

Presented at

# Great Rivers Reference Condition Workshop

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The U.S. Environmental Protection Agency and The Council of State Governments



**EMAP**  
Great River Ecosystems



U.S. EPA Office of Research and Development

Environmental Monitoring and Assessment Program

A herd of brown and white cows is wading through a shallow, turbid river. The water is a murky, light brown color, and the cows are partially submerged. The background shows a dense line of green trees and foliage. The text is overlaid on the top half of the image.

# Setting Expectations for the Ecological Condition of Rivers: The Concept of Reference Condition

Modified from:

Stoddard, J. L., D. P. Larsen, C. P. Hawkins, R. K. Johnson, and R. H. Norris. In Press. Setting expectations for the ecological condition of streams: the concept of reference condition. *Ecological Applications*.

# Underlying Questions

- Science Question: How does human activity affect aquatic ecosystems and, in particular, aquatic biota?
  - What is our Benchmark for assessing current condition?
- Management Question: What should we do about the fact that human activities have degraded aquatic ecosystems?
  - What should we use as a target for management actions?

# Where does the concept come from?

- Clean Water Act objective:  
*“to restore and maintain the physical, chemical, and biological integrity of the nation’s waters”*
- Biological Integrity definition:  
*“community of organisms having a species composition, diversity and functional organization comparable to those of natural habitats within a region”*

# A confusion of terms

- Reference condition
- Pristine condition
- Undisturbed condition
- Natural Condition
- Minimally disturbed condition
- Least disturbed condition
- Historical condition
- Attainable condition
- Expected condition

## Reference Condition – RC(BI)

- The condition unaffected by anthropogenic disturbance; pristine; unpolluted; natural
- Reserve the term as a descriptor for biological integrity
- General international agreement on use of the term

# Minimally Disturbed Condition (MDC)

- Condition nearly unaffected by anthropogenic disturbance
  - And related stressors/exposures
- Approximately equivalent to:
  - Pristine
  - Natural
  - Undisturbed

# Least Disturbed Condition (LDC)

- Present-day condition found in conjunction with the best available physical, chemical, and biological habitat conditions.
- Condition found in presence of lowest amount of human disturbance and stressors
- “Best of What’s Left”



