MARINE IMPACTS IN THE ANTHROPOCENE

An assessment of discarded catches from the bottom pair trawling fishery in southern Brazil

Luis G. Cardoso[1, *], Danielle da Silveira Monteiro[1, 2] and Manuel Haimovici[1]

[1]Universidade Federal do Rio Grande, Instituto de Oceanografia, Caixa Postal 474, Avenida Itália km 8, CEP 96201-900, Rio Grande, RS, Brazil. [2]Núcleo de Educação e Monitoramento Ambiental, Rua Maria Araújo, 450, CEP 96207-480, Rio Grande, RS, Brazil.
ORCID *Luis G. Cardoso* https://orcid.org/0000-0003-1026-0853

ABSTRACT. Onboard discards of a fraction of the catch can be considered one of the main issues related to bottom trawling fisheries. The magnitude and composition of the discards still need to be better understood. We assessed the industrial bottom pair trawling fishery's discards from southern Brazil by monitoring 159 fishing hauls during four fishing trips. From the 318.9 mt captured, 77.7 t were discarded (24%). The discards per haul were highly variable, on average 488.9 kg (95% CI: 433.6-544.2 kg) and 31% (95% CI 28-34%) of the total. The rejected catch comprised 64 species, 37 teleosts (78.4% in weight) and 13 elasmobranchs (21.3% in weight), besides crustaceans, mollusks, cnidarians, and echinoderms. The three most commercially important species in the region (*Umbrina canosai*, *Cynoscion guatucupa*, and *Micropogonias furnieri*) accounted for 13% of the discarded biomass, and most of them were individuals under 20-25 cm. The discard rates and species composition did not change over the last 40 years; however, the discarded biomass for both teleost fishes and elasmobranchs decreased sharply, reflecting the abundance decrease of these groups in the region. This work highlights the need for management measures to reduce the bottom pair trawling fishery discards in southern Brazil.

Key words: Bycatch, discard rates, endangered species, juvenile fish.

Evaluación de las capturas descartadas de la pesquería de arrastre de fondo a la pareja de fondo en el sur de Brasil

RESUMEN. Los descartes a bordo de una fracción de la captura pueden considerarse uno de los principales problemas relacionados con las pesquerías de arrastre de fondo. Aún es necesario comprender mejor la magnitud y composición de los descartes. Evaluamos los descartes de la pesca industrial de arrastre de fondo a la pareja en el sur de Brasil mediante el seguimiento de 159 lances de pesca durante cuatro salidas de pesca. De las 318,9 tm capturadas, se descartaron 77,7 t (24%). Los descartes por lance fueron muy variables, en promedio 488,9 kg (95% CI: 433,6-544,2 kg) y 31% (95% CI 28-34%) del total. La captura descartada estuvo compuesta por 64 especies, 37 teleósteos (78,4% en peso) y 13 elasmobranquios (21,3% en peso), además de crustáceos, moluscos, cnidarios y equinodermos. Las tres especies de mayor importancia comercial de la región (*Umbrina canosai*, *Cynoscion guatucupa* y *Micropogonias furnieri*) representaron el 13% de la biomasa descartada y la mayoría fueron individuos menores de 20-25 cm. Las tasas de descarte y la composición de especies no cambiaron durante los últimos 40 años; sin embargo, la biomasa descartada tanto de peces teleósteos como de elasmobranquios disminuyó drásticamente, lo que refleja la disminución de la abundancia de estos grupos en la región. En este trabajo se destaca la necesidad de medidas de gestión para reducir los descartes de la pesca de arrastre de fondo a la pareja en el sur de Brasil.

Palabras clave: Captura incidental, tasas de descarte, especies amenazadas, peces juveniles.

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*Correspondence:
cardosolg15@gmail.com

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INTRODUCTION

Incidental catches and subsequent discards of marine life are frequent features of many fisheries worldwide and one of the most important biological and political issues faced by modern fisheries (Gillis et al. 1995; Bellido et al. 2011). Regulation on discards is not common in most fishing jurisdictions (Hall and Mainprize 2005; FAO 2011). However, discards are considered a waste of living resources, and their ecological consequences are still not fully understood (Heath et al. 2014).

Despite trawling fisheries present different métiers, its characteristics of low selectivity generally generate unwanted catches of species besides the targeted ones (Davie and Lordan 2011; Samy-Kamal et al. 2014). The decision to discard is a function of the relative costs and benefits of storing and landing fish or rejecting it (Pascoe 2000). For species without commercial interest, this decision is quite simple since, from the fishers' point of view, there are no benefits associated with landing the discard. For species with a commercial interest, the decision to discard depends on several factors: the price that the catch can attain, the cost of landing it, and the opportunity cost of stocking fish on board (Clucas 1997).

Between 2010 and 2014, on average, 9.1 million t were discarded globally per year, with a massive heterogeneity between fishing gears and regions (Pérez Roda et al. 2019). The trawling fleets accounted for 4.2 million t per year. The shrimp trawling fisheries present the highest discard rate by weight (~ 50% of global catch), and they are exceptionally high in tropical and subtropical regions. Still, otter board and bottom pair trawling's rate of discards were also considerable (Pérez Roda et al. 2019).

