

Spatio-temporal variability of per- and polyfluoroalkyl substances (PFAS) in the Baltic Sea

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We present data on PFAS from the Swedish Monitoring Program for Contaminants in Marine Biota covering 40 years and 27 coastal and offshore stations spanning from the Northern Baltic Sea (the enclosed river-impacted Bothnian Bay) to Skagerrak (that exchanges water with the North Sea; Figure 1). PFAS were analyzed in four fish and three bird species. Observations from other studies on river, marine surface water, sediment, and top predators are also included in the analysis. Target compounds were perfluoroalkyl sulfonic acids (PFSA; C4, C6, C8), perfluoroalkyl carboxylic acids (PFCA; C6-C15) and FOSA. Geographical patterns along the Baltic Sea salinity gradient as well as time series change points were investigated.

After an initial exponential increase in PFAS concentrations, we found that PFAS displayed a rapid response to phase-out and regulations in the early 2000s. As a result, PFAS concentrations stabilized (rather than displaying an immediate decrease). This is linked to few removal pathways of the long-lived PFAS homologues in the Baltic Sea water column. However, in the last decade PFAS displayed significant declines at many stations, the exception being a few PFAS homologues (PFOA (C8) and PFNA (C9)).

PFAS concentrations and homologue distribution in fish differ geographically at present day. We use historic herring observations (1990-2019) to show that the differences have existed for the past three decades. However, the geographical pattern for PFAS in present day surface water does not match the fish. We determined that two different water masses influence the fish PFAS concentration, North Sea (saline) water and Baltic Sea (brackish) water. This affects the PFAS concentration, and FOSA:PFOS and *n*-FOSA:*b*-FOSA ratios. Due to inflow of North Sea water below outflowing Baltic Sea water, the signature of North Sea water only manifest itself in fish in Skagerrak/Kattegat and is not observed in any surface waters. Different lifetime of water masses in the northern and southern parts of the Baltic Sea further affect the concentration and response time with regards to changes in external sources for individual homologues. These and other results will be discussed.

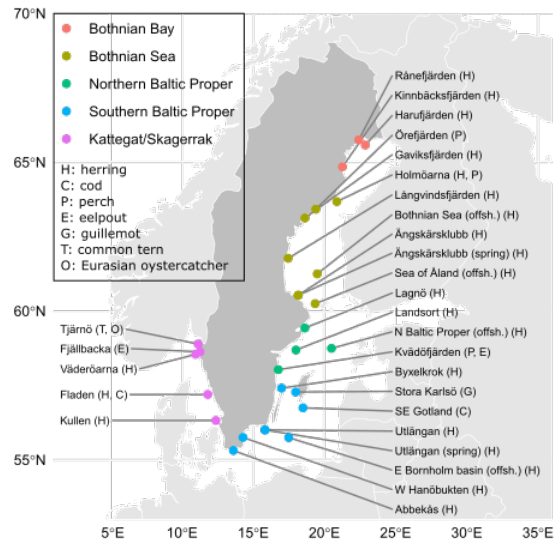


Figure 1. Sampling sites within the Swedish National Monitoring Programme for Contaminants in marine biota