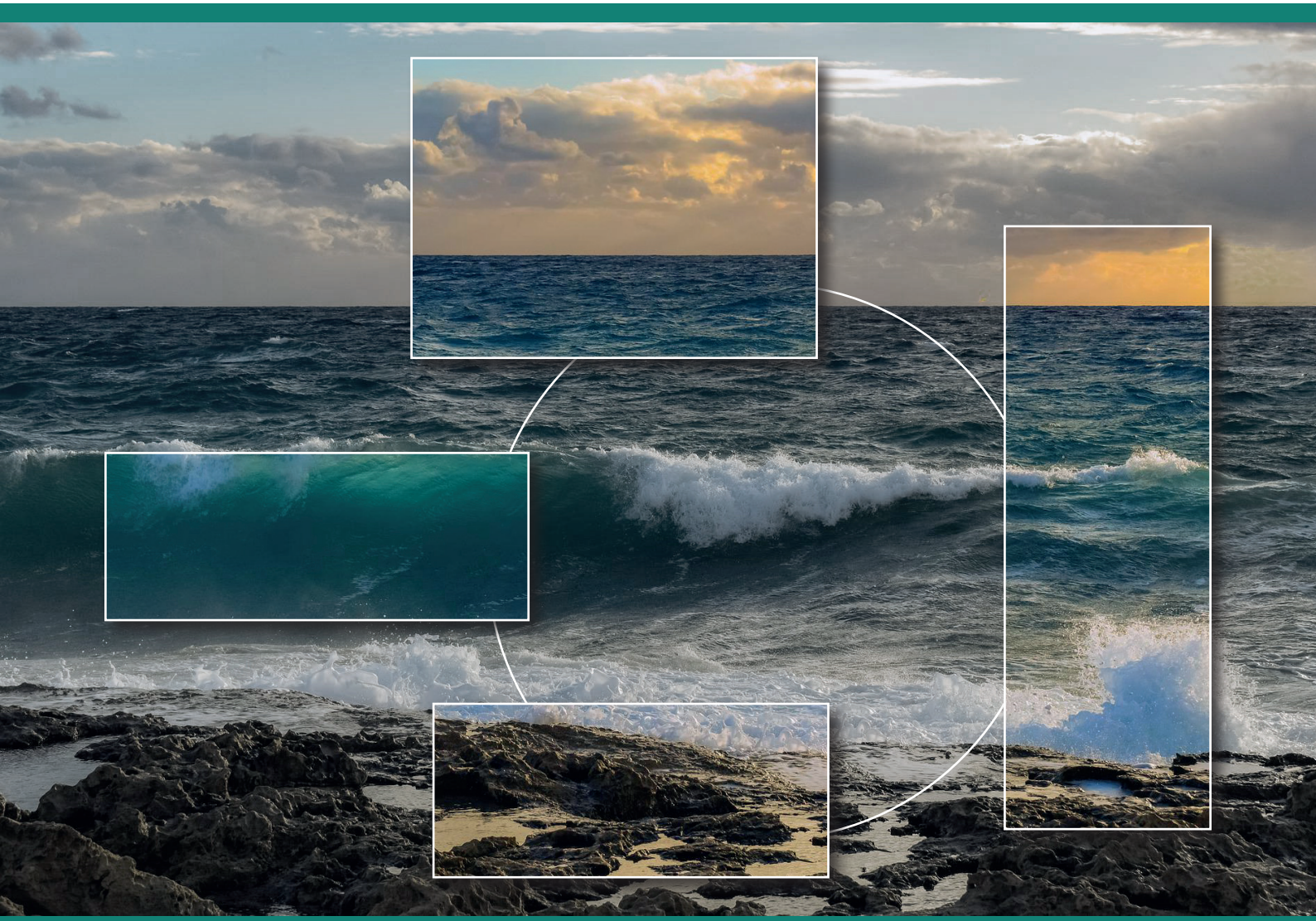
ETC/ICM Report 1/2022

Comparison of multi-metric indicator-based tools for assessment of the environmental status in Europe's seas



Authors:
Jesper H. Andersen, Kathrine J. Hammer, Ciarán Murray

ETC/ICM Consortium Partners:
Helmholtz Centre for Environmental Research (UFZ), Fundación AZTI, Czech Environmental Information Agency (CENIA), Stichting Deltares, Ecologic Institute, International Council for the Exploration of the Sea (ICES), Italian National Institute for Environmental Protection and Research (ISPRA), Joint Nature Conservation Committee Support Co (JNCC), Middle East Technical University (METU), Norsk Institutt for Vannforskning (NIVA), Finnish Environment Institute (SYKE), Thematic Center for Water Research, Studies and Projects development (TC Vode), Federal Environment Agency (UBA), University Duisburg-Essen (UDE)

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Author affiliation
Jesper H. Andersen, Kathrine J. Hammer, Ciarán Murray – NIVA Denmark

Reviewed by
Ángel Borja, ETC Science Manager

EEA Project manager
Johnny Reker – European Environment Agency, Denmark

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European Topic Centre on
Inland, Coastal and Marine Waters (ETC/ICM)
c/o Helmholtz Centre for Environmental Research – UFZ
Brückstraße 3a
39104 Magdeburg
Germany

Web: https://icm.eionet.europe.eu/

Contents

Authors and acknowledgements

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List of acronyms

EEA	European Environment Agency
BARCOM	Barcelona Commission
BEAT	HELCOM Biodiversity Assessment Tool
BSC	Black Sea Commission
CHASE	HELCOM Chemical Status Assessment Tool
D1	MSFD Descriptor 1: Biodiversity
D5	MSFD Descriptor 5: Eutrophication
D8	MSFD Descriptor 8: Contaminants
EU	European Union
GES	Good Environmental Status
HEAT	HELCOM Eutrophication Assessment Tool
HELCOM	Helsinki Commission
MESH	Marine Ecosystem Health Assessment Tool
MIBAT	Multi-metric indicator-based assessment tool
MSFD	Marine Strategy Framework Directive
NEAT	Nested Environmental status Assessment Tool
NPA	Non-Problem Area
OSPAR	Oslo Paris Commission
PA	Problem Area
uPBT	Ubiquitous, persistent, bio-accumulative and toxic substance
WFD	Water Framework Directive
WISE	Water Information System for Europe

1 Introduction

MIBATs are nested frameworks combining multiple indicators and their specific target values into an integrative assessment of environmental status.

The use of MIBATs for classification of ecological and/or environmental status in marine waters has grown over the past two decades (Andersen et al. 2016b, Borja et al. 2016).

A widely-used predecessor – or prototype – MIBAT is the OSPAR Common Procedure (OSPAR COMP, Claussen et al. 2009). The approach developed by OSPAR is a simple framework addressing indicators and whether target values have been met or exceeded in three categories (nutrient levels, direct effects and indirect effects). For more information about OSPAR COMP, its principles and applications, please confer with OSPAR (2003, 2009 and 2017a).

The Helsinki Commission, inspired by OSPAR COMP as well as the EU Water Framework Directive (WFD, 2000) developed, tested and applied the HELCOM Eutrophication Assessment Tool (HEAT). A first application of HEAT took place in 2009 (HELCOM 2009, Andersen et al. 2011). HEAT was subsequently restructured according to the initial requirements of the EU Marine Strategy Framework Directive (MSFD 2008, 2010). Follow-up assessments were carried out in 2012 (HELCOM 2013, Fleming-Lehtinen et al. 2015) and 2018 (HELCOM 2018). HEAT has also been used as an analytical tool focusing on long-term trends in eutrophication status in the open waters of the Baltic Sea region 1910–2010 (Andersen et al. 2017) and on past, present and future eutrophication status of the open parts of the Baltic Sea (Murray et al. 2019).

Over the past decade, HEAT has been widely used, firstly in the Baltic Sea region, but also in the North Sea and Black Sea regions. The acceptance has resulted in the development of a suite of tools anchored in the original version of HEAT but modified in ways allowing not only indicator-based assessments of 'eutrophication status', but also 'chemical status' (CHASE; see HELCOM 2010, Andersen et al. 2016a, Andersen et al. 2019b), 'biodiversity status' (BEAT; see HELCOM 2010, 2018, Nygaard et al. 2018, Vaughan et al. 2019) and 'ecosystem health' (HELCOM 2010, Reker et al. 2020). Further, there has been a development of more complex tools, i.e. NEAT and WATERS, allowing not only status assessment but also confidence assessments (Berg et al. 2016, Uusitalo et al. 2016, Borja et al. 2019, 2021).

In this study, we compare EU Member States' MSFD 2018 reporting on MSFD Art. 8, 9 and 10 with the recent EEA thematic assessments on eutrophication, biodiversity, contaminants and ecosystem health applying multi-metric indicator-based tools, i.e. new versions of HEAT, BEAT, CHASE and MESH. The aim of this comparison is to explain the observed differences between the assessments. Further, special focus has been put on the EEA tools and their strengths and weaknesses.

2 Methodology

We describe the study areas as well as the data sources, the latter including both EU Member States' assessments of Good Environmental Status under the MSFD (regarding D1, D5, D8 and cumulative impacts) and the EEA's thematic assessment reports on biodiversity, eutrophication and chemical status (equivalent to D1, D5 and D8) as well as 'ecosystem health' and cumulative impacts.

2.1 Study area

The European seas are divided into four marine regions: the Baltic Sea, the North-East Atlantic Ocean, the Mediterranean Sea and the Black Sea. Of the 27 Member States within the European Union, 23 have coastlines and marine territories.

The Baltic Sea is a brackish inland sea bordered by eight EU Member States and Russia. It consists of the Baltic Sea proper and three large gulfs (i.e. Gulf of Bothnia, Gulf of Finland and Gulf of Riga) and is connected to the North Sea through the Kattegat and the Danish Straits (Szymczycha et al. 2019). Losses of nutrients from agricultural catchments and direct discharges from industries and cites have led to a well-documented large-scale eutrophication problem along with impacts from other pressures, in particular fishing, and hazardous substances (Murray et al. 2019). Due to their status as inland sea with reduced water exchange with the North-Atlantic Ocean, the Baltic waters have a residence time of 25 years. The EU Member States with sea territory within the Baltic Sea have joined forces in the Helsinki Convention (HELCOM; www.helcom.fi) to work towards achieving a good ecological status in the Baltic Sea. For more information, please refer to HELCOM (2010, 2018) and Reusch et al. (2018).

Covering the European waters from the Barents Sea in the north, over the sea territories of Iceland, Ireland, Norway and the United Kingdom in the west to the Canary Islands in the South, the European part of the North-East Atlantic Ocean covers the largest part of the European marine waters. Nine EU Member States border the region along with Iceland, Norway and the United Kingdom. The North-East Atlantic Ocean, corresponds to the OSPAR Convention area (www.ospar.org), and consists of five sub-regions: Arctic water, the wider North Sea, the Celtic Sea, Bay of Biscay and Iberian Coast, and the wider Atlantic, which is directly connected to the rest of the Atlantic Sea. The North-East Atlantic Ocean provides multiple resources, including biological resources (fish and shellfish) and natural resources (oil, gas, minerals, etc.). The greatest human pressures and threats to the ecosystems are overfishing and pollution. Within OSPAR the bordering countries cooperate on the management of the health of the North-East Atlantic marine waters. For more information, please refer to OSPAR (2010, 2017a,b) and Reker et al. (2020).

To the south, Europe is separated from Africa by the Mediterranean Sea. The Mediterranean Sea is almost enclosed by the bordering eight EU Member States, North Africa and the Levant to the East. It is connected to the Black Sea via the Turkish Straits, to the Atlantic Ocean via the Strait of Gibraltar and to the Red Sea via the Suez Channel. The Mediterranean Sea contains a rich biodiversity and several endemic species. The Mediterranean Sea serves as one of the most exploited resources by fishing, which has led to high pressures on fish stocks (Coll et al. 2012). The countries surrounding the Mediterranean Sea cooperate within the Barcelona Convention (BARCOM; https://www.unenvironment.org/unepmap) and the UNEP/MAP BARCOM Secretariat to ensure sustainable exploration and a healthy environment within the region. For more information, please refer to UNEP/MAP & Plan Bleu (2020) and Reker et al. (2020).

The Black Sea is a large brackish, inland water body bordered to the west by two EU Member States, i.e. Bulgaria and Romania and by the Ukraine, Russia, Georgia and Turkey (Todorova et al. 2019). The Black Sea is connected to the Sea of Azov in the north and to the Mediterranean via the Marmara Sea, while many other countries drain into the Black Sea via large rivers (Todorova et al. 2019). Nutrient inputs have led to a large-scale eutrophication problem within the Black Sea (Yunev et al. 2017). Black Sea countries cooperate through the Commission on the Protection of the Black Sea Against Pollution (BSC; http://www.blacksea-commission.org). For more information, please refer to BSC (2019) and Reker et al. (2020).

2.2 Data sources

The work has been based on the information available from the recent application of HEAT ('Eutrophication in Europe's seas' by Andersen et al. 2019a), BEAT ('Biodiversity in Europe's seas' by Vaughan et al. 2019), CHASE ('Contaminants in Europe's seas' by Andersen et al. 2019b), 'Marine Messages II' (Reker et al. 2020) and 'Pressures and their combined effects in Europe's seas' (Korpinen et al. 2019) as well as the information and results reported by Member States under the second MSFD reporting round.

All three EEA tools are simple frameworks that can combine different categories/groups of indicators and their associated threshold values (assessment criteria) into integrative classification of the status, either in two overarching categories ('non-problem areas' consisting of the classes 'high' and 'good' vs 'problem areas' consisting of the classes 'moderate', 'poor' and 'bad'). It should be emphasized that no target values have been developed for EEA purposes - all threshold values used in the context of EEA assessments are official values derived from national or EU legislation or process.

Member States' reporting on environmental status for the descriptors D1 Biodiversity, D5 Eutrophication and D8 Contaminants during the second MSFD reporting round was accessed via WISE Marine (2020). This information was compared to the classifications in the EEA's thematic assessment reports for 'Biodiversity' (Vaughan et al. 2019), 'Eutrophication' (Andersen et al. 2019a), 'Contaminants' (Andersen et al. 2019b) and 'Ecosystem health' (Reker et al. 2020). Further, information in Members States' reporting in relation to 'Cumulative pressures' was compared to the EEA's mapping of 'Combined effects' (Korpinen et al. 2019).

2.3 Comparison approach

A key difference between EU Member States' MSFD reporting and the EEA assessments is the definitions of assessments units. This relates to the fact that we are dealing with separate processes: One being Member States' official MSFD reporting (using marine reporting units; MRUs), the second being the EEA's work on producing coordinated and harmonized pan-European assessment reports of the state of Europe's seas (using the official EEA grid covering land and sea).

