Long-Term Trends in Nutrient Concentrations in Central Puget Sound

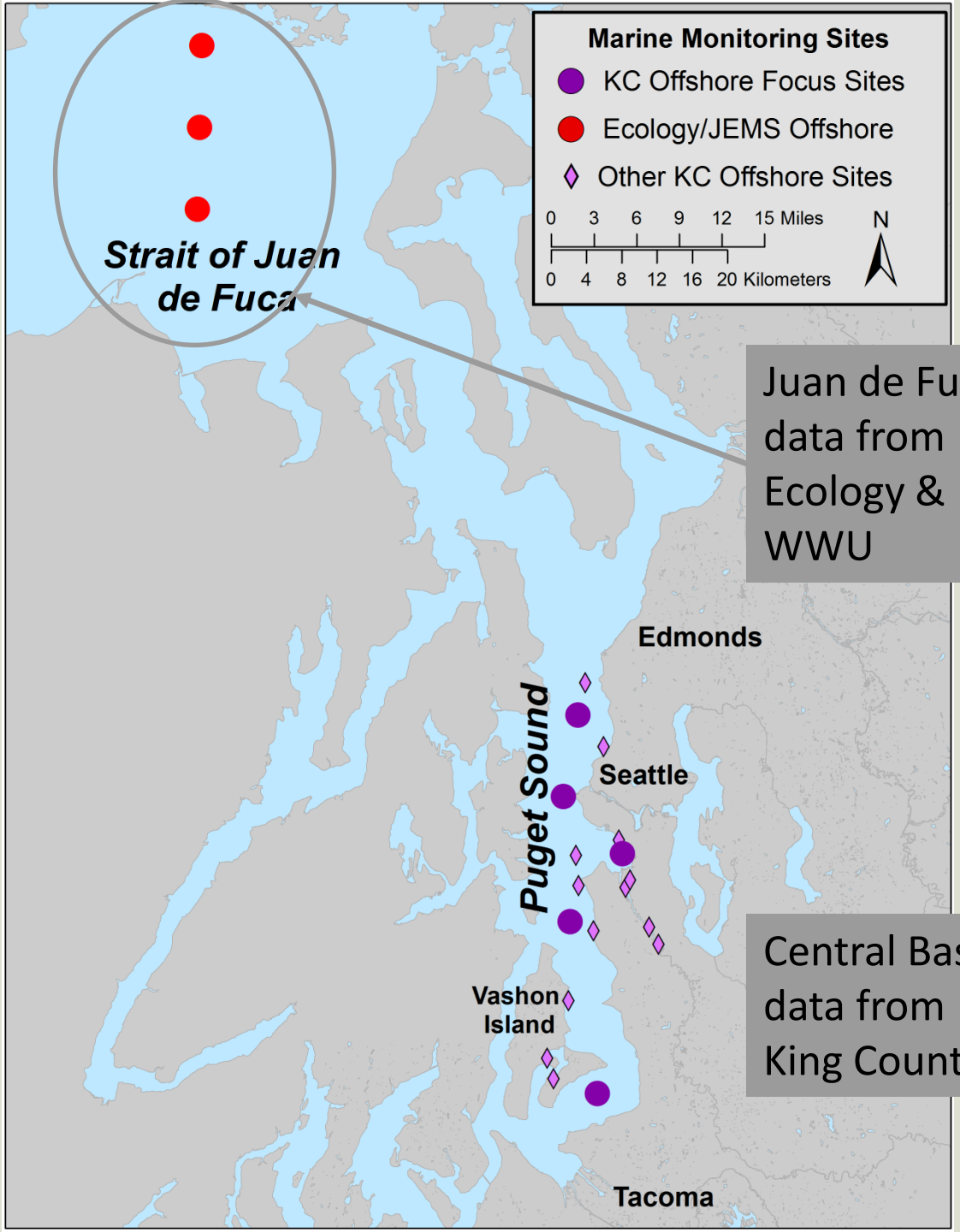
Ben Larson, Stephanie Jaeger, Kimberle Stark

Science Seminar November 2018

Water and Land Resources Division

King County

Study Site: Puget Sound



Juan de Fuca data from Ecology & WWU

Central Basin data from King County

Why Monitor Water Quality?

- One Reason: Monitor for Eutrophication
  - Process by which a waterbody becomes overly enriched with nutrients that causes excessive growth of algae and aquatic plants.
  - Can lead to oxygen depletion.

China

Australia

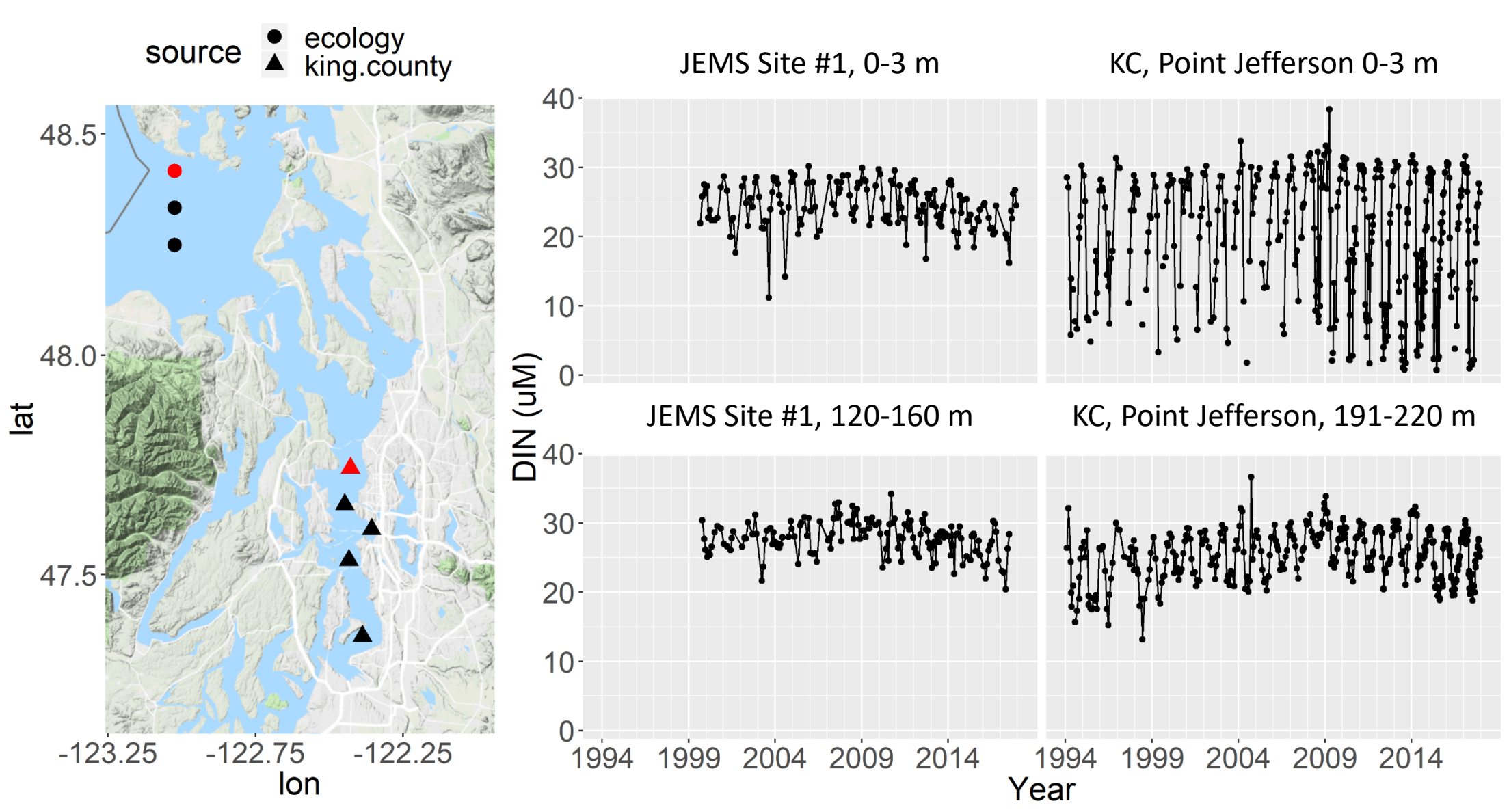
How Can We Monitor for Eutrophication in Marine Systems?

