HELCOM

**Total phosphorus**

INDICATOR TYPE: Core
INDICATOR CATEGORY: State
BSAP SEGMENT: Eutrophication
MSFD CRITERIA: D5C1

# Total phosphorus

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# 1 Key message

The core indicator evaluates average total phosphorus (TP) concentration in surface waters (0 – 10 m) during the entire year (January - December) in open sea assessment units for the assessment period 2016-2021.

Of the 19 open sea assessment units, only in the Great Belt good status was achieved with TP concentrations below the defined threshold value (Figure 1). In the remaining 18 sub-basins TP concentrations are still at elevated levels failing to achive good status. Long-term trends show predominantly deteriorating trends since the 1990s in 6 sub-basins (primarily located in the Baltic Proper and the Gulf of Bothnia) and only in the Great Belt and Kiel Bay an improving trend with decreasing TP concentrations has been observed. No clear trend could be identified in 11 sub-basins, but considerable multi-year variability was observed, especially in the Bay of Mecklenburg, Pomeranian Bay and Gdansk Basin. TP concentrations have generally remained at the level of the 1990s with some inter-annual variations in Arkona Basin, Gulf of Riga and Gulf of Finland Western.

When comparing the latest two assessments of HOLAS II and HOLAS 3 no status change was observed. Four sub-basins showed a deteriorating trend (Åland Sea, Bothnian Sea, The Quark and Bothnian Bay) with partly high exceedances of the respective thresholds for TP concentrations. No improving trend between the current and the previous assessment could be detected, while seven sub-basins showed a more or less stable status with generally decreasing EQRS values (increasing TP concentrations) in HOLAS 3 compared to HOLAS II indicating a further worsening. In eight sub-basins, the TP indicator was applied for the first time, so no comparison was possible. The first iteration of the TP indicator was either due to now commonly agreed threshold values or as a result of new subdivisions in the eutrophication assessment for the Pomeranian Bay, which was separated from the Bornholm Basin, and the subdivision of the Gulf of Finland into a western and an eastern part.

Concerning the coastal waters TP was assessed in Estonian, Finnish, German, Polish and Swedish waters. In coastal water assessment units the threshold values set for total phosphorus mostly failed to achieve good status. Only in some assessment units of Estonian, Finnish, Polish and Swedish coastal waters TP concentrations were below the threshold values and good status was achieved (Annex Table 1). There were a number of cases where a good status of coastal water bodies was assessed adjacent to open sea basins that had a moderate or worse status. This could be due to a lack of alignment of threshold values between coastal waters and open sea basins (Table 3 and Annex Table 1) and internal load of phosphorus in the open sea areas.

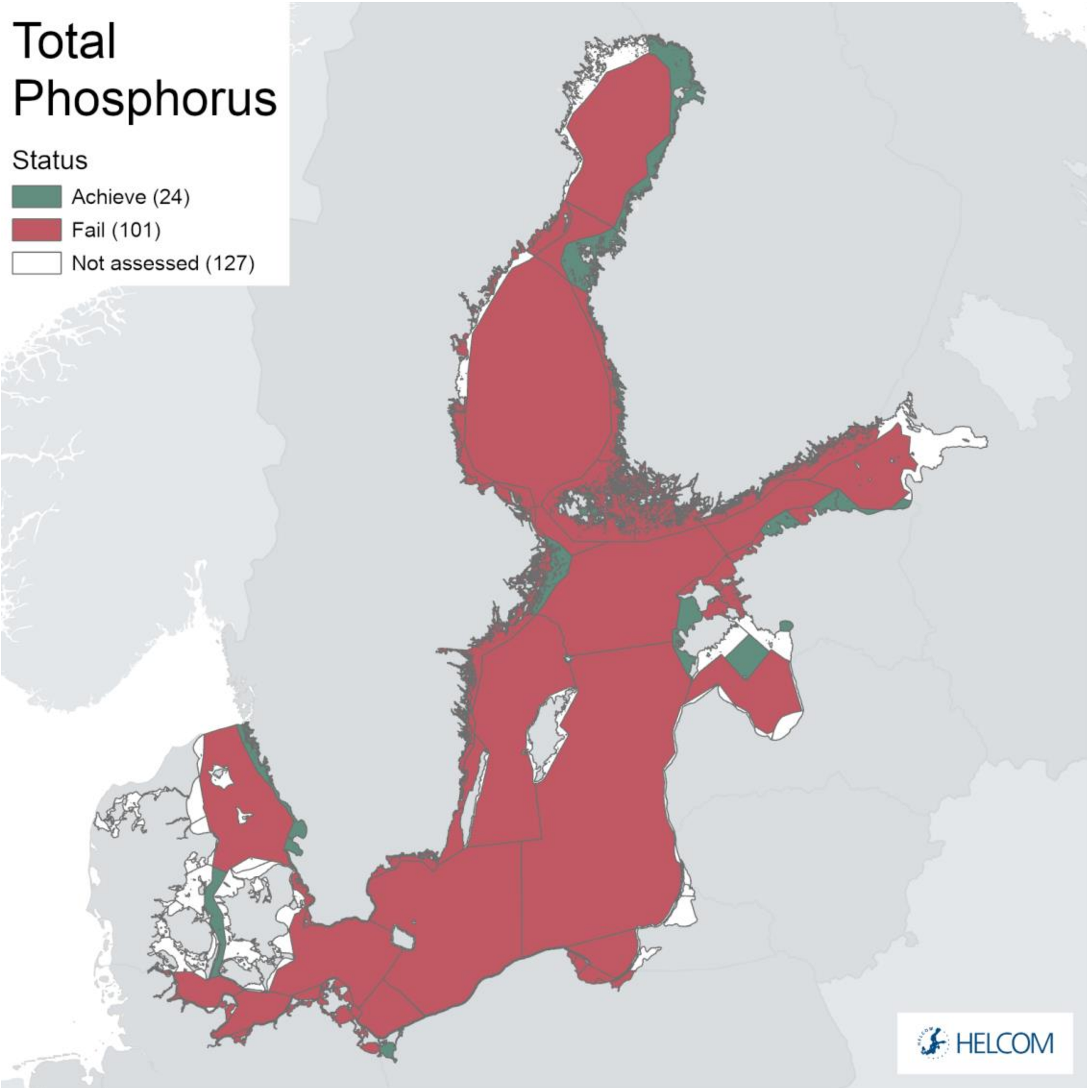



**Figure 1.** Status evaluation of the indicator 'Total phosphorus' - annual monitoring. The evaluation is carried out using Scale 4 HELCOM assessment units (defined in the HELCOM Monitoring and Assessment Strategy Annex 4). Please note that in coastal areas the assessment is based on annual data, summer data and winter data, as reported by HELCOM Contracting Parties, and these details are defined in Table 4. See Results section below for details. **See 'data chapter' for interactive maps and data at the HELCOM Map and Data Service.**

The confidence in the indicator TP status evaluation was high in 10 basins, moderate in 8 basins and low in one basin (see Figure 5). Low confidence was caused by insufficient temporal and spatial sampling.

The indicator is applicable in all open sea assessment units and coastal areas. In HOLAS II, the indicator was not operational in all assessment units due to the lack of agreed threshold values in some areas. However, this was successfully resolved and thresholds were agreed so that all open sea assessment units could be assessed for HOLAS 3. The indicator period and method of calculation varies between open sea and coastal areas, and thus the thresholds or assessment concentrations are not directly comparable between the open sea and the coast, nor between all coastal assessment units where nationally binding thresholds values may have been set in line with the national assessments under the Water Framework Directive.

## 1.1 Citation

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

HELCOM (2023). Total phosphorus (TP). HELCOM core indicator report. Online. [Date Viewed], [Web link].

ISSN 2343-2543.

## 2 Relevance of the indicator

Eutrophication is caused by excessive inputs of nutrients (nitrogen and phosphorus) resulting from various human activities. High concentrations of nutrients and the ratios of these nutrients (e.g. N:P stoichiometric ratios) form the preconditions for algal growth, 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 since they directly link to increased nutrient inputs.

*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 total phosphorus, this indicator contributes to the overall eutrophication assessment along with the other eutrophication core indicators.

### 2.1 Ecological relevance

*Role of total phosphorus (TP) in the ecosystem*

Marine eutrophication is mainly caused by nutrient enrichment, leading to increased production of organic matter in 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. Adding total nutrients alongside inorganic nutrients as core indicators strengthens the link from nutrient concentrations in the sea to nutrient enrichment. In particular these parameters allow to take account of climate change in the eutrophication assessment since higher temperatures will lead to year-round phytoplankton proliferation and / or possible changes in zooplankton communities.

In a simplified conceptual model for nitrogen and phosphorus nutrients (Figure 2), flows between the different components are illustrated. To get a good understanding of the trend in nutrient concentrations in the marine environment the assessment of both, total and dissolved nutrients, is important. In contrast to dissolved inorganic phosphorus (DIP), total phosphorus is a parameter not subject to strong seasonal fluctuations and reflects a more or less stable situation during the year, allowing a reliable annual average to be calculated for surface water (0-10 m). Total phosphorus comprises of dissolved and particulate inorganic phosphorus components and phosphorus already bound in organic matter, including algae and bacteria. A simplified assumption is that phosphorus stays in the system, and is basically converted between the inorganic dissolved and the organic reservoir (without taking sedimentation into account). Thus, an approximately stable situation can be assumed over the year and a reliable annual average for the surface water (0-10 m) can be calculated.

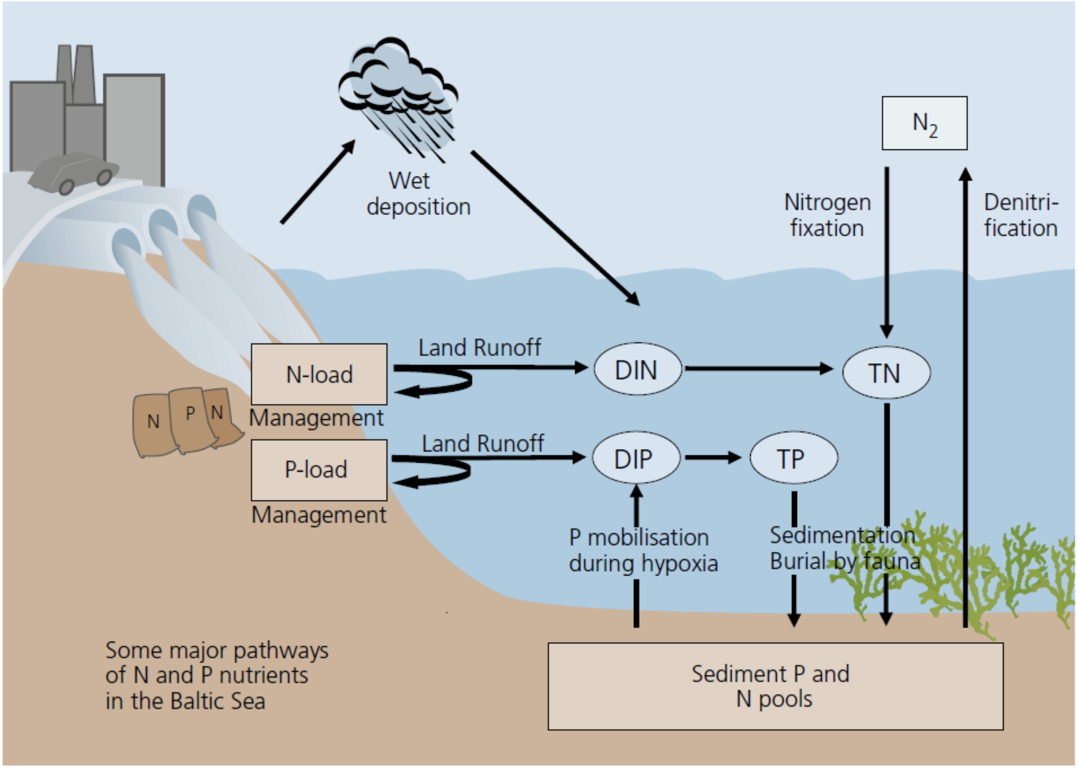



**Figure 2.** Simplified conceptual model for N and P nutrients in the Baltic Sea, where DIN = Dissolved inorganic nitrogen, TP = Total phosphorus, DIP = Dissolved inorganic phosphorus and TP = Total phosphorus. Flows along arrows into the blue sea area tend to increase concentrations, and flows along arrows out from the sea act in the opposite direction. Management refers to nutrient load reductions.

