

# EXPLOITATION PATTERNS OF BOTTOM FISHERIES AFTER THE “CACHUCHO” MPA MANAGEMENT PLAN IMPLEMENTATION

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## Introduction

In the Central Cantabrian Sea, south of the Bay of Biscay, is the Le Danois seamount (44°03'N-004°53'W), located more than 60 km off the Asturian coast of Llanes. The presence of large vulnerable species (i.e. corals, gorgonians and sponges) make it a highly representative area of habitat-1170, a habitat of great ecological value included in Annex I of the Habitats Directive (HD). Its summit is located at a depth of less than 500 metres and its internal basin, a depression between 800 and 1000 metres deep, favours its isolation and the appearance of habitat-forming species (HFS). Its geological structure and the effects of the slope currents in the area favour the appearance of fish species of great interest for the Spanish fleet, such as the greater forkbeard (*Phycis blennoides*), the blue whiting (*Micromesistius poutassou*), the monkfish (*Lophius* spp.) or the goatfish (*Beryx decadactylus*), which find in this area an essential habitat for their reproduction. Due to the importance of the habitats-1170 present in the “El Cachucho” area, in December 2008 the area was closed to all bottom fishing activities and three years later (December 2011) “El Cachucho” was declared a Marine Protected Area (MPA). This protected area is divided into two well-defined regions, the Le Danois Bank and its buffer zone, located between the bank and the Cantabrian Sea’s continental shelf (Fig. 1). This study analyses the effect of the first high seas MPA declared in Spain, “El Cachucho”, on the spatial distribution patterns, in terms of fishing intensity (hours, FI), and on the economic performance (euros, EP) of bottom fisheries in the area of influence of the MPA between the years 2009-2020.

## Materials and Methods

Fishing data obtained from VMS, a satellite based monitoring system that provides information related to the location, heading and speed of vessels, roughly every 2 hours, were combined with and logbooks, which contain information fishing trip (gear used, ...) and daily landings (kg, species). In addition, the databases of first market records were used to obtain catch sales data. These three datasets were combined and the to obtain the spatial distribution of fishing activity (hours) and economic performance (euros) by gear type: Bottom Otter Trawl (OTB), Bottom Pair Trawl (PTB), Set Longlines (LLS) and Set Gillnets (GNS). Data covering the period of 2009–2020 for the study area (“El Cachucho” MPA and area of influence of the MPA) were provided by the Spanish Ministry of Agriculture, Food and Environment (MAGRAMA).

For the analysis of fishing activity grid of 0.01° × 0.01° was used (c-square). The mean FI and EP were mapped for the period (Fig. 2). In order to assess the spatial and temporal fluctuation of the fishing, in terms of fishing intensity (h), a nested General Linear Model (GLM) was performed. With this model, a temporal trend of fishing intensity (h) was obtained for each grid cell. The resulting correlation tendency (positive or negative and their significance) was plotted for each variable for gear (OTB, PTB, LLS, GNS) across the study area (Fig. 3).

