Arquivos de Ciências do Mar

ANALYSIS OF MARINE CATCHES OFF THE STATE OF SERGIPE (1950-2010)

Análise da produção de pescado marinho do Estado de Sergipe (1950-2010)

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ABSTRACT

The state of Sergipe has no official electronic version of the database of catch statistics available in printed national bulletins. Thus, the objective of this study was to update its statistics on fish production of a previously reconstructed national database to obtain a time series for 1950-2010, analyzing catch composition with higher taxonomic resolution, and estimating some missing components of fisheries. Reconstructed total catches were higher than original catches and indicated an increase in catches from 1950 to 1979. In the 1980s and 1990s a stabilization was observed, and decreasing catches from 2005 to 2010. Catches were almost exclusively artisanal. The better taxonomic resolution of the reconstructed database allowed for the identification of the following species with the highest catches in 2010: Xiphopenaeus kroyeri, Mugil curema, Ucides cordatus, Goniopsis cruentata *and* Macrodon ancylodon. *Catches for these species amounted for about 50% of the total extracted off Sergipe in 2010. Recreational catches were estimated at 16 t in 2010, and annual discards at 818 t in the 1980s/1990s. Ornamental and subsistence catches were not estimated. Our analysis indicated that taxonomic losses are observed in two stages: when local data are compiled into a national database, and then from a national to an international one.*

***Keywords**: Sergipe State, commercial fishery, landings, artisanal fishery, recreational fishery, discards.*

RESUMO

O estado de Sergipe não dispõe de uma versão eletrônica oficial do banco de dados de estatística de captura disponível em boletins nacionais impressos. Assim, o objetivo desse trabalho foi atualizar a parte referente ao estado de Sergipe de um banco de dados nacional eletrônico reconstruído, a fim de obter uma série histórica para 1950-2010, analisando a composição da captura com maior resolução taxonômica e estimando componentes ausentes da pesca. As capturas totais reconstruídas foram sempre mais elevadas do que as originais e indicaram um aumento nas capturas de 1950 a 1979. Nas décadas de 1980 and 1990, foi observada uma estabilização nas capturas, e uma queda de 2005 a 2010. As capturas foram extraídas quase exclusivamente pela frota artesanal. A melhor resolução taxonômica permitiu a identificação das seguintes espécies com as de maiores capturas em 2010: Xiphopenaeus kroyeri, Mugil curema, Ucides cordatus, Goniopsis cruentata *e* Macrodon ancylodon. *As capturas para essas espécies representaram cerca de 50% do total extraído em Sergipe em 2010. Capturas recreativas foram estimadas em 16 t em 2010, e descartes anuais em 818 t nas décadas de 1980 e 1990. Capturas ornamentais e de subsistência não foram estimadas. Nossa análise indicou que perdas taxonômicas foram observadas em duas etapas: quando dados locais são incorporados em um banco nacional e posteriormente, de um banco nacional para um internacional.*

***Palavras-chaves**: Estado de Sergipe, pesca comercial, desembarques, pesca artesanal, pesca amadora, descartes.*

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INTRODUCTION

Sergipe is the smallest state in Brazil, being located in its northeastern region. This state was chosen as the first case study to be analyzed within a larger project aiming at reconstructing Brazilian marine catches (Freire *et al.*, 2014) due to logistic reasons, as there was a project being carried out at the same time dealing with commercial fisheries (Piauí/Real Rivers Project, A.R.R Araújo, unpublished data) and the possibility of checking correspondence between common and scientific names with local fishers. Even though the Piauí/Real Rivers Project had a smaller spatial scale, it could be used as a starting point to be able to identify species caught off Sergipe. Besides, there is a collection system of catch statistics in place in the state since mid-2009 that could provide a very important anchor point for 2010 (Thomé-Souza *et al.*, 2012).

Based on the official bulletins, annual marine catches of Sergipe for the period 1995-2004 were about 1,600 t, the third smallest marine production in the country (aquaculture excluded), after the states of Amapá and Paraná, a landing database was reconstructed by Freire & Oliveira (2007). Data provided by the last official bulletin published by IBAMA for 2007 indicated that 11,273 t were produced in Sergipe, 54% from capture and 46% from aquaculture. Considering capture alone, 82% originated from marine/estuarine waters and 18% from fresh waters (IBAMA, 2007), the main species caught were: Atlantic seabob shrimp, mullets, white shrimp, weakfishes and crabs. Unidentified fishes represented a very high proportion of catches (about 30%). Later national volumes published by the Ministry of Fisheries and Aquaculture (MPA), from 2008 to 2011, presented only estimated total catches based on models and did not present estimates by species.

The population living in the state of Sergipe was about 2.1 million inhabitants in 2010 (IBGE, 2012), most of them concentrated in the state's capital city, Aracaju. In 1983 the fish consumption rate was estimated as 5 kg per capita (Decken, 1986). Previous estimates had indicated an average consumption of 3.2 kg per capita for the northeastern region (Anon., 1963), which was partially supplied by frozen fish from the southeastern region (40%) and 10% by fresh fish from Bahia State (Decken, 1986). There is no current estimate available on fish consumption in Sergipe, on the relative contribution of fish consumed locally that originate from other states or the amount exported to other states, even though it is known that part of the production leaves the state to Bahia and southeastern Brazil (personal observation).

The continental shelf of Sergipe has an area of 3,602 km^2 (Jonas dos Santos, GEORIOEMAR, Universidade Federal de Sergipe, pers. com.), extending from the São Francisco estuary in the north of the state, down to the estuaries of Piauí/Real rivers in the south. Fleets operating in this region are essentially artisanal, even though larger boats from northern/northeastern regions started operations in Sergipe in the early 1980s (Decken, 1986), which is shown in the catch statistics for that period, when catches from the industrial fleet are reported. According to that author, the infrastructure was very poor until 1986 when some improvement occurred including port facilities, and ice and fuel supply.

The objective of this study was to update the part referring to Sergipe of a previously reconstructed electronic catch databank, including landings for the period 2005-2010, analyzing catch composition with higher taxonomic resolution, and estimating missing components of catches that are not officially recorded.

MATERIAL AND METHODS

For the reconstruction process, we started with official national bulletins as in Freire & Oliveira (2007) and Freire *et al.* (2014).The details of all sources used are presented in Freire *et al.* (2014). For the beginning of the period (1950-1955 and 1956-1961), there was only information available on total catch and catch by group, respectively. For 1950-1955, we used the earliest proportion available between catch per species and total catches to estimate missing values backwards. The proportion between catch per species and total per group (fishes, crustaceans and mollusks) was used for the period 1956-1961. Values were estimated backwards until the year when each fishery started, for example, 1962 for shrimp. For the end of the period (2008-2010), we estimated missing values using linear regressions including 2010 anchor points available in Thomé-Souza *et al.* (2012) for most of the species. Otherwise, we considered the mean of the last three years of available data for each species for the period 1981-1989, catches reported as zero (due to a rounding procedure), but with monetary value associated to it.

For discards, we estimated catch based on the discarded proportions mentioned in Decken (1986). For recreational fisheries, we used the number of licenses sold in Sergipe (Michel Machado, IBAMA/MS, pers. com.) and the proportion of licensed/total (11%) estimated for the municipality of Ilhéus, in the

neighbour state of Bahia (K.M.F. Freire, unpublished data), to estimate the total number of anglers in Sergipe. This proportion was applied to estimated values of the population in the state each year from 1974 onwards based on a logistic model (see Freire *et al.*, 2014 for details) in order to obtain the existing number of fishers each year. The proportion of fishers fishing in marine waters (in opposition to fresh waters) was obtained from a questionnaire available together with the fishing license, and then applied to the total number of fishers. Finally, the number of recreational fishers was multiplied by the average number of fishing days obtained from the same questionnaire and by the mean daily catch (732 g) by fisher obtained for Ilhéus (K.M.F. Freire, unpublished data).

RESULTS AND DISCUSSION

The original landing data from official bulletins indicate that there are 105 common names reported in landing statistics for the state of Sergipe, corresponding to 72 scientific names. In the reconstructed database, however, 112 common names were reported, mainly due to better resolution provided by Thomé-Souza *et al.* (2012), which are associated to 133 scientific names. Thus, much more taxonomic detail was provided in the reconstructed database and this will be discussed in details below.

