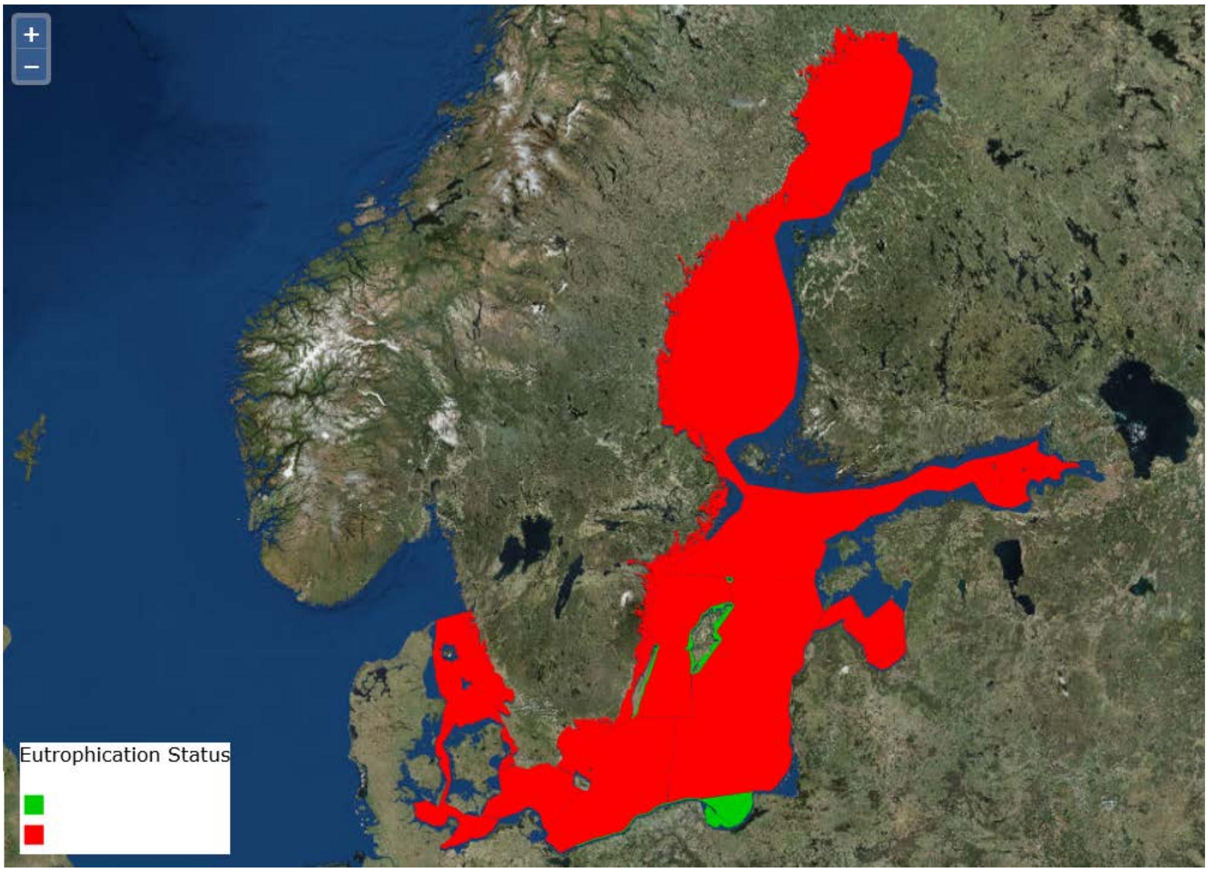
HELCOM core indicator report
July 2017

Dissolved inorganic nitrogen (DIN)

Key Message

The core indicator evaluates average dissolved inorganic nitrogen concentration in the surface (0 – 10 m) during winter (December – February) during the assessment period 2011-2015.

Of the 17 assessed open-sea assessment units, good status has been achieved only in the Gdansk Basin (DIN concentration below defined threshold value, which reflects good conditions).Though the winter-time DIN is still at elevated levels in the remaining 16 sub-basins, it has decreased in the 1990s or the early 2000s and remained since then on the same level.



Key message figure 1: Status assessment results based evaluation of the indicator 'DIN'. The assessment is carried out using Scale 4 HELCOM assessment units (defined in the HELCOM Monitoring and Assessment Strategy Annex 4).

The confidence of the presented DIN status estimate is moderate in all 17 open sub-basins. Of all coastal waters where DIN was assessed, good eutrophication status was only found in Polish coastal waters and around the Swedish islands in Gotland Basin.

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

Relevance of the core indicator

Eutrophication is caused by excessive inputs of nutrients (nitrogen and phosphorus) resulting from various human activities. High concentrations of nutrients and their ratios form the preconditions for huge algal blooms, reduced water clarity and increased oxygen consumption. Long-term nutrient data are key parameters for quantifying the effects of anthropogenic activities and evaluating the success of measures undertaken.