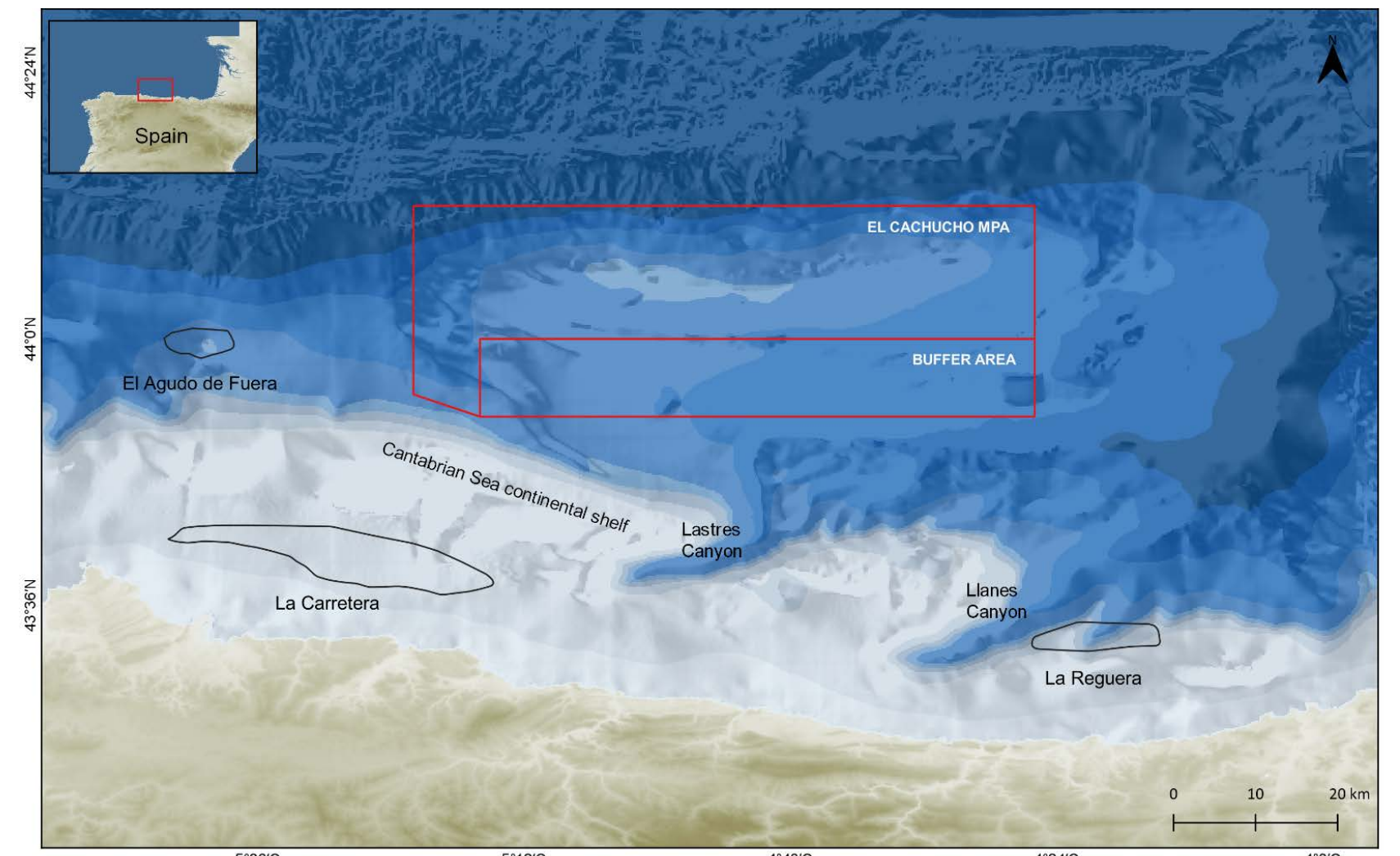


Figure 1. Delimitation of the Cachucho MPA (Le Danois Bank and buffer area) and its location in the Cantabrian Sea.

## Spatial changes in fishing intensity and economic performance by gear

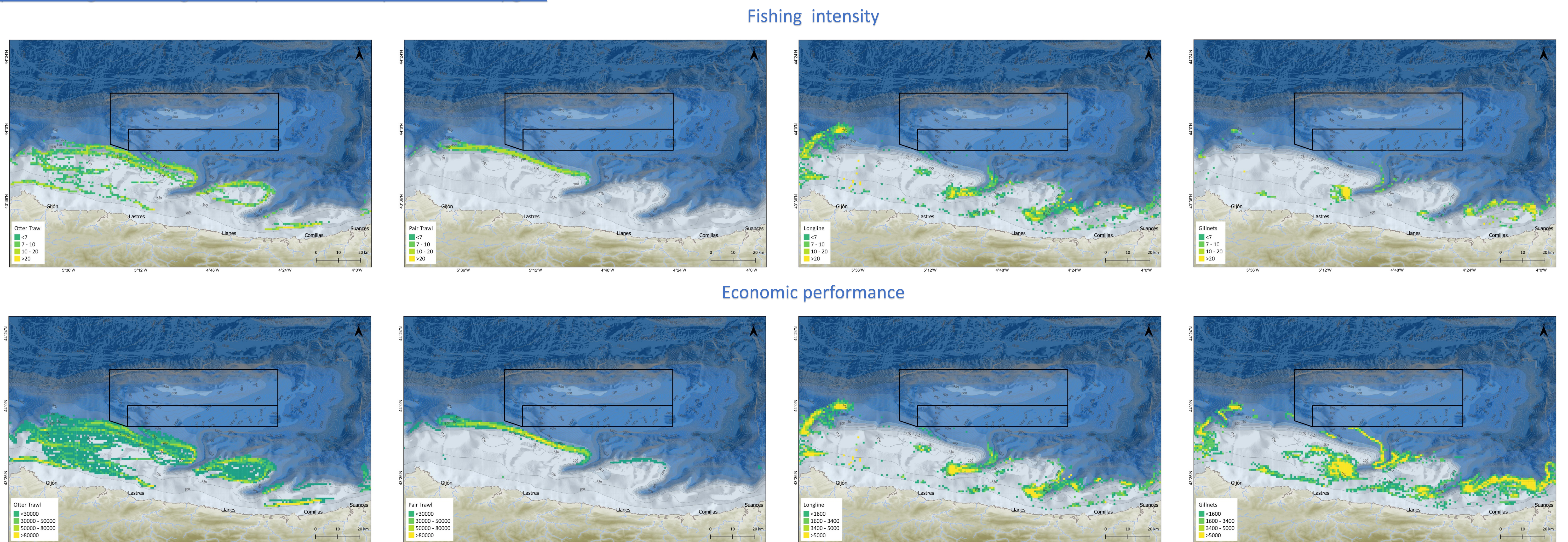


Figure 2. Mean fishing intensity (h) and economic performance (euros) in the period 2009–2020 for Bottom Otter Trawl (OTB), Bottom Pair Trawl (PTB), Set Longlines (LLS) and Set Gillnets (GNS). The effort is estimated from VMS and logbook data as total hours in grid cells of c-square (0.01x 0.01).

