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Management Units and Management Recommendations for the Artisanal Fishery in Tenerife (the Canary Islands)

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ABSTRACT: The Canary Islands marine ecosystem is very vulnerable due to the low abundance of the high number of species and, the complex relationships between them. On the other hand, several studies have concluded that the coastal resources off the Canary Islands have long been over-exploited. However, this fact has not motivated a significant change in political management strategies and most of the management plans focussed on the artisanal fishery have not been design with the collaboration of the sector and therefore some of the measures implemented are not accomplished.

The high number of target species and gears in the artisanal fishery as well as the difficulties for monitoring and surveillance, and lack of scientific information generate difficulties to establish management plans in the Canary Islands. As contribution to improve this situation, it was carried out the case study “*Tenerife island fisheries (The Canary Islands)*” in the framework of the international project *GEPETO-Fisheries Management and Transnational Objectives. Atlantic Area Programme Project 2011-1/159*, co-financed by the EU. This paper presents the two Management Units identified in the artisanal fishery of Tenerife (The Canary islands) (*Traíñas* – purse seiners – and *Other Artisanal fleet*) as well as some Management Recommendations, as contribution

to the establishment of management plans leading to sustainable pattern of fisheries activity for the preservation of the resources. All of that were carried out in collaboration with the stakeholders (Fishermen organizations – *cofradías* –, a marketing organization, regional and national fisheries administrations, scientifics of the IEO – *Instituto Español de Oceanografía* – in the Canary Islands, and the SWW RAC (*Southern Western Waters Regional Advisory Councils*).

Keywords: The Canary Islands, artisanal fishery, management units, management recommendations, stakeholders.

RESUMEN: El ecosistema marino canario es muy vulnerable debido a la baja abundancia del elevado número de especies y a las complejas relaciones entre ellas. Por otra parte, varios estudios han concluido que los recursos costeros de las Islas Canarias han sido sobreexplotados durante mucho tiempo. Sin embargo, este hecho no ha motivado un cambio significativo en las estrategias de gestión políticas y la mayoría de los planes de manejo enfocados hacia la pesca artesanal no fueron diseñados con la colaboración del sector y, en consecuencia, algunas de las medidas implementadas no se cumplen.

El elevado número de especies objetivo y artes en la pesca artesanal, así como las dificultades para el seguimiento y la vigilancia, además de la falta de información científica, generan dificultades para establecer planes de gestión en las Islas Canarias. Como contribución para mejorar esta situación, se llevó a cabo el caso de estudio “Pesquerías de la isla de Tenerife (Islas Canarias)” en el marco del proyecto internacional GEPETO-Gestión de Pesquerías y Objetivos Transnacionales. Programa Espacio Atlántico Proyecto 2011-1/159, cofinanciado por la UE.

En este trabajo se presentan las dos Unidades de Gestión identificadas en la pesquería artesanal de Tenerife (Islas Canarias) (Traíñas y Resto de la Flota Artesanal), así como algunas recomendaciones de gestión, como contribución al establecimiento de planes de gestión que conduzcan a una actividad pesquera sostenible para la conservación de los recursos. Todo esto se llevó a cabo en colaboración con las partes interesadas (organizaciones de pescadores —cofradías—, una organización de comercialización, administraciones pesqueras regionales y nacionales, científicos del IEO (Instituto Español de Oceanografía) en Canarias y el CCR Sur (Consejo Consultivo Regional de Aguas Occidentales del Sur).

Palabras clave: Islas Canarias, pesquería artesanal, unidades de gestión, recomendaciones de gestión, sector pesquero.

INTRODUCTION

Fishing activities in the Canary Islands were of little significance until the 1900s when an increase in population and urbanization brought a new demand for fish (Pascual, 2004). As compared with the very rich fishing grounds in the upwelling area, waters around the Canaries are relatively poorer, whereas the narrow continental shelf of the islands limits the abundance of demersal resources. Nevertheless, fishing activities represent a fundamental part of the identity of the Canary Islands, and many Canarian municipalities are highly dependent on this sector (Popescu & Ortega, 2013).

In the Canary Islands there are three main type of fleets: i) tuna fish fleet that target exclusively tunas when their abundance near the islands is high, ii) inshore fleet targets small pelagic species, demersals, crustaceans and molluscs using on average 30 different gears that has declined significantly over time, and iii) African Grounds Fleet (Martín-Sosa, 2012; Santamaría *et al.*, 2013). Artisanal fishing communities are organised into *cofradías* that are local non-profit corporations with public rights, which represent the interests of the whole fishing sector playing a key role within the fishing activity, maintaining social cohesion and representing local economic interests (Pascual, 1999; Corral & Romero, 2017) which in 2015 was organized as a Regional Federation (BOC, 108).

Artisanal fishery activities in the Canary Islands are characterized by: a) a high heterogeneity of the units of the fleet; (b) the polyvalence of them, with few specialized vessels; c) a wide variety of fishing gears used (multi-gear fishery); and (d) a high number of target and secondary species (multi-species fishery) (Balguerías, 2001; Santamaría *et al.*, 2013).

The Canary Islands marine ecosystem is very vulnerable due to the low abundance of the high number of species and, the complex relationships between them. Several studies have concluded that the coastal resources off the Canary Islands have long been over-exploited (García-Cabrera, 1970; Bas *et al.*, 1995; Pajuelo & Lorenzo, 1995; Falcón *et al.*, 1996; Tuya *et al.*, 2004; González, 2008), particularly as a result of the loss of North African fishing grounds and the staggering rise of recreational fishing (MAPyA, 2006; Castro, 2011). However, this fact has not motivated a significant change in political management strategies. The high number of target species and gears in the artisanal fishery as well as the difficulties for monitoring and surveillance, lack of scientific information generate difficulties to establish management plans in the Canary Islands.

