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ARTISANAL FISHERIES IN THE CANARY ISLANDS (EASTERN-CENTRAL ATLANTIC): DESCRIPTION, ANALYSIS OF THEIR ECONOMIC CONTRIBUTION, CURRENT THREATS, AND STRATEGIC ACTIONS FOR SUSTAINABLE DEVELOPMENT

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Background. Fishing is a primary activity of great importance in the Canaries and has traditionally played an important role in reducing poverty, in job creation, strengthening food security and sovereignty, and increasing the value of its products. This study is needed to analyze fishing contribution in a region strongly based on tourism. Aims were: to update the inventory of fishing techniques, to detail the biodiversity involved, and for the first time to analyze the contribution of the landings. We also identify threats to the activity and draft a plan with strategic actions for its sustainability.

Materials and methods. Data on the fisheries and the 2007–2018 series of landings were taken from the regional government website. Once the database was refined, data were analyzed in main four environmental resource categories: shellfish (SHS), demersal fish (DMF), coastal pelagic fish (CPF), and oceanic pelagic fish (OPF). To analyze the economic contribution of the fisheries, first-sale reference prices were compiled from fisheries entities. To estimate the contribution of this sector to the regional GDP, its economic value was compared with the mean value of GDP for 2014–2018 GDP.

Results. The versatility is the main characteristic of the fleet, which was stabilized around 600 vessels within 2016–2018. Fishing techniques vary enormously, and eight categories of fishing gear were identified. Total landings ranged between 5560 t in 2007 and 15 466 t in 2016, with a mean value of 11 254 $t \cdot y^{-1}$. SHS reached a mean value of 111 t, representing only 1%, DMF 1683 t (16%), CPF 1926 t (17%), and OPF 7533 t (65%). Biodiversity targeted by these fisheries throughout the 2007–2018 period involved about 200 species. As a primary sector, the Canary Islands' fishing activity made a mean value of the economic contribution of €73.19 million per year at first-sale in 2007–2018, contributing 0.19% of the regional GDP overall during 2014–2018. When the fishing activity is considered together with other local socio-economic sectors in the added-value chain of seafood, it contributes acceptably to the regional economy.

Conclusion. Overexploitation of fish stocks is the greatest problem to solve, followed by poaching and the growth of intense recreational fishing. Ad-hoc strategic and structured actions for the sustainable development of the fishing activity are proposed.

Keywords: artisanal fishing techniques, seafood products, economic value, action plan, Canary Islands

INTRODUCTION

The Canary Islands (eight inhabited islands covering a total of 7500 km^2) are an overseas Spanish territory and an outermost European piece of land situated in the eastern-central Atlantic Ocean. With more than 2.2 million inhabitants, the Canary economy is mainly based on the tourism industry, receiving in recent years about 16 million visitors and tourists per year.

The archipelago is close to the African continent (104 km from Morocco) but separated from it by depths generally not exceeding 1500 m (Fig. 1). The age of the islands varies from east to west between 21 and 0.7 million

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years. Their volcanic characteristics are seen in their lack of wide insular shelves, often with a mean bottom depth of 200 m near the coast. This archipelago has nearly 1600 km of coastline and is washed by the oligotrophic ocean (Braun and Molina 1984).

Within the currently established 66 Large Marine Ecosystems (LME) of the World (Sherman 2006), the Canary Current includes a major cool upwelling off the coast of north-west Africa, stretching from the Straits of Gibraltar to Guinea-Bissau (Belkin et al. 2009), bordered by Morocco and southwards to Guinea-Bissau, and by the Canary and Cabo Verde Islands. Oceanographically, the Canaries are under the influence of the subtropical gyre of the eastern-central Atlantic, which facilitates the transport of plankton and rafting organisms to the archipelago. The mean seawater temperature around the islands is 18.5°C in February, rising up to 24°C within August–September (Barton et al. 1998). Mesoscale distribution of larval communities was described in filaments of the upwelling system from the African coast that reaches the archipelago (Landeira et al. 2010). As a result, there is a thermal gradient of up to 2°C between the eastern islands—closest to Africa and with cooler sea surface temperatures—and the western islands. A similar phenomenon occurs with the salinity of surface waters, which increases in locations progressively further away from the north-west African coast (Mascareño 1972, Brito 1984). The Canary region is characterized by the presence of three water masses in the first 1000 m of depth, the Eastern North Atlantic Central Water, the Antarctic Intermediate Water, and the Mediterranean Water, located at different depths and with characteristic thermohaline properties (Hernández-Guerra et al. 2002). These water masses generate changes in salinity and particularly in temperature, resulting in the presence of density and thermal barriers that affect the distribution of decapod crustacean (Pajuelo et al. 2015) and fish species (Pajuelo et al. 2016) in the region.

The geomorphological, geographical, and oceanographic particularities of the Canary archipelago may explain the great diversity in the biogeographic patterns of the biota inhabiting this area. These physical and biodiversity characteristics, together with the climatic conditions of the Canary Islands—a temperate-subtropical area—compared with the surrounding region highlight the uniqueness of the Canary Islands and their oceanographic connectivity with the adjacent waters (González et al. 2012a, González 2016).

The Canary Islands are the southernmost archipelago in Macaronesia, i.e., the Azores–Madeira–Canaries ecoregion (Spalding et al. 2007, González 2018), within the Lusitanian biogeographic province of the Temperate Northern Atlantic realm. However, a marine multi-taxon biogeographical approach (coastal fishes, echinoderms, gastropods, brachyurans, polychaetes, and macroalgae) has recently redefined the Macaronesia biogeographic unit, and a newly proposed ecoregion—Webbnesia—comprises the archipelagos of Madeira, Selvagens, and the Canary Islands (Freitas et al. 2019).

The fishing activity is a primary sector of great social importance in the Canary Islands, and this archipelago is the only Spanish region where fishing is entirely artisanal (Fig. 2). This sector has traditionally played an important role in reducing poverty, in job creation, strengthening food security and sovereignty, and increasing the value of regional production and gastronomy. Fresh fish constitutes an important source of animal protein commonly consumed by the Canary population and highly in demand from visitors.

Economically, official data sources provide estimates that the regional fishery sector accounts for a modest percentage of gross domestic product (GDP). However, taking into account the contribution of socioeconomic activities related to fishing, as well as fish processing and commercialization, the impact of the fisheries sector on GDP is far beyond its importance merely as primary

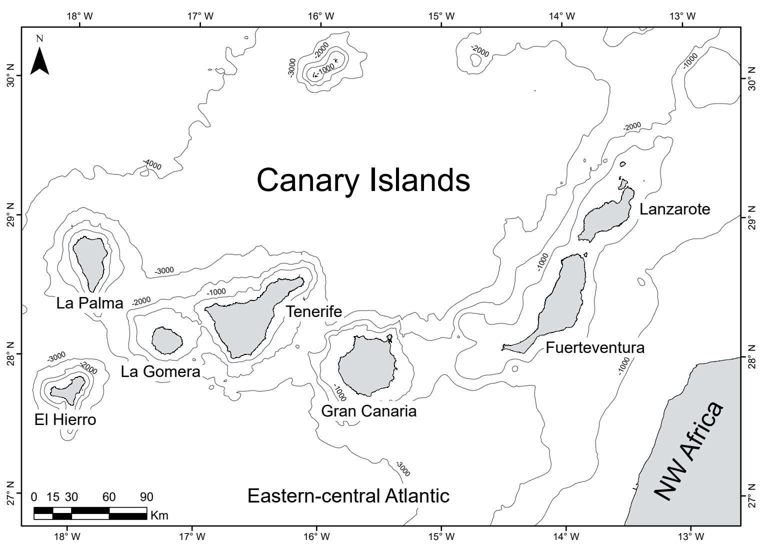

Fig. 1. The Canary Islands and their geographic situation; map adapted from BlueChart Atlantic v9.5

Fig. 2. A typical artisanal fishing vessel from the Canary Islands

production. According to official statistics, the potential employment was estimated at 1600 jobs in artisanal extractive fishing and aquaculture for 2017–2019. However, it is necessary to consider the generation of employment by the fish processing industries, fish commercialization, and other indirect jobs, namely those related to the activities of stowage, storage, construction, and repair of marine equipment for fishing (ISTAC, the Canary Institute of Statistics 2019[*]).

The presently reported study had the following objectives:

- to update the inventory of fishing techniques in the Canaries;
- to describe the biodiversity involved in fisheries activity; and
- for the first time in the region, to analyze qualitatively and quantitatively the contribution of their landings—in terms of weight and economic value—according to environmental groups and resources exploited.

Moreover, here we identify current and potential threats to the continuity of the activity and recommend an ambitious plan with ad-hoc strategic actions to further its sustainability.

MATERIAL AND METHODS

Study area. This study covers all marine artisanal fisheries and their target fish and shellfish species in the Canary archipelago from the intertidal zone to deep waters. The study area is bounded by the 30°N and 27°N parallels, the 19°W meridian and, in the Canaries–Africa channel, the 13°W meridian. This area occupies a band of about 600 km from east to west and about 330 km from north to south. The depth is generally not exceeding 1500 m; in the north and west it is greater than 4000 m and on the southern edge greater than 3500 m (Fig. 1).

Information sources. The authors have extensive experience in the study and field observation of the artisanal fisheries of the Canary Islands, having participated in previous descriptive works, research actions and fishing campaigns, visits to fisheries communities and markets, and also in the activity of official fishing control (González 1991, Mena et al. 1993, Bas et al. 1994, González et al. 1995, González and Lozano 1996, Rico et al. 1999, González unpublished[**], González Pajuelo unpublished[***]). Other pioneer publications on this subject (García Cabrera 1970, Anonymous 1977, Santana et al. 1987, Franquet and Brito 1995) were also consulted.

The present inventory of the recent and current artisanal fishing gears in the Canary archipelago follows the FAO and related classification and nomenclature for the small-scale fisheries, which are based on the mode of capture of the targeted fisheries resources (Anonymous 1972, Nédélec and Prado 1987), adapted to the peculiarities of this region. Taxonomic nomenclature of the fisheries families and species follows FishBase (Froese and Pauly 2019), Eschmeyer's Catalog of Fishes (Fricke et al. 2020), and World Register of Marine Species (WoRMS Editorial Board 2020).

The available data on the fishing vessels, fishermen, and different aspects of the organization of fishing activity (fishing communities, ports, and infrastructure), as well as the 2007–2018 time series of landings, were taken from the official website of the regional department for fisheries of the Canary Islands Government[****].

Artisanal fisheries landings are defined as the catches of marine fish and shellfish caught by the local fleet in the

[*] *http://www.gobiernodecanarias.org/istac/temas_estadisticos*

[**] González J.A. 1991. Biología y pesquería de la vieja, *Sparisoma (Euscarus) cretense* (Linnaeus, 1758) (Osteichthyes, Scaridae), en las Islas Canarias. Tesis Doctoral. Universidad de La Laguna, Tenerife, Spain.

