CEMP Guideline: PH3 Changes in Plankton Diversity

(OSPAR Agreement 2019-07)[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

1.1. General introduction to the indicator

Species composition and abundance of plankton assemblages are influenced by environmental conditions and their variability, such as available light, nutrients, prey, currents and climate. As a result, plankton communities fluctuate in space and time. Environmental perturbations such as pollution and/or eutrophication (i.e. excessive nutrients) can create unusual marked changes in community composition because only a small number of species can cope with or can benefit rapidly of the new situation. In Baltic seas, for example, phytoplankton species composition has been observed to change with different nutrient levels and ratios (HELCOM, 2017 and references therein).

Monitoring plankton biodiversity is important since long-term and drastic changes in biodiversity can alter marine ecosystems in terms of their functioning, such as food webs and the uptake and transfer of carbon in the oceans, and the services they provide. In order to quantify changes in biodiversity**,** indices based on the number of species and/or their relative abundances in the community can be calculated for water quality assessment. A plethora of indices exist in the scientific literature but their use will depend on (1) the objective of the study, (2) their ecological relevance and (3) mathematical properties. Currently, taxonomic diversity indicators for phytoplankton are being revised within the Water Framework Directive for French waters. In a wider management context (MSFD), only few community composition indicators are currently applied and this probably reflects the difficulty in setting reference conditions and environmental objectives for these indicators (Garmendia et al., 2013). On the other hand, diversity indices are relatively easy to calculate and their interpretations are intuitive.

The aim was to develop a multimetric indicator to describe the structure, composition and change in the phytoplankton community. The Pelagic Habitat Indicator (PH3) describes the alpha diversity, i.e. the diversity within a site or sample, and the beta diversity that focuses on the rate of change, or turnover, in species composition (Rombouts et al., 2019). For the IA-2017, a pilot study using 3 coastal time-series in the English Channel and Bay of Biscay, tested the efficiency and performance of PH3 to quantify the state of marine phytoplankton communities and to detect significant changes in their temporal structure. The

[1] This Guideline exists in English only

concept of proof described in the IA 2017 may be applicable to data in the Celtic Seas region, wherein it is a common indicator, and later on also in other OSPAR sub-regions in the next assessment cycles if data becomes accessible.

To date PH3 focuses on the phytoplankton but the biological component of pelagic habitats also includes zooplankton organisms, the animal part of the plankton. The state of development for zooplankton indicators for use in the MSFD is less advanced (and less data than for phytoplankton are currently available for stations) and only preliminary tests of PH3 using zooplankton data has been carried out to date (Budria et al., 2016). The final aim of PH3, however, will be to integrate both phytoplankton and zooplankton assessments. Until then, a major activity is still required to understand potential plankton community responses to human pressures.

Finally, for a more robust assessment of pelagic habitats, other measurements, such as total biomass/abundance of the community and information on functional groups should be included in addition to the information on the community composition. A combination of each common pelagic habitat indicator (PH) will then consider the plankton 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.

2 Monitoring

2.1 Purpose

- What is the objective of assessing the indicator; only status of the environment, or also to support identification of pressures and programmes of measures?

  Currently, PH3 is a state indicator which does not provide a direct link to pressures. PH3 belongs to the category of 'surveillance' indicators, such as defined by Bedford et al. (2018). These surveillance indicators are early-warning indicators of physical hydro-climatic changes and can result in triggering management action when pre-defined bounds are passed. With continued development PH3 can be used for the identification of “events”, i.e. unusual temporal changes in community structure, and will provide information supporting evidence for D2, D3, D4 and D5.

2.2 Quantitative Objectives

- Phytoplankton monitoring guidelines are relevant for several other indicators in development such as for food webs and eutrophication.
- Information from monitoring phytoplankton can be used to (see CEMP Eutrophication Monitoring Guidelines: Phytoplankton Species Composition):
  - establish the composition, spatial distribution and frequency of phytoplankton blooms;
  - establish long term temporal and spatial trends in phytoplankton species composition and their relative abundance in order to detect:
    - changes in length of growing season, timing of blooming, etc.,
    - changes that may be caused by eutrophication, warming, ocean acidification, etc.,
    - changes in frequency and magnitude of harmful algal blooms,
    - occurrence of non-indigenous/cryptogenic species,
    - changes in the foodweb,
    - changes in diversity indices.

- Information from monitoring zooplankton can be used to:
  - establish long term temporal and spatial trends in zooplankton species composition and their relative abundance in order to detect:
    - changes that may be caused by eutrophication, warming, ocean acidification, etc.,
    - occurrence of non-indigenous/cryptogenic species,
    - changes in the foodweb,
    - changes in diversity indices.
  - Also, one plankton sample can be used to inform the two Pelagic Habitat indicators PH1/FW5, and PH3. Therefore one set of monitoring data can be used in multiple ways.

- Which parameters need to be measured?
  - Phytoplankton abundance and composition (per species/genera/taxa)
  - Zooplankton abundance and composition (per species/genera/taxa)
- For which criteria is PH3 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). It is also relevant for criteria D4C1: The diversity (species composition and their relative abundance) of the trophic guild is not adversely affected due to anthropogenic pressures.
  - Also used to inform MSFD D2, D3, D5

2.3 Monitoring Strategy

- Monitoring methods have to be consistent over a long time period to facilitate the detection of changes and trends and to allow comparison within the monitoring program (HELCOM 2017).
- Currently, data for testing the indicator comes from fixed point stations in coastal areas in France and Spain. However, several other CP's have useable monitoring programmes in place for calculating PH3 (e.g. UK, Ireland, Germany, Netherlands). The results of the new case studies will show if current monitoring is sufficient for regional assessment. On the other hand, final national monitoring programmes depend on the results of national public consultations on monitoring.
- In further testing, data from the Continuous Plankton Recorder (CPR) survey could be used for calculating PH3 in the offshore areas covered by this survey. Whilst zooplankton diversity has been calculated from this data, its relevance for phytoplankton abundance and composition data for PH3 still needs to be challenged. Moreover, regular annual or seasonal fisheries and/or research cruises will provide a set of data, which will cover large marine areas from coastal to shelf and open ocean, but is unlikely to meet the measurement frequency requirement. In that case, the indicator should be adapted before use.