The MSFD marine reporting units (MRUs) are of varying size and follows the sub-regional approach in the MSFD and the sub-divisions used by the Regional Seas Conventions, the EEA assessment grid is 100 x 100 km offshore and in coastal water, a subdivision of 20 x 20 km. Accordingly, the scales are not directly comparable. To compare the results, the status 'GES achieved' in the MSFD reporting was compared to the two better categories of the EEA assessment scale 'High' and 'Good' environmental status, collectively termed as non-problem areas (NPAs). The MSFD statuses 'GES expected to be achieved by 2020' and 'GES expected to be achieved later than 2020' were collectively compared to the EEA assessment scales 'moderate', 'poor' and 'bad', collectively termed as problem areas (PAs). An intersect analysis in GIS was performed to categorize the EEA grid cells within each MRU. Then the EEA status result of each MRU was calculated as an area-weighted mean and extrapolated to the entire MRU. Thus, the comparison of a MIBAT result with the reported status for an MRU is based on the overlap of the MRU with a spatial assessment unit from CHASE, HEAT or BEAT. In some cases, only a small fraction of the MRU is matched with MIBAT results. In these cases, this result is considered representative for the entire MRU and the area of the whole MRU still counts towards the overall results showing the percentage of area in agreement or disagreement.

The comparison regarding 'Biodiversity', comparing the D1 report in the MSFD context with the BEAT classifications in the EEA context, was made by using the BEAT categories 'Birds', 'Fish', 'Mammals' and 'Pelagic habitats' and comparing them with the same categories within the MSFD. Benthic habitats and communities are considered under Descriptor 6 on 'seafloor integrity' in the MSFD. The MSFD categories 'Cephalopods' and 'Reptiles' were not included in the comparison as these data were not part of the BEAT analysis. The MSFD reporting further divides the biodiversity categories into the following sub-categories (in parenthesis): Birds (Benthic-feeding birds, Grazing birds, Pelagic-feeding birds, Surface-feeding birds, Wading Birds), Mammals (Small toothed cetaceans, Baleen Whales, Deep diving toothed cetaceans, Seals), Fish (Coastal fish, Demersal shelf fish, Commercially exploited fish and shellfish, Deep-sea fish, Pelagic shelf fish) and Pelagic habitats (Pe-

lagic broad habitats, Other pelagic habitats). This results in multiple statuses for each MRU under every category while BEAT gives one integrated status for each category. To compare the results of the two methods, the percentage of MSFD subgroups agreeing with the BEAT status was calculated for each MRU.

The comparison regarding 'Eutrophication', comparing D5 reporting in the MSFD context with HEAT classifications in the EEA context, was made directly using the GES status reported by Member States (MSFD) and HEAT-based assessment results as one integrated status was given for each MRU.

The comparison regarding 'Contaminants', in the MSFD context D8 and in the EEA context CHASE, is split into three parts, comparing contaminants in sediment, biota and water, for uPBT substances and non-uPBT substances, respectively, and for biological effects of contaminants.

Member States report on contaminants within biota, sediments and water combined in two categories: uPBT substances and non-uPBT substances. uPBT substances is a smaller group of priority hazardous substances identified in the Priority Substances Directive as uPBT (ubiquitous[1], persistent, bio accumulative and toxic). The uPBTs are mercury, brominated diphenyl ethers (pBDE), tributyltin and certain polyaromatic hydrocarbons (PAHs). Furthermore, Member States report on adverse effects on species or habitats.

The thematic EEA report on contaminants analyses the status of contaminants in four categories: seawater, sediments, biota and biological effects using the CHASE tool, which calculate an integrated value (see EEA 2019 and Andersen et al. 2019b). The two MSFD categories 'Contaminants – uPBT substances' and 'Contaminants – non-uPBT substances' were thus, both compared to an integrated/ combined CHASE analysis on contaminants within 'water', 'sediments' and 'biota'.

Adverse biological effects were compared directly between the CHASE category 'Biological effects' and the MSFD categories 'Adverse effects on Benthic broad habitats, Marine species, Pelagic shelf fish, Surface-feeding birds'. Additionally, Member States report on acute pollution events which were not included in the current analysis as this data is not part of the CHASE analysis.

The MRUs used by Member States to report environmental status varied depending on which descriptor was assessed. On several occasions, we found overlapping MRUs both within the EEZ of individual Member States but also between Member State sea territories. For example, a Member State could report an overall status for its entire marine area, as well as for smaller MRUs which are part of the larger area. In addition, the status of these overlapping areas did not always agree. In cases of disagreement between MRUs within the same Member State territories, the status of the smaller MRU was used in the overlapping areas. We also found cases where Member States reported beyond their own territories. In these cases, only the area within the state's own EEZ was considered. Some overlaps were due to inconsistencies in the polygons demarcating the MRUs. In cases where the overlap did not exceed 1 % of the area of either of the overlapping MRUs, the overlaps were ignored, even though, strictly speaking, this meant that the overlapping areas were double counted. In several cases, Member States had overlapping MRUs with other Member States. In these cases, where it was not clear to which Member State the territory belongs, the overlapping area was counted for both Member States and thus double counted when calculating areas. See Supplementary material for more information on these areas.

The EEA classification of 'ecosystem health' is equivalent to an overall GES assessment involving multiple descriptors. This was compared with Member States' approaches to arrive at an integrative and overarching assessment of GES. Finally, we compared Member States MSFD reporting of 'Cumulative pressures', with the EEA's take on mapping of combined effects of multiple human pressures in Europe's seas.

Of 23 EU Member States with sea territories, 20 had finalised their reporting, while Bulgaria and Greece had not yet finalised their MSFD 2018 reporting at the time of this current analysis (cf. WISE Marine). We were not able to find information on Latvia's methods, even though they have assessed their territorial waters and finalised their MSFD reporting. The Latvian marine status of D1, D5 and D8 is included in the comparison analysis.

[1]Present, appearing or found everywhere

3 Results and discussion

3.1 MIBAT's used in MSFD Initial Assessments

In total, five MIBATs were identified within the MSFD initial assessments reported by Member States. These include (1) OSPAR Common Procedure (OSPAR COMP), used within the North-east Atlantic Ocean marine region to assess D5 Eutrophication (2) HEAT, used within the Baltic Sea marine region to assess D5 Eutrophication, (3) BEAST, a variation of HEAT for the Black Sea, used by countries within the Black Sea marine region to assess D5 Eutrophication, (4) CHASE, used within the Baltic Sea marine region to assess D8 Contaminants and (5) BEAT, used to assess D1 Biodiversity within the Baltic Sea marine region.

The most frequently used MIBAT was OSPAR COMP, which was used by seven out of nine Member States within OSPAR. In addition, Spain also used OSPAR COMP within their Mediterranean waters. This MIBAT was the first developed and is thus used widely. The second most used MIBAT was HEAT which was used by five countries of eight within the Baltic Sea marine region. BEAST was used by Romania within the Black Sea marine region. CHASE was used by four out of eight Member States in the Baltic Sea marine region and the least used MIBAT was BEAT, used by only three Member States within the Baltic Sea marine region. The use of MIBATs by EU Member States thus varied markedly among the four regional sea conventions (Figure 1). Among the four marine regions, Member States within the Baltic Sea marine region used tools most frequently when looking across the three descriptors. Also, Member States within the North-East Atlantic Ocean marine region used tools frequently, while Member States within the Mediterranean Sea region alone did not use any tools. Nevertheless, Spain, which has territory in both the Mediterranean Sea and North-East Atlantic Ocean used OSPAR COMP to evaluate eutrophication in both regions. In addition, we also found great variation in the frequency of MIBAT use among the three descriptors D1, D5 and D8 (Figure 1). It was clear, that most Member States used tools to assess D5 Eutrophication, while only a few used tools to assess biodiversity.

There appear to be (at least) three driving factors that determines the use of MIBATs among EU Member States: (1) The age of the individual tool (determines how commonly the tool is used – HEAT was one of the first used , which was followed by CHASE and BEAT), (2) the history and specific assessment strategy/ process within each regional convention and (3) the applicability of the tool within the present reporting structure under the MSFD.

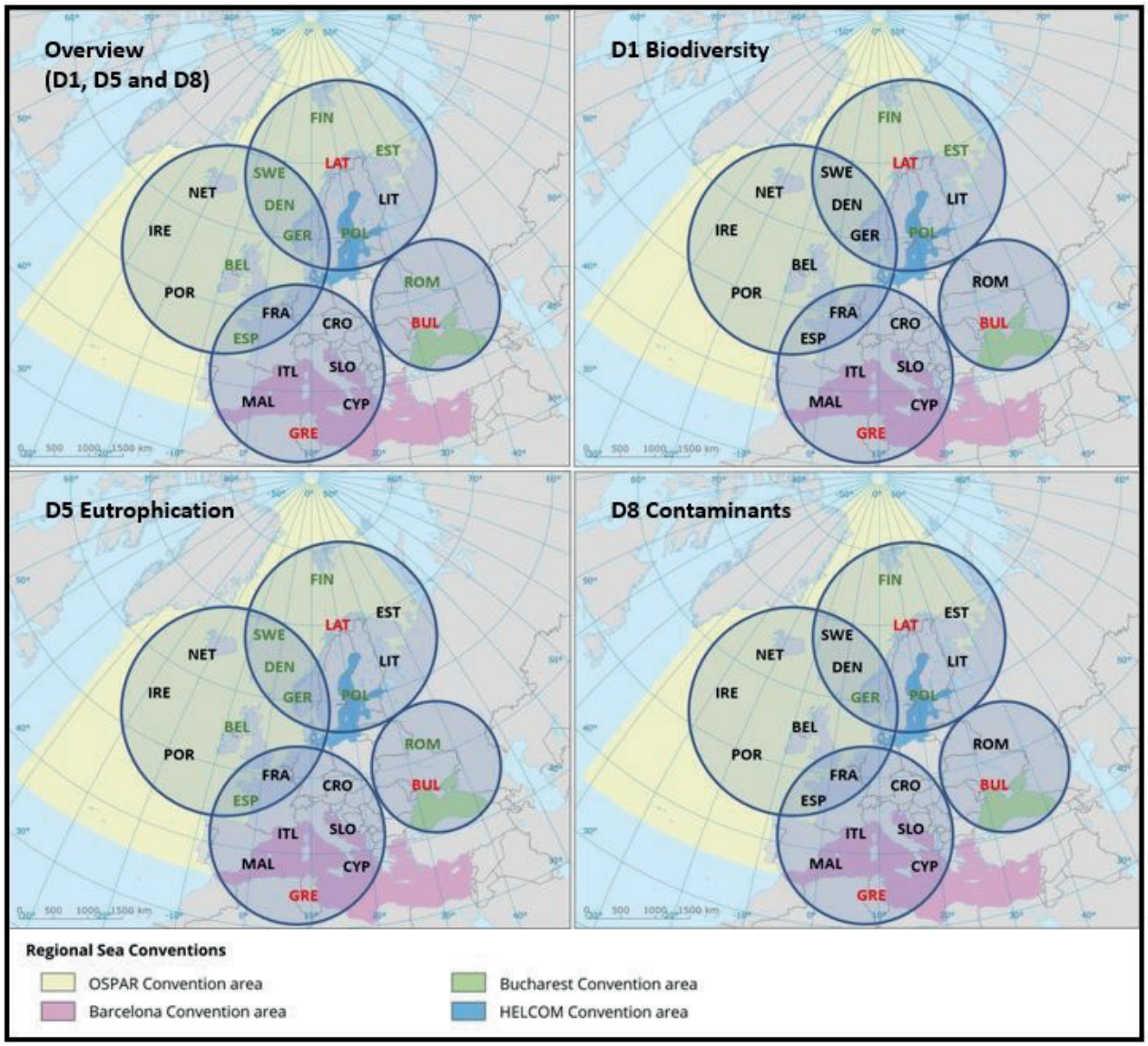
In the following, the above aspects will be discussed with special focus on tools used to evaluate the three descriptors D1 Biodiversity, D5 Eutrophication and D8 Contaminants.

3.1.1 D1 – Biodiversity

Multiple methods were used by Member States to assess status for D1 (see Annex 1). The EEA biodiversity tool BEAT was the only tool used for D1 and this was used by only three countries to assess biodiversity in marine waters, i.e. Estonia, Finland and Poland. These countries are all part of the Baltic Sea marine region and contracting parties to the HELCOM convention. Nevertheless, BEAT was only used partly for integration on a parameter level and thus not to a full integration of criteria as intended. Finland referred to the HELCOM analysis which uses BEAT to integrate the two bird indicators: 'core indicators for breeding bird species' and 'wintering bird species'. Estonia used BEAT as a part of a BEAT based national application for birds as well, without going into detail with the application. Poland used BEAT for integrating parameters when assessing pelagic broad habitats.

The BEAT tool was developed for the HELCOM countries and, as we see, it might be expected that the limited application of this tool is restricted to the HELCOM contracting parties, where the development of the tool originated from.

Figure 1: The use of assessment tools to evaluate environmental status of Descriptor 1 (biodiversity), 5 (eutrophication) and 8 (contaminants) by the EU Member States within the four marine regions, i.e. the North-East Atlantic Ocean (OSPAR), the Baltic Sea (HELCOM), the Mediterranean Sea (Barcelona Convention) and the Black Sea (Bucharest Convention). Green colour indicates use of tools at any extent* while black colour indicates no use of assessment tools. Member States with no available data are marked red. *Different methods were used to assess different criteria within the three descriptors by the same Member States. In addition, it varied if tools were used to integrate criteria or parameters depending on the descriptor. See appendix and supplied spreadsheet for details on when tools were used by Member States.



Another reason for the limited application of BEAT in general and for a full integrated assessment for D1 Biodiversity might be that the Member States are required to report an individual environmental status for various sub-groups under the main GES components (i.e. Birds, Cephalopods, Fish, Mammals, Pelagic habitats and Reptiles). This detailed reporting requirement does not encourage the use of a MIBAT, even though it would be a good supplement to the detailed status report.

3.1.2 D5 – Eutrophication

Nine Member States of a total of 22 used tools for the evaluation of Descriptor 5, Eutrophication. The OSPAR Common Procedure was used by Belgium, Denmark, Germany, Spain, Sweden and France, while HEAT was used by Finland, Poland, Denmark, Germany and Sweden. In addition, BEAST, a special version of HEAT for use in the Black Sea, was used by Romania.

Member States having water territories within two marine regions often used different tools when determining status for MRUs in different regions if regional procedures prescribed different approaches. This was the case for Sweden, Denmark and Germany who used HEAT in areas within the Baltic Sea and OSPAR COMP in their North-East Atlantic waters. Spain used OSPAR COMP in both their Atlantic and Mediterranean areas. They were the only Member States within the Mediterranean Sea using tools, thus implying a 'spreading' of tool usage from one marine sea region to another.

Descriptor 5 Eutrophication was clearly the descriptor most countries used tools to evaluate. Both OSPAR COMP and HEAT have existed for some time and are widely applied within their respective regions, the North-East Atlantic Ocean and the Baltic Sea. The key difference between these two regions is the access to data, where HELCOM has a well-functioning data-sharing strategy. Unlike D1, the reporting structure for D5 under the MSFD, only requires a single status for each MRU, which gives obvious rise to the use of MIBATs.

