National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs

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RFC 101

Establishing Reference Condition for the Development of Numerical Biological Criteria in Ohio

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Biological Criteria: I

- Narrative ratings or numerical values that are based on the numbers and kinds of aquatic organisms (i.e., assemblage) which are found to inhabit a particular stream or river sampling location.

Biological Criteria: II

- Biological criteria are indexed to the reference assemblage of aquatic organisms within a particular geographical region (i.e., ecoregion) and with respect to stream and river size.

Biological Integrity: Operational Definition

‘‘The ability of an aquatic community to support and maintain a structural and functional performance comparable to the natural habitats of a region.”

As modified from Karr and Dudley (1981)

Biological Integrity: Putting Theory Into Practice

Essential Elements of the Regional Reference Site Approach

- Biological Performance - need ways to measure (e.g., IBI, ICI, BI, RIVPACS, etc.).
- Natural Habitats - come to grips with the attainability issue (e.g., ‘‘least impacted’’ reference sites.
- Region - need to stratify and account for natural variability (e.g., ecoregions and tiered uses).
- Reference site ‘‘re-sampling’’ to account for broad scale, long term changes in attainable conditions.

Establishing Reference Condition

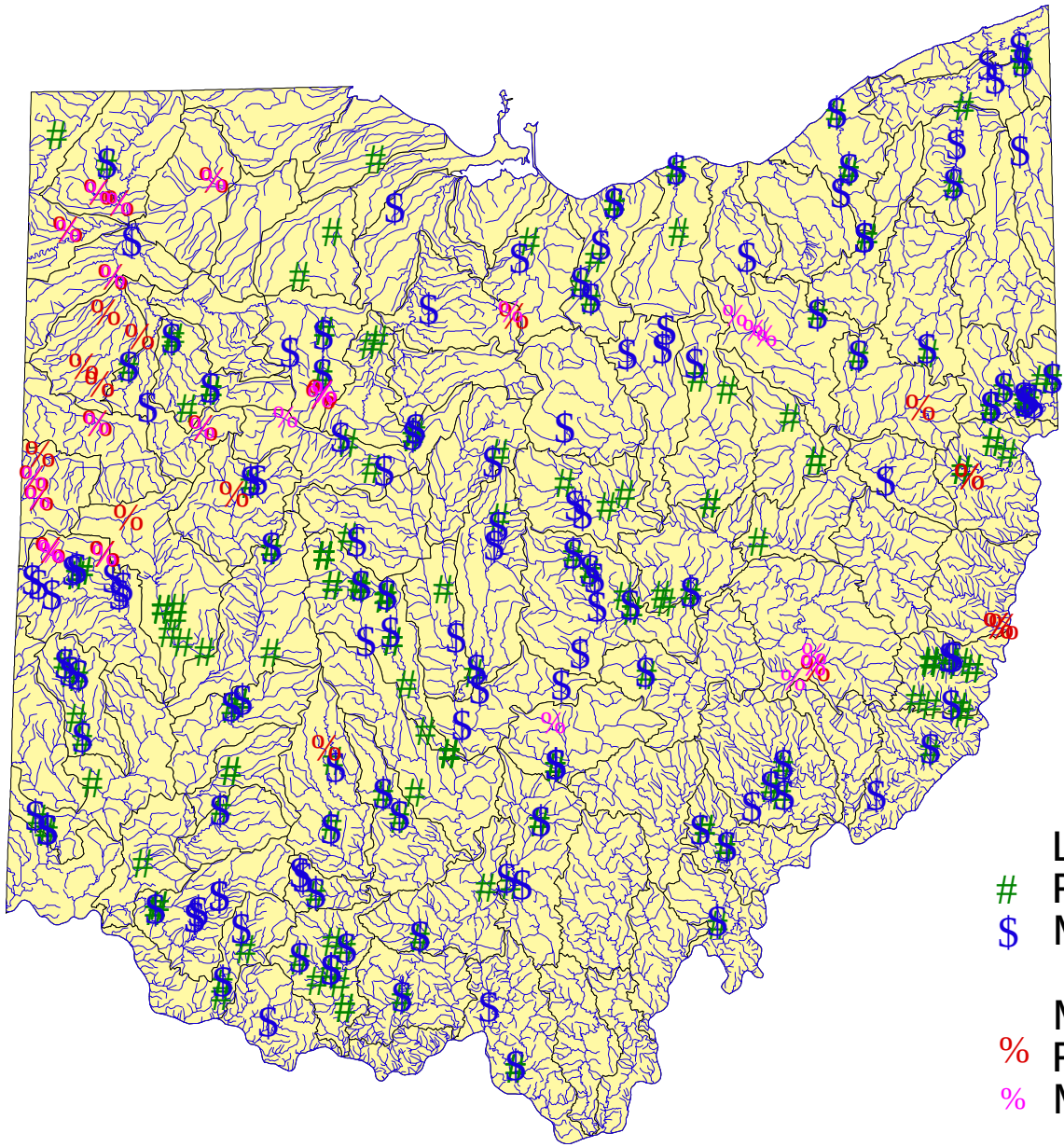
Reference Sites

- A collection of sites within a homogenous regional area which represent the best attainable conditions (unimpaired) for all waters *with similar physical dimensions and attributes* for that particular region.

Control Sites

- A single site usually located on or adjacent to the waterbody under study which represents the *best or most appropriate condition for that waterbody* whether it is impaired or unimpaired.

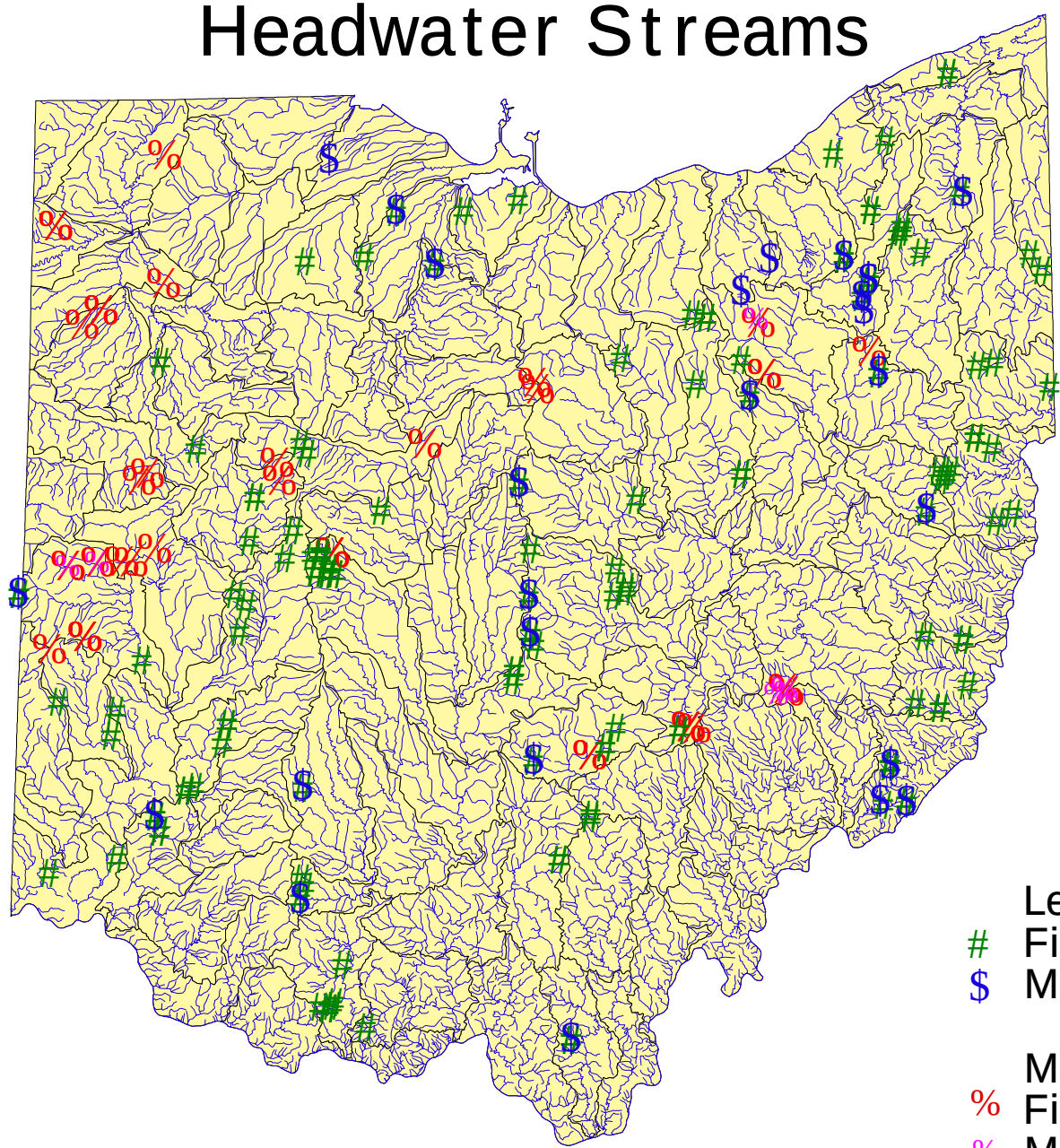
Ohio Biocriteria Reference Sites
Wadeable Streams



