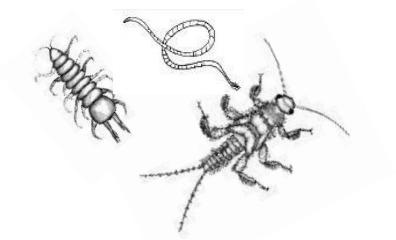
Identifying stressor risk to biological health in western Washington streams

Elene Dorfmeier [1], Leska Fore [2]

[1] *King County Seattle, WA*
[2] *Statistical Design, Seattle, WA*



Benthic Monitoring EPA Grant Advisory Board meeting
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King County

DEPARTMENT OF ECOLOGY
State of Washington

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Identifying stressors of ecological importance

Utilize monitoring data to:

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

Assessing Stressor Risk

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)

- Identify regionally important stressors
- Summarize impact of stressor on study population
- Describe association between poor stressor condition and poor biological conditions
- Derive 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.

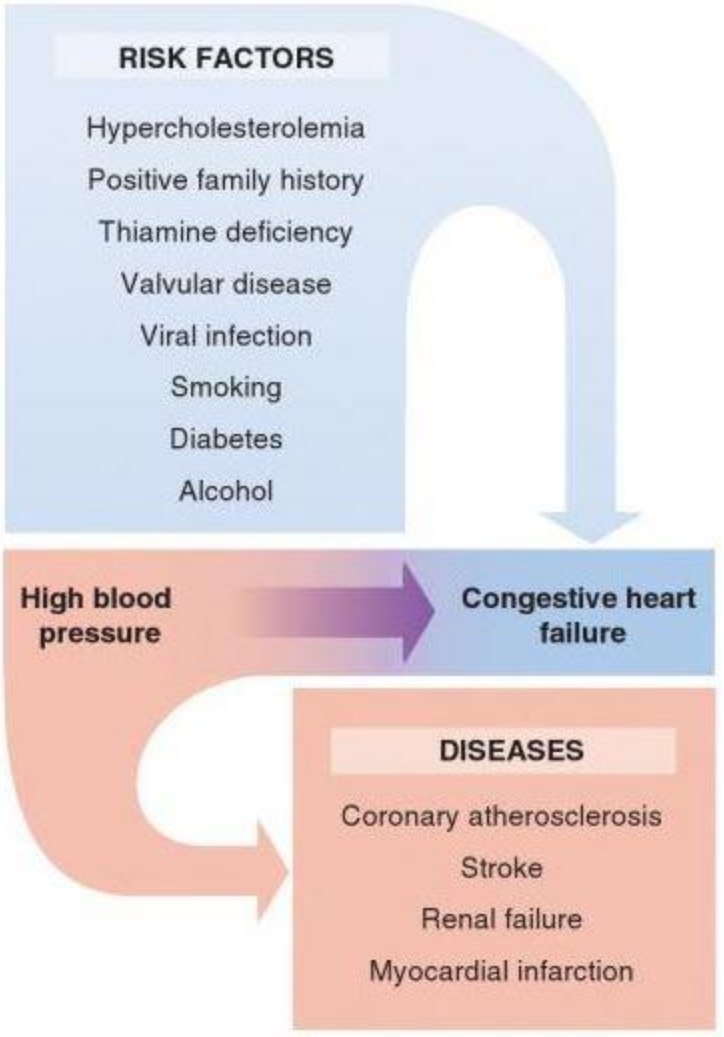


Illustration: Fletcher and Fletcher, Clinical Epidemiology: The Essentials

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

Map: Rentfrow et al. 2013

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

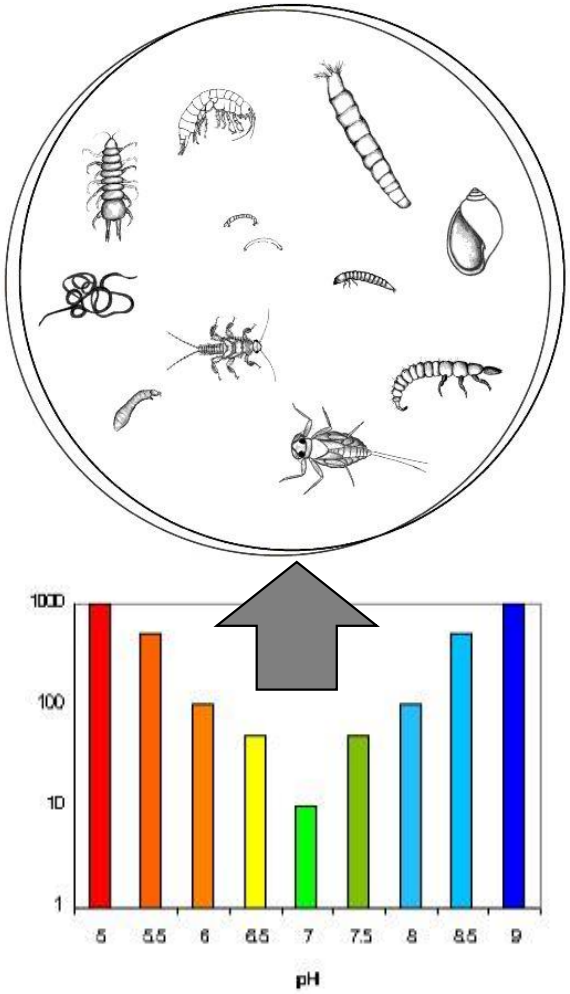


Illustration: Annabel Wildrick, http://www.seanet.com/~leska/Online/Guide.html

3. Population attributable risk

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

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

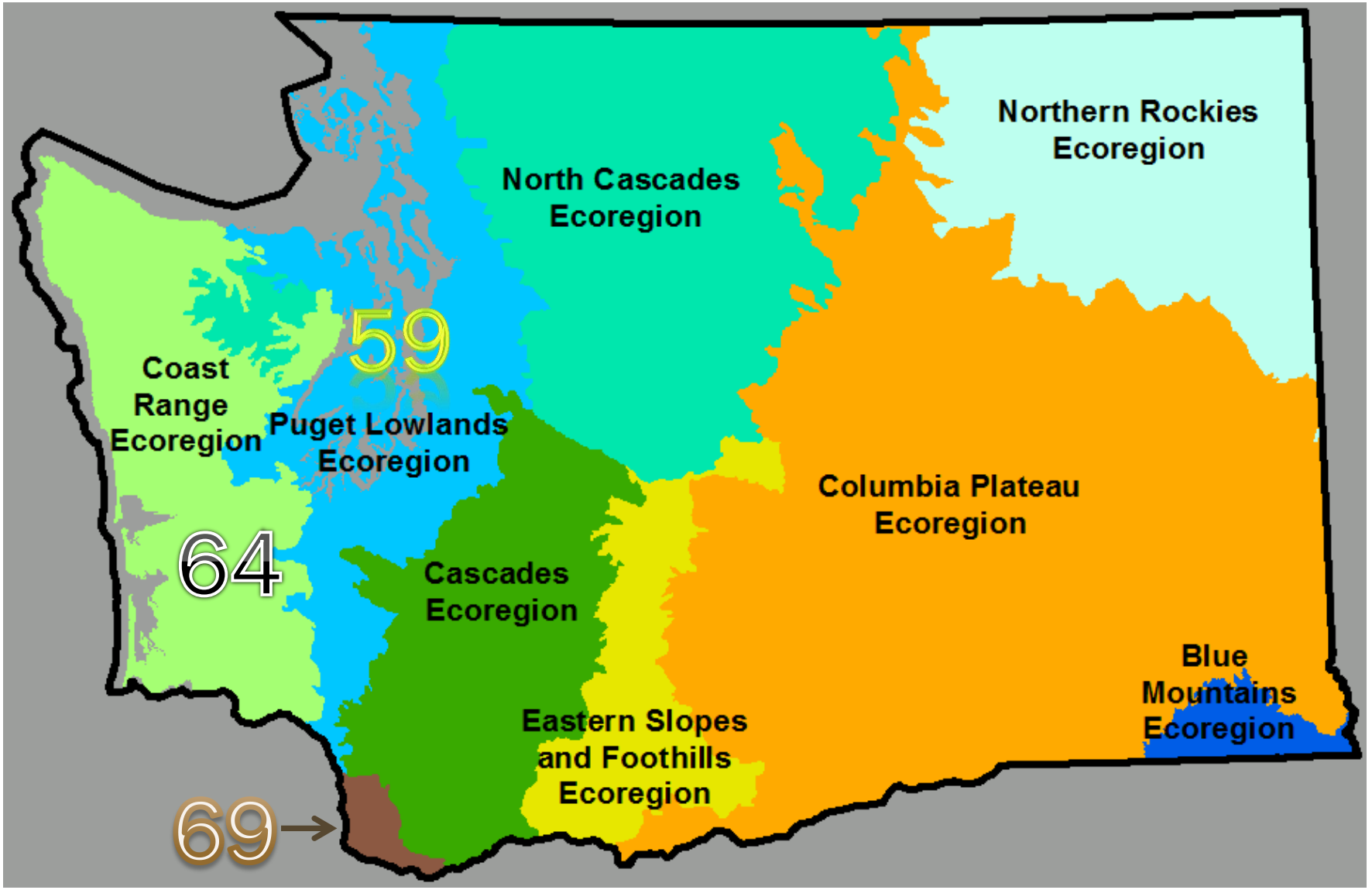
Risk Analysis

- Assumes causality
- Assumes reversibility
- Assumes independence
- Detangling confounding variables

Methods

- WA Dept of Status and Trends Monitoring for Watershed Health (n = 146)
  - Puget Sound Basin (n = 47)
  - Coastal (n = 49)
  - Lower Columbia (n = 50)
- Data: Habitat assessment (EMAP), water quality, sediment chemistry, 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



