Thematic assessment of hazardous substances 2011–2016

Baltic Marine Environment Protection Commission

Supplementary report to the HELCOM 'State of the Baltic Sea' report (PRE-PUBLICATION)

STATE OF THE BALTIC SEA
- HOLISTIC ASSESSMENT -

HELCOM Thematic assessment of hazardous substances 2011-2016. Supplementary report to the HELCOM 'State of the Baltic Sea' report

NOTE: This is a pre-publication version. The report will be given a professional layout and then re-published during summer 2018.

The production of this report was carried out through the HELCOM Project for the development of the second holistic assessment of the Baltic Sea (HOLAS II). The methodology was developed through the HELCOM BalticBOOST project and the assessment was carried out by the HELCOM SPICE project. The work was financially supported through HELCOM and the EU co-financing of the HELCOM coordinated projects BalticBOOST and SPICE.

The basis for the assessment of status of the Baltic Sea are the HELCOM core indicators and associated threshold values. In this context the following has been agreed:

Regarding threshold values

"At this point in time, HOLAS II indicators and threshold values should not automatically be considered by the Contracting Parties that are EU Member States, as equivalent to criteria threshold values in the sense of Commission Decision (EU) 2017/848 laying down criteria and methodological standards on good environmental status, but can be used for the purposes of their Marine Strategy Framework Directive obligations by those Contracting Parties being EU Member States that wish to do so".

Regarding testing of indicators

Note that some indicators and/or their associated threshold value are still being tested in some countries and may be further developed in HELCOM as a result of the outcome of the testing. In some cases the results may show that the indicator is not suitable for use in a specific sub-basin. These indicators are marked in the assessment report and the results should be considered as intermediate.

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Cover photo: Cezary Korkosz

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Summary

Man-made chemicals and heavy metals enter the Baltic Sea via numerous sources, including waste water treatment plants, leaching from household materials, leaching from waste deposits, and atmospheric deposition from industrial plant emissions, amongst others. Once in the Baltic Sea, they can cause various types of damage to the ecosystem. Some are highly visible in the form of oil-spills, others however can remain unnoticed or are only apparent when detrimental impacts on the ecosystem or biota are observed. Many contaminants degrade slowly and their impacts can magnify as they accumulate within the aquatic food web. The contamination status is elevated (compared to natural conditions) in all parts of the Baltic Sea (HELCOM 2018a).

A major objective of the Baltic Sea Action Plan (BSAP) is to attain an ecosystem undisturbed by hazardous substances, particularly focussing on reaching concentrations close to natural levels, fish that are safe to eat, healthy wildlife, and radioactivity at pre-Chernobyl levels.

The integrated (CHASE assessment tool) assessment results show that the Baltic Sea remains heavily impacted by hazardous substances, strongly driven by substances or substance groups such as mercury, polybrominated diphenyl ethers (PBDEs), and the radioactive isotope cesium-137. The overall contamination scores according to CHASE are high, indicating a status that is markedly impeded by hazardous substances, with those areas appearing to show better relative status generally indicating low confidence in the assessment.

In comparison to previous integrated assessments of hazardous substances carried out within HELCOM (2010b), this assessment contains newer tools, specific threshold values, and new indicators; defining an approach that will facilitate the clear evaluation of progress towards improved status. Although status has not markedly changed since the previous holistic assessment (HELCOM 2010b), there are signs of improvement.

Indicators included

Thousands of environmentally hazardous substances have been identified as potentially occurring in the Baltic Sea. The most harmful substances are persistent, toxic and accumulate in biota. Some hundreds of substances are regularly monitored. A subset of these are represented in the core indicators included in this assessment.

Out of these, seven core indicators were used as the cornerstone of the integrated assessment, encompassing twelve substances, or substance groups. These core indicators cover important heavy metals, organic contaminants and radioactive substances (Core indicator reports; HELCOM 2018b-h). Concentrations are determined relative to regionally agreed threshold values in Baltic Sea biota, seawater and/or sediment. In addition, results for a core indicator

on concentrations of organo-metals (tributyltin, TBT[6]), as well as on a pharmaceutical; diclofenac[7], the occurrence of oil spills, and on the productivity of the white-tailed sea eagle (HELCOM 2018i-l) provide a further assessment of the status and impacts of hazardous substances in the Baltic Sea (Figure 1).

This report focuses on regionally agreed and monitored substances (or substance groups). However, it must be recognised that these monitored substances represent a small proportion of all potentially hazardous substances released into the Baltic Sea environment.

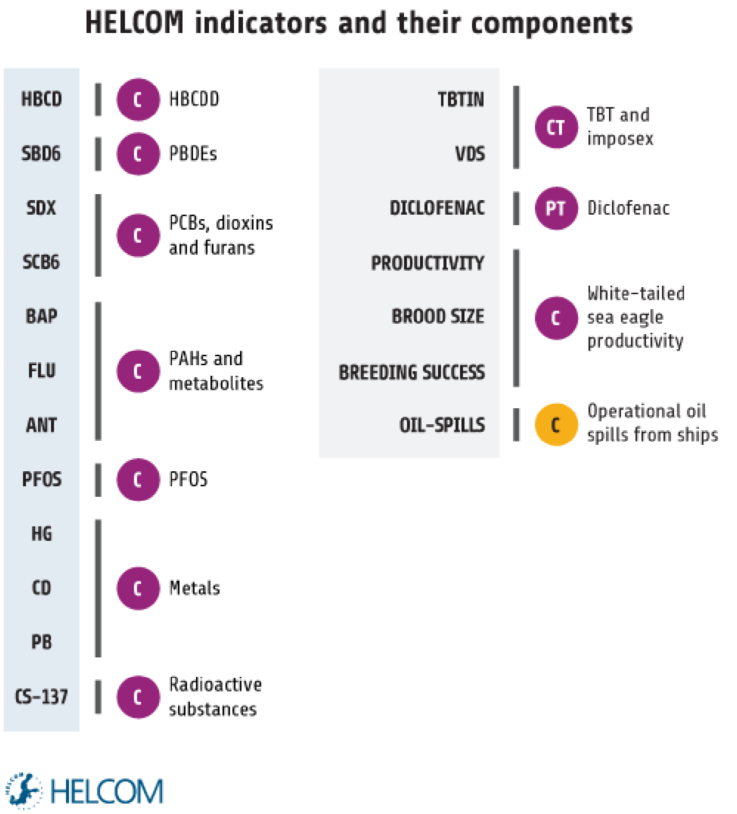

Figure 1. HELCOM indicators used in the assessment, and the components that contribute to indicator evaluations. The indicators on the left enter the integrated assessment, and those on the right are used to support the overall hazardous substances assessment. The 12 substances or substance groups (blue background) that enter the integrated assessment can be identified by the codes assigned to them in the HELCOM COMBINE database (for details, see Table 1). The circles indicate the type of indicator (C = core, P = pre-core, and T = tested in this report) and the indicator category (purple = hazardous substances and orange = maritime).

[6] Included as test.
[7] Included as test.

Integrated assessment results in brief

The integrated assessment of hazardous substances for the assessment period 2011-2016 show that:

- All assessed areas of the Baltic Sea show high contamination scores, indicating elevated levels of one or more contaminants, and thus a deteriorated status.
- The impeded status is commonly driven by elevated levels of polybrominated flame retardants (Polybrominated diphenyl ethers, PBDEs) and mercury, with radioactive substances (Cesium-137) also being an important contributor.
- Although status has not markedly changed since the previous holistic assessment (HELCOM 2010b) there are signs of improvement. Out of the 559 contaminant data series assessed for trends, 236 showed downward trends, 311 series had no detectable trend, and only 12 showed upward trends.
- 152 of the 236 downward trends were represented by radioactive substances. Cesium deposited after the Chernobyl nuclear power plant accident in 1986 is now at acceptable levels in some sub-basins, and can be expected to meet the threshold values in the whole Baltic Sea by 2020.
- The assessment is moderated with a low confidence score in some areas, indicating that those areas showing slightly better contamination status are generally lacking in data or do not meet the minimum number of core indicator substances (or substance groups) to be assessed extensively.
- Although the integrated assessment encompasses an array of important contaminants, these represent only a small number of potentially harmful substances known to enter the Baltic Sea.

Chapter 1. Background

Thousands of environmentally hazardous substances have been identified as potentially occurring in the Baltic Sea (Figure 2). The most environmentally hazardous substances are those that are persistent, toxic and accumulate in biota. Some hundreds of substances are regularly monitored. Out of these, twelve hazardous substances (or substance groups), forming seven core indicators, are used in the integrated contamination status assessment. The core indicators cover substances of specific concern to the Baltic Sea, as described in the HELCOM Baltic Sea Action Plan, and are based on data from the HELCOM monitoring programme (Core indicator reports: Core indicator reports; HELCOM 2018s-y, Figure 1). In addition core indicators have been developed to monitor effects on a top-predator, the white-tailed sea eagle, and to detect trends in oil-spills, as well as in concentrations of organo-metals (tributyltin, TBT). A summary of the new pharmaceuticals indicator on diclofenac is also included.

Since the previous holistic assessment, HELCOM has further developed the assessment system for hazardous substances, and taken steps towards applying regionally harmonised methods. To further support future assessments the indicators, threshold values and monitoring strategies are to be continuously developed to ensure that the management and assessment is proactive in relation to continued or new usages of potentially hazardous man-made substances that enter the environment.

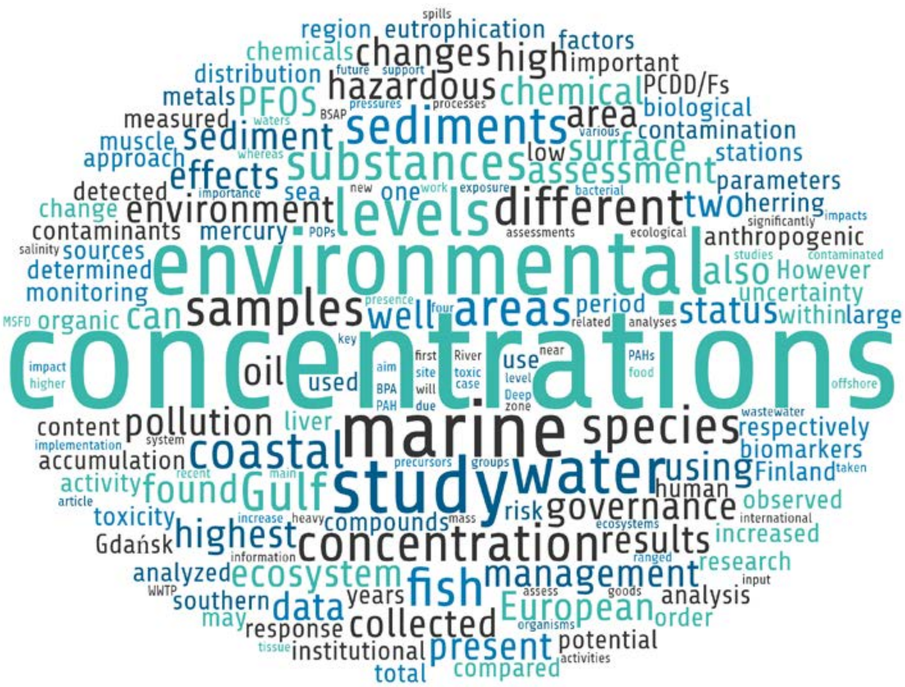

Figure 2. Words used in publications about hazardous substances in the Baltic Sea. The word cloud is based on the full abstracts of the first 100 publications to occur in a Google Scholar search, carried out on 31 May 2018, using the terms 'Baltic Sea Hazardous Substances' and with the year of publication range (custom range) set as 2011–2016. The image contains all words occurring 10 or more times, except for the words Baltic and Sea, scaled so that more commonly occurring words appear in larger font size. The initial word cloud was prepared using www.wordclouds.com. A number of terms, monitored substances, and pressures defined in this word cloud correspond closely with HELCOM hazardous substances indicators and the assessment carried out.

This report summarises the current knowledge on the status of hazardous substances in the Baltic Sea, based on information gathered through regionally agreed monitoring and the HELCOM core indicators. Furthermore, it details the methodology and results of the integrated assessment of selected hazardous substances to support the second HELCOM holistic assessment of ecosystem health in the Baltic Sea. The key results from the integrated assessment are presented, and these are also given in the 'State of the Baltic Sea' summary report. This report additionally shows more detailed assessment results, additional information on the position of monitoring stations, data sources, and a summary of the data type and quality entering the assessment, and includes the confidence in the status assessment. The integrated hazardous substances assessment was based on specific HELCOM core indicators, and was carried out using the HELCOM hazardous substances assessment tool CHASE.

In all, a large number of man-made substances have been identified as being of environmental concern (AMAP 2017). Greater awareness of how substances are used in society, and greater clarity on their lifecycles, as well as careful planning to prevent unnecessary release to the environment are imperative.

A large number of potentially hazardous substances or substance groups have been identified as of environmental concern (e.g. AMAP 2017), and extensive work is being carried out to determine the role and fate of these substances in the environment. Pharmaceuticals is one group of substances of emerging concern, with wastewater treatment plants being identified as a major pathway to the environment (UNESCO and HELCOM 2017). A number of pharmaceuticals considered to be of special concern to the aquatic environment have been included on a 'watch list' under the European Union directive regarding priority substances in the field of water policy (European Commission 2013) in a drive to gain greater understanding on the fate and impact of these substances.

Chapter 2. Indicators used in the assessment

2.1 SUMMARY OF INDICATORS THAT WERE INCLUDED

The assessment builds on the continued work of HELCOM experts to develop core indicators with regionally agreed threshold values and common methodological practices. The core indicators generally have a wide spatial and temporal monitoring coverage. The core indicators on hazardous substances assess the status of the marine environment and progress towards good status based on the concentrations of important and well documented contaminant substances or substance groups, on the occurrence of oil spills, and on the breeding success and brood size of white-tailed sea eagles, the latter being directly susceptible to loads of certain hazardous substances. The hazardous substances currently assessed include oil, organic contaminants, heavy metals, an organo-metal, and a pharmaceutical.

The integrated assessment of hazardous substances (the CHASE assessment tool) is based on seven core indicators, encompassing twelve substances or substance groups. Additionally the overall assessment is supported by four other substances or substance groups and two breeding parameters. Indicators formed with different data types (e.g. the white-tailed sea eagle or oil spills), which are not compatible with the contamination ratios used in the integrated assessment, or indicators with preliminary thresholds (e.g. diclofenac or TBT and imposex) are included in the report in support of the overall assessment.

Some indicators included in this report are tested in the current assessment, as they have further requirements for methodological development or threshold value agreement. These are not included in the integrated assessment, and the evaluations from such indicators should be treated with caution at this time. The full array of indicators and a brief description is provided in Table 1.

While the twelve substances or substance groups evaluated in the integrated assessment represent only a fraction of potentially hazardous substances entering the Baltic Sea, they are characterised as substances for which potentially damaging effects have been clearly defined. HELCOM continues to develop the assessment system for hazardous substances, including responding to new contaminants of concern with: possible indicator development, agreement on threshold values, regionally harmonised methods, and expansive monitoring.

Table 1. HELCOM indicators used in the assessment of hazardous substances. The upper section presents indicators included in the integrated assessment. The lower section shows indicators for which results are presented separately in the report. More details on threshold values are given in table 2 (see also Box 1).

Indicator	Code (Substance or substance group)	Description
Hexabromocyclo-dodecane (HBCDD)	HBCD (HBCDA, HBCDB, HBCDG)	Core indicator measuring the sum of three stereoisomers, the sum compared to threshold. Organic contaminant measured in biota and sediment
Polybrominated diphenyl ethers (PBDEs)	SBD6 (BD28, BD47, BD99, BD100, BD153, BD154)	Core indicator measuring the sum of congeners, the sum compared to threshold. Organic contaminant measured in biota and sediment
Polychlorinated biphenyls (PCBs), dioxins and furans	SDX (CB118, CB126, CB169, CDD1N, CDD6X, CDF2N, CDF2T, CDF4X, CDF6X, CDFP2, TCDD. SCB6 (CB28, CB52, CB101, CB138, CB153, CB180)	Core indicator measuring the concentration of two component substance groups: SDX – dioxin-like PCBs, dioxins and furans, SCB6 – non dioxin-like PCBs. Sum of congeners for each substance group compared to specific threshold. Organic contaminant measured in biota
Polyaromatic hydrocarbons (PAHs) and their metabolites	BAP (benzo(a)pyrene) FLU (fluoranthene) ANT (anthracene)	Core indicator measuring the concentration of three component substances in biota, biota and sediment respectively, each compared to a specific threshold. Organic contaminant measured in biota and sediments.
Perfluorooctane sulphonate (PFOS)	PFOS	Core indicator measuring concentration compared to threshold. Organic contaminant measured in biota and water
Metals	CD (Cadmium) PB (Lead) HG (Mercury)	Core indicator measuring three component substances compared to unique thresholds. Heavy metal contaminants measured in biota, sediment and water (CD and PB) and biota (HG)
Radioactive substances: Cesium-137 in fish and surface water	CS-137	Core indicator measuring the radioactive isotope Cesium-137 in biota and water, compared to specific thresholds
Indicators not used in integrated assessment		
TBT and imposex	TBTIN VDS	Core indicator measuring the two components compared to specific thresholds, concentrations of the organo-metal TBT in water and sediment and the Vas Deferens Sequence in biota. Included as test.
Diclofenac	N/A	Pre-core indicator measuring concentrations against provisional threshold. Included as test.
White-tailed sea eagle productivity	N/A	Core indicator assessing the brood size and breeding success of the white-tailed sea eagle.
Operational oil spills from ships	N/A	Core indicator assessing oil spill occurrence through aerial surveillance.

2.2 ASSESSMENT SCALE

For the purpose of monitoring and assessment the Baltic Sea is sub-divided according to a coherent and agreed structure. Four hierarchical assessment scales are used:

1) HELCOM Marine area. No division: the whole Baltic Sea encompassing the entire HELCOM area.

2) HELCOM Subbasins. Division of the Baltic Sea into 17 sub-basins.

3) HELCOM Subbasins with coastal and offshore division. Division of the Baltic Sea into 17 sub-basins and further division into coastal and off-shore areas, including in total 40 coastal areas.

4) HELCOM Subbasins with coastal WFD water types or water bodies. Division of the Baltic Sea into 17 sub-basins and further division into coastal and off-shore areas and division of the coastal areas by Water Framework Directive (WFD) water types or water bodies, including in total 240 coastal areas.

Detailed maps of the assessment scales as presented in attachment four of the HELCOM Monitoring and Assessment Strategy (HELCOM 2013). All HELCOM core indicators for hazardous substances are carried out at HELCOM assessment scale 4. The integrated assessment of hazardous substances is carried out at HELCOM assessment scale 3.

2.3 THRESHOLD VALUES

The core indicators are assessed against regionally agreed threshold values (Table 2). These are derived from a number of sources to select values that have been scientifically tested and developed with the purpose of assessing environmental status or ensuring human safety. However, a risk can never be fully excluded even when the threshold value is achieved - especially for persistent or bio-accumulating substances - and the long-term goal is to reach zero concentrations of man-made chemicals.

Monitoring of hazardous substances takes place in three types of matrices, namely biota, water and sediment. Each of these has specific threshold values defined for each substance (or substance group). Primary threshold values identify the matrix deemed to be most appropriate for monitoring the specific substance or substance group, though secondary threshold values are commonly established and used where monitoring in the primary matrix is not available. If several threshold values are available, thresholds based on environmental quality standards (EQS) and the sampling matrix biota are preferred. Monitoring of biota reflects the accumulation of contaminants in the living environment.

In certain cases, normalisation processes are also carried out (see Table 2, Box 1). In the future, for threshold values related to biota, normalisation based on trophic position within the food web is an aspect that will be explored.

The threshold values undergo regular assessment to ensure that they are up to date with the latest scientific knowledge and methodological advances. Continuous evaluation is essential as the understanding of the impact of different substances on the environment continuously develops. For example, toxicity tests and knowledge on bioaccumulation rates or routes develop, and methodological advances are made (e.g. regarding new methods or improved detection limits). Hence, it can be vital to adjust the threshold values to ensure better protective measures and to review targets or measures. This process takes place at the source of the threshold value. For example, the need for a review of the threshold value for polybrominated diphenyl ethers (PBDEs) in biota is currently under discussion within the EU Chemicals WG. The threshold values for the pharmaceutical diclofenac are also currently being assessed as part of the ongoing clarification related to this substance, now that sufficient information has been collected for there to be a decision on its inclusion on the European list of priority substances.

Table 2. HELCOM hazardous substances indicator details and threshold values. Indicators are divided into those entering the integrated assessment and those used to support the overall assessment provided in this report. Indicator name is provided and where multiple substances or substance groups are assessed within the same indicator then these divisions are presented and the codes used in the report are also provided. The matrix (biota, water or sediment) in which samples are collected is defined and the threshold type (primary or secondary). Indicators using multiple matrix types and threshold types incorporate the various threshold-matrix combinations to give widest spatial coverage and all assessed aspects are presented in the indicator reports, and outlined in Chapter 5 of this report. Details related to normalisation or filtration procedures are provided and the threshold values and origin. Abbreviations used: CORG = organic carbon concentration, Al = Aluminium, AA = Annual average, BAC = Background Assessment Cconcentrations, DW = dry weight EcoQO= Ecological Quality Objectives, EQS = Environmental quality standard, QS= Quality standard, TEQ=Toxic Equivalent, WW = wet weight.

Indicator	Substance or substance group (code)	Matrix (threshold type)	Details	Threshold value
Hexabromocyclo-dodecane (HBCDD)	**HBCDD** (HBCD)	Biota (primary)	5% lipid normalisation	EQS – 167 µg/kg WW human health[1]
		Sediment (secondary)	5% CORG normalisation	QS from EQS dossier 170 µg/kg DW[2]
Polybrominated diphenyl ethers (PBDEs)	**PBDEs** (SBD6)	Biota (primary)	5% lipid normalisation	EQS – 0.0085 µg/kg WW human health[3]
		Sediment	5% CORG normalisation	QS from EQS dossier 310 µg/kg DW benthic community protective[3]
Polychlorinated biphenyls (PCBs), dioxins and furans	**Dioxin-like PCBs, dioxins and furans** (SDX)	Biota (primary)	5% lipid normalisation	EQS – 0.0065 TEQ/kg WW human health[1]
	Non dioxin-like PCBs (SCB6)	Biota (primary)	5% lipid normalisation	EC - 75 µg/kg WW foodstuff[5, 9]
Polyaromatic hydrocarbons (PAHs) and their metabolites	**Benzo(a)pyrene** (BAP)	Biota (primary)		EQS – 5 µg/kg WW human health[1]
	Fluoranthene (FLU)	Biota (secondary)		EQS – 30 µg/kg WW human health[1]
	Anthracene (ANT)	Sediment (secondary)	5% CORG normalisation	QS from EQS dossier 24 µg/kg DW[4]
Perfluorooctane sulphonate (PFOS)	**PFOS** (PFOS)	Biota (primary)	Conversion from liver to muscle	EQS – 9.1 µg/kg WW human health[1]
		Water (secondary)	Unfiltered ideally	EQS AA – 0.00013 µg/l[1]
Metals	**Cadmium** (CD)	Water (primary)	Filtered or unfiltered*	EQS AA - 0.2 µg/l[6]
		Biota (secondary)		BAC 960 µg/kg DW mussels*
		Sediment (secondary)	5% Al normalisation	QS from EQS dossier 2.3 mg/kg DW[7]
	Lead (PB)	Water (primary)	Filtered or unfiltered*	EQS AA – 1.3 µg/l[1]
		Biota (secondary)		BAC 26 µg/kg WW fish liver*
				BAC 1300 µg/kg DW mussels*
		Sediment (secondary)	5% Al normalisation	QS from EQS dossier 120 mg/kg DW[8]
	Mercury (HG)	Biota (primary)		EQS – 20 µg/kg WW secondary poisoning[9]
Radioactive substances: Cesium-137 in fish and surface water	**Cesium-137** (CS-137)	Biota (primary)		2.5 Bq/kg herring[10] 2.9 Bq/kg flounder[10]
		Water (primary)		15 Bq/m^3 seawater[10]

Indicators not used in integrated assessment				
TBT and imposex[8]	Tributyltin (TBTIN)	Sediment (primary)	5% CORG normalisation	QS 1.6 µg/kg DW[11]
		Water (secondary)	Unfiltered ideally	EQS AA – 0.2 ng/l[1,6]
	Vas Deferens Sequence (VDS)	Biota (primary)		OSPAR EcoQO[12] – EAC: *Nucella lapillus*: 2.0 *Neptunea antiqua*: 2.0 *Hinia reticulate*: 0.3 *Buccinum undatum*: 0.3 *Littorina littorella*: <0.3 *Peringia ulvae*: 0.1
Diclofenac	Diclofenac	Water		EQS AA proposal - 0.005 µg/l[14]
		Biota		QS from EQS proposal dossier 1 µg/kg WW[14]
White-tailed sea eagle productivity	Brood size	N/A (primary)		1.64 (reference period)[13]
	Breeding success	N/A (primary)		0.59 (reference period)[13]
Operational oil spills from ships	Oil spills	Water (primary)		Region specific volumes (reference period)[15]

1) European Commission (2013) Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy. Off. J. Eur. Union L 226: 1-17.
2) HBCDD EQS dossier 2011.pdf - CIRCABC - Europa EU.
3) PBDE EQS dossier 2011.pdf – CIRCABC – Europa EU.
4) Review of EQS for Anthracene - CIRCABC - Europa EU, 2011.
5) COMMISSION REGULATION (EU) No 1259/2011 of 2 December 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non-dioxin-like PCBs in foodstuffs.
6) European Commission Directive 2008/105/EC of the European Parliament and the Council on environmental quality standards in the field of water policy (Directive on Environmental Quality Standards). Off. J. Eur. Union L 348.
* Long term aim to calculate threshold value based on HELCOM regional data (currently based on OSPAR regional data).
7) Cadmium and its compounds – Europa EU, 2005.
8) Lead and its compounds - CIRCABC - Europa EU, 2011.
9) EC (2008): Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council. OJ L 348:84
10) Pre-Chernobyl level.
11) Threshold derived from Swedish legislation (HVMFS 2013:19, https://www.havochvatten.se/download/18.1d58828a15f50337fd41fcd5/1508942603512/2013-19-keu-20170101.pdf) and incorporated into HELCOM processes during CORESET II (https://portal.helcom.fi/meetings/CORESET%20II%202015%20HZ%20BE-220/MeetingDocuments/Outcome%20of%20CORESET%20II%202015%20HZBE%20-%20BALSAM%20WP2.pdf).
12) OSPAR EcoQO, Gercken & Sordyl 2009, and Magnusson et al. 2016.
13) See indicator reports for detailed description of reference periods and calculation: http://www.helcom.fi/baltic-sea-trends/indicators/
14) Dossier Diclofenac_Draft_JRC-2017_V4.1-GM(update 31-05-2017)_JRC 25June2017 as viewed on 13.11.17 at: https://circabc.europa.eu/w/browse/412c0e12-6235-497f-8607-2d8dc1d95da7.

[8] Included as test.

Box 1. Approaches for the setting of threshold values

The environmental quality standards (EQSs), as defined in the EU Environmental Quality Standards Directive (2008/105/EC, updated with 2013/39/EU (EC 2008 and EC 2013)) and linked to the EU Water Framework Directive (2000/60/EC), represent one type of threshold value used. Those EQS threshold values with a particular focus on biota were considered as the highest priority where possible to implement. The reasoning behind this is that even when substances may be detected at low concentrations in the environment, this approach would ensure that by preferentially targeting EQS values in biota those thresholds designed to detect potential harm in the environment are addressed, as is the potential for the persistent bioaccumulation of contaminants despite low environmental concentrations.

EQS values are set for priority substances with respect to concentrations in water, and where relevant for biota (fish or shellfish). For EQS values in water the annual average concentration is used. Equivalent values for sediment are provided in the substance EQS dossiers and are defined as quality standards (QS values), derived from these EQS values. The environmental quality standard values are used by EU Member States for the classification of chemical status of water bodies under the Water Framework Directive, and relate to an expected 'safe' level of exposure. At concentrations below this level it is assumed that no harm will be caused to the freshwater or marine environment. When measurements in biota are used, different trophic levels of the food web are analysed depending on the substance (for example, mussels or predatory fish), and different parts of the fish (for example muscle, liver or whole fish). Hence, the measured concentrations often need to be converted in order to conform to the environmental quality standard threshold value. Overall, four principal matrices and protection goals are considered on the basis of toxicity tests with representative organisms when defining QS values; the pelagic community ('QSwater'), benthic habitats ('QSsediment'), top predators ('QSbiota - secondary poisoning'), and human health through food consumption ('QSbiota - human health'). A QS value can be used for the assessment provided that it corresponds to at least the same level of protection as the environmental quality standard. The value for the most sensitive of these matrices and protection goals is used.

Background assessment concentrations (BACs) have been developed by OSPAR and ICES to illustrate progress towards background concentrations, defined as concentrations of contaminants at pristine or remote sites based on contemporary or historical data. Observed concentrations are said to be 'near background' if the mean concentration is statistically significantly below the corresponding background concentrations. The defined values do not take ecotoxicological aspects into consideration directly, though using background concentrations of naturally occurring substances as the threshold value may represent an even more precautionary approach than the use of other threshold values devised to indicate no environmental harm. Values based on background assessment concentrations are currently not available for the HELCOM region, but could be calculated in future work.

Foodstuff threshold values stem from legislation of the European Union (EC 2006). They are derived taking into consideration information beyond the environmental parameters, such as: dietary standards, the health concerns of the human population, typical levels of contaminants in different foodstuff, and trade issues. The aim is to identify and prevent contaminated foodstuff from being placed on the market and thus ensure human health is not detrimentally impacted. Thus, the foodstuff threshold values do not cover all combinations of matrices and contaminants relevant for an environmental assessment of the marine environment. Because of this, a full equivalence between foodstuff threshold values and EQS-values should not be expected, although the values can in some cases be very similar or even the same.

Chapter 3. Method for the integrated assessment of hazardous substances

The integrated assessment was done using the HELCOM CHASE tool, which integrates individual results for indicator substances (or substances groups) into a quantitative estimate of overall contamination status.

In the integrated assessment, the threshold value for each individual substance (or substance group sum) and for each matrix is used to calculate the contamination ratio (CR). The contamination ratio forms the starting data point for the integration and is expressed as the measured concentration divided by the threshold value. Thus, the contamination ratio can indicate the distance from threshold value of monitored substances. The use of contamination ratios prior to entry into the integrateted assessment ensures an equal weighting of the different data types.

The current version of the CHASE integrated assessment tool is developed for use in R, a free statistical software[9] (See also Box 2). The CHASE code is freely available at GitHUB (https://github.com/helcomsecretariat/CHASE-integration-tool), an online open-source repository and version-control system for software codes.