# Distinguishing minimally and least disturbed

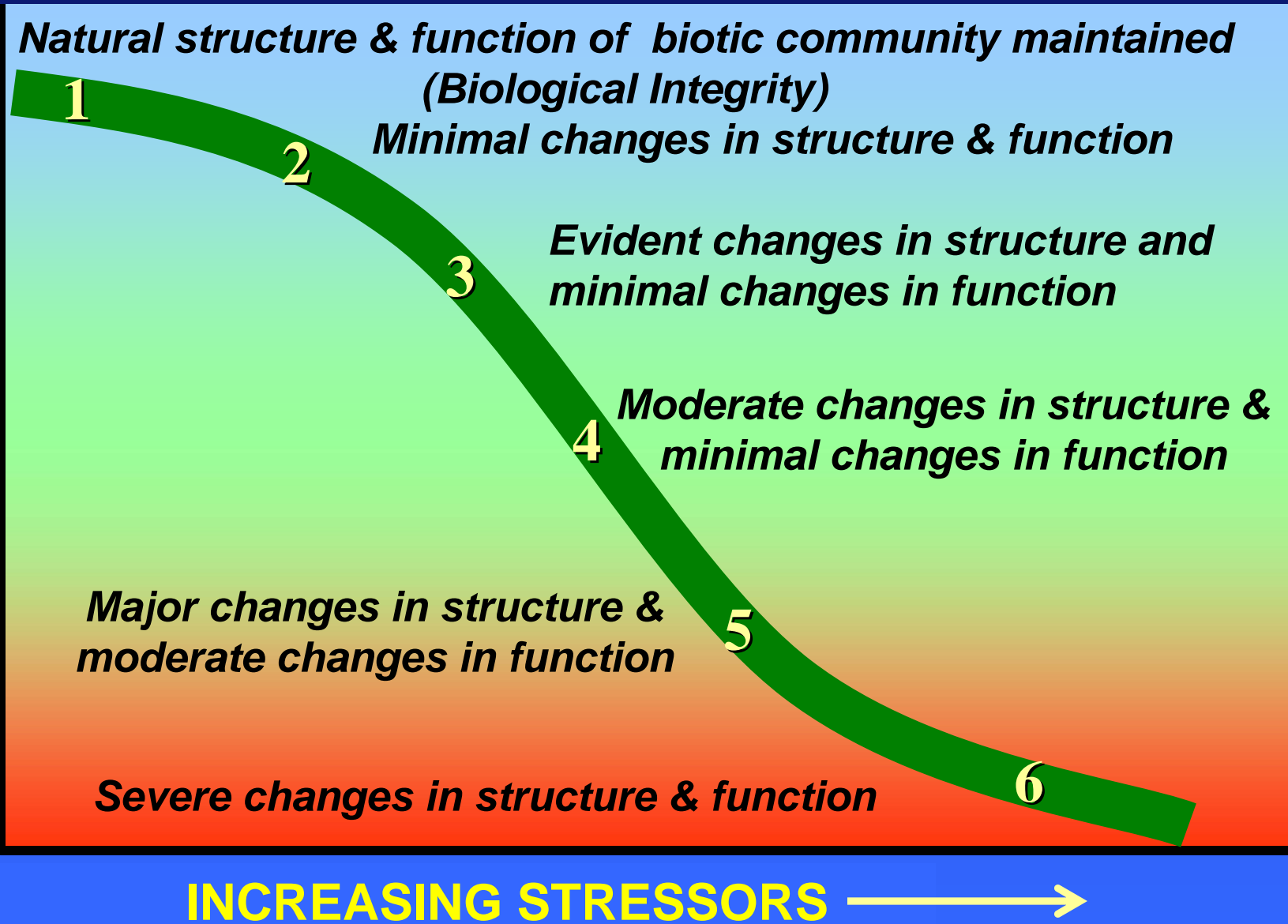
- Minimally Disturbed: Absolute
  - Some regions might have no sites that meet minimal disturbance criteria.
- Least Disturbed: Relative
  - No matter how disturbed the region, some sites are likely less disturbed than others.

# (Best) Attainable Condition

- An expected condition taking into account best management practices, societal will to improve condition, economic resources
- Reduced effect of human activities on aquatic biota (i.e., manage for best condition in face of human disturbance)
- Can be better than current day conditions (i.e., better than LDC)