The regulation of fishing activities is complex and is subject to regional, national and supranational (European and transnational) legislations. Although despite that the regional regulation considers some particular aspects of each island, many laws are issued without the consensus of all the actors and do not always reflect the reality of the Canary artisanal fishery.

As a result of their recent evolution (loss of the access to the rich Saharan fishing grounds, the change of status in an Autonomous Community, access to EU structural aids and fishing agreements, and application of the Common Fisheries Policy) there has been a certain convergence between the various levels involved with fisheries management in the Canary Islands (Pérez-Labajos *et al.*, 1996; Popescu & Ortega, 2013):

- At local level, fisheries management is the responsibility of the Canarian Government through its Viceconsejería de Pesca y Aguas. The Canary Islands have exclusive rights over the fishing policy affecting inland waters, harvesting of sea food and aquaculture.

- At national level, the Spanish Ministry of Agriculture, Food and Environment, through its General Secretariat for Fisheries, is the central government administration responsible for marine fisheries. The Spanish government has full jurisdiction in matters relating to sea fishing, and hence the relevant legislation and its implementation.

- At EU level, the CFP is applied in the Canaries, though not the TACs and quota system. As an outermost region, the Canary Islands are beneficiaries of POSEI Fisheries – a scheme aimed at mitigating the extra costs associated with marketing certain fisheries products.

In addition, the *Cabildos* are an administrative entity with certain competences over fisheries, among others. At a larger scale, the Southern Western Waters Regional Advisory Councils (SWW RAC), composed by a wide range of stakeholders (fishermen, NGOs), has currently a consultative role, so they do not manage fisheries.

On the other hand, there is not a clear definition of what a fisheries Management Unit is. However, the accurate definition of management unit is of key importance for the elaboration, agreement and implementation of Management Plans. In the European Union (EU) the concept of management unit (MU) has not been formally introduced neither defined in the Community's regulatory framework for fisheries. Fisheries management has been usually based on the Total Allowable Catch (TAC) defined for single stocks. Management units would be operational and sustainable and to overcome the limitations of current single stock based MU, and to move towards the ecosystem based management introduced by the MSFD (Marine Strategy Framework Directive. Directive 2008/56/EC), and the CFP (Common Fisheries Policy. Regulation 1380/2013) (Uriarte *et al.*, 2014).

During the period 2012-2014 it was carried out the international project *GEPETO-Fisheries Management and Transnational Objectives. Atlantic Area Programme Project 2011-1/159*, financed by the EU, with participation, among others partners, of the Instituto Español de Oceanografía (IEO) through its centres in Vigo and the Canary Islands. The general objectives of the project were: i) to develop proposals for the long-term management of fisheries; ii) to acquire shared knowledge concerning fisheries management and develop a governance model which optimizes cooperation between the fishing sector and the scientific institutes; iii) to give an opportunity to the professionals of the fishing sector to put forward proposals for the future of their profession; and iv) to improve knowledge of SWW RAC and NWW RAC, to strengthen their role as advisory bodies for the European Commission.

Their activities were defined in relation to:

- The collection of data for the atlas and the sector's participation.
- The definition of the *management units* based on the activity of the fleets, the species and work place.
- The collection of *management proposals* for the development of long-term plans.

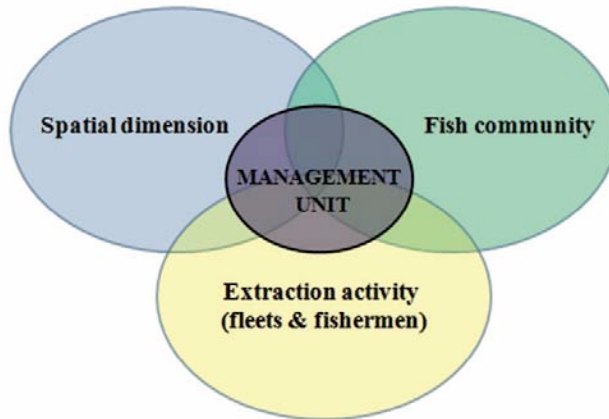


Figure 1.- The three pillar definition of management units. *Source:* Uriarte *et al.* (2014).

Seven case studies were selected as a representation of the multitude of the European fisheries, ranging from industrial to artisanal fisheries and among them the case study “*Tenerife island fisheries (The Canary Islands)*”, in which it was expected to identify the Management Units as well as to propose improvements in the current Management Plans on the artisanal fishery, all of that in collaboration with the stakeholders.

In the framework of GEPETO project, it was defined a Management Unit (MU) as “*The set of fishing fleets exploiting a common pool of fish resources with strong spatial overlapping and sharing of habitats, which make them being typically fished together*”. The proposed MUs will therefore rest on three pillars (fish/shellfish communities, spatial dimension and fishing fleets) (Uriarte *et al.*, 2014) (figure 1):

The aim of this paper is to summarize the main results of the case study “*Tenerife island fisheries*” concerning the Management Units identified and Management Recommendations proposed for the artisanal fleet (Falcón, 2014; Santamaría *et al.*, 2014), as contribution to the establishment of management plans leading to sustainable pattern of fisheries activity for the preservation of the resources.

METHODOLOGY

Study area

As was mentioned above, the case study was focused to the professional artisanal fishery on the island of Tenerife (located at 28°-28.6°N and 16°-17°W) (figure 2). Information on the knowledge and skills of fishermen concerning their artisanal activity, state of the resources in the fishing area, socio-economic context and their perception on marine environment, resources, regulation and future, was collected by means of an extensive survey among fishermen of the island (for further information, see Santamaría *et al.*, 2014).