COMMERCIAL FISHERIES

Mollusks

The main groups of Mollusca caught in estuarine/marine waters of Sergipe are: *Mytella*, *Crassostrea*, *Lucina*, and *Anomalocardia*. Two species of *Mytella* are caught, namely: *M. charruana* (97%) and *M. guyanensis* (3%), even though both are referred as "sururu" in the 2007 official national bulletin (*Mytella* spp. and *M. falcata*). The category of oysters certainly includes *Crassostrea brasiliana* (= *C. gasar*) and possibly *Crassostrea rhizophorae* (Cláudia Helena Tagliaro, Universidade Federal do Pará, pers. comm.). As this issue was not solved yet, we decided to keep only one species identified up to now for the state by Tagliaro (*C. brasiliana*).

"Lambreta" corresponds to *Lucina pectinata*, but it was reported as *Lucina* spp., the only category available in the FAO/ASFIS database of common names. Thus, it was not properly recorded in FAO/FISHSTAT-J/BRAZIL, as it was attributed to 'marine molluscs nei'. According to local fishers, "lambreta" exploitation began in 2004 after increasing demand from the state of Bahia and decreasing catches of mangrove crab (*Ucides cordatus*). As we do not have any information related to the trend, the same value for 2010 was repeated backwards until 2004.

"Maçunim" corresponds to *Anomalocardia brasiliana* (Araujo, 2004; Lira *et al.*, 2004; Boehs *et al.*, 2008). However, according to IBAMA (2007), "maçunim" represents *Tivela mactroides* and this should be corrected. Data were reconstructed backwards to 1950, even though catch for molluscs in 1956 was reported as zero in the national bulletin. As this is an exclusively artisanal activity, we assumed it had already begun by 1950. Reconstructed catches for mollusks are shown in Figure 1.

The main change in the reconstructed database was new information included for 2010, and estimates calculated for the period 1950-1956 and 1965. For the period 1990-1994, estimates based on

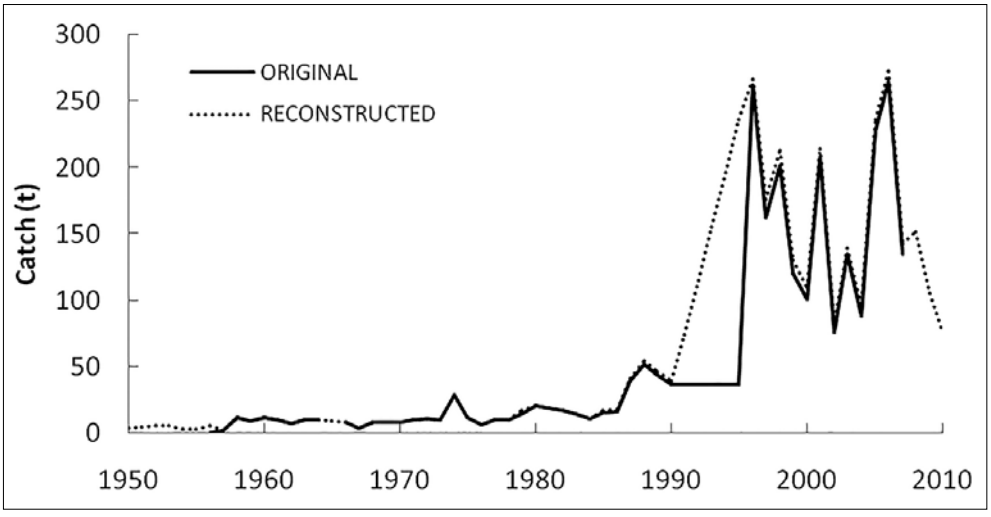

Figure 1: Original and reconstructed catches for mollusks caught in marine/estuarine waters off Sergipe, in 1950-2010.

linear trends replaced mean repeated values presented in the official bulletins. The second main contribution with the reconstruction process for this group was the taxonomic resolution (Table I). Catches for mollusks increased from 3.5 t in early fifties to 266 t in 1996. After that year, catches decreased, recovering in 2005-2006, mainly due to *Mytella* spp.. Currently, catches have decreased to about 100 t.

Table I - Common name of molluscs as presented in official bulletins, the original identification based on IBAMA (2007), the reconstructed scientific names and FAO common name used in FISHSTAT-J/BRAZIL.

Common name	Original identification (IBAMA, 2007)	Reconstructed identification	FAO common name
Sururu	*Mytilus falcata*	*Mytella charruana*	Sea mussels nei
	Mytella spp.	*Mytella guyanensis*	Sea mussels nei
Ostra	*Crassostrea* spp.	*Crassostrea brasiliana*	Cupped oysters nei
Maçunim	*Tivela mactroides*	*Anomalocardia brasiliana*	Triangular tivela
Lambreta	*Lucina pectinata*	*Lucina pectinata*	Marine molluscs nei
Moluscos	Mollusca	–	Marine molluscs nei

Crustaceans

According to Cavalcanti (1965/1966), the potential for crustacean fisheries in Sergipe is low. Shrimp fishers started operation off the states of Sergipe and Alagoas by 1979 (Coelho & Santos, 1994/1995). Interestingly enough, there are landings reported in SUDEPE volumes from 1962 onwards. No catch was then reconstructed for the period before 1962 based on the information provided by Coelho & Santos (1994/1995). Before 1977, landings were not split between artisanal and industrial. As there was only artisanal shrimp fishery in 1978-1980, then we assumed only artisanal fishery for shrimp for the beginning of the time series.

One of the most important issues associated with shrimp fisheries in Sergipe is the recording system based on size: small shrimp ("camarão pequeno") and large shrimp ("camarão grande"). "Camarão pequeno" was used as synonymous for *Xiphopenaeus kroyeri* ('Atlantic seabob') and "camarão grande" was considered as "camarão branco" (*Litopenaeus schmitti*) and "camarão rosa" (*Farfantepenaeus subtilis*). Based on Dias-Neto and Dornelles (1996), the proportion of "camarão rosa" in relation to the sum of "camarão branco" and "camarão rosa" was 26%. All estimates of shrimp landings are currently artisanal (Thomé-Souza *et al.*, 2012). Thus, from 1995 onwards, all shrimp catches were considered artisanal. For the industrial shrimp fishery, we considered the mean value for 1986-1988 as the relation between "camarão branco" and "camarão sete barbas" (15% for previous years) (Table II).

Based on local fishers in Barra dos Coqueiros (pers. comm. in January 2012), only *Panulirus laevicauda* is caught in Sergipe (small, greenish specimens). However, taxonomic details are lost in the FISHSTAT-J/BRAZIL and even though most of the Brazilian landings are *Panulirus argus*, there are catches for two other species *P. laevicauda* and *P. echinatus* (Table II).

As an artisanal activity, we considered that crab fishery was practiced in Sergipe since 1950, even though there was no record for 1950-1961 due to the lack of species resolution during that period. We used a mean proportion between marine crabs and total crustaceans of 62% for three years (1962-

Table II - Common names of crustaceans as presented in the official bulletins, the original identification based on IBAMA (2007), the reconstructed scientific names and the FAO common name used in FISHSTAT/FAO.

