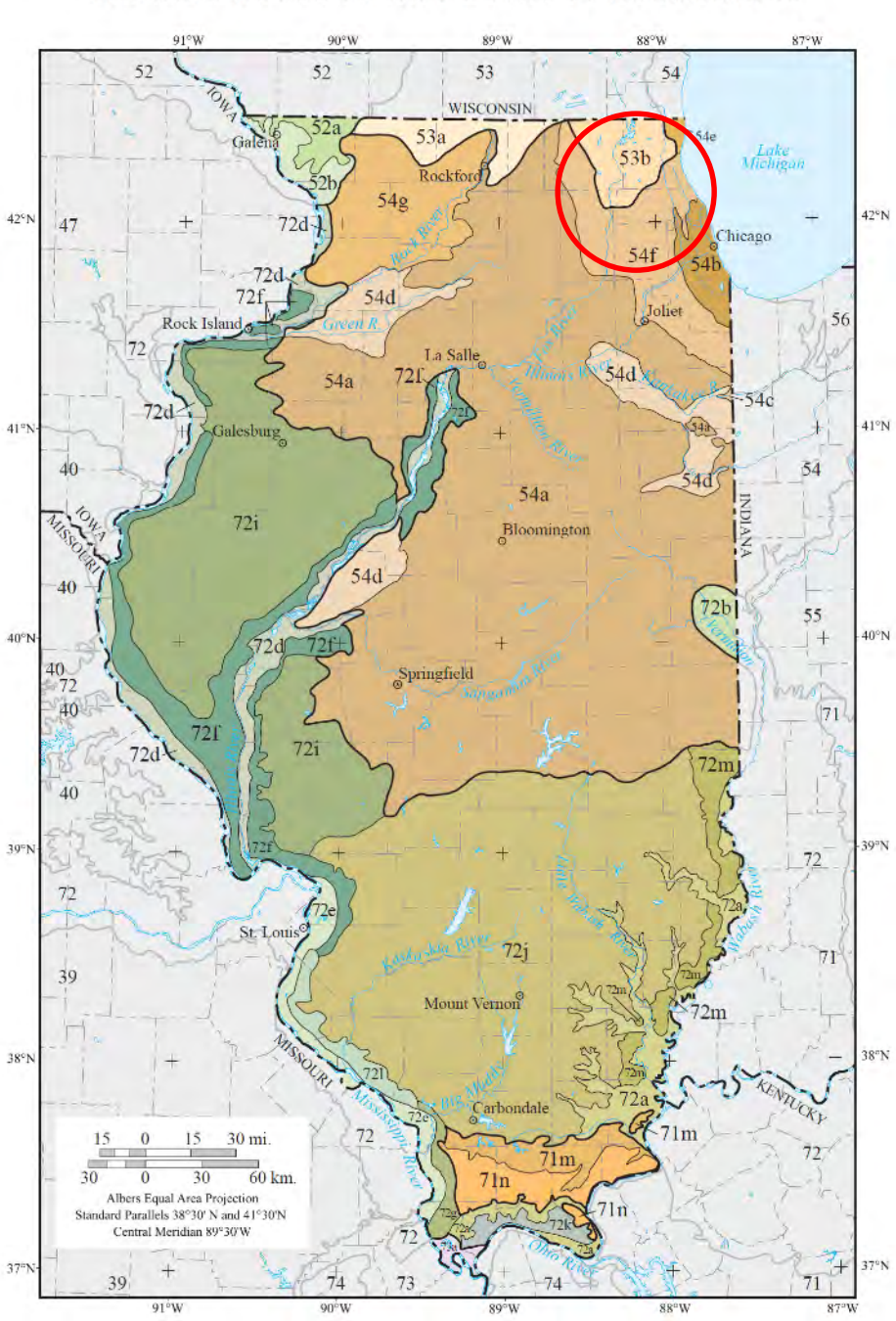


Fortunately we have 30+ years of consistent data from Ohio EPA.

