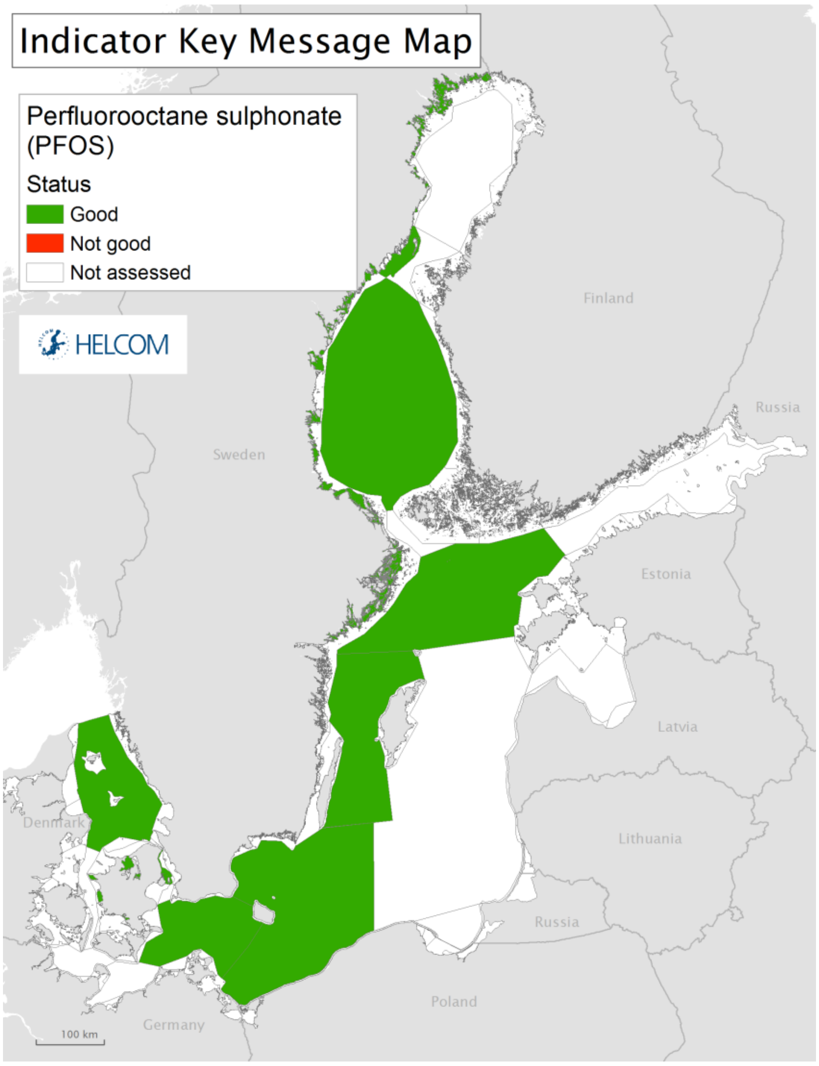
HELCOM INDICATORS

HELCOM core indicator report
July 2017

Perfluorooctane sulphonate (PFOS)

Key Message

This core indicator evaluates the status of the marine environment based on concentrations of perfluorooctane sulphonate (PFOS) in Baltic Sea fish. Good status is achieved when the concentrations of PFOS are below the threshold value. The current evaluation considers the assessment period 2011-2015.



Key message figure 1: Status assessment results based on evaluation of the indicator 'perfluorooctane sulphonate (PFOS)'. The assessment is carried out using scale 4 HELCOM assessment units (defined in the [HELCOM Monitoring and Assessment Strategy Annex 4](#)) based on data from stations where 3 or more years of data are available.

Good status is achieved for all evaluated areas using all available data up until 2015 to evaluate the assessment period 2011-2015. At present, data are only available from Denmark and Sweden, and there are areas where data are absent, therefore, extended monitoring is required to enable status evaluation throughout the Baltic Sea. Additional data exist from Finland, however with less than 3 years from each station which is required to be included in the aggregated assessment (Key message figure 1.). The ambition is to develop a method to include this type of data with lower uncertainty due to only a few years of monitoring in the coming update of the indicator. Poland experienced data reporting issues which are to be fixed when the report is updated in June 2018.

Time series of PFOS levels in biota show increasing concentrations since the 1970s and 1980s in Baltic Proper and Bothnian Sea. However, in the most recent ten-year period downward trends of PFOS concentrations are observed in the Baltic Sea.

Confidence of the indicator evaluation results is considered to be **high** for those areas for which data are available.

The indicator is applicable in the waters of all the countries bordering the Baltic Sea.

