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Incidental capture of *Myliobatis goodei* and *Myliobatis ridens* in artisanal fishing in southern Brazil

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This study described the myliobatids caught in artisanal beach seine fisheries in southern Brazil. Fieldwork was carried out from spring 2012 to winter 2014 in Cassino Beach (Rio Grande, Brazil). Both retained and discarded specimens were identified to species level, and sex, maturity and disc width (DW in cm) were recorded. A total 359 specimens of Myliobatis *spp. were recorded, of which 43.4% were from fishery discards, 31.5% from beach seine and 25.1% from drifting gill-net ('lance de praia', a fishery that has developed recently in the study area). Catches of myliobatids were higher in the spring and autumn. A total of 94* Myliobatis goodei *(24 males, 69 females (eight pregnant) and one unsexed), and 179* Myliobatis ridens *were recorded (24 males, 148 females (17 pregnant) and seven unsexed).* Myliobatis goodei *ranged in size from 45.0–65.0 cm DW (males) and 43.3–115.0 cm DW (females).* Myliobatis ridens *were 45.0–59.0 cm DW (males) and 41.2–98.0 cm DW (females). Both beach seine and gill-net fisheries operated in potential nursery areas for these myliobatid rays, as indicated by the proportionally high number of mature females (including pregnant females) and juveniles found in this study. The rays probably feed and give birth during the warmer seasons of the year (spring and summer) in these areas.*

Keywords: artisanal fishing, Myliobatidae, fishing discards, bycatch, southern Brazil

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INTRODUCTION

The continental shelf of southern Brazil is a dynamic and productive area. The seasonal oceanographic and ecological processes which in turn support a high abundance and diversity of species and fishing activities in this area suggests that it should be considered a discrete unit for management purposes (Castello *et al.*, 1997; Vooren, 1997; Odebrecht & Castello, 2001; Vooren & Klippel, 2005; Braga & Niencheski, 2006). High densities of benthic macroinvertebrates can occur in the inner surf zone, and are an important food source for a variety of species, including Plata pompano *Trachinotus marginatus*, the mullets *Mugil liza* and *M. curema*, Gulf kingcroaker *Menticirrhus littoralis*, southern kingcroaker *Menticirrhus americanus*, whitemouth croaker *Micropogonias furnieri* and several species of rays and sharks (Garcia & Gianuca, 1997). Diversity and abundance of these species is higher in spring and summer (Rodrigues & Vieira, 2010, 2013).

During the summer, the inner areas of the continental shelf are important spawning grounds for commercially important teleosts (including young of the year Argentine anchovy *Engraulis anchoita*) and elasmobranchs (Brazilian guitarfish *Pseudobatos horkelii*, scalloped hammerhead *Sphyrna lewini*, and myliobatid rays) (Castello *et al.*, 1997). According to Vooren & Klippel (2005), these are key areas for the reproduction of 21 species of elasmobranchs in the southernmost coastal waters of Brazil.

The southern Brazilian coastal zone and continental shelf is also an area of intense fishing activities due to the high diversity and abundance of both elasmobranchs and teleosts, which may be targeted or taken as bycatch in commercial fisheries (Vooren, 1997; Boffo & Reis, 2003). Artisanal fishing fleets also operate in fresh water, estuaries and coastal waters. Fishing operations as a whole have intensified in coastal grounds because of the overexploitation of estuarine resources (Reis *et al.*, 1994; Lucena & Reis, 1998; Haimovici *et al.*, 2006). The coastal fishery activities in the region that capture *Myliobatis* rays are beach seine fishing (Vooren, 1997; Velasco *et al.*, 2011) and a new fishing gear, locally known as 'lance de praia'. The 'lance de praia' is a drifting gill-net used perpendicularly to the coast line, which has not been recorded in technical or peer-reviewed publications previously (see details below).

Micropogonias furnieri is the target species for beach seine fishing, which is a traditional fishing gear in the area. This type of fishing uses a motorized boat (up to 8.0 m long, and up to 18 HP power engine), and a beach seine. This is enabled by Federal Ordinance. The beach seine consists of two lateral sections (wings 600 m long, 8 m high and 140 mm mesh size, knot to knot) and a central bag section (100 m long, 25 m high and 90 mm mesh size), where the fishes are retained (Vooren & Klippel, 2005).