Policy relevance of the core indicator

	BSAP Segment and Objectives	MSFD Descriptors and Criteria
Primary link	Baltic Sea unaffected by eutrophication	D5 Human-induced eutrophication - D5C1 Nutrient concentrations are not at levels that indicate adverse eutrophication effects
Secondary link		D1 Biological diversity of species and habitats Theme: Pelagic habitats -D1C6 The condition of the habitat type, including its biotic and abiotic structure and its functions, is not adversely affected due to anthropogenic pressures. Theme: Benthic habitats -D6C5 The extent of adverse effects from anthropo-genic pressures on the condition of the habitat type, including alteration to its biotic and abiotic structure and its functions, does not exceed a specified proportion of the natural extent of the benthic habitat type in the assessment area.
Other relevant legislation: EU Water Framework Directive		

Cite this indicator

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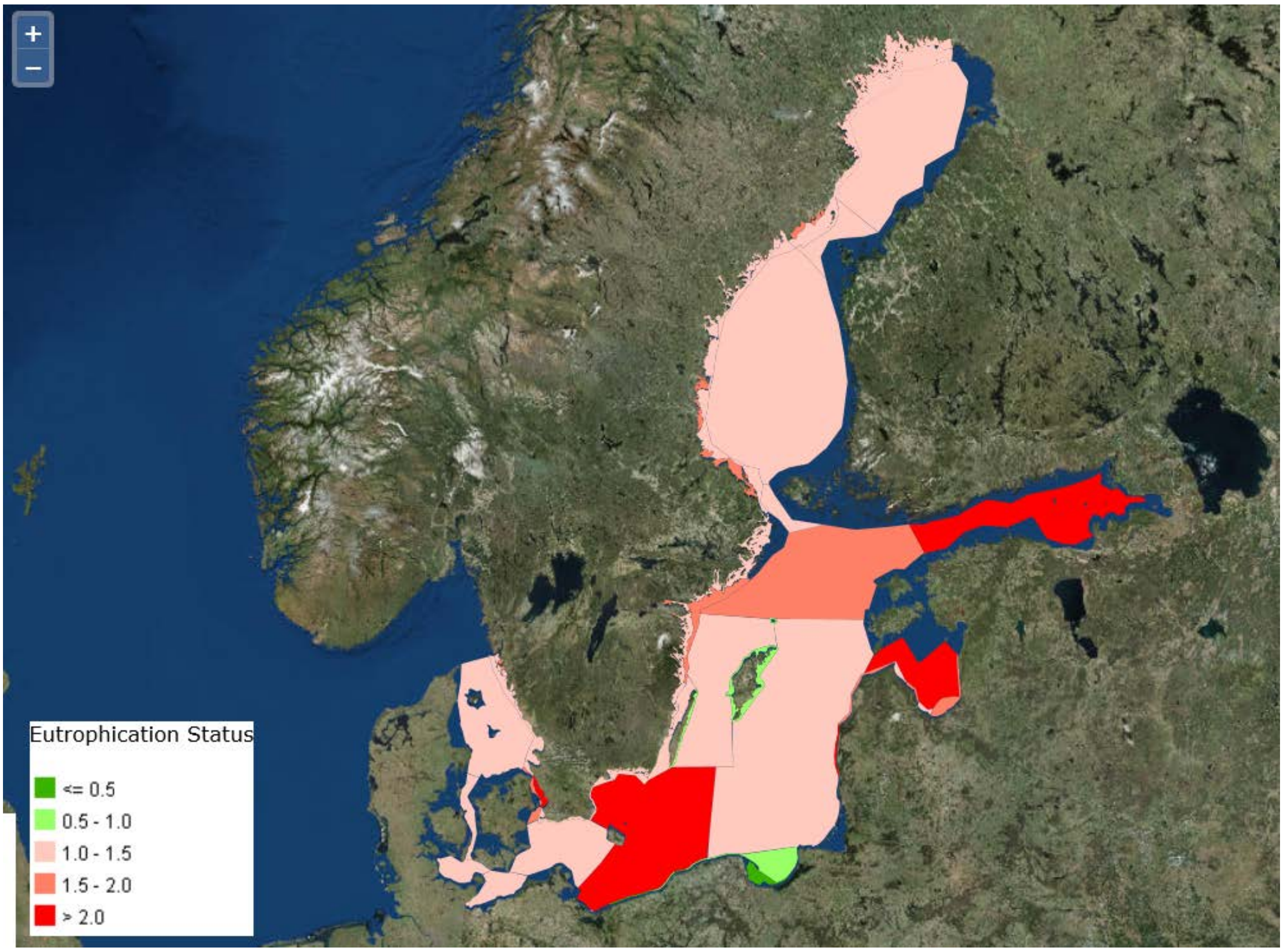
Results and Confidence