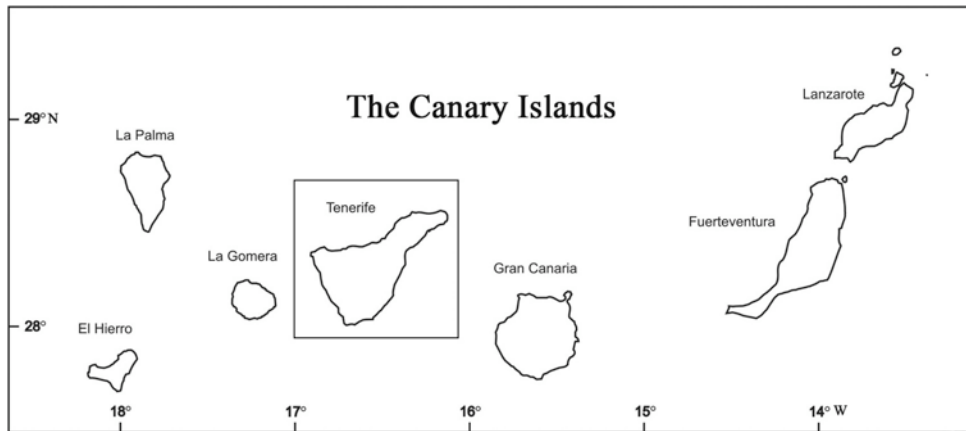


Figure 2.- Location of the Tenerife island.

Management units

Excluding specialized tuna fishing vessels, the artisanal fleet of Tenerife used in the analysis was of 146 boats, whose main technical characteristics are summarized in table I.

The methodological approach for the identification of potential homogeneous management units consisted in applying multivariate analysis (PCO and Cluster) on the data matrix of the fleet as exploratory methods. The aim was to find patterns of association (groupings) of vessels according to common factors (fishermen associations, home port, fishing zone, side of the island and type of activity of the vessel), based on a comprehensive database of each unit of the fleet. Due to the different quality of data, the total matrix

Table I.- Main technical characteristics of the artisanal fleet used in the analysis. GRT: Gross register tonnage, s.d.: standard deviation.

N: 146	Mean	s.d.	Min.	Max.
Year of construction (1974-2010)				
Crew (1-8)				
GRT	4.13	4.35	0.47	23.28
Power (hp)	34.26	39.08	4.00	200.00
Length (m)	7.28	2.32	4.20	14.48

was divided into four different sub-sets, i.e. technical characteristics of the vessels, auxiliary equipment for fishing and detection, main fishing gears (6 main gears from a total of 14 used) and the relative importance of the resources (64 species, on a scale from 0 to 4). The activity of tuna fishing fleet with exclusive dedication, constituted by bigger boats that carry out longer trips and of a larger-scale spatial dimension, was not included in the present study, because it is subject to other management units of greater spatial scale (national and international) and is annually assessed in the framework of the ICCAT (International Commission for the Conservation of Atlantic Tunas).

The differences between the groups for any categorical variable (factor) were statistically tested using permutational analysis of variance (PERMANOVA), using different models or experimental designs according to the quality of the data (Anderson, 2001, 2003, 2004; Clarke & Warwick, 2001; Mearldle & Anderson, 2001; Anderson & Braak, 2003; Clarke & Gorley, 2006; Anderson *et al.*, 2008). For more detailed information on the methods used, see Falcón (2014).

Management recommendations

In order to identify the management recommendations, discussion and adoption of the proposal technical management measures were carried out in a regional meeting among stakeholders.

To be effective, the conservation and management plan should include a system of control or monitoring based on the evaluation of indicators, increasingly developed and used as management tools of environmental issues (OECD 1991, 1994; EEA 1999a,b). Before selecting the indicators, it is necessary to clearly define the cause-effect relationships between the different components of the system, as well as to establish a conceptual framework from which the most appropriate indicators can be selected.

Our proposal consists in using a DPSIR conceptual framework (acronym for *driving forces - pressure - state - impact - response*), which makes it easier to identify and analyse the indicators. Moreover, it simplifies the complexity of the environmental management and facilitates communication among the administrations, scientists and users in general, providing a tool for decision making. It is important that the selected indicators include information about the “*key elements*”, as those key components of the ecosystem (for example, species or habitats that are protected or threatened, target species, etc.) that are likely to be affected by any of the DPSIR components (Ojeda-Martínez *et al.*, 2008, 2009). In the final selection it is necessary to take into account some requirements that a good indicator must fulfil (Meadows, 1998; Ojeda-Martínez *et al.*, 2008).

RESULTS

Management Units

In a summarized manner, the exploratory methods (PCO and Cluster) showed a clear tendency consisting in two main vessels groups: purse seiners and the rest. Among the latter, there was also a certain tendency to separate occasional tuna vessels from the others, al-

