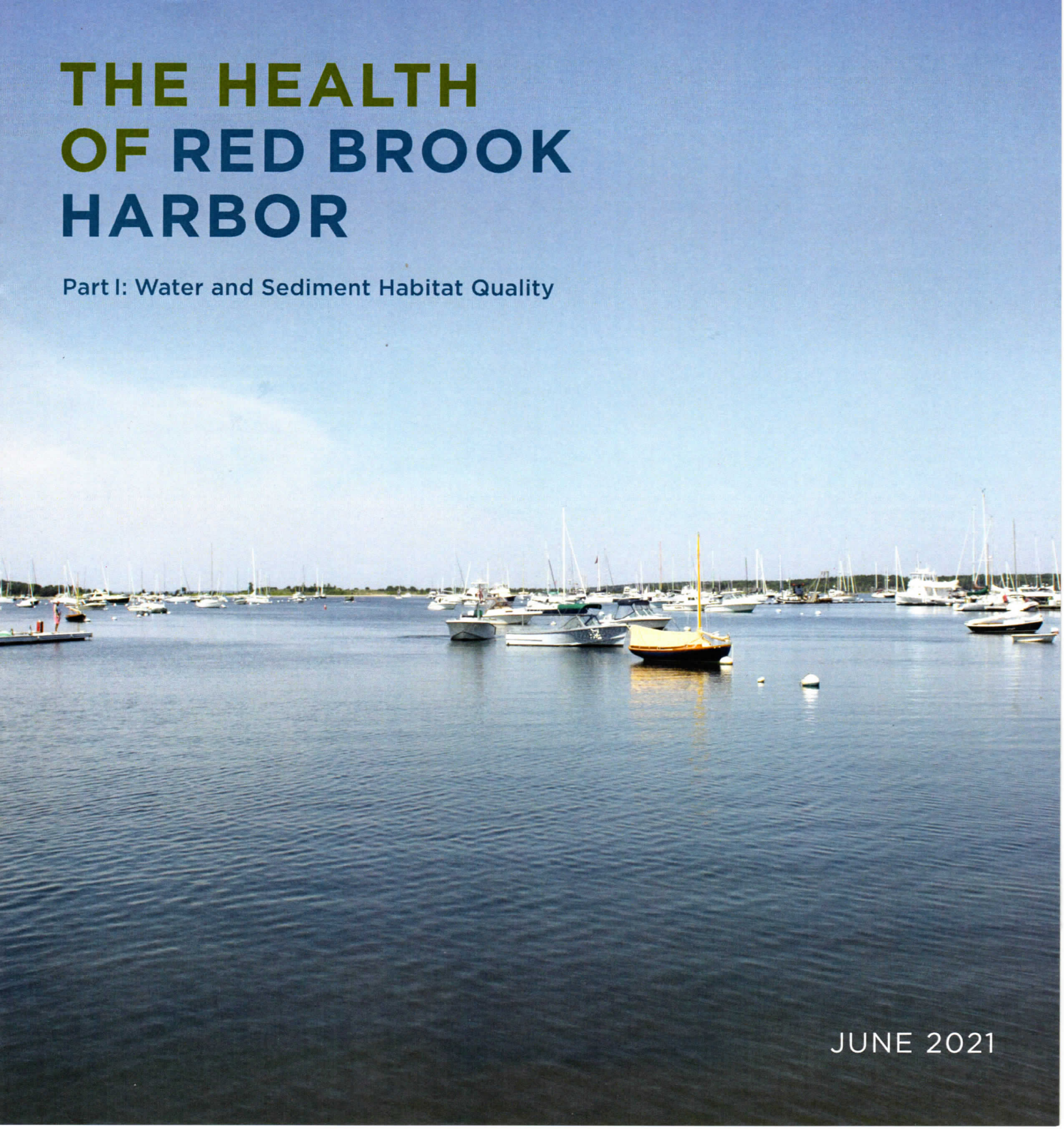
THE HEALTH OF RED BROOK HARBOR

Part I: Water and Sediment Habitat Quality



JUNE 2021

THIS PROJECT

This project brought together the town of Bourne, the Buzzards Bay Coalition, and the Massachusetts Maritime Academy to document water quality conditions and the bottom habitat quality in Red Brook Harbor. The information is needed to establish a nitrogen pollution limit for Red Brook Harbor. Studies of water quality and the bottom environment are complementary – water quality can change on short timescales, whereas the bottom environment changes more slowly, providing a longer-term indication of habitat health. All the methods used for this project were reviewed and approved by the federal Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP).

