Relationships among exceedences of metals criteria, the results of ambient bioassays, and community metrics in metals-impaired streams

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Three Methods

- **Chemical criteria** – AWQCs or sediment effect levels – for the protection of aquatic life
- **Ambient Bioassays** – assess the ambient toxicity of water or sediment
- **Bioassessments** of selected biotic assemblages – fish or macroinvertebrates

Measurement Endpoints

- **Chemical criteria**: based on measures of individual responses in bioassays – individual-level effects
- **Ambient bioassays**: measure individual responses of selected species – individual-level effects
- **Bioassessments**: measure community-level effects

Other Differences

- differences in the stressor specificity:

Chemical criteria - measured contaminants with criteria

Ambient bioassays - bioavailable toxicants in the tested media

Community metrics - although sensitive to a toxicant, may also be sensitive to other stream alterations

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Objectives

- Compare conclusions: effects of contaminants in different reaches - three methods for assessment of contaminant exposure and effects (waters or sediments)
- Greater understanding of relationships: levels of biological organization used as measurement endpoints in these methods

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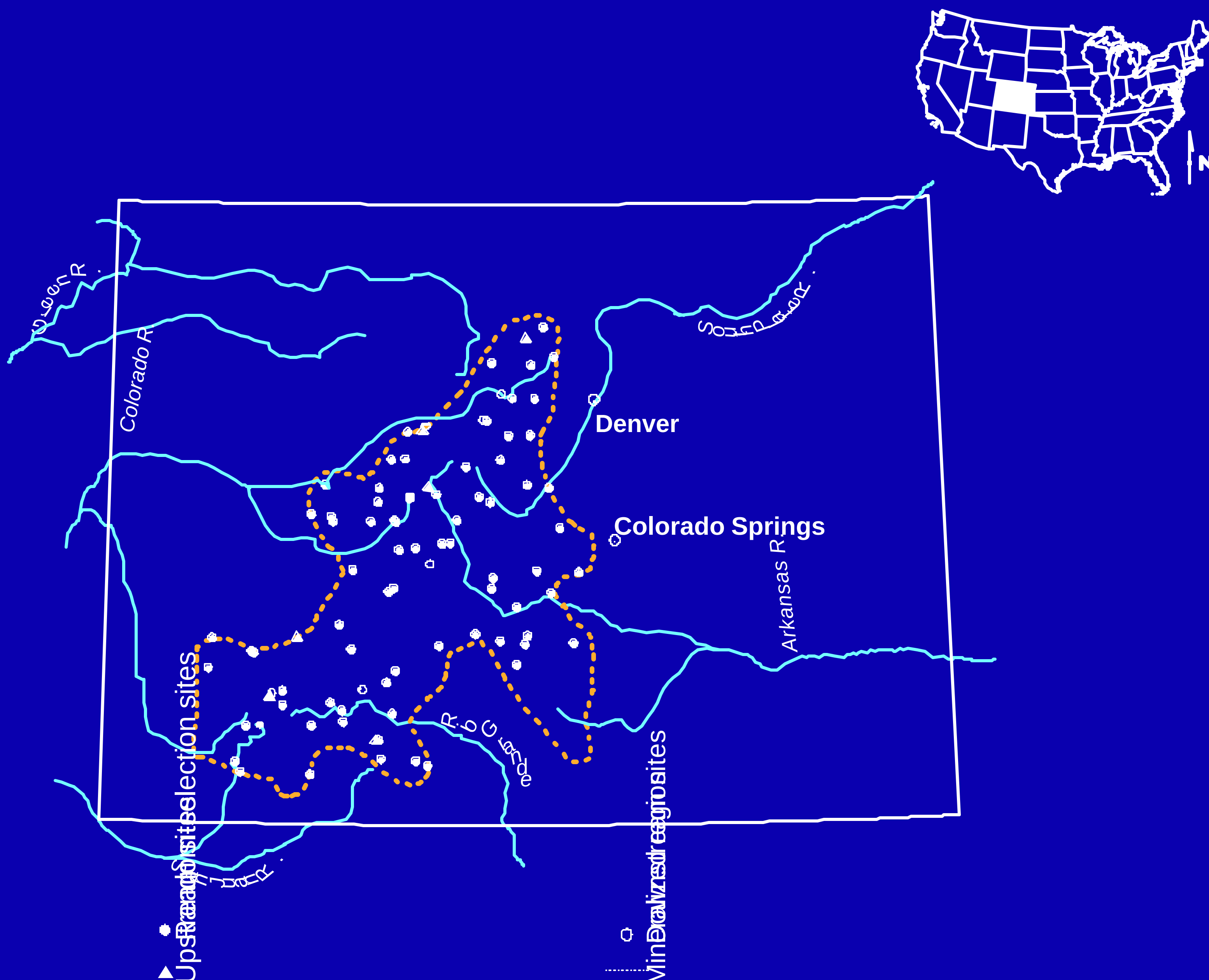