Common name	Original identification (IBAMA, 2007)	Reconstructed identification	FAO common name
Camarão sete-barbas	*Xiphopenaeus kroyeri*	*Xiphopenaeus kroyeri*	Atlantic seabob
Camarão branco	*Litopenaeus schmitti*	*Litopenaeus schmitti*	Penaeus shrimps nei
Camarão	Penaeidae	*Xiphopenaeus kroyeri*	Penaeus shrimps nei
(includes "pequeno"		*Litopenaeus schmitti*	Penaeus shrimps nei
and "grande")		*Farfantepenaus subtilis*	Penaeus shrimps nei
Caranguejo-uçá	*Ucides cordatus*	*Ucides cordatus*	Marine crabs nei
Siri	*Callinectes* spp.	*Callinectes exasperatus*	Dana swimcrab
Siri	*Callinectes* spp.	*Callinectes danae*	Dana swimcrab
Siri	*Callinectes* spp.	*Callinectes ornatus*	Dana swimcrab
Siri	*Callinectes* spp.	*Callinectes bocourti*	Dana swimcrab
Siri	*Callinectes* spp.	*Callinectes sapidus*	Dana swimcrab
Guaiamum	*Cardisoma guanhumi*	*Cardisoma guanhumi*	Marine crabs nei
Lagosta	*Panulirus* spp.	*Panulirus laevicauda*	Caribbean spiny lobster

1964) to estimate catch for marine crabs for the period 1956-1961. For 1950-1955, only total catch was recorded. Thus, we used the mean proportion of crustaceans for the period 1956-1958 of 14% for the earlier period and applied the proportion estimated above to estimate catches for marine crabs. Landings reported as "caranguejo de água doce" (freshwater crab) from 1962 to 1972 were probably "caranguejo-uçá" (mangrove crab *Ucides cordatus*). This conclusion was reached as the time series for freshwater and marine crabs were complementary. For some unknown reason, they were recorded differently throughout time. According to IBGE (1984), "caranguejo" in the 1980s is "caranguejo-uçá". CEPENE (1997) considered "caranguejo" in 1996 as "caranguejo-uçá" and IBAMA (2003) also refers to "caranguejo" as "caranguejo-uçá". Thus, we considered all landings reported as "caranguejo" for the 1980s as "caranguejo-uçá".

There was no record of the giant land crab (*Cardisoma guanhumi*) in FISHSTAT-J/BRAZIL for 1950-2010. It was probably included in the category 'marine crabs nei'. For the 1960s and 1970s, there was no catch reported for "guaiamum" ('giant land crab'). We decided to consider proportion for the three earliest years (1980, 1983 and 1984) between "caranguejo-uçá and "guaiamum" to split landings for "caranguejo" between these two species. Then we added to 'caranguejo-uçá' landings that were already reported.

If we assume that swimming crab fishery is associated to shrimp trawl, then its capture begins with the start of the shrimp fishery. Thus, wereconstructed its catches backwards until 1962. According to Medeiros (1982), five species are found in the estuary of Sergipe River: *C. danae* (86.7%), *C. ornatus* (12.2%), *C. exasperatus* (0.5%), *C. bocourti* (0.4%), and *C. sapidus* (0.2%).These proportions may not be valid for the entire coast of Sergipe, but it was the only information found on proportion of *Callinectes* species for this state. Thus, these proportions were used in the reconstruction. Crustaceans represent the main group caught in marine waters off Sergipe, with a peak of about 2,680 t in 1987 and again in 1998 (Figure 2). Catches for crustaceans have been declining since then. Besides gaining in taxonomic resolution, one of the main features of the reconstruction process was to present a time series for "aratu" (*Goniopsis cruentata*), currently the fourth most important species caught in Sergipe (Figure 3), with 115 t in 2010 (Thomé-Souza *et al*., 2012).

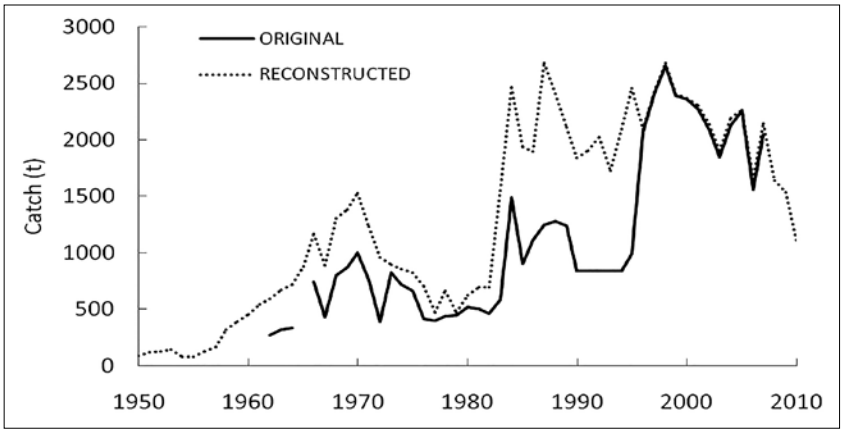

Figure 2 - Original and reconstructed catches for Crustaceans caught in marine waters off Sergipe in 1950-2010.

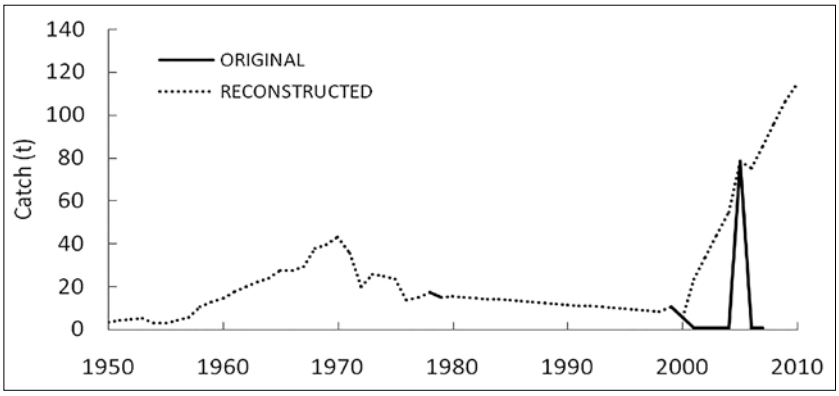

Figure 3 - Original and reconstructed catches for "aratu" (*Goniopsis cruentata*) caught in marine waters off Sergipe in 1950-2010.

Fishes

The analysis of fishes is more challenging due to the high number of species involved. In the original database, based on official bulletins, 101 common names of fishes were reported for the state of Sergipe. In this study, we associated common names to scientific names based on the best local information available (Table III). Unfortunately, not much has been published on fishes for this state and most of the correspondence was based on Alcântara (undated), Alcântara (2006), Thomé-Souza *et al.* (2012), and preliminary results of the Piauí/Real Rivers Project (A.R.R. Araújo, unpublished data). After the reconstruction, all 101 common names were asscoiated to 111 species and six groups of higher taxonomic rank (genus, family, order or even class).

When considering only the original database, the top five species with the highest cumulative landings throughout the period analyzed (1962-2007) were: "tainha" (mullet), "pescada" (weakfish), "vermelho" (snappers), "bagre" (catfish), and "robalo" (snook) (Figure 4). "Mistura" (unidentified fishes) also figures out as one important component of landings and its importance would increase if we also considered landings associated to other names in different periods ("outros peixes não identificados", "outros peixes não especificados", or "outras espécies"). Some other characteristics of this time series are: there is no detail on catch composition before 1962; there is no national bulletin available for 1965 (document lost); and there is no landing data for each species available in official bulletins by state after 2007. Due to the high richness of species caught in waters off Sergipe, we will discuss in more details the reconstruction process only for the top five groups of species and some other important ones from different points of view (market, subsistence or conservationist values).

