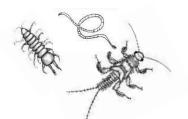
# Assessing stressor risk to biological indicators of watershed health in western Washington

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# Causation of environmental impairment

Utilize monitoring data to:

- 1. Identify sources of environmental impairment to watershed systems
- 2. Analyze relationships among environmental factors and biological indices of impairment



## **Ecological Risk Assessment**

EPA definition: An ERA evaluates "the likelihood that adverse ecological effects may occur as a result of exposure to one or more stressors."

→ Identify, characterize, and prioritize risks for resource management

# Relative Risk Assessment for Resource Management

(Paulsen et al. 2008; Van Sickle and Paulsen 2008; Van Sickle 2006; 2013)

Model and the second stressors is the second stressors in the second stressors is the second stressors in the second stressors is the second stressors in the second stressors is the second stressors and stressors is the second stressors are second stressors and stressors are second stressors are second

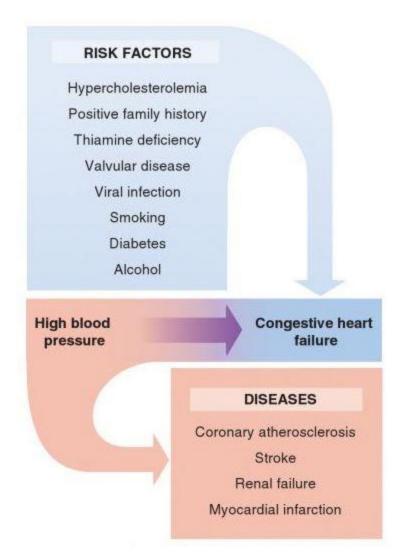
Summarize impact of stressor on study population

Describe association between poor stressor condition and poor biological conditions

Merive the potential biological benefits of stressor management

# **Relative Risk**

Originally an epidemiological measure that determines strength of the relationship between a variable (health, environment, genetics...) to disease.



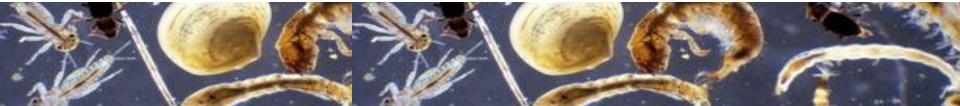
# Relative Risk: Ecoepidemiology



Picture: Washington State Toxic Algae

## **Relative Risk Measures**

- 1. Extent
- 2. Relative Risk
- 3. Attributable Risk



# 1. Population Extent

#### How wide-spread is the problem?

- Proportion of total stream
  length in poor biological
  condition per stressor
- The probability of finding a poor stressor condition in a randomly selected stream



# 2. Relative Risk

# What is the impact of the stressor when present?

Measures strength of association between good/bad stressor levels and poor biological condition

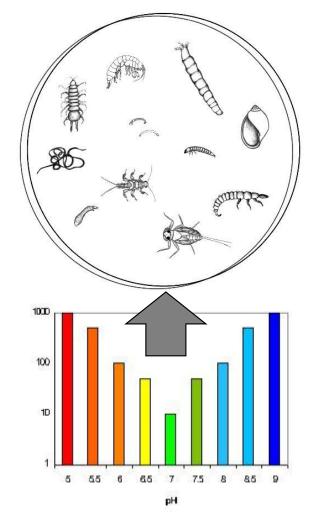


Illustration: Annabel Wildrick, http://www.seanet.com/~leska/Online/Guide.html

# 3. Population attributable risk

How much does a risk factor contribute to indicators of overall stream health?

- Combines severity and impact into a single measure of overall stressor impact to a population
- 2. Estimates the reduction in regional extent of poor biological condition that would result from eliminating stressor

## **Relative Risk**



Assumes reversibility

Assumes independence

Mode Notice Confounding Variables

# Methods

WA Dept of Ecology's Status and Trends monitoring sites (n = 146)

