Executive Summary – State of the Bay – 2025

Overview

Duxbury Bay is an ecologically, economically and culturally important resource that supports extensive recreational activities, a thriving oyster aquaculture industry, and diverse habitats for fish and invertebrates. The bay's clean water underpins commercial shell fishing, recreation, and tourism, while sustaining valuable ecosystem services such as nutrient cycling, sediment stabilization, and biodiversity support.

Over twenty years of data has been analyzed and summarized in this report related to water quality and the health of Duxbury Bay. Key water quality indicators show that Duxbury Bay remains biologically productive with overall good water quality, but upper reaches of Duxbury Bay, (see light green areas in figure below from 2017 MA DEP) are increasingly stressed by nutrient enrichment and climate-related impacts.

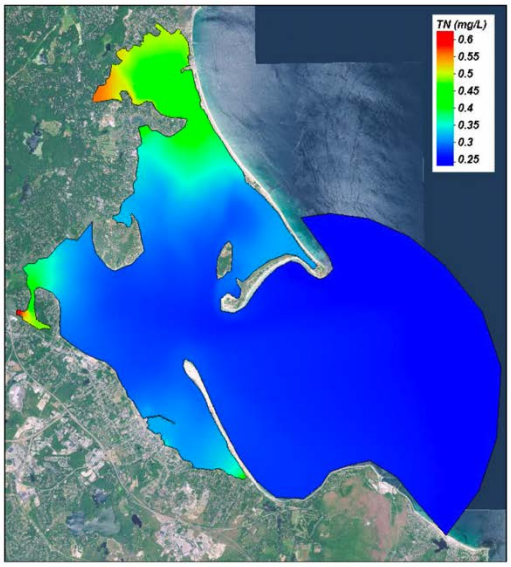

Figure VI-7. Contour plot of average total nitrogen concentrations from results of the present conditions loading scenario, for Plymouth Bay system.

Nutrient Enrichment and Algal Growth

Nitrogen concentrations are highest in the Bluefish River and have increased at Powder Point Bridge and Harbormaster Dock since 2006, often exceeding established ecological thresholds for good water quality. Excess nitrogen fuels phytoplankton blooms, leading to oxygen depletion and habitat degradation. Phosphorus, primarily from detergents and

runoff, is present at lower levels but peaks seasonally in the upper bay. Both nutrients reflect watershed inputs from septic systems, fertilizer use, and stormwater.

Chlorophyll-a, a measure of phytoplankton biomass, has increased at multiple sites, particularly in the upper bay. Cyanobacteria blooms have been detected periodically, creating potential risks for shellfish aquaculture and ecosystem stability. These patterns indicate a need for targeted nutrient management in high-load sub-watersheds, along with continued monitoring to detect harmful algal blooms.

Massachusetts Department of Environmental Protection – MA Estuaries Project – 2017 Draft Report

The Massachusetts Estuaries Project (MEP), initiated in 2001 by MassDEP and UMass Dartmouth, aims to assess nitrogen impairment in coastal estuaries using a science-based framework aligned with the Clean Water Act. The project employs a comprehensive modeling approach—combining watershed analysis, hydrologic simulations, water quality monitoring, and scenario testing—to estimate Total Maximum Daily Loads (TMDLs) for nitrogen.

In Duxbury Bay, model projections indicate nitrogen concentrations exceeding the conservative threshold of 0.33 mg/L, primarily due to septic system contributions.

Although the bay shows only marginal signs of impairment, regulatory consequences may follow if TMDLs are not met, including restrictions on development and funding.

Dissolved Oxygen and Temperature Stress

There has been extensive reporting on overall warming trends of the water in Cape Cod Bay and the Gulf of Maine. However, from review of the past twenty years of data, there is not statistically significant evidence of average warming temperatures in Duxbury Bay. However, the over the last twenty years does indicate there is a significant increase in the number of (days), and duration (hours), when water temperature in Duxbury Bay exceeds 25 Deg. C (77 Deg F), considered a critical threshold temperature.
Overall, dissolved oxygen levels are generally above concern thresholds, but high-frequency monitoring reveals short-term low oxygen events—especially during warm, calm summer periods. These episodic low-oxygen conditions, which may not be captured by periodic sampling, can stress or kill aquatic life, including in particular eel grass, and juvenile fish.

Eelgrass Decline

Eelgrass (Zostera marina) meadows have declined by more than 60% in Duxbury Bay over the past 20 years. Eelgrass provides critical habitat for juvenile fish, enhances water

clarity, and stabilizes sediments. Losses are driven by nutrient-driven turbidity, disease, physical disturbance from boating and aquaculture, and warming waters.

Water clarity remains generally favorable in much of the bay, but the Bluefish River shows persistently high turbidity, likely from organic matter and sediment resuspension in marshes.
Restoration success depends on improving water quality and protecting sensitive areas from disturbance.

