		
CHAPTER 2.1.10.3: FRIGATE TUNA	AUTHORS: B. MOURATO, T. BARRETO AND F. LUCENA-FRÉDOU	LAST UPDATE: June 2021 Original: English

2.1.10.3 Description of frigate tuna (FRI)

1. Names

1.a. Classification and Taxonomy

Species name: *Auxis thazard* (Lacepède, 1800)

ICCAT species code: FRI

ICCAT names: Frigate tuna (English), Melva (Spanish), Auxide (French).

According to the Collette and Nauen (1983), frigate tuna is classified as follows:

- Phylum: Chordata
- Subphylum: Vertebrata
- Superclass: Gnathostomata
- Class: Osteichthyes
- Subclass: Actinopterygii
- Order: Perciformes
- Suborder: Scombroidei
- Family: Scombridae
- Genus: *Auxis*
- Species: *Auxis thazard*
- Subspecies: *Auxis thazard thazard*

1.b. 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.

Angola: Chapouto, Judeo.

Australia: Frigate mackerel, Leadenall.

Brazil: Albacora-bandolim, Bonito, Bonito-cachorro, Cachorro, Cadelo, Cavala, Judeu, Serra.

Cabo Verde: Cachorra, Cachorrinha, Chapouto, Gaiado, Judeo-liso, Judeu, Merma, Panguil, Serra.

China Main: 圓舵鯷, 扁舵鯷.

Chinese Taipei: 扁花鯷.

Cuba: Melva aletilargo.

Denmark: Auxide.

Djibouti: Auxide, Frigate tuna.

Dominican Republic: Bonito.

Ecuador: Botellita.

Finland: Auksidi.

France: Auxide.

Germany: Fregattmakrele.

Greece: Τουμπαρέλι, Κοπάνι, Κοπανάκι, Βαρελάκι, Κορاني-Κορανάκι.

India: Ayila soora, Bugudi, Churai, Ellichooru, Frigate mackerel, Frigate-tuna, Gedar, Gedara, Kuppa, Kutteli-churai, Ragondi, Urulan-churai.

Indonesia: Balaki.

Iran: Batch-e-zardeh.

Italy: Mpisu, Biso, Bisu, Bonitu, Culariau, Istrumbu, Istrumbulu, Motolo, Motulu, Muetolo, Pisantuni, Pizzutellu, Sanguisu, Scurmo, Scurmu, Sgamirru, Sgamirru, Sgionfeto, Strumbo, Strumbu, Strumbulu, Strummulu, Tambarela, Tambarello, Tambarelo, Tamburello, Tombarello, Tonnetto, Tumbarello, Tunnacchiu.

Japan: Hiramejika, Hirasoda, Hirasôda, Hirasodakatsuo, Oboso, Obosogatsuwo, Shibuwa, Soda-gatsuo, Soma, Suma.

Malaysia: Aya, Aya selaseh, Baculan, Bakulan, Kayau, Kayu, Selasih, Tongkol, Tongkol selasih.

Martinique: Bonit queue raide.

Mexico: Barrilete negro, Bonito, Melva.

Micronesia: Mackerel tuna, Yasiuneiu-yauma.

Mozambique: Judeu.

Netherlands: Fregatmakreel.

New Zealand: Frigate tuna.

Nicaragua: Melva.

Norway: Auxid.

Oman: Deraiga, Sadah, Tibban.

Papua New Guinea: Frigate mackerel, Frigate tuna.

Peru: Barrileto negro.

Philippines: Aloy, Budburon, Buroboto, Ehalason, Frigate tuna, Ilahason, Kantorayan, Mangko, Mangkoh, Perit, Pidlayan, Pirit, Super Aloy, Tangi, Tologan, Tulingan, Tulingan lapad, Vahuyo.

Poland: Tazar.

Portugal: Judeu, Judeu-liso e judeu.

Romania: Melva, Ton negru.

Sao Tome Prn: Fulu fulu.

Somalia: Jaydar-dhiiglow.

Spain: Melva.

St Helena: Mackerel tuna.

Sweden: Auxid.

Tanzania: Sehewa.

Trinidad Tobago: Bonito.

Türkiye: Gobene, Tombile.

UK: Frigate tuna.

United Arab Emirates: Tabban.

USA: Bullet mackerel, Frigate mackerel, Frigate tuna.

Venezuela: Cabaña negra.

Vietnam: Cá Ngừ chù, Frigate mackerel.