Relevance of the core indicator

PFOS is a persistent, bioaccumulative and toxic compound with possible effects on the immune, reproductive and developmental systems as well as lipid metabolism in organisms. It is considered a global environmental contaminant. PFOS has been produced since the 1950s, and has been used for production of fluoropolymers and used commercially to provide grease, oil and water resistance to materials such as textiles, carpets, paper and coatings in general. PFOS has also been used widely in firefighting foams.

The presence of PFOS in biological samples provides information on the contaminant load of the Baltic Sea and reflects the bioavailable part of the contaminant. (Top) predators and humans are exposed to the contaminant through consumption of the species assessed in this indicator.

Policy relevance of the core indicator

	BSAP segment and objectives	MSFD Descriptor and criteria
Primary link	Hazardous substances • Concentrations of hazardous substances close to natural levels	D8 Concentrations of contaminants D8C1 Within coastal and territorial and beyond territorial waters, the concentration of contaminants do not exceed the threshold values.
Secondary link	Hazardous substances • Fish safe to eat	D9 Contaminants in fish and seafood D9C1 The level of contaminants in edible tissues (muscle, liver, roe, flesh or other soft parts, as appropriate) of seafood (including fish, crustaceans, molluscs, echinoderms, seaweed and other marine plants) caught or harvested in the wild (excluding fin-fish from mariculture) does not exceed the threshold values
Other relevant legislation: The Water Framework Directive and EC regulation No 850/2004 (and its following amendments) and the Stockholm Convention on Persistent Organic Pollutants.		

Cite this indicator

HELCOM (2017) Perfluorooctane sulphonate (PFOS). HELCOM Core Indicator Report. Online. [Date Viewed], [Web link].

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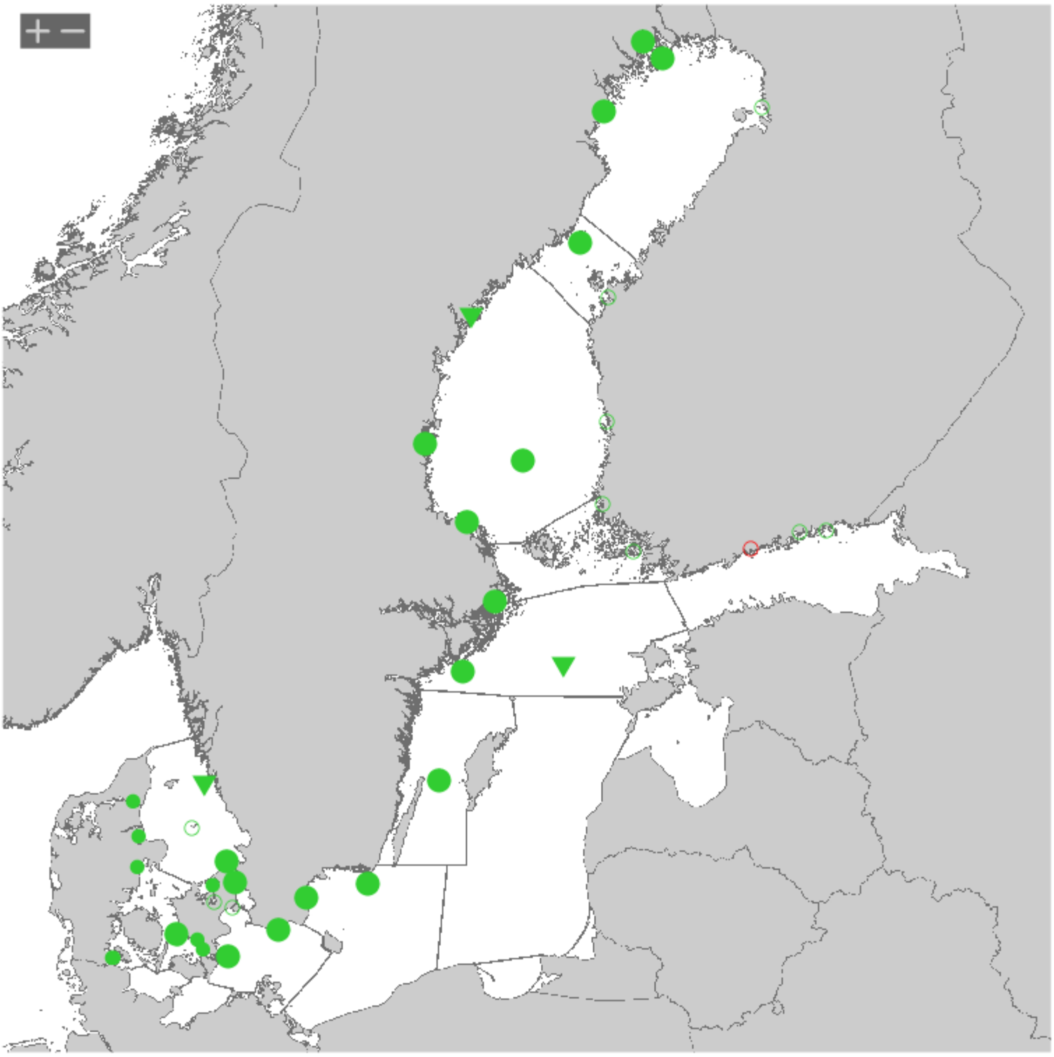
Results and Confidence

