

LONG-TERM CHANGES OF NUTRIENT CONCENTRATIONS AND PHYTOPLANKTON BIOMASS IN THE NORTHERN ADRIATIC SEA

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Abstract

A significant reduction of the Po River flow in the season February-April and a marked increase in autumn occurred during the years 1993-2000, compared to previous periods. Reduction of the orthophosphate and ammonia concentrations, and of phytoplankton biomass were observed except in October when the freshwater discharge was often much greater than normal.

Key-words: Adriatic Sea, Biomass, Nitrogen, Phosphorous

Introduction

Both seasonal and long-term changes in the nutrient loads, primarily contributed by the Po River (75% of the total inputs), significantly affect the ecosystem of the shallow northern Adriatic Sea (1). Data series collected during the period 1993-2000 along an eutrophication gradient between the Po Delta and the opposite Istrian coast together with a previous 25-year data set (1969-1992) were used to investigate changes in the nutrient cycles and phytoplankton biomass (chlorophyll a) during the nineties.

Material and Methods

The data collected at stations SJ108, 12 Nm off the Po River delta (44° 45,4' N; 12° 45,0' E), and SJ107, 13 Nm off Rovinj, western Istria coast, Croatia (SJ107- 45° 2,8' N; 13° 19,0' E) were selected and presented in this paper. The water was collected with 5 L Niskin (salinity and nutrients) and 6 L VanDorn (chlorophyll a) samplers. Nutrient analyses were performed aboard immediately after sample collection with spectrophotometric methods widely used in oceanography (2). The chlorophyll a was determined fluorimetrically after acetone extraction (2).

Results and Discussion

The mean seasonal flow model of the Po River (calculated from daily averages) for the period 1993-2000 substantially differs from those for the periods 1917-1992, 1969-1980, and 1981-1992, particularly in the months February-April and October-November (Fig.1). While lower values were recorded in the first season of the most recent period, the flows were markedly higher during the autumn months. For example, in five years of the period 1993-2000 the mean flow for the season October-November was 1000-3000 m³ s⁻¹ higher than the long-term average (1917-1992; 1772 m³ s⁻¹). This analysis indicated that recently the hydrological regime over the Po River watershed has been substantially modified, influencing also the nutrient and phytoplankton biomass distributions in the marine environment.

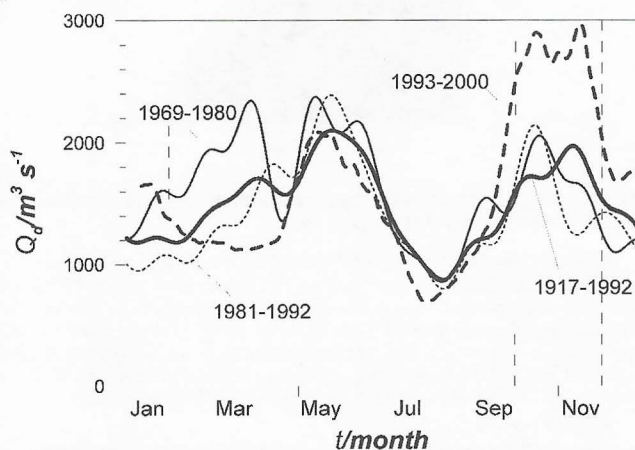


Figure 1. Average daily Po River flow (Q_d) at Pontelagoscuro for four different periods.

Generally, the average surface salinity and Secchi disk depth in the period 1993-2000 did not differ significantly from the long-term averages (1969-2000) at both stations, if the October value is excepted. In fact, salinity was exceptionally lower (by 5) than the long-term averages, indicating that the freshwater impact on the area was often substantial in October during the period 1993-2000. Consequently, values for the nutrient surface concentrations, significantly higher than the averages, were measured in the area off the Po Delta (station SJ108;

Fig. 2), but this was not the case for the more oligotrophic area off Rovinj. Nevertheless, the chlorophyll a level was markedly increased also in this area, indicating that the nutrient excess was incorporated in the biomass during the eastwards advection of the diluted waters.

In contrast, in the most of the months of the period 1993-2000 the nutrient concentrations were near the long-term averages (nitrate) or significantly lower (orthophosphate and ammonia; Fig.2). A decrease in phosphorous, probably resulting from reduction of polyphosphate contents in detergents, was observed since the mid 1980's (1) and it persisted through the last period. The reduction of the chlorophyll a concentration in the more eutrophic area (Fig. 2) can be ascribed to an enhanced phosphorous limitation. Consequently, the lower ammonia levels observed recently may be also related to a decrease of the organic matter remineralization rate.

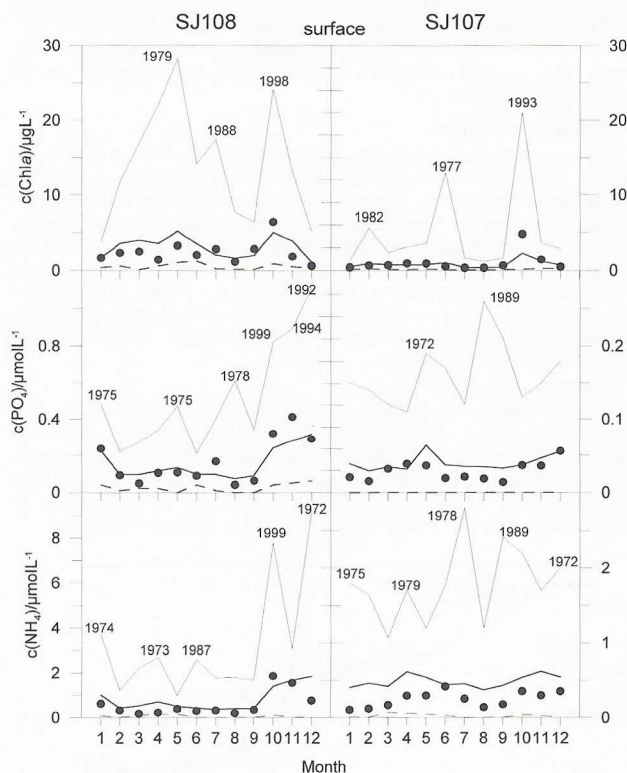


Figure 2. Monthly means, maxima, and minima for the period 1969-2000, and monthly means for the period 1993-2000 (C) of chlorophyll a, orthophosphate and ammonia concentrations at stations SJ108 and SJ107.

Exceptionally high freshwater discharges during the autumn have lesser consequences for the marine ecosystem than in spring when the nutrient utilization is much faster, and the water exchange between the northern and the rest of the Adriatic is reduced (1).

References

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