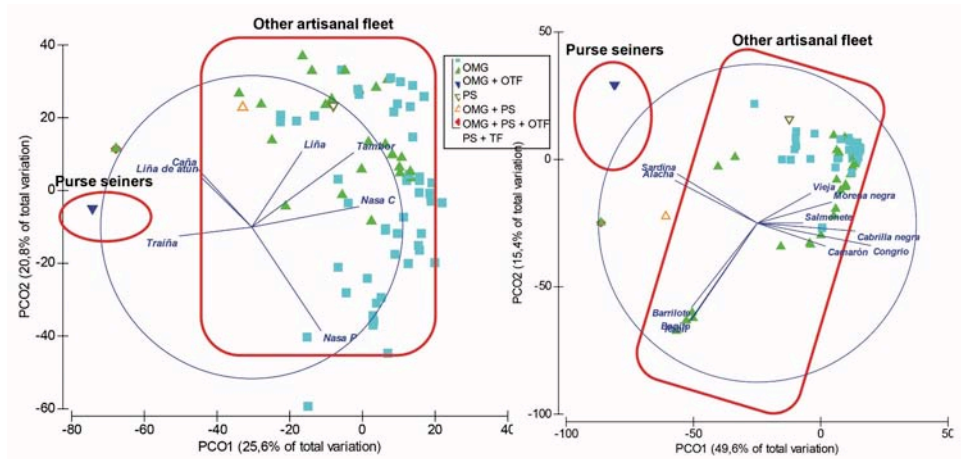


Figure 3.- Results of the PCO analysis based on gear data (left) and species data (right). Symbols represent units of the Artisanal fleet (OMG = other minor gears; OTF = occasional tuna fishers; PS = purse seiners). It is worth mentioning the great homogeneity of purse seiners (they are shown overlapped) in contrast to the greater heterogeneity shown by the rest of the fleet (adapted from Falcón, 2014).

though with some degree of overlap between them. This trend was consistent when data matrix used was based on technical characteristics of the vessels, main fishing gears and relative importance of the resources (figure 3). For these three data matrix, permutational analysis of variance (PERMANOVA) applied and *a posterior* paired test associated detected significant differences that confirmed such tendency. Also, some differences were found when using other factors, mainly for side of the island and fishing zone, and to a lesser extent for home port and fishermen associations, but these were less consistent and tendencies varied depending on the data matrix used. Finally, for the auxiliary equipment data matrix, no clear trends were found. For further information on the results obtained, see Falcón (2014).

As a result of the analysis, and taking into account the definition of Management Units (MU) in the framework of GEPETO project and its objectives, two main MU were identified (Santamaría *et al.*, 2014):

a. Management Unit “Traiñas (purse seiners)”: a small part of the fleet, although very well defined, targeting on small pelagic fish resources with purse seine (“traíña”).

b. Management Unit “Other Artisanal fleet”: the largest and most diverse fraction of the fleet, which mainly targets on a large variety of demersal resources and employs a wide range of minor fishing gears.

A 23.5 % of the boats (32 boats) that are dedicated to fishing with other minor gears (MU “Other Artisanal fleet”) also targets on large migratory pelagic fish (tuna) when passing close to the island. So, each identified management unit in the Artisanal fishery (excluding exclusive tuna fishing vessels) in Tenerife was described and analyzed under the criteria of the three pillars (Falcón, 2014; Santamaría *et al.*, 2014):

Spatial dimension criteria

From an oceanographic point of view, the waters of the island of Tenerife, as of the rest of the archipelago, are oligotrophic (Braun & Molina, 1984), which determines that the overall productive capacity of the ecosystem is very limited. The influence of the North-western African up-welling is very low, in contrast to what happens in the easternmost islands, where it slightly increases the productivity. On the other hand, due to the influence of the Canary Current, the surrounding waters of the archipelago are colder than they would be according to latitude. However, there are oceanographic differences around the island. This way, for example, the southwest area is protected against the dominants trade winds and currents most of the year, which is translated into a moderate-low hydrodynamism and gives particularly warm features within the general context of the island.

a. Management Unit “*Trañás* (purse seiners)”

The fishing activity of this fleet is developed in a wide area of the coast, which covers the eastern and western sides of the island, even though most of it is concentrated in the south and southwest area. In the northern side, coastal pelagic fishing is rare. There are some boats that sometimes move to other islands, particularly to La Gomera. Although the target species are not strictly linked to the coast, they tend to come close to it, so that fishing is normally in the waters over the shelf or the slope. Therefore, it is not normally necessary to move too far from the coast, given the narrow shelf and the proximity of the edge of the slope to the coast. The purse seine fleet accesses to the resources mainly from four ports: three located in the south/south-west sector of the island (Los Cristianos, Alcalá and Playa de San Juan), and one in the north-east (San Andrés) (figure 4).

b. Management Unit “*Other Artisanal fleet*”

Its fishery activity is developed throughout the coastal perimeter of the island, usually on the bottoms of the insular shelf, but also on the adjacent bottoms to the shelf and the uppermost part of the slope, rarely exceeding 800-1 000 m in depth. The intertidal zone is exploited by some boats for the catch of limpets (*Patella* spp.). In regard to the shelf, the most interesting are the rocky bottoms and seagrass beds (*sebadales*), together with the *maërl* beds and the circalittoral biogenic detritic bottoms (*cascabullo*). Regarding the slope, mainly rocky and rocky-sandy bottoms are exploited. It is possible to access to the demersal resources from around forty major and secondary ports and grounding beaches throughout the entire island (figure 4).

Fleets included criteria

a. Management Unit “*Trañás* (purse seiners)”

According to the information available, there are at least 9 specialized purse seiners (6.16% of the artisanal fleet). In addition, there are also three other vessels that alternate purse seine fishing with other minor gears and/or tuna fishing. In general, the purse seiners are among the most modern and with the largest length and power of the artisanal fleet. Due to the fishing requirements, these are the vessels that need a greater number of crew members (table II).

