Mixed-fish commercial categories as a strategy for reducing discards from the small-scale fleet

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ABSTRACT

Mediterranean small-scale fleets catch a substantial amount of untargeted fish that are sold at a low market price. Most of these catches are pooled into mixed-fish boxes (MFBoxes), which are usually labeled and sold as mixed-fish commercial categories (MFCategories). In this paper, we describe the MFBoxes and the MFCategories from the small-scale fleet of Mallorca Island in terms of species composition, size distribution and economic value. We used (i) daily sales records of MFCategories between 2004 and 2015 and (ii) a sample of 141 photographs of MFBoxes, collected over one year (2009–2010). MFCategories represent a non-negligible fraction of the landings, between 18 and 51 tons/year which represents 100–300 K€/year. Some of the sampled MFBoxes were sold as one of the three identified MFCategories, which differ in species composition, size and average price (3.9 €/kg for the category LARGE MORRALLA, 2.2 €/kg for SMALL MORRALLA and 7.0 €/kg for VARIAT). However, more than half (52%) of the sampled MFBoxes were actually labeled and sold not as MFCategories but as one of the most abundant species in the box. This strategy might seem unprofitable because the market price is lower for MFBoxes sold as non-mixed categories than for non-mixed boxes of the same category. However, we observed that the label itself does not affect the selling price, but species composition does. Therefore, when sorting fish into boxes, fishers may be trying to optimize the tradeoff between not selling some low-priced fish and mixing them with other more valued fish. This alternative marketing strategy should be explored in depth and properly assessed, not only to maximize profits but also to promote a zero-discard European policy.

1. Introduction

Small-scale fleets are considered more ecosystem-friendly than large-scale fleets (Pauly and MacLean, 2003). Small-scale fleets typically target a wide diversity of species, not only because some gears used are relatively unspecific (Merino et al., 2008; Palmer et al., 2017) but also because they shift among diverse gears, fishing techniques and fishing grounds in order to maximize the catch and profit (Matić-Skoko et al., 2011).

Small-scale fleets are composed of small boats (boats less than 12 m long using static gears according to the Council Regulation EC No 1198/2006 of 27 July 2006) and exploit fishing grounds usually located on the continental shelf within a few hours of the port where the boat is based (Forcada et al., 2010; Morales-Nin et al., 2010). Nevertheless, small-scale fisheries provide over half of the fish for human

consumption (FAO, 2003; Stergiou et al., 2006). In the Mediterranean, the small-scale fleet plays an important socio-economic role and has a long-standing tradition (Morales-Nin et al., 2010; Stergiou et al., 2006). This fleet represents 79% (27,900 boats) of the EU Mediterranean fishing vessels and contributes 12% of the EU Mediterranean weight of landings (STECF, 2017). Mediterranean small-scale fisheries provide approximately 42,800 jobs and represent 60.4% of the EU Mediterranean fishing sector employment (STECF, 2017).

In the Balearic Islands, up to 318 small-scale boats were recorded in 2016 (official data from the Regional Fisheries Administration, *Direcció General de Pesca i Medi Marí, DGPMM*), but this number is continuously decreasing (Merino et al., 2008). This decrease has been attributed to new EU enforcement rules (e.g., effort reduction measures) and to the retirement of old fishers (Maynou et al., 2013). Recruitment of young fishers is scarce due to the limited profits because fish prices have

stagnated or even deflated in the past few years (Maynou et al., 2013), although the appreciation of fresh fish of quality by consumers is increasing (Morales-Nin et al., 2013). Moreover, small-sized, low-priced species captured by the small-scale fleet have experienced a loss of market share in the recent years (*DGPMM* unpublished data).

Given that the profitability of small-scale fishing may often be close to the economic sustainability limit (Maynou et al., 2013), fishers must optimize their selling strategy. The landings are usually sorted into separate boxes, and their average price at first sale depends significantly on species and body size (Maynou et al., 2013; Reglero and Morales-Nin, 2008). In some Mediterranean fisheries, the boxes are labeled with the species name, which allows species-specific records of landings, which in turn have been used for stock assessment of target species (Guillen and Maynou, 2015; Merino et al., 2008; Reglero and Morales-Nin, 2008). However, in addition to target species, the small-scale fisheries catch a substantial amount of untargeted captures with a relatively low market price. This fraction may represent a non-negligible contribution to the total income (Forcada et al., 2010). However, in several worldwide fisheries, this fraction of miscellaneous captures is usually pooled into mixed-fish boxes (MFBoxes) and sold as mixed-fish commercial categories (MFCategories; Baisre, 2000; García-Rodríguez et al., 2006; Samy-Kamal et al., 2014). The composition and labeling strategies of the MFBoxes remain unknown, and these uncertainties are not included in the landings statistics, which may have some impact on fisheries assessment. Moreover, these captures might be discarded if not sold mixed, which is against the EU strategy (Regulation EU No 1380/2013 of the Common Fisheries Policy) of minimizing discards. In fact, the implementation of this new strategy should induce an increase in the categories that are usually sold at low prices.

