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Marine Policy 31 (2007) 573–581
MARINE POLICY
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Artisanal fishing in Andalusia: A statistical study of the fleet

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Received 16 May 2006; accepted 25 October 2006

Abstract

Andalusia is a region of Spain with an area of some 90,000 km^2 and almost 900 km length of coastline. It has an important tradition in the fishing industry that makes it one of the areas of the European Union where fisheries policies have a great significance for the population. The present statistical study deals comprehensively with the so-called "artisanal fleet", especially in respect of data on the typology of vessels (construction particulars) and on the extractive effort made (distances and depths where they fish, duration of fishing voyages, the fishing gear used and target species), with the aim of presenting a new approach in the policies for regulating this important fisheries sector.

Keywords: Safety at sea; Fisheries management; Andalusia; Spain

1. Introduction

Andalusia is one of the 17 autonomous regions of Spain, and its area of 87,268 km^2 makes it larger than countries like Belgium, Holland, Denmark, Austria or Switzerland. Its shoreline is roughly 900 km. The Andalusian fishing tradition began with the emergence of its first inhabitants, as one of the characteristic activities of the Andalusian shore. In Roman times it was known as Betica, and even before then, there was a fish salting industry established on these coasts. A visit to the ruins of the Roman town of Jimena de la Frontera, to the Cave of Laja Alta, or to the prehistoric sanctuary of the cave of La Pileta, where sea fishes appear in paleolithic paintings, highlights the important role that fishing has played in this region of the south of Europe [1–3].

In the past 15 years, annual landings of fresh fish catches in Andalusia have amounted to between 100,000 and 150,000 tonnes, for every port in the region, with an approximate value of 250 million euros per year. Today, the fishing activity has been reduced drastically in those ports whose fisheries are covered by the Treaties of the European Union with the Kingdom of Morocco, recently interrupted, as it is very evident in the case of the port town of Barbate [4].

The fishing ports currently managed by the Regional Government through the public company Empresa Pública de Puertos de Andalucía (EPPA) are: Isla Cristina, Punta Umbría, El Terrón (Lepe), El Rompido and Ayamonte located in the province of Huelva; Conil, Barbate, Bonanza (Sanlúcar), Rota, Chipiona and La Atunara (La Línea) in Cádiz; Caleta de Vélez, Marbella, Estepona and Fuengirola in Málaga; and Adra, Roquetas de Mar and Garrucha in Almería [5]. The other ports in Andalusia are managed by Puertos del Estado, the port holding authority of the central Government, which is part of and responsible to the Ministry of Development (Fomento); these are: Huelva, Bay of Cádiz (Cádiz and Puerto de Santa María), Bay of Algeciras (Algeciras, Tarifa and La Linea), Málaga and Almería–Motril (Motril, Almería and Carboneras) [6].

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doi:10.1016/j.marpol.2006.10.004

Fishing vessels may be classified as

- *the Deepwater and Ocean-going Fleets*, working outside fishing grounds, with a tonnage exceeding 100 GRT and 250 GRT, respectively, that undertake industrial activity with appropriate mechanisation of fishing tasks and product preparation;
- *the coastal or Shallow-water Fleet*, working waters under Spanish jurisdiction or closed fishing grounds, with a tonnage between 20 and 100 GRT, that carry out a primary industrial activity;
- *and the Artisanal or craft fishing Fleet*, comprising small vessels, with a tonnage of less than 20 GRT, and that get underway daily to fish.

The Coastal and Artisanal fleets have similar characteristics: the ship owner usually works on board as one more crew members, since the company is usually family-owned and managed. The number of crew per vessel does not usually exceed 10. The fisherman is an artisan or craftsman who has a thorough understanding of all aspects of fishing; there is no clear hierarchy among the crew, and the remuneration system is by shares of the net proceeds, known as "a la parte".[1] The time spent at sea varies from one to seven days per voyage, working from 60 to 80 h a week, and the technology and productivity are low, in contrast to the situation in the industrial fleet comprising the Deepwater and Ocean-going Fleets [7].

There exists a classification of the typology based on the Census of the Fishing Fleet, with a total of 12 basic types: stern trawler, side trawler, seine net with catharpin, seine net without catharpin, hand lines, longline, other hook gear (rods and lines, tuna longline, and currican/trolling), traps/pound nets, gill nets, dragnets, multi-purpose gear and multi-purpose vessels [8]. The Andalusian fishing fleet is made up of some 2612 boats, with a total tonnage of 63,655.3 GRT; the low tonnage artisanal boats are the most numerous [9]. At present, a clear division exists between the more modernised fleets, and the fleets that continue undertaking artisanal fishing [10]. Despite this, the Andalusian fishing fleet is second in importance of all the Spanish regions: it accounts for 15% of total vessels, and the catches represent more than 20% of the total value of fishing in our country.

