How Environmental Data Are Different And Why This Matters

Introdution to Clean Water Act
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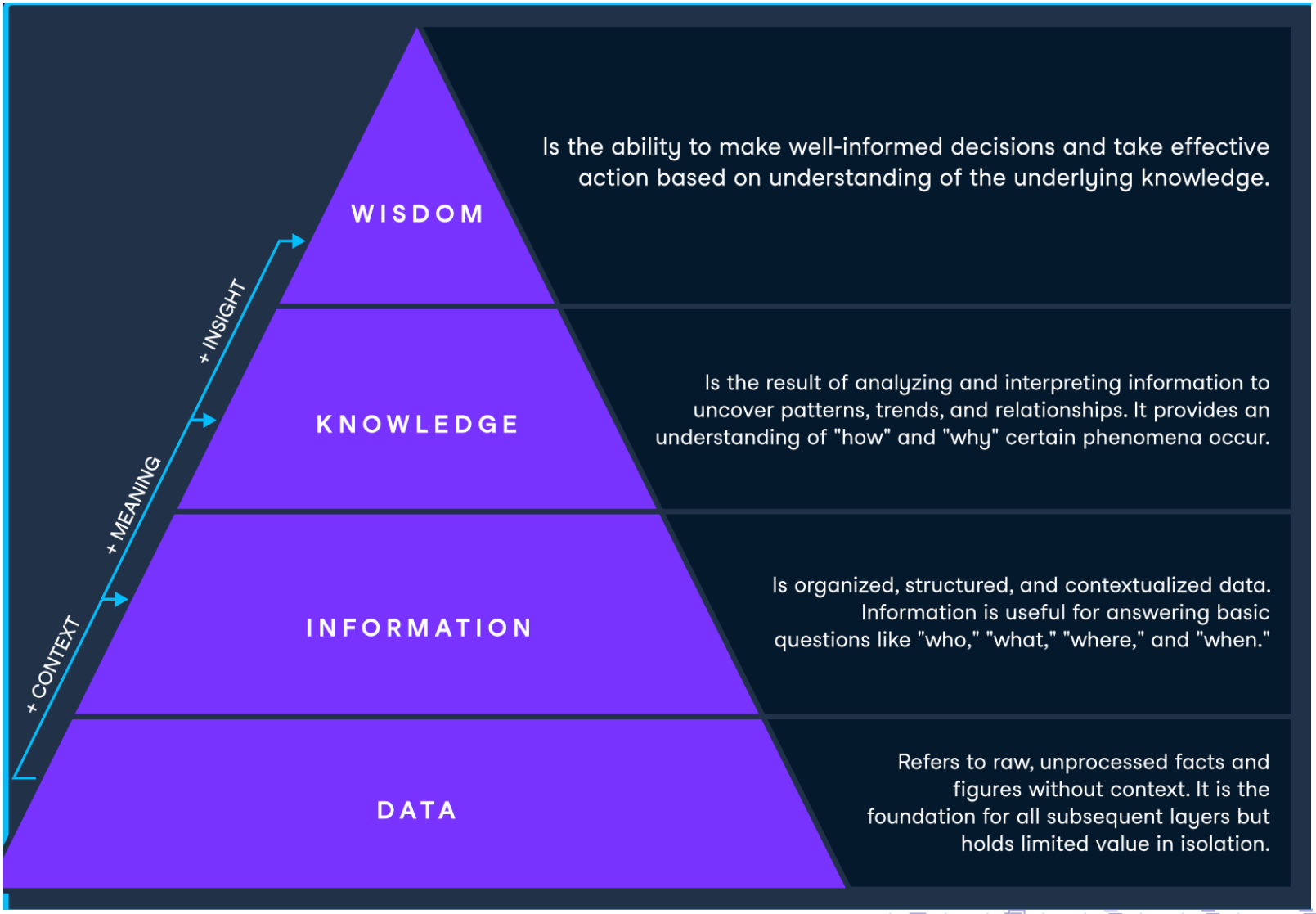
Three topics to remember

1. That environmental data differ from other data types.
2. Why this matters in analyzing and presenting data.
3. How this addresses the CWA's objective and goal.

CWA objective and goal

- The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.
- The CWA's national goal is for water quality that provides protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water.
- Ambient conditions are the physical, chemical, and biological components at a specific reach of flowing water ecosystems (or static water bodies such as reservoirs, lakes, and ponds.)