All evaluated assessment units achieved good status during the period 2011-2015 since the average concentration of PFOS in sampled fish was below the threshold value (Key message figure 1). The threshold value is set to 9.1 µg/kg wet weight (or 9.1 ng/g ww) with the protection goal of human health.

There are currently areas in the Baltic Sea that are not covered by any PFOS monitoring (Results figure 1). The eastern part of the Baltic Sea and the eastern coastline (with the exception of the Gulf of Finland) lack reported PFOS concentrations. There are also areas where there is not enough data to make a full status assessment (only 1-2 years), based on robust statistical methods. Thus increased monitoring is needed to enable a status evaluation for the entire Baltic Sea. The lowest concentrations (0.074 ng/g ww muscle) are observed in eelpout from the Great Belt and the highest concentration in perch from the Gulf of Finland (11.8 ng/g ww muscle).

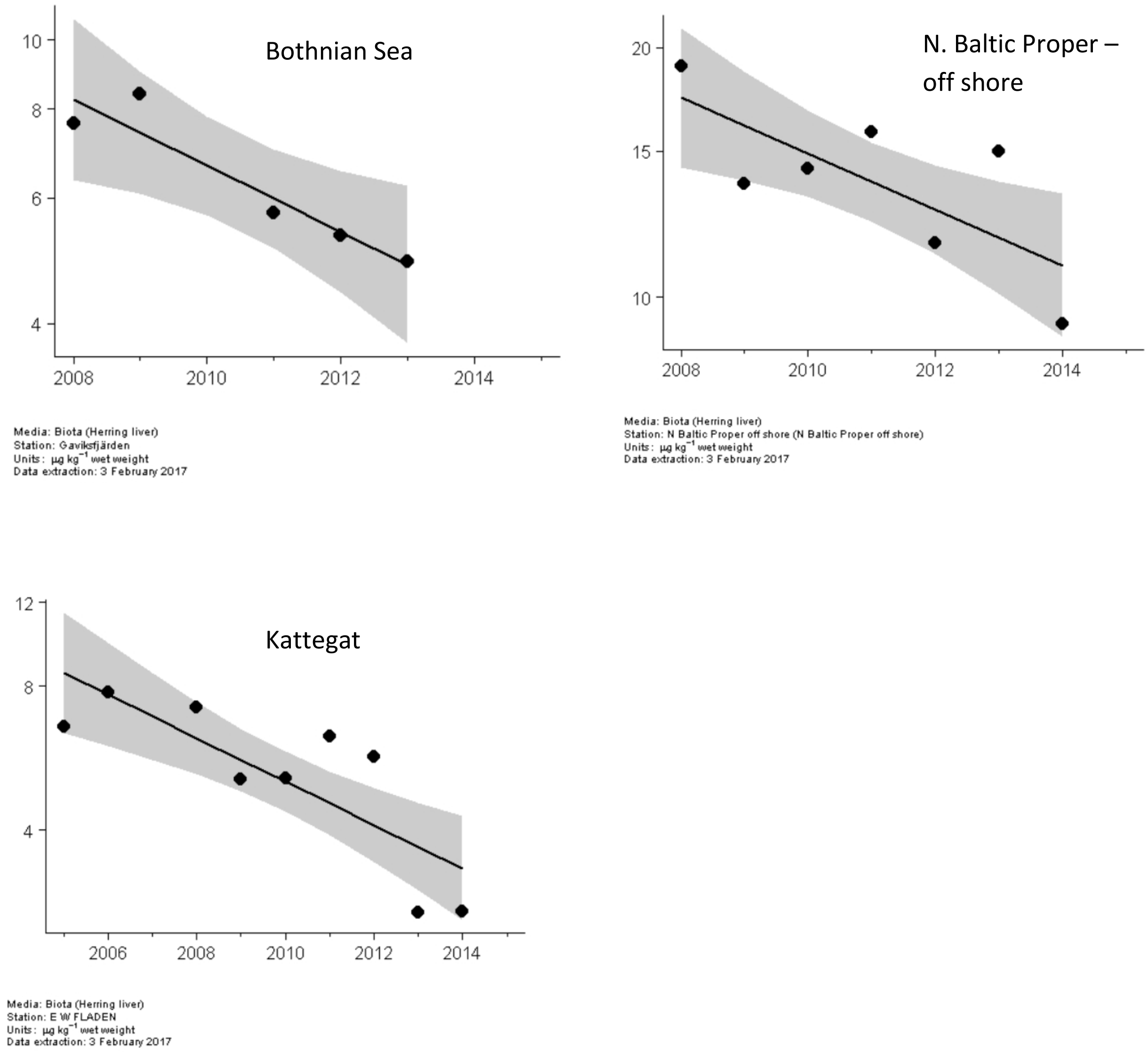


Results figure 1. Spatial distribution of PFOS monitoring stations for fish. Green colour indicates that the measured concentrations are below the threshold value and red colour that the station is above. Small open circles indicate an informal status assessment with only 1-2 years of data, small filled circles indicate that there is not enough data to assess a trend, large filled circles that there is no significant trend in concentration during the whole monitoring period and the filled arrow that there is an upward or downward trend during the monitoring period.

It is important to be aware that the results used for this core indicator are mainly (but not completely) based on fish from stations considered as reference stations with no local pollution. There are most likely local areas within the Baltic Sea where the pollution load of PFOS is higher than presented in the evaluation outcome of this indicator.

Evaluation of temporal trends

Increasing PFOS concentrations have been shown in biota time trend series starting at the 1970s and 1980s (Bignert et al. 2017). However, downward trends are seen in herring from the Bothnian Sea, the offshore station in the Northern Baltic Proper and in Kattegat in the more recent time period (Results figure 2).



Results figure 2. Temporal trend of PFOS concentration (ng/g wet weight) in herring liver from the Bothnian Sea, the off shore station in the Northern Baltic Proper and in Kattegat (HQS – threshold level, grey colour- confidence level 95% range (see Assessment protocol)) [source: http://dome.ices.dk/HELCOMHZ2016/main.html].

