National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs

Coeur d'Alene, Idaho
31 March – 4 April, 2003

BIO 101

INTRODUCTION TO BIOLOGICAL ASSESSMENTS & CRITERIA

Course Presenters

William Swietlik, Michael Barbour, Chris Yoder

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BIO 101

Introduction

Presented by

William Swietlik, USEPA
Office of Science & Technology

Take Home Concepts

The Basics:

- What are biological assessments and criteria.
- How they are derived.
- How they fit into water quality standards.
- How they can be used in water quality management.

THEME

“The true health of our aquatic environments is reflected by the biological communities that reside within them”

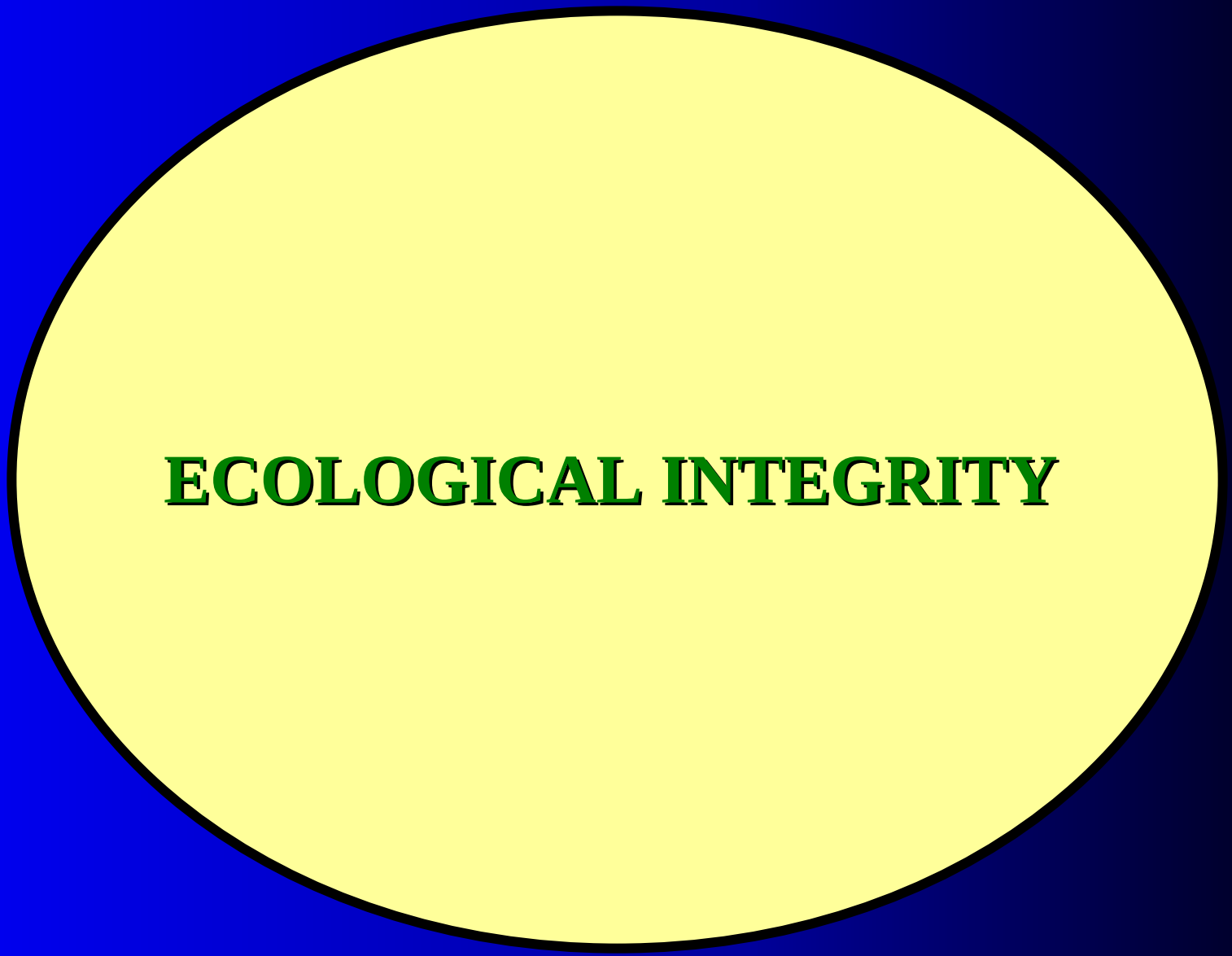
Prof. J. Karr

University of Washington

CWA SECTION 101 Objective

To Restore & Maintain the Chemical, Physical, & *Biological Integrity* of the Nation's Waters

