

Popponneset Bay Water Quality Overview (2010-2020)

The Mashpee Water Quality Monitoring Program is an on-going collaborative effort between the Mashpee Wampanoag Tribe, the Town of Mashpee and the Coastal Systems Program (CSP) within the University of Massachusetts – Dartmouth, School of Marine Science and Technology (SMAST). The project has a two-fold goal: 1) to sustain a continuing assessment of the nutrient related water quality of the Popponneset Bay Estuary relative to regulatory standards (TMDL's) and 2) monitor improvements in water quality resulting from restoration efforts (e.g. oyster propagation, dredging, nitrogen removals by freshwater systems, wastewater treatment, etc.) as undertaken by the Town, Tribe and others. The program goals are achieved through the collection and analysis of water samples at specific monitoring locations distributed throughout the system and associated field parameters relevant to assessing the health of estuarine habitats within the Popponneset Bay System, Cape Cod, MA.



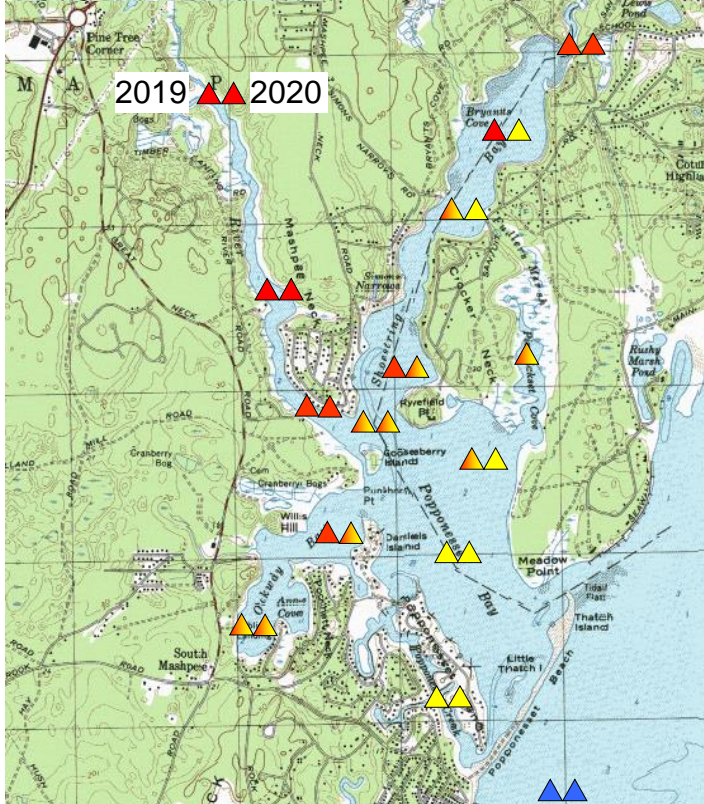
Estuarine Quality Index

Red = Poor

Yellow = Moderate

Blue = High

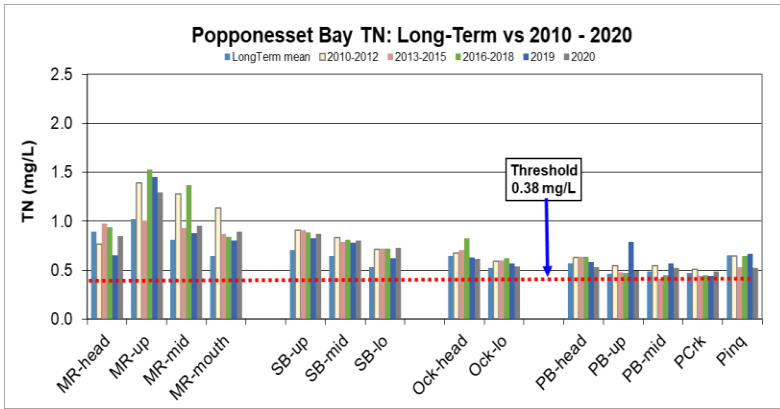
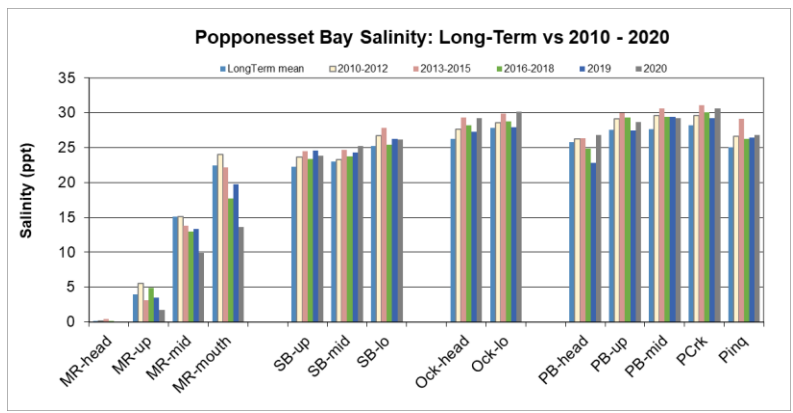
Popponneset Bay Health Index: 2019 & 2020



