

The Trophic Index Criterion

A Brief History, Testing in Recent Surveys, & Questions Related to Causal Assessments

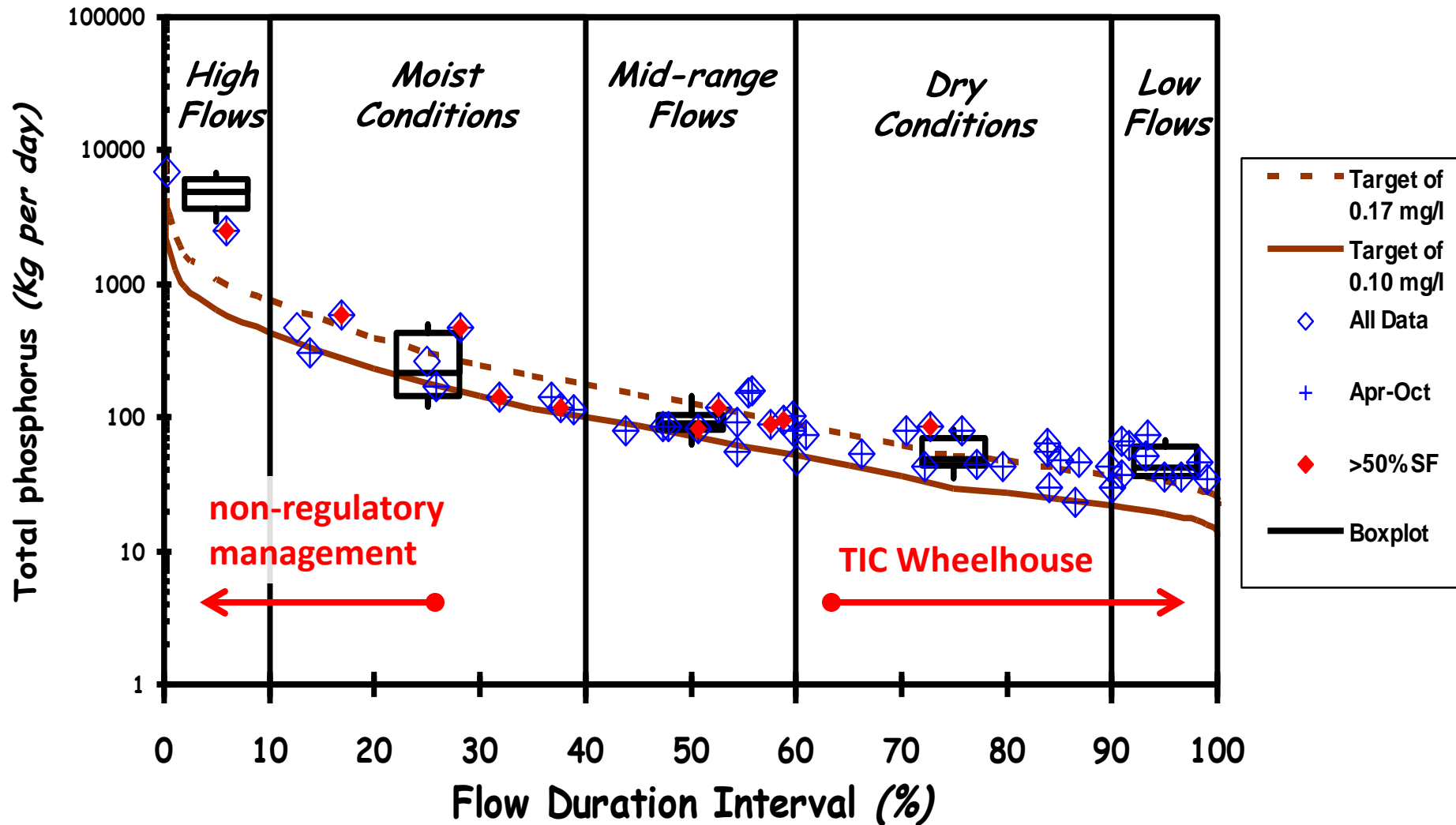


Bob Miltner, Ohio EPA
Nutrient Technical Advisory Group, 11/19/2013

Little Miami River

Load duration curve (2005 - 2008)

