A photograph of a desert landscape. In the foreground, a stream flows over dark, wet rocks. The middle ground shows a rocky, light-colored hillside with several tall, columnar cacti and some green shrubs. The background is a clear blue sky.

Bioindicator use in Arizona's Water Quality Program

Patrice Spindler
Arizona DEQ



Arizona's Stream monitoring program

- Chemical water quality for human health designated uses, aquatic life (A&W_w, A&W_c, A&W_e, A&W_{edw}), irrigation & livestock watering
- Biological monitoring (macroinvertebrates) for aquatic life condition (A&W_w, A&W_c)
- Physical integrity monitoring (stream bottom deposits & channel stability)

Biological monitoring

- Probabilistic monitoring design on 3 year statewide rotation
- Annual monitoring reference sites for maintenance of reference condition
- Historic biological samples from 1992- present collected to develop biocriteria for standards & assessment purposes.

Biocriteria Standard

- Newly adopted biological standard in AZ WQS (Dec 2, 2008)
- Hybrid standard; narrative & numeric
- Based on macroinvertebrate community
- Empirically based with approx 70 reference sites statewide & 250 samples to develop warm and cold water Indexes of biological integrity

Narrative Biocriterion

E. A wadeable, perennial stream shall support and maintain a community of organisms having a taxa richness, species composition, tolerance, and functional organization comparable to that of a stream with reference conditions in Arizona.



Numeric Biocriteria

■ C. Arizona Index of Biological Integrity (IBI)

Macroinvertebrate bioassessment result	Index of Biological Integrity Score	
	Cold water	Warm water
Greater than the 25 th percentile of reference condition	≥ 52	≥ 50
Greater than the 10 th and less than the 25 th percentile of reference condition	46 – 51	40 – 49
Less than the 10 th percentile of reference condition	≤ 45	≤ 39

R18-11-108.01

Biological Criterion



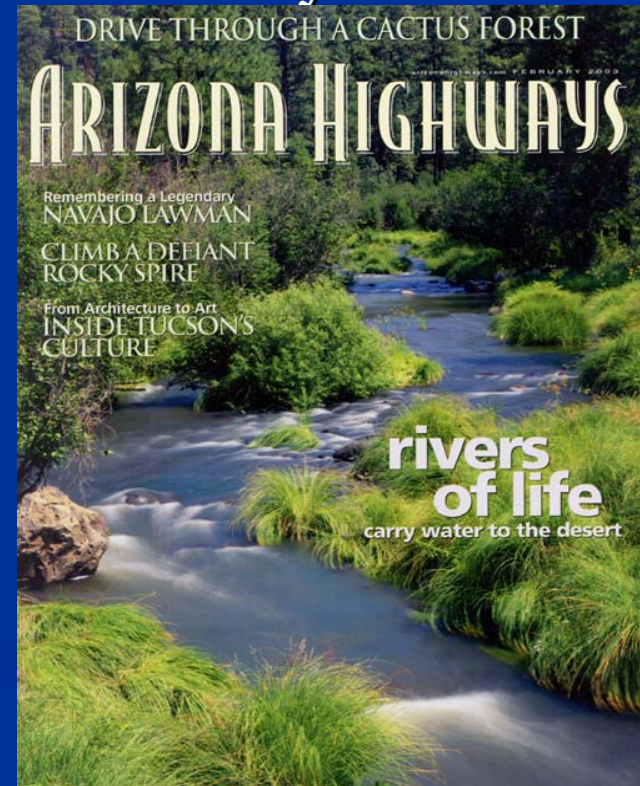
- $\geq 25^{\text{th}}$ percentile of reference = **Pass**
- $\leq 10^{\text{th}}$ percentile of reference = **Fail**
- $> 10^{\text{th}}$ and $< 25^{\text{th}}$ = Inconclusive.
 - Requires a second bioassessment. If second bioassessment is $< 25^{\text{th}}$ percentile of reference = **Fail**.

Biocriteria applicability

- Apply to wadeable, perennial streams with riffle/run habitat, sampled during spring index period, and have A&Wc and A&Ww designated uses **only**.

