9.1 YFT - Yellowfin

The most recent stock assessment for yellowfin tuna was conducted in 2019 using catch and effort data through 2018, although catch reports for 2018 were incomplete at the time of the stock assessment meeting, with 42% of the total catch being estimated using the average of the previous three years, by CPC and gear type. Species composition and catch at size from Ghanaian baitboats and purse seiners has been thoroughly reviewed during the past few years. This review led to new estimates of Task 1 and Task 2 catch/effort and size data for the period 1973-2013. Task 1 and 2 estimations for the period 2012 to 2018 (Ortiz and Palma, 2019) were updated for the 2019 ICCAT Yellowfin Tuna Stock Assessment Meeting (Anon., 2020a). The catch table presented in this Executive Summary (**YFT-Table 1**) has been updated to include these changes.

Readers interested in a more complete summary of the state of knowledge on yellowfin tuna stock status should consult the detailed report (Anon., 2020a). The Tropical Tunas Workplan (item 17.1.10) includes plans to address research and assessment needs for yellowfin tuna.

YFT-1. Biology

Yellowfin tuna is a cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three oceans. The exploited sizes typically range from 30 cm to 170 cm fork length (FL). Juvenile yellowfin tuna form mixed schools with skipjack and juvenile bigeye, and are mainly limited to surface waters, while larger fish form schools in surface and sub-surface waters. Spawning on the main fishing grounds, the equatorial zone of the Gulf of Guinea, occurs primarily from December to April. Spawning also takes place in the Gulf of Mexico, the southeastern Caribbean Sea and off Cabo Verde, although peak spawning can occur in different months in these regions. The relative importance of the various spawning grounds is unknown.

Although the distinct spawning areas might imply separate stocks, or substantial heterogeneity in the distribution of yellowfin tuna, a single stock for the entire Atlantic is currently assumed. This assumption is based upon information such as observed transatlantic movements indicated by conventional tagging and longline catch data that indicates yellowfin are distributed continuously throughout the tropical Atlantic Ocean. Movement rates and timing, migratory routes, and local residence times remain uncertain, but recent tagging activities (e.g., Atlantic Ocean Tropical tuna Tagging Programme (AOTTP)) offer insights (**YFT-Figure 1**). In addition, some electronic tagging studies in the Atlantic as well as in other oceans suggest that there may be some degree of extended local residence times and/or site fidelity.

The length at 50% maturity was estimated at 115.1 cm when vitellogenesis was used for the maturity threshold. Lacking additional information about the relationship between fecundity and age/length, the Committee agreed to retain a fecundity schedule based upon length - or weight-at-age at the peak of the spawning season.

A comprehensive set of direct ages was made available from yellowfin tuna sampled in the US Gulf of Mexico and the western Atlantic. Ages up to 18 years were observed using annual otolith increment counts validated using 14C bomb radiocarbon. Preliminary results of the AOTTP oxytetracycline (OTC) validation work also support the annual deposition of otolith increments. A second study of yellowfin tuna captured in the Ascension Islands also observed ages up to 18 years and confirmed that individuals as old as 18 occur outside of the US, and closer to the areas where fishing pressure is higher (e.g., Gulf of Guinea). This information supported a change in maximum age from 11 to 18 years (**YFT-Figure 2**).

Information concerning growth was also available from the AOTTP. The data suggest that the growth of yellowfin tuna is better estimated using a Richards function than a von Bertalanffy function. Therefore, the age-structured models used that functional shape (**YFT-Figure 3**). The AOTTP data also support the previous conclusion that growth rates are relatively slow initially, increasing at the time the fish leave the nursery grounds.

Tagging studies of yellowfin in the Pacific and Indian Oceans suggest that natural mortality is age-specific, and higher for juveniles than for adults. As was done in the previous assessments of yellowfin and bigeye, an age-specific natural mortality function (e.g., Lorenzen) was developed and applied to the 2019 assessment of yellowfin tuna. The implied natural mortality based on the t_{MAX} of 18 is 0.35 yr^{-1}, which is lower than the 2016 assessment assumption of 0.54 yr^{-1} based on a t_{MAX} of 11 years. (**YFT-Figure 4**). The most recent stock assessment does not consider sex-specific natural mortality or growth, yet there are disparities in average size by gender. Males are predominant in the catches of larger sized fish (over 145 cm), which could result if large females experience a higher natural mortality rate, perhaps as a consequence of spawning. In contrast, females are predominant in the catches of intermediate sizes (120 to 135 cm), which could result from differential growth (e.g., females having a lower asymptotic size than males). Recent results from studies in the Indian Ocean suggest a combination of the two hypotheses.

Younger age classes of yellowfin tuna (40-80 cm) exhibit a strong association with floating objects (FOBs: any type of object that can affect fish aggregation). The Committee noted that this association with FOBs, which increases the vulnerability of these smaller fish to surface fishing gears, may also have an impact on the biology and on the ecology of yellowfin due to changes in feeding and migratory behaviors. These uncertainties in stock structure, natural mortality, and growth could have important implications for the stock assessment. Data collected by AOTTP will continue to reduce these uncertainties.

YFT-2. Fishery indicators

Yellowfin tuna have been exploited by three major gears (longline, baitboat and purse seine fisheries) and by many countries throughout its range. Detailed data are available since the 1950s. Overall Atlantic catches declined by nearly half from the peak in 1990 (193,584 t) to 106,333 t estimated for 2013 but have since increased to an average of nearly 140,000 t during 2020-2022. A low catch was observed in 2021 (119,454 t), coincident with the COVID-19 pandemic and the imposition of the most recent moratorium. However, catches in 2022 rebounded to 148,211 t, well above the recommended TAC. The most recent catch distribution is given in **YFT-Figure 5**.