[***] González Pajuelo J.M. 1997. La pesquería artesanal canaria de especies demersales: análisis y ensayo de dos modelos de evaluación. Tesis Doctoral. Universidad de Las Palmas de Gran Canaria, Spain.

[****] *http://www.gobiernodecanarias.org/agp/sgt/temas/estadistica/pesca/index.html*

Canary and adjacent waters and then landed in domestic ports, with the regional aquaculture production not covered by presently reported study.

The first-sale reference prices for the majority of fished species during 2014–2018 were taken from three fishery entities based in western, central, and eastern islands of the archipelago, i.e., the *Sociedad Cooperativa del Mar PescaRestinga* (PescaRestinga Professional Fishermen's Cooperative) on El Hierro, the *Cooperativa de Pescadores de San Cristóbal* (San Cristobal Professional Fishermen's Cooperative) on Gran Canaria, and the fish processing company *Inver Pescatron Lanzarote* on Lanzarote.

The information on regional GDP and its contribution to the tourism industry for the 2014–2018 period were taken from the ISTAC (Canary Institute of Statistics 2019[*]) and the non-profit group Exceltur (Alliance for Excellency in Tourism).

Data analysis. According to FAO guidelines by Caddy and Bazigos (1985) and authors' experience, data on fisheries landings were checked, treated, and classified. Thus, once the 2007–2018 database of regional fish landings was refined, data were analyzed by four widely-accepted environmental categories of fishery resource species: shellfish (SHS) (mainly crustaceans and mollusks), demersal fish (DMF) (both benthic and benthopelagic), coastal pelagic fish (CPF), and oceanic pelagic fish (OPF). In general, each of these ecological groups of species is closely related to the main groups of local fishing techniques as follows. Shellfish were collected by a range of small-scale harvesting methods and some selective traps; demersal fish were exploited by traps, gill nets, hook-and-line, and other minor fishing gear; small and medium-sized coastal pelagics by means of purse seines and other minor techniques; and finally, large-sized oceanic pelagics with very specialized hook-and-line methods. In a second approach, fishing landings were calculated for the most fished zoological families of resources. Lastly, in a third approach, landings were calculated for the most fished species, that is, fisheries resources at the species level.

For each environmental category, the 2014–2018 mean landings [$kg \cdot y^{-1}$]—i.e., for the last 5 years of the available historical series—were calculated for the most important species exploited. Then, using the reference prices compiled [$€ \cdot kg^{-1}$] the mean economic contribution per year [$€ \cdot y^{-1}$] was calculated.

The sums of the economic contributions of the species were calculated for each of the four established environmental categories. Finally, the sum of these four sub-totals provided the economic value [€] of the fishing activity as a primary sector in the Canary Islands. To reach a wider public, columns with the Spanish vernacular names used in the Canaries and with the zoological families are included.

To estimate the weight/contribution [%] of the local fisheries sector in the regional GDP, the economic value [€] of fishery activity was compared with the 2014–2018 mean GDP generated in the Canary Islands.

[*] See footnote on page 271.

RESULTS

Fishing vessels and organizational aspects of fisheries activity. Fishing vessels in the Canary Islands vary notably in terms of size and on-board equipment. Their level of technology and sophistication ranges from undecked boats with little equipment to purse-seiners with a power block head to haul in the nets and on-board fish-detection systems.

Small vessels, 3–4 m in length with a crew of 1–2 fishermen, are used as auxiliary boats in beach-seine operations—they do not usually carry a motor, and are propelled by oars—or operate independently with jigs and fishing poles for coastal demersal fish. Medium-sized vessels, 4–12 m in length with a crew of 2–5 fishermen, operate with large cast nets, gillnets (gillnetters), traps (trappers), pole-and-line gears, and short longlines for coastal demersal fish species. Large-sized vessels, 12–30 m in length with a crew of up to 14 fishermen, operate with longlines for deep-water demersal fish species (longliners), purse seines (purse-seiners), and pole-and-line gears for tunids (tuna-bait vessels). Seasonally, several large surface longliners from mainland Spain work in Canary waters.

However, versatility or polyvalence is the main characteristic of the Canary Islands' fishing vessels. Medium-sized boats are able to operate alternating seasonally, or even daily in some cases, between cast nets, gillnets, traps, pole-and-line, and small longlines. Most large-sized boats combine the characteristics and equipment/systems of purse-seiners and tuna-bait vessels, sometimes operating as pure purse-seiners on coastal pelagic fish or sometimes as tuna-bait vessels fishing tunas and allied species. In general, these boats practice rotation in the use of fishing gear according to the availability of the different fishery resources, but also within a strategy of maximizing catches and their economic value.

According to the official data from the Spanish Ministry for Fisheries, the Spanish Institute of Oceanography, and first-sale records in fish markets, the Canary Islands artisanal fleet was stabilized around 600 units in the triennium of 2016 to 2018.

Within the archipelago, the eight populated islands have fishing activity from those with the highest (Tenerife, Gran Canaria, and Lanzarote) to the least fishing activity (La Gomera and La Graciosa). There are between one and many landing ports and sheltered bays on each island. Fishing ports are adequately equipped with the necessary infrastructure to support fishing activity, including cold storage and freezing facilities as well as an administrative structure. Fishermen are organized in fishermen' guilds/fraternities and cooperatives, to which groups of boats are attached according to their geographical proximity or economic interest. Each island has between one and several establishments (*lonjas de pescado*) where landings from fishing boats are veterinary and statistically monitored and then sold daily, but there is no auction as occurs in the larger fishing markets of mainland Spain. A significant fraction of the landings, although this is not the case for tuna, is directly marketed by the fishermen to their clients, who are generally fish restaurants. In addition, some islands (Tenerife, Gran Canaria, Lanzarote, and El Hierro) have semi-private producer organizations or fishing cooperatives that market (and sometimes partially process) the fish landings. A few private companies acquire artisanal fishery catches for processing and transformation (including deep freezing), and then distribute and sell various products to wholesalers, hotels and restaurants. Some guilds and ship-owners have agreements with large wholesalers or hypermarkets to buy their catches daily on an exclusive or priority basis.

The administrative-financial organization of the artisanal fishing sector of the Canary Islands is based on the fishermen' guilds and cooperatives (currently 27 spread across the eight islands), their two provincial federations and their regional federation, under the tutelage and administrative-political control of the Directorate for Fisheries of the regional government.

Fishing techniques. Fishing techniques in the Canaries vary enormously from fish harvesting (with no vessel requirements and involving simple technology) to purse seines (with some amount of technology onboard). Eight categories of local small-scale fishing gear (both recent and current) are considered in this work:

1) Purse seines. Three types of encircling fishing techniques deployed from boats were identified. These are based on encircling nets with purse-line or without (the latter practically in disuse since the 1980s), or encircling gillnets. The fisheries resources exploited with purse seines are small and medium-sized coastal pelagic bony fishes, mainly clupeids (European pilchard *Sardina pilchardus*, round sardinella *Sardinella aurita*, and Madeira sardinella *Sardinella maderensis*), scombrids (Atlantic chub mackerel *Scomber colias*), and engraulids (European anchovy *Engraulis encrasicolus*). The sand smelt *Atherina presbyter* (Atherinidae) is legally caught for its use as live bait in tuna fisheries. The main associated species are bogue, *Boops boops* (Sparidae), mackerel scads (*Decapterus* spp.) (Carangidae), and yellowmouth barracuda *Sphyraena viridensis* (Sphyraenidae). Although they are now prohibited, encircling gillnets were sporadically used to capture mugillids (*Chelon*, *Liza*, *Mugil*), and some sparids such as salema (*Sarpa salpa*) and Moroccan white seabream (*Diplodus cadenati*).

2) Beach seines. Two types of encircling-trawling fishing techniques deployed from shore or beach were identified. All beach seines are currently prohibited, although their use is authorized during the festivities of the fishing communities. The fisheries resources exploited with them are both benthic and pelagic coastal species, such as clupeids (*S. pilchardus*), engraulids (*E. encrasicolus*), carangids (pompano *Trachinotus ovatus* and horse mackerels *Trachurus* spp.), sparids (*B. boops*), atherinids (*A. presbyter*), scombrids (*S. colias*), soleids (chiefly bastard sole *Microchirus azevia*, and sand sole *Pegusa lascaris*), and mullids (surmullet *Mullus surmuletus*). Many varied benthic species were seen within these catches, including cephalopods. Although they are prohibited, some gillnet-based beach seines are sporadically used for sparids (seabreams *Diplodus* spp., sand steenbras *Lithognathus mormyrus*, *S. salpa*, and black seabream *Spondyliosoma cantharus*), carangids (white trevally *Pseudocaranx dentex*), scarids (Mediterranean parrotfish *Sparisoma cretense*), and mugillids.

3) Lift nets. Two types of lift fishing techniques deployed from small boats were identified. Small lift nets are used near shore for benthic fish species such as labrids (ornate wrasse *Thalassoma pavo*), pomacentrids (Azores chromis *Chromis limbata*), and scarids (*S. cretense*), or even for neritic pelagic species such as *E. encrasicolus* and *A. presbyter*. Large lift nets are used in the open sea for coastal pelagic fish species such as *S. colias*, *B. boops*, *S. pilchardus*, *S. maderensis*, *S. aurita*, and *A. presbyter*, which are subsequently used as bait in other local fisheries.

4) Cast nets. Today these fishing techniques are virtually obsolete. They were deployed from shore for the capture of mugillids, salema, and small individuals of many other species.

5) Set gill nets. Three types of set gill nets deployed from small boats were observed, consisting in a single (the most used), double or triple netting walls. The most fished resources are scarids (*S. cretense*), mullids (*M. surmuletus*), sparids (*L. mormyrus*, common pandora *Pagellus erythrinus*, *S. cantharus*, and axillary seabream *Pagellus acarne*), sphyraenids (*S. viridensis*), and soleids (chiefly *M. azevia* and *P. lascaris*). The predominant associated species are numerous and diverse, such as crabs, cephalopods, benthic sharks, and bony fishes. The Canary fishermen historically practiced lobster fishing in the former Spanish Saharan Bank using drift gillnets, although this technique was never used in Canary waters.

