



Seasonal closures as a measure of trawling effort control in two Mediterranean trawling grounds: Effects on epibenthic communities

M. Demestre^{a,*}, S. de Juan^a, P. Sartor^b, A. Ligas^b

^a Institut de Ciències del Mar, CSIC, Passeig Marítim de la Barceloneta 37-49, 08003 Barcelona, Spain

^b Centro Interuniversitario di Biologia Marina ed Ecologia Applicata, viale N. Sauro 4, 57128 Livorno, Italy

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ABSTRACT

Within the framework of ecosystem-based management, we focused on the use of seasonal closures as effective measures to minimise the degradation of benthic communities by trawling. These closures imply the complete cessation of trawling fleet activity and are commonly used in the Mediterranean to reduce the annual fishing effort, with the ultimate goal of effective resource management. In this study, we aimed to investigate how epibenthic communities respond to seasonal closures. The potential benefits of short-term annual closures in two Mediterranean fishing grounds were evaluated by analysing changes in community structure and composition that were linked to the closure. A decrease of faunal abundance was observed with the resumption of fishing activity after the closure at both fishing grounds. Remarkably, results indicated that some large and mobile fauna were able to respond to these closures. We concluded that the currently planned closures are too short to benefit benthic communities.

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1. Introduction

Over the last decades, fisheries management has shifted from a single-species approach to multispecies management, including the reduction of by-catch. Despite these remarkable advances, the current agreement that trawling alters overall benthic community structure and may result in impoverished communities and habitats (Churchill, 1989; de Groot, 1984; Dayton et al., 1995; Jennings and Kaiser, 1998; Auster and Langton, 1999; Hall, 1999; Agardy, 2000; Palanques et al., 2001; NRC, 2002; Thrush and Dayton, 2002) implies that fisheries management must also include within its objectives the protection of entire ecosystems (Gislason et al., 2000; Murawski, 2000; FAO, 2003; Browman and Stergiou, 2004). In this context, one of the most effective steps towards minimising the effects of trawling on ecosystems is the overall reduction of fishing effort (Caddy, 1993; Kaiser et al., 2002; Frid et al., 2005), by means of implementing permanent or temporary closures (Dayton et al., 2000; Dinmore et al., 2003; Frid et al., 2005).

Mediterranean fishing grounds are generally managed by the fishing fleet from the nearest harbour, with appropriate measures dictated by the particular species targeted. The activity of each fleet can be locally regulated by the fishermen's association from each harbour, e.g., limitation of fishing hours per day, fishing days

per week, or landed biomass per vessel (Demestre, 1986; Leonart, 1990; Caddy, 1993; Farrugio et al., 1993). The regulation of commercial trawling in the Mediterranean is based primarily on effort control. Temporary closures of fishing grounds demand complete cessation of trawling fleet activity for a variable period, and can result in up to a 20% reduction of annual effort (Caddy, 1993; Leonart and Franquesa, 1999). Seasonal closures are generally imposed with the aim of protecting demersal resources at the most vulnerable point of their life cycles, recruitment. The duration and seasonality of these closures varies among countries and harbours, ranging from 30–45 days in Italy to 2 months in Spain, or 4–5 months in Greece (Horwood, 1998; Leonart and Franquesa, 1999; Smith et al., 2000; Dinmore et al., 2003; Demestre, 2006). Research suggests that the closure of areas to trawling could have negative effects for benthic communities if it encourages a displacement of trawling effort to other previously less-fished areas (Dinmore et al., 2003; Hiddink et al., 2006). Theoretically, the closure of Mediterranean trawling grounds consists of the complete cessation of fleet activity, without effort relocation to other areas.

Results obtained after several studies performed in the Mediterranean indicate an increase in commercial yields for some demersal species after closure (Relini et al., 1996; Pipitone et al., 2000; Machias et al., 2001; Demestre et al., 2007). However, within the framework of an ecosystem approach to fisheries management, we aimed to assess the potential response of epibenthic organisms to a short-term seasonal closure. The following analysis examines whether these closures benefit benthic communities

* Corresponding author. Fax: +34 93 230 95 55.

E-mail address: montse@icm.csic.es (M. Demestre).

from commercially exploited fishing grounds. The study is focused on epibenthic communities from two Mediterranean fishing grounds located in the Catalan and Adriatic Seas (northwestern and central Mediterranean), which encompass muddy and sandy-muddy sediments, respectively. Moreover, the areas are subjected to different trawling intensities. We analysed the epibenthic fauna, as this benthic assemblage can be divided into two broad categories. Mobile organisms are able to migrate within areas with various degrees of disturbance intensity, while sessile fauna cannot. Delicate interplay between the two groups contributes to community structure, encompassing an important food-web within the demersal ecosystem (Kaiser et al., 2002; Thrush and Dayton, 2002). This study is a unique opportunity to investigate the alteration of these epibenthic communities (Collie et al., 1997; Ball et al., 2000; Gray et al., 2006), considering the specific case of seasonal closure in two Mediterranean fishing grounds characterised by different trawling intensities and sediment compositions.