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Methods

- Standard EMAP protocols – biological assemblages, physical habitat, and water chemistry
- Water – dissolved metals and hardness, 48-hr mortality tests with *Ceriodaphna dubia* & *Pimephales promelas*
- Sediment – total metals, 7-d growth and mortality tests with *Hyallela azteca*

Variables to Classify Reaches

Variable	Endpoint
Dissolved concentrations – Cd, Cu, Pb, or Zn	> Hardness-adjusted dissolved chronic criteria
Survival – *C. dubia* or *P. promelas* (48-hr test)	< 80% survival
Sediment concentrations – Cd, Cu, Pb, or Zn	> TEL (28-day H. azteca sediment toxicity test)
Survival or growth – *H. azteca* (7-day test)	< 85% survival or < 90% growth

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Comparing Media

Criteria (? = +0.89)		Were water criteria exceeded?		
		No	Yes	Total
Were sediment TELs exceeded?	No	53	3	56
	Yes	15	15	30
	Total	68	18	n = 86
Bioassays (? = +0.83)		**Did water bioassays show effects?**		
		No	**Yes**	**Total**
Did sediment bioassays show effects?	No	63	4	67
	Yes	10	7	17
	Total	73	11	n = 84

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Comparing Methods

Water (? = +0.98)		Were water criteria exceeded?		
		No	Yes	Total
Did water bioassays show effects?	No	65	8	73
	Yes	1	10	11
	Total	66	18	n = 84

Sediment (? = +0.73)		Were sediment TELs exceeded?		
		No	Yes	Total
Did sediment bioassays show effects	No	49	18	67
	Yes	5	12	17
	Total	54	30	n = 84

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Metrics exhibiting differences

Macroinvertebrates

Total taxa richn.
Total abundance
Abundance per taxon
Intolerant taxa richn.
Ephemeroptera taxa richn.
Plecoptera richn.
Trichoptera taxa richn.
EPT taxa richn.
Chironomidae taxa richn.
% Ind., tolerant taxa
Orthoclainae taxa richn.
Tanytanrsini taxa richn.
Coleoptera taxa richn.
% Ind., Ephemeroptera
% Orthocladinae (Chironomidae)
% Tanytarsini (Chironomidae)
% Ind., Coleoptera
% Ind., Diptera & noninsects
% Ind., 5 most common taxa
Collector-filterer taxa richn.
Collector-gatherer taxa richn.
Predator taxa richn.
Shredder taxa richn.
Scraper taxa richn.

Fish

Total species richn.
Salmonidae species richn.
Total abundance
Adult abundance
Salmonidae abundance
% Ind., native species
% Ind., Salmonidae
% Ind., native Salmonidae
% *Oncorhynchus* (Salmonidae)

