CHAPTER 2.1.10.11 SERRA SPANISH MACKEREL	AUTHORS: F. LUCENA-FRÉDOU, T. FRÉDOU AND R. SIQUEIRA LIMA (UFRPE); B. MOURATO (UNIFESP)	LAST UPDATE: 30 Jun 2021 Original: English

2.1.10.11 Description of Serra Spanish mackerel (BRS)

1. Names

1.a. Classification and Taxonomy

Species name: *Scomberomorus brasiliensis* (Collette, Russo & Zavalla-Camin, 1978)
ICCAT species code: BRS
ICCAT names: Serra Spanish mackerel (English), Serra (Spanish), Thazard serra (French).

According to Froese and Pauly (2021), the Serra Spanish mackerel is classified as follows:

•Phylum: Chordata
•Subphylum: Vertebrata
•Class: Actinopterygii
•Order: Perciformes
•Suborder: Scombroidei
•Family: Scombridae
•Subfamily: Scombrinae
•Genus: *Scomberomorus*
•Species: *Scomberomorus brasiliensis*

1.b Taxonomic notes

Scomberomorus brasiliensis was previously identified as *Scomberomorus maculatus* from the Caribbean and the Atlantic coasts of Central and South America, so pre-1978 data are applied to the Serra Spanish mackerel (Collette and Russo, 1985).

1.c Common names

List of vernacular names used by different countries according to ICCAT, FAO and Fishbase (www.fishbase.org). The list of countries is not exhaustive, and some local names might not be included.
Brazil: Cavala, Cavala-pintada, Cararoca, Escalda-mar, Sarda, Serra, Serra-pina, Serra-pininga, Serrapinima, Serrinha, Sororoca.
China, Main: 巴西馬鮫
Colombia: Carite pintado, Carrita, Carrite.
Denmark: Brasiliansk kongemakrel.
Estonia: Brasiilia kuningmakrell.
France: Thazard serra, Thazard tacheté du Sud.
French Guiana: Bonite, Maquereau.
Japan: Mizutama-sawara.
Martinique: Taza doré, Thazard franc.
Mexico: Serra.
Nicaragua: Carite pintado.
Portugal: Serra-brasileira.
Spain: Serra.
Trinidad & Tobago: Batali, Carite, Serra Spanish mackerel.
United States: Atlantic sierra, Spanish mackerel.
Venezuela: Carite pintado.

2. Identification

Figure 1. Picture of an adult Serra Spanish mackerel (by Italo Lutz).

Characteristics of *Scomberomorus brasiliensis* (see Figure 1)

Serra Spanish mackerel is a medium tuna species with a reported maximum size of 125 cm fork length (FL) (Collette and Nauen, 1983) and maximum weight of 6.7 kg (Szpilman, 2000).

Colour:

- Body silvery on sides with the presence of several rows of yellowish bronze round spots
- Number of spots increases with the fish growth, 20 cm FL with 30 spots; 50 and 60 cm with 45 and 60 spots.
- The anterior part of the first dorsal fin is black or dusky as well as the pectoral fin; pelvic and anal fins are light.

External:

- Body entirely covered with small scales.
- Snout much shorter than rest of the head.
- Gillrakers on first arch: 1-3 on upper limb; 9-13 on lower limb; usually 13-15 total.
- First dorsal fin with 17-18 spines (rarely 19); second dorsal with 15-19 (usually 17-18), followed by 8-10 finlets (usually 9).
- Anal fin with 16-20 rays (usually 18-19) followed by 7-10 finlets (usually 8).
- Pectoral fin with 21-24 rays (usually 22-23), fairly short, 3.6 to 5.9% of the FL.
- Lateral line progressively descends to the midline on caudal peduncle.
- Inter-pelvic process short and bifid.

Internal:

- Swim bladder absent.
- A total of 47-49 vertebrae, 19-21 in the precaudal area and 27-29 in the caudal.
- Intestine with two folds and three limbs.

3. Distribution and population ecology

3.a Geographical distribution

Serra Spanish mackerel is distributed in the Western Atlantic along the Caribbean and Atlantic coasts of Central and South America, from Belize to Rio Grande do Sul (Brazil) (**Figure 2**).