6) Fish traps. Deployed from small boats, fish or shellfish species (cephalopods and decapods) may be caught by these fishing methods. Six types of traps were identified, five of them are benthic and the remaining model an epibenthic or semi-floating design:

- Traps for demersal fish species—the most used trap model—have several sizes (small, medium, and large traps) and shapes (cylindrical or prismatic), depending on the species targeted. The most fished resources are octopodids (common octopus, *Octopus vulgaris*), sepiids (common cuttlefish, *Sepia officinalis*), scarids (*S. cretense*), serranids (dusky grouper *Epinephelus marginatus*, island grouper *Mycteroperca fusca*, and three species of combers *Serranus* spp.), sparids (mainly pink dentex *Dentex gibbosus*, red porgy *Pagrus pagrus*, and several other family species), mullids (*M. surmuletus*), carangids (*P. dentex* and amberjacks *Seriola*), and monacanthids (planehead filefish, *Stephanolepis hispidus*). Associated species are numerous and varied, including muraenids, balistids, labrids, haemulids, mugillids, pomacentrids, scorpaenids, and sebastids, to name just a few.
- Two types of traps are laid on their base or side. The latter design, called *tambor*, is very selective in terms of species caught and used for moray eels (mostly several species of *Muraena* and *Gymnothorax*). A currently obsolete trap was used for the capture of coastal crabs

(mainly spinous spider crab *Maja brachydactyla*, and spiny spider crab *Neomaja goltziana*), and lobsters (European spiny lobster *Palinurus elephas* and Mediterranean locust lobster *Scyllarides latus*). Another trap in use is selective for the narwal shrimp *Plesionika narval* (Pandalidae), with the forkbeard *Phycis phycis* (Phycidae) as the main accompanying species, and yet another design of trap is selective for deep-water big crabs (toothed rock crab *Cancer bellianus*, box crab *Paromola cuvieri* and deep-sea red crab *Chaceon affinis*), with two associated pandalid species (smooth nylon shrimp, *Heterocarpus grimaldii*, and giant smooth nylon shrimp *H. laevigatus*).

- Finally, the multiple semi-floating shrimp trap is a very selective method for the capture of the striped soldier shrimp (*Plesionika edwardsii*) (Pandalidae), with other pandalids (i.e., *P. narval* and the armed nylon shrimp *Heterocarpus ensifer*) and fish species (offshore rockfish *Pontinus kuhlii*) (Scorpaenidae) as associated resources.

7) Hook-and-line. According to their components and species targeted it is necessary to consider six categories: electric reels, handlines, trolls, jigs, poles, and longlines.

- Electric reels. They are currently the most used method within this category, being efficient and not taking up space on board. They are targeting combers (*Serranus* spp.), grey triggerfish (*Balistes capriscus*), *P. kuhlii*, blackbelly rosefish (*Helicolenus dactylopterus*), and alfonsinos (*Beryx splendens* and *B. decadactylus*), to name just a few.
- Handlines. Within the handline-based techniques, four types were identified. Those for demersal bony fishes are targeting many fish species representing the merluccids (European hake *Merluccius merluccius*), phycids (*P. phycis*), morids (common mora *Mora moro*), berycids (*B. splendens* and *B. decadactylus*), serranids (*Epinephelus*, *Mycteroperca*, *Serranus*), polyprionids (wreckfish *Polyprion americanus*), epigonids (black cardinal fish *Epigonus telescopus*), carangids (*Seriola* spp.), sparids (*Dentex*, *Pagrus*, *Pagellus*), scorpaenids (*P. kuhlii* and red scorpionfish *Scorpaena scrofa*), sebastids (*H. dactylopterus*), gempylids (roudi escolar *Promethichthys prometheus*, oilfish *Ruvettus pretiosus*), and balistids (*B. capriscus* and ocean triggerfish *Canthidermis sufflamen*), among others. Associated species are: muraenids, other sparids, haemulids, trichiurids (silver scabbardfish *Lepidopus caudatus*), and some chondrichthyans. A very specialized handline (*puyón*) is used in waters of El Hierro for *S. cretense*. Handlines for oceanic pelagic fish species are dedicated to large scombrids such as true tunas (*Thunnus thynnus*, *T. obesus*, *T. albacares*, and *T. alalunga*) and wahoo (*Acanthocybium solandri*), as well as carangids (*Seriola*) and swordfish (*Xiphias gladius*). The handlines for deep-water benthic and mesopelagic sharks (Dalatiidae, Centrophoridae, Somniosidae, and Pseudotriakidae)—their meat and liver oil were formerly consumed/used—are nowadays obsolete and prohibited.
- Trolls. Trolling fishing techniques are used for the capture of skipjack tuna (*Katsuwonus pelamis*) and tunas (Scombridae), and also for *M. fusca* and glasseye (*Heteropriacanthus fulgens*) and, to a lesser extent, for bluefish *Pomatomus saltatrix* (Pomatomidae), *X. gladius*, dolphinfishes (*Coryphaena hippurus*, and *C. equiselis*) (Coryphaenidae), and *S. viridensis*.
- Jigs. Within this category, hand-jigs are the most basic fishing gear, and three types of traditional jigs for benthic and benthopelagic cephalopods (also called squid-jigs) were identified, such as: jigs for the European squid (*Loligo vulgaris*), and *S. officinalis*; those for deep-water veined squid (*Loligo forbesi*); and particularly the most typical jigs for flying squids (four species of Ommastrephidae). Another modern modality is jig-fishing: jigging is the practice of fishing with a jig, a type of lure, generally targeting large-sized fish predators such us *M. fusca*, *E. marginatus*, *P. dentex*, common dentex (*Dentex dentex*), *D. gibbosus*, redbanded seabream (*Pagrus auriga*), *P. pagrus*, and *B. capriscus*. Lastly, there has been some experimenting with *taru-nagashi* techniques for the diamond squid (*Thysanoteuthis rhombus*) off Tenerife, however these methods have recently been prohibited in the Canary Islands.
- Fishing poles. Four types of traditional pole-and-line techniques (without reel) were witnessed. Poles for shore crabs (the intertidal lightfoot crab *Grapsus adscensionis*, and the subtidal grey rock crab *Plagusia depressa*) where the hook is wrapped in a piece of greased net or tow and used during the day. Poles for demersal fish species, generally practiced from shore targeting carangids (*P. dentex*, *T. ovatus*), serranids, priacanthids (*H. fulgens*), moronids (spotted seabass *Dicentrarchus punctatus*), sparids (mainly *Diplodus* spp.), kyphosids (Bermuda sea chub *Kyphosus sectatrix*), balistids (*B. capriscus*), mugillids, pomacentrids, and muraenids, among others. Specialized poles for *S. cretense* where the rod has a long flexible toe made with goat horn. Poles for tunids, with a rod 3 to 4 m in length, mainly targeting *K. pelamis*, and to a lesser extent *Thunnus*, *Coryphaena*, and *S. viridensis*.
- Longlines. Both vertical and horizontal bottom longlines deployed by boats were identified, mainly aiming to catch muraenids, phycids, morids, berycids, serranids, polyprionids, sparids, scorpaenids, and sebastids. Associated catch are houndsharks (Triakidae, three species) and European conger (*Conger conger*), among others. Two types of longlines were specialized for *M. merluccius* and for seabreams of the genus *Diplodus*. The former also catch berycids, gempylids, scorpaenids, sebastids, and dogfish sharks (Squalidae, two species of *Squalus*) as associated species. Longliners from mainland Spain operate seasonally with surface drifting longlines for swordfish and associated epipelagic species. Under a fleet exchange agreement, Madeiran longliners operate with specialized midwater drifting longlines for black scabbardfishes (Trichiuridae, two species of *Aphanopus*). These sets of catches are not registered as domestic fish landings.

8) Small-scale fish harvesting. A range of methods is applied. Manual harvesting (by bare hand or with the aid

of a simple scraper or gaff) is traditionally practiced for collecting intertidal and subtidal shellfish species, such as gastropods (several species of limpets *Patella*, two species of topshells *Phorcus*, periwinkle *Littorina striata*, red-mouth purpura *Stramonita haemastoma*, tritons *Charonia* spp., and abalone *Haliotis tuberculata*), bivalves (thorny oyster *Spondylus senegalensis*, and brown mussel *Perna perna*), echinoderms (four species of sea urchins), and crustaceans (eight species of brachyuran crabs: *Xantho* spp., *Pachygrapsus* spp. and *Percnon gibbesi*, rockpool prawn *Palaemon elegans*—all used as live bait, Azorean barnacle *Megabalanus azoricus*, and Atlantic goose barnacle *Pollicipes pollicipes*), however most of these shellfish species are currently protected. Small trawled diggers equipped with projecting prongs are used to gather sea urchins in some localities. A variety of harpoons and hooks are traditionally used for the capture of *O. vulgaris* and Muraenidae in the intertidal, and a specialized model (*vara* or *anzuelón*) is dedicated to *A. solandri* in the open sea around the westernmost islands.

Contribution analysis of the fishery landings. Artisanal fishery landings in the Canary Islands (in kg) in the period 2007–2018 in each environmental category are presented in Table 1. Expressed in an approximate number of metric tons (t), total fish landings ranged between 5560 t in 2007 and 15 466 t in 2016, a mean value of about 11 254 t · y^{-1}. Comparing the different environmental resource species: SHS landings reached a mean value of about 111 t (representing only 1% of total landings), DMF landed attained a mean value of about 1637 t with 16%, CPF reached about 1973 t with 18%, and lastly, OPF reached about 7533 t with 65% (Table 1).

In a second assessment, landings were calculated and expressed as the most fished family groups and species within each environmental category (Tables 2–7). Shellfish species landed between 2012 and 2018 appeared to be stabilized at around 125 t · y^{-1} in total, however, they reached near 145 t in 2009. The most fished groups were: pandalid shrimps (mean value of about 48.4 t · y^{-1}), brachyuran crabs (0.8 t · y^{-1}), and penaeoid prawns (0.8 t · y^{-1}), within the decapod crustaceans; and cephalopods (40.7 t · y^{-1}), and gastropods (20.6 t · y^{-1}), within the mollusks (Tables 2 and 3). A third analysis revealed the most harvested shellfish species as follows: *P. narval* (Pandalidae) with 42.1 t · y^{-1}, *O. vulgaris* (Octopodidae) with 33.4 t · y^{-1}, black limpet (*P. candei*) (Patellidae) with 13.4 t · y^{-1}, white limpet (*P. aspera*) (Patellidae) with 7.1 t · y^{-1}, *P. edwardsii* (Pandalidae) with 6.0 t · y^{-1}, and the remaining species or groups less than 1.2 t · y^{-1} (Table 3).