The present study is part of a wider study of the Artisanal Fishing Fleet conducted throughout the year 2002, financed by the Regional Government of Andalusia. In this paper we are presenting the results referring specifically to the typology of the vessels (construction particulars) and to the extractive effort carried out (distances and depths where they fish, duration of the fishing voyage, and the gear employed or target species) [11,12].

[1]The "salary" of the workers takes the form of a proportional share, in function of the job position held, and the profits obtained from the catch. This system permits all the crew to obtain a benefit from their work, but can be a risk factor that encourages fishermen to accept unsafe working conditions and prolonged working days.

2. Method

2.1. Design of the sampling

The geographic area of application covers the entire shoreline of the Autonomous Region of Andalusia, which consists of two well-differentiated regions: the South Atlantic and the South Mediterranean. As the first step in the design of the sampling, the census chosen as the survey base is that produced by the Andalusian Federation of Fishermen's Guilds, since this was the most up-to-date [13]. The number of boats by port was quantified for each segment of the fleet; sampling ports were selected for each sector in function of the ports in which each particular segment was best represented in each of the provinces. In addition it was taken into account that, in certain provinces, significant differences could exist between ports within the same segment; advice was therefore sought from the Fishermen's Guilds of the zone and the list of ports to study was completed. Subsequently it was necessary to determine the absolute size required for a reliable sample, and the distribution of this sample, so that it should be representative of the population. The total number of boats to be surveyed was set at 10% of the total population: 202 boats of the total of 2027 in the census. The sample was distributed among the four fishing techniques and gear (metiers) that would be studied; bottom trawling, small-scale gears, seine net and longliners, respecting the proportion existing in the population; then the number corresponding to each port was determined. To finalise the calculation of the sample size, an adjustment was made with the intention of making it possible to compare fleets using the same fishing gear from different ports. The last step was to select randomly the specific boats of each port utilising the census of the port, and assigning a reserve alternative for each boat thus selected.

2.2. Conduct of the surveys

To achieve more reliability, the interviewer always attempted first to get the ship's master to respond to the survey, and whenever this was possible to arrange for the interview to take place if not on board ship then in close physical proximity to her: the purpose of this was to be able to check and amplify the information provided by the master with that obtained visually by the interviewer. The survey interviews were conducted anonymously.[2]

[2]Technical specification of the survey:

1. *Universe*: Vessels of the Andalusian artisanal and coastal fishing fleets (ships of up to 20 GRT, and of 20–100 GRT, respectively). According to the census of the Andalusian Federation of Fishermen's Guilds, the total size of this population is 2027 ships.
2. *Size of the sample*: The objective set was to survey 10% of the population, and the number finally surveyed was higher than this, at 298 ships (14.7%).
3. *Design of the sample*: In the first place, for each fishing modality (longlines, seine net, bottom trawling and small-scale gears), the fishing

The software tools employed for the various statistical analyses and tabulations were the statistical packages STATGRAPHICS 5.0 (1994–2000, Statistical Graphics Corporation) and SPSSv10, which are customarily used in these type of study.[3] In the calculation of the relative frequencies (percentages) in the results, a prior adjustment was made in the sample, after first verifying what characteristics these variables had.[4,5,6] Regression analysis is a statistical tool for evaluating the relationship between one or more independent variables and a dependent continuous variable [14]; in the present study, only one independent variable has been considered in the various analyses (simple regression analysis).[7] Non-parametric tests have been employed to make comparisons in a variable between different groups, because it cannot be guaranteed that the variable follows a normal distribution.[8] Dispersion diagrams, graphs of means, and "box and whisker" diagrams have been employed (Table 1).

Table 1
Sampling ports

Ports	Bottom trawling	Small-scale gears	Seine nets	Longlines	Total
Isla Cristina	13	11	2		26
Lepe		9	2		11
Punta Umbría	1	16	3		20
Sanlúcar	8				8
Puerto de Santa María	5				5
Barbate			8		8
Conil		36			36
Tarifa		19			19
Algeciras		2	7	3	12
La Línea		25			25
Estepona	1	19			20
Fuengirola	5	1			6
Vélez-Málaga	2	13	6		21
Motril	11				11
Adra	1	10	8		19
Almería	8	1	4		13
Roquetas		15			15
Carboneras	1			12	13
Garrucha	8	1		1	10
Total	64	178	40	16	298

3. Results

3.1. General results

One crew member per vessel was interviewed; in 86% of cases, this was the master of the vessel, in 9% of cases the ship owner, and in the remaining 5%, the Engineer or another sailor. The variables studied next have given negative results in the tests of normality ($p = 0$). It is for this reason that, in addition to the mean and the standard error, for each variable the median and the lower and upper quartiles are provided. The non-normality of the

(*footnote continued*)
ports were selected; a non- random selection was made with a view to ensuring an adequate representation of the whole sector. Once the ports to be visited were known and the modalities to be studied in each port, the number of ships in the sample size was distributed respecting the percentages present in the population. The definitive selection of ships was done by simple random sampling.

