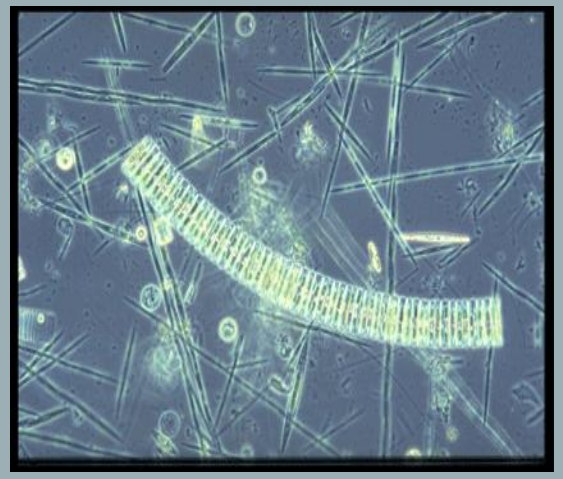


BIOLOGICAL CRITERIA

Water Quality Standards Academy

February 2026

DISCLAIMERS

- This presentation does not:
  - Impose any binding requirements
  - Determine the obligation of the regulated community
  - Change or substitute for any statutory provision or regulatory requirement
  - Change or substitute for any Agency policy or guidance

- The views expressed in this presentation are those of the author(s) and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency

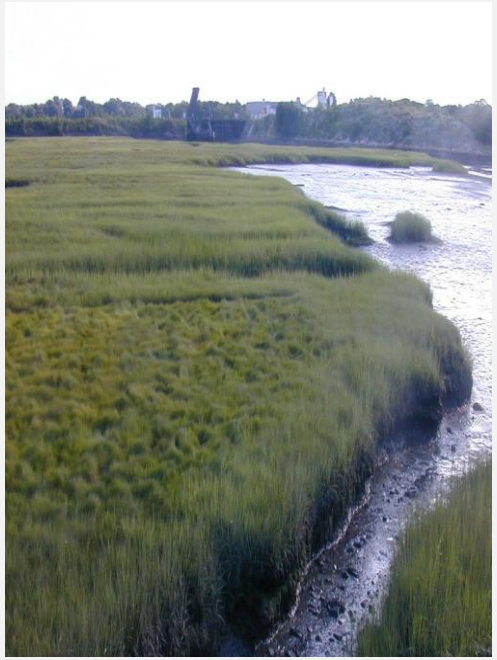
WHAT ARE BIOCRITERIA ?

NARRATIVE EXPRESSIONS OR NUMERIC VALUES CHARACTERIZING THE AQUATIC COMMUNITIES PROTECTED BY THE DESIGNATED AQUATIC LIFE USE

STATUTORY BASIS: CWA SECTION 101

Objective

To restore and maintain the chemical, physical, and *biological integrity* of the nation's waters.



BIOLOGICAL INTEGRITY

The capability [of an aquatic ecosystem] to support and maintain a balanced, integrated, adaptive community of organisms having a composition and diversity comparable to that of the natural habitats of the region (adapted from Frey 1977 – see slide listing references at end of this presentation).

What we measure

BIOLOGICAL INTEGRITY

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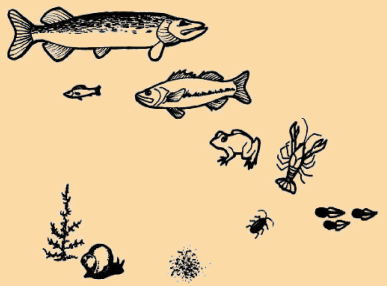
Benthic Macroinvertebrates
Fish
Diatoms



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Fish
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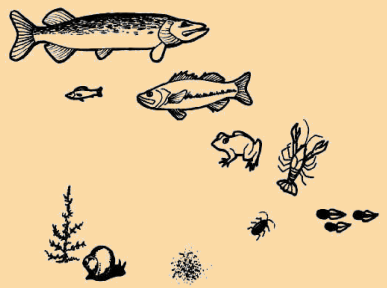


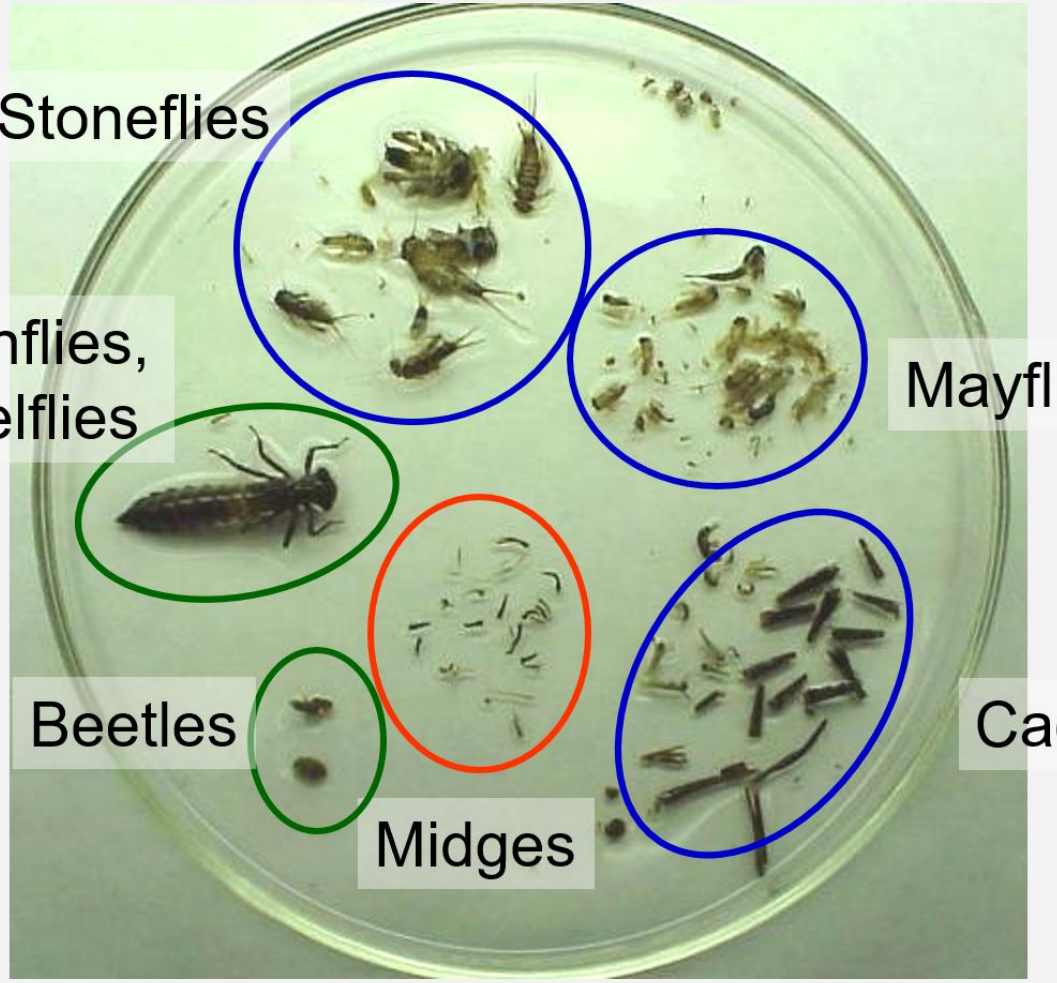
Amphibians
Birds
Aquatic Macrophytes

EX: BENTHIC MACROINVERTEBRATES

- Animals without backbones, living in or on the sediments for one or more life stages
- Large enough to be seen by the unaided eye.
- Are susceptible to degradation of water quality and habitat, and therefore serve as good indicators of environmental conditions.

FILM (ONE MINUTE): BENTHIC MACROINVERTEBRATES IN THEIR HABITAT

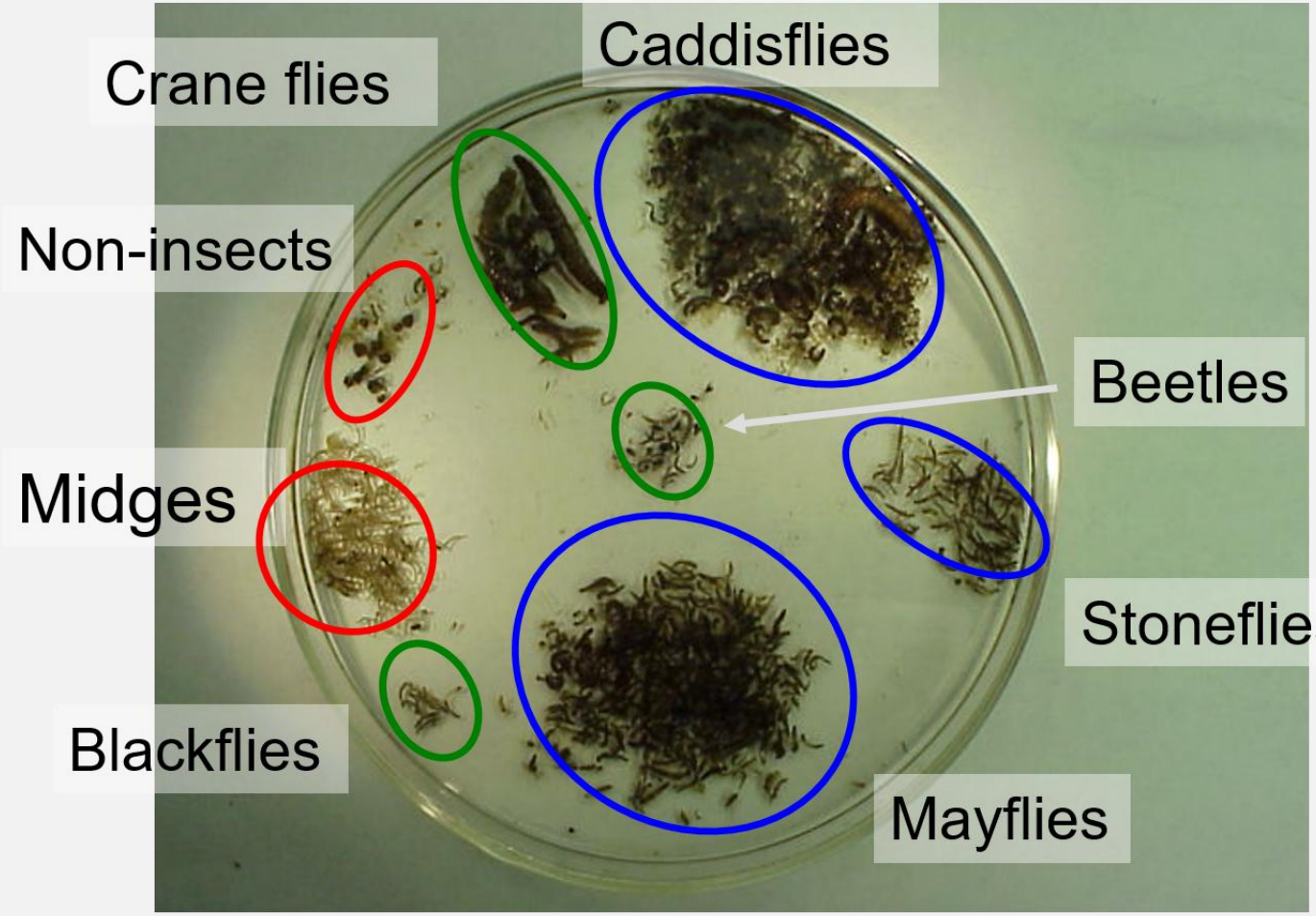
UNDISTURBED/MINIMALLY DISTURBED STREAM



Blue: Sensitive taxa
Green: Moderately sensitive taxa
Red: Tolerant taxa

Courtesy of Susan Davies, ME DEP

NUTRIENT ENRICHED STREAM



Blue: Sensitive taxa
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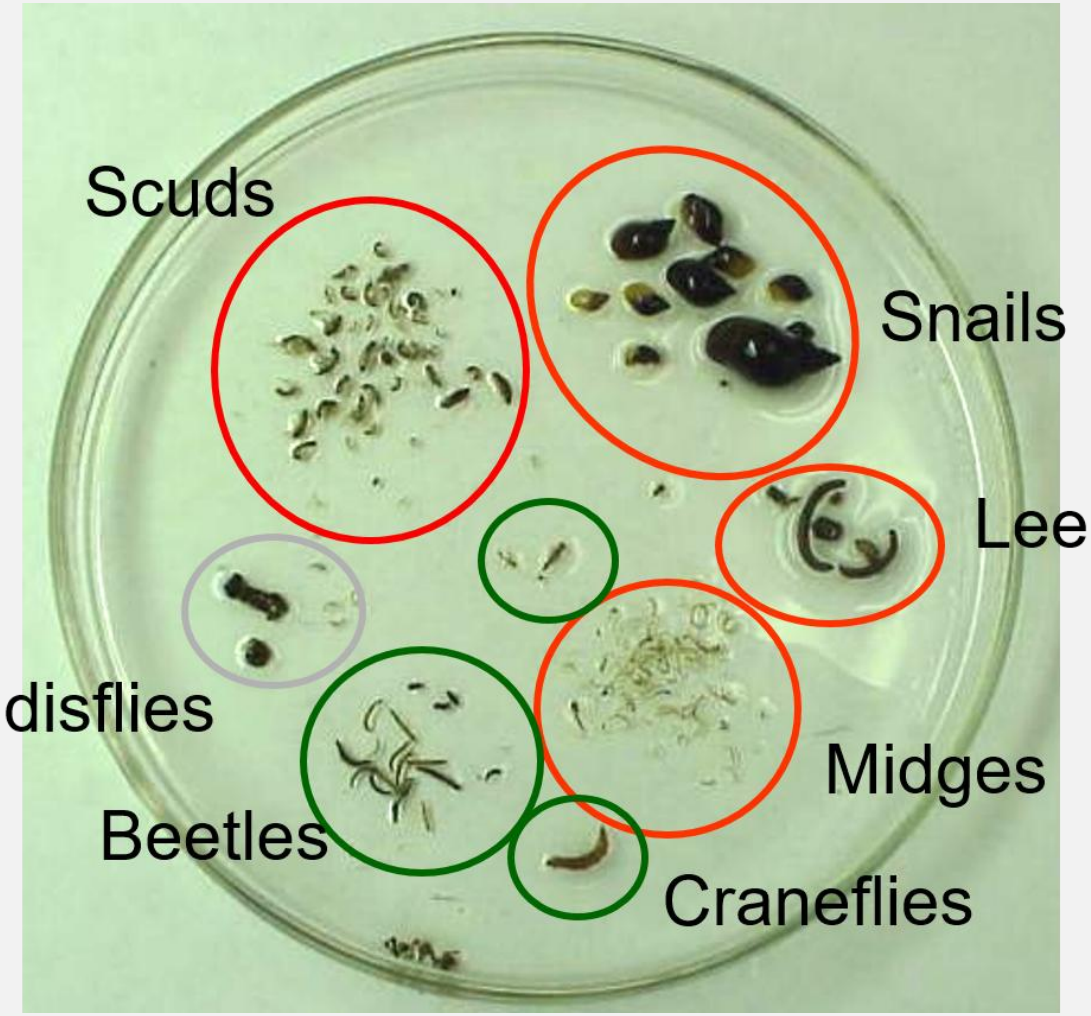
Courtesy of Susan Davies, ME DEP

DRAINAGE FROM A SHOPPING MALL PARKING LOT



1 inch

Blue: Sensitive taxa
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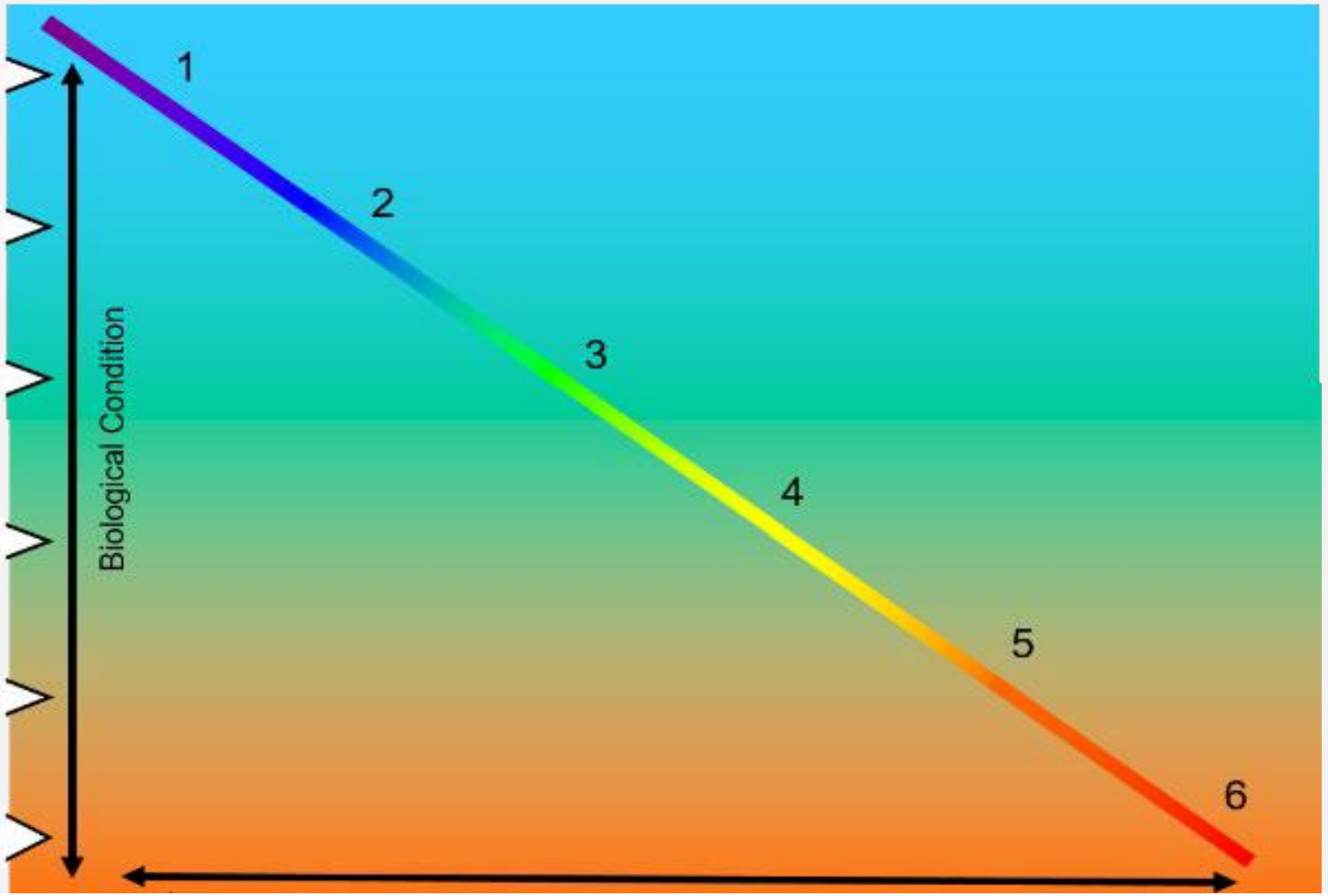
Courtesy of Susan Davies, ME DEP

BIOLOGICAL CONDITION GRADIENT (BCG)

Natural, undisturbed

Severely altered



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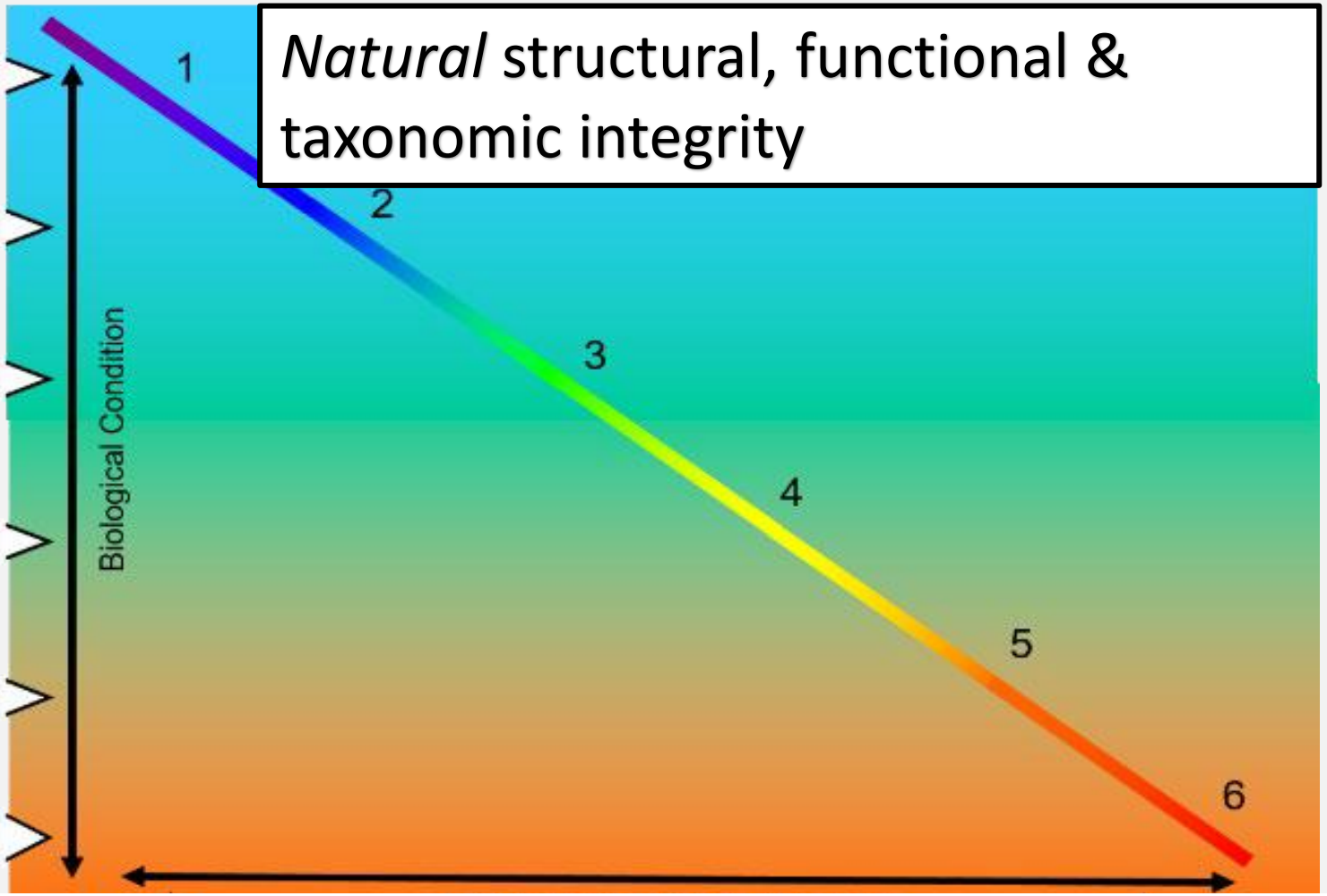