DIKW pyramid



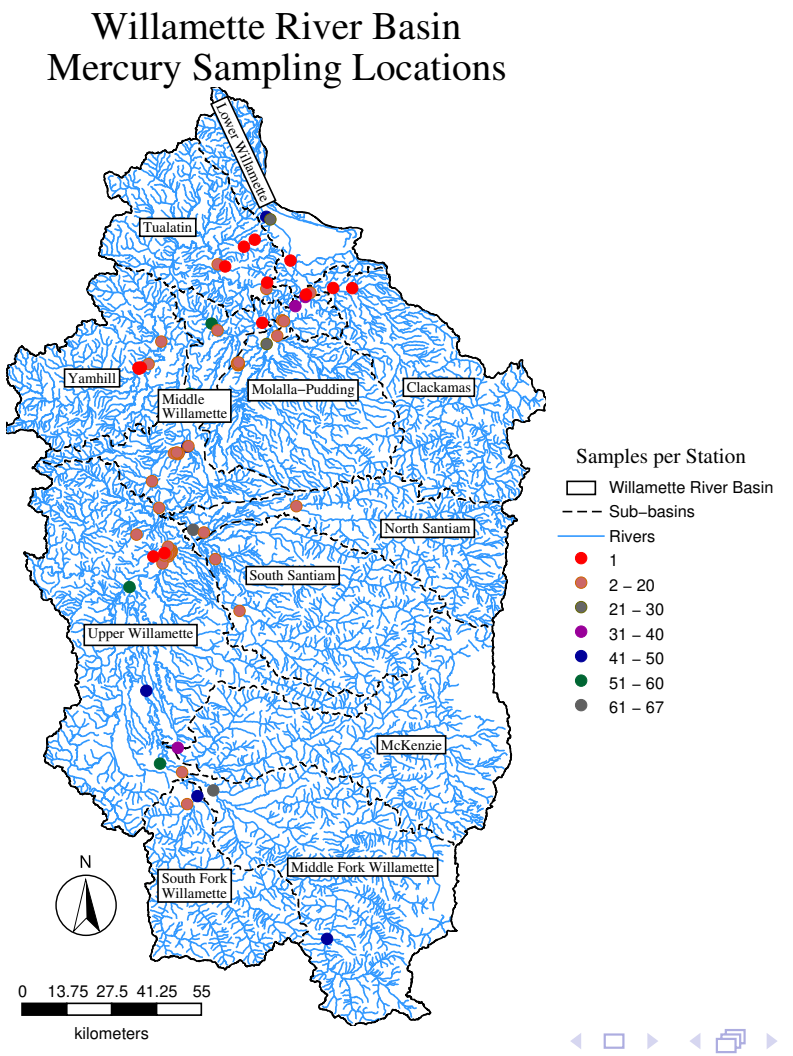
How environmental data differ

- Environmental data are observational, not experimental.
- Data are very sparse spatially and temporally.
- Toxic chemicals commonly are non-detectable.

Observational data

- The most important difference.
- Independent variables measured without prior setting of their value.
- Not assigned to treatment or control levels.
- Environmental regulatory science does not involve experiments.
- Require analytic models designed for observational data.