- Status Indicators
  - Nutrient Concentrations: Increased Dissolved Inorganic Nitrogen (DIN) (NO_2 + NO_3 + NH_4)
  - Decreased Silica:Nitrogen ratio
  - Water Clarity

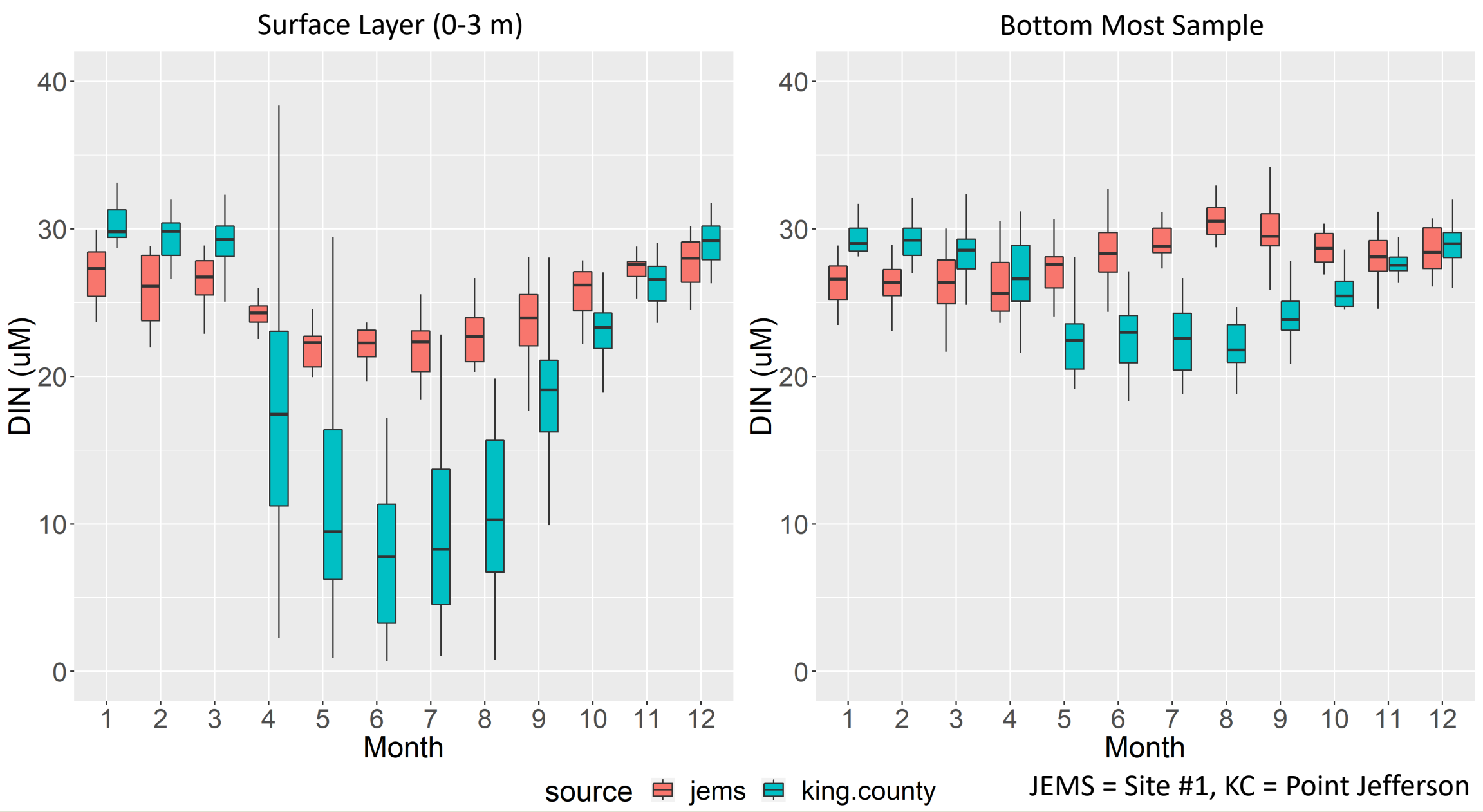
- Biological Response
  - Phytoplankton (chlorophyll-a) biomass
  - Phytoplankton and Zooplankton species composition and abundance
  - Harmful algal blooms & toxin concentrations
  - Dissolved oxygen levels