## 2.2 Policy relevance

Eutrophication is one of the thematic segments of the HELCOM Baltic Sea Action Plan (BSAP). HELCOM BSAP has a strategic goal of a Baltic Sea unaffected by eutrophication (HELCOM 2021). 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. Elevated 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 BSAP management objective is to “minimize inputs of nutrients from human activities”.

The EU Marine Strategy Framework Directive (2008/56/EC) 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 water column’ (including TP) are one of the criteria elements in MSFD GES Decision ((EU) 2017/848) for assessing eutrophication under the criterion ‘D5C1 – Nutrient concentrations are not at levels that indicate adverse eutrophication effects’.

The EU Water Framework Directive (2000/60/EC) 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 and the chemical characteristics, including phosphorus concentration.

**Table 1.** Eutrophication links to policy.

| | **Baltic Sea Action Plan (BSAP)** | **Marine Strategy Framework Directive (MSFD)** |
|---|---|---|
| **Fundamental link** | Segment: Eutrophication<br>Goal: "Baltic Sea unaffected by eutrophication"<br>• Ecological objective: "Concentrations of nutrients close to natural levels", "Clear waters", "Natural level of algal blooms", "Natural distribution and occurrence of plants and animals", and "Natural oxygen levels".<br>• Management objective: "Minimize inputs of nutrients from human activities"<br>• The achievement of regional nutrient input targets – Maximum Allowable Inputs (MAI) and Nutrient Input Ceilings (NIC) – for all sub-basins, as identified in this BSAP, is the key prerequisite for achieving the ecological objectives. | Descriptor 5 Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters - Macrofaunal communities of benthic habitats.<br>• Criteria D5C1 Nutrient concentrations are not at levels that indicate adverse eutrophication effects. The threshold values are as follows:<br>(a) in coastal waters, the values set in accordance with Directive 2000/60/EC;<br>(b) beyond coastal waters, values consistent with those for coastal waters under Directive 2000/60/EC. Member States shall establish those values through regional or subregional cooperation.<br>• Feature – Eutrophication.<br>• Element of the feature assessed – DIN, DIP, TP and TP. |
| **Complementary link** | Segment: Sea-based activities<br>Goal: "Environmentally sustainable sea-based activities"<br>• Ecological objective: "No or minimal disturbance to | Descriptor 6 Benthic habitats - Benthic broad habitat types.<br>• Criteria D5C5 The extent of adverse effects from anthropogenic pressures on the condition of the habitat type, including alteration to its biotic and abiotic structure and its functions (e.g. its typical species |

| | | |
|---|---|---|
| | biodiversity and the ecosystem".<br>• Management objective: "Minimize the input of nutrients, hazardous substances and litter from sea-based activities", "Minimize harmful air emissions", and "Zero discharges from offshore platforms".<br><br>Segment: Biodiversity<br><br>Goal: "Baltic Sea ecosystem is healthy and resilient"<br><br>• Ecological objective: "Natural distribution, occurrence and quality of habitats and associated communities".<br>• Management objective: "Minimize disturbance of species, their habitats and migration routes from human activities". | composition and their relative abundance, absence of particularly sensitive or fragile species or species providing a key function, size structure of species), does not exceed a specified proportion of the natural extent of the habitat type in the assessment area.<br>• Feature – Benthic habitats.<br>• Element of the feature assessed – Benthic broad habitat types.<br><br>Descriptor 1 Species groups of birds, mammals, reptiles, fish and cephalopods<br><br>• Criteria D1C6 The condition of the habitat type, including its biotic and abiotic structure and its functions (e.g. its typical species composition and their relative abundance, absence of particularly sensitive or fragile species or species providing a key function, size structure of species), is not adversely affected due to anthropogenic pressures.<br>• Feature – Pelagic broad habitats.<br>• Element of the feature assessed – Trophic guilds. |
| **Other relevant legislation:** | EU Water Framework Directive<br><br>UN Sustainable Development Goal 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) is most clearly relevant, though SDG 12 | |

## 2.3 Relevance for other assessments

This indicator is utilised in the integrated assessment of eutrophication (HEAT tool).

## 3 Threshold values

Status is evaluated in relation to scientifically based and commonly agreed sub-basin specific threshold values, which define the concentration that should not be exceeded (Table 2 and Results Table 1).

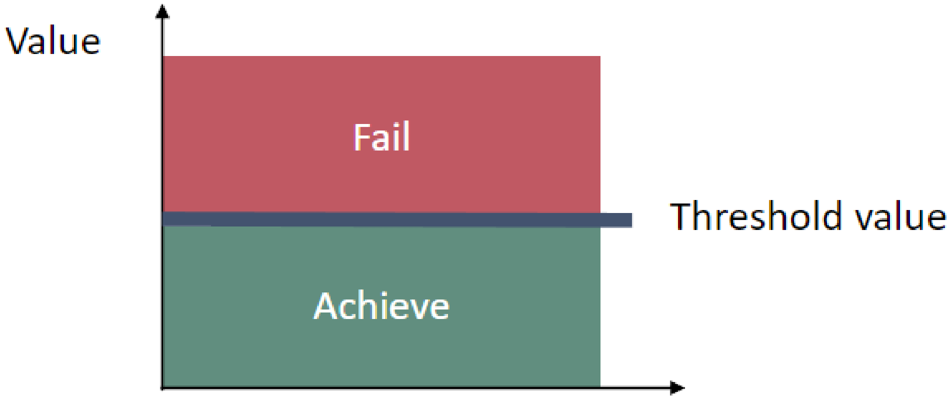



**Figure 3.** Schematic representation of the threshold values applied in the TP core indicator, the threshold values are assessment unit specific (see Table 2).

### 3.1 Setting the threshold value(s)

Indicator threshold values were based on the results obtained in the TARGREV project (HELCOM 2013), also taking 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 via intersessional activity to develop core eutrophication indicators (HELCOM CORE EUTRO), and the threshold values were adopted by the HELCOM Heads of Delegations 39/2012. The threshold values were principally not changed since HOLAS II, but for the new assessment units Pomeranian Bay and the split of the Gulf of Finland into an eastern and western assessment unit new thresholds were derived using the HOLAS II thresholds as a basis and adopted by HELCOM HOD 61-2021. The newly agreed threshold values for Kiel Bay, Bay of Mecklenburg and Arkona Basin are based on a national modelling approach and in line with the general approach in the eutrophication assessment to choose the most precautionary target.

**Table 2.** Assessment unit specific threshold values for total phosphorus.

| HELCOM_ID | Assessment unit<br><br>(open sea) | Threshold value<br><br>[µmol $l^{-1}$] |
|---|---|---|
| **SEA-001** | Kattegat | 0.64 |
| **SEA-002** | Great Belt | 0.95 |
| **SEA-003** | The Sound | 0.68 |
| **SEA-004** | Kiel Bay | 0.41 |
| **SEA-005** | Bay of Mecklenburg | 0.45 |
| **SEA-006** | Arkona Basin | 0.48 |
| **SEA-007** | Bornholm Basin | 0.55 |
| **SEA-007B** | Pomeranian Bay | 0.74 |
| **SEA-008** | Gdansk Basin | 0.60 |
| **SEA-009** | Eastern Gotland Basin | 0.45 |
| **SEA-010** | Western Gotland Basin | 0.45 |
| **SEA-011** | Gulf of Riga | 0.70 |
| **SEA-012** | Northern Baltic Proper | 0.38 |
| **SEA-013A** | Gulf of Finland Western | 0.54 |
| **SEA-013B** | Gulf of Finland Eastern | 0.56 |
| **SEA-014** | Åland Sea | 0.28 |
| **SEA-015** | Bothnian Sea | 0.24 |
| **SEA-016** | The Quark | 0.24 |
| **SEA-017** | Bothnian Bay | 0.18 |

# 4 Results and discussion

The results of the indicator evaluation underlying the key message map and information are provided below.

## 4.1 Status evaluation

Current status of the Baltic Sea TP concentration

TP concentration below the threshold was only achieved in the Great Belt, while in the remaining 18 sub-basins the threshold values were failed, resulting in a not good status (Figure 4 and Table 3). Accordingly, the scaled Ecological quality ratio (EQRS) was 0.88 for the Great Belt indicating a high status. A minor exceedance of the threshold for TP by up to 25% was found in Kattegat, The Sound and Bothnian Bay with EQRS values between 0.43 to 0.48 indicating a moderate status. Most of the assessment units (10 sub-basins with TP concentrations ranging from 40% to 95% above the threshold value) were found to be in a poor status with EQRS values between 0.21 and 0.34. Whereas TP concentrations about twice as high as the threshold value were of concern in Kiel Bay, Eastern Gotland Basin, Northern Baltic Proper, Åland Sea and Bothnian Sea with EQRS values below 0.20, indicating a bad status. All EQRS values were related to the good/moderate boundary of 0.6 to evaluate if TP concentrations were below or above the threshold.

The variability of the TP concentrations between the individual years of the assessment period is shown in Figure 5. The variability was largest in Gdansk Basin, indicating the strong influence of the Vistula river. However, fluctuating TP concentrations or exceptional years with higher concentrations were also observed in other sub-basins, e.g. in the Bay of Mecklenburg and The Quark. In general, smaller assessment units that are more strongly influenced by riverine nutrient inputs and have higher TP concentrations, show a larger variability between the years. TP concentrations in recent years 2020 and 2021 were mostly stable or decreasing compared to the first years of the assessment period, but in some sub-basins increased TP concentrations were observed, e.g. in Kiel Bay and Pomeranian Bay.

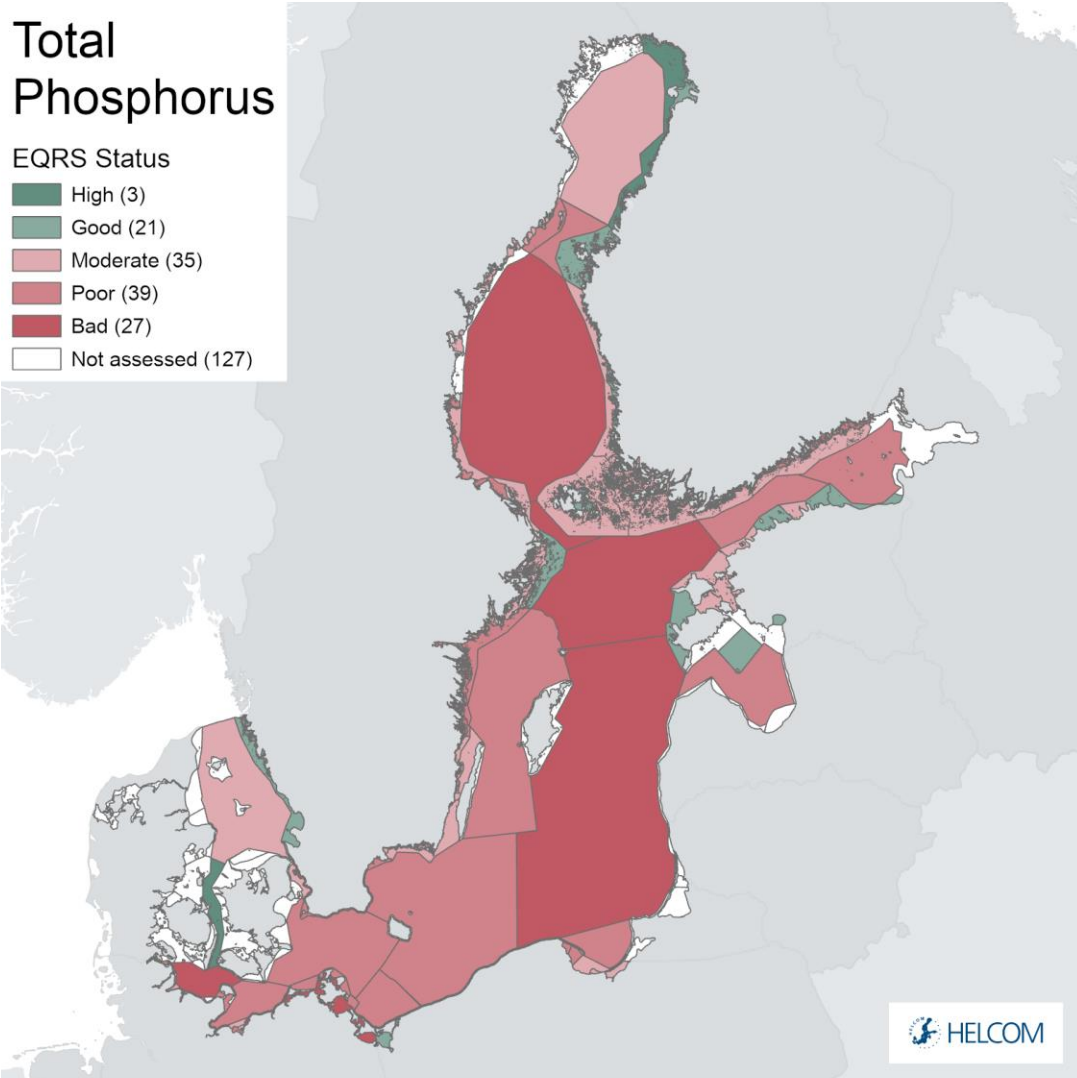



**Figure 4.** Detailed eutrophication assessment with the ecological quality ratio scaled (EQRS). EQRS of total phosphorus being split into 5 classes to show a more differentiated picture than the 2-class division used in the key message figures. EQRS is calculated as the ratio of the average concentration during assessment period and the reference value, decreasing along with increasing eutrophication. When EQRS ≥ 0.6 good status is achieved.

