

CEMP Guideline: PH2 “Changes in Phytoplankton Biomass and Zooplankton Abundance”

(OSPAR Agreement 2019-06)¹

This OSPAR biodiversity indicator is still in the early stages of implementation and as a result of iteration and learning, it is anticipated that there will be evolution of the methods and approaches documented in the CEMP guidelines. Version updates will be clearly indicated and be managed in a phased approach via ICG-COBAM through its expert groups and with the oversight and steer of BDC.

1 Introduction

Plankton biomass and/or abundance in the Ocean are hydro-climatic variables and as such have been demonstrated to reflect environmental changes, as illustrated by already numerous phytoplankton and zooplankton published studies. Being at the base of the food-web and representing a food of importance for numerous species of higher trophic levels, such as fish of commercial interest, the fluctuation of plankton biomass and/or abundance can have significant impacts on the whole trophic food web but also on carbon cycles and nutrient recycling. The intrinsic characteristics of these organisms at the base of the food chain, such as small size, short life cycles and distribution over the whole globe, render them particularly interesting in the frame of monitoring programmes and they have a high potential to reflect environmental changes at short and long-term scales in the marine systems.

In practice, the use of total biomass and/or abundance is often favoured over indicators using species, since indices of species-specific abundance are frequently subject to large inter-annual variation, often due to natural physical dynamics rather than anthropogenic stressors (de Jonge, 2007). Combining both, phytoplankton biomass and zooplankton abundance, can provide an indication of changes in the energy transfer from primary to secondary producers.

The indicator is still under development. Further investigations are needed to precise the assessment method, and to make the indicator flexible enough to include data from innovative approaches and techniques (see further).

Since different indices provide complementary information on the community structure, we propose a combination of diversity indices to assess GES for plankton communities. Moreover, each PH indicator considers the community at different resolutions, PH1 at the life-form level of the community, PH2 the total biomass/abundance of the community and PH3 at the species level. Hence, by combining the information from these three indicators, a more holistic assessment of plankton dynamics can be obtained than from each indicator individually.

¹ This Guideline exists in English only

2 Monitoring

2.1 Purpose

Currently, PH2 is a state indicator which does not provide a direct link to pressures. It belongs to the category of “surveillance” indicators, such as defined by Bedford et al. (2018). They are early-warning indicators of physical hydro-climatic changes and can result in triggering management action when pre-defined bounds are passed. However, PH2 could be used in conjunction with pressure descriptors such as Eutrophication (MSFD D5), if links to human pressures can be found in further assessments of the ongoing development of the indicator.

2.2 Quantitative Objectives

Plankton sampling collects data, which can not only be used for pelagic diversity indicators, but also for food web indicators. One plankton sample can be used to inform PH1/FW5, PH2 and PH3. Data collected can also be used to inform MSFD D2, D3, D4 (further work needed to confirm) and D5. Therefore, one set of monitoring data can be used in multiple ways.

- Which parameter needs to be measured?
 - Phytoplankton biomass. It can be measured as biovolume, carbon content or assessed through chlorophyll-a, which is present in all phytoplankton organisms, as a proxy. Estimates of chlorophyll *a* from satellite ocean colour algorithms provide a wide spatial cover and a synoptical view, at higher frequency than classical monitoring. A semi-quantitative measurement of phytoplankton biomass is also possible by using the so-called Phytoplankton Colour Index (PCI), a method applied on the CPR data. Both chlorophyll *a* and PCI are used in this assessment as they represent the two types of data regularly monitored in many OSPAR areas.
 - Zooplankton abundance. To date, only copepods (total copepod abundance) are considered in the calculation as a proxy for main zooplankton abundance.
- For which criteria is PH2 relevant?
 - The condition of the habitat type, including its biotic and abiotic structure and its functions [...] is not adversely affected due to anthropogenic pressures (D1C6)
 - Also used to inform MSFD D2, D3, D4, D5.

2.3 Monitoring Strategy: design of specific **monitoring strategy**

- Plankton abundance or biomass should be monitored. PH2 has been developed using existing datasets which are required for informing the indicator.
- Several protocols can be used. It's most cost effective to go with what we already have than to get all CPs to use the same methodology; this also enables establishments of baselines through use of historical data. Integration of existing time-series is a key – the pelagic team has considered this practical approach throughout.
- The following data sources were used for the IA 2017:
 - Data from the Continuous Plankton Recorder (CPR) survey, a regional monitoring programme at European scale, including offshore areas, were provided by UK (PCI data for regions II, III, and IV for the periods 1958–2012, 1958–2012 and 1958–2013 respectively; total copepod abundance for regions II and III for the period 1958–2012).

