CEMP guidelines for coordinated monitoring for hazardous substances[1]

Contents

[1] Revised in 2021

1 Introduction

In 2019 the OSPAR Commission adopted a revised OSPAR Joint Assessment and Monitoring Programme (JAMP) 2014–2023[2] (http://www.ospar.org/work-areas/cross-cutting-issues/jamp) focusing on the development of assessments of the quality status of the marine environment for the QSR 2023. OSPAR coordinates repeated measurement and assessment of the marine environment over a 10–20 year timeframe.

The OSPAR Commission's strategic objective with regard to hazardous substances is to prevent pollution of the OSPAR maritime area by continuously reducing discharges, emissions and losses of hazardous substances, with the ultimate aim to achieve concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.

The Hazardous Substances Strategy will be implemented progressively by making every endeavour, through appropriate actions and measures:

a. to achieve concentrations of contaminants at levels not giving rise to pollution effects, and contaminants in fish and other seafood for human consumption not exceeding levels established by EU legislation or other relevant standards, and finally;

b. to move towards the targets of the cessation of discharges, emissions and losses of hazardous substances by the year 2020[3].

To achieve these goals, programmes for monitoring the state of and pressures caused by hazardous substances to the marine environment have been implemented, comprising monitoring different compartments of the sea and inputs from rivers and atmosphere.

This document provides links to the monitoring guidelines, data sources, processing procedures and assessment products.

2 Monitoring for hazardous substances

Regular activities under the Strategy for the JAMP for status and pressure monitoring of hazardous substances and biological effects are set out in the Coordinated Environmental Monitoring Programme (CEMP) (OSPAR Agreement 2016-01[4]).

This guideline also includes Arctic monitoring requirements under the auspices of the Arctic Monitoring and Assessment Programme (AMAP)

2.1 Purpose

The aim of the monitoring programmes for hazardous substances is to deliver comparable data from across the OSPAR maritime area, which can be used in assessments to address the specific questions raised in the JAMP:

- Assessment of the status of the marine environment

[2] OSPAR Agreement 2014-02
[3] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) L164/19
[4] OSPAR Agreement 2016-01

- Assessment of the pressures on the marine environment
- Assessment of the effectiveness of measures

3 Monitoring of Hazardous substances in the marine environment

The Coordinated Environmental Monitoring Programme CEMP[5]

The general outline of monitoring requirements within the CEMP is defined at

http://www.ospar.org/work-areas/cross-cutting-issues/cemp

A general description of AMAP's strategy for implementing monitoring in the Arctic is available at

https://www.amap.no/about/

The following guidelines are available from http://www.ospar.org/work-areas/cross-cutting-issues/cemp

Under the *Hazardous substances & eutrophication CEMP guideline* heading:

- CEMP Guidelines on Quality Assurance for Biological Monitoring in the OSPAR Area (Agreement 2002-15). Revised in 2018/19
- CEMP Guidelines for Monitoring Contaminants in Sediments (Agreement 2002-16). Revision 2018
- JAMP Guidelines for General Biological Effects Monitoring. Revised technical annexes 2007 (Agreement 1997-07)
- JAMP Guidelines for Contaminant-Specific Biological Effects (Agreement 2008-09) (Replaces Agreement 2003-10)
- JAMP Guideline on the analysis of PFCs in Seawater (Agreement 2010-08)
- CEMP Guidelines for Monitoring Contaminants in Biota (Agreement 1999-02). Revision 2018
- CEMP Guidelines for coordinated monitoring for hazardous substances (Agreement 2016-04).

Eutrophication related guidelines are described in a separate guideline, Agreement 2016-05.

Plastic pollution is not handled in the Hazardous substance part of CEMP, but is assessed within the Environmental Impacts of Human activities with the following guidelines in place

- CEMP Guidelines for monitoring marine litter washed ashore and/or deposited on coastlines (beach litter)
- CEMP Guidelines on Litter on the Seafloor
- CEMP Guidelines for Monitoring and Assessment of plastic particles in stomachs of fulmars in the North Sea area

3.1 Monitoring Indicators

[5]OSPAR Agreement: 2016-01

These Guidelines are focused on monitoring of the concentrations and effects of selected contaminants in the marine environment as follows:

- metals (cadmium, mercury and lead) in sediment and biota
- PAHs in biota and sediment
- PCBs in biota and sediment
- brominated flame retardants in biota and sediment
- the effects of tributyltin in gastropods and concentrations in sediment and/or biota

The CEMP also includes a pre-CEMP covering components which the Contracting Parties are preparing to monitor in a co-ordinated manner through the development of monitoring guidance, quality assurance procedures and/or assessment tools. Currently the pre-CEMP includes the following components:

- planar PCBs in biota
- alkylated PAHs in biota and sediment
- PFOS in sediment, biota and water
- dioxins and furans in biota and sediment
- PAH- and metal-specific biological effects
- general biological effects

The components listed as OSPAR Common Indicators for regional compliance monitoring under MSFD Descriptor 8 are also part of CEMP.