Results

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

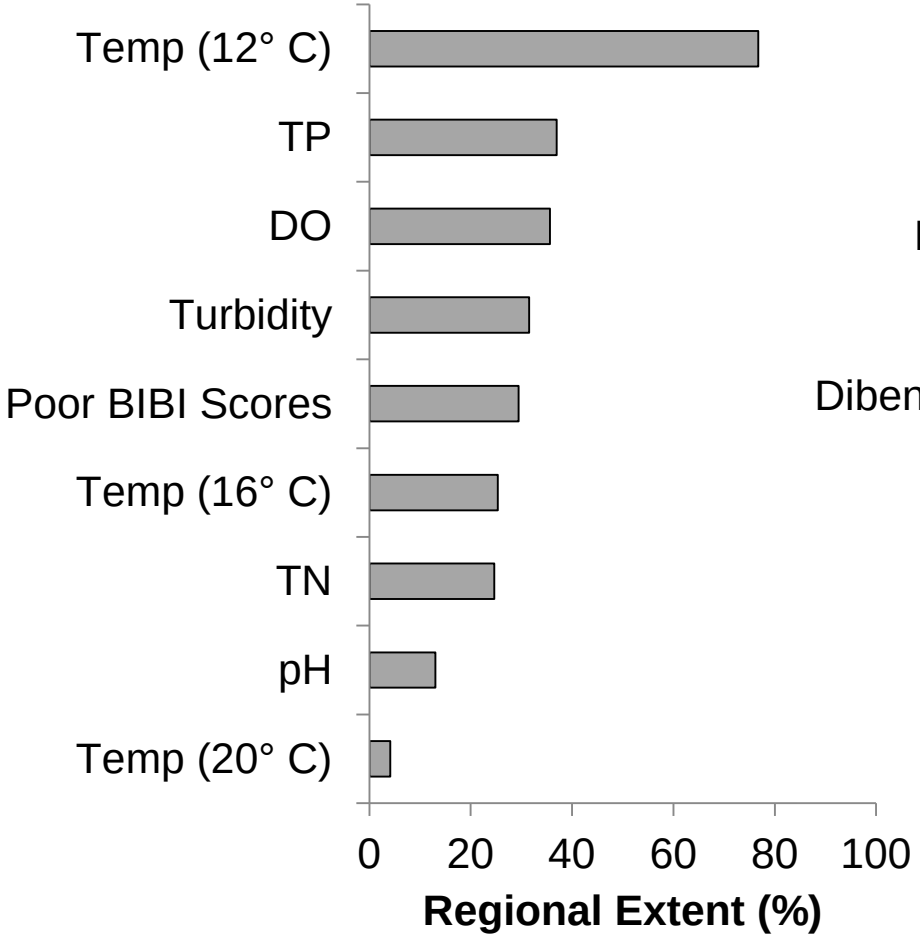
Results

1. Water Quality
2. Sediment Chemistry
3. Habitat Assessment

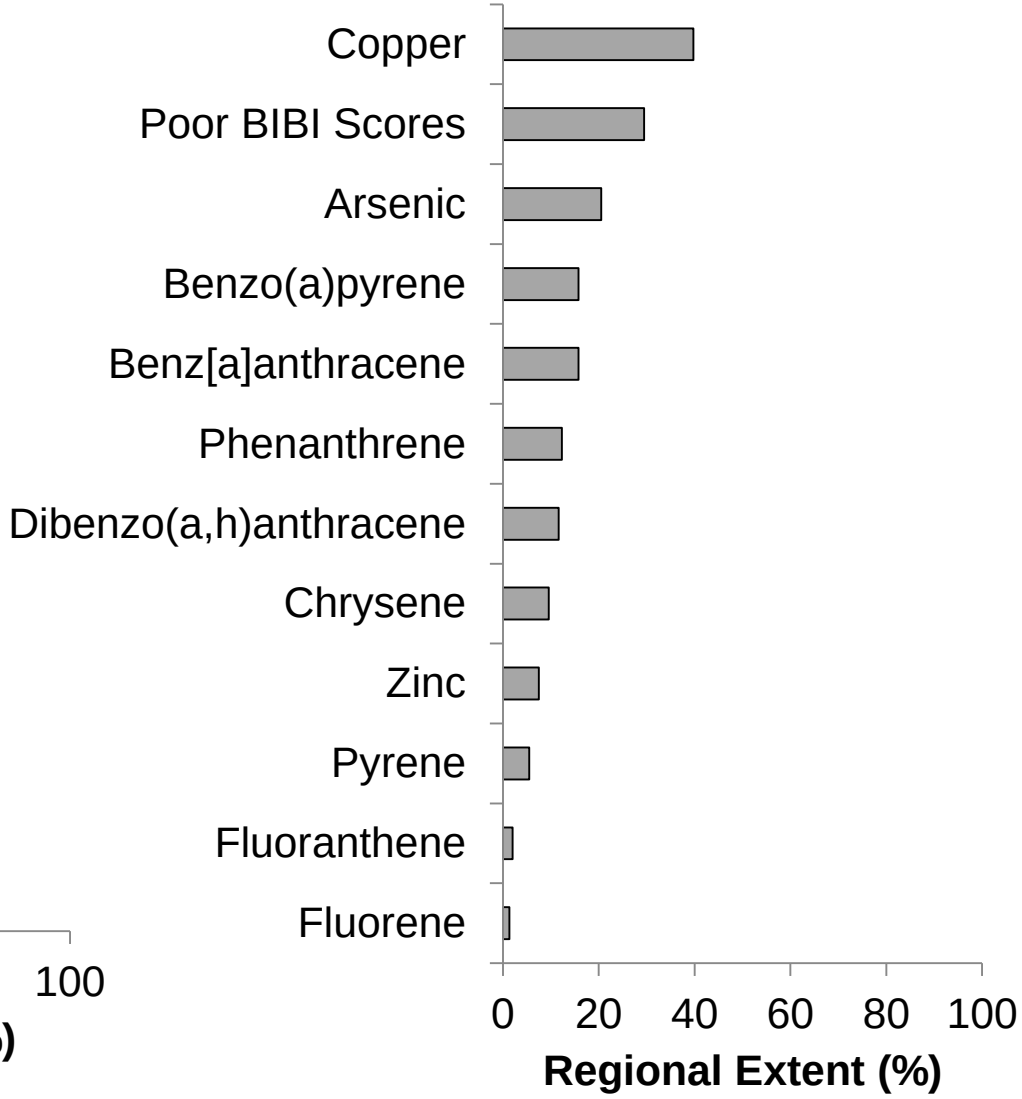
Results

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

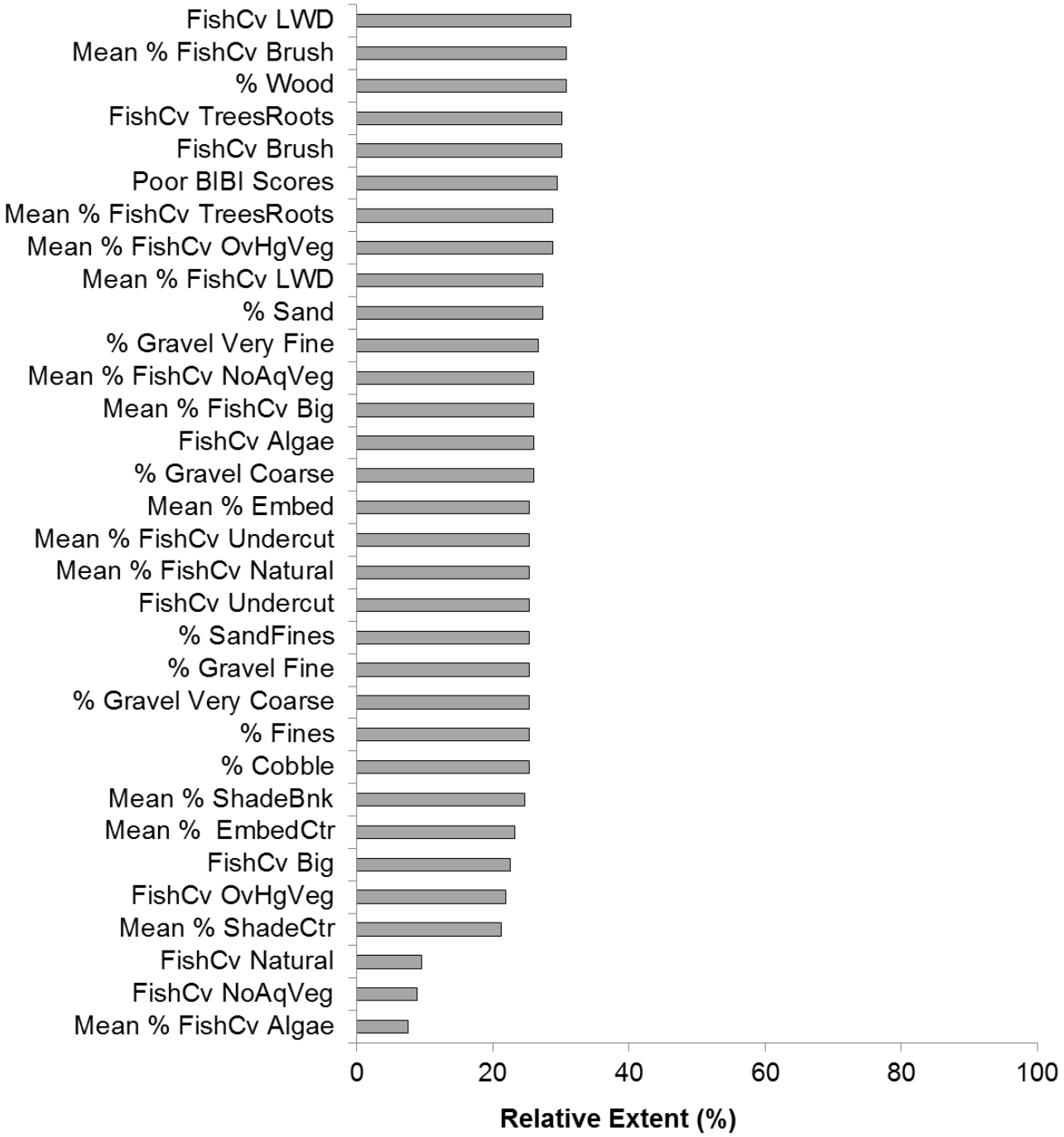
Water Quality



Sediment



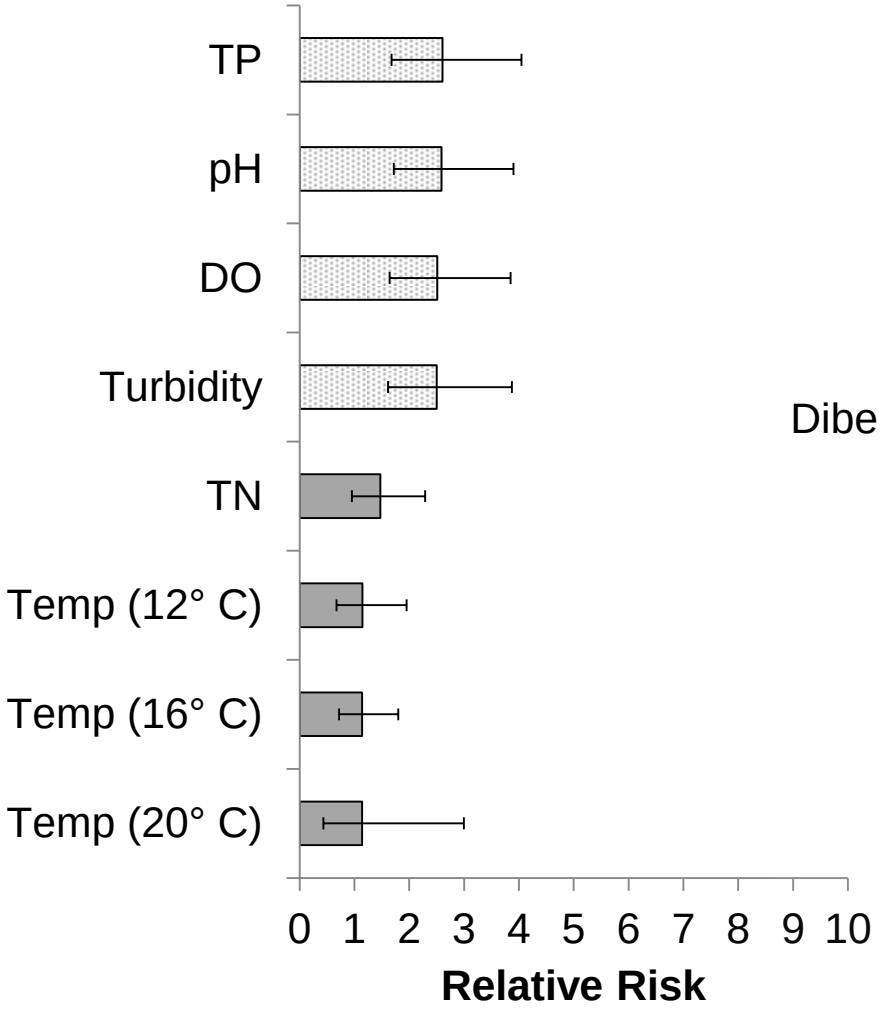
Habitat: Extent



Results

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