2. Identification

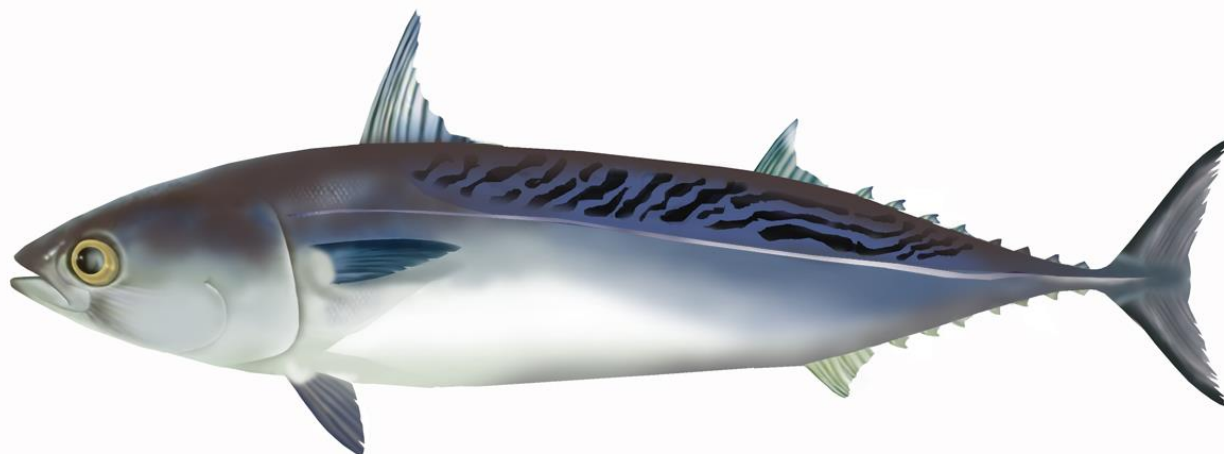


Figure 1. Drawing of an adult *Auxis thazard* (by A. López, 'Tokio').

Characteristics of *Auxis thazard* (see Figure 1 and Figure 2)

The frigate tuna is one of the smallest members of the tribe Thunnini (the true tunas). The maximal length was reported by Morice (1953) *apud* Cayré *et al.* (1993) in 65 cm of fork length off the eastern Atlantic Ocean.

Colour:

- Colour bluish on dorsal parts turning to deep purple or almost black on the head.
- Pattern of 15 or more narrow dark bars or wavy lines, oblique to nearly horizontal, in the scaleless area above lateral line.
- White belly without stripes or spots.
- Pectoral and pelvic fins are purple, with black inner sides.

External:

- Body robust, elongated and rounded.
- Body naked, except for the corselet which is well developed and narrow under second dorsal fin (no more than 5 scales wide under second dorsal fin origin).
- Strong median keel on each side of caudal peduncle, between two smaller keels.
- Two dorsal fins separated by a large interspace (at least equal to length of first dorsal fin base).
- First dorsal fin: 10-12 spines.
- Second dorsal lower than first: 8 finlets.
- Anal fin: 7 finlets.
- Short pectoral fin but reaching past vertical line from anterior margin of scaleless area above corselet.
- Pectoral rays: 22-25.
- Gill rakers on first gill arch: 36-44, usually 38-42.
- Inter-pelvic process single and exceptionally large, equal to length of pelvic fins.
- Teeth small and conical, in a single series.

Internal:

- Swim bladder absent.
- Right lobe of liver exceptionally long, extending the length of the body cavity and left lobe greatly reduced.
- Vertebrae: 39.
- Cutaneous artery present but divided into separate dorsal and ventral branches. The ventral branch is very poorly developed.

