coasts

MDPI

Article

Opening Pandora's Box: Reconstruction of Catches in Southeast-South Brazil Revealed Several Threatened Elasmobranch Species under One Umbrella Name

Rafael Schroeder [1,2,*], Luís G. Cardoso [3], Luciano G. Fischer [4], Bruno L. Mourato [5], Danielle S. Monteiro [6] and Rodrigo Sant'Ana [1]

1 Laboratório de Estudos Marinhos Aplicados, Escola Politécnica, Universidade do Vale do Itajaí (UNIVALI), Itajaí 88302-901, SC, Brazil; rsantana@univali.br
2 Centro Interdisciplinar de Investigação Marinha e Ambiental (CIIMAR/CIMAR), 4450-208 Matosinhos, Portugal
3 Laboratório de Recursos Pesqueiros Demersais e Cefalópodes, Instituto de Oceanografia, Universidade Federal do Rio Grande (FURG), Rio Grande 96501-900, RS, Brazil; cardosolg15@gmail.com
4 Laboratório de Biologia Marinha, Instituto de Biodiversidade e Sustentabilidade (NUPEM), Universidade Federal do Rio de Janeiro (UFRJ), Macaé 27965-045, RJ, Brazil; luciano.fischer@gmail.com
5 Laboratório de Ciências da Pesca, Instituto do Mar, Universidade Federal de São Paulo (UNIFESP), São Paulo 11070-100, SP, Brazil; bruno.mourato@unifesp.br
6 Laboratório de Estudos para a Pesca Responsável, Instituto de Oceanografia, Universidade Federal do Rio Grande (FURG), Rio Grande 96501-900, RS, Brazil; danismonteiro@yahoo.com.br
* Correspondence: schroederichthys@gmail.com

Abstract: Endangered sharks and rays usually often lack basic information specific to conservation, such as population size. Previous studies have reconstructed shark and ray catch statistics between 1950 and 2019 for the southeast = south of Brazil, but lacking detail at the species level, because the catches were grouped by family, genus or even common name (e.g., skates and rays, Dasyatidae, *Rhinobatos*, Sphyrnidae, Squatinidae). In this study, we used proportions between species from scientific observer fishing trips and Dirichlet regression modelling to reclassify these categories. This model is a multivariate extension of beta regression and enables the modeling of asymmetric and heteroscedastic compositional data, allowing multinomial data to be obtained in a more informative way. The reconstruction of catches for unclassified data showed a massive dominance of the Squatinidae family until the late 1970s, when catches showed signs of decline. At the same time, the rays of the "emplastro" family showed a progressive increase from 2006 onwards. However, this scenario changed after the reclassification. The category Squatinidae was maintained almost exclusively by *S. guggenheim*, while 16 categories of species were observed within "emplastro" rays, many of which fall into "endangered", "vulnerable" and "critically endangered" criteria. These reconstructed series provide a more reliable scenario of the catches of thirty elasmobranch species in the southeast and south of Brazil and serve as baseline information for understanding the conservation status of these species.

Keywords: species proportions; onboard observers; Dirichlet regression; *Squatina guggenheim*; skates and rays; sharks; commercial fisheries

check for updates

Citation: Schroeder, R.; Cardoso, L.G.; Fischer, L.G.; Mourato, B.L.; Monteiro, D.S.; Sant'Ana, R. Opening Pandora's Box: Reconstruction of Catches in Southeast-South Brazil Revealed Several Threatened Elasmobranch Species under One Umbrella Name. *Coasts* **2024**, *4*, 552–567. https://doi.org/10.3390/coasts4030028

Academic Editor: Hidetoshi Urakawa

Received: 8 July 2024
Revised: 18 July 2024
Accepted: 26 July 2024
Published: 1 August 2024

1. Introduction

The proportion of marine elasmobranch species classified as endangered in Brazil has exceeded the global average of 25% estimated by the International Union for Conservation of Nature (IUCN) [1–3]. Basic information on elasmobranch species that would allow abundance estimates or the application of management measures is often lacking [4–6]. Rays and sharks are often landed in the form of carcasses and their identification is at risk depending on genetic markers [7–9]. In addition, the capture of some of these endangered species is prohibited [10], making it even more difficult to obtain species-level information.

Some currently threatened species were once important fishery resources in the southeast and south of Brazil and have been severely depleted by fishing in recent decades [4,11–14]. These include the Scalloped hammerhead shark *Sphyrna lewini* (Griffith and Smith, 1834), the Angular angelfish *Squatina guggenheim* Marini, 1936, the Brazilian guitarfish *Pseudobatos horkelli* (Müller and Henle, 1841), the Spiny butterfly ray *Gymnura altavela* (Linnaeus, 1758), the La Plata skate *Atlantoraja platana* (Günther, 1880), the Caribbean sharpnose shark *Rhizoprionodon porosus* (Poey, 1861) and the Butter ray *Dasyatis hypostigma* Santos and Carvalho, 2004. Most of them, as such *Atlantoraja platana*, *D. hypostigma*, *G. altavela*, *P. horkelli* and *S. guggenheim*, are endemic to South America, occurring on the continental shelf and slope waters from southeast Brazil (20° S) to northern Argentina (45° S), while *S. lewini* has a circunglobal distribution in warm temperate and tropical waters, occurs along the entire Brazilian coast and in oceanic international waters [15–18] and *R. porosus* occurs over the continental shelf from the Caribbean to Uruguay. Despite the knowledge of the biology, distribution and conservation status of these species, historical catch series still lack detail at the species level.

Some initiatives have been undertaken to reconstruct previous catches for these species [5,19,20]. The Sea Around Us initiative has compiled fisheries data by sector (artisanal, industrial, recreational and subsistence fisheries) with the aim of presenting an atlas of global marine catches [21]. Some studies have emphasized the importance of using quantitative data that are difficult to obtain, such as onboard data collection, which can be combined with qualitative information from local experts, resulting in better coverage of catch statistics [20,22,23]. More recently, commercial marine landings for industrial and artisanal fisheries in Brazil were reconstructed from 1950 to 2019 [21].

During this period (1950–2019), catch statistics in Brazil were compiled from various sources and fisheries management was carried out by different institutions [19]. The integration of this database during this period meant that many elasmobranch species were grouped by family, genus or even a general category [5,20,21]. Thus, to reveal these fish categories, accurate indicators were needed to reconstruct the proportion of these species in the catches (i.e., data collected onboard commercial vessels). Data collected onboard by scientific observers in the southeast and south of Brazil have already been shown to be efficient and reflect commercial landings [22,24].

In this case, the existence of solid quantitative information, such as the proportion of species within each category defined by Sea Around us in the catch collected onboard fishing vessels by trained scientific observers, was used to calculate the proportions among species previously categorized into their families, genera or even common names. In the hereby study, these proportions were used from two scientific observation programs onboard industrial fishing vessels conducted by the Universidade Federal do Rio Grande (FURG, Rio Grande, Brazil) and the Universidade do Vale do Itajaí (UNIVALI, Itajaí, Brazil) to reconstruct previous catches of the critically endangered species *A. platana*, *D. hypostigma*, *G. altavela*, *P. horkelli*, *R. porosus*, *S. lewini* and *S. guggenheim*, with the aim of obtaining up-to-date information on historical catches for the conservation of these severely depleted species off southeast and south Brazil.

2. Materials and Methods

2.1. Data Sources

Catches were reconstructed using two different datasets: (1) total catches reconstructed for the southeast and south of Brazil as part of the annual catch reconstruction program conducted by the Sea Around Us initiative between 1950 and 2019 [21], and (2) information collected by scientific observers onboard fishing vessels between 2007 and 2022.

The data reconstructed by Sea Around Us combine official reports and reconstructed estimates of unreported fisheries data (including discards) related to each EEZ [21]. The officially reported data come mainly from the FishStat database of the Food and Agriculture Organization of the United Nations (FAO, see [25], for details). The database has been divided regionally for the southeast and south regions (Figure 1).

