ELASMOBRANCH BYCATCH ON ARTISANAL TRAMMEL NET FISHERY IN THE CANARY ISLANDS

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Abstract

In this work we studied an artisanal trammel net fishery targeting red stripped mullet *Mullus surmuletus*. Catches and discards were evaluated on 30 fishings trials using 3 experimental net mesh sizes around 2 fishing grounds at the East coast of Tenerife (Canary Islands). A total of 48 species were identified with *M. surmuletus*, axillary seabream *Pagellus acarne* and parrotfish *Sparisoma cretense,* being the most frequently captured. Catches and discards represented 89.77% and 10.23%, respectively, of total catch weight. Experimental mesh sizes showed a clear decrease in the proportion of abundance catches caught as mesh size increased. Elasmobranchs were represented in high percentages reaching 37.61% of total catch weight. European Union protected angel shark *Squatina squatina* was also caught during the experimental fishings and represented 51.14% of the elasmobranch total catch weight. Findings of the study are intended to contribute to increasing knowledge about the artisanal fishing and allow suggestions to be made on fishing practices that will reduce future catches of the European Union protected elasmobranchs.

Keywords: bycatch, discard, *Squatina squatina*, artisanal fishery, Canary Islands.

CAPTURA INCIDENTAL DE ELASMOBRANQUIOS EN LAS PESQUERÍAS CON TRASMALLO EN LAS ISLAS CANARIAS

Resumen

En este trabajo hemos estudiado una pesquería artesanal con trasmallo que tiene como especie objetivo al salmonete *Mullus surmuletus*. Evaluamos las capturas en 30 pescas experimentales con tres tamaños de malla diferentes y en dos zonas de pesca en la costa este de Tenerife (islas Canarias). Un total de 48 especies fueron identificadas, siendo las especies *M. surmulletus*, el besugo *Pagellus acarne* y la vieja *Sparisoma cretense*, las más capturadas. Las capturas y descartes representaron el 89,77% y 10,23%, respectivamente, del peso de las capturas totales. A medida que aumentamos el tamaño de malla utilizada se observó una clara disminución en las proporciones de abundancias de las capturas. Los elasmobranquios estuvieron representados en un porcentaje alto, alcanzando 37,61% del peso de las capturas totales. El angelote *Squatina squatina*, protegido por la Unión Europea, fue también capturado durante las pescas experimentales y representó el 51,14% del peso de las capturas totales. Los resultados de este estudio pretenden contribuir al incremento del conocimiento de las pesquerías artesanales y permiten realizar sugerencias sobre las prácticas de pesca que puedan reducir en un futuro las capturas de los elasmobranquios protegidos por la Unión Europea.

Palabras clave: captura accidental, descarte, *Squatina squatina*, pesca artesanal, islas Canarias.

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1. INTRODUCTION

Worldwide, many species are captured by a variety of fishing gears and discard rates are high. Discarding occurs for a number of reasons such as specimens have little or no commercial value, are in poor condition and are below the legal size (Hall *et al.* 2000). Other discarding reasons are fishing boats storage capacity, high grading or sorting ability of the crew (Clucas 1996). Discarding practices are affected by bycatch composition, which are determined by environmental and social factors (Catchpole *et al.* 2005). In general, bycatch and subsequent discarding is unavoidable due to size selectivity of different gears and mixed-species fisheries. Thus, the relative importance of discards depends largely on the gear, the gear characteristics (e.g. mesh size, hanging ratios), fishing strategies, marketing constraints and legislation (e.g. Hall, 1996).

Most small-scale fisheries around the world have no management strategies in place and when existent they are based on landings data which do not take into consideration bycatch or discards (Lleonart and Maynou 2003; Merino *et al.* 2008). Artisanal trammel net fisheries are among the most significant small-scale fisheries in southern Europe (Erzini *et al.* 2001) and several studies have shown that discard rates from trammel nets are higher than other static gears like longlines or gill nets (Borges *et al.* 2001).