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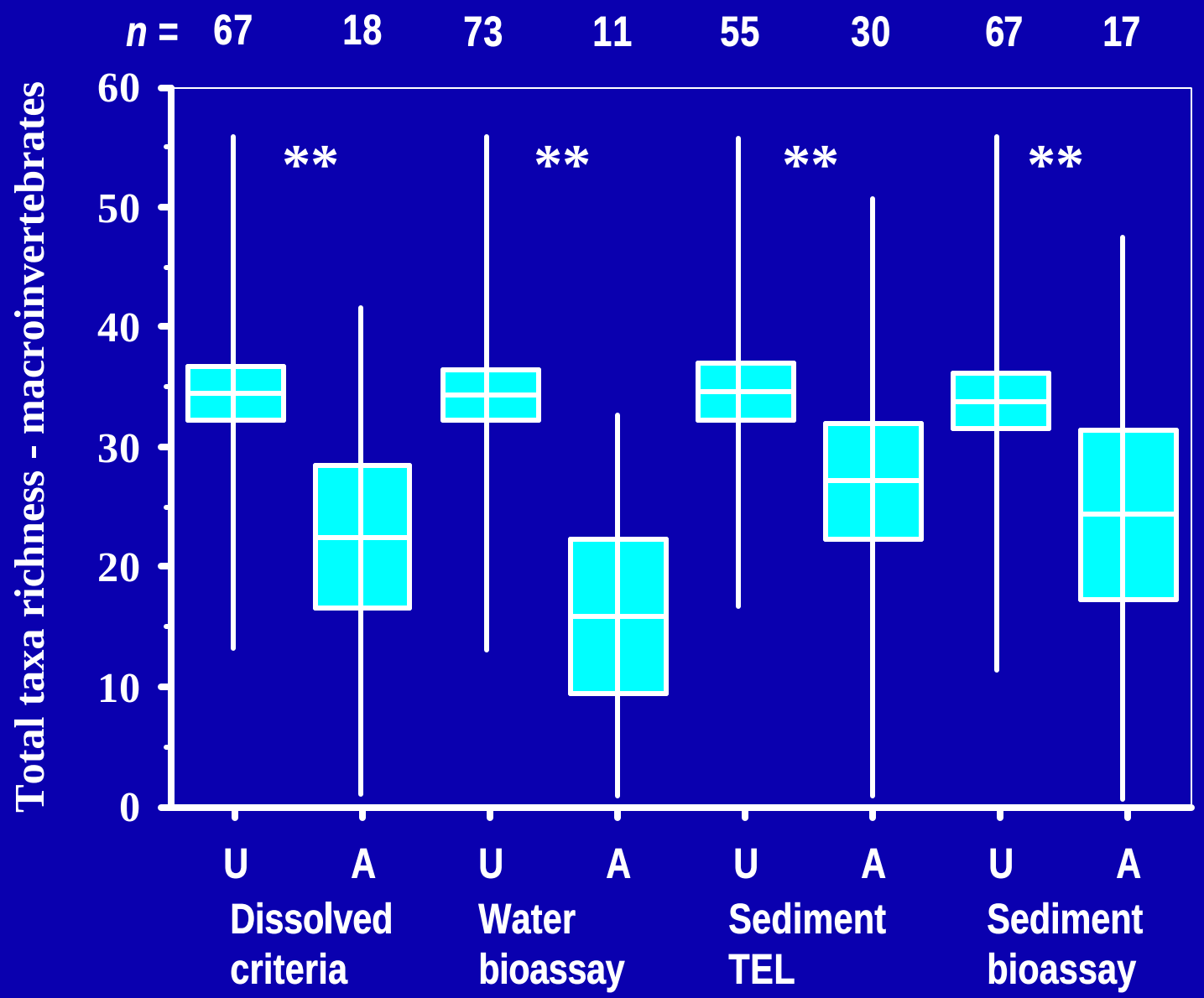

