ATLANTIC BLUEFIN TUNA FISHERIES: TEMPORAL CHANGES IN THE EXPLOITATION PATTERN, FEASIBILITY OF SAMPLING, FACTORS THAT CAN INFLUENCE OUR ABILITY TO UNDERSTAND SPAWNING STRUCTURE AND DYNAMICS

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SUMMARY

The several fisheries for the Atlantic bluefin tuna showed many changes in the exploitation patterns over the years. Some of them are known and duly described, many others are not. Management decision of course also induced important changes in fishery strategies and patterns. Many of these changes affected the opportunities for properly sample bluefin tuna and therefore understand its spawning structure and dynamics, because most of the fisheries were and are carried out around or during its spawning period. This paper presents a comprehensive review of the bluefin tuna fisheries in all areas of the Convention as they were reported to the ICCAT Task I Data Base, adding any possible available knowledge, trying to analyse the main changes in the fishery patterns and the major problems for sampling over the years.

RÉSUMÉ

Les différentes pêcheries de thon rouge de l'Atlantique ont montré de nombreux changements dans les schémas d'exploitation au fil des ans. Certains d'entre eux sont connus et dûment décrits, beaucoup d'autres ne le sont pas. Bien entendu, les décisions de gestion ont également entraîné des changements importants dans les stratégies et les modèles de pêche. Nombre de ces changements ont affecté les possibilités d'échantillonner correctement le thon rouge et donc de comprendre sa structure et sa dynamique de frai, car la plupart des pêcheries étaient et sont actives autour ou pendant sa période de frai. Le présent document présente un examen exhaustif des pêcheries de thon rouge dans toutes les zones de la Convention telles qu'elles ont été déclarées à la base de données de la tâche I de l'ICCAT, en ajoutant toutes les connaissances disponibles possibles, en essayant d'analyser les principaux changements dans les schémas de pêche et les principaux problèmes d'échantillonnage au fil des ans.

RESUMEN

Las diversas pesquerías del atún rojo del Atlántico han presentado muchos cambios en los patrones de explotación a lo largo de los años. Algunos de ellos son conocidos y han sido debidamente descritos, muchos otros no. Las decisiones en materia de ordenación inducen también importantes cambios en las estrategias y patrones pesqueros. Muchos de estos cambios afectaron a las oportunidades para muestrear adecuadamente al atún rojo y, por tanto, poder comprender su estructura y dinámica reproductivas, porque la mayoría de las pesquerías se realizaban y realizan en torno o durante el periodo de reproducción. Este documento presenta una revisión exhaustiva de las pesquerías de atún rojo en todas las zonas del Convenio tal y como fueron declaradas a la base de datos de Tarea I de ICCAT, añadiendo cualquier posible conocimiento disponible, intentando analizar los principales cambios en los patrones pesqueros y los principales problemas para el muestreo a lo largo de los años.

KEYWORDS

Bluefin tuna fisheries, longline fishery, purse-seine fishery, trap fishery, hand-line fishery, harpoon fishery, bait boats fishery, rod and reel fishery, trolling fishery, trawl fishery, gillnet fishery, driftnet fishery, changes, exploitation pattern, spawning structure, spawning dynamics, stocks, Atlantic bluefin tuna, Thunnus thynnus

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1. Introduction

The goal of this paper is to summarise the available information about the many changes in the Atlantic bluefin tuna[4] (BFT, *Thunnus thynnus*) fishing patters happened in the ICCAT Convention area over the years, along with the correlated opportunities, problems and limits for carrying out the sampling. All components can affect or bias our capability to understand the spawning structure and dynamic of the species. This was not an easy duty, due to the many components of the BFT fisheries and the many changes over the years and therefore the overview will be surely incomplete.

Anyway, this overview provides a synthesis which can be useful for better understand the important changes, which are not always easy to understand from the usual annual summaries provided by ICCAT SCRS. This study is organised by management area, and then by fishing gear and by CPC.

This work was firstly presented to the ICCAT GBYP Workshop on Bluefin Tuna Reproductive Biology (Madrid, Spain, 26-28 November 2018) and it was updated with the latest data available on the ICCAT Task I BFT data bank till August 2019.

Ideally, having an homogeneous distribution of a given fish species (in this case the BFT) over the various months, or a perfect knowledge of its distribution by area and season, and then if fishing fleets are able to provide comparable data over the years, with a very well-known fishing effort, according to a very well-described fishing pattern and fishing locations, it should be possible to get very useful data about the reproductive biology of the species, according to a well-designed sampling.

Of course, these data should be further integrated by the necessary sampling just before and during the full spawning season, carried out in a significant way not only on the spawning ground, but also in the remaining parts of the distribution area of the species, for trying to perfectly assess the percentage of spawning fish at age.

This report tries to describe how the many changes in exploitation patterns by gear, area and CPC and the management measures over the years affected (or not) our understanding of the reproductive biology of this species and the possibility to properly carry out the necessary samplings.

2. Methods

The data provided by the SCRS reports over the years, since the very first year of the ICCAT Biennial Report series, were the basis for setting-up this summary study (comprehensive ICCAT Commission and SCRS Reports, Anon., 1971 to 1981 and 1982a to 1994; SCRS Reports, Anon., 1995 to 2002 and 2003a to 2019a; Annual Reports, Anon., 2003b to 2019b). Additional data and information were provided by the huge number of papers on BFT that were published annually on the ICCAT Collective Volume of Scientific Papers, but it was decided not to specifically list all these papers due to the huge amount of references. Important information was provided also by the comprehensive review done by Mather *et al*., 1995.

The most relevant management measures were obviously taken from the ICCAT Biennial Reports (Commission).

The important issue of the old longline catches in central and southern Atlantic Ocean was based on the information provided by Wise and Davis (1973), Mather *et al*. (1995), Tacheuchi *et al*. (2009) and the recent review by Schalit (2019).

3. Overview

It is clear that most fishing patterns changed over the years for many reasons and, of course, the sampling coverage was different and usually unbalanced, biasing several data sets (if not all) in different ways, lacking a general sampling design or strategy. **Figure 1** provides a general overview of how the most relevant BFT fisheries in the ICCAT Convention area changed over the decades, according to the official data provided by MS.

[4] Or northern bluefin tuna, as reported by ICCAT in Task I

Due to the many areas included in the ICCAT Convention area, this paper presents the overview by area and then, within each area, by gear and possibly fishery. The areas have been those considered by the new BFT MSE approach (**Figure 2**), as much as possible, because some areas (as they are defined by MSE) are not necessarily fitting the information of some fisheries, due also to the partial lack of overlapping with the ICCAT BFT Statistical Areas. Due to the fact that the ICCAT Task I BFT Data Base is fundamentally based on the ICCAT Statistical Areas for bluefin tuna (**Figure 3**), as they were defined by SCRS, some data/fishery have been also referred to this map.

3.1 Western Atlantic

Looking at the data and the information which are available, the first impression is that the western part of the Atlantic has several data problems which seriously affect the understanding of the bluefin tuna situation and the related fisheries.

Several areas have no data since many years and a specific big hole concerns the central and southern western Atlantic. There, it is very clear that BFT fishery data simply disappeared after 2006, again after the huge peak of LL catches off Brazil in the '60s. IUU catches in the area are known even in recent years (mostly SPOR and by-catch in LL).

If these huge catches off Brazil were really WBFT is still a pending question, because this view is not supported by any scientific evidence, but these catches are driving the WBFT assessment since decades, because they are considered the historical upper reference.

Another problem concerns the western tropical Atlantic, including the Gulf of Mexico (GOM) and the Caribbean. In the GOM most of the data are from the US fisheries (LL, RR, RRFB, RRFS) and Mexico (LL) and most of the research is within the US area. Cuba provided LL data up to 2006. Sporadic data are coming from some Caribbean islands but it is clear that several data are missing.

It is clear that one of the major changes in the fishery pattern happened at the end of the '60s, when the huge catches off Brazil were not available anymore and some fleets moved away from that area. From the '70s, the fisheries expanded in the central-northern Atlantic and then further North.

Another major change happened when the WBFT quota was set in 1982, bringing seriously down all catches. This fact surely had an impact on all fishery data. It is difficult to assess if the data series before 1982 can be compared in some way with those after 1982, but this is the same fundamental doubt which exists for all fisheries concerned by the enforcement of a quota regime after a period of free fishery.

Some fisheries are poorly monitored, but the most important problem for the sampling is that only a portion of the GOM is sampled, while samples from the remaining part of the GOM, the Caribbean and the southern-western Atlantic are simply not existing since many decades.

These facts very seriously affect not only our understanding of the bluefin tuna spawning area(s) structure and dynamics, but also our basic understanding of the population dynamics, because the population components in this huge area are still fully obscure. The tagging data are not helping, because only very few tags went from the northern areas to the central-southern Atlantic, therefore sampling in the western central-southern Atlantic is absolutely essential and it is clearly one of the must to do in BFT research.

Sampling bluefin tuna in all parts of the GOM, in the Caribbean and along the US East coast during the spawning season is another must, because this will be essential for clarifying the size at first maturity and the extension of the spawning areas in this part of the ocean.

3.1.1 Western Atlantic Longlines (LL)

BFT data are reported on ICCAT Task I as LL, LLFB, LL-B, LL-Surf and LLSWO (by-catch) and then are difficult to understand in general. 15 different countries participated to these fisheries over the years. Due to the high mobility of the fleets and the huge area, the data will be presented by area, taking into account that not always the Task I area is providing the reality of the effective fishing location. The areas are those specified in ICCAT WEB Task I data base.

WEST Atlantic:

- Korea Rep. (LL) from 1972 to 1979 with small amount of catches;
- Panama (LL) from 1979 to 1982 with low quantities and LLFB from 1973 to 1978, max 157 t in 1976;
- Chinese Taipei (LL) from 1968 to 1995 (not continuously) with few catches (max 49 t in 1979).

NW Atlantic:

- Canada (LL-Surf) from1986 to 2017, max 112 t in 2011, range 45-112 t in the last decade;
- USA (LL) from 1952 to 2017, max 541 t in 1986, range 79-216 t in the last decade and LL-B in 1952 and 1958, max 26 t in 1958 (note: it seems that effort changed from 1986);
- FR-St. Pierre et Miquelon (LL) from 1999 to 2015, max 10 t in 2004, range <1-10 t in the last decade;
- Japan (LL) from 1957 to 2017, max 12044 in 1964, range 162-578 t in the last decade (note: it seems that the catches obtained in the SW, WTROP and GOM are included here);
- Korea Rep. (LL) from 2005 to 2006, max 18 t in 2006;
- Cuba (LL) from 1965 to 2006, max 2352 t in 1967, range 11-74 t in the last decade (note: it is unclear if some of these catches were in the GOM);
- Panama (LL) in 2006 with <1 t;
- UK-Bermuda (LLSWO) from 2009 to 2015, always <1 t;
- UK-Turks & Caicos (LL) in 2014, <1 t.

NWC Atlantic:

- USA (LL) from 1987 to 2014, max 57 t in 2009, range 4-57 in the last decade;
- Canada (LL-Surf) reported catches in 2010, 2013 and 2014, ranging from 3 to 17 t.

GOM:

- Mexico (LL) from 1972 to 2017, max 55 t in 2016, range 7-55 in the last decade;
- USA (LL) from 1981 to 2017, max 184 t in 1991, range 9-112 in the last decade;
- (note: it is suspected that catches from other countries are not included in this area).

WTROP Atlantic:

- USA (LL) from 1986 to 2016 but just for 6 years, range <1-1 t;
- Dominica (LL-Surf) in 2014 and 2015 with <1t, and LL-B in 2016 with <1t;
- Trinidad and Tobago (LL) in 1985 with 1 t.

SW Atlantic:

- Brazil together with Japan (LLFB) from 1978 to 1999, range <1-14 t and LL in 2012 for <1 t;
- Argentina (LL) from 1962 to 1973, range 2-106 t, max 271 t in 1963 (note: other more recent catches from Argentina are officially published on national fishery statistical reports but they were not reported to ICCAT);
- Korea Rep. (LL) in 2006 with 34 t.

Except for the important shifting of the fleets operating off the Brazilian waters from 1956 to the '60s, which moved partly to the GOM, to the SW Atlantic, to West Africa and to NW Atlantic (**Figure 4, Figure 5, Figure 6, Figure 7**), it is difficult to detect changes in fishing pattern without the full availability of detailed data and information, even if two recent papers (Tacheuchi *et al.*, 2009, and Schalt, 2019), provided a good overview.

Sampling on all the LL fleets operating in Western Atlantic would be important, particularly during the spawning season (for obtaining additional details on maturity) and, more important, in central-southern Atlantic (for all data: size composition, genetic, micro-chemistry and maturity), but observers on board are necessary.

Unofficial and anecdotic information confirmed that by-catch of BFT still occurs in various LL fisheries targeting other pelagic species in central and southern Atlantic; these BFT are not reported due to quota problems.

3.1.2 Western Atlantic Purse Seines (PS)

The PS fishery is carried out by only two CPC in the West Atlantic. The data are reported as PS, PSFB and PSFM and are all related to North-West Atlantic; the PS fishery in the GOM does not appear in ICCAT WEB Task I.

- USA reported PS catches from 1950 to 2015; the peak was in 1963 (5,447 t), while important decreases happened from 1968 and again from 2003; catches ranged from 2 to 43 t in the last decade. US reported also PSFB data from 1970 to 1979, with a peak in 1970 (779 t), and PSFB data from 1969 to 1979, with a peak in 1971 (2,371 t). The fishery was mostly in the NE part of the US East Coast.

- Canada reported PS catches from 1963 to 1981 (but according to other sources the range was more extended), with a peak in 1970 (1,161 t) (the quantities seems underestimated). This fishery was mostly targeting juveniles (according to the WBFT maturity age used in previous assessments).

Information about these fisheries is poor. It is very clear that there were changes in the fishing effort, mostly after setting the quota in 1982, while it is less clear if there were changes in the fishing pattern.

Due to the lack of recent information, it is supposed that all fish are immediately harvested. This should provide good sampling opportunities if the researchers can have access to the fish

3.1.3 Western Atlantic Rod and Reel (RR) and various lines

This category includes RR, RRFB, RRFS, TROL, TE and SPOR, which means several types of lines, operated in different ways. The overview of this category on ICCAT WEB Task I is difficult, because of the many components and areas.

RR: NWA: in general, RR catches in the area ranged from 112 to 722 t in the last decade;
- USA reported data are from 1960 to 2017, having a large hole (2001 to 2015), a peak in 1966 (3615 t) and important catches in the '60s;
- Canada reported catches from 1990 to 2017 with a peak in 2006 (626 t);
- UK-Bermuda reported catches from 1996 to 2013 ranging from <1t to 2 t.

