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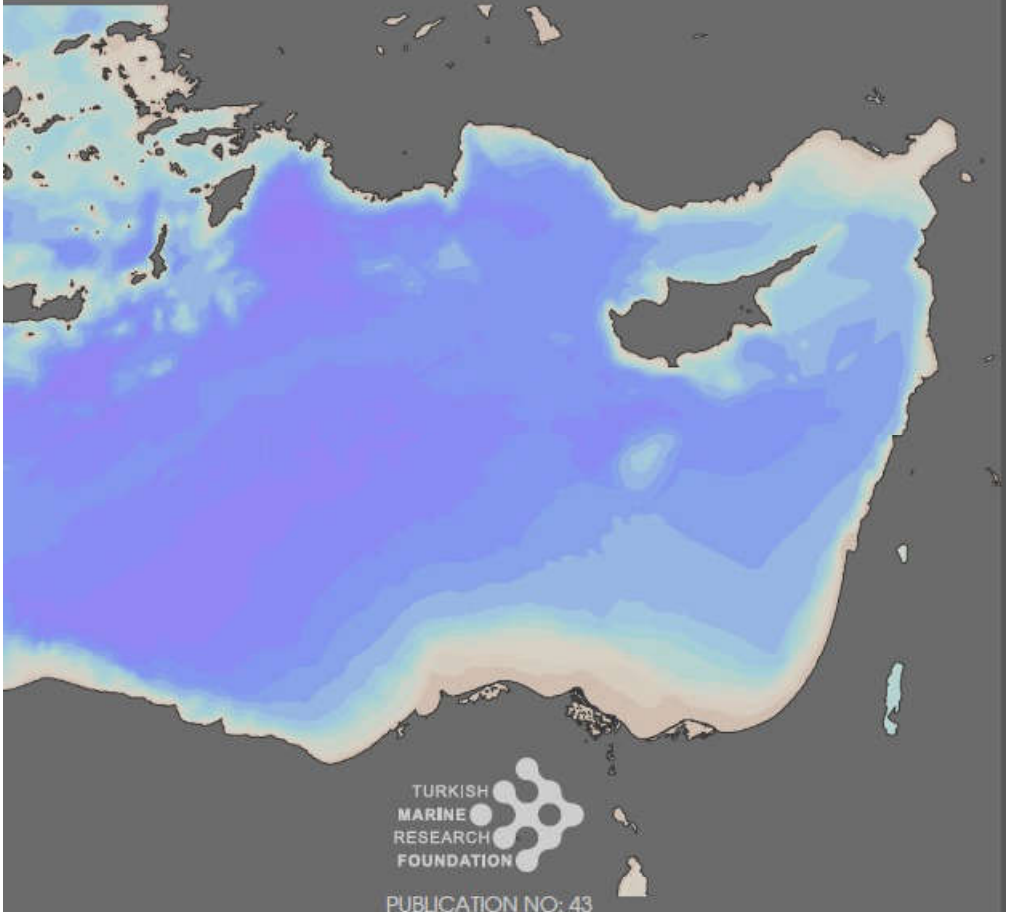
THE TURKISH PART OF THE MEDITERRANEAN SEA

MARINE BIODIVERSITY, FISHERIES, CONSERVATION AND GOVERNANCE

EDITORS :
CEMAL TURAN, BARIŞ SALİHOĞLU, ELİF ÖZGÜR ÖZBEK, BAYRAM ÖZTÜRK



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ATLANTIC BLUEFIN TUNA IN THE MEDITERRANEAN SEA: FISHERIES, FARMING, MANAGEMENT AND CONSERVATION

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1. Introduction

Atlantic bluefin tuna (ABFT) mainly live in the pelagic ecosystem of the entire North Atlantic and its adjacent seas, primarily the Mediterranean Sea. Among the tunas, ABFT has the widest geographical distribution and is the only large pelagic fish living permanently in temperate Atlantic waters (Bard *et al.* 1998; Fromentin and Fonteneau 2001). Archival tagging and tracking information confirmed that ABFT can sustain cold (down to 3°C) as well as warm (up to 30°C) temperatures, while maintaining stable internal body temperature (Block *et al.* 2001). ABFT is also a highly migratory species that seems to display a homing behavior and spawning site fidelity in both the Mediterranean Sea and Gulf of Mexico, which constitute the two main spawning areas being clearly identified today (Figure 1) (Fromentin, 2006).