Data Used in the IPS

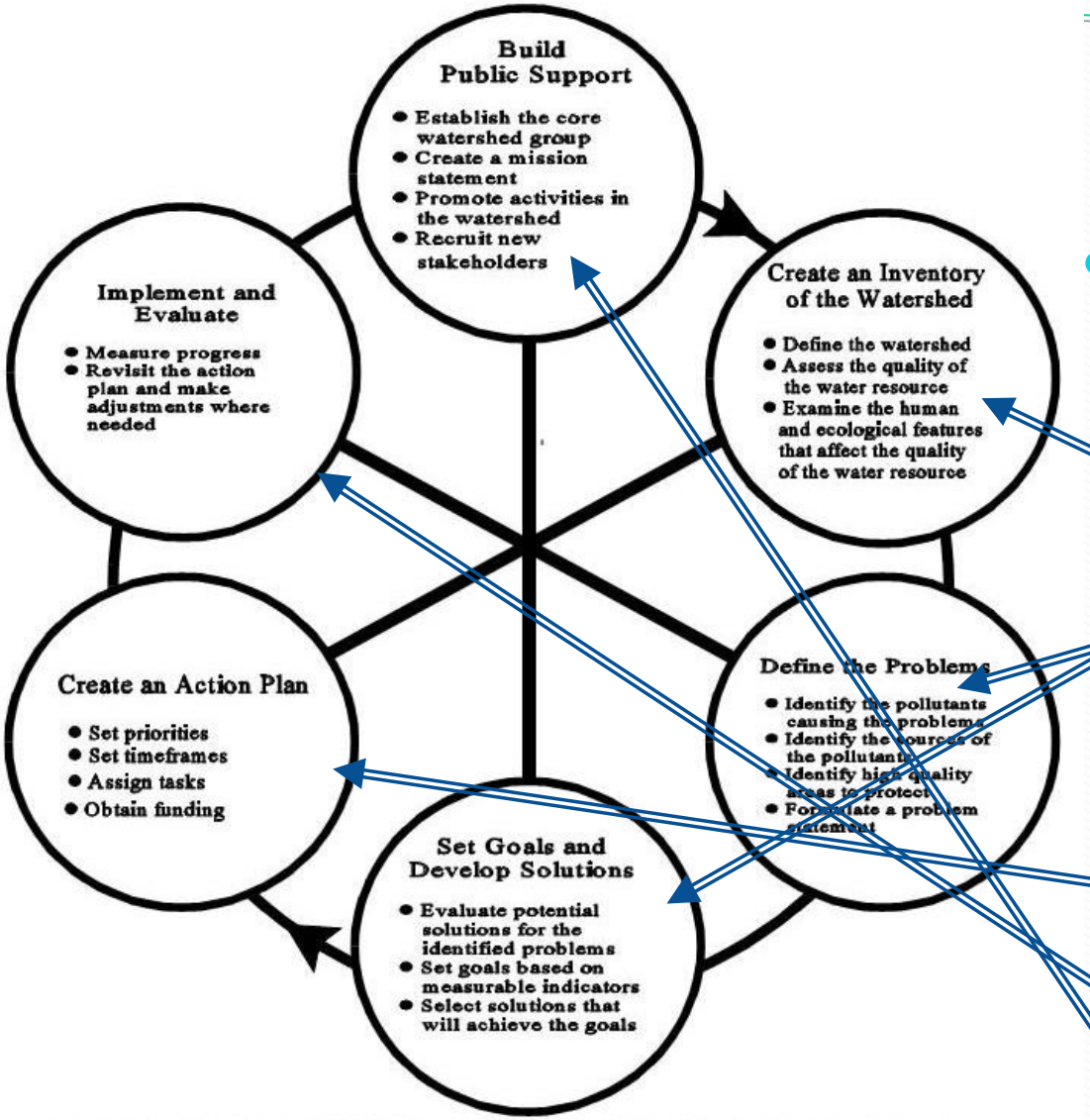


Regional data used to develop Restorability and Susceptibility/threat ratings at the site, reach, and Huc12 watershed scales.



NE Illinois IPS Data

IPS & Annual Watershed Assessments



- Addresses all of the ***DATA*** functions in a **Watershed Action Plan**
  - **Inventory**: Aquatic life use attainment status
  - **Identify & quantify** pollutants, sources, high quality waters, ecological features
  - **Prioritize** abatement projects
  - **Measure** Progress
  - **Inform** Public

IPS: A Data Driven Foundation

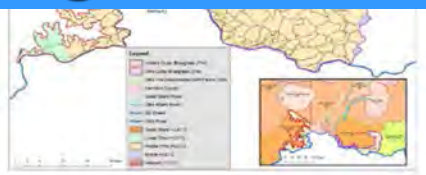
- Ambient monitoring data that includes:
  - Biological data
    - To evaluate biocriteria compliance
  - Water and sediment chemistry data
    - To evaluate water quality criteria
    - Compare to biocriteria based benchmarks
    - Compare to reference site benchmarks
  - Habitat data
    - Key limiting factor to biota
  - Land use and flow data
    - Effects of land use on the natural flow regime is a key issue

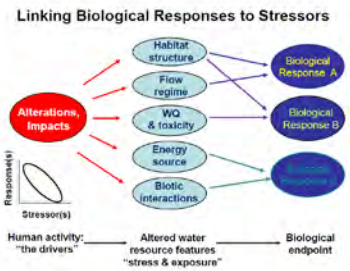
METROPOLITAN SEWER DISTRICT of greater CINCINNATI

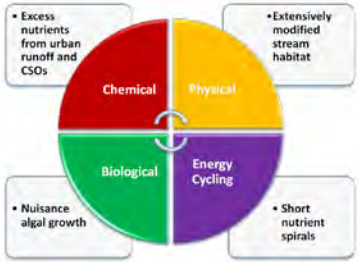
PROJECT GROUNDWORK
your pipeline to clean water

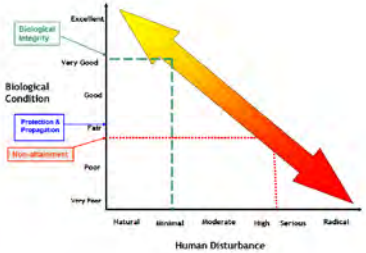
Integrated Prioritization System (IPS) Documentation and Atlas of Biological Stressor Relationships for Southwest Ohio