Water Quality



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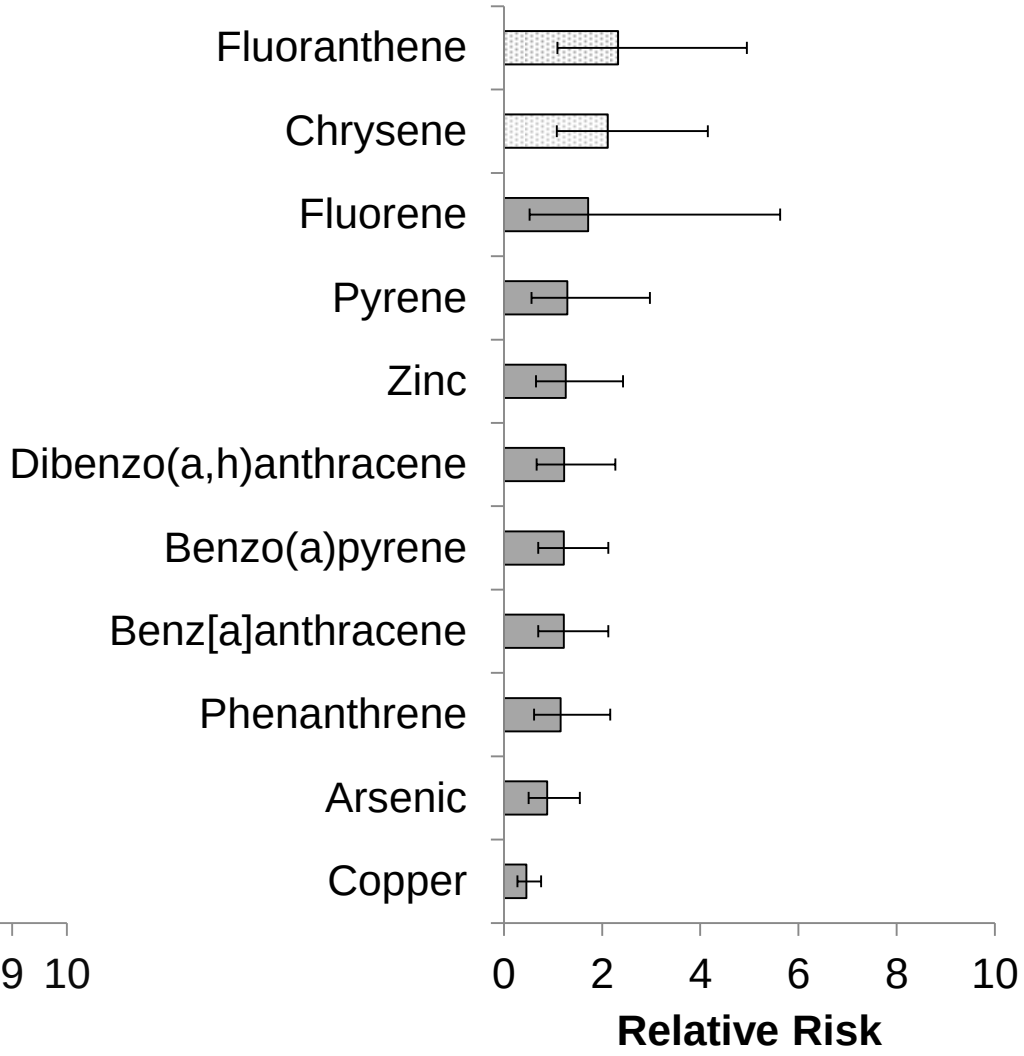

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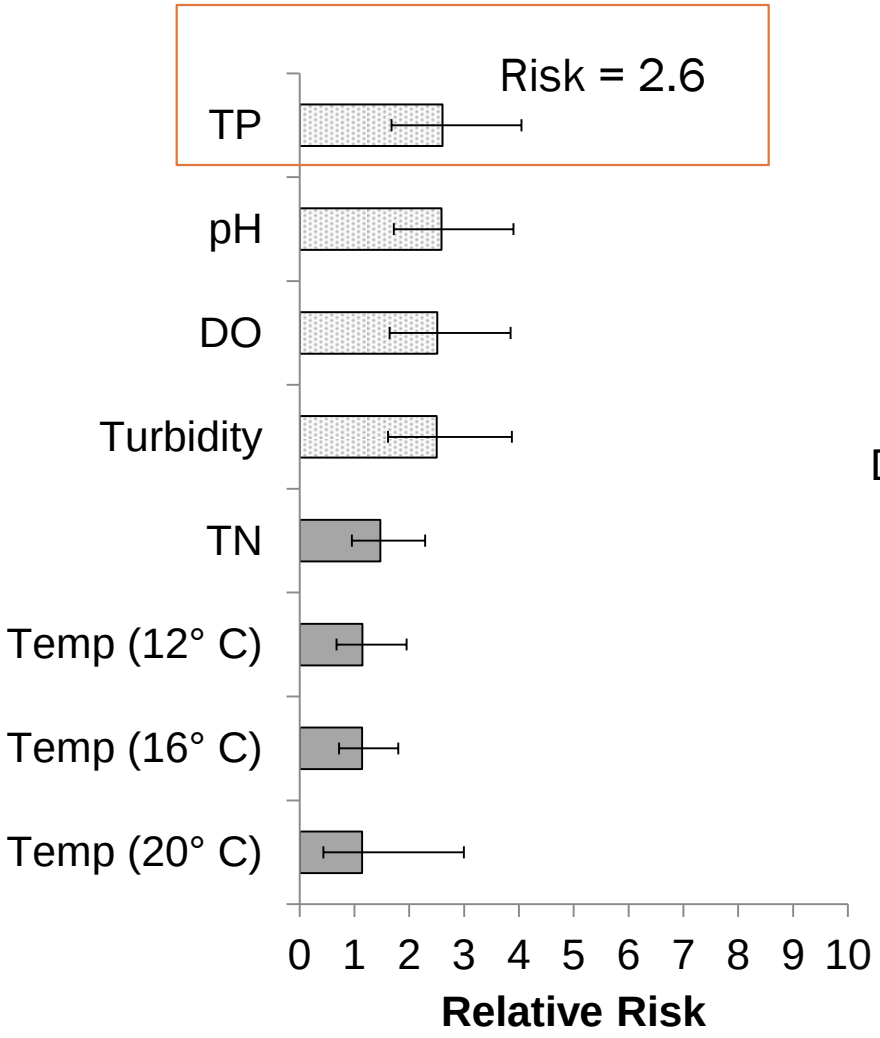
Water Quality



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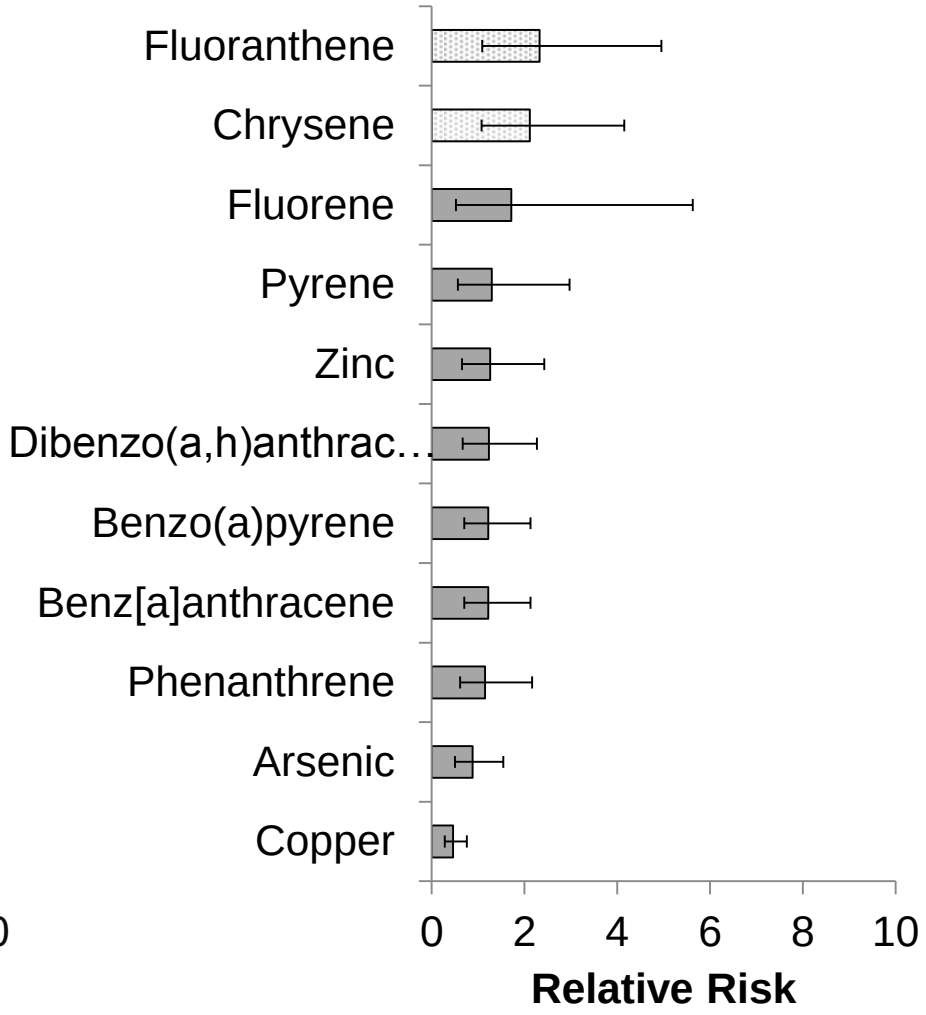

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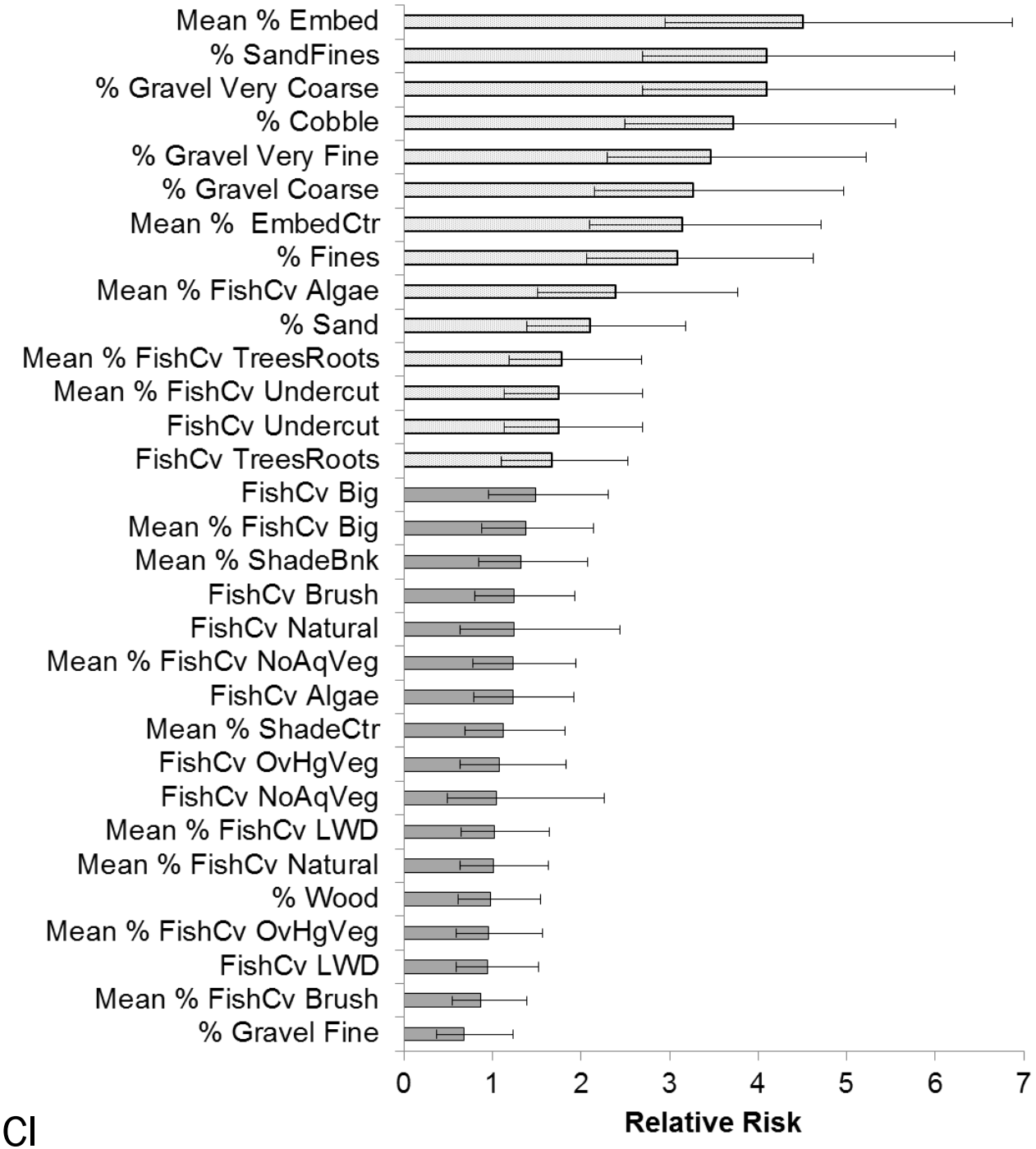
Habitat: Relative Risk



