ICCAT Manual
INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS
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CHAPTER 3.1.2: LONGLINE	AUTHORS: Domingo A., Forselledo R., Miller P., Jiménez S., Mas F. and Pons M.	LAST UPDATE: March 2014

3.1.2 General description of longline fisheries

1. General description of longline gear and vessels

Longline is a fishing gear that is comprised of a main line, with secondary lines attached and hooks placed on the end of them. Longline is a very old gear, derived from "*volantín*" or "three hook line", which was used by the Phoenicians and the Egyptians in the Mediterranean Sea (Canterla, 1989).

The word "longline" is possibly of Catalonian origin, and derived from southern Italian or Greece (Prat Sabater, 2006; González García, 2008).

Since their beginnings and up to the 15th century at least, the longlines that were used were fixed, anchored to the coast with stalks. Later, in the open sea, "*jeito*" and "*vareque*" net gears were used which drifted while remaining moored to the vessels, and which could have given rise to drift gears, one of which is longline (Canterla, 1989).

1.a General description of pelagic longline

1.a.1 Introduction

Drifting pelagic longline is used worldwide to catch widely distributed pelagic and semi-pelagic fish. This gear is very effective in catching tunas, billfish and sharks, among others (Doumenge, 1998; Matsuda, 1998). It consists of a main line or "mother" line, suspended in the water by secondary lines called float lines, which carry the floats. The branch lines hang from the main line and carry hooks on the ends. The characteristics of the materials, dimensions, types of floats and hooks, as well as the configuration of the lines are quite variable, depending mainly on the origin of the fleets, the fishermen and the target species.

Drifting longline is used by a large number of countries throughout the Atlantic Ocean and Mediterranean Sea, on vessels up to approximately 60 meters in length, to catch mainly tunas and swordfish and, to a lesser extent, sharks and other pelagic fish.

The expansion of this fishery occurred in the late 1950s, when the oriental fleets, especially the Japanese fleet, started to operate in the Atlantic and Pacific Oceans (Pintos Paiva, 1961a; Suda, 1971; Honma, 1973). Since then, longline has continued to evolve and integrate new technologies and today this fishing gear is used by modern and efficient fleets, with large fishing power.

1.a.2 General description of pelagic longline

Gear category: Drifting pelagic longline
Standard abbreviation: LLD
ISSCFG Code: 09.4.0
Length of the gear: Up to approximately 120 nautical miles
Depth of the gear: Up to approximately 300 meters

There is a wide variety of longlines, whose design and configuration depend mainly on the target species, the origin of the fleets, the size of the vessels, the technology used and the fishing areas. Some examples are shown in **Figure 1a, b and c**.

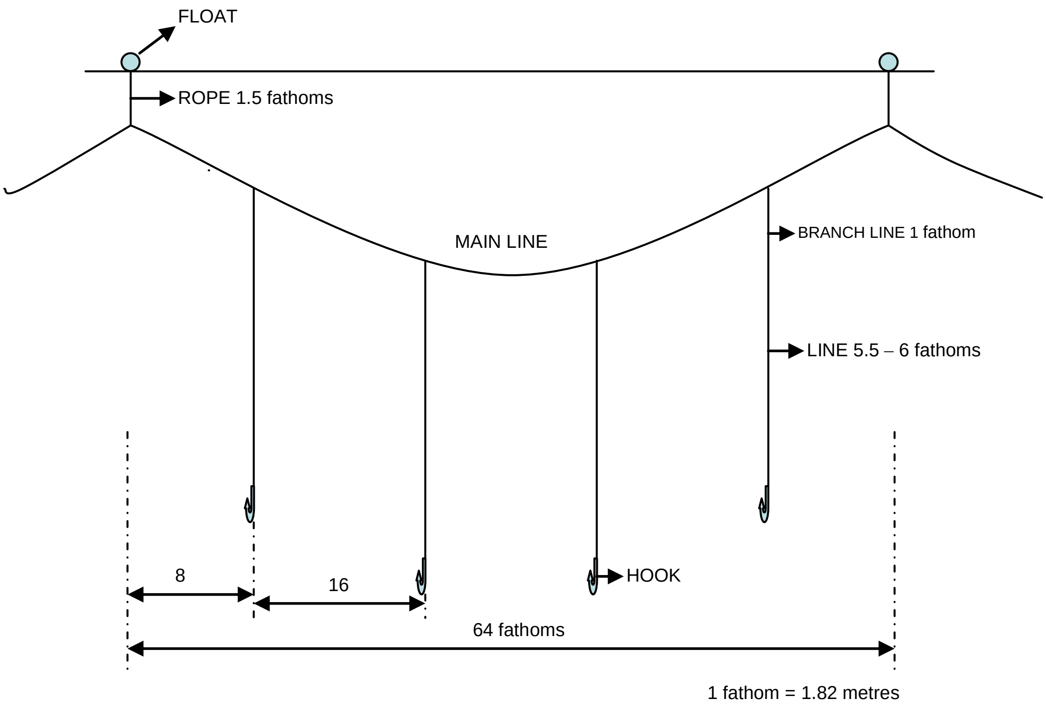


Figure 1a. Longline used by the Spanish fleet in the Mediterranean Sea in the late 20th century to fish swordfish (modified from Rey and Alot, 1984).

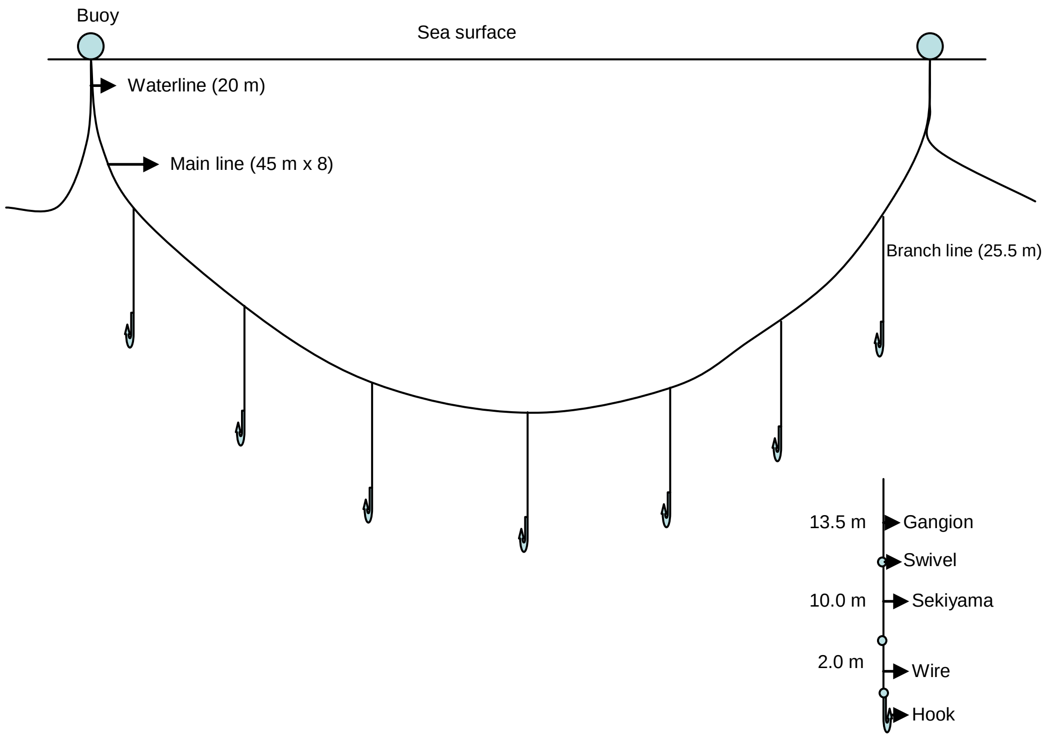


Figure 1b. Longline used by the Korean fleet in the 1970s (modified from Choo 1976).

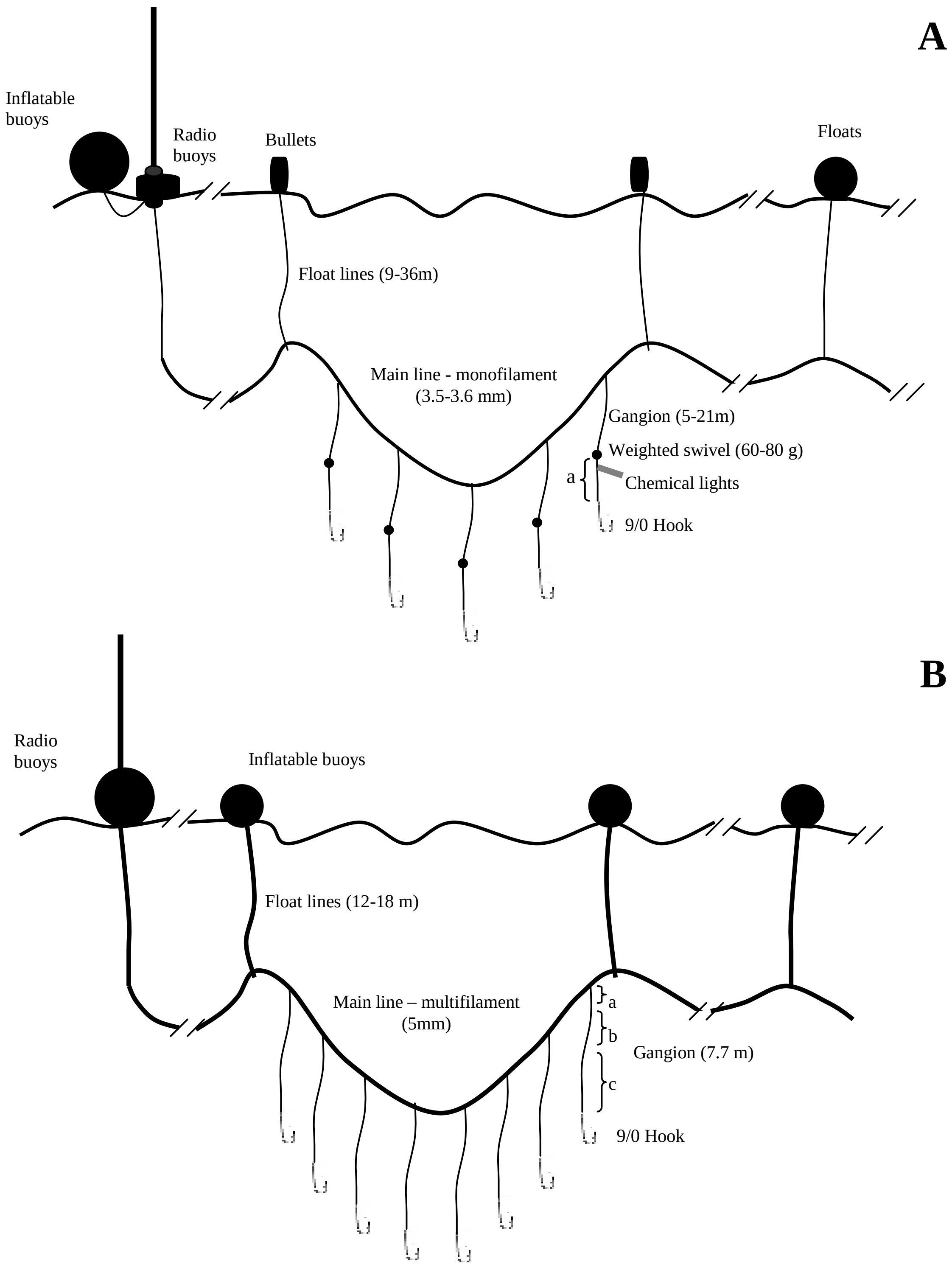


Figure 1c. Diagram of the two different types of longlines used by the Uruguayan fleet (modified from Jiménez *et al*., 2009).

Drifting longline has a main line or mother line which can be either monofilament or multifilament and which is currently made of synthetic materials such as nylon, polyamide, polyester, etc. This line can vary in size, but it is always the thickest and most resistant of the longline (**Figure 2**).

Figure 2. Nylon multifilament main line, polyamide monofilament and woven nylon (from top to bottom).

Secondary lines, called float lines, carrying a float or buoy at the end are attached to the main line. The depth at which the mother line is set depends on the length of float lines. The floats or buoys can be of various forms and materials and their number and distribution along the main line partially determines the depth at which the hooks will be set. **Figure 3** shows various types of floats.

Figure 3. Different buoys used in the longlines.

While the main line is continuous, it is configured in sections or segments, which often maintain the same conformation. These sections have a radio buoy at one or both ends (**Figure 4**) which transmits a signal at regular intervals that is received on the vessel and enables its location. By using a radiogoniometer, the location of the signal can be determined and the course to follow can be set in order to locate it. In some cases, radio buoy floats equipped with GPS are used, which transmit their position by radiofrequency, making it possible to locate them and position the longline more precisely.

Figure 4. Radio buoys.

Other secondary lines, called branch lines, which hang from the main line, have hooks on their ends. These lines are made up of different materials and sections, depending on the target species and the origin of the fleets. In some cases the branch lines are different in the same longline or in some of its sections. **Figure 5** shows the different branch lines used in drifting longlines.

Figure 5. Branch lines.

The fishing power, selectivity and catchability of pelagic longline depend on different variables. Following analysis, Ward (2008) has set out a number of factors which are described below and which should be taken into account in evaluating these variables. The displacement rate of individuals: Larger animals swim faster through larger volumes of water and compete more successfully for bait than smaller animals. Depth of gear: Catchability increases as similarity between the distribution of the gear and the species increases. Vessel masters' skill: Many studies have shown that the master's skill is one of the most important variables in commercial catch rates. Time of day of the gear operation: Decreased levels of light change the behavior of prey and predators and affect their ability to detect each other. Loss of bait: Whether the bait remains on the hook is determined by different factors, such as the quality of the bait, its positioning on the hook or the presence of scavengers. Gear saturation: When an animal is hooked, the hook is no longer available for others. When the gear is saturated, abundance tends to be underestimated. Gear detection: Animals can avoid bait on highly visible gear that does not resemble their natural environment. Food needs: The individual needs of animals to obtain energy for their activities and, accordingly, to consume bait. Competition between gears: It is assumed that the catchability of each hook declines based on the proximity of other hooks. Consequently, the distance between hooks can affect catchability. Bait type: The bait attracts animals by visual imitation (size, shape, etc.) or by the chemical and tactile properties (vibrations and movements) of natural prey, which are decisive in the choice of prey. Hook and bait loss: This depends on the configuration of the gear and the materials used. Other variables are the associations between the bait (prey) and the target species of the fishery (predators), fish detection equipment, hooks, cooperation among fishers and environmental conditions (Ward, 2008).

1.a.3 General description of longline vessels

Type of vessel: Longliner
ISSCFV Code: **06.26**
Total length: 15 to 60 m
Capacity of the fish holds: 20 to 500 metric tons

Due to the different longline fishing methods and types, there is a wide variety of vessels in this fishery. Many fleets of coastal countries of the Atlantic Ocean and Mediterranean Sea have small vessels that land their product fresh and therefore carry out trips lasting less than 20 days. There are many long-range fleets which often also pertain to coastal countries that land their product frozen (-4/-30°C) and which can combine this operation with fresh product. Their trips generally are not longer than 90 days. There are also fleets, mostly from extra-regional countries that land their products frozen up to -60°C and have autonomy to carry out trips that can last between 140 and 180 days (**Figure 6a, b, c, d and e**).

The vessels have their superstructure in the bow or in the stern. Although the majority of the vessels deploy the gear at the stern, some do this on the starboard side of the vessel. Many vessels carry out the haul back of the gear on the starboard side. The work or processing area, which may or may not be sheltered, can be at the bow or at the stern (**Figure 7a, b, c**).

Figure 6. Longline vessels.

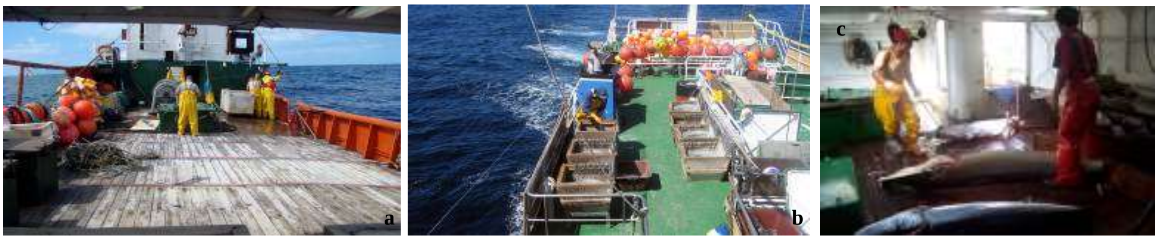


Figure 7. Processing areas.

The longline main line is stowed in various ways, on spools (**Figure 8**), in areas below deck **(Figure 9)** or in a tub **(Figure 10)**.

Figure 8. Spool to stow the monofilament main line.

Figure 9. Main line below deck. **Figure 10.** Main line in tubs.

The floats are detached from branch lines that are coiled (**Figure 11)** or put on smaller reels (**Figure 12**). The branch lines with hooks are coiled (**Figure 13**) or are placed in baskets or tanks (**Figure 14**).

Figures 11, 12, 13 and 14. (from left to right) Secondary lines (float lines and branch lines).

The majority of the vessels have sophisticated navigation and information equipment which enables them to obtain environmental data which are used to decide where and how to set the longline (**Figure 15)**.