Information on the actual status of the substances and compartments monitored, the links to the related assessment guidance documents as well as Contracting Parties monitoring is compiled in the related (expanded) CEMP appendices. The links to the assessment guidance documents are also listed under chapter 3.8.1.

3.2 Qualitative objectives

Qualitative objectives of the monitoring programme for hazardous substances have been established, based on measurements of the concentrations and bioeffects of hazardous substances in the marine environment:

To detect:

- whether those hazardous substances monitored are at, or approaching, background levels for naturally occurring substances and close to zero for man-made substances,
- how are the concentrations/bioeffects changing over time?
- whether the concentrations/bioeffects of either individual substances or mixture of substances are such that they are giving or not giving rise to pollution effects

To assess:

- the effectiveness of measures taken for the reduction of marine contamination by performing trend monitoring,
- the status of the environment regarding hazardous substances against set criteria and/or standards as environmental assessment criteria and/or thresholds defining a good environmental standard.

Monitoring of bioeffects supply qualitative or quantitative information on activities, concentrations, frequency or abundance of effects or their measurable reactions which can be used comparably to concentrations, and additionally can detect problems to marine organisms caused by multiple impacts, often on levels below possibilities of chemical analytical measurements or not discoverable by these methods.

3.3 Quantitative objectives

Quantitative objectives can be formulated in order:

- to assure the sample quality in environmental monitoring.

For temporal trend assessments a minimum trend of e.g. 5 or 10% a year should be possible to detect during a sampling period of ten years with a statistical power of 80% and significant level of 5%. This does not require that there is a trend present today but that the monitoring programme should be able to detect the suggested minimum trend, should it occur in future. To fulfil this objective the between-year unexplained variation must not be too large and the sample size not too small. Normally the contribution to the total variation is much larger from sample variation (biological, small scale spatial and temporal variation etc.) than from the analytical error achieved at the chemical analysis. As the concentrations of some anthropogenic contaminants have decreased considerably and become close to detection limit the analytical error increases in relation to the sample variation. At some point temporal trend assessments become pointless. This point may well be defined. However, it is not necessary to abandon the quantitative objective approach, because it may still be relevant in other areas or matrices or if the contaminant situation changes or the analytical technique improves.

- for compliance monitoring

For example, the programme should be able to show compliance with a target value (e.g. EQS) at a distance of x% from the target value with the achieved sample variance. If the target value is 0 or at background concentration a constant has to be added to the target to maintain the Quantitative objective approach.

3.4 Monitoring Strategy

See monitoring manual: http://www.ospar.org/work-areas/cross-cutting-issues/cemp

3.5 Sampling Strategy

See monitoring manual: http://www.ospar.org/work-areas/cross-cutting-issues/cemp

For Arctic areas, the AMAP Trends and Effects Monitoring Programme (ATEMP) (currently under revision), defines the sampling strategy for AMAP marine monitoring. This focuses on marine mammals as top-predator monitoring organisms for hazardous substances, as well as fish and seabirds. It also highlights screening for new substances, including chemicals of emerging Arctic concern (see https://www.amap.no/publications?keywords=ceac&type=).

ATEMP is based largely on ongoing national monitoring and research activities as formulated in AMAP national implementation plans (NIPs) and is coordinated with relevant international programmes. It complements the Circumpolar Biodiversity Monitoring Programme (CBMP), with both of these programmes contributing to the Sustaining Arctic Observing Systems (SAON) initiative.

3.6 Screening Strategy

For substances or matrices that are not part of CEMP or pre-CEMP, consideration of their possible inclusion in CEMP/pre-CEMP monitoring can be facilitated by performing screening studies in areas expected to be particular sensitive or close to known/expected sources of the (new) substances. The screening can be performed by one Contracting Party or several, but often involve analyses at only one laboratory, to maximise comparability between different areas. For screening to be relevant on a Convention-wide basis, representative stations from several OSPAR areas should be included.