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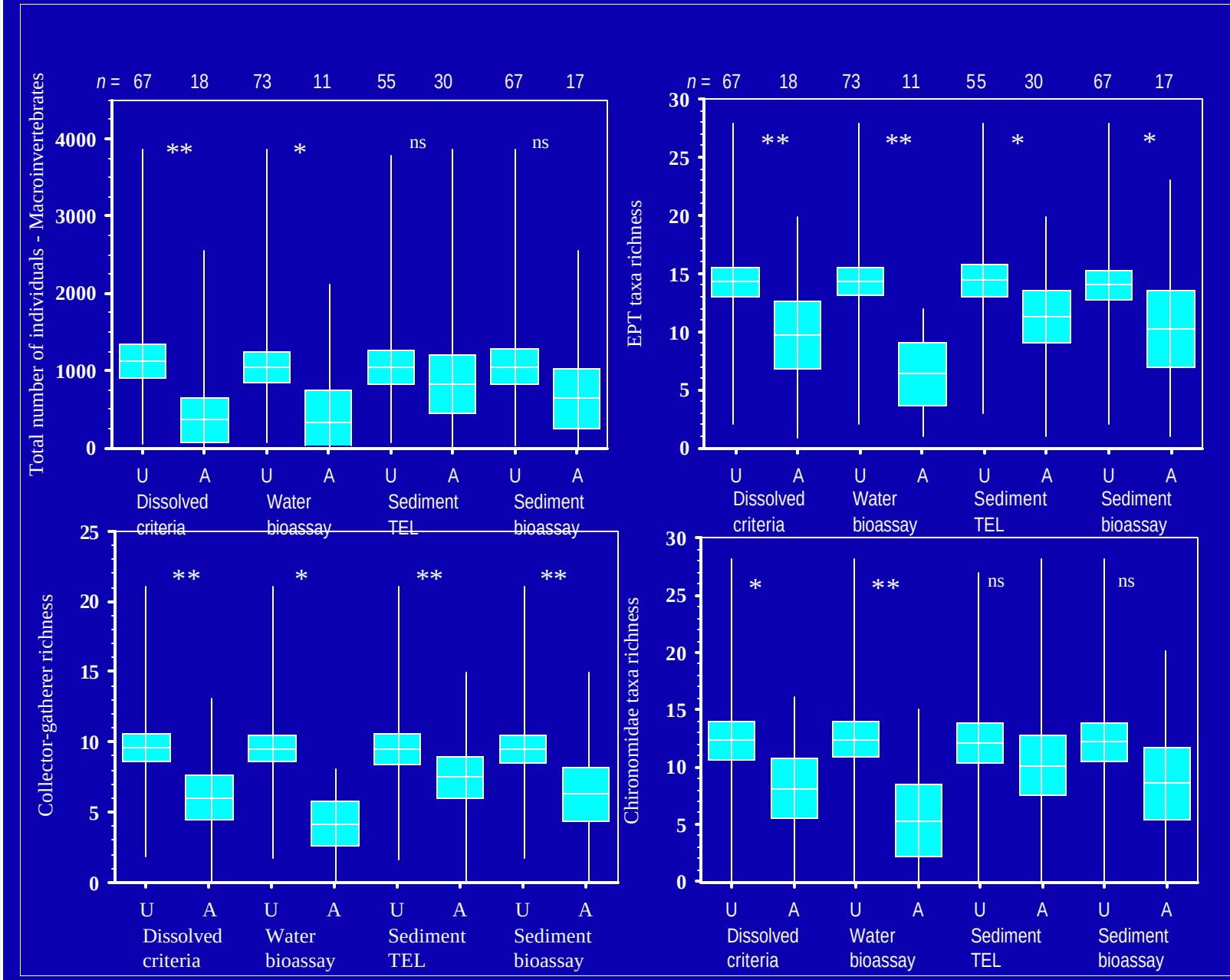

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Individual-effects measures versus community metrics - water

Metric	Classified as unimpaired	Metric < 95% LCL for unimpaired group	Classified as impaired	Metric > 95% UCL for impaired group
Water criteria				
Total taxa richn.- inverts	67	28	18	6
Total no. individuals	67	36	18	1
EPT taxa richn.	67	20	18	4
Water bioassays				
Total taxa richn.– inverts	73	29	11	3
Ephemeroptera t. richn.	73	24	11	2
Chironomidae t. richn.	73	32	11	3

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Individual-effects measures versus community metrics – sediment

Metric	Classified as unimpaired	Metric < 95% LCL for unimpaired group	Classified as impaired	Metric > 95% UCL for impaired group
Sediment TELs				
Total taxa richn.- inverts	55	21	30	13
Ephemeroptera t. richn.	55	25	30	9
Shredder taxa richn.	55	30	30	8
Sediment bioassays				
Total taxa richn.– inverts	67	26	17	7
Tanytarsini t. richn.	73	24	11	2
Tanytarsini/Chironomidae	73	32	11	3