RR: other western areas (NWC, GOM, WTRO);
- Canada reported catches in the NWC just for three years between 2010 and 2014, ranging from 2 to 10 t;
- USA reported catches in the GOM for 7 years, between 1984 to 2017, ranging from <1 t to 2 t;
- UK Virgin Islands reported catches in WTROP in 2014 and 2015, for < 1t.

RRFB: NW: in general, RRFB catches in the area ranged from 235 to 717 t in the last decade;
- USA reported data from 1952 to 2014, with a peak in 2002 (1002 t);
- Canada reported catches from 1950 to 1998 with a peak in 1974 (409 t).

RRFB: Other areas.
- Only USA reported catches in the GOM for just three years, from 2001 to 2006, ranging from 1 to 2 tons.

RRFS:
- USA reported catches in NWA from 1950 to 2014, with a peak in 1974 (2361 t), ranging from 100 t to 399 t in the last decade; USA reported also catches in the GOM for just one year, 2014, for less than 1 ton.

TROL: NW:
- Canada reported catches in 2011 only, for 16 tons;
- UK Bermuda reported catches in 2017 only for <1 t.

TROL: WTRP:
- Dominica reported catches in 2014 for <1 t.

TE: NW:
- Canada reported catches from 1982 to 2017, with a peak in 1989 (579 t), ranging from 15 to 37 t in the last decade.

TE: NWC:
- Canada reported catches in 2010, 2011 and 2013, ranging from 19 to 24 t.

Information on RR and other gear is not really useful, because of the several categories in this group of gear, but also because the reported catches by category are not always clear and there is a mixture of commercial, sport and recreational fishermen. All these factors together make impossible to reliably detect changes in the exploitation pattern, except for the fact that data seem largely incomplete (several WATL CPCs have these fisheries, as it is well known) and that these fisheries were much more active before the adoption of the quota system.

Sampling these fisheries needs a permanent control in many landing ports and over many hours, because of the many vessels. Retained fish are immediately harvested at landing (or after the tournaments) and sampling is theoretically possible, with many efforts. This sampling could potentially provide important data on spawners.

3.1.4 Western Atlantic hand lines (HAND)

The data on HAND fisheries are reported since 1950 and they area on ICCAT WEB Task 1 data base.

- USA (NW) has a complete HAND series. The peak was in 1979 with 457 tons, but catches were decreasing from 1996. In the last decade. Important changes surely happened in this fishery, but they are not clearly explicated. US HAND catches ranged from less than 1 ton to 5 tons in the last decade;
- Canada (NW) reported HAND catches for two years (2015-2016) with a maximum of 13 tons in 2016;
- St. Lucia (NW but more possibly WTROP) reported HAND catches from 1987 to 1996, with a peak of 43 tons in 1994;
- Dominica (WTROP) reported HAND catches only in 2014 with <1 ton;

Information on HAND fisheries is very scarce in general. Some details are mixed-up with other fisheries (RR, SPOR and TE). US releases actually about 600 "open access permits" and HAND is inside them. It seems that US fishery is between January and March off Cape Hatteras and from June to December in the NE coast (Gulf of Maine and Outer Banks). In Canada the fishery is from late Jun to November.

Sampling in HAND needs a permanent control in landing ports. Retained fish are immediately harvested at landing and sampling is theoretically possible, with many efforts. Winter/spring fishery could provide important data for the next spawning season.

3.1.5 Western Atlantic Traps (TRAP)

The data on TRAP fishery are reported since 1950 and they are included in ICCAT WEB Task 1 data base. There were many traps along the NE coast of US (Massachusetts) and Canada (St. Margarete's Bay), several of them were specifically targeting bluefin tuna for about 4 to 6 weeks per year (post-spawners), sometimes also ranching them. The maximum catch is 869 t for the USA (in 1958) and 372 t for Canada (in 1977).

- USA officially reported the last TRAP catches in 1974 but some SCRS papers show catches at least till 1980, while catches after 1980 were considered as "incidental" and seem not reported. The maximum catch (869 t) was in 1958.
- Canada reported TRAP catches from 1950 to 2017, with a peak of 372 t in 1977. Reported TRAP catches ranged from 4 to 39 tons in the last decade. The important decrease in catches is after 1980, possibly corresponding to a decrease in the number of traps. Several traps, targeting squids, cups and mackerels, are still by-catching BFT. It is unknown if there is any IUU percentage in this fishery.

Sampling in TRAPs was and is relatively easy, because all fish are immediately harvested and those which are going to the Japanese market are sold without the head, which allows also for the otolith sampling. Post-spawning gonads can provide good info on spawners.

3.1.6 Western Atlantic Harpoon (HARP)

The data on HARP fishery are reported since 1950 and they are included in ICCAT WEB Task 1 data base.

Harpoon fishery is carried out by about 30 US vessels only, mostly targeting potential post-spawning bluefin tuna; the fishing season is usually June-July, sometimes extending to August. The fishing areas are the Gulf of Maine and Cape Hatteras.

The maximum catch is 233 t in 1975 and catches are very variable from year to year, possibly depending on effort and sea-state. Reported HARP catches ranged from 23 to 82 tons in the last decade.

Sampling in HARP requires observers in the landing harbours, but it is feasible because all fish are immediately harvested. Gonads can provide good info on spawners, including those from the Slope Sea.

3.1.7 Western Atlantic Electric Harpoon (HARPE)

The data on HARPE fishery are reported since 1950 and they are included in ICCAT WEB Task 1 data base.

The electric harpoon fishery is carried out by about 10 Canadian vessels only, mostly targeting post-spawning bluefin tuna; the fishing season is usually August-October. The fishing area is mostly the Bay of Fundy (NW). The maximum catch is 357 tons in 1950 and catches are very variable from year to year, possibly depending on the number of vessels, effort and sea-state. There are no data for the period 1960 to 1992. Reported HARPE catches decreased since 1955, while vessels decreased also since 1997. Catches ranged from 17 to 31 tons in the last decade.

Additional HARPE catches are reported by Canada in the NWC in 2010 and 2013 (15 and 4 t).

Sampling in HARPE requires observers in the landing harbour(s), but it is feasible because all fish are immediately harvested. Gonads can provide good info on post spawners.

3.1.8 Western Atlantic Gillnets (GILL)

The data on GILL fishery are reported since 1950 and they are included in ICCAT WEB Task 1 data base. It is very possible that the data includes also driftnets.

Catch data on GILL fishery are available from 1950 to 2001 for just two CPCs in the NW: USA and Canada.

- USA reported catches from 1950 to 2001, but data have holes from 1955 to 1964, 1972 to 1991 and from 1977 to 2000. The US maximum catch was 5 tons in 1967.
- Canada reported GILL catches only in 2001 (less than 1 ton).

Information on GILL fisheries in the North-western Atlantic is less than scarce. There are no data on the type of gear, vessels and fishing areas. It is possible that bluefin tuna was a by-catch in some GILL fisheries targeting other species.

EU-UK reported few (<1 t) GILL catches in SW Atlantic in 2002. It is difficult to attribute any meaning to these few catches, which seem incidental.

It is possible that the reason why the GILL data stopped in 2002 is related to the adoption of the UN driftnet ban in the same year.

3.1.9 Western Atlantic Trawler (TRAWL)

The data on TRAWL fishery are scarce and they are possibly referred to by-catch in various types of trawl fisheries; it is unknown if pelagic trawler are included or not.

Argentina (SW) reported BFT catches from 1985 to 1999, within a range <1-6 t.

It seems that BFT by-catch in trawl fishery is not occurring anymore or, more probably, it is not reported.

3.2 East Atlantic and adjacent Seas

The complexity in this large part of the ICCAT Convention area is huge, because many fisheries are active since many centuries, and almost all fishing gear are used.

The available historical data have been recovered and collected by ICCAT GBYP, showing how fishing patterns considerably changed over the centuries. The purpose of the present report is to examine the situation over the decades covered by the ICCAT management.

Even if data are not always complete, most of the fisheries are covered, but not all fisheries are reported for the right statistical sub-area, creating additional problems for understanding changes in fishery patterns. For the purposes of this paper, reported catches were reallocated according to the most probable fishing area of the fishery, creating a discrepancy with the officially reported area. All changes are duly marked in the text.

An important change happened before the '60s, when the fishery in the North Sea disappeared (**Figure 1**). Another change happened at the beginning of the '90s, when several LL moved to the northern Atlantic.

The most relevant changes happened when the quota system was adopted (since 1999, ICCAT Rec. 98-05), because all fishery-related indices were seriously impacted but, from a sampling point of view, the problems initiated when commercial practices for BFT changed due to the export in far areas and when the tuna ranching became a common practice.

In the EATL too, a very important problem concerns the central-southern Atlantic, where reported catches disappeared from 2006, when a residual unallocated quota was cancelled, while confidential but verified information referred about huge BFT catches off Angola in 2011 (±2,000 t) and in 2015 (±800 t), which were never reported to ICCAT by any CPC. Other smaller anecdotic catches of BFT are known for some LL vessels fishing in that area and also these catches were never reported to ICCAT.

A limited amount of fisheries reported their catch as EATL but it seems not clear what really the EATL means, because many catches are reported as sub-areas (Azores, Canary Islands, Madeira), making difficult understanding the various fisheries and patterns.

Some catches were reported as NEI or obtained with UNCL gear and therefore they were not considered in this overview.

Usually the fisheries in EATL are catching post-spawners and foraging fish (even if juveniles and young adults are fished in the Bay of Biscay and in some parts of the Mediterranean Sea), therefore studies on the reproductive biology are very difficult in this area, but not everywhere. Sampling was partly carried out in general.

3.2.1 East Atlantic Longlines (LL and LLFB)

Catches were reported as longlines and longlines for big fish (LL and LLFB) by few fleets, targeting medium-giant fish. Information on these fisheries is clearly not complete.

- Chinese Taipei: catches are reported as LL, without any EATL area specification, making difficult understanding any change in the fishery. Catches are reported from 1968 to 2017, ranging from 1 to 205 t and the maximum in 1998.
- Korea Republic: catches are reported as LL, without any EATL area specification, making difficult understanding any change in the fishery. Catches are reported from 1972 to 1997, ranging from 1 to 350 t and the maximum in 1995.
- Faroe Islands: catches are reported as LL, in EATL, possibly in the NE sector. Catches are reported only in 1999 and 2000, for 36 and 93 t. respectively.
- Panama: catches are reported as LLFB, without any EATL area specification, making difficult understanding any change in the fishery. Catches are reported from 1973 to 1999, ranging from 1 to 550 t and the maximum in 1996.

These fisheries were all seriously affected after the enforcement of the EBFT Recovery Plan and the quota system.

3.2.1.1 East Atlantic (including also Azores, Madeira, Canary Islands) Longlines (LL, LL-surf, LLJAP, LLALB and LLSWO)

All these three areas are clearly sub-areas of the EATL. The various types of longlines (LL, LL-surf, LLJAP, LLALB and LLSWO) reported by the CPCs are those included in the ICCAT WEB Task I BFT data base, but it is not very clear if the different acronyms are always really linked to different fisheries.

- EU-Portugal: mainland: catches are reported as LL-surf, LLALB and LLSWO, officially for NEAT; for LL-surf, catches are reported from 1982 to 2017, ranging from <1 to 102 t, with the maximum in 1987; for LLALB, catches are reported from 1996 to 2000, ranging from 18 to 404 t, with the maximum in 1999; for LLSWO catches are reported only in 2006 for 7 t. The patterns of these fisheries are unclear, but it is supposed they should be in EATL.
- EU-Portugal: Azores: catches are reported as LL-surf and LLSWO, being unclear the separation; LL-surf catches are reported from 2005 to 2017, ranging from <1 to 5 t, with the maximum in 2017; LLSWO catches are reported in 2002 only, for 29 t.

- EU-Portugal: Madeira: BFT catches are reported as LL, LL-surf, LLJAP and LLALB; LL catches are reported from 2006 to 2017 with holes, ranging from 4 to 10 t, with the maximum in 2017; LL-surf catches are reported for 2005 and 2006, for <1 and 14 t respectively; LLJAP catches are reported for 2006 only, for 34 t; LLALB catches are reported from 1991 to 1995, ranging from 70 to 134 t, with the maximum in 1995.
- Morocco: catches are reported as LL for the NEAT, from 2003 to 2007, ranging from 1 to 273 t, with the maximum in 2007. This fishery effectively operates off the Moroccan waters in the sub-area called "Canary Islands".

These fisheries were seriously affected after the enforcement of the EBFT Recovery Plan and the quota system. Sampling these fisheries could seriously improve the understanding of the BFT reproductive biology in these key areas, where additional potential spawning grounds are supposed to be.

3.2.1.2 East Atlantic (including also Azores, Madeira, Canary Islands), other fisheries (BB, BBF, HAND, PS, TRAP and GILL)

The various types of fishing gears (BB, BBF, HAND, PS, TRAP and GILL) reported by the CPCs are those included in the ICCAT WEB Task I BFT data base.

The TRAP fishery in EU-Portugal, EU-Spain and Morocco can be regarded as the most stable fishery over the centuries, even if the number of traps changed considerably between the end of the XIX century and the current days. In any case, this fishery is possibly the most documented one and it provided many samples and biological data, including many on the BFT reproductive biology.

- EU-Portugal: mainland: catches are reported as BB, PS and TRAP, officially for NEAT;
  BB, catches are reported only in 2006, for 7 t; for PS, catches are reported from 1986 to 2017, ranging from <1 to 8 t, with the maximum in 1998 and an average of 1.3 t in the last decade, looking as a by-catch; for TRAP, one of the historical activities, catches are reported from 1950 to 2017, ranging from <1 to 3,150 t, with a maximum in 1953, and an average of 193.7 t in the last decade; TRAW catches are reported for 1996 only, for 7 t.
- EU-Portugal: Azores: catches are reported as BB and PS; BB catches are reported from 1974 to 2016, ranging from <1 to 303 t, with the maximum in 1975; PS catches are reported from 1983 to 1986, ranging from 3 to 123 t, with the maximum in 1986.
- EU-Portugal: Madeira: BFT catches are reported as BB and HAND; BB catches are reported from 1976 to 2017 with holes, ranging from 1 to 340 t, with the maximum in 1997; HAND catches are reported from 1979 to 1990, ranging from 1 to 25 t and the maximum in 1979.
- EU-Spain: mainland: catches are reported as HAND and TRAP, officially for NEAT; for HAND, catches are reported from 1977 to 2017, ranging from 2 to 998 t, with the maximum in 1979 and an average of 30.5 t in the last decade; for TRAP, catches are reported from 1950 to 2017, ranging from 10 to 9,200 t, with the maximum in 1957, and an average of 1,157.4 t in the last decade; these fisheries are both close to the Strait of Gibraltar. HAND is usually carried out mostly in the Strait of Gibraltar.
- EU-Spain: Canary Islands: catches are reported only as BB, from 1965 to 2017, ranging from 2 to 1,548 t, with the maximum in 1978 and an average of 75.5 t in the last decade. It is likely that these data include also the Spanish BB fishery in the Strait of Gibraltar, because the catches are not separated in the ICCAT Task I data.
- Morocco: catches are reported as PS, TRAP and GILL, for the NEAT, PS catches are reported from 1958 to 2006, ranging from 24 to 3,486 t and with the maximum in 1959; TRAP catches are reported from 1950 to 2017, ranging from 2 to 5,422 t and with the maximum in 1958 from 2003 to 2007, ranging from 1 to 273 t, with the maximum in 2007; the average is 1,348 t in the last decade. GILL catches are reported from 1983 to 2011, ranging from 3 to 84 t and with the maximum in 1983.

