National Biological Assessment and Criteria Workshop

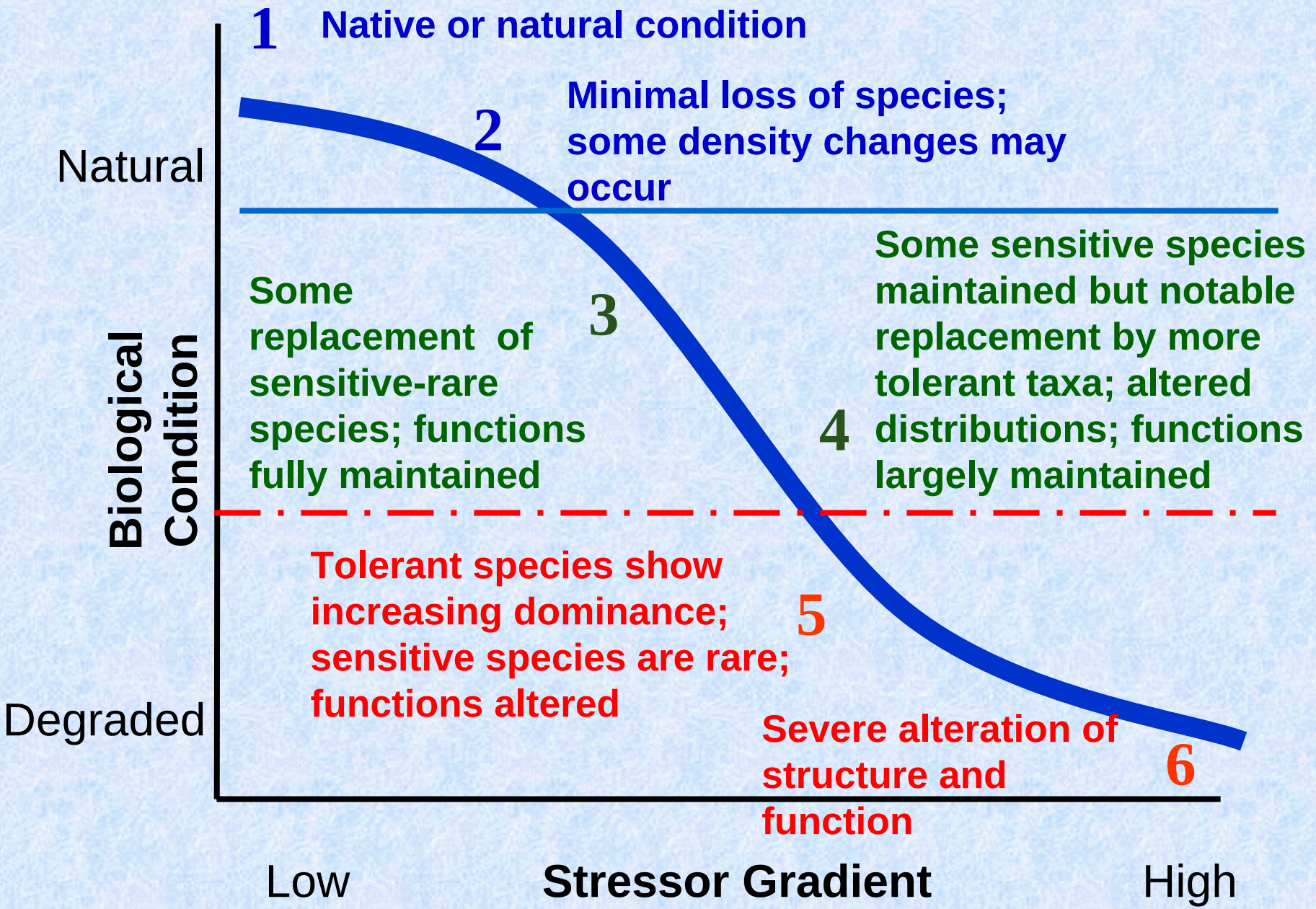
Advancing State and Tribal Programs

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

The Biological Condition Gradient

Michael T. Barbour, Tetra Tech

Adapted from Susan Davies (ME DEP) presentation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Native or natural condition
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Biological Condition
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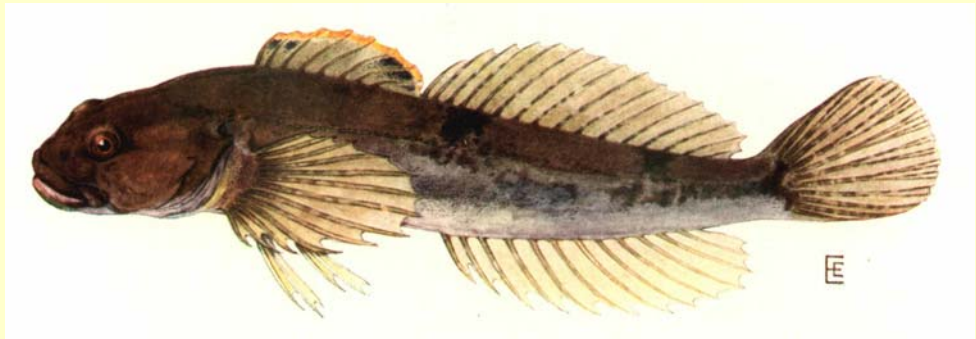
Tolerant species show increasing dominance; sensitive species are rare; functions altered
5
Degraded
Severe alteration of structure and function
6
Low
Stressor Gradient
High