Confidence of the indicator status evaluation

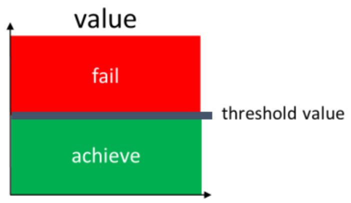
The geographical resolution for the coverage of the whole Baltic Sea is low. No detailed geographical studies to investigate the variability have yet been carried out. The conversion of PFOS concentrations in liver to muscle values introduce uncertainties into the status evaluation. In addition, the trophic level of the fish used for monitoring (predominantly herring, which has a trophic level of approximately 3 in the Baltic Sea) is lower than recommended for the threshold value, thus leading to possible underestimations in relation to the threshold value.

With the uncertainties and low geographical coverage taken into account, but with values considerably lower than the threshold value, the confidence in the evaluation of the aggregated assessment units is considered to be high.

Good Environmental Status

Good status is achieved when the concentration of perfluorooctane sulphonate (PFOS) in fish muscle is below 9.1 µg/ kg fish wet weight (Good environmental status figure 1).

The threshold value is an environmental quality standard (EQS), derived at EU level as a substance included on the list of priority substances under the Water Framework Directive (European Commission 2000, 2013). GES, in accordance with the MSFD is defined as 'concentrations of contaminants at levels not giving rise to pollution effects'.



Good environmental status figure 1. Good status is achieved if the concentration of PFOS is below the threshold value of 9.1 µg/ kg fish wet weight. The threshold value is an environmental quality standard (EQS) derived at EU level as a substance included on the list of priority substances under the Water Framework Directive.

EQS are derived from ecotoxicological studies to protect freshwater and marine ecosystems from potential adverse effects of chemicals, as well as adverse effects on human health via drinking water and food from aquatic environments. Quality Standards (QS) are derived for different protection goals, i.e.: pelagic and benthic communities, top-predators in these ecosystems, and human health. The most stringent of these QS is the basis for the EQS. The EQS boundary for PFOS is based on the QS set for biota to protect human health (9.1 µg/ kg fish ww), defined for edible parts in fish.