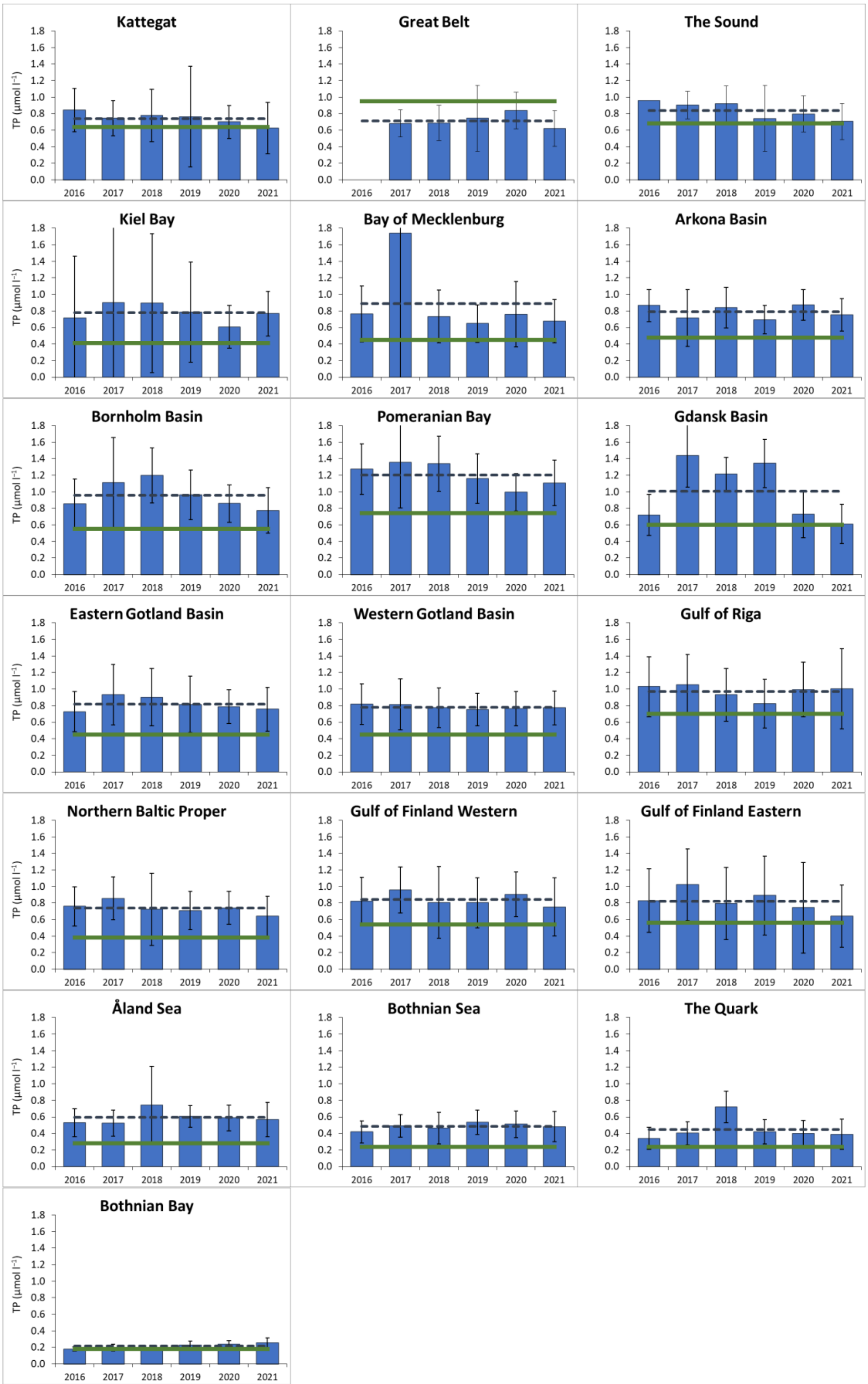



**Figure 5.** Average annual surface total phosphorus concentrations (dashed dark blue line; average for 2016-2021) in µmol $l^{-1}$ and threshold levels as agreed by HELCOM HOD 39-2012 or HOD in 2022 via correspondence (green line) for assigned Assessment Units (AU).

**Table 3.** Threshold values, present concentration (as average 2016-2021), Ecological quality ratio scaled (EQRS) and status of total phosphorus in the open sea basins. EQRS is calculated as the ratio of the average concentration during assessment period and the reference value. Please note that coastal areas shown are from national reporting and can reflect annual or summer data (see Table 4 for details).

| Assessment unit (open sea) | Threshold value (µmol $l^{-1}$) | Average 2016-2021 (µmol $l^{-1}$) | Ecological quality ratio (scaled) (EQRS) | STATUS (fail/achieve threshold value) |
|---|---|---|---|---|
| Kattegat | 0.64 | 0.74 | 0.48 | Fail |
| Great Belt | 0.95 | 0.71 | 0.88 | Achieve |
| The Sound | 0.68 | 0.84 | 0.43 | Fail |
| Kiel Bay | 0.41 | 0.78 | 0.196 | Fail |
| Bay of Mecklenburg | 0.45 | 0.89 | 0.23 | Fail |
| Arkona Basin | 0.48 | 0.79 | 0.24 | Fail |
| Bornholm Basin | 0.55 | 0.96 | 0.23 | Fail |
| Pomeranian Bay | 0.74 | 1.20 | 0.25 | Fail |
| Gdansk Basin | 0.60 | 1.01 | 0.32 | Fail |
| Eastern Gotland Basin | 0.45 | 0.82 | 0.199 | Fail |
| Western Gotland Basin | 0.45 | 0.78 | 0.21 | Fail |
| Gulf of Riga | 0.70 | 0.97 | 0.34 | Fail |
| Northern Baltic Proper | 0.38 | 0.74 | 0.18 | Fail |
| Gulf of Finland Western | 0.54 | 0.84 | 0.27 | Fail |
| Gulf of Finland Eastern | 0.56 | 0.82 | 0.32 | Fail |
| Åland Sea | 0.28 | 0.59 | 0.17 | Fail |
| Bothnian Sea | 0.24 | 0.48 | 0.17 | Fail |
| The Quark | 0.24 | 0.44 | 0.22 | Fail |
| Bothnian Bay | 0.18 | 0.21 | 0.46 | Fail |

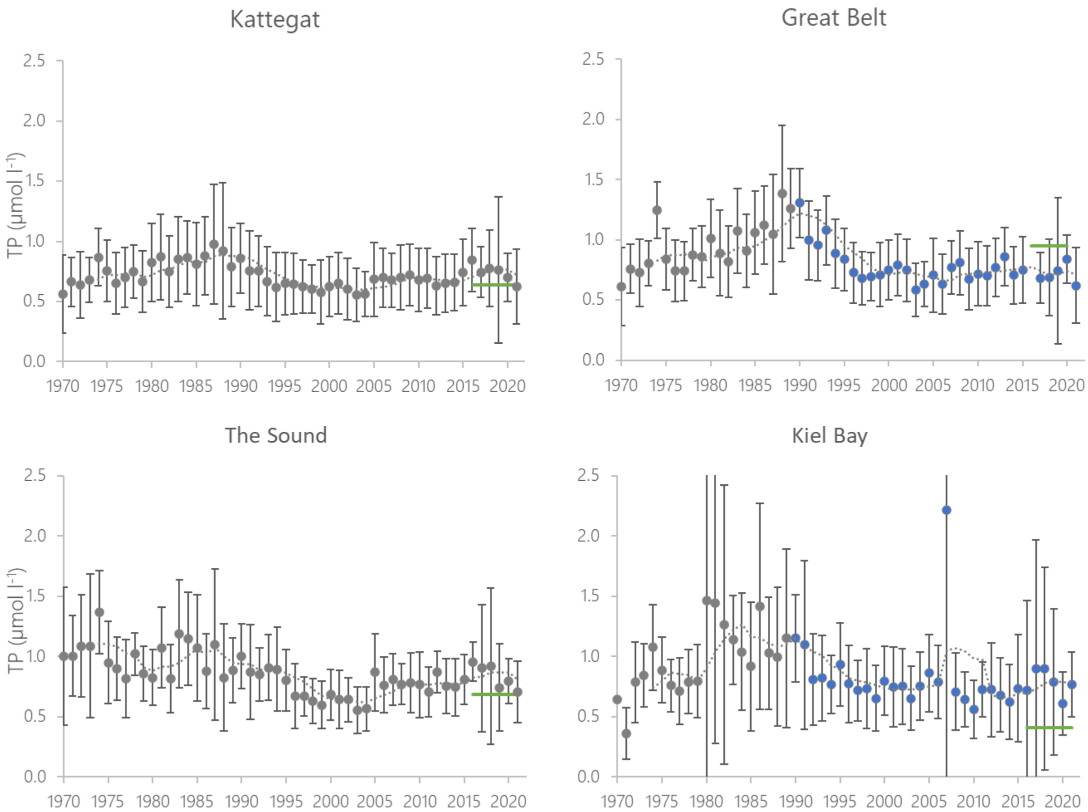
Concerning the coastal waters TP was assessed in Estonian, Finnish, German, Polish and Swedish waters. In German coastal waters none of the 40 water bodies assessed achieved good status. In Estonian waters seven out of 16 water bodies assessed achieved good status. In Finnish waters more than half of the water bodies assessed reached good status (seven out of 12). The Finnish coastal types expressing Good status were situated in The Quark and Bothnian Bay areas. In Polish waters four water bodies out of 19 achieved good status. In Swedish coastal waters, TP assessments were carried out for different seasons (summer and winter). Out of 19 water bodies with two potential assessment results each for summer and winter, 15 assessment results indicated good status, either for summer or winter. The majority of assessment areas in good status was achieved for total phosphorus in summer (ten assessment areas), while only five assessment areas achieved good status in winter. In three water bodies, good status was achieved in both seasons for total phosphorus, all located in the Kattegat (Kattegat West Coast inner and outer coastal waters, South Halland coastal waters).

