



Using biomonitoring data to assess possible causes of biological impairment: predictive models

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The Challenge

- **Bioassessment → impaired condition**
- **Causes of impairment (physical, chemical, biological) difficult to infer**
 - **Multiple stressors**
 - **Lack of data**
- **Need to infer proximal causes → TMDL**

A Tool from Ecological Theory?

- Species have inherent traits for survival
 - optima for natural conditions
 - tolerances to contaminants
 - habitat preferences
 - life-history characteristics
- Species with some traits selectively removed by anthropogenic environmental changes—
stressor ID?

Using Traits for Stressor Identification

- **Known traits**
- **Stressor specificity**
- **Site-specific assessment**
 - Are the traits observed at a site different than what would be expected in the absence of anthropogenic disturbance?

Known “Species” Traits

- Database of aquatic North American invertebrate traits:
www.usgs.gov/nawqa/ecology/
(Vieira et al. 2006)
- Life history, current preference, habitat preference
- Genus tolerance values for 5 physical-chemical stressors
 - ~1100 NAWQA sites nation wide
 - Ranked (1-10) weighted averages

Traits Indicative of Specific Stressors

- **Nutrients---** Nutrient or DO tolerance value
- **Flow Reduction---** Current Preference Trait

Assessment of Traits: Do traits at a site differ from natural condition?

Predictive models (RIVPACS, Wright et al. 1984)

- Generates site-specific estimates of probabilities of occurrence for taxa under natural conditions
- If we can predict taxon occurrence (E), THEN we can predict trait occurrence because taxa “carry” the traits

Example: O/E for Traits

<u>Taxon</u>	<u>Pc</u>
<i>Baetis</i>	0.8
<i>Epeorus</i>	0.9
<i>Sialis</i>	0.7



<u>Taxon</u>	<u>Fast</u>	<u>Slow</u>	<u>Tolerance</u>
<i>Baetis</i>	1	0	6
<i>Epeorus</i>	1	0	4
<i>Sialis</i>	0	1	9



<u>Taxon</u>	<u>Fast</u>	<u>Slow</u>	<u>Tolerance</u>
<i>Baetis</i>	0.8	0	4.8
<i>Epeorus</i>	0.9	0	3.6
<i>Sialis</i>	0	0.7	6.3