Elements of Ecological Integrity

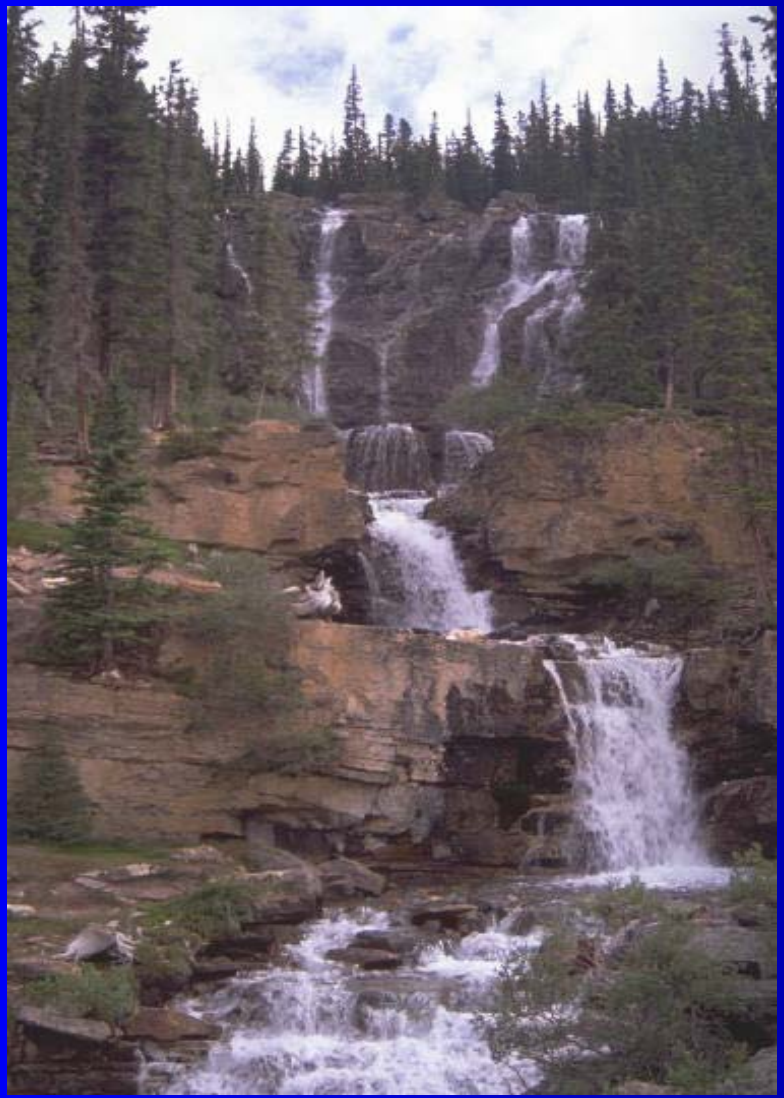


BIOLOGICAL INTEGRITY

Definition:

The ability of an aquatic ecosystem to support and maintain a balanced adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region.

STATUTORY AUTHORITY



Section 303(c)2(B):

"...where numeric criteria are not available, States shall adopt criteria based on biological.. assessment methods…"

STATUTORY AUTHORITY

Section 303(c)2(A):

...State water quality standards shall consist of designated uses of navigable waters and the criteria for protecting such uses.

...State water quality standards shall protect and enhance the quality of water and serve the purposes of the Act, including propagation of fish and wildlife.

THE LINKAGE FROM STRESSOR EFFECTS TO ECOSYSTEM RESPONSE

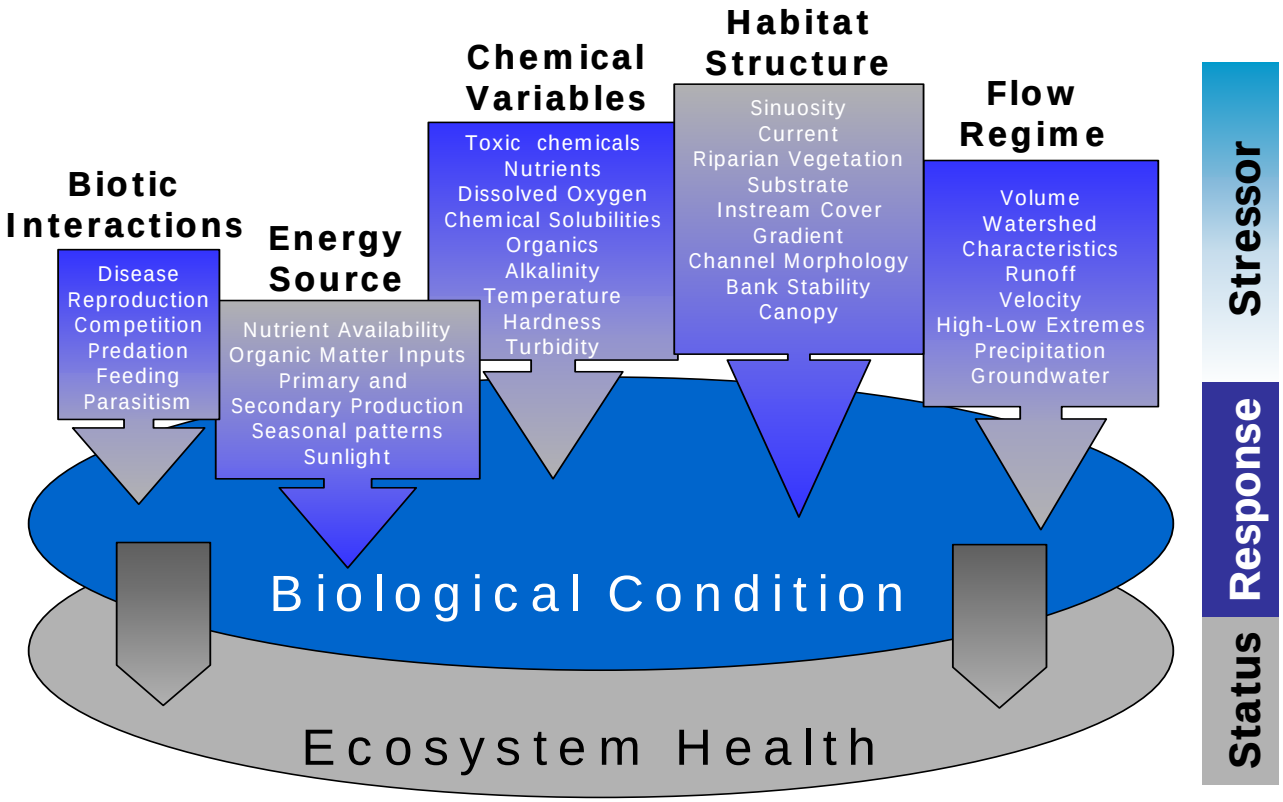


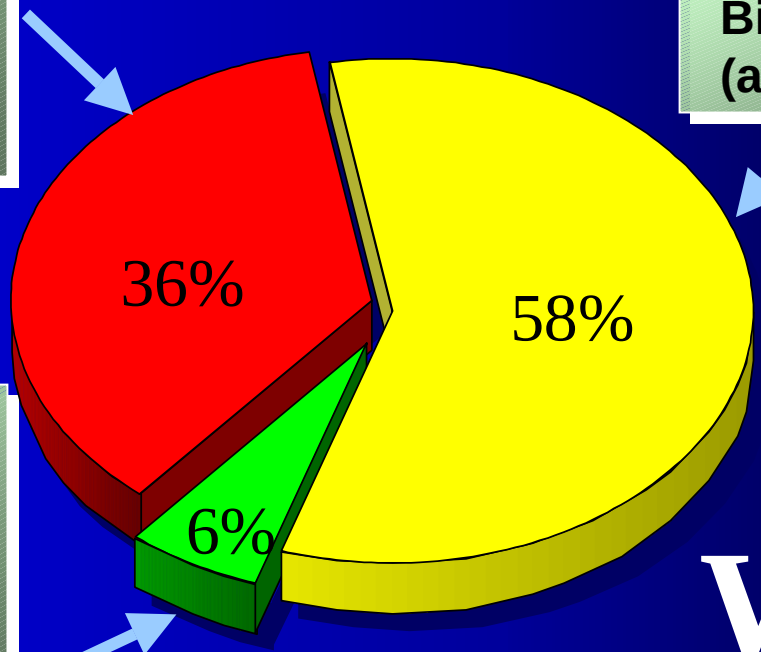
Figure 1. Five classes of environmental variables that affect water resource integrity and overall biological condition (modified from Karr et al. 1986).