Regarding DMF resources, the most landed families were sparids (562.2 t · y^{-1}), scarids (197.7 t · y^{-1}), carangids (127.5 t · y^{-1}), muraenids (106.3 t · y^{-1}), berycids (98.3 t · y^{-1}), serranids (81.6 t · y^{-1}), merlucciids (67.7 t · y^{-1}), and haemulids (66.3 t · y^{-1}), with the maximum values generally attained in the biennium 2015–2016 (Table 4). The sharks/rays group, as a range of cartilaginous fish species with some of them currently endangered and prohibited, only reached 10.2 t · y^{-1}. The most fished species were: *S. cretense* (Scaridae) with 197.7 t · y^{-1}, *D. gibbosus* (Sparidae) with 112.1 t · y^{-1}, *P. pagrus* (Sparidae) with 102.8 t · y^{-1}, *B. splendens* (Berycidae) with 90.2 t · y^{-1}, *S. cantharus* (Sparidae) with 68.4 t · y^{-1}, *M. merluccius* (Merlucciidae) with 67.7 t · y^{-1}, Mediterranean moray (*Muraena helena*, Muraenidae) with 56.1 t · y^{-1}, rubberlip grunt (*Plectorhinchus mediterraneus*, Haemulidae) with 55.4 t · y^{-1}, *S. salpa* (Sparidae) with 51.6 t · y^{-1}, and *P. dentex* (Carangidae) with 45.4 t · y^{-1}. The remaining species resources—i.e. the large-eye dentex (*Dentex macrophthalmus*), *C. conger*, *P. erythrinus*, greater amberjack (*Seriola dumerili*), *S. viridensis*, *D. cadenati*, *S. hispidus*, black moray (*Muraena augusti*), *M. surmuletus*, *E. marginatus*, two-banded seabream (*Diplodus vulgaris*), *B. capriscus*, *H. dactylopterus*, longfin yellowtail (*Seriola rivoliana*), comber (*Serranus cabrilla*), *P. phycis*, *P. americanus*, Morocco dentex, blacktail comber (*Serranus atricauda*), *M. fusca*, red pandora (*Pagellus bellottii*), *T. ovatus*,

Table 1

Landings of the four main environmental categories of the Canary Islands artisanal fisheries within 2007–2018

Year	Shellfish	Demersal fish species	Coastal pelagic fish	Oceanic pelagic fish	Total
2007	61 665	1 243 891	1 112 301	3 088 150	5 506 007
2008	84 531	1 916 026	1 250 990	6 622 253	9 873 800
2009	144 775	2 202 154	1 627 141	5 097 748	9 071 817
2010	79 345	1 887 989	1 470 543	4 699 076	8 136 952
2011	86 919	1 751 278	2 091 856	6 672 396	10 602 449
2012	127 516	1 216 225	1 992 801	11 697 663	15 034 205
2013	115 036	1 261 441	2 458 810	7 138 716	10 974 003
2014	121 104	1 403 213	2 294 345	9 820 726	13 639 389
2015	134 068	1 685 855	2 433 157	7 383 576	11 636 657
2016	128 626	1 774 097	2 462 017	11 101 560	15 466 299
2017	114 334	1 676 619	2 482 763	9 569 966	13 843 683
2018	139 432	1 623 417	1 996 030	7 503 549	11 262 428
Mean [kg·y^{-1}]	111 446	1 636 850	1 972 729	7 532 948	11 253 974
Mean [%]	1	16	18	65	100

Table 2

Landings of the principal higher taxa of invertebrates of the Canary Islands artisanal fisheries within 2007–2018

Year	Landings [kg · y^{-1}]						
	SHS	Pandalidae	Penaeoidea	Brachyura	Cephalopoda	Gastropoda	Other
2007	61 665	20 977	48	36	36 445	4 098	61
2008	84 531	27 410	416	425	40 359	15 500	420
2009	144 775	56 021	1 031	386	65 812	21 442	82
2010	79 345	33 716	862	654	26 587	17 139	387
2011	86 919	44 293	972	1 257	27 008	13 383	6
2012	127 516	41 881	1 062	495	72 327	11 748	3
2013	115 036	46 807	1 213	734	46 759	19 523	0
2014	121 104	62 722	700	625	36 812	20 246	0
2015	134 068	67 293	446	1 098	37 139	28 089	3
2016	128 626	63 525	1 101	1 762	32 192	30 042	3
2017	114 334	54 726	546	1 427	27 176	30 368	90
2018	139 432	61 862	1 428	1 280	39 702	35 075	85
Total [kg]	1 337 351	581 233	9 827	10 179	488 320	246 652	1 141
Mean [kg · y^{-1}]	111 446	48 436	819	848	40 693	20 554	95

SHS = shellfish species, total.

Table 3

Landings of the principal target groups or species of invertebrates of the Canary Islands artisanal fisheries within 2007–2018

Year	Landings [kg · y^{-1}]						
	Narwal shrimp	Common octopus	Black limpet	White limpet	Striped soldier shrimp	Common cuttlefish	Brachyuran crabs
2007	19 129	23 002	3 380	718	1 595	1 743	36
2008	25 973	37 345	10 732	4 757	1 449	1 715	425
2009	49 420	54 364	11 677	9 765	6 574	2 041	386
2010	28 833	24 504	7 672	9 798	1 929	481	654
2011	39 486	22 475	8 283	5 094	4 807	598	1 257
2012	38 960	65 409	4 540	7 191	2 921	3 049	495
2013	39 735	43 490	12 768	6 730	7 011	1 125	734
2014	52 690	25 608	13 699	6 525	10 010	1 440	625
2015	60 888	24 367	20 017	7 988	6 402	633	1 098
2016	59 617	27 158	23 413	6 529	3 908	245	1 762
2017	46 058	23 241	21 700	8 317	8 668	547	1 427
2018	44 656	29 601	22 751	12 106	17 195	765	1 280
Total [kg]	505 446	400 565	160 633	85 517	72 468	14 381	10 179
Mean [kg · y^{-1}]	42 121	33 380	13 386	7 126	6 039	1 198	848

Narwal shrimp = *Plesionika narval*, common octopus = *Octopus vulgaris*, black limpet = *Patella candei*, white limpet = *Patella aspera*, Striped soldier shrimp = *Plesionika edwardsii*, common cuttlefish = *Sepia officinalis*, brachyuran crabs = *Chaceon affinis* and others.

P. acarne, two medusafishes (Centrolophidae), and *P. auriga*, among others—accounted between 45.3 t · y^{-1} and 1.3 t · y^{-1} (Table 5), with the houndsharks (Triakidae) yielding 8.9 t · y^{-1}.

The most fished CPF families were scombrids, clupeids, and carangids. At specific level, 11 fish species are traditionally exploited, and *S. colias* (Scombridae) with 797.9 t · y^{-1} reached by far the highest value, followed by *Trachurus* spp. (Carangidae) with 390.2 t · y^{-1}, *S. pilchardus* (Clupeidae) with 299.7 t · y^{-1}, *S. aurita* with 295.6 t · y^{-1} (Clupeidae), and *S. maderensis* with 112.9 t · y^{-1} (Clupeidae), among others (Table 6).

Lastly, concerning OPF resources, scombrids were by far the most fished family. Twelve species or groups are traditionally exploited, of these *K. pelamis* with 2994.5 t · y^{-1} and *T. obesus* with 2538.7 t · y^{-1} attained by far the highest weights, followed by *T. alalunga* with 1425.3 t · y^{-1}, *T. albacares* with 327.9 t · y^{-1}, *T. thynnus* with 95.0 t · y^{-1}, *A. solandri* with 54.8 t · y^{-1}, and Atlantic bonito (*Sarda sarda*) with 34.3 t · y^{-1} (all Scombridae), among others (Table 7).

Economic contribution of fisheries landings. Within each environmental resource category, the mean landings (kg · y^{-1}) for the most important species fished, their

Table 4

Landings of the principal higher taxa of finfish (demersal species) of the Canary Islands artisanal fisheries within 2007–2018 (part 1)

Year	Landings [kg · y⁻¹]									
	Sparidae	Scaridae	Carangidae	Muraenidae	Berycidae	Serranidae	Merlucciidae	Haemulidae	Congridae	Sphyraenidae
2007	509 995	155 004	102 470	98 722	41 971	36 014	12 970	58 190	23 614	28 394
2008	775 016	219 731	99 964	128 476	65 286	71 536	44 479	125 324	35 146	34 557
2009	896 509	182 339	128 627	130 056	83 502	107 099	90 643	148 755	58 510	33 485
2010	580 195	177 940	197 999	114 262	85 746	72 237	108 074	93 776	49 937	36 694
2011	656 522	161 144	143 434	118 355	95 184	67 437	47 594	137 462	50 601	42 827
2012	401 786	200 245	72 430	93 687	60 642	76 851	38 607	13 096	35 464	19 095
2013	374 510	192 085	107 732	103 325	89 323	87 524	18 126	11 864	27 075	52 318
2014	446 287	196 927	130 068	111 104	106 504	95 063	20 407	26 268	36 096	30 065
2015	602 021	214 112	144 113	118 602	121 548	96 820	23 607	79 433	54 649	31 531
2016	513 951	221 872	147 558	97 239	136 943	91 534	172 583	35 557	60 141	29 892
2017	492 376	221 164	153 907	86 577	125 949	92 590	133 996	34 237	54 060	46 684
2018	497 554	229 281	102 245	74 617	167 116	84 794	101 846	31 518	54 015	56 493
Total [kg]	6 746 722	2 371 844	1 530 547	1 275 022	1 179 714	979 499	812 932	795 481	539 309	442 036
Mean [kg · y⁻¹]	562 227	197 654	127 546	106 252	98 310	81 625	67 744	66 290	44 942	36 836

Table 5

Landings of the principal target groups or species of finfish (demersal species) of the Canary Islands artisanal fisheries within 2007–2018 (part 2)

Year	Landings [kg · y⁻¹]										
	DMF	Mediterr. parrotfish	Pink dentex	Red porgy	Splendid alfonsino	Black seabream	European hake	Mediterr. moray	Rubberlip grunt	Salema	White trevally
2007	1 243 891	155 004	40 998	100 487	35 948	82 837	12 970	43 291	46 903	64 740	16 669
2008	1 916 026	219 731	137 930	84 880	58 213	134 916	44 479	54 241	114 435	71 196	29 307
2009	2 202 154	182 339	166 978	112 849	76 390	160 884	90 643	69 522	141 143	67 243	26 861
2010	1 887 989	177 940	95 906	88 630	77 779	84 253	108 074	66 139	86 964	64 722	93 637
2011	1 751 278	161 144	116 409	117 579	86 419	93 479	47 594	68 311	130 617	46 596	24 314
2012	1 216 225	200 245	52 693	116 271	57 205	37 141	38 607	50 706	4 402	43 187	39 954
2013	1 261 441	192 085	87 038	103 355	80 397	22 502	18 126	61 515	2 253	40 675	35 175
2014	1 403 213	196 927	100 035	98 981	101 227	36 047	20 407	61 391	13 045	59 874	49 315
2015	1 685 855	214 112	133 692	113 810	113 161	70 405	23 607	65 616	64 323	44 986	49 267
2016	1 774 097	221 872	133 387	95 683	125 823	33 911	172 583	57 489	24 235	40 414	58 258
2017	1 676 619	221 164	140 471	89 859	115 488	29 280	133 996	49 701	22 953	35 446	55 068
2018	1 623 417	229 281	139 194	110 777	153 936	35 565	101 846	25 223	13 391	40 172	67 296
Total [kg]	19 642 204	2 371 844	1 344 730	1 233 161	1 081 986	821 220	812 932	673 145	664 663	619 250	545 123
Mean [kg·y⁻¹]	1 636 850	197 654	112 061	102 763	90 165	68 435	67 744	56 095	55 389	51 604	45 427

DMF = demersal fish species, total; Mediterr. parrotfish = *Sparisoma cretense*, pink dentex = *Dentex gibbosus*, red porgy = *Pagrus pagrus*, splendid alfonsino = *Beryx splendens*, black seabream = *Spondyliosoma cantharus*, European hake = *Merluccius merluccius*, Mediterr. moray = *Muraena helena*, rubberlip grunt = *Plectorhinchus mediterraneus*, salema = *Sarpa salpa*, white trevally = *Pseudocaranx dentex*.