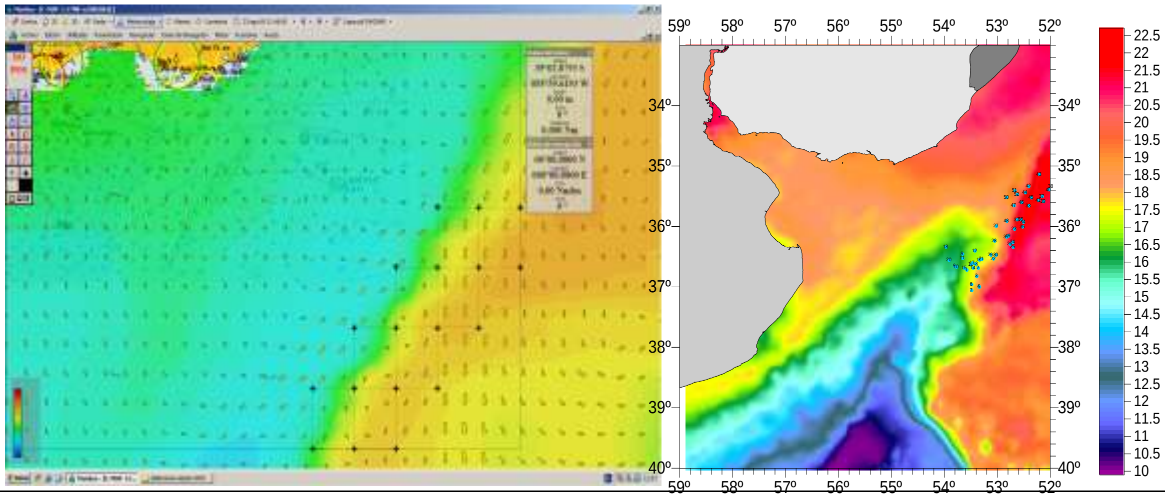


Figure 15. Satellite and navigation information obtained from vessels.

The haul back operation is almost always carried out on the stern side using mechanical equipment. The fish caught are brought on board through a gangway and deposited on the deck for processing. Generally, the catch is hoisted aboard manually using boathooks, except for the largest fish for which a winch is used (**Figure 16**).

Figure 16. Swordfish hoisted on board using a winch.

The reefer vessels carry ice in their fish holds and some can even make ice on board. Some vessels combine the fresh storage method with holds having a freezing capacity between -4 and -30°C. This makes them more versatile since they can store products for different markets. The large reefer vessels have holds with freezer tunnels that enable them to freeze product up to -60°C. Thus, a high quality product is achieved, which can be stored for several months **(Figure 17 a, b)**.

Figure 17a. Freezing room at -10°C.

Figure 18. Some target species of longline fisheries.

The target species of these fleets can be classified as tunas – bluefin tuna (*Thunnus thynnus* and *T. maccoyii*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*) and albacore (*T. alalunga*) – billfishes, swordfish (*Xiphias gladius*) and sharks, mainly blue shark (*Prionace glauca*), and shortfin mako (*Isurus oxyrinchus*) **(Figure 18)** (Anon. 2012).

2. Description of surface longline gear and vessels

Some coastal countries of the Atlantic Ocean and Mediterranean Sea already had fisheries directed at tunas and tuna-like species before the expansion of longline. The United States has fished bluefin tuna with longline since the 1940s (Wilson, 1960). Spain had coastal longline fisheries in the 15th century (Canterla, 1989). Other countries, such as Brazil, Cuba and Venezuela, developed their longline fisheries at the same time as the development of the fisheries in the entire Atlantic in the early 1960s (Novoa y Ramos, 1974; Pintos Paiva, 1971).

2.1 Description of the gear and fishing operations with surface longline

Surface drift longlines have varied in their design and materials over a long period and in various regions.

In the 19th and early 20th centuries, longlines called "*marrajeras*" were used in the southern Iberian Peninsula (Mediterranean Sea and Atlantic Ocean), (Rey 1980; Rey and Alot 1984; Rey *et al.* 1988; Mejuto, 2007). These referred to those that were dedicated to fishing shortfin mako shark (*Isurus oxyrinchus*) and, by extension, to other vessels that fished using longline, to the fishing gear and, in some cases, even to the type of hook, perhaps because it is characteristic of the fishing gears used to catch this species (González García, 2008).

The "*marrajera*" vessels carried various longlines (between 40 and 70), each measuring 100 to 150 m in length, with about 12 hooks. The hook size varied depending on the species to be caught. The longlines were placed in wooden 80 x 80 cm boxes, with the main line arranged in circles with the hooks on the edge of them (Márquez, 1998).

In Massachusetts (USA), up to the end of the 1940s, some fishing vessels of about 12 m, often manned by a single fisher, used longlines adapted to fishing in coastal waters to target bluefin tuna. The main lines of the longlines were usually made of synthetic material, while the floats were made of a considerable variety of materials, some of which were taken from other fisheries (cork buoys from purse seine nets, pots and trawl nets), as well as beer kegs and oil barrels. The branch lines were made of natural fibers (Manila hemp) or from synthetic material; the gangion with the hook was made of galvanized steel cable. The hooks were Japanese-type tuna fishing hooks of varying sizes, and the quantity used (from 200 to 400) depended on the vessel. These longlines were anchored to the seafloor using barrels or truck tires as anchors and were launched various times in each set instead of leaving them in place for longer periods and hauling them just once (Wilson 1960) **(Figure 19)**.

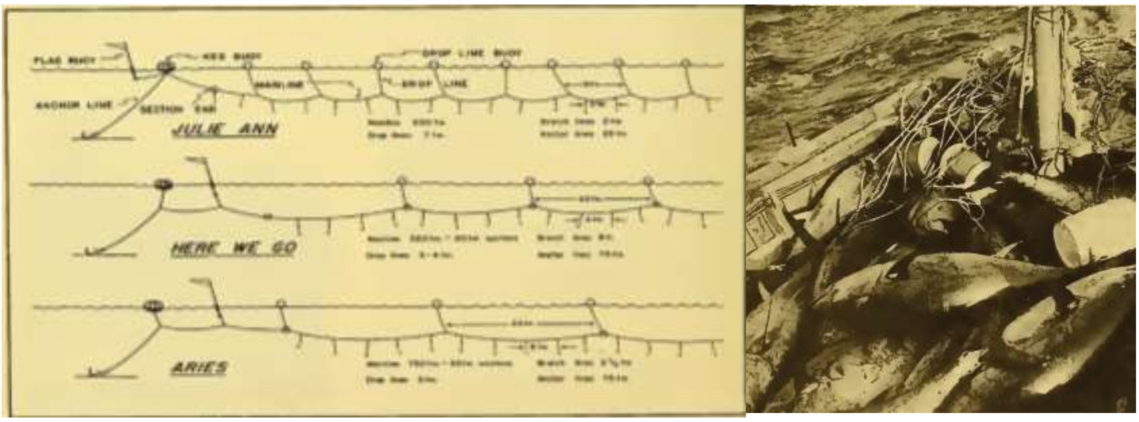


Figure 19. Diagram of bottom-set longline (left) used for fishing bluefin tuna (right) off the coasts of Massachusetts, obtained from Wilson 1960.

Starting in the mid-1950s the use of longline intensified and various technological advances were introduced in some fleets. U.S. and Canadian vessels, which until the 1960s fished with harpoon, intensively installed longlines directed at swordfish. At the same time, swordfish fishing extended throughout the entire North Atlantic coast, from the Gulf of Mexico to Canada (Gibson, 1998; Mejuto 2007).

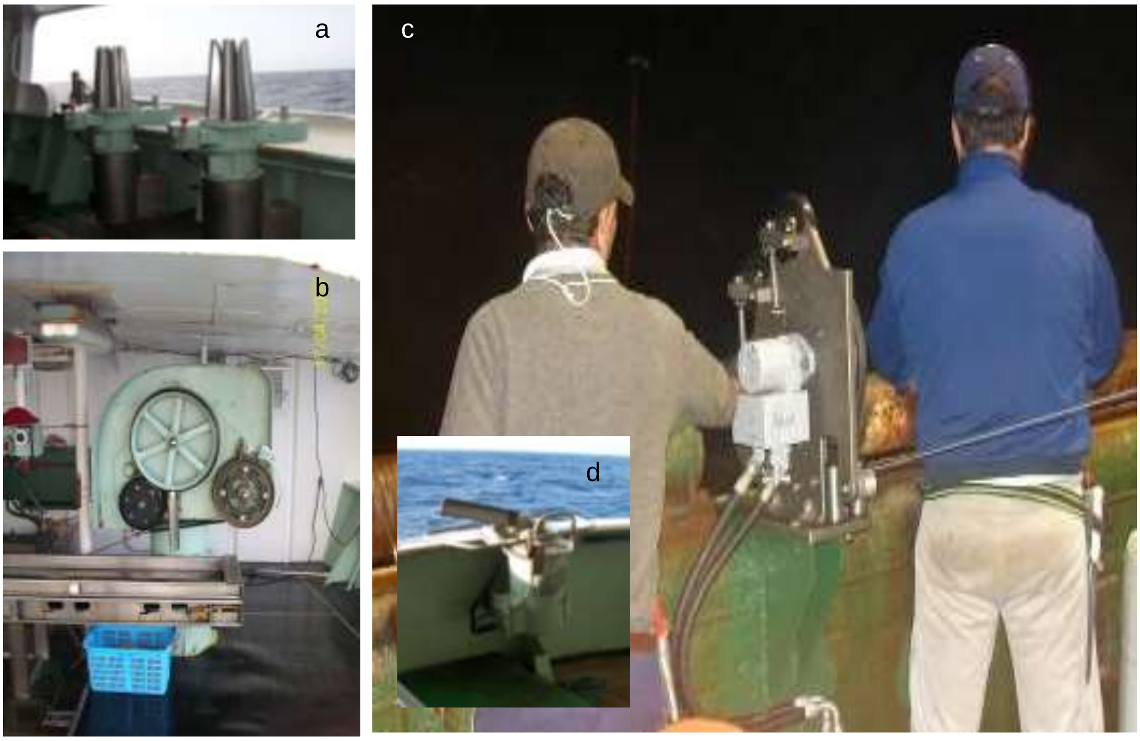


Figure 20. a) Branch line hauler; b) Main line hauler; c) Main line setter and d) Bait setter.

In the mid-1970s, some fleets (especially the U.S. fleet) started using mechanisms that contributed to improving efficiency and to reducing operating costs, such as hydraulic line setters and haulers **(Figure 20)**, monofilament nylon lines **(Figure 21)**, snaps **(Figure 22)**, chemical and electrical light sticks **(Figure 23)**, among others (Mejuto, 2007). These advancements enabled increasing effort and the area covered in each set, as well as adapting the floatability of the gear and hence the fishing mortality (Mejuto, 2007).

Figure 21. Snaps. **Figure 22.** Electric lights. **Figure 23.** Chemical lights.

As regards the regional differences in surface longline, many of these have gradually ceased to exist, while currently those that refer to the target species have been maintained. Two major types of longline are used: the "Florida" or "American" type, that is the most used, where the main line, comprised of a single monofilament line is coiled on spools; and the "Spanish" type which generally has a multifilament main line, whose configuration in sections is stored in baskets or tanks.

The "Florida" type surface longline has a monofilament main line, generally made of polyamide (from 3.0 to 4.0 mm in diameter) and branch lines made of the same material (from 2.0 to 2.5 mm in diameter). These branch lines (gangions) are used to attach the floats to the main line. The gangions are often configured in sections, which have a snap swivel on the tips to connect them to the main line and/or to connect several lines to obtain a longer length, thus enabling different combinations in the configuration of the gear.

Although there are many types of floats, four types are mainly used: extruded foam, hard plastic and inflatable polyethylene plastic floats **(Figure 24)** and radio buoys **(Figure 25)**. Some floats are protected by net covering which minimizes the effects of impacts. Strobe lights, placed within a metallic or fiber structure which rises to about 2 meters, are also used in some floats to alert and monitor their location in the water (Chocca *et al.* 2000).

Figure 24. Polyurethane buoys, inflatable PVC buoys and rigid plastic buoys (from left to right).

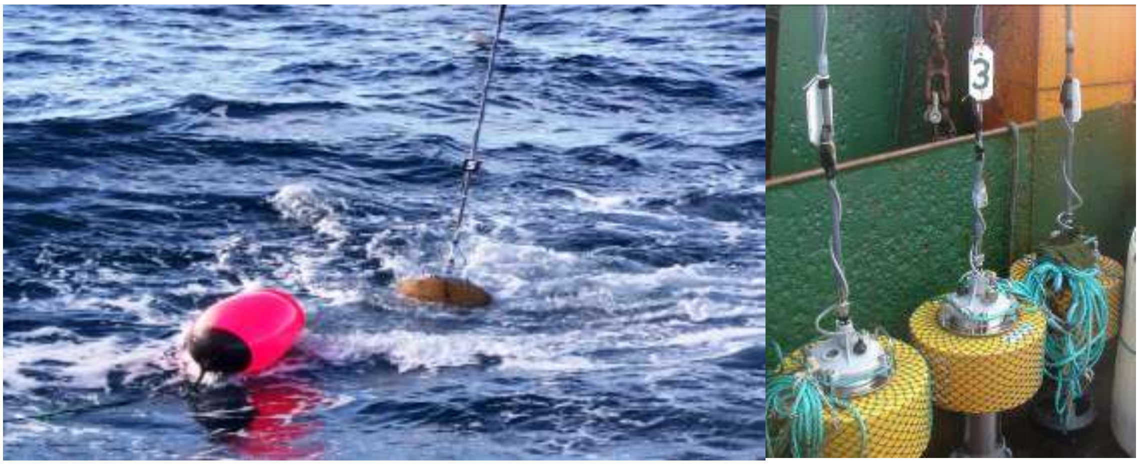


Figure 25. Radio buoys.

Other secondary lines (branch lines) are generally configured in sections - each one called a gangion - that are usually separated by a swivel (**Figure 26**), which sometimes have lead inside. These leads have different weights which generally range from 65 to 100 g. (**Figure 27**).

Figure 26. Swivels. **Figure 27.** Leaded swivels.

Some gangions are connected to the hook directly or, for more resistance, by a steel line or with a double or triple woven monofilament line (**Figure 28**).

Figure 28. Gangion with twine (left) and with steel (right).

The hooks used vary in size and can either be J-type or circular (**Figure 29**). These hooks can have a left or right offset (**Figure 30**), an eye on the shank, no hoop or a pallet on the shank (**Figure 31**), depending mainly on the origin of the fleet, the target species or simply the availability of local markets. The number of hooks per setting varies between 800 and 1,500, although they often number as many as 2,500 or more.

Figure 29. J and circular hooks.

Figure 31. Spatula hooks, an eye on the shank and a hoop on the shank.

Figure 30. Offset hooks.

The configuration and the assembly of all the parts of the gear can have as many variations as fishing masters working in the fishery. The length of the gear can vary between 18 and 90 kilometers, launching up to 130 kilometers or more of main line.

The radio buoys are placed on the ends of the gear and at regular intervals, in order to locate the gear in the event of breaks. The gear is configured in the same manner between two radio buoys and this part is called the section.

Many longlines use lights to attract the fish. These lights can be chemical, in which case there are two liquids, one in a glass capsule that, upon breaking, mixes with the other liquid and generates a light that can be green, blue or white, among other colors. Electric lights of various colors with rechargeable batteries are also used. The duration of the chemical lights sometimes enables them to be used during two consecutive settings.

The main difference between the "Spanish" type longline and the "Florida" type is in the main line, which is multifilament. It is comprised of segments or sections and has fixed points with knots to support the branch lines, called snoods. The branch line is placed on the free end of the snood, usually by a snap. In this way, all the branch lines are located at regular intervals. The rest of the components have diverse variations the same as the "Florida" type longline.

2.1.1 Fishing operation

A fishing operation consists of the activity from the start of the setting of the fishing gear to the final haul back of this gear and the collection and storage of the catch. Whilst there are differences in the fishing operations in accordance with the fleet characteristics, these operations can generally be described in the following way.

2.1.1.1 Setting

Figure 32. Main line setter.

In the surface fleets, this maneuver usually starts at dusk and takes from 3 to 4 hours of work. The setting is generally performed on the stern side, using, in some cases, a line-setter (**Figure 32**), such that the launch speed of the main line is independent from the speed of the vessel. While this tool is widely used at the world level, some fleets and/or vessels are not equipped with it. In these cases the main line is launched by the tension produced by the equipment once it is launched in the sea and the movement of the vessel. This limits the possibilities of regulating the amount of main line launched per nautical mile navigated and thus makes it more difficult to position the gear in depth. The use of the line-setter enables a better positioning of the gear, reaching greater depths.

The setting operation requires from 3 to 5 crew members, depending on the vessel, the amount of hooks and the degree of automation available (**Figure 33 a, b**).

Figure 33. a) Setting with 3 crew members without a main line setter; b) Setting with 5 crew members and a main line setter.

As the main line moves by the movement of the vessel, one of the crew works on connecting the floats to the main line. Another crew member baits the hook and tosses the hook to the water, while a third member of the crew attaches the branch line, by fitting a snap to the main line. More crew members can work in supporting this operation (**Figure 34**).

Figure 34. Setting with 5 crew members, two assisting with the bait and the necessary materials.

2.1.1.2 Haul back

This work starts early in the morning, at sunrise. In the current industrial fleets this work is done by mechanized equipment (line haulers), but in all cases manual assistance is needed. In the majority of the longliners the haul back is carried out on the starboard side of the vessel. A crew member is in charge of the line hauler which is positioned in such a way that enables him to see the boat's course and the longline. Using this device, the crew member operates the spool. In many vessels this is found next to the vessel controls, enabling the same operator to haul the gear and control the vessel during this maneuver (**Figure 35**). This is useful as it necessary to chart a course of approximately 30° with respect to where the longline is located, to have a better position for the haul back. When a fish is caught on the longline, the vessel must often stop the engine in order to hoist the fish on board.

Two or more crew are positioned to receive the hooks and store them in rectangular or cylindrical crates (**Figure 36**). Once the catch arrives it is brought on board manually or mechanically through a gangway located on the starboard side of the vessel.

Figure 35. A crew member hauling back the gear and controlling the vessel.

Figure 36. Different crates for stowing the hooks.

The duration of the setting and haul back operations vary considerably, depending on the type of longline, the quantity of hooks, the amount of catch and the conditions of the sea. **Table 1** shows the average duration for the surface and deep longline operations. To prepare this table, data from the "*Programa de Observadores a Bordo de la Flota Atunera Uruguaya-PNOFA*" as well as data obtained by PNOFA on board the Japanese fleet, were used.

Table 1. Average duration, in hours, of the setting and haul back operations in surface and deep longline fishing.

	Longline set				*Longline haul back*			
Duration	*Average*	*Maximum*	*Minimum*	*No. sets*	*Average*	*Maximum*	*Minimum*	*No. sets*
Surface longlin	04:50	09:30	00:30	1519	08:28	23:32	00:50	1605
Deep longlin	04:21	07:00	01:21	498	11:54	20:20	03:45	493

2.1.2 Fishing equipment

Spool: This is the part of the fishing equipment where the main line is retrieved. The diameter and length of the spool are variable and its capacity ranges from approximately 20 to 160 miles of line, depending on the spool's diameter and the reel.