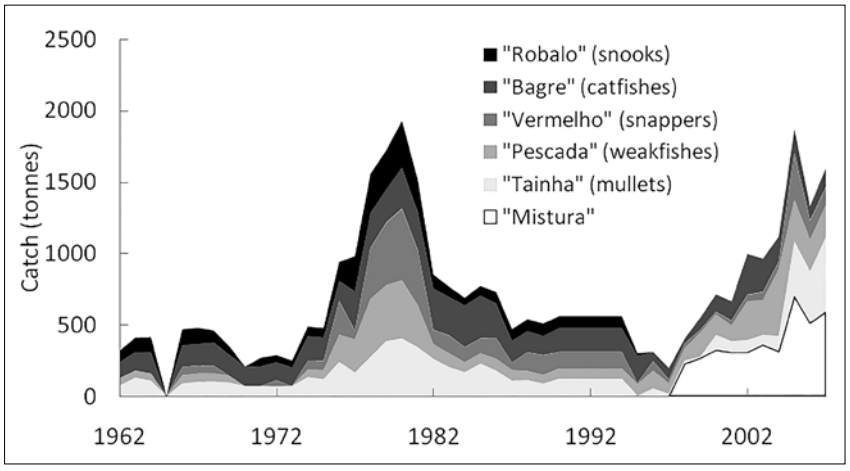

Figure 4 - Landings for the top five species (and "mistura = unidentified fish species) caught off Sergipe in 1962-2007.

a) Mullets

According to IBAMA (2007), "tainha" is synonym of "cacetão", "curimã", "saúna", and "tainhota", all referring to *Mugil* spp. In CEPENE (2007), "curimã" corresponds to *Mugil liza*, and "tainha" is used for *M. curema, M. incilis, M. liza,* and *M. trichodon* in northeastern Brazil. For the period 1996 to 2005, there were separate records for "curimã" and "tainha" in Sergipe. Thus, we were able to estimate that "curimã" represents about 13% of total landings of mullets. This percentage was applied for the other years when only "tainha" was reported but probably included both categories. In the Piauí/Real Rivers Project, two species were reported: *M. curema* and *M. gaimardianus*. A.R.R. Araújo (unpublished data) found five species in Sergipe: *Mugil liza* ("curimã"), and *M. curema, M. curvidens, M. gaimardianus,* and *M. incilis* (all known as "tainha). Within the second group, *M. curema* represents 85% of local landings and the last three species correspond to 5% each.

Landings for "tainha" and "curimã" were recorded as artisanal for all years except for 1979, when no catch originating from artisanal fisheries was recorded. This is a nomenclatural issue (artisanal vs. industrial) and industrial records were moved to artisanal. Clearly, there was a loss in taxonomic resolution from the local to the national bulletin, and all species were reported in FISHSTAT-J/BRAZIL as 'mullets nei' since 1950.

b) Catfishes

Alcântara (unpublished manuscript) found the following species in the Vaza-Barris estuary: *Sciades herzbergii, Notarius grandicassis, Sciades proops, Bagre bagre, Cathorops spixii* and *Aspistor luniscutis* (note the scientific names were updated based on Froese & Pauly, 2012). According to Alcântara (2006), the species of catfishes found in the estuaries of Sergipe, Sal, Cotinguiba and Pomonga rivers were *Sciades herzbergii, Notarius grandicassis, Bagre bagre, Cathorops spixii*,

Cathorops sp., and *Aspistor luniscutis*. According to the *Relatório de Impacto Ambiental da Petrobrás* (2007), *Aspistor luniscutis* ("bagre amarelo") and *Cathorops spixii* ("bagre capadinho") are the dominant species. In FishBase (Froese & Pauly, 2012), there are only five species of Ariidae reported for Sergipe: *Aspistor luniscutis, Bagre bagre, Bagre marinus, Cathorops spixii* and *Genidens genidens*. Thus, we used the proportions defined by Thomé-Souza *et al.* (2012) for 2010 to split total catfish landings between "bagre" and "bagre amarelo". Then we used Alcântara (2006) to split landings among three species of "bagre" (*Notarius grandicassis, Sciades herzbergii* and *Bagre bagre*) and between two species of "bagre amarelo" (*Cathorops spixii* and *Aspistor luniscutis*). We used the same procedure for both artisanal and industrial fisheries. The industrial composition could be different as it probably catches different species. However, as there is no published information that allows its estimation, all catches were recorded in FISHSTAT-J/BRAZIL as 'sea catfishes nei'.

c) Weakfishes

In relation to weakfishes, there are only three names reported in the official bulletins for Sergipe: "pescada banana", "pescadinha", and "pescada". Artisanal catches for "pescada" were initially split into four species/group of species (step I) based on the proportion observed in 2010, according to Thomé-Souza *et al.* (2012): "pescada", "pescada branca", "pescadinha", and "boca mole". The name "pescada banana" is not reported in the taxonomic lists of IBAMA (2007) or CEPENE (2007). However, it shows up in IBGE (1985) as synonym of "pescada" together with other twenty-six other common names. In the database compiled by Freire & Pauly (2005), "pescada banana" corresponds to 'smalleye croaker' (*Nebris microps*).

According to IBAMA (2007), "pescadinha" is also known as "araúja", "pescadinha real" and "milonga", and corresponds to *Macrodon ancylodon*. CEPENE (2007) does not include "pescadinha" in its taxonomic list, but reports *Macrodon ancylodon* under the name "pescada". According to preliminary results from the Piauí/Real Rivers Project, "pescadinha" corresponds to *Macrodon ancylodon* and *Larimus breviceps* (also reported as "boca mole" by Thomé-Souza *et al.*, 2012). We used the proportion of landings reported in Thomé-Souza *et al.* (2012) to split landings of "pescadinha" between these two species: 0.89 and 0.11, respectively. It is worth pointing out that records for "pescadinha" in Brazilian official bulletins for Sergipe are included only for the period 1987-1994. However, in FISHSTAT-J/BRAZIL, there are records for 'king weakfish' only from 1995 onwards. Thus, no record for this species coming from waters off Sergipe would have been included in this category.

According to IBAMA (2007), "pescada branca" is *Cynoscion leiarchus* ('smooth weakfish'). On the other hand, CEPENE (2007) does not include this common name in its taxonomic list, but only "pescada", which is associated to six species, including *Cynoscion jamaicensis* ('Jamaica weakfish'). Preliminary results from the Piauí/Real Rivers Project indicate that both species are caught off Sergipe under the name "pescada branca", together with *Cynoscion striatus* ('striped weakfish'). Thus, we split landings equally among these three species.

Finally, landings for "pescada" were split into four species (step II) based on information originating from preliminary results obtained in the Piauí/Real Rivers Project: 1% for *Cynoscion acoupa* ("salvagem"='acoupa weakfish'), 33% for *Nebris microps* ("pescada banana"='smalleye croaker'), 33% for *Cynoscion microlepidotus* ("pescada dentão"='smallscale weakfish'), and 33% for *Cynoscion virescens* ("pescada cambucu"='green weakfish'). It is interesting to point out that *N. microps* and *C. microlepidotus* were never reported in FISHSTAT-J/BRAZIL and the other two species were reported only from 2002 onwards. For previous years, landings for these two species were probably reported under 'weakfishes nei', which have been reported since 1950. Thus, the final correspondence between common and scientific names is presented in Table III.

d) Snappers

The snappers, family Lutjanidae, were analyzed together as there was detailed information by species for some years, but not for others. No pattern was observed in relation to the proportion between landings originating from industrial and artisanal fleets (54 times in some years and 0.9 in others). This is probably associated with the lack of proper definition of fleets. Landings for 'snappers, jobfishes nei' are reported in FISHSTAT-J/BRAZIL from 1980 onwards, but there are catches recorded for Sergipe since 1966, which were possibly attributed to 'marine fishes nei'.

The 1978 national bulletin was the first to present landings separately for the artisanal and industrial fleets, and all landing values for

"vermelho" (356 t) and "caranha" (1 t) were reported as artisanal. Thus, all landings for previous years were also considered as artisanal. From 1979 to 1989, there were records for both industrial and artisanal fisheries. For industrial catches, we added landings reported for each species under the generic term "vermelho" that was equally split among "cioba", "dentão", "guaiúba", and "pargo", the four species associated to landing records (1 t each in 1979). Catches for the industrial fleet in 1990-1995 were not included in the reconstructed database as there was no data collection in those years. We did not extrapolate industrial catches outside the period 1979-1989, as there is no official record for any of these species.

For artisanal fisheries we used the proportion observed in 2010 for each lutjanid ("ariacó", "caranha", "cioba", "dentão", "guaiúba" and "pargo") to estimate landings for all years with records for "vermelhos" (about 0.32, 0.19, 0.19, 0.30, 0.005, and 0.0005, respectively, based on Thomé-Souza *et al*., 2012). For those years with detailed data for some species, we split "vermelho" among them and added landings already reported for that species. In the taxonomic list of IBAMA (2007), "ariacó" corresponds to *Lutjanus synagris* ('lane snapper'). However, landings for this species were never reported for Sergipe, except after a more intensive sampling effort deployed in 2010 by Thomé-Souza *et al.* (2012), even though represents 32% of total landings for Lutjanidae (17 t). All catches were considered artisanal. 'Lane snapper' is presented in FISHSTAT-J/BRAZIL only from 1995 onwards.