Regarding the marine and estuarine fisheries in southern Brazil, several authors quantified the discards rates (Haimovici and Maceira 1981; Haimovici and Habiaga 1982; Haimovici and Mendonça 1996; Vieira et al. 1996; Dumont and D'Incao 2011; Rezende et al. 2019). Haimovici and Habiaga (1982) quantified in detail the bottom pair trawling fisheries discards from two commercial fishing trips occurring in the summer (sum) of 1978 (Haimovici and Maceira 1981) and the spring (spr) of 1979. In the summer cruise, the discard rate was more significant, 40% of the catch's weight, and 26% in the spring. In terms of species composition by weight of the rejected catch, the dominance was of several species of small sharks and rays (sum: 30% and spr: 56%); of largehead hairtail *Trichiurus lepturus* (sum: 19% and spr: 12%) and the Argentine croaker *Umbrina canosai* (sum: 7% and spr: 8%). Discards in numbers of juveniles of the three most important fish species varied between seasons, reaching high percentages: sum: 70% and spr: 26% of *U. canosai*, sum: 63% and spr: 37% of striped weakfish *Cynoscion guatucupa*, sum: 66% and spr: 37% of king weakfish *Macrodon atricauda*. Studies that aged *U. canosai*, *C. guatucupa*, and *M. atricauda* have shown that discarded individuals were juveniles from 1 to 1.5 years old who still were not fully recruited to the adult stock. Other species such as banded croaker *Paralonchurus brasiliensis* and the bluewing searobin *Prionotus punctatus* also occurred in the discarded catch.

The 'Pescadores por Natureza' project carried out by the non-governmental organization Núcleo de Educação e Monitoramento Ambiental (NEMA) sampled several commercial fishing trips of bottom pair trawling by onboard scientific observers. This study aimed to assess the discarded catches in a qualitative and quantitative way and compare the results with those observed by Haimovici and Habiaga (1982) three decades ago.

MATERIALS AND METHODS

We analyzed data from 159 hauls collected by onboard scientific observers during four bottom pair trawling fishing trips carried out from Santa Marta Grande cape (28° 37′ S) to Chuí (33° 41′ S) between 10 and 48 m deep (Figure 1). The trips occurred between November 2011 and May 2012. Three trips lasted 6, 14, and 13 days, respectively, and took place in two industrial fishing boats measuring 23 m in length, with 360 HP engines and a storage capacity of 57 t of fish each. The fourth trip lasted 19 days and took place in a pair of vessels of 25 m in length, with 360 HP engines and a storage capacity of 70 t each.

Bottom trawling nets were made of nylon multifilament and had headropes measuring 38 m and footropes 45 m. The net measured 56 m in length, the bellies 28 m, and the cod-end 28 m. The mesh of the cod-end and the overcoat were 9 cm and 20 cm between opposite knots, respectively.

Hauls lasted between 2.25 and 7 h long (on average 4 h 18 min) and the trawling speed was of approximately 4 nautical miles per hour. After each haul, four fishermen selected the catch to be stored and packed it in hampers. The discarded part of the catch was thrown back to the sea through the deck hatches. To make the fishermen's work compatible with the samplings, the observer recorded the number of hampers per species of the stored catch and visually estimated, together with the vessel's master, the amount of discarded catch. Whenever possible, from each sampled haul, the observer collected a 20 kg box from the catch to be discarded for species discrimination, counting, weighing, and measuring the individuals. Species identifications were made based on the observers' previous experi-