Least Impacted
Fish
$ Macros

Modified Sites
% Fish
% Macros

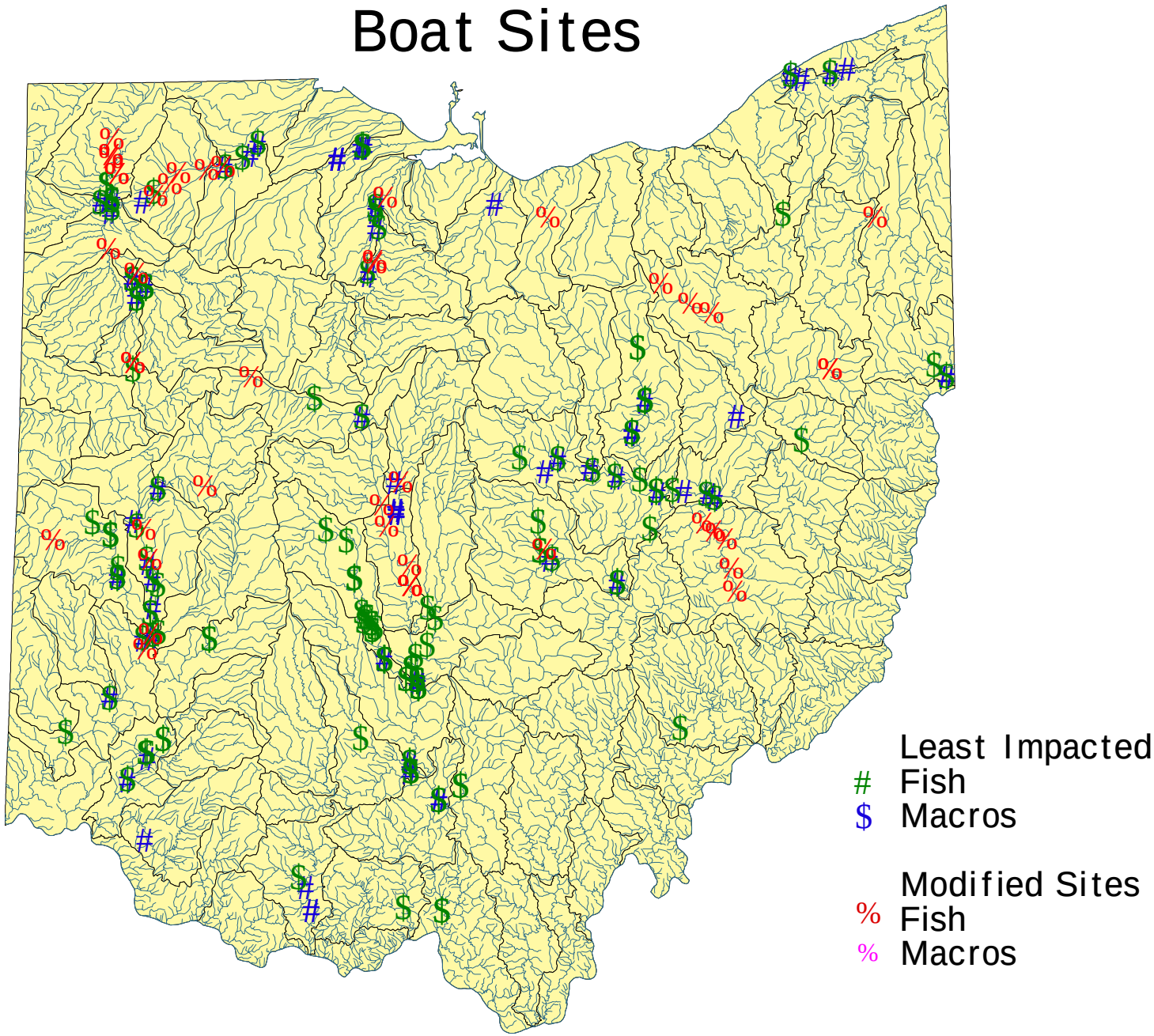
Ohio Biocriteria Reference Sites
Headwater Streams



Least Impacted
Fish
$ Macros

Modified Sites
% Fish
% Macros

Ohio Biocriteria Reference Sites
Boat Sites



Misperceptions of Reference Condition: I

Myth

- Reference sites reflect a pristine condition.

Reality

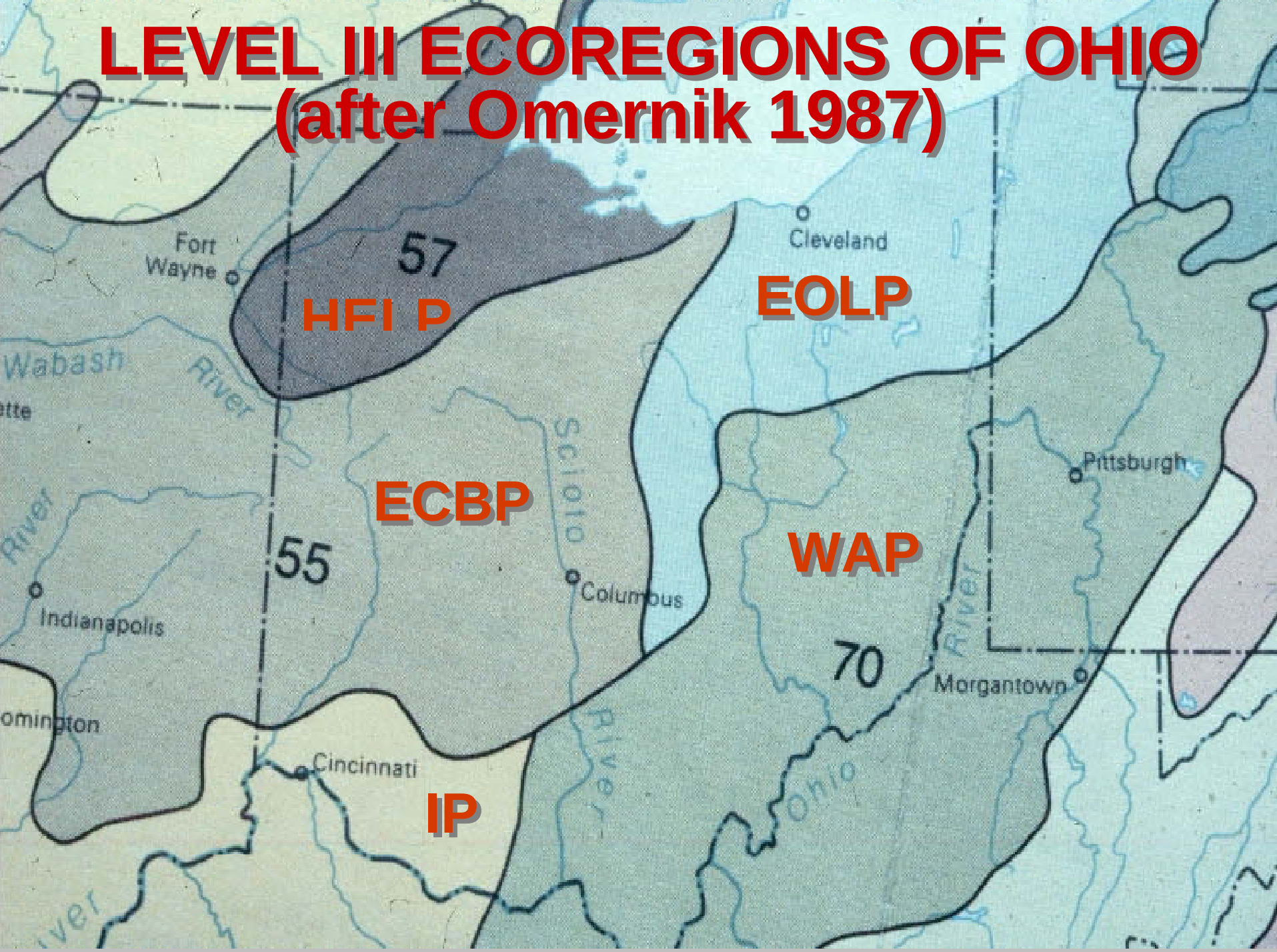
- In developed states few, if any, reference sites reflect a truly pristine condition.
- Most reflect substantially altered conditions, the results of decades of settlement and land use.

The Challenge

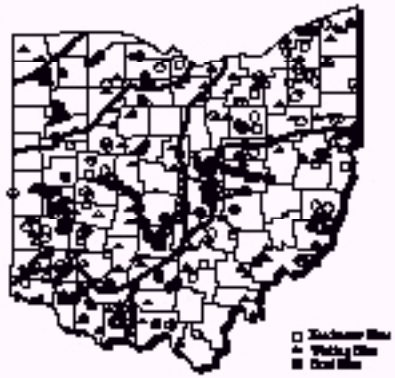
- Setting realistically attainable endpoints that meet CWA goals (biological integrity, propagation, fishable/ swimable).
- Incorporation into WQS (uses and criteria) and assessment.

Reference Site Selection: General Guidelines and Cautions

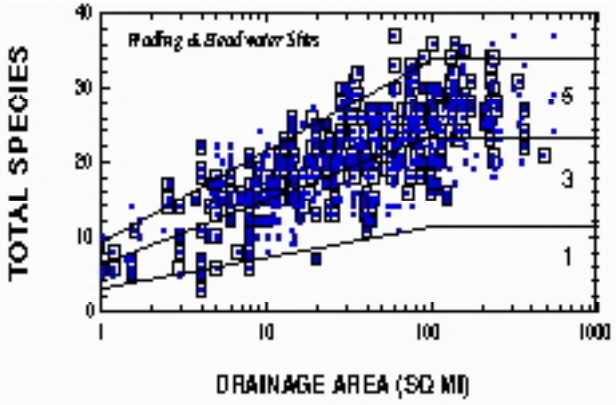
- Definition of biological integrity provides theoretical basis for design and selection, i.e., done in a biological context.
- Goal is to select least impacted sites which represent the best attainable background conditions for a homogenous area.
- Sites are selected based on the ‘‘cultural setting’’ independent of basic sampling data, especially chemical/physical data.
- Avoidance of sites with obvious impacts such as point sources, intensive urbanization, direct habitat degradation, gross nonpoint source impacts, and other influences (spills, kills).
- Representative distribution in accordance with principal stratifying factors such as bioregions, watershed size, physical attributes, and other factors which drive biological variance.


