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Guidelines for eutrophication data aggregation, harmonisation and Quality Control

Version 3

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History

Authors	Date	Comments	Version
Lipizer M., Molina Jack M. E., Wesslander K., Fyrberg L., Tsompanou M., Iona A., Buga L., Sarbu G., Gatti J., Larsen M. M., Østrem A. K., Giorgetti A.	06/03/2023	Annex 1 is a working-in-progress document provided here as a reference.	1
Lipizer M., Molina Jack M. E., Wesslander K., Fyrberg L., Tsompanou M., Iona A., Buga L., Sarbu G., Gatti J., Larsen M. M., Østrem A. K., Giorgetti A.	14/11/2023	One table in Annex 1 has been corrected	2
Lipizer M., Molina Jack M. E., Wesslander K., Fyrberg L., Tsompanou M., Iona A., Buga L., Sarbu G., Gatti J., Larsen M. M., Østrem A. K., Giorgetti A.	20/01/2026	Title has been modified; Quality control steps have been updated; Annex 2 “Review of N:P ratios in the sub-basins of the European Seas” has been added.	3

1 Introduction

Data Quality Control (QC) is an important issue in oceanographic data management, especially for the creation of multidisciplinary and comprehensive datasets which include data from different and/or unknown origins, covering long time periods.

This document describes the data management steps and the Quality Control procedure adopted by EMODnet Chemistry to obtain standardised, harmonised and validated regional data collections concerning eutrophication (nutrients, chlorophyll and oxygen) and ocean acidity (pH and alkalinity), for the European Sea Basins (namely: the Mediterranean Sea, Black Sea, Arctic Region, Baltic Sea, Greater North Sea and North East Atlantic Ocean).

This "Quality Control loop" involves several actors with different roles and responsibilities: Data Originators (DO), Data Managers (DM), and Regional Coordinators (RC).

DOs are responsible for data collection, including sampling and laboratory analysis, data validation and provision of methodological information and Quality Assurance (QA) metadata. Methodological information and QA metadata are collected via a harmonized questionnaire based on protocols from EEA, ICES, UNEP-MAP, and the NORMAN network (French and Lipizer, 2023). This information is published as open-access in a dedicated Zenodo community (EMODnet Chemistry QC/QA questionnaires community, https://zenodo.org/communities/emodnetchemquestionnaire/) and has to be included in the CDI (in the "Quality" fields, Partescano et al., 2024, doi.org/10.6092/e25b219f-b17d-411e-a0ee-e12db5685e23).

DMs are responsible for managing data according to standard protocols developed in the framework of SeaDataNet, which involve the use of commonly agreed metadata, standard vocabularies, dataset formats and data validation (QC) process (Level 1 QC, Maillard and Fichaut, 2001).

Lastly, RCs perform Level 2 QC using a common protocol, which is adapted to the environmental condition of the individual Sea Basins. This includes aggregation of variables, harmonization of units, cross-parameter consistency checks (e.g., nutrient ratios, oxygen saturation, comparisons with historical climatologies) and comparison with concentration ranges proposed at sub-regional scale. This last step is, **however**, adopted with a precautionary principle in territorial waters (within 12 nm from the coast) due to variability related to land-sea interactions and continental inputs which often exceeds regional broad ranges.

Newly introduced metadata (Location qualification) indicating the distance of sampling stations from the coast, enables filtering data within the 12 nm and offshore areas (beyond 12 nm) to refine validation strategies.

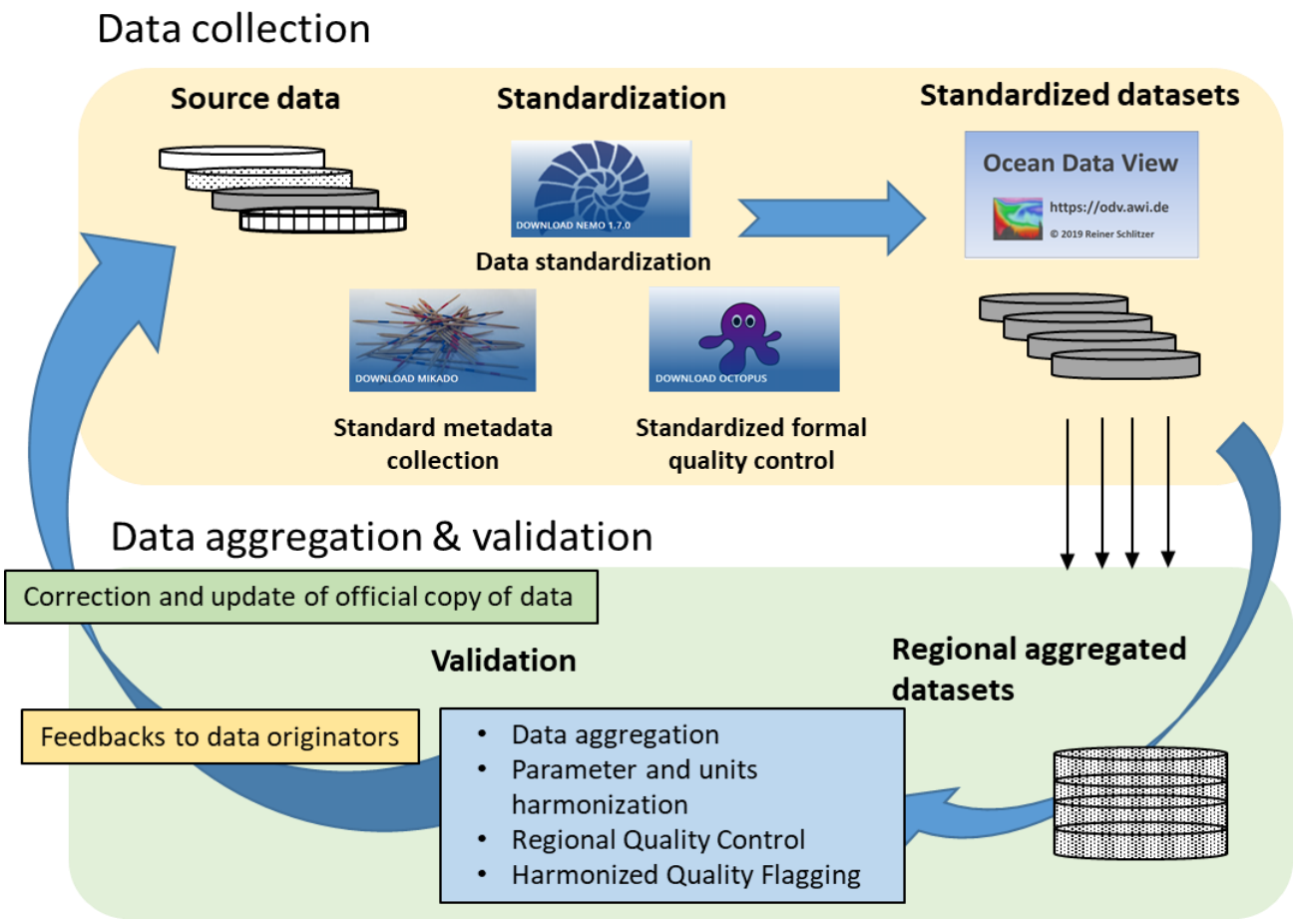

Figure 1: *The loop implemented within EMODnet Chemistry for data quality control assures continuous data quality upgrade (from Giorgetti et al, 2020, modified).*

All data entering EMODnet Chemistry are managed according to standard protocols developed in the framework of the European consolidated SeaDataNet marine data infrastructure (https://www.seadatanet.org), and undergo a commonly agreed metadata and data validation process (Giorgetti et al., 2020).

An automatic Robot Harvester, properly configured with predefined criteria of geographical and temporal coverage and parameters, is adopted to retrieve specific data sets from distributed data centres to obtain data collections per sea region ("regional aggregated datasets") from the heterogeneous datasets originating from multiple institutions. Two types of data are available:

- vertical profiles (VP) for data that have been collected roughly at the same time and location for several consecutive vertical depths,
- time series (TS) for data collected at the same location and depth but repeated in time.

The resulting collections are aggregated, harmonised and validated by regional experts using ODV software and following a commonly agreed methodology, compiled in discussion with the wider

international community (e.g. IOC/IODE, ICES and the former JCOMM: SeaDataNet Data Quality Control Procedures, SeaDataNet, 2010). As a result, quality flags are assigned to all data according to a standard scale (SeaDataNet measurand qualifier flags, L20 vocabulary, https://vocab.nerc.ac.uk/collection/L20/current/) (Tab. 1).

Code	Description
0	no quality control
1	good value
2	probably good value
3	probably bad value
4	bad value
5	changed value
6	value below detection
7	value in excess
8	interpolated value
9	missing value
A	value phenomenon uncertain
B	nominal value
Q	value below limit of quantification

***Table 1**: List of Quality Flags according to L20 vocabulary (19.01.2026).*

Parameter aggregation is carried out at Regional Sea scale by means of a dedicated vocabulary (P35 vocabulary: EMODnet Chemistry aggregated parameter names https://vocab.nerc.ac.uk/collection/P35/current/) implemented to combine various P01 terms associated to the same substance (e.g. nitrate in seawater) described with heterogeneous names, measured with different instruments or expressed with different measurement units, into a unified aggregated term with a uniquely identified standard unit which was proposed according to major EU directives, to scientific literature and agreed within the EMODnet Chemistry scientific community. The ODV software (Schlitzer, 2025) has a built-in aggregation procedure, making use of the P35 vocabulary and also applying a number of business rules, such as for averaging and unit conversions. The information related to the specific parameters (as described by the P01 vocabulary) is available as metadata, together with details about the data acquisition instrument, if provided by data originators. Data validation, or Quality Control, is done according to the steps described in the following section.

EMODnet Chemistry Eutrophication aggregated datasets are the result of a "Quality Control loop" process which involves "Level 1 QC", "regional sea data collection preparation", "Level 2 QC" and, lastly, reporting back results from Level 2 QC to DMs, who may then contact DOs.

2 Regional sea data collection preparation

This process is carried out with standard tools and services (e.g. Ocean Data View - ODV software, https://odv.awi.de/; NERC Vocabulary Server (NVS) managed by BODC https://vocab.nerc.ac.uk/search_nvs/) implemented in the framework of SeaDataNet. Guidelines to produce SeaDataNet ODV are available here: https://doi.org/10.13120/c1933032-9fa9-4678-8539-effa1560921c

The procedure involves following steps:

1	Import into ODV the original SDN ODV files and associated metadata; prepare separate collections according to the primary variable (e.g.: time, depth, pressure): one for time series, other for profiles (one collection for ocean depth profiles and one for ocean pressure profiles);
2	If possible, correct the ODV.txt files which are not imported because of format errors;
3	Import the corrected ODV.txt files in the corresponding collections;
4	Correct wrong P01/P02 mapping to avoid the mixing of data from different matrices (water column, sediment and biota)
5	Run the P35 aggregation using the best-of ODV algorithm;
6	Correct stations with primary variable “pressure” expressed in metres;
7	Delete variables that don't belong in the eutrophication collection (not aggregated variables, contaminants, …);
8	Merge the “ocean pressure” and the “ocean depth” collections into one “**ocean depth profiles**” collection using Depth/Pressure conversion;
9	Delete duplicate stations;
10	Correct latitude and longitude of stations on land (if information is available);
11	Exclude the stations outside the specific sea basin, according to the basin-specific boundaries and send them to the regional leader responsible for the area;
12	Exclude trajectory data outside the considered domain (e.g. NE Atlantic, Mediterranean, Black Sea,...) from the profiles collection;
13	The Argo float profiles with biogeochemical parameters (oxygen, nitrate, pH and Chla) not validated in delayed mode (DM) are removed from the collections;
14	Delete stations with no metadata;
15	Delete stations with only Temperature and Salinity data or with only “not eutrophication related” data;
16	Export data to a new dataset containing only stations with relevant data (nutrients, oxygen, chlorophyll, pH and alkalinity), keeping also salinity, temperature and other relevant “ancillary parameters (e.g. Secchi depth, particulate matter, total suspended matter, turbidity...)”.

