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Discards of the beach seine fishery in the central coast of Portugal

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Abstract

The beach seine fishery is performed regularly along the Portuguese coast in shallow water sandy areas. The catches and discards of this fishery were studied from March until November 1999, on the coast south of Lisbon. Fishing operations were monitored weekly and estimates of the weight of catches and discards per species were determined for each haul. A total of 60 fish species was identified in the catches but *Scomber japonicus*, *Trachurus trachurus* and *Diplodus bellottii* represented approximately 90% of the catches. For most of the species the percentage of discarded fish was extremely high (ca. 100%). The species for which the estimates of discards were lower than 25% of the catches were *Sardina pilchardus*, *Merluccius merluccius*, *Dicentrarchus labrax*, *Dicentrarchus punctatus*, *T. trachurus*, several Sparidae species, *Spicara maena*, *S. japonicus*, *Solea senegalensis*, and *Solea solea*. Most of the species exhibited a marked seasonal abundance pattern that varied according to the species. Discards also varied considerably within and between seasons. The relationships between discards and total catch, species catch, mean length of fish and percentage of fish above minimum legal size were different according to species. For *S. japonicus* and *S. pilchardus* discards were negatively correlated with their catch, mean length of fish and percentage of fish above minimum legal size, while for *T. trachurus* significant correlations were obtained only for the last two variables.

Keywords: Beach seine; Fishery; Bycatch; Discards; Coastal areas; Portugal

1. Introduction

The beach seine fishery is an old commercial fishery on the Portuguese coast, being reported since early XV century (Franca and Costa, 1979; Martins et al., 2000). It is conducted by small fishing communities distributed along the coast, mainly in the northwest coast. In the past few years the number of fishing licenses has been almost 80 (Martins et al., 2000).

The main target species of the beach seine fishery are small pelagic fish such as mackerel, *Scomber japonicus* (Houttuyn, 1782), anchovy, *Engraulis encrasicolus* (Linnaeus, 1758), horse mackerel, *Trachurus trachurus* (Linnaeus, 1758) and sardine, *Sardina pilchardus* (Walbaum, 1792). According to Martins et al. (2000), these four species represent more than 80% of the total landings.

The grounds of this fishery are coastal shallow sandy areas. Although few studies on the structure and dynamics of fish assemblages of these coastal areas exist for the Portuguese coast (e.g. Cabral et al., 2000), it has been recognized in a large number of studies conducted worldwide that these areas are important nursery grounds for fish (e.g. Gibson, 1973; Lasiak, 1984; Robertson and Lenanton, 1984). The fish assemblages of coastal areas are generally characterized by a marked seasonal variation, which mainly reflect the peak abundance of 0-group fish

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(e.g. Blaber et al., 1995; Moreno and Castro, 1995; Hyndes et al., 1999; Cabral et al., 2000).

Besides the impact on juveniles of target species, the beach seine fishery also produces a large amount of bycatches, since it uses a low selective fishing gear (e.g. Faltas, 1997; Lamberth et al., 1997). Due to the low commercial value of bycatches or to legal constrains, this fishery is responsible for a large quantity of discards.

In Europe, studies on the impact of the beach seine fishery are scarce. The present study aims to estimate the catches and discards of the beach seine fishery at Fonte da Telha and to evaluate their seasonal variation. The relationships between discards and catches, mean length of fish and percentage of individual above legal size in the catches were also studied.

2. Material and methods

The study area is a coastal shallow sandy area, located south to Lisbon (Fig. 1). Commercial beach