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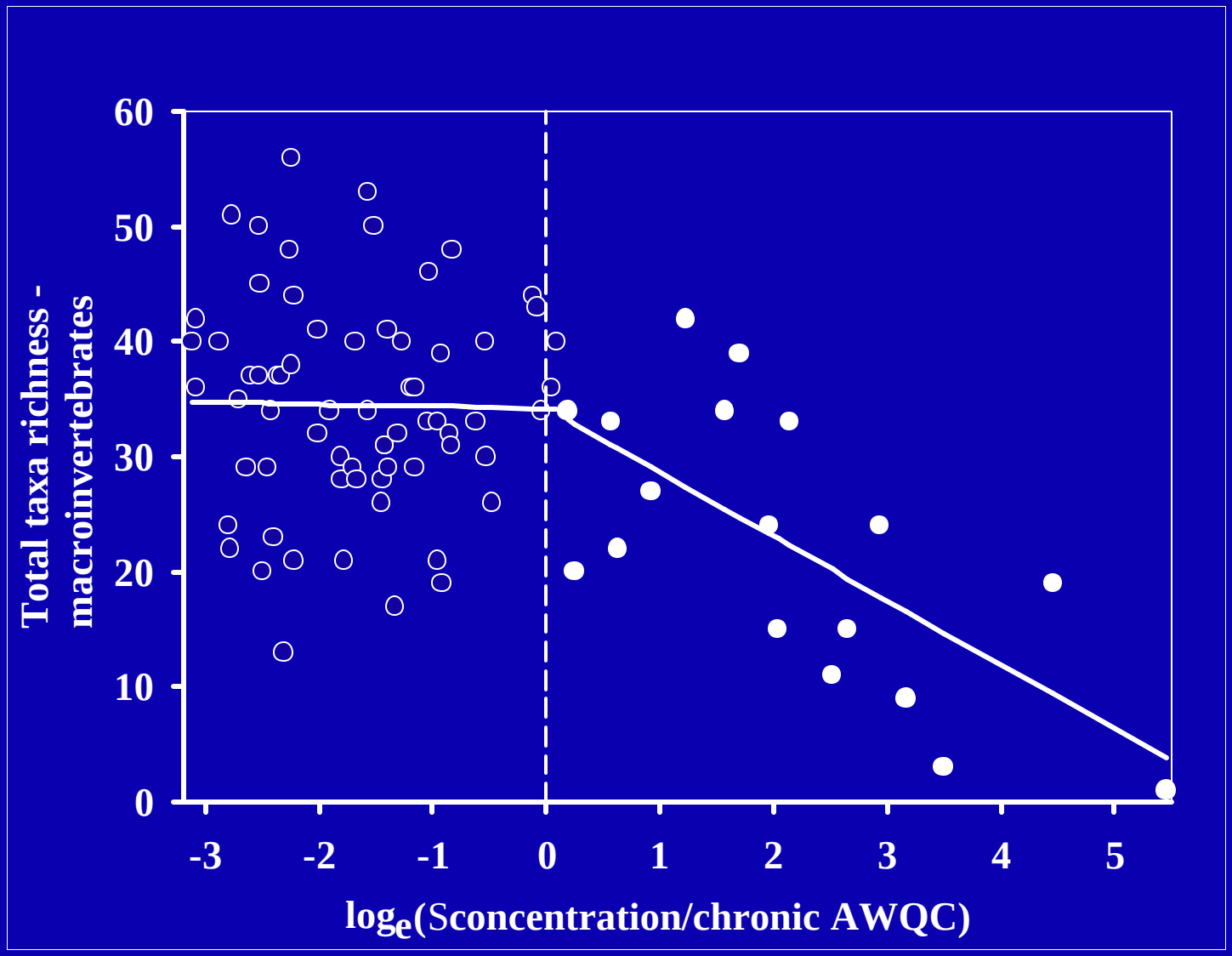
$$y = a_0 + a_1 x_1 + b_0 \log_e x_2 + b_1 x_1 \log_e x_2 \quad (1)$$