Line setter or line shooter: This equipment is synchronized with the reel by the hydraulic system and enables the launch of the main line at a speed independent of the vessel speed (**Figure 37 a, b**).

a

b

Figure 37a, b. Hydraulic main line setters.

Hydraulic unit: This enables synchronizing the reel activity with the line setter and with the line hauler, independently from the other vessel equipment (**Figure 38**).

2.2 Description of surface longline vessels

There are different types of vessels, those designed specifically for this fishery and those adapted from other fisheries, with wooden, steel or fibreglass hulls (**Figure 39**). These vessels have a Gross Registered Tonnage (GRT) that ranges from 15-20 to 200-300 GRT and, in some cases, 500 GRT. Because of its characteristics, the surface longline fleet is very heterogeneous, and includes a considerable variety of vessels.

Figure 38. Hydraulic unit.

Figure 39. Vessels used for drifting longline.

3. Description of deep longline gear and vessels

The development of deep longline in the Atlantic Ocean started in 1955, with the first trips of Japanese vessels, which carried out research and exploration of the tuna resources (**Figure 40**) (Pintos Paiva, 1961a; Nomura *et al.* 1965; Jones, 1966; Wise and Le Guen, 1969; Suda, 1971; Yao, 1988).

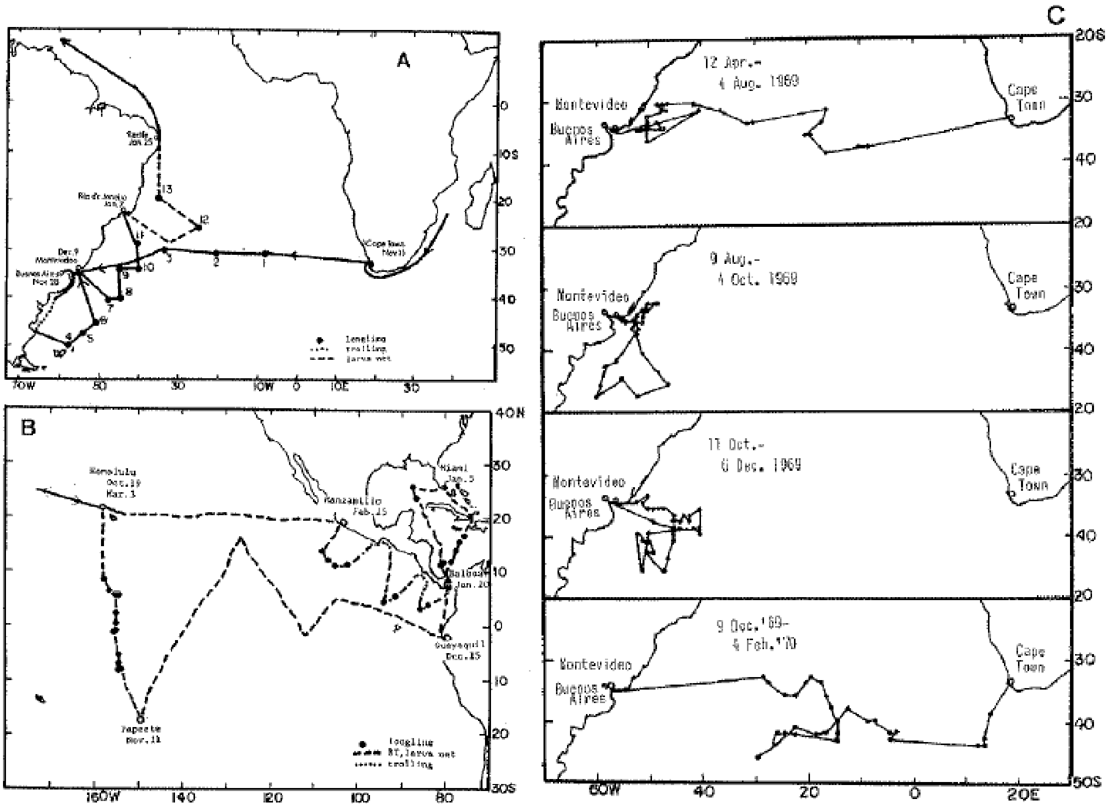


Figure 40. Route of the first Japanese research cruises for fishing tuna in the Atlantic Ocean (extracted from Suda, 1971).

Whilst in the following year (1956) four commercial trips were carried out, it was in 1957 when the fleet's activity expanded considerably with more than 60 trips made, fishing mainly in the areas of the tropical Atlantic (Shomura 1966; Miyake *et al.* 2004). When it started, this fleet landed 90% of tunas, mostly yellowfin, bigeye and albacore (Jones, 1966). Other deep longline fleets (Chinese Taipei and Korea) started operating in the fisheries in the Atlantic Ocean in the 1970s (Yang and Yuan, 1973; Choo, 1976).

At the end of the 1960s, Chinese Taipei had 88 vessels ranging from 200 to 500 GRT and 5 vessels over 500 GRT that operated in the Atlantic Ocean. Japan deployed an effort of more than 54 million hooks and, in 1974 Korea had a total of 132 vessels operating in the Atlantic, the majority of them between 200 to 300 GRT (ICCAT, 1973; Yang and Yuan, 1973; Choo, 1976; Miyake *et al.*, 2004).

3.1 Description of the gear and fishing operations with deep longline

Generally, deep longline is configured the same way as other longlines. The major difference with surface longline is the materials used in its construction and the lengths of the main line, the gangions and the branch lines, as well as the design of the branch lines. The main line ranges between 90 and 160 km, the gangions between 15 and 50 m and the branch lines between 35 and 50 m.

The increasing use of synthetic fibers in industrial fisheries as from the 1970s resulted in considerable changes in the fishing operation and in the reduction of the diameter of the lines. On the other hand, the overall technological advances enabled the number of hooks between floats to be increased, which numbered between 4 and 6 in the early years and rose to 12 as from the 1980s, reaching as many as 18.

Until about 1975, Japanese fishers used their observations of the contrasts in sea temperature to define the fishing areas. This was possible through widespread cartographic work, with areas of isotherms and the structure of the water masses which were carried out through the efforts of professional organisations and research laboratories, with daily observations at sea on thousands of vessels. From 1976, the use of satellite observations improved, making cartography more accessible. During this same period, the general use of the fax enabled the vessels to receive images daily. This change gave rise to a new period in which more precise information was obtained on temperature and sea conditions, productivity and ocean dynamics, which provided better understanding of the areas prone to aggregation of pelagic species (Doumenge, 1987a).

There are now mainly two deep longline fishing methods, those that use from 7 to 12 hooks between floats and those that use from 15 to 18, which target bigeye and bluefin tunas, respectively (Miyake *et al.* 2004). These changes in gear configuration, together with the mechanization of the haul back of the branch lines, which was all done manually until the end of the 1970s, has resulted in an important increase in effort.

In the early years of its expansion in the Atlantic, deep longline usually operated up to a depth of 140 m. From the experiments initiated by Saito in 1964 in the Fiji Islands, and which continued until 1969, depths of about 300 m were reached (Saito, 1973).

3.1.1 Fishing operation

Normally, deep longline fishing uses a considerable number of hooks, which is why the fishing operation lasts more than 20 hours and requires a larger number of crew members than surface longline. The vessel characteristics, the number of crew members and mechanization has permitted reaching speeds of up to 12 knots during the setting, and in some cases exceeding 3,000 hooks in each set.

The haul back is carried out on the starboard side of the vessel and the operation requires numerous crew members, since the processing on board of the catch and equipment repairs require considerable manpower.

Choo (1976) described the fishing operation of the Korean flag fishing vessel *Taechang 2*, which operated in the Atlantic in 1975. Although this vessel´s fishing operation was mechanized, the retrieval of the branch lines was done manually. Thus, the duration of the setting and haul was approximately a full day, setting between 1,500 and 2,900 hooks.

3.1.1.1 Setting

The setting is performed at a speed between 10 and 12 knots. The times when this work is done vary depending on the fishing areas, the target species, and weather and oceanographic conditions. The number of hooks ranges between approximately 2,000 and 3,500 and the number between floats goes from 4 to 18. A minimum of five crew members should work on the set. One member of the crew deploys the branch lines in the area where they are baited, while another puts the bait on the hook. This work is done on the stern of the vessel and a conveyor belt is usually used, where the baiting takes place. This conveyor belt transports the baited branch line to the set area. A third crew member casts the hooks and positions the snap on the main line. In many cases, a hook casting machine is used. A fourth member of the crew deploys the floats and one or two more prepare and bring the floats and baited hooks close to the set area (López *et al.* 1979). A variety of baits are used, often in the same section, alternating between squid, mackerel and other small pelagic fishes (**Figure 41**).

Figure 41. Setting in a Japanese longline vessel.

3.1.1.2 Haul back

Four or five hours after finishing the line setting, the haul back of the gear is initiated, generally starting from the last float set. Sometimes, depending on the final position of the set, the site where the set was started is returned to, in order to begin the haul back of the gear. The haul back operation requires a considerable number of crew members, 12 or more, and lasts an average of 12 hours (**Table 1: Figure 42**). This operation is carried out at a speed between 4 and 7 knots **(Figure 43)**, and is stopped when there are large fish and/or species of high market value. The branch lines are coiled and then stored in baskets and transported to the stern, to the set area, generally by conveyor belt. On less mechanized vessels, this operation is carried out manually. The main line is stowed below deck and is coiled automatically. The fish are brought on board manually or with the help of mechanical equipment (**Figure 44**). In some cases, equipment is used that glides along the branch line and serves to position the heads of the fish enabling them to be hoisted without using the boat hook. After being hoisted on deck, the fish are processed and taken to the freezer tunnels for stowage. Generally, the operators who work on deck rotate their tasks, except for those who clean the fish (López *et al.* 1979).

Figure 42. Haul back of a Japanese longliner.

Figure 43. Haul back in bad weather at 7 knots.

Figure 44. Hoisting of the catch manually and mechanically.

3.1.2 Fishing equipment

Line setter: The main line is pulled from the tank at a speed independent of that of the vessel. In many vessels there is hook launching equipment, to launch the baited hook towards a side at a distance of approximately 60 meters from the stern.

Line hauler: Enables mechanical recovery of the equipment that is in the water, the main line is transported by conveyor belt to the storage area, generally on the upper deck. The branch lines are raised with the help of mechanical winders.

3.2 Description of deep longline vessels

In general, the deep longline vessels that operate in the Atlantic are 40 to 60 meters in length, while some can be as long as 100 meters with 300-500 GRT. They are not very high and most of the work areas are sheltered so that the crew can work safely when the sea conditions are rough and the crew is on the bow part of the vessel. The crew on board is comprised of some 20-25 persons. In the case of the Japanese fleet, more than 70% of the crew is comprised of foreigners, mostly from Indonesia and the Philippines. In other fleets, such as those of Chinese Taipei and Korea, the percentage of foreign crew members is lower.

4. Major Atlantic fisheries

The major longline fisheries have varied over time, depending on the markets, the socio-economic situation of the countries and access to the fishing areas. Albacore have been caught by longline in the South Atlantic and Mediterranean since the start of the fishery and although this species is currently caught by other gears (baitboat and purse seine), longline continues to report the highest catches. While longline is widely used in the North Atlantic, albacore are mainly caught by troll and baitboat (Anon. 2011a).

Bluefin tuna are caught by longline in the northeast Atlantic and Mediterranean as well as in the northwest Atlantic and the catches by this gear are among the most important. In the northeast Atlantic and Mediterranean the baitboat and trap catches historically exceeded those by longline until the early 1980s, when this gear became the second fishery after purse seine for this species. In the northwest Atlantic longline is surpassed only by the sport fishery.

Of the tropical tunas, bigeye is the species with the highest catches by longline, which has been its main catching gear since the early 1960s up to the present, followed by purse seine and baitboat. For the western yellowfin stock, longline is the also the gear with the highest catches. However, in the East stock, longline was replaced by purse seine and baitboat in the late 1970s and the early 1980s.

Swordfish are caught mainly by longline in the North and South Atlantic. In the Mediterranean, it is also principally caught by longline, although since the early 1980s there are relatively important gillnet fisheries, which have started to decline in recent years.

Other billfishes (marlins) are caught incidentally by the industrial longline fleets in wide areas of the Atlantic Ocean and particularly in the central area. The major catches are made by the artisanal fleets in the East Atlantic and artisanal fleets and sport fishing in the West Atlantic.

4.1 Special characteristics of the gear/vessel

There are differences among longline gears and vessels, depending on the origin of the fleet and the target species. In the ICCAT registers there are vessels less than 50 GRT, as well as some between 900 and 1000 GRT. The majority of the vessels are less than 50 GRT and between 200 and 300 GRT.

***4.2** Flag States involved*

The following table (**Table 2)** shows the countries that have reported catches for the various tuna species, swordfish and sharks (*Prionace glauca*, *Isurus oxyrinchus* and *Lamna nasus*) in the longline fisheries for most years between 1960 and 2010.

	ALB	BET	BFT	YFT	SWO	BSH	SMA	POR
Belize	X			X	X	X	X	
Brazil	X	X		X	X	X	X	X
Canada	X	X	X	X	X	X	X	X
China, People´s Rep.	X	X	X	X	X	X	X	
Chinese Taipei	X	X	X	X	X	X	X	X
EU-Spain	X	X	X		X			
EU-Portugal	X	X	X	X	X	X	X	X
Japan	X	X	X	X	X	X	X	X
Korea, Rep.	X	X	X	X	X			
Mexico			X	X	X			
Namibia	X	X			X	X	X	
Panama	X	X		X		X	X	
Philippines	X	X		X	X			
South Africa	X	X		X	X	X	X	X
United States	X	X	X	X	X	X	X	X
Uruguay	X	X		X	X	X	X	X
Vanuatu	X	X		X				
Venezuela	X	X		X	X		X	

Some flag countries, such as Chinese Taipei, Japan, People´s Republic of China and Uruguay, report that their fishing activity is carried out exclusively with longline, while others mainly use longline, but also operate using other fishing gears.

Many of the current principal flag countries initiated their development with the expansion of the Japanese fleet in the Atlantic in the 1950s. This expansion was the result of various agreements after the end of the Second World War. The signing of a peace treaty with the United States (September 1951), the normalization of relations with the URSS (March 1956) and its subsequent entry in the United Nations (December 1956) enabled Japan to recover its freedom of movement in the Far East and to go out in the world (Doumenge, 1987b). The rapid recovery of the economy, the technological advances achieved during the war, and the repatriation of some 5 million Japanese enabled the organization of a strong fishing industry, which would extend throughout the world's oceans, during an expansionist period spanning 15 years (1955-1970) (Doumenge, 1987b).

Chinese Taipei started its longline fisheries in 1913, which were initially limited to coastal areas in the southern part of the island and used the port of Kaohsiung as a base for its operations. Gradually they were extended towards the western part of the Island of Luzon and south of the Sea of China. In 1956 they reached the Indian Ocean and in 1960 the Atlantic Ocean and the Mediterranean Sea. In about 1971, there were 108 Chinese Taipei vessels operating in the Atlantic, which accounted for 24% of the total number of vessels under this flag in the three oceans (Pacific, Indian and Atlantic) (Yang and Yuan, 1973).

Brazil initiated its fishery on an industrial scale in 1956, with Japanese vessels that operated mainly between 10ºN and 15ºS and, in some cases, as far as the coasts of Africa (Pintos Paiva, 1961 a, b).

The participation of other flag countries is worthy of mention, either for having been pioneers in this fishery or because of their participation in a given period or a specific area.

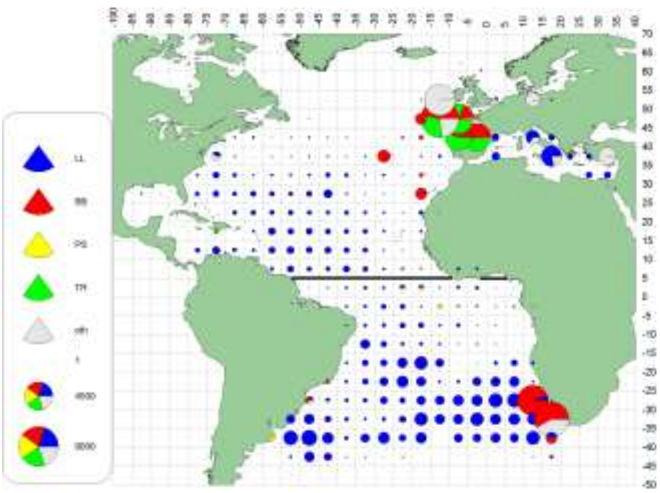
Argentina conducted its first campaign in 1956, using the small wooden trawler "*Foca*". This vessel carried out trials off the coasts of Mar de Plata and Uruguay and used Japanese type longline, which was hauled with the drum where the trawl net is coiled. Many of the tasks were performed manually, which limits the number of hooks. As a result of the yields attained, between 1958 and 1959 and over a two-year period, two Japanese vessels of 300 and 700 tons started fishing from the port of Mar de Plata. Between 1964 and 1967, three Japanese vessels flying the Argentine flag operated from the same port. After a period of inactivity in this fishery, one vessel was in operation between 1985 and 1991. After that time there were no reported longline vessels targeting tunas and tuna-like species with this flag (Pájaro *et al.*, 2011).

In 1963, five vessels of Japanese origin, with a Japanese crew and flying the Cuban flag started their activities in areas close to Brazil and in the Caribbean Sea, between 1º-28ºN and 27º-84ºW, forming one of the first fleets in the region (Nomura *et al.*, 1965).

4.3 Fishing area(s)

The zones where the longliners operate in the Atlantic Ocean are determined by the areas of distribution and abundance of the different target species. The areas and target species of the fleets have varied over time. Below, information is provided on the catches, by fishing gears, of the various species in recent years.

4.3.1 Temperate tuna fisheries (Albacore: Thunnus alalunga *and bluefin tuna:* Thunnus thynnus*)*



Albacore are distributed in temperate and tropical waters, including the Mediterranean, from 50ºN to 40ºS. Their abundance declines between 10ºN and 10ºS (Anon. 2010b). Due to its wide distribution, this species is caught by various fishing methods, including longline which is the main fishing type, together with baitboat and troll (**Figure 45**).