- Does not apply to:

- Large rivers
- EDWs
- Intermittent waters
- Ephemeral waters
- Lakes and reservoirs



Bioassessment in Water Quality Programs in Arizona

- Water quality assessment of streams (305b) reporting to USEPA
- Listing of “impaired waterbodies” (303d)
- AZPDES permits – ambient water quality testing using bioassessment
- Effectiveness monitoring of TMDLs, restoration projects (319)

Indexes of Biological Integrity

- Developed separately for warm and cold water regions
- 5000' elevation threshold
- Multi-metric approach

Warm water metrics in the IBI

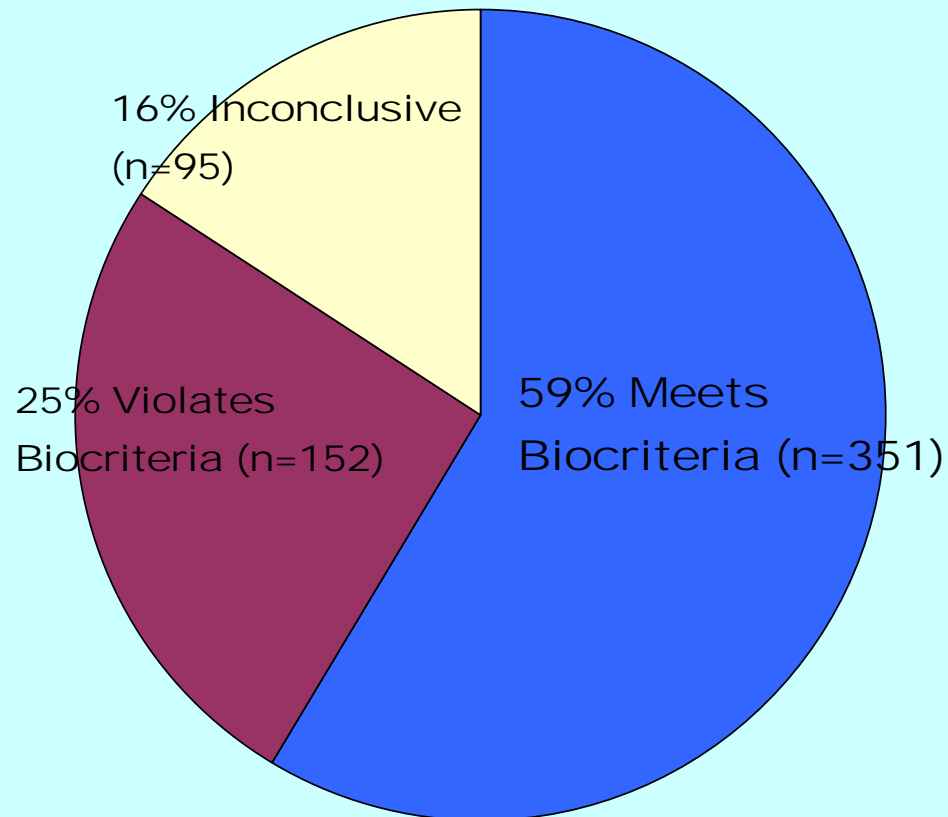
- Total taxa richness (ref. Value 37)
- Mayfly taxa richness (ref. Value 9)
- Caddisfly taxa richness (ref. Value 9)
- Diptera taxa richness (ref. Value 10)
- Percent dominant taxon (ref. Value 19.1)
- Percent composition by mayflies (ref. Value 70)
- Hilsenhoff Biotic Index (HBI) (ref. Value 4.9)
- Percent Scraper composition (ref. Value 23.7)
- Scraper taxa richness (ref. Value 7)

