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ECOLOGICAL BASIS FOR FISHERIES MANAGEMENT IN THE CANTABRIAN SEA

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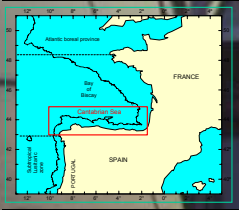
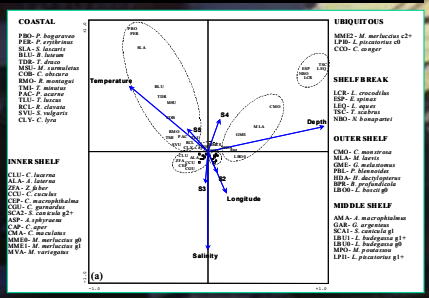
The Ecosystem



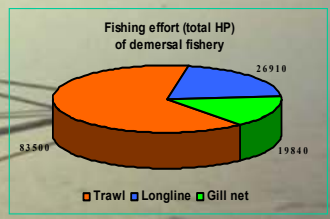
The Cantabrian Sea is located in the zone of subtropical/boreal transition of the NE Atlantic. Typical temperate southern species coexist with others of northern origin and, consequently, high biodiversity indexes have been described (Sánchez, 1993). In addition, the complex topography and the wide range of substrates on the continental shelf result in many different types of habitats. This diversity is reflected in the biological richness of the region, that includes a wide range of species, many of which have commercial interest. This region is in addition the winter spawning area for some species, such as hake, megrims and horse mackerel, and the feeding area for others, such as anchovy and tuna. Two main seasonal hydrographic driving agents, the winter Poleward Current and the spring-summer upwelling, determine the water dynamic and productivity.

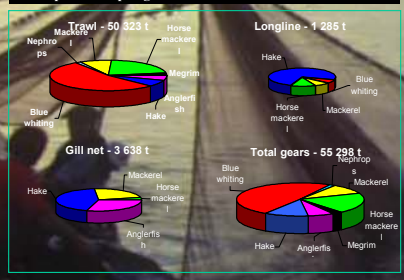
The structure of the demersal fish communities of the Cantabrian Sea is strongly influenced by environmental variables, though the depth of the narrow continental shelf is the main factor. Five bathymetric groups of species (coastal, inner shelf, middle shelf, outer shelf and shelf break) were determined using canonical analysis on a extensive surveys database. The depth in conjunction with near-bottom temperature, near-bottom salinity, and longitude explains 21.4% of the variance of species data and 72.9% of the variance of species-environment relationship (Sánchez and Serrano, 2001). Also, the ground type is determinant of the distribution of the communities on the shelf. Rocky bottoms appear near the coast and shelf break and muddy bottoms in the middle and outer shelf.



The Fishery

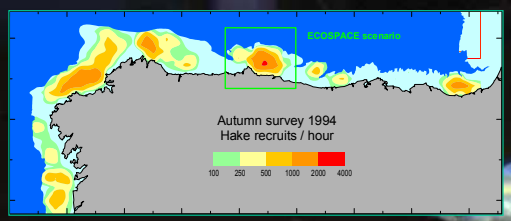
The fisheries have an strong impact on the structure and dynamics of the Cantabrian Sea ecosystem. Large commercial fleets have been operating for centuries, although more intensively, in an industrial way, during the last 50 years. Fishing is an important economic resource in the region (approximately 200 000 tonnes per year). Trawlers fish on the muddy bottoms of the shelf, whereas longliners operate mainly on the shelf break bottoms and gill nets are used on rocky grounds near the coast and also on the shelf break. Pelagic fisheries are seasonal and they catch anchovy (purse seine) and tuna (troll and bait boats) during the trophic migrations of these species on spring and summer.





The industrial trawl fishery produces the highest demersal landings and artisanal fishery (longline and gill net) have decreased its percentage of catches during the last years. Single-species assessment approaches, mainly based on TACs and quota regimes, have been used historically for the management of European Atlantic fisheries. The latest estimates by ICES assessment Working Groups show that the southern stocks of hake and anglerfish are below the safe biological limits and the southern stocks of megrims and horse mackerel are overfished. Landings of hake (the main demersal commercial species) in the last four years have been below the agreed TACs and the spawning biomass is at a historical minimum.