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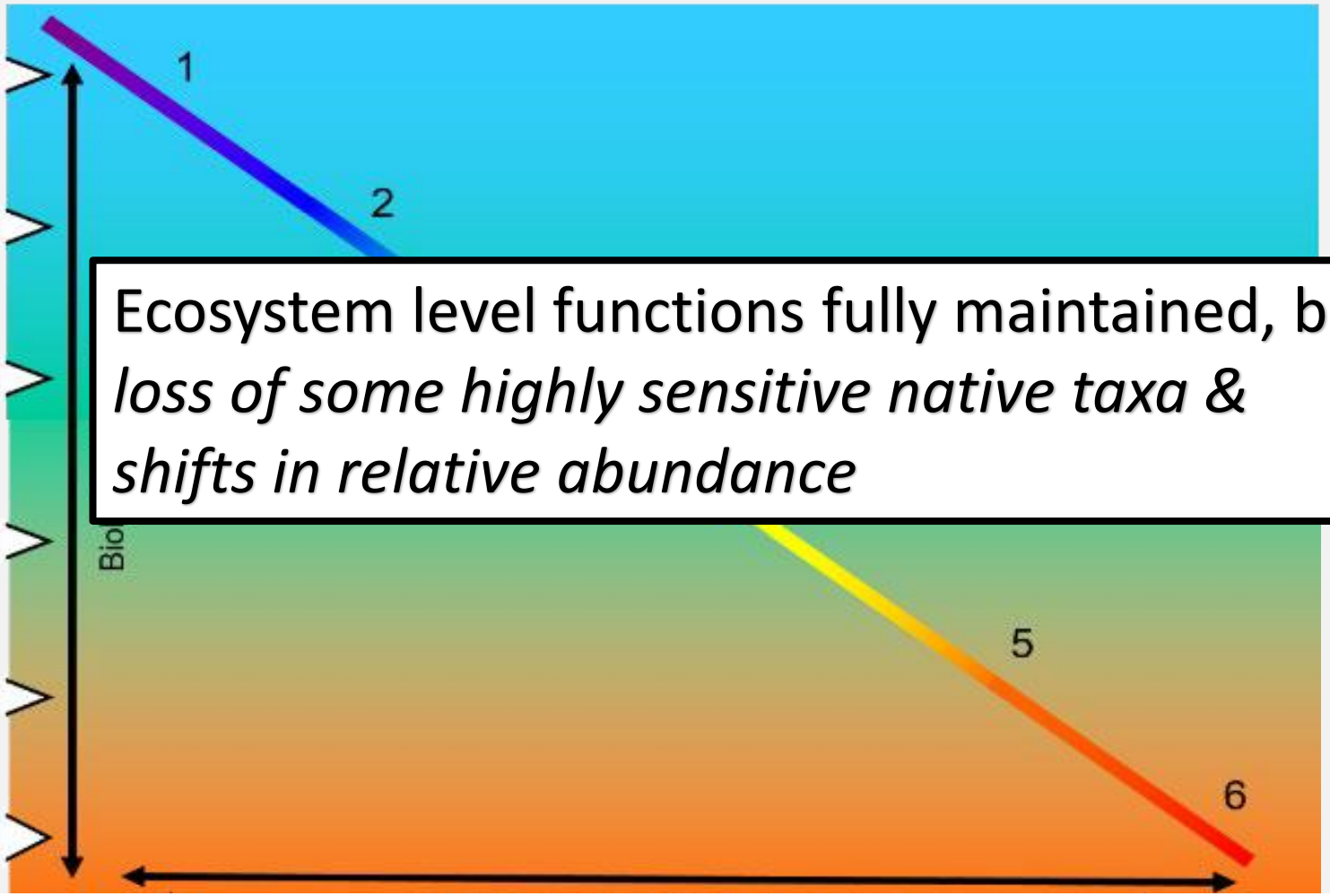
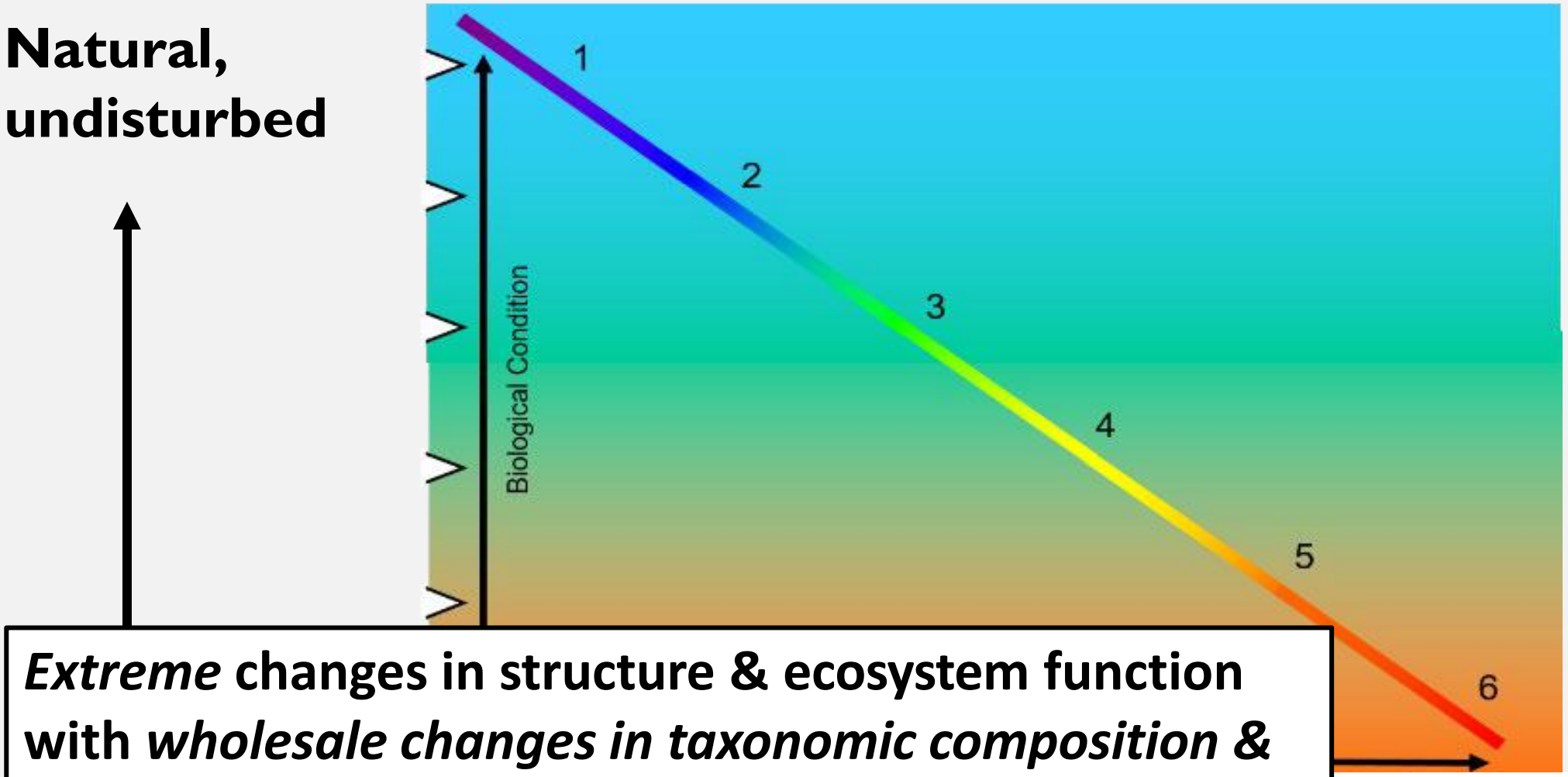


Ecosystem level functions fully maintained, but *loss of some highly sensitive native taxa & shifts in relative abundance*

BIOLOGICAL CONDITION GRADIENT (BCG)



Extreme **changes in structure & ecosystem function with** ***wholesale changes in taxonomic composition & poor organism condition***

BIOLOGICAL CONDITION GRADIENT (BCG)

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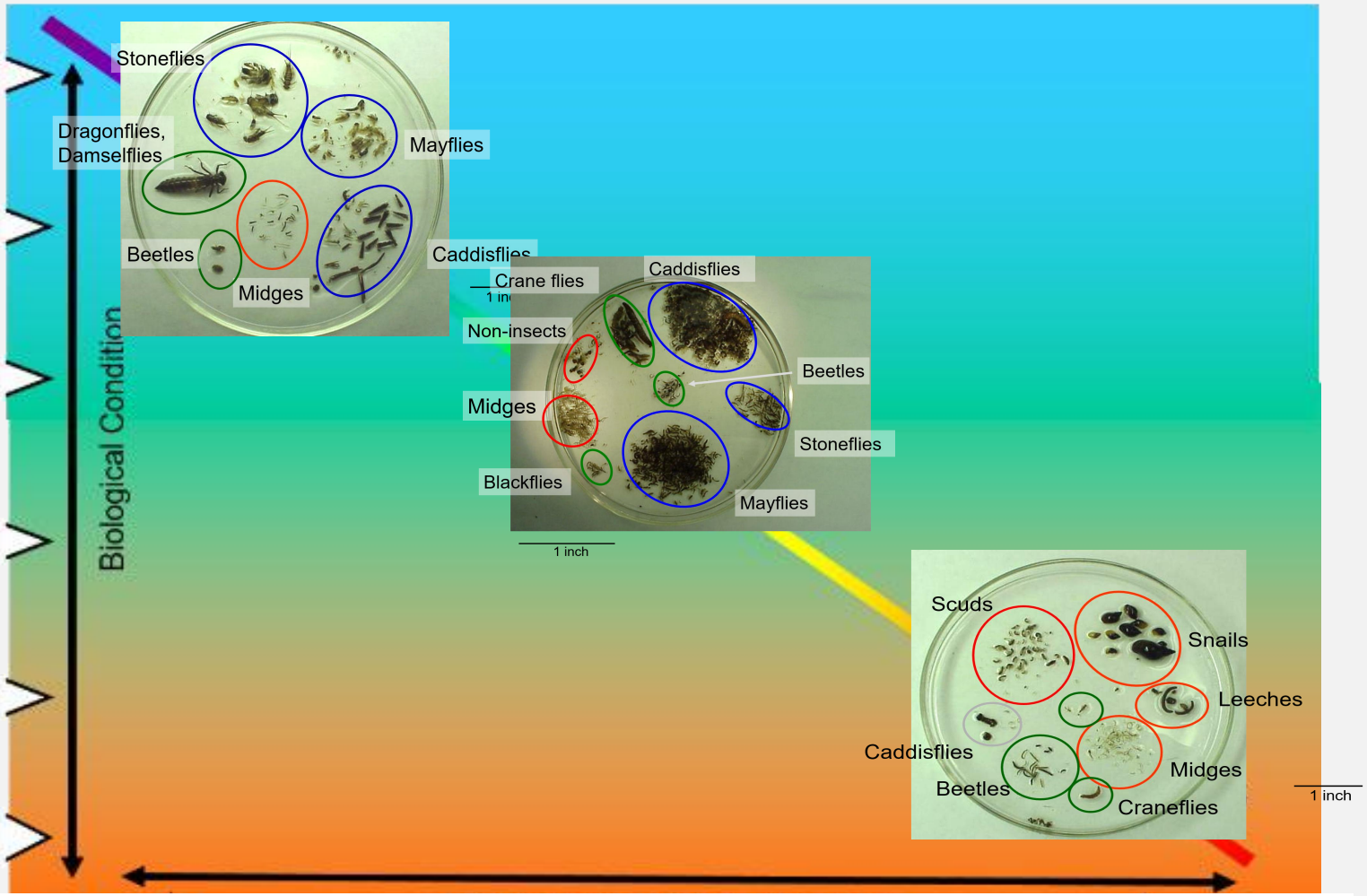


HOW DO WE MEASURE?

DATA

Bioassessments are evaluations of the biological condition of a waterbody using surveys of the structure and function of a community of resident biota.

Invertebrate community bioassessment using a Surber sampler

Invertebrate community bioassessment using a kicknet

Fish community bioassessment

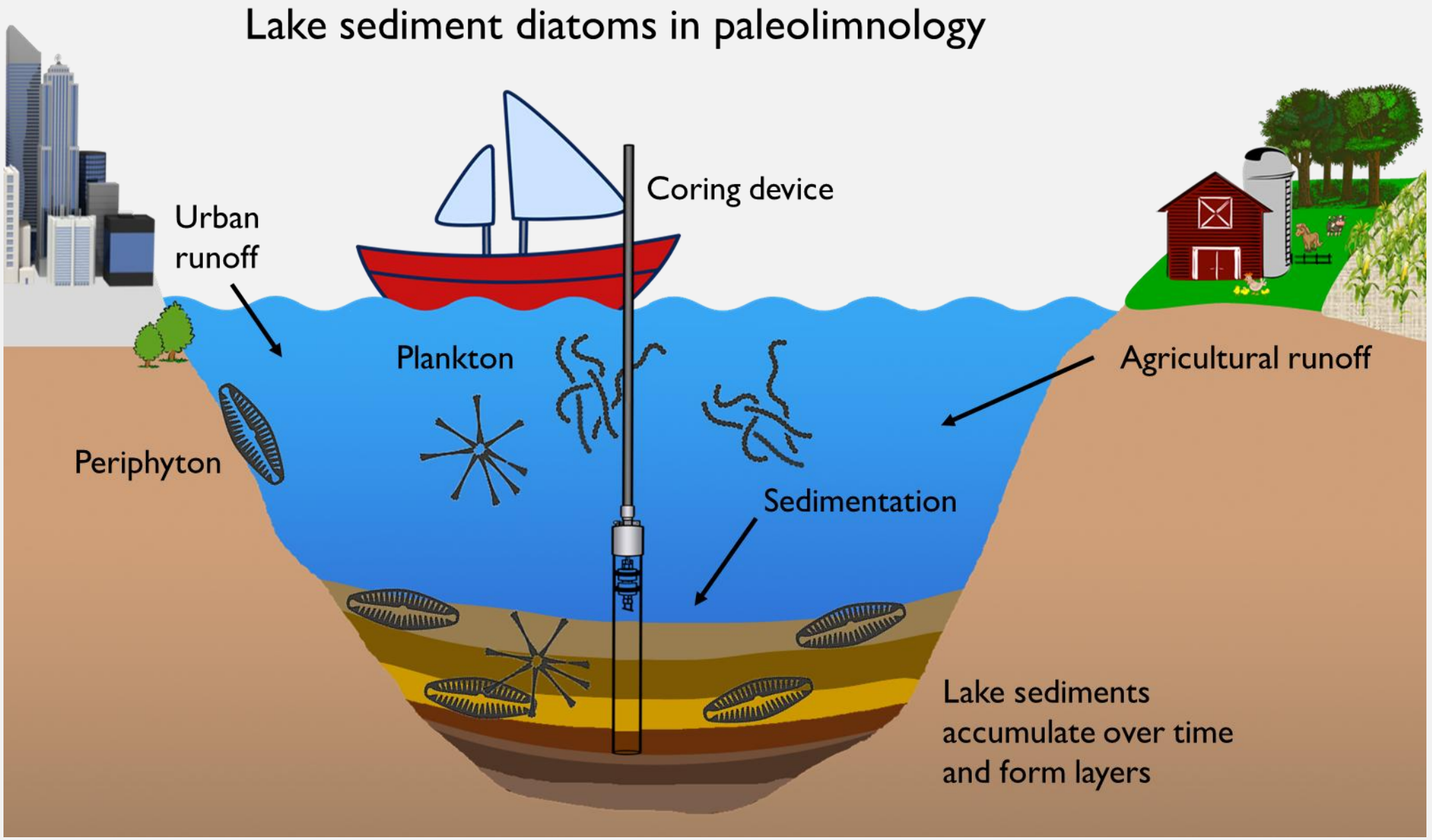
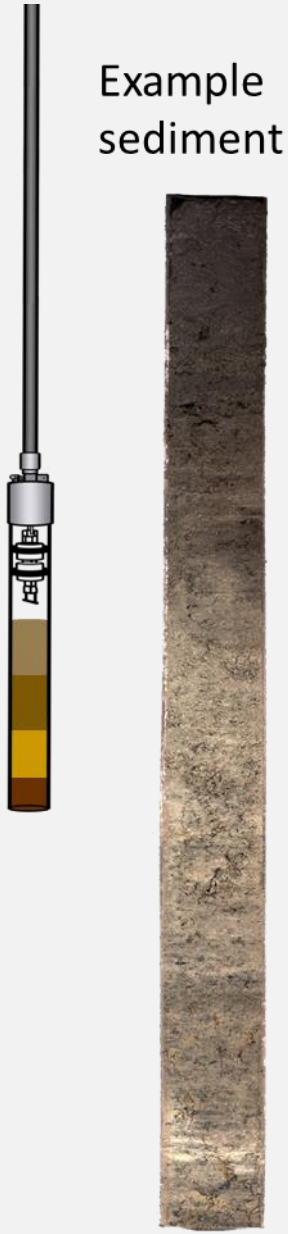
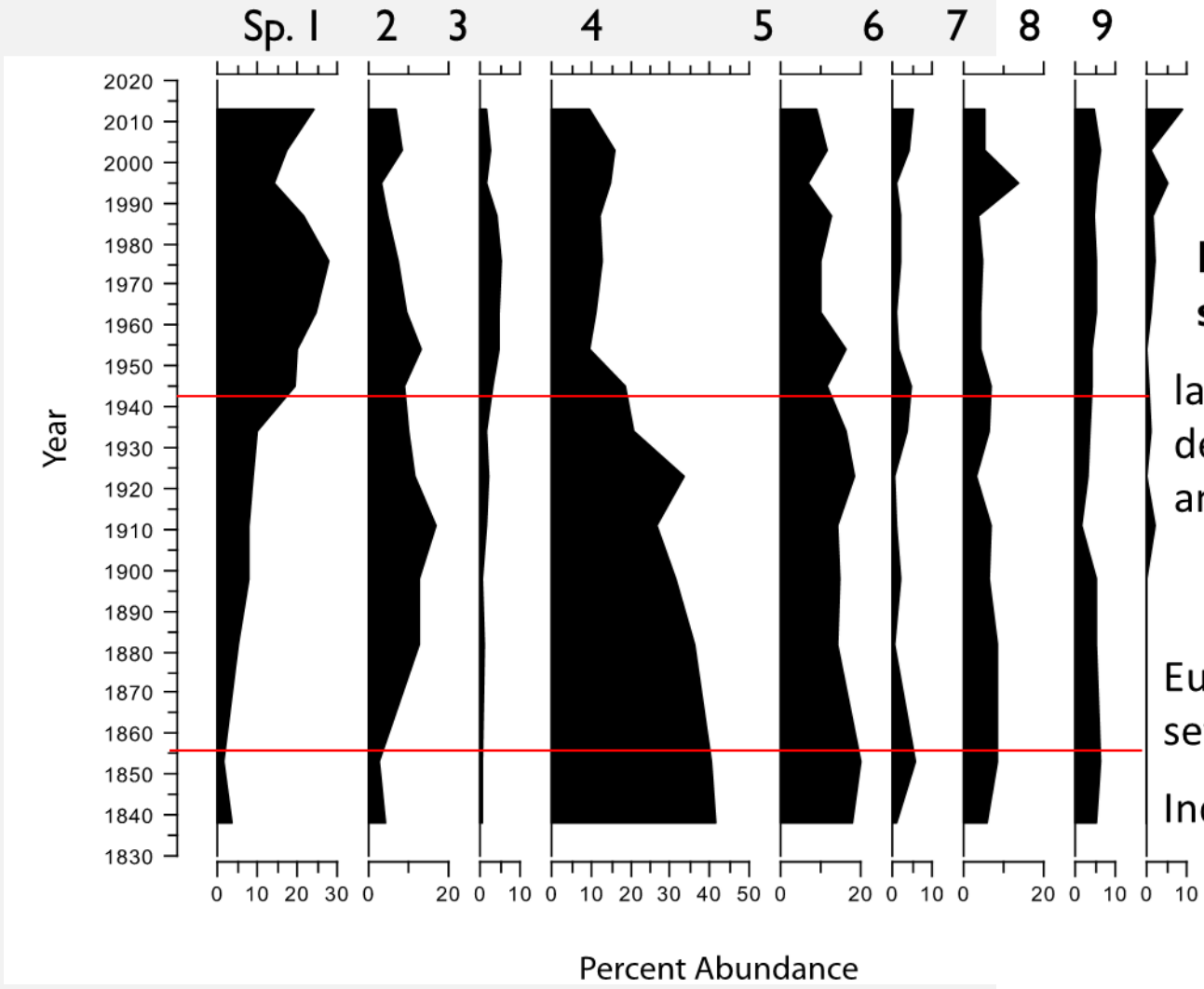


Image credit: Alaina Fedie

Example sediment core



Example diatom species abundances



Potential stressors

lakeshore development and agriculture

Euroamerican settlement

Indigenous time

Example:

Modern community

Historical community

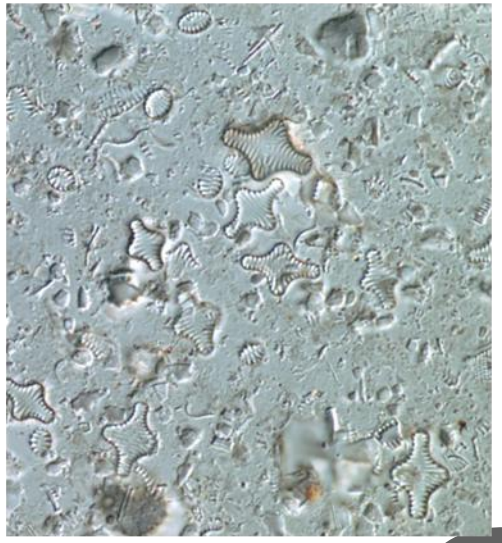


Image credit: Mark Edlund

HOW DO WE INTERPRET THE DATA?

