ICCAT Manual
INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS
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CHAPTER 3.1.3: GILLNET	AUTHORS: N. ABID and M. IDRISSI	LAST UPDATE: Jun. 15, 2007

3.1.3 Description of the fisheries with gillnet

1. General description of the gear and vessels according to ISSCFG/ISSCFV classifications

1.a Drifting gillnet

Gear category: Gillnets and entangling nets
Standard abbreviation: GND
ISSCFG code: 7.2.0

Drifting gillnets are set close to the surface or below it with the use of floats. These nets drift freely with the current, either separately or with the boat to which they are attached (Nédélec and Prado, 1990) (**Figure 1**).

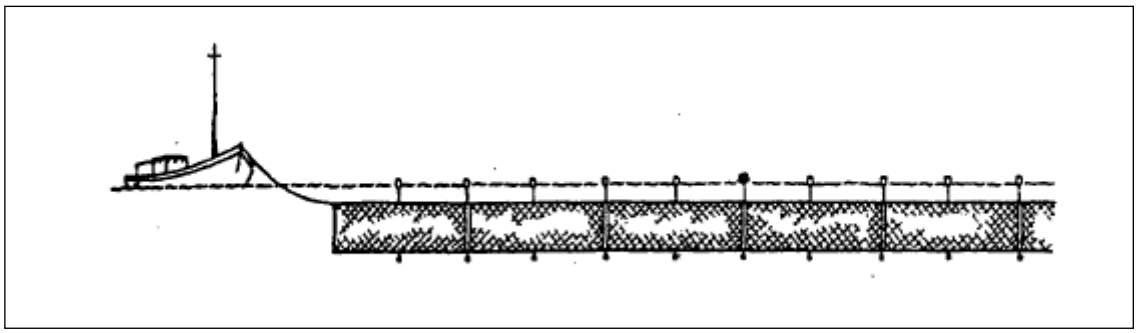


Figure 1. Diagram of a drifting gillnet (Nédélec and Prado, 1990).

1.b Gillnetters

Vessel category: **Gillnetter**
Standard abbreviation: GO
ISSCFV code: 05.0.0
Length: All
Power: All
Tonnage: All
Deck type: Decked and undocked vessels

The size of the vessels varies from open boats up to large specialised drifters, operating on the high sea. Gillnets can be operated from boats and canoes on inland waters and inshore, small decked vessels in coastal waters and medium sized vessels fishing offshore (**Figure 2**).

Since most of the boats concerned are small and as they probably use more than one type of gear, there are considerable limitations on the deck equipment and working deck layout which may be adopted. Many gillnet boats are not decked at all, and are simply open vessels adapted to enable them to work the gear in question. Small decked gillnetters can have their wheelhouse either aft or forward. On medium-sized vessels, using drifting gillnets and called drifters, the bridge is usually located aft.

Deck equipment: Setting and hauling operations are performed by hand on small open boats. All other vessels are often equipped with hydraulic or occasionally mechanical net haulers. Haulers supported by plastic tubes

may accomplish the necessary transportation of the gear from the hauling position in the forepart of the vessel to the setting position in the aft part of the vessel. Net drums may also be used for gill nets.
Fish detection equipment: The search for fish is more often linked to the fishermen's personal knowledge fishing grounds rather than the use of special detection equipment. This kind of vessels can be equipped with an echo-sounder.

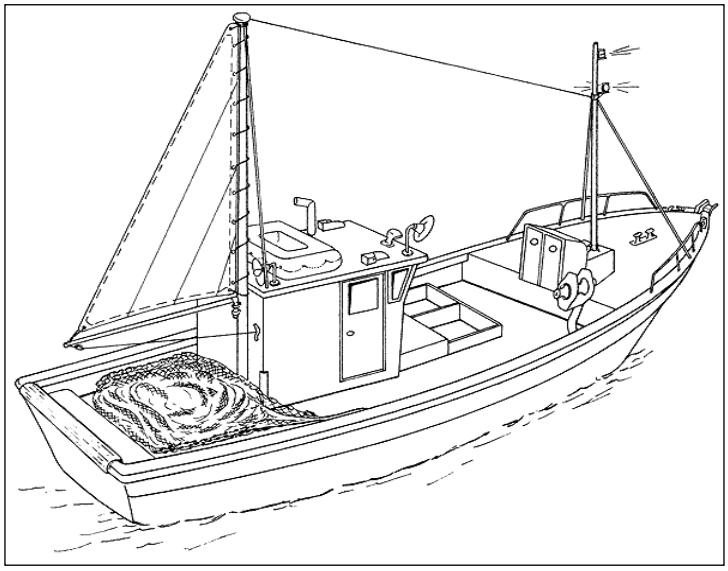


Figure 2. Diagram of a gillnetter (FAO, 2001).

2. General description of fishing operations with gillnets

The nets are usually cast in the evening and are left for a few hours and then hauled in (Feretti, 1990).

Casting is free and is done by simply throwing one end of the net into the water whilst the boat is moving fast. The action of the gear on the water makes the net enter the water without the need for the vessel to act (Feretti, 1990).

To prevent the fish from swimming in parallel throughout the length of the gillnet and returning to its original route, the net is wet in zigzag movements so that the fish is forced to make a half turn to follow the sections that form the net, which the fish do not normally do. When trying to circumvent the obstacle, the fish gets closer and closer and ends up being caught in the net (Feretti, 1990).

The twisting and turning of the gear is achieved by a net-turner usually located towards the aft of the vessel (Feretti, 1990).

3. Main drifting gillnet fisheries

3.a Mediterranean swordfish fisheries

Specific gear/vessel characteristics

The use of drifting gillnets for swordfish started in the Mediterranean in the mid-1980s (Di Natale, 1990a). This gear was introduced by other flag States such as EC-Spain, Morocco, and Algeria at the beginning of the 1990s to target the species during their genetic and trophic migrations (Srour, 1993; Anon. 1996).

The Italian fleet is the largest in terms of the number of vessels involved in this fishery and in terms of catch volume (Di Natale, 1995a). That fleet was estimated to exceed 600 fishing units until 1998 (Anon., 2006).

Despite the 2002 ban on drifting gillnets in EU territorial waters, some Italian netters continue to fish for swordfish illegally (Di Natale *et al*, 2006).

The main characteristics of nets and fleets fishing Mediterranean swordfish are summarised in **Table 1**.

Table 1. Characteristics of fishing fleets and gear used to target swordfish in the Mediterranean.

	Fleet			*Fishing gear*		
Flag State	*Number*	*Power (CV)*	*Total length (m)*	*Length (km)*	*Mesh size (mm)*	*Drop (m)*
Italy[1]	103	320	17	12	340-460	25-33
Morocco[2]	300	110	13	2-4	400	20-30
Algeria[3]	155	-	6-24	3	-	-
Turkey[4]	100-150	-	9-14	1-1.5	240-260	4

[1] Feretti, 1990; Di Natale, 1990a; Di Natale *et al.*1993; Potoshi *et al.* 1994a.
[2] Abid, 1998; Srour *et al.* 2004; Idrissi *et al.* 2006.
[3] Northridge, 1991; ICCAT, 2006b.
[4] Aliçli *et al.*1996; Aliçli *et al.* 2001; Öztürk *et al.* 2001.

Flag States involved

The Mediterranean swordfish fishery is mainly fished by EC-Italy, Morocco, Algeria and Turkey (ICCAT, 2006).

Areas of operation

The main fishing zones are located in central and southern Tyrrhenian Sea, in the Strait of Sicily, in the Sea of Marmara, north and south of the Aegean Sea, south of the Alboran Sea and in the Strait of Gibraltar (Potoshi *et al.* 1994a; Aliçli *et al.* 1995; Aliçli *et al.* 1996; Aliçli *et al.* 2001; Di Natale *et al.* 2006; Idrissi and Abid, 2006; Abid and Idrissi, 2006).

Seasonality

In the Straits of Gibraltar and in the Tyrrhenian Sea swordfish are mostly caught during their genetic migration or during their spawning period from April to August although fishing may last until December (Srour *et al.*, 2004; Di Natale *et al.* 2006).

In the southern Alboran Sea and in the Strait of Sicily, fishing for swordfish with drifting gillnets takes place throughout the year (Srour *et al.* 2004; Di Natale *et al.* 2006).

In the Sea of Marmara the swordfish are fished from September to November (Aliçli *et al.* 1995; Aliçli *et al.* 1996; Aliçli *et al.* 2001).

Target species and size composition

This fishery catches young and adult specimens in almost equal proportions. Swordfish size oscillates between 55 and 235 cm but the dominant size is between 90 and 190 cm. The mean and mode sizes are 131 and 125 cm, respectively (**Figure 3).** It is important to stress that the mean size of swordfish has increased noticeably during the last decade (Di Natale *et al.* 2006; Abid and Idrissi, 2006).

There are different size structures observed depending on the fishing zones. Catches in the Strait of Gibraltar are characterised by adults whose mean size is 146 cm, those caught in the Tyrrhenian Sea and in the Strait of Sicily measure an average of 132 cm (Potoshi *et al.* 1994a; Srour *et al.* 2003; Srour *et al.* 2004; Idrissi and Abid, 2005; Abid and Idrissi, 2006; Di Natale *et al.* 2006).

The swordfish caught in the southern Alboran Sea and in the Aegean Sea are young specimens measuring less than 110 cm (Aliçli *et al.* 2003; Srour *et al.* 2003; Srour *et al.* 2004).