In IBAMA (2007), "caranha" is listed together with "caranho", "dentão" and "vermelho", all representing *Lutjanus* spp. and *Rhomboplites aurorubens*. Freire & Pauly (2005) associates "caranha" to *Lutjanus apodus, Lutjanus cyanopterus,* and *Lutjanus griseus* in Sergipe. Based on Alcântara (undated), we considered "caranha" as *L. cyanopterus* ('cubera snapper'). However, this species is not recorded in FISHSTAT-J/BRAZIL, but it is reported in national bulletins in 1978-1979, and also in 2010 by Thomé-Souza *et al.* (2012). Their landings were probably attributed to 'snappers, jobfishes nei' in 1980-1985 and 1995-2010 and as 'marine fishes nei' otherwise.

"Dentão" is associated with *Lutjanus jocu* in IBAMA (2007) and CEPENE (2007). However, it is not listed in FISHSTAT-J/BRAZIL, even though 1 t was officially recorded in Sergipe in 1979 (industrial fleet) and another 0.5-8 t from 1996 onwards (artisanal fleet). These landings were probably attributed to 'snappers, jobfishes nei' in FISHSTAT-J BRAZIL in 1980-1985 and 1995-2010, and as 'marine fishes nei' otherwise.

In the taxonomic list provided by IBAMA (2007), "cioba" corresponds to *Lutjanus analis* and *Ocyurus chrysurus*. In CEPENE (2007) and the preliminary report for the Piauí/Real Rivers Project, "cioba" corresponds only to *L. analis* ('mutton snapper'). However, this species is not listed in FISHSTAT-J/BRAZIL and their landings were probably attributed to 'snappers, jobfishes nei' in 1980-1985 and 1995-2009, and as 'marine fishes nei' otherwise. According to IBAMA (2007) and CEPENE (2007), "guaiúba" corresponds to *Ocyurus chrysurus* and this species has been reported as 'yellowtail snapper' in FISHSTAT-J/BRAZIL since 1950.

Thomé-Souza *et al.* (2012) did not report landings for "pargo" in 2010, but for "vermelho". However, as catches were recorded by species for the other five species, we considered "vermelho" as "pargo", which represented 0.05% of total landings for lutjanids. This low proportion is reasonable for a species that has been overexploited off northeastern Brazil (Paiva, 1997). "Pargo" landings were recorded as industrial in the 1980s and as artisanal in the 1990s, again revealing some problems in the categorization of local fleets. According to IBAMA (2007), "pargo" is also known as "pargo verdadeiro" and corresponds to *Lutjanus purpureus*, one of the main fishery resources off northeastern Brazil (Paiva, 1997). However, "pargo" is also associated with *Pagrus pagrus*. On the other hand, CEPENE (2007), which refers to the northeastern region of Brazil, links "pargo" only to *Lutjanus purpureus*, the correspondence we used here. 'Southern red snapper' is reported in FISHSTAT-J/BRAZIL from 1950 onwards.

e) Snooks

The Centropomidae family (snooks) is associated to the ninth highest landings in the state of Sergipe. According to IBAMA (2007), "camurim" and "robalo" correspond to *Centropomus* spp.. CEPENE provides more detailed information: *Centropomus parallelus* and *Centropomus undecimalis*. According to FishBase, three species occur in Sergipe: *Centropomus ensiferus, Centropomus parallelus,* and *Centropomus pectinatus*. The local study in the Piauí/Real estuaries added a fourth species: *C. undecimalis* (A.R.R. Araújo, unpublished data). In some years, landings for "camurim" and "robalo" were recorded together and in others separately. We decided to add them, to search for a trend, to estimate missing

values, and to split landings among these four species. All of them were reported in FISHSTAT-J/BRAZIL as 'snooks (=robalos) nei'.

f) Other species

Tuna is an important fishing resource in Brazil due its high market value. In 1976 and 1977, landings were reported for "atum" in Sergipe.From 1979 to 1995, there were landings reported only for "albacora" and from 1996 to 2007 the name "atum" was used again. We considered both names as synonymous. However, Fonseca & Barros (1963) considered "atum" as *Thunnus thynnus* and called attention that usually landings under this name also included *Thunnus albacares*. Based on an interview in Barra dos Coqueiros-Sergipe, where tunas are landed, about 65% is probably *Thunnus albacares* ("albacora amarela") and 35% is *Thunnus atlanticus* ("albacora cascuda"). According to Moraes (1962), there was no fishery targeting tunas and tuna-like fishes in Brazil in those earlier years, even though some boats using hook and line used to catch some individuals. Thus, we decided to back-estimate landings until 1950. Tuna catches have increased in the last years to about 116 t (Figure 5), ranking fourth in catches off Sergipe, and this deserves some attention from the management authorities, even though these catches are lower than the 123 t peak observed in 1988. Together with tunas, many other species are caught: marlin, sailfish, dolphin fish, barracudas, mackerels, and wahoo. It is interesting to note that in FISHSTAT-J/BRAZIL, there are landings recorded as 'mackerels nei' for Brazil only for the years 2008 and 2009 when the national bulletin published by the Ministry of Fisheries and Aquaculture (MPA) was based only on estimates from historical trends. No national collection of catch statistics was in place.

For the group of 'Anguilliformes eels and morays', we would like to point out that neither "corongo" or "miroró" are cited in the taxonomic list provided by IBAMA (2007). CEPENE (2007) only mentions "mororó", which refers to *Gobionellus oceanicus*. According to Thomé-Souza *et al.* (2012), 2.4 t of "corongo" were landed in Sergipe in 2010. Oliveira (2014) mentions that *G. oceanicus* is one of the most important species found in tanks of *Penaeus vannamei* in the municipality of São Cristóvão, in the state of Sergipe, and has a high contribution for local food security. Besides Sergipe, where landings never surpassed 4 t, this species was caught only in the state of Pernambuco where landings as high as 60 t were reported in 1980 (based on the database reconstructed by Freire *et al.*, 2014). There is no English common name for this species in ASFIS/FAO database and thus landings for Sergipe and Pernambuco were probably reported in FISHSTAT-J/BRAZIL under 'marine fishes nei'.

In FISHSTAT-J/BRAZIL, only three categories are listed within groupers (since 1950): 'Brazilian groupers nei' (*Mycteroperca* spp.), 'groupers nei' (*Epinephelus* spp.), and 'red grouper' (*Epinephelus morio*). According to IBAMA (2007), CEPENE (2007), and IBAMA (2014), "mero" is *Epinephelus itajara*. This species is called 'jewfish' in ASFIS/FAO, but it was never reported in FISHSTAT-J/BRAZIL. They were probably reported under 'groupers nei' from 1950-2010. This clearly should be changed considering this is a critically endangered species in Brazil (IBAMA, 2014).

From the conservationist point of view, other group that should be considered is 'sharks and rays'. For sharks, we used Meneses (2008) to split landings among twelve species (Table III), and the three most important species caught were *Rhizoprionodon porosus* (70.9%), *Rhizoprionodon lalandii* (13.6%), and *Carcarhinus porosus* (6.4%). There is a category in ASFIS/FAO database called 'various sharks nei' that could be linked to landings for "cação" (shark). However, this category is not listed in FISHSTAT-J/BRAZIL. There are only two general categories in that database: 'requiem sharks nei' and 'sharks, rays, skates, etc. nei' (the former associated to catches only from 2003 onwards). Considering that "cação" landings are recorded in national bulletins from 1976 onwards, then they were probably associated to 'sharks, rays,