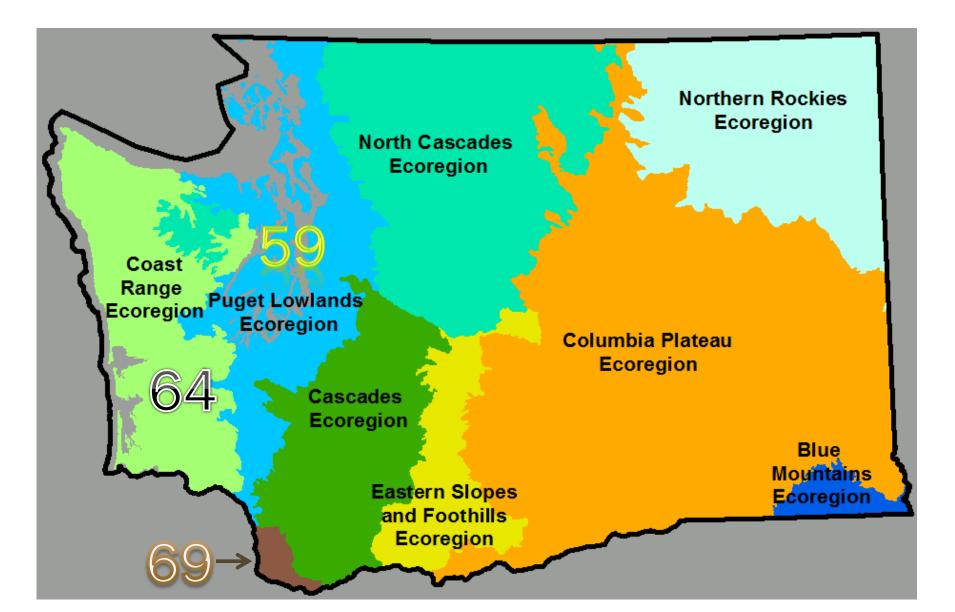
 $\rightarrow$  Puget Sound Basin (n = 47)

→ Coastal (n = 49)

 $\rightarrow$  Lower Columbia (n = 50)

- Mata: Habitat (EMAP), water quality, sediment chemistry, fish abundance, B-IBI
- Stressor conditions and response split into classes of "Poor" or "Not Poor"
- Response variable = B-IBI score and individual metrics