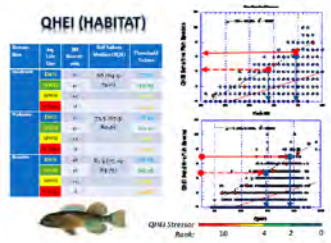
http://www.msdgc.org/initiatives/water_quality/index.html

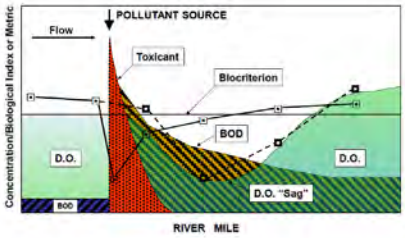


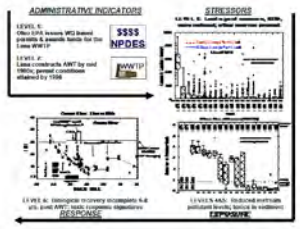










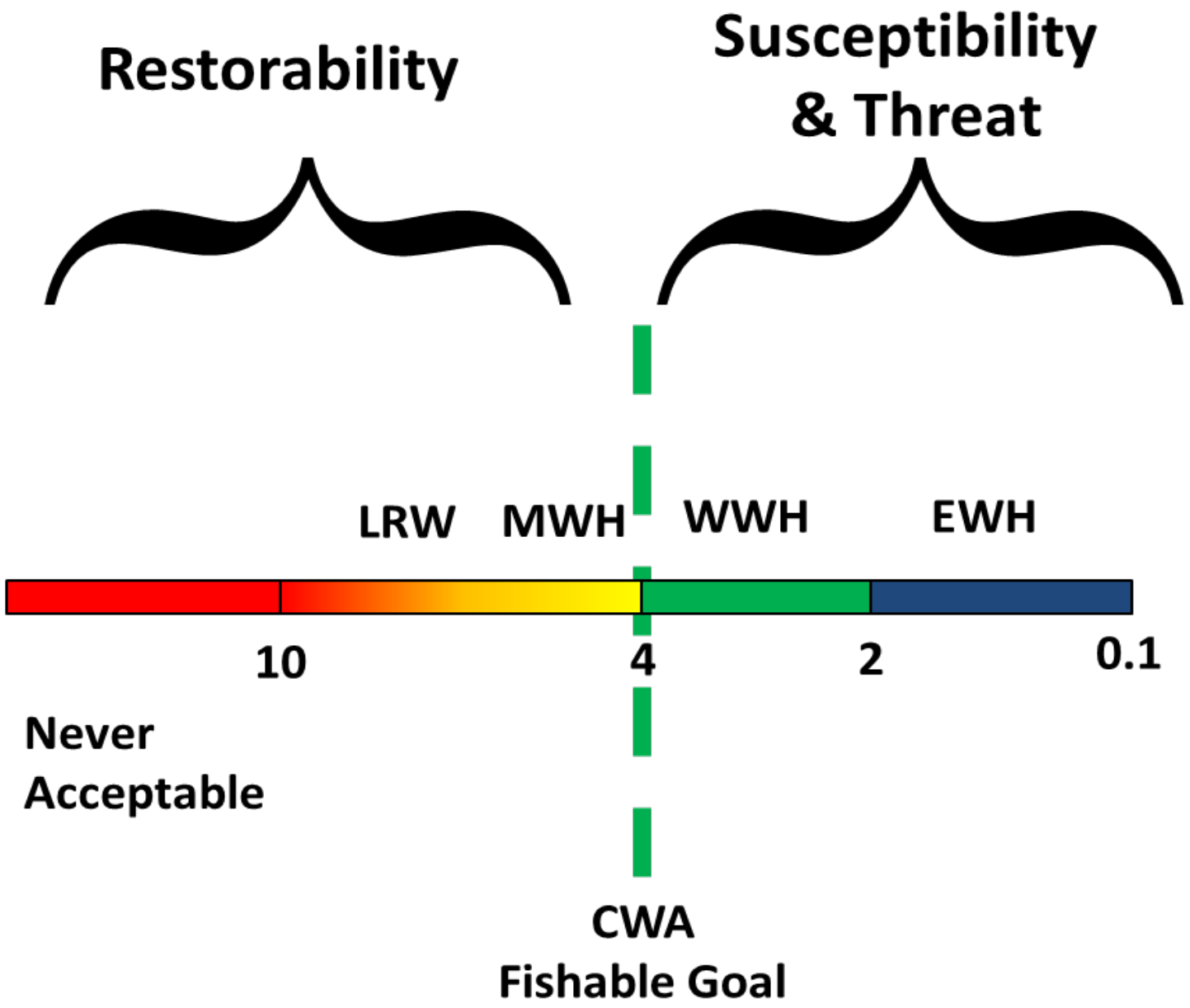


Stressor and Response Variables are Normalized to the Same Scale

Stressor Rank Guide		
Narrative Description	**Aquatic Life Use Equivalent**	**Numeric Range**
Excellent	Exceptional Warmwater Habitat (EWH)	0-2
Good	Warmwater Habitat (WWH)	2-4
Fair	Modified Warmwater Habitat (MWH)	4-6
Poor	Limited Resource Water (LRW)	6-8
Very Poor	Never Acceptable	8-10

