Supplementary Information
Indicator H: Nutrients
State of Casco Bay 6th Edition

References

Gray, Whitley, 2019. Improved estimates of tributary nitrogen load to Casco Bay, Maine. Master of Science in Marine Policy, Graduate School, University of Maine. Electronic Theses and Dissertations. 3087. https://digitalcommons.library.umaine.edu/etd/3087

Further Reading

Bohlen, C., Blair, M., Boundy, V., Freshley, C., & Sands, K. (2019). (rep.). *Nutrient Pollution in Casco Bay, Maine: State of the Science and Recommendations for Action*. Casco Bay Nutrient Council, Casco Bay Estuary Partnership. Retrieved from https://www.cascobayestuary.org/wp-content/uploads/2019/06/Casco-Bay-Nutrient-Council-Report-Final-6-12-19.pdf.

Casco Bay Nutrient Council was a group comprised of government officials, wastewater treatment and stormwater management professionals, researchers, community development organizations, and water quality advocacy organizations to educate policymakers and funders on the threats of excess nutrients in Casco Bay. This report contains an explanation of the issue, recommendations for solutions, and a list of policy and regulatory tools impacting Casco Bay.

Liebman, Matthew. (2015). Eutrophication in the Gulf of Maine. State of the Gulf of Maine Report. 10.13140/RG.2.1.2839.7288. https://www.researchgate.net/publication/281118458_Eutrophication_in_the_Gulf_of_Maine_State_of_the_Gulf_of_Maine_Report

A report on the state of eutrophication in the Gulf of Maine. Although there is no one dataset dedicated to nutrient levels on a Gulf-wide basis, data was sourced from many individual bays and estuaries in the region. The report provides a region-wide summary of the impacts of excess nutrients on water quality and coastal ecosystems. The report includes actions and suggestions to improve nutrient levels in the gulf.

Bricker, S.B., B. Longstaff, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. 2008. Effects of nutrient enrichment in the nation's estuaries: A decade of change. Harmful Algae 8 (2008) 21–32.

Latimer, J.S. and M.A. Charpentier, 2010. Nitrogen inputs to seventy-four southern New England estuaries: Application of a watershed nitrogen loading model. Estuarine, Coastal and Shelf Science 89(2010): 125-136

Scavia, D. and S.B. Bricker. 2006. Coastal Eutrophication assessment in the United States. Biogeochemistry 79(2006):187-208. DOI 10.1007/s10533-006-9011-0.

Three technical papers about nutrient loads to U.S. and especially Northeastern U.S. estuaries and their consequences.

Sinha, E., A.M. Michalak, and V. Balaji. 2017. Eutrophication will increase during the 21st century as a result of precipitation changes. Science 357, 405–408. https://www.science.org/doi/10.1126/science.aan2409

Rabalais, N.N., R.E. Turner, R.J. Díaz, and D. Justić. 2009. Global change and eutrophication of coastal waters. ICES Journal of Marine Science, 66(7):1528–1537. https://doi.org/10.1093/icesjms/fsp047

Breitburg, Denise; Levin, Lisa A.; Oschlies, Andreas; Grégoire, Marilaure; Chavez, Francisco P.; Conley, Daniel J.; Garçon, Véronique; Gilbert, Denis; Gutiérrez, Dimitri; Isensee, Kirsten; Jacinto, Gil S.; Limburg, Karin E.; Montes, Ivonne; Naqvi, S. W. A.; Pitcher, Grant C.; Rabalais, Nancy N.; Roman, Michael R.; Rose, Kenneth A.; Seibel, Brad A.; Telszewski, Maciej; Yasuhara, Moriaki; Zhang, Jing (2018). *"Declining oxygen in the global ocean and coastal waters"*. Science. **359** (6371): eaam7240.*doi*:*10.1126/science.aam7240*..

Three papers that put coastal nutrient enrichment into global context, especially with regard to global change, including climate change. The first paper details the effects of climate change on precipitation and acidification globally, and how that may affect coastal waters. The second reviews how global change is likely to affect eutrophication of coastal waters, and the third documents widespread deoxygenation of coastal and ocean waters.

Methods and Data Sources

The water quality data we used in this chapter was provided by Friends of Casco Bay (FOCB) and the Maine Department of Environmental Protection (DEP). FOCB has been tracking nutrients in Casco Bay for most of their thirty-year history of water quality monitoring, with long-term records available from five locations, and recent data from many more. DEP monitored nutrient levels at many locations around Casco Bay over the last few years, filling in details at many locations without a long-term monitoring record.

Data on atmospheric deposition of nitrogen are from the National Atmospheric Deposition Program National Trends Network monitoring site, at Wolfe's Neck, in Freeport. The site is managed by DEP. Data was accessed from the National Trend Network online data portal. The data is currently available at https://nadp.slh.wisc.edu/sites/ntn-ME96/.

Data on nitrogen loads was assembled by CBEP from the most recent available data. Calculations of total annual loads are based on CBEP calculations based on data provided by others. Data on estimated tributary loads are as reported in Whitley Gray's Master's thesis. Gray kindly shared river nitrogen data data with CBEP. Data on wastewater discharges is based on data provided by DEP. Those data, in turn, are based on reports from discharges on total wastewater volumes, and periodic (usually monthly) analyses of total nitrogen in wastewater samples. Years covered by both flow and nitrogen concentration data vary from wastewater facility to wastewater facility. Data on atmospheric deposition is based on the data just described for atmospheric nitrogen deposition, scaled to the area of the Bay's open waters.

Data presentation in the final State of Casco Bay report emphasizes graphical presentations that show all observations. Long-term trends for FOCB monitoring sites are based on a multivariate linear model that included sampling location, year, and a term for months of the year. Since nitrogen levels show seasonal patterns, fitting a month term reduces the "error" in the regression model, improving our ability to detect trends. The trend analysis for atmospheric deposition is based on a "robust" regression technique called a median-based linear model. That method was used to reduce the impact of the anomalous observation from 2012 on the fitted trendline.

Access to data and summary of data analysis can be found at https://github.com/CBEP-SoCB. For a full archive of data and all analyses steps head to https://github.com/CBEP-SoCB-Details.