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Revisiting Brazilian Catch Data for Brazilian Marine Waters (1950-2010)

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REVISITING BRAZILIAN CATCH DATA FOR BRAZILIAN MARINE WATERS (1950-2010)

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ABSTRACT

Catch data are the most basic information to be collected for managing fisheries everywhere. However, in many regions around the globe, including Brazil, this information is not available with satisfactory quality. The objective of the initiative described in this paper was to compile a country-wide database of marine commercial catch data in its original form (only landings) and a reconstructed version (which includes artisanal, industrial, recreational, and subsistence landings, as well as major discards) and to analyze historical trends. The basis for the country-wide database of marine catch statistics compiled here were the national official bulletins published in Brazil for the period 1950 to 2010. They represent an update of previous databases compiled for 1980-2000 and later for 1950-2004. These databases were revised and extended to include the whole period from 1950 to 2010 and all 17 coastal states in Brazil, from Amapá to Rio Grande do Sul. Estimates for recreational and subsistence catches, and discards were added. Our analysis indicates that total catches for Brazil may be almost 2 times the reported baseline determined for Brazil. Besides the previously known low taxonomic resolution of catch statistics in Brazil, taxonomic losses were observed when local data were incorporated into the national bulletins and later in the FAO database (FishStat J). Regional analyses indicate that the highest catches are associated with the southern region, except when there is a peak in the production of sardine. However, this result may be biased as those values may include catches off southeastern region that end up being landed in the south. The same is true for other regions in Brazil. Brazilian sardine and demersal fishes comprise most part of the catches. The present reconstruction may be viewed as preliminary and could be revised by local experts to improve the local database and hence the national and global databases.

1. INTRODUCTION

Catch data are the most basic information to be collected in order to manage fisheries. However, in many regions around the globe this information is not available with satisfactory quality. The same is true even for economies in transition such as Brazil. In 1953, the Food and Agriculture Organization of the United Nations (FAO) released a report where the reasons for the deficiency of the collection system of catch statistics in Brazil were pointed out: time lag of over six months between the period when catch data was sent by state or region and arrival in Rio de Janeiro where data were processed, catch data not species-specific, different weight measurements presented together, among others (FAO 1953). In fact, during that period, the national bulletins available for Brazil reported only total catch, with no detail about species or groups caught.

Pauly (2013) discusses the danger of some discourses stressing that lower catches do not mean fewer fish (Hilborn 2013). According to that author, this can lead to the erroneous message that there is no need to collect such information. In Brazil, for example, the collection system of catch statistics has collapsed. Currently, there is no national standardized collection system in place and has been as such for a long time. The compilation of heterogeneous data has ended in 2007. In that year, Freire & Oliveira (2007) compiled historical catch series for the period 1950-2004, based on a previous effort by Freire (2003). However, the authors were not able to establish a reasonable connection between common and scientific names for the species caught. The most recent information available on catch statistics for Brazil are based only on estimation models and refers to the years 2008-2011, with no detail provided about catches by species.

In 1995, a National System of Information on Fisheries and Aquaculture (Sistema Nacional de Informações da Pesca e Aquicultura – SINPESQ) was created. The objectives of the system were to

collect, compile, analyze, exchange, and disseminate information about the national fishing sector. This system comprises many modules, some of which active and others inactive. It is available through the site http://sinpesq.mpa.gov.br, but none include catch data. Instead, the Ministry of Fisheries and Aquaculture make available written reports for the period 2005-2011 (http://www.mpa.gov.br/index.php/informacoes-e-estatisticas/estatistica-da-pesca-e-aquicultura).

Only the states of Santa Catarina and São Paulo have online systems of catch statistics. However, the first only deals with industrial fisheries and the second reports data for both artisanal and industrial fleets combined (Ávila-da-Silva *et al.* 1999; Mendonça and Miranda 2008; UNIVALI/CTTMar 2013). Thus, the objective of the initiative described in this paper was to compile a national database of marine commercial catch data in its original form (only landings) and a reconstructed version (which also includes estimates of unreported artisanal, industrial, recreational, and subsistence catches, and major discards) to make them available online and to analyze historical trends. We hope this study will trigger the interest of other scientists to review and update the database for the states where they have been working on.

2. MATERIAL AND METHODS

The basis for the country-wide database of marine catch statistics compiled here were the national official bulletins published in Brazil for the period 1950 to 2010. They represent an update of previous databases compiled by Freire (2003) for 1980-2000 and Freire & Oliveira (2007) for 1950-2004. These databases were revised and extended to include the whole period between 1950 and 2010 and all 17 coastal states in Brazil, from Amapá to Rio Grande do Sul (Fig. 1). Estimates for unreported recreational and subsistence catches, and discards were added.

The original database was based only on the sources listed in Table 1. The nature of data available was very heterogeneous throughout the period: total landings (with no detail by species) for 1950-1955, landings by group (fishes, crustaceans, mollusks, reptiles, and mammals) for 1956-1961, landings by main species for 1962-1977, landings by species and by fleet – artisanal and industrial (1978-1989), repeated mean values for 1990-1994, landings by species and by fleet (1995-2007), and back to total landings in 2008-2010 (Table 2). We used a "bottom-up" strategy to rebuild commercial catches. This strategy consisted of starting the reconstruction of catches based on data from national bulletins and estimated missing values for each species in the beginning, middle and/or end of the time series, excluding categories such as "mistura", "caíco", "outros peixes", and "outras espécies" (all representing miscellaneous fishes). Whenever the sum of reconstructed catches for all species by state did not reach or surpass original catches, we topped up with catches associated to miscellaneous fishes.

For the purposes of the *Sea Around Us* database, adjustments of the reported landings data for the years 1950-1961, 1965, and 2008-2010 were made. We assumed for these adjustments that the catches from the recreational and subsistence sectors, as well as all discards are entirely unreported. Thus, adjustments were only made to the industrial and artisanal sectors, i.e. the commercial catches, in terms of input, i.e., whether the catches are deemed reported or unreported.

For the years 1950-1958, zero to very little catches were reported in the national data sources. However, as there are FAO data for this period, and since national statistics and FAO data were almost identical in the first few years of mutual availability (i.e., 1959-1961), we decided to accept the FAO data as the reported tonnage for the beginning of the time period.

However, the reconstructed commercial landings for those years were less than the FAO data. Thus, we accepted all of the commercial catches reconstructed for this period (1950-1958) as reported. Hence, during this period, there are no unreported landings for the artisanal and industrial sector. In the year 1965, there was a sudden and unexplained drop in reported landings which rebounded immediately in the next year. We deemed this abrupt one-year drop to be a data reporting error, and therefore interpolated reported landings between 1964 and 1966 to derive a new reported catch amount for 1965.

For the years 2008-2010, the ratio between the reported FAO landings and the reconstructed catches in 2007 was maintained and the new reported landings were calculated. The total reconstructed catch amount was not changed.

Thus, when referring to the baseline reported landings, it is the combination of the data from the national/local bulletins and the amount assigned from the FAO data which are accepted as the reported landings data in this study.

2.1. Commercial landings

Commercial landings include those originating from both large-scale (industrial) and small-scale (artisanal) fleets. The limit between these two fleets is blurry and traditionally 20 GT (gross tonnage) was considered as a cut-off point in Brazil. Landings were reported for each of these two fleet types from 1978 onwards. Thus, landings for previous years were split among them based on the proportion observed for 1978-1980 for each species. We also considered, based on the literature, information on the beginning of industrial operation for each species or group of species in each state. Most artisanal fisheries were reconstructed until 1950 unless we found any reference stating otherwise.

Landings have been reported in official national bulletins by common name. The correspondence between common and scientific names was established preferentially based on local references. Otherwise, we used information from an updated version of the national database of common names available for Brazilian marine fishes (Freire and Pauly 2005) and from the list of names provided by Freire & Carvalho Filho (2009). Our team included experts from most of the states in an attempt to improve this correspondence. Unfortunately, some invited local experts were unable to contribute on time for this initiative and were not included here. With the help of local experts, local references or even interviews with fishers or data collectors, we were able to split landings reported for each common names among all species associated with that name. Whenever this was not possible, landings were attributed to a genus or a family. Based on more recent detailed landings data (species-specific), we managed to split earlier catches for “pescada” (weakfishes) or “vermelhos” (lutjanids), e.g., among species. However, this was possible neither for all generic names nor for all states.

Figure 1: Brazilian coastal states from Amapá in the north to Rio Grande do Sul in the south. The Brazilian Exclusive Economic Zone (EEZ) and shelf waters (to 200 m depth) are shown also.

In the 1980s, two bulletins were annually released (with the exception of 1980). In these bulletins, there were records with zero landings (0), but with a monetary value associated with the entry. In those cases, each zero landings entry was replaced by 0.5 t. Thus, the following criteria were adopted in order to guarantee that even small landings show up in the reconstructed database:

- 0 and – (in two bulletins): replaced by 0.5 t;
- 0 and 0 (in two bulletins): replaced by 1 t;
- 10 and 0 (in two bulletins): 10 was retained.

For those years when only landings for major species were reported, we estimated landings for the other species based on their proportion in relation to total landings for the closest three years (and these were later subtracted from miscellaneous fishes). Whenever landings were missing for one or more years in the middle of the historical catches, they were estimated based on linear trends.

Values for the period 1990-1994 in the national bulletins were repeated and represent the average for the previous four years (1986-1989; CEPENE 1995a), except for some more important species that used to be studied by Permanent Study Groups (GPEs – *Grupos Permanentes de Estudos*): sardine, lobster, southern red snapper, etc. Those repeated values were replaced by estimated values using linear trends that also considered posterior values (1995 onwards). For 1995, two bulletins were released: one in March/1997 and other in May/1997. In the first bulletin, artisanal and industrial landings were combined in some cases and attributed to the wrong category in other cases. Landings were properly split between artisanal and industrial fleets in the second bulletin. Thus, we used the second bulletin here. For more recent years (2008-2010), due to the absence of catch data by species for each state, we used different data sources to complete the time series. For the state of Ceará, José Augusto Aragão provided a database for 2008 (artisanal and industrial). For Rio Grande do Norte, José Airton Vasconcelos contributed with a catch database for 2008-2009 (artisanal and industrial) and for 2010 (only industrial). For Sergipe, Mário Thomé de Souza (Universidade Federal de Sergipe/PMPDP) provided an unpublished manuscript with catch data for 2010. For the state of Rio Grande do Sul, there were local bulletins recording catch data from 1997 to 2010 (IBAMA/CEPERG 2011). For the remaining states, linear trends (when evident), average means or repeated values were used depending on each case.

As two co-authors are responsible for the collection system of catch data for the state of São Paulo, a different procedure was possible. Landing information was available for the years 1944 (Vieira *et al.* 1945), 1959-1965 (Braga *et al.* 1966), and 1969-2010 (ProPesq institutional database, Ávila-da-Silva *et al.* 1999). All fishery-related information available after 1959 was obtained through dockside interviews with fishers, using census, and through records from fishing industries. There has been no interruption in the data collection system in the state of São Paulo since 1969. Information gathered is forwarded to the federal government for the composition of the national fisheries statistics. Landing reconstruction for the period with missing values (1950-1958 and 1966-1968) was performed by species applying LOESS (locally weighted scatterplot smoothing) models or linear cubic spline interpolation on the available time series. Landings for 1950-1958 were estimated considering data for 1944 and 1959-1965, while landings for 1966-1968 were estimated based on 1959-1965 data and from 1969 onwards. Categorization into artisanal and industrial fleets was done considering fishing fleets and species caught.

For the state of Rio de Janeiro, most of the data previously estimated by Freire & Oliveira (2007) were used, but some corrections/inclusions were made. Landings data for each species for the period 2008-2010 were reconstructed through information provided in spreadsheets by municipality of coastal towns such as Angra dos Reis and Cabo Frio (unpublished data), spreadsheets and reports produced by the Fishing Institute of the state of Rio de Janeiro (FIPERJ/MPA/UFRJ undated; FIPERJ/Prefeitura Municipal de Cabo Frio undated) and of São Paulo (PMAP/Instituto de Pesca de São Paulo undated) and spreadsheets from monitoring programs of some oil and gas activities (Petrobrás undated). For missing values of some species in the middle of the time series, linear interpolation was used as for other states.

Table 1: Sources used to compile marine landings for Brazilian commercial fisheries (artisanal and industrial) from 1950 to 2010.