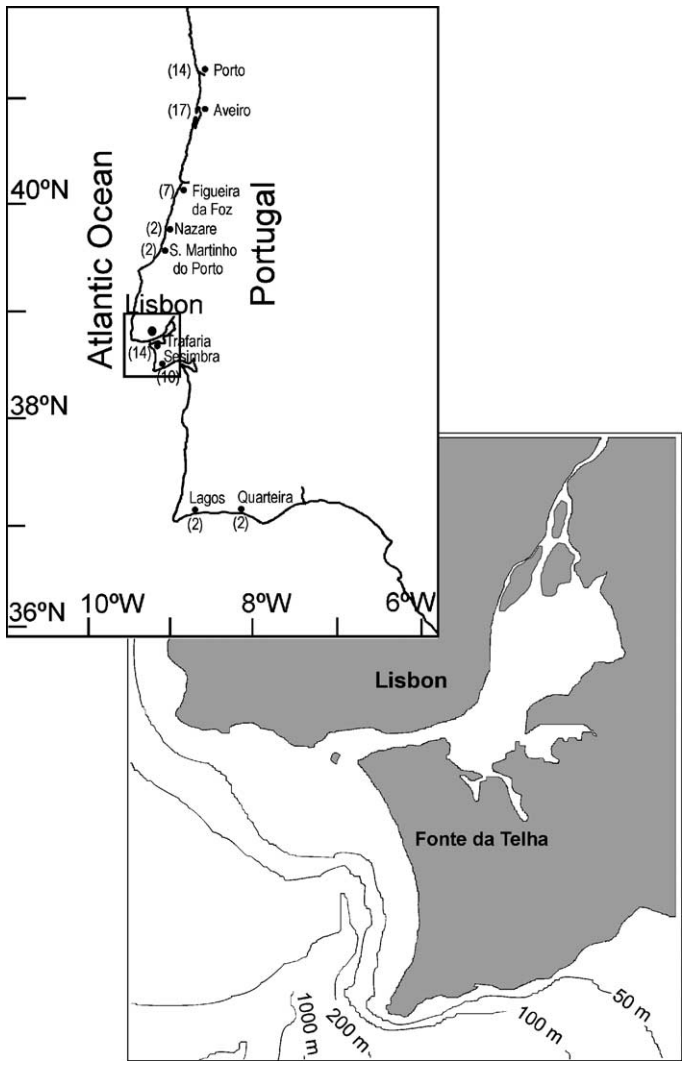

Fig. 1. Location of the study area and of the most important sites for the beach seine fishery along the Portuguese coast (number of vessels that regularly operate are given in brackets).

seine activities were monitored weekly, from March until November 1999 (from December until February this fishery stops due to bad whether conditions in winter period). A total of 72 beach seine hauls was sampled (the number of hauls sampled per week varied between 1 and 3). The vessels that were monitored were randomly selected. Both day- and night-time hauls were sampled. The beach seine nets used in this fishing area were 170 m long and have a central bag of approximately 30 m long with a stretched mesh size of ca. 20 mm. The nets were rowed out into the surf on a boat 3–8 m long, leaving the end of the trailing rope on the shore. The net was then shot around an area and the leading rope brought back to shore. The net was then hauled beachwards. A total of 14 vessels operate regularly in the coastal areas adjoining to Fonte da Telha, having similar characteristics and fishing gears.

For each haul, the total catch per species and the amount discarded were recorded. For the most abundant species, ca. 100 individuals per species in each haul were measured (total length with 1 mm precision) to obtain length frequency distributions.

The fishing effort was estimated based on inquiries made to fishermen at Fonte da Telha. The information collected in these inquiries was relative to the number of hauls performed per day and number of fishing days per week, according to month.

The differences in the estimates of catches and discards (in percentage of the catches) of the most abundant species determined for each period (spring, summer and autumn) were evaluated by a Kruskal–Wallis test. These test procedures were performed using SPSS software and a 0.05 significance level was considered. Whenever the null hypothesis was rejected, post-hoc multiple comparison tests (Dunn test) were performed (Zar, 1996).

Also for the most abundant species in the catches, the relationships between discards and total catch, catch of the species, mean length of fishes and percentage of individuals above legal size were evaluated by Spearman rank correlations. The SPSS software was used and a 0.05 significance level was considered.

3. Results

Fishing effort was extremely variable. The inquiries to fishermen indicated that the number of hauls per day of fishing were from 2 to 12 (mean value 3.1 hauls per day per vessel, for the period between March and November 1999). Fishing operations were carried out throughout the year whenever whether conditions were suitable (generally from March until November), except during weekends and holidays. The number of fishing licenses in this coastal area is 14: three for Fonte da Telha and 11 for Trafaria.