# **B-IBI Overall Scores**



# **Preliminary Results: Relative Risk**

1. Water Quality and Sediment Chemistry

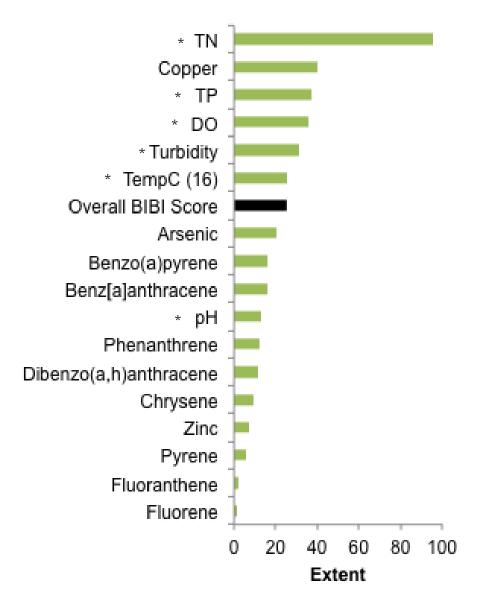
2. Habitat

# **Preliminary Results: Relative Risk**

1. Water Quality and Sediment Chemistry

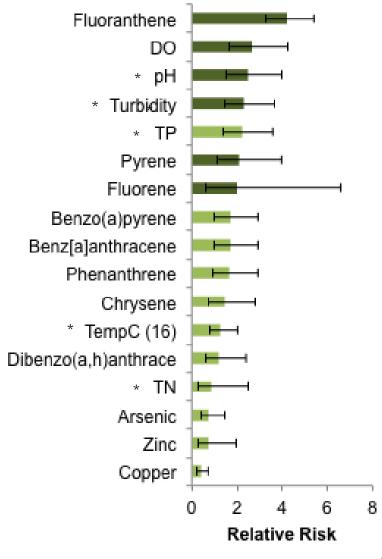
2. Habitat

#### Extent of Poor variable condition: WQ, SC



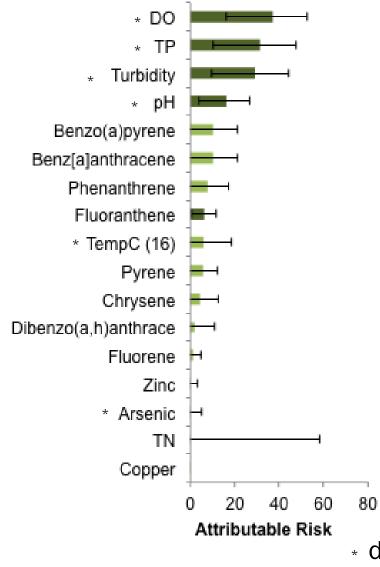
denote Water Quality Results

#### Relative Risk: WQ, Sediment Chemistry



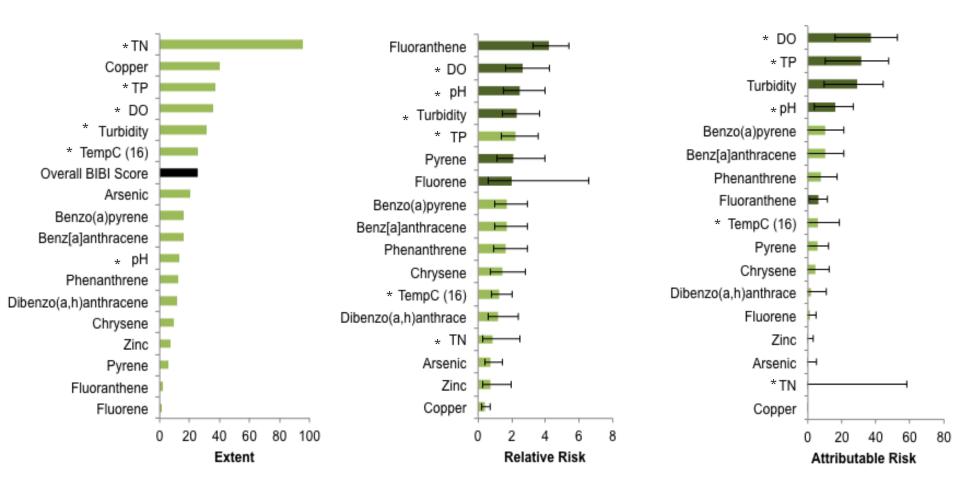
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#### Attributable Risk: WQ, Sediment Chemistry



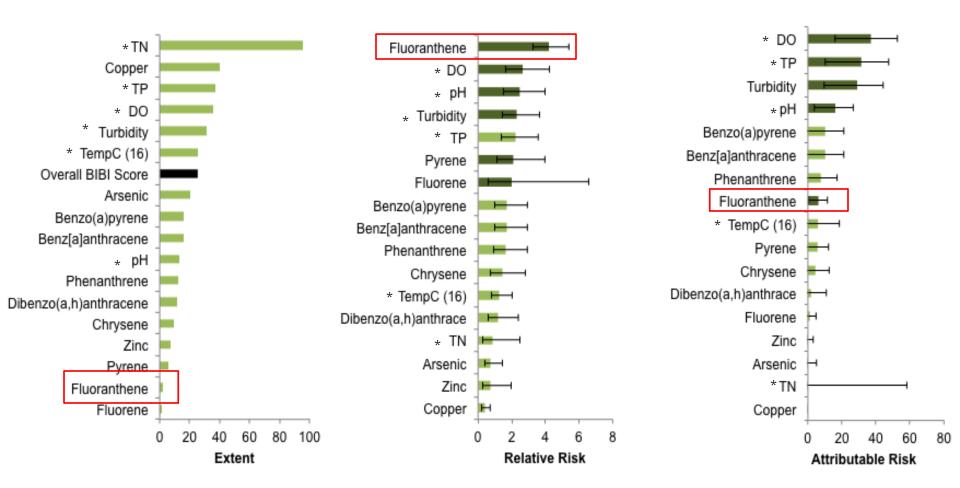
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#### Relative Risk: WQ, Sediment Chemistry