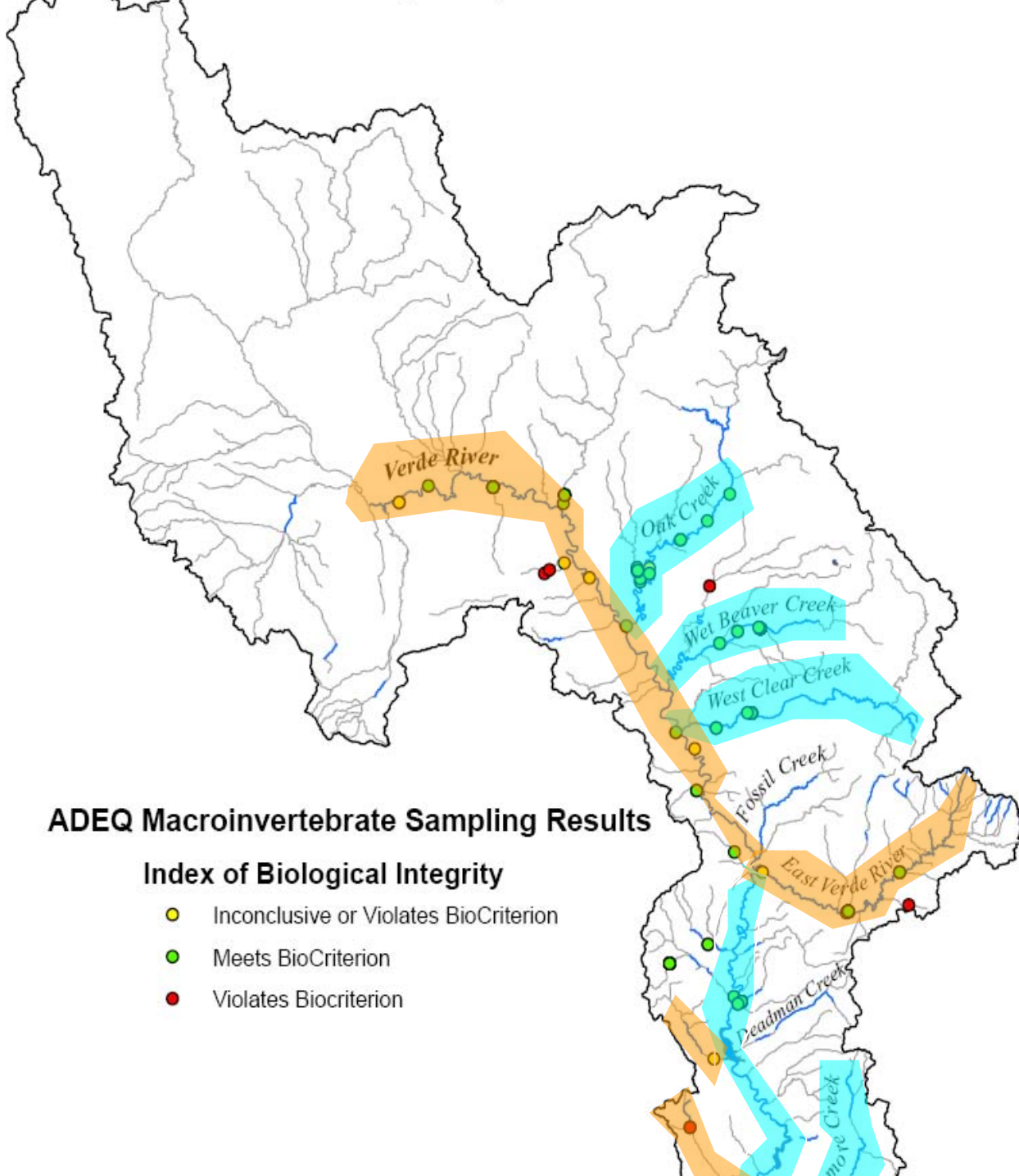
Cold water metrics in the IBI

- Total taxa richness (ref.value 38)
- Diptera taxa richness (ref.value 11)
- Intolerant taxa richness (ref.value 6)
- Hilsenhoff Biotic Index (ref.value 4.2)
- Percent stonefly composition (ref.value 19)
- Percent scraper composition (ref.value 45.1)
- Scraper taxa richness (ref.value 11)