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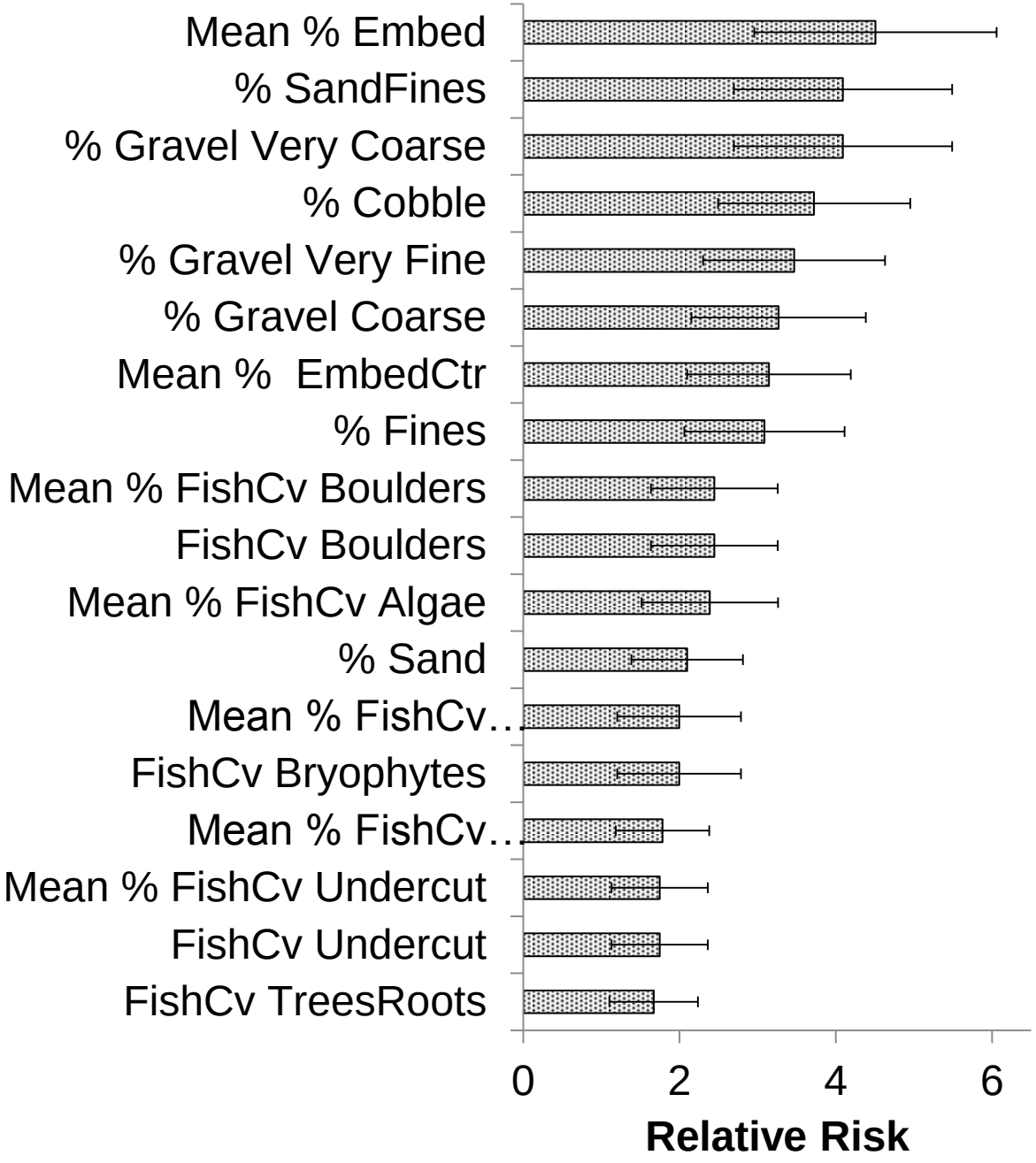
Habitat: Relative Risk



Results

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

Attributable Risk: Review

1. Single measure of stressor severity and impact
2. Estimates the reduction in poor condition that would result from eliminating stressor

→ Rank stressor risk
→ Estimate impact to biology

Attributable Risk: Review

1. Single measure of stressor severity and impact
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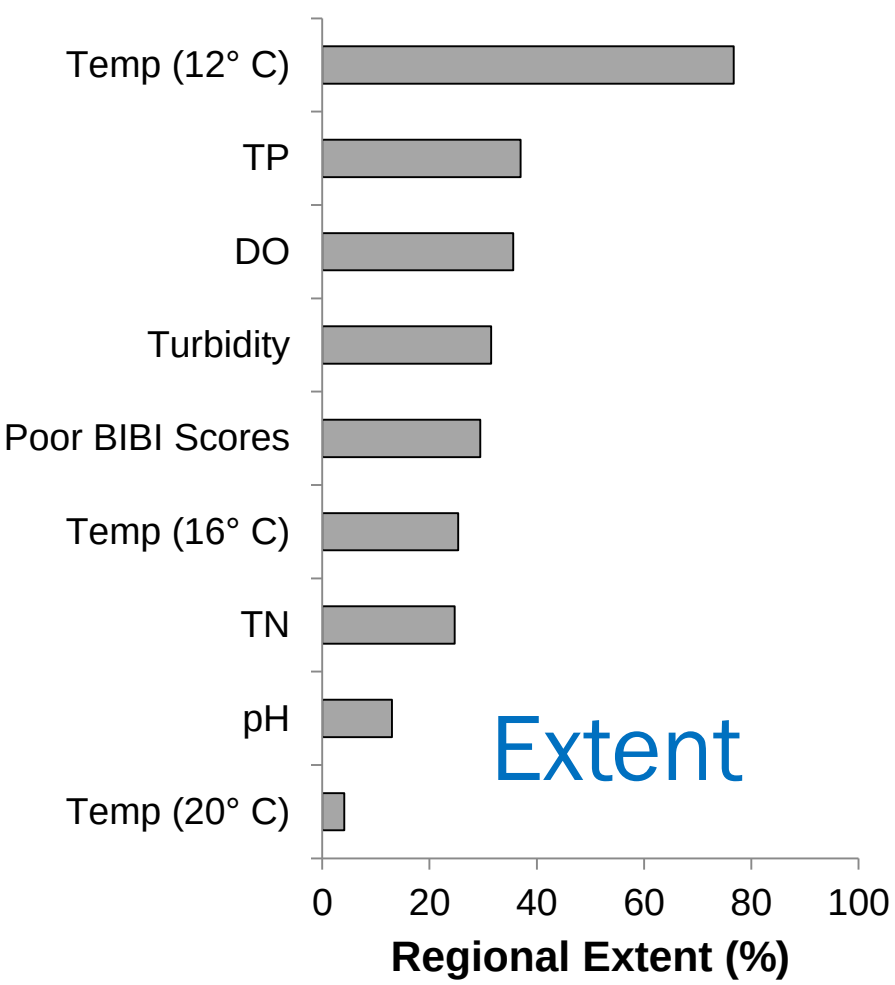
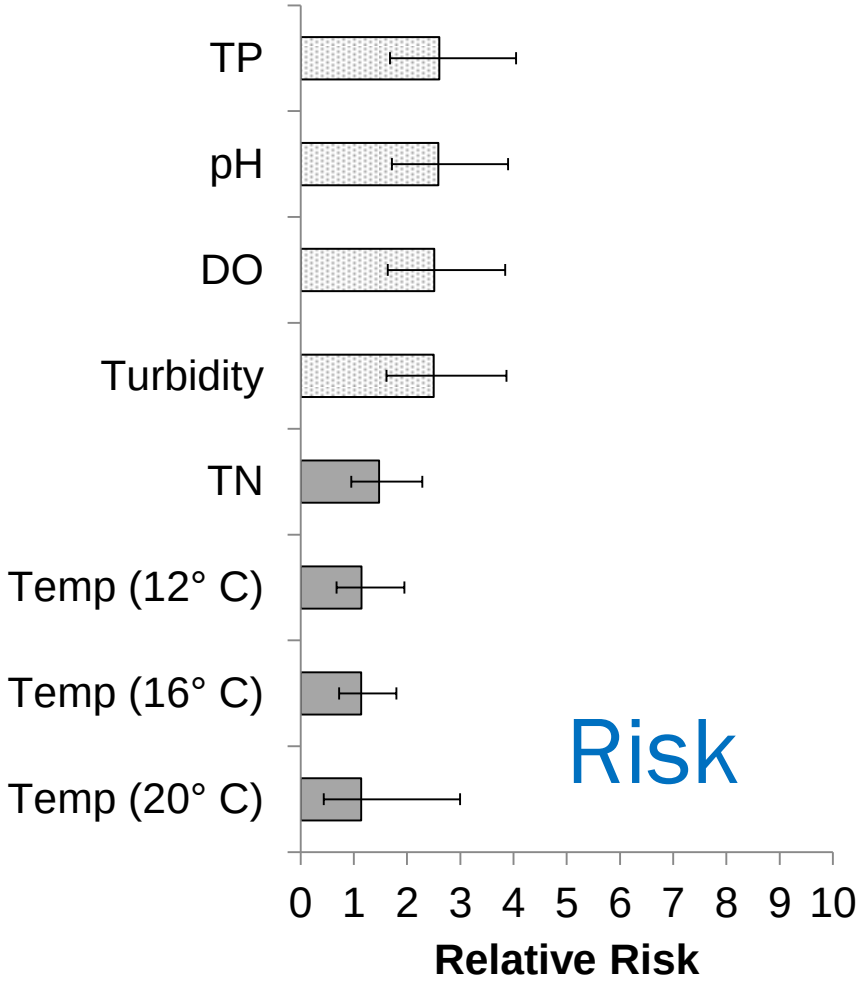
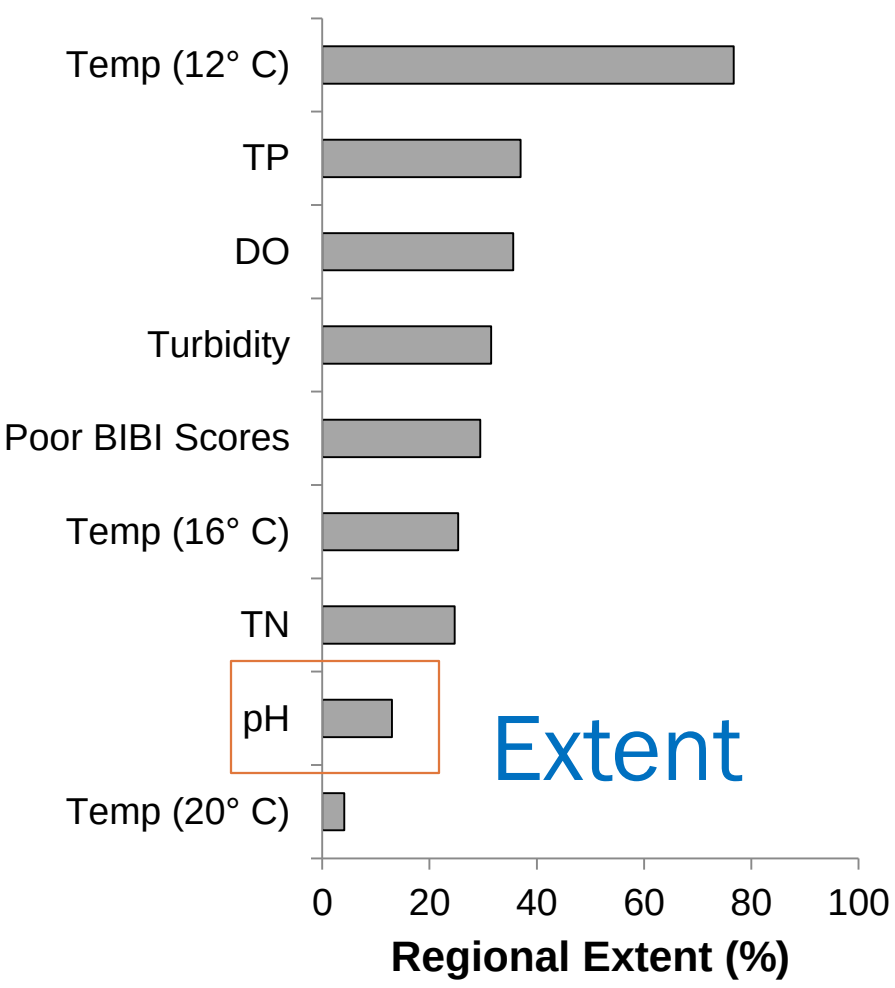
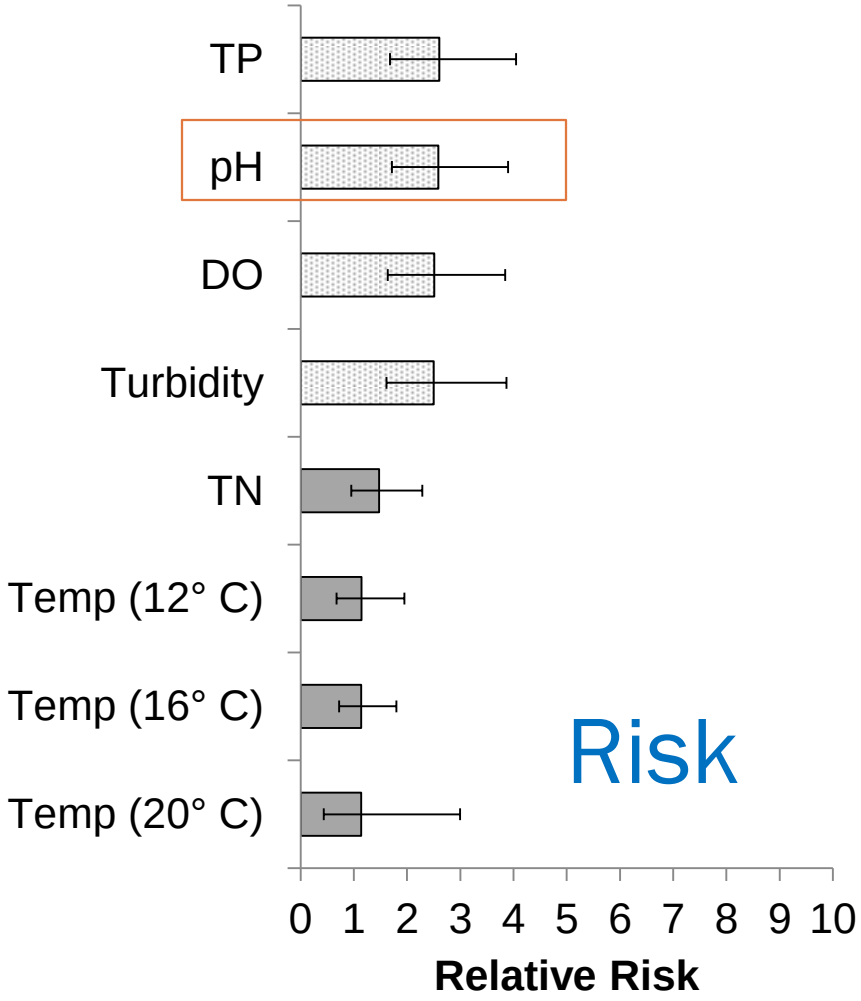
Water Quality: Extent and Risk