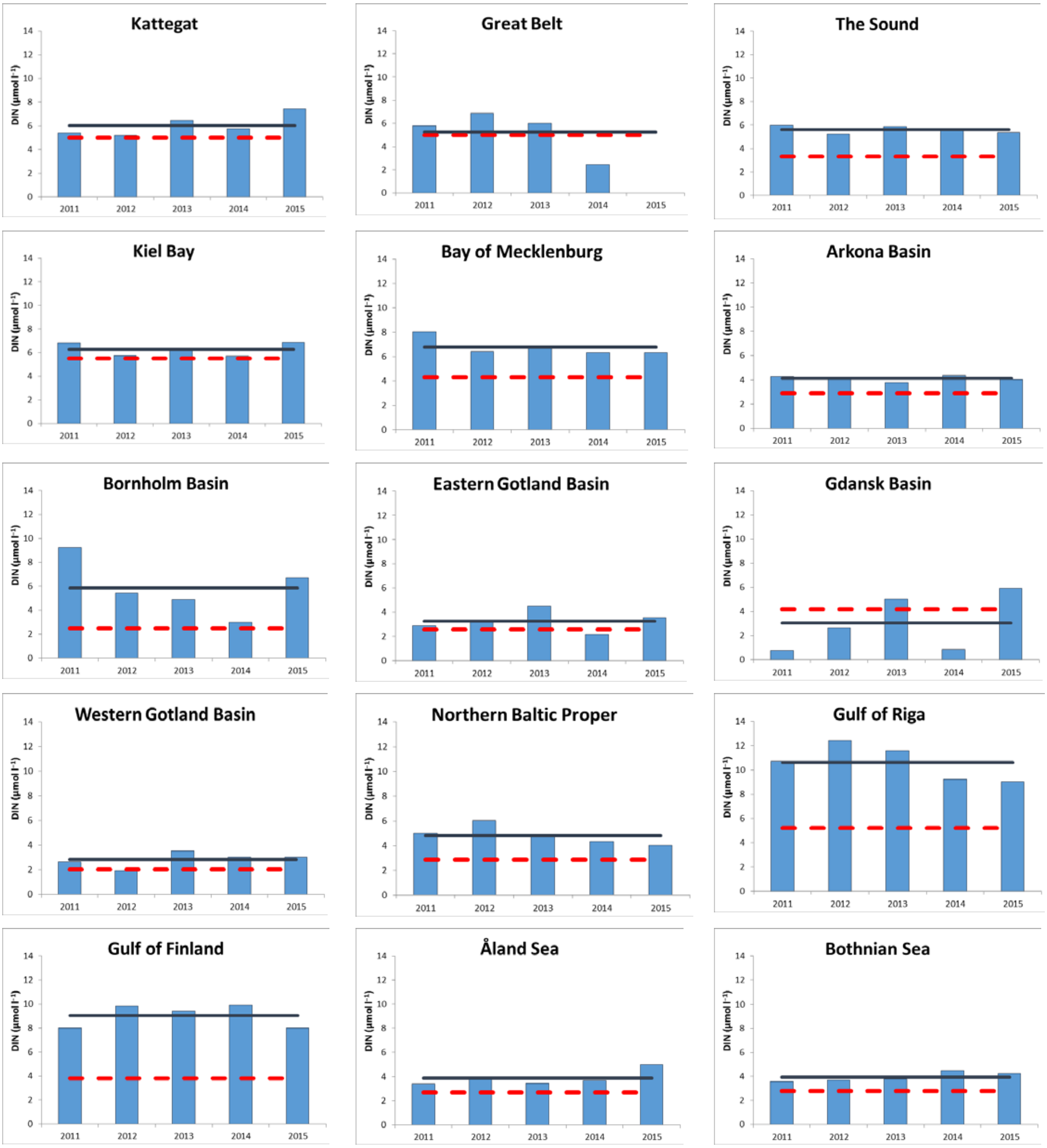
Current status of the Baltic Sea DIN concentration

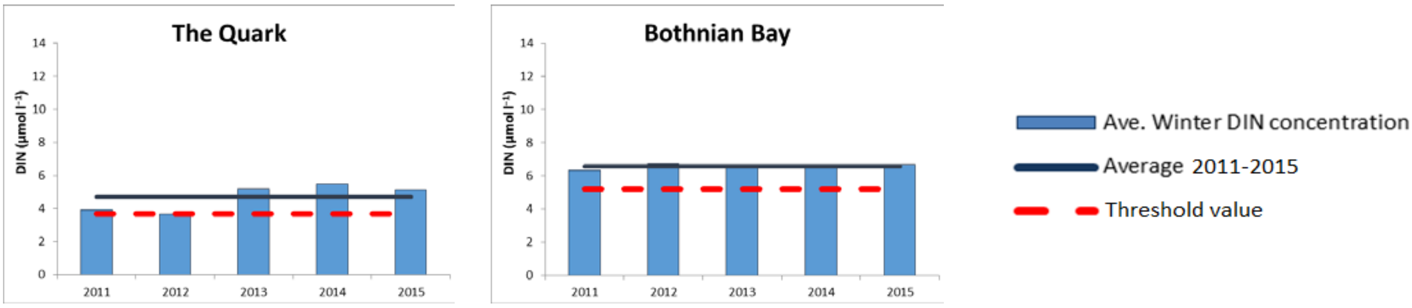
Of 17 open-sea sub-basins, good status (concentrations below threshold) for nitrogen (DIN) has been achieved only in the Gulf of Gdansk (Results figure 1). The sub-basin causing greatest concern regarding nitrogen status is the Gulf of Finland, Gulf of Riga, and Bornholm Basin. The status of Kattegat, Great Belt, Kiel Bay, eastern and western Gotland Basin, Åland Sea, Bothnia Sea, the Quark and Bothnian Bay are only slightly above threshold values.

Of all coastal waters where DIN was assessed, Good eutrophication status was only found in coastal waters of Poland and around the Swedish islands in Gotland Basin.



Results Figure1**.** Status of the DIN indicator, presented as eutrophication ratio (ER). ER shows the present concentration in relation to the threshold value, increasing along with increasing eutrophication. The threshold value is ER ≤ 1.00.