YEAR	SOURCE	TYPE
1950-52	IBGE (1955)	PDF (http://biblioteca.ibge.gov.br/d_detalhes.php?id=720)
1953-55	IBGE (1956)	PDF (http://biblioteca.ibge.gov.br/d_detalhes.php?id=720)
1956-57	IBGE (1959)	PDF (http://biblioteca.ibge.gov.br/d_detalhes.php?id=720)
1958-60	IBGE (1961)	PDF (http://biblioteca.ibge.gov.br/d_detalhes.php?id=720)
1961	IBGE (1962)	PDF (http://biblioteca.ibge.gov.br/d_detalhes.php?id=720)
1962	MA/SEP (1965b)	Paper
1963	MA/SEP (1965a)	Paper
1964	MA/SEP (1965b)	Paper
1965	No bulletin found	—
1966	MA/SEP (1967)	Paper
1967	MA/ETEA (1968)	Paper
1968	MA/ETEA (1969)	Paper
1969	MA/ETEA (1971)	Paper
1970	MA/EE (1971)	Paper
1971	SUDEPE/IBGE (1973)	Paper
1972	SUDEPE/IBGE (1975)	Paper
1973	SUDEPE/IBGE (1976a)	Paper
1974	SUDEPE/IBGE (1976b)	Paper
1975	SUDEPE/IBGE (1977)	Paper
1976	SUDEPE/IBGE (1979a)	Paper
1977	SUDEPE/IBGE (1979b)	Paper
1978	SUDEPE (1980a)	Paper
1979	SUDEPE (1980b)	Paper
1980	IBGE (1983a)	Paper
1981	IBGE (1983b, 1983c)	Paper
1982	IBGE (1983d, 1984a)	Paper
1983	IBGE (1984b, 1985a)	Paper
1984	IBGE (1985b, 1985c)	Paper
1985	IBGE (1986, 1987a)	Paper
1986	IBGE (1987b, 1988a)	Paper
1987	IBGE (1988b, 1988c)	Paper
1988	IBGE (1989a, 1989b)	Paper
1989	IBGE (1990, 1991)	Paper
1990	CEPENE (1995a)	Paper
1991	CEPENE (1995b)	Paper
1992	CEPENE (1995c)	Paper
1993	CEPENE (1995d)	Paper
1994	CEPENE (1995e)	Paper
1995	CEPENE (1997a)	Paper
1996	CEPENE (1997b)	Paper
1997	CEPENE (1998)	Paper
1998	CEPENE (1999)	Paper
1999	CEPENE (2000)	Paper
2000	CEPENE (2001)	PDF(reduced version) and Excel
2001	IBAMA (2003)	PDF (www.ibama.gov.br/documentos-recursos-pesqueiros/estatistica-pesqueira)
2002	IBAMA (2004a)	PDF (www.ibama.gov.br/documentos-recursos-pesqueiros/estatistica-pesqueira)
2003	IBAMA (2004b)	PDF (www.ibama.gov.br/documentos-recursos-pesqueiros/estatistica-pesqueira)
2004	IBAMA (2005)	PDF (www.ibama.gov.br/documentos-recursos-pesqueiros/estatistica-pesqueira)
2005	IBAMA (2007a)	PDF (www.ibama.gov.br/documentos-recursos-pesqueiros/estatistica-pesqueira)
2006	IBAMA (2008)	PDF (www.ibama.gov.br/documentos-recursos-pesqueiros/estatistica-pesqueira)
2007	IBAMA (2007b)	PDF (www.ibama.gov.br/documentos-recursos-pesqueiros/estatistica-pesqueira)
2008	MPA (undated)	PDF (www.mpa.gov.br/index.php/informacoes-e-estatisticas/estatistica-da-pesca-e-aquicultura)
2009	MPA (undated)	PDF (www.mpa.gov.br/index.php/informacoes-e-estatisticas/estatistica-da-pesca-e-aquicultura)
2010	MPA (2012)	PDF (www.mpa.gov.br/index.php/informacoes-e-estatisticas/estatistica-da-pesca-e-aquicultura)

Table 2: Type of data used in the catch reconstruction for Brazilian marine waters for the period 1950-2010 (national and local bulletins, and other sources as also indicated in the database).

Years	AP	PA	MA	PI	CE	RN	PB	PE	AL	SE	BA	ES	RJ	SP	PR	SC	RS
1950-55	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB	TotalB
1956-61	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB	GroupB
1962-75	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB	SpRB
1976-77	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB	SpHB
1978-79	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB	SpB
1980-89	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM
1990-94	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp	SpMRp
1995-2007	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM	SpM
2008	None	None	None	None	SpM	SpM	None	None	None	None	None	None	SpM	SpM	None	SpMI	SpM
2009	None	None	None	None	None	SpM	None	None	None	None	None	None	SpM	SpM	None	SpMI	SpM
2010	None	None	None	None	None	SpMI	None	None	None	SpM	None	None	SpM	SpM	None	SpMI	SpM

TotalB (both) = only total landings for the state provided (both marine and freshwater together, not separated into artisanal and industrial);
GroupB (both) = landings per group (fishes, crustaceans, molluscs, mammals, chelonians) (both marine and freshwater together, not separated into artisanal and industrial);
SpRB (reduced/both) = landings only for a reduced number of main species (both marine and freshwater in the same table; not separated into artisanal and industrial);
SpHB (higher/both) = landings per species for a higher number of species, representing 75-80% of total landings (both marine and freshwater in the same table; not separated into artisanal and industrial);
SpB (both) = landings per species for a higher number of species (both marine and freshwater in the same table; separated into artisanal and industrial);
SpM (marine) = landings per species for a higher number of marine species (separated into artisanal and industrial);
SpMRp (marine/repetition): there was no system of data collection in Brazil during this period (except for a few main species for which there were working groups) and a mean for the previous four years was calculated for each of all other species and printed in the national bulletin (separated into artisanal and industrial);
SpMI (marine/industrial): landings per species for a higher number of marine species (only for industrial fleet);
None = there was no collection system in that state for those years and the Ministry of Fisheries and Aquaculture (MPA) published bulletins where a general estimation procedure was used to estimate total landings for each state, but no landing data per species was estimated. However, we were able to compile detailed data from local initiatives, including some supported by MPA.

2.2. Recreational catches

Brazil has no system of data collection for recreational catches. The reconstruction included catches from competitive events, based on a updated and extended version of the database compiled by Freire (2005). The second component of the reconstruction refers to daily recreational activities. We used data on human population size available in Table 1.4 from IBGE (2010) and fitted a Verhulst logistic equation in the format provided by Miranda & Lima (2010) to estimate the population each year. For each state, we used information from local studies that provided the percentage of recreational fishers interviewed that had fishing license to extrapolate the total number of recreational fishers based on the number of licenses issued in 2009. For those states were such a ratio was not available, we considered a national mean value of 13.5% (Freire *et al.* 2012). To adjust the number of recreational fishers, we considered only the proportion of fishers fishing in marine waters (estuarine, coastal, offshore). This information was collected in a questionnaire answered online in 2009 and required to obtain the license. Finally, we estimated total catch multiplying the number of fishers by the number of days fishing and by the mean daily catch for each fisher. The last information came from local studies, when available, or from neighboring states: Bahia (K.M.F. Freire, unpublished data), Espírito Santo (Chiappani 2006), Rio de Janeiro (Couto 2011), São Paulo and Paraná (Atlantic & Fishing Project), Santa Catarina (Schork *et al.* 2010), and Rio Grande do Sul (Peres and Klippel 2005).

For the sates of Rio de Janeiro, São Paulo and Paraná, the procedure was more complex as there was detailed information for different sectors. Thus, we used the proportion among A, B and C license categories (as described in Freire *et al.* 2012), where category A includes only coastal, shore-based fishers, and B and C categories operating from boats. Category C includes spearfishing. Catches were estimated separately for these categories (A and B/C) considering different number of fishing days per year and CPUE (g/fisher·day) and finally they were added to represent total recreational catch for each state.

2.3. Subsistence catches

The estimate of subsistence catches was obtained through the following two equations:

Total consumption (fresh and marine) = number of registered fishers * fecundity rate (+2) * consumption per capita

And

Subsistence catch (marine) = total consumption * proportion of non-commercial 'fish' acquisition

where (+2) represents fisher and his wife/partner.

The number of officially registered fishers by coastal state was obtained from statistical yearbooks (IBGE, 1955-1982), IBAMA (2003, 2004a, 2004b, 2005, 2007a), SEAP/IBAMA/PROZEE (2005), and MPA (2012, undated). In order to estimate the number of persons by family, the fecundity rate by region and decade was used (Table 4, IBGE 2010a). A *per capita* consumption rate (kg·person^{-1}·year^{-1}) by state was used, based on the 'fish' consumption typical of each region (Anon. 1963; Wiefels *et al.* 2005; Silva and Dias 2010; Sartori and Amancio 2012). 'Fish' includes fishes, crustaceans and molluscs.

The Household Budget Survey (*Pesquisa de Orçamentos Familiares* - POF) conducted by the Brazilian Institute of Geography and Statistics (IBGE) gathered data about the average *per capita* monetary and non-monetary acquisition of food in Brazil (IBGE 1967, 2004, 2010b). This survey

provided information on how the population acquires food (including fishes) and also its average consumption, highlighting the profile of living conditions of the Brazilian population by region from the analysis of their household budgets. The POF survey was conducted in urban and rural areas including coastal regions and consumption of both marine and freshwater fishes were available separately (IBGE 2010b). Thus, we estimated subsistence catches by Brazilian State using the percentage of marine fish obtained by fishers through non-monetary acquisition. The non-monetary acquisition is that made without payment, being obtained through donation, removal from the business or own production (IBGE 2010b). Anchor points and a linear trend were used to estimate missing catches for the period of this study (1950-2010).

Table 4: Official reported fecundity rate by decade and region used as anchor points to estimate the average number of persons in Brazilian fisher families.

	Total fecundity rate						
	1950	1960	1970	1980	1991	2000	2010
Brazil	6.2	6.3	5.8	4.4	2.9	2.4	1.9
North	8.0	8.6	8.2	6.5	4.2	3.2	2.5
Northeast	7.5	7.4	7.5	6.1	3.8	2.7	2.1
Southeast	5.5	6.3	4.6	3.5	2.4	2.1	1.7
South	5.7	5.9	5.4	3.6	2.5	2.2	1.8

Source: IBGE (2010a)

The taxonomic breakdown of subsistence catches was obtained by applying the reported proportions of each marine fish species (or group of species) (IBGE 2010b) over the estimated subsistence catches obtained. Reported common names were then associated with the lowest taxon possible.

2.4. Discards

The methodology for calculating discards was done separately for the artisanal and industrial sectors due to varying gear and discarding practices employed.

a) Industrial sector

In order to estimate discards for the industrial sector, we first allocated landings to gear type. Data on gear are available for Rio Grande do Sul from 1975 to 1994 in Haimovici *et al.* (1998) and from 1997 to 2010 in CEPERG (2011). Here, we assume this breakdown by gear is representative of the entire industrial sector because:

1. The fisheries and gears used in the southeastern and the southern regions are “quite similar” (FAO 2014); and
2. For the 1950-2010 time period, the southern and southeastern regions account for 93% of all industrial landings (and the southern region alone accounts for 53%).

Historically, in Rio Grande do Sul, the major industrial gears used since 1950 were trawlers (otter and pair) and purse seine. In the mid-1970s, the pelagic longline was introduced and the industrial fleet began using handline to target white grouper on the upper slope of the continental shelf. In later years, handline was replaced by vertical longline and bottom longline. Around 1990, there was a significant shift in the gear distribution as new gear types entered the industrial fleet. These new gears were the double-rig trawl, bottom gillnet, and pole and line gears (Haimovici *et al.* 1998).

For the time period between 1950 and 1974, we used landings by gear type from 1975 to 1979 (the earliest gear-based landings available). However, we excluded pelagic longline and demersal 'line' gears (handline, vertical longline, and bottom longline), as these gears were introduced in the mid-1970s. Thus, gear-based landings were adjusted to reflect this difference (Table 5). For the time period from 1975 to 1994, landing data from Haimovici et al. (1998) were used. Data from CEPERG (2011) were used for the year 2010 and earlier volumes for the years 1997–2009. We excluded landings from trap gears (targeting deep sea red crab) because there were only landings from 1988 to 1992 and this amount was very small. We applied the gear breakdown percentages for each year to total landings, e.g., the sum of reported and unreported industrial landings. Discard rates for the relevant gears were compiled from various sources (Table 6). These rates were then applied to the gear-specific total catch as reconstructed previously.

Table 5: Industrial gear breakdown (%) by time period for the south and southeastern regions of Brazil.

Time period	Otter trawl	Pair trawl	Double-rig trawl	Seine	Gillnet	Longline	Live bait[1]	Line[2]
1950 - 1974	28.0	58.9	0.0	13.1	0.0	0.0	0.0	0.0
1975 - 1989	23.0	65.6	0.0	7.3	0.0	3.7	0.0	0.4
1990 - 2010	4.1	30.6	8.0	7.1	34.6	1.6	13.7	0.3

[1] Rod and live bait gear targeting skipjack; [2] Line gear includes bottom longline, vertical longline, and handline used on the upper slope of the continental shelf by the industrial fleet

Table 6: Discard rate by industrial gears for the south and southeastern regions of Brazil.