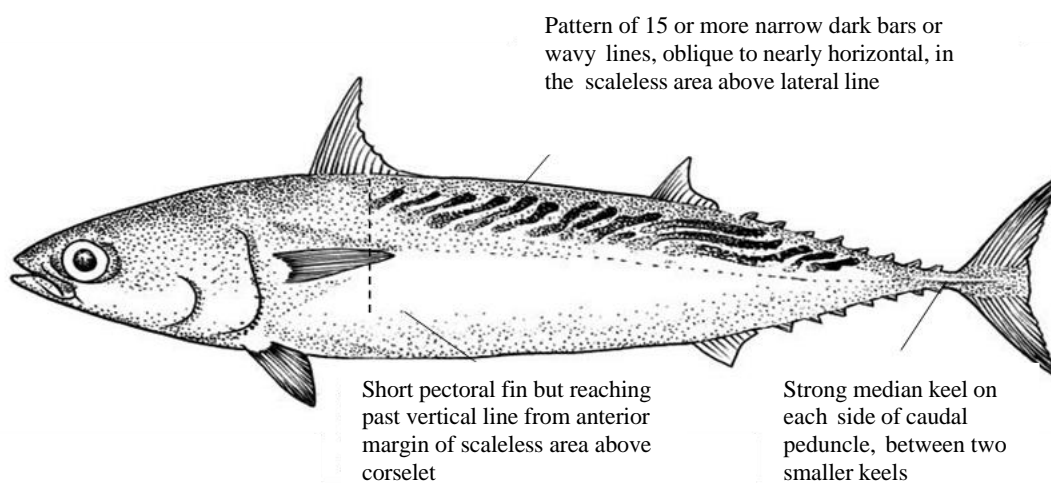


Figure 2. Synthesis of the most outstanding characteristics of *Auxis thazard* (by A. López, 'Tokio').

3. Distribution and population ecology

3.a. Geographical distribution

Frigate tuna is a coastal species found circumglobally in tropical and subtropical oceans (**Figure 3**). However, the eastern Pacific population is recognized as a subspecies named as *Auxis thazard brachydorax* (Collette and Aadland, 1996). Morphometric analysis of eastern Pacific populations of *A. thazard* differed significantly from the rest of the world, supporting recognition of an eastern Pacific subspecies named *Auxis thazard brachydorax* (Collette and Aadland, 1996; Collette *et al.*, 2011). In the Atlantic Ocean, frigate tuna is distributed in both sides of the tropical and subtropical areas with a high probability of occurrence between 40°N - 35°S, including the Caribbean Sea and Gulf of Mexico. Although occurrence of frigate tuna has been recognized in the Mediterranean Sea (Collette and Nauen, 1983), nowadays, it is known that this species is less frequent and has a lower probability of occurrence in the Mediterranean. Therefore, most specimens of genus *Auxis* caught in the Mediterranean Sea might be bullet tuna (*Auxis rochei*) (Collette *et al.*, 2011; Ollé, *et al.*, 2019).

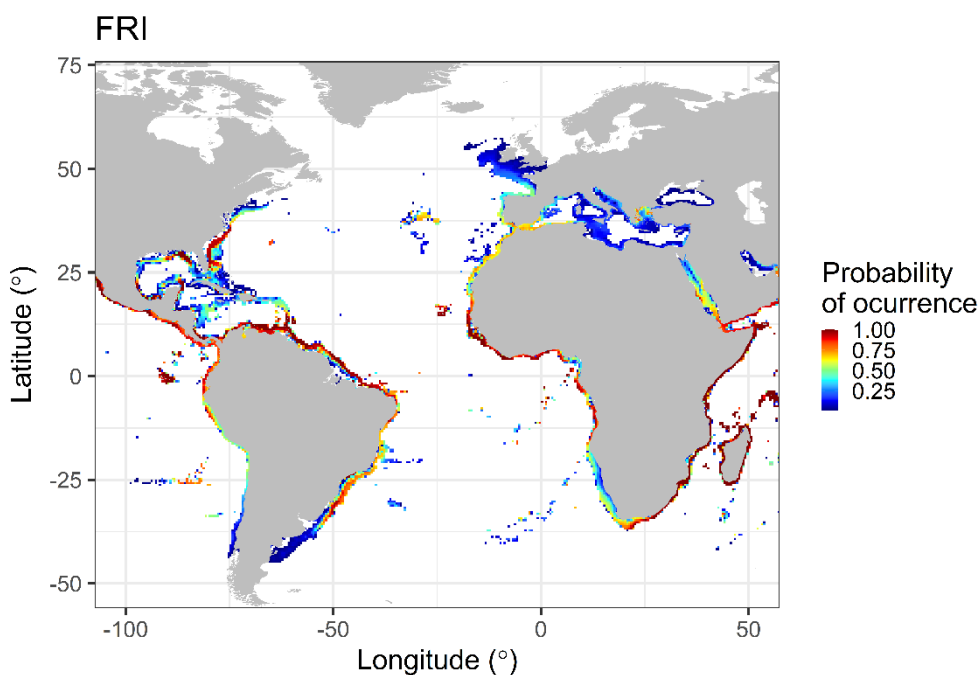


Figure 3. Geographical distribution showing the probability of occurrence of *Auxis thazard* based on data available on FishBase and aquamaps.org website.