All these fisheries were seriously affected after the enforcement of the EBFT Recovery Plan and the quota system. The TRAP fishery was largely sampled in the past, before the development of tuna fattening activities, providing many data on BFT reproductive biology. The Spanish BB fisheries are still regularly sampled. Sampling all other fisheries could seriously improve the understanding of the BFT reproductive biology in these key areas, where additional spawning grounds are supposed to be.

3.2.1.3 East Atlantic (Azores, Madeira, Canary Islands), trawlers (TRAW and TRAWP)

Information on these fisheries is almost missing or extremely poor.

- Iceland: catches are reported as TRAW and TRAWP, for the NEAT. TRAW catches are reported only for 2017, for <1 t; TRAWP catches are reported from 1998 to 2016, ranging from 1 to 10 t and with the maximum in 2015. Therefore, it was possibly a by-catch.
- EU- Portugal: catches are reported as TRAWP, without any EATL area specification, for just one year (1996) and for 7 t. Therefore, it was possibly a by-catch.

These recent limited catches can be explained by a possible increasing presence of BFT in the area.

3.2.2 Northeast Atlantic, including the North Sea

A high amount of fisheries reported their catch as NEAT, but even here some catches are reported as Bay of Biscay while the Faroe Islands are included in the EATL, apparently with some overlapping and some confusion.
Some catches were reported as NEI or obtained with UNCL gear and therefore they were not considered in this overview. Some gear types and related catches in NEAT seems wrongly attributed (Norwegian TRAP, French HARP) and therefore they were not considered.

Usually the fisheries in NEAT are catching post-spawners and foraging fish, except some that are targeting immature fish, therefore studies on the reproductive biology are very difficult in most of this area. Sampling was partly carried out in general; some fisheries were sampled regularly, others are not.

The BFT fisheries in this area are well known, because of the full collapse happened in the '80s, after the extremely high catches in the '50s and '60s, due to several reasons. The BFT came back to these areas in 2011 and now it is re-expanding its presence.

3.2.2.1 Northeast Atlantic, including the North Sea, longlines (LL – LL-surf – LL-deri – LLSWO – LLALB)

Longline catches are reported under different categories by various CPCs and it is not always clear if the reported gear is really different from another one or if there is simply a code confusion. Usually these fisheries are catching post-spawners and foraging fish, therefore studies on the reproductive biology are very difficult.

Size frequencies are usually available, but sampling was partly carried out in general; some fisheries were sampled regularly, others are not.

- Japan: catches are reported as LL, from 1957 to 2017, ranging from 2 to 3,971 t, with the maximum in 1995; the average in the last decade is 1,473 t. This fishery changed its pattern several times and in the past several of these catches were possibly made in SEAT, while recently the fleet moved south of Iceland.
- China P.R.: catches are reported as LL, from 1998 to 2017, ranging from 37 to 103 t, with the maximum in 2017; the pattern of this fishery is not clear.
- Iceland: catches are reported as LL, from 1998 to 2016, ranging from 1 to 27 t, with the maximum in 1999 and 2015.
- Norway: catches are reported as LL, from 1961 to 2015 (with a hole from 1971 to 2014), ranging from 4 to 207 t, with the maximum in 1970.
- EU-United Kingdom: catches are reported as LL, in 1997 and 1999 only, for <1 and 10 t respectively.
- EU-France: catches are reported as LL and LL-deri, being unclear the separation; for LL, catches are reported for 2016 and 2017 only, with 24 and 2 t respectively; for LL-deri, catches are reported only in 2017 for 43 t.
- EU-Spain: catches are reported as LLSWO, from 1975 to 2008, ranging from <1 to 104 t, with the maximum in 1982. These catches are possibly just a by-catch and it is unclear why there are no more reported catches after 2008.
- Morocco: catches are reported as LL for the NEAT, but in this overview they have been re-allocated in the Canary Islands sub-area, where they should be.
- Sierra Leone: catches are reported as LL for the NEAT, but it is very possible that this fishery operated in Eastern Tropical Atlantic and therefore the catches were moved there.

3.2.2.2 Northeast Atlantic, including the North Sea, various surface nets (PS, TRAW, TRAWP and TRAWPP)

Size information and sampling on these fisheries is generally missing (except for PS), but they were targeting medium-giant fish, even if for TRAW it was possibly a by-catch of BFT. The recent catches can be explained by the increasing presence of BFT in the area, because no quota was attributed to three of these fisheries.

- Norway: catches are reported as PS, TRAW and TRAWP. PS catches are reported from 1950 to 2017, with a large hole from 1986 to 1999, ranging from <1 to 14,752 t and the maximum in 1952; TRAW catches are reported in 2016 and 2017, for 2 and 3 t respectively; TRAWP catches are reported in 2008 and 2013, for <1 t.
- EU-Denmark: catches are reported as TRAW for just one year (2017) and for 1 t. Therefore, it was possibly a by-catch.
- EU- Nederland: catches are reported as TRAWP, but for EATL, for just one year (2017) and for <1 t. Therefore, it was possibly a by-catch.
- EU-Ireland: catches are reported as TRAWPP, but for EATL, for just one year (2016) and for 32 t. No further information is available.
- EU-United Kingdom: catches are reported as TRAWPP from 1998 to 2009, ranging from <1 to 2 t.
- EU-France: PS catches are reported from 2004 to 2006, ranging from 223 to 236 t, with the maximum in 2005; TRAWP catches are reported from 1988 to 2017, ranging from 28 to 829 t, with the maximum in 2006 and an average of 149.9 t in the last decade; TRAWPP are reported for 2017 only, for 8 t.

3.2.2.3 Northeast Atlantic, including the North Sea, various surface lines and set nets (BB, TROL, RR, HAND, GILL and TN)

Size and sampling on these fisheries is generally missing, but they were targeting medium-giant fish during the feeding season, having limited interest for reproductive studies.

- EU-Sweden: HAND catches are reported from 1950 to 1991, ranging from 1 to 316 t, with the maximum in 1952, mirroring the abundance of BFT in the area at that time.
- EU-Germany: HAND catches are reported from 1950 to 1981, ranging from 1 to 1,319 t, with the maximum in 1957, mirroring the high abundance of BFT in the area at that time.
- EU-Denmark: HAND catches are reported from 1950 to 1969, ranging from 1 to 2,113 t, with the maximum in 1952, mirroring the high abundance of BFT in the area at that time.
- EU-United Kingdom: GILL catches are reported from 1995 to 2002, ranging from <1 to 1 t; TN catches are reported only in 2008 for <1; both fisheries are clearly showing a by-catch.

BB historical data series from the Bay of Biscay have been recovered and double-checked by ICCAT GBYP, being this fishery used as one of the indices for the BFT stock assessment. The series had recent troubles due to the fact that most of the BB Spanish Cantabrian vessels sold their quota to other fisheries.

- EU-France: BB catches are reported as professional fishery from 1950 to 2017, ranging from 2 to 3,451 t, with the maximum in 1954 and an average of 65.8 t in the last decade; BB catches are reported as recreational fishery only in 2017 for 8 t. TROL catches are reported from 1973 to 2016 with several holes, ranging from <1 to 110 t with the maximum in 1985. RR catches are reported from 1992 to 2015, ranging from 1 to 95 t with the maximum in 2006. GILL catches are reported from 1988 to 2002, ranging from 3 to 497 t and with the maximum in 1993.
- EU-Spain: BB catches are reported for the NEAT from 1963 to 2017 with some recent holes (2013 to 2015), ranging from 10 to 2,318 t including the by-catch in the ALB BB fishery, with the maximum in2002 and an average of 814.3 t in the last decade. These amounts are considered not accurate and they are different from those recovered by ICCAT GBYP (Cort *et al*., 2015). GILL catches are reported from 1984 to 1994, ranging from 1 to 4 t. Other catches were reported specifically for the Bay of Biscay: BB BFT from 1950 to 2010, ranging from 305 to 5,139 t with the maximum in 1997; BB ALB from 1950 to 2000, ranging from 82 to 1245 t and the maximum in 1983, TROL in 2012 only, for <1 t.

Sampling from the BB fisheries was carried out for several years; catches are mostly concerning juvenile and young adult fish, but it should be very useful to better check the maturity of the young adults, particularly in late spring and summer, for better characterise the opportunistic spawing area of the Bay of Biscay.

3.2.3 East Atlantic, Cape Verde Area

This EATL sub-area is one of the key areas for better understanding the population dynamics of the BFT, because it is an important transition area for those BFT going to the South Atlantic and for those moving towards the Atlantic Moroccan coast and the Canary Islands, but also because of the extremely poor information available from all the area in recent times.

BFT Samples from this area are needed and would be extremely useful.

There are not so many BFT fisheries reported in this area, but we are aware that some IUU catches are happening from time to time.

- EU-Portugal: catches are reported as LL-surf for the years 2006 and 2009, for 1 t each. No further information is available, but these catches appear as a by-catch in fisheries targeting other tuna species.
- Cabo Verde: catches are reported as BBF for the years 1983 and 1984, for 10 and 1 t respectively. No further information is available, even if few TROLL recreational catches are anecdotally known.

3.2.4 Eastern Tropical Atlantic

This EATL sub-area is another of the key areas for better understanding the population dynamics of the BFT, but also its biology and behaviour, because some BFT larvae were found in the past in the Gulf of Guinea and because of the extremely poor information available on BFT from all the area in recent times.

There are not so many BFT fisheries reported in this large area but all the catches reported to ICCAT are listed below. We are also aware that some IUU catches are happening from time to time.

- Japan: BB catches are reported for 1964 only, for 3 t.
- Norway: LL catches are reported for the years 1965 and 1966, for 30 and 31 t respectively.
- EU-Portugal: PSM catches are reported in 1983 only, for 60 t.
- Sierra Leone: catches are reported as LL but for the NEAT, for the years 2000 and 2001, for 93 and 113 t respectively.
- Senegal: catches are reported as BB in 2013 only, for 6 t, as an incidental catch.

Important LL catches were obtained in this area between the ‘50s and the ‘60s, particularly between April and June, by the Japanese fleet, but these catches are not separated on ICCAT Task I Web. These catches are part of the famous “Brazilian catch”, which is considered the historical highest reference for the WBFT stock even if the origin of these fish is fully unknown.

The catches reported by EU-Poland in this area from 1971 to 1976 (ranging from 3 to 100 t) were not considered, because they were reported as UNCL.

BFT samples from this area are needed and would be extremely useful for many studies (spawning structure, genetics, etc.).

3.2.5 South-Eastern Atlantic

This EATL sub-area is possibly the most important for understanding the population dynamics of the BFT, because of the extremely poor information available from all the area in recent times. As for the SWATL, important LL catches were obtained also in this area between the ‘50s and the ‘60s, in all seasons, by the Japanese fleet, but these catches are not separated on ICCAT Task I Web. The origin of these fish is fully unknown.

There are not so many BFT fisheries reported in this large area, except for those listed below.

- Korea Republic: LL catches are reported for 2000 and 2001, for <1 and 6 t respectively.
- Seychelles: LL catches are reported for 2002 only, for 2 t.
- Guinea Equatorial: HAND catches are reported in 2015, for 1 t.

We are aware that some important IUU catches are happening in this area from time to time (i.e.: off Angola, 2011, ±2,000 t, and in 2015, ±800 t), while other occasional catches are also known (both in professional and recreational fisheries).

BFT samples from this large area are a first priority for understanding many aspects of the bluefin tuna population dynamics and biology.

3.3 South Atlantic

Many important questions arise from the situation existing in this large part of the Ocean in relation with the bluefin tuna.

BFT catches officially disappeared from this huge part of the Atlantic (about half of the ICCAT Convention area!) since 2006, when it became impossible reporting BFT catches without falling in a compliance issue and because no catches were allowed for any CPC in the area (Di Natale *et al*., 2013). IUU catches happened and are happening, simply ICCAT is missing these data. Why nobody seems interested in looking into this basic and fundamental issue?

Catches "off Brazil" (but in the reality not only there, because catches were obtained also in the central-eastern Atlantic) (Mather *et al*., 1995, Schalit, 2019) are currently attributed to WBFT, but there is no evidence at all of any scientific (genetic or microchemical) study on any fish from the southern Atlantic for defining the population origin of these fish. This investigation is fundamental.

Natural marks (**Figure 8**) from *Isistius brasilensins* found on large BFT in many EATL fisheries (including the Mediterranean Sea) are showing that these fish remained or transited for a certain part of their life in southern or central Atlantic and the percentage of fish having these natural marks is not negligible; natural marks are much more present on male than females (98% against 2%) and this might imply an unknown separation (vertical or horizontal) at a certain stage of their life. The issues related to these natural marks need serious investigation.

SCRS was requested several times to rise these important questions, but nothing was done.

3.4 Mediterranean Sea

The BFT fishery is an historical activity in all the Mediterranean Sea. The fisheries changed over the centuries, changing also the fishing patterns. Almost all known fishing gear have been used in the Mediterranean Sea so far for catching BFT.

Trying to track the changes in the fishing patters is not an easy exercise, because data and information are not always available. This report tried to provide a detailed overview for each gear. Several catches were reported as NEI or for UNCL gear and they were not considered in this overview.

Theoretically, the Mediterranean should be able to provide a big amount of data about the BFT reproductive biology, but scientific data were concentrated in some countries for several decades. These data are still the most important source of information for EBFT reproductive biology. Sampling was easier in the past, when all fish were harvested at landing and researchers were usually more or less welcomed. After the adoption of the quota system and in the fattening caging era, samplings for reproductive biology became much more difficult and sometimes impossible. Only the recent GBYP research activities are collecting biological data, but not on reproductive biology.

3.4.1 Mediterranean Sea: purse seines (PS)

The tuna purse seine fishery initiated in the '50s by the Italian fleet and the former Yugoslavia (now EU-Croatia) fleet, in the '60s by the Spanish fleet and in the '80s by the Spanish fleet, targeting bluefin tuna of all size classes. All other PS fleets operated later. The spotting aircrafts were used since the late '70s. When the tuna fattening activity was initiated, at the very end of the '90s, even the fishing strategies changed substantially.