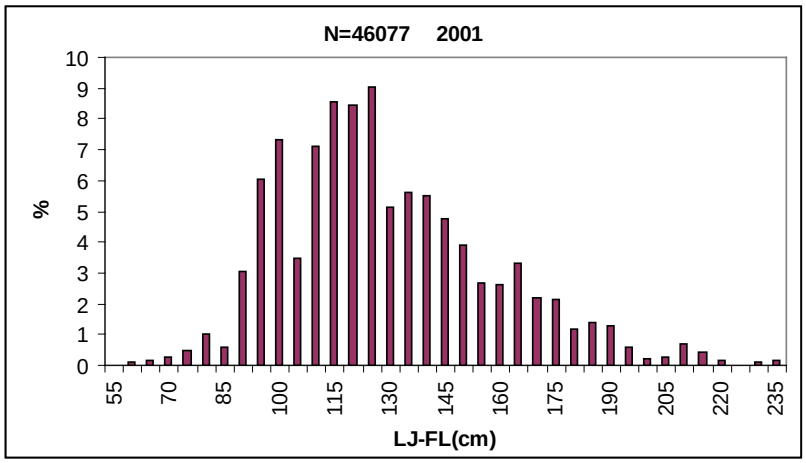


Figure 3. Size composition of Mediterranean swordfish caught by Italian and Moroccan netters in 2001(ICCAT, 2006).

Fish storage/processing

Mediterranean swordfish are mainly consumed fresh or frozen. Most of the fish caught are destined for Spain and Italy where there is a high demand for the species. EC-Italy and EC-Spain import large amounts of frozen swordfish from other countries (Malouli, 2006; FAO, 2007).

Landing ports

The main Mediterranean landing ports for swordfish are Ponza, Lipari and Sant'Agata Militello in Italy; Tangiers, Al Hoceima and Nador in Morocco; Béni-Saf and Beu Hareun in Algeria; and Istanbul in Turkey. (Chalabi, 1993; Aliçli *et al.* 1995; Di Natale, 1999 and Abid and Idrissi, 2007).

Historic trends

− Nominal effort

Historic data series on fishing effort for the majority of Mediterranean fisheries are either unavailable or incomplete and include a great deal of uncertainty. However, it is possible to reveal a global trend in effort.

The fishing effort of the Italian fleet, the main participant in the global effort to catch swordfish, suffered drastically in the 1990s following the introduction of national, regional and international measures (Di Natale, 1991; Di Natale *et al.* 1995a, Di Natale, 1999, Anon., 2001).

Moreover, in 1998, Italy adopted the European draft ban on drifting gillnets which came into force in 2002. This contributed to a decline in that fleet's fishing effort. The number of Italian netters was cut within the framework of the restructuring plan from more than 600 in 1998 to 103 in 2000 (ICCAT, 2002).

The effort of Moroccan netters has fallen slightly during the last decade (Abid and Idrissi, 2006).

− Technological changes and changes to gear/fishing vessels

Fishermen used to use nets made of natural fibres such as hemp or cotton. The only real problem was maintenance because the material was handled manually. However, the automation of fishing operations and the introduction of synthetic, nylon-based fibres has led to a spectacular increase in drifting gillnet fishing (Ferretti, 1990).

Another change to drifting gillnet fishing for swordfish has been the increase in mesh size. EC-Italy made gillnets in the 1970s of up to 300 mm. Today, mesh size can be up to 460 mm. This increase in mesh size has led to an increase in the height and the length of the gillnet of up to 35 m and 30 km, respectively, in some cases (Ferretti, 1990; Di Natale, 1990a).

− Fishing zones

There has been no significant change in fishing zones recorded for this fishery. However, Task I statistics indicate that the Italian fleet, moved from the Mediterranean towards the Tyrrhenian Sea and to the south Ionian Sea throughout 1990-1995 (ICCAT, 2006).

− Catch by species/zone/season/year

Catches generally increased between 1984 and 2000 with a historic peak of 8,600 tons registered in 1997. Swordfish catches have been falling drastically since 2001 and did not exceed 1,033 tons in 2005. This big drop is mainly due to EC-Italy declaring zero swordfish catches following the ban on drifting gillnets (**Figure 4**).

The fall in swordfish catches in the Mediterranean Sea between 1990 and 1995 is mainly due to the Italian fleet moving towards the Tyrrhenian Sea and the southern Ionian Sea (ICCAT, 2006).

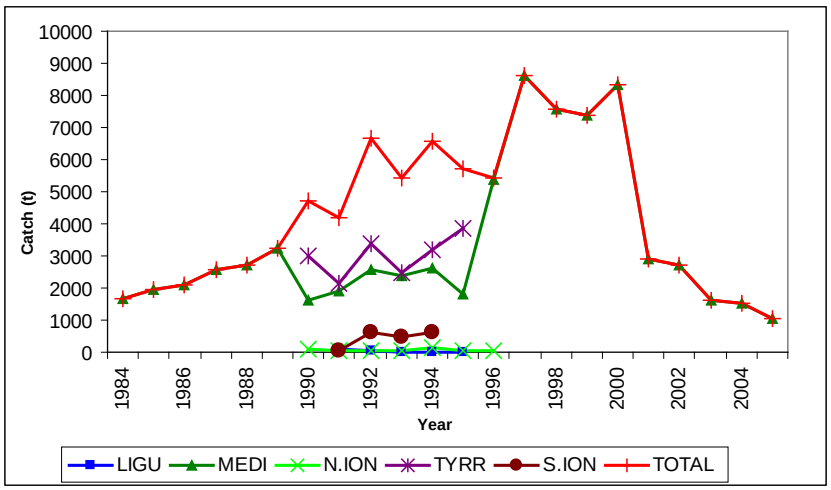


Figure 4. Annual trend in swordfish drifting gillnet catches in the Mediterranean and surrounding seas (ICCAT, 2006).

Specific sampling considerations

In EC-Italy, within the framework of the European Data Collection Programme (EC Reg. 1543), data on the size of swordfish caught with drifting gillnets have been collected every year since 2000. Biological data, such as sex, sexual maturity and age composition, are collected every three years (Di Natale *et al.* 2006).

Landing checks are carried out every fortnight at Ponza (the main Tyrrhenian Sea port), Lipari, Milazzo and Messina (southern Tyrrhenian Sea) and Mazaro del Vallo and Marsala (Strait of Sicily). Other data are collected by on-board observers (Di Natale *et al.* 2006).

In Morocco, the biological sampling programme is implemented in the major swordfish landing ports: Tangiers, Al Hoceima and Nador in the Mediterranean and Larache in the Atlantic. The sampling is made twice a week and basically consists of data concerning the size and weight of specimens (gutted or whole).

The main data concerning national sampling programmes for swordfish are summarised in **Table 2.**

Table 2. Information on national swordfish sampling programmes.

Country	*Landings/Catches*	*Catches – fishing effort*	*Size data*	*Author*
Italy	Census	Proportional probability sampling (PPS)	Proportional probability sampling (PPS)	Anon. 2006
Morocco	Census	Census	Sampling	Anon. 2006
Algeria	Census	Sampling	Fish is not measured	Anon. 2006

Potential impacts on the ecosystem including by-catch

Because of its great entangling capacity and efficient technology, the drifting gillnet is able to catch a huge variety of pelagics of different sizes, including protected species. (Di Natale *et al.* 1995a).

Several cetacean species, including striped dolphins (*Stenella coeruleoalba*), great dolphins (*Tursiops truncatus*), Risso dolphins (*Grampus griseus*), sperm whales (*Physeter macrocephalus*), fin whales (*Balaenoptera physalus*) and pilot whales (*Globicephala melas*) have been caught incidentally by Italian swordfish nets. It has been estimated that between 1,400 and 1,600 cetaceans have been caught every year (Di Natale, 1990b; Di Natale *et al.* 1995a; Di Natale *et al.* 1995b).

Gillnet fishing could have an impact on the populations of some species, especially striped dolphin, sperm whale, black pilot whale and Risso dolphin. Striped dolphins have the highest recorded mortality rate among cetaceans (Di Natale, 1995; Öztürk *et al.* 2001).

Environmental impact on fishing operations

The phases of the moon have an impact on the relative abundance of swordfish caught by gillnets. The CPUEs record a definite decline when there is a full moon because the full moon makes the gillnet more visible to the fish. The phases of the moon act on the vertical distribution of cephalopods and thus the swordfish , which prey on them. The combination of the three factors would seem to induce a drop in the catchability of the target species (de la Serna *et al.* 1991; Di Natale and Mangano, 1995) (**Figure 5**).

Wind would also seem to have an impact on swordfish catches (de la Serna *et al.* 1991).

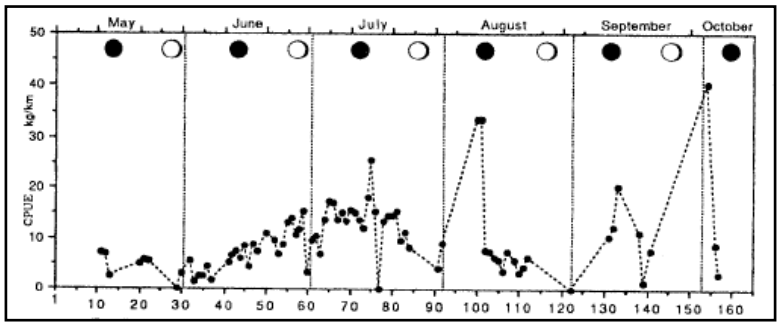


Figure 5. The average daily CPUE (kg/km) for swordfish caught by the Italian drifting gillnet fleet in the Tyrrhenian Sea in 1992. The phases of the moon are shown at the top of the graph (Di Natale and Mangano, 1995).

3.b The Mediterranean albacore tuna fishery

Specific gear/vessel characteristics

The albacore fishing fleet in the Mediterranean Sea is artisan in nature and consists of approximately 100 vessels whose average length is 14 m (Potoschi *et al.* 1994b).

The drifting gillnet gear used to catch albacore is made of nylon and is usually brownish-red in colour. Inspection reports are very high, close to or even in excess of 100% in some cases. The mesh of this net varies between 160 to 180 mm and has an average drop of 23 to 24 m. The length of the net varies between 3 to 6 km (Ferretti, 1990; Potoschi, 1994).

Flag States involved

Only the Italian fleet operates the Mediterranean albacore fishery (ICCAT, 2006).

Areas of operation

Fishing is concentrated in the southern and central Tyrrhenian Sea and on the Sicilian coast of the Ionian Sea (Potoschi *et al.* 1994b; Di Natale *et al.* 1995c, Di Natale, 2005).

