# Linking Land Uses, Stressors and Invertebrate Assemblages in Nevada Streams

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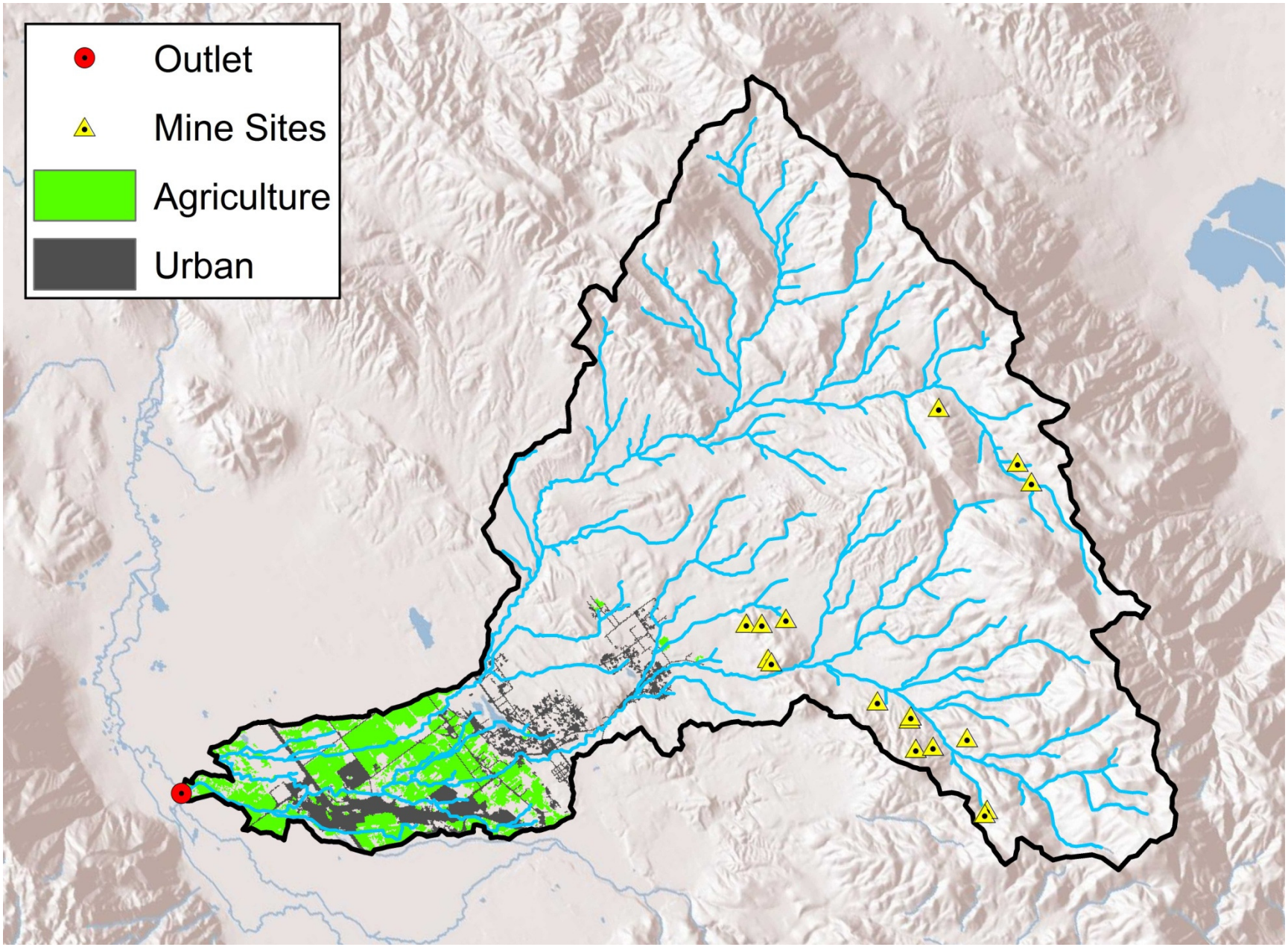
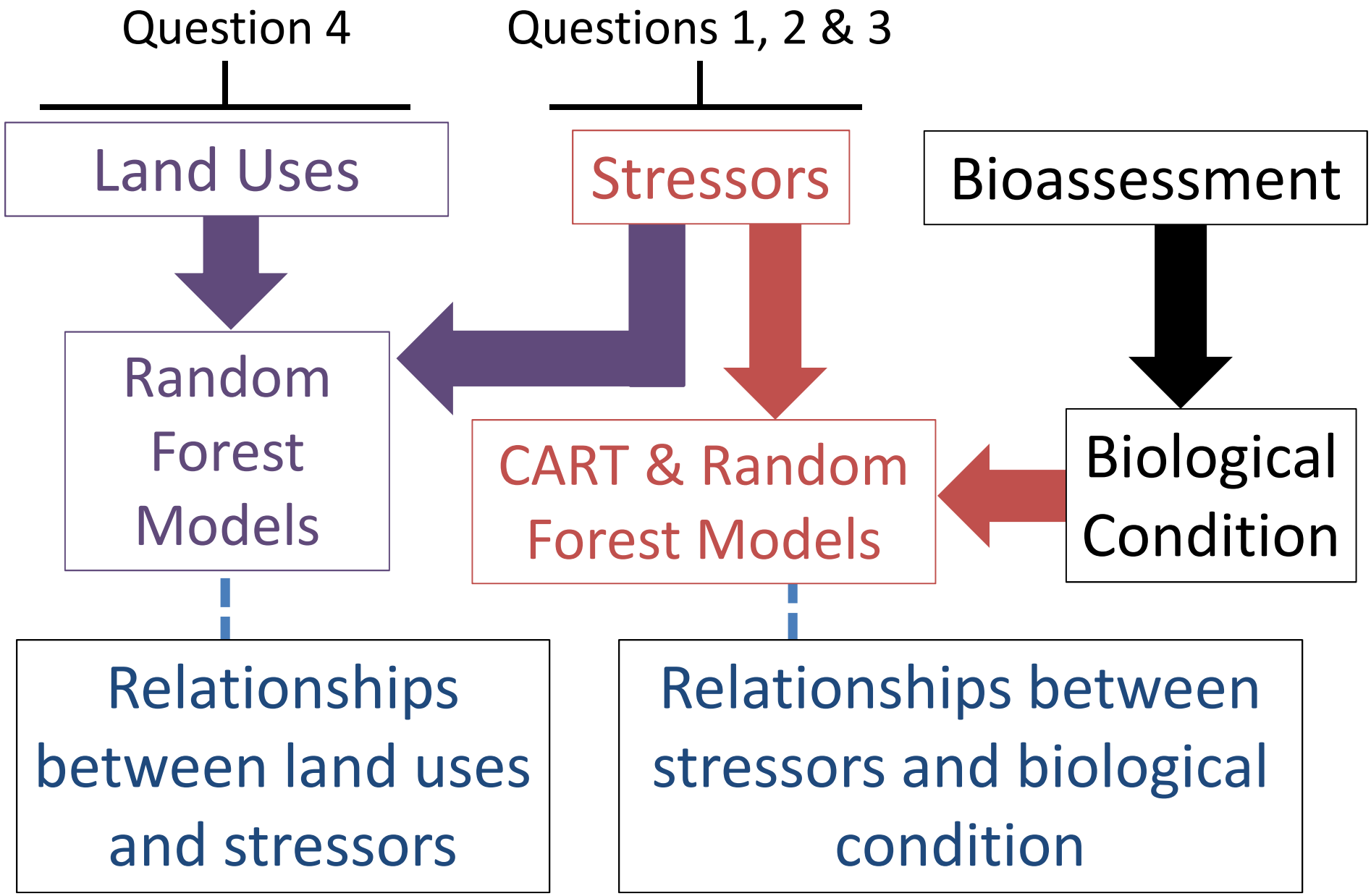
# Outline & Research Questions

1. What are stressors of interest in Nevada?
2. What are the individual and cumulative effects of stressors on biological condition?
3. Can impaired biological condition be attributed to the presence of stressors?
4. Are stressor concentrations related to land uses?