Site: RM 50.25 Downstream Caesar Creek



N=51

667 square miles

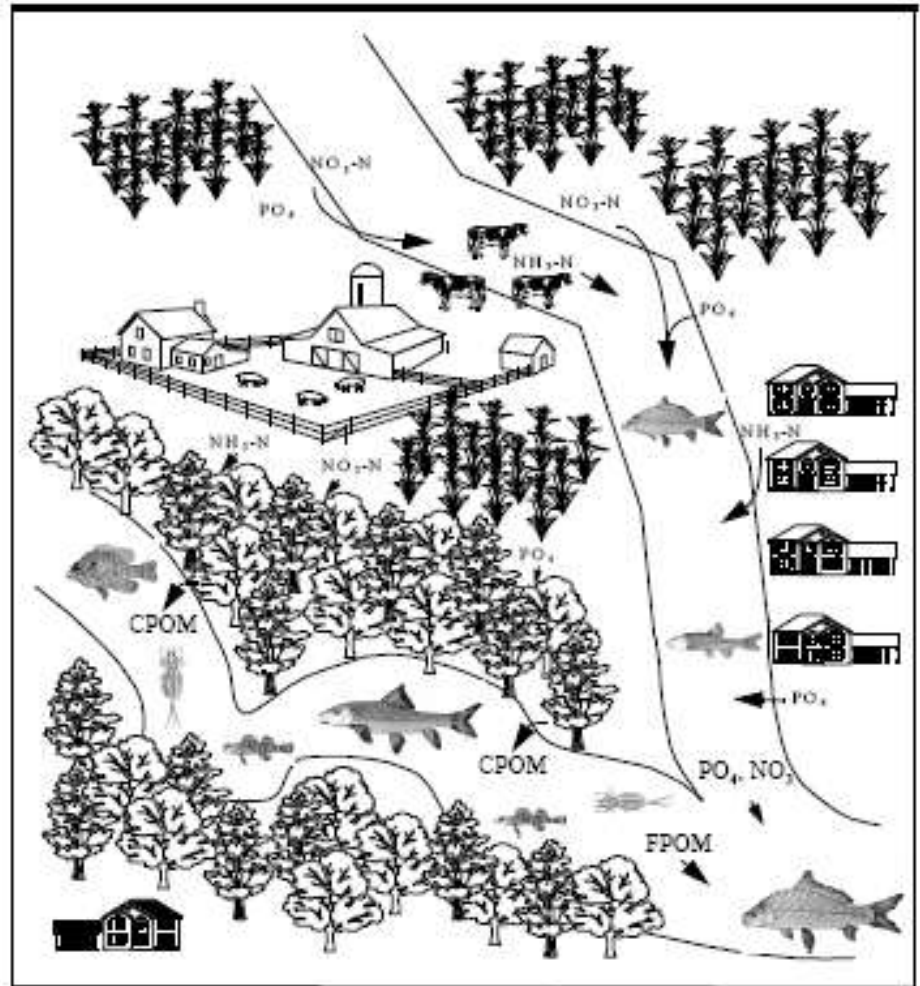
Ohio EPA and discharger data

Nutrient Indicators and Causal Assessments

Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams

Ohio EPA Technical Bulletin MAS/1999-1-1

- Retrospective analyses of state-wide data (c. 1981-1994)
- Percentiles from reference sites
- Distributions within quality rankings
- Statistical associations with biological measures (Miltner & Rankin 1998; Freshwater Biology 40:145-158)
- “Target” values used in numerous TMDLs since 1998



Nutrient Targets From the “Associations” Document

- Table 2. Median total phosphorus concentrations by IBI range (from the ALL data set), ANOVA results, and suggested criteria for the protection of aquatic life.

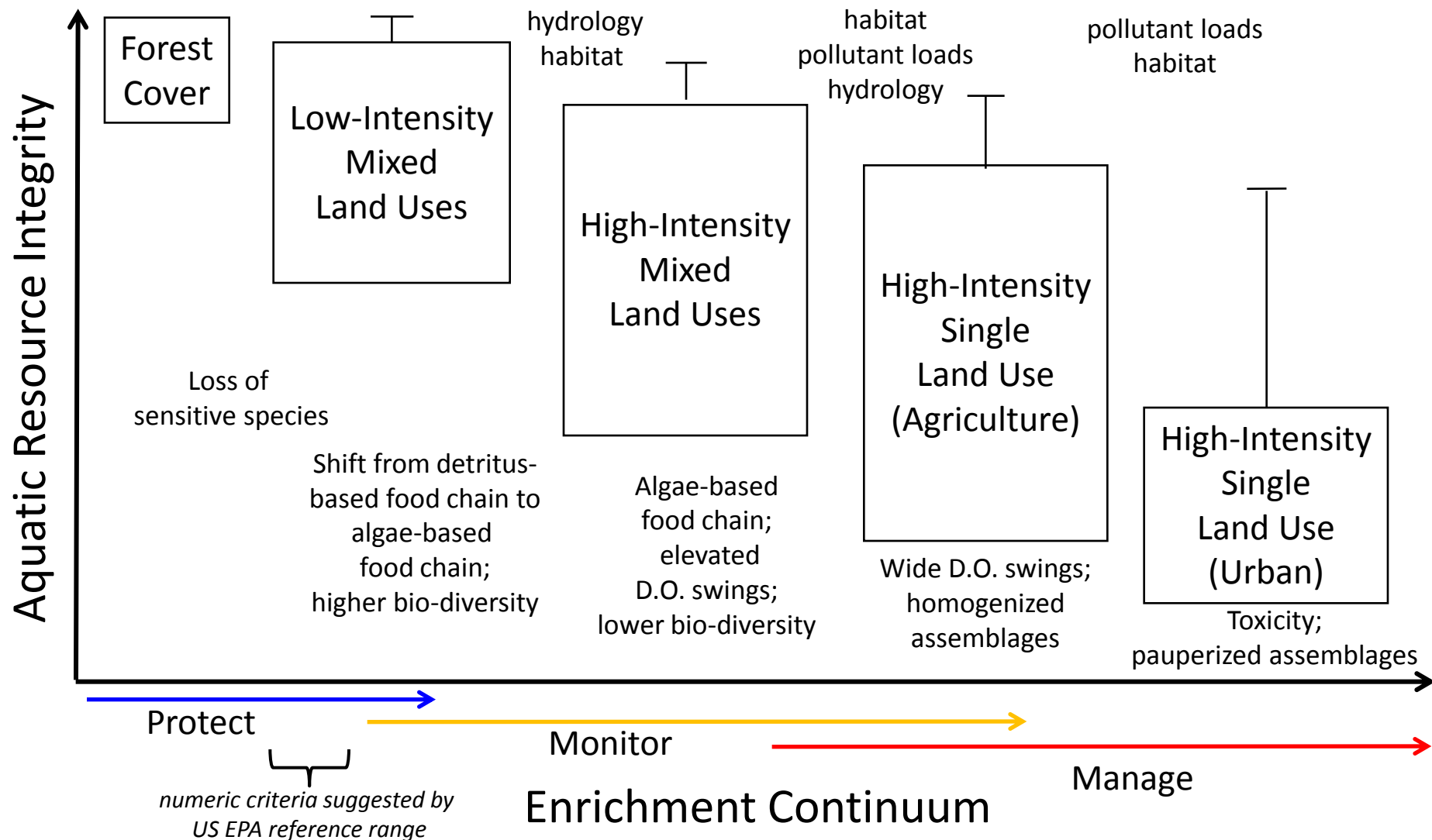
IBI Range ¹	Ecoregion Criteria					ALL ³	Statewide Criteria		
	HELP	IP	EOLP	WAP	ECBP		WWH [†]	EWB [†]	MWH
<i>Headwaters (drainage area < 20 mi²)</i>									
20 - 29	0.42	2.88	0.19	0.05	0.58	0.34			
40 - 49	-	0.13	0.05	0.05	0.07	0.06			
50 - 60	-	0.05	-	0.05	0.05	0.05			
ANOVA ²	ns	ns	0.05	ns	0.05	0.05	0.08	0.05	0.34
<i>Small Rivers (drainage area ≥ 200 mi² < 1000 mi²)</i>									
20 - 29	0.25	-	0.20	0.25	0.25	0.25			
40 - 49	-	0.33	0.12	0.08	0.16	0.18			
50 - 60	-	0.15	0.08	0.05	0.17	0.14			
ANOVA	ns	ns	0.10	0.10	ns	ns	0.17	0.10	0.25