Table 6

Landings of the principal target groups or species of finfish (coastal pelagic species) of the Canary Islands artisanal fisheries within 2007–2018

Year	Landings [kg · y⁻¹]											
	CPF	Chub mackerel	Horse mackerels	European pilchard	Round sardinella	Madeira sardinella	European anchovy	Bogue	Mackerel scads	Bullet tuna	Needle fishes	Sand smelt
2007	1 112 301	439 391	139 136	271 241	48 901	100 027	80 354	2 489	20 859	5 650	3 408	846
2008	1 250 990	545 876	157 192	118 813	133 563	202 966	22 468	15 110	45 715	5 410	2 794	1 083
2009	1 627 141	744 553	151 530	162 034	279 791	124 513	96 209	30 659	31 754	2 259	2 666	1 173
2010	1 470 543	707 907	129 254	215 679	228 834	121 625	27 529	26 373	3 451	7 006	2 028	857
2011	2 091 856	883 706	187 197	230 475	540 818	194 079	275	22 186	1 891	28 859	1 591	780
2012	1 992 801	742 189	299 717	259 656	503 414	105 170	53 484	19 476	0	9 394	300	0
2013	2 458 810	933 314	585 275	315 982	477 001	110 602	280	33 542	0	2 700	114	0
2014	2 294 345	855 224	492 508	293 545	419 748	124 399	58 414	40 211	35	10 190	71	0
2015	2 433 157	851 658	662 271	580 325	251 083	51 801	10 468	24 940	68	527	16	0
2016	2 462 017	723 399	730 854	537 941	266 464	81 169	99 468	21 107	121	1 413	80	0
2017	2 482 763	994 428	706 173	354 354	321 877	84 097	10 668	9 439	60	1 641	26	0
2018	1 996 030	1 152 557	441 554	256 691	76 200	54 866	4 183	8 501	377	1 076	26	0
Total [kg]	23 672 753	9 574 203	4 682 662	3 596 735	3 547 694	1 355 313	463 799	254 033	104 330	76 125	13 119	4 739
Mean [kg·y⁻¹]	1 972 729	797 850	390 222	299 728	295 641	112 943	38 650	21 169	8 694	6 344	1 093	395

CPF = coastal pelagic fish species, total; chub mackerel = *Scomber colias*, horse mackerels = *Trachurus* spp., European pilchard = *Sardina pilchardus*, round sardinella = *Sardinella aurita*, Madeira sardinella = *Sardinella maderensis*, European anchovy = *Engraulis encrasicolus*, bogue = *Boops boops*, mackerel scads = *Decapterus* spp., bullet tuna = *Auxis rochei*, needlefishes = *Belone belone* and *Tylosurus acus*, sand smelt = *Atherina presbyter.*

Table 7

Landings of the principal target groups or species of finfish (oceanic pelagic fish species) of the Canary Islands artisanal fisheries within 2007–2018

Year	Landings [kg · y⁻¹]												
	OPF	Skipjack	Bigeye	Albacore	Yellowfin	Bluefin	Wahoo	Swordfish	Bonito	Sharks	Dolphinfishes	Marlins	Little tunny
2007	3 088 150	823 672	1 706 241	211 927	180 097	59 366	59 473	7 145	15 349	22 866	939	1 074	0
2008	6 622 253	3 520 146	1 822 000	728 507	349 002	12 220	42 428	12 712	106 215	22 020	697	5 443	864
2009	5 097 748	1 549 102	3 060 333	48 816	256 045	1 447	79 485	6 739	63 665	9 074	2 544	6 719	13 779
2010	4 699 076	1 523 318	1 775 102	419 265	825 126	13 968	58 109	34 266	20 913	15 851	6 321	6 839	0
2011	6 672 396	1 328 383	3 363 910	341 574	1 293 242	52 625	77 374	158 521	21 514	29 795	2 642	2 392	425
2012	11 697 663	7 571 349	2 268 704	1 601 116	73 970	53 529	36 205	70 160	12 906	4 793	1 401	3 389	142
2013	7 138 716	3 246 000	2 202 798	1 154 992	216 532	137 735	54 659	45 656	49 081	25 366	1 744	4 155	0
2014	9 820 726	4 303 792	2 839 064	2 401 667	58 315	66 692	38 982	72 277	28 548	3 991	2 503	4 897	0
2015	7 383 576	1 456 383	2 935 829	2 733 319	69 301	119 099	40 478	1 653	17 451	145	9 306	613	0
2016	11 101 560	2 876 784	2 802 863	4 970 321	223 489	139 843	53 116	18	29 365	66	4 812	882	0
2017	9 569 966	3 360 798	3 228 352	2 397 408	282 268	176 316	44 203	50 776	24 860	1 335	2 934	706	9
2018	7 503 549	4 374 396	2 458 824	94 205	107 144	307 042	73 337	44 074	21 287	14 327	8 879	35	0
Total [kg]	90 395 381	35 934 123	30 464 020	17 103 117	3 934 532	1 139 881	657 846	503 997	411 153	149 628	44 723	37 143	15 219
Mean [kg·y⁻¹]	7 532 948	2 994 510	2 538 668	1 425 260	32 7878	94 990	54 820	42 000	34 263	12 469	3 727	3 095	1 268

OPF = oceanic pelagic fish species, total; skipjack = *Katsuwonus pelamis*, bigeye = *Thunnus obesus*, albacore = *Thunnus alalunga*, yellowfin = *Thunnus albacares*, bluefin = *Thunnus thynnus*, wahoo = *Acanthocybium solandri*, swordfish = *Xiphias gladius*, bonito = *Sarda sarda*, sharks = several families, dolphinfishes = *Coryphaena* spp., marlins = Istiophoridae gen. sp., little tunny = *Euthynnus alletteratus*.

first-sale reference prices [€ · kg^{-1}] and mean economic contribution [€] for the period 2014–2018 are presented in Table 8. The four categories—i.e., all the around 200 marine species commercially exploited by fishing activity in the Canaries—yielded just over €74.03 million per year at first-sale (within the primary sector only).

Ten fishery species or groups were assessed within the SHS category, which accounted for just over €2 million per year, of these *P. narval* contributed €79 1730 per year, *O. vulgaris* €59 7887 per year, *P. edwardsii* €254 006 per year, and *P. candei* €172 687 per year. Sixty-two DMF species/groups yielded just over €21.6 million per year, notably with *S. cretense* contributing €3.25 million per year, *D. dentex* €1.94 million per year, *B. splendens* €1.83 million per year, *M. merluccius* €1.81 million per year, and *P. pagrus* about €1.53 million per year. Nine CPF species/groups contributed €13.6 million per year, with *S. colias* €5.49 million per year, *S. pilchardus* €3.24 million per year, *Trachurus* spp. just over €2.73 million per year, and *S. aurita* €1.47 million per year. Lastly, twelve OPF species/groups accounted for just over €36.8 million per year, with *T. alalunga* near €13.86 million per year, *T. obesus* €12.84 million per year, and *K. pelamis* €6.88 million per year (Table 8, mostly approximate figures).

In Table 9, the Canary Islands' mean GDP is compared with a mean economic contribution by the local fisheries (in millions of €) at first-sale for the period 2014–2018. The mean impact/contribution [%] of small-scale fisheries was initially 0.17%, just as the primary sector.

DISCUSSION

Components of artisanal fisheries. Around the world, small-scale fisheries generally operate using low capital investment in boat and equipment per fisher on board. Nonetheless, artisanal fishing in the Canary Islands is not a subsistence activity, but a series of activities capable of generating significant economic exchanges.

Although such fishing vessels frequently operate with a great variety of techniques, versatility or polyvalence is the fundamental characteristic of the Canary fleet. It is trained and equipped to rotate among fisheries according to the spatial and seasonal availability of the highly varied fishing resources.

Biodiversity direct- or indirectly targeted by multi-species artisanal fishing boats in waters of the Canary Islands throughout the 2007–2018 period involved an average of 200 species, as corresponds to a volcanic archipelago nestled in a temperate-subtropical region. About 24 of them were shellfish species (around 11 crustaceans and 13 mollusks), 148 demersal fish species (including both benthic and benthopelagic forms), 10 small and medium-sized coastal pelagic fishes, and 18 large-sized oceanic pelagic fishes. When the period between 2007 and 2011 was analyzed, the exploited species were about 240. The use of echinoderms (sea urchins) and cnidarians (anemones) is currently anecdotal in the Canaries, but some pressure from Asian operators is being noted, particularly towards sea cucumbers and sea urchins. As usual in artisanal fisheries, there are practically no discarded species. However, the return to the sea of individuals of non-commercial or protected species (e.g. some rays and skates) or small individuals is frequent, but some of them are used by fishermen as bait (e.g., hermit crabs *Dardanus* spp.) or for their own consumption.

In the last 40 years, due to the increasing fishing power of the professional fleet and also to an intense activity of recreational fishing, some fish and shellfish resources have been overexploited. This has motivated the implementation of protection and conservation regulations—promulgated by European, Spanish and/or Canary regulatory bodies—that, in most cases have implied the prohibition of fishing and marketing of certain endangered species. In addition, the amount and frequency with which some marine resources—especially coastal shellfish species—are subject to poaching by the Canarian population is not negligible, since most of the islands' coastal perimeter is accessible and the region has always had insufficient means of surveillance. This complex situation acquires greater importance in the framework of a small volcanic archipelago with fragile limited marine ecosystems. There are many examples of species that have been the target of artisanal fishing or harvesting by the Canary islanders; three groups can be distinguished:

- Species formerly protected: *S. latus*;
- species currently protected and banned from capture: *P. elephas*, brown spiny lobster (*Panulirus echinatus*), *S. haemastoma*, *Charonia* spp., *H. tuberculata*, Canary limpet (*Patella candei*), *S. senegalensis*, and rough pen shell (*Pinna rudis*), within the shellfishes, and Canary moray (*Gymnothorax bacalladoi*), goldentail moray (*Gymnothorax miliaris*), ballan wrasse (*Labrus bergylta*), brown meagre (*Sciaena umbra*), some rays and skates, angel shark (*Squatina squatina*), and some large-sized pelagic sharks (threshers, hammerheads and makos), within the fishes; and
- currently protected by spatial closure: *P. pollicipes*, *M. azoricus*, and *P. perna*. Since 2012, catches of *A. presbyter* cannot be commercialized as they were traditional; it can only be used as bait for tuna fishing, generally live.