Principal IPS Outputs

Indivi Response		hreat
Narrative Scale/Aq Use		hreat
Excellent		w 0-50
Good		gh 51-100
Fair		*threat*
Poor		*ed to*
Very Poo		*s.*



Derivation of Stressor Benchmarks

- Multiple options for stressor benchmarks:
  - Water quality criteria where they exist (ammonia, dissolved oxygen).
  - Regionally derived biological stressor benchmarks.
  - Regional reference conditions.
- Regionally derived benchmarks provide thresholds for parameters without WQ criteria and more relevant and accurate effect thresholds for parameters with statewide criteria.

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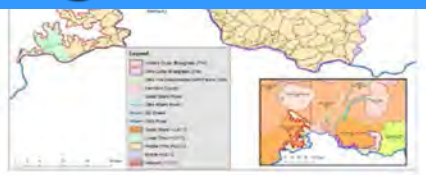
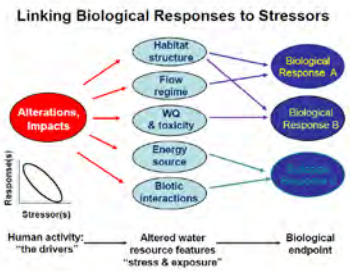
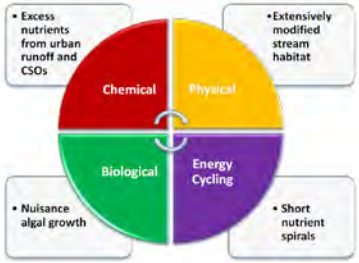
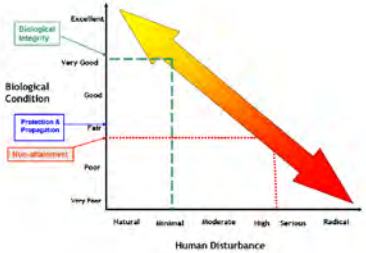
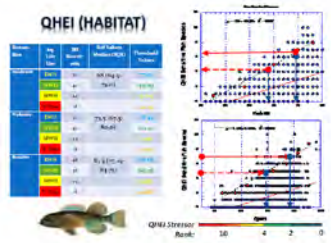
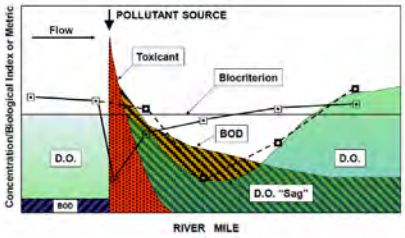