4. *Margin of error*: Taking a level of confidence for the results of 95% ($Z = 1.96$) and considering the maximum dispersion of the results (p and $q = 0.5$ in dichotomous variables), the resulting margin of error is 5.24%.
5. *Field work*: This present work was carried out intermittently from 16 April to 29 June, by means of personal interviews with the fishermen of the ships.

[3]STATGRAPHICS 5.0 (1994–2000, Statistical Graphics Corp.). SPSS v10. DIET-Source v1.03.

[4]The reason for this was that the distribution of ships finally surveyed differed from that initially foreseen, so that the totality of the sample was not a faithful reflection of the Andalusian fishing fleet. Therefore some ships were eliminated in conducting this analysis, in order that the proportions of each type of metier (trawling, seine net, small-scale gears and longlines) in the sample should be the same as those in the total population; the number of ships finally included in this analysis was 272. For the rest of the analyses, the full number of the sample, 298 ships, was employed. Occasionally the total number of responses considered in a particular question does not coincide with either of the two previous numbers, due to an absence of responses or because, by the nature of the question, only a sector of the sample was capable of responding.

[5]Three different classes of indices have been utilized:

1. Indices of localisation or of central trend. Mean and median.
2. Indices of variability or dispersion. Standard deviation and standard error.
3. Indices of position or percentiles that allow the subject to be positioned with respect to the set of the distribution. The interpretation is made in terms of percentage of subjects with a score of less than or equal to the range of the percentile.

[6]One of them is if the data of the sample allows it to be stated that the variable follows a normal distribution. To verify this hypothesis, the goodness of fit test of χ^2 has been employed.

[7]The analysis provides different mathematical models by means of an equation that links the two variables, and the model that presents the highest value of the r^2 statistic is selected. This statistics measures the percentage of variability explained with the model chosen, in such a way that the higher the value of the statistics, the better the fit provided by the model. The equation also permits values of the dependent variable to be predicted for new values of the independent variable. Thus, for example, from the equation:

$$\text{PAPER HP} = 0.988454 \times \text{LENGTH}^{1.89669}$$

it can be estimated what value of HP would correspond to a particular value of length. This model of equation is the type known as the multiplicative

(*footnote continued*)
model and is the one that has been considered to be the most suitable in all the cases. The analysis also provides a bidimensional graph with the two axes representing the dependent and independent variables.

[8]From among this group of tests, two tests in particular have been used:, the *U*-test of Mann–Whitney and the Kruskal–Wallis test. The function of the first is to compare the values of a variable between two groups by their medians, and the second performs the same function when the comparison is between more than two groups. From this comparison, the statistical software provides a value known as the p-value. If the p-value is less than 0.05, then it can be stated with a level of confidence of 95% that there exist significant differences in the value of the variable between the groups (Statistical Graphics Corp, 2000).

Table 2
General results

	Min	Max	Median	lq[a]	uq[b]	Mean	SE[c]
Year of construction	1915	2002	1987	1973	1997	1982	1.10
Length (m)	4	26	9.9	7.05	15.27	11.54	0.32
Beam (m)	0.83	12	3.15	2.6	4.7	3.70	0.09
Draught (m)	0.4	4.5	1.35	1	2.1	1.60	0.05
Power (HP)	7	1050	90	33	183.5	145.9	9.67
Tonnage (in GT)	0.5	123.5	6.08	2.78	26.4	18.90	1.62
Tonnage (in GRT)	0.38	90	6.82	2.88	25.39	6.82	1.36
Crew members	1	22	4	2	5	4.65	0.20

[a]Lower quartile.
[b]Upper quartile.
[c]Standard error.