Seasonality

Albacore are fished in the southern and central Tyrrhenian Sea in spring and autumn. In summer, albacore are only caught as by-catch by fishermen targeting swordfish with drifting gillnets (Did Natale *et al.* 1995c, Di Natale, 2005).

Target species and size composition

The albacore is the target species of the Italian drifting gillnet fleet. Specimens caught in the southern and central of the Tyrrhenian Sea measured between 50 and 90 cm, with a mean size of 76 cm (Di Natale *et al.* 1995c, Di Natale, 2005) (**Figure 6**). The mean size of albacore caught in this area has remained relatively stable with a slight increase in the last six years (Di Natale, 2005).

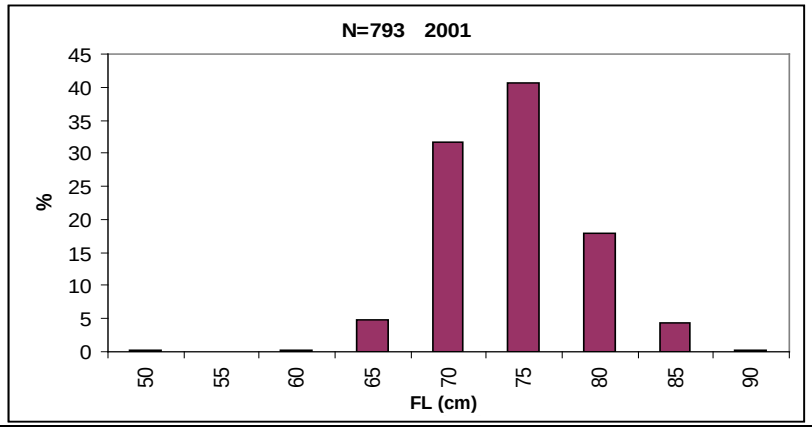


Figure 6. Size composition of Mediterranean albacore caught by the Italian drifting gillnet fleet in 2001(ICCAT, 2006).

Fish storage/ processing

There is a large albacore canning industry in Italy to satisfy local demand (FAO, 2007).

Landing ports

The main landing ports for albacore tuna are: Milazzo, Santa Agata Militello and Lipari in the southern Tyrrhenian Sea. In the central Tyrrhenian Sea the fish are landed at Ponza (Di Natale *et al.* 1995c).

Historic trend

− Nominal effort

As has already been explained for swordfish, different national, regional and international regulations have been imposed on this fishery since 1990. Moreover, the fleet was subject to a restructuring plan (conversion to longliners) from 1998 onwards. These factors have had a significant impact on the fishing effort of the fishing vessel targeting albacore using drifting gillnets (Di Natale, 1995c; Di Natale, 1999; Anon., 2001).

− Technological changes and changes to fishing gear/vessels

Mesh size, and the drop and length of nets for albacore tuna has increased just as they did for swordfish. Mesh size has gone from 160 mm in the 1970s to 200 mm in the early 1990s. Net length has increased rapidly and now exceeds 10 km of nets per boat (Ferretti, 1990).

− Fishing zones

No significant changes in fishing zones have been recorded for this fishery.

− Catches by species/zone/season/year

Albacore tuna catches in the Mediterranean Sea have followed a similar trend to swordfish catches. They rose until 1990, reaching a peak of 2,254 tons in 1999, and then fell to 397 tons in 2002. No albacore tuna catches were declared for the 2003-2005 period (**Figure 7**).

The significant drop in catches from 2000 onwards is mainly due, as in the case of swordfish, to the implementation of a restructuring plan for this fleet (conversion to longlines) and also the draft ban on this gear introduced in 1998.

The drop in albacore tuna catches in the Mediterranean between 1990 and 1995 is due to the Italian fleet moving to the Tyrrhenian Sea (ICCAT, 2006).

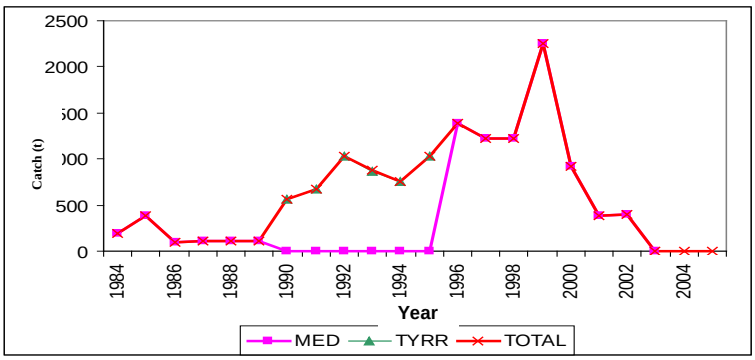


Figure 7. Annual trend in drifting gillnet albacore tuna catches in the Mediterranean and Tyrrhenian Seas (ICCAT, 2006).

Specific sampling considerations

Within the European data collection programme, size data corresponding to albacore tuna caught with Italian drifting gillnets has continued to be collected since 2000 based on the proportional probability sampling strategy (PPS). Sometimes only one parameter is collected, size or total weight) because of difficulties in handling the fish. Biological data, notably sex, sexual maturity and age composition, are collected every three years. The data are collected according to the same methodology recommended by ICCAT,

Landing checks take place at Ponza (centre for the Tyrrhenian Sea), Lipari, Milazzo and Messina (southern Tyrrhenian Sea) and Mazara del Vallo and Marsala (Strait of Sicily) twice a month.

Observers on board vessels in the Strait of Sicily collect high quality supplemental data (Di Natale *et al.* 2005).

Potential impacts on the ecosystem, including by-catch

Cf. Section 3.a.

Environmental impact on fishing operations

There is no specific information on this fishery currently available. The elements discussed in section 3.a regarding swordfish may be equally valid for this fishery.

3.c Northeast Atlantic albacore tuna fishery

Specific characteristics of gear/vessels

The drifting gillnet technique for albacore tuna was introduced by EC-France in 1986. This new fishing technique was later adopted by EC-Ireland in 1990 and by EC-United Kingdom in 1991(Liorzou, 1989; Anon., 1998; Anon., 2000).

Up to 001, albacore fishing was carried out by a fleet of approximately 98 netters of which 64 were French, 18 Irish and 16 British (Goujon *et al.* 1996; Anon., 1998; Anon., 2002).

The net used is conceived to be balanced between two waters at the chosen depth, regulated by rings and buoys located every 50 m. It is generally cast at the end of the day and pulled in during the night or before dawn (Liorzou, 1989).

The nets were originally measured between 2,500 and 6,000m (Liorzou, 1989). From 1994 onwards, net size was regulated to 2.5 km per fishing vessel (Anon., 2002). The drop varied between 20-36m with mesh sizes between 80-120 mm (Liorzou, 1989).

Flag States involved

Until 2001 the main countries involved in this fishery were: EC-France, EC-Ireland and EC-United Kingdom.

Area of operations

French netters operated throughout the Bay of Biscay at more than 200 nautical miles from the coast. Fishing started in June, close to the Azores and the vessels then followed the albacore schools towards the north and the east (Northdrige, 1992; Goujon *et al.* 1996).

Seasonality

Albacore tuna fishing took place between June and September, mainly in the Bay of Biscay (Goujon *et al.* 1996); Anon., 2000).

Target species and size composition

Most albacore tuna caught in 2000-2001 measured between 50 and 80 cm. The mean size was approximately 67cm. the mode was 62, 66 and 67 cm (**Figure 8).** This size structure is very similar to that encountered by Goujon *et al.* (1996).

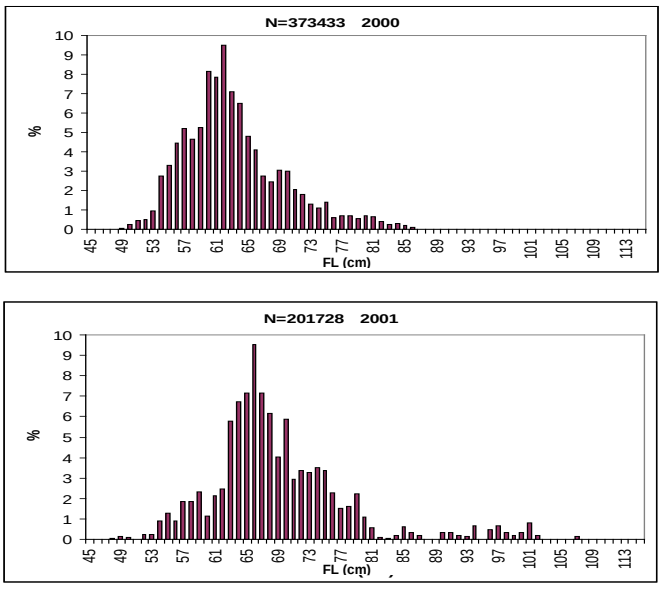


Figure 8. Size composition of albacore tuna caught by French and Irish netters between 1999-2001 (ICCAT, 2006).

Fish storage/processing

Mainly used by the canning industry and its derivatives and also fresh (especially in EC-Spain).

A large albacore tuna canning industry has developed in the countries that fish this species to satisfy local demand (FAO, 2007).

Landing ports

The main landing ports for this species are on the northern coast of EC-Spain, the French Basque coast, Brittany and EC-Ireland.

Historic trend

− Nominal effort

Netters' fishing effort increased noticeably in the 1990s (Liorzou, 1989; Goujon *et al.* 1996; Anon., 2006).

Despite the 2002 ban, French vessels seem to have continued to fish for albacore tuna. It is estimated that the number of active units in the area is currently between 45-75 units (Anon., 2006).

− Technological changes and changes to fishing gear/vessels

No information is currently available on this subject.

− Fishing zones

No change in the albacore tuna netters' fishing zones has been recorded for this fishery. Traditional fishing zones are located throughout the Bay of Biscay (Goujon *et al.* 1996).