$$y = a_0 + b_0 \log_e x_2 \quad (2)$$



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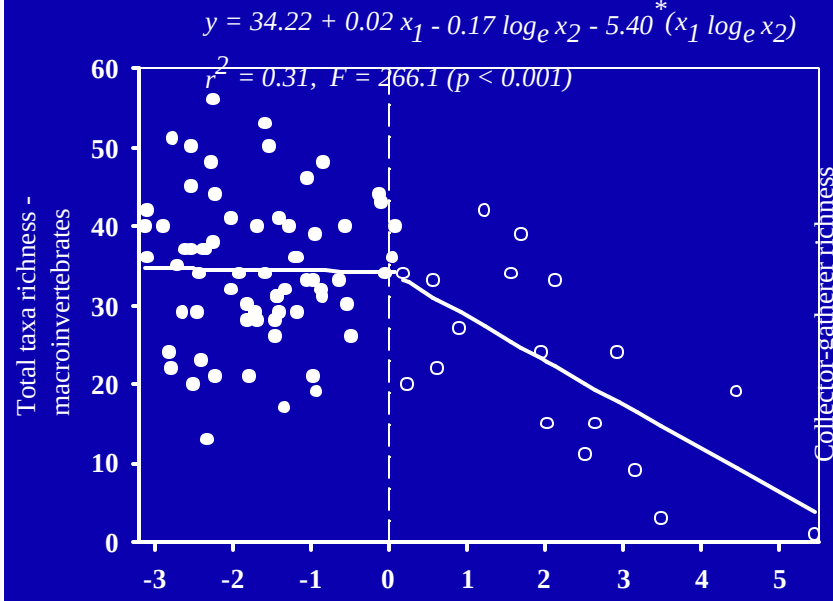

