HELCOM indicator report
July 2017

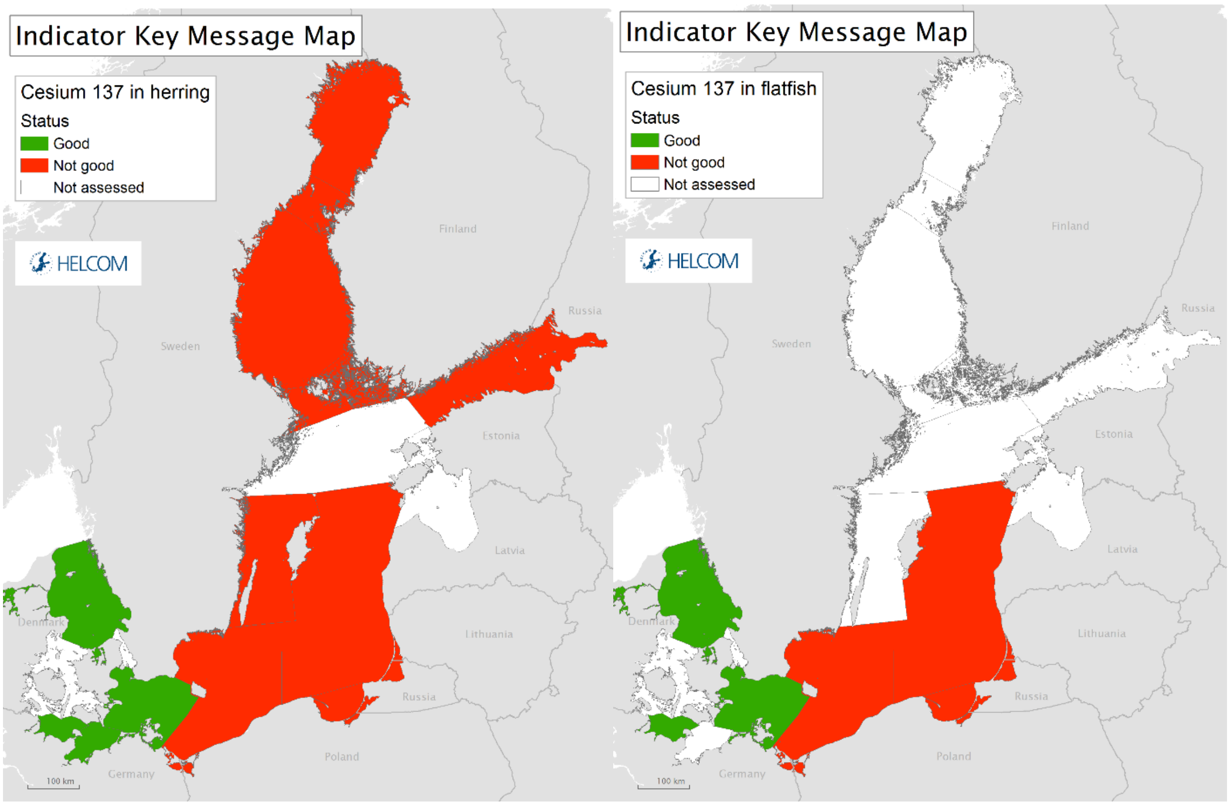
Radioactive substances: Cesium-137 in fish and surface seawater

Key Message

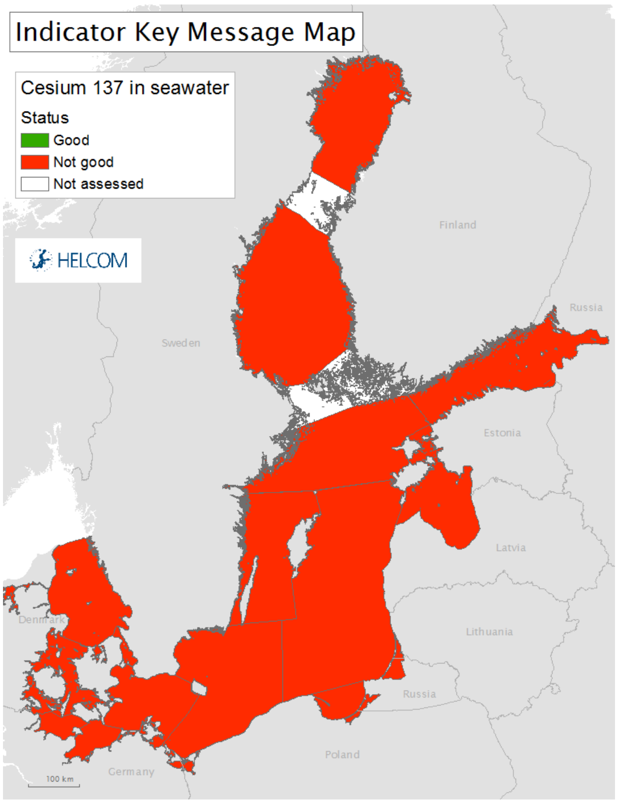
This core indicator evaluates the state of the environment using the concentration of the radioactive isotope cesium-137 (^{137}Cs) in herring, flatfish and surface waters. Good status is achieved when concentrations reach levels measured before the Chernobyl accident in 1986 when the biota of the Baltic Sea received the most significant contribution to their level of artificial radionuclides, predominantly in the form of ^{137}Cs.

The indicator presents a status evaluation using data from 2011-2015.

In general, the activity concentrations of radioactive isotope cesium-137 (^{137}Cs) in herring, flatfish and surface waters are still above the pre-Chernobyl levels which constitute the boundary for good status – threshold values.



Key message figure 1: Status assessment results based on evaluation of concentrations of cesium-137 in herring and flatfish. The assessment is carried out using Scale 2 HELCOM assessment units (defined in the [HELCOM Monitoring and Assessment Strategy Annex 4](#)).



Key message figure 2: Status assessment results based evaluation of concentrations of cesium-137 in seawater. The assessment is carried out using Scale 2 HELCOM assessment units (defined in the [HELCOM Monitoring and Assessment Strategy Annex 4](#)).

For herring, good status is only achieved in the Arkona Basin, the Bay of Mecklenburg, the Kiel Bay and the Kattegat. For flatfish, good status is also achieved in the Arkona Basin, the Kiel Bay, the Great Belt and the Kattegat. All other assessed sub-basins are characterized by not-good status. For surface waters, good status is not achieved in any of the sub-basins.

Time series analyses show that the ^{137}Cs activity concentrations in herring, flatfish and surface waters in the Baltic Sea basins are decreasing and approaching pre-Chernobyl levels. It is expected that good status may be reached in the Baltic Sea by about 2020 - 2025.

The confidence of the indicator status evaluation is considered to be high.

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

Relevance of the core indicator

The radionuclide cesium-137 (^{137}Cs) is the greatest contributor to the level of artificial radionuclides in the Baltic Sea, where the level of ^{137}Cs contamination is still higher than in any other oceans of the world. The main source of ^{137}Cs deposited to the Baltic Sea stems from the accident at the Chernobyl nuclear power plant in 1986. The ^{137}Cs was introduced into the Baltic seawater by atmospheric deposition and, to a lesser extent, through riverine input. ^{137}Cs introduced to the Baltic Sea is bioaccumulated in marine flora and fauna and is eventually deposited in the marine sediments. Therefore ^{137}Cs activity concentrations are the key factors in an assessment of the radiological hazard to marine organisms and humans (Nielsen et al. 1999).

