5.2 BFT – ATLANTIC BLUEFIN TUNA

The primary efforts of the Committee have been directed at implementing the workplan outlined for 2020 under the current extraordinary circumstances. This workplan originally focused on two areas: a strict update stock assessment and the ongoing development of the Management Strategy Evaluation (MSE), and has had to be adapted to the limitations imposed as a result of the outbreak of COVID-19. The MSE process has been compromised by these abnormal circumstances because the time allocated for technical meetings had to be reduced for reallocation to BFT Species Group intersessional meetings. These have been needed to ensure the completion of the stock assessment update to provide advice on the 2021 TACs, which has become the primary priority of the Committee. The bluefin tuna MSE Technical Group continues with its progress in developing operating models (OMs) by examining a broader spectrum of conditioned OMs, and is well advanced towards recommending a final reference set (or "grid") of OMs.

Given these impediments, the MSE process will not be completed in time to provide TAC advice to the Commission in 2021 for 2022-2024 based on a management procedure (MP). Accordingly, the Committee recommends extending the MSE process for another year with a goal of completing the MSE process in time for the 2022 Commission meeting to provide TAC advice for 2023-2025. In the event of a further delay in the MSE process, the decision on TAC advice for 2023 will be determined at the 2022 SCRS meeting. The Committee advises that interfacing with the Commission for further input (Panel 2, Scientists and Managers meeting, etc.) will be required intersessionally during 2021, but only once the MSE work is sufficiently advanced. This is because these interactions will be most effective only once interim results from the MSE are available which are sufficient to convey the inherent trade-offs on which the final selection of an MP will need to be based. Multiple dialogue sessions will be required commencing in the second half of 2021 and through 2022, before the Committee provides final advice regarding MP selection at its 2022 annual meeting.

This year's assessments for both East BFT and West BFT were conducted as strict updates as proposed by the SCRS and then approved by the Commission in 2019. This in turn means that the Committee did not attempt to improve the assessment models by undertaking further analyses, so that the various reservations raised in 2017 concerning this assessment still remain. Furthermore, the models could not be adjusted to take full account of new data and information in ways which might have led to improved results. This leads to additional uncertainty in the results obtained, compared to the uncertainty associated with those reported to the Commission in 2017.

The Committee considered that the strict update assessment of the East stock did not provide reliable information on which to base TAC advice for 2021 which once more brings into focus the need to investigate alternative assessment models to the VPA. However, based on an analysis of the stock size indices, the Committee did not find any clear evidence of changes in stock biomass from 2017 to 2020 to support changing the current TAC (Rec. 19-04) for 2021 and 2022. For the West, the updates of the VPA and Stock Synthesis were informative and the Committee found evidence of stock decline and provides a range of options for 2021, 2022 and 2023 TAC advice.

BFT-1. Biology

Atlantic bluefin tuna (BFT) have a wide geographical distribution but live mainly in the temperate pelagic ecosystem of the entire North Atlantic and its adjacent waters, for example the Gulf of Mexico, Gulf of St. Lawrence and the Mediterranean Sea. Historical catch information documents the presence in the South Atlantic (**BFT-Figure 1**). Electronic archival tagging information has confirmed that bluefin tuna can tolerate cold as well as warm water temperatures while maintaining a stable internal body temperature. Bluefin tuna preferentially occupy the surface and subsurface waters of the coastal and open-sea areas, but archival electronic tagging and ultrasonic telemetry data indicate that they frequently dive to depths of more than 1,000 m. Bluefin tuna are a highly migratory species that seems to display a homing behavior and spawning site fidelity to primary spawning areas in both the Mediterranean Sea and the Gulf of Mexico. Evidence indicates that spawning in other areas, for example the vicinity of the Slope Sea off the Northeast USA and more recently the Cantabrian Sea, though the persistence and importance of these other areas as spawning grounds remain to be determined. Electronic tagging is also resolving the movements to the foraging areas within the Mediterranean and the North Atlantic, and indicates that bluefin tuna movement patterns vary by tagging site, by month of tagging and according to the age of the fish. The reappearance of bluefin tuna in historical fishing areas (e.g. Norway and, more recently, the Black Sea) suggest that important changes in the spatial dynamics of bluefin tuna may also have resulted from interactions between biological factors, environmental variations and a reduction in fishing effort.

The fisheries for Atlantic bluefin tuna are managed as two management units, conventionally separated by the 45°W meridian. However, efforts to understand the population structure through tagging, genetic and microchemistry studies indicate that mixing is occurring at variable rates between the two management areas.

The ICCAT GBYP, as well as national research programmes, have provided the basis for improved biological studies. Substantial progress has been made in estimating regional, time varying mixing rates for Atlantic bluefin tuna, using otolith stable isotope and genetic analyses. Research on the larval ecology of Atlantic bluefin tuna has advanced in recent years through oceanographic habitat suitability models. Direct age estimation, using otoliths and dorsal fin spines from both stock areas, have been calibrated between readers from several institutions resulting in stock specific age length keys and a new growth model for the western population. Otolith preparation and reading protocols have been updated to minimize bias in age estimation. In 2020 a substantial part of the GBYP on-going activities has had to be postponed or cancelled due to the outbreak of COVID-19. Following Rec. 18-02 parag. 28, a research study of growth in farms was launched in 2019 at five locations, and a new database will be created to integrate all the data from stereo-camera measurements and harvesting operations. Additionally, a Sub-Group on growth of BFT in farms was established in 2020 within the BFT Species Group. This Sub-Group was created to ensure that the best scientific data would be provided to the Commission. Due to the timing of the harvesting operations, the first meaningful results will become available in 2021 (see SCRS/2020/129).

Currently, the Committee assumes for assessment purposes that eastern Atlantic and Mediterranean bluefin tuna contributes fully to spawning at age 5. There are also indications that some young individuals (of age 5) of unknown origin caught in the West Atlantic are mature, but there is considerable uncertainty with regards to their contribution to the western stock spawning. Therefore, the Committee has considered two spawning schedules for the western stock; one identical to that used for the East and one with peak spawning at age 15. However, the latest review of reproductive biology has shown that both the current vectors for spawning fraction at-age might be biased, and that the magnitude of that bias is unknown. Juvenile growth is rapid for a teleost fish, but slower than for other tuna and billfish species. Fish born in June attain a length of about 30-40 cm and a weight of about 1 kg by October. After one year, fish reach about 4 kg and 60 cm in length. At 10 years of age, a bluefin tuna is about 200 cm and 170 kg and reaches about 270 cm and 400 kg at 20 years of age. Bluefin tuna is a long-living species, with a lifespan of about 40 years as indicated by radiocarbon deposition, and can reach 330 cm (SFL) and weigh up to 725 kg. In 2017, the Committee revised the natural mortality assumptions, and adopted a single new age specific natural mortality vector for both stocks.

Important electronic and conventional tagging activity has been conducted for both juvenile and adult fish for several years in the Atlantic and Mediterranean by the ICCAT GBYP, National Programmes and NGOs. Contributions from e-tag data from all groups are supporting ongoing efforts to provide important insights into bluefin tuna stock structure, distribution, mixing and migrations, and are helping to estimate fishing mortality rates and to condition the MSE operating models.

EAST BLUEFIN TUNA

BFTE-2. Fishery trends and indicators –East Atlantic and Mediterranean

Reported catches in the East Atlantic and Mediterranean reached a peak of over 50,000 t in 1996 and then decreased substantially, stabilizing at around TAC levels established by ICCAT for the most recent period (**BFTE-Figure 1**). Catches between 2015 and 2019 (as of 18 August 2020) were 16,201 t, 19,131 t, 23,616 t, 27,757 t and 28,760 t for the East Atlantic and Mediterranean, of which, 11,360 t, 13,163 t, 16,401 t, 19,600 t and 19,434 t were reported for the Mediterranean for those same years (**BFT-Table 1**). The Committee has been informed of the existence of unquantified IUU catches which should be taken into account.

Available information has demonstrated that catches of bluefin tuna from the East Atlantic and Mediterranean were seriously under-reported between the mid-1990s through 2007. The Committee estimated that the realized total catch during this period was likely of the order of 50,000 t to 61,000 t per year, based on the number of vessels operating in the Mediterranean Sea and their respective catch rates. Since the 2017 assessment (Anon., 2018), these estimates (1996-2007) have been treated as the actual catches.

During the 2017 Stock Assessment meeting (Anon. 2018), the decision was made to use ten abundance indices up to 2015 (seven CPUE series and three fisheries independent indices). The 2020 updated stock assessment has included the indices used for the 2017 stock assessment which were updated up to 2018, with the exception of the larval index which was updated to 2017 (**BFTE-Figure 2**). The Committee anticipates that additional indices could be used for tracking the abundance of the stock (e.g. GBYP aerial survey).

CPUE indices (**BFTE-Figure 2**) have been affected appreciably by regulatory measures through changes to operational patterns, length of the fishing season and target sizes; thus it is difficult to distinguish the effect of these changes on CPUE index values from the effects of changes in abundance.

BFTE-3. State of the stock

There have been considerable improvements in data quality and quantity over the past few years; nevertheless important gaps remain in the temporal and spatial coverage for detailed size and catch-effort statistics for several fisheries, especially in the Mediterranean before the implementation of stereo video cameras in 2014. However, inconsistencies have been found in the length frequencies for some of the purse-seiner catches since 2014; these consequently require further revision.

The 2017 and 2020 assessment results from the VPA base case indicated that the spawning stock biomass (SSB) peaked in the mid-1970s after increasing initially, and then declined until 1991 and remained steady until the mid-2000s. From the late 2000s, SSB exhibited a substantial increase through to 2018 (**BFTE-Figure 3**). This increase as estimated in 2020 was appreciably larger than for the 2017 assessment, and not confirmed by the updated indicators (**BFTE-Figure 3**). The uncertainty about the magnitude of the recent SSB increase estimated by the VPA is even higher than for the 2017 assessment due to considerable instability in the recruitment estimates. Recruitment estimates for 2008 onwards (**BFTE-Figure 3)** are noticeably higher than for the 2017 assessment, showing a reverse of the trend of those estimated in the 2017 assessment. This was seen to be of concern when projecting the VPA forward to provide advice based on short-term projections, as well as leading to concern that the model results were very sensitive to adding one additional year of data (i.e. they led to an estimate of a substantial overall increase in biomass with the addition of only the last year of data). Concerns also remain that the size composition of many eastern Atlantic and Mediterranean fleets is poorly characterized for a number of years before the implementation of stereo video cameras in 2014.

The estimated fishing mortality rates on the younger ages (i.e., average F for ages 2 to 5) displayed a continuous increase until the late 1990s, and then showed a sharp decline to reach very low levels after the late 2000s (**BFTE-Figure 3**). This result is a consequence of the dramatic reduction in the catches of ages 2 to 3 in recent years in response to the new minimum size regulations implemented in 2007 [Rec. 06-05]. The trend of F in young ages was similar to that for the 2017 assessment. For the oldest fish (F at plus group for ages 10 and older) showed (**BFTE-Figure 3)** an initial decline from 1968 to 1973, and fluctuated slightly a little below 0.05 afterwards. This F increased in 1994 and continued increasing to 2005 (F_{10+}=0.26). This period (from the mid-1990s to the mid-2000s) evidenced the highest fishing mortality on larger fish. As noted in previous assessments, decreased TACs and catches resulted in substantial decreases in F10+ from the mid 2000s to 2010.

The current perception of the stock status depends on recruitment estimates which are highly unstable and is also closely related to the assumptions made about stock structure and migratory behaviour, which remain poorly known. Nonetheless, compared to 2017, the extra data now available confirm a recent stock biomass increase, although the magnitude of the increase remains difficult to quantify. F_{CUR} appears to be clearly below $F_{0.1}$ ($F_{CUR[2015\text{-}2017]}/F_{0.1}$= 0.426), indicating a stock status determination of not overfishing.

BFTE- 4. Outlook

The Committee considers that recent recruitment estimates from the updated VPA assessment are highly uncertain and any short term catch advice based on $F_{0.1}$ from the updated assessment would not be robust. Consequently, the Committee is not presenting new short-term projections. Due to the limited possibilities for improving the quality of the data, the Committee does not expect to be able to provide further clarity regarding future recruitment in 2021.

In 2018 and 2019, as requested in Rec. 18-02 the Committee evaluated whether the stock size indicators supported the TAC advice for 2019 (32,240 t) and 2020 (36,000 t), which arose from the 2017 assessment, and found that to be the case on both occasions. Evaluation of recent changes in these indicators in 2020 (SCRS/2020/128) has strengthened the support for Rec. 18-02 as these indicators did not indicate any substantial change since the 2017 assessment.

Consequently, based on an analysis of the updated stock size indices, the Committee finds no clear evidence which would warrant a change to the current TAC (Rec 19-04).

