

Integrating fishing spatial patterns and strategies to improve high seas fisheries management



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ABSTRACT

Fishing activity in waters beyond national jurisdiction generates multiple management issues, such as data poor fisheries, management of straddling fish stocks and lack of impact assessments on deep-sea Vulnerable Marine Ecosystems (VMEs). Fishing strategy is the key to understanding and managing high seas fisheries, targeting highly migratory resources that are widely distributed. An international fleet, including Spanish flag bottom trawlers, operates along the Patagonian shelf in Southwest Atlantic waters, which includes an unregulated strip of continental shelf beyond national jurisdiction. The Spanish fleet's fishing strategy was analyzed, and based on on-board observer data collected from 1989 to 2015, three main fishing seasons were identified: a first season mainly targeting Argentinean squid (*Illex argentinus*) from January to March, a second season targeting hake (*Merluccius hubbsi*) from April to August, and a third season from September to December showing an opportunistic and heterogeneous behavior. Findings were framed within current knowledge on resource distribution. A preliminary observation of the inter-annual CPUE rates of target species during their respective fishing seasons highlights the possible existence of species linkages and bioclimatic cycles which may affect species distribution and abundance in the area and might require future research. Even if current fishing activity from the Spanish fleet does not overlap deep-water VMEs, any slight change in the fishing strategy to deeper waters (i.e. the fleet targeting high density *I. argentinus* areas below 300 m, or a change in the target species) would be critical for the conservation of VMEs in these waters.

1. Introduction

The management of fishing activities in the high seas (areas beyond national jurisdictions) is a major challenge, not only for the sustainability of straddling stocks [7] but also for the conservation of deep-sea Vulnerable Marine Ecosystems (VMEs) [18,27,36,37], especially cold-water corals [29,32]. These issues were acknowledged by the United Nations General Assembly (UNGA), adopting resolutions 61/105 [70] and 64/72 [71] calling on flag states and Regional Fisheries Management Organizations (RFMOs) to take immediate actions towards the sustainable management of fish stocks and protection of VMEs from destructive fishing practices, consistent with the 2009 FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas [28]

The Southwest Atlantic contains one of the largest continental shelves in the world, even exceeding the Exclusive Economic Zone of coastal countries and thus leaving a strip of unregulated high seas rich in fishing resources. Between 25 and 30 demersal freezer trawlers with

the Spanish flag fish each year on the Patagonian shelf, performing their activities both in the high seas of the Patagonian Shelf (hereafter HSPS) and in waters under jurisdiction of the Malvinas/Falklands islands. In addition, the main species targeted in the Patagonian Shelf, such as the Argentinean hake (*Merluccius hubbsi*), the Argentine short fin squid (*Illex argentinus*) or the Patagonian squid (*Doryteuthis gahi*), belong to trans-zonal stocks which extend throughout the continental shelf, being caught either in the Argentinean EEZ, in Malvinas/Falklands waters or in the HSPS. However, in practice, and mainly because of political issues, there is no RFMO operating in the region for the shared management of the resources, although previous attempts have been made in this regard.

Since 1991, due to Argentinean territorial claims and the northern extension of the FOCZ (Falklands Outer Conservation Zone), HSPS waters were almost limited to the so-called 'Division 46' [54] (Fig. 1). Research on fishing activity and yields in this fishing ground have been confined to studies based on logbook data from the Taiwanese squid fishery [13–15] and on-board observer data for the Spanish trawling