- Attribute: any measurable component of a biological system.
- Metric: attribute that shows a quantitative change in value along a gradient of human influence.
- Multimetric index: a number that integrates several biological metrics to express a site's condition or health (ex. Index of Biological Integrity).

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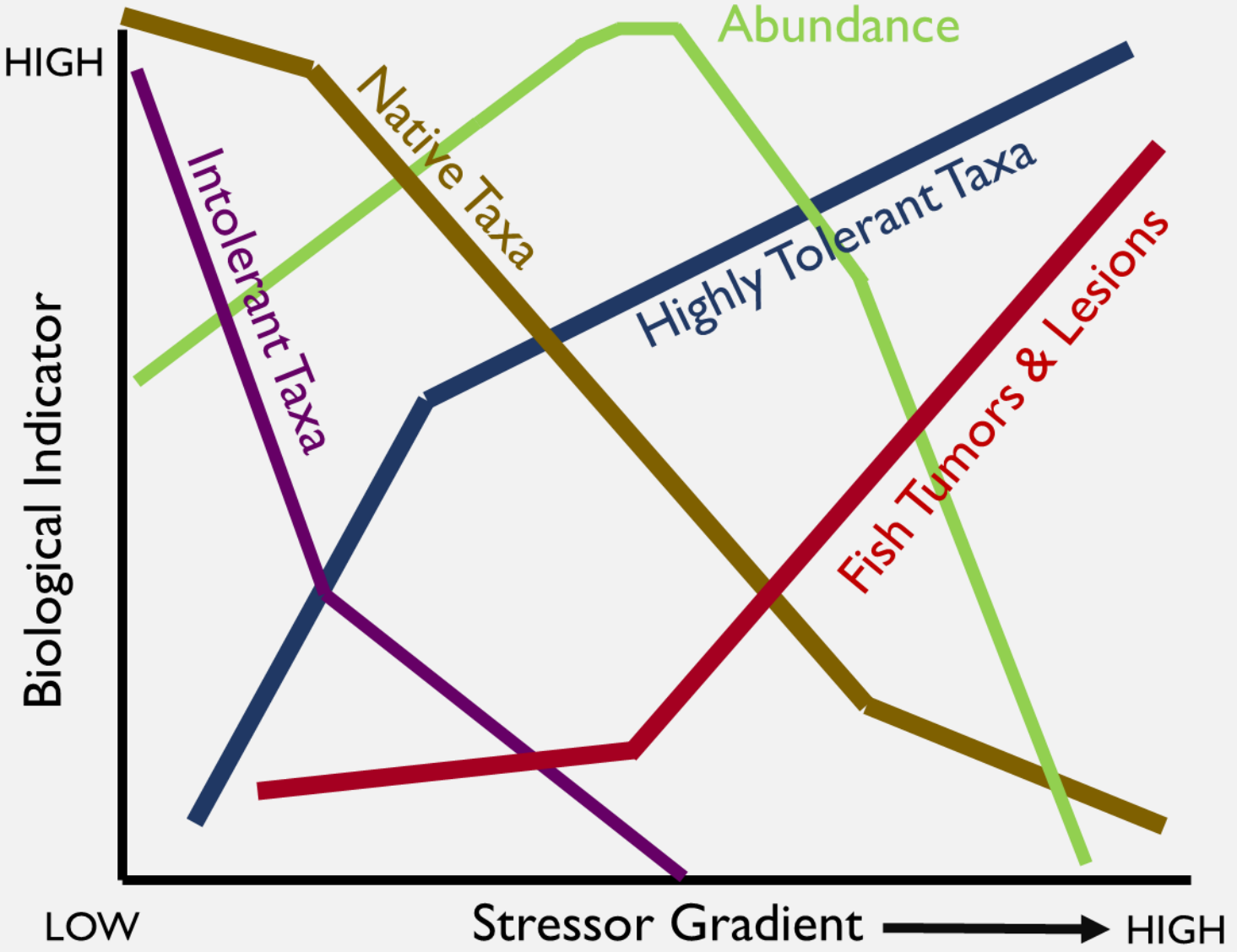
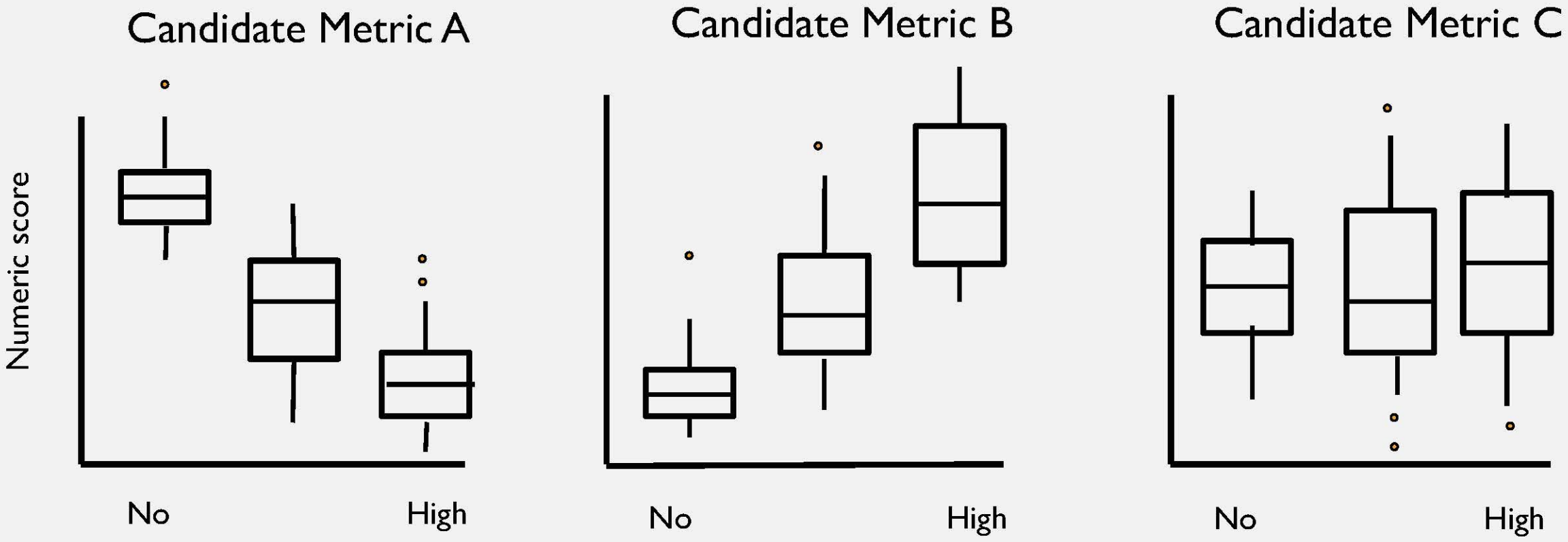
BIOLOGICAL INDICATOR GRAPH (1)

Biological Indicator: Response Along the Stressor Gradient



Modified original courtesy of Chris Yoder, CABB

EX: METRIC SELECTION USING BOX PLOTS



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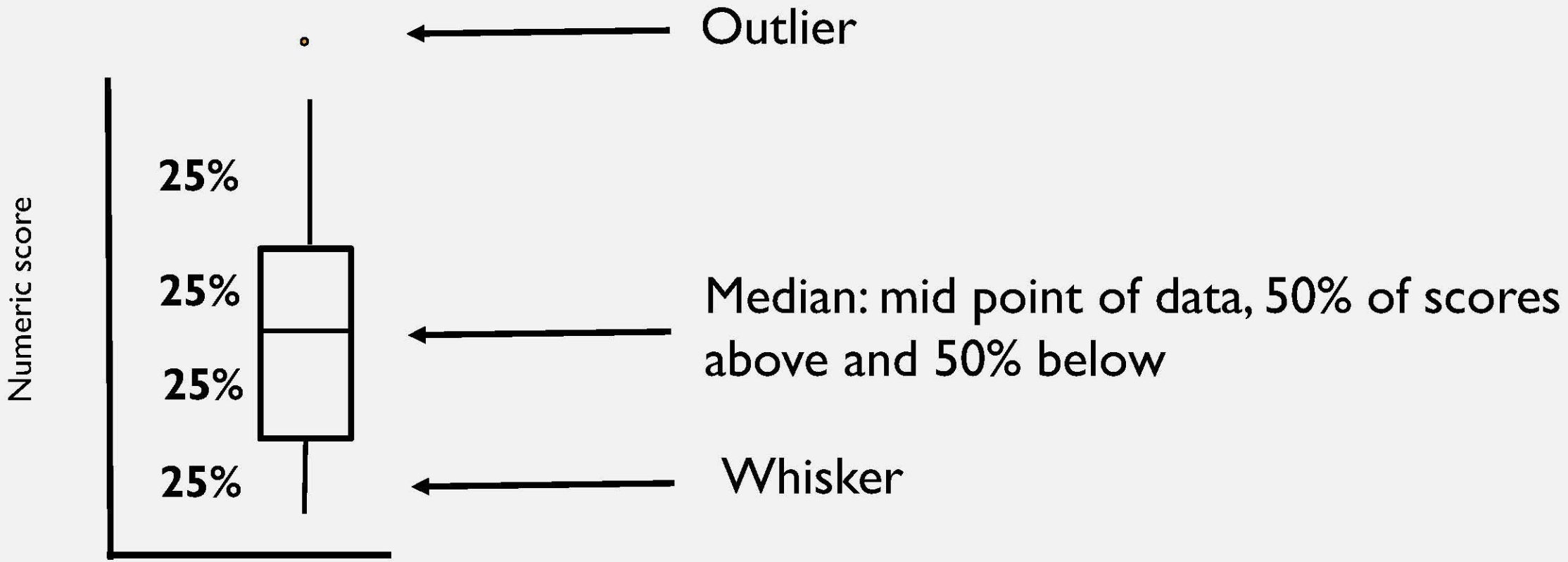

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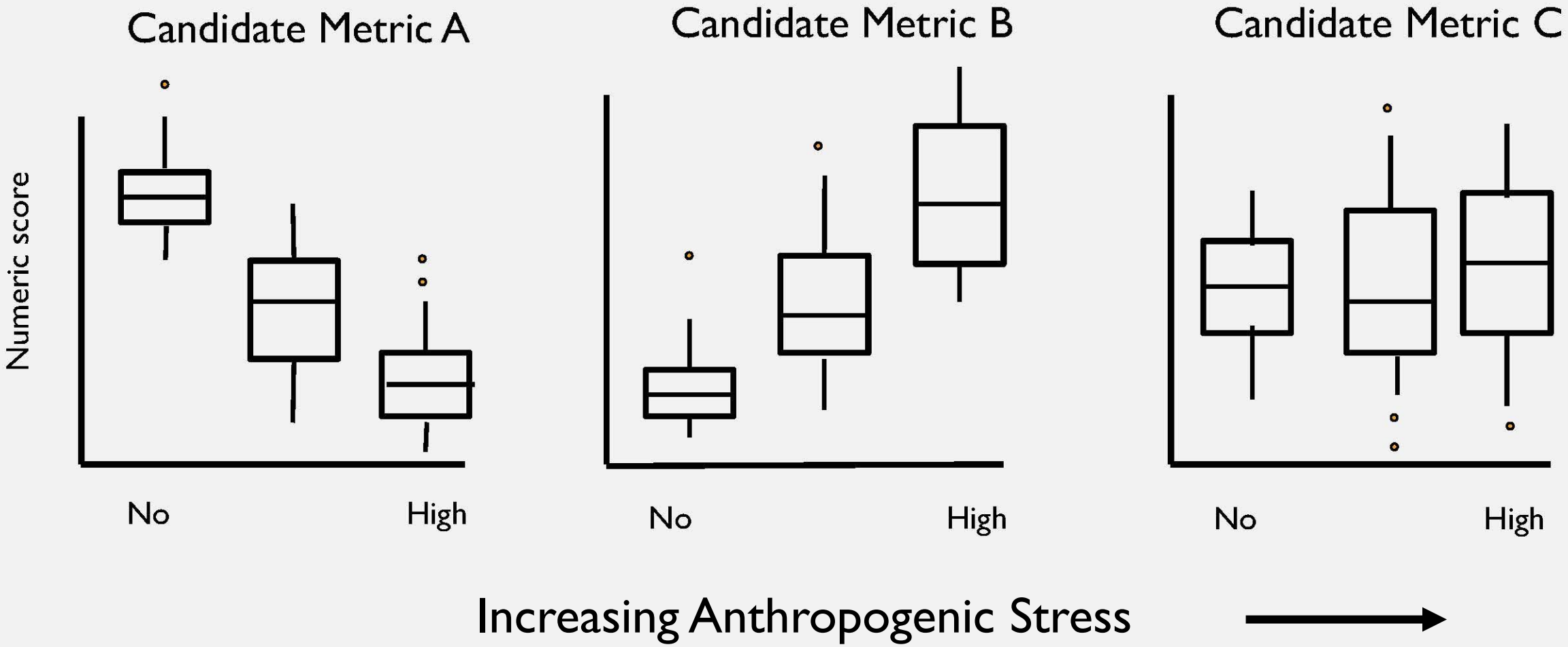

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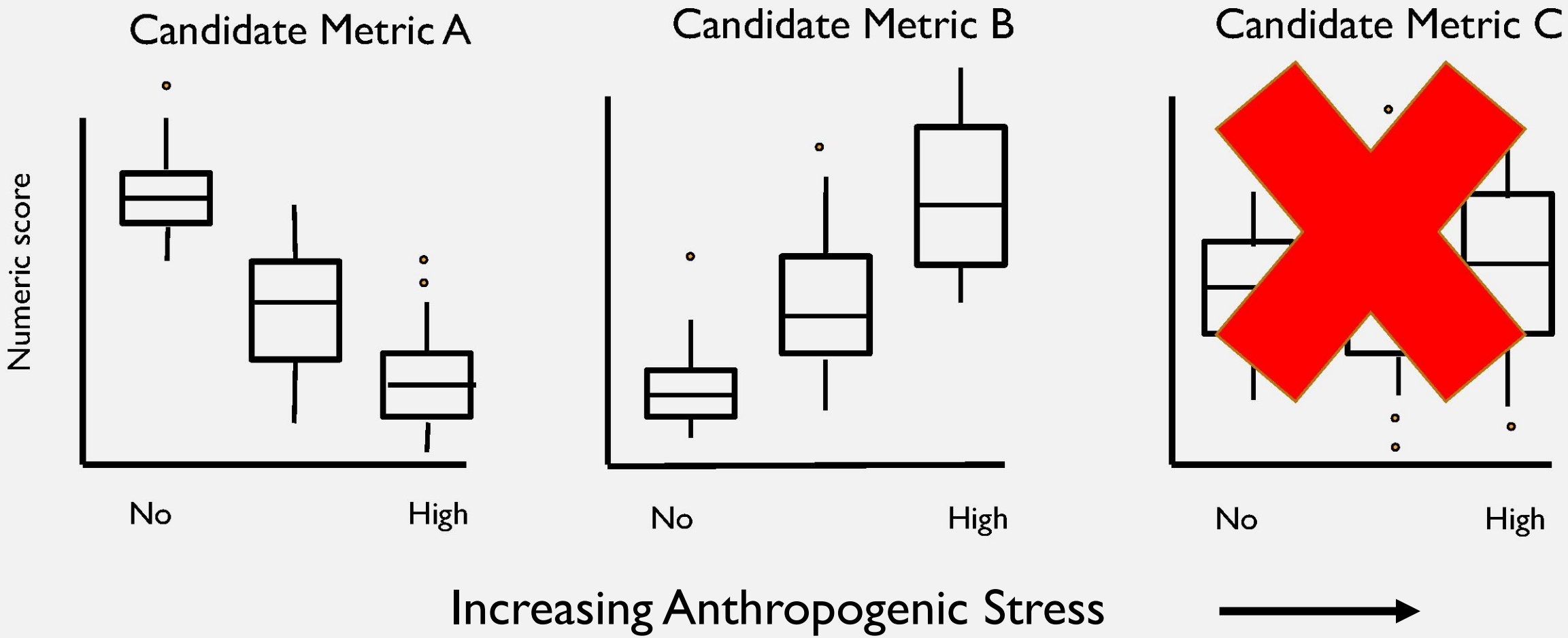

INDICATOR SELECTION

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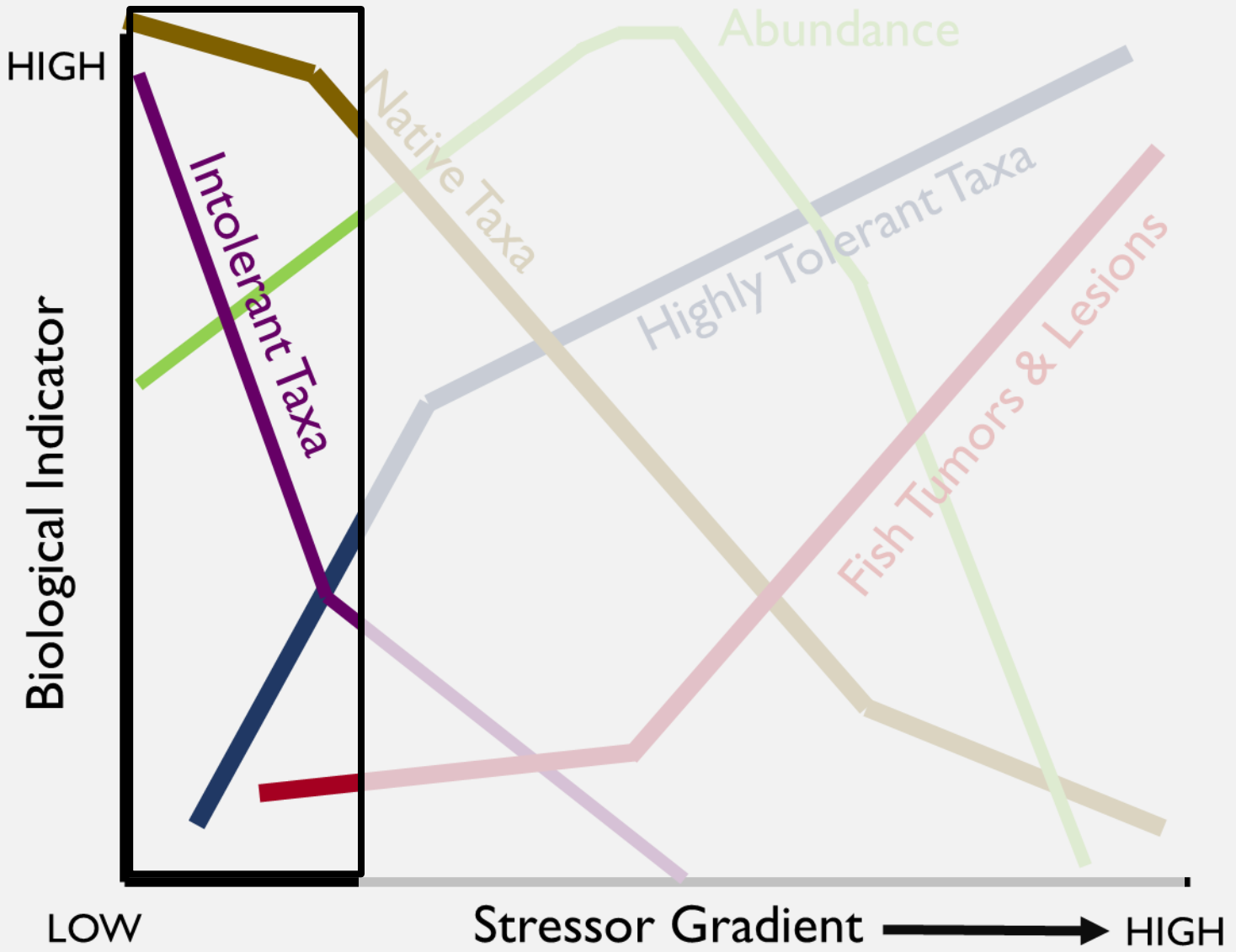
BIOLOGICAL INDICATOR GRAPH