3.b. Habitat preferences

Frigate tuna is an epipelagic and neritic fish, but it can also occur in oceanic waters in the tropical and subtropical regions. The species has a preference of depth range up to 50 m of the water column, with a localized migratory habit and mainly restricted to continental shelves and oceanic islands (Collette and Nauen, 1983; Maguire *et al.*, 2006). Juveniles and pre-adults are found over the continental shelf (Deepti and Sujatha, 2012).

3.c. Migrations

No tagging experiments have been recorded. Therefore, little is known about the frigate tuna movement patterns. However, this species is known to be less migratory than other tuna species and seems to not perform extensive migratory movements but is occasionally caught offshore (Collette and Nauen, 1983; Maguire *et al.*, 2006).

3.d. Recruitment

Knowledge of the early life stages in tunas is very scarce. It is assumed that the larval period is short. During the first life stages frigate tuna are not caught and juvenile life history is unknown. Immature fish first appear in the fishery from around 25 cm of fork length. In the Southwest Atlantic, juveniles were observed in higher abundance from June to September, while immature individuals were more common from December to May (Bahou *et al.*, 2016).

4. Biology and life history parameters

For this manual and species, four stocks unit areas, previously defined by ICCAT for data collection and management purposes, were considered to summarize results: Southwest Atlantic (SW), Northwest Atlantic (NW), Southeast Atlantic (SE) and Northeast Atlantic (NE).

4.a. Growth

For frigate tuna, there is only one age and growth study in the Atlantic Ocean (Grudtsev and Korolevich, 1986). This study was based on 237 individuals caught off the eastern equatorial Atlantic (NE Atlantic) and age was estimated by reading spines of the first dorsal fin. The growth parameters of this study are: $L_{\infty}=51.47$ cm, $K=0.32$ y^{-1} , $t_0=-0.83$ years and maximum age of 4 years.

4.b. Length-Weight relationship

Most of the studies on length-weight relationships of *A. thazard* off the Atlantic Ocean are summarized in **Table 1**.

Table 1. Published frigate tuna length-weight relationships. Southwest Atlantic (SW), Southeast Atlantic (SE) and Northeast Atlantic (NE).

Year	<i>a</i>	<i>b</i>	<i>r</i> ²	Length (cm)	range	Location	Reference
1993-2000	0.00890	3.170	0.926	24.6-31.7 (FL)		SW (Brazil)	Frota <i>et al.</i> , 2004.
1993-2000	0.00600	3.194	0.951	26.9-34.8 (TL)		SW (Brazil)	Frota <i>et al.</i> , 2004.
1993-2000	0.00800	3.273	0.944	23.0-29.3 (SL)		SW (Brazil)	Frota <i>et al.</i> , 2004.
2010-2018	0.00150	3.240		21-43 (TL)		NE	Petukhova, 2019
2003-2004	0.00723	3.206	0.98	25-48 (FL) *		SE (Côte D'Ivoire)	Bahou <i>et al.</i> , 2016
2016	0.0036	3.4118	0.91	26.0-49.0 (FL)*		SE (Gulf of Guine)	Edoukou <i>et al.</i> , 2017
2016	0.0039	3.4108	0.93	26.5-46.3 (FL)**		SE (Gulf of Guine)	Edoukou <i>et al.</i> , 2017
	0.00166	3.6426				MED (Gilbratar Strait)	Ramos <i>et al.</i> , 1985
	0.0000225	2.9705				SW	Diouf, 1988

*females

**males

TL: Total length

FL: Fork length

SL: Standard length

4.c. Conversion factors

There is a lack of information on this topic.

4.d. Reproduction

Frigate tuna present four main phases of the reproduction: resting, maturation, spawning and post spawning phase (Bahou *et al.*, 2016).

- Spawning

Spawning of frigate tuna has been recorded over extended periods depending on the geographical area. Spawning is closely related to the environmental temperature, which was observed at the surface water temperatures of 21.6-30.5°C, with massive spawning at 25-28°C (Collette and Nauen, 1983; Rudomiotkina, 1984). From larval records, it is deduced that frigate tuna spawn throughout its distribution range. Timings of spawning of *A. thazard* off the Atlantic Ocean are summarized in the **Table 2**.

Table 2. Spawning period of the frigate tuna off the Atlantic Ocean. Northwest Atlantic (NW), Southeast Atlantic (SE) and Northeast Atlantic (NE).