Table 3
Fishing data

	Min	Max	Median	lq	uq	Mean	SE
Maximum distance from the coast (miles)	0.02	200	7	2	15	10.56	0.81
Depth for fishing (fathoms)	2	2000	27.34	12.5	82.02	77.57	8.34
Length of time of fishing voyage (h)	3	744	10	8	12	32.90	6.62

variables has also meant that non-parametric tests[9] have had to be utilised in the comparisons between different groups. With reference to the technical data on the vessels, the year of construction of the vessels ranges from 1915 to the year 2002, i.e. boats of very recent construction; the average year of construction is 1982, with a standard error of approximately one year. The lower and upper quartiles are, respectively, 1973 and 1997, and the median corresponds to the year 1987. The length of the boats also covers a wide range, between 4 m as the minimum and 26 m as the maximum. This wide spread has also been observed in the variables of beam, draught, tonnage and power of the boat (Table 2). A series of questions were also asked relating to the type of fishing performed (Table 3). A wide variety of fishing techniques and gear are employed, but all basically within the category of small-scale fishing gears. A classification was made into four large groups: Bottom trawling (BT), Seine net (SN), Longlines (LL) and Small-scale gears (SG). This last group, in turn, comprises Drag lines (DL), Bottom longlines (BL), Trammel nets (TN), Drags (DD), Pitcher Traps (''Alcatruces'') (AL), Traps (''Nasas'') (NA), Handjigs (''Pulperas'') (PU), Tuna fish net (TN) and other types of net (OT), normally of a single panel.

In response to the question whether the fishing gear used was changed during the year, 41% responded affirmatively, most of these belonging to the group of small-scale gears (>80%).

[9]Kruskal–Wallis and Mann–Whitney.

3.2. Year of construction

In the study of the boats' age (year of construction), the hypothesis was put forward that the fishing modality influenced the value of this variable. The Kruskal–Wallis test has confirmed this hypothesis, for significant differences were detected between the years of construction of the vessels employing different fishing techniques and gear ($p<0.01$). Thus, the boats using longlines are the most modern (average year of construction: 1993), followed by those using bottom trawling, (average year of construction: 1986); the oldest are those dedicated to small-scale gears and to seine net, with an average year of 1980 and 1983, respectively (Fig. 1). Among the different small-scale gears studied, significant differences were also found (Kruskal–Wallis, $p<0.04$): boats fishing with alcatruz traps and those using dragnets had the longest mean age while the hydraulic dredgers were the most modern, although it should be borne in mind that the hydraulic dredger as a type has only been fishing in Andalusia for a few years. When analysed by home port, in the boats using small-scale fishing gears differences were detected in function of the port (Kruskal–Wallis, $p<0.05$), with the fishing fleet of the port of La Linea (Cádiz) being the oldest, with an average year of construction of 1965, and the fleets of Isla Cristina and Punta Umbría are the most modern. In trawlers, despite not presenting significant differences (Kruskal–Wallis, $p>0.3$), the ports of the eastern part of Andalusia (Almería, Garrucha and Motril), that account for 41% of the trawlers surveyed, and those of the province

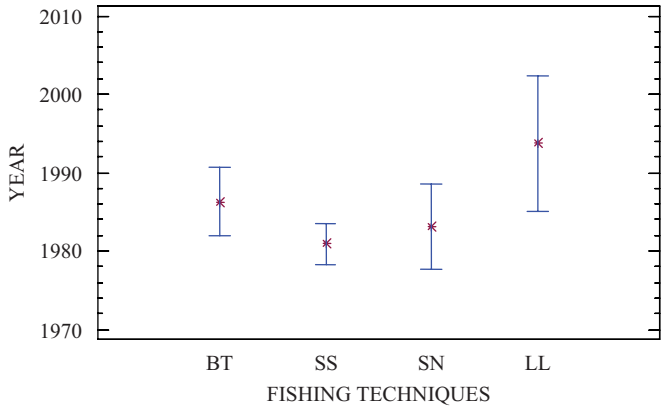

Fig. 1. Year of construction according to the type of fishing techniques. Mean values and intervals of confidence.

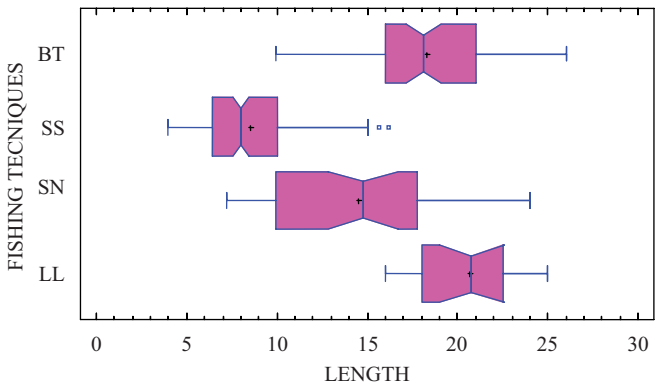

Fig. 2. Length according to the type of fishing techniques: statistical values.