2. Materials and methods

2.1. Study areas: Catalan Sea and Adriatic Sea

The Catalan Sea study area is located in the northwestern Mediterranean on the continental shelf off the Ebro Delta (Fig. 1A). The selected fishing ground is between 35 and 70 m deep, with a surface area of approximately 400 km², and is composed of muddy sediment (>95% mud). This fishing ground is operated by St. Carles de la Ràpita otter trawl fleet, which, with 59 vessels, is considered one of the largest fleets in the Catalanian region. This fleet trawls within the selected fishing ground, targeting the red mullet (*Mullus barbatus*), spotted flounder (*Citharus linguatula*), squid (*Loligo vulgaris*), octopus (*Octopus vulgaris*), swimming crab (*Liocarcinus depurator*), and the mantis shrimp (*Squilla mantis*). The fishing ground encompasses a 2.7 km² area that has remained undisturbed for about 20 years, due to the scattered remains of an abandoned oil platform that cause trawlers to avoid towing within this portion of the fishing ground (Demestre, 2006).

The northern Adriatic Sea study area, within the continental shelf impacted by the Po river plume (Fig. 1B), is characterised by sandy-muddy sediment (about 60% sand and 40% mud). The selected fishing ground is located off Fano harbour, between 50 and 55 m in depth, with a surface area of about 200 km², where the fishing fleet operates with 27 otter trawlers. The main target species are European hake (*Merluccius merluccius*), red mullet (*Mullus*

barbatus), common sole (*Solea vulgaris*), mantis shrimp (*S. mantis*), and squid (*L. vulgaris*). The fishing ground includes an area of about 2 km² that has remained undisturbed due to a gas platform structure restricting trawling for 1 km all around. The oil platform has been functioning since 1990.

Two sites were selected within each fishing ground: the fished site corresponded to a portion of the fishing ground subjected to the activity of the trawling fleet, and the reference site corresponded to the undisturbed portion. An experimental cruise was carried out at each fishing ground prior to this study, in order to characterise the selected sites and to ensure no differences in the benthic community assemblage and environmental characteristics between the fished and reference sites. Samples of fauna and sediment from the two sites were obtained for a qualitative description of the communities (considering sediment grain size and faunal composition). These efforts confirmed that both fished and reference sites had similar habitat characteristics and were therefore comparable. Each fishing ground was surveyed with side scan sonar recording the trawl marks on the sea bed, which determined that the fished sites were homogeneously trawled and confirmed that the reference sites had not been recently disturbed (Demestre, 2006; Sartor et al., 2007).

2.2. Seasonal closures and collection of samples

The local fishermen's associations, from both St. Carles de la Ràpita and Fano harbours, regularly collect data on fishing activity and landings per vessel (daily records at St. Carles de la Ràpita and weekly records at Fano). The analysis of these records revealed seasonal variation of the fleet activity and the total trawling effort within each of the two fishing grounds. The fishing fleet activity in the Catalan Sea trawling ground varies from high fishing activity in September through February (average of 7550 fishing hours/month), to low activity in March through June (average of 5520 fishing hours/month), and a 2 month fishing closure from the 1st of July to the 31st of August (Demestre et al., 2007). The seasonality of the fleet activity operating in the Adriatic Sea fishing ground goes from high fishing activity January through May (average of 656 fishing hours/month), to low activity June through December (average of 398 fishing hours/month). In the year of the study, a 40-day fishing closure was enforced (04 August–11 September) (Demestre, 2006).

Samples obtained before, during and after the closure periods at the fished and undisturbed sites were compared to assess the effects of the seasonal closures at each of the two fishing grounds. Six experimental cruises were undertaken in the Catalan Sea from June to November 2003: one in June (B), just before the fishing closure with low fishing activity, two in July (C1, C2), and one in August (C3), during the fishing closure. Additional single cruises occurred in September (A1) and in November (A2), one and 3 months after the end of the fishing closure, during times of high fishing activity. Five experimental cruises were carried out in the Adriatic Sea from July to November 2003: one in July (B), before the fishing closure and with high fishing activity, one in August (C1) and one in September (C2), during the fishing closure. One cruise occurred in October (A1), 1 month after the end of the fishing closure and with low fishing activity, and the last one was in November (A2), 2 months after the fishing closure at a time of low activity.

The epibenthic faunal populations were sampled at each study site with similar experimental designs. Samples were collected with an epibenthic dredge, a modified 2 m beam trawl with a 10 mm cod-end (Sanchez, 1991; Giovanardi et al., 1998). The device facilitated three hauls at each fished and reference study site on every cruise. The duration of each haul was approximately 15 min at the Catalan Sea and 20 min at the Adriatic Sea, and the

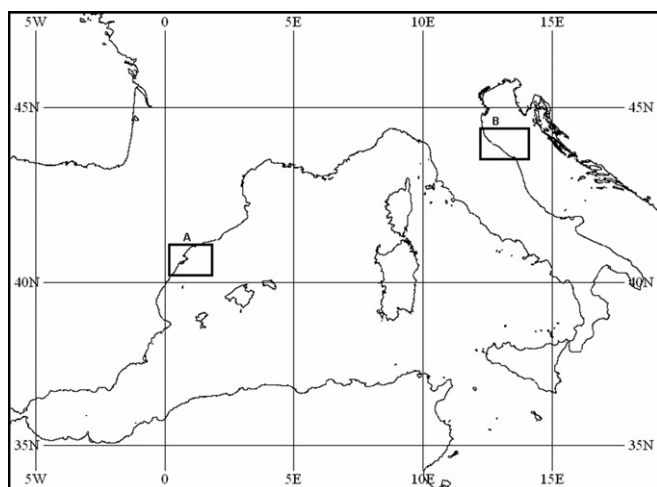


Fig. 1. Location of the study areas: Catalan Sea (A) and Adriatic Sea (B) fishing grounds.

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