National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs

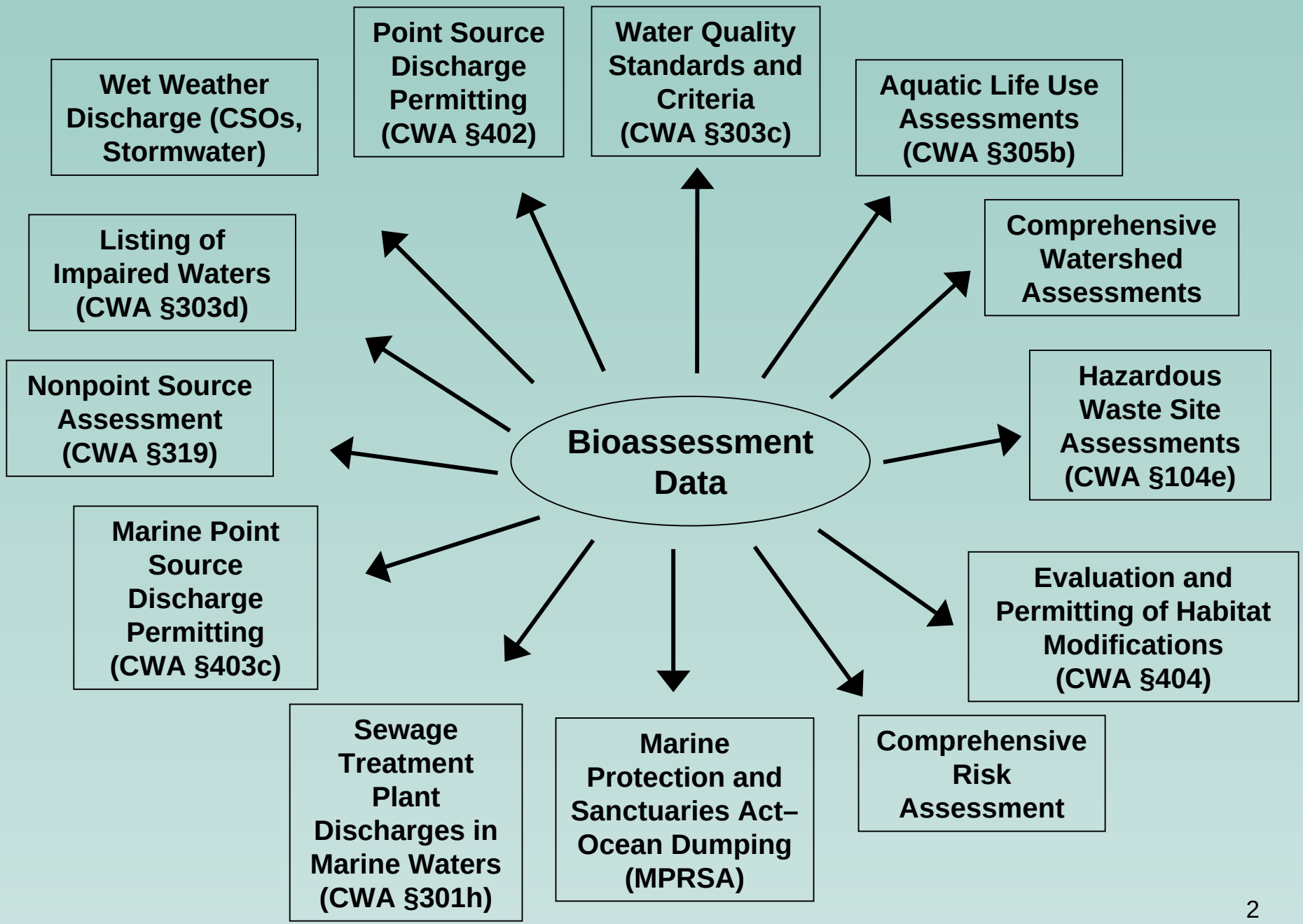
Coeur d'Alene, Idaho
31 March – 4 April, 2003

BIO 101

Technical Components of an Adequate Bioassessment Program

Michael Barbour, Tetra Tech, Inc.