<i>Location</i>	<i>J</i>	<i>F</i>	<i>M</i>	<i>A</i>	<i>M</i>	<i>J</i>	<i>J</i>	<i>A</i>	<i>S</i>	<i>O</i>	<i>N</i>	<i>D</i>	<i>Reference</i>
NE (Sierra Leone)													Rudomiotkina, 1984
SE (Gulf of Guinea)													Rudomiotkina, 1984
SE (Congo and Angola)													Rudomiotkina, 1984
NW (Costa Rica)													Collette and Nauen, 1983
SE (Senegal, Côte D'Ivoire)													Bahou <i>et al.</i> , 2016
SE (Gulf of Guinea)													Edoukou <i>et al.</i> , 2017

- *Maturity*

Estimates of length of sexual maturity of *A. thazard* off the Atlantic Ocean are summarized in **Table 3**.

Table 3. Published frigate tuna maturity studies off the Atlantic Ocean. Southeast Atlantic (SE) and Northeast Atlantic (NE).

<i>L₅₀ (cm)</i>	<i>Size range (cm)</i>	<i>N</i>	<i>Sex</i>	<i>Location</i>	<i>Reference</i>
29.0 FL	25-48	496	Females	SE (Côte d'Ivoire)	Bahou <i>et al.</i> , 2016
31.7 TL	21-43	1527	Unsexed	NE (Morocco, Mauritania, Senegal)	Petukhova, 2019
30.0 FL			Unsexed	NE	Cayré <i>et al.</i> , 1993

- *Fecundity*

Spawning usually occurs in several batches with fecundity of about 1.37 million eggs per year in a 44.2 cm female (Collette and Nauen, 1983). In the Southeastern Atlantic, fecundity was estimated between 305,000 and 891,000 eggs in females measuring in size between 33 and 45 cm FL (Bahou *et al.*, 2016).

4.e. First life stages

- *Eggs and larvae*

Eggs are pelagic, 0.84-0.92 mm in diameter and with one oil globule (0.24-0.29 mm in diameter). The yolk is homogeneous. The hatch size is 2.32 mm. The embryo presents melanophores and large green chromatophores on posterior half. Larvae present pigmentation on midbrain, hindbrain, gut, cleithral symphysis dorsal, lateral and ventral margins of tail (Richards, 2005). *Auxis thazard* larvae is distinguished from the *A. rochei* by a more rapid rate of development, a deeper body depth, a short caudal portion of body and more intense body intense pigmentation (Collette and Aadland, 1996). Frigate tuna larvae are tolerant of a wide range of temperature as they can live in waters with temperature between 21.6°C and 30.5°C (Valeiras and Abad, 2010) with optimum temperature between 27° and 27.9°C (Collette and Nauen, 1983).

4.f. Diet

Food is primarily selected by the size of gill rakers. The species feeds on small fish, planktonic crustaceans (such as megalops), cephalopods (squids, mainly), stomatopod larvae and others. Fish prey largely on small pelagic fishes, particularly anchovies and other clupeoids (Etchevers, 1976).

Predators: several tuna species, pelagic sharks, billfishes and big pelagic fish (*Coryphaena hippurus*, *Alepisaurus sp.*, *Sphyraena sp.*). Because of its abundance, they are considered an important element of the food chain, being a forage prey for other commercial species (Olson, 1982).

4.g. Physiology

There is a lack of information on this topic.

4.h. Behaviour

Little is known about frigate tuna behavior patterns, however it is recognized that this species has a strong schooling behavior.

4.i. Natural mortality

Pons *et al.* (2019a) estimated natural mortality empirically through different methods and a value of 1.01 year⁻¹ was considered for the Northeast and Southeast stocks.

4.j. Stock structure

There are no clear stock boundaries defined for frigate tuna species in the Atlantic Ocean. However, the SCRS consider four stocks unit areas, which were previously defined by ICCAT for data collection and management purposes: Southwest Atlantic (SW), Southeast Atlantic (SE), Northwest Atlantic (NW) and Northeast Atlantic (NE).