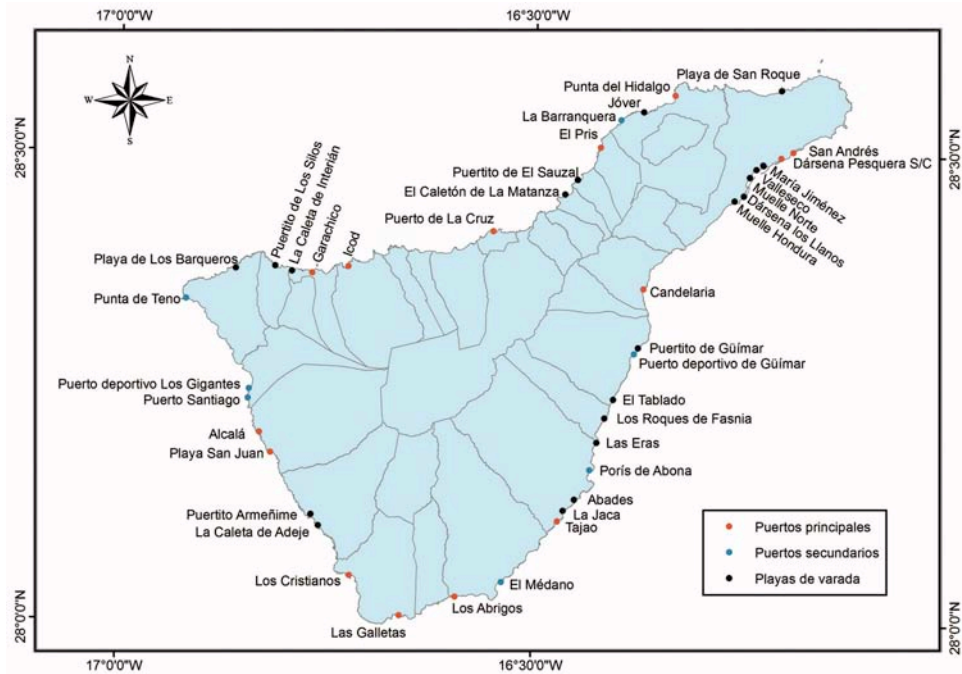


Figure 4.- Main ports (red), secondary ports (blue) and grounding beaches of the island of Tenerife.

Table II.- Main technical characteristics of the MU “*Trañás* (purse seiners)” fleet in Tenerife. GRT: Gross register tonnage, s.d.: standard deviation.

N: 12	Mean	s.d.	Min.	Max.
Year of construction (1971-2008)				
Crew (2-8)				
GRT	10.90	6.89	4.19	23.28
Power (hp)	93.89	65.41	12.00	200.00
Length (m)	10.96	2.35	7.89	14.48

b. Management Unit “*Other Artisanal fleet*”

As result, a total of 137 boats were included in this MU, which is equivalent to a 93.15% of the census of the artisanal fleet of Tenerife. The gears and fishing practises of this MU are varied (multi-gear fishery) and they are dedicated to fishing with other minor gears at least at some time during the year. The most commonly used are the traps (for fish, shrimp or morays), but different hook and line based gears are also used (handlines and pole lines,

Table III.- Main technical characteristics of the MU “*Other artisanal fleet*” in Tenerife. For the total (on the left) (N= 137) and for the occasional tuna fishers (on the right) (N= 32). GRT: Gross register tonnage.

	Mean	s.d.	Min.	Max.
Year of construction (1923-2010 / 1931-2009)				
Crew (1-4 / 1-4)				
GRT	3.54/5.35	3.46/3.90	0.47/1.25	17.01/17.01
Power (hp)	29.72/38.40	31.52/33.01	4.00/4.00	160/135
Length (m)	6.98/8.24	2.02/1.94	4.20/5.10	14.05/14.05

bottom long-lines, trolling line, gillnets, lift nets and harpoon for wahoo, in addition to shellfish collection (Pascual, 1991; Aguilera *et al.*, 1994; Santamaría *et al.*, 2013). Which method is used depends on the ports, and also varies throughout the year depending on the availability of resources (opportunistic fishery).

In general, this is a relatively old fleet, although the majority of the vessels have undergone reforms and have built-in auxiliary equipment for fishing (winch...) and for detection and navigation (echo sounder, GPS, etc.), even though many of them still have no deck or bridge. They are small or medium-sized vessels (average length: 6.98 m), of low-power and tonnage, which rarely carry more than two crew members on board. The vessels that alternate fishing with minor gears with tuna fishing tend to be a bit more modern and have a greater length, tonnage and power, as well as a larger number of crew members than the ones in the average fleet (table III). They are dedicated to fishing with other minor gears at least at some time during the year.

Fish/shellfish communities criteria

a. Management Unit “*Trañás* (purse seiners)”

The most caught target species is the Atlantic chub mackerel (*Scomber colias* Gmelin, 1789), followed by some clupeids, such as sardine (*Sardina pilchardus* Walbaum, 1792), Round sardinella (*Sardinella aurita* Valenciennes, 1847) and, to a lesser extent, Flat sardinella (*Sardinella maderensis* Lowe, 1838). Also important are the horse mackerels (especially *Trachurus picturatus* Bowdich, 1825). In general, the availability of these species in the waters around the island fluctuates considerably throughout the year, due to their own biological characteristics, and between years.

b. Management Unit “*Other Artisanal fleet*”

The number of target and by-catch or secondary species is greater than fifty, being the most frequent among them: parrotfish (*Sparisoma cretense* Linnaeus, 1758), seabreams (*Diplodus spp.*), combers (*Serranus spp.*), morays (*Muraena spp.* and *Gymnothorax spp.*), common octopus (*Octopus vulgaris* Cuvier, 1797) and shrimps (*Plesionika spp.*) (Santamaría *et al.*, 2013).

The catch and importance that each species represents for fishermen in the Management Unit “Other Artisanal fleet” varies among the ports. As a common denominator, it is always observed that the list is extensive and usually there is no clear difference between target and secondary species, typical of a clearly multi-species fishery.

Management recommendations for the Artisanal Fishery in Tenerife

Artisanal fisheries in the Canary Islands are mainly managed by a complex mixture of input and output controls, which are mainly focused on: i) Limiting the fishing effort (input control); ii) Limiting total catch (output control): prohibition to catch some species of crustaceans, molluscs and fishes; and, iii) Establishing technical measures. Concerning to the island of Tenerife, the regional and national regulations could be summarizing as follows (Santamaría *et al.*, 2013):

I) Professional fishing activity regarding limiting fishing effort, technical measures of dimensions of nets, traps, longlines, lift nets, grappling and wounding gears, prohibition of trawl fishing, seasonal closures for some set gillnets and prohibition of catching and landing of species under minimum landing size/weight established.

