



Status and Trends in the Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in Sediment



MSFD Descriptor: 8 - Concentration of contaminants

MSFD Criteria: 8.1 - Concentration of contaminants

Key Message Mean concentrations of polycyclic aromatic hydrocarbons (PAHs) in sediment are below levels likely to harm marine species in the areas assessed, but are above natural background concentrations in four of the six areas assessed. Mean concentrations show no statistically significant change in four areas and are decreasing in two

Background

Polycyclic aromatic hydrocarbons (PAHs) are natural components of coal and oil, and are also formed during the combustion of fossil fuels and organic material. PAHs also occur as a result of natural processes such as forest fires. PAHs enter the marine environment through atmospheric deposition, road run-off, industrial discharges and oil spills. PAHs in the marine environment often end up in marine sediment, where they can become trapped in lower layers unless the sediments are disturbed. Associations have been demonstrated between the incidence of some diseases in flatfish and the concentrations of PAHs in the sediment over which they live and feed.

The OSPAR Hazardous Substances Strategy has the ultimate aim of achieving concentrations in the marine environment near natural background values for naturally occurring substances and close to zero for man-made synthetic substances. Due to their persistence in the marine environment, their potential to bioaccumulate and their toxicity, analyses of PAH concentrations in sediment and shellfish is reported in the OSPAR Coordinated Environmental Monitoring Programme (CEMP). Monitoring PAHs in sediment across the OSPAR Maritime Area began between 1995 and 1999.

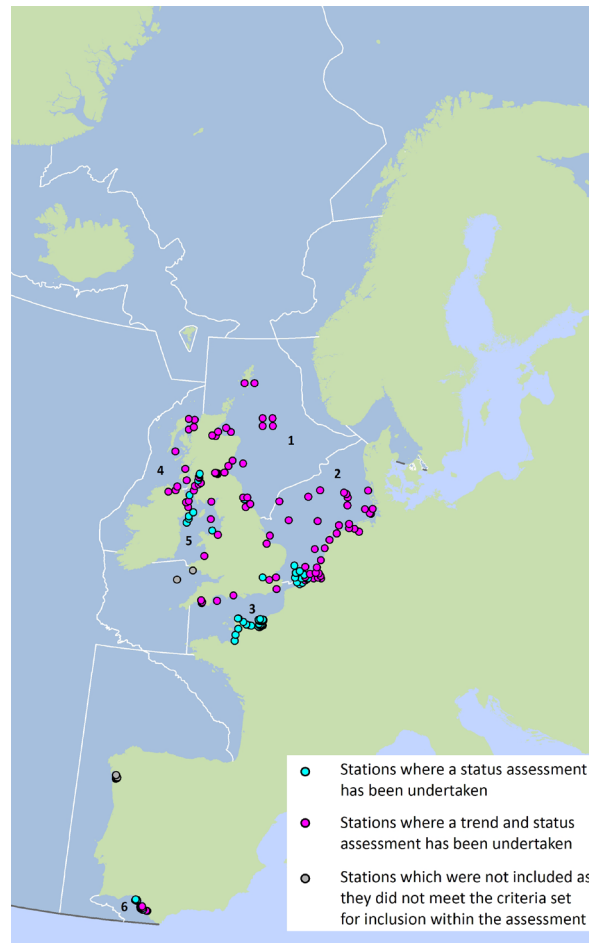


Figure 1: Monitoring sites used to assess PAH concentrations in sediment by OSPAR contaminants assessment area (white lines) determined by hydrogeographic principles and expert knowledge, not OSPAR internal boundaries.

Results

Polycyclic aromatic hydrocarbon (PAH) concentrations were measured in sediment samples collected between 1995 and 2015 from monitoring sites throughout much of the Greater North Sea, Celtic Seas, and Bay of Biscay and Iberian Coast (Figure 1), at frequencies ranging from annually to every five years.

The number of monitoring sites varied widely between OSPAR regions and sub-regions, with the Greater North Sea having the most. Only OSPAR sub-regions with at least three monitoring sites and a reasonable geographic spread were included in the sub-regional assessment of status and temporal trends.

PAH concentrations were compared against two assessment criteria: the OSPAR Background Assessment Concentration (BAC) and the United States Environmental Protection Agency's Effects-Range Low (ERL). Adverse effects on marine organisms are rarely observed when concentrations are below the ERL value.

Mean PAH concentrations in sediment are statistically significantly below the ERL in all OSPAR sub-regions (Figure 2). Therefore adverse biological effects in marine species are unlikely. Concentrations are lowest in the Gulf of Cadiz and in the Irish and Scottish West Coast sediments and are at background (i.e. statistically significantly below the BAC). In the other four sub-regions mean concentrations are below the ERL but not statistically significantly below the BAC (Figure 2).