# Multi-Stressor Environments

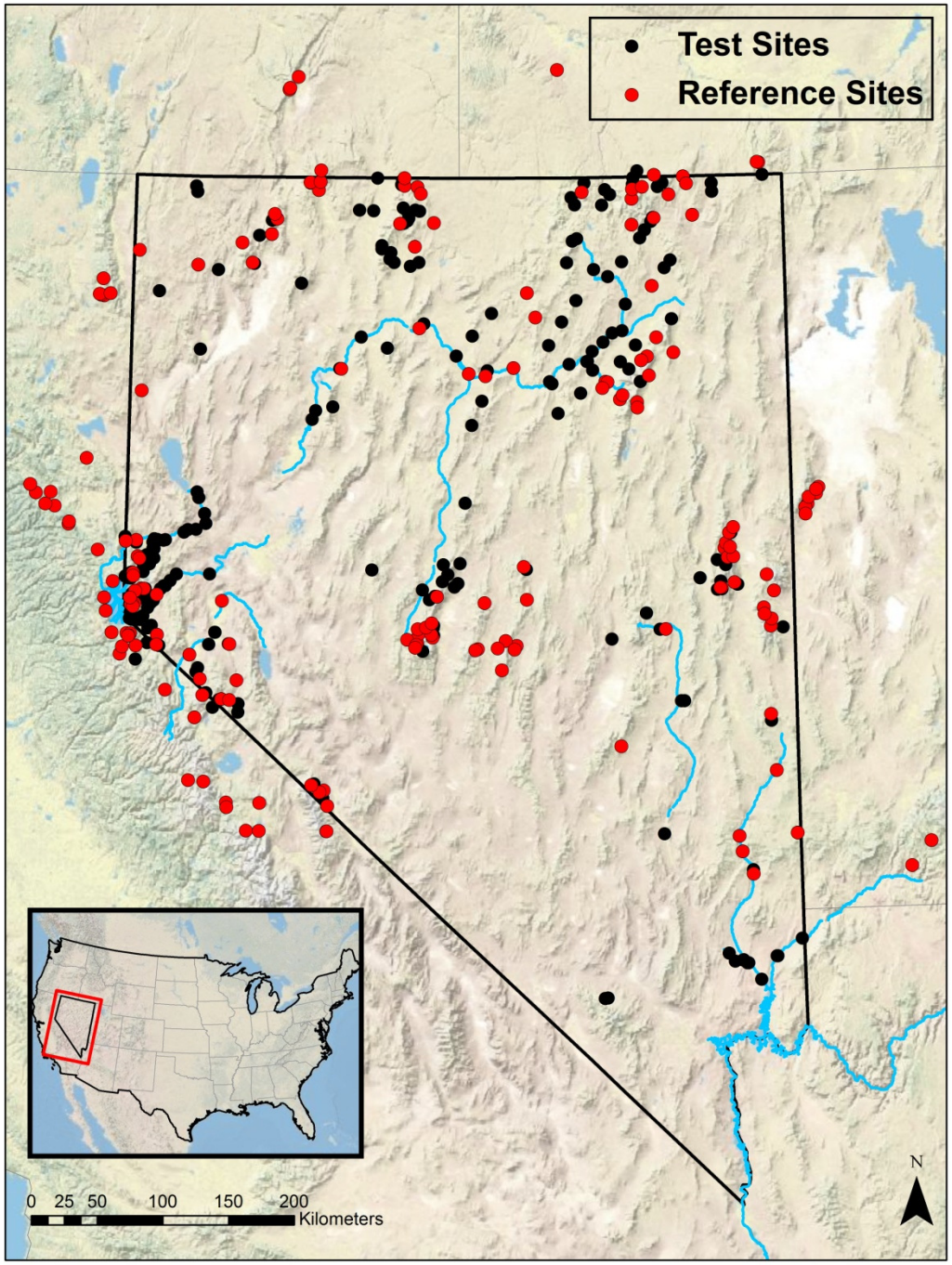


# Research Design



# Study Area and Data

- Samples previously collected by NDEP, EPA, or USU at 500 sites.
- Defined 165 sites as reference.
- 416 test and 80 reference samples with corresponding chemistry data.



# Research Questions

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# Measuring Biological Condition

- RIVPACS-type model to predict expected invertebrate assemblages.
- Observed to expected (O/E) taxa ratio used to measure biological condition.

# Stressor Selection

- **Total Dissolved Solids**:
  - Conductivity
- **Thermal alteration**:
  - Stream temperature
- **Nutrient enrichment**:
  - Total N and Total P
- **Dams**:
  - Normal storage volume of largest dam within watershed
- **Metal contamination** (dissolved):
  - Used PCA to identify independent axes of variation
  - Selected one metal from each axis to use in modeling

# Stressor Effects on O/E

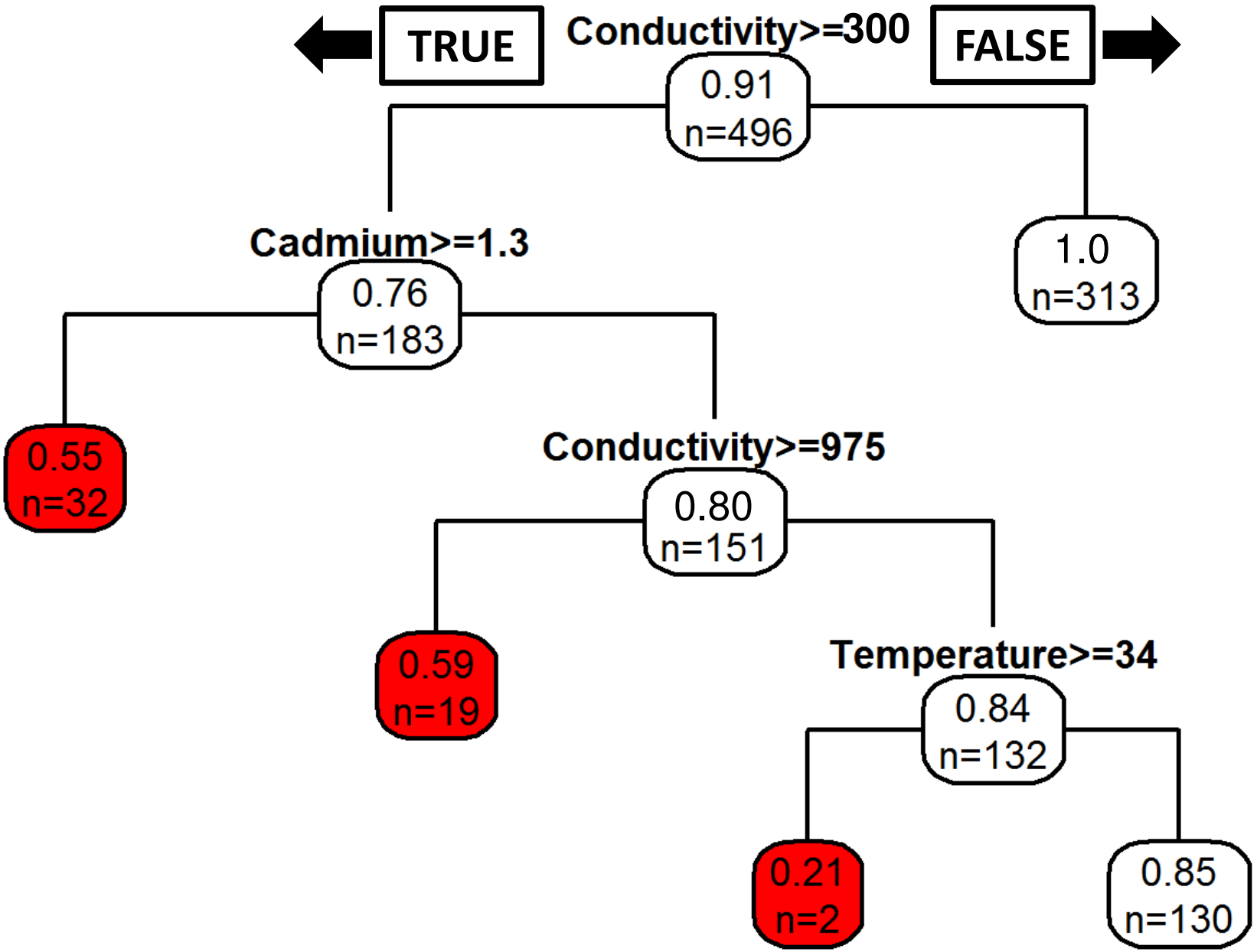
Regress O/E on stressors

- Regression Tree
- Random Forest Regression
  - Variable importance
  - Partial dependence plots
- Accounts for individual and interactive effects of stressors