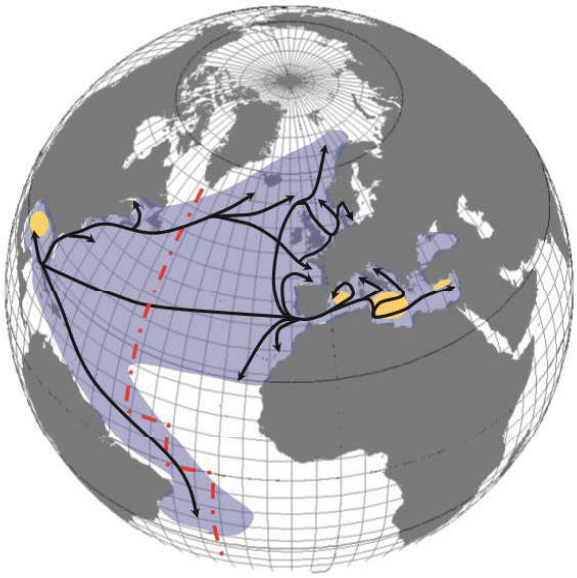

Figure 1. Map of the spatial distribution of ABFT (blue), main migration routes (black arrows) and main spawning grounds (yellow areas) (Fromentin and Powers 2005, Fromentin, 2006).

Cetti (1777) has first mentioned about migration of ABFT between Mediterranean and North Atlantic. Pavesi (1889) has put forward an idea to being a distinct stock in the Mediterranean as well and this hypothesis was accepted by many researchers. (Roule 1917; de Buen 1925; Scordia 1938). Migration between Mediterranean and North Atlantic was determined by tagging studies conducted in 1960s and 1970s and this migration was agreed (Sara, 1963; Mather *et al.* 1995; Fromentin and Powers, 2005). Electronic tagging results has been indicate that migration and movement patterns of ABFT might be varied among individuals, years, and areas (Lutcavage *et al.* 1999; Block *et al.* 2001).

Four defined ABFT spawning areas are known in the Mediterranean (Piccinetti *et al.* 1997; Nishida *et al.* 1998; Garcia *et al.* 2003; Oray *et al.* 2005): the Balearic Sea, around Malta Island, the north Levant Sea and defined marine areas to the east coast of Sicily and South Tyrrhenian Sea (Figure 2). Spawning period of ABFT is between May and July (Rodriguez-Roda, 1967; Susca *et al.* 2001; Medina *et al.* 2002; Karakulak *et al.* 2004; Heinisch *et al.* 2008). ABFT median sexual maturity (L_{50}) in the Mediterranean is 103.6 cm in fork length (FL) (3 years), %100 maturation length is 135 cm in FL (4-5 years) (Corriero *et al.* 2005).