Elasmobranch fish are a common component of the bycatch and discard from fisheries (Bonfil 1994). Elasmobranchs are also vulnerable to overexploitation due to life strategies (Brito *et al.* 1998; Pratt and Casey 1990; Smale and Goosen 1999; Wintner and Cliff 1999; Hazin *et al.* 2002; Coelho and Erzini 2002). These life strategies are defined by a number of factors that characterize elasmobranchs: large maximum body size, slow growth, late maturation (at a large size) and long lifespan. (Walker and Hislop 1998; Dulvy *et al.* 2000; Stevens *et al.* 2000; Frisk *et al.* 2001).

Bycatch of elasmobranch is unmanaged in most fisheries and elasmobranchs are less able to sustain their populations under fishing pressures that are sufficient to sustain many teleost species for which most fishing quotas have been designed (Heuter 1998). Most elasmobranchs are predators at or near, the top of marine food webs, and as such they play a fundamental role in the structure and trophic functioning of the ecosystem (Cortés 1999; Stevens *et al.* 2000). Most studies on bycatch and discards of elasmobranchs have considered only trawl and longline fisheries (Stobutzki *et al.* 2002; Carbonell *et al.* 2003; Clarke *et al.* 2005; Megalofonou *et al.* 2005; Coelho and Erzini 2008); few have focused on trammel net fisheries and none of these have been carried out in southern Atlantic waters.

Angel sharks *Squatina squatina* Linnaeus, 1758 are highly susceptible to bycatch in trawls and trammel nets as they are bottom-dwelling (Couch 1822; Day 1880-1884). *Squatina squatina* has been fully protected in European waters since January 2011, and capture, retain onboard, transship and landing is forbidden by

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European Union regulation n.º 44/2012. To manage bycatch and conserve vulnerable species we need better knowledge of discard rates from different fishing gears and to evaluate the impacts on population, trophic and ecosystem dynamics (Hall *et al.* 2000; Borges *et al.* 2001).

Trammel nets are highly represented by Canary Island artisanal fisheries but catches and related bycatch have never been studied around Tenerife's coastline (*BOC* 2005/04). The trammel net fishery of Candelaria harbor has 9 authorized artisanal fishing boats and a restricted fishing season from February to March. Red strippet mullet *Mullus surmuletus* Linnaeus, 1758 was the target species of the studied fishery, but it is known that additional species are accidentally caught by the nets. Bycatch in this area consists of a wide range of species including elasmobranchs with commercial value as the angel shark (*S. squatina*) and Smooth-hound *Mustelus mustelus* Linnaeus, 1758. The main objectives of this study were: (1) to characterize an experimental trammel nets in fishing areas where trammel net fishery is allowed in Tenerife island, and (2) to contribute to improvement of the trammel net artisanal fishery by suggesting how different mesh sizes could be used to reduce bycatch and discards.

2. MATERIAL AND METHODS

2.1. Study area

The sampling area is located off the southeast coast of Tenerife (Canary Islands) at a latitude between 28° 11-22' N and 16° 21-25' W, in the municipality of Candelaria (fig. 1). The average wind speed at the sampling sites ranged from: 7.77 - 17.4 knots (11.6 ± 1.67). Experimental fishings were performed with good sea conditions (2-3 Beaufort wind force scale). Sampling was carried out using a 5 m (length) artisanal fishing boat from Candelaria and a 2-3-person crew. Fishing grounds were selected by scientists in order to cover the whole fishing area where trammel net is allowed and separated in two grounds, one to the north of Candelaria and one to the south.

2.2. Experimental design

To study the development of experimental fishings we collected all data relating to the fishing area, duration of fishing, fishing effort, catch composition, catch size and catch weight. Normal fishing practices were followed from February 2010 to March 2010. During experimentation the same observer accompanied a single crew for one full day. Fishing took place over 10 fishing days aboard the same artisanal fishing boat (*La Orca)* on 2 fishing areas (north and south). In each fishing day, three experimental trammel nets with different net mesh sizes (50, 60 and 80 mm), were used simultaneously with 2 or 4 panel nets each. Trammel nets were set between 10 and 40 m depth in experimental fishing grounds where the scientist chose previously. A total of 30 deployments, 18 and 12 at North and South areas, respectively, were observed in total. The total length of each the panel nets was 70 m. After retrieving