Table 2: *List of steps for Regional sea data collection preparation.*

Ancillary parameters to be maintained in the collections used for eutrophication:

- Temperature
- Salinity
- Secchi depth
- Total suspended matter
- Turbidity

3 Level 2 QC

Level 2 QC involves a series of manual checks which regard inspection of temporal, spatial distribution of data, of cross-parameter comparison, of calculation of derived variables, of comparison with "broad ranges" derived from the literature (Belgacem et al., 2021; Giorgetti et al., 2005; Mavropoulou et al., 2020; HELCOM, 2018; Hansen J.W. & Høgslund S., 2021) and with climatologies available from historical data (WOA 2001, Manca et al., 2004). This protocol has been developed within EMODnet Chemistry data management community, it is based on expertise gained within previous initiatives (EU-MAST/MEDAR/MEDATLAS II project, 1998-2001; EU SeaDataNet project, 2006 - 2011; EU SeaDataNet 2 project, 2011 - 2015; EU SeaDataCloud, 2016 - 2020; EMODnet Chemistry Phase 1-5) and is being updated and revised as new knowledge and expertise becomes available. The aim is to evaluate and, if needed, update the quality flags assigned to the data.

A key component of the validation process is the comparison with regional broad ranges, designed to encompass natural variability across seasons and years and highlight clearly erroneous data, flagged as 4 (Garcia et al., 2023, Supplementary Material). The broad ranges used for each European Sea basin are summarised in Annex 1, which is, however, a work-in-progress document as ranges are being revised according to the larger data availability. Furthermore, as concentration ranges have been proposed mostly for open sea areas, these are adopted with a precautionary approach in coastal areas which are characterised by large variability (thus much broader concentration ranges) due to possible continental inputs, land-sea interactions and sediment resuspension processes (Lipizer et al., 2012; Grilli et al., 2020; Radach et al., 2007).

According to "Location qualification" metadata field it is possible to filter "beyond 12 nm" stations (open water data) and adopt the whole series of QC steps listed below (Table 3), using as reference the "broad ranges" reported in the Annex.

On the other hand, for stations within 12 nm from the coast, the "broad ranges" comparison should not be used to update the existing quality flags to QF 4 (bad data) but mainly work as alerts to spot possible anomalies which need to be carefully investigated through additional checks which require, for example, evaluation of vertical patterns of data, comparison with other parameters and cross parameter checks (e.g. nutrient versus salinity). Table 3 lists the criteria adopted by EMODnet Chemistry to validate eutrophication and ocean acidity data and the proposed QC flag applied.

QC steps and associated proposed Quality Flag:

Quality Flag	***Criteria adopted by EMODnet Chemistry***	***Introduced by EMODnet Chemistry***
Q	*Values below limit of quantification (BelowLoQ, Limit of Quantification)*	*x*
9	*Default values used for missing data, such as 9999 or 999.999*	
	Blank cell	
6	*Values equal to 0**	*x*
	Values below detection (LoD, Limit of Detection)	*x*
4	*Stuck data (constant profile/constant values)*	
	Impossible regional values (min - max, broad range)	
	Check vertical stability[1]	
	Check for increasing reference (pressure)	
	Data point below bottom depth	
	*Negative values**	*x*
	*Values equal to 0**	*x*
	Negative depths in ARGO profiles, and the corresponding values in other variables	*x*
	Two or more identical consecutive depth values	*x*
	Nutrient comparison (inorganic nutrients/total nutrients >2)	*x*
	Data are equal to other variables (same values in different columns corresponding to different variables)	*x*
3	*Check for spikes*	
	Only for oxygen saturation: exceeding limits indicated in the guidelines (the upper limit is capped at 115% saturation above 150 m, 130% above 100 m, and 150% above 10 m depth)	*x*
	Nutrient comparison (N03 plus NO2 – NO3 <0; N03 plus NO2 – NO2 <0; N03 – NO2<0; inorganic nutrients/total nutrients 1.15 - 2)	*x*
	Profiles starting with negative values (e.g. from CTD or ARGO): when several negative values are part of vertical profiles, assuming the effect of a negative offset common to the whole profile	*x*
2	*Compare with pre-existing statistics (narrow range)*	
	Nutrient comparison (inorganic nutrients/total nutrients 1 - 1,15)	*x*
	Higher than N/P ranges derived from literature review	*X***
	Comparison between nutrients and salinity	*X***

Table 3: *List of data QC steps proposed to produce regional aggregated and harmonized data collections for the European seas by EMODnet Chemistry. *Depending on parameters and on DOs' feedback; X**used as alerts to further investigate data and consult DOs.*

[1] This is not usually applied in EMODnet Chemistry since it is derived from hydrographic data (temperature and salinity) which are outside EMODnet Chemistry focus.

Additional checks for Nutrients: N:P ratio

An additional step of validation is proposed, in cases of anomalies in nutrient concentrations are identified in the previous QC steps. This QC step is based on the relative proportion of Nitrogen to Phosphorus in seawater which, at least in open waters, far from continental inputs and in oxygenated waters, are fairly constant. In fact, it is well known that, under aerobic conditions, the assimilation and the regeneration of nutrients occur in constant ratios (Redfield ratio: N:P= 16:1; Redfield et al., 1963). However, especially in coastal waters influenced by continental discharges, but also in oligotrophic open waters such as in the Mediterranean Sea, N:P can vary over a broad range, from ratios below 2:1 to over 500:1 (Lipizer et al., 2011; 1999; Socal et al., 2008; Degobbis et al., 2005). Particular broad ranges are typical of the north Adriatic due to the much larger nitrogen river input in relationship with phosphorus. However, even though N:P can assist identifying possible errors, at the moment Quality Flags are not yet being assigned on the basis of N:P ratios due to the large variability in the ranges, particularly in coastal waters, and to the lack of an agreed and consolidated approach to identify the variable (e.g. nitrogen or phosphorus) driving exceptional ratios. Therefore, the N:P ratio is used to identify data which need further consultation and validation by experts.

A review of N:P ratios for the European Sea Basins that can be used for QC purposes, is provided in Annex 2.

Specific instructions to calculate and validate derived variables:

Identify cases where “NO3 plus NO2” is < NO3 and flag them. The same approach is used also for cases where “NO3 plus NO2” is < NO2. The check consists of the following steps:

- Calculate the derived variable “N03 plus NO2” – NO3 and “N03 plus NO2” – NO2 and find negative values.
  - When the flag of NO3 plus NO2 and NO3 is QF=1, change both NO3 plus NO2 and NO3 flags to QF=3.
  - When the flag of NO3 plus NO2 is QF=6 and NO3 is QF=1, change the NO3 flags to QF=3.

Identify cases where N02>N03 and flag them. The check consists of the following steps:

- Calculate the derived variable “N03 – NO2” and find negative values.
  - When the flag of NO3 and NO2 is QF=1, change both NO3 and NO2 flags to QF=3.
  - When the flag of NO3 and NO2 is QF=6, keep both NO3 and NO2 flags to QF=6.
  - When the flag of NO3 is QF=6 and NO2 is QF=1, change the NO2 flag to QF=3.
  - When the flag of NO3 is QF=1 and NO2 is QF=6, change the NO3 flag to QF=6

Check if ratios of **inorganic nutrients / total nutrients** (e.g. PO4:TP and DIN:TN) is higher than 1.1. After inspection of the profiles, change the flag of the outlier parameter to QF=3 or change the flags

of all the parameters associated (for DIN: Nitrate, Nitrite and Ammonium) if **there is no obvious outlier parameter.**

At the end of the regional "Level 2 QC", all modifications are reported to each Data Manager and/or Data Originator (identified by its EDMO code) in order to obtain confirmation and revision of the original datasets (official version of the data) (Fig. 1).

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5 Annex 1. Work in progress analysis and updates of broad ranges of concentrations of biogeochemical parameters

Broad-range check values in the European sea basins:

Mediterranean

The broad-range check values in the Mediterranean were defined within EU-MAST/MEDAR/MEDATLAS II project (Mediterranean Data Archaeology and Rescue of temperature, salinity and bio-chemical parameters, 1998-2001).

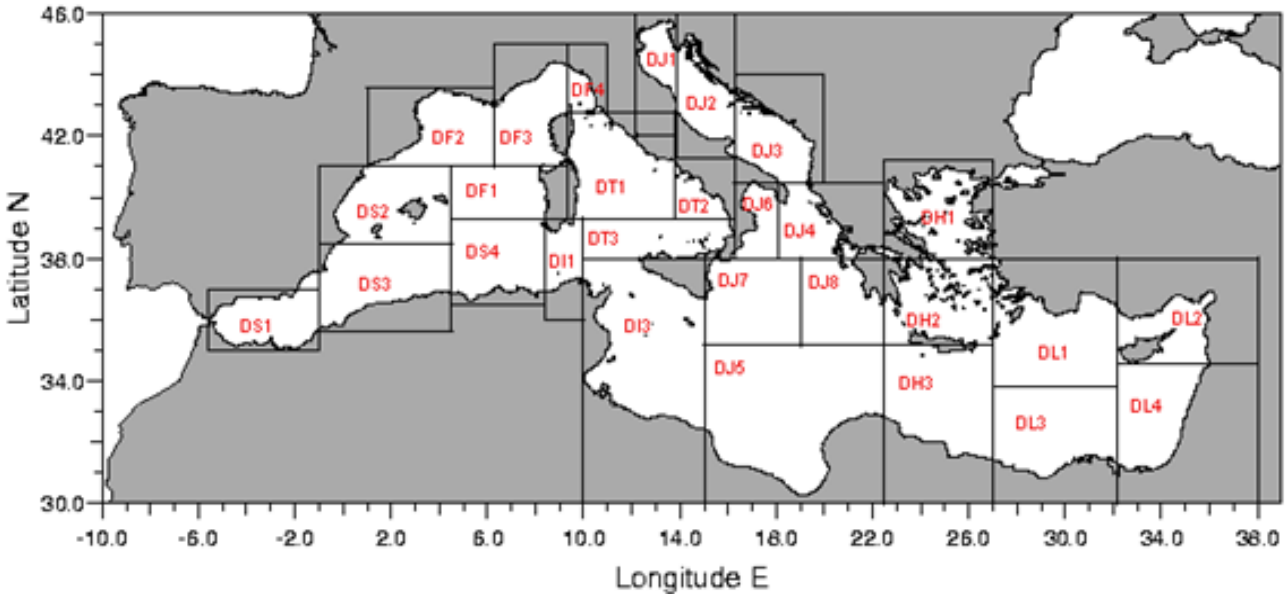

Figure 1: *Regional sub-domains defined in the Mediterranean for the broad range check.*

Table 1: *Geographical limits of the central Mediterranean regions for broad range scale definition and the corresponding maximum depth.*