BFTE-5. Effect of current regulations

Based on SCRS advice, in 2017 the Commission adopted Rec. 17-07 and updated it in 2019 with Rec. 19-04. It is too early since the associated TACs (2018-2020) were implemented to be able to evaluate their effect on the resource.

The Committee noted that reported catches are in line with recent TACs. However, the Committee has been informed of the existence of unquantified illegal catches of unknown magnitude.

The combination of size limits and the reduction of catch has certainly contributed to a rapid increase in the abundance of the stock.

BFTE-6. Management recommendations

The Committee noted that biomass indicators did not provide any evidence to alter the current management advice originally provided in 2017. The Committee points out that the projections from the 2017 advice showed that a constant catch of 36,000 tons from 2018 onwards reflects $F<F_{0.1}$ with a probability higher than 60% in 2021 and in 2022 (**BFTE-Table 1**).

Consequently, the Committee recommends that the 2020 TAC [Rec 19-04 para. 5] of 36,000 t be maintained for 2021 and 2022. However, the 2022 advice will be reviewed in 2021 based on updates of the abundance indicators as has been done in recent years.

EAST ATLANTIC AND MEDITERRANEAN BLUEFIN TUNA SUMMARY	
Current reported catch (2019)	28,760 t*
$F_{0.1}$	0.107 (0.081-0.147)[1]
$F_{2015\text{-}2017}/F_{0.1}$[2]	0.426 (0.359-0.502)[1]
Stock Status [3]	Overfishing: No
[Rec. 19-04] TAC 2020	36,000 t

[1] Median and approximate 80% confidence interval from bootstrapping from the assessment.
[2] $F_{2015\text{-}2017}$ refers to the geometric mean of the estimates for 2015-2017 (a proxy for recent F levels).
[3] Biomass reference points to determine stock status were not estimated in the 2017 assessment or its 2020 update due to uncertainty in recruitment potential
* As of 18 August 2020.

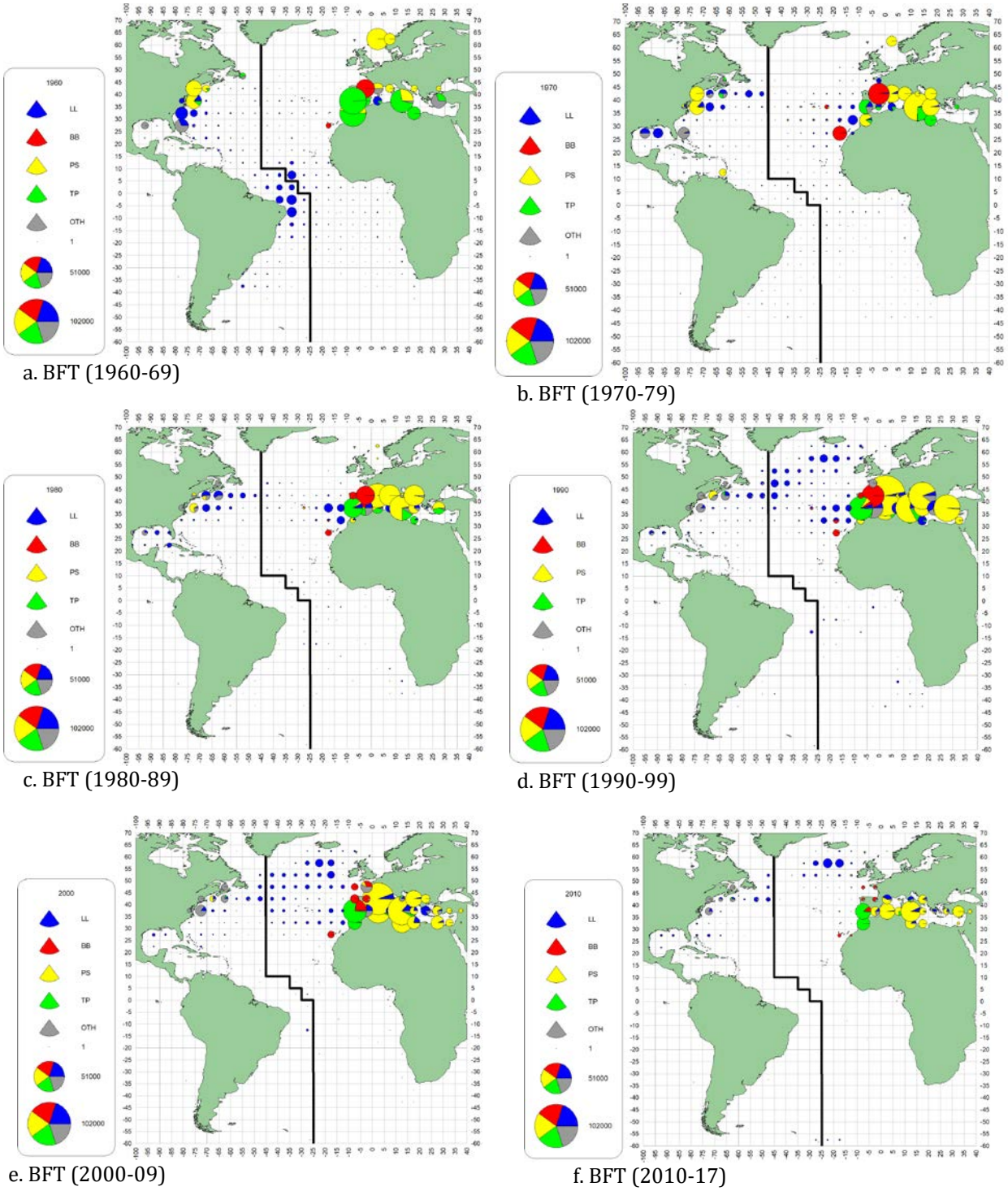
BFT-Table 1. Estimated catches (t) of Northern bluefin tuna (*Thunnus thynnus*) by area, gear and flag.

				1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
TOTAL				26381	29318	34128	36642	48881	49751	54009	53545	52657	52772	52775	52784	53319	52305	52125	51756	51812	62638	26460	21798	13195	11781	12688	14725	14887	18042	21032	25466	29784	31065
BFT-E				23599	26389	31831	34258	46769	47303	51497	51211	50000	50000	50000	50000	50000	50000	50000	50000	50000	61000	24460	19818	11338	9774	10934	13243	13261	16201	19131	23616	27757	28760
	ATE			6313	6543	7396	9317	7054	9780	12098	16379	11630	10247	10061	10086	10347	7394	7402	9023	7529	8441	8243	6684	4379	3984	3834	4163	3918	4841	5968	7216	8157	9326
	MED			17286	19846	24435	24941	39715	37523	39399	34831	38370	39753	39939	39914	39653	42606	42598	40977	42471	52559	16217	13133	6959	5790	7100	9080	9343	11360	13163	16401	19600	19434
BFT-W	ATW			2782	2929	2296	2384	2113	2448	2512	2334	2657	2772	2775	2784	3319	2305	2125	1756	1811	1638	2000	1980	1857	2007	1754	1482	1627	1842	1901	1850	2027	2305
Landings	ATE	Bait boat		1993	1653	1422	3884	2284	3093	5369	7215	3139	1554	2032	2426	2635	1409	1902	2282	1263	2436	2393	1260	725	636	283	243	95	172	1085	1195	692	845
		Longline		1510	3196	3618	2802	2311	4522	4212	4057	3789	3570	3736	3303	2896	2748	2064	2700	2033	1705	2491	1951	1194	1125	1139	1167	1194	1467	1829	2208	2730	3177
		Other surf.		252	126	523	976	590	555	273	60	387	404	509	558	631	521	290	424	831	502	181	297	124	35	49	141	210	193	261	295	340	319
		Purse seine		54	46	462	24	213	458	323	828	700	726	661	153	887	490	1078	1197	408	0	0	2	1	0	0	2	0	0	42	49	11	24
		Sport (HL+RR)		1	0	7	0	25	0	0	237	28	33	126	61	63	109	89	11	99	11	12	11	44	51	53	46	43	104	35	101	118	357
		Traps		2504	1522	1365	1631	1630	1152	1921	3982	3586	3960	2996	3585	3235	2116	1978	2408	2895	3788	3166	3164	2292	2137	2311	2564	2376	2905	2716	3363	4258	4594
	MED	Bait boat		25	148	158	48	0	206	5	4	11	4	38	28	1	9	17	5	0	0	0	38	1	0	2	2	9	25	0	50	56	72
		Longline		1178	3057	3145	2470	6993	8469	9856	7313	4117	3338	3424	4144	3234	3484	3036	3427	3408	3269	2376	1344	1242	962	587	605	588	776	1523	1184	1517	1436
		Other surf.		344	356	447	371	776	545	417	282	284	228	728	354	340	198	197	175	81	85	0	0	1	1	1	20	29	3	37	90	34	51
		Purse seine		11797	13805	18580	20065	27948	23799	26021	24279	31792	33798	33237	33043	34044	37291	37869	36639	38363	48994	13540	11448	4986	4293	6172	7982	8184	9993	11315	14466	17119	17200
		Sport (HL+RR)		1559	769	952	1238	2307	3562	2149	2340	1092	1533	1773	1167	1520	1404	1325	619	494	117	149	160	448	356	202	240	289	361	284	335	567	319
		Traps		2382	1711	1152	749	1691	942	951	613	1074	852	739	1177	515	221	154	112	125	93	152	144	281	165	125	222	232	192	0	272	300	353
	ATW	Longline		741	903	689	712	539	491	545	382	764	915	858	610	729	186	644	425	565	420	606	366	529	743	478	470	498	553	562	559	664	675
		Other surf.		536	578	509	406	307	384	429	293	342	279	283	201	107	139	97	89	85	63	78	121	107	147	117	121	119	138	93	123	77	168
		Purse seine		384	237	300	295	301	249	245	250	249	248	275	196	208	265	32	178	4	28	0	11	0	0	2	29	38	34	0	0	0	
		Sport (HL+RR)		1004	1083	586	854	804	1114	1032	1181	1108	1125	1121	1650	2036	1399	1139	924	1005	1023	1134	1251	1009	888	917	692	810	1085	1204	1144	1263	1450
		Traps		2	0	1	29	79	72	90	59	68	44	16	16	28	84	32	8	3	4	23	23	39	26	17	11	20	6	10	13	3	4
Discards	ATE	Longline		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	9
	MED	Purse seine		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	12	9	11	2	4	5	6	4
		Longline		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	
	ATW	Longline		115	128	211	88	83	138	167	155	123	160	222	105	211	232	181	131	149	100	159	207	174	202	224	145	139	19	29	10	17	7
		Other surf.		0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	2	2
		Purse seine		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	4	5	0	0	0	
		Sport (HL+RR)		0	0	0	0	0	0	0	14	3	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATE	CP	Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			China PR	0	0	0	0	0	0	0	0	85	103	80	68	39	19	41	24	42	72	119	42	38	36	36	38	37	45	54	64	79	89
			EU.Denmark	0	0	0	37	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**0**
			EU.España	3830	2273	2318	4962	3137	3819	6186	9519	4565	4429	3493	3633	4089	2172	2801	3102	2339	3680	3536	2409	1550	1483	1329	1553	1282	1655	1986	2509	2489	2729
			EU.France	510	565	894	1099	336	725	563	269	613	588	542	629	755	648	561	818	1218	629	253	366	228	135	148	223	212	254	343	350	461	462
			EU.Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.Ireland	0	0	0	0	0	0	0	14	21	52	22	8	15	3	1	1	2	1	1	1	2	4	10	13	19	14	32	16	17	6
			EU.Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	
			EU.Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.Portugal	27	103	128	91	363	169	199	712	323	411	441	404	186	61	27	82	104	29	36	53	58	180	223	235	243	263	327	429	450	475
			EU.Sweden	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.United Kingdom	0	0	0	0	0	1	0	1	1	12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	
			Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	
			Guinée Rep.	0	0	0	0	330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Iceland	0	0	0	0	0	0	0	0	2	27	0	0	1	0	0	0	0	0	0	0	0	2	5	4	30	37	6	0	0	
			Japan	1464	2981	3350	2484	2075	3971	3341	2905	3195	2690	2895	2425	2536	2695	2015	2598	1896	1612	2351	1904	1155	1089	1093	1129	1134	1386	1578	1905	2262	2514
			Korea Rep.	0	0	0	0	4	205	92	203	0	0	6	1	0	0	3	0	1	0	0	0	0	0	0	0	0	0	161	181	208	232
			Maroc	408	531	562	415	720	678	1035	2068	2341	1591	2228	2497	2565	1795	1953	2389	1923	2418	1947	1909	1348	1055	990	960	959	1176	1433	1703	2164	2790
			Norway	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	44	51	12	18
			Panama	0	0	0	0	1	19	550	255	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	
			Sierra Leone	0	0	0	0	0	0	0	0	0	0	93	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NCC	Chinese Taipei	0	0	0	6	20	4	61	226	350	222	144	304	158	0	0	10	4	0	0	0	0	0	0	0	0	0	0	0	0	
		NCO	Faroe Islands	0	0	0	0	0	0	0	0	67	104	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	
			NEI (ETRO)	74	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	85	144	223	68	189	71	208	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