Kattegat
Great Belt
The Sound
Kiel Bay
Bay of Mecklenburg
Arkona Basin
Bornholm Basin
Eastern Gotland Basin
Gdansk Basin
Western Gotland Basin
Northern Baltic Proper
Gulf of Riga
Gulf of Finland
Åland Sea
Bothnian Sea
DIN (µmol l⁻¹)
0
2
4
6
8
10
12
14
2011
2012
2013
2014
2015



Results figure 2. Winter DIN concentration (black line; average for 2011-2015) and threshold values as agreed by HELCOM HOD 39/2012 (red broken line). It should be noted that the results for Bornholm Basin strongly depend on stations in the open-sea area of Pomeranian Bay, which is influenced by the Odra plume. The low concentration value in Gulf of Gdansk in 2011 are due to data handling problems. The issue is being investigated and is planned to be rectified for the next update of this indicator report.

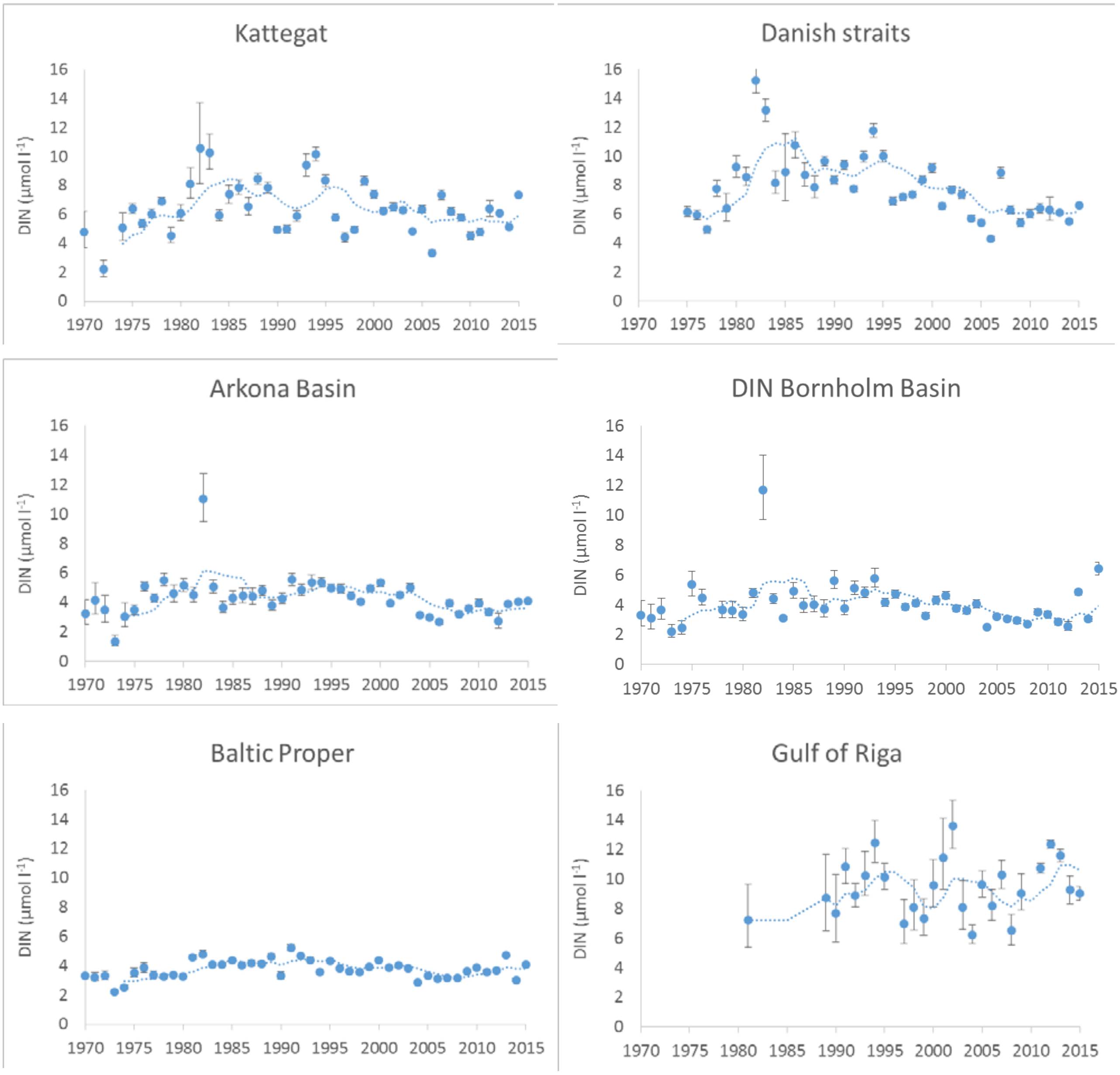
Results table 1. Threshold values, present concentration (as average 2011-2015), eutrophication ratio (ER) and status of DIN in the open-sea basins. ER is a quantitative value for the level of eutrophication, calculated as the ratio between the threshold value and the present concentration – when ER > 1, threshold value has not been reached.