In the eastern Atlantic, purse seine catches declined between 1990 and 2007 (129,144 t to 50,306 t) but have subsequently increased to 97,643 t in 2022 (**YFT-Table 1; YFT-Figure 6**). Baitboat catches declined between 1990 (19,625 t) and 2022 (6,504 t). Longline catches, which were 10,253 t in 1990, declined to 5,328 t in 2022. In the western Atlantic, purse seine catches (predominantly from Venezuela) were as high as 23,151 t during the mid-1990s have since declined to 1,479 t in 2022. Baitboat catches also declined since a peak in 1994 (7,094 t), and for 2022 were estimated to be 2,067 t. Since 1990, longline catches have generally fluctuated between 10,000 t and 20,000 t.

It is difficult to discriminate fishing effort between free schools (composed of large yellowfin tunas) and FOB fishing (targeting skipjack) in the eastern Atlantic because the fishing strategies can change from one year to the next. In addition, the sea time devoted to activities on FOBs and the assistance provided by supply vessels are difficult to quantify. Nominal purse seine effort, expressed in terms of carrying capacity, decreased regularly from the mid-1990s until 2006. Since that time, several European Union purse seiners have transferred their effort to the eastern Atlantic due to piracy in the Indian Ocean, and a fleet of new purse seiners has started operating from Tema (Ghana), whose catches are probably underestimated. These factors have contributed to the growth in carrying capacity of the purse seiners, which is approaching the level observed in the early 1990s.

Numerous changes have occurred in the yellowfin fishery since the early 1990s (e.g., the progressive use of FOBs and the latitudinal expansion and the westward extension of the fishing area). Since 2011, significant catches of yellowfin tuna have been obtained by EU purse seiners South of 15°S off the coast of West Africa (in association with skipjack and bigeye on FOBs). There has also been a significant increase in catches of yellowfin and bigeye by a new Brazilian "vessel associated-school" handline fishery, where the vessel is used to aggregate fish, operating in the western Atlantic. These catches have increased seven-fold from 1,570 t in 2012 to 11,841 t in 2022. Finally, a new strategy of fishing on floating objects off Mauritania (north of 15°N) began in 2012. Catches on floating objects in this area tended to consist almost entirely of skipjack, therefore, effort directed in this manner may have a minimal impact on yellowfin tuna.

Four indices of abundance were used in various stock assessment model runs used to develop management advice (**YFT-Figure 7**). A major advancement in this assessment was the development of a joint longline index using high resolution catch and effort information from the main longline fleets operating in the Atlantic (Brazil, Korea (Rep.), Japan, United Stetes and Chinese Taipei). The indices were developed for 3 regions, but only two were used in the assessment: the North Atlantic (Region 1), and the tropical area (Region 2). A new echosounder-based buoy associated index (BAI) was developed and was assumed to represent the abundance of juvenile yellowfin tuna. An index of larger yellowfin tuna (>80 cm, 10 kg) in free schools for the EU purse seine fleet (EUPSFS index) was also used.

Longline indices from several individual nations were updated since the last assessment (**YFT-Figure 8**). The index trends suggest the biomass of yellowfin available to the various longline fleets has remained generally stable or increased since 2019. Cautious interpretation is warranted since individual longline indices were not used in the most recent assessment, and the joint longline index has not yet been updated.

The recent average weight in European purse seine catches, which represent the majority of the landings, had declined to about half of the average weight of 1990. This decline is at least in part due to changes in selectivity associated with fishing on floating objects beginning in the 1990s, which was observed in the increased catches of small yellowfin. A declining trend in average weight and a corresponding increase in the catch of small yellowfin is also evident in eastern tropical baitboat catches. Longline mean weights and catch at size have been more variable.

YFT-3. State of the stock

A full stock assessment was conducted for yellowfin tuna in 2019, applying two production models (Just Another Bayesian Biomass Assessment (JABBA), biomass production model (MPB)) and one age-structured model (Stock Synthesis (SS)) to the available catch data through 2018. The four SS model runs, were regarded as representing alternative recruitment, and steepness hypotheses. Likewise, the JABBA runs addressed different hypotheses about initial priors for *r*, and about which indices of abundance were representing the population. Finally, the base case selected for MPB estimated biomass and fishing mortality trends that varied somewhat from JABBA. The Group decided that, in order to capture this uncertainty in the population dynamics for developing the management advice, it was best to incorporate results from all of the accepted model runs.

The trend in the estimated biomass (relative to B_{MSY}) for all models shows a general continuous decline through time. SS runs suggest a few periods of large increases in spawning biomass associated with episodes of high recruitment. The model estimates that such very high recruitments have happened three times in the period 1960 to 2017. Production models show much less pronounced increases in total biomass at the equivalent times. Note, however, that for all models there are large uncertainties in the value of biomass at any point in the history, including 2018. Most model runs lead to biomasses at the end of 2018 above the level that produces maximum sustainable yield (MSY) (**YFT-Figure 9**).

Estimates of historical fishing mortality (relative to F_{MSY}) show similar trends for all models. For most model runs, fishing mortality increased progressively until the early 1980s, it varied in level until the mid-1990s, after which it declined gradually until the mid-2000s. Since the mid-2000s, the fishing mortality has had a generally increasing trend with fluctuations until 2018. Overall, the models estimate that the fishing mortality in 2018 was near the fishing mortality that would produce MSY. Again, for all models there are large uncertainties in the value of fishing mortality at any point in the history, including 2018 (**YFT-Figure 10**).