[9] https://www.r-project.org/

Box. 2 Development of the CHASE tool

The HELCOM Hazardous Substances Status Assessment Tool (CHASE) was originally developed for the first HELCOM holistic assessment (HELCOM 2010a), where an integrated thematic assessment of hazardous substances was one component (HELCOM 2010b). CHASE 1.0 performs an integrated status assessment of hazardous substances based on the four ecological objectives which define the strategic goal for hazardous substances in the HELCOM Baltic Sea Action Plan: (1) concentrations of hazardous substances close to natural levels, (2) all fish safe to eat, (3) healthy wildlife, and (4) radioactivity at pre Chernobyl level (HELCOM 2010b). A further version of the tool (CHASE 2.0) was developed to carry out the integrated assessment but also include the different sampling matrix types (Andersen et al 2016).

For the second holistic assessment, the CHASE tool was developed further to meet the needs of the 'State of the Baltic Sea' report. The development was carried out within the HELCOM BalticBOOST project, which was co-funded by the EU, and included the development of test cases where different types of hazardous substances information (i.e. different sets of indicators) were integrated. The development of the CHASE tool was guided by two HELCOM workshops with participation of experts from the Contracting Parties of HELCOM, the HOLAS II Core Team and the State and Conservation Working Group. The further developed tool, CHASE 3.0, and the method for integrated assessment of hazardous substances was approved by the HELCOM Heads of Delegation (HELCOM 2016b) for the assessment of contamination status presented in the 'State of the Baltic Sea' report.

In CHASE 3.0, as applied in the current integrated assessment of hazardous substances, only seven core indicators, covering twelve substances or substance groups are used. These indicators and their substances are used as they meet the requirements of having wide ranging spatial and temporal monitoring (core indicators) and have threshold values that are agreed by all HELCOM Contracting Parties. The CHASE tool is constructed so that further indicators or substances can be added as the number of relevant core indicators expands.

3.1 STRUCTURE AND ASSESSMENT APPROACH OF CHASE

The CHASE tool produces an assessment of contamination status by nesting evaluation results for indicators (or substances and substance groups) sampled within three matrix categories: water, biota, sediment. The categories relate to matrices in which hazardous substances are typically measured and the indicator evaluation results are carried out at designated HELCOM assessment scales. Hence, the CHASE tool integrates the regionally agreed HELCOM core indicator evaluation results, based on the matrix used for the respective threshold values in each indicator. The assessment structure of the CHASE tool and the calculation steps involved is shown in Figure 3.

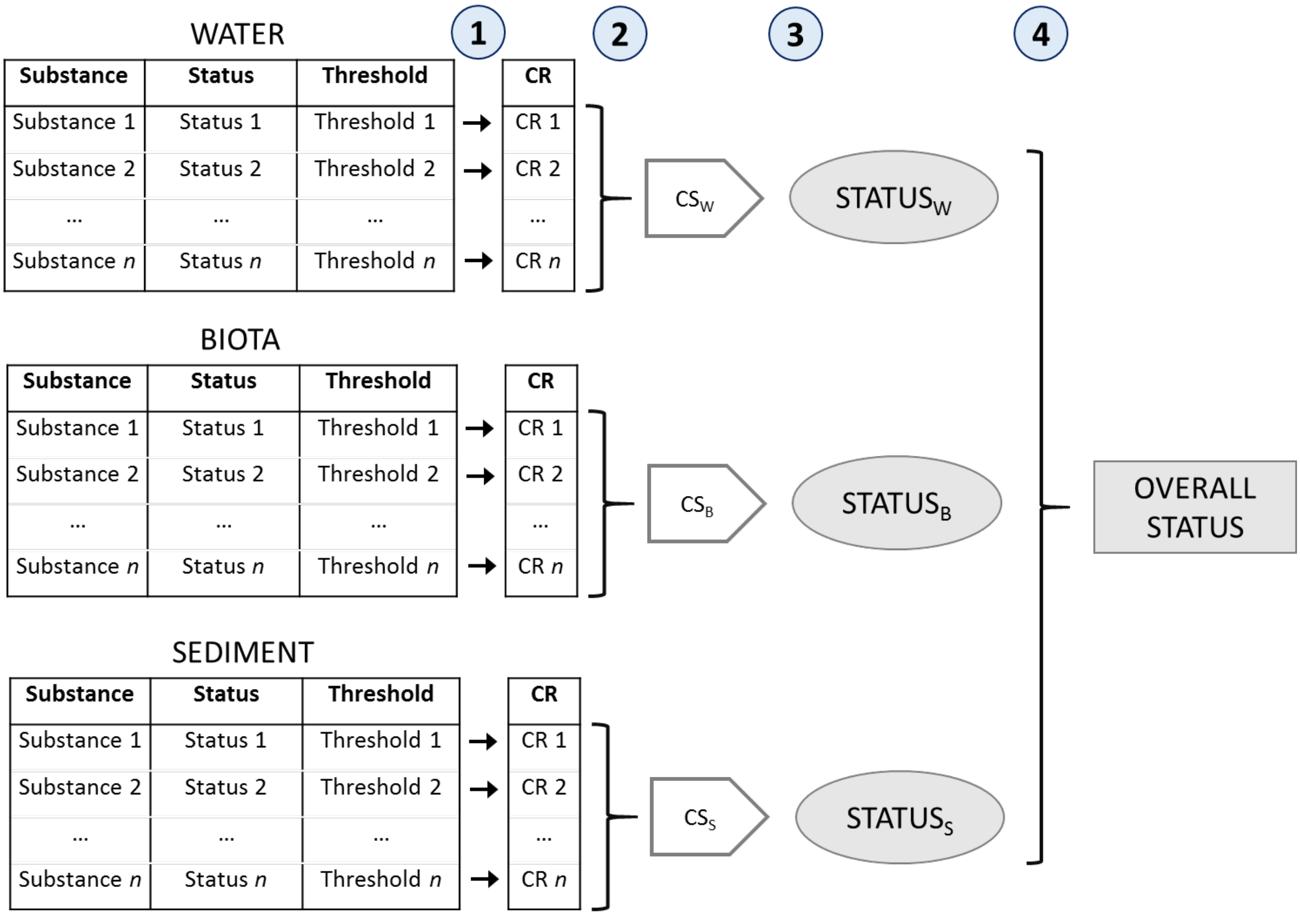

Figure 3 Structure of the CHASE tool, describing the flow of information within the tool. The numbers in the blue circles correspond to the steps which are described in detail below: 1) Status values (=observed values) for each substance (substance group) and the associated threshold values are used to calculate a Contamination Ratios (CR). 2) The contamination ratios within each matrix category (water, biota or sediment) are calculated to give a 'matrix' Contamination Score (CS). 3) The Contamination score is used to determine the Category Status. 4) The overall status for the assessment unit is defined as the status of the category showing the highest score, corresponding to the worst status.

Step 1. For each indicator substance (or substance group), a contamination ratio (CR) is calculated as the ratio of the observed value (monitored value; C_{mon}) to the specific threshold value ($C_{threshold}$). Note that the indicator calculation script (MIME) generates this CR value and the CHASE integrated assessment tool can also be provided with the CR values as direct input data.

$$\mathrm{CR} = \frac{C_{mon}}{C_{threshold}}$$

When the observed value exceeds the threshold value, the resulting contamination ratio will be greater than 1.0, and if it is below the threshold value, the contamination ratio will be 1.0 or less. For all hazardous substances (indicators), an increase in concentration is associated with worsening status, hence the indicator fails the threshold value when the observed value exceeds it.

Step 2. An aggregated contamination score (CS) is calculated separately for each matrix category (CI= water, CII = biota, CIII = sediment):

$$\mathrm{CS} = \frac{1}{\sqrt{n}} \sum_{i=0}^{n} \mathrm{CR}_i$$

As explained in Andersen *et al.* (2016), and also shown by the BalticBOOST test cases, the CHASE tool is robust against the so called 'dilution effect' - which describes a situation when several low-scoring indicators can mask the effect of one or a few indicators having a high contamination ratio.

Step 3. If the aggregated contamination score (CS) from step 2 (the matrix CS) is less than 1.0 within one matrix (water, biota or sediment), the status for that individual matrix is determined to be good (matrix status). If above 1.0 that matrix is classified as not good. This is reflected as a 'low' or 'high' respective contamination status. The low contamination status class is further subdivided into two categories, and the high contamination status class is subdivided into three categories, based on the value of the aggregated contamination score (Table 3). The five categories give a coarse estimate of how far the obtained result is from the 'target', and can help distinguish an area with a very high contamination score from an area with a score closer to 1.

Step 4. The overall status assessment result is determined by the "One-out-all-out" approach, so that the matrix category with the worst status of the three categories (water, biota, sediment) determines the overall status for an individual assessment unit. The score of the category with the worst status is retained to indicate how far from 1 the overall assessment result is (Table 3).

Table 3. Result categories of the contamination status assessment.

	Contamination score (CS)	**Contamination status category**
Contamination score less than 1.0	≤0.5	Low contamination score
	0.5 < CS ≤1.0	Low contamination score
Contamination score above 1.0	1.0 < CS ≤5.0	High contamination score
	5.0 < CS ≤10.0	High contamination score
	>10.0	High contamination score

3.2 CONFIDENCE ASSESSMENT METHODOLOGY

The hazardous substances and substance groups which are used in the integrated assessment are known to enter the Baltic Sea ecosystem due to human activity, generally meeting the requirements for core indicators of having wide ranging spatial and temporal monitoring, and threshold values agreed by all HELCOM Contracting Parties.

There are, however, significant regional differences in how much monitoring data is available for each assessment unit. HELCOM assessment units at scale 3 are used in the CHASE integrated assessment. Since the underlying indicator evaluation, based on the MIME script, applies defined calculation rules (and normalisation procedures in certain cases), only data meeting these conditions are processed to the result evaluation point and forms the output that enters the CHASE tool. The variation in monitoring of substances (or substance groups) is highlighted by an example for the open sea assessment units (Figure 4). Similar information for coastal assessment units can be derived from Annex 4.

The approach applied in the integrated assessment allows a wide range of spatial and temporal data to be incorporated, despite regional differences, and it should be noted that the confidence setting approach (described below) provides a balance.

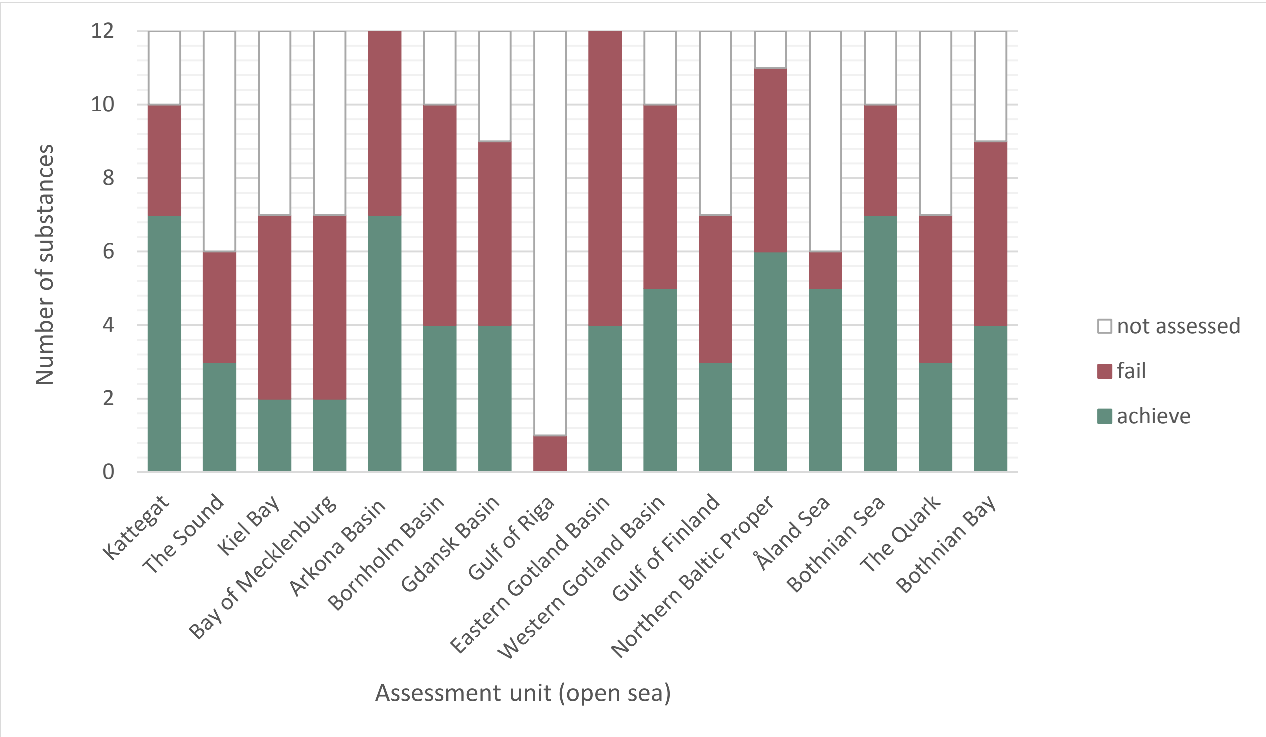

Figure 4. Assessment of the 12 hazardous substances (substance groups) in open sea assessment units, the basis of the integrated contamination status evaluation. Comparability between the open sea assessment units is reduced as there are differing availability of data for the substances between areas.

The confidence assessment is carried out in parallel to the status assessment in the CHASE tool, and gives an overall confidence rating based on the type or quality of underlying monitoring data and the reliability of the threshold value. An overall confidence value is calculated per assessment unit from all input data for the 'threshold confidence' and the 'assessment status confidence'.

Confidence in the threshold value is informed by the rules provided by the HELCOM Expert Network on Hazardous Substances (HELCOM 2017a; Table 4). The rules are applied based on the type of threshold values used for each indicator, and within each indicator matrix (e.g. biota, sediment and water). In some instances the threshold values in place are current recommendations based on prevailing scientific knowledge. The threshold values undergo regular review.

Table 4. Rules for assigning confidence rating to the threshold value.

Threshold value type	Confidence rating	Comment
Environmental quality standard (EQS)	High	
Quality Standard (QS)	High	
Background Assessment Concentrations (BAC)	Moderate	There is high confidence that the threshold is sufficiently protective, however the threshold values have not been developed by taking ecotoxicological effects on organisms into account so the confidence is moderate.
Environmental Assessment Criteria (EAC)	Moderate	The EACs are developed based on several studies, but the assessment needs to take into consideration that in some cases the derivation of the EAC is not clearly reported.
EC foodstuff threshold values (EC 2006)	Low	The thresholds have not been developed for the purpose of assessing environmental status nor on ecotoxicity.
Study deriving a threshold value	Moderate	Studies that have been carried out to propose a threshold value using ecotoxicological methods are considered appropriate, however confidence cannot be considered to be high if there is only one study available, compared to EQS/QS values where many studies have generally been considered.

Confidence in the assessment status is created based on an appraisal of the data type, assessing its quality and in some cases quantity, entering the assessment for each indicator substance (substance group) within a single assessment unit. The data utilised in the hazardous substances indicator evaluations vary in terms of time series length and in the frequency of sampling. Thus, several data types are represented in the HELCOM regional assessment, and often within any given assessment unit, all of which are processed within the individual indicator evaluations. The data series are categorised as either 'full' data or 'initial' data based on their attributes. Data series that have longer time series and are frequently sampled, thus allowing assessment of downward trends, upward trends or no detected (statistical) trends to be identified, are classified as 'full' data. Data series classified as 'initial' are composed of either of two data types: data series consisting of only 1-2 years of data during the assessment period, and those data series for which trends could not be statistically assigned. Full and initial data are processed with specific methodologies within the MIME indicator evaluation script (for detailed explanation see section 3.5 Data sources).

Confidence in the assessment status is, thus, informed by the rules provided in Table 5.

Table 5. Rules for assigning confidence rating to the status assessment for a single assessment unit.

Confidence rating	Criteria applied
High	Two or more 'full' data series in the assessment unit (irrespective of supporting 'initial' data
Moderate	One 'full' data set in the assessment unit, supported with 'initial data'
Low	Only 'initial' data or only a single data series present in the assessment unit

When calculating the overall confidence score in the CHASE tool, the confidence rating is first translated to a numerical format so that rating 'High' is given value 1.0, rating 'Moderate' is given value 0.5 and rating 'Low' is given value 0:

$$c_i = \begin{cases} 1.0, & "High" \\ 0.5, & "Moderate" \\ 0.0, & "Low" \end{cases}$$

The confidence score for the category (water, biota or sediment) is the average of the indicator confidence scores:

$$c_{cat} = \frac{1}{n}\sum_{i=1}^{n} c_i t$$

The overall confidence score is the average of the category confidence scores:

$$c\mathit{overall}=1\mathit{ni}=\mathrm{l}\mathit{III}c\mathit{cat}$$

Finally, the overall Confidence Score is provided in the output additionally as a Confidence Class, which is converted to an Overall Confidence Status, according to Table 6.

Table 6. Confidence classes applied in the integrated hazardous substances assessment using the CHASE tool

Confidence Score	Confidence Status	Overall Confidence Status
≥ 0.75	Class I	High
between 0.5 and 0.75	Class II	Moderate
<0.50	Classs III	Low

As a final step, the overall confidence is evaluated based on which substances were included, and a penalty is applied to the overall confidence if minimum requirements are not met. The minimum requirements consider substances, and not indicators, and the requirements are detailed in Table 7.

Table 7 Criteria that need to be fulfilled at the level of assessment unit in the integrated assessment of hazardous substances. If the minimum requirement criteria are not met, a penalty is applied to the overall confidence.

Minimum requirement criteria	Penalty applied to the confidence score if the criteria is not met
At least two heavy metal substances are included in the assessment (all categories)	50% reduced confidence
At least three organic substances are included in the assessment (all categories)	50% reduced confidence

Currently, the CHASE tool utilised means that the requirements for heavy metals can be fulfilled if, for example, the substance cadmium is measured both in sediment and water in a single assessment unit. Thus the current penalty application is based on the term 'Type' and not 'Substance' (see Table 8).

This overall confidence rating system is applied at the level of each individual assessment unit (HELCOM assessment unit scale 3), providing an overview map though which the data-based status assessment can be moderated. It is, for example, an important way in which to address areas for which a contamination status is provided but for which the underlying data or threshold values appear less certain.

3.3 CHASE ASSESSMENT DATA

The integrated assessment presented here was based on evaluation results for hazardous substances core indicators (see Table 2), derived at HELCOM assessment scale 3 during 2011-2016.

The CHASE tool does not process raw measurement data, such as the data collated in the HELCOM COMBINE database, but is based on outputs derived from the MIME script, the MIME script being the calculation tool for the core indicator evaluation. Evaluation of indicators with the MIME script ensures that the measurement data are appropriately processed, that normalisation processes are applied, and that the concentrations are evaluated against the specific and approved threshold values. This process also incorporates substances where a sum of congeners is part of the calculation process, the sum being evaluated against the threshold value. The details and specific rules related to this are provided within the individual indicator reports.

The CHASE tool R-script requires an input table where the core indicator (or substance) evaluation results have been calculated for each assessment unit in each of the respective matrix types (biota, sediment or water). The script can calculate the overall contamination score based on either the input of a concentration value for the assessment unit and the respective threshold values for specific compounds (base on which CHASE derives a contamination ratio), or it can be based on the direct input of contamination ratios. In the current CHASE integrated assessment the calculations have been carried out using the contamination ratios for core indicators derived from MIME (In the MIME output, the contamination ratio per assessment unit is termed 'concentration'). An example with input values for part of the Arkona Basin (SEA-006, open sea) is given in Table 8.

Table 8. Example input data table to the CHASE tool. The table includes core indicator evaluation results using the MIME script determined contamination ration (CR) for part of the open sea Arkona Basin, and other parameters required for the running of the CHASE integrated assessment. Explanation to the column headings: Waterbody=Name of the assessment unit (in this instance based on HELCOM assessment scale 3 units), Matrix=Matrix in which specific indicator substance is measured (Water, Biota, Sediment), Substance=Code from COMBINE database and MIME script (see Tables 1 and 2 for clarification) defining the substance monitored, Type=Classification of substance as used in applying confidence evaluation and penalties (Org=Organic contaminant, HM=Heavy metal, and Rad=Radioactive Substances), Unit=Measurement unit(s) for the raw data of the substance or substance group measured (norm=normalised to, AL=Aluminium, CORG=sediment organic carbon content, SB=soft body, MU=muscle, EP=skin, LI=liver, WW=wet weight, DW=dry weight), Response=The direction of the indicator in response to worsening contamination (assumed to be positive in the current assessment), ConfThresh=Confidence rating assigned to the threshold value, as defined above (H=high, M=moderate, and L=low), ConfStatus=Confidence rating assigned to the status assessment, as defined above (H=high, M=moderate, and L=low), Datatype=Optional information to define data type (e.g. 'full' or 'initial'), though in this instance the term 'All' is used to inform that give assessment units contained all data in the for the given unit and substance (i.e. since 'full' and 'initial' data are incorporated into the indicator evaluation from which this CHASE input data is derived).

Waterbody	Matrix	Substance	Type	CR	Unit	Response	Conf Thresh	Conf Status	Data type
Arkona Basin	Biota	CD	HM	2.0994	ug/kg WW mussels (SB)	+	M	L	All
Arkona Basin	Sediment	CD	HM	0.2256	mg/kg sediment (norm AL)	+	H	H	All
Arkona Basin	Water	CD	HM	0.4200	ug/l water	+	H	L	All
Arkona Basin	Biota	HG	HM	0.6426	ug/kg WW fish (fish MU - fillet)	+	H	H	All
Arkona Basin	Biota	PB	HM	0.7917	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All
…	…	…	…	…	…	…	…	…	…

Note: the CR values shown are rounded up to four decimal places in this example, but will be determined by the input data.

3.4 OUTPUTS FROM THE CHASE TOOL

The CHASE R-script generates five output files, which can also be exported as csv and png files. The 'plot.png' file offers a visual summary of the Contamination Sum per assessment unit and separately for each matrix (biota, water, sediment), coloured by status category. The file named 'CHASE' summarises the results per waterbody as defined by the matrix with the worst Contamination Sum value, and includes a summary of the status, confidence and confidence penalties applied. The file named 'out' reproduces the input data (as shown in Table 7) and places the overall status and confidence result for each waterbody unit-matrix combination against each input data row. The file named 'QE' defines the Concentration Sum, status and confidence for each matrix in each waterbody with additional information supplied that forms the basis of the plot.png figure. The final file, named 'QEspr' presents an overall summary in each included waterbody, summarising: the contamination scores per matrix, identifying the matrix with the worst contamination score, the worst contamination score representing the ContaminationSum (ConSum), defining the status, summarising the confidence score and class, listing the number of heavy metals and organic contaminants monitored, and listing the penalties applied. In cases where a certain category or matrix is not present in any waterbody, the corresponding column will not be displayed in the results table or will be filled with NA.

An example of the summary output (QEspr) for the Arkona Basin (SEA-006, open sea) is provided in Table 9. The overall output provided allows a deeper understanding of which indicator and substances contribute most strongly to the integrated assessment result, in addition to the matrix (See annexes 1-4).

Table 9. Example of summary output (Qespr) from the CHASE tool. Explanation to the column headings: Waterbody=name of assessment unit, Biota/Water/Sediment=ConSum value for each matrix in the assessment, Worst= name of matrix with worst status, ConSum= contamination sum of the category with worst status, Status= Assigned assessment status class, ConfScore=overall confidence value, Confidence= assigned confidence class (see Table 6), HM= count of heavy meatal values entering the assessment (currently a value is counted per substance and per matrix), Org= count of organic contaminant values entering the assessment (as described for metals), Penalty= the % confidence penalty applied based on failure to meet the minimum criteria (Table 7).

Waterbody	Biota	Water	Sediment	Worst	ConSum	Status	ConfScore	Confidence	HM	Org	Penalty
Arkona Basin	19.09	1.36	0.83	Biota	19.09	Not good	0.90	Class I	7	10	0%

Note: the values shown are rounded up to two decimal places in this example, but will be determined by the input data.

3.5 DATA SOURCES

The integrated contamination status of the Baltic Sea is assessed based on selected HELCOM core indicator evaluations (as listed in table 2), utilising 12 substances (or substance groups) monitored regularly in three different matrix types (biota, water and sediment). Some core indicators used in this assessment are based on a group of related substances and the sum of these is compared to the agreed threshold value. The details of these are provided in the indicator reports.

The core indicators have been developed under regional agreements and use regular environmental monitoring data gathered by the HELCOM countries. The hazardous substances core indicators used in this assessment utilise data from the HELCOM COMBINE database, following defined monitoring programmes and sampling guidelines (HELCOM 2017b). In some cases collection of supporting parameters is also required for normalising the data (see Table 2). Environmental monitoring data are reported annually by HELCOM countries (by 1st September) to the HELCOM COMBINE database, which is hosted by the International Council for the Exploration of the Sea (ICES).

The data used for the current indicator evaluation was extracted from the HELCOM COMBINE database on 12 February 2018 and covers the assessment period 2011-2016. The indicator specific data and result values are available as snapshots for the assessment period via the individual HELCOM indicator reports (http://www.helcom.fi/baltic-sea-trends/indicators/) and the HELCOM map and data service (http://maps.helcom.fi/website/mapservice/index.html).

All HELCOM hazardous substances core indicators follow a common assessment protocol for the statistical treatment of the data (though with their respective thresholds and normalisation parameters applied) by using the MIME indicator assessment protocol R-script. The MIME script was originally developed in the OSPAR Commission Working Group on Monitoring of trends and Effects of substances in the Marine Environment (ICG-MIME) and has been adapted to HELCOM core indicator requirements. The MIME script is currently being implemented into a dedicated HELCOM workspace for the calculation of HELCOM hazardous substances indicators and will be publically available once finalised.

The MIME script fits a statistical model to the assessment values and compares the 95% upper confidence value to the threshold value to determine if the threshold value is failed or achieved. The method is considered to be robust and to minimize the risk for false positive assessments (i.e. minimize the probability that the threshold value is indicated as achieved when in reality it has not been met - failed). In order to fit the model, a minimum of three years of data from a monitoring station is required. Such data series are classified as ‘full’ data. Processing ‘full’ data series enables trends to be statistically established, with data series showing downward trends, upward trends or no detectable trend.

In addition, a large number of data series incorporated into the HELCOM hazardous substances indicator evaluations are classified and handled as 'initial' data. These data series are represented by two major forms of data series: data series composed of data for two years or less within the six year assessment period (which is typical in some monitoring programs, or for particular substances or matrix types), and data series for which three or more years of data are available but due to the inherent qualities of the data it is not possible to statistically assign trends (for example, data are below the threshold value but due to analytical limits of quantification a defined sample value is not given, so called 'less-than' values).

All initial data are handled in a highly precautionary manner to further ensure that the risk of false positives is minimalised. For all initial data the 95% confidence limit on the mean concentration, based on the uncertainty seen in longer time series throughout the HELCOM area, is used. Applying a precautionary approach, the 90% quantile (psi value, Ψ) of the uncertainty estimates in the longer time series from the entire HELCOM region are used. The same approach is used for time series with three or more years of data, but which are dominated by less-than values (i.e. no parametric model can be fitted). The mean concentration in the last monitoring year (meanLY) is obtained by: restricting the time series to the period 2011-2016 (the last six monitoring years), calculating the median log concentration in each year (treating 'less-than' values as if they were above the limit of detection), calculating the mean of the median log concentrations, and then back-transforming (by exponentiating) to the concentration scale. The upper one-sided 95% confidence limit (clLY) is then given by: exp(meanLY + qnorm(0.95) * Ψ / sqrt(n)), where n is the number of years with data in the period 2011-2016 (HELCOM 2018).

In this specific assessment the low number or absence of any 'full' data series for certain substances in the water and sediment matrix types meant that specific Ψ values were not possible to calculate in all instances. In these instances the highest psi value from the specific matrix was applied to the other respective substances in that matrix.

A detailed visualisation of the distribution of these data types is possible for each indicator (and substance-matrix combination) within the relevant indicator reports (http://www.helcom.fi/baltic-sea-trends/indicators/) and on the HELCOM map and data service (http://maps.helcom.fi/website/mapservice/index.html). In brief, large symbols indicate types of 'full' data (with assignable trends) and smaller symbols indicate types of 'initial' data (open symbol being data series of less than two years and small filled symbols indicating data for which trends can not be statistically assigned).

Chapter 4. Results from the integrated assessment

Pressure on the marine environment from contaminants is high in all parts of the Baltic Sea (Figure 5). The ecosystem remains impacted by hazardous substances. Mercury, polybrominated diphenyl ethers, and the radioactive isotope cesium-137 show particularly high contamination scores in the integrated assessment.

Eleven of the assessed open sea areas were classified into the worst status category, with the Kiel Bay, Eastern Gotland Basin and Bothnian Bay being indicated as the most contaminated. Meanwhile, areas appearing to show better relative status are generally associated with low confidence in the assessment.

An enlarged confidence map is shown in Figure 6, and the integrated assessment result together with the distribution of monitoring sites is shown in Figure 7.

