MODELLING THE ECOLOGICAL ROLE OF SMALL PELAGIC FISH IN THE CATALAN SEA (NW MEDITERRANEAN)

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Abstract

This contribution aims at investigating the ecological role of small pelagic fish in the South Catalan Sea (NW Mediterranean) by applying mass-balance and trophodynamic modelling. Results describe the high importance of these organisms within Mediterranean food webs and evidence the need of progressing towards a sustainable management of their fisheries.

Keywords : Pelagic, Fishes, Food Webs, Models, Western Mediterranean.

Small pelagic fish (SPF) are important elements of marine ecosystems due to their relevant biomasses at intermediate levels in the food web, notably contributing to canalize the energy connecting the lower and upper trophic levels. Fluctuations in SPF populations due to fishing or to environmental factors can contribute to modify the structure and functioning of marine ecosystems [1]. Environmental factors are essential to explain their dynamics, which are subjected to fluctuations due to their relatively short life cycle (3-4 years). Moreover, an intense fishing activity can contribute to impair their populations.

Main SPF inhabiting the NW Mediterranean Sea are anchovy (*Engraulis encrasicolus*), sardine (*Sardina pilchardus*), round sardinella (*Sardinella aurita*) and sprat (*Sprattus sprattus*). Anchovy and sardine represent almost 50% of the total landings in the Catalan Sea and support important biomasses [2]. Both landings statistics and biomass estimates have shown a steadily decline in the area during the last decades. The production of sardine and anchovy in the region is clearly influenced by changes in the environment [3].

An ecological model of the South Catalan Sea [4] using Ecopath with Ecosim (EwE) approach [5] was used to put available ecological data from SPF into an ecosystem context. Global results showed how they are essential mid trophic levels of the food web, in line with results from other Mediterranean and upwelling areas [1,6]. They are involved in main trophic flows and constitute important elements controlling prey and predator populations (Figure 1), most probably related with bottom-up and wasp-waist flow control situations.

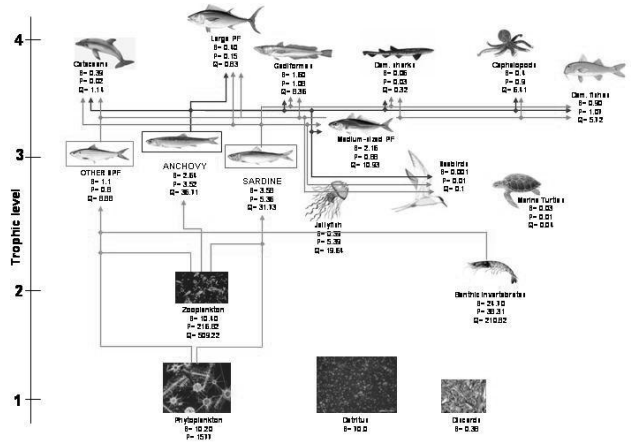

Fig. 1. Schematic flow diagram of the South Catalan Sea, where SPF trophic links are highlighted. B = Biomass (t km^{-2}); P = Production and Q = Consumption (t km^{-2} yr^{-1}). Drawings from www.gencat.net.

Results of the ecological model also highlighted how fishing activity had a high impact on these groups during the 1990s (Table 1). SPF were related with high exploitation rates and high primary production required to sustain their catches, and consumption of SPF production by the fishery was also high. These results are in line with an increasing concern of high fishing intensity on these species and a recruitment overfishing situation related with anchovy stocks [7]. Moreover, cross-system comparisons of standardized trophic models of South Catalan Sea with upwelling systems from Humboldt and Benguella regions had evidenced the higher fishing impact on small pelagic fish in the Mediterranean area due to the smaller production and biomass rations and higher fishing rates [8].

Tab. 1. Indicators for small pelagics' fisheries in the Catalan Sea.

Group	TL[1]	PPR SPF (%)[3]	F/Z[5]	Consumption (%)[6]
Anchovy	3.09	9.78	0.30	27.80
Sardine	3.01	15.80	0.53	54.28
Other SPF	3.05	0.19	0.10	10.39
Total Catch	3.12 [2]	10.6 [4]	-	20.20 [7]

[1] TL = trophic level of species; [2] mean trophic level of the catch; [3] PPR SPF (%) = primary production required to sustain the catch of SPF in relation with total %PPR; [4] Total PPR%; [5] F/Z = exploitation rate; [6] Consumption (%) = consumption of SPF production by fishing; [7] Total consumption of fishable production (%).

The impact of fishing was also analysed by developing dynamic simulations with trophodynamic modelling [5]. The steady decline of pelagic landings between 1994 and 2003, coupled with a decrease of the pelagic biomass within the ecosystem, could be reproduced by the model combining different scenarios of moderate increase of fishing effort and an environmental forcing under wasp-waist flow control [4]. This decline underlined the low resistance of the system in front of perturbations and the relevance of fishing, in conjunction to environmental forcing, to understand the dynamics of small pelagic fish in the area. These results are of relevance in terms of management of exploited marine resources in the area since the high exploitation of small pelagic fish can produce important impacts of the structure and functioning of the exploited ecosystem.

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