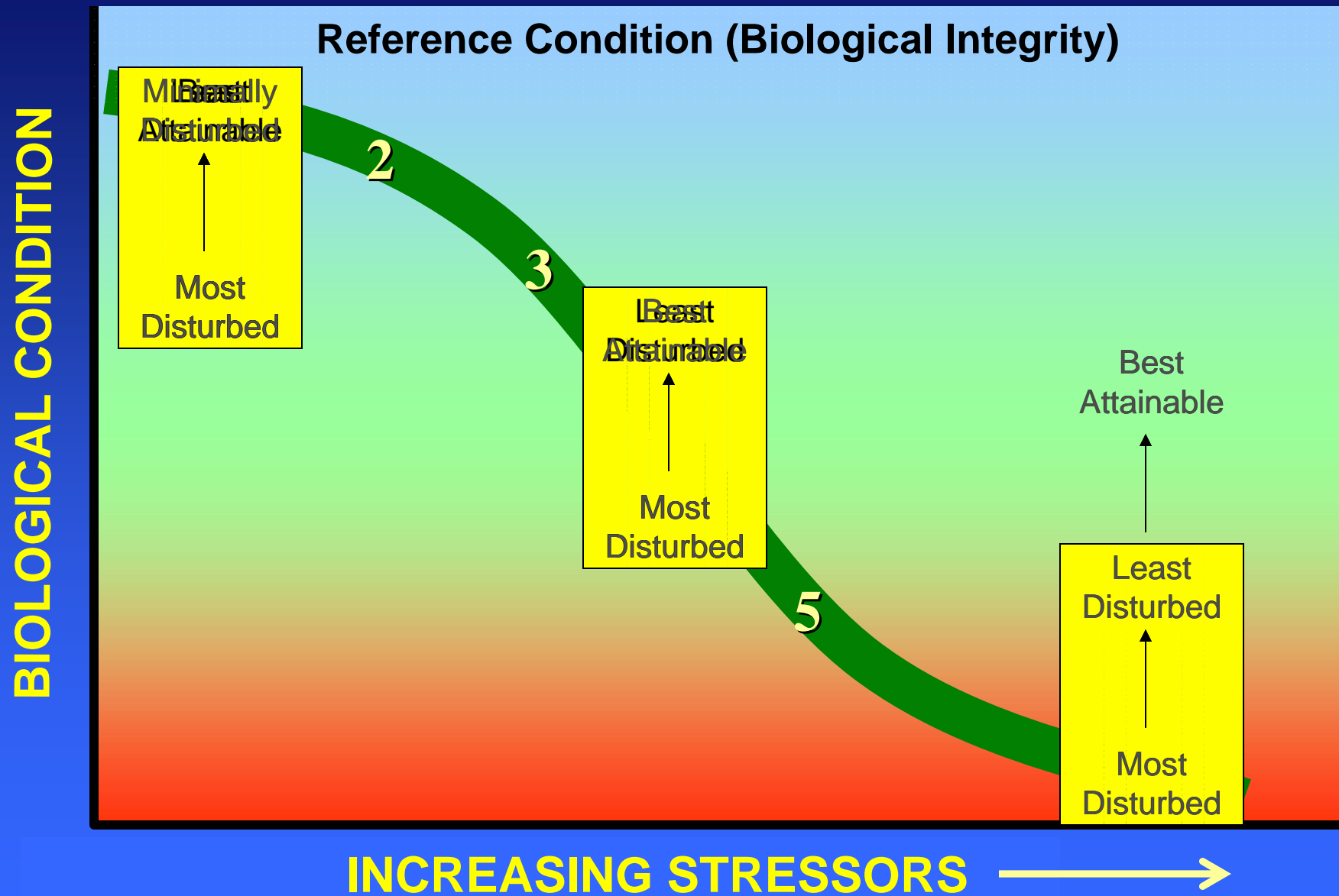
# The Biological Condition Gradient

**BIOLOGICAL CONDITION**



From Davies and Jackson (in press)

