ASSESSING THE IMPACT OF FISHING AND PROTECTION ON THE DYNAMICS OF THE SEA BREAM POPULATION IN THE NORTH-WESTERN MEDITERRANEAN SEA USING A SIMULATION MODEL

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Abstract

We used ISIS-fish model to evaluate the impact of spatial and seasonal management measures on the dynamics of the sea bream population *Diplodus sargus sargus* (L., 1758) of the French Catalan fishery (North-Western Mediterranean). First, in order to identify the most significant parameters of model, a sensitivity analysis were carried out according to a fractional factorial experimental design. The method used consists in modifying some input parameters of the model by ± 20% around its initial value. Second, we attempted to disentangle the effects of several measures jointly implemented; as marine protected areas MPAs, changes in gillnet mesh size and fishing effort reduction.

Keywords: Biodiversity, Coastal Management

Introduction

Over-exploitation of marine fisheries resources remains a serious problem worldwide. The traditional management measures (quotas, limiting fishing effort, size minimum capture) does not ensure the sustainability of fisheries [1], marine protected areas MPAs have been strongly advocated as an ideal tool and a central element of many marine resource management plans. In the study area, the legislative framework focused on marine protected areas (Cèrbère-Banyuls reserve) and on the minimum landing size. In the present paper, our interest is twofold. First, study the influence of uncertainty model on a sensitivity analysis, which is to identify, quantify and analyze how to react exits from one model to disturbances on the variable entry. Second, we present the results of the simulation numeric to assess quantitatively the impact of various management measures of fishing and protection on the sea bream population.

Materials and methods

In this paper, we used ISIS- fish model to evaluate the impact of spatial and seasonal management measures on the dynamics of the sea bream population *Diplodus. Sargus Sargus*, of the French Catalan fishery . In our model, numerous parameters are fixed as they present a range of variation. This is the case of the fecundity rate [2], recruitment [3], growth [2], [4], catchability [5], mortality [6]. Then, uncertain parameters were identified and grouped into 9 groups: length range, fecundity coefficients, migration coefficients, natural mortality, catchability coefficients, gears standardisation factors, target factors and the number of inactivity days for each strategy. Analysing the effect of several parameters simultaneously makes it possible both to show their possible interactions and to rank them according to their importance of the model. The method used consists in modifying each input parameter of the model by ± 20% around its initial value. The effect of each operated modification is analysed on 5 outputs of the model (biomass at the last time step. last year catches, five last year's cumulative catches, last year nominal effort and five last year's cumulative nominal effort).

Results

The outputs considered showed particularly sensitive to some parameters such as natural mortality, length stage, gears standardisation factors, fecundity and catchability coefficients. Various management measures of commercial and recreational fisheries were simulated during 10 years in order to evaluate potential impact of fishing and to reduce over exploitation of the fishery, including for example, the imposition of AMPs in the nursery areas and in the spawning areas. An increase in gillnet minimum mesh size, from 60 to 80 mm were adopted to improve gear selectivity in the groundfish fishery. Finally, we attempts to reduce effort by 50% during the 5 first years and during the simulation duration. According to our model assumptions, the fishery has been overfished. In the model simulations carried out to explore the impact of possible management intervention:(a) MPAs nursery zones which would be an alternative management tool for conserving marine resources and ecosystems, (b) a change in the minimum mesh size to 80mm would cause an increase of 33% in the total catch (kg) and 51% in the gillnet catch in the long term, and (c) Limiting the fishing effort current levels resulted in higher levels of biomass and catches for the fishery (from the current 779t. up to an average 1766t in the 10 year horizon: a 226.65% increase.

Discussion

Our study has evaluated a broad range of assumptions concerning the status of the area being protected (spawning ground and (or) nursery ground), and fishing selectivity. The experiments and analyses presented in this paper have clearly demonstrated the potentials for ISIS-Fish. This enabled us to carry out preliminary explorations the impacts of these measures and to make a general diagnosis about the significance of the impact and finally to group them with respect to the consequences on both biomasses and catches of sea bream population.Results of the analysis in two different areas of the no-take zone indicate that the seasonal closure (Jan.-Jun.) of the nursery zones is beneficial for fish stock recovery, thereby increasing the biomass of fishes , it will result in an about 50% increase of the total catch and an about 76% reduction of juvenile catches (about 25 t.). A change in the minimum mesh size to 80mm would cause an increase of 33% in the total catch (kg) and 51% in the gillnet catch in the long term, providing that the minimum landing size of sea bream was simultaneously raised from 23 cm to 23.65 cm. Limiting the fishing effort current levels resulted in higher levels of biomass and catches for the fishery where the stock size responses are likely to occur on two distinct time scales associated with growth of existing fish and future recruitment. In conclusion, in the present situation of existing management policy and with the knowledge currently available, we recommended a potential framework of a project aimed at evaluating the potential of a novel co-management approach adopted at the actual situation along the French Catalane coastline.

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