SUMMARY CONCLUSIONS

- The water quality and benthic (harbor bottom) environment in Red Brook Harbor show signs of ecological stress as a result of nitrogen pollution. Abundant algae reduce summer water clarity and oxygen levels. The bottom has a reduced number of animal species and individuals, and a pollution-tolerant organism is very abundant.

- These results confirm the need to develop a nitrogen pollution limit that sets how much nitrogen Red Brook Harbor can handle and be healthy. This project was a first step and the Buzzards Bay Coalition and Town of Bourne will keep working with partners to develop the remaining pieces needed to establish a nitrogen pollution limit.

What Affects the Health of Red Brook Harbor?

Fifty years ago, the waters around Buzzards Bay were clear and clean. Sunlight reached deep into the water allowing eelgrass to thrive, which supported healthy populations of bay scallops and fish. Over time however, more and more areas around Buzzards Bay have seen water quality decline. Waters have become murky and sandy bottoms have become soft muck. Lettuce-like clumps of macroalgae replace eelgrass. Bay scallops are rare. The cause of the water quality decline is nitrogen pollution.

Too much nitrogen fuels the overgrowth of algae – like over-fertilizing a garden. Algae blooms block out sunlight. Without enough sunlight, eelgrass dies. The young fish, crabs, bay scallops, and other species that depend on eelgrass as a nursery ground and safe haven from predators vanish too. Too much algae growth also leads to less oxygen in the water. All of the Bay's species – from big fish to tiny clams – need oxygen to survive.

Inadequate wastewater treatment is the major source of nitrogen pollution. In many areas, homeowners rely on septic systems. The typical septic system – even a new, properly functioning Title 5 system – is not designed to remove nitrogen. Nitrogen seeps from the leach field into groundwater. From there, nitrogen can travel underground for many miles to the nearest waterway. Other sources of nitrogen pollution to Buzzards Bay are small compared to wastewater, but add to the problem. Each time it rains, stormwater washes fertilizer off lawns and fields and animal waste into the water. Cars emit nitrogen oxides into the air, which eventually fall back onto the land and water surface as acid rain. In some places, cranberry bogs are also part of the nitrogen pollution puzzle.

How is Clean Water Protected?

Massachusetts water quality standards require that estuaries like Red Brook Harbor support high quality habitat for swimming and fishing. All levels of government play a role managing water quality to achieve that goal. Every two years, the state is required to report to the federal EPA on whether water bodies are meeting the standards. When a water body does not meet the standards, a Total Maximum Daily Load (TMDL) has to be developed. TMDLs are pollution limits that describe how much pollution a water body can handle and remain healthy. EPA approves TMDLs and towns are responsible for implementing them. In the case of nitrogen, this means that towns have to take steps to reduce nitrogen by building or extending sewage treatment plants, having homeowners install nitrogen-reducing septic systems, encouraging less fertilizer use, treating stormwater run-off, etc. If towns do not take action to reduce pollution, courts may step in to dictate to the town how the pollution will be reduced. This result may make it much more expensive for the town.

How much nitrogen a water body can cope with and maintain good water quality depends on things like its shape, how deep it is, and how well flushed it is. Scientific studies establish how much nitrogen different land areas contribute to a waterbody and how the nitrogen impacts the condition of the water quality and habitat. In Bourne, the scientific studies are complete and nitrogen TMDLs have been established for Phinneys Harbor and Megansett/ Squeteague Harbors.