Code	Region Name	Lat. min	Lat. max	Lon. min	Lon. max	Max depth
DJ1	Adriatic North	42 00.00'	46 00.00'	12 10.00'	13 50.00'	150
DJ2	Adriatic Middle	41 18.00'	46 00.00'	13 50.00'	16 16.00'	270
DJ3	Adriatic South	40 36.00'	44 00.00'	16 16.00'	20 00.00'	1350
DJ4	Ionian NE	38 00.00'	40 36.00'	18 00.00'	22 30.00'	3650
DJ5	Ionian South	30 00.00'	35 10.00'	15 00.00'	22 30.00'	4300
DJ6	Ionian NW	38 00.00'	40 36.00'	16 16.00 '	18 00.00'	2770
DJ7-8	Ionian Middle	35 10.00'	38 00.00'	15 00.00'	22 30.00'	5100
DI3	Sicily Strait	30 00.00'	38 00.00'	10 00.00’	15 00.00'	1550
DI1	Sardinia Strait	36 00.00'	39 18.00'	8 24.00'	10 00.00'	2660
DT1	Tyrrhenian 1 NW	39 18.00'	42 48.00'	9 18.00'	13 48.00'	3100
DT2	Tyrrhenian 2 NE	39 18.00'	41 18.00'	13 48.00'	16 16.00'	3100 m
DT3	Tyrrhenian 3 South	38 00.00'	39 18.00'	10 00.00'	16 16.00'	3100 m
DF3	Ligurian W	41 00.00'	45 00.00'	6 18.00'	9 18.00'	2900 m
DF4	Ligurian E	42 48.00'	45 00.00'	9 18.00'	11 00.00'	1050 m

Table 2: *Minimum and maximum control values for the two layers (0-200 m, 201-bottom) in the Central Mediterranean regions as used for the broad-range check of biogeochemical parameters.*

Code-Region Name	Oxygen (ml/l)				Oxygen (µmol/l)			
	0 - 200 m		201 m - bottom		0 - 200 m		201 m - bottom	
DJ1 - Adriatic North	0	10.0	/	/	0	446	/	/
DJ2 - Adriatic Middle	3.0	9.0	2.0	9.0	134	402	134	402
DJ3 - Adriatic South	3.0	9.0	3.0	8.0	134	402	134	357
DJ4 - Ionian NE	3.0	8.0	3.0	6.0	134	357	134	268
DJ5 - Ionian South	3.0	8.0	3.0	6.0	134	357	134	268
DJ6 - Ionian NW	3.0	8.0	3.0	6.0	134	357	134	268
DJ7 - Ionian Middle	3.0	8.0	3.0	6.0	134	357	134	268
DI3 - Sicily Strait	3.0	8.0	3.0	6.0	134	357	134	268
DI1 - Sardinia Strait	3.0	8.0	3.0	6.0	134	357	134	268
DT1 - Tyrrhenian NW	3.0	8.0	3.0	6.0	134	357	134	268
DT2 - Tyrrhenian NE	3.0	8.0	3.0	6.0	134	357	134	268
DT3 - Tyrrhenian South	3.0	8.0	3.0	6.0	134	357	134	268
DF3 - Ligurian W	3.0	8.0	3.0	6.0	134	357	134	268
DF4 - Ligurian E	3.0	8.0	3.0	6.0	134	357	134	268

Code-Region Name	Nitrate (µmol/l)			
	0 - 200 m		201 m - bottom	
DJ1 - Adriatic North	0	16.0	/	/
DJ2 - Adriatic Middle	0	9.0	0	9.0
DJ3 - Adriatic South	0	9.0	0	9.0
DJ4 - Ionian NE	0	9.0	0	9.0
DJ5 - Ionian South	0	9.0	0	11.0
DJ6 - Ionian NW	0	9.0	0	9.0
DJ7 - Ionian Middle	0	9.0	0	9.0
DI3 - Sicily Strait	0	9.0	0	12.0
DI1 - Sardinia Strait	0	9.0	0	12.0
DT1 - Tyrrhenian NW	0	9.0	0	9.0
DT2 - Tyrrhenian NE	0	9.0	0	9.0
DT3 - Tyrrhenian South	0	9.0	0	11.0
DF3 - Ligurian W	0	7.0	0	9.0
DF4 - Ligurian E	0	7.0	0	9.0

Code-Region Name	Phosphate (µmol/l)				Silicate (µmol/l)			
	0 - 200 m		201 m - bottom		0 - 200 m		201 m - bottom	
DJ1 - Adriatic North	0	1.5	/	/	0	60.0	/	/
DJ2 - Adriatic Middle	0	1.0	0	1.0	0	20.0	0	26.0
DJ3 - Adriatic South	0	1.0	0	1.0	0	11.0	0	25.0
DJ4 - Ionian NE	0	1.0	0	1.0	0	10.0	0	16.0
DJ5 - Ionian South	0	1.0	0	1.0	0	9.0	0	11.0
DJ6 - Ionian NW	0	1.0	0	1.0	0	9.0	0	11.0
DJ7 - Ionian Middle	0	1.0	0	1.0	0	9.0	0	11.0
DI3 - Sicily Strait	0	1.0	0	1.0	0	9.0	0	12.0
DI1 - Sardinia Strait	0	1.0	0	1.0	0	9.0	0	12.0
DT1 - Tyrrhenian NW	0	1.0	0	1.0	0	9.0	0	10.0
DT2 - Tyrrhenian NE	0	1.0	0	1.0	0	9.0	0	10.0
DT3 - Tyrrhenian South	0	1.0	0	1.0	0	9.0	0	12.0
DF3 - Ligurian W	0	1.0	0	1.0	0	9.0	0	11.0
DF4 - Ligurian E	0	1.0	0	1.0	0	9.0	0	11.0

	Alkalinity (µmol/ l)				Ammonium (µmol/l)			
	0 - 200 m		201 m - bottom		0 - 200 m		201 m - bottom	
DJ1 - Adriatic North	2000	3000	/	/	0	30.0	/	/
DJ2 - Adriatic Middle	2500	3000	2500	3000	0	10.0	0	7.0
DJ3 - Adriatic South	2500	3000	2500	3000	0	10.0	0	7.0
DJ4 - Ionian NE	2500	3000	2500	3000	0	10.0	0	7.0
DJ5 - Ionian South	2500	3000	2500	3000	0	2.0	0	1.0
DJ6 - Ionian NW	2500	3000	2500	3000	0	2.0	0	1.0
DJ7 - Ionian Middle	2500	3000	2500	3000	0	2.0	0	1.0
DI3 - Sicily Strait	2500	3000	2500	3000	0	2.0	0	1.0
DI1 - Sardinia Strait	2500	3000	2500	3000	0	2.0	0	1.0
DT1 - Tyrrhenian NW	2500	3000	2500	3000	0	2.0	0	2.0
DT2 - Tyrrhenian NE	2500	3000	2500	3000	0	2.0	0	2.0
DT3 - Tyrrhenian South	2500	3000	2500	3000	0	2.0	0	2.0
DF3 - Ligurian W	2500	3000	2500	3000	0	2.0	0	2.0
DF4 - Ligurian E	2500	3000	2500	3000	0	2.0	0	2.0

Code-Region Name	Chlorophyll-a (µg/l)				Nitrite (µmol/l)			
	0 - 200 m		201 m - bottom		0 - 200 m		201 m - bottom	
DJ1 - Adriatic North	0	20.0	/	/	0	10	/	/
DJ2 - Adriatic Middle	0	2.0	0	0.5	0	3	0	3
DJ3 - Adriatic South	0	2.0	0	0.5	0	2	0	2
DJ4 - Ionian NE	0	2.0	0	0.5	0	1	0	0.5
DJ5 - Ionian South	0	1.0	0	0.5	0	1	0	0.5
DJ6 - Ionian NW	0	1.0	0	0.5	0	0.5	0	0.2
DJ7 - Ionian Middle	0	1.0	0	0.5	0	0.5	0	0.2
DI3 - Sicily Strait	0	1.0	0	0.5	0	0.5	0	0.5
DI1 - Sardinia Strait	0	1.0	0	0.5	0	0.5	0	0.5
DT1 - Tyrrhenian NW	0	1.0	0	0.5	0	0.5	0	0.2
DT2 - Tyrrhenian NE	0	1.0	0	0.5	0	0.5	0	0.2
DT3 - Tyrrhenian South	0	1.0	0	0.5	0	0.5	0	0.2
DF3 - Ligurian W	0	3.0	0	0.5	0	1	0	0.5
DF4 - Ligurian E	0	1.0	0	0.5	0	1	0	0.5

Code-Region Name	Total Nitrogen (µmol/l)				Total Phosphorus (µmol/l)			
	0 - 200 m		201 m - bottom		0 - 200 m		201 m - bottom	
DJ1 - Adriatic North	4	15	/	/	0	1.5	/	/
DJ2 - Adriatic Middle	4	15	6	15	0	1.0	0	1.0
DJ3 - Adriatic South	4	30	6	30	0	1.0	0	1.0
DJ4 - Ionian NE	4	20	6	20	0	1.5	0	1.0
DJ5 - Ionian South	4	20	6	20	0	1.0	0	1.0
DJ6 - Ionian NW	4	20	6	20	0	1.0	0	1.0
DJ7 - Ionian Middle	4	20	6	20	0	1.0	0	1.0
DI3 - Sicily Strait	4	9	6	12	0	1.0	0	1.0
DI1 - Sardinia Strait	4	9	6	12	0	1.0	0	1.0
DT1 - Tyrrhenian NW	4	9	6	9	0	1.0	0	1.0
DT2 - Tyrrhenian NE	4	9	6	9	0	1.0	0	1.0
DT3 - Tyrrhenian South	4	9	6	9	0	1.0	0	1.0
DF3 - Ligurian W	4	7	6	9	0	1.0	0	1.0
DF4 - Ligurian E	4	7	6	9	0	1.0	0	1.0

Code-Region Name	pH			
	0 - 200 m		201 m - bottom	
DJ1 - Adriatic North	6.0	9.0	/	/
DJ2 - Adriatic Middle	7.0	9.0	7.0	9.0
DJ3 - Adriatic South	7.0	9.0	7.0	9.0
DJ4 - Ionian NE	7.5	9.0	7.5	9.0
DJ5 - Ionian South	7.5	9.0	7.5	9.0
DJ6 - Ionian NW	7.5	9.0	7.5	9.0
DJ7 - Ionian Middle	7.5	9.0	7.5	9.0
DI3 - Sicily Strait	7.5	9.0	7.5	9.0
DI1 - Sardinia Strait	7.5	9.0	7.5	9.0
DT1 - Tyrrhenian NW	7.5	9.0	7.5	9.0
DT2 - Tyrrhenian NE	7.5	9.0	7.5	9.0
DT3 - Tyrrhenian South	7.5	9.0	7.5	9.0
DF3 - Ligurian W	7.5	9.0	7.5	9.0
DF4 - Ligurian E	7.5	9.0	7.5	9.0

***Table 3**. Geographical limits of the Eastern Mediterranean regions for broad range scale definition and the corresponding maximum depth*

Code	Region Name	Lat. min	Lat. max	Lon. min	Lon. max	Max depth
DH1	Aegean North	38 00'	41 12'	22 30'	27 00'	1747 m
DH2	Aegean South	35 10'	38 00'	22 30'	27 00'	4424 m
DH3	Cretan Passage	30 00'	35 10'	22 30'	27 00'	4007 m
DL1	Levantine North	33 50'	38 00'	27 00’	32 10'	4227 m
DL2	Levantine North-East	34 35'	38 00'	32 10'	38 00'	2452 m
DL3	Levantine South	30 00'	33 50'	27 00’	32 10'	3133 m
DL4	Levantine South-East	30 00'	34 35'	32 10'	38 00'	2650 m

***Table 4**. Minimum and maximum control values for the two layers (0-200 m, 201-bottom) in the Eastern Mediterranean regions as used for the broad-range check of biogeochemical parameters.*