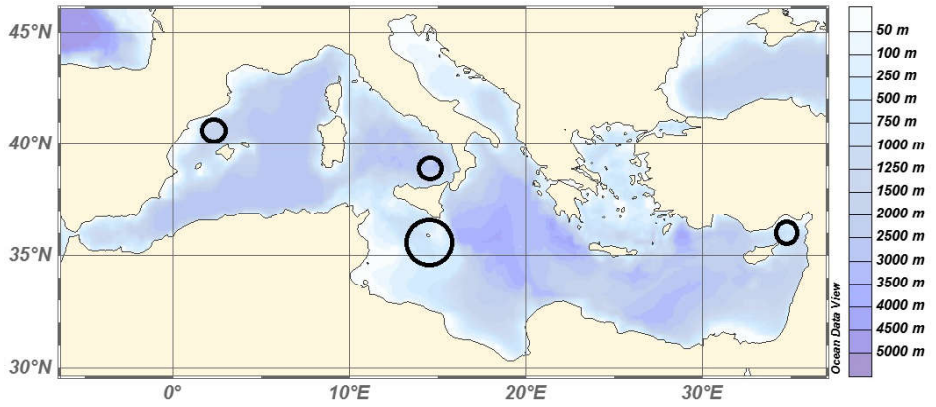

Figure 2. The spawning areas in the Mediterranean Sea (Karakulak *et al.* 2016).

ABFT are managed as two separate stocks by The International Commission for the Conservation of Atlantic Tunas (ICCAT): the western stock spawns in the Gulf of Mexico, whereas the eastern stock spawns in the Mediterranean Sea. Electronic tagging, genetics and microchemistry studies suggests that the population structure of ABFT is much more complex (Rooker *et al.* 2008; Riccioni *et al.* 2013). Support for the existence of two separate stocks of ABFT is provided by several genotypic and phenotypic markers. Analyses of DNA microsatellites (Carlsson *et al.* 2007), mitochondrial DNA (Boustany *et al.* 2008), otolith shape (Brophy *et al.* 2016), chemical composition of the otolith (Secor *et al.* 2002; Rooker *et al.* 2003) and isotopes in otoliths (Rooker and Secor, 2004) all show

significant divergence of the two population. Moreover, some researchers suppose that ABFT also forms metapopulations between the eastern Atlantic and the Mediterranean (Fromentin and Powers, 2005).

Recent studies of ABFT genetic population structure within the Mediterranean are uncertain. Some researchers found significant heterogeneity among this species from western and eastern Mediterranean Sea (Broughton and Gold, 1997; Carlsson *et al.* 2004; Boustany *et al.* 2008). On the contrary, other genetic studied concluded that no genetic differences could be detected within Mediterranean ABFT (Alvarado Bremer *et al.* 1999; Vinãs, 2001; Vinãs, 2003; Vella *et al.* 2016). These contradictory results could be consequence of differential sampling and methodological techniques used among studies. In the case of ABFT population structure, genetic analyses need to be improved and standardized to avoid conflicting results.

ABFT Fishing

ABFT fishing has come to head with production of 53.335 ton in 1996. In comparison with the Atlantic Ocean, the Mediterranean Sea is an important fishing area (Figure 3). In 2000s, catch volumes have showed a decrease due to the quota implementation of ICCAT (Figure 4). The most decline in fishing has been seen in the Mediterranean Sea. Fishing gears used in the Mediterranean Sea during the recent years; set traps (almadrabas), longlines, bait boat, rod and reel, hand trolling and purse seines (Figure 5). Going into action of ABFT farming in the Mediterranean Sea in 1997 has changed ABFT fishing in the Mediterranean Sea and caused to increasing in purse seine fishing.

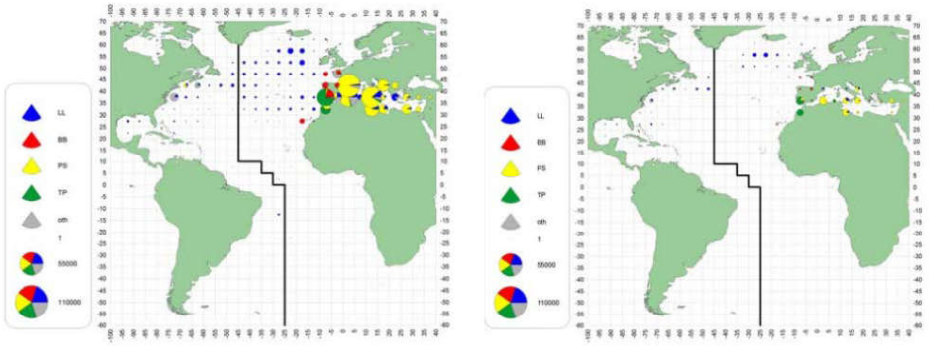

Figure 3. ABFT fishing areas with respect to main gears from 2000 to 2013 (LL-longline, BB-bait boat, PS-purse seine, TP-trap and OTH-other fishing gear) (ICCAT, 2016a).