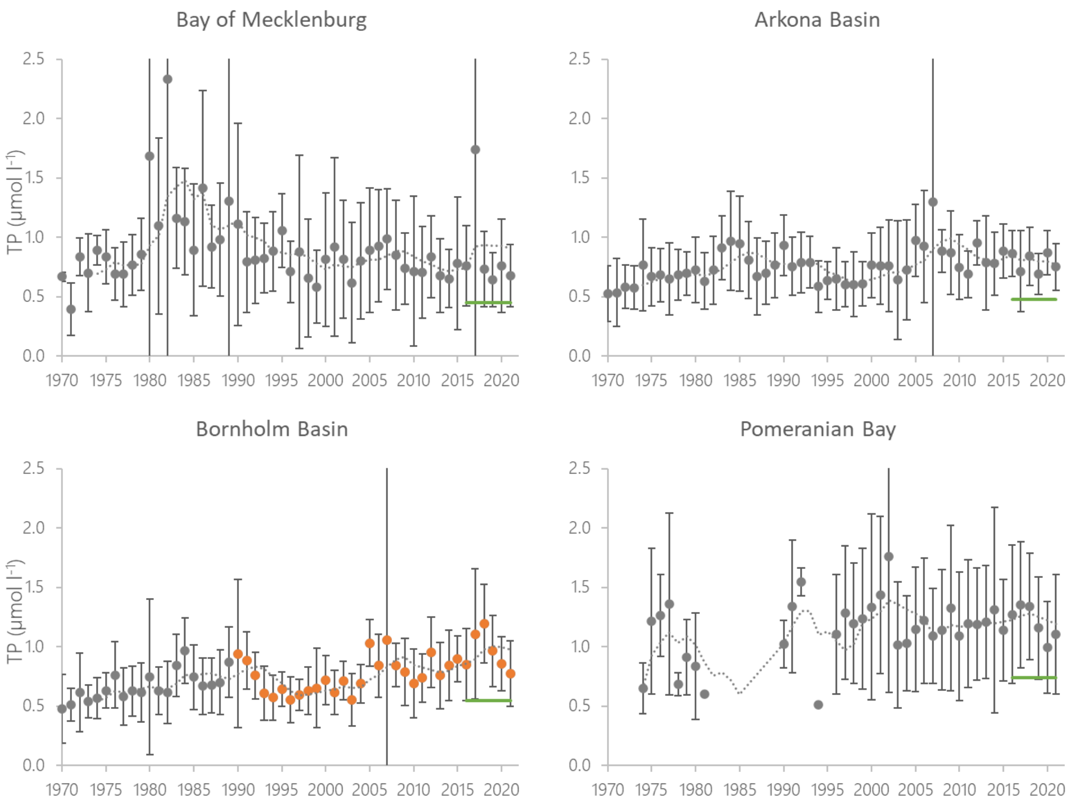
## 4.2 Trends

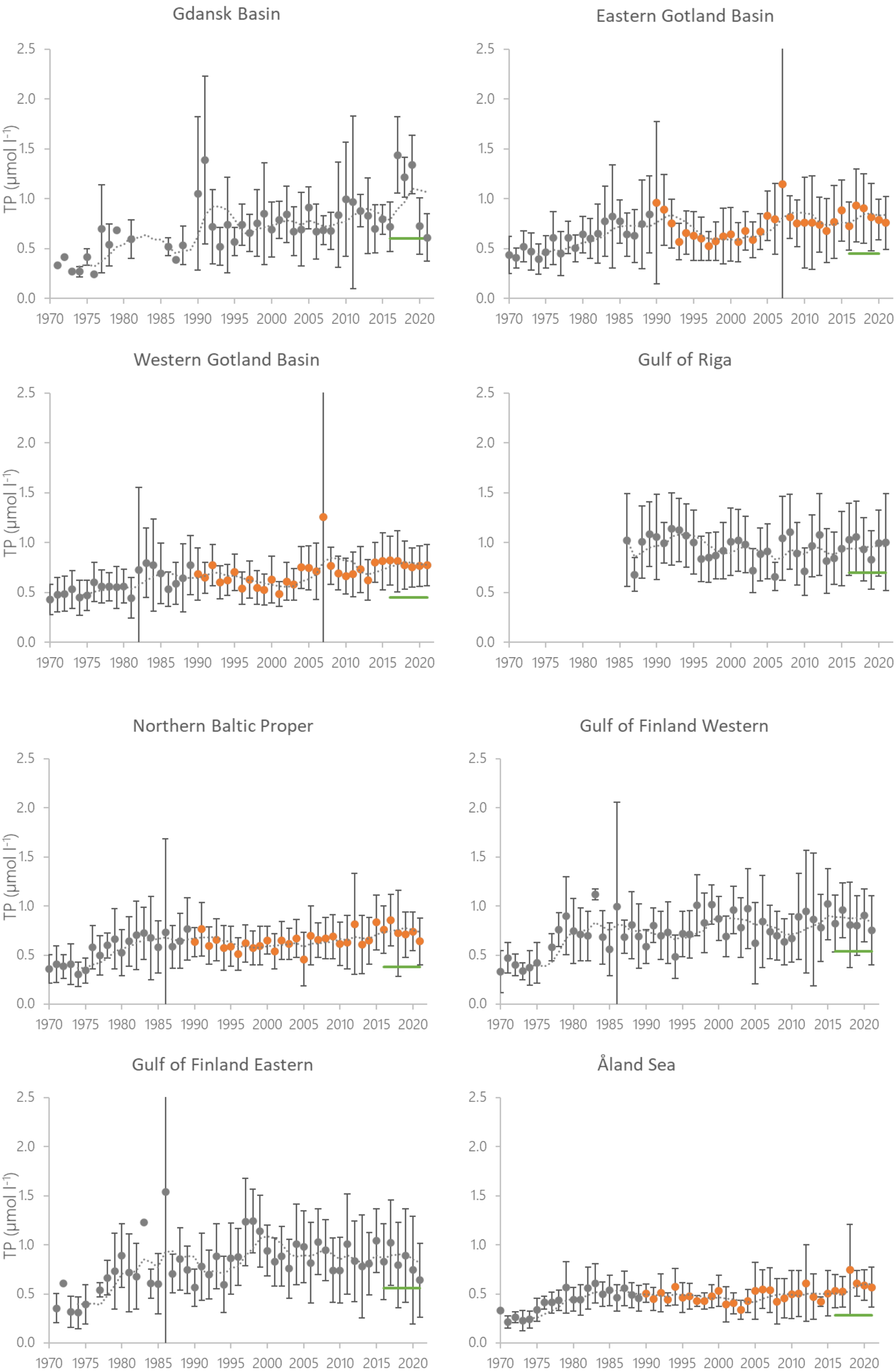
*Long-term trends*

Long-term temporal trends allow to evaluate the actual six-years assessment period in its annual changes compared to previous evaluation periods and to previous decades. Moreover, they provide an impression what can be expected for the near future and perhaps when thresholds will be met or concentrations fall below the thresholds in the future. Data of TP concentrations are presented for all assessment units for the extended time period of 50 years in Figure 6, with the exception of the Gulf of Riga, where TP data are only available since the mide 1980s, and considerable data gaps in the Pomeranian Bay between 1980 and 1995. A significant improving trend (decreasing TP concentrations) since the 1990s were only identified in the Great Belt and Kiel Bay. A deteriorating trend (increasing TP concentrations) was observed in six assessment units (Bornholm Basin, Eastern Gotland Basin, Western Gotland Basin, Northern Baltic Proper, Åland sea and Bothnian Sea) since the 1990s, while 11 sub-basins showed a relative stable situation during the recent decades. The sound, Pomeranian Bay and Gulf of Finland Eastern showed stronger inter-annual variability with no clear trend.

In the current assessment period of the last six years, a declining trend of total phosphorus can be deduced for the Kattegat, The Sound, Bornholm Basin, Pomeranian Bay and Eastern Gotland Basin. All other assessment units showed more or less inter-annual variability without a clear tendency or trend. Only the Great Belt was in good status with TP concentrations below the threshold, while Kattegat and Bothnian Bay were closest to the threshold, but still not in good status. All others sub-basins were above the aimed threshold values as indicated by the green line in Figure 6.


Kattegat
Great Belt
The Sound
Kiel Bay
TP (µmol l⁻¹)
2.5
2.0
1.5
1.0
0.5
0.0
1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020


Bay of Mecklenburg
Arkona Basin
Bornholm Basin
Pomeranian Bay
TP (µmol l⁻¹)
2.5
2.0
1.5
1.0
0.5
0.0
1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020


Gdansk Basin
Eastern Gotland Basin
Western Gotland Basin
Gulf of Riga
Northern Baltic Proper
Gulf of Finland Western
Gulf of Finland Eastern
Åland Sea
TP (µmol l$^{-1}$)
0.0
0.5
1.0
1.5
2.0
2.5
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

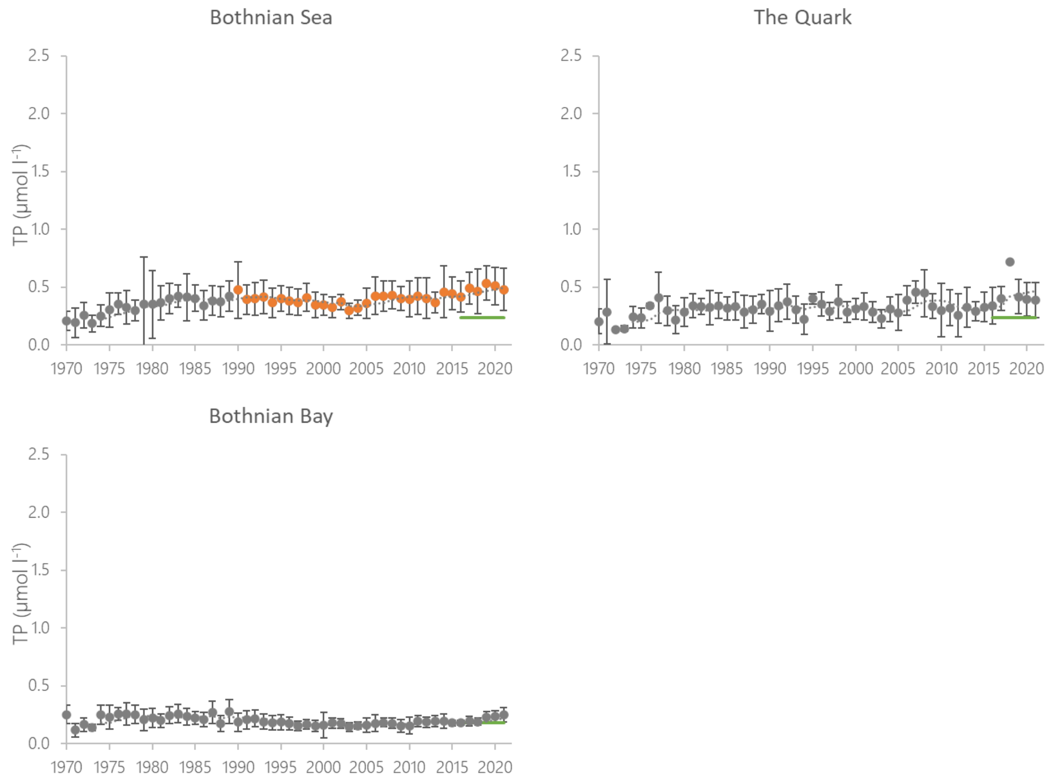



**Figure 6.** Temporal development of total phosphorus (TP) concentrations in the open sea assessment units in 1970-2016. Dashed lines show the five-year moving averages and error bars the standard deviation. Green lines denote the indicator threshold. Significance of trends was assessed with Mann-Kendall non-parametric tests for the period from 1990-2016. Significant ($p<0.05$) improving trends are indicated with blue, deteriorating trends with orange data points and those without colour were insignificant.

## 4.3 Discussion text

Assessment results for TP concentrations (as EQRS values) were compared between the latest two assessments of HOLAS II and HOLAS 3 (Table 4). No status change was observed between the two assessment periods. The majority of sub-basins showed a more or less stable status, meaning no distinct change (within 15% change between HOLAS II and 3), with generally decreasing EQRS values (increasing TP concentrations) between the assessment periods, indicating a further worsening of the existing not good status. In three assessment units (Arkona Basin, Pomeranian Bay and Gulf of Finland Western), EQRS values increased, indicating a slight improvement, but no distinct change. In Great Belt a slight improvement (increasing EQRS value) of the already good status could be observed. In five assessment units, the status deteriorated to varying extents, with slighter deterioration in the Bornholm Basin, Bothnian Sea, Bothnian Bay and Åland Sea, while The Quark showed a stronger worsening. Only in Gulf of Finland Eastern a distinct positive change was observed between HOLAS II and HOLAS 3 with increasing EQRS values.

