DYNAMICS OF TEMPERATURE, TURBIDITY, AND NUTRIENT LOADING IN THE GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE

New Hampshire's Great Bay Estuary spans 2,300 hectares and is notable for its rich history of community engagement, including a successful effort in the 1970s to protect the Bay by blocking the largest proposed oil refinery at the time. Today, the Great Bay National Estuarine Research Reserve safeguards approximately 10,000 acres, focusing on research, education, and stewardship.

Home to numerous species, including over 20 that are threatened or endangered, the Estuary faces significant challenges ffrom climate change and urbanization. Warming waters attract new species, while urban stormwater runoff harms sea grasses and disrupts fish feeding habits.

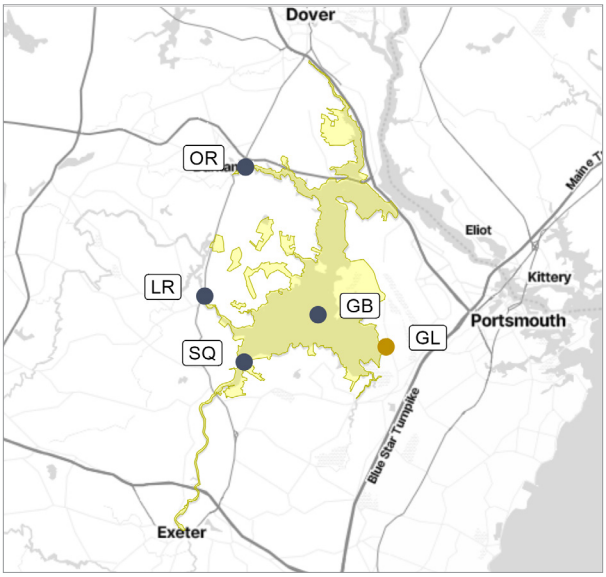

Figure 1. Map of Great Bay Reserve's System-Wide Monitoring Program stations.

To address these and other challenges, Great Bay 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 analyzed SWMP data for trends in temperature, turbidity, and nutrient levels (Figs. 2 and 3). Significant warming trends were observed, with temperatures rising annually and during specific seasons. Turbidity showed declines, which may be real or an artifact of sampling. Trends in nutrient concentrations were inconclusive. Additional analysis is required to verify these findings.

The study compared conditions at the Squamscott river mouth to the open Estuary using data collected every 15 minutes and monthly nutrient samples from 2002 to 2022, though gaps occurred due to ice cover and quality control measures. Analysis included system identification, wavelet transforms, and trend tests. However, due to data filtering decisions made at the national level,

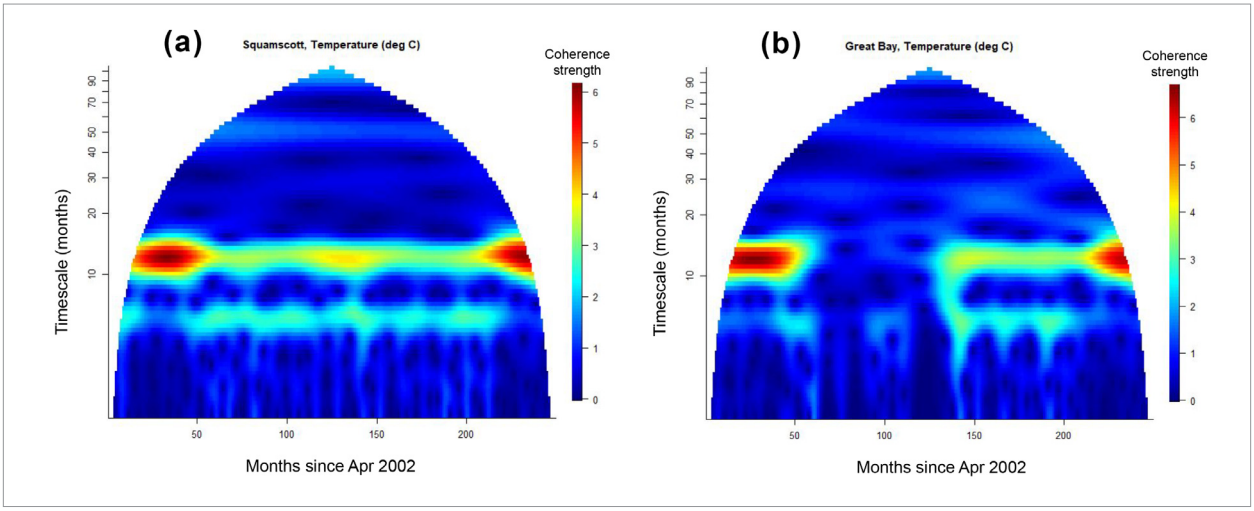

Figure 2. Wavelet transform temperature results showing coherence strength at specific frequencies (y-axis) over time (x-axis) at (a) the Squamscott site and (b) Great Bay.

