PLASMAR

Bases para la planificación sostenible de áreas marinas en la Macaronesia

Distribution of fishing effort for the Canary artisanal fleet: a survey based approach

Optimise and finding the pertinent monitoring methods for the marine and coastal waters environmental monitoring (Act. 2.3.1)

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TABLE OF CONTENTS

List of figures

I. Introduction

Regulation (EU) No 508/20144 defines small-scale coastal fisheries as “fisheries carried out by fishing vessels of an overall length of less than 12 metres and not using towed fishing gear as listed in Table 3 of Annex I to the Commission Regulation (EC) 26/2004”. In Europe, small-scale coastal fleet represents the 82% of the EU active vessels and the 63% of the total number of days at sea[1] . However, despite its importance small-scale fisheries have traditionally received less research effort than industrial fisheries and can be considered under-studied in most cases.

To assess the impacts of fishing on the marine ecosystems is necessary, at least, time-series of catch and effort data, as well as quantify the areas over which fishing potentially takes place in order to develop successful fisheries management strategies and to make more realistic predictions about the ecological impacts of fishing (Hinz et al., 2013). In the case of industrial or large-scale fisheries, obtaining information on fishing areas can be a relatively simple task, since vessels more than 15 meters in length have a monitoring system (VMS) incorporated that must be turned on when fishing to record the trajectories of the vessels and their positions. But this is not the case in small-scale fisheries, since artisanal vessels do not have a VMS and fishermen have no obligation to report the positions of their fishing beyond to indicate the fishing sub-area or fishing division listed by FAO (Regulation EU No 1379/2013).

When the spatial component of the fishing effort is ignored, data collected often provide inaccurate relative abundance estimates and lead to misleading interpretations of the species biology, such as their distribution, growth, reproductive and feeding patterns (Booth, 2000). Likewise, knowing the fishing areas would also help to integrate this activity into marine spatial planning (MSP) policies since several scientific studies highlight the strong relation between both (Qiu and Jones, 2013; Brennan et al., 2014; Jentoft and Knol, 2014; Jones et al., 2016; Ansong et al., 2017; Janßen et al., 2018). The transposition of the Directive 2014/89/EU in the ‘Real Decreto’ 363/2017 has established a framework for Maritime Spatial Planning (MSP) into Spanish law. One of the essential requirements of this process is to collect and analyze spatial information to establish the distribution and timing of current activities and uses in the corresponding sectors. This state regulation establishes that the plans must be approved before 31.03.21. Regarding the content of the plans (art.10) it is necessary to include fishing areas.

In Canary Islands, artisanal fisheries are characterized by their complexity, since they include multiple species and the most of vessels are considered multipurpose, employing different types of gear that combine and alternate according to the season and depending on the biological cycles of the target species. This high heterogeneity, as well as the high geographical dispersion of the vessels and fishing grounds, makes it difficult to obtain reliable catch statistics and a realistic approximation of fishing effort (Couce Montero, 2015). New approaches to fisheries research have promoted the integration of fishers’ knowledge into conservation planning and fisheries management through the use of geographical information systems (GIS) through surveys conducted to fishermen to locate their main fishing areas or spots, using different methodologies including visual support (latitude/longitude grids, topographical maps, bathymetric charts or aerial pictures) or referring to travel time and direction (Léopold et al., 2014; Prestrelo and Vianna, 2016).

In this context, a mapping tool to assess fishing effort in Canary Islands, by fishing ground, through face-to-face to artisanal fishermen, including information regarding the fishing gear used, species caught and depth ranges were these are fished and, transfer all these information to maps of the archipelago of different grid sizes, separating the

[1] EU Commission: https://ec.europa.eu/fisheries/sites/fisheries/files/docs/publications/2016-small-scale-coastal-fleet_en.pdf

fractions of the fleet dedicated to live-bait tuna fishing from bentho-demersal fish species and middle-sized pelagic fish. The goal of the analysis is to compare the relative density of coastal fishing effort in order to detect which coastal areas, or fishing grounds, are supporting a higher fishing intensity due to concentration of vessels/gears.

II. Methodology

2.1 Survey design

To collect data about small-scale fishing effort, a face-to-face survey was designed to interview artisanal fishermen. These surveys allow longer and more complex questions since any doubts that arise can be solved in situ, increasing the likelihood of receiving more accurate responses.