Information Needs for Causal Assessments

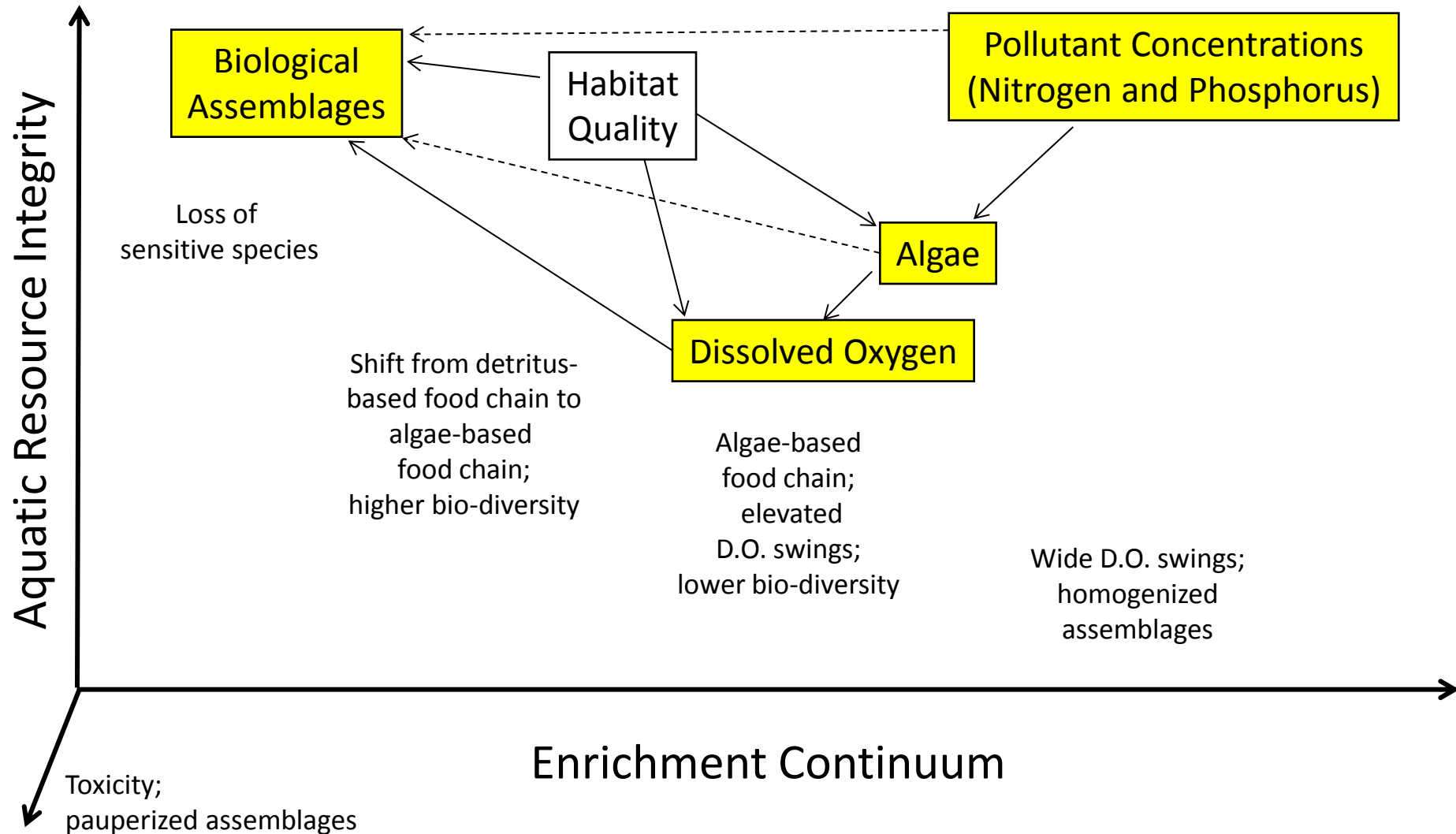
- Associations target values were robust for management
 - In causal assessments, linking biological impairment to high nutrient concentrations not as robust
 - Need for response indicators to use in causal assessments
 - Chlorophyll a
 - Dissolved Oxygen
 - Inferentially demonstrate cause-effect relationship
 - Wealth of information in the literature demonstrating cause-and-effect
- Trophic Index Criterion
 - Causal Variables (nitrogen and phosphorus)
 - Enrichment Response Indicators (Chlorophyll and D.O.)
 - Biological Endpoint