VALUE OF BIOLOGICAL CRITERIA:
Ohio Comparison of Biosurvey with Chemical Evaluation

Chemical Evaluation Indicates No Impairment

Biosurvey Shows Impairment

Chemical Prediction & Biosurvey Agree (about status only)



Biosurvey Shows No Impairment

Chemical Evaluation Indicates Impairment

WHY?

BIOASSESSMENT

Definition:

An evaluation of the biological condition of a water body using biological surveys of the structure and function of the community of resident biota.

BIOLOGICAL CRITERIA (Biocriteria- in Standards Sense)

Definition: ***narrative descriptions or numerical values of the structure and function of aquatic communities in a water body necessary to protect the designated aquatic life use, implemented in, or through water quality standards.***

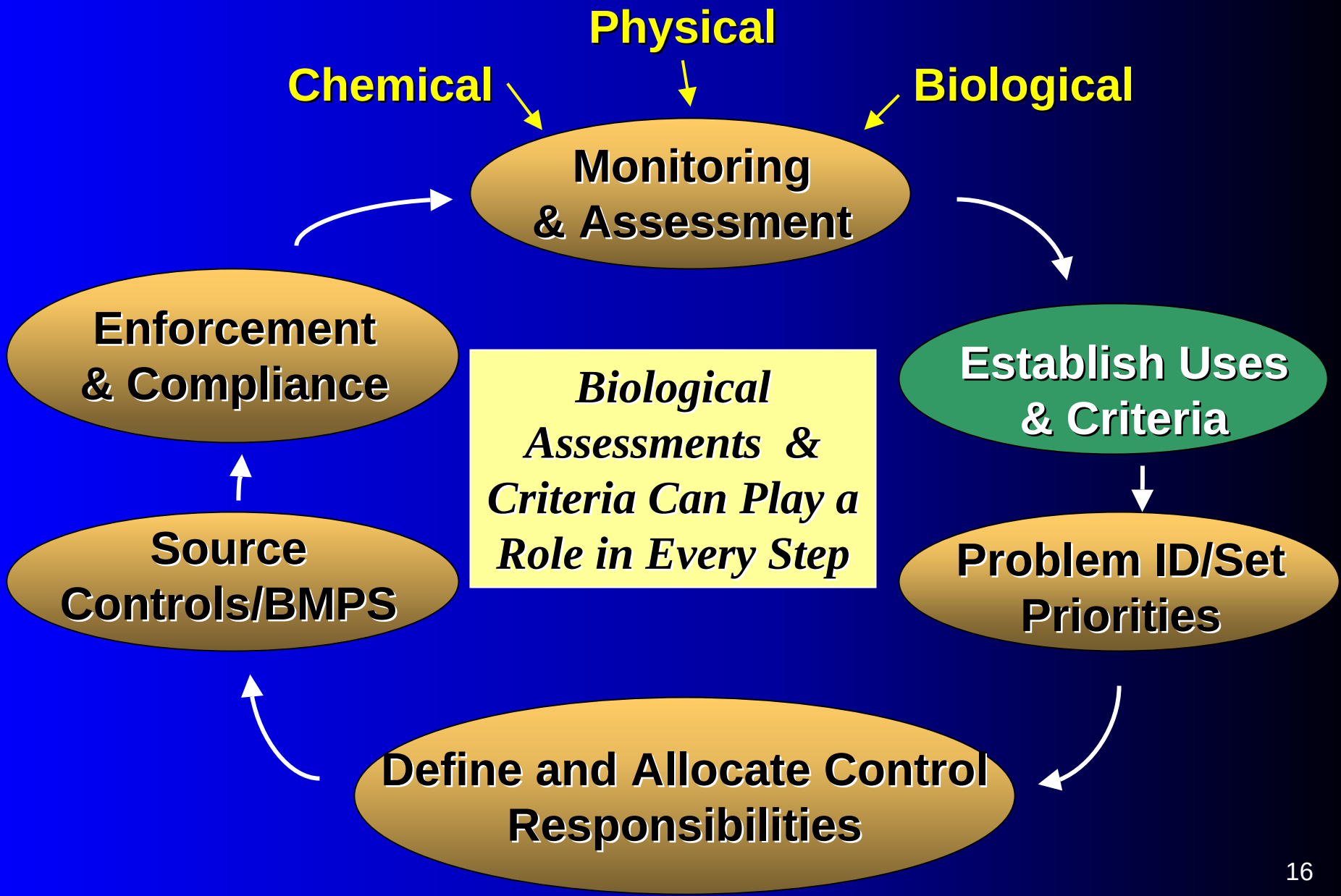
NARRATIVE AND NUMERIC BIOCRITERIA

- ***Narrative Biocriteria***- General Statements of the Structure and Function of Aquatic Communities in a Water Body Necessary to Protect the Designated Aquatic Life Use.
- ***Numeric Biocriteria***- Specific Quantitative Measures of the Structure and Function of Aquatic Communities in a Water Body Necessary to Protect the Designated Aquatic Life Use.

Other Meaning

- **Biocriteria– (scientific)** ***quantified values representing the biological condition of a water body as measured by structure and function of the aquatic communities typically at reference condition.***

CWA WATER PROGRAM



TYPICAL APPROACHES TO BIOCRITERIA DEVELOPMENT

✓***Multimetric Index:*** a number that integrates one or more biological metrics to express a site's condition or health. (IBI).

