PPCI $_{MED}$, A NEW PHYTOPLANKTON COMPOSITION INDEX RESPONDING TO ANTHROPOGENIC PRESSURE IN THE MEDITERRANEAN SEA

Anne Goffart [1]*
[1] Oceanology, FOCUS Research Unit, University of Liège, Belgium - A.Goffart@uliege.be

Abstract
As phytoplankton reflect immediate effects of changes in nutrient inputs in ecosystems, they have been retained by several European legislations to assess the health status of marine ecosystems. Here, we present a new phytoplankton composition index, PPCI $_{Med}$ (**P**igment **P**ressure **C**omposition **I**ndex) adapted to the specificities of the Western Mediterranean coastal waters. It uses diagnostic pigments of total phytoplankton measured by HPLC. Only pigments responding positively to pressures (*i.e.* nutrient concentrations) are considered. The calculation protocol is described, and an evaluation grid is proposed. PPCI $_{Med}$ is designed to be scientifically robust yet easy to implement by stakeholders lacking expertise in phytoplankton biodiversity. PPCI is transferable in other coastal zones if pigments/ pressure relationships are established.

Keywords: Western Mediterranea, Phytoplankton, Pigments, Bio-indicators

Materials and methods
PPCI $_{Med}$ was developed in the French coastal waters of the Med Sea where a robust dataset of nutrients and phytopigments was collected in reference sites and impacted water masses (15 stations, 744 nutrients/ pigments samples; [1]).

Index elaboration and calculation protocol (Fig. 1)
1. Relationships between pigments and proxies for pressure
Only pigments responding positively to nutrient concentrations (as proxies for pressure) are integrated to PPCI (Spearman correlations, rho $\geq$ 0.45, p value < 0.0001). For phytoplankton groups identified by multiple diagnostic pigments, only the one that is most responsive to pressure is chosen. In our study, 4 diagnostic pigments, peridinin, fucoxanthin, prasinoxanthin and alloxanthin, were selected according to the criteria defined above. In the Med Sea, they act as biomass tracors for photosynthetic dinoflagellates, diatoms, prasinophytes, and cryptophytes, respectively. Consequently, PPCI $_{Med}$ is composed of 4 sub-indexes (S_i) : S_i Peridinin, S_i Fucoxanthin, S_i Prasinoxanthin and S_i Alloxanthin.

2. Construction of reference curves
Reference curves are established for reference stations identified by the Water Framework Directive monitoring and/or ongoing programs. For each selected pigment, a reference curve is constructed. It describes the seasonal evolution of this pigment. Ideally, the curves are constructed from bi-monthly data acquired over a sliding 6-year period. Each curve comprises 12 values (1 value per month) obtained by calculating the monthly P_{90} of pigment concentrations and adding a 50% safety margin to account for natural variability. For very low pigment concentrations, a minimum threshold of 5 ng L^{-1} is imposed. The principle of sliding reference curves contributes to incorporate long-term effects of climate change.

3. PPCI calculation
To assess phytoplankton composition quality at a site, a score and an ecological quality ratio (EQR) are calculated for each selected pigment :
3.1. Compare the pigment concentrations at the site to be assessed with the reference values, respecting the temporality,
3.2. Calculate the frequency (%) of overpassings from the reference, the relative magnitude (%) of each overpassing during the observation period (1-6 years) and the averaged overpassing (%),
3.3. Calculate a score for the considered pigment : score = (frequency of overpassings x averaged overpassing) / 1000,
3.4. Transform scores $\leq$ 20 into EQR by applying the formula : EQR = 1 - (0.050 x score). If the score is > 20, EQR = 0. The threshold of 20 was defined on the basis of our field expertise.

4. Repeat step 3 for all selected pigments and calculate the final EQR
The final EQR is the arithmetic mean of the sub-indexes EQRs. PPCI ranges from 0 (phytoplankton composition highly degraded) to 1 (phytoplankton composition in very good condition). Classification boundaries (Fig. 1) were established on the basis of our field knowledge, and what we consider to be very good and poor phytoplankton compositions in the study area. We then set the boundaries for the different states, checking the consistency of the classifications obtained with our expertise and other expert judgement.

Applications of PPCI
PPCI $_{Med}$ allows to detect the effects of anthropogenic disturbances on phytoplankton composition over different spatial and temporal scales. It can also be used to highlight the seasonality of disturbances, such as those caused by recreational boating, and to measure improvements in environmental quality following restoration efforts.

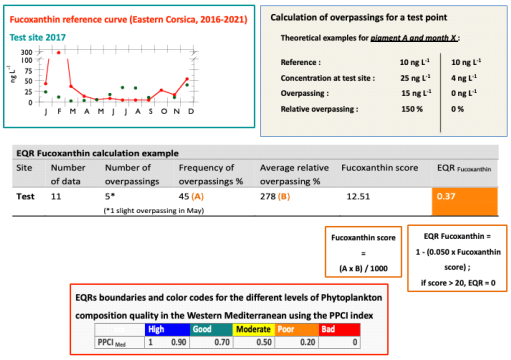

Fig. 1. Example of score and EQR calculation ; PPCI $_{Med}$ quality grid.

References
1 - Goffart A., 2019. Rapport final de l'action 1 du projet "Indicateur de composition phytoplanctonique", Convention de subvention ONEMA – Université de Liège, 30 pp. https://hdl.handle.net/2268/235028