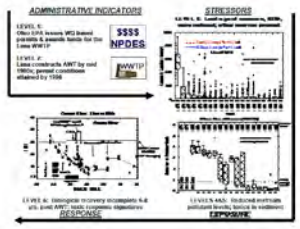












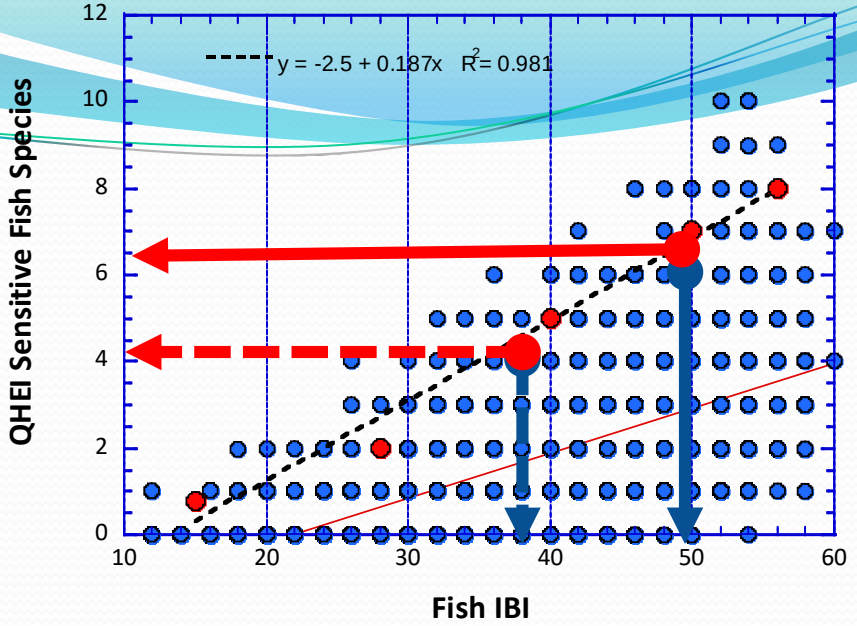
IPS Variables & Endpoints

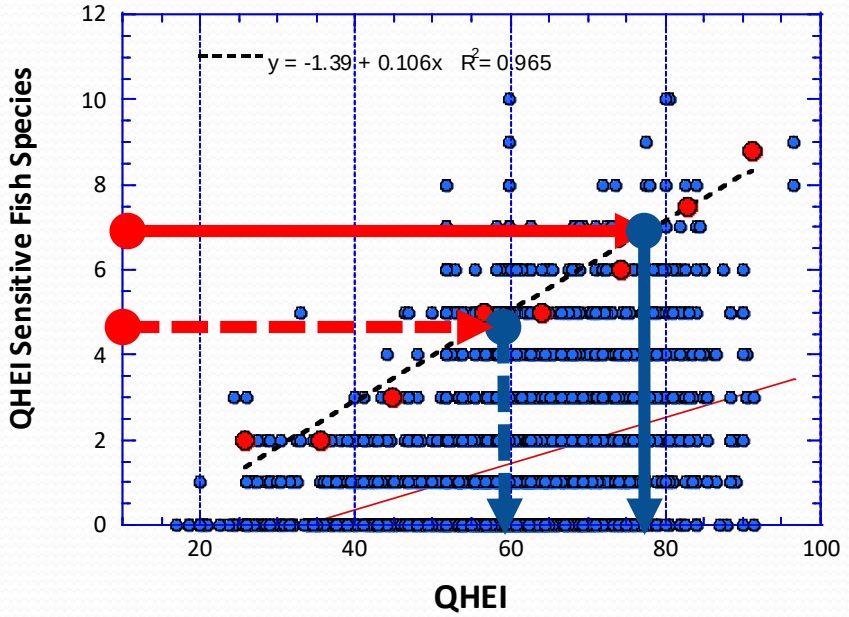
Stressor Categories	Common Indicators (Italic – Used in the IPS)
Habitat Diversity	*QHEI, QHEI Channel*
Bedded Sediment	*QHEI Substrate Metric*, QHEI Embeddedness and Silt Scores
Stream Flow Regime	Base Flow Index (LF), *HydroQHEI (LF), Impervious Surface* (LF/HF), Mean Sept Flows (LF)
Oxygen Demand	*Minimum DO, BOD*
Acid/Alkaline Conditions	*pH*
Dissolved Substances	*Total Chloride, Conductivity, TDS*
Suspended Substances	*TSS*
Nutrients	TP, *Nitrate, TKN*
Conventional Toxics	*Ammonia*
Metals	*Copper, Zinc, Lead, Manganese*
Flood Plain/Land Use Quality	QHEI Riparian, *Buffer Land Use, Catchment Land Use (Heavy Urban)*

Parameter	Stream Size	Fish/Bugs	Aquatic Life Use (IBI or ICI)	Threshold	Reference Sites Median (IQR)
HydroQHEI	Headwater	Fish	EWH (50)	14.54	9.0 (5.0-11.25)
			WWH (40)	9.72	
			MWH (24)	2.02	
			LRW (18)	-	
	Wadeable	Fish	EWH (50)	17.72	11.0 (9.0-16.0)
			WWH (40)	11.28	
			MWH (24)	0.97	
			LRW (18)	-	
	Boatable	Fish	EWH (50)	16.93	17.0 (11.8-20.0)
			WWH (40)	10.64	
			MWH (24)	1.84	
			LRW (18)	-	
Dissolved Oxygen	All Stream Sizes	Macros	EWH (48)	9.05	8.80 (7.41-11.40)
			WWH (30)	5.30	
			MWH (24)	3.43	
			LRW (2)	-	
QHEI	Headwater	Fish	EWH (50)	77.35	68 (64.5-74.0)
			WWH (40)	59.79	
			MWH (24)	31.69	
			LRW (18)	21.15	
	Wadeable	Fish	EWH (50)	78.45	73.5 (67.5-80.0)
			WWH (40)	60.41	
			MWH (24)	31.56	

QHEI (HABITAT)

Stream Size	Aq. Life Use	IBI Biocrit-eria	Ref Values Median (IQR)	Threshold Values
Headwater	EWH	50	68 (64.5-74.0)	77.35
	WWH	40		59.79
	MWH	24		31.69
	V. Poor	18		21.15
Wadeable	EWH	50	73.5 (67.5-80.0)	78.45
	WWH	40		60.41
	MWH	24		31.56
	V. Poor	18		20.74
Boatable	EWH	48	83.5 (77.25-84.75)	76.65
	WWH	38		60.06
	MWH	24		36.83
	V. Poor	18		26.88





