Project *brief*

Thünen Institute of Fisheries Ecology 2025/08a

PFAS FISCH – Per- and Polyfluoroalkyl Substances (PFAS) in Fish from German Coastal Areas

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- **PFAS contents and profiles of dab from the German Bight showed clear regional differences.**
- **Of the PFAS analysed, perfluorooctane sulfonate (PFOS) was the dominant substance in terms of quantity in all samples.**
- **Some of the limits for fish as food were exceeded. However, environmental limits are not exceeded.**
- **Statistical analysis of PFAS patterns indicates different sources of individual PFAS.**

Background and objectives

Per- and polyfluorinated alkyl substances (PFAS) are a group of anthropogenic chemicals that are widely used in a variety of industrial and commercial applications. These substances are extremely persistent, bioaccumulative and potentially toxic, which can lead to environmental and health problems. PFAS are therefore regularly monitored in the European Marine Environmental Monitoring Programme (Marine Strategy Framework Directive, MSFD). Unfortunately, the data situation for fish is still incomplete and PFAS in fish from the North Sea EEZ was not assessed in the last status report (BMUV, 2024). This gap was closed with the "PFAS FISCH" project.
In the project, the PFAS range was expanded from two to eight substances, enabling pattern analyses for the first time. Fish from coastal regions were also included.
The data collected is available for environmental assessment by BLANO and the Specialist Working Group on Pollutants and Biological Effects.

Material and methods

There were 105 fish of the flatfish species dab (Limanda limanda) available, which were caught on various trips with research vessels in 2023. These were fish from the German EEZ from stations GB4, GB3 and N01, as well as from German coastal waters from stations GB1, WesMün, NornN and Bork (Fig. 1). Fish from the latter three stations originate from the CONMAR research project and were caught in the vicinity of munitions dumping areas. 15 individuals from each of the seven stations were analysed for their PFAS levels.
The PFAS analysed were: perfluorooctane sulfonate (PFOS) branched and unbranched, perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorotridecanoic acid (PFTrDA) and perfluorotetradecanoic acid (PFTeDA). Fish muscle samples were extracted with water/acetonitrile and purified by solid phase extraction. The extracts were identified using high-resolution chromatography (LC-MS/MS) and quantified using isotope-labelled standards.

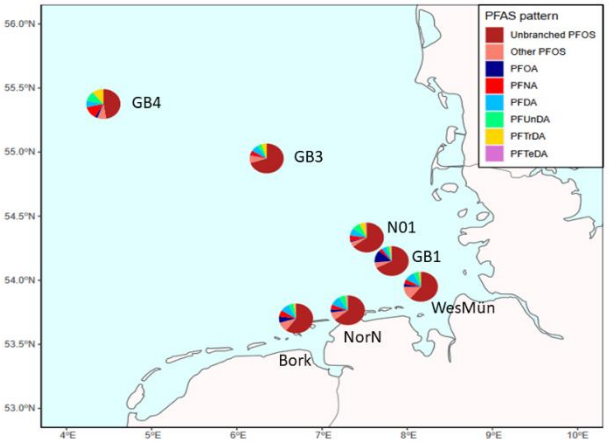

Figure 1: PFAS analysed as relative patterns in muscle tissue of dab (*Limanda limanda*) from different catch locations in the German Bight (© Thünen Institute).

Results

Between two and eight PFAS were detected in the samples analysed. The highest concentrations were found for µg/kg. Several measured values were below the detection limits, which were between 0.02 and 0.06 µg/kg depending on the substance.unbranched PFOS - up to a maximum value of 3.75 µg/kg in a fish from GB1. The sum of all PFAS reached values of up to 4.81
As expected, PFAS concentrations were lowest at station GB4 far from the coast, but fish from the western station Bork also showed low PFAS levels. Stations GB1 and N01 showed the highest mean PFOS levels (Fig. 2). PFOA was highest in GB1. All other PFAS concentrations were highest on average in N01.