It is important to note that the SS model is the only one used that can provide estimates of recent recruitment (**YFT-Figure 11**). Recruitments were not estimated to vary from the stock-recruit relationship for 2018, due to the large uncertainty in terminal year recruitment estimates. The estimate of recruitment in 2017 is also more uncertain than for previous years, in part because there is no 2018 size frequency data to corroborate or contrast with it. SS models which use the buoy index suggest very high recruitment in 2017, whereas models that do not use the buoy index suggest that recruitment in 2017 was above average but not particularly high.

The Group gave equal weight to surplus production model and integrated assessment model results. Within surplus production models, JABBA and MPB were also given equal weight. Each run within a modeling platform (JABBA, and SS) were also given equal weight. For the combined results (MPB, JABBA, SS) used to develop management advice, the median estimate of B_{2018}/B_{MSY} is 1.17 - and the median estimate of F_{2018}/F_{MSY} is 0.96 **-**. The median FMS estimated is 121,298 t. Combining the results of all models provides a way to estimate the probability of the stock being in each quadrant of the Kobe plot in 2018 (**YFT-Figure 12**). The corresponding probabilities are 54% in the green quadrant (not overfished not subject to overfishing), 21% in the orange (subject to overfishing but not overfished) 2% in the yellow (overfished but not subject to overfishing) and 22% in the red (overfished and subject to overfishing). In summary, the results point to a stock status of not overfished (24% probability of overfished status), with no overfishing (43% probability of overfishing taking place).

The Group cautioned that the differences between the 2016 and 2019 assessment results are not due to stock recovery. In fact, the 2019 models indicate that the stock biomass declined between 2014 and 2018. Instead, the perceived improvement is more likely due to changes in key data inputs (natural mortality (M), growth, indices) and the suite of models applied (JABBA, MPB, SS).

The Group noted that catch reports for 2018 were incomplete, at the time when the assessment was conducted with 42% of the total catch being estimated using the average from the previous three years by CPC and gear type. Furthermore, no size data for 2018 were available at the time of the assessment. The 2018 estimated catch assumed for the stock assessment was 131,042 t. This has since been revised upwards to 136,530 t after additional reporting. It was not possible to re-run the stock assessment results with the new 2018 catch estimates, however a change of this magnitude was not expected to have substantial implications.

YFT-4. Outlook

Combined catch projections from 9 runs JABBA (Base Case, S2, S3, and S5), MPB, SS (runs 1, 2, 3 and 4) were provided at constant catches scenarios of 0 t and ranging from 60,000 to 150,000 t. The method used to combine the projection results is described in section 4.4 of the detailed report (Anon., 2020a). In the projection results from the SS and JABBA models, some iterations were predicted with exceptionally small biomass ratios and extremely high fishing mortality (F) ratios indicating the potential for stock collapse. Thus, probability of biomass being less than 20% of the biomass that supports MSY was calculated for each projection year and catch scenario (**YFT-Table 2**). The probability increased with higher catch levels and in later projected years. The probabilities more than 1% or 10% were observed with the constant catch more than 110,000 t or 140,000 t, respectively. The highest probability was 23.3% with 150,000 t constant catch in 2033. It should be noted that the reference chosen, 20% of biomass that supports MSY, was selected for informational purposes and has not been adopted formally by the SCRS for tropical tunas.

The combined projections show that 120,000 t constant catch will maintain more than 50% probability of being in green quadrant through 2033 (**YFT-Figure 13** and **YFT-Table 3**).

YFT-5. Effect of current regulations

Concern over the catch of small yellowfin tuna partially led to the establishment of spatial closures to surface fishing gear FAD sets in the Gulf of Guinea (Recs. 04-01, 08-01, 11-01, 14-01, 15-01) or entire Atlantic (Recs. 19-02, 21-01, and 22-01). In 2022, the Committee investigated the seasonal pattern of purse seine catch based on the data available at the Secretariat for the period 1991-2020 (Hordyk, 2023). The average proportion of the catch of yellowfin tuna (in weight) that was comprised of juveniles was 62.7% to 71% on FOBs, and was highest in the fourth quarter. The proportion of juveniles in the catches associated with free-school fishing was quite low, ranging from 1.6% to 4.9%.

Rec. 11-01 (reiterated in Rec. 22-01) also implemented a TAC of 110,000 t for 2012 and subsequent years. The catches have been above the TAC every year since 2013, averaging nearly 136,400 t. The implications for management are not known but are a cause for concern. The Committee strongly recommends a stock assessment of yellowfin tuna be conducted in 2024.

YFT-6. Management recommendations

The Group expressed strong concern that catches above 120,000 t are expected to further degrade the condition of the yellowfin stock if they continue. Furthermore, given that significant overages are frequent, existing conservation and management measures appear to be insufficient, and the Committee recommends that the Commission strengthen such measures.

The Commission should also be aware that increased harvests on small yellowfin tuna has had negative consequences to both long-term sustainable yield and stock status (**YFT-Figure 14**), and that continued increases in the harvest of small yellowfin tuna will continue to reduce the long-term sustainable yield the stock can produce. Should the Commission wish to increase long-term sustainable yield, the Committee continues to recommend that effective measures be found to reduce fishing mortality on small yellowfin tuna (e.g., FOB-related and other fishing mortality of small yellowfin tuna).