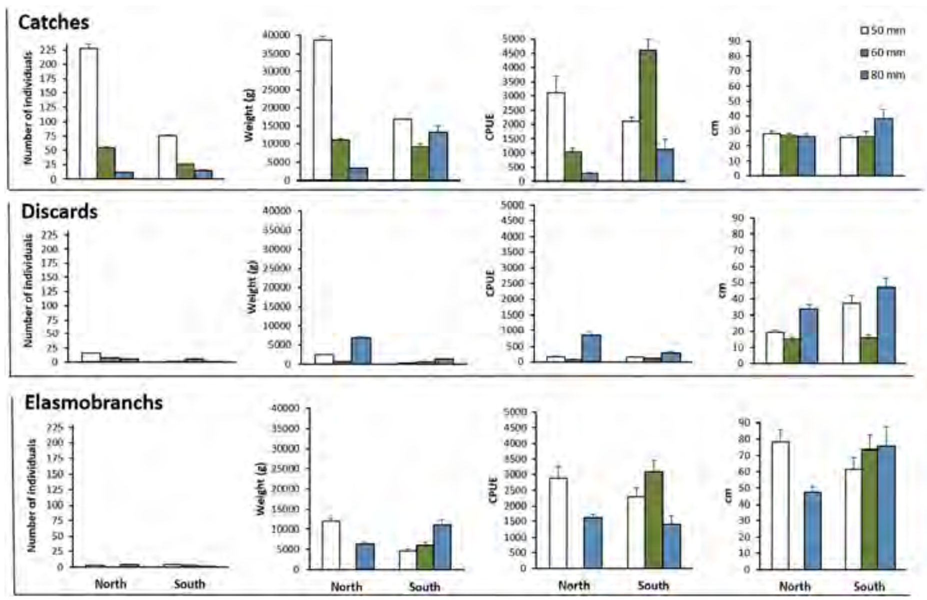

Figure 1. Mean abundance, weight (g), length (cm) and CPUE of catches, discards and elasmobranchs for the three different experimental mesh sizes in the artisanal trammel net fishery off the east coast of Tenerife (Canary Islands).

each net, specimens were untangled from the net by the fishermen who then decided which fish to retain and which to discard. The crew retained all fish that had some commercial value to supplement their *Mullus surmuletus* fishery income; among these were several fish including axillary seabream *Pagellus acarne* Risso, 1827 *and* parrotfish *Sparisoma cretense* Linnaeus*,* 1758, the common octopus *Octopus vulgaris* Cuvier, 1797 and the common cuttlefish *Sepia officinalis* Linnaeus, 1758.

Specimens were discarded if they were damaged, of little or no commercial value or below the legal catch size. All discards were identified and length (TL) and weight were recorded.

2.3. Data analyses

Total catch was recorded for each of the 30 experimental fishings. All specimens caught were sorted in catches or discards under fishermen judgment, identified to species level, counted, weighed (total weight, g) and measured (total length, cm). Analyses of variance were performed using Primer 6 + Permanova software in order to evaluate the effect of mesh size and fishing ground on catch abundance, weight, length and CPUE (Capture Per Unit of Effort). Catch per unit of fishing effort was the total catch divided by the total amount of number of net panels used (2 or 4). Capture abundance and weight were standardized to one panel net or sample unit. Data regarding each specimen caught were analyzed after being ascribed to one of

