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Can a square-mesh panel inserted in front of the codend improve the exploitation pattern in Mediterranean bottom trawl fisheries?

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ABSTRACT

A 50 mm square-mesh panel was inserted in front of the codend in a Mediterranean bottom trawl as an attempt to improve the exploitation pattern for *Trachurus trachurus* (Atlantic horse mackerel), *Merluccius merluccius* (European hake), *Mullus barbatus* (red mullet), *Trisopterus minutus capelanus* (poor cod), *Illex coindetii* (broadtail shortfin squid), and *Parapenaeus longirostris* (deep-water rose shrimp). Escapement through the square-mesh panel was low, never estimated to be above 10% of the total escapement, implying that a square-mesh panel inserted in front of the codend only had minor effect on the exploitation pattern in the fishery.

1. Introduction

Increased exploitation rates and inadequate release efficiency of target species below the Minimum Conservation Reference Size (MCRS) and of non-target species in general, are identified as one of the main reasons why the majority of assessed Mediterranean fish stocks are currently exploited beyond the Maximum Sustainable Yield (STECF, 2010; Vasilakopoulos et al., 2014). According to Colloca et al. (2013), a radical improvement in selectivity and thereby in the exploitation pattern is very important in order to maximize stock biomass, fisheries yield, and revenues. In general, the simplest way to change trawl's exploitation pattern is by changing codend mesh size or mesh geometry (Sala et al., 2006, 2008, 2015; Sala and Lucchetti, 2010, 2011; Tosunoğlu et al., 2009; Aydin and Tosunoglu, 2009; Kaykac, 2010); however, these measures can lead to a significant loss of targeted species above MCRS and thereby to a dis-favourable exploitation pattern (Suuronen and Sardà, 2007). Replacing a portion of the upper part of the extension piece with a square-mesh panel can be an alternative method to address this problem without negatively affecting profitability. This study investigates whether a 50 mm square-mesh panel placed before a 50 mm diamond-mesh codend improves the exploitation pattern in the Mediterranean bottom trawl fisheries.

2. Material and methods

2.1. Experimental design

Fishing trials were conducted in the Tyrrhenian Sea using a typical Mediterranean bottom trawl, named "Tartana" (Eigaard et al., 2011; Notti et al., 2013). The trawl was entirely made of knotless polyamide (PA) netting, equipped with "Danese" type otterboards, 230 m long sweeps, and 1600 m long warps. Trials were conducted on board the commercial trawler "Angela Madre" (206 kW, LOA 22.7 m, 67 GT).

A square-mesh panel made of 50 mm (51.6 ± 0.5 mm) PA netting was mounted in the final tapered section of the trawl body, which is made of 44 mm diamond-mesh polyethylene netting with 280 meshes around the circumference. The distance between the panel aft end and the codline was 8 m.

The attached codend was made of 50 mm (51.9 ± 0.3 mm) PA diamond-mesh polyamide netting. It was 6 m long and had 246 meshes around the circumference. The meshes of the wet net were measured with an electronic OMEGA mesh gauge (Council Regulation (EC) No 517/2008).