ATLANTIC YELLOWFIN TUNA SUMMARY

Estimates	Mean (90% confidence intervals)
Maximum Sustainable Yield (MSY)	121,298 t (90,428 - 267,350 t)[1]
2022 Yield	148,211 t
Relative Biomass[2]: B_{2018}/B_{MSY}	1.17 (0.75 - 1.62)
Relative Fishing Mortality: F_{2018}/F_{MSY}	0.96 (0.56 - 1.50)

2018 Total Biomass[3]		729,436 t
Stock Status (2018)	Overfished: No[4] Overfishing: No[5]	

(Rec. 17-01, Rec. 22-01)

- No fishing with natural or artificial floating objects from 1 January to 13 March 2023, throughout the Convention area. Prohibition of drifting FADs during a period of 15 days prior to the start of the closure period
- TAC of 110,000 t (since Rec. 11-01)
- Specific authorization to fish for tropical tunas for vessels 20 meters or greater
- Prohibition of discarding from purse seine
- Specific limits on FADs, non-entangling FADs required

[1] Minimum and maximum values of 90%LCI and 90%UCI among all runs by the SS, JABBA, and MPB
[2] SSB (Stock Synthesis) or exploited biomass (production models)
[3] Mean of the central estimates of the SS, JABBA and MPB models
[4] (24% probability of overfished status)
[5] (43% probability of overfishing taking place)

YFT-Table 1. Estimated catches (t) of yellowfin (*Thunnus albacares*) by area, gear and flag.

			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	2020	2021	2022
TOTAL			163561	173185	154725	149206	137304	144561	134817	132453	153101	136461	123192	119573	105075	105892	102843	111874	117915	118280	113918	113686	106333	115024	130699	151385	137519	136530	136875	154547	119454	148211
	ATE		124725	124849	119431	116151	104363	113615	103601	96825	112772	106797	98205	88267	75559	77614	78667	93744	99135	97251	94678	91176	82445	89880	102473	114124	98841	102632	107952	124415	92260	114004
	ATW		38836	48336	35294	33056	32941	30946	31217	35628	40329	29665	24987	31305	29516	28278	24176	18130	18780	21029	19239	22510	23888	25144	28226	37262	38678	33898	28922	30131	27194	34207
Landings	ATE	Bait boat	18297	15496	13390	11250	12529	14080	16444	9830	13950	11398	9956	14511	9540	12492	12795	9457	8750	9305	12219	9029	6748	9352	9173	9862	7785	7274	6814	6354	5435	6499
		Longline	9079	14876	13935	14493	10740	13872	13063	11588	7576	5864	9183	11537	7206	7234	13437	8562	7443	5161	6298	5337	5657	4742	4343	4860	4583	5025	6132	4519	3962	5320
		Other surf.	1570	1817	1839	1839	1879	1752	1581	2437	2021	1714	2467	2886	2350	2988	2129	1595	1844	1752	1264	2040	3032	1702	1774	2651	2550	1803	3469	5886	3491	4530
	ATE	Purse seine	92332	89601	87759	87755	77720	82423	70730	70920	88838	87499	75294	57798	55409	54153	49471	73122	79675	79164	71875	72897	65676	72682	85146	94245	82477	86950	89919	105905	78541	96158
	ATW	Bait boat	6383	7094	5297	4560	4275	5511	5364	6753	5572	6009	3764	4868	3867	2695	2304	886	1331	1436	2311	1299	1602	520	810	1238	925	742	862	826	1028	2067
		Longline	13675	12626	11560	12605	11896	12426	14259	16168	15699	11926	10167	18166	18171	15469	16106	13780	14654	14888	11977	13005	10067	9059	10027	13129	11710	11236	11512	11591	9898	10935
		Other surf.	2606	5465	4907	5107	4459	3826	4900	4838	5107	3763	6445	5004	4826	5667	3418	1392	1417	1975	2686	4432	8181	12431	14293	16881	20493	17550	13288	14615	15238	19706
	ATW	Purse seine	16172	23151	13530	10784	12310	9184	6527	7870	13951	7966	4611	3266	2652	4442	2341	2067	1370	2722	2256	3768	4035	3131	3037	5948	5499	4331	3224	3053	1011	1479
Landings(FP)	ATE	Bait boat	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	5
		Purse seine	3447	3059	2509	813	1495	1488	1781	2051	387	321	1305	1534	1054	747	836	1008	1423	1869	3021	1872	1332	1401	1901	2506	1384	1533	1596	1725	803	1459
	ATW	Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	63	49	35	32	28	0	
Discards	ATE	Bait boat	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	0
		Longline	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	6	5	7	10	7
		Other surf.	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	
		Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	137	0	63	40	17	20	19	25
	ATW	Longline	0	0	0	0	0	0	167	0	0	0	0	0	0	5	6	5	9	8	9	7	3	3	3	3	3	5	4	18	18	20
		Other surf.	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	
		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	0	0	0	0	0	0	
Landings	ATE CP	Angola	211	137	216	78	70	115	170	35	34	34	34	34	0	0	23	98	0	0	0	0	0	0	0	0	2	3	0	1	8	16
		Belize	0	0	1	0	3	963	0	326	406	0	0	0	0	0	0	0	405	1794	3172	5861	5207	7036	7132	3497	5811	8121	9152	8688	7571	9036
		Brazil	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	194
		Canada	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	**0**
		Cape Verde	1612	1943	1908	1518	1783	1421	1663	1851	1684	1953	1868	3236	6019	5648	4568	7905	4638	5856	6002	4603	7513	4507	7823	6990	2756	5498	3699	6239	2043	952
		China PR	139	156	200	124	84	71	1535	1652	586	262	1033	1030	1112	1056	1000	365	214	169	220	170	130	20	78	286	346	188	163	81	32	140
		Curaçao	0	0	0	3183	6082	6110	4039	5646	4945	4619	6667	4747	24	1939	1368	7351	6293	5302	4413	6792	3727	5152	6140	7905	6535	7543	7751	8986	7700	3027
		Côte d'Ivoire	0	0	0	0	2	0	0	673	213	99	302	565	175	482	216	626	573	470	385	1481	2077	324	251	315	952	116	2649	4460	2117	3336
		EU-Denmark	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-España	40403	40612	38278	34879	24550	31337	19947	24681	31105	31469	24884	21414	11795	11606	13584	24409	32793	25560	21026	18854	11878	14225	21094	19266	12308	10669	14457	19418	9885	11207
		EU-Estonia	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	**0**
		EU-France	36087	34793	29594	33838	29351	30760	29900	29923	31861	34444	33035	23913	22662	18940	13733	16115	18927	20342	22037	18506	20258	22533	20451	26085	25831	24581	17745	15867	12454	16606
		EU-Ireland	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-Italy	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	**0**
		EU-Latvia	16	0	55	151	223	97	25	36	72	334	334	334	334	334	0	0	0	200	143	15	0	0	23	0	0	0	0	0	0	**0**
		EU-Lithuania	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	**0**
		EU-Malta	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	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	**0**
		EU-Portugal	128	126	231	288	176	267	177	194	4	6	4	5	16	274	865	300	990	537	452	355	335	69	76	112	67	133	125	127	19	126
		El Salvador	0	0	0	0	0	0	0	0	933	0	0	0	0	0	0	0	0	0	0	0	0	0	2750	8252	6227	5553	3959	8694	6337	6175
		Gabon	12	88	218	225	225	295	225	162	270	245	44	6	2	44	0	1	0	0	0	0	0	0	0	1	3	0	0	0	0	**0**
		Gambia	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	1	0	
		Ghana	13283	9984	9268	8182	15087	13850	21450	12673	23845	18546	15839	15444	13019	14037	15570	16521	15858	20252	18501	15994	13552	18426	18896	19582	18969	21970	24099	24599	20111	29550
		Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	21	22	1	0	0	0	0	0	0	0	0	**0**
		Guatemala	0	0	0	0	0	0	0	0	0	0	2207	1588	2906	5265	3461	3736	2603	3124	2803	2949	4023	3754	5200	2703	3647	2499	2944	2581	1841	4228
		Guinea Ecuatorial	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	892	892	199	0	2	11	9	6	0	8	10	8	7	4
		Guinée Rep	0	0	208	1956	820	0	0	0	0	0	0	0	0	0	0	0	0	298	292	1559	1484	823	0	0	0	0	0	0	322	1327
		Honduras	0	0	4	3	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Japan	2627	4194	4770	4246	2733	4092	2101	2286	1550	1534	1999	5066	3088	4206	8496	5266	3563	3041	3348	3637	3843	3358	2857	2914	2708	2946	3395	2349	2727	3592
		Korea Rep	169	436	453	297	101	23	94	142	3	8	209	984	95	4	303	983	381	324	20	26	97	77	36	356	408	449	507	563	249	390
		Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	71	89	100	88	76	88	1	6	1731	10	0
		Libya	0	0	0	0	0	0	0	0	208	73	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Maroc	2396	3017	2290	3430	1947	2276	2307	2441	3000	2111	1675	814	1940	222	102	110	110	44	272	55	137	107	72	115	113	108	228	344	493	640
		Mauritania	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	**0**
		Namibia	0	35	14	72	69	3	147	59	165	89	139	85	135	59	28	11	1	9	90	24	6	15	42	53	53	424	82	327	256	356
		Nigeria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	3	1	0	0	0	0	0	0	0	0	0	**0**
		Norway	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	**0**
		Panama	10973	12066	13442	7713	4293	2111	1315	1322	626	1112	0	1887	6170	8557	9363	6175	5982	5048	4358	5004	3899	4587	3202	4305	5073	4071	5863	8187	8346	10835
		Philippines	0	0	0	0	0	126	173	86	0	50	9	68	13	30	88	53	152	89	134	5	56	0	0	0	0	0	0	0	0	**0**
		Russian Federation	2160	1503	2936	2696	4275	4931	4359	737	0	0	0	0	4	42	211	42	33	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		S Tomé e Príncipe	181	125	135	120	109	124	114	122	122	122	122	134	145	137	144	160	165	169	173	177	182	186	301	301	266	3	17	13	15	24
		Senegal	15	1	94	77	152	248	663	194	279	558	253	589	1106	1347	1071	720	1146	939	1235	1875	1081	603	1883	6850	3988	5029	8161	8177	8228	9407