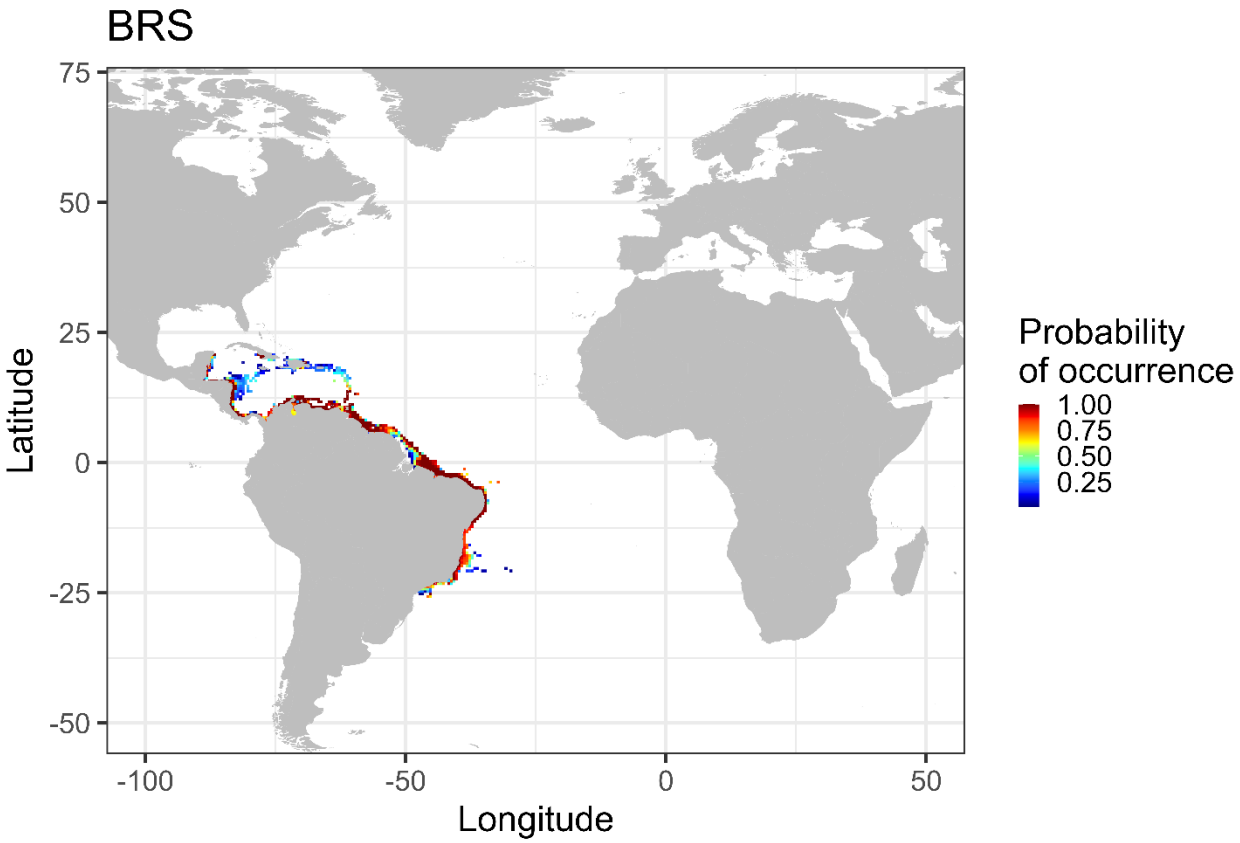

Figure 2. Native spatial distribution map for Serra Spanish mackerel based on data available on aquamaps.org website. Distribution range colours indicate degree of probabilities of occurrence.

3.b Habitat preferences

This species is an epipelagic and neritic fish, commonly found on rocky coasts, islands, and open beaches (Collette and Nauen, 1983; Lima *et al*., 2021).