**Table 4.** Comparison of TP EQRS values between HOLAS II and HOLAS 3 (coloured red or green depending on whether the assessment unit achieves or fails to achieve good status) and a description of the trend observed (distinct change when >15%).

| HELCOM Assesment Unit name | HOLAS II 2011-2016 (EQRS) | HOLAS 3 2016-2021 (EQRS) | Distinct trend between current and previous assessment. |
|---|---|---|---|
| Kattegat | 0.52 | 0.48 | No distinct change |
| Great Belt | 0.83 | 0.88 | No distinct change |
| The Sound | 0.47 | 0.43 | No distinct change |
| Kiel Bay | 0.22 | 0.20 | No distinct change |
| Bay of Mecklenburg | 0.24 | 0.23 | No distinct change |
| Arkona Basin | 0.22 | 0.24 | No distinct change |
| Bornholm Basin | 0.28 | 0.23 | Distinct deteriorating change |
| Pomeranian Bay | 0.23 | 0.25 | No distinct change |
| Gdansk Basin | 0.36 | 0.32 | No distinct change |
| Eastern Gotland Basin | 0.23 | 0.20 | No distinct change |
| Western Gotland Basin | 0.24 | 0.21 | No distinct change |
| Gulf of Riga | 0.36 | 0.34 | No distinct change |
| Northern Baltic Proper | 0.20 | 0.18 | No distinct change |
| Gulf of Finland Western | 0.24 | 0.27 | No distinct change |
| Gulf of Finland Eastern | 0.27 | 0.32 | Distinct improving change |
| Åland Sea | 0.20 | 0.17 | Distinct deteriorating change |
| Bothnian Sea | 0.21 | 0.17 | Distinct deteriorating change |
| The Quark | 0.39 | 0.22 | Distinct deteriorating change |
| Bothnian Bay | 0.56 | 0.46 | Distinct deteriorating change |

## 5 Confidence

The overall confidence of the indicator is based on the temporal confidence, spatial confidence and accuracy of the monitoring data for the assessment period 2016-2021 carried out in the HEAT tool. In general, the aspect of temporal coverage of monitoring data considers the confidence of the indicator in terms of its year-to-year variation and the continuity of observations during the indicator-specific assessment season, in this case the entire year from January to December. The general temporal confidence (GTC) is assessed based on the number of annual observations during the assessment period, whereas for the specific temporal confidence (STC) the number of missing months in the respective assessment season (entire year) determines the classification. The specific spatial confidence (SSC) evaluates the spatial representability of the monitoring data and is based on a gridded approach. Lastly, the accuracy confidence (ACC) indicates how certain the assessment is in relation to the variability of the data to estimate the probability of correct classification in terms of failing or achieving good status. To combine the different confidence assessments GTC and STC are averaged to an overall result for temporal confidence and this result is then averaged with SSC and subsequently combined with ACC to obtain a result for the indicator.

The overall confidence of the indicator status evaluation in open sea areas, based on the spatial and temporal coverage of data and the accuracy of the classification results was high in the Kattegat, Kiel Bay, Bay of Mecklenburg, Arkona and Bornholm Basin, Western and Eastern Gotland Basin, Gulf of Riga, Northern Baltic Proper and Gulf of Finland Western. The overall confidence was moderate in Great Belt and The Sound, Pomeranian Bay, Gdansk Basin, Gulf of Finland Eastern, Bothnian Sea, The Quark and Bothnian Bay. Only in Åland Sea the overall confidence was low (see Figure 7). Looking at the different components of the overall confidence assessment separately (Figure 8), the accuracy of the assessment was high for all assessment units indicating correct classifications with a probability >90%. Selected assessment units showed a moderate to low temporal confidence and the spatial confidence was overall assessed to be worst, with a larger number of assessment units showing a moderate or low spatial confidence, necessitating an increase and better spread of monitoring stations (see Figure 8). High spatial confidence was only achieved in the Kattegat, Bay of Mecklenburg, Arkona Basin, Gulf of Riga and Gulf of Finland Western.

Confidence was assessed in all open sea assessment units, but not in coastal waters.

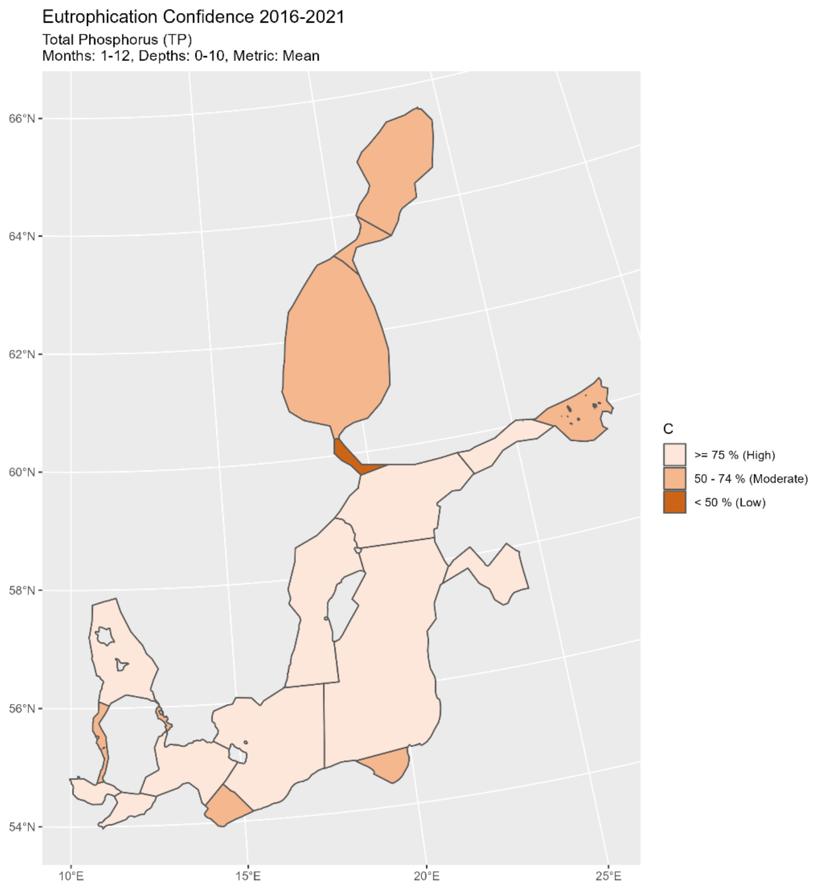



**Figure 7**. Overall indicator confidence (C), determined combining information on data availability and the accuracy of the classification for failing or achieving good status. Low indicator confidence calls for increase in monitoring.

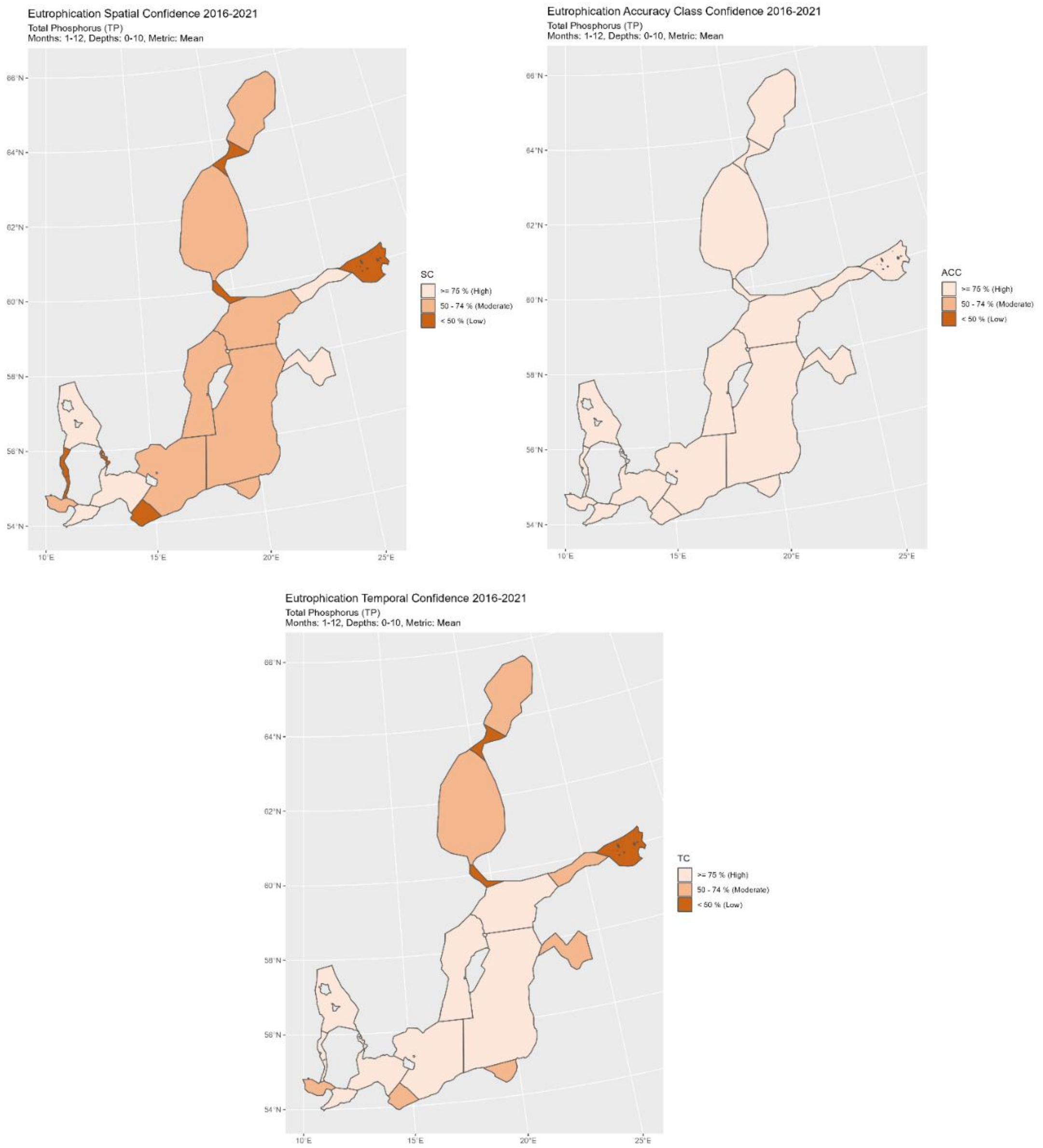



**Figure 8**. : Confidence maps for accuracy class confidence (ACC), spatial confidence (SC) and temporal confidence (TC).

## 6 Drivers, Activities, and Pressures

For HOLAS 3 initial work has been carried out to explore Drivers (and driver indicators) to evaluate how such information can be utilised within such management frameworks as DAPSIM. Although it is recognised as only addressing a small portion of the drivers (via proxies) of relevance for eutrophication wastewater treatment (Drivers and driver indicators for Wastewater Treatment) and agriculture (Drivers and driver indicators for Agricultural Nutrient Balance) have been explored in these pilot studies for HOLAS 3 Nutrient concentrations in the water column are affected by increased anthropogenic nutrient loads from land and air. Diffuse sources constitute the highest proportion of total phosphorus (about 56%) inputs to the Baltic Sea (HELCOM 2022). Natural background loads have the second highest share of total phosphorus inputs to the Baltic Sea (20%), followed by point sources (17%) and atmospheric deposition (7%). The importance of the four sources varies between the different sub-basins. Point sources include activities such as municipal wastewater treatment plants, industrial plants and aquacultural plants and diffuse sources consists of natural background sources, and anthropogenic sources as agriculture, managed forestry, scattered dwellings, storm water etc.

A significant reduction of nutrients input has been achieved for the whole Baltic Sea. The normalized total input of phosphorus was reduced by 28% between the reference period (1997-2003) and 2020 (HELCOM 2023). The maximum allowable input (MAI) of phosphorus in this period was fulfilled in the Bothnian Bay, Bothnian Sea, Danish Straits and Kattegat. This has, however, not yet resulted in a good status of total phosphorus concentrations in these basins, as demonstrated in this indicator assessment, indicating the delay in recovery processes from eutrophication and possibly the effects of internal phosphorus loads (Gustafsson *et al.* 2012).

Further developing an overview of such components and the relevant data to be able to better quantify the linkages within a causal framework provide the opportunity for more informed management decisions, for example targeting of measures, and can thereby support the achievement of Good Environmental Status. This indicator itself addresses the inputs of nutrients to the Baltic Sea (i.e. pressures) and a number of status indicator exist, thus an improved understanding of the relevant components related to drivers and activities (their data sources and how to evaluate them) can significantly improve the overall understanding of eutrophication and appropriate management of the issue.

**Table 5.** Brief summary of relevant pressures and activities with relevance to the indicator.

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

## 7 Climate change and other factors

The current knowledge of the effects of climate change to eutrophication is summarized in the HELCOM climate change fact sheet (HELCOM and Baltic Earth 2021). The effect of climate change to the nutrient pools is not yet separable from the other pressures, and the future nutrient pools will dominantly be affected by the development of nutrient loading. The phytoplankton growth season has already prolonged due to changes in cloud cover and stratification. Climate change is, with medium confidence, considered to increase the stratification, further deteriorate near-bottom oxygen conditions, and increase the internal nutrient loading (Gustafsson *et al*. 2012). Climate change also leads to a higher variability in riverine nutrient inputs, with an increase of floods and droughts. Such extreme events might have a direct impact on the nutrient concentrations in the Baltic Sea.