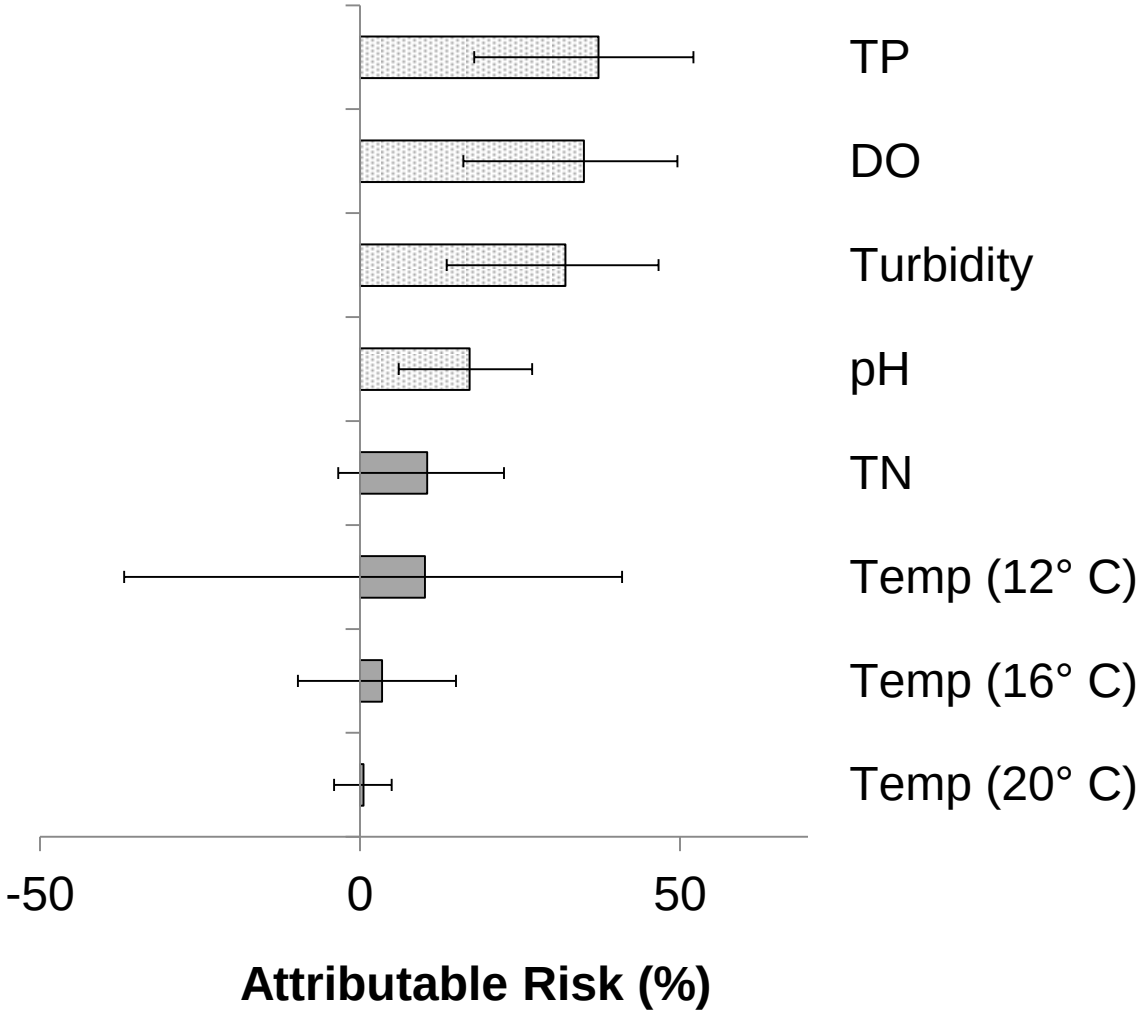


Water Quality: Extent and Risk





Attributable Risk: Water Quality



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Attributable Risk: Review

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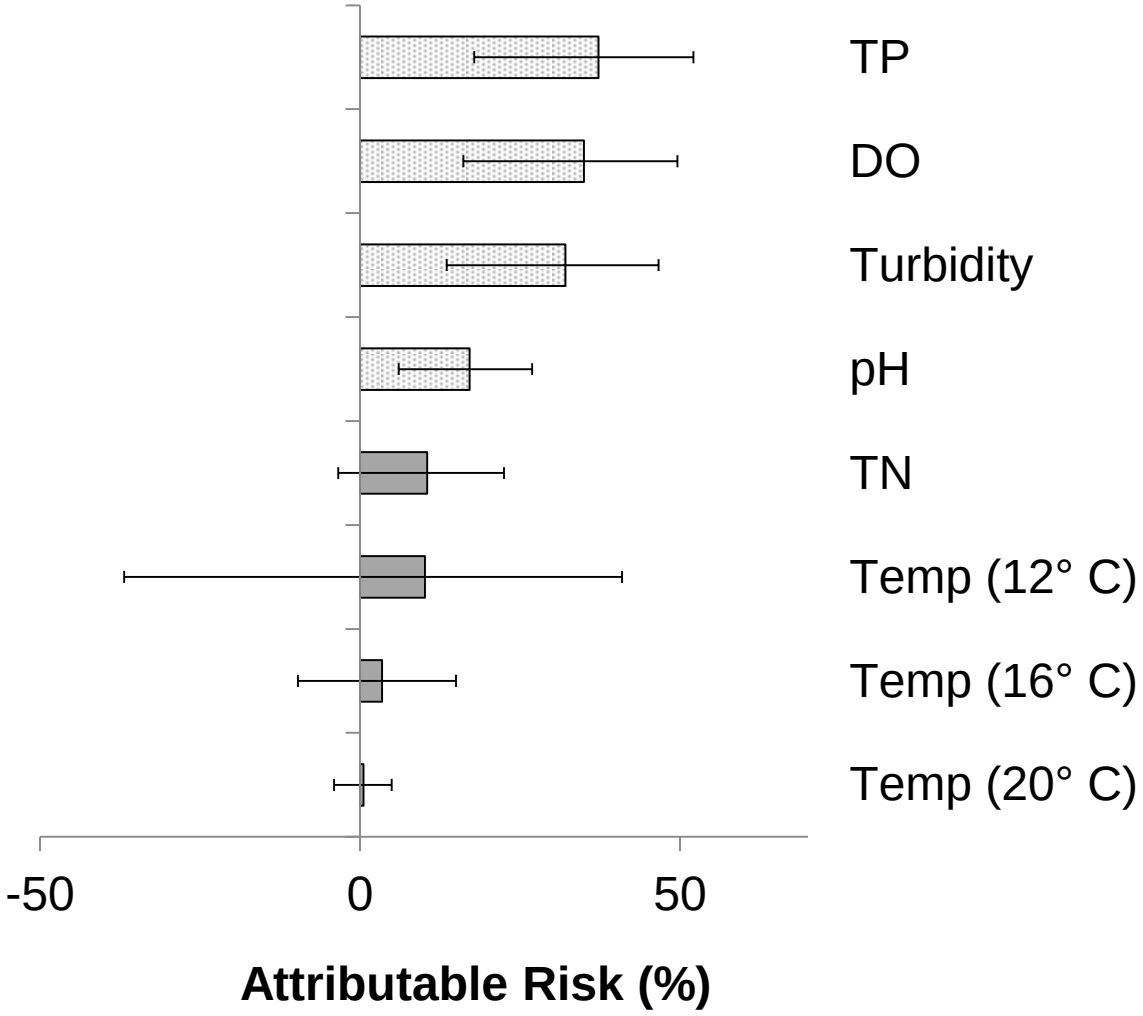
Attributable Risk: Water Quality



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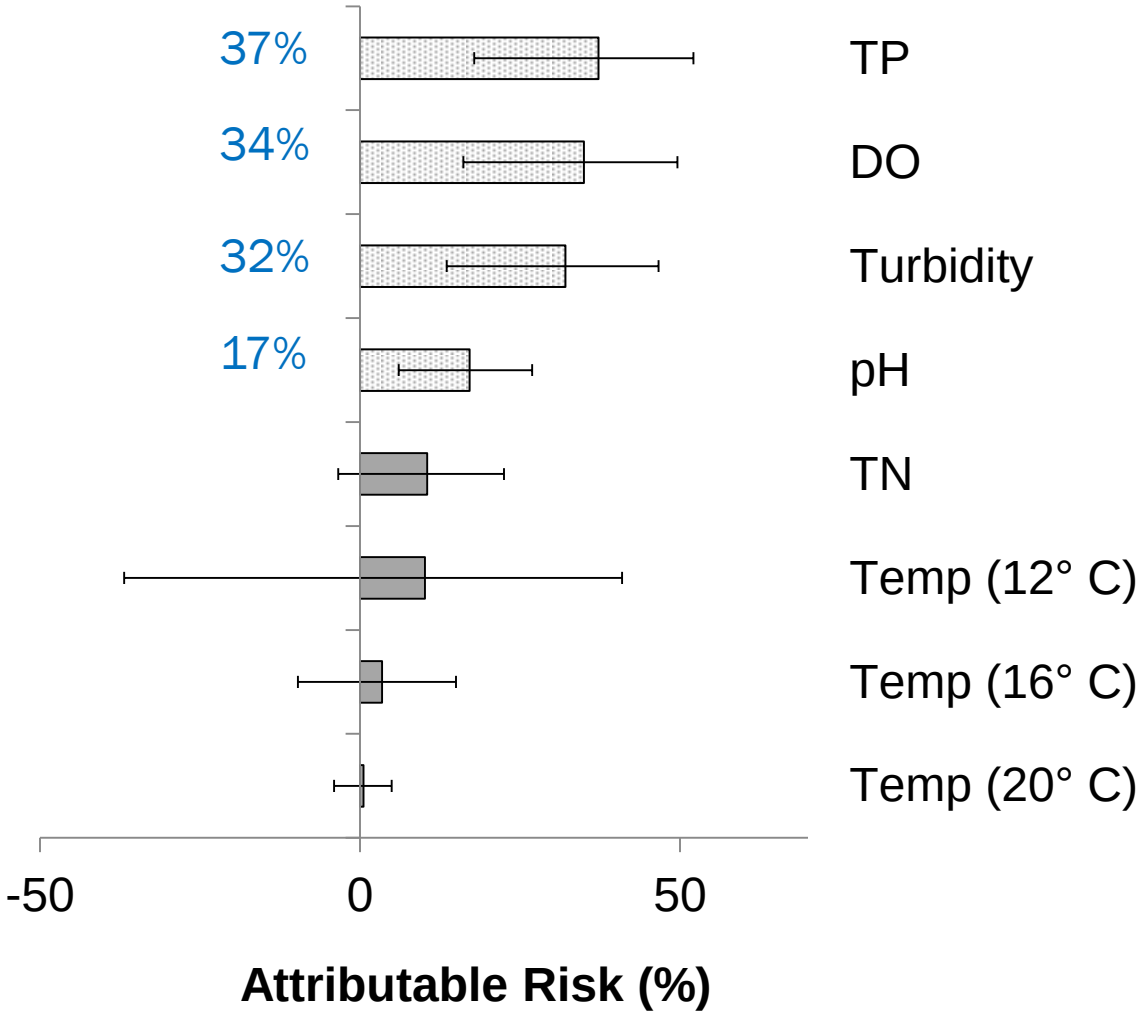
Attributable Risk: Water Quality