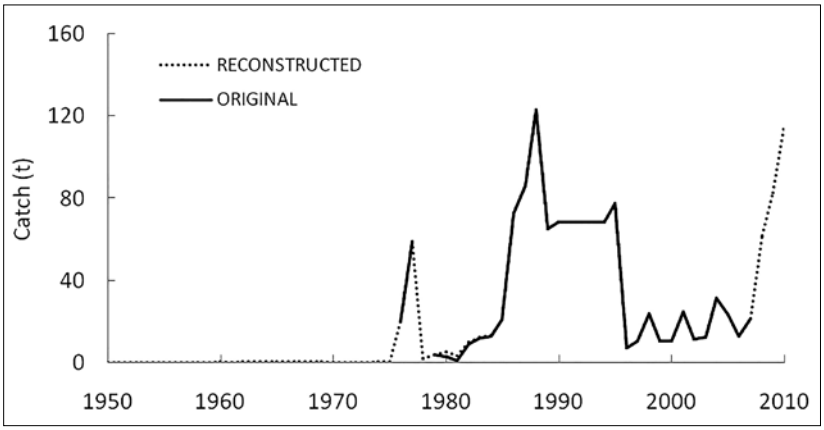

Figure 5 - Original and reconstructed catches for tunas caught in marine waters off Sergipe in 1950-2010.

skates, etc. nei' indicating again a loss in information from national to international databases. For rays, information on catch composition was obtained from Meneses *et al.* (2006). These authors analyzed catches only for bottom longline in 2003-2004. We considered 5% of total ray catches as *Rhinobatos percellens*, as this species has no commercial interest, according to Meneses *et al.* (2006). The remaining 95% were equally split between three species: *Dasyatis guttata*, *Dasyatis americana* and *Rhinoptera bonasus*. All ray species were reported as 'rays, stingrays, mantas nei' in FISHSTAT-J/BRAZIL since 1950.

Table III -: Comparison between reconstructed and IBAMA (2007) scientific names, families (or higher taxon), and FAO common name (ASFIS) as reported by FISHSTAT-J/FAO for Brazil mainly in the most recent years of the studied period. Question marks indicate doubt about the correspondence. *When two names are included indicate that names changed through time, mainly from 'marine fishes nei' to a more specific name.

Common name in Brazilian official bulletins	Original scientific name in IBAMA (2007)	Reconstructed identification	Family	FAO common name
Agulhão	*Tetrapturus albidus* *Tetrapturus pfluegeri* *Makaira nigricans* *Istiophorus albicans*	*Makaira nigricans*	Istiophoridae	Marlins, sailfishes,etc.nei
Albacora/Atum	*Thunnus obesus* *Thunnus alalunga* *Thunnus albacares* *Thunnus atlanticus*	*Thunnus albacares* *Thunnus atlanticus*	Scombridae	True tunas nei
Anchova	*Pomatomus saltatrix*	*Pomatomus saltatrix*	Pomatomidae	Bluefish
Arabaiana	*Seriola lalandi* *Seriola dumerili* *Seriola fasciata* *Elagatis bipinnulata*	*Seriola dumerili* *Seriola rivoliana*	Carangidae	Amberjacks nei
Arenque/Mulata/Mulatinha	–	*Anchoa spinifer*	Engraulidae	Marine fishes nei
Ariocó	*Lutjanus synagris*	*Lutjanus synagris*	Lutjanidae	Lane snapper Snappers, jobfishes nei Marine fishes nei
Arraia/Raia	Dasyatidae Gymnuridae Myliobatidae Narcinidae Rajidae Rhinobatidae	*Dasyatis guttata* *Dasyatis americana* *Rhinoptera bonasus* *Rhinobatos percellens*	Dasyatidae Myliobatidae Rhinobatidae	Rays, stingrays, mantas nei
Bagre	*Bagre bagre* *Bagre marinus* *Bagre panamensis* *Bagre pinnimaculatus*	*Notarius grandicassis* *Sciades herzbergii* *Bagre bagre* *Cathorops spixii* *Aspistor luniscutis*	Ariidae	Sea catfishes nei
Baiacu	*Lagocephalus laevigatus*	*Lagocephalus laevigatus*	Tetraodontidae	Marine fishes nei
Barbudo	–	*Polydactylus virginicus*	Polynemidae	Marine fishes nei
Beijupirá	*Rachycentron canadum*	*Rachycentron canadum*	Rachycentridae	Cobia
Bicuda/Barracuda	*Sphyraena tome*	*Sphyraena barracuda* *Sphyraena guachancho*	Sphyraenidae	Barracudas nei
Biquara	*Haemulon plumieri*	*Haemulon plumierii*	Haemulidae	Grunts, sweetlips nei
Bonito	*Auxis thazard thazard* *Euthynnus alletteratus* *Katsuwonus pelamis*	*Auxis thazard* *Katsuwonus pelamis*	Scombridae	Frigate and bullet tunas?
Cação/Tubarão	Alopiidae Carcharhinidae Lamnidae Odontaspididae Sphyrnidae Squalidae Triakidae	*Carcharhinus acronotus* *Carcharhinus falciformis* *Carcharhinus limbatus* *Carcharhinus porosus* *Galeocerdo cuvier* *Ginglymostoma cirratum* *Mustelus canis* *Rhizoprionodon lalandii* *Rhizoprionodon porosus* *Sphyrna lewini* *Sphyrna mokarran* *Sphyrna tiburo*	Carcharhinidae Ginglymostomatidae Triakidae Sphyrnidae	Sharks, rays, skates, etc. nei Requiem sharks nei ?

Camurim/Robalo	*Centropomus* spp.	*Centropomus ensiferus* *Centropomus parallelus* *Centropomus pectinatus* *Centromomus undecimalis*	Centropomidae	Snooks(=robalos) nei
Camurupim	*Megalops atlanticus*	*Megalops atlanticus*	Megalopidae	Tarpon
Cangulo	*Balistes* spp. *Aluterus monoceros*	*Balistes vetula*	Balistidae	Triggerfishes, durgons nei Marine fishes nei
Caranha	*Lutjanus* spp. *Rhomboplites aurorubens*	*Lutjanus cyanopterus*	Lutjanidae	Snappers, jobfishes nei Marine fishes nei
Carapeba	*Diapterus auratus*	*Diapterus auratus* *Diapterus rhombeus*	Gerreidae	Marine fishes nei Irish mojarra
Cavala	*Scomberomorus cavalla* *Acanthocybium solandri*	*Scomberomorus cavalla*	Scombridae	King mackerel Wahoo
Cavalinha	*Scomber japonicus*	*Scomberomorus cavalla*	Scombridae	Chub mackerel
Castanha	*Umbrina canosai*	*Umbrina coroides*	Sciaenidae	Argentine croaker Demersal percomorphs nei
Catana/Espada/Peixe espada	*Trichiurus lepturus*	*Trichiurus lepturus*	Trichiuridae	Largehead hairtail
Cherne	*Epinephelus* spp.	*Epinephelus niveatus*	Serranidae	Groupers nei
Chicharro/Xixarro	*Trachurus lathami*	*Trachurus lathami*	Carangidae	Rough scad
Cioba	*Lutjanus analis* *Ocyurus chrysurus*	*Lutjanus analis*	Lutjanidae	Snappers, jobfishes nei Marine fishes nei
Congro	—	Anguilliformes	Anguilliformes	Cusk-eels, brotulas Marine fishes nei
Corongo/Miroró	—	*Gobionellus oceanicus*	Gobiidae	Marine fishes nei
Corvina	*Micropogonias furnieri*	*Micropogonias furnieri* *Bairdiella ronchus*	Sciaenidae	Whitemouth croaker
Curimã	*Mugil* spp.	*Mugil liza*	Mugilidae	Mullets nei
Dentão	*Lutjanus jocu*	*Lutjanus jocu*	Lutjanidae	Snappers, jobfishes nei Marine fishes nei
Dourado	*Coryphaena hippurus*	*Coryphaena equiselis* *Coryphaena hippurus*	Coryphaenidae	Common dolphinfish
Galo/Galo-de-penacho	*Selene* spp.	*Selene setapinnis* *Selene vomer*	Carangidae	Atlantic moonfish
Garacimbora/Guaraximbora	—	*Caranx latus*	Carangidae	Jacks, crevalles nei
Garapau	*Selar crumenophthalmus*	*Selar crumenophthalmus*	Carangidae	Bigeye scad
Garoupa	*Epinephelus* spp.	*Epinephelus morio*	Serranidae	Groupers nei
Guaiúba	*Ocyurus chrysurus*	*Ocyurus chrysurus*	Lutjanidae	Yellowtail snapper
Guarassuma/Guaracema Guaricema/Xarelete/Xerelete	*Caranx latus*	*Caranx crysos*	Carangidae	Jacks, crevalles nei Blue runner
Linguado	*Paralichthys* spp. *Bothus* spp. *Gymnachirus* spp. *Scyacium* spp. *Citharichthys* spp. *Cyclopsetta* spp.	*Achirus lineatus* *Symphurus tessellatusCitharichthys cornutus*	Achiridae Cynoglossidae Paralichthyidae	Bastard halibuts nei
Mangangá/Niquim	—	*Scorpaena plumieri*	Scorpaenidae	Marine fishes nei
Manjuba/Pilombeta	*Anchoa spp.* *Cetengraulis edentulus* *Anchoviella spp.* *Lycengraulis grossidens*	*Anchoviella lepidentostole* *Anchovia clupeoides*	Engraulidae	Atlantic bumper
Mariquita/Jaguariçá	—	*Holocentrus adscensionis*	Holocentridae	Marine fishes nei
Merluza	*Merluccius hubbsi*	Osteichthyes	Osteichthyes	Argentine hake
Mero	*Epinephelus itajara*	*Epinephelus itajara*	Serranidae	Groupers nei
Miraguaia/Mirucaia	—	*Bairdiella ronchus*	Sciaenidae	Demersal percomorphs nei
Moréia/Amoréia/Camuru/ Caramuru	—	Muraenidae	Muraenidae	Marine fishes nei
Namorado	*Pseudopercis* spp.	Osteichthyes	Osteichthyes	Marine fishes nei