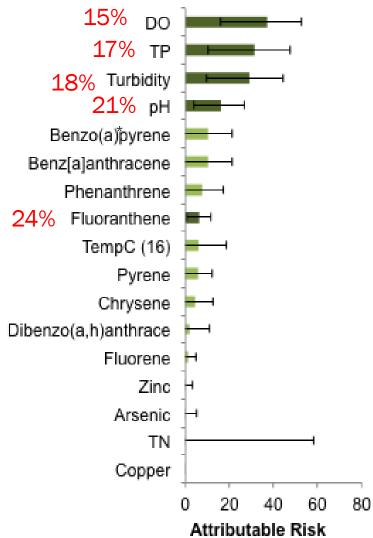
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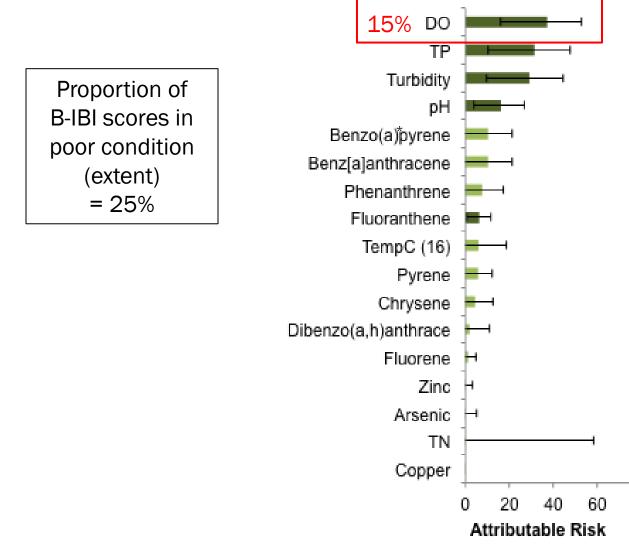
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denote Water Quality Results

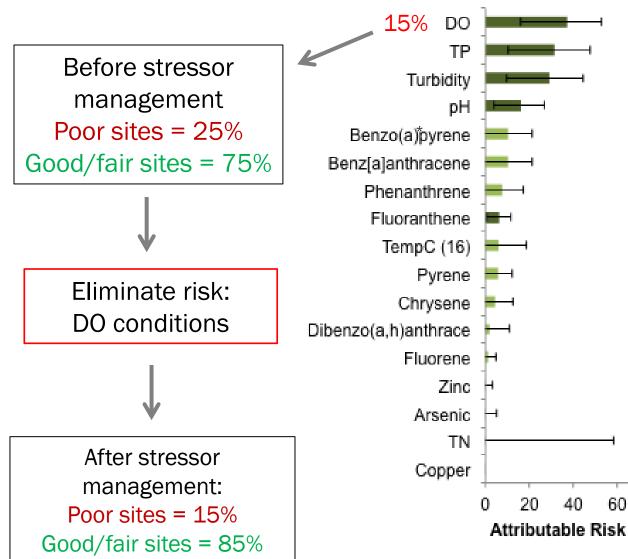
Proportion of B-IBI scores in poor condition (extent) = 25%





Error Bars = 95% CI

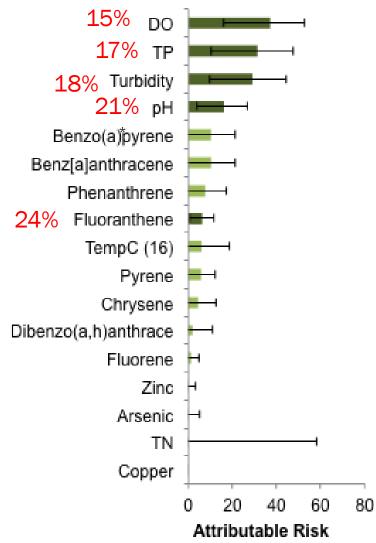
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Error Bars = 95% Cl

80

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# **Preliminary Results: Relative Risk**