Methods: Field Sampling & Lab Analysis

Results: Water Quality Time Series, Lots of Variability

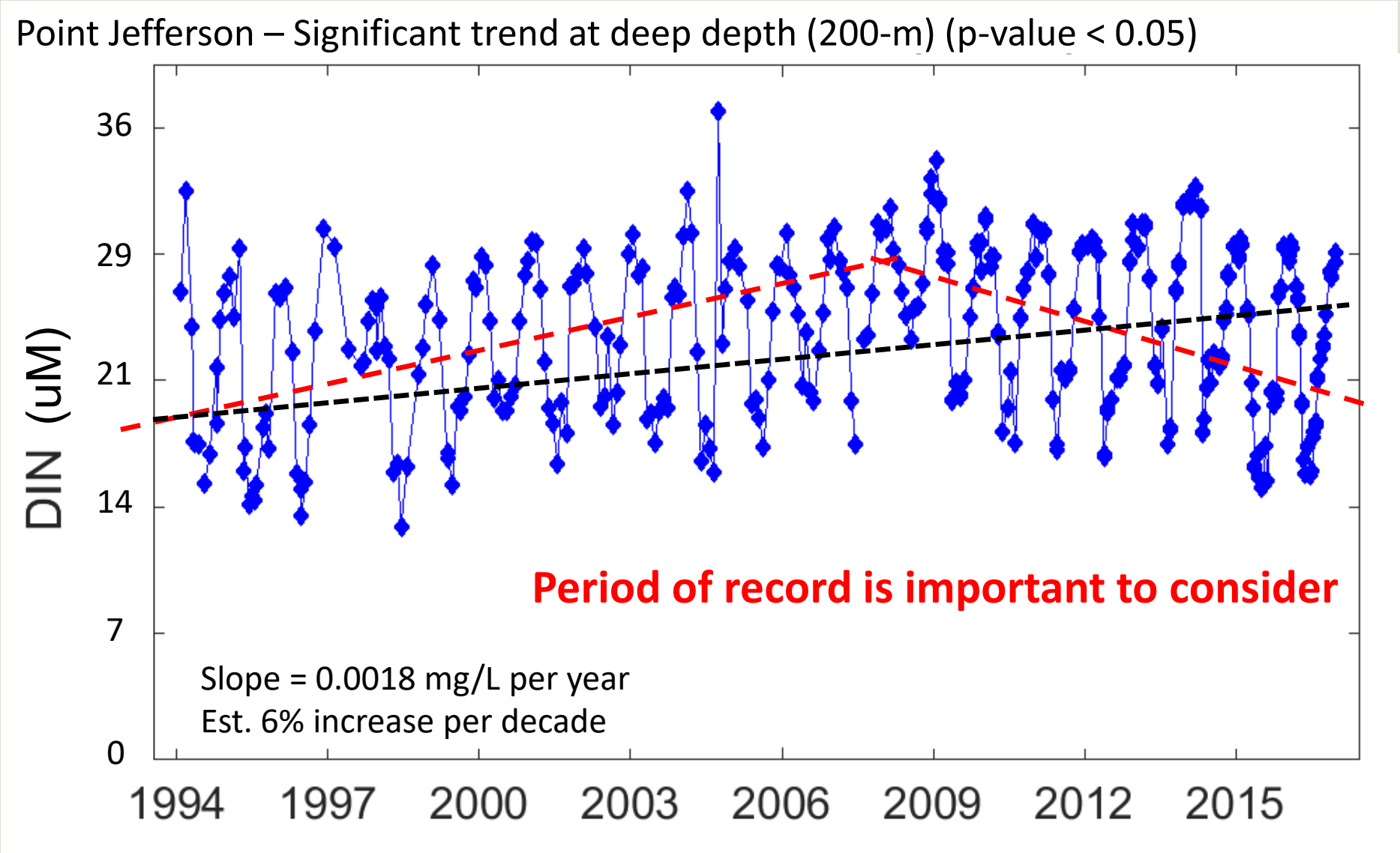


Results: Pronounced Seasonality

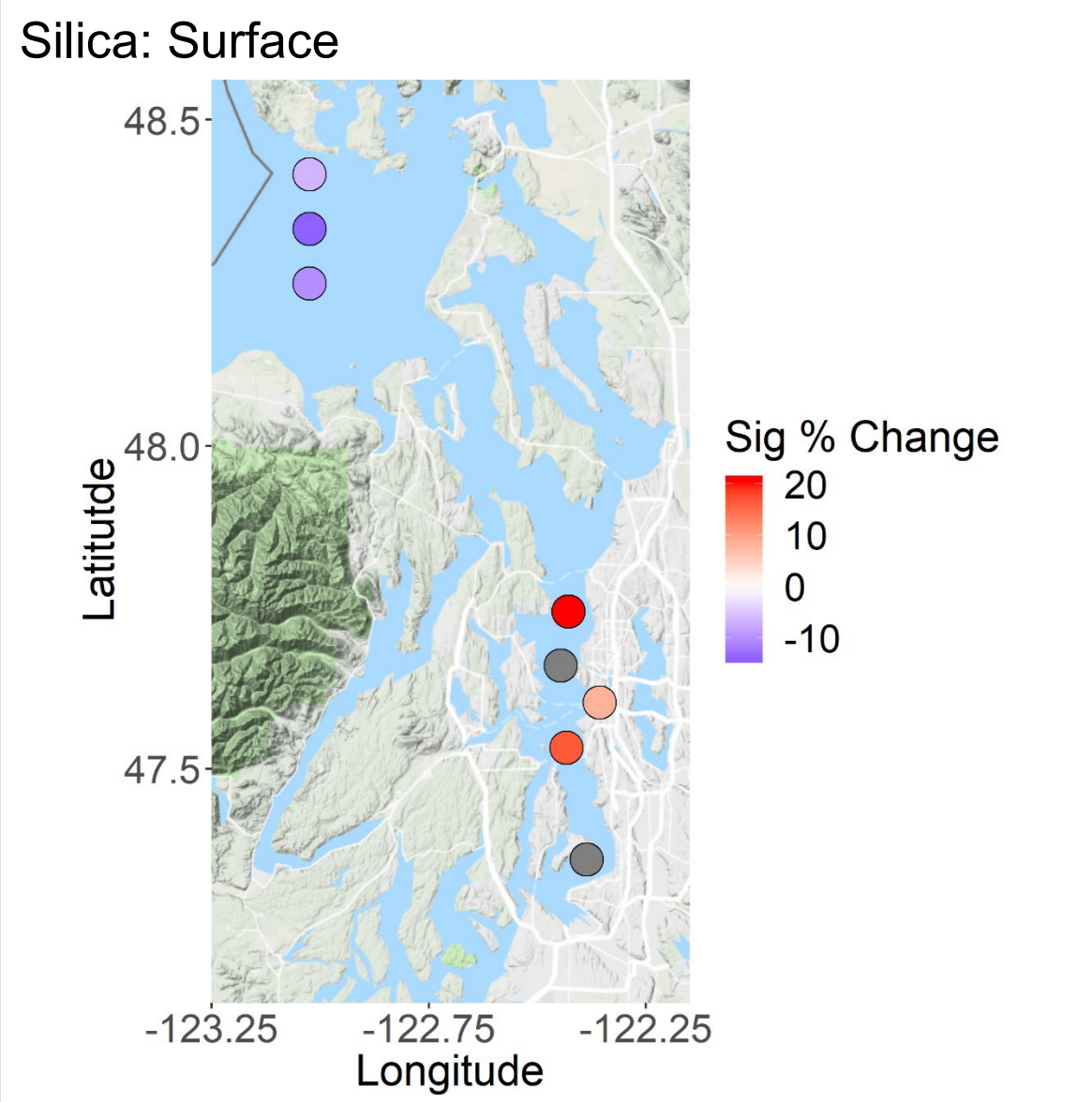


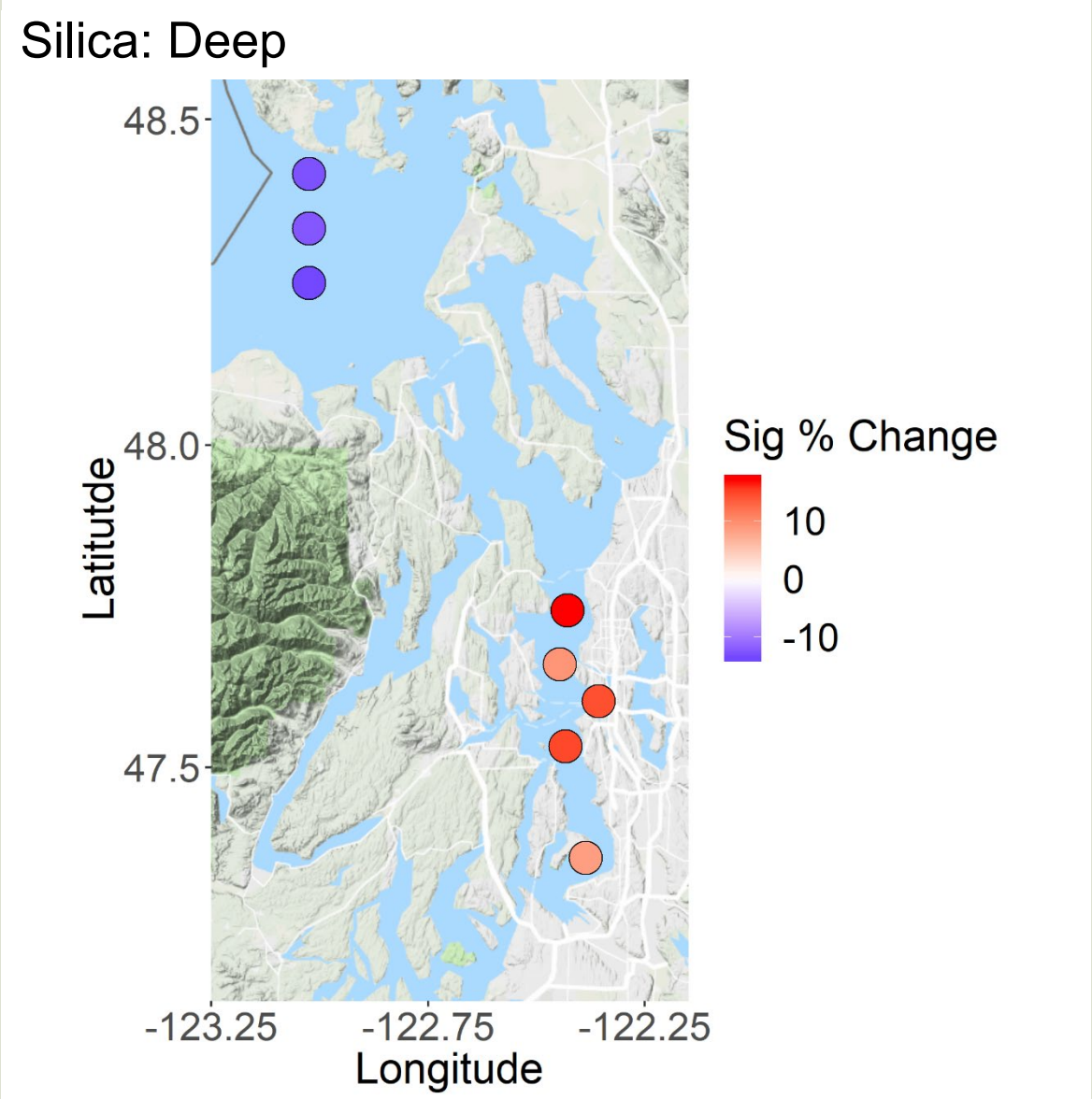
How can we measure trends with high seasonal variability?