In the South Atlantic, the major areas of catch are found close to the coasts of South Africa and southern Brazil and Uruguay (Abuabara and Petrere, 1997).

Figure 45. Geographical distribution of albacore in the Atlantic Ocean and the Mediterranean Sea, by gear type, from 2010 to 2011 (Anon. 2012).

Atlantic bluefin tuna are distributed throughout the North Atlantic and its adjacent seas, mainly the Mediterranean (Anon. 2010b), from at least 60ºN to 10-20ºS. When the longline fishery first began in the Atlantic (1956) two bluefin tuna fishing scenarios were observed: the fisheries in the equatorial area in 1962-1965 where a peak of 60,000 fish were caught in 1963 and fishing in the oceanic areas from Florida to New York¸ USA, between 1964-1966, where catches fluctuated between 20,000 and 40,000 fish (Shingu *et al.*, 1975).

The major longline catches between 2000 and 2009 are observed in the northeast Atlantic, between 30 and 60ºN (**Figure 46**).

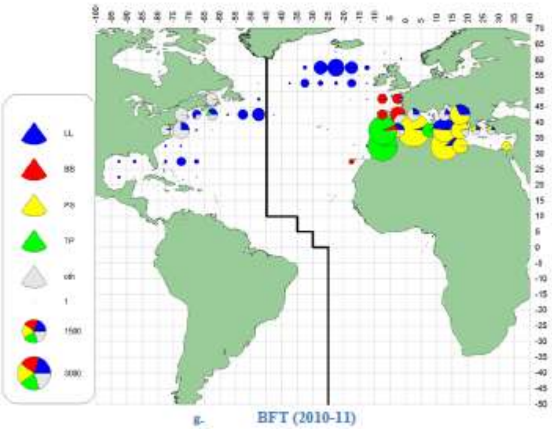


Figure 46. Geographical distribution of bluefin tuna catches in the Atlantic Ocean and Mediterranean Sea, by gear type, from 2010 to 2011 (Anon. 2011).

4.3.2 Tropical tuna fisheries (Yellowfin: Thunnus albacares *and bigeye tuna:* Thunnus obesus*)*

Yellowfin tuna are distributed in the tropical and sub-tropical waters of the Atlantic Ocean between 50ºN and 50ºS, but are not found in the Mediterranean Sea (Anon. 2010c). The wide distribution of this species has led to the development of numerous and diverse fisheries. In the mid-1950s, small French and Spanish baitboats that caught albacore in southern Europe moved to Africa to catch yellowfin (Lenarz and Sakagawa, 1973). The longline fishery was initiated at the end of the 1950s and quickly became important, attaining maximum catches of more than 50,000 t in the early 1960s. Since then, catches declined gradually to about 30,000 t in the early 1970s. Catch levels in the last decade have been about 23,000 t (19,302 t in 2010).

In the last 40 years, major longline fisheries have developed in west and central Atlantic (**Figure 47**). The principal fleets are those of Chinese Taipei, Japan, United States, Mexico and Brazil.

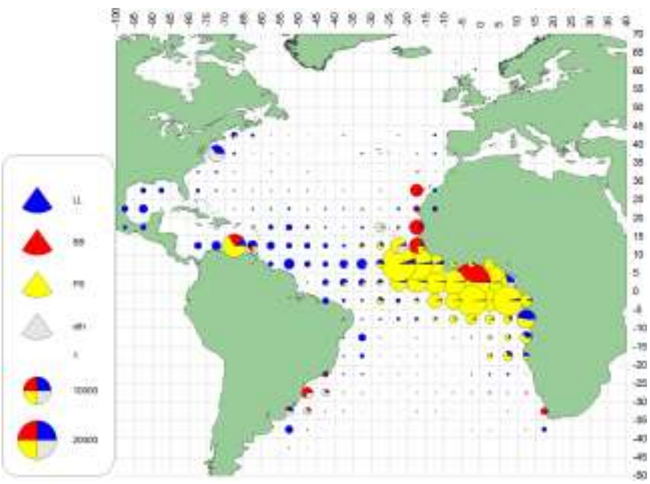


Figure 47. Geographical distribution of yellowfin tuna catches in the Atlantic Ocean and Mediterranean Sea, by gear type, from 2000 to 2009 (Anon. 2011).

Since the beginning and up to at least 1971, Japan, Korea and Chinese Taipei were the countries that caught the most yellowfin with longline in the Atlantic (Lenarz and Sakagawa, 1973). Since the mid-1970s and early 1980s, Japanese and Chinese Taipei vessels started shifting their target species from yellowfin and albacore to bigeye tuna, using deep longline. In the 1980s and 1990s yellowfin tuna represented 20% of the catches of the Japanese fleet in the Atlantic, which concentrated its effort in the Gulf of Guinea, along Senegal, the Cape Verde Islands and the American coasts. For the Chinese Taipei fleet, yellowfin tuna is a by-catch species, whose catches did not exceed 6% of Chinese Taipei´s total catches in the period from 1983 to 1986. These catches were made in the same areas where albacore were caught, in the central Atlantic (Diouf, 1991).

In the Gulf of Mexico, there are U.S. and Mexican longline fisheries directed at yellowfin tuna. The longline fisheries on the northeastern U.S. coast, which fished yellowfin incidentally, expanded in the mid-1980s, since the operators encountered a growing market for “sushi”. U.S. and Mexican fishers in the Gulf of Mexico took advantage of this opening and in 1988 there were 200 longline vessels fishing yellowfin tuna in this area (Browder *et al.*, 1991). In the period from 1994 to 2006, the average weight of the fish caught by these fleets was between 32 and 39 kg. Although there are four major areas where the U.S. fleet catches yellowfin (North Atlantic coasts between Cape Hatteras and Grand Banks, Atlantic coasts of South Florida, the Caribbean and the Gulf of Mexico), the highest catches are made in the Gulf of Mexico (Browder and Scott 1992).

Venezuelan longliners also target yellowfin tuna, at least seasonally (Anon. 2011).

In Uruguay, the longline fleet catches yellowfin in the southwestern Atlantic, generally as by-catch in the fishery directed at swordfish (Domingo, *et al.* 2009).

Since 2000, a fleet has been operating in Brazil from Cape Frio, Rio de Janeiro State (22º-24ºS and 40º-44ºW). This fleet was small but it has expanded and in 2010 it had about 350 vessels. Although this fleet targets dorado (*Coryphaena hippurus*) using various gears, it catches yellowfin mostly by hand line (55%) and mid-water longline (8%) (Anon. 2011b).

Bigeye tuna, which have a slightly wider distribution than yellowfin tuna (60º N-50ºS), are not found in the Mediterranean (Anon. 2010d). This species is mainly caught by longliners and, in recent years (2000-2009), the catches have been concentrated in the central Atlantic between 25ºN and 15ºS (**Figure 48**). Up to 1960, Japan was the only country that caught bigeye tuna with longline in the Atlantic Ocean. Subsequently, in 1962, Chinese Taipei joined the fishery. In 1965, Cuba started its longline fishery and a year later Korea joined the fishery, reaching longline catches of about 18,000 t in 1970 (Hisada, 1973).

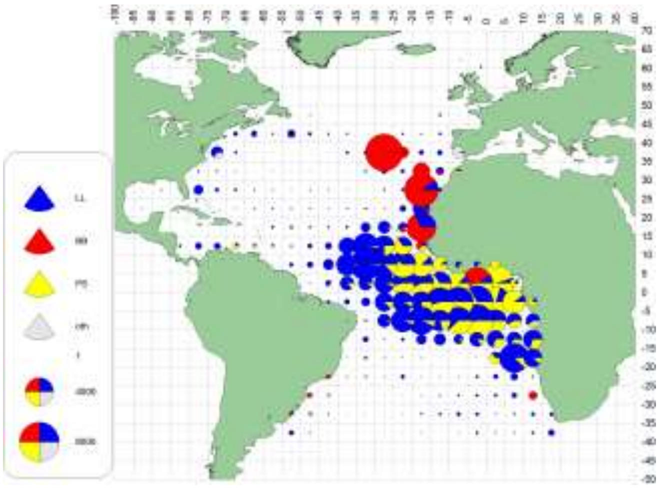


Figure 48. Geographical distribution of bigeye tuna catches in the Atlantic and Mediterranean Sea, by gear type, from 2000 to 2009 (Anon. 2011).

*4.3.3 Swordfish fisheries (*Xiphias gladius*)*

This is a species that has wide distribution, which is concentrated in tropical and temperate waters between 45ºN and 45ºS, including the Mediterranean, Black and Marmara Seas (Anon. 2010g). As occurs with tropical and temperate tuna species, the extensive distribution of swordfish has resulted in the development of an important number of fisheries targeting this species. In addition to its extensive horizontal distribution, swordfish carry out vertical migrations, swimming on the surface during the night and carrying out immersions of 1000 m or more during the day, probably following their prey (Ward & Elscot, 2000; Mejuto, 2007).

At the world level, longline is almost exclusively the gear used to catch swordfish. Some catches are also made by gillnet and harpoon in the Mediterranean and in the northwest Atlantic (Ward and Elscot, 2000; Anon. 2011a).

In recent years (2000-2009) the major catches were observed in the West Atlantic and in the Mediterranean (**Figure 49**). The first reports of catches of swordfish at the world level date back to 1000 AC, by harpoon fishing, and from 177 AC by driftnets, both in the Mediterranean (Ward and Elscot, 2000). Currently, about nine countries actively participate in swordfish fishing in this area (Italy, Morocco, Spain, Algeria, Cyprus, Greece, Malta, Tunisia and Turkey) using longline and, in lesser measure, driftnets. Swordfish have been caught in the North Atlantic since 1800, initially by harpoon. The swordfish longline fishery in this area developed based on two experiences, that of Japan, directed at tunas and that of Norway, directed at sharks, and it was seen that it was possible to catch swordfish (Beardsley, 1978). The major fishing countries of this species are: Spain, United States, Canada, Japan, Portugal, Chinese Taipei, Morocco and Venezuela.

In the South Atlantic, this fishery started later (1955) and the major fishing countries are Spain, Brazil, Uruguay, Portugal, Japan and Chinese Taipei. At the end of the last century, 41% of the world catches were from the Atlantic and the Mediterranean Sea (Ward and Elscot, 2000).

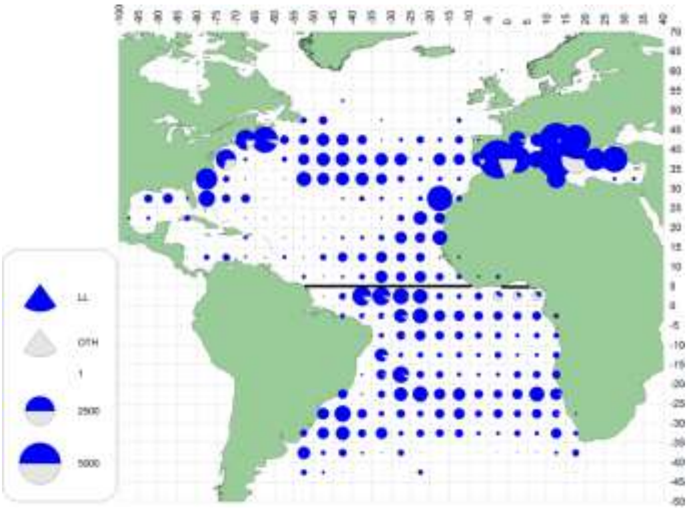


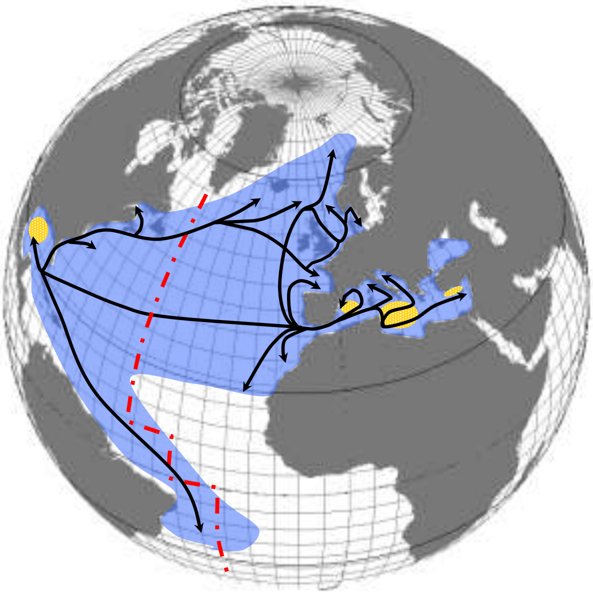
Figure 49. Geographical distribution of swordfish catches in the Atlantic Ocean and Mediterranean Sea, by gear type, from 2000 to 2009 (Anon. 2011).

4.4 Seasonality

4.4.1 Temperate tunas

Albacore: It seems that juveniles as well as adults winter in the North Atlantic, apparently in the central area (although they have also been found in the East and in the West). In spring, the young fish move towards northeast Atlantic waters. In May they start to concentrate in waters close to the Azores, at 38ºN latitude, and begin their movement towards northern waters. Within 1 or 2 months, the stock is found to the southwest of Ireland and in the Bay of Biscay (Anon. 2010a). In early autumn, they initiate the return migration to the central Atlantic through southern Portugal, the Canary Islands and the Azores. The adults carry out migrations for spawning when summer approaches. They migrate towards their spawning areas in the western part of the North Atlantic (off Venezuela and the Sargasso Sea).

The Chinese Taipei longline fleet, which includes flag vessels from Belize and St. Vincent and the Grenadines, is the major fleet which targets this species and fishes throughout the year (Anon. 2012). While the Japanese fleet is very stable, it increases it catches during the first and fourth quarters (Diouf, 1991). Brazil directs its catch in the southwestern Atlantic (5-20ºS), mainly during the first and last quarters of the year.



Bluefin: Knowledge on bluefin tuna migrations dates back many centuries (**Figure 50**). This knowledge has led to the use of different gears in certain areas and periods to attain a higher catch of this species. Shingu *et al.* (1975) indicate that north of 20°N two areas of bluefin tuna concentrations are observed. One of these areas is located in the West, in the Gulf of Mexico up to Florida in May-June, shifting towards the North of the American coast during July-September. Then, in December and January the highest concentrations are found at around 40°N, and as the spring season advances, the concentrations again shift towards the South. In the other area, i.e. the East area, the highest density occurs on the Atlantic side of the Strait of Gibraltar in May and in the Mediterranean in June-July.

Figure 50. Migratory routes of bluefin tuna (extracted from ICCAT 2010).

These same authors contend that between 15°N and 10°S the catch rates start to increase in February, reaching a maximum in March, and they start to decrease in the South in April, disappearing in June. A minor increase in the catch rates are observed again from September to November. However, south of 20°S, catches of this species are extremely rare.
The results of the tagging programs indicate that this stock carries out transatlantic migrations from the U.S. EEZ to the East Atlantic and even enters the Mediterranean, and also vice versa.

It has been determined that in the North Atlantic two stocks of bluefin tuna overlap, one of which spawns mainly in the Gulf of Mexico in spring and early summer, and the other in the Mediterranean. From electronic tagging it has been observed that some individuals that remain between 1 and 3 years in the northeast Atlantic then cross the ocean to enter the Mediterranean (Block *et al.* 2001, 2005).

Figure 51 shows the monthly-annual distribution of bluefin tuna catches of the Japanese longline fleet in five areas of the Atlantic Ocean and in the Mediterranean (Fonteneau, 2011).

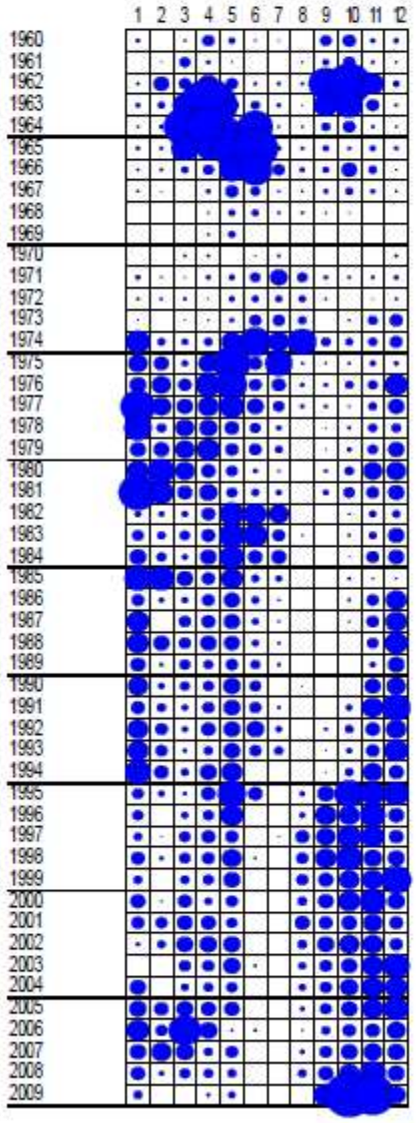


Figure 51. Bluefin tuna catches in number of individuals by the Japanese fleet by month (1 to 12) from 1960 to 2009 (extracted from Fonteneau 2011).

4.4.2. Tropical tunas

Yellowfin: Of the tropical tunas, this is the species for which the largest migrations have been observed. In the eastern Atlantic, the smaller fish (<50 cm FL) remain in the coastal areas, with moderate migrations (30 miles) (Anon. 2010c). The pre-adults (65-110 cm) migrate towards the higher latitudes, between Angola and Senegal and even as far as the Canary and Azores Islands. These seasonal migrations occur based on the productivity of the waters. Concentrations of fish of this species have been observed during the northern hemisphere summer (July-September) in Cape Lopez and Senegal and during the winter (January-March) in the equatorial area. The mature fish return to the spawning areas, mostly during the first quarter of each year (Anon. 2010c).

In the western Atlantic, small fish are found from May to October, with an increase in the ratio of adults observed from August to April. The ratio of juveniles increases from May to July when, most likely, the adults migrate towards the Venezuelan Caribbean to spawn in August and September (Anon. 2010c).