REPORT SUMMARY

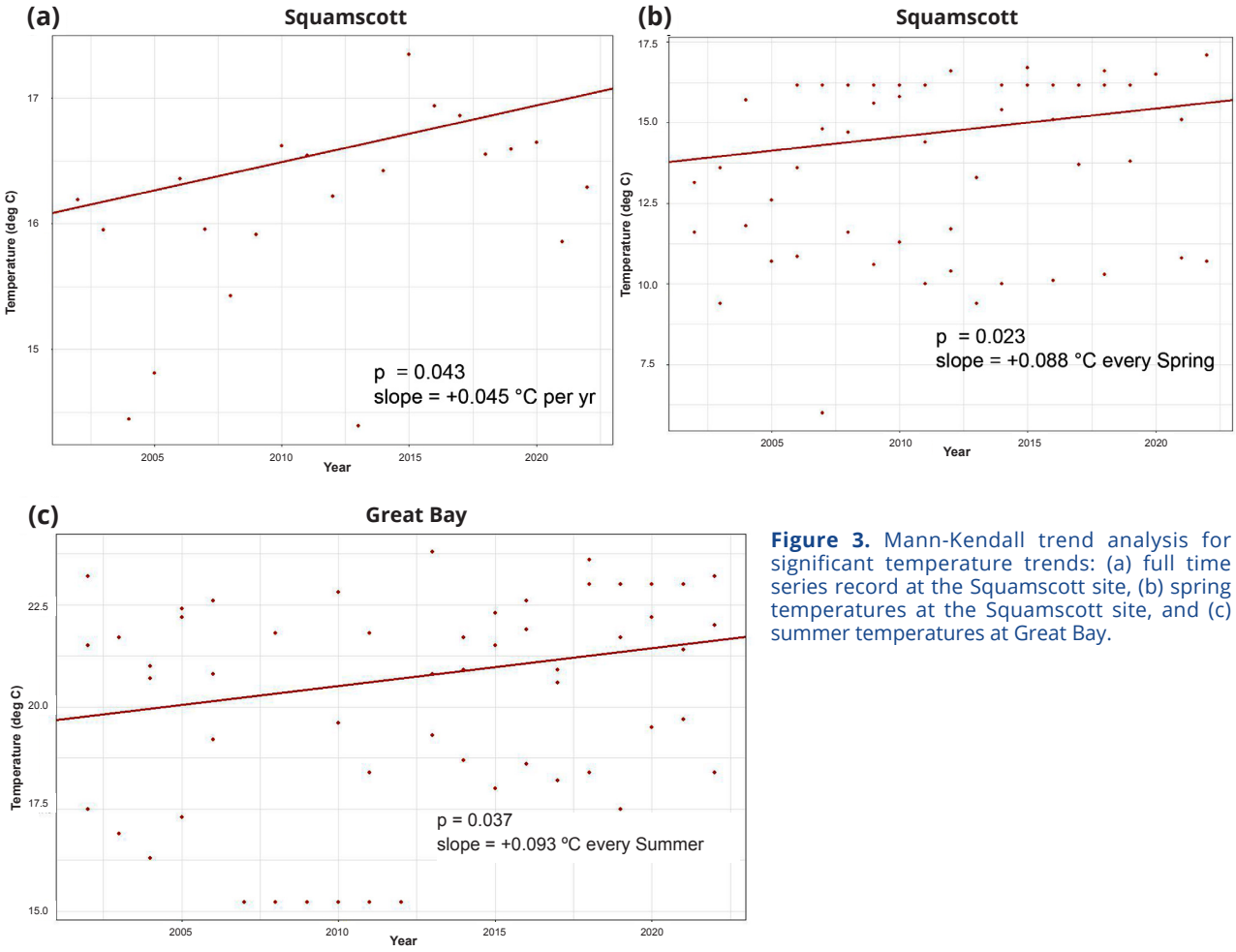

Figure 3. Mann-Kendall trend analysis for significant temperature trends: (a) full time series record at the Squamscott site, (b) spring temperatures at the Squamscott site, and (c) summer temperatures at Great Bay.

some data points were excluded, making the results preliminary. The study's methods and code are available online.

The findings revealed that water temperature and turbidity in the Estuary are influenced by complex processes, with greater complexity observed at the Squamscott river mouth compared to the open Estuary. Significant increases in water temperatures were noted in the spring at the river mouth and in the summer in the open Estuary.

The past five years have seen record global and regional temperatures, with the Gulf of Maine identified as one of the fastest-warming bodies of water worldwide. Reduced spring precipitation likely leads to fewer storms and less sediment inflow, potentially reducing turbidity. Lower turbidity allows more sunlight to penetrate the water, potentially contributing to rising temperatures. However, the declines in turbidity should be further investigated, as they may result from an incomplete dataset due to national-level quality control measures that removed large portions of data throughout the time record.

Future studies using a more comprehensive data record could examine factors like wind speed and trends in chlorophyll and vegetation to better grasp how reduced turbidity affects macrophyte communities. Investigating nutrient dynamics, particularly in relation to population growth and wastewater nitrate reductions, would also be valuable.

This study provides constructive insights into the evolving water quality dynamics within the Great Bay Estuary, laying the groundwork for future conservation and management efforts to protect this vital ecosystem.

This study was conducted by Lizzie Emch and Lindsay Platt at the University of Wisconsin–Madison in collaboration with researchers at the Great Bay National Estuarine Research Reserve and the University of New Hampshire: Amanda Giacchetti, Lara Martin, Thomas Gregory, and Chris Peter.