Causal Assessments Take Place in a Broad Context

Especially When Considering Nutrient Over-Enrichment



Positioning a Waterbody on the Enrichment Continuum



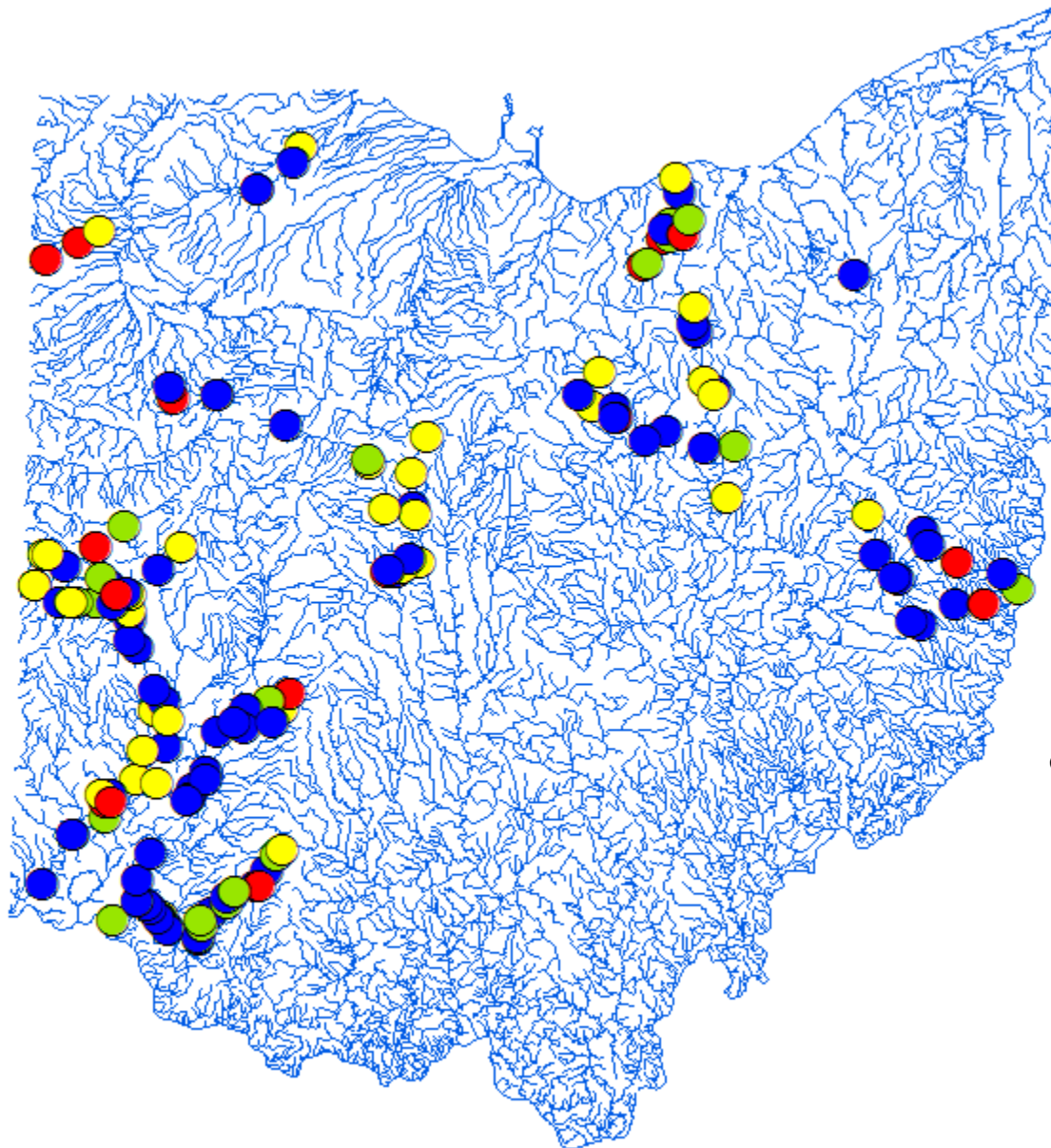
Numeric Values Assigned to the Enrichment Continuum: The Trophic Index Criterion

	Biological Assemblages	Dissolved Oxygen	Benthic Algae	Nutrients	Trophic Index Criterion
Un-enriched	Meet applicable biocriteria (12)	Normal variation <6 mg/l (12)	<107 mg/m2 (8)	Concentrations typical of low disturbance (6)	Acceptable 38-22 Hold (21-20)
Typical waters		Modest swings >6 mg/ (6)	<183 mg/m2 (4)	Concentrations typical of working landscapes (3)	
Enriched	Within the range of non-significant departure (6)	Wide swings >7 mg/l (1)	<320 mg/m2 (1)	Exceeds ranges typically observed in reference sites (1)	Threatened 19-14
Over-enriched	Fail biological criteria (0)	Swings anomalously wide >9 mg/l or swings >7 mg/l and minimum D.O. <WQS (0)	>320 mg/m2 (0)	Exceeds concentrations associated with 50% chance of biological impairment (0)	Impaired 13-0