Some Sensitive Organisms in Streams

Mayflies

Stoneflies

Slimy Sculpin



Photographs by Larry Abele, NYS Department of Environmental Conservation

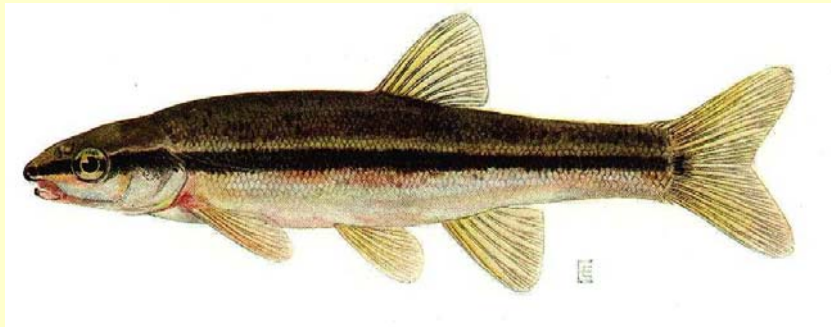
Some Tolerant Organisms in Streams

Midges

Snails

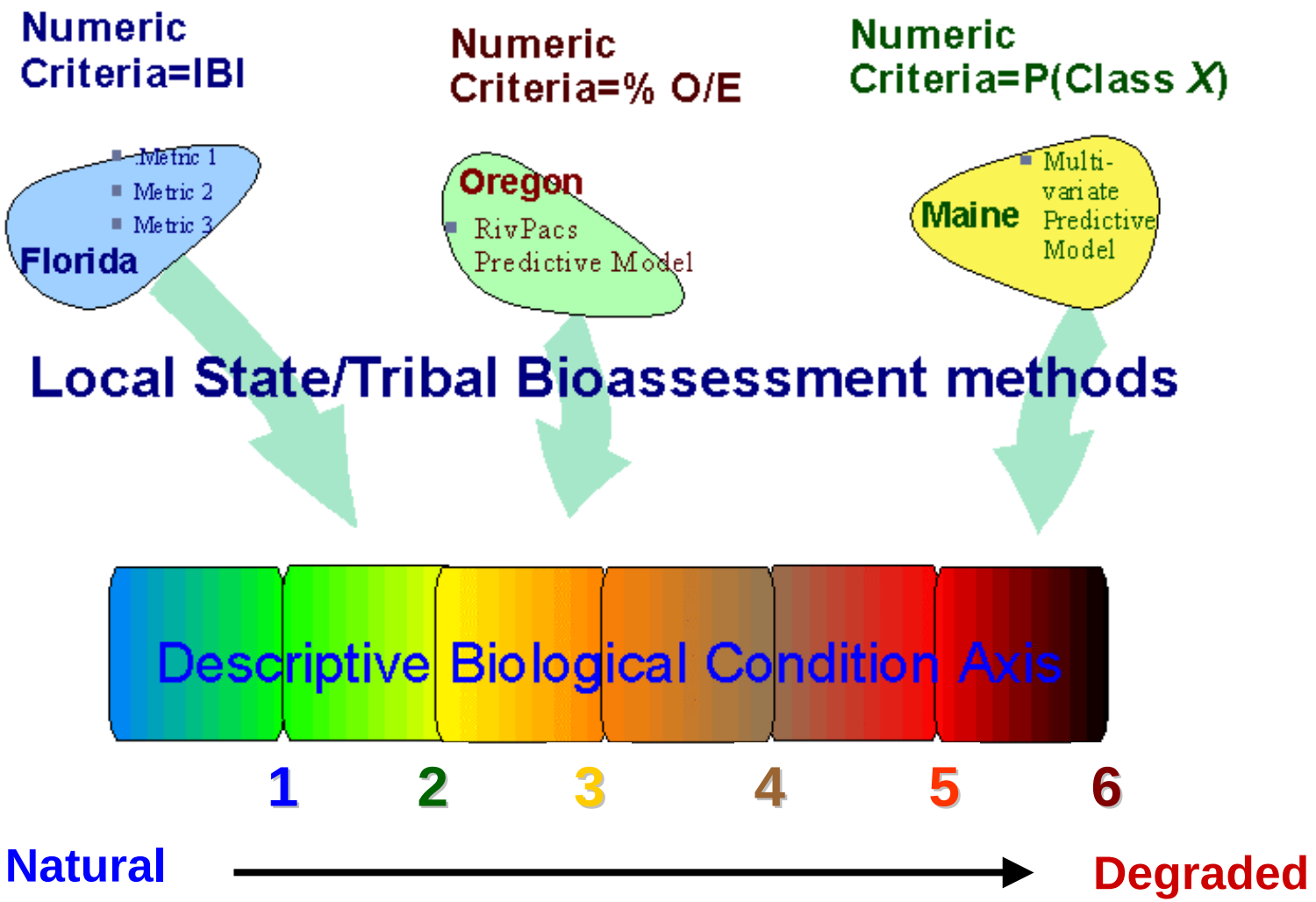
Leeches

Blacknose dace

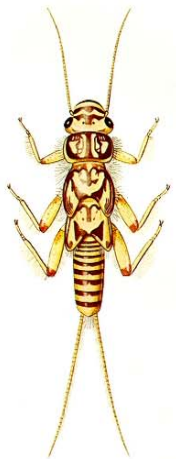


Photographs by Larry Abele, NYS Department of Environmental Conservation

BCG Tiers Provide Consistency



Susan P. Davies, MDEP



Characteristics of the BCG

- A conceptual model
- A common observational scale
  - *not a prescription or mandate from EPA*
- A heuristic (tool for learning and communication)
  - *not a formula*
- A quality gradient
  - *not a "classification of data"*

2001 BCG Meeting Data Exercise

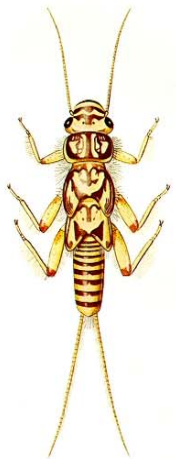
33 biologists from 21 states

six BCG categories

81% concurrence !

four regions of the U.S.