				1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	MED	CP	Albania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	9	34	40	47	56	100	156
			Algerie	782	800	1104	1097	1560	156	638	829	1674	1760	2083	2098	2056	1504	1440	1500	1673	1489	1311	0	0	0	69	244	244	370	448	1038	1300	1437
			China PR	0	0	0	0	97	137	93	49	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.Croatia	0	1418	1076	1058	1410	1220	1360	1105	906	970	930	903	977	1139	828	1017	1022	825	834	619	389	371	369	384	385	456	515	630	738	817
			EU.Cyprus	10	10	10	14	10	10	10	10	21	31	61	85	91	79	105	149	110	1	132	2	3	10	18	17	18	22	59	110	133	151
			EU.España	1822	1392	2165	2018	2741	4607	2588	2209	2000	2003	2772	2234	2215	2512	2353	2758	2689	2414	2465	1769	1056	942	1064	948	1164	1238	1467	1688	2706	2660
			EU.France	4713	4620	7376	6995	11843	9604	9171	8235	7122	6156	6794	6167	5832	5859	6471	8638	7663	10200	2670	3087	1755	805	791	2191	2216	2565	3054	3661	4360	4919
			EU.Greece	201	175	447	439	886	1004	874	1217	286	248	622	361	438	422	389	318	255	285	350	373	224	172	176	178	161	195	218	235	267	313
			EU.Italy	4122	3787	5006	5379	6901	7076	10200	9619	4441	3283	3847	4383	4628	4981	4697	4853	4708	4638	2247	2749	1061	1783	1788	1938	1946	2273	2488	3196	3860	4286
			EU.Malta	85	113	81	259	580	590	402	396	409	449	378	224	244	258	264	350	270	334	296	316	136	142	137	155	160	182	212	261	308	338
			EU.Portugal	62	240	211	164	306	313	274	37	54	76	61	64	0	2	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	
			Egypt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64	77	77	155	99	124	181	
			Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	
			Japan	172	85	123	793	536	813	765	185	361	381	136	152	390	316	638	378	556	466	80	18	0	0	0	0	0	0	0	0	0	
			Korea Rep.	0	0	0	0	684	458	591	410	66	0	0	0	0	0	700	1145	26	276	335	102	0	0	77	80	81	0	0	0	0	
			Libya	328	370	737	635	1422	1540	1388	1029	1331	1195	1549	1941	638	752	1300	1091	1327	1358	1318	1082	645	0	756	929	933	1153	1368	1631	1792	
			Maroc	1149	925	205	79	1092	1035	586	535	687	636	695	511	421	762	827	108	463	641	531	369	205	182	223	309	310	322	350	439	407	130
			Panama	74	287	484	467	1499	1498	2850	236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Syria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	41	0	34	0	0	0	0	40	47	57	66	72
			Tunisie	406	1366	1195	2132	2773	1897	2393	2200	1745	2352	2184	2493	2528	791	2376	3249	2545	431	2679	1932	1042	852	1017	1057	1047	1248	1461	1755	2092	2380
			Turkey	2059	2459	2817	3084	3466	4219	4616	5093	5899	1200	1070	2100	2300	3300	1075	990	806	918	879	665	409	519	536	551	555	1091	1324	1515	1284	1771
		NCC	Chinese Taipei	0	0	0	328	709	494	411	278	106	27	169	329	508	445	51	267	5	0	0	0	0	0	0	0	0	0	0	0	0	
		NCO	ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	1	0	1	1	0	
			Israel	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	0	0	0	427	639	171	1058	761	78	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (combined)	360	1799	1398	0	773	211	0	101	1030	1995	109	571	508	610	709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (inflated)	0	0	0	0	0	0	0	0	9471	16893	16458	15298	15880	18873	18376	14164	18343	28234	0	0	0	0	0	0	0	0	0	0	0	
			Serbia & Montenegro	0	0	0	0	0	2	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Yugoslavia Fed.	940	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ATW	CP	Brazil	1	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
			Canada	438	485	443	459	392	576	597	503	595	576	549	524	604	557	537	600	733	491	575	530	505	474	477	480	463	531	466	472	508	666
			FR.St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	1	0	0	3	1	10	5	0	4	3	2	8	0	0	0	0	9	0	0	0	
			Japan	550	688	512	581	427	387	436	322	691	365	492	506	575	57	470	265	376	277	492	162	353	578	289	317	302	347	345	346	406	406
			Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	52	0	0	0	0	0	0	0	0	0	0	0	0	
			Mexico	2	9	15	17	4	23	19	2	8	14	29	10	12	22	9	10	14	7	7	10	14	14	51	23	51	53	55	34	80	39
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			U.S.A.	1636	1582	1085	1237	1163	1311	1285	1334	1235	1213	1212	1583	1840	1426	899	717	468	758	764	1068	803	738	713	502	667	877	1002	986	1013	1185
			UK.Bermuda	0	0	0	0	0	0	1	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
			UK.British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			UK.Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NCC	Chinese Taipei	0	0	0	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NCO	Argentina	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	0	0	0	0	0	0	0	0	0	0	0	0	74	11	19	27	19	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (ETRO)	24	23	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	0	0	0	0	0	0	0	0	429	270	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta. Lucia	14	14	14	2	43	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discards	ATE	CP	Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	9
	MED	CP	Albania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.Croatia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	5	2	2	4	5	6	4
			EU.España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	
			Libya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	0	0	0	0	0	
			Tunisie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	
			Turkey	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	
	ATW	CP	Canada	0	0	0	0	0	0	0	6	16	11	46	13	37	14	15	0	2	0	1	3	25	36	17	0	0	3	8	1	3	3
			Japan	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
			U.S.A.	115	128	211	88	83	138	171	155	110	149	176	98	174	218	167	131	147	100	158	204	150	166	206	159	143	22	24	10	15	6

BFTE-Table 1. The probabilities of $F<F_{0.1}$ for quotas from 0 to 50,000 t for 2018 through 2022 under the recent 6 years (2006-2011) recruitment scenario, as estimated in 2017 stock assessment. Shading corresponds to the probabilities of being in the ranges of 50-59%, 60-69%, 70-79%, 80-89% and greater or equal to 90%. Catches for 2016 and 2017 are assumed to be equal to the 2016 and 2017 TAC in all scenarios.

Catch (t)	2018	2019	2020	2021	2022
18,000	100	100	100	100	100
20,000	99	99	99	99	99
22,000	99	99	98	98	98
23,655	98	98	98	98	98
24,000	98	98	97	98	97
26,000	97	96	96	96	96
28,000	95	94	94	94	94
30,000	93	92	92	90	89
31,000	90	90	89	89	88
32,000	89	88	87	86	83
33,000	86	85	83	81	80
34,000	82	81	79	78	75
35,000	79	77	76	72	70
36,000	75	73	70	68	64
37,000	70	68	65	62	59
38,000	65	63	60	57	54
39,000	59	57	54	52	49
40,000	56	52	49	46	44
45,000	36	35	34	30	28
50,000	24	22	20	18	18



a. BFT (1960-69)

b. BFT (1970-79)

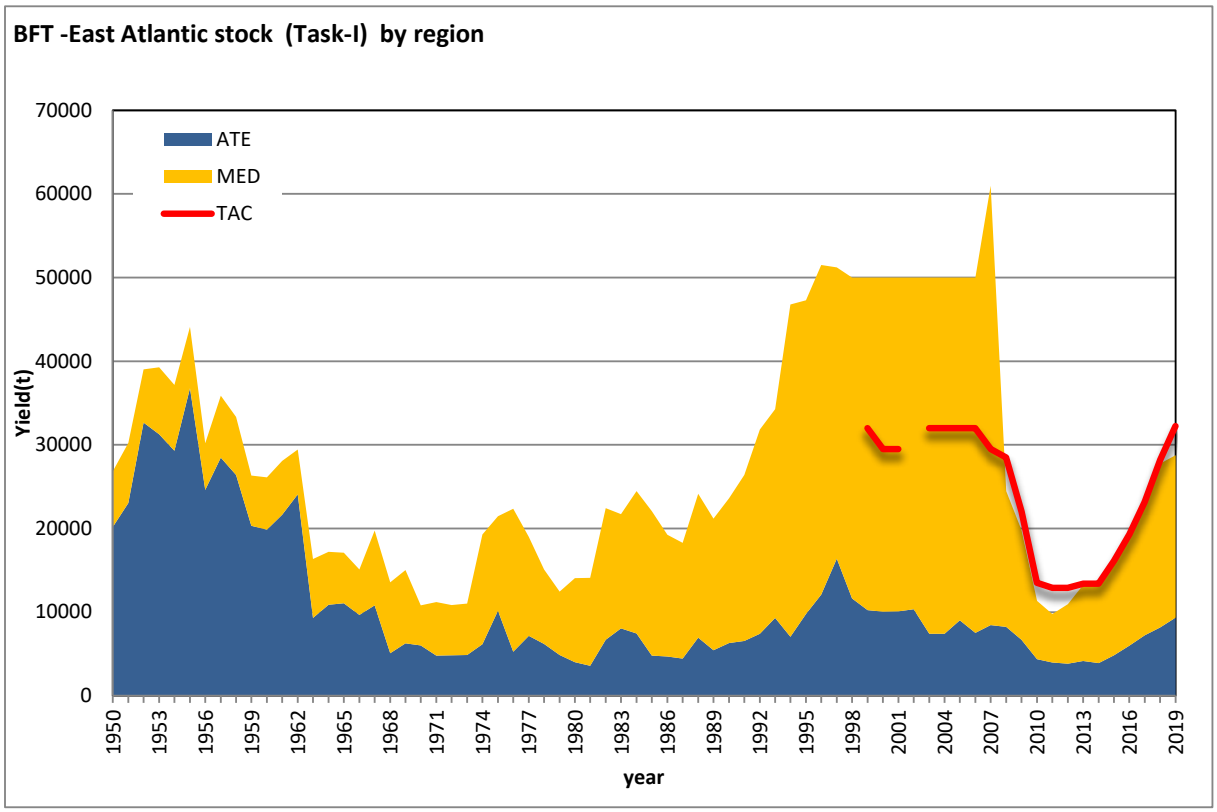
c. BFT (1980-89)

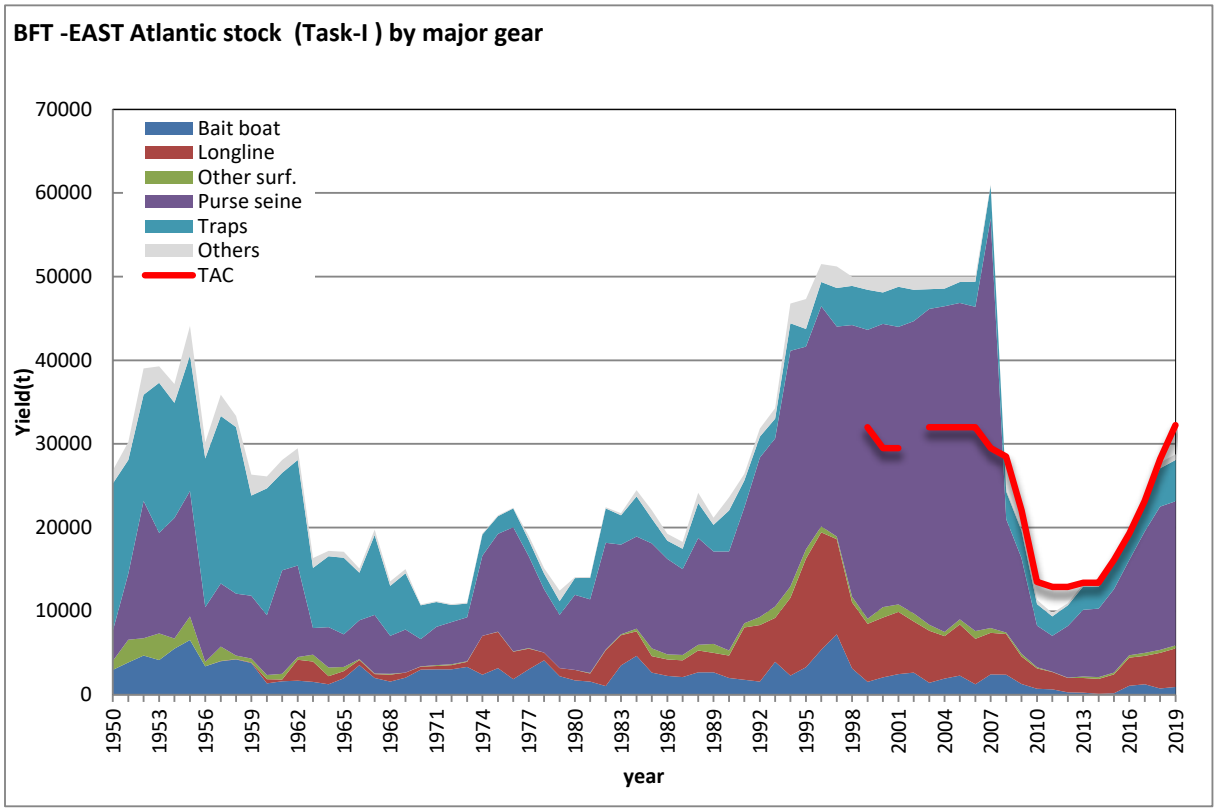
d. BFT (1990-99)

e. BFT (2000-09)