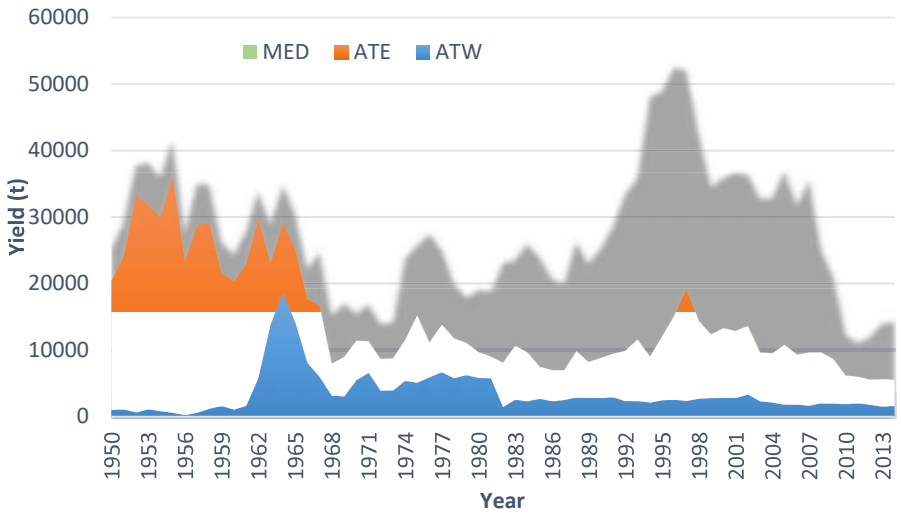

Figure 4. Reported catch for the West Atlantic, East Atlantic and Mediterranean from 1950 to 2014 split by main geographic areas (ICCAT, 2016a).

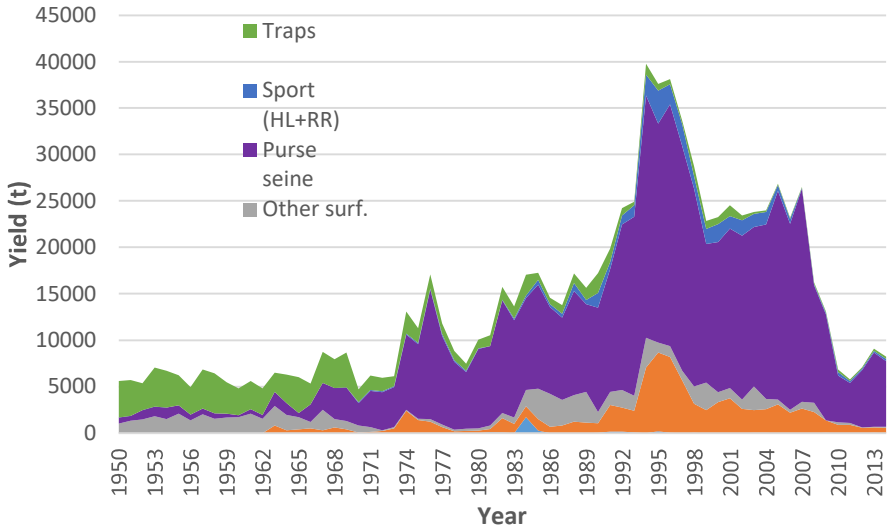

Figure 5. Reported catch for the Mediterranean from 1950 to 2014 split by gears (ICCAT, 2016a).