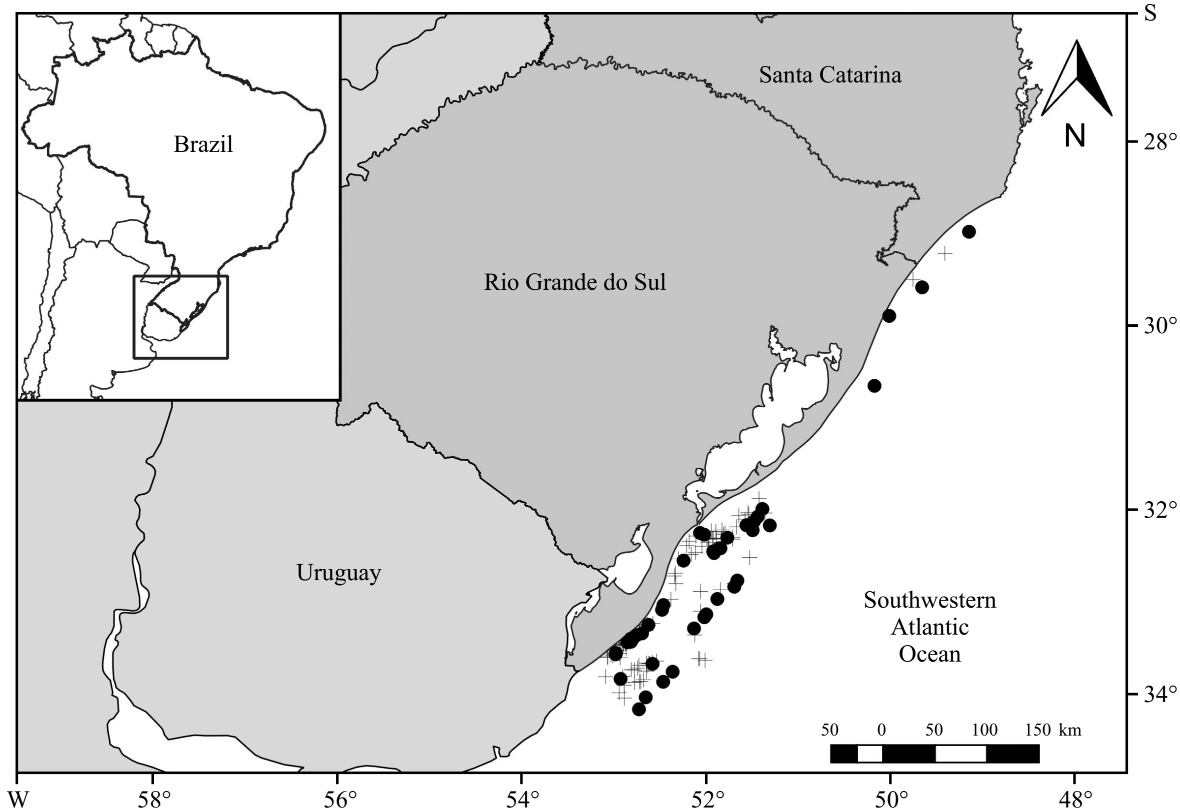

Figure 1. Area with monitored bottom pair trawling fishing hauls in southern Brazil. Crosses represent hauls in which the percentage of total discards was estimated. Solid circles represent hauls in which the composition of discards was sampled.

ence in sampling landings and with the help of identification guides for species present in the coastal waters of southern Brazil by Figueiredo and Menezes (1978, 1980); Menezes and Figueiredo (1980, 1985) and Fischer et al. (2011). Unidentified species were labeled and photographed for later identification.

For each 10 m depth bins, the number of species in the discarded catch was calculated (R = species richness) and the Shanon-Weaver (H) Shanon and Weaver (1949) diversity index, defined as:

$$H = (n \log(n) - \sum_{i=1}^{k} f_i \log(f_i)) \;/\; nt$$

where k is the number of species present in the discards, n is the total number of individuals of all species, and f_i is the number of individuals of each species.

The discarded catch was calculated as average total catches per species, stored catches per species, discarded catches per species, and discarded rates per species. These metrics were compared with those calculated by Haimovici and Habiaga (1982) for two fishing trips with the same fleet realized in the 1970s.

RESULTS

Discards quantification

From a total of 318.9 t caught in the 159 monitored hauls, 77.7 t were discarded, 24% of the total. On average, 488.9 kg (± 55.3 kg) were dumped per haul, however, hauls with between 200 and 400 kg of discards were more frequent (23%) (Figure 2 A). On average, 31% of the total catch was discarded (± 3%, 95% confidence interval). In 26.2% of the hauls, the discarded catch was less than 20% of the total, in 25% was between 20 and 29.9%, and in 48.8% was 30% or more (Figure 2 B).

The discards varied according to haul's depths (Figure 3). The discarded catch percentage was higher between 10 and 20 m (40%) and showed a decreasing trend with increasing depths (Figure 3 A). Total discards (kg) were not significantly different between 10 and 40 m deep (Figure 3 B).

Each monitored fishing trip took place in a different season in the southern hemisphere, spring 2011, summer and autumn 2012. Average discard rates for each season were 31.6% in spring / 2011

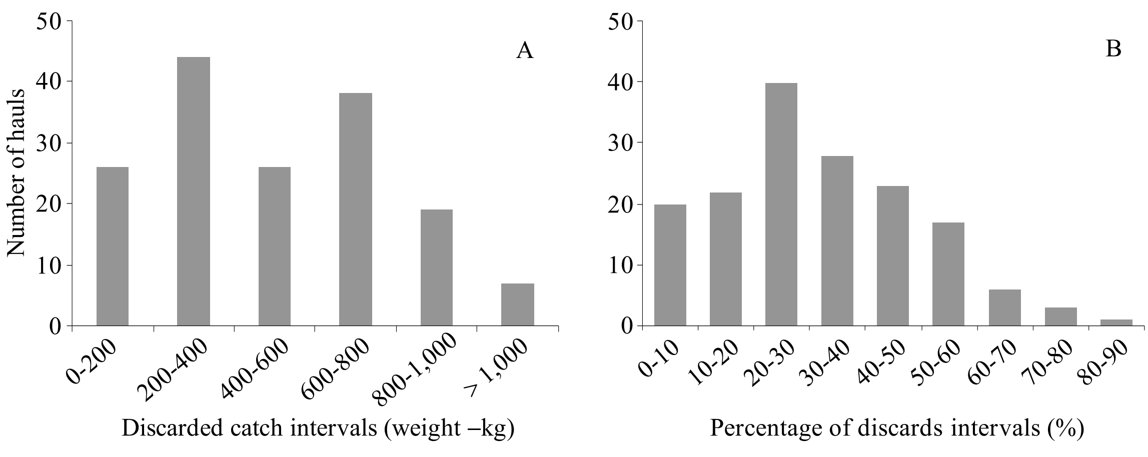

Figure 2. Number of hauls per bin of 200 kg (A) and per bin of 10% (B) of discarded catch on the bottom pair trawling fishing trips monitored in southern Brazil.

