

Applying Tiered Aquatic Life Uses and the Biological Condition Gradient Model to Maine Wetlands

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Biological Monitoring Program
Maine Department of
Environmental Protection



Maine DEP Biological Monitoring Program

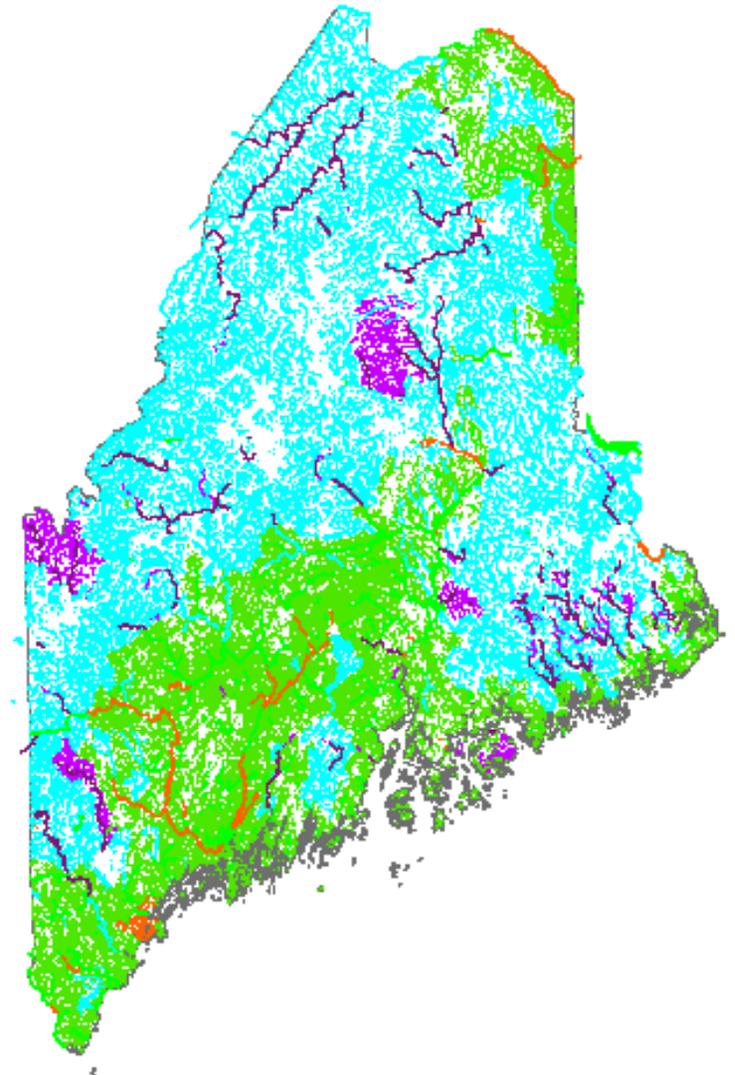
- Resides within State water quality assessment program
- Integrated approach for rivers, streams and freshwater wetlands
- Determines if water bodies are attaining aquatic life criteria
- Provides data and technical support to other programs

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Maine's Water Classification Law

- State legislature established management classes (**AA**, **A**, **B**, & **C**) and goals (**designated uses**) for fresh surface waters.
- Lakes and estuarine/marine waters have separate classes (not displayed).
- Wetlands assume class of associated water body
- Each class has water quality criteria, including **aquatic life criteria** (biomonitoring program focus)



Narrative Tiered Aquatic Life Criteria

Class Lakes and ponds

GPA Habitat natural. Stable or decreasing trophic state free of culturally induced algal blooms.

Other fresh surface waters

AA Habitat natural and free flowing. Aquatic life as naturally occurs.

A Habitat natural. Aquatic life as naturally occurs.

B Habitat unimpaired. Must support all indigenous aquatic species. No detrimental changes to resident biological community.

C Must support all indigenous fish species and maintain structure and function of resident biological community.