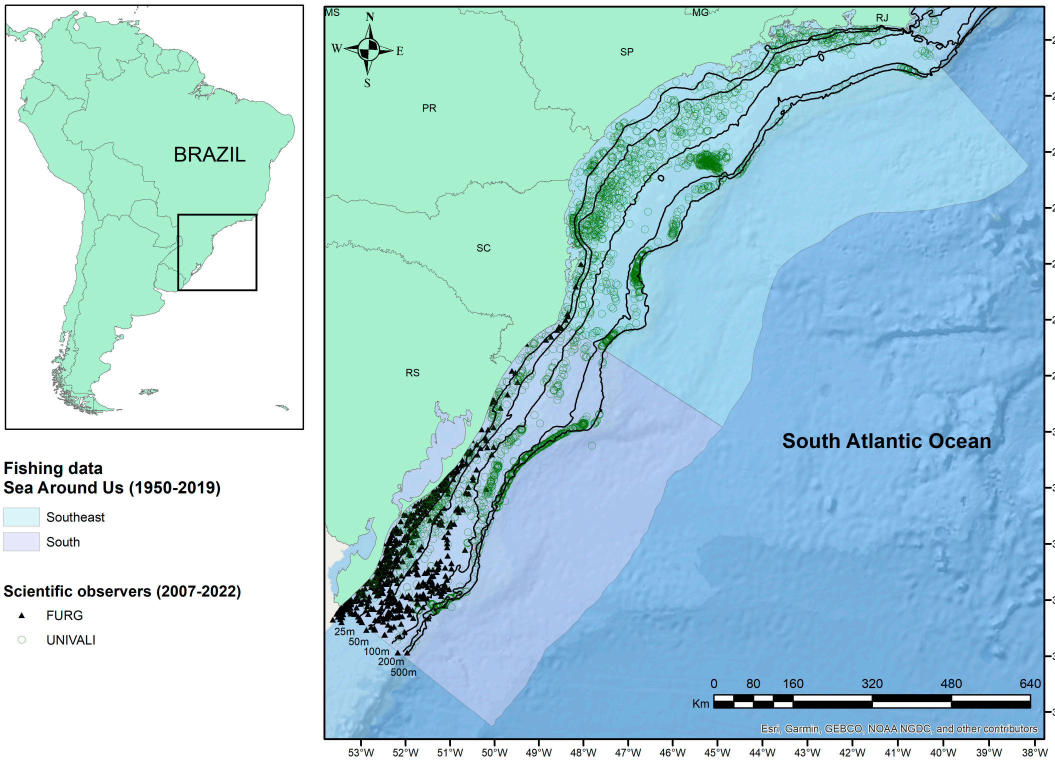

Figure 1. Geographical representation of the total catches reconstructed for the southeast and south of Brazil as part of the annual catch reconstruction program conducted by the Sea Around Us initiative between 1950 and 2019 [21]. The green circles and the black triangles represent the geographical distribution of fishing operations monitored onboard commercial vessels in scientific observation programs carried out by the Universidade do Vale do Itajaí (UNIVALI) and the Universidade Federal do Rio Grande (FURG) between September 2007 and September 2022.

The information observed onboard comes from 3641 fishing operations. Of these, 2970 were from commercial operations from vessels fishing in the southeast region with double trawls, single trawls, purse seines and bottom gillnets, while 671 were from commercial operations from vessels fishing in the south region with pair trawls, purse seine gillnets, bottom gillnets and surface gillnets (Table 1, Figure 1).

Table 1. Summary of the fishing trips performed by the vessels that have operated in the southeast and south of Brazil between September 2007 and September 2022, as part of scientific observation programs carried out by the Universidade do Vale do Itajaí (UNIVALI) and the Universidade Federal do Rio Grande (FURG). Values are presented as minimum and maximum. N, number of fishing operations monitored. Names in brackets represent the target species.

Source	Fishing Gear	Year	Latitude	Longitude	Depth	N
Santa Catarina (UNIVALI)	Double-rig trawl	2008 2014	−23.033 −34.524	−42.969 −52.165	20 445	625
	Simple trawl	2009 2013	−27.329 −32.512	−47.786 −51.076	42 150	223
	Purse seine	2009 2015	−22.021 −33.984	−40.710 −52.196	13.6 196	407
	Bottom gillnet (*Urophycis mystacea*)	2009 2011	−24.545 −30.863	−44.292 −49.067	377 713	17
	Bottom gillnet (*Micropogonias furnieri*)	2008 2011	−23.035 −33.781	−42.615 −53.075	7 141	58
	Bottom gillnet (*Lophius gastrophysus*)	2007 2012	−23.677 −33.874	−41.678 −51.434	200 520	713

Table 1. *Cont.*

Source	Fishing Gear	Year	Latitude	Longitude	Depth	N
Rio Grande do Sul (FURG)	Pair trawl	2022 2022	−27.505 −33.333	−48.318 −51.947	22 90	52
	Gillnet with purse seine	2013 2014	−30.550 −31.556	−50.333 −51.214	7.5 17	18
	Bottom gillnet	2013 2022	−28.661 −36.277	−48.744 −53.934	4 335	551
	Surface gillnet	2013 2022	−31.209 −33.999	−50.771 −53.564	8.6 24	50

2.2. Catch Reconstruction

The catch series reconstructed for the Sea Around Us initiative were grouped by family, genus or even common name, as indicated in brackets: *A. platana* (Skates and Rays), *D. hypostigma* (Dasyatidae–*Dasyatis*), *G. altavela*, *P. horkelli* (*Rhinobatos*, synonym of *Pseudobatos* [18]), *R. porosus*, *S. lewini* (Sphyrnidae–*Sphyrna*) and *S. guggenheim* (Squatinidae). Only *Gymnura altavela* and *Rhizoprionodon porosus* were directly recognized. The other categories required further reclassification.

The proportions of species identified during fishing cruises with scientific observers were determined by counting the organisms during each fishing operation in the southeast and south of Brazil (Table 2, Figure 1). These onboard proportions were first compared with biological samples of elasmobranch species randomly collected from food products sold along the Brazilian coast [7,9,26,27] using a binomial test. This test evaluates the null hypothesis that the two sources of information are not significantly different from a Bernoulli experiment.

Once the proportions of species had been determined, each unclassified category from Sea Around Us [21] was reclassified by multiplying the catch series by these proportions. Once reclassification was complete, the specific catch series were modeled using Dirichlet regression (DirichletReg package). This model is a multivariate extension of beta regression and allows for the modeling of asymmetric and heteroscedastic compositional data [28]. The proportions between species obtained from the onboard observations were fitted to a quadratic regression:

$$y = \text{year} + \text{Iyear}^2 \mid \text{year} \tag{1}$$

where y is the proportions adapted for each species within each category. The model makes it possible to obtain multinomial data in a more informative way and to determine confidence intervals for the model parameters from the variance-covariance matrix.

Subsequently, the catch series were analyzed for temporal variability in a multivariate distance-based redundancy analysis (DB-RDA, vegan package). The DB-RDA model was run twice, for the unclassified and for the reclassified catch series from the Dirichlet regression. Following these analyses, a cluster analysis (k-means) was performed to assess the presence of groups over time [29]. Finally, an average catch curve was reconstructed for all species. In parallel, the evolution of the IUCN-defined threat criteria was presented for three assessments: (i) 2000, (ii) 2004–2009 and (iii) 2016–2020.

Table 2. Summary of the species categories with the catches reconstructed by the Sea Around Us initiative and the respective threatened species using the proportions obtained onboard scientific cruises in the southeast and south of Brazil between 1950 and 2019. Table also shows the respective conservation criteria designated by IUCN and the proportions between the species obtained with data originating onboard in other studies and from genetic analysis (mtDNA). The results of the binomial test are also presented for the target species of this study: *A. platana*, *D. hypostigma*, *G. altavela*, *P. horkelli*, *R. porosus*, *S. lewini* and *S. guggenheim*. DD, data deficient. LC, least concern. NT, near threatened. VU, vulnerable. EN, endangered. CR, critically endangered.