54 stream invertebrate samples



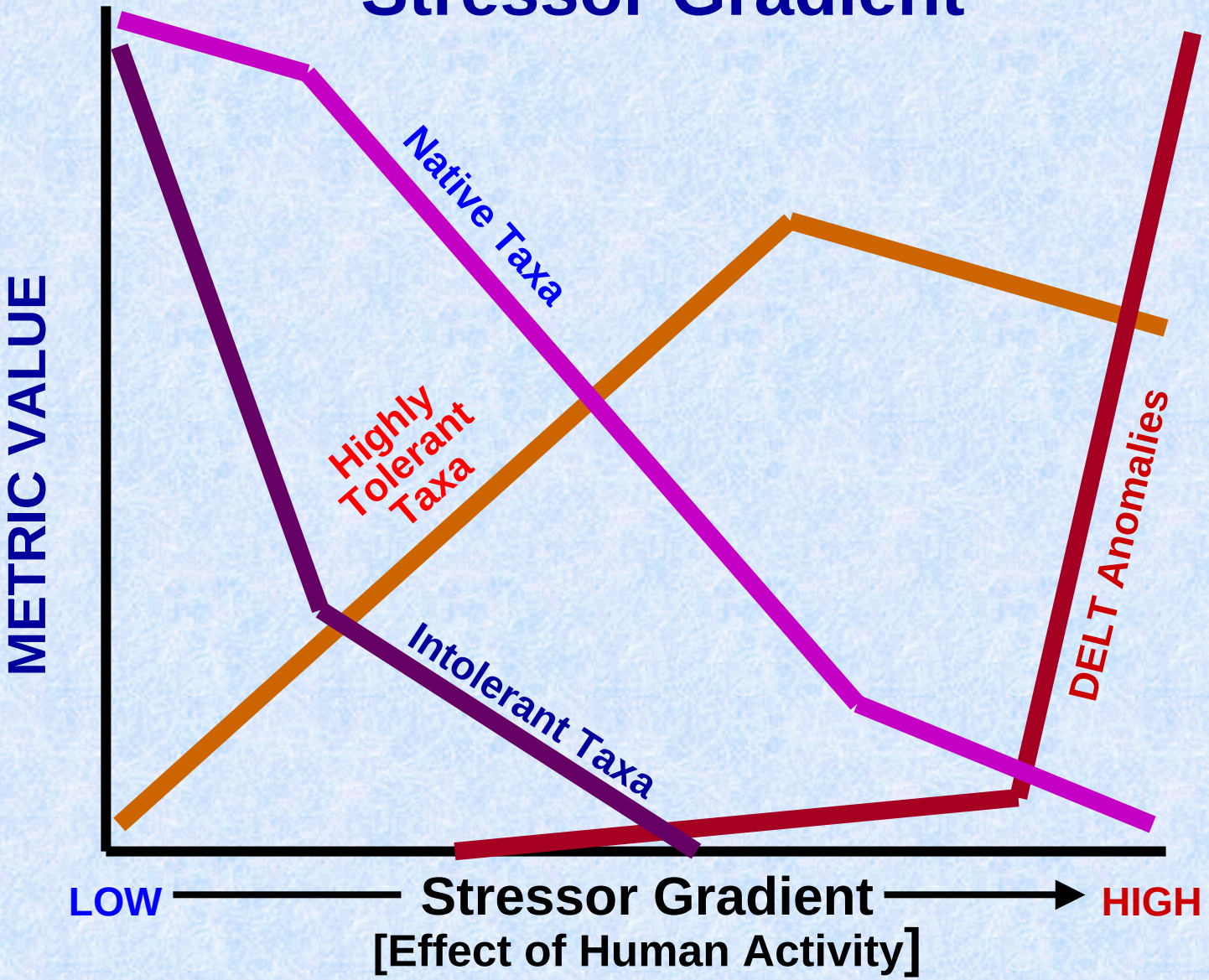
Overview of Attributes

- **Taxonomic composition and tolerance**
  - Attributes I-V
  - *Sensitive-Endemic* through *Tolerant*
- **Non-native taxa**
  - Attribute VI
- **Organism condition**
  - Attribute VII
- **Ecosystem function**
  - Attribute VIII
- **Physical-biotic interactions**
  - Attributes IX-X

Overview of Attributes

- **I - Historically documented, sensitive, long-lived, regionally endemic taxa**
  - documented presence prior to CWA
  - unique life history requirements
  - may be a listed RTE or Special Concern species
  - ex: **Brook Floater mussel; Apache trout; steelhead**
- **II - Sensitive - rare or specialist taxa**
  - may require special habitats;
  - intolerant of disturbance in environmental conditions
  - naturally low densities;
  - commonly k-strategists (slow development, longer lifespan, stable population density over time)
  - ex: ***Taeniopteryx*; slimy sculpin, bull trout; plains killifish**

Fish Metric Behavior Along the Stressor Gradient



Courtesy of Chris Yoder, CABB

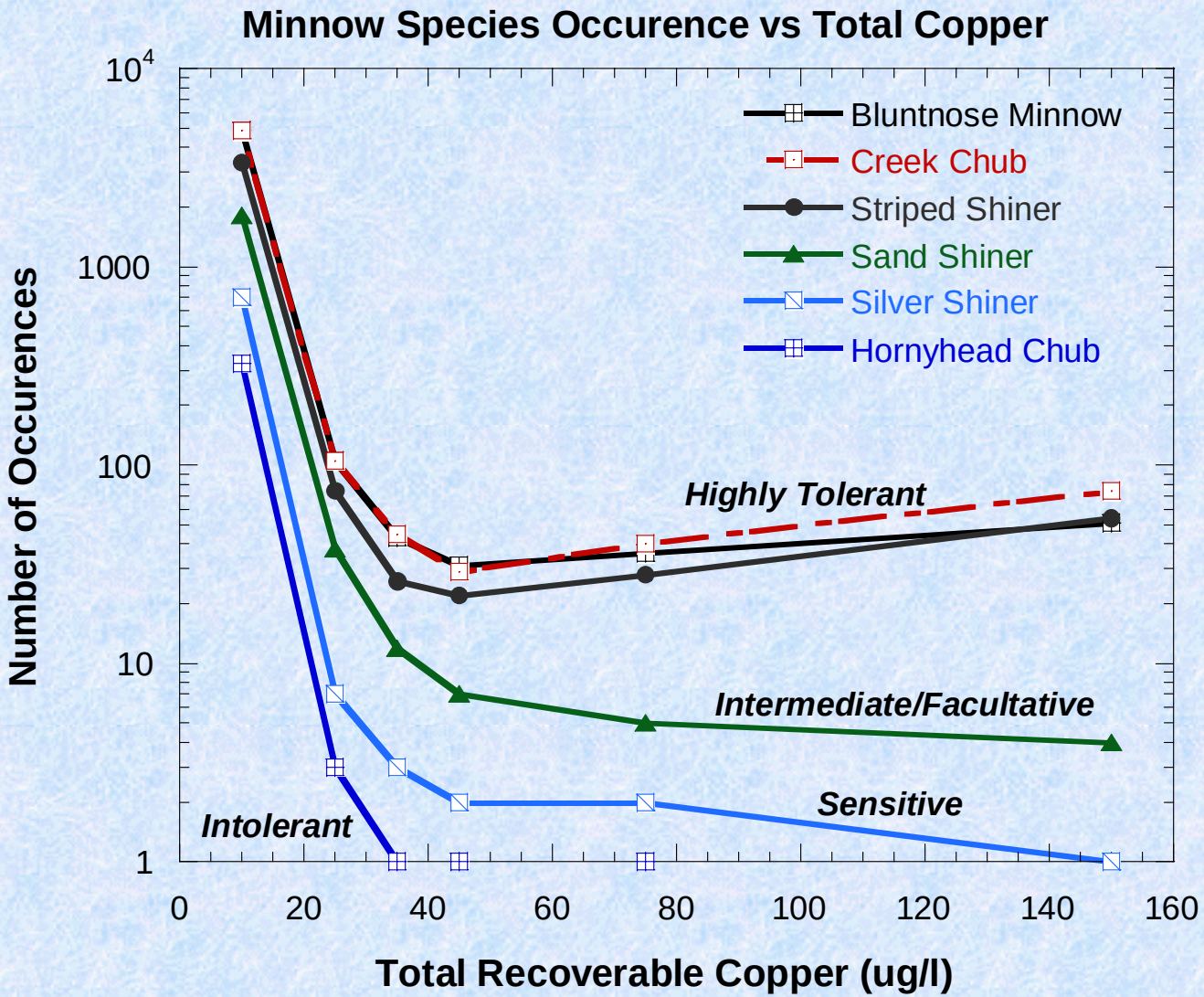
Overview of Attributes (cont.)