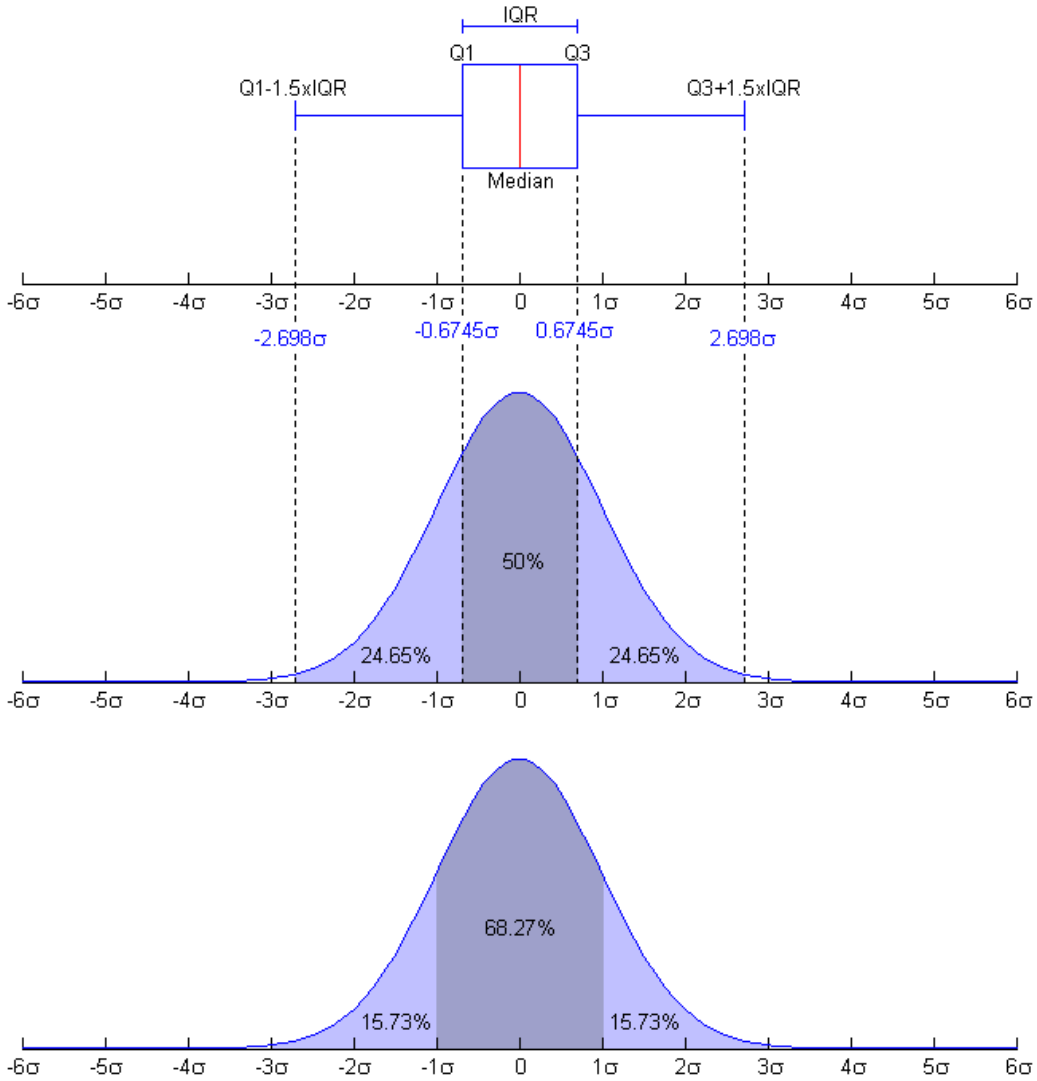
Spatial and temporal sparseness



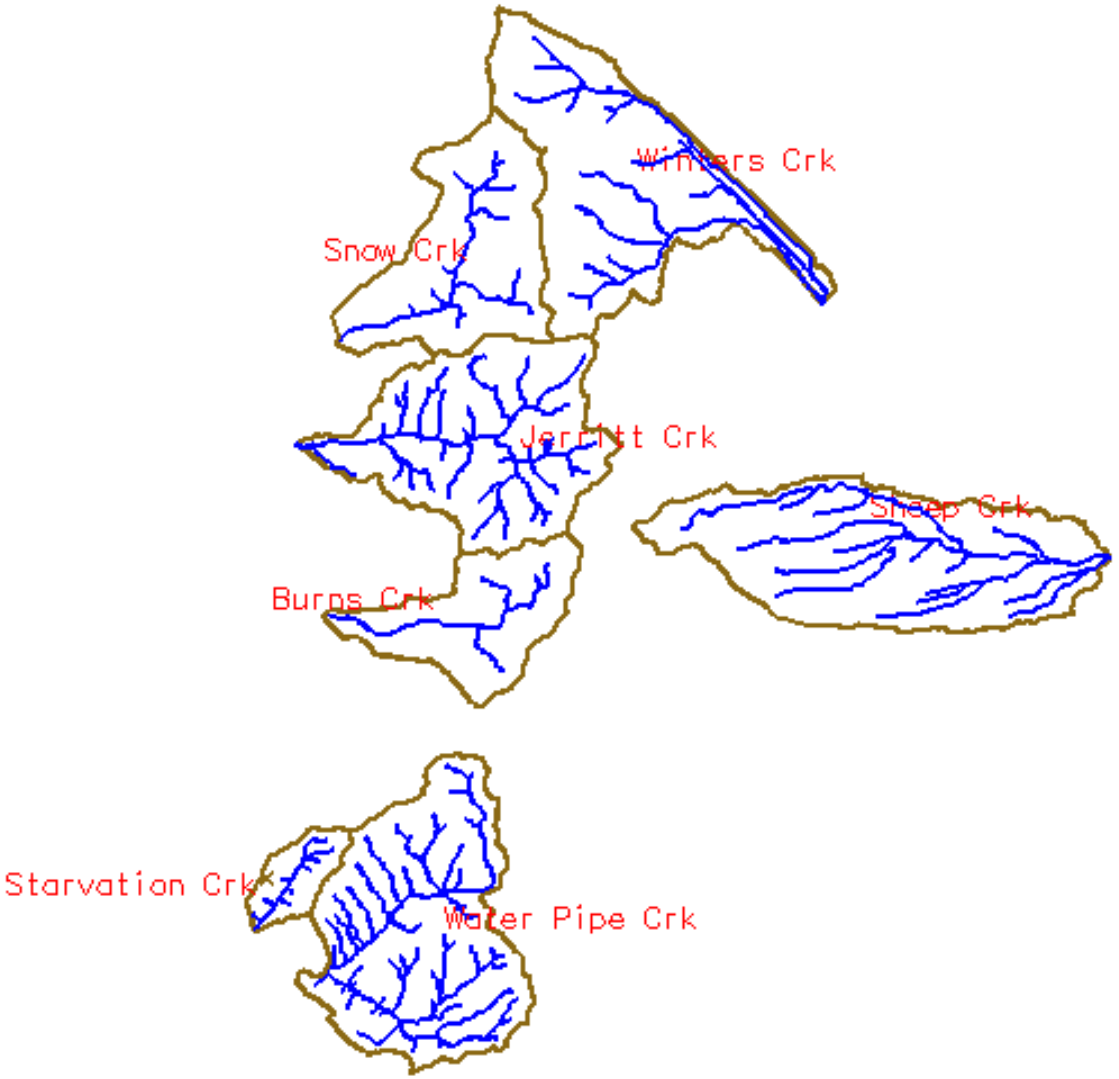
Four ways to mis-handle censored data

- Ignore them.
- Set all to zero.
- Set all to lab's reporting limit.
- Set all to $^1/_2$ the difference between zero and reporting limit or any other arbitrary number.
- They're all wrong; don't do these!