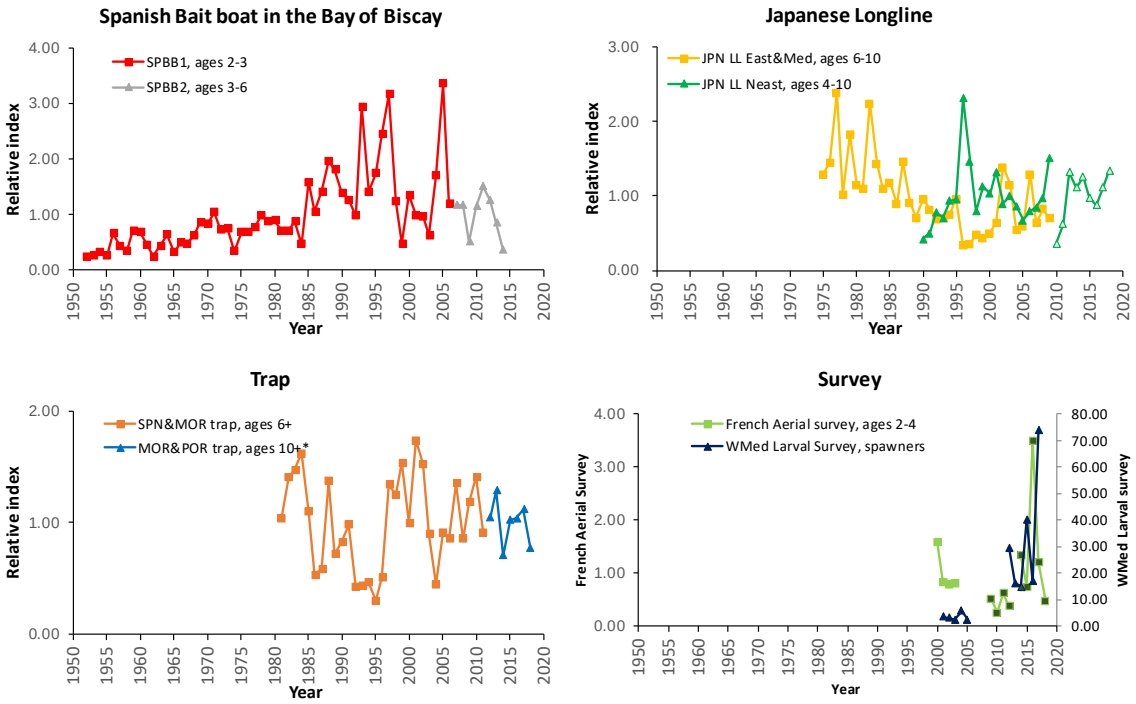
f. BFT (2010-17)

BFT-Figure 1. Geographic distribution of bluefin tuna catches per 5x5 degrees and per main gears from 1960 to 2017 (last decade only covers 8 years).

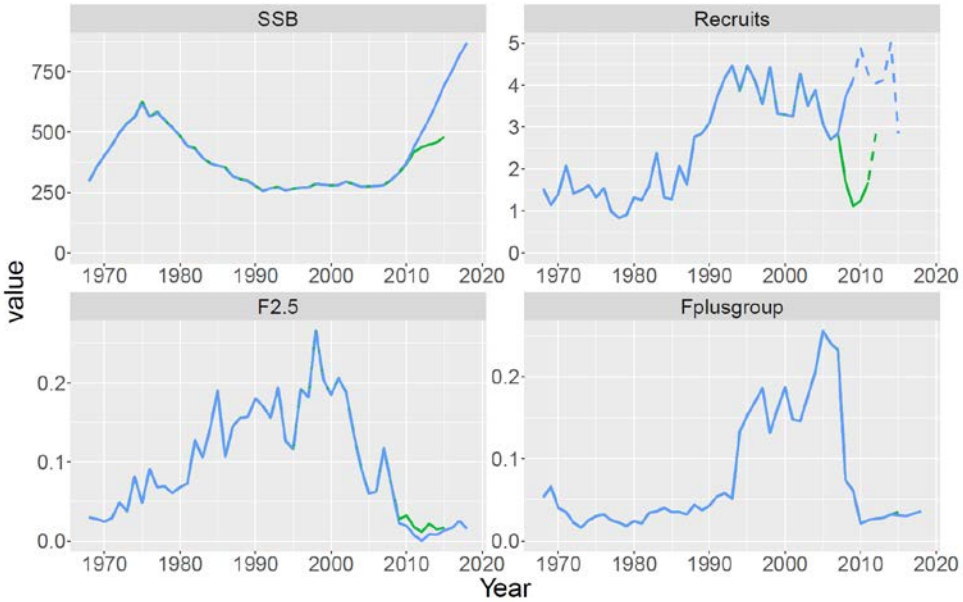




BFTE-Figure 1. Reported catch for the East Atlantic and Mediterranean from Task I data from 1950 to 2019 split by main geographic areas (top panel) and by gears (bottom panel) together with unreported catch estimated by the SCRS from 1998 to 2007 and TAC levels since 1998.



BFTE-Figure 2. Plots of the updated fishery dependent and independent indicators used for the East Atlantic and Mediterranean bluefin tuna stock. All indicators are standardized series and scaled to their averages. Indices denoted with "*" represent revised indices rather than strict updates of indices used in the 2017 stock assessment. The Spanish BB series was split in two series to account for changes in selectivity patterns, and the latest series was calculated using French BB data due to the sale of the quota by the Spanish fleet. The Japanese Longlines CPUE for the Northeast Atlantic (split in 2009/2010), the Morocco-Portugal Trap combined CPUE and French aerial survey index (split in 2008/2009) have been updated until 2018. The larval survey in the western Mediterranean was updated until 2017.



BFTE-Figure 3. Spawning stock biomass (in thousand metric ton), recruitment (in million), and fishing mortality (average over ages 2 to 5, and 10+) estimates from VPA base run in the 2020 stock assessment (blue) compared to the 2017 stock assessment (green) for the period between 1968 and 2015. The last years recruitments (dashed line: 2012-2013 for the 2017 stock assessment, and 2010-2015 for the 2020 stock assessment) were poorly estimated.

BLUEFIN TUNA - WEST

BFTW-2. Fishery indicators

The total catch for the West Atlantic peaked at 18,608 t in 1964, mostly due to the Japanese longline fishery for large fish off Brazil (that started in 1962) and the U.S. purse seine fishery for juvenile fish (**BFT-Table 1**, **BFTW-Figure 1**). Catches dropped sharply thereafter to slightly above 3,000 t in 1969 with declines in longline catches off Brazil in 1967 and in purse seines. Catches increased to over 5,000 t in the 1970s due to the expansion of the Japanese longline fleet into the northwest Atlantic and Gulf of Mexico and an increase in purse seine effort targeting larger fish for the sashimi market. Catches declined abruptly in 1982 from close to 6,000 t in the late 1970s and early 1980s with the imposition of a catch limit. The total catch for the West Atlantic, including discards, fluctuated without trend after 1982, reaching 3,319 t in 2002 (the highest since 1981, with all three major fishing nations indicating higher catches). Total catch in the West Atlantic subsequently declined steadily to 1,638 t in 2007 and then fluctuated without pronounced trend. The catch in 2017 was 1,850 t , 2,027 t in 2018 and 2,305 t (as of 18 August 2020) in 2019 (**BFTW-Figure 1**).

The Committee notes that ongoing work conducted as part of the MSE process is evaluating the sensitivity to assumed stock of origin of the large catches coming from the South Atlantic. Future modelling considerations of these catches should consider that while these catches are currently assumed to be of Western stock origin the true stock of origin remains unknown.

The Committee notes that the TAC in the West has not been caught for the last 6 years. Based on information received, the Committee considers that this is not due to low stock abundance but rather to market and operational conditions.

The most recent (2020) stock assessment used 9 CPUE and two survey indices up to and including 2018 (**BFTW-Figure 2**). Indices presented here are strict updates of these indices except as denoted with an asterisk where slight modifications to the data or model structure have been made.

Several indices exhibit trends that may be indicative of environmentally driven changes in availability. As in 2017, the 2020 Stock Synthesis assessment reconciled the conflicting trends in some Canadian and United States indices under a hypothesis of environmentally mediated availability of fish to the two regions. The Canada Acoustic index experienced a very low value for 2018 and subsequently also for 2019; it appears that the index is in a state of transition, possibly due to environmentally driven changes in the spatial distribution of the fish or of their prey. For modelling the Committee chose to split the index for this assessment, which is equivalent to removing the 2018 datapoint from the assessment. Additionally, the USRR 115-144 index provided an extremely low value for 2018.

BFTW-3. State of the stock

The SCRS cautions that conclusions from the latest assessment (Anon., 2020), using data through to 2018, do not capture the full degree of uncertainty in the assessments and projections. The various major contributing factors to uncertainties include mixing between the stocks, recruitment, age composition, age at maturity, and indices of abundance. As in 2017 the 2020 assessment also applied two stock assessment methods (VPA and Stock Synthesis) for management advice for the western stock. Models used in 2020 are strict updates of the 2017 models, with some modifications to estimated recruitment specifications to better account for uncertainty in recent and future recruitment.

Previous stock assessments determined stock status based on MSY-related reference points using two alternative recruitment potential scenarios: a 'low recruitment' scenario and a 'high recruitment' scenario. The 2017 assessment did not provide management advice based on MSY reference points. Instead, the focus was on giving short-term advice based on an $F_{0.1}$ reference point (taken to be a proxy for F_{MSY}) using recent recruitment and assuming that near term recruitment will be similar to the recent past recruitment (**BFTW-Figure 3**). As in the 2017 assessment two spawning fraction scenarios (a young age at spawning, consistent with the eastern stock and older age of spawning with 100% spawning contribution at age 15) were considered in the assessment methods. Rather than presenting two series of spawning stock biomass (SSB) based on these two spawning fraction scenarios, total biomass is presented as this does not depend on which of these scenarios is selected.

Results from the VPA indicate quite similar biomass and recruitment trends to the 2017 model. Biomass decreased sharply between 1974 and 1981 (**BFTW-Figure 4**), followed by more than two decades of stability (at about 50% of the 1974 biomass) across the turn of the century, and then by a gradual increase from 2004 to 60% of the 1974 biomass in 2018. Recruitment was high in the early 1970s, but subsequently fluctuated around a lower average until 2003 when there was a strong year class (**BFTW-Figure 4**). Recruitment has shown a downward trend since 2004, with recent (2010-2015) recruitments quite low. The three additional years (2013-2015) remain low with some of the lowest estimated recruitment in the time series.

Stock Synthesis gave a longer time series view of the population, (**BFTW-Figure 4**), capturing the higher recruitments estimated in the 1960s (though this is dependent on the assumption that the catches in the west were primarily of western rather than eastern origin fish). In 2017 the Stock Synthesis models estimated higher biomass than the VPA, but in 2020 the updated Stock Synthesis model and VPA estimates now are similar in magnitude for the overlapping period 1979 – 2015 (**BFTW-Figures 3-5**). Total biomass in 2015 was 14% of biomass in 1950 and 36% of biomass in 1974. Similar to VPA, Stock Synthesis estimates a mostly declining recruitment trend since 2003 with a slight increase in 2014-2016, though these recent increases are considered not to be well informed by data.

Though numbers of age 9+ fish are at or above 40-year peaks (**BFTW-Figure 5**) for both models, the numbers of age 6-8 year old fish is estimated to be at the lowest in the last 40 years due to low recent recruitments.

The Committee notes that further work is being conducted as part of the GBYP to collect more data on mixing, movement and stock of origin. These data are being incorporated into the Management Strategy Evaluation whereby they should help refine understanding of stock mixing.