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The drifting gill-net 'lance de praia' fishery targets various members of the family Sciaenidae (e.g. *Menticirrhus littoralis*, *M. americanus* and *Macrodon atricauda*). The gill-net is, on average, 1098 m long and 2.75–3.66 m high, with a mesh size of 70 mm, knot to knot (CEPERG/IBAMA, 2011). The beach drifting gill-net is not formally recognized in the current Brazilian fisheries regulations as a specific fishing gear, although it is considered under the 'Diversified Coastal Fishery' category by the fisheries authorities in order to make the legal use of the gear possible (Weigert, 2012).

Myliobatids are viviparous, aplacentary matrotrophic rays that live in coastal waters from the tropics to warm temperate regions. They have a wide disk, elongated thin tails with strong stinging thorns, more or less lateral eyes in the head and small mouth, with teeth forming grinding plates adapted for feeding on crustaceans, molluscs and other invertebrates (Bigelow & Schroeder, 1953; Bond, 1996; Hamlett, 1999; McEachran & de Carvalho, 2002). In the southern continental shelf of Brazil, three species of the genus *Myliobatis* occur: *M. freminvillei* Lesueur, 1824, *M. goodei* Garman, 1885, and *M. ridens* Ruocco, Lucifora, Astarloa, Mabragaña & Delpiani, 2012 (Vooren, 1997). The latter was described by Ruocco *et al.* (2012) and was previously treated as *Myliobatis* BT 'broad teeth' by Vooren (1997).

In southern Brazil, *Myliobatis* spp. are an incidental catch in coastal fisheries (Vooren & Klippel, 2005; Velasco *et al.*, 2011; Velasco & Oddone, 2015), with both adults and neonates of *M. goodei* and *M. ridens* occurring along the coast of the Rio Grande do Sul state (Vooren & Klippel, 2005). The bycatch of myliobatids from beach seine fisheries in this area has been highlighted in recent years. Up to 150 individuals were observed as being caught and discarded in a single throw (Velasco *et al.*, 2011), and there is a report of 178 individuals discarded during fishing operations in spring (Velasco & Oddone, 2015). Nevertheless, details about the fishing mortality of *Myliobatis* spp. are still unknown. The aim of this study was to characterize the incidental capture of these species and other elasmobranchs by the coastal artisanal fishery in southern Brazil, so as to better understand the potential impacts and to better support the design of potential conservation measures for *Myliobatis* spp.

MATERIALS AND METHODS

Study area

The study was conducted on Cassino Beach, part of a 110 km stretch of coastline between latitudes 32°17′30.83″S and 33°11′55.6″S and longitudes 52°15′41″W and 52°41′48.1″W (Figure 1). This area is an intermediate beach with moderate or low mobility (Figueiredo & Calliari, 2006; Pereira *et al.*, 2010) and is one of the main fishing grounds for coastal artisanal and industrial fishing fleets in south and south-west Brazil (Vooren & Klippel, 2005; Velasco *et al.*, 2011).

The fishing gear

In the beach seine fishery, the boat enters the water perpendicularly to the beach, and travels to beyond the surf zone ~300–400 m away from the shore, where the net is set in waters of between 6–8 m water depth. The shore-based fishermen (~16) then pull each end of the net, closing the seine, and the operation is finished when the central section of the net is landed. The captured specimens are found in a sac in this central section of the net. According to the fishermen, the whitemouth croaker season extends from October to January, although catches were low during the study period. The beach seine fishery operated more frequently at sites 1 and 2 (Figure 1), although it was also carried out near site 4 (Figure 1).

In the drifting gill-net fishery 'lance de praia', the boat enters the water perpendicularly to the beach. Immediately after the first or second sandbar (~3 m water depth), the net is set parallel to the shore-line. The shore-based fishermen (~8) then pull one end of the net in the same direction as the coastal current and towards the other end of the net, which is kept secure by one fisherman. When both ends of the net are closer together, then the fishers redistribute themselves to pull the two ends simultaneously, until the net is landed. The king-croaker is the main target of this fishery, with the main fishing season from May to September. The main fishing grounds for this gear were sites 1 and 2 (Figure 1), but it was also carried out at site 4.