Code-Region Name	Oxygen (ml/l)				Oxygen (µmol/l)			
	0 – 200 m		201 m – bottom		0 – 200 m		201 m – bottom	
DH1 – Aegean North	3.0	6.0	3.0	7.0	134	268	134	312
DH2 – Aegean South	3.0	6.0	3.0	7.0	134	268	134	312
DH3 – Cretan Passage	3.0	6.0	3.0	7.0	134	268	134	312
DL1 – Levantine North	3.0	6.0	3.0	7.0	134	268	134	312
DL2 – Levantine NE	3.0	6.0	3.0	7.0	134	268	134	312
DL3 – Levantine South	3.0	6.0	3.0	7.0	134	268	134	312
DL4 – Levantine SE	3.0	6.0	3.0	7.0	134	268	134	312

Code-Region Name	Nitrate (µmol/l)			
	0 – 200 m		201 m – bottom	
DH1 – Aegean North	0	7.0	0	7.0
DH2 – Aegean South	0	7	0	10.0
DH3 – Cretan Passage	0	7	0	10.0
DL1 – Levantine North	0	5.0	0	10.0
DL2 – Levantine NE	0	5.0	0	10.0
DL3 – Levantine South	0	5.0	0	10.0
DL4 – Levantine SE	0	5.0	0	10.0

Code-Region Name	Phosphate (µmol/l)				Silicate (µmol/l)			
	0 – 200 m		201 m – bottom		0 – 200 m		201 m – bottom	
DH1 – Aegean North	0	7.0	0	2.0	0	15.0	0	25.0
DH2 – Aegean South	0	2.0	0	2.0	0	15.0	0	20.0

DH3 – Cretan Passage	0	1.0	0	2.0	0	10.0	0	15.0
DL1 – Levantine North	0	1.0	0	1.0	0	10.0	0	15.0
DL2 – Levantine NE	0	1.0	0	1.0	0	10.0	0	15.0
DL3 – Levantine South	0	0.5	0	1.0	0	5.0	0	11.0
DL4 – Levantine SE	0	1.0	0	1.0	0	20.0	0	11.0

***Table 5**. Geographical limits of the Western Mediterranean regions for broad range scale definition and the corresponding maximum depth*

Code	Region Name	Lat. Min	Lat. Max	Lon. Min	Lon. Max	Max depth
DF1	Algero-Provencal	39 18’	41 00’	4 30’	9 18’	2791m
DF2	Gulf of Lions	41 00’	43 36’	100’	6 18’	2642m
DS1	Alboran Sea	35 00’	37 30’	-5 36’	-1 00’	2583m
DS2	Balearic Sea	38 30’	41 00’	-1 00’	4 30’	2653m
DS3	Algerian Basin SW	35 36’	38 30’	-1 00’	4 30’	2728m
DS4	Algerian Basin SE	36 30’	39 18’	4 30’	8 24’	2799m

***Table 6**. Minimum and maximum control values for the two layers (0-200 m, 201-bottom) in the Western Mediterranean regions as used for the broad-range check of biogeochemical parameters.*

Code-Region Name	Oxygen (ml/l)				Oxygen (µmol/l)			
	0 – 200 m		201 m – bottom		0 – 200 m		201 m – bottom	
DF1 – Algero-Provencal	3.0	6.0	3.0	7.0	134	268	134	312
DF2 – Gulf of Lions	3.0	6.0	3.0	7.0	134	268	134	312
DS1 – Alboran Sea	3.0	6.0	3.0	7.0	134	268	134	312
DS2- Balearic Sea	3.0	6.0	3.0	7.0	134	268	134	312
DS3 – Algerian Basin SW	3.0	6.0	3.0	7.0	134	268	134	312
DS4 – Algerian Basin SE	3.0	6.0	3.0	7.0	134	268	134	312

Code-Region Name	Nitrate (µmol/l)			
	0 – 200 m		201 m – bottom	
DF1 – Algero-Provencal	0	15.0	0	30.0
DF2 – Gulf of Lions	0	50.0	0	10.0
DS1 – Alboran Sea	0	15.0	0	15.0
DS2- Balearic Sea	0	10.0	0	10.0
DS3 – Algerian Basin SW	0	10.0	0	10.0
DS4 – Algerian Basin SE	0	10.0	0	10.0

Code-Region Name	Phosphate (µmol/l)				Silicate (µmol/l)			
	0 - 200 m		201 m - bottom		0 - 200 m		201 m - bottom	
DF1 - Algero-Provencal	0	1.0	0	1.0	0	25.0	0	25.0
DF2 - Gulf of Lions	0	2.0	0	1.5	0	40.0	0	15.0
DS1 - Alboran Sea	0	2.0	0	1.0	0	20.0	0	20.0
DS2- Balearic Sea	0	1.0	0	1.0	0	10.0	0	15.0
DS3 - Algerian Basin SW	0	1.0	0	1.0	0	10.0	0	12.0
DS4 - Algerian Basin SE	0	1.0	0	1.0	0	10.0	0	10.0

	Alkalinity (µmol/l)				Ammonium (µmol/l)			
	0 - 200 m		201 m - bottom		0 - 200 m		201 m - bottom	
DF1 - Algero-Provencal	2000	3000	2000	3000	0	50.0	0	10.0
DF2 - Gulf of Lions	2000	3000	2000	3000	0	6.0	0	6.0
DS1 - Alboran Sea	2000	3000	2000	3000	0	10.0	0	10.0
DS2- Balearic Sea	2000	3000	2000	3000	0	2.0	0	2.0
DS3 - Algerian Basin SW	2000	3000	2000	3000	0	0.5	0	0.1
DS4 - Algerian Basin SE	2000	3000	2000	3000	0	10.0	0	10.0

	Chlorophyll-a (µg/l)				Nitrite (µmol/l)			
	0 - 200 m		201 m - bottom		0 - 200 m		201 m - bottom	
DF1 - Algero-Provencal	0	1.0	0	0.5	0	2.0	0	2.0
DF2 - Gulf of Lions	0	3.0	0	0.5	0	3.0	0	2.0
DS1 - Alboran Sea	0	1.0	0	0.5	0	2.0	0	2.0
DS2- Balearic Sea	0	1.0	0	0.5	0	2.0	0	2.0
DS3 - Algerian Basin SW	0	1.0	0	0.5	0	2.0	0	2.0
DS4 - Algerian Basin SE	0	1.0	0	0.5	0	2.0	0	2.0

	Total Nitrogen (µmol/l)				Total Phosphorus (µmol/l)			
	0 - 200 m		201 m - bottom		0 - 200 m		201 m - bottom	
DF1 - Algero-Provencal	0	10	0	9	0	1.5	0	1.5
DF2 - Gulf of Lions	0	7	0	9	0	1.0	0	1.0
DS1 - Alboran Sea	0	10	0	9	0	1.0	0	1.0
DS2- Balearic Sea	0	10	0	9	0	1.0	0	1.0
DS3 - Algerian Basin SW	0	10	0	9	0	1.0	0	1.0
DS4 - Algerian Basin SE	0	10	0	9	0	1.0	0	1.0

Code-Region Name	pH			
	0 - 200 m		201 m - bottom	
DF1 - Algero-Provencal	7.5	8.5	7.5	8.5
DF2 - Gulf of Lions	7.5	9.0	7.0	9.0
DS1 - Alboran Sea	7.5	8.5	7.0	8.5
DS2- Balearic Sea	7.5	8.5	7.5	8.5
DS3 - Algerian Basin SW	7.5	8.5	7.5	8.5
DS4 - Algerian Basin SE	7.5	8.5	7.5	8.5

Black Sea

The broad-range check values in the Black Sea were defined within EU-MAST/MEDAR/MEDATLAS II project (Mediterranean Data Archaeology and Rescue of temperature, salinity and bio-chemical parameters, 1998-2001) and during the EMODnet Chemistry Pilot Project (2009-2012) by MHI.

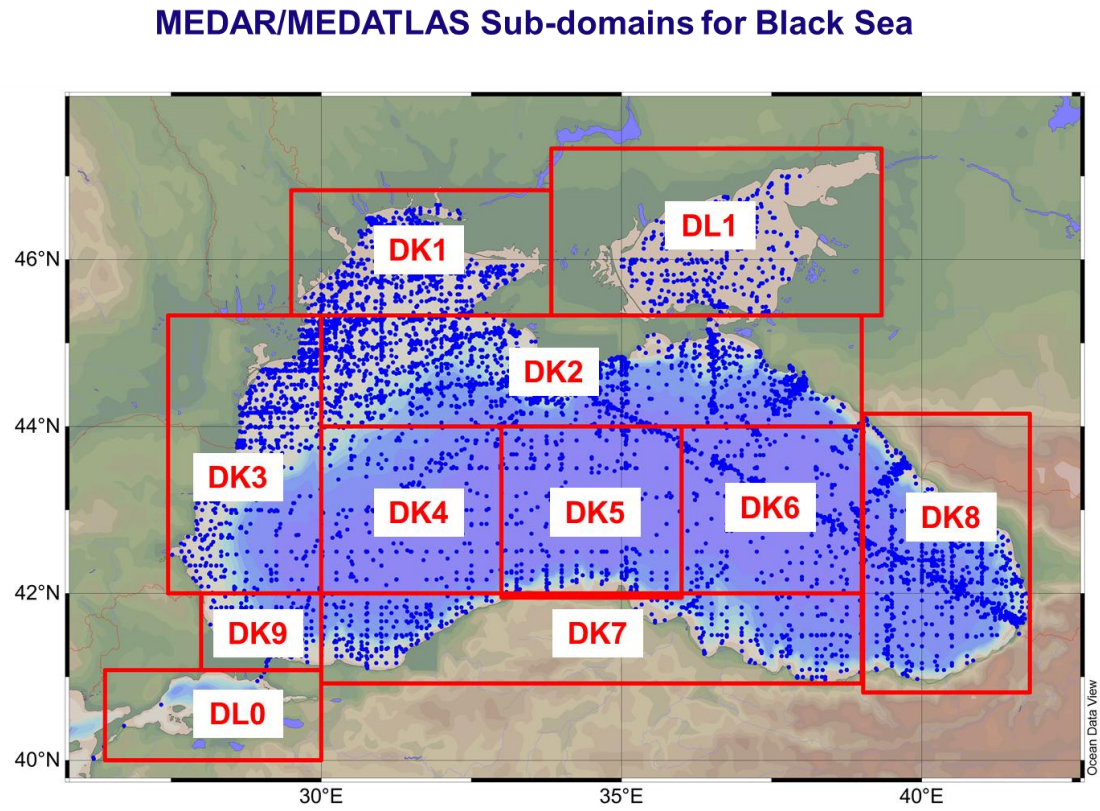

Figure 2: Regional sub-domains defined in the Black Sea for the broad range check.