(n = 22, sd = 0.19), 35.7% in summer / 2012 (n = 109, sd = 0.15) and 15.2% in autumn / 2012 (n = 26, sd = 0.11). Values differed significantly between seasons (ANOVA, $p < 0.05$). A Tukey test showed that the difference was between autumn and spring and summer. Spring and summer did not differ.

Composition of the discarded catch

In 47 of the monitored hauls, samples were taken from the discarded catch. In each sample, species were identified to the lower taxon, and individuals of each species were counted, weighed (g), and measured (total length –TL in mm). Observers identified 64 species, 37 of which were teleost, 13 elasmobranch, 11 crustaceans, three mollusks in addition to cnidarians and echinoderms that were not identified at the species level (Table 1).

Teleost fish represented 92.5% in number and 78.4% in weight. Elasmobranchs accounted for 5% in number and 21.3% in weight, and crustaceans (crabs and shrimps) accounted for 1.6% in number and 0.8% in weight. Molluscs, cnidarians, and echinoderms represented less than 1% of the total.

Among the teleost fishes, the most abundant in weight was the banded croaker *P. brasiliensis* (18% in number and 20% in weight of teleost fish and present in 62% of the hauls). The most common species was the largehead hairtail *T. lepturus*, present in 79% of the hauls, representing 9% in number and 20% in weight. Seven species represented 80% in number, and 70% of the total rejected teleosts' weight (Figure 4 A).

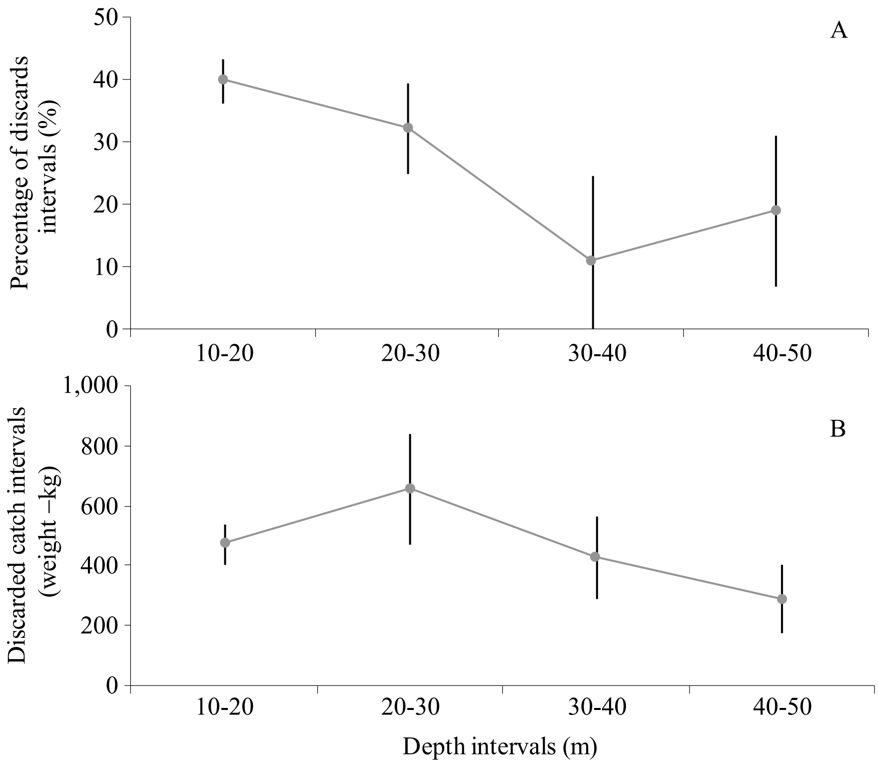

Figure 3. Average discards per depth bin in the bottom pair trawling monitored hauls in southern Brazil. A) Average percentage of discards per haul. B) Average discards in weight per haul. Vertical bars indicate confidence intervals of the means at the 95% level.

Table 1. Number of individuals, total weight, average weight, and frequency of occurrence (FO) of each of the species sampled from the discarded catches in 47 hauls of bottom pair trawling fishing trips monitored in southern Brazil.