# Selected Stressors

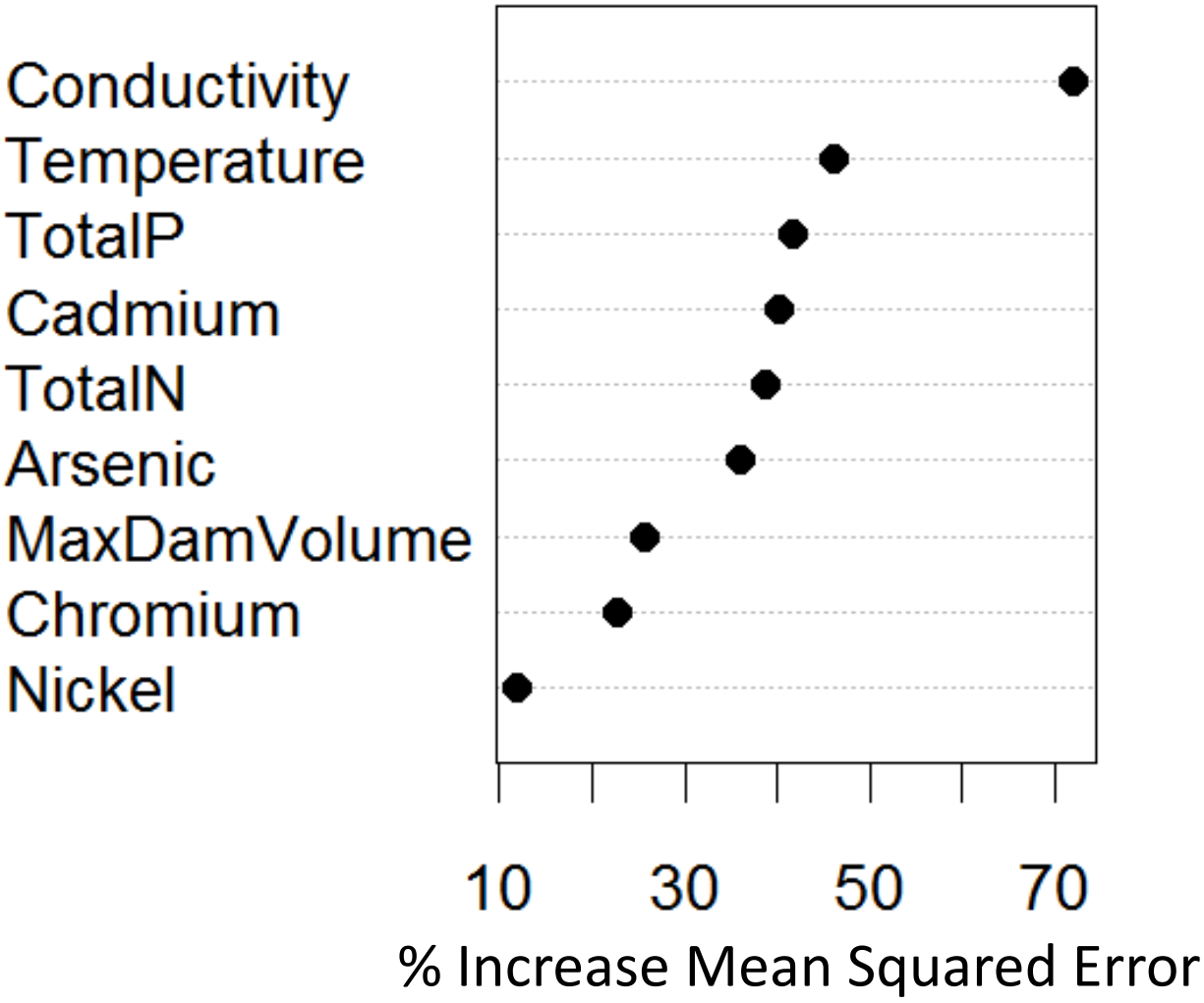
- Conductivity
- Stream Temperature
- Total N
- Total P
- Storage volume of largest dam
- Metal Contamination (PCA):
  - **Cadmium** (ug/L) – heavy metals (Cd, Cu, Pb, Zn, Hg)
  - **Arsenic** (ug/L)
  - **Nickel** (ug/L) – Ni & Se
  - **Chromium** (ug/L) – Cr & Ag