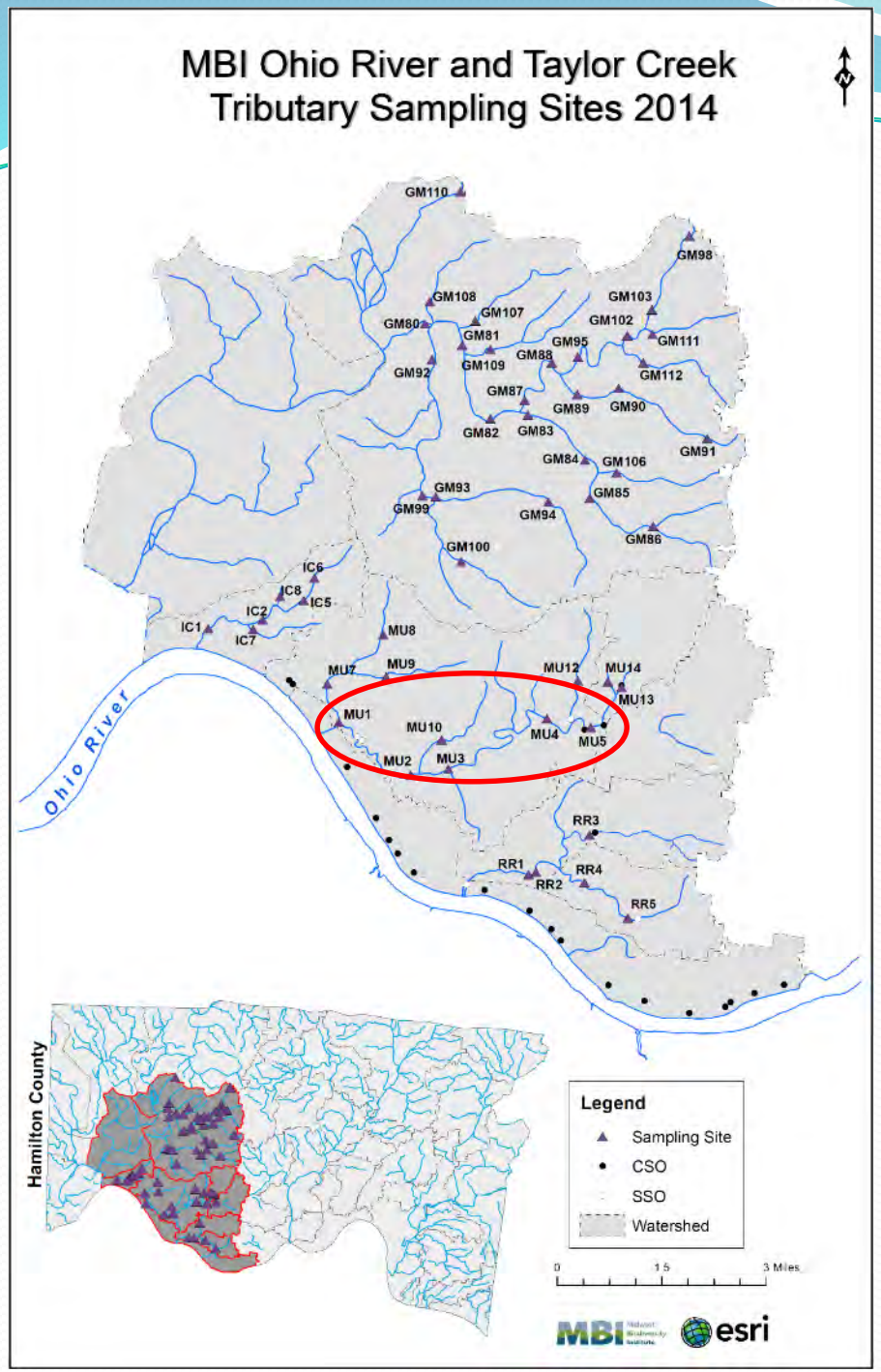
QHEI Stressor Rank: **10 4 2 0**

Restorability Algorithm

- Each of the restorability factors are scaled from 0-10:
  - A *lower* score indicates full attainment and/or a high potential for restoration;
  - A *higher* score indicates an accumulation of precluding stressors some of which make restorability more difficult or cost-prohibitive.
- Each factor is ranked separately with multiple options for combining scores in IPS.
- IPS tool set up to evaluate at site, reach, or watershed scale.