Pocasset Harbor
HC2
RB5
Hen Cove
HC1
RB9
RB8
RB4
Red Brook Harbor
RB1
RB3
RB7
RB2
RB10
Hospital Cove
WATER QUALITY STATIONS
BENTHIC STATIONS

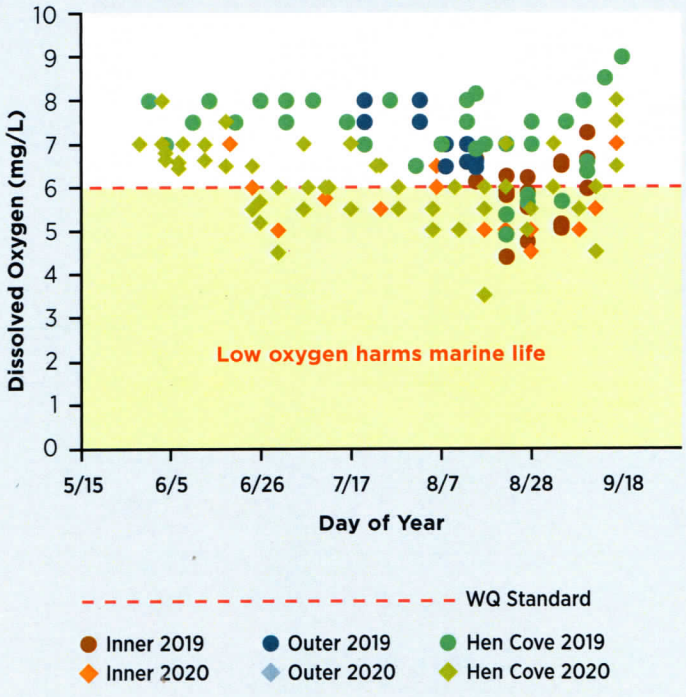
Water Quality

Buzzards Bay Coalition Baywatchers have documented water quality in Red Brook Harbor for 30 years. As a part of this project, water quality was assessed at long-term monitoring sites during the summers of 2019 and 2020 (yellow dots on map). Water quality measurements provide a snapshot of a very dynamic environment that can change on timescales of hours to days. Each day oxygen concentrations normally peak in the late afternoon when a day of sunshine has allowed oxygen to build-up from photosynthesis. As the sun sets and photosynthesis stops, oxygen is drawn down overnight to a daily low.

Dissolved Oxygen

Abundant oxygen is needed for fish and shellfish. Higher levels of oxygen were observed in the Outer Harbor than in the Inner Harbor or Hen Cove. Oxygen concentrations were higher in 2019 than in 2020, which is a trend that was observed generally at stations around Buzzards Bay. Massachusetts water quality standards state that Red Brook Harbor should have at least 6 mg/L dissolved oxygen to support excellent habitat for fish. In the Outer Harbor, dissolved oxygen was above 6 mg/L, but in the Inner Harbor and Hen Cove, concentrations regularly fell below the state standard. There were 22 measurements of oxygen below 6 mg/L in both the Inner Harbor and in Hen Cove in 2019 and 2020. These results are in-line with long-term data. Since 1992, 20% of the dissolved oxygen measurements in Hen Cove and 50% of those in the Inner Harbor are below 6 mg/L. Low oxygen levels literally suffocate marine animals, fish and shellfish.