− Catches by species/zone/season/year

Albacore catches increased between 1987 and 1994 when they totalled 7,077 tons. They declined between 1995 and 1997 and then increased, totalling a record 7,364 tons in 1999. Albacore tuna catches have fallen significantly since 2000 and did not exceed 2,900 tons in 2001 (**Figure 9**).

Since the ban on driftnet in EU waters in 2002, no albacore tuna catches have been declared to ICCAT, except for EC-United Kingdom that declared 5 tons in 2005.

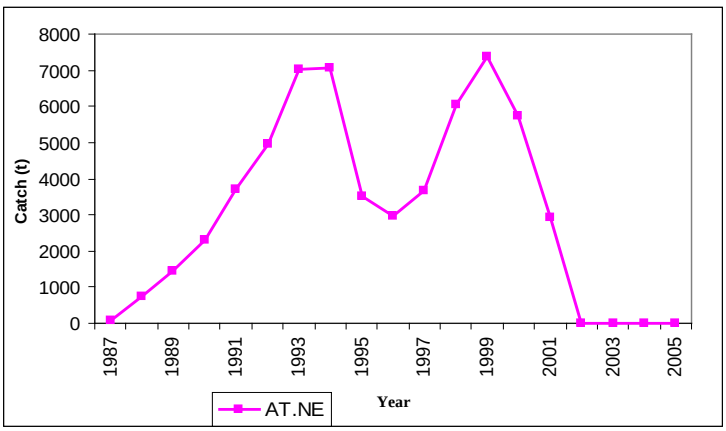


Figure 9. Annual trend in drifting gillnet albacore catches by in the northeast Atlantic (ICCAT, 2006).

Specific sampling considerations

Data on French fishery catches and fishing effort are obtained from the vessel's log and recounts at dealers. Size sampling covers about 1% of total albacore caught (Anon., 2006).

Potential impacts on the ecosystem, including by-catch

The additional mortality of dolphins, notably the common dolphin (*Delphinus delphis*) and the blue and white dolphin (*Stenella coeruleoalba)*, due to incidental catches by the whole fleet would no doubt lead to a reduction in those populations in the short-term unless there's some sort of biological compensatory mechanism is introduced. The accidental entrapment of other cetaceans, birds and turtles is minimal. (Goujon *et al.* 1996).

Swordfish by-catches, mainly composed of juveniles may also have an impact on the longline swordfish fisheries in the North Atlantic (Goujon *et al.* 1996).

Environmental impact on fishing operations

There is a lack of information on this subject.

3.d Northeast Atlantic swordfish fishery

Specific characteristics of gear/vessels

Fishing for swordfish using driftnet in the northeast Atlantic started at the end of the 1980s (Srour, 1993). The fleet operational in the area consists of about 40 vessels. Their average tonnage is 13 tons, their engine capacity is 110 HP and their total length is about 13 (Srour *et al.* 2004).

Most drifting gillnets are between 3-4 km long, their mesh size is some 400mm and their drop varies between 15 and 35 m (Srour *et al.* 2004).

Flag States involved

Historically, EC-Spain and Morocco were the main countries involved. Since the driftnet ban in EC-Spain in 1992, Morocco is the only country that continues to operate this fishery.

Areas of operation

Fishing vessels generally operate on the Atlantic side of the Strait of Gibraltar, between 5 and 30 nautical miles from the coast (Anon., 2006).

Seasonality

Fishing takes place between April and June, coinciding with swordfish genetic migration along the coasts of Morocco (Anon., 2006).

Target species and size composition

The Swordfish is the main target species. Most specimens vary between 100 and 200 cm with a mean size of 137cm. The mode is between 110 and 120 (Abid and Idrissi, 2006) (**Figure 10**).

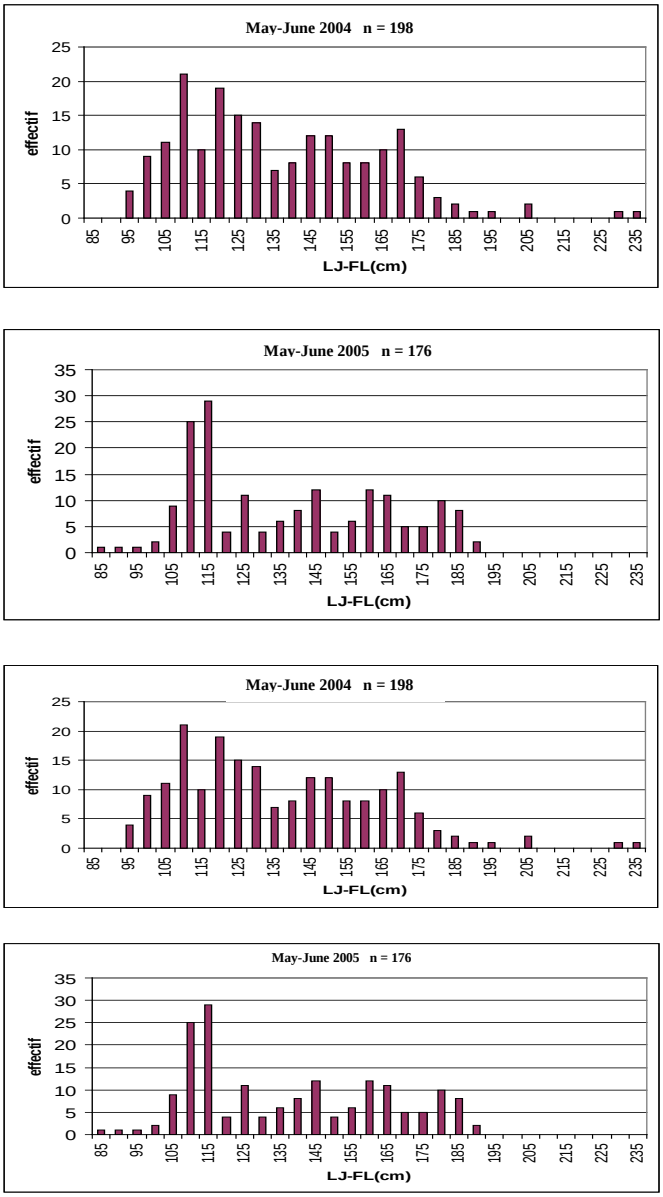


Figure 10. Size composition of swordfish caught by Moroccan netters in the northeast Atlantic 2004-2005 (Abid and Idrissi, 2006).

Fish storage/ processing

Almost all the fish caught are for export. The market is dominated by EC-Spain, and, to a lesser extent, EC-Italy.

Landing ports

Larache and Asilah are currently the major landing ports.

Historic trend

− Nominal effort

There are no historic data on fishing effort available for this fishery. However, it would seem to have increased since the beginning of this fishery.

− Technological changes and changes to fishing gear/vessels

In the early 1990s, fishermen used drifting gillnet with a smaller mesh (55 mm) mainly to target Atlantic bonito (Srour, 1993). Later, towards the mid-1990s, large mesh drifting gillnet (400 mm) was introduced in the Moroccan North Atlantic, thus significantly increasing swordfish catches.

− Fishing zones

No change has been recorded for this fishery.

− Catches by species/zone/season/year

Swordfish catches fell overall between 1989 and 2005. Until 1992, the Spanish fleet was the only one operating in this fishery, with an average catch of 580 tons. That activity fell as it was officially banned in 1992. Towards the mid-1990s, Morocco developed a new fishery targeting swordfish although recent catches do not exceed 104 tons. Between 1994 and 2001, French and Irish netters targeting albacore caught swordfish (**Figure 11**).

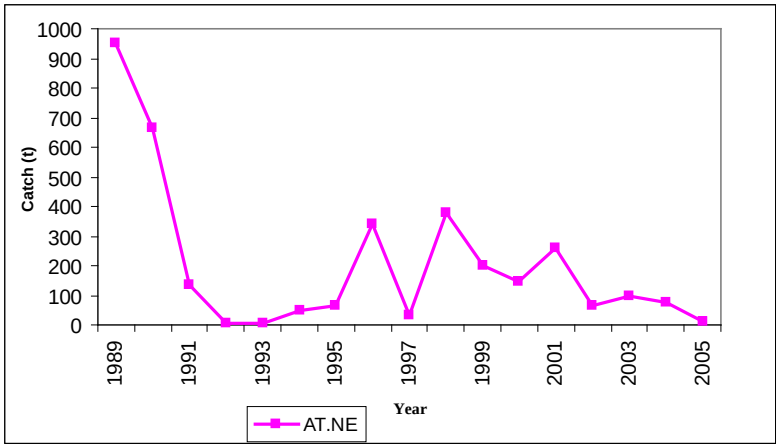


Figure 11. Annual trend in driftnet swordfish catches in the northeast Atlantic (ICCAT, 2006).

Specific sampling considerations

Morocco implemented a size sampling programme for landed swordfish several years ago. Catch and fishing effort data are collected monthly.

Potential impacts on the ecosystem, including by-catches

There has been no study on the impact of drifting gillnet swordfish fishing on the environment to date.

Environmental impact on fishing operations

The phases of the moon have a remarkable impact on drifting gillnet swordfish catches. The highest catches take place during the new moon whilst the smallest catches occur at full moon. This is probably linked to changes in species behaviour which affects it bathymetric distribution and therefore the catching capacity of the gear (de La Serna *et al.* 1992).

3.e Southeast Atlantic Istiophoridae fishery

Specific characteristics of gear/vessels

Iin the southeast and tropical Atlantic was started by Ghana in 1974 (Mensah *et al.* 1994). A similar fishery, that of Côte d'Ivoire started towards the end of 1983 (Amon Kothias *et al.* 1989; Bard *et al.* 1993).

About 490 artisanal units are involved, of which 400 are canoes from Ghana and 90 from Côte d'Ivoire (ICCAT, 2006). These canoes are between 9 and 12 m long and are equipped with a 40 HP outboard engine (Mensah *et al.* 1994; Bard *et al.* 2002).