3.c Migrations

Serra Spanish mackerel does not migrate extensively, however, it carries out some seasonal and reproductive related movements. For example, this species spawns from October to April in Venezuelan waters and then migrates to Trinidad, peaking in abundance from May to September (Sturm, 1978). On the Brazilian coast, when migrating for reproduction or to feed, it becomes a target for fisheries (Santo, 2012; Chaves *et al*., 2021). According to Santo (2012), *S. brasiliensis* follows the migration of sardines from the families Clupeidae and Engraulidae, direction north-northeast Brazil, between October and May. In Northeastern Brazil, there are two proposals regarding species movement: a species' migratory circuit, which may exceed 300 nautical miles (Batista and Fabré, 2001), and small-scale displacements in large areas (Collette *et al*., 2011). However, on the coast of Paraná (South Brazil), there are continuous landings throughout the year, indicating the stock's permanency in the area and small-scale fishery availability (Chaves *et al*., 2021).

4. Biology and life history parameters

For this manual and species, two stocks unit areas, previously defined by ICCAT for data collection and management purposes, were considered to summarize results: Southwest Atlantic (SW) and Northwest Atlantic (NW). Aspects of the biology of Serra Spanish mackerel for both Northwest and Southwest Atlantic are available and, overall, for K, $L\infty$, L_{50} and Tmax, estimates between areas may not be considered similar (**Figure 3**).