## Spatio-temporal trends of fishing intensity by gear

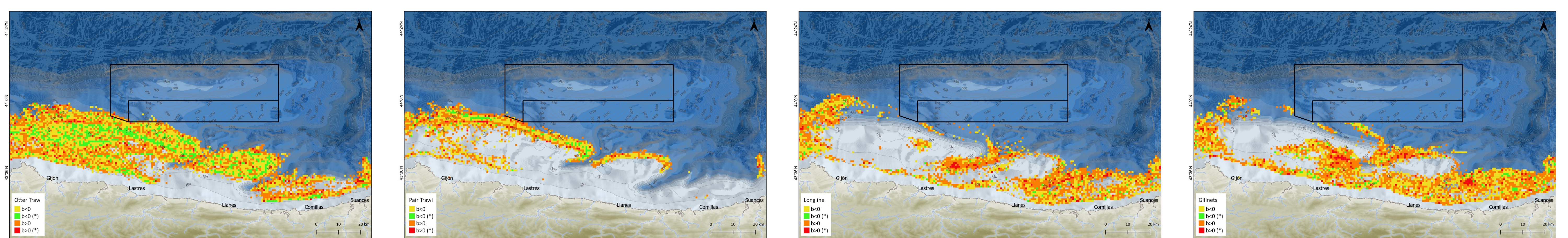
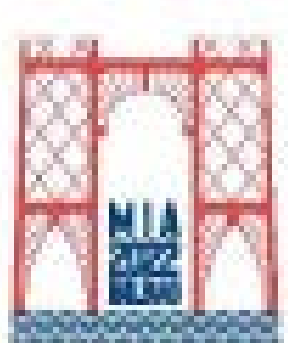


Figure 3. Spatial distribution of the correlation trends and their significance (\*) resulting from the lineal model for the period 2009–2020 for Bottom Otter Trawl (OTB), Bottom Pair Trawl (PTB), Set Longlines (LLS) and Set Gillnets (GNS). Green and yellow grid cells represent a negative trend of fishing intensity (h) over time, while orange and red grid cells represent areas where fishing intensity (h) increases over time. Green and red regression has p values <0.1.

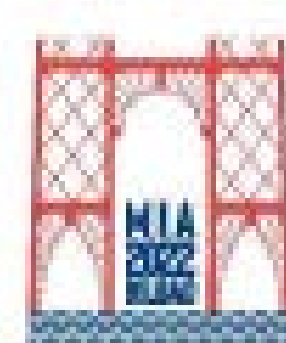
## Results and Conclusions

The results show changes in the spatial distribution of the mean fishing effort of bottom-fishing gears (OTB, PTB, LLS, GNS) since the implementation of the MPA (Fig. 2). No bottom fishing activity is observed either in the MPA (bottom fishing gear exclusion zone) or in the buffer zone, an area located far from the upper part of the Le Danois bank, in the intrasurface basin, where fishing is authorized to a closed list of longline vessels. By gear, bottom trawl fishing effort (OTB and PTB) is concentrated in the soft bottom fishing grounds, the southwest of the MPA, especially on the edge of the upper slope shelf (150 to 600 m deep), where species such as blue whiting and mackerel (*Scomber* spp.) are caught, and where a good economic performance is obtained (euros). In OTB there are also two other areas of high effort, one located southeast of the Lastres Canyon and northwest of the Llanes Canyon, where species such as hake (*Merluccius merluccius*) are caught, and other between 100-200 m depth off the coast of Comillas. In these areas, the fishing grounds are zones of high economic performance (euros), especially area near Comillas, where the highest performance of the whole study area are observed. Bottom longline effort is concentrated almost exclusively at the head of the canyons, especially in the Lastres and Llanes canyons, where there are rocky bottom fishing grounds where species such as hake are caught. The high intensity of effort observed in the fishing grounds of El Agudo de Fuera, an area where species of high economic value such as sea bream (*Pagellus bogaraveo*) or monkfish are caught, is particularly noteworthy. As in the LLS, the greatest effort in the GNS is located at the head of the canyons, mainly in the Lastres canyon, and in fishing grounds such as La Reguera, to the southeast of the MPA, where monkfish and scorpionfish (*Scorpaena* spp.) are caught. The fishing grounds with the highest economic performance for the GNS fisheries are located at the head of the canyons, especially the Lastres canyon, and in the area to the southeast of the MPA.

The analyses and plotting of the correlation values resulting from the multiple linear regression models of fishing intensity of OTB show a decreasing trend to the southwest of the MPA, on the edge of the bathyal upper slope, and in the area between the Lastres and Llanes canyons. However, there are exceptions, such as the region west of the Llanes Canyon and La Carretera fishing ground, where effort tend to increase. In the case of PTB, a significant downward trend in effort is observed in the northeast of the Lastres Canyon. As for static gears, the LLS tends towards an increase in effort in the head of the Lastres and Llanes canyons. While in GNS, there is a trend towards an increase in effort to the northwest and at the head of the Lastres Canyon, and in the surroundings of La Reguera fishing ground, to the southeast of the Llanes Canyon.



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