3.1.3 D8 – Contaminants

In total, three EU Member States used tools to evaluate Descriptor 8 Contaminants. CHASE was used by Finland, Germany and Poland within the Baltic Sea region. Thus, no Member States within the North-East Atlantic Ocean, Mediterranean and Black Sea marine regions used tools for their assessments of contaminants.

CHASE was the second MIBAT applied by the EEA and was also found to be the second-most used tool together with BEAT among the three tools HEAT, BEAT and CHASE when reviewing the methods used by the EU Member States. In addition, the frequency of the use of CHASE appears to coincide with the details required for Member State reporting within the D8. The reporting structure of D8 Contaminants requires Member States to report on (1) Acute pollution events, (2) Adverse effects on habitats and species (with further sub-categorizing into marine species, birds and fish) and (3) Contaminants (divided into two categories: uPBT substances and non-uPBT substances). Like Descriptor 1, this detailed reporting requirement does not encourage an integrated assessment. In addition, the primary criteria used to assess D8 are concentrations of contaminants and acute pollution events, and therefore, an integration on criteria level was not relevant. In the cases where CHASE was applied by Member States, it was used to integrate parameters within the contaminant categories (i.e. uPBT substances and non-uPBT substances).

3.1.4 Good Environmental Status (GES)

We were not able to find information on an overarching GES assessment by Member States integrating all MSFD descriptors. It is not likely to have been done because such an integrative approach is not required by the MSFD. Neither are integrated results available on the WISE marine web page, where data is instead presented as status of individual descriptors. In addition, no Member States used HEAT, CHASE and BEAT to evaluate D5, D8 and D1 respectively into an integrated assessment result for each descriptor, and consequently no Member States have had a basis for carrying out an overall assessment across multiple descriptors. Also, since MIBATs for the remaining descriptors are not yet developed, the prerequisites for a full overall ecosystem health assessment from an MSFD perspective are not yet fulfilled.

3.1.5 Cumulative impacts (CEA/CIA)

Information on the assessments of cumulative pressures by Member States and Regional Seas Conventions is scattered. Focusing on regional seas, it is evident that HELCOM is a forerunner and have carried out this specific type of assessment twice (HELCOM 2010, 2018) using EcoImpactMapper. Other regional sea conventions are not yet as advanced and comprehensive efforts to map potential cumulative effects of multiple human activities and pressures have not been made. Some Member States also involved in HELCOM, have reported cumulative impacts in their national waters based on HELCOM (2018). Denmark and Sweden, both involved in HELCOM and OSPAR assessments, have carried out detailed national mapping efforts and should be regarded as forerunners. The same is in the case of the EEA, which via the assessment of combined effects of human activities in Europe's seas (Korpinen et al. 2019), have for the first time ever

mapped and validated potential combined effects on a pan-European scale. Thus, the EEA has provided a proof of concept, which could inspire others, firstly Regional Sea Conventions not yet mapping cumulative pressures, as well as Member States still considering which method to use.

3.2 Comparison of Member State's GES assessments vs. EEA's MIBAT-based classification results

We found clear overall agreement between environmental status when comparing status reported during the second MSFD reporting period with the results from the EEA thematic assessments for D5 Eutrophication (using HEAT), D8 Contaminants (using CHASE) and D1 biodiversity (using BEAT).

In the following we will make a detailed comparison between the Member States' reported statuses for D5, D8 and D1 vs. HEAT, CHASE and BEAT respectively. In addition, we will focus on areas with divergent results and discuss the differences in methods. In this analysis, references to 'HEAT', 'BEAT' and 'CHASE' imply the EEA application of the tool in question, rather than the potential use of the same tool (or another version of the same tool) to arrive at Member States' own status.

3.2.1 D5 – HEAT

The comparison between the Member States' reported status for D5 Eutrophication and the EEA HEAT analysis showed agreement to a great extent (Figure 2). Looking only at areas with a status convertible to either 'GES' or 'not GES' (thus excluding the status 'unknown', 'not relevant' and 'not assessed' within the MSFD) 1,524,700 km^2 out of a total reported 2,143,900 km^2 had a status agreeing with the HEAT assessment statuses 'non-problem areas' and 'problem areas' respectively (Table 1). This corresponds to 71 %. When focusing on the four marine sea regions, the Baltic Sea, North-East Atlantic Ocean and the Black Sea had a > 99 % agreement. Within the Mediterranean Sea only 28 % of the reported area had an agreeing status.

Table 1 Areas with agreement and discrepancies between the Member State reported status for D5 Eutrophication and the status from the EEA thematic assessment using the HEAT tool within the four marine sea regions

Region	Reported area (1000 km^2)	Agreement (1000 km^2)	Discrepancy (1000 km^2)
Baltic Sea	369.4 (17.2 %)	366.4 (99.2 %)	3.0 (0.8 %)
North-East Atlantic Ocean	912.6 (42.6 %)	905.5 (99.1 %)	8.1 (0.9 %)
Mediterranean Sea	839.3 (39.1 %)	231.2 (27.5 %)	608.1 (72.5 %)
Black Sea	22.5 (1.1 %)	22.5 (100 %)	0 (0 %)
Total	2143.9 (100 %)	1524.7 (71.1 %)	619.2 (28.9 %)

Concentrating on the areas with a discrepancy between the two methods, the disagreements were found within MRUs of only three Member States, i.e. Italy, Sweden and Spain (Table 2). Most discrepancies resulted from HEAT determining the MRU as an NPA while the Member States reported 'Not GES' (Table 2).

Within the Mediterranean Sea, both Spain and Italy[2] had areas with diverging status cf. Figure 2. In the Baltic Sea, Sweden[3] had areas where the MSFD status differed from HEAT status.

The simple reporting structure of Descriptor 5 Eutrophication with only one status per MRU made the comparison with HEAT results simple. This may explain why we found great similarities between the results of the two methods. Overall, the discrepancies found between MSFD and HEAT are explicable.

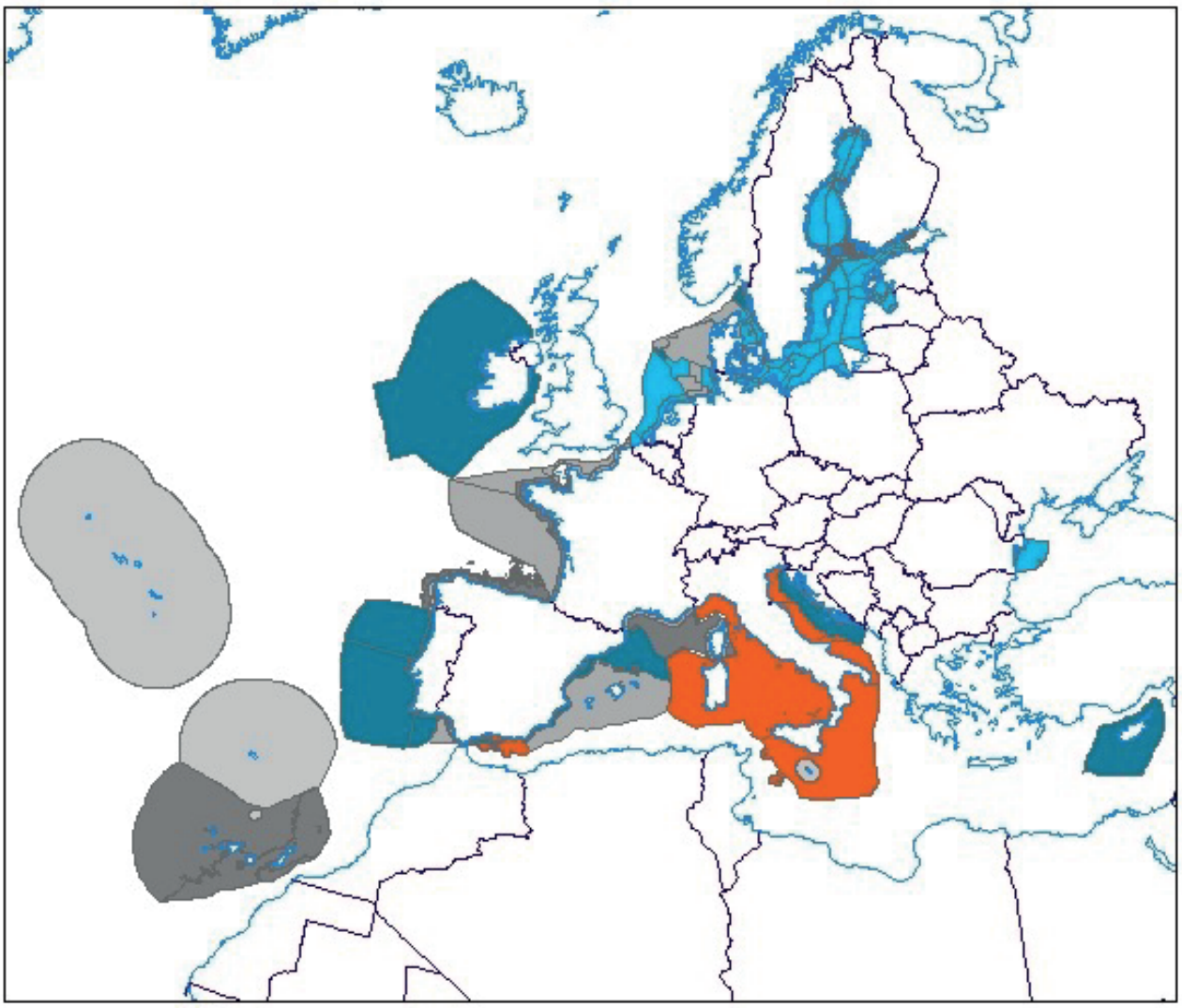
Table 2 Areas with disagreement between EU Member States and HEAT assessment

Country	HEAT status	MSFD status	% of reported area	Use of tool
Italy	NPA	Not GES	100 %	No
Sweden	NPA	Not GES	2.8 %	OSPAR COMP/HEAT
	PA	GES	1.2 %	HEAT
Spain	NPA	Not GES	24.8 %	OSPAR COMP

[2]100 % of the reported status for the Italian area was 'Not GES' which diverged from the HEAT status 'NPA'. This is a large area of 587,152 km^2 which constitutes 70 % of the reported area within the Mediterranean Sea region and is thus the main reason for a lack of agreement within this region. The diverging result may be due to the fact the national data was not available when the HEAT analysis was performed, and data from EMODnet was used instead for the EEA thematic assessment of eutrophication in Italian waters. Differences between the two data sets may have caused the difference in eutrophication status between the two methods. In addition, the officially reported Italian status was 'GES expected by 2020' for two out of five MRUs, which is the status closest to GES within the 'not GES' categories in this present analysis. The remaining three MRUs had the status 'GES expected to be achieved later than 2020'. Nevertheless, all areas are regarded as 'Not GES' within this present analysis as only the status 'GES achieved' is regarded as GES. It should be noted that there appears to be inconsistency between the official reported status for the Italian MRUs, on which this present analysis is based, and the written Italian report. Italy has used five MRUs in the D5 reporting and uses national policies rather than tools to evaluate environmental status. To achieve GES, according to Italian policies, two out of three primary criteria must be in good status. This is achieved in four out of five areas cf. the written status report from Italy where they report that status is good. In the last MRU, only one of three primary criteria is rated as 'in good status' while one is rated as 'not good' and the last is not assessed due to a missing threshold which is under development. Consequently, this MRU does not achieve good status. The official status is 'GES expected by 2020' for two out of five areas while the status for the remaining three was 'GES expected to be achieved later than 2020'. Please see details in the supplied spreadsheet under D5 Eutrophication.

[3]This was seen in both of their areas within the North-East Atlantic Ocean and the Baltic Sea. All diverging areas were smaller coastal areas and, in total, accounted for only 4 % of the reported Swedish area. Since Sweden used the HELCOM Eutrophication Assessment Manual, 2015 to evaluate water status within HELCOM, we did not expect any discrepancies within the Baltic Sea area. All the concerned areas had weighted HEAT scores placing them in the classes of "Moderate" and "Good", i.e. those closest to the "NPA" / "PA" boundary used within this study. Therefore, small discrepancies due to differences in spatial resolution between the EEA assessment grid and the Swedish MRUs could potentially affect the classifications.

Figure 2: Comparison between environmental status for Descriptor 5 Eutrophication reported by EU Member States under MSFD and by the EEA thematic assessment using the tool HEAT. Blue colours indicate agreement between results (dark blue = agreement on 'GES' and 'NPA' respectively, light blue = agreement on 'not GES' and 'PA'), orange colours indicate disagreement (dark orange = EEA assessment determines 'NPA' and Member States determines 'not GES', light orange = EEA assessment determines 'PA' and Member States determines 'GES') and grey colours indicate missing status from either EEA assessment (light grey), Member States (intermediate grey) or both (dark grey).



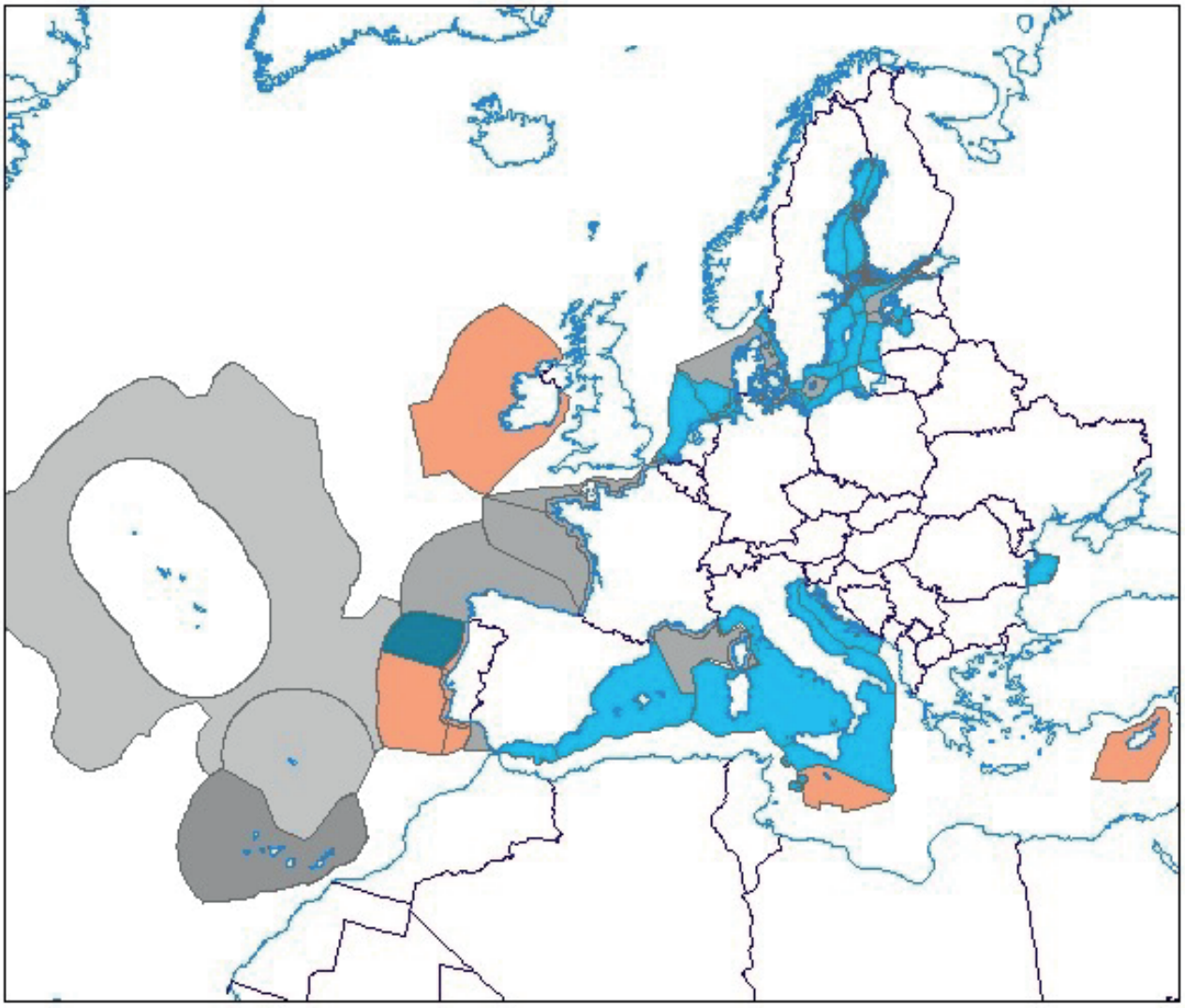
D8 – CHASE

The comparison between Member States status for D8 Contaminants (uPBT substances) and the EEA CHASE (water, sediment and biota categories) analysis showed an agreeing status in 1,457,100 km^2 out of a total reported 2,340,200 km^2, corresponding to 62 % of the reported area (Figure 3, Table 3). The comparison between CHASE and non-uPBT substances showed similar overall results and this analysis is therefore only mentioned when relevant (See supplementary for more information on this analysis).