Summary

Both sets of results from the VPA and Stock Synthesis were equally weighted to formulate advice. Current F (average of 2015-2017) relative to the $F_{0.1}$ reference point was 0.8 (VPA) and 0.84 (Stock Synthesis), indicating that overfishing is not occurring (**BFTW-Table 1, BFTW-Figure 4**). Under the updated models the current TAC (Rec. 17-06) is likely to have led to overfishing relative to $F_{0.1}$ beginning in 2018.

Management advice is based on a fishing mortality reference point to project short-term catches based on recent recruitments. $F_{0.1}$ was considered a reasonable proxy for F_{MSY}, although it can be higher or lower than F_{MSY} depending on the stock recruitment relationship, which in this case is poorly determined.

BFTW-4. Outlook

In 1998, the Commission initiated a 20-year rebuilding plan designed to achieve SSB_{MSY} with at least 50% probability. As indicated above, the Committee did not use biomass-based reference points in formulating 2017 advice, nor in the 2020 update. The Committee is not evaluating if the stock is rebuilt because it has been unable to resolve the long-term recruitment potential. If an $F_{0.1}$ strategy were to continue to be applied, over the longer term the resource would fluctuate around the true, but unknown, value of $B_{0.1}$ whatever the future recruitment level. The $F_{0.1}$ strategy compensates for the effect of recruitment changes on biomass by allowing higher catches when recent recruitment is higher and reducing catches when recent recruitments are lower. Under this strategy, biomass may decrease at times because the stock is above $B_{0.1}$ or following lower recruitments.

The 2020 assessment indicates that recent (2012-2015) recruitments are low and further are lower than those estimated for the same time period in the 2017 assessment and from the averages assumed for the 2017 projections. In 2017 the population was projected to decline by ~7.5% from 2017 to 2020 at the current (2020) TAC of 2,350 tons (Anon, 2019). However, based on the updated assessments, biomass is estimated to have actually experienced an 11.7% decline over the same time period (**BFTW-Table 2)**. The expected changes in biomass under constant catch scenarios and one constant $F_{0.1}$ scenario, are shown in **BFTW-Table 3** and **BFTW-Figure 6.**

With three additional years added to the 2017 assessment (2016-2018), the overall biomass continues to decrease due to the 2003 year-class having passed its peak biomass together with below average recruitment in recent years. While the high numbers of 9 plus year old fish continue to contribute to catches, 6-8 year old fish that will form a large component of the next three year TACs are at very low abundance and hence lead to declining allowable catch in order to remain consistent with an $F_{0.1}$ strategy where declining recruitment implies commensurate reductions in catch.

The Committee reiterates that the effects of mixing and management measures on the eastern stock remain a considerable source of uncertainty for the outlook of the western stock. Consequently, changes to assessment and management approaches that take explicit account of mixing are a high priority.

BFTW-5. Effect of current regulations

The 2020 assessment estimates that the biomass has decreased by 11.7% (**BFTW-Table 2**) over the time period 2017-2020. The current TAC recommendation (Rec. 17-06) is set to end in 2020 with new TAC advice requested by the Commission. Under the updated models the current TAC is likely to have led to overfishing relative to F0.1 beginning in 2018 (**BFTW-Figure 3)**. Roll-over of the 2020 TAC in Rec. 17-06 to 2021 is also expected to lead to overfishing (**BFTW-Table 1**)-and would result in a 6.4% reduction in the population biomass relative to 2020 (**BFTW-Table 4)**.

BFTW-6. Management recommendations

The Commission recommended total allowable catches (TAC) of 2,350 t in 2018, 2019 and 2020 (Rec. 17-06). The Committee provides management options including the constant TAC scenarios shown in the Kobe II strategy matrix as well as a six scenarios for TAC advice. The TAC for each year, resulting impact on total stock biomass, percent change in biomass and probability of not overfishing associated with each scenario are shown in **BFTW-Table 4** to illustrate trade-offs for the Commission to consider.

Scenario 1 corresponds to fishing at approximately $F_{0.1}$ for 2021-2023. Scenario 2 is an approximate but not exact 60% probability of not overfishing in each year 2021, 2022 and 2023. Scenario 3 corresponds to a strict rollover of the 2020 TAC for 2021 and then fishing at $F_{0.1}$ in 2022 and 2023. Scenario 4 is a stepwise reduction in TAC designed to achieve a similar biomass in 2023 as the $F_{0.1}$ strategy in 2023 and to end overfishing with >50% probability by 2023. Scenario 5 and 6 are constant TAC scenarios derived from interpolating the Kobe Strategy matrix to achieve at least a 50 and 60% probability of not over fishing at any time over the three year period.

TAC should be reviewed annually by the Commission on the advice of the SCRS (which would be based on consideration of updates of the fishery indicators as well as intersessional work conducted to improve indices). This would permit the SCRS to, on any of those occasions, recommend that the next TAC be amended given sufficiently strong signals in the indicators.

SUMMARY TABLE

Estimated recent fishing mortality rate (geometric mean of apical F for the period 2015 to 2017) relative to the F reference point, $F_{0.1}$ (a proxy for F_{MSY} based on two recent recruitment specifications). Range across Stock Synthesis and VPA models are shown in parentheses.

WEST ATLANTIC BLUEFIN TUNA SUMMARY	
Current Catch including discards (2019)	2,305*
$F_{current}$ (2015-2017)	0.088 (0.076-0.10)
$F_{0.1}$	0.112 (0.089-0.135)
Estimated probability of overfishing ($F_{current(2015-2017)}$)/$F_{0.1}$)	3%
Stock status[1]	Overfishing : No
Management Measures:	[Rec. 17-06] TAC of 2,350 t in 2018-2020, including dead discards.

* As of 25 August 2020

[1] Biomass reference points to determine stock status were not estimated in the 2020 assessment due to uncertainty in recruitment potential.

BFT-Table 1. Estimated catches (t) of Northern bluefin tuna (*Thunnus thynnus*) by area, gear and flag.

				1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
TOTAL				26381	29318	34128	36642	48881	49751	54009	53545	52657	52772	52775	52784	53319	52305	52125	51756	51812	62638	26460	21798	13195	11781	12688	14725	14887	18042	21032	25466	29784	31065
BFT-E				23599	26389	31831	34258	46769	47303	51497	51211	50000	50000	50000	50000	50000	50000	50000	50000	50000	61000	24460	19818	11338	9774	10934	13243	13261	16201	19131	23616	27757	28760
	ATE			6313	6543	7396	9317	7054	9780	12098	16379	11630	10247	10061	10086	10347	7394	7402	9023	7529	8441	8243	6684	4379	3984	3834	4163	3918	4841	5968	7216	8157	9326
	MED			17286	19846	24435	24941	39715	37523	39399	34831	38370	39753	39939	39914	39653	42606	42598	40977	42471	52559	16217	13133	6959	5790	7100	9080	9343	11360	13163	16401	19600	19434
BFT-W	ATW			2782	2929	2296	2384	2113	2448	2512	2334	2657	2772	2775	2784	3319	2305	2125	1756	1811	1638	2000	1980	1857	2007	1754	1482	1627	1842	1901	1850	2027	2305
Landings	ATE	Bait boat		1993	1653	1422	3884	2284	3093	5369	7215	3139	1554	2032	2426	2635	1409	1902	2282	1263	2436	2393	1260	725	636	283	243	95	172	1085	1195	692	845
		Longline		1510	3196	3618	2802	2311	4522	4212	4057	3789	3570	3736	3303	2896	2748	2064	2700	2033	1705	2491	1951	1194	1125	1139	1167	1194	1467	1829	2208	2730	3177
		Other surf.		252	126	523	976	590	555	273	60	387	404	509	558	631	521	290	424	831	502	181	297	124	35	49	141	210	193	261	295	340	319
		Purse seine		54	46	462	24	213	458	323	828	700	726	661	153	887	490	1078	1197	408	0	0	2	1	0	0	2	0	0	42	49	11	24
		Sport (HL+RR)		1	0	7	0	25	0	0	237	28	33	126	61	63	109	89	11	99	11	12	11	44	51	53	46	43	104	35	101	118	357
		Traps		2504	1522	1365	1631	1630	1152	1921	3982	3586	3960	2996	3585	3235	2116	1978	2408	2895	3788	3166	3164	2292	2137	2311	2564	2376	2905	2716	3363	4258	4594
	MED	Bait boat		25	148	158	48	0	206	5	4	11	4	38	28	1	9	17	5	0	0	0	38	1	0	2	2	9	25	0	50	56	72
		Longline		1178	3057	3145	2470	6993	8469	9856	7313	4117	3338	3424	4144	3234	3484	3036	3427	3408	3269	2376	1344	1242	962	587	605	588	776	1523	1184	1517	1436
		Other surf.		344	356	447	371	776	545	417	282	284	228	728	354	340	198	197	175	81	85	0	0	1	1	1	20	29	3	37	90	34	51
		Purse seine		11797	13805	18580	20065	27948	23799	26021	24279	31792	33798	33237	33043	34044	37291	37869	36639	38363	48994	13540	11448	4986	4293	6172	7982	8184	9993	11315	14466	17119	17200
		Sport (HL+RR)		1559	769	952	1238	2307	3562	2149	2340	1092	1533	1773	1167	1520	1404	1325	619	494	117	149	160	448	356	202	240	289	361	284	335	567	319
		Traps		2382	1711	1152	749	1691	942	951	613	1074	852	739	1177	515	221	154	112	125	93	152	144	281	165	125	222	232	192	0	272	300	353
	ATW	Longline		741	903	689	712	539	491	545	382	764	915	858	610	729	186	644	425	565	420	606	366	529	743	478	470	498	553	562	559	664	675
		Other surf.		536	578	509	406	307	384	429	293	342	279	283	201	107	139	97	89	85	63	78	121	107	147	117	121	119	138	93	123	77	168
		Purse seine		384	237	300	295	301	249	245	250	249	248	275	196	208	265	32	178	4	28	0	11	0	0	2	29	38	34	0	0	0	
		Sport (HL+RR)		1004	1083	586	854	804	1114	1032	1181	1108	1125	1121	1650	2036	1399	1139	924	1005	1023	1134	1251	1009	888	917	692	810	1085	1204	1144	1263	1450
		Traps		2	0	1	29	79	72	90	59	68	44	16	16	28	84	32	8	3	4	23	23	39	26	17	11	20	6	10	13	3	4
Discards	ATE	Longline		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	9
	MED	Purse seine		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	12	9	11	2	4	5	6	4
		Longline		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	
	ATW	Longline		115	128	211	88	83	138	167	155	123	160	222	105	211	232	181	131	149	100	159	207	174	202	224	145	139	19	29	10	17	7
		Other surf.		0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	2	2
		Purse seine		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	4	5	0	0	0	
		Sport (HL+RR)		0	0	0	0	0	0	0	14	3	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATE CP	Cape Verde		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		China PR		0	0	0	0	0	0	0	0	85	103	80	68	39	19	41	24	42	72	119	42	38	36	36	38	37	45	54	64	79	89
		EU.Denmark		0	0	0	37	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**0**
		EU.España		3830	2273	2318	4962	3137	3819	6186	9519	4565	4429	3493	3633	4089	2172	2801	3102	2339	3680	3536	2409	1550	1483	1329	1553	1282	1655	1986	2509	2489	2729
		EU.France		510	565	894	1099	336	725	563	269	613	588	542	629	755	648	561	818	1218	629	253	366	228	135	148	223	212	254	343	350	461	462
		EU.Germany		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EU.Ireland		0	0	0	0	0	0	0	14	21	52	22	8	15	3	1	1	2	1	1	1	2	4	10	13	19	14	32	16	17	6
		EU.Netherlands		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	
		EU.Poland		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EU.Portugal		27	103	128	91	363	169	199	712	323	411	441	404	186	61	27	82	104	29	36	53	58	180	223	235	243	263	327	429	450	475
		EU.Sweden		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EU.United Kingdom		0	0	0	0	0	1	0	1	1	12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	
		Guinea Ecuatorial		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	
		Guinée Rep.		0	0	0	0	330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Iceland		0	0	0	0	0	0	0	0	2	27	0	0	1	0	0	0	0	0	0	0	0	2	5	4	30	37	6	0	0	
		Japan		1464	2981	3350	2484	2075	3971	3341	2905	3195	2690	2895	2425	2536	2695	2015	2598	1896	1612	2351	1904	1155	1089	1093	1129	1134	1386	1578	1905	2262	2514
		Korea Rep.		0	0	0	0	4	205	92	203	0	0	6	1	0	0	3	0	1	0	0	0	0	0	0	0	0	0	161	181	208	232
		Maroc		408	531	562	415	720	678	1035	2068	2341	1591	2228	2497	2565	1795	1953	2389	1923	2418	1947	1909	1348	1055	990	960	959	1176	1433	1703	2164	2790
		Norway		0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	44	51	12	18
		Panama		0	0	0	0	1	19	550	255	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Senegal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	
		Sierra Leone		0	0	0	0	0	0	0	0	0	0	93	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	NCC	Chinese Taipei		0	0	0	6	20	4	61	226	350	222	144	304	158	0	0	10	4	0	0	0	0	0	0	0	0	0	0	0	0	
	NCO	Faroe Islands		0	0	0	0	0	0	0	0	67	104	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		ICCAT (RMA)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	
		NEI (ETRO)		74	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NEI (Flag related)		0	85	144	223	68	189	71	208	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Seychelles		0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