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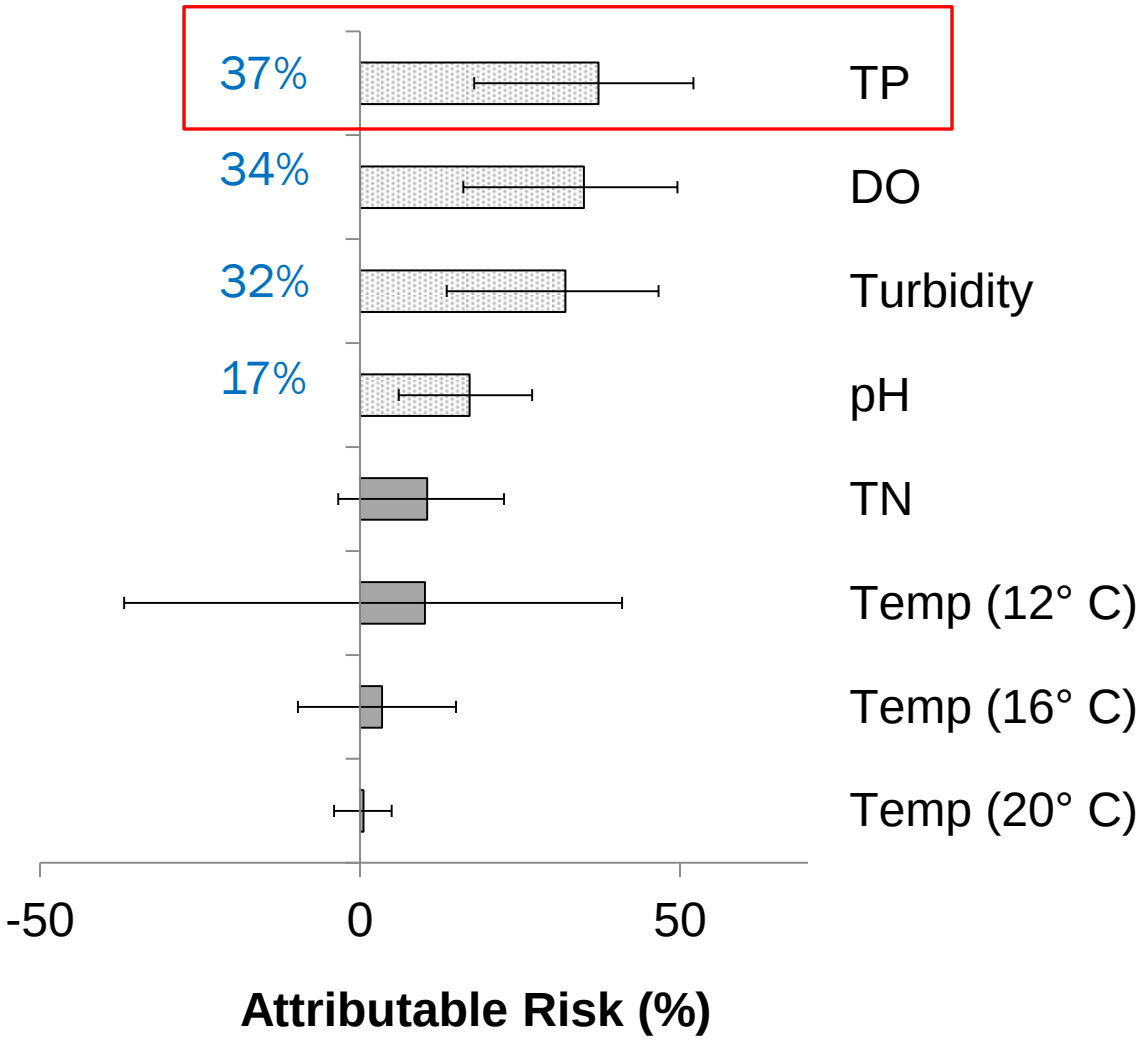
Attributable Risk: Water Quality



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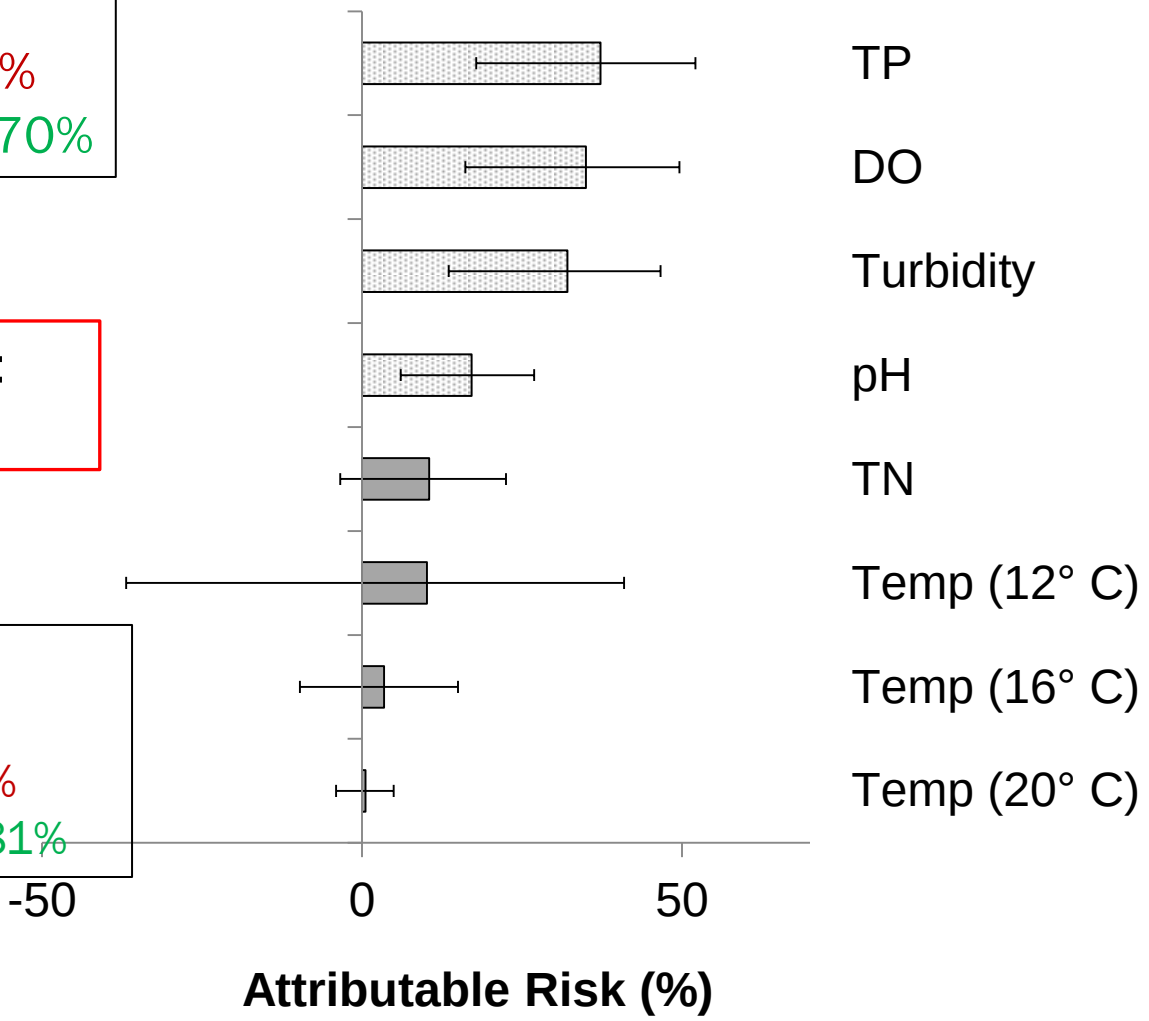
Attributable Risk: Water Quality

37% proportional reduction of poor scores

Before stressor management
Poor sites = 30%
Good/fair sites = 70%

Eliminate risk: Phosphorous

After stressor management:
Poor sites = 19%
Good/fair sites = 81%



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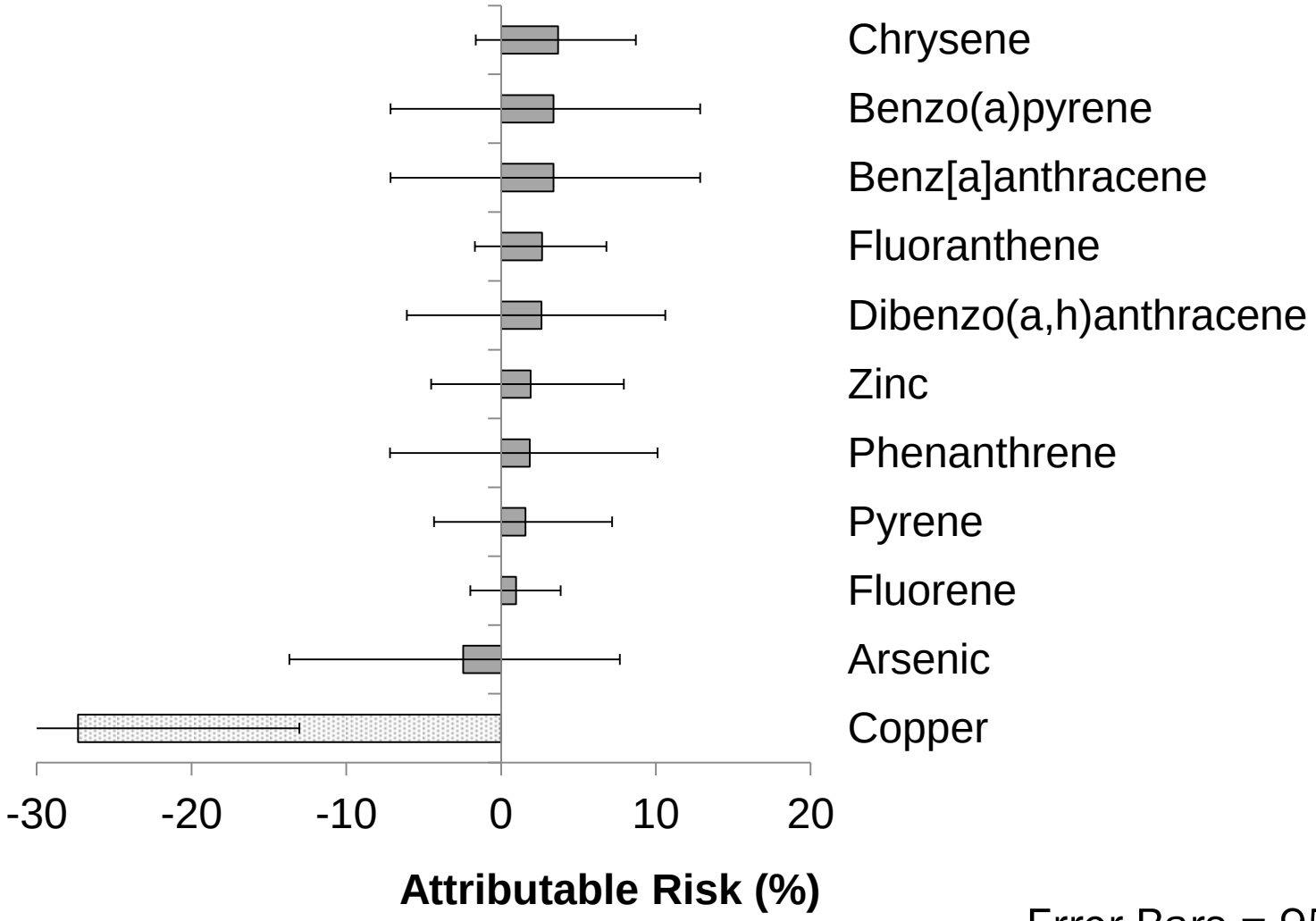
Attributable Risk: Sediment Chemistry