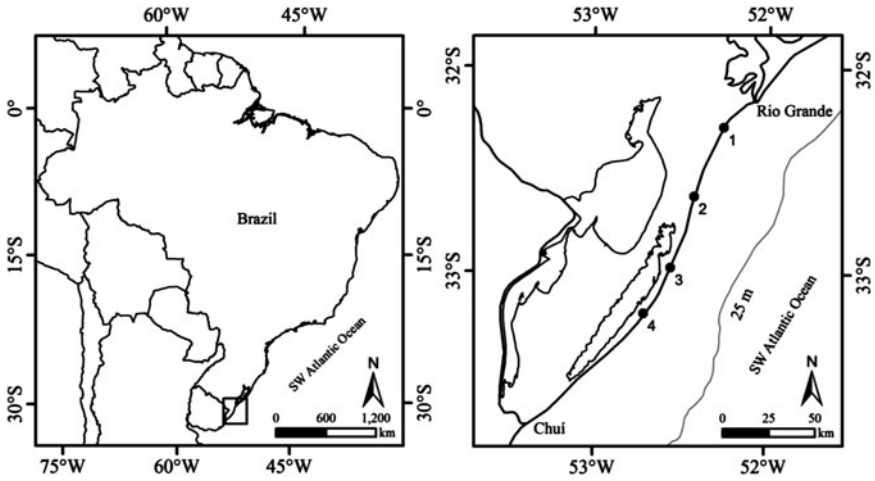

Fig. 1. Map of the study area showing South America (left) and details of the study area, Cassino Beach, southern Brazil (right). Coordinates system and Datum WGS84; Polyconic projection. Produced by Marco Antonio de Oliveira. 1 – Ship Altair; 2 – Sarita lighthouse; 3 – Verga Small lighthouse; 4 – Albardão lighthouse.

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Sampling and data handling

Weekly samples were collected between November 2012 and July 2014, across a total of 114 field trips. The artisanal fishing operations were observed in full, and all captured species were registered (targeted and bycatch). The specimens of *Myliobatis* spp. captured and/or already discarded by the fishermen were recorded and taken for analysis in the laboratory when possible. The fishermen were interviewed for detailed information on the fishing gear, such as the net size and mesh size, as well as fishing time, number of throws per day, catch estimate by throw, and name and size of the boat.

The 'fishing discards' refer to situations in which only the carcasses of myliobatids and other elasmobranchs were found on the beach with no evidence of the type of fishery that discarded them. And when neither fishery operation nor carcasses were observed on the beach the field trips were classified as 'without sampling'.

Specimens of *Myliobatis* were identified according to Figueiredo (1977), Bigelow & Schroeder (1953) and Ruocco *et al.* (2012), the latter was used specially to identify *M. ridens*. Specimens that were in an advanced state of decomposition and the identification to the species level was not possible are referred to as *Myliobatis* spp. in this study. Specimens were sexed and disc width (DW; the pectoral fins measured from tip to tip), and length of the body (LB) (measured from the tip of the snout to the posterior margin of the pelvic fin) were recorded in centimetres. The state of maturation of the gonads was analysed macroscopically and was determined based on the proposed maturity scale for matrotrophic viviparous elasmobranchs of the International Council for the Exploration of the Sea (ICES, 2010, 2013).

The CPUE (catch per unit of fishing effort) was calculated as the number of specimens of *Myliobatis* rays captured by a given fishing operation, i.e. each haul, for both gears, independently.

A multivariate approach (Principal Coordinates Analysis, PCoA) was applied to explore the presence/absence of specimens depending on four factors: seasons, origin of the sample (beach seine fishery; drifting gill-net 'lance de praia'; and fishing discards), sex and state of maturity. Three different types of PCoA were used to understand the relationships between (a) occurrence of species of *Myliobatis* rays and origin of the sample; and the origin of the sample and the seasonal occurrence of each sex and state of maturation of (b) *M. goodei* and (c) *M. ridens*. This type of multivariate approach aims to extract the relationships between variables or objects based on a matrix with indices of similarity or dissimilarity (Manly, 2008). In PCoA, the binary variable, i.e., presence (1) or absence (0), was analysed using the Jaccard similarity index (Romesburg, 1984).

RESULTS

Incidental capture of *Myliobatis* rays

A total of 359 *Myliobatis* rays (94 *M. goodei*; 179 *M. ridens*; two *M. freminvillei* and 84 unidentified *Myliobatis* spp.) were collected between November 2012 to July 2014. There were differences between seasons: 191 individuals were recorded in spring (October to December), 108 in autumn (April to June), and 11 in winter (July to September) and 32 in summer (January to March). The eagle ray *M. freminvillei* was excluded from further analysis, as only two specimens were recorded.