				1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	MED	CP	Albania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	9	34	40	47	56	100	156
			Algerie	782	800	1104	1097	1560	156	638	829	1674	1760	2083	2098	2056	1504	1440	1500	1673	1489	1311	0	0	0	69	244	244	370	448	1038	1300	1437
			China PR	0	0	0	0	97	137	93	49	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.Croatia	0	1418	1076	1058	1410	1220	1360	1105	906	970	930	903	977	1139	828	1017	1022	825	834	619	389	371	369	384	385	456	515	630	738	817
			EU.Cyprus	10	10	10	14	10	10	10	10	21	31	61	85	91	79	105	149	110	1	132	2	3	10	18	17	18	22	59	110	133	151
			EU.España	1822	1392	2165	2018	2741	4607	2588	2209	2000	2003	2772	2234	2215	2512	2353	2758	2689	2414	2465	1769	1056	942	1064	948	1164	1238	1467	1688	2706	2660
			EU.France	4713	4620	7376	6995	11843	9604	9171	8235	7122	6156	6794	6167	5832	5859	6471	8638	7663	10200	2670	3087	1755	805	791	2191	2216	2565	3054	3661	4360	4919
			EU.Greece	201	175	447	439	886	1004	874	1217	286	248	622	361	438	422	389	318	255	285	350	373	224	172	176	178	161	195	218	235	267	313
			EU.Italy	4122	3787	5006	5379	6901	7076	10200	9619	4441	3283	3847	4383	4628	4981	4697	4853	4708	4638	2247	2749	1061	1783	1788	1938	1946	2273	2488	3196	3860	4286
			EU.Malta	85	113	81	259	580	590	402	396	409	449	378	224	244	258	264	350	270	334	296	316	136	142	137	155	160	182	212	261	308	338
			EU.Portugal	62	240	211	164	306	313	274	37	54	76	61	64	0	2	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	
			Egypt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64	77	77	155	99	124	181	
			Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	
			Japan	172	85	123	793	536	813	765	185	361	381	136	152	390	316	638	378	556	466	80	18	0	0	0	0	0	0	0	0	0	
			Korea Rep.	0	0	0	0	684	458	591	410	66	0	0	0	0	0	700	1145	26	276	335	102	0	0	77	80	81	0	0	0	0	
			Libya	328	370	737	635	1422	1540	1388	1029	1331	1195	1549	1941	638	752	1300	1091	1327	1358	1318	1082	645	0	756	929	933	1153	1368	1631	1792	
			Maroc	1149	925	205	79	1092	1035	586	535	687	636	695	511	421	762	827	108	463	641	531	369	205	182	223	309	310	322	350	439	407	130
			Panama	74	287	484	467	1499	1498	2850	236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Syria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	41	0	34	0	0	0	0	40	47	57	66	72
			Tunisie	406	1366	1195	2132	2773	1897	2393	2200	1745	2352	2184	2493	2528	791	2376	3249	2545	431	2679	1932	1042	852	1017	1057	1047	1248	1461	1755	2092	2380
			Turkey	2059	2459	2817	3084	3466	4219	4616	5093	5899	1200	1070	2100	2300	3300	1075	990	806	918	879	665	409	519	536	551	555	1091	1324	1515	1284	1771
	NCC		Chinese Taipei	0	0	0	328	709	494	411	278	106	27	169	329	508	445	51	267	5	0	0	0	0	0	0	0	0	0	0	0	0	
	NCO		ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	1	0	1	1	0	
			Israel	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	0	0	0	427	639	171	1058	761	78	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (combined)	360	1799	1398	0	773	211	0	101	1030	1995	109	571	508	610	709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (inflated)	0	0	0	0	0	0	0	0	9471	16893	16458	15298	15880	18873	18376	14164	18343	28234	0	0	0	0	0	0	0	0	0	0	0	
			Serbia & Montenegro	0	0	0	0	0	2	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Yugoslavia Fed.	940	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ATW	CP	Brazil	1	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
			Canada	438	485	443	459	392	576	597	503	595	576	549	524	604	557	537	600	733	491	575	530	505	474	477	480	463	531	466	472	508	666
			FR.St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	1	0	0	3	1	10	5	0	4	3	2	8	0	0	0	0	9	0	0	0	
			Japan	550	688	512	581	427	387	436	322	691	365	492	506	575	57	470	265	376	277	492	162	353	578	289	317	302	347	345	346	406	406
			Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	52	0	0	0	0	0	0	0	0	0	0	0	0	
			Mexico	2	9	15	17	4	23	19	2	8	14	29	10	12	22	9	10	14	7	7	10	14	14	51	23	51	53	55	34	80	39
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			U.S.A.	1636	1582	1085	1237	1163	1311	1285	1334	1235	1213	1212	1583	1840	1426	899	717	468	758	764	1068	803	738	713	502	667	877	1002	986	1013	1185
			UK.Bermuda	0	0	0	0	0	0	1	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
			UK.British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			UK.Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	NCC		Chinese Taipei	0	0	0	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	NCO		Argentina	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	0	0	0	0	0	0	0	0	0	0	0	0	74	11	19	27	19	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (ETRO)	24	23	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	0	0	0	0	0	0	0	0	429	270	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta. Lucia	14	14	14	2	43	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discards	ATE	CP	Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	9
	MED	CP	Albania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			EU.Croatia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	5	2	2	4	5	6	4
			EU.España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	
			Libya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	0	0	0	0	0	
			Tunisie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	
			Turkey	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	
	ATW	CP	Canada	0	0	0	0	0	0	0	6	16	11	46	13	37	14	15	0	2	0	1	3	25	36	17	0	0	3	8	1	3	3
			Japan	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
			U.S.A.	115	128	211	88	83	138	171	155	110	149	176	98	174	218	167	131	147	100	158	204	150	166	206	159	143	22	24	10	15	6

BFTW-Table 1. Kobe II matrix giving the probability that the fishing mortality rate (F) will be less than the F reference point ($F \leq F_{0.1}$, overfishing not occurring) over the next three years for alternative constant annual catches, based on results from the 2020 VPA and Stock Synthesis (combined as indicated in the main text).

TAC	2021	2022	2023
0	100%	100%	100%
1000	100%	100%	99%
1250	98%	96%	94%
1500	91%	86%	80%
1550	89%	82%	75%
1600	85%	76%	67%
1650	82%	67%	56%
1700	75%	57%	45%
1750	67%	48%	35%
1800	57%	37%	27%
1850	46%	28%	21%
1900	38%	23%	17%
1950	29%	17%	13%
2000	23%	14%	12%
2250	9%	6%	6%
2350	6%	5%	4%
2500	4%	2%	2%
2750	1%	1%	0%
3000	0%	0%	0%

BFTW-Table 2. Relative change in total stock biomass relative to 2017 under alternative closest catch scenarios to 2350 t from the 2017 assessment (top rows) and depletion relative to 2017 from the 2020 assessments projected with either the realized or assumed TAC for 2018-2020, showing that the stock is now more depleted than original predicted. For both the 2017 and 2020 models, Stock Synthesis biomass is biomass as the beginning of the year and VPA represents mid-year biomass. For the 2020 model, Stock Synthesis and VPA projections come from averaging the deterministic model runs for 2 recruitment and 2 maturity specifications.

	TAC	2018	2019	2020
2017 model	2250	-1.7%	-4.0%	-7.2%
2017 model	2500	-1.7%	-4.8%	-8.7%
Realized or assumed TAC		2027	2350	2350
2020 model		-2.6%	-6.2%	-11.7%

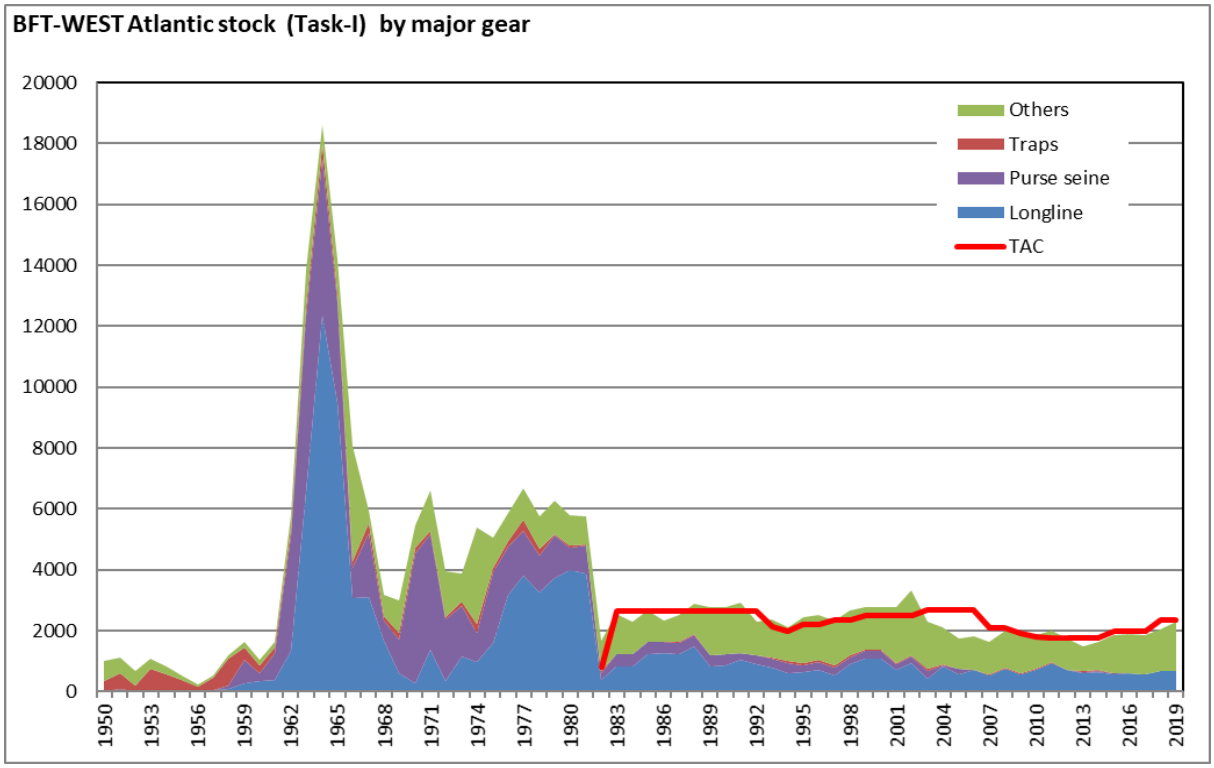
BFTW-Table 3. Percentage change in total stock biomass at the middle of the year relative to 2020 under alternative constant catch scenarios from the 2020 assessment, based on the projections from Stock Synthesis and VPA, averaged across 2 recruitment and 2 maturity specifications. Stock Synthesis and VPA projections come from averaging the deterministic model runs.