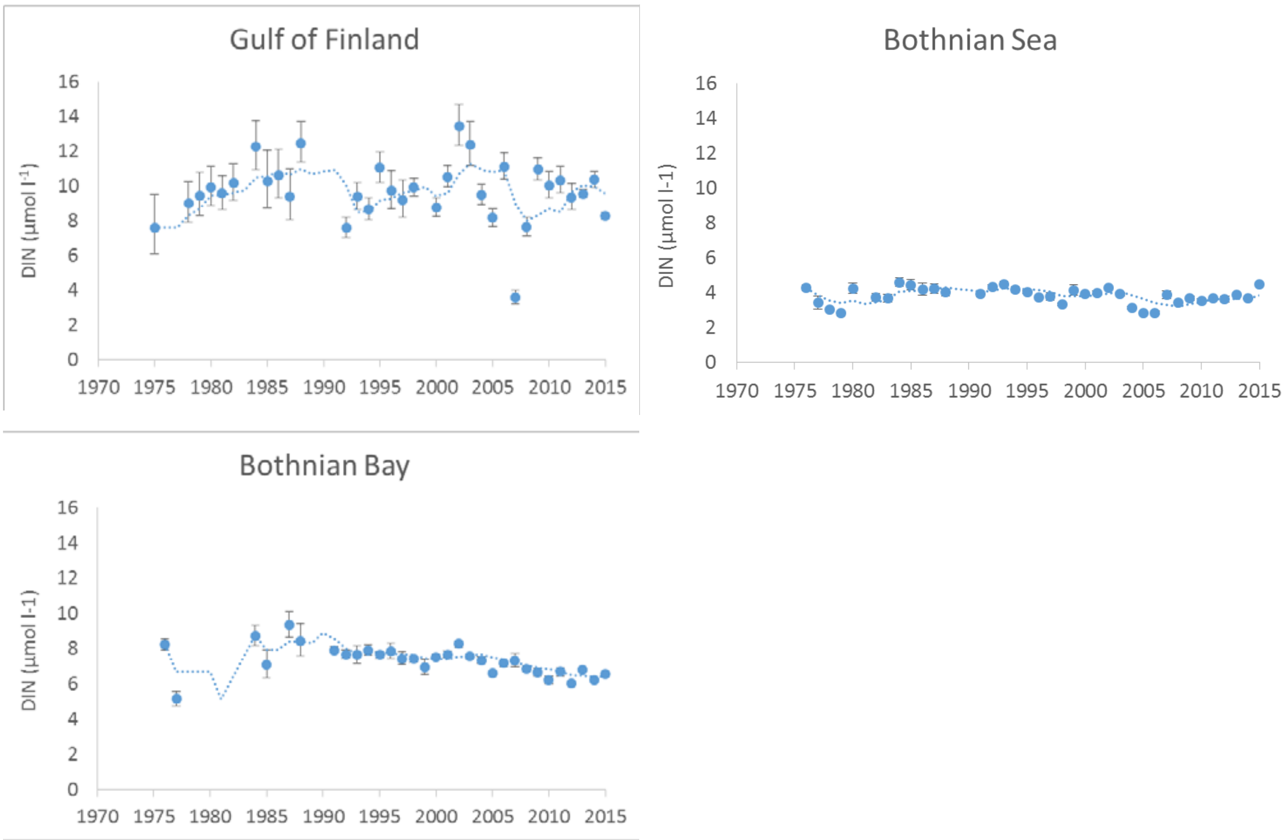
Assessment unit (open sea)	Threshold value (µmol l^{-1})	Average 2011-2015 (µmol l^{-1})	Eutrophication ratio, ER	Status (fail/achieved threshold value)
Kattegat	5.00	5.84	1.168	fail
Great Belt	5.00	5.30	1.059	fail
The Sound	3.30	5.60	1.697	fail
Kiel Bay	5.50	5.88	1.068	fail
Bay of Mecklenburg	4.30	6.41	1.491	fail
Arkona Basin	2.90	4.05	1.397	fail
Bornholm Basin	2.50	9.06	3.626	fail
Eastern Gotland Basin	2.60	3.30	1.269	fail
Gdansk Basin	4.20	3.03	0.721	achieve
Western Gotland Basin	2.00	2.92	1.460	fail
Northern Baltic Proper	2.90	4.86	1.677	fail
Gulf of Riga	5.20	10.75	2.067	fail
Gulf of Finland	3.80	8.98	2.362	fail
Aland Sea	2.70	3.90	1.443	fail
Bothnian Sea	2.80	3.87	1.381	fail
The Quark	3.70	4.72	1.275	fail
Bothnian Bay	5.20	6.46	1.242	fail

Long-term trends

The long-term trends are provided as additional information and do not influence the status assessment. It should be noted that the information is not presented in the HELCOM assessment units, but for areas as defined in the BALTSEM model.

Though the wintertime DIN is still at elevated levels in the remaining 16 sub-basins, it decreased in the 1990s or the early 2000s and has since then remained on the same level.