1. Water Quality and Sediment Chemistry

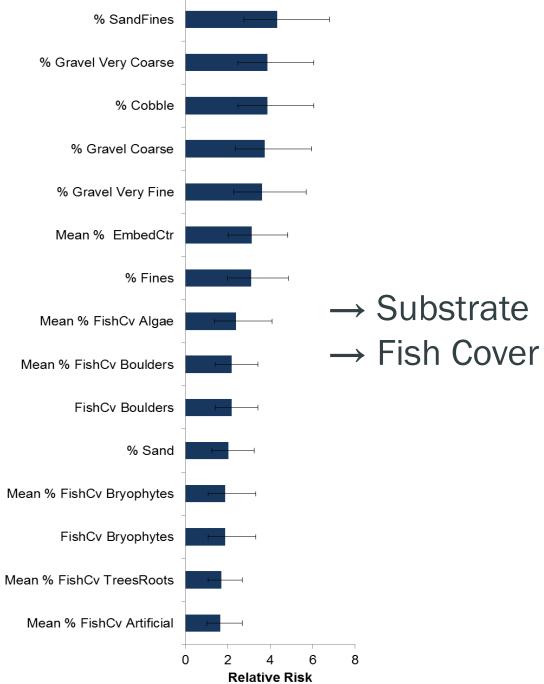
2. Habitat

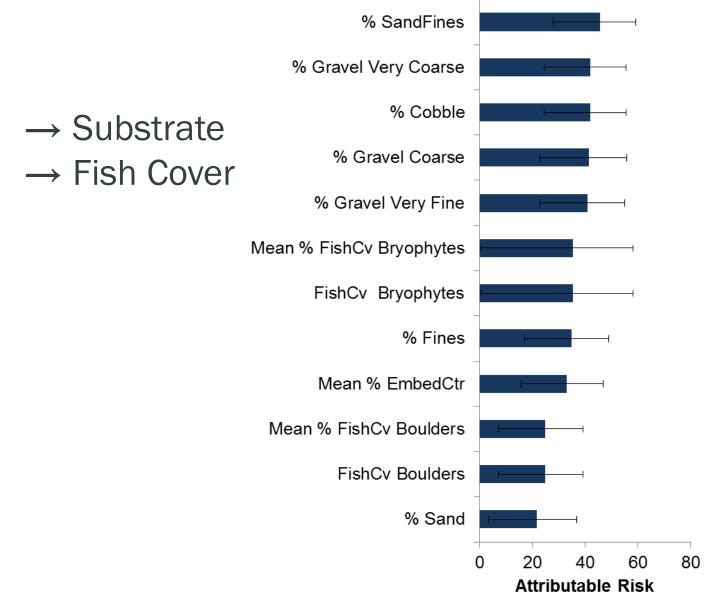
#### **Poor Habitat Extent**

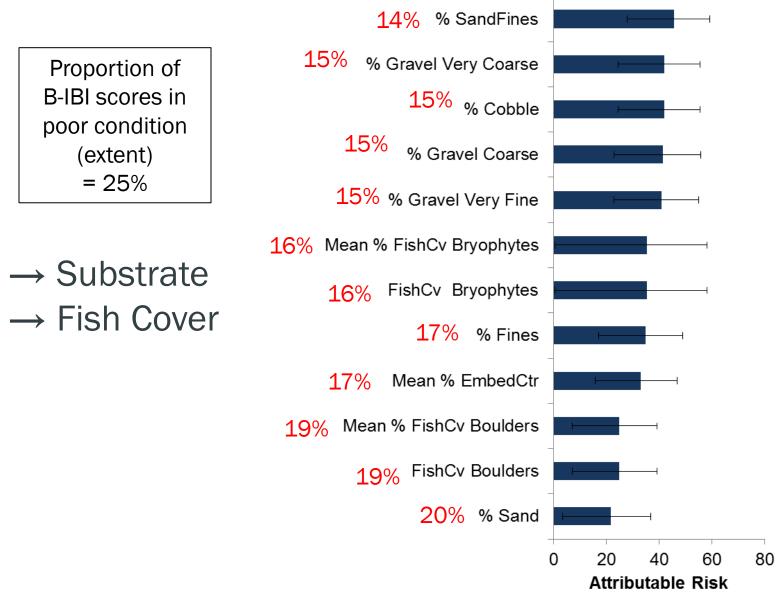
Mean % Embed Mean % FishCv Macrophytes FishCv Macrophytes Mean % FishCv Bryophytes FishCv Bryophytes FishCv LWD Mean % FishCv Brush % Wood FishCv TreesRoots FishCv Brush Mean % FishCv TreesRoots Mean % FishCv OvHgVeg Mean % FishCv Boulders FishCv Boulders Mean % FishCv LWD % Sand SD Embed % Gravel Very Fine Mean % FishCv NoAqVeg Mean % FishCv Big FishCv Algae % Gravel Coarse Mean % FishCv Undercut Mean % FishCv Natural FishCv Undercut % SandFines % Gravel Fine % Gravel Very Coarse % Fines % Cobble Overall BIBI Mean % ShadeBnk Mean % EmbedCtr Mean % FishCv Artificial SD EmbedCtr FishCv Big FishCv OvHgVeg Mean % ShadeCtr FishCv Natural FishCv NoAqVeg Mean % FishCv Algae % Pavement 20 40 60 0 Extent