II) Recreational fishing activity regarding limiting total catch and technical measures as prohibition of catching and landing of species under minimum landing size/weight established and seasonal closures for underwater fishing.

III) Shellfish gathering regarding limiting fishing effort, limiting total catch and technical measures on traps, grappling and wounding gears specifications, seasonal closures for some species (professional and recreational activity), and establishment of minimum size/weight for some species (for professional and recreational activity).

In the framework of GEPETO project, the main problems identified to implement a Management Plan in the Canary Islands were:

- Lack of official statistics catches from the professional fishery before 2002;
- Lack of official statistics catches from the recreational fishery;
- Lack of information on the distribution of fishing effort;
- Monitoring and surveillance of this fishery is difficult due to the vast number of landing points (main ports, secondary ports and grounding beaches);
- Lack of scientific information concerning the biology and stock unities of the species;
- Abundance estimates very scarce, exceptional and ancient;
- Lack of stock assessment information;
- Lack of studies regarding the fishing activity impact on the ecosystem.

Due to the multigears and multispecies characteristics, as well as the difficulties for monitoring and surveillance and the lack of scientific information, it is very difficult to establish management plans for the Artisanal Fishery in the Canary Islands. However, it was pointed out some technical management recommendations in the framework of meetings with the partners: fishermen organizations from Tenerife (*Federación Provincial de Cofradías de Pescadores de Santa Cruz de Tenerife, Cofradías of San Andrés, Garachico, Icod, Candelaria, El Pris and Tajao*), a marketing organization (*ISLATUNA*), regional fish-

eries administrations (*Cabildo de Tenerife, Viceconsejería de Pesca y Aguas del Gobierno de Canarias*), national fisheries administrations (*MAGRAMA. Dirección del Área de Agricultura y Pesca de Canarias*), scientific of the IEO (*Instituto Español de Oceanografía* in the Canary Islands), and the SWW RAC (*Southern Western Waters Regional Advisory Councils*).

Once the management units were identified and adopted, the management recommendations proposed by the stakeholders for each one can be summarized as follows:

Management Unit “ Traiñas (purse seiners)”

It was mainly proposed to commit on the established normative, with special emphasis on avoiding commercialization of live bait (prohibited activity).

Management Unit “Other Artisanal fleet”

Effort

- Possibility to combine different artisanal gears during the same trip;
- Not to limit the number of fishing days nor the power of the engines for professional fishermen;
- To limit the number of licenses and fishing effort (number of days) for recreational fishing.

Technical measures

- To increase the mesh size of the fish traps;
- Moray traps: To eliminate minimum depth. To request the measures of caught specimens. Implement a minimum size for the catch of morays;
- To vary (in regulations) the description of characteristics and uses of some gears;
- To vary (in regulations) some technical specifications of the vessels dedicated to minor gears.
- Seasonal closures of certain areas for both professional and recreational fishing activity.

Catch

- To consider the other islands in the archipelago as areas reserved for traditional fishing;
- To revise the minimum sizes for the catch of some species;
- Recreational fishing: to control the possible sale of fish (poaching). To revise its regulations. To request its association, federation and statement of catches;
- To obtain quota for the bluefin tuna. To request support to the administration.

Others

- To create Marine Protected Areas including some closed areas to any fishing activities.
- More inspection and modification of marketing legislations in the catches coming from third countries;

- Revision of the regulations of declaration of First Sale;
- Permanence of the current legislation that regulates the beaconing of fishing gears;
- Request for additional grants for biological rest-period;
- Request for improvements in administrative management for the development of the professional activity.

Monitoring Plan recommendations

The monitoring plan proposed was the following:

Requirements

- Availability of fishery statistics, which have to be complete and reliable. It is necessary to review the operation of information gathering processes in the points of first sale;
- Maintenance of an effective Network of Information and Sampling (NIS), capable of collecting and reviewing the information and periodically sampling catches (mainly size structure);
- Collaboration of administrations in the transfer of data;
- Collaboration of the fisheries sector in the provision of information, in the sampling of the NIS and in possible experimental fishing;
- Monitoring the catches of key species (species that are increasing or decreasing in catches, vulnerable, of restricted distribution and of ecological/fishing interest) for their sampling, abundance estimates and size analysis;
- Selection of a sufficient number of representative fleet units (vessel type), for each zone (sides of the island and ports) and type of fishing, in order to carry out reliable and continuous sampling.

Indicators and their assessment

It was proposed a plan based in the framework of the conceptual DPSIR model, taking into account the recommendations and criteria for the selection of the indicators (Meadows, 1998; Ojeda-Martínez *et al.*, 2008; Ojeda-Martínez *et al.*, 2009) (table IV).

Additionally, it was recommended an annual assessment of the evolution of the indicators, as well as the possibility of being able to enter or delete some of them if necessary, in order to evaluate the effectiveness of management measures.

Assessment and advisory system

For a Canary Fishing Management, a Joint Management Committee composed by the stakeholders (professional, fishing administrations, scientists, NGOs) should be created. Ideally, the Committee should:

- Ensure that all parties are represented;
- Meet regularly (at least once a year);
- Establish a procedure for the decision-making process;
- Analyse, always under scientific supervision, the evolution of the indicators;

- Be able to implement changes to the own monitoring system (if needed) to adapt the management for the following years;
- Agree on and propose management measures and define the mechanisms to implement them.