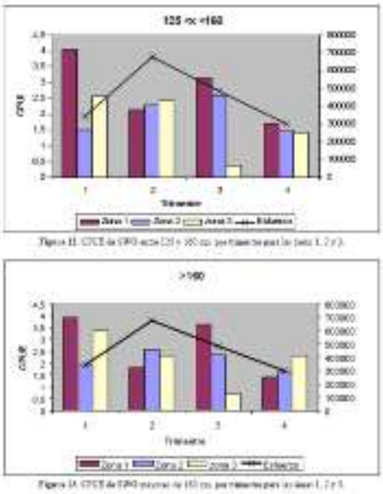
This marks the seasonal fisheries of the U.S. and Mexican longliners and Venezuelan vessels in the Gulf of Mexico fishing yellowfin tuna.

In the West Atlantic, the most important fisheries take place in the fourth quarter in the coastal areas and in the second and third quarters in the central Atlantic area (Diouf, 1991).

Bigeye: This species remains mostly in the Gulf of Guinea from the time of birth until the arrival of spring, when it initiates movements towards the tropics (Anon. 2010d). Some bigeye tuna migrate towards the African coasts, reaching as far as the Azores, Canary and Madeira Islands, while others migrate towards the central Atlantic (Anon. 2010d). The pre-adults (70-100 cm FL) migrate towards the North and towards the southern Gulf of Guinea. They are caught in large quantities between April and September in the Cape Lopez area and between November and January in Liberia, in the baitboat fisheries. The adult fish (>100 cm FL) are caught throughout the Atlantic by longline (Anon. 2010d).

4.4.3 Swordfish

In the North Atlantic, swordfish move seasonally in a circular pattern. During the summer (July-September) swordfish are caught in higher latitudes and in winter in lower latitudes. Adult swordfish enter the Mediterranean through the Strait of Gibraltar and are caught in areas close to Sicily (Italy) in May (Ward and Elscot, 2000). In the southwestern Atlantic, the highest catches of the Brazilian fleet are made in winter and the lowest catches in the spring (Amorim, 1977; Amorim *et al.* 1979), whereas the Uruguayan fleet obtains the highest catches in fall-winter and the least catches in summer and spring (Domingo *et al.* 2007) (**Figure 52**).



The Spanish fleet that fishes in the Atlantic operates throughout the year with some variation in fishing intensity. The vessels that operate in the southwestern area are more active during the third and fourth quarters of the year and less active in the first quarter. Those that operate in the northwestern area have more activity in September-October and less activity during the summer months (June-August). This fleet also fishes the entire year in the Mediterranean with major activity during the third and fourth quarters (summer-fall), and decreasing activity in the first quarter (winter) (Rey *et al.* 1988) (**Figure 53**).

Although the Japanese fleet does not target this species, it obtains the best yields in different months, depending on the fishing area: in the northwest Atlantic, between September-February; in the northeast area, between March and July; in the southwestern Atlantic, in the same periods as the Uruguayan and Brazilian fleets, between April and August; and in the southeast, between March and October (Yao, 1988).

Figure 52. Quarterly CPUE of the Uruguayan fleet (Domingo *et al*. 2007).

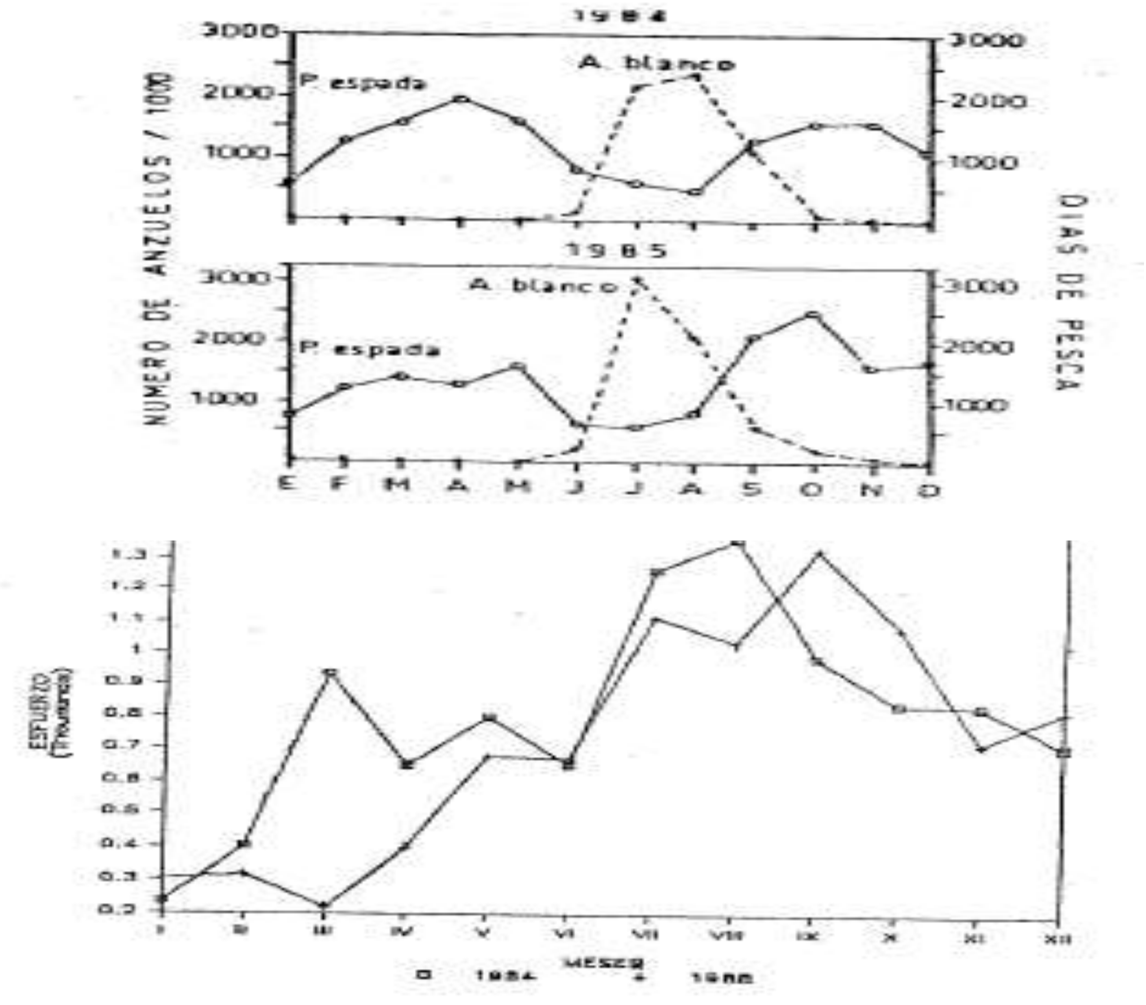


Figure 53. Monthly catches by unit effort of albacore and swordfish and effort of the Spanish fleets in the North Atlantic and Mediterranean, 1984-1985 (extracted from Rey *et al*. 1988).

4.5 Target species and size composition

The major target species of pelagic drift longline fishing are the following:

- Albacore (*Thunnus alalunga*)
- Bluefin tuna (*Thunnus thynnus*)
- Yellowfin tuna (*Thunnus albacares*)
- Bigeye tuna (*Thunnus obesus*)
- Swordfish (*Xiphias gladius*)
- Blue shark (*Prionace glauca*)

Longline mostly catches larger fish than other fisheries, due to the selectivity of this gear, which is related mainly to the size of the hook and, in many cases, to the depth that at which the hook is set.

In the last 20 years, effort directed at sharks has increased in the some tuna fleets, due to the high value of shark meat as well as shark fins. Although there are reports of effort directed at sharks, the majority of the fleets report sharks as by-catches in their tuna fisheries (Amorim *et al.*, 1997).

4.5.1 Temperate tunas

Albacore: Albacore catches by longline are taken by fleets that direct their effort at this species or that catch it incidentally in the swordfish and bigeye tuna fisheries. The longliners targeting albacore catch larger size fish than the surface fleets (**Figures 54, 55**), i.e. between 60 and 120 cm in length. The Chinese Taipei fleet catches more than 50% of the world catch of albacore in the South Atlantic.

Bluefin tuna: Japanese longliners catch a large amount of these tunas in the Atlantic and Mediterranean, reaching 70% of the catches with this fishing gear (Fonteneau, 2009). Compared to other gears (baitboat and traps), a larger range of sizes are observed in the longline catches, with fish mostly between 100 and 260 cm FL (**Figure 56**) (Fromentin, 2009).

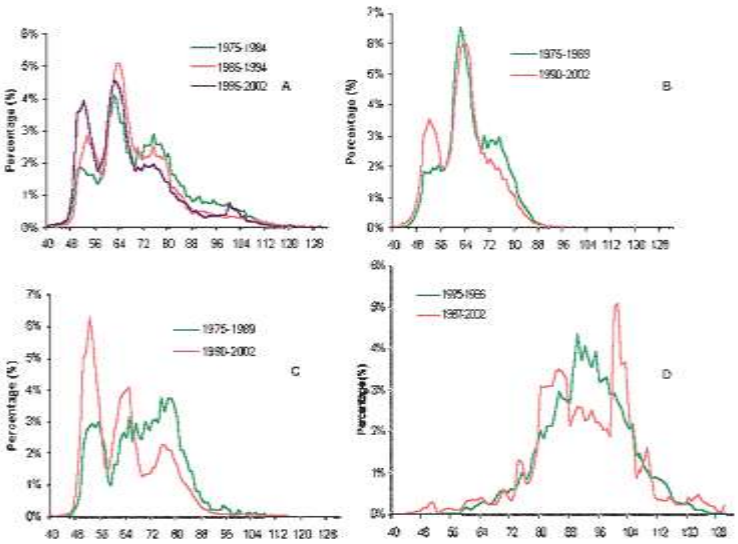


Figure 54. Size distribution of the albacore catches in the North Atlantic stock: A) All fisheries; B) Troll Spain; C) Baitboat Spain; D) Longline Chinese Taipei (Anon. 2010 a).

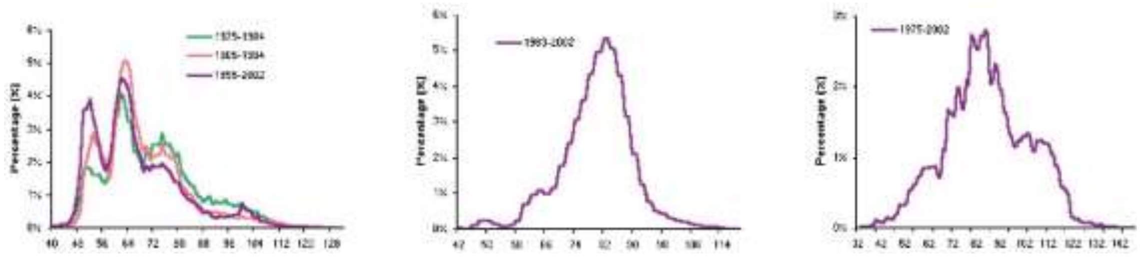


Figure 55. Size distribution (cm) of albacore catches in the South Atlantic: A) All fisheries; B) Baitboat South Africa; C) Longline Chinese Taipei (Anon. 2010a).

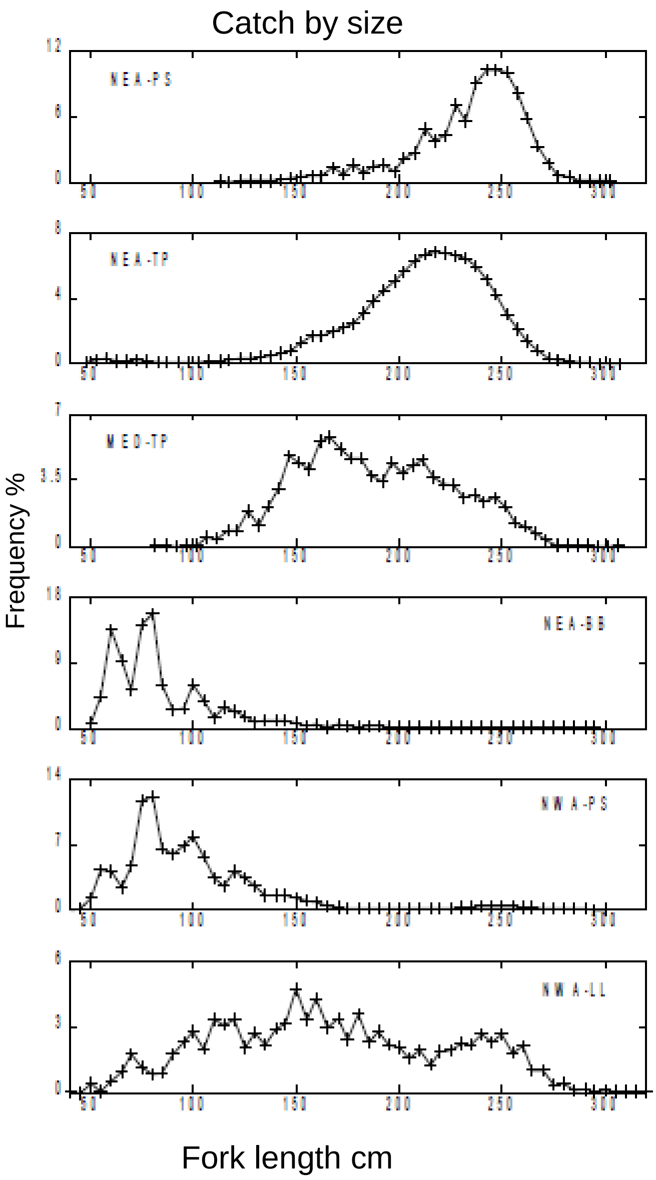
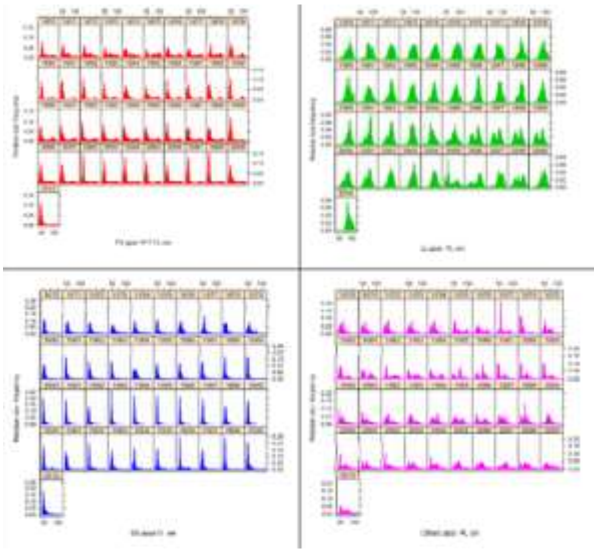


Figure 56. Size range of BFT caught by different gears (from top to bottom): NE Atlantic: Purse seine, trap; Mediterranean: Trap; NE Atlantic: Baitboat; NW Atlantic: Purse seine and longline (modified from Fromentin 2009).

4.5.2 Tropical tunas

Yellowfin: The longline fisheries generally catch adult fish, mainly by deep longline. This is mostly a by-catch of the fisheries directed at bigeye tuna and albacore (deep longline) and swordfish (surface longline). **Figure 57** shows the size frequencies of yellowfin tuna caught by the longline fleets. As in other species, the sizes caught by longline are larger than those caught by other fishing gears (**Figure 58**) (Anon. 2011b).

Figure 57. Size frequency of yellowfin tuna caught by longline.



Bigeye: The sizes of bigeye tuna caught by longline vary from medium to large (**Figure 59**); the average weights are between 45-50 kg.

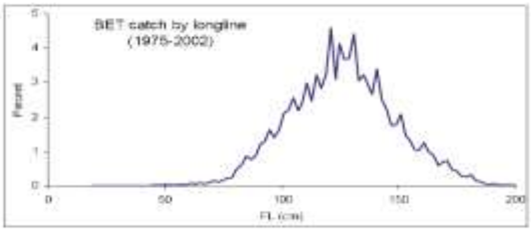


Figure 59. Percentage of size frequencies of bigeye tuna caught by longline, 1975-2002 (Anon. 2010 d).

Figure 58. Relative frequency of the size distribution of yellowfin tuna caught by different fleets (purse seine, longline, baitboat and other gears) from 1970 to 2010.

Figure 60 shows the size frequencies of bigeye tuna caught by the Chinese Taipei fleet, obtained from the fishing logbooks and the observer programs for the period 2005-2008.

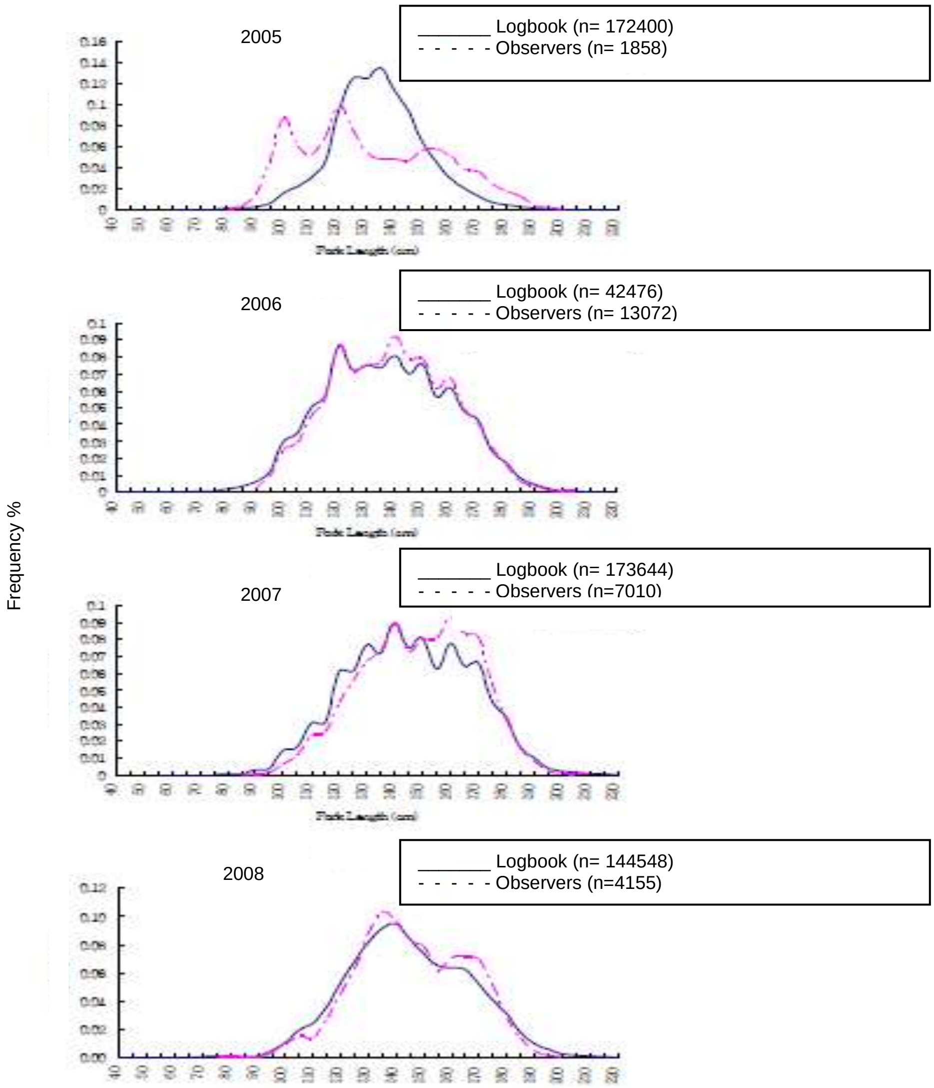


Figure 60. Size frequency by percentage of bigeye tuna caught by Chinese Taipei's longline fleet, obtained from fishing reports and observers from 2005 to 2008 (modified from Liu 2011).