- One method = Non-parametric linear trend test by month (seasonal Mann-Kendall)

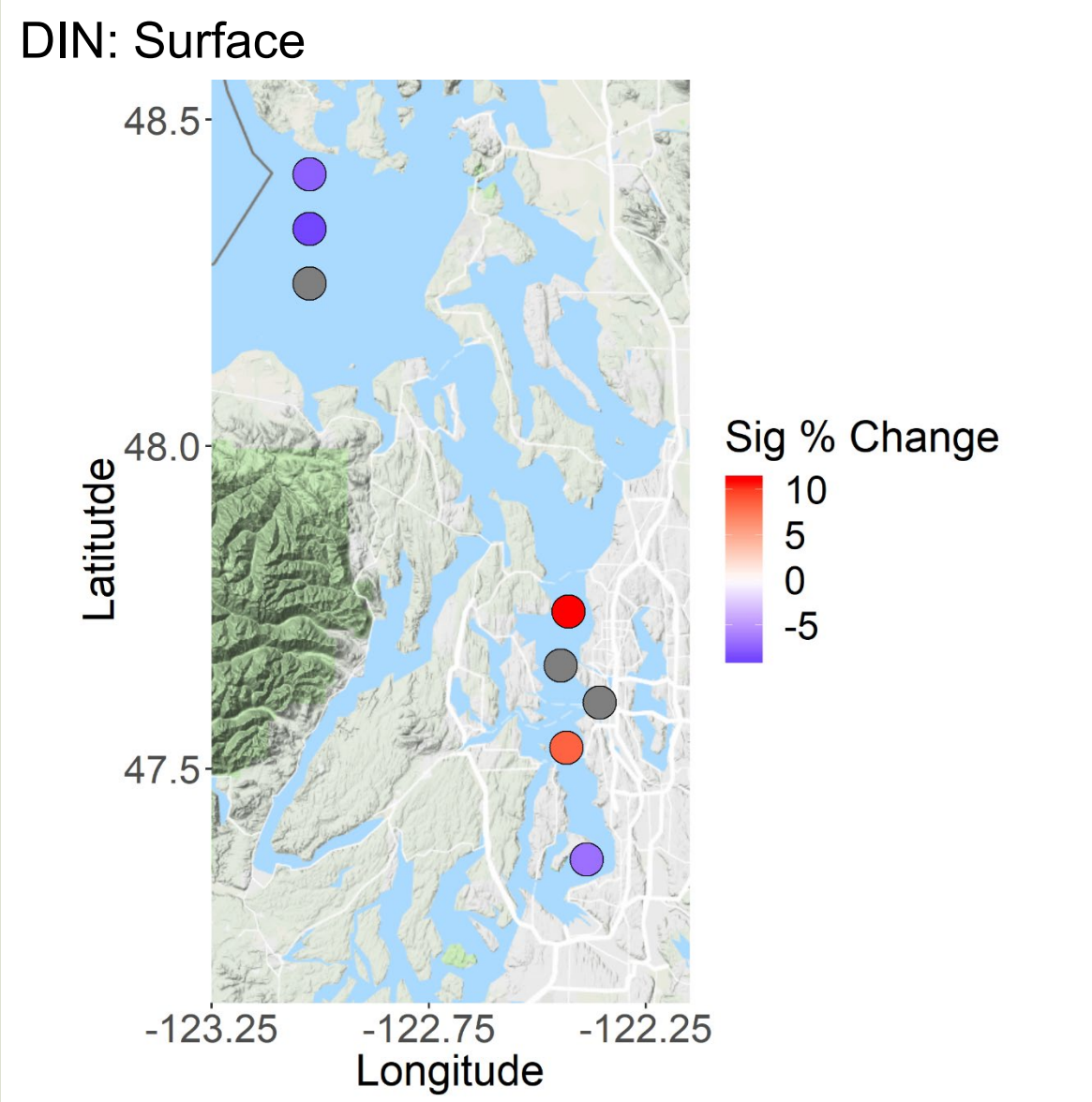


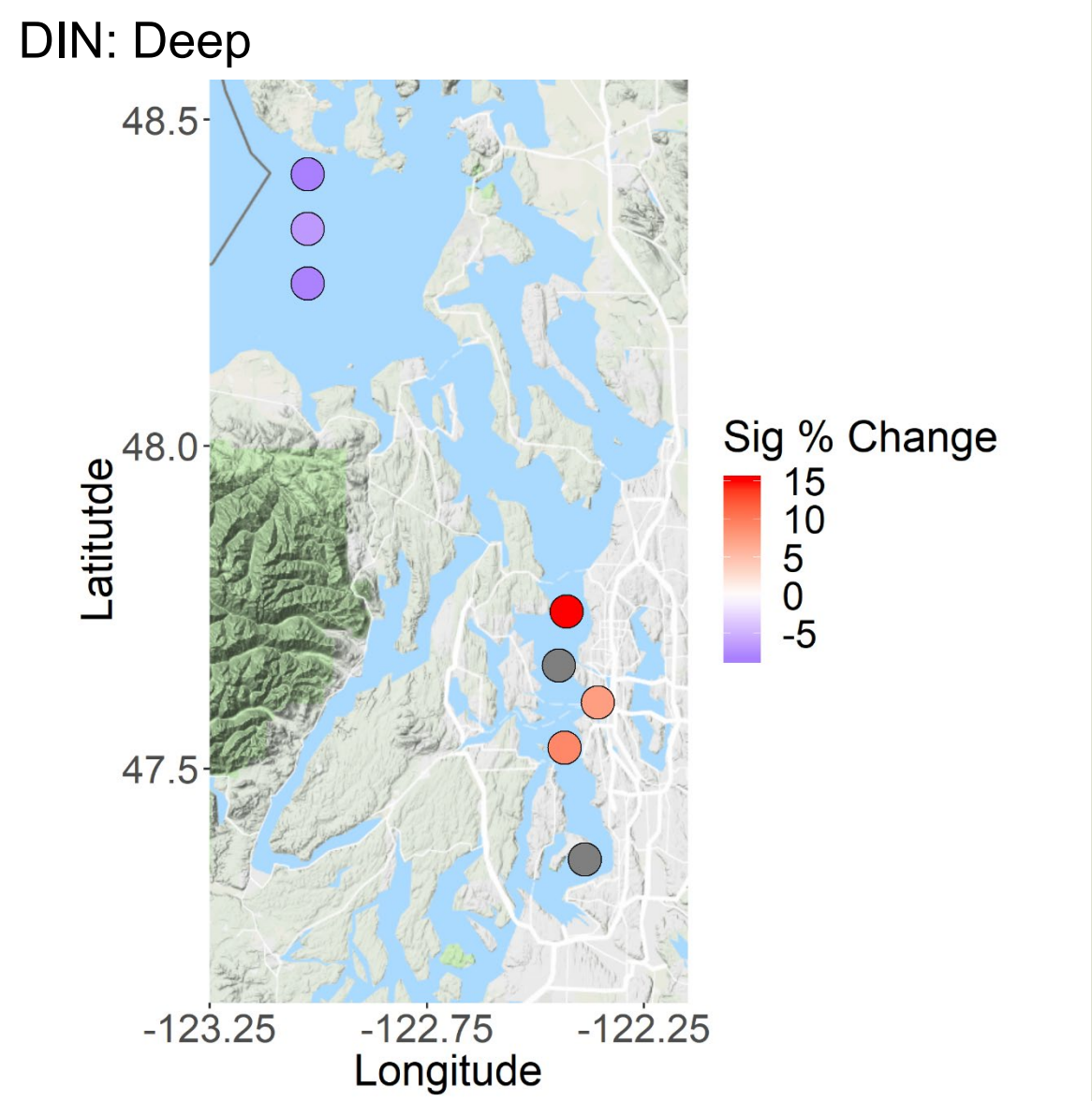
Results: Trends by Parameter and Location