Biological Indicator: Response Along the Stressor Gradient



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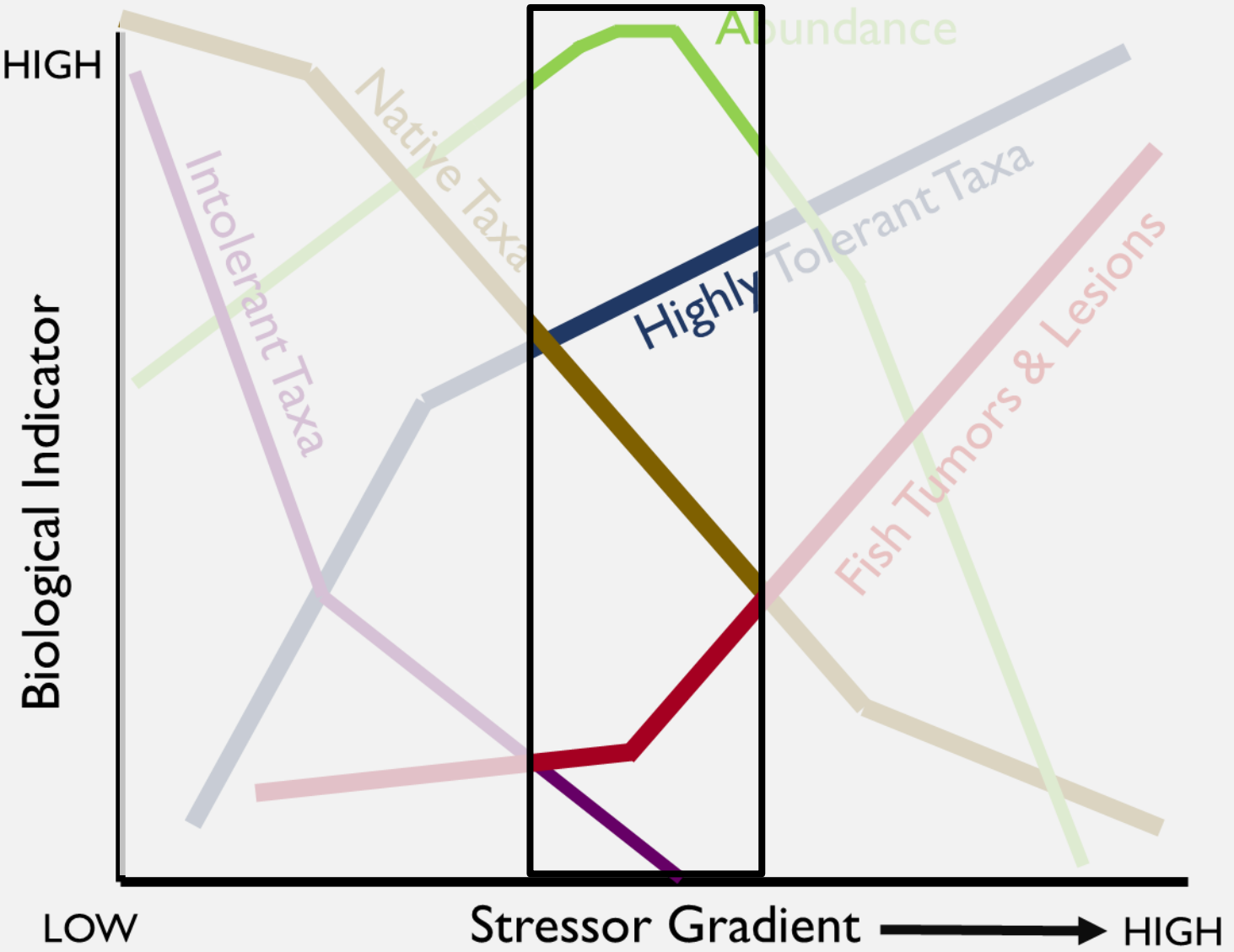

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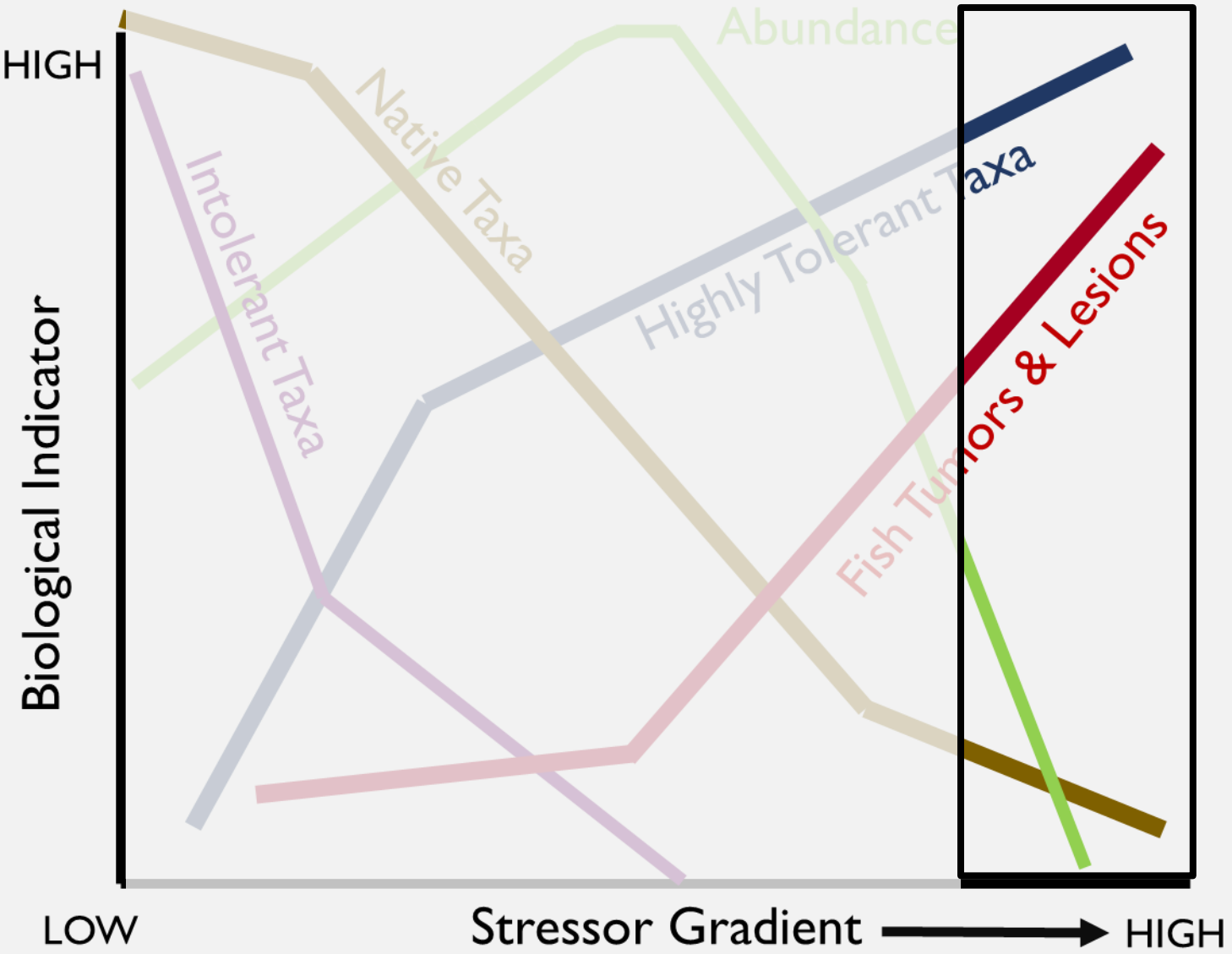

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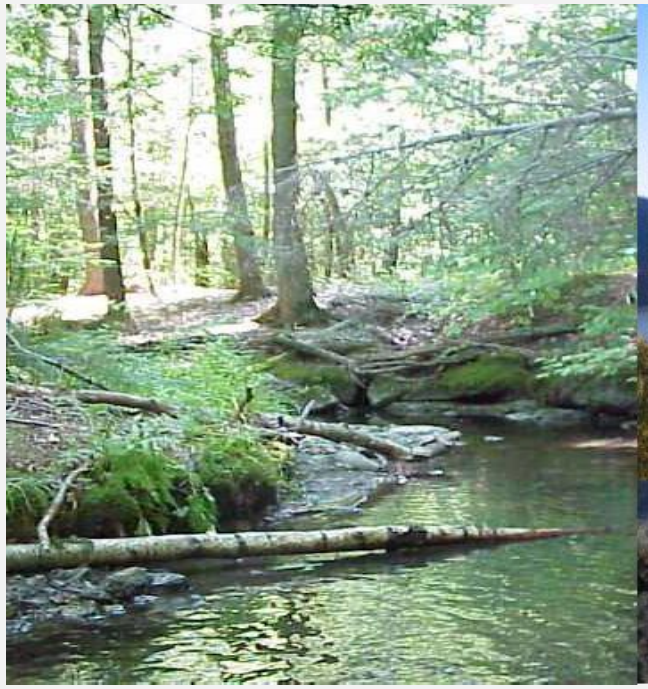
HOW ELSE DOES THE CWA INFORM DEVELOPMENT OF BIOCRITERIA?



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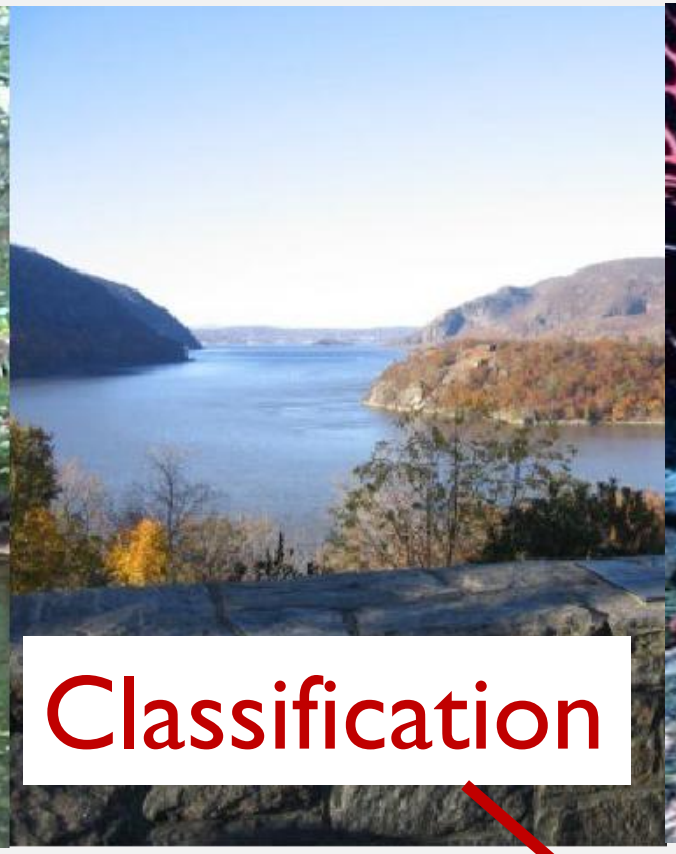

Classification

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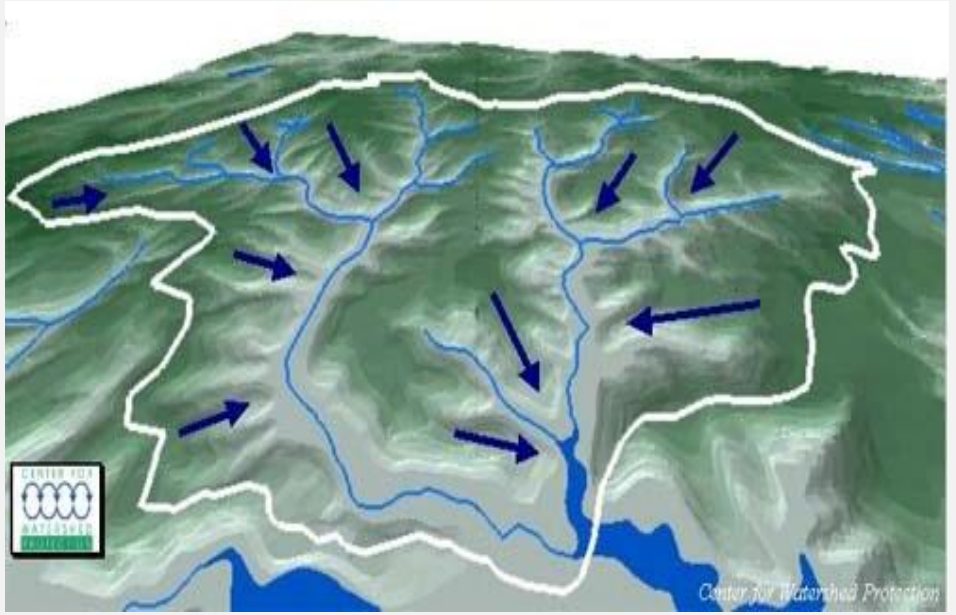
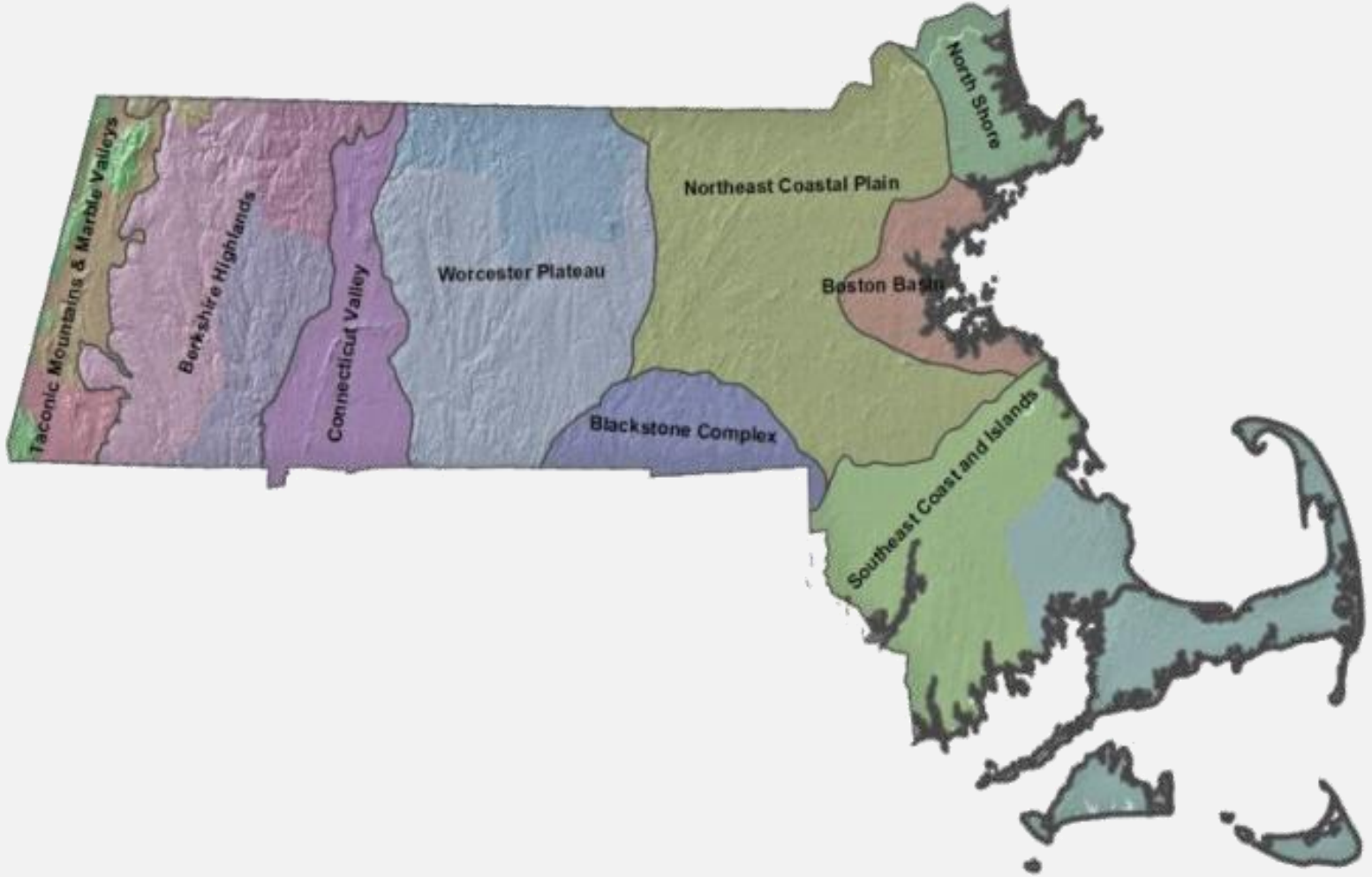
WATERBODY CLASSIFICATION

- Biota vary naturally in different environments.
- Classification of waterbodies allows you to compare waterbodies with similar biological expectations.
- Some ways to classify waterbodies are by aquatic resource type and ecological region.



ECOREGIONS

Ecoregions: areas of relative ecosystem homogeneity. They are based on soils, geology, elevation, climate, and other factors.



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REFERENCE SITES AS A BENCHMARK

What is reference condition?

- **The biological expectation for a given waterbody type in a given region that would occur with no or minimal human disturbance.**

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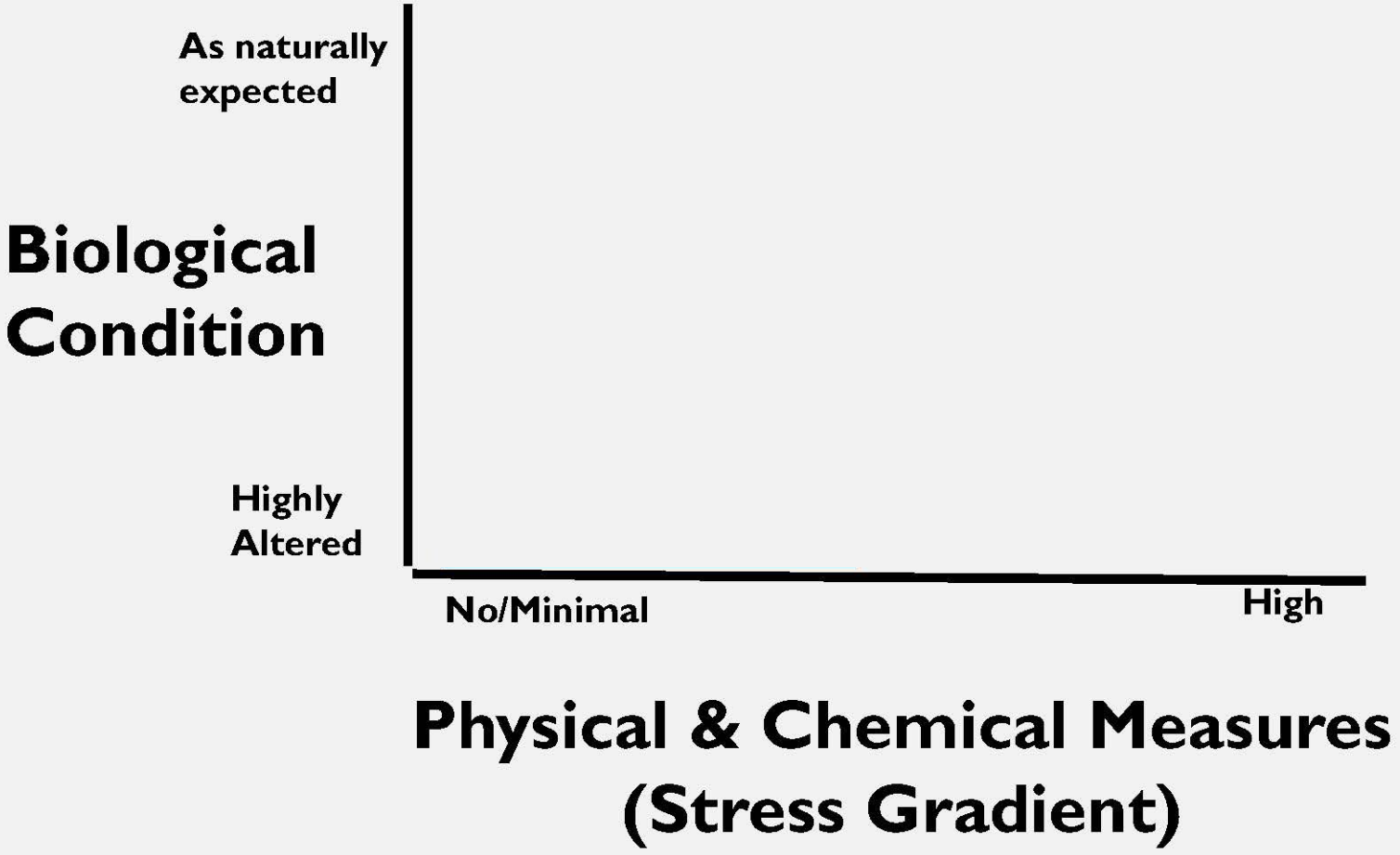
REFERENCE CONDITION SERVES AS THE BENCHMARK