We developed a survey to record information about fishing effort deployed by the artisanal fishermen by gear and main target species (including by-catch). The survey also was addressed to collect information about the characteristics of each fishing operation, including the mean time (hours) inverted in the fishing journeys, and the depth range where fishing usually takes place.

In the Canary Islands, approximately 90% of the artisanal vessels have lengths that do not exceed 12 meters; so there is no obligation to have a vessel monitoring system indicating their positions. Since the information gap is so wide, our method includes a four-step integrated framework for mapping small-scale fishing effort: (i) stratified random sampling of active vessels; (ii) collection of fishers' knowledge on fishing effort, catch and fishing areas through map-based interviews; (iii) data integration into a database and a geographical information system (GIS) and (iv) estimation of the spatial distribution of effort.

Canarian small-scale fishery had been historically focused on three target groups: benthic and demersal species, medium-sized coastal pelagic fish, tunas and tuna-like species. Fishermen move throughout the archipelago during the tuna season so surveys included a map that encompassed the entire archipelago overlain with a grid of 5 nm cells only for tuna fishing effort, while for the rest of the target species, maps with a grid of 1.5 nm cell sizes was used, since they are captured closer to the coast. Each cell of both grids is georeferenced and identified with a unique ID for the subsequent processing of the data.

The objective of these surveys is that fishermen mark the cells where they usually fish, which will allow determining in which areas fishing effort is concentrated and, subsequently, this information will feed ecosystem models that will allow assessing the resources status.

2.2 Sample survey

A list of current fishing vessels to establish the target population was obtained from the first sale notes provided by the Canarian Government and checked with the fleet register of the Ministry of Agriculture, Fisheries and Food (MAPA). Each vessel was categorized according it length overall (LOA), and the island where was located its base port.

Vessels that exclusively fish tuna employ different fishing gears, including hand lines, live bait, and trolling lines, but as the number of these vessels is scarce their activity has not been separated by fishing gear or fishing techniques. As geographic regions, the seven islands of the Canary archipelago were considered and the fleet was stratified according the LOA in four categories: (i) < 6 m., (ii) 6-11.99 m., (iii) 12-17.99 and (iv) ≥ 18 m. LOA was chosen to classify the fleet because it is a technical and dimensional variable, since this type of attributes helps to reduce the degree of bias. When using stratified sampling, researchers have a higher statistical precision compared to when they elect to use simple random sampling alone. This is due to the fact that the variability within the subgroups is lower compared to the variations when dealing with the entire population at large. To define the sample size we applied the algorithm resulting from Neyman (1934):

$$n_i = \frac{1}{d^2/(Z^2_{1-\propto/2} \cdot \sigma_i^2) + 1/N_i}$$

where:

n_i is the optimal sample size of segment *i*; *d* is the accepted error (the maximum difference tolerated between the true value and the estimated value from the survey. The lower the acceptable error on the final estimate, the smaller the required sample size will be); N_i is the size of stratum *i*; *Z* is the quartile of the normal distribution and is the significance level (Z = 1.96 along with α = 0.05, as common in conventional surveys (Neyman and Pearson, 1933) and σ_i^2 is the variance of the segment's population. Different sample sizes were calculated, assuming different errors and 50% heterogeneity, but finally it was decided to achieve a sample size with a maximum error of 7.5%. Surveys were carried out taking into account all the fishermen´s associations and cooperatives of the archipelago. Nevertheless, in the island of Gran Canaria due to lower cooperation of three fishermen's associations that refused to participate in the study, the minimum required sample size was not reached.

2.3 Data processing

Survey data-processing was realized with ArcGis 10.6 software. The Jenks optimization method included in the program was used to classify features using natural breaks in data values.

III. Results and discussion

As a result of the surveys carried out, two maps (Figure 1 y Figure 2) were created to represent the spatial effort of the small-scale fleet in the Canary Islands, assuming that this fleet distribution takes place throughout the year and using the density of vessels per area as measure of effort. Although in the surveys the fishermen indicated all the fishing gear they use, we did not develop a map for each gear because that was not the main objective of this work, since it is a first approach to know if this method could be used for artisanal and data-poor fisheries. Despite this, in many cases fishermen were asked if they would provide such information to create more detailed maps in the future. Some fishermen provided such information, however most refused to give such detailed information by distrusting what could be done with it. One possible reason for this refusal could be that depending on the fishing area, some gears are prohibited or their use is regulated and only allowed certain months throughout the year. This methodology notwithstanding, provide an important first step to considering fishing impacts of this activity in Canarian marine ecosystems from a direct measure.

