Biodiversity hot spots and gradients on a summer transect across the North Sea

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Summary

In July 2014 we deployed the remotely operated towed vehicle (ROTV) Triaxus on a transect across the North Sea ranging from Helgoland (German Bight) to Stonehaven (Scotland). Physical properties, chlorophyll a, zooplankton, fish, bird and marine mammal diversity and abundance were monitored.
High abundance, size- and biodiversity were determined at topographic features like the outer rim of the Doggerbank. Generally higher particle densities, size diversity fish and bird abundance were observed closer to the coast and in the German Bight. Zooplankton diversity obtained from Bongo samples analyzed with a Zooscan correlated diversity determined by visual plankton counts. Particle size diversity was related to zooplankton diversity but not to higher trophic level diversity.

Introduction

Biodiversity is considered to be an indicator for the quality of a habitat or ecosystem, its stability against perturbations and its resilience capacity but significant changes in biodiversity can be expected in the future (Cheung et al., 2009). Productivity and stability of a system seems to be directly linked to biodiversity (Cusson et al. 2015, Gamfeldt et al. 2015).The latter is measured as temporal variance of species richness, total abundance and community structure. Thus, it is important to determine the actual state of a system and to identify the main drivers of biodiversity. However, monitoring whole marine ecosystem diversity would require the taxonomic classification of species of all trophic levels which expensive and time consuming while spatiotemporal resolution is usually limited. Determining easy accessible indicators of biodiversity are therefore required along with a sound understanding of which factors determine biodiversity. Here we used an ROTV to analyze spatial gradients in biodiversity across the North Sea and to test which indicators might be suitable to describe biodiversity.

Materials and Methods

The ROTV TRIAXUS (Fig. 1A) was equipped with CTD, O_2, turbidity and fluorescence sensors to measure physical properties and phytoplankton biomass. Additionally a laser optical particle counter (LOPC) and a video plankton recorder (VPR, results not shown) provided zooplankton size and species composition. The ROTV was towed with 8 kn and undulated over the whole water. An onboard deployed scientific echo sounder (EK60, SIMRAD) collected data on fish distribution. Bird and marine mammal abundances were recorded along the whole transect following an internationally standardized protocol. At 15 stations zooplankton samples (Bongo, 300 μm) were collected. The latter were analyzed by visual counting and by applying a Zooscan.

Results and Discussion

Pronounced differences in species composition and abundance were determined at the outer rim of the Dogger Bank (~6°E) and between coastal and offshore areas which is in line with Gray (1997). Biodiversity determined based on Bongo samples using the Zooscan correlated with biodiversity determined by visual counts (r^2 0.4) and both were variable along the whole transect with slightly higher values in the German Bight comparable to findings by Beaugrand et al. (2000). Particle size diversity was related to temperature diversity likely due to accumulation of small particles (high Chl-a) along the thermocline. VPR data are not available so far but will be a valuable addition for fast zooplankton diversity measurements. Although further analysis are required the results indicate that in situ methods like LOPC and VPR and semiautomatic sample analysis like Zooscan can be used to determine Zooplankton biodiversity more quickly. However, relating habitat (T, S) or lower trophic level diversity to upper trophic level diversity or productivity remains difficult.