Taxonomic group	Species	Number of individuals on the samples	Total weight (kg)	Average weight (kg)	FO (%)
Elasmobranch	*Sympterygia acuta*	174	71.31	0.41	40
Elasmobranch	*Atlantoraja platana*	51	28.2	0.55	13
Elasmobranch	*Atlantoraja cyclophora*	28	16.6	0.59	4
Elasmobranch	*Zapterix brevirostris*	25	5.36	0.21	28
Elasmobranch	*Psammobatis* sp.	23	9.94	0.43	11
Elasmobranch	*Sphyrna lewini*	8	0.3	0.04	2
Elasmobranch	*Sympterygia bonapartii*	7	2.5	0.36	6
Elasmobranch	*Squatina gugenheim*	7	5.5	0.79	9
Elasmobranch	*Atlantoraja castelnaui*	4	1.94	0.49	9
Elasmobranch	*Mustelus* sp.	4	0.42	0.11	9
Elasmobranch	*Pseudobatos horkellii*	4	0.89	0.22	9
Elasmobranch	*Myliobatis* sp.	3	0.2	0.07	2
Elasmobranch	*Gimnura altavela*	7	2.23	0.32	2
Teleost	*Paralonchurus brasiliensis*	1,148	112.43	0.10	62
Teleost	*Stephanolepis hispidus*	1,097	46.57	0.04	53
Teleost	*Cynoscion guatucupa*	922	46.05	0.05	40
Teleost	*Trichiurus lepturus*	562	109.6	0.20	79
Teleost	*Umbrina canosai*	523	36.76	0.07	38
Teleost	*Prionotus punctatus*	448	33.21	0.07	51
Teleost	*Trachurus lathami*	448	9.25	0.02	11
Teleost	*Steliffer* sp.	176	15.5	0.09	15
Teleost	*Peprilus paru*	153	14.94	0.10	45
Teleost	*Micropogonias furnieri*	149	14.62	0.10	21
Teleost	*Dules auriga*	120	10.18	0.08	32
Teleost	*Macrodon atricauda*	114	12.16	0.11	26
Teleost	*Brevoortia pectinata*	107	47.36	0.44	23
Teleost	*Ctenosciaena gracilicirrhus*	89	10	0.11	2
Teleost	*Porychthys porosissimus*	63	5.06	0.08	11
Teleost	*Chylomicterus spinosus*	46	7.67	0.17	17
Teleost	*Cynoscion jamaicensis*	45	4.05	0.09	6
Teleost	*Urophycis brasiliensis*	44	6.24	0.14	34
Teleost	*Mullus argentinus*	40	1.751	0.04	23
Teleost	*Percophis brasiliensis*	28	2.17	0.08	19
Teleost	*Syngnathus folletti*	28	1.55	0.06	9
Teleost	*Paralichtys orbignianus*	24	4.7	0.20	11
Teleost	*Oncopterus darwinii*	13	0.85	0.07	9
Teleost	*Paralichthys patagonicus*	10	0.66	0.07	9

Table 1. Continued.

Taxonomic group	Species	Number of individuals on the samples	Total weight (kg)	Average weight (kg)	FO (%)
Teleost	*Astroscopus sexspinosus*	8	0.85	0.11	9
Teleost	*Pagrus pagrus*	7	0.2	0.03	6
Teleost	*Gymnachirus nudus*	5	0.2	0.04	4
Teleost	*Selene* sp.	4		0.00	9
Teleost	*Citharichtays spilopterus*	3	0.2	0.07	2
Teleost	*Engraulius anchoita*	3		0.00	4
Teleost	*Lagocephalus laevigatus*	3	0.45	0.15	2
Teleost	*Menticirrhus americanus*	3	0.36	0.12	6
Teleost	*Zalieutes mcgintyi*	3	0.033	0.01	6
Teleost	*Balistes capriscus*	1		0.00	2
Teleost	*Paralichtys isosceles*	1	0.13	0.13	2
Teleost	*Oligoplites saliens*	1	0.5	0.50	2
Crustacea	*Arenaeus cribrarius*	2	0.093	0.05	4
Crustacea	*Dardanus insignis*	6		0.00	4
Crustacea	*Hepatus pudibundus*	3		0.00	2
Crustacea	*Ovalipes trimaculatus*	38	4.25	0.11	11
Crustacea	*Portunus spinimanus*	10	1	0.10	9
Crustacea	*Artemesia longinaris*	2		0.00	2
Crustacea	*Callinectes sapidus*	18	0.159	0.01	15
Crustacea	*Libina spinosa*	5	0.24	0.05	2
Crustacea	*Loxopagurus loxochelis*	24	0.31	0.01	17
Crustacea	*Scyllarides* sp.	4	0.31	0.08	6
Mollusc	*Adelomelon brasiliensis*	3	0.2	0.07	2
Mollusc	*Doryteuthis* sp. (lulas)	34	0.7	0.02	17
Mollusc	*Octopus tehuelchus*	2	0.1	0.05	2
Cnidaria		7	14.4	2.06	4
Echinoderm		6	0.4	0.07	2

Among the elasmobranchs, the most abundant and frequent species was the stingray *Sympterygia acuta* (50% in number, 49% in weight of elasmobranchs, and present in 40% of the hauls). Five species accounted for 87% of the abundance in number and 90% by weight of the total of discarded elasmobranchs: stingray *S. acuta*, the Atlantic stingrays *Atlantoraja platina*, and *A. cyclophora*, *Zapterix brevirostris*, and *Psammobatis* spp. (Figure 4 B).

Among the crustaceans, the most abundant species was the swimmer crab *Ovalipes trimaculatus* which represented 32% in number and 62% by weight of the total crustaceans and was present in 11% of the hauls. The most frequent species was the hermit crab *Loxopagurus loxochelis*, which was present in 17% of the hauls and represented 20% of the total number of individuals in the crustacean group (Figure 4 C).

