APPLICATION OF THE TROPHIC INDEX (TRIX) IN ITALIAN COASTAL WATERS : PRELIMINARY EVALUATION OF TROPHIC STATE AND ASSOCIATED COASTAL WATER QUALITY

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Abstract

The present work resulted from a 4-year (1997-2000) monitoring study of Italian coastal waters, aimed at the application of the Trophic Index TRIX for a preliminary evaluation of trophic status and associated surface water quality. The results showed a fairly high spatial variability in trophic status, with highly productive waters (>5 TRIX Units) in the NW Adriatic Sea and in some locations of the Central Tyrrhenian Sea, and low trophic levels (2 to 4 TRIX Units) in the Ionian Sea and in Sicilian coastal waters.

Keywords : Monitoring, coastal waters, eutrophication.

In order to obtain a better basis for the environmental planning and management of marine coastal systems by objectives, it is necessary to improve our knowledge of current status of coastal water quality. The application of synthetic indices is particularly useful when interpreting a large number of data collected over a multi-annual period on a variety of parameters, since it introduces objective criteria in making comparisons among different spatial and temporal situations and delivers simple and straightforward results to the end-users of research and monitoring activities, such as regional and local authorities.

Eutrophication and effects of persistent organic pollutants and metals are among the most serious threats to the coastal environment. The aim of the present study is to achieve a preliminary characterisation of the trophic status of Italian coastal waters, as a part of a multi-disciplinary work, which includes the evaluation of phytoplankton taxonomic composition and biomass, the physico-chemical characterization of sediments and the assessment of bioaccumulation levels and effects of contaminants on the biota. The classification of coastal waters and sediments will then allow a comprehensive assessment of the 'ecological status' of coastal systems, as required by the Italian current legislation (D.Lgs. 152/99) and by the recent EU Water Framework Directive.

The development and validation of the Trophic Index TRIX (1) resulted from a long-term study along the NW coast of the Adriatic basin, chronically subjected to eutrophication and eutrophication-related phenomena. The TRIX Index is composed of 4 commonly measured and ecologically relevant parameters and is defined by the following equation:

$TRIX = [Log_{10} (Chl \times D\%O \times TP \times DIN) + 1.5]/1.2$;

where Chl = chlorophyll 'a' ($\mu g.L^{-1}$); D%O = deviation, in absolute value, of dissolved O2 from 100% saturation; TP = Total Phosphorus ($\mu g.L^{-1}$); DIN = Dissolved Inorganic Nitrogen ($\mu g.L^{-1}$). The Index is scaled from 0 to 10 and is comprehensive of both the actual productivity indicator log10 (Chl x D%O), and the potential productivity indicator log_{10} (TP x DIN).

By the application of the TRIX Index it is possible to derive some general characteristics of trophic status and surface water quality of the investigated site, as reported in Table 1.

Table 1. Trophic scale and associated surface water

Trophic Scale	Status	Water quality
< 4	HIGH	Low trophic level Good water transparency Absence of water discolorations Absence of subsaturation of dissolved oxygen in bottom waters Average trophic level
4 - 5	GOOD	Occasional clouding of water Occasional water discolorations Occasional hypoxias in bottom waters
5 - 6	MEDIOCRE	High trophic level Low water transparency Water discolorations Hypoxias and occasional anoxias of bottom water States of suffering of benthic organisms
> 6	POOR	Very high trophic level High turbidity Widespread and persistent water discolorations Widespread and persistent hypoxias/anoxias of bottom waters Dying off of benthic organisms Alterations of benthic communities

We evaluated the trophic levels of the entire Italian coast, with the only exception of the Sardinia Island, during 6 oceanographic surveys conducted between October 1997 and June 2000. In agreement with the monitoring strategy of other survey programmes, carried out on a Regional basis with the support of the Italian Ministry of the Environment (2), the transects were located away from the mouths of major rivers, large cities, harbours, major capes and 'reference sites', where the anthropogenic impact is considered to be minimal. Two sites per transect were chosen: at 500 m and at 3000 m off the coast. For each sampling site, we performed nutrient analysis ($P\text{-}PO_4$, $N\text{-}NH_3$, $N\text{-}NO_2$, $N\text{-}NO_3$, TP, TN) and phytoplankton analysis (biomass and taxonomic composition) in surface waters, and CTD, dissolved oxygen and fluorescence measurements in the water column.

High TRIX values (i.e. high productivity and low trophic quality) are found in the NW Adriatic Sea and in some stations of the Central Tyrrhenian Sea, mainly in association with riverine nutrient inputs. Low to moderately-productive areas (i.e. with TRIX values <5) are generally located in the Ionian Sea, along the Island of Sicily, and in the Northern portion of the Tyrrhenian Sea. As expected, we found a general decrease in trophic levels during the Summer months compared to the Fall and Spring situation (not shown), because of lower nutrient concentration in the euphotic zone and reduced phytoplankton biomass. Nonetheless, 'poor' water quality is still found in some locations of the Northern Adriatic Sea (away from the mouths of the Po and Piave rivers, see stations 115 through 118 and station 122) and 'mediocre' water quality in some stations of the Central Tyrrhenian Sea (Genoa harbour, station 1; Tevere and Garigliano rivers, stations 17 and 21, respectively) (Figure 1).

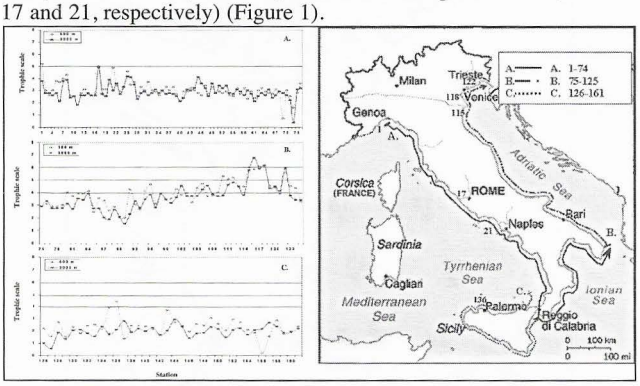

Figure 1. Trophic levels of Italian coastal waters on Summer. A. Tyrrhenian and Ionian Sea. July 1999. B. Adriatic Sea. July-August 1999. C. Sicilian coastal waters. August 2000. The numbers on the map refer to the stations in the graphs

In conclusion, the TRIX Index allows to identify coastal areas at 'eutrophic risk' or currently subjected to eutrophication, to follow their temporal evolution, and to perform a classification based on trophic characteristics. We consider such approach very informative for coastal zone management purposes, particularly for an effective planning of nutrient reduction programmes and for the assessment of the system response to remedial actions.

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