# EFFECTS OF PO DISCHARGE AND NUTRIENTS ON SMALL PELAGIC FISH IN THE NORTH-WESTERN ADRIATIC SEA

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## Introduction

The small pelagic species, anchovy (*Engraulis encrasicolus*, Linnaeus 1758) and sardine (*Sardina pilchardus*, Walbaum 1792), represent key species for the Adriatic Sea ecosystem. In the last decade, the status of these stocks turned in an alarming situation as a consequence of an increasing fishing exploitation. However, the fishing activity is probably not the only factor influencing these stocks, also the environmental changes can affect the dynamics of these species (Grbec et al., 2002). The aim of this poster is to investigate the effects of the modifications occurred in the last 40 years of the Po River discharge and the loading of nutrients in the north-western Adriatic Sea (GSA 17).

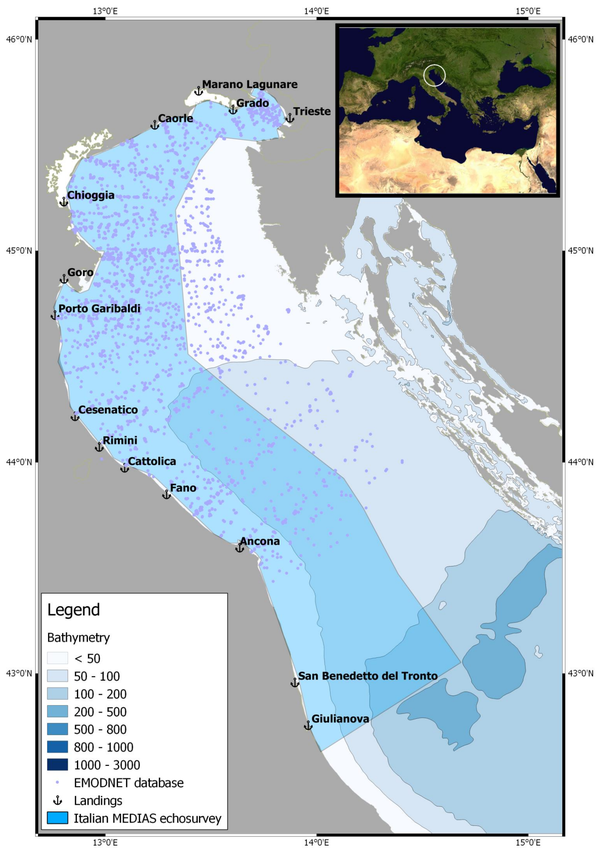


**Figure 1.** Study area. Ports are indicated, points represent EMODNET casts and polygon corresponds to the MEDIAS echosurvey area

## Materials and Methods

For the study area (Fig.1), three sources of information were examined: landing data, collected annually by the CNR-IRBIM of Ancona from the most important harbours, biomass acoustic data from the Italian MEDIAS (Pan-MEDiterranean International Acoustic Surveys) survey (EchoAdri survey before 2009) and environmental data extracted by Emodnet-Chemistry portal. Also, the daily average flow rates ($m^3$ $s^{-1}$) of Po River at Pontelagoscuro station were provided by the Servizio Idro-Meteo-Clima of ARPAE-ER.

Comparison between Po river discharge and environmental data with the acoustic biomass were shifted of one year, as environmental variables should act on larval and juvenile stages of anchovy and sardine (Leonori et al., 2007, Santojanni et al. 2006).

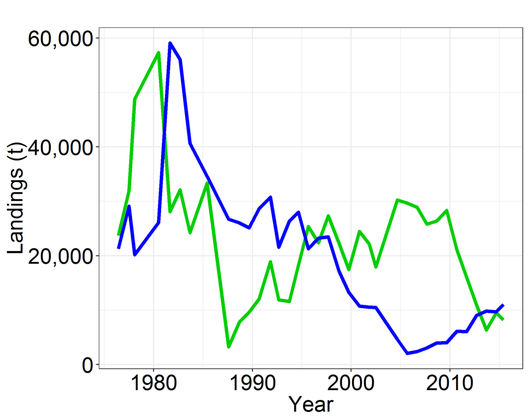


**Figure 2.** Landings data; linear trend decreased from year 1976 to 2015 (p-value: anchovy 0.0169, sardine 2.69e-08)

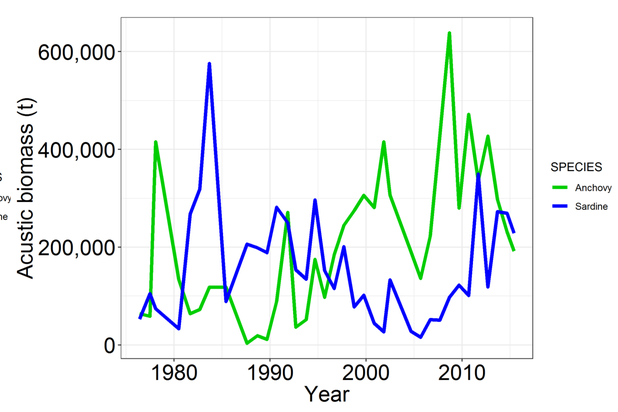


**Figure 3.** Acoustic biomass; from year 1976 to 2015 linear trend increased for anchovy (p-value 0.000144) and stable for sardine (p-value 0.559)