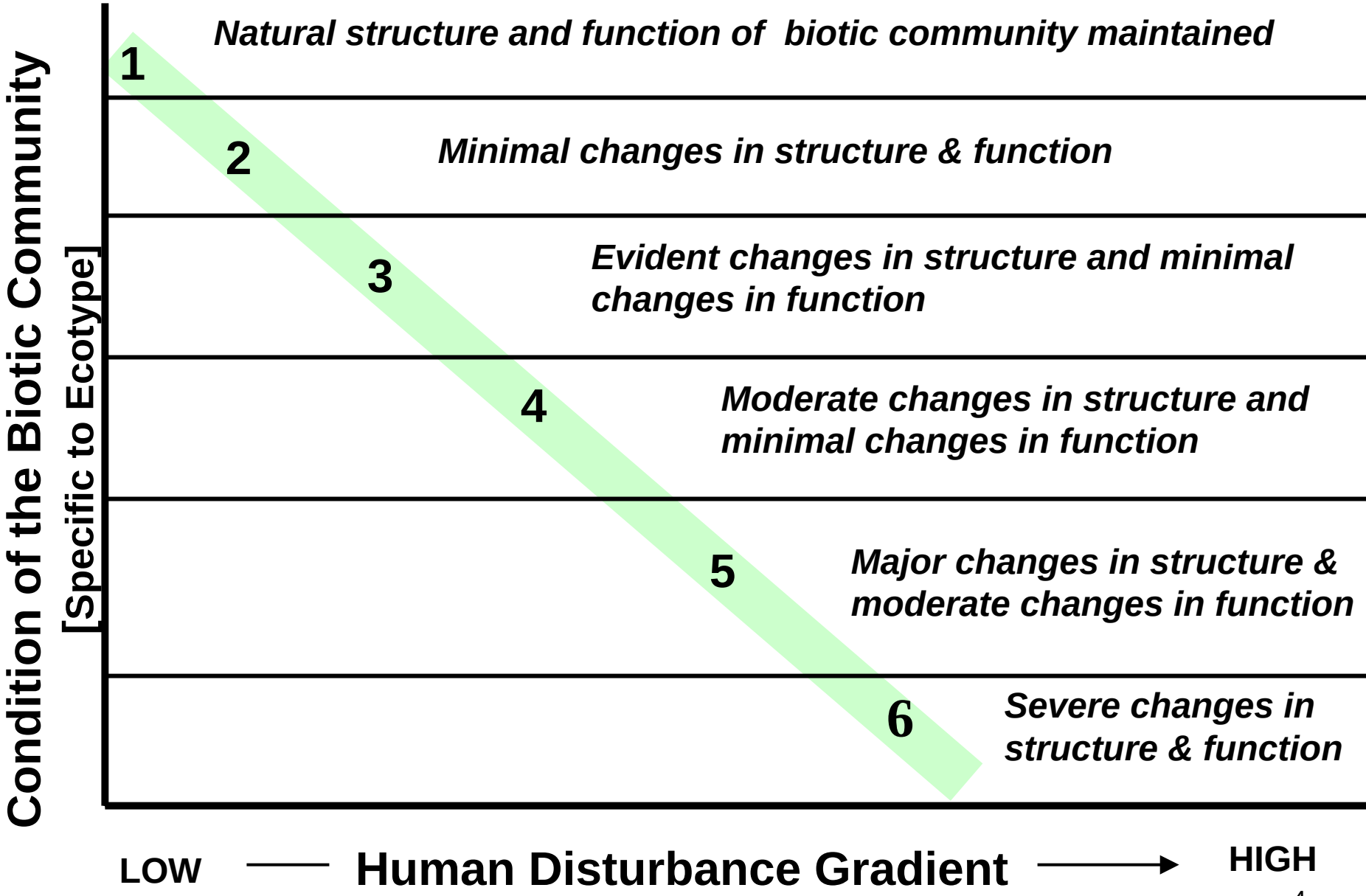
Chris Yoder, Midwest Biodiversity Institute