# The Biological Condition Gradient



# Let's Be Clear

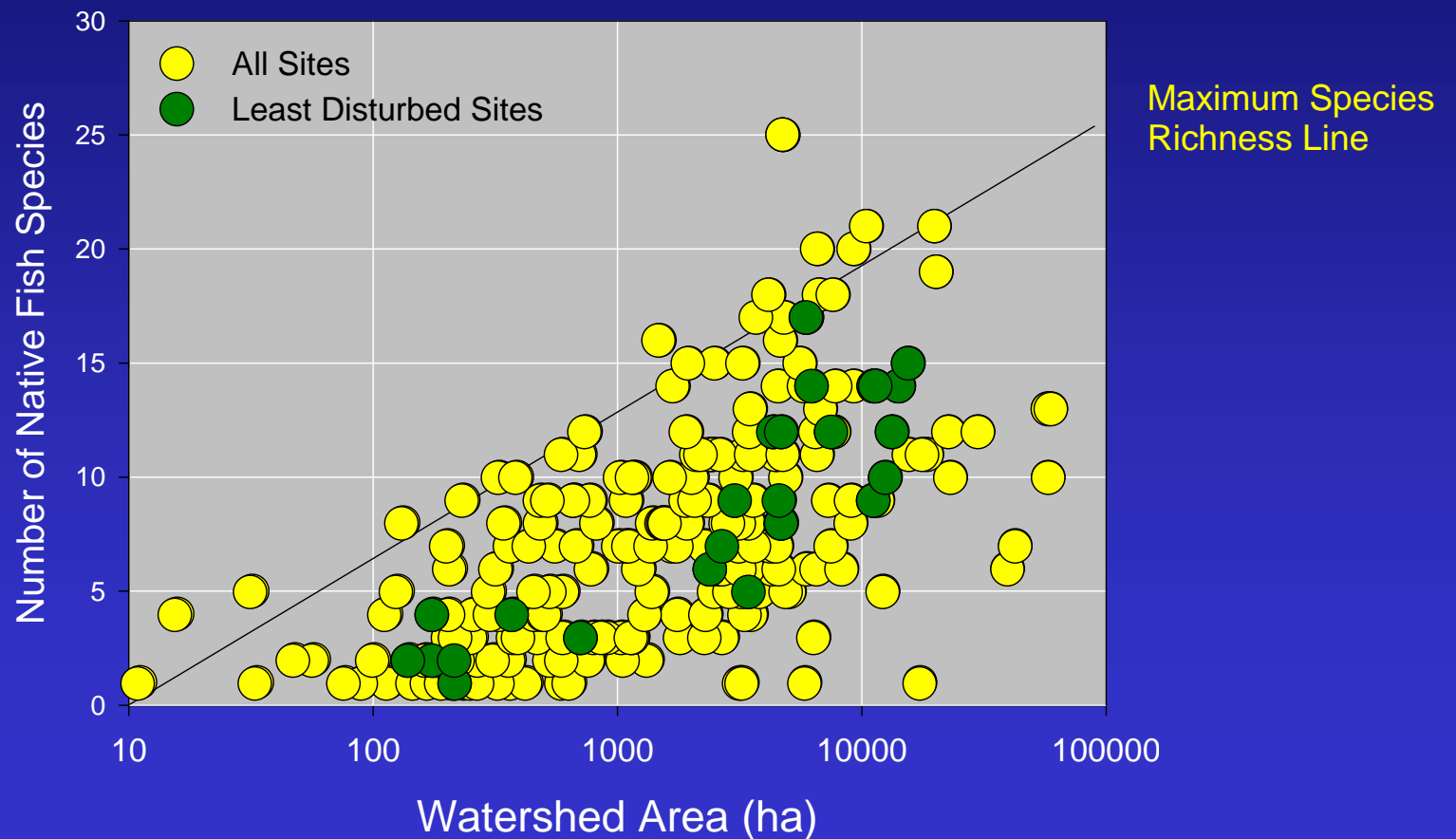


# Methods for Estimating Reference Condition

- The Reference Site Approach:
  - Minimally Disturbed Condition?
  - Least Disturbed Condition
- Application of ecological theory

# Application of ecological theory

## Mid-Atlantic Highlands Streams



# Methods for Estimating Reference Condition

- The Reference Site Approach:
  - Minimally Disturbed Condition?
  - Least Disturbed Condition
- Application of ecological theory
- Interpreting historical condition