For harmonization purposes the EC Guidance Document No. 32 on biota monitoring (the implementation of EQS_{biota}) under the WFD was developed (European Commission 2014). This guidance document recommends that the results from the monitoring should be standardized to represent fish at a trophic level of 4, which is an estimate of the general trophic level in commercial fish in Europe. The recommendation to obtain PFOS data in fish at a trophic level of 4 is to adjust the values from monitoring in accordance with trophic magnification factors and trophic level.

An alternative, secondary threshold value at 0.00047 µg/l is set for water. It is derived within the EQS process by using a bioconcentration factor and biomagnification factor for PFOS and represents the corresponding water concentration to the selected QS biota, secondary poisoning (PFOS EQS dossier, 2011). The secondary threshold value should only be used when it is not possible to evaluate an area using the primary biota-based threshold value.

Article 3 of the EU Directive on environmental quality standards (EQSD) states that also long-term temporal trends should be assessed for substances that accumulate in sediment and/or biota, such as PFOS (European Commission 2008a). A trend indicates if the status of the environment is improving and approaching the threshold value or if the status is deteriorating.

Assessment Protocol

Data processing

Since the threshold value is defined with the protection goal to prevent adverse effects on human health via consumption of fishery products, and human fish consumption is mainly focused on muscle fillet of fish, the status evaluation is calculated based on PFOS concentrations in fish muscle. The data may require transformation into the relevant unit and base for the threshold value which is µg/kg wet weight.

Ideally, the data should be expressed in the same matrix, which for the purposes of the indicator evaluation ought to be muscle fillet concentrations in fish, representing a trophic level of 4 (European Commission 2014). However, the majority of the PFOS data reported are analysed in liver tissue in different fish species at varying trophic levels. The PFOS concentration values are originally measured in fish liver and then recalculated to concentrations in muscle.

In the present indicator report, conversion from PFOS concentrations in liver to PFOS concentrations in muscle was done by the use of conversion factors generated in a study, based on Swedish national monitoring, comparing muscle and liver concentrations (Faxneld et al. 2014). The conversion was performed with the use of the general conversion factors for 'all species' (liver:muscle ratio: 17:9).

Assessment protocol table 1. Mean liver:muscle ratios for PFOS with 95% confidence intervals within parentheses. The column indicated "all species" includes herring, perch (marine and limnic), eelpout, pike, arctic char and cod. Data taken from (Faxneld et al. 2014).

	All species	**Herring**	**Perch**	**Eelpout**
PFOS	17:9 (16-20)	19:0 (17-21)	18:2 (16-20)	11.1 (6.0-16)

The use of liver values would lead to an overestimation of PFOS concentrations in relation to the threshold value since PFOS is reported by several studies to accumulate in protein rich tissue, with liver being one of the tissues where the highest concentrations are found (Goeritz et al. 2013; Shi et al. 2012). However, it is of great importance to be aware of the uncertainties introduced to the results in the conversion procedure.

Additionally, no correction for trophic level has been made. The monitored species are at a lower trophic level than the general trophic level estimated for commercial fish and suggested by the EC Guidance Document No. 32 (European Commission 2013), implying a risk of underestimation of the concentrations, since PFOS biomagnifies in the food web. The information on trophic level, are lacking for the reported results and a proper trophic magnification factor (TMF) has not been agreed upon yet. It is therefore presently not possible to translate the results to the recommended trophic level 4 for the status evaluation. The results should therefore be considered tentative at this time.

More studies on relations between liver, muscle and whole body concentrations of PFOS in relevant Baltic Sea fish species are needed in order to improve the comparisons to the threshold value.

Statistical evaluation

[***Assessment methodology for contaminants in biota, sediment and water***]

The assessment protocol is structured in three main parts, 1) changes in log concentrations over time are modelled, 2) check for compliance against threshold value and evidence for temporal change of contaminant concentration per station and 3) a spatial aggregation of status per assessment unit.

It should be noted that the assessment protocol makes the assumption that monitoring data stems from the same monitoring stations during consecutive years. The stations used by the protocol are defined in the ICES Station Dictionary. Stations with similar station name are grouped together, but it is also possible to define a group of stations with different names to be defined as the same station in the Station Dictionary. Usually a station is defined in the Station Dictionary with coordinates and a valid box around these coordinates, but coordinates outside of the box will only give a warning when reporting the data, and are not used in the actual data extraction.