Bioassessment Data
Point Source Discharge Permitting (CWA §402)
Water Quality Standards and Criteria (CWA §303c)
Wet Weather Discharge (CSOs, Stormwater)
Aquatic Life Use Assessments (CWA §305b)
Listing of Impaired Waters (CWA §303d)
Comprehensive Watershed Assessments
Nonpoint Source Assessment (CWA §319)
Hazardous Waste Site Assessments (CWA §104e)
Marine Point Source Discharge Permitting (CWA §403c)
Evaluation and Permitting of Habitat Modifications (CWA §404)
Sewage Treatment Plant Discharges in Marine Waters (CWA §301h)
Marine Protection and Sanctuaries Act– Ocean Dumping (MPRSA)
Comprehensive Risk Assessment

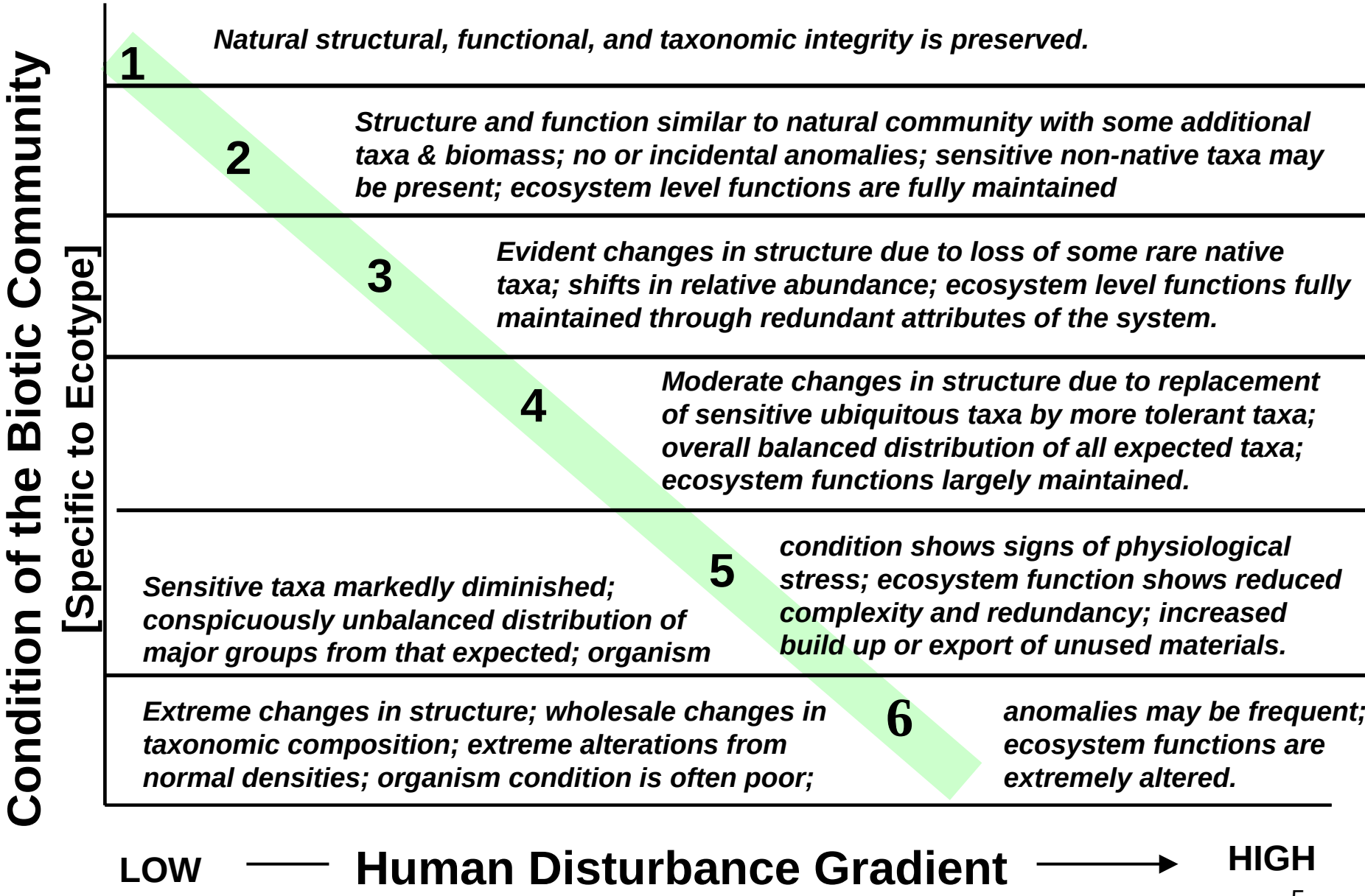
Levels of Rigor for Bioassessment

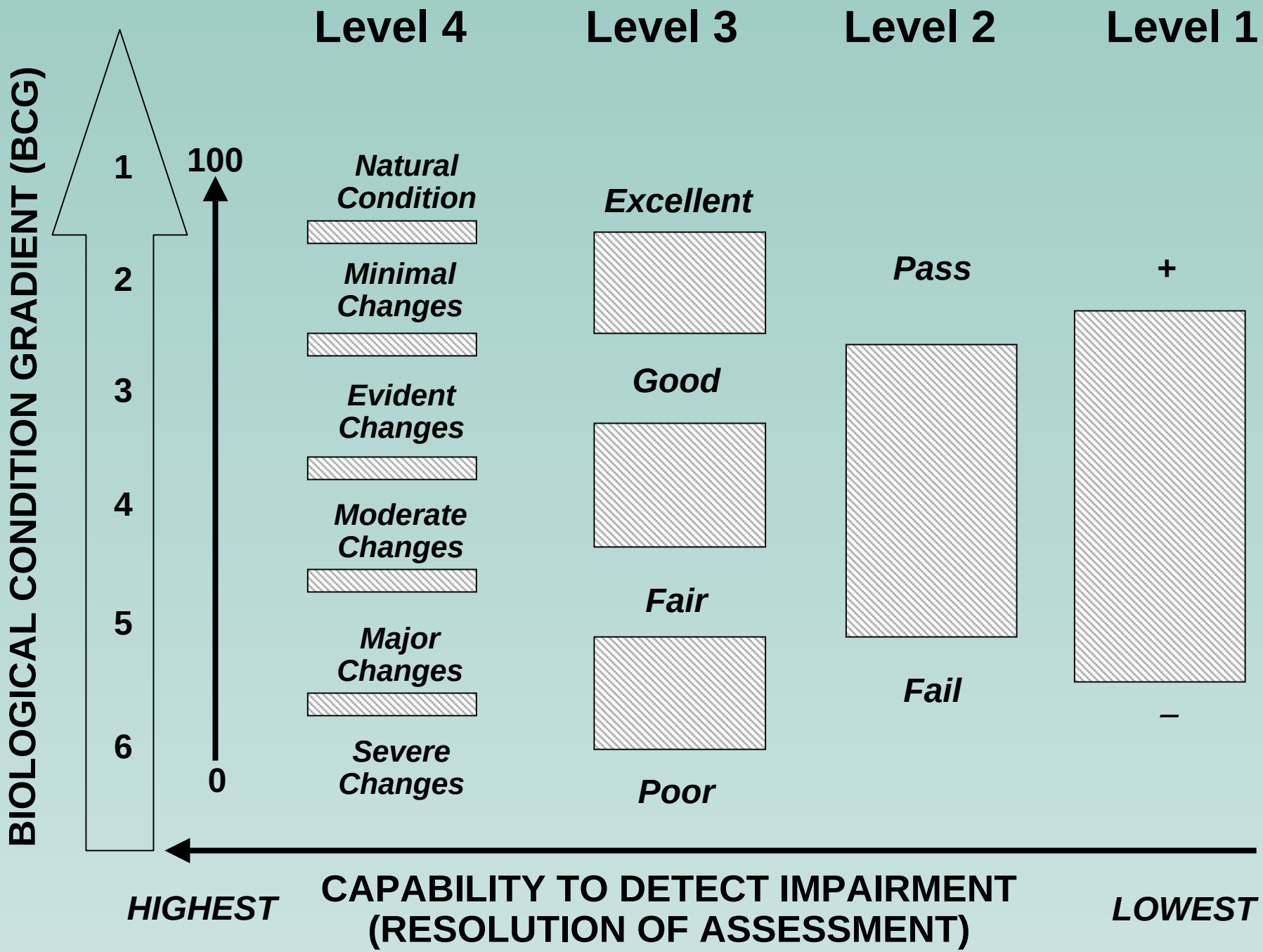
- Good quality ecological data are integral to effectively answer questions on condition, protection, restoration, etc.
- The rigor and quality of biological data are variable among agencies even though states and tribes use their data to address the same questions.
- Techniques with a low level of rigor will not be able to meet the levels of confidence required to support different decisions.