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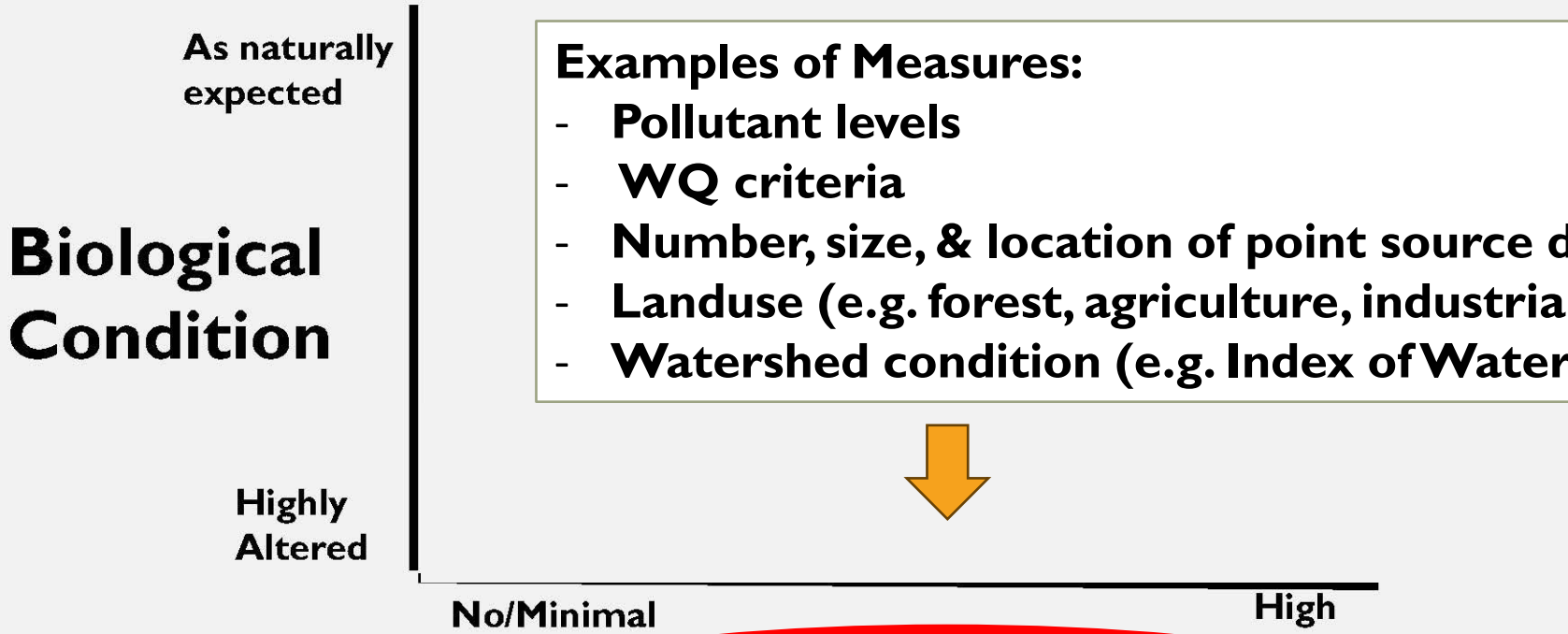
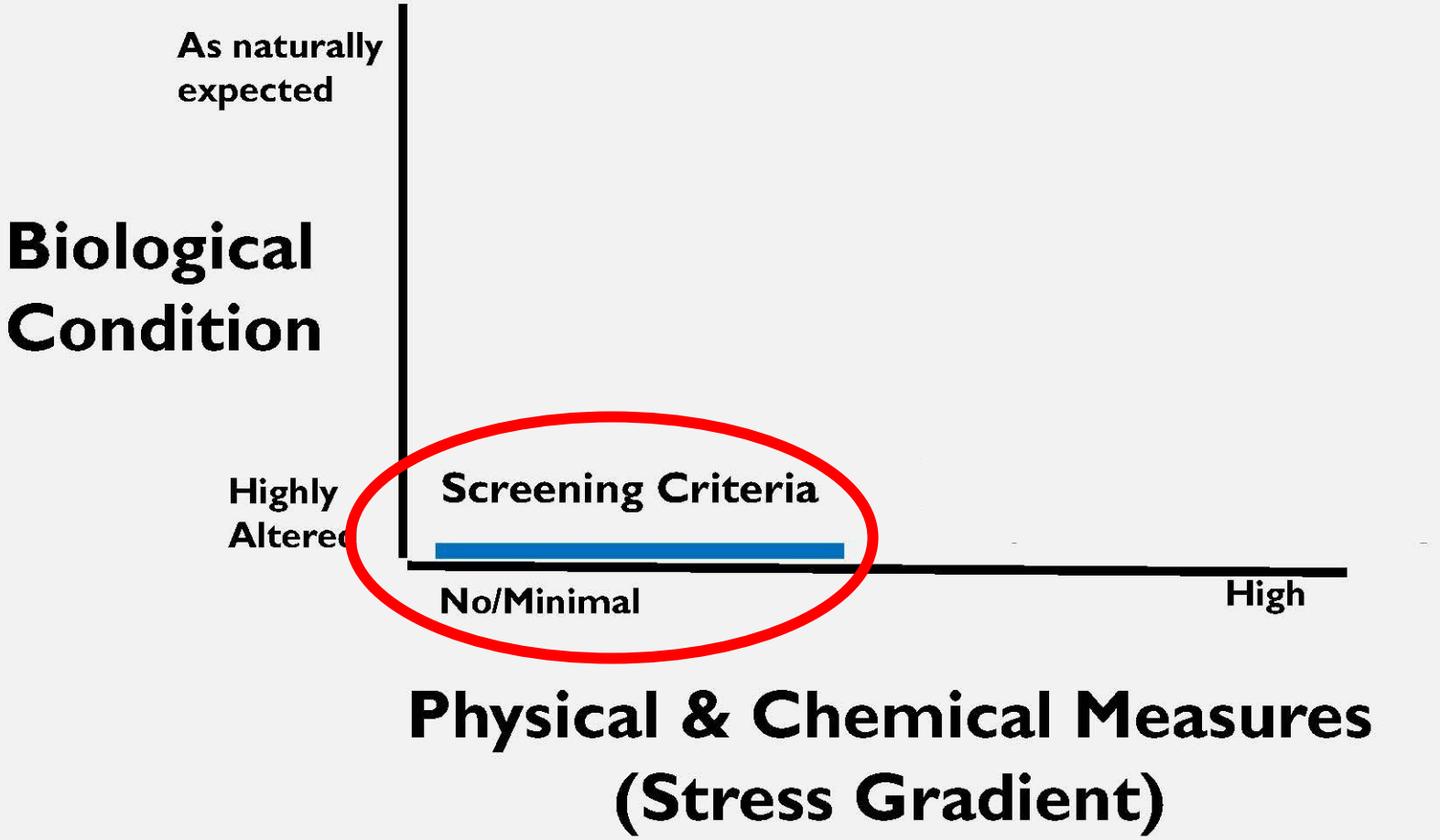


Examples of Measures:

- **Pollutant levels**
- **WQ criteria**
- **Number, size, & location of point source discharges**
- **Landuse (e.g. forest, agriculture, industrial, residential)**
- **Watershed condition (e.g. Index of Watershed Integrity)**

Physical & Chemical Measures (Stress Gradient)

REFERENCE CONDITION SERVES AS THE BENCHMARK



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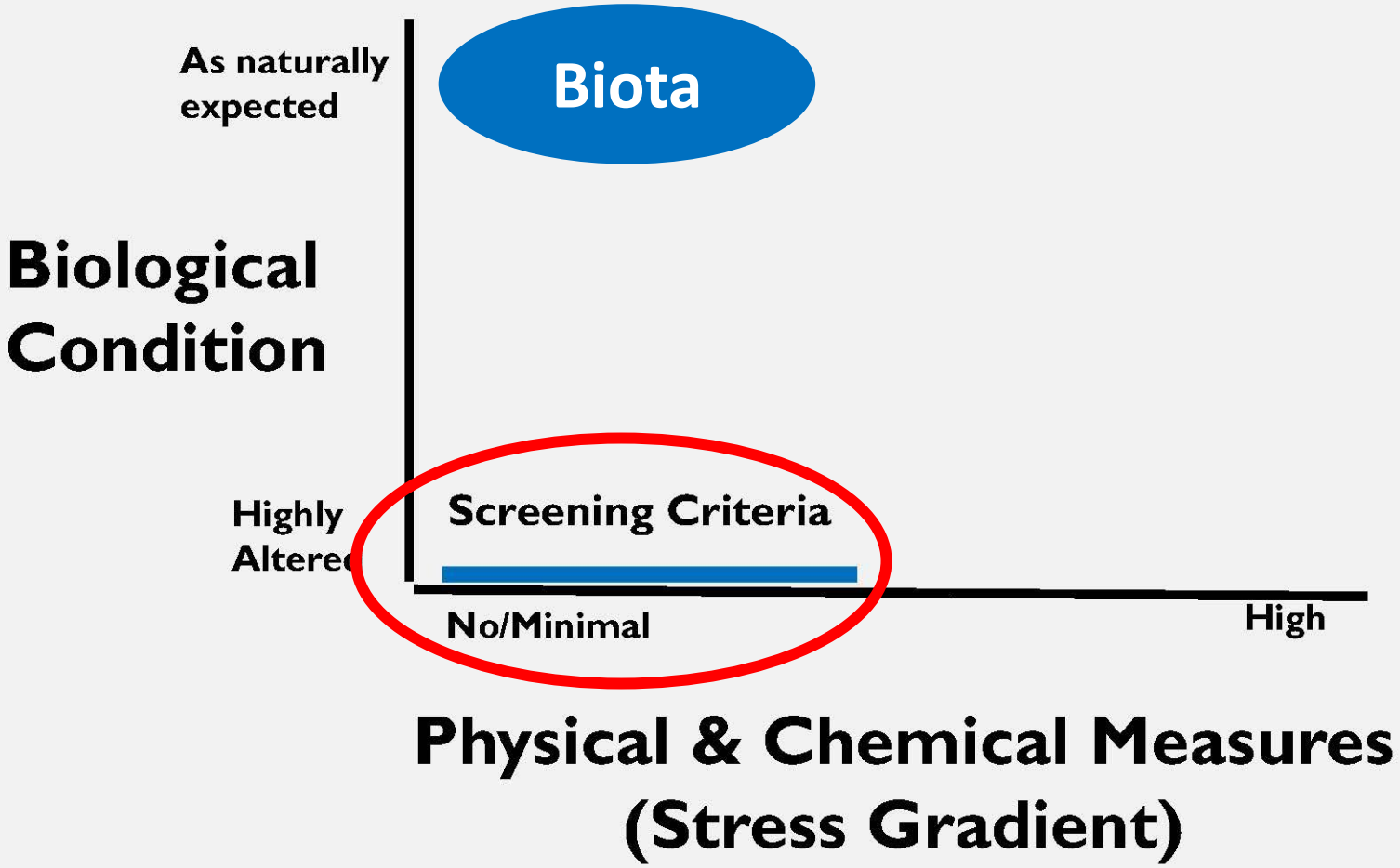

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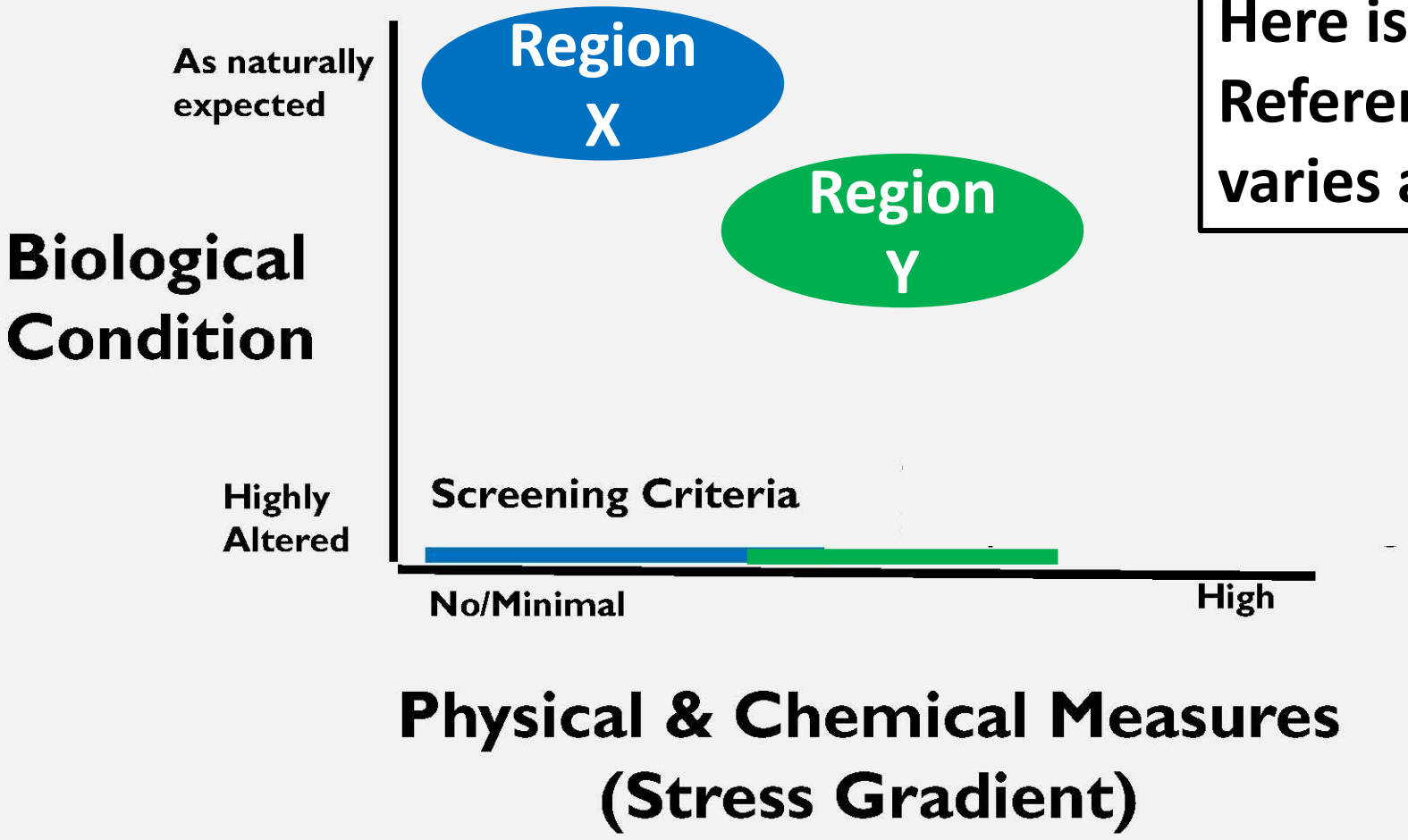
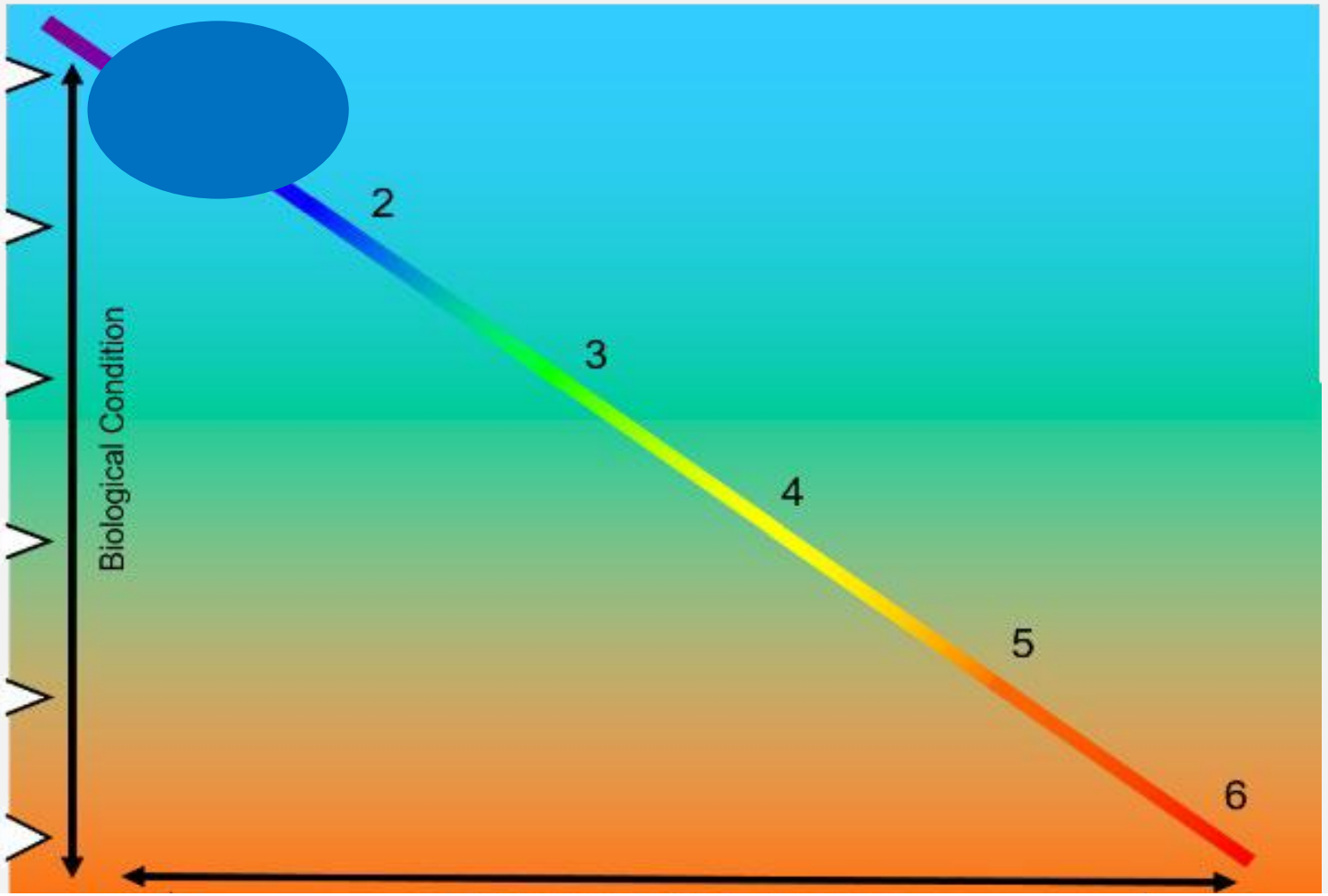


Here is the hitch: Reference site quality varies across regions

BIOLOGICAL CONDITION GRADIENT (BCG)

Natural, undisturbed

Severely altered



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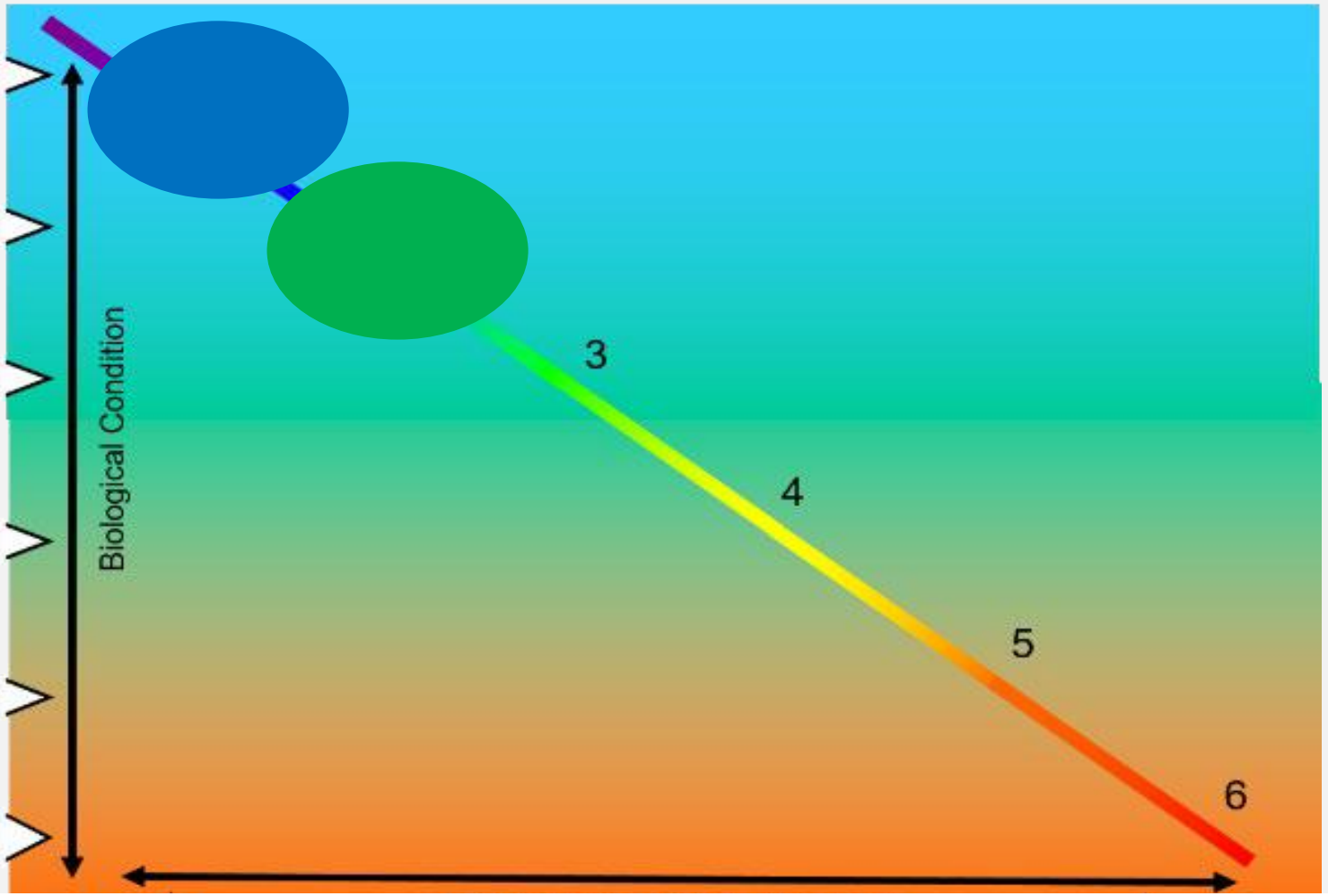