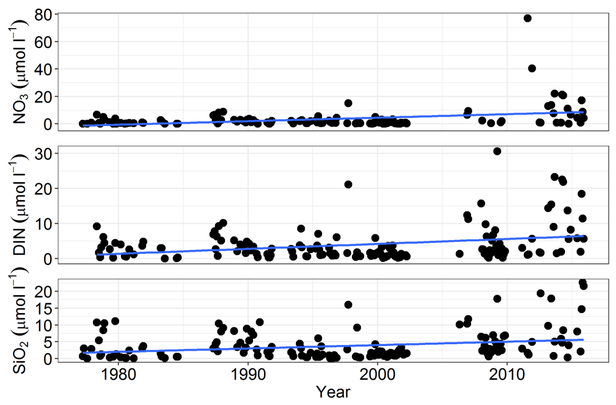


**Figure 4.** Environmental parameters; linear trends increased from 1976 to 2015 (p-value: $SiO_2$ 0.00172, $NO_3$ 9.18e-05, DIN 0.000237)

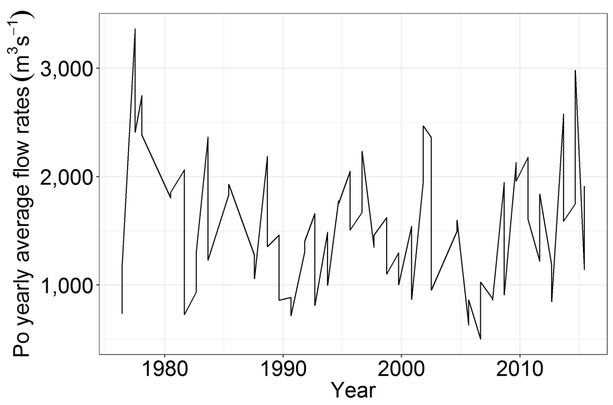


**Figure 5.** Po River discharges; no linear trend over the years (p-value 0.487)

## Results

Landings show a significant decrease for both anchovy and sardine (Fig. 2). Acoustic biomass displays a significant increase for anchovy, even if the values in the last years are decreasing, whereas sardine remains more stable over the years (Fig. 3). Of the environmental variables considered, only few of them varied over the years. In particular, $SiO_2$, $NO_3$, and DIN increased over the time interval considered (Fig. 4). The Po discharges showed no significant trend over the considered period (Fig. 5).

Nutrients ($SiO_2$, $NO_3$ and DIN) resulted to have a negative impact on the landings of both species (Table 1). Whereas, acoustic biomass resulted not to be significantly affected by the environmental variables (Table 1). Po discharges did not influence neither the environmental data neither the biomass of these stocks.

| Environmental variables | | | | |
|---|---|---|---|---|
| | ***Species*** | ***$SiO_2$*** | ***$NO_3$*** | ***DIN*** |
| ***Acoustic biomass*** | ANE | 0.146* | 0.375* | 0.276* |
| | PIL | 0.498* | 0.086* | 0.828* |
| ***Landings*** | ANE | **0.019** | **0.023** | **0.019** |
| | PIL | **0.024** | **0.006** | **0.030** |

**Table 1.** Linear trend p-value for the two stocks (ANE: *Engraulis encrasicolus*; PIL: *Sardina pilchardus*) in relation to the environmental variables that significantly vary along the considered years. In bold the values resulting significant; values with * are those using shifted year

## Discussion

In the last 40 years, nutrients presented a significant increasing trend. Despite stable Po River discharges, this is probably due to other sources like minor rivers and cloudburst. However, this enrichment does not effectively correspond to an increase in biomass of anchovy and sardine. The negative effects of the nutrient enrichment of sea waters was also showed in other studies. For example, Santos et al. (2001) verified that upwelling conditions favored a negative impact on recruitment of small pelagic species on the Portuguese coast, thus causing a higher larval mortality. Gamito et al. (2015) reported a negative correlation between the landings of European sardine and environmental variable, such as winter SST and winter NAO.

## Conclusion

This study represents one of the first efforts in correlating trends of Adriatic small pelagic stocks to the environment.

We want also to point out that in this work only the northern and western Adriatic Sea were taken into account. Thus, to have a better picture of the status of these resources, it could be worthwhile to refer to the complete stock assessment carried out annually within the GFCM framework.

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