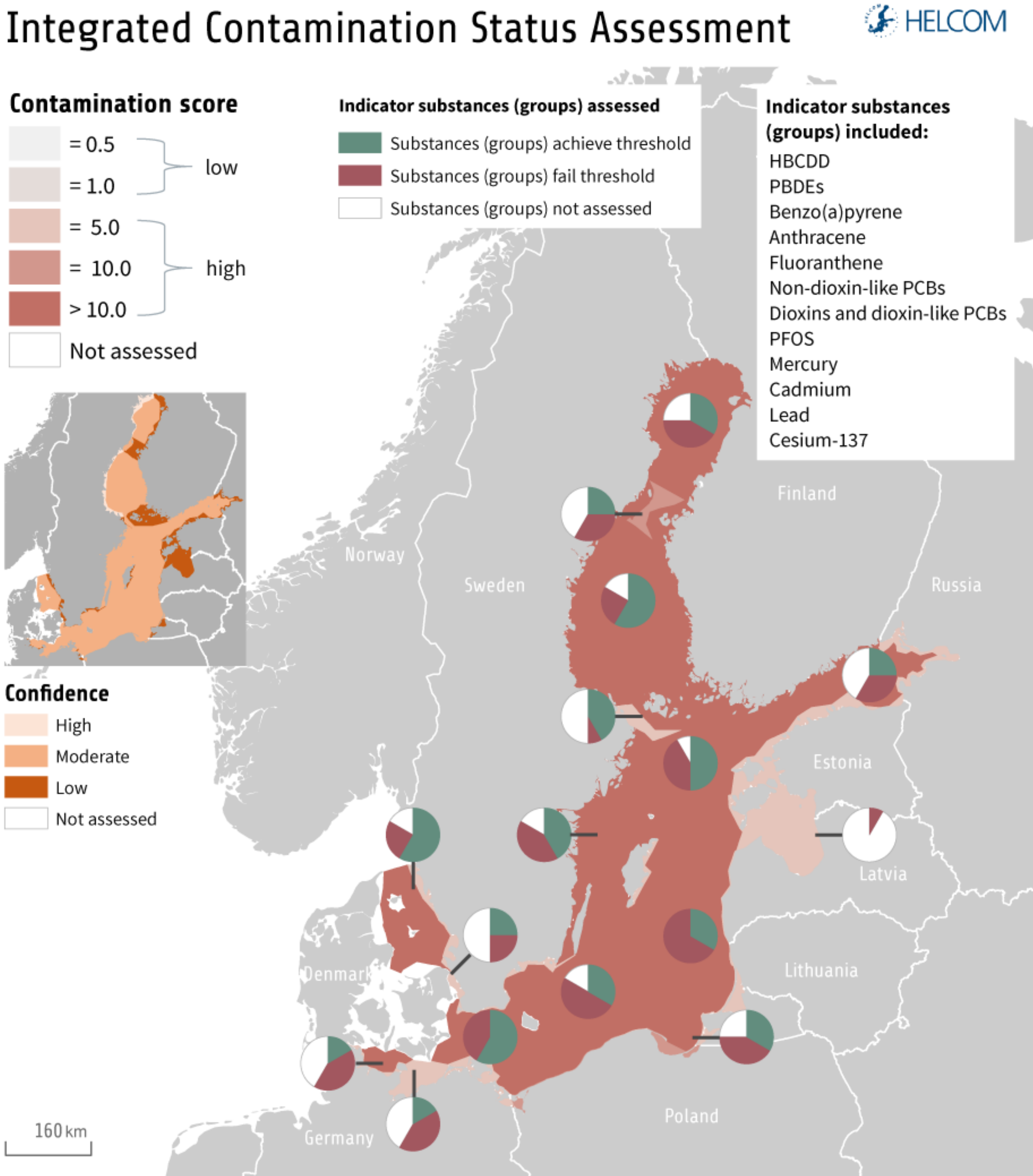

Figure 5. The integrated contamination status of the Baltic Sea assessed using the CHASE tool. The assessment shows that hazardous substances give cause for concern in all assessed units. The integrated assessment is based on seven core indicators integrating concentrations-to-threshold derived values (Contamination ratios) for twelve individual hazardous substances (or substance groups). The pie charts indicate how many out of the twelve substances were assessed, defining those that achieved (green) or failed (red) their respective threshold value in each of the open sea assessment units. The overall assessment is moderated by a parallel assessment of confidence (see left inset map) and can be considered as an appraisal of the data coverage and quality in any given assessment unit. For Denmark the assessments of hazardous substances have been done in accordance with the Water Framework Directive due to consideration of the national management of the coastal and territorial waters. The assessment can be found in the Danish national River Basin Management Plans.

Polybrominated diphenyl ethers (PBDEs) have mainly been used as flame retardants in plastic materials and polyurethane foams, and enter the Baltic Sea through waste water treatment plants and diffuse sources. The use of polybrominated diphenyl ethers as flame retardant has been banned in most products in Europe since 2004. Therefore, decreasing concentrations are expected in the future.

The main source of heavy metals, such as mercury, is burning of fossil fuels, which enter the Baltic Sea through atmospheric deposition. Mercury is currently legally used in some applications such as low-energy light sources for example, but its use in several previous industries, including amalgams in dentistry, electrodes in paper bleaching, and thermometers, have been phased out.

The matrix 'biota' was commonly classified as having the worst status, and was thus a strong driver of the overall contamination status.

Biota was recorded as worst in thirty-three out of the forty-nine assessed units, with sediment and water being worst in two and fourteen units, respectively (see Annex 1). A similar result can be observed at the indicator level, as well, as seen for open sea areas presented in Table 9 (for maps on this aspect, see the indicator reports). At the indicator level there are, however, also some obvious exceptions to this, such as anthracene in sediments in more southerly regions, cadmium in sediments in more northerly regions, and radioactive substances in seawater. Tributyltin (TBT)[10] also shows highest values in sediments (not included in the integrated assessment). However, in many of these cases, the pattern is also indicative of the sampling matrix most commonly used.

[10] Included as test.

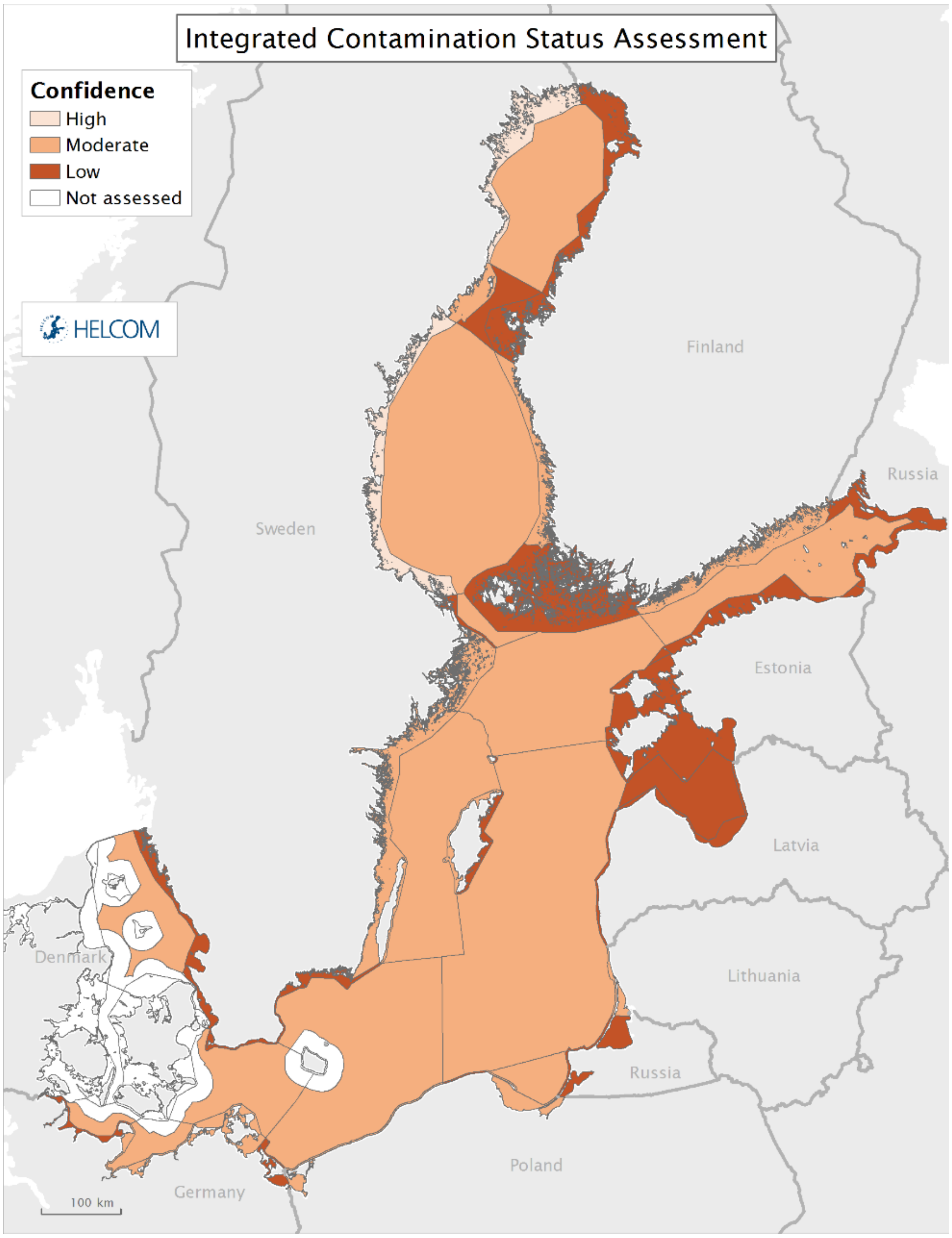

Figure 6. Confidence map derived from the CHASE integrated assessment of hazardous substances at the HELCOM assessment scale 3. The integrated assessment of contamination status is based on data series from seven core indicators, encompassing 12 substances (substance groups), during the period 2011-2016.

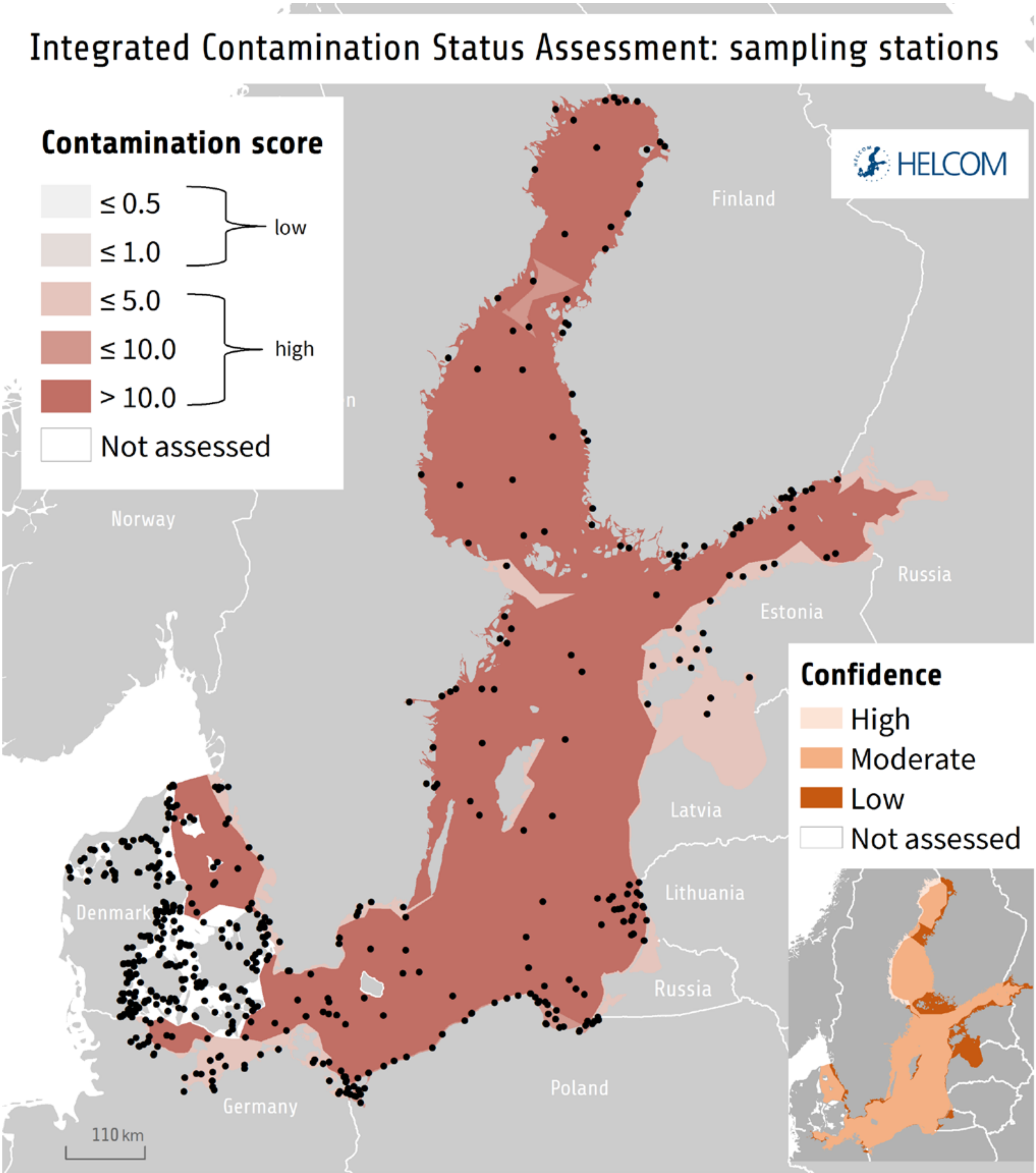

Figure 7. Integrated contamination status of the Baltic Sea assessed using the CHASE tool, indicating the spatial coverage of monitoring stations used for the HELCOM core indicators. Note 1: Not all stations are sampled for all parameters and the stations presented may be sampled for 1-12 of the substances or substance groups and may contain different data series types ('full' or 'initial') dependent on substance/substance group or matrix. The integrated assessment of contamination status is based on data series from seven core indicators, encompassing 12 substances, during the period 2011-2016. The confidence in the status assessment is indicated in the map in the lower right corner. Note 2: Some assessment units at scale 3 are also assessed in the integrated assessment despite no sampling station occurring in the specific scale 3 unit. These scale 3 assessment units are assessed since radioactive substances are assessed at scale 2 and applied to all scale 3 assessment units. These assessment units receive penalties for not meeting the minimum confidence requirements, as can be seen in the confidence map.

4.1 MORE DETAILED RESULTS FROM THE INTEGRATED ASSESSMENT

All open sea assessment units were classified as of low status (having high contamination scores), with eleven of the assessed open sea areas being within the worst status category (CS >10, see Table 3), one within the intermediate low status category (CS 5-10), and four within the least low status category (CS 1-5). Of the open sea assessment units the Kiel Bay, Eastern Gotland Basin and Bothnian Bay were classified as the most contaminated. It should however be noted that those areas exhibiting lower contamination scores (i.e. relatively better status) were also generally of lower confidence status or have confidence penalties applied (see Annex 2). It is thus conceivable that contamination status could markedly change in these areas with greater sampling coverage.

In the open sea assessment units, biota was responsible for the 'worst' contamination values in all but 2 instances, The Quark and the Gulf of Riga, though it is important to note that these assessment units received the lowest confidence scores (see Annex 2 and Figure 6). Furthermore, biota is generally the most widely sampled matrix in the current assessment (see Figure 8). In the open sea assessment units PBDEs, radioactive substances and heavy metals commonly failed to meet their threshold values (fail status), as were assessment units for tributyltin (TBT and imposex indicator[11]), though the latter is not included in the integrated assessment.

In coastal areas all assessment units were also classified as low status (high contamination scores), with ten of the assessed areas being within the worst status category (CS >10, see Table 3), two within the intermediate low status category (CS 5-10), and twenty-one within the least low status category (CS 1-5). It should however be noted that those coastal areas exhibiting relatively better contamination status (i.e. smaller contamination scores) were also generally of lower confidence status or had confidence penalties applied (see Annex 3). It is thus conceivable that contamination status could markedly change in these areas with greater sampling coverage and this highlights the importance of the confidence moderation when carrying out the integrated assessment.

In coastal assessment units biota was responsible for all 'worst' contamination scores that were classified in the two most contaminated categories (i.e. CS 5 and above). Water was a strongly represented matrix in those assessment units classified in the least low status category (CS 1-5), though these assessment units were generally moderated by reduced confidence. This could relate to the current selection of substance-matrix combinations used in monitoring or the penalties applied for not meeting minimum criteria.

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[11] Included as test.

A more detailed summary of the data used for the CHASE integrated assessment is provided in Annex 4, with data sorted by waterbody. It is possible to examine which substance in each assessment unit is responsible for the highest contamination ration (CR).

Detailed results per core indicator and substance per open sea assessment unit are presented in Figure 8. The total range of contamination ratios for the HELCOM core indicators, by substance or substance group is shown in Figure 9 for all coastal and open sea assessment units.

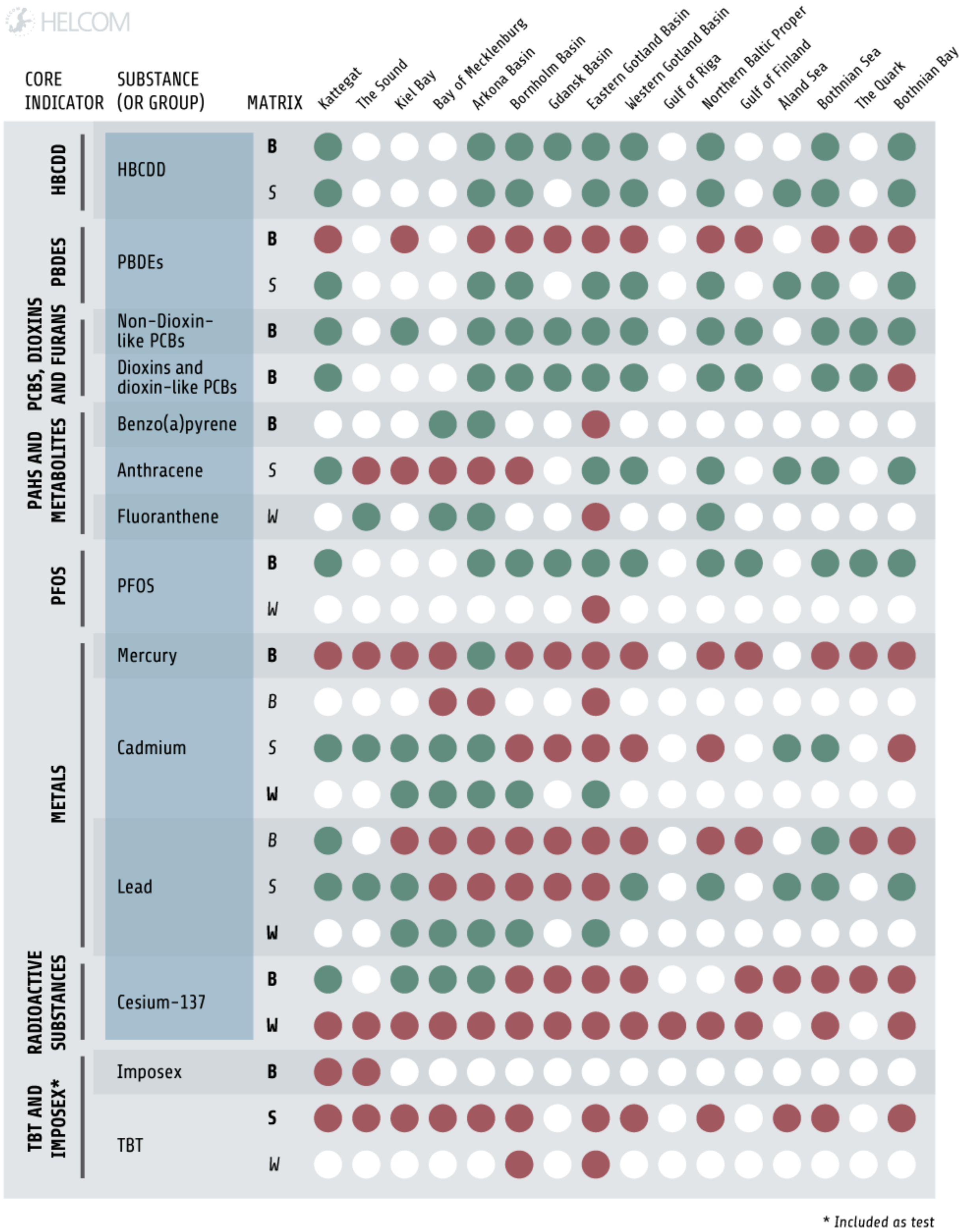

Figure 8. Detailed results for the hazardous substances assessment in the open sea assessment units, by core indicators and substances. Red denotes that the substance fails the threshold value, and green denotes that threshold value is achieved. White circles are shown for units not assessed due to a lack of data. The core indicators have primary and secondary substances and threshold values. Primary substances and the matrix in which the primary threshold is set are shown in bold. Secondary substances and threshold values are shown in italics. Abbreviations used for matrices: B=biota; S=Sediment, W=Water, for substances (or groups): BCDD = hexabromocyclododecane, PBDEs = polybrominated diphenyl ethers, PCBs = polychlorinated biphenyls, PAHs = polyaromatic hydrocarbons, PFOS = perfluorooctane sulphonate, TBT = tributyltin. The twelve substances (or groups) used in the integrated assessment are marked with pale blue shading.

4.2 COMPARISON TO PREVIOUS ASSESSMENT

The overall contamination status has not changed markedly since the previous holistic assessment (HELCOM 2010b), showing that contamination from hazardous substances still gives cause for concern throughout the Baltic Sea area.

Based on an analyses at core indicator level, the situation seems, however, not to be deteriorating. Out of 559 data series analysed with respect to trends over time, close to half (236) showed downward trends, 311 showed no detectable trend, and only 12 showed upward trends (Figure 10).

Due to the methodological differences between assessment periods, it is not possible to make a direct comparison between the current (2011-2016) and the previous holistic assessment. For example, there has been a development of regionally agreed threshold values, different substances or substance groups are sampled, and there is a substantial increase in the monitoring data included in the assessment.

The method developments represent improvements to ensure that future assessments, particularly assessments of measures or progress towards threshold values, will be continuously more viable, and to follow the societal development in how hazardous substances are used and managed. Developments in recent years have also enabled a more extensive monitoring, so that the spatial and temporal sampling coverage of the current substances or substance groups is on a generally much greater scale, indicated by the several thousand data series included in this assessment (discussed in detail below) compared to less than 150 data series used in the previous assessment. Over time, longer assessment periods will also allow larger numbers of data series to have statistical trends assigned in the future, and offer greater insights into the behaviour and trends of hazardous substances.

Changes can, however, be seen with respect to selected aspects. For example, polychlorinated biphenyls (commonly known as PCBs) and dioxins were identified amongst the substances having highest contamination ratios in the previous assessment (HELCOM 2010b), but PCBs, dioxins and furans do to not appear to be a major driver of the integrated assessment status in 2011-2016 (Figure 8).

Although 14 of 61 HELCOM scale 4 assessment units still fail the threshold value, the dominant status across the region indicates that the threshold value is achieved. Furthermore, of the 149 data series utilised in this indicator, 15 downward trends, 25 no detectable trends, and zero upward trends were recorded, the remaining data series being treated with the methodology for initial data.

Other substances or substances groups categorised as distant from their threshold values in the 2010 assessment were lead, mercury, cadmium, tributyltin[12] (TBT) and cesium-137. These substances or substance groups generally remain pertinent in the current assessment with lead, cadmium and TBT failing to achieve their specific threshold values in numerous HELCOM scale 4 assessment units (see indicator reports). However, mercury, polybrominated diphenyl ethers (PBDEs), and radioactive substances are the major drivers of the degraded status in the current integrated assessment (Figure 8).

In addition, a number of substances that were assessed in the initial holistic assessment (HELCOM 2010b), such as hexachlorocyclohexane (HCH, lindane) and dichlorodiphenyltrichloroethane (DDT) and its metabolites are no longer considered to be of significant concern. Substances that appear to have decreased in concern, however, still warrant careful future checking and monitoring, to ensure that concentrations remain low and that alternative or secondary sources do not result in degraded environmental status. For example, hexachlorobenzene has recently been recorded at increasing levels in air at some European monitoring stations and concentrations in sediment have been found to increase in at Swedish offshore sampling stations (EMEP 2017, Apler and Josefsson 2016).

The consideration of substances as no longer of concern, in conjunction with the promising number of downward trends recorded in this assessment, and observed ecosystem responses such as improved breeding success in the white-tailed sea eagle that has been attributed to reductions in DDT compounds, would suggest that policy and measures are facilitating steps towards improved status. Overall this would suggest that while hazardous substances in the Baltic Sea remain a major concern in all assessed areas, Those substances most distant from their threshold values and failing the threshold value (based on the whole regional scale) are PBDEs, mercury, cesium-137 and TBT[13]. (Figure 9). This also highlights the specific behaviour (and environmental recovery due to banning) of substances or substance groups, for example HBCDD and PBDEs that show very different status in the current assessment. Although this may in part relate to the potentially highly precautionary threshold currently applied to PBDEs in biota it is important to understand the factors underlying the recorded trends when exploring reasons behind ecosystem recovery and when planning appropriate measures, and such aspects may warrant further exploration.

[12] Included as test.
[13] Included as test.

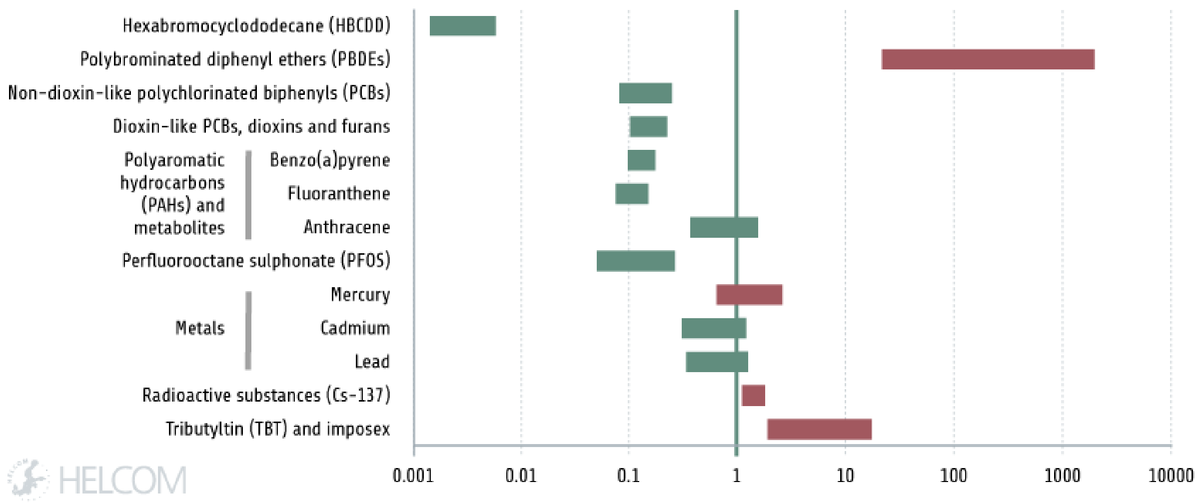

Figure 9. Range of contamination ratios of the evaluated hazardous substances. The contaminant ratios are the observed concentration value divided by the threshold value, based on the mean concentrations for the assessment period 2011-2016. The horizontal bars show the range of contamination ratios from percentile 20 to 75 for each substance on a log-transformed scale. Red bars indicate that the median value fails the threshold value, as identified by the green line. The figure is based on the coastal and open sea data used in the integrated assessment. In addition, corresponding results for the core indicator on tributyltin[14] and imposex, which is not used in the integrated assessment, is presented. The core indicators are presented in more detail in the Core indicator reports (HELCOM 2018b-i).

The specific trends for each of these substances or substance groups, for all the HELCOM core indicators, are detailed below.

4.3 CONFIDENCE IN THE ASSESSMENT

The integrated results for the geographical areas are regionally comparable, however the variation in confidence needs to be considered. Assessment units with lower confidence generally showed better status than those with high confidence, which can partly be attributed to the absence of monitoring of polybrominated diphenyl ethers or mercury, the two substances generally being the furthest from their respective threshold values, in these areas. Polybrominated diphenyl ethers and mercury were highly influential in areas being assessed as not achieving good status in all areas where they were monitored.

The confidence in the status evaluation is based on the confidence in the threshold value and the confidence in the overall status assessment, which are combined to give an overall confidence status. As part of this, the data type used in the indicator evaluation is appraised for each assessment unit based on the data abundance and type of data series

[14] Included as test.

available. Furthermore, calculated confidence values are assigned a penalty resulting in a further reduced confidence where existing data do not cover all key substances.

Assessment units with lower confidence generally showed better status (lower contamination scores) than those with high confidence (see Figure 2 and 5). This can partly be attributed to the absence of monitoring of polybrominated diphenyl ethers (PBDEs) or mercury (Hg), the two substances generally furthest from their respective threshold values, in these assessment units. Of 25 assessment units showing better contamination scores (≤5.0), PBDEs were not assessed in any assessment units and Hg was only assessed in 12. In such instances, the absence of one or both of these substances or substance groups within the evaluation, results in a better overall assessment status; though confidence in the status assessment is generally lower (20 with low and 5 with intermediate confidence). The most optimal scenario would be for the integrated assessment of contamination status to be based on all 12 substance (substance groups) that compose the HELCOM core indicators in all assessed regions of the Baltic Sea. While confidence is currently set for each data item that entered into the CHASE assessment, and penalties are applied if only a limited number of substance groups have been evaluated, there is clear variation in the number of substances assessed within each area. For example, the number of evaluated substances (or groups) differs between different open sea assessment units (Figure 4), and this will have an impact on the overall confidence of the assessment. Furthermore, an important consideration should also be that while this integrated assessment covers a wide range of important substances there are an extensive number of hazardous substances that are currently not monitored through agreed regional actions (thus not included in this assessment), in addition to an array of emerging contaminants that may also be pertinent for the ecosystem, and this integrated assessment thus offers a good summary assessment for the compounds included only.

The balance between the assessment status and the confidence status (Figures 5-6) is a vital consideration when using these results, as it clarifies the likelihood for the status assessment to be incorrectly presented based on the rules defined above. Thus assessment units in which few data series are available, where penalties are applied for missing the minimum criteria for included compounds, or where 'initial' data series dominate the assessment, will be assigned low confidence and should be treated with caution. This approach allows a wide range of spatial data to be incorporated into the assessment while tempering the status assessment through an assigned confidence.

In future assessments it may be pertinent to consider further development of the confidence setting protocols. For example, the setting for the confidences in the threshold values could be developed to reflect the fact that BAC threshold values (assessing close to background levels) may be more protective than ecotoxicological threshold values in some instances, to determine if specific study derived threshold values warrant higher confidence, to reflect those threshold values due or undergoing review, and to alter the penalty system so that the penalty is applied where two different heavy metals or three different organic contaminants are not included in a single assessment unit.

Furthermore, the penalty application could be further developed to define specific substances or substance groups from the current indicator evaluation, or from the previous integrated assessment (e.g. PBDEs or Hg), with known importance, which if missing in an assessment unit result in a penalty application.

Chapter 5. Indicator evaluations

A brief summary of each HELCOM hazardous substances indicator is given below. The full indicator reports are available via the designated HELCOM indicator webpage (http://www.helcom.fi/baltic-sea-trends/indicators/), through which the key message, policy relevance, specific details on sampling and methodology, detailed results, and discussion on the substances and substance groups can be found.

Altogether, 2,517 individual contaminant data series were assessed to produce the hazardous substances core indicator evaluations of this assessment. Of these data series, 559 of were classified as full data to which trends could be assigned and 1,958 were treated with the methodology for initial data. In all cases, as status assessment was made the underlying methodology differed (See section 3.5 and summary provided per indicator substance in Annex 5). Out of the 559 data series, 236 downward trends, 311 series with no detectable trend, and only twelve upward trends were detected (Figure 10).

However, the classification of indicator on radioactive substances is not done using the same statistical analysis as carried out for the other core indicator substances or substance groups (i.e. the MIME tool), but assessed by eye from the data series included.