			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	2020	2021	2022
		South Africa	266	486	199	157	116	261	320	191	342	152	298	402	1156	1187	1063	351	303	235	673	174	440	1512	925	706	387	389	551	700	398	1018
		St Vincent and Grenadines	5391	2476	2142	2981	3146	3355	2170	2113	3715	189	56	14	0	101	209	83	74	28	0	0	0	0	0	0	71	0	0	0	0	**0**
		UK-Sta Helena	171	150	181	151	109	181	116	136	72	90	158	226	240	344	177	97	104	65	163	149	53	152	178	181	221	199	310	87	79	67
		USA	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	**0**
		USSR	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	**0**
		Uruguay	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Venezuela	0	0	0	0	0	0	0	0	0	3612	245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	NCC	Chinese Taipei	1301	3851	2681	3985	2993	3643	3389	4014	2787	3363	4946	4145	2327	860	1707	807	1180	537	1463	818	1023	902	927	761	563	550	464	437	180	253
	NCO	Benin	1	1	1	1	3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cambodia	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cayman 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	
		Congo	17	14	13	12	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	541	238	212	257	269	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Faroe Islands	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Georgia	10	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)	388	477	1847	0	148	0	0	0	1510	1345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NEI (Flag related)	1157	2524	2975	3588	3368	5464	5182	3072	2019	43	466	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	6	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Ukraine	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	
		Vanuatu	1624	2357	2357	1130	576	0	228	0	0	0	0	0	24	145	483	450	331	23	10	124	21	0	0	0	0	0	0	0	0	
ATW	CP	Barbados	161	156	255	160	149	150	155	155	142	115	178	211	292	197	154	156	79	129	131	195	188	218	262	324	270	248	121	173	212	202
		Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	143	1164	1160	940	264	42	41	38	33	0	2163	359	623	955	653	625	1082
		Brazil	5131	4169	4021	2767	2705	2514	4127	6145	6239	6172	3503	6985	7223	3790	5468	2749	3313	3677	3615	4639	7277	11645	13643	16682	18362	16381	12907	13183	13664	15522
		Canada	71	52	174	155	100	57	22	105	125	70	73	304	240	293	276	168	53	166	50	93	74	34	59	19	193	15	108	75	110	198
		Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0	81	86	0	21	0	**0**
		China PR	0	0	0	0	0	628	655	22	470	435	17	275	74	29	124	284	248	258	126	94	81	73	91	182	232	172	158	380	108	388
		Curaçao	170	155	140	130	130	130	130	130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	127	107	126	72	22	96	28	95
		EU-España	989	7	4	36	34	46	30	171	0	0	0	0	0	1	84	81	69	27	33	32	138	155	105	360	357	239	299	200	317	156
		EU-France	91	121	20	0	600	27	4	0	9	0	4	49	18	0	0	0	122	456	712	412	389	690	641	403	346	488	864	1222	808	634
		EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	151	60	88	179	260	115	127	92	4	2	0	15	70	505	131	3	3	8
		El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	381	91	21	18	119	0	64
		FR-St Pierre et Miquelon	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	**0**
		Ghana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	476	369	513	763	636	1429	2376	2144	1836	0	**0**
		Grenada	858	385	410	523	302	484	430	403	759	593	749	460	492	502	633	756	630	673	0	0	0	0	1167	1607	1257	1391	818	784	287	630
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	71	40	13	14	15	9
		Japan	469	589	457	1004	806	1081	1304	1775	1141	571	755	1194	1159	437	541	986	1431	1539	1106	1024	734	465	612	462	415	147	655	306	684	582
		Korea Rep	11	0	0	84	156	0	0	0	0	0	0	0	580	279	270	10	52	56	470	472	115	39	11	12	3	6	0	16	123	91
		Mexico	855	1093	1126	771	826	788	1283	1390	1084	1133	1313	1208	1050	938	890	956	1211	916	1174	1414	1004	1045	968	1279	1241	1028	760	817	881	606
		Panama	0	0	0	0	0	0	5	0	20	28	0	0	0	2804	227	153	119	2134	1126	1630	1995	902	1580	1863	1620	2104	2382	2189	1304	1125
		Philippines	0	0	0	0	0	36	106	78	12	79	145	299	230	234	151	167	0	0	0	30	72	76	0	0	0	0	0	0	0	**0**
		St Vincent and Grenadines	65	16	43	37	35	48	687	1989	1365	1165	568	4251	3430	2680	2989	2547	2274	854	963	551	352	505	153	434	701	373	105	226	3	106
		Trinidad and Tobago	4	120	79	183	223	213	163	112	122	125	186	224	295	459	615	520	629	788	799	931	1128	1141	1179	1057	890	1214	982	973	1244	1080
		UK-Bermuda	58	44	44	67	55	53	59	31	37	48	47	82	61	31	30	15	41	37	100	66	36	12	10	9	25	32	50	52	74	61
		UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	3	10	5	0	0	0	0	0	6	5
		UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6	2	0	0	0	0	0	0	0	**0**
		USA	6283	8298	8131	7745	7674	5621	7567	7051	6703	5710	7695	6516	5568	7091	5529	2473	2788	2679	3315	4777	4177	3184	2798	4104	4444	2720	2625	3648	3948	7732
		Uruguay	20	59	53	171	53	88	45	45	91	91	95	204	644	218	35	66	76	122	24	6	7	0	0	0	0	0	0	0	0	**0**
		Venezuela	16663	24789	9714	13772	14671	13995	11187	11663	18687	11421	7411	5792	5097	6514	3911	3272	3198	4783	4419	4837	5050	3772	3127	4204	5059	2743	2029	1931	1973	3167
	NCC	Chinese Taipei	2895	2809	2017	2668	1473	1685	1022	1647	2018	1296	1540	1679	1269	400	240	315	211	287	305	252	236	139	293	181	213	395	272	433	288	416
		Costa Rica	0	0	0	0	0	0	6	5	4	0	1	1	0	7	9	7	4	6	14	15	32	120	117	139	183	114	74	117	150	54
		Guyana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	183	181	3	43	116	164	**0**
	NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	327	327	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	
		Colombia	2404	3418	7172	238	46	46	46	46	46	46	46	46	46	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cuba	1	14	54	40	40	15	15	0	0	65	65	65	65	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Dominica	30	31	9	0	0	0	80	78	120	169	119	81	119	65	103	124	102	110	132	119	120	256	194	179	145	110	179	307	0	
		Dominican Republic	0	0	0	0	0	89	220	226	226	226	226	226	226	226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Jamaica	0	0	0	21	21	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)	1514	1880	1227	2374	2732	2875	1578	2197	765	14	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	29	13	0	6	0	
		Seychelles	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Sta Lucia	92	130	144	110	110	276	123	134	145	94	139	147	172	103	82	106	97	223	114	98	136	93	175	191	232	199	172	190	156	174
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	681	689	661	555	873	816	720	330	207	124	17	0	0	0	0	0	0	0	
Landings(FP)	ATE CP	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	50	71	27	109	35	0	0	0	0	0	0	0	**0**
		Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	77	28	39	40	103	152	58	35	82	256	267	174	50	66	60	67	0	**0**