# Historical Condition

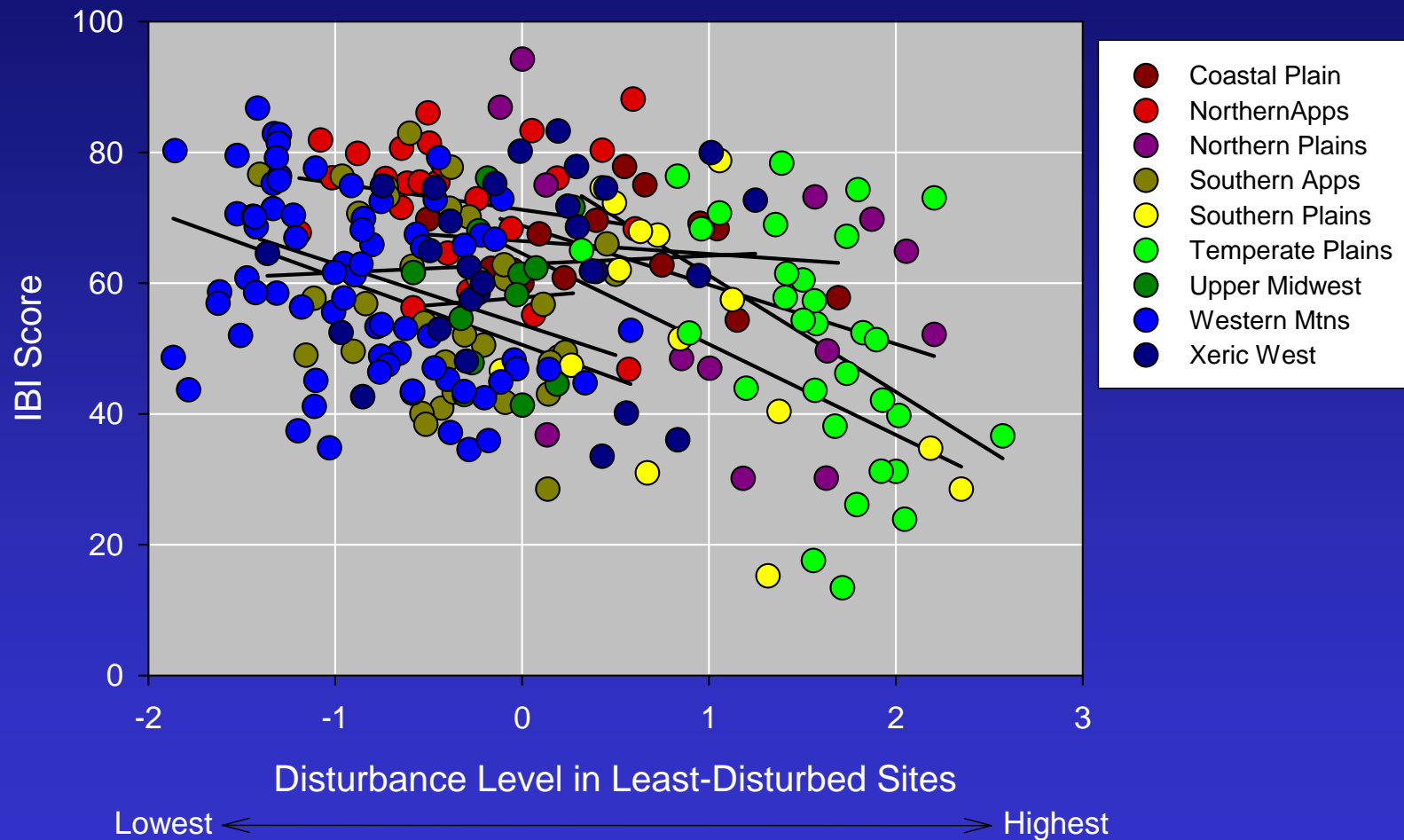
- Pre-Columbian
- Pre-European settlement
- Pre-intensive agriculture
- Other?

# Methods for Estimating Reference Condition

- The Reference Site Approach:
  - Minimally Disturbed Condition?
  - Least Disturbed Condition
- Application of ecological theory
- Interpreting historical condition
- Extrapolating from empirical models