✓***Multivariate Predictive Model:*** a predicted value of the biological condition based on what is observed at a site versus what is expected. (RIVPACS)

✓***Discriminant Models:*** based on aquatic life use classes

MULTIMETRIC APPROACH

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. ***Index of Biotic Integrity (IBI).***

MEASURES OF COMMUNITY STRUCTURE AND FUNCTION (Metrics)

- ✓ Species Richness
- ✓ Tolerant/Intolerant Species
- ✓ Distribution of Trophic Feeding Groups
- ✓ Diseases and Anomalies
- ✓ Number of Individuals
- ✓ Non-native Species
- ✓ Reproductive Preferences
- ✓ Total Number of Species
- ✓ Mean Individual Size Measurement
- ✓ Biomass

PROCESS FOR DEVELOPING & IMPLEMENTING BIOLOGICAL CRITERIA

DEVELOPING BIOCRITERIA (Multimetric approach)

1. Select Standardized, Consistent Biosurvey Protocols
2. Classify Water Bodies into Similar Groups or Classes
3. Identify Reference Sites in Each Class
4. Conduct Bioassessments at Unimpaired Reference Sites in Each Class
5. Derive Reference Conditions for Each Class
6. Conduct Bioassessments at Impacted Sites

DEVELOPING BIOCRITERIA

7. Test Attributes for Response to Gradient of Conditions
8. Select Responsive Metrics
9. Develop Scoring Criteria for Each Metric
10. Aggregate Metrics With Scoring Criteria to Derive Biocriteria Index
11. Develop Biocriteria for each Aquatic Life Use
12. Apply Biocriteria to Water Bodies to Protect Those Uses

Review Fish IBI Metrics for North America and Karr IBI

Multivariate Approach – (RIVPACS)

Figure out which taxa you should probably capture = E

Compare to what you actually observe = O

The final measure = percent of expected taxa present

= O / E

Steps in the Multivariate Process

1. Describe the continuum of assemblage types using ‘reference’ streams
2. Link assemblage types to physical-chemical features
3. Predict expected (E) assemblage of a test stream based on physical appearance
4. Compare to the observed (O) assemblage
5. O/E provides a simple measure

KEY COMPONENTS OF BIOLOGICAL CRITERIA

- ✓ **Biological Surveys**
- ✓ **Classification**
- ✓ **Reference Condition**

KEY COMPONENTS OF BIOLOGICAL CRITERIA

Biological Surveys

SELECTING COMMUNITY COMPONENTS

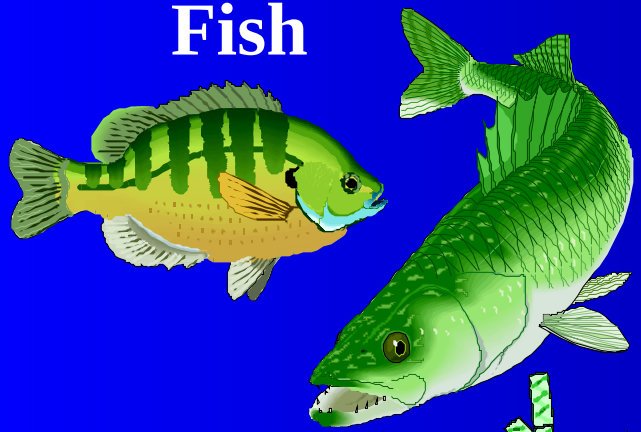
Target Species & Taxa

- ✓ **Serve as Effective Indicators of Biological Response to Effects of Human Activity**
- ✓ **Represent a Range of Pollution Tolerances**
- ✓ **Provide Predictable, Repeatable Results**
- ✓ **Are Readily Identifiable by State Personnel**