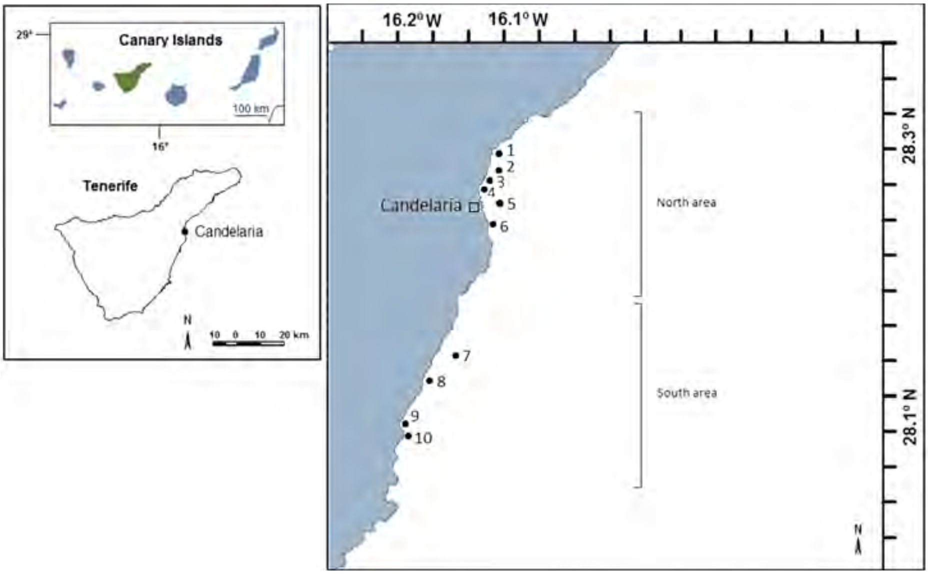

Figure 2. Location of experimental fishing grounds off the east coast of Tenerife, Canary Islands. North Area: 1) Central de Caletillas (28° 22' 27" N, 16° 21' 20" W), 2) Cueva de La Barca (28° 21' 55" N, 16° 21' 31" W), 3) Cabezo del Pozo (28° 21' 27" N, 16° 22' 02" W), 4) La playa de Candelaria (28° 21' 17" N, 16° 22' 04" W) 5) Cabezo la Barca (28° 22' 04" N, 16° 21' 17" W) and 6) Cabezo del Socorro (28° 19' 55" N, 16° 21' 37" W). South Area: 7) Casa Quemada (28° 14' 52" N, 16° 23' 13" W), 8) Los Barrancos (28° 13' 56" N, 16° 24' 22" W), 9) Recodo de la Hondura (28° 12' 04" N, 16° 25' 24" W) and 10) La Punta de la Hondura (28° 11' 48" N, 16° 25' 11" W).

two groups: catches and discards. Since elasmobranchs received particular emphasis in this study, additional analyses were carried out for individual elasmobranch species. When the number of permutations was very low, a Monte Carlo Test was used to estimate the p-value (Anderson 2001).

3. RESULTS

A total of 48 species were identified during the experimental fishings (table 1). In terms of weight, catches of *Mullus surmuletus* (26.83%) was higher than that of any other species, followed by *Squatina squatina* (19.23%). When considering the number of individuals caught, the most abundant species in catches were *M. surmuletus*, *Pagellus acarne* and *Sparisoma cretense*. A total of 5 elasmobranch species were caught (17 specimens; 40,730 g.). Among these were 2 Rajiforms, 1 Torpediniform, 1 Carchariniform and 1 Squatiniform, accounting for 37.61% of the total catch weight. *Mustelus mustelus* was the most abundant species, representing 52.94% of the total elasmobranch catches. In terms of weight, *S. squatina* made up 51.14% of the total elasmobranch catches. The number of catches and discards declined as net mesh size was increased from 50 mm, to 60 mm to 80 mm (fig. 2).