LEVEL III ECOREGIONS OF OHIO
(after Omernik 1987)
Fort Wayne
57
HFI P
Cleveland
EOLP
Wabash River
ECBP
Scioto River
55
Indianapolis
Columbus
WAP
Pittsburgh
70
Morgantown
Ohio River
Cincinnati
IP

Ohio IBI Calibration & Biocriteria Derivation Process



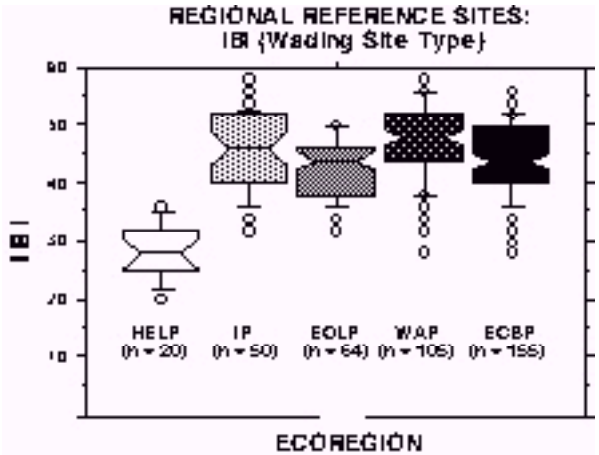
I. Select & sample reference sites



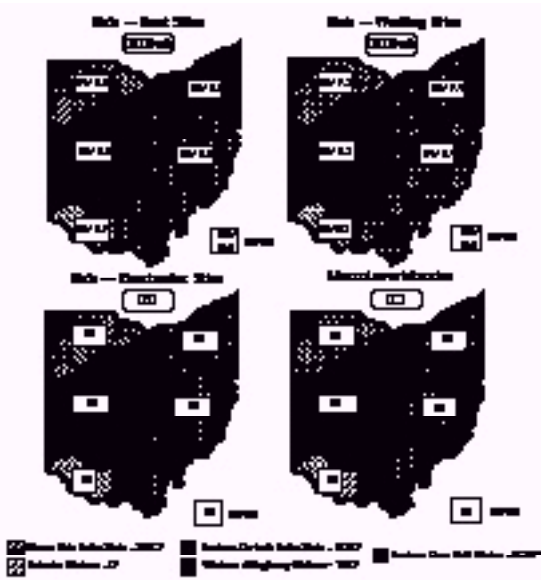
II. Calibration of IBI metrics

Metric	5	3	1
Number of Species	Varies x Drainage Area		
No. of Darter Spp.	Varies x Drainage Area		
No. of Sunfish Spp.	>3	2-3	<2
No. of Sucker Spp.	Varies x Drainage Area		
Intolerant Species			
>100 sq. mi.	>5	3-5	<3
<100 sq. mi.	Varies x Drainage Area		
%Tolerant Species	Varies x Drainage Area		
%Omnivores	<19	19-34	>34
%Insectivores			
<30 sq. mi.	Varies x Drainage Area		
>30 sq. mi.	>55	26-55	<26
%Top Carnivores	>5	1-5	<1
%Simple Lithophils	Varies x Drainage Area		
%DELT Anomalies	>1.3	0.5-1.3	<0.5
Relative Abundance	>750	200-750	<200

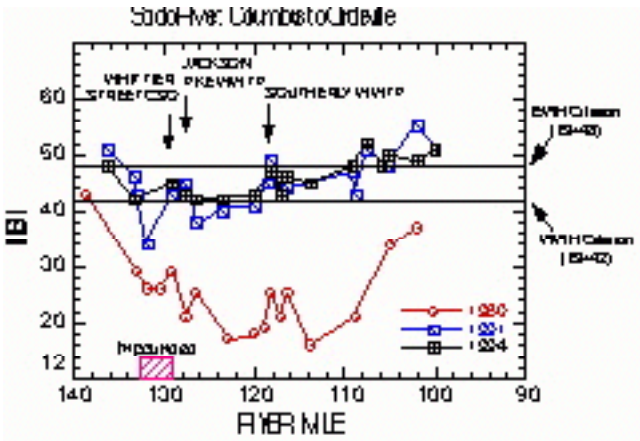
III. Calibrated IBI modified for Ohio waters



IV. Establish ecoregional patterns/expectations



V. Derive numeric bio-criteria: Codify in WQS



VI. Numeric biocriteria are used in bioassessments

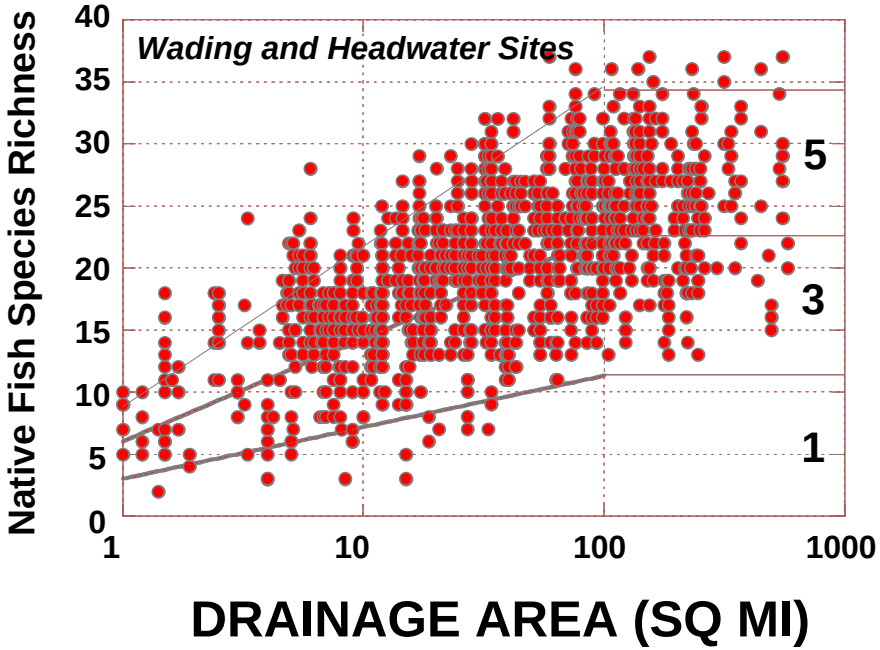
OHIO EPA MODIFIED IBI METRICs	HEADWATER SITE TYPE (<20 SQ. MI.)	WADEABLE SITE TYPE (20-300 MI^2)	BOATABLE SITE TYPE (200-6000 MI^2)
1. Total Native Species	X	X	X
2. #Darter Species		X	
#Darters + Sculpins	X*		
%Round-bodied Suckers			X*
3. #Sunfish Species		X	X
#Headwater Species	X*		
%Pioneering Species	X*		
4. #Sucker Species		X	X
#Minnow Species	X*		
5. #Intolerant Species		X	X
#Sensitive Species	X*		
6. %Tolerant Species	X	X	X
7. %Omnivores	X	X	X
8. %Insectivores	X	X	X
9. %Top Carnivores		X	X
10. %Simple Lithophils	X*	X*	X*
11. %DELT Anomalies	X	X	X
12. Number of Individuals	X	X	X

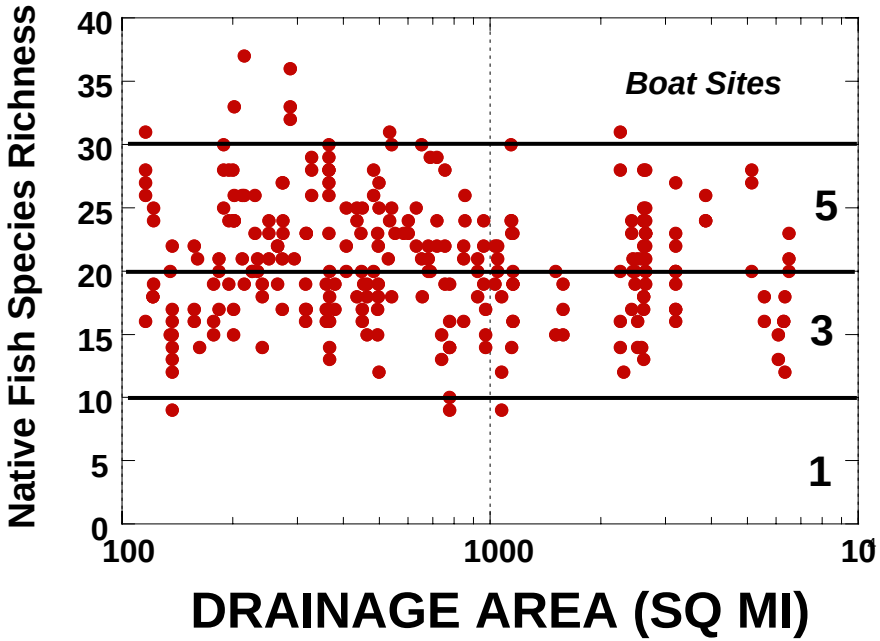
* - Substitute for original IBI metric described by Karr (1981) and Fausch et al. (1984)

Invertebrate Community Index (Ohio EPA 1987; DeShon 1995)

- Taxa Richness
- #Mayfly taxa
- #Caddisfly taxa
- #Dipteran taxa
- %Mayflies
- %Caddisflies
- %Tanytarsini Midges
- %Other Diptera/Non-Insects
- %Tolerant taxa
- Qualitative EPT taxa