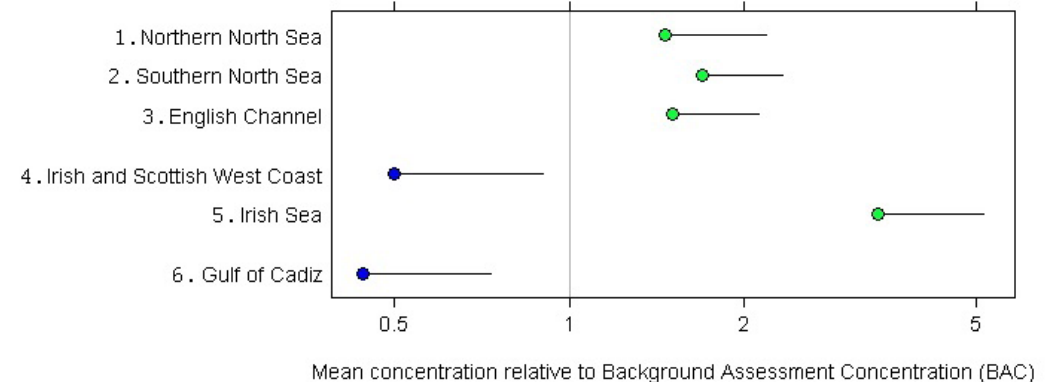


Figure 2: Mean PAH concentration in sediment in each OSPAR sub-region relative to the Effects Range-Low (ERL) (with 95% upper confidence limits), where value of 1 means that the mean concentration equals the ERL. Blue: the mean concentration is statistically significantly ($p < 0.05$) below the Background Assessment Concentration (BAC) and the ERL. Green: mean concentration is statistically significantly below the ERL but not statistically significantly below the BAC

Results cont...

Temporal trends in the PAH concentrations in sediment were assessed for the period between the earliest monitoring date (1995 to 1999) and 2014. PAHs in sediment were assessed in six OSPAR sub-regions where there were at least five years of data (**Figure 3**). PAH concentrations are decreasing in the Gulf of Cadiz and the English Channel. In the other four assessed sub-regions concentrations show no statistically significant trend.

There is high confidence in the assessment and sampling methodology and high confidence in the data used.

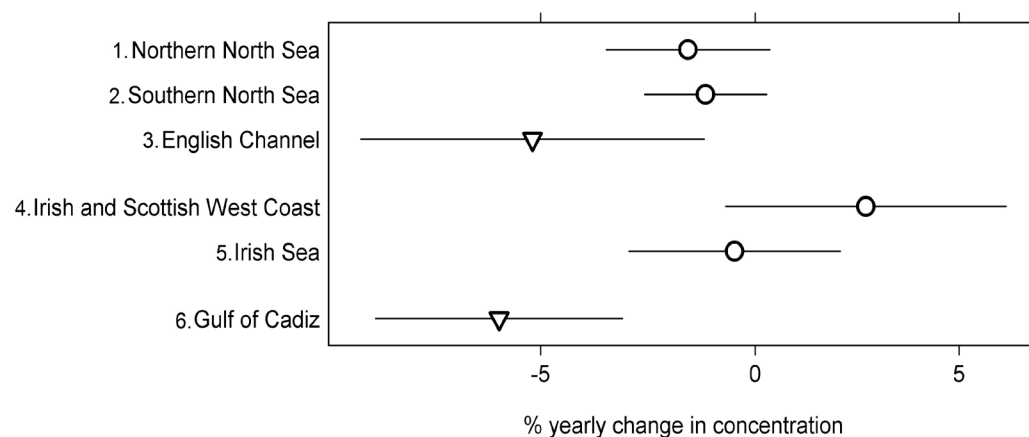


Figure 3: Percentage yearly change in PAH concentrations in each OSPAR sub-region. Statistically significant ($p < 0.05$) downward temporal trends (downward triangle), no statistically significant ($p < 0.05$) change (circle). 95% confidence limits (lines)

Conclusion

Mean polycyclic aromatic hydrocarbon (PAH) concentrations in sediment were at background levels in two of the six assessed OSPAR sub-regions. Mean PAH concentrations were below the Effects-Range Low (ERL) in all OSPAR sub-regions and therefore are unlikely to cause adverse effects in marine organisms.

However, PAH concentrations in sediment need to be kept under surveillance, because in four sub-regions concentrations are above background levels. Concentrations show no statistically significant trend in four areas, and are in decline only in the English Channel and Gulf of Cadiz.

Whilst PAHs originate from natural sources and so will always be present in the marine environment, better use of emission control technology in combustion processes could improve the situation further and reduce concentrations to natural levels.

Knowledge Gaps

There is a lack of monitoring data for polycyclic aromatic hydrocarbons (PAHs) in sediment, particularly for Arctic Waters and some parts of the Greater North Sea, Celtic Seas, and Bay of Biscay and Iberian Coast. Cooperation between OSPAR and the Arctic Monitoring and Assessment Programme (AMAP) would improve access to data for Arctic Waters.

The Effects-Range Low (ERL) developed by the United States Environmental Protection Agency was used in the assessment because there are no OSPAR Environmental Assessment Criteria (EACs) currently available. There is a need for EACs to be developed for both alkylated and parent PAH in sediment.



Image: Oil rig – Polycyclic aromatic hydrocarbons (PAHs) can enter the marine environment via industrial discharges and as a result of oil spills © Justin Gwynn

Inset: Sediment grab - Polycyclic aromatic hydrocarbons (PAHs) can accumulate in marine sediments © Marine Scotland Science