The Gulf of Maine Register of Marine Species now lists >4,000 species, but only a subset has well-documented distributions. The best-known are the fishes, sampled >200 times per year since 1963 by extensive demersal trawl surveys following statistical assessment methods by US and Canadian federal fisheries agencies (NMFS and DFO). Invertebrates have been sampled in a less systematic way using a wide range of sampling devices with uneven spatial and temporal effort (major efforts by the US between 1933 and 1986). Here we consider just the metazoans.

Biodiversity cannot be sampled with high economic, spatial and temporal resolution everywhere. Rather, the elucidation of biodiversity patterns, processes and change must rely on a combination of data and knowledge gained through observation and analysis at multiple scales. Detailed studies will occur in many places following specific needs and the interests of individual investigators. Yet, geographically oriented strategies can help encourage more comprehensive coverage and provide a spatially coherent framework for assessing patterns and processes at multiple scales.

We examine several recent multi-institution research efforts underway within the Gulf of Maine Area that are integrating historical survey information and applying new survey methodologies and statistical approaches to examine biodiversity relationships at three scales.

Note the growing reliance on optical methods as a way to characterize and analyze biodiversity and habitats, and communicate biodiversity patterns at multiple scales among and within habitat domains, from the intertidal to the base of the slope, including the water column and benthic environments.

Below: Two approaches to detailed ecological studies and discovery. Stellwagen Bank National Marine Sanctuary (LEFT) is near shore, has many habitat types, is well mapped in terms of substrates and environmental conditions, and has considerable biological documentation. Increasingly automated techniques are being tested for statistical analysis of macrofaunal distributions (see machine-assembled mosaics of images at bottom), which must be augmented and integrated with other biological, physical and chemical data to understand ecosystem processes. Canada’s “Discovery Corridor” (RIGHT) provides an assessable framework for describing and understanding biodiversity patterns at multiple scales among and within habitat domains, from the intertidal to the base of the slope, including water column and benthic environments. Note the growing reliance on optical methods as a way to characterize and analyze biodiversity and habitats, and communicate results.

Affiliates: 1. University of Southern Maine, Portland, ME, USA; 2. Fisheries and Oceans Canada, Biological Station, St. Andrews, NB, Canada; 3. Centre for Marine Biodiversity, Dalhousie University, Halifax, NS, Canada; 4. Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, NS, Canada; 5. Memorial University, St. John’s, NF, Canada; 6. CSIRO, Brisbane, AU; 7. Woods Hole Oceanographic Institution, Woods Hole, MA, USA

ABAVER, LEFT TO RIGHT: Three views of fish biodiversity using long-term data on 297 species caught in annual fall demersal trawl surveys. PCA shows distinct spatial patterns. Knowledge of assemblages can be used to predict or understand changes in composition/function/distribution expected (observed) from natural and human pressures. The average diversity seen when sampling [middle figure] shows high diversity along the coastal shelves and in the southern Gulf of Maine [and southern New England Shelf]. However, total fish diversity declines as one moves northward and clockwise around the Gulf and into the deeper interior basins. The fish community on the continental slope is sampled primarily on the upper slope.

RIGHT: The three largest fish and benthic invertebrate databases from the US and Canada [>6,000 samples, <600 species, now on OBIS], representing five distinct contemporary and historical surveys, were used to explore relationships of fish and invertebrate biodiversity to 23 environmental variables (some shown in figure). The variables explained an average of 30% of the variation in biological patterns. Four variables were consistently important (checked). For various reasons (mostly low abundance or infrequent occurrence), only 17% of the invertebrate species and 53% of fish species in the databases were used for this analysis. Thus, there is a wealth of additional information that can be considered (species-habitat relationships, species occurrence patterns, etc.), but by other means.

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