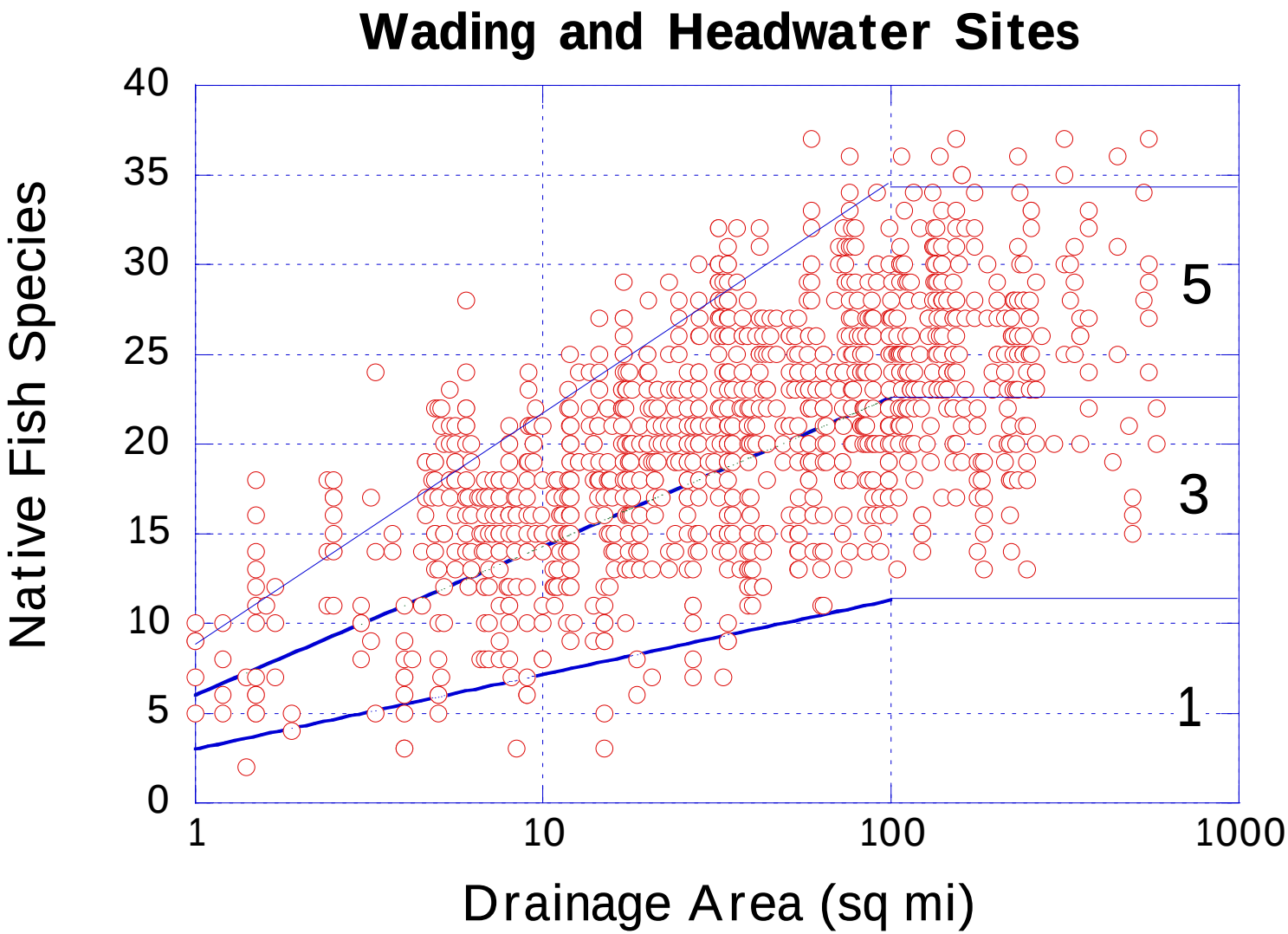
- 6,4,2,0 metric scoring categories
- 0 to 60 scoring range
- Calibrated on regional basis
- Scoring adjustments needed for very low numbers of specific taxa