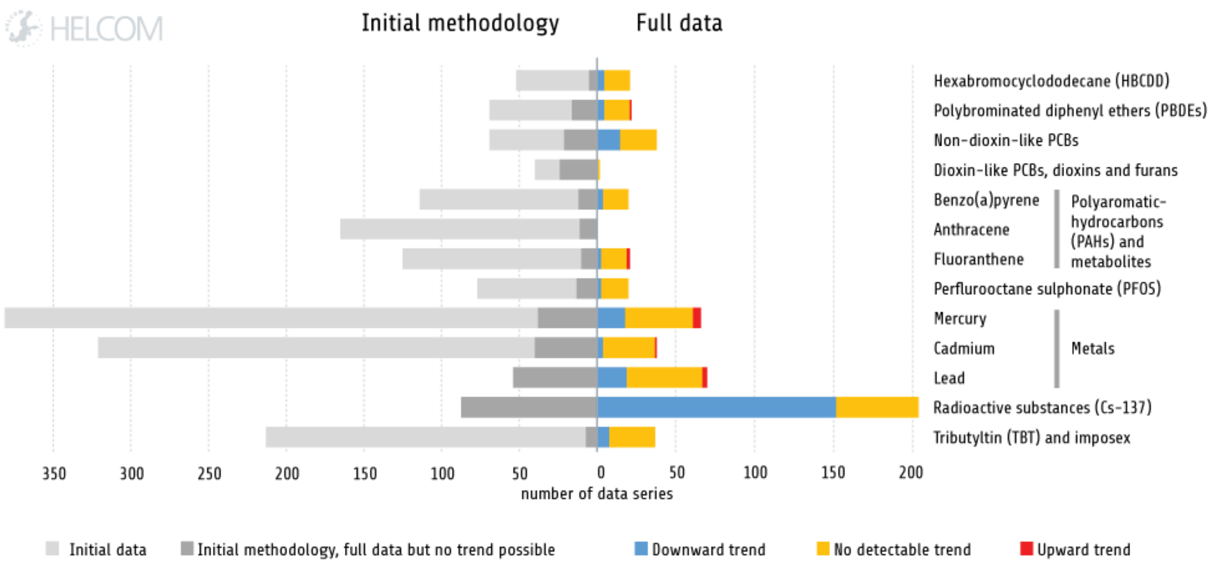

Figure 10. Trends in indicator substances or substance groups shown as counts of data series based on the type of assessment methodology applied. The available data for which the trends are calculated differ between substances and stations, covering roughly the following years for each substance; polybrominated diphenyl ethers (PBDEs): 1999–2016; mercury: 1979–2016; cadmium: 1985–2016; lead: 1979–2016; hexabromocyclododecane (HBCDD): 1999–2016; perfluorooctane sulphonate (PFOS): 2005–2016; benzo(a)pyrene: 1997–2016; anthracene: 1990–2016; non-dioxine-like polychlorinated biphenyls (PCBs): 1978–2016; fluoranthene: 1997–2016, Cesium-137: 2011-2016, and for Tributyltin (TBT) and imposex: 1998–2016.

In the following sections each hazardous substances indicator is briefly reviewed. Further detailed information elaborating the methodologies, threshold values and evaluation results can be found on the designated HELCOM indicator webpage http://www.helcom.fi/baltic-sea-trends/indicators/.

5.1 HEXABROMOCYCLODODECANE (HBCDD)

Hexabromocyclododecane (HBCDD) is a persistent, bioaccumulating and toxic substance with possible impacts on the reproductive and developmental system. It is a brominated flame retardant which is used in insulation material for the construction industry and as textile coating to improve the fire resistance of materials. HBCDD is placed on the Stockholm Convention list of chemicals for which measures are required to eliminate their use and production, and for the use of which specific exemption permits are required. Levels of HBCDD are below the threshold value in biota, which is set to protect the marine ecosystem and humans consuming fish, from adverse effects (Core indicator report; HELCOM 2018b Figure 11) and are below the QS threshold value for sediments, indicating that overall this substance achieves the threshold (One-out-all-out combination of all matrix-threshold values per assessment unit). The monitoring of HBCDD concentrations in biota mainly show no detectable trends and in some cases even downward trends. A detailed description can be found at the HELCOM indicator webpage http://www.helcom.fi/baltic-sea-trends/indicators/.

Several other man-made brominated substances have been found in the environment, but little is yet known on their effects on the environment, or on human health. To keep up with the developments and the emerging risks from novel substances such as these, there is a need to continue and further develop collaborative monitoring and mapping of their occurrence and use in the Baltic Sea region (Kemikalieinspektionen 2017a, Gustavsson *et al* 2017).

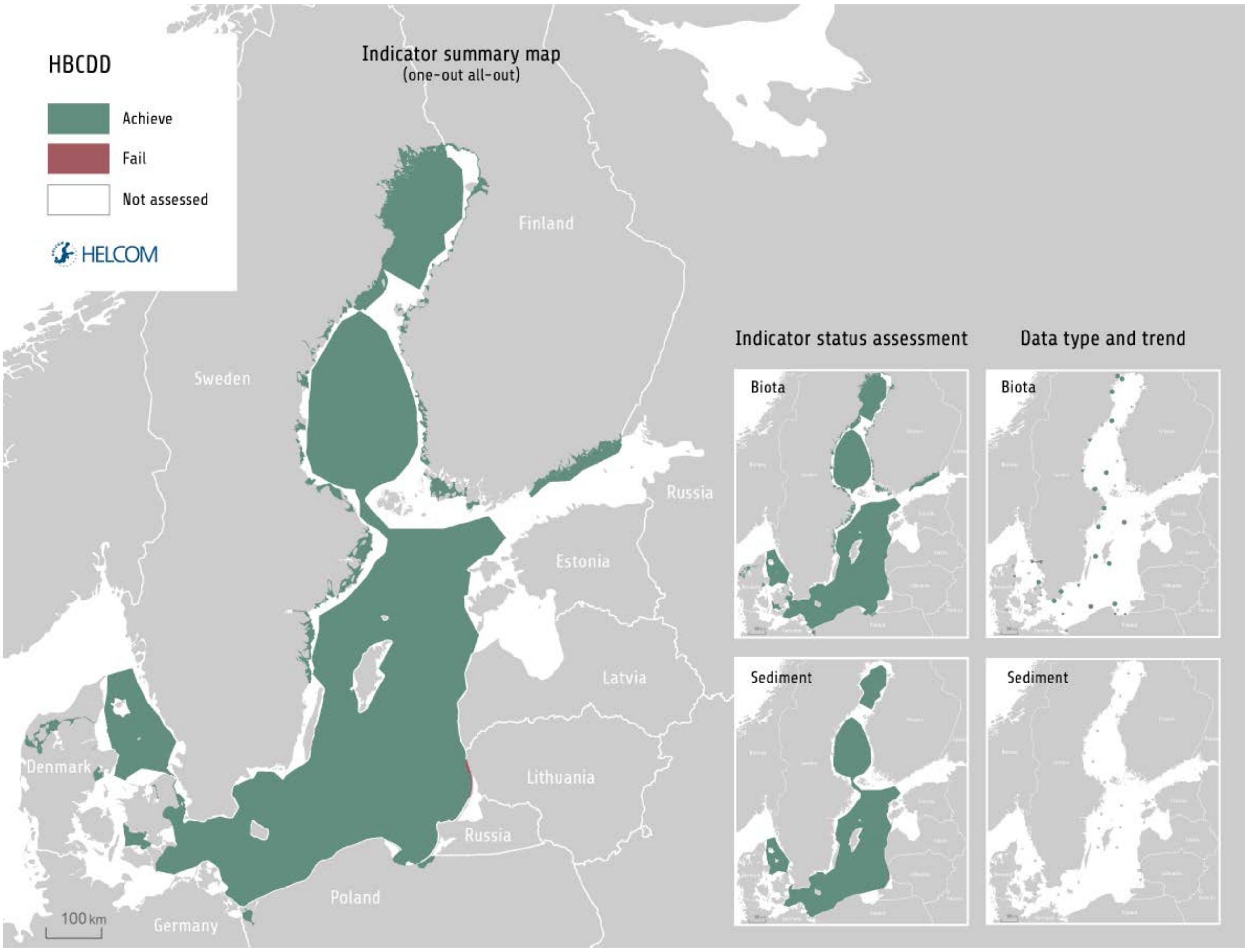

Figure 11. Status assessment for hexabromocyclododecane (HBCDD). The one-out-all-out approach is used to summarise all matrix-threshold combinations (main map), with the primary threshold in biota (top inset row) and secondary threshold in sediment (bottom inset row) also shown. Status is evaluated in biota based on HBCDD concentrations in herring, cod, flounder, dab, eelpout and perch. Green colour indicates that the measured HBCDD concentrations are below the threshold value (achieve the threshold). Symbols on map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectable trends.

5.2 POLYBROMINATED DIPHENYL ETHERS (PBDEs)

Polybrominated diphenyl ethers (PBDEs) are toxic and persistent substances which bioaccumulate in the marine food web. The sum of six PBDE congeners are compared to the threshold value. The threshold value for biota is an environmental quality standard set to protect both the marine ecosystem, and humans consuming fish, from adverse effects. It is currently due for scientific re-assessment.

Polybrominated diphenyl ethers fail the threshold value for biota in all areas where they are monitored (Core indicator report; HELCOM 2018c, Figure 12). For sediments, the threshold value is achieved. For example the green area in the indicator summary map around the Åland Sea reflects an assessment based on the secondary threshold value in sediments, while there is a lack of data from biota in that area.

In addition to polybrominated diphenyl ethers, several other man-made brominated substances have been found in the environment, but little is yet known on their effects on the environment and human health. To keep up with the developments and the emerging risks from such novel substances, it is important to continue and develop further collaborative monitoring and to map their occurrence and use in the Baltic Sea region (Kemikalieinspektionen 2017a, Gustavsson et al. 2017).

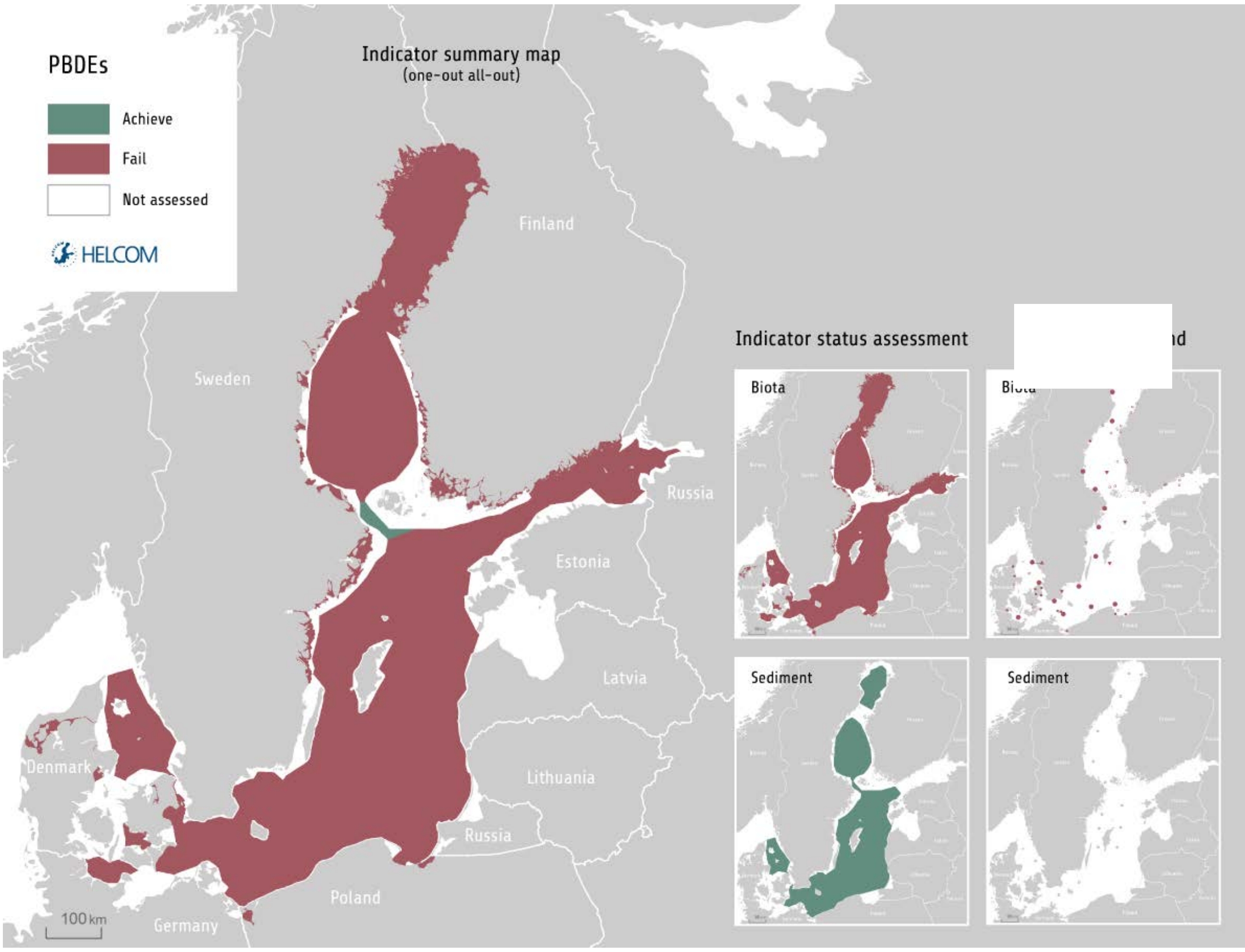

Figure 12. Status assessment for polybrominated diphenyl ethers (PBDEs). The summary map (main map) shows the status assessed by the one-out-all-out approach, meaning that the matrix-threshold combination with the worst status is shown for each assessment unit. Status based on the primary threshold in biota (top inset row) and secondary threshold in sediment (bottom inset row) is also shown. Status in biota is evaluated in herring, cod, flounder, dab, eelpout and perch. Red colour indicates that PBDEs fail the threshold value and green colour indicates that the measured PBDEs concentrations are below the threshold value (achieve the threshold). Symbols on map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectible trends. For more details, see HELCOM (2018c).

5.3 PCBs, DIOXINS AND FURANS

Polychlorinated biphenyls (PCBs) are persistent, toxic substances and bio-accumulate in the marine food web. The substances have been used in a wide variety of applications and manufacturing processes, especially as plasticizers, insulators and flame-retardants. Polychlorinated biphenyls enter the marine environment due to inappropriate handling of waste material or leakage from transformers, condensers and hydraulic systems. Dioxins (PCDD/Fs) were never produced intentionally, but they are minor impurities in several chlorinated chemicals (e.g., PCBs, chlorophenols, hexachlorophene, etc.) and are formed in several industrial processes, mainly from combustion processes.

HELCOM has recommended bans and restrictions on transport, trade, handling, use and disposal of polychlorinated biphenyls. The HELCOM Ministerial Declaration of 1998, and the 1995 'Declaration of the Fourth international conference of the protection of the North Sea' called for measures against persistent, bioaccumulating toxic substances like PCBs by the year 2020. The Stockholm Convention on Persistent Organic Pollutants is ratified by the Baltic Sea countries to protect human health and environment and PCBs are placed on the Stockholm Convention list of chemicals for which measures are required to eliminate their use and production, and for the use of which specific exemption permits are required.

Non-dioxin-like PCBs were assessed in relation to a threshold value that is based on food safety, showing values above the threshold value in some areas (Core indicator report; HELCOM 2018d, Figure 13). Over time concentrations of non-dioxin-like PCBs showed no detectable trends or downward trends (Figure 10 and 13). Dioxins, furans and dioxin-like PCBs, were assessed against an EQS based on levels in foodstuffs (WHO TEQ). Similar to non-dioxin-like PCBs, some areas had concentrations above the threshold value. Even though the dioxin concentrations are below the EQS in many areas, dioxins are still considered to be one of the most problematic pollutants in the Baltic Sea for the marine environment.

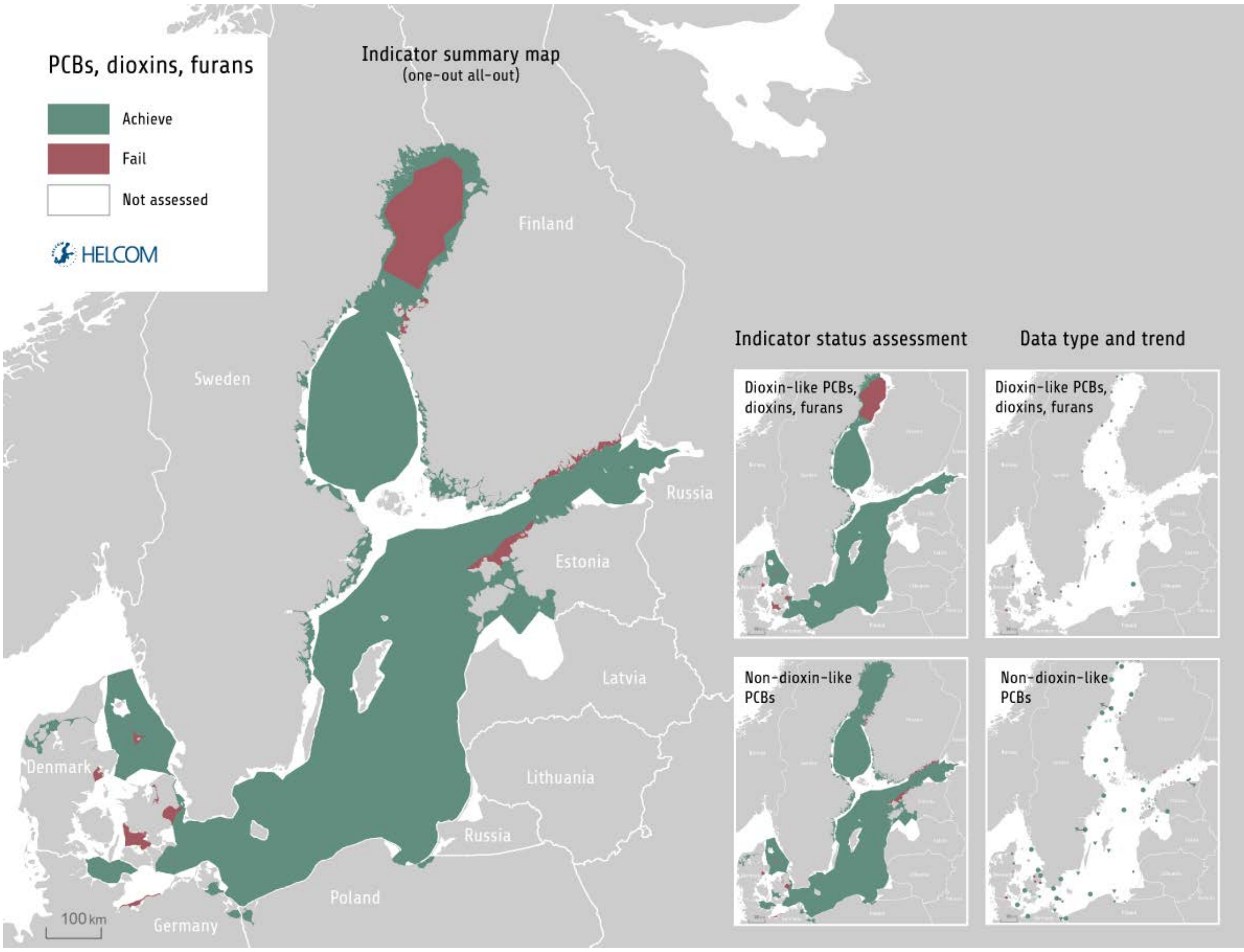

Figure 13. Status assessment for dioxin-like polychlorinated biphenyls (PCBs), dioxins and furans, and non-dioxin-like PCBs. The one-out-all-out approach is used to summarise all matrix-threshold combinations (main map), with the primary threshold in biota for dioxin-like polychlorinated biphenyls (PCBs), dioxins and furans (top inset row) and primary threshold in biota for non-dioxin-like PCBs (bottom inset row) shown. Status is evaluated in biota based on concentrations in herring, cod, flounder, dab, eelpout and perch. Red colour indicates that the threshold value is failed (i.e. concentrations are higher) and green colour indicates that the measured concentrations are below the threshold value (achieve the threshold). Symbols on map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectable trends.

5.4 POLYAROMATIC-HYDROCARBONS (PAHs) AND THEIR METABOLITES

Polyaromatic hydrocarbons (PAHs) with low-molecular-weight, such as anthracene, are acutely toxic to many marine organisms. High-molecular-weight PAHs, such as benzo(a)pyrene, are less toxic but have greater carcinogenic potential. PAHs enter the marine environment via the release of crude oil products and all types of incomplete combustion of fossil fuels – coal, oil and gas or wood and waste incineration.

Benzo(a)pyrene concentrations in shellfish are below the threshold value in all areas where measured, indicating that they will not cause adverse effects to the ecosystem or for humans consuming shellfish (Core indicator report; HELCOM 2018e, Figure 14). Four downward and 16 no detectable trends were observed in the current assessment (Figure 10).

When measurements of benzo(a)pyrene are not available, the secondary substances fluoranthene (in shellfish) and anthracene (in sediments) are considered. No detectable trends were recorded for anthracene, however, three downward, 16 no detectable trends and two upward trends were recorded for fluoranthene. Initial status assessments show that anthracene concentrations fail the threshold value in the southwestern Baltic Sea.

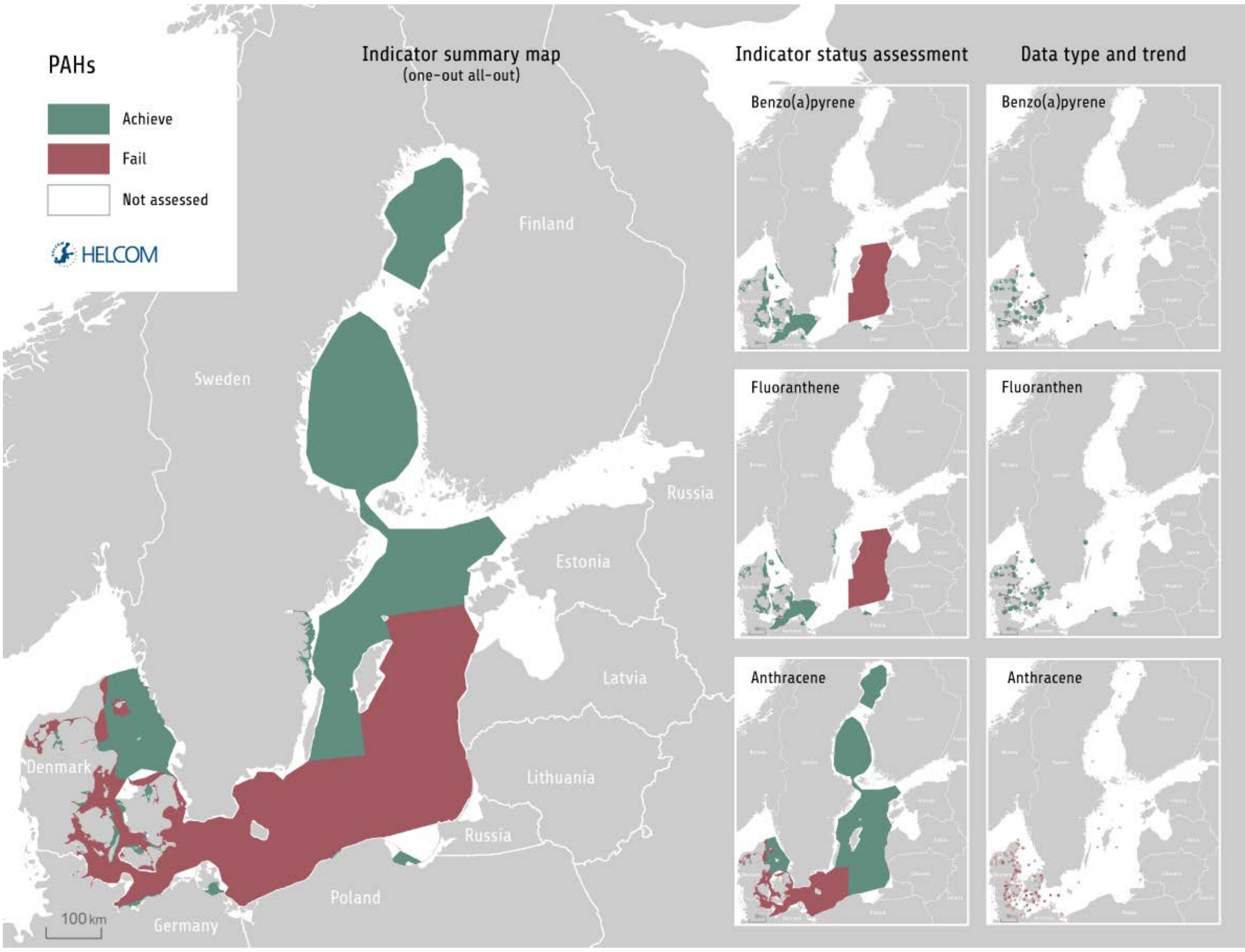

Figure 14. Status assessment for polyaromatic-hydrocarbons (PAHs). The one-out-all-out approach is used to summarise all matrix-threshold combinations (main map), with the primary threshold in biota for benzo(a)pyrene in crustaceans and molluscs (top inset row), secondary threshold for fuoranthene in crustaceans and molluscs (middle inset row), and secondary threshold for anthracene in sediment (bottom inset row). Red colour indicates that the threshold value is failed (i.e. concentrations are higher) and green colour indicates that the measured concentrations are below the threshold value (achieve the threshold). Symbols on map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectable trends.

5.5 PERFLUOROOCTANE SULPHONATE (PFOS)

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

Concentrations of perfluorooctane sulphonate are below the threshold value in biota in all the monitored areas (Core indicator report; HELCOM 2018f). However, concentrations in seawater exceed the threshold value (EQS for water) where measured, which is reflected in the red area in summary map (Figures 15). There are a few downward trends in biota but no general trends are detected (Figures 10, 15).

Perfluorooctane sulphonate has been banned in the EU since 2008 for most of its used categories, but it has been replaced with other similar substances (per- and polyfluoroalkyl substances; PFAS) which have widespread use. Most PFAS are highly persistent and bio-accumulating, and other PFAS (in addition to perfluorooctane sulphonate) are also a cause for concern. Some per- and polyfluoroalkyl substances (PFAS) are listed on the EU candidate list on 'Substances of very high concern' under the REACH regulation (ECHA 2017). Inclusion of additional PFAS as core indicators should be considered in the future to keep track of their use and occurrence in the Baltic Sea region.

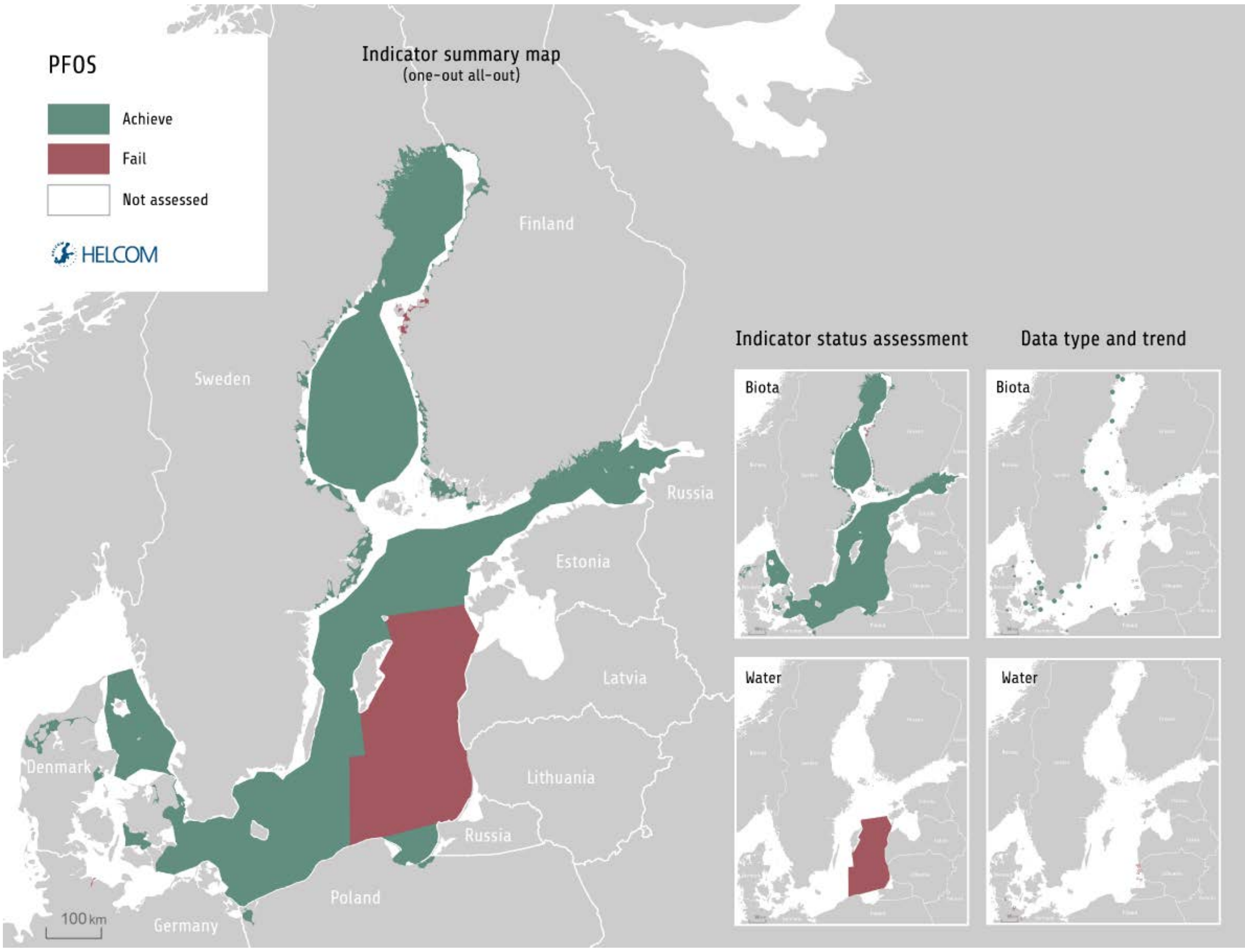

Figure 15. Status assessment for perfluorooctane sulphonate (PFOS). The one-out-all-out approach is used to summarise all matrix-threshold combinations (main map), with the primary threshold in biota (top inset row), secondary threshold in water (bottom inset row). Biota analyses is carried out in herring, cod, flounder, dab, eelpout and perch. Symbols on map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectable trends. For more details, see the Core indicator report; HELCOM 2018f).

5.6 METALS

Three heavy metals were assessed: mercury, cadmium and lead. The heavy metals are toxic and some are bio-accumulated in marine organisms, causing harmful effects. The severity of effect mainly depends on the concentration in the tissues. Additionally, both cadmium and mercury are known to biomagnify, meaning that their concentration levels increase in organisms higher up in the food web. A major current source of heavy metals is the burning of fossil fuels, leading to atmospheric deposition.

Legislation is in place to decrease inputs of mercury, cadmium and lead to the Baltic Sea. The atmospheric deposition of cadmium and mercury to the Baltic Sea has decreased since the 1990s (Figure 16). All three metals are addressed in the Baltic Sea Action Plan, included in the European Water Framework Directive (Lead and cadmium in water, mercury in biota), and represented in the Marine Strategy Framework Directive.