TABLE 1. TOTAL CATCHES FOR SPECIES CAUGHT DURING THE EXPERIMENTAL FISHING USING TRAMMEL NETS ABOARD *'LA ORCA'* OFF THE EAST COAST OF TENERIFE (CANARY ISLANDS)							
Catches							
Mesh size (mm)	Species	Specimens		Total Catch			
		Number	(%)	Weight (g)	(%)	Mean Length (cm) ± SD	
50	*Boops boops*	1	0.21	80	0.07	22.5	-
50	*Chromis limbata*	11	2.35	549	0.51	14.4	±0.97
50	*Diplodus vulgaris*	2	0.43	339	0.31	22	±0.71
50	*Mullus surmuletus*	173	36.89	24350	22.49	22.1	±1.19
50	*Mustelus mustelus*	5	1.07	4600	4.25	61.5	±4.27
50	*Pagellus acarne*	78	16.63	6320	5.84	18.6	±1.16
50	*Pagellus erythrinus*	2	0.43	430	0.40	23	±1.41
50	*Pagrus pagrus*	3	0.64	462	0.43	23.3	±5.13
50	*Promethichthys prometheus*	1	0.21	300	0.28	44.5	-
50	*Pseudocaranx dentex*	2	0.43	2200	2.03	55	±1.41
50	*Sarpa salpa*	1	0.21	150	0.14	23	-
50	*Sepia officinalis*	4	0.85	842	0.78	15.8	±4.57
50	*Serranus atricauda*	2	0.43	240	0.22	21.5	±1.41
50	*Squatina squatina*	1	0.21	10830	10.00	107	-
50	*Sparisoma cretense*	9	1.92	2300	2.12	24.7	±4.07
50	*Spondyliosoma cantharus*	1	0.21	150	0.14	23.5	-
50	*Synapturichthys kleini*	1	0.21	200	0.18	31.5	-
50	*Synodus saurus*	3	0.64	707	0.65	30.8	±2.57
60	*Bodianus scrofa*	1	0.21	250	0.23	26	-
60	*Boops boops*	7	1.49	578	0.53	20.7	±3.46
60	*Chromis limbata*	4	0.85	157	0.15	14.3	±1.71
60	*Diplodus puntazzo*	1	0.21	104	0.10	16.5	-
60	*Diplodus sargus cadenati*	1	0.21	78	0.07	16.1	-
60	*Diplodus vulgaris*	3	0.64	581	0.54	21.8	±6.25
60	*Lithognathus mormyrus*	1	0.21	200	0.18	26	-
60	*Mullus surmuletus*	22	4.69	3907	3.61	23.4	±1.69
60	*Mustelus mustelus*	4	0.85	6200	5.73	73.5	±19.69
60	*Pagellus acarne*	12	2.56	886	0.82	18.7	±1.16
60	*Pagellus erythrinus*	5	1.07	1459	1.35	25.4	±2.38
60	*Pagrus auriga*	1	0.21	198	0.18	23.5	
60	*Pagrus pagrus*	1	0.21	239	0.22	25	
60	*Promethichthys prometheus*	2	0.43	400	0.37	46.3	±1.06

60	*Pseudocaranx dentex*	1	0.21	90	0.08	19	
60	*Sarpa salpa*	6	1.28	2500	2.31	16	±2.06
60	*Sepia officinalis*	5	1.07	954	0.88	19.2	±4.62
60	*Sparisoma cretense*	10	2.13	2700	2.49	25.3	±2.99
60	*Sphyraena viridensis*	2	0.43	690	0.64	51.8	±7.42
60	*Spondyliosoma cantharus*	2	0.43	202	0.19	19.8	±1.06
60	*Synodus saurus*	4	0.85	1339	1.24	30.5	±5.93
80	*Balistes capriscus*	2	0.43	1100	1.02	32	±4.24
80	*Boops boops*	9	1.92	800	0.74	21.1	±0.70
80	*Mullus surmuletus*	4	0.85	800	0.74	22.9	±2.68
80	*Pagellus erythrinus*	1	0.21	100	0.09	21.5	-
80	*Sarpa salpa*	1	0.21	233	0.22	26	-
80	*Scorpaena scrofa*	1	0.21	1600	1.48	24	-
80	*Squatina squatina*	1	0.21	10000	9.24	104	-
80	*Sparisoma cretense*	3	0.64	273	0.25	33	±2.78
80	*Synodus saurus*	4	0.85	1700	1.57	36.1	±3.97
			Discards				
50	*Abudefduf luridus*	3	0.64	216	0.20	13	±0.00
50	*Aulostomus strigosus*	1	0.21	300	0.28	57	-
50	*Bothus podas*	3	0.64	180	0.17	17.7	±0.58
50	*Polymixia nobilis*	1	0.21	80	0.07	18.5	-
50	*Pomadasys incises*	4	0.85	350	0.32	18.9	±0.85
50	*Scorpaena canariensis*	1	0.21	34	0.03	12	-
50	*Scorpaena notate*	3	0.64	189	0.17	14.5	±1.73
50	*Stephanolepis hispidus*	3	0.64	266	0.25	15.7	±1.15
50	*Synodus synodus*	2	0.43	300	0.28	25	±1.41
50	*Taeniura grabata*	1	0.21	1200	1.11	49.5	-
60	*Bothus podas*	5	1.07	206	0.19	14.8	±2.54
60	*Trigloporus lastoviza*	1	0.21	100	0.09	23	-
60	*Scorpaena canariensis*	2	0.43	331	0.31	19.5	±4.95
60	*Scorpaena maderensis*	5	1.07	166	0.15	11.8	±1.10
60	*Stephanolepis hispidus*	3	0.64	222	0.21	14.8	±1.04
60	*Synodus synodus*	1	0.21	179	0.17	27.5	-
60	*Trachinus radiates*	3	0.64	599	0.55	23.8	±13.4
80	*Bothus podas*	1	0.21	83	0.08	19	-
80	*Dasyatis pastinaca*	1	0.21	1300	1.20	50	-
80	*Taeniura grabata*	1	0.21	1200	1.11	47	-
80	*Torpedo marmorata*	3	0.64	5400	4.99	45.2	±4.80