Both are highly interconnected as the dominating exposure pathway of humans from man-made radioactivity in the Baltic Sea is related to the ingestion of ^{137}Cs in fish.

Policy relevance of the core indicator

	BSAP segment and objectives	MSFD Descriptor and criteria
Primary link	Hazardous substances • Radioactivity at pre-Chernobyl level	D8 Concentrations of contaminants D8C1 Within coastal, territorial and areas beyond territorial waters the concentration of contaminants do not exceed the threshold values
Secondary link		D9 Contaminants in fish and seafood D9C1 The level of contaminants in edible tissues of seafood caught or harvested in the wild does not exceed maximum levels which are the threshold values

Cite this indicator

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HOLAS II component - Core indicator report – web-based version July 2017 (pdf)

Results and Confidence

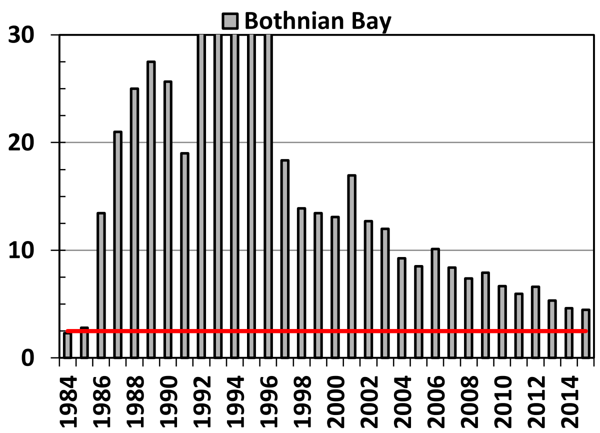
The current evaluation of whether good status is achieved, using concentrations of ^{137}Cs in biota and seawater, is based on data from the period 2011-2015.

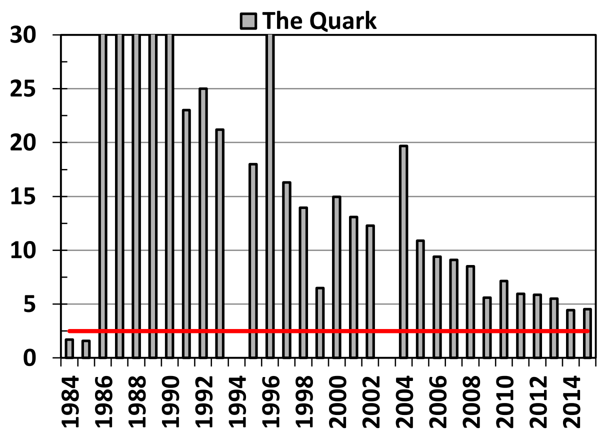
The results indicate that the activity concentrations of ^{137}Cs in biota and seawater still reflect not-good status in many HELCOM assessment units. Currently the activity concentrations of ^{137}Cs are approaching the pre-Chernobyl levels, representing good status boundary in all matrices. ^{137}Cs in fish and seawater reached their maximum values in the late 1980s and early 1990s (Results figures 1-3). Since then concentrations of ^{137}Cs in fish and seawater have continued to decrease in all regions of the Baltic Sea, it is expected that good status may be reached in all the HELCOM assessment units of the Baltic Sea by about 2020-2025.

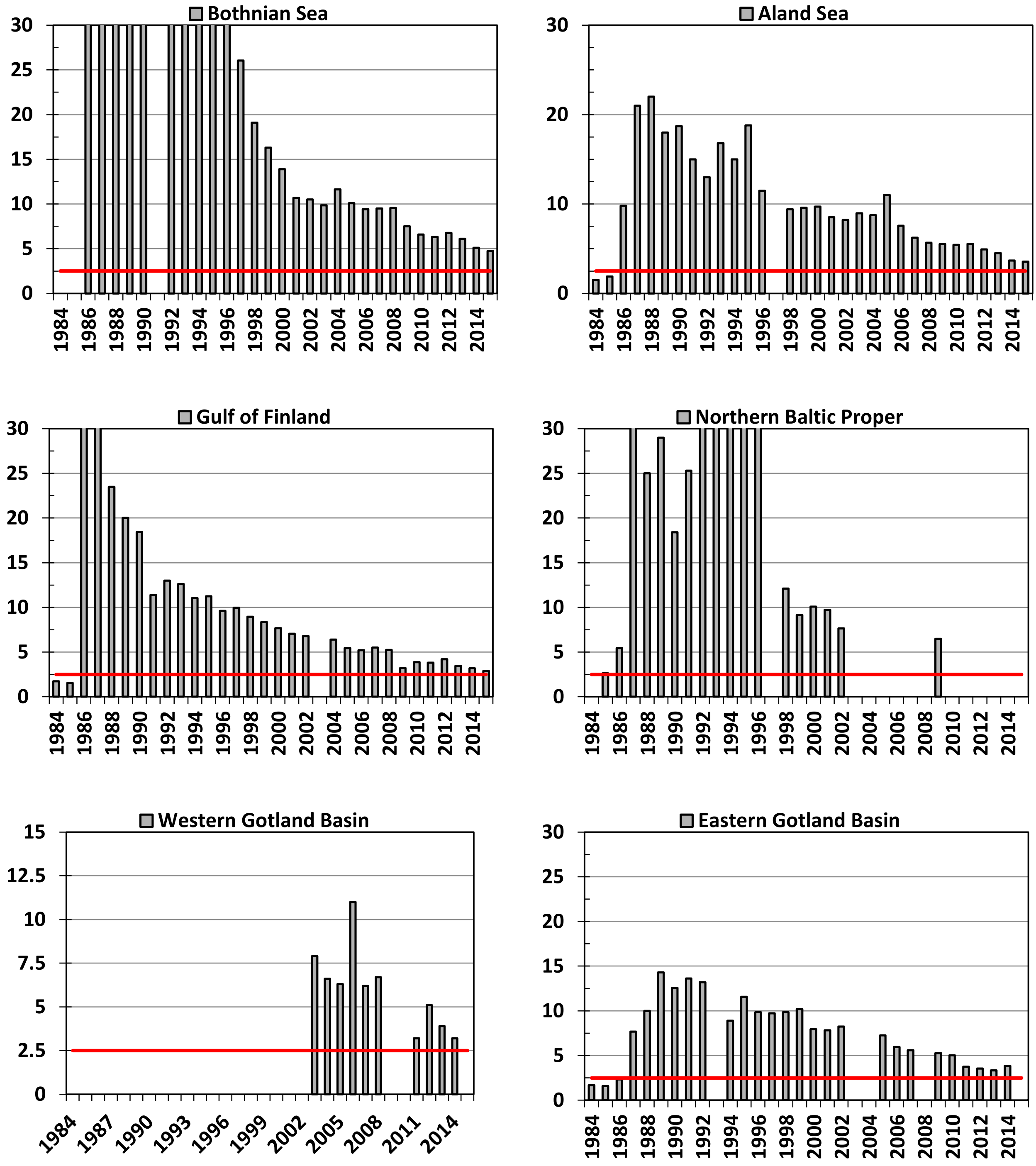
Herring

Basing on data from 2011 to 2015, good status for ^{137}Cs in herring, is not achieved in most of the HELCOM sub-basins, except for the Arkona Basin, where the average concentration of ^{137}Cs is equal to 1.4 Bq kg^{-1} wet weight and sub-basins west to Arkona Sea (Kiel Bay - 0.8 Bq kg^{-1} wet weight, Bay of Mecklenburg – 0.7 Bq kg^{-1} wet weight and Kattegat – 0.7 Bq kg^{-1} wet weight) (Results figure 1). In the Gulf of Finland, the Gdańsk Basin, the Eastern and Western Gotland Basins, the Bornholm Basin and the Åland Sea the average concentrations calculated for the period 2011-2015 were in the range from 3.5 to 4.4 Bq kg^{-1} wet weight, while the highest mean value was found in the Bothnian Sea – 5.8 Bq kg^{-1} wet weight.