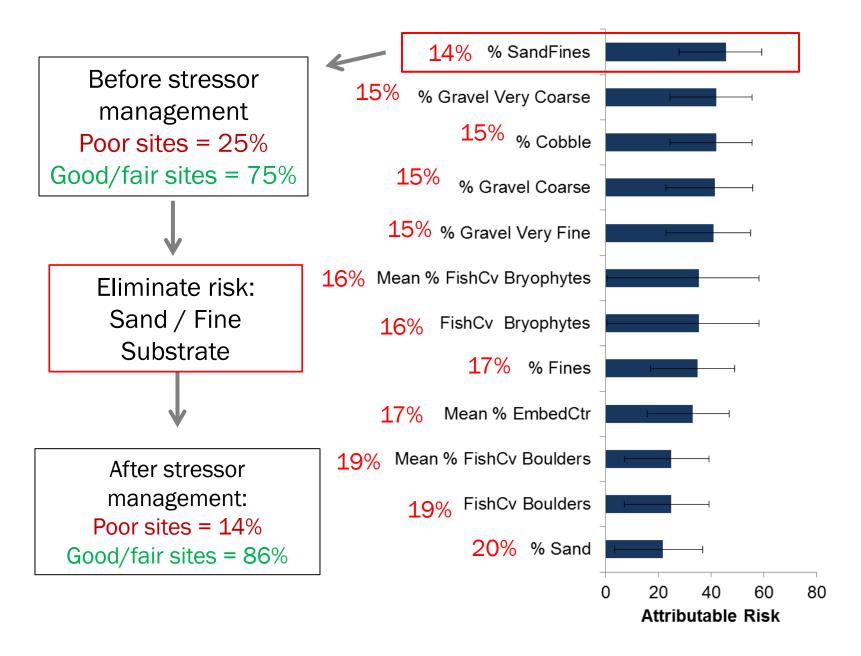
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#### **Relative Risk: Habitat**









# Attributable Risk Summary

		Overall	Taxa Rich	Ephem Rich	Plecopt Rich	Trichopt Rich	Clinger Rich	LL Rich	Intol Rich	% Dominant	% Predator	% Tolerant	EPT Rich	Total
	% Cobble	0			4				_	6	6	6		9
	% Fines													8
	% Gravel Coarse													9
a	% Gravel Very Coarse													9
rat	% Gravel Very Fine													9
Substrate	% Sand													10
Su	% SandFines													9
	% Wood													1
	Mean % EmbedCtr													8
	SD EmbedCtr													2
	FishCv Big													1
S	FishCv Boulders													7
iparian / Fish Cover / Woody Debris	FishCv Brush													1
De	FishCv Bryophytes													2
λþα	FishCv OvHgVeg													2
ΛοΟ	FishCv TreesRoots													2
>	FishCv Undercut													3
/er	Mean % FishCv Algae													1
õ	Mean % FishCv Artificial													2
sh	Mean % FishCv Big													1
/ Fi	Mean % FishCv Boulders													6
an	Mean % FishCv Bryophytes													3
aria	Mean % FishCv OvHgVeg													2
Rip	Mean % FishCv TreesRoots													3
	Mean % FishCv Undercut													3
	Mean % ShadeBnk													3
Water	Dissolved Oxygen													7
Ма	Total Phosphorus													6
	pH													6
	Fluoranthene													4

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Water	Total Phosphorus													6
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	Fluoranthene													4

# **Relative Risk Summary**

- Substrate composition is important to B-IBI scores and metrics. Sites dominated by a single substrate tend to have lower B-IBI scores.
- Benthic macroinvertebrates sensitive to surface water quality parameters DO, pH, P
- Working on adding more water and sediment chemistry variables needed for more robust picture
- Weight analysis tool to help prioritize watershed restoration decisions





Illustrations: Annabel Wildrick, http://www.seanet.com/~leska/Online/Guide.html

# Acknowledgements

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### WA Dept. of Ecology

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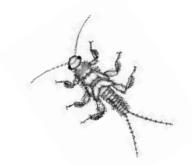


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# Thank you!