Tiered Aquatic Life Use Conceptual Model: Draft Biological Tiers



Tiered Aquatic Life Use Conceptual Model: Draft Biological Tiers -2




Level 4
Level 3
Level 2
Level 1
BIOLOGICAL CONDITION GRADIENT (BCG)
1
2
3
4
5
6
100
0
Natural Condition
Minimal Changes
Evident Changes
Moderate Changes
Major Changes
Severe Changes
Excellent
Good
Fair
Poor
Pass
Fail
+
–
HIGHEST
CAPABILITY TO DETECT IMPAIRMENT
(RESOLUTION OF ASSESSMENT)
LOWEST

Level of Bioassessment: Water Quality Management Program Support

Relative degrees to which the four different levels of bioassessment defined by the CALM process support selected water quality management program areas.

	Basic Reporting		WQS Program					Watersheds/NPS			TMDL/303d			NPDES/Other Permitting						
	Status	Trend	Tiered Uses	UAA	Refin-ed WQC	Anti-deg.	Site Spec-ific Crit. Mod.	NPS/ BMP Effect.	Hab-itat	Stre-ssor ID	List/ Delist	TMDL Dev.	Sever-ity/Ex-tent	WQ BELs	Priority Setting	CSOs/ SSOs	Storm-water Ph I & II	WET Limits/ Cond.	Enforc-ement	Dredge & Fill
1	W	W	—	—	—	—	—	W	W	—	—	—	—	—	—	—	—	—	—	—
2	W	W	W	W	—	W	—	W	W	—	W	—	W	—	—	W	W	—	—	—
3	W W	W W	W W	W W	W W	W W	W W	W W W	W W	W W	W W	W W	W W	W W	W W	W W	W W	W W	W W	W W
4	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W	W W W

www Comprehensively fulfills program support role by providing robust and complete assessment including scientific certainty, accuracy and relevancy of condition assessment, and causal associations.

ww Capable of providing program support, but cannot provide sufficiently robust, detailed, or accurate assessment information in all cases or at all scales; determination of causal associations may be limited in given instances.

w Insufficient to provide the level of detail and resolution needed to go beyond pass/fail assessments; accuracy is limited and little or no resolution for determining severity and magnitude and for causal associations.

— Inadequate for program support due to limited accuracy, resolution, detail, and power of assessment.

C. Levels of rigor for bioassessment ranging from the lowest (Level 1) to the highest rigor (Level 4). Make a check ☑ in the appropriate box for each topical category:

	L1	L2	L3	L4
I. Key Technical Elements for a Bioassessment Program				
1. Temporal Coverage				
o **No consistent index period**				
o **Index period for convenience, varies**				
o **Documented index period, may vary**				
o **Comprehensive coverage within index period**				
2. Spatial Coverage				
o **Simple design, no statewide coverage**				
o **"Synoptic" design (8 digit HUC)**				
o **Rotating basin; single design (8 digit HUC)**				
o **Statewide; comprehensive rotating basin; multiple designs (11-14 digit HUC)**				

1. Temporal Coverage

Level 1	Level 2	Level 3	Level 4
• No index period • Sampling can be scattered throughout the year	• Index period for convenience in sampling or to match existing programs • Sampling outside the index period may be done, but reserved for emergency response monitoring	• Well-documented seasonal index period(s), or coverage is comprehensive • Sampling outside index period is adjusted for seasonal influences	• Well-documented seasonal index period(s) • Multiple samplings at sites during index period(s) • Index period(s) based on known ecology to minimize natural variability and maximize gear efficiency