Within the marine regions, the Baltic and Black Sea regions had > 99 % of the reported areas with an agreement between the two methods. The Mediterranean Sea had 84 % and the North-East Atlantic Ocean only 24 % of the reported area with an agreement between the MSFD and the CHASE assessment result.

In contrast with the analysis for HEAT, most areas with discrepancies within the CHASE/D8 comparison analysis achieved GES when analysed by Member States while the CHASE analysis found these areas as problem areas (PAs) (Table 4).

Figure 3: Comparison between environmental status for Descriptor 8 Contaminants reported by EU Member States under MSFD (uPBT substances*) and by the EEA thematic assessment using the tool CHASE (water, biota and sediment categories). Blue colours indicate agreement between results (dark blue = agreement on 'GES' and 'NPA' respectively, light blue = agreement on 'not GES' and 'PA'), orange colours indicate disagreement (dark orange= EEA assessment determines 'NPA' and Member States determines 'not GES', light orange= EEA assessment determines 'PA' and Member States determines 'GES') and grey colours indicate missing status from either EEA assessment (light grey), Member States (intermediate grey) or both (dark grey).



*uPBT substances – A smaller group of priority hazardous substances were identified in the Priority Substances Directive as uPBT (ubiquitous (present, appearing or found everywhere), persistent, bio-accumulative and toxic). The uPBTs are mercury, brominated diphenyl ethers (pBDE), tributyltin and certain polyaromatic hydrocarbons (PAHs).

Looking closer at these areas, the large discrepancy within the North-East Atlantic Ocean marine region is mainly caused by divergence of 100 % within the Irish area (Ireland has only one MRU). This is a relatively large area of 488,763 km^2. Ireland does not appear to monitor contaminants in sediment on a regular basis, which is why this data is not included in the CHASE analysis (Andersen et al 2019b). This is likely the main reason for the resulting status divergence within this area.

Within the Mediterranean Sea region, Cyprus reports that their result is based on metals in sediments, biota and water, while the EEA reported CHASE result for Cyprus only include data for contaminants in water. Poland agreed with the EEA CHASE result in 91.4 % of their reported area, while smaller coastal areas did not show an agreement (not visible in Figure 3). This is the only country using the CHASE tool that has areas with different a status from the EEA CHASE analysis. The reasons for the differences are unclear. Both

Slovenia and Estonia had discrepancies with CHASE on non-uPBT substances, where Slovenia and Estonia reported 'GES' and the CHASE analysis reported 'PA'. Nevertheless, the status of uPBT substances was 'not GES' for both Member States within the areas of discrepancies, and an overall contaminants status would therefore be 'not GES' if status for uPBT and non-uPBT substances were combined. Thus, the discrepancies for Slovenia and Estonia are not considered actual discrepancies between the status of CHASE and MSFD reporting. Malta and Portugal show disagreements in status with CHASE but do not report any methods or details for their analysis. In addition, Malta reported contaminants status for a large MRU overlapping with the Italian waters. It should be noted, that very limited CHASE data were available within the Portuguese offshore waters, thus the CHASE status of this large area – in contrast to the coastal waters where data were made available – is unsure.

Comparing the CHASE category 'Biological effects' and the MSDF categories 'Contaminants - Adverse effects on marine species, Surface-feeding birds and pelagic shelf fish', a total of nine Member States reported a status convertible to either GES or 'not GES'. Of the reported MRUs only Ireland and the Netherlands had overlapping results with the CHASE analysis. For Ireland, the MSFD and CHASE status agreed determining 'GES' and 'NPA' respectively within the Irish MRU, while for the Netherlands, CHASE determined NPA and the Netherlands reported 'not GES'. The Netherlands used the marine reporting unit 'The Southern North Sea' as the assessment area, so only the Dutch EEZ was considered within this analysis. Thus, underlying data may vary and is probably the reason for this discrepancy. In addition, it is unclear if the Dutch assessment result is based on another overall assessment for the North Sea.

Overall, we found great similarities between Member States' reported status and the status derived by the EEA thematic assessment of contaminants using the CHASE tool. However, the discrepancies between the two assessments were explicable.

Table 3 Reported areas with agreement and discrepancies between the Member State reported status for D8 Contaminants (category uPBT substances*) and the EEA thematic assessment using the CHASE tool (water, biota, and sediments categories)

uPBT substances	Area (1000 km^2)	Agreement (1000 km^2)	Discrepancy (1000 km^2)
Baltic Sea	313.6 (13.4 %)	311.3 (99.2 %)	2.4 (0.8 %)
North-East Atlantic Ocean	931.1 (39.8 %)	223.8 (24.0 %)	707.3(76.0 %)
Mediterranean Sea	1072.9 (45.8 %)	899.4 (83.8 %)	173.5 (16.2 %)
Black Sea	22.5 (1.0 %)	22.5 (100.0 %)	0 (0.0 %)
Total	2340.2 (100.0 %)	1457.1 (62.3 %)	883.2 (37.7 %)

*uPBT substances – A smaller group of priority hazardous substances were identified in the Priority Substances Directive as uPBT (ubiquitous, persistent, bio-accumulative and toxic). The uPBTs are mercury, brominated diphenyl ethers (pBDE), tributyltin and certain polyaromatic hydrocarbons (PAHs).

Table 4 Areas with discrepancies between Member States status reporting for D8 Contaminants (categories uPBT* and non-uPBT substances) and the EEA thematic Table 4 Areas with discrepancies between Member States status reporting for D8 Contaminants (categories uPBT* and non-uPBT substances) and the EEA thematic assessment for contaminants using the CHASE tool (categories: water, biota and sediment). Percentages are given as % of the Member State reported area with discrepancy

Country	EEA CHASE status	MSFD status		Discrepancy (% of area)		Use of tool
		UPBT subs.	Non-UPBT subs.	UPBT subs.	Non-UPBT subs.	
Cyprus	PA	GES	GES	100	100	No
Estonia	PA	Not GES	GES	0	15.2	No
Ireland	PA	GES	GES	100	100	No
Poland	PA	GES	GES	2.3	6.8	CHASE
Slovenia	PA	Not GES	GES	0	100	No
Sweden	PA	GES	GES	1.0	4.4	No
Portugal	PA	GES	GES	100	69.3	No
Malta	PA	GES	GES	100	100	No

*uPBT substances – A smaller group of priority hazardous substances were identified in the Priority Substances Directive as uPBT (ubiquitous, persistent, bio-accumulative and toxic). The uPBTs are mercury, brominated diphenyl ethers (pBDE), tributyltin and certain polyaromatic hydrocarbons (PAHs).

D1 – BEAT

Thirteen Member States reported a status convertible to either GES or not GES for Descriptor 1 Biodiversity. The comparison showed an overall agreement of 56 % for birds, 67 % for fish, 62 % for mammals and 56 % for pelagic habitats of the total reported area when comparing the percentage of agreeing sub-groups under the four categories with BEAT results within each MRU.

Birds: A total of nine countries reported a status convertible to either GES or not GES for bird status within their MRUs. These countries were all part of either the Baltic Sea or North-East Atlantic Ocean marine regions. The overall analysis showed that 56 % of the area for the reported MRUs for bird status had 100 % sub-groups, i.e. benthic feeding birds, grazing birds, pelagic-feeding birds, surface-feeding birds and wading birds with environmental status agreeing with the EEA BEAT status (Figure 4, Table 5). In many cases, an MRU had different statuses among sub-groups, resulting in a varying degree of agreement between Member State status and BEAT status.

Only two MRUs did not have any agreement, i.e. Netherlands EEZ and Lithuanian coastal waters (too small to be visible on Figure 4). The Netherlands reported the status 'not GES' while the BEAT analysis indicated NPA within the Dutch EEZ. Nevertheless, the reporting units used by the Netherlands to assess bird status was 'The Greater North Sea' and 'The Southern North Sea'. This current analysis was therefore carried out within the Dutch EEZ and it remains unclear if the Netherlands were referring to a wider spatial analysis. Nonetheless, there are likely differences in the underlying datasets that causes the observed differences within the reported environmental status of the Netherlands and BEAT.

Within all areas with discrepancies between the BEAT analysis and Member State reporting, the BEAT analysis reported NPA while Member States reported 'not GES'. This systematic divergence implies a general difference in methods. For the HELCOM members, it can be explained by the fact that BEAT uses averages when aggregating species indicators while HELCOM uses the 'one-out-all-out' principle on species indicators.

Figure 4 Comparison between environmental status (GES = good environmental status) for D1 Biodiversity – Birds reported by EU Member States under MSFD and the EEA BEAT analysis. Colours indicate percentage of sub-groups (i.e. benthic feeding birds, grazing birds, pelagic-feeding birds, surface-feeding birds and wading birds) agreeing with the BEAT status within each MRU.

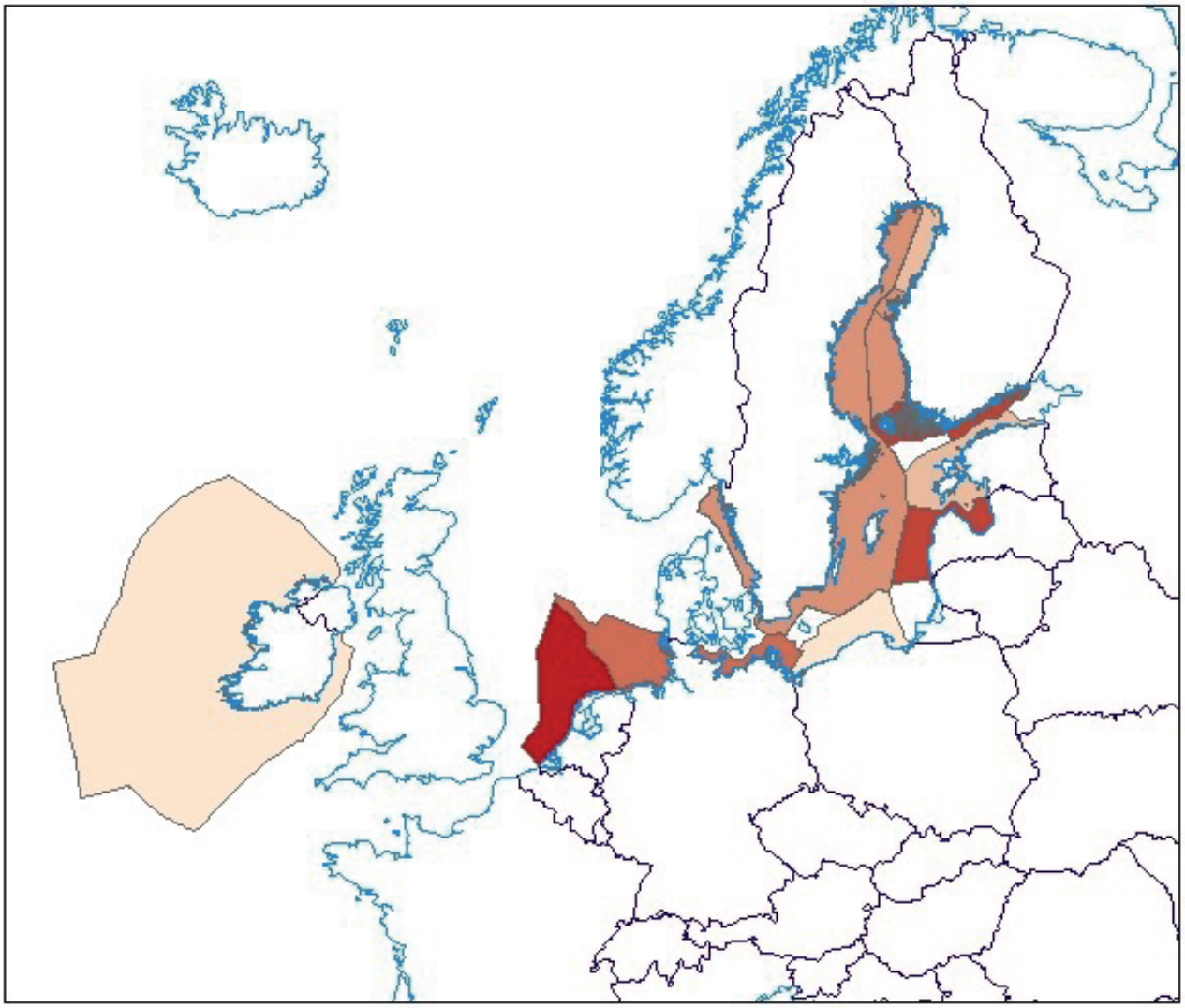


Table 5 Areas with agreement between the Member State reported status for D1 Biodiversity – Birds and the EEA thematic assessment using the BEAT tool indicating percentage of sub-groups (i.e. benthic feeding birds, grazing birds, pelagic-feeding birds, surface-feeding birds and wading birds) agreeing with the BEAT status within each MRU. Percentages in parenthesis indicate % of the total reported area within each marine region.