Captures obtained with 50 mm mesh trammel nets consisted of 28 different species: 1 cephalopod, 3 elasmobranchs and 24 bony fish, plus some other invertebrates (primarily sea urchins and corals) (table 1). Catches reached 93.16% in terms of abundance and 95.07% of total weight. Discards reached 6.84% in terms of abundance and 4.93% of total weight. Although elasmobranchs made up only a small percentage of the total catch in number (2.17%), due to the size of individuals in this group they accounted for a high percentage of total catch weight (28.59%).

Using nets of 60 mm mesh size a total of 28 different species were captured: 1 cephalopod, 1 elasmobranch and 26 bony fish (table 1). Catches reached 82.60% in terms of abundance and 92.93% of total weight. Discards reached 17.40% in terms of abundance and 7.07% of total weight. Elasmobranchs reached only 3.31% of total catch size (24.29% of total catch weight).

The 80 mm mesh trammel nets captured a total of 13 different species: 4 elasmobranchs and 9 teleosts (table 1). The most numerous species was bogue *Boops boops* Linnaeus, 1758, followed by *M. surmuletus*. Catches reached 81.25% in terms of abundance and 67.53% of total weight. Discards reached 18.75% in terms of abundance and 32.47% of total weight. Elasmobranchs represented 18.76% of the total individual catch which equated to 72.79% of total catch weight.

There were no significant effects of any source of variation between catches, discards and elasmobranchs (table 2) including for the elasmobranch species (table 3).

4. DISCUSSION

The results obtained in this study revealed that there was a great number of species caught in this trammel net fishery. The number of catches declined significantly as net mesh size was increased from 50 mm, to 60 mm to 80 mm, a result that was consistent across all of the studied fishing ground areas. The decrease in catches by the larger mesh net can be attributed to the fact that abundance generally declines exponentially with size (e.g., Jennings *et al.* 2001). The results obtained revealed a clear effect of mesh size on catches but results obtained for discards were less clear and no clear management action regarding elasmobranch can be derived from the usage of different mesh size.

The diversity of species caught by trammel nets in the current study was probably due to the variety of mechanisms by which these nets work to catch fish - gilling, wedging, entangling and pocketing (Erzini *et al.* 2006). In total 21 different species were discarded by the fishery, a number which constituted 10.23% of the total catch abundance. Discard rates are lower in small scale static fisheries (such as those using trammel nets) compared to larger scale fisheries using active gear: 37% (Monteiro *et al.* 2001) to 70% for deepwater crustacean trawlers (Borges *et al.* 2001), 62% for trawlers (Borges *et al.* 2001; Erzini *et al.* 2002), and 50.5% for demersal purse seiners (Gonçalves *et al.* 2004). However, lower mean discard rates (27%) have also been reported for pelagic purse seiners (Borges *et al.* 2001; Erzini *et al.* 2002). Discard rates recorded here were lower to those reported in other studies of artisanal trammel net bycatch (e.g 15 - 49% in Iberian Peninsula waters, Gonçalves

TABLE 2. ANALYSIS OF VARIANCE FOR ABUNDANCE, WEIGHT, LENGTH AND CATCH PER UNIT EFFORT (CPUE) OF CATCHES, DISCARDS AND ELASMOBRANCHS USING 3 DIFFERENT MESH SIZES (50, 60 AND 80 MM) AND FISHING GROUNDS (NORTH-SOUTH); M = MESH; FG = FISHING GROUND; PS-F = PSEUDO F STATISTIC; *= P-VALUE (< 0.05) OBTAINED WITH MONTE CARLO TEST