				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	2020	2021	2022
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	15	25	22	16	176	95	89	114	86	78	0	0	0	0	0	0	67	0
			Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	267	116	24	0	0	0	0	0	0	0	0
			EU-España	1149	910	559	87	384	494	733	714	0	0	335	368	142	154	67	270	279	352	358	140	146	353	511	547	418	276	342	269	260	312
			EU-France	1554	1461	1074	472	658	703	832	914	344	309	672	597	244	128	33	52	203	181	344	347	129	115	332	349	158	293	290	291	388	990
			El Salvador	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	83
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	57	35	17	32	9	34	8	12	13	19	0	0	0	0	0	0	27	26
			Guinée Rep	0	0	0	0	0	0	0	0	0	0	0	0	72	0	66	20	67	95	389	876	487	461	0	0	0	0	0	0	0	0
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	155	125	177	114	99	54	101	54	163	59	0	0	0	0	0	0	62	53
			St Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCO	Mixed flags (EU tropical)	744	688	876	254	452	291	216	423	42	13	298	570	292	251	416	464	467	857	1601	0	0	0	791	1436	757	898	903	1098	0	
	ATW	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	5	5	5	7	0	3	0	0
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	24	21	9	24	7	0	0
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3	3	0	0	0
		NCO	Mixed flags (EU tropical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	32	19	15	6	18	0	
Discards	ATE	CP	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	137	0	63	40	17	20	19	25
			EU-Portugal	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	0
			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	6	5	7	10	7
			Korea Rep	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	0
			South Africa	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	0
			UK-Sta Helena	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	0
		NCC	Chinese Taipei	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	0	0	0	0
	ATW	CP	Canada	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	0
			EU-France	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	0
			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	0	0	0
			Korea Rep	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	0
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	5	9	8	9	7	3	3	3	3	3	5	3	4	5	3
			UK-Bermuda	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	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	0
			USA	0	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	13	17
		NCC	Chinese Taipei	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	0