Overview

Time series of contaminant concentrations are assessed in three stages:

1. For sediment, the concentrations are normalised prior to the assessment to account for changes in the bulk physical composition of the sediment such as particle size distribution or organic carbon content. The concentrations are log transformed and changes in the log concentrations over time are modelled using linear mixed models. The type of temporal change that is considered depends on the number of years of data:
    1. 1-2 years: no model is fitted because there are insufficient data
    2. 3-4 years: concentrations are assumed to be stable over time and the mean log concentration is estimated
    3. 5-6 years: a linear trend in log concentration is fitted
    4. 7+ years: more complex (smooth) patterns of change over time are modelled
2. The fitted models are used to assess status against available threshold value and evidence of temporal change in contaminant levels in the last twenty years
3. The fitted models are also used for spatial aggregation to assess status against available threshold value and evidence of temporal change in contaminant levels on a scale 4 level HELCOM assessment unit.

These stages are described in more detail below. There is also information on how the methodology is adapted when there are 'less-than' measurements, i.e. some concentrations are reported as below the detection limit, and missing uncertainties, i.e. the analytical variability associated with some of the concentration measurements was not reported.

Assessment units

PFOS is considered as a global environmental chemical, widely spread in biological samples and even present in samples from as remote places such as the Arctic region. The PFOS core indicator is therefore relevant for the whole Baltic Sea and can theoretically be applied in all regions.

The core indicator evaluates the status with regard to concentration of PFOS using HELCOM assessment unit scale 4 (division of the Baltic Sea into 17 sub-basins and further division into coastal and offshore areas and division of the coastal areas by WFD water types or water bodies). This division is applied in order to take into account the different routes by which PFOS enters the Baltic Sea - via air and via run-off from land, including also potential point sources.

The assessment units are defined in the HELCOM Monitoring and Assessment Strategy Annex 4.

Relevance of the Indicator

Hazardous substances assessment

The status of the Baltic Sea marine environment in terms of contamination by hazardous substances is assessed using several core indicators. Each indicator focuses on one important aspect of the complex issue. In addition to providing an indicator-based evaluation of the status of the Baltic Sea in terms of concentrations of perfluorooctane sulphonate (PFOS) in the marine environment, this indicator along with the other hazardous substances core indicators are used to achieve an overall assessment of hazardous substances.

Policy relevance

The core indicator on PFOS concentrations addresses the Baltic Sea Action Plan's (BSAP) hazardous substances segment's ecological objectives 'Concentrations of hazardous substances close to natural levels' and 'All fish safe to eat'.

The core indicator is relevant to the following specific BSAP commitment:

- 'Agree to start by 2008 to work for strict restrictions on the use in the whole Baltic Sea catchment area of the Contracting States.'

PFOS is included in the HELCOM list of substances or substance groups of specific concern to the Baltic Sea which was adopted as part of the BSAP.

The core indicator also addresses the following qualitative descriptors of the MSFD for determining good environmental status (European Commission 2008b):

- Descriptor 8: 'Concentrations of contaminants are at levels not giving rise to pollution effects' and
- Descriptor 9: 'Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards',

and the following criteria of the Commission Decision (European Commission 2010):

- D8C1 (concentration of contaminants)
- D9C1 (levels, number and frequency of contaminants)

PFOS is included on the revised list of the EU Priority Substances (European Commission 2013) and in the Stockholm Convention list of persistent organic pollutants (POPs), Annex B, which requires the parties to the convention to restrict the production and use of the substance.

The production and use of perfluorooctane sulfonate (PFOS) has been regulated in some countries (e.g., US, Canada, and the EU), but large-scale PFOS production continues in other parts of the world, e.g. China. PFOS has been produced and used since the 1950s, but due to findings of detectable concentrations in human blood in the general population and negative health effects on living organisms, PFOS was phased out in 2002 by its main producer 3M.

Role of PFOS in the ecosystem

Perfluorooctane sulphonate (PFOS), perfluoro octanoic acid (PFOA) and other perfluorinated compounds are considered global environmental contaminants. PFOS and PFOA are chemically and biologically inert and very stable (Poulsen et al. 2005). PFOS meets the P (Persistent) and vP (very Persistent) criteria due to slow degradation. PFOS is also bioaccumulative (B) and toxic (T) (OSPAR 2005). PFOA is considered as very persistent (vP) and toxic (T), but not bioaccumulative (Van der Putte et al. 2010). It has a capacity to undergo long-range transportation.

PFOS related substances and PFOA are members of the larger family of perfluoroalkylated substances (PFAS). Perfluorooctanyl sulfonate compounds are all derivatives of PFOS and can degrade to PFOS, also called as PFOS-related compounds. Some 100–200 PFOS-related compounds have been identified (KEMI 2006). PFOS binds to blood proteins and bioaccumulates in the liver, egg yolks, serum, and gall bladder unlike most persistent organic pollutant compounds that typically accumulate into fat (Renner 2001; Nordén et al. 2013; Goeritz et al. 2013; Shi et al. 2012).