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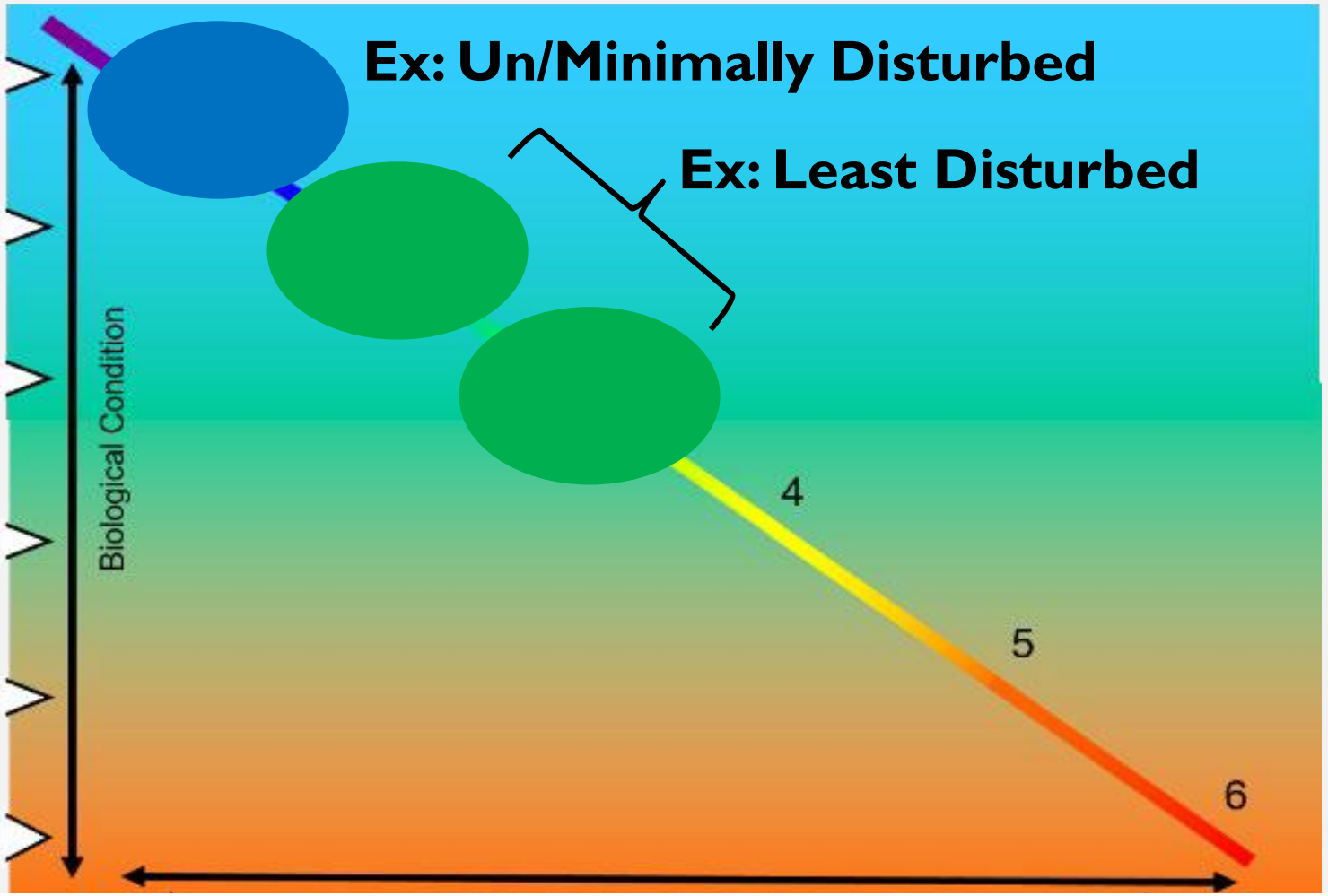


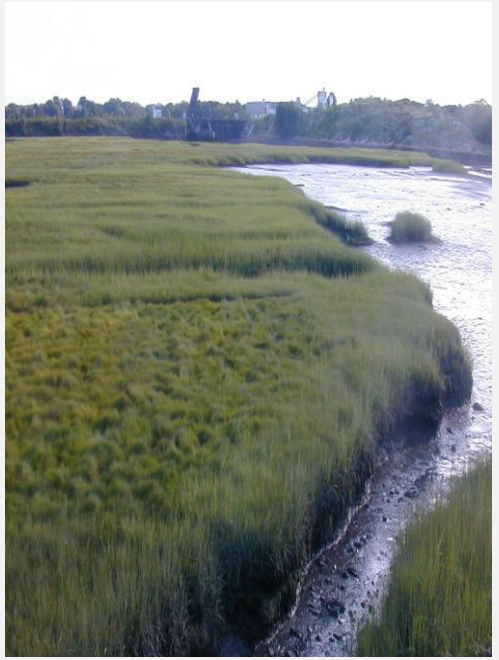
CWA SECTION 101

Objective

To restore and maintain the chemical, physical, and *biological integrity* of the nation's waters.

101(a)(2) Goal

Protection and propagation of fish, shellfish, and wildlife …



CWA SECTION 303

CWA Section 303(c)(2)(B):

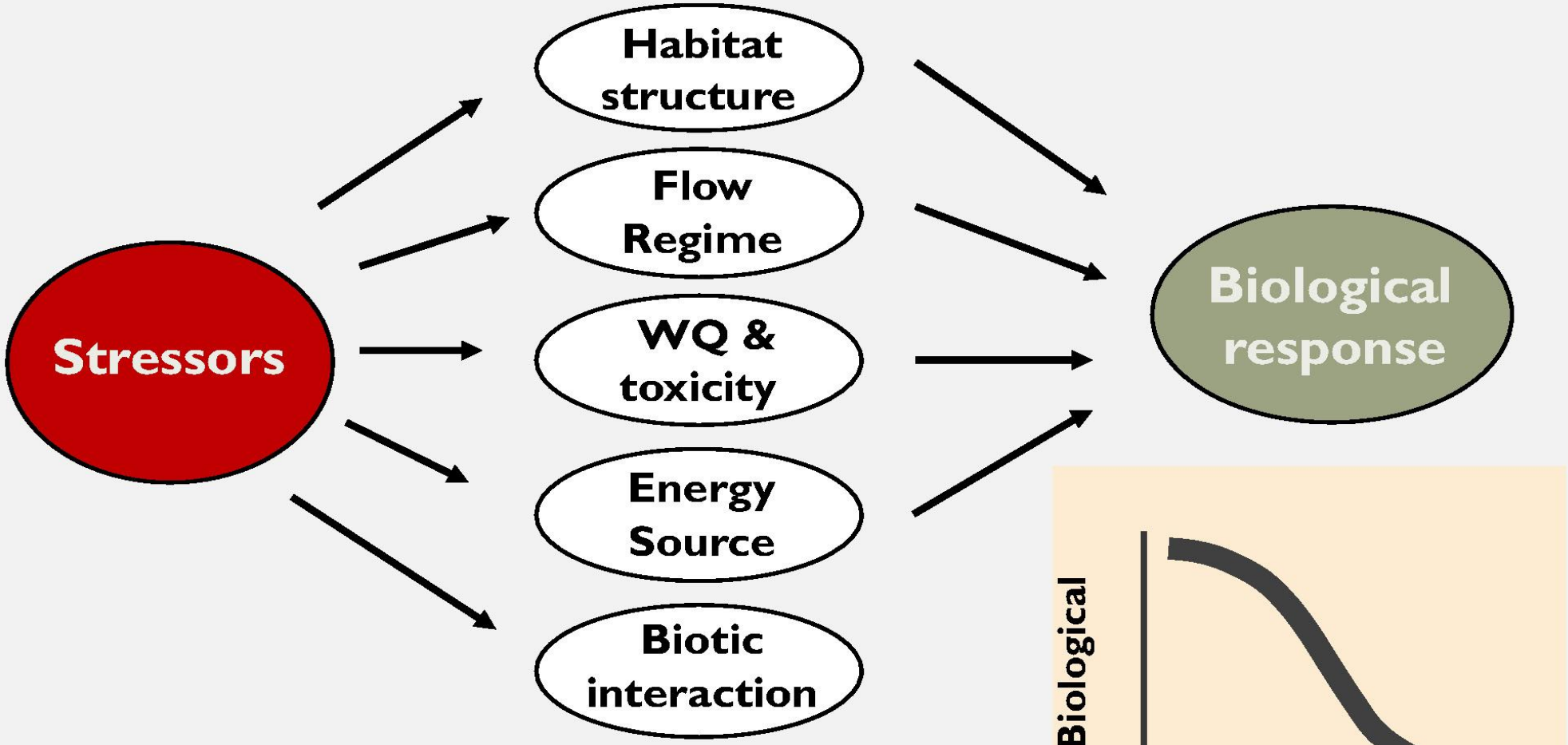
"Where such numerical criteria are not available, whenever a State reviews water quality standards pursuant to paragraph (1), or revises or adopts new standards pursuant to this paragraph, such State shall adopt criteria based on biological monitoring or assessment methods consistent with information published pursuant to section 1314(a)(8) of this title."

CWA SECTION 304(A)(1)

CWA Section 304(a)(1)(C):

"… on the effects of pollutants on biological community diversity…"

WHAT DO BIOLOGICAL CRITERIA ADD?



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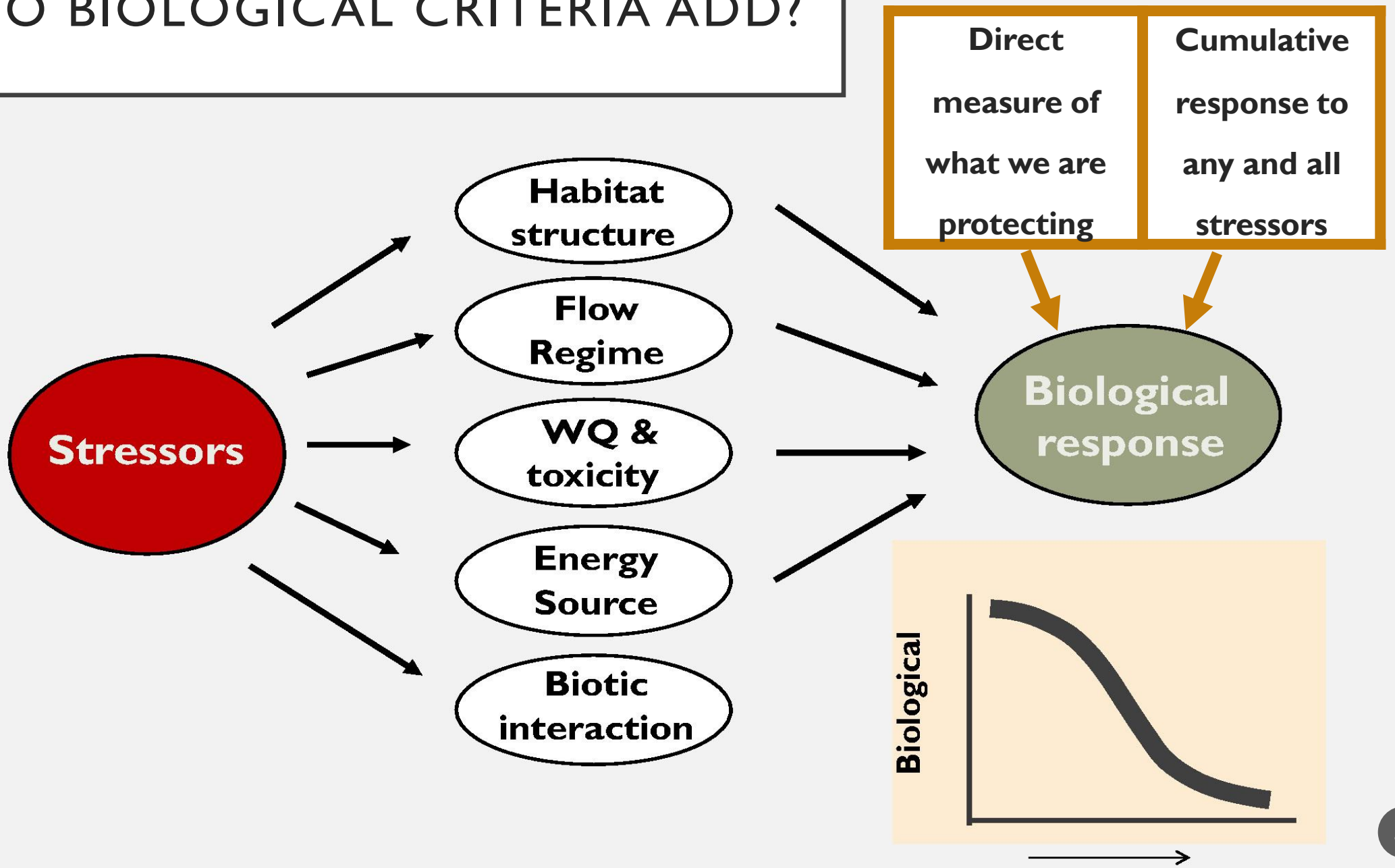
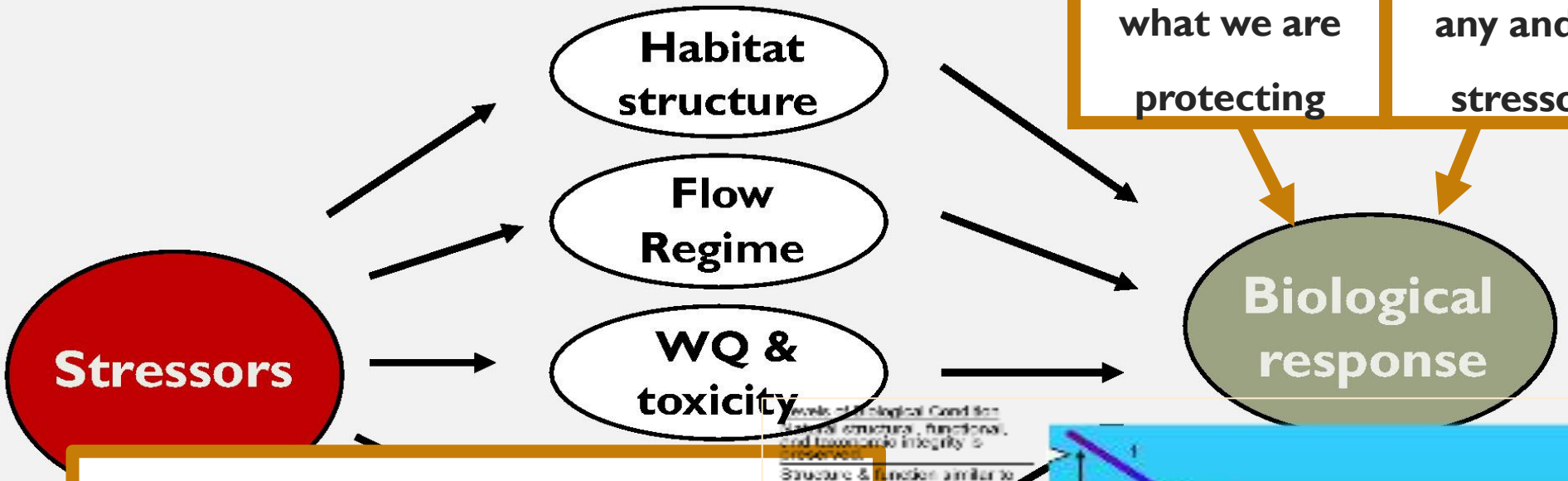
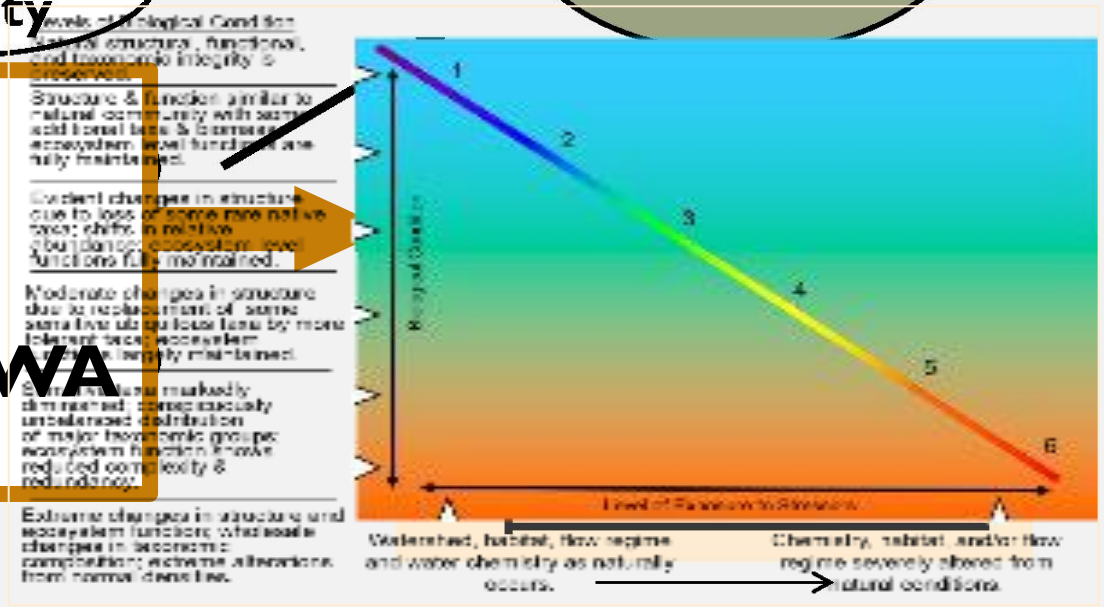


WHAT DO BIOLOGICAL CRITERIA ADD?

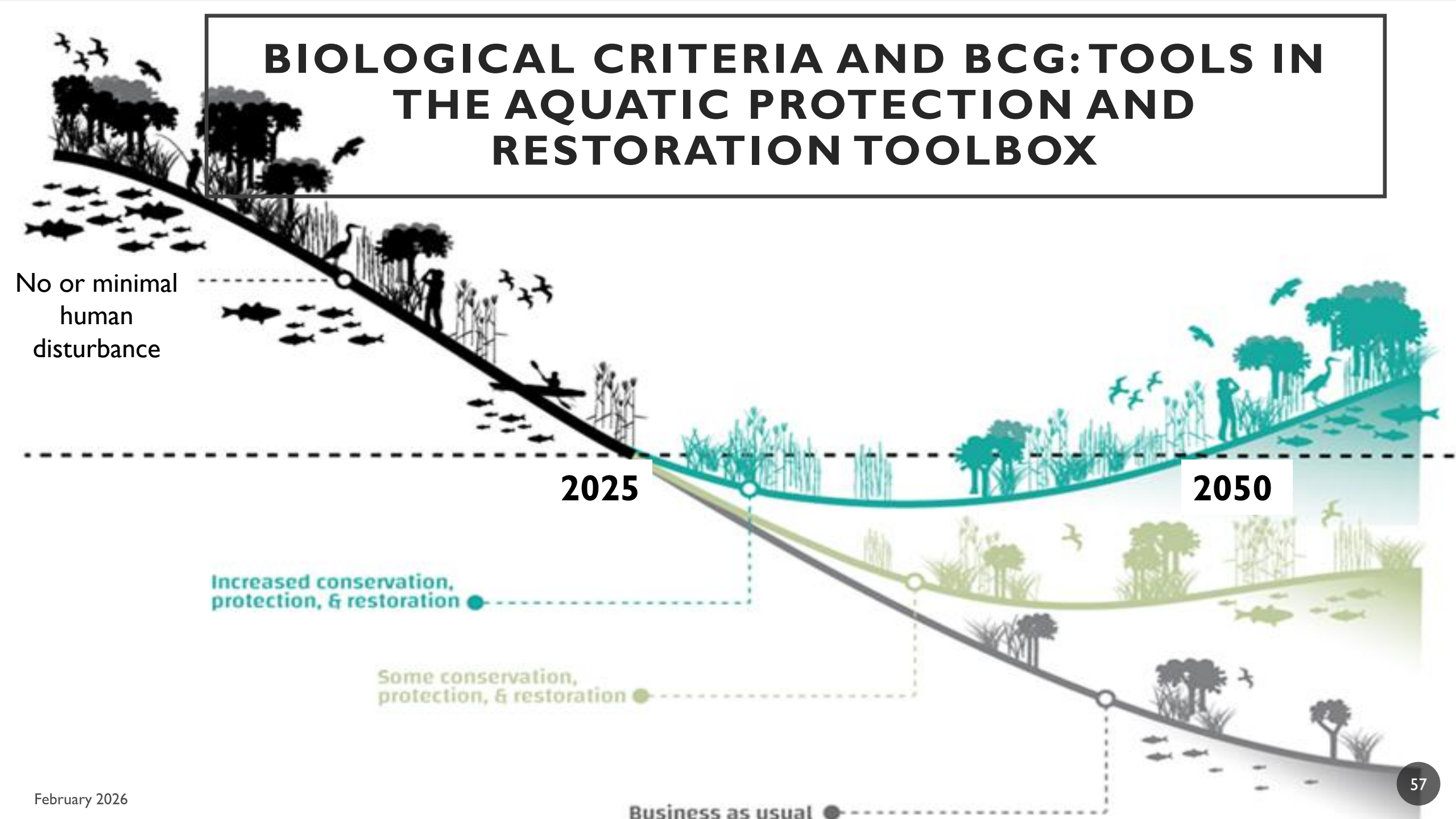
Aquatic Life Use	
Direct measure of what we are protecting	Cumulative response to any and all stressors