Region	Total reported area	Area of total reported area within marine regions with % sub-groups agreeing with the EEA BEAT status (1000 km²)					
	(1000 km²)	0 %	20 %	40 %	60 %	80 %	100 %
Baltic Sea	328.7 (35.3 %)	0.4 (0.1 %)	53.2 (16.2 %)	15.5 (4.7 %)	173.8 (52.9 %)	52.4 (15.9 %)	33.4 (10.2 %)
North-East Atlantic Ocean	602.3 (64.7 %)	58.9 (9.8 %)	0 (0 %)	40.5 (6.7 %)	14.2 (2.4 %)	0 (0 %)	488.8 (81.2 %)
Total	931.0 (100 %)	95.2 (6.4 %)	53.2 (5.7 %)	56.0 (6.0 %)	188.0 (20.2 %)	52.4 (5.6 %)	522.2 (56.1 %)

Fish: A total of 11 countries reported a status convertible to either 'GES' or 'not GES' for their MRUs. A 66.8 % of the total area had 100 % sub-groups i.e. coastal fish, demersal shelf fish, pelagic shelf fish and deep-sea fish agreeing with the EEA BEAT status, while 31.6 % of the total area did not show any agreement (Figure 5, Table 6). The highest degree of agreement was found within the Mediterranean Sea, where 100 % of the area showed agreement, and the Baltic Sea with 89 % agreement. The small discrepancy within the Baltic Sea region is due to the Lithuanian coastal area (not visible in Figure 5) with 0 % agreement and the Latvian marine waters where only 33 % of the sub-groups agreed with the BEAT status.

Within the North-East Atlantic Ocean marine region only 39 % of the reported area agreed with BEAT. The main reason for this disagreement was found within three areas: the Swedish part of the North Sea and the Irish and Dutch territorial waters. The Netherlands' status is 'not GES' while BEAT is NPA. The Dutch reporting unit was the Southern North Sea. Thus, this present analysis was performed only within the Dutch EEZ. The Netherlands reports: 'Condition improves, but good environmental condition not yet achieved' and does not report any further details on methods or their assessment. It is therefore difficult to know the exact reason for the diverging result. Ireland's status for fish is 'not GES' while BEAT shows NPA. Ireland reports that 'collective expert judgement was used to determine criteria integration', which is likely the main reason for the diverging result. The result in the Swedish part of the North Sea is 'not GES' while BEAT status is NPA. This is likely explained by the Swedish use of national legislation-based indicator thresholds within their assessment of fish status. Overall, we found great amount of agreement between status reported on the environmental condition of fish between Member State reports and the BEAT tool. However, the few discrepancies were explicable.

Figure 5: Comparison between environmental status (GES = good environmental status) for D1 Biodiversity – Fish reported by EU Member States under MSFD and the EEA BEAT analysis. Colours indicate percentage of sub-groups (i.e. coastal fish, demersal shelf fish, pelagic shelf fish and deep-sea fish) agreeing with the BEAT status within each MRU.

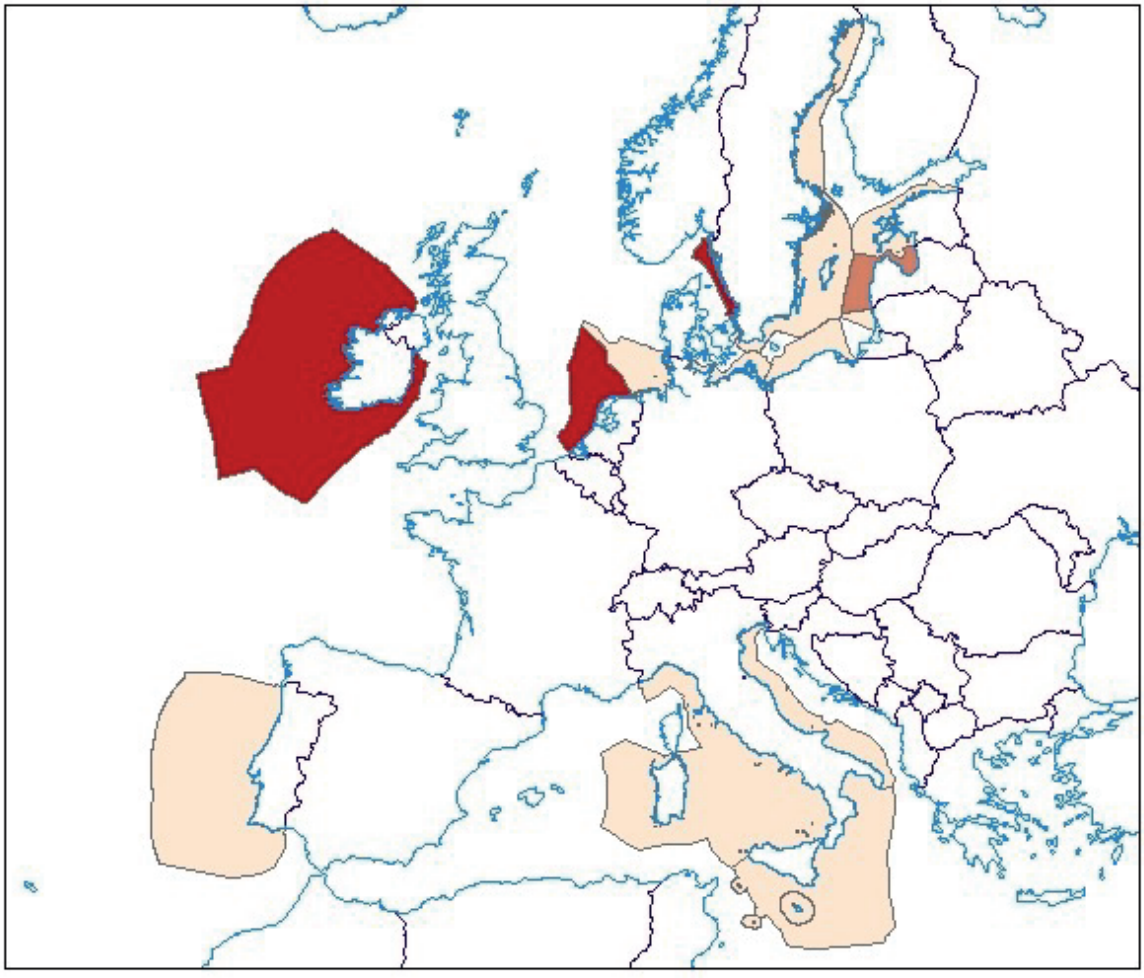


Table 6 Areas with agreement between the Member State reported status for D1 Biodiversity – Fish and the EEA thematic report using the BEAT tool indicating percentage of sub-groups (i.e. coastal fish, demersal shelf fish, pelagic shelf fish and deep-sea fish) agreeing with the BEAT status within each MRU. Percentages in parenthesis indicate percentage of the total reported area within each marine region.

Region	Total reported area	Area of total reported area within marine regions with % sub-groups agreeing with EEA BEAT status (1000 km²)		
	(1000 km²)	0 %	33 %	100 %
Baltic Sea	263.5 (14.8 %)	0.4 (0.1 %)	28.3 (10.8 %)	234.7 (89.1 %)
North-East Atlantic Ocean	917.5 (51.6 %)	561.8 (61.2 %)	0 (0 %)	355.7 (38.8 %)
Mediterranean Sea	598.6 (33.6 %)	0 (0 %)	0 (0 %)	598.6 (100 %)
Total	1779.6 (100 %)	562.2 (31.6 %)	28.3 (1.6 %)	178.0 (66.8 %)

Mammals: A total of nine countries reported a status convertible to either 'GES' or 'not GES' for their MRUs. The overall analysis showed that within the reported 30 MRUs, 62 % of the reported area had all (100 %) sub-groups for mammals, i.e. baleen whales, deep-diving toothed cetaceans, seals and small-toothed cetaceans with a status agreeing with the status of BEAT (Figure 6, Table 7). Eighteen MRUs showed a 100 % agreement between the two assessments while eight showed no agreement. The areas with 100 % disagreement were found within the Swedish and Finnish parts of the Bothnian Bay and the Dutch and Latvian marine waters. All disagreements between Member States and BEAT resulted from BEAT giving a status of NPA for marine mammals while Member States assessments showed that they were not in GES.

Within the Baltic Sea marine region 60 % of the reported area had 100 % agreeing status when comparing Member State status with BEAT status, while 40 % did not have any agreement. Within the Baltic Sea in general, Finland, Sweden and Latvia all reported 100 % not GES for marine mammals within all their areas. The areas with discrepancies, were all areas where BEAT status was NPA. This indicates a general difference between methods of the HELCOM assessment manual and BEAT and can be explained by the fact that HELCOM employed the 'one-out-all-out' principle on species indicators while BEAT uses the mean.

Within the North-East Atlantic Ocean marine region 48 % of the reported area showed a 100 % agreement between the Member States' status and BEAT status. The remaining areas varied in the degree of agreement from 0 to 67 % of the sub-groups status agreeing with BEAT status. The only MRU with no agreeing sub-groups was within the Dutch EEZ. As for birds and fish, the Dutch reporting unit was The Southern North Sea, thus this present analysis was performed only within the Dutch EEZ. The Netherlands report: 'Condition improves, but good environmental condition not yet achieved' and do not report any further details on methods or their assessment. For the remaining areas with 33–67 % of sub-groups agreeing with BEAT, different reasons, not discussed here, may have caused the divergence such as differences in the underlying data sets or methods.

Figure 6: Comparison between environmental status (GES = good environmental status) for D1 Biodiversity – Mammals reported by EU Member States under MSFD and the EEA BEAT analysis. Colours indicate percentage of sub-groups (i.e. baleen whales, deep-diving toothed cetaceans, seals and small-toothed cetaceans) agreeing with the BEAT status within each MRU.

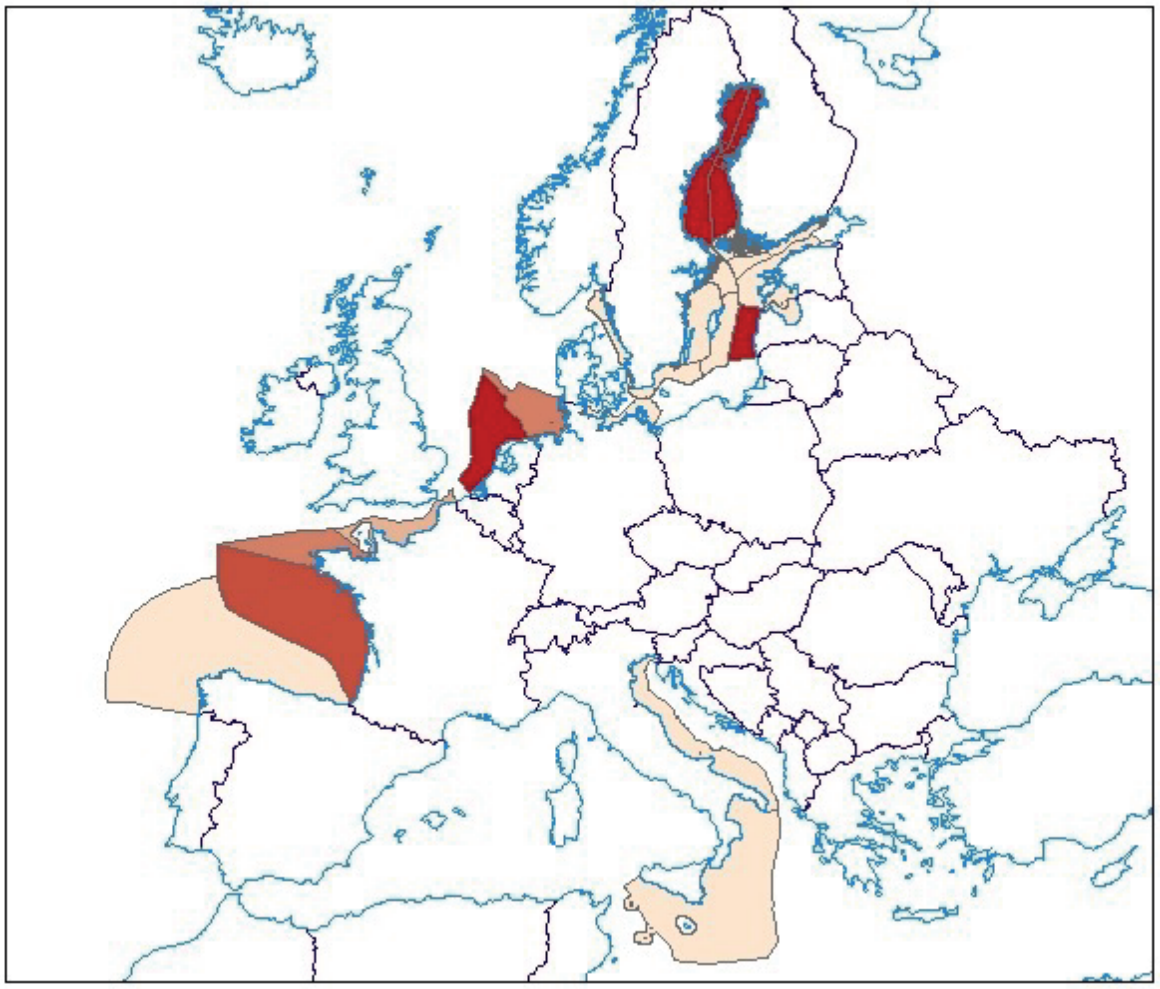


Table 7 Areas showing agreement between the Member State reported status for D1 Biodiversity – Mammals and the EEA thematic assessment using the BEAT tool indicating percentage of sub-groups (i.e. baleen whales, deep-diving toothed cetaceans, seals and small-toothed cetaceans) agreeing with the BEAT status within each MRU. Percentages in parenthesis indicate % of the total reported area within each marine region.

Region	Total reported area	Area of total reported area within marine regions with % sub-groups agreeing with the EEA BEAT status (1000 km²)				
	(1000 km²)	0 %	33 %	50 %	67 %	100 %
Baltic Sea	303.4 (24.0 %)	120.4 (39.7 %)	0 (0 %)	0 (0 %)	0 (0 %)	183.0 (60.3 %)
North-East Atlantic Ocean	686.6 (54.2 %)	58.9 (8.6 %)	188.2 (27.4 %)	84.3 (12.3 %)	28.3 (4.1)	327.0 (47.6 %)
Mediterra-nean Sea	276.6 (21.8 %)	0 (0 %)	0 (0 %)	0 (0 %)	0 (0 %)	276.6 (100 %)
Total	1266.6 (100 %)	179.3 (14.2 %)	188.2 (14.9 %)	84.3 (6.7 %)	28.3 (2.2 %)	786.6 (62.1 %)

Pelagic habitats: The overall analysis showed that 56 % of the area reported by Member States for pelagic habitats had an agreeing status with BEAT (Table 8, Figure 7). Five Member States had divergence in status, i.e. Croatia, Denmark, Finland, Germany and Poland, and divergence was thus found within both the Baltic Sea, the North-East Atlantic Ocean and the Mediterranean Sea marine regions. Because 'Pelagic broad habitats' was the only reported sub-group under the D1 Biodiversity - 'Pelagic habitats' all MRUs had either a 0 or 100 % agreement between Member State and BEAT status.

