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Historical Trends of Benthic Invertebrate Biodiversity over 182 Years in Narragansett Bay

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Narragansett Bay has high benthic invertebrate biodiversity that supports influential ecosystem functions and services including shellfish production, energy flow to fishes, and crucial processes for biogeochemical cycles. To examine biodiversity trends over time, a master list was compiled of all benthic invertebrate species collected from the Bay beginning with Totten’s 1834 descriptions of molluscs, Leidy’s collections in 1855, Verrill and Smith’s survey in 1871, and studies at Alexander Agassiz’s Marine Zoological Laboratory in Newport, 1877–1910. The list, spanning 182 years, was compiled from 99 studies and includes invertebrate macrofauna (>0.5 mm) and more limited studies of meiofauna. It currently holds ~1,200 unique taxa from 21 phyla, the majority of all animal phyla on Earth. A permuted estimator of number of species suggested more are yet to be discovered. Often, the only data available from early studies are lists of species. When abundance data were available, widely-varying sampling gear and sieve mesh sizes preclude a quantitative comparison of abundances. Instead, non-metric multidimensional scaling and Average Taxonomic Distinctness (a measure of taxonomic biodiversity) were used with presence-absence data (species lists) to examine trends over time. Taxonomic Distinctness steadily declined from the 1880s to the 1980s; then partially recovered in the 1990s and following decades, but not up to the level of the 1880s. A total of 279 taxa captured prior to 1950 have not been seen again. Current status and recent trends (1990–2015) were determined using quantitative abundance data from a national EPA monitoring program that sampled random stations throughout the Bay. There were significant decadal changes in taxonomic distinctness. A stepwise regression showed that pollution parameters (eutrophication, hypoxia, sediment contaminants) were the primary factors influencing biodiversity. Trends using quantitative abundance data were examined at a reference site (North Jamestown in mid-Bay) and at a more impacted site at Spar Island in Mount Hope Bay. The North Jamestown site is characterized by the typical Narragansett Bay Nephtys-Nucula community and has been sampled by 17 different studies, 1957–2010. Community composition and biodiversity were relatively stable, although that appears to have changed in the most recent decade. At Spar Island (five studies, 1975–2015), an Analysis of Similarity on a Bray-Curtis similarity matrix and an ANOVA on Average Taxonomic Distinctness showed that changes in natural and anthropogenic factors forced a significant (p<0.01) decade-to-decade decline in biodiversity. Biodiversity is a useful ecological indicator of historical trends in the Bay ecosystem.

Key words: marine benthic invertebrates, biodiversity, taxonomic distinctness, historical trends, Narragansett Bay