As a simple guide for water quality assessment, key nutrient related parameters collected as part of the monitoring program are integrated into a single Index. This combined metric, the Bay Health Index, was constructed based on the multi-year monitoring results (long-term, 2010-2012, 2013-2015 and 2016-2018, 2019-2020). It is clear that there is a strong gradient in nutrient related water quality within the Popponneset Bay system which continued through 2019 and 2020. Popponneset Bay shows only poor to moderate quality throughout the whole of its tidal reaches, with poorest water quality within the tidal rivers and tributary basins and moderate quality in the main basin. No high water quality areas remain in this estuary. Popponneset Bay has shown a pattern of lower water quality in the main basin in 2016-2020 compared to historical levels due to periodic phytoplankton blooms and bottom water oxygen depletions. It is clear that this system is nutrient impaired and is not improving and may be getting worse as macroalgal accumulations expand, water clarity decreases during bloom periods and oxygen levels decrease.

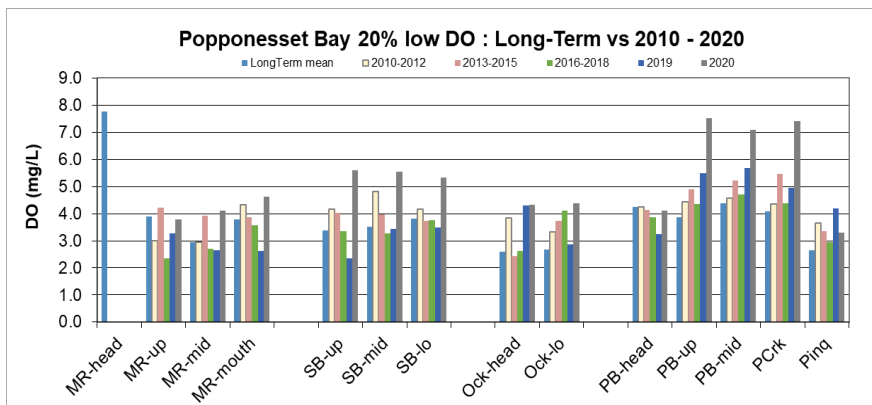
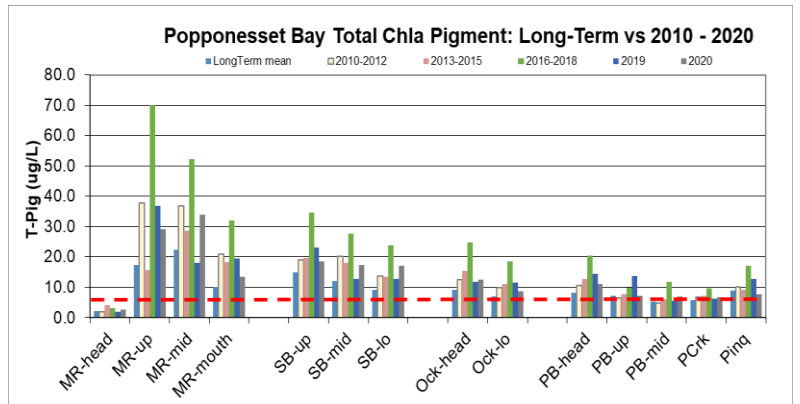


The **salinity gradient** in Popponneset Bay (2010-2020) is consistent with historical patterns but with slightly lower levels observed in upper tidal reaches during the high rainfall year of 2017. The gradient shows the effect of large freshwater discharges to the headwaters of the upper tributary basins. The uppermost reaches of the Quashnet River and the Mashpee River show salinities generally ~5 ppt. In 2019 and 2020 the salinity of the Mashpee River was below baseline levels (2 ppt in 2020) with a clear gradient of near freshwater at the headwaters at Rt. 28 and increasing to the mouth. The Upper Mashpee River shows significant inter-annual variation in salinity in response to rainfall and groundwater levels.



Total nitrogen levels throughout Popponneset Bay are significantly enriched over the high quality inflowing waters of Nantucket Sound (0.28 mg/L TN) entering during flooding tides. TN data are generally consistent with prior historical data except for periodic spikes in the semi-enclosed small tidal river basins. The pattern of nitrogen gradients across the system roughly follows the salinity gradients, as the major source of the "excess" nitrogen is from groundwater and surface freshwater inflows

The consequences of elevated TN levels can be seen in the high amounts of phytoplankton biomass (measured as chlorophyll-a pigments), which saw bloom conditions in 2016-2019 (Mashpee River, Shoestring Bay), and associated depletion of bottom water oxygen. In 2016-2020 CHLA levels are generally higher than the long-term historical data in some basins (Mashpee River, Shoestring Bay, Ockway Bay and portions of the main Popponneset Bay basin), supporting the contention that the overall estuary is presently nitrogen enriched, resulting in high levels of phytoplankton production and blooms when environmental conditions are right. Overall, water and habitat quality appear to be declining in Popponneset Bay (2010-2020).



Oxygen depletion of bottom water was variable but still not meeting water quality standards within the systems in 2010-2020 and data were generally consistent with historical record, except for the low 2018 DO levels in Shoestring Bay. Anomalously high DO levels were found in lower Mashpee River, Shoestring Bay and portions of Popponneset Bay in 2020.