Catch	2021	2022	2023
1000	-4%	-4%	-4%
1250	-4%	-6%	-7%
1500	-5%	-7%	-10%
1550	-4.7%	-7.6%	-10.1%
1600	-4.8%	-7.9%	-10.7%
1650	-4.9%	-8.2%	-11.2%
1700	-5.1%	-8.5%	-11.7%
1750	-5.2%	-8.8%	-12.2%
1800	-5.3%	-9.1%	-12.7%
1850	-5.4%	-9.4%	-13.3%
1900	-5.5%	-9.8%	-13.8%
1950	-5.6%	-10.1%	-14.3%
2000	-5.7%	-10.4%	-14.8%
2250	-6.2%	-12.0%	-17.4%
2350	-6.4%	-12.6%	-18.5%
2500	-6.8%	-13.5%	-20.0%
2750	-7.3%	-15.1%	-22.7%
3000	-7.9%	-16.7%	-25.3%

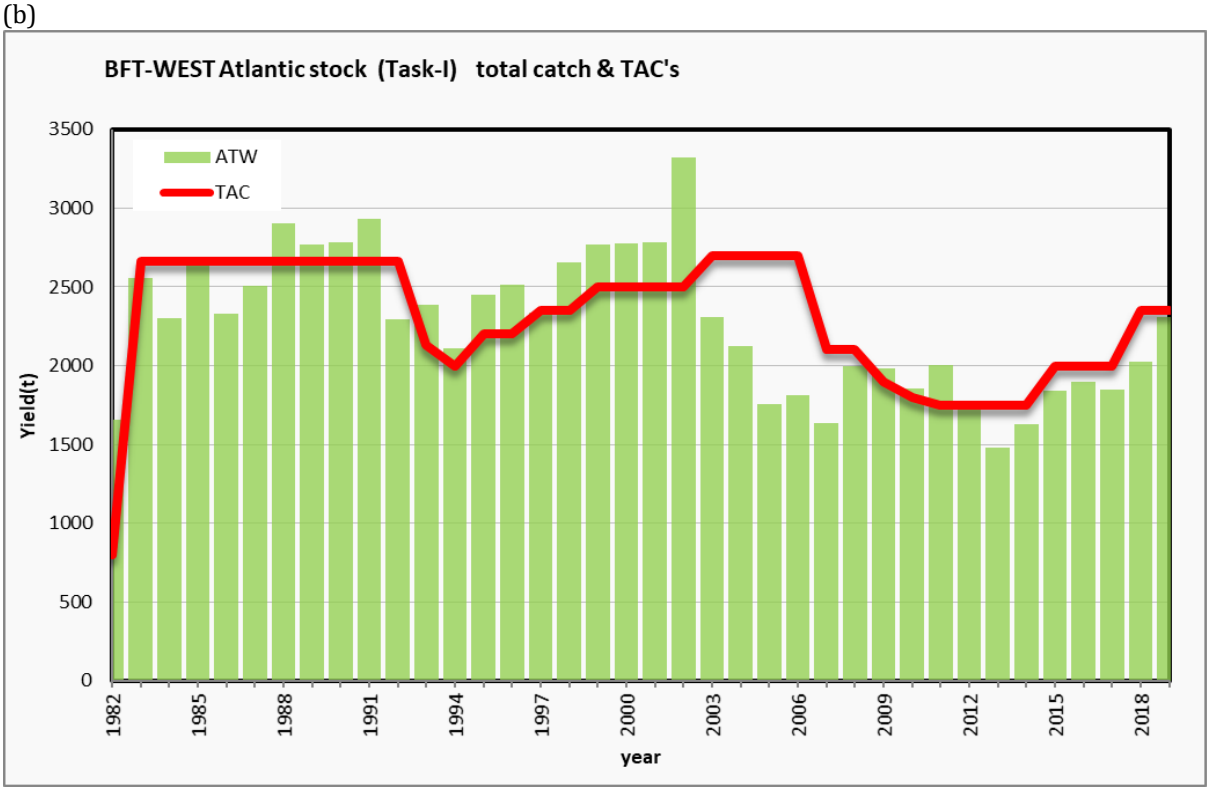
BFTW-Table 4. Scenarios for three-year TAC advice. Predicted yield (t), total stock biomass (t), % total biomass change from 2020 and probability of not overfishing, by management scenario averaged across both VPA and Stock Synthesis. Scenarios 1 and 2 come from an approximation of a 50 and 60% probability of not overfishing in each year but did not quite achieve the desired intent in the time available. All TAC scenarios reflect running projections with the prescribed TAC to accurately estimate probabilities resulting from having taken the previous year's TAC shown below.

Management Scenario	Predicted Yield (t)			Predicted (mid-year) Total Biomass (t)			Percent Change in Total Biomass (mid-year) from 2020			Probability of Not Overfishing		
	2021	2022	2023	2021	2022	2023	2021	2022	2023	2021	2022	2023
1. Approximate 50% Probability of Not Overfishing or approximate Constant $F=F_{0.1}$	1831	1738	1678	22918	22000	21218	-5.3%	-9.1%	-12.4%	49%	46%	44%
2. Approximate 60% Probability Not Overfishing	1785	1684	1633	22940	22072	21342	-5.2%	-8.8%	-11.8%	58%	58%	54%
3. Rollover in 2021 to $F=F_{0.1}$	2350	1685	1632	22647	21506	20778	-6.4%	-11.2%	-14.2%	6%	50%	48%
4. 255 mt step 2021 -2023	2095	1840	1585	22780	21681	20900	-5.9%	-10.4%	-13.7%	15%	27%	56%
5. 1630 t constant	1630	1630	1630	23021	22257	21551	-4.9%	-8.1%	-11.0%	83%	71%	61%
6. 1680 t constant	1680	1680	1680	22995	22181	21424	-5.0%	-8.4%	-11.5%	78%	61%	50%

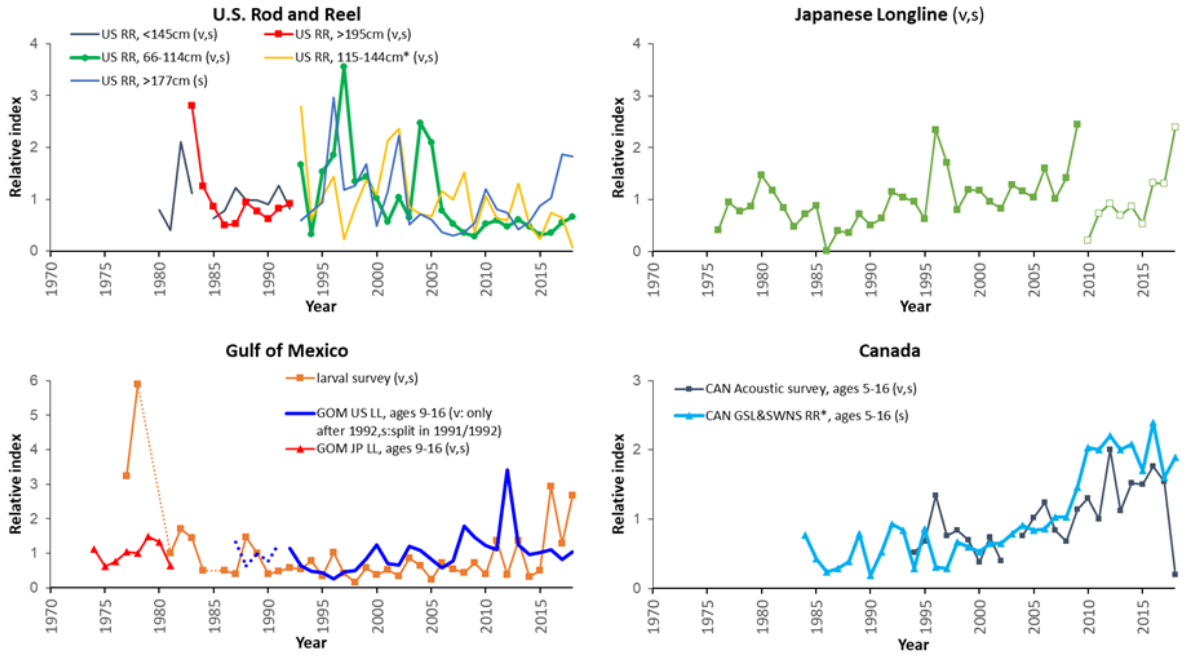
(a)



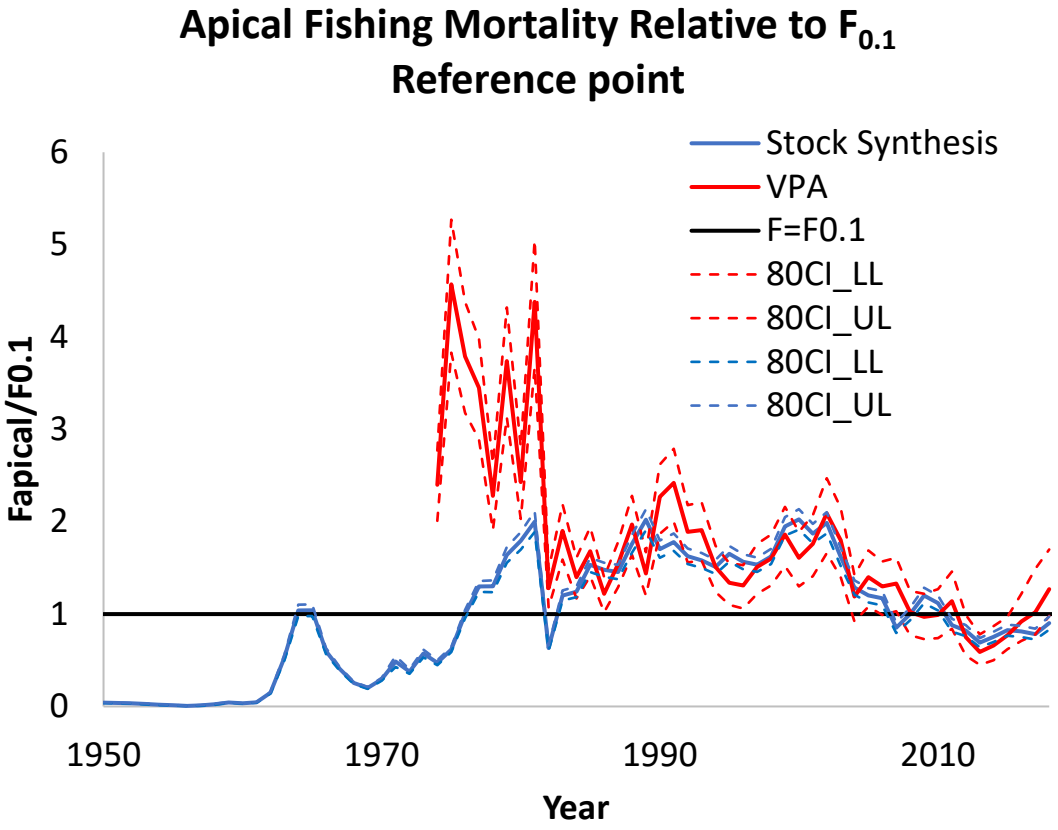
(b)



BFTW-Figure 1. Historical catches of western bluefin tuna: (a) by gear type and (b) TACs agreed by the Commission (which are shown for comparison).

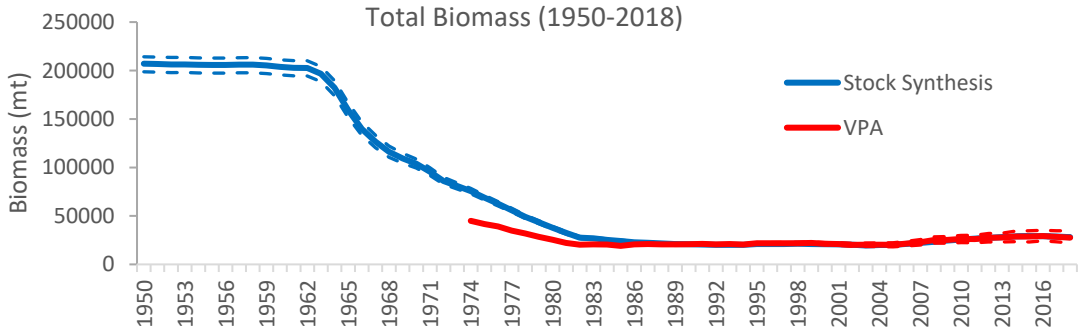


BFTW-Figure 2. Indices of relative abundance for western bluefin tuna. Indices denoted with "*" represent revised indices rather than strict updates of indices used in the 2017 stock assessment. Indices denoted with an "s" were used in Stock Synthesis and indices with a "v" were used in VPA. The Canadian Acoustic index data point for 2018 was not used in the assessment models.