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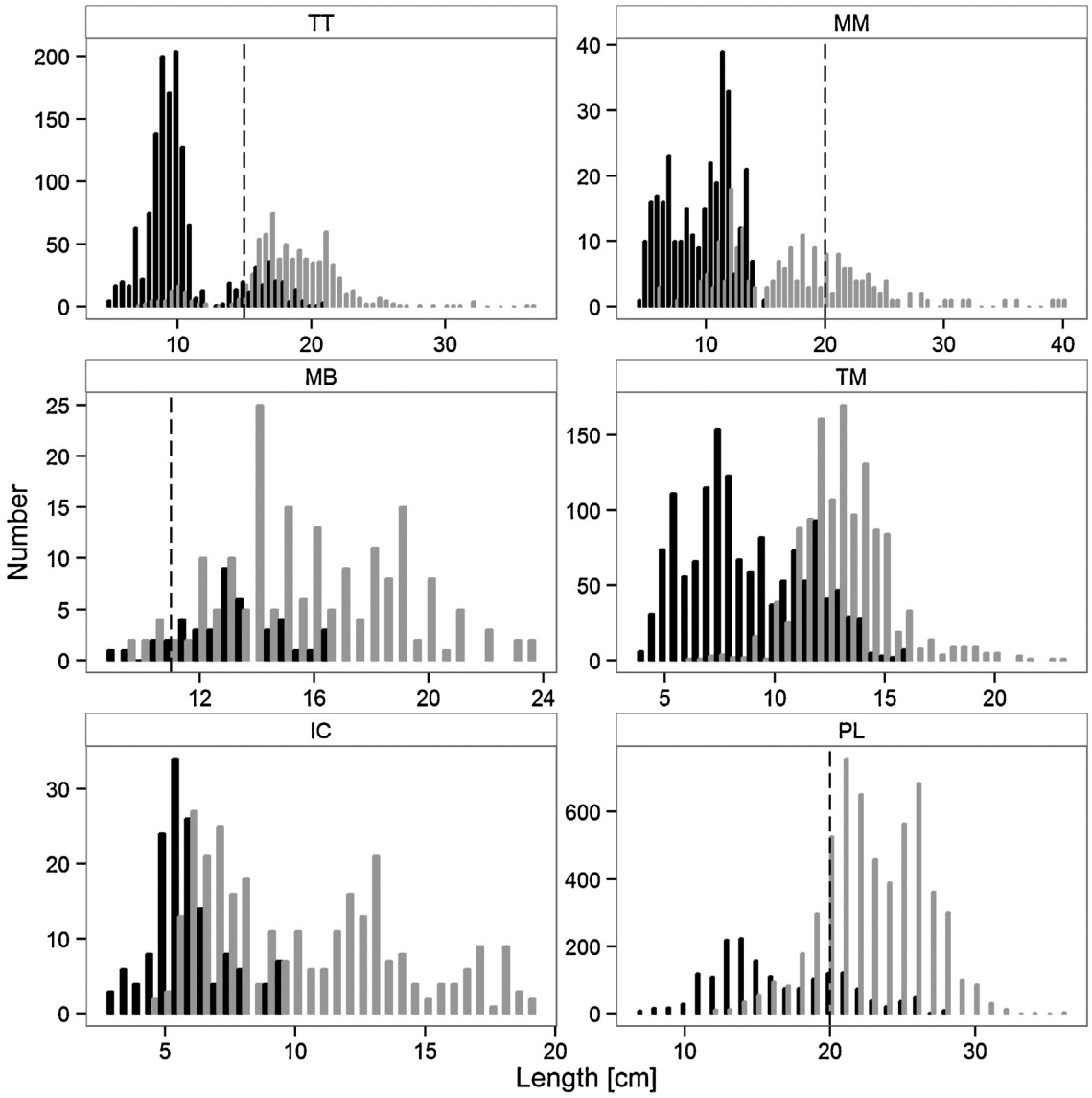

Fig. 1. Raised population structure of the investigated species released (black) and retained (grey) by the experimental fishing gear. TT: *T. trachurus*; MM: *M. merluccius*; MB: *M. barbatus*; TM: *T. minutus capelanus*; IC: *I. coindetii*; PL: *P. longirostris*; Vertical grey dashed line represent species minimum conservation reference size (MCRS).

Data on the retained and released sizes of the investigated species were collected using the covered codend method (Wileman et al., 1996), where a cover was placed over the square-mesh panel and another over the codend. The covers were made of knotless PA netting with a nominal mesh opening of 20 mm.

After each haul, the total catch from each compartment (codend, CD; codend cover, CC; and panel cover, PC) was weighed separately, sorted, and species length measured to the nearest 0.5 cm. The species investigated were *T. trachurus* (Atlantic horse mackerel), *M. merluccius* (European hake), *M. barbatus* (red mullet), *T. minutus capelanus* (poor cod), *Illex coindetii* (broadtail shortfin squid) and *P. longirostris* (deep-water rose shrimp).

2.2. Estimation of exploitation pattern indicators

The effect of inserted square-mesh panel on the exploitation pattern of the gear was quantified by calculating the values for a number of indicators (described in detail below), using the data collected during the fishing trials. To quantify to what extent the experimental gear supports a sustainable and efficient fishery, based on the population size structure for the different species caught during the experimental fishing, the average percentage of retained individuals below (rP_-), above (rP_+) the MCRS and the average percentage of all individuals retained by the gear (rP_{total}) were estimated for *T. trachurus*, *M. merluccius*, *M. barbatus* and *P. longirostris*, while for *T. minutus capelanus* and *I. coindetii,* species not subjected to the MCRS, only rP_{total} values were estimated. The formulae used to calculate rP_-, rP_+ and rP_{total} values are reported below:

$$rP_- = 100 \times \frac{\sum_j \sum_{l<MCRS} \{NCD_{jl}\}}{\sum_j \sum_{l<MCRS} \{NCD_{jl} + NCC_{jl} + NPC_{jl}\}}$$
$$rP_+ = 100 \times \frac{\sum_j \sum_{l>MCRS} \{NCD_{jl}\}}{\sum_j \sum_{l>MCRS} \{NCD_{jl} + NCC_{jl} + NPC_{jl}\}} \quad (1)$$
$$rP_{total} = 100 \times \frac{\sum_j \sum_l \{NCD_{jl}\}}{\sum_j \sum_l \{NCD_{jl} + NCC_{jl} + NPC_{jl}\}}$$

where for each haul j and length class l, NCD_{jl}, NPC_{jl} and NCC_{jl} are the raised number of individuals in the codend, panel cover and cover codend, respectively. These are calculated by dividing the measured