April 2018

Extending observations further: using historic biogeochemical data to understand trends in Puget Sound

Ben Larson
King County, United States, benjamin.larson@kingcounty.gov

Stephanie Jaeger
King County, United States, stephanie.jaeger@kingcounty.gov

Wendy Eash-Loucks
King County, United States, wendyeash-loucks@kingcounty.gov

Kimberle Stark
King County, United States, kimberle.stark@kingcounty.gov

Bruce Nairn
King County, United States, bruce.nairn@kingcounty.gov

Follow this and additional works at: https://cedar.wwu.edu/ssec

Part of the Fresh Water Studies Commons, Marine Biology Commons, Natural Resources and Conservation Commons, and the Terrestrial and Aquatic Ecology Commons

Larson, Ben; Jaeger, Stephanie; Eash-Loucks, Wendy; Stark, Kimberle; and Nairn, Bruce, "Extending observations further: using historic biogeochemical data to understand trends in Puget Sound" (2018). Salish Sea Ecosystem Conference. 277.
https://cedar.wwu.edu/ssec/2018ssec/allsessions/277

This Event is brought to you for free and open access by the Conferences and Events at Western CEDAR. It has been accepted for inclusion in Salish Sea Ecosystem Conference by an authorized administrator of Western CEDAR. For more information, please contact westerncedar@wwu.edu.
Extending Observations Further: Using Historical Biogeochemical Data to Understand Changes in an Estuary

Stephanie Jaeger*, Ben Larson†, and Bruce Naim
King County Dept. of Natural Resources and Parks, Seattle, Washington
*stephanie.jaeger@kingcounty.gov, †benjamin.larson@kingcounty.gov

WHAT ARE SOME CHALLENGES?

Objective 1: How does changing target sample depth impact our results? Application: Surface NO3

In order to simulate and quantify the impact of the choice of depth for sample collection, typical target depths from the Collias and King County sampling programs are used as part of a bootstrapping protocol to determine uncertainty in depth integrated averages.

Objective 2: Can we evaluate how method changes over time may impact our results? Application: Mid to Deep NO3

In this case, historical data are not provided with any qualitifiers or detection limits, so data are evaluated first in context of the last two decades. Ranges and parameter co-variates can be used to identify data for further scrutiny including in trends over time. For nitrate, while the data has been in use since the 1990’s, reducing agents and procedures have made improvements (Moorcroft et al., 2001).

Objective 3: Can this lead to improvements in understanding trends over time? Application: Deep O2

The King County routine site (Pt. Jefferson) was co-located near the historical site, allowing for dissolved oxygen (DO) observations over an 85-year period. To assess trends, DO at 200 m was selected as the deepest depth with overlap by both King County and UW/Collias sampling.

WHAT ARE SOME BENEFITS?

A. Pt. Jefferson DO by month, 200-m

OC: To minimize bias due to method changes, only Niskin samples analyzed by Winkler titration were used. Data quality was verified by comparing bottle measurements to the in-situ DO sensor. The difference between measurements were approximately normally distributed, and measurements with a difference beyond three standard deviations were rejected.

B. DO anomaly at Pt. Jefferson, 200-m

Trends: The seasonal component in DO (shown to the left in panel A) was first removed by subtracting the mean from the data within a 16-year period (2002 – 2017) from both datasets. Multiple linear regression was used on the anomaly with time, salinity, temperature, and water temperature as co-variates. As shown in the plot of monthly anomalies on the left panel (B), no significant temporal trend was found. A slight correlation with temperature is present (p<0.05).

Dissolved oxygen dynamics from one site

- Split by dataset and shown by month for samples near 200 m as means and 95% confidence intervals. At least 16 samples are available for each site.
- Monthly DO anomalies from both datasets from 1933 – 2017, using 2002 – 2017 as the baseline in this example.

SUMMARY

- In the absence of metadata and qualifiers, historical data requires careful evaluation before including in water quality status and trends, particularly due to method changes.
- Variance in a quality-assured dataset can be used to predict and identify outliers in a historical dataset, with an understanding that some relationships can change over decadal scales.
- Integrating samples over a depth range from upper water layers can be used to compare datasets with different target depths, with an estimate of variance from continuous profiles.
- Next steps include assessing additional sites and parameters, such as chlorophyll-a, and comparing with river and input discharges, to better understand seasonal differences over time.
- For example, investigate if higher DO concentrations in May/August and lower nitrate levels in the summer may be a reflection of higher phytoplankton growth. In Puget Sound, deep waters are a mix of oceanic sources and relatively warm surface water due to mixing at silts at the entrance.
- More work is needed in order to better understand drivers over decadal scales in Central Puget Sound, including any links to climate changes and oscillations in watershed loading over time.