Table IV.- Monitoring plan proposed for the evaluation of the fishery and the effectiveness of the management actions for the artisanal fishery of Tenerife. Adapted from Ojeda-Martínez *et al.* (2009).

DPSIR	Type of indicator	Indicators	Periodicity
Driving forces	Fishing	Number of fishing boats. Number of fishermen. Power of fishing boats.	Yearly
		Number of fishing boats with a kind of gear.	Quarterly
	Fishing & Socio-economic	Recreational boats. Number of licenses by each kind of recreational fishing.	Yearly
	Socio-economic	Profit of the fishing sector.	Yearly
Pressures	Fishing	Boats fishing/day.	Daily
		Biomass extracted (total and by species). CPUE (total and by species) by each gear.	Yearly
	Fishing & Socio-economic	Number of recreational boats.	Yearly
State	Ecological & Fishing	Abundance and biomass for key species.	Yearly
		Size structure of key species.	Quarterly
	Ecological	Richness. Diversity. Community structure.	Yearly
	Socio-economic	Economic value of each species.	Quarterly
Impacts	Ecological & Fishing	Species size variation of targeted species.	Quarterly
	Ecological	Changes in community structure, richness and diversity. Changes in abundance and biomass of key species.	Yearly
Responses	Fishing	Legislation changes. Zoning (surface for each use).	Yearly
	Ecological & Fishing	Marine protected areas created.	Yearly
	Socio-economic	Budget invested in fishery sector (total and actions for improvement, research, surveillance and educational programmes). Licenses for sport fishing. Meeting between the stakeholders.	Yearly
		Surveillance hours.	Daily
		Denounces.	Monthly

DISCUSSION

According to Britten *et al.* (2016), average recruitment capacity has declined at a rate approximately equal to 3% of the historical maximum per decade due to environmental changes and chronic overfishing. In accordance with Kooiman & Bavinck (2005), there are three main related causes maintaining this negative trend: a) the collapse of fish stocks caused by the degradation of aquatic ecosystems; b) fishing overcapacity, and c) a deficient fisheries governance. Thus, some authors suggest a need for improved monitoring of all fisheries, including, often neglected, small-scale fisheries, recreational fisheries as well as illegal and other problematic fisheries, such as discarded catches (Pauly *et al.*, 2003; Pauly & Zeller, 2016) (*In Corral & Romero, 2017*).

The main problem to assessing the state of the most important resources in the Canary Islands is related to the limited data available, particularly in what refers to the series of catches and fishing effort developed in the insular environment (Hernández-García *et al.*, 1998; Couce-Montero, 2009; Castro, 2011; Morales-Malla, 2011; Sistiaga-Mintegui, 2011) or biological information of the main target species (González, 2008; Martínez-Saavedra, 2011; García-Martín, 2011). In this region, there is a lack of systematic scientific data on fish distribution, fish mortality and recruitment, thus, there are no official reference indicators about the status of stocks (Corral & Romero, 2017). In order to control the landings of the artisanal fleet, in 2006 the decree of the first sale by the Government of the Canary Islands was implemented. However, this information is partial and inaccurate (Martínez-Saavedra, 2011). Additionally, the official information on catches and effort of the recreational fishing is non-existent (Jiménez-Alvarado, 2010).

In addition, Castro (2011) considers that the situation of the fishery management in the Canary Islands is also related to: i) complex regulations and excessive external interference (arbitrariness and loss of objectivity); ii) inadequate monitoring; iii) excessive fishing power and overfished species; iv) social conflict; and v) a significant decline in the number of professional fishermen and few expectations for the future.

To be effective, a management plan should consider the general characteristics of the Canary Islands fisheries, but also the particular ones of each island and each type of fleet. Although there is not a clear definition of what a fisheries Management Unit (MU) is, as mentioned in the Introduction, the one defined in the framework of GEPETO project (Uriarte *et al.*, 2014), permits to differentiate relatively homogeneous types of fleets.

In the case of the artisanal fishery of Tenerife, apart from the specialized tuna fishing vessels, two MU were identified: purse seiners (*Traña*) and the rest of the fleet using other minor fishing gears (the latter including vessels that alternate fishing with minor gears with tuna fishing close to the island). Each MU is composed of vessels of similar characteristics that use similar fishing gears and harvest on similar fishing resources. At a local scale, there are some minor differences depending on side of the island and fishing zone, and to a lesser extent for home port and fishermen associations, but at an insular scale they must be considered that present the same problems and, thus, any management plan should be made for each MU as a whole. However, in order to implement the proposed monitoring plan, local particularities should be taken into account, covering each of the three sides of the island and a significant and sufficient number of ports.

In the island of Tenerife there is a large group of vessels (~350) which are included, in theory, in List 7th (recreational sector), with similar characteristics to those included in Lists 3rd (commercial sector) (Santamaría *et al.*, 2013). In some places retired commercial fishers occasionally fish ‘recreationally’ and then sell their catches (poaching) to restaurants and local fishmongers as a way to supplement their low retirement pension. Also, other fishers use their recreational boat to obtain large catches and sell in the market, or even fishers without a boat may use trammel, swimming from the coast, to develop an illegal fishery activity, selling their catches. This trend has increased the pressure on commercial fishers over time (Pascual-Fernández & De la Cruz Modino, 2011), as a consequence the number of active artisanal boats and fishers continually decline. Furthermore, the number of recreational licenses is very high, according to data from the *Consejería de Agricultura, Ganadería, Pesca y Aguas del Gobierno de Canarias*, more than 90 000 recreational fishing licenses were active at the beginning of 2017 in the Canary Islands. The great fishing effort provided by the recreational sector and by the poachers that develop their activities in the island, together with that of the professional sector has led to the state of overexploitation of the main species of fishing interest, so a change in the management of fishing is necessary to achieve the sustainability of the fishing activity (Winter-Cabrera, 2012). A key factor in this arena is the market. Too frequently, local small-scale commercial catches are undifferentiated in the market vs the catches of large-scale fleets, imports from other areas, aquaculture produce or even poacher catches, which is misleading for consumers and a disaster for small-scale fisheries as happens in Tenerife. In this island, the lack of differentiation is especially relevant in the case of imports of the nearby African coast, and for poacher catches. In some areas of the Island fishers frequently do not target some emblematic species like *vieja* (*Sparisoma cretense* Linnaeus, 1758) because the market is overloaded with poacher catches. A need for differentiation in the market has driven to develop a collective label named “*Pesca artesanal*”, driven by the Island Government (*Cabildo*) and supported by the Fisher Local Action Group (FLAG) of Tenerife, that is slowly being implemented in restaurants and selling places in the Island. The implementation of collective labels is not an easy task, and in this arena, we can find many conflicts and some success cases. A good successful example is Conil (Andalusia, Spain), where the *Cofradía* has been effective in developing a collective labelling strategy that is widely recognised in the region, providing more secure access to markets and better prices for SSF fishers. In Tenerife case, the development of the collective label needs to be supported also with an increase in the control of the illegal fishing activities.