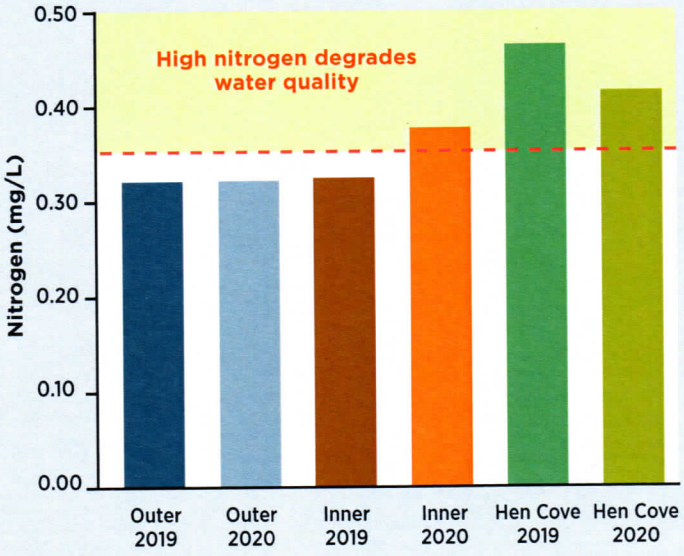
DISSOLVED OXYGEN IN RED BROOK HARBOR



Nitrogen

Excess nitrogen fuels the algae blooms that lead to low oxygen concentrations. The pattern of nitrogen concentrations reflect this, with highest nitrogen concentrations in Hen Cove and lowest nitrogen concentrations in the Outer Harbor. A target nitrogen concentration has not been set for Red Brook Harbor. In nearby Phinneys Harbor, the TMDL set a target nitrogen concentration for an inner harbor station at 0.35 mg/L or less for a healthy ecosystem and an appropriate level for Red Brook is likely similar. In both 2019 and 2020, the Hen Cove nitrogen concentrations were more than 0.35 mg/L and in 2020 the Inner Harbor nitrogen levels were above 0.35 mg/L. 2019 was only the 4th time out of 25 years of data (and the first time since 2000) when the Inner Harbor nitrogen values were below 0.35 mg/L.

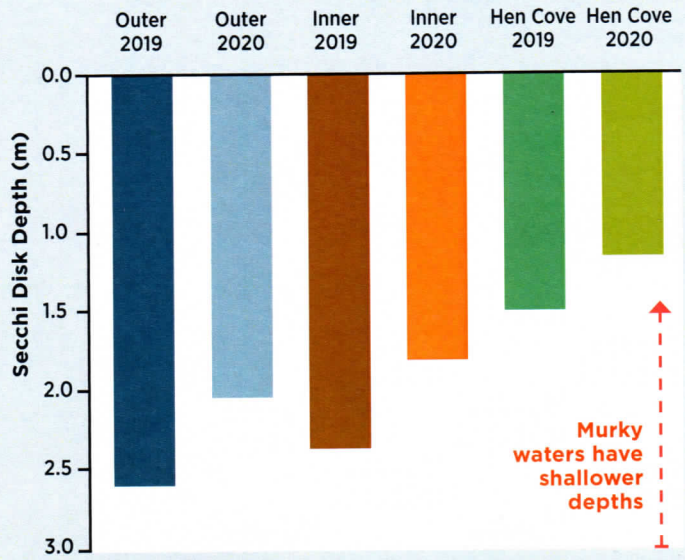
TOTAL NITROGEN



Water Clarity and Algae

Nitrogen pollution fuels excess algae growth that clouds the water. While the state has not set a specific criteria for algal levels, values over 10 µg/L have been used to indicate an unhealthy over-abundance of algae. The yearly average in the Outer Harbor in 2020 and Hen Cove in both 2019 and 2020 were greater than 10 µg/L. During this project, 25% of the algal measurements in the Outer Harbor, 30% in the Inner Harbor, and 60% in Hen Cove were over 10 µg/L. Water clarity was measured more frequently than algal pigments. The water clarity was greatest in the Outer Harbor and lowest in Hen Cove. In Hen Cove in 2020, the average water clarity was only 1.2 m, which means when an average person waded in a little above their waist, they would not have seen their toes.