Gear	Discard per total catch (%)[3]	Discard per landings, as applied (%)[4]	Source
Otter trawl	38.0	61.0	Haimovici and Mendonça (1996)[5]
Pair trawl	38.0	61.0	Haimovici and Mendonça (1996)[5]
Double-rig trawl	38.0	62.0	Haimovici and Mendonça (1996)[5]
Seine	1.0	1.0	Kelleher (2005)[6]
Gillnet	44.0	77.0	Kelleher (2005)[7]
Longline[1]	15.0	18.0	Kelleher (2005)[8]
Live bait	1.0	1.0	Kelleher (2005)[6]
Line[2]	5.3	6.0	Kelleher (2005)[9]

[1]Pelagic; [2]Includes handline, vertical longline, and bottom longline; [3]Discards as a percentage of total catch, not landings; [4]Discards as a percentage of landings; rate applied to landings; [5]Discard rate was obtained by averaging two discard rates for double-rig trawl with comparable landings: 52.3% for flatfish-directed and 23.9% for shrimp-directed; [6]Due to lack of data, Kelleher assumed 1% as a conservative estimate; [7]Discard rate for multi-gear (gillnet and hook) for the South of Brazil from Haimovici (1996); [8]Due to lack of data on longline discard rate for Brazil, rates for Uruguay (9.1%) and Argentina (20.5%) were averaged; [9]Discard rate came from data on the North (artisanal lines and demersal lines, gillnet, and traps) based on Isaac and Braga (1999).

To disaggregate the estimated discards among relevant taxa, we used data from four research trawlers (two otter and two pair trawlers) fishing off Rio Grande do Sul in 1978 and 1979 (Haimovici and Maceira 1981), but pooled the data from the four trawlers to yield an average taxonomic composition (Table 7).

Table 7: Derived taxonomic composition of industrial discards for south and southeastern Brazil based on Haimovici and Maceira (1981).

Scientific name	Common name	Discard (%)
Cynoscion guatucupa	Striped weakfish	10
Umbrina canosai	Argentine croaker	23
Macrodon atricauda	King weakfish	2
Prionotus spp.	Searobins	2
Paralonchurus brasiliensis	Banded croaker	3
Trichiurus lepturus	Largehead hairtail	10
Marine fishes nei	Marine fishes	4
Batoidea	Skates and rays	23
Mustelus schmitti	Narrownose smooth-hound	8
Mustelus spp.	Smoothhounds	8
Squalus spp.	Dogfishes	8

b) Artisanal sector

Artisanal discards were estimated based on a year-long study of artisanal discards per gear in Paraná (southern region of Brazil). The local 'canoes' in the study were made either from single carved tree trunk or molded fiberglass, and averaged 10 m long with a small engine (Carniel and Krul 2012). Artisanal boats in the northern region were also described as "small, wooden boats, motor-powered or sail-propelled" (Isaac 1998). Although differences between the regions exist, we assumed that this study was representative for all of Brazil. Future investigations should improve this assumption and consider local differences. We believe this study is relatively conservative, as the 'canoes' are considered the "least technical and least powerful fishing effort on the inner shelf" (Carniel and Krul 2012).

The most common gear employed is driftnetting and shrimp fishing. Discards while driftnetting averaged 5 $kg \cdot boat^{-1} \cdot day^{-1}$, whereas shrimp fishing produced an average of 100 $kg \cdot boat^{-1} \cdot day^{-1}$ (Carniel and Krul 2012) . Additionally, it was stated that in the sample area, shrimp fishing accounted for 64% of the total discards (Carniel and Krul 2012). We adjusted this proportion to the variation in discard rates of each gear, and derived the proportion of boats engaged in driftnetting (92%) and shrimp fishing (8%). We applied this breakdown to the total number of artisanal boats in Brazil.

Data on the number of boats in Brazil were generally available by region. In the southern region, which includes the states of Paraná, Santa Catarina, and Rio Grande do Sul, the artisanal sector was comprised of 23,000 small and medium capacity vessels (FAO 2001). For all states north of Rio de Janeiro, in addition to a very small portion of the northern coast of Rio de Janeiro state, Diegues *et al.* (2006) reported the number of artisanal boats at 37,812. The only gap in boat data was for the states of São Paulo and the majority of Rio de Janeiro. For this area, we took the proportion of artisanal catches in 2001 for Rio de Janeiro and São Paulo (i.e., 26,215 t) to all other coastal states (i.e., 258,590 t), which was just over 10%. We used catches in 2001 because all of the sources on boat data were dated around 2001. We lowered this estimate to 9% in order to account for the small portion of coast already considered, resulting in an estimate of 5,473 artisanal boats in Rio de Janeiro and São Paulo, and thus 66,285 artisanal boats for all of Brazil. We assumed that artisanal fishing takes place on 200 days per year.

As stated earlier, we assumed that 92% of these boats are engaged in driftnetting and the other 8% in shrimp fishing. We applied the discard rate of 100 $kg \cdot boat^{-1} \cdot day^{-1}$ for shrimp fishing boats and 5 $kg \cdot boat^{-1} \cdot day^{-1}$ for driftnet boats (Carniel and Krul 2012). Thus, the total discards for artisanal fishing in 2001 came to 169,095 t. Total artisanal catches in 2001 were 284,805 t, which gave us a discard rate of approximately 59% of landings. We assumed this rate was constant for all other years. Additionally, annual discards were disaggregated by state using artisanal catch.

The taxonomic disaggregation of artisanal discards varies by region. For the northern and northeastern regions, we used a study on by-catch composition for the state of Maranhão (Araújo Júnior *et al.* 2005). Sixteen species were recorded in the by-catch. Although the weights by species were not given, the numbers of individuals along with average length were available. Using the length-weight relationships available in FishBase (Froese and Pauly 2014), we derived an average weight for each taxon. The proportions of taxa discarded by weight were then derived (Table 8). Some changes in the scientific names were proposed to accommodate variations among states.

Table 8: Taxonomic composition of artisanal discards in northern and northeastern Brazil (based on Araújo Júnior *et al.* 2005).

Scientific name	Common name	Discards (%)
Clupeidae	Sardine	24.00
Siluriformes	Catfish	9.00
Ariidae	Sea catfishes	2.60
Mugil spp.	Mullets	4.00
Anableps anableps	Largescale foureyes	1.00
Belonidae	Needlefishes	0.03
Carangidae	Jacks and pompanos	0.10
Genyatremus luteus	Torroto grunt	0.40
Macrodon ancylodon	King weakfish	21.00
Micropogonias furnieri	Whitemouth croaker	28.00
Sciaenidae	Drums or croakers	0.10
Chaetodipterus faber	Atlantic spadefish	0.20
Symphurus spp.	Duskycheek tonguefish	1.00
Achirus spp.	Soles	1.00
Tetraodontidae	Puffers	8.00

For the southern and southeastern regions, we used a study on discarded fish in the artisanal shrimp fishery of São Paulo (Coelho *et al.* 1986a). As in the previous study, the number of fish and average length of fish were given, and were converted as above. Only the 15 major taxa were taken from this study (Table 9).

Table 9: Taxonomic composition of artisanal discards in south and southeastern Brazil (based on Coelho *et al.* 1986b).

Species name	Common name	Discards (%)
Paralonchurus brasiliensis	Banded croaker	17
Isopisthus parvipinnis	Bigtooth corvina	6
Stellifer brasiliensis	Drums or croakers	6
Stellifer rastrifer	Stardrums	18
Menticirrhus spp.	Kingcroakers	3
Micropogonias furnieri	Whitemouth croaker	2
Macrodon atricauda	King weakfish	2
Nebris microps	Smalleye croaker	3
Cynoscion virescens	Green weakfish	7
Ariidae	Sea catfishes	13
Pellona harroweri	American coastal pellona	4
Selene setapinnis	Atlantic moonfish	3
Symphurus spp.	Duskycheek tonguefish	7
Porichthys porosissimus	Porichthys porosissimus	4
Trichiurus lepturus	Largehead hairtail	6

2.5. Ornamental (aquarium) fishery

No catch data originating from ornamental fisheries were included in the reconstructed database. Most of the Brazilian aquarium catches originate from inland waters, even though there has been an increasing interest in marine fishes from the 2000s onwards (Gasparini *et al.* 2005).

3. RESULTS AND DISCUSSION

3.1. Correspondence between common and scientific names

Two levels of loss in taxonomic resolution along the data reporting chain were observed: from the state level to the national level, and from the national to the international level (FishStat/FAO). One example of this loss could be observed for Elasmobranchii in the state of Rio Grande do Sul where in 2003 four species reported in the local bulletin IBAMA/CEPERG (2004) were eliminated from the national landing bulletins and added to the category "cações" (sharks): "cação-gato", "cação-moro", cação-vaca", and "machote". On the other hand, 10 tonnes originally reported for "cação-moro" (*Isurus oxyrinchus*) in the state bulletin were attributed to "cacao-azul" (*Prionace glauca*) in the national bulletin (IBAMA 2004b). Another example was observed for mullets in the state of Sergipe. The state bulletin reported that 12.7 t of "curimã" (*Mugil liza*) and 63.5 t of "tainha" (*Mugil* spp.) in 2001 (CEPENE 2002). However, the national bulletin reported 76.0 t for "tainha" only (Mugil spp.), resulting in a taxonomic loss. For some taxonomic groups such as sharks, these problems are prominent in a regional scale. For instance, 24 common names were attributed to six biological shark species in the southern Bahia (Previero *et al.* 2013).

The detailed analysis of catch records indicated that there were also change in names throughout the period studied: "agulhão-azul" changed to "agulhão-negro" (*Makaira nigricans*), "coró" to "roncador" (*Conodon nobilis*), "paru" to "saberé" and back to "paru" (*Chaetodipterus faber*), etc. This was a pattern observed for most states. Besides, some names are associated to different species depending on the state. One of the most important cases is *Ocyurus chrysurus*. It represents one of the most important fish resources in the state of Espírito Santo, where is known as "cioba". However, this name is used for *Lutjanus analis* in all other states in Brazil. In some cases, catches reported as "cioba" may include *Lutjanus jocu* together with *L. analis* (K.M.F. Freire, personal observation in the state of Rio Grande do Norte). Other interesting case is "roncador" and "corcoroca", which were used as synonymous in the 1980s in Santa Catarina (IBGE 1985a). However, these names represent two different species according to the analysis of more recent bulletins for that state (UNIVALI, 2011): *Conodon nobilis* and *Haemulon aurolineatum*, respectively. The problems of associated with correspondence between common and scientific names had been already pointed out in the 1950s and was later assessed by Freire & Pauly (2005).

In Rio de Janeiro, we noticed that landings for "sororoca", "serra" and "sarda" are confusing. Rocha & Costa (1999) established the following correspondence: *Sarda sarda* = "serra", *Scomberomorus brasiliensis* = "sororoca" or "sarda", and *Scomberomorus regalis* = "sororoca". But the complimentary character of the historical data in fact indicates that "sororoca" and "serra" should be the same species (*Scomberomorus brasiliensis* and probably includes *S. regalis*) and "sarda" would be a different species (*Sarda sarda*). "Xerelete" and "garacimbora" correspond to different species in different states. We decided to use, for Rio de Janeiro, "xerelete" as *Caranx latus*, according to Vianna (2009), as it was a name also used for São Paulo. Thus, garacimbora and its variations (garaximbora, graçainha, guaracimbora) were associated to *Caranx crysos*. But this correspondence should be revisited.

Problems with common names in the landing statistics do not occur only with fishes, but with crustaceans and mollusks as well. One of the most common problem with crustaceans in observed for shrimps, as names such as "camarão pequeno" (small), "médio" (medium) and "grande" (large) are used, or even worse, only "camarões" (shrimps). We tried to establish the correspondence of catches with each species based on local references, consulting local experts or using Dias-Neto (2011). For mollusks, we noticed that *Lucina pectinata* ("lambreta") does not even show up in the ASFIS/FAO list, even though is caught in the state of Bahia and more recently in the state of Sergipe. The genus *Lucina* was included in the ASFIS/FAO list, but no common name was associated with it. Thus, catches for that species cannot be included in the FishStat/FAO database as it uses only common names.

In order to better compare the national and the international database, we decided to analyze in details data reported in FishStat J and IBAMA (2007b), the latest national bulletin with detailed information of catches by species for each state (Table 10). A total of 135 species (or group of species) are reported in FishStat J against 160 in the national bulletin (IBAMA 2007b). Thus, this represent the second type of taxonomic loss in the process of reporting catch statistics in Brazil (and probably in other countries as well). Catches for "biquara" (*Haemulon plumieri*) and "cambuba" (*Haemulon flavolineatum*) were added and reported as Grunts, sweetlips nei in FishStat J. Catches reported for "cioba" in IBAMA (2007b), representing *Lutjanus analis* and *Ocyurus chrysurus* were reported as Snappers, jobfishes nei (Lutjanidae) in FishStat J. This is an unnecessary loss of taxonomic resolution as in most of Brazil (with the exception of the state of Espírito Santo) "cioba" refers to *Lutjanus analis*, which is not included in FishStat J. Additionally, catches may also be attributed to the wrong FAO common name. For example, catches for "abrótea" should be reported in FishStat J as *Urophycis* nei but it was reported as Brazilian codling (*U. brasiliensis*), even though other species is also caught in Brazilian waters, *U. cirrata*, according to IBAMA (2007b), and possibly refers to *U. mystacea*, according to this study. Additionally, divergence in total landings reported for both databases are observed. See for example the case of blue marlin and Atlantic white marlin, where catches reported in IBAMA (2007b) are smaller. Detailed catches for shrimps and mollusks were lost in the global database. For some important resources such as lobsters, errors were also detected

3.2. Analysis of commercial catches

For those states where we had access to published or unpublished local databases (such as Rio Grande do Norte, Santa Catarina and Rio Grande do Sul), we noticed that local databases report landings in kilograms and national bulletins round landings to the closest tonne or half tonne. Data in FishStat J are rounded to the closest tonne.

