

Eutrophication and Hypoxia Degrade Ecosystem Functions and Services of Narragansett Bay Benthic Communities

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Excessive input of nitrogen to estuaries and coastal waters leads to eutrophication; the resulting organic matter over-enrichment of the sediments and seasonal hypoxia of the bottom water have well-known deleterious effects on benthic community biodiversity, abundance, and biomass. To better understand how these losses carry through to impairment of key ecosystem functions of benthic communities, a benthic data set spanning 20 years and 152 stations in Narragansett Bay, RI, along with ancillary data, was used to compare measures of community structure and function from stations in seasonally hypoxic areas with stations in normoxic areas. Stations with sediments contaminated by metal or organic pollutants were removed from the analysis. Mean species richness in the seasonally hypoxic areas was one-third that in normoxic areas (21 vs. 65; $p=0.03$). Many rare species found in normoxic areas were not present in hypoxic areas—total number of occurrences of species present on three or fewer sampling instances was 15 in hypoxic areas vs. 145 in normoxic areas. A multidimensional scaling of species abundances was significantly different ($p=0.01$). Mean biomass and secondary production were both lower in hypoxic areas. Mean fluxes of ammonia and phosphate out of the sediments in hypoxic areas were about double. Mean flux of dissolved oxygen into the sediments and mean flux of nitrogen gas (from sediment denitrification) out of the sediments were slightly higher. Flux of nitrous oxide, a potent greenhouse gas, out of the sediments was about six times higher. Benthic communities in the hypoxic areas were at a significantly earlier successional stage. Lastly, the mean depth of the sediment Redox Potential Discontinuity, a measure of sediment bioturbation by macrofauna, was less than half that of normoxic areas. Eutrophication-driven year-round over-enrichment of organic matter and seasonal hypoxia in the northwest part of the Bay have led to degradation of benthic community structure and function, which has serious implications for sustainable provision of ecosystem services (e.g., fish and shellfish, water quality, recreational opportunities, aesthetic values) that are desired by the human population surrounding and using the Bay.