Test Driving the TIC



Locations With a Full Compliment of Enrichment Indicators

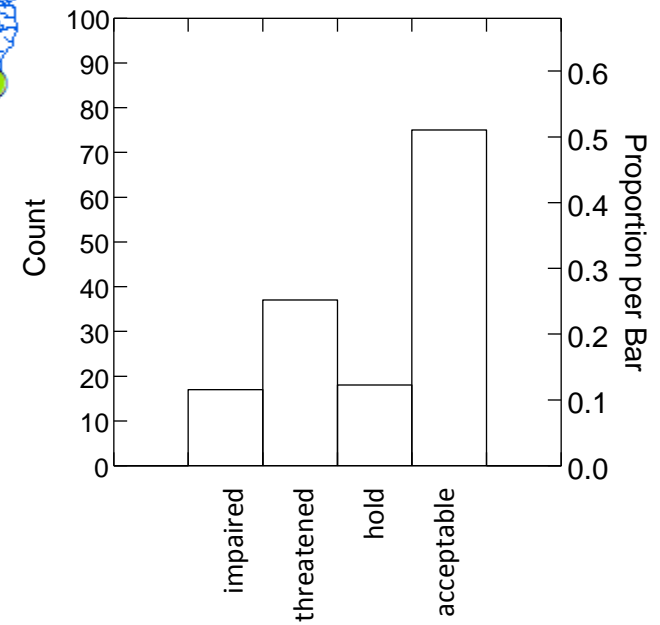


Legend

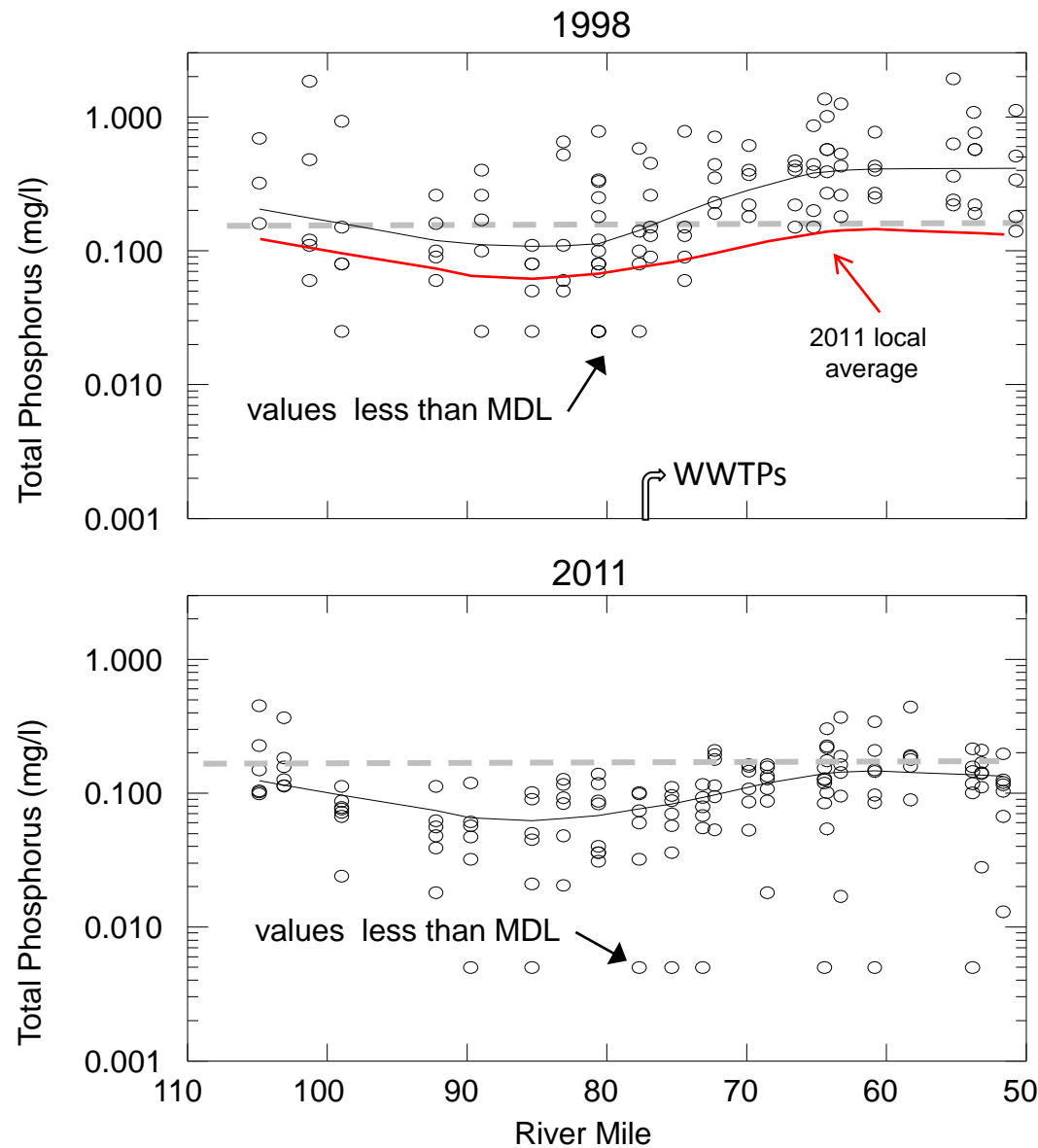
Sheet1\$ Events

