NUTRIENT AND PHYTOPLANKTON TRENDS IN PADILLA BAY, WASHINGTON

Figure 1. Water quality monitoring station at Bayview Channel in Padilla Bay.

Washington's Padilla Bay National Estuarine Research Reserve, situated in the Salish Sea, is home to the second-largest eelgrass meadow on North America's Pacific Coast, spanning over 8,000 acres. Eelgrass serves as a nursery for juvenile salmon, crab, and herring, and provides crucial habitat for waterfowl and marine birds. It plays a key role in state Shoreline Master Plans and Puget Sound restoration efforts. Additionally, the estuary offers valuable recreational and educational opportunities for the local community.

The Padilla Bay estuary is surrounded by a watershed that is used in many ways. The largest freshwater input to the estuary comes from Joe Leary Slough, which drains approximately 10,000 acres, 79% of which is agricultural land (Figure 2). Land in Padilla Bay's watershed is also used for transportation, residential housing, and commercial development. In other estuaries, run-off from the watershed can carry nutrients and other substances that can lead to algae blooms.

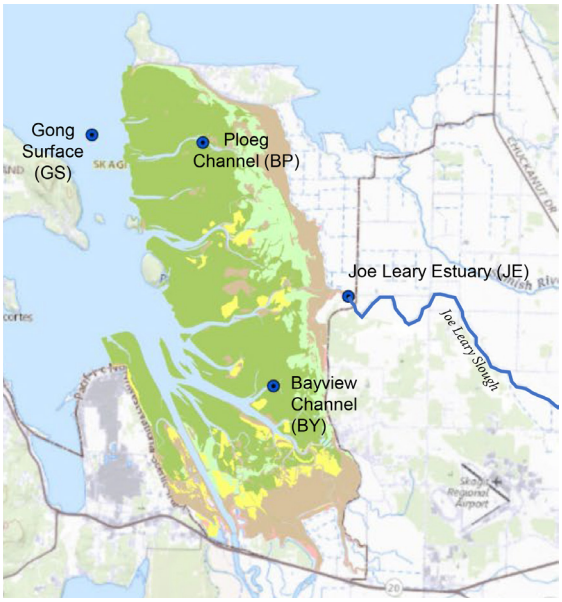

Figure 2. Map of Padilla Bay showing locations of SWMP water quality monitoring stations.

To understand how inputs from the watershed could affect water quality in Padilla Bay, the Padilla Bay Reserve participates in the National Estuarine Research Reserve System's System-Wide Monitoring Program (SWMP), which gathers data to track short- and long-term changes in the ecosystem. Ammonium is a nutrient that promotes phytoplankton (microalgae), which can be monitored by measuring chlorophyll (Figure 3). Recently, graduate students Emily Adler and Eldon Ager from the University of Wisconsin analyzed SWMP data to examine spatial and temporal variation in ammonium and chlorophyll concentrations at four key sampling points within the bay: Joe Leary Slough, Ploeg Channel, Bayview Channel, and Gong (Figure 2). The study aimed to identify trends in these substances across and between monitoring sites.

Data analyzed included SWMP data collected every 15 minutes and ammonium and chlorophyll sampled on a monthly basis at these sites. To ensure data consistency and suitability for statistical analyses, missing values were filled with the mean of the time series. The analysis employed Mann-Kendall trend tests, empirical dynamic modeling, cross-correlation analyses,

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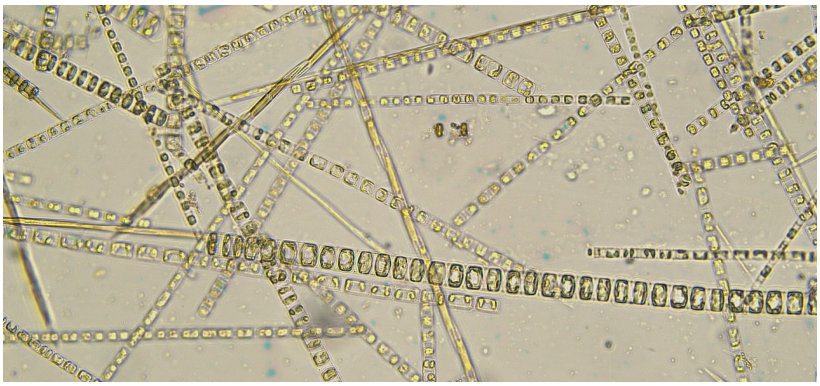

Figure 3. Phytoplankton contain photosynthetic pigments such as chlorophyll.

and seasonal decompositions. The methods and code used in the study are available online.

Results from the students' study: In Padilla Bay, annual chlorophyll remains stable, indicating a steady abundance of phytoplankton. However, the relationship between ammonium and chlorophyll in the eelgrass meadow is complex.

Ammonium is highest at Joe Leary Slough and decreases significantly toward Ploeg Channel, being 30 times lower at Gong. Bayview Channel has shown a consistent decrease in ammonium since 2002. Chlorophyll concentration remains stable across sites, despite higher ammonium levels being generally associated with lower algal abundance.

Differences between Bayview and Ploeg channels highlight variations in nutrient cycling (Figure 4). The decrease in ammonium at Bayview Channel could indicate changes in nitrogen cycling or inputs. Seasonal patterns show chlorophyll peaks in spring and summer, and ammonium rises in winter. Stable chlorophyll levels suggest other factors like phosphorus or water temperature might influence phytoplankton growth.

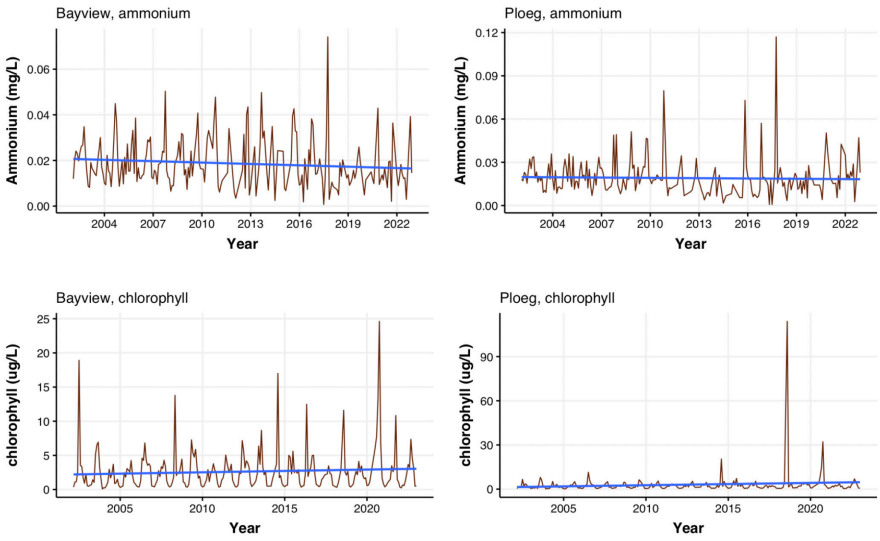

Figure 4. Time series of ammonium and chlorophyll-a concentrations in the Bayview & Ploeg Channels (2002-2023).

Figure 5. Changing water quality instrumentation at the Joe Leary monitoring station.

These findings emphasize the importance of continued monitoring for effective management of estuarine environments and underscore the need for conservation strategies in Padilla Bay and similar coastal ecosystems.

This study was conducted by Emily Adler and Eldon Ager at the University of Wisconsin – Madison in collaboration with Sylvia Yang and Nicole Burnett at the Padilla Bay National Estuarine Research Reserve.

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