	Abundance			Weight			Length			CPUE		
	MS	Ps-F	P	MS	Ps-F	P	MS	Ps-F	P	MS	Ps-F	P
Catches												
M	1771.2000	5.883	0.184*	3.4992E7	2.315	0.297*	137.650	0.635	0.626*	1.1507E7	6.299	0.179*
FG	291.340	0.845	0.397	8.0681E5	4.6864E-2	0.841	119.220	0.534	0.474	25389	7.381E-3	0.936
MxFG	301.070	0.874	0.495	1.5115E7	0.877	0.444	216.710	0.972	0.422	1.8268E6	0.531	0.630
Res	344.450			1.7216E7			222.910			3.4397E6		
Discards												
M	3.005	0.882	0.441*	9.6358E5	1.958	0.341*	55.671	0.414	0.785*	36511	0.980	0.611*
FG	5.338	2.549	0.121	9.4149E5	0.571	0.586	20.910	9.2103E-2	0.774	71687	0.674	0.539
MxFG	3.405	1.626	0.231	4.9206E5	0.298	0.879	134.460	0.592	0.570	37247	0.350	0.845
Res	2.093			1.6465E6			227.030			1.0622E5		
Elasmobranchs												
M	0.216	0.213	0.875*	3.4204E6	0.688	0.588*	518.150	0.494	0.634*	3.8347E5	0.442	0.772*
FG	2.450	1.266	0.329	4.6529E6	0.456	0.526	1125	1.042	0.326	5.2488E5	0.302	0.597
MxFG	1.016	0.525	0.596	4.9701E6	0.487	0.647	1048.3	0.971	0.375	8.6577E5	0.499	0.636
Res	1.934			1.0192E7			1079.6			1.7334E6		

TABLE 3. ANALYSIS OF VARIANCE FOR ABUNDANCE, WEIGHT, LENGTH AND CATCH PER UNIT EFFORT (CPUE) OF ELASMOBRANCH SPECIES USING 3 DIFFERENT MESH SIZES (50, 60 AND 80 MM) AND FISHING GROUNDS (NORTH-SOUTH); M = MESH; FG = FISHING GROUND; PS-F = PSEUDO F STATISTIC; *= P-VALUE (< 0.05) OBTAINED WITH MONTE CARLO TEST

	Abundance			Weight			Lenght			CPUE		
	MS	Ps-F	P	MS	Ps-F	P	MS	Ps-F	P	MS	Ps-F	P
Squatina squatina												
M	3.333E-2	0.333	0.737*	3.633E6	0.334	0.751*	371.23	0.333	0.745*	7.344E5	0.448	0.707*
FG	1.192E-1	1.788E-1	1*	22963	3.170E-3	0.896	0.3	4.042E-4	0.911	2.832E5	0.238	0.72
MxFG	0.1	1.5	0.308	1.085E7	1.498	0.299	1113.1	1.499	0.297	1.637E6	1.38	0.266
Res	6.666E-2			7.243E6			742.17			1.185E6		
Mustelus mustelus												
M	0.7	1	0.494*	1.036E6	1	0.498*	155.48	1	0.491*	2.59E5	1	0.49*
FG	2.7	1.975	0.235	3.888E6	1.957	0.215	607.5	1.984	0.222	9.72E5	1.957	0.241
MxFG	0.7	0.512	0.666		0.521	0.655	155.48	0.507	0.644	2.59E5	0.521	0.668
Res	1.366						306.15			4.966E5		
Dasyatis pastinaca												
M	3.333E-2	1	0.506*	56333	1	0.531*	83.333	1	0.51*	3520.8	1	0.496*
FG	3.333E-2	1	0.425	56333	1	0.427	83.333	1	0.333*	3520.8	1	0.409
MxFG	3.333E-2	1	0.458	56333	1	0.437	83.333	1	0.464	3520.8	1	0.452
Res	3.333E-2			56333			83.333			3520.8		