# Stressor Effects on O/E

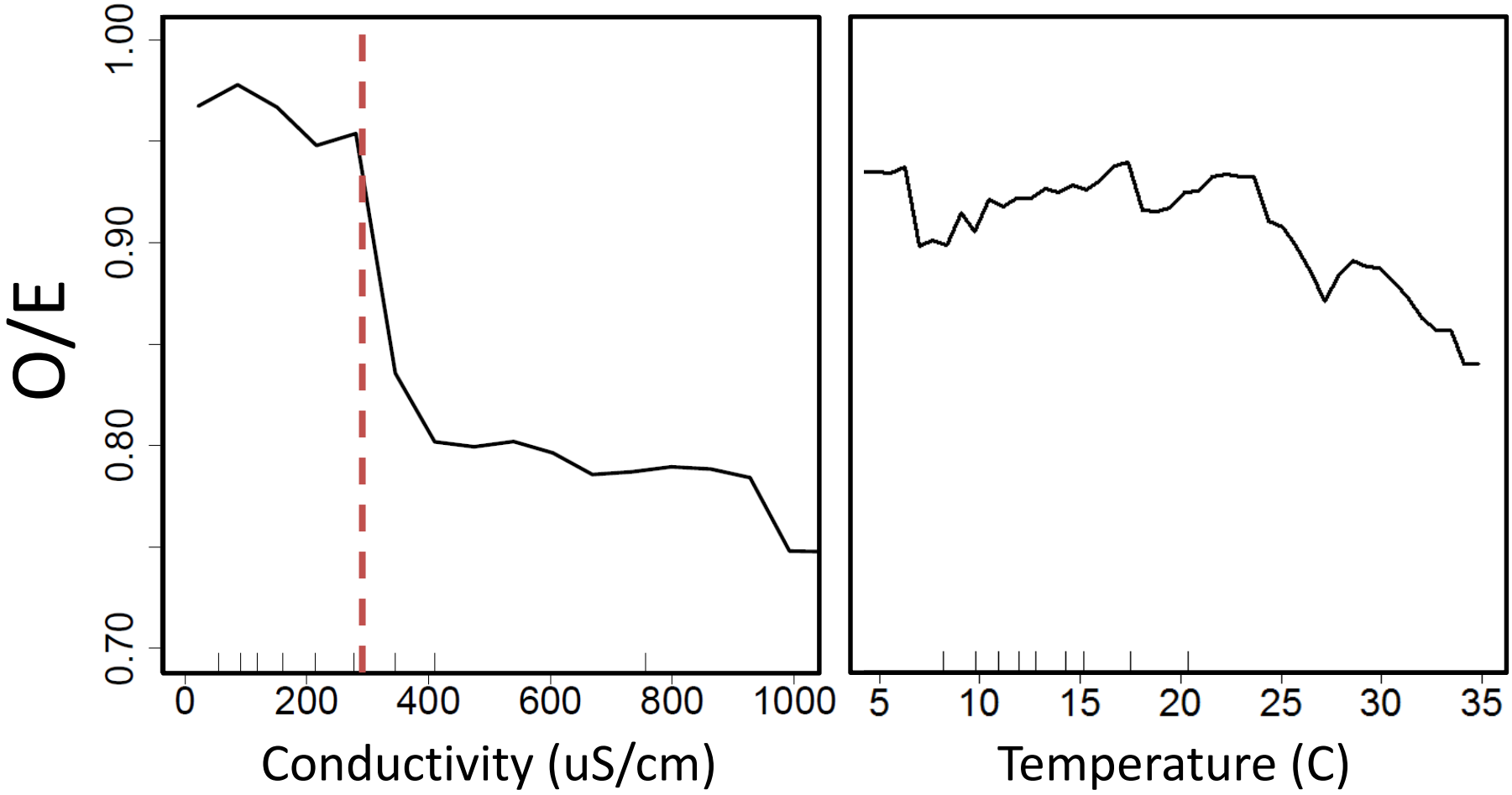


# Stressor Effects on O/E

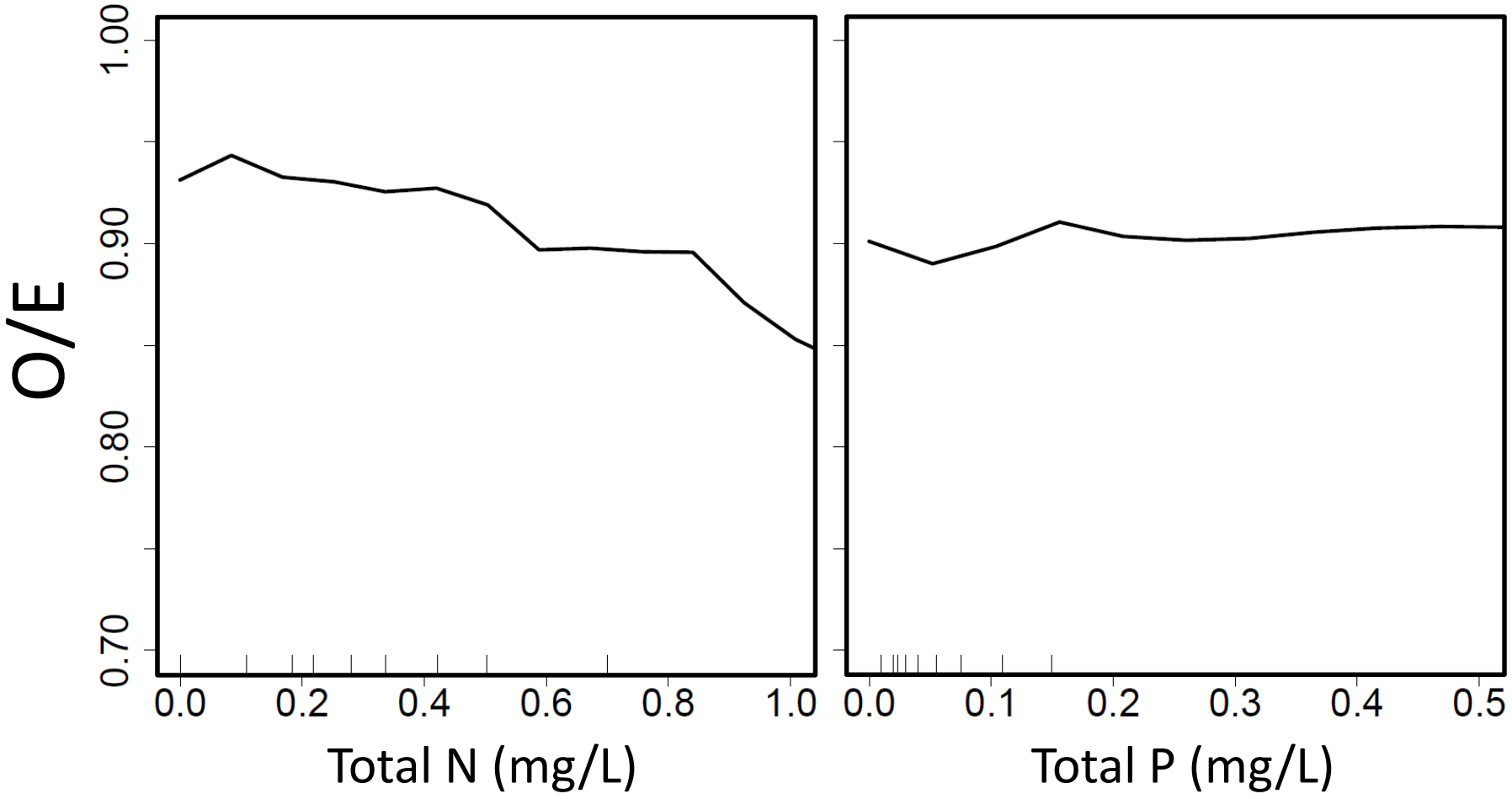
% Variation of O/E explained = 23%



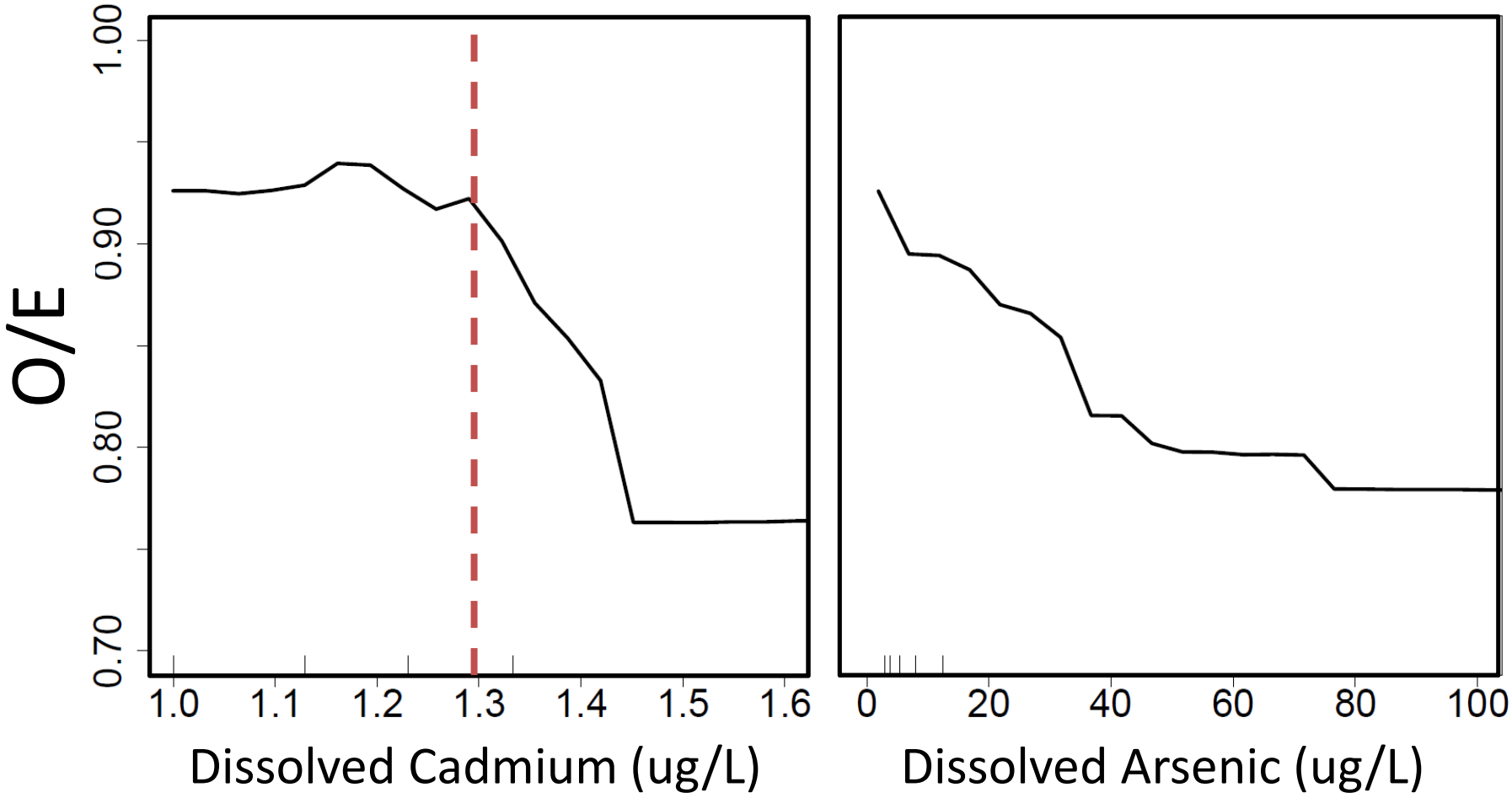
# Conductivity and Temperature Effects on O/E