The annual mean values of concentrations of ^{137}Cs in herring muscle in each sub-basin since 1984 are compared to the threshold value, showing a steady downward trend after the Chernobyl accident in 1986 (Results figure 1). In 2015, in the western parts of the Baltic Sea (i.e. the Kattegat and the Arkona Basin), the mean values were well below the target value of 2.5 Bq kg^{-1} wet weight, which was calculated as average of pre-Chernobyl (1984-1985) concentrations. In the remaining Baltic Sea sub-basins, the target value is still not reached as the concentrations are higher than the pre-Chernobyl levels. In 2015, the highest mean concentrations of ^{137}Cs in herring (whole fish without head and entrails or flesh without bones) of the level of 4.5 to 4.7 Bq kg^{-1} wet weight were noted in the Bothnian Bay, the Bothnian Sea and the Quark. In the Åland Sea and the Bornholm Basin the concentrations remained at the level of 3.6 Bq kg^{-1} wet weight while in the Gulf of Finland mean concentration was equal to 2.9 Bq kg^{-1} wet weight.






Bothnian Sea
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Aland Sea
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Gulf of Finland
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Northern Baltic Proper
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Western Gotland Basin
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7.5
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2.5
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Eastern Gotland Basin
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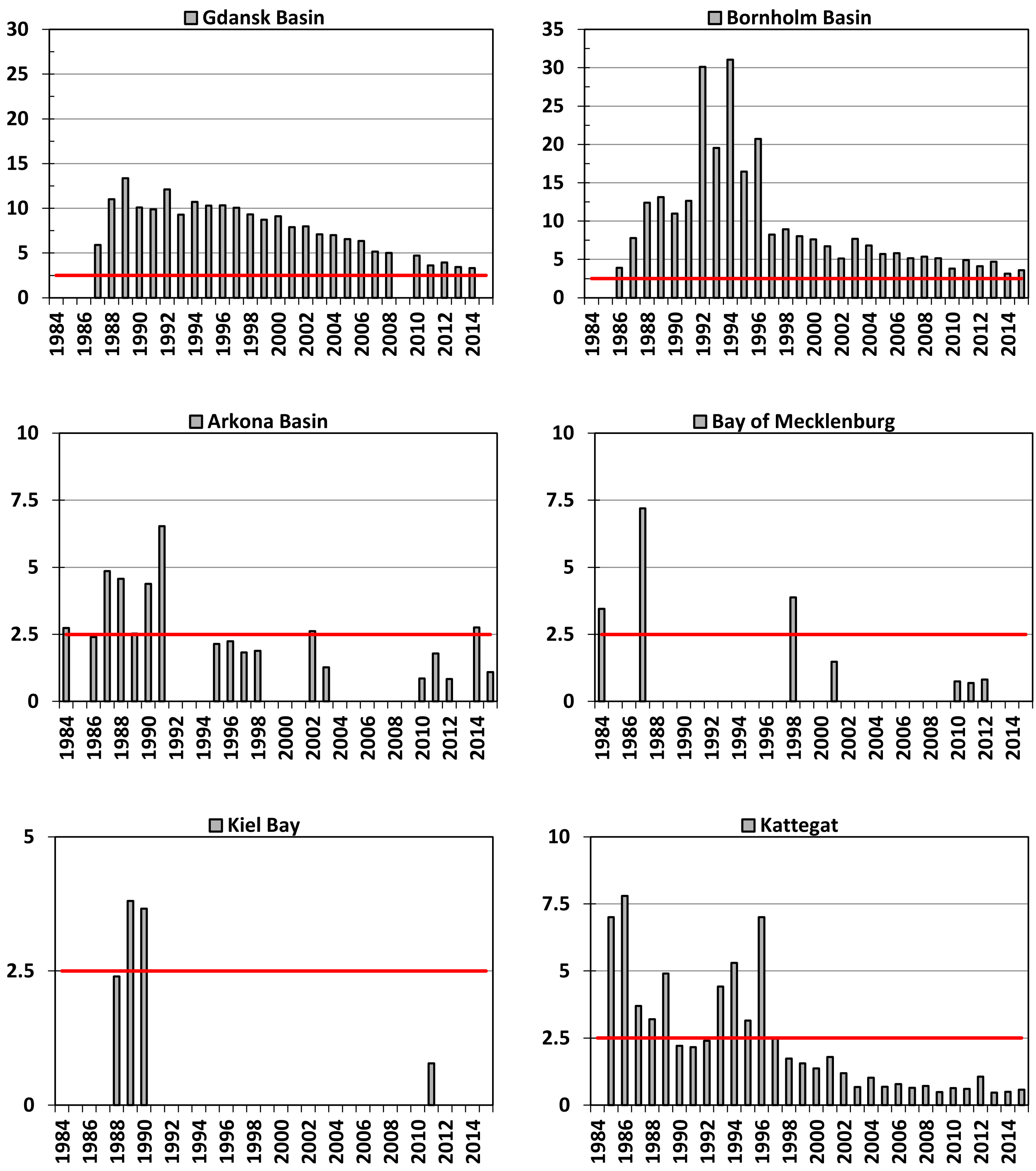
1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014