BEACH SEINE FISHERY

A total of eight operations were observed (all during the spring), of which seven captured *Myliobatis* rays. This fishing gear captured 16 *Myliobatis* rays in spring 2012 and 97 in spring 2013 (Table 1). For each operation observed (sampling units), the CPUE ranged from zero to 56 (Table 1). Samples of *M. goodei* (N = 28) comprised 11 males (one immature, eight developing and two mature) and 17 females (two immature, eight developing and seven mature, of which three were pregnant). Samples of *M. ridens* (N = 23) comprised nine males (four immature and five developing) and 14 females (seven immature, two developing and five mature, of which four were pregnant). A further 62 specimens could only be recorded to genus (Table 2). Other elasmobranchs recorded in this fishery were *Sphyrna lewini*, *Mustelus schmitti*, *Narcine brasiliensis*, *Pseudobatos horkelii*, *Gymnura altavela* and *Dasyatis* sp.

DRIFTING GILL-NET `LANCE DE PRAIA´ FISHERY

A total of 59 operations were observed, of which 22 captured *Myliobatis* rays. This fishing gear captured one *Myliobatis* ray in autumn 2013, 31 in spring 2013, 17 in summer 2014, 38 in autumn 2014 and three individuals in winter 2014 (Table 1). The CPUE ranged from zero to 23 (Table 1). Samples of *M. goodei* (N = 27) comprised five developing males and 22 females (one immature, four developing and 17 mature, of which four were pregnant). Samples of *M. ridens* (N = 53) comprised six males (two immature, three developing and one mature) and 47 females (seven immature, 14 developing and 26 mature, of which six were pregnant). Ten specimens were recorded to genus only (Table 2). This fishery also caught specimens of *Squatina guggenheim*, *Sympterygia acuta*, *S. bonapartii*, *Pseudobatos horkelii*, *Sphyrna* spp., *Rhizoprionodon lalandii*, *Mustelus fasciatus*, *Mustelus schmitti* and *Carcharias taurus*.

FISHING DISCARDS

Fishing discards were recorded during 26 field trips (one in spring 2012, one in summer 2013, 12 in autumn 2013, eight in winter 2013, 63 in spring 2013, 14 in summer 2014 and 57 individuals in autumn 2014; Table 1). Samples of *M. goodei* (N = 39, including one unsexed) comprised eight males (one immature, six developing and one mature) and 30 females (five immature, nine developing and 16 mature, of which one was pregnant). Samples of *M. ridens* (N = 103, including seven unsexed) comprised nine males (two immature and seven developing) and 87 females (six immature, 22 maturing and 59 mature, of which seven were pregnant). Fishing discards also included *M. freminvillei* (N = 2) and unidentified *Myliobatis* spp. (N = 12).

SIZE OF SPECIMENS

Specimens of *M. goodei* taken in the beach seine fishery were 45–85.9 cm DW, the 'lance de praia' fishery captured specimens of 46.5–90 cm DW and in the fishing discard specimens of 43.3–115 cm DW were recorded. Overall, the size of *M. goodei* ranged from 45.0–65.0 cm DW (males) and 43.3–115.0 cm DW (females). Immature, developing and mature males were observed over the size ranges 45, 46.9–59.6 and

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Table 1. Number of each *Myliobatis* species observed for each sampling type by season; number of each sampling type observed by season, and CPUE (number of *Myliobatis* rays/fishing operation) average for each fishing gear by season between spring 2012 and winter 2014 in southern Brazil.

	Seasons								
Type of sampling	**Sp 2012**	**Su 2013**	**Au 2013**	**Wi 2013**	**Sp 2013**	**Su 2014**	**Au 2014**	**Wi 2014**	**Total**
Beach seine fishing									
M. g	10				18				28
M. r	6				17				23
M. f									
M. s.					62				62
SN	4				4				8
CPUE	5.3				24.3				
Drifting gill-net 'lance de praia'									
M. g					14		12	1	27
M. r			1		15	17	19	1	53
M. f									
M. s.					2		7	1	10
SN			5	5	7	2	35	5	59
CPUE			1		7.8	8.5	3.2	1	
Fishing discards									
M. g			1	2	25	4	7		39
M. r			9	5	33	8	48		103
M. f			1		1				2
M. s.	1	1	1	1	4	2	2		12
SN	2	1	3	3	9	4	4		26

SP, spring; SU, summer; AU, autumn; WI, winter; *M. g*, *M. goodie*; *M. r*, *Myliobatis ridens*; *M. f*, *M. freminvillei*; *M. s*, *Myliobatis* spp.; SN, sampling number.

60.3–65 cm DW, respectively. The observed size ranges of immature, developing and mature females were 43.3–59, 51.6–72 and 68.5–115 cm DW, respectively. Pregnant females were 77.6–98 cm DW (Table 2).