- Station data for coastal areas with long-term datasets where provided by UK (Chlorophyll-a from 1 station for the period 2001–2013), by Swedish Meteorological and Hydrological Institute (SMHI) (Chlorophyll-a from 1 station for the period 1990–2014 and 1983–2015; from 2 stations for the period 2003–2013) and by French SOMLIT (Chlorophyll-a from 1 coastal and 1 offshore station for the period 1998–2013).

2.4 Sampling Strategy - ensure adequate **sampling or observation methodologies**

- PH2 will be assessed at a spatial assessment unit scale (as the ecohydrodynamic regions) where possible. Considering the natural temporal variability of phytoplankton biomass and zooplankton abundance and the relative short response time of the indicator, the frequency of samplings should be at least monthly or fortnightly².
- Changes in PH2 trends could be detected at least within 2 or 3 years, which should reasonably be set as the frequency of indicator updates.
- Minimum sampling strategy:

	Coastal	Shelf	Open Sea
³ Frequency of data collection*	Monthly	Monthly	Monthly
Monitoring method	<i>In situ</i>	<i>In situ</i>	<i>In situ</i>
Who is responsible for monitoring?	Member state	Member state	Member state
Frequency of indicator update and assessment	2 or 3 years	2 or 3 years	2 or 3 years
Minimal amount of monitoring locations	Monitoring must cover all spatial assessment units (e.g. ecohydrodynamic regions).	Monitoring must cover all spatial assessment units (e.g. ecohydrodynamic regions).	Monitoring must cover all spatial assessment units (e.g. ecohydrodynamic regions).
Current data availability	Single point stations exist mainly in coastal waters but there are gaps in some regions. Station data accessibility is not always guaranteed.	The CPR is a European scale plankton monitoring programme, focusing on the shelf and offshore regions. However, CPR time series in some areas present several interruptions, preventing the assessment of PH2. Regular fisheries and/or research cruises should also be used for plankton collection.	The CPR is a European scale plankton monitoring programme, focusing on the shelf and offshore regions. However, CPR time series in some areas present several interruptions, preventing the assessment of PH2. Regular fisheries and/or research cruises should also be used for plankton collection.

² Monthly frequencies would be optimal and may not be achievable for all Contracting Parties

³ Monthly frequencies would be optimal and may not be achievable for all Contracting Parties

- *A complementary need exists for both long-term time-series and wider spatial cover, as well as high frequency monitoring, particularly in habitats considerably influenced by anthropogenic pressures.

2.5 Quality assurance/ Quality Control

- For zooplankton, the CPR has a QA/QC method which has remained virtually unchanged since 1948. SAHFOS procedures are documented, plankton analysts have BEQUALM qualifications and SAHFOS chairs the UK's National Marine Biological Analytical Quality Control Scheme which is working to develop first a standard and then a quality control scheme. The analysts of the Swedish samples do yearly inter-calibrations using either the service of IPI or HELCOM.
- Quality assurance (QA) for chlorophyll *a* is described extensively in the JAMP guidelines on Quality Assurance for biological monitoring in the OSPAR area⁴ and CEMP appendices 6 and 7⁵. The analysts of the French SOMLIT do yearly inter-calibrations.

2.6 Data reporting, handling and management

- *Reporting format (Available via a link in the CEMP Appendices)*
- *Data metadata schema (Link to ODIMS, INSPIRE compliant)*
 - Each dataset is responsible for its own metadata
- *Confidence levels in data*
 - See "Quality assurance/ Quality Control"
- *Data flows described (Additional to information in CEMP Appendix)*
 - *Each dataset will eventually perform its own analysis once the methodology is finalised. The indicator lead will then aggregate this information.*
- *Data Storage*
 - *A vulnerability of the process is that there is no central storage area for data or documents.*
 - *A central temporary storage area, such as a server at OSPAR is required and could support the process for the following assessments.*

3 Assessment

3.1 Data acquisition

- *How you extract the data specifically for your assessment question*
 - CPR Data were extracted by David Johns at SAHFOS and by contacting the data host in each member state.
 - Phytoplankton data from the French REPHY coastal monitoring are extracted from the Quadrige Database.