Pampo	–	*Trachinotus carolinus,* *Trachinotus falcatus* *Trachinotus goodei*	Carangidae	Carangids nei Pompanos nei
Papaterra/Betara/Judeu	*Menticirrhus americanus* *Menticirrhus littoralis*	*Menticirrhus americanus*	Sciaenidae	Kingcroakers nei
Pargo	*Lutjanus purpureus* *Pagrus pagrus*	*Lutjanus purpureus*	Lutjanidae	Southern red snapper
Paru/Parum 1	*Chaetodipterus faber*	*Chaetodipterus faber*	Ephippidae	Spadefishes nei Marine fishes nei
Peixe-pena/Outros esparídeos	–	*Calamus* spp.	Sparidae	Marine fishes nei
Peixe-rei	*Atherinella brasiliensis* *Odontesthes* spp. *Odontesthes argentinensis*	*Atherinella brasiliensis* *Elagatis bipinnulata*	Carangidae	Silversides(=Sand smelts) nei
Pescada	*Cynoscion* spp. *Macrodon* spp.	*Cynoscion acoupa* *Nebris microps* *Cynoscion microlepidotus* *Cynoscion virescens*	Sciaenidae	Weakfishes nei
Pescada/Pescada banana	–	*Nebris microps*	Sciaenidae	Weakfishes nei
Pescada/Pescada branca	*Cynoscion leiarchus* *Cynoscion* spp. *Macrodon* spp.	*Cynoscion leiarchus* *Cynoscion striatus* *Cynoscion jamaicensis*	Sciaenidae	Weakfishes nei
Pescadinha/Boca mole	*Macrodon ancylodon*	*Macrodon ancylodon* *Larimus breviceps*	Sciaenidae	King weakfish
Pirá	–	*Malacanthus plumieri*	Malacanthidae	Marine fishes nei
Prejereba	*Lobotes surinamensis*	*Lobotes surinamensis*	Lobotidae	Tripletail Marine fishes nei
Roncador	*Conodon nobilis*	*Conodon nobilis*	Haemulidae	Barred grunt
Saberé	–	*Chaetodipterus faber*	Ephippidae	Marine fishes nei
Sardinha	–	*Opisthonema oglinum* *Sardinella aurita* *Harengula jaguana*	Clupeidae	Scaled sardines
Sargo/Outros esparídeos	–	*Archosargus probatocephalus*	Sparidae	Marine fishes nei
Sauara	–	*Genyatremus luteus*	Haemulidae	Marine fishes nei
Serra/Sororoca/Sarda	*Scomberomorus maculatus* *Scomberomorus brasiliensis* *Sarda sarda*	*Scomberomorus brasiliensis*	Scombridae	King mackerel
Solteira/Salteira/Xaveia	–	*Oligoplites palometa* *Oligoplites saurus* *Oligoplites saliens*	Carangidae	Carangids nei
Tainha	Mugil spp.	*Mugil curema* *Mugil curvidens* *Mugil gaimardianus* *Mugil incilis*	Mugilidae	Mullets nei
Tinga	–	*Eugerres brasilianus*	Gerreidae	Marine fishes nei
Ubarana	–	*Elops saurus*	Elopidae	Ladyfish
Xaréu	*Caranx hippos*	*Caranx hippos*	Carangidae	Carangids nei
Xira	–	*Haemulon* spp.	Haemulidae	Marine fishes nei

DISCARDS FROM COMMERCIAL FISHERIES

Shrimp landings represent 33% of all marine landingsoff the state of Sergipe. Thus, this is by far the main fishery in the state, with its production mainly exported to other states in Brazil. Until early 1980s, most of by-catch was landed (Decken, 1986). However, with the arrival of the industrial fleet from other states, this started to change, and 80% of by-catch was discarded into the sea (Decken, 1986). According to this author, by-catch of shrimp fisheries represented 60% of total shrimp catches in the 1980s. The proportion that each species/group of species

represented in relation to total catch was: 33% weakfishes (*Cynoscion* spp.), 17% kingcroakers (*Menticirrhus* spp.) , 10% *Lycengraulis* spp., 13% catfishes (Ariidae), 12% *Anchoa* spp., 10% croakers (*Micropogonias* sp.), 3% rays (*Raja* spp. and *Pteroplatea* spp.), and 2% sharks (*Sphyrna* spp. and *Carcharhinus* spp.) (Anonymous, undated). For weakfishes and catfishes, we used the proportion described above for industrial fleet. As there is no *Raja*or Rajidae reported for Sergipe, and *Pteroplatea* spp. has changed to *Gymnura* spp., we equally split catches for rays into *G. altavela* and *G. micrura*, the only ones reported for this state. For sharks, we adjusted the proportions above among seven species included under the two discarded genera: *Sphyrna lewini* (14.7%), *Sphyrna mokarran* (5.4%), *Sphyrna tiburo* (2.1%), *Carcharhinus acronotus* (11.3%), *Carcharhinus falciformis* (2.7%), *Carcharhinus limbatus* (22.0%), and *Carcharhinus porosus* (*41.8%).*

RECREATIONAL FISHERIES

The first fishing club in Sergipe was established in 1967: Clube de Pescadores Amadores de Molinete do Estado de Sergipe (CPAM/SE). This club used to promote competitive fishing events. However, there were some internal conflicts in 1994 that led to the establishment of a new club, the Associação Sergipana de Pescadores Amadores - Bons Ventos (ASPA-BV) (Freire, 2010), and CPAM/SE was closed. Currently, ASPA-BV has 150 members, with 137 of them very active.

For recreational fisheries we used the number of licenses sold in Sergipe (Table IV). If we consider that only 11% of recreational fishers purchased licenses in the neighbour state of Bahia, we were able to estimate the number of recreational fishers in Sergipe in 2011 in about 1500 (which would include 150 members of ASPA-BV). This represents about 0.02% of total population of this state. We used this percentage to extrapolate the number of fishers until 1974, the first year we could consider recreational fisheries as an organized activity in the state due to the establishment of its first fishing club.