The behaviour of demersal target species

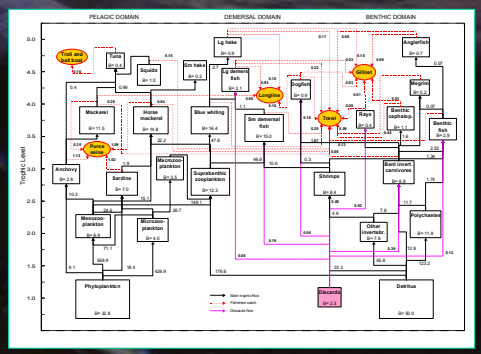


Hake is the main target species of the demersal fishery and its stock is at present in critical conditions. Hake recruits tend to be distributed in patches that appear all the years in the same areas of the inner shelf, due to larval retention and drift mechanisms (Sánchez and Gil, 2000), where there have been massively caught by trawlers. Adults live mainly on the shelf break and are caught by artisanal fishery. Blue whiting is the main prey of hake and lives on the outer shelf and shelf break. The low overlap between the distribution of juveniles of hake and blue whiting allow us to concentrate the trawl effort outside the well defined hake nursery areas.

Megrims and Norway lobster live on muddy bottoms of the middle and outer shelf. Due to the low displacements observed in the Cantabrian Sea, no migratory habits are therefore expected. They are only caught by trawlers and their distribution area can be defined as exclusive of this fishing gear. Mackerel and Horse mackerel show a wide distribution in the East Atlantic and their migratory and pelagic habits imply wide management measures in the European context.

The Model

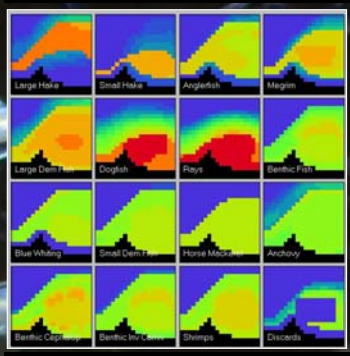
A mass-balance model of trophic interactions (ECOPATH) has been used, in order to know the role of the fisheries that operate in the area (Sánchez and Olaso, 2001). The model (28 trophic groups and five fisheries) is based on database of bottom trawl surveys, ICES assessment Working Groups, stomach analyses, fisheries research and economics. The results indicate a level of fisheries impact in the Cantabrian Sea comparable to the most intensively exploited temperate shelf ecosystems of the world. The high PP required value corroborates the fact that most commercially important shelf stocks in the area are either fully or overexploited, and the landings are expected to decrease with the current fishing pressure.



Ecospace scenario

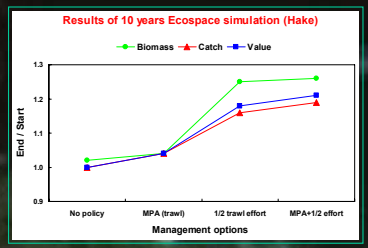
ECOSPACE (Walters, *et al.*, 1998) was used as an exploratory tool for the analysis of trophic relationships in the time/space and for the evaluation of the effect of some management options. To explore the simulation capacity of Ecospace, we have defined a base-map of the central area of Cantabrian Sea with five habitats corresponding with the main demersal fish communities. We have also defined the habitat preferences of trophic groups and 5 gear activities, and the movement rates and vulnerability in bad habitats of the 26 living trophic groups. To test the impact of management measures in the ecosystem, we have located the existing restricted areas (MPA) where the use of trawl gear is forbidden.

Simulation of some management options

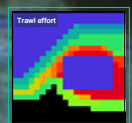


Ecospace predictions of biomass densities in the central Cantabrian Sea during a 10 years simulation, show that rays and dogfish (large-bodied species which have low rates of turn-over), megrim (only trawl catch), hake (strong trawl effect on juveniles), benthic cephalopods and large demersal fish are the main trophic groups which increase their biomass when the trawl fishing regime decrease. The exclusion of trawling in some areas produces similar effects with additional low values of discards. These estimations have been validated using real data of bottom trawl surveys inside and outside an closed area, what suggests that the simulations provided by Ecospace are realistic.

Simulations with different rates of trawl effort and closed areas (MPA) show that the fishing effort reduction is more efficient for the recovery of hake fishery than the MPA application. Trawl effort reduction produces an increase of biomass and mean length of individuals and consequently hake is more accessible for the selective artisanal fishery (longline and gill net). The higher market value of fish from artisanal fishery in relation to the trawl catches produces an increment of total value of the catch at the end of the 10 years Ecospace simulation.



The low efficiency of MPA as a management measure is probably due to the effect of the concentration of trawl effort in the surrounding zone of the MPA that minimizes the positive effect of the protection of juveniles.



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