A 13-year temporal and spatial analysis of nutrient levels in Possession Sound and their seasonal relationship with river discharge

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Introduction

Background Information: Understanding nutrient cycles in marine ecosystems can be vital in understanding the health of the environment. Eutrophication can lead to hypoxia, which can also affect ocean acidification.

Study Summary: In this study, nutrient trends measured at multiple sites in the Snohomish River estuary and Possession Sound were analyzed to understand nutrients dynamics in tandem with river discharge spatially and temporally.

Hypothesis: Nutrient levels follow similar trends seasonally and share a strong positive relationship with river discharge. Nitrogen has the highest concentration in Possession Sound.

Study Site

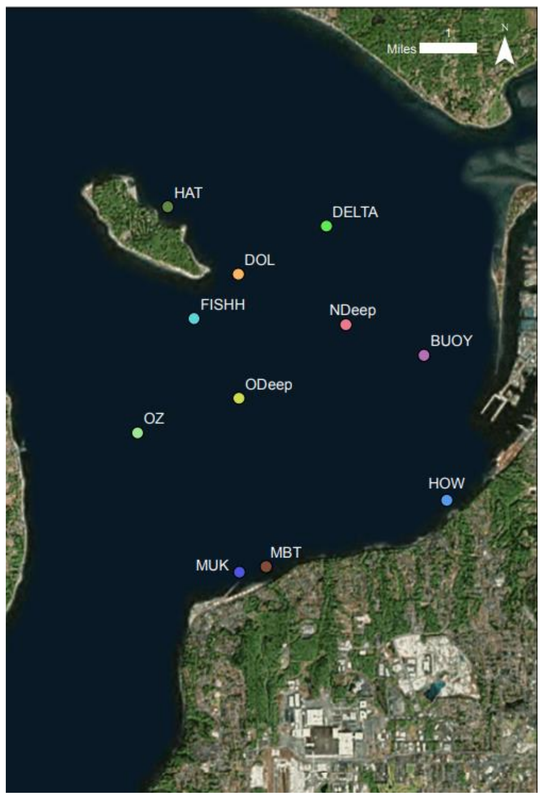

Fig. 1 Map showing eleven sampling sites in Possession Sound, located by the Snohomish River and off the coast of Everett, Washington.

Methods

This study utilized water samples collected with a Niskin bottle. These samples were analyzed at the UW Marine Chemistry Lab. Values measured at the surface, usually the halocline, and occasionally near the bottom at all eleven sites were used. Samples were taken at the various sites with an average of about 39.5 samples per site over 13 years and about 38.6 samples taken a year. The nutrient values used in this study are chiefly nitrates collected at the surface.

ORCA

The Ocean Research College Academy is a dual enrollment program where high school juniors and seniors experience innovative, interdisciplinary and student-centered learning. A longitudinal study of the local estuary forms the backbone of the first-year experience, and leads students to conduct independent research in their second year of the program. ORCA has received grants for a research lab, research vessel, and summer research funded by the National Science Foundation.