Owing to the own target species and their habitat, the fishery concerning the purse seiners does not usually come into conflict with the rest of the artisanal fishery of the island, nor with foreign longline vessels targeting on marlin/swordfish or pelagic sharks, nor with recreational fishing or poachers. Simply, the technology needed for developing this activity, the need to market large catches and the short period for marketing the catches visibly fresh makes difficult the competence from illegal fishers or imports.

However, demersal fishery is the most severely affected by recreational fishing and poachers (angling from the shore, from boat or speargun fishing), since they share many target species and fishing areas. The conflict of interests is greater with respect to the resources inhabiting on shallower bottoms, but it also exists with those living on the slope, due to the

increase in recreational boats equipped with modern systems for detection and positioning and powerful electric reels. The catches of recreational fishing are unknown, but there is a very widespread idea that, for some species, it can be higher than the one of professional fishing. Some evaluations have been made for Tenerife recreational catches (Pascual-Fernández *et al.*, 2012), but these research effort have not been supported by systematic data gathering about recreational catches from the administration. The problem is greater when there is an illegal sale of fish. Its fishing production, absolutely uncontrolled at the moment, could be high enough to justify the setting up of a system to control their activity and to estimate the size of their catches and fishing effort made. This will not be an easy task, especially taking into account the peculiarities of this type of vessels, which lack regularity in the carrying out of their activity (Santamaría *et al.*, 2014).

There are still discrepancies in regard to professional and recreational sectors. These comparisons between different sectors have been creating awareness about the rights of access and the role that each plays on the conservation estate and / or damage to fisheries resources (Martínez-Saavedra, 2011).

However, most of the management measures were not design with the collaboration of the sector and therefore some of the measures implemented are not accomplished. Therefore, it is fundamental to involve stakeholders in their design, in particular the fishing sector, providing and an opportunity to spell out arrangements, in to guarantee their successfully implementation.

In addition to the management recommendations presented in this paper as a result of the research carried out in the GEPETO project in relation to artisanal fisheries in Tenerife, authors such as Pascual-Fernández *et al.* (2005), Frangoudes *et al.* (2008), Macías (2013) and Castro (2011) have also proposed the co-management or co-governance as an alternative to this situation. In this sense, perhaps one of the main challenges for small-scale fishers, also in Tenerife, is how to develop organizations capable of coping with the current and diverse challenges they face. It is not an easy task, and frequently too dependent on specific leaderships. Supporting the development of organizations and leaderships is one of the pending tasks in many places. Governments may contribute to this endeavour, as happened with the Galician shellfisher women (*mariscadoras*) on-foot in the 1990s, when shell-fisher organizations were created with the help of the regional government (Frangoudes *et al.*, 2008). Since that moment on, these shellfisher women have developed a successful management system in collaboration with biologist and the regional government. In Tenerife some of this effort from different actors is needed, as most of the fisher organizations in the island are rather weak. For instance, the majority of *cofradías* in the island have no role in fish marketing, apart from controlling the register of the first sale of the catches. Only for tuna there exists a fisher organization (ISLATUNA) that markets most of the island catches, as they need to be exported. This marginal role of fisher organizations in most fish marketing contribute to the lack of differentiation of local catches in the island, and indirectly to the relevance of poaching. Frequently, the strength of fisher organizations is related to their role in fish marketing, and this explains some of the difficulties for fisher organizations in Tenerife. This constitutes a key element to improve in order to facilitate the active co-governance of fisheries in the Island.

Probably, from all the challenges faced by small-scale fisheries in Tenerife improving the capacity of organizations is the main factor, and this is a key element for improving co-governance. Co-governance opens up a lot of possibilities for improving the situation of natural resources, but building the co-governance is not a fast and simple process. In some cases we can find the wicked nature of the challenges faced to built co-governance (Jentoft & Chuenpagdee, 2009), problems that have no easy technical solutions and tend to reappear in one way or another, making especially important the collective judgment and knowledge of a diversity of stakeholders that need to be engaged in decision making and action processes, interacting with administrations. These processes of change are going to be linked with conflicts, as many actors with different interest converge on the coastal zone and fish markets. These processes require the support from administrations and other actors to facilitate the agreements and the confluence of images (Jentoft *et al.*, 2012). An important factor also is the presence of leaderships in different actor groups. No immediate results can be expected, as these processes need transformations in institutions, organizations, relationships, markets, and even on how the main actors understand their relationship with natural resources. The Galician experience of *mariscadoras* that we commented before is a perfect example that something like this is feasible, but requires a lot of efforts from different actors to materialize.

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