Bacterial and Pathogen Monitoring
Bacterial water quality in Duxbury's coastal waters has been consistently good since 2009, with rare exceedances linked to stormwater runoff after extended dry periods. Weekly summer sampling of public beaches for E. coli and multiple annual inspections of shellfish beds by the Massachusetts Division of Marine Fisheries ensure compliance with public health standards.

Persistent problem areas remain closed to shell fishing due to contamination, but targeted infrastructure upgrades, septic improvements, and public education have reduced risk.

Shellfish Aquaculture and Water Quality

Commercial oyster aquaculture dominates Duxbury's shellfish industry, operating under strict local and state regulations. The Aquaculture Management Plan limits total lease area to 1.3% of the bay, mandates habitat protections, and requires ongoing environmental monitoring.
Oysters provide measurable water quality benefits by removing nitrogen and improving clarity through filtration. However, the industry faces challenges from invasive species, fouling organisms, disease, and climate variability. Coordinating aquaculture policy with nutrient management strategies can maximize ecological benefits while sustaining economic viability.

Invasive Species Pressure

The bay is experiencing increased pressure from invasive marine species, notably European green crabs, tunicates (sea squirts), and bryozoans (moss animals). These species damage eelgrass beds, prey on juvenile shellfish, and foul aquaculture gear. Climate change and vessel traffic have facilitated their spread.

Early detection programs like Marine Invader Monitoring and Information Colloborative ("MIMIC"), combined with targeted removal, gear innovations, and biosecurity measures, are essential to limiting ecological and economic damage.

Recreational and Commercial Fisheries Context

Recreational fishing, lobstering, and nearby offshore species contribute to the local economy but are influenced by habitat condition and water quality. Striped bass, flounder, and other species are sensitive to nutrient-driven algal blooms, warming waters, and habitat loss. Habitat restoration—particularly eelgrass and salt marsh protection—supports fishery resilience.

Duxbury Beach, Climate and Sea Level Rise

Duxbury Beach serves a critical role in coastal protection as a barrier beach by absorbing wind and wave energy generated in Cape Cod Bay. In addition, wetlands lining the west side of the barrier create a healthy and well-maintained system that provides a natural buffer and safeguards the bay and the coastal community of Duxbury.

As a prominent coastal ecosystem in Massachusetts, Duxbury Beach supports a diverse range of wildlife, including 284 species of birds (ebird.org), 12 species of mammals, 89 species of invertebrates, and 206 species of plants (107 native, 90 non-native and 13 invasive). The entirety of Duxbury Beach is mapped by NHESP as Priority Habitat of Rare Species and Estimated Habitat of Rare Wildlife.

Sea level along the Massachusetts coast is projected to rise 10–14 inches by 2050, increasing flooding frequency – and poses ongoing challenges and increasing costs to preserve Duxbury Beach. Higher water levels, combined with storms, can mobilize sediments, alter salinity, and exacerbate nutrient loading from upland areas. Protecting and restoring wetlands, dunes, and marshes provides natural water filtration and buffers flood impacts, indirectly improving water quality.

Conclusion and Recommendations

With coordinated management, community engagement, and sustained investment in monitoring and restoration, Duxbury Bay can remain both a productive ecosystem and a resilient economic asset in the face of environmental change.

1. Nutrient Reduction & Water Quality Improvement

- **Target high-load sub-watersheds** (Bluefish River, Back River, Island Creek, Kingston/Duxbury Bay) for nitrogen reduction.
- **Address primary nutrient sources** by upgrading septic systems, reducing fertilizer use, and maintaining effective stormwater Best Management Practices (BMPs).

2. Monitoring, Research & Data Integration

- **Expand high-frequency water quality monitoring** for nutrients, dissolved oxygen, temperature, and algal blooms using sondes and continuous sensors.

- **Maintain long-term habitat mapping** (eelgrass, salt marsh) via aerial, drone, and sonar surveys.
- **Integrate monitoring results** into adaptive management decisions, aquaculture licensing, and habitat restoration planning.

3. Habitat Protection & Restoration

- **Protect and restore eelgrass** in historically vegetated, high-clarity areas using proven replanting methods and anchoring/dredging restrictions.
- **Implement coastal habitat safeguards** for bayside mudflats, marshes, and dunes through restoration projects and targeted protections.
- **Leverage nature-based solutions** (living shorelines, wetland restoration, oyster reefs, quahog aquaculture) to remove nutrients, buffer flooding, improve water filtration, and stabilize sediments.

4. Invasive Species & Aquaculture Resilience

- **Control priority invasives** (green crabs, tunicates) through targeted removal and trapping.
- **Support resilient aquaculture** by developing gear and farming practices that minimize fouling, withstand climate variability, and maximize nitrogen bio extraction.