In general, screening can be either targeted or non-targeted.

In a **targeted screening study**, a specific analyte or set of analytes are investigated, typically selected from a list of candidate substances of possible concern; where possible the following criteria will be met:

- Analytical methods are established for the analyte and matrix to be analysed (i.e. water, sediment or biota); i.e. the substance can be identified.
- Establishment of a minimum acceptable detection limit achievable by analytical method for the expected matrices (i.e. the analyte concentration can be quantified) and if possible, a predicted no effect concentration level determined.
- Screening locations initially address expected sources of pollution (e.g. relevant industry or large cities/densely populated areas)

In a **non-targeted screening-study**, a general analytical method (usually high-resolution LC-MS or GC-MS, potentially MS-MS or other 2d/3d chromatographic techniques) is applied to a number of samples. The resulting chromatographs are then examined to identify 'peaks' that relate to unknown substances; these can then be further investigated to try to identify the substance present. Thus, the pattern of contaminants present in samples is investigated by qualitative or quantitative analysis to determine potential problem substances in the area(s), compared to background/reference samples.

A screening study should always try to identify:

- The most relevant/appropriate matrix for investigating the presence/levels of the substance concerned; that is water, sediment or biota (preferably including best organs to use for future monitoring) based for example on chemical properties such as K_{ow}, possible metabolism in organisms, and affinity for associating with particulates.
- Data from expected hot spots and baseline/reference stations
- Validation of methods used; typically, screening is used for chemicals where methods are newly developed.

A positive outcome of targeted screening for a substance may result in a recommendation for its inclusion in pre-CEMP (with preferred matrix and expected detection limits for reliable results). A negative outcome (i.e. failure to measure the substance in the used matrices) may result in a conclusion that no further action for this substance is necessary and/or its removal from the list of substances of possible concern; or identify a need to retry with methods with lower detection limits, if the achieved detection limits are not sufficient to measure predicted no effect concentration levels.

Non-targeted screening could result in either addition or removal of substances of possible concern and/or suggestions for inclusion in pre-CEMP once identified 'peaks' have been associated with a specific substance; or further research and/or comparative screening to identify the substances concerned. Evaluation of the need for developing specific methods for identified substances, based on the price, precision and accuracy of the screening method compared to the analytical quality demands for time trend analysis, should also be made.

Examples of targeted screenings are the Joint Nordic screening group (https://www.norden.org/en/publication/joint-nordic-screening-emerging-pollutants) and of non-targeted screening are the NORMAN approach (https://www.norman-network.net/?q=node/190).

3.7 Quality management

Three requirements are essential for the inclusion of a substance or an element or groups of it into the CEMP. These are:

- guidelines;
- quality assurance tools;
- assessment tools.

For analytical quality assurance and control, contracting parties should follow EN ISO/IEC 17025:2017 (General requirements for the competence of testing and calibration laboratories).

Consequently, all CEMP components should have external QA/QC in place, e.g. via one of the following laboratory proficiency testing schemes:

QUASIMEME: http://www.quasimeme.org/

BEQUALM now handled by WGBEC: https://www.ices.dk/community/groups/Pages/WGBEC.aspx

3.8 Data reporting, handling and management

ICES data centre serves for data handling, management and storage in DOME (https://www.ices.dk/data/data-portals/Pages/DOME.aspx) and for making available environmental monitoring data via the Internet to other authorities (e.g. the EEA) and to the public. https://www.ices.dk/data/dataset-collections/Pages/default.aspx

3.8.1 Data reporting

Data for the CEMP are preferably submitted to ICES in the environmental report format 3.2 (or later versions), or in case this is not possible in the relevant simplified format (https://www.ices.dk/data/data-portals/Pages/DOME.aspx). The data should further be checked for errors using the DATSU tool (datsu.ices.dk) before submission.