The Croatian PS fleet always targeted juveniles, even for fattening, usually in the Adriatic Sea but not only. After some initial trials to catch also small adults for fattening (Spain), most of the vessels were targeting medium-size spawners, the best for fattening, trying to avoid big giant tunas. This approach induced a particular behaviour of the fleets and a selective approach by the captains.

When the use of aircraft was prohibited in 2007, even a part of the activity changed, because the fleets became fully dependent from the sonar equipment on board or from the info coming from other fishing vessels. The sonar became very sophisticated and there are some vessels now using up to more than 6 different sonars (some are able even to estimate the size and number of tunas).

It is anecdotally known that some IUU PS catches are still existing, made also by vessels not on the ICCAT official lists. It is also known that very few illegal spotting aircrafts have been used after the ban.

Sampling was easier up to the late '90s, because fish were landed in few places and immediately harvested; several high quality data on reproductive biology were collected in those years, along with size frequencies when research programs were in place. Sampling of the PS catches became impossible when fish were moved into cages, preventing the biological data collection in real time, while it was possible only at the harvesting in farms, after the spawning season, at high costs.

- Korea Republic: catches are reported as PS, without any area specification or target size specification, making difficult understanding any change in the fishery. Catches are reported from 2004 to 2014, the area is MEDI**,** ranging from 77 to 1,145 t, with the maximum in 2005.
  The activity of this not-Mediterranean fleet is poorly known but it is possible that the fleet operated mostly in the central Mediterranean; joint fishing activities were carried out with the Maltese fleet from 2007 to 2009.
  No information is available on sampling, but possibly all catches were caged for fattening.
- EU-Spain: catches are reported as PS**,** without any sub-area or target size specification, making difficult understanding the changes in the fishery that are roughly known.
  Spanish PS catches are reported from 1981 to 2017, the area is MEDI**,** max 2896 t in 1995, range 45-2,896 t.
  The fleet targeted to mostly juveniles until it was allowed, in late summer and autumn, especially in the Balearic area, in the Catalan Sea and in the southern part of the Gulf of Lion. In the last 15 years, the Spanish PS sometimes moved to the central Mediterranean, in some cases for joint fishing operations with other fleets, targeting adult fish. The data are not available by sub-area.
  In the last years, the Spanish vessels operated almost exclusively in the western Mediterranean, because of the limited quota. The fishing activity was often reduced to very few days.
  Sampling was relatively easy up to the late '90s, because fish were landed in few places and immediately harvested. Sampling became impossible when fish were moved into cages for fattening, preventing the biological data collection, which was possible only at the harvesting at farms, after the spawning season. The biological sampling was carried out under GBYP contracts in recent years. Costs can be high.
- EU-France: catches are reported as PSM and PS**,** without any sub-area or target size specification, making difficult understanding the changes in the fishery that surely happened.
  PSM catches are reported from 1966 to 1989, the area is MEDI**,** max 5,750 t in 1988, range 1,000-5,750 t.; it is likely that these fish were mostly juveniles and the fishing area was mostly the Gulf of Lion but sometimes in the Corso-Provençal area and in the northern Balearic Sea; some fishing operations were carried out also in the southern Tyrrhenian Sea, targeting spawners.
  PS catches are reported from 1990 to 2017, the area is MEDI**,** max 11,803 t in 1994, range 678-11,803 t. It is possible that catches of juveniles and medium-big adults are mixed up to 2006, the seasons and the areas were separated, while in the last decade catches were limited to medium-large fish.
  The French PS fleet was used to catch juveniles until it was allowed, in late summer and autumn, mostly in the Gulf of Lion, in the northern Balearic Sea, and in the the Liguro-Provençal basin, often fishing together with Spanish or Italian PS.
  In the last 25 years, the French PS catching medium-large fish moved very often at the beginning to the northern Balearic Sea and to the southern Tyrrhenian Sea, then to the central and southern Mediterranean, in some cases for joint fishing operations with other fleets. Some vessels were active in the Levantine Sea, off Cyprus, and off Egypt in the first decade of the year 2000. The data are not available by sub-area.
  In recent years, the fishing activity was often reduced to very few days due to the quota.

The sampling was easier up to the late '90s, because fish were landed in few places and immediately harvested, but it was much reduced anyway and an important number size data were initially created by an algorithm and then removed from the ICCAT Task II data base, after a SCRS decision. The sampling became impossible when fish were moved into cages, preventing the biological data collection, which was again potentially possible only at the harvesting in farm, after the spawning season. Sampling in farms has a high cost.

- EU-Italy: catches are reported as PS, PSFB and PSFS, quite often by area, some other times by fleet, making difficult understanding the many changes in the fishery.
  Due to the adoption of different gear codes, Italian PS catches are reported only for the last two years, 2016 and 2017, the area is MEDI and catches are 2,050 and 2,409 t.
  PSFB catches are reported from 1952 to 2015, max 7,068 t in 1996, ranging from 2 to 7,068 t. Data are available by area. MEDI: from 1952 to 1969, max 989 t in 1963; Tyrrhenian: from 1970 to 2011, max 4,179 t in 1977; Adriatic: from 1990 to 2004, max 2,000 t in 1993; Ionian: from 1990 to 1994, max 526 t in 1994; Strait of Sicily: from 1998 to 2010, max 4,311 t in 2007.
  PSFS catches are reported from 1952 to 2006, max 5,487 t in 1976, ranging from 5 to 5,487 t. Data are available by area. Adriatic: from 1952 to 2006, max 1,913 t in 1984; Ligurian: from 1953 to 2005, max 4,890 t in 1976.
  The sampling was easier up to the late '90s, because fish were landed in few places and then they have been immediately harvested; several data on reproductive biology were collected in those years, along with an important number of size frequencies when research programs were in place. Sampling became impossible when fish were moved into cages, preventing the biological data collection, which was possible only at the harvesting in farms, after the spawning season. The sampling has been carried out under GBYP contracts in recent years (but in Malta). Costs can be high.
  A major change happened in 1978, when the fleet decided to use aircrafts for BFT spotting. The use of aircraft was prohibited since 2007 (ICCAT Rec. 06-05).
  The technological creeping has a major impact on the fishing capacity and strategies.
  A big change happened in 1996, when many concentration of spawners moved from the Tyrrhenian Sea to the Strait of Sicily, due to a change of the Eastern Mediterranean Transient; this situation continued up to 2006, when several schools moved back to the Tyrrhenian Sea. It is logical that this fact affected also other PS fleets.
  When the quota system was enforced, in 1999, it was necessary to reduce the Italian PS fleet. In the following years, almost all the small and medium PS, mostly from the Adriatic and Ligurian fleets, left the BFT fishery.
  Another important change happened in 1999, when the ranching activities were initiated in the Mediterranean and several PS vessels started not to land the fish; in few years, all fish were not landed but moved into cages and then to fattening facilities.
  Another big change happened in 2006, when the Italian PS fleet based in the southern Tyrrhenian Sea stopped the usual autumn fisheries for juveniles in the Gulf of Lion and in the Ligurian Sea; as well as, the Ligurian PS fleet stopped the activities in 2006. The minimum size of 30 kg was enforced in 2007.
- EU-Croatia: catches are reported as PS**.** Up to 1990 catches were reported as former Yugoslavia.
  Croatian PS catches are reported from 1950 to 2017, the area is MEDI**,** max 1,523 t in 1988, range 87 - 1,523 t.
  The fleet catches juveniles under a special ICCAT derogation. Most of the catches are made in the Adriatic Sea or in the Ionian Sea, but some catches, in few years, were made also in the central Mediterranean and in the southern Tyrrhenian Sea. It is not clear how to detect these partial changes in the fishing pattern.
  In recent years, the fishing activity was sometimes reduced to very few days due to the quota.
  The sampling is usually made at the harvesting in cages and it could be a good opportunity for defining the very first maturity.
- Albania: catches are reported as PS**.**
  Albanian PS catches are reported from 2009 to 2017, the area is MEDI**,** the range is <1 - 56 t with the max in 2017.
  The Albanian PS fleet catches adults for caging. Information about the areas is not available, but it is possible that the fishery is usually carried out in the Adriatic Sea, in the Ionian Sea and in the central Mediterranean. It is not clear if the fishery pattern had changes over the years.
  The fishing activity was sometimes reduced to very few days due to the quota.
  The sampling could be possible at the harvesting in cages.
- EU-Greece: catches are reported as PS**.** The fishing area is unclear.
  Greek PS catches are reported from 1987 to 2013, the area is MEDI and the range is 4 - 247 t, with the max in 2007. This fishery targeted mostly adult spawners.

- EU-Cyprus: catches are reported as PS and PSFB**.** The fishing area is unclear but it is supposed to be the Levantine Sea and/or the Aegean Sea.
  PS catches are reported in 2004 and 2008, for 94 and 127 t; PSFB catches are reported only in 2017, for 59t, the area is MEDI. Catches were made mostly on adult spawners.
  It is supposed that recent catches are going to fattening farms; therefore, the sampling problems are the same of other PS fisheries. Sampling fish from the Levantine or the Aegean Sea can provide interesting additional data on spawning and dynamics.
- EU-Malta: catches are reported as PS**,** from 2005 to 2017, the area is MEDI, the range is 25 - 190 t with the max in 2007. Catches were made mostly on adult spawners in the central Mediterranean Sea.
  Due to the quota, the PS fishing season is usually very short. All catches are going to cages and fattening facilities on the same island.
  Sampling problems are the same of other PS fisheries, but sampling has been carried out under GBYP contracts in recent years. The costs can be high. Studies on reproductive biology are difficult, because fish are harvested several months after the spawning season.
- Turkey: all catches are reported as PS**,** from 1985 to 2017, the area is MEDI, the range is 0 - 5,899 t, with the max in 1998. Catches were made mostly on adult spawners in the Levantine Sea, even if some vessels operated also in the southern-western Mediterranean area in few years.
  Due to the quota, the PS fishing season is usually very short and slightly anticipated, but in the past the pattern was partly different. All catches are going to cages and fattening facilities, in the same country.
  Sampling problems are the same of other PS fisheries, but a limited sampling has been carried out under GBYP contracts in recent years. The costs can be high. Studies on reproductive biology are difficult, because fish are harvested several months after the spawning season, but they could be extremely interesting because of the poorly known situation in the Levantine Sea. Surely, sampling the specimens dying during the fishery or the transport could provide essential information, because spawning in the Levantine Sea takes place several weeks in advance compared to other Mediterranean areas.
- Syria: catches are reported as PS, from 2007 to 2017 with holes, the area is MEDI, ranging from 17 to 74 t with the max in 2017. Catches were made mostly on adult spawners in the Levantine Sea. There are not so many details on this fishery.
- Egypt: catches are reported as PS, from 2012 to 2017, the area is MEDI, the range is 64 - 155 t, with the max in 2015. Catches were made mostly on adult spawners in the SE Mediterranean. Due to the quota, the PS fishing season is usually very short. Information on this fishery is very poor, when any.
  Considering the fact that some French PS went in that area in the past, it is supposed that spawning may occur also in this part of the Mediterranean Sea, which was originally selected by GBYP for the aerial survey. The area was cancelled after several problems with the flight permits.
  No sampling has been carried out in this part of the Mediterranean Sea so far. Sampling, which could be extremely interesting on these fish, was never tried.
- Libya: catches are reported as PS, from 1990 to 2017, the area is MEDI, the range is 32 - 1,631 t, with the max in 2017. Catches were made mostly on adult spawners in the central-southern Mediterranean.
  The fishing pattern of this fleet changed a lot over the years. At the beginning, several vessels were managed together with French vessels and some with Italian vessels and the fishing activities were carried out together with other fleets, sharing also the aircraft spotting support. The political problems which happened in the last years in Libya affected also the behaviour of the fleet, because the vessels were moved to other countries. The fishing activity was mostly concentrated in the central-southern Mediterranean.
  Due to the quota, the PS fishing season is usually very short and all recent catches went to fattening farms. Information on this fishery is very poor, but it is monitored by ROPs. Sampling was never carried out on these catches, but it could be possible at the harvesting in cages, with high costs. Anyway, catches are usually obtained where other PS fleets do operate.
- Tunisia: catches are reported as PS, from 1977 to 2017, the area is MEDI, range 11 - 3,245 t with the max in 2005. Catches were made mostly on adult spawners in the central-southern Mediterranean.
  The fishing pattern of this fleet changed substantially over the years. At the beginning, the fishing activities were carried out together with other fleets, sharing also the aircraft spotting support. Then, autonomous activities have been also carried out. The fishing activity was mostly concentrated in the central-southern Mediterranean.
  Due to the quota, the PS fishing season is usually very short and all recent catches went to fattening cages. Information on this fishery is very poor, but it is monitored by ROPs. Sampling was never carried out on these catches, but it could be possible at the harvesting in cages, with high costs. Anyway, catches are usually obtained where other PS fleets do operate.
- Algeria: catches are reported as PSS and PS.

PSS catches are reported from 1986 to 1994, the area is MEDI, the range is 170 - 1,092 t with the max in 1994. Catches were made mostly off the Algerian waters.
PS catches are reported from 1998 to 2017, the area is MEDI, the range is 69 - 1,038 t with the max in 2017. Catches were made mostly on adult spawners in the central-southern Mediterranean.
There is no detailed information about the use of aerial spotters when it was permitted. Some activities have been carried out together with other fleets, including the Turkish one.
Due to the quota, the PS fishing season is usually very short and all recent catches went to fattening farms. General information on this fishery is very poor, but it is monitored by ROPs. Sampling was never carried out on these catches, but it could be possible at the harvesting in cages, with high costs. Anyway, catches are usually obtained where other PS fleets do operate.

- Morocco: all catches are reported as PS, from 1971 to 2017, the area is MEDI, the range is 1 - 515 t, with the max in 2007. Catches in the past were on mixed sizes fish, while they were made mostly on adult spawners since the beginning of the trade with Japan. The fishing area was mostly off the Mediterranean Moroccan coast at the beginning of the fishery, then the fleet moved towards other parts of the northern African coast and even to the central Mediterranean.
  It seems that the fishing pattern of this fleet changed substantially over the years, particularly due to the different size of the vessels after the first period. In some years, some fishing activities were carried out also in cooperation with Turkish vessels; there is no detailed information about the use of aerial spotters when it was permitted. Some activities have been carried out together with other fleets. Recently, the fishing activity was mostly concentrated in the central-southern Mediterranean, with some activities off the Algerian waters.
  Due to the quota, the PS fishing season is usually very short and all recent catches went to fattening farms. Information on this fishery is very poor, but it is monitored by ROPs. The sampling was never carried out on these catches, but it could be possible at the harvesting in cages, with high costs. Anyway, catches are usually obtained where other PS fleets do operate.