Results

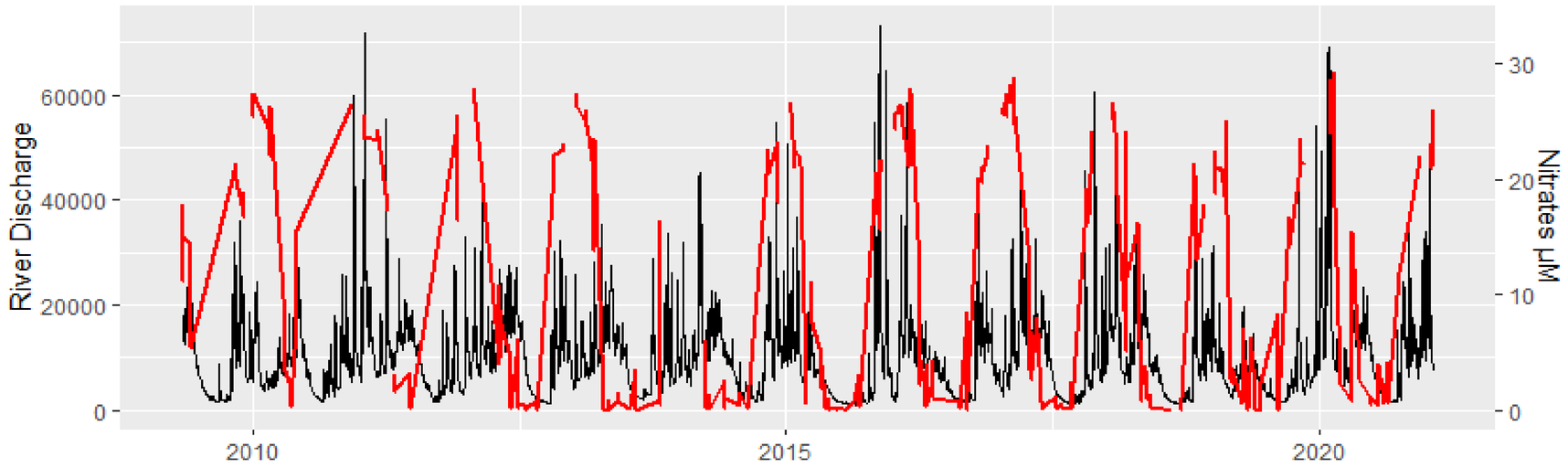

Fig. 2 Time series from 2009 to 2021 of measured river discharge of the Snohomish River in cubic feet per second (in black) compared to measured nitrates at surface of multiple sites in Possession Sound in micromoles (in red). A positive, seasonal trend can be observed, but the sample sizes are drastically different (nitrates, n=488, river discharge, n=4284).