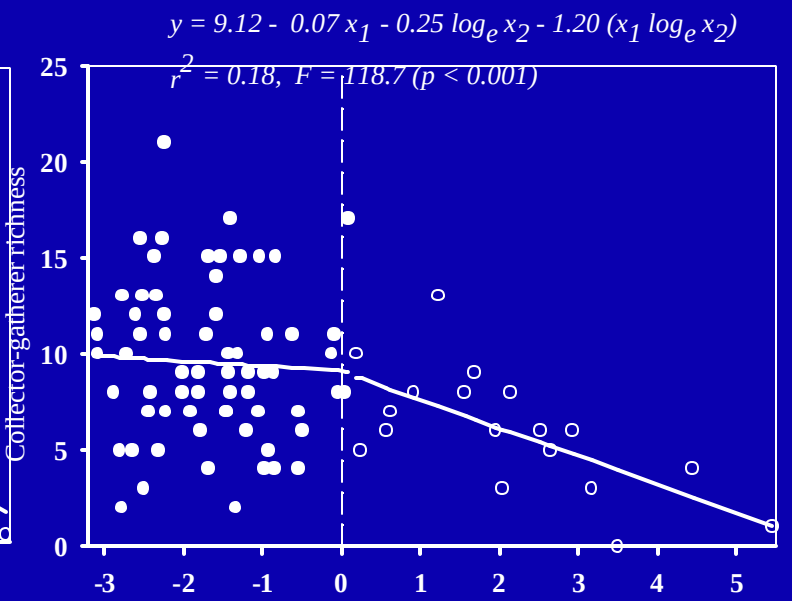

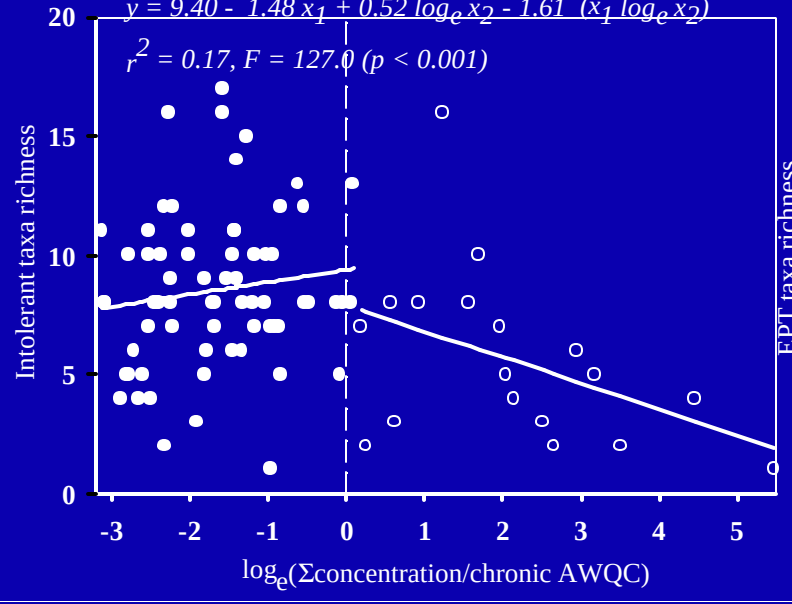

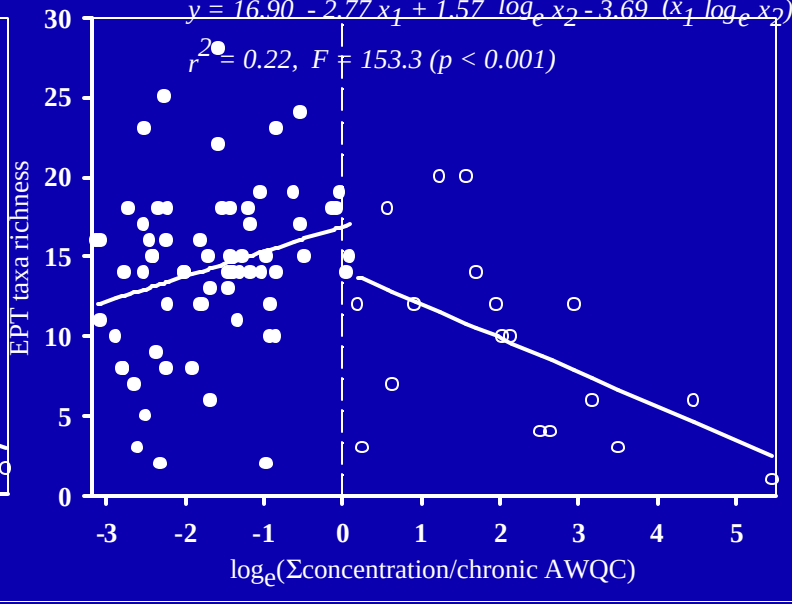

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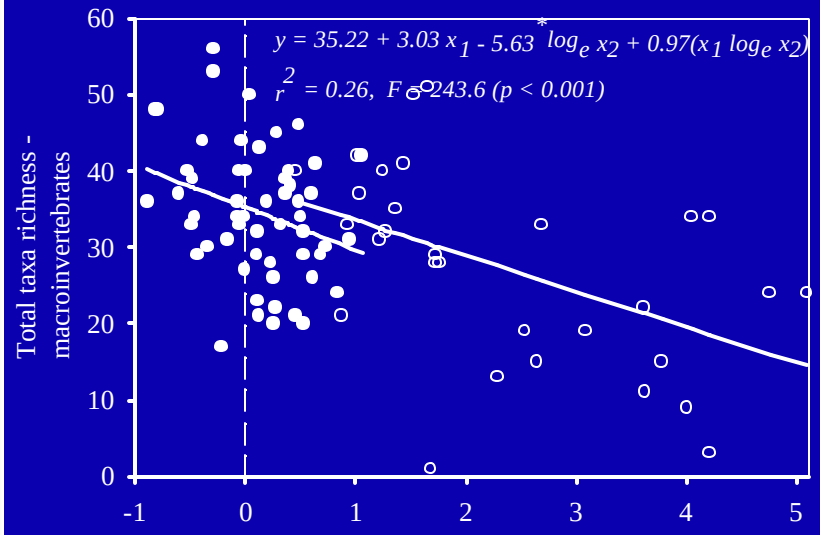