# Nutrients Effects on O/E



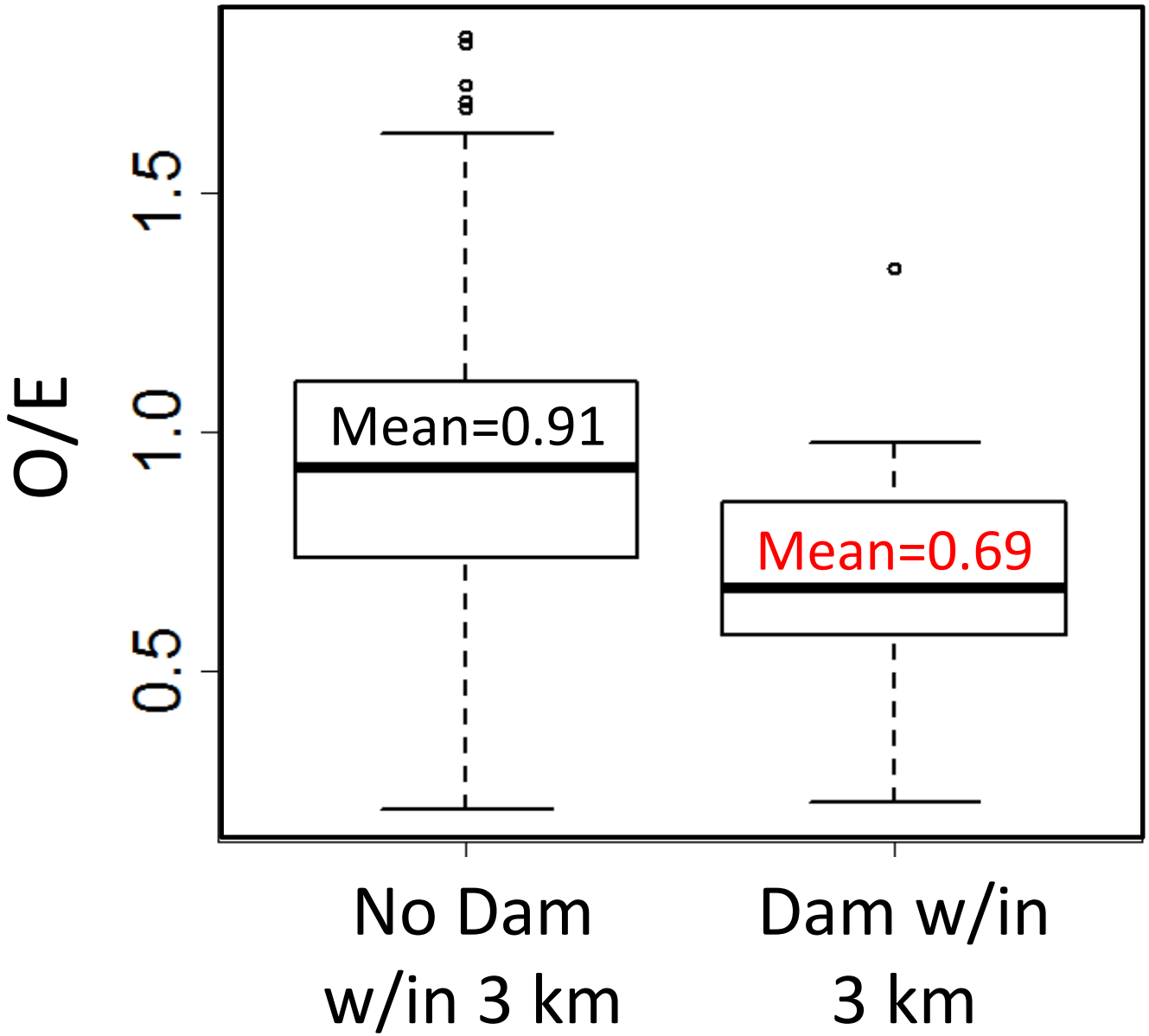
# Metals Effects on O/E




EPA Chronic Criterion = **0.25 ug/L**

EPA Chronic Criterion = **150 ug/L**

# Dam Effects on O/E



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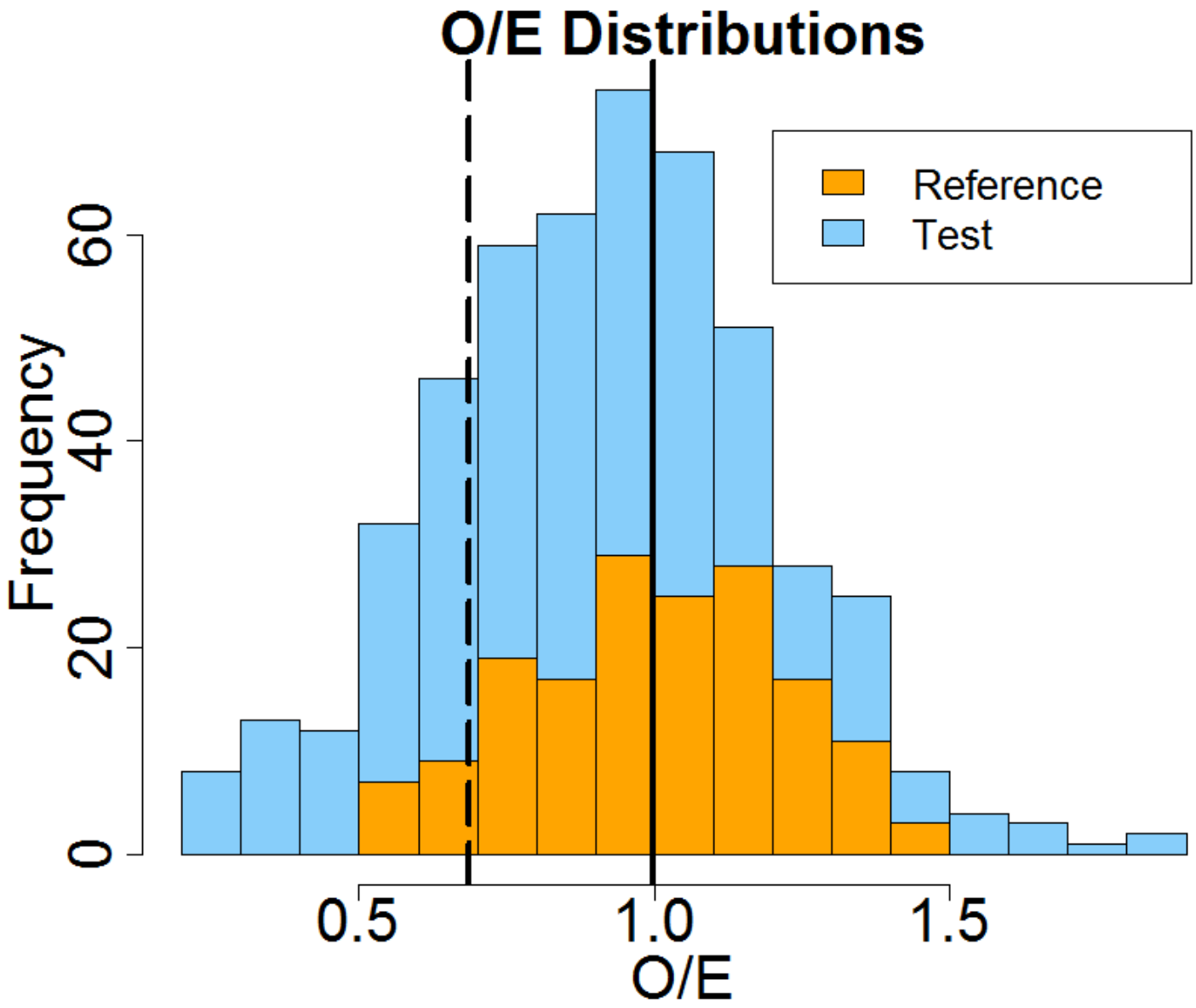
# Defining Impairment



# Predicting Biological Degradation

- Use Random Forest classification
- Stressors as predictors, reference or non-reference condition as response

# Predicting Degraded Samples

| | | Predicted | | |
|---|---|---|---|---|
| | | Reference | Non Reference | % Correct |
| Observed | Reference | **285** | 34 | 90% |
| | Non Reference | 53 | **44** | 46% |

Percent Correctly Classified = 80%

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# Characterizing Land Use

- Agriculture
  - Percent of whole watershed
  - Percent of watershed within 3 km of sample
- Urbanization
  - Percent of whole watershed
  - Percent of watershed within 3 km of sample
- Mining
  - Density of mine sites within watershed