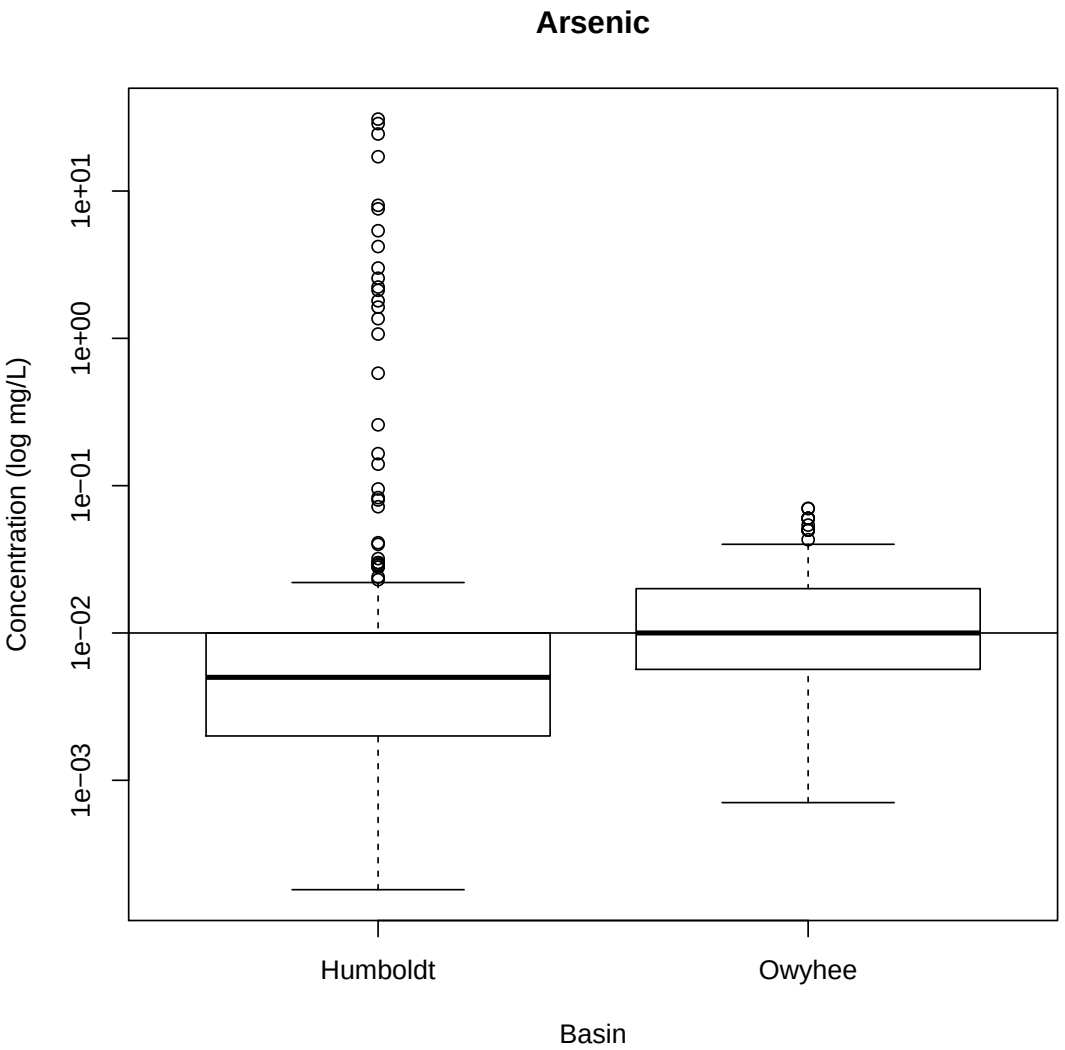
From data to information: box-and-whisker plots