BFTW-Figure 3. Fishing mortality relative to the $F_{0.1}$ reference point as estimated by VPA (red) and Stock Synthesis (blue) for the 2020 assessment. The 80% confidence intervals are indicated with dashed lines.

a)



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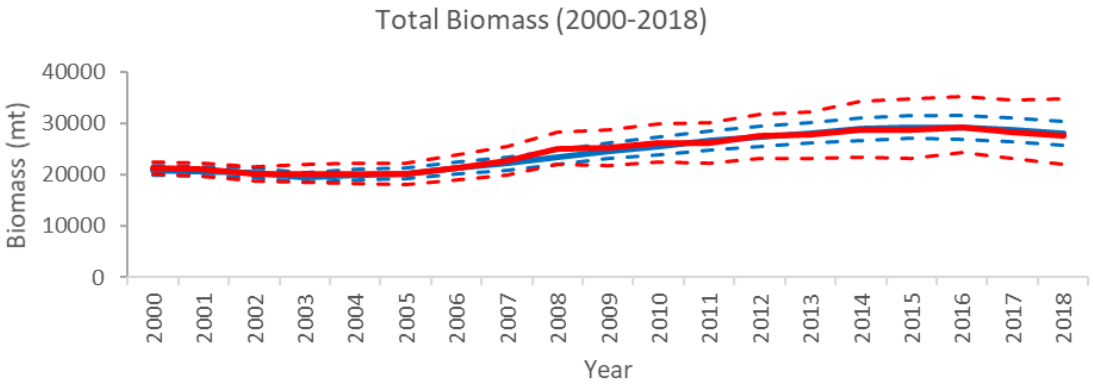
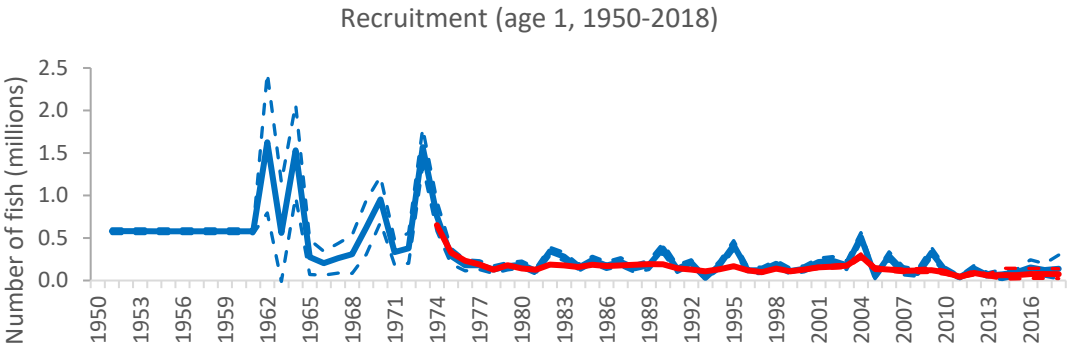
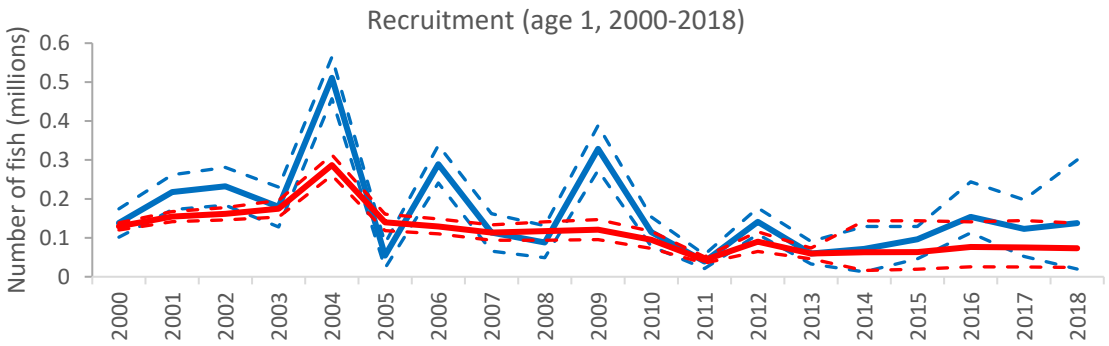


c)

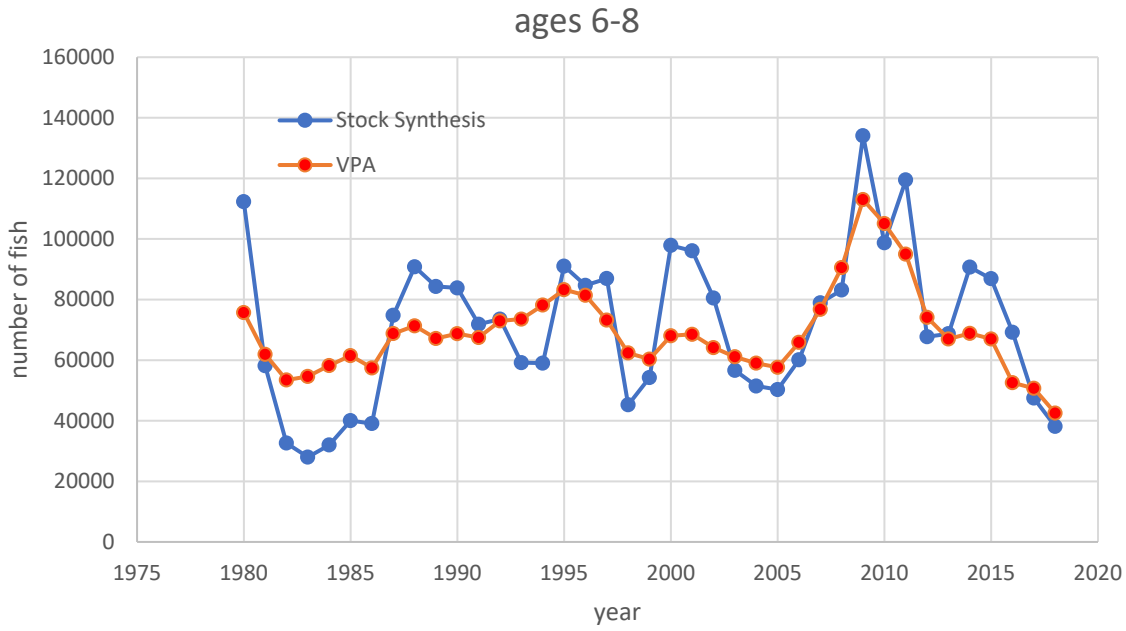


d)

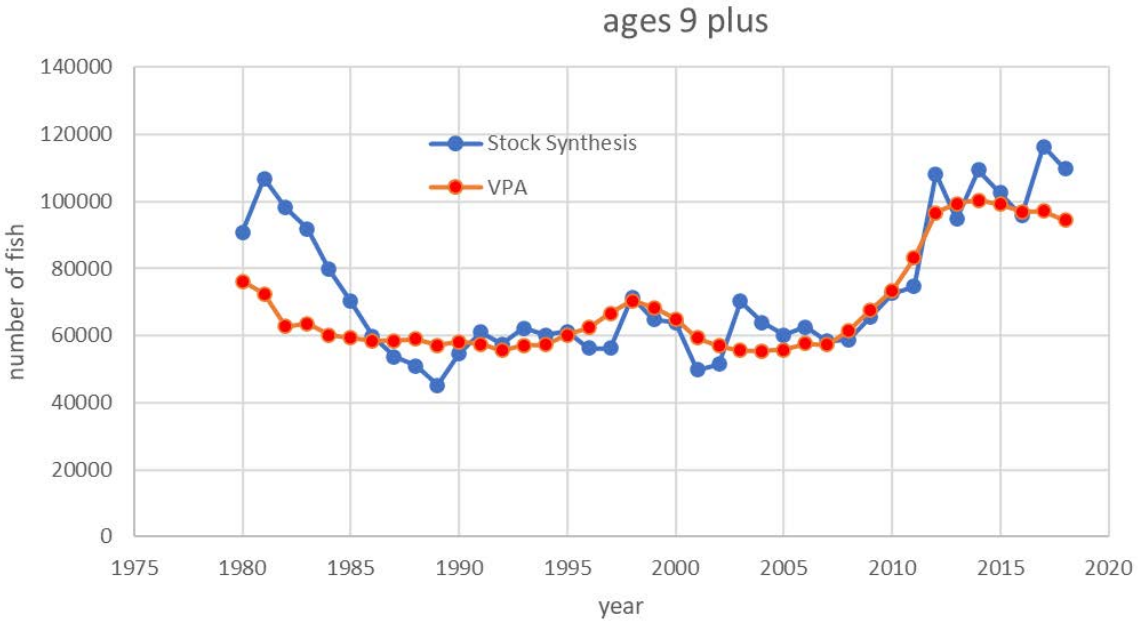


BFTW-Figure 4. Estimates of (a) total stock biomass for 1950-2018 and (b) for 2000-2018, and (c) recruitment for 1950-2018 and (d) for 2000-2018 for the base VPA (red) and Stock Synthesis (blue) models from the 2020 assessment. The 80% confidence intervals are indicated with dashed lines. For VPA recruitment estimates for the recent years (e.g. 2014-2018) have been replaced by the values obtained from the recruitment specifications (average with autocorrelation).

a)

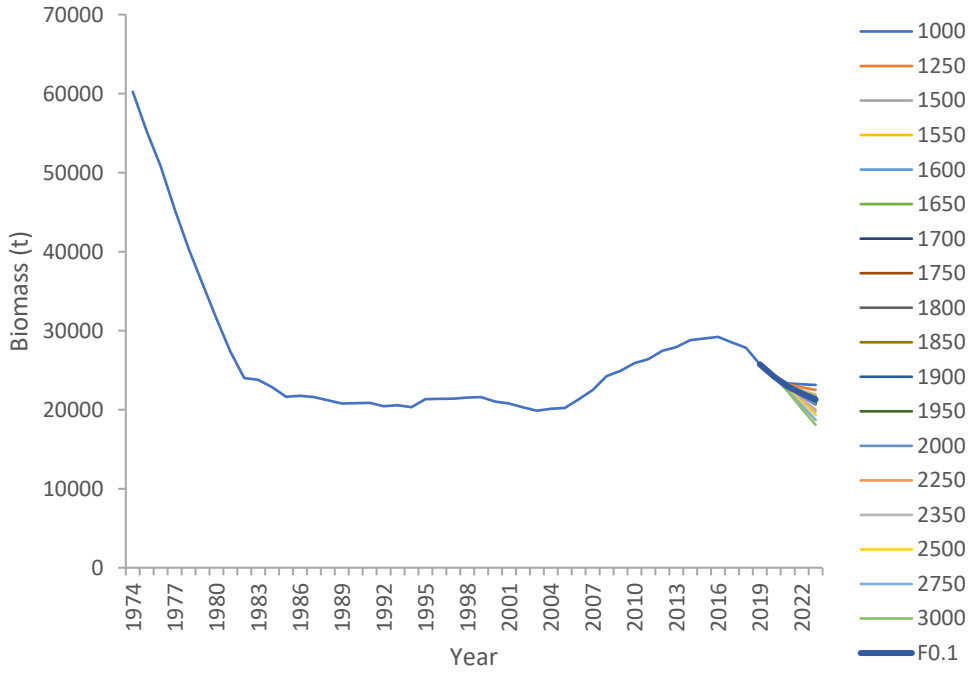


b)

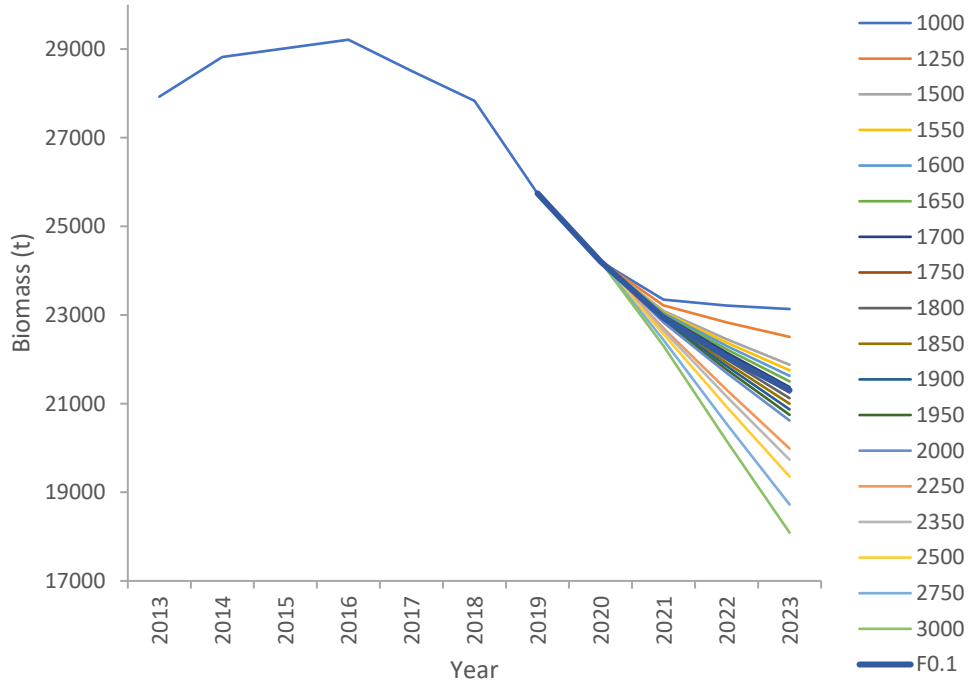


BFTW-Figure 5. a) Numbers of age 6-8 fish predicted by VPA and Stock Synthesis and b) age 9 and above.

a)



b)



BFTW-Figure 6. Projected total stock biomass (mt) of bluefin tuna in the West Atlantic under alternative constant catch scenarios, averaged across both recruitment and maturity specifications and both Stock Synthesis and VPA. The deterministic model runs are averaged across all scenarios. (a) Upper panel: 1974-2023, (b) lower panel: zoomed in to 2013 to 2023.