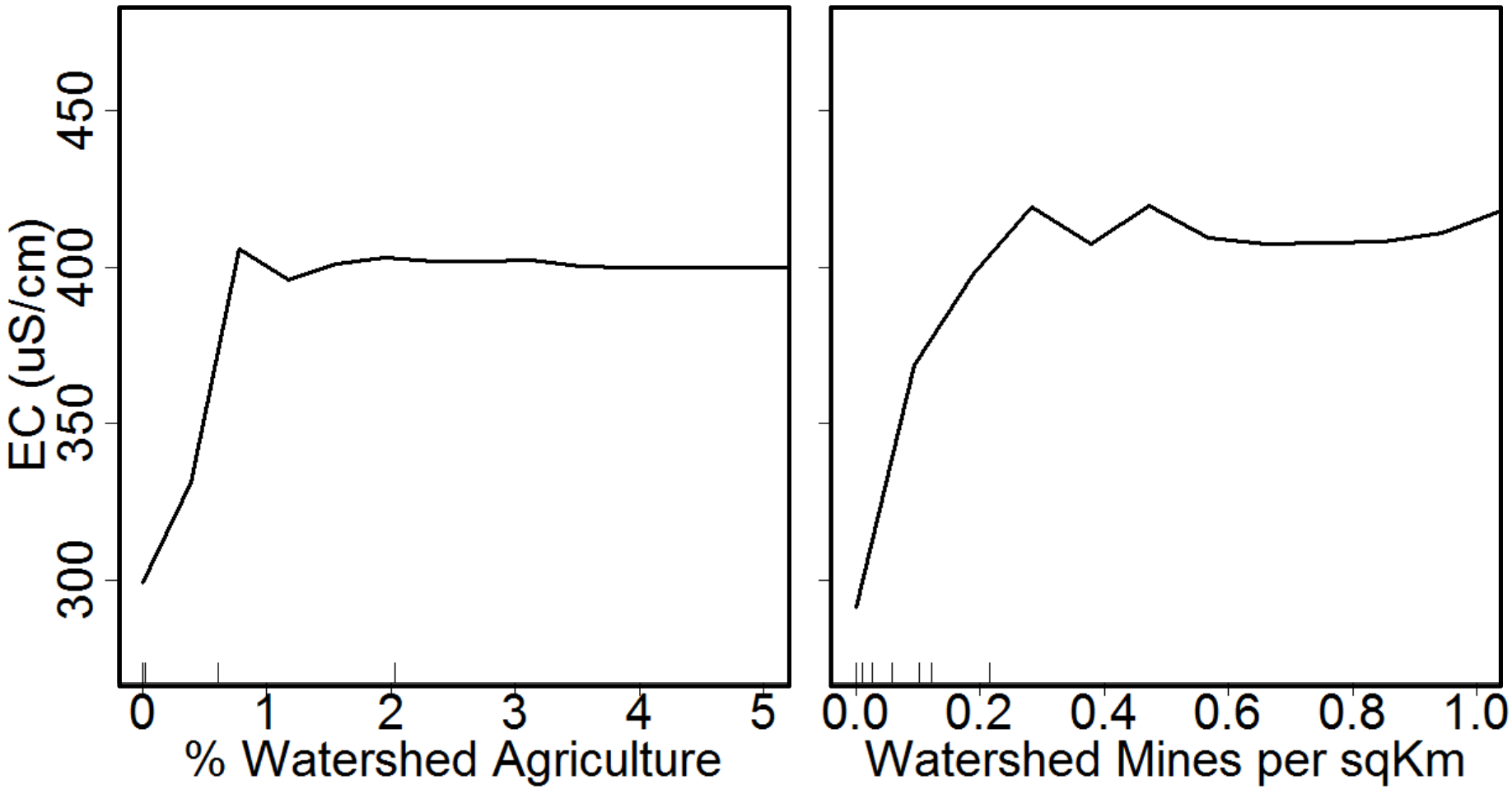
# Land Use Effects on Stressors

- Regress stressor concentrations on land use variables – Random Forest model
- Stressors also vary naturally
  - Models included environmental gradients as predictors to account for natural variability
  - Precipitation, air temperature, elevation, watershed area

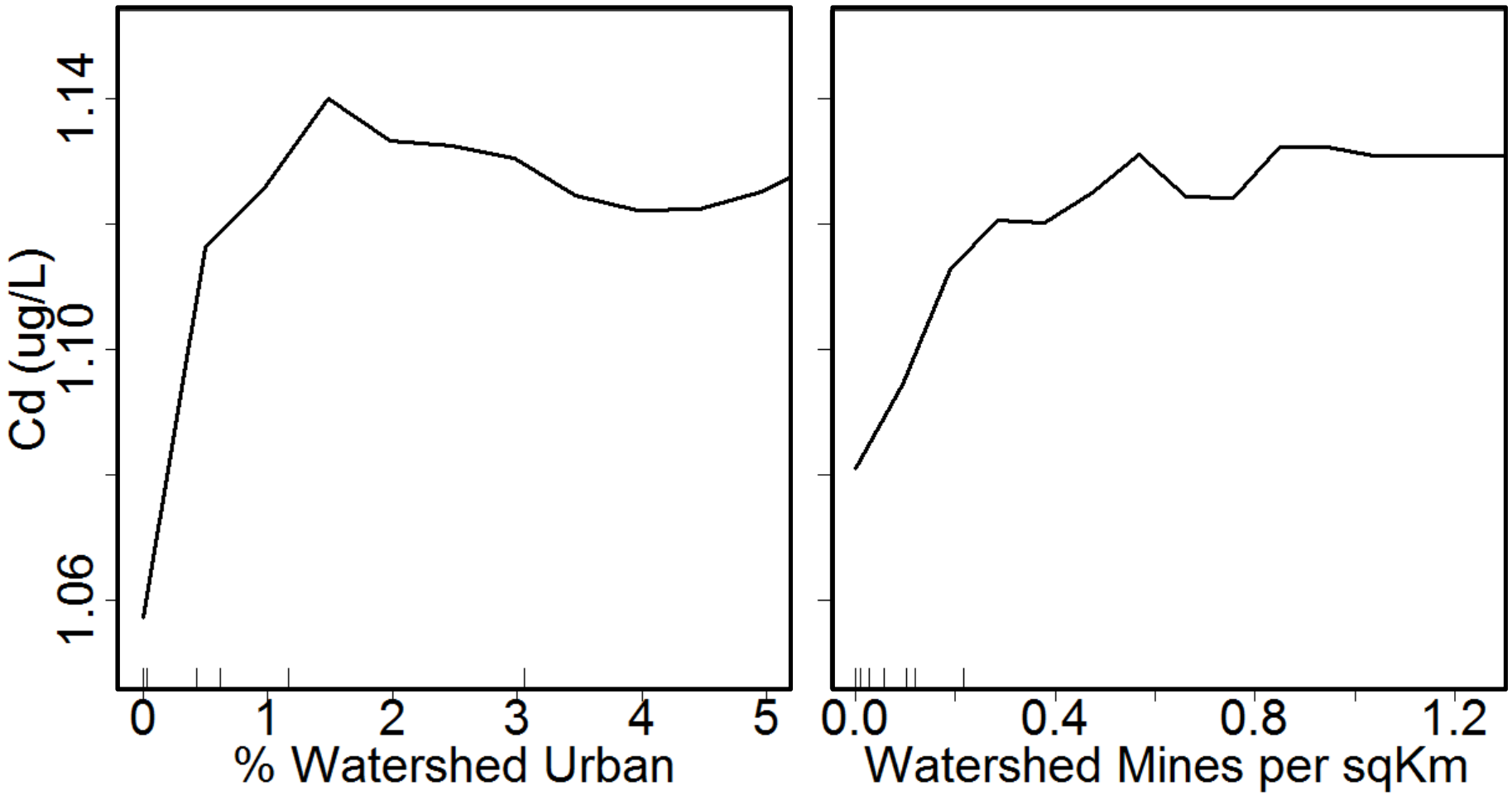
# Relating Stressors to Land use

| Stressor | % Variation Explained | Influential Land Uses |
|---|---|---|
| Conductivity | 96% | Agriculture, Mining |
| Temperature | 83% | Urban, Agriculture |
| Cadmium | 67% | Urban, Mining |
| Total N | 62% | Agriculture, Mining |
| Total P | 58% | Agriculture |
| Arsenic | 7% | |