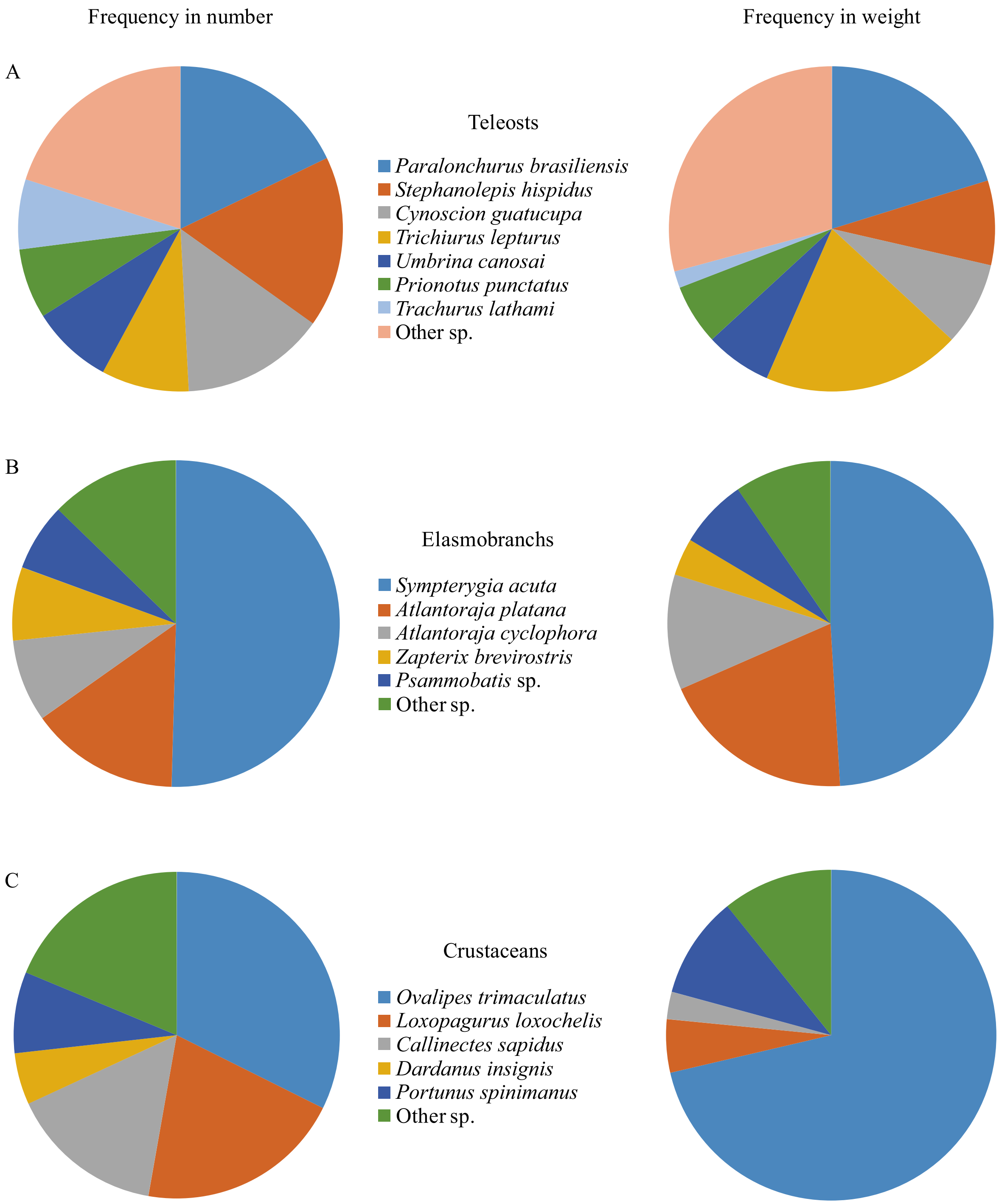

Figure 4. Specific composition of the discarded catch from bottom pair trawling fishing trips monitored in southern Brazil. Percentage in number and weight of species to the total in the taxonomic group. Teleost (A); elasmobranchs (B); crustaceans (C).

Species richness and diversity of the discarded catch per depth range

Both the number of species and the diversity were higher between 20 and 30 m deep (R = 47; H = 1.04) (Figure 5). No pattern was observed between the number of species and the diversity index, as between 30 to 40 m despite a smaller number of species (< 30), the diversity index was higher because the number per species did not differ much. The lack of pattern is because the diversity index considers, in addition to the number of species, the number of individuals per species, and the more equal this number is, the greater the diversity index. The lower diversity was observed between 10 to 20 m, in which a few species dominate. In this depth range, despite the discards being composed of more than 40 species, the diversity index is low since only two species, *P. brasiliensis* and *T. lepturus*, represent 63.2% of the total number of individuals.

Discards of the species of commercial interest

Top five commercial interest species accounted for 27% in number and 21% by weight of the discarded catches of teleost fishes. Among the discarded teleost fishes, *M. furnieri* represented 2% in number and 3% in weight, *U. canosai* 8% and 7%, *C. guatucupa* 14% and 8%, *M. atricauda* 2% and 2% and *Urophycis brasiliensis* 1% and 1%, respectively.