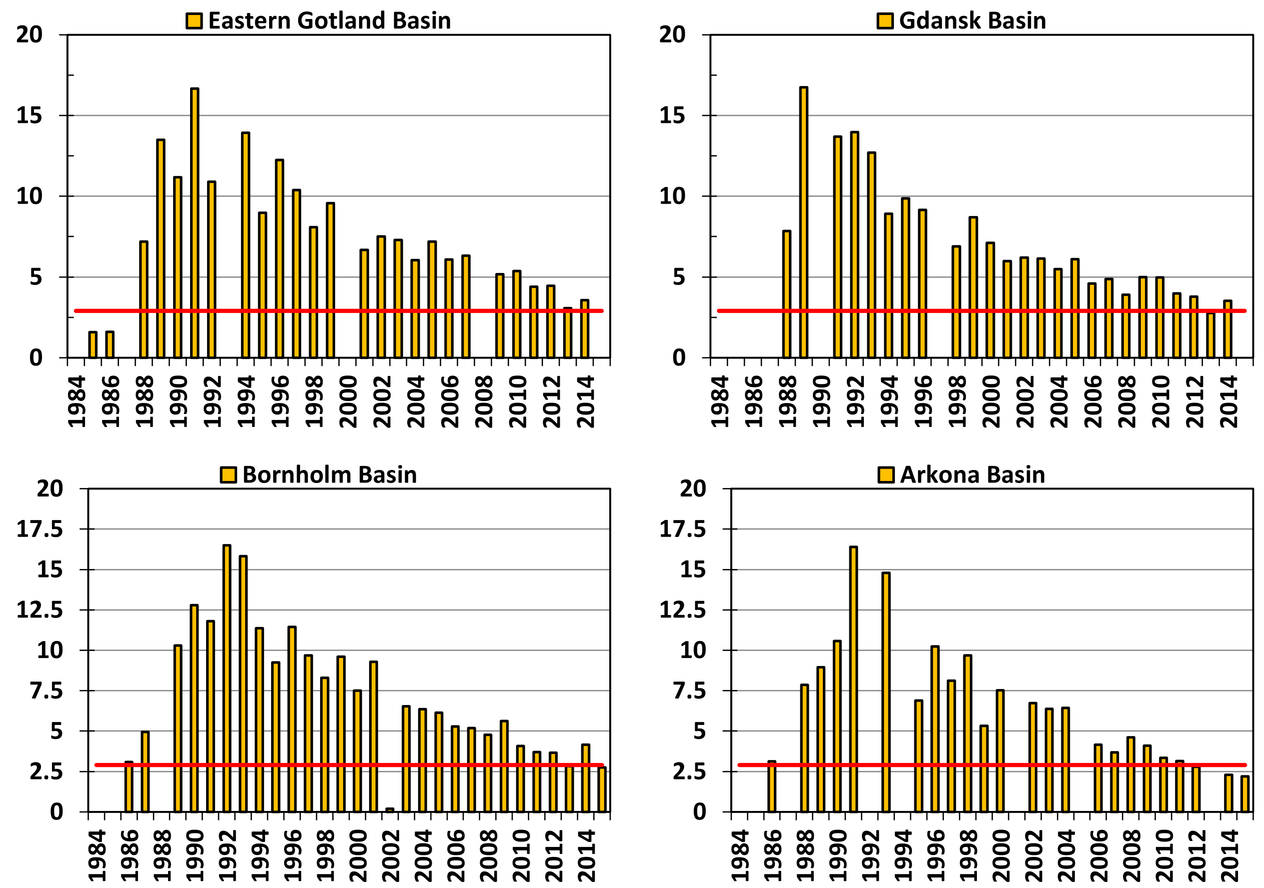


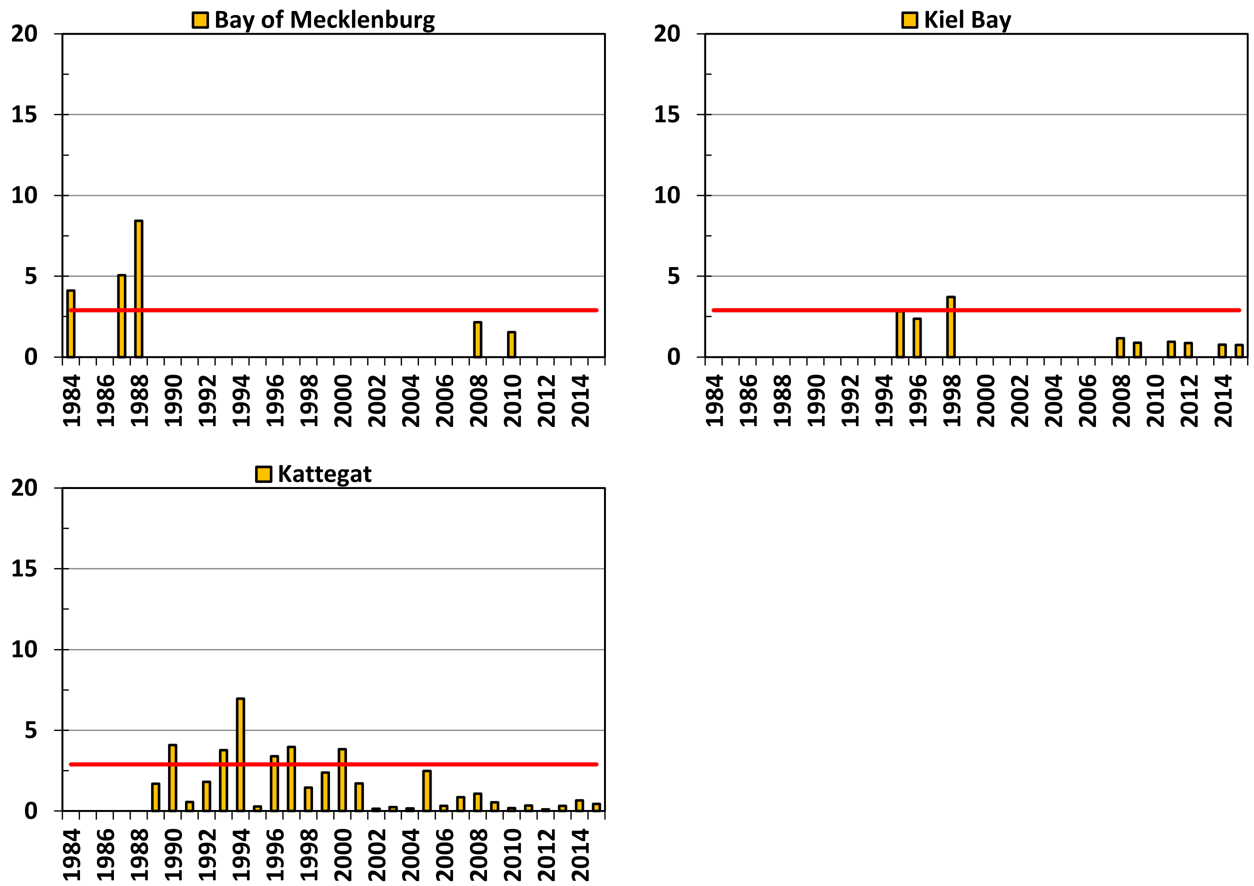
Results figure 1. ^{137}Cs mean concentrations (in Bq kg^{-1} wet weight) in herring (whole fish without head and entrails or flesh without bones) in 1984–2015, as annual mean by sub-basin. Red line indicates the good status boundary (threshold value 2.5 Bq kg^{-1}) calculated as average of pre-Chernobyl (1984–1985) concentrations. Notice variable scale in graphs.

Flatfish

Based on data from the period 2011-2015 for flatfish, good status is achieved in the Arkona Basin, where the average concentrations is equal to 2.7 Bq kg^{-1} wet weight, in the Kiel Bay (0.8 Bq kg^{-1} wet weight) and in the Kattegat (0.4 Bq kg^{-1} wet weight), while ^{137}Cs concentrations above the threshold value were found in the Eastern Gotland Basin with average value equal to 3.8 Bq kg^{-1} wet weight, in the Gdańsk Basin (3.5 Bq kg^{-1} wet weight) and in the Bornholm Basin (3.6 Bq kg^{-1} wet weight) (Results figure 2).

Results figure 2 shows time series of ^{137}Cs concentrations in flatfish samples (whole fish without head and entrails, or flesh without bones), which include flounder (*Platichthys flesus*) and plaice (*Pleuronectes platessa*). In 2015, the mean values of ^{137}Cs concentrations were below target value 2.9 Bq kg^{-1} wet weight in four basins. They were at the levels of 2.2 Bq kg^{-1} wet weight in the Arkona Basinin, 2.8 Bq kg^{-1} wet weight in the Bornhom Basin, 0.4 Bq kg^{-1} wet weight in the Kattegat and 0.7 Bq kg^{-1} wet weight in the Kiel Bay.