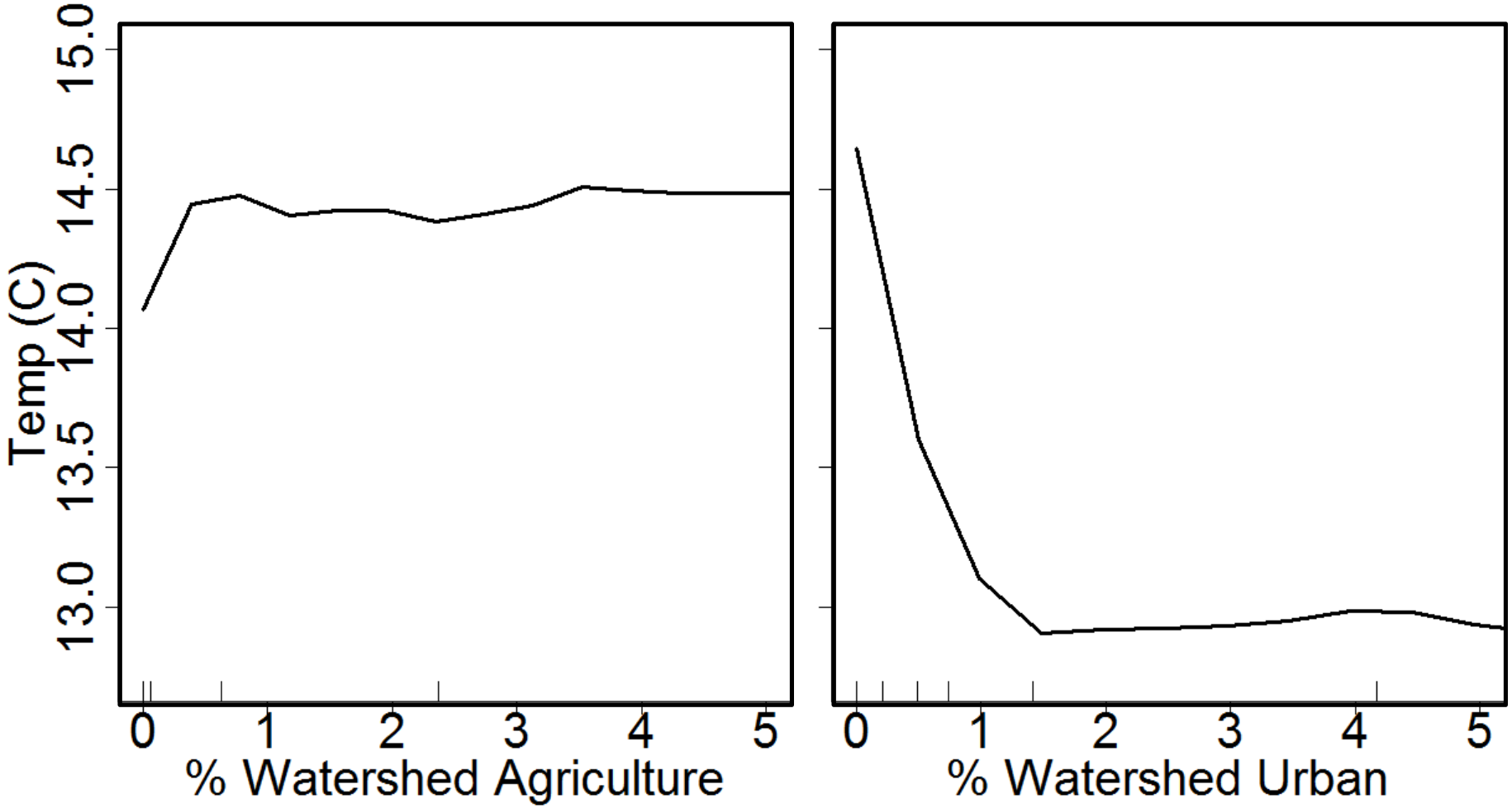
# Conductivity



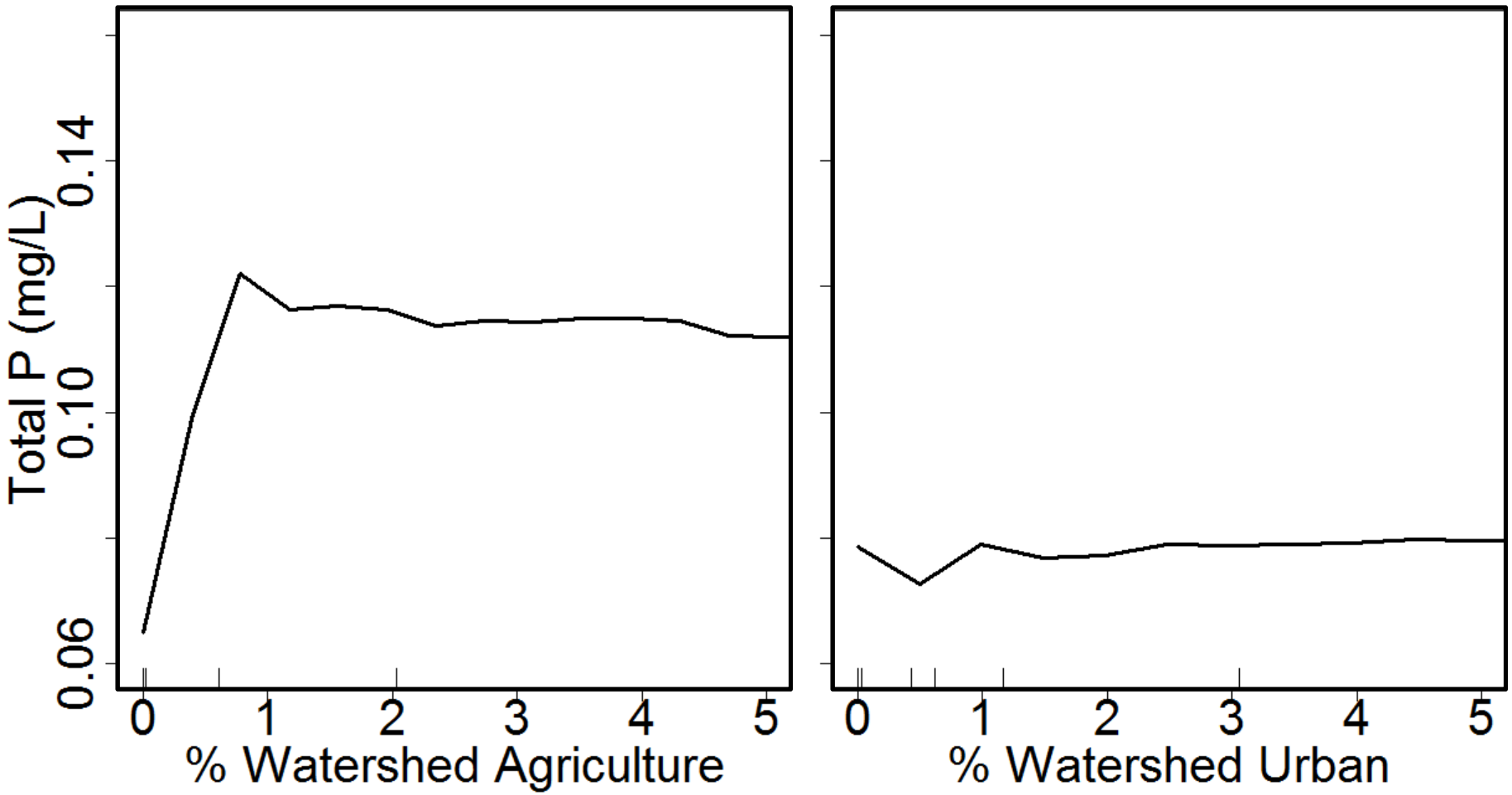
# Cadmium


Cd (ug/L)
1.06
1.10
1.14
0
1
2
3
4
5
% Watershed Urban
0.0
0.4
0.8
1.2
Watershed Mines per sqKm

