Long-term (1987-2013) dynamics in the winter zooplankton size distribution and species composition obtained from a so far unconsidered data series taken in the southern North Sea

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Summary

Zooplankton forms the key linkage between primary production and upper trophic levels. The energy flow through zooplankton strongly depends on size as often relatively fixed predator-prey size relations can be observed. Understanding the factors that influence secondary production are therefore crucial for understanding marine ecosystem functioning, foodweb dynamics and energy flows. Here we present a timeseries suitable for describing zooplankton dynamics (size-spectra and species composition) spanning the period from 1987 to 2013, taken from the eastern English Channel during winter. Samples were analysed using the Zooscan, giving accurate size measurements to estimate normalised biomass size spectra. The size spectra of copepods show a decline in mean size over the years, especially of smaller copepod genera. Larger size classes were dominated by shrimp and chaetognaths, whereas smaller classes mainly included copepods and zoea larvae. The obtained data and observed changes in the dominance- and size-patterns over time were discussed in the light of environmental drivers like temperature, salinity and inflow events. Future investigations will use these findings to initiate numerical models of energy flow from algae through zooplankton towards higher trophic levels like fish.

Introduction

Zooplankton system dynamics have become much better understood in the wake of regime shifts (Beaugrand 2004) and the ecosystem approach to fisheries. Although the North Sea is a prime example in this respect, there are only four local long-term datasets available and most of the zooplankton studies have either been based on local and standardized or large scale meta-analyses. Here we present a "new" long-term dataset of winter zooplankton of the south-west North Sea ranging from 1987 to 2013. . In contrast to the regularly explored spring bloom situation the winter period is generally less sampled, although it forms an important spawning period for several North Sea fish species like herring, cod, plaice or sandeel. Especially these early life stages are often influenced by bottom-up effects like match-mismatch events, which do not only include abundance, but also the right "sized" food to be available at the right time. We examined the size spectrum, of copepods in particular, and species composition to see whether there are size trends and what drives these.

Materials and Methods

Samples were taken during the annual International Herring Larvae Survey from 1987 to 2013 using a GulfIII plankton net with a mesh size of 300µm and a stored in formaldehyde. Due to the original purpose of the cruises all fish larvae and eggs had been taken out and analysed, but have not yet been included in this dataset. 1095 samples were analysed using the ZooScan and zooplankton was classified into major groups above genus level. All particles were measured for size in equivalent spherical diameter (ESD) using ImageJ software. The preliminary results presented here include 287 samples spread over 15 years.

Results and Discussion

Although only parts of the dataset are complete so far, there is a significant negative size trend regarding copepods (p<0.001, R²=0.53 excluding 2009). While the large copepod size classes, mainly consisting of the order Calanoida, do not exhibit so profound changes, the smaller copepod size classes range wider into sizes above 750 µm ESD as shown in figure 1. Preliminary results indicate that this might be an effect of increased abundance of *Temora sp*. In 2009 the major component of copepod abundance was *Temora sp*. As the sampling site had been heavily disturbed by storms during sampling, and while *Temora sp* abundance in the German Bight (Helgoland Roads Time Series, WGZE) was generally low, it remains in question whether this is a general pattern or whether there is a direct effect on the increased occurrence of that genus.
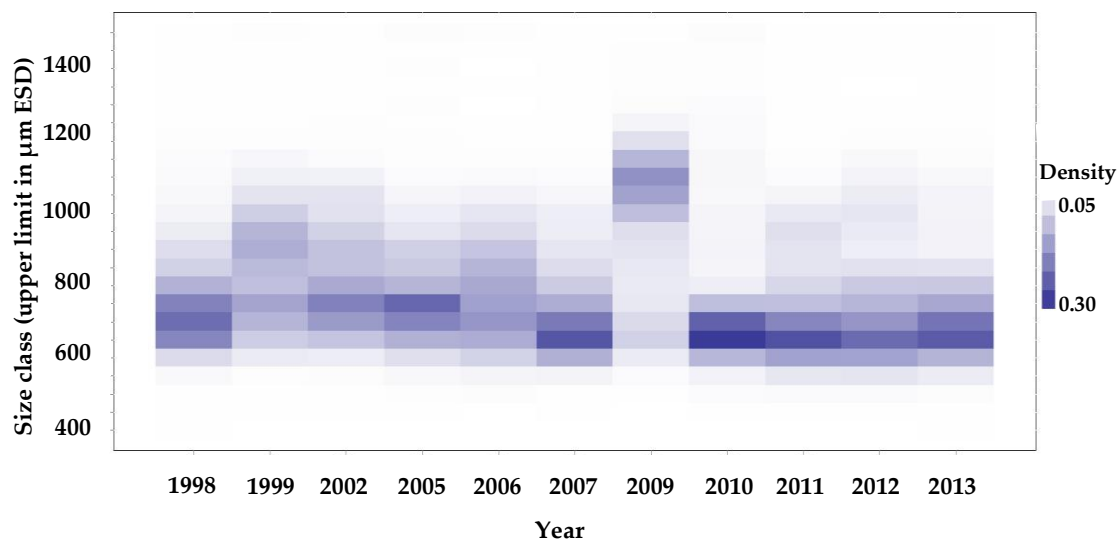

Figure 1: Relative annual copepod abundance per size class as fraction of copepod annual total abundance. Size classes range from 350µm to 1500µm, each being 50µm wide. Darker blue colour represents a larger fraction of total abundance as shown in the density scale bar.

Zooplankton species composition did not change effectively. Considering that the analyses are aimed at size spectra and the optical limitations of the ZooScan "species" composition refers to coarse groups such as copepod and chaetognaths. Further consideration is needed for the importance of chaetognaths in size classes above 2000µm ESD.

Considering the work of Beaugrand *et al.* (2000) and Alheit *et al.* (2005), the size spectra of zooplankton may also reveal correlations with the North Atlantic Oscillation index. Normalised biomass size spectra could also examine the dynamics of size versus abundance, which simple species abundance analyses would mask. Future studies will include the development of a size spectrum model of zooplankton, which will investigate the trophic dynamics of the southern North Sea.

References

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