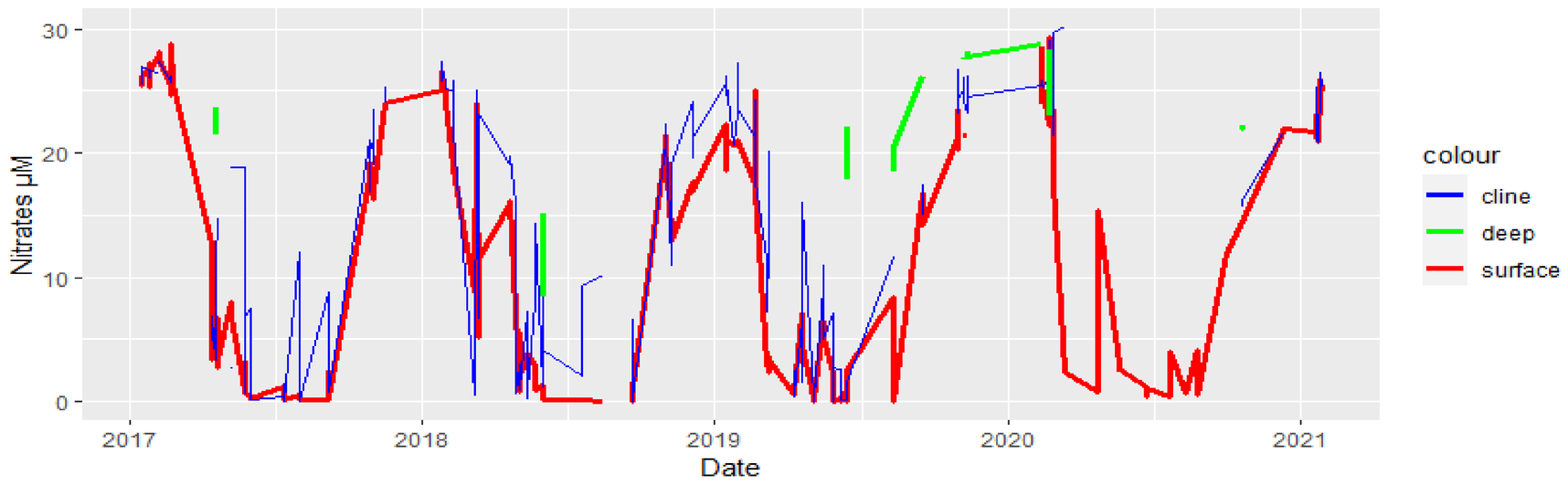

Fig. 3 Time series of nitrate values from 2017 to 2021 from all sites. Different color lines indicate depth of sampling- the surface (0-1 m from the surface), halocline, and near deep (depth differs between sites). There are 496 surface values, 471 cline values, and 31 deep values. While there are very few deep values and less cline values than surface values, the lower the depth, the higher the values.

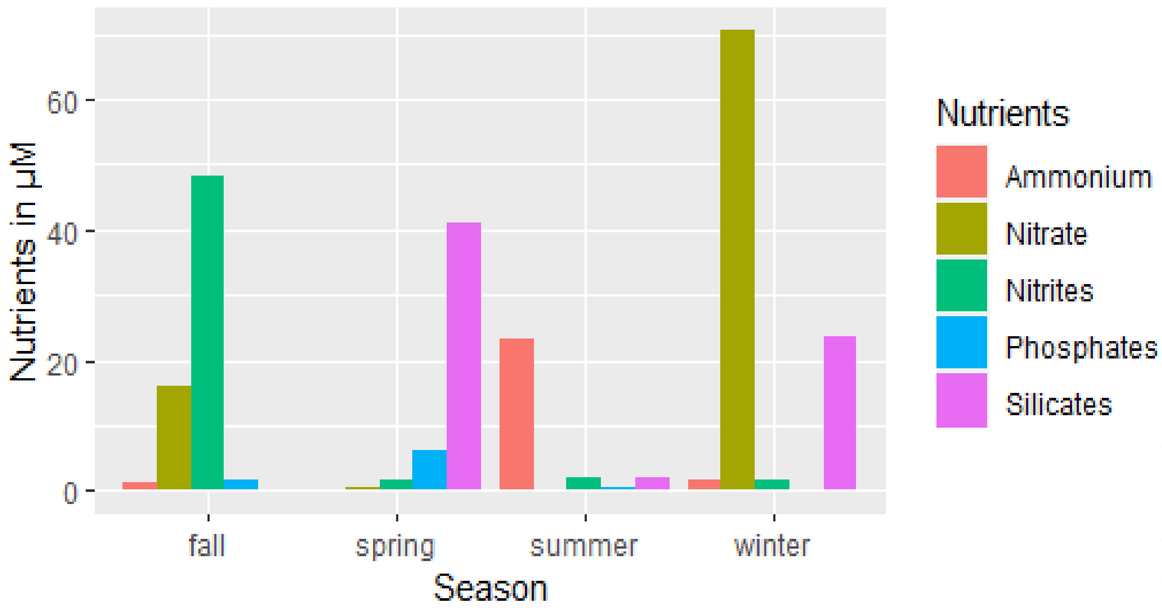

Fig. 4 Bar graph displaying seasonal averages of various nutrient levels collected in Possession Sound at the surface of the water column. Nitrates levels are high in the winter with an average of about 70.6 micromoles, and silicates are high in spring with an average of around 41.2 micromoles. Nutrients are generally higher in winter and fall, most likely due to increased river discharge.

Conclusion

The aim of this study was to create a comprehensive overview of nutrient dynamics in Possession Sound and how they were influenced by variables such as river discharge, season, and depth. Overall, my initial hypothesis was supported. Nitrogen, particularly in the form of nitrates, follows a strong seasonal trend of higher values in fall and winter, and lower values in spring and summer. This trend correlates with river discharge, which most likely affected by Washington seasonal weather patterns. For future studies, incorporating weather and tidal data in tandem with river discharge could more strongly support current trends. Also using this data with dissolved oxygen and chlorophyll levels can indicate the role nutrient dynamics play in broader marine occurrences, such as hypoxia or harmful algal bloom events.

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