The gear used is a large-meshed (45 to 60 cm stretched mesh) drifting gillnet, cast at night in perpendicular to the coast and drawn in at dawn (Amon Kothias *et al.* 1989; Bard *et al.* 1993; Mensah *et al.* 1994). These nets, conceived by Ghanaian fishermen in 1974 (Amon Kothias *et al.* 1996) each measure between 1,500 to 2,500 m in length with a drop of between 15 to 30 m (N'Goran *et al.* 2002).

Flag States involved

The main artisan gillnet fisheries are Ghana and Côte d'Ivoire (ICCAT, 2006).

Areas of operation

Ghanaian units usually operate in the central region, along the edge of the continental shelf, between 19 and 80 km from the coast (Mensah *et al.* 1994). In 1984, Ghanaian canoes extended their fishing operations towards Abidjan where fish are in heavy demand (Amon Kothias *et al.* 1992; Bard *et al.* 2001).

Those from Côte d'Ivoire also tend to operate beyond the continental shelf but at a short distance, between 5 to 10 miles from the (N'Goran, *et al.* 2001).

Seasonality

Istiophoridae catches are very significant between December and April, reaching a peak in January and February. Sharks, tunas and rays are caught throughout the year but are at their peak between July and September, coinciding with upwellings that favour significant primary activity (Mensah *et al.* 1994).

Target species and size composition

Istiophoridae are a significant part of the fish caught by this fishery. The main species caught are blue marlin (*Makaira nigricans*), Atlantic sailfish (*Istiophorus albicans*) and, to a lesser extent, white marlin (*Tetrapturus albidus*) which only started to appear sporadically in catches from (Mensah, 1994; N'Goran *et al.* 2006).

Other tuna species, especially skipjack, albacore and swordfish have also been fished in quite large quantities in recent years. Sharks also appear in catches but they are of less importance compared to the other species. The main species caught are smooth hammerhead (*Sphyraena zygaena)*, scalloped hammerhead (*Sphyrna lewini*), the shortfin mako (*Isurus oxyrhinchus*), silky shark (*Carcharhinus falciformis*) and spinner shark (*Carcharhinus brevipinna*) (N'Goran *et al.* 2002).

Sailfish sizes vary between 105 and 235 cm whilst the mode and mean are 175 and 178 cm, respectively. The size of blue marlin specimens is between 175 and 375 cm, with a maximum of 180 cm and a mean size of 228cm. White marlin specimens vary between 135 and 280 cm. The mode and the mean are 175 and 182 cm (ICCAT, 2006) (**Figure 12**).

Most blue marlin in Côte d'Ivoire caught by gillnets are adult-sized specimens (N'Goran *et al.* 2001). This istiophoridae size range is found in the west Atlantic, especially blue marlin (Goodyear, 1998).

The average length of landed sharks is about 170 cm for both hammerhead species *(Sphyrna lewini* and *Sphyrna zygaena)*, 155 cm for the shortfin mako (*Isurus oxyrhynchus)* and 115 cm for the silky shark (*Carcharhinus falciformis)*. Spinner shark (*Carcharhinus brevipinna*) shows two peaks, one at 95 cm and the other at 140 cm, representing the presence of a juvenile class of 95 cm and an adult class of 140 cm (N'Goran *et al.* 2005).
The size of swordfish specimens landed varies between 55 and 270 cm whilst the mode is about 115 cm (Amon Kothias *et al.* 2001).

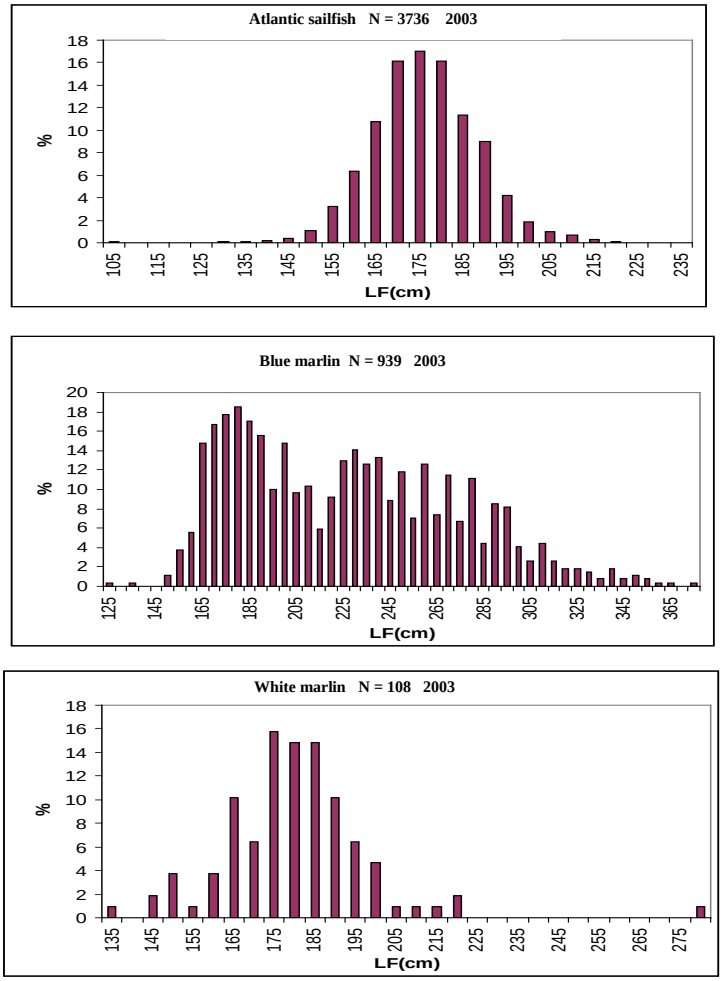


Figure 12. Size composition of Istiophoridae caught in 2003 by the Côte d'Ivoire drifting gillnet fishery (ICCAT, 2006).

Fish storage/processing

Marlins and sailfish are landed and sold at local markets. They are essentially consumed fresh locally (FAO, 2007).

Tunas landed basically go to the three large canneries at Abidjan thus guaranteeing socio-economic activity (ICCAT, 2006b).

Shark fins are dried and then sent to Ghana from where they are exported by specialist dealers. The revenues obtained by fishermen enable them to purchase additional elements to increase the size of their nets (N'Goran *et al.* 2001).

Landing ports

The main landing ports for Istiophoridae are Abidjan in Côte d'Ivoire, and Shama, Dixcove, Axim, Apam, Tema and Kpone in Ghana (Mensah *et al.* 1994).

Historic trend

− Nominal effort

Available data show that the fishing effort of canoes increased ten-fold between 1998 and 2004 (N'Goran *et al.* 2006). That increase in fishing effort can be observed in the increased size of the nets which doubled throughout that period (Bard *et al.* 2001) (**Figure 13**).

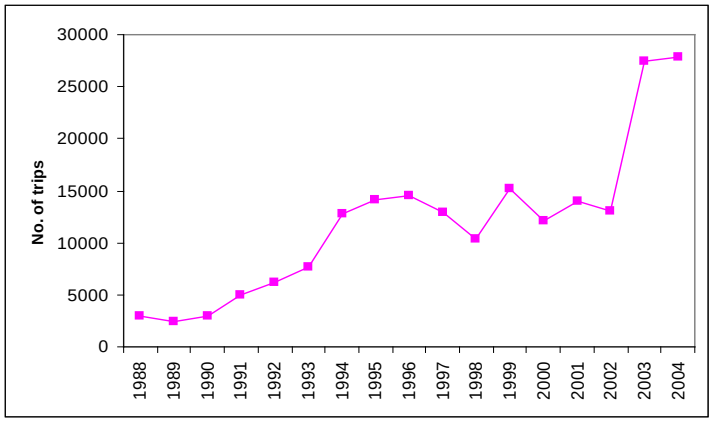


Figure 13. Trend in the fishing effort of Côte d'Ivoire canoes (N'Goran *et al.* 2006).

− Technological changes and changes to fishing gear/vessels

The current gear was based on a coastal gillnet originally used to catch alose (*Ethmalosa fimbriata)*. The new gear designed to catch tuna species had thicker strings but the stretched mesh size was the same (75 mm), as was the drop (5,4 m) and the length (274 m). The net was later modified to accommodate even thicker strings, larger mesh size and greater length (Mensah *et al.* 1994).

− Fishing zones

No significant changes in the fishing zones of this fishery have been documented. However, Bard *et al.* (2001) did mention that the Ghanaian artisan fishermen had extended their fishing operations towards Abidjan from 1984 onwards as the demand for fish is much higher there.

− Catches by species/zone/season/year

Sailfish catches fell significantly between 1974 to 2005, from an average of 2,300 tons between 1974 to 1983 to 355 tons for 1994-2005. The downward trend from 1984 is mainly due to a decrease in the relative abundance of sailfish in the tropical east Atlantic (Mensah, 1994, N'Goran *et al.* 2006). The catches reported in the southeast Atlantic for 2003-2005 correspond to the Ghanaian fleet which has been present in this zone since 2003 (ICCAT, 2006).

Blue marlin catches fluctuated between 9 and 430 tons during 1980-1992, with an average of 148 tons. Catches increased overall between 1993-2005 to record an average of 583 tons. This upward trend is linked to the increased fishing effort by the Ghanaian fleet, given that the relative abundance of blue marlin remained virtually stable throughout that period (N'Goran *et al.* 2006).

White marlin catches remain low compared to those of sailfish and blue marlin. They have not exceeded an average of 5 tons throughout the last decade (**Figure 14**).

Swordfish catches have increased considerably since 2001. They have varied between 86 and 777 tons, with an average of 430 tons. The catches were made mainly by the Ghanaian fleet in the southeast Atlantic.

Albacore and skipjack catches are quite recent. The average catches for these two species between 2000-2005 were 340 and 620 tons, respectively (**Figure 15**).

