SYNTHESIZING LONG-TERM CHESAPEAKE BAY MARYLAND NERR SWMP DATASETS TO COMPARE NUTRIENT LOADS PRE- AND POST-UPGRADE OF A WASTEWATER TREATMENT PLANT IN THE PATUXENT RIVER

The Chesapeake Bay Estuary is the largest estuary in the U.S. In 1985, the Chesapeake Bay Maryland National Estuarine Research Reserve was established to protect this vital watershed. The reserve comprises three areas—Otter Point Creek, Jug Bay, and Monie Bay—representing the Bay's diversity. Jug Bay is located on the Patuxent River, the largest and longest river entirely within Maryland.

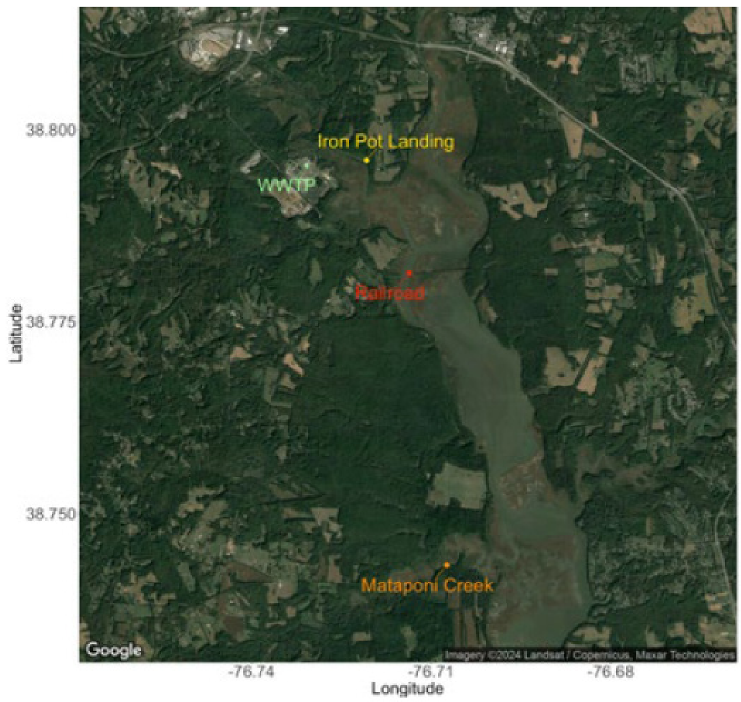

Figure 1. Jug Bay monitoring stations and Western Branch Wastewater Treatment Plant.

Bay area, is situated just downstream from a Wastewater Treatment Plant (WWTP) outflow. Traditionally, the WWTP used a combined sewer and stormwater overflow system, treating and discharging both types of water into the west branch of the Patuxent River. This method risked releasing untreated sewage into the river during high flow periods when the WWTP reached its capacity. Upgrades to the WWTP in 2015 aimed to reduce these overflow events and comply with new state standards.

To address this and other challenges, Chesapeake Bay Maryland participates in the NERRS System-Wide Monitoring Program (SWMP), which gathers data to track short- and long-term changes in the ecosystem. A recent study used SWMP data to assess whether the 2015 WWTP upgrades affected nutrient levels in the Patuxent River Watershed. The study found significant decreases in nutrient levels, both in the main river and the western branch downstream of the WWTP at Iron Pot Landing.

The study compared conditions at three monitored sites within four miles of each other using SWMP data collected every 15 minutes and nutrient samples collected monthly from 2003 to 2022. Iron Pot Landing is located in an urban area where 44% of the land is developed. Railroad is located within the Jug Bay Wetlands Sanctuary on the main Patuxent River, reflects conditions in the upper half of the river's watershed. Mataponi Creek is located in a smaller, less developed area and is considered a relatively pristine site. Statistical analyses and data visualizations were conducted in R to identify trends, seasonal patterns, and changes in nutrient levels at these three sites over time. The study’s methods and code are available online.

The study found that nutrients in the Jug Bay region are generally decreasing, likely due to improvements in watershed nutrient loading. Annual concentrations of nitrogen significantly decreased at Iron Pot Landing and Railroad Crossing, but not at Mataponi Creek. Phosphate levels also significantly dropped at Iron Pot Landing and Railroad Crossing, while they increased at Mataponi Creek. Seasonal variations in nutrient levels were generally minor across the sites, with Iron Pot Landing showing consistent nutrient loads year round, likely due to the nearby wastewater treatment plant.