Specimens of *M. ridens* caught by the beach seine fishery were 39.8–86 cm DW, whilst the 'lance de praia' fishery captured specimens of 41.2–84 cm DW and in the fishing discard were recorded specimens of 42.2–98 cm DW. Overall, *M. ridens* were observed over a length range of 45.0 and 59.0 cm DW (males) and 41.2–98.0 cm DW (females). Immature, developing and mature males were observed over the size ranges 39.8–48.5, 47.7–59 and 55.4 cm DW, respectively. The observed size ranges of immature, developing and mature females were 41.2–56, 47–66.7 and 60.3–98 cm DW, respectively. Pregnant females were 67.9–86 cm DW (Table 2).

Characterization of captures of *Myliobatis* spp

According to the Principal Coordinates Analysis (PCoA) that looked into the seasonal occurrence of species of *Myliobatis* rays and origin of the sample (Figure 2), axis I had 24.7% of the explained variance and axis II had 18.6%. On axis I, the field trips 'without sampling' were more frequent in the summer. *Myliobatis goodei* and *M. ridens* had a higher occurrence in fishing discards in the spring. Unidentified *Myliobatis* spp. were common in beach seine fishing because they were returned alive to the sea by fishermen immediately after their capture, preventing the sampling and classification. On axis II, the drifting gill-net 'lance de praia' was more frequent in autumn and winter (Figure 2).

In the PCoA that included the origin of the sample and the seasonal occurrence of each sex and maturity stage of *Myliobatis goodei* (Figure 3), axis I accounted for 13.7% of the explained variance and axis II accounted for 12.3%. On axis I, developing males were more frequent in the beach seine fishery in spring. Females were more frequent in the drifting gill-net 'lance de praia' fishery in autumn. On axis II, immature females and males were more frequent in the fishing discards in winter and summer (Figure 3).

Finally, in the PCoA with the origin of the sample and the seasonal occurrence of each sex and maturity stage of *Myliobatis ridens* (Figure 4), axis I accounted for 17.4% of the explained variance and axis II for 12.5%. On axis I, developing and mature females were more frequent in the fishing discards in autumn. Males and immature and pregnant females were more frequent in the beach seine fishery in spring. On axis II, the drifting gill-net 'lance de praia' fishery captured more *M. ridens* in summer (Figure 4).

DISCUSSION

This study showed that *Myliobatis goodei* and *M. ridens* move to the shallower waters off southern Brazil during the warmest periods of the year, probably to give birth. More studies with artisanal fisheries in coastal waters are needed in order to provide reliable data for the management of such vulnerable elasmobranch species.

Unidentified *Myliobatis* spp. made up the majority of the samples, as during the fishing operations the fishermen released rays back into the water before it was possible to identify the exact species, as reliable identification requires close observation of the mouth and dental plates (Ruocco *et al.*, 2012). The difficulty in identifying discarded specimens found along the shore, due to their advanced state of decomposition, also contributed to the high frequency of unidentified individuals. Such fishing discards represented the largest samples of *Myliobatis* rays during the study, occurring primarily in spring. It was not possible to determine the type

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Table 2. Number of *Myliobatis goodei* Garman, 1885, and *Myliobatis ridens* Ruocco, Lucifora, Astarloa, Mabragaña & Delpiani, 2012, identified in relation to the maturity stage and sex captured by beach seine fishing and drifting gill-net 'lance de praia' between spring 2012 and winter 2014 in southern Brazil.

Species		*Myliobatis goodei*							*Myliobatis ridens*						
Sex		Male			Female				Male		Female				
Maturity stage		I	D	M	I	D	M	P	I	D	M	I	D	M	P
Beach seine (Sp 2012, 2013)	N	1	8	2	2	8	7	3	4	5	0	7	2	5	4
	SR	45	46.9–59.6	55.5–60.3	50–50.6	55.7–67.1	60.5–85.9	81.4–85.9	39.8–48	47.7–56	–	43.3–48.3	51.5–61	72–86	78.7–86
Drifting gillnet (Sp 2013)	N	0	4	0	0	1	9	1	1	1	1	1	6	5	0
	SR	–	53–58	–	–	ND	68.5–90	90	46	58	55.4	54.9	52–65.3	73.5–84	–
Drifting gillnet (Su 2014)	N	0	0	0	0	0	0	0	1	2	0	6	4	4	3
	SR	–	–	–	–	–	–	–	45	51.6–52.9	–	41.2–52.4	54–61.9	67.9–75.2	67.9–74.1
Drifting gillnet (Au 2013, 2014)	N	0	1	0	1	3	7	3	0	0	0	0	4	16	3
	SR	–	53.2	–	46.5	51.6–59	69.5–88.7	77.6–88.7	–	–	–	–	47–63.4	64.8–83.8	74–83.8
Drifting gillnet (Wi 2014)	N	0	0	0	0	0	1	0	0	0	0	0	0	1	0
	SR	–	–	–	–	–	87	–	–	–	–	–	–	67.3	–