The map representing tuna fishing (Figure 1) shows a higher density of boats in the chanel between Tenerife and La Gomera islands, the seamounts of Amanay and El Banquete (south of Fuerteventura) and around the island of La Palma. The other map (Figure 2) corresponding to the fleet dedicated to fish bentho-demersal species indicates high fishing pressure on Amanay and El Banquete seamounts, being these part of the site LIC-ESZZ15002, of Community Importance in Canary Islands, according the European Commission Habitats Directive (92/43/EEC). Moreover, high concentration of fishing boats has been also observed in the marine reserve of La Graciosa and islets at the North of Lanzarote. In a previous work carried out in the south of Fuerteventura, the results showed the same area of fishing interest for the multi-purpose fleet (IEO, 2013).

On the other hand, the results obtained in Gran Canaria should be interpreted with caution, since not enough information is available for the entire islands and, only the northeast and eastern fishing grounds were well represented in the data collected during the survey. Caution should also be taken with the information reported from Tenerife, because an unequal distribution of fishing effort was observed, with a high proportion of fishermen, particularly those from Los Cristianos port (south of the island), dedicated to tuna fishing. However, in the westernmost islands the greatest stress density is concentrated in the western slope of the islands.

This survey methodology permits to obtain a regional overview of the spatial distribution of the artisanal fishing fleet, a better forward planning and, more specific, sampling and monitoring methods of fishing data and activities. Also, the cell size seems to be adequate for fishermen to indicate their fishing grounds without revealing the exact position of their fishing spots, but providing adequate information for management. Another interesting aspect is that the results obtained serve to support the objectives sought by different European directives such as the Marine Spatial Planning (MSP) or Marine Strategy Framework Directive (MSFD), as well as other regional development and protection strategies. However, this methodology also has disadvantages such as the difficulty that fishermen have in locating their fishing areas directly on a map, the ability of the interviewer to transmit the objectives of the work and to interpret, process and detect the reliability of the information obtained or the refusal of the fishermen to participate in the study (12% of fishermen interviewed refused to participate due to mistrust). One impression after monitoring is that participation could be increased if these types of studies are disseminated from administrations with competence in fisheries and MSP. In general, it is considered that this method, despite its limitations, can be a useful tool in fisheries management, especially in small-scale and data-poor fisheries, as in this case.