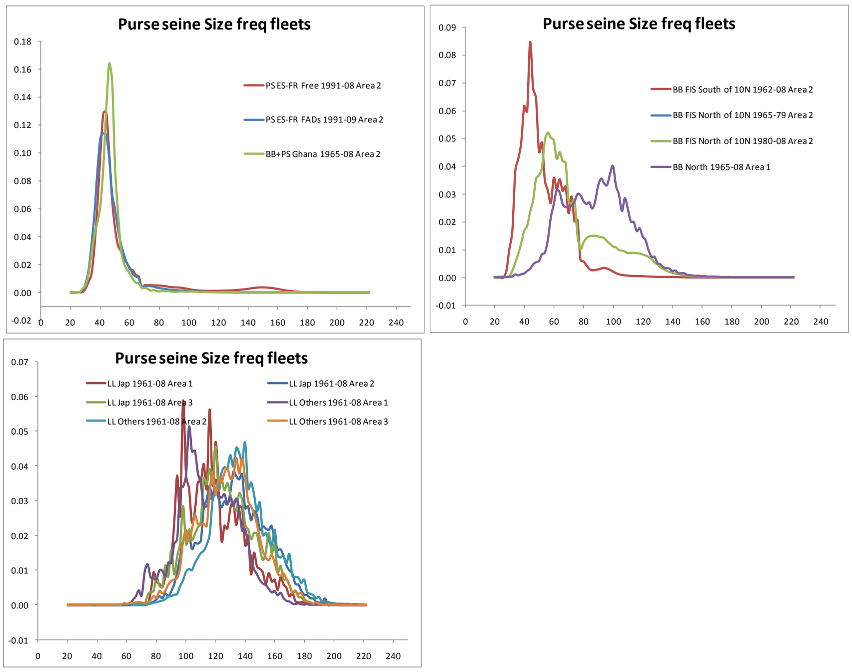


Figure 61. Size frequency of bigeye tuna for purse seine, baitboat and longline (Anon. 2010d).

As is the case for other species, the sizes of bigeye tuna caught by longline are larger than those caught by purse seine and those caught by hand line (**Figure 61).**

4.5.3 Swordfish

Swordfish catches are mostly made by surface longline in the Atlantic and Mediterranean, although some flag States, like Japan, catch this species with deep longline and others, such as Morocco, do so using driftnets (Abid and Idrissi, 2010). In spite of the prohibition in 2002 on the use of driftnets in EU waters, a number of Italian vessels continue carrying out illegal swordfish fishing using this gear (Abid and Idrissi, 2007). The size frequencies are similar in the northern and southern hemispheres of the Atlantic (**Figure 62 a, b**).

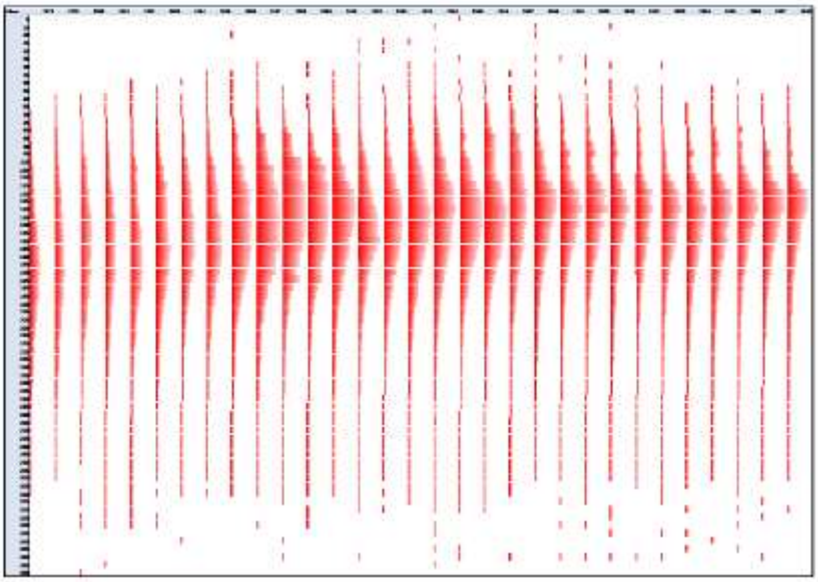


Figure 62a. Catch by year and size of swordfish in the North Atlantic for the period 1978 to 2008 (Anon. 2009).

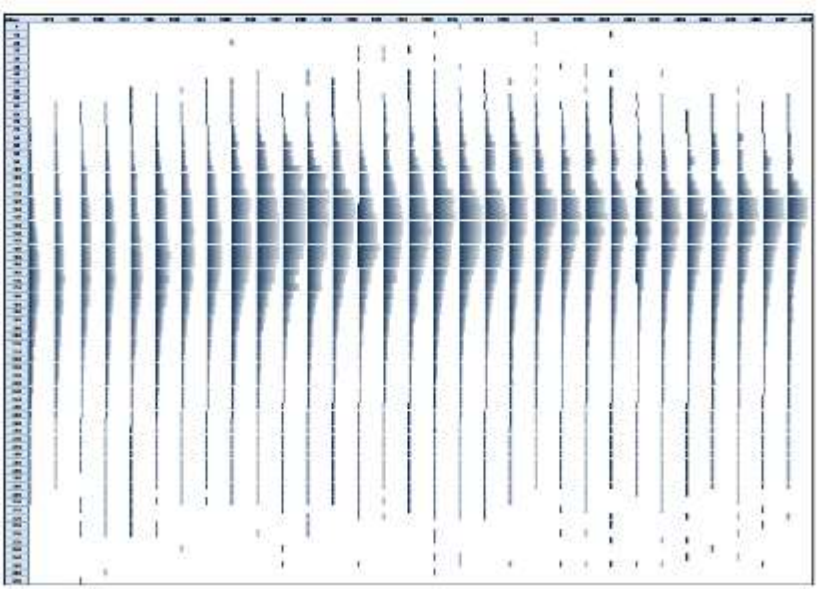


Figure 62b. Catch by year and size of swordfish in the South Atlantic for the period 1978 to 2008 (Anon. 2009).

The geographic distribution depends on the size and sex of the swordfish. Studies on the sex and size ratios indicate that there are three types of behavior patterns in the Atlantic (feeding, reproduction and transition). Fish over 25 kg are predominate in the longline catches at latitudes over 35^{o} and in warm waters it is more common to find small fish, although some adults are also caught (Ward and Elscot, 2000).

The average sizes of swordfish caught by the Moroccan fleet using gillnets are larger than those caught by longline by this fleet (**Figures 63, 64**) (Abid and Idrissi, 2010; Abid *et al.*, 2010).

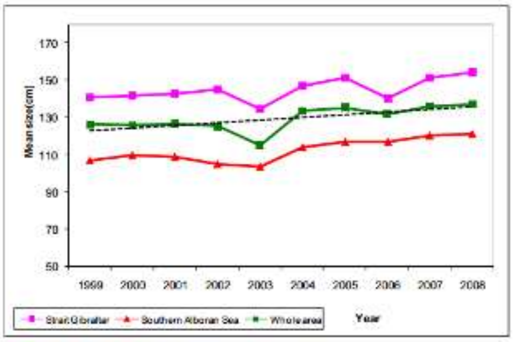
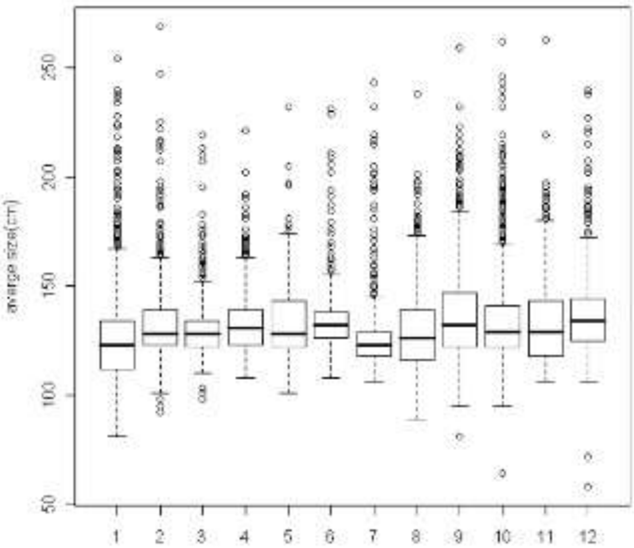


Figure 63. Average size of swordfish caught by Morocco's gillnet fleet, 1999-2008 (extracted from Abid and Idrissi 2010).



There are differences in the growth rates of males and females and in the longline catches, in sizes over 120 cm, females are predominate, which would indicate that the males either grow more slowly or have a greater natural mortality (Ward and Elscot, 2000).

Figure 64. Average size of swordfish caught by Morocco's longline fleet, 2004-2008 (Abid *et al.* 2010).

4.6 Storage/processing of the catch

The various species caught by longline are processed and stored in different ways, depending on the type of vessel (*fresquero* or reefer) and the final destination of the catch. In general, all the fish must be brought on board without damaging them, especially tuna and swordfish. This is done by using tools that enable hooking the fish in the head, mouth or fins, while avoiding the trunk. In the case of the tuna, the posterior ventral part of the head should not be hooked since that is where the heart is located. Species such as swordfish and tuna should be handled on a soft surface like a carpet but not directly on the deck, to avoid bruising, the loss of scales or any damage during processing. Generally, all the species that are retained are killed as soon as they are brought on board. Some, such as sharks, are killed for the safety of the crew and others, such as tuna, to obtain a better quality product.

On the reefer (*fresquero*) vessels, the entire catch retained is processed on board. However, not all the species are processed in the same manner, since this depends on the final product that is desired. The species are gutted and all the internal organs are removed from the abdominal and branchial cavity and, in some cases, the head and fins are also removed. For example, in the majority of cases, the shark heads are cut off and discarded and the fins are removed and stored separately from the carcass.

Generally, the reefer vessels store the fish in the well and cover them with ice, although in some vessels the fish are stored in tanks with refrigerated sea water or in a mixture of ice and sea water. Often these tanks are not used to conserve the fish during the entire trip, but are used (mostly in the case of tuna) to lower the body temperature before storage in the well, since cooling with a liquid is much faster than directly on ice. This cooling process can take from approximately 6 to 12 hours, depending on the size of the fish. In the well, the fish are separated by species and by size, tuna, swordfish, sharks and other fish. The abdominal cavity is filled with ice and each fish is covered with a layer of ice to separate it from the pieces beside, above and below it. The ice has to be monitored every day, and all the accumulated water removed to avoid the formation of "igloos" from the melting of the ice due to the temperature of the fish surrounding the pieces. To obtain quality fresh fish, the fishing trips should not exceed 20 days from the first catch up to the time of landing.

On the reefer vessels, the processing method is quite variable and depends, among others, on the species, the size and the destination of the catch. Generally, in the Asian deep longline fleets directed at large tunas, the catch is destined for the *sashimi* market and these fish are processed with great care to ensure the quality of the product. Other tunas which are not destined for this market, such as albacore in some cases, are not gutted and only the tail and the fins are cut before freezing. In other cases, these tuna as well as the billfishes (swordfish) may be cut in loins, which are then carefully wrapped for freezing and stored in crates.

After the catch is processed, the fish are taken to the cooling tunnels where they are placed on shelves for rapid and even freezing without any loss of product quality. The cooling tunnels reach a lower temperature than the fish well which, depending on the type of freezer, can range from -35ºC to -60ºC. In general, the *sashimi* market is more demanding regarding the temperatures that are required to obtain a better quality product, which is achieved with freezing temperatures between -55 and -60ºC.

The tuna for the *sashimi* market, fresh as well as frozen, must be processed in the following manner. First, if the fish is alive, it should be stunned by a blow to the head just between the eyes, using a wooden stick. Then the nervous system should be destroyed to inactivate the temperature control and thus avoid the meat from turning brown, as if it does, it cannot be used for *sashimi*. This is why the tuna's brain, which is located in the head and appears as a smooth spot between the eyes, is pieced with a spike. A piece of monofilament is introduced into the hole made by the spike to destroy the nervous system. To obtain a quality product, it is essential to bleed the fish before freezing it. This is done by making a cut on each side behind the pectoral fins and on the sides of the head, cutting the arteries that lead to the gills. Finally, the fish is gutted and the abdominal and branchial cavity is cleaned using a brush and salt water. Usually, the pieces are wrapped in a cloth before freezing to protect the skin from the cold and bruising (Beverly *et al.* 2003).

4.7 Landing port(s)

The ports used by the fleets have varied over time, due to the changes in fishing grounds and to the economic development that has taken place in different countries, as well as to the various international management measures. At the start of the fishery there were more ports used by the international fleets than at the present time. One example is the Chinese Taipei fleet which, during the period 1969-1971, used 15 different ports in the Atlantic for its vessels (St. Maarten, Abidjan, Cape Town, Las Palmas, Sâo Vicente, Monrovia, Tema, Dakar, Santa Cruz, Walvis Bay, Buenos Aires, Recife, Montevideo, Paranaguá and Tenerife) (Yang & Yuan, 1973).

The coastal countries that fish with longline in the diverse fisheries use their ports to land the various products caught by their fleets. Some of these countries that have extensive coast lines use various landing points (Brazil, South Africa, and the European Union, among others).

Those fleets that move to areas very far from their ports, such as the Asian fleets and some fleets of the European Union (Spain and Portugal) need to operate in ports in different areas. In the southwest Atlantic, the port with the most operations of third party vessels is Montevideo, Uruguay. The fleets of Spain, Portugal and Chinese Taipei operating in the region usually use that port. In the eastern Atlantic, South Africa is one of the countries with the largest port infrastructure and where vessels of various flags operate, utilizing the ports of Cape Town, Port Elizabeth and Durban.

In the northeast Atlantic the Spanish ports in the Canary Islands, Balearic Islands and Vigo are widely used by the longline vessels.

As for the landing of bluefin tuna, the ICCAT Recommendation 10-04 requires that each Contracting Party designate the ports authorized for the landing of bluefin tuna.

4.8 Historical development

The world catches of tunas (albacore, bigeye, bluefin and yellowfin) reached about 2.1 million tons in 2010, maintaining approximately the same volume since 2002. Some 70% of these catches were from the Pacific and only 10% from the Atlantic and Mediterranean. This figure increases to 4.3 million tons (2010) if skipjack tuna (*Katsuwonus pelamis*) is included, whose catches are nine times higher than in 1950 when 0.5 million tons were caught. Catches of bigeye tuna, Atlantic bluefin tuna, Pacific bluefin tuna, southern bluefin tuna and yellowfin tuna have gradually decreased after reaching record levels (Bayliff *et al.*, 2005; FAO, 2012).

In the last three years, the tuna market has been unstable due to the wide variations observed in the catches.

In the 1950s the major industrial fisheries were the Japan longline fishery and the U.S. hand line fishery which operated in the Pacific. At the end of this period, the fishing area of the longline fleet extended towards the Atlantic. Some hand line fleets based at local European ports also started fishing off the west coast of Africa. During the following decade, European hand line and purse seine vessels, together with Japanese hand line vessels, started catching tunas in tropical waters off western Africa. The Japanese fleet also extended its operations throughout the world, directed mainly at albacore and yellowfin tuna for canning. In the mid-1960s, longliners from the Republic of Korea and Chinese Taipei started large-scale tuna fishing. At the end of this decade, the development of cold storage systems and greater freezing capacity of the Japanese longliners enabled access to the *sashimi* market. Hence, the objective of the fleet ceased to be yellowfin tuna and albacore for canning, and instead shifted to bluefin tuna and bigeye tuna for *sashimi*. In the eastern Pacific, the U.S. hand line vessels were virtually all rapidly replaced by purse seiners. Yellowfin tuna fishing quotas were applied in that area for the first time in 1966.

The European purse seine fishery in the eastern tropical Atlantic developed rapidly during the 1970s. Tuna fishing increased considerably during the 1990s. Purse seiners started fishing with fish aggregating devices

(FADs) in the Atlantic in the early 1990s and this method quickly started to be used in the Indian and Pacific Oceans (Bayliff *et al.*, 2005).

4.8.1 Nominal effort

The longline unit of effort is measured in the number of hooks set, although other more general measures are also used, such as the number of vessels or days at sea.