SP, spring; SU, summer; AU, autumn; WI, winter; I, immature, D, developing; M, mature; P, pregnant; N, number of individuals; SR, size range; ND, no data.

of fishing gear responsible for each sample, as both drifting gill-net 'lance de praia' and beach seine fisheries operated, sometimes, in the same sites and seasons.

The fishing discards are specimens brought ashore, but are not sold or consumed. The myliobatids released alive do not show post-release mortality. The discards registered in the shoreline come from fisheries carried out some hours ago, and due to this long time the individuals don't survive.

The two fishing gears use different materials and techniques. Because of this, the composition of the capture of *Myliobatis* rays also was different. The beach seine fishing had the highest CPUE values. This fishing gear has a greater capacity to catch large numbers of individuals (of both target species and bycatch), due to the greater height and resistant material of the central section of the net. The beach seine mesh size is larger than in the drifting 'lance de praia' gill-net, and the whitemouth croaker season coincides with the period of parturition of *Myliobatis* spp. Therefore, the beach seine fishery has a high potential for capturing these rays, as shown in the present work.

In contrast, the drifting gill-net 'lance de praia' has a mesh size specifically designed to capture relatively smaller target species, and sharks and rays may not get entangled and retained by the smaller mesh size. Additionally, the net does not encircle an area, which might allow larger and faster-moving species to escape. Furthermore, the Kingcroaker season occurs during the coldest part of the year, when *Myliobatis* rays are found in deeper waters (Vooren, 1997), so this fishery may have fewer interactions.

In the present study, only two individuals of *Myliobatis freminvillei* were found. According to Vooren (1997), this species is a summer migrant on the southern continental shelf off Brazil. The species is a subtropical marine ray, found between the shore-line and down to 100 m deep, and it is distributed in two sections of the Atlantic Ocean: from Massachusetts to south-east Florida, USA; and from south-eastern Brazil to Argentina (McEachran & de Carvalho, 2002; Cousseau *et al.*, 2007).

Although the other two *Myliobatis* species occurred together in the three types of sampling (beach seine fishing, drifting gill-net 'lance de praia', and fishing discards), especially in spring and autumn, *M. ridens* was more frequent than *M. goodei*. Mature females of both species occurred in all seasons, although were particularly frequent in spring and autumn, whereas immature and developing males and females occurred, almost exclusively, in summer. During autumn, groups of *M. goodei* and *M. ridens*, including females in early pregnancy, concentrated in the shallow waters of the southern continental shelf of Brazil to feed, coinciding with the activities of the drifting gill-net 'lance de praia' fishery (Araújo, personal observation). Pregnant females with near-term embryos (fully developed) were found in spring, when they give birth, coinciding with the activities of the beach seine fishery.

According to Capapé *et al.* (2007), *Myliobatis aquila* uses the shallow coastal waters of southern France during the warmest part of the year to give birth, feed and mate, coinciding with the fishing practices in this region. Martin & Cailliet (1988) suggested that *M. californica* is a summer breeder in the shallow waters of California with a reasonably well-defined annual reproductive cycle. In Anegada Bay, Argentina, *Myliobatis* spp. (given as *M. goodei*, as data were collected prior to the description of *M. ridens* in 2012)