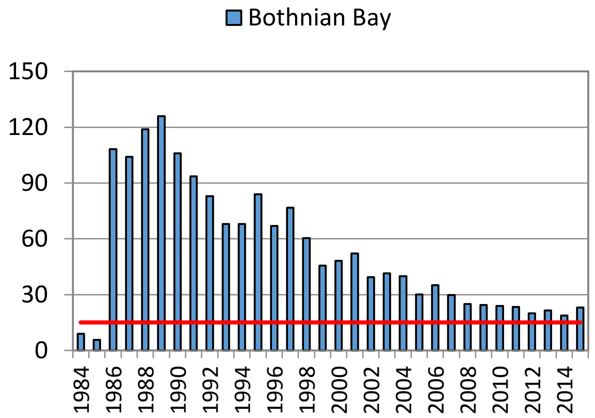


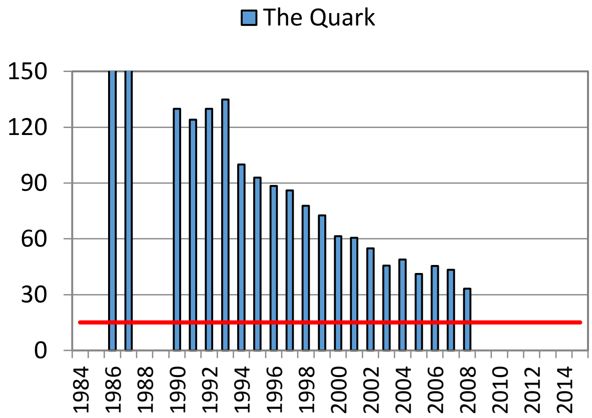
Results figure 2. ^{137}Cs concentrations (in Bq kg^{-1}) in plaice and flounder muscle (whole fish without head and entrails, or flesh without bones) in 1984–2015, as annual means by sub-basin. Red line indicates the threshold value-2.9 Bq kg^{-1} calculated as average of pre-Chernobyl (1984–1985) concentrations.

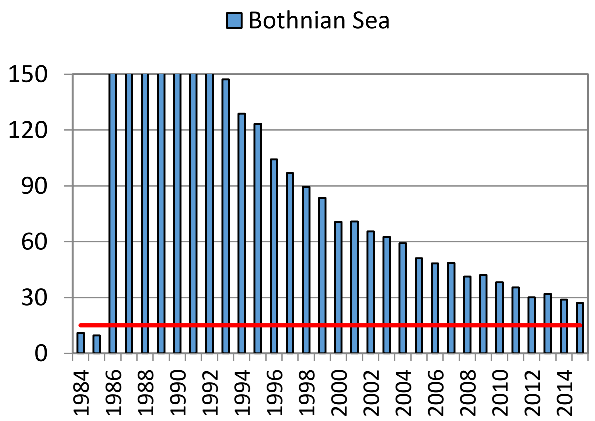
Surface water

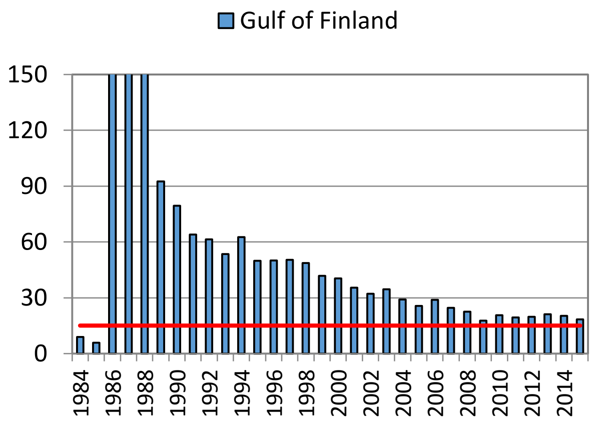
Based on the averages concentrations of ^{137}Cs calculated for period 2011-2015 for surface seawaters, none of the HELCOM sub-basins achieve good status (Results figure 3). The highest average concentration of ^{137}Cs equal to 31.0 Bq m^{-3} was found in the Bothnian Sea. Slightly lower values were calculated for the Eastern Gotland Basin (28.7 Bq m^{-3}), Western Gotland Basin (27.2 Bq Bq m^{-3}), Northern Baltic Proper (26.9 Bq m^{-3}) and Arkona Basin (26.4 Bq m^{-3}). The lowest average concentration of ^{137}Cs equal to 18.4 Bq m^{-3} was specific for the Kattegat.

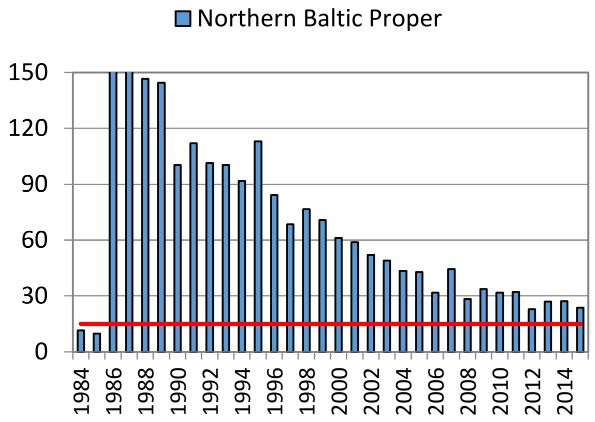
In 2015, the concentrations of ^{137}Cs in seawater were significantly uniform (Results figure 3) in comparison to the distribution of ^{137}Cs in surface waters after the Chernobyl accident, when in the most contaminated areas (the Bothnian Sea and the Gulf of Finland) activities exceeding 500 Bq m^{-3} were observed while in the western parts of the Baltic Sea they were close to 100 Bq m^{-3}. In 2015, in the Baltic northern areas: in the Bothnian Bay and Bothnian Sea the mean concentrations were 23.0 Bq m^{-3} and 27.0 Bq m^{-3} respectively. Similar values were found in the Northern Baltic Proper (23.7 Bq m^{-3}), in the Eastern Gotland Basin (25.1 Bq m^{-3}), but also in Arkona Basin (23.6 Bq m^{-3}) and Bay of Mecklenburg (24.0 Bq m^{-3}). Lower mean concentrations of ^{137}Cs, but still above the target level, were specific for the Gulf of Finland (18.3 Bq m^{-3}), Gdańsk Basin (18.1 Bq m^{-3}) and Kiel Bay (19.2 Bq m^{-3}). In 2015, for the first time mean concentrations of discussed isotope reached the pre-Chernobyl level in three basins: the Great Belt (12.6 Bq m^{-3}), the Kattegat (12.0 Bq m^{-3}) and The Sound (14.5 Bq m^{-3}).