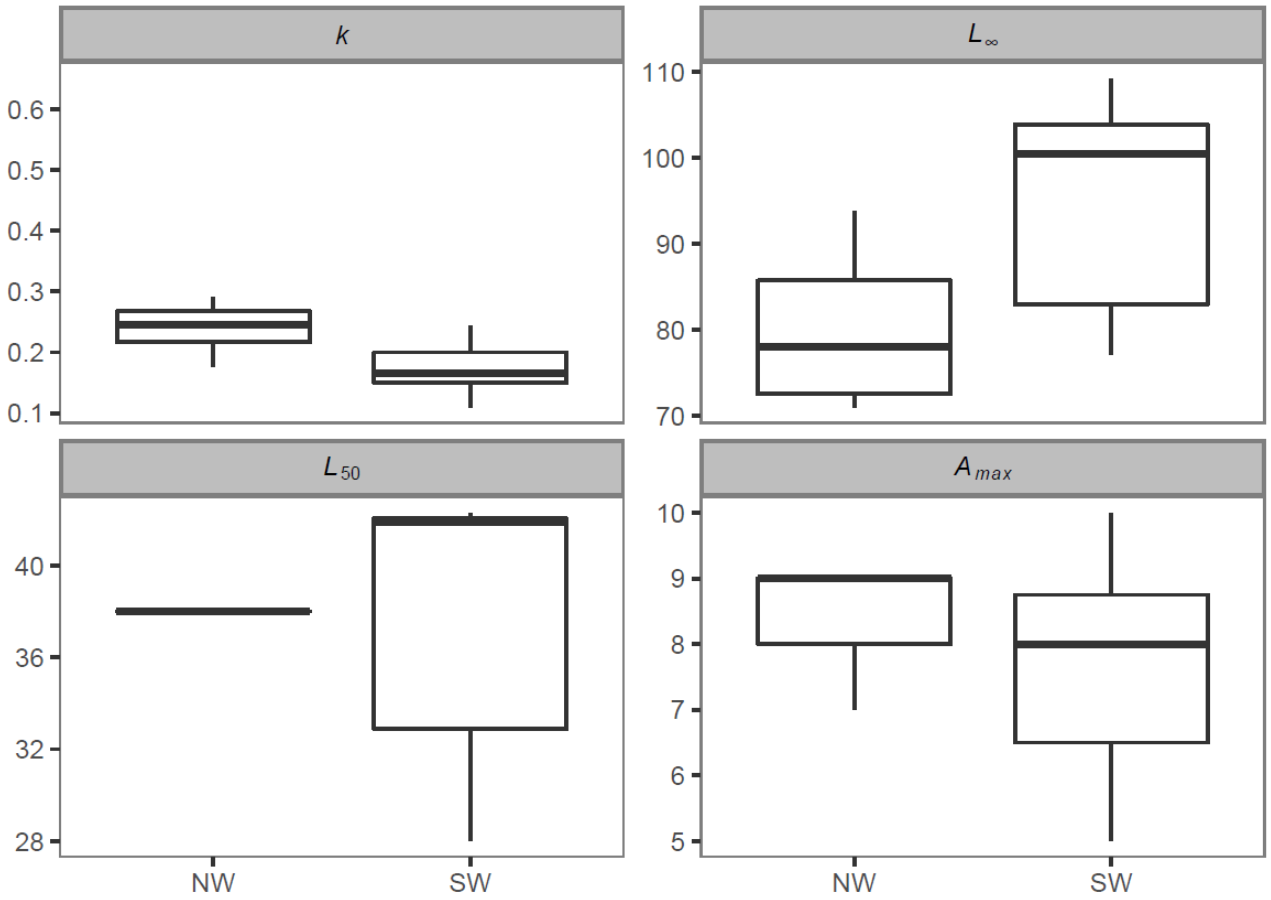

Figure 3. Life history parameters for Serra Spanish mackerel by ICCAT area. Von Bertalanffy body growth coefficient(k), Von Bertalanffy asymptotic length (L∞), length at 50% maturity (L_{50}), Maximum Age (Amax, years). Fork Length in cm.

4.a Growth

Estimates of growth parameters for the Serra Spanish mackerel date back to the 60s. The most recent estimates are for the Southwest area (Nóbrega and Lessa, 2009). No recent estimates are available for the Northwest Atlantic. Overall, growth parameters may differ between males and females. Females have slower growth and higher asymptotical length in all cases. The maximum ages reported are similar between the Northwest (9 years) and Southwest (10 years) Atlantic (Nomura, 1967; Sturm, 1978).

Table 1. Growth parameters (L∞ in cm, K in y-1, to in y) and Tmax (years) for Serra Spanish mackerel (L∞ in cm, K in y-1, to in y). NW – Northwest Atlantic. SW – Southwest Atlantic.

Growth parameters								
L∞	K	to	Tmax	Area	Country	Reference	Sex	Method
95.7	0.15	-0.212	8	SW	Brazil	Nóbrega and Lessa, 2009	All	Otoliths
10918	0.114	-0.414	8	SW	Brazil	Nóbrega and Lessa, 2009	Females	Otoliths
79.52	0.189	-0.384	8	SW	Brazil	Nóbrega and Lessa, 2009	Males	Otoliths
107	0.21	-1.39	10	SW	Brazil	Nomura, 1967	All	Otoliths
102.6	0.16	-0.13	10	SW	Brazil	Nomura, 1967	Females	Otoliths
96.38	0.2	-0.05	9	SW	Brazil	Nomura, 1967	Males	Otoliths
73	0.29	-0.55	9	NW	Trinidad and Tobago	Sturm, 1978	All	Otoliths
83	0.23	-0.74	7	NW	Trinidad and Tobago	Sturm, 1978	Females	Otoliths
71	0.26	-0.73	9	NW	Trinidad and Tobago	Sturm, 1978	Males	Otoliths
106.7	0.16	-	6	SW	Brazil	Ximenes, 1981	All	Otoliths
101.9	0.176	-	6	SW	Brazil	Ximenes, 1981	Females	Otoliths
81.6	0.243	-	5	SW	Brazil	Ximenes, 1981	Males	Otoliths
77.16	0.65	-0.102	6.5	SW	Brazil	Chaves *et al*., 2021	All	Size-Frequency
93.81	0.1765	-	-	NW	Trinidad and Tobago	Julien-Flüs, 1988	Females	Size-Frequency
100.48	0.11	-	-	SW	Brazil	Morales-Nim, 1989	All	Otoliths

4.b Length-Weight relationship

Published length-weight relationships are only available for the Southwest Atlantic and are shown in **Table 2**.

Table 2. Published length-weight relationships for Serra Spanish mackerel. SW – Southwest Atlantic.

Equation	N	FL range (cm)	Sex	Area	Country	Reference
$W=0.00001 \times FL^{2.9465}$	428	≈ 116 - 680	All	SW	Brazil	Nóbrega *et al*., 2009
$W=0.0159 \times FL^{2.81}$	786	16- 830	All	SW	Brazil	Nomura, 1967
$W=0.000053 \times FL^{2.69}$	49	-	All	SW	Brazil	Chaves *et al*., 2021
$W=0.000005 \times FL^{3.011}$	230	≈ 410 - 750	All	SW	Brazil	Silva *et al*., 2005

4.c Conversion factors

There is a lack of information on this topic.