Categories (Sea Around Us)	**Species**	**IUCN**	**Brazilian Region**		**[7]**	**[9]**	**[26]**	**[27]**	**[28]**	**Binomial Test**	
			Southeast	**South**						**Probability**	***p*-Value**
Skate and rays	*Atlantoraja casteunaui*	CR	16.14	10.93		97.87					
	Atlantoraja cyclophora	EN	50.9	12.83		2.13					
	Atlantoraja platana	EN	4.41	4.57		0				1	0.001
	Dipturus leptocauda	VU	1.8	0							
	Dipturus mennii	CR	1.76	0							
	Dipturus spp.	-	8.21	0							
	Psammobatis bergi	LC	0.12	0							
	Psammobatis extenta	LC	1.29	0							
	Psammobatis lentiginosa	LC	0.05	0							
	Psammobatis rutrum	LC	0.98	11.86							
	Psammobatis spp.	-	0.04	0.31							
	Rioraja agassizi	VU	3.43	7.58							
	Sympterigia acuta	CR	1.22	39.68							
	Sympterigia spp.	-	0	6.1							
	Sympterygia bonapartii	NT	0.81	6.13							
	Non discriminated	-	8.83	0							
Dasyatidae; Dasyatis	*Bathytoshia centroura*	VU	2.09	0			2.04				
	Hypanus guttatus	NT	0.3	0			2.04				
	Dasyatis hypostigma	EN	97.61	100		100	90.7			0.96	1
Gymnura altavela	*Gymnura altavela*	EM	100	100				100		1	1
Rhinobatos	*Pseudobatos horkelli*	CR	98.12	99.72	100	93.33		100		0.98	1
	Pseudobatos percellens	EM	0.52	0.28		6.67					
	Pseudobatos spp.	-	1.36	0							
Rhizoprionodon porosus	*Rhizoprionodon porosus*	VU	100 (18.54 *)	100		100		20		0.98	1
	Rhizoprionodon lalandii	VU	100 (81.45 *)	0				80			

Table 2. *Cont.*

Categories (Sea Around Us)	Species	IUCN	Brazilian Region		[7]	[9]	[26]	[27]	[28]	Binomial Test	
			Southeast	South						Probability	*p*-Value
Sphyrnidae; *Sphyrna*	*Sphyrna lewini*	CR	12.09	47.99		43.75		87.5	35	0.54	0.79
	Sphyrna mokarran	CR	1.97	0							
	Sphyrna zygaena	VU	33.77	52.01		52.25		12.5	65		
	Sphyrna spp.	-	52.17	0							
Squatinidae	*Squatina argentina*	CR	24.14	0.04							
	Squatina guggenheim	EM	64.72	99.41	93.75	85		50		0.92	1
	Squatina occulta	CR	5.21	0.53	6.25	15		50			
	Squatina spp.	-	5.93	0.01							

* Proportion between species.

3. Results

3.1. Catch Reconstruction

The reconstructed catches showed that *A. platana* made up 4.56% of the entire "emplastro" category. The "emplastro" category included 15 other rays, namely *Atlantoraja casteunaui* (Miranda Ribeiro, 1907) (14.71%), *Atlantoraja cyclophora* (Regan, 1903) (41.13%), *Dipturus leptocauda* (Krefft and Stehmann, 1975) (9.69%), *Dipturus mennii* (Gomes and Paragó, 2001) (1.20%), *Dipturus* spp. (5.61%), *Psammobatis bergi* (Marini, 1932) (6.03%), *Psammobatis extenta* (Garman, 1913) (0.09%), *Psammobatis lentiginosa* (McEachran, 1983) (0.88%), *Psammobatis rutrum* (Jordan, 1891) (0.04%), *Psammobatis* spp. (0.67%), *Rioraja agassizii* (Müller and Henle, 1841) (1.33%), *Sympterigia acuta* (Garman, 1877) (4.90%), *Sympterigia bonapartii* (Müller and Henle, 1841) (14.24%), *Sympterigia* spp. (2.06%) and undifferentiated "emplastro" (2.63%). Catches of Skates and Rays were modest until 1966 and showed an upward trend from 1967 to 2001, with a peak in 1973 (Figure 2A). From 2002 onwards, catches stabilized and showed a slight downward trend. During the period from 2007 to 2019, catches of *A. platana* were estimated at 627 t, with an average of 48 t per year (Figure 2A).

Dasyatis hypostigma accounted for 97.66% of the total catch of the classes Dasyatidae and *Dasyatis*, followed by the species *Bathytoshia centroura* (Mitchill, 1815) (1.56%) and *Hypanus guttatus* (Bloch and Schneider, 1801) (0.77% of the total). Catches of Dasyatidae and *Dasyatis* were modest until 1977 and showed an upward trend from 1978 to 2000, with a peak in 1984. From 2001 onwards, catches stabilized and showed a slight upward trend. Between 2001 and 2019, catches of *D. hypostigma* were estimated at 2503 t, with an average of 192 t per year (Figure 2B).

Reconstructed catch series for *Gymnura altavela* were possible between 1977 and 1994 (Figure 2C). Catches peaked in 1979 and fluctuated widely throughout the period (1977–1994, Figure 2C).

Pseudobatos horkelli made up 98.08% of the entire *Rhinobatos* category. The *Rhinobatos* class included one other species, *Pseudobatos percellens* (Walbaum, 1792), which accounted for 0.84% of the total, and *Pseudobatos* spp. with 1.08%. Catches were modest until 1958 and showed an upward trend from 1959 to 1997, with a peak in 1977 (Figure 2D). Catches stabilized from 1998 onwards. During 2007 to 2019, catches of *P. horkelli* were estimated at 871 t, with an average of 67 t per year (Figure 2D).

The reconstructed catches for *Rhizoprionodon porosus* were modest until 1969 and showed an upward trend from 1970 to 2006 (Figure 2E). In the period between 2007 and 2019, a downward trend was observed, with catches estimated at 160 t, with an average of 12 t per year (Figure 2E). This species was detected 100% of the time by scientific observers in the southeast region. In relation to its relative *Rhizoprionodon lalandii* (Müller and Henle, 1839), it accounted for 18.54% of the occurrences (Table 2).

In the southeast of Brazil, *S. lewini* accounted for 12.09 per cent of the class Sphyrnidae and *Sphyrna*, followed by *Sphyrna* spp. (52.17%), *S. zygaena* (33.17%) and *S. mokarran* (12.09%). Catches of Sphyrnidae and Sphyrna can be divided into three phases (Figure 2F). Until 1978, catches were modest, showing an upward trend from 1979 to 1989, declining progressively until 2019, peaking in 2012. Between 2007 and 2019, catches of *S. lewini* were estimated at 282 t, with an average of 21 t per year (Figure 2F).

Finally, *Squatina guggenheim* accounted for up to 90% of the weight of the class Squatinidae, followed by *Squatina argentina* (Marini, 1930) (6.7%), *Squatina occulta* (Vooren and da Silva, 1991) (1.8%) and *Squatina* spp. (1.6%). Catches showed an upward trend until 1977, followed by a sudden decline (Figure 2G). Between 1979 and 1997, catches showed a new upward trend and a further sharp decline until 2006. Between 2006 and 2019, catches showed an almost constant profile. Between 2007 and 2019, catches of *S. guggenheim* were estimated at 1964 t, with an average of 151 t per year (Figure 2G).