- **III - Sensitive - ubiquitous taxa**
  - ordinarily common and abundant
  - broader range of thermal and habitat tolerance; mild pollution loads have a negative effect on populations;
  - ex: ***Acroneuria*; Baetidae; Ephemerellidae; brook trout; black redhorse**
- **IV - Taxa of intermediate tolerance**
  - may have generalist feeding strategies
  - densities commonly increase in response to nutrient enrichment
  - may be r-strategists (early colonizers with rapid turnover times and boom/bust populations)
  - ex: **Hydropsychidae; Polycentropodidae; common shiner; mooneye; Rio Grande sucker**

Overview of Attributes (cont.)

- **V - Tolerant taxa**
  - often tolerant of a broad range of environmental conditions
  - often r-strategists or opportunist taxa; densities may increase greatly in absence of competition and predation
  - ex: **leeches; gastropods; white sucker; green sunfish**
- **VI - Non-native taxa**
  - species that do not naturally occur in a given locale or ecosystem
  - ex: ***Corbicula*; zebra mussels; rudd**
- **VII - Organism condition**
  - DELT anomalies and parasites of fish;
  - evidence of reproduction; sex ratios; biomass of YOY

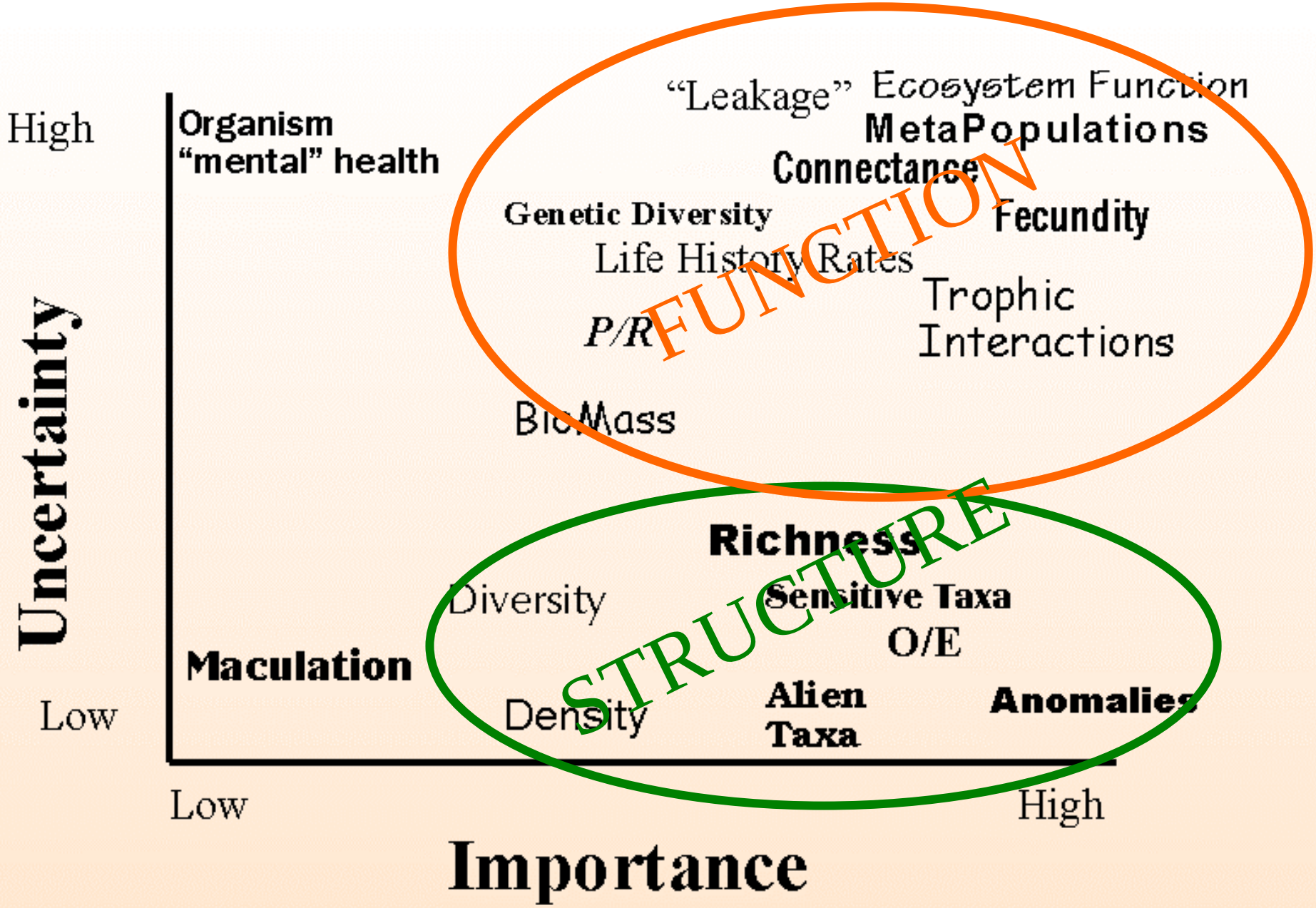
Ohio Fish Monitoring Data

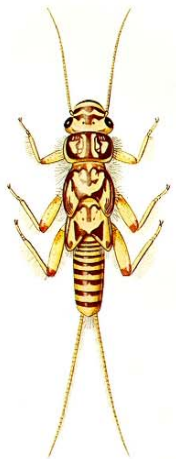


Courtesy of Chris Yoder, CABB

Overview of Attributes (cont.)