Aquatic Life Use Attainment Determinations

Lakes and ponds:

- **Trophic state indicators** - chlorophyll a, secchi disk transparency, total phosphorus, color)

Rivers and Streams (lotic habitats):

- **Benthic macroinvertebrates** - numeric biocriteria based on linear discriminant model, Maine DEP Rule Chapter 579 (predicts aquatic life use attainment)
- **Algae** - narrative criteria and provisional linear discriminant model

Aquatic Life Use Attainment Determinations for Wetland Habitats

- **Aquatic macroinvertebrates** – Professional judgment used to interpret narrative criteria based on provisional data analysis
 - Statistical model under development to predict wetland class attainment
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Data Collection

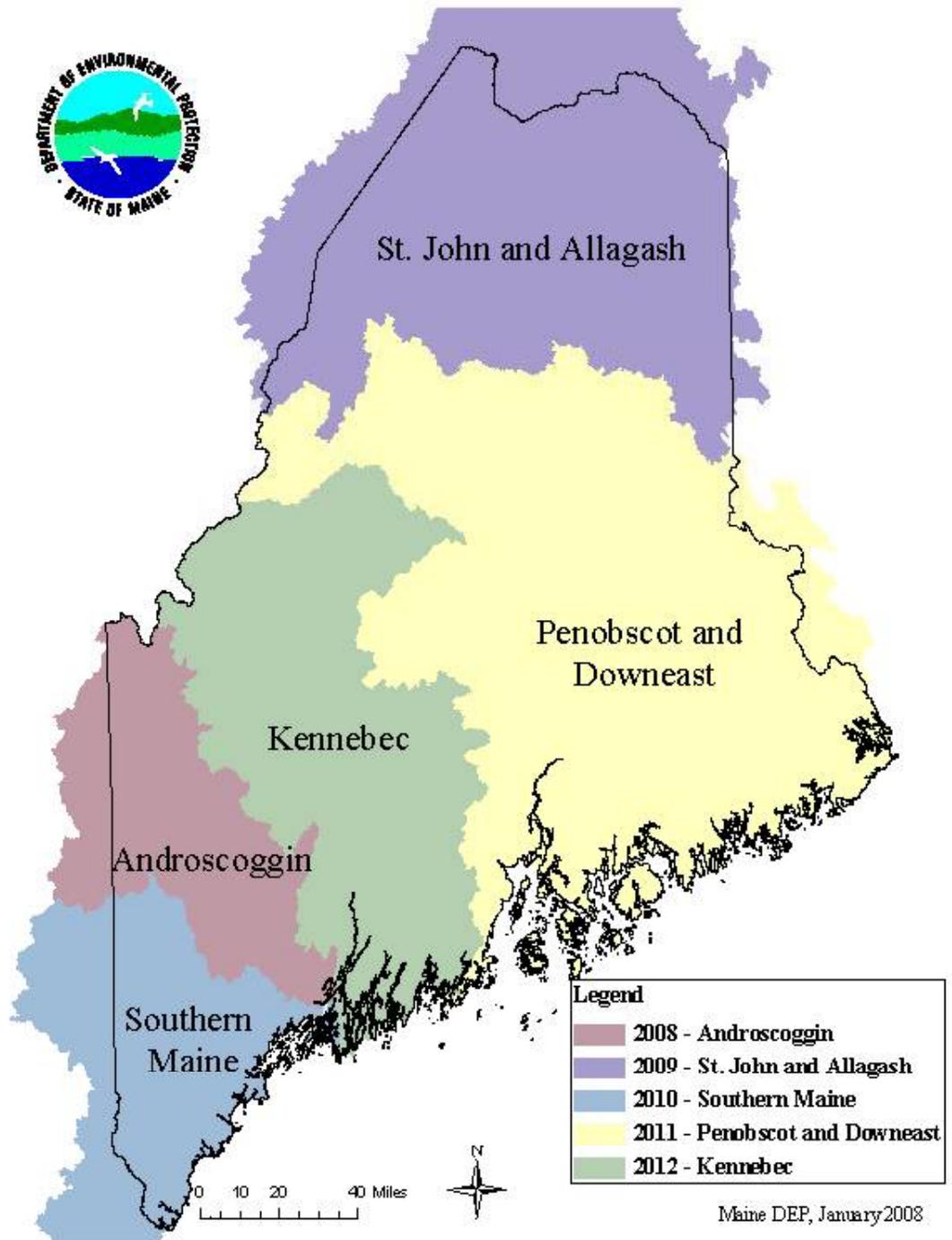


Rotating basin schedule

Lacustrine and riverine
fringe marshes

Emergent and aquatic
bed vegetation

Water depth < 1 meter



Aquatic Macroinvertebrates

Three 1 meter D-net sweeps



Wetland Algae

Phytoplankton and Epiphytes



Water Chemistry



Site Characterization



Human Disturbance Score (Field-based stressor identification)