Contribution by weight of fisheries landings. Between 2011 and 2018, total fish landings ranged between 10 602 t in 2011 and 15 466 t in 2016, stabilizing around 13 000 t · y^{-1}, with a mean value of about 11 254 t for the 2007–2018 study period (Table 1).

Within the SHS resources, landings of both pandalid shrimps and patellid limpets seem to show a clear increase. *P. narval* landings reached a maximum in 2014–2016 with about 61 t in 2015, and the species has potential for development since it is practically only targeted around the western islands, mainly Tenerife. *P. edwardsii* reached its maximum landings in 2018 with 17.2 t, and clearly has potential for increase because it is mainly caught off the eastern islands and chiefly in Lanzarote. Moreover, this latter resource was preliminarily assessed at about 80 t · y^{-1} (maximum sustainable yield) for the entire archipelago (González et al. 2010). *P. candei* attained a maximum landing in 2015–2018 with about 23.4 t in 2016, while

Table 8

Mean landings of the Canary Islands artisanal fisheries for the most important species (or environmental categories) caught within 2014–2018, their first-sale reference prices, and mean economic contribution

FISHERIES RESOURCE							
Spanish vernacular name (Canary Islands)	English vernacular name	Scientific name	Higher taxon	Mean landings [kg·y^{-1}]	Reference price at first sale [€·kg^{-1}]	Mean economic contribution [€·y^{-1}]	%
Mariscos	Shellfish						
Camarón (narval)	Narwal shrimp	*Plesionika narval*	Pandalidae	52 782	15.00	791 730	
Pulpo	Common octopus	*Octopus vulgaris*	Octopodidae	25 995	23.00	597 887	
Camarón soldado	Striped soldier shrimp	*Plesionika edwardsii*	Pandalidae	9 237	27.50	254 006	
Lapa negra	Black limpet	*Patella candei*	Patellidae	20 316	8.50	172 687	
Calamares y potas	Squids	*Loligo* spp.	Loliginidae etc.	7 883	14.50	114 306	
Lapa blanca	White limpet	*Patella aspera*	Patellidae	8 293	7.50	62 197	
Cangrejos (rey y otros)	Brachyuran crabs	*Chaceon affinis* etc.	Geryonidae etc.	1 238	12.50	15 481	
Choco	Common cuttlefish	*Sepia officinalis*	Sepiidae	726	10.00	7 260	
Burgados	Topshells	*Phorcus* spp.	Trochidae	155	6.50	1 007	
Otros	Other species			888	10.00	8 878	
					SUB-TOTAL	2 025 437	2.73
Pescado demersal	Demersal fish species						
Vieja	Mediterranean parrotfish	*Sparisoma cretense*	Scaridae	216 671	15.00	3 250 069	
Sama de pluma	Pink dentex	*Dentex gibbosus*	Sparidae	129 356	15.00	1 940 338	
Fula de altura, alfonsiño	Splendid alfonsino	*Beryx splendens*	Berycidae	121 927	15.00	1 828 905	
Merluza (europea)	European hake	*Merluccius merluccius*	Merlucciidae	90 488	20.00	1 809 754	
Bocinegro, pargo	Red porgy	*Pagrus pagrus*	Sparidae	101 822	15.00	1 527 328	
Jurel (de aleta amarilla)	White trevally	*Pseudocaranx dentex*	Carangidae	55 841	15.00	837 615	
Medregal limón	Greater amberjack	*Seriola dumerili*	Carangidae	36 527	20.00	730 533	
Mero	Dusky grouper	*Epinephelus marginatus*	Serranidae	33 882	20.00	677 647	
Antoñito	Large-eye dentex	*Dentex macrophthalmus*	Sparidae	58 465	10.00	584 654	
Morena pintada	Mediterranean moray	*Muraena helena*	Muraenidae	51 884	10.00	518 841	
Chopa	Black seabream	*Spondyliosoma cantharus*	Sparidae	41 042	10.00	410 415	
Medregal negro	Longfin yellowtail	*Seriola rivoliana*	Carangidae	20 472	20.00	409 441	
Breca	Common pandora	*Pagellus erythrinus*	Sparidae	39 234	10.00	392 335	
Congrio	European conger	*Conger conger*	Congridae	51 792	7.50	388 442	
Cabrilla reina	Comber	*Serranus cabrilla*	Serranidae	24 966	15.00	374 490	
Brota, agriote	Forkbeard	*Phycis phycis*	Phycidae	24 589	15.00	368 829	
Gallito verde	Planehead filefish	*Stephanolepis hispidus*	Monacanthidae	33 414	10.00	334 141	
Bocanegra	Blackbelly rosefish	*Helicolenus dactylopterus*	Sebastidae	29 709	10.00	297 091	
Bicuda	Yellowmouth barracuda	*Sphyraena viridensis*	Sphyraenidae	38 933	7.50	291 998	

Table continues on next page.

Table 8 cont.

FISHERIES RESOURCE				Mean landings [kg·y⁻¹]	Reference price at first sale [€·kg⁻¹]	Mean economic contribution [€·y⁻¹]	%
Spanish vernacular name (Canary Islands)	English vernacular name	Scientific name	Higher taxon				
Gallo cochino	Grey triggerfish	*Balistes capriscus*	Balistidae	27 935	10.00	279 348	
Burro costero	Rubberlip grunt	*Plectorhinchus mediterraneus*	Haemulidae	27 589	10.00	275 893	
Cherne romerete	Wreckfish	*Polyprion americanus*	Polyprionidae	13 711	20.00	274 221	
Sargo (blanco)	White seabream	*Diplodus cadenati*	Sparidae	26 682	10.00	266 820	
Morena negra	Black moray	*Muraena augusti*	Muraenidae	26 512	10.00	265 121	
Abade	Island grouper	*Mycteroperca fusca*	Serranidae	14 872	17.50	260 261	
Salmonete	Surmullet	*Mullus surmuletus*	Mullidae	16 288	15.00	244 324	
Cabrilla negra	Blacktail comber	*Serranus atricauda*	Serranidae	15 598	15.00	233 963	
Salema	Salema	*Sarpa salpa*	Sparidae	44 178	5.00	220 891	
Seifía	Two-banded seabream	*Diplodus vulgaris*	Sparidae	19 911	10.00	199 114	
Fula ancha, tableta	Alfonsino	*Beryx decadactylus*	Berycidae	9 685	20.00	193 697	
Sama roquera/catalineta	Redbanded seabream	*Pagrus auriga*	Sparidae	12 380	15.00	185 697	
Medregal, blanquilla	Lesser amberjack	*Seriola fasciata*	Carangidae	7 415	20.00	148 295	
Palometa blanca	Pompano	*Trachinotus ovatus*	Carangidae	14 545	10.00	145 451	
Cazones	Houndsharks	*Mustelus* spp., *Galeorhinus galeus*	Triakidae	9 762	12.50	122 027	
Burrito listado	African striped grunt	*Parapristipoma octolineatum*	Haemulidae	10 996	10.00	109 963	
Besuguito	Axillary seabream	*Pagellus acarne*	Sparidae	9 750	9.00	87 754	
Pejeperro	Barred hogfish	*Bodianus scrofa*	Labridae	7 507	10.00	75 068	
Cantarero	Red scorpionfish	*Scorpaena scrofa*	Scorpaenidae	4 775	15.00	71 628	
Merluza canaria	Common mora	*Mora moro*	Moridae	6 557	10.00	65 569	
Garapello	Red pandora	*Pagellus bellottii*	Sparidae	6 389	9.00	57 502	
Sargo breado	Zebra seabream	*Diplodus cervinus*	Sparidae	5 680	10.00	56 800	
Pámpanos	Medusafishes	*Hyperoglyphe perciformis, Schedophilus ovalis*	Centrolophidae	3 268	15.00	49 023	
Gallo plateado	Silvery John dory	*Zenopsis conchifer*	Zeidae	5 773	7.50	43 298	
Sama dorada/guachilanga	Common dentex	*Dentex dentex*	Sparidae	2 569	15.00	38 534	
Gallo cristo, gallo barbero	John dory	*Zeus faber*	Zeidae	2 342	15.00	35 130	
Verrugatos, burrogatos	Drums	*Umbrina canariensis, Umbrina ronchus*	Sciaenidae	3 483	10.00	34 828	
Peje candil	Black cardinal fish	*Epigonus telescopus*	Epigonidae	2 887	12.00	34 650	
Salmón de hondura, lirio	Stout beardfish	*Polymixia nobilis*	Polymixiidae	3 110	10.00	31 096	

Table continues on next page.

Table 8 cont.