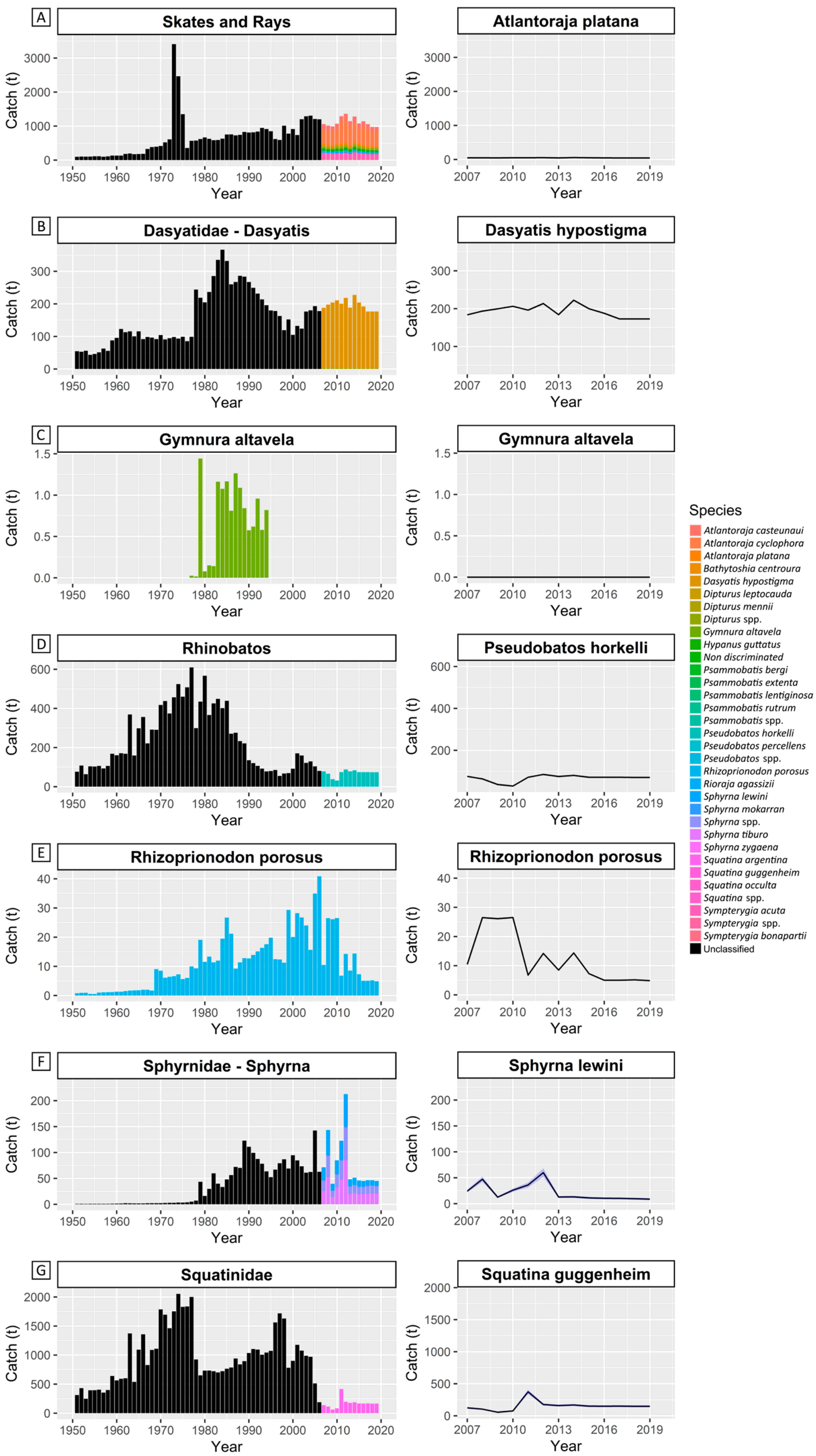

Figure 2. Catch reconstruction for the species identified within each class: Skates and Rays/*Atlantoraja platana* (**A**), Dasyatidae–Dasyatis/*Dasyatis hypostigma* (**B**), *Gymnura altavela* (**C**), *Rhinobatos*/*Pseudobatos horkelli* (**D**), *Rhizoprionodon porosus* (**E**), Sphyrnidae–Sphyrna/*Sphyrna lewini* (**F**) and Squatinidae/*Squatina guggenheim* (**G**) in the southeast and south of Brazil between 1950 and 2019 from proportions calculated using Dirichlet regression. The blue area represents the confidence interval of the estimates.

3.2. Reclassification of the Generic Classes

Between 1950 and 2019, the Squatinidae family and the "emplastro" rays were the most important categories (Figure 3A). The Squatinidae family showed a progressive decline, while the "emplastro" rays increased progressively. This change was most pronounced in 2006. At the same time, the reconstructed catches of *Rhinobatos* decreased progressively during this period, while the Dasyatidae and Dasyatis class showed an almost constant participation over the entire series. The family Sphyrnidae showed greater participation from 1977 onwards. The other species were less expressive (Figure 3A).

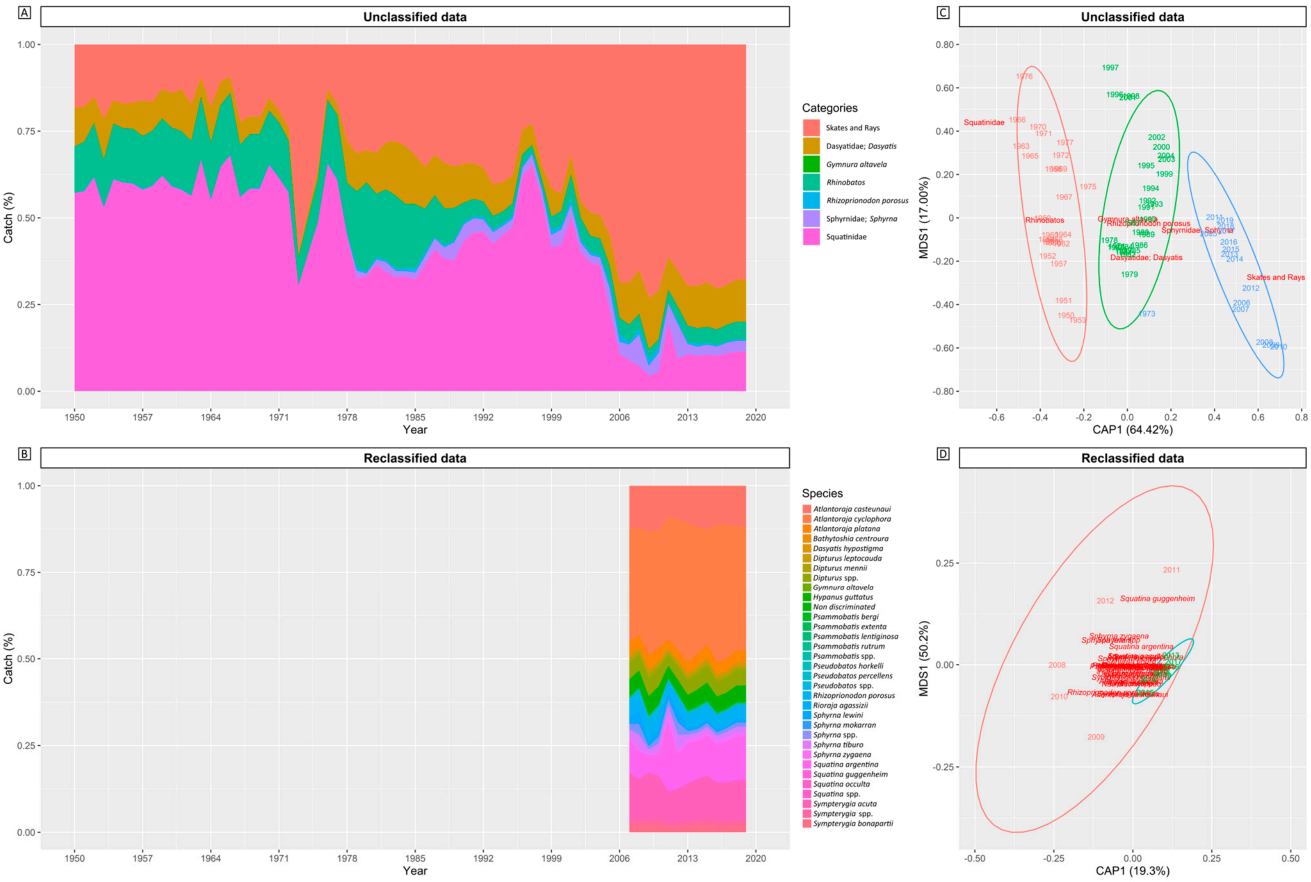

Figure 3. (**A**) Proportion between the species categories reconstructed by the Sea Around Us initiative: Skates and rays, Dasyatidae; *Dasyatis*, *Gymnura altavela*, *Rhinobatos*, *Rhizoprionodon porosus*, Sphyrnidae; *Sphyrna*, and Squatinidae and (**B**) the respective decomposed species: *Atlantoraja castelnaui*, *Atlantoraja cyclophora*, *Atlantoraja platana*, *Dipturus leptocauda*, *Dipturus mennii*, *Dipturus* spp., *Psammobatis bergi*, *Psammobatis extenta*, *Psammobatis lentiginosa*, *Psammobatis rutrum*, *Psammobatis* spp., *Rioraja agassizi*, *Sympterigia acuta*, *Sympterigia* spp., *Sympterygia bonapartii*, Non-discriminated, *Bathytoshia centroura*, *Hypanus guttatus*, *Dasyatis hypostigma*, *Gymnura altavela*, *Pseudobatos horkelli*, *Pseudobatos percellens*, *Pseudobatos* spp., *Rhizoprionodon porosus*, *Rhizoprionodon lalandii*, *Sphyrna lewini*, *Sphyrna mokarran*, *Sphyrna zygaena*, *Sphyrna* spp., *Squatina argentina*, *Squatina guggenheim*, *Squatina occulta*, *Squatina* spp. in the southeast and south of Brazil between 1950 and 2019 and the respective groups identified in each approach (**C**,**D**).

After the reclassification, *S. guggenheim* represented 11% of the total catch between 2007 and 2019 (Figure 3B). The gradual decline of the Squatinidae category (mostly *S. guggenheim*) was followed by a progressive increase in catches of *A. cyclophora*, *A. casteunaui* and *S. acuta* (Figure 3B). In this period, skates and rays represented 76% of the total catch. The results of the k-means analysis for both the unclassified (Figure 3C) and the reclassified reconstructed catches (Figure 3D) showed the presence of two different groups (or time periods) between 2007 and 2019.