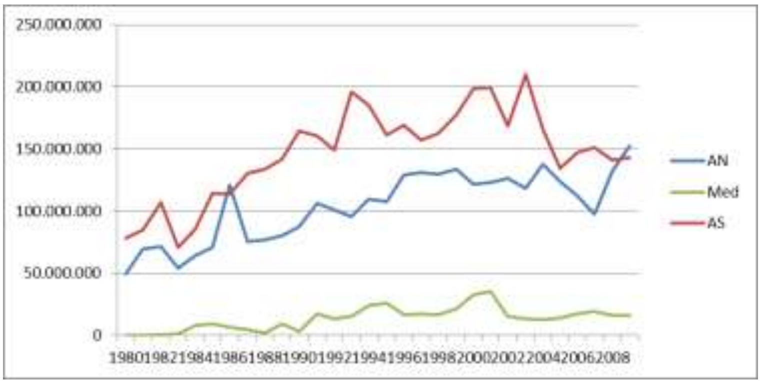


Figure 65 shows the development of the number of hooks and **Figure 66** shows the number of longline vessels by GRT, reported to ICCAT. An important decline is noted in 2003 and an increase, mostly in vessels less than 50 GRT in 2006, with the start of the implementation of Recommendation 05-02 which limited Chinese Taipei effort in the Atlantic Ocean.

Figure 65. Effort in number of hooks reported by major area from 1980 to 2009.

For the period 1980 to 2009, an increasing trend is observed in effort in the number of vessels, particularly those less than 50 GRT and those over 500 GRT. In the last three years, the number of vessels of 50-100 GRT has also increased.

While the effort is directed at the target species, mainly albacore, bluefin tuna, bigeye tuna and swordfish, these fisheries are multi-species, which make it impossible to clearly discriminate the effort by species.

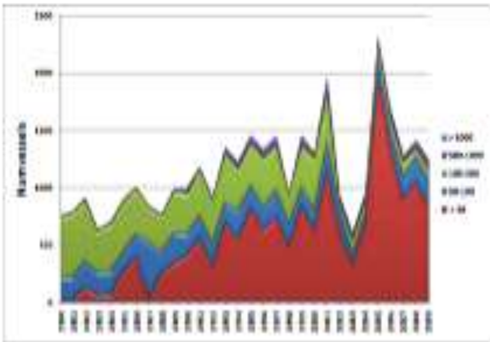


Figure 66. Distribution by GRT of longline vessels reported to ICCAT from 1980 to 2009 (Anon. 2011c).

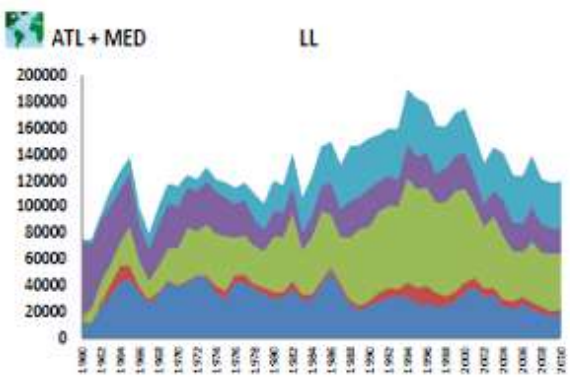


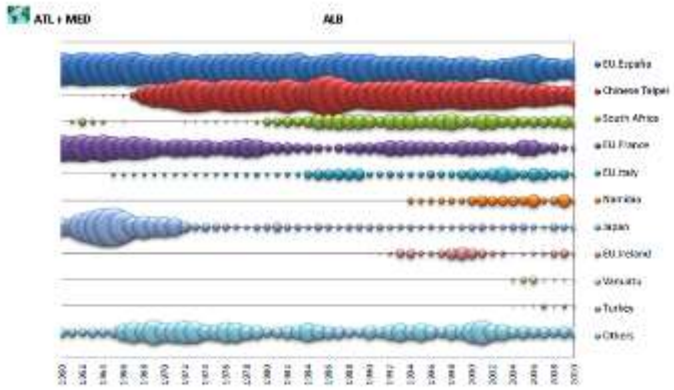
Figure 67 shows the development of the longline catches by species. These trends do not match those observed in the reported number of vessels (**Figure 66**).

Figure 67. Total cumulative catches by longline of albacore, bluefin tuna, bigeye tuna, yellowfin tuna and swordfish in the Atlantic and Mediterranean from 1960 to 2010 (Anon. 2012a).

4.8.2 Catches (by species/area/season/year)

The historical changes observed are influenced by a series of conditions linked to fishing aspects and to the political, social, cultural and economic situation of the countries, which often escape specific fishing analysis.

4.8.2.1 Temperate tunas



Albacore: Chinese Taipei has caught the most albacore with longline since the start of its fisheries in the Atlantic at the end of the 1960s (**Figure 68**).

The Spanish fleet, the second most important fleet, makes some catches with longline, but mostly fishes with hand line.

Figure 68. Relative distribution of the albacore catch by major fleet (Anon. 2012a.).

While there have been changes in the geographic distribution of the albacore catches, they have not been as significant as in other species. Between 1970 and 1979 higher longline catches were observed in the tropical area and since the 1990s catches have increased in the South Atlantic area (**Figure 69**). This is due to the change in the target species of the major fleets (Chinese Taipei and Japan) to bigeye tuna and to the shift in area of some of its vessels towards the south.

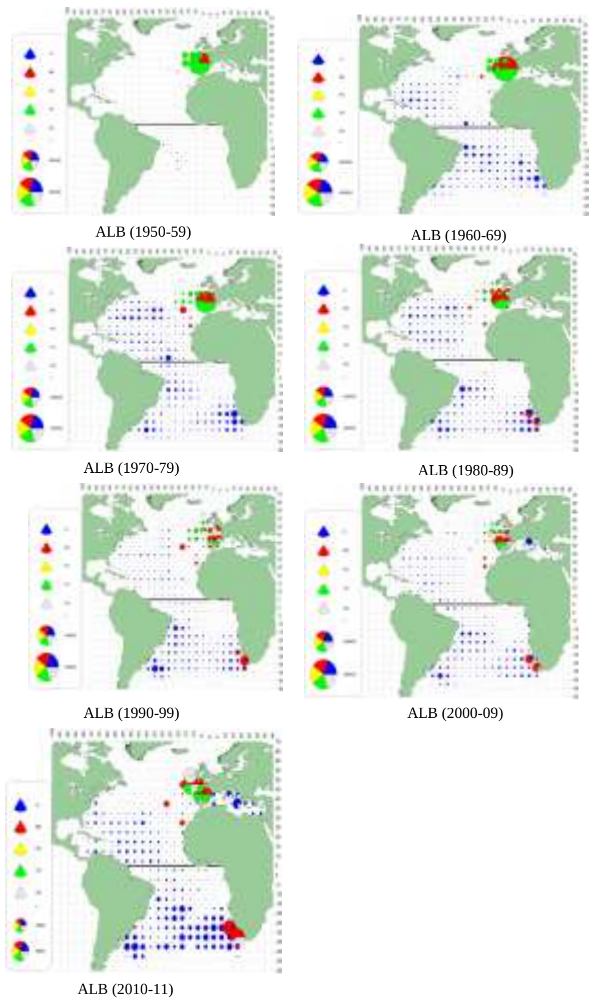


Figure 69. Geographical distribution of bluefin tuna catches by gear.

Bluefin tuna: The longline fisheries have varied their effort considerably in terms of area over time. Since the start of the deep longline fisheries when high catch volumes were made in the tropical Atlantic off the coasts of Brazil (1960-1969), no more catches have been reported in this area. Starting in the 1990s the fleets moved to higher latitudes to catch both stocks, not only along the continental margins but also in the central area of the ocean. In the Mediterranean, an increase has been observed in catches with purse seine, hand line and longline since the 1970s and a decrease in trap catches (**Figure 70**).

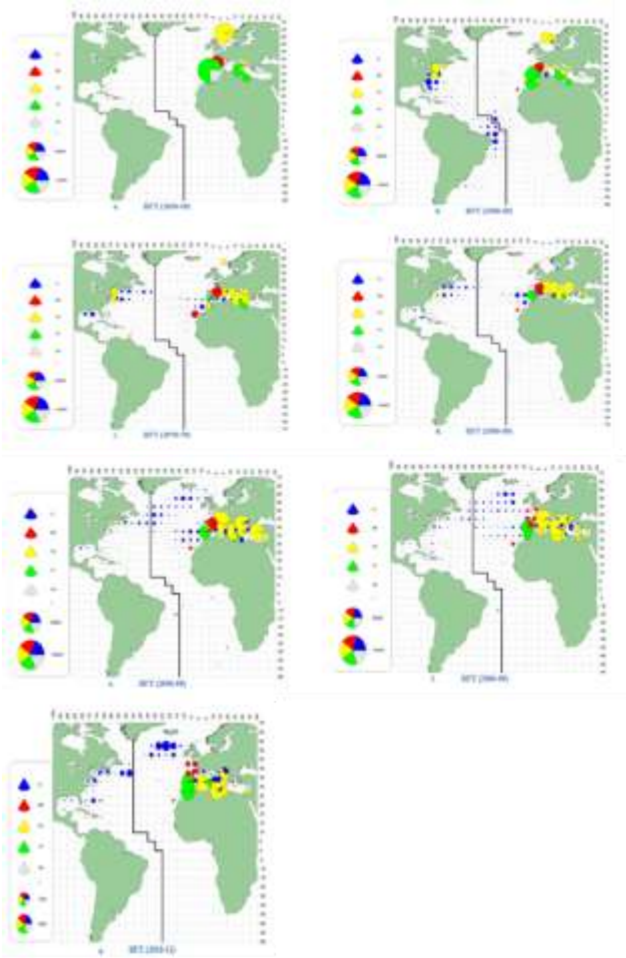


Figure 70. Geographical distribution of BFT catches (t) by major gear and decade (Anon. 2012a).

4.8.2.2 Tropical tunas

Yellowfin: The highest catches for all the gears combined were confirmed in the East area (**Figure 71**) and correspond to purse seine and longline in order of importance (**Figure 72**) (Anon. 2011b).

Figure 71. Yellowfin tuna catches in the Atlantic Ocean by area.

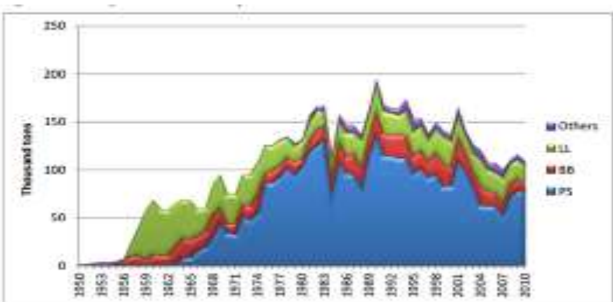
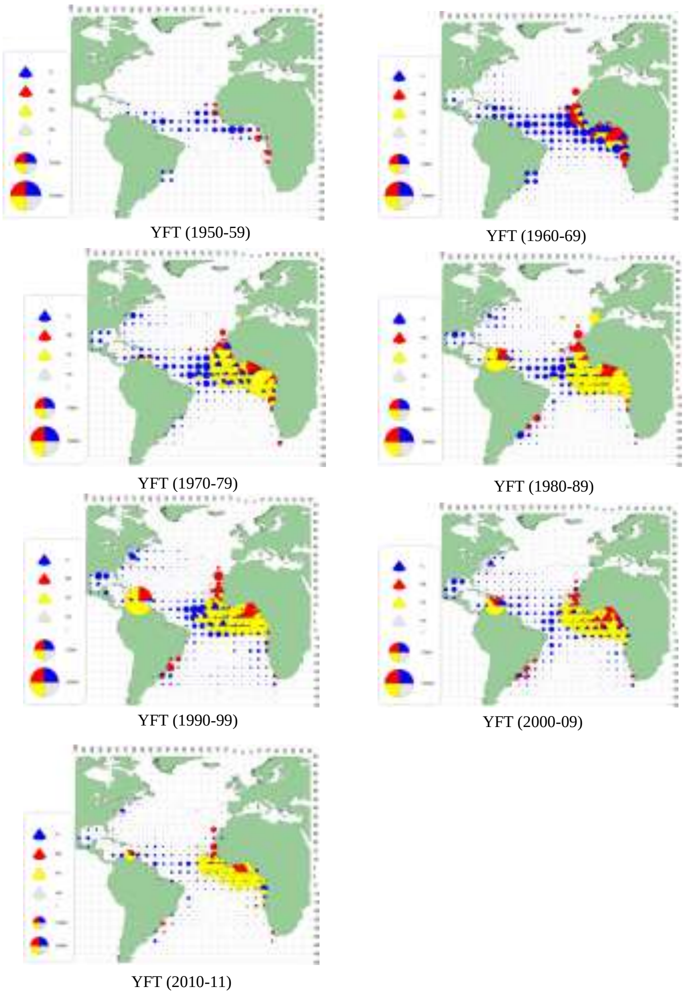


Figure 72. Total yellowfin tuna catches by gear.

Between 1956 and 1970, the Japanese longline fleet mostly deployed its effort in the Atlantic and the yellowfin catches were obtained mainly in the Caribbean and the Gulf of Guinea (Honma 1973). The U.S., Mexican and Venezuelan longliners also catch this species seasonally in the Gulf of Mexico and the Caribbean. In the last 40 years, the principle longline fisheries have been carried out in areas of the West and central Atlantic (**Figure 73**).



After attaining a high of 50,000 t in the late 1950s, longline catches decreased around 30,000 t toward the end of the 1970s. In the first decade of the 2000s, longline catches reached 23,000 t and so far in this second decade (2010-2011) they have declined even further to reach 17,300 t.

Figure 73. Geographical distribution of yellowfin tuna catches (t) by major gear and decade (Anon. 2012a).

Bigeye: Longline is the most important fishery, with a higher percentage of catch than that of the other gears. Since the 1990s, the fleets of Japan and Chinese Taipei are the major fleets in the bigeye longline fishery (**Figure 74**).

The longline fisheries have concentrated in the eastern tropical Atlantic. Between the 1970s and 2000, an increase in catches was observed in the northwest Atlantic, and in the 1980s in the southwestern area (**Figure 75**). Effort in number of hooks increased since the end of the 1970s from 45 million hooks to 120 million at the end of the 1990s, and decreased in early 2000 (Anon. 2010d). The Chinese Taipei fleet increased its effort aimed at this species from the 1990s, reaching 20,000 t at the end of that decade.

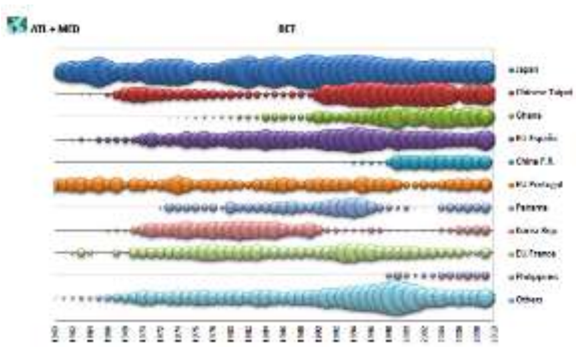


Figure 74. Relative distribution of bigeye tuna catch by major fleet. Classification of catches based on the average of the last five years (Anon. 2012a).

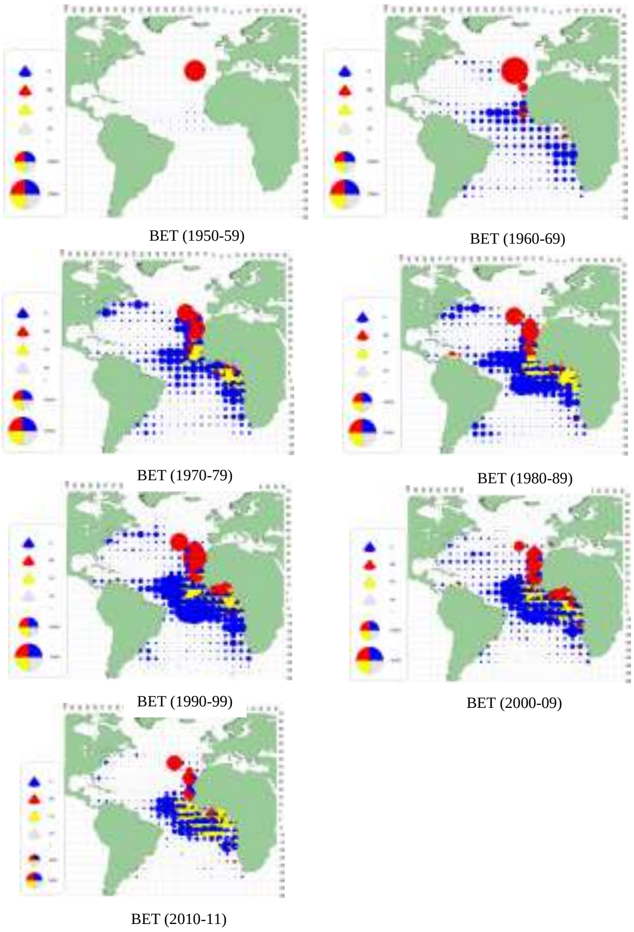


Figure 75. Geographical distribution of bigeye tuna catches (t) by major gear and decade.

4.8.2.3 Swordfish

Swordfish fishing with longline is conducted throughout the Atlantic area, except for minor catches as by-catch in other fisheries (**Figure 76**).

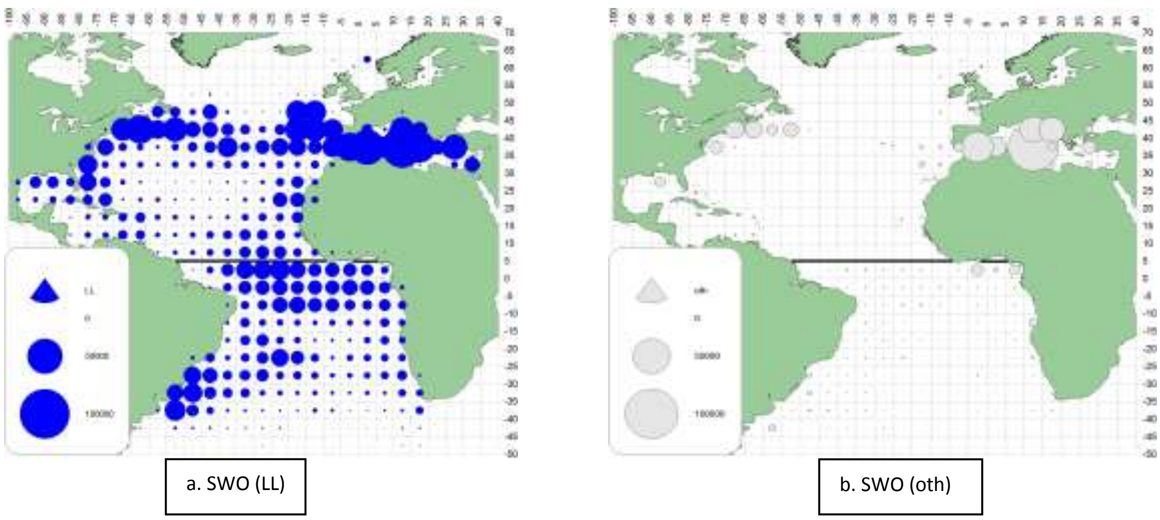


Figure 76. Geographical distribution of swordfish catches (t) by major gear for the entire period from 1960 to 2009 (Anon. 2012a).