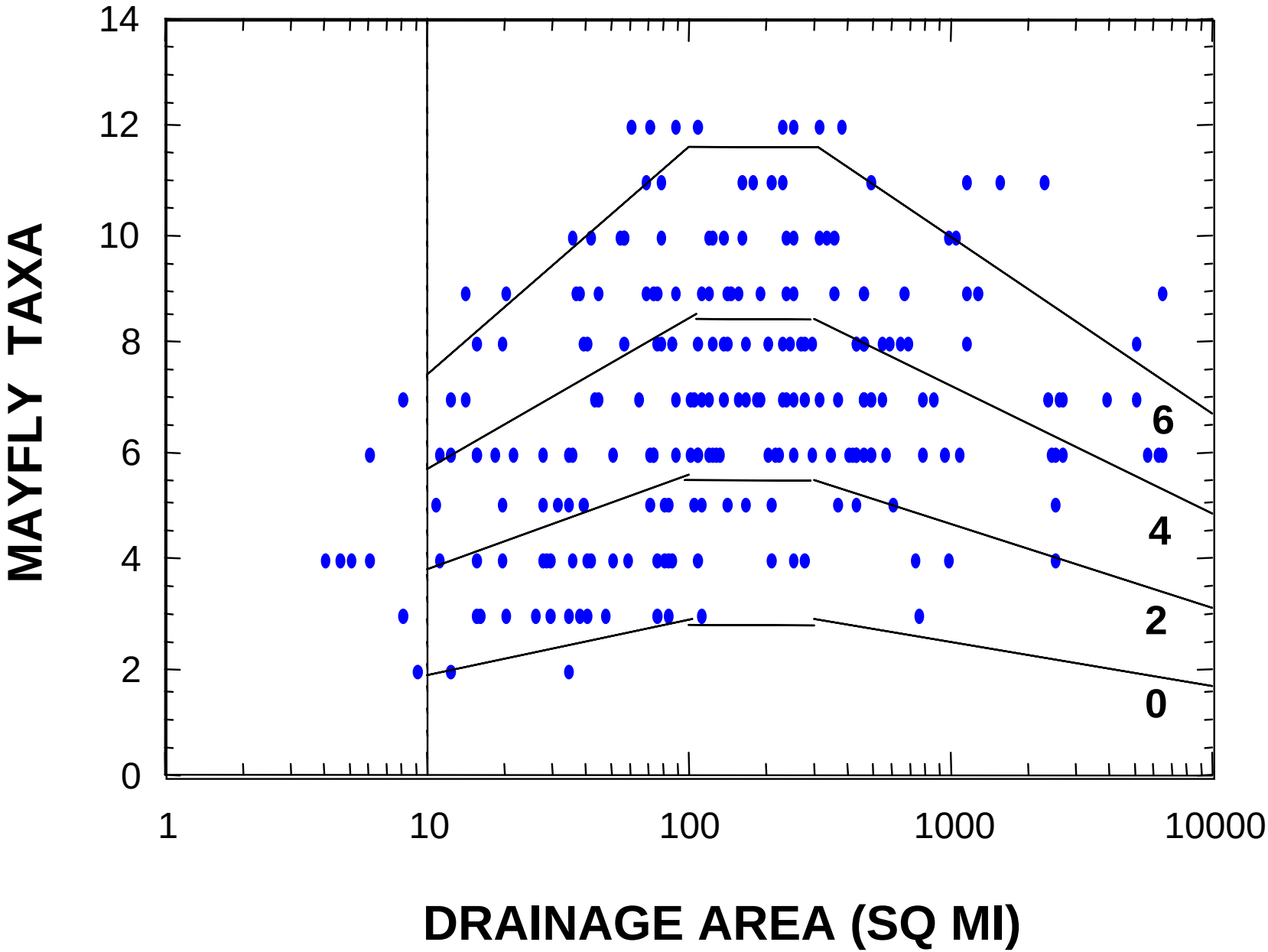


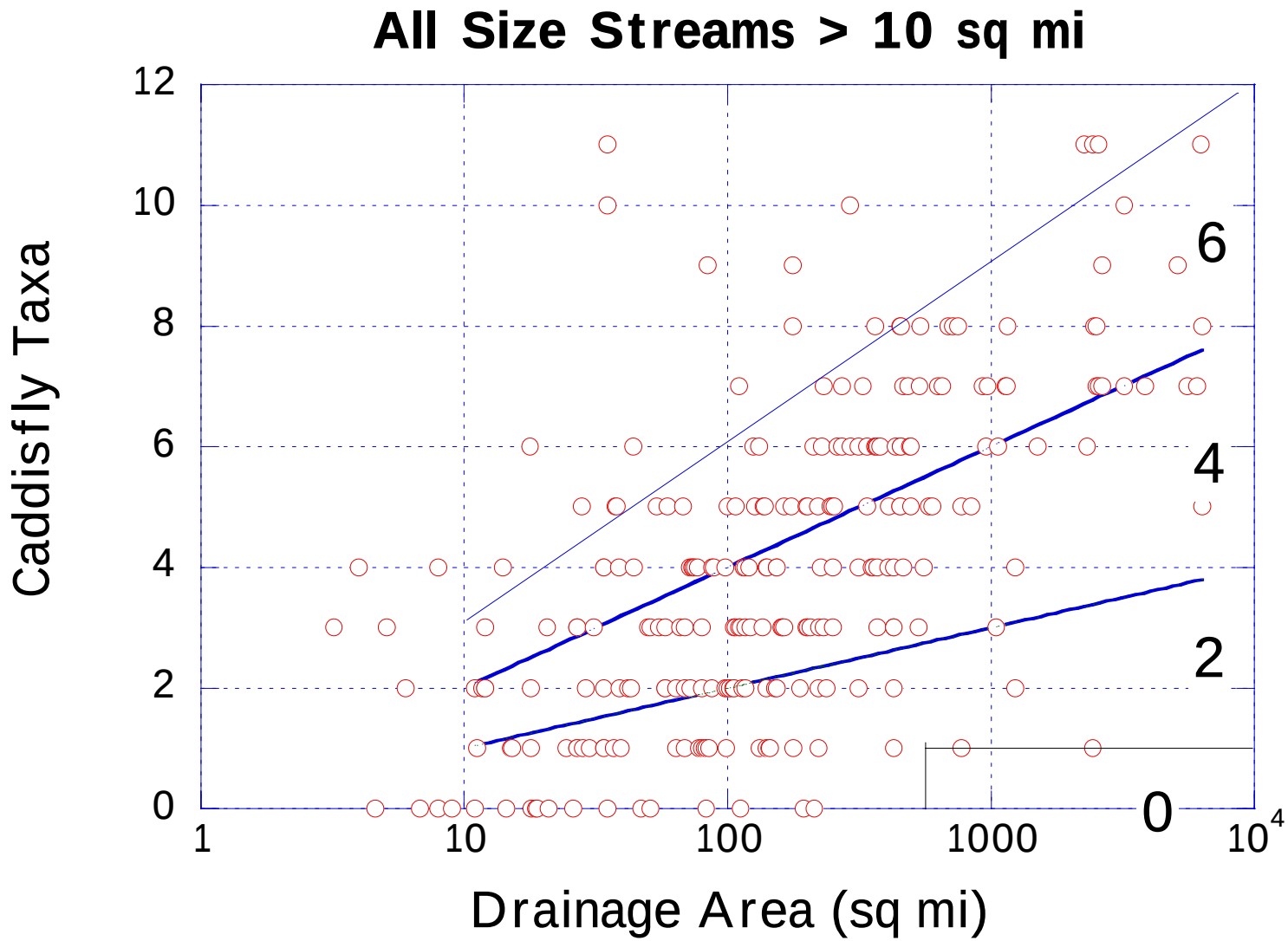


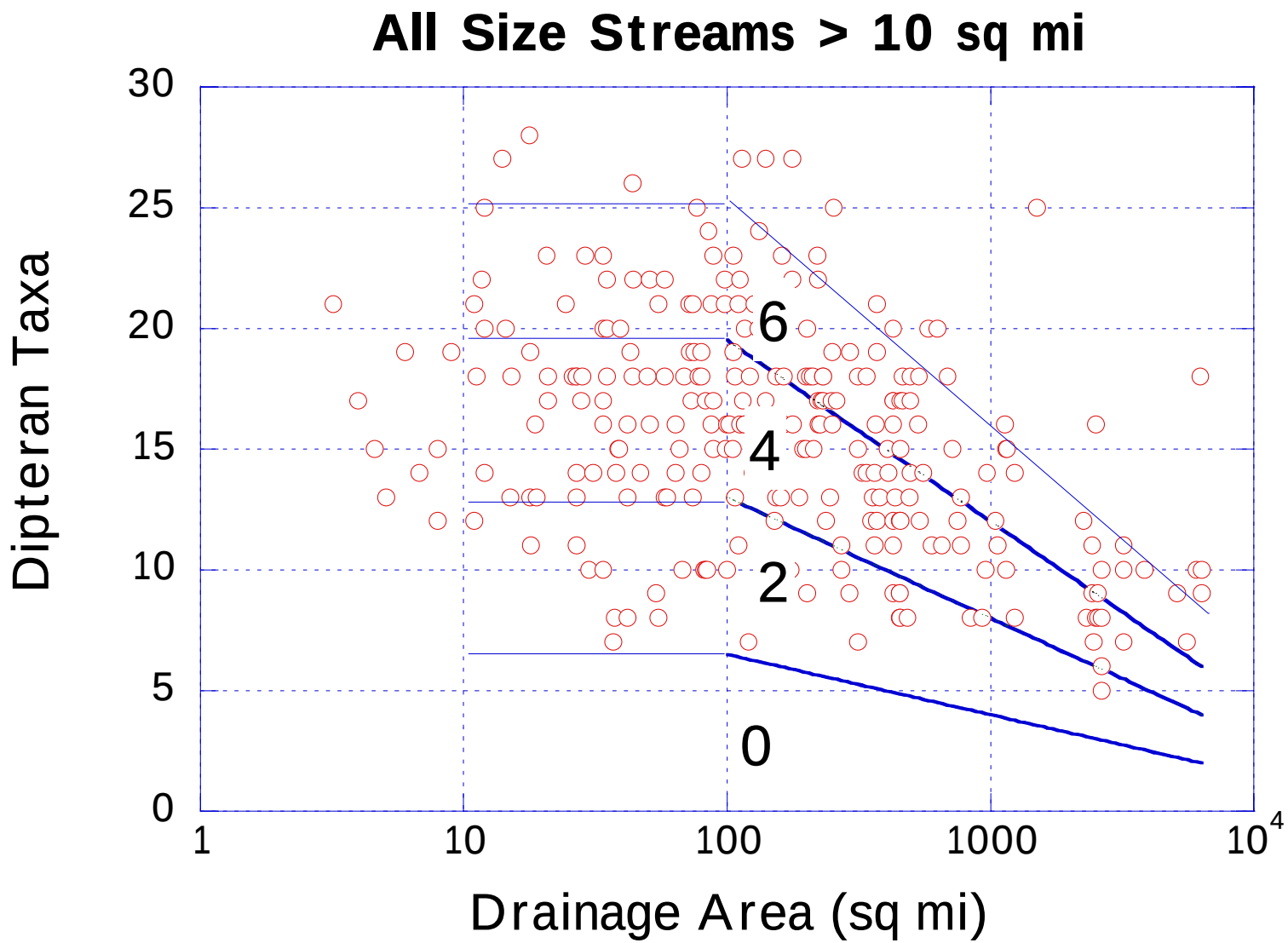
Calibration of Metrics Using Regional Reference Sites

- Scatter plot of metric value by appropriate calibration vector (e.g., watershed area).
- Determine 95% maximum line of best fit across surface of scatterplot; *driven by best reference sites.*
- Area beneath 95% line is subdivided (e.g., trisection) to determine metric scores - most data points should occur in upper ranges.
- This method reduces the influence of slightly degraded sites that may not biologically reflect the intent of reference condition.
- Slope of 95% line conservatively assumed to be zero for boat sites.


Wading and Headwater Sites
Native Fish Species
Drainage Area (sq mi)
0
5
10
15
20
25
30
35
40
1
10
100
1000
5
3
1