2. Spatial Coverage

Level 1	Level 2	Level 3	Level 4
• Individual site survey • Up/downstream and Fixed station design • No statewide assessment	• Multiple sites • Spatial design limited to a few basins • Synoptic design at 8-digit HUC common	• Well established spatial network • Statewide design using rotating basins • Single design	• Well established spatial network • Statewide design using comprehensive rotating basins • Multiple study designs

3. Reference Conditions

Level 1	Level 2	Level 3	Level 4
• No formal reference conditions • Basis may be presence and absence of key taxa • Professional opinion may be used	• Pre-established by professional and based on known ecology of area • Site-specific control or paired watershed approach • Regional sites generally not used	• Site-specific or watershed based • Regional reference sites developed but too few or do not reflect statewide coverage	• Regional reference conditions for each waterbody ecotype, consisting of sites and/or other means of establishing regional expectations

4. Criteria for Reference Sites

Level 1	Level 2	Level 3	Level 4
• Best professional judgment (BPJ) • Support from quantitative data lacking	• Based on “best biology”, i.e., BPJ on what best biology would be at reference • Minimal non-biological data	• Non-biological criteria supported by narrative descriptors only • Combine BPJ with narrative description of land use and site characteristics	• Quantitative descriptors to support non-biological criteria • Best expectations established for a biological framework • Phys/chem secondary

5. Natural Classification

Level 1	Level 2	Level 3	Level 4
• No partitioning of natural variability in aquatic ecosystems • Minimal classification limited to watersheds or basins	• Statewide or regional classification based on one stratum	• Classification based on a combination of landscape features and physical habitat structure of waterbody type	• True regional classification that transcends jurisdictional boundaries to strengthen inter-regional classification

6. Aquatic Resource Classification

Level 1	Level 2	Level 3	Level 4
• Classification strata lacking • Single, general aquatic resource considered throughout waterbody type	• General classification recognizes sub-assemblage attributes, e.g., fishery based coldwater and warmwater streams • No subcategories	• Well-defined subcategories of aquatic resource with distinctive assemblages • May only be developed for one ecotype	• Fully partitioned and stratified classification of resource • All relevant ecotypes addressed and includes full range of BCG

7. Indicator Assemblages

Level 1	Level 2	Level 3	Level 4
• Single assemblage • Visual observation of biota • Poor taxonomic resolution	• Single assemblage (usually macro-invertebrates) • Low taxonomic resolution (family level or higher)	• Single assemblage • High data quality and reliable taxonomic resolution to lower levels (genus/species) • If multiple assemblages, one is low resolution or used infrequently	• Two or more assemblages • High taxonomic resolution to the lowest practical taxon (mostly genus/species) • Formal certification program

8. Sample Collection

Level 1	Level 2	Level 3	Level 4
• Cursory documentation of methods, usually not written as SOPs • Highly variable methods, relying primarily on best professional judgment (BPJ)	• Textbook methods documented • Training consists of short courses (1-2 days)	• Methods detailed for state purposes • Formal QA/QC program • Rigorous training for new staff; periodic for all staff	• Same as Level 3, but methods cover multiple assemblages • Certification program in place

9. Sample Processing

Level 1	Level 2	Level 3	Level 4
• Field processing using visual guides • Dependent on operator skill	• Field processing and enumeration • No estimates of precision or accuracy • If fish, cursory examination of presence and absence	• Laboratory processing of all samples when QC control is high • Precision and accuracy is known	• Same as Level 3, but methods cover multiple assemblages • Whole samples may be processed

10. Precision of Assessments

Level 1	Level 2	Level 3	Level 4
• Precision is not determined • Capability of indicator to distinguish between human and natural influences is unknown	• Precision is known; enables more consistent sampling and higher precision • Capability of indicator to distinguish between human and natural influences has been determined based on other state or region studies	• Moderately high precision • Capability of indicator to distinguish between human and natural influences has been documented within state or tribe, but without gradient of stressors	• Highest precision • Capability of indicator to distinguish between human and natural influences high and based on a gradient of stressors