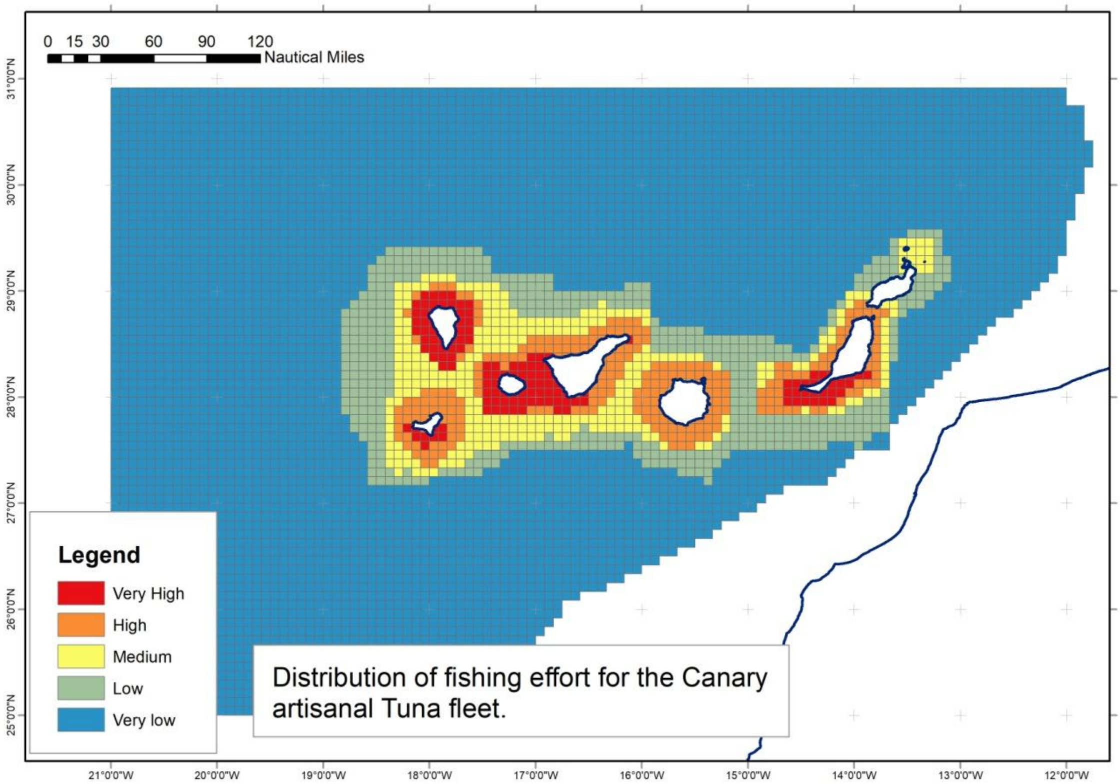

Figure 1. Spatial distribution of the tuna fleet effort expressed as density of vessels per area (cell size 5.0 nautic miles), assuming annual time frame.

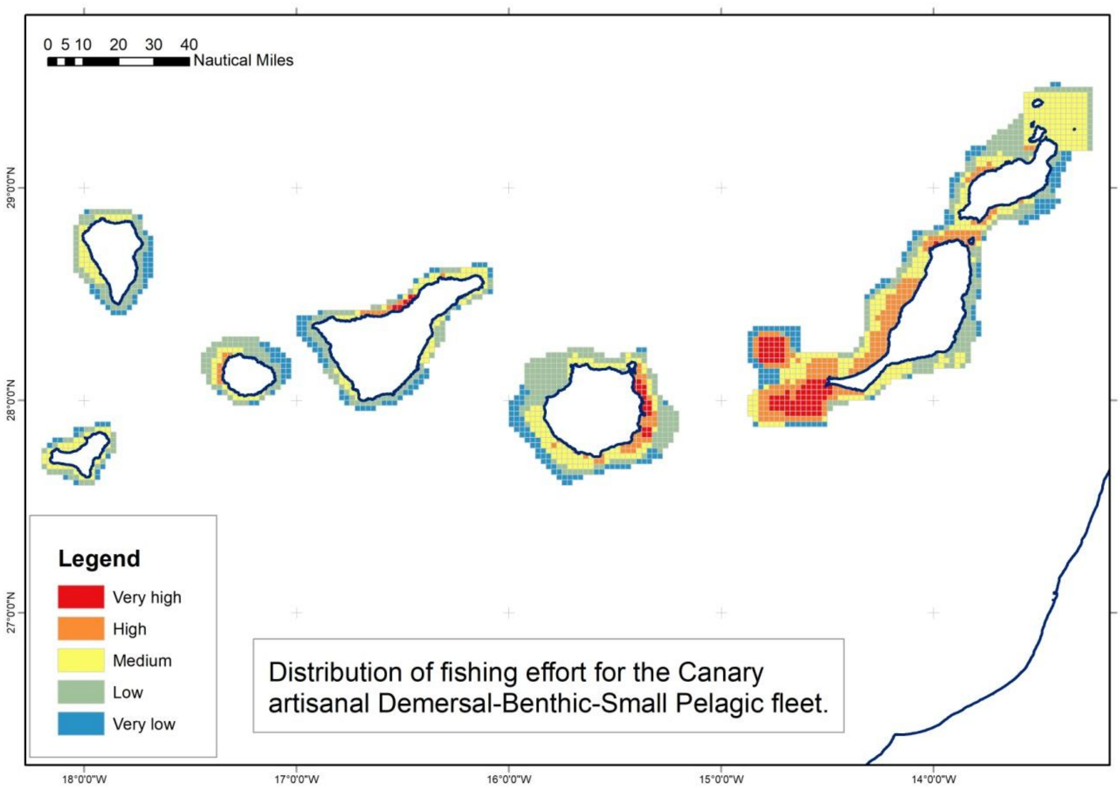

Figure 2. Spatial distribution of the multiporpose fleet effort expressed as density of vessels per area (cell size 1.5 nautic miles), assuming annual time frame.

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