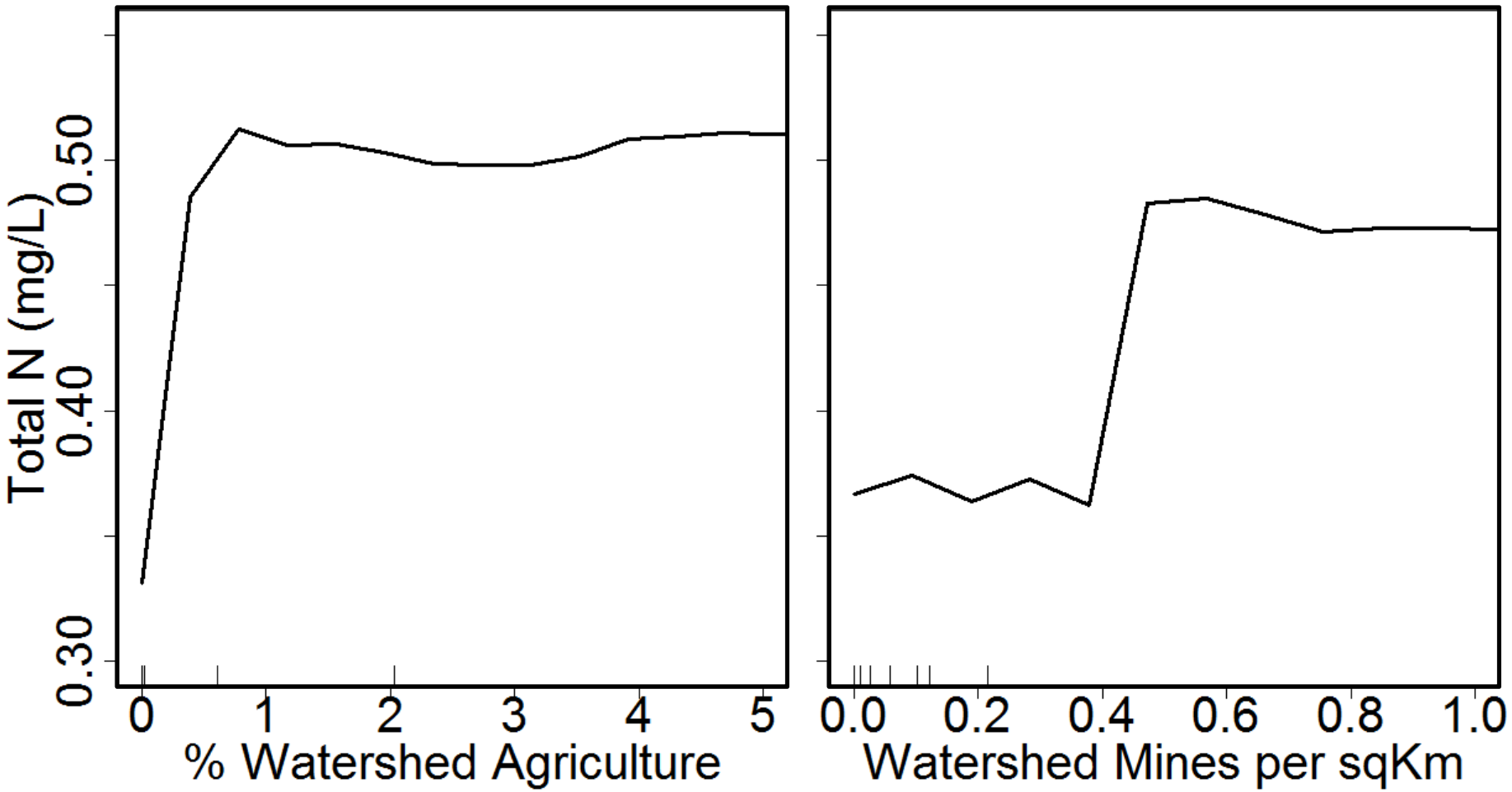
# Temperature



# Nutrients – Total P



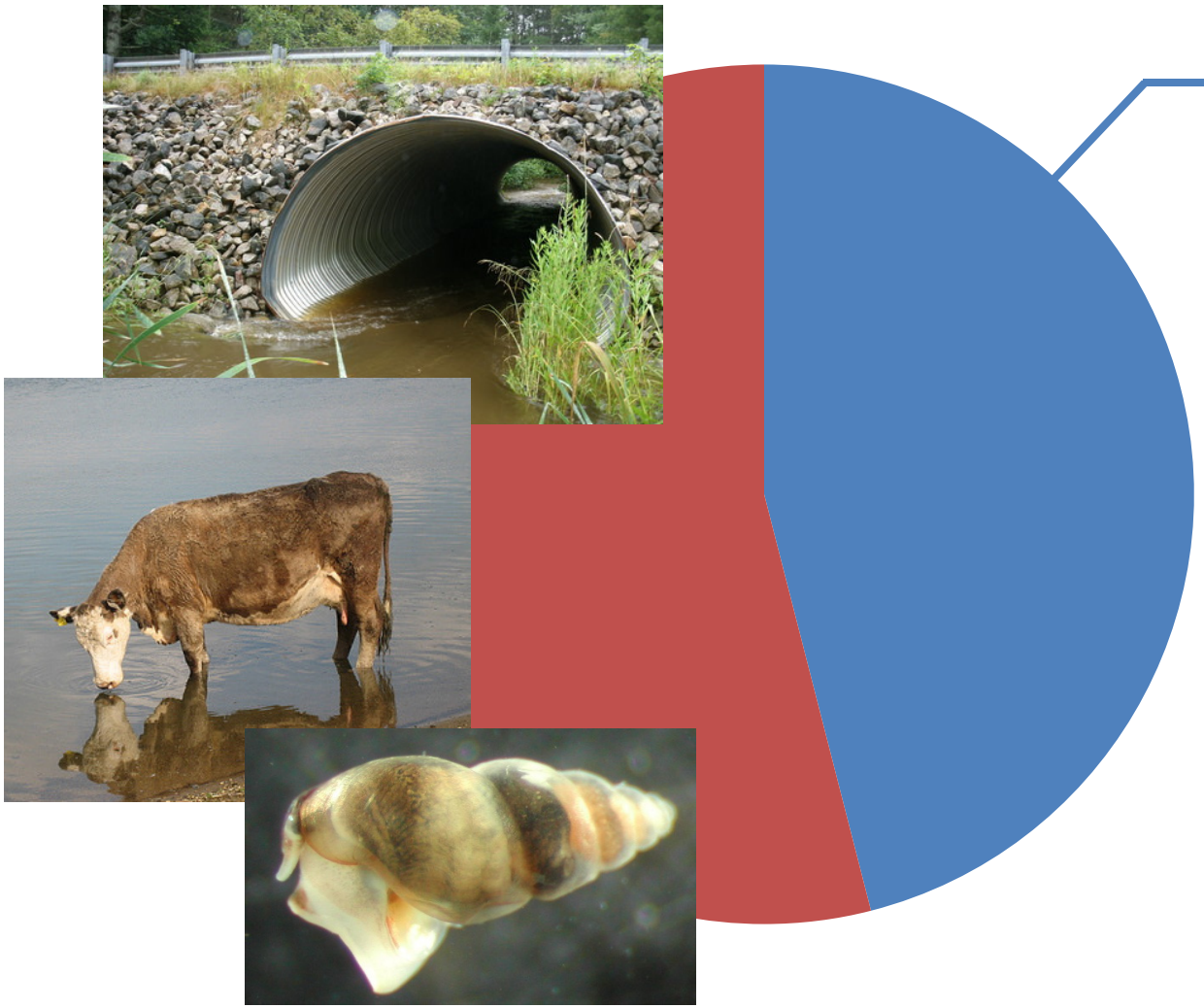
# Nutrients – Total N



# How can these stressors lead to biological degradation?

- Metals:
  - Directly toxic to organisms
- Nutrients:
  - Enrichment may alter algal communities and lead to changes in macroinvertebrate communities via food web or microhabitat alterations
- Conductivity:
  - Extremely high conductivities can be toxic
  - Increases from low to moderate conductivity may change chemical niche space and reduce fitness of taxa adapted to very low conductivities
- Dams:
  - Change flow, thermal and sediment regimes

# Other Sources of Degradation



Conductivity, metals, and nutrients

~46% of impaired samples

# Contacts

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