4.d Reproduction

- *Spawning*

Most estimates provided for the Serra Spanish mackerel, either in the Northwest and Southwest, are within the tropical Atlantic (approximately between 9º N and 3º S). In these cases, spawning takes places throughout the year, but mainly between October and March (**Table 3**). In northeastern Brazil, spawning appears to take place in a sequential manner: in Natal the spawning season is from March-June (Chellappa *et al.*, 2010), whereas in Maranhão, spawning occurs from October to March (Batista and Fabré, 2001). According to Fonteles-Filho (1988), in Ceará, Northeast Brazil, Serra Spanish mackerel spawns on the continental shelf, probably between depths of 15 and 36 m, or between 10 and 30 m from the coast. Recently, for the first time, Chaves *et al.* (2021) reported the spawning cycle for *S. brasiliensis*, which is from October to June, peaking from January to March.

Table 3. Period of main spawning activity for the Serra Spanish mackerel off the Atlantic Ocean (grey). NW – Northwest Atlantic; SW – Southwest Atlantic.

Location	J	F	M	A	M	J	J	A	S	O	N	D	Reference
AT-NW (Venezuela)													Bashirullah, 1990
AT-SW (Brazil)													Batista and Fabré, 2001
AT-SW (Brazil)													Lima et *al.*, 2007
AT-NW (Trinidad Tobago)													Sturm, 1978
AT-SW (Brazil)													Chaves et al., 2021
AT-SW (Brazil)													Chellappa *et al*., 2010
AT-SW (Brazil)													Gesteira and Mesquita, 1976

- *Maturity*

Length at first maturity estimates available for Southwest Atlantic Serra Spanish mackerel vary between 31.25 and 42.10 cm FL (Lima *et al*., 2007; Nóbrega *et al*., 2009). In South Brazil, more recently, Chaves *et al*. (2021), estimated L_{50} at 44.6 cm FL. For the Northwest Atlantic, a single estimate is available (38 cm FL, Bashirullah, 1990). Age at first maturity varies between 1.4 (Chaves *et al*., 2021) and three years (Nóbrega *et al*., 2009). Average generation length across the species range has been estimated between five and seven years (Collette *et al*., 2011).

- *Sex ratio*

The sex ratio is unbalanced with a predominance of males in Northeast Brazil (Lima *et al.*, 2007; Nóbrega *et al*., 2009), but of females in the South of the country (Chaves *et al.*, 2021).

- *Fecundity*

Absolute and relative fecundity for Serra Spanish mackerel in Northeast Brazil (SW Atlantic) were estimated at 871,523 oocytes and 952 oocytes per gram of fish weight (Lima *et al*., 2007). Gesteira (1972) estimated absolute and relative fecundity for the species at 2,047,000 and 1,892 eggs per gram of individual weight, respectively, for the State of Ceará, also in Northeastern Brazil. Recently, in South Brazil, individual fecundity was estimated by Chaves *et al*. (2021) and varied between 34,484 (410 mm FL) and 390,786 oocytes (650 mm FL), progressively increasing with FL and ovary weight.

4.e First life stages

- *Eggs and larvae*

Eggs and larvae are pelagic (da Cunha *et al.*, 2020) and no further information on this topic is available.

- *Recruitment*

This species present prolonged spawning and recruitment in South Brazil (Chaves *et al*., 2021)

4.f Diet

Serra Spanish mackerel have strong, compressed, triangular or knife-like teeth (Collette *et al*., 1978). This species feeds mainly on fishes, shrimps, and cephalopods. On the northeast coast of Brazil, the diet mainly consists of *Opisthonema oglinum* (thread herring), jacks, half-beaks, grunts, and anchovies (Collette and Nauen, 1983; Nóbrega, 2002).

4.g Physiology

There is a lack of information on this topic.

4.h Behaviour

During the juvenile phase, Serra Spanish mackerel forms large schools, mainly during the reproduction season. This species also enters tidal estuaries (Sturm, 1978; Nóbrega, 2002; Lima *et al*., 2021).