# 8 Conclusions

The status evaluation fails to achieve good status in all assessed sub-basins except for Great Belt.

## 8.1 Future work or improvements needed

A better harmonisation of the thresholds for total phosphorus between coastal waters and the open Baltic Sea basins might be necessary in the future, in particular in areas where coastal waters are already assessed as achieving good status while the open basins still fail to achieve good status. Although high phosphorus concentrations are mainly caused by riverine nutrient inputs, sediments are becoming a more and more important source of phosphorus due to the increasing spread of hypoxia. A better understanding needs to be developed on how phosphorus concentrations react to ongoing climate change and how they are influenced by expanding oxygen deficit areas.

## 9 Methodology

### 9.1 Scale of assessment

The core indicator is applicable in the 19 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.

### 9.2 Methodology applied

For the open sea assessment, this core indicator is 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 Table 6 (see HELCOM Eutrophication assessment manual).

**Table 6**. Specifications for the TP indicator.

| **Indicator** | **Total phosphorus (TP)** |
|---|---|
| **Response to eutrophication** | Positive |
| **Parameters** | Total phosphorus concentration (µmol $l^{-1}$) |
| **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)** | 2016-2021 |
| **Assessment season** | Annual / Summer (June-September) |
| **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 annual/seasonal average values (mostly average = arithmetic mean, in some Contracting Parties the median is used instead to assess status versus threshold) |
| **Eutrophication Quality Ratio (EQR)** | EQR = BEST/ ES,<br><br>where |

<table>
<tr>
<td></td>
<td>
BEST= ET / (1 + ACDEV / 100)
ET= threshold (table 1)
ACDEV= acceptable deviation: 50 % for TP.
The final EQR values are scaled after normalisation to five classes of 0.2 width and a Scaled Eutrophication Quality Ratio is obtained (EQRS).
</td>
</tr>
<tr>
<td>Indicator confidence</td>
<td>
The confidence assessment for eutrophication indicators is included in HEAT, and includes aspects of temporal, spatial and accuracy confidence. The general methodology of the confidence assessment is described in Document 4.2 of IN-Eutrophication 16-2020 and updates are described in documents 4J-80 of State & Conservation 14-2021 and 4-2 of EG-EUTRO 20-2021. The R-code is available via https://github.com/ices-tools-prod/HEAT.
The aspect of temporal coverage of monitoring data considers the confidence of the indicator in terms of its year-to-year variation and the continuity of observations during the indicator-specific assessment season (annual/summer). The general temporal confidence (GTC) is assessed based on the number of annual observations during the assessment period, whereas for the specific temporal confidence (STC) the number of missing months in the respective assessment season (annual/summer) determines the classification. The specific spatial confidence (SSC) evaluates the spatial representability of the monitoring data and is based on a gridded approach.  Lastly, the accuracy confidence (ACC) indicates how certain the assessment is in relation to the variability of the data to estimate the probability of correct classification for failing or achieving good status. To combine the different confidence assessments GTC and STC are averaged to an overall result for temporal confidence and this result is then averaged with SSC and subsequently combined with ACC to obtain a result for the indicator.
The evaluation criteria for general and specific temporal confidence are given in the table below.
<table>
<tr><td>Confidence class</td><td>Evaluation criteria for general temporal confidence</td><td>Evaluation criteria for specific temporal confidence</td></tr>
<tr><td>High (100)</td><td>The evaluation is based on > 20 annual observations during the given assessment period</td><td>0 missing months per year</td></tr>
<tr><td>Medium (50)</td><td>The evaluation is based on 7 - 20</td><td>1 missing month per year</td></tr>
</table>
</td>
</tr>
</table>

| | | |
|---|---|---|
| | annual observations | |
| Low (0) | The evaluation is based on < 7 annual observations | ≥ 2 missing months per year |

If the specific temporal confidence is high (100) for at least half of the assessed years, it is set as high (100) for the assessment period. The total temporal confidence is the average of the general and specific temporal confidence aspects.

The evaluation criteria for spatial confidence are given in the table below.

| Confidence class | Evaluation criteria for spatial confidence |
|---|---|
| High (100) | Sampled grid cells cover > 70 % of the assessment-unit area |
| Medium (50) | Sampled grid cells cover 50-70 % of the assessment-unit area |
| Low (0) | Sampled grid cells cover < 50 % of the assessment-unit area |

The accuracy aspect assesses the probability of correct classification (the classification being below or above the threshold for good status).

The evaluation criteria for accuracy aspect are given in table below.

| Confidence class | Evaluation criteria for spatial confidence |
|---|---|
| High (100) | GES has been/ not been achieved by ≥ 90% probability |
| Medium (50) | GES has been/ not been achieved by 70 - < 90% probability |
| Low (0) | GES has been/ not been achieved by < 70% probability |

| | |
|---|---|
| **Indicator threshold value confidence** | MODERATE |

## 9.3 Monitoring and reporting requirements

*Monitoring methodology*

Monitoring of phosphorus concentrations by 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 total phosphorus are adopted and published.

*Current monitoring*

The monitoring activities relevant to the indicator, as 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 total phosphorus is considered sufficient to support the indicator evaluation. Increased temporal and spatial monitoring in certain areas would further improve the confidence in future assessments.

## 10 Data

The data and resulting data products (e.g. tables, figures and maps) available on the indicator web page can be used freely given that it is used appropriately and the source is cited.

Result: Total phosphorus (TP)

Data source: The average for 2016-2021 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 total phosphorus observations, determined as explained in the HELCOM monitoring 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 monitoring programme, added occasionally with data from research cruises.

Temporal coverage: The raw data includes observations throughout the year, during the assessment period 2016-2021. For the summer average, observations taken during June-September were included only.

Data aggregation: The 2016-2021 averages for each sub-basin were produced as inter-annual estimates using observations from all months / June-September.

## 11 Contributors

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## 12 Archive

This version of the HELCOM core indicator report was published in April 2023:

The current version of this indicator (including as a PDF) can be found on the HELCOM indicator web page.

Earlier versions of the core indicator report are available:

Total phosphorus (TP) HELCOM core indicator 2018 (pdf)

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

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

# 13 References


Directive 2000/60/EC of the European parliament and of the council of 23 October 2000 establishing a framework for community action in the field of water policy. Official Journal of the European Communities L 327/1.

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.

Gustafsson, B.G.; Schenk, F.; Blenckner, T.; Eilola, K. et al (2012): Reconstructing the Development of Baltic Sea Eutrophication 1850–2006. Ambio 41, pages 534-548

HELCOM (2009) Eutrophication in the Baltic Sea - An Integrated Thematic Assessment of the Effects of Nutrient Enrichment and Eutrophication in the Baltic Sea Region. *Balt. Sea Environ. Proc. No. 115B*, 148.

HELCOM (2013) Approaches and Methods for Eutrophication Target Setting in the Baltic Sea Region. *Balt. Sea Environ. Proc. No. 133*.

HELCOM (2021) “Baltic Sea Action Plan. 2021 Update.” https://helcom.fi/wp-content/uploads/2021/10/Baltic-Sea-Action-Plan-2021-update.pdf.

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HELCOM (2023) “Inputs of Nutrients to the Sub-Basins (2023). HELCOM Core Indicator Report. Online.” 2023.

HELCOM and Baltic Earth (2021) Climate Change in the Baltic Sea. 2021 Fact Sheet. Baltic Sea Environment Proceedings N°180. https://doi.org/ISSN: 0357-2994.

## 14 Other relevant resources

HELCOM: First version of the 'State of the Baltic Sea' report – June 2017, Baltic Marine Environment Protection Commission – HELCOM, Helsinki, Finland, 197, 2017.

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)

Annex providing an overview of additional coastal evaluations reported by Contracting Parties

**Table 7.** Results for national coastal Total phosphorus indicators by coastal WFD water type/water body. The table includes information on the assessment unit (CODE, defined in the HELCOM Monitoring and Assessment Strategy Annex 4) and description, assessment period (start year and/or end year), threshold value (ET) in µmol/l with exceptions of **3002 and 7003-7004 indicators** being measured in mg/l. Average concentration during assessment period (ES) in µmol/l with exceptions of **3002 and 7003-7004 indicator** being measured in mg/l and standard deviation (SD), Ecological Quality Ratio (EQR) and Ecological Quality Ratio Scaled (EQRS). EQRS shows the present concentration in relation to the reference value, decreasing along with increasing eutrophication. EQRS_class estimates the ecological status based on the EQRS value.