Table 7: *Geographical limits of the Black Sea regions for broad range scale definition and the corresponding maximum depth.*

Code	Region Name	Lat. min	Lat. max	Lon. min	Lon. max	Max depth
DK0	BLACK SEA AND SEA OF ASOV	40 12.00'	47 24.00'	27 18.00'	41 54.00'	2313
DK1	BLACK SEA NORTH WEST SHELF	45 20.00'	46 50.00'	29 30.00'	33 50.00'	1000
DK2	BLACK SEA NORTH SLOPE	44 00.00'	45 20.00'	30 00.00'	39 00.00'	1500
DK3	BLACK SEA WEST SLOPE	42 00.00'	45 20.00'	27 30.00'	30 00.00'	1500
DK4	BLACK SEA WEST ABYSSAL	42 00.00'	44 00.00'	30 00.00'	33 00.00'	2313
DK5	BLACK SEA CENTRAL ABYSSAL	42 00.00'	44 00.00'	33 00.00'	36 00.00'	2313
DK6	BLACK SEA EAST ABYSSAL	42 00.00'	44 00.00'	36 00.00'	39 00.00'	2313
DK7	BLACK SEA SOUTH SLOPE	40 55.00'	42 00.00'	30 00.00'	39 00.00'	1500
DK8	BLACK SEA SOUTH-EAST SLOPE	40 50.00'	44 10.00'	39 00.00'	41 40.00'	1500
DK9	BLACK SEA ADJACENT TO BOSPHORUS	41 05.00'	42 00.00'	28 00.00'	30 00.00'	1500
DL0	MARMARA SEA	40 12.00'	41 05.00'	26 50.00'	30 00.00'	1000
DL1	SEA OF AZOV	45 20.00'	47 20.00'	33 50.00'	39 20.00'	200

Table 8: *Minimum and maximum control in the Black Sea regions as used for the broad-range check biogeochemical and physical parameter (T, S).*

Code	Region Name	Oxygen (ml/l)		Oxygen (µmol/l)		Ammonium (µmol/l)	
DK0	BLACK SEA AND SEA OF ASOV	0	13.3	0	600	0	100
DK1	BLACK SEA NORTH WEST SHELF	0	13.3	0	600	0	15
DK2	BLACK SEA NORTH SLOPE	0	12.7	0	570	0	70
DK3	BLACK SEA WEST SLOPE	0	12.8	0	580	0	96
DK4	BLACK SEA WEST ABYSSAL	0	10	0	450	0	98
DK5	BLACK SEA CENTRAL ABYSSAL	0	8.4	0	380	0	100
DK6	BLACK SEA EAST ABYSSAL	0	10.6	0	480	0	105
DK7	BLACK SEA SOUTH SLOPE	0	8.8	0	400	0	94
DK8	BLACK SEA SOUTH-EAST SLOPE	0	11.5	0	520	0	100

Code	Region Name	Nitrate (µmol/l)		Nitrite (µmol/l)		Phosphate (µmol/l)	
DK0	BLACK SEA AND SEA OF ASOV	0	33	0	15	0	13
DK1	BLACK SEA NORTH WEST SHELF	0	33	0	6	0	6
DK2	BLACK SEA NORTH SLOPE	0	24	0	3	0	10

DK3	*BLACK SEA WEST SLOPE*	*0*	*20*	*0*	*1.5*	*0*	*10*
DK4	*BLACK SEA WEST ABYSSAL*	*0*	*15*	*0*	*0.8*	*0*	*10*
DK5	*BLACK SEA CENTRAL ABYSSAL*	*0*	*13*	*0*	*0.8*	*0*	*11*
DK6	*BLACK SEA EAST ABYSSAL*	*0*	*13*	*0*	*1*	*0*	*12*
DK7	*BLACK SEA SOUTH SLOPE*	*0*	*10*	*0*	*0.5*	*0*	*10*
DK8	*BLACK SEA SOUTH-EAST SLOPE*	*0*	*21*	*0*	*15*	*0*	*13*

Code	***Region Name***	***Silicate (µmol/l)***		***pH***		***Alkalinity (µmol/l)***	
DK0	*BLACK SEA AND SEA OF ASOV*	*0*	*330*	*7*	*9.1*	*1000*	*4600*
DK1	*BLACK SEA NORTH WEST SHELF*	*0*	*160*	*7.4*	*9.1*	*1200*	*4300*
DK2	*BLACK SEA NORTH SLOPE*	*0*	*200*	*7.2*	*8.9*	*1400*	*4500*
DK3	*BLACK SEA WEST SLOPE*	*0*	*310*	*7.5*	*8.9*	*2800*	*4200*
DK4	*BLACK SEA WEST ABYSSAL*	*0*	*330*	*7.4*	*8.9*	*2900*	*4500*
DK5	*BLACK SEA CENTRAL ABYSSAL*	*0*	*330*	*7.5*	*9*	*2800*	*4500*
DK6	*BLACK SEA EAST ABYSSAL*	*0*	*320*	*7.5*	*8.7*	*2700*	*4600*
DK7	*BLACK SEA SOUTH SLOPE*	*0*	*310*	*7.6*	*8.7*	*2700*	*4200*
DK8	*BLACK SEA SOUTH-EAST SLOPE*	*0*	*310*	*7.5*	*8.9*	*1900*	*4500*

Code	***Region Name***	***Salinity (psu)***		***Temperature (°C)***	
DK0	*BLACK SEA AND SEA OF ASOV*	*0*	*24*	*-1*	*29*
DK1	*BLACK SEA NORTH WEST SHELF*	*0*	*21*	*-1*	*28*
DK2	*BLACK SEA NORTH SLOPE*	*4*	*23*	*2*	*28*
DK3	*BLACK SEA WEST SLOPE*	*7*	*23*	*3*	*27*
DK4	*BLACK SEA WEST ABYSSAL*	*12*	*24*	*5*	*27*
DK5	*BLACK SEA CENTRAL ABYSSAL*	*16*	*23*	*5*	*27*
DK6	*BLACK SEA EAST ABYSSAL*	*15*	*23*	*6*	*28*
DK7	*BLACK SEA SOUTH SLOPE*	*13*	*24*	*6*	*28*
DK8	*BLACK SEA SOUTH-EAST SLOPE*	*4*	*23*	*6*	*29*

DK9	*BLACK SEA ADJACENT TO BOSPHORUS*	*No Regional Limits defined for the parameters.* *Global limits (DK0 - BLACK SEA AND SEA OF AZOV) are taken for QC of the parameters.*
DL0	*MARMARA SEA*	
DL1	*SEA OF AZOV*	

Atlantic area

The broad-range check values in the Atlantic area are defined within our internal QA/QC control software.

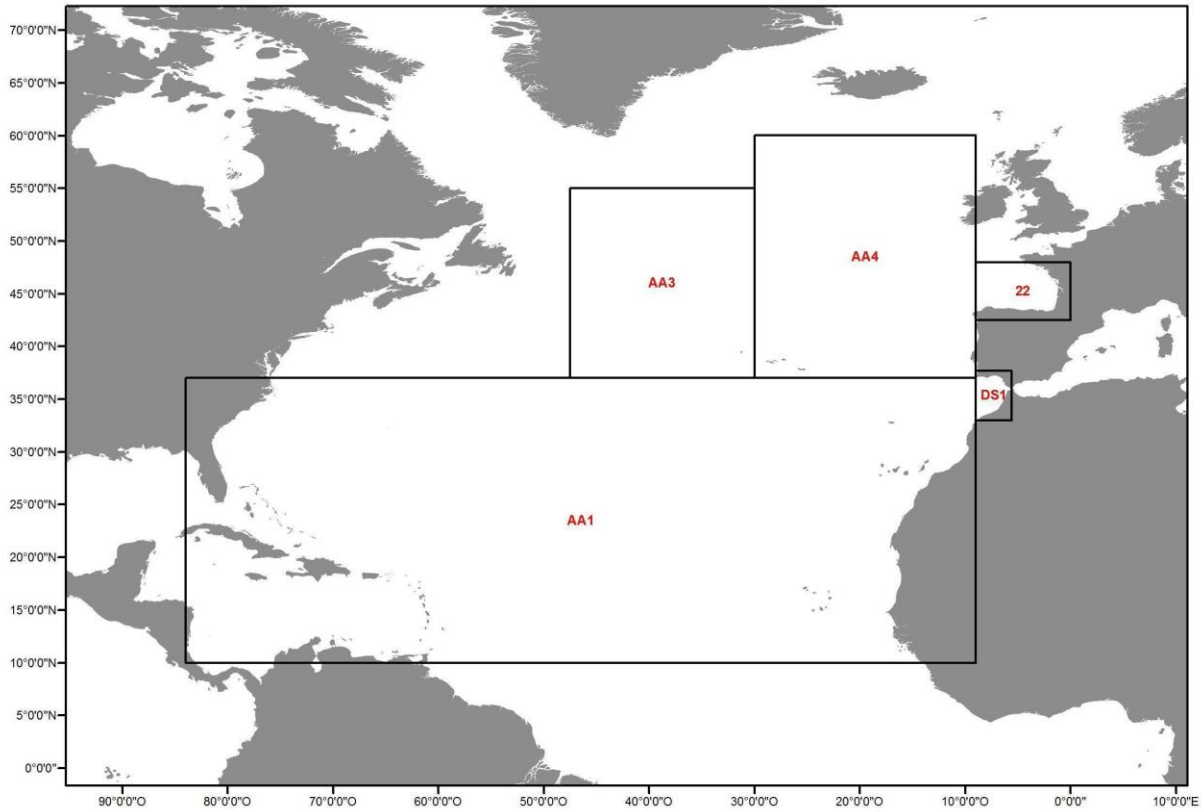

Figure 3: *Regional sub-domains defined in the Atlantic area for the broad range check.*

Table 9: *Geographical limits of the Atlantic regions for broad range scale definition and the corresponding maximum depth.*

Code	*Region Name*	*Lat. min*	*Lat. max*	*Lon min.*	*Lon max.*	*Max depth*
AA1	*NORTH ATLANTIC 1*	*10 00.00'*	*37 00.00'*	*84 00.00'*	*09 00.00'*	*6000*
AA3	*NORTH ATLANTIC 3*	*37 00.00'*	*55 00.00'*	*47 30.00'*	*30 00.00'*	*6000*
AA4	*NORTH ATLANTIC 4*	*37 00.00'*	*60 00.00'*	*30 00.00'*	*09 00.00'*	*6000*
DS1	*GIBRALTAR STRAIT*	*33 00.00'*	*37 42.00'*	*09 00.00'*	*05 36.00'*	*3000*
22	*Bay of Biscay*	*42 30.00'*	*48 00.00'*	*09 00.00'*	*00 00.00'*	*5000*

Table 10: *Minimum and maximum control values in the Atlantic regions as used for the broad-range check of hydrological core parameters.*

Code-Region Name	***Oxygen (ml/l)***		***Oxygen (µmol/l)***		***Nitrate (µmol/l)***	
	min	*max*	*min*	*max*	*min*	*max*
AA1 – NORTH ATLANTIC 1	*0*	*7*	*4*	*312*	*0*	*48*
AA3 – NORTH ATLANTIC 3	*ND*	*ND*			*0*	*48*
AA4 – NORTH ATLANTIC 4	*ND*	*ND*			*0*	*48*
DS1 – GIBRALTAR STRAIT	*0*	*7*	*4*	*312*	*ND*	*ND*
22 – Bay of Biscay	*0*	*7*	*4*	*312*	*0*	*48*
Global	*0*	*10*	*4*	*446*	*0*	*48*

Code-Region Name	***Phosphate (µmol/l)***		***Silicate (µmol/l)***		***pH***	
	min	*max*	*min*	*max*	*min*	*max*
AA1 - NORTH ATLANTIC 1	*0*	*3.6*	*0*	*150*	*7.5*	*8.4*
AA3 - NORTH ATLANTIC 3	*0*	*3.6*	*0*	*150*	*ND*	*ND*
AA4 - NORTH ATLANTIC 4	*0*	*3.6*	*0*	*150*	*ND*	*ND*
DS1 - GIBRALTAR STRAIT	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
22 - Bay of Biscay	*0*	*3.6*	*0*	*150*	*ND*	*ND*
Global	*0*	*4*	*0*	*200*	*7.4*	*8.4*

REGION	***Alkalinity (µmol/l)***		***Ammonium (µmol/l)***		***Chlorophyll-a (µg/l)***		***Nitrite (µmol/l)***		***Total Nitrogen (µmol/l)***		***Total phosphorus (µmol/l)***	
	min	*max*	*min*	*max*	*min*	*max*	*min*	*max*	*min*	*max*	*min*	*max*
Global	*1500*	*2500*	*0*	*10*	*0*	*99*	*0*	*10*	*0*	*90*	*0*	*10*

ND: No Data

Baltic Sea

The broad-range check values in the Baltic Sea are defined on the basis of the available data.