A total of 60 fish species was identified in the catches of the beach seine fishery at Fonte da Telha. The most abundant species were *S. japonicus*, *T. trachurus* and *Diplodus bellottii* (Steindachner, 1882) that represented ca. 90% of the catches. For these species, mean values per haul (catch per unit effort) were 99.4, 86.7 and 31.1 kg, respectively (Table 1). Other abundant species were *Spicara maena* (Linnaeus, 1758), *Boops boops* (Linnaeus, 1758), *S. pilchardus*, *Atherina presbyter* (Cuvier, 1829), and *Trisopterus luscus* (Linnaeus, 1758), although their values were much lower when compared to the three most abundant species (Table 1). The majority of the other species were caught irregularly and presented a low abundance.

Discards estimates were considerably high for most of the species (Table 1). The lower discards estimates were obtained for *Merluccius merluccius* (Linnaeus, 1758), *Dicentrarchus labrax* (Linnaeus, 1758), *Dicentrarchus punctatus* (Bloch, 1792), *T. trachurus*, *Diplodus annularis* (Linnaeus, 1758), *Diplodus sargus* (Linnaeus, 1758), *Pagrus pagrus* (Linnaeus, 1758), *Sparus aurata* (Linnaeus, 1758), *Spondyliosama cantharus* (Linnaeus, 1758), *S. maena*, *S. japonicus*, *Solea senegalensis* (Kaup, 1858), and *Solea solea* (Linnaeus, 1758) (Table 1).

Species abundance in the catches was extremely variable according to season. *S. pilchardus* was more abundant in spring ($H = 14.2$, $P < 0.05$), *S. japonicus* and *S. maena* presented a peak abundance in summer ($H = 6.5$, $P < 0.05$; $H = 7.0$, $P < 0.05$; respectively) and *T. trachurus*, *D. bellottii* and *B. boops* were capture in higher numbers in autumn ($H = 7.2$, $P < 0.05$; $H = 14.9$, $P < 0.05$; $H = 9.8$, $P < 0.05$; respectively) (Table 2). For *A. presbyter* and *T. luscus* the differences in the catches per season were not significant ($H = 1.1$, $P > 0.05$; $H = 1.4$, $P > 0.05$).

The percentage of fish discarded was also considerably variable according to species, haul and season

Table 1
Mean weight per haul, frequency of occurrence (FO), period of higher abundance (PA, for the most abundant species) and discards (percentage of weight) for each species capture in the beach seine fishery at Fonte da Telha (standard deviation values are given in brackets)

Species	Mean weight (kg)	FO (%)	PA	Discarded (%)
Raja undulata	0.01 (0.21)	3		100 (0)
S. pilchardus	4.91 (24.71)	56	March	13 (37)
S. aurita	0.01 (0.05)	3		100 (0)
E. encrasicolus	0.22 (1.28)	21		100 (0)
Belone belone	0.55 (0.90)	59	May	100 (0)
Macroramphosus scolopax	0.02 (0.11)	12		100 (0)
Hippocampus hippocampus	<0.01 (0.02)	3		100 (0)
Syngnathus abaster	<0.01 (0.03)	3		100 (0)
M. merluccius	0.15 (2.81)	6		<1 (2)
T. luscus	1.87 (6.21)	47	August	76 (23)
Ciliata mustela	0.01 (0.02)	3		100 (0)
Zeus faber	0.01 (0.02)	6		100 (0)
D. labrax	0.05 (0.37)	12		<1 (5)
Dicentrarchus puntactus	0.05 (0.38)	12		<1 (4)
Trachinotus ovatus	0.01 (0.02)	6		100 (0)
T. trachurus	86.66 (120.30)	97	September–October	2 (24)
Mullus surmuletus	0.08 (1.00)	12		84 (13)
B. boops	6.81 (42.83)	47	September–October	83 (31)
D. annularis	0.01 (0.02)	3		<1 (3)
D. bellottii	31.09 (215.75)	62	September	96 (35)
D. sargus	0.03 (0.25)	9		2 (4)
Diplodus vulgaris	0.02 (0.40)	6		100 (0)
Pagellus acarne	0.27 (0.99)	53		100 (0)
Pagellus bogaraveo	0.01 (0.03)	3		100 (0)
Pagellus erythrinus	0.08 (0.33)	21		100 (0)
P. pagrus	0.01 (0.04)	3		<1 (2)
Sarpa salpa	<0.01 (0.02)	3		100 (0)
S. aurata	0.04 (0.17)	6		<1 (2)
Spondyliosoma cantharus	0.01 (0.03)	3		<1 (3)
S. maena	7.40 (87.24)	24	September	2 (26)
Symphodus bailloni	0.02 (0.10)	15		100 (0)
Ammodytes tobianus	0.23 (1.36)	41		100 (0)
Echiichthys vipera	0.65 (1.11)	97	August	100 (0)
Trachinus draco	0.02 (0.15)	12		100 (0)
S. japonicus	99.44 (250.28)	76	June–September	7 (49)
Scomber scombrus	0.01 (0.02)	3		100 (0)
Pomatoschistus minutus	<0.01 (0.03)	3		100 (0)
Callionymus lyra	0.05 (0.31)	12		100 (0)
Callionymus maculatus	<0.01 (0.02)	3		100 (0)
Callionymus reticulatus	<0.01 (0.03)	3		100 (0)
Chelon labrosus	0.01 (0.02)	6		100 (0)
Liza aurata	0.29 (1.81)	18		100 (0)
Liza ramada	0.12 (1.35)	6		100 (0)
A. presbyter	2.18	88	August	88 (16)
Aspitrigla obscura	0.19	35		100 (0)
Aspitrigla cuculus	<0.01	3		100 (0)
Trigla lucerna	0.62	74	March	72 (17)
Psetta maxima	0.04	9		29 (9)
Scophthalmus rhombus	0.09	41		62 (21)
Arnoglossus imperialis	<0.01	3		100 (0)
Arnoglossus laterna	0.56	65	August	100 (0)
Arnoglossus thori	0.22	50		100 (0)