A reconstructed average catch curve for all species showed an upward trend in the first period, which was between 1950 and 1972 (Figure 4). A second period, between 1974 and 2004, was characterized by almost stable average catches. The third period covered the end of the time series between 2005 and 2019, including the year 1973, with a clear downward trend from 1973, when the highest average catch was recorded. In the evolution of the threat criteria assessed by the IUCN (2000–2020), the percentage of species falling under the VU, EN and CR criteria was 28% in 2000, increased to 48% between 2004–2009 and reached 68% between 2016–2020.

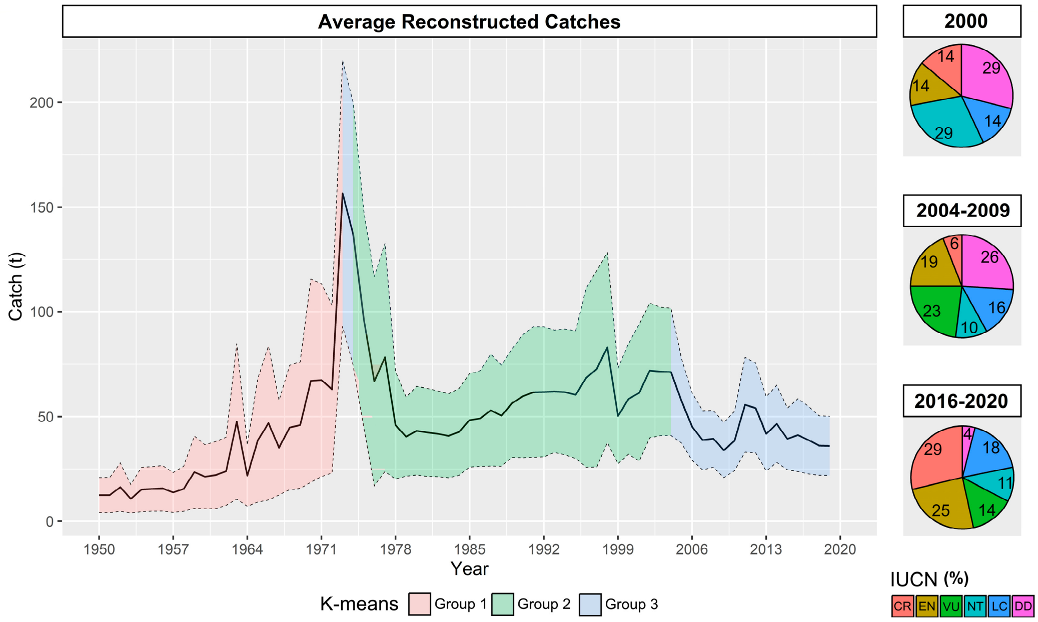

Figure 4. Average catches reconstructed for all species in the southeast-south of Brazil between 1950 and 2019. The colored areas represent the standard error and the colors the groups identified in the K-means analysis. The pie charts represent the conservation criteria assigned to the species present in three moments: (i) 2000, (ii) 2004–2009 and (iii) 2016–2020. DD, data deficient. LC, least concern. NT, near threatened. VU, vulnerable. EN, endangered. CR, critically endangered.

4. Discussion

The reconstruction of the catch series revealed that there are a large number of endangered species. The proportion of species used to reconstruct the catches from the information collected onboard showed a high degree of convergence between the sources of information. This convergence observed between the data collected onboard from different sampling programs without temporal overlap indicates that this information is robust and has low spatial and temporal variability. Consistent with these results, the proportions of species obtained from the onboard data were also in agreement with the sampling programs conducted onboard for *Sphyrna* species [28] and the genetic analyses (mtDNA) for *Dasyatis*, *Gymnura*, *Pseudobatos* and *Squatina* [7,9,26,27]. The exception to this pattern was the proportion of "emplastro" rays. In addition, no specimens of *A. platana*, *Dipturus*, *Rioraja*, *Psammobatis* or *Sympterigia* were found in biological samples of elasmobranch species randomly collected from food sold along the Brazilian coast [29,30].

This difference between sampling programs may be related to the different target species and fishing gear used in each region. In south Brazil, the vessels that caught "emplastro" fished with pair trawls, bottom gillnets and surface gillnets in a more inshore range between 4–92 m, with an average of 29 m. In the southeast region, the vessels worked with double trawlers and single trawls, bottom gillnets and purse seines, which were used in deeper fishing grounds (10–635 m) with an average of 224 m. The use of bottom gillnets to catch Brazilian codling *Urophycis mystacea* and monkfish *Lophius gastrophysus* on the upper and middle slope (240–635 m) in the southeast region captured some species of the family Rajidae, including *Dipturus* rays, which are found exclusively in deep sea [16,18].

On the other hand, studies on the certification of the monkfish fishery have shown that the rays caught in this fishery are destined for export to other countries (Dias, personal communication). In fact, the demand for skate meat under the common name "emplastro" for the Korean market is so great that a movement has been detected aimed at overriding Normative Instruction N° 445 [10], which is one of the instruments regulating trade in marine products [2,9]. Species such as *S. acuta*, *S. bonapartii*, *R. agassizi*, *A. casteunaui*, *A. platana*, *A. cyclophora* and *Hypanus say* (Lesueur, 1817) were previously detected in the class "emplastro" [2], which confirms the results of the present study.

The rays in the category "emplastro" were of great importance in the present study and showed an upward trend during the sampling period. However, *A. platana* is caught intensively with various trawls throughout its range [13,31]. The increase in catches for this species reflects the development of trawling in southeast Brazil in the early 1960s [32]. It is believed that the high fishing pressure exerted on this species by artisanal and industrial fisheries in recent decades has led to a decline in its abundance in this area [13].

Dasyatis hypostigma is still a poorly known species whose distribution limits are not yet well defined [33]. This species is mainly caught with bottom trawls and gillnets in the southeast and south of Brazil [14,34]. Although there are no biomass assessments for this species, the reconstructed catch series reflect the evolution of fisheries throughout the range, with the rapid expansion of the trawler fleet between the 1960s and 2000s in the southeast and south of Brazil [32]. In the south range of species distribution, many stocks in Uruguayan waters were overfished until the late 1990s [14,35].

In the 1980s, *Gymnura altavela* was caught year-round off southeast Brazil at depths between 10–150 m by both artisanal and industrial vessels [36]. Between 1982 and 2005, a decline in catch rates of more than 90% was observed based on data from scientific cruises [37]. The reconstructed catch rates for *G. altavela* showed extreme fluctuations and were not complete for the entire series. In Uruguayan and Argentinean waters, its biomass decreased by 87.4% between 1981 and 2006 [38].

Pseudobatos horkelii is often caught as bycatch in industrial coastal fisheries, e.g., in pair and single trawl fisheries for fish and in double trawl fisheries for shrimp species [39]. In the 1980s, this species was one of the most important fisheries resources and caught with different types of trawls, beach seines and gillnets [40]. Subsequently, declines in catches of more than 80% were observed in its range [37,39,41], confirming the trends observed in this study.

Rhizoprionodon porosus is a target species and is also caught as bycatch in commercial gillnet, longline and trawl fisheries throughout its range, with an overall population decline of 30–49% in the last 14 years [42]. This species has been recognized 100% of the time by scientific observers in the southeast region. However, the relationship with its relative *R. lalandii* reflects the mtDNA studies [30], with a lower abundance in relation to the south region.

Sphyrna lewini is affected by fishing at all life stages [42]. As newborns and juveniles, they are caught in coastal areas mainly with gillnets and trawls [17], as adults mainly with longlines (pelagic and demersal fisheries). Although there are no abundance series for the South Atlantic, the series reconstructed in this study are consistent with trends observed globally [4].

The species of the genus *Squatina* occur from shallow waters on the continental shelf to the upper slope (4–400 m) [16]. The most abundant species, *S. guggenheim*, occurs from estuarine waters to the upper slope (4–360 m) [16], while *S. occulta* inhabits the coastal waters of Rio Grande do Sul (10–350 m) and *S. argentina* is the species with the largest depth range, occurring up to 400 m [43]. In the 1980s and 1990s, trawling and gillnetting posed the greatest threat to this species, which probably led to its sharp decline off south Brazil, causing it to be classified as endangered [43].