4.i Natural mortality

In Northeast Brazil, M was obtained as 0.3 (Nóbrega *et al*., 2009)

4.j Stock structure

Many studies have suggested that there is a single genetic stock of the Serra Spanish mackerel in Western Atlantic. Gold *et al*. (2010) revealed a genetically discrete subpopulation of the species between the coast of Venezuela and Trinidad and Tobago, containing a small and divergent clade of four mtDNA haplotypes, probably related to recent admixture of formerly isolated subpopulations. da Cunha *et al.* (2020) observed the existence of a single genetic stock of *S. brasiliensis* between eastern Venezuela and southern Brazil, and Siccha-Ramirez *et al.* (2018) suggested the absence of any genetic structure among the local populations, despite the sampling points in the Brazilian coast, being distant of approximately 3,000 km.

5. Description of fisheries:

5.a. Catch composition

Scomberomorus species are caught with drift (gill) nets, trolling lines, hook lines, baited hand lines, beach seines, bamboo stake traps, set nets and various other gears, including sport gear in the charter boat industry. ICCAT annual catches reported, from 1950 to 2019, a mean landing of 8667 t. Mean landings are higher in the Northwest (5636 t) than in the Southwest Atlantic (2961 t). However, most catches are from unknown gears (**Figure 4**).

Serra Spanish mackerel is one of the most harvested marine fish species on the Brazilian coast (da Cunha *et al*., 2020), caught mainly by gill nets (Lima *et al.*, 2007; Nóbrega and Lessa, 2009). Although recreational spearfishing in Brazil is a growing activity, its impacts are poorly understood. However a study in Bahia (Northeast Brazil), pointed to *S. brasiliensis* as one of the main species affected by this activity (Costa Nunes *et al*., 2012). In Northeast Brazil, Serra Spanish mackerel is most frequently caught between the 10 and 50 m isobaths, although it occurs at depths of up to 100 m, mainly by gill nets, followed by the handline. In South Brazil (Paraná State), from 2017–2019, Serra Spanish mackerel occupied the third position in landings (PMAP, 2020) and, although it is landed throughout the year (as a target species and as bycatch) (Chaves and Silva, 2019), it is mainly reported during warmer months (October to March) (UNIVALI, 2013). The species is also very important in Trinidad, representing around 19% of the average annual landings by the Trinidadian artisanal fleet and 25% of the landed fish value (Gold *et al*., 2010).