Here, our objective was to describe, for the first time in the Mediterranean, the fraction of low-priced fish that is distributed by the fishers in MFBoxes and sold as MFCategories. Specifically, the case study selected was the small-scale fishery in the Balearic Islands. Our specific goals were (i) to analyze the long-term temporal patterns of MFCategories in terms of landings and market price; (ii) to identify and characterize the species composition and size distribution of the MFCategories; (iii) to evaluate the effects of métier and the season on MFCategories; and (iv) to understand the price formation of MFBoxes. An understanding of how these MFCategories are devised might contribute to a better management of the small-scale fisheries, which are relevant worldwide and experiencing a general decline.

2. Materials and methods

The case study analyzed here is the small-scale fleet from Mallorca, the largest of the Balearic Islands (western Mediterranean, Spain). The fleet consisted of 178 vessels smaller than 10 gross tons (Decree 17/2003 of February 21) and was based in 15 harbors. The catches were sorted by fishers in standard boxes with a capacity of approximately 7.5 kg (see Fig. 1). Each of these boxes is sold in a downward daily auction that occurs at the Palma Fishing Wharf (Reglero and Morales-Nin, 2008). The auction is managed by a producers' cooperative (*OP-MallorcaMar*) that includes all fishers from the island. Provided that the enforced maximum fishing journey for all vessels in the small-scale fleet from the Balearic Islands is kept to one day, the daily sales from a boat correspond to a single fishing journey.

2.1. Long-term temporal data analysis of MFCategories

The way the fish are distributed in boxes for the auction is decided by the fisher, but the commercial category to which each box belongs is decided by the auctioneer. The strategy adopted by the fisher has a capital relevance in the context of this paper because fishes of different species can either be pooled or not in a single box. The number of common commercial categories in the Majorcan auctions is 170. Three of them ("MORRALLA GR.", "MORRALLA PT." and "VARIAT")

Fig. 1. Image of a mixed box collected prior to auction during the sampling in 2009–2010. Note the presence of undersized specimens such as *Scorpaena notata*.

correspond to the mixtures of different species that are the objective of this study. "MORRALLA PT." (thereafter named SMALL MORRALLA) and "MORRALLA GR." (thereafter named LARGE MORRALLA) are traditionally composed of low valued fishes of small and larger size, respectively, while "VARIAT" is composed of mixed fishes with variable value.

During the auction, when a box is bought, the weight (kg) and price (Euro/kg) are automatically recorded along with the fisher's data (e.g., boat name), date and commercial category (i.e., each record corresponds to a box). These data are transferred daily to the IMEDEA (*Instituto Mediterráneo de Estudios Avanzados*, CSIC-UIB), where the identity of the fisher is encrypted in accordance with the terms of a confidentiality agreement.

At the IMEDEA, the available data covers from 2004 to the present, but this long-term temporal pattern study refers to 2004–2015. The data received from the producers' cooperative were reorganized by pooling raw records (i.e., boxes) into a large matrix, the rows of which were all the landings of a given boat on a given day (i.e., by fishing trip) and each column was one of the 170 commercial categories. Two separate matrices were produced for either weight (kg) or gross revenues (Euros). The records corresponding to the small-scale fleet were filtered using the algorithm described in Palmer et al. (2017). The size of each filtered matrix was 162,815 rows (boat-day) by 170 columns (commercial categories).

The filtered matrix was used here (i) to describe the temporal (on the year scale) patterns of the landings weight (kg) and the gross revenues (Euros) of sales corresponding to the MFCategories, (ii) to describe the temporal (on the year scale) trends of the price (Euros/kg) of the three MFCategories, and (iii) to test the existence of price differences among the three MFCategories using a generalized linear model (GLM) that included the average price of all the landed fish in the day (Euros/kg) and its interaction with the MFCategories as covariables for proper between-category comparison. The statistical model, fitted with the *glm* function of the R package (http://www.rproject.org/), was:

$$\log(Prize_j) = MFCategory_j + MeanPrize_j + MFCategory_j*MeanPrize_j + \varepsilon_j$$

where $Prize_j$ is the prize (Euros/kg) of the j box, $MFCategory_j$ is one of the three considered categories, $MeanPrize_j$ is the averaged prize of all the landed fish in the day, and ε_j is a normally distributed term with zero mean and a given standard distribution.

2.2. Sampling MFBoxes

MFBoxes were sampled just before the auction during 2009 and