3.4.2 Mediterranean Sea: longlines (LL)

Usually, in the Mediterranean area the drifting LL was not originally targeting BFT. The BFT catches have been, for several years, mostly a by-catch in other LL fisheries, particularly in LLSWO for small-medium size fish and in LL-ALB for BFT between age 0 and age 1.

When some Japanese large vessels entered the Mediterranean for catching bluefin tunas, in 1972, this was the beginning of the LL BFT target fishery in the area. Some fleets were already reporting BFT catches in LL fisheries since 1974, but the specific LLBFT was not available for the Mediterranean fleets at that time. At the beginning of the ‘80s the Italian fleet scientifically tested the first LLBFT (based mostly on the Japanese technology, with some variations) and immediately after the system was adopted by some commercial vessels. The number increased quite rapidly and the fishery was extended to other CPCs.

The details of all these changes are not always available on the national reports. Therefore, it is very difficult to understand when and in which way the LL fishing patterns changed in each fleet, but changes were substantial and they are generally not taken into account in any analysis. Even the type of the gear is not always clear, while the differences between types are extremely important.

When the EBFT quota system was enforced, then several limitations entered into force, the number of authorised LL was limited and therefore the effort changed dramatically, at least officially, because the by-catch in LL targeting other pelagic species remained important (particularly in LLSWO) and largely obscure. The mandatory national observers programs are not providing so far any reliable insight for these important fisheries.

A full revision of all LL catches for BFT should be necessary, because of the many different gear codes which are used, sometimes creating clear biases for the data understanding. It seems that some CPCs used different gear codes over the years for the same gear, while some types of LL were not always mentioned for avoiding compliance problems when assessing the BFT by-catch rates.

Sampling has been always difficult on LL catches, because fish were gilled and gutted on board (preventing basic studies on the reproductive biology) and because landings were highly unpredictable. The problem was partly smoothed with the observers on board, but data are not always available.

- Japan: reported BFT catches in longlines as LL, from 1972 to 2009, the area is MEDI, catches ranged from 18 to 2,195 t, with the max in 1974.

This fleet was usually coming to the Mediterranean in the first part of the year, leaving the area after the 22nd of May, according to a domestic regulation. It was controlled also by Japanese Maritime Patrol vessels. The fishing area was the south-western Med, the Strait of Sicily and the central Med.
The catches from this fishery are used as a fundamental index for the EBFT assessment and the MSE.
During two ICCAT workshops (1995-1996) it was noted that a variable but important percentage of the catches was removed from the LL and stolen by several Mediterranean vessels, heavily and variably affecting in an unknown manner the Japanese LL MED CPUE, making unreliable the CPUE calculations for this fleet. At that time, it was assessed that much more than 300 t of BFT catches were stolen annually[5]. This important fact is not considered anymore in any current analysis.
Obviously, even this fishery was affected by the limitations imposed by the ICCAT rules after the adoption of the EBFT recovery plan.
The catches were monitored in terms of size frequencies, but the information on the BFT maturity is missing.

- Panama: reported BFT catches as LL from 1987 to 1997, the area is MEDI, ranging from 67 to 2,850 t, with the max in 1996.
- China: reported BFT catches as LL from 1994 to 1999, the area is MEDI, ranging from 20 to 137 t, with the max in 1995.
- Chinese Taipei: reported BFT catches as LL from 1993 to 2006, the area is MEDI, ranging from 5 to 709 t, with the max in 1994.

  According to the few information available, the Panama, China and Chinese Taipei fleets were usually coming to the Mediterranean just before the spawning season. The fishing area was the south-western Mediterranean, the Strait of Sicily and the central Mediterranean. Some vessels have been noticed in the Mediterranean also in recent years, but no catches have been reported. Obviously, even these fleets have been affected by the limitations imposed by the ICCAT rules after the adoption of the EBFT recovery plan. The catches were partly monitored in terms of size frequencies, but the biological information is missing.
- EU-Portugal: reported BFT catches in longlines as LL, LLALB and LL-surf; the fishing area was MEDI.
  LLALB: catches are reported from 1990 to 2000, ranging from 37 to 313 t, with the max in 1995. Due to the high catches, it is possible that the gear was not exactly targeting ALB in the Mediterranean Sea; being those vessels belonging to the Madeira fleet, it is possible that the gear was a normal pelagic LL for tropical tunas.
  LL: catches are reported only in 2001, for 64 t.
  LLsurf: catches are reported from 2003 to 2006, ranging from <1 to 11 t.
  This fleet was usually coming to the Mediterranean in summer time, from Madeira. Its activity in the Mediterranean is poorly known, but it is possible that it was restricted to the western Mediterranean Sea. Obviously, even this fishery was affected by the limitations imposed by the ICCAT rules after the adoption of the EBFT recovery plan. **T**he catches were partly monitored in terms of size frequencies, but the information on the BFT maturity is missing.
- EU-Spain reported BFT catches in longlines as LLHB, LL, LLALB, LLJAP, and even LLPB.
  LLHB: catches are reported from 1963 to 2017, the area is MEDI, the catches ranged from 4 to 800 t with the max in 1963; the average in the last 10 years is 18.2 t. As a matter of fact, these home-based vessels are LLSWO, therefore these catches should be regarded as by-catch and they are medium BFT. The area should be the western Mediterranean Sea.
  LL: catches are reported from 1984 to 1989, the area is MEDI, the catches ranged from 22 to 162 t with the max in 1989. The target species of this fishery is unclear.
  LLALB: catches are reported from 1990 to 2017, the area is MEDI, the catches ranged from 7 to 424 t with the max in 2006; the average in the last 10 years is 72.5 t. These catches are by-catch and they should be small (and maybe even juvenile) BFT; catches and frequencies are reported by 5°x5°, according to the system. The area should be the Balearic Sea and the Alboran Sea.
  LLJAP: catches are reported from 1990 to 2017 with some holes, the area is MEDI, the catches ranged from 2 to 511 t with the max in 2008; the average in the last 10 years is 182 t. Catches concerns mostly medium-big fish, while the fishing area is not only the western Mediterranean Sea, but also the central Mediterranean.
  LLPB: catches are reported only in 2017, with less than 1 t. This is a gear mostly used for "besugo" (*Pagellus bogaraveo*), but it is also used for targeting swordfish; the very few tunas in the by-catch are medium-large BFT.

[5] This amount was referred to just one fleet based in a single harbour; therefore, it is supposed that the amount stolen every year by the various vessels should be much higher.

It is very difficult to understand when and in which way the LL fishing patterns changed by fishery, but it is possible that a basic change happened in 1990, when the Japanese LL type entered in the fishing activities. The LL fishing closure should be regarded also taking into account the regulation for other target species, because of the important by-catch.

According to the available knowledge, not all these Spanish LL fisheries were regularly monitored and sampled, at least in the past years. The problem was partly smoothed in more recent years, with the observers on board, but detailed data are not always available because they are reported 5°x5°. Sampling is opportunistic.

- EU-France reported BFT catches in longlines as LL, LL-deri and LLBFT.

  LL: catches are reported from 1995 to 2016, the area is MEDI, the catches ranged from 60 to 614 t with the max in 2007, the average in the last 10 years is 225 t. This seems a target fishery and the fishing area is the full western Mediterranean, possibly including Corsica.

  LL-deri: catches are reported only in 2017, the area is MEDI, catches are 81 t. It is not clear if these catches are coming from a different gear or if there is a gear reporting bias.

  LLBFT: catches are reported only in 2017, the area is MEDI, catches are 208 t. It is not clear if these catches are coming from a different gear or if there is a gear reporting bias.

  Lacking any detailed information, it is very difficult to understand if, when and in which way the LL fishing patterns changed over the years and if BFT was always the target species of these fisheries. Usually the BFT catches in the area are small-medium size fish.

  If a part of the fishery is carried out during the spawning season, it should be very important to collect data on the reproductive status of these fish, particularly using the national observers on board, but no data on this aspect have been reported so far.

- EU-Italy reported BFT catches as LLBFT, LL and LLsurf and by sub-area; therefore the overview is not easy, even if it is more detailed compared to other Mediterranean LL fisheries.

  LLBFT: catches are reported from 1981 to 2017, the areas are MEDI, S.SIC, SARD, LIGU, TYR, ADRI, N.ADR, S.ADR, IONIA, N.ION and S.ION., in total catches ranged from 4 to 2,098 t with the max in 1995; the average in the last 10 years is 487.1 t. LLBFT fishery was initially tested in the Strait of Sicily and in the Sardinian Sea, then developed in the Tyrrhenian Sea, then in 1990 it was extended to the Adriatic Sea, the Ionian Sea and the Sardinian Sea, and finally to the Strait of Sicily in 1998. This fishery is targeting medium and big BFT.

  LL: catches are reported only for 2017, for 434 t; the area is MEDI. It is unclear if those catches included also any by-catch and what type of gear was concerned.

  LLsurf: catches are reported from 1991 to 2010, the area is LIGU**,** catches ranged from 1 to 19 t with the max in 1997. It is supposed that LLsurf could be LL-SWO. These catches should be regarded as by-catch and they should be small-medium BFT.

  It is very difficult to really understand why no catches have been reported so far for LLSWO and LLALB (both traditional gear for the Italian fishery), because both these fisheries are well known to have BFT by-catch (medium size for the first and juveniles for the second). The national observers are not providing any useful insight on the by-catch so far. The enforcement of the EBFT recovery plan certainly changed the fishing pattern of all the LL fisheries in various ways, including those not targeting BFT.

  Size frequencies were made available for various Italian LL fisheries, but data on reproductive biology were difficult to collect, because the fish were gutted on board. This problem could be solved by the national observers or specific research programmes.

- EU-Croatia reported BFT catches as LL from 1997 to 2017, the areas are MEDI, ADRI and N.ADR, the catches ranged from <1 to 16 t with the max in 1998; the average in the last 10 years is 1.6 t. This fishery is targeting mostly medium BFT.

- EU-Greece reported BFT catches as LL-deri, LLBFT and LL; the area is always MEDI.

  LL-deri: catches are reported from 1987 to 2015, ranging from 3 to 209 t with the max in 2004 and an average of 59.4 t in the last decade. These catches could be both target and by-catch.

  LLBFT: catches are reported only in 2016 for 183 t.

  LL: catches are reported only in 2017 for 191 t; this seems a fishery targeting BFT.

  It is difficult to understand why no catches have been reported so far for LLSWO and LLALB (both traditional gear for the Greek fishery), because both these fisheries are known to have BFT by-catch of different size, also according to past scientific papers. The national observers are not providing any useful insight on the by-catch. It is supposed that LL-surf could be also LLSWO. The enforcement of the EBFT recovery plan certainly changed the fishing pattern of all the LL fisheries in various ways.

  Size frequencies were made available for various LL fisheries, but data on reproductive biology were difficult to collect, because the fish were gutted on board. This problem could be solved by the national observers or specific research programmes.

- EU-Cyprus reported BFT catches as LL, LLBFT, LLSWO and LLALB. The fishing area is MEDI, possibly in the Levantine Sea and in the Aegean Sea.
  LL: catches are reported from 1980 to 2009, ranging from 1 to 149 t with the max in 2005. This fishery possibly includes both target and by-catch, mostly medium and big BFT.
  LLBFT: catches are reported from 2011 to 2017, ranging from 7 to 57 t, with the max in 2016 and an average of 25.7 t in the last decade. The catches are mostly medium and big BFT.
  LLSWO: catches are reported from 2010 to 2017, ranging from <1 to 4 t with the max in 2014 and an average of 2.1 t in the last decade. These catches are clearly by-catch and they should be possibly small and medium BFT.
  LLALB: catches are reported from 2012 to 2014, for < 1 t every year. The BFT catches are obviously by-catch and they are likely all juveniles.
  Information on changes of the fishing pattern are not available. The enforcement of the EBFT recovery plan certainly changed the fishing pattern of all the LL fisheries in various ways.
  Data on reproductive biology from this fishery are not available, even if they should be very important for the Levantine Sea. This problem could be solved by the national observers or specific research programmes.
- EU-Malta reported BFT catches as LL, LL-surf, LLBFT and LLSWO. The fishing area is always MEDI, possibly in the central Mediterranean Sea.
  LL: catches are reported from 1974 to 2016 with gaps, ranging from 3 to 587 t with the max in 1995. This fishery possibly includes both target and by-catch, mostly medium and big BFT.
  LL-surf: catches are reported from 2005 to 2015 with gaps, ranging from 2 to 136 t with the max in 2010 and an average of 55.6 t in the last decade. The catches are supposed to be by-catch and they are possibly small-medium BFT.
  LLBFT: catches are reported from 2005 to 2017, ranging from 3 to 311 t, with the max in 2005 and an average of 114 t in the last decade. The catches are mostly medium and big BFT.
  LLSWO: catches are reported in 2016 and 2017 only, ranging from 7 to 10 t with the max in 2017. These catches are clearly by-catch and they should be small and medium BFT.
  Information on changes of the fishing pattern are not available. The enforcement of the EBFT recovery plan certainly changed the fishing pattern of all the LL fisheries in various ways.
  Data on reproductive biology from this fishery are not available, even if they should be very important for the central Mediterranean Sea. This problem could be solved by the national observers or specific research programmes.
- Turkey reported BFT catches as LL, LLBFT, LLSWO and LLALB. The fishing area is always MEDI, possibly in the Levantine Sea and in the Aegean Sea.
  LL: catches are reported from 1980 to 2009, ranging from 1 to 149 t with the max in 2005. This fishery possibly includes both target and by-catch, mostly medium and big BFT.
  LLBFT: catches are reported from 2011 to 2017, ranging from 7 to 57 t, with the max in 2016 and an average of 25.7 t in the last decade. The catches are mostly medium and big BFT.
  LLSWO: catches are reported from 2010 to 2017, ranging from <1 to 4 t with the max in 2014 and an average of 2.1 t in the last decade. These catches are clearly by-catch and they should be small and medium BFT.
  LLALB: catches are reported from 2012 to 2014, for <1 t every year. The catches are obviously by-catch and they are likely all juveniles.
  Information on changes of the fishing pattern are not available. The enforcement of the EBFT recovery plan certainly changed the fishing pattern of all the LL fisheries in various ways.
  Data on reproductive biology from this fishery are not available, even if they should be very important for the Levantine Sea. This problem could be solved by the national observers or specific research programmes.
- Syria reported BFT catches as LL in 2007 and 2008 only, ranging from 15 to 33 t with the max in 2007. The fishing area is MEDI, usually the Levantine Sea. This fishery seems targeting BFT, mostly medium and big fish.
- Libya reported BFT catches as LL from 1990 to 2009, ranging from 34 to 1,867 t with the max in 2001. The fishing area is MEDI, usually in the central and southern Mediterranean. This fishery has BFT as main target, mostly medium and big fish. The Libyan LL vessels are quite big.
  The enforcement of the EBFT recovery plan certainly changed the fishing pattern of this fishery but no info is available.
  Data on reproductive biology from this fishery are not available, even if they should be very important for both the Levantine Sea and the Gulf of Sirte. The national observers or specific research programmes could solve this problem, when the situation will allow the monitoring.

