Development trends of marine communities in protected areas of the North Sea: baseline and tools for long-term monitoring

Michael Weinert[1], Hermann Neumann[1], Casper Kraan[1], Holger Haslob[1]

- **Mobile bottom trawling (MGF) is an anthropogenic stressor and is to be excluded from parts of the Natura 2000 sites in the German Exclusive Economic Zone.**
- **In the present project, we generate baseline data to investigate the long-term effects on the occurrence of fish and epifauna communities following the exclusion of MGF in these areas.**
- **In developing a future monitoring concept, alternative methods were additionally assessed in terms of their applicability and feasibility.**

Background and Objectives

In the German Exclusive Economic Zone (EEZ) of the North Sea, the three Natura 2000 sites Sylter Außenriff (SAR), Borkum Riffgrund (BRG), and Doggerbank (DB) are designated as protected areas under the EU Habitats Directive (FFH Directive). However, this designation does not completely exclude commercial fishing in these areas. Although the exclusion of mobile bottom trawling (MGF = Abbreviation of the German term "Mobile Grundberührende Fischerei") from large parts of the three Natura 2000 sites was planned at the start of the project, it was only implemented by the European Commission in May 2023, after the project had concluded. The MGF North Sea project examined the status of fish and epifauna communities in these areas. The objective was to estimate the long-term effects of MGF exclusion on communities and habitats in protected areas using a Before-After-Control-Impact (BACI) design. The data collected provide a scientific basis for this assessment and are intended to culminate in a monitoring concept that will enable the future evaluation of fishing exclusion measures.

Approach

At the beginning of the project, we reviewed, analyzed, and mapped the available Vessel Monitoring System (VMS) data. VMS data are part of an EU-mandatory satellite-based vessel monitoring system and must be transmitted at regular intervals by fishing vessels. This allowed us to illustrate gradients and fluctuations in fishing pressure across the three Natura 2000 sites. The data were used by all project partners to select suitable study areas. Existing datasets from long-term monitoring series, as well as data newly collected during the project, formed the basis for characterizing fish and epifauna communities in the study areas.

For the monitoring, a 3-m beam trawl (BT) was tested as an alternative to the standard 7-m BT. In particular, the catch efficiency of the two BTs was compared in terms of species composition and size distribution. Additionally, non-invasive imaging methods (video sleds, Baited Remote Underwater Video—BRUV) were employed as alternative approaches, and water samples were analyzed for environmental DNA (eDNA).
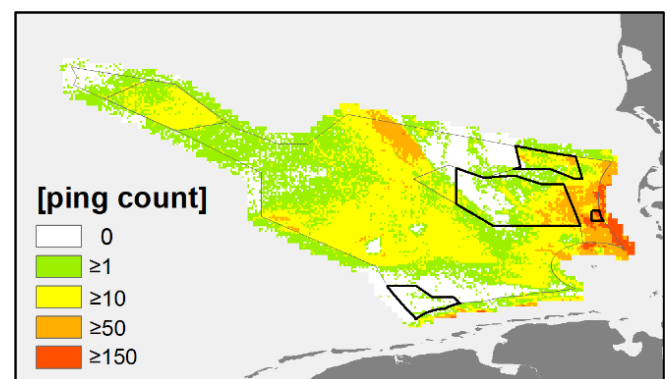

Figure 1: Spatial distribution of fishing pressure by bottom-contact gear in the German EEZ. Shown is the number of fishing events (VMS "ping counts") at a spatial resolution of 1×1 nautical mile for the period 2012–2020. The MBF exclusion areas within the Natura 2000 sites SAR and BRG are indicated by a black outline (Source: Thünen Institute / H. Neumann).

Results

The distribution of fishing pressure in the German EEZ is heterogeneous (Fig. 1). In the eastern part of the SAR, fishing pressure is highest and decreases toward the west. Shrimp fishing is prevalent in the eastern SAR, while beam trawl and otter trawl fisheries targeting flatfish and cod operate both in the western, deeper part of the SAR and on the DB. In the BRG, fishing pressure by mobile bottom-contact gear was comparatively low during the period shown.

Analysis of the long-term datasets (VMS data) revealed that the fish communities of the three Natura 2000 sites differ in terms of species composition, with the two nearshore communities in the BRG and SAR being more similar to each other than to the offshore community of the DB (Fig. 2).