One important feature of the time series of catch statistics for Brazil is the interruption of the collection system in the earlier 1990s. Thus, as previously mentioned, values representing an arithmetic mean of catches for each species in 1986-1989 were repeated for 1990-1994, except for some species studied by Permanent Working Groups. These repeated values were replaced here by values estimated using linear trends considering values for later years. In other cases, there were local data available for that period and repeated values were replaced. Besides, two bulletins were published in 1995. The first one was released in March 1997 and values for artisanal and industrial fisheries were added or exchanged. The volume later released (in May 1997) contained separated reasonable values for artisanal and industrial fisheries. The second important feature is the interruption of the data collection system from 2008 onwards and estimates are based only on models (MPA 2012, undated).

Another feature of the national bulletins is data reporting for the states of Rio de Janeiro and Guanabara separately until 1975. These two states were united in 1975, but in the 1976 bulletin, data were presented twice under the state of Rio de Janeiro. One of them was considered as originating from Guanabara and both data were added and reported for Rio de Janeiro in our database. It is also important to point out that São Paulo was considered as part of the southern region until 1968 and changed to southeastern Brazil from 1969 onwards. It is worth to consider this change when analyzing historical trends among regions. IBGE is responsible for defining the regional division of Brazil. In 1950, Brazil was divided into north, northeast, east, center-west, and south (the latter including the state of São Paulo). In 1970, São Paulo was considered part of the southeastern region. The current regional division (north, northeast, center-west, southeast, and south) with all their states was established in 1990.

It is mentioned in IBGE (1976, 1977) that shrimp and its by-catch caught by foreign fleet from Barbados, United States of America, Suriname and Trinidad & Tobago based on Fishing Agreements were not included in those bulletins. These catches are not included in this version of our database either. Catches included in those bulletins only accounted for 75-80% of the total landings (main species). We hope that our procedure of estimation of missing values have been able to raise these percentages to 100%. A source of underestimation of catches is the usage of weight of eviscerated fishes and of crustaceans without the cephalothorax. No attempt was made here to correct this source of underestimation, although FAO data are generally corrected to whole wet weight.

Some of the most important detailed observations about data reported for some groups will be discussed in the next sections. This will not be an exhaustive analysis but rather intend to point some discrepancies to make the reader aware of their existence. Thus, they should compare national bulletins with local bulletins whenever possible.

Fisheries for “mero” were banned in 2002 in Brazilian waters (Legal instrument: Portaria IBAMA N. 121, September 20, 2002). However, in all regions of Brazil, there are states where there are still catches officially reported for “mero” (0.5 to 1130 t per year according to the state. Either this represents one more case of ill-defined relation between common name and scientific name, or threatened species continue to be openly exploited. Gerhardinger *et al.* (2006) had already called attention that non-consideration of local names in the legal instrument does not allow for its proper implementation in some regions.

Similar case was observed for billfishes. IN SEAP N. 12 (14 July 2005) oblige fishers to return to the sea all white and blue marlin (*Kajikia albida* and *Makaira nigricans*) that are still alive after being caught and their commercialization is prohibited. However, for the years 2006 and 2007, we noticed that 0.5-69 t of Atlantic white marlin were reported annually for the states of Rio Grande do Norte, Paraíba, Espírito Santo, Rio de Janeiro and Paraná, and 1.5 to 103.5 t of blue marlin in the first three states. This may represent only catches of dead specimens or non-compliance to a legal instrument. Catches for sailfish (*Istiophorus platypterus*) may contain small proportion of *Tetrapturus pfluegeri* (K.M.F. Freire, personal observation).

Some examples of over-reporting were observed in the national bulletins. In the state of Rio Grande do Sul, for example, 1841.5 t of “bonito-listrado” were reported for the industrial fleet in 2007 by IBAMA (2007b), but only 0.28 t were reported as “bonito” (which includes *Auxis thazard*, *Euthynnus alleteratus*, *Katsuwonus pelamis*) in the state bulletin (IBAMA/CEPERG 2008). “Bonito-listrado” was not even mentioned separately. In this volume it was also mentioned that there was no record of live bait fishery for “bonitos” in Rio Grande do Sul in 2007. Additionally, some boats could be landing in the state of Santa Catarina. Catches for shrimps reported in Valentini *et al.* (1991) for the state of Rio de Janeiro are much smaller than officially reported. In some years, catches reported for Rio de Janeiro alone in the national bulletins were

close to total production for all southeastern-southern region in Valentini et al. (1991). Also artisanal (1978) and industrial (1979) catches for shrimps were mixed, resulting in unrealistic high values. Thus, we decided to keep the data reported in Valentini et al. (1991) data.

Problems with landings originating from fresh and salt waters were also observed. The first bulletins presented data from both water bodies together until the early 1970s. From 1978 onwards they were properly separated (Freire and Oliveira 2007). Mangrove crab (*Ucides cordatus*) was reported in some years as originating from fresh water and from salt water in others in all states. Here we considered all records as marine catches (Palomares and Pauly 2014). For the state of Rio Grande do Sul, in some years catches for marine guitarfishes (Rhinobatidae) were reported together with freshwater species (Antero-Silva 1990), but it was not possible to corrected this problem in this version of the database.

The beginning of lobster fisheries in Brazil is not precise. According to Fonteles-Filho (1992), it began in 1955 (place not mentioned). According to Santos & Freitas (2002), it was in 1950 in the state of Pernambuco. However, lobster was already cited in Schubart (1944) as one of the species caught off Pernambuco and by Oliveira (1946) as consumed in the state of Rio de Janeiro. In 1955, lobster fishery would have been introduced in the state of Ceará and, in 1961, in the states of Rio Grande do Norte and Espírito Santo. In the 1970s, it started in Piauí, Maranhão, Pará, Amapá, and Bahia. Finally, in the 1980s, it reached the state of Alagoas. Nowadays lobster fisheries are also found in the state of Rio de Janeiro (Tubino *et al.* 2007). In our database, we considered the beginning in 1950. Main species caught are *Panulirus argus* and *P. laevicauda*, but smaller catches are observed for *Panulirus echinatus* and *Scillarides brasiliensis*. The highest catches are for *Panulirus argus*. However, with the overexploitation of this resource, catches of *P. laevicauda* are increasing as well for *P. echinatus* and *S. brasiliensis*. However, in FISHSTAT/Brazil there are only records for Caribbean spiny lobster (*P. argus*) and Tropical spiny lobsters nei (*Panulirus* spp.).

We would like to point out that problems are not restricted to minor landings. *Goniopsis cruentata* ("aratu") is the sixth most important resource exploited in marine waters off the state of Sergipe (northeastern Brazil), with 115 t landed in 2010 and 139 t in 2011 (Souza *et al.* 2012; Souza *et al.* 2013). Additionally, landings are reported from all states between Rio Grande do Norte and Bahia (with the exception of Paraíba). However, landings for this species are not reported in FishStat J and the species name is not even listed in ASFIS/FAO (2013 or 2014 versions).

Finally, we observed that FishStat J includes catches for Guyana dolphin, *Sotalia guianensis* (in number). A total of 114 individuals was caught in 2007 (Table 10), followed by 22, 22, and 60 in 2008, 2009 and 2010, respectively. These catches are not reported in IBAMA (2007) even though there was a footage obtained by IBAMA and broadcast in 07/16/2007 showing 83 carcasses of this species that was probably used as bait in shark fisheries (Secchi, 2012). As the *Sea Around Us* does not consider catches of marine mammals, reptiles or marine plants, we did not include these data in our database.

Table 10: Comparison between common names and associated catches (tonnes) reported in FishStat J/FAO database and IBAMA (2007b) for 2007. The order of common names as cited in IBAMA (2007b) may be slightly altered to place associated names together such as "albacora" and "atum" (true tunas nei). Differences between FishBase J and IBAMA (2007b) are listed in bold. Asterisk indicates catch in number and do not add to total catch in tonnes.

COMMON NAME – ASFIS/FishStat J	COMMON NAME IBAMA	SCIENTIFIC NAME ASFIS	SCIENTIFIC NAME IBAMA	COMMENTS	CATCH FishStat J	CATCH IBAMA
Brazilian codling	Abrótea	*Urophycis brasiliensis*	*Urophycis brasiliensis* *U. cirrata*	It should be Urophycis nei but it was reported as Brazilian codling (*U. brasiliensis*) in FishStat J, but at least one other species is also caught (*U. mystacea*). The occurrence of *U. cirrata* in Brazil, although reported in our database, is not widely accepted	6579	6579
Ballyhoo halfbeak	Agulha	*Hemiramphus brasiliensis*	*Hyporhamphus unifasciatus* *Hemiramphus brasiliensis*	It should be Hemiramphidae (no common name associated to this family in FishStatJ) and not ballyhoo halfbeak (*Hemiramphus brasiliensis*)	2081	2080.5
Marlins, sailfishes,etc. nei	Agulhão	Istiophoridae	*Tetrapturus albidus* *Tetrapturus pfluegeri* *Makaira nigricans* *Istiophorus albicans*	It may include catches for Belonidae, if originating from artisanal fishery. Total catches for all billfish species in FishStat J (461.0 t) are smaller than in IBAMA, 2007 (760.5 t)	**3**	**429**
Atlantic white marlin	Agulhão-branco	*Tetrapturus albidus*	*Tetrapturus albidus*	It should be *Kajikia albida*	**70**	**142.5**
Blue marlin	Agulhão-negro	*Makaira nigricans*	*Makaira nigricans*	None	**261**	**101.5**
Atlantic sailfish	Agulhão-vela	*Istiophorus albicans*	*Istiophorus albicans*	Consider replacing by *Istiophorus platypterus* according to Eschmeyer (CofF vers. May. 2014), following Collette *et al.* (2006)	**123**	**87.5**
Longbill spearfish	–	*Tetrapturus pfluegeri*	–	This species is referred separately as "agulhão verde", but there was no catch value reported for this species. Thus, it is not known where this value was obtained from	**4**	–
–	Albacora Atum	–	*Thunnus obesus* *Thunnus alalunga* *Thunnus albacores* *Thunnus atlanticus*	Correspondence of catches between FishStat J and IBAMA (2007) should be checked Total catches for all tuna species in FishStat J (7830 t) are smaller than in IBAMA, 2007 (10529.5 t)	–	**603.5** **734.5** **(1338.0)**
Bigeye tuna	Albacora-bandolim	*Thunnus obesus*	*Thunnus obesus*	It is reported only as "Atum-cachorra" in the list of correspondence between common and scientific names in IBAMA (2007b)	**1595**	**1596.5**
Albacore	Albacora-branca	*Thunnus alalunga*	*Thunnus alalunga*	Difference in catches may be associated to splitting catches reported under the generic name "Albacora" or "Atum"	**534**	**591**
Yellowfin tuna	Albacora-lage	*Thunnus albacares*	*Thunnus albacares*	Difference in catches may be associated to splitting catches reported under the generic name "Albacora" or "Atum"	**5468**	**6702**
Blackfin tuna	Albacorinha	*Thunnus atlanticus*	*Thunnus atlanticus*	Difference in catches may be associated to splitting catches reported under the generic name "Albacora" or "Atum"	**233**	**302**
Tuna-like fishes nei	–	Scombroidei	–	Check correspondence	**22**	–
–	Bonito	–	*Auxis thazard* *Katsuwonus pelamis* *Euthynnus alletteratus*	Catches should be reported for each species separately	**–**	**1696**
Frigate and bullet tunas	Bonito cachorro	*Auxis thazard* *A. rochei*	*Auxis thazard*	National bulletin should report as *Auxis* spp.	**203**	**1212**
Skipjack tuna	Bonito listrado	*Katsuwonus pelamis*	*Katsuwonus pelamis*	Difference in catches should be investigated	**24191**	**24390**