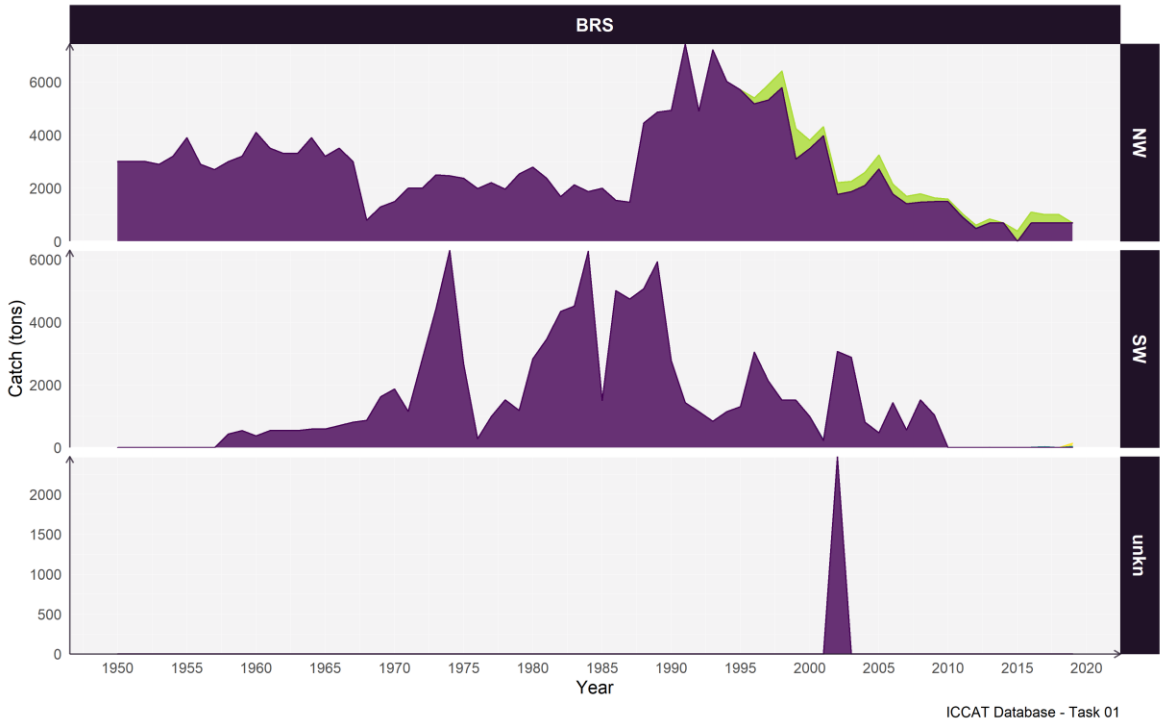

Figure 4. Catch distribution by gear and region of Serra Spanish mackerel in the Atlantic Ocean for 1950 to 2019 (t). purple: unknown; green: gillnets.

5.b Length and age composition

In the northeast of Brazil (SW Atlantic) during the period from 1998 to 2000, specimens between 95 and 965 mm FL were caught and young individuals from 95 to 350 mm FL were frequent, mainly in February, August, and September. In terms of age, the main catches were of individuals between 0 and 2 years old. Different fishing gear caught specimens with different lengths: the gillnet captured 74.2% of the samples, with an average size of 435 mm FL; the handline was responsible for 18.2% of the individuals collected, with an average length of 518 mm FL, while the beach seine totaled 7.6% of the registered specimens and an average of 171 mm FL (Nóbrega *et al*., 2009). In South Brazil, landings comprised individuals from 210 to 779 mm FL, mainly adults (age 1 and 2) (Chaves *et al*., 2021).

No size data for the Serra Spanish mackerel is available in ICCAT Task 2 size data.

There are no catch-at-size or catch-at-age estimates for Serra Spanish mackerel.

6. Stock assessment

There are no recent estimates of the stock status of *S. brasiliensis* in the Atlantic. During the late 90son both the North and Northeast Brazilian coast, the population was at its maximum exploitation limit (Nóbrega *et al*., 2009, Lucena-Frédou and Asano-Filho, 2006), average annual biomass was estimated to be 4,237 t, and 35.9% of the stock was being exploited annually (Nóbrega and Lessa, 2009). Moreover, there has been a decrease of the percentage of juveniles' average length of individuals caught since the 60s. Between 1963-1986, the participation of juveniles was 8.1% (Oliveira *et al*., 2015); between 1970-1975 the percentage increased to 14.2% of immatures captured (Fonteles-Filho, 1988). Between 1998-2000, the average length decreased from 50.3–38.2 cm total length (TL) (Nóbrega and Lessa, 2009). A stock assessment carried out in 1991 categorized this species in the waters of Trinidad as fully exploited (Henry and Martin, 1992) and, in the following decade, this species' biomass was below maximum sustainable yield (MSY) and that F was above Fmsy (Martin and Nowlis, 2004).

Using a semi-quantitative risk assessment (Productivity and Susceptibility Analysis PSA), amongst the small tunas, Serra Spanish mackerel was considered moderately vulnerable (Lucena-Frédou *et al*., 2017). Considering the global assessment carried out by the International Union for Conservation of Nature (IUCN) in its Red List of Threatened Species, the category of Least Concerned (LC) has been assigned (see https://www.iucnredlist.org/; Collette *et al.*, 2011).

Lucena-Frédou *et al*. (2021) found that there are many knowledge gaps regarding species of small tunas, *S. brasiliensis* included. At the moment, datasets required for these "classical" stock assessments are unavailable for the Serra Spanish mackerel and "data-poor" or "data-limited" approaches are currently the most recommended. Overall, length-based methods show a more promising applicability than any other assessment methods to estimate proxies for stock status for small tunas, since collecting length measurements from a portion of the catch might be more feasible than collecting total landings data (Pons *et al*., 2019), which are clearly underestimated in the Atlantic.

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