REFERENCES


Acknowledgments: Data from UW/Collias study obtained from Mitsuhiro Kawase and EPA/New. Thanks to the King County Environmental Lab field crew and analysts for all the sample and results. Their diligent dedication to high quality results makes these analyses possible.

WHAT USE HISTORICAL DATA?

Increased understanding of biogeochemical changes over decadal scales is needed to help explain long-term water quality status and trends. Traditionally, monitoring programs use their own data. Here, other available data measured at different temporal scales are combined to explore deep dissolved oxygen and nutrient dynamics at a single location in Central Puget Sound, a deep inland estuary.

King County’s marine monitoring program began in the 1960’s to assess Puget Sound receiving waters for impacts from municipal wastewater discharges but did not become routine until the 1980’s. Data from the Atlas of Puget Sound (Collias et al, 1974) are included, with some data back to the 1930’s. Natural conditions and variability within a waterbody can at times mask anthropogenic impacts. Extended data records can help to inform water quality trends and management decisions to effectively address marine water quality.

Marine Offshore Monitoring

Collias Atlas

- Data available between 1932 – 1975
- Collection frequency varied from weekly (for spring in some years) to roughly quarterly, with some years missing
- Discrete samples since 1994 for dissolved nutrients (ammonia, nitrate-nitrite, silica, orthophosphate), TSS, fecal indicator bacteria, chlorophyll-a
- Most samples analyzed for nitrate and nitrite (nitrate, nitrite, silica, orthophosphate, and some ammonia).
- Due to method constraints, nitrate was measured only briefly in 1933, and then again from 1965 – 1975 when large method improvements were made (Armstrong et al., 1967).
- Data obtained from UW, and can also be accessed through EPA STORE: https://www.epa.gov/waterdata/water-quality-data-ftp

Coastal Atlas

- Data collected bi-weekly at 14 sites (monthly Jan & Dec and pre-2014)
- Full CTD profiles since 1979 (temperature, salinity, density, DO, fluorescence, PAR, transmissivity, nitrate).
- Discrete samples since 1994 for dissolved nutrients (ammonia, nitrate-nitrite, silica, orthophosphate), TSS, fecal indicator bacteria, chlorophyll-a.
- Discrete samples collected in 1985 for dissolved oxygen by Winkler.
- CTD and mooring data can be accessed at: http://green2.kingcounty.gov/marine

Methods

- This analysis focuses primarily on one site near Point Jefferson (shown as the purple star to the right), where both programs were co-located. This site is in the deepest part of Central Puget Sound (~280 m).
- Date ranges, sampling frequency, and data distribution explored
- King County samples at 1, 15, 25, 35, 55, 100, 200 m discrete depths.
- Collins data varies, collected primarily at 0, 10, 20, 50, 100, 200, 400, 2,500.
- Deep data outside of the euphotic zone are examined first for trends.
- Detection limits have changed over time for King County nutrient analyses; however, there are no reported detection limits for the Collins dataset. When values are below a reported detection limit, the values are substituted as ‘0’ for the limit of the parameter analysis. In deep data, these low values are near the parameters analyzed.

Collmss Atlas

- Sampling bi-weekly at 14 sites
- Collection frequency varied from weekly for spring in some years to roughly quarterly with some years missing
- Discrete samples for temperature, salinity, dissolved oxygen by Winkler, and dissolved nutrients (nitrate, nitrite, silica, orthophosphate, and some ammonia).
- Due to method constraints, nitrate was measured only briefly in 1933, and then again from 1965 – 1975 when large method improvements were made (Armstrong et al., 1967).
- Data obtained from UW, and can also be accessed through EPA STORE: https://www.epa.gov/waterdata/water-quality-data-ftp

Location of routine offshore stations in Central Puget Sound for King County and UW/Collias datasets. (Note: King County reports nitrate+nitrite together, while Collins reported nitrate separately. Nitrite fraction varies from 0 – 0.8 uM)

Pt. Jefferson, depths > 50-m

Central Puget Sound, depths > 50-m

King County Marine Monitoring Webpage and data access: http://green2.kingcounty.gov/marine