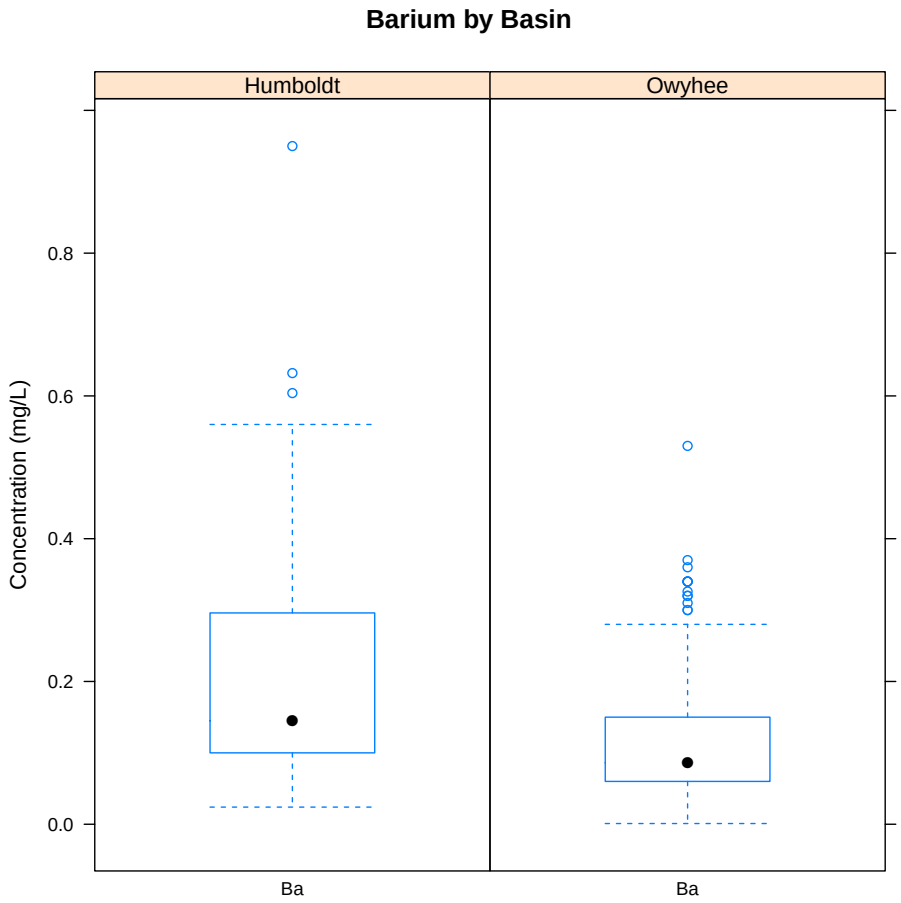
Independence Mountains, Nevada



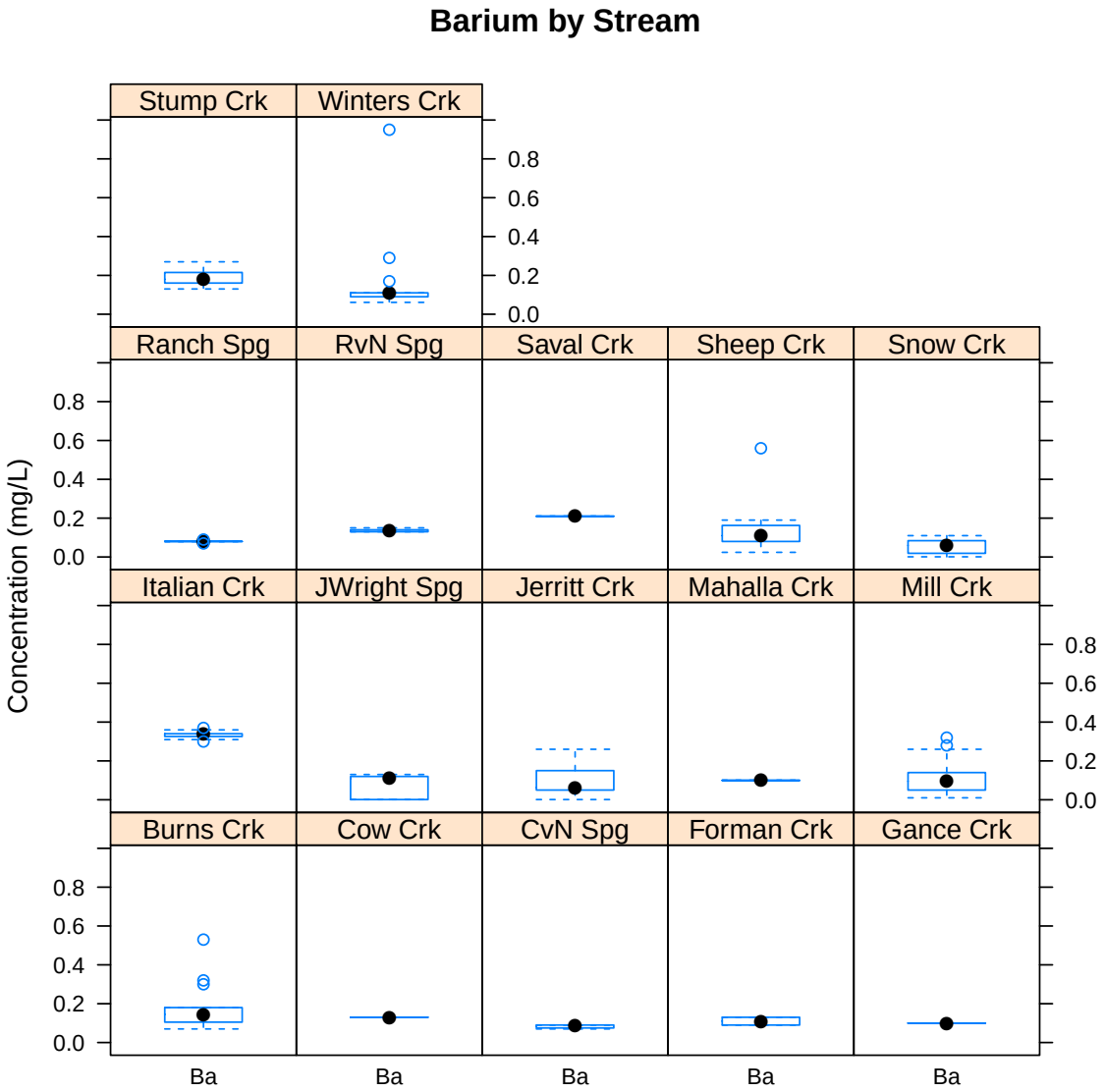
Toxic metal box plot example



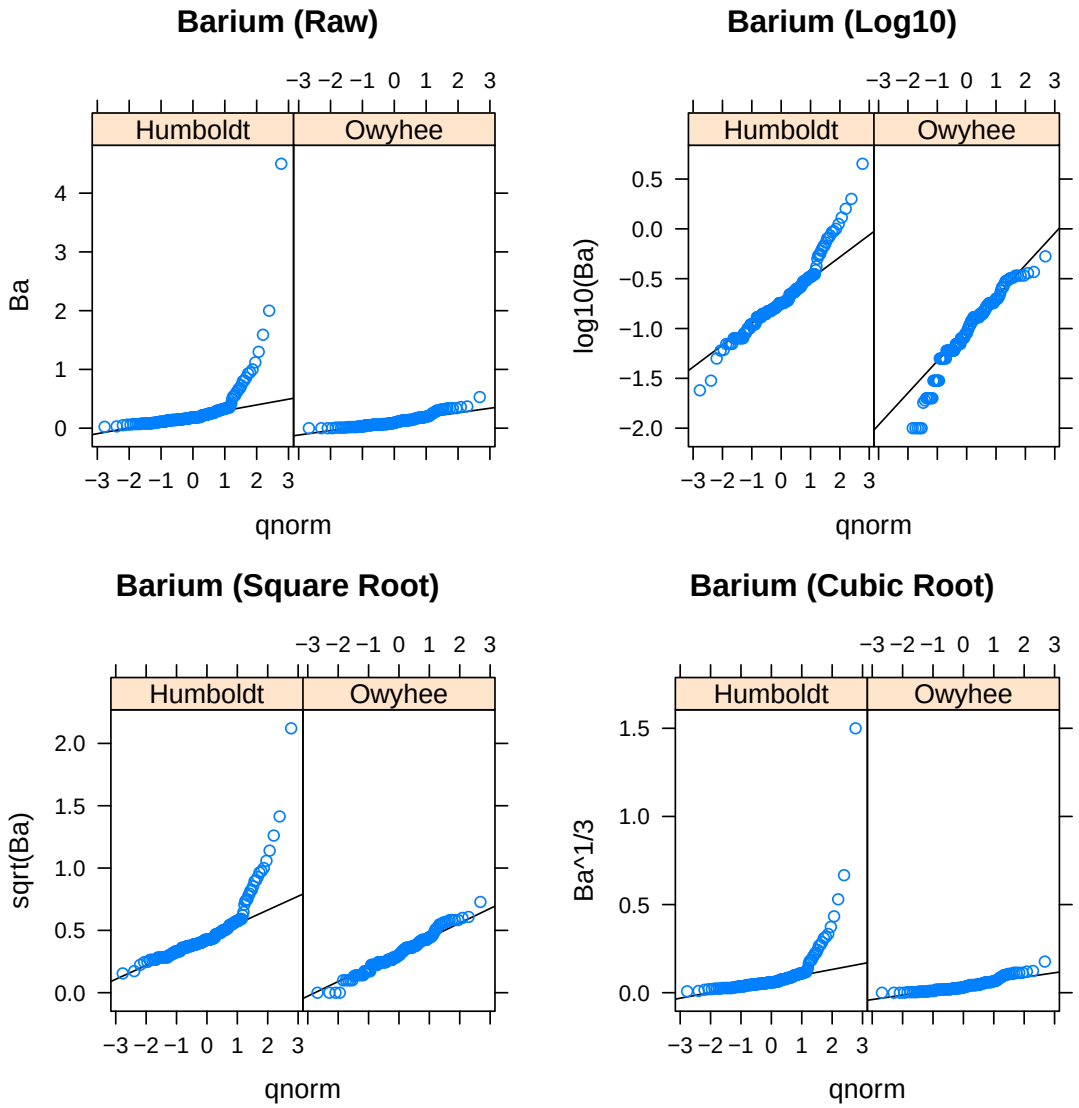
Barium concentrations by basin



Barium concentrations by stream



From information to knowledge



Wisdom