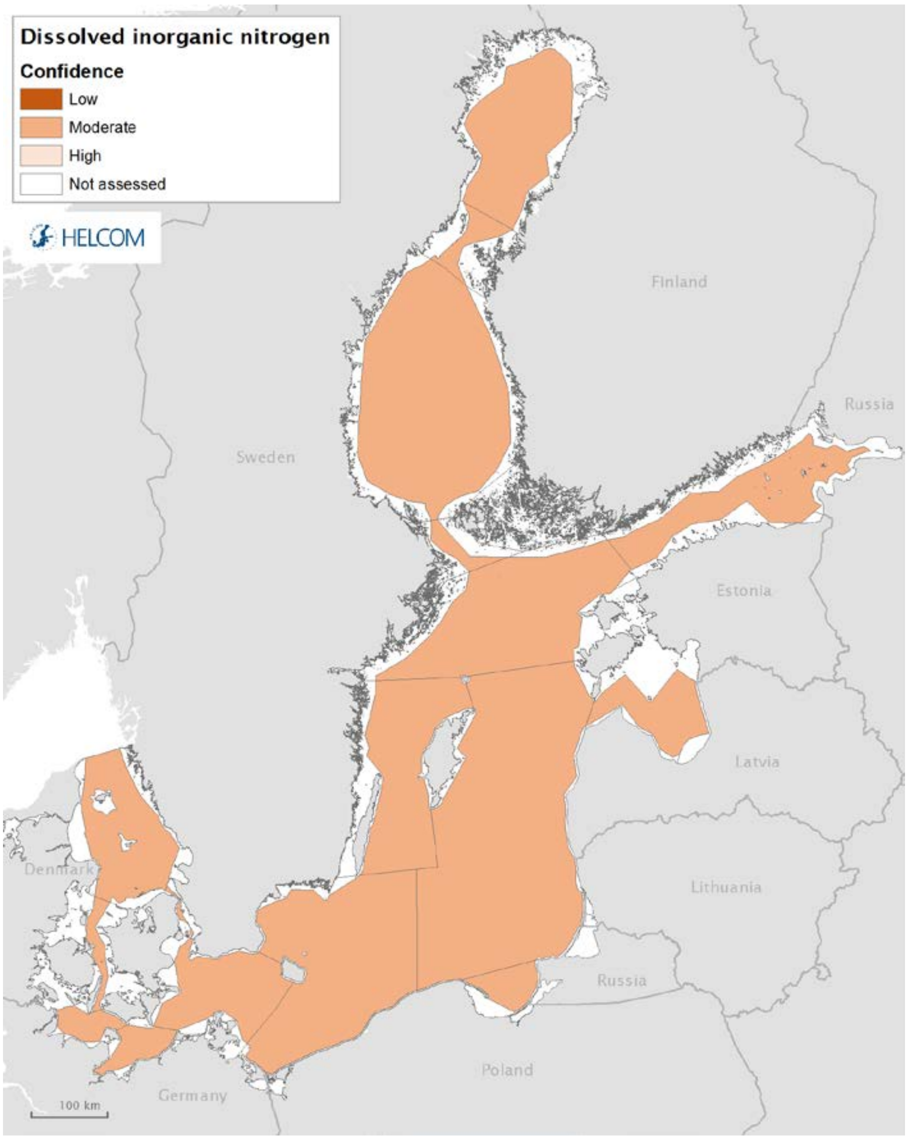




Result figure 3. Long-term trends of DIN in the BALTSEM basins (see BSEP 133) for 1970-2015. The spatial and seasonal patterns of historical are separated across the years, using a GLM-GAM model according to Carstensen et al. 2006. The data until 2012 is from TARGREV project and data for 2013-2015 has been based on data extraction from the assessment database. Lines represent standard errors (SE).

Confidence of the indicator status evaluation

The confidence of the indicator status estimate in open sea areas, based on the spatial and temporal coverage of data as well as the accuracy of the protocol for setting threshold values, was moderate in all sub-basins.

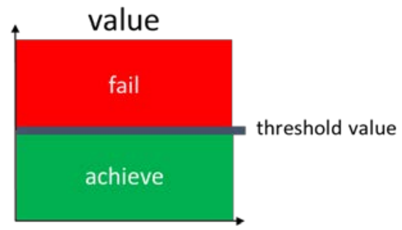


Results figure 4. Indicator confidence, determined combining information on data availability and the accuracy of the protocol for setting threshold values. Low indicator confidence calls for increase in monitoring.

The indicator confidence was estimated through confidence scoring of the threshold value (ET-Score) and the indicator data (ES-Score). The ET-Score was rated based on the uncertainty of the threshold value setting procedure. The ES-Score is based on the number as well as spatial and temporal coverage of the observations for the assessment period 2011-2015. To estimate the overall indicator confidence, the ET- and ES-Scores were combined. See Andersen et al. 2010 and Fleming-Lehtinen et al. 2015 for further details.

Good Environmental Status

Good environmental status is measured in relation to scientifically based and commonly agreed sub-basin-wise threshold value, which defines the concentration that should not be exceeded (Good Environmental Status figure 1).



Good environmental status figure 1. Schematic representation of the threshold value applied in the DIN core indicator, the threshold values are assessment unit specific (see Good environmental status table 1).

These indicator threshold values were based on the results obtained in the TARGREV project (HELCOM 2013a), taking also advantage of the work carried out during the EUTRO PRO process (HELCOM 2009) and national work for EU WFD. The final threshold values were set through an expert evaluation process done by the intersessional activity on development of core eutrophication indicators (HELCOM CORE EUTRO) and the threshold values were adopted by the HELCOM Heads of Delegations 39/2012.

Good environmental status table 1. Assessment unit specific threshold values for the DIN core indicator.