TIC

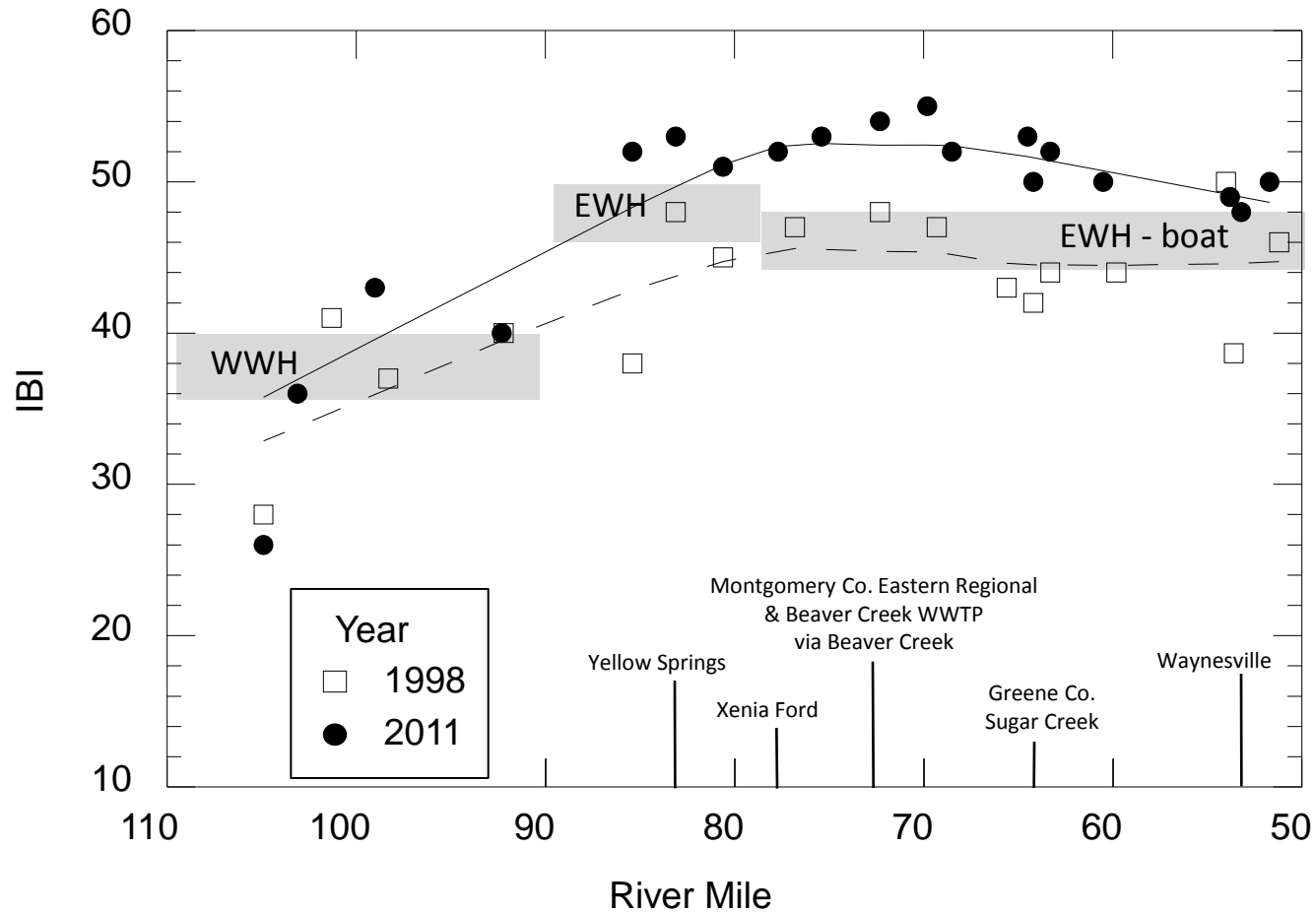
- Impaired
- Threatened
- Hold
- Acceptable
- Pemsotrace



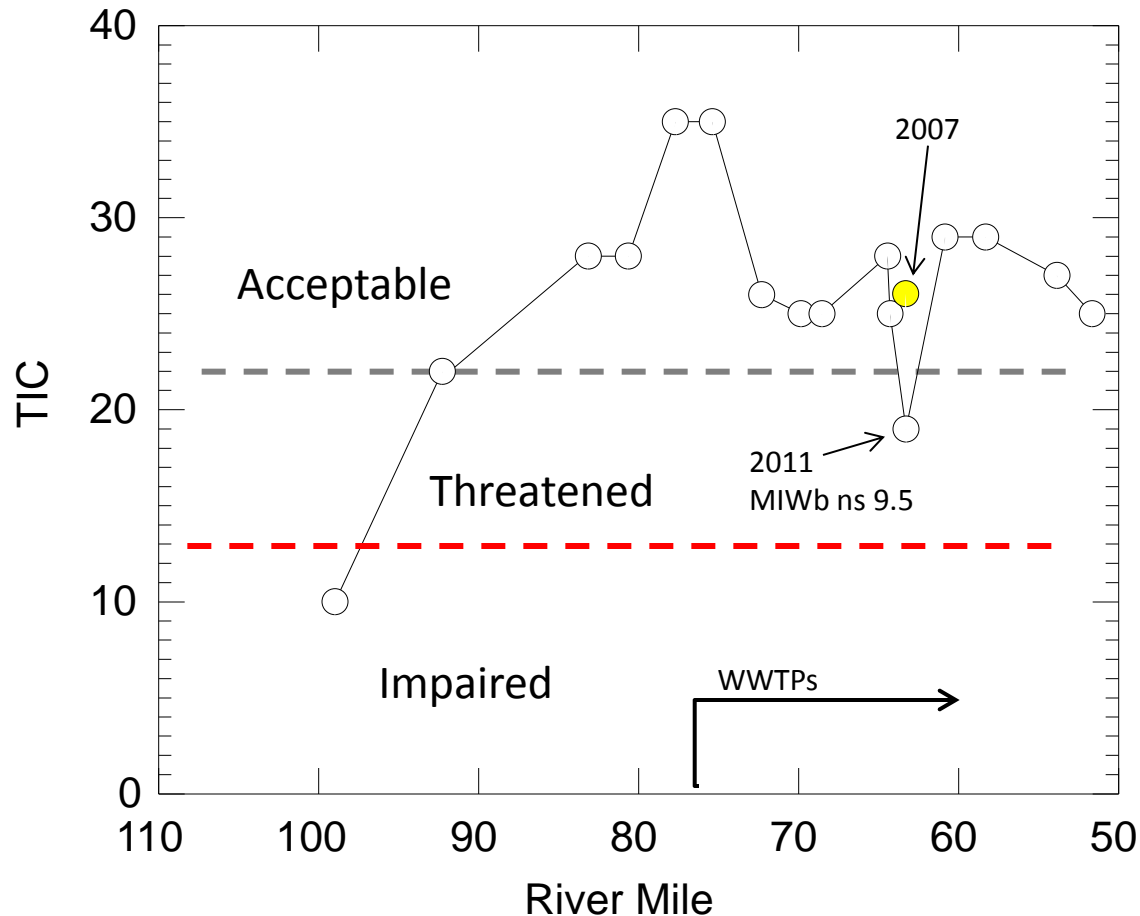
Phosphorus Concentrations in LMR Mainstem