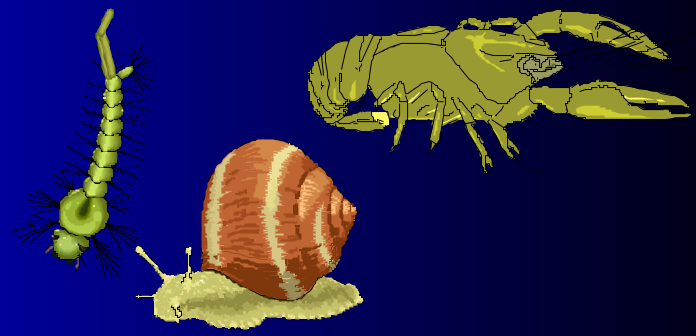
COMMUNITY COMPONENTS

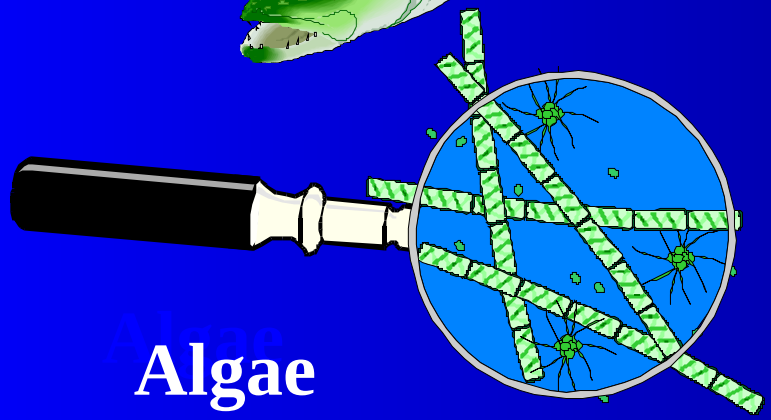
Streams, Small Rivers, Lakes, Estuaries

Fish



Macroinvertebrates





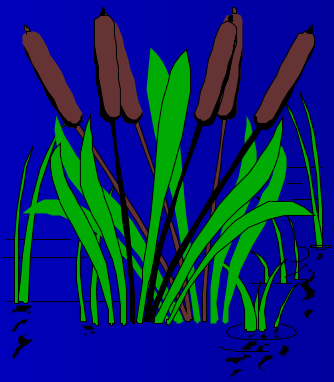
Algae

Zooplankton

COMMUNITY COMPONENTS

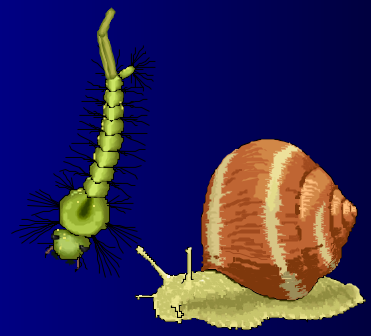
Wetlands

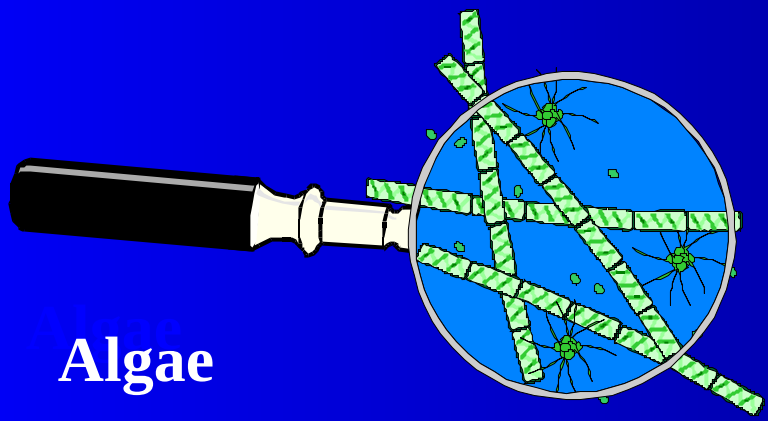
Birds



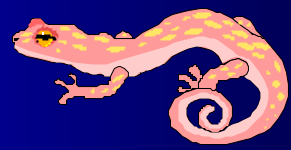
Vascular Plants

Macroinvertebrates





Algae



Amphibians

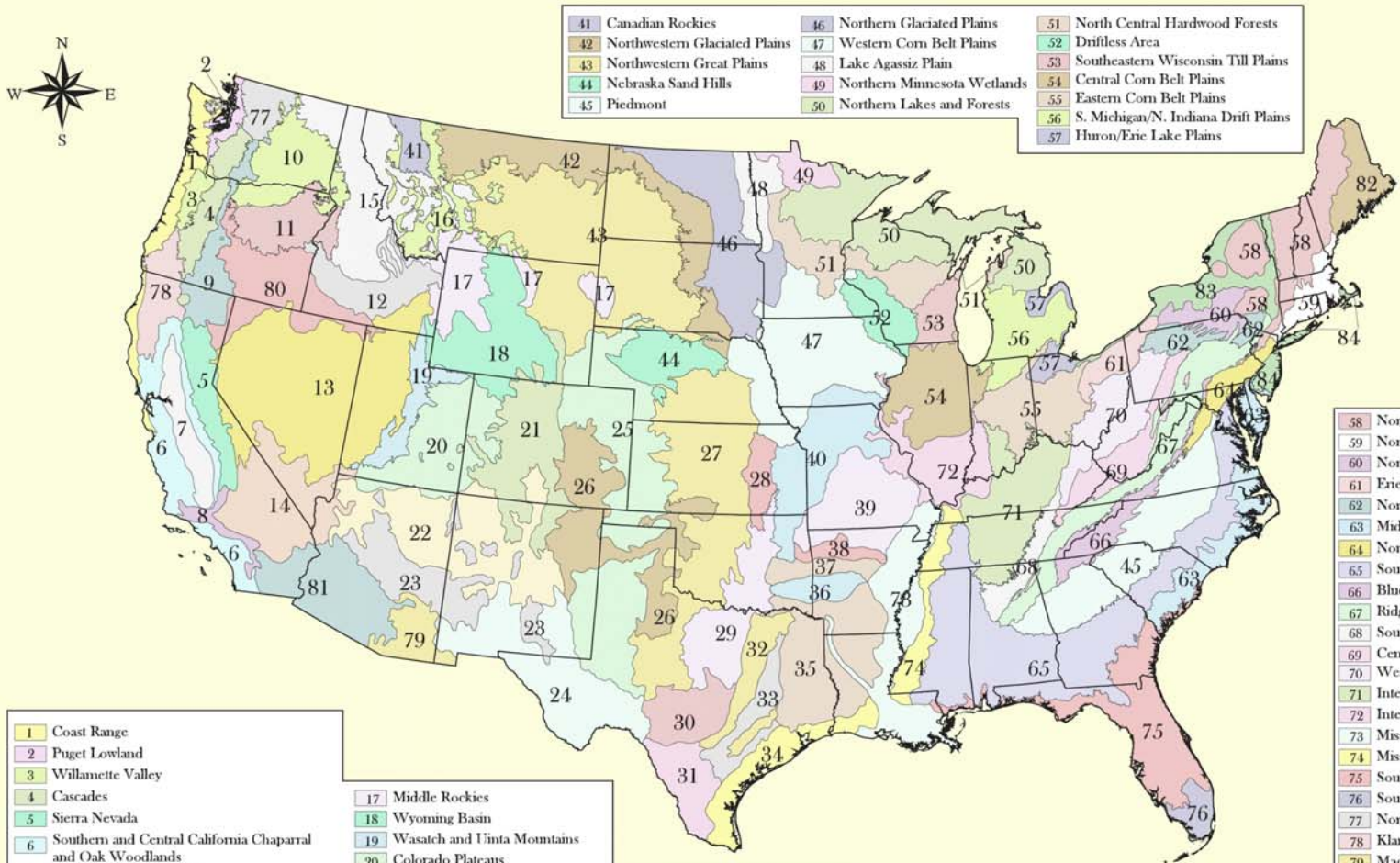
Bioassessment -- Streams and Small Rivers

Invertebrate community bioassessment using a kicknet

CLASSIFICATION

- ✓ **Identifies Regions of Ecological Similarity from Which To Select Reference Sites.**
- ✓ **Biological Conditions Expected to be Similar.**

Level III Ecoregions of the United States



41 Canadian Rockies
42 Northwestern Glaciated Plains
43 Northwestern Great Plains
44 Nebraska Sand Hills
45 Piedmont
46 Northern Glaciated Plains
47 Western Corn Belt Plains
48 Lake Agassiz Plain
49 Northern Minnesota Wetlands
50 Northern Lakes and Forests
51 North Central Hardwood Forests
52 Driftless Area
53 Southeastern Wisconsin Till Plains
54 Central Corn Belt Plains
55 Eastern Corn Belt Plains
56 S. Michigan/N. Indiana Drift Plains
57 Huron/Erie Lake Plains

1 Coast Range
2 Puget Lowland
3 Willamette Valley
4 Cascades
5 Sierra Nevada
6 Southern and Central California Chaparral and Oak Woodlands
7 Central California Valley
8 Southern California Mountains
9 Eastern Cascades Slopes and Foothills
10 Columbia Plateau
11 Blue Mountains
12 Snake River Basin
13 Central Basin and Range
14 Mojave Basin and Range
15 Northern Rockies
16 Montana Valley and Foothill Prairies
17 Middle Rockies
18 Wyoming Basin
19 Wasatch and Uinta Mountains
20 Colorado Plateaus
21 Southern Rockies
22 Arizona/New Mexico Plateau
23 Arizona/New Mexico Mountains
24 Chihuahuan Deserts
25 Western High Plains
26 Southwestern Tablelands
27 Central Great Plains
28 Flint Hills
29 Central Oklahoma/Texas Plains
30 Edwards Plateau
31 Southern Texas Plains
32 Texas Blackland Prairies
33 East Central Texas Plains
34 Western Gulf Coastal Plain
35 South Central Plains
36 Ouachita Mountains
37 Arkansas Valley
38 Boston Mountains
39 Ozark Highlands
40 Central Irregular Plains