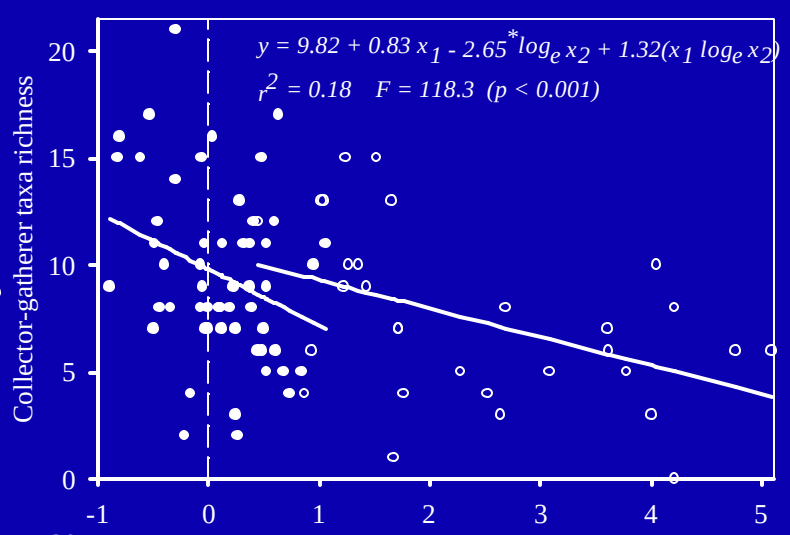

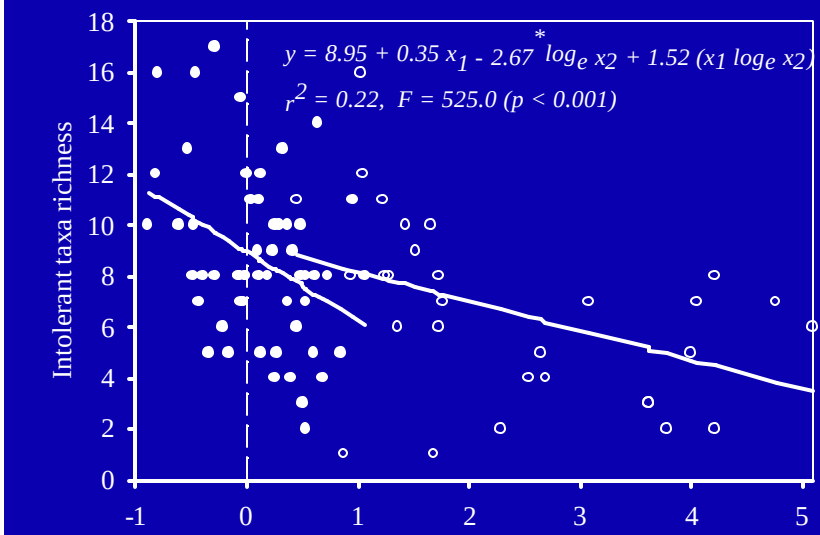

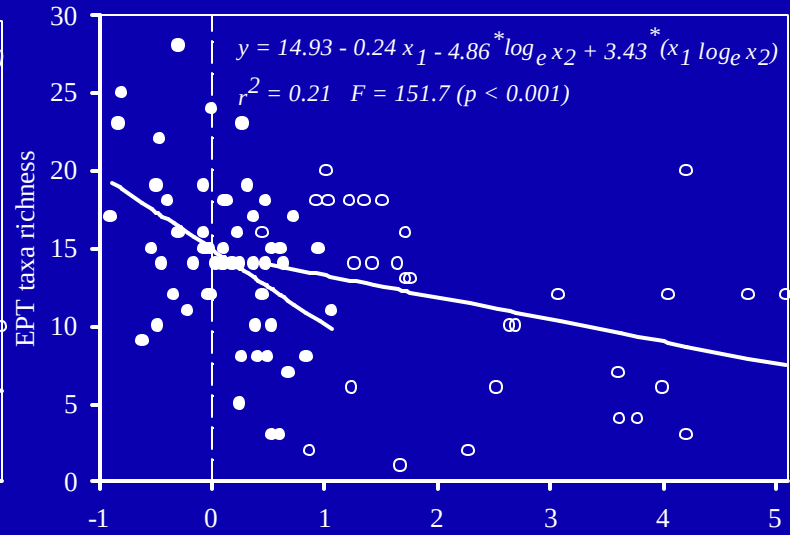

loge(Σconcentration/TEL)

loge(Σconcentration/TEL)

Conclusion

- Using a simple approach, we demonstrated effects shown by criteria or ambient bioassays are both predictive of community effects as reflected in **community metrics**.