Marine Policy 83 (2017) 204–214

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Improving the ecological efficiency of the bottom trawl fishery in the Western Mediterranean: It's about time!

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ARTICLE INFO

Keywords:
Fishing impact
Fuel consumption
Efficiency
Gears design
Bottom trawl
Western Mediterranean

ABSTRACT

The improvement of fishing technology has been detrimental to the sustainability of fisheries, which is particularly clear for the bottom trawl fishery. Reducing its environmental impact is a key point for the development of a more sustainable fishery. The present work analyzed different possibilities to mitigate the impact of gears on the seabed and to increase the efficiency of the bottom trawl fishery of the Western Mediterranean. The analysis of three experiments showed that innovative technical and regulation measures can lead to benefits such as the reduction of fishing effort, the improvement of the cost-benefit relation and the reduction of the direct impact on the seabed and the indirect effect on the ecosystems through reduce discards and the emission of CO_2 into the atmosphere. After years of studies focused on improving the sustainability of this fishery, it's about time to turn this improvement into reality.

1. Introduction

During the last century, the improvement in fisheries technologies (more efficient vessel design, more powerful engines, mechanization of fishing operations, vessel positioning systems, echo-sounders and radar, among others) has increased the fishing capacity of fleets. In most cases these technical improvements have been detrimental to the sustainability of fisheries, due to the fact that most of the fishing fleets became overcapitalized [1]. This fact would have led to a decline in the proportion of assessed marine fish stocks exploited within biologically sustainable levels, from 90% in 1974 to 71% in 2011, when 29% of fish stocks were estimated as fished at a biologically unsustainable level and, therefore, overfished [2]. Reducing fishing mortality (F) is a key point to enhance the state of exploitation of marine resources. Fleet reduction and limits in time at sea are some of the direct measures that can be applied to reduce F, although other indirect options, such as catch limits or changes in mesh regulation, are also applicable measures to take into account. In fact, there is not a single way of regulating fisheries and successful programs of fisheries management would involve a mix of direct and indirect fishing effort regulations and other technical conservation measures [3].

The ecosystem approach to fisheries (EAF) is a widely accepted concept in the field of fisheries assessment and management, and it has been proposed as the way forward to reach more sustainable fisheries. The goals of EAF include social, economic and ecological aspects, but a central focus is reconciling the short term need for catches with the long term need for sustainability of target species, other ecosystems components and fisheries itself [4]. Advances in fishing gear technology, including selectivity improvements and the development of gears that reduce the environmental impact, that would allow to mitigate some of the unwanted effects of fishing, are essential to the achievement of an environmentally responsible fishing, which is necessary for the implementation of the EAF [5,6].

The environmental impacts of fishing activities are well known. Besides the direct and indirect impacts on the seabed, target and non-target species, habitats, trophic webs, and biological and functional diversity, the emission of CO_2 into the atmosphere by means of fuel consumption should not be overlooked. Tyedmers et al. [7] estimated that fisheries globally burned almost 50 billion liters of fuel in the process of catching 80.4 million tons of reported landings, and directly emit 130 million tons of CO_2 into the atmosphere at an average rate of 1.7 t of CO_2 per ton of live-weight landed product. Since these authors, fisheries globally represent approximately 1.2% of total global oil consumption and the energy content of the fuel burned by global fisheries is 12.5 times greater than the edible-protein energy content of the resulting catch.

Among the wide variety of fishing techniques currently practiced, trawling is one of the most widespread fishing methods used in the world. Bottom trawling has become increasingly controversial in recent years due to its low ecological efficiency, the impact of the different elements of the gear (doors, sweeps and net) on the seabed, the amount of discarded catches and the fuel consumption per fish harvested

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http://dx.doi.org/10.1016/j.marpol.2017.06.007
Received 27 June 2016; Received in revised form 1 May 2017; Accepted 2 June 2017
Available online 10 June 2017

[8–12], including the bottom trawl targeting crustaceans which has been identified as one of the least energy-efficient fisheries in the world [13]. Measures should also aim at minimizing the impact in the marine environment and also in the entire ecosystem [14], by improving selectivity and reducing both, the impact on the seabed and benthic habitats, and the emission of CO_2 into the atmosphere by means of reducing the fuel consumption, which would also improve the economic efficiency of this fishery.

In this sense, the Green Paper aimed at stimulate a debate and to elicit views on the future Common Fisheries Policy (CFP), recognized that “crucial challenges such as climate change, emission policies and energy efficiency must be factored in when defining the future CFP and its role in shaping the future of the fisheries and aquaculture sector”. The requirement to reduce fossil fuel consumption and the emission of CO_2 into the atmosphere, the need of improving energy efficiency of animal production systems and the continued increase in oil prices (currently, fuel costs represent in average 55% of the total running costs of fishing fleets) suggests that fuel consumption should be considered not only a current environmental but also an economic problem of fisheries. A fact highlighted in the Green Paper regarding the public financial support is that “it has been estimated that the cost of fishing to the public budgets exceeds the total value of the catches. In simple terms, this means that European citizens almost pay for their fish twice: once at the shop and once again through their taxes”. To tackle this profits/costs ratio problem will strongly depend on the possibility to reduce energy consumption, as far as increasing the amount of catch is not a presumable scenario and fishermen's possibilities to influence the prices is kept low [15].