Due to the size of the SAR and the resulting habitat heterogeneity, fish communities within this site also show considerable variation. For some species, a clear decrease or increase in abundance can be observed from east to west. Additionally, differences in sediment structure and depth within the SAR lead to variations in fish occurrence.

To analyze whether the functional composition of epibenthic communities changes following the exclusion of MGF, a fishery-sensitive trait index was adapted and applied. Low index values were calculated for epibenthic communities in the western SAR, in rocky areas, and in regions with high silt content in the sediment, indicating high vulnerability. For the remaining communities in the eastern and central SAR, lower vulnerability was observed (Fig. 3).
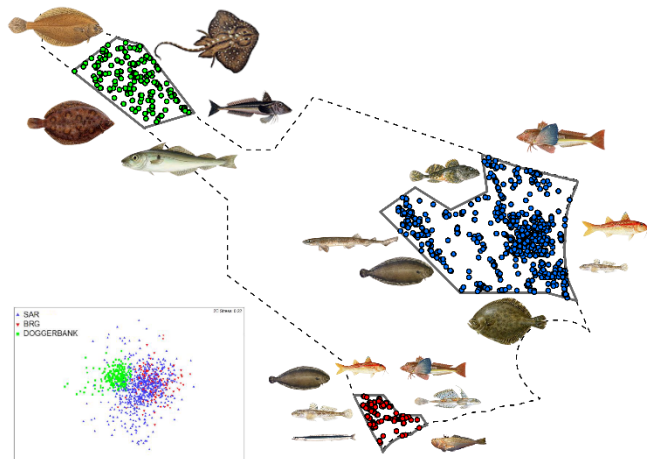

Figure 2: Multivariate analysis (inset: nMDS = non-metric multidimensional scaling) and spatial distribution of selected characteristic species for the three Natura 2000 sites DB, BRG, and SAR (Source: Thünen Institute / H. Haslob).

When testing alternative catch and monitoring methods, both beam trawls tested showed good agreement in terms of the biodiversity of fish and epibenthic communities. However, notable differences were observed in the fish length distributions.
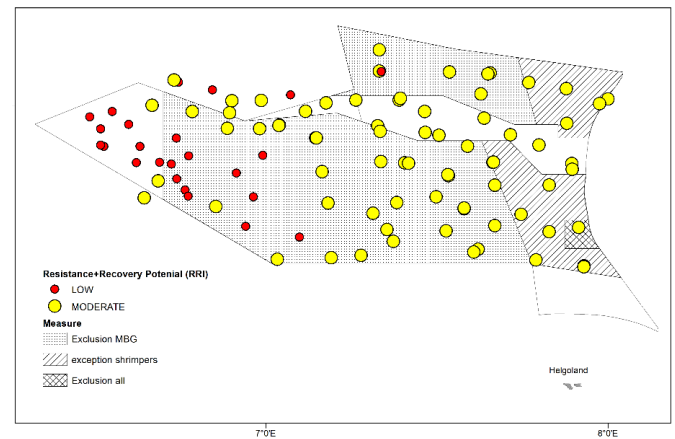

Figure 3: Values of the fishery-sensitive trait index for the epibenthic communities in the SAR. Red dots = low index (high vulnerability), yellow dots = moderate index (moderate vulnerability) - (Source: Thünen Institute / H. Neumann).

Conclusions

The MGF North Sea project collected valuable baseline data on fish and epibenthic communities in the three Natura 2000 sites within the German North Sea EEZ. The fishery-sensitive trait index indicates low to moderate values for the epibenthic communities in the SAR. Future studies using this index are intended to determine whether the functional composition of species communities in these areas shifts toward more sensitive communities following the exclusion of MGF.

The small sample size and the observed differences make further parallel sampling necessary. This is intended to determine whether the 3-m beam trawl, which has less impact on the seabed, can be used as a standard tool in future monitoring. The use of the video sled worked well and provided usable footage for habitat characterization and for less mobile epibenthic organisms. However, manual video analysis is still very time-consuming and therefore not a short-term option for non-invasive monitoring. In a second project phase, automated analysis of the video material will be advanced in collaboration with project partners. Compared to conventional methods, eDNA analyses have already shown promising results regarding species composition.