For the first three species (*M. furnieri*, *U. canosai*, and *C. guatucupa*), discarded individuals were composed mainly of fishes smaller than 200 mm TL (Figure 6), corresponding to sexually immature individuals with a maximum of two years old (Haimovici and Reis 1984; Miranda and Haimovici 2007; Cavole and Haimovici 2015). For *M. atricauda*, discarded individuals were also mainly composed of fishes smaller than 200 mm TL (Figure 6), which correspond to a maximum of one year old and can be sexually mature if males and sexually immature if females (Cardoso and Haimovici 2014). For *U. brasiliensis*, the discarded individuals were composed mainly of fishes smaller than 300 mm TL, which, if females can reach two years old and males more than three years old, included sexually mature organisms (Cavole et al. 2018).

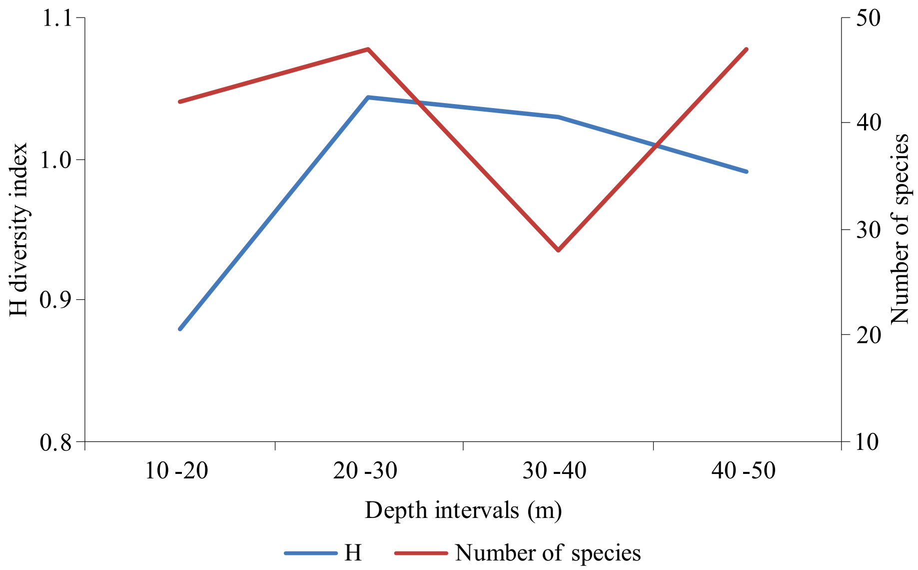

Figure 5. Shannon diversity indices (H) and number of species present in samples from the discarded catch per depth range.

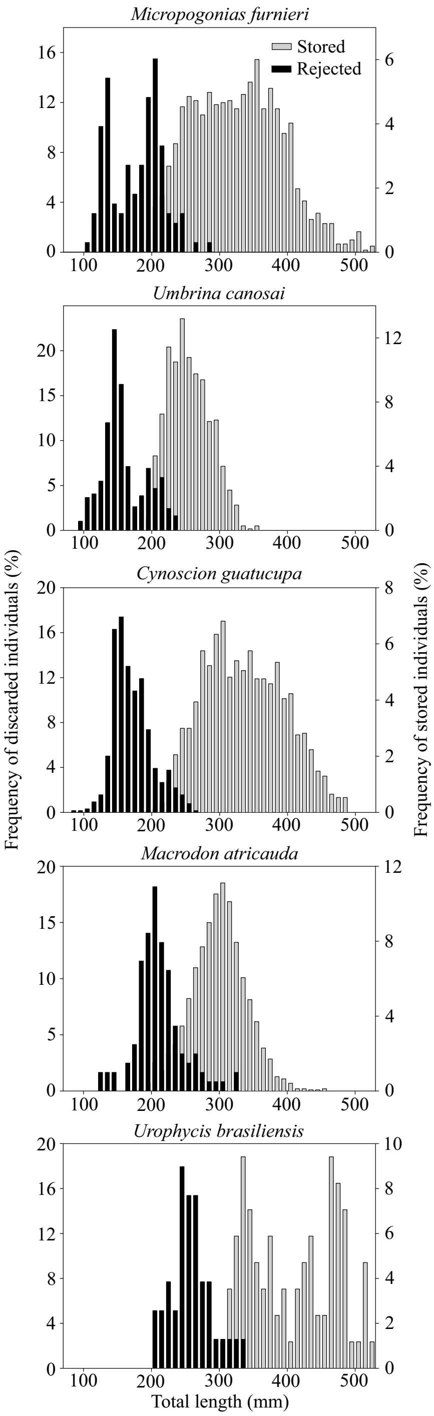

Figure 6. Length composition of stored and discarded individuals for the five main fishing targets of the bottom pair trawling in southern Brazil.

Comparison with the 1970s

Total discard rates presented in this work did not differ significantly from those estimated by Haimovici and Maceira (1981) and Haimovici and Habiaga (1982) three decades ago from commercial bottom pair trawling fishing trips samples (Table 2). However, they differed for some species, e.g. *U. canosai* was much more frequent in the discarded catches in the 1970s while *P. brasiliensis* has been more frequent in recent years (Table 2).