- Tunisia: never reported any LL catch for BFT, even if Tunisia has an important LLSWO fleet which certainly has a BFT by-catch, like all other LLSWO fleets.
- Algeria reported BFT catches as LL from 1996 to 2009, ranging from 7 to 678 t with the max in 2007. The fishing area is MEDI, usually off the Algerian coast. This fishery seems targeting BFT, mostly medium and big fish.
- Morocco reported BFT catches as LL from 2007 to 2013, ranging from 1 to 517 t with the max in 2008 and an average 148.2 t in the last decade. The fishing area is always MEDI, usually in the western Mediterranean. This fishery is supposed to have BFT as main target, mostly medium and big fish.
  The enforcement of the EBFT recovery plan certainly changed the fishing pattern of these North African fisheries but no info is available.
  Data on reproductive biology from these LL fisheries are not available, even if they could be very important. This problem could be solved by the national observers or specific research programmes.

3.4.3 Mediterranean Sea: traps (TRAP)

This gear is the one having the longest history in the Mediterranean area and it was a real industrial activity since the beginning, a labour-intensive one and possibly the very first human industry. Ancient historical information was collected by ICCAT GBYP since the VI century b.C., while catch data have been collected since 1512 and they are all incorporated in the ICCAT BFT Data Base

Being a fixed gear, the fishing pattern is mostly related to the distribution of the tuna traps along all the Mediterranean coasts, including several islands. The numerosity and distribution of the tuna traps changed substantially over the centuries, but the number decreased in an important way after the '50s, decreasing again in the XXI century. Nowadays (2019), just five traps are active in the Mediterranean: 4 in Sardinia and 1 in Sicily, while a small trap, targeting a large variety of species, is active in Liguria.

Traps were usually targeting BFT of all sizes, depending by the type of trap, the location and the seasonality of the operations. Most of the traps were targeting medium and big BFT, while smaller traps were targeting also juveniles.

When the EBFT quota system was enforced, then several limitations entered into force. This fact changed the way of operating for the traps, shortening their season and making difficult to compare the fishing effort and the yields.

Historically, the traps provided an important amount of both size and biological information until the end of the '90s. Most of the information on the BFT reproductive biology were obtained from the traps in the XX century, because the fish were harvested immediately and it was possible for the researchers to collect good samples and observations.

Now even traps are moving most of the BFT to fattening farms and this strategy prevent almost entirely the sampling during the spawning season. The few direct fishing operations are extremely limited in number and not always it is possible for the researchers to take samples.

- EC-Spain reported BFT TRAP catches in MEDI, in the western Mediterranean Sea, from 1950 to 2015, ranging from <1 to 1,235 t with the max in 1965. This fishery targeted mostly medium and big BFT, except for one trap in La Linea (close to the Strait of Gibraltar), which targeted juveniles and small BFT in late summer.
- EC-Italy reported BFT TRAP catches in MEDI, for three areas: S.SIC, TYRR and SARD.
  TRAP S.SIC: catches are reported from 1950 to 2006, ranging from 31 to 1,972 t with the max in 1957. This fishery was targeting mostly medium and big BFT.
  TRAP TYRR: catches are reported from 1950 to 1979, ranging from 8 to 463 t with the max in 1958. This fishery was targeting mostly medium and big BFT, with the exception of a very small trap which was active South of Naples (Punta Campanella) for few years, targeting juveniles (but it is unclear if those few catches were never reported).
  TRAP SARD: catches are reported from 1950 to 2015 (but the fishery is still active and it is unknown why recent catches are not in the ICCAT Task I BFT Data Base), ranging from 5 to 1,524 t with the max in 1950. This fishery was targeting all sizes of BFT, mostly small-medium with few big fish.
  The enforcement of the EBFT recovery plan certainly changed the fishing pattern of these fisheries, limiting the fishing operations to just a few.
  It is unclear why the few BFT catches of the small trap in Liguria were never reported to ICCAT.

Data on reproductive biology from these fisheries are available, but they are much less in the last decade, also because now all Italian traps are sending most of the catches to tuna fattening cages.

- Turkey reported BFT TRAP catches in MEDI, but it is supposed that this ancient fishery was carried out in the Marmara Sea, where many traps ("dalyan") were active. The catches were reported from 1957 to 1984, ranging from 17 to 1,488 t with the max in 1967. This fishery targeted mostly medium and big BFT.
  Data on BFT reproductive biology from this fishery are not available.
- Libya reported BFT TRAP catches in MEDI, but all traps were located in the central-southern Mediterranean, along the western Libyan coast in Tripolitania. The catches were reported from 1950 to 2005, ranging from 34 to 2,000 t with the max in 1969. This fishery targeted mostly medium and big BFT.
  Data on BFT reproductive biology from this fishery are poorly available.
- Tunisia: reported BFT TRAP catches in MEDI, and the activity was carried out in the southern side of the Strait of Sicily. The catches were reported from 1957 to 2004, ranging from 1 to 729 t with the max in 1951. This fishery targeted mostly medium and big BFT.
  Data on BFT reproductive biology from this fishery are partly available.
- Algeria: reported BFT TRAP catches in MEDI, in the western Mediterranean, along the Algerian coast. The catches were reported from 1950 to 2002, ranging from 1 to 468 t with the max in 1994. This fishery targeted mostly medium and big BFT.
  Data on BFT reproductive biology from this fishery are poorly available.
- Morocco: reported BFT TRAP catches in MEDI, in the western Mediterranean, in the southern part of the Alboran Sea. The catches were reported from 1950 to 2008, ranging from 1 to 1,118 t with the max in 1990. This fishery targeted mostly medium and big BFT.
  Data on BFT reproductive biology from this fishery are poorly available.

3.4.4 Mediterranean Sea: harpoon (HARP)

This gear is among those having the longest history in the Mediterranean area, but usually it was mainly targeting SWO and Mediterranean spearfish (MSP), even if BFT was also among the targets.

- EC-Italy: reported BFT HARP catches in MEDI, in two areas close to the Strait of Messina: TYRR and N.ION, even if the fishing grounds were contiguous and mostly linked to the Strait of Messina. For very few years a harpoon vessel operated also in the Ligurian Sea. The catches were reported from 1976 to 2005, ranging from 1 to 56 t with the max in 1981. This fishery targeted mostly medium and big BFT. This fishery had no BFT quota until 2019 and catches are not reported for the period 2006 to 2018.
  Information on this fishery is available, but data on BFT reproductive biology are not available. Sampling these catches is feasible, with observers on board.
- EC-France: reported BFT HARP catches in MEDI for 2017 only, for less than 1 t. It is suspected that the activity was carried out in the Ligurian-Provencal basin, but no information is available for this fishery.
- Turkey: no BFT catches were reported from Turkey, even if the harpoon fishery is traditional and it is still carried out.
  Information on this fishery is available in a limited manner for SWO, but data on BFT are not available. Sampling these catches is feasible, with observers on board.

3.4.5 Mediterranean Sea: rod and reel and trolling line (RR, TROL)

These two fisheries are mostly used by sport and recreational fishermen in the Mediterranean, but some vessels used them also for professional fishery. The fishing pattern is opportunistic, sometimes linked to tournaments. Target are fish of any size, including juveniles in some fisheries. When the EBFT quota system was enforced, then several limitations entered into force, limiting these fisheries. Sampling is also occasional and opportunistic, providing very few data if any.

- EU-Spain: catches are provided as TROL and the fishing area is MEDI (the western Mediterranean, including the Balearic Sea); catches are reported from 1994 to 2005, ranging from 5 to 76 t, with the maximum in 1996.
- EU-France: the fishing area is MEDI for both gears, probably the NW Mediterranean and the Corsica Sea.
  RR catches are reported from 1978 to 2011, ranging from <1 to 60 t, with the maximum in 1982 and 1983.
  TROL catches are reported from 2013 to 2016, ranging from 2 to 32 t, with the maximum in 2016.

- EU-Italy: catches are provided as RR and the fishing areas are several (LIGU, ADRI, SARD, IONI, MEDI).
  In the Ligurian Sea catches are reported from 1984 to 2010, ranging from 5 to 70 t, with the maximum in 1994.
  In the Adriatic Sea catches are reported from 1984 to 2015, ranging from 4 to 475 t, with the maximum in 1995.
  In the Sardinian Sea catches are reported from 1990 to 2010, ranging from 2 to 75 t, with the maximum in 2002.
  In the Ionian Sea catches are reported from 1990 to 2010, ranging from 29 to 282 t, with the maximum in 1994.
  In the Mediterranean Sea catches are reported only in 2017, for 15 t.
  Taking into account the fact that sport and recreational fisheries have a BFT quota set by EU-Italy, in is unclear why catches are not reported in some years.
- EU-Malta: the fishing area is MEDI for both gear, specifically the central Mediterranean.
  RR catches are reported from 2014 to 2017, ranging from 1 to 2 t.
  TROL catches are reported from 1954 to 2006, ranging from <1 to 56 t, with the maximum in 1973.

It is known that some not-ICCAT countries have RR and TROL fisheries targeting BFT in the Levantine Sea. The level of these catches is very partly known (Bariche and Di Natale, 2019).

3.4.6 Mediterranean Sea: bait boats (BB)

The BB fishery is not typical in the Mediterranean Sea but it was carried on in the recent past, while it was initiated by a CPC in the last years. The target are mostly small BFT. Sampling could be maybe occasional and opportunistic even if data seem not available, but it would be possible with observers on board.

- EU-Spain: the fishing area is MEDI (the Northwestern Mediterranean and the Strait of Gibraltar); catches are reported from 2009 to 2017 with holes, ranging from 1 to 38 t, with the maximum in 2005 and an average of 20.5 t. No information is available for this fishery, but it seems that it is carried out by few local vessels in the Strait of Gibraltar, while a Bask vessel entered in the past in the Mediterranean, carrying out some fishing activity in the NW area. It is not clear if all these catches in Task I are really related to MEDI or if there are catches from the Strait of Gibraltar that should be moved to EATL.
- EU-France: the fishing area is MEDI (possibly the Northwestern Mediterranean); catches are reported from 1981 to 2005, ranging from 1 to 1,699 t, with the maximum in 1984. These were French Bask vessels, coming at the end of the summer into the Mediterranean for a couple of months. It seems that the fishing pattern was always similar, but the effort was different.
- EU-Italy: few vessels practiced this fishery for very few years in the ‘70s in the southern Tyrrhenian Sea (Aeolian Islands) but BFT catches were never reported. No additional information is available.

3.4.7 Mediterranean Sea: hand lines (HAND)

The HAND fishery is one of the ancient traditional fisheries in the Mediterranean and it is practiced since historical times in almost all areas, with various types of lines, by professional, recreational and sport fishermen. The targets are several size classes, from YOY to medium-large fish and usually the target and the season can distinguish the fisheries. Usually the vessels are very small coastal ones.

Fishing for small, medium and large fish requires special skills and the fishery is carried out by experienced fishermen, mostly in the Straits (Strait of Gibraltar, Strait of Messina, Strait of Sicily and, in the past, also in the Adriatic Sea), but not only; catches were traditionally made mostly in two season (spring and autumn), but in the last decades catches are all year round.

When the EBFT quota system was enforced, then these fisheries were quite often excluded in the domestic sharing and they sometimes operated on the by-catch allowance.

Fishing for BFT YOY (0.2 to 2 kg) could be also a subsistence fishery and it is practiced since ever, when YOY approaches the coast, from late summer to very early winter in most of the Mediterranean areas; usually this fishery is not reported at all and catches are fully IUU because of the minimum size regulation. It is suspected that this fishery for YOY BFT takes place in almost all the Mediterranean countries, with different intensity. Annual catches concerning YOY can be extremely important in number of individuals.

Size frequencies are usually poorly available for these fisheries, making difficult even understanding the size target.

Sampling is usually poor, occasional and opportunistic, because observers are needed in all ports and beaches where these many small vessels land at any time of the day. Game tournaments might be easier to monitor. Sampling HAND in general might be difficult because many catches are mostly IUU. Sampling these fisheries could be extremely important: monitoring the YOY fishery can provide real-time data on the recruitment and basic data for setting the genetic and microchemical references about the origin of the fish; sampling small and medium pre-spawners or spawners can provide important data on the maturity, while sampling in late autumn and winter can provide data on "resident" fish.

- EU-Spain: the reported fishing area is MEDI (currently, the Strait of Gibraltar and the western Mediterranean); catches are separated between professional and recreational fishermen; possibly, the HAND catches related to the Strait of Gibraltar should be moved to EATL. Catches from professional fishermen are reported from 1983 to 2017, ranging from <1 to 732 t, with the maximum in 1995 and an average of 6.9 t in the last decade. Catches from recreational fishermen are reported from 1975 to 2017, ranging from 1 to 88 t, with the maximum in 1977 and an average of 14.6 t in the last decade. The Spanish HAND vessels targeting adult BFT in the Strait of Gibraltar are known to suffer some direct interferences and predation by killer whales (*Orcinus orca*).
- EU-France: no HAND fishery is reported, but the Marine Stewardship Council (MSC) in 2018 reports that a HAND fishery catching 200 t/year is active in the MEDI (southern France and Corsica)[6].
- EU-Italy: the fishing areas are mostly the TYRR and the S.SIC; catches are separated between professional and recreational fishermen.
  In the Tyrrhenian Sea catches from professional fishermen are reported from 1970 to 2015, ranging from <1 to 507 t, with the maximum in 1990 and an average of 66 t in the last decade; catches from recreational fishermen are reported from 1984 to 2010, ranging from 80 to 260 t, with the maximum in 2002 and an average of 174.1 t in years 2000.
  In the Strait of Sicily catches from recreational fishermen are reported from 1988 to 2010, ranging from 1 to 21 t, with the maximum in 2002 and an average of 11.6 t in years 2000. It is not clear if holes and the lack of data in recent years are due to reporting problems.
  HAND BFT catches are known to occur in other Italian seas, but catches are not reported.
  The Italian HAND vessels targeting adult BFT in the Strait of Messina are known to suffer some direct predation by the great white shark (*Carcharodon carcharias*) and, in the past, also by false-killer whales (*Pseudorca crassidens*).
- EU-Croatia: the fishing areas are MEDI, ADRI and the N.ADR, but it is possible that the real area is the northern-central Adriatic Sea; it is not clear why catches are reported in such manner. Catches are separated between professional and recreational fishermen.
  In MEDI catches from professional fishermen are reported from 1977 to 2004, ranging from <1 to 39 t, with the maximum in 1999. Catches up to 1990 were reported by the former Yugoslavia.
  In ADRI catches from professional fishermen are reported from 2000 to 2007, ranging from 5 to 44 t, with the maximum in 2017 and an average of 11.5 t; catches from recreational fishermen are reported from 2010 to 2017, ranging from 18 to 78 t, with the maximum in 2017 and an average of 2.3 t in the last decade.
  In the N.ADR catches from professional fishermen are reported only in 2015 and 2016, for18 and 78 t; catches from recreational fishermen are reported only in 2015 and 2016 for 2 and 3 t.
- EU-Greece: the fishing area is MEDI (possibly the Ionian Sea and the Aegean Sea); catches are reported from 1950 to 2017, ranging from 5 to 1,200 t, with the maximum both in 1955 and 1963 and an average of 66.7 t in the last decade.
- EU-Cyprus: the fishing area is MEDI (possibly the Levantine Sea); catches are reported only in 1993 and 2008, for 3 and 4 t.
- Turkey: the fishing area is MEDI (possibly the Levantine Sea, nothing is specified about the Marmara Sea); catches are reported only in 2015 and 2016, for <1 and 1 t.
- Tunisia: the fishing area is MEDI (possibly the Strait of Sicily and the Gulf of Gabes); catches are reported from 1979 and 2007, ranging from 1 to 113 t, with the maximum in 1997.