| IndicatorID | Name | Period | Unit ID | HELCOM ID | HELCOM ID description | Assessment Unit | ET | ES | SD | EQR | EQRS | EQRS Class |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1004** | Total Phosphorus | 20162020 | 1001 | GER-001 | mesohaline inner coastal waters, Wismarbucht, Suedteil | Bay of Mecklenburg | 0.73 | 1.41 | NA | 0.35 | 0.18 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1002 | GER-002 | mesohaline inner coastal waters, Wismarbucht, Nordteil | Bay of Mecklenburg | 0.73 | 1.00 | NA | 0.49 | 0.35 | Poor |
| **1004** | Total Phosphorus | 20162020 | 1003 | GER-003 | mesohaline inner coastal waters, Wismarbucht, Salzhaff | Bay of Mecklenburg | 0.73 | 1.37 | NA | 0.36 | 0.19 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1004 | GER-004 | mesohaline open coastal waters, Suedliche Mecklenburger Bucht/ Travemuende bis Warnemünde | Bay of Mecklenburg | 0.65 | 0.81 | NA | 0.54 | 0.42 | Moderate |
| **1004** | Total Phosphorus | 20162020 | 1005 | GER-005 | mesohaline inner coastal waters, Unterwarnow | Bay of Mecklenburg | 0.59 | 2.11 | NA | 0.19 | 0.10 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1006 | GER-006 | mesohaline open coastal waters, Suedliche Mecklenburger Bucht/ Warnemünde bis Darss | Bay of Mecklenburg | 0.65 | 0.88 | NA | 0.49 | 0.35 | Poor |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1004** | Total Phosphorus | 20162020 | 1007 | GER-007 | oligohaline inner coastal waters, Ribnitzer See / Saaler Bodden | Arkona Basin | 1.42 | 3.84 | NA | 0.25 | 0.13 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1008 | GER-008 | oligohaline inner coastal waters, Koppelstrom / Bodstedter Bodden | Arkona Basin | 1.42 | 2.92 | NA | 0.32 | 0.17 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1009 | GER-009 | mesohaline inner coastal waters, Barther Bodden, Grabow | Arkona Basin | 0.59 | 1.94 | NA | 0.20 | 0.11 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1010 | GER-010 | mesohaline open coastal waters, Prerowbucht/ Darsser Ort bis Dornbusch | Arkona Basin | 0.62 | 0.87 | NA | 0.48 | 0.33 | Poor |
| **1004** | Total Phosphorus | 20162020 | 1011 | GER-011 | mesohaline inner coastal waters, Westruegensche Bodden | Arkona Basin | 0.59 | 1.32 | NA | 0.30 | 0.16 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1012 | GER-012 | mesohaline inner coastal waters, Strelasund | Arkona Basin | 0.59 | 1.58 | NA | 0.25 | 0.13 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1013 | GER-013 | mesohaline inner coastal waters, Greifswalder Bodden | Arkona Basin | 0.59 | 1.48 | NA | 0.27 | 0.14 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1014 | GER-014 | mesohaline inner coastal waters, Kleiner Jasmunder Bodden | Arkona Basin | 0.59 | 2.99 | NA | 0.13 | 0.07 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1015 | GER-015 | mesohaline open coastal waters, Nord- und Ostruegensche Gewaesser | Arkona Basin | 0.62 | 0.84 | NA | 0.49 | 0.35 | Poor |
| **1004** | Total Phosphorus | 20162020 | 1016 | GER-016 | oligohaline inner coastal waters, Peenestrom | Bornholm Basin | 1.42 | 3.35 | NA | 0.28 | 0.15 | Bad |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1004** | Total Phosphorus | 20162020 | 1017 | GER-017 | oligohaline inner coastal waters, Achterwasser | Bornholm Basin | 1.42 | 3.73 | NA | 0.25 | 0.13 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1018 | GER-018 | mesohaline open coastal waters, Pommersche Bucht, Nordteil | Arkona Basin | 0.62 | 1.05 | NA | 0.39 | 0.21 | Poor |
| **1004** | Total Phosphorus | 20162020 | 1019 | GER-019 | mesohaline open coastal waters, Pommersche Bucht, Südteil | Bornholm Basin | 0.62 | 1.33 | NA | 0.31 | 0.16 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1020 | GER-020 | oligohaline inner coastal waters, Kleines Haff | Bornholm Basin | 1.42 | 3.99 | NA | 0.24 | 0.12 | Bad |
| **1004** | Total Phosphorus | 20132018 | 1021 | GER-021 | mesohaline inner coastal waters, Flensburg Innenfoerde | Kiel Bay | 0.52 | 0.88 | NA | 0.40 | 0.22 | Poor |
| **1004** | Total Phosphorus | 20132018 | 1023 | GER-023 | meso- to polyhaline open coastal waters, seasonally stratified, Flensburger Aussenfoerde | Kiel Bay | 0.50 | 0.66 | NA | 0.50 | 0.37 | Poor |
| **1004** | Total Phosphorus | 20132018 | 1025 | GER-025 | mesohaline inner coastal waters, Schleimuende | Kiel Bay | 0.52 | 2.22 | NA | 0.16 | 0.08 | Bad |
| **1004** | Total Phosphorus | 20132018 | 1026 | GER-026A | A.mesohaline inner coastal waters, Mittlere Schlei | Kiel Bay | 1.10 | 3.85 | NA | 0.19 | 0.10 | Bad |
| **1004** | Total Phosphorus | 20132018 | 1027 | GER-026B | B.mesohaline inner coastal waters, Mittlere Schlei | Kiel Bay | 1.10 | 3.85 | NA | 0.19 | 0.10 | Bad |
| **1004** | Total Phosphorus | 20132018 | 1029 | GER-028 | mesohaline open coastal waters, Eckerfoerder Bucht, Rand | Kiel Bay | 0.44 | 0.56 | NA | 0.53 | 0.40 | Moderate |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1004** | Total Phosphorus | 20132018 | 1030 | GER-029 | meso- to polyhaline open coastal waters, seasonally stratified, Eckerfoerderbucht, Tiefe | Kiel Bay | 0.50 | 0.60 | NA | 0.55 | 0.44 | Moderate |
| **1004** | Total Phosphorus | 20132018 | 1032 | GER-031 | meso- to polyhaline open coastal waters, seasonally stratified, Kieler Aussenfoerde | Kiel Bay | 0.50 | 0.60 | NA | 0.56 | 0.44 | Moderate |
| **1004** | Total Phosphorus | 20132018 | 1033 | GER-032 | mesohaline inner coastal waters, Kieler Innenfoerde | Kiel Bay | 0.52 | 0.85 | NA | 0.41 | 0.23 | Poor |
| **1004** | Total Phosphorus | 20132018 | 1034 | GER-033 | mesohaline open coastal waters, Probstei | Kiel Bay | 0.44 | 0.67 | NA | 0.44 | 0.28 | Poor |
| **1004** | Total Phosphorus | 20132018 | 1037 | GER-036A | A.mesohaline open coastal waters, Fehmarnsund | Kiel Bay | 0.44 | 0.62 | NA | 0.48 | 0.33 | Poor |
| **1004** | Total Phosphorus | 20132018 | 1038 | GER-036B | B.mesohaline open coastal waters, Fehmarnsund | Bay of Mecklenburg | 0.44 | 0.62 | NA | 0.48 | 0.33 | Poor |
| **1004** | Total Phosphorus | 20132018 | 1039 | GER-037 | mesohaline inner coastal waters, Orther Bucht | Kiel Bay | 0.52 | 0.63 | NA | 0.55 | 0.44 | Moderate |
| **1004** | Total Phosphorus | 20132018 | 1040 | GER-038A | A.mesohaline open coastal waters, Fehmarnbelt | Kiel Bay | 0.44 | 0.61 | NA | 0.48 | 0.34 | Poor |
| **1004** | Total Phosphorus | 20132018 | 1041 | GER-038B | B.mesohaline open coastal waters, Fehmarnbelt | Bay of Mecklenburg | 0.44 | 0.61 | NA | 0.48 | 0.34 | Poor |
| **1004** | Total Phosphorus | 20132018 | 1043 | GER-040 | mesohaline open coastal waters, Groemitz | Bay of Mecklenburg | 0.44 | 0.64 | NA | 0.46 | 0.30 | Poor |
| **1004** | Total Phosphorus | 20132018 | 1044 | GER-041 | mesohaline open coastal waters, Neustaedter Bucht | Bay of Mecklenburg | 0.44 | 0.71 | NA | 0.41 | 0.24 | Poor |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1004** | Total Phosphorus | 20132018 | 1046 | GER-043 | mesohaline inner coastal waters, Poetenitzer Wiek | Bay of Mecklenburg | 1.10 | 4.44 | NA | 0.16 | 0.09 | Bad |
| **1004** | Total Phosphorus | 20132018 | 1047 | GER-044 | mesohaline inner coastal waters, Untere Trave | Bay of Mecklenburg | 1.10 | 4.23 | NA | 0.17 | 0.09 | Bad |
| **1004** | Total Phosphorus | 20162020 | 1048 | GER-111 | mesohaline inner coastal waters, Nordruegensche Bodden | Arkona Basin | 0.59 | 1.57 | NA | 0.25 | 0.13 | Bad |
| **3002** | Total Phosphorus | 20162021 | 3001 | EST-001 | Narva-Kunda Bay CWB | Gulf of Finland | NA | NA | NA | 0.82 | 0.79 | Good |
| **3002** | Total Phosphorus | 20162020 | 3002 | EST-002 | Eru-Käsmu Bay CWB | Gulf of Finland | NA | NA | NA | 0.69 | 0.64 | Good |
| **3002** | Total Phosphorus | 20212021 | 3003 | EST-003 | Hara and Kolga Bay CWB | Gulf of Finland | NA | NA | NA | 0.61 | 0.58 | Moderate |
| **3002** | Total Phosphorus | 20162021 | 3004 | EST-005 | Muuga-Tallinna-Kakumäe Bay CWB | Gulf of Finland | NA | NA | NA | 0.72 | 0.68 | Good |
| **3002** | Total Phosphorus | 20212021 | 3005 | EST-006 | Pakri Bay CWB | Gulf of Finland | NA | NA | NA | 0.64 | 0.59 | Moderate |
| **3002** | Total Phosphorus | 20212021 | 3006 | EST-007 | Hiiu Shallow CWB | Gulf of Riga | NA | NA | NA | 0.58 | 0.55 | Moderate |
| **3002** | Total Phosphorus | 20182021 | 3007 | EST-008 | Haapsalu Bay CWB | Gulf of Riga | NA | NA | NA | 0.23 | 0.24 | Poor |
| **3002** | Total Phosphorus | 20212021 | 3008 | EST-009 | Matsalu Bay CWB | Gulf of Riga | NA | NA | NA | 0.59 | 0.55 | Moderate |
| **3002** | Total Phosphorus | 20212021 | 3009 | EST-010 | Soela Strait CWB | Northern Baltic Proper | NA | NA | NA | 0.69 | 0.63 | Good |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3002** | Total Phosphorus | 20212021 | 3010 | EST-011 | Kihelkonna Bay CWB | Eastern Gotland Basin | NA | NA | NA | 0.73 | 0.68 | Good |
| **3002** | Total Phosphorus | 20162021 | 3011 | EST-013 | Pärnu Bay CWB | Gulf of Riga | NA | NA | NA | 0.70 | 0.66 | Good |
| **3002** | Total Phosphorus | 20162018 | 3012 | EST-014 | Kassari-Õunaku Bay CWB | Gulf of Riga | NA | NA | NA | 0.49 | 0.49 | Moderate |
| **3002** | Total Phosphorus | 20212021 | 3013 | EST-016 | Väinameri CWB | Gulf of Riga | NA | NA | NA | 0.54 | 0.52 | Moderate |
| **3002** | Total Phosphorus | 20212021 | 3014 | EST-017 | NW part of the Gulf of Riga CWB | Gulf of Riga | NA | NA | NA | NA | NA | NA |
| **3002** | Total Phosphorus | 20212021 | 3015 | EST-018 | NE part of the Gulf of Riga CWB | Gulf of Riga | NA | NA | NA | NA | NA | NA |
| **3002** | Total Phosphorus | 20212021 | 3016 | EST-019 | Central part of the Gulf of Riga CWB | Gulf of Riga | NA | NA | NA | 0.82 | 0.79 | Good |
| **4002** | Total Phosphorus (summer) | 20162021 | 4001 | FIN-001 | Lounainen sisäsaaristo | Åland Sea | NA | NA | NA | NA | 0.45 | Moderate |
| **4002** | Total Phosphorus (summer) | 20162021 | 4002 | FIN-002 | Lounainen ulkosaaristo | Åland Sea | NA | NA | NA | NA | 0.51 | Moderate |
| **4002** | Total Phosphorus (summer) | 20162021 | 4003 | FIN-003 | Suomenlahden sisäsaaristo | Gulf of Finland | NA | NA | NA | NA | 0.37 | Poor |
| **4002** | Total Phosphorus (summer) | 20162021 | 4004 | FIN-004 | Suomenlahden ulkosaaristo | Gulf of Finland | NA | NA | NA | NA | 0.45 | Moderate |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **4002** | Total Phosphorus (summer) | 20162021 | 4005 | FIN-005 | Lounainen välisaaristo | Åland Sea | NA | NA | NA | NA | 0.55 | Moderate |
| **4002** | Total Phosphorus (summer) | 20162021 | 4006 | FIN-006 | Merenkurkun sisäsaaristo | The Quark | NA | NA | NA | NA | 0.62 | Good |
| **4002** | Total Phosphorus (summer) | 20162021 | 4007 | FIN-007 | Merenkurkun ulkosaaristo | The Quark | NA | NA | NA | NA | 0.76 | Good |
| **4002** | Total Phosphorus (summer) | 20162021 | 4008 | FIN-008 | Selkämeren sisemmät rannikkovedet | Bothnian Sea | NA | NA | NA | NA | 0.62 | Good |
| **4002** | Total Phosphorus (summer) | 20162021 | 4009 | FIN-009 | Selkämeren ulommat rannikkovedet | Bothnian Sea | NA | NA | NA | NA | 0.57 | Moderate |
| **4002** | Total Phosphorus (summer) | 20162021 | 4010 | FIN-010 | Perämeren sisemmät rannikkovedet | Bothnian Bay | NA | NA | NA | NA | 0.61 | Good |
| **4002** | Total Phosphorus (summer) | 20162021 | 4011 | FIN-011 | Perämeren ulommat rannikkovedet | Bothnian Bay | NA | NA | NA | NA | 0.83 | High |
| **4002** | Total Phosphorus (summer) | 20162021 | 4012 | FIN-012 | Åland innerskärgård | Åland Sea | NA | NA | NA | 0.79 | 0.70 | Good |
| **4002** | Total Phosphorus (summer) | 20162021 | 4013 | FIN-013 | Åland mellanskärgård | Åland Sea | NA | NA | NA | 0.73 | 0.62 | Good |

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| **4002** | Total Phosphorus (summer) | 20162021 | 4014 | FIN-014 | Åland ytterskärgård | Åland Sea | NA | NA | NA | 0.68 | 0.57 | Moderate |
| **7007** | Total Phosphorus | 20162021 | 7001 | POL-001 | PL TW I WB 9 very sheltered, fully mixed, substratum: silt/sandy silt/silty sand; ice cover >90 days, water residence time 52 days | Bornholm Basin | 0.15 | 0.15 | 0.06 | 0.72 | 0.66 | Good |
| **7007** | Total Phosphorus | 20162021 | 7002 | POL-002 | PL TW I WB 8 very sheltered, fully mixed, substratum: silt/sandy silt/silty sand; ice cover >90 days, water residence time 52 days | Bornholm Basin | 0.15 | 0.14 | 0.02 | 0.72 | 0.67 | Good |
| **7007** | Total Phosphorus | 20162021 | 7003 | POL-003 | PL TW I WB 1 very sheltered, fully mixed, substratum: silt/sandy silt/silty sand; ice cover >90 days, water residence time 52 days | Gdansk Basin | 0.12 | 0.13 | 0.03 | 0.64 | 0.57 | Moderate |
| **7007** | Total Phosphorus | 20162021 | 7004 | POL-004 | PL TW II WB 2 very sheltered, fully mixed, substratum: lagoonal fine snd medium grained sand/silty sand; residence time 138 day, ice cover >90 days | Gdansk Basin | 0.03 | 0.04 | 0.01 | 0.47 | 0.34 | Poor |
| **7008** | Total Phosphorus | 20162021 | 7005 | POL-005 | PL TW III WB 3 partly protected, partly stratified, substratum: medium grained sand/pebbles/marine silty sand; ice-incidental | Gdansk Basin | 0.04 | 0.05 | 0.01 | 0.45 | 0.31 | Poor |