- **VIII - Ecosystem Function**
  - processes required for normal performance of a biological system
  - may be applied to any level of biological organization
  - Not commonly measured directly by state/tribal programs
  - **Examples**:
    - **Individual**- % organisms with …(anomalies, disease, parasites, etc.)
    - **Population**- fecundity, age class distributions, sex ratios, presence/absence
    - **Community**- structural composition and complexity
    - **Ecosystem**- Primary and secondary production, P/R, immigration and emigration, trophic complexity, resource leakage


High
Low
Uncertainty
Low
High
Importance
Organism
"mental" health
"Leakage"
Ecosystem Function
MetaPopulations
Connectance
Genetic Diversity
Fecundity
Life History Rates
Trophic
Interactions
P/R
BioMass
FUNCTION
Richness
Diversity
Sensitive Taxa
O/E
Maculation
Density
Alien
Taxa
Anomalies
STRUCTURE

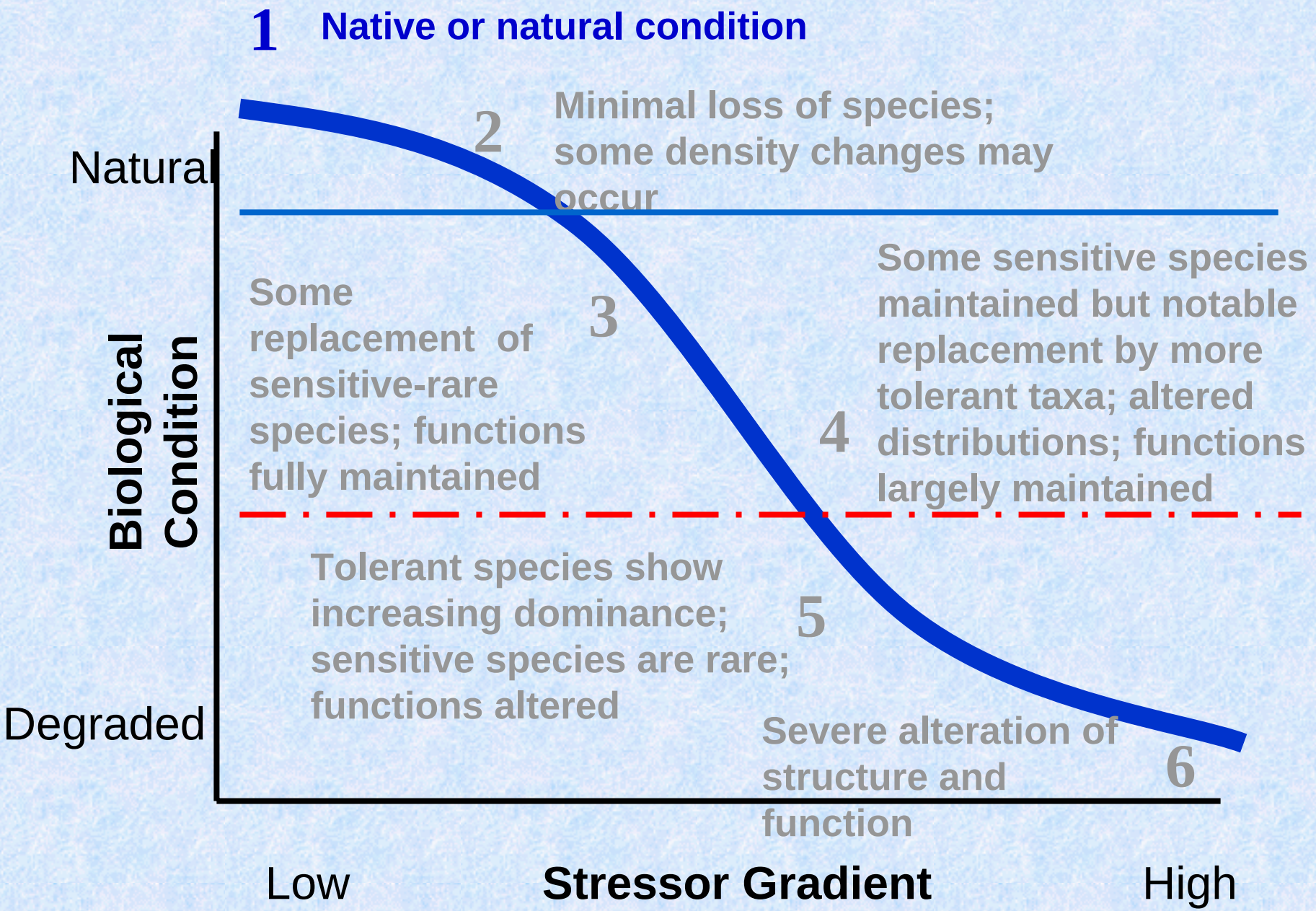


Overview of Attributes (cont.)

IX- Spatial and temporal extent of detrimental effects and X- Ecosystem connectance

- **physical:biological interactions**
- ***Cross-cutting attributes***
- **Provides linkage to the "Human Disturbance Gradient"**
- **Expands the interpretation to larger spatio-temporal scales**
- **Informs the management perspective**

  (e.g., prioritization)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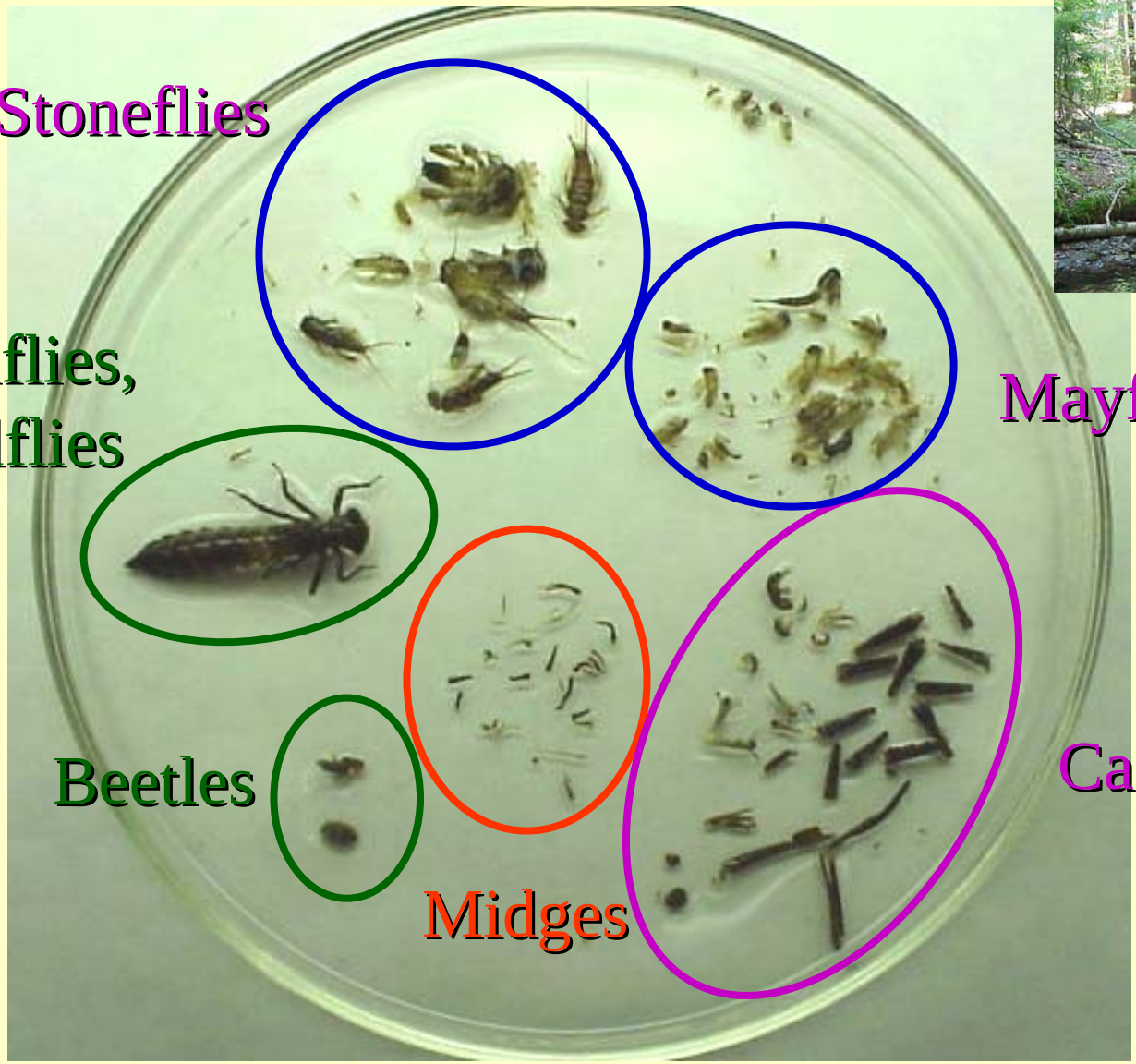
Second order stream in a minimally disturbed, forested watershed