Northern Baltic Proper
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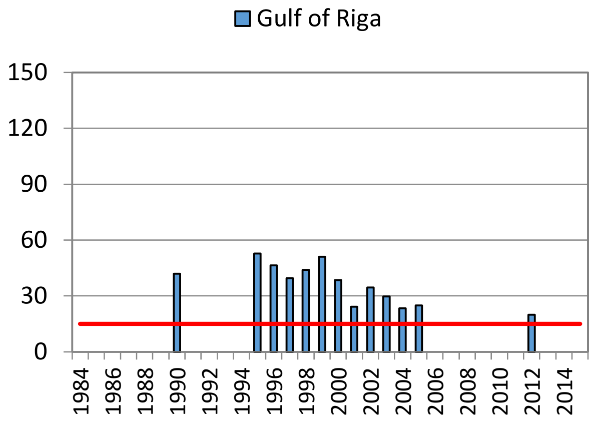
Gulf of Riga
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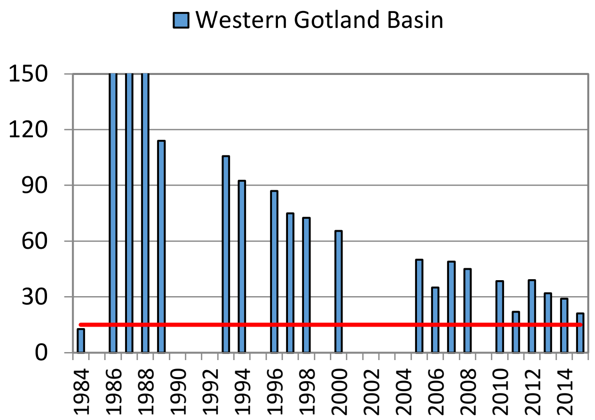
Western Gotland Basin
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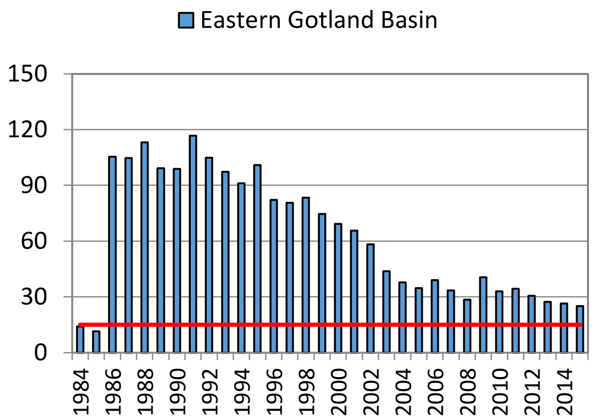
Eastern Gotland Basin
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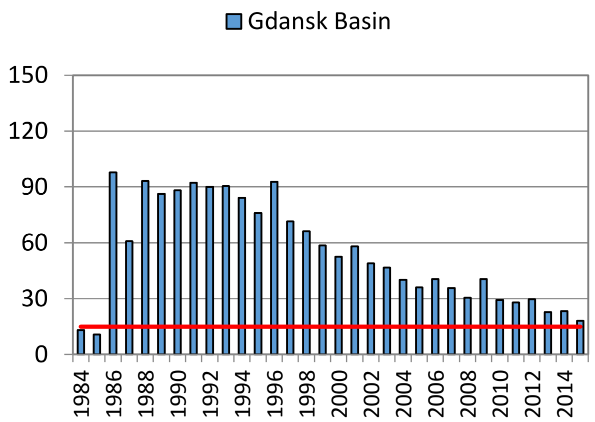
Gdansk Basin
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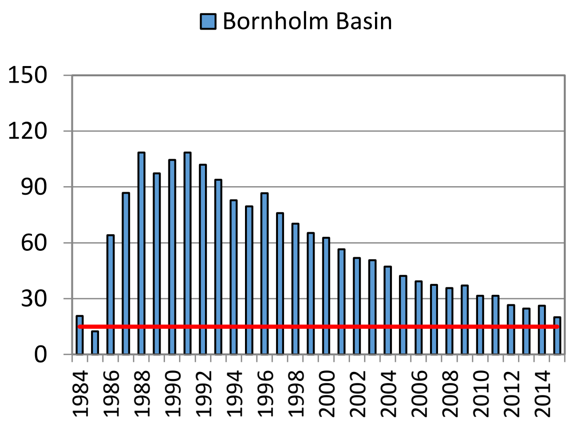
Bornholm Basin
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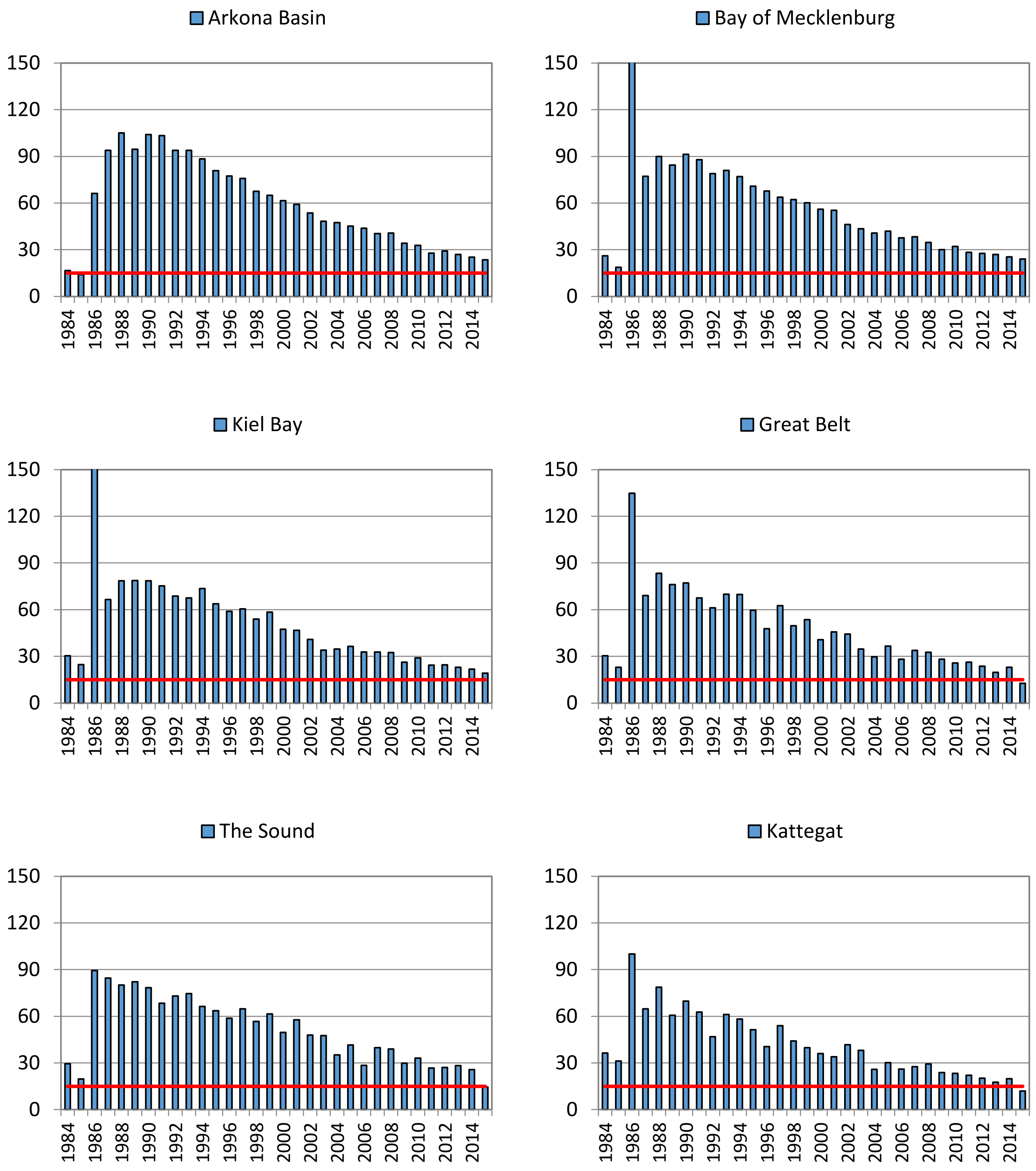


Results figure 3. ^{137}Cs concentrations (in Bq m^{-3}) in seawater (sampling depth less than 10 m) in 1984-2015, as annual mean values by sub-basin. Red line indicates the threshold value (15 Bq m^{-3}) calculated as average of pre-Chernobyl (1984-1985) concentrations.

