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From surface to mid-water: Is the swordfish longline fishery "hitting rock bottom"? A case study in southern Italy

Giulia Cambiè[a,b,*], Ramón Muiño[c], Toni Mingozzi[d], Juan Freire[e]

[a] School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey LL59 5AB, UK
[b] Departamento de Zoología y Antropología Física, Universidad de Santiago de Compostela, 15782 Santiago de Compostela, Spain
[c] Grupo de Recursos Marinos y Pesquerías, Facultad de Ciencias, Universidade da Coruña, 15008 A Coruña, Spain
[d] Dipartimento di Ecologia, Università della Calabria, 87030 Rende CS, Italy
[e] Barrabés Next, C. Serrano 16-1, 28001 Madrid, Spain

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ABSTRACT

Fleet expansion, increased gear efficiency, increased effort and the constant improvement in fishing methods have greatly contributed to the current overexploitation of many target stocks. It is therefore essential to identify and monitor the changes in fishing practices as well as the technological creep to determine their implications for the conservation of target and non-target species. The present study documents the recent technical and operational changes in a longline fishery targeting swordfish (*Xiphias gladius*) operating in southern Italy (Ionian Calabria). Data collected during the swordfish fishing seasons of 2007, 2010 and 2011 showed a significant change in fishing practices over the survey years, as the longline fishery switched from surface (10–100 m) to mid-water (100–500 m) depth and from 11 h to 25–30 h soak time. These modifications in fishing operations, which result in an increase and redistribution of the effort, were motivated by a drastic decrease in the swordfish catches made with the traditional surface longline. They have modified the fleet structure, catch species composition and size of the target species. Although these operational changes resulted in an increase in the swordfish size and a decrease in the sea turtle bycatch, their implications for less known and potentially more vulnerable commercial and bycatch species are unclear. Moreover, the shift of fishing effort into deeper water is a well-documented evolution of many fisheries worldwide in response to the decline in shallow coastal water resources. The change in fishing practice of the pelagic longline fishery reported in the present study could be considered an additional alarm bell of the current state of overexploitation of the Mediterranean swordfish.

1. Introduction

Pelagic longline is one of the world's most widespread fishing gears and is used in all oceans, from temperate to tropical waters (Worm et al., 2003). The main target species are large predatory fish, namely tuna (Thunnini), billfish (Istiophoridae) and swordfish (Xiphiidae). Although the pelagic longline fishery has been favored and subsidized in the past decades because it has been considered a more selective alternative to driftnets (e.g. Crowder and Myers, 2001), it has come under criticism due to the high levels of bycatch of large marine vertebrates, such as sea turtles, sharks and seabirds (Lewison et al., 2004; Wallace et al., 2010). Considerable attention has been given to possible changes in fishing gears and practices in order to reduce bycatch, such as the implementation of circle hooks, bird scaring (tori) lines, line-setting devices and spatial management of the bycatch hotspots (Lewison et al., 2004; Serafy et al., 2012; Cambiè et al., in press). However, bycatch is not the sole problem associated with the pelagic longline fishery. Regional fishery organizations have raised serious concerns about the status and/or catch levels of a number of tuna and billfish stocks, and recent studies have demonstrated that the Mediterranean swordfish the Atlantic and southern bluefin tuna and the North Atlantic albacore tuna are overexploited, and the western Pacific bigeye tuna is overfished (Tserpes et al., 2011; Juan-Jordá et al., 2011).

From its origin until today, the pelagic longline and the associated fishing practices have been continuously modified to increase the catch and associated income. The first longline fleet able to implement relevant technological changes was the Japanese fleet, which rapidly became the largest in the world (Watson and Kerstetter, 2006). The introduction of diesel-powered vessels was the first essential change in this fleet (Beverly et al., 2003), which has resulted in the extension of the fishing grounds and in the general mechanization of the tuna and swordfish fisheries since the

* Corresponding author at: School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey LL59 5AB, UK. Tel.: +44 1248 382615.
E-mail addresses: giulia.cambie@gmail.com, g.cambie@bangor.ac.uk (G. Cambiè).

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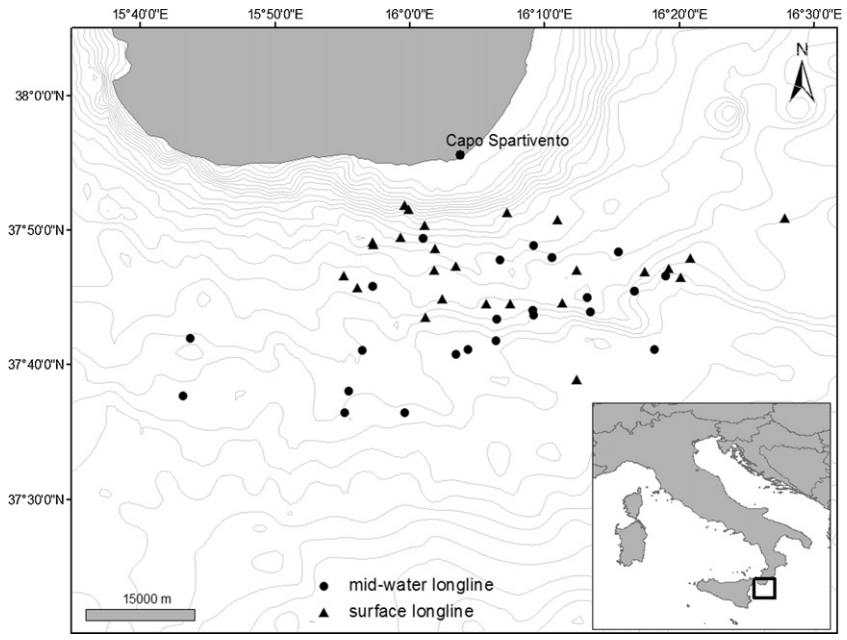