5. Description of fisheries

Since 1950, the total reported catches of frigate tuna have increased up to the mid 80s, when the landings reached more than 21,000 t in 1987, followed by a strong decline until the beginning of 2000s (**Figure 4**). After 2005, the landings of frigate tuna start to increase again up to 2016, when more than 23,000 t were landed. In general, most of the catches come from unknown areas (**Figure 4**), particularly between 1967 and 1990, accounting for ~ 70% in average of the total landed catch. After 1990, the proportion of catch coming from unknown areas decreased significantly, while landings from the Northeast and Southeast Atlantic increased, accounting for 75% on average of the total catch between 1991 and 2019 (**Figure 4**). Landings from the western Atlantic are considerably lower in comparison to the eastern side.

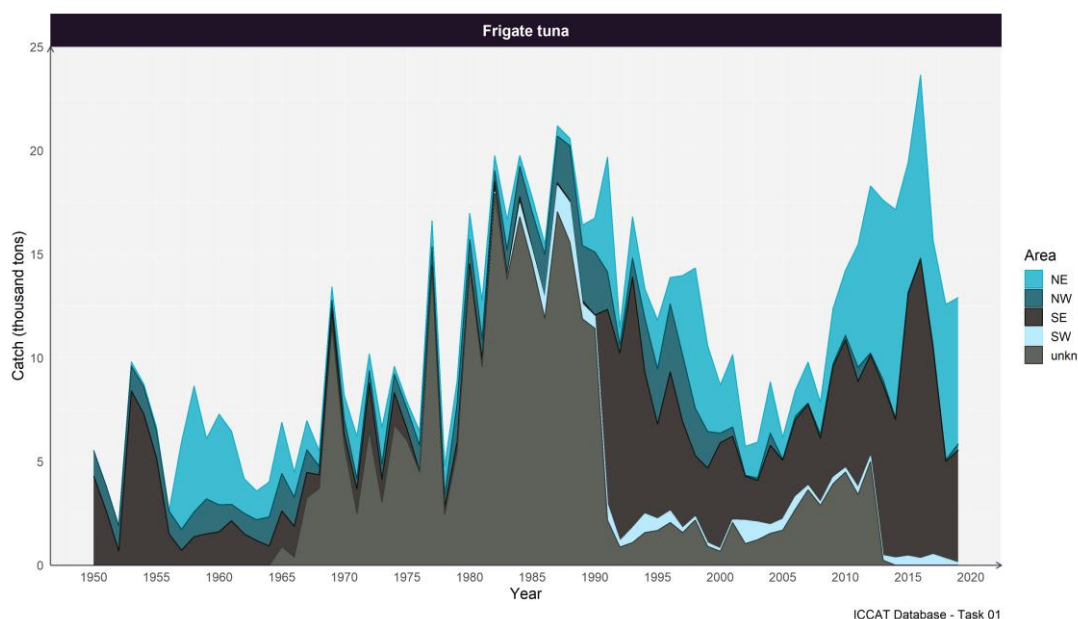


Figure 4. Catch of frigate tuna available in the ICCAT database by region from 1950 to 2019.

Frigate tuna is exploited mainly by surface gears and artisanal fisheries such as trolling lines, handlines, small-scale longlines, and a wide variety of nets, especially traps, gill or drift nets, ring nets, beach seines, otter trawls, and purse seines. In the eastern Atlantic, purse seine fisheries were the most important in terms of landings in recent decades (**Figure 5**), with frigate tuna being taken incidentally as bycatch in purse seine fisheries for yellowfin and skipjack tuna. In the Northwest Atlantic, most of the catch come from unknown fishing gears, but there is a high proportion of catch in the past decade derived from purse seine fisheries (**Figure 5**). In the Southwest Atlantic, baitboat fisheries accounted for most of the landings (**Figure 5**), but unknown gears were more important before 1995. For the unknown areas, landings of frigate tuna after 1990 come from purse seine fisheries, but with a higher proportion of catch from unknown fishing gears before 1988 (**Figure 5**).