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COMMON NAME – ASFIS/FishStat J	COMMON NAME IBAMA	SCIENTIFIC NAME ASFIS	SCIENTIFIC NAME IBAMA	COMMENTS	CATCH FishStat J	CATCH IBAMA
Little tunny(=Atl.black skipj)	Bonito pintado	*Euthynnus alletteratus*	*Euthynnus alletteratus*	None	397	396.5
Amberjacks nei	Arabaiana, Olho-de-boi	*Seriola* spp	*Seriola lalandi* *Seriola dumerili* *Seriola fasciata* *Elagatis bipinnulata*	"Olho-de-boi" should be Greater amberjack and "arabaiana" may include *Elagatis bipinnulata* together with *Seriola* spp.	904	729.5 174.0 (903.5)
Yellowtail amberjack	Olhete, Arabaiana, Olho-de-boi	*Seriola lalandi*	*Seriola lalandi* *Seriola dumerili*	These catches should be added to the previous one and associate to "Amberjacks nei". However, some effort should be put into separate from *Elagatis bipinnulata*	279	278.5
Jacks, crevalles nei	Aracimbora Garacimbora Guaraximbora Xaréu Xerelete, xarelete	*Caranx* spp	*Caranx latus* *Caranx latus* *Caranx latus* *Caranx hippos* *Caranx latus*	Difference in catches should be checked. Taxonomic details are lost from national to global databases but they should be kept. Data for "guaraximbora" may have been entered twice in FishStat J as it corresponds to the difference between FishStat J and IBAMA totals	**6971**	**74.0** **98.5** **132.5** **2391.5** **4142.0** **(6838.5)**
Carangids nei	Canguira Guaivira Timbira Galo, galo-de-penacho, peixe galo	Carangidae	– *Oligoplites* spp. *Oligoplites* spp. *Selene* spp	"Guaivira" and "timbira" should be associated to Leatherjackets nei "Galo" should be in a separate category for Selene spp, but there is no name in FishStat J	**1203**	**459.5** **1104.5** **739.5** **2529.0** **(4832.5)**
Atlantic moonfish	Galo de profundidade	*Selene setapinnis*	–	It should be *Zenopsis conchifer* (Silvery John dory in ASFIS) as it was reported only for Santa Catarina (UNIVALI/CCTMar 2008)	23	23
Blue runner	Garajuba	*Caranx crysos*	*Caranx crysos*	None	1384	1383.5
Bigeye scad	Garapau	*Selar crumenophthalmus*	*Selar crumenophthalmus*	It may also include *Chloroscombrus chrysurus*	262	262
Rough scad	Xixarro, chicharro	*Trachurus lathami*	*Trachurus lathami*	It may include other carangids: *Decapterus* spp., *Selar crumenophthalmus*	2291	2291
Pompanos nei	Pampo	*Trachinotus* spp	*Trachinotus* spp.	None	152	152
Lane snapper	Ariacó	*Lutjanus synagris*	*Lutjanus synagris*	None	2036	2036
Rays, stingrays, mantas Nei	Arraia	Rajiformes	None	Several species reported and detailed information lost in tha national and global database	5279	5279
Brazilian groupers nei	Badejo, sirigado Sirigado	*Mycteroperca* spp	*Mycteroperca* spp.	Do not include two data entries: "badejo" and "sirigado"	1781	1238.5 542.5 (1781.0)
Groupers nei	Cherne Mero	*Epinephelus* spp	*Epinephelus* spp., *E. flavolimbatus, Polyprion americanus* *Epinephelus itajara*	National bulletin should differentiate between 'cherne" (*Epinephelus* spp.) and "cherne poveiro" (*Polyprion americanus*). *P. americanus* is wreckfish in ASFIS/FAO, but there is no catch associated to this common name in FishStat J	833	479.0 353.5 (832.5)

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COMMON NAME – ASFIS/FishStat J	COMMON NAME IBAMA	SCIENTIFIC NAME ASFIS	SCIENTIFIC NAME IBAMA	COMMENTS	CATCH FishStat J	CATCH IBAMA
				Epinephelus flavolimbatus changed to *Hyporthodus flavolimbatus*		
Sea catfishes nei	Bagre Bandeirado Cambeua Cangatá Gurijuba Jurupiranga	Ariidae	Ariidae	It probably includes more common names. Taxonomic details should not be lost: Bagre = Ariidae Bandeirado = *Bagre* spp. Cambeua = *Notarius grandicassis* (Thomas sea catfish) Cangatá = *Aspistor quadriscutis* (Bressou sea catfish) Gurijuba = Sciades parkeri Jurupiranga = *Amphiarius rugispinis* (Softhead sea catfish) Uritinga = *Sciades proops*	28781	7445.5 4193.0 1098.0 3730.0 6344.5 294.0 5676.0 (28781.0)
Puffers nei	Baiacu	Tetraodontidae	*Lagocephalus laevigatus*	Tetraodontidae	409	409
Tilefishes nei	Batata	Branchiostegidae	*Caulolatilus chrysops* *Lopholatilus villarii*	Branchiostegidae in ASFIS, but it should be Malacanthidae. However, this family is not in the ASFIS list. It includes two species: *Lopholatilus villarii* and *Caulolatilus chrysops*	924	923.5
Cobia	Beijupirá	*Rachycentron canadum*	*Rachycentron canadum*	None	635	634.5
Barracudas nei	Bicuda	*Sphyraena* spp	*Sphyraena tome*	The national bulletin should use *Sphyraena* spp. as in FishStat J	375	375
Grunts, sweetlips nei	Biquara Cambuba Corcoroca Sapuruna Xira Golosa Peixe-pedra	Haemulidae	*Haemulon plumieri* *H. flavolineatum* *Haemulon* spp., *Pomadasys* spp., *Osthopristis ruber* – – *Genyatremus luteus* *Genyatremus luteus*	Even though IBAMA (2007) reports the species *Haemulon plumieri* as "biquara", it may include other species. Haemulidae is the best option if taxonomic detail is not provided. *Genyatremus luteus* = "golosa" or "peixe-pedra" and it should be reported as Torroto grunt in FishStat J	3792	1286.5 20.5 259.5 208.5 4.0 0.5 2012.5 (3792.0)
Parrotfishes nei	Budião	Scaridae	*Sparisoma* spp.	National bulletin should change to Scaridae	135	135
Atlantic searobins	Cabra	*Prionotus* spp.	*Prionotus* spp.	None	5246	5246
Sharks, rays, skates, etc. nei	Cação Tubarão	Elasmobranchii	Lamnidae, Carcharhinidae, Triakidae, Odontaspididae, Sphyrnidae, Alopiidae, Squalidae	National bulletin should provide catches by species. Taxonomic resolution should not be lost in the global database; thus, Various sharks nei should be used, which corresponds to Selachimorpha (Pleurotremata)	**7862**	**7698.0** **4256.0** **(11954.0)**
Bigeye thresher	–	*Alopias superciliosus*	–	Interesting case of resolution loss in the national bulletin and resolution recuperated in the global database	**69**	–
Blue shark	–	*Prionace glauca*	–	Interesting case of resolution loss in the national bulletin and resolution recuperated in the global database	**2318**	–
Requiem sharks nei	–	Carcharhinidae	–	Interesting case of resolution loss in the national bulletin and resolution recuperated in the global database	**1414**	–

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COMMON NAME – ASFIS/FishStat J	COMMON NAME IBAMA	SCIENTIFIC NAME ASFIS	SCIENTIFIC NAME IBAMA	COMMENTS	CATCH FishStat J	CATCH IBAMA
Scalloped hammerhead	–	*Sphyrna lewini*	–	Interesting case of resolution loss in the national bulletin and resolution recuperated in the global database Other species are also caught, so it should be changed to *Sphyrna* spp. (Hammerhead sharks nei)	**120**	–
Shortfin mako	–	*Isurus oxyrinchus*	–	Interesting case of resolution loss in the national bulletin and resolution recuperated in the global database	**157**	–
Tiger shark	–	*Galeocerdo cuvier*	–	Interesting case of resolution loss in the national bulletin and resolution recuperated in the global database	**6**	–
Oceanic whitetip shark	–	*Carcharhinus longimanus*	–		**14**	–
Tarpon	Camurupim Pirapema	*Megalops atlanticus*	*Tarpon atlanticus* –	National bulletin should report as *Megalops atlanticus*	636	342.0 293.5 (635.5)
Snappers, jobfishes nei	Caranha (vermelho) Carapitanga Cioba Dentão Vermelho	Lutjanidae	*Lutjanus* spp., *Rhomboplites aurorubens* – *Lutjanus analis* and *Ocyurus chrysurus* *Lutjanus jocu* –	Carapitanga is not listed in IBAMA (2007); cioba = *Ocyurus chrysurus* only in Espírito Santo and *Lutjanus analis* in all other states; dentão = *Lutjanus jocu*. These specific details should not be lost in the global database	7875	154.0 297.5 3025.5 1168.0 3229.5 (7874.5)
Irish mojarra	Carapeba	*Diapterus auratus*	*Diapterus auratus, Eugerres brasilianus, Eucinostomus argenteus*	It should be "Mojarras, etc. nei" in the global database (Gerreidae)	2074	2074
Argentine croaker	Castanha	*Umbrina canosai*	*Umbrina canosai*	It may include *U. coroides* in some states	11164	11163.5
Largehead hairtail	Catana Espada	*Trichiurus lepturus*	– *Trichiurus lepturus*	"Catana" should be in the list of common names in IBAMA (2007b). Only "Espada" was included	3390	31 3359 (3390)
King mackerel Wahoo	Cavala	*Scomberomorus cavalla* *Acanthocybium solandri*	*Scomberomorus cavalla, Acanthocybium solandri*	Not sure how catches for "cavala" in IBAMA (2007b) were split between two species (wahoo and king mackerel) in FishStat J. Besides, they do not add to 3706 t reported.	**33** **76** **(109)**	**3706**
Serra Spanish mackerel	Serra Sororoca	*Scomberomorus brasiliensis*	– *Scomberomorus brasiliensis*	It includes a smaller proportion of *S. regalis* (Cero) Difference between FishStat J and IBAMA should be better investigated.	**563**	**7887** **445** **(8832)**
Atlantic bonito	Sarda (serra)	*Sarda sarda*	*Scomberomorus maculatus, Sarda sarda*	National bulletin should correct to *Scomberomorus brasiliensis, S. regalis* and *Sarda sarda*, and provide catches separately for each species	334	334
Chub mackerel	Cavalinha	*Scomber japonicus*	*Scomber japonicus*	It should be *Scomber colias*	8262	8262

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COMMON NAME – ASFIS/FishStat J	COMMON NAME IBAMA	SCIENTIFIC NAME ASFIS	SCIENTIFIC NAME IBAMA	COMMENTS	CATCH FishStat J	CATCH IBAMA
Red grouper	Garoupa	*Epinephelus morio*	*Epinephelus* spp.	It includes other species besides *E. morio*. Thus, Groupers nei should be used	863	862.5
Argentine conger Cusk-eels, brotulas nei	Congro Congro-rosa	*Conger orbignyanus* Ophidiidae	– *Genypterus brasiliensis*	It could be *Conger orbignianus*, *Genypterus brasiliensis* or *Ophichthus* spp.. More detail should be provided in national bulletin and taxonomic detail improved in FishStat J, using *Genypterus brasiliensis* for "congro rosa"	12 626	12 626
Barred grunt	Coró Roncador	*Conodon nobilis*	*Conodon nobilis* *Conodon nobilis*	None	161	51.0 109.5 (160.5)
Whitemouth croaker	Corvina Cururuca	*Micropogonias furnieri*	*Micropogonias furnieri* –	None	44374	44053.5 320.0 (44373.5)
Common dolphinfish	Dourado	*Coryphaena hippurus*	*Coryphaena hippurus*	It includes a small proportion of *Coryphaena equiselis* (Pompano dolphinfish), but these two species are never reported separately in landing ports	8873	8872.5
Guyana dolphin	–	*Sotalia guianensis*	–	Not reported in the national bulletin (IBAMA, 2007)	114*	–
Bluefish	Enchova	*Pomatomus saltatrix*	*Pomatomus saltatrix*	None	3926	3926
–	Enguia	–	–	Not located in FishStat J or in the taxonomic list provided in IMABA (2007b)	–	**35**
Swordfish	Espadarte	*Xiphias gladius*	*Xiphias gladius*	Unknown reasons for difference in catches	**4243**	**4201.5**
Jamaica weakfish	Goete	*Cynoscion jamaicensis*	*Cynoscion jamaicensis*	It should be analyzed carefully as it may be *Macrodon ancylodon* in northeastern Brazil. Thus, correct correspondence should be established before national compilation	2776	2776
Yellowtail snapper	Guaiúba	*Ocyurus chrysurus*	*Ocyurus chrysurus*	None	3717	3717
Bastard halibuts nei	Linguado	*Paralichthys* spp	Paralichthyidae Bothidae Achiridae	It should be changed to Pleuronectiformes (Flatfishes nei) in FishStat J	2566	2566
Argentine hake	Merluza	*Merluccius hubbsi*	–	Even though the correspondence is correct, one should consider recent catches reported for *Macruronus magellanicus* (merluza de cola) and *Dissostichus eleginoides* (merluza negra) in southern and southeastern Brazil, respectively.	2075	2074.5
Moray	Mororó	Muraenidae	–	It should be *Gymnothorax* spp., but there is no common name in ASFIS	–	**51.5**
Argentinian sandperch	Namorado	*Pseudopercis semifasciata*	*Pseudopercis* spp.	Two species occur in Brazil*: P. semifasciata* and *P. numida*. It should be *Pseudopercis* spp. (but there is no common name in ASFIS for it). Catches for northeastern Brazil should be better investigated.	687	687.5
Bigeyes nei	Olho de cão	*Priacanthus* spp.	*Priacanthus* spp.	According to Froese & Pauly (2014), there is only one species in Brazil: *Priacanthus arenatus*. However, there is some possibility that	398	398