Catch amounts of ABFT between years of 2009 and 2014 by Mediterranean countries were given in Table 1. Countries that have the most fishery are France, Italy, Tunisia, Spain, Libya and Turkey. Japan and Korea Republic have fishing quotas with regard to historical fishing backgrounds (ICCAT 2016a).

According to the recommendations of ICCAT, ABFT fishing shall be done in 1 January-31 May for large-scale pelagic longline vessels, in 26 May-24 June for purse seine fishing, in 1 July-31 October for bait boats and trolling boats, in 16 June-14 October for recreational and sport fishing (ICCAT 2016b [Rec.14-04]).

Table 1. ABFT catch quotas by counties (ICCAT, 2016a).

	2009	**2010**	**2011**	**2012**	**2013**	**2014**
Albania	50	0	0	0	9	34
Algerie	0	0	0	69	244	244
EU.Croatia	619	389	371	369	384	385
EU.Cyprus	2	3	10	18	17	17
EU.Spain	1769	942	942	1064	948	1164
EU.France	3087	1754	805	791	2191	2207
EU.Greece	373	224	172	176	178	161
EU.Italy	2749	1060	1783	1788	1938	1946
EU.Malta	263	136	142	137	155	160
Egypt	0	0	0	64	77	155
Japan	18	0	0	0	0	0
Korea Rep.	102	0	0	77	80	81
Libya	1082	645	0	756	929	933
Morocco	369	205	182	223	309	310
Syria	0	34	0	0	0	0
Tunisia	1932	1042	852	1017	1057	1047
Turkey	665	409	519	536	551	555

Figure 6. Turkish purse seine vessel specialized for ABFT

Farming and fattening of ABFT in the Mediterranean Sea

ABFT farming and fattening in the Mediterranean Sea is a seasonal activity. Fishes have been caught from nature during spawning migration and kept in cages between 3 months and 2 year (Mylonas *et al.* 2010). Due to low muscle fat content of fish and market price during the catching period, the fishes keep within cages then they are sold to Asian markets notably Japanese at a premium when they have high fat content after a good nutrition. Under the date of January 2013, a total of 1.76 million $ were payed for a 222 kg ABFT in the Tokyo's Tsukji market (The Atlantic news, http://www.theatlantic.com/international/archive/2014/01/sushinomics-how-bluefin-tuna-became-a-million-dollar-fish/282826/).

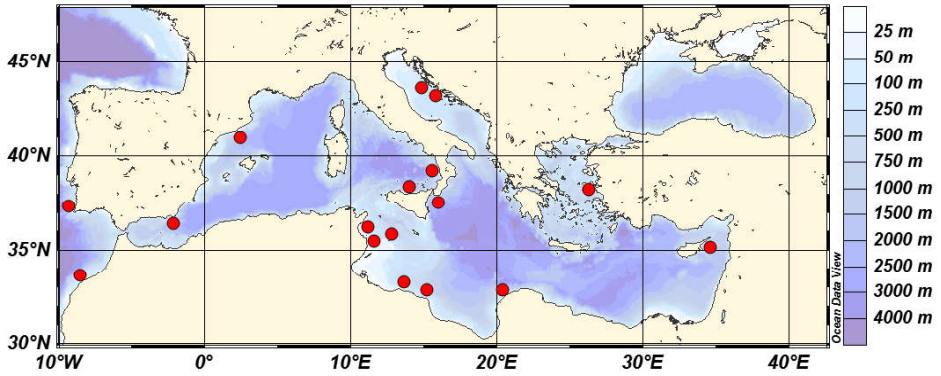

Figure 7. The locations of the bluefin tuna farms in Mediterranean Sea.

In the Mediterranean, the first ABFT farm was started in southern Spain in 1985 and farming activity immediately spread in 1997 (FAO 2005). In 2016, the number of farms registered to ICCAT in the Mediterranean is 53 and potential capacity is 58.562 tonnes (Table 2). The countries involved in ABFT farming in Mediterranean are Croatia, Cyprus, Greece, Italy, Libya, Malta, Spain, Tunisia and Turkey (Figure 7).