Within the reported areas of the Baltic Sea, BEAT status was 'PA', and thus in agreement within 73 % of the area where Member States also reported the pelagic habitats were not in good status. The remaining 27 % of the area was within the northern part of Finish Bothnian Bay and within Polish waters, in both cases the countries reported that GES was achieved. The divergence is likely explained by differences within the underlying data or threshold values used, since BEAT average status within these MRUs was moderate (class 3) which was the status closest to NPA of the three PA statuses defined within BEAT and this present study. Nevertheless, Poland uses BEAT to evaluate pelagic habitats and the causes of observed differences for Poland are not obvious.

In contrast to the Baltic Sea, the divergence within the North-East Atlantic Ocean was caused by BEAT giving the status NPA while Denmark and Germany evaluated these areas to have 'not GES'. Denmark describes the overall trend for phytoplankton from 1978 to 2016 and bases their status of 'not GES' on a slight increase in phytoplankton from 2012. In addition, they report that thresholds have not yet been set for pelagic habitats that are not exploited commercially. Therefore, there are obvious differences in the methods used by Denmark and the BEAT assessment such as the use of trend by Denmark and the use of a tool such as BEAT. Within the German EEZ, the BEAT status for pelagic habitats follows a gradient with bad status close to land and good status offshore. The same is found for the German status reporting. One area in the middle of the gradient deviated in status between the two assessments probably because of a different reporting unit size used between the two methods. For this area Germany determined 'not GES' while BEAT determined 'NPA'.

Within the Mediterranean Sea region, the only Member State with overlapping results with the BEAT analysis was Croatia. While BEAT indicated that the Croatian MRU was a PA with respect to pelagic habitats, Croatia itself reported GES. Croatia did not report methods in detail, so the diverging status is likely due to differences in underlying data since the BEAT assessment had limited data for the Croatian waters.

Figure 7: Comparison between environmental status (GES = good environmental status) for D1 Biodiversity – Pelagic habitats reported by EU Member States under MSFD and the EEA BEAT analysis. Colours indicate percentage of status agreeing with the BEAT status within each MRU. Since the category 'Pelagic habitats' did not have any reported status for other sub-groups, the result is directly comparable with BEAT and thus result in either 0 or 100 % agreement.

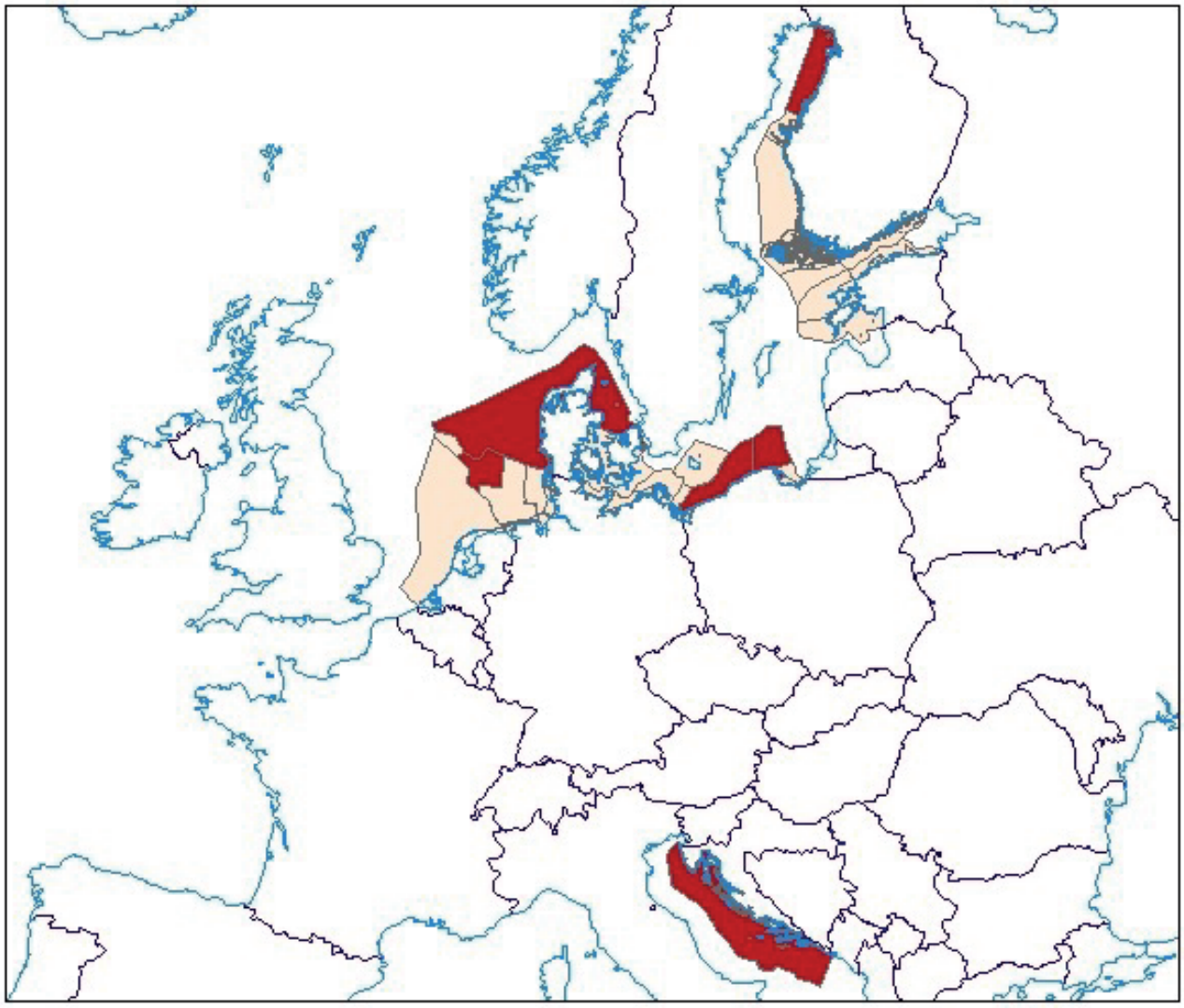


Table 8 Areas with agreement between the Member State reported status for D1 Biodiversity – Pelagic habitats and the EEA thematic assessment using the BEAT tool indicating percentage status agreeing with the BEAT status within each MRU. Percentages in parenthesis indicate % of the total reported area within each marine region. Since the category 'Pelagic habitats' did not have any reported status for other sub-groups, the result is directly comparable with BEAT and thus result in either 0 or 100 % agreement.

Region	Total reported area	Area of total reported area within marine regions agreeing with the EEA BEAT status (1000 km²)	
	(1000 km²)	0 %	100 %
Baltic Sea	166.9 (39.1 %)	44.9 (26.9 %)	122.0 (73.1 %)
North-East Atlantic Ocean	204.6 (47.9 %)	86.0 (42.0 %)	118.6 (58.0 %)
Mediterranean Sea	55.5 (13.0 %)	55.5 (100 %)	0 (0 %)
Total	427.0 (100 %)	186.4 (43.6 %)	240.6 (56.4 %)

4 Conclusions and recommendations

We report the results and conclusions from a European-wide comparison of multi-metric indicator-based assessment tools (MIBATs) used by EU Member States in their second MSFD reporting of MSFD art. 8 and by the EEA in their assessment of the state of Europe's seas.

Anchored in this comparison, we conclude that MIBATs are applied in all four marine regions of Europe, i.e. the Baltic Sea, the Black Sea, the Mediterranean Sea and the North-East Atlantic Ocean, and by the EEA. With respect to the application of MIBATs in the MSFD reporting, we conclude that:

- HEAT, originally developed by HELCOM more than a decade ago, and its derivative (BEAST), is widely used, primarily in the Baltic Sea but also in the Black Sea and parts of the Greater North Sea region. In total six Member States and one regional convention use HEAT/BEAST.
- BEAT, originally developed by HELCOM and in its current version based on NEAT, is used by three Member States and one regional convention. Other D1 related MIBATs are not used.
- CHASE, originally developed by HELCOM, is only used in the Baltic Sea region and by the EEA. In the Baltic Sea, three Member States as well as HELCOM have used this tool. Despite a simple one-out all-out principle amongst Priority Substances, other D8 related tools are not used.
- OSPAR COMP was used by seven countries within the North-East Atlantic Ocean and by one regional convention.

Comparing the environmental status obtained by using EEA tools (identification of 'non-problem areas' vs. 'problem areas') with the status from other tools and methods, we find a lot of common ground, both with respect to assessment principles and results:

For D5 Eutrophication, the degree of agreement between Member States second MSFD reporting and the EEA application of the HEAT tool is 71.1 % of the total reported area, with 100 % in the Black Sea region, 99.2 % in the Baltic Sea region and 99.1 % in the North-East Atlantic Ocean region, but only 27.5 % in the Mediterranean Sea region. The poor result for the Mediterranean Sea is a result of missing access to existing monitoring data and an inadequate process for the development of assessment criteria.

For D8 Contaminants – uPBT substances only, the degree of agreement between Member States' 2nd MSFD reporting and the EEA application of the CHASE tool is 62.3 % of the total reported area, with 100 % in the Black Sea marine region, 99.2 % in the Baltic Sea marine region and 83.8 % in the Mediterranean Sea region, but only 24.0 % in the North-East Atlantic Ocean region. The discrepancies in the Baltic Sea, Black Sea and Mediterranean Sea are mostly related to the use of different assessment units, while the discrepancy in the North-East Atlantic Ocean marine region is related to different assessment principles.

Regarding D1 Biodiversity, the picture is less clear and mostly related to the differences in the structure of the BEAT tool and the complexity in relation to the D1 criteria in COM DEC 2017.

We conclude that the most widely used MIBATs are those with a simple structure, e.g. HEAT and partly the currently used version of BEAT, which is a simplified version of the NEAT tool. When comparing the use of these tools with the methods used within the MSFD reporting based on requirements of the 2017 COM DEC, we tentatively conclude that the simpler and more transparent a MIBAT is, the more widely it is used.

We also conclude that access to good synoptic indicator data sets, including both monitoring data and target values, is an obvious prerequisite for carrying out large-scale assessments of environmental status. In addition, access to a relevant and well-documented MIBAT is also a prerequisite for performing these assessments.

It appears that the existing reporting structure under the MSFD (being anchored in the 2017 COM DEC) with parameters and criteria may not support the development and use of simple MIBATs for two reasons.

Firstly, the data set required by Member States for reporting is immense and requires a wide array of monitoring activities to be carried out. Secondly, the so-called primary criteria do not always agree with the structure of the available tools, e.g. HEAT, BEAT and CHASE.

Integrative assessment of GES across all relevant MSFD descriptors is not carried out routinely, but indirectly as done by the EEA assessment of 'Ecosystem health'. The reason for this is twofold: 1) The MSFD does not require such an assessment, and 2) the tools developed and available (e.g. MESH and NEAT) are not widely accepted. Similarly, assessments and mapping of cumulative pressures, sometimes referred to as 'cumulative impacts' or 'combined effects' are done routinely only by HELCOM (in 2010 and 2019) and by very few Member States. However, the EEA has recently published the first ever pan-European attempt to assess the potential combined effects of multiple human pressures in Europe's seas.

In the future, a more widespread use of MIBATs would likely eliminate some of the discrepancies found within this study and ensure greater alignment amongst Member States. A process where Member States sustain the monitoring activities, support the continued development of assessment criteria and make use of MIBATs will probably lead to a situation where Member States, regional seas conventions and the EEA could co-develop tools and make use of each other's experience in heading towards a mutual benefit.

In order to achieve this, several key challenges need to be addressed:

- The definition of assessment units and their influence of the results of the assessment would have to be examined and understood. Secondly, the integration principles vary and may need to be re-examined and better understood – for example, the 'one out, all out'-principle may be too stringent, but if not applied, we may risk disregarding the Precautionary Principle. Accordingly, we suggest the following next steps following up on this study.
- We suggest updating existing EEA tools and making them available for future EEA assessment cf. the planned work in the ETC/ICM Environmental trend task as well as Regional Seas Conventions and EU Member States.
- We suggest initiating a convergence process where the EEA not only develop, test and apply new versions of HEAT, BEAT, CHASE and MESH in upcoming EEA assessments but also coordinate and harmonise this work with a similar process in relation to the MSFD CIS process and the ongoing work in regional sea conventions.

All in all, this study confirms a high degree of agreement between the multi-metric indicator-based assessment tool applied by the EEA on the one hand and, on the other hand, the assessments of GES by Member States under the MSFD. With the planned updates of the EEA assessment tools (HEAT, BEAT, CHASE and MESH), the EEA now has a capacity to produce pan-European assessments and analyses with a higher pace than the formal and regular reporting obligations under the MSFD.

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Annex 1: Methods and tools used for assessing D1 Biodiversity

Methods used by Member States to assess D1 Biodiversity. Special emphasis has been on identifying the use of integration tools and thus, not all methods are described and included in the table. The written statuses/method descriptions have been evaluated using Google Translate in some cases and thus some minor unclarities may occur. Please refer to the supplied spreadsheet for original and full Member State reports.