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COMMON NAME – ASFIS/FishStat J	COMMON NAME IBAMA	SCIENTIFIC NAME ASFIS	SCIENTIFIC NAME IBAMA	COMMENTS	CATCH FishStat J	CATCH IBAMA
				Heteropriacanthus cruentatus is also caught. This should be better investigated.		
Shorthead drum	Oveva	*Larimus breviceps*	*Larimus breviceps*	None	254	254
Bocon toadfish	Pacamão	*Amphicthys cryptocentrus*	*Amphicthys cryptocentrus*	It should de corrected to *Amphichthys cryptocentrus*. It may include Batrachoides surinamensis. In this case, it should be changed to Batrachoididae (Toadfishes, etc. nei) until proper identification of both species and separated catch reporting	311	310.5
Atlantic bumper	Palombeta Pilombeta	*Chloroscombrus chysurus*	*Chloroscombrus chysurus* –	Catches reported as "pilombeta" (Engraulidae) originating from Sergipe are also included with "palometa" (Carangidae). However, it should not as it may include *Anchovia clupeoides, Anchoviella lepidentostole, Anchoviella vaillanti,* and *Lycengraulis grossidens*. As this is a resource locally important for Sergipe, it should be reported separately. However, as it includes four species (not easy identification on site), their catches should be added to Anchovies, etc. nei	2868	2759.5 108.0 (2867.5)
Kingcroakers nei	Papa-terra, betara	*Menticirrhus* spp	*Menticirrhus* spp.	Only two species occur in Brazil: *Menticirrhus littoralis* and *M. americanus*	1948	1948
–	Papuda	–	–	It was not included in the taxonomic list of IBAMA (2007b). We were not able to associate with any scientific name, even though there are catches reported for the states of Pernambuco and Bahia (0.5 to 51.5 $t \cdot year^{-1}$)	–	–
Southern red snapper	Pargo, pargo verdadeiro	*Lutjanus purpureus*	*Lutjanus purpureus*	None	3694	3694
Red porgy	Pargo-rosa	*Pagrus pagrus*	*Pagrus pagrus*	It may include *Lutjanus vivanus* or *Pagrus pagrus*, depending on the state. This should be clarified when obtaining and reporting data locally	2051	2050.5
Spadefishes nei	Parú, enchada, sabara	Ephippidae	*Chaetodipterus faber*	It could include also *Pomacanthus paru* (Pomacanthidae). To be investigated on site (easy distinction)	198	198
Silversides(=Sand smelts) nei	Peixe-rei	Atherinidae	*Atherinella brasiliensis, Odontesthes argentinensis*	It includes *Odontesthes argentinensis, Atherinella brasiliensis* (Atherinopsidae), and possibly *Elagatis bipinnulata*. Data should be properly reported and checked before national compilation.	1	0.5
Blackfin goosefish	Peixe-sapo, diabo, pescador, rape	*Lophius gastrophysus*	*Lophius gastrophysus*	None	2508	2508
Flyingfishes nei	Peixe-voador, voador holandês	Exocoetidae	*Cheilopogon cyanopterus, Hirundichthys affinis*	It may include 'falso voador' (*Dactylopterus volitans*). This should be investigated locally	1256	1255.5
–	Voador	–	–	It should be included in Flyingfishes nei	–	**37**
Triggerfishes, durgons nei	Peroá, cangulo, peixe porco	Balistidae	*Balistes capriscus, Aluterus monoceros*	*Aluterus monoceros* belongs to the family Monacanthidae. Thus, the name used in FishStat J should consider this. Besides, *Balistes vetula* is also caught in Brazilian waters and has been replacing *B. capriscus* in	3787	3787

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COMMON NAME – ASFIS/FishStat J	COMMON NAME IBAMA	SCIENTIFIC NAME ASFIS	SCIENTIFIC NAME IBAMA	COMMENTS	CATCH FishStat J	CATCH IBAMA
				landings off Espírito Santo after its commercial extinction (Freitas-Netto and Madeira di Beneditto 2010)		
Weakfishes nei	Pescada Pescadinha-gó	*Cynoscion* spp	*Cynoscion* spp., *Macrodon* spp. –	Catches for each genus should be reported separately and more detail for catches of *Cynoscion* could be provided based on local data. Pescadinha-gó is caught in northern Brazil, where it is associated to *Macrodon ancylodon*. Thus, its catches should be added to King weakfish	19239	7987.5 11252.0 (19239.5)
Acoupa weakfish	Pescada-amarela	*Cynoscion acoupa*	*Cynoscion acoupa*	None	20411	20411
Smooth weakfish	Pescada-branca	*Cynoscion leiarchus*	*Cynoscion leiarchus*	It may include three other species besides *C. leiarchus*: *C. guatucuba*, *C. jamaicensis*, and *C. virescens*	692	692
Green weakfish	Pescada-cambuçu, pescada-cururuca	*Cynoscion virescens*	*Cynoscion virescens*	"Pescada cambuçu" may include *Macrodon* spp.	331	330.5
Stripped weakfish	Pescada-olhuda	*Cynoscion guatucupa*	*Cynoscion guatucupa*	Note some bulletins are still using *C. striatus*, which was considered *nomen dubium* by Figueiredo (1992)	3050	3049.5
King weakfish	Pescadinha-real	*Macrodon ancylodon*	*Macrodon ancylodon*	It should consider *M. atricauda* for southeastern/southern Brazil and *M. ancylodon* otherwise (Carvalho-Filho *et al.* 2010)	3651	3651
Sea chubs nei	Pirajica	Kyphosidae	*Kyphosus spp*	It should be changed to Kyphosus sea chubs nei in FishStat J	44	44
Tripletail	Prejereba	*Lobotes surinamensis*	*Lobotes surinamensis*	None	14	13.5
Snooks(=Robalos) nei	Robalo	*Centropomus* spp	*Centropomus* spp.	None	3947	3946.5
Goatfishes, red mullets nei	Saramonete Trilha	Mullidae	*Pseudupeneus maculatus*	Catches are associated to three species: *Mulloidichthys martinicus*, *Mullus argentinae*, and *Pseudupeneus maculatus*. Thus, national bulletin should properly attribute catches to the correct species based on the state catches originate from	1388	322.5 1065.5 (1388.0)
Atlantic thread herring	Sardinha-lage, sardinha-chata, sardinha-bandeira	*Opisthonema oglinum*	*Opisthonema oglinum*	None	13252	13252
Brazilian sardinella	Sardinha verdadeira, maromba	*Sardinella brasiliensis*	*Sardinella brasiliensis*	None	55940	55939.5
Scaled sardines	Sardinha cascuda	*Harengula* spp	–		226	226
Anchovies, etc. nei	Manjuba	Engraulidae	Engraulidae Engraulidae	None	4374	4374
Clupeoids nei	Arenque Sardinha	Clupeoidei	–	Detailed catches should be provided by species	18190	48.5 18141.5 (18190.0)
Brazilian menhaden	Savelha	*Brevoortia aurea*	*Brevoortia* spp.	Catches are associated to *Brevoortia aurea* (Brazilian menhaden) and *B. pectinata* (Argentine menhaden). Besides, it may include *Harengula*	1078	1077.5

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COMMON NAME – ASFIS/FishStat J	COMMON NAME IBAMA	SCIENTIFIC NAME ASFIS	SCIENTIFIC NAME IBAMA	COMMENTS	CATCH FishStat J	CATCH IBAMA
				spp.. Thus, Brazilian menhaden should be replaced by ??? (Brevoortia spp.) in FishStat J		
Mullets nei	Tainha, saúna, curimã, cacetão, tainhota	Mugilidae	*Mugil* spp.	There is no common name associated to Mugil spp. in ASFIS, but it should be included to accommodate catches associated to "tainha". Each local name is associated to different species and the proper correspondence should be established in each state	21864	21864
Brazilian flathead	Tira-vira	*Percophis brasiliensis*	*Percophis brasiliensis*	None	941	940.5
Bigtooth corvina	Tortinha	*Isopisthus parvipinnis*	*Isopisthus parvipinnis*	None	16	16
Marine fishes nei	Uricica Cabeçudo Outros peixes	– – *Osteichthyes*	– – –	Taxonomic resolution lost. More effort should be put to increase resolution Uricica should be included in Sea catfishes nei Cabeçudo = *Stellifer* spp. (no name in ASFIS)	**60823**	**1200** **231** **38587.5**
Marine crabs nei	Caranguejo-uçá	Brachyura	*Ucides cordatus*	It should be reported in FishStat J as Swamp ghost crab (according to ASFIS). It may consider a more adequate name for the species, "mangrove crab" (Palomares and Pauly 2014)	6818	6818
Southwest Atlantic red crab	Caranguejo-de-profundidade, caranguejo-real, caranguejo-vermelho	*Chaceon notialis*	*Chaceon ramosae* *Chaceon notialis*	It should be reported in FishStat J as Chaceon geryons Nei (*Chaceon* spp.) as two species are caught	1	0.5
Dana swimcrab	Siri	*Callinectes danae*	*Callinectes* spp.	It should be reported as Callinectes swimcrabs nei in FishStat J (*Callinectes* spp.) as it includes several species	1461	1461
Penaeid shrimps nei	Camarão Camarão-barba-ruça, camarão-serrinha, ferrinho Camarão branco Camarão-santana	Penaeidae	Penaeidae *Artemesia longinaris* *Litopenaeus schmitti* *Pleoticus muelleri*	Species should be separated, as taxonomic resolution was lost: Camarão-barba-ruça = *Artemesia longinaris* should be reported as Argentine stiletto shrimp in FishStat J Camarão branco = *Litopenaeus schmitti* = Southern white shrimp Camarão-santana = *Pleoticus muelleri* = Argentine red shrimp	12244	3861.5 3467.0 4099.5 816.0 (12244.0)
Redspotted shrimp	Camarão-rosa	*Penaeus brasiliensis*	*Farfantepenaeus brasiliensis* *Farfantepenaeus paulensis* *Farfantepenaeus subtilis*	It should be Penaeus shrimps Nei (Penaeus spp.). AFSIS does not consider *Farfantepenaeus* as a valid genus	8238	8237.5
Atlantic seabob	Camarão-sete-barbas	*Xiphopenaeus kroyeri*	*Xiphopenaeus kroyeri*	None	15060	15060
Caribbean spiny lobster	Lagosta	*Panulirus argus*	*Panulirus argus, P. laevicauda, P. echinatus*	Taxonomic resolution should be kept considering three species ("lagosta-vermelha", "lagosta-verde", and "lagosta-pintada")	6479	6478.5
Marine crustaceans nei	Aratu Guaiamum Lagostim Outros crustáceos	– – – –	*Goniopsis cruentata* *Cardisoma guanhumim* *Metanephrops rubellus* –	Note that purple mangrove crab = *Goniopsis cruentata* in SealifeBase but to *Goniopsis pelii* in ASFIS. It seems *G. pelii* is synonymy for *G.cruentata* It should be changed to *Cardisoma guanhumi* = Giant land crab	484	57.5 89.5 156.5 180.5

Table 10: Comparison between common names and associated catches (tonnes) reported in FishStat J/FAO database and IBAMA (2007b) for 2007. The order of common names as cited in IBAMA (2007b) may be slightly altered to place associated names together such as "albacora" and "atum" (true tunas nei). Differences between FishBase J and IBAMA (2007b) are listed in bold. Asterisk indicates catch in number and do not add to total catch in tonnes.