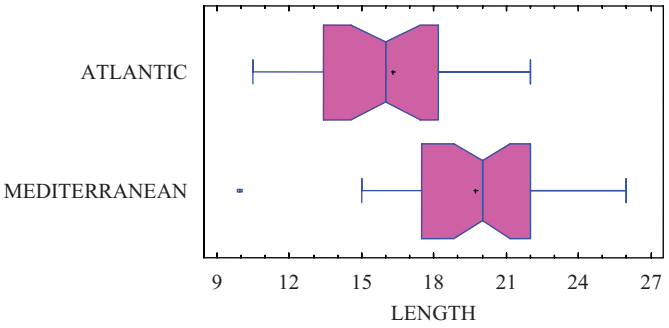

Fig. 3. Length according to the type of fishing geographical areas: statistical values.

of Cádiz (Puerto de Santa María and Sanlúcar) possess the most modern fleets of bottom trawlers, and the ports of Vélez–Málaga and Fuengirola have the oldest. In respect of the boats dedicated to longlines and seine net fishing, the test of Kruskal–Wallis showed that there were no significant differences by home port in the year of construction ($p > 0.2$).

3.3. Length, beam and draught

A wide range of values has been observed in respect of the length of vessels. The comparison of length according to the different fishing modalities (Kruskal–Wallis, $p = 0$) shows that the longest boats are those dedicated to longlines, followed by bottom trawlers and seine netters (Fig. 2). Within the group corresponding to small-scale fishing gears, the range of lengths is between 4 and 16 m, with the hydraulic dredgers being the longest and the hand jigs (pulperas), dragnets and trammel nets the shortest. The variables of beam and draught maintain a moderately close and directly proportional relationship with the length, as the regression analysis shows. ($r^2 = 79.75$ and 59.67 in multiplicative models for the beam-length and draught-length ratios, respectively). Hence in respect of both beam and draught, the same ranking applies when considering the fishing modality (LL > BT > SN > SS).

The trawlers of greatest length correspond to the ports of Eastern Andalusia (Almería, Garrucha and Motril), mean length: 21 m, with a notable difference from the rest of the ports, where the mean length found is between 15 and 17 m. In respect of small-scale fishing gears, the shortest boats dedicated to this fishing modality are those of Estepona (their mean length is 6.75 m), whereas those of Punta Umbría are the longest (their mean length is 11.59 m). The length of the seiners ranges from 10 m for the port of Algeciras, to 18 m for the port of Barbate. With respect to the longlines, there are no significant differences between the different fishing ports (Kruskal–Wallis, $p > 0.5$). When comparing the South Mediterranean with the South Atlantic regions, differences are only observed in the bottom trawlers (Mann–Whitney, $p < 0.01$), where the mean length of the trawlers of Cádiz and Huelva is 16.28 m, against 19.7 m for the ports of Málaga, Granada and Almería (Fig. 3). Among the boats using small-scale gears, the length is slightly less in those that change between different gears (multi-purpose), compared with those that do not change (single-purpose) (Mann–Whitney, $p < 0.05$).

3.4. Power (HP)

Again the Kruskal–Wallis test confirmed significant differences between the different fishing modalities ($p = 0$). The boats employing longlines are those with the most engine power, followed by bottom trawlers and seine netters, coinciding with the results in respect of boat length. Relating the two variables, horsepower and length, by means of a regression analysis, the most suitable model is found to a multiplicative one (Fig. 4), according to which:

$$\text{PAPER HP} = 0.988454 \times \text{LENGTH}^{1.89669}.$$

The value of the r^2 statistic indicates that the fitted model explains 69.62% of the variability in horsepower. The coefficient of correlation is 0.834, indicating a moderately strong relationship between the variables. In studying the power of boats employing small-scale fishing gears,

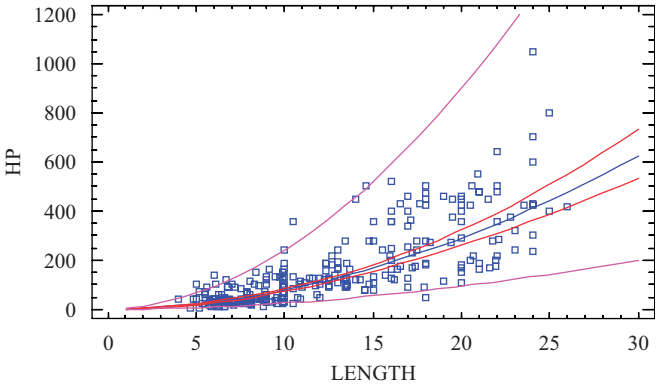

Fig. 4. Relation between length and power of the fishing boats.