⁴ OSPAR Agreement 2002-15

⁵ OSPAR Agreement 2016-01

3.2 Preparation of data

- *Normalisation of data (If it has come from different monitoring methods)*
 - So far, each different dataset has been used alone, no normalisation has been done. Different depths in different datasets will have to be normalised if used together.
 - The indicator relies on existing monitoring programmes but further development will depend on funding and the accessibility of additional datasets. Also, the possibility for integration of plankton data from different sources and sampling strategies (fixed point data, scientific and fisheries cruises and platforms of opportunity) will need further investigation. Moreover, as for the WFD, the discussion will be established on the relevance of including data from innovative/automated approaches and techniques, as remote sensing or continuous recording (of total chlorophyll *in vivo* fluorescence and zooplankton).

- *Aggregation and integration of data acquired*
 - CPR data, phytoplankton biomass and zooplankton abundance are aggregated into means for each calendar month (e.g. January 1958, February 1958, etc). All years are used, regardless of how many monthly data are present.
 - In the North Sea and Celtic Seas, data are analysed at one specific spatial assessment unit, the eco-hydrodynamic area scale). Because no EHD model was available for the time of the IA 2017 for the Bay of Biscay, the Bay of Biscay is treated as one sub-region (see below for further detail).

3.3 Assessment criteria

- *Defining assessment unit/scale (Temporal and spatial)*
 - For the North Sea and Celtic Seas, we report state according to eco-hydrodynamic areas (Level 2). For the Bay of Biscay this is not yet possible (as of May 2018) so we have reported state according to Level 1 areas.

- *Baseline/ reference level*
 - The present time-series analysis treats the totality of the time series, and no reference periods have been set up. Once reference periods are defined it should be possible to determine GES. Establishing reference periods will require that environmental and human pressure data are made available, as well as specific area knowledge provided by experts. Setting up reference periods is a part of the PH2 co-leaders workplan for 2018 and 2019.
 - In accordance with our target, the absence of significant changes for an indicator and/or the lack of a significant correlation between the indicator and the human pressure will be used as evidence that the target for GES (for that criterion and the plankton community as a whole) has been met. However, this presupposes that the reference point of the time-series represented baseline (or reference) conditions and hence GES. This may not be the case. Where data exist, it will be necessary to use this to determine the current status of the plankton at those locations but at least 2 – 3 years of data will have to be collected to characterise the status of the plankton. If, however, existing types of data sets can be used to characterise GES for plankton communities (using ecological theory, remote sensing, modelling, the absence of obvious human pressure and expert opinion), it may be possible to use such data as baseline conditions for new monitoring sites and existing sites at which the status of the plankton does not meet GES.

- *Proposed Environmental target*
 - Plankton biomass/abundance is not significantly influenced by anthropogenic pressures

3.4 Spatial Analysis and / or trend analysis

- The time series analysis, run with an R script is the same for any type of data, both fixed-station data and CPR data, as long as the pre-analysis steps have been followed (the step of creating monthly averages is provided as a separate R script). When the data are in the form of monthly means (the data have to be under the same format originally), the time series analysis can be run. The script is provided with comments and in a step-order as it is commonly done for an R script.
- Statistical analyses (e.g. method for trend analysis, establishment of confidence limits) are at the moment not fully established but will be further developed in the near future.

3.5 Presentation of assessment results

- *Consideration of target audience and appropriate communication style*
- *Assessment metadata schema (link to ODIMS)*

The common indicator assessment is published on the OSPAR Assessment Portal

<https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/habitats/plankton-biomass/>

4 Change Management

- *Responsibility for follow up of assessment (e.g. if the monitoring is not adequate) (Tech sub group - > Committee e.g. for Beach litter – ICG-ML->EIHA)*
 - ICG-COBAM Pelagic expert group

References

- Bedford, J., Johns, D., Greenstreet, S., McQuatters-Gollop, A., 2018. Plankton as prevailing conditions: A surveillance role for plankton indicators within the Marine Strategy Framework Directive. *Marine Policy* 89, 109–115. <https://doi.org/10.1016/j.marpol.2017.12.021>
- De Jonge, V.N., 2007. Toward the application of ecological concepts in EU coastal water management. *Marine pollution bulletin* 55 10-12, 407–14.
- Domingues, R.B., Barbosa, A., Galvão, H., 2008. Constraints on the use of phytoplankton as a biological quality element within the Water Framework Directive in Portuguese waters. *Marine Pollution Bulletin* 56, 1389–1395. <https://doi.org/10.1016/j.marpolbul.2008.05.006>