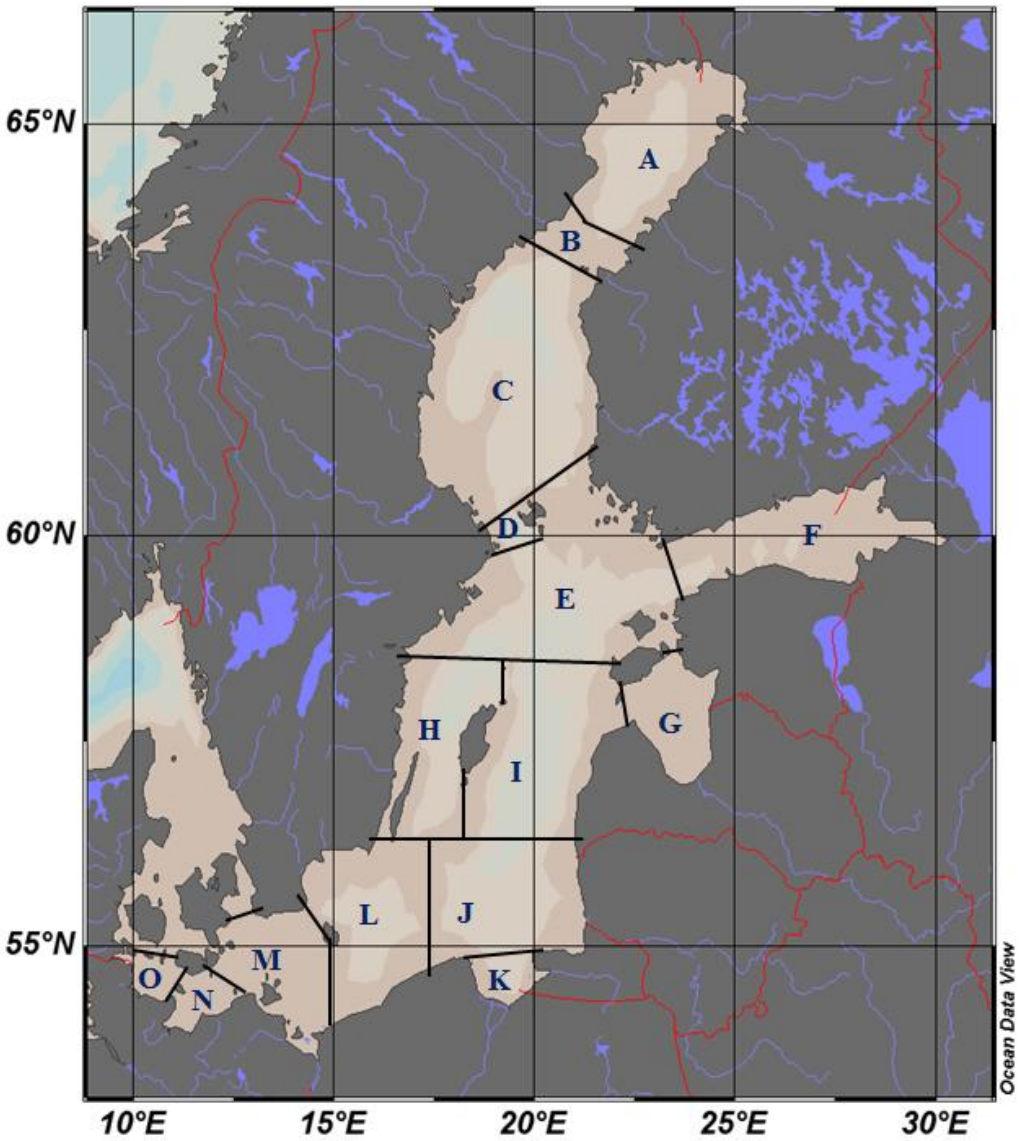

Figure 4: *Regional sub-domains defined in the Baltic Sea for the broad range check.*

A. Bothnian Bay
B. The Quark
C. Bothnian Sea
D. Åland Sea
E. Northern Baltic Sea Proper
F. Gulf of Finland
G. Gulf of Riga
H. Western Gotland Basin
I. Eastern Gotland Basin
J. South Eastern Basin
K. Gdansk Basin
L. Bornholm Basin
M. Arkona Basin
N. Bay of Mecklenburg
O. Bay of Kiel

Table 11: *Geographical limits of the Baltic Sea regions for broad range scale definition and the definition of surface and deep-water layers.*

Code	Region Name	Lat. Min	Lat.max	Long. Min	Long.max	Maxdepth	Surface water	Deep water
A	Bothnian Bay	63 30.00'	65 50.00'	20 40.00'	25 30.00'	146	0 - 50	50 - 140
B	The Quark	63 00.00'	64 00.00'	19 40.00'	21 40.00'	49	0 - 50	"-"
C	Bothnian Sea	60 20.00'	63 30.00'	17 00.00'	21 40.00'	293	0 - 50	50 - 250
D	Åland Sea	59 40.00'	60 20.00'	18 10.00'	21 00.00'	301	0 - 50	50 - 290
E	Northern Baltic Sea Proper	58 30.00'	59 40.00'	16 50.00'	23 30.00'	459	0 - 60	60 - 450
F	Gulf of Finland	59 10.00'	60 50.00'	23 20.00'	30 20.00'	123	0 - 40	40 - 110
G	Gulf of Riga	57 00.00'	58 30.00'	21 50.00'	24 40.00'	51	0 - 25	25 - 50
H	Western Gotland Basin	56 20.00'	58 30.00'	16 20.00'	22 00.00'	205	0 - 50	50 - 200
I	Eastern Gotland Basin	56 20.00'	58 30.00'	18 20.00'	22 20.00'	249	0 - 60	60 - 240
J	South Eastern Basin	54 20.00'	56 20.00'	16 30.00'	20 10.00'	114	0 - 40	40 - 100
K	Gdansk Basin	54 20.00'	55 00.00'	18 40.00'	20 30.00'	114	0 - 70	70 - 110
L	Bornholm Basin	54 00.00'	56 20.00'	15 00.00'	16 30.00'	105	0 - 40	40 - 100
M	Arkona Basin	54 00.00'	55 30.00'	12 00.00'	15 00.00'	53	0 - 30	30 - 50
N	Bay of Mecklenburg	54 00.00'	54 40.00'	10 50.00'	12 30.00'	26	0 - 15	15 - 25
O	Kiel Bay	54 40.00'	55 00.00'	09 40.00'	11 30.00'	35	0 - 15	15 - 35

Table 12: *Minimum and maximum control values in the surface and bottom layers for the Baltic Sea regions as used for the broad-range check of hydrological core parameters.*

Code	Region Name	Oxygen (ml/l)				Oxygen (umol/l)			
		Surfacemin	max	Bottom min	max	Surfacemin	max	Bottom min	max
A	Bothnian Bay	4	11	5	11	178	491	223	491
B	The Quark	5	11	"-"	"-"	223	491	"-"	"-"
C	Bothnian Sea	0	12	0	11	4	535	4	491
D	Åland Sea	5	12	4	10	223	535	178	446
E	Northern Baltic Sea Proper	-5	12	-5	11	-223	535	-223	491
F	Gulf of Finland	0	13	-1	11	4	580	-45	491
G	Gulf of Riga	1	13	7	9	45	580	312	402
H	Western Gotland Basin	-0.5	10	-3	14	-22	446	-134	625
I	Eastern Gotland Basin	-0.2	12	-8	9	-9	535	-357	402
J	South Eastern Basin	2	21	-4	11	89	937	-178	491
K	Gdansk Basin	1	10	-3.5	9	45	446	--156	402
L	Bornholm Basin	1	13	-4	11	45	580	-178	491
M	Arkona Basin	0	15	0	11	4	669	4	491
N	Bay of Mecklenburg	0	21	0	17	4	937	4	758
O	Kiel Bay	1	27	0	17	45	1205	4	758

Code	Region Name	Chlorophyll-a (ug/l)	
		Surfacemin	max
A	Bothnian Bay	0	5
B	The Quark	1	3
C	Bothnian Sea	0	99
D	Åland Sea	0	9
E	Northern Baltic Sea Proper	0	23
F	Gulf of Finland	0	
G	Gulf of Riga	1	7
H	Western Gotland Basin	0	34
I	Eastern Gotland Basin	0	36
J	South Eastern Basin	0	31
K	Gdansk Basin	0	31
L	Bornholm Basin	0	53
M	Arkona Basin	0	50
N	Bay of Mecklenburg	0	21
O	Kiel Bay	0	50

Code	Region Name	Phosphate (µmol/l)				Total phosphorus (µmol/l)			
		Surfacemin	max	Bottom min	max	Surfacemin	max	Bottom min	max
A	Bothnian Bay	0	0.9	0	3.5	0	1	0	8.4
B	The Quark	0	0.7	"-"	"-"	0	1.4	"-"	"-"
C	Bothnian Sea	0	13	0	4	0	13	0	8.1
D	Åland Sea	0	1.1	0	3	0	1.8	0	3.3
E	Northern Baltic Sea Proper	0	36	0	12	0	30	0	16
F	Gulf of Finland	0	6	0	11	0	4	0	11
G	Gulf of Riga	0	1	0	2	0	1.4	0	2
H	Western Gotland Basin	0	36	0	20	0	40	0	20
I	Eastern Gotland Basin	0	3	0	10	0	4	0	12
J	South Eastern Basin	0	11	0	10	0	16	0	17
K	Gdansk Basin	0	11	1	10	0	16	1	10
L	Bornholm Basin	0	11	0	15	0	13	0	25
M	Arkona Basin	0	28	0	7	0	28	0	7.1
N	Bay of Mecklenburg	0	13	0	13	0	18	0	13
O	Kiel Bay	0	3.6	0	17	0	4	0	19

Code	Region Name	Nitrite (µmol/l)				Nitrate (µmol/l)			
		Surfacemin	max	Bottom min	max	Surfacemin	max	Bottom min	max
A	Bothnian Bay	0	0.9	0	0.8	3	11	0	10
B	The Quark	0	0.6	"-"	"-"	0	15	"-"	"-"
C	Bothnian Sea	0	2.2	0	1.5	0	14	0	12
D	Åland Sea	0	0.5	0	0.5	0	7	0	8
E	Northern Baltic Sea Proper	0	4.2	0	3.4	0	71	0	15
F	Gulf of Finland	0	3.4	0	1.1	0	195	0	11
G	Gulf of Riga	0	1.2	0	0.7	NED			
H	Western Gotland Basin	0	10	0	2.7	0	99	0	34
I	Eastern Gotland Basin	0	1.1	0	4.4	0	11	0	17
J	South Eastern Basin	0	2	0	2.3	0	12	0	15
K	Gdansk Basin	0	3.3	0	2.4	0	215	0	17
L	Bornholm Basin	0	1.7	0	3	0	48	0	19
M	Arkona Basin	0	5.2	0	1.9	0	340	0	40
N	Bay of Mecklenburg	0	2.1	0	1.9	0	13	0	13
O	Kiel Bay	0	1.9	0	1.3	0	15	0	14