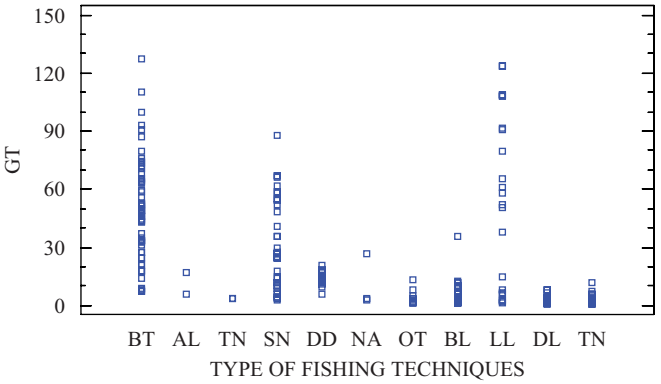

Fig. 5. Power according to the type of fishing techniques: statistical values.

differences were detected between the different types of gear grouped under this modality (Kruskal–Wallis, $p<0.01$): the hydraulic dredgers are the highest powered vessels, with an average of 145 HP. The possible influence of the home port on the vessel was also considered, but no significant differences by port were detected in the power of the vessels dedicated to longlines (Kruskal–Wallis, $p>0.4$), nor to bottom trawling ($p>0.1$) or seine netting ($p>0.2$). However in respect of the small-scale fishing gears, differences are observed ($p<0.01$), and a wide variation can be seen in the horsepower employed. Thus, the boats from ports of the Huelva coast are those with the highest power ratings, due basically to the presence of the hydraulic dredgers that need extra horsepower for their particular mode of fishing.

3.5. Tonnage (GT and GRT)

The tonnage follows the same ranking as the preceding variables: the vessels of greatest tonnage are those fishing with longlines, followed by bottom trawling, seine netting and finally small-scale gears (Kruskal–Wallis, $p=0$) (Fig. 5). Again, within the group of the small-scale gears, the hydraulic dredge is the type of vessel with the highest tonnage and the drag net the lowest. The fact that both the GT and the GRT depend on volume of space in the boat makes this variable directly related to the length, as has been demonstrated in the regression analysis ($r^2=87.87$ and 84.13 in multiplicative models for the ratios of GT-length and GRT-length, respectively). Analogously, the variables GT and GRT are also directly related ($r^2=92.06$ in the multiplicative model for the GRT-GT ratio). In the group of bottom trawlers, there is a wide range of tonnage between ports (Kruskal–Wallis, $p<0.01$): 31.7 average GT for Sanlúcar and 82.4 average GT for Garrucha. In small-scale gears (Kruskal–Wallis, $p<0.01$) the range extends from 2.5 average GT for Estepona up to 11.4 and 11.7 average GT in Isla Cristina and Punta Umbría, respectively, due to the hydraulic dredge. In respect of the seiners, considering that the existence of sardine netters widens the range, those of highest tonnage are found in Barbate (average GT 60.4) and those of lowest in Algeciras (10.2).

Table 4
Tonnage Fleet according to the fishing techniques

Fishing techniques	Boats	Sample tonnage (GRT)	Fleet tonnage (GRT)	%
Bottom trawling	43	1634	13,792	44.8
Seine nets	28	745	6734	21.9
Small-scale gears	126	623	6569	21.3
Longlines	11	495	3691	12.0
Total	208	3497	30,786	

In the longlines, there are no significant differences of tonnage by fishing port ($p>0.59$). Considering the total GRT of each fleet, bottom trawling occupies the first position, followed by seine netting, small-scale gears and, finally, longlines (in Table 4 the sum of the GRT of the boats surveyed is given).

In the comparison between the South Mediterranean and South Atlantic regions, significant differences were detected in trawling (Mann–Whitney, $p<0.01$): average GT of 34.57 in South Atlantic and 58.48 in South Mediterranean. It was also found that the multi-purpose vessels have a lower GT that those that do not change the gear employed during the year (Mann–Whitney, $p<0.03$).

3.6. Number of crew members

Significant differences were detected (Kruskal–Wallis, $p=0$). Vessels of the seine net modality carry the most crew members (average of 10 per vessel, but a wide range from 4 to 22) (Table 5). In small-scale gears no significant differences exist, and within this group, the hydraulic dredge modality accounts for the highest number of crew members, with an average of 4 per vessel (Fig. 6). In absolute terms, small-scale gears generate the greatest number of direct jobs (43% of the total), followed by seiners, trawlers and longlines. (Table 6). Barbate is the homeport for the largest vessels dedicated to seine net fishing, and therefore is the port with the highest total

Table 5
Number of crew members according to the fishing techniques (statistical values)

Tipo de arte	Min	Max	Mean
Seine nets	4	22	10
Longlines	6	11	9
Bottom trawling	3	8	5
Small-scale gears	1	8	3