	Abundance			Weight			Lenght			CPUE		
	MS	Ps-F	P	MS	Ps-F	P	MS	Ps-F	P	MS	Ps-F	P
Taenuria grabata												
M	3.333E-2	0.333	0.736*	48000	0.333	0.727*	77.758	0.333	0.741*	4333.3	0.351	0.752*
FG	-1.133E-17	<0		-9.890E-1	<0		0.208	1.341E-3	0.911	333.33	4E-2	0.784
MxFG	0.1	1.5	0.23	1.44E5	1.5	0.271	232.86	1.499	0.296	12333	1.48	0.289
Res	6.666E-2			96000			155.31			8333.3		
Torpedo marmorata												
M	0.3	1	0.508*	9.72E5	1	0.502*	68.101	1	0.532*	60750	1	0.529*
FG	0.3	1	0.392	9.72E5	1	0.457	68.101	1	0.401	60750	1	0.4
MxFG	0.3	1	0.463	9.72E5	1	0.453	68.101	1	0.465	60750	1	0.465
Res	0.3			9.72E5			68.101			60750		

et al. 2007). This is probably due to trammel net canarian fishermen retain more variety of species than Iberian Peninsula artisanal fisheries based on custom and commercial acceptance differences between both regions.

In a trammel net fishery on the western coast of Portugal, Coelho *et al.* (2005) found that 16 elasmobranch species were caught (4.3% of the total catch). Baeta *et al.* (2010) observed catches of 11 elasmobranch species which made up 4% of the total catch. In our study elasmobranchs represented 3.62% of the total catch in number and 37.61% in weight. However, our catch included a smaller number of different elasmobranch species (5 elasmobranchs) probably due to the smaller range of depths sampled and fished or due to inherent characteristics of the Canary Islands elasmobranch fauna composition (Brito *et al.* 2002). *Mustelus mustelus* was the most frequently caught elasmobranch, which could be due to the abundance of the species in the study area. Furthermore, in Europe has been an unregulated rapid rise in reported landings of catches of smaller sharks, particularly smoothhounds (*Mustelus* spp.) and a detailed assessment is needed of where specific species are caught and in what numbers (Nieto *et al.* 2015).

Other measures to reduce discards in the studied trammel net fishery require further testing, but may include: (1) a reduction in soak time of the trammel nets, (2) choice of alternative fishing grounds, and (3) use of different mesh designs.

It was noted throughout the study that most of the discarded elasmobranchs were still alive. In some instances, the fishermen exterminated elasmobranchs in order to sell them or due to the cultural belief that reducing the number of predators will benefit stocks of their target species (Carmelo Dorta 2001, personal observation). Although squatiniforms do feed on commercial fish species including goatfishes (Mullidae) (Baremore *et al.* 2010), in the long term removal of elasmobranch predators would destabilize the balance of the ecosystem with adverse effects of commercial fish stocks. Elasmobranchs are very sensitive to overfishing; some species are already listed on the IUCN Red List as endangered, for example the Angelfish (*Squatina squatina*) which is critically endangered. *Squatina squatina* is an important demersal predator across large portions of the Canarian Archipelago but most of this region is subject to intense demersal fishing (Bravo de Laguna 1973; Bravo de Laguna and Escánez 1975). Angelshark (*S. squatina*) was formerly found throughout European waters, and now it is inferred that almost all of the remaining population is found around the Canary Islands. (Nieto *et al.* 2015). As a conclusion and due to the relatively high catch rates of *S. squatina* obtained by these fisheries there is an urgent need to confirm the species' status in the Canary Islands. It is possible that high numbers of *S. squatina* may still be present around the Canaries and the region could be a hotspot for elasmobranch conservation in Europe, as suggested by the high number of diver observations (De la Cruz *et al.* 2010). It would also be advisable to start a campaign among local Canarian fishing villages to explain the importance of protecting sharks and to promote good fishing practices such us releasing sharks alive since management regarding mesh size have been demonstrated to not be useful.

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6. AUTHORS'S CONTRIBUTION

Conceptualization: JCM, JCH.
Methodology and field work: CD, JCH.
Data analysis: JCH.
Original draft: JCM.
Review and edition of the final draft: JCM, AB, JCH.

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