BCG:
Interpret incremental change in context of CWA



BIOLOGICAL CRITERIA AND BCG: TOOLS IN THE AQUATIC PROTECTION AND RESTORATION TOOLBOX



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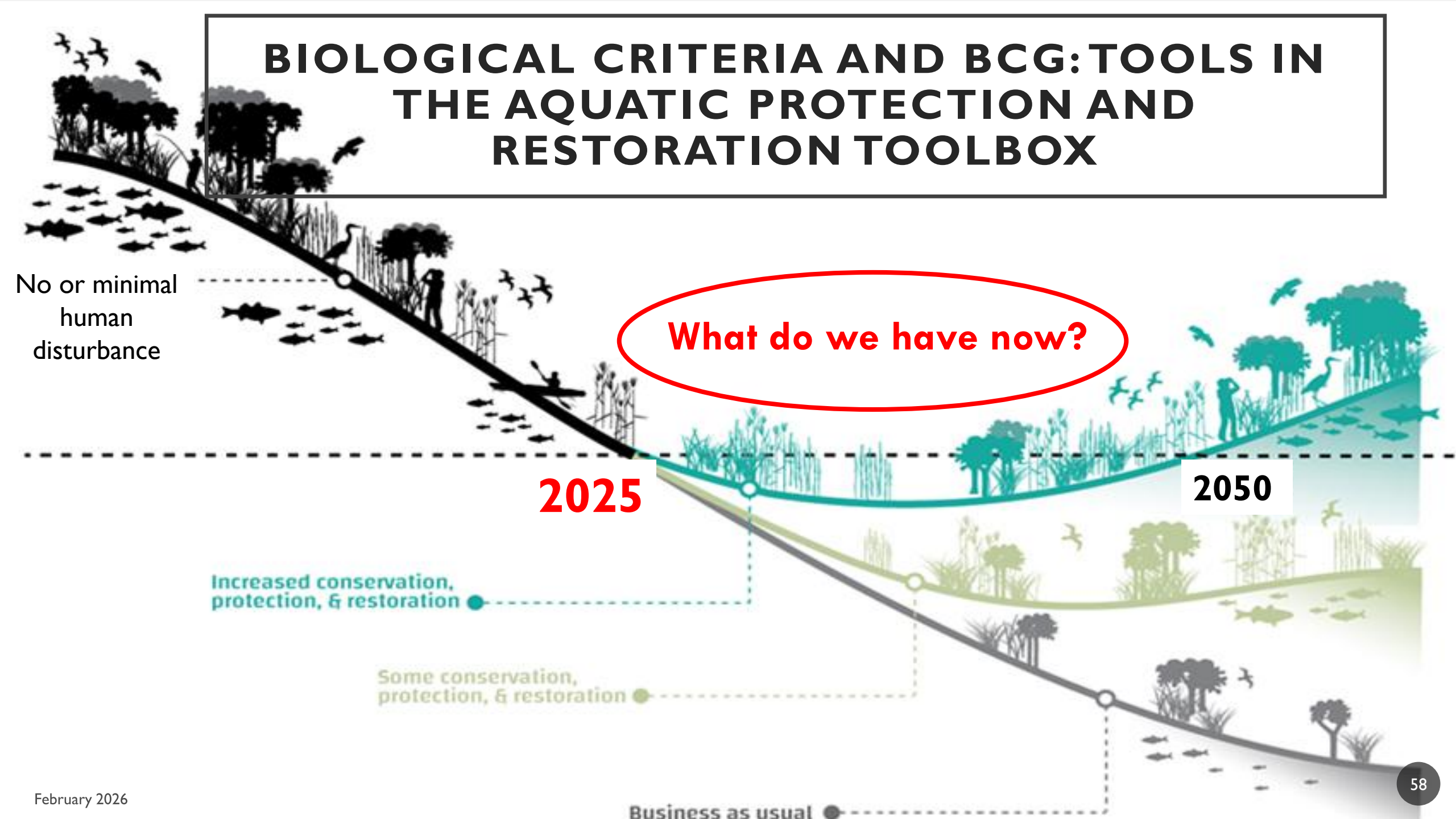

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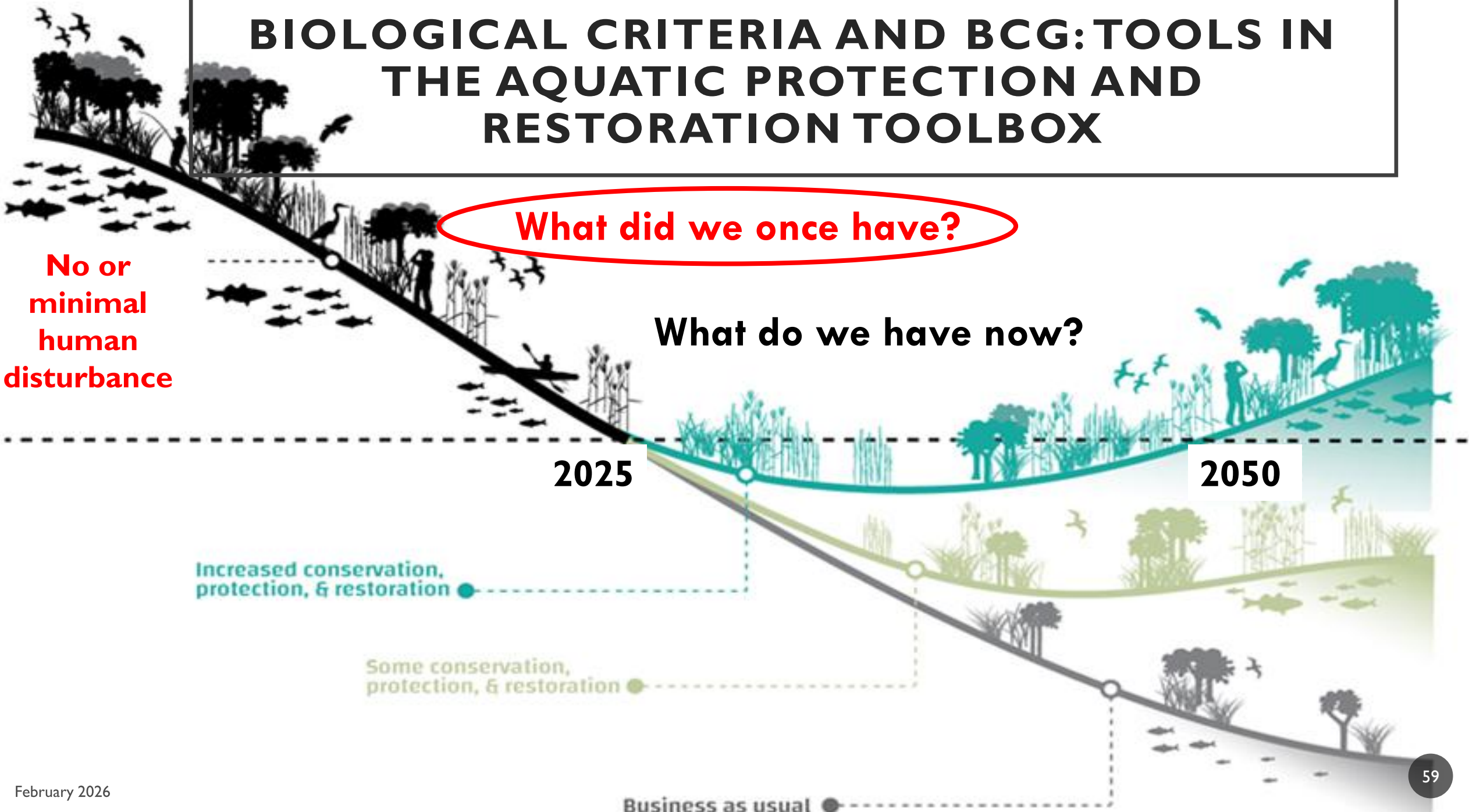

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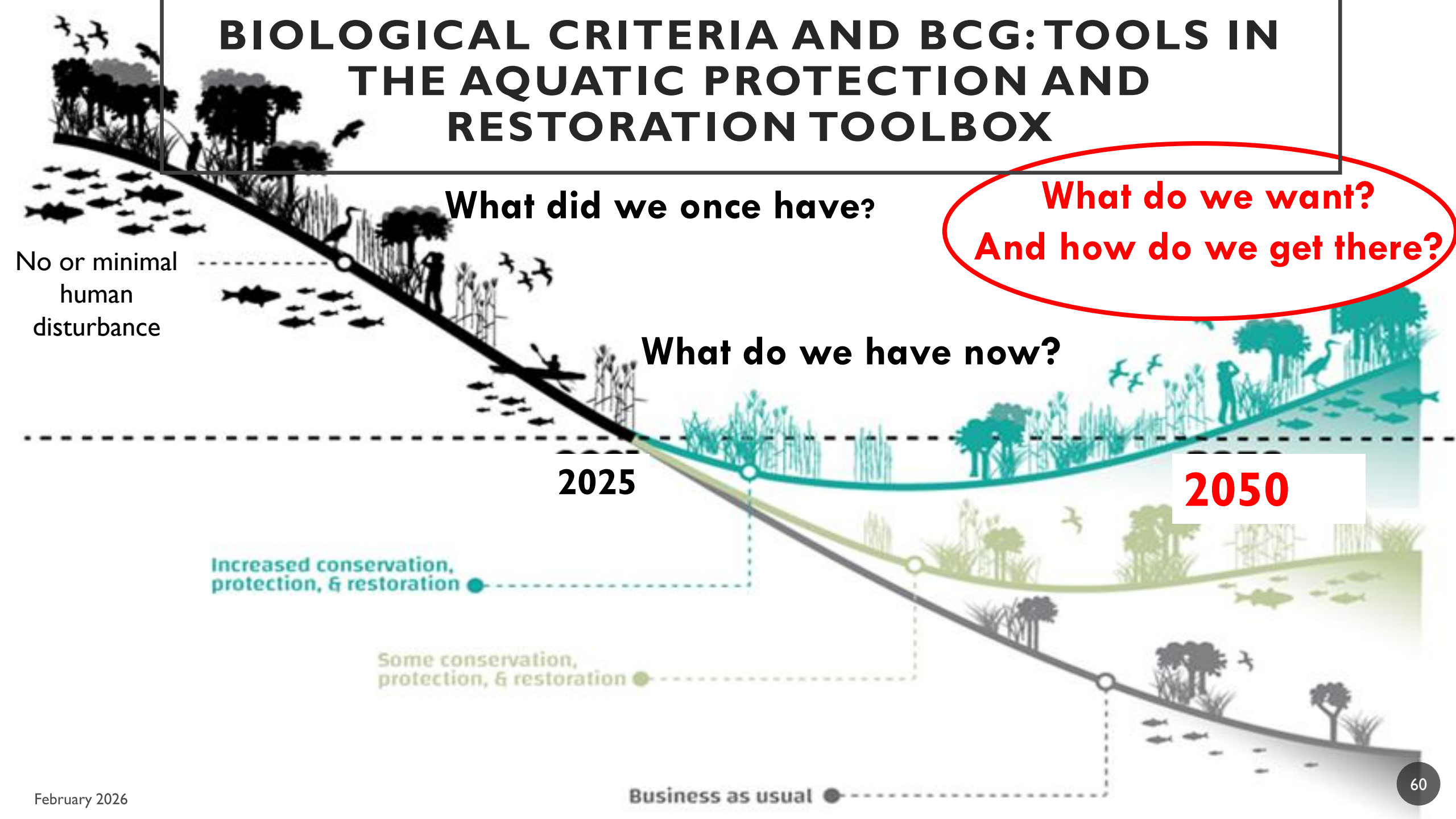
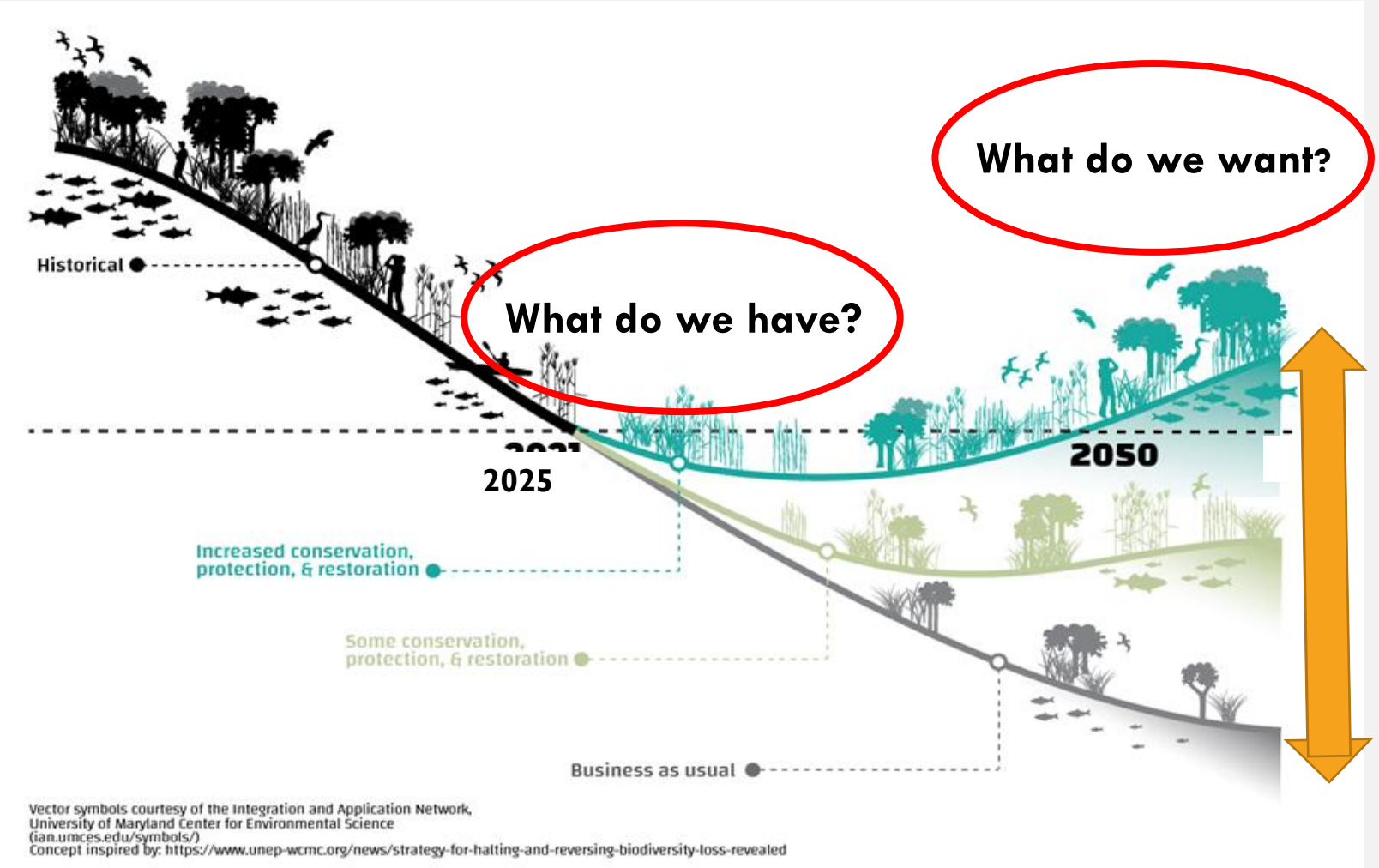


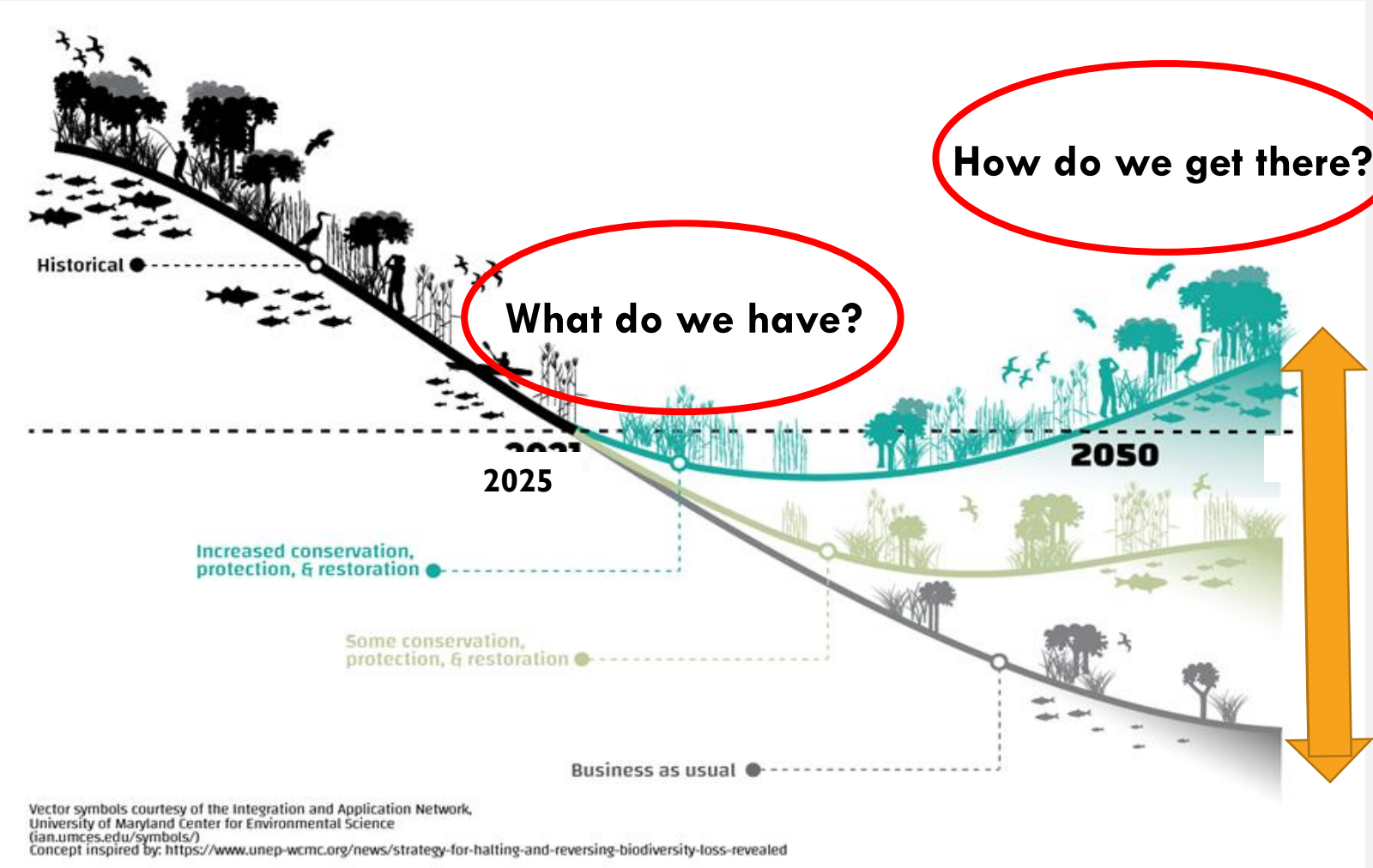
PAIRING BIOLOGICAL CONDITION WITH ECOSYSTEM SERVICES



Gains and losses:

- **outdoor experience (e.g., birdwatchers, kayakers, hikers)**
- **recreational fisheries**
- **commercial fisheries**
- **service industry**
- **property values**
- **city or county tax income**

COMPREHENSIVE TOOLBOX: STRESSOR ID, WQ CRITERIA, AND BMP



What is the cause of biological impairment?

What are management options?

How track progress?

WHAT DOES A BIOCRITERIA LOOK LIKE?

A GENERAL EXAMPLE

AQUATIC LIFE USES AND BIOCRITERIA

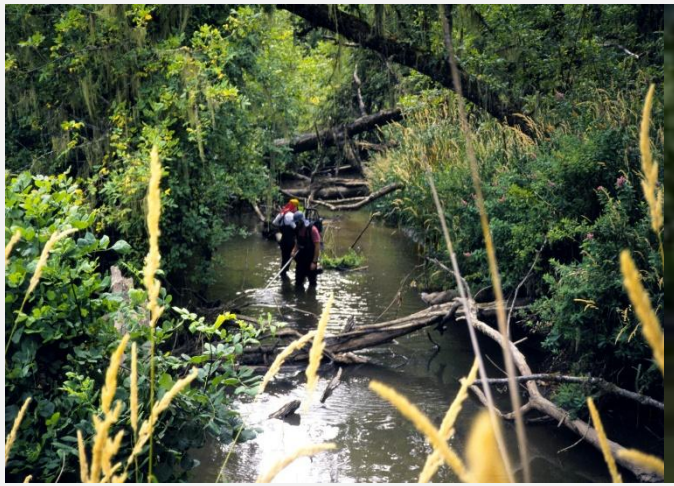
- Management Goals ideally developed for protection and restoration of aquatic life
  - General description of the expected biological characteristics of a waterbody
- Narrative descriptions/quantifiable thresholds

designated aquatic life uses

biocriteria

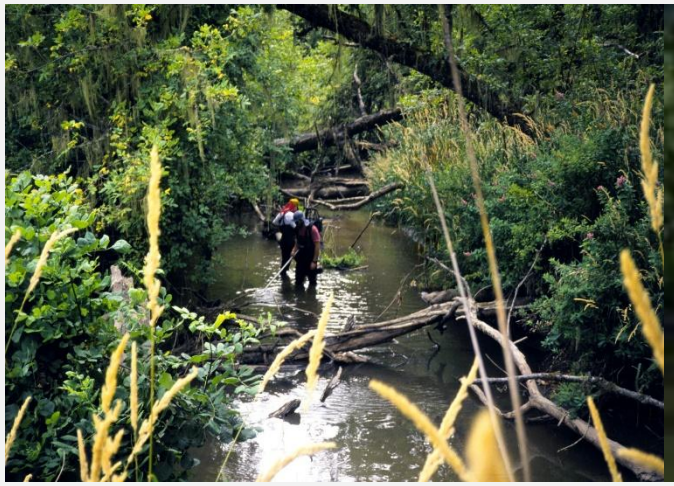
NARRATIVE BIOLOGICAL CRITERIA

Narrative Biocriteria - Written statement describing the structure and/or function of aquatic communities in a waterbody that support a given designated ALU (e.g., "as naturally occurs," "balanced community of taxa," lists of expected taxa and/or verbal description of type of aquatic community expected).



NUMERIC BIOLOGICAL CRITERIA

- Written statement describing the structure and/or function of aquatic communities in a waterbody that support a given designated ALU and with method for quantification cited.
- Specific quantitative measures (e.g., metrics) of desired level of biological condition for a given ALU designated.



EXAMPLE: DESIGNATED ALU

Minimal changes in structure of the biotic community - native taxa are maintained with some changes in biomass and/or abundance.

EXAMPLE: NARRATIVE BC

Narrative BC for cool-cold water streams (MW)

Overall taxa richness and density is as naturally occurs (e.g., moderate to high levels). Most sensitive taxa and native taxa are present and make up a significant fraction of the total richness and abundance.