A total of 80% of the respondents of the questionnaire filled when acquiring the fishing license stated they fished in marine waters off Sergipe. They were also asked about the number of fishing days per year (Table V) and results indicated an average of 17.7 days per year. Preliminary results obtained in a study with coastal recreational fisheries in Ilhéus (State of Bahia), where species caught are very similar to the ones caught in Sergipe, indicate that each fisher catches 3.2 individuals in average per fishing day, with a mean weight of about 732 g. If we consider that coastal fisheries off southern Bahia and Sergipe are similar, we would estimate catches of about 15 t originating from recreational fisheries in 2010 (daily activities). These catches were then added to those originating from competitive fishing events promoted by ASPA-BV since 1995 (Table VI). Unfortunately, there is no data available for events promoted by CPAM as documents were burnt in an accidental fire. Thus, the estimated total catch originating from recreational fisheries (daily activities plus jamborees/tournaments) in Sergipe was approximately 16 t in 2010. There is no information available on species caught by recreational fishers. Thus, it was not possible to split catches among species and all catches were attributed to 'unidentified fishes'.

A private owner of a recreational fishing boat started taking a few tourists to go fishing offshore targeting tunas and tuna-like fishes since January 2012. More recently two other companies have started their operations in Sergipe. However, there is

Table IV - Number of fishing licenses issued for recreational fishers through the internet in Sergipe (Source: IBAMA and MPA; data provided by Michel Machado, IBAMA/MS).

Year	Number of licenses
2002	1
2003	23
2004	18
2005	20
2006	28
2007	101
2008	61
2009	94
2010	57
2011	162

Table V - Number of fishing days per year in Sergipe, according to a questionnaire provided together with the fishing license issued in 2009 (mean number of fishing days = 17.7).

Fishing days/year	Number of licenses	%
1	3	3.9
2	6	7.9
3	17	22.4
12	33	43.4
48	17	22.4
No answer	18	-
Total	94	100.0

no catch data available to be added from this sector for the period considered in this study (1950-2010).

Table VI - Total weight of fishes caught in fishing events promoted by ASPA-BV from 1995 to 2010 (after Freire *et al.*, 2014).

Year	Catch (t)
1993	0.495
1994	0.626
1995	1.080
1996	1.409
1997	1.541
1998	1.766
1999	1.727
2000	1.007
2001	1.396
2002	0.747
2003	0.744
2004	0.665
2005	1.116
2006	0.745
2007	0.816
2008	0.820
2009	0.807
2010	0.793

ORNAMENTAL FISHERIES

In Sergipe there are currently six shops commercializing ornamental fishes in its capital (Aracaju). Besides these officially registered shops, there are some others with precarious infra-structure called "lojas de bairro" (*neighbourhood shops*). Currently, there are only two of the larger shops that sell marine fishes in Sergipe (a third one stopped selling marine fishes in 2011): the first one established itself 35 years ago and the second has been in activity for about 10 years. One of them does not sell Brazilian marine fishes, but instead import specimens from São Paulo, which originate from Indonesia and Australia. The largest one also imports fishes from Australia (80%) and New Zealand, but also from the state of Bahia. IBAMA only reported catches for ornamental exports, but not for local uses. Data is available for 2006 and 2007 and there is no data for Sergipe. Thus, catches for this sector were considered as zero in this reconstruction.

ILLEGAL FISHERIES (other countries)

There is no information available on illegal fisheries in waters off the state of Sergipe. Thus, no catches were added to the reconstructed database.

After proceeding with the reconstruction process, we noticed that catches are much higher than originally reported by official documents during the 1980smainly due to the discards added (Figure 6). Catches originating from recreational

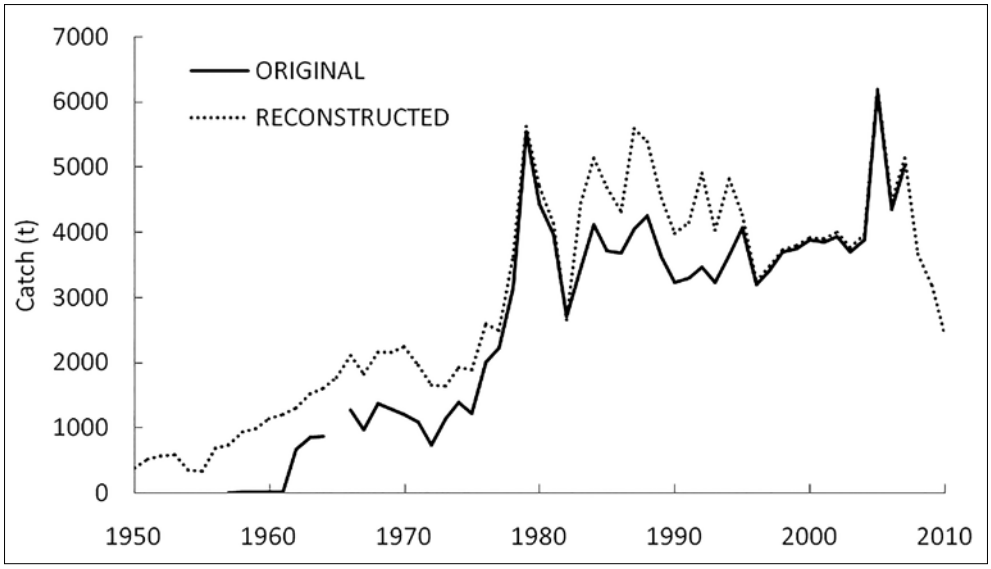

Figure 6 - Original and reconstructed catches for all groups caught in marine waters off Sergipe in 1950-2010 (discards and recreational catches included).

fisheries are low and have low impact in the general trend, which is dominated by trends observed for shrimps, crabs, mullets and weakfishes. Lower total catches observed in 2010 (2,386 t) may not reflect a real decline in catches but rather an improvement over the previous collection system of catch statistics which could be overestimating local production or an adjustment in the process of data collection that has to be further investigated.

The better taxonomic resolution of the reconstructed database allowed to identify the following species with the highest individual annual catches: *Xiphopenaeus kroyeri*, *Mugil curema*, *Ucides cordatus*, *Goniopsis cruentata* and *Macrodon ancylodon* (Figure 7). All other species had catches lower than 100 t in 2010.

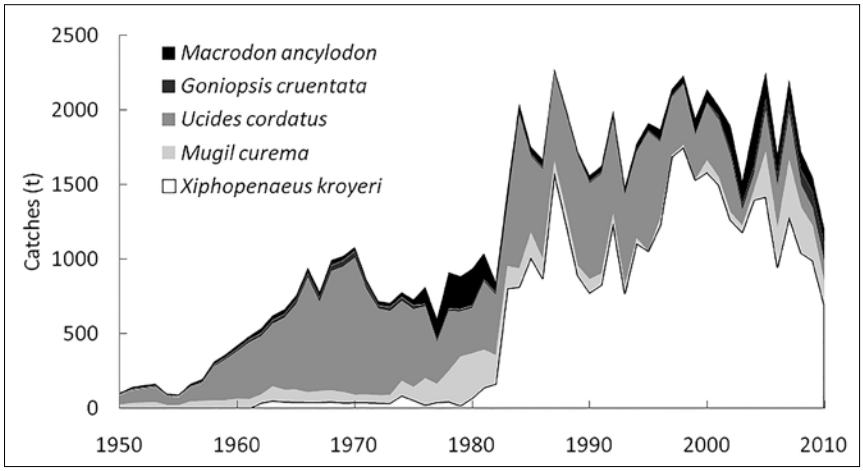

Figure 7 - Catch composition of the five top species caught in marine waters off the State of Sergipe in 1950-2010.

CONCLUSIONS

This is the first time an electronic historical catch database has been built for Sergipe with such a taxonomic resolution. This procedure has shown that resolution is lost in two steps: from the state level to the national level, and from there to the international level (FISHSTAT-J/BRAZIL).

Several important changes in the dynamics of local stocks may continue unnoticed if such initiative is not taken. Thus, important resources such as "aratu" and "tunas" have indicated important changes through time. "Caranguejo-uçá" in one of the most important cases, as their associated catches were considered as originating from marine waters in some years and fresh waters in others. Finally, catches for threatened species may continue unnoticed until local extinction is observed.

The database reconstructed here inherits all problems involved in the collection system, but represents an improvement over the original database, mainly due to its better taxonomic resolution and easier and faster access. Some of the percentages used to split catches among species should be revisited through fieldwork in future studies in order to better represent the entire coast of the state of Sergipe. We hope this study inspire other groups of researchers to revisit the reconstruction process used for all the other Brazilian states that is part of a larger global project.

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