In south Brazil, the landings of elasmobranchs consisted of four categories until the 1980s: sharks, angelfish, skates and rays, with the angelfish catch consisting mainly of *S. guggenheim* [11,39,43]. Angelfish were fished intensively until the mid-1980s, when catches peaked at 2000 tons per year [11]. Similar to angelfish, the stock of *Pseudobatos* spp. also peaked between the late 1970s and early 1980s. This population was greatly reduced from the 1980s onwards due to the use of beach trawls and trammel trawls [11,39,41,43]. The Brazilian guitarfish *Pseudobatos horkelli* and the angelfish *Squatina* spp. are the two species of interest to the trade [12,41,43]. In comparison, it is possible to speculate that the progressive increase in the "emplastro" category may be related to the decline in catches of species of the genus *Squatina*, the most abundant category among the species with reconstructed catches. At the beginning of the 1980s, the abundance of demersal elasmobranchs was 90 per cent made up of angel sharks, rays and skates [44–46], which was very similar of those observed in the hereby study, where angel sharks, rays and skates constituted 93.26% of the total demersal elasmobranchs. Despite the present estimates approximate the historical data, most of the previous landing statistics extrapolate the study area in the southeast-south Brazil or were grouped by several species [36,47,48], making it impossible to determine proportions between species in order to reconstruct the catch series between 1950 and 2007 at species level, especially for skates and rays.

The catches of skates and rays have increased for large specimens or were destined for fishmeal since the 1980s [36,44,48]. Commercial interest in these species has increased since the 2000s [49]. Nowadays, the international commerce of ray meat from the Rajidae family follows the Mercosul Common Nomenclature (NCM) under the name Rajidae. This inclusion in a common category is also known as an umbrella name [50], a characteristic name for several species with similar morphological characteristics under a common name [51,52]. This practice does not necessarily include endangered species [8,50], but increased fishing pressure on ray meat, especially from the deep-sea species, which live in a more stable environment and have typical k-strategist characteristics (slow growth, low fecundity, high longevity and deposition of a limited amount of eggs on the ocean floor), can generate a deleterious effect on these species [1,53,54].

The "emplastro" rays showed a peak in reconstructed catches in 1973. In the common average catch curve, the year 1973 was associated with the most recent years in the k-means analysis, which also showed a downward trend from 2005 onwards. In 2005, coincidentally, the Normative Instruction MMA-N° 5 came into force, banning the catches of Squatinidae family (*S. guggenheim* and *S. occulta*) and also *Pseudobatos horkelli* [55]. Nevertheless, the "emplastro" rays quickly changed from a data deficient (DD) to a vulnerable (VU) status (*D. leptocauda*, *R. agassizi*), endangered (*S. bonapartii*), threatened (*A. cyclophora*, *A. platana*) and critically endangered (*A. casteunaui*, *D. mennii*, *S. acuta*). These results showed that there are a larger number of endangered species in southern Brazil than was hitherto thought within 20 years. Only the "emplastro" rays of the genus *Psammobatis* met the criteria of least concern (LC).

In this case, the inclusion of several members of the Rajidae family in the same category even alludes to the term "umbrella" [50]. However, in the hereby study, the decomposition of the "emplastro" category, showing a large number of critically endangered species, was analogous to opening Pandora's box. This box will have contained several sins of humanity. According to the Greek mythology, although popularized as a "box" in early versions of the myth, the container is said to be a jug [56], thus making the shape of an "umbrella" a perfect lid. These reconstructed catch series provide a baseline information for thirty endangered elasmobranch species in the southeast and south of Brazil, serving for the assessment of the abundance levels via data-poor models based on catch (e.g., Catch Maximum Sustainable Yield–CMSY [57]).

5. Conclusions

The hereby large number of endangered elasmobranch species in southern Brazil placed under one umbrella name (e.g., Rajidae) can be minimized by applying a correct species-specific identification to commercial products that would aid in the solution to the mislabeling. As a consequence of species-specific identification, the abundance levels of permitted species would also be reported at species level in fisheries statistics, thus allowing to have species-specific catch series in the future. Conversely, the application of species-specific identification will reduce the abundance of endangered species as a commercial product. To achieve this objective, an identification handbook based on morphological characteristics (on muscle, for instance) and combined with genetics (mtDNA) could be developed to be used by regulatory agencies and in fisheries statistical programs in southeast-south Brazil, as previously proposed by [2].

Author Contributions: Conceptualization, R.S. (Rafael Schroeder) and R.S. (Rodrigo Sant'Ana); methodology, R.S. (Rafael Schroeder); formal analysis, R.S. (Rafael Schroeder); investigation, R.S. (Rafael Schroeder), L.G.C., L.G.F., B.L.M., D.S.M. and R.S. (Rodrigo Sant'Ana); resources, L.G.F.; data curation, L.G.C., L.G.F., B.L.M., D.S.M. and R.S. (Rodrigo Sant'Ana); writing—original draft preparation, R.S. (Rafael Schroeder); writing—review and editing, R.S. (Rafael Schroeder), L.G.C., L.G.F., B.L.M., D.S.M. and R.S. (Rodrigo Sant'Ana); supervision, R.S. (Rodrigo Sant'Ana); project administration, L.G.C. and L.G.F.; funding acquisition, L.G.C. and L.G.F. All authors have read and agreed to the published version of the manuscript.

Funding: This study was developed in the context of the "Projeto SALVAR–Ciência para a conservação de tubarões do sudeste e sul do Brasil", which received support from the "Marine and Fisheries Research Project". The Marine and Fisheries Research Project is an offset measure established under a consent decree agreed between the company PRIO and the Federal Public Prosecutors' Office in Rio de Janeiro. It is implemented by FUNBIO.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data will be available upon a reasonable request.

Acknowledgments: Sincere thanks to the fish processing industries, vessel owners and all the people who provide biological samples and fishing data that made this study possible.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Dulvy, N.K.; Fowler, S.L.; Musick, J.A.; Cavanagh, R.D.; Kyne, P.M.; Harrison, L.R.; Carlson, J.K.; Davidson, L.N.K.; Fordham, S.V.; Francis, M.P.; et al. Extinction risk and conservation of the world's sharks and rays. *eLife* **2014**, *3*, e00590. [CrossRef] [PubMed]
2. Bornatowski, H.; Braga, R.R.; Barreto, R.P. Elasmobranchs consumption in Brazil: Impacts and consequences. In *Advances in Marine Vertebrate Research in Latin America*; Rossi-Santos, M.R., Finkl, C.W., Eds.; Springer: Cham, Switzerland, 2018; pp. 251–262. [CrossRef]
3. Lessa, R.; Rosa, R.S.; Barreto, R.; Santana, F.M.; Nunes, J.; Lana, F.O.; Araújo, M.L.G.; Vianna, M.; Gadig, O.B.F. Oconhecimento sobre as populações de elasmobrânquios marinhos ameaçados de extinção no Brasil. In *PAN Tubarões: Primeiro Ciclo do Plano de Ação Nacional para a Conservação dos Tubarões e Raias Marinhos Ameaçados de Extinção*; Kotas, J.E., Vizuete, E.P., Santos, R.A., Baggio, M.R., Salge, P.G., Barreto, R., Eds.; ICMBio/CEPSUL: Itajaí, Brasília, 2023; pp. 279–297.
4. Rigby, C.L.; Dulvy, N.K.; Barreto, R.; Carlson, J.; Fernando, D.; Fordham, S.; Francis, M.P.; Herman, K.; Jabado, R.W.; Liu, K.M.; et al. Sphyrna lewini. Lista Vermelha das Espécies Ameaçadas da IUCN. 2019. Available online: https://www.iucnredlist.org/species/pdf/2921825/attachment (accessed on 1 April 2023).
5. Freire, K.M.F.; Almeida, Z.S.; Amador, J.R.E.T.; Aragão, J.A.; Araújo, A.R.R.; Ávila-da-Silva, A.O.; Bentes, B.; Carneiro, M.H.; Chiquieri, J.; Fernandes, C.A.F.; et al. Reconstruction of marine commercial landings for the Brazilian industrial and artisanal fisheries from 1950 to 2015. *Front. Mar. Sci.* **2021**, *8*, 659110. [CrossRef]
6. Carlson, J.; Charvet, P.; Avalos, C.; Briones Bell-lloch, A.; Cardenosa, D.; Espinoza, E.; Morales-Saldaña, J.M.; Naranjo-Elizondo, B.; Pacoureau, N.; Pilar Blasco, M.; et al. *Rhizoprionodon porosus*; The IUCN Red List of Threatened Species 2021; IUCN: Gland, Switzerland, 2021; e.T61407A3103881. [CrossRef]
7. Bunholi, I.V.; Ferrette, B.L.S.; Biasi, J.B.; Magalhães, C.d.O.; Rotundo, M.M.; Oliveira, C.; Foresti, F.; Mendonça, F.F. The fishing and illegal trade of the angelshark: DNA barcoding against misleading identifications. *Fish. Res.* **2018**, *206*, 193–197. [CrossRef]