- Hydrologic modifications
- Vegetative modifications
- Evidence of chemical pollutants
- Impervious surface in watershed
- Other potential non-point sources

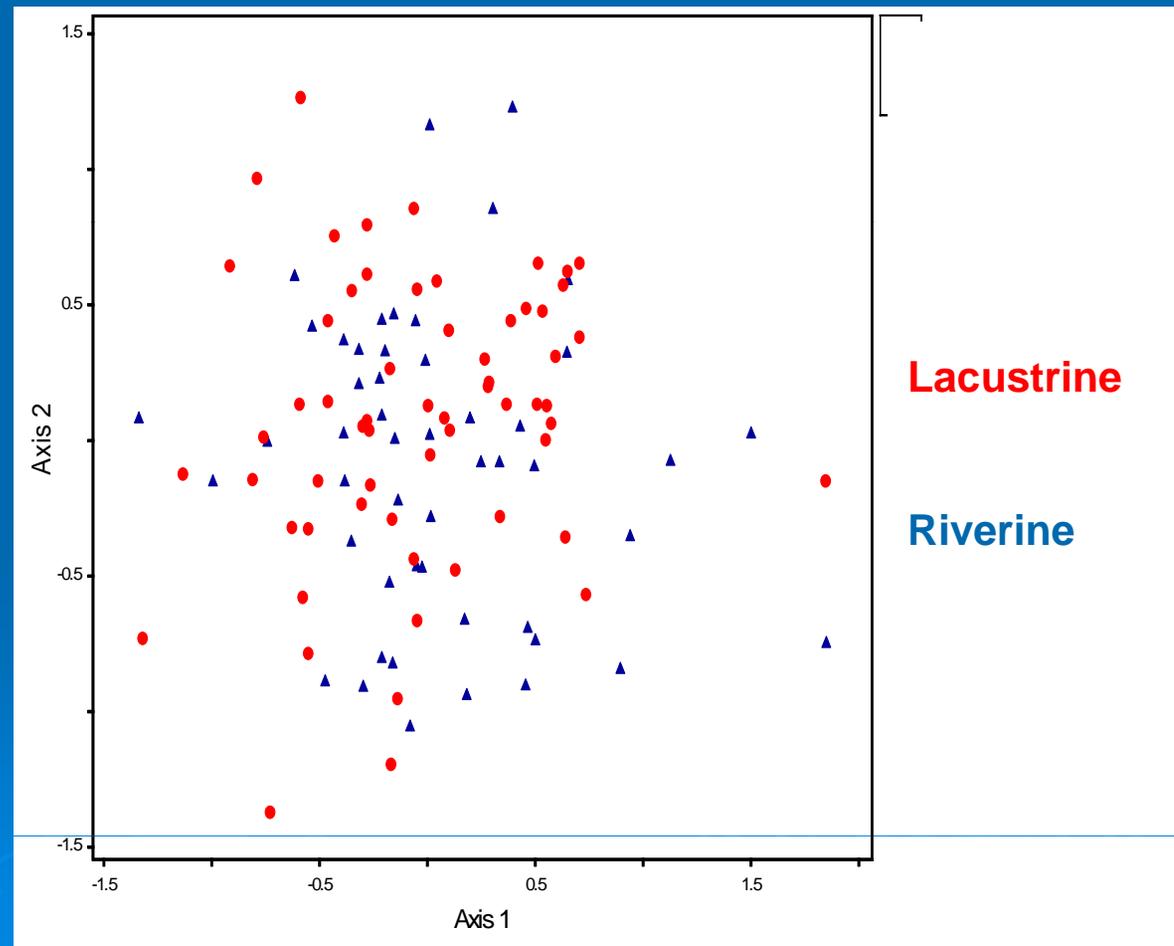
Data Analysis and Interpretation

Current focus on macroinvertebrates
2000-2008 data



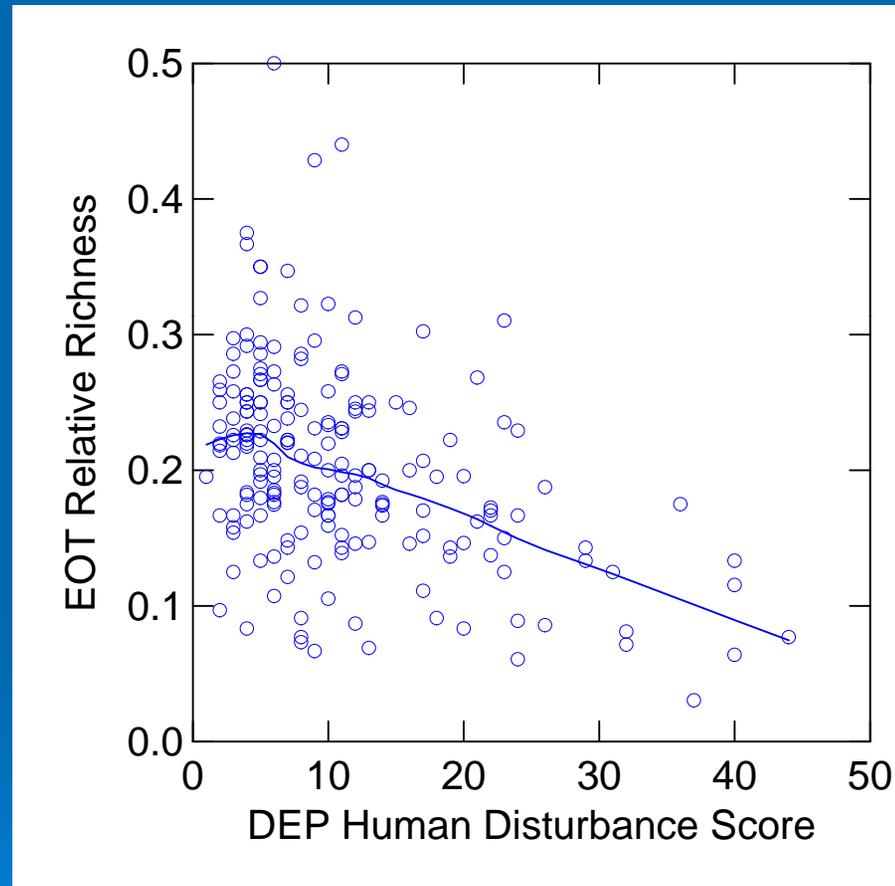
Ordination

- Non-metric multi-dimensional scaling (NMS)
- No major patterns in data related to riverine vs. lacustrine sites (habitat sampled virtually the same)
- Can proceed with a single model



Metric Development

Tested over 100
biological attributes
for predictable
response to
disturbance gradient