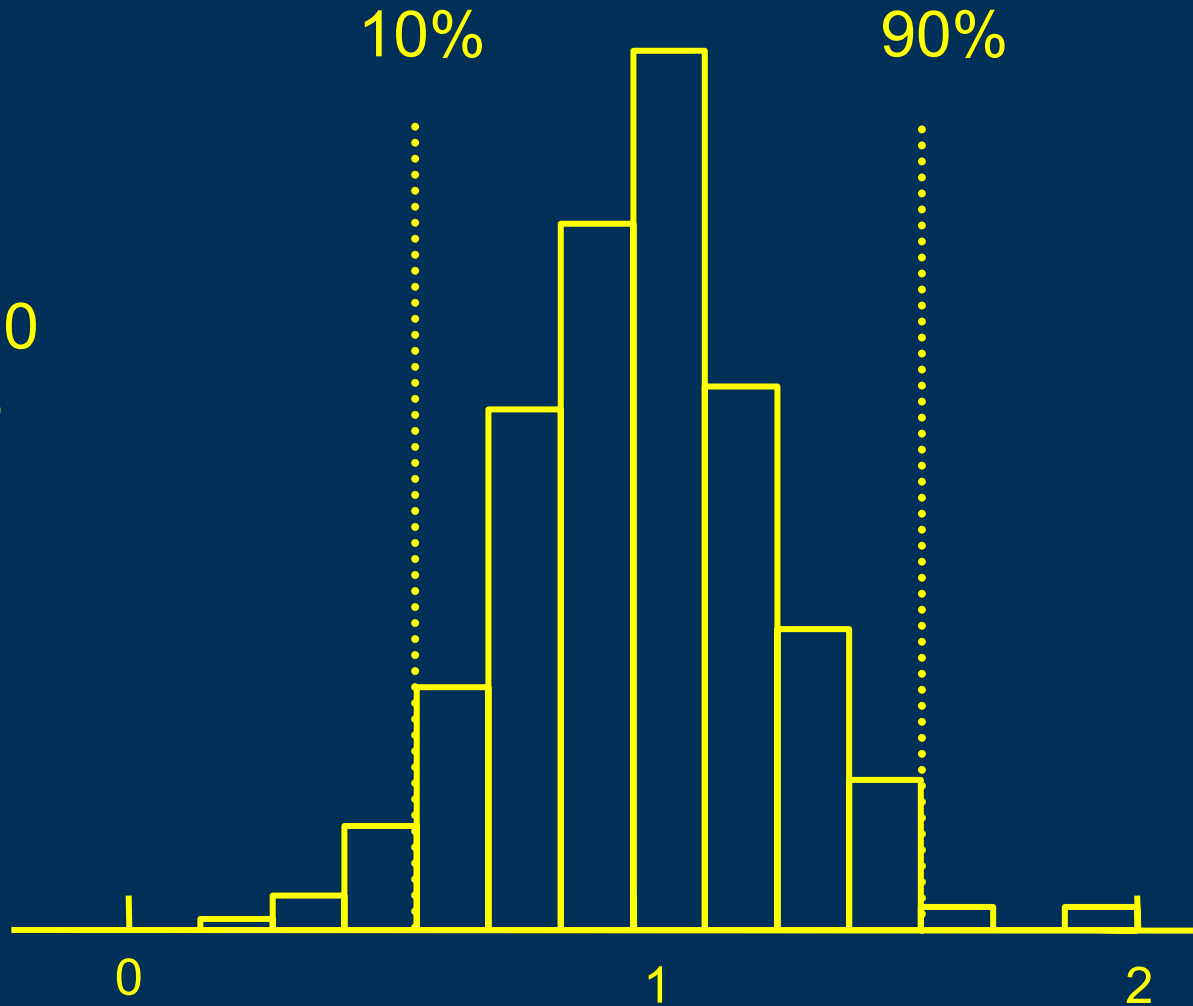
E	1.7	0.7	6.1
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Observed: O	1	1	9
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O/E	0.6	1.4	1.5
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Thresholds for Traits Assessment

Mean=1.0
SD=0.26



An Example Application

- **Predictive model for invertebrates**
 - 310 reference-quality sites: calibration
 - 30 reference-quality sites: model validation
- **30 sites in New England along gradient of urbanization**
 - State and local assessments of impairment (11) and stressor ID