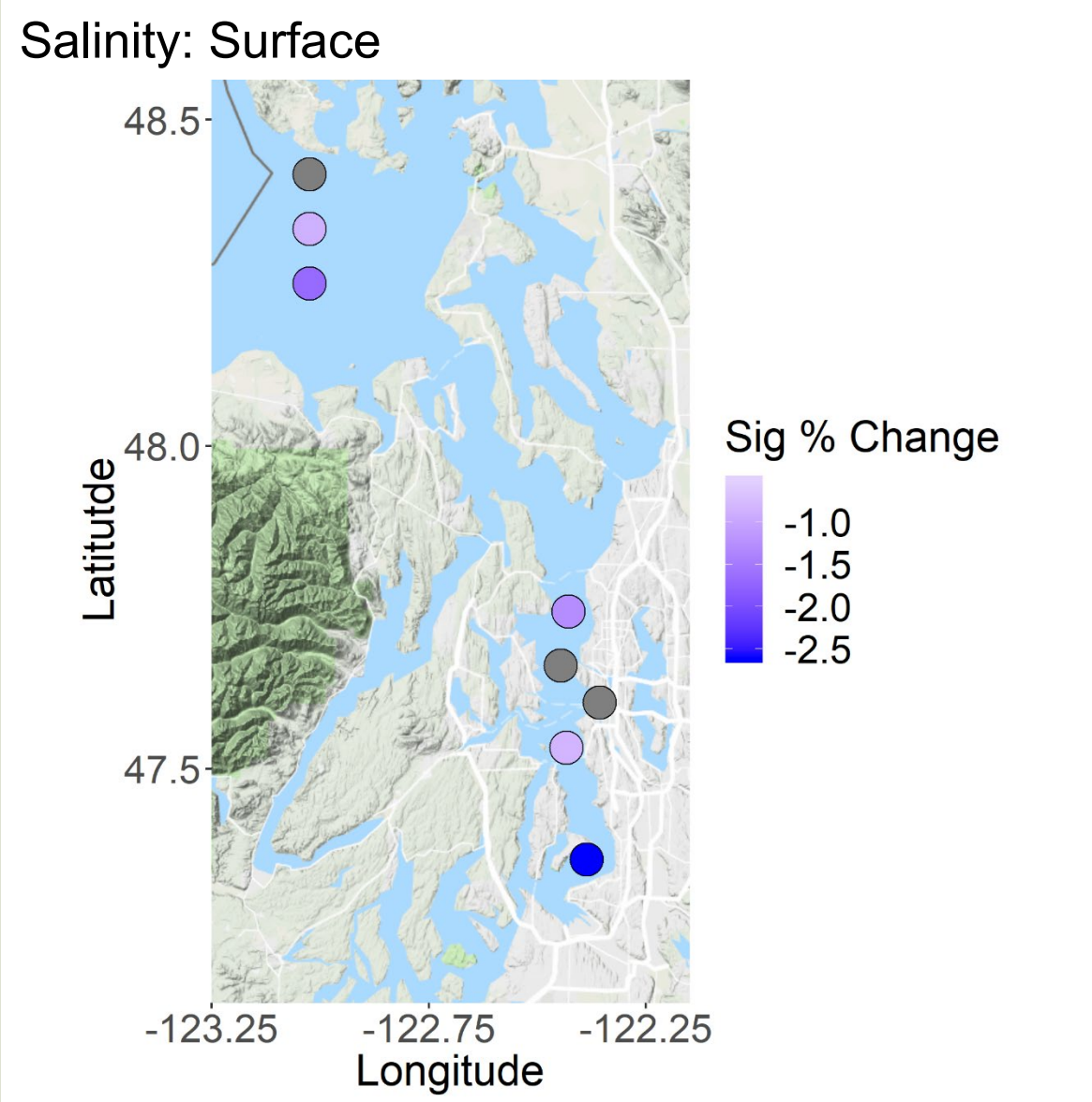


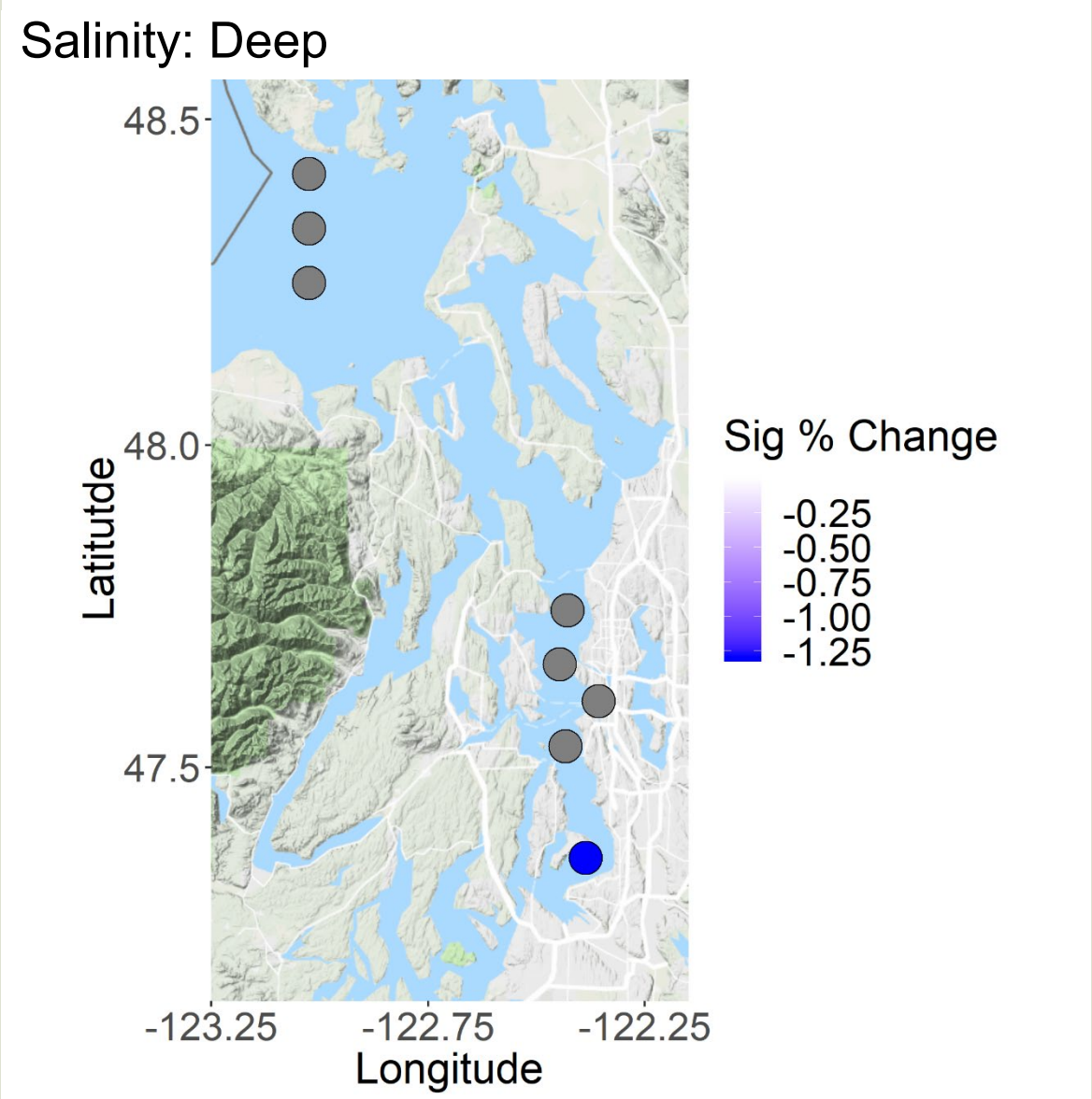
Results: Trends by Parameter and Location