Fish IBI Scores in the LMR Mainstem



Little Miami River 2011



EWB Reach
10 boat sites
4 wading sites
= 42 possible scores
IBI, MIWb, ICI
high statistical chance
of at least one being in
ns departure

TIC Scores in Context for Causal Assessments

RM	DIN	TP	CHL	Range	Biology	TIC	QHEI
Little Miami River							
98.98	4.211	0.105	184	12.2	NS	8	72.5
92.27	3.341	0.049	294	2.19	NS	22	75.8
85.38	3.260	0.036	165	4.4	FULL	31	87
75.38	3.508	0.090	91	1.84	FULL	33	76.8
63.28	3.388	0.117	565	2.42	NS	19	79
60.84	3.274	0.185	167	2.54	NS	23	91
58.3	3.230	0.185	160	1.55	FULL	29	80
53.84	2.922	0.081	340	1.47	FULL	25	70.5
51.65	2.837	0.090	446	1.98	FULL	25	84.5
50.25	2.654	0.291	65	1.89	FULL	33	85
Stillwater River							
41.3	0.872	0.209	190	3.99	NON	15	77.3
33.5	2.317	0.160	180	10.58	NS	11	77.5
27.86	2.594	0.140	290	4.87	FULL	26	82
17.45	2.032	0.078	277	3.95	FULL	28	82
5.78	2.189	0.107	253	3.19	FULL	26	87
1.5	2.323	0.104	165	4.42	FULL	29	79.5
Greenville Creek							
30.24	2.313	0.089	258	3.42	NON	14	63.8
22.35	1.981	0.092	195	2.03	FULL	26	72.5
18.33	2.972	0.147	203	2.24	NON	14	60.8
16.22	2.449	0.117	257	1.53	NS	20	77
10.87	1.931	0.102	205	2.93	NS	20	79.3
6.1	3.117	0.118	149	2.47	NS	23	77.8