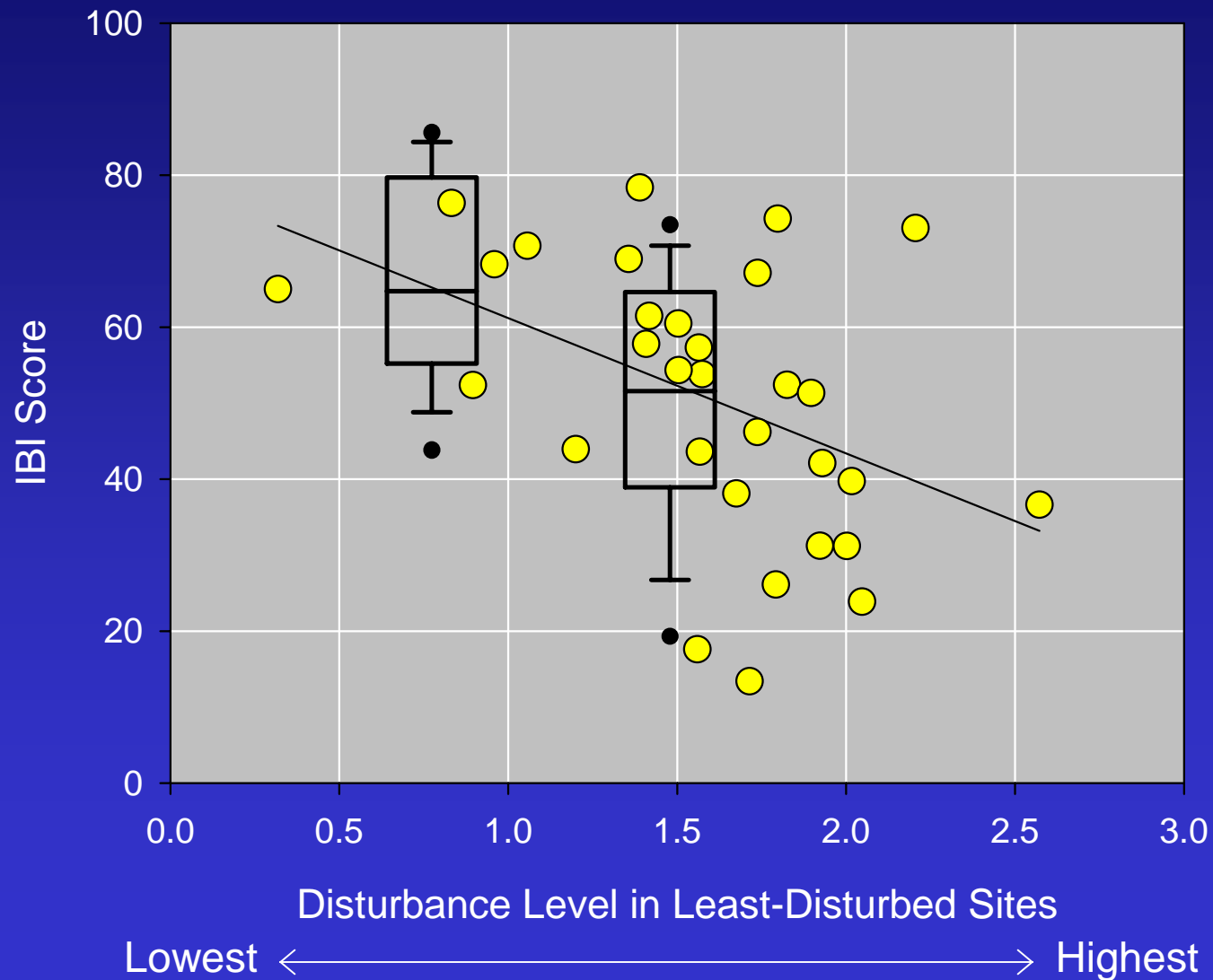
# Extrapolating from Empirical Models

Wadeable Streams Assessment "Reference Sites"