Prediction on achieving pre-Chernobyl status

Based on the inventory estimates, the effective half-life of ^{137}Cs in Baltic seawater has been 10.2 years during the period 1986 - 2015. The effective half-life of a radioactive contaminant is the time required for its concentration to decrease by 50% as a result of physical, chemical and biological processes which are specific of each radionuclide and each environment where they may occur. With this decay rate, the ^{137}Cs inventory in the Baltic Sea would reach the pre-Chernobyl levels (250 TBq) by the year 2020, presuming that the effective half-life would remain constant, and no substantial remobilization of ^{137}Cs from sediments should occur.

It should be pointed out that the ^{137}Cs input from Fukushima fallout (the Fukushima Daichii disaster took place in 2011) did not result in a significant increase in ^{137}Cs concentration in seawater and biota of the Baltic Sea (Kanisch & Aust 2013).

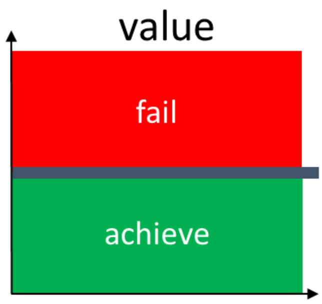
Confidence of the indicator status evaluation

The confidence of the indicator results is **high**.

Quality assurance is a fundamental part of radioanalytical procedures, needed to confirm the precision and the long-term repeatability of analyses. The radiochemical procedures and counting techniques used by laboratories are well tested, up-to-date, and similar to those used by laboratories worldwide. Eight intercomparison exercises were organised during the HELCOM MORS-PRO project during the period (1999–2006), including seawater and sediment samples, and their results are also presented in the thematic assessment of radioactivity. The intercomparison exercises confirmed that the data provided by the MORS group are of very good quality and can be considered comparable. Less than five percent of the results were considered outliers.

Good Environmental Status

The good status is achieved when the activity concentration of radionuclide cesium-137 (^{137}Cs) is below 2.5 Bq kg^{-1} for herring, 2.9 Bq kg^{-1} for flounder and plaice and 15 Bq m^{-3} for seawater. The quantitative boundaries used for defining the threshold values corresponds to pre-Chernobyl activity concentration levels, in other words the levels before 1984.



Good environmental status figure 1. Good status is achieved when the activity concentration levels of the radionuclide cesium-137 (^{137}Cs) are below the threshold value, i.e. at pre-Chernobyl level. The threshold values are 2.5 Bq kg^{-1} for herring, 2.9 Bq kg^{-1} for flounder and plaice and 15 Bq m^{-3} for seawater.

The activity concentration of the radionuclide cesium-137 (^{137}Cs) is evaluated in herring, flatfish and seawater and compared against the threshold values. Currently, no internationally accepted criteria for the assessment of good status in fish exist. There are only upper levels available in the literature, where fish will suffer from doses of radioactive substances (e. g. ICRP 2008). Therefore, threshold values for ^{137}Cs concentrations in sea water, sediments and biota have been set at pre-Chernobyl levels. The good status boundaries are averages based on monitoring measurements from 1984-1985 calculated from data in the HELCOM MORS database.

Threshold values are uniform across all assessment units due to uniform distribution of pre-Chernobyl radiation levels caused by atmospheric fallout from nuclear weapons testing.

The confidence of the threshold values is considered to be high, as there are numerous observations from the pre-Chernobyl time, even if the length of the time series is short (1984-1985).

Assessment Protocol

The pre-Chernobyl values used to derive the threshold value have been calculated based on data in the HELCOM MORS database. The data used for defining the threshold value for ^{137}Cs concentrations in herring, flatfish (plaice and flounder) and surface waters were collected between 1984 and 1985. The mean pre-Chernobyl ^{137}Cs concentrations have been used as threshold values.

The evaluation of whether the threshold is achieved or not is carried out by calculating the mean value for all samples during the assessed year in each assessment unit and comparing this against the threshold values.

Assessment units

This core indicator evaluates the activity concentrations of ^{137}Cs using HELCOM assessment unit scale 2 (division of the Baltic Sea into 17 sub-basins). The assessment units are defined in the HELCOM Monitoring and Assessment Strategy Annex 4.

Relevance of the Indicator

Hazardous substances assessment

The status of the Baltic Sea marine environment in terms of contamination by hazardous substances is assessed using several core indicators. Each indicator focuses on one important aspect of the complex issue. In addition to providing an indicator-based evaluation of the status of radioactivity in the Baltic Sea, this indicator also contributes to the overall hazardous substances assessment.

Policy relevance

The core indicator on cesium-137 in fish and surface waters addresses the Baltic Sea Action Plan's (BSAP) hazardous substances segment's ecological objective 'Radioactivity at pre-Chernobyl level'.

The HELCOM Monitoring of Radioactive Substances (MORS) Expert Group has been working to implement the Helsinki Convention on matters related to the monitoring and assessment of radioactive substances in the Baltic Sea based on HELCOM Recommendation 26/3 Monitoring of Radioactive Substances.

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

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

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

- Criterion D8C1 Within coastal, territorial and areas beyond territorial waters the concentration of contaminants do not exceed the threshold values
- Criterion D9C1 The level of contaminants in edible tissues of seafood caught or harvested in the wild does not exceed maximum levels which are the threshold values.

The core indicator also supports the implementation of the Euratom Treaty, of which all EU Member States are signatories. The Euratom Treaty requires actions in relation to monitoring and effects of discharges on neighbouring states.

Role of radioactive substances in the ecosystem

A worldwide study on marine radioactivity has shown that the Baltic Sea has the highest average ^{137}Cs levels in surface water compared to other marine areas of the world (IAEA 2005). Levels of radionuclides in marine biota are linked to the corresponding levels in seawater and sediments, via accumulation through food chains. Anthropogenic radionuclides, including ^{137}Cs, entering seawater can be bioaccumulated and/or adsorbed on suspended particulate matter (composed mainly of plankton and mineral particles), which accumulates in bottom sediments. Radionuclides can also be accumulated by higher flora and fauna organisms.

The complexity of food chains increases with the trophic level of the species considered. Fish are mainly exposed to radionuclides and accumulate them through their food sources, not from water. Predators such as cod and pike, have shown the highest ^{137}Cs levels, but there was some delay in reaching their maximum values after 1986, when compared to the trends in seawater. In the long-term, ^{137}Cs time trends in biota closely follow the trends in seawater (Zalewska & Suplińska 2013).