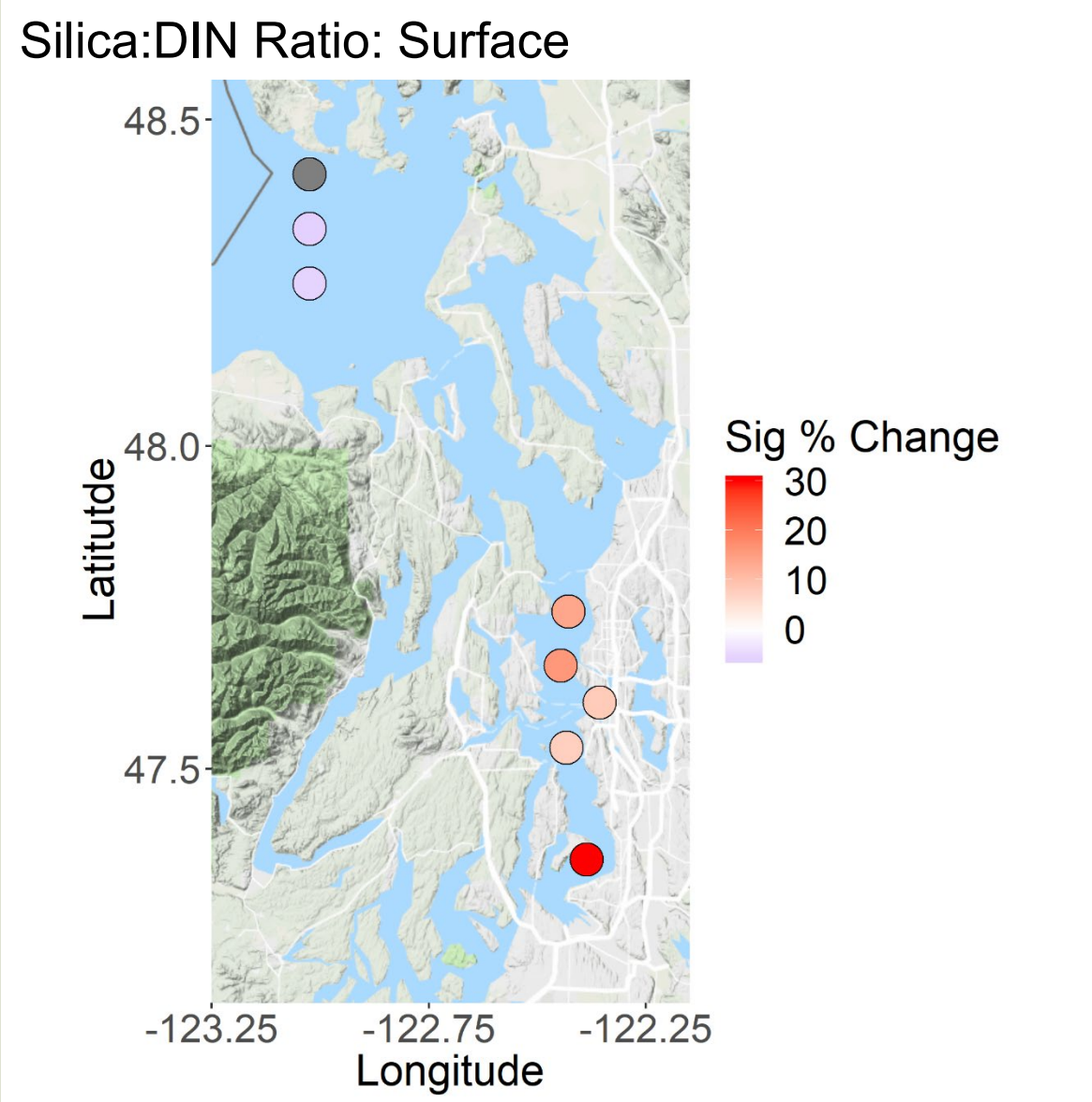


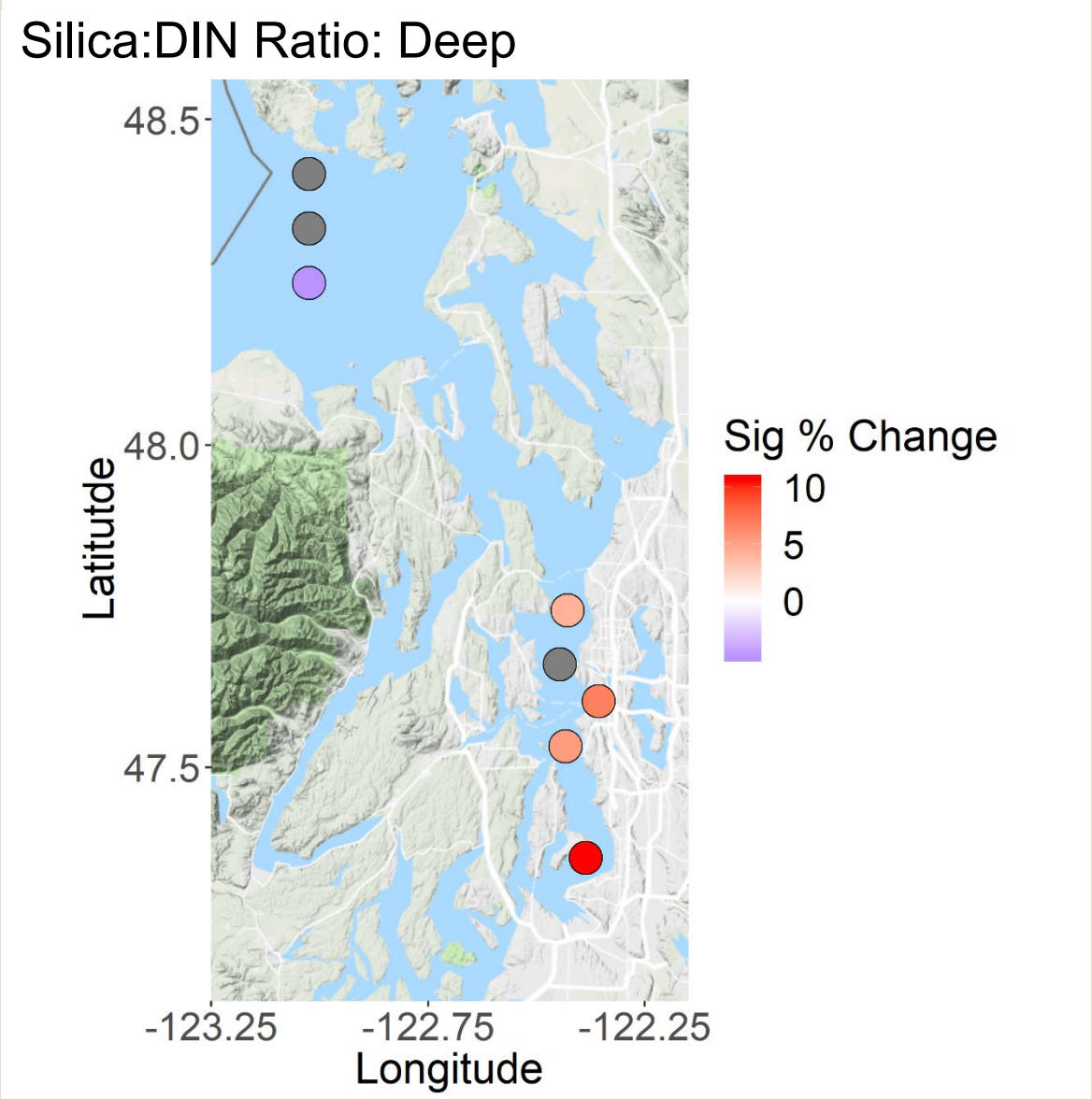
Results: Trends by Parameter and Location