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Numeric BC	Cool Water	Cold Water
# Total taxa	≥ 14 (11 – 16)	≥ 20 (16 – 24)
% Most sensitive taxa (Att I + II)	> 10% (7 – 13%)	> 5% (3 – 7%)
% Most sensitive individuals (Att I & II)	-	> 8% (6 – 10%)
% Sensitive taxa (Att II + III)	>30% (25 – 35%)	> 30% (25 – 30%)
% Sensitive individuals (Att II + III)	>30% (25 – 35%)	> 30% (25 – 30%)
% Most dominant tolerant taxa (Att V)	< 5% (3 – 7%)	-
% Sensitive EPT taxa (Att I + II + III)	> 10% (7 – 13%)	> 10% (7 – 13%)

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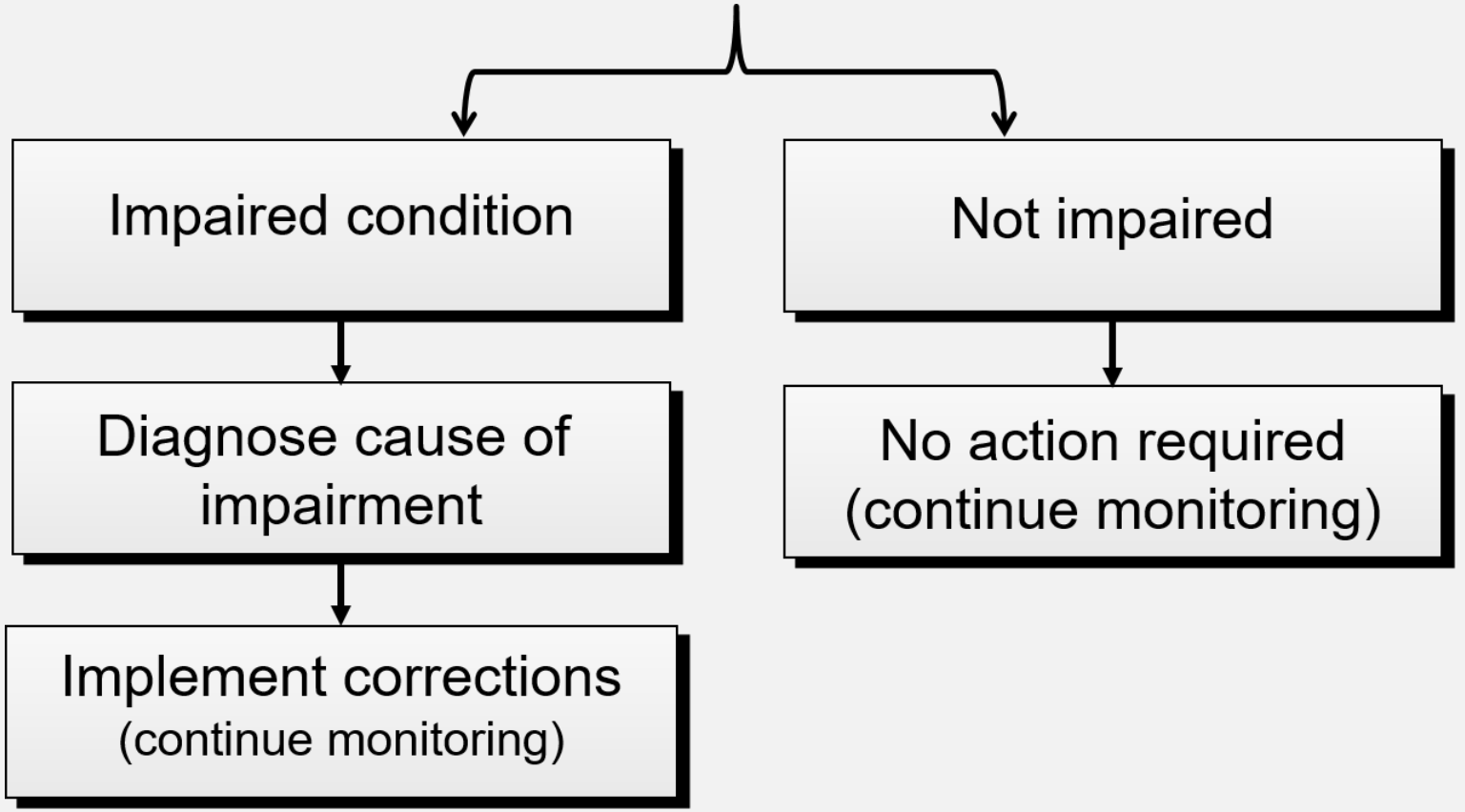
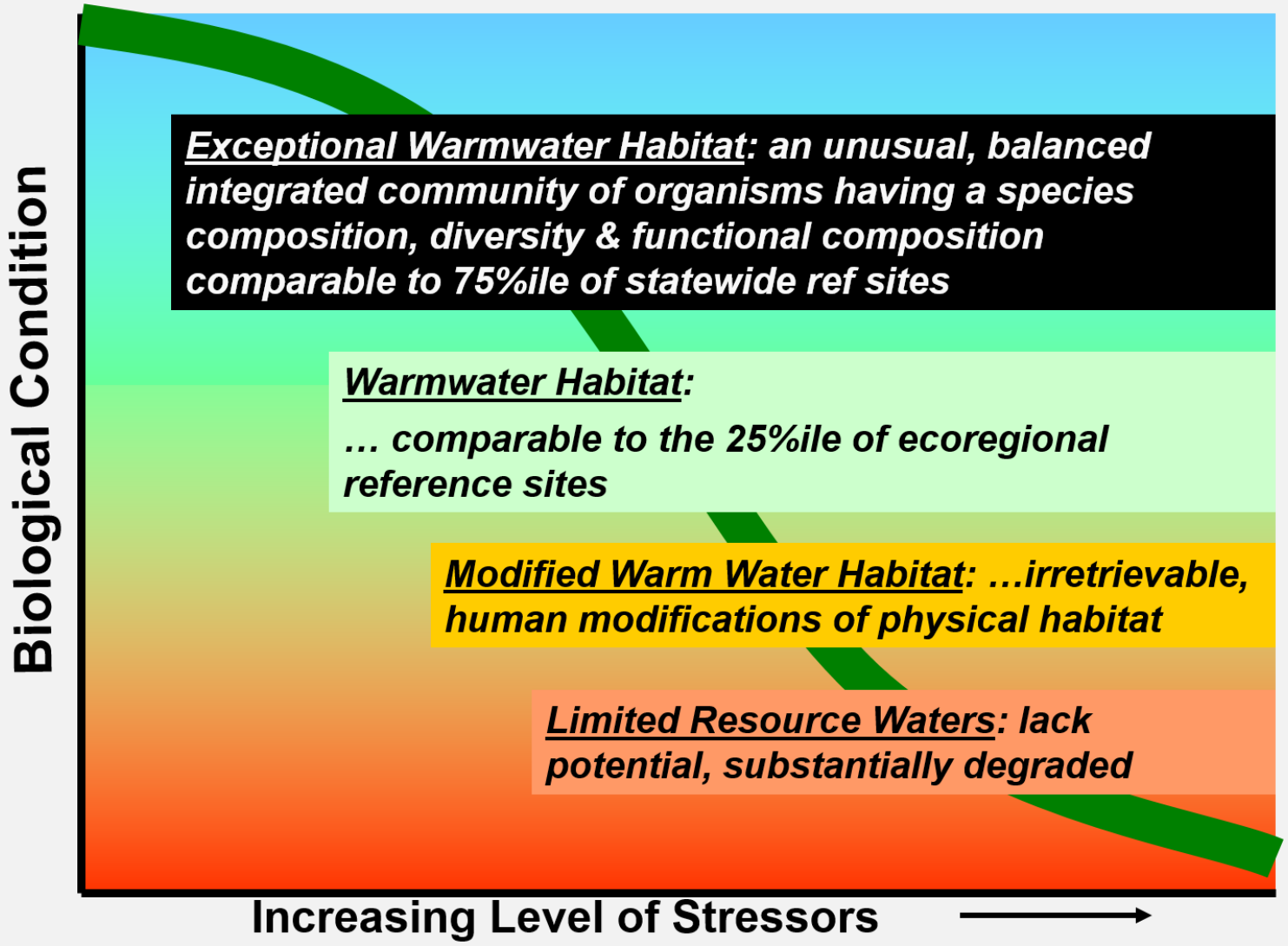
APPLYING BIOLOGICAL CRITERIA

Sample test sites and compare biocriteria

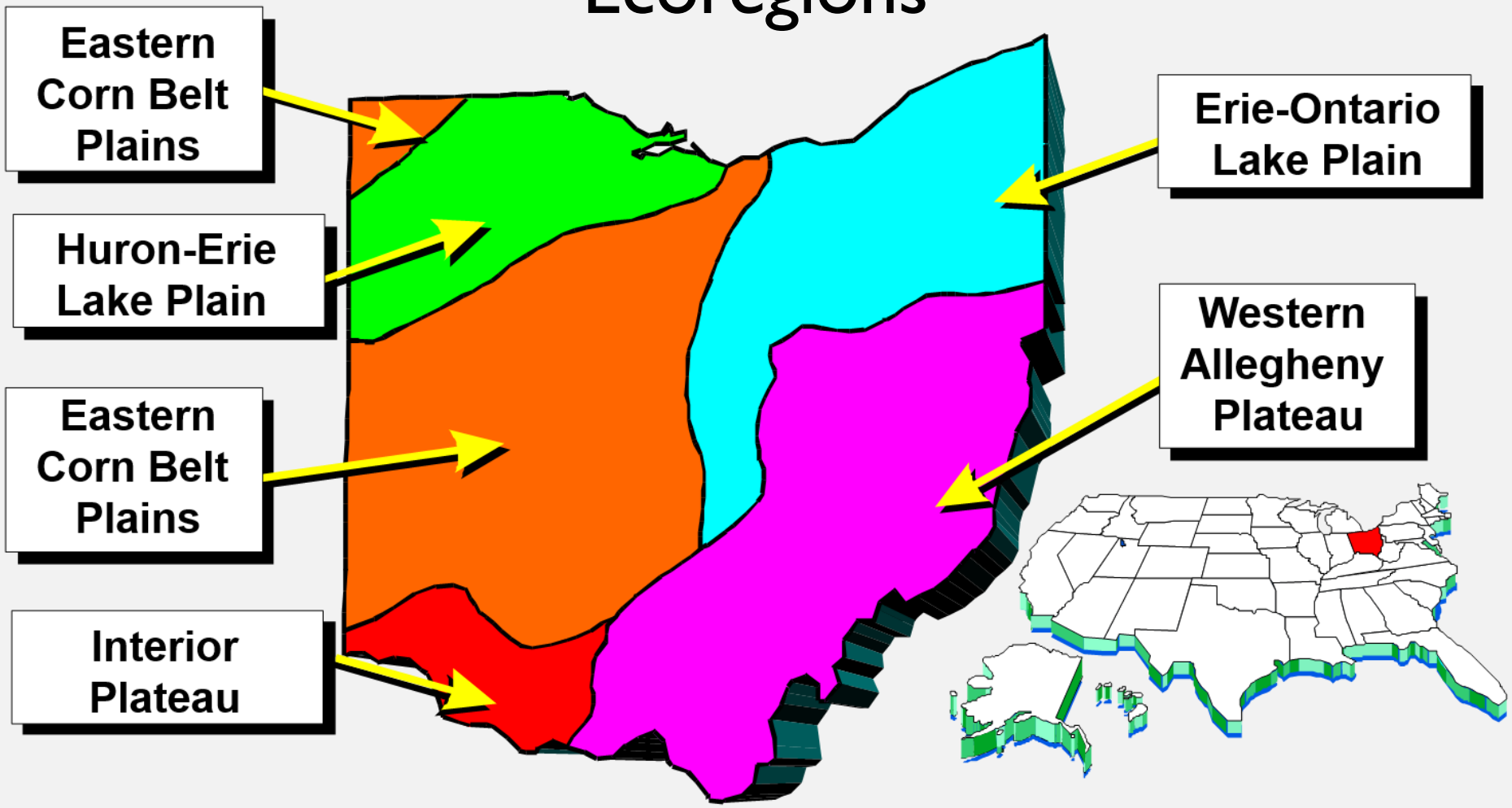


EXAMPLE: OHIO BIOLOGICAL STANDARDS



OHIO: CLASSIFICATION

Ecoregions



OHIO BIOLOGICAL CRITERIA

Benthic Invertebrates and Fish

Huron Erie Lake Plain (HELP)

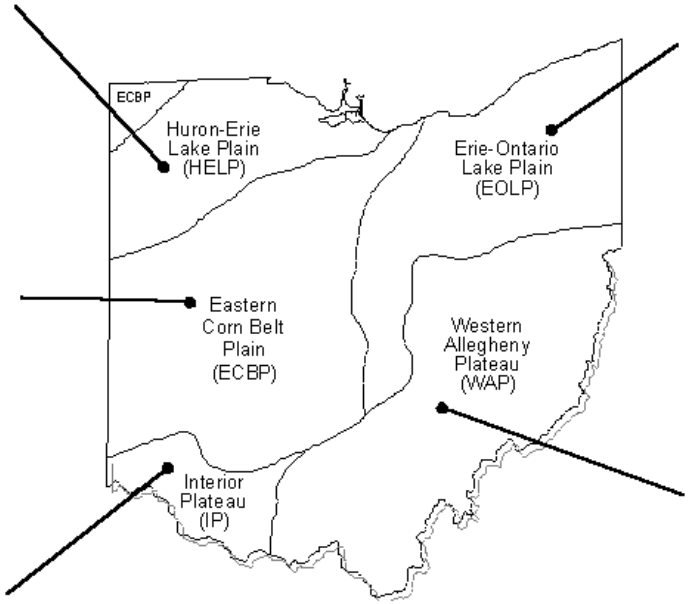
Use	Size	IBI	MIwb	ICI
WWH	H	28	NA	34
	W	32	7.3	34
	B	34	8.6	34
MWH-C	H	20	NA	22
	W	22	5.6	22
	B	20	5.7	22
MWH-I	B	30	5.7	NA

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

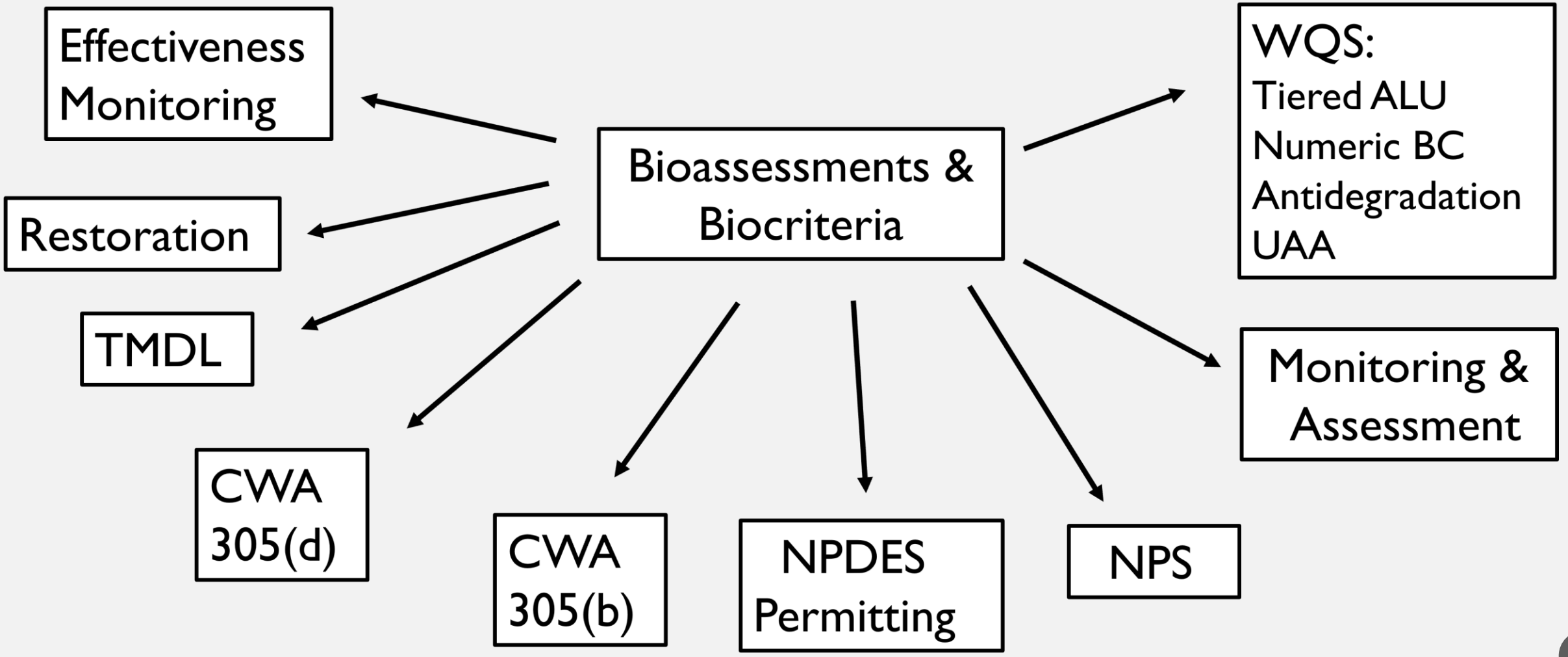
Western Allegheny Plateau (WAP)

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

Table 3 Narrative quality ranges of the Invertebrate Community Index (ICI) scaled to Level 3 ecoregions[2] in Ohio.

Narrative	Invertebrate Community Index (ICI) Range				
	Huron/Erie Lake Plains HELP (1)	Interior Plateau IP (2)	Erie/Ontario Lake Plains EOLP (3)	Western Allegheny Plateau WAP (4)	Eastern Corn Belt Plains ECBP (5)
Exceptional	46 - 60				
Very good	42 - 44				
Good	34 - 40	30 - 40	34 - 40	36 - 40	36 - 40
Marginally Good	30 - 32	26 - 28	30 - 32	32 - 34	32 - 34
Fair	22 - 28	22 - 24	22 - 28	22 - 30	22 - 30
Low Fair	14 - 20				
Poor	8 - 12				
Very Poor	0 - 6				

OHIO APPLICATION



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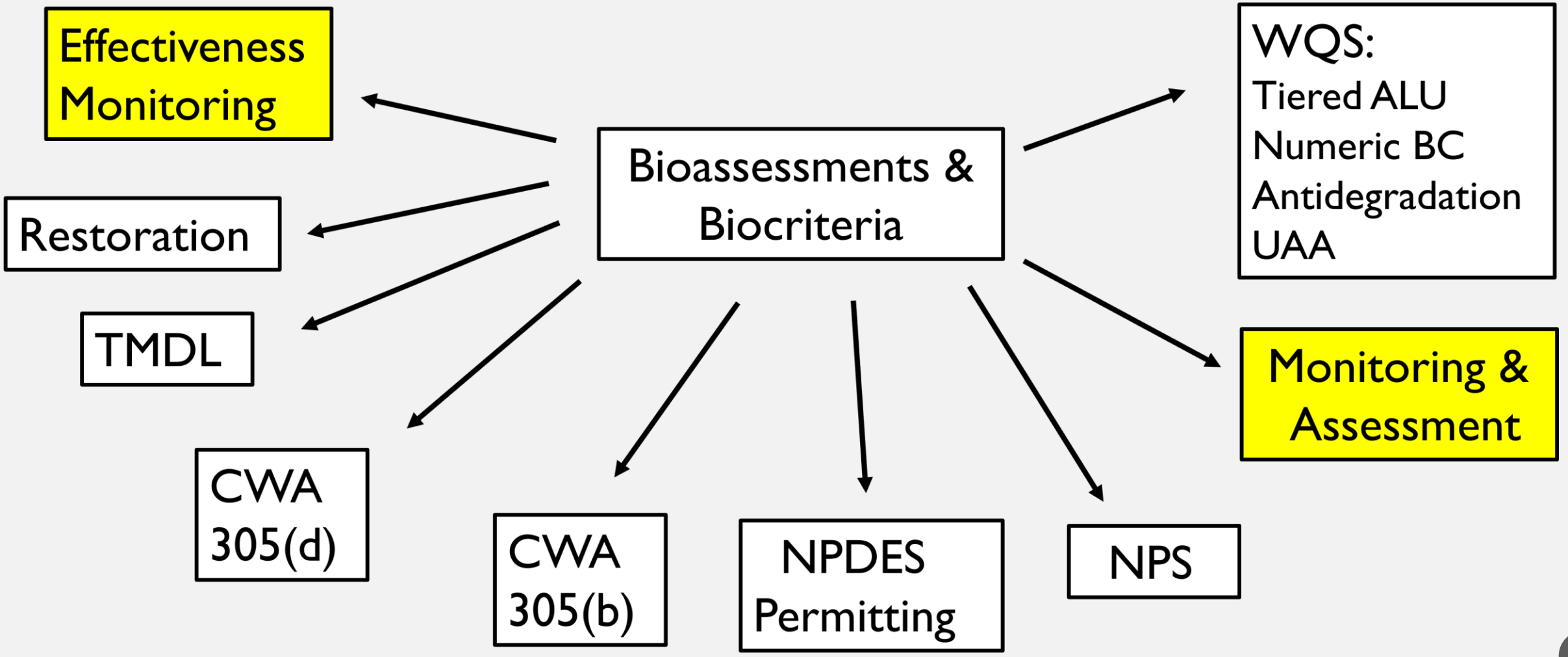

ANY QUESTIONS?

Susan Jackson

US EPA Biological Criteria Program

Jackson.Susank@epa.gov

REFERENCES AND INFORMATION

EPA Biological Criteria

https://www.epa.gov/wqc/biological-water-quality-criteria

Summary Info: Stream bioassessment and biocriteria programs

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