Table 2. Numbered of registered BFT farming in the Mediterranean in 2016 (ICCAT, 2016c).

	Numbered registered	**Potential capacity (tonnes)**	**Starting date**
EU Croatia	4	7.880	1996
EU Cyprus	3	3.000	2003
EU Greece	2	2.100	2004
EU Italy	14	12.600	2001
EU Malta	8	12.300	2000
EU Spain	10	11.852	1985
Libya	1	1.000	2003
Tunisia	5	1.690	2007
Turkey	6	6.140	2002

Fishes caught from sea for farming purpose have been composed of juvenile individuals which reach the first spawning length and mature individuals (between >30 kg – 600 kg). Minimum landing size was determined as 30 kg (115 cm fork length) for ABFT (ICCAT, 2016b [Rec.14-04]). Besides, it is allowed to catch fishes which ranged between 8-25 kg in weights for farming and to stock in cages at least two years in only Croatia.

The total Mediterranean tuna production derived from the farming activities is difficult to calculate as the initial cage stocking information, i.e. biomass and fish size, is only a rough estimate and any weight gain is generally kept confidential by the farmers (Ottolenghi, 2008). ICCAT has increased audits and controls for better ABFT stock assessments. Jurisdiction the farm is located shall ensure that transfer activities from cages to the farm shall monitored by video camera in the water. Besides that, all member countries to ICCAT are obliged to fill out ABFT catch documents (BCD) form during fishing and exporting.

ABFT farming activities have provided opportunities to new work areas and important income generations. Although ABFT farming activities are high in economic and social benefits, it caused some problems accompany. Tuna capture-based aquaculture generates impacts and conflicts with other resource users such as the traditional tuna trap and longline operator. The activity of tug boats towing tuna cages disturb the traditional longline fisheries in many countries (Italy, Malta, Tunisia) as well as reducing tuna catches. Bluefin tuna farmers in Croatia and Turkey have caused problems and strong conflicts with tourism activities in the use of the coastal zone (Ottolenghi, 2008; Karakulak, 2007; Karakulak *et al.* 2016).

ABFT Management and Conservation

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and adjacent seas. The Commission, composed of 50 Contracting Parties (countries/political entities) is a Regional Fisheries Management Organization (RFMO) responsible for combining a wide array of scientific and socio-economic information into setting total allowable catch (TAC) of Atlantic tuna species.

Although much of the focus of tuna management in the Mediterranean Sea is on the actions of ICCAT, its yearly TAC is only a recommendation, with implementation left to the individual member states. Currently, it is not clear, any ICCAT members that manage their share of the TAC using tradable permits or Individual Transferable Quotas (ITQs) in the Mediterranean Sea. It appears that the majority of ICCAT members fishing in this area use licensing systems to manage their fisheries (Sumaila and Huang, 2012).

Both the over-fishing of this species during the decade 1998-2008 as well as the level of catch underreporting and/or misreporting and the dwindling weight/size structure of its population, spiraled out of control to such magnitudes, that the immediate commercial future of this particular fishery as well as the prospect of a proper scientific-based management, relying on pertinent size/age-at-catch datasets, became all but too seriously compromised (Ambrosio and Xandri, 2015).

Analysis on the status of eastern ABFT populations carried out by the ICCAT- the Standing Committee on Research and Statistics (SCRS) in 2006 and 2009 (ICCAT, 2007; ICCAT, 2010) pointed out to a rapid deterioration of the eastern ABFT stock. In particular, the analysis described a sharp increase of fishing mortality over the large spawner fraction of the population (age 8+) in recent past years, which was attributed to the high purse seiners catches driven by the increasing demand for large live-fish by Mediterranean tuna farms (ICCAT, 2007). Overfished ABFT was listed "endangered" species in the World Conservation Union (IUCN) Red List of Threatened Species (criterion A2bd) in 2011 (Collette *et al.* 2011).