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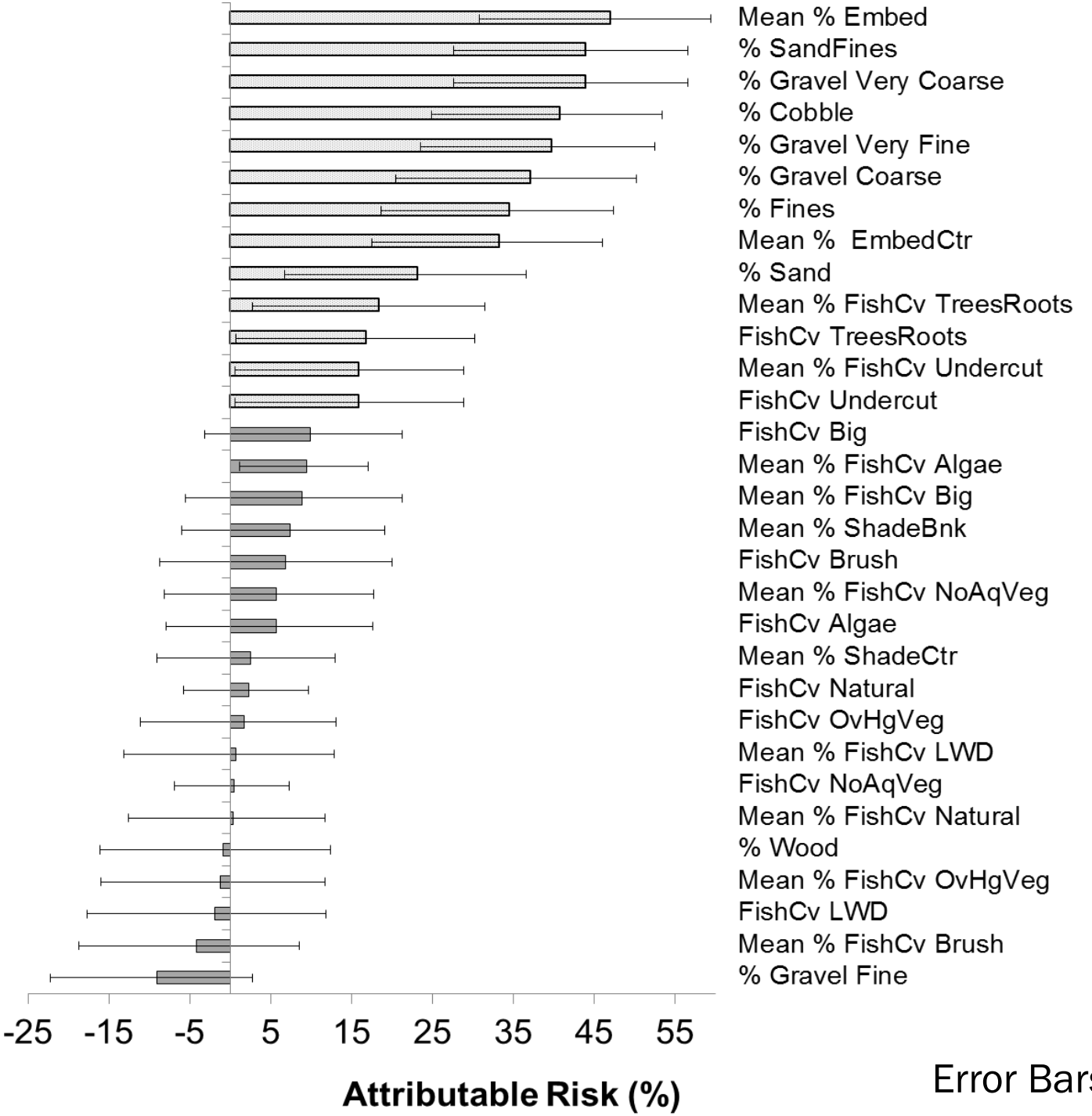
Attributable Risk: Habitat



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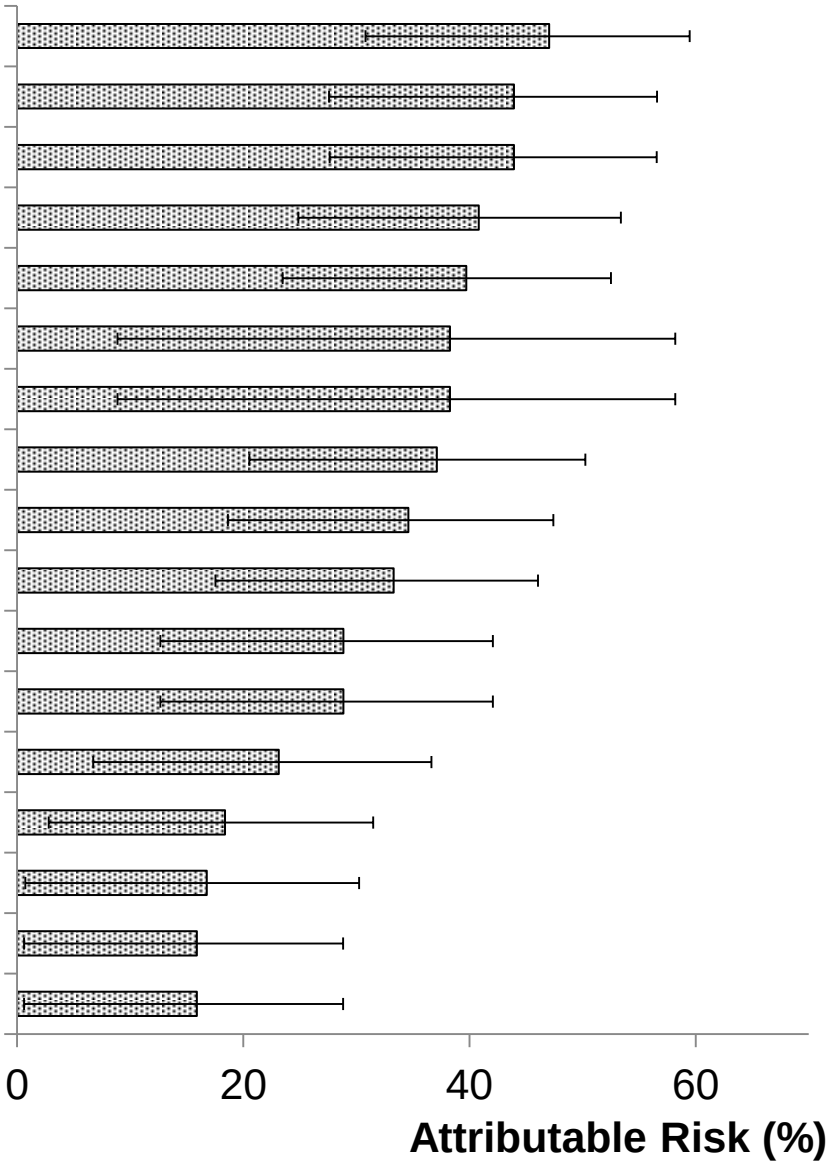
Habitat: Attributable Risk

→ Substrate
→ Fish Cover



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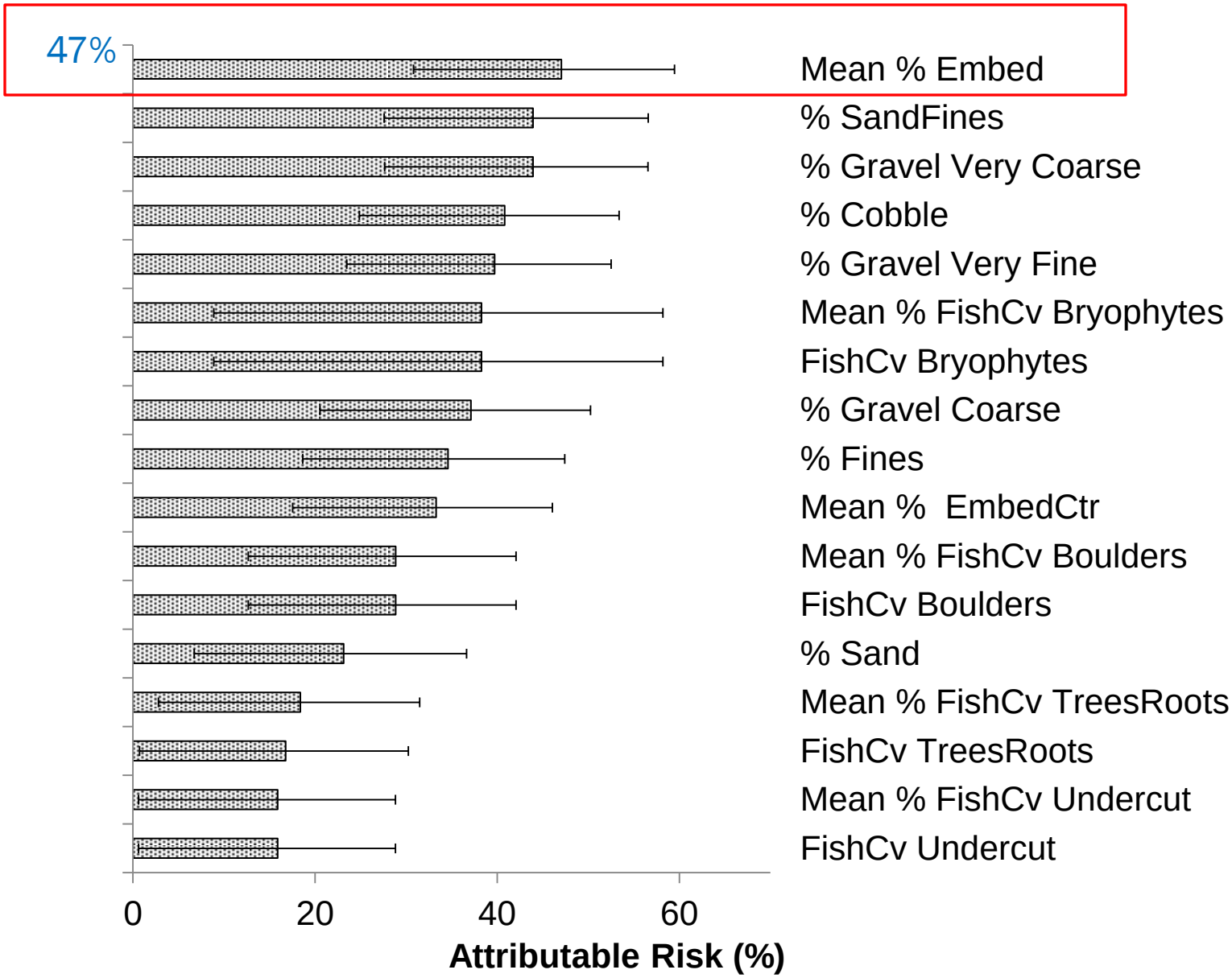
Habitat: Attributable Risk