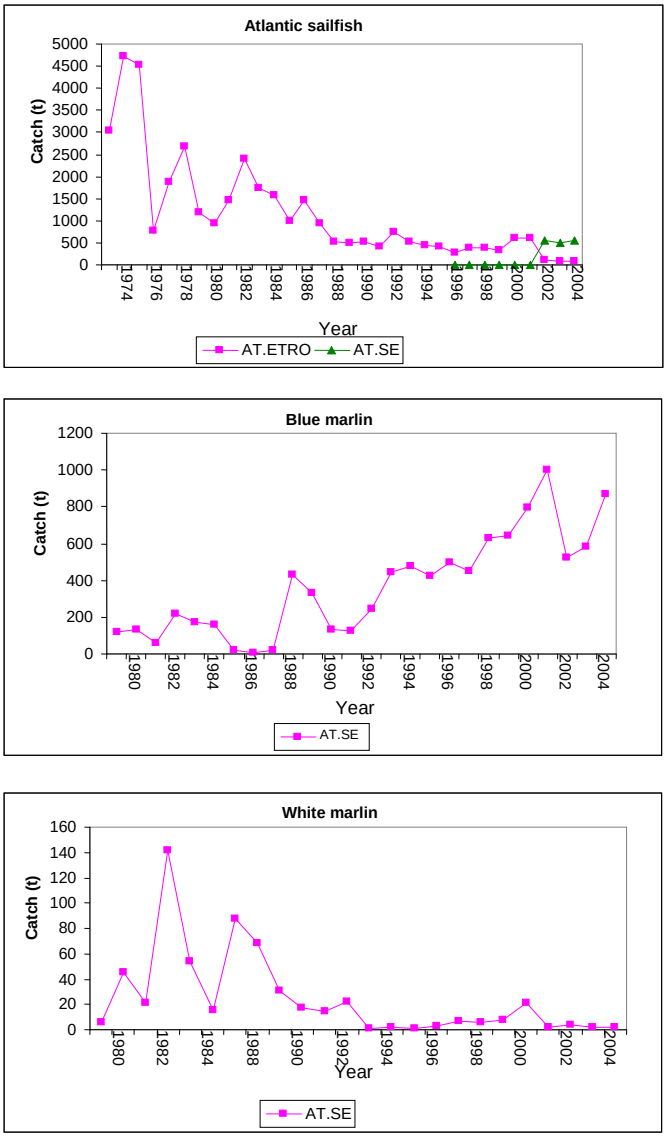


Figure 14. Annual trend in billfish catches by fishing zone (ICCAT, 2006).

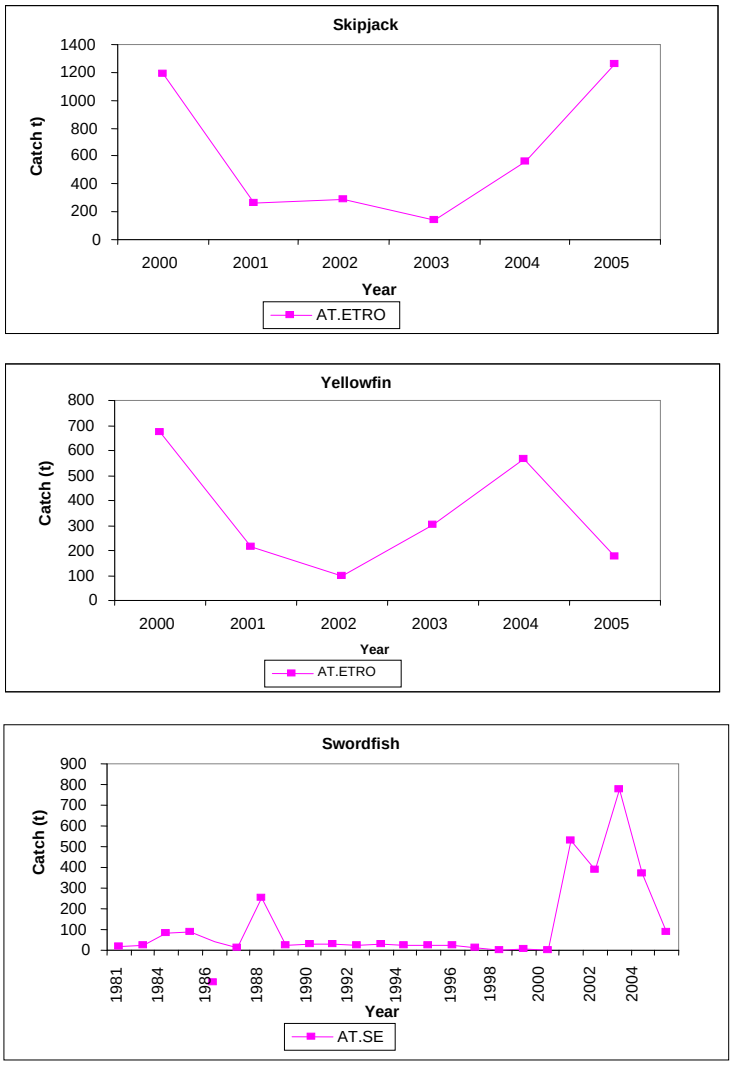


Figure 15. Annual trend in tuna and related catches, by fishing zone (ICCAT, 2006).

Specific sampling considerations

For the Côte d'Ivoire fishery, size measurements are converted directly to weight from size/weight equations in order to determine the annual catch by landed species (N'Goran *et al.* 2005).

The method by which total Istiophoridae catches along the coasts of Ghana are estimated is explained in detail by Mensah (1994). Sampling is monitored at 11 out of 32 fishing sites. Sampling takes place 2 weeks per month, with at least one week of sampling per month (**Table 3**).

In 2006, the billfish working group recommended obtaining age and growth estimates for adult marlins and to evaluate the use of adult marlin habitats through the use of electronic markers. The working group believed that these data would facilitate the use of more sophisticated models to evaluate Istiophoridae (Anon., 2006).

Table 3. Information on national sampling programs.

Country	*Landings/catches*	*Catches – fishing effort*	*Size data*	*Author*
Côte d'Ivoire	All sizes converted into weight to estimate total catch by species.	Daily recount of all active canoes.	All fish caught every day are measured.	Bard and N'Goran, 2000; N'Goran *et al.* 2005; N'Goran *et al.* 2006
Ghana	The sampled catch is extrapolated to total effort to estimate total catch by species.	Stratified age sample. (PPS)	2 weeks /month sampling. All the fish from a canoe are measured.	Mensah, 1994

Potential impacts on the ecosystem, including by-catches

Nothing has yet been published on the environmental impact of this fishery. However, N'Goran *et al.* (2001) has mentioned that turtles and dolphins are caught accidentally (*Chelonia mydas*, *Dermochelys coriacea*).

Environmental impact on fishing operations

The availability of the different target species is very much affected by upwellings. During the great upwelling period, between August and October, billfish completely disappear from catches (Joanny *et al.* 1995; N'Goran *et al.* 2001; N'Goran, 2006). That means that the cold upwelling seasons are unfavourable to billfish fishing. One hypothesis is that the fish remain further out during these cold periods and are therefore not accessible to gillnets as this gear remains quite close to the coast (N'Goran *et al.* 2001; N'Goran, 2006).

The abundance of tunas increases during the upwelling period (Bahou, 2001 *in* Bard *et al.* 2002). This coming up from cold waters also favours an abundance of sharks which feed on the small pelagics, dependent on the upwelling (N'Goran *et al.* 2002).

3.f Northwest Atlantic mackerel fishery

Specific gear/vessel characteristics

The nets are an average of 2.7 m or more long, with a mesh size of 127 mm and with a 15 to 24 m drop. Drifting gillnet fishing takes place at night and vessels are out on the water for 12 hours (Northdrige, 1992).

Flag States involved

The United States of America is the only country engaged in this fishery (ICCAT, 2006).

Areas of operation

Most catches of king mackerel (*Scomberomorus cavalla*) are taken in North Carolina and Florida. It is believed that a very large fishing area off Louisiana will re-emerge. Spanish Atlantic mackerel (*Scomberomorus maculatus*) are mainly caught in the Chesapeake Bay and in Florida (Anon. 2006a).

Seasonality

The mackerel fishing season extends from April to September (Northdrige, 1992).

Target species and size composition

This fishery mainly targets king mackerel. It started at the beginning of the 1980s (Northdrige, 1992).

Most Spanish Atlantic mackerel caught measure between 34 and 62 cm with a mean size of 47 cm. King mackerel sizes vary between 62 and 98 cm with a mean size of 77 cm (**Figures 16** and **17**).

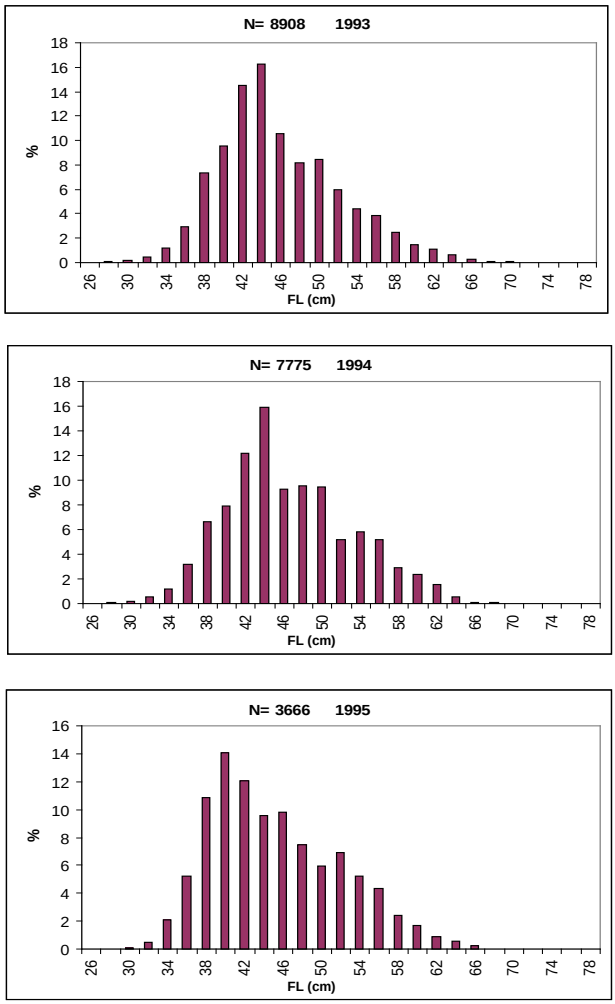


Figure 16. Size composition of Spanish Atlantic mackerel catches by the US fishery in the northwest Atlantic 1993-1995 (ICCAT, 2006).