COMMON NAME – ASFIS/FishStat J	COMMON NAME IBAMA	SCIENTIFIC NAME ASFIS	SCIENTIFIC NAME IBAMA	COMMENTS	CATCH FishStat J	CATCH IBAMA
				Taxonomic resolution lost for lagostim. Effort should be put to clarify, as it may also include *Scyllarides brasiliensis*		(484.0)
Common squids nei	Calamar-argentino Lula	*Loligo* spp	Ommastrephidae Loliginidae	More taxonomic detail needed and change in FishStat J is required	2160	344 1816 (2160)
Octopuses, etc. nei	Polvo	Octopodidae	*Octopus* spp. *Eledone* spp.	None	2195	2195
Cupped oysters nei	Ostra	*Crassostrea* spp.	*Crassostrea* spp.	None	800	800
Triangular tivela	Maçunim	*Tivela mactroides*	*Tivela mactroides*	None	1820	1819.5
Sea mussels nei	Berbigão Sarnambi Sururu	Mytilidae	*Anomalocardia brasiliensis* *Mytilus falcata, Mytella* spp	"Berbigão" and "sarnambi" = West Indian pointed venus (Veneridae) = *Anomalocardia brasiliana* "Sururu" = *Mytella charruana* and *Mytella guyanensis* (Mytilidae)	1348	58.0 0.5 1289.5 (1348.0)
Marine molluscs nei	Mexilhão Vieira Outros moluscos	Mollusca	*Perna perna* *Euvola ziczac* –	Mexilhão = *Perna perna* = South American rock mussel Vieira = *Euvola ziczac* = Zigzag scallop	**5389**	**5361.5** **1** **25.5** **(5388.0)**
TOTAL					539966.5	539967

3.3. Recreational catches

Total estimated catches indicated an increase throughout the period analyzed (Fig. 2). In the 1980s, there was a sharp increase resulting from a population increase, establishment of fishing clubs and the promotion of recreational fishing events. Freire (2005) indicated that results of competitive events are lost and earlier results are probably missing. Other sources of error include absence of information on the proportion of license holders in relation to total number of anglers. For many states, a national estimate had to be used (Freire *et al.* 2012). The same occurred with estimates of daily catch by recreational fisher, as values for neighbor states were used when unavailable. Additionally, we used as criterion to start the reconstruction the year of establishment of the first fishing club in each state. Many clubs in northeastern Brazil, for example, were established in the 1980s (Freire 2010). Anglers certainly were fishing before that but we decided to use an objective criterion as a start point assuming that better organization may imply higher catches. Finally, for competitive events, there is no national database with catches originating from those events. Thus, there are many missing values that have been only recently reconstructed in other small projects (see, e.g., Freire *et al.* submitted). However, for most of the states, this reconstruction is not completed at this point and only results readily available were used.

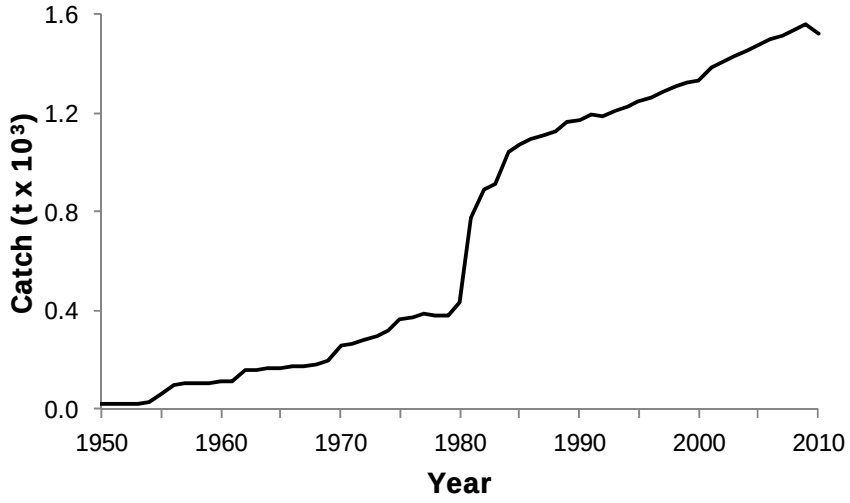

Figure 2: Catches originating from Brazilian recreational marine fisheries (daily activities and competitive events).

The national trend was defined mostly by values estimated for southern Brazil (Fig. 3). This trend was mainly defined by catches estimated for the state of Santa Catarina where local data available indicated high catch rates for recreational fishers of category B (boat-based) (Schork *et al.* 2010). Catches for the north region were the lowest, even though it is known that many fishing events are promoted in the state of Pará (Frédou *et al.* 2008). However, for that region it is expected that most recreational fisheries are practiced in fresh waters. No detail on catch composition was provided as for most states this information is not available yet, with some exceptions such as for some regions in the states of Bahia, São Paulo, Santa Catarina, and Rio Grande do Sul (Peres and Klippel 2005; Nascimento 2008; Schork *et al.* 2010; Barcellini *et al.* 2013).

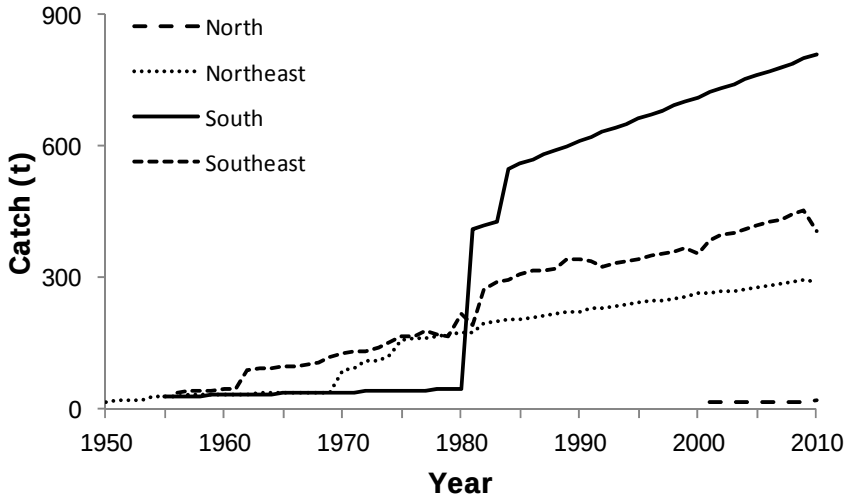

Figure 3: Catches originating from Brazilian recreational marine fisheries by region (daily activities and competitive events).

3.4. Subsistence catches

The overall estimated marine subsistence catches, based on the "nonmonetary marine 'fish' acquisition" provided by the Household Budget Survey, reached about 5,000 t in 2010 (Fig. 4). The number of registered fishers rose from 11,000 in 1950 to 72,000 in 2010 and the state that presented the higher number of fishers was Pará (in northern Brazil) with about 31%, while Pernambuco (in northeastern Brazil) accounted for less than 2%. The fish consumption rate (kg.capita.year^{-1}) by geographic region also varied considerably: north (38.1), northeast (14.6), southeast (5.4) and south (3.1). The average number of persons by family in fishing communities ranged from 4 to 9 for the study period, which has a direct influence in the subsistence fish consumption (including fresh and marine fishes), along with social and economic changes. The most representative families consumed were: Sciaenidae (28% of total estimated catches), followed by Mugilidae (27%), Clupeidae (10%) and Ariidae (5%) (Table 11). Elasmobranchs and shrimps also had some participation in the subsistence consumption of marine fish (1% and 12%, respectively). The remaining 17% encompassed different marine fish families.

Table 11: Proportion of the taxonomic breakdown used to estimate catches by species (or group of species) reported as subsistence catches in each region. The Household Budget Survey (POF) reported these values in kg·person^{-1}·year^{-1} (non-monetary acquisition for both urban and rural areas), which were here calculated as proportion within each region (Based on IBGE 2010b).

ITEM	North	Northeast	Southeast	South
Anchova fresca (fresh bluefish)	–	–	–	0.023
Bacalhau (codling)	–	0.009	0.008	–
Bagre fresco (fresh marine catfish)	0.060	0.018	–	–
Cação fresco (fresh shark)	–	0.056	–	0.134
Camarão fresco (fresh shrimp)	0.152	0.023	0.041	–
Corvina fresca (fresh whitemouth croaker)	0.007	0.051	0.063	0.046
Merluza em filé congelado (frozen hake fillet)	–	0.004	0.008	–
Merluza em filé fresco (fresh hake fillet)	–	–	0.086	–
Parati fresco (fresh mullet)	0.026	–	–	–
Pescada fresca (fresh weakfish)	0.286	0.140	–	0.090
Pescadinha fresca (fresh king weakfish)	0.006	0.027	0.008	–
Sardinha em conserva (preserved sardine)	0.006	0.023	0.219	0.046
Sardinha fresca (fresh sardine)	0.108	0.037	0.041	0.090
Tainha fresca (fresh mullet)	0.293	0.145	–	0.468
Outros pescados em filé fresco (other fresh fish fillet)	–	0.013	0.019	0.012
Outros pescados frescos (other fresh fish)	0.047	0.455	0.508	0.068
Outros pescados salgados (other salted fish)	0.007	–	–	0.023

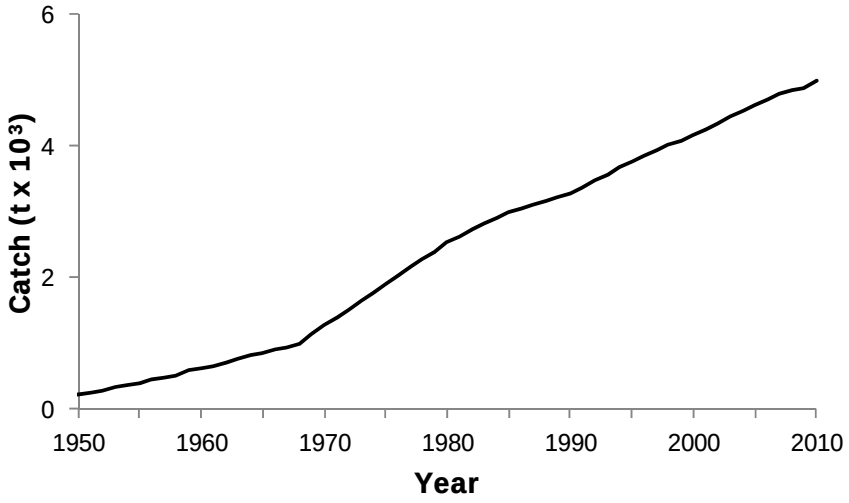

Figure 4: Subsistence catches from "nonmonetary marine fish acquisition" (marine fish catches for food purposes) based on the household budget survey for the Brazilian waters from 1950 to 2010.

3.5. Discards

Industrial discards were estimated at 26,000 t·year^{-1} in the early 1950s, increasing nearly tenfold throughout the next few decades to peak in the mid-1980s at approximately 250,000 t·year^{-1} (Fig. 5). Thereafter, industrial discards declined to 110,000 t in 1990 and for the next two decades averaged approximately 130,000 t·year^{-1}. This decline was largely driven by a shift in the use of industrial gear types, away from pair- and otter-trawls towards an increase in gillnets (Fig. 6). The vast majority of discards were from the south and southeastern regions, namely Paraná, Santa Catarina, Rio Grande do Sul, Espírito Santo, Rio de Janeiro, and São Paulo (Fig. 7). The average discard rate from 1950 to 2010 was 55% of industrial landings.

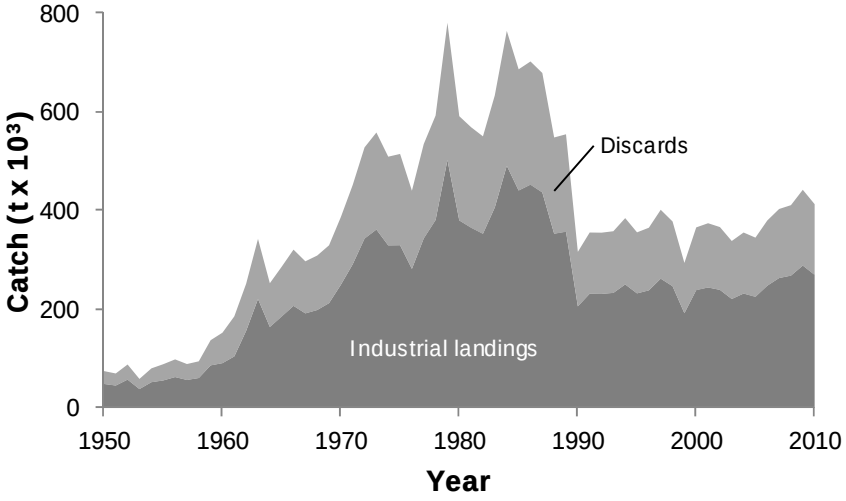

Figure 5: Discards and catches in the industrial sector of Brazilian fisheries.

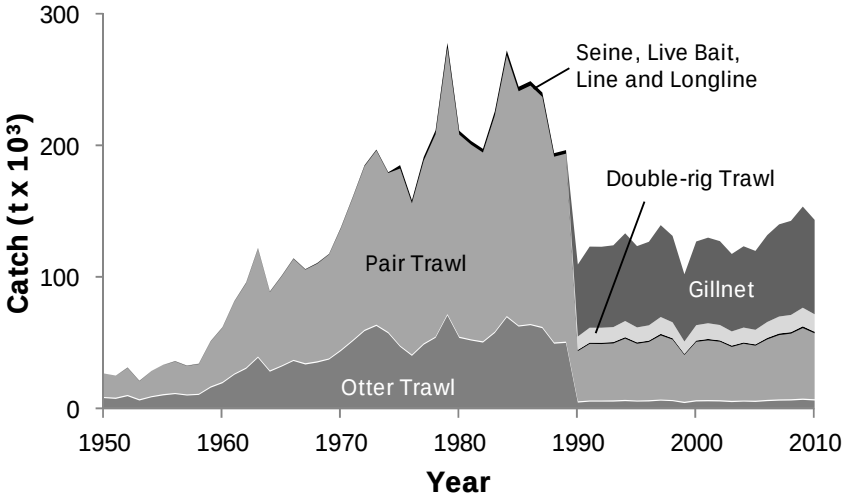

Figure 6: Discards in the Brazilian industrial sector by fishing gear.