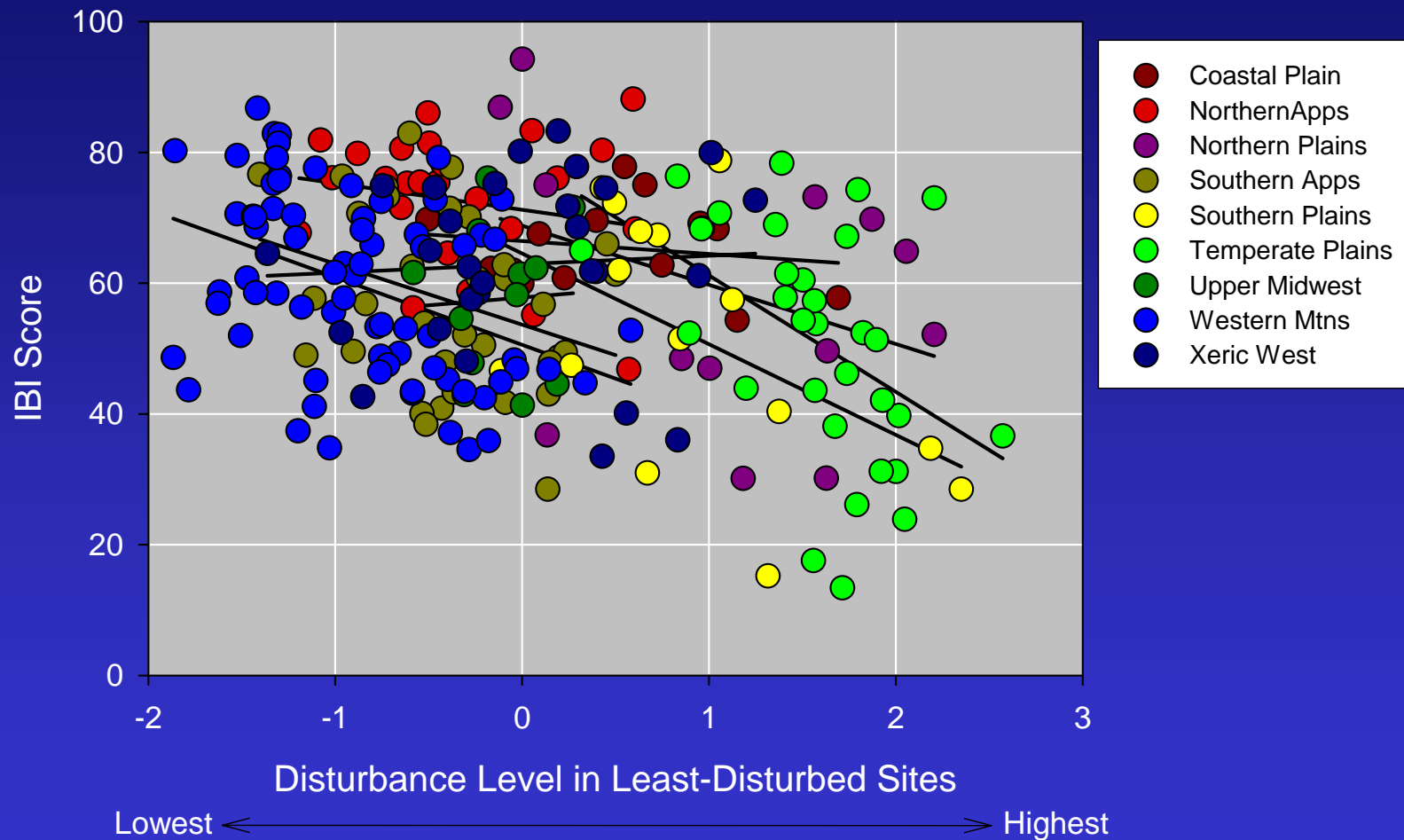
# Extrapolating from Empirical Models

Temperate Plains "Reference Sites"



# Extrapolating from Empirical Models

Wadeable Streams Assessment "Reference Sites"



# Methods for Estimating Reference Condition

- The Reference Site Approach:
  - Minimally Disturbed Condition?
  - Least Disturbed Condition
- Application of ecological theory
- Interpreting historical condition
- Extrapolating from empirical models
- Best professional judgment

# Best Professional Judgment



# Summary

- Reserve use of Reference Condition, or RC(BI), to describe biotic integrity
- Use other terms (MDC, LDC, Attainable Condition) to describe other benchmarks
- Recognize that choice of method may force a choice of definition
- We may never all agree on the “right” definition – in the meantime, be clear about what we mean by the terms we use