58 Northeastern Highlands
59 Northeastern Coastal Zone
60 Northern Appalachian Plateau and Uplands
61 Erie Drift Plains
62 North Central Appalachians
63 Middle Atlantic Coastal Plain
64 Northern Piedmont
65 Southeastern Plains
66 Blue Ridge
67 Ridge and Valley
68 Southwestern Appalachians
69 Central Appalachians
70 Western Allegheny Plateau
71 Interior Plateau
72 Interior River Lowland
73 Mississippi Alluvial Plain
74 Mississippi Valley Loess Plains
75 Southern Coastal Plain
76 Southern Florida Coastal Plain
77 North Cascades
78 Klamath Mountains
79 Madrean Archipelago
80 Northern Basin and Range
81 Sonoran Basin and Range
82 Laurentian Plains and Hills
83 Eastern Great Lakes and Hudson Lowlands
84 Atlantic Coastal Pine Barrens

Source:
Corvallis Environmental Research Laboratory
U.S. EPA

0 300 600 900 1200 Miles

EPA R3 GIS Team SIG 777 Bob Walker 6/26/2000 Map 1189

REFERENCE CONDITION

The benchmark for determining biological conditions.

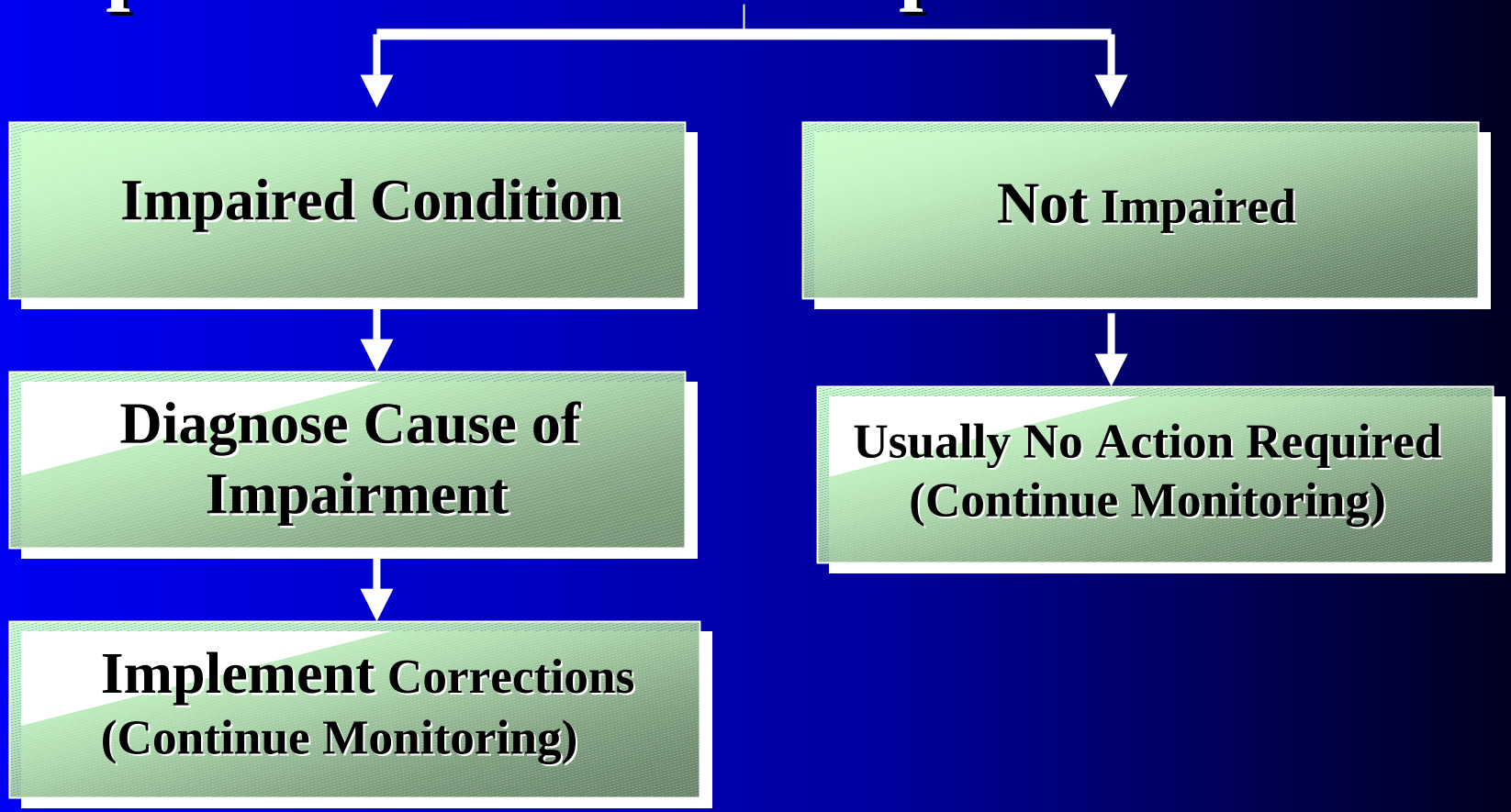
- **Regional Reference Sites**
- **Site-Specific Reference Sites**
- **Historical Data**
- **Model-Based Approach**
- **Expert Opinion**