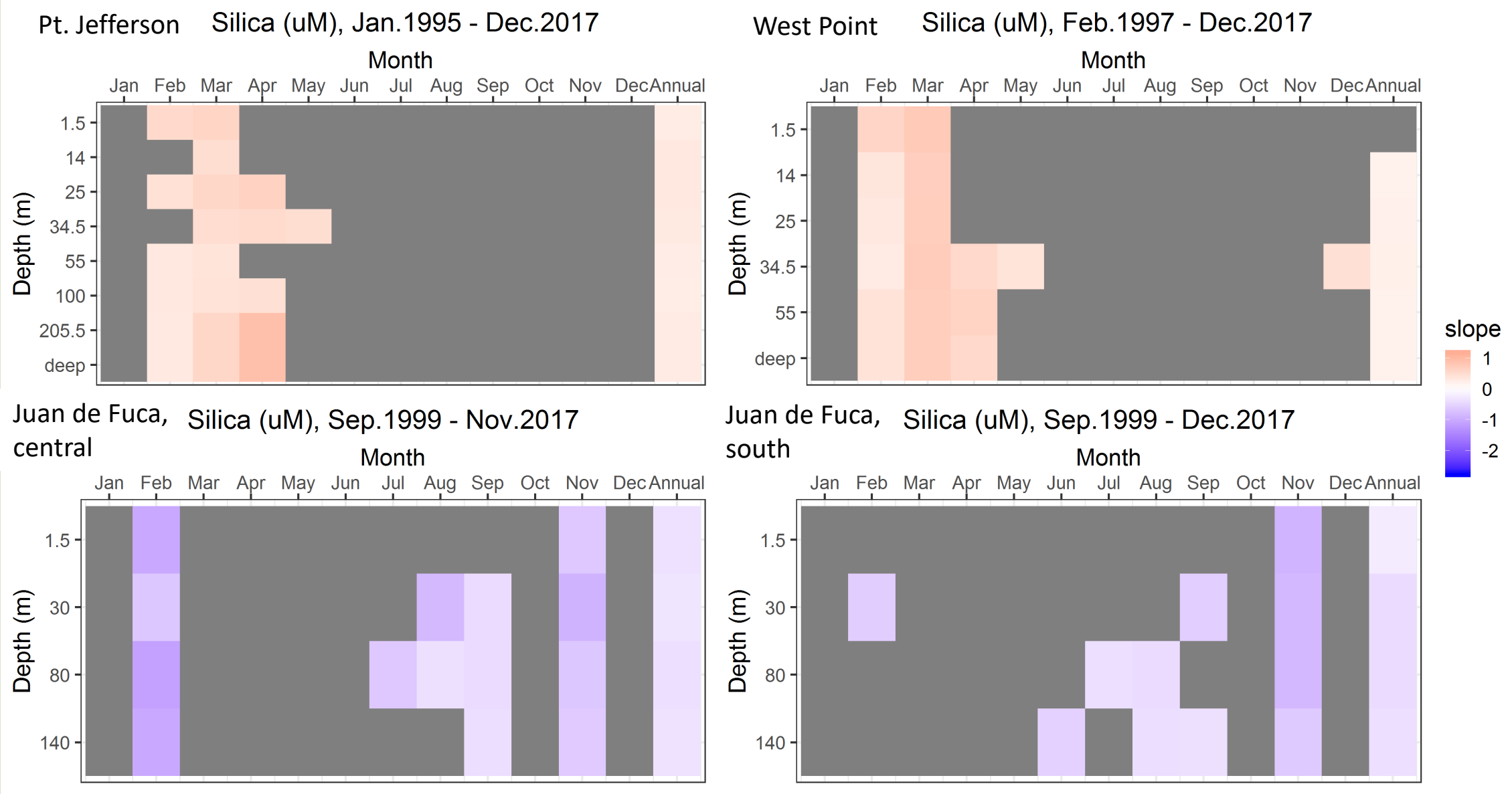


Results: Trends by Parameter and Location





Results: Site Trends Similar in Depth, Variable in Time

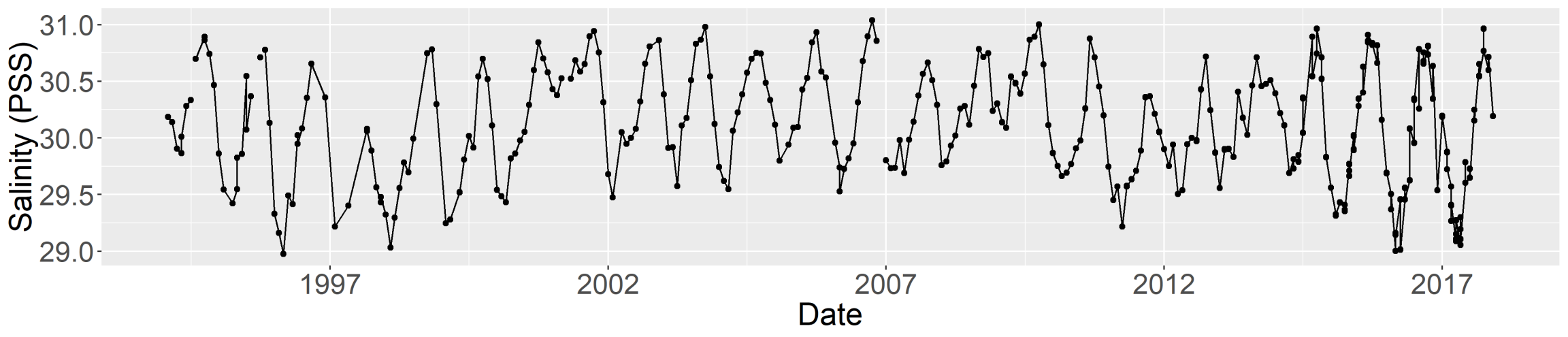


What is driving the Silica trends?

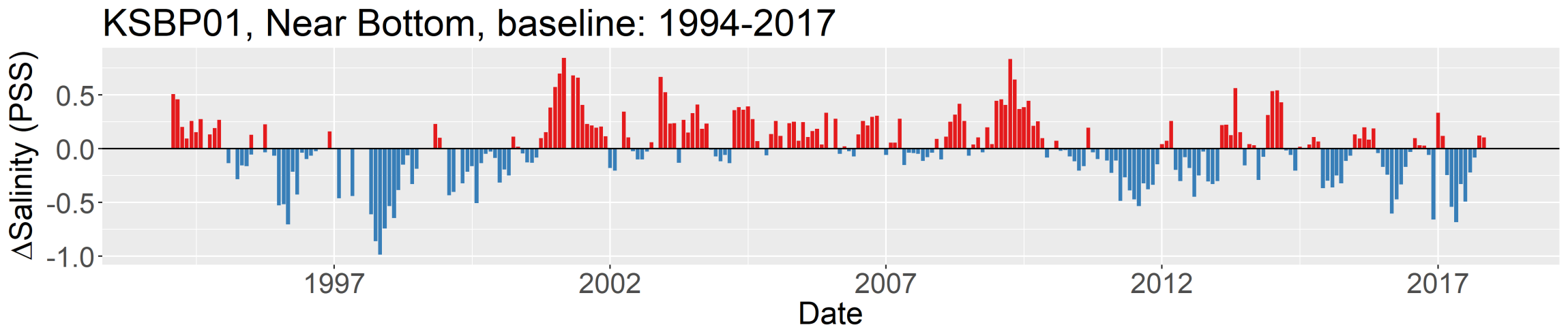
- For this, investigate the impact of river flow

- Salinity variability

Methods: Working in Anomaly Space

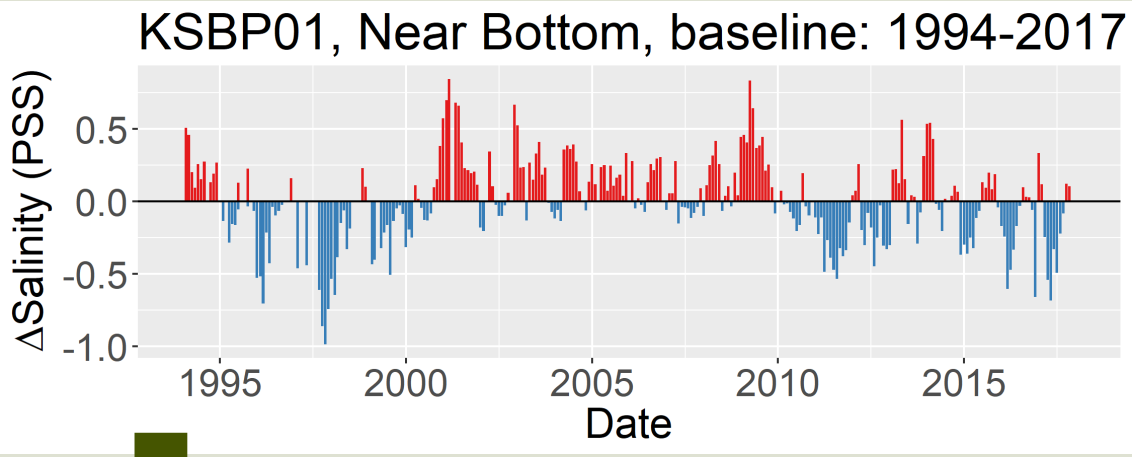


Subtract average monthly value over each month for all years



Methods: Prepare for Comparison

- Compute a running total anomalies
- Fit a smooth curve to the result
- Do the same for River flow…



