Trends in Bay Water Quality Signal Need for Further Research

While water quality can encompass many different environmental measurements, this indicator combines 23 years of data on basic parameters such as dissolved oxygen, water clarity, nutrient concentrations, and pH—offering unparalleled insight into the changing condition of Casco Bay.


Will Parson

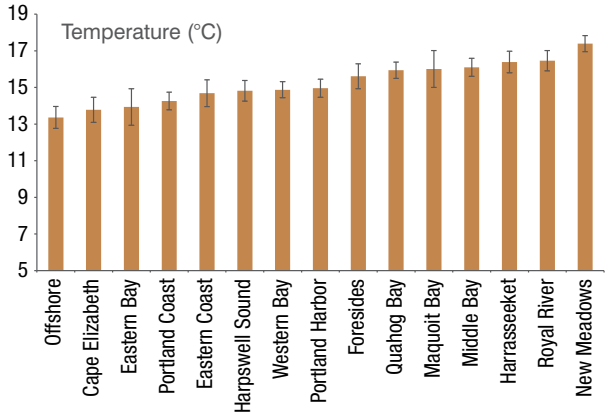
Tracking Conditions for Two Decades

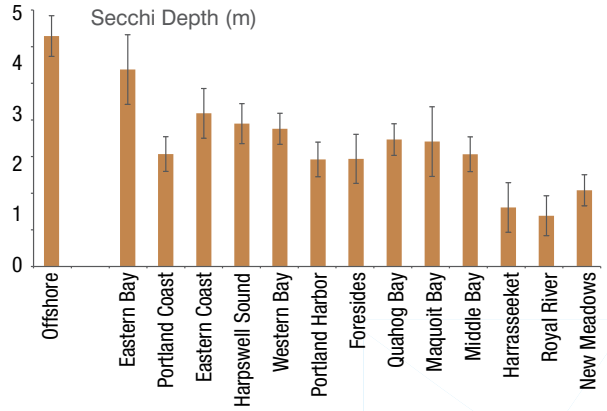
For more than 20 years, Friends of Casco Bay (FOCB) has worked with volunteers to collect standard water-quality parameters including salinity, dissolved oxygen, pH (a measure of acidity), Secchi Depth (a measure of water clarity), and temperature around the Bay (at 36 sites in 2014). In recent years, measurements have been taken twice a day every other week for seven months each year. Each month, FOCB staff visit by boat 10 "profile" sites to characterize conditions further from shore. Since sampling locations have changed over time, data cited here include measurements collected since 1993 at 63 sites. FOCB also has collected data on Total Nitrogen (TN) concentrations in the Bay, providing data from 17 sites (between 2007 and 2014). Results are based on statistical methods that account for sampling history (as data collection methods changed over time).

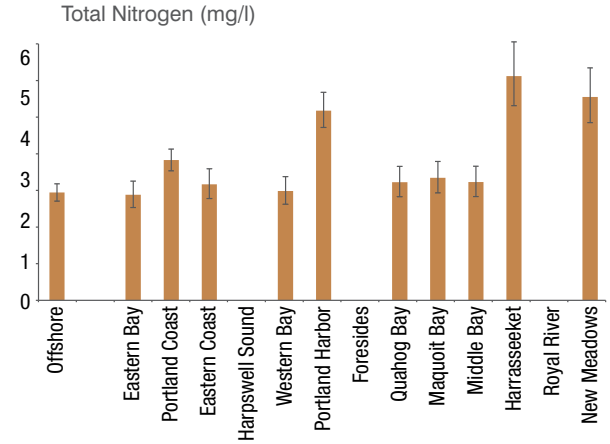
Water Quality Varies Significantly between Sites