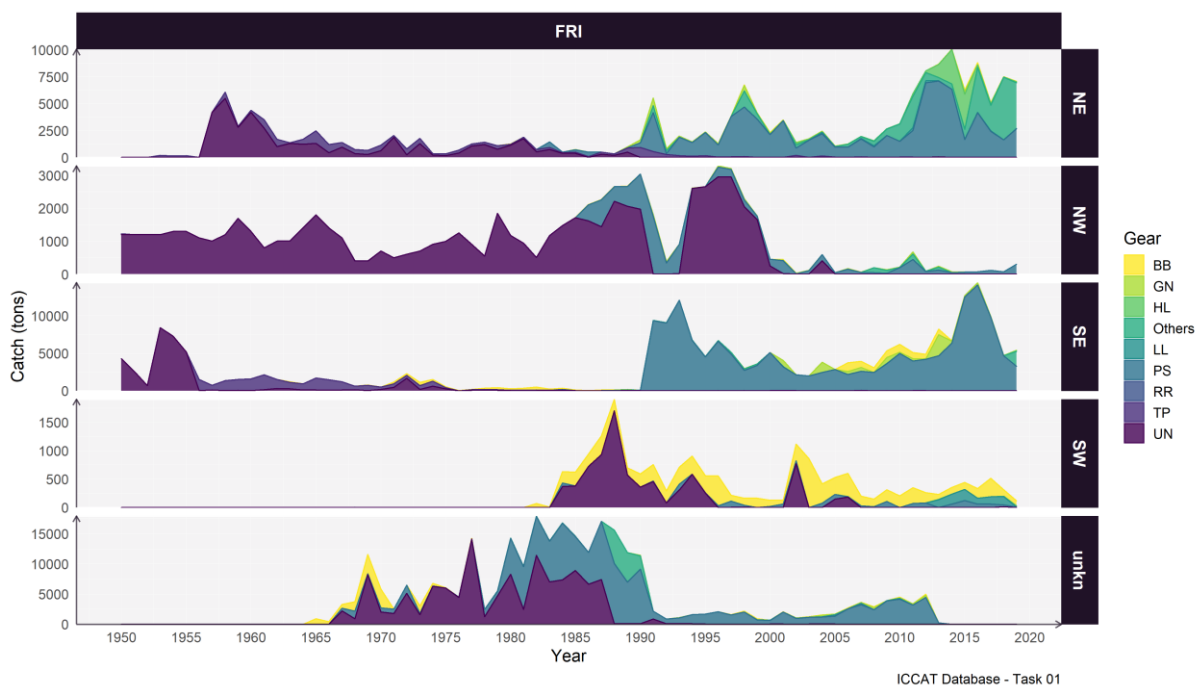


Figure 5. Total catch of frigate tuna by ICCAT region and fishing gear. TP: traps. RR: rod and reel. PS: purse seine. BB: baitboat. LL: longline. HL: handline. GN: gillnet. UN: unknown. Others include in order from highest to lowest catch: trawl (TW), trolling (TR), haul seine (HS), trammel net (TN), sport (SP), tended line (TL), and harpoon (HP).

6. Description of size information

There are no estimates of catch-at-size or catch-at-age for frigate tuna. However, there is a relatively large sample size from main fisheries available in the ICCAT Task 2 size database. In general, size samples are not well represented throughout its distribution, with the largest number and spatial coverage of sampling in the eastern tropical Atlantic (**Figure 6**). The largest specimens of frigate tuna occurred in the equatorial zone, medium sized fish in the western Atlantic, and the smallest (below 40 cm), in the Southeast Atlantic (**Figure 6**). Frigate tuna size samples come mainly from the purse seine fisheries (Lucena-Frédou *et al.*, 2021) and show an overall decline in the mean size over all years and regions, but with a slightly more pronounced decline in the eastern Atlantic (**Figure 7**).

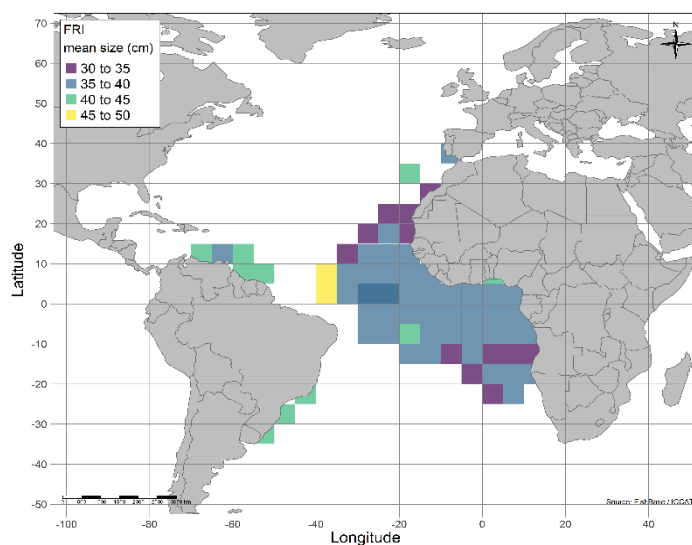


Figure 6. Mean size of frigate tuna, across gear types, in each quadrant of 5x5° between 1979 and 2019.