In absolute terms, both the stored total catches and the discarded catch per hour of trawling have decreased along time (Table 2). The most evident change can be seen in the discarded catch per unit of effort for the juveniles of *U. canosai*, *C. guatucupa*, and *M. atricauda* and in total catches of elasmobranch species, which have decreased significantly.

DISCUSSION

The analysis of the discarded catch is essential to evaluate the real impact of fishing on the fish stocks and also to assess the impact of fishing on the entire marine biological community, which is vulnerable to the fishing gears (Heath et al. 2014; Hiddink et al. 2017).

The industrial bottom pair trawling and the double rig bottom trawling affect both juveniles of commercially important species and the demersal biodiversity of the continental shelf of southern Brazil (Haimovici and Habiaga 1982; Haimovici and Mendonça 1996). The discard in kg per haul did not differ between depth ranges, but the rate between the discard and the total catch was higher between 10 to 20 m. Between 20 and 30 m deep, discards were composed of a more significant number of species and a greater biological diversity. Higher discard rates and biological diversity highlight the impact of trawling

Table 2. Average total catches (Tot), stored (Sto), discarded (Disc), and discarded rates (%Disc) per species or species groups in bottom pair trawling fishing trips carried out in southern Brazil during the spring and summer from the 1970s and the 2010s.

	Espada-Delfim March 1978				Espada-Delfim Nov.-Dec. 1979				Primavera VII/VIII Jan.-Feb. 2012				Primavera VII/VIII Nov. 2011			
Species	Tot (kg h^{-1})	Stor (kg h^{-1})	Disc (kg h^{-1})	%Disc (%)	Tot (kg h^{-1})	Stor (kg h^{-1})	Disc (kg h^{-1})	%Disc (%)	Tot (kg h^{-1})	Stor (kg h^{-1})	Disc (kg h^{-1})	%Disc (%)	Tot (kg h^{-1})	Stor (kg h^{-1})	Disc (kg h^{-1})	%Disc (%)
Micropogonias furnieri	105.8	105.8		0	136.6	136.6		0	79.3	70.50	8.87	5	87.5	87.5		0
Umbrina canosai	118.5	56.4	62.1	29	342.8	322.9	19.9	8	56.3	44.40	11.83	6	117.2	113.2	4.1	3
Cynoscion guatucupa	103.2	87.4	15.8	7	174.7	169.5	5.2	2	79.3	68.90	10.45	6	30.4	26.3	4.1	3
Macrodon atricauda	44.6	37.2	7.4	3	30.9	27.6	3.3	1	94.2	82.70	11.48	6	8.3	7.8	0.4	0
Trichiurus lepturus	42.0		42.0	19	30.9		30.9	12	26.5	1.82	24.66	13	14.1		14.1	11
Paralonchurus brasiliensis	19.4		19.4	9	5.3		5.3	2	26.3		26.35	14	3.4		3.4	3
Prionotus punctatus					7.6	2.9	4.7	2	9.5	2.18	7.28	4	14.0		9.0	7
Stephanolepis hispidus									5.6		5.56	3	27.3		27.3	21
Other teleosts	26.8	16.6	6.4	3	33.4	20.4	13.0	5	90.9	62.58	28.33	15	84.4	41.3	43.1	33
Angel sharks and guitarfish	23.3	23.3		0	60.7	28.7	32.0		9.2		9.2	5	2.1		2.1	2
Rays and small sharks	64.3		64.3	30	178.4		178.4		40.4		40.4	22	22.1	0.3	21.8	17
Total	547.9	326.7	217.4	40	995.6	734.9	260.7	26	517.5	333.10	184.4	35	410.9	281.4	129.5	35

in the coastal zone on juveniles of commercially important species, reducing the potential fisheries in the region and preventing the recovery of endangered species of elasmobranchs.

This work shows that 33 years after the first study (Haimovici and Maceira 1981), discard rates of the bottom pair trawling remain high (> 30%) in the spring and summer in southern Brazil. Furthermore, the sizes from which the main species of commercially important teleost species start to be stored remain the same; in general, fish smaller than 20-25 cm are discarded. The fact that the sizes in which fishes are discarded have not changed allows us to suppose that the decrease in discard rates of juveniles of the four main species (Table 2) results from the decrease in the abundance of the adult stocks, which have been suffering intense fishing exploitation for more than seven decades (Haimovici 1998; Vasconcellos et al. 2006; Haimovici and Cardoso 2016). Regarding the elasmobranchs, total catches decreased moderately but discards remain high. The reason is not the lack of a market for small sharks, angelfish, and guitarfish, but the prohibition of landings that discourage directed fishing. The decrease of the elasmobranch catches reflects the substantial decline in their abundance recorded in the last decades in the region (Vooren and Klippel 2005). Some differences regarding the composition of the discarded catches were verified. Currently, *Stephanolepis hispidus* appears the second most abundant species in the discarded catches from spring and summer, while it was not significant in the 1970s.

Our results highlight the necessity for management measures to mitigate discard in the bottom pair trawling fisheries in southern Brazil. Discarded catches include small fish that could be caught in bigger sizes and provide higher yields. Their catch and disposal in smaller sizes mean economically inefficient exploitation of critical natural resources for thousands of fishers, a large number of industries, and consumers. Furthermore, discards include a large number of endangered species whose ecological importance cannot be overlooked.

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