Calculate Running Total

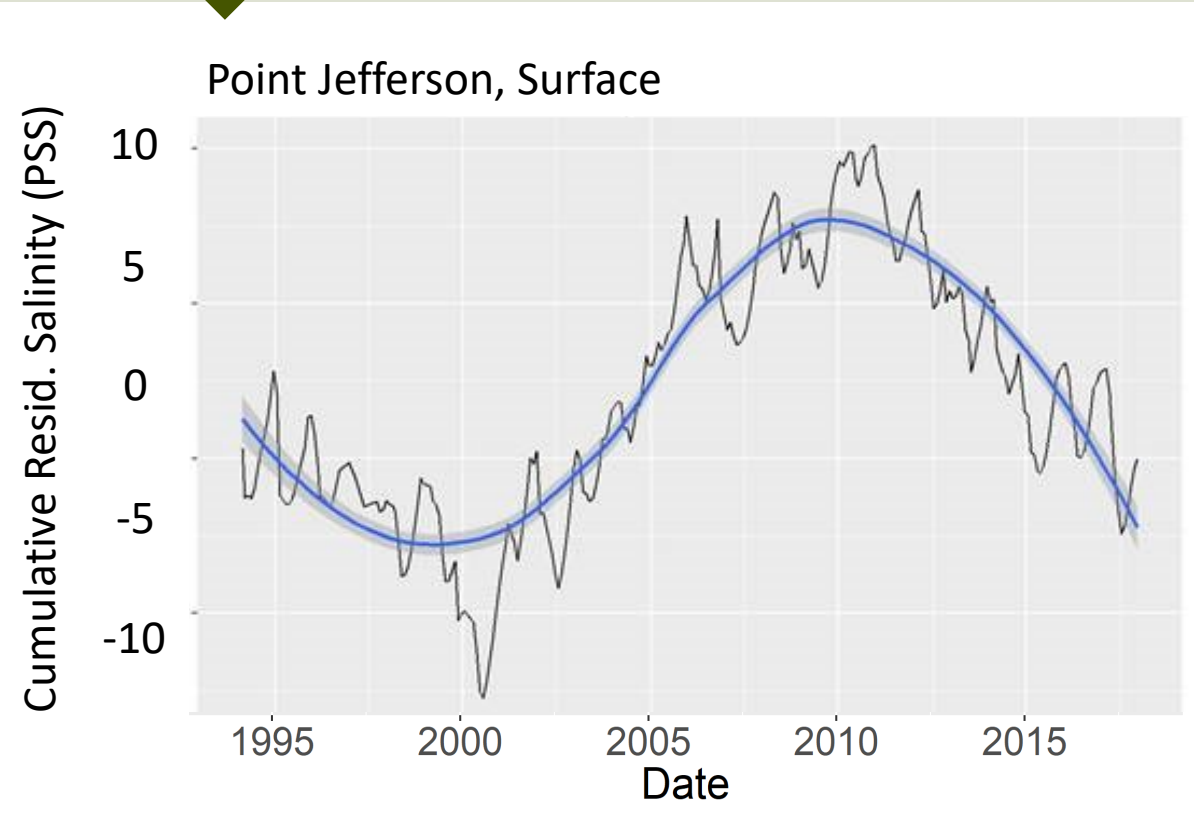
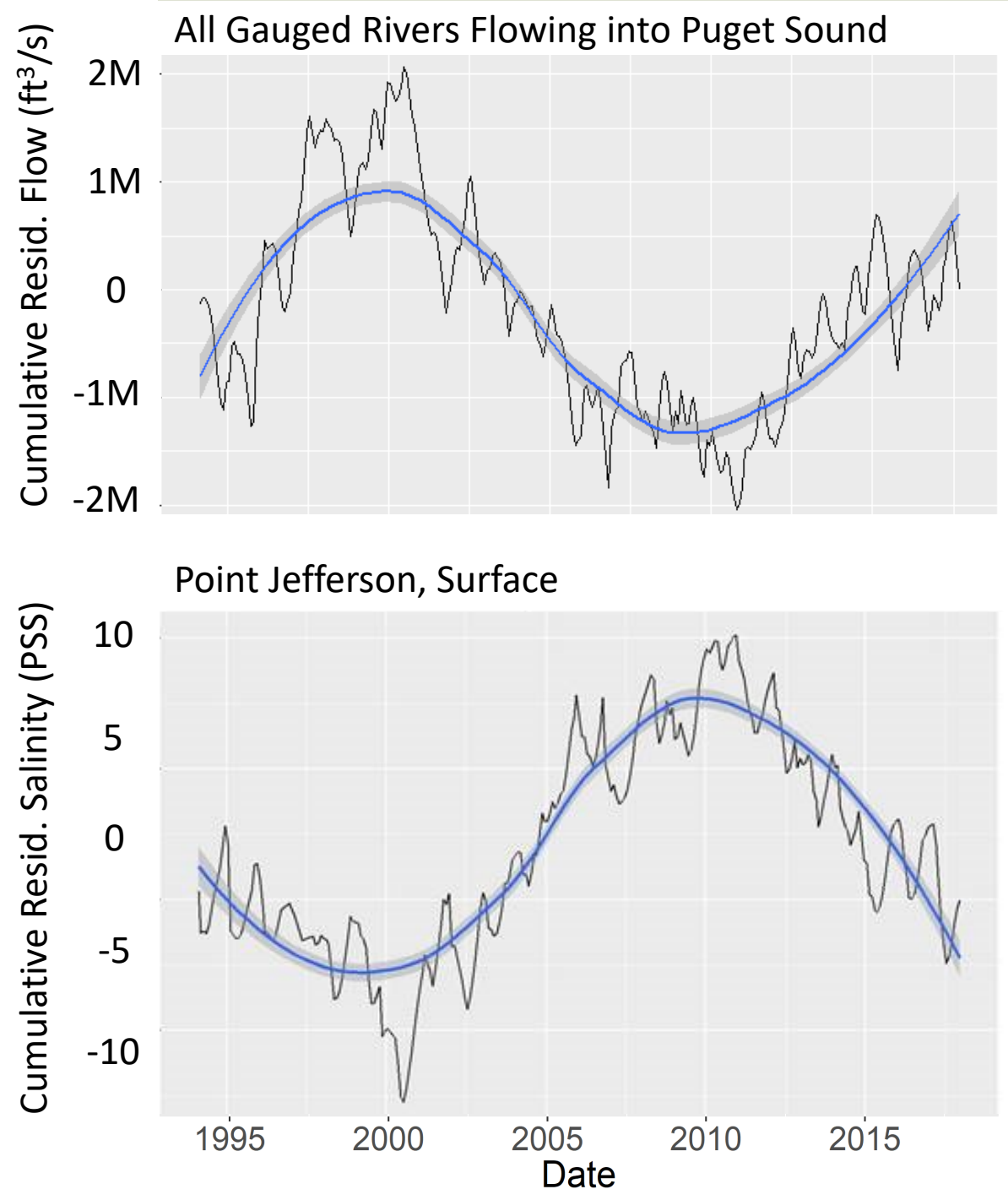


Figure by C. DeGasperi

Methods: Comparing River Flow and Salinity

- Cumulative residuals of river flow on top
- Cumulative residuals of salinity on bottom
- Strong inverse correlation implicates rivers as a driving environmental factor



Figures by C. DeGasperi

Summary

Conclusions: Trends

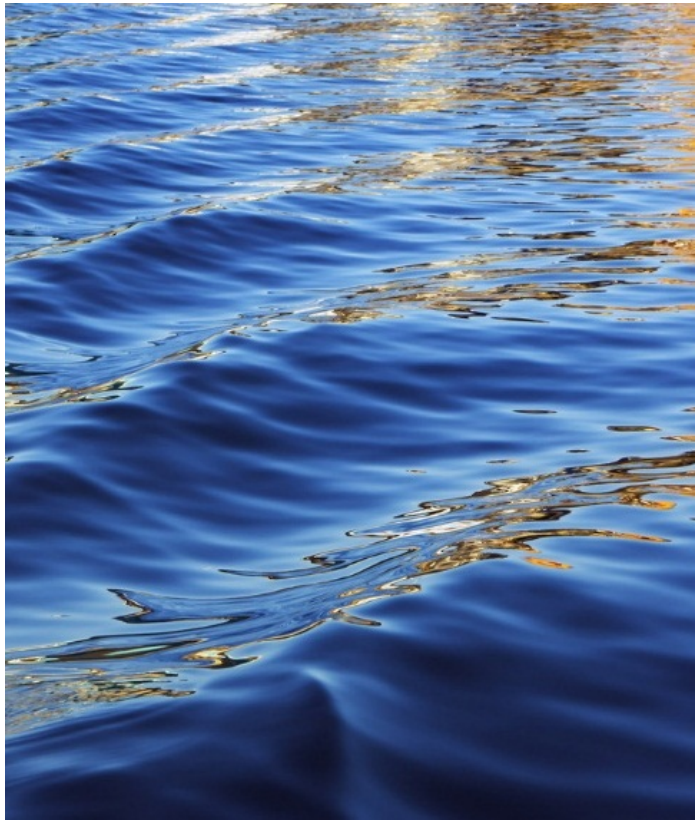
1. Salinity and Silica exhibit statistically significant monotonic trends in Central Basin
2. DIN trends up in some sites, down in others
3. Low trend variability in vertical dimension
4. Certain parts of the year drive the trends
5. Salinity and River Flow inversely correlated as expected

How does this compare to eutrophication indicators?

- Increased DIN?
  - Trends are inconclusive
- Decreased Silica:Nitrogen ratio?
  - Observed trends are the opposite of what we might expect for eutrophication

Acknowledgements

- King County Environmental Lab for sample analysis
- SoundGuardian Crew
- Curtis DeGasperi for analysis of river data

Thank you.

Ben Larson, Marine Scientist / Water Quality Planner II
Benjamin.Larson@kingcounty.gov, (206) 263-0103
Water and Land Resources Division
King County Department of Natural Resources and Parks