YFT-Table 2. Estimated probabilities of biomass the Atlantic YFT stock levels < 20% of B_{MSY} in the combined projections of JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1-4) in a given year for a given catch level (0, 60,000 – 150,000 t). This result was used to develop the management advice of Atlantic YFT stock.

TAC	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
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%
60000	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%
70000	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%
80000	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
90000	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%
100000	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%	0.3%	0.3%	0.4%	0.4%	0.5%	0.5%	0.6%	0.6%
110000	0.0%	0.0%	0.1%	0.1%	0.2%	0.4%	0.6%	0.7%	0.8%	0.9%	1.0%	1.2%	1.4%	1.5%
120000	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	1.0%	1.2%	1.5%	1.8%	2.1%	2.4%	2.6%	2.9%
130000	0.0%	0.1%	0.2%	0.5%	0.8%	1.2%	1.6%	2.1%	2.6%	3.0%	3.5%	3.9%	4.3%	4.7%
140000	0.0%	0.1%	0.3%	0.7%	1.2%	1.8%	2.6%	3.2%	4.0%	4.8%	10.4%	12.2%	12.9%	13.4%
150000	0.0%	0.1%	0.3%	1.0%	1.7%	2.7%	3.7%	4.8%	11.9%	12.7%	15.9%	21.3%	22.1%	23.3%

YFT-Table 3. Estimated probabilities of the Atlantic YFT stock (a) being below F_{MSY} (overfishing not occurring), (b) above B_{MSY} (not overfished) and (c) above B_{MSY} and below F_{MSY} (green zone) in a given year for a given catch level (0, 60,000 – 150,000 t), based upon the combined projections of JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1-4). This result was used to develop the management advice of Atlantic YFT stock.

a) Probability that $F \leq F_{MSY}$.