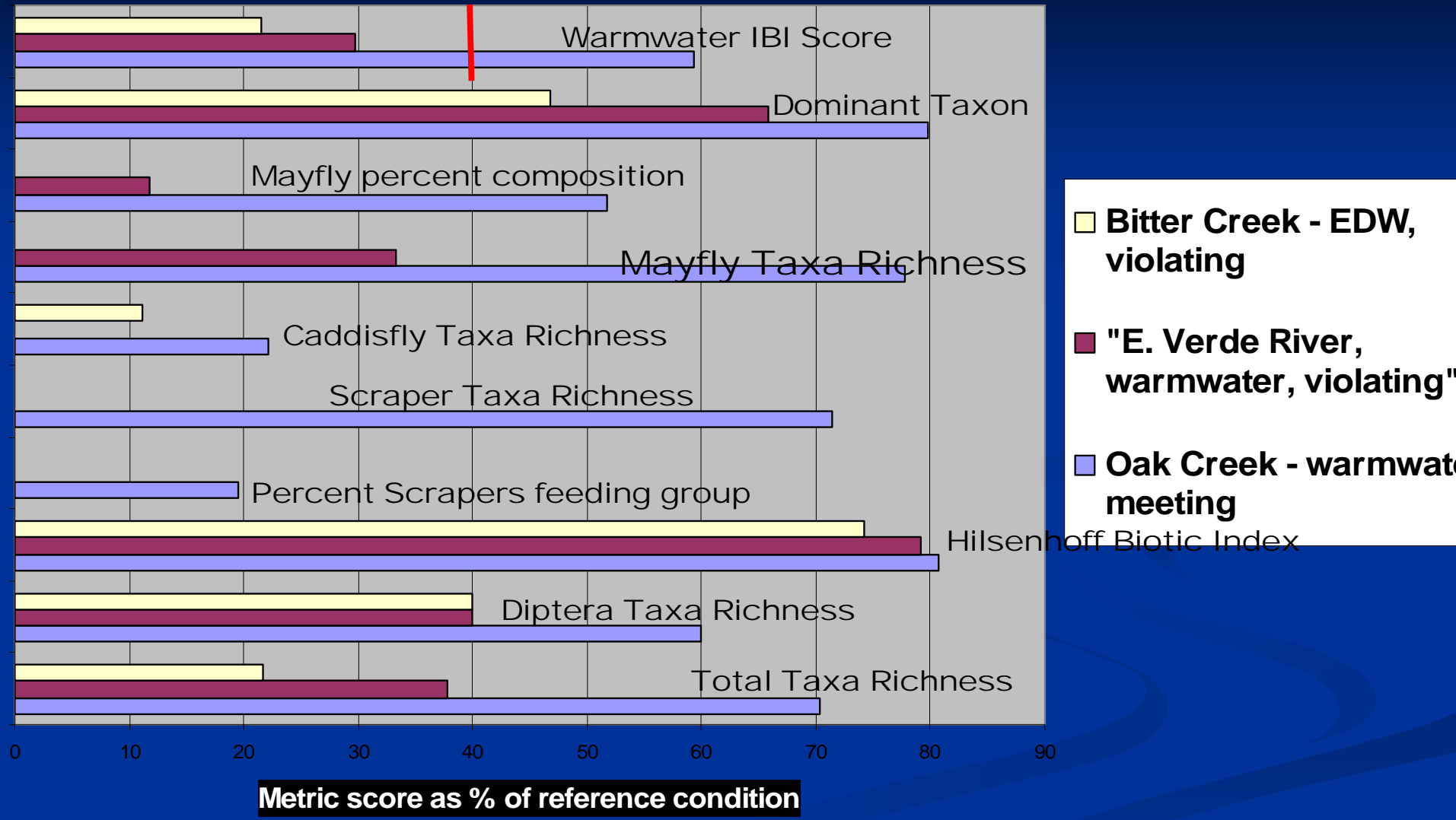
Bioassessment Results

Percent of AZ Macroinvertebrate Samples Meeting ADEQ Biocriteria (1992-2007)





Metric scores for 3 Verde River Basin macroinvertebrate samples



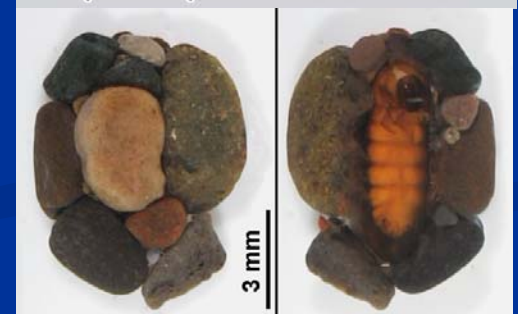
REMAP

Bioassessment Objectives

- Conduct methods comparison study of ADEQ and EPA-EMAP macroinvertebrate & habitat methods
- Produce EMAP probabilistic assessment of perennial streams in the LCR watershed



Ephemeroptera - Baetidae - Baetis



Trichoptera - Glossosmatidae - Glossosoma



Trichoptera - Lepidostomatidae - Lepidostoma

REMAP

Methods comparison study

- Macroinvertebrates are the bioindicator
- Random selection of 30 perennial stream reaches in the Little Colorado River Basin
- Selected 6 targeted sites: 3 reference + 3 stressed
- Collect macroinvertebrates + habitat data using DEQ & EPA methods
- Evaluate ability of each approach to detect disturbed and reference communities using ADEQ cold water Index of Biological Integrity



Macroinvertebrate Methods		
Parameter	ADEQ method	EPA method
Reach length	100m min.	150m min.
Habitat sampled	Riffle/run erosional habitat	Reach-wide, Multi-habitat, erosional & depositional
Area sampled	27 ft ²	11 ft ²
Net mesh size	500 μ	500 μ
Sampling approach	Traveling kick net	Stationary box
Sampling effort	3 minutes	5.5 minutes
Preservation	99% Isopropanol	95% Ethanol
Index period	Spring, avoid high flows	No index period, avoid high flows
Macroinvertebrate identification	Genus level taxonomy, 500 count minimum	Genus level taxonomy, 500 count minimum
Assessment tool	AZ empirically derived	EPA west-wide Xeric

Predicted Outcomes of AZ REMAP Project

- Enable use of ADEQ Indexes of Biological Integrity with both sampling methods to achieve comparable results
- Determine how the probabilistic bioassessment approach will work with current 305b assessment approach
- Provide input into monitoring strategy on probabilistic design and EPA sampling methods



Future Research

- Intermittent and ephemeral streams
- Effluent Dependent Waterbodies
- Large rivers
- Lakes

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- **For More Information about Arizona's Bioassessment Program:**
 - **www.azdeq.gov/envIRON/water/assessment**