Table 1 (*Continued*)

Species	Mean weight (kg)	FO (%)	PA	Discarded (%)
Bothus podas	0.01	15		100 (0)
Buglossidium luteum	0.58	65	August	100 (0)
Dicologlossa cuneata	0.28	41		74 (11)
Solea lascaris	0.67	62	August	99 (8)
S. senegalensis	0.01	3		0 (0)
S. solea	<0.01	3		0 (0)
Balistes carolinensis	<0.01	3		100 (0)

(Table 2). For *T. trachurus*, the mean values of the percentage of fish discarded were lower than 10% for all the seasons ($H = 6.2$, $P < 0.05$). For *S. japonicus*, *B. boops* and *S. pilchardus* the periods with lower discards rates were summer and autumn ($H = 7.1$, $P < 0.05$), autumn ($H = 9.2$, $P < 0.05$) and summer ($H = 7.6$, $P < 0.05$), respectively. For the other abundant species, the percentage of discards was extremely high for all the periods considered and the differences between seasons were not significant.

Discards were not exclusively related to commercial value of fish species. For a large number of species with low commercial value (<6€ kg^{-1}) discards were quite high (Fig. 2). However, for other low commercial value species such as *S. japonicus*, *S. pilchardus*, *T. trachurus* and *S. maena*, discards estimates were extremely low (<20% of the weight of the catches). The percentage of discarded fish of high valuable species was generally low, although most of these species were not abundant.

The relationships between discards estimates determined for each haul and total catch, species catch, mean length of fish and percentage of fish above minimum legal size were different according to species (Table 3). For *S. japonicus* and *S. pilchardus*, the percentage of fish discarded was negatively correlated with species catch, mean length of fish and percentage of fish above minimum legal size, while for *T. trachurus* the significant values of Spearman rank correlation were obtained only for mean length of fish and percentage of fish above minimum legal size (Table 3 and Figs. 3–5). A significant negative correlation was found between percentage of discards of *D. bellottii* and *B. boops* and the weight of the catches of these species (Table 3 and Figs. 3–5). For the other most abundant species no significant correlation values were found.

Table 2
Mean values of estimates of catches and discards (in percentage of weight of fish caught) per season for the most abundant fish species (standard deviation values are given in brackets)