Fig. 1. Study area with the location of the beginning of each longline set ($n = 48$) observed during June–August of 2007, 2010 and 2011. The triangles indicate the surface longline sets observed in June–August of 2007 ($n = 10$), 2010 ($n = 13$) and 2011 ($n = 2$). The circles indicate the mid-water longline sets observed in June–August of 2010 ($n = 10$) and 2011 ($n = 13$).

early 1920s (Watson and Kerstetter, 2006). The global expansion of longline fisheries began in the 1950s and 1960s with the introduction of large freezer longliners across the Pacific, Indian and Atlantic Oceans to cover all tuna resources known today (Ward and Hindmarsh, 2007). In the same decades, significant swordfish catches by the Japanese tuna fleet and Norwegian shark fishery in the Atlantic resulted in exploratory longline fishing by Canadian and American fishing fleets (Tobias, 1989). In the Mediterranean, the swordfish longline fishery was first documented at the beginning of the twentieth century, and it expanded in the basin during the 1960s and 1970s (Macías et al., 2004). Like in other fishing areas, longline fishers in the Mediterranean are constantly adapting and changing the technology and methods to increase their fishing performance.

Technological advances by the 1950s included the adoption of a monofilament nylon mainline, chemical light sticks, mechanical line haulers, GPS equipment, chart plotters and sonar, all of which allowed fishers to increase the number of hooks, the time spent at the fishing grounds, the distance from the coast and the hook depth (e.g. Watson and Kerstetter, 2006). Increasing the hook depth was one of the most significant global strategies for most of the pelagic longline fleets (e.g. Baum and Myers, 2004; Ward and Hindmarsh, 2007; Ward and Myers, 2005). While before the 1970s the longline fisheries targeting tuna were characterized by longlines deployed at relatively shallow depths (Miyake et al., 2004), after this date the deep setting longline technique rapidly spread. The Korean fleet was the first to use deep longlines in the early 1970s (Koido, 1985; Lee et al., 1997) followed by the Japanese fleet, first in the Pacific and Indian Oceans and then in the Atlantic in 1978 (Sakagawa et al., 1987). This change in fishing strategy greatly increased the catch of deep-swimming and higher value bigeye tuna (*Thunnus obesus*), which became the main target species for the Japanese fleets. Today modern tuna longline vessels can deploy more than 30 hooks between two consecutive floats and use a "line shooter" to set an additional mainline between floats, and thus fish at even greater depths (Beverly et al., 2004).

The fleet expansion, increased gear efficiency and the constant improvement in the fishing methods have greatly contributed to the current overexplotation of many target stocks. Continual technological advances in fishing fleets increase catch efficiency. This phenomenon, known as technological creep, has a direct effect on fish stocks (Ellis & Wang, 2006). A fleets's technological creep is usually related to the increase in the skipper's skills, investments in auxiliary equipment, more efficient gear and materials, replacement of old vessels by new ones and, to a lesser extent, upgraded engines (Rijnsdorp et al., 2006).

It is therefore essential to identify the changes in fishing practices and determine the implications these could have for the conservation of the target and non-target species. Moreover, the variations in strategies and fishing gear configurations need to be documented to "standardize" the fishing effort, and thus to make abundance indices comparable in the long time-series as well as make inferential statistics possible (Bishop, 2006; Rice et al., 2007; Ward and Myers, 2005). According to these considerations, the case study presented here documents the recent technical and operational changes in a longline swordfish fishery operating in southern Italy (Ionian Calabria) and the relative variations in the catch species composition and fishing performance. Comparing our findings with recent changes in other longline fisheries allowed us to assess the possible presence of a general trend in the evolution of the fishing strategies in response to changes in the distribution and/or abundance of the target species.

2. Materials and methods

2.1. Data collection and analysis

Data were collected through two integrated approaches: (1) observations on board fishing vessels to describe the fishing strategy, the catch species composition and the economic performance of the activity; and (2) interviews with ship owners to estimate trends in the fishing practices for the entire longline fleet targeting swordfish in the study area.

A total of 48 pelagic longline sets were observed on board two commercial fishing vessels operating off the southern coast of Ionian Calabria. The first vessel was 8.9 m and its activity was monitored between June and August of 2007 (no. of sets = 10). The second vessel was 11 m and its activity was monitored between June and