2.4 Sampling Strategy

- Phytoplankton communities are highly dynamic with a strong temporal (inter-annual and seasonal) and spatial variability. Therefore, the monitoring should be organised accordingly to capture rapid variations and/or patchiness in plankton communities[2].
- A detailed account of sampling and monitoring equipment for phytoplankton community composition is outlined in the CEMP guidelines for eutrophication (OSPAR 2017).
- PH3 will be assessed at the ecohydrodynamic scale where possible. The identification of the ecohydrodynamic areas is currently being established by modelling techniques. To date, different models exist that describe pelagic regions across the OSPAR area (e.g. Van Leeuwen, 2015 for the North Sea) and that were specifically developed to suit the regions' hydrodynamics based on a number of relevant parameters. Currently, no single model covers the entire OSPAR area.
- In order to capture the temporal trends, sampling needs to cover the entire growth season, which can extend over the entire year (HELCOM 2017). To calculate PH3, at least monthly samples of phytoplankton for community composition and abundance analyses across all seasons are required.

Table 1: Minimum sampling strategy:

	Coastal	Shelf	Open ocean
[3]Frequency of data collection*	Monthly	Monthly	Monthly
Monitoring method	*In situ*	*In situ*	*In situ*
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 water masses or ecohydrodynamic areas (spatial assessment units).	Monitoring must cover all water masses or ecohydrodynamic areas (spatial assessment units).	Monitoring must cover all water masses or ecohydrodynamic areas (spatial assessment units).
Current data availability	Regular (monthly). Single point stations exist mainly in coastal waters but there are gaps in some regions.	Regular (yearly or seasonal) fisheries and research cruises could be used for sample collection but relevance for the current indicator needs to be tested especially in terms of temporal frequency.	Regular (yearly or seasonal) fisheries and research cruises could be used for sample collection but relevance for the current indicator needs to be tested especially in terms of temporal frequency).

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

[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

2.5 Quality assurance/ Quality Control

Extensive knowledge of the taxonomy, identification and counting procedures of phytoplankton is essential in order to produce high-quality data (HELCOM 2017).

For French data, Quadrige² (REPHY network) meets the quality demands for the WFD (http://wwz.ifremer.fr/institut-eng/Marine-science/French-facilities/Data-Centres/Quadrige-2). Currently, there is no quality assurance for the RESOMAR-PELAGOS database (to be established within the PhytObs monitoring network, a new integrated RESOMAR-REPHY observatory).

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*

The quality of the data depends largely on the sample collection and taxonomic expertise of the analysts and of the quality control for each of the monitoring networks. Hence, caution is required when compiling data from different sources, at least at the first stage.

- *Data flows described (Additional to information in CEMP Appendix)*

Data flows will be established according to the policy on data sharing of each network and institution.

- *Data storage*

Raw data is currently stored in national databases.

3 Assessment

3.1 Data acquisition

- *How you extract the data specifically for your assessment question*

For French data: data were extracted from online data portals: RESOMAR-PELAGOS (CNRS-INSU) and Quadrige (REPHY for phytoplankton; IFREMER); Spanish data from the Bay of Biscay were extracted from EmoDNeT. Complementary data from the Irish Sea is needed to attain a regional assessment for region III.

3.2 Preparation of data

- *Normalisation of data (If it has come from different monitoring methods)*

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 WFD, the discussion will be established on the relevance of including data from innovative approaches and techniques, as continuous recording data, allowing to consider the whole size range of plankton species, on a regular and high frequency monitoring basis.

- *Aggregation and integration of data acquired*

For the calculation of the indicator, data were integrated per sampling station where abundance data was pooled monthly. Only years where all months were sampled were used in the analysis.

No spatial aggregation was done at this time as not enough data was available per spatial assessment unit (the eco-hydrodynamic area scale).

3.3 Assessment criteria

- *Defining assessment unit/scale (Temporal and spatial)*

Assessment will be done at the level of ecohydrodynamic areas (Level 2). However, additional data is still needed to perform a robust regional scale analysis. A minimum of monthly data of phytoplankton community composition should be used in order to best capture the possible variation in community composition on a seasonal and yearly basis. For detecting long-term trends, a minimum of 10 years of data should be used.

- *Baseline/reference condition/assessment value*

To be developed and discussed

- *Proposed assessment value*
  - Plankton community

3.4 Spatial Analysis and / or trend analysis

- *Statistical analysis (e.g. method for trend analysis, establishment of confidence limits)*

As only fixed-point data has been used to date, no large-scale spatial analysis has been performed yet. For fixed station data, seasonal and annual trends in community composition (diversity indices) were calculated. In terms of longer trend analysis, community variance across years was investigated for each dataset (Legendre and Gauthier, 2014). More specifically, the Local Contributions to Beta Diversity (LCBD) indices were calculated following the method described in detail by Legendre and De Cáceres (2013). This index could indicate an important change/shift or uniqueness in species composition of the local community. More details on this method are available in the "Pilot assessment for changes in plankton diversity" drafted for the IA 2017 and published on the OSPAR website.

3.5 Presentation of assessment results

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

The pilot assessment of the indicator is published on the OSPAR Assessment Portal

https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/habitats/pilot-assessment-changes-plankton/

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