A Tier 1 Community

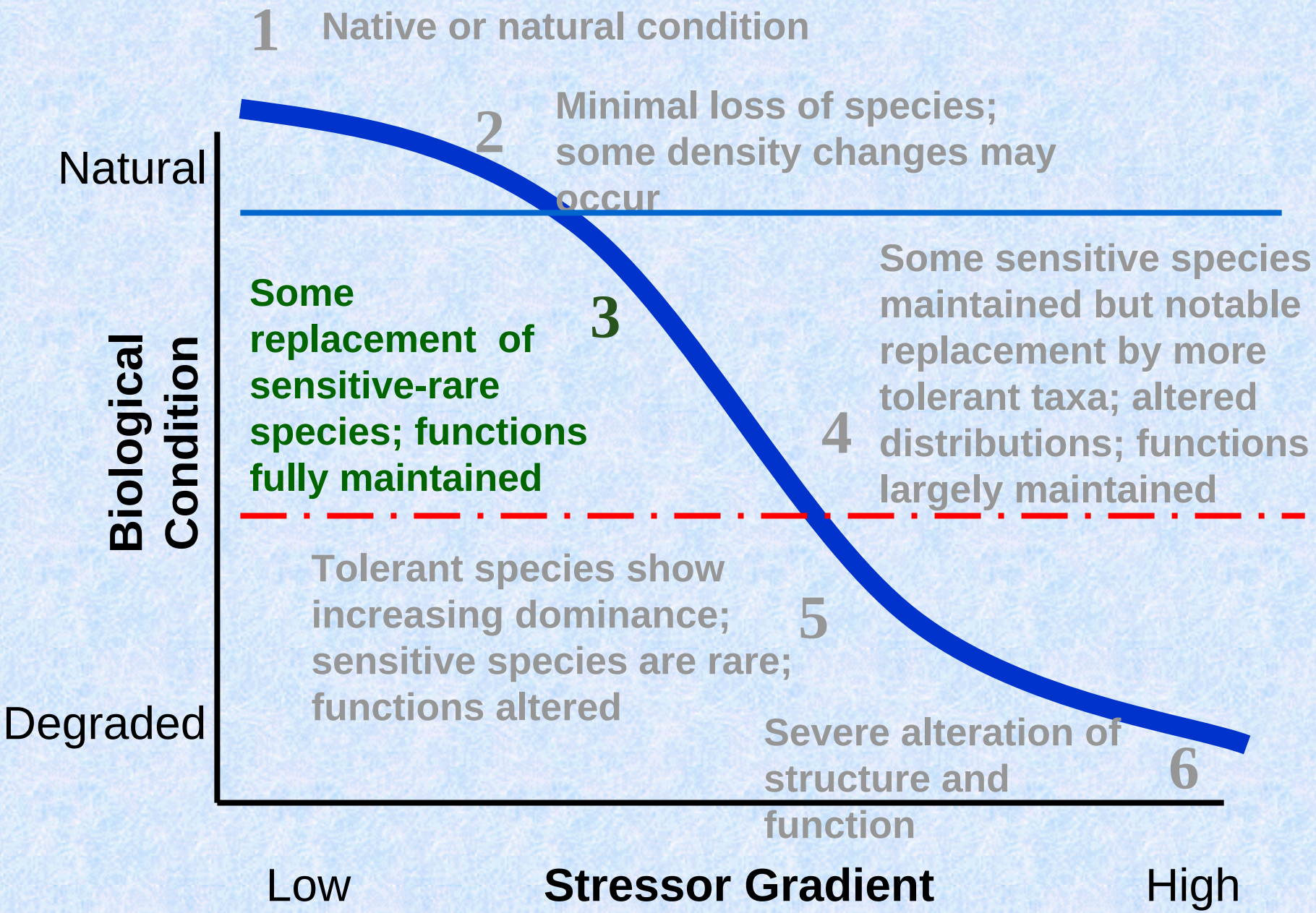


ME Example BCG Tier 1

Intact watershed

- **Generic Richness**
  - Total = 51
  - EPT = 25 (49%)
  - Mayfly = 8
  - Stonefly = 6
  - Caddisfly = 11
  - Midges = 10
- **Abundance**
  - Total = 312
  - Mayfly = 157
  - Stonefly = 57

- **II - Sensitive- rare, specialist**
  - Taeniopteryx 48
  - Epeorus 13
  - Hexatoma 8
  - Probezzia 8
  - Isoperla 7
  - Pteronarcys 1
  - Capniidae 1
  - Chloroperlidae 1
  - Glossosoma 1
  - Brachycentrus 1
- **III - Sensitive - ubiquitous, generalist**
  - Ephemerella 127
  - Acentrella 13
  - Stenonema 8
- **IV - Intermediate tolerance, opportunistic**
  - Hydropsyche 24
  - Cheumatopsyche 5
- **V - Tolerant Taxa**
  - Polypedilum 8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Third order stream, downstream of agricultural impacts