Restorability or Susceptibility/Threat Scores at Each Site, Reach, & Huc 12

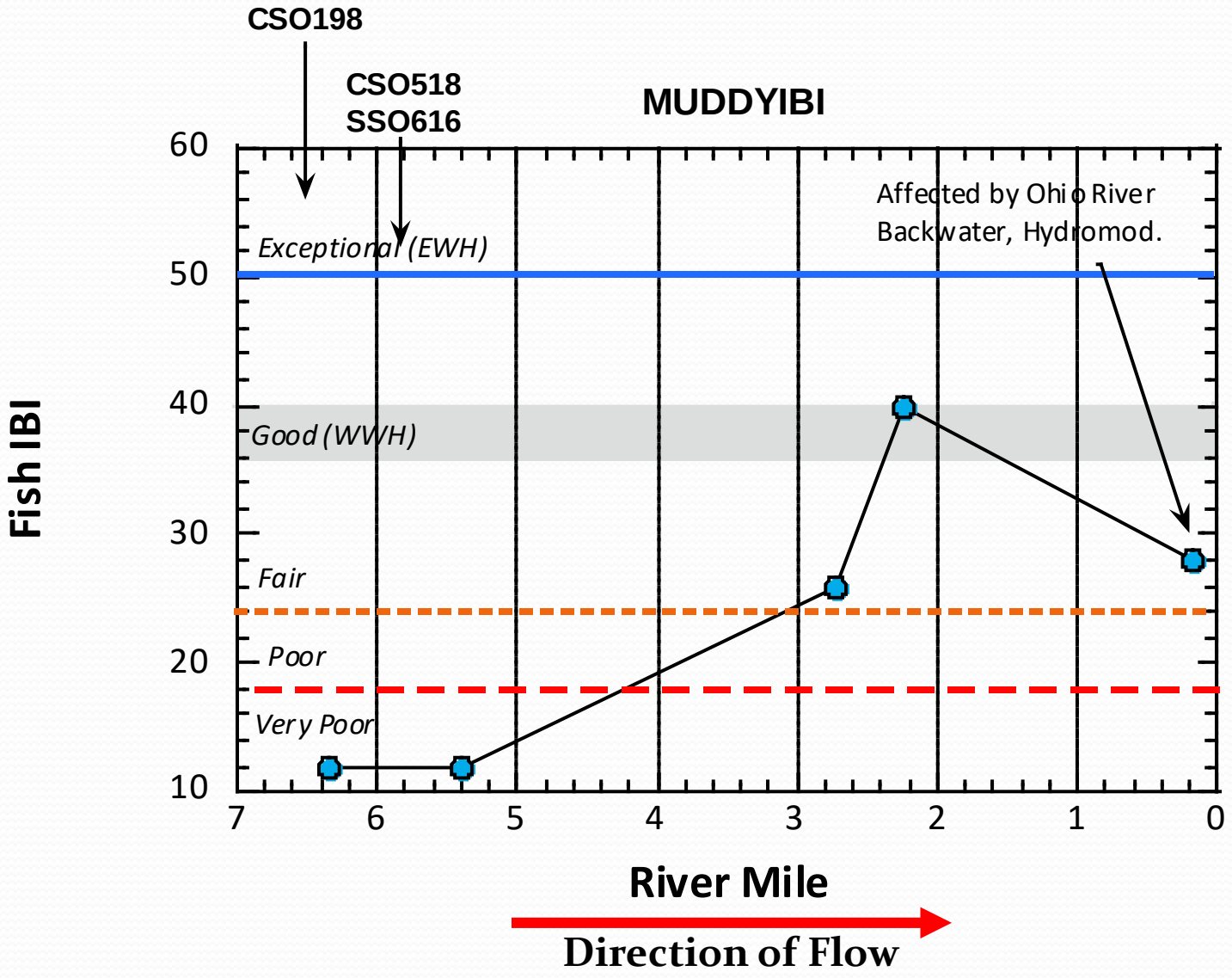
Individual Stressor and Response Variables (0-10 Scale)				Summary Restorability, Susceptibility and Threat Scores (0-100 Scale)		
Narrative Condition Scale/Aquatic Life Use Tier[1]		Stressor Rank		Restorability	Susceptibility	Threat
Excellent	EWH	0.1-2.0		*A restorability score is not assigned to sites that attain their designated use.*	50-100 High	Low 0-50
Good	WWH	2.01-4.0			0-50 Low	High 51-100
Fair	MWH	4.01-6.0		High 67-100	*A susceptibility or threat score is not assigned to impaired sites.*	
Poor	LRW	6.01-8.0		Intermediate 34-66		
Very Poor	-	8.01-10.0		Low 0-33		