[6] https://www.msc.org/en-us/media-center/news-media/artisanal-french-bluefin-tuna-fishery-enters-msc-assessment; https://www.undercurrentnews.com/2018/09/26/artisanal-french-bluefin-tuna-fishery-enters-msc-assessment/

- Morocco: the fishing area is MEDI (possibly the Strait of Gibraltar and the southern part of the Alboran Sea); catches are reported from 1994 and 2017, ranging from 2 to 816 t, with the maximum in 1995; the average is 94.5 t in the last decade. The Moroccan HAND vessels targeting adult BFT in the Strait of Gibraltar are known to suffer some direct predation by killer whales (*Orcinus orca*).

3.4.8 Mediterranean Sea: driftnets (GILL)

The GILL fishery targeting BFT (by driftnets) was practised mostly for YOY and juveniles, while adult BFT by-catch may happens sometimes in other types of GILL fisheries, targeting other species (i.e. SWO). Driftnets were officially banned in 2002. Sampling was not easy, because small fish were traded entire, but it was possible with observers on board or at landings, buying the fish.

These fisheries were all affected by the EBFT recovery plan, because they were mostly excluded by the domestic quota sharing, and by the driftnet ban in 2002.

- EU-Spain: the fishing area was MEDI (the western Mediterranean, mostly in the southern Spain); catches are reported from 1994 to 1993, ranging from <1 to 3 t, with the maximum in 1984. No information is available for this fishery, but these driftnets were mostly targeting swordfish and these small quantities are related to the by-catch.
- EU-France: the fishing area is MEDI (possibly the North-western Mediterranean and Corsica); catches are reported from 1950 to 1965 and again in 2017, ranging from <1 to 966 t, with the maximum in 1952. No information is available for this fishery and it is very strange to notice data in 2017.
- EU-Italy: catches are reported for LIGU, TYRR, IONI, N.ION.
  Catches in the Ligurian Sea are reported from 1991 to 2000, ranging from <1 to 5 t, with the maximum both in 1991 and 1992.
  Catches in the Tyrrhenian Sea are reported from 1984 to 1997, ranging from 35 to 322 t, with the maximum in 1985.
  Catches in the northern Ionian Sea are reported from 1990 to 1997, ranging from 3 to 55 t, with the maximum in 1997.
  Catches in the Ionian Sea are reported from 1999 to 2001, ranging from 10 to 26 t, with the maximum in 2001.
  The various areas are not exactly showing the changes in the fishing pattern. Few additional information is available.
- Turkey: the fishing area is MEDI (the Levantine Sea); this is possibly a by-catch of the driftnets for swordfish; catches are reported only in 2010 for <1 t. No information is available for this fishery.
- Algeria: the fishing area is MEDI (possibly the southern-western Mediterranean); catches are reported from 1998 to 2007, ranging from 75 to 312 t, with the maximum in 2001. No information is available for this fishery.
- Morocco: the fishing area is MEDI (possibly the Strait of Gibraltar and the southern Alboran Sea). Catches are reported from 1990 to 2003, ranging from 4 to 92 t, with the maximum in 1995. No information is available for this fishery.

3.4.9 Mediterranean Sea: trawlers, pelagic trawlers, pair pelagic trawlers (TRAW, TRAWP, TRAWPP)

Usually the different types of trawl fisheries are not taken into account for BFT. This is mostly because BFT might be taken as by-catch during activities targeting other species. In the Mediterranean, it is well known that several bottom trawlers (TRAW) were used to catch BFT during their fisheries, using hand lines left at sea with an empty barrel and then recovered at the end of the haul. Bottom trawlers, also, for many years, were accused to steal BFT from Asiatic longlines, mostly from the Japanese ones. BFT catches were not negligible (they were assessed in about 300 t in one year for just one fleet in the Strait of Sicily) but usually they were IUU and never reported, but a part of these catches appears on some domestic reports (Di Natale *et al*., 1996).

- EU-France: the fishing area is MEDI (possibly the northern-western Mediterranean). TRAW catches are reported for 2017, for 1 t; TRAWP catches are reported from 2010 to 2015, ranging from 1 to 2 t. No information is available for this fishery.
- EU-Italy: the fishing area is MEDI (possibly the Adriatic Sea). TRAWPP catches are reported in 2016, for 4 t. No information is available for this fishery to ICCAT.

Due to the origin of most of these fish, BFT catches were always obscure. Sampling was never possible. The pattern changed dramatically after the adoption of the EBFT Recovery Plan.

3.5 Black Sea

The Black Sea was one of the historical distribution area of the BFT since ancient times.

There are no official catches reported for the Black Sea by any CPC, except a series of Bulgarian PS catches from 1950 to 1971 that were recently recovered by ICCAT GBYP (Di Natale, 2017).

As a matter of fact, there are several papers reporting that BFT fisheries were active in the Black Sea possibly till the '80s and mostly in Turkish waters. The data on catches (with several gears) are possibly and partly mixed-up with the other Turkish catches in the Mediterranean Sea, in the Marmara Sea and in the Straits (Bosporus and Dardanelles). Even in these last two areas, the BFT fishery ended in 1986.

In all cases, it is supposed that BFT had left the Black Sea and the other nearest areas because of the huge pollution of the waters.

According to a very recent paper (Di Natale *et al*., 2019), BFT is back again in the Black Sea and in the nearest areas since 2007, except for three fish caught in 2002 in the Marmara Sea. The current fisheries seem opportunistic (PS, HAND, GILL, SPOR), but they are still not reported to ICCAT.

4. Discussion

Many important and dramatic changes happened in the fishing patters of many BFT fisheries from 1950.

Some of these changes are well known (i.e.: the LL fisheries in the southern Atlantic, the BFT fisheries in northern Europe), but not all the data are clear, while many other changes are currently not taken into account.

A full detailed revision of Task I is needed in terms of distribution of the fisheries by area and gear, particularly taking into account the use and the relevance of the catch data in the new BFT MSE (and OMs) approaches.

The adoption of the quota system strongly affected all fishery-dependent indices but also the opportunities for sampling over a larger period of time and in more areas. Those collateral effects of the quota system are quite often underestimated.

The tuna fattening industry resulted in a very serious limitation for following the reproductive biology of ABFT in the wild, particularly for the EBFT.

The sampling opportunities for better understanding the WBFT reproductive biology are very seriously limited by the existing fisheries and by the size limits, but even by the sampling strategy (which is very limited in space and time) and weak since the adoption of the WBFT quota.

There are not fisheries for young EBFT adults during the spawning season in any other area outside the Mediterranean Sea (with the exception of the Bay of Biscay), therefore it is currently almost impossible to understand if the percentage of young spawners historically sampled in the Mediterranean spawning ground are fully representative of the spawning population at age or not. Furthermore, the BFT is extremely adaptive and it changes its distribution from time to time and we only very partly know which are the main factors inducing these changes.

It would be important and essential to study the additional and potential spawning areas outside the Gulf of Mexico (where data cover just a portion of the whole) and the Mediterranean Sea, i.e.: the southern part of the Gulf of Mexico, the Caribbean Sea, the eastern US coast from Florida to the Gulf of Maine, the Azores, the Gulf of Biscay, the area close to Madeira, the Spanish coastal area NW of the Strait of Gibraltar, the area between the Canary Islands and Morocco and the Gulf of Guinea.

Huge oceanic areas (i.e.: the central and southern Atlantic), about half of the ICCAT Convention area, are currently not sampled and not monitored, but also poorly studied in terms of BFT presence and distribution, clearly affecting in a very serious manner our understanding of the BFT population dynamics.

The use of a natural marks, like the scars due to the bites of the cookie-cutter shark (*Isistius brasilensis*) (**Figure 8**), may help for better understanding the large-scale displacements of ABFT (Di Natale *et al*., 2013). Sampling these fish with natural marks will possibly increase our understanding of the stock origin, composition and mixing.

In an ideal world and in an open fishery system, the fishermen go where the fish are. For optimising the catches, the fishermen go where the highest concentration of fish are, but leaving all other areas, so nobody can say how many fish are in the other areas. This is particularly true with the EBFT, because most of the catches are obtained from the main spawning area during the spawning season or just immediately before or after in the nearest areas.

Having a shorter fishing season due to the quota systems means that even these previous points are no more valid. Therefore, we can only use the data we have, particularly those taken during the open fishery times and when sampling for obtaining data on the ABFT reproductive biology was much more feasible.

The data are these mentioned above and they are not few. We can interpret them as we like, but sometimes there is too much speculation; when the speculation brings to concepts which are biologically illogical, possibly we should bring the discussion on more biologically logic concepts.

Vuolsi così colà ove si puote ciò che si vuole e più non dimandare.
It is so willed there where is power to do that which is willed; and ask no further question.
(Dante Alighieri, 1472, Divine Comedy. The Hell, 3rd song).

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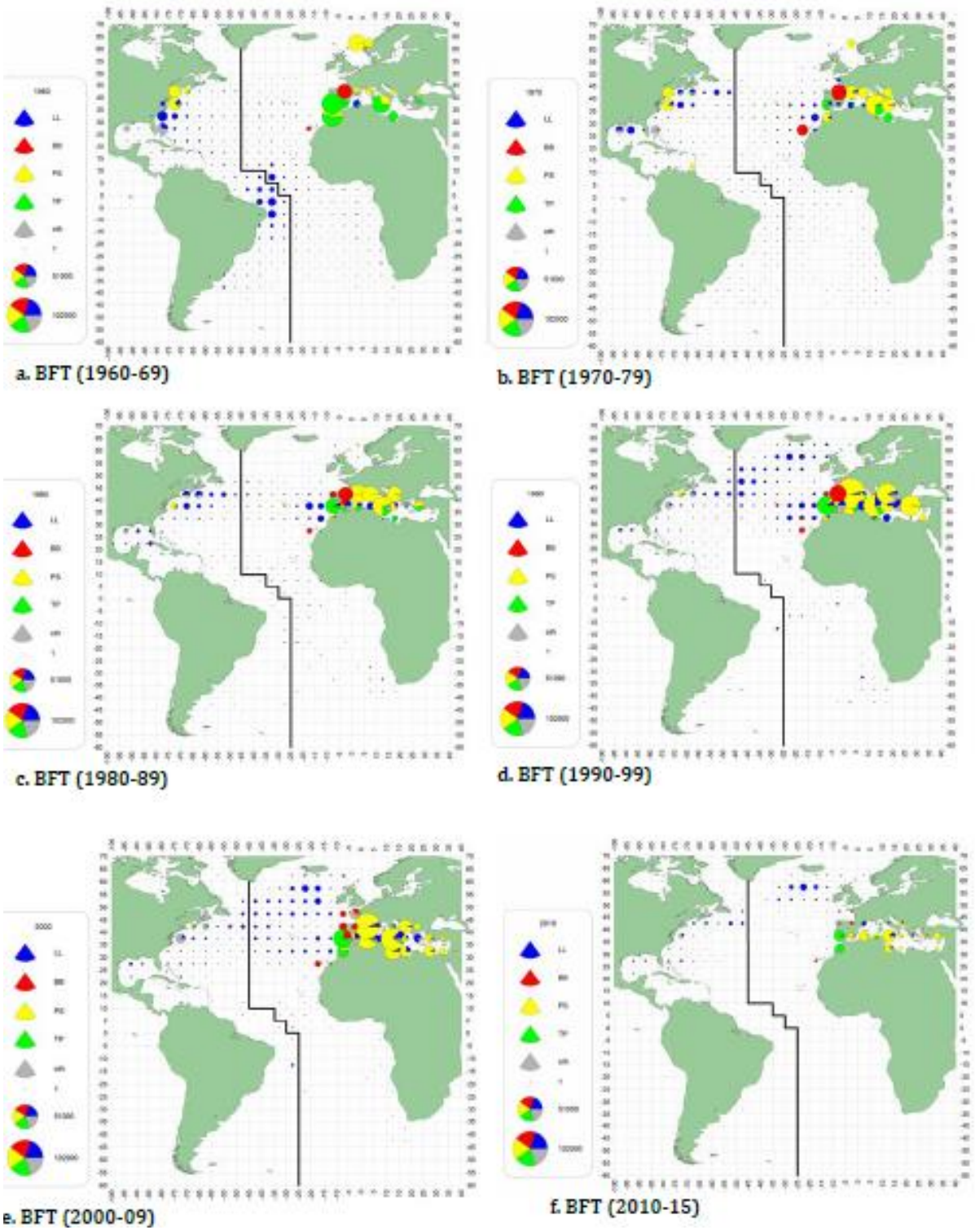

Figure 1. Changes in the BFT fisheries over the decades (1960-2015), according to the data existing in the ICCAT BFT Task I, provided by the ICCAT CPC and revised by ICCAT SCRS every year.