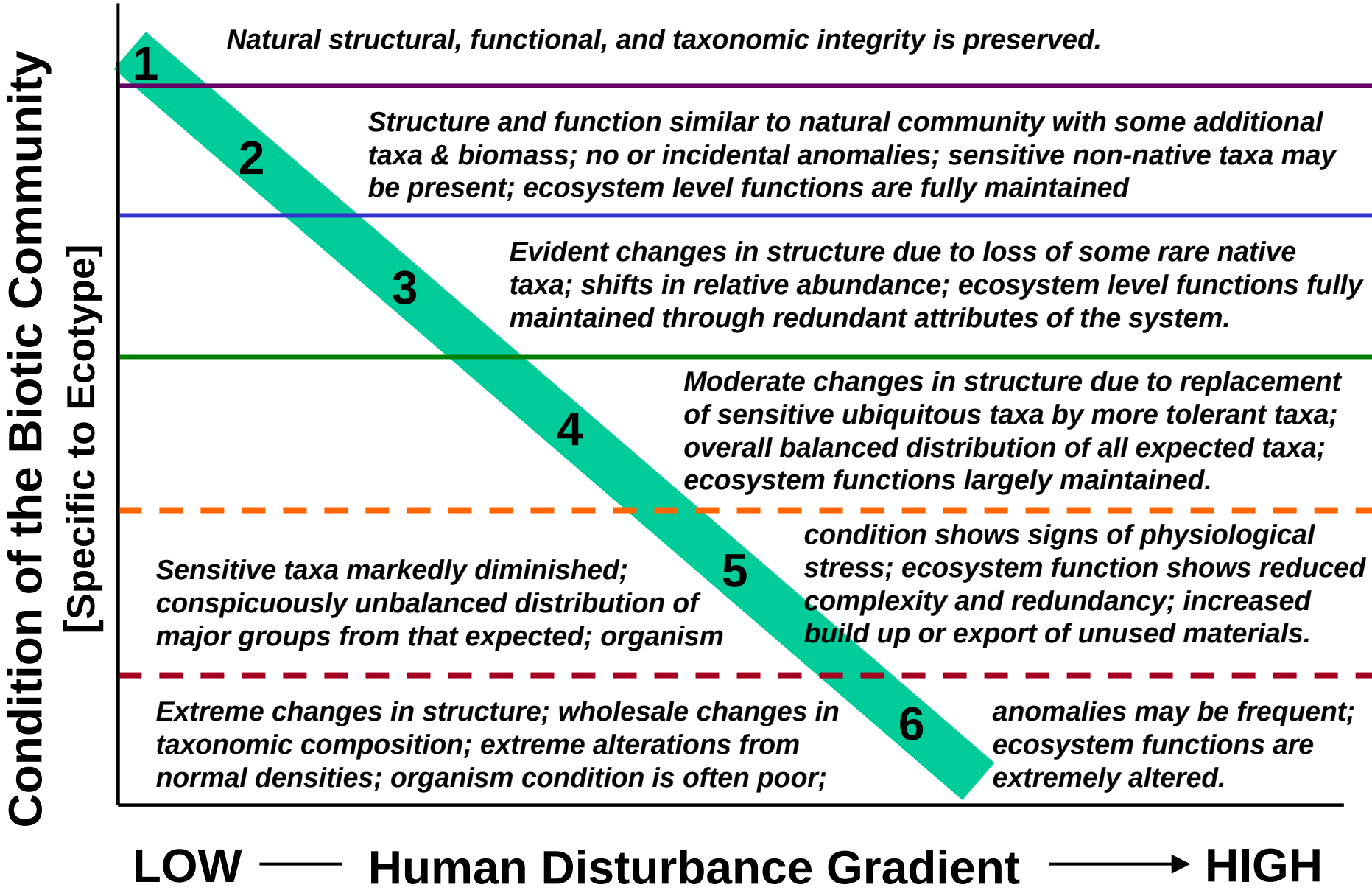

MAYFLY TAXA
DRAINAGE AREA (SQ MI)
0
2
4
6
8
10
12
14
1
10
100
1000
10000
6
4
2
0

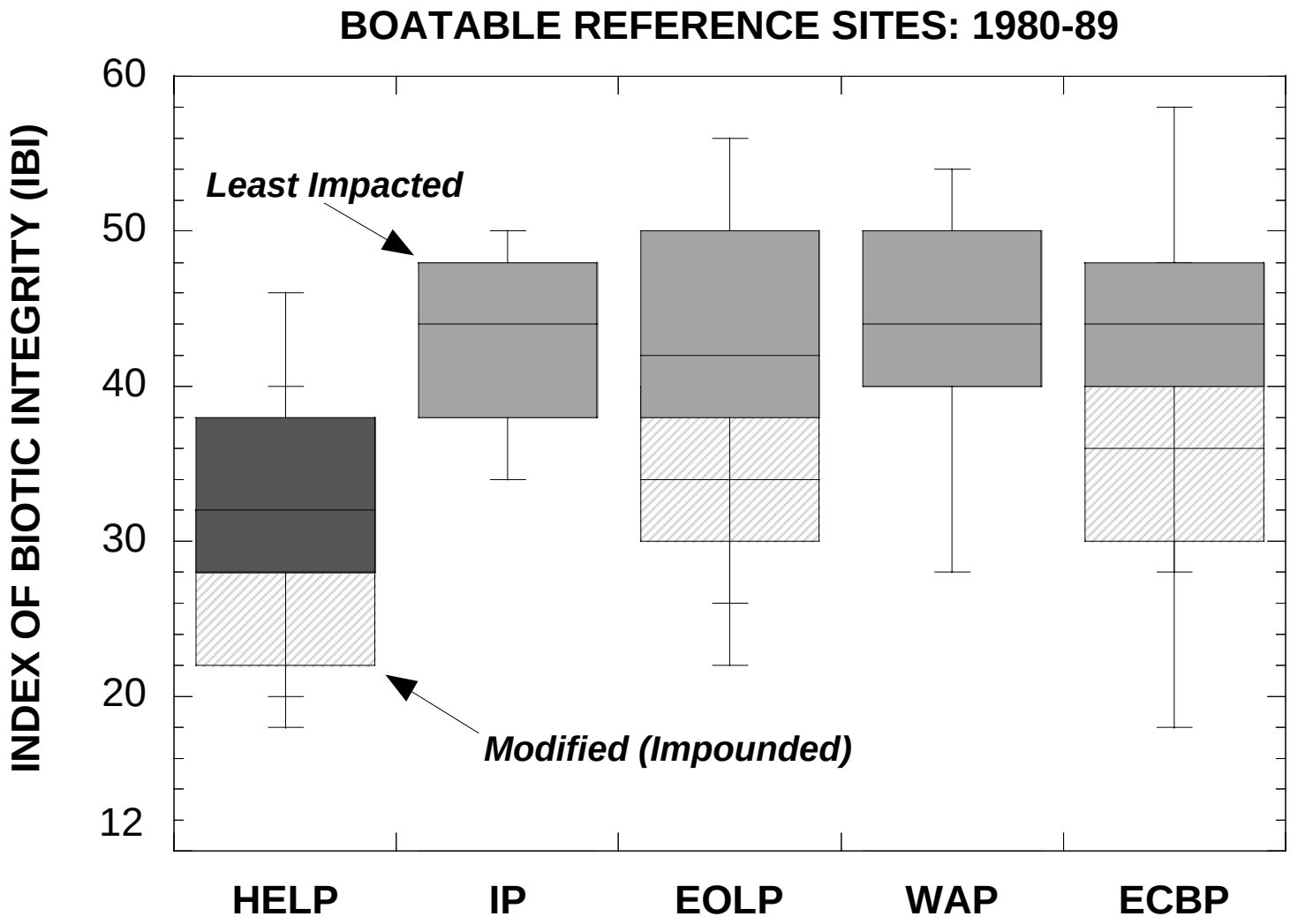

All Size Streams > 10 sq mi
Caddisfly Taxa
Drainage Area (sq mi)
12
10
8
6
4
2
0
1
10
100
1000
10^4
6
4
2
0


All Size Streams > 10 sq mi
Dipteran Taxa
Drainage Area (sq mi)
30
25
20
15
10
5
0
1
10
100
1000
10^4
6
4
2
0

Tiered Aquatic Life Use Conceptual Model: Draft Biological Tiers

(10/22 draft)




BOATABLE REFERENCE SITES: 1980-89
INDEX OF BIOTIC INTEGRITY (IBI)
60
50
40
30
20
12
Least Impacted
Modified (Impounded)
HELP
IP
EOLP
WAP
ECBP

Ohio Biological Criteria: Adopted May 1990 (OAC 3745-1-07; Table 7-14)

Huron Erie Lake Plain (HELP)

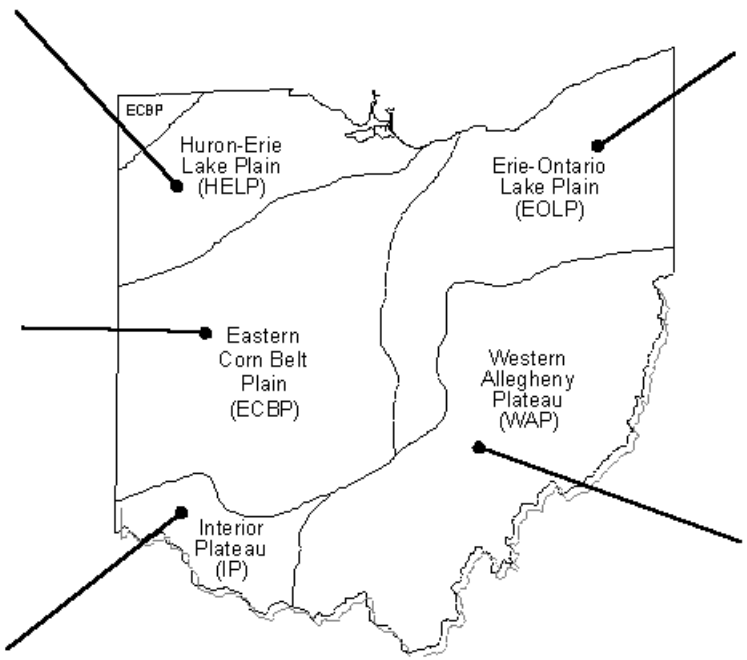
Use	Size	IBI	MIwb	ICI
WWH	H	28	NA	34
	W	32	7.3	34
	B	34	8.6	34
MWH-C	H	20	NA	22
	W	22	5.6	22
	B	20	5.7	22
MWH-I	B	30	5.7	NA

Eastern Corn Belt Plains (ECBP)

Use	Size	IBI	MIwb	ICI
WWH	H	40	NA	36
	W	40	8.3	36
	B	42	8.5	36
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-I	B	30	6.6	NA

Interior Plateau (IP)

Use	Size	IBI	MIwb	ICI
WWH	H	40	NA	30
	W	40	8.1	30
	B	38	8.7	30
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-I	B	30	6.6	NA



Statewide Exceptional Criteria

Use	Size	IBI	MIwb	ICI
EWH	H	50	NA	46
	W	50	9.4	46
	B	48	9.6	46

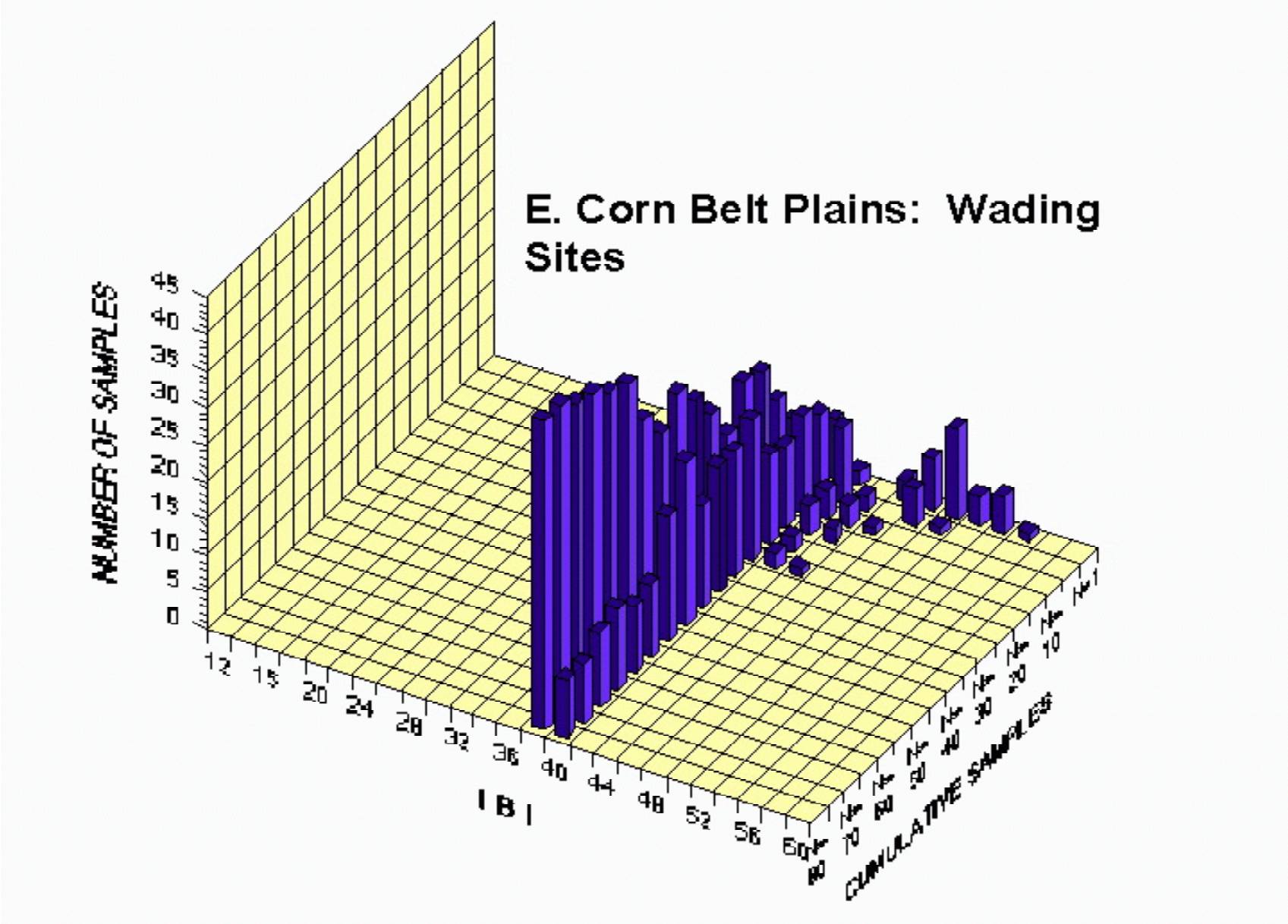
Erie Ontario Lake Plain (EOLP)