A Tier 3 Community

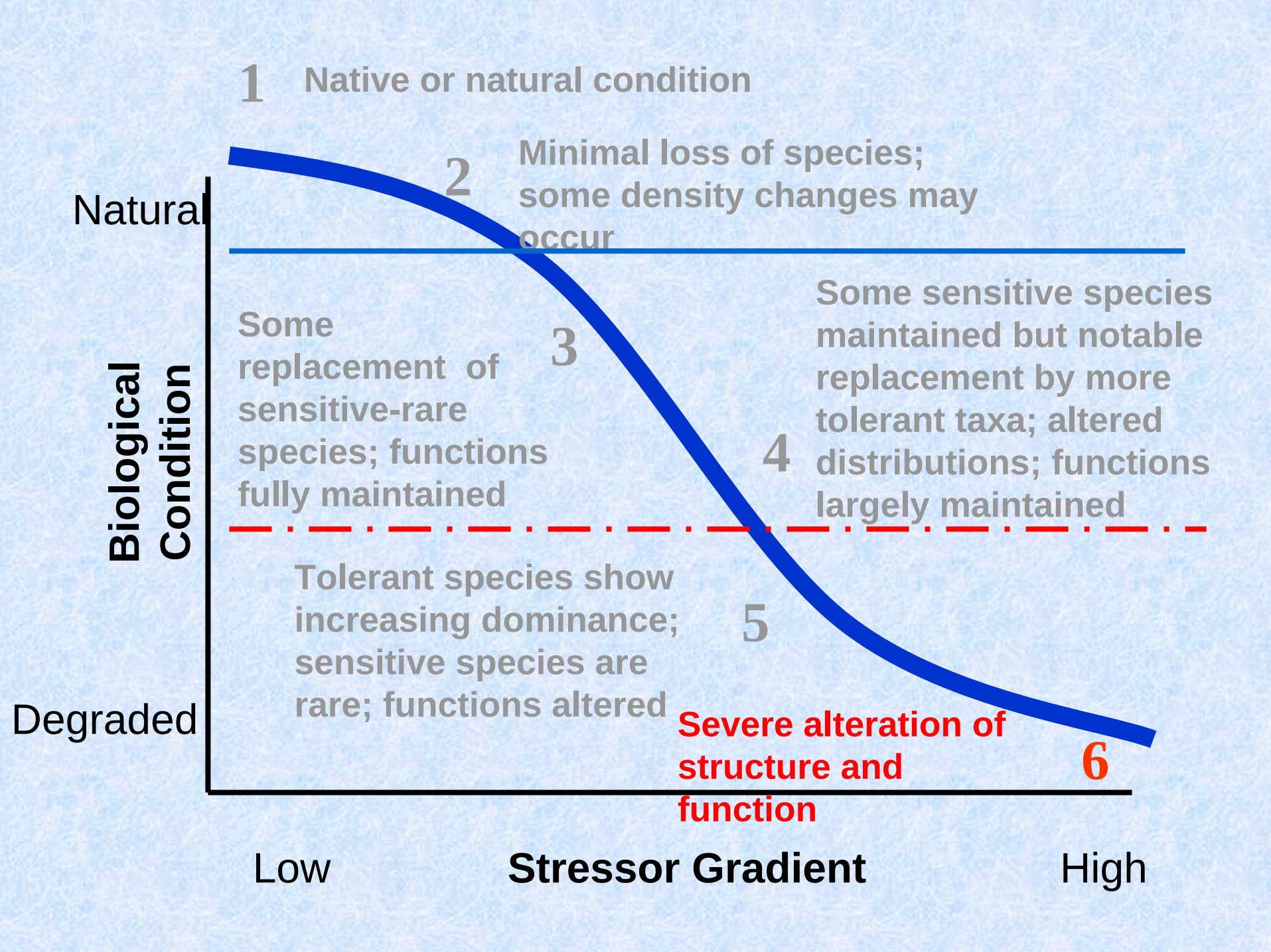
"evident/moderate disturbance"

ME Example BCG Tier 3

Agricultural NPS

- **Generic Richness**
  - Total = 58
  - EPT = 21 (36%)
  - Mayfly = 7
  - Stonefly = 1
  - Caddisfly = 13
  - Midges = 12
- **Abundance**
  - Total = 835
  - Mayfly = 220
  - Stonefly = 16

- **II - Sensitive- rare, specialist**
  - Serratella 8
  - Leucrocuta 5
- **III - Sensitive - ubiquitous, generalist**
  - Baetis 127
  - Ephemerella 67
  - Acroneuria 16
  - Acentrella 6
  - Stenonema 5
- **IV - Intermediate tolerance, opportunistic**
  - Simulium 203
  - Hydropsyche 92
  - Rheotanytarsus 62
  - Chimarra 40
- **V - Tolerant Taxa**
  - Cricotopus 33
  - Polypedilum 32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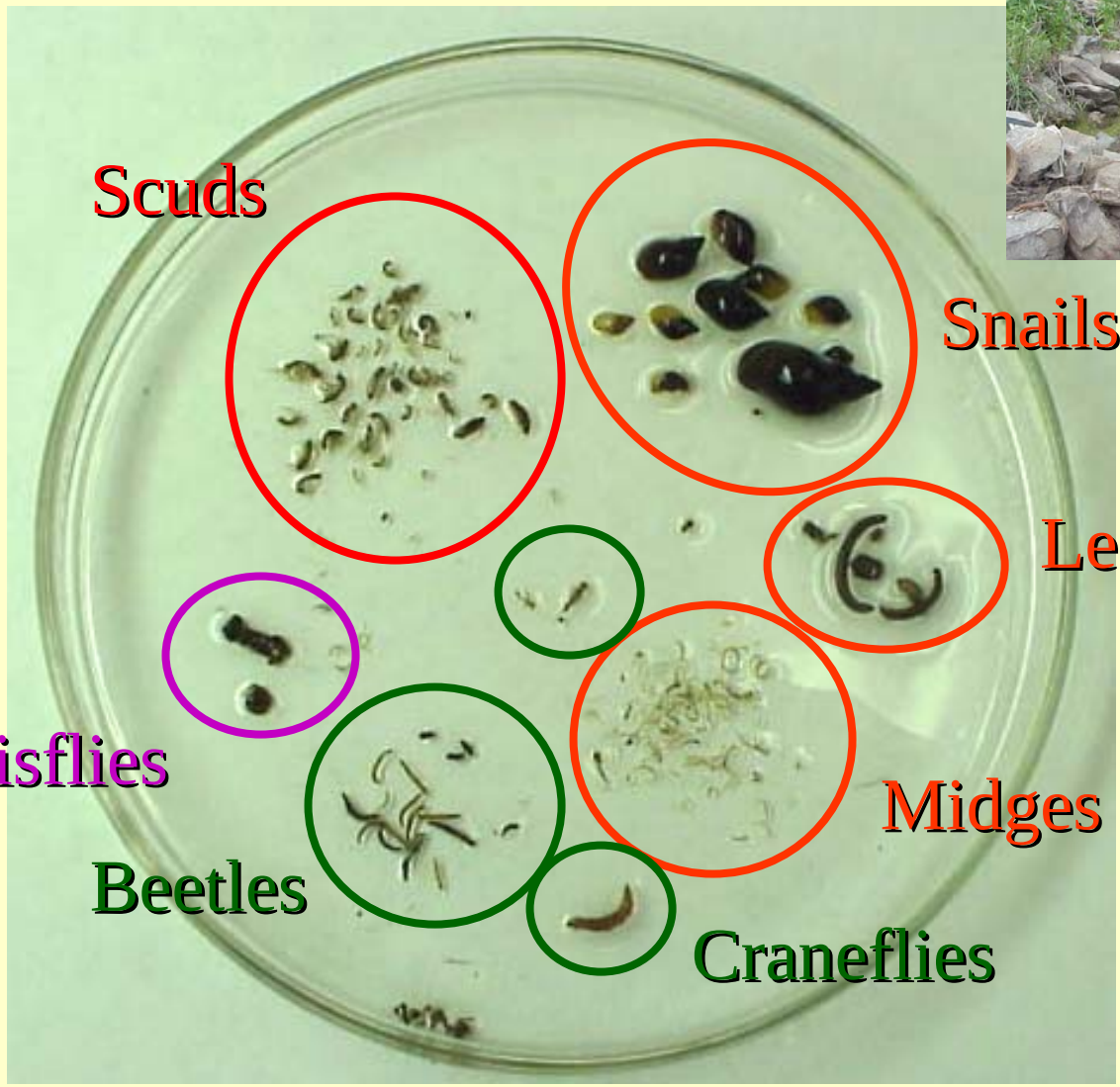
Third order stream draining a shopping mall