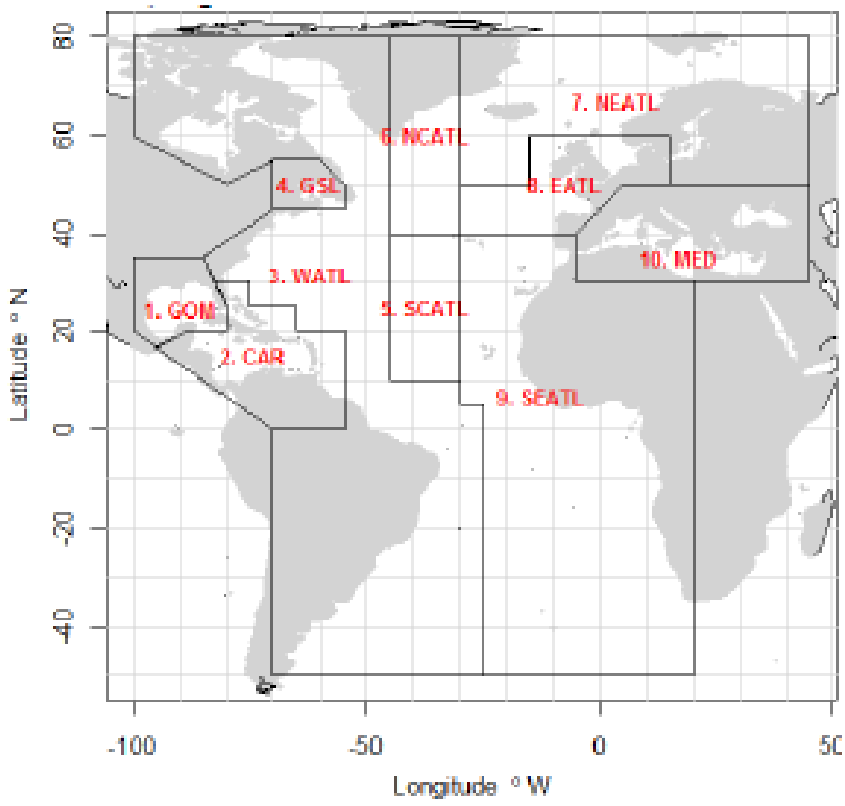

Figure 2. Spatial definitions tabled by the 2015 ICCAT data preparatory meeting, with simplification to a single Mediterranean area, as used by the current BFT MSE process.

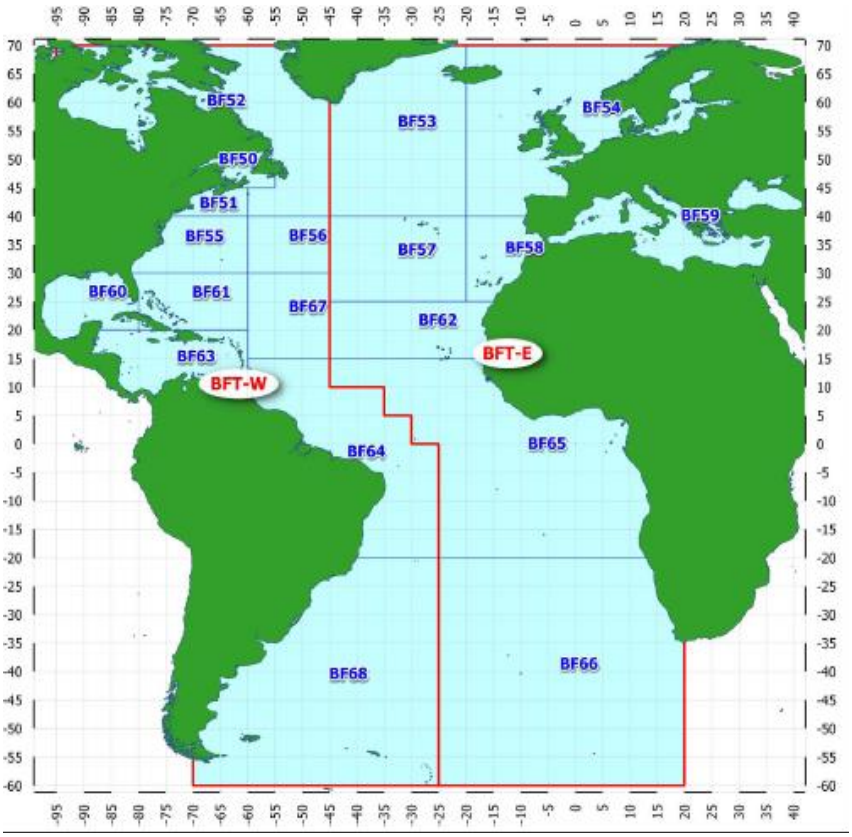

Figure 3. Official map of the ICCAT BFT reporting areas for statistical purposes.

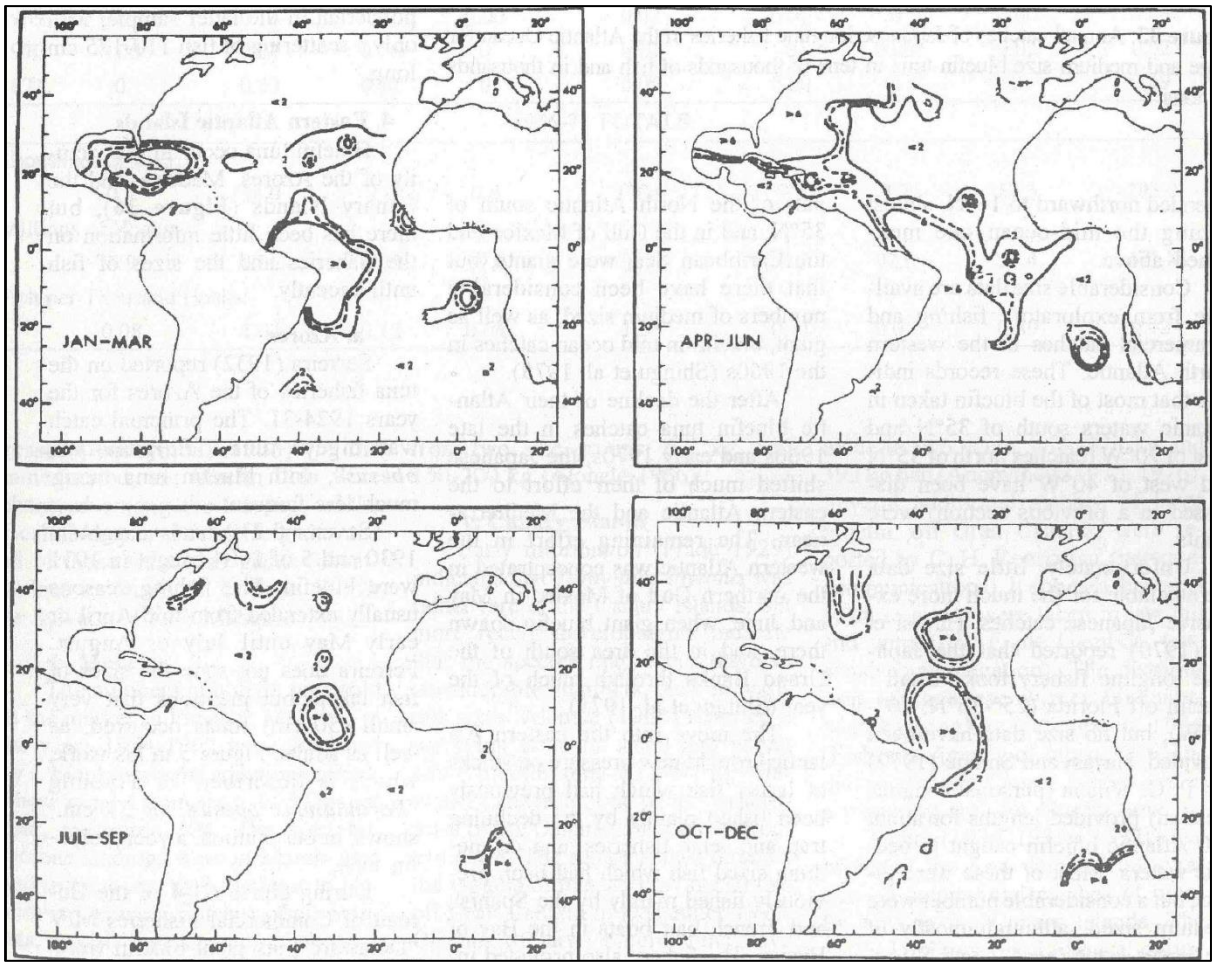

Figure 4. Cumulative LL fishing areas by quarter for the years 1956-1968 (from Mather *et al*., 1995).

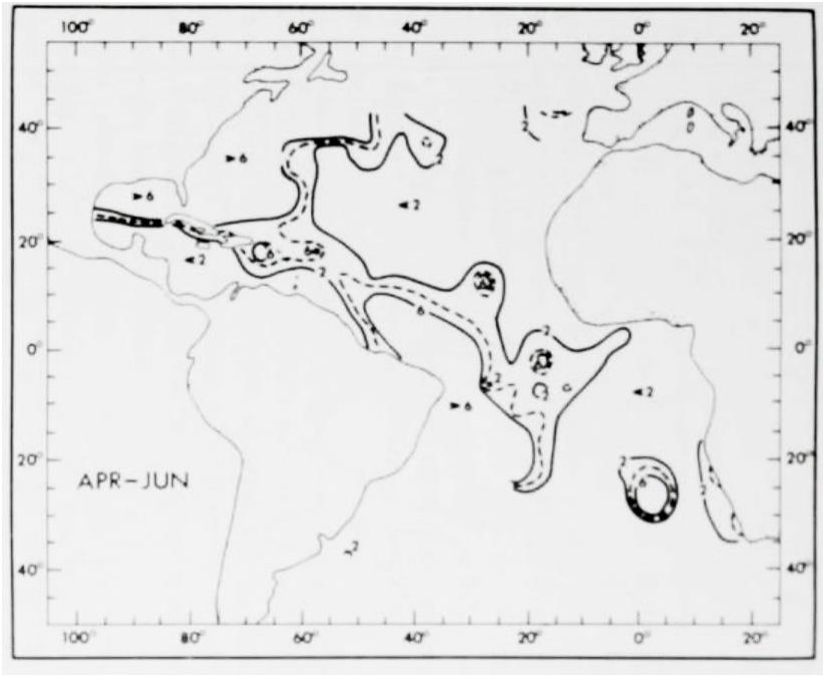

Figure 5. Cumulative Japanese LL fishing areas in the 2nd quarter for the years 1956-1963 (from Wise and Davis, 1973).

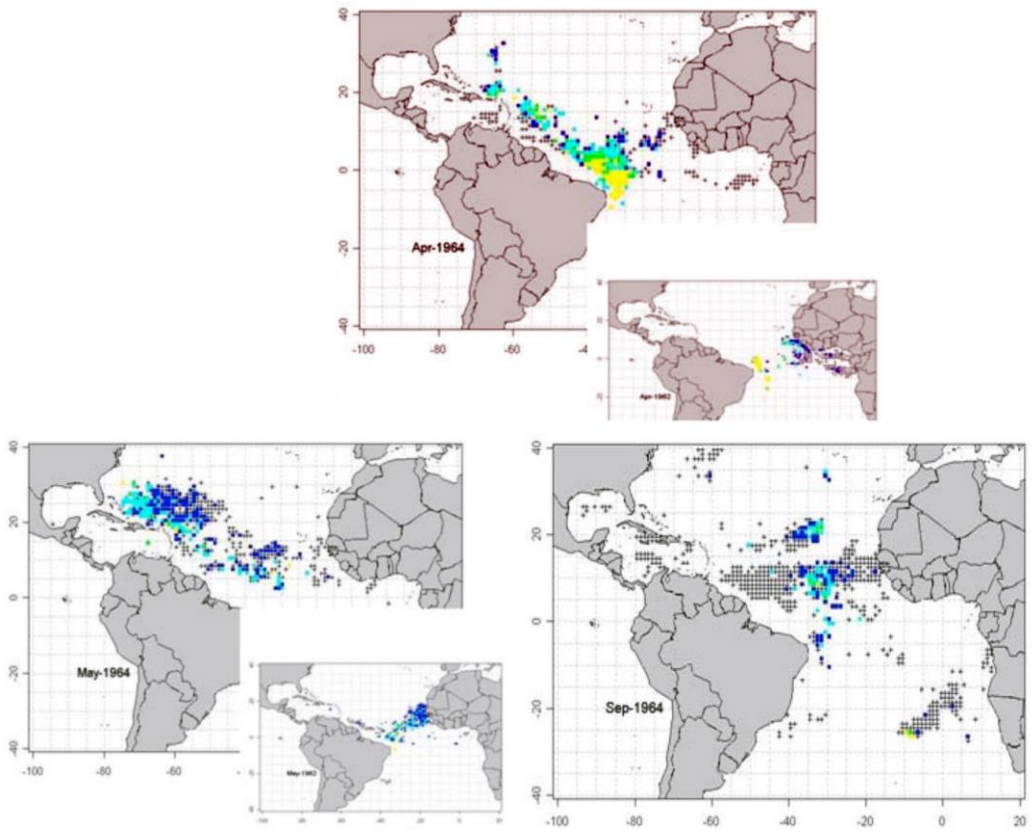

Figure 6. Japanese LL fishing areas in April 1993 (upper figures), in May 1964 (lower left figures) and in September 1964 (from Tacheuchi *et al*., 2009).

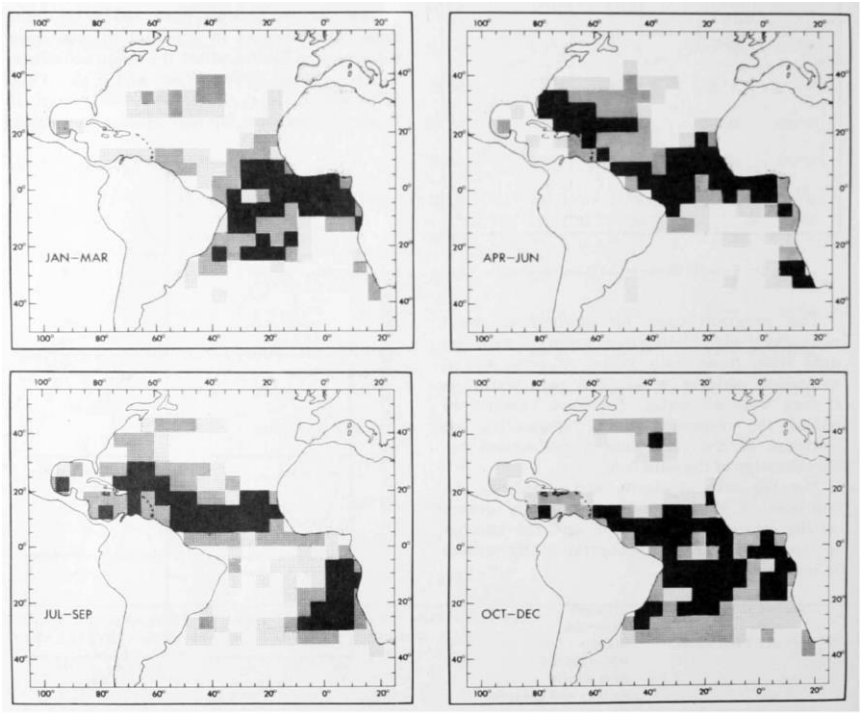

Figure 7. Cumulative relative Japanese LL fishing effort distribution by quarter in the years 1856-1968 (from Wise and Davis, 1973).

Figure 8. Images of the circular scares due to bites made by the cookie-cutter shark *Isistius brasilensis* on bluefin tuna, possibly in South-central Atlantic (from the ICCAT ROP form provided by ICCAT GBYP).