PFOS has been shown to disturb the immune system, development and reproduction (endocrine disruption) of organisms and influence lipid metabolism. It is also suspected to induce liver necrosis. Falandysz et al. (2006) have suggested that the consumption of contaminated fish from the Baltic Sea contributes significantly to human blood levels of perfluoroalkyl compounds.

Marine mammals have considerably higher contamination levels of PFOS compared to marine and freshwater fish, and were found to be the most contaminated by PFOS of all Nordic biota studied (HELCOM 2010). Several hundreds to one thousand µg kg^{-1} ww of PFOS have been found in the livers of grey seals (in the southern Baltic Proper and Bothnian Sea; Nordic Council of Ministers 2004), harbour seals (Great Belt and the Sound; Nordic Council of Ministers 2004) as well as ringed seals (Bothnian Bay; Kannan et al. 2002). In the eggs of common guillemots (Western Gotland Basin), PFOS concentrations were greater than 1,000 µg kg^{-1} ww (Holmström et al. 2005). An OSPAR risk assessment (OSPAR 2005) on the marine environment concluded that the major area of concern for PFOS is the secondary poisoning of top predators, such as seals and predatory birds.

The evaluations in this core indicator are made based on concentrations mainly sampled in fish, usually from reference areas with no specific local pollution load. The case studies and measurements from marine mammals in the Baltic Sea, highlight that PFOS may pose more severe contamination risks to the Baltic Sea than the current indicator evaluation would suggest.

Only a few measurements of PFAS in the Baltic Sea surface water exist (Nordic Council of Ministers 2004; Theobald et al. 2007; Lilja et al. 2009) and they were mostly performed in potentially affected coastal areas. PFOA and PFOS dominated the water samples. Concentrations of PFOA were determined in the range 0.57-0.68 ng l^{-1} (Little Belt, Kiel Bight, Mecklenburg Bight, Arkona Basin) up to 4–7 ng l^{-1} (Little Belt, the Sound, coast of Poland, Gulf of Finland). PFOS was found at levels of 0.34-0.90 ng l^{-1} for all locations mentioned, with the exception of single measurements of 2.9 ng l^{-1} (coast of Poland) and 22 ng l^{-1} close to Helsinki (Gulf of Finland). Farther away from the coast, in the Arkona Basin, PFOA and PFOS levels were 0.35-0.40 ng l^{-1}.

Limited data exist for PFAS concentrations in Baltic Sea sediments (Nordic Council of Ministers 2004; SEPA 2006; NERI 2007; Theobald et al. 2007). PFOS and/or PFOA were occasionally detected, but consistently at levels below 1 µg kg^{-1} dw or ww. The highest levels reported so far have been from the Gulf of Finland close to Helsinki (PFOS 0.9 µg kg^{-1} ww), close to Stockholm (PFOS 0.6 µg kg^{-1} ww) and along the coast of Poland (PFOS and PFOA both around 0.6 µg kg^{-1} dw). Along the German Baltic Sea coast, concentrations of PFOS in sediments were in the order of 0.02-0.67 µg kg^{-1} dw and those of PFOA 0.09-0.68 µg kg^{-1} dw (Theobald et al. 2007).

The most important route of PFOS for humans is uptake from food (especially fish), drinking water and exposure to indoor dust (FOI 2013).

Human pressures linked to the indicator

	General	MSFD Annex III, Table 2a
Strong link	Use of synthetic compounds to increase grease, oil and water resistance of materials Use of firefighting foams	Substances, energy and litter - Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) – diffuse sources, point sources, atmospheric deposition, acute events
Weak link		

PFOS is both intentionally produced as well as an unintended transformation product of related anthropogenic chemicals. PFOS is still produced in several countries, such as China. Some PFAS have been manufactured for more than five decades. They are applied in industrial processes (e.g., production of fluoropolymers) and in commercial products such as water- and stain-proofing agents and fire-fighting foams, electric and electronic parts, photo imaging, hydraulic fluids and textiles (Paul et al. 2009).

The American company 3M, was the main producer of PFOS and its related substances until 2002. They started the production of perfluorochemicals already in 1949. The production of PFOS increased between 1966 and 1990 and peaked between 1990 and 2000. In 2003, China started a large scale production of PFOS. Between 2003 and 2008 China was both the main global producer and user of PFOS substances. However, also Japan and Germany produced PFOS during the same time period, but after 2007 no PFOS production occurs in Germany (Carloni 2009).