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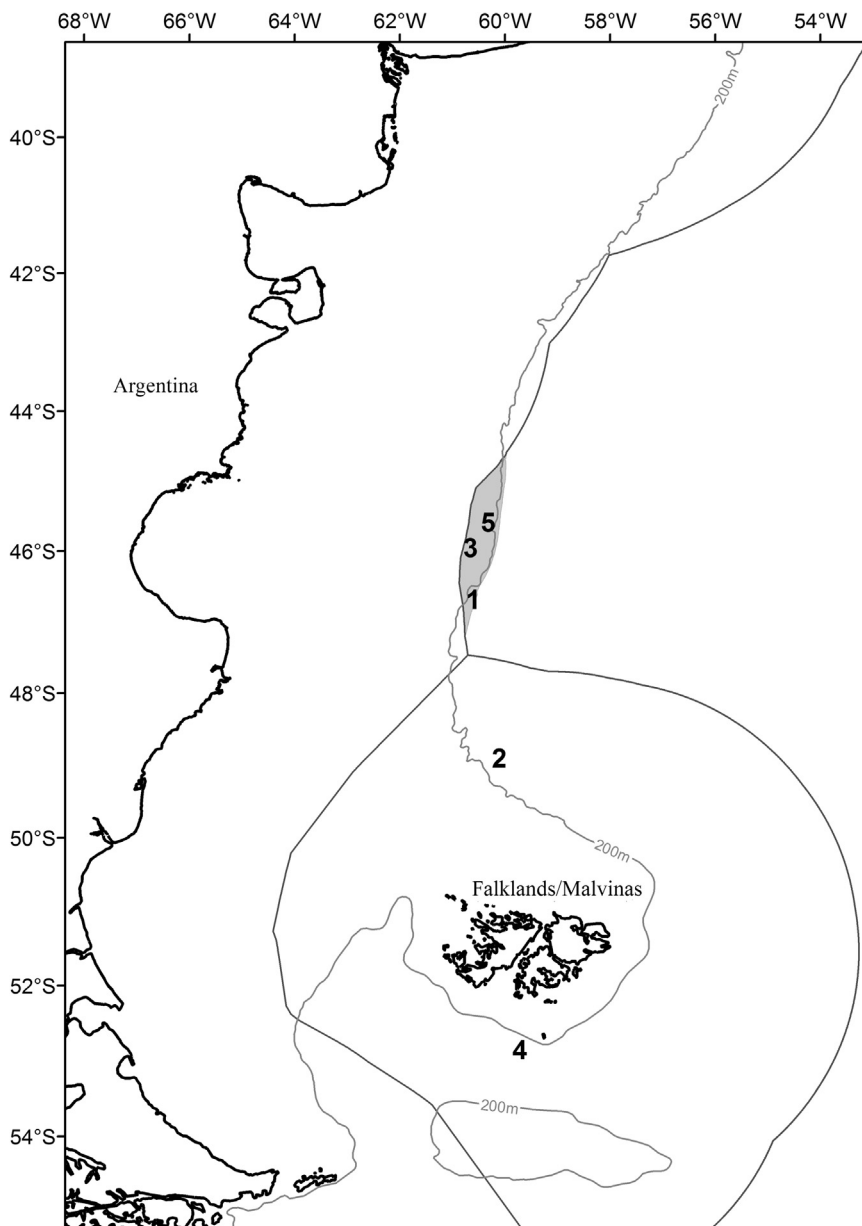


Fig. 1. Location of Division 46 (in grey). The 200-meter bathymetric contour, indicating the continental shelf border, and EEZ limits are shown as reference. Overall strategy trends are shown: 1) Fleet targeting *I. argentinus* in the high seas slope between January and March; 2) *I. argentinus* fishing season in Falklands/Malvinas waters between mid-February and May; 3) Fleet targeting *M. hubbsi* in the high seas continental shelf between April and August; 4) Second fishing season in Falklands/Malvinas waters, mainly targeting the *D. gahi* season between July and September and the hake season between August and September; 5) Opportunistic fishing strategy in the high seas continental shelf between September and December, mainly targeting hake at lower yields.

fishery [3,56,66,74]. However, none of them offered insights into the fishing strategies of the fleet.

Marine resource distribution in the region is heavily influenced by oceanographic features of the Patagonian shelf itself; in particular the HSPS comes under the direct effect of the Malvinas/Falklands current and the Patagonian shelf break front [1]. In addition, tidal fronts on the continental shelf, fresh water discharge from the River Plate, and the Brazil-Falklands currents confluence play an important role in species recruitment and the distribution of commercial stocks fished in the region [46,53,30,65,39].

A series of 13 multi-disciplinary research cruises carried out by the IEO in the HSPS between the years 2007 and 2010 identified aggregations of cold-water corals at depths of between 400 and 1000 m, colonized by many other species [61], high diversity coral garden communities between 300 and 500 m depth, sponge aggregates between 250 and 1300 m depth and a number of deep marine rocky environments. These series of surveys also allowed for the first time a stock assessment to be performed from independent data of marine resources in the area [11,59] and the impact of fisheries on VMEs to be assessed [61].

Even if the overlap of VMEs with current fishing operations was found to be almost negligible, it remained unknown whether this absence was a consequence of the impact of previous fishing activities. On the other hand, the distribution of current and potentially commercial species actually overlapped deep-water VMEs, and therefore any change in the fishing strategy of the fleet (i.e. a change of target species or deep-water fishing) might directly impact VMEs in the area. Correct identification of the fishing strategy may help to support management plans to protect high seas singular ecosystems where fishing activity occurs or may occur.

However, detailed multi-disciplinary studies of this kind are infrequent in high seas waters, and therefore fishery dependent data, together with effort estimated from VMS (Vessel Monitoring System) data, are still the only data sources available for a number of industrial fisheries worldwide. These data sources are nevertheless a valuable asset for determining fishing strategy, identifying the presence of VMEs [28,50,67] and estimating spatial-temporal changes in the stock of target and by-catch species [23,40].

Both prior knowledge of fishing behavior and understanding of the fishery are crucial not only for establishing a correct strategy for

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