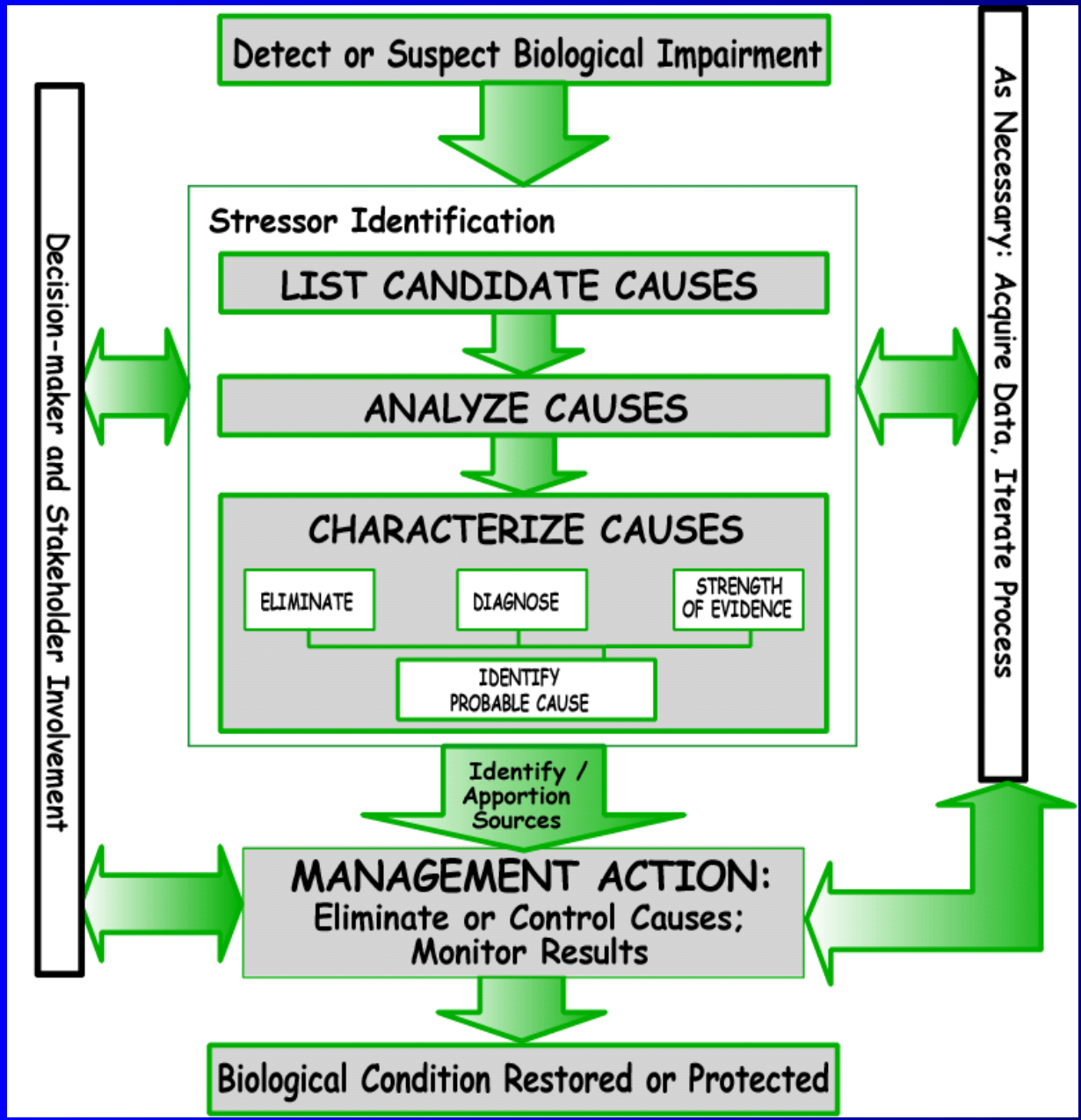
Review Examples of Narrative Biocriteria

Review Examples of Numeric Biocriteria

APPLYING BIOCRITERIA

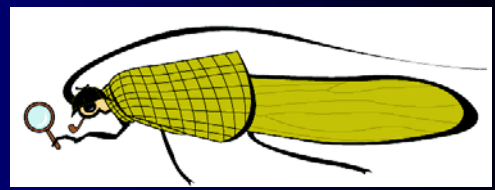
Sample test sites and compare to biocriteria





Stressor Identification

Identifying Unknown causes of biological impairment



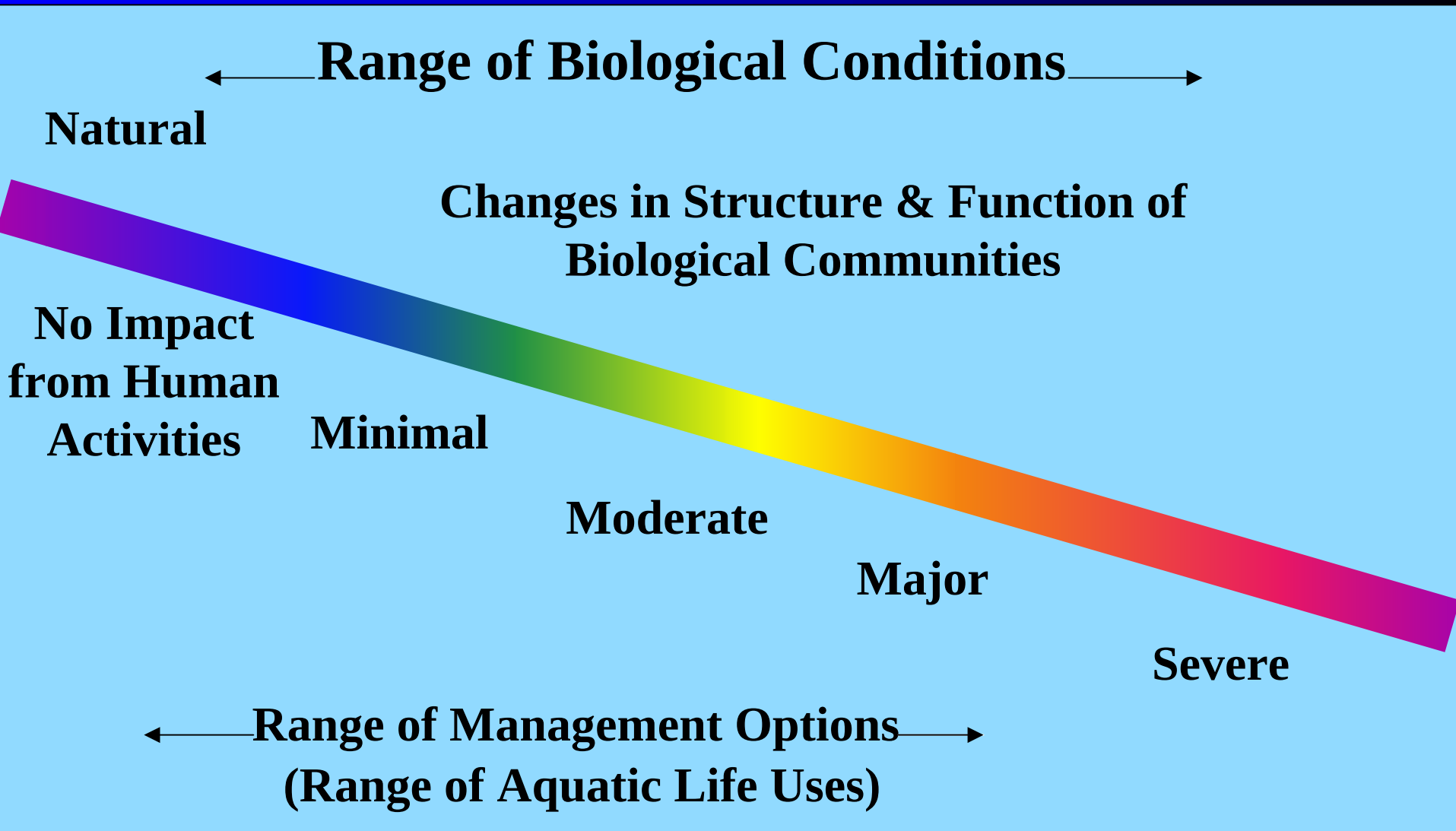
APPLYING BIOCRITERIA IN WATER QUALITY STANDARDS