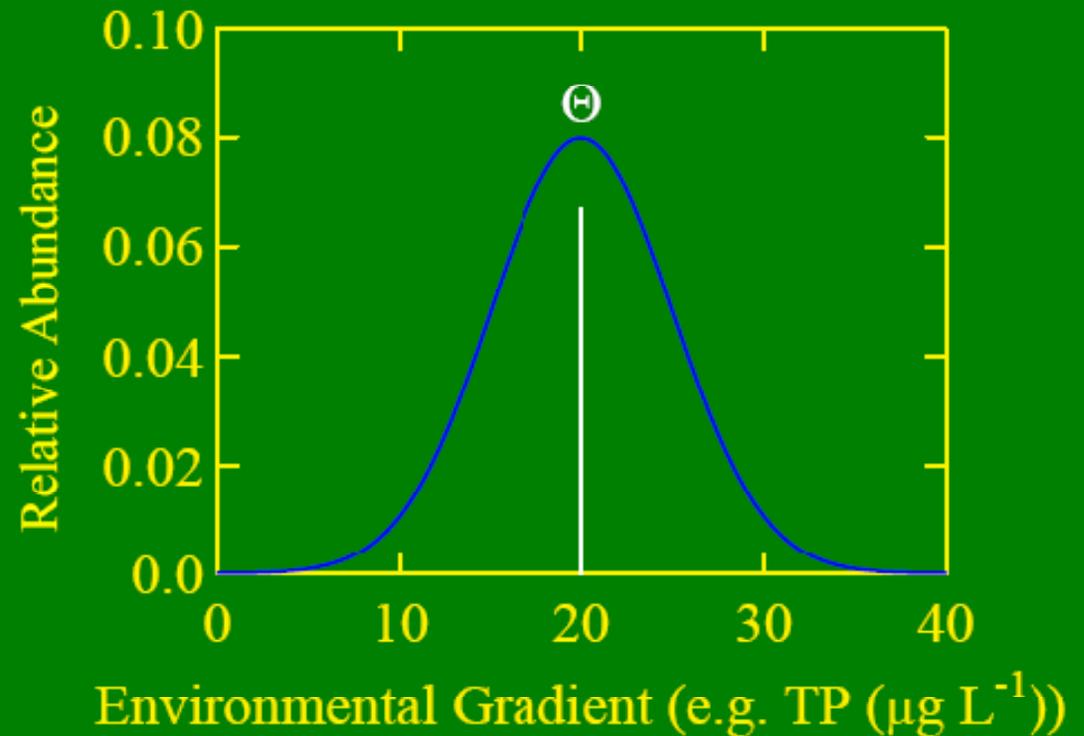


Taxa Optima

Predict “preferred” environmental conditions for each taxon

Calculated weighted average taxa optima for environmental stressors:

- total phosphorus
- conductivity
- human disturbance score
- % impervious surface
- % buffer alteration)



Courtesy Jan Stevenson

Maine Tolerance Index for Wetland Invertebrates

- Tolerance values for individual taxa calculated using species optima. Resulting tolerance values scaled from 1-100.
- Calculated weighted average community biotic index value for each site sampled (similar to Hillsenhoff Biotic Index, but with Maine data)

Environmental Inference Models

- Constructed models that use taxa optima and relative abundances to infer site-specific environmental stressor values
- Expected to help diagnose stressors and determine relative importance of multiple stressors

Biological Condition Gradient (BCG) Model*

Describes biological response to increasing stressor levels using 10 attributes encompassing:

- Taxonomic composition and tolerance
- Non-native taxa
- Organism condition
- Ecosystem functions
- Scale dependent factors
 - spatial/temporal extent of impacts
 - ecosystem connectance

* Susan P. Davies and Susan K. Jackson, *Ecological Applications*, 16(4), 2006, pp. 1251-1266.