A statistical analysis using principal component analysis (Fig. 3) shows that two stations differ in their PFAS concentration: GB1 is characterised by higher PFOA concentrations and N01 shows high levels for the other PFAS.

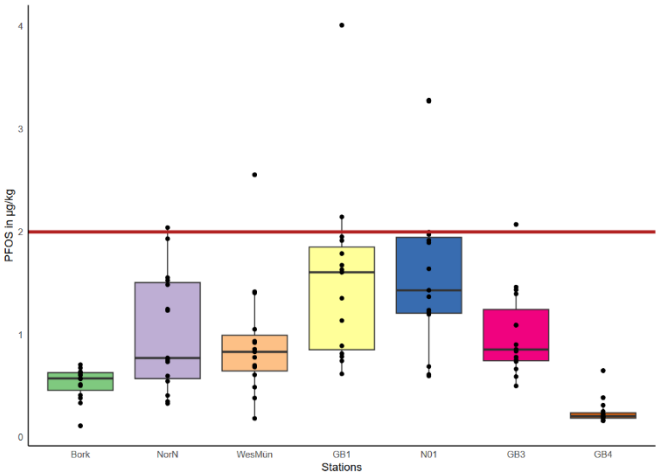

Figure 2: Perfluorooctane sulfonate (PFOS), unbranched as individual values (points) and in the boxplot (median, 25% and 27% percentiles, range without outliers) in dab (*Limanda limanda*) from various stations (see Fig. 1) in µg/kg. Horizontal red line: Food limit of 2 µg/kg for fish according to the EU (2023) (© Thünen Institute).

Discussion

With the new measured values for fish from EEZ and coastal waters, the assessment of good environmental status can be improved in future in accordance with the requirements of the MSFD. The environmental limit value of 9.1 µg/kg PFOS (OGew, 2016) used in the last status report (BMUV, 2024) was not exceeded in any of the samples analysed. However, the lower limit value for the food product fish of 2.0 µg/kg PFOS in muscle meat (EU, 2023) was exceeded by a total of six of the fish analysed. All fish from GB1 showed concentrations above the food limit of 0.20 µg/kg PFOA. These results clearly show that PFAS contamination in fish from German marine areas is of great relevance for the environment and consumers.
The pattern analysis in Fig. 3 provided indications of deviating sources of PFOA in GB1. This high contamination should be checked together with the results from N01 and investigated further if necessary. Expanding future analyses to include more PFAS substances and other fish species would further improve the results. The results from the EEZ stations are transmitted to the corresponding database and incorporated into the next MSRL assessment cycle.

Conclusion

The monitoring of environmental contaminants from the PFAS group is of particular importance for environmental assessment and for consumers. Our results show that food limits are partially exceeded and that regional differences in PFAS distribution indicate different sources.

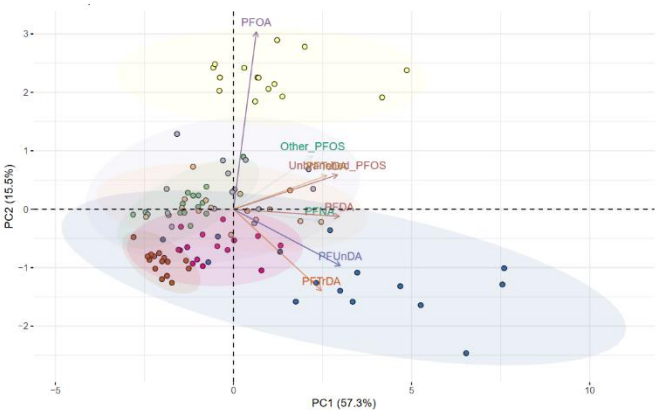

Figure 3: Principal component analysis of PFAS patterns from dab (*Limanda limanda*) in the German Bight. Dots indicate individual fish from the stations (yellow: GB1; purple: NorN; orange: Wesmün; brown: GB4; pink: GB3; blue: N01, green: Bork; see Fig. 1). Arrows: PFAS in the factor space (© Thünen Institute).

Literature

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Further information

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