Second order stream through a cow pasture

A Tier 5-6 Community



ME Example BCG Tier 6

Toxic discharge

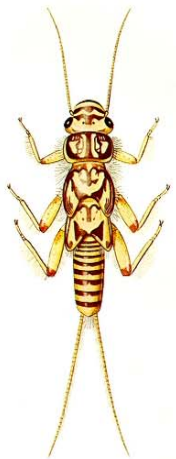
- **Generic Richness**
  - Total = 8
  - EPT = 0 (0%)
  - Mayfly = 0
  - Stonefly = 0
  - Caddisfly = 0
  - Midges = 3
  - Snails= 2
- **Abundance**
  - Total = 74
  - Mayfly = 0
  - Stonefly = 0
  - Snail= 52

- **II - Sensitive- rare, specialist**
  - none
- **III - Sensitive - ubiquitous, generalist**
  - none
- **IV - Intermediate tolerance, opportunistic**
  - none
- **V - Tolerant Taxa**
  - Helisoma 48
  - Thienemannimyia 16
  - Physa 4
  - Cricotopus 2
  - Ablabesmyia 1
  - Helobdella 1

TIER 1 COMMUNITY Vs. TIER 6 COMMUNITY

- **II - Sensitive- rare, specialist**
  - Taeniopteryx 48
  - Epeorus 13
  - Hexatoma 8
  - Probezzia 8
  - Isoperla 7
  - Pteronarcys 1
  - Capniidae 1
  - Chloroperlidae 1
  - Glossosoma 1
  - Brachycentrus 1
- **III - Sensitive - ubiquitous, generalist**
  - Ephemerella 127
  - Acentrella 13
  - Stenonema 8
- **IV - Intermediate tolerance, opportunistic**
  - Hydropsyche 24
  - Cheumatopsyche 5
- **V - Tolerant Taxa**
  - Polypedilum 8

- **II - Sensitive- rare, specialist**
  - none
- **III - Sensitive - ubiquitous, generalist**
  - none
- **IV - Intermediate tolerance, opportunistic**
  - none
- **V - Tolerant Taxa**
  - Helisoma 48
  - Thienemannimyia 16
  - Physa 4
  - Cricotopus 2
  - Ablabesmyia 1
  - Helobdella 1



Results of Regional BCG Workgroups:

ARID WEST

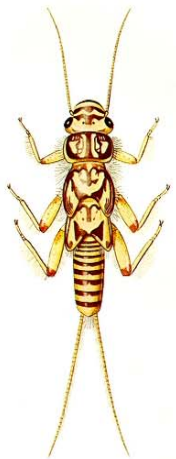
GREAT PLAINS

Attribute I- Historically documented, sensitive, long-lived, regionally endemic taxa

MAINE	*yellow lampmussell*	*brook stickleback*
WASHINGTON	spotted frog	steelhead
ARIZONA	spring snail	Gila trout
KANSAS	hickorynut mussell	blue sucker

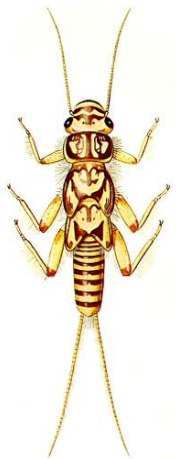
Attribute II- Sensitive-rare taxa

MAINE	*Taeniopteryx*	*longnose dace*
WASHINGTON	*Drunella dodsi*	bull trout
ARIZONA	*Drunella*	cutthroat trout
KANSAS	*Pseudiron centralis*	Plains killifish



Summary of 2001 Group Consensus

- **Tiers 1& 2 meet CWA biointegrity goal**
- **Tiers 1 thru 4 meet Interim Goal**
  - S&F maintained by replacement and redundancy;
  - some sensitive taxa still supported
  - balanced distribution of major groups
- **Tiers 5 & 6 do not meet the Interim Goal**
  - loss of function
  - sensitive taxa lost
  - hyperdominance or ‘unnatural’ distributions
- **High importance attributes should be retained (function, connectance, etc) even if not well-assessed now**.



Things we're thinking about for California

- How many classes of streams are in California from which BCGs would be constructed?
- How do we anchor the upper end of the BCG for significantly altered streams, such as in the Central Valley?
- Should non-native taxa be in Tier 1?
- How does the Biocondition Gradient relate to the Endangered Species Act?
- How do we transition from ***describing what we see*** to ***establishing thresholds***?

Applications - Establishing Reference Conditions