ND=No Data; NED= Not Enough Data

Code	Region Name	Ammonium (µmol/l)				Total nitrogen (µmol/l)			
		Surfacemin	max	Bottom min	max	Surfacemin	max	Bottom min	max
A	Bothnian Bay	0	23	0	7	10	56	10	44
B	The Quark	0	25	"-"	"-"	10	24	"-"	"-"
C	Bothnian Sea	0	99	0	9	6	33	8	34
D	Åland Sea	0	3	0	7	9	29	9	35
E	Northern Baltic Sea Proper	0	85	0	34	8	39	4	54
F	Gulf of Finland	0	25	0	31	0	380	3	43
G	Gulf of Riga	0	2	0	3	22	44	24	40
H	Western Gotland Basin	0	98	0	25	10	25	10	70
I	Eastern Gotland Basin	0	3	0	73	0	40	0	73
J	South Eastern Basin	0	43	0	29	0	67	0	70
K	Gdansk Basin	0	43	0	30	2	226	2	63
L	Bornholm Basin	0	32	0	30	0	80	2	63
M	Arkona Basin	0	63	0	17	0	610	0	209
N	Bay of Mecklenburg	0	24	0	28	0	465	0	63
O	Kiel Bay	0	12	0	54	3	390	3	72

Code	Region Name	Silicate (µmol/l)			
		Surfacemin	max	Bottom min	max
A	Bothnian Bay	4	225	2	51
B	The Quark	0	230	"-"	"-"
C	Bothnian Sea	0	230	0	91
D	Åland Sea	0	92	0	62
E	Northern Baltic Sea Proper	0	140	0	113
F	Gulf of Finland	0	141	0	84
G	Gulf of Riga	0	30	0	51
H	Western Gotland Basin	0	115	0	226
I	Eastern Gotland Basin	0	74	0	200
J	South Eastern Basin	0	115	0	120
K	Gdansk Basin	0	246	0	85
L	Bornholm Basin	0	220	0	115
M	Arkona Basin	0	300	0	80
N	Bay of Mecklenburg	0	195	0	101
O	Kiel Bay	0	180	0	155

Code	Region Name	pH				Alkalinity (µmol/l)			
		Surfacemin	max	Bottom min	max	Surfacemin	max	Bottom min	max
A	Bothnian Bay	6.5	8.8	7.3	8.2	500	1100	600	1200
B	The Quark	6	8.8	"-"	"-"	ND			
C	Bothnian Sea	6	9	6.7	8.4	800	1800	1000	1800
D	Åland Sea	7.5	8.7	7.4	8.5	ND			
E	Northern Baltic Sea Proper	6.5	9.4	6.5	8.4	ND			
F	Gulf of Finland	6.2	9	6.8	8.7	700	1200	1200	1700
G	Gulf of Riga	7.3	9.4	7.3	8.8	ND			
H	Western Gotland Basin	6.5	9.5	6.7	10	NED			
I	Eastern Gotland Basin	6.8	9	6.5	8.3	1400	1700	1500	2100
J	South Eastern Basin	6.5	9	6.7	9	NED			
K	Gdansk Basin	7.3	8.3	7.2	8.1	ND			
L	Bornholm Basin	6.6	9	6.6	8.5	NED			
M	Arkona Basin	7	9.5	7	8.7	NED			
N	Bay of Mecklenburg	7.2	10	7	8.3	ND			
O	Kiel Bay	5.6	9	6.9	8.3	ND			

NED=Not Enough Data; ND: No Data

North Sea

The broad-range check values in the North Sea are defined on the basis of the available data. The Areas are checked in boxes shown in table 9, but mainly for the divisions used by OSPAR, e.g. North sea/Norwegian Trench. No data were available for Iceland West, and only the eastern part of Iceland East.

Top-bottom levels are set after typical depth profiles and chlorophyll profiles, and bottom depth is the deepest measurement in the areas. Nitrite, Alkalinity and pH was only available in Skaggerak and the Sound/Belt Sea.

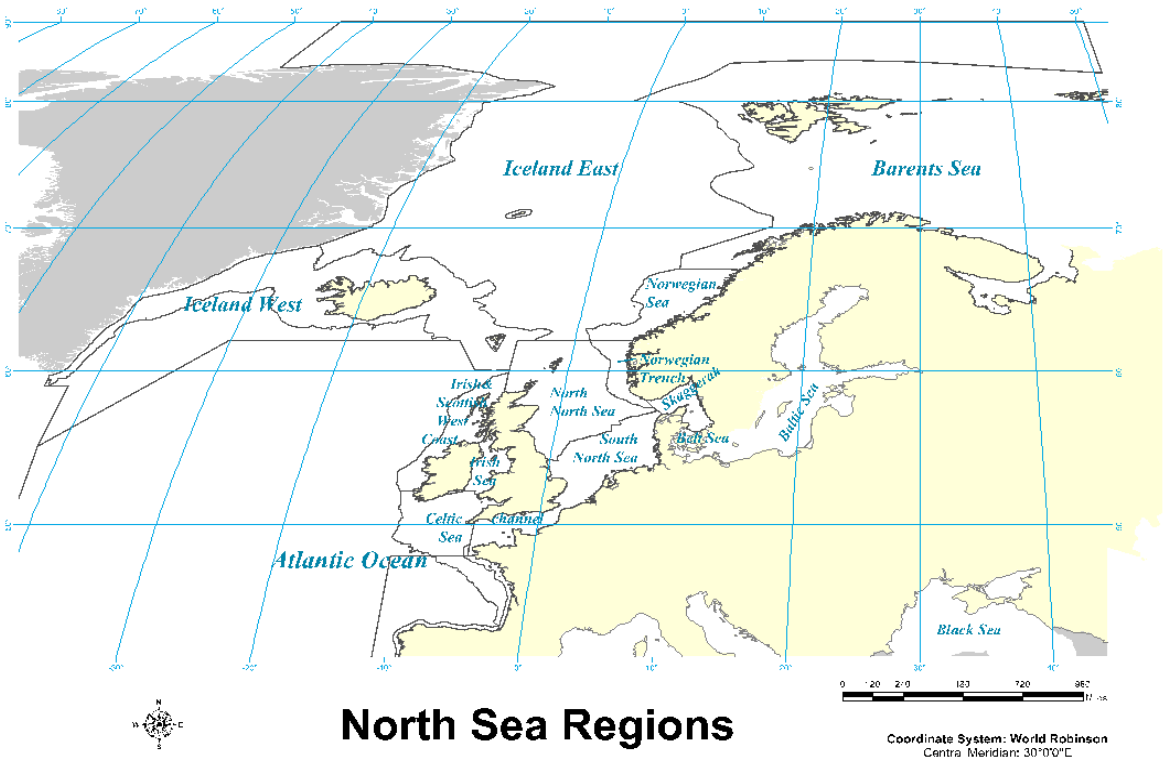

Figure 5: *Regional sub-domains defined in the North Sea for the broad range check*

Table 13: *Geographical limits of the North Sea regions for broad range scale definition and the corresponding maximum depth.*

Code	Region Name	Lat.Min	Lat.max	Long. Min	Long.max	Max.depth	Surface water	Deep water
SBS	Sound-Belt Sea	54 50	56 50	9 30	13 20	65	0-5	5-65
Sk	Skaggerak	55 90	60 00	8 00	13 00	700	0-50	50-700
NT	Norwegian Trench	57 50	62 00	1 30	8 00	300	0-50	50-300
Ch	Channel	48 00	51 30	-5 00	1 80	110	0-20	20-110
NNS	North North Sea	54 00	62 00	-5 00	8 50	100	0-50	50-100
SNS	South North Sea	52 00	57 15	-8 5	9 20	50	0-10	10-50
CS	Celtic Sea	48 00	52 17	-11 50	-1 00	110	0-20	20-110

IS	*Irish Sea*	*52 00*	*56 00*	*-8 00*	*-2 50*	*140*	*0-20*	*20-140*
WC	*Irish and Scottish West Coast*	*52 20*	*60 00*	*-12 00*	*-5 00*	*110*	*0-20*	*20-110*
IW	*Iceland West*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
IE	*Iceland East*	*62 00*	*73 26*	*-5 00*	*16 00*	*3250*	*0-100*	*100-3000*
NS	*Norwegian Sea*	*62 00*	*67 00*	*5 00*	*15 00*	*900*	*0-100*	*100-800*
BS	*Barents Sea*	*67 00*	*73 26*	*7 70*	*21 80*	*1100*	*0-100*	*100-1100*

ND=No Data

Table 14: *Minimum and maximum control values in the surface and bottom layers for the North Sea regions as used for the broad-range check of hydrological core parameters*

Code	***Region Name***	***Oxygen (µmol/l)***				***Chlorophyll-a (µg/l)***	
		Surfacemin	*max*	*Bottom min*	*max*	*Surfacemin*	*max*
SBS	*Sound-Belt Sea*	*0*	*1000*	*0*	*925*	*0*	*700*
Sk	*Skaggerak*	*<0*	*725*	*<0*	*375*	*0*	*100*
NT	*Norwegian Trench*	*45*	*425*	*130*	*335*	*0*	*13*
Ch	*Channel*	*220*	*320*	*210*	*325*	*0*	*80*
NNS	*North N. Sea*	*45*	*600*	*17*	*350*	*0*	*15*
SNS	*South N. Sea*	*40*	*850*	*110*	*750*	*0*	*300*
CS	*Celtic Sea*	*175*	*325*	*140*	*350*	*0*	*10*
IS	*Irish Sea*	*40*	*730*	*110*	*360$*	*0*	*80*
WC	*I/S West Coast*	*210*	*335*	*180*	*420*	*0*	*30*
IE	*Iceland East*	*200*	*400*	*250*	*350*	*0*	*3,5*
NS	*Norwegian Sea*	*10*	*350*	*150*	*300*	*0*	*13*
BS	*Barents Sea*	*175*	*350*	*50*	*330*	*0*	*10*

Code	***Region Name***	***Phosphate (µmol/l)***				***Total phosphorus (µmol/l)***			
		Surfacemin	*max*	*Bottom min*	*max*	*Surfacemin*	*max*	*Bottom min*	*max*
SBS	*Sound-Belt Sea*	*0*	*110*	*0*	*50*	*0*	*160*	*0*	*85*
Sk	*Skaggerak*	*0*	*30*	*0*	*10*	*0*	*1100*	*0*	*5*
NT	*Norw. Trench*	*0*	*4*	*0.2*	*3*	*NED*	*NED*	*NED*	*NED*
Ch	*Channel*	*0*	*16*	*0*	*2*	*NED*	*NED*	*NED*	*NED*
NNS	*North N. Sea*	*0*	*4.5*	*0.15*	*3.2*	*0.06*	*4*	*0.4*	*1*
SNS	*South N. Sea*	*0*	*25*	*0*	*6.5*	*0*	*22*	*0*	*13*
CS	*Celtic Sea*	*0*	*0.7*	*0*	*1*	*NED*	*NED*	*NED*	*NED*
IS	*Irish Sea*	*0*	*6*	*0*	*2*	*NED*	*NED*	*NED*	*NED*
WC	*I/S West Coast*	*0*	*4*	*0*	*1*	*NED*	*NED*	*NED*	*NED*
IE	*Iceland East*	*0*	*90*	*0.2*	*60*	*NED*	*NED*	*NED*	*NED*
NS	*Norwegian Sea*	*0*	*14*	*0*	*2*	*NED*	*NED*	*NED*	*NED*
BS	*Barents Sea*	*0*	*4*	*0.1*	*1.5*	*ND*	*ND*	*ND*	*ND*