Biological Condition Tiers

Tier 1: Native or natural condition

Tier 2: Minimal changes in biotic community structure and ecosystem function

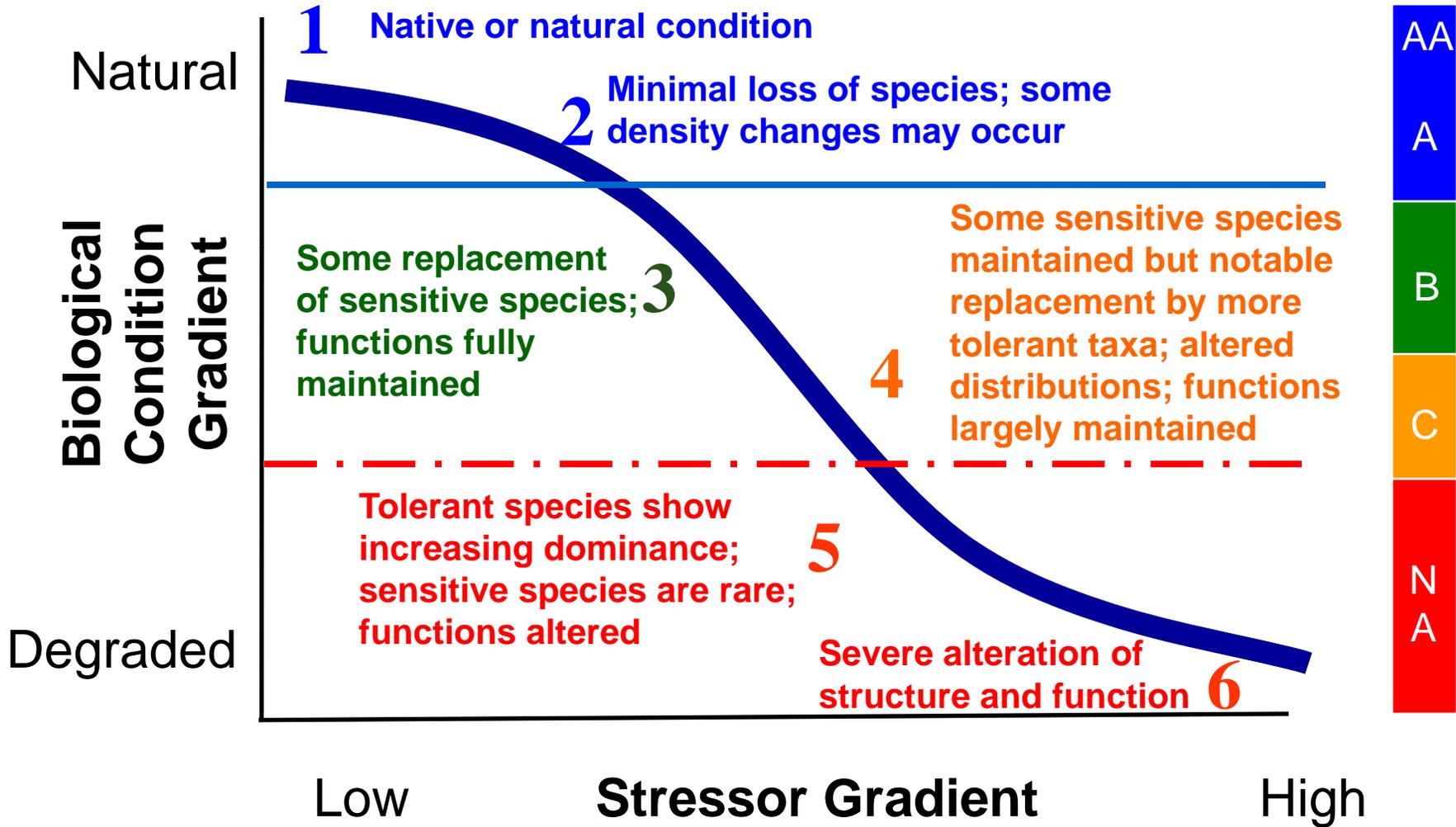
Tier 3: Evident changes in community structure; minimal changes in ecosystem function

Tier 4: Moderate changes in community structure; minimal changes in ecosystem function

Tier 5: Major changes in community structure; moderate changes in ecosystem function

Tier 6: Severe alteration of community structure and function

Biological Condition Gradient (BCG) and Tiered Aquatic Life Use (TALU)



Wetland Macroinvertebrate BCG Model Development

- Assembled monitoring data along full disturbance gradient
- Described biological assemblages expected under undisturbed (reference) conditions
- Identified regional stressors
- Characterized and described expected biological responses to increasing stressor levels (narrative description of BCG tiers)

Provisional Wetland Class and BCG Tier Determinations

- Team of biologists assigned Maine water quality class attainment and BCG tiers for 201 macroinvertebrate samples
- Initial calls done “blind” by individual team members (site names not revealed) based solely on biological data
- Compiled results for each team member and resolved differences by consensus

Next Steps

- Build and test statistical model to predict class attainment of unknown wetland invertebrate samples (incorporate expert judgment through initial set of class determinations)
- Develop models for additional biological assemblages (algae, plants) and wetland types

Using Results

- Monitor ambient condition, identify threats
- Develop/support biological criteria
- Inform permit decisions (discharges, hydropower, wetland/stream alterations, etc.)
- Integrated watershed assessments (305b/303d)
- Evaluate mitigation success
- Support TMDL development
- Target conservation and restoration efforts
- Support wetland education and outreach activities