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| **7008** | Total Phosphorus | 20162021 | 7006 | POL-006 | PL TW IV WB 4 partly stratified, moderately exposed, substratum: sand/silt; ice - incidental | Gdansk Basin | 0.04 | 0.04 | 0.01 | 0.55 | 0.44 | Moderate |
| **7008** | Total Phosphorus | 20162021 | 7007 | POL-007 | PL TW V WB 6 river mouth, partly stratified, partly sheltered, substratum: medium grained sand/silty sand | Bornholm Basin | 0.04 | 0.06 | 0.02 | 0.51 | 0.39 | Poor |
| **7008** | Total Phosphorus | 20162021 | 7008 | POL-008 | PL TW V WB 5 river mouth, partly stratified, partly sheltered, substratum: medium grained sand/silty sand | Gdansk Basin | 0.05 | 0.05 | 0.01 | 0.58 | 0.47 | Moderate |
| **7008** | Total Phosphorus | 20162021 | 7009 | POL-009 | PL TW V WB 7 river mouth, partly stratified, partly sheltered, substratum: medium grained sand/silty sand | Bornholm Basin | 0.05 | 0.06 | 0.00 | 0.53 | 0.40 | Moderate |
| **7008** | Total Phosphorus | 20162021 | 7010 | POL-010 | PL CWI WB2 coastal waters, moderately exposed, fully mixed, substratum:sand/fine sand | Gdansk Basin | 0.03 | 0.04 | 0.02 | 0.51 | 0.40 | Moderate |
| **7008** | Total Phosphorus | 20162021 | 7011 | POL-011 | PL CWI WB1 coastal waters, moderately exposed, fully mixed, substratum:sand/fine sand | Gdansk Basin | 0.03 | 0.06 | 0.02 | 0.45 | 0.32 | Poor |
| **7008** | Total Phosphorus | 20162021 | 7012 | POL-012 | PL CWI WB3 coastal waters, moderately exposed, fully | Gdansk Basin | 0.03 | 0.09 | 0.07 | 0.29 | 0.17 | Bad |

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| | | | | | mixed, substratum:sand/fine sand | | | | | | | |
| **7008** | Total Phosphorus | 20162021 | 7013 | POL-013 | PL CW II WB 8 central Polish coast, coastal waters, exposed, fully mixed, substratum: sand/pebbles/gravel | Bornholm Basin | 0.03 | 0.04 | 0.01 | 0.60 | 0.50 | Moderate |
| **7008** | Total Phosphorus | 20162021 | 7014 | POL-014 | PL CW II WB 6W central Polish coast, coastal waters, exposed, fully mixed, substratum: sand/pebbles/gravel | Bornholm Basin | 0.03 | 0.03 | 0.01 | 0.76 | 0.71 | Good |
| **7008** | Total Phosphorus | 20162021 | 7015 | POL-015 | PL CW II WB 6E central Polish coast, coastal waters, exposed, fully mixed, substratum: sand/pebbles/gravel | Bornholm Basin | 0.03 | 0.02 | 0.01 | 0.86 | 0.83 | High |
| **7008** | Total Phosphorus | 20162021 | 7016 | POL-016 | PL CWII WB5 central Polish coast, coastal waters, exposed, fully mixed, substratum: sand/pebbles/gravel | Eastern Gotland Basin | 0.03 | 0.05 | 0.02 | 0.47 | 0.34 | Poor |
| **7008** | Total Phosphorus | 20162021 | 7017 | POL-017 | PL CWII WB4 central Polish coast, coastal waters, exposed, fully mixed, substratum: sand/pebbles/gravel | Gdansk Basin | 0.03 | 0.04 | 0.01 | 0.52 | 0.40 | Poor |
| **7008** | Total Phosphorus | 20162021 | 7018 | POL-018 | PL CW III WB 9 central Polish coast, coastal waters, exposed, fully mixed, | Bornholm Basin | 0.04 | 0.04 | 0.01 | 0.59 | 0.49 | Moderate |

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| | | | | | substratum: sand/pebbles/gravel | | | | | | |
| **7008** | Total Phosphorus | 20162021 | 7019 | POL-019 | PL CW III WB 7 central Polish coast, coastal waters, exposed, fully mixed, substratum: sand/pebbles/gravel | Bornholm Basin | 0.03 | 0.04 | 0.01 | 0.56 | 0.46 | Moderate |
| **80041** | Total Phosphorus winter | 20182018 | 8001 | SWE-001 | 1s West Coast inner coastal water | Kattegat | 0.89 | 0.86 | NA | 0.80 | 0.65 | Good |
| **80041** | Total Phosphorus winter | 20182018 | 8002 | SWE-003 | 4 West Coast outer coastal water, Kattegat | Kattegat | 0.88 | 0.87 | NA | 0.79 | 0.62 | Good |
| **80041** | Total Phosphorus winter | 20182018 | 8003 | SWE-004 | 5 South Halland and north Öresund coastal water | Kattegat | 0.90 | 1.29 | NA | 0.54 | 0.76 | Good |
| **80041** | Total Phosphorus winter | 20182018 | 8004 | SWE-005 | 6 Öresund inner coastal water | The Sound | 0.90 | 1.82 | NA | 0.39 | 0.15 | Bad |
| **80041** | Total Phosphorus winter | 20172017 | 8005 | SWE-006 | 7 Skåne coastal water | Arkona Basin | 0.73 | 1.20 | NA | 0.42 | 0.33 | Poor |
| **80041** | Total Phosphorus winter | 20182018 | 8006 | SWE-007 | 8 Blekinge archipelago and Kalmarsund, inner | Western Gotland Basin | 0.74 | 4.04 | 4.34 | 0.65 | 0.59 | Moderate |
| **80041** | Total Phosphorus winter | 20182018 | 8007 | SWE-008 | 9 Blekinge archipelago and Kalmarsund, outer | Western Gotland Basin | 0.73 | 1.02 | NA | 0.50 | 0.42 | Moderate |

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| **80041** | Total Phosphorus winter | 20172017 | 8010 | SWE-011 | 12n Östergötland and Stockholm archipelago | Northern Baltic Proper | 0.68 | 0.99 | NA | 0.45 | 0.42 | Moderate |
| **80041** | Total Phosphorus winter | 20182018 | 8011 | SWE-012 | 12s Östergötland and Stockholm archipelago | Western Gotland Basin | 0.68 | 1.12 | NA | 0.40 | 0.36 | Poor |
| **80041** | Total Phosphorus winter | 20172017 | 8012 | SWE-013 | 13 Östergötland inner coastal water | Western Gotland Basin | 0.83 | 1.71 | NA | 0.32 | 0.25 | Poor |
| **80041** | Total Phosphorus winter | 20172017 | 8013 | SWE-014 | 14 Östergötland outer coastal water | Western Gotland Basin | 0.60 | 1.10 | NA | 0.36 | 0.31 | Poor |
| **80041** | Total Phosphorus winter | 20182018 | 8015 | SWE-016 | 16 South Bothnian Sea,inner coastal water | Bothnian Sea | 0.57 | 0.93 | NA | 0.44 | 0.31 | Poor |
| **80041** | Total Phosphorus winter | 20182018 | 8017 | SWE-018 | 18 North Bothnian Sea, Höga kusten, inner | Bothnian Sea | 0.52 | 0.69 | NA | 0.54 | 0.43 | Moderate |
| **80041** | Total Phosphorus winter | 20172017 | 8019 | SWE-020 | 20 North Quark inner coastal water | The Quark | 0.49 | 0.55 | NA | 0.57 | 0.54 | Moderate |
| **80041** | Total Phosphorus winter | 20182018 | 8024 | SWE-025 | 25 Göta and Nordre älv estuary | Kattegat | 0.88 | 0.87 | NA | 0.79 | 0.63 | Good |
| **80042** | Total Phosphorus summer | 20182018 | 8001 | SWE-001 | 1s West Coast inner coastal water | Kattegat | 0.55 | 0.52 | NA | 0.76 | 0.69 | Good |

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| **80042** | Total Phosphorus summer | 20182018 | 8002 | SWE-003 | 4 West Coast outer coastal water, Kattegat | Kattegat | 0.55 | 0.50 | NA | 0.78 | 0.72 | Good |
| **80042** | Total Phosphorus summer | 20182018 | 8003 | SWE-004 | 5 South Halland and north Öresund coastal water | Kattegat | 0.56 | 0.70 | NA | 0.57 | 0.95 | High |
| **80042** | Total Phosphorus summer | 20182018 | 8004 | SWE-005 | 6 Öresund inner coastal water | The Sound | 0.56 | 1.39 | NA | 0.29 | 0.97 | High |
| **80042** | Total Phosphorus summer | 20172017 | 8005 | SWE-006 | 7 Skåne coastal water | Arkona Basin | 0.41 | 3.91 | 3.50 | 0.78 | 0.84 | High |
| **80042** | Total Phosphorus summer | 20182018 | 8006 | SWE-007 | 8 Blekinge archipelago and Kalmarsund, inner | Western Gotland Basin | 0.40 | 0.95 | NA | 0.31 | 0.36 | Poor |
| **80042** | Total Phosphorus summer | 20182018 | 8007 | SWE-008 | 9 Blekinge archipelago and Kalmarsund, outer | Western Gotland Basin | 0.40 | 0.76 | NA | 0.39 | 0.70 | Good |
| **80042** | Total Phosphorus summer | 20182018 | 8010 | SWE-011 | 12n Östergötland and Stockholm archipelago | Northern Baltic Proper | 4.65 | 9.00 | NA | 0.38 | 0.85 | High |
| **80042** | Total Phosphorus summer | 20182018 | 8011 | SWE-012 | 12s Östergötland and Stockholm archipelago | Western Gotland Basin | 0.43 | 0.80 | NA | 0.39 | 0.68 | Good |
| **80042** | Total Phosphorus summer | 20172017 | 8012 | SWE-013 | 13 Östergötland inner coastal water | Western Gotland Basin | 0.51 | 0.69 | NA | 0.55 | 0.52 | Moderate |

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| **80042** | Total Phosphorus summer | 20182018 | 8013 | SWE-014 | 14 Östergötland outer coastal water | Western Gotland Basin | 0.42 | 0.74 | NA | 0.42 | 0.44 | Moderate |
| **80042** | Total Phosphorus summer | 20182018 | 8014 | SWE-015 | 15 Stockholm archipelago, outer coastal water | Northern Baltic Proper | 0.44 | 0.47 | NA | 0.69 | 0.63 | Good |
| **80042** | Total Phosphorus summer | 20182018 | 8015 | SWE-016 | 16 South Bothnian Sea,inner coastal water | Bothnian Sea | 0.36 | 0.82 | NA | 0.32 | 0.38 | Poor |
| **80042** | Total Phosphorus summer | 20182018 | 8016 | SWE-017 | 17 South Bothnian Sea, outer coastal water | Bothnian Sea | 0.35 | 0.40 | NA | 0.64 | 0.40 | Moderate |
| **80042** | Total Phosphorus summer | 20182018 | 8017 | SWE-018 | 18 North Bothnian Sea, Höga kusten, inner | Bothnian Sea | 0.35 | 0.49 | NA | 0.50 | 0.45 | Moderate |
| **80042** | Total Phosphorus summer | 20182018 | 8019 | SWE-020 | 20 North Quark inner coastal water | The Quark | 0.33 | 0.65 | NA | 0.35 | 0.43 | Moderate |
| **80042** | Total Phosphorus summer | 20182018 | 8020 | SWE-021 | 21 North Quark outer coastal water | The Quark | 0.33 | 0.29 | NA | 0.79 | 0.29 | Poor |
| **80042** | Total Phosphorus summer | 20182018 | 8023 | SWE-024 | 24 Stockholm inner archipelago | Northern Baltic Proper | 0.51 | 0.86 | NA | 0.44 | 0.51 | Moderate |
| **80042** | Total Phosphorus summer | 20182018 | 8024 | SWE-025 | 25 Göta and Nordre älv estuary | Kattegat | 0.56 | 0.61 | NA | 0.65 | 0.55 | Moderate |