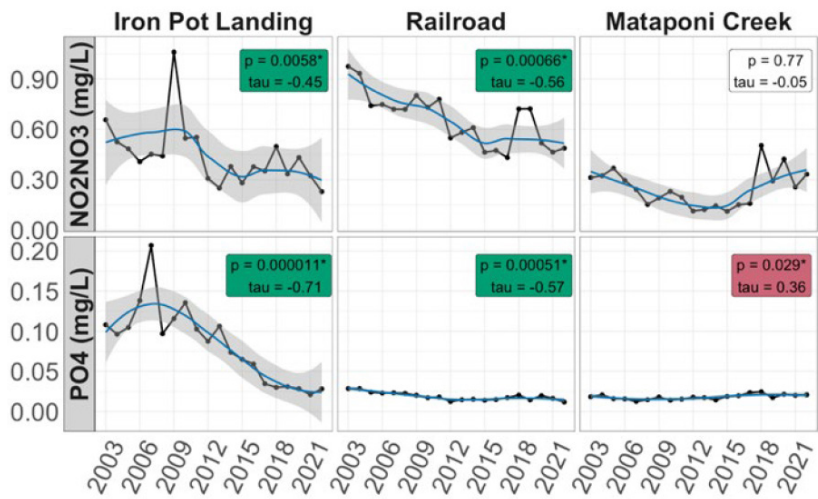

Figure 2. Mean annual NO2/3 and PO4 concentrations (mg/L) from 2003-2022 at Iron Pot Landing, Railroad, and Mataponi Creek. Decreasing trends are shown with green boxes, and increasing trends with a red box.

The study concluded that nutrient levels at Iron Pot Landing and Railroad Crossing have decreased and become more stable, likely due to WWTP upgrades and regional nutrient reduction efforts. However, the increase in nutrient levels at Mataponi Creek was unexpected and remains unexplained, suggesting a need for further investigation.

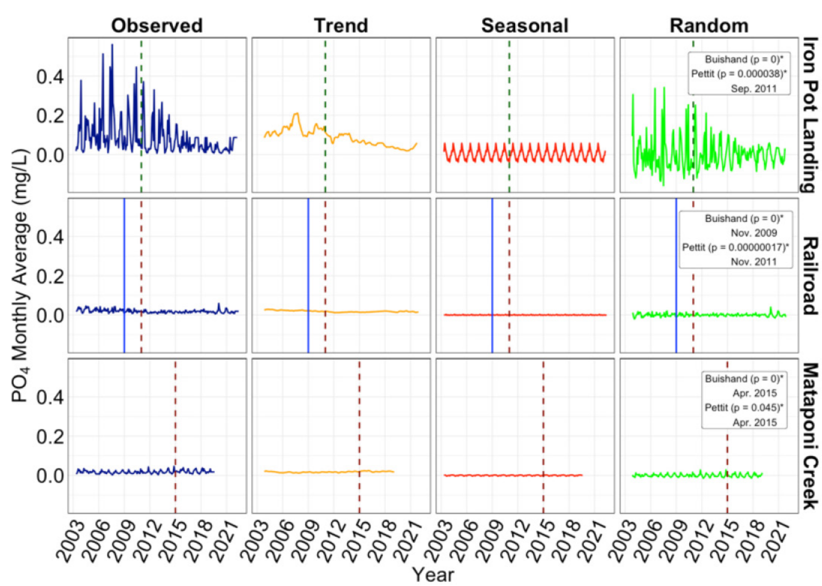

Figure 3. Time series decomposition of monthly PO4 (mg/L) from 2003-2022 at Iron Pot Landing, Railroad, and Mataponi Creek. Breakpoints identified by Buishand (red dashed) and Pettit (blue dashed) methods are shown, with the green dashed line indicating points of agreement between both methods.

This study provides valuable insights into the evolving water quality dynamics within the Chesapeake Bay Maryland Estuary, laying the groundwork for future conservation and management efforts to protect this crucial ecosystem.

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