To submit data, all stations in the given year should be defined in the station dictionary. It should be noted that the field "Long name" is used in the assessment tool for identifying stations and should be completed with a name that is meaningful to the general public. The fields for monitoring program (MPROG) and type of monitoring station (MSTAT) are used in the data acquisition (see below), and each station should be marked as being "*CEMP*" in the MPROG field. The options used for the MSTAT field are *B* for Background/reference station (WFD B), *RH* for Representative of general conditions in terms of hazardous substances (WFD R(HZ)), *IH* for Impacted directly by discharges containing hazardous substances (WFD I(HZ)),

with the possibility of also indicating the type of impact at the station (e.g. IH-H for harbours, whole list available at https://www.ices.dk/data/vocabularies/Pages/default.aspx). It should be noted that at the moment no advice has been given on the criteria for setting a station as *IH*, and Contracting Parties have different ways of defining whether a station is *IH* or *RH* in the vicinity of potential sources. Stations within 1 km from a point source should be treated as potentially impacted, unless otherwise documented by analysing transects from the point source. Guidance from the WFD on I(HZ) stations is;

"*Impact stations are monitoring stations within the zone (area or volume of water) where initial mixing of emissions from a particular discharge or concentrated group of discharges takes place with the receiving waters (sometimes called 'hot spots')*" (Eurowaternet: Technical guidelines for implementation in transitional, coastal and marine waters, technical report 97 EEA; http://www.eea.europa.eu/publications/technical_report_2003_97)

3.8.2 Data acquisition

The data are extracted from the ICES database, with technical and scientific support by the ICES Data Centre. Note that the data fields MPROG and MSTAT from the station dictionary are used in the extraction, and therefore need to be completed correctly. Data used for CEMP monitoring should be marked with "CEMP" in the MPROG field. All data are used for presentation in the assessment tool, but the use in the regional assessment depends on the MSTAT field, including only stations marked representative for hazardous substances or nutrients/organic matter ("RH"or "RP"). The aim of this assessment is to give a regional overview, and any impacted or background stations are considered not representative for the regional area.

3.8.3 Preparation of data

The measurements each year are summarised by an annual contaminant index. To account for differences in analytical quality, an analytical weight is assigned to each index based on the available analytical quality information. The analytical weights are then converted into statistical weights that account for the relative magnitudes of the analytical and environmental variability in the data.

For assessment, concentrations in biota are expressed on wet weight basis, apart from organics in shrimp and herring, which are expressed on a lipid weight basis.

Concentrations in sediment are commonly first normalised to account for differences in sediment composition. Concentrations in sediment are expressed on a dry weight basis.

Details on the methods used for concentrations of hazardous substances and most biological effects can be found at: https://ocean.ices.dk/ohat/, after selecting the substance and then choosing "assessment criteria" in the righthand column just below the "more information" heading.

3.9 Assessment

The assessment methodology is fully described in the online help files.

3.9.1 Assessment criteria

Concentrations are compared to both Background Assessment Concentrations (BACs) and Environmental Assessment Criteria (EACs) or their equivalent. Details for the latest year can be found by selecting biota, sediment or water for all countries and for all species one substance group and substance, and then selecting *assessment criteria* on the right-hand side More information menu.

This brings up the assessment criteria used in the latest assessment, and the substance groups can be changed just below the heading Assessment criteria for contaminants in biota, sediment or water after what was chosen

3.9.2 Spatial Analysis and / or trend analysis

Information on spatial differences in the status are illustrated by the maps of the annual assessments (link see above at the beginning of §3).

Time series are assessed by fitting a weighted regression model to the annual contaminant indices. The type of model depends on the number of years of data:

- 1-2 years: no model
- 3-4 years: mean
- 5-6 years: linear trend
- 7+ years: smoother (with amount of smoothing estimated from the data)

The fitted models are used to assess environmental status against available assessment criteria and evidence of temporal change in contaminant levels in the last twenty years.

Details for assessment of the different matrices can be found as described for assessment criteria, but selecting *assessment methodology* from the More information menu instead. For biological effects or imposex methodology, select a biological effect or imposex as the *measurement types* before selecting assessment methodology. For the contaminants, all use the same assessment methodology.

3.9.3 Presentation of assessment results

The assessment results are published by OSPAR as CEMP Assessment Reports “Levels and trends in marine contaminants and their biological effects”, available online at the OSPAR website. The maps and graphs of the annual assessment as well as additional information in help files are available at: https://ocean.ices.dk/ohat/.

3.10 Change Management

Actions required to update the CEMP are described in section 4 of the CEMP.

The OSPAR subsidiary body responsible for monitoring hazardous substances in the marine environment is OSPAR’s Working Group on Monitoring and on Trends and Effects of Substances in the Marine Environment (MIME), which should periodically consider the implementation of the CEMP, for those aspects of the JAMP where monitoring guidelines, quality control procedures and assessment tools are in place. This consideration should track the progress of these programmes, e.g. collating data, producing assessment reports and initiating new programmes as and when opportunities arise.