Swordfish fishing has been carried out since the 1940s in the North Atlantic, mainly off the western coasts. The longline fishery is more recent and has expanded since the 1980s in the North as well as in the South and the Mediterranean. In recent years, a decline has been noted in the catches due, among other reasons, to a diversification of the catch and the access of sharks to the market (**Figure 77**).

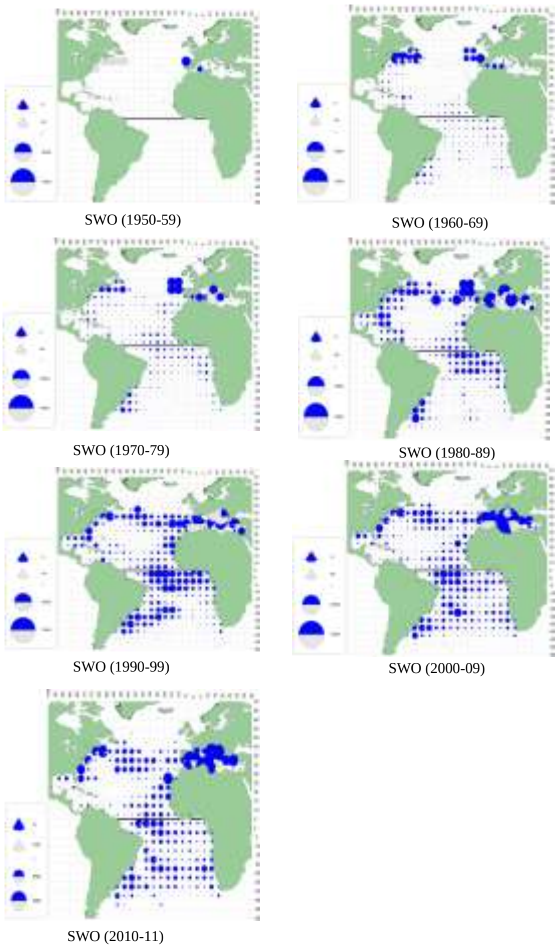


Figure 77. Geographical distribution of swordfish catches (t) by major gear and decade (Anon. 2012a).

In the Mediterranean, longline is also the major gear, although the catches in many coastal countries are carried out using other gears, such as gillnets (**Figure 78**).

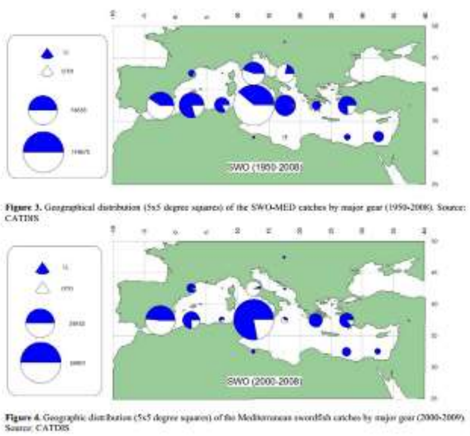


Figure 78. Geographical distribution of swordfish catches from the Mediterranean 2000-2009 (Anon. 2010f).

4.9 Sampling characteristics

Samples are obtained from various sources. Information is obtained from the fishing logbooks, consisting of reports made by the fishing vessel master informing the competent authority on the fishing area, fishing effort and the catches by species, as well as diverse data on the fishery. Information is also available based on the landings and the notifications transmitted by the fishing companies concerning their landings, such as the individual and average weights of the species caught.

Scientific sampling of landings is carried out at some ports where information is collected on size and weight by species. In some cases, where the product is landed with viscera, it is possible to determine the sex of the individuals.

The most important biological sampling is carried out through the observer programs already implemented in the majority of the large fleets. Improvement in the coverage of these programs is in progress, aimed at ensuring that the information obtained is representative.

4.10 Potential impact on the ecosystem, including by-catch

Below is a list of the species associated with the longline fisheries in the Atlantic Ocean and Mediterranean Sea (Castro *et al*. 2000; Dai and Liu, 2000; Diaz *et al.* 2009; Dimench *et al.* 2009; Domingo *et al.* 2009; Mejuto *et al.* 2009; Burgess *et al.* 2010).

Famili	Código	Especie	Nombre común
PECES OSEOS			
Tetraodontidae	LGH	*Lagocephalus lagocephalus*	Oceanic puffer
Alepisauridae	ALO	*Alepisaurus brevirostris*	Short snouted lancetfish
		Alepisaurus ferox	Long snouted lancetfish
Sphyraenidae	GBA	*Sphyraena barracuda*	Barracuda
Trachipteridae	TRP	*Trachipterus* spp.	Dealfish
Gempylidae	GES	*Gempylus serpens*	Snake mackerel
	LE	*Lepidocybium flavobrunneum*	Escolar
	OIL	*Ruvettus pretiosus*	Oilfish
Trichiuridae	LHT	*Trichiurus lepturus*	Largehead hairtail
	SFS	*Lepidopus caudatus*	Silver scabbardfish
Scombridae	WAH	*Acanthocybium solandri*	Wahoo
	FRI	*Auxis thazard*	Frigate tuna
	LTA	*Euthynnus alletteratus*	Little
	BUK	*Gasterochisma melampus*	Butterfly kingfish
	SKJ	*Katsuwonus pelamis*	Skipjack tuna
	BON	*Sarda sarda*	Atlantic
	BFT	*Thunnus thynnus*	Northern bluefin tuna
	SBF	*Thunnus maccoyii*	Southern bluefin tuna
	YFT	*Thunnus albacares*	Yellowfin tuna
	ALB	*Thunnus alalunga*	Albacore
	BE	*Thunnus obesus*	Bigeye tuna
	BLF	*Thunnus atlanticus*	Blackfin tuna
	MAS	*Scomber japonicus*	Chub mackerel
	KGM	*Scomberomorus cavalla*	King mackerel
Xiphiidae	SWO	*Xiphias gladius*	Swordfish
Isxtiophoridae	SAI	*Istiophorus albicans*	Atlantic sailfish
	BUM	*Makaira nigricans*	Atlantic blue marlin
	WHM	*Tetrapturus albidus*	Atlantic white marlin
	MSP	*Tetrapturus belone*	Mediterranean spearfish
	SPF	*Tetrapturus pfluegeri*	Longbill spearfish
	RSP	*Tetrapturus georgei*	Roundscale spearfish
Molidae	MOX	*Mola mola*	Ocean sunfish
		Mola spp.	
	RZV	*Ranzania laevis*	Slender sunfish
	MRW	*Masturus lanceolatus*	Sharp-tail sunfish
Bramidae	POA	*Brama brama*	Atlantic pomfret
	TAL	*Taractichthys longipinnis*	Big scale pomfret
Coryphaenidae	DOL	*Coryphaena hippurus*	Dolphinfish
	CFW	*Coryphaena equiselis*	Pompano dolphinfish
Lampridae	LAG	*Lampris guttatus*	Opah
Carangidae		*Caranx* spp.	Jacks
	RRU	*Elagatis bipinnulata*	Rainbow runner
	AMB	*Seriola dumerili*	Greater amberjack
	YTC	*Seriola lalandi*	Yellowtail
Congridae	COE	*Conger conger*	European conger
Centrolophidae	CEO	*Centrolophus niger*	Rudderfish
Luvaridae	LVM	*Luvarus imperialis*	Luvar
Regalecidae		*Regalecus* spp.	Oarfish
Lophotidae		*Lophotus* spp.	
Monacanthidae		*Aluterus* spp.	Filefish
Nomeidae	CUP	*Cubiceps* spp.	Bigeye cigarfish
Lobotidae	LOB	*Lobotes surinamensis*	Tripletail
Megalopidae		*Megalops atlanticus*	Atlantic tarpon
Pomatomidae	BLU	*Pomatomus saltatrix*	Bluefis
Rachycentridae	CBA	*Rachycentron canadum*	Cobi

Famili	Código	Especie	Nombre común
PECES CARTILAGINOSOS			
Hexanchidae	NTC	*Notorynchus cepedianus*	Broadnose sevengill shark
Squalidae	DGS	*Squalus acanthias*	Picked dogfish
	QUK	*Squalus mitsukurii*	Shortspine spurdog
Dalatiidae	ISB	*Isistius brasiliensis*	Cookie cutter shark
	QUL	*Squaliolus laticaudus*	Spined pygmy shark
Odontaspididae	CCT	*Carcharias taurus*	Sand tiger shark
	LOO	*Odontaspis ferox*	Small tooth sand shark
	ODH	*Odontaspis noronhai*	Small tooth sand
Pseudocarchariidae	PCH	*Pseudocarcharias kamoharai*	Crocodile shark
Alopiidae	BTH	*Alopias superciliosus*	Bigeye thresher
	ALV	*Alopias vulpinus*	Thresher crocodile shark
Lamnidae	SMA	*Isurus oxyrinchus*	Shortfin mako crocodile shark
	LMA	*Isurus paucus*	Longfin mako
	POR	*Lamna nasus*	Porbeagle
	WSH	*Carcharodon carcharias*	Great white shark
Triakidae	GAG	*Galeorhinus galeus*	Tope shark
	CTI	*Mustelus canis*	Dusky smooth-hound
Carcharhinidae	CCN	*Carcharhinus acronotus*	Blacknose shark
	CCA	*Carcharhinus altimus*	Bignose shark
	BRO	*Carcharhinus brachyurus*	Copper shark
	CCB	*Carcharhinus brevipinna*	Spinner shark
	FAL	*Carcharhinus falciformis*	Silky shark
	CCG	*Carcharhinus galapagensis*	Galapagos shark
	CCO	*Carcharhinus isodon*	Finetooth shark
	CCE	*Carcharhinus leucas*	Bull
	CCL	*Carcharhinus limbatus*	Blacktip shark
	OCS	*Carcharhinus longimanus*	Oceanic whitetip shark
	DUS	*Carcharhinus obscurus*	Dusky shark
	CCV	*Carcharhinus perezi*	Caribbean reef shark
	CCP	*Carcharhinus plumbeus*	Sandbar shark
	CCS	*Carcharhinus signatus*	Night shark
	TIG	*Galeocerdo cuvier*	Tiger shark
	BSH	*Prionace glauca*	Blue shark
	RHR	*Rhizoprionodon porosus*	Caribbean sharpnose shark
	RHT	*Rhizoprionodon terraenovae*	Atlantic sharpnose shark
Sphyrnidae	SPL	*Sphyrna lewini*	Scalloped hammerhead
	SPK	*Sphyrna mokarran*	Great hammerhead
	SPZ	*Sphyrna zygaena*	Smooth hammerhead
Somniosida	GSK	*Somniosus microcephalus*	Greenland shark
Dasyatidae	PLS	*Pteroplatytrygon violacea*	Pelagic stingray
Mobulidae	RMB	*Manta birostris*	Manta ray
	RMH	*Mobula hypostoma*	Atlantic devil ray
	RMM	*Mobula mobular*	Devil ray

Famili	Código	Especie	Nombre común
TORTUGAS			
Cheloniidae	LKY	*Lepidochelys kempii*	Kemps Ridley turtle
		Lepidochelys olivacea	Olive Ridley turtle
	TTL	*Caretta caretta*	Loggerhead turtle
	TUG	*Chelonia mydas*	Green turtle
	TTH	*Eretmochelys imbricata*	Hawksbill turtle
Dermochelyidae	DKK	*Dermochelys coriacea*	Leatherback turtle
AVES			
Diomedeidae	DIX	*Diomedea exulans*	Wandering albatross
	DDA	*Diomedea dabbenena*	Tristan albatross
	DEP	*Diomedea epomophora*	Southern royal albatross
	DIS	*Diomedea sanfordi*	Northern royal albatross
		Thalassarche steadi	White-capped albatross
	DIM	*Thalassarche melanophrys*	Black-browed albatross
	TCH	*Thalassarche chlororhynchos*	Atlantic yellow-nosed albatross
	PHF	*Phoebetria fusca*	Sooty
Procellariidae	MGI	*Macronectes giganteus*	Southern giant petrel
	MHA	*Macronectes halli*	Northern giant petrel
	PRO	*Procellaria aequinoctialis*	White-chinned petrel
	PCO	*Procellaria conspicillata*	Spectacled petrel
	DAC	*Daption capense*	Cape petrel
	PUG	*Puffinus gravis*	Great shearwater
	PGR	*Puffinus griseus*	Sooty shearwater
		Puffinus yelkouan	Yelkouan shearwater
MAMIFEROS			
Delphinidae	KIW	*Orcinus orca*	Killer whale
	DBO	*Tursiops truncatus*	Bottlenose
	DELFÍN	*Delphinus delphis*	Common dolphin
Otariidae		*Arctocephalus tropicalis*	Subantarctic fur seal
		Otaria flavescens	South American sea lion

There is little knowledge on the impact that these fisheries have on many of the species caught as by-catch. Some groups, such as sea birds, have been assessed by ICCAT and management measures have been designed aimed at reducing their incidental catch through the mandatory use of weighted branch lines, the use of tori lines and night setting (Recommendation 11-09). Several fleets have contributed information obtained from their observer programs in an attempt to gain greater insight into these aspects and to minimize the collateral damage of this fishery (Jimenez *et al.* 2010, 2012).

Other species that are being assessed and which are of considerable concern to ICCAT are sea turtles; it is known that there is substantial interaction with longline, and a large incidental catch (Pons *et al.*, 2009, 2010).

Large amounts of sharks, such as blue shark and porbeagle, are caught, retained and landed by many fleets. During the period 2001-2011, there were total reported catches of 476,834 and 66,887 t of blue shark and porbeagle respectively, with a record high for both species in 2010 of 71,861 t and a record low in 2011 of 33,217 t (Anon. 2012). Other pelagic sharks and rays are discarded, either because of the ICCAT Recommendations that prohibit their retention (Recommendations 09-07, 10-07, 10-08, and 11-08) or because of their low commercial value. ICCAT has carried out two Ecological Risk Assessments on this group of species (Cortes *et al.* 2010 and Cortes *et al.* in preparation).

At least five species of billfishes are also regulated by ICCAT (Recommendations 01-10, 00-13 and 02-13). While many catches are reported by the industrial longline fleets, catches by artisanal and sport fleets are important but less known however, in some cases, such as sailfish (*Istiophorus platypterus*) they even exceed the industrial longline catches (Anon. 2010e; Anon. 2013).

As for the bony fish that are caught and discarded, there is little knowledge available and in general there are no studies on the impact on these stocks.

4.11 Influence of the environment on the fishing operations

As in the case of any fishery, various environmental factors affect the longline fishing operations and the catch yields and may even determine the possibility of carrying out these operations.

These factors are considered by the vessel master in deciding how and where best to carry out the fishing operations, striving to maximize the catch yields, while maintaining the safety of the crew and the vessel and seeking to avoid or minimize the loss of the fishing equipment.

In regard to the yield of the fishing operations, some environmental factors directly affect the possibility of catching the target species and there are others factors that can affect the quantity and quality (and therefore the economic value) of the catch retained.

The sea temperature partially determines the availability of the different species. The majority of the target species of the pelagic longline fisheries are characterized by having a wide range of tolerance to sea temperature, even when they have preferences and very dynamic behavior. Thus, in some cases, depending on the environmental conditions, different longline configurations are used to catch the same species.

Given that the target species are highly migratory and often show segregation by size classes, in many areas where the longline fisheries operate, their abundance and yields do not remain constant throughout the different seasons. As a result, the fleets respond to the spatial-temporal dynamics that are characteristic of each region, according to the target species of their fishing effort.

In some cases, the target species undertake diel vertical migrations and therefore the probability of catching these species with longline at a given depth would vary depending on the time of day. Because of this, in some areas deep pelagic longline is not used during the day and surface longline is not used at night. Although it has been determined that the lunar phase affects the vertical behavior of some species, this effect does not apply in the same manner to all individuals.

The characteristics of the water masses, including sea surface temperature, the concentration of chlorophyll, the speed of the current, the altimetry, and the depth of the thermocline are used by the vessel masters to choose the fishing areas and decide how to configure and set the longline. For this, the vessel masters use information obtained by remote sensors and received on board the vessel from various communication and information systems, as well as data obtained from the vessel itself from thermometers, depth and temperature sensors, disposable bathythermographs, timer devices, and Doppler current meters, among others.

The presence of temperature fronts, upwellings and geographic features such as seamounts and, in some cases, the continental slope itself, are variables that also affect the local abundance of various target species of the pelagic longline fisheries.

Another environmental factor that can affect pelagic longline fishing operations is the predation of the catch by some odontocete cetaceans and sharks. The damage that they cause by eating the fish that have been caught by the longline can result in highly substantial economic losses, since the damaged fish have a much lower market value and in some cases the damage is so substantial that the fish caught have no value at all. At times, different methods are used (acoustic deterrent devices and evasive maneuvers) to reduce this problem and to be able to continue the operation. However, in extreme situations, the economic evaluation of this predation made by the vessel masters causes them to change the fishing area.

At the operational level, the wind and the resulting waves can restrict the vessel master´s options with regard to the direction of setting and hauling of the longline. This affects the smaller vessels more, as they are more susceptible to the intensity of the wind and the waves during the haul back of the longline. The currents can cause difficulties, since in some cases they cause the gear to shift several miles during the inactive period, resulting in complications if working close to a jurisdictional limit (EEZ, MPA), or even causing tangling and/or breakage of the longline. At times, sections of the longline that have become detached move several miles away, resulting in delays of several hours in the fishing operation.

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