8. Bernardo, C.; Adachi, A.M.C.d.L.; Cruz, V.P.d.; Foresti, F.; Loose, R.H.; Bornatowski, H. The label "Cação" is a shark or a ray and can be a threatened species! Elasmobranch trade in Southern Brazil unveiled by DNA barcoding. *Mar. Pol.* **2020**, *116*, 103920. [CrossRef]
9. Alvarenga, M.; Solé-Cava, A.M.; Henning, F. What's in a name? Phylogenetic species identification reveals extensive trade of endangered guitarfishes and sharks. *Biol. Conserv.* **2021**, *257*, 1–9. [CrossRef]
10. Brasil. Portaria MMA No 5. Diário Oficial da União. 2004. Available online: https://www.icmbio.gov.br/cepsul/images/stories/legislacao/Portaria/2014/p_mma_445_2014_lista_peixes_amea%C3%A7ados_extin%C3%A7%C3%A3o.pdf (accessed on 1 April 2023).
11. Haimovici, M. Present state and perspectives for the Southern Brazil shelf demersal fisheries. *Fish. Manag. Ecol.* **1998**, *5*, 277–289. [CrossRef]
12. Oddone, M.; Awruch, C.A.; Barreto, R.; Charvet, P.; Chiaramonte, G.E.; Cuevas, J.M.; Dolphine, P.; Faria, V.; Paesch, L.; Rincon, G.; et al. Squatina guggenheim. In *The IUCN Red List of Threatened Species 2019*; IUCN: Gland, Switzerland, 2019. [CrossRef]
13. Pollom, R.; Barreto, R.; Charvet, P.; Chiaramonte, G.E.; Cuevas, J.M.; Faria, V.; Herman, K.; Montealegre-Quijano, S.; Motta, F.; Paesch, L.; et al. Atlantoraja platana. In *The IUCN Red List of Threatened Species 2020a*; IUCN: Gland, Switzerland, 2020. [CrossRef]
14. Pollom, R.; Barreto, R.; Charvet, P.; Chiaramonte, G.E.; Cuevas, J.M.; Faria, V.; Herman, K.; Montealegre-Quijano, S.; Motta, F.; Paesch, L.; et al. Dasyatis hypostigma. In *The IUCN Red List of Threatened Species 2020b*; IUCN: Gland, Switzerland, 2020. [CrossRef]
15. Lessa, R.; Santana, F.M.; Rincón, G.; Gadig, O.B.F.; El-Deir, A.C.A. *Biodiversidade de Elasmobrânquios do Brasil*; Ministério do Meio Ambiente, Projeto de Conservação e Utilização Sustentável Diversidade Biológica Brasileira: Brasília, Brasil, 1999; 174p.
16. Bernardes, R.Á.; Figueiredo, J.L.; Rodrigues, A.R.; Fischer, L.G.; Vooren, C.M.; Haimovici, M.; Rossi-Wongtschowski, C.L.D.B. *Peixes de Zona Econômica Exclusiva da Região Sudeste-sul do Brasil: Levantamento com Armadilhas, Pargueiras e rede de Arrasto de Fundo*; Editora da Universidade de São Paulo: São Paulo, Brasil, 2005; pp. 1–295.
17. Vooren, C.M.; Klippel, S. *Ações para Conservação de Tubarões e Raias no sul do Brasil*; Igaré: Porto Alegre, Brasil, 2005; 262p.
18. Last, P.R.; White, W.T.; Carvalho, M.R.; Séret, B.; Stehmann, M.F.W.; Naylor, G.J.P. *Rays of the World*; CSIRO Publishing, Comstock Publishing Associates: Clayton, Australia, 2016; 790p.
19. Freire, K.M.F.; Aragão, J.A.N.; Araújo, A.R.R.; Ávila-da-Silva, A.O.; Bispo, M.C.S.; Velasco, G.; Carneiro, M.H.; Gonçalves, F.D.S.; Keunecke, K.A.; Mendonça, J.T.; et al. Reconstruction of catch statistics for Brazilian marine waters (1950–2010). *Fish. Cent. Res. Rep.* **2015**, *23*, 3–30.
20. Freire, K.M.F.; Belhabib, D.; Espedido, J.C.; Hood, L.; Kleisner, K.M.; Lam, V.W.L.; Machado, M.L.; Mendonça, J.T.; Meeuwig, J.J.; Moro, P.S.; et al. Estimating global catches of marine recreational fisheries. *Front. Mar. Sci.* **2020**, *7*, 7–12. [CrossRef]
21. Pauly, D.; Zeller, D.; Palomares, M.L.D. Sea around Us Concepts, Design and Data. 2023. Available online: http://www.seaaroundus.org/ (accessed on 1 April 2023).
22. Schroeder, R.; Pio, V.M.; Bail, G.C.; Lopes, F.R.A.; Wahrlich, R. Análise espaço-temporal da composição da captura da pesca com emalhe de fundo no Sudeste/Sul do Brasil. *Bol. Inst. Pesca.* **2014**, *40*, 323–353.
23. Pauly, D.; Palomares, M.L.D. Editorial. Historical reconstructions of marine fisheries catches: Challenges and opportunities. *Front. Mar. Sci.* **2019**, *6*, 128. [CrossRef]
24. Perez, J.A.A.; Wahrlich, R. A bycatch assessment of the gillnet monkfish *Lophius gastrophysus* fishery off southern Brazil. *Fish. Res.* **2005**, *72*, 81–95. [CrossRef]
25. Zeller, D.; Pauly, D. Reconstructing marine fisheries catch data. In *Catch Reconstruction: Concepts, Methods and Data Sources*; Pauly, D., Zeller, D., Eds.; Sea Around Us, University of British Columbia: Vancouver, BC, Canada, 2015; 13p.
26. Schmidt, B.F.; Amorim, A.F.; Hilsdorf, A.W.S. PCR–RFLP analysis to identify four ray species of the genus *Dasyatis* (Elasmobranchii, Dasyatidae) fished along the southeastern and southern coast of Brazil. *Fish. Res.* **2015**, *167*, 71–74. [CrossRef]
27. Almerón-Souza, F.; Sperb, C.; Castilho, C.L.; Figueiredo, P.I.C.C.; Gonçalves, L.T.; Machado, R.; Oliveira, L.R.; Valiati, V.H.; Fagundes, N.J.R. Molecular Identification of Shark Meat From Local Markets in Southern Brazil Based on DNA Barcoding: Evidence for Mislabeling and Trade of Endangered Species. *Front. Genet.* **2018**, *9*, 138. [CrossRef] [PubMed]
28. Maier, M.J. DirichletReg: Dirichlet Regression in R. R Package Version 0.6. 2022. Available online: http://dirichletreg.r-forge.r-project.org (accessed on 1 April 2023).
29. Schroeder, R.; Correia, A.T.; Medeiros, S.D.; Pessatti, M.L.; Schwingel, P.R. Spatiotemporal Variability of the Catch Composition and Discards Estimates of the Different Methods of Onboard Preservation for the Brazilian Sardine Fishery in the Southwest Atlantic Ocean. *Thalassas* **2022**, *38*, 573–597. [CrossRef]
30. Amorim, C.A.; Della-Fina, N.; Piva-Silva, N. Hammerheads sharks, *Sphyrna lewini* and *S. zygaena* caught by longliners off Southern Brazil, 2007–2008. *Collect. Vol. Sci. Pap. ICCAT* **2011**, *66*, 2121–2133.
31. Araujo, N.L.F.; Lopes, C.A.; Bettcher, V.B.; Neves, L.S.; Barbosa-Filho, M.L.V.; Amaral, C.R.L.; Siciliano, S.; Hauser-Davis, R.A. Artisanally landed elasmobranchs along the coast of Rio de Janeiro, Brazil. *Bol. Lab. Hidrobiol.* **2020**, *30*, 33–53. [CrossRef]
32. Port, D.; Perez, J.A.A.; Menezes, J.T.D. The evolution of the industrial trawl fishery footprint off southeastern and southern Brazil. *Lat. Am. J. Aquat. Res.* **2016**, *44*, 908–925. [CrossRef]