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
BEL	OSPAR	Not relevant	-	Not relevant	-	
BUL	Bucharest					
CRO	Barcelona	-	-	-	-	
CYP	Barcelona	Not relevant	Habitat directive reporting		Habitat directive reporting	Only information on seals and turtles
DEN	OSPAR	Other/not relevant/ OOAO	No integration – different comments/ reasons	Not relevant	No integration – different comments/ reasons	OSPAR assessment is mentioned
	HELCOM	Other/not relevant/ OOAO	No integration – different comments/ reasons	Not relevant	No integration – different comments/ reasons	HELCOM assessment is mentioned

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
ESP	OSPAR	Not relevant/OOAO/ Hierarchical/-	See comment	Not relevant/-		Different methods were used depending on the sort of biodiversity parameter and water unit. For some water units no integration was carried out, and others e.g. following ICES recommendations or using OOAO directly. NOTE: differences between marine waters are not noted here. For details go to main spreadsheet
	Barcelona	Not relevant/OOAO/ Hierarchical/-	See comment	Not relevant/-		Same as above
EST	HELCOM	Not relevant/OOAO		Threshold methods/ not relevant/ non-hierarchical/ OOAO	HELCOM BEAT used in some cases	
FIN	HELCOM	OOAO (with few exceptions)	Interim rule applied (with few exceptions)	OOAO/ multi-metric indices	HELCOM BEAT/ 75 % abundance trends/interim rule	
FRA	OSPAR	OOAO/other/not relevant/-	OOAO (See comment)/ other (see main spreadsheet)	Not relevant/other/-	Different comments but no tool used (see main spreadsheet)	Integration between the criteria and species levels is carried out based on the OOAO. If only one criterion was evaluated, it was used directly as state for the species
	Barcelona	Not relevant/other/-	OOAO (See comment)/ other (see main spreadsheet)		Different comments but no tool used (see main spreadsheet)	Integration between the criteria and species levels is carried out based on the OOAO. If only one criterion was evaluated, it was used directly as state for the species

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
GER	HELCOM	Not relevant/OOAO/ Other			Different integration methods on parameter level have been used	For single coastal water units: No integrated assessment is carried out at this aggregation level of the combined coastal water bodies, since the MSFD assessment of the German Baltic Sea waters a) is carried out on the basis of the WFD assessment of the individual water bodies (water body-specific, HELCOM Level 4) and b) aggregated across all coastal waters (see BALDE_CW). BALDE_CW: For the overall assessment of the German Baltic Sea coastal waters of the 1 nautical mile zone, the overall assessments of the individual coastal water bodies were aggregated.
	OSPAR	Non-hierarchical/ other/-/OOAO			Different integration methods on parameter level have been used	Same as above
GRE	Barcelona					
IRE	OSPAR	Other	Collective expert judgment was used to determine criteria integration			
ITA	Barcelona	Not relevant/-/OOAO	'Under development' for some groups	Not relevant/-		
LAT	HELCOM					

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
LIT	HELCOM			For fish: Two Parameters were used to assess the state of the marine environment according to the D1C4 criterion: 1) Fish Community Diversity Index (Shanon Index), 2) Fish Community Trophic Index. The environmental status of the marine area was good according to the indicator "Fish Community Diversity Index (Shanon Index)" and did not achieve good according to the indicator "Fish Community Trophic Index". After the application of the OOAO rule, the general environmental condition of the Lithuanian sea area (BAL-LT-AA-01) according to the D1C4 criterion is not good.		For birds in coastal areas: When assessing the status of functional groups of seabird species, the proportion (%) of species in the group that were assessed as good was determined. A group of functional seabird species shall be considered to be in good condition if at least 75 % of the individual species assessed for that species have been assessed as good. At the level of two functional groups of birds (pelagic and benthic), GAB was not achieved (40 % of pelagic species and 0 % of benthic species in functional groups were GAB). According to the OOAO rule, the general environmental condition of the Lithuanian sea area according to the D1 descriptor for birds is not good. Fish: Fish indicators were used to assess the state of the marine environment according to the D1 descriptor: 1) Abundance of key species in the Baltic Sea coastal fish communities (plaice abundance) (criterion D1C2); 2) Fish Community Diversity Index (Shanon Index) (D1C4); 3) Fish Community Trophic Index (D1C4). The abundance of the key species of the Baltic Sea coastal fish communities (plaice abundance) and the Fish Community Diversity Index (Shanon index) – reached the GAB values, the Fish Community trophic index – did not reach the GAB value. After applying the OOAO rule, the general state of the environment of the Lithuanian Sea Region (BAL-LT-AA-01) according to the D1C4 criterion – does not reach good, according to the D1 descriptor for fish – does not reach good.

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
MAL	Barcelona					For biodiv. parameters: The integration method used for the criteria was the following: If 2/3 criteria assessed were 'good', the overall status of the species was determined to be 'good'; if two criteria were assessed and one was determined to be 'good' and the other as 'not good', the overall status of the species was determined to be as 'not assessed'; if 2/3 criteria assessed were 'not good', the overall status of the species was determined to be 'not good'. In accordance with the 'Guidance for Assessments Under Article 8 of the Marine Strategy Framework Directive' integration at species level shall be agreed at Union level taking into account regional or sub-regional specificities; however, since the majority of the species were found to be in 'not good' status, on the basis of expert judgement, GES for both fish and cephalopods is expected to be achieved later than 2020. For others: The Habitats Directive (Council Directive 92/43/EEC)
NET	OSPAR	Other	No integration	Other	No integration	
POL	HELCOM	Not relevant/OOAO/-		Not relevant/-/ hierarchical/OOAO	BEAT used for pelagic habitats (interpreted from written report – see comment)	Different methods were used depending on the sort of biodiversity parameter and water unit. For pelagic broad habitats: Achieved values of indices: HELCOM-Dia/Dino, HELCOM-CyaBI and HELCOM-Chl_a were normalized according to the method applied in the HELCOM second holistic assessment of the Baltic Sea (http://stateofthebalticsea.helcom.fi/). The weighted averaging was applied to normalized values with the following weight coefficients: 0.4 (HELCOM-Dia/Dino), 0.4 (HELCOM-Chl_a) and 0.2 (HELCOM-CyaBI) providing BQRs. The resulting BQRs (biological quality ratios) were compared with the threshold value of 0.6 indicating good environmental status.

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
POR	OSPAR	Only one criterion was assessed/-/other		See comment		Only status for fish and cephalopods Written information on remaining categories. See main spreadsheet for more information. Mammals reach unknown status: The integration of the assessments of the different criteria for determining the condition of the element followed the methodology proposed by the Habitats Directive, ensuring agreement between the results of the two Directives. The global assessment of the conservation status of the species, under that Directive, when "favourable", requires that none of the criteria is in the "unfavourable" state and only one criterion is "unknown" For fish: The BEA was integrated at the level of the species group only in cases where the number of species evaluated was equal to or greater than 3. For the calculation of the proportion, only the species with evaluation were considered.
ROM	Bucharest	-	-	-	-	
SLO	Barcelona	-	-	Threshold methods	Use of a combination of limit values, where available, and expert judgment	Only pelagic habitats are assessed
SWE	HELCOM	Not relevant/OOAO/-		Not relevant/OOAO/-		In some groups no integration has taken place (pelagic habitats) while others (mammals) have used Habitats Directive (92/43/EEC)
	OSPAR	Not relevant/OOAO/-		Not relevant/OOAO/-		In some groups no integration has taken place (pelagic habitats) while others (mammals) have used Habitats Directive (92/43/EEC)

Annex 2: Methods and tools used for assessing D5 Eutrophication

Methods used by Member States to assess D5 Eutrophication. Special emphasis has been on identifying the use of integration tools and thus, not all methods are described and included in the table. The written statuses/method descriptions have been evaluated using Google Translate in some cases and thus some minor unclarities may occur. Please refer to the supplied spreadsheet for original and full Member State reports.

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
BEL	OSPAR	Other	OSPAR comp. (coastal waters: OOAO WFD)	OOAO		Parameter – based on whole BPNS
BUL	Bucharest					
CRO	Barcelona	-	-	-	-	All marine units achieve GES
CYP	Barcelona	Not relevant	-	-	-	Only one marine unit (thus no distinction between coastal and offshore waters) – GES is achieved
DEN	OSPAR	Not relevant	No integration rule has been applied // OSPAR assessment	-	-	For coastal waters: WFD Denmark refers to the OSPAR assessment
	HELCOM	Other	Each assessment unit shows the result for the criteria group furthest away from good status // HELCOM assessment	-	-	Description implies that OOAO is used at criteria level For coastal waters: WFD Denmark refers to the HELCOM assessment
ESP	OSPAR	Other	OSPAR comm.	Threshold methods		For coastal waters: Unclear if WFD methods were used at both criteria and parameter level. Reporting also implies use of OSPAR comm.
	Barcelona	Other	OSPAR comm.	Threshold methods		For coastal waters: Unclear if WFD methods were used at both criteria and parameter level. Reporting also implies use of OSPAR comm.

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
EST	HELCOM	OOAO	-	Non-hierarchical	-	
FIN	HELCOM	Multi-metric	HELCOM HEAT	Multi-metric	HELCOM HEAT	Not all indicators were available in all waters
FRA	OSPAR	Hierarchical (OOAO – see description)	National scoring approach	Other	National scoring approach	See description in main spreadsheet For criteria: At the scale of each coastal water body (geographical assessment unit), the integration of the criteria is done in two stages: 1 / The first step is to assign a score relating to the achievement or not of good status for each criterion. Thus, a criterion for which the good state is reached receives a score of 0. A criterion for which the good state is not reached receives a score of 2 if it is a primary criterion and of 1 if it is a secondary criterion. For criterion D5C1, a score of 2 is awarded as soon as one of the phosphate or nitrate elements is downgraded ("One Out All Out"). 2 / In the next step, the criteria are integrated for each body of coastal water, by adding the scores for each criterion. Thus, if the sum of the scores is greater than or equal to 5, then the coastal water body considered is not achieving good status. Note that if good status is not reached for criterion D5C6, then the coastal water body considered is systematically downgraded. For parameter: The evaluation of criterion D5C7 is carried out at the scale of the coastal water body considered individually. The state of the water body for D5C7 is obtained by an integration of the "One Out, All Out" type between the three parameters "Quality index – Subtidal macroalgae", "Quality index – Intertidal / mediolittoral macroalgae" and "Quality index – Herbarium". For the other criteria, the state of the parameter directly informs the corresponding criterion, no integration rule is necessary (type "Not relevant").

						(cont.) In the e-mail, scale (geographical evaluation unit), the integration of criteria is done in two periods: 1 / The first step consists in attributing a note relative to the eighth or non-BEE for each criterion. Thus, a criterion for which the BEE is achieved obtains a score of 0. A criterion for which the BEE does not achieve a score of 2 if it is a primary criterion and if it is a secondary criterion. For criterion D5C1, a score of 2 is assigned since one of the phosphates or nitrates elements is classified ("One Out All Out"). 2 / The integration of the criteria is achieved, at each level, in addition the notes related to each criterion. Thus, if the sum of the notes is superior or equal to 3, then the email is not considered the BEE.
	Barcelona	Hierarchical (OOAO – see description)	National scoring approach	Other	National scoring approach	Same as above
GER	HELCOM	Other/OOAO – see description	HELCOM prefill was not used, but the assessment is based on HELCOM, HEAT	Non-hierarchical	HELCOM HEAT	For criteria: The HELCOM HEAT 3.0 assessment tool was used to assess the state of Eutrophication of the German Baltic Sea. HEAT 3.0 uses "one-out-all-out" between the categories of "nutrient concentrations", "direct effects" and "indirect effects". The "Nutrient Concentrations" category consists of the D5C1 criterion. The category "direct effects" consists of the criteria D5C2, D5C3 and D5C4. The "indirect effects" category consists of the criteria D5C5 and D5C8. For parameter: At the level of the parameters and within the categories, a weighted averaging was carried out, whereby the weighting factor for the HELCOM assessment units Kiel Bay, Mecklenburg Bay, Arkona Basin and Bornholm Basin, in which Germany has a share, was 1, so that only a simple averaging of the individual parameters took place.
	OSPAR	OOAO	OSPAR comm.	Other	OSPAR comm	Criteria: According to the OSPAR Common Procedure, the one-out-all-out principle was applied between the criteria D5C1, D5C2, D5C3, D5C6, D5C7, D5C8.
GRE	Barcelona					
IRE	OSPAR	Threshold methods	-	-	-	

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
ITA	Barcelona	Other	National policies	Other	National policies	Coastal waters: WFD, See description for integration rule description parameter
LAT	HELCOM					
LIT	HELCOM	OOAO	-	-	-	Also applies for the 'Transitional waters' marine unit: Information from description – integrating indicators at the level of criteria and applying the OOAO rule Coastal waters: Information from description – integrating indicators at the level of criteria and applying the OOAO rule
MAL	Barcelona	OOAO	An integration method has not as yet been regionally agreed for the Mediterranean. However, Malta has tentatively adopted the OOAO approach as per methodologies outlined in the Article 8 guidance document and since all indicators and criteria are in good status, the overall status is considered to be good.	-	-	

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
NET	OSPAR	Other	No integration	Other	No integration	Assuming that the WFD goals are achieved, it is estimated that the good environmental status for nutrients is within reach in the years after 2020. Nevertheless, an Article 14 exception has been reported for eutrophication. The MSFD program of measures provides the maximum possible effort, together with other countries, to achieve good environmental status for the descriptor eutrophication, both with regard to measures on land (implementation of the WFD) and at sea. No (additional) technical measures will be taken that could eliminate the presence of eutrophic substances in the Dutch part of the North Sea.
POL	HELCOM	Hierarchical application of OOAO	HELCOM HEAT	Hierarchical	HELCOM HEAT	
POR	OSPAR					
ROM	Bucharest	Other	BEAST	Other	BEAST	
SLO	Barcelona	OOAO	Guidance for Assessments Under Article 8 of the MSFD Integration of assessment results; Feb 2018	Threshold methods		For coastal waters: The rule applies only to elements of criteria for which we have certain limit values at national level - MOP. 2017. Methodol. evaluation of ecol. coastal conditions sea on the basis of general phys.-chem. el. quality Offshore waters: The rule applied to the elements of the criteria for which limit values are set at national level - MOP. 2017. Methodol. evaluation of ecol. coastal conditions sea on the basis of general phys.-chem. el. quality

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/Method	Parameter Integration Rule	Parameter Integration Tool/ Method	Comment
SWE	HELCOM	Hierarchical application of OOAO	HELCOM Eutrophication Assessment Manual, 2015	Non-hierarchical	HELCOM Eutrophication Assessment Manual, 2015	Integration rule applied to D5C1 and D5C2 when more than one parameter used, not relevant for other elements/criteria as only a single parameter is used per element/criterion Coastal waters: Sweden has not used the prefilled data for coastal waters reported under the Water Framework Directive because they are not aggregated on a relevant scale. The relevant scale is coastal water types and we asked for that but did not get it. In the assessment, the aggregation is therefore done in another way, as is done in the HELCOM and OSPAR assessments respectively.
	OSPAR	Hierarchical application of OOAO	OSPAR agreement	Non-hierarchical	OSPAR agreement	Integration rule applied to D5C1 and D5C2 when more than one parameter used, not relevant for other elements/criteria as only a single parameter is used per element/criterion

Annex 3: Methods and tools used for assessing D8 Contaminants

Methods used by Member States to assess D8 Contaminants. Special emphasis has been on identifying the use of integration tools and thus, not all methods are described and included in the table. The written statuses/method descriptions have been evaluated using Google Translate in some cases and thus some minor discrepancies may occur. Please refer to the supplied spreadsheet for original and full Member State reports.

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/method	Parameter Integration Rule	Parameter Integration Tool/ method	Comment
BEL	OSPAR	Not relevant	-	OOAO	-	
BUL	Bucharest					
CRO	Barcelona	OOAO	-	OOAO	-	There is not yet an agreed definition of "significant acute pollution events" at EU or national level. Moreover, no threshold values are set for the criteria D8C3, therefore, the criteria is not applied for the assessment of the status of the environment.
CYP	Barcelona	Not relevant	-	Not relevant	-	No significant pollution or pollution sources. Monitoring programme has just been implemented – see main spreadsheet
DEN	OSPAR	Not relevant	No integration	-	-	Coastal waters: according to WFD
	HELCOM	Not relevant	No integration	-	-	Coastal waters: according to WFD
ESP	OSPAR	Not relevant	Threshold methods	-	-	For contaminants: The results for different pollutants have not been integrated. They are presented individually with the degree of agreement with environmental criteria or threshold values defined for their toxicity.
	Barcelona	Not relevant	Threshold methods	-	-	Some integration has been carried out – see main spreadsheet for details
EST	HELCOM	OOAO	-	OOAO	-	
FIN	HELCOM	No integration	No integration	OOAO	HELCOM HOLAS for contaminants	For acute pollution: The threshold value is defined based on a modern baseline using the reference period 2008–2013 when the estimated volume of oil was considered to be at a historically low level.