The major transport ways of PFOS to the Baltic Sea has been shown to be rivers (77%) but also atmospheric deposition (20%). Waste water treatment plants on the other hand were shown to have a negligible contribution (less than 2%) (Filipovic et al. 2013). The sources of PFOS to the atmosphere are still not clear, but a major contributor is believed to be transformation of precursor compounds (FOSA (Perfluorooctane sulfonamide) and FOSE (Perfluorooctane sulfonamidoethanol)) that have been emitted from production facilities and fluorochemical products (Armitage et al. 2009). Seventy-eight percent of the total PFOS in the Baltic Sea was estimated to be stored in the water column (Filipovic et al. 2013).

PFAS can be introduced into the environment both from point sources (e.g. landfills, manufacturing plants, application of firefighting foam containing PFOS) and non-point sources such as atmospheric deposition and degradation of precursors (Ahrens & Bundschuh 2014). High amounts of PFOS have been found in both sludge and groundwater close to military air base sites and airports where firefighting foam has been used to prevent fires (FOI 2013; Arias et al. 2015). Furthermore high levels of PFAS, including PFOS, have been found close to industries producing fluortelomers (Wang et al. 2014; Shan et al. 2014).

Monitoring Requirements

Monitoring methodology

Environmental monitoring of perfluorooctane sulphonate (PFOS) in biota is currently not coordinated in the HELCOM community, but general information about monitoring in the region is documented in the HELCOM Monitoring Manual under the **sub-programme: Contaminants in biota.**

So far, there are no technical guidelines related to PFOS monitoring in biota in the HELCOM Monitoring Manual and there is a need to develop such common monitoring guidelines.

Current monitoring

Monitoring activities relevant to the indicator, currently carried out by HELCOM Contracting Parties are described in the HELCOM Monitoring Manual in the relevant Monitoring Concept Table.

Sub-programme: Contaminants in biota
Monitoring Concept Table

Denmark, Finland, Germany and Sweden monitor PFOS concentrations in their national monitoring programmes. During the period 2014-2019, Poland will include PFOS analysis in fish muscle to their national monitoring. Germany monitors PFOS in biota on a project basis. Lithuania monitors PFOS in water, sediments and biota every 3 years since 2015. Estonia will include PFOS analyses in coastal waters (water, sediment and biota) from 2017. The substance is not included in the monitoring programmes in Latvia. No information is available from Russia. A few measurements in water and fish (flounder and herring) were taken from Estonia, Latvia, Lithuania and Poland during the HELCOM SCREEN project (2009). Finland has screening data from several fish species for human consumption along the coast line (Koponen et al. 2015).

Description of optimal monitoring

The core indicator for PFOS requires better geographical coverage in national monitoring programmes and time series data to enable evaluation of temporal trends. In addition, common HELCOM sampling guidelines would enhance the comparability of results.

The performance of existing monitoring should be evaluated in relation to the monitoring objectives, but first there is a need to quantify these objectives. These quantitative objectives need to be specified for each kind of monitoring, e.g. temporal trend-, incident-, geographical (spatial)- and compliance monitoring for environmental status and/or human exposure. For example, for temporal trend monitoring: what statistical power is required, during what time period should a certain trend be possible to detect and with what specified power (with certain one-or two-tailed statistical tests at a specified significant level)? With these definitions at hand it is possible to estimate e.g. required sample sizes and sampling frequencies. It can be shown that for a monitoring period of 12 years or shorter, generally the power to detect trends will decrease substantially if the sampling is carried out every second or every third year compared to annual sampling. For geographical studies the required spatial resolution should be determined. For compliance monitoring, it is imperative to know the distance to target levels (and variance) before sample sizes are estimated.

Time series of PFOS concentrations in fish are missing or too short to enable evaluation for several sub-basins in the Baltic Sea region. The geographical resolution is generally too poor to make reliable generalized maps from interpolation of the existing stations using Krieging. No serious attempts to study patterns of variation in fish (coastal- offshore) through variograms have been made that could give guidance to the uncertainty and to the distance between sites needed to achieve required confidence in generalized maps.

Data and updating

Access and use

The data and resulting data products (tables, figures and maps) available on the indicator web pages can be used freely given that the source is cited. The indicator should be cited as following:

HELCOM (2017) Perfluorooctane sulphonate (PFOS). HELCOM core indicator report. Online. [Date Viewed], [Web link].

ISSN: 2343-2543

Metadata

Result: Perfluorooctane sulphonate (PFOS)

Data: Perfluorooctane sulphonate (PFOS) data

The data used in the assessment is based on data from the HELCOM COMBINE database to which Contracting Parties report regular monitoring data.The data are extracted based on the HELCOM core indicator extraction table.

Contributors and references

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Archive

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