FISHERIES RESOURCE				Mean landings [kg·y⁻¹]	Reference price at first sale [€·kg⁻¹]	Mean economic contribution [€·y⁻¹]	%
Spanish vernacular name (Canary Islands)	English vernacular name	Scientific name	Higher taxon				
Pejerrey, anjova	Bluefish	*Pomatomus saltatrix*	Pomatomidae	4 087	7.50	30 649	
Herrera	Sand steenbras	*Lithognathus mormyrus*	Sparidae	2 758	9.00	24 818	
Dentón, calé	Morocco dentex	*Dentex maroccanus*	Sparidae	2 473	10.00	24 730	
Sargo picudo, morruda	Sharpsnout seabream	*Diplodus puntazzo*	Sparidae	2 466	10.00	24 656	
Escolar	Oilfish	*Ruvettus pretiosus*	Gempylidae	4 655	5.00	23 273	
Peje tostón, japuta	Atlantic pomfret	*Brama brama*	Bramidae	1 912	10.00	19 120	
Galana	Saddled seabream	*Oblada melanura*	Sparidae	3 745	5.00	18 725	
Obispo, volón	Offshore rockfish	*Pontinus kuhlii*	Scorpaenidae	1 783	10.00	17 830	
Catalufa	Glasseye	*Heteropriacanthus fulgens*	Priacanthidae	2 052	8.00	16 418	
Roncador	Bastard grunt	*Pomadasys incisus*	Haemulidae	2 817	5.00	14 085	
Fulas (de orilla)	Damselfishes	*Chromis limbata, Similiparma lurida*	Pomacentridae	2 388	5.00	11 942	
Gallo aplomado/oceánico	Ocean triggerfish	*Canthidermis sufflamen*	Balistidae	1 343	8.00	10 744	
Lenguado negro/rabudo	Bastard sole	*Microchirus azevia*	Soleidae	1 244	8.00	9 953	
Chopa perezosa, chopón	Bermuda sea chub	*Kyphosus sectatrix*	Kyphosidae	957	5.00	4 783	
Otros	Other species			34 798	8.00	278 385	
					SUB-TOTAL	21 608 940	29.19
Pescado pelágico costero	Coastal pelagic fish species						
Caballa	Atlantic chub mackerel	*Scomber colias*	Scombridae	915 453	6.00	5 492 720	
Sardina (de ley)	European pilchard	*Sardina pilchardus*	Clupeidae	404 571	8.00	3 236 568	
Chicharros	Horse mackerels	*Trachurus* spp.	Carangidae	606 672	4.50	2 730 024	
Alacha	Round sardinella	*Sardinella aurita*	Clupeidae	267 075	5.50	1 468 910	
Boquerón, longorón	European anchovy	*Engraulis encrasicolus*	Atherinidae	36 640	8.00	293 120	
Machuelo, arenque	Madeira sardinella	*Sardinella maderensis*	Clupeidae	79 266	3.50	277 432	
Boga	Bogue	*Boops boops*	Sparidae	20 840	3.50	72 939	
Melva	Bullet tuna	*Auxis rochei*	Scombridae	2 969	3.25	9 651	
Otros	Other species			176	4.50	791	
					SUB-TOTAL	13 582 156	18.35
Pescado pelágico oceánico	Oceanic pelagic fish species						
Barrilote, bonito del norte	Albacore	*Thunnus alalunga*	Scombridae	2 519 384	5.50	13 856 611	
Tuna, atún	Bigeye tuna	*Thunnus obesus*	Scombridae	2 852 986	4.50	12 838 439	
Bonito listado	Skipjack tuna	*Katsuwonus pelamis*	Scombridae	3 274 431	2.10	6 876 305	
Patudo, atún rojo	Bluefin tuna	*Thunnus thynnus*	Scombridae	161 798	10.00	1 617 983	
Rabil, atún aleta amarilla	Yellowfin tuna	*Thunnus albacares*	Scombridae	148 103	5.00	740 517	

Table continues on next page.

Table 8 cont.

FISHERIES RESOURCE							
Spanish vernacular name (Canary Islands)	English vernacular name	Scientific name	Higher taxon	Mean landings [kg·y⁻¹]	Reference price at first sale [€·kg⁻¹]	Mean economic contribution [€·y⁻¹]	%
Aguja paladar, pez espada	Swordfish	*Xiphias gladius*	Xiphidae	33 760	15.00	506 395	
Peto	Wahoo	*Acanthocybium solandri*	Scombridae	50 023	5.25	262 620	
Sierra, corrigüela	Atlantic bonito	*Sarda sarda*	Scombridae	24 302	2.50	60 755	
Tiburones	Sharks			3 973	10.00	39 728	
Dorados	Dolphinfishes	*Coryphaena* spp.	Coryphaenidae	5 687	2.00	11 374	
Picudos, agujas	Marlins	*Makaira nigricans*	Istiophoridae	1 427	4.00	5 706	
Albacoreta, bacoreta	Little tunny	*Euthynnus alletteratus*	Scombridae	2	3.25	6	
					SUB-TOTAL	36 816 440	49.73
					TOTAL	74 032 973	100

P. aspera reached its maximum in 2018 with 12.1 t. Both species are subject to intense extractive pressure by professionals, recreationals, and poachers. The landings of the remaining SHS groups (penaeoid prawns, brachyuran crabs, and cephalopods) showed no clear any annual trend and their figures may indicate environmental and/or fishing effort variations (Tables 2 and 3).

Regarding DMF species, more than 30 fish families were targeted in accordance with the enormous complexity of marine ecosystems in temperate-subtropical latitudes, explaining the vast panoply of artisanal fishing techniques necessary for their exploitation. At the species level, landings of *S. cretense*—by far the most captured demersal species—seem stabilized near 200 t · y^{-1}. A comparable pattern was observed for *D. gibbosus*, *P. pagrus*, *C. conger*, *E. marginatus*, and *S. atricauda*, among others. An increasing trend was found for *B. splendens* (maximum value in 2018), *P. dentex* (but still far from its peak in 2010), *S. viridens*, *B. capriscus*, *H. dactylopterus*, barred hogfish (*Bodianus scrofa*), and African striped grunt (*Parapristipoma octolineatum*). There was a decreasing trend for *M. helena*, *D. cadenati*, *S. hispidus*, *D. vulgaris*, Morocco dentex (*Dentex maroccanus*), *S. atricauda*, *P. bellottii*, Triakidae, and *D. dentex*, and perhaps for *S. salpa* and *M. surmuletus*. The significant decline in recent years of *Seriola* spp. landings and *P. americanus* could be explained by the recent increase in their large individuals, which causes ciguatera fish poisoning (Tables 4 and 5).

However, in the particular case of these demersal species, the observed trends could reflect, in some cases, a fishing activity situation well-focused on certain seafood products as a direct response to market demand, while other species are temporarily "forgotten" by the local market.

In the case of CPF resources, more than 10 fish species were targeted due to the fact the Canary Islands is an offshore archipelago placed in the middle of the Canary Current LME. It is striking that landings of *S. colias* — the only *Scomber* occurring around the Canaries— exceed the total for the three clupeids concerned (*S. pilchardus* and the two *Sardinella* species). They also exceed the total for the varied *Trachurus* exploited, with seasonal and interannual oscillations related to oceanographic conditions (Jurado-Ruzafa et al. 2019). It is necessary to clarify that the latter landings were of mainly *T. picturatus* spread among all the islands and to a much lesser extent *T. trachurus* from the easternmost islands Fuerteventura and Lanzarote, near the African continent. *E. encrasicolus* has great potential in Canary Island waters and the low figures recorded in 2001 and 2013 reflected non-activity of the fleet due to a restrictive minimum landing size applied in all EU fishing grounds. The irregular landings of the tropical *Decapterus macarellus* and *D. punctatus* could be explained in the current scenario of regional tropicalization of fish assemblages in temperate biogeographic transition zones, including Macaronesia (e.g., González-Lorenzo et al. 2010, Afonso et al. 2013). Nevertheless, it is difficult to estimate their real importance in the landings, since

Table 9

Mean economic contribution (in million € and %) of the Canary Islands artisanal fisheries as primary sector, including main (landings) and secondary contributions (catches for bait), compared to regional GDP and tourist industry in the period of 2014–2018.

Year / period	Canary Islands regional GDP [M€]	Artisanal fisheries economic contribution [M€]	Artisanal fisheries contribution [%]	Tourist industry economic contribution [M€]	Tourist industry economic contribution [%]
2018	45 720			16 099	35.00
2017	44 251			15 573	35.20
2016	42 014			14 499	34.10
2015	40 566			13 268	32.40
2014	39 267			12 361	31.00
Mean 2014–2018	42 364	74	**0.17**	14 360	33.54
Other economic contributions from local fisheries					
Harvesting of littoral crabs to be used as bait			0.005		
Fishing of cephalopods to be used as bait			0.005		
Fishing of small CPF to be used as bait			0.010		
Artisanal fisheries TOTAL contribution [%]			**0.19**		

GDP = gross domestic product; CPF = coastal pelagic fishes

they are frequently labeled or assigned as belonging to *Trachurus* spp. (González-Lorenzo et al. 2010) (Table 6). The tropicalization process is also valid to justify the occurrence of several tropical jacks (*Caranx* spp.) in Canary waters. We have considered them as demersal forms since they are mainly fished near the bottom by handlines.

Another aspect is that the annual availability of the different types of bait influences the catch volume of the different demersal fish species. For example, years with good catches of sardines, cephalopods, or shrimps are reflected in good catches of demersals such as pink dentex, amberjacks, or scorpionfish. Therefore, there is a direct relation between landings of coastal pelagic and demersal fish, and particularly between those of oceanic pelagics and demersals. Indeed, in a good tuna season, a significant fraction of the versatile demersal fish fleet diverts effort towards tunas. Consequently, in the artisanal fisheries context, landings of hook-caught species are not in themselves an accurate indicator of the abundance of targeted fish species in the fishing ground concerned.

Lastly, 12 OPF species or groups were exploited traditionally, since Canary Islands waters are exceptionally well-located on the migratory route of tunas with both temperate and tropical affinities. It is striking but expected that landings of both *K. pelamis* and *T. obesus* exceed the total of the other three true tuna (*Thunnus*). Since it is only fished around the westernmost islands, the landings of *A. solandri* have a potential to increase, but the ciguatera hosted by its large individuals has somewhat slowed its catches (Table 7).

Economic contribution of fisheries landings. Within SHS species, traditional coastal resources such as *P. narval*, *O. vulgaris* and *Patella* (two species), and to a lesser extent benthopelagic squids and flying squids, yielded most economic value (Table 8). In addition, as a result of recent research (selective fishing techniques, prospection, and stock evaluation) on mid- and deep-water complementary resources, *P. edwardsii*, and to a lesser extent *C. affinis*, are progressively more in demand as high-priced gourmet products (Table 8). Both limpets are harvested on all coasts of the archipelago. *Plesionika narval* is mainly fished around the western islands (chiefly Tenerife), *O. vulgaris* and *C. affinis* mainly off Gran Canaria; and *P. edwardsii* mainly off Lanzarote. In all, the economic contribution of shellfish (€2 025 437 per year) (Table 8) represents 2.74% of the total. Additionally, on all islands, some littoral brachyurans and cephalopods are caught to provide bait (live or dead) for demersal fisheries with handlines. As such they are not computed in the landing statistics.

Among the DMF species, *S. cretense* contributed €3.25 million per year. Two more coastal species, *D. gibbosus* and *P. pagrus*, jointly yielded near €3.47 million per year. Two deep-water species, *B. splendens* and *M. merluccius*, provided €3.64 million per year (Table 8). *Sparisoma cretense* is fished all around the archipelago's coasts; *D. gibbosus* and *P. pagrus* are caught with a similar distribution pattern, but mainly around Gran Canaria. *Beryx splendens* is chiefly fished off Fuerteventura, El Hierro, Gran Canaria, and La Palma, while *M. merluccius* is mainly caught off Lanzarote and Fuerteventura. The set of 62 demersal species included amounted to €21 608 940 per year (Table 8), 29.19% of the total economic contribution.

Looking at the CPF species, *S. colias* contributed about €5.49 million per year, three clupeids yielded together near €5.0 million per year and horse mackerels accounted for just over €2.73 million per year (Table 8). The encircling fisheries addressed to these coastal pelagic species are mostly around Gran Canaria and Tenerife. In all, the economic contribution of the coastal pelagic species (€13 582 156 per year) (Table 8) represents 18.35% of the total. On all islands, a fraction of these catches (not computed in the landing statistics) is used as live or dead bait in tuna fisheries with pole-and-line and in demersal fisheries with handlines.