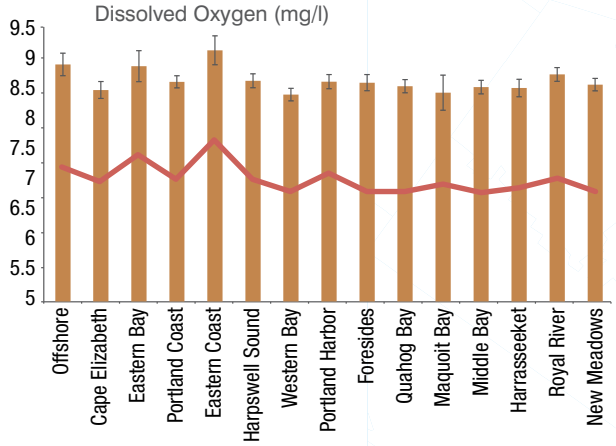
Water quality in Casco Bay, while generally good, varies markedly between inshore (where runoff from the land, shallow depth and restricted water movement influence conditions) and offshore (where waters are typically colder, more clear, less acidic, lower in TN and higher in dissolved oxygen).

Dissolved oxygen levels throughout the Bay are generally at or above 8.5 mg/l. More than 90 percent of FOCB's dissolved oxygen observations in each region have been above 6.5 mg/l in recent years (a level high enough not to affect aquatic biota).