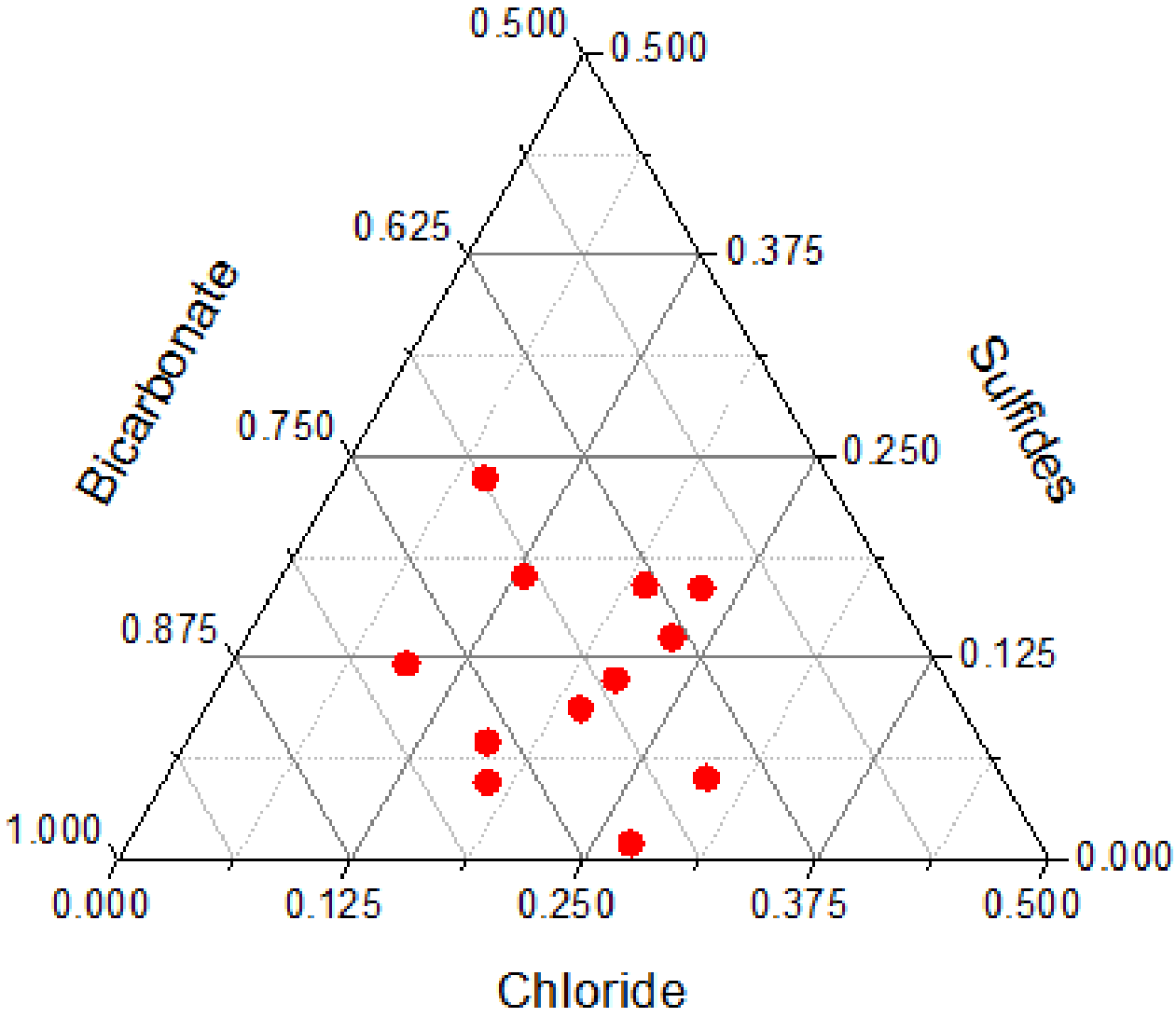
Water quality wisdom

- Almost 40% of all observations were censored.
- 37% of all chemicals had >50% observations censored.
- Dissolved metals concentrations too low to impair biota.
- Base permit compliance on all observations, not only MCL exceedances.