HELCOM_ID	Assessment unit (open sea)	Threshold value ($\mu mol\ l^{-1}$)
SEA-001	Kattegat	5.00
SEA-002	Great Belt	5.00
SEA-003	The Sound	3.30
SEA-004	Kiel Bay	5.50
SEA-005	Bay of Mecklenburg	4.30
SEA-006	Arkona Sea	2.90
SEA-007	Bornholm Sea	2.50
SEA-008	Eastern Gotland Basin	4.20
SEA-009	Gdansk Basin	2.60
SEA-010	Western Gotland Basin	2.00
SEA-011	Northern Baltic Proper	5.20
SEA-012	Gulf of Riga	2.90
SEA-013	Gulf of Finland	3.80
SEA-014	Åland Sea	2.70
SEA-015	Bothnian Sea	2.80
SEA-016	The Quark	3.70
SEA-017	Bothnian Bay	5.20

Assessment Protocol

This core indicator are updated using data reported by Contracting Parties to the HELCOM COMBINE database hosted by ICES, using the algorithms developed for the eutrophication assessment work flow. The values are achieved using indicators specifications shown in Assessment protocol table 1 (see HELCOM Eutrophication assessment manual).

Assessment protocol table 1. Specifications of the indicator DIN.

Indicator	DIN
Response to eutrophication	Positive
Parameters	DIN = NO2 + NO3 + NH4 concentration (µM/l)
Data source	Monitoring data provided by the HELCOM Contracting Parties, and kept in the HELCOM COMBINE database, hosted by ICES (www.ices.dk)
Assessment period (test assessment)	December 2010 – February 2015
Assessment season	Winter = December + January + February
Depth	Surface = average in the 0 – 10 m layer
Removing outliers	No outliers removed
Removing close observations	No close observations removed
Indicator level	average of yearly average values
Eutrophication ratio (ER)	ER = ES / ET
Status confidence (ES-Score)	LOW (=0%), if no more than 5 annual status observations are found during one or more years. MODERATE (=50%), if more than 5 but no more than 15 status observations are found per year. HIGH (=100%), if more than 15 spatially non-biased status observations are found each year.
Indicator threshold value confidence	MODERATE
Indicator confidence (I-Score)	Confidence (%) = average of ES-Score and ET-Score

The indicators within the criteria were weighted according to their relevance for eutrophication in each sub-basin.

Assessment units

The core indicator is applicable in the 17 open sea assessment units (at least one nautical mile seawards from the baseline).

In the coastal units, the indicator is assessed using comparable indicators developed nationally for the purposes of assessments under the EU Water Framework Directive.

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

Relevance of the Indicator

Eutrophication assessment

The status of eutrophication 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 dissolved inorganic nitrogen, this indicator contributes to the overall eutrophication assessment along with the other eutrophication core indicators.

Policy relevance

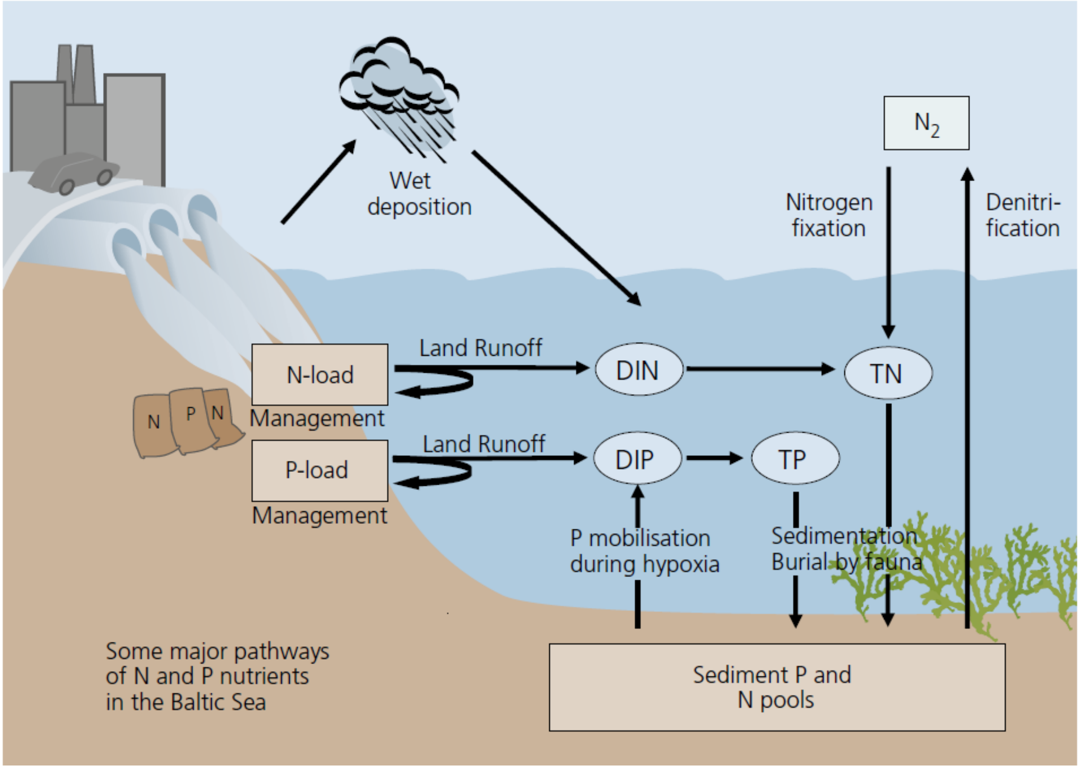
Eutrophication is one of the four thematic segments of the HELCOM Baltic Sea Action Plan (BSAP) with the strategic goal of having a Baltic Sea unaffected by eutrophication (HELCOM 2007). Eutrophication is defined in the BSAP as a condition in an aquatic ecosystem where high nutrient concentrations stimulate the growth of algae, which leads to imbalanced functioning of the system. Nutrient concentrations in the water column are caused by increased anthropogenic nutrient loads from land and air. The goal for eutrophication is broken down into five ecological objectives, of which one is “concentrations of nutrients close to natural levels”.