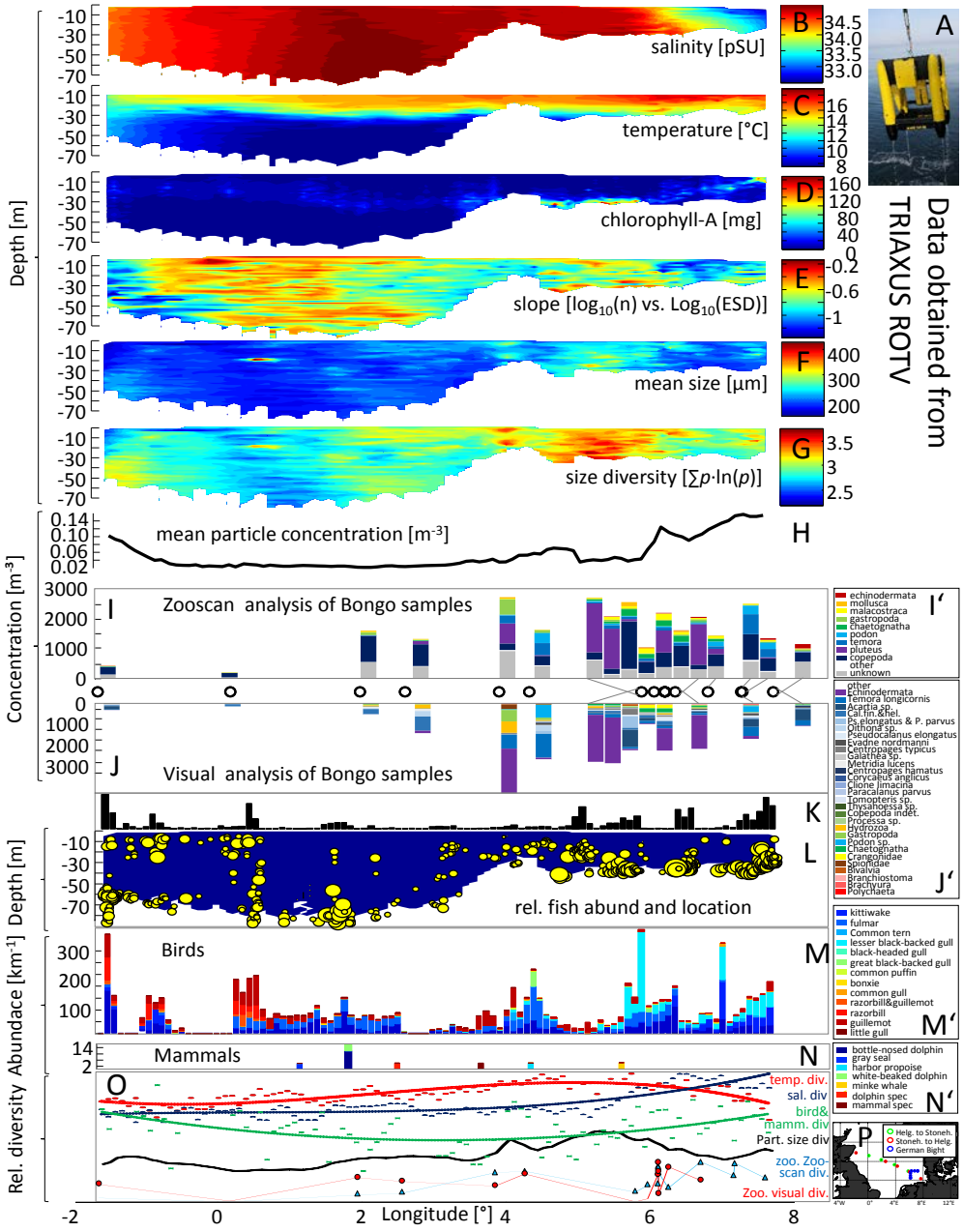

Figure 1: **A**: Image of the Triaxus ROTV used to obtain the data displayed in panel B to H. **B**: Salinity [psu] measured along the transect. **C**: Temperature [°C] D: Chlorophyll concentration [mg] **E**: Slope of double logged size spectrum of particles in the water measured with a Laser Optical Particle Counter (LOPC) covering 15 to 2000 µm ESD (Equivalent Spherical Diameter). **F**: Mean size of all particles **G**: Size diversity calculated following Shannon Wiener **H**: Mean particle concentration obtained with LOPC **I**: Results from semiautomatic Zooplankton Bongo sample analysis using Zooscan longitude of the stations are indicated by the black dots underneath and are shown in panel O. Legend is shown in I′ **J**: Results from visual zooplankton analysis based on the Bongo samples, Legend in J′. **K**: Relative Fish abundance (school counts) based on EK60 echo sounder data. **L**: Distribution of fish echos [log(NASC m²/n.mi²)]. **M**: Observed bird abundances per km. Legend in M′. **N**: Observed marine mammls per km. Legend in N′ **O**: Temperature (red), Salinity (blue), Bird & Mammal (green), Zooplankton size (black) and Zooplankton Bongo sample (blue: Zooscan, red: visual analysis) diversity following calculation method of Shannon using a natural log base. **P**: General route of the transect and location of the Bongo sampling station.

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