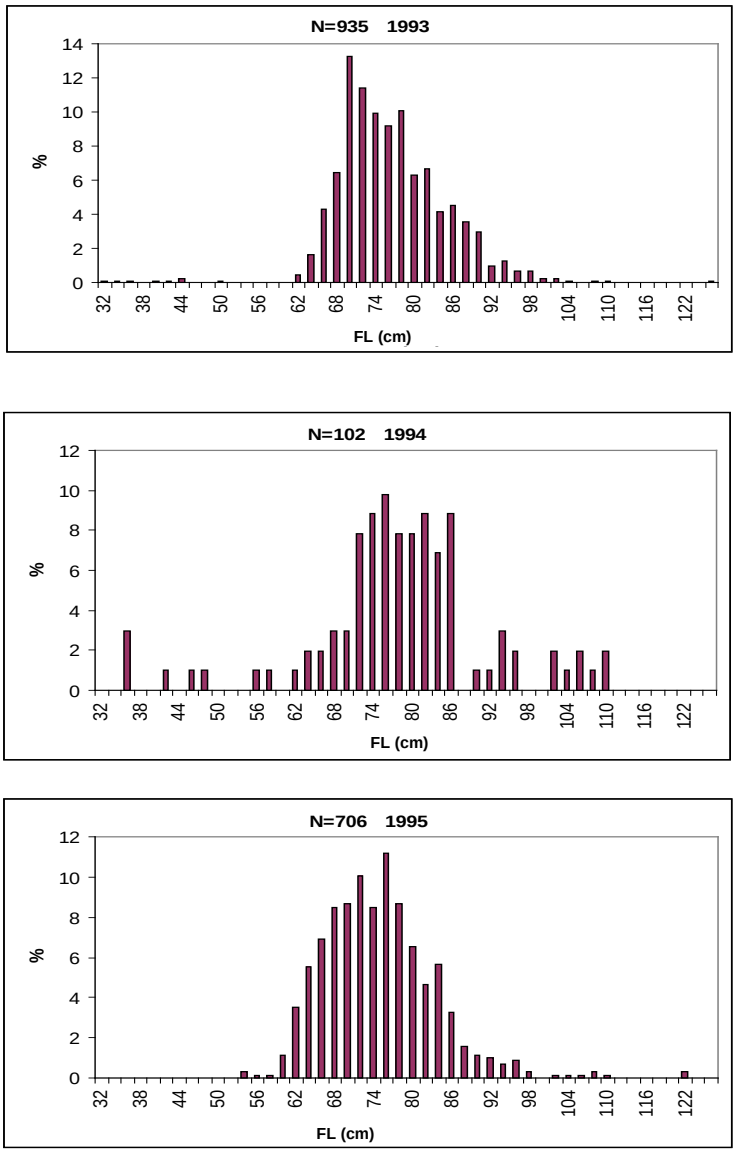


Figure 17. Size composition of U.S. northwest Atlantic fishery king mackerel catches 1993-1995 (ICCAT, 2006).

Fish storage/processing

Mackerel catches are mainly destined for the canning industry. There is a big canning industry to serve local demand (FAO, 2007).

Landing ports

The main landing ports are those of North Carolina, Chesapeake Bay and Florida.

Historic trend

− Nominal effort

There is currently no information available on this subject.

− Technological changes and changes to fishing gear/vessels

There is currently no information available on this subject.

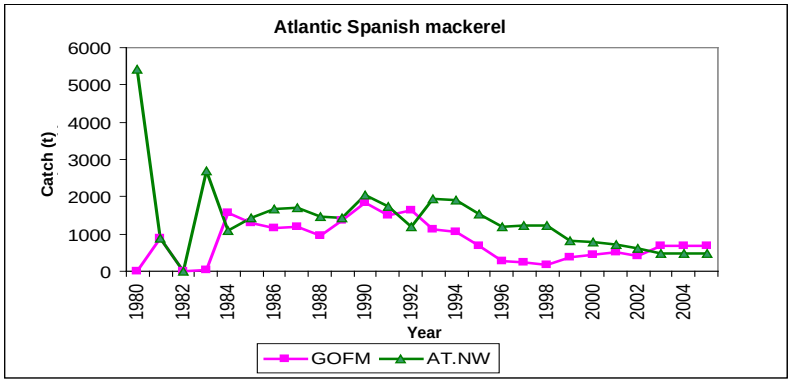
− Fishing zones

No change has been recorded for this fishery (*Cf.* traditional fishing areas above).

− Catches by species/zone/season/year

Spanish Atlantic mackerel catches fell between 1980-2005, more so in the northwest Atlantic. Catches in the Gulf of Mexico have increased over the last five years and have fallen in the northwest Atlantic. Average mackerel catches 1980-2005 for the northwest Atlantic and the Gulf of Mexico stood at 1,390 and 800 tons, respectively.

King mackerel catches fluctuated between 1979-2005 with a downward trend that was more marked in the northwest Atlantic than in the Gulf of Mexico. Average production throughout that time was 370 and 350 tons, respectively. The largest catches were in 1990 with catches amounting to 1,900 tons. (**Figure 18**).



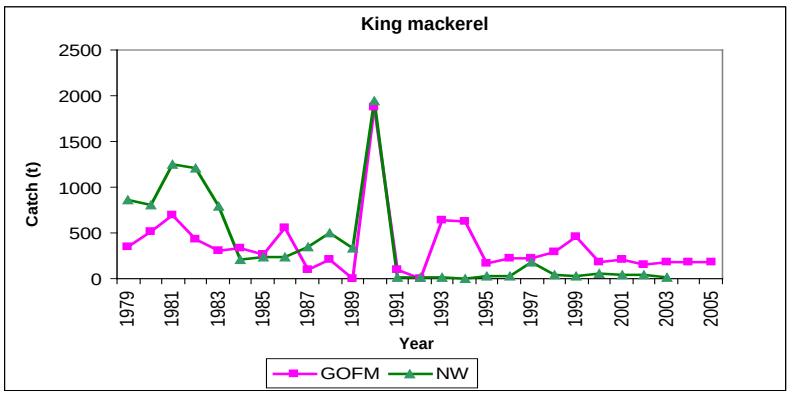


Figure 18. Annual trend in drifting gillnet mackerel catches in the north west Atlantic (ICCAT, 2006).

Specific sampling considerations

A sampling programme for this fishery has been implemented. Catch and effort statistics are obtained from the wholesale fish merchants and the log hooks. Individual weight information is submitted by skippers and through surveys. The data are completed by those provided by scientific observers (ICCAT, 2006).

Potential impacts on the ecosystem, including by-catches

No marine mammals or turtles were recorded as caught (Schaefer *et al.*, 1989 *in* Northdrige, 1992).

Environmental impact on fishing operations

There is a lack of information on this subject.

3.g Northwest Atlantic billfish fishery

Specific characteristics of gear/vessels

The Venezuelan artisan drifting gillnet fishery targeting billfish was developed in 1988 along the central coast of Venezuela (Alió *et al.,* 1994; Marcano *et al.,* 2001).

The fleet consists of 33 wooden artisanal vessels, from 8 to 12 m long, equipped with 2 outboard engines between 48 and 75 hp, Trips are daily and last between 14 to 18 hours (Alió, *et al.* 1994; Marcano *et al.* 1999; Marcano *et al.* 2001).

The net used measures between 600 and 1,200 m with a mesh size between 15 to 25 cm when extended (Marcano *et al.* 2001). The drop varies between 7 and 14 m (Alió *et al.* 1994).

Flag States involved

Venezuela is the only country that operates this fishery.

Areas of operation

Fishing units operate at a distance between 10 to 15 nautical miles to the north of the port of La Guaira, a sector in the southern Caribbean Sea where billfish tend to concentrate (Alió *et al.* 1994; Marcano *et al.* 2001).

Seasonality

Fishing takes place throughout the year but billfish are more abundant in March and between June and November. Blue marlin is more abundant in the first half of the year whilst white marlin is present during the second half (Alió, *et al.* 1994).

Target species and size composition

Billfish are the main species targeted. Landings are composed of 50% sailfish, 46% blue marlin and 4% white marlin.

The size of sailfish caught by this fishery varies between 115-210 cm whilst the mode is 165 cm and the mean is 168 cm. The blue marlin landed measure between 155 and 360 cm whilst the mode is 200 cm and the mean is 209 cm. The white marlin landed measure between 130 and 195 cm whilst the mode is 170 cm and the mean is 166 cm (**Figure 19**).

The average size of the three billfish species varied significantly between 1991-1999 but the general trend does not indicate any clear trend over time (Marcano *et al.* 2001).