The harmful effects of ^{137}Cs on marine organisms are related to the emission of ionizing radiation, which can lead to internal damage, i.e. the effects are observed at the cellular level. It is difficult to establish unequivocally which ^{137}Cs concentrations can be considered as harmless because of the complexity of reactions of individual organisms to its effects. Especially in the presence of other hazardous substances the effects of radionuclides could be intensified (synergetic effects). Taking into account the present concentration levels in Baltic Sea biota, no effects on animal health by ^{137}Cs are expected as the lowest effect levels observed in fish are more than three orders of magnitude higher compared to the measured doses to these animals (according to ICRP 2008).

Ingestion of ^{137}Cs with fish is the dominating exposure pathway of humans to man-made radioactivity in the Baltic Sea. Therefore, ^{137}Cs concentrations in herring, plaice and flounder can be suitable as indicators for man-made radioactivity in the Baltic Sea. Internationally recommended maximal permitted concentrations of ^{137}Cs in foodstuff are in the range 100–1250 Bq/kg (European Commission 2012, 2010b).

Human pressures linked to the indicator

	General	MSFD Annex III, Table 2a
Strong link		Substances, litter and energy - Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) – diffuse sources, point sources, atmospheric deposition, acute events
Weak link		

The development and use of nuclear power for military and peaceful purposes has resulted in the production of a number of man-made radioactive substances and their release into the environment. For example, even the routine operations of nuclear power plants cause small controlled discharges of radioactive substances, but accidents at nuclear power plants can release considerable amounts of radioactivity into the environment. Artificial radionuclides of particular concern to man and the environment, including ^{137}Cs, are formed by nuclear fission.

^{137}Cs reaches the Baltic Sea waters from different sources (such as atmospheric fallout, river discharges, and controlled liquid and gaseous discharges from working nuclear facilities) and becomes distributed within other compartments of the marine environment. Radioactive fallout from the Chernobyl accident in 1986 is the dominating source for ^{137}Cs in the Baltic Sea.

The total collective dose of radiation from ^{137}Cs in the Baltic Sea is estimated at 2,600 manSv of which about two thirds (1,700 manSv) originate from the Chernobyl fallout, about one quarter (650 manSv) from the fallout from nuclear weapons testing, about 8% (200 manSv) from European reprocessing facilities, and about 0.04% (1 manSv) from nuclear installations bordering the Baltic Sea area.

Dose rates and doses from natural radioactivity have been dominating except for the year 1986 where the individual dose rates from Chernobyl fallout in some regions of the Baltic Sea approached those from natural radioactivity.

Since 1950, the maximum annual equivalent dose to individuals from any critical group in the Baltic Sea area due to ^{137}Cs is estimated at 0.2 mSv y^{-1}. This value is lower than the doses that humans receive from natural radionuclides in foodstuffs, which are e.g. 0.215- 0.521 mSv in Germany (BfS 2014), and much lower than the dose limit of 1 mSv y^{-1} set for the exposure of members of the public in the IAEA - International Basic Safety Standards (IAEA 1996). Considering the uncertainties involved in the assessment, it is unlikely that any individual has been exposed from marine pathways at a level above this dose limit. Doses to man due to liquid discharges from nuclear power plants in the Baltic Sea area are estimated at or below the levels mentioned in the Basic Safety Standards to be of no regulatory concern (individual dose rate of 10 µSv y^{-1} and collective dose of 1 manSv). It should be noted that the assumptions made throughout the assessment were chosen to be realistic and not conservative. Consequently, this also applies to the estimated radiation doses to man.

Monitoring Requirements

Monitoring methodology

HELCOM common monitoring relevant to radioactivity in the marine environment is documented on a general level in the HELCOM Monitoring Manual under the **sub-programme: Contaminants in biota** and **sub-programme: Contaminants in water.**

Monitoring methodology including methods, frequency and stations is described in detail in MORS Guidelines (HELCOM Recommendation 26/3).

Over ten laboratories from the nine countries bordering Baltic Sea have contributed to the monitoring programmes of the Baltic Sea by analyzing radionuclides in marine samples. The various analytical methods used in the different laboratories are summarized in the HELCOM thematic assessment: Radioactivity in the Baltic Sea, 1999–2006 (HELCOM 2009).

Current monitoring

The monitoring activities relevant to the indicator that are currently carried out by HELCOM Contracting Parties are described in the HELCOM Monitoring Manual in the relevant Monitoring Concept Tables.

Sub-programme: Contaminants in biota
Monitoring Concept Table

Sub-programme: Contaminants in water
Monitoring Concept Table

Stations are described in detail in the MORS Guidelines (HELCOM Recommendation 26/3) and in the HELCOM MORE map service.

Description of optimal monitoring

The current annual sampling of biota and seawater is considered to be of adequate frequency for the core indicator. The monitoring of biota in each sub-basin depends on the availability of certain species during the time of monitoring cruises and cannot be secured at all times.

Gaps in monitoring in relation to the HELCOM assessment units are defined in HELCOM Monitoring and Assessment Strategy Annex 4: ^{137}Cs in seawater is sampled in all HELCOM sub-basins except for the Quark and the Åland Sea.

Currently, the coverage of ^{137}Cs in herring extends to most of the HELCOM sub-basins. There are, however, no samples from the Northern Baltic Proper, Gulf of Riga, The Sound, or the Great Belt. Also, the northern part of Eastern Gotland Basin is not covered by annual samplings.

^{137}Cs in flatfish is sampled only in the most relevant southern Baltic Sea sub-basins.

Data and updating

Access and use

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

HELCOM (2017) Radioactive substances: Cesium-137 in fish and surface water. HELCOM core indicator report. Online. [Date Viewed], [Web link].

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Metadata

Result: Radioactive substances: Cesium-137 in seawater

Result: Radioactive substances: Cesium-137 in flatfish

Result: Radioactive substances: Cesium-137 in herring

Data: Radioactive substances: Cesium-137 seawater data

Data: Radioactive substances: Cesium-137 in fish data

Data source: HELCOM MORS Database.

Description of data: Herring and seawater data cover most of the Baltic Sea, but flatfish covers only southern parts of the Baltic Sea. For time series maps, data from the year 2012 were used. The data are based on ^{137}Cs concentrations in a) herring (*Clupea harengus L.*), b) flounder (*Platichthys flesus L.*) and plaice (*Pleuronectes platessa L.*) and c) surface seawater (samples 0–10 m). Analyses have been done either in round fish (without head and entrails) or filets (herring), and for plaice and flounder from filets only. Concentrations (Bq kg^{-1}) have been calculated per wet weight of the samples. Seawater concentrations (Bq m^{-3}) have been analyzed in surface (0–10 m) water samples. Data of each matrix (herring, plaice and flounder and sea water) have been averaged by sub-basin and by year.

The data is collected by national authorities and reported annually to the HELCOM MORS Database. In addition to national quality assurance procedures, manual quality assurance is applied to the reported data and data entries are verified annually by the HELCOM MORS Expert Group.

Contributors and references

Contributors

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Archive

This version of the HELCOM core indicator report was published in July 2017:

HOLAS II component - Core indicator report – web-based version July 2017 (pdf)

Earlier versions of the core indicator:

2013 Indicator report (pdf)

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