Because of this situation, it was established an eastern ABFT Recovery-Plan which evolved around a number of stringent management measures: Fishing-fleet reduction, the banning of aerial tuna-spotting, real-time reporting, the BCD scheme, onboard observers, the contraction of fishing seasons, quotaslashes, fisheries policing both at port and at fishing grounds, war against IUU eastern ABFT trade, etc.

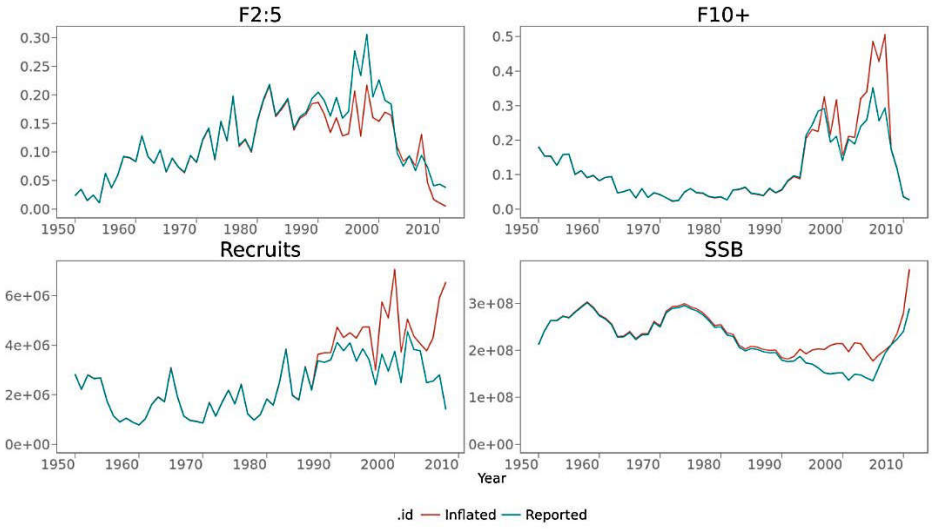

Figure 8. Fishing mortality (for ages 2 to 5 and 10+), spawning stock biomass (in tonnes) and recruitment (in number of fish) estimates from VPA continuity run. Blue line: reported catch; red line: inflated (from 1998 to 2007) catch (ICCAT, 2014).

According to ICCAT-SCRS latest 2014 updated eastern ABFT stock assessment, results indicated that the spawning stock biomass (SSB) showed clear signs of sharp increase in all the runs (Figure 8) that have been investigated by the ICCAT-SCRS accepted a general scientific precautionary approach to sound fisheries management that would rely on trustworthy accurate and comprehensive eastern ABFT size/age-at-catch historical datasets (ICCAT, 2014).

2. Conclusion

Nowadays most of ABFT fishing is aiming to fattening. At issue in the case of this activity has left ICCAT managers and scientists in a difficult situation during stock assessment and fishing management. In international trade of dead ABFT, presence of a certificate (BCD) is a necessity. However, since that is not in question for live fish, farmed fish can be exchanged. In this case, due to origin of farmed fish is not known control of the country whether exceed quota is getting difficult. Moreover, since fishes that caught and kept in cages cannot be enumerated and cannot be weighed owing to stress, stocks in the cages are not known.

ICCAT Atlantic wide research programme for ABFT (GBYP) was started in 2010. The main objective of the GBYP is to improve our knowledge and understanding of the ABFT stocks and populations. In recent years, various studies have been conducted to estimate the weight of fishes by video camera recording. At the same time, ABFT stock status have been investigated with fishing-independent researches. An improved understanding of ABFT migration patterns, spawning locations and stock structure is clearly necessary for fishery management regulations to be equitable and for rebuilding efforts to have maximal effect.

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