← See next slide

← Previous slides

← Manure spill in Swamp Creek

← Enriched – 2^o to organic enrichment

← EWH

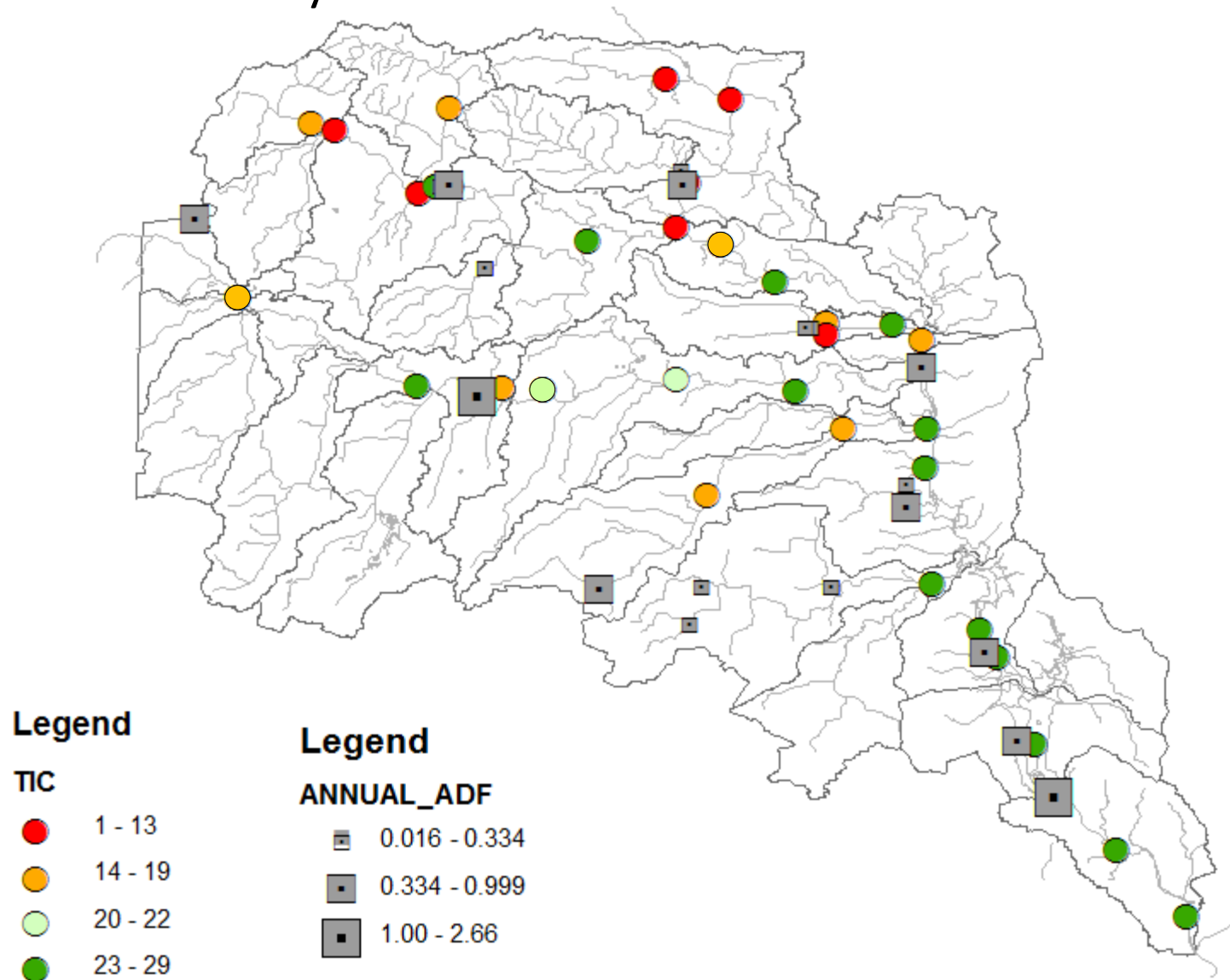
← WWH

← EWH

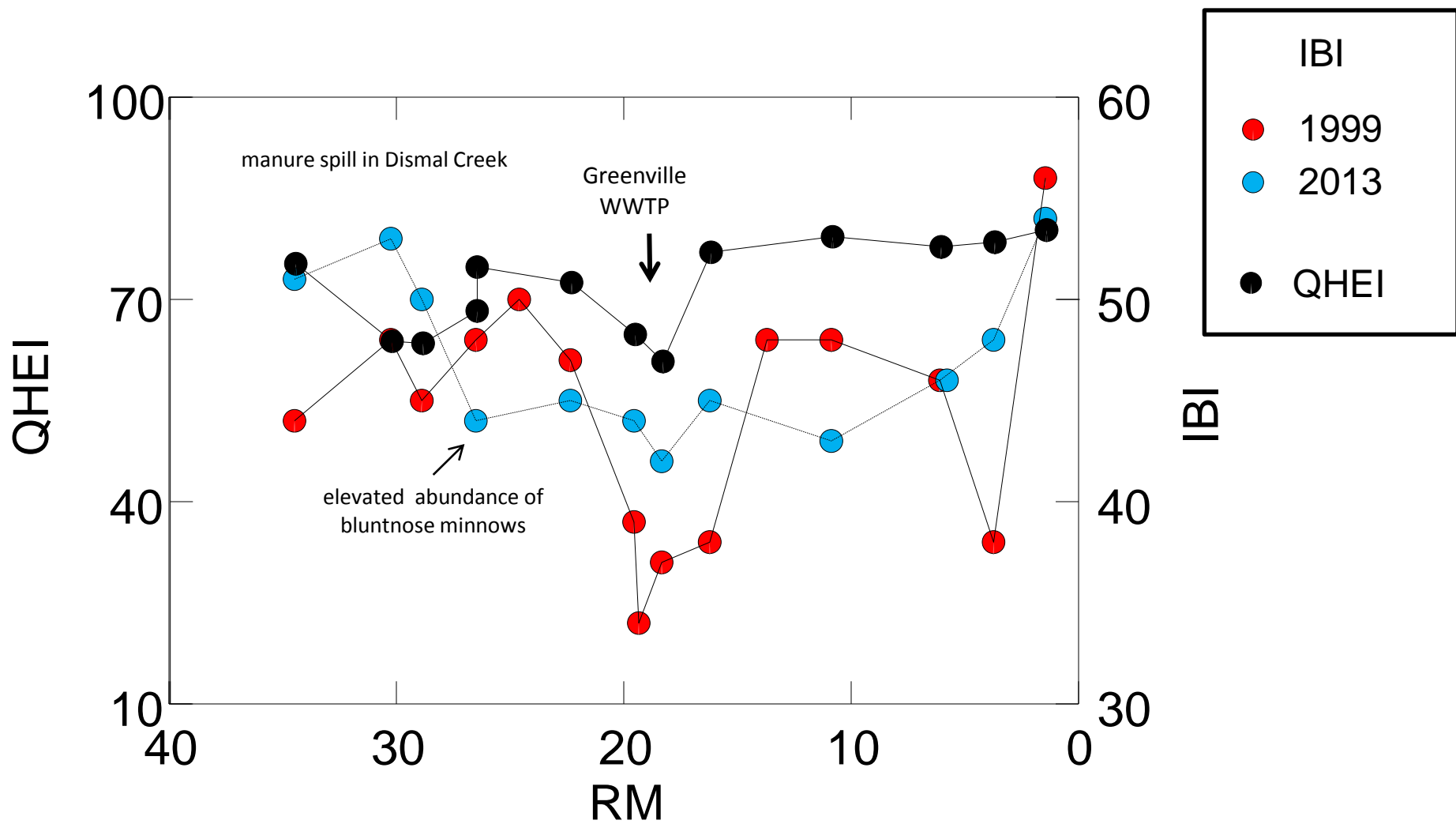
Little Miami River at Dolly Varden Road (RM 98.98)



Preliminary TIC Scores from the 2013 Stillwater Survey



Greenville Creek



Implementation Issues for Surveys and Condition Assessments

Survey Concerns

- Spatial and Temporal Extent
 - Catchment scale: how much coverage is needed?
 - prior knowledge of survey area (e.g., AFOs in the Stillwater)
 - desktop evaluation (land use)
 - Reach scale
 - longitudinal evaluation of point sources
 - upstream + several sites downstream (one discharger on a reach)
 - sites spaced along the entire linear extent (multiple dischargers, e.g., LMR, Stillwater)
 - Chlorophyll and D.O. frequency
 - once during the critical period; twice and average, or worse of the two
 - atypical precipitation year
 - Flexibility to document un-anticipated events
 - Document pass-through
 - re-prioritize sampling of downstream assessment units

Implementation Issues for Surveys and Condition Assessments

Assessment Concerns

- What constitutes a one-off event
 - chance occurrence of NS departure in multiple samples
 - high chlorophyll values co-occurring with narrow D.O. swings
 - chlorophyll concentrations can vary by 3x during the day
- Counterfactuals
 - what evidence is needed to over-rule nutrients as a cause when TIC scores are in the threatened or impaired category
 - i.e., determination of most proximate stressor
- Improving Trajectories
 - how do we handle TIC scores in the threatened range when biology is on an improving trajectory (compared to a prior survey)
 - e.g., LMR, Greenville Creek near WWTP