The EU Marine Strategy Framework Directive (Anonymous 2008) requires that “human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters” (Descriptor 5). ‘Nutrients in the watercolumn’ (including DIN) are determined as the criteria elements for assessing eutrophication under the criterion ‘D5C1 – Nutrient concentrations are not at levels that indicate adverse eutrophication effects’.

The EU Water Framework Directive (Anonymous 2000) requires good ecological status in the European coastal waters. Good ecological status is defined in Annex V of the Water Framework Directive, in terms of the quality of the biological community, the hydrological characteristics and the chemical characteristics, including nitrogen concentration.

Role of dissolved inorganic nitrogen (DIN) in the ecosystem

Marine eutrophication is mainly caused by nutrient enrichment leading to increased production of organic matter supplied to the Baltic Sea with subsequent effects on water transparency, phytoplankton communities, benthic fauna and vegetation as well as oxygen conditions. Phytoplankton as well as benthic vegetation need nutrients, mainly nitrogen and phosphorus, for growth.



Relevance figure 1. Simplified conceptual model for N and P nutrients in the Baltic Sea, where DIN = Dissolved inorganic nitrogen, TN = Total nitrogen, DIP = Dissolved inorganic phosphorus and TP = Total phosphorus. Flows along arrows into the blue sea area tend to increase concentrations, and flows along arrows out from the sea act in the opposite direction. Management refers to nutrient load reductions.

Human pressures linked to the indicator

	General	MSFD Annex III, Table 2
Strong link		Substances, litter and energy - Input of nutrients – diffuse sources, point sources, atmospheric deposition
Weak link		

Nutrient concentrations in the water column are affected by increased anthropogenic nutrient loads from land and air.

Monitoring Requirements

Monitoring methodology

Monitoring of nitrogen concentration in the Contracting Parties of HELCOM is described on a general level in the **HELCOM Monitoring Manual in the sub-programme Nutrients**.

Monitoring guidelines specifying the sampling strategies for nitrate, nitrite and ammonium are adopted and published.

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 **sub-programme Nutrients** monitoring concepts table

Description of optimal monitoring

Regional monitoring of dissolved organic nitrogen is considered sufficient to support the indicator evaluation.

Data and updating

Access and use

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

HELCOM (2017) Dissolved inorganic nitrogen (DIN). HELCOM core indicator report. Online. [Date Viewed], [Web link].

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Metadata

Result: Dissolved inorganic nitrogen

Data source: The average for 2011-2015 was estimated using monitoring data provided by the HELCOM Contracting Parties, and kept in the HELCOM COMBINE database, hosted by ICES (www.ices.dk). Nominated members of HELCOM STATE & CONSERVATION group were given the opportunity to review the data, and to supply any missing monitoring observations, in order to achieve a complete dataset.

Description of data: The data include the sum of *in-situ* NO_2 and NO_3 samples, determined using colorimetric methods, as explained in the HELCOM COMBINE manual. Measurements made at the depth of 0 – 10 m from the surface were used in the assessment.

Geographical coverage: The observations are distributed in the sub-basins according to the HELCOM COMBINE programme, added occasionally with data from research cruises.

Temporal coverage: The raw data includes observations throughout the year, during the assessment period 2011-2015.

Data aggregation: The 2011-2015 averages for each sub-basin were produced as an inter-annual winter (December-February) estimates.

Contributors and references

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HELCOM Expert Network on Eutrophication

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)

Older versions of the core indicator report are available:

DIN concentrations 2007-2011 (pdf)

Nutrient concentrations 2003-2007 - HELCOM Core Indicator Report (pdf)

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Anonymous (2008) Directive 2008/56/EC of the European Parliament and of the Council. 17 June 2008. Establishing a Framework for Community Action in the Field of Marine Environmental Policy. Marine Strategy Framework Directive. 22p.

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HELCOM (2007) Baltic Sea Action Plan. Baltic Sea Environment Protection Commission. 101p.

HELCOM (2013) Approaches and methods for eutrophication target setting in the Baltic Sea region. Balt. Sea Environ. Proc. No. 133

Additional relevant publications

Eutrophication status of the Baltic Sea 2007-2011 - A concise thematic assessment (2014)

Approaches and methods for eutrophication target setting in the Baltic Sea region (2013)

HELCOM core indicators. Final report of the HELCOM CORESET project (2013)

Eutrophication in the Baltic Sea. An integrated thematic assessment of the effects of nutrient enrichment in the Baltic Sea region (2009)

Development of tools for assessment of eutrophication in the Baltic Sea (2006)

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