Biological Assessments and Criteria Can Be Used to Better Define and Protect Aquatic Life Uses

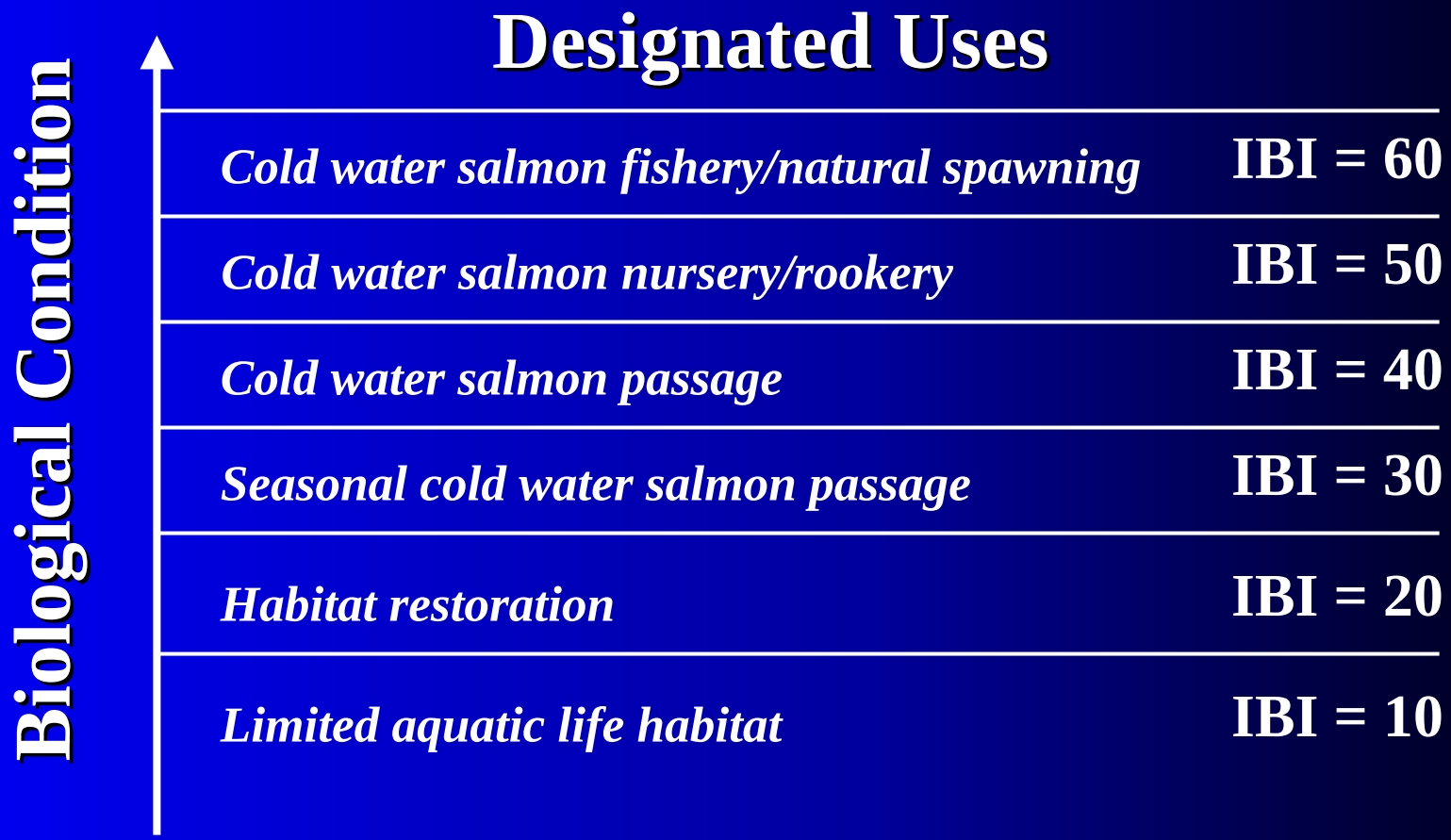
- **"*Bioassessment-based*" designated uses can be subcategorized (or tiered) according to reference conditions, restoration potential, human disturbance and management objectives.**

- **Once *bioassessment-based* designated uses are established, they can be protected by biocriteria.**

BIOLOGICAL INTEGRITY AND DESIGNATED USES



Hypothetical Subcategorized Biologically-Based Aquatic Life Uses



PROGRAM GOALS

✓All States use bioassessments to **evaluate the health** of aquatic life in all waterbodies

✓Bioassessment data is used to **better define aquatic life uses**

✓**Quantifiable biocriteria** are in all State/Tribal water quality standards to protect aquatic life uses

✓Biocriteria/bioassessments used to **assess the effectiveness of water quality management efforts**

✓Bioassessment data and biocriteria used to better **communicate the health** of the Nation's waters

FUTURE DIRECTIONS

- Great Rivers
- Coral Reefs
- Great Lakes
- Intermittent and ephemeral streams