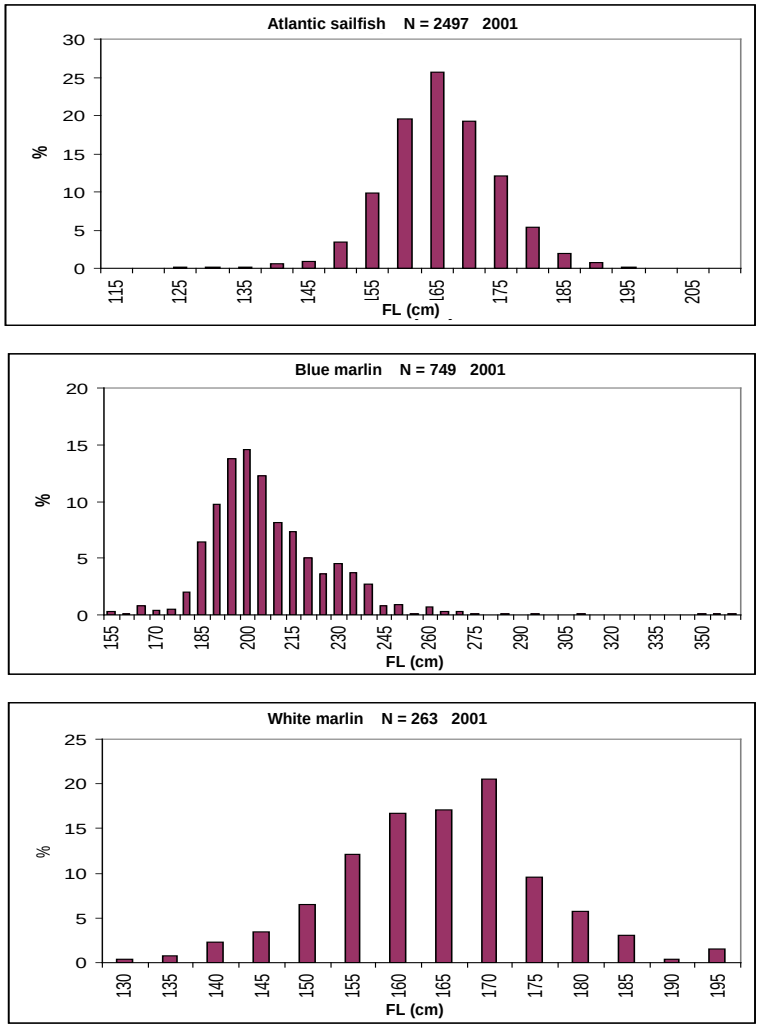


Figure 19. Size composition of billfish caught by the Venezuelan fishery in the western tropical Atlantic in 2001 (ICCAT, 2006).

Fish storage and processing

In Venezuela, marlins are basically destined for local, fresh consumption (FAO, 2007).

Landing ports

The main landing ports for billfish are La Guaira, Playa Verde and Juangriego, located off the central Venezuelan coast.

Historic trend

− Nominal effort

Fishing effort almost tripled between 1991 and 1998. However, it showed a downward trend between 1999 and 2001 (ICCAT, 2006) (**Figure 20**).

Figure 20. Evolution of the Venezuelan drifting gillnet fleet fishing effort targeting billfish.

− Technological changes and changes to fishing gear/vessels

The mesh size used has progressively increased since the beginning of this fishery. Fishermen thus increased the fishing capacity of their gear in order to catch larger billfish specimens (Marcano *et al.* 2001).

− Fishing zones

Prior to 1989, fishing took place close to the islands in the southern Caribbean Sea (Las Aves island). Since then, fishing activity has moved to the La Guaria area, 20 km to the north of the port of the same name. This area is known to have an abundance of billfish throughout the entire year.

− Catches by species/zone/season/year

Sailfish catches in the northwest Atlantic increased constantly from 2001 onwards and reached a 130 ton peak in 2005. Blue marlin catches have also shown an upward trend with a maximum of 190 tons in 1999. In 2000, catches plummeted but then stabilised. The decline was linked to a reduction in fishing effort but also to the local abundance of the species (Arocha *et al.* 2006).

White marlin catches fluctuated between 1991-2005 with a general upwards trend. Catches of this species are quite low and have never really exceeded an average of 10 tons (**Figure 21**).

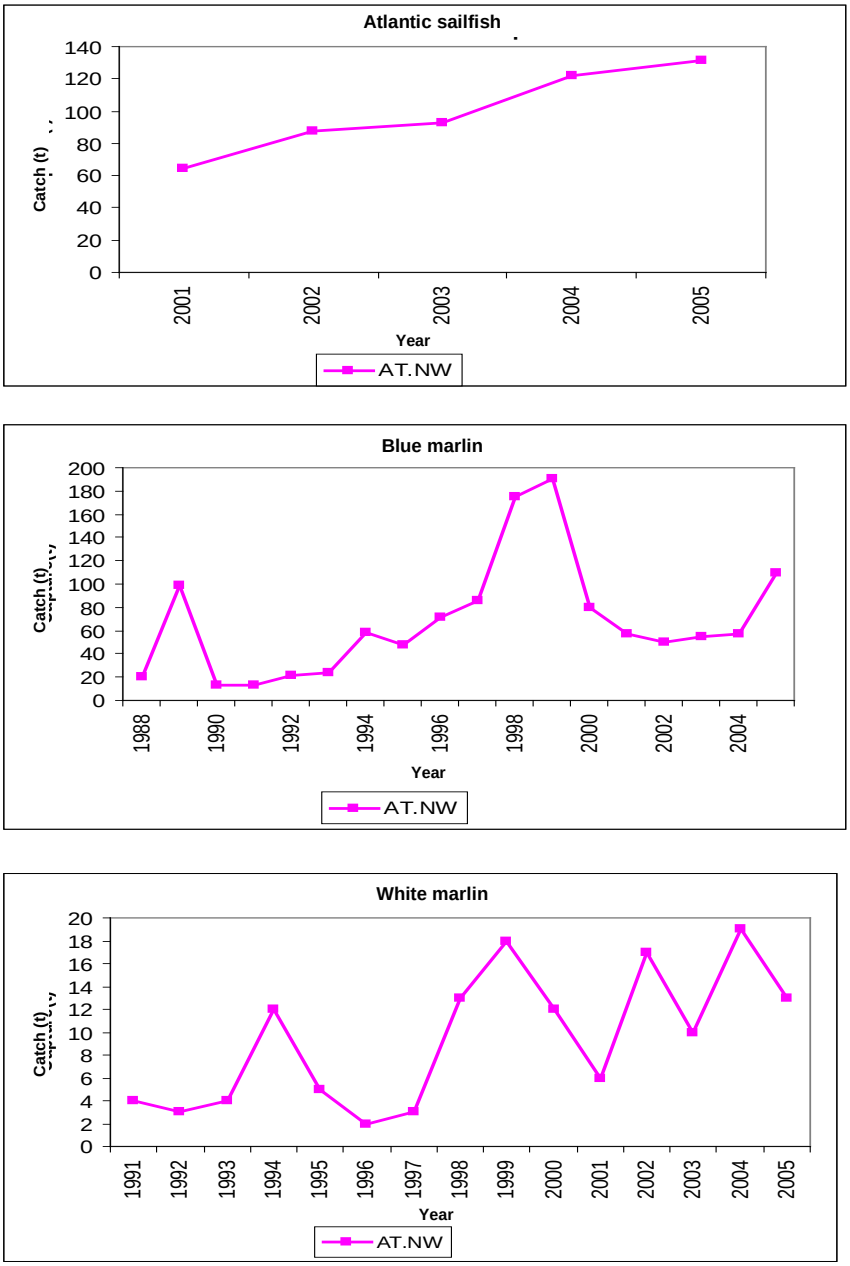


Figure 21. Annual trend in northwest Atlantic drifting gillnet catches of marlin (ICCAT, 2006).

Specific sampling considerations

The ICCAT Enhanced Research Program on Billfish was launched in 1991 and continues to take samples of billfishes at main landing ports (ICCAT, 2005).

Morphometric data as well as total weight, gutted weight and sex are recorded. A daily check of catches and fishing effort (number of vessels and trips) are also carried out by this same programme (Marcano *et al.* 2001).

Potential impacts on the ecosystem, including by-catches

There is a lack of information on this subject.

Environmental impact on fishing operations

There is a lack of information on this subject.

3.h Northwest Atlantic shark fishery

Specific characteristics of gear/vessels

Fishing for sharks using drifting gillnets was developed in Guyana at the beginning of the 1980s when a ban on imported fish products was introduced. There are currently 371 vessels using this gear.

The boats used have a total length of between 12 to 15 m and have a cabin and a diesel engine. A boat is usually at sea for 7 to 21 days (ICCAT, 2006a). Small quantities of sharks are caught by smaller vessels (7 to 9 m) with a 48 HP outboard engine (Peters *et al.* 2006).

The gillnets used are made of polyethylene. The sharks are caught by two, six and eight inch mesh sized nets. The two inch mesh nets catch small sharks in small quantities (Peters *et al.* 2006).

Flag states involved

Guyana is the only country that operates this fishery.

Areas of operation

There is a lack of information on this subject.

Seasonality

Shark fishing takes place throughout the year but is greatest from July to January (Peters *et al.* 2006).

Target species and size composition

This fishery catches sharks and scombridae. Most of the shark species landed are not identified. The most common are tiger shark (*Galeocerdo cuvier*), smooth hammerhead (*Sphyrna zygaena*) and blacktip shark (*Carcharhinus limbatus)*. Two scombridae species are also caught: serra Spanish mackerel (*Scomberomorus brasiliensis*) and king mackerel (*Scomberomorus Cavalla*).

Fish storage and processing

There is strong competition within this fishery due to the fact that there is heavy demand for fish products and by-products (fins, bladders and bones). There are three shark processing plants in Guyana (Peters *et al.* 2006).

Landing ports

The port of Guyana is the main landing port for sharks.

Historic development

− Nominal effort

There is a lack of information on this subject.

− Technological changes and changes to fishing gear/vessels

There is a lack of information on this subject.

− Fishing zones

There is a lack of information on this subject.

− Catches by species/zone/season/year

Task I catch statistics are available only for 2001, 2004 and 2005. Total squaliform catches in Guyana amounted to 2,634 tons in 2005, compared to 3,054 tons in 2004, a 22% reduction. Blacktip shark catches increased to 547 tons in 2005 compared to only 7 tons in 2004. King mackerel catches fell by 21%, from 312 tons in 2004 to 245 tons in 2005. Serra Spanish mackerel catches increased from 494 tons in 2004 to 523 tons in 2005.

Specific sampling considerations

There is currently no biological sampling programme or data collection concerning fishing effort due to lack of research funding. Only Task I data are reported to ICCAT (ICCAT, 2006).

Potential impacts on the ecosystem, including by-catches

There is a lack of information on the environmental impact of this fishery.

Environmental impact on fishing operations

There is a lack of information on this subject.

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