Species	Mean catches (kg per vessel)			Discards (%)		
	Spring	Summer	Autumn	Spring	Summer	Autumn
S. japonicus	8.5 (17.5)	183.9 (297.8)	36.1 (26.2)	67.2 (49.1)	32.2 (46.4)	34.6 (56.6)
T. trachurus	56.1 (45.4)	57.0 (41.7)	312.3 (249.8)	8.0 (27.7)	6.4 (25.0)	4.3 (6.5)
D. bellottii	2.0 (3.7)	1.1 (2.8)	253.0 (492.5)	75.3 (45.7)	100.0 (0.0)	67.3 (56.7)
S. maena	0.0 (0.0)	14.8 (59.9)	0.1 (0.1)	–	85.7 (37.7)	100.0 (0.0)
B. boops	0.3 (0.9)	0.7 (1.4)	54.2 (79.8)	100.0 (0.0)	100.0 (0.0)	39.3 (52.7)
S. pilchardus	9.4 (29.3)	2.4 (7.6)	1.2 (1.3)	91.8 (28.4)	33.5 (57.6)	100.0 (0.0)
A. presbyter	1.0 (0.9)	2.3 (6.8)	2.7 (4.8)	100.0 (0.0)	100.0 (0.0)	77.5 (45.0)
T. luscus	1.2 (3.0)	2.3 (6.0)	0.0 (0.1)	100.0 (0.0)	90.0 (30.0)	100.0 (0.0)
All species	246.7 (355.6)			44.3 (41.6)		
Total (t per year)[a]	1365.1 (1967.7)			604.7 (567.9)		

[a] Considering a mean value of the fishing effort of 3.1 hauls per day per vessel, from March to November, and 14 vessels operating in the study area.

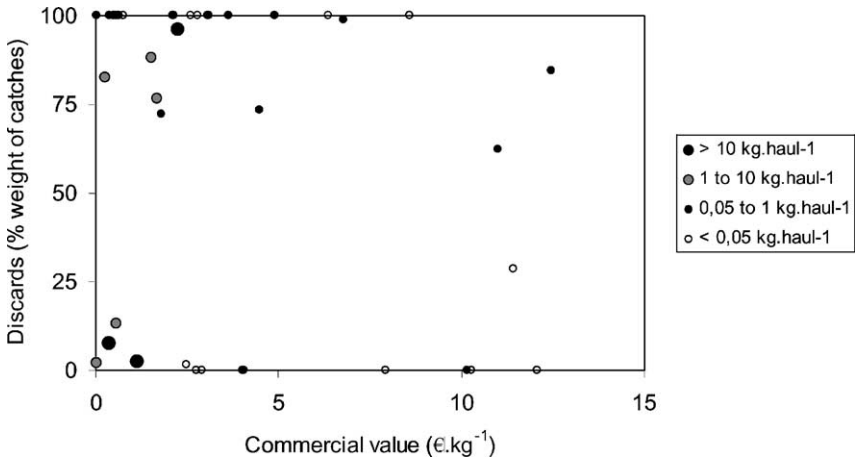

Fig. 2. Percentage of fish discarded (in weight of the catches) in relation to commercial values of species (different symbols were used according to species abundance).

Table 3
Spearman rank correlations between discards estimates (%) for the most abundant species and total weight of the catch, weight of the species catch, mean length of fish in the catch and percentage of fishes above the minimum legal size

Discards	Total catch	Species catch	Mean length	Percentage above MLS
S. japonicus	−0.24	−0.56[a]	−0.42[a]	−0.49[a]
T. trachurus	0.14	0.11	−0.37[a]	−0.41[a]
D. bellottii	−0.15	−0.49[a]	−0.28	–[b]
S. maena	−0.08	−0.58	–	–
B. boops	−0.25	−0.49[a]	–	–
S. pilchardus	0.01	−0.62[a]	−0.43[a]	−0.51[a]
A. presbyter	−0.12	−0.27	–	–
T. luscus	0.14	−0.36	−0.03	–

[a] Significant values, i.e. $P < 0.05$.
[b] Insufficient data.

4. Discussion

The fishing effort of the beach seine fishery at Fonte da Telha was difficult to estimate, since it was only based on inquiries performed to local fishermen communities. The results obtained outlined a high variation of the fishing effort, both in a short- and long-term basis, and that it is mainly influenced by factors such as weather conditions, catches, crowdedness of the beaches and profits in the catches.

Few fish species dominated the catches, particularly several small pelagic fishes, which were the main target species of this fishery. The few studies on the beach seine fishery in North Atlantic and Mediterranean coastal areas also emphasized the importance of these species in the catches. Garcia et al. (1981) reported that the species most frequently found in the catches of the beach seine fishery at Bay of Malaga were *S. pilchardus* and *E. encrasicolus*, mainly as juveniles. Al-Sayes et al. (1981), in a study conducted in Egypt coastal waters, noted that the catches were mainly composed of the commercially important species *Sardinella aurita* (Vallenciennes, 1847), *Sardinella madeirensis* (Lowe, 1838) and *S. pilchardus*. In northeastern Mediterranean, Lefkaditou and Adamiou (1997) reported that *S. pilchardus* accounted for 51% of the catches of the beach seine fishery.