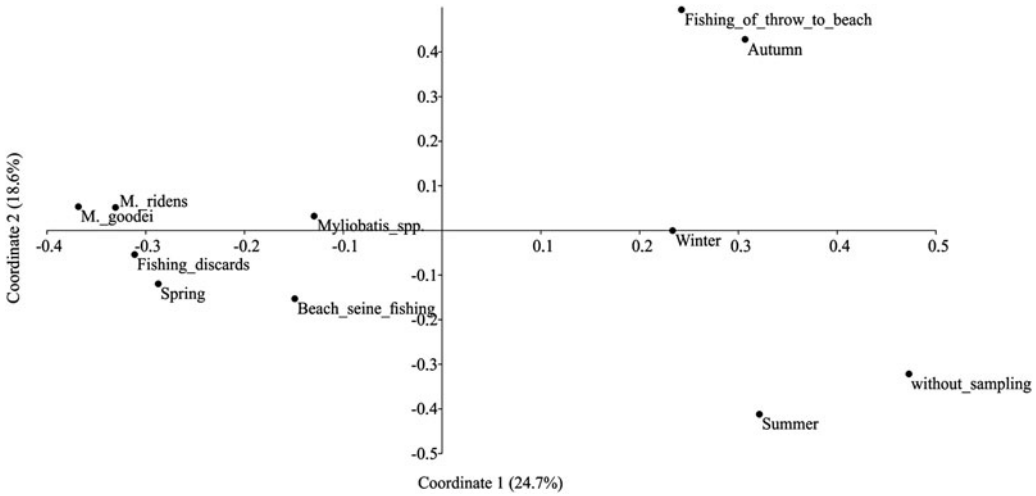

Fig. 2. Principal Coordinates Analysis related to seasons, occurrence of species of *Myliobatis* rays (including the unidentified individuals) and type of sampling between spring 2012 and winter 2014 in southern Brazil.

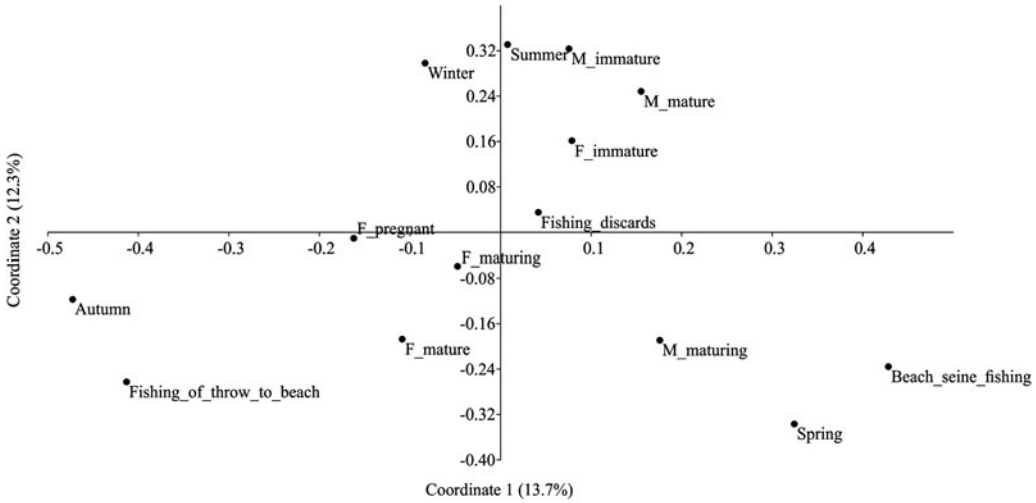

Fig. 3. Principal Coordinates Analysis of seasons, type of sampling and the occurrence for each sex and state of maturation of *Myliobatis goodei* Garman, 1885, between spring 2012 and winter 2014 in southern Brazil. F, Female; M, male.

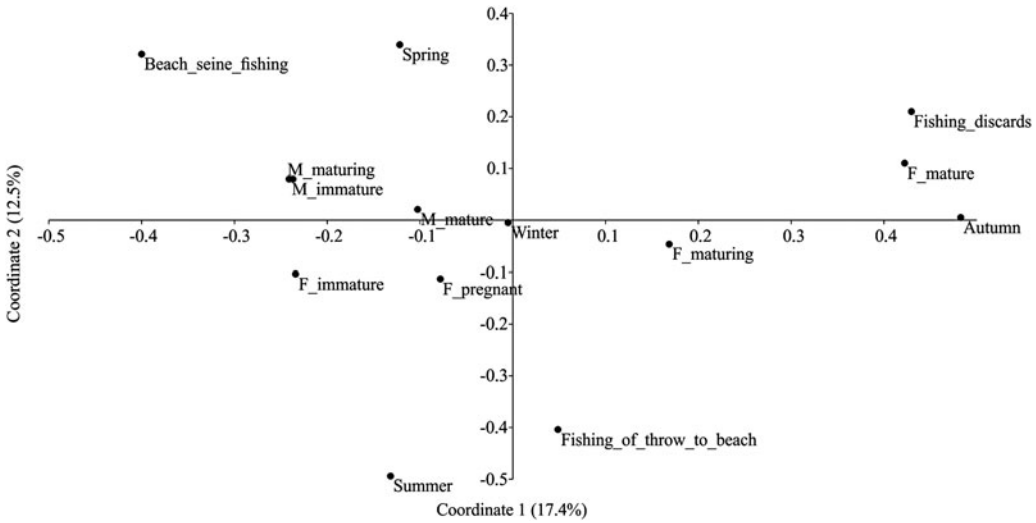

Fig. 4. Principal Coordinates Analysis of the seasons, the type of sampling and the occurrence of each sex and state of maturation of *Myliobatis ridens* Ruocco *et al.*, 2012, between spring 2012 and winter 2014 in southern Brazil. F, Female; M, male.