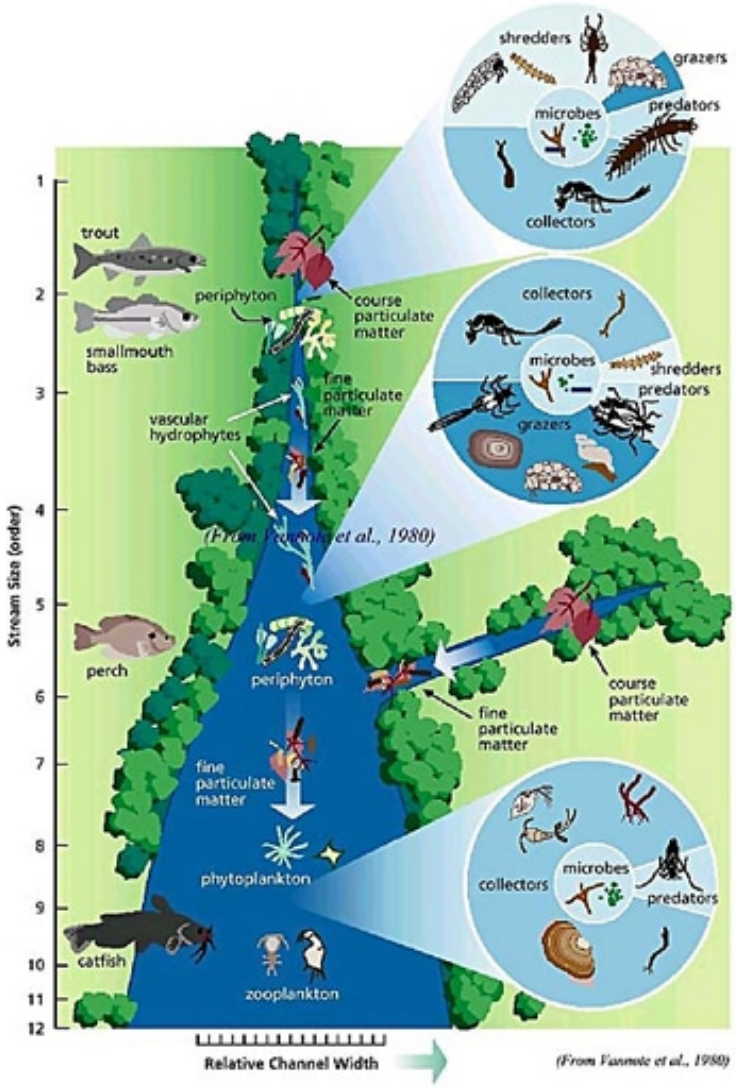
Ambient water quality: compositional data analysis

- A composition is a small sub-set of all constituents in a chemical or biolological collection.
- Each constituent is a relative percentage of the whole.
- The total percentages of all constituents is 100%.
- A list of monitored chemicals in a permit is a composition.
- A sub-set of benthic macroinvertebrate feeding strategies is a composition.