Due to the EU restrictions of public funding for new vessels construction, the opportunities to reduce fuel consumption are mainly linked to modifications in vessel operation routines and the development of innovative fuel-efficient gears, rather than commissioning new energy-saving vessels. The strategy to analyze innovative improvements should consist in comparing traditional designs with new ones operating under full scale commercial conditions [15]. Experimental sea trials in Portuguese coastal fish trawlers demonstrated that the percentage of fuel consumed in navigation is substantially lower compared to trawling (24% of the whole fishing trip), being this the most important phase for fuel reduction effects [14]. These authors demonstrated fuel reduction of up to 18% with simple changes at the trawl level (steeper cuttings in the wings and bellies, and mesh size increases in the respective net sections).

The objective of this paper is to show different ways to mitigate the impact of fishing gears on the seabed and to increase the efficiency of the bottom trawl fishery of the Western Mediterranean, by improving the selectivity (and thus indirectly reduce fishing mortality) and reducing the fuel consumption in comparison to the traditional gears and fishing activity. Data coming from three different pilot projects, with sampling based on the modification of fishing operations and/or the trawl gear design, were used. The first experiment (EXP1) consisted in changing the vessel operation, from the usual discontinuous work during five daily trips of 12–16 h per week, to a continuous work during 46 h per week. In the other two experiments, the traditional bottom doors were replaced by two types of doors: (i) bottom doors more hydrodynamic and lighter (EXP2); and (ii) mid-water doors not touching the seabed (EXP3). Additionally, in EXP2 the sweeps were shortened and the net was replaced by an experimental lighter net, with larger meshes and thinner twine in the wings and square. In EXP1 and EXP2, the change from diamond to square 40 mm nominal size in the mesh shape of the codend was also assessed. The feasibility to implement these new fishing strategies and technologies was also assessed, trough developing the experiments under commercial conditions and comparing yields among current and innovative fishing procedures and gears.

2. Material and methods

2.1. EXP1: Change of vessel operation routine

This experiment was conducted at the Gulf of Lions (North-Western Mediterranean), from 24th October to 18th December of 2007, on board two commercial bottom trawlers with similar characteristics: F/V *Berto* (length 27.3 m, 138 grt, nominal engine power 473 hp) and F/V *Sort de Taranet* (length 24.4, 126 grt, nominal engine power 540 hp). These vessels used to operate on slope fishing grounds, located between 70 and 100 nm far from their harbor, El Port de la Selva (Fig. 1). The normal activity of the trawl fishing fleet of this port, and most of the Spanish ports in the Mediterranean, consists in 12 h duration daily trips from Monday to Friday, with 48 h of weekly rest (Saturday and Sunday). In some ports, additional time is authorized to reach distant fishing grounds. That is the case of El Port de la Selva, where the activity of the bottom trawl fleet is from 06:00 to 18:00 on Wednesday, Thursday and Friday, when the fleet operates not farther than ~50 nm from El Port de la Selva, and from 02:00 to 18:00 on Monday and Tuesday when the fleet can reach the international waters of Gulf of Lions, placed at more than 70 nm away from that harbor.

The experiment was developed during 8 fishing trips, and consisted in working continuously a maximum of 46 h per week, from 02:00 a.m. on Monday to 12:00 midnight on Tuesday, the vessels remaining in port the rest of the week. The type of net used during the experiment was the same, a “cuadrado/dragón”-type of 75 m headline and 110 m footrope of polyamide (PA) in the wings and belly and polyethylene (PE) from the funnel to the cod-end, which is routinely used by the commercial fleet in the area. This net was linked by 50 m PE legs (∅40) and 150 m steel and polypropylene (PP) sweeps (∅44) to metallic bottom doors MAPSA model EXPLORER 1300 (4 m^2 and 900 kg) and to steel warp ∅16. The two vessels carried out parallel hauls, one vessel using a

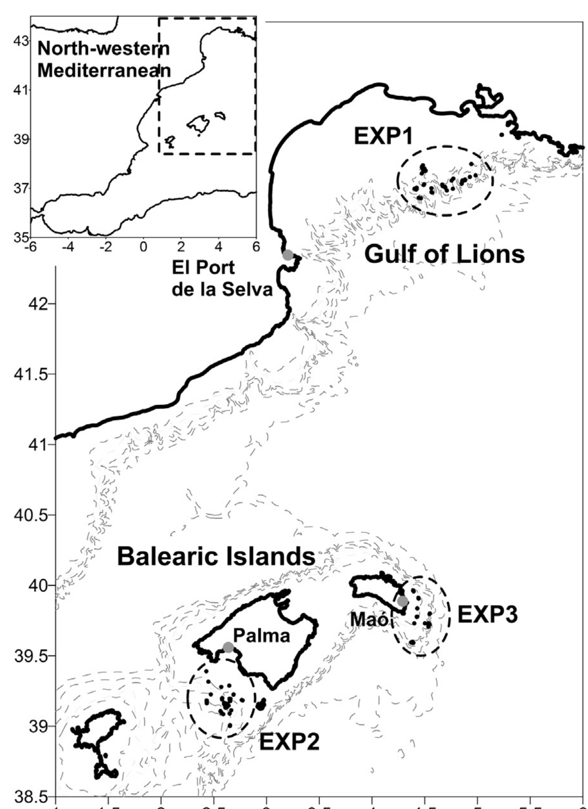

Fig. 1. Map of the sampled areas off the North-Western Mediterranean: Gulf of Lions (EXP1) and Balearic Islands (EXP2 and EXP3). Sampling stations are shown as black dots. Isobaths 200, 400, 500, 800, 1000 and 2000 m are shown.