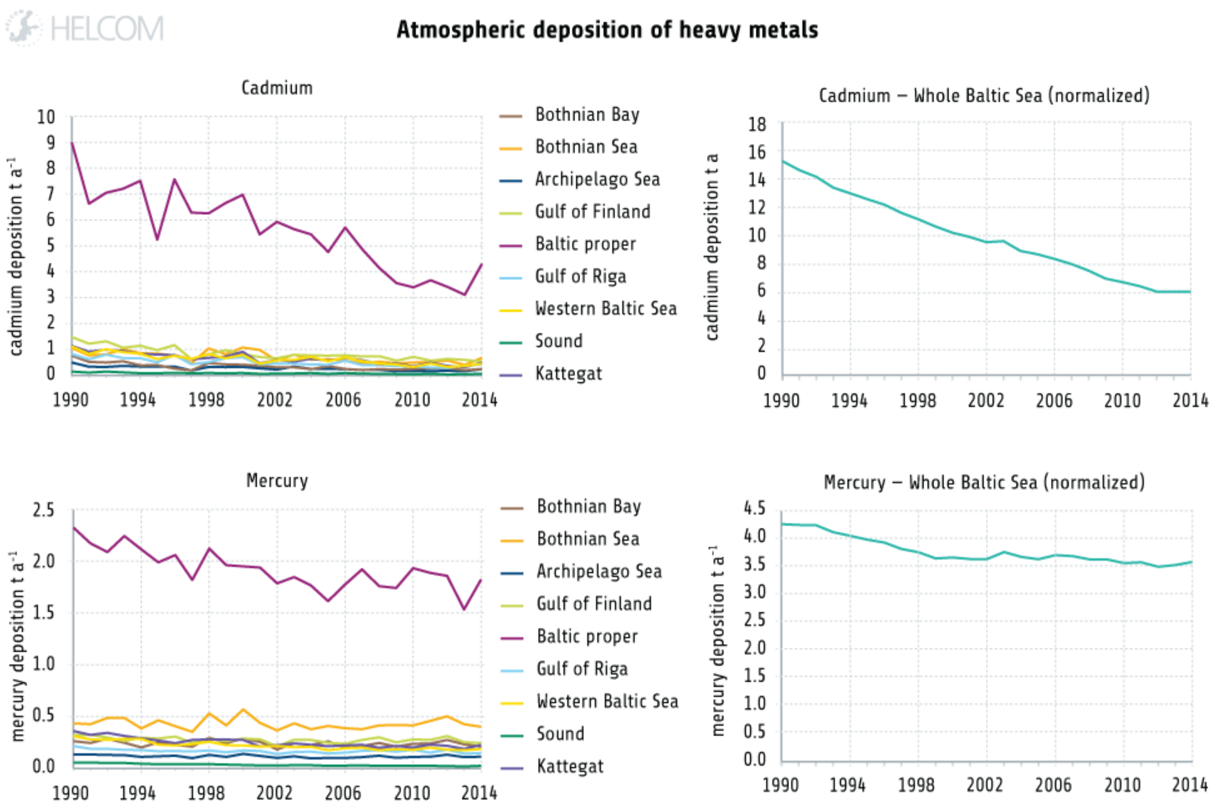

Figure 16. Temporal trend in the total annual atmospheric deposition of cadmium and mercury to the Baltic Sea sub-basins. The right hand figures show values for the whole Baltic Sea. These are given as normalised atmospheric deposition to reflect the deposition independently of variability between years in weather conditions. Note that the scales between figures differ. Source: HELCOM (2017).

In the core indicators, mercury is analysed in fish muscle as a primary matrix. The most common species in which it is measured are herring and cod in the open sea area and flounder and perch in coastal areas. Mercury concentrations in fish muscle exceeded the threshold level in almost all monitored sub-basins indicating not good status (Core indicator report; HELCOM 2018g, Figure 17). The threshold value was also failed in some of the coastal areas. Good status was only achieved in the Arkona Basin and in a few coastal Danish and Swedish areas. There is no common general trend for mercury in fish muscle for the investigated time series, though eighteen downward trends, forty-three no detectable trends and five upward trends were recorded.

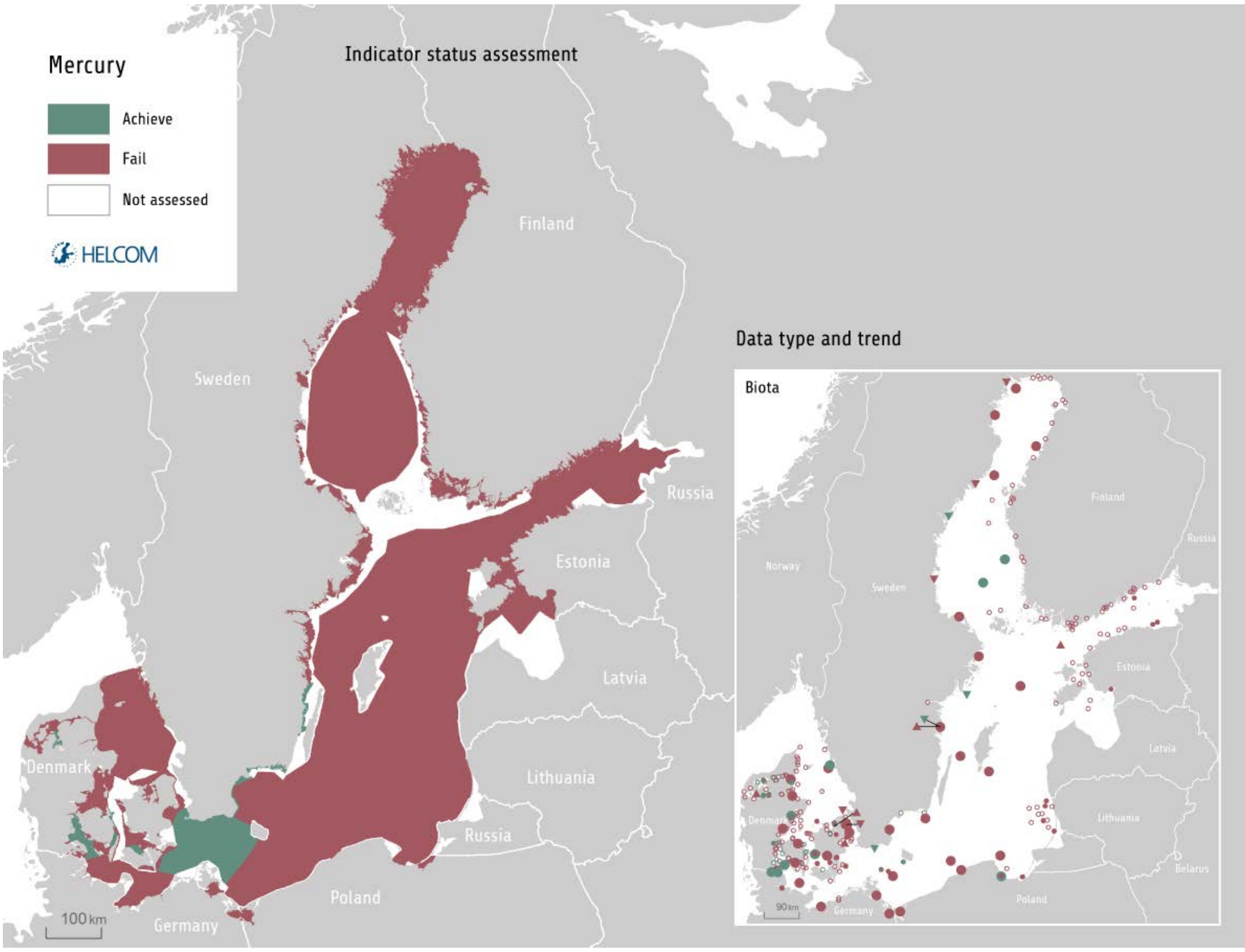

Figure 17. Status assessment for mercury (Hg). The status is assessed in biota: herring, cod, flounder, dab, eelpout, perch and mussels samples. Symbols on the smaller inset map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectable trends. For more details, see the Core indicator report; HELCOM (2018g).

For cadmium, data on concentrations in seawater, biota and sediment was used for the status assessment. Good status was not achieved in the Northern Baltic Proper, Western Gotland Basin, Eastern Gotland Basin, Gdansk Basin or Bornholm Basin, nor in some Polish, German and Danish coastal areas (Core indicator report; HELCOM 2018g, Figure 18). Only four downward trends were identified, with thirty-three not detectable trends and one upward trend recorded.

The primary matrix for cadmium is water, as the primary threshold value for the core indicator is agreed to be the EQS value for water. In the assessment period the monitoring of cadmium in seawater was carried out only by three countries: Germany, Lithuania and Poland. The integrated assessment based on Cd concentrations in seawater showed that good status was achieved in five basins: Eastern Gotland Basin, Bornholm Basin, Arkona Basin, Bay of Mecklenburg and Kiel Bay (Figure 18). The assessment of cadmium levels in biota was carried out only on the basis of Cd concentrations in mussels, which is the secondary matrix used for the assessment. Practically, in all areas, that is, in three sub-basins: the Eastern Gotland Basin, Arkona Basin and Bay of Mecklenburg and in coastal areas: Danish, German, Swedish and Polish, good status was not achieved (Figure 18). Only in few areas of Danish coastal waters Cd concentrations in mussels were below the threshold value. The assessment based on the Cd concentrations in bottom sediments showed that good status was achieved in the Bothnian Sea and in the Åland Sea in the north, and in the Arkona Basin, Bay of Mecklenburg, Kiel Bay, Great Belt, The Sound and Kattegat in the west.

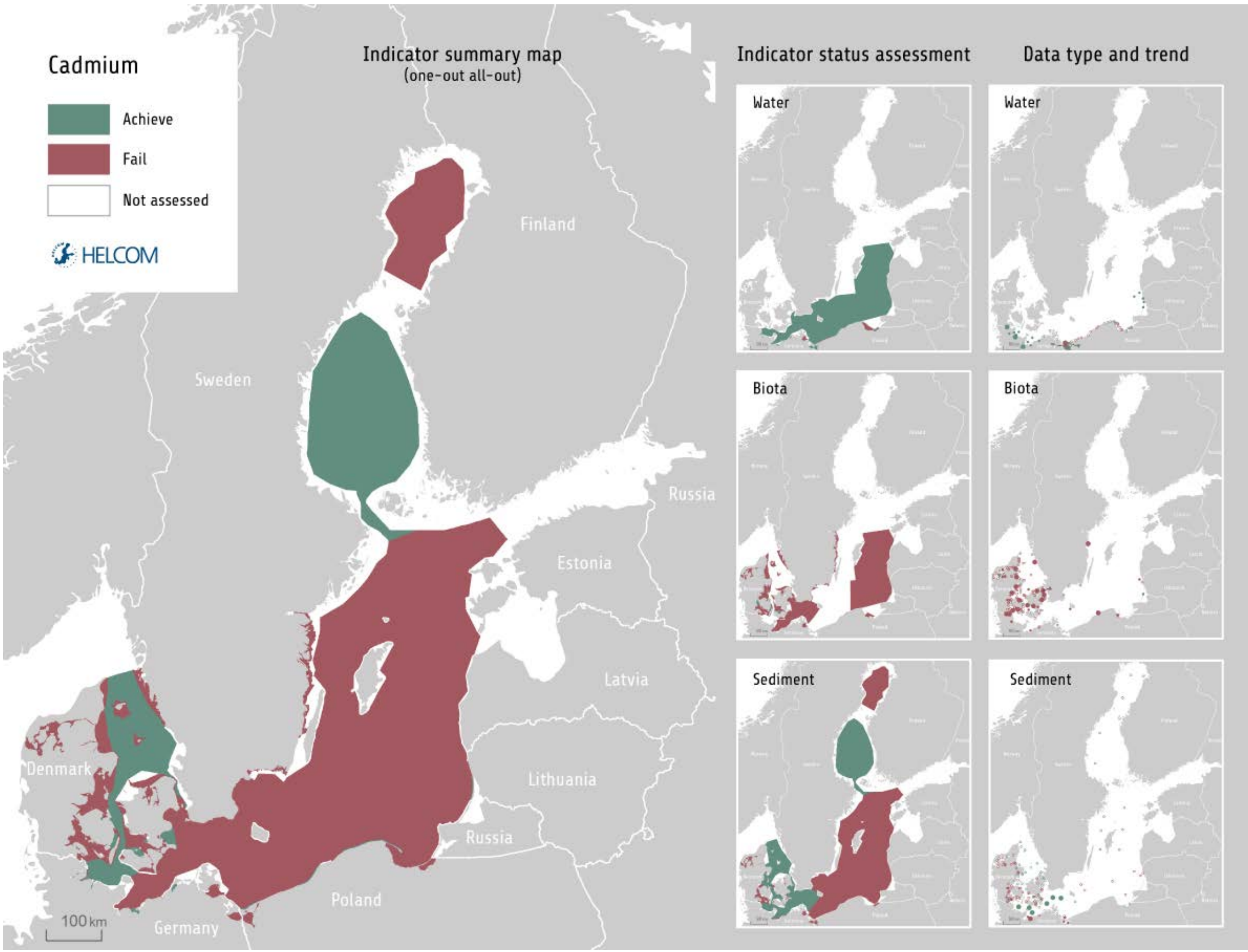

Figure 18. Status assessment for cadmium (Cd). The one-out-all-out approach is used to summarize all matrix-threshold combinations (main map), with the primary threshold in water (top inset row), secondary threshold in biota (middle inset row) and secondary threshold in sediment (bottom inset row) shown. Biota analyses is carried out on molluscs. Symbols on the map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectible trends. For more details, see HELCOM (2018g).

Lead is most widely sampled in biota and sediment. It generally fails the threshold value in biota, with the exception of the Kattegat Bothnian Sea, and a few coastal areas (Figure 19). No general trend can be shown, although there were nineteen downward trends, forty-eight no detectable trends and three upward trends detected.

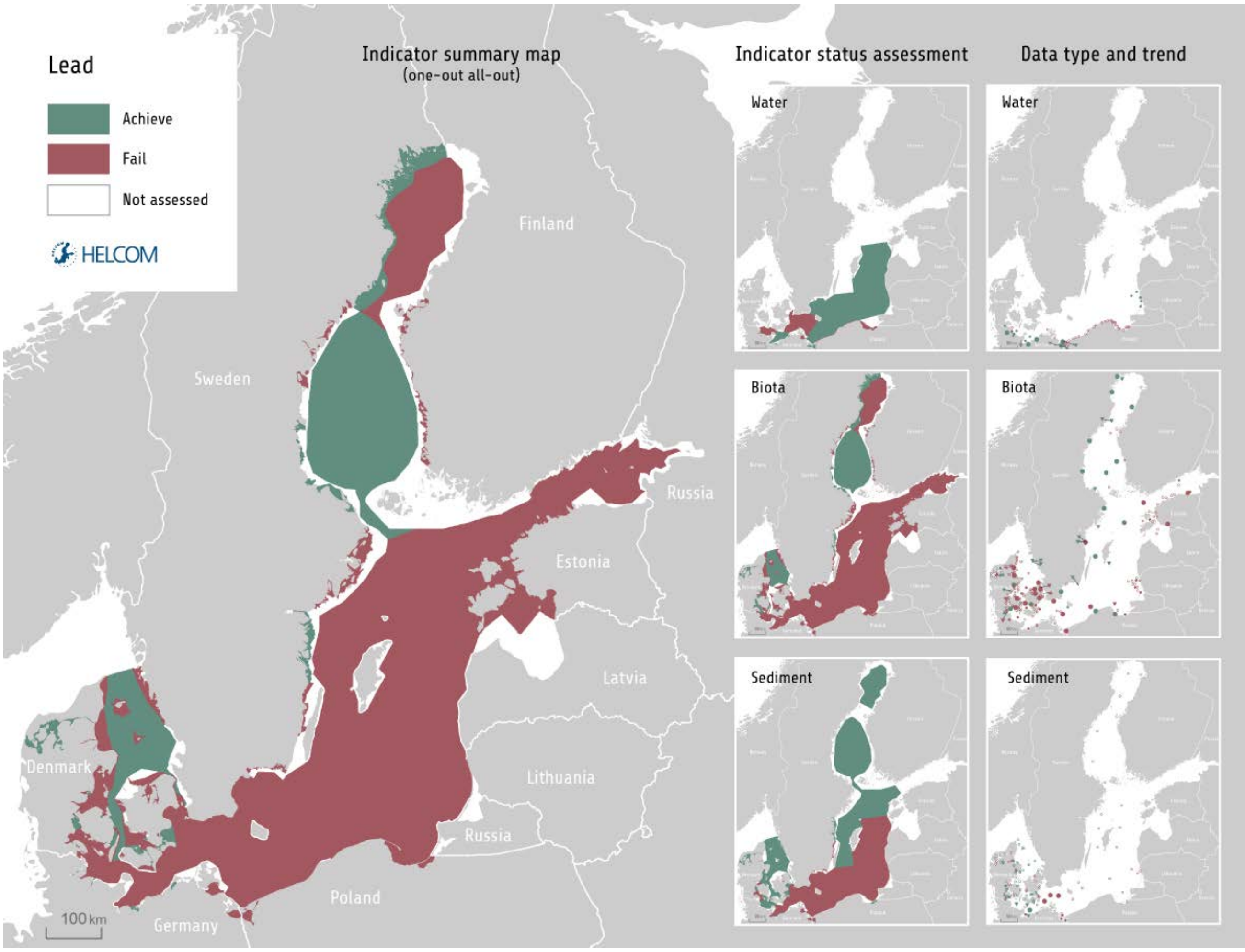

Figure 19. Status assessment for lead (Pb). The one-out-all-out approach is used to summarize all matrix-threshold combinations (main map), with the primary threshold in water (top inset row), secondary threshold in biota (middle inset row) and secondary threshold in sediment (bottom inset row) shown. Biota analyses was carried out on herring, cod, flounder, dab, eelpout, perch and molluscs. Symbols on map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectible trends. For more details, see HELCOM (2018g).

5.7 RADIONUCLIDES

Cesium (Cs-137) is the greatest contributor of artificial radionuclides to the Baltic Sea. It emits ionizing radiation, which can have effects at the cellular level and lead to internal damage of organisms. The radionuclide was deposited in the Baltic Sea after the Chernobyl nuclear power plant accident in 1986. Since then it has bio-accumulated in marine flora and fauna, and has been deposited in marine sediments. The concentrations in herring have decreased from the high values in the 1990s in all sub-basins (Figure 20).

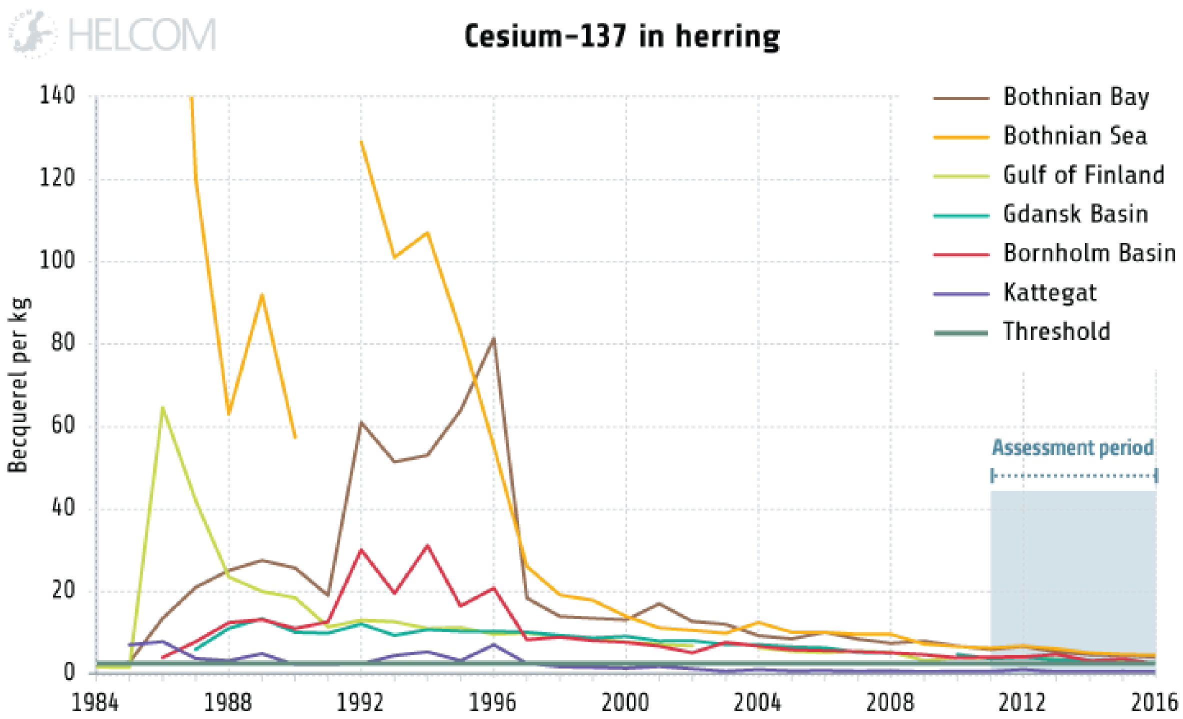

Figure 20. Temporal development of the mean concentration of cesium in herring (measured without head and entrails or in filets, by sub-basin). Concentrations are given as Becquerels per kilogram, calculated per wet weight. The green line shows the threshold value.

The concentrations of radionuclides are below the threshold value when measured in fish from the Arkona Basin, Bay of Mecklenburg and the Kattegat, indicating good status, but they are above the threshold value in all basins when measured in water (Core indicator report; HELCOM 2018h, Figure 21). Due to the steady half-life of radioactive decay it is expected that concentrations below the threshold value in biota and water may be achieved in all of the Baltic Sea by 2020.

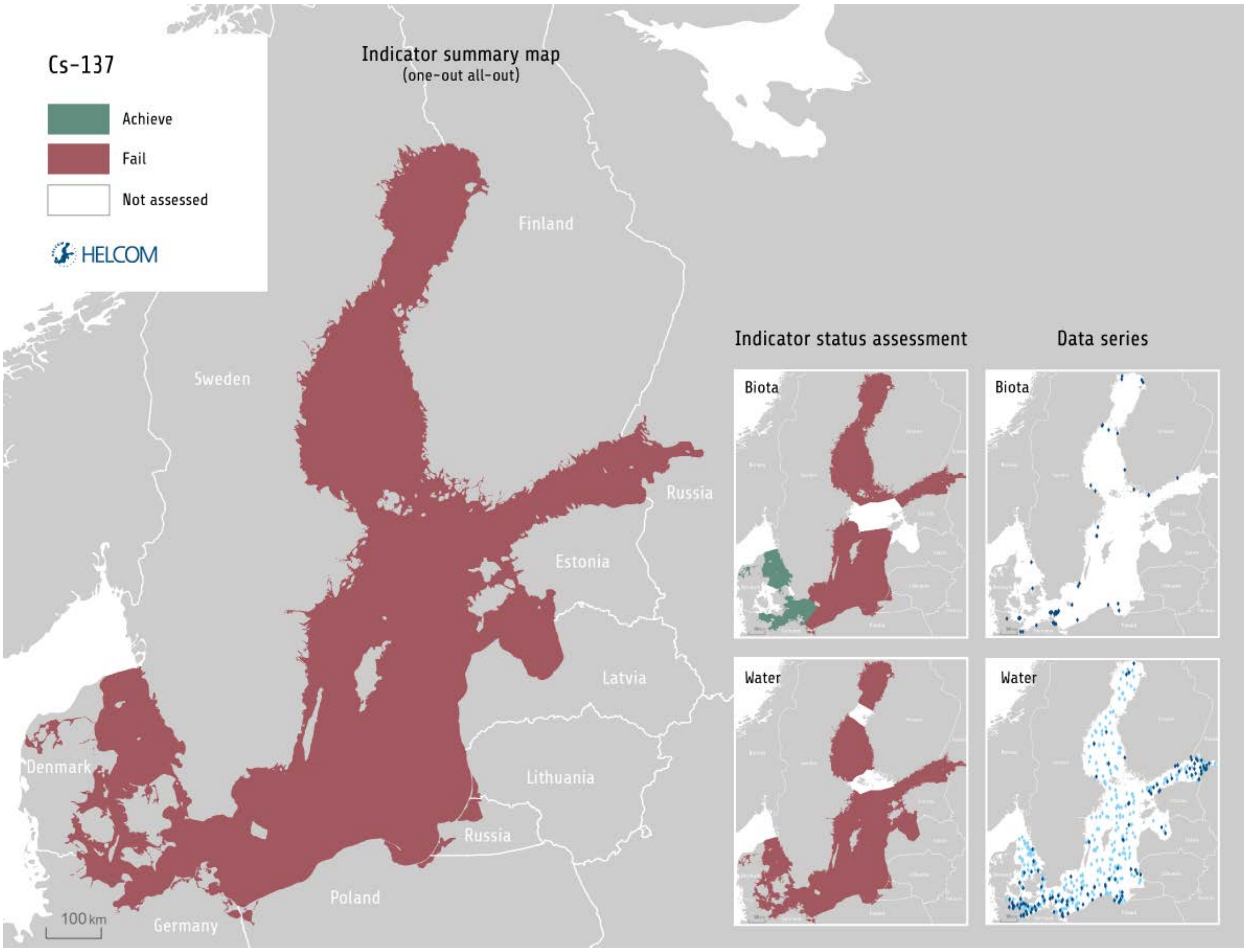

Figure 21. Status assessment for radioactive substances (Cs-137). The one-out-all-out approach is used to summarise all matrix-threshold combinations (main map), with the primary threshold in biota (top inset row), primary threshold in water (bottom inset row). Sampling stations used for historical trends (light blue and dark blue) and those used in the current assessment period (dark blue) are shown for biota and seawater. Biota analyses is carried out in herring and flounder. Symbols on map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectable trends.

5.8 TBT AND IMPOSEX[15]

The test of organotin indicators showed that in most areas, TBT is still a problem in water, sediment and biota. The main problem for the indicator was the detection limits which are in the same area as the target values in both sediment and water phase. Only Poland and Lithuania measures in water, and up to 2015, the detection limit in Lithuania was above the EQS value of 0.2 ng/l, but was reduced to 0.06 in 2015, and results since 2015 have been below the detection limit, and hence below the EQS in water (Core indicator report; HELCOM 2018i).

[15] Included as test.

For sediments, 178 measured stations failed the proposed threshold value of 1.6 µg/kg, only in two cases the mean value was between 1.4 and 1.6, and no results was reported as below detection limits (usually between 0.3-1 ng/kg). Only in one case, monitoring included 3 years of results, and in 25 cases 2 years, so no trends were assessed for sediments.

The biological effect of imposex was measured at 33 stations, with six or more years of monitoring reported in 14 stations. Levels of imposex were found below the suggested EcoQO threshold value in the Southern Kattegat and the north of the Sound. Eight of the stations indicated declining effects, clearly indicating that the levels of TBT are decreasing in Gothenburg, Great Belt and the Sound, all areas with heavy ship traffic. This is in agreement with the findings in the North Sea area, where 48% of the imposex stations showed decreasing trends (https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/imposex-gastropods/).

Even though the TBT situation is improving, the levels of TBT in sediments and caused effects in marine gastropods indicate that the historic pollution is still impacting the Baltic Sea (Figure 22). Other uses of organotins than in antifouling paints and the release from previously contaminated sediments should be checked to ensure the continuation of the decreasing trends.

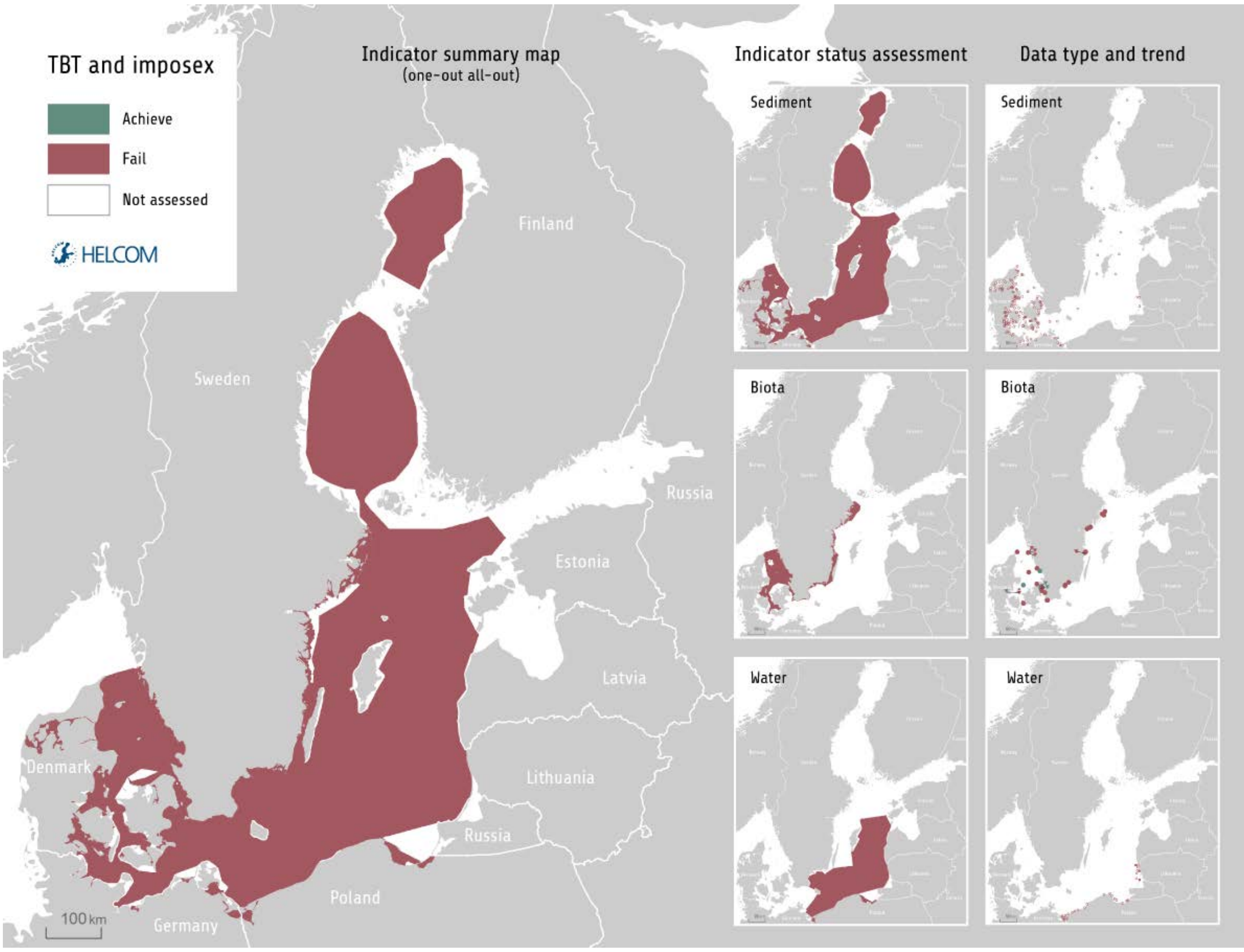

Figure 22. Status assessment for tributyltin (TBT) and imposex. The one-out-all-out approach is used to summarise all matrix-threshold combinations (main map), with the primary threshold in sediment (top inset row), primary threshold in biota (middle inset row) and secondary threshold in water (bottom inset row) shown. Biota analyses is carried out in gastropods. Symbols on map define data type and trend (see section 3.5) with downward triangles indicating decreasing concentrations, upward triangles indicating increasing concentrations and circles indicating no detectable trends.