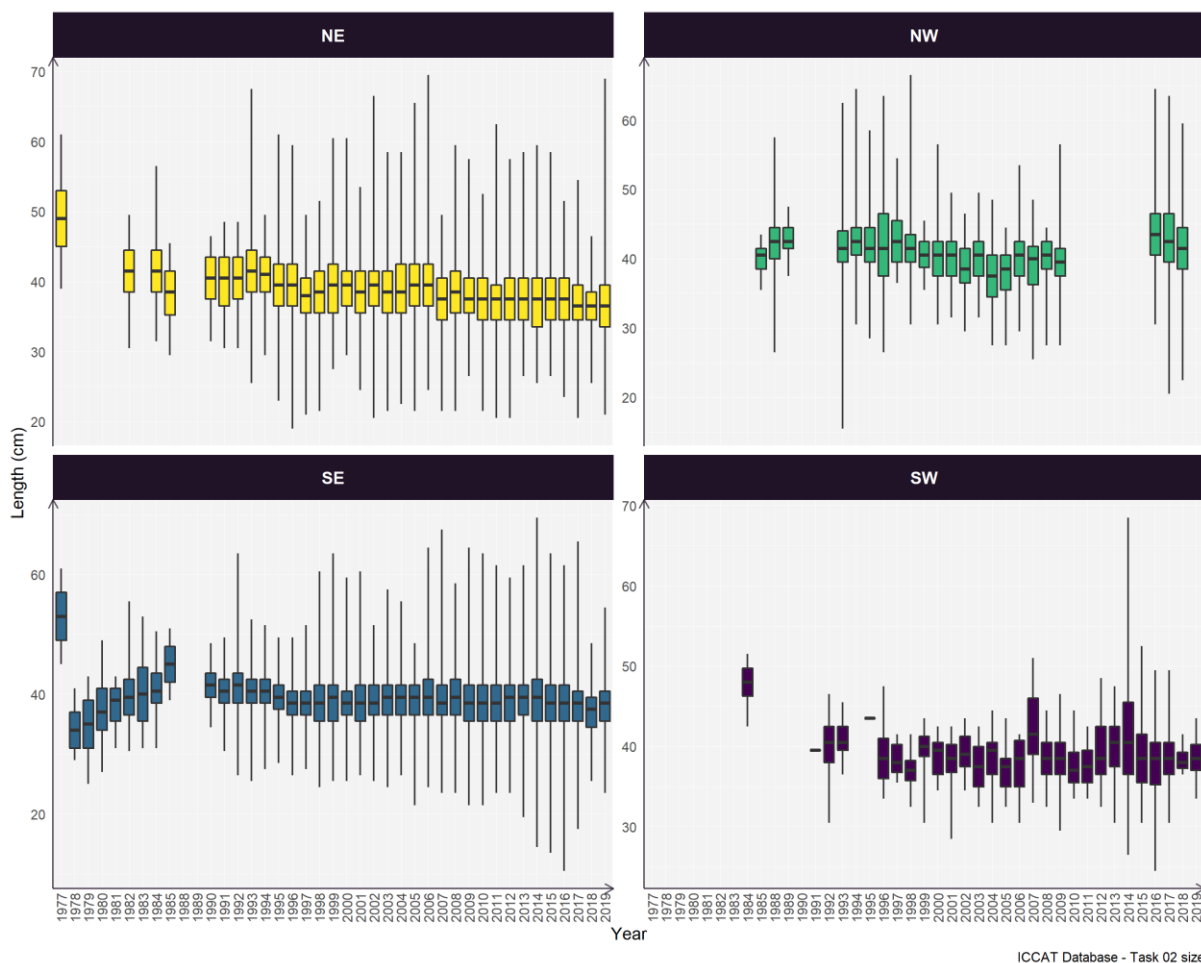


Figure 7. Length data for frigate tuna in the Atlantic between 1977 and 2019.

7. Stock assessment

Using a semi-quantitative risk assessment (Productivity and Susceptibility Analysis PSA), among the small tunas, frigate tuna in the Atlantic Ocean was considered moderately and low vulnerable in the North and South Atlantic respectively (Lucena-Frédou *et al.*, 2017). Results from data-limited stock assessment methods showed that frigate tuna in the Northeast and Southeast Atlantic are not overfished based on length-based (Pons *et al.*, 2019a) and catch-based assessments models (Pons *et al.*, 2019b).

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