Chemical composition example



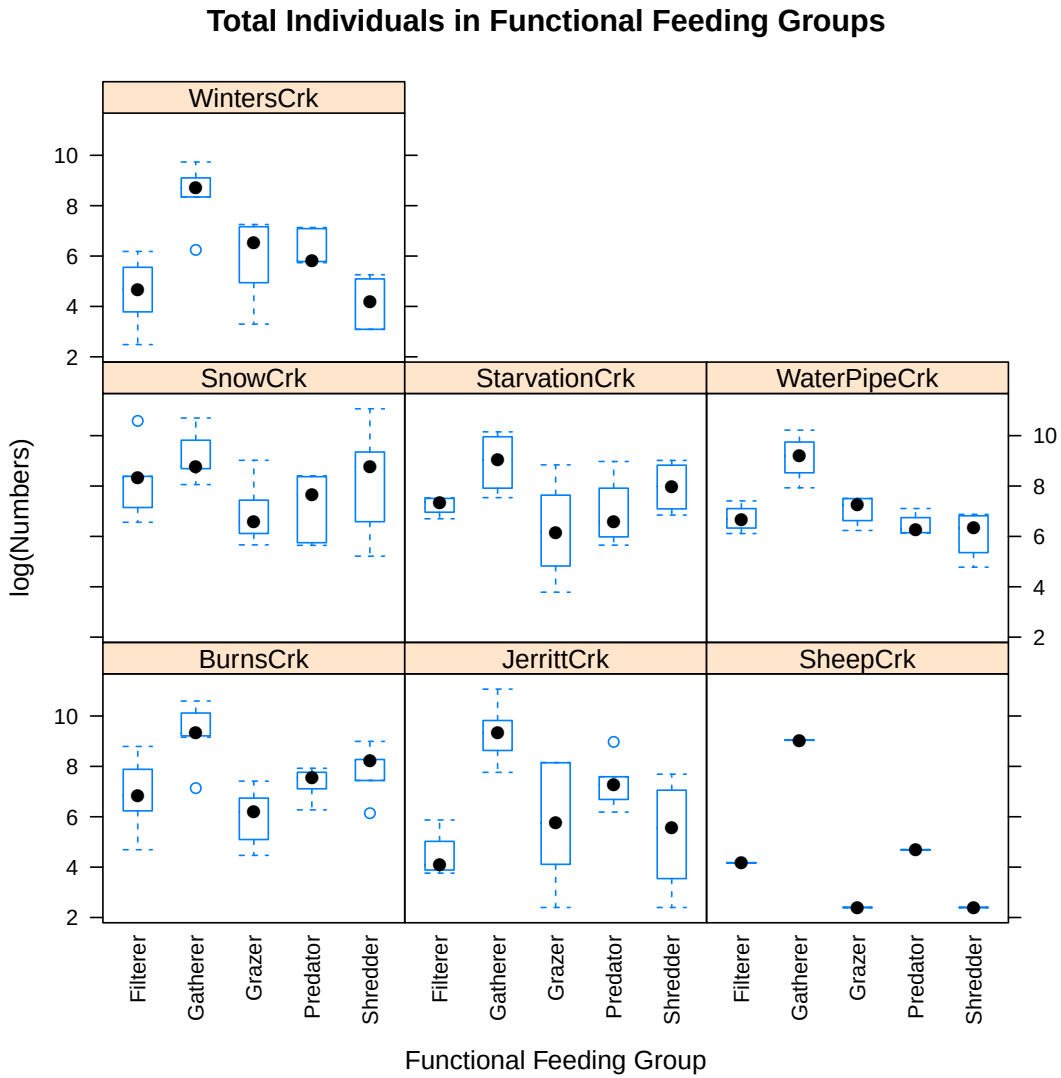
Aquatic biota



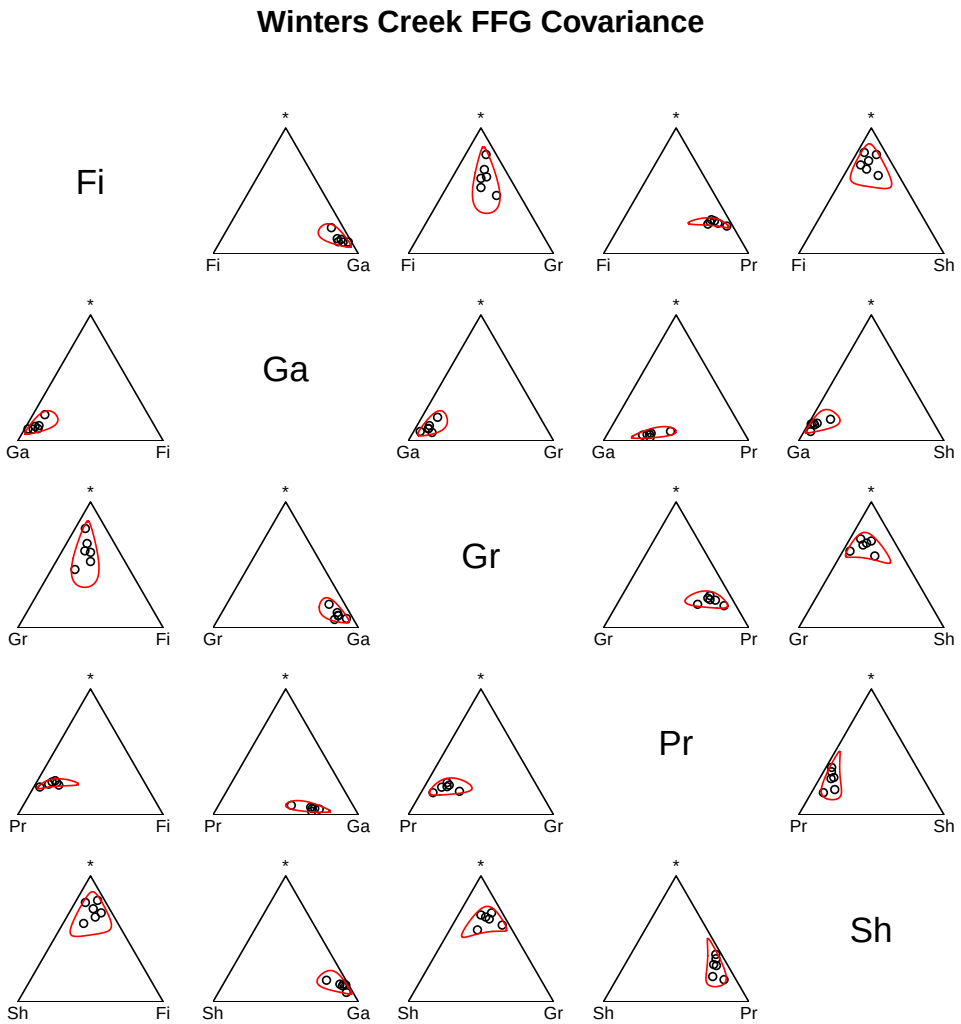
Functional feeding groups (FFG)

- Shredders: large particulate organic matter (LPOM) on the water body substrate.
- Filterers: collect find particulate organic matter (CPOM) from water column.
- Gatherers: collect CPOM loose on water body substrate.
- Grazers: scrape algae, moss, CPOM from solid substrates.
- Predators: eat other animals.

All streams FFG information



Winters Creek FFG knowledge/wisdom



Thank you

You've been a great audience and I thank you for attending my presentation.