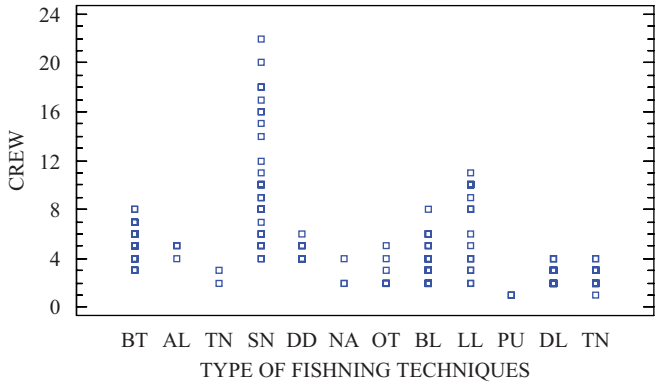

Fig. 6. Number of crew members according to the type of fishing techniques: statistical values.

Table 6
Number of crew members according to the fishing techniques (in absolute terms)

Fishing techniques	Boats	Number of crew members-sampling	Number of crew members-fleet	%
Small-scale gears	178	545	4061	43.1
Seine nets	34	353	2631	27.9
Bottom trawling	49	262	1952	20.7
Longlines	11	104	775	8.2
Total	272	1264	9419	

Table 7
Length of time of fishing voyage (h)

	Min	Max	Median	lq	uq	Mean	SE
Longlines	12	960	468	90	720	426.7	94
Bottom trawling	3	144	12.5	12	36	36.2	5.3
Seine nets	4	24	11	9	12	11.6	0.7
Small-scale gears	3	78	9	6	12	9.5	0.5

number of crew members. In small-scale gears, Tarifa and Isla Cristina have the highest total crew numbers In bottom trawling there are hardly any differences between the ports (the number of crew is between 4 and 6), and similarly in longlines. A small minority of cases is found where only one crew member is reported as embarked, but this is an irregular and dangerous situation (3 boats, 1% of the sample).

3.7. Length of time of fishing voyage

There are significant differences in this variable (Kruskal–Wallis, $p<0.01$). The fleet that spends most time on fishing voyages is the longliners (426.7 h, $\approx$18 days); this modality presents a considerable difference compared with trawling, seine netting and small-scale gears (Table 7). In small-scale gears significant differences are also observed (Kruskal–Wallis, $p<0.01$), with the tuna boats, hydraulic dredgers and longliners being the types spending more time fishing, and boats that employ hand jigs (pulperas) and traps (nasas) spending less time. Considering the home port, the Kruskal–Wallis test has shown differences in the trawler fleet ($p<0.01$). Those sailing from the ports of El Puerto de Santa María (100 h) and Sanlúcar (96.5 h) are those with the longest duration of fishing voyage, in contrast to those of Fuengirola (9.6 h) that fish for the shortest period. This also produces a significant difference ($p<0.01$) when comparing the South Atlantic and the South Mediterranean regions (57 against 21 h).

3.8. Maximum distance from the coast

Divergences have been observed between the different fleets (Kruskal–Wallis, $p<0.01$); the longliners fish furthest from the coast (average maximum distance of 73.8 miles), followed by bottom trawlers (average of 20.9 miles), seine netters (13.6 miles) and small-scale gears (7.2 miles) (Fig. 7). In small-scale gears there are also differences (Kruskal–Wallis, $p<0.01$): bottom longliners fish furthest from the coast (14.5 miles on average) and the handjigs (pulperas) (0.7 miles), drag nets (2.4 miles) and dredgers (2.8 miles) work closest inshore.

In the comparison between fishing ports, differences have been observed in both seine netting (Kruskal–Wallis, $p<0.01$) and trawling (Kruskal–Wallis, $p<0.01$). Among those ports from which vessels dedicated to seine netting sail, those of the ports of Barbate (average of 28 miles) and Punta Umbría (26 miles) are those that work furthest from the coast, and those of Algeciras (2.5 miles) work the closest. In bottom trawling, the vessels of the ports of Sanlúcar (36.5 miles) and Almería (31.1 miles) are those that work furthest from the coast, and those of Fuengirola (4.5 miles) work the closest. Although differences by port have also been detected in small-scale gears, these can be explained by the different fishing modalities present in each port. These differences between ports have been translated, in the case of bottom trawling, in divergences between the South Mediterranean and South Atlantic regions (Mann–Whitney, $p<0.01$) (16.1 and 27.2 miles). However, the same does not occur in seine netters, where differences are not detected (Mann–Whitney, $p>0.11$).