A similar catch composition could also be recognized in distant geographical areas, namely in South Africa, where Clark et al. (1994) and Lamberth et al. (1994) reported that few species represented more than 80% of the total catch.

Coastal areas are important nursery areas for the main target species of the beach seine fishery, and several authors recorded a migration towards deeper marine areas as fish grow (Murta and Borges, 1994; Hyndes et al., 1999). Thus, the fishing activity in these

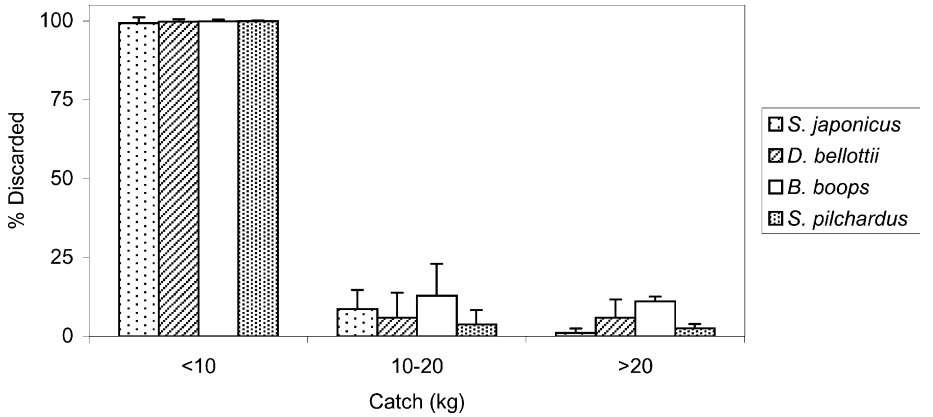

Fig. 3. Percentage of fish discarded according to the catch of the species, for *S. japonicus*, *D. bellottii*, *B. boops*, *S. pilchardus* (standard deviation: lines above bars).

coastal areas is mainly directed to juveniles on their nursery grounds.

The high variability in the catches, both daily and seasonally, reflects the highly dynamic spatial and temporal fish abundance patterns reported for coastal fish assemblages (Lamberth et al., 1995a). Small scale daily variations in some environmental factors such as temperature, waves, wind direction and intensity could have a significant impact in catches (Lefkaditou et al., 1998). Fish behavioral aspects are also important since the majority of the species caught in this fishery aggregate in schools (Masse et al., 1996), which have a considerable impact on estimates variability. The marked seasonal variability found in the present study is characteristic of coastal fish assemblages and mainly reflects the peak abundance of 0-group fish (e.g. Moode and Ross, 1981; Ross et al., 1987; Moreno and Castro, 1995; Lekve et al., 1999).

The beach seine fishery at Fonte da Telha produces a large amount of bycatches, which are mainly discarded. The survival of discards is negligible since they are left in the sand for a long time, and usually above the intertidal area. Faltas (1997) estimated that near 80% of the catches of the beach seine fishery in southeastern Mediterranean (Egypt) were composed of low-valued species, which were mainly

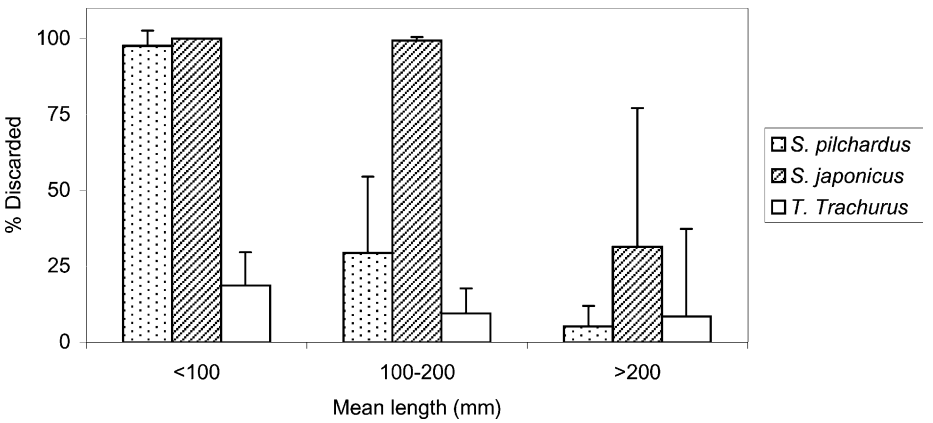

Fig. 4. Percentage of fish discarded according to mean length of fish, for *S. pilchardus*, *S. japonicus* and *T. trachurus* (standard deviation: lines above bars).