5.9 DICLOFENAC

The main source of pharmaceuticals to the Baltic Sea come from humans and animals, via urine and faeces, as well as the inappropriate disposal of unused medical products into sewers. Municipal wastewater treatment plants are considered a major pathway for introduction to the aquatic environment, with an estimated release of about 1,800 tons of pharmaceuticals per year to the Baltic Sea. Current wastewater treatment processes are effective at removing only a few of the detected pharmaceuticals (UNESCO and HELCOM 2017). The fate and impacts of those pharmaceuticals in the environment is still largely unknown.

During 2003-2014, pharmaceuticals were detected in Baltic Sea water, sediment and biota, as well as in wastewater treatment plant influents, effluents and sludge. The most frequently detected pharmaceutical substances belong to the therapeutic groups of anti-inflammatory and analgesics, cardiovascular and central nervous system agents. Diclofenac – an anti-inflammatory drug -was detected in 25 % of samples for which it was analysed (UNESCO and HELCOM 2017).

An indicator for diclofenac is currently being tested in HELCOM (Core indicator report; 2018j, Figure 23). Pharmaceuticals represent a major group of substances of emerging concern and it is important that an understanding of their distribution, role and fate in the environment is developed.

Diclofenac is one of the most used and most widely sold anti-inflammatory and analgesics in the Baltic Sea region and it has been utilised for an extended period of time. This pre-core indicator targets the development of a status evaluation of the occurrence and concentrations of diclofenac in the Baltic Sea marine environment. Currently the distribution, role and fate of diclofenac in the Baltic Sea is not clearly understood, with limited information from few monitoring and screening studies available. Records of high sale volumes and prescriptions of diclofenac have been recorded, with elevated levels and poor degradation being detected in municipal wastewater treatment plants (WWTPs). High levels have been detected in WWTP effluent waters and in river waters, with levels that fail the provisional threshold values being detected in coastal waters and biota in the Baltic Sea. Diclofenac was included in the EU first watch list under the Environmental Quality Standards Directive, requiring those HELCOM Contracting Parties who are also EU Member States, to gather suitable monitoring data for the purpose of facilitating the development of appropriate methods and addressing any risk posed. It has recently been proposed that diclofenac should be removed from this watch list since sufficient data has been collected and it remains to be clarified if diclofenac will be added to the list of priority substances.

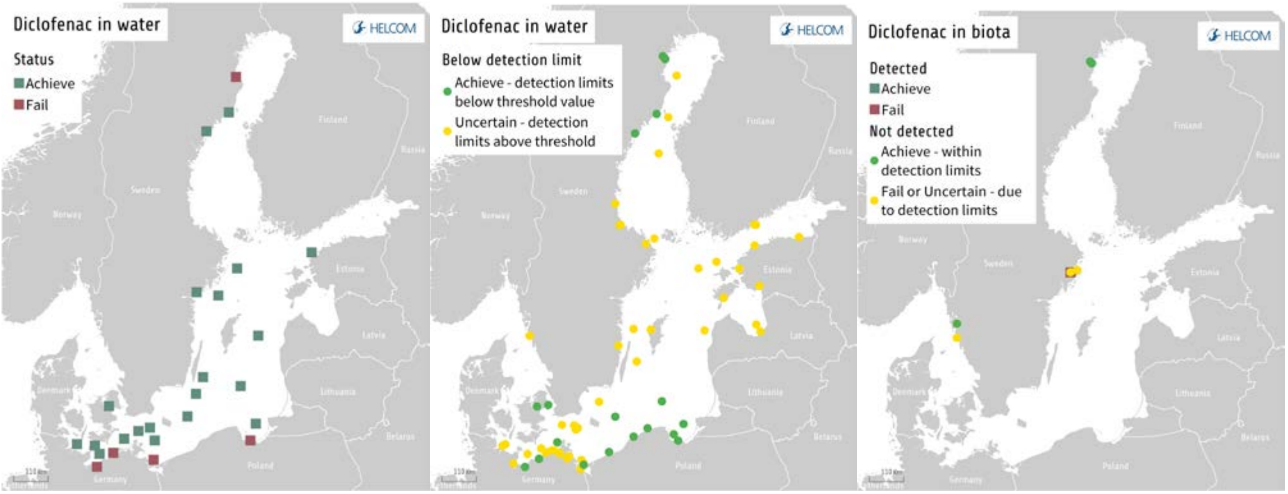

Figure 23. Overview of sample location in Baltic Sea water (left and middle) and biota (right) where diclofenac concentrations have been assessed. Samples in which diclofenac were detected are indicated by squares (left and right), with colours indicating good (green) and not good (red) status. Circles (middle and right) indicate samples in which diclofenac was not detected, with colours indicating the detection limit certainty, green having a detection limit below the set threshold value (i.e. reliable) and yellow having a detection limit above the set threshold value or unknown (i.e. uncertain reliability). The thresholds applied are provisional thresholds and the indicator is a pre-core indicator (HELCOM 2018j).

5.10 WHITE-TAILED SEA EAGLE PRODUCTIVITY

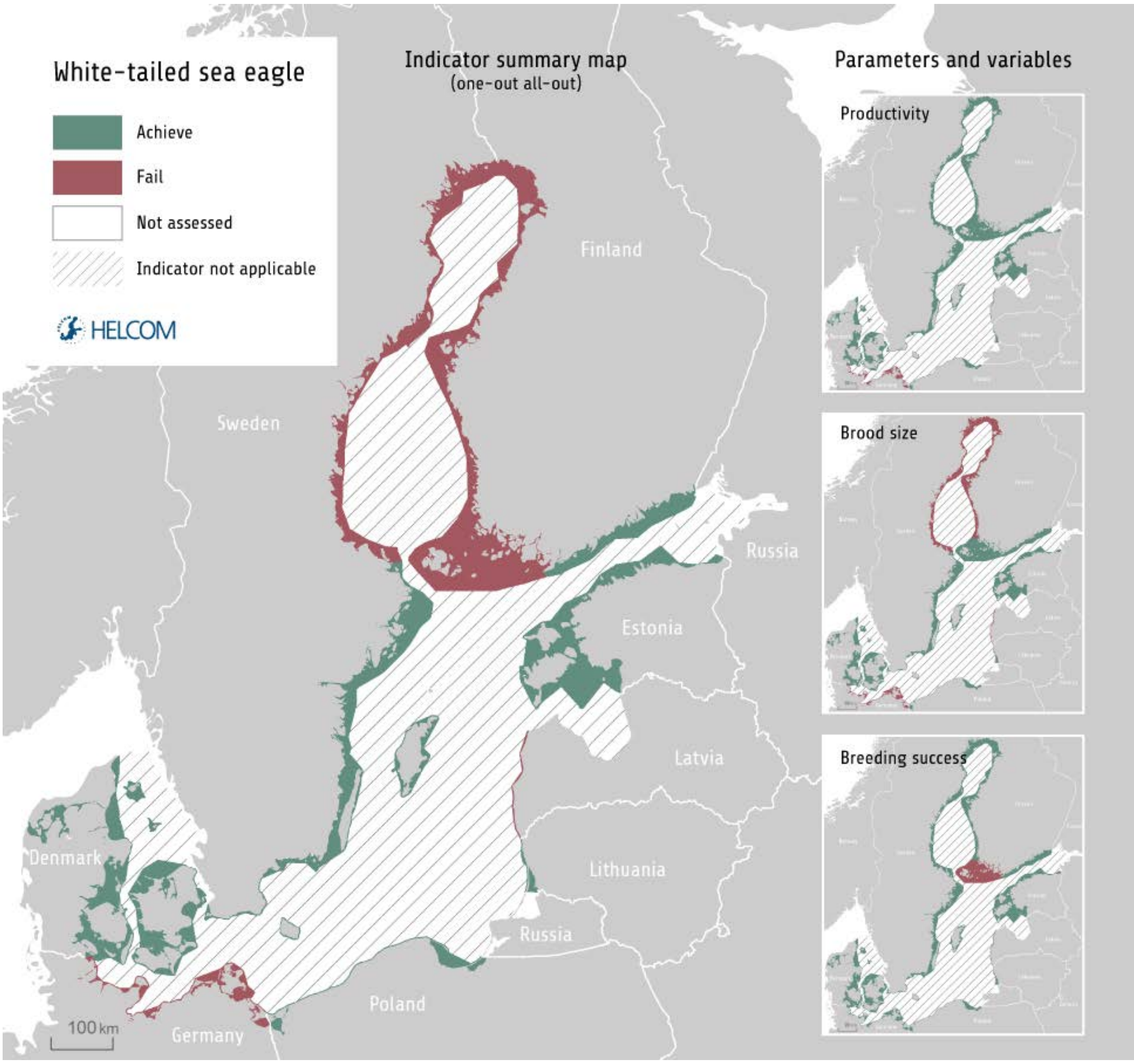

Figure 24. Status assessment of white-tailed sea eagle productivity. Productivity is derived from the breeding success and brood size parameters in coastal sub-populations of the Baltic Sea.

White-tailed sea eagles are top predators in the coastal food web, which makes them highly vulnerable to hazardous substances that accumulate and biomagnify. The white-tailed sea eagle has suffered for decades from the effects of persistent chemicals in the Baltic Sea environment. Impacts have been apparent since the 1950s and it was identified at that time that widely used insecticides (DDTs) and possibly polychlorinated biphenyls were major causes. Bans on the use of these substances have been in place for decades and positive development has occurred since the 1980s. (Figure 24).

Negative effects of long-standing environmental contaminants, as well as emerging new contaminants can become apparent in white-tailed sea eagles before they are visible in other species. Parameters describing the number of hatchlings in nests (brood size) and the proportion of nests producing young (breeding success) can inform on overall productivity (productivity), and can rapidly signal effects from contaminants. While changes in the abundance of adult birds might only occur over a period of several years, an increased mortality of eggs or chicks, and thus a lowered productivity, is often an early warning signal of elevated concentrations of hazardous substances.

The assessment shows that the white-tailed sea eagle productivity reached the threshold value in many coastal areas of the Baltic Sea (Core indicator report; HELCOM 2018k). In German coastal areas productivity was calculated to be just below the threshold value due to low brood size. In the Gulf of Bothnia Finnish coastal areas, Gulf of Bothnia Swedish coastal areas and Latvian coastal areas brood size also narrowly failed the threshold value, and in the Åland sea Finnish coastal areas the breeding success parameter was at the threshold value (examples shown in Figure 25).

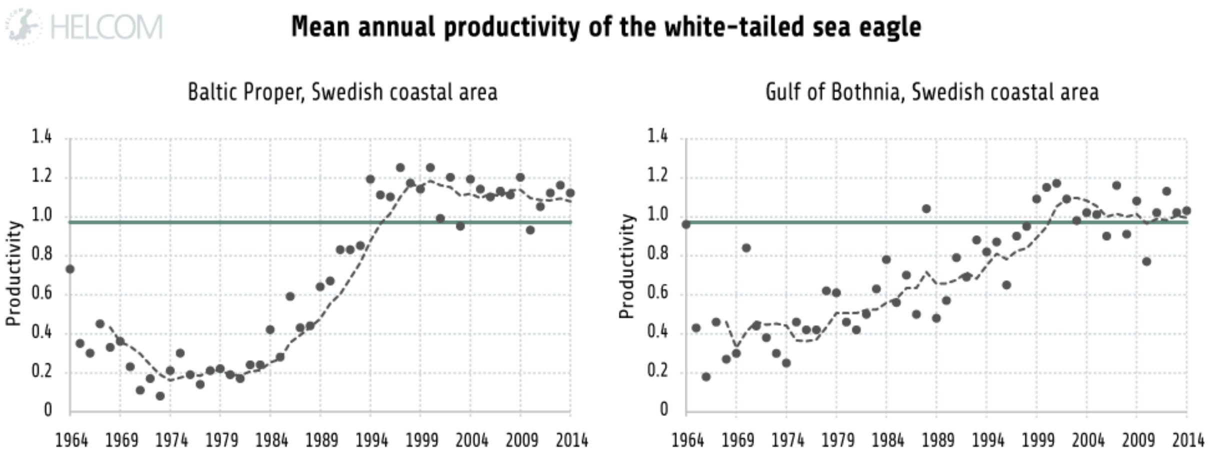

Figure 25. Mean annual productivity of the white tailed sea eagle, estimated as the number of nestlings per occupied territory in coastal sub-populations of the Baltic Proper and Gulf of Bothnia (based on data from Sweden) from 1964-2014. The green line illustrates the threshold value of the core indicator. For more information, see the Core indicator report; HELCOM (2018k).

5.11 OPERATIONAL OIL-SPILLS FROM SHIPS

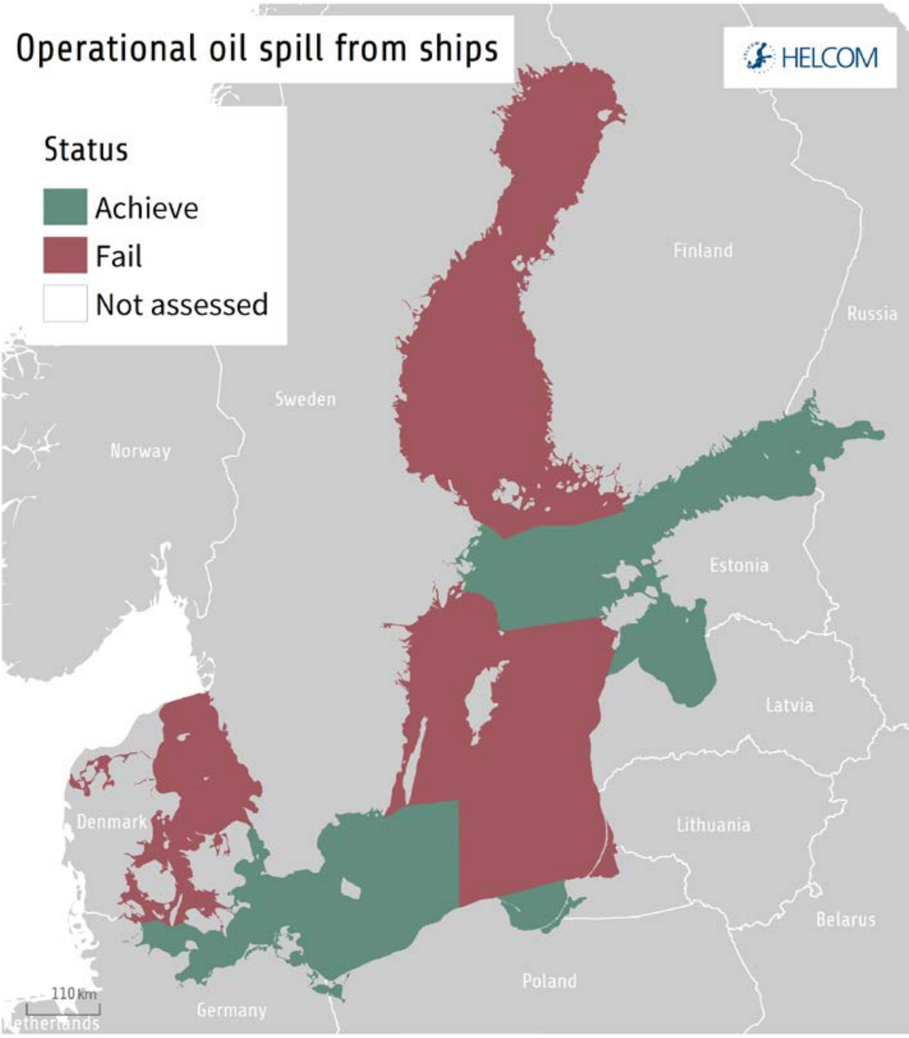

Figure 26. Status assessment of oil-spill from ships. Status assessment for the period 2011-2016 is carried out against a threshold value derived from a reference period (2008-2013) for which the estimated volume of oil spills was at a historically low level.

Oil is the main fuel of ships in the Baltic Sea region, and large amounts of oil are transported across the Baltic Sea. Oil and other petroleum products are released into the sea intentionally or due to negligence, often as oil in bilge water or via dumping of waste oil. Oil may also be released during shipping accidents. Most oil spills are detected along the main shipping routes. Oil spills are a serious threat to the marine environment, causing toxic effects and death of marine animals. Even small amounts of oil on the sea surface can harm waterbirds by contaminating their plumage, which reduces their buoyancy and thermal insulation.

Illegal oil spills have been monitored using aerial surveillance since 1988 in the Baltic Sea area. The aerial surveys today are conducted by all HELCOM Contracting Parties with standardised methods, and cover nearly the whole Baltic Sea area. The effort is focused on the busiest shipping routes. The information collated through the aerial surveillance is used in the core indicator evaluation (Core indicator report; HELCOM 2018l).

The core indicator 'Operational oil-spills from ships" fails the threshold value in the Bothnian Bay, the Quark, Bothnian Sea, Åland Sea, Eastern Gotland Basin, Western Gotland Basin, the Great Belt, and the Kattegat during the assessment period 2011–2016 (Figure 26 and Core indicator report; HELCOM 2018l). The threshold values are set based on the volumes of oil spills into each sub-basin during a modern baseline status defined by the reference period 2008–2013, when the estimated volume of oil spills was at a historically low level. The long-term goal in HELCOM is to reach a level of zero oil spills.

Both the number of observed illegal oil spills and the estimated volume of detected oil have decreased in all sub-basins during recent decades (Figure 4.2.13). The size of single spills has also shown a decreasing trend, with a significant decrease in spills larger than 10 cubic meters. This decrease has been achieved despite no concomitant decrease in maritime traffic occurring, indicating that measures conducted to decrease oil spills to the environment have been successful.

Both the number of observed illegal oil spills and the estimated volume of detected oil have decreased in all sub-basins during recent decades (Figure 27). The size of single spills has also shown a decreasing trend, with a significant decrease in spills larger than 10m^3. This decrease in oils spills has been achieved although no concomitant decrease in maritime traffic has occurred, indicating that measures conducted to decrease oil spills to the environment have been successful.

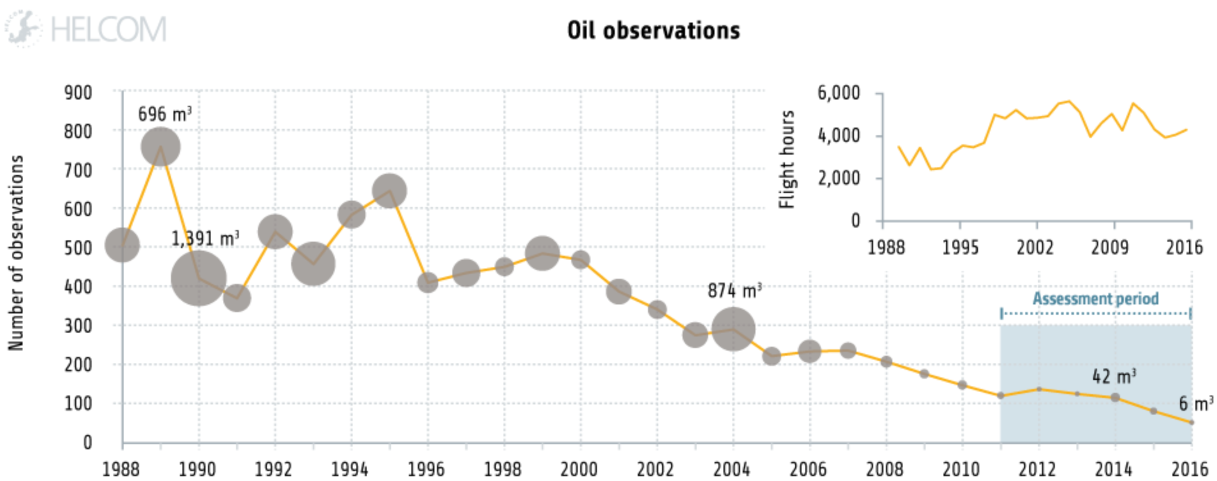

Figure 27. The number of oil-spills detected in aerial surveillance by the Baltic Sea countries between 1988 and 2016. The number of flight hours are shown in the inserted figure. The size of the circles indicates the amount of spilled oil in cubic meters. The peaks in the amount of spilled oil detected in 1990 and 2004 were likely caused by single events. In 1990 an accidental spill due to a collision between the Soviet tanker Volgonef 1263 and the West German dry cargo ship Betty at the south coast of Sweden is the main cause, whereas the underlying cause for the high estimated amount of oil in 2004 is undocumented. The peak values highlight that single oil spills may introduce large amounts of oil to the environment, and underline the importance of estimating the volume of introduced oil when evaluating whether the pressure is at a level allowing the environment to reach good status. For more information, see the Core indicator report; HELCOM (2018l).

Chapter 6. Implications and future perspective

The assessment shows that hazardous substances remain a concern in the Baltic Sea, but also that policy and measures do have an impact. Long recovery times are often required for persistent historical contamination. Despite this, and the problem of re-release from historic sediment-deposited contaminants, initial signs of improvement can be detected.

Downward trends are seen for a number of the monitored substances or substance groups. For example, lead inputs have decreased markedly and shows among the largest number of declining trends. Furthermore, a number of substances, such as hexachlorocyclohexane (γ-HCH, lindane), and dichlorodiphenyltrichloroethane (DDT) and its metabolites (DDD, DDE) are no longer considered of significant concern in the Baltic Sea. The improved breeding success in the white-tailed sea eagle is attributed to such reductions. In future assessments it can be expected that radioactive substances will achieve their threshold value, and a number of other substances can be expected to show improvements. Also, it should be recalled that while strong initial decreases may often be observed, latter stages of improvement can be slow, as the levels get closer to the threshold values.

This positive development is however counteracted by the emergence of new contaminants of concern, and by the risk for re-emerging contaminants via secondary sources. Pharmaceuticals is one group of substances of emerging concern, with wastewater treatment plants being identified as a major pathway to the environment (UNESCO and HELCOM 2017). A number of pharmaceuticals considered to be of special concern to the aquatic environment have been included on a 'watch list' under the European Union directive regarding priority substances in the field of water policy (European Commission 2013) in a drive to gain greater understanding on the fate and impact of these substances.

To support future assessments it will be necessary to review the threshold values utilized in the individual indicators, so as to ensure their relevance and application, for example the application of a food-related threshold value for dioxins where an ecotoxicologically based one may be more suitable. It will also be important to develop relevant monitoring strategies, protocols and indicators to encompass emerging contaminants of concern, and it would be astute to carry out this work in coordination with other relevant bodies and with defined policy requirements in mind. By further understanding those hazardous substances or industries for which no current regulation exists it will be possible to identify candidate substances of potential concern. Gaining a comprehensive overview of novel sources of contaminants, particularly emerging from off-shore activities (e.g. wind farms, shipping and the oil and gas industry) would also be beneficial. In addition to targeting these identified substances alternative approaches may be profitable, for example the use of sediment cores to show clear reductions in accumulation of substances due to policy actions, or the greater application of integrated water samples (e.g. passive sampling). Lastly, a major consideration for future assessments should be determining the environmental realities due to multiple mix effects, i.e. the impact on the environment not just by single substances or substance groups but the complex and potentially magnifying effects of numerous contemporary hazardous substances.

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Annex 1. Summary output from CHASE integrated assessment tool

Waterbody	Biota	Water	Sediment	Worst	ConSum	Status	ConfScore	Confidence	HM	Org	Penalty
Åland Sea	1.78	NA	0.19	Biota	1.78	Not good	0.63	Class II	2	3	0%
Åland Sea - Archipelago Sea Finnish Coastal Waters	46.35	NA	NA	Biota	46.35	Not good	0.23	Class III	1	4	50%
Åland Sea Swedish Coastal Waters	1.78	NA	NA	Biota	1.78	Not good	0.19	Class III	0	0	75%
Arkona Basin	19.09	1.36	0.83	Biota	19.09	Not good	0.65	Class II	7	10	0%
Arkona Basin German Coastal Waters	3.03	1.25	0.98	Biota	3.03	Not good	0.50	Class II	7	3	0%
Arkona Basin Swedish Coastal Waters	0.74	1.76	NA	Water	1.76	Not good	0.19	Class III	0	0	75%
Bay of Mecklenburg	1.94	1.10	1.26	Biota	1.94	Not good	0.57	Class II	7	3	0%
Bornholm Basin	17.99	1.57	1.43	Biota	17.99	Not good	0.74	Class II	6	8	0%
Bornholm Basin German Coastal Waters	2.93	1.22	3.22	Sediment	3.22	Not good	0.29	Class III	5	1	50%
Bornholm Basin Polish Coastal Waters	8.1	1.82	6.49	Biota	8.12	Not good	0.56	Class II	7	6	0%
Bornholm Basin Swedish Coastal Waters	1.35	1.70	NA	Water	1.70	Not good	0.30	Class III	3	0	50%
Bothnian Bay	20.98	1.32	0.52	Biota	20.98	Not good	0.56	Class II	4	8	0%
Bothnian Bay Finnish Coastal Waters	140.76	1.32	NA	Biota	140.76	Not good	0.30	Class III	1	4	50%
Bothnian Bay Swedish Coastal Waters	22.64	1.32	NA	Biota	22.64	Not good	0.78	Class I	2	5	0%
Bothnian Sea	11.67	1.96	0.18	Biota	11.67	Not good	0.66	Class II	4	8	0%
Bothnian Sea Finnish Coastal Waters	54.69	1.96	NA	Biota	54.69	Not good	0.59	Class II	2	4	0%
Bothnian Sea Swedish Coastal Waters	14.08	1.96	NA	Biota	14.08	Not good	0.78	Class I	2	5	0%
Eastern Gotland Basin	22.26	3.53	1.49	Biota	22.26	Not good	0.58	Class II	7	11	0%

Waterbody	Biota	Water	Sediment	Worst	ConSum	Status	ConfScore	Confidence	HM	Org	Penalty
Eastern Gotland Basin Estonian Coastal Waters	3.24	1.88	NA	Biota	3.24	Not good	0.28	Class III	2	1	50%
Eastern Gotland Basin Latvian Coastal Waters	1.36	1.88	NA	Water	1.88	Not good	0.19	Class III	0	0	75%
Eastern Gotland Basin Lithuanian Coastal Waters	1.45	2.62	0.89	Water	2.62	Not good	0.51	Class II	7	5	0%
Eastern Gotland Basin Polish Coastal Waters	1.36	2.10	NA	Water	2.10	Not good	0.33	Class III	2	0	50%
Eastern Gotland Basin Russian Coastal Waters	1.36	1.88	NA	Water	1.88	Not good	0.19	Class III	0	0	75%
Eastern Gotland Basin Swedish Coastal Waters	1.36	1.88	NA	Water	1.88	Not good	0.19	Class III	0	0	75%
Gdansk Basin	11.15	1.59	1.44	Biota	11.15	Not good	0.56	Class II	4	5	0%
Gdansk Basin Polish Coastal Waters	8.92	2.01	0.35	Biota	8.92	Not good	0.52	Class II	7	6	0%
Gdansk Basin Russian Coastal Waters	1.31	1.59	NA	Water	1.59	Not good	0.19	Class III	0	0	75%
Gulf of Finland	11.34	1.28	NA	Biota	11.34	Not good	0.63	Class II	2	4	0%
Gulf of Finland Estonian Coastal Waters	3.16	1.28	NA	Biota	3.16	Not good	0.28	Class III	2	1	50%
Gulf of Finland Finnish Coastal Waters	44.68	1.28	NA	Biota	44.68	Not good	0.59	Class II	2	4	0%
Gulf of Finland Russian Coastal Waters	1.41	1.29	NA	Biota	1.41	Not good	0.19	Class III	0	0	75%
Gulf of Riga	NA	1.33	NA	Water	1.33	Not good	0.19	Class III	0	0	75%
Gulf of Riga Estonian Coastal Waters	3.51	1.33	NA	Biota	3.51	Not good	0.29	Class III	2	1	50%
Gulf of Riga Latvian Coastal Waters	NA	1.33	NA	Water	1.33	Not good	0.19	Class III	0	0	75%
Kattegat	14.08	1.18	0.30	Biota	14.08	Not good	0.68	Class II	4	8	0%
Kattegat Swedish Coastal Waters	1.16	1.18	NA	Water	1.18	Not good	0.33	Class III	3	2	50%
Kiel Bay	26.65	0.99	0.71	Biota	26.65	Not good	0.61	Class II	6	3	0%
Kiel Bight German Coastal Waters	2.57	1.48	3.32	Sediment	3.32	Not good	0.31	Class III	5	2	50%

Waterbody	Biota	Water	Sediment	Worst	ConSum	Status	ConfScore	Confidence	HM	Org	Penalty
Mecklenburgh Bight German Coastal Waters	2.88	2.30	0.75	Biota	2.88	Not good	0.64	Class II	7	4	0%
Northern Baltic Proper	10.34	1.76	1.36	Biota	10.34	Not good	0.64	Class II	4	8	0%
Northern Baltic Proper Estonian Coastal Waters	1.34	1.76	NA	Water	1.76	Not good	0.11	Class III	1	1	75%
Northern Baltic Proper Swedish Coastal Waters	16.12	1.76	NA	Biota	16.12	Not good	0.57	Class II	2	5	0%
The Quark	9.35	NA	NA	Biota	9.35	Not good	0.43	Class III	2	4	0%
The Quark Finnish Coastal Waters	32.30	NA	NA	Biota	32.30	Not good	0.43	Class III	2	4	0%
The Quark Swedish Coastal Waters	12.13	NA	NA	Biota	12.13	Not good	0.69	Class II	2	5	0%
The Sound	NA	1.58	1.30	Water	1.58	Not good	0.31	Class III	2	1	50%
The Sound Swedish Coastal Waters	NA	1.58	NA	Water	1.58	Not good	0.19	Class III	0	0	75%
Western Gotland Basin	14.53	1.81	1.45	Biota	14.53	Not good	0.69	Class II	4	8	0%
Western Gotland Basin Swedish Coastal Waters	14.18	1.81	NA	Biota	14.18	Not good	0.66	Class II	3	6	0%