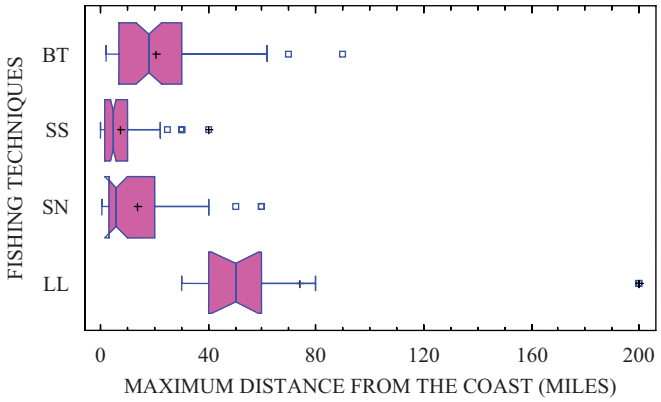

Fig. 7. Maximum distance from the coast according to the type of fishing techniques: statistical values.

4. Discussion and conclusions

The fishing fleet of Andalusia is found in some cases to be obsolete, with boats chartered since 1915 still in active employment and with 50% of the fleet constructed more than 15 years ago. This high average age is one of the problems that the fleet has traditionally presented [15]. However, it can be seen that a gradual process of reconversion of the fleet is taking place, since a considerable number of boats have been modernised or constructed thanks to the financial assistance given by the European Union to the ship owners; in addition some of those surveyed state their intention of taking advantage of the subsidies for this purpose in the near future. In fact, 25% of the boats have been chartered since 1997, a date that coincides with the launching of the regional Modernisation Plan: the average age has declined from 29 years (in 1997) to 20 years, obtained in this study; this age coincides with the limit established by the European Parliament [9]. It is thus desirable that the current level of support should be maintained or even increased, to make possible the existence of a modernised fishing fleet with the technical characteristics that should ensure safety at sea.

The differences between the years of construction by fishing modalities indicate that the process of modernisation is not being carried out at an equal rate in all the sectors. Possible factors for this may be:

1. The administration is favouring certain sectors, such as trawling or boulter/longline fishing.
2. More resources are available to these sectors for their modernisation.
3. Their boats have suffered greater structural wear.
4. The technology that they employ requires more frequent updating.
5. Owners have eliminated more boats of these modalities than of others.

The dimensions of the boats studied have varied in respect of length, beam and depth in function of the type of fishing gear that the boat employs. The characteristics of each modality, such as the distance at which the longliner line boats work, or the power necessary to carry out bottom trawling, imply different needs. On the other hand, despite this variability, the boats of the fishing fleet have remained within a length range of between 4 and 26 m, with 99% of the boats having a length of less than 24 m. This means that the agreement of Torremolinos [16] is not applicable in the majority of cases, and there is a notable scarcity of legislation regulating the sector; the complementary standards of the SOLAS [17] are being utilised. With the object improving this situation, the compilation in a single document of all the existing legislation applicable to the fishing fleet of Andalusia would be of great value.

The close relationship existing between the length of a boat and other variables such as the beam, the depth/draught, the power or the tonnage of the vessel suggests that the previous comment could usefully be extrapolated to these other variables, such that the same differences apply and that the ranking by modalities coincides with what has been observed in respect of the length. In addition, this close relationship suggests the possibility of employing the length as the variable that in a certain way includes the rest of variables, with a view to making distinctions in the legislation or groupings for other purposes.

When the zone in which the boat carries out its fishing activity is taken into account, differentiating between the South Mediterranean and the South Atlantic regions, differences have been observed exclusively in the trawler fleet. In these vessels it has been shown that those working the South Atlantic region, despite having a shorter length and less GT that those working the South Mediterranean region, carry out their fishing at greater distances from the coast and for periods of longer duration.

In respect of engine power, in a considerable number of boats (approximately 25% of those surveyed) a discrepancy is observed between the horsepower declared and that really possessed. This discrepancy in some cases only translates to a reduction of the time employed in travelling to and from the fishing zone, as in the seine net or the trammel net boats, but in other cases can have negative repercussions, as in the case of bottom trawling carried out at a power greater than that authorised.

With reference to the number of crew employed, the sequence that has been observed in other variables is changed; in terms of number of crew mustered the seine net vessels move into first place, followed by surface longline boats, then trawlers and finally small-scale fishing boats. The reason for this change in ranking is that more hands are required to manage the seine net, compared with other fishing modalities (such as bottom trawling) in which the progressive mechanisation of the elements involved in the various different tasks comprising the fishing activity has caused a decrease in the numbers of crew embarked. However, in terms of the total number of fishermen employed in each fleet, the small-scale fleet generates the most jobs. Both factors should be taken into account in

putting forward policies aimed at regulating the fishing sector of Andalusia.

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