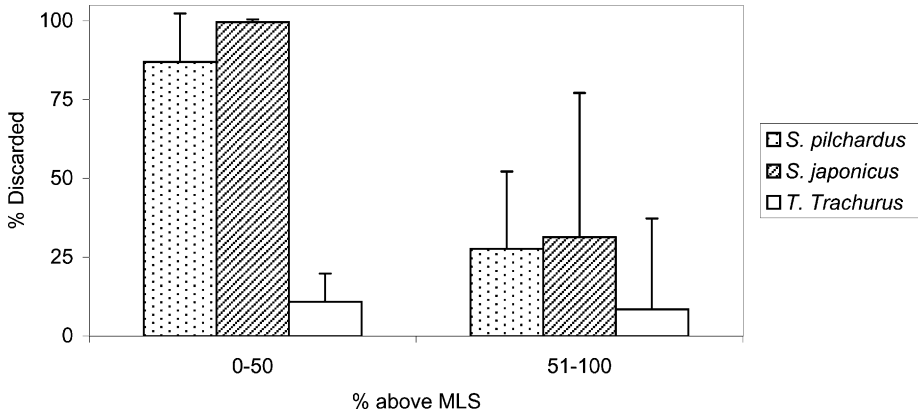

Fig. 5. Percentage of fish discarded according to the percentage of fish with length above the mean legal size (MLS), for *S. pilchardus*, *S. japonicus* and *T. trachurus* (standard deviation: lines above bars).

discarded. Several studies conducted in South Africa, where beach seine is an important fishery, also reported high quantities of bycatches and discards (Clark et al., 1994; Lamberth et al., 1997).

The relationships of discards with several factors considered in the present work were different according to species. Discards of low valuable target species such as *S. japonicus* and *S. pilchardus* were high when the catches of these species were low and when large quantities of fish of small size were caught. In the face of reduced catches of these species, fishermen considered it a waste of time to sort larger specimens among catches. For *T. trachurus*, that has a higher commercial value compared to *S. japonicus* and *S. pilchardus*, discards were independent of its catches values and were only negatively related to the amount of small size fish caught. For this species a higher investment in sorting was confirmed by fishermen, being the discards mainly due to legal constrains of the commercialization of undersized fish.

Several problems could be addressed related to beach seine fishery. Concern over the impact of fishing gear on benthic organisms has been emphasized (e.g. de Groot, 1984; Kaiser et al., 1999; Prena et al., 1999). However, according to Lamberth et al. (1995b), in a study performed in South Africa, beach seine netting does not have a significant detrimental effect on the benthic flora and invertebrate species.

Another major problem that should be addressed is the impact of beach seine fishery on fish juvenile mortality. Although presumably the levels of juveniles mortality are high, Clark et al. (1994), in South Africa, concluded that mortality attributable to this fishery is at most 10% of the natural mortality (which estimates ranged from 30 to 60% of existing standing stocks per month), and in most cases is less than 0.5%. According to these authors, beach seine fishing is therefore unlikely to inflict significant mortality on overall stocks for the majority of the species. However, in this geographical area discards are generally returned to the sea, which strongly decrease mortality estimates. In the Portuguese coast the situation is completely different since discards mortality is surely very high.

Management issues related to this fishery are also of concern. Besides the lack of control and assessment of real fishing effort, a large proportion of the catches with commercial value are sold directly after capture at the beach. Thus, the official landings records, does not incorporate estimates of the discarded fishes, and also underestimate the catches of commercially important species. It is urgent to provide reliable information to support a management plan. Further studies focused on the species abundance and fishing effort estimation are needed to provide an accurate assessment of the impacts of this fishery in coastal nursery areas.

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