WATER CLARITY



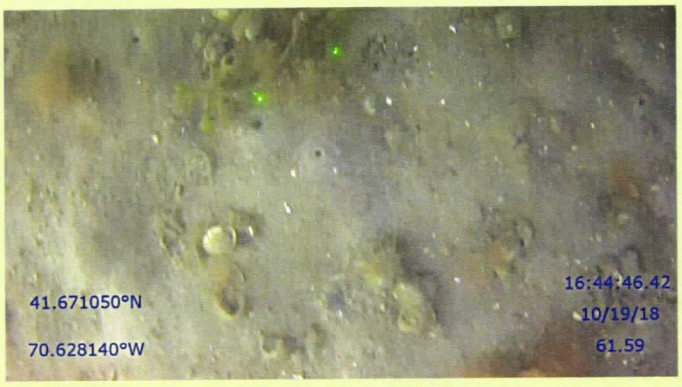
Benthic Survey

Under the water, the area around the seafloor – or benthic environment – collects particles that sink including dead algae, marine organism's fecal material, and sediment. Because the benthic environment collects material from the water column over time, it provides an integrated measure of ecosystem health. The sediment characteristics and the organisms present in the sediments provide valuable information about ecosystem status and the potential impact of pollution sources.

In fall 2018, six stations were surveyed (red dots on map). Photographs and video of the seafloor were taken and sediment samples were collected.

Sediment Quality

The texture and organic content of sediments affects whether benthic species (animals that live on the Harbor floor) are able to thrive. With very low organic material (<0.1%), there is not enough food for the organisms, but when the organic levels get too high (>3%) oxygen becomes too low making it hard for the organisms to survive. High organic levels are often associated with more mucky sediments that generally support low-diversity, shallow-dwelling organisms. High-diversity deep-burrowing organisms typically live in sandier sediments. In Red Brook Harbor, four sampling stations were in the range of healthy organic content. Two stations – 1 in the Inner Harbor and 1 in the Outer Harbor – had organic content above 3%.



Sandy bottom at the Hospital Cove station

Benthic Organisms

Healthy environments are characterized by an abundance of individual organisms and diverse species. State reports consider high quality benthic environments those with at least 20 species and 400 individuals. All the stations except for one, in the Inner Harbor (RB7), had 20 or more species. The Outer Harbor station near Bassetts Island was the only station with more than 400 individuals. The Inner Harbor stations and the Outer Harbor station near the mouth of Hen Cove had relatively low numbers of individuals with less than 200. These results are similar to a benthic survey of Megansett-Squeteague Harbors. However, the benthic community in Red Brook Harbor was not as diverse. Another measure of habitat health is what species are present – when there is a high level of nutrients, certain worm species are able to survive when crustaceans and shellfish cannot. At five stations in Red Brook Harbor, a pollution-tolerant worm species that is used as a high nutrient indicator was highly abundant. The abundance of a pollution-tolerant indicator species and the relatively low diversity demonstrate that excess nitrogen is degrading the benthic habitat.

***Exogone dispar* is a worm that is common in Red Brook Harbor. A red dye is applied to help locate small animals among the sediment and plant debris.**

CONCLUSIONS AND NEXT STEPS

Red Brook Harbor is polluted with nitrogen. The water quality and benthic environment in Red Brook Harbor show signs of ecological stress. Nitrogen pollution is contributing to algae growth that reduces water clarity and oxygen levels. The bottom community has a reduced number of species and individuals, and a pollution-tolerant organism is very abundant. These results confirm the need to develop a nitrogen TMDL – a pollution limit that sets how much nitrogen Red Brook Harbor can handle and remain healthy. The water quality and benthic survey presented here are parts of the scientific studies needed for a nitrogen TMDL. The Town of Bourne has funding from MassDEP to continue the needed scientific studies. Next, the Town will assess nitrogen pollution sources to Red Brook Harbor in partnership with scientists from the Buzzards Bay National Estuary Program, the Buzzards Bay Coalition, and the Woods Hole Oceanographic Institution. This work in Red Brook Harbor is part of the Town's efforts to improve water quality by developing TMDLs for Bourne's water bodies, developing a comprehensive plan for how to manage wastewater throughout all of Bourne, and working to address stormwater pollution through the MS4 program.

ACKNOWLEDGEMENTS

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