NED=Not Enough Data; ND: No Data

Code	Region Name	Nitrate (µmol/l)				Nitrite+Nitrate (µmol/l)			
		Surfacemin	max	Bottom min	max	Surfacemin	max	Bottom min	max
SBS	Sound-Belt Sea	0	110	0	55	0	1250	0	250
Sk	Skaggerak	0	95	0	23	0	310	0	20
NT	Norw. Trench	0	23	0	23	ND	ND	ND	ND
Ch	Channel	0	80	0	22	0	400	0	23
NNS	North N. Sea	0	13	1.2	15	0.5	15	1.3	13
SNS	South N. Sea	0	550	0	100	0	310	0	85
CS	Celtic Sea	0	10	0	11	0	10	0.7	10
IS	Irish Sea	0	220	0	23	0	220	0	25
WC	I/S West Coast	0	85	1	11	0	125	1	11
IE	Iceland East	0	15	0.05	22	ND	ND	ND	ND
NS	Norwegian Sea	0	23	1.5	16	ND	ND	ND	ND
BS	Barents Sea	0	15	2	20	ND	ND	ND	ND

ND=No Data;

Code	Region Name	Ammonia (µmol/l)				Total-Nitrogen (µmol/l)			
		Surfacemin	max	Bottom min	max	Surfacemin	max	Bottom min	max
SBS	Sound-Belt Sea	0	900	0	300	0	1650	0	500
Sk	Skaggerak	0	100	0	20	0	350	0	100
NT	Norw. Trench	ND	ND	ND	ND	NED	NED	NED	NED
Ch	Channel	0	11	0	6	2	17	6	15
NNS	North N. Sea	0	5	0	6	4	60	7,5	35
SNS	South N. Sea	0	100	0	55	0	850	0	180
CS	Celtic Sea	0	5.5	0	7	NED	NED	NED	NED
IS	Irish Sea	0	85	0	7	NED	NED	NED	NED
WC	I/S West Coast	0	15	0	5	NED	NED	NED	NED
IE	Iceland East	ND	ND	ND	NED	NED	NED	NED	NED
NS	Norwegian Sea	ND	ND	ND	NED	NED	NED	NED	NED
BS	Barents Sea	ND	ND	ND	ND	ND	ND	ND	ND

ND=No Data; NED= Not Enough Data

Code	Region Name	Nitrite (µmol/l)				Silicate (µmol/l)			
		Surfacemin	max	Bottom min	max	Surfacemin	max	Bottom min	max
SBS	Sound-Belt Sea	0	5	0	13	0	400	0	185

Sk	*Skaggerak*	*0*	*3.5*	*0*	*4*	*0*	*250*	*0*	*200*
NT	*Norw. Trench*	*0*	*2.5*	*0*	*1*	*0*	*50*	*0.6*	*26*
Ch	*Channel*	*0*	*2*	*0*	*1.5*	*0*	*36*	*0*	*20*
NNS	*North N. Sea*	*0*		*0*		*0*	*8*	*0.7*	*9*
SNS	*South N. Sea*	*0*	*7*	*0*	*6*	*0*	*250*	*0*	*50*
CS	*Celtic Sea*	*0*	*1.4*	*0*	*1.6*	*0*	*5.5*	*0*	*7.5*
IS	*Irish Sea*	*0*	*5*	*0*	*1*	*0*	*175*	*0*	*12*
WC	*I/S West Coast*	*0*	*1*	*0*	*0.5*	*2*	*8*	*2*	*7*
IE	*Iceland East*	*0*	*0.7*	*0*	*0.9*	*0*	*15*	*0.6*	*11*
NS	*Norwegian Sea*	*0*	*2*	*0*	*0.5*	*0*	*50*	*0.5*	*26*
BS	*Barents Sea*	*0*	*2*	*0*	*0.3*	*0*	*22*	*1*	*15*

ND=No Data; NED= Not Enough Data

Code	***Region Name***	***pH***				***Alkalinity (µmol/l)***			
		Surfacemin	*max*	*Bottom min*	*max*	*Surfacemin*	*max*	*Bottom min*	*max*
SBS	*Sound-Belt Sea*	*8.11*	*8.20*	*8.14*	*8.21*	*ND*	*ND*	*ND*	*ND*
Sk	*Skaggerak*	*7.81*	*8.37*	*7.71*	*8.26*	*1885*	*2015*	*2280*	*2400*
NT	*Norw. Trench*	*NED*	*NED*	*NED*	*NED*	*ND*	*ND*	*ND*	*ND*
Ch	*Channel*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
NNS	*North N. Sea*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
SNS	*South N. Sea*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
CS	*Celtic Sea*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
IS	*Irish Sea*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
WC	*I/S West Coast*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
IE	*Iceland East*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
NS	*Norwegian Sea*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
BS	*Barents Sea*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*

ND=No Data; NED= Not Enough Data

Specific focus on Danish waters:

Nutrient limits for Danish open waters and coastal waters and fjords based on the monthly long – term range minimum-maximum values (covering 1989-2019) are available from Hansen & Høglund, 2021. The open waters cover mainly Kattegat, Skaggerak and the North Sea part of Danish waters. The maximum and minimum average values for the three months of each season was used.

Substance (µmol/l)	*Season*	*min open water*	*max open water*	*max coastal waters and fjords*
Dissolved Inorganic Nitrogen (NH4 +NO2+NO3)	*winter*	*0.7*	*10.0*	*53.6*
Dissolved Inorganic Nitrogen	*spring*	*0.4*	*1.4*	*21.4*
Dissolved Inorganic Nitrogen	*summer*	*0.0*	*0.7*	*7.1*
Dissolved Inorganic Nitrogen	*fall*	*0.4*	*5.7*	*35.7*
Total Nitrogen	*winter*	*14.3*	*28.6*	*85.7*
Total Nitrogen	*spring*	*12.9*	*25.0*	*57.1*
Total Nitrogen	*summer*	*12.9*	*25.0*	*42.9*
Total Nitrogen	*fall*	*14.3*	*25.0*	*71.4*
Dissolved Inorganic Phosphorus	*winter*	*0.2*	*1.0*	*1.5*
Dissolved Inorganic Phosphorus	*spring*	*0.03*	*0.3*	*0.6*
Dissolved Inorganic Phosphorus	*summer*	*0.03*	*0.3*	*1.6*
Dissolved Inorganic Phosphorus	*fall*	*0.2*	*0.8*	*1.3*
Total Phosphorus	*winter*	*0.6*	*1.6*	*2.6*
Total Phosphorus	*spring*	*0.3*	*1.3*	*1.8*
Total Phosphorus	*summer*	*0.5*	*1.0*	*3.1*
Total Phosphorus	*fall*	*0.6*	*1.3*	*2.3*
Silicate	*winter*	*0.2*	*1.1*	*1.6*
Silicate	*spring*	*0.04*	*0.4*	*0.7*
Silicate	*summer*	*0.04*	*0.4*	*1.8*
Silicate	*fall*	*0.2*	*0.9*	*1.4*

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6 Annex 2. Review of N:P ratios in the sub-basins of the European Seas

Basin	Region/Basin	Depth/Layer	Season	Reported N:P ratio	Reference(s)
Mediterranean	Western Mediterranean	Surface (0–120 m)	Year-round	2–165 (local), 10–289 (E–W section)	Djaoudi et al. 2018
	Western Mediterranean	Deep water	Year-round	20–24	Markaki et al. 2010; Krom et al. 2004
	Ionian–Tyrrhenian	Surface (0–120 m)	Year-round	10 - 289	Djaoudi et al. 2018
	Eastern Mediterranean	Surface (0–100 m)	Year-round	2–825	Levantine LTER (2021); Ezra et al., 2021
	Eastern Mediterranean	Deep water	Year-round	25–28	Krom et al. 2004; Pujo-Pay et al. 2011
	North Adriatic	Water column	Year-round	1 - 600	Socal et al., 2008; Lipizer et al., 1999; 2011; Degobbis et al., 2005; Malone et al., 2020
	Middle Adriatic	Surface (0 - 200)	Year-round	8 - 46	Veža et al., 2024
	South Adriatic	Deep water	Winter	20 - 30	Batistić et al., 2017
Black Sea	Basin-scale open waters	Surface mixed layer	Year-round	2 - 38	Yunev et al., 2021; BSC, 2008; Tuğrul et al., 2014
	NW Black Sea (Danube–Black Sea mixing zone)	Surface; 0.3 < S < 17	Spring - Summer	3–1808	Cauwet et al., 2002; Cociasu et al, 1997
	SE Black Sea (Turkish coast)	Surface (coastal & offshore)	2015–2019 (multi-season)	4.8*(mean)	Alkan et al., 2022
	Romanian Black Sea – All stations	Surface (0–10 m)	1980–2023 (multi-season)	1 -400	Lazăr et al., 2024; ANEMONE Project, 2021; Ristea et al., 2025
North Sea	Open North Sea	Surface	Annual mean	25–60	Danish Marine Nutrient Assessment; Ærtebjerg et al., 2003; OSPAR 2017
	Open North Sea	Deep water	Year-round	12 - 30	Siems et al., 2024
	Southern North Sea	Surface	April (spring bloom)	1–375	Burson et al. 2016
	Southern North Sea - near estuaries	Bottom waters	Year-round	>20 up to >40 locally	OSPAR (2017; QSR 2023)

	Northern offshore - Estuaries	Surface	Winter	14 - 160	OSPAR 2017
	Belt Sea & Kattegat	Surface	Annual mean	10–20	Danish Marine Nutrient Assessment
	Wadden Sea	Surface	Winter/Annual	41–123	Wadden Sea QSR 2022; van Beusekom, J.E.E. et al. (2017)
Baltic	Whole Baltic (open basins)	Surface	Winter / spring	3 - 15	Savchuk 2018; Gustafsson et al. 2012; Kuliński et al., 2022; HELCOM (2009); Mollica et al. (2025)
	Bothnian Sea (offshore)	Surface	Winter surface (0–10 m)	1 - 16	Rolff & Elfwing 2015; Savchuk 2018; Kuliński et al., 2022
	Bothnian Bay (offshore)	Surface	Winter surface (0–10 m)	>100 to >250	Savchuk 2018; Gustafsson et al. 2012; Kuliński et al., 2022
	Gulf of Finland (open sea)	Surface	Winter surface (0–10 m)	1 - 16 Well below 16	Rolff & Elfwing 2015; Savchuk 2018; Kuliński et al., 2022
	Gulf of Riga (central)	Surface	April (start of spring bloom)	1 - 17	HELCOM assessments; regional studies (e.g., Gulf of Riga studies); Kalve et al. (2018)
North East Atlantic	English Channel — Western (L4, Plymouth)	Surface	Summer rainfall event	1 - 49	Rees, A.P., et al. (2009)
	Celtic Sea (seasonally stratified shelf)	Bottom waters	Summer rainfall event	13*(mean)	Davis, C.E., et al. (2014)
	Irish Sea — Western offshore	Winter (typical)	Winter	7.5*(mean)	Gowen, R.J., et al. (2005)
	Bay of Biscay (shelf & plume-influenced)	Surface	Year-round	1 - 650	Ratmaya, W., et al. (2019); Guillaud, J.-F., et al. (2008)
	Wider NE Atlantic (open ocean transect, 45–66°N; 15–20°W)	Surface	Late spring (June, post-bloom)	15 - 43	Leblanc, K., et al. (2009)
Arctic waters	Atlantic sector of the Arctic	surface	Summer	12 - 16	Duarte et al., 2021; Jones et al. 2003
	Atlantic sector of the Arctic	intemediate	Summer	13 - 15	Duarte et al., 2021; Jones et al. 2003
	Atlantic sector of the Arctic	deep	Summer	15*(median)	Duarte et al., 2021; Jones et al. 2003
	Barents Sea (Atlantic influenced)	surface	Summer	0 - 24	Downes et al., 2021
	Barents Sea (Arctiic influenced)	surface	Summer	0 - 66	Downes et al., 2021

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