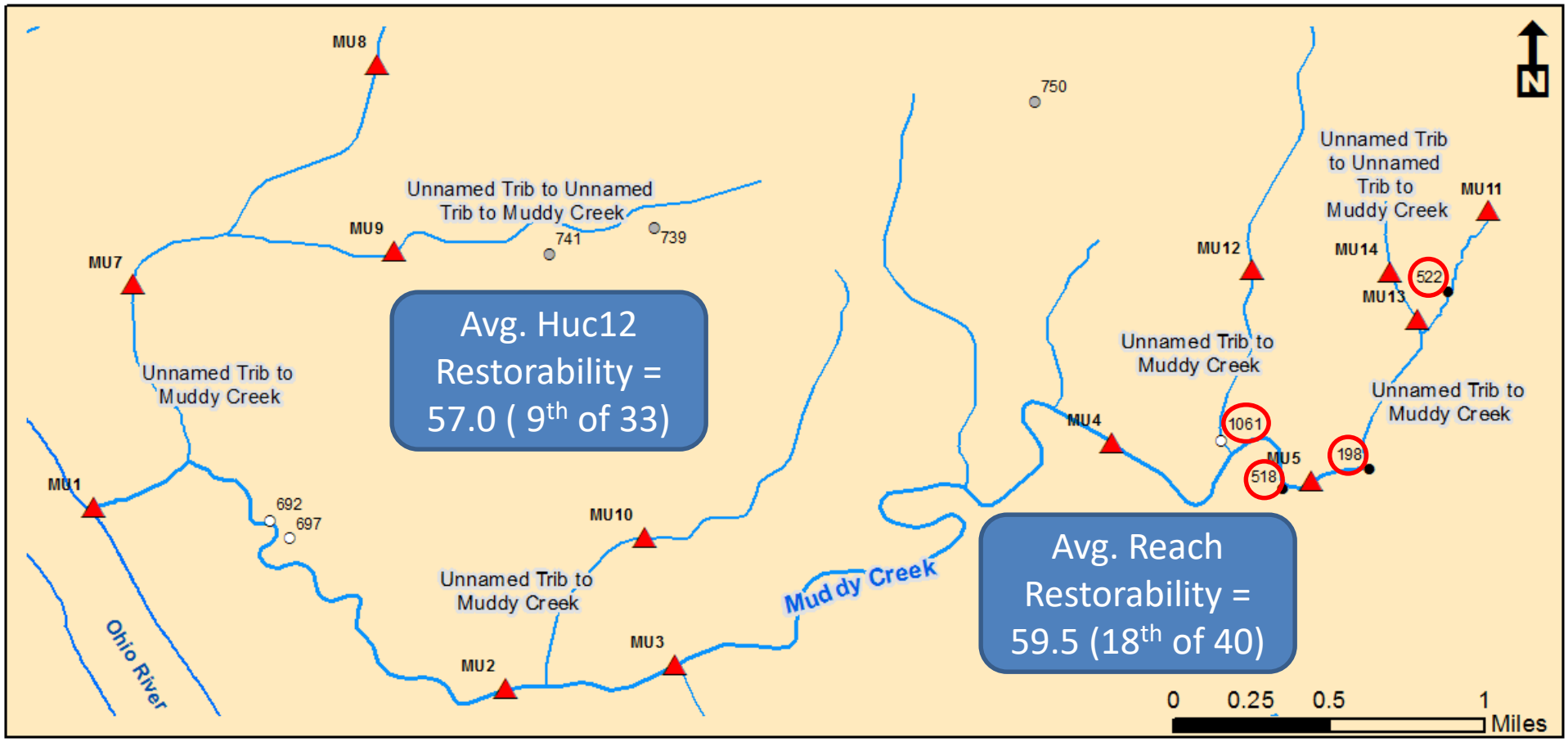
Ohio R. Tributaries & Taylor Creek Survey Design

- Pollution survey design – uses geometric allocation of sampling sites
- Additional sites positioned in proximity to suspected sources of stress & contamination
- Each site assigned a consistent site code (e.g., MU 01, MU 02)
- 51 total sites
- Each sampled for biological & water quality parameters
- Employed 3 crews over the June-October index period
- Followed Ohio EPA methods to ensure data consistency and usefulness of results

Muddy Creek Results



Muddy Creek Example



Muddy Creek : Selected Stressor Variables/Ranks

		Habitat	Ionic Strength		Organic Enrichment			Suspended Materials	Conventional Toxics	pH	Metals	Land Use
Site ID	RM	QHEI	Conductivity	Chloride	TKN	Min D.O.	BOD	TSS	Max. Total Ammonia	pH	Zinc	% Low-High Urban
MU05	6.35	62.0	478	61.1	3.09	1.14	7.00	7.0	2.08	7.23	0.03	79.9
MU04	5.40	63.25	447	51.1	0.67	3.60	2.00	4.0	0.07	7.71	0.02	68.9
MU03	2.72	46.0	683	68.8	0.46	4.25	2.00	8.0	0.03	7.77	0.02	55.97
MU02	2.25	63.5	622	68.3	0.36	7.99	2.00	8.17	0.03	7.71	0.02	51.4
MU01	0.17	38.0	395	31.6	0.99	5.13	3.67	43.7	0.05	7.17	0.03	47.7
Reference Values (Median and IQR)												
		68 (64.5-74.0)	402.9 (275-445)	17.8 (13-32)	0.39 (0.2-0.57)	9.9 (7.4-11.8)	2 (2.0–2.0)	8.0 (5-17)	0.05 (0.05-0.05)	7.8 (7.5-8.0)	0.01 (0.01-0.012)	2.01 0.5-1.5)

- Habitat is largely intact (with exception of Ohio R. backwater).
- Biological response suggests strong WWH impact.
- Pollution "footprint" is 4 miles.
- Recovery to WWH at MU02 demonstrates attainability.
- High urban, but good riparian is an offset.

An example of where biological response based threshold are serving as "virtual" criteria for pollutants with no WQ criteria.

Susceptibility & Threat

- ***Susceptibility*** refers to the sensitivity of *attaining* aquatic assemblages with more diverse and sensitive assemblages (e.g., reflected by high IBI & ICI scores) being more susceptible.
- ***Threatened*** are waters that attain their aquatic life use, but which have elevated stressor levels.
- The more stressor categories that are elevated and the higher the level of stress, the greater the threat.

IPS Dashboard

- Lists, graphs, & maps of waters ranked by restorability or susceptibility and threat.
- Identification of limiting factors (causes) and the extent and severity of their effect(s).
- Maps showing spatial distribution of streams by restorability, susceptibility/threat, and associated causes.
- Linking to planned projects - ask if they are sufficient to restore, improve, or protect specific stream reaches.
- IPS can be integrated with administrative and/or social measures.