Use	Size	IBI	MIwb	ICI
WWH	H	40	NA	34
	W	38	7.9	34
	B	40	8.7	34
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-I	B	30	6.6	NA

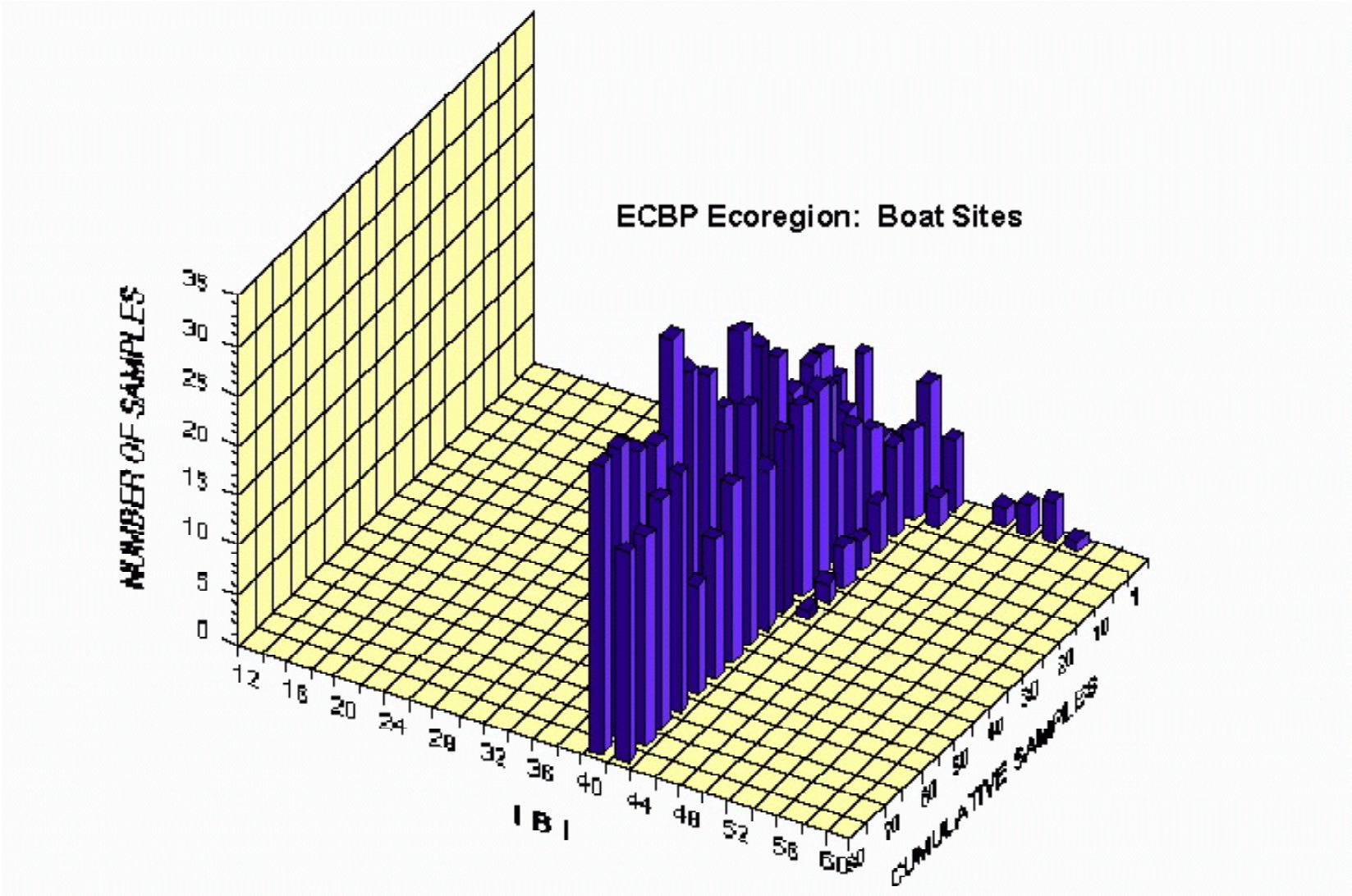
Western Allegheny Plateau (WAP)

Use	Size	IBI	MIwb	ICI
WWH	H	44	NA	34
	W	44	8.4	34
	B	40	8.6	34
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-A	H	24	NA	30
	W	24	5.5	30
	B	24	5.5	30
MWH-I	B	30	6.6	NA

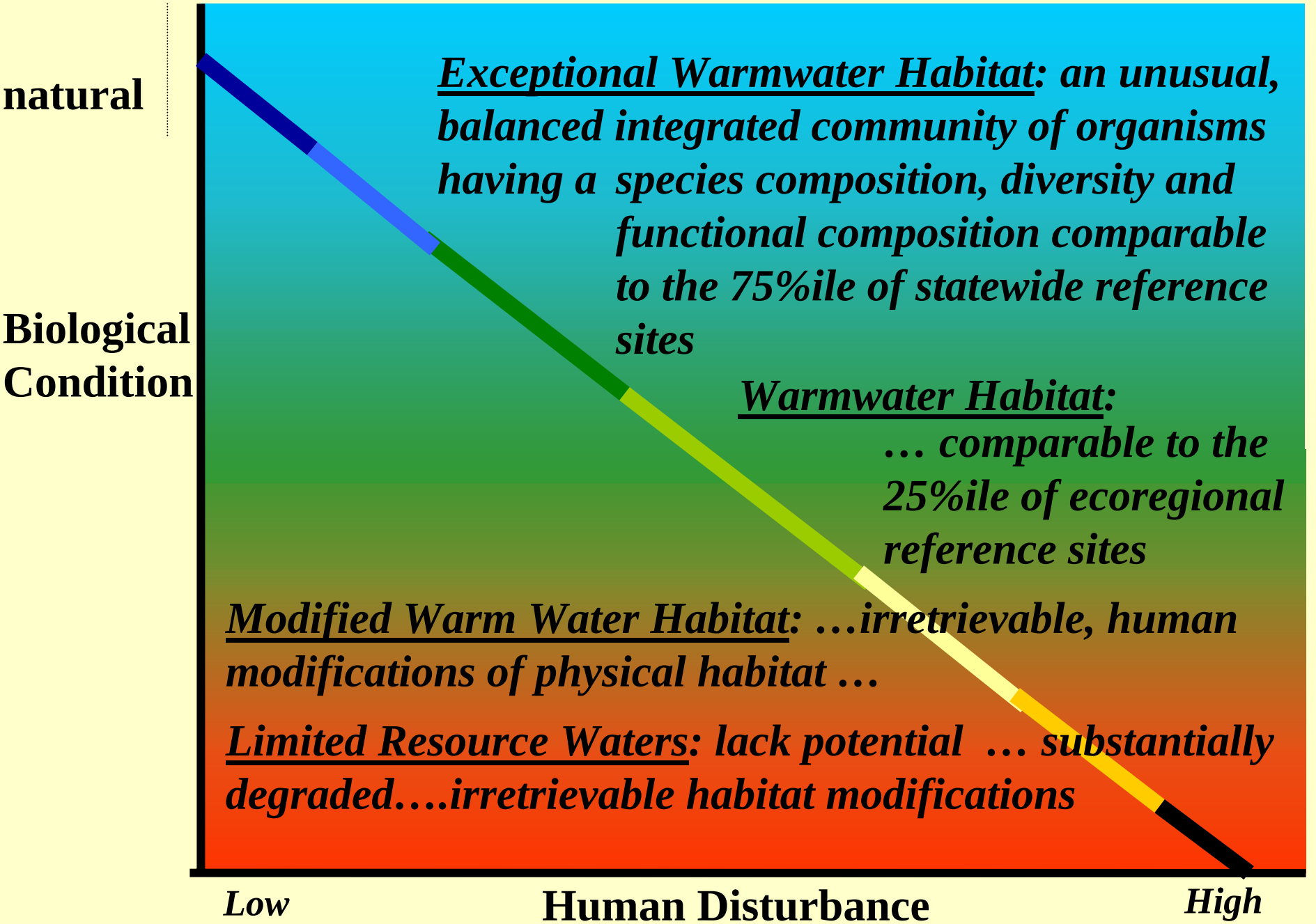
Effect of Increased Numbers of Reference Site Samples on IBI Biocriteria Derivation