Annex 2. Open sea assessment units ranked from highest ConSum value

Waterbody	Biota	Water	Sediment	Worst	ConSum	Status	ConfScore	Confidence	HM	Org	Penalty
Kiel Bay	26.65	0.99	0.71	Biota	26.65	Not good	0.61	Class II	6	3	0%
Eastern Gotland Basin	22.26	3.53	1.49	Biota	22.26	Not good	0.58	Class II	7	11	0%
Bothnian Bay	20.98	1.32	0.52	Biota	20.98	Not good	0.56	Class II	4	8	0%
Arkona Basin	19.09	1.36	0.83	Biota	19.09	Not good	0.65	Class II	7	10	0%
Bornholm Basin	17.99	1.57	1.43	Biota	17.99	Not good	0.74	Class II	6	8	0%
Western Gotland Basin	14.53	1.81	1.45	Biota	14.53	Not good	0.69	Class II	4	8	0%
Kattegat	14.08	1.18	0.30	Biota	14.08	Not good	0.68	Class II	4	8	0%
Bothnian Sea	11.67	1.96	0.18	Biota	11.67	Not good	0.66	Class II	4	8	0%
Gulf of Finland	11.34	1.28	NA	Biota	11.34	Not good	0.63	Class II	2	4	0%
Gdansk Basin	11.15	1.59	1.44	Biota	11.15	Not good	0.56	Class II	4	5	0%
Northern Baltic Proper	10.34	1.76	1.36	Biota	10.34	Not good	0.64	Class II	4	8	0%
The Quark	9.35	NA	NA	Biota	9.35	Not good	0.43	Class III	2	4	0%
Bay of Mecklenburg	1.94	1.10	1.26	Biota	1.94	Not good	0.57	Class II	7	3	0%
Åland Sea	1.78	NA	0.19	Biota	1.78	Not good	0.63	Class II	2	3	0%
The Sound	NA	1.58	1.30	Water	1.58	Not good	0.31	Class III	2	1	50%
Gulf of Riga	NA	1.33	NA	Water	1.33	Not good	0.19	Class III	0	0	75%

Annex 3. Coastal assessment units ranked from highest ConSum value

Waterbody	Biota	Water	Sediment	Worst	ConSum	Status	ConfScore	Confidence	HM	Org	Penalty
Bothnian Bay Finnish Coastal Waters	140.76	1.32	NA	Biota	140.76	Not good	0.30	Class III	1	4	50%
Bothnian Sea Finnish Coastal Waters	54.69	1.96	NA	Biota	54.69	Not good	0.59	Class II	2	4	0%
Åland Sea - Archipelago Sea Finnish Coastal Waters	46.35	NA	NA	Biota	46.35	Not good	0.23	Class III	1	4	50%
Gulf of Finland Finnish Coastal Waters	44.68	1.28	NA	Biota	44.68	Not good	0.59	Class II	2	4	0%
The Quark Finnish Coastal Waters	32.30	NA	NA	Biota	32.30	Not good	0.43	Class III	2	4	0%
Bothnian Bay Swedish Coastal Waters	22.64	1.32	NA	Biota	22.64	Not good	0.78	Class I	2	5	0%
Northern Baltic Proper Swedish Coastal Waters	16.12	1.76	NA	Biota	16.12	Not good	0.57	Class II	2	5	0%
Western Gotland Basin Swedish Coastal Waters	14.18	1.81	NA	Biota	14.18	Not good	0.66	Class II	3	6	0%
Bothnian Sea Swedish Coastal Waters	14.08	1.96	NA	Biota	14.08	Not good	0.78	Class I	2	5	0%
The Quark Swedish Coastal Waters	12.13	NA	NA	Biota	12.13	Not good	0.69	Class II	2	5	0%
Gdansk Basin Polish Coastal Waters	8.92	2.01	0.35	Biota	8.92	Not good	0.52	Class II	7	6	0%
Bornholm Basin Polish Coastal Waters	8.12	1.82	6.49	Biota	8.12	Not good	0.56	Class II	7	6	0%
Gulf of Riga Estonian Coastal Waters	3.51	1.33	NA	Biota	3.51	Not good	0.29	Class III	2	1	50%
Kiel Bight German Coastal Waters	2.57	1.48	3.32	Sediment	3.32	Not good	0.31	Class III	5	2	50%
Eastern Gotland Basin Estonian Coastal Waters	3.24	1.88	NA	Biota	3.24	Not good	0.28	Class III	2	1	50%
Bornholm Basin German Coastal Waters	2.93	1.22	3.22	Sediment	3.22	Not good	0.29	Class III	5	1	50%

Waterbody	Biota	Water	Sediment	Worst	ConSum	Status	ConfScore	Confidence	HM	Org	Penalty
Gulf of Finland Estonian Coastal Waters	3.16	1.28	NA	Biota	3.16	Not good	0.28	Class III	2	1	50%
Arkona Basin German Coastal Waters	3.03	1.25	0.98	Biota	3.03	Not good	0.50	Class II	7	3	0%
Mecklenburgh Bight German Coastal Waters	2.88	2.30	0.75	Biota	2.88	Not good	0.64	Class II	7	4	0%
Eastern Gotland Basin Lithuanian Coastal Waters	1.45	2.62	0.89	Water	2.62	Not good	0.51	Class II	7	5	0%
Eastern Gotland Basin Polish Coastal Waters	1.36	2.10	NA	Water	2.10	Not good	0.33	Class III	2	0	50%
Eastern Gotland Basin Latvian Coastal Waters	1.36	1.88	NA	Water	1.88	Not good	0.19	Class III	0	0	75%
Eastern Gotland Basin Russian Coastal Waters	1.36	1.88	NA	Water	1.88	Not good	0.19	Class III	0	0	75%
Eastern Gotland Basin Swedish Coastal Waters	1.36	1.88	NA	Water	1.88	Not good	0.19	Class III	0	0	75%
Åland Sea Swedish Coastal Waters	1.78	NA	NA	Biota	1.78	Not good	0.19	Class III	0	0	75%
Arkona Basin Swedish Coastal Waters	0.74	1.76	NA	Water	1.76	Not good	0.19	Class III	0	0	75%
Northern Baltic Proper Estonian Coastal Waters	1.34	1.76	NA	Water	1.76	Not good	0.11	Class III	1	1	75%
Bornholm Basin Swedish Coastal Waters	1.35	1.70	NA	Water	1.70	Not good	0.30	Class III	3	0	50%
Gdansk Basin Russian Coastal Waters	1.31	1.59	NA	Water	1.59	Not good	0.19	Class III	0	0	75%
The Sound Swedish Coastal Waters	NA	1.58	NA	Water	1.58	Not good	0.19	Class III	0	0	75%
Gulf of Finland Russian Coastal Waters	1.41	1.28	NA	Biota	1.41	Not good	0.19	Class III	0	0	75%
Gulf of Riga Latvian Coastal Waters	NA	1.33	NA	Water	1.33	Not good	0.19	Class III	0	0	75%
Kattegat Swedish Coastal Waters	1.16	1.18	NA	Water	1.18	Not good	0.33	Class III	3	2	50%

Annex 4. Summary of CHASE input data.

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Åland Sea	Sediment	ANT	Org	0.059	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.19	Good	0.50	Class II
Åland Sea	Sediment	CD	HM	0.132	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.19	Good	0.50	Class II
Åland Sea	Biota	CS-137	Rad	1.776	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.78	Not	0.75	Class I
Åland Sea	Sediment	HBCD	Org	0.008	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.19	Good	0.50	Class II
Åland Sea	Sediment	PB	HM	0.215	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.19	Good	0.50	Class II
Åland Sea	Sediment	SBD6	Org	0.002	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.19	Good	0.50	Class II
Åland Sea - Archipelago Sea Finnish Coastal Waters	Biota	CS-137	Rad	1.776	Bq/kg WW (fish)	+	M	H	All	Low	0.75	46.35	Not good	0.46	Class III
Åland Sea - Archipelago Sea Finnish Coastal Waters	Biota	HBCD	Org	0.005	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	46.35	Not good	0.46	Class III
Åland Sea - Archipelago Sea Finnish Coastal Waters	Biota	HG	HM	4.695	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	46.35	Not good	0.46	Class III
Åland Sea - Archipelago Sea Finnish Coastal Waters	Biota	PFOS	Org	0.183	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	46.35	Not good	0.46	Class III
Åland Sea - Archipelago Sea Finnish Coastal Waters	Biota	SBD6	Org	106.654	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	46.35	Not good	0.46	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Åland Sea - Archipelago Sea Finnish Coastal Waters	Biota	SCB6	Org	0.229	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	46.35	Not good	0.46	Class III
Åland Sea - Archipelago Sea Finnish Coastal Waters	Biota	CS-137	Rad	1.776	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.78	Not good	0.75	Class I
Arkona Basin	Sediment	ANT	Org	0.865	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.83	Good	0.70	Class II
Arkona Basin	Biota	BAP	Org	0.139	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	19.09	Not	0.66	Class II
Arkona Basin	Biota	CD	HM	2.099	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	19.09	Not	0.66	Class II
Arkona Basin	Sediment	CD	HM	0.226	mg/kg sediment (norm AL)	+	H	H	All	Low	1.00	0.83	Good	0.70	Class II
Arkona Basin	Water	CD	HM	0.420	ug/l water	+	H	L	All	Low	0.50	1.36	Not	0.58	Class II
Arkona Basin	Biota	CS-137	Rad	0.735	Bq/kg WW (fish)	+	M	H	All	Low	0.75	19.09	Not	0.66	Class II
Arkona Basin	Water	CS-137	Rad	1.764	Bq/m^3	+	M	H	All	Low	0.75	1.36	Not	0.58	Class II
Arkona Basin	Biota	FLU	Org	0.086	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	19.09	Not	0.66	Class II
Arkona Basin	Biota	HBCD	Org	0.001	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	M	All	Low	0.75	19.09	Not good	0.66	Class II
Arkona Basin	Sediment	HBCD	Org	0.010	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.83	Good	0.70	Class II
Arkona Basin	Biota	HG	HM	0.643	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	19.09	Not	0.66	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Arkona Basin	Biota	PB	HM	0.792	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	19.09	Not	0.66	Class II
Arkona Basin	Sediment	PB	HM	0.765	mg/kg sediment (norm AL)	+	H	H	All	Low	1.00	0.83	Good	0.70	Class II
Arkona Basin	Water	PB	HM	0.163	ug/l water	+	H	L	All	Low	0.50	1.36	Not	0.58	Class II
Arkona Basin	Biota	PFOS	Org	0.079	ug/kg WW (fish MU, MU&EP, LI)	+	H	M	All	Low	0.75	19.09	Not	0.66	Class II
Arkona Basin	Biota	SBD6	Org	58.367	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	19.09	Not good	0.66	Class II
Arkona Basin	Sediment	SBD6	Org	0.001	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.83	Good	0.70	Class II
Arkona Basin	Biota	SCB6	Org	0.138	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	19.09	Not good	0.66	Class II
Arkona Basin	Biota	SDX	Org	0.228	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	19.09	Not good	0.66	Class II
Arkona Basin German Coastal Waters	Biota	BAP	Org	0.045	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	3.03	Not	0.43	Class III
Arkona Basin German Coastal Waters	Biota	CD	HM	3.667	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	3.03	Not	0.43	Class III
Arkona Basin German Coastal Waters	Sediment	CD	HM	0.797	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.98	Good	0.50	Class II
Arkona Basin German Coastal Waters	Water	CD	HM	0.318	ug/l water	+	H	L	All	Low	0.50	1.25	Not	0.58	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Arkona Basin German Coastal Waters	Biota	CS-137	Rad	0.735	Bq/kg WW (fish)	+	M	H	All	Low	0.75	3.03	Not	0.43	Class III
Arkona Basin German Coastal Waters	Water	CS-137	Rad	1.764	Bq/m³	+	M	H	All	Low	0.75	1.25	Not	0.58	Class II
Arkona Basin German Coastal Waters	Biota	FLU	Org	0.027	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	3.03	Not	0.43	Class III
Arkona Basin German Coastal Waters	Biota	HG	HM	1.633	ug/kg WW fish (fish MU - fillet)	+	H	M	All	Low	0.75	3.03	Not	0.43	Class III
Arkona Basin German Coastal Waters	Biota	PB	HM	1.672	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	3.03	Not	0.43	Class III
Arkona Basin German Coastal Waters	Sediment	PB	HM	0.584	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.98	Good	0.50	Class II
Arkona Basin German Coastal Waters	Water	PB	HM	0.083	ug/l water	+	H	L	All	Low	0.50	1.25	Not	0.58	Class II
Arkona Basin German Coastal Waters	Biota	SCB6	Org	0.231	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	3.03	Not good	0.43	Class III
Arkona Basin Swedish Coastal Waters	Biota	CS-137	Rad	0.735	Bq/kg WW (fish)	+	M	H	All	Low	0.75	0.74	Good	0.75	Class I
Arkona Basin Swedish Coastal Waters	Water	CS-137	Rad	1.764	Bq/m³	+	M	H	All	Low	0.75	1.76	Not	0.75	Class I
Bay of Mecklenburg	Sediment	ANT	Org	1.134	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.26	Not	0.67	Class II
Bay of Mecklenburg	Biota	BAP	Org	0.089	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	1.94	Not	0.46	Class III
Bay of Mecklenburg	Biota	CD	HM	2.559	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	1.94	Not	0.46	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bay of Mecklenburg	Sediment	CD	HM	0.282	mg/kg sediment (norm AL)	+	H	M	All	Low	0.75	1.26	Not	0.67	Class II
Bay of Mecklenburg	Water	CD	HM	0.095	ug/l water	+	H	L	All	Low	0.50	1.10	Not	0.58	Class II
Bay of Mecklenburg	Biota	CS-137	Rad	0.291	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.94	Not	0.46	Class III
Bay of Mecklenburg	Water	CS-137	Rad	1.687	Bq/m^3	+	M	H	All	Low	0.75	1.10	Not	0.58	Class II
Bay of Mecklenburg	Biota	FLU	Org	0.063	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	1.94	Not	0.46	Class III
Bay of Mecklenburg	Biota	HG	HM	0.581	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	1.94	Not	0.46	Class III
Bay of Mecklenburg	Biota	PB	HM	1.175	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	1.94	Not	0.46	Class III
Bay of Mecklenburg	Sediment	PB	HM	0.773	mg/kg sediment (norm AL)	+	H	M	All	Low	0.75	1.26	Not	0.67	Class II
Bay of Mecklenburg	Water	PB	HM	0.127	ug/l water	+	H	L	All	Low	0.50	1.10	Not	0.58	Class II
Bornholm Basin	Sediment	ANT	Org	1.546	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.43	Not	0.50	Class II
Bornholm Basin	Sediment	CD	HM	0.827	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.43	Not	0.50	Class II
Bornholm Basin	Water	CD	HM	0.516	ug/l water	+	H	H	All	Low	1.00	1.57	Not	0.92	Class I
Bornholm Basin	Biota	CS-137	Rad	1.419	Bq/kg WW (fish)	+	M	H	All	Low	0.75	17.99	Not	0.81	Class I
Bornholm Basin	Water	CS-137	Rad	1.701	Bq/m^3	+	M	H	All	Low	0.75	1.57	Not	0.92	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bornholm Basin	Biota	HBCD	Org	0.005	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	17.99	Not good	0.81	Class I
Bornholm Basin	Sediment	HBCD	Org	0.005	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.43	Not	0.50	Class II
Bornholm Basin	Biota	HG	HM	0.991	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	17.99	Not	0.81	Class I
Bornholm Basin	Biota	PB	HM	0.714	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	17.99	Not	0.81	Class I
Bornholm Basin	Sediment	PB	HM	0.823	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.43	Not	0.50	Class II
Bornholm Basin	Water	PB	HM	0.505	ug/l water	+	H	H	All	Low	1.00	1.57	Not	0.92	Class I
Bornholm Basin	Biota	PFOS	Org	0.088	ug/kg WW (fish MU, MU&EP, LI)	+	H	H	All	Low	1.00	17.99	Not	0.81	Class I
Bornholm Basin	Biota	SBD6	Org	47.272	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	17.99	Not good	0.81	Class I
Bornholm Basin	Sediment	SBD6	Org	0.001	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.43	Not	0.50	Class II
Bornholm Basin	Biota	SCB6	Org	0.087	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	17.99	Not good	0.81	Class I
Bornholm Basin	Biota	SDX	Org	0.314	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	17.99	Not good	0.81	Class I
Bornholm Basin German Coastal Waters	Sediment	CD	HM	3.115	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	3.22	Not	0.50	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bornholm Basin German Coastal Waters	Water	CD	HM	0.366	ug/l water	+	H	M	All	Low	0.75	1.22	Not	0.83	Class I
Bornholm Basin German Coastal Waters	Biota	CS-137	Rad	1.419	Bq/kg WW (fish)	+	M	H	All	Low	0.75	2.93	Not	0.42	Class III
Bornholm Basin German Coastal Waters	Water	CS-137	Rad	1.701	Bq/m^3	+	M	H	All	Low	0.75	1.22	Not	0.83	Class I
Bornholm Basin German Coastal Waters	Biota	HG	HM	3.354	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	2.93	Not	0.42	Class III
Bornholm Basin German Coastal Waters	Sediment	PB	HM	1.443	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	3.22	Not	0.50	Class II
Bornholm Basin German Coastal Waters	Water	PB	HM	0.041	ug/l water	+	H	H	All	Low	1.00	1.22	Not	0.83	Class I
Bornholm Basin German Coastal Waters	Biota	SCB6	Org	0.296	ug/kg WW (MU,MEÃ™&EP, fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	2.93	Not good	0.42	Class III
Bornholm Basin Polish Coastal Waters	Biota	BAP	Org	0.064	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	8.12	Not	0.53	Class II
Bornholm Basin Polish Coastal Waters	Biota	CD	HM	1.442	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	8.12	Not	0.53	Class II
Bornholm Basin Polish Coastal Waters	Sediment	CD	HM	7.475	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	6.49	Not	0.50	Class II
Bornholm Basin Polish Coastal Waters	Water	CD	HM	0.385	ug/l water	+	H	M	All	Low	0.75	1.82	Not	0.67	Class II
Bornholm Basin Polish Coastal Waters	Biota	CS-137	Rad	1.419	Bq/kg WW (fish)	+	M	H	All	Low	0.75	8.12	Not	0.53	Class II
Bornholm Basin Polish Coastal Waters	Water	CS-137	Rad	1.701	Bq/m^3	+	M	H	All	Low	0.75	1.82	Not	0.67	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bornholm Basin Polish Coastal Waters	Biota	FLU	Org	0.003	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	8.12	Not	0.53	Class II
Bornholm Basin Polish Coastal Waters	Biota	HBCD	Org	0.001	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	8.12	Not good	0.53	Class II
Bornholm Basin Polish Coastal Waters	Biota	HG	HM	1.355	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	8.12	Not	0.53	Class II
Bornholm Basin Polish Coastal Waters	Biota	PB	HM	0.370	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	8.12	Not	0.53	Class II
Bornholm Basin Polish Coastal Waters	Sediment	PB	HM	1.710	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	6.49	Not	0.50	Class II
Bornholm Basin Polish Coastal Waters	Water	PB	HM	1.075	ug/l water	+	H	L	All	Low	0.50	1.82	Not	0.67	Class II
Bornholm Basin Polish Coastal Waters	Biota	PFOS	Org	0.307	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	8.12	Not	0.53	Class II
Bornholm Basin Polish Coastal Waters	Biota	SBD6	Org	20.643	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	8.12	Not good	0.53	Class II
Bornholm Basin Polish Coastal Waters	Biota	SCB6	Org	0.087	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	8.12	Not good	0.53	Class II
Bornholm Basin Swedish Coastal Waters	Biota	CD	HM	0.757	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	1.35	Not	0.44	Class III
Bornholm Basin Swedish Coastal Waters	Biota	CS-137	Rad	1.419	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.35	Not	0.44	Class III
Bornholm Basin Swedish Coastal Waters	Water	CS-137	Rad	1.701	Bq/m^3	+	M	H	All	Low	0.75	1.70	Not	0.75	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bornholm Basin Swedish Coastal Waters	Biota	HG	HM	0.210	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	1.35	Not	0.44	Class III
Bornholm Basin Swedish Coastal Waters	Biota	PB	HM	0.320	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	1.35	Not	0.44	Class III
Bothnian Bay	Sediment	ANT	Org	0.051	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.52	Good	0.50	Class II
Bothnian Bay	Sediment	CD	HM	0.639	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.52	Good	0.50	Class II
Bothnian Bay	Biota	CS-137	Rad	2.105	Bq/kg WW (fish)	+	M	H	All	Low	0.75	20.98	Not	0.44	Class III
Bothnian Bay	Water	CS-137	Rad	1.320	Bq/m^3	+	M	H	All	Low	0.75	1.32	Not	0.75	Class I
Bothnian Bay	Biota	HBCD	Org	0.005	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	20.98	Not good	0.44	Class III
Bothnian Bay	Sediment	HBCD	Org	0.006	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.52	Good	0.50	Class II
Bothnian Bay	Biota	HG	HM	0.986	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	20.98	Not	0.44	Class III
Bothnian Bay	Biota	PB	HM	0.299	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	20.98	Not	0.44	Class III
Bothnian Bay	Sediment	PB	HM	0.475	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.52	Good	0.50	Class II
Bothnian Bay	Biota	PFOS	Org	0.068	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	20.98	Not	0.44	Class III
Bothnian Bay	Biota	SBD6	Org	54.532	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	20.98	Not good	0.44	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bothnian Bay	Sediment	SBD6	Org	0.001	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.52	Good	0.50	Class II
Bothnian Bay	Biota	SCB6	Org	0.164	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	20.98	Not good	0.44	Class III
Bothnian Bay	Biota	SDX	Org	1.174	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	20.98	Not good	0.44	Class III
Bothnian Bay Finnish Coastal Waters	Biota	CS-137	Rad	2.105	Bq/kg WW (fish)	+	M	H	All	Low	0.75	140.76	Not	0.46	Class III
Bothnian Bay Finnish Coastal Waters	Water	CS-137	Rad	1.320	Bq/m^3	+	M	H	All	Low	0.75	1.32	Not	0.75	Class I
Bothnian Bay Finnish Coastal Waters	Biota	HBCD	Org	0.004	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	140.76	Not good	0.46	Class III
Bothnian Bay Finnish Coastal Waters	Biota	HG	HM	7.630	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	140.76	Not	0.46	Class III
Bothnian Bay Finnish Coastal Waters	Biota	PFOS	Org	0.281	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	140.76	Not	0.46	Class III
Bothnian Bay Finnish Coastal Waters	Biota	SBD6	Org	334.522	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	140.76	Not good	0.46	Class III
Bothnian Bay Finnish Coastal Waters	Biota	SCB6	Org	0.244	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	140.76	Not good	0.46	Class III
Bothnian Bay Swedish Coastal Waters	Biota	CS-137	Rad	2.105	Bq/kg WW (fish)	+	M	H	All	Low	0.75	22.64	Not	0.81	Class I
Bothnian Bay Swedish Coastal Waters	Water	CS-137	Rad	1.320	Bq/m^3	+	M	H	All	Low	0.75	1.32	Not	0.75	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bothnian Bay Swedish Coastal Waters	Biota	HBCD	Org	0.003	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	22.64	Not good	0.81	Class I
Bothnian Bay Swedish Coastal Waters	Biota	HG	HM	2.225	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	22.64	Not	0.81	Class I
Bothnian Bay Swedish Coastal Waters	Biota	PB	HM	0.247	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	22.64	Not	0.81	Class I
Bothnian Bay Swedish Coastal Waters	Biota	PFOS	Org	0.055	ug/kg WW (fish MU, MU&EP, LI)	+	H	H	All	Low	1.00	22.64	Not	0.81	Class I
Bothnian Bay Swedish Coastal Waters	Biota	SBD6	Org	58.998	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	22.64	Not good	0.81	Class I
Bothnian Bay Swedish Coastal Waters	Biota	SCB6	Org	0.080	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	22.64	Not good	0.81	Class I
Bothnian Bay Swedish Coastal Waters	Biota	SDX	Org	0.311	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	22.64	Not good	0.81	Class I
Bothnian Sea	Sediment	ANT	Org	0.084	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.18	Good	0.50	Class II
Bothnian Sea	Sediment	CD	HM	0.109	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.18	Good	0.50	Class II
Bothnian Sea	Biota	CS-137	Rad	2.323	Bq/kg WW (fish)	+	M	H	All	Low	0.75	11.67	Not	0.72	Class II
Bothnian Sea	Water	CS-137	Rad	1.955	Bq/m^3	+	M	H	All	Low	0.75	1.96	Not	0.75	Class I
Bothnian Sea	Biota	HBCD	Org	0.002	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	M	All	Low	0.75	11.67	Not good	0.72	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bothnian Sea	Sediment	HBCD	Org	0.010	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.18	Good	0.50	Class II
Bothnian Sea	Biota	HG	HM	0.826	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	11.67	Not	0.72	Class II
Bothnian Sea	Biota	PB	HM	0.466	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	11.67	Not	0.72	Class II
Bothnian Sea	Sediment	PB	HM	0.193	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.18	Good	0.50	Class II
Bothnian Sea	Biota	PFOS	Org	0.078	ug/kg WW (fish MU, MU&EP, LI)	+	H	M	All	Low	0.75	11.67	Not	0.72	Class II
Bothnian Sea	Biota	SBD6	Org	28.964	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	M	All	Low	0.75	11.67	Not good	0.72	Class II
Bothnian Sea	Sediment	SBD6	Org	0.001	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.18	Good	0.50	Class II
Bothnian Sea	Biota	SCB6	Org	0.065	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	11.67	Not good	0.72	Class II
Bothnian Sea	Biota	SDX	Org	0.282	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	11.67	Not good	0.72	Class II
Bothnian Sea Finnish Coastal Waters	Biota	CS-137	Rad	2.323	Bq/kg WW (fish)	+	M	H	All	Low	0.75	54.69	Not	0.43	Class III
Bothnian Sea Finnish Coastal Waters	Water	CS-137	Rad	1.955	Bq/m^3	+	M	H	All	Low	0.75	1.96	Not	0.75	Class I
Bothnian Sea Finnish Coastal Waters	Biota	HBCD	Org	0.004	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	54.69	Not good	0.43	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bothnian Sea Finnish Coastal Waters	Biota	HG	HM	7.046	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	54.69	Not	0.43	Class III
Bothnian Sea Finnish Coastal Waters	Biota	PB	HM	0.402	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	54.69	Not	0.43	Class III
Bothnian Sea Finnish Coastal Waters	Biota	PFOS	Org	0.143	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	54.69	Not	0.43	Class III
Bothnian Sea Finnish Coastal Waters	Biota	SBD6	Org	134.579	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	54.69	Not good	0.43	Class III
Bothnian Sea Finnish Coastal Waters	Biota	SCB6	Org	0.191	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	54.69	Not good	0.43	Class III
Bothnian Sea Swedish Coastal Waters	Biota	CS-137	Rad	2.323	Bq/kg WW (fish)	+	M	H	All	Low	0.75	14.08	Not	0.81	Class I
Bothnian Sea Swedish Coastal Waters	Water	CS-137	Rad	1.955	Bq/m^3	+	M	H	All	Low	0.75	1.96	Not	0.75	Class I
Bothnian Sea Swedish Coastal Waters	Biota	HBCD	Org	0.002	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	14.08	Not good	0.81	Class I
Bothnian Sea Swedish Coastal Waters	Biota	HG	HM	1.017	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	14.08	Not	0.81	Class I
Bothnian Sea Swedish Coastal Waters	Biota	PB	HM	0.277	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	14.08	Not	0.81	Class I
Bothnian Sea Swedish Coastal Waters	Biota	PFOS	Org	0.034	ug/kg WW (fish MU, MU&EP, LI)	+	H	H	All	Low	1.00	14.08	Not	0.81	Class I
Bothnian Sea Swedish Coastal Waters	Biota	SBD6	Org	35.839	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	14.08	Not good	0.81	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Bothnian Sea Swedish Coastal Waters	Biota	SCB6	Org	0.082	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	14.08	Not good	0.81	Class I
Bothnian Sea Swedish Coastal Waters	Biota	SDX	Org	0.253	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	14.08	Not good	0.81	Class I
Eastern Gotland Basin	Sediment	ANT	Org	0.076	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.49	Not	0.50	Class II
Eastern Gotland Basin	Biota	BAP	Org	0.406	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	22.26	Not	0.68	Class II
Eastern Gotland Basin	Biota	CD	HM	4.480	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	22.26	Not	0.68	Class II
Eastern Gotland Basin	Sediment	CD	HM	2.371	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.49	Not	0.50	Class II
Eastern Gotland Basin	Water	CD	HM	0.479	ug/l water	+	H	L	All	Low	0.50	3.53	Not	0.56	Class II
Eastern Gotland Basin	Biota	CS-137	Rad	1.357	Bq/kg WW (fish)	+	M	H	All	Low	0.75	22.26	Not	0.68	Class II
Eastern Gotland Basin	Water	CS-137	Rad	1.878	Bq/m^3	+	M	H	All	Low	0.75	3.53	Not	0.56	Class II
Eastern Gotland Basin	Biota	FLU	Org	0.629	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	22.26	Not	0.68	Class II
Eastern Gotland Basin	Biota	HBCD	Org	0.005	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	22.26	Not good	0.68	Class II
Eastern Gotland Basin	Sediment	HBCD	Org	0.018	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.49	Not	0.50	Class II
Eastern Gotland Basin	Biota	HG	HM	1.477	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	22.26	Not	0.68	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Eastern Gotland Basin	Biota	PB	HM	1.469	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	22.26	Not	0.68	Class II
Eastern Gotland Basin	Sediment	PB	HM	0.855	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.49	Not	0.50	Class II
Eastern Gotland Basin	Water	PB	HM	0.769	ug/l water	+	H	L	All	Low	0.50	3.53	Not	0.56	Class II
Eastern Gotland Basin	Biota	PFOS	Org	0.074	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	22.26	Not	0.68	Class II
Eastern Gotland Basin	Water	PFOS	Org	3.933	ug/l water	+	H	L	All	Low	0.50	3.53	Not	0.56	Class II
Eastern Gotland Basin	Biota	SBD6	Org	63.368	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	22.26	Not good	0.68	Class II
Eastern Gotland Basin	Sediment	SBD6	Org	0.001	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.49	Not	0.50	Class II
Eastern Gotland Basin	Biota	SCB6	Org	0.096	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	22.26	Not good	0.68	Class II
Eastern Gotland Basin	Biota	SDX	Org	0.470	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	M	All	Low	0.75	22.26	Not good	0.68	Class II
Eastern Gotland Basin Estonian Coastal Waters	Biota	CS-137	Rad	1.357	Bq/kg WW (fish)	+	M	H	All	Low	0.75	3.24	Not good	0.38	Class III
Eastern Gotland Basin Estonian Coastal Waters	Water	CS-137	Rad	1.878	Bq/m^3	+	M	H	All	Low	0.75	1.88	Not good	0.75	Class I
Eastern Gotland Basin Estonian Coastal Waters	Biota	HG	HM	3.487	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	3.24	Not good	0.38	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Eastern Gotland Basin Estonian Coastal Waters	Biota	PB	HM	1.526	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	3.24	Not good	0.38	Class III
Eastern Gotland Basin Estonian Coastal Waters	Biota	SCB6	Org	0.111	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	3.24	Not good	0.38	Class III
Eastern Gotland Basin Latvian Coastal Waters	Biota	CS-137	Rad	1.357	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.36	Not good	0.75	Class I
Eastern Gotland Basin Latvian Coastal Waters	Water	CS-137	Rad	1.878	Bq/m^3	+	M	H	All	Low	0.75	1.88	Not good	0.75	Class I
Eastern Gotland Basin Lithuanian Coastal Waters	Sediment	ANT	Org	0.338	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.89	Good	0.50	Class II
Eastern Gotland Basin Lithuanian Coastal Waters	Biota	BAP	Org	0.076	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	1.45	Not good	0.46	Class III
Eastern Gotland Basin Lithuanian Coastal Waters	Biota	CD	HM	0.369	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	1.45	Not good	0.46	Class III
Eastern Gotland Basin Lithuanian Coastal Waters	Sediment	CD	HM	0.520	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.89	Good	0.50	Class II
Eastern Gotland Basin Lithuanian Coastal Waters	Water	CD	HM	0.464	ug/l water	+	H	L	All	Low	0.50	2.62	Not good	0.56	Class II
Eastern Gotland Basin Lithuanian Coastal Waters	Biota	CS-137	Rad	1.357	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.45	Not good	0.46	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Eastern Gotland Basin Lithuanian Coastal Waters	Water	CS-137	Rad	1.878	Bq/m^3	+	M	H	All	Low	0.75	2.62	Not good	0.56	Class II
Eastern Gotland Basin Lithuanian Coastal Waters	Biota	FLU	Org	0.065	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	1.45	Not good	0.46	Class III
Eastern Gotland Basin Lithuanian Coastal Waters	Sediment	HBCD	Org	0.142	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.89	Good	0.50	Class II
Eastern Gotland Basin Lithuanian Coastal Waters	Biota	HG	HM	0.801	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	1.45	Not good	0.46	Class III
Eastern Gotland Basin Lithuanian Coastal Waters	Biota	PB	HM	0.879	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	1.45	Not good	0.46	Class III
Eastern Gotland Basin Lithuanian Coastal Waters	Sediment	PB	HM	0.780	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.89	Good	0.50	Class II
Eastern Gotland Basin Lithuanian Coastal Waters	Water	PB	HM	0.769	ug/l water	+	H	L	All	Low	0.50	2.62	Not good	0.56	Class II
Eastern Gotland Basin Lithuanian Coastal Waters	Water	PFOS	Org	2.125	ug/l water	+	H	L	All	Low	0.50	2.62	Not good	0.56	Class II
Eastern Gotland Basin Polish Coastal Waters	Water	CD	HM	0.328	ug/l water	+	H	L	All	Low	0.50	2.10	Not	0.58	Class II
Eastern Gotland Basin Polish Coastal Waters	Biota	CS-137	Rad	1.357	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.36	Not	0.75	Class I
Eastern Gotland Basin Polish Coastal Waters	Water	CS-137	Rad	1.878	Bq/m^3	+	M	H	All	Low	0.75	2.10	Not	0.58	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Eastern Gotland Basin Polish Coastal Waters	Water	PB	HM	1.428	ug/l water	+	H	L	All	Low	0.50	2.10	Not	0.58	Class II
Eastern Gotland Basin Russian Coastal Waters	Biota	CS-137	Rad	1.357	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.36	Not good	0.75	Class I
Eastern Gotland Basin Russian Coastal Waters	Water	CS-137	Rad	1.878	Bq/m^3	+	M	H	All	Low	0.75	1.88	Not good	0.75	Class I
Eastern Gotland Basin Swedish Coastal Waters	Biota	CS-137	Rad	1.357	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.36	Not good	0.75	Class I
Eastern Gotland Basin Swedish Coastal Waters	Water	CS-137	Rad	1.878	Bq/m^3	+	M	H	All	Low	0.75	1.88	Not good	0.75	Class I
Gdansk Basin	Sediment	CD	HM	1.199	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.44	Not	0.50	Class II
Gdansk Basin	Biota	CS-137	Rad	1.314	Bq/kg WW (fish)	+	M	H	All	Low	0.75	11.15	Not	0.44	Class III
Gdansk Basin	Water	CS-137	Rad	1.590	Bq/m^3	+	M	H	All	Low	0.75	1.59	Not	0.75	Class I
Gdansk Basin	Biota	HBCD	Org	0.000	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	11.15	Not good	0.44	Class III
Gdansk Basin	Biota	HG	HM	2.900	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	11.15	Not	0.44	Class III
Gdansk Basin	Biota	PB	HM	1.423	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	11.15	Not	0.44	Class III
Gdansk Basin	Sediment	PB	HM	0.837	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.44	Not	0.50	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Gdansk Basin	Biota	PFOS	Org	0.100	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	11.15	Not	0.44	Class III
Gdansk Basin	Biota	SBD6	Org	25.350	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	11.15	Not good	0.44	Class III
Gdansk Basin	Biota	SCB6	Org	0.053	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	11.15	Not good	0.44	Class III
Gdansk Basin	Biota	SDX	Org	0.404	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	11.15	Not good	0.44	Class III
Gdansk Basin Polish Coastal Waters	Biota	BAP	Org	0.142	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	8.92	Not	0.48	Class III
Gdansk Basin Polish Coastal Waters	Biota	CD	HM	2.036	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	8.92	Not	0.48	Class III
Gdansk Basin Polish Coastal Waters	Sediment	CD	HM	0.315	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.35	Good	0.50	Class II
Gdansk Basin Polish Coastal Waters	Water	CD	HM	0.569	ug/l water	+	H	L	All	Low	0.50	2.01	Not	0.58	Class II
Gdansk Basin Polish Coastal Waters	Biota	CS-137	Rad	1.314	Bq/kg WW (fish)	+	M	H	All	Low	0.75	8.92	Not	0.48	Class III
Gdansk Basin Polish Coastal Waters	Water	CS-137	Rad	1.590	Bq/m^3	+	M	H	All	Low	0.75	2.01	Not	0.58	Class II
Gdansk Basin Polish Coastal Waters	Biota	FLU	Org	0.008	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	8.92	Not	0.48	Class III
Gdansk Basin Polish Coastal Waters	Biota	HBCD	Org	0.001	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	8.92	Not good	0.48	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Gdansk Basin Polish Coastal Waters	Biota	HG	HM	1.621	ug/kg WW fish (fish MU - fillet)	+	H	M	All	Low	0.75	8.92	Not	0.48	Class III
Gdansk Basin Polish Coastal Waters	Biota	PB	HM	0.869	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	M	All	Low	0.50	8.92	Not	0.48	Class III
Gdansk Basin Polish Coastal Waters	Sediment	PB	HM	0.179	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.35	Good	0.50	Class II
Gdansk Basin Polish Coastal Waters	Water	PB	HM	1.324	ug/l water	+	H	L	All	Low	0.50	2.01	Not	0.58	Class II
Gdansk Basin Polish Coastal Waters	Biota	PFOS	Org	0.161	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	8.92	Not	0.48	Class III
Gdansk Basin Polish Coastal Waters	Biota	SBD6	Org	21.965	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	8.92	Not good	0.48	Class III
Gdansk Basin Polish Coastal Waters	Biota	SCB6	Org	0.076	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	8.92	Not good	0.48	Class III
Gdansk Basin Russian Coastal Waters	Biota	CS-137	Rad	1.314	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.31	Not	0.75	Class I
Gdansk Basin Russian Coastal Waters	Water	CS-137	Rad	1.590	Bq/m^3	+	M	H	All	Low	0.75	1.59	Not	0.75	Class I
Gulf of Finland	Biota	CS-137	Rad	1.407	Bq/kg WW (fish)	+	M	H	All	Low	0.75	11.34	Not	0.50	Class II
Gulf of Finland	Water	CS-137	Rad	1.277	Bq/m^3	+	M	H	All	Low	0.75	1.28	Not	0.75	Class I
Gulf of Finland	Biota	HG	HM	1.317	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	11.34	Not	0.50	Class II
Gulf of Finland	Biota	PB	HM	3.337	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	M	All	Low	0.50	11.34	Not	0.50	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Gulf of Finland	Biota	PFOS	Org	0.030	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	11.34	Not	0.50	Class II
Gulf of Finland	Biota	SBD6	Org	23.557	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	11.34	Not good	0.50	Class II
Gulf of Finland	Biota	SCB6	Org	0.085	ug/kg WW (MU,MEÃ™&EP, fillet, LI, whole fish) (norm 5% lipid)	+	L	M	All	Low	0.25	11.34	Not good	0.50	Class II
Gulf of Finland	Biota	SDX	Org	0.269	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	11.34	Not good	0.50	Class II
Gulf of Finland Estonian Coastal Waters	Biota	CS-137	Rad	1.407	Bq/kg WW (fish)	+	M	H	All	Low	0.75	3.16	Not good	0.38	Class III
Gulf of Finland Estonian Coastal Waters	Water	CS-137	Rad	1.277	Bq/m^3	+	M	H	All	Low	0.75	1.28	Not good	0.75	Class I
Gulf of Finland Estonian Coastal Waters	Biota	HG	HM	2.392	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	3.16	Not good	0.38	Class III
Gulf of Finland Estonian Coastal Waters	Biota	PB	HM	2.393	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	3.16	Not good	0.38	Class III
Gulf of Finland Estonian Coastal Waters	Biota	SCB6	Org	0.120	ug/kg WW (MU,MEÃ™&EP, fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	3.16	Not good	0.38	Class III
Gulf of Finland Finnish Coastal Waters	Biota	CS-137	Rad	1.407	Bq/kg WW (fish)	+	M	H	All	Low	0.75	44.68	Not good	0.43	Class III
Gulf of Finland Finnish Coastal Waters	Water	CS-137	Rad	1.277	Bq/m^3	+	M	H	All	Low	0.75	1.28	Not good	0.75	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Gulf of Finland Finnish Coastal Waters	Biota	HBCD	Org	0.004	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	44.68	Not good	0.43	Class III
Gulf of Finland Finnish Coastal Waters	Biota	HG	HM	5.850	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	44.68	Not good	0.43	Class III
Gulf of Finland Finnish Coastal Waters	Biota	PB	HM	0.868	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	44.68	Not good	0.43	Class III
Gulf of Finland Finnish Coastal Waters	Biota	PFOS	Org	0.229	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	44.68	Not good	0.43	Class III
Gulf of Finland Finnish Coastal Waters	Biota	SBD6	Org	109.548	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	44.68	Not good	0.43	Class III
Gulf of Finland Finnish Coastal Waters	Biota	SCB6	Org	0.307	ug/kg WW (MU,MEÃ™&EP, fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	44.68	Not good	0.43	Class III
Gulf of Finland Russian Coastal Waters	Biota	CS-137	Rad	1.407	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.41	Not good	0.75	Class I
Gulf of Finland Russian Coastal Waters	Water	CS-137	Rad	1.277	Bq/m^3	+	M	H	All	Low	0.75	1.28	Not good	0.75	Class I
Gulf of Riga	Water	CS-137	Rad	1.333	Bq/m^3	+	M	H	All	Low	0.75	1.33	Not	0.75	Class I
Gulf of Riga Estonian Coastal Waters	Water	CS-137	Rad	1.333	Bq/m^3	+	M	H	All	Low	0.75	1.33	Not	0.75	Class I
Gulf of Riga Estonian Coastal Waters	Biota	HG	HM	3.247	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	3.51	Not	0.42	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Gulf of Riga Estonian Coastal Waters	Biota	PB	HM	2.715	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	M	All	Low	0.50	3.51	Not	0.42	Class III
Gulf of Riga Estonian Coastal Waters	Biota	SCB6	Org	0.124	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	M	All	Low	0.25	3.51	Not good	0.42	Class III
Gulf of Riga Latvian Coastal Waters	Water	CS-137	Rad	1.333	Bq/m^3	+	M	H	All	Low	0.75	1.33	Not	0.75	Class I
Kattegat	Sediment	ANT	Org	0.384	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.30	Good	0.50	Class II
Kattegat	Sediment	CD	HM	0.060	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.30	Good	0.50	Class II
Kattegat	Biota	CS-137	Rad	0.188	Bq/kg WW (fish)	+	M	H	All	Low	0.75	14.08	Not	0.78	Class I
Kattegat	Water	CS-137	Rad	1.176	Bq/m^3	+	M	H	All	Low	0.75	1.18	Not	0.75	Class I
Kattegat	Biota	HBCD	Org	0.001	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	14.08	Not good	0.78	Class I
Kattegat	Sediment	HBCD	Org	0.011	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.30	Good	0.50	Class II
Kattegat	Biota	HG	HM	1.658	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	14.08	Not	0.78	Class I
Kattegat	Biota	PB	HM	0.332	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	M	All	Low	0.50	14.08	Not	0.78	Class I
Kattegat	Sediment	PB	HM	0.225	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	0.30	Good	0.50	Class II
Kattegat	Biota	PFOS	Org	0.016	ug/kg WW (fish MU, MU&EP, LI)	+	H	H	All	Low	1.00	14.08	Not	0.78	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Kattegat	Biota	SBD6	Org	37.412	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	14.08	Not good	0.78	Class I
Kattegat	Sediment	SBD6	Org	0.001	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.30	Good	0.50	Class II
Kattegat	Biota	SCB6	Org	0.138	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	14.08	Not good	0.78	Class I
Kattegat	Biota	SDX	Org	0.084	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	14.08	Not good	0.78	Class I
Kattegat Swedish Coastal Waters	Biota	BAP	Org	0.011	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	1.16	Not	0.58	Class II
Kattegat Swedish Coastal Waters	Biota	CD	HM	1.653	ug/kg WW mussels (SB)	+	M	M	All	Low	0.50	1.16	Not	0.58	Class II
Kattegat Swedish Coastal Waters	Biota	CS-137	Rad	0.188	Bq/kg WW (fish)	+	M	H	All	Low	0.75	1.16	Not	0.58	Class II
Kattegat Swedish Coastal Waters	Water	CS-137	Rad	1.176	Bq/m^3	+	M	H	All	Low	0.75	1.18	Not	0.75	Class I
Kattegat Swedish Coastal Waters	Biota	FLU	Org	0.020	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	1.16	Not	0.58	Class II
Kattegat Swedish Coastal Waters	Biota	HG	HM	0.534	ug/kg WW fish (fish MU - fillet)	+	H	M	All	Low	0.75	1.16	Not	0.58	Class II
Kattegat Swedish Coastal Waters	Biota	PB	HM	0.423	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	M	All	Low	0.50	1.16	Not	0.58	Class II
Kiel Bay	Sediment	ANT	Org	0.525	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	0.71	Good	0.83	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Kiel Bay	Sediment	CD	HM	0.175	mg/kg sediment (norm AL)	+	H	H	All	Low	1.00	0.71	Good	0.83	Class I
Kiel Bay	Water	CD	HM	0.100	ug/l water	+	H	L	All	Low	0.50	0.99	Good	0.58	Class II
Kiel Bay	Biota	CS-137	Rad	0.296	Bq/kg WW (fish)	+	M	H	All	Low	0.75	26.65	Not	0.40	Class III
Kiel Bay	Water	CS-137	Rad	1.463	Bq/m^3	+	M	H	All	Low	0.75	0.99	Good	0.58	Class II
Kiel Bay	Biota	HG	HM	0.995	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	26.65	Not	0.40	Class III
Kiel Bay	Biota	PB	HM	1.908	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	26.65	Not	0.40	Class III
Kiel Bay	Sediment	PB	HM	0.532	mg/kg sediment (norm AL)	+	H	H	All	Low	1.00	0.71	Good	0.83	Class I
Kiel Bay	Water	PB	HM	0.154	ug/l water	+	H	L	All	Low	0.50	0.99	Good	0.58	Class II
Kiel Bay	Biota	SBD6	Org	56.132	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	26.65	Not good	0.40	Class III
Kiel Bay	Biota	SCB6	Org	0.256	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	26.65	Not good	0.40	Class III
Kiel Bight German Coastal Waters	Sediment	ANT	Org	3.318	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	3.32	Not	0.50	Class II
Kiel Bight German Coastal Waters	Biota	CD	HM	1.607	ug/kg WW mussels (SB)	+	M	M	All	Low	0.50	2.57	Not	0.63	Class II
Kiel Bight German Coastal Waters	Water	CD	HM	0.089	ug/l water	+	H	M	All	Low	0.75	1.48	Not	0.75	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Kiel Bight German Coastal Waters	Biota	CS-137	Rad	0.296	Bq/kg WW (fish)	+	M	H	All	Low	0.75	2.57	Not	0.63	Class II
Kiel Bight German Coastal Waters	Water	CS-137	Rad	1.463	Bq/m^3	+	M	H	All	Low	0.75	1.48	Not	0.75	Class I
Kiel Bight German Coastal Waters	Biota	HG	HM	2.063	ug/kg WW fish (fish MU - fillet)	+	H	M	All	Low	0.75	2.57	Not	0.63	Class II
Kiel Bight German Coastal Waters	Biota	PB	HM	1.180	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	M	All	Low	0.50	2.57	Not	0.63	Class II
Kiel Bight German Coastal Waters	Water	PB	HM	0.147	ug/l water	+	H	H	All	Low	1.00	1.48	Not	0.75	Class I
Kiel Bight German Coastal Waters	Water	PFOS	Org	1.269	ug/l water	+	H	L	All	Low	0.50	1.48	Not	0.75	Class I
Mecklenburgh Bight German Coastal Waters	Biota	BAP	Org	0.074	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	2.88	Not good	0.43	Class III
Mecklenburgh Bight German Coastal Waters	Biota	CD	HM	2.906	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	2.88	Not good	0.43	Class III
Mecklenburgh Bight German Coastal Waters	Sediment	CD	HM	0.687	mg/kg sediment (norm AL)	+	H	M	All	Low	0.75	0.75	Good	0.75	Class I
Mecklenburgh Bight German Coastal Waters	Water	CD	HM	0.366	ug/l water	+	H	M	All	Low	0.75	2.30	Not good	0.75	Class I
Mecklenburgh Bight German Coastal Waters	Biota	CS-137	Rad	0.291	Bq/kg WW (fish)	+	M	H	All	Low	0.75	2.88	Not good	0.43	Class III
Mecklenburgh Bight German Coastal Waters	Water	CS-137	Rad	1.687	Bq/m^3	+	M	H	All	Low	0.75	2.30	Not good	0.75	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Mecklenburgh Bight German Coastal Waters	Biota	FLU	Org	0.044	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	2.88	Not good	0.43	Class III
Mecklenburgh Bight German Coastal Waters	Biota	HG	HM	1.770	ug/kg WW fish (fish MU - fillet)	+	H	M	All	Low	0.75	2.88	Not good	0.43	Class III
Mecklenburgh Bight German Coastal Waters	Biota	PB	HM	2.097	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	2.88	Not good	0.43	Class III
Mecklenburgh Bight German Coastal Waters	Sediment	PB	HM	0.380	mg/kg sediment (norm AL)	+	H	M	All	Low	0.75	0.75	Good	0.75	Class I
Mecklenburgh Bight German Coastal Waters	Water	PB	HM	0.087	ug/l water	+	H	H	All	Low	1.00	2.30	Not good	0.75	Class I
Mecklenburgh Bight German Coastal Waters	Water	PFOS	Org	2.462	ug/l water	+	H	L	All	Low	0.50	2.30	Not good	0.75	Class I
Mecklenburgh Bight German Coastal Waters	Biota	SCB6	Org	0.435	ug/kg WW (MU,MEÃ™&EP, fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	2.88	Not good	0.43	Class III
Northern Baltic Proper	Sediment	ANT	Org	0.042	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.36	Not	0.50	Class II
Northern Baltic Proper	Sediment	CD	HM	2.657	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.36	Not	0.50	Class II
Northern Baltic Proper	Water	CS-137	Rad	1.760	Bq/m^3	+	M	H	All	Low	0.75	1.76	Not	0.75	Class I
Northern Baltic Proper	Biota	HBCD	Org	0.003	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	10.34	Not good	0.68	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Northern Baltic Proper	Sediment	HBCD	Org	0.010	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.36	Not	0.50	Class II
Northern Baltic Proper	Biota	HG	HM	1.265	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	10.34	Not	0.68	Class II
Northern Baltic Proper	Biota	PB	HM	0.541	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	10.34	Not	0.68	Class II
Northern Baltic Proper	Sediment	PB	HM	0.327	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.36	Not	0.50	Class II
Northern Baltic Proper	Biota	PFOS	Org	0.053	ug/kg WW (fish MU, MU&EP, LI)	+	H	M	All	Low	0.75	10.34	Not	0.68	Class II
Northern Baltic Proper	Biota	SBD6	Org	25.198	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	M	All	Low	0.75	10.34	Not good	0.68	Class II
Northern Baltic Proper	Sediment	SBD6	Org	0.001	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.36	Not	0.50	Class II
Northern Baltic Proper	Biota	SCB6	Org	0.064	ug/kg WW (MU,MEÃ™&EP, fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	10.34	Not good	0.68	Class II
Northern Baltic Proper	Biota	SDX	Org	0.245	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	10.34	Not good	0.68	Class II
Northern Baltic Proper Estonian Coastal Waters	Water	CS-137	Rad	1.760	Bq/m^3	+	M	H	All	Low	0.75	1.76	Not good	0.75	Class I
Northern Baltic Proper Estonian Coastal Waters	Biota	PB	HM	1.759	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	1.34	Not good	0.13	Class III
Northern Baltic Proper Estonian Coastal Waters	Biota	SCB6	Org	0.132	ug/kg WW (MU,MEÃ™&EP, fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	1.34	Not good	0.13	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Northern Baltic Proper Swedish Coastal Waters	Water	CS-137	Rad	1.760	Bq/m^3	+	M	H	All	Low	0.75	1.76	Not good	0.75	Class I
Northern Baltic Proper Swedish Coastal Waters	Biota	HBCD	Org	0.001	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	16.12	Not good	0.39	Class III
Northern Baltic Proper Swedish Coastal Waters	Biota	HG	HM	2.121	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	16.12	Not good	0.39	Class III
Northern Baltic Proper Swedish Coastal Waters	Biota	PB	HM	0.490	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	16.12	Not good	0.39	Class III
Northern Baltic Proper Swedish Coastal Waters	Biota	PFOS	Org	0.127	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	16.12	Not good	0.39	Class III
Northern Baltic Proper Swedish Coastal Waters	Biota	SBD6	Org	39.421	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	16.12	Not good	0.39	Class III
Northern Baltic Proper Swedish Coastal Waters	Biota	SCB6	Org	0.206	ug/kg WW (MU,MEÃ™&EP, fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	16.12	Not good	0.39	Class III
Northern Baltic Proper Swedish Coastal Waters	Biota	SDX	Org	0.287	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	16.12	Not good	0.39	Class III
The Quark	Biota	CS-137	Rad	2.106	Bq/kg WW (fish)	+	M	H	All	Low	0.75	9.35	Not	0.43	Class III
The Quark	Biota	HG	HM	1.000	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	9.35	Not	0.43	Class III
The Quark	Biota	PB	HM	0.769	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	9.35	Not	0.43	Class III