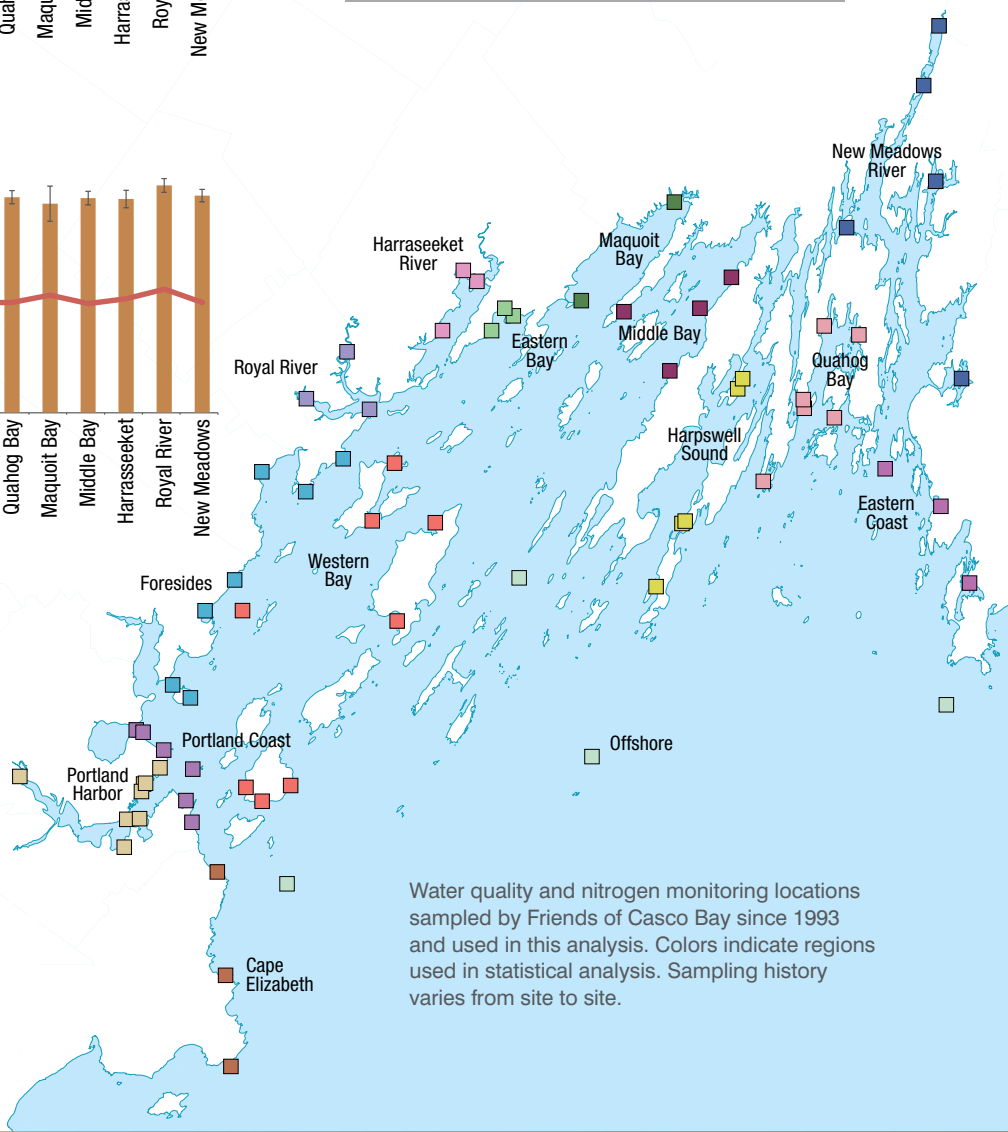




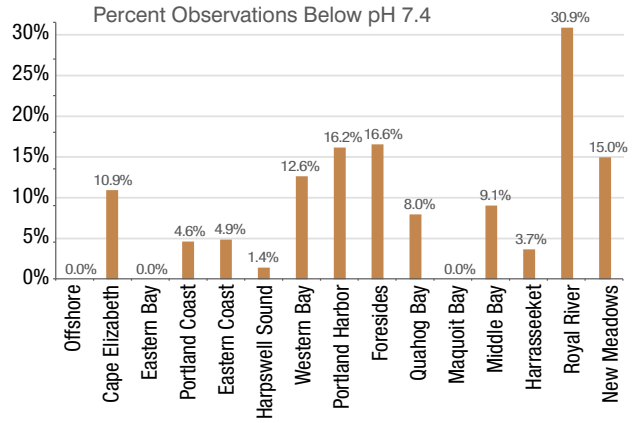
Average water-quality conditions by region for the period 2010-2014, adjusted for sampling history. Results for Temperature, Secchi depth and Dissolved Oxygen are based on data from 2010 through 2014. Data on Total Nitrogen shows estimated geometric mean since 2008. Ninety percent of all dissolved oxygen observations in the last five years fall above the red line.

In contrast, nitrogen levels in parts of Casco Bay are high. According to 2009 report prepared for Maine Department of Environmental Protection, 90 percent of measurements statewide were below 0.42 mg/l. (Cadmus Group 2009). Average conditions (geometric means) for three Casco Bay sub-embayments (Portland Harbor, Harraseeket River and New Meadows River) exceed those values, suggesting that these areas consistently have among the highest nitrogen levels observed in Maine coastal waters.

Coastal acidification is driven both by rising atmospheric CO_2 and by local water-quality conditions.



Water quality and nitrogen monitoring locations sampled by Friends of Casco Bay since 1993 and used in this analysis. Colors indicate regions used in statistical analysis. Sampling history varies from site to site.



Over the past five years, average pH observed by FOCB staff and volunteers was 7.84, with 11.1 percent of measured values Bay-wide showed acidified conditions (pH below 7.4). Few offshore areas had acidified conditions, while nearly a third of all pH measurements in the Royal River were below that threshold. Coastal acidification is driven both by rising atmospheric $C0_2$ and by local water-quality conditions. Elevated nutrient levels, as seen in some inshore areas of Casco Bay, have been associated with higher primary productivity and increased risk of acidification.

Water Quality Reveals Some Troubling Trends

With more than 11,000 observations over a long period of record (23 years), even relatively weak trends can reach statistical significance. FOCB's data suggest that Casco Bay water temperatures have climbed 3.6°F on an average, seasonally adjusted basis since monitoring began in 1993. Average dissolved oxygen levels have declined slightly (0.30 mg/l over 13 years), probably due to warmer waters. Water clarity, as a measured by the Secchi Depth, has also declined (0.39 meters; 1.28 feet) over the same period.

While long-term trends in pH (data not shown) are statistically significant, the change is small (0.04 pH point over 23 years), and measurement techniques have changed, making the practical importance of the finding unclear.

Surprisingly, Casco Bay's salinity appears to be changing slightly (declining ~ 1.8 PSU over the period of record). While salinity is dropping or unchanged in most of the Bay (including offshore), it has increased in the Royal River and Portland Harbor, both areas influenced by river discharge (data not shown).

For additional references and information, please view the Bibliography of the full *State of the Bay 2015* report at www.cascobayestuary.org/state-of-the-bay-2015.