Lastly, within the OPF species, the temperate-affinity *T. alalunga* and tropical-affinity *T. obesus* jointly provided just over €36.8 million per year, and *K. pelamis*, historically the most fished species in Canary waters, accounted for nearly €6.9 million per year (Table 8). The twelve target species or groups within this category are considered highly migratory forms, therefore their catches usually show certain fluctuations, according to oceanographic and hydrological variations on a long and medium scale. Furthermore, the recent use of sophisticated fish-aggregating devices (FAD) off the northwest-African coasts is altering their migration routes and decreasing the volume of available stocks as they pass through the Canary Islands. In all, the economic contribution of oceanic pelagic species (€36 816 440 per year) (Table 8) represents 49.73% of the total.

As a primary sector activity, the Canary Islands' artisanal fishing makes an average economic contribution of just over €74 million per year at first-sale. As expected, comparing this with the regional economy for the 5-year period 2014–2018 reveals it represents 0.17% of GDP (Table 9). At the other end of the scale, the Canary tourism industry contributed 33.5% of GDP for the same assessment period (Table 9).

However, other economic contributions by local fisheries need to be considered. These consist of catches not registered as official landings but essential for many subsequent professional fishing operations, as above mentioned, i.e., bait supply (generally live) for both demersal and oceanic pelagic fish species. These economic contributions assigned to each fishing modality and species targeted are:

- harvesting of littoral brachyuran crabs (0.005%);
- cephalopod fishing (0.005%); and
- a fraction of coastal pelagic fish individuals caught in regular fishing activity (0.01%)

(Table 9). Usually, crabs are kept alive in the refrigerator, while cephalopods and fish are acclimatized on board inside a tank specially prepared for keeping live bait. In all, the total economic contribution of the Canary Islands small-scale fisheries, as a primary sector, is thus more exactly 0.19% of the regional GDP.

The official regional government agencies do not provide disaggregated data on local fisheries in relation to the primary sector as a whole. However, according to the present results and authors' experience, the Canaries' small-scale fisheries are highly dynamic, labor-intensive, well-integrated with local marketing frameworks. Moreover, when this fishing activity (fishermen + fleet + fish stocks) is considered together with other local socioeconomic sectors within the added-value chain of seafood (transformation, commercialization, services, supplies, bait, public aquariums, etc.), it makes a welcome contribution to the regional economy.

Current and potential threats to the artisanal fisheries in the Canary Islands. During the last 40 years, overexploitation of fish and shellfish stocks has been the biggest problem to solve. Empirical evidence of overfishing is lowered fishing yields (in terms of catch-per-unit-effort) and also the reduced sizes commonly caught. How have fishermen dealt with this problem? Advocating a more rational activity that favors the recovery of stocks? Evidently not, they have increased the fishing effort, while the responsible administrations have looked the other way. Additionally, as pointed out in the present results and discussion a decreasing pattern is observed in the landing statistics for some key resources.

At this point, it is worth highlighting the traditional disunity among fishermen and their insufficient culture of cooperativism and collaborative work. On the other hand, fishermen have usually preferred to negotiate with the administrations and have not been too interested in scientific advice, except when this favors their bargaining positions or directly benefits their short-term interests.

Other palpable added problems permanently found in the region are poaching and the competition exerted by intense and growing recreational fishing activity (González et al. 2012b). These are not minor issues. Added to this situation is the fact that the region's fisheries surveillance service has always been short of human and material resources, and governed by an ineffective administrative scheme. Another aspect to assess is a competition between different fishing techniques, which affects the common fishery resources they target.

This scenario is also dominated by the local tourist industry, altogether forming perhaps the largest holiday destination in EU territory. Consequently, coastal habitat degradation and pollution disrupt the marine ecosystem, through land runoff, ship pollution, noise, light, eutrophication, plastic debris, traditional or emerging chemical pollutants, etc. These other anthropogenic impacts exacerbate the generalized overfishing.

The authors have identified other threat factors affecting Canary fishing activity. There is a double jurisdiction of territorial waters. The internal waters of each island are those included between the coastline and the lines connecting geographical prominences and are the legal competence of the Canary autonomous region. External waters beyond these limits are the responsibility of the Spanish state. This hinders traditional fishing activity, together with prohibitions (not always technically or scientifically justified) that restrict some types of artisanal fishing or the Minimum Landing Size (MLS) applicable to individuals captured from the widely varied target species. It is worth highlighting the following two examples. Harvesting the threatened Canary mussel is currently only prohibited on the coasts of the island of Fuerteventura, where it can be considered as a resource due to its abundance, but any fisherperson (professional or recreational) can collect it on any of the other islands, where only small isolated populations survive. Several species important in fishing activity have a different MLS for internal and external waters, or otherwise, this has only been regulated for the external waters by national or European legislation. Such anomalies affect fishing operations targeting the red porgy, large-eye dentex, black seabream, axillary seabream, comber, black comber, yellowmouth barracuda, and black moray, among other demersal fish resources, and the European pilchard and bogue within coastal pelagic species.

The construction and expansion of large port infrastructures manifested in the lengthening of the docks, increasing of offshore anchorage areas, and passage/navigation easements, all hinder fishing, particularly traditional operations. This occurs especially around the most populated islands Tenerife and Gran Canaria (see Triay-Portella et al. 2015). The Canary Islands are geographically located on a very important maritime route, and both ships and oil platforms have been recognized as major vectors for the introduction of non-native species (González et al. 2012a, Triay-Portella et al. 2015). Intensification of heavy port traffic is bringing tropical species (some potentially invasive) to the region, associated with ballast waters and oil platforms. These undoubtedly have a negative impact on the native fauna subject to traditional exploitation (Triay-Portella et al. 2015, Pajuelo et al. 2016, González et al. 2017).

Additionally, the recent appearance of scientific infrastructures, such as the funding of permanent platforms for research and technological development (laboratories, ships, wind turbines) has reduced the traditionally used fishing grounds.

Something similar occurs with the effect of tropicalization processes confirmed by scientific studies in this temperate transition zone of the eastern-central Atlantic (Macaronesia) (Afonso et al. 2013, Horta Costa et al. 2014), probably associated with global warming (Perry et al. 2005, Occhipinti-Ambrogi 2007). Climate change has an impact on the foundation species, favoring the displacement of some populations of traditionally exploited marine organisms towards more northern latitudes and their gradual replacement by other exotic species from nearby subtropical and tropical areas, and is expected to have important social and economic implications (Vergés et al. 2014, Wernberg et al. 2016). The introduction and spread of exotic species are considered one of the main threats to marine biodiversity (Lockett and Gomon 2001, Molnar et al. 2008).

Ad-hoc strategic actions for the sustainable development of fishing in the Canary Islands. To develop this section, the authors have taken into account the FAO's basic management concepts for small-scale fisheries, and in particular, their economic and social aspects as published by Panayotou (1983). In this regard, it should be noted that a fishery is made up of fishermen, the fleet, and the fish stocks (Panayotou 1983).

In the regional context of the Canary Islands, we have also considered the conclusions and recommendations made by a vast panel of experts (González unpublished*), reflecting on them and, where appropriate, adapting them to the current situation.

Coastal shellfish resources are mostly in a state of overexploitation and, applying a precautionary approach, immediate measures are necessary for them to recover and improve their economic value, as well as to adopt a technical health code to ensure food security. Here we propose the following strategic actions:

- improvement of the regulatory framework;
- establishment of a shellfish resources management program;
- regulation of harvesting activity;
- immediate improvement of surveillance and control activity including reduction of poaching; and
- evaluation of shellfish species populations.

Coastal demersal resources are also largely overexploited and immediate adoption of drastic measures from a precautionary perspective is necessary for their recovery, as well as baselines for their sustainable exploitation. Management measures should be applied for their conservation. Strategic actions:

- immediate adoption of measures for the regeneration of the resource biomass of each island, based on the precautionary principle; and
- establishment of scientific-technical policy lines for the sustainable management and exploitation of resources, based on the ecosystem approach.

Deep-sea resources need to be investigated and evaluated to establish bases for their sustainable management and to address the development of new fisheries. These resources may constitute an alternative or complement to those currently exploited. As an example, the recent and incipient activity targeting the striped soldier shrimp could be further developed immediately with innovative, environmentally friendly technologies based on highly-selective semi-floating traps, precautionary regulations, and scientific monitoring. Strategic actions:

- promotion and development of research into deep water resources;
- establishment of scientific-technical bases for their sustainable management;
- development of new deep-sea fisheries with scientific monitoring; and
- reinforcement of infrastructure (primarily a multipurpose research vessel) and qualified human resources for fisheries research.

The abundance and state of exploitation of coastal pelagic species is effectively unknown due to the absence of continuous evaluations, while oceanic resources are periodically assessed in the ICCAT scientific forum. However, the targeted species important for the Canary Islands economy seem to be at the maximum exploitation level of their populations. Both types of resources are clearly dependent on the variations in oceanographic conditions, so interdisciplinary studies of these influences on them are necessary. For coastal pelagic species, here we propose the following strategic actions:

- permanent regular monitoring of fishing activity;

* González J.A. (ed.) 2008. Memoria científico-técnica final sobre el Estado de los Recursos Pesqueros de Canarias (REPESCAN). Agencia Canaria de Investigación, Innovación y Sociedad de la Información, Las Palmas de Gran Canaria. Unpublished report.

- continuous evaluation of the populations in its distribution area; and
- determination of biological and population parameters.

For the oceanic pelagic species:

- knowledge of the incidence of oceanographic conditions on tunids (and allied species) populations locally; and
- representation of the Canary fisheries administration in international forums.

Marine Protected Areas (MPAs) are an excellent tool for the management and conservation of biodiversity, habitats, and resources, and can generate socioeconomic benefits that are difficult to achieve with other management strategies. In addition, they have been proposed by the Intergovernmental Panel on Climate Change to combat the effects of climate change on biodiversity. The implementation and empowerment of MPAs in the Canary Islands is recommended, within the framework of integrated coastal management. Strategic actions for MPAs:

- planning, definition and design, adapting them to current knowledge and characteristics of this archipelago;
- promotion of their coordinated participatory management;
- development of a specific multidisciplinary research protocol, with coordinated participation of the different research and management institutions; and
- strengthening participation processes and disclosure channels.

Among the socio-economic problems of the artisanal fishing sector in the Canary Islands, it is necessary to call attention to the decline and aging of the population linked to it, related among other factors to a loss of profitability of the activity. In addition to promoting multidisciplinary research in this sector, as strategic actions in this field, we focus on the need to:

- highlight the importance of fishing activity regulation at insular level;
- increase the profitability of the activity by improving marketing, creating a quality brand at the regional level involving fishing organizations;
- empower and dynamize fishermen's guilds and their federations;
- revitalize the cultural values of fishing and maritime heritage; and
- optimize the fleet and the use of existing infrastructures.

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