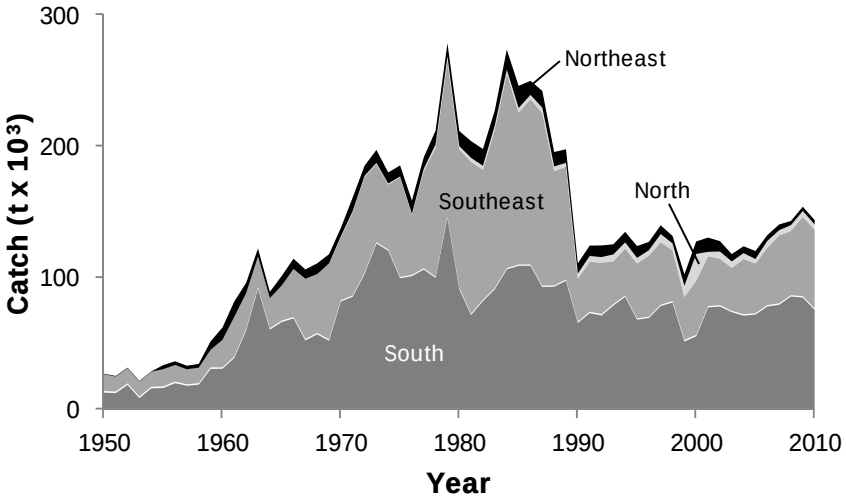

Figure 7: Discards in the Brazilian industrial sector by region.

In 1950, artisanal discards amounted to around 42,000 t (Fig. 8), increasing throughout the next few decades to peak in 1985 of 173,000 t. Discards dropped in the 1990s, averaging 120,000 t·year^{-1}, but then increased in the 2000s to nearly 170,000 t·year^{-1}. Artisanal discards occurred primarily in the northeastern region (Fig. 9). The average discard rate from 1950 to 2010 was 59% of artisanal landings.

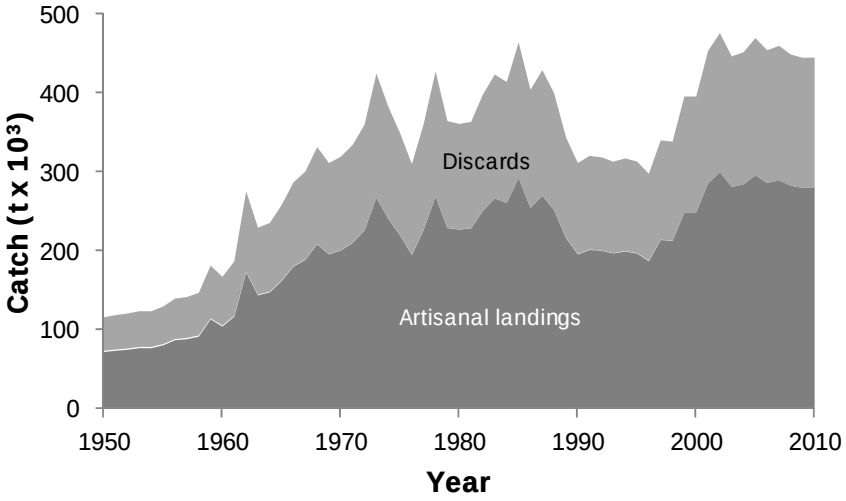

Figure 8: Discards and catches in the artisanal sector of Brazilian fisheries.

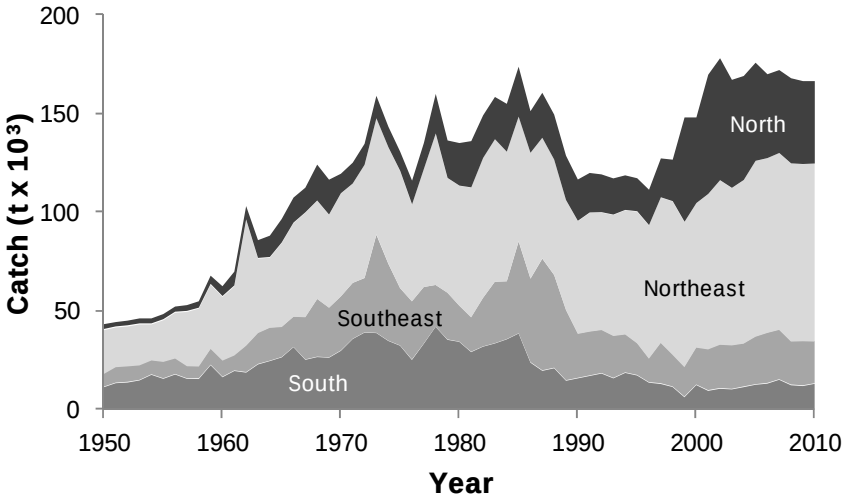

Figure 9: Discards in the artisanal sector by Brazilian region.

Total discards averaged 57% of industrial and artisanal landings. In 1950, around 69,000 t were discarded (Fig. 10). Discards increased to over 400,000 t·year^{-1} in the mid-1980s, and then dropped to nearly half this level in the early 1990s. Since then, discards have slowly increased again, reaching almost 310,000 t of discards in 2010.

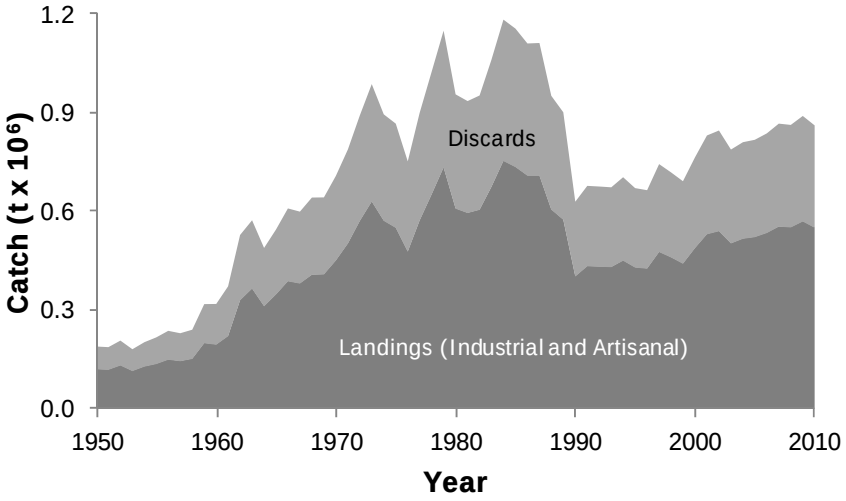

Figure 10: Discards and catches in the industrial and artisanal Brazilian fisheries.

As seen by the gear breakdown of discards in the industrial sector (Fig. 6), the shift in gear in 1990 corresponded to a significant drop in discards. There is a parallel trend in landings, where industrial catch dropped 42% from 1989 to 1990. This resulted from the collapse of the main Brazilian industrial fishery (including sardine), which was followed by targeting previously unexploited species with new gears or expanding existing fisheries. Indeed, many commonly

targeted species that were heavily fished by pair and otter trawlers in the 1970s and 1980s are currently heavily exploited (Haimovici 1998; FAO 2011).

We believe that our discard estimates on trawling activities are very conservative. According to Conolly (1992), "*361,000 tonnes per year of accompanying fauna are incidentally by-caught in trawling activities in Brazil, of which over 80% are discarded*". This totals 288,800 tonnes in annual discards. Our calculations suggest that approximately 198,000 tonnes were discarded annually by trawlers from 1950 to 1992, the year of publication of Conolly (1992). The estimate given in 1992 is about 46% higher than what is estimated in the present study.

Additionally, the discard rate used for industrial shrimp trawling activities (23.9% of total catch by the double rig trawl gear) is very low compared to other studies done on shrimp trawling. This discard rate corresponds to 31.4% of reported landings. Comparatively, discard studies done in southeastern Brazil directed at pink shrimp list discard rates at 3130% of landings (Keunecke *et al.* 2007). Discard rates in northern Brazil are also high, with trawling directed at southern brown shrimp producing discards in the order of 500% of landings (Isaac 1998). These preliminary estimates should be revised by local experts with the inclusion of more local information. Important references such as Santos (1996), Tischer & Santos (2001), and Vianna & Almeida (2005) were not included here.

3.6. Reconstructed total catches (commercial, recreational, subsistence and discards)

Reconstructed total catches, aggregated to national level (but omitting Brazil's oceanic islands), averaged to 192,000 $t \cdot year^{-1}$ in the early 1950s, peaked at 1,183,000 t in 1984, at the height of the industrial fishery for Brazilian 'sardine' (*Sardinella brasiliensis*), and returned to lower levels after this fishery collapsed, averaging 874,000 $t \cdot year^{-1}$ in the late 2000s (Figure 11A). The reconstructed catches were 1.8 times the reported landings baseline determined for Brazil, and dominated by demersal fishes and sardine from the southeastern and southern regions (Figure 11B).

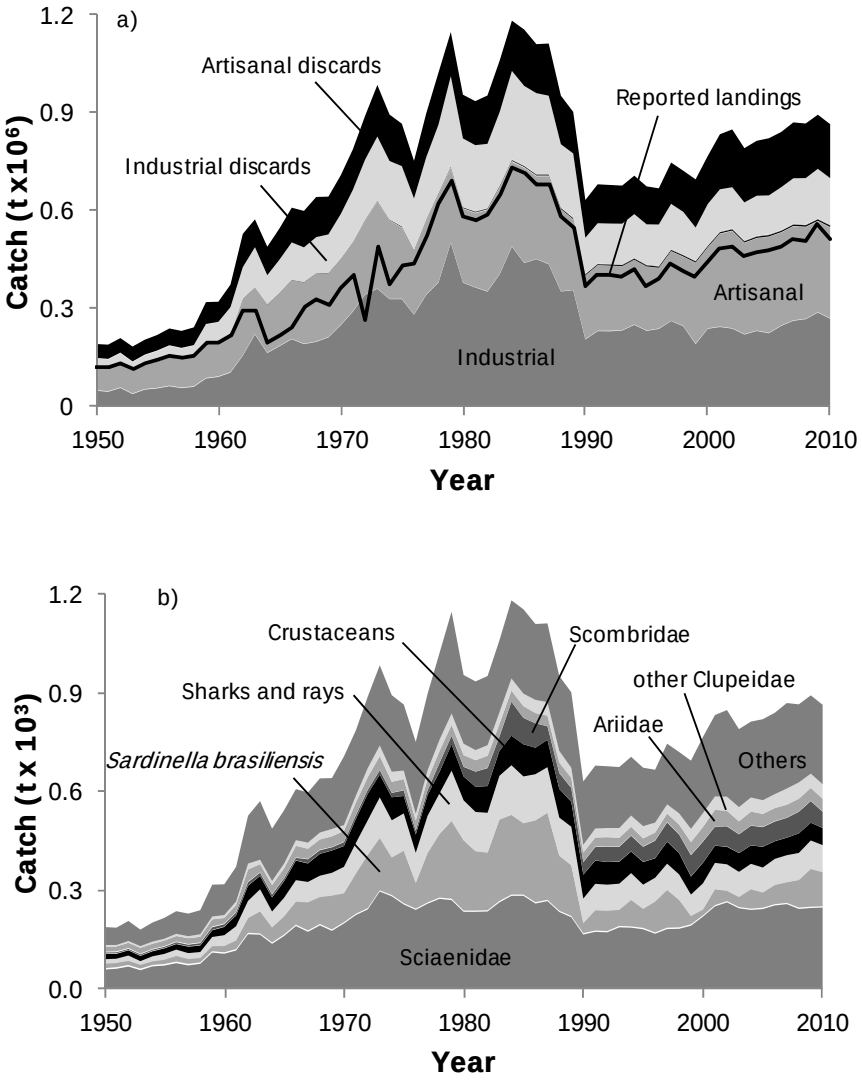

Figure 11. Total reconstructed marine catches of Brazil (1950-2010), a) by sector, including commercial, recreational, and subsistence fisheries, with discards show separately, and the reported landings overlaid as a line graph (note that recreational and subsistence fisheries are too small to be visible); and b) by taxonomic group. 'Others' represents 303 minor taxonomic categories.

4. CONCLUSION

It is crucial for Brazil to resume the data collection system for Brazilian fisheries, considering all local initiatives that continue working in some states of Brazil. Catch data are fundamental to effective fisheries policy and management (Pauly 2013). The inclusion of other components of fisheries (recreational, subsistence, and discards), based on local data is very important to properly access the total impact of fisheries on Brazilian marine ecosystems. The first step was taken in this study, and can be viewed as preliminary. The data should be revised by local experts to improve the local database and hence the national database. Making this resulting database openly available online is a fundamental condition for transparent and accountable public resource use.

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