11. Ecological Attributes (as per BCG)

Level 1	Level 2	Level 3	Level 4
• No linkage to the BCG • No adherence to the ecological attributes	• Only inferences made to a few simple structural attributes • Sensitive/ tolerant ubiquitous	• Ecological attributes used as foundation • May not be fully developed • Surrogate measures used for key functional attributes • BCG conceptual underpinnings	• Level of rigor adequate to directly or indirectly address ecological attributes • Multiple assemblages

12. Biological Endpoints and Thresholds

Level 1	Level 2	Level 3	Level 4
• No formal index or community-based endpoint • Presence/ absence of targeted species based on visual assessment • Attainment thresholds not specified	• Index established for specific water-bodies, but likely not calibrated • Index relevant to only one assemblage • Presence/ absence based on all taxa • BPJ thresholds based on single dimension attributes	• Index developed and calibrated for state or region • Index relevant to only one assemblage • Attainment thresholds based on discriminant model or distribution of reference sites, or some means of quantifying reference condition	• Indexes for multiple assemblages developed and calibrated for use throughout state or region • Multiparameter evaluations based on integrated data calibrated to a regional reference condition

13. Sensitivity

Level 1	Level 2	Level 3	Level 4
• Coarse method (low signal) detects only high and low values	• Limited to pass/fail determinations of attainment status • No incremental measurement along BCG	• High signal to noise ratio • Power to detect 3 or 4 discrete levels on BCG • Quantitative support for narrative descriptions	• Integrated signal able to detect status on an incremental scale • Power to detect at least $5 categories of condition

14. Diagnostic Capabilities

Level 1	Level 2	Level 3	Level 4
• No diagnostic capability due to lack of resolution • No interpretive experience	• Coarse indications of response via assemblage attributes • Little or no supporting analysis across spatial and temporal scales	• Development of indicator guilds and other aggregated attributes • Usually involves refined taxonomy • Supported by analysis of comprehensive datasets	• Response patterns are most fully developed and supported by case studies • Involves refined taxonomy for two or more assemblages

Bioassessment and Biocriteria Program Development Timeline

INITIAL DEVEOPMENT PHASE

0-18 MONTHS

INITIAL IMPLEMENTATION PHASE

12-24 MONTHS

INITIAL ASSESSMENT PHASE

18 MO – 6 YEARS

FULL ASSESSMENT PHASE

5 – 10 YEARS

Start-Up Tasks: Logistics

Acquire Staffing:
- Professional biologists with expertise & training
- Database manager
- Interns/technicians (field work, lab tasks

Acquire Facilities & Equipment:
- Outfit laboratory and field facility
- Office accommodations
- Database support infrastructure

Methods Development:
- Review and select candidate methods and protocols
- Consider MQO/DQO needs
- Test methods for applicability
- Analyze test results – select methods

Start-Up Tasks: Implementation

Initiate Field Sampling:
- Review spatial designs
- Develop QA/QC and QAPP
- Develop sampling plans in accordance with monitoring strategy
- Pilot assessments

Classification Issues:
- Consider spatial stratification issues
- Develop and test reference condition approach
- Select and sample reference sites
- Develop index development and calibration strategy

Program Implementation

Biocriteria Development:
- Select candidate metrics and/or assessment tools
- Develop refined uses - narratives
- Test metrics and develop calibrated indices
- Evaluate via bioassessments

Water quality Program Support:
- Develop capacity to support WQ programs (WQS/UAAs, TMDLs, permits, planning)
- Formalize water quality program support as capacity is developed

Program Maintenance

Biocriteria Development:
- Refine metrics and develop calibrated indices
- Develop reference benchmarks for calibrated indices according to classification scheme and by major aquatic ecotype

Water quality Program Support:
- Fully functioning bioassessment program supports WQS (UAAs, aquatic life use support) and basic program needs (305b/303d)
- Program development should be fully initiated – e.g., integrated chemical, physical, and biological database supports criteria & policy development

Continuously evaluate program

Quality Improvement Process

Evaluate effectiveness of initial decisions – make needed adjustments