33. Santos, H.R.S.; Carvalho, M.R. Description of a new species of whiptailed stingray from the southwestern Atlantic Ocean (Chondrichthyes, Myliobatiformes, Dasyatidae). *Bol. Mus. Nac. Zool.* **2004**, *516*, 1–24.
34. Rodrigues, A.F.S.; de Sousa Rangel, B.; Wosnick, N.; Bornatowski, H.; Santos, J.L.; Moreira, R.G.; Amorim, A.F. Report of injuries in batoids caught in small-scale fisheries: Implications for management plans. *Oecol. Aust.* **2018**, *23*, 78–89. [CrossRef]
35. Defeo, O.; Puig, P.; Horta, S.; de Álava, A. Coastal fisheries of Uruguay. In *Coastal Fisheries of Latin America and the Caribbean*; Salas, S., Chuenpagdee, R., Charles, A., Seijo, J.C., Eds.; FAO Fisheries and Aquaculture Technical Paper. No. 544; FAO: Rome, Italy, 2011; pp. 1–444.
36. Vooren, C.M. Demersal Elasmobranchs. In *Subtropical Convergence Environments: The Coast and Sea in the Southwestern Atlantic*; Seeling, U., Odebrecht, C., Castello, J.P., Eds.; Springer: Berlin, Germany, 1997; pp. 141–146.
37. Vooren, C.M.; Klippel, S.; Galina, A.B. Os elasmobrânquios das águas costeiras da Plataforma Sul. In *Ações para a Conservação de Tubarões e raia no sul do Brasil*; Vooren, C.M., Klippel, S., Eds.; Igaré: Porto Alegre, Brazil, 2005; pp. 113–120.
38. Ruocco, N.L.; Lucifora, L.O.; de Astarloa, J.M.D.; Mabragaña, E.; Delpiani, S.M. Morphology and DNA Barcoding Reveal a New Species of Eagle Ray from the Southwestern Atlantic: *Myliobatis ridens* sp. Nov. (Chondrichthyes: Myliobatiformes: Myliobatidae). *Zool. Stud.* **2012**, *51*, 862–873.
39. Miranda, L.V.; Vooren, C.M. Captura e esforço da pesca de elasmobrânquios demersais no sul do Brasil nos anos de 1975 a 1997. *Frente Marít.* **2003**, *19B*, 217–231.
40. Klippel, S.; Vooren, C.M.; Lamónaca, A.F.; Peres, M.B. A pesca industrial no sul do Brasil. In *Ações para a Conservação de Tubarões e raias no sul do Brasil*; Vooren, C.M., Klippel, S., Eds.; Igaré: Porto Alegre, Brazil, 2005; pp. 135–178.
41. Vooren, C.M.; Lessa, R.P.T.; Barreto, R.R.P.; Montealegre-Quijano, S.; Kotas, J.E.; Santos, R.A. Pseudobatos horkelii Müller & Henle, 1841. In *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção: Volume VI—Peixes*; Soares, A.H.S.d.B., Martins, D.d.S., Oliveto, F.A., Leonhardt, G., Cortês, L.G., Pimenta, M., Arimoro, O.A.S., Silva, T.R., Silva, T.C., Novaes e Silva, V.d., Eds.; ICMBio: Brasília, Brazil, 2018; pp. 1092–1096.
42. Kotas, J.E.; Petrere, M., Jr.; Santos, R.A.; Bustamante, A.; Lin, C.F.; Silveira Menezes, A.A.; Micheletti, E.L.V. The horizontal migration of hammer-head sharks along the southern Brazilian coast based on their exploitation pattern and considerations about the impact of anchored gillnets activities on these species. *Ver. CEPSUL Biodiver. Conserv. Mar.* **2012**, *3*, 45–68.
43. Vooren, C.M.; Montealegre-Quijano, S.; Lessa, R.P.T.; Barreto, R.R.P.; Soto, J.M.R.; Kotas, J.E.; Santos, R.A. Squatina guggenheim Marini, 1936. In *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção: Volume VI—Peixes*; Soares, A.H.S.d.B., Martins, D.d.S., Oliveto, F.A., Leonhardt, G., Cortês, L.G., Pimenta, M., Arimoro, O.A.S., Silva, T.R., Silva, T.C., Novaes e Silva, V.d., Eds.; ICMBio: Brasília, Brazil, 2018; pp. 1112–1116.
44. Vooren, C.M.; Araujo, M.L.G.; Betito, R. Análise das estatísticas da pesca de elasmobrânquios demersais no porto de Rio Grande, de 1973 a 1986. *Ci Cult.* **1990**, *42*, 1106–1114.
45. Yesaki, M. *Sumário dos Levantamentos de Pesca Exploratória ao Largo da costa do Sul do Brasil e Estimativa de Biomassa de Peixe Demersal e Potencial Pesqueiro*; Série Documents Técnicos; SUDEPE/PDP: Rio de Janeiro, Brazil, 1973; Volume 1, 27p.
46. Yesaki, M.; Bager, K.J. *Histórico da Evolução da Pesca Industrial em Rio Grande*; Série Documents Técnicos; SUDEPE/PDP: Rio de Janeiro, Brazil, 1975; Volume 11, 15p.
47. Haimovici, M. *Recursos Pesqueiros Demersais da Região Sul. Avaliação do Potencial Sustentável de Recursos Vivos da Zona Económica Exclusiva (Revizee)*; Editado pela Fundação de Estudos do Mar (FEMAR): Rio de Janeiro, Brazil, 1997; 81p.
48. Haimovici, M.; Palacios Maceira, R. Observações Sobre a Seleção a bordo e Rejeição na Pesca de Arrasto de fundo no Rio Grande do Sul. In Proceedings of the Anais do II Congresso Brasileiro de Engenharia de Pesca, Recife, Brazil, July 1981.
49. Santos, P.R.S.; Balanin, S.; Gadig, O.B.F.; Garrone-Neto, D. The historical and contemporary knowledge on the elasmobranchs of Cananeia and adjacent waters, a coastal marine hotspot of southeastern Brazil. *Reg. Stud. Mar. Sci.* **2022**, *51*, 102224. [CrossRef]
50. Sharrad, A.E.; Reis-Santos, P.; Austin, J.; Gillanders, B.M. Umbrella terms conceal the sale of threatened shark species: A DNA barcoding approach. *Food Control* **2023**, *148*, 109606. [CrossRef]
51. Carvalho, D.C.; Palhares, R.M.; Drummond, M.G.; Frigo, T.B. DNA Barcoding identification of commercialized seafood in South Brazil: A governmental regulatory forensic program. *Food Control* **2015**, *50*, 784–788. [CrossRef]
52. Luque, M.G.; Donlan, C.J. The characterization of seafood mislabeling: A global meta-analysis. *Biol. Conserv.* **2019**, *236*, 556–570. [CrossRef]
53. Bräutigam, A.; Callow, M.; Campbell, I.R.; Camhi, M.D.; Cornish, A.S.; Dulvy, N.K.; Fordham, S.V.; Fowler, S.L.; Hood, A.R.; McClennen, C.; et al. Global Priorities for Conserving Sharks and Rays. 2015, Volume 1, pp. 1–26. Available online: https://sharks.panda.org/images/downloads/263/gsri_globalprioritiesforconservingsharksandrays_web_spreads.pdf (accessed on 1 April 2023).
54. Dulvy, N.K.; Pacoureau, N.; Rigby, C.L.; Pollom, R.A.; Jabado, R.W.; Ebert, D.A.; Finucci, B.; Pollock, C.M.; Cheok, J.; Derrick, D.H.; et al. Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. *Curr. Biol.* **2021**, *31*, 4773–4787. [CrossRef]
55. Brasil. Instrução Normativa MMA No 5. Diário Oficial da União. 2004. Available online: https://www.icmbio.gov.br/cepsul/images/stories/legislacao/Instrucao_normativa/2004/in_mma_05_2004_especiesdeinvertebradosaquaticosepeixesameacadosdeextincaoesobreexplotada_altrd_in_mma_52_2005.pdf (accessed on 1 April 2023).

56. Schlegel, C.M.; Weinfield, H. *Theogony and Works and Days Hesiod*; The University of Michigan Press: Ann Arbor, MI, USA, 2009; 120p.
57. Froese, R.; Demirel, N.; Coro, G.; Kleisner, K.M.; Winker, H. Estimating fisheries reference points from catch and resilience. *Fish Fish.* **2017**, *18*, 506–526. [CrossRef]