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occurs only during spring and summer, suggesting the use of sheltered, inshore areas to maximize the survival of newborns (Molina & Lopez Cazorla, 2015).

In this study, both species had a higher number of individuals recorded in the fishing discards. Regarding the type of fishing gear, the drifting gill-net 'lance de praia' captured more *M. ridens* and the beach seine fishing captured more *M. goodei*. It has been suggested that *M. ridens* lives in relatively shallow water, so the drifting gill-net 'lance de praia', which operates at depths down to 3 m, tends to capture this species more often (P.R.V. Araújo, personal observation). On the other hand, *M. goodei* lives in slightly deeper waters and is therefore more vulnerable to beach seine fishing, which operates at depths down to 8 m. The males of both species had the greatest number of individuals captured by beach seine fishing in the spring, so this suggests that they live at greater depths than the females.

Similarly, in Argentina, *Myliobatis goodei* showed a wider bathymetric distribution (5–45 m) than *M. ridens* (5–25 m) (Ruocco, 2012). According to Vooren (1997), on the continental shelf of the Rio Grande do Sul state, *Myliobatis ridens* lives in the coastal area (from the coast to 90 m), while the distribution of *Myliobatis goodei* extends from coastal waters down to 180 m deep. According to Crespi-Abril *et al.* (2013), in a study of bottom trawling in Patagonia, *Myliobatis* rays were found only sporadically throughout the samples because they are coastal species.

Myliobatis rays on the southern shelf off Brazil use shallow waters in the warmest periods of the year to give birth; however, the bathymetric distribution differences between the two species could also be due to feeding habits. According to Ruocco (2012) and Rezende *et al.* (2015), *M. goodei* consumes mainly polychaetes, and *Myliobatis ridens* consumes bivalves and gastropods. In Anegada Bay, Argentina, *M. goodei* had a diet composed mainly of bivalves, even though those authors did not know there could be two species, as *M. ridens* was described only in 2012 (Molina & Lopez Cazorla, 2015). The differences in feeding habitats of the two species are related to the differences in the mouth and head morphometry. *Myliobatis goodei* has a small mouth and delicate dental plates that are adapted to soft and small prey, whereas *M. ridens* has a bigger mouth and more robust dental plates that are adapted to eat prey with harder shells (Ruocco, 2012; Rezende *et al.*, 2015). These differences may also explain the bathymetric distributions of these rays. In the southern continental shelf off Brazil, the vertical distribution of benthic macroinvertebrates in the surf zone is influenced by depth. The shallow waters (2–5 m) are inhabited mainly by gastropods and bivalves; molluscs, gastropods and polychaetes occur in waters of 5–8 m depth; and polychaetes are dominant in deeper (8–10 m) water (Gianuca, 1997). Therefore, *M. goodei* that consumes polychaetes feeds in deeper waters and *M. ridens* that eats bivalves and gastropods feeds in shallower waters.

The movements of *Myliobatis goodei* and *M. ridens* groups to the shallow waters off southern Brazil during the warmest seasons coincides with the activities of the beach seine fishing and the drifting gill-net 'lance de praia' in the region. Comparing the two types of fishing gear, the beach seine fishing presented a greater potential for incidentally capturing *Myliobatis* rays and other elasmobranchs. The gear used in drifting gill-net 'lance de praia' is more specific and selective for its target species and does not threaten bycatch species, and therefore can be implemented without major concerns. Despite such promising findings, the high vulnerability of *Myliobatis* rays reinforces the need for specific conservation measures in southern Brazil to prevent their decline and avoid what happened with the Brazilian guitarfish, a viviparous elasmobranch with restricted geographic distribution (Camhi *et al.*, 1998). It is therefore necessary: (1) to monitor the artisanal fisheries in this region, (2) to develop tools to communicate key facts about the biology of these species effectively to fishermen, (3) to determine the critical areas and the critical periods to prevent or minimize the incidental capture of elasmobranchs during periods of parturition, and (4) promote the live release of incidental bycatch.

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