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Habitat: Attributable Risk

47% proportional reduction of poor scores

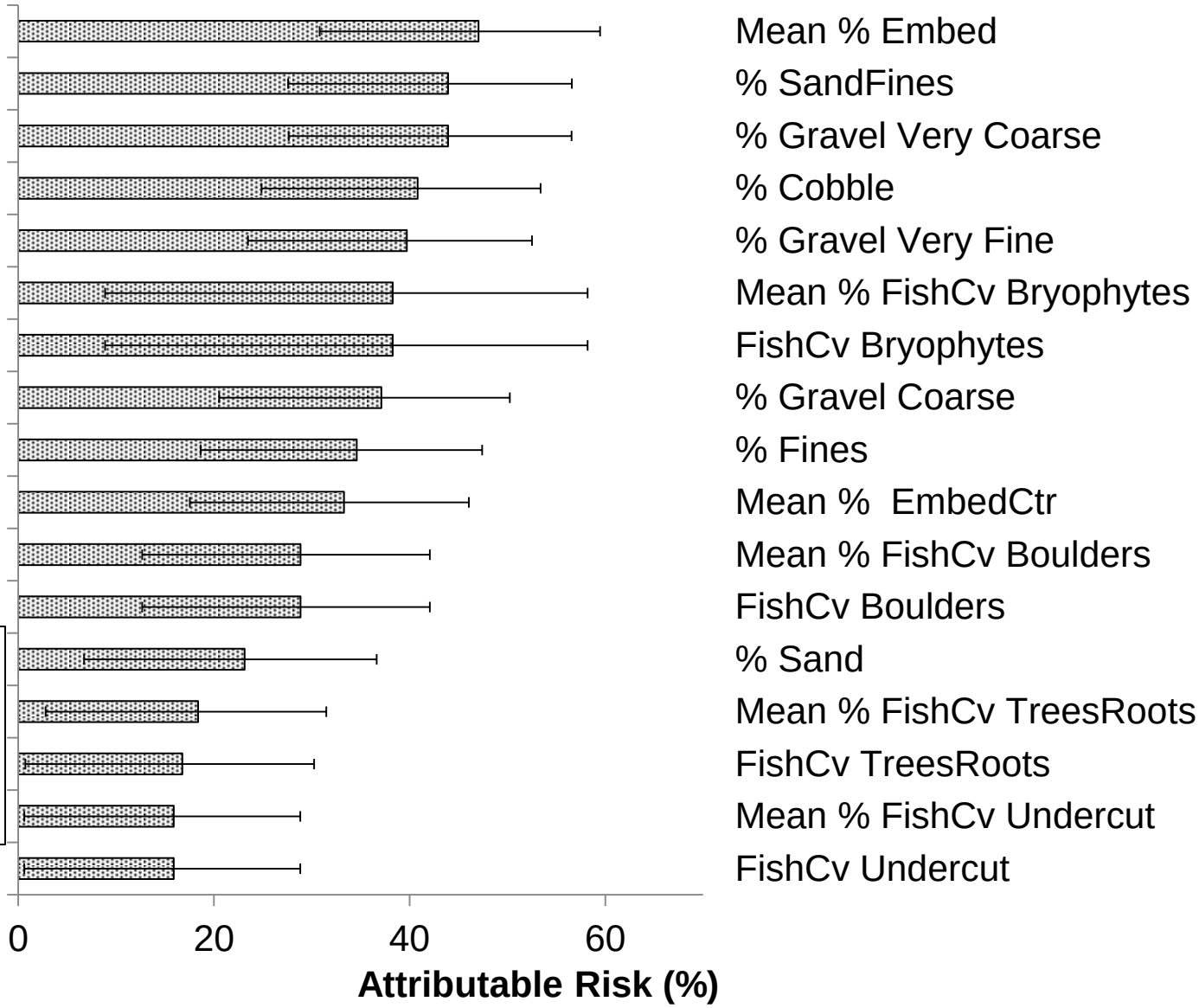
Before stressor management
Poor sites = 30%
Good/fair sites = 70%

↓

Eliminate risk: Embeddedness

↓

After stressor management:
Poor sites = 16%
Good/fair sites = 84%



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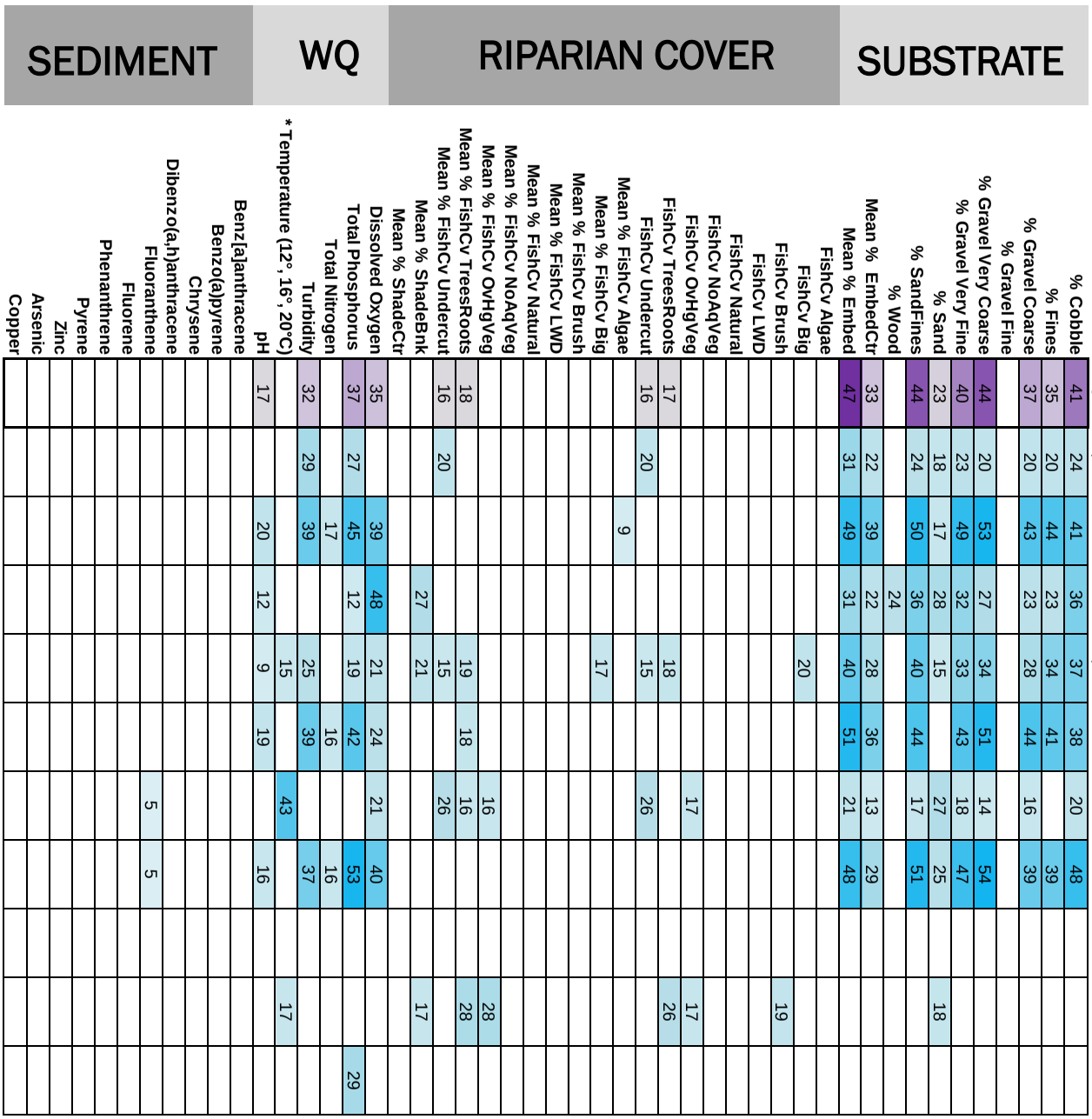
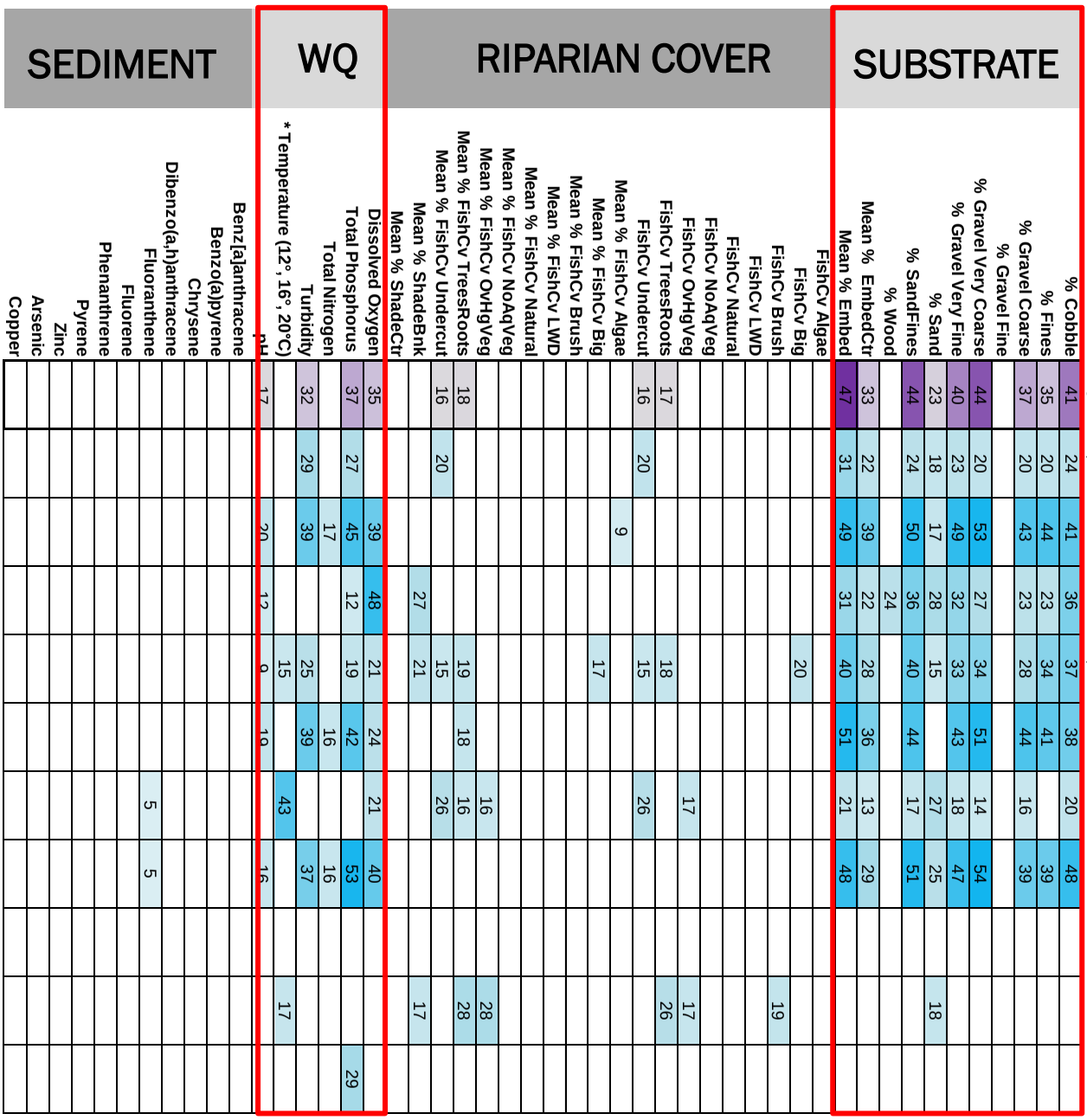
Attributable Risk Summary



Attributable Risk Summary



Risk Summary

- Substrate composition is important to B-IBI and metrics
- B-IBI and metrics are sensitive to surface water quality parameters – Phosphorous, Turbidity, DO, pH
- Target restoration: physical habitat
  - Rebuilding riparian buffers
  - Eliminating sedimentation sources
- Management and continued monitoring of water quality characteristics should be prioritized
- Valuable analysis tool to help prioritize watershed restoration decisions

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

Future Risk Analyses

- Weighted analysis
- Reference site data for threshold determination
- Grouping/scaling down variables
- Updated habitat metrics with hydrology
- Expanding analysis other biological data

Acknowledgements

EPA

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King County

Deb Lester, Jo Wilhelm

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Glenn Merritt

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Thank you!