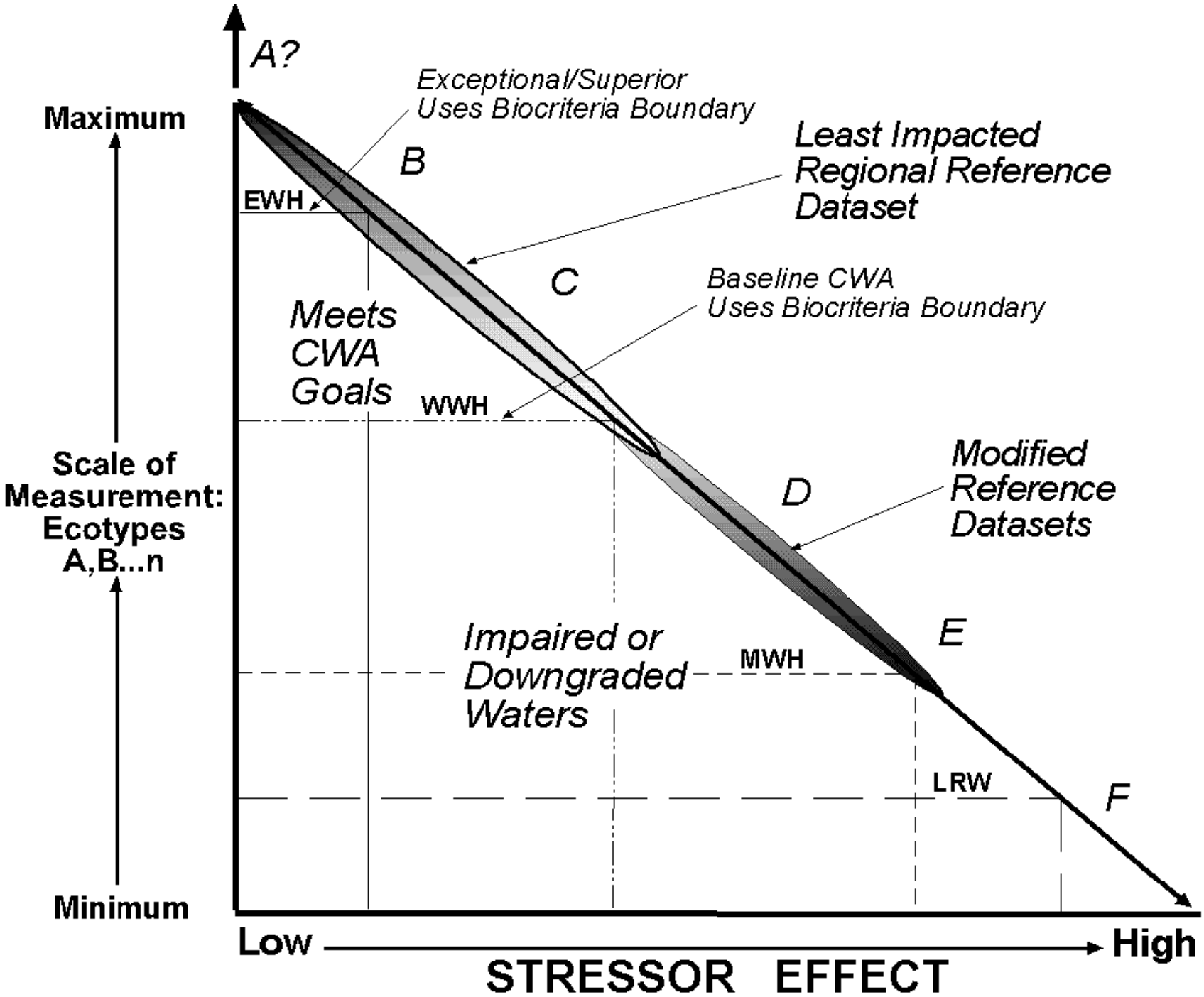


Effect of Increased Numbers of Reference Site Samples on IBI Biocriteria Derivation

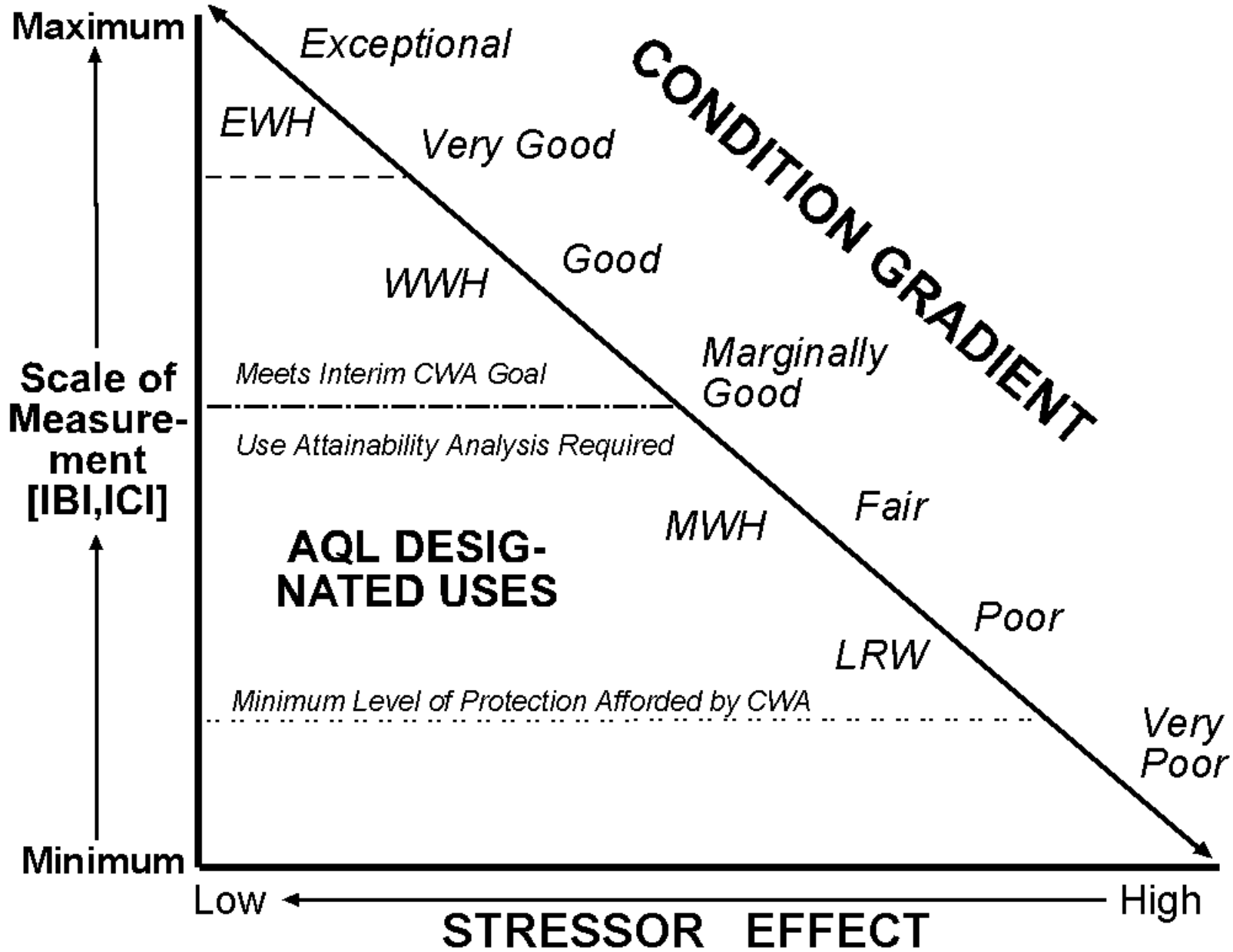


Designated Aquatic Life Uses: Ohio/Streams & Rivers




A?
Maximum
Exceptional/Superior
Uses Biocriteria Boundary
B
Least Impacted
Regional Reference
Dataset
EWH
C
Baseline CWA
Uses Biocriteria Boundary
Meets
CWA
Goals
WWH
Scale of
Measurement:
Ecotypes
A,B...n
D
Modified
Reference
Datasets
E
Impaired or
Downgraded
Waters
MWH
LRW
F
Minimum
Low
High
STRESSOR EFFECT

DESIGNATED USE OPTIONS ALONG THE BIOAXIS AND BIOLOGICAL CONDITION GRADIENT



The Regional Reference Site Approach: The Role of Stratification

Recognizing the relative importance of landscape, geographic, physical, and socioeconomic factors in deriving regionally relevant benchmarks or criteria

Inter-Regional Factors:

- Ecoregions - overall synthesis of taxonomy, biogeography, diversity, ecological function, and attainability.
- Water Quality Standards - define goals and criteria.

Intra-Regional Factors:

- Site-Specific Stratification - stream size (drainage area, width), gradient, temperature, elevation, latitude etc.

Biological Criteria: III

- Biological criteria represent a calibrated assessment tool which fosters an organized goal setting process in an effort to reconcile human impacts and guide restoration efforts.

Coping With Biological Data Variability

- **Compress Variability**: use multi-metric measures (e.g. IBI, ICI, etc.).
- **Stratify Variability**: use ecoregions (or subsets) and tiered aquatic life use classification system.
- **Control Variability**: select efficient sampling methods that yield informative and consistent results.

Misperceptions of Reference Condition: II

Some Solutions

- Use integrative measures such as biological criteria.
- Tiered uses in WQS foster stratified management goals.
- Understand full range of system response - gradient of quality and degradation.

Important Framework Elements

- Robust biological assessment tools with sufficient data quality objectives and calibration processes.
- Regionalization to support WQ management at the appropriate scale.
- Adequate monitoring & assessment using multiple indicators in their most appropriate roles.

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).*