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/method	Parameter Integration Rule	Parameter Integration Tool/ method	Comment
FRA	OSPAR	No integration rule defined/-	Not relevant	-		Different reasons why no integration has been caried out – see main spreadsheet
	Barcelona	No integration rule defined/-	Not relevant	-		Different reasons why no integration has been carried out – see main spreadsheet
GER	HELCOM	OOAO for contaminants	For the evaluation of good status with regard to pollutants, the available individual results are combined according to the "one out – all out" principle. This applies to spatial summaries and to summaries between indicators and criteria.	OOAO for contaminants		Coastal waters: Based on WFD or HELCOM Offshore waters: HELCOM state of the Baltic Sea 2018
	OSPAR	OOAO for contaminants	For the evaluation of good status with regard to pollutants, the available individual results are combined according to the "one out – all out" principle. This applies to spatial summaries and to summaries between indicators and criteria.	OOAO for contaminants		Coastal waters: Based on WFD or HELCOM Offshore waters: OSPAR procedure
GRE	Barcelona					
IRE	OSPAR	Other	OSPAR procedure	-	-	No acute pollution

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/method	Parameter Integration Rule	Parameter Integration Tool/ method	Comment
ITA	Barcelona	Not relevant	-	Non-hierarchical	-	Data coverage not good enough for contaminants – see main spreadsheet
LAT	HELCOM					
LIT	HELCOM	-	-	OOAO	-	Based on the concentrations of pollutants in different test media (water, bottom sediment and biota), the overall chemical status of the marine area is assessed according to the OOAO principle.
MAL	Barcelona	-	-	-	-	GES is achieved in all marine units
NET	OSPAR	Other	No integration	Other	No integration	
POL	HELCOM	-	-	-	Helcom CHASE for contaminants (see comment) for other criteria other methods have been used	To assess the status of the environment within criteria D8C1, the mean concentrations calculated for each of the assessed areas were used: concentrations of substances or groups of substances in specific matrices, where the data for each group of matrices: water, organisms (biota), sediments were grouped separately. For each substance or group for substances in the appropriate matrices, contamination ratios (WS) were calculated as the ratio of mean concentration in the environment to the threshold value defining the boundary between good and inadequate status. Basing on the WS values, the chemical score (ZWC) values for each matrix (parameter): organisms – biota, sediments, water for each area were determined (HELCOM HOLAS II Project, CHASE Tool). If the ZWC value is less than 1, then the status of the environment in terms of the substances evaluated for a given matrix (parameter) can be considered good. Integration under the criteria D8C1 was carried out based on the assessments carried out for the parameters (matrices): (1) concentrations in water, (2) concentrations in biota, (3) concentrations in sediment. The status of the entire basin, including all matrices, is determined by the "one out all out" method, which means that good status within D8C1 is achieved while it is achieved for all matrices (parameters). The method is based on the rules adopted in HELCOM HOLAS II Project (CHASE TOOL).

Member State	Regional Sea Convention	Criteria Integration Rule	Criteria Integration Tool/method	Parameter Integration Rule	Parameter Integration Tool/ method	Comment
POR	OSPAR	Not relevant	-	Not relevant	-	Coastal waters: Threshold methods
ROM	Bucharest	-	-	OOAO	-	No marine units achieve GES
SLO	Barcelona	OOAO	-	OOAO	See comment	OOAO for contaminants, not acute poll. Guidance for Assessments Under Article 8 of the MSFD Integration of assessment results; Feb 2017
SWE	HELCOM	Not relevant	-	OOAO	HELCOM (see comment)	OOAO for contaminants and marine species not acute pollution. Sweden has not used the prefilled data reported under the Water Framework Directive. The primary data sources for the assessment are the national monitoring programmes for metals and organic contaminants in sediment and biota, processed using protocols agreed in HELCOM and OSPAR. Because of differences in monitoring and data used for the respective assessment it has not been possible to systematically combine the results. However, threshold values for biota and sediment are the same as those used under the Water Framework Directive, whereby there is an agreement on substances that generally do not achieve threshold values. Additionally, in the national report it is noted that higher concentrations of contaminants may occur on local scales, and that this may be expressed on the level of water bodies under the Water Framework Directive. The national legislation sets down a different assessment level for substances under criterion D8C1 (except cesium-137) as well as for GES assessment. The national legislation may be revised as regard the level of assessment in line with the present reporting.
	OSPAR	Not relevant	-	OOAO	OSPAR (see comment)	See comment above

Annex 4: Supplementary material

Member States with territorial water overlap and MRUs exceeding EEZ

Table A4.1 Overlapping areas among Member State MRUs used to assess D5 Eutrophication. In cases where the MSFD reported status was 'Unknown', 'Not relevant' or 'Not assessed' or the EEA thematic assessment using the HEAT tool did not have data for one or both of the overlapping MRUs, the given area was not double counted (as only MRUs with a status from both Member State and EEA was included in area calculations).

Country 1	Country 2	Overlap (km²)	Area double counted
Spain	Portugal	40 778	No
Spain	France	24 291	No
Spain	France	2 153	No
Poland	Germany	98	Yes
Italy	Malta	7 650	No
Netherlands	Germany	70	Yes
Netherlands	Germany	75	Yes
Poland	Germany	0.5	Yes
Poland	Denmark	3 554	Yes
Finland	Sweden	144	Yes

Table A4.2 Overlapping areas among Member State MRUs used to assess D8 Contaminants – uPBT substances. In cases where the MSFD reported status was 'Unknown', 'Not relevant' or 'Not assessed' or the EEA thematic assessment using the CHASE tool did not have data for one or both of the overlapping MRUs, the given area was not double counted (as only MRUs with a status from both Member State and EEA was included in area calculations).

Country 1	Country 2	Overlap (km²)	Area double counted
Poland	Germany	98	Yes
Poland	Germany	0.5	Yes
Poland	Denmark	3 554	No
Spain	Portugal	40 778	No
Spain	France	26 182	No
Spain	France	26 632	No
Spain	Portugal	1 635	No
Netherlands	Germany	70	Yes
Italy	Malta	57 103	Yes
Finland	Sweden	144	Yes

Other remarks on MRUs used for D8: The Netherlands used The Southern North Sea as MRU for assessing D8 Contaminants – uPBT substances. Therefore, only the Dutch EEZ was considered.

Table A4.3 Overlapping areas among Member State MRUs used to assess D8 Contaminants – non-uPBT substances. In cases where the MSFD reported status was 'Unknown', 'Not relevant' or 'Not assessed' or the EEA thematic assessment (using the CHASE tool) did not have data for one or both of the overlapping MRUs, the given area was not double counted (as only MRUs with a status from both Member State and EEA was included in area calculations).

Country 1	Country 2	Overlap (km²)	Area double counted
Poland	Germany	98	Yes
Poland	Germany	0.5	Yes
Poland	Denmark	3554	No
Spain	Portugal	40 778	No
Spain	France	26 182	No
Spain	France	26 632	No
Spain	Portugal	1 635	No
Netherlands	Germany	70	Yes
Italy	Malta	57 103	Yes

Other remarks on MRUs used for D8: Netherlands used The Southern North Sea as MRU for assessing D8 Contaminants – non-uPBT substances. Therefore, only the Dutch EEZ was considered. Estonia used four ICES areas to assess this category in addition to the usual national MRUs. These areas were large and overlapping with both the areas of Estonia and other countries. Therefor these areas were not included in the analysis.

Few MRUs was uses to assesses D1 Biodiversity for each of the groups birds, fish, mammals and pelagic habitats, and these areas were therefore visually inspected for overlaps in ArcGIS. Only areas with status from both MSDF and BEAT analysis was inspected.

Netherlands used The Southern North Sea as MRU for assessing D1 Biodiversity. Therefore, only the Dutch EEZ was considered. In addition, both The Southern North Sea and the Greater North Sea was used to assess birds.

Poland used special MRUs designated for reporting birds and fish status. Nevertheless, these areas were large, and both overlapped the Polish waters and other Member States' water territories, and were therefore excluded from the analysis for birds because Poland already had given a bird status for their national MRU. For fish, these special areas designated for fish reporting was only considered within the national waters, since there were no other marine units reported with fish status.

Belgium reported on an MRU named 'ANS' for birds, and since tis likely refers to the North Atlantic Ocean, this MRU was not included within the comparison. Belgium also reported bird status within their national territories while the status was unknown for all bird sub-groups within this MRU. For fish, Belgium only reported for the MRU for the Southern North Sea and only for one fish sub-group which had the status 'unknown'.

Table A4.4 The use of assessment tools at any hierarchical level and any extent to evaluate environmental status of descriptor 1 (biodiversity), 5 (eutrophication) and 8 (contaminants) by the EU Member States within the four regional sea conventions.

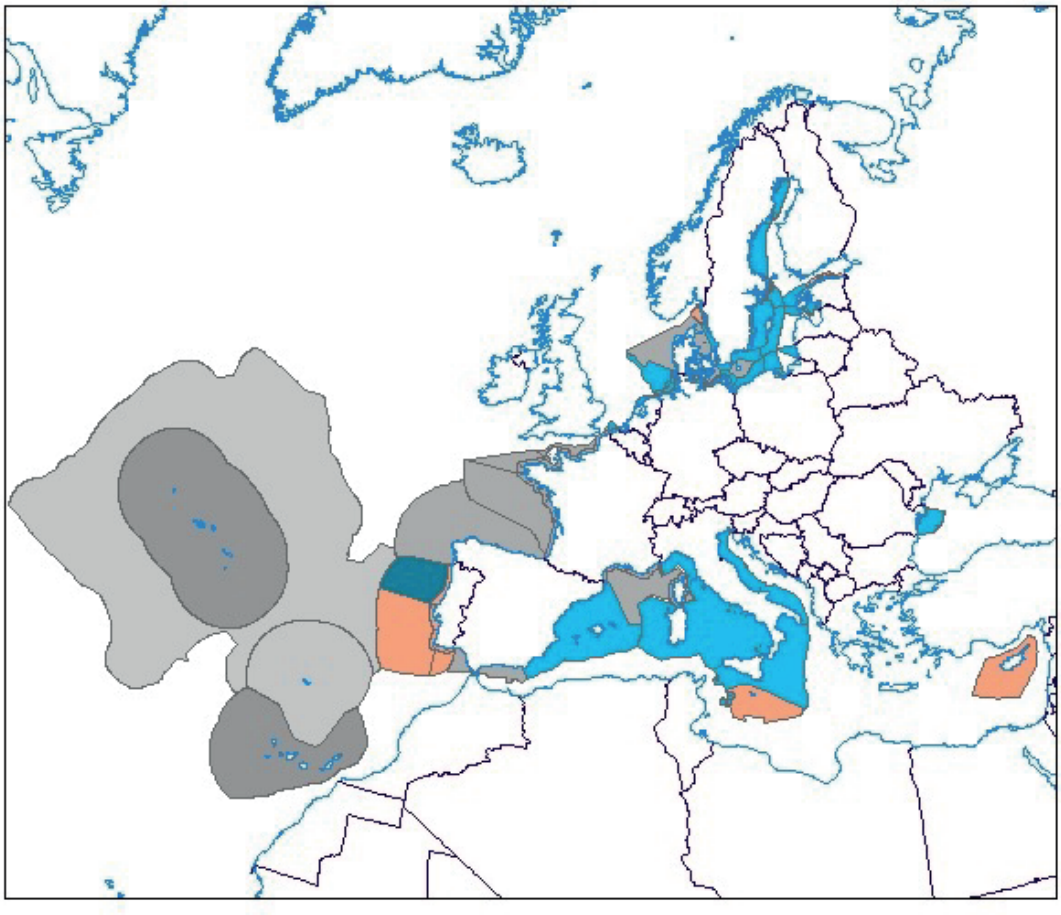
Member State	D1 Biodiversity	D5 Eutrophication	D8 Contaminants
Northeast Atlantic Ocean (OSPAR)			
1. BEL	-	X	-
2. DEN	-	X	-
3. FRA	-	-	-
4. GER	-	X	-
5. IRE	-	-	-
6. NET	-	-	-
7. POR	-	-	
8. ESP	-	X	-
9. SWE	-	X	-
Baltic Sea (HELCOM)			
10. DEN	-	X	-
11. EST	X	-	-
12. FIN	X	X	X
13. GER	-	X	X
14. LAT			
15. LIT	-	-	-
16. POL	X	X	X
17. SWE	-	X	-
Mediterranean Sea (Barcelona Convention)			
18. CRO	-	-	-
19. CYP	-	-	-
20. FRA	-	-	-
21. GRE			
22. ITL	-	-	-
23. MAL	-	-	-
24. SLO	-	-	-
25. ESP	-	X	-
Black Sea (Bucharest Convention)			
26. BUL			
27. ROM	-	X	-

Table A4.5 Areas with agreement and discrepancies between the Member State reported status for D8 Contaminants (category non-uPBT substances*) and the EEA thematic assessment using the CHASE tool (water, biota, and sediments categories).

Non-uPBT subst.	Area (1000 km²)	Agreement (1000 km²)	Discrepancy (1000 km²)
Baltic Sea	220.6 (9.9 %)	213.6 (96.9 %)	6.9 (3.1 %)
North-East Atlantic Ocean	931.6 (41.9 %)	217.5 (23.3 %)	714.1 (76.7 %)
Mediterranean Sea	1 047.9 (47.1 %)	874.2 (83.4 %)	173.7 (16.6 %)
Black Sea	22.5 (1.3 %)	22.5 (100 %)	0 (0 %)
Total	2 222.6 (100 %)	1 327.9 (59.71 %)	894.7 (40.3 %)

* uPBT substances – A smaller group of priority hazardous substances were identified in the Priority Substances Directive as uPBT (ubiquitous (present, appearing or found everywhere), persistent, bio-accumulative and toxic). The uPBTs are mercury, brominated diphenyl ethers (pBDE), tributyltin and certain polyaromatic hydrocarbons (PAHs).

Figure A4.1: Comparison between environmental status for Descriptor 8 Contaminants reported by EU Member States under MSFD (non-uPBT substances*) and by the EEA thematic assessment using the tool CHASE (water, biota and sediment categories). Blue colours indicate agreement between results (dark blue = agreement on 'GES' and 'NPA' respectively, light blue = agreement on 'not GES' and 'PA'), orange colours indicate disagreement (dark orange = EEA assessment determines 'NPA' and Member States determines 'not GES', light orang e= EEA assessment determines 'PA' and Member States determines 'GES') and grey colours indicate missing status from either EEA assessment (light grey), Member States (intermediate grey) or both (dark grey). * uPBT substances – A smaller group of priority hazardous substances were identified in the Priority Substances Directive as uPBT (ubiquitous (present, appearing or found everywhere), persistent, bio accumulative and toxic). The uPBTs are mercury, brominated diphenyl ethers (pBDE), tributyltin and certain polyaromatic hydrocarbons (PAHs).



European Topic Centre European Topic Centre on Inland, Coastal and Marine waters (ETC/ICM)
c/o Helmholtz Centre for Environmental Research – UFZ
Brückstraße 3a
39104 Magdeburg

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