Road density
2 km/km²

Muddy Pond

Image MassGIS, Commonwealth of Massachusetts EOE

Stones Bridge

Google



42.22 -70.99888889

Road density
6 km/km²



Image MassGIS, Commonwealth of Massachusetts EOE

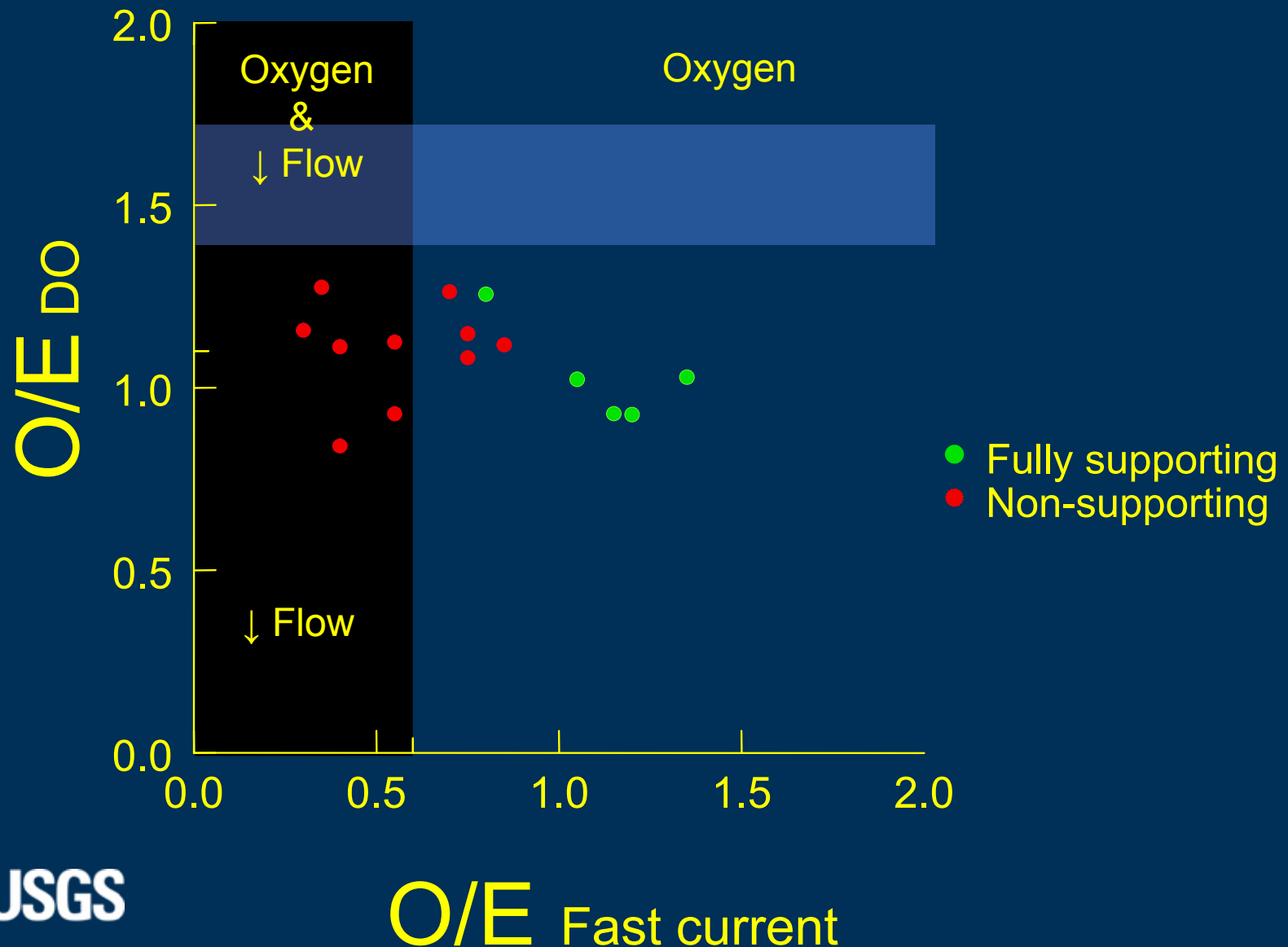
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Pointer 42°12'55.62" N 70°59'36.99" W elev 97 ft

Streaming ||||| 100%

Eye alt 4007 ft

Site Impairment: Oxygen & flow



Concordance with Local Stressor ID?

Site	Local	Traits
Aberjona	Flow, nutrients, DO	Flow, nutrients, DO
Saugus	Flow, nutrients, DO	Flow, nutrients
Monatiquot	Flow, DO	Flow, nutrients, DO
Ipswich	Flow, DO	Flow, nutrients
Neponset	DO	Nutrients
Assabet	Flow, nutrients, DO	Nutrients, DO
Middle	Flow, nutrients, DO	Flow, Nutrients
Wading	DO	Nutrients
Stony Brook	Flow, nutrients, DO	
Elizabeth	Flow, DO	Nutrients, DO
Stillwater	Flow	

Conclusions

- Species traits = theoretical basis, sensitive to environmental changes, may facilitate stressor diagnosis
- Predictive models can be extended for use in diagnostic efforts
- National / regional tool with local relevance

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Tolerance Values & Urban Land Cover