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
The Quark	Biota	PFOS	Org	0.027	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	9.35	Not	0.43	Class III
The Quark	Biota	SBD6	Org	20.546	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	9.35	Not good	0.43	Class III
The Quark	Biota	SCB6	Org	0.087	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	9.35	Not good	0.43	Class III
The Quark	Biota	SDX	Org	0.201	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	9.35	Not good	0.43	Class III
The Quark Finnish Coastal Waters	Biota	CS-137	Rad	2.106	Bq/kg WW (fish)	+	M	H	All	Low	0.75	32.30	Not	0.43	Class III
The Quark Finnish Coastal Waters	Biota	HBCD	Org	0.001	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	32.30	Not good	0.43	Class III
The Quark Finnish Coastal Waters	Biota	HG	HM	3.462	ug/kg WW fish (fish MU - fillet)	+	H	L	All	Low	0.50	32.30	Not	0.43	Class III
The Quark Finnish Coastal Waters	Biota	PB	HM	0.518	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	L	All	Low	0.25	32.30	Not	0.43	Class III
The Quark Finnish Coastal Waters	Biota	PFOS	Org	0.510	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	32.30	Not	0.43	Class III
The Quark Finnish Coastal Waters	Biota	SBD6	Org	78.544	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	32.30	Not good	0.43	Class III
The Quark Finnish Coastal Waters	Biota	SCB6	Org	0.328	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	L	All	Low	0.00	32.30	Not good	0.43	Class III
The Quark Swedish Coastal Waters	Biota	CS-137	Rad	2.106	Bq/kg WW (fish)	+	M	H	All	Low	0.75	12.13	Not	0.69	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
The Quark Swedish Coastal Waters	Biota	HBCD	Org	0.001	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	M	All	Low	0.75	12.13	Not good	0.69	Class II
The Quark Swedish Coastal Waters	Biota	HG	HM	2.285	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	12.13	Not	0.69	Class II
The Quark Swedish Coastal Waters	Biota	PB	HM	0.100	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	12.13	Not	0.69	Class II
The Quark Swedish Coastal Waters	Biota	PFOS	Org	0.031	ug/kg WW (fish MU, MU&EP, LI)	+	H	L	All	Low	0.50	12.13	Not	0.69	Class II
The Quark Swedish Coastal Waters	Biota	SBD6	Org	29.504	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	M	All	Low	0.75	12.13	Not good	0.69	Class II
The Quark Swedish Coastal Waters	Biota	SCB6	Org	0.075	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	12.13	Not good	0.69	Class II
The Quark Swedish Coastal Waters	Biota	SDX	Org	0.196	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	12.13	Not good	0.69	Class II
The Sound	Sediment	ANT	Org	1.770	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.30	Not	0.50	Class II
The Sound	Sediment	CD	HM	0.086	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.30	Not	0.50	Class II
The Sound	Water	CS-137	Rad	1.578	Bq/m^3	+	M	H	All	Low	0.75	1.58	Not	0.75	Class I
The Sound	Sediment	PB	HM	0.397	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.30	Not	0.50	Class II
The Sound Swedish Coastal Waters	Water	CS-137	Rad	1.578	Bq/m^3	+	M	H	All	Low	0.75	1.58	Not	0.75	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Western Gotland Basin	Sediment	ANT	Org	0.072	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.45	Not	0.50	Class II
Western Gotland Basin	Sediment	CD	HM	2.775	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.45	Not	0.50	Class II
Western Gotland Basin	Biota	CS-137	Rad	1.696	Bq/kg WW (fish)	+	M	H	All	Low	0.75	14.53	Not	0.81	Class I
Western Gotland Basin	Water	CS-137	Rad	1.813	Bq/m^3	+	M	H	All	Low	0.75	1.81	Not	0.75	Class I
Western Gotland Basin	Biota	HBCD	Org	0.004	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	14.53	Not good	0.81	Class I
Western Gotland Basin	Sediment	HBCD	Org	0.009	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.45	Not	0.50	Class II
Western Gotland Basin	Biota	HG	HM	0.738	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	14.53	Not	0.81	Class I
Western Gotland Basin	Biota	PB	HM	0.467	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	14.53	Not	0.81	Class I
Western Gotland Basin	Sediment	PB	HM	0.390	mg/kg sediment (norm AL)	+	H	L	All	Low	0.50	1.45	Not	0.50	Class II
Western Gotland Basin	Biota	PFOS	Org	0.080	ug/kg WW (fish MU, MU&EP, LI)	+	H	H	All	Low	1.00	14.53	Not	0.81	Class I
Western Gotland Basin	Biota	SBD6	Org	37.778	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	H	All	Low	1.00	14.53	Not good	0.81	Class I
Western Gotland Basin	Sediment	SBD6	Org	0.001	ug/kg DW sediment (norm 5% CORG)	+	H	L	All	Low	0.50	1.45	Not	0.50	Class II
Western Gotland Basin	Biota	SCB6	Org	0.071	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	14.53	Not good	0.81	Class I

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Western Gotland Basin	Biota	SDX	Org	0.265	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	14.53	Not good	0.81	Class I
Western Gotland Basin Swedish Coastal Waters	Biota	BAP	Org	0.044	ug/kg WW (crustacean and molluscs SM, TM)	+	H	L	All	Low	0.50	14.18	Not good	0.58	Class II
Western Gotland Basin Swedish Coastal Waters	Biota	CD	HM	4.133	ug/kg WW mussels (SB)	+	M	L	All	Low	0.25	14.18	Not good	0.58	Class II
Western Gotland Basin Swedish Coastal Waters	Biota	CS-137	Rad	1.696	Bq/kg WW (fish)	+	M	H	All	Low	0.75	14.18	Not good	0.58	Class II
Western Gotland Basin Swedish Coastal Waters	Water	CS-137	Rad	1.813	Bq/m^3	+	M	H	All	Low	0.75	1.81	Not good	0.75	Class I
Western Gotland Basin Swedish Coastal Waters	Biota	FLU	Org	0.019	ug/kg WW (crustacean and molluscs All, SM, TM)	+	H	L	All	Low	0.50	14.18	Not good	0.58	Class II
Western Gotland Basin Swedish Coastal Waters	Biota	HBCD	Org	0.001	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	14.18	Not good	0.58	Class II
Western Gotland Basin Swedish Coastal Waters	Biota	HG	HM	1.972	ug/kg WW fish (fish MU - fillet)	+	H	H	All	Low	1.00	14.18	Not good	0.58	Class II
Western Gotland Basin Swedish Coastal Waters	Biota	PB	HM	0.388	ug/kg WW fish (LI) - ug/kg DW mussels (SB)	+	M	H	All	Low	0.75	14.18	Not good	0.58	Class II
Western Gotland Basin Swedish Coastal Waters	Biota	SBD6	Org	36.281	ug/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	14.18	Not good	0.58	Class II

Waterbody	Matrix	Substance	Type	CR	Units	Response	ConfThresh	ConfStatus	Datatype	Confidence	ConfScore	ConSum	QEStatus	QEConfSco	QEConfide
Western Gotland Basin Swedish Coastal Waters	Biota	SCB6	Org	0.084	ug/kg WW (MU,MEÃ™&EP , fillet, LI, whole fish) (norm 5% lipid)	+	L	H	All	Low	0.50	14.18	Not good	0.58	Class II
Western Gotland Basin Swedish Coastal Waters	Biota	SDX	Org	0.221	TEQ/kg WW (MU, MU&EP, fillet, LI, whole fish) (norm 5% lipid)	+	H	L	All	Low	0.50	14.18	Not good	0.58	Class II

Annex 5. Summary of data series used in each indicator

Substance or substance group	Status assessment - full data with trends assessed			Status assessment – treated as initial data, trend not possible		Number of trend assessments	Total number of data series
	Downward trend	No detectable .	Upward trend	*Full data but no trend*	*Initial data*		
Hexabromocyclododecane (HBCDD)	5	16	0	5	47	21	73
Polybrominated diphenyl ethers (PBDEs)	5	16	1	16	53	22	91
Non-dioxin-like PCBs	15	23	0	21	48	38	107
Dioxin-like PCBs, dixins and furans	0	2	0	24	16	2	42
Benzo(a)pyrene	4	16	0	12	102	20	134
Fluoranthene	3	16	2	10	115	21	146
Anthracene	0	0	0	11	154	0	165
Perfluorooctane sulphonate (PFOS)	3	17	0	13	64	20	97
Mercury	18	43	5	38	207	66	311
Cadmium	4	33	1	40	281	38	359
Lead	19	48	3	54	327	70	451
Radioactive substances (Cs-137)	152	52	0	87	0	204	291
Tributyltin (TBT) and imposex	8	29	0	7	206	37	250
TOTALS	**236**	**311**	**12**	**338**	**1620**	**559**	**2517**