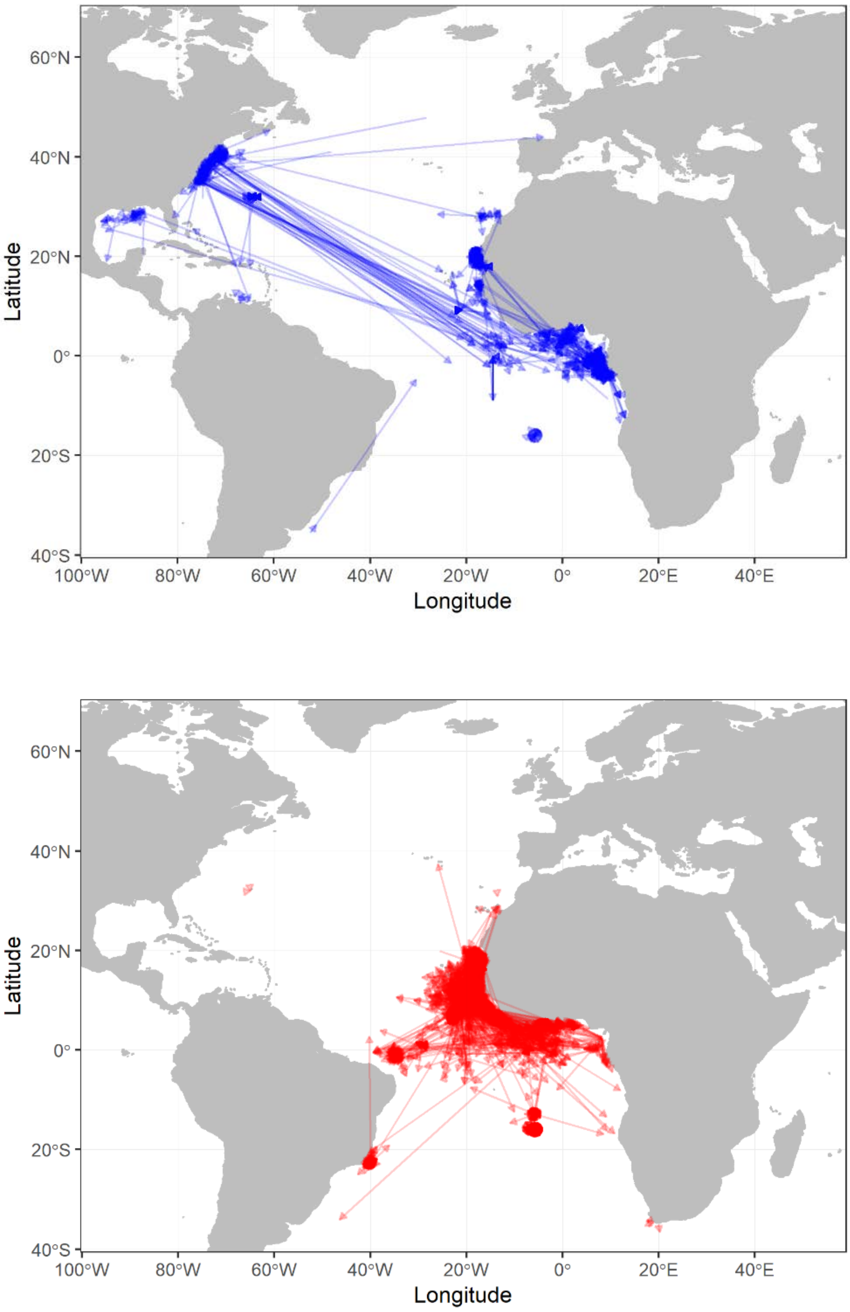
TAC | Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	100	100	100	100	100	100	100	100	100	100	100	100	100	100
60000	99	99	100	100	100	100	100	100	100	100	100	100	100	100
70000	98	99	99	99	100	100	100	100	100	100	100	100	100	100
80000	96	97	98	98	99	99	99	99	99	100	100	100	100	100
90000	93	95	96	97	97	98	98	98	98	99	99	99	99	99
100000	88	90	92	93	94	95	95	95	96	96	97	97	97	97
110000	81	84	85	86	87	87	88	88	89	90	90	90	90	90
120000	71	72	72	73	73	74	74	74	74	74	70	70	70	70
130000	60	59	58	56	55	53	50	49	47	46	46	45	39	39
140000	48	46	43	39	36	32	30	26	24	23	22	21	21	19
150000	39	35	30	25	22	17	15	13	13	12	11	10	10	8

b) Probability that $B \geq B_{MSY}$.

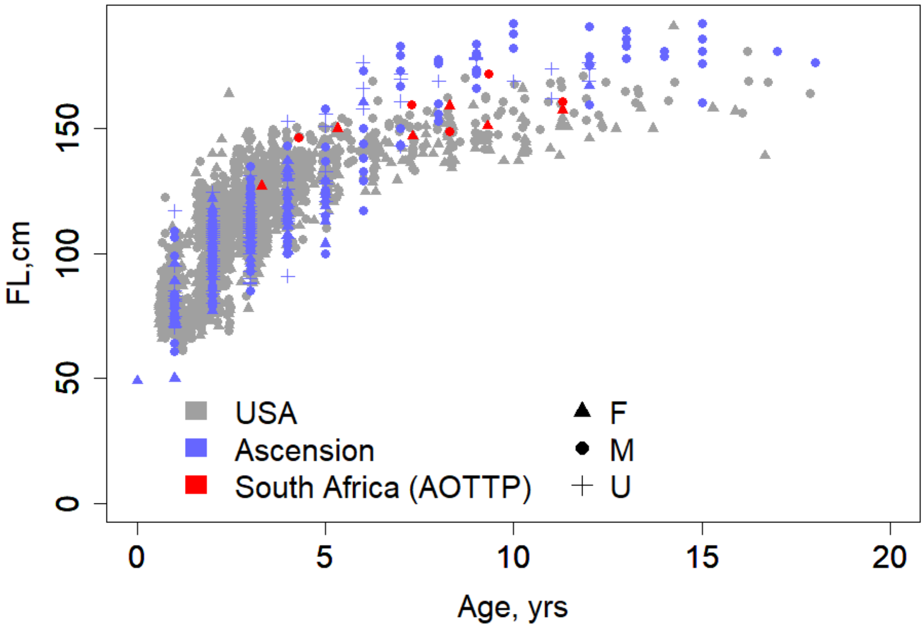
TAC | Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	64	84	95	99	100	100	100	100	100	100	100	100	100	100
60000	64	75	85	92	96	97	98	99	99	99	100	100	100	100
70000	64	74	83	90	94	96	97	98	98	99	99	99	100	100
80000	64	72	79	86	91	94	96	97	97	98	98	99	99	99
90000	64	70	77	82	87	90	92	94	95	96	97	97	98	98
100000	64	68	73	78	82	85	87	89	91	92	93	94	94	95
110000	64	67	69	72	75	77	79	81	83	84	85	86	86	87
120000	64	65	65	67	68	68	69	70	71	71	68	69	69	69
130000	65	63	62	61	60	59	56	56	55	53	52	51	46	45
140000	64	61	59	56	54	49	46	40	37	34	31	29	27	25
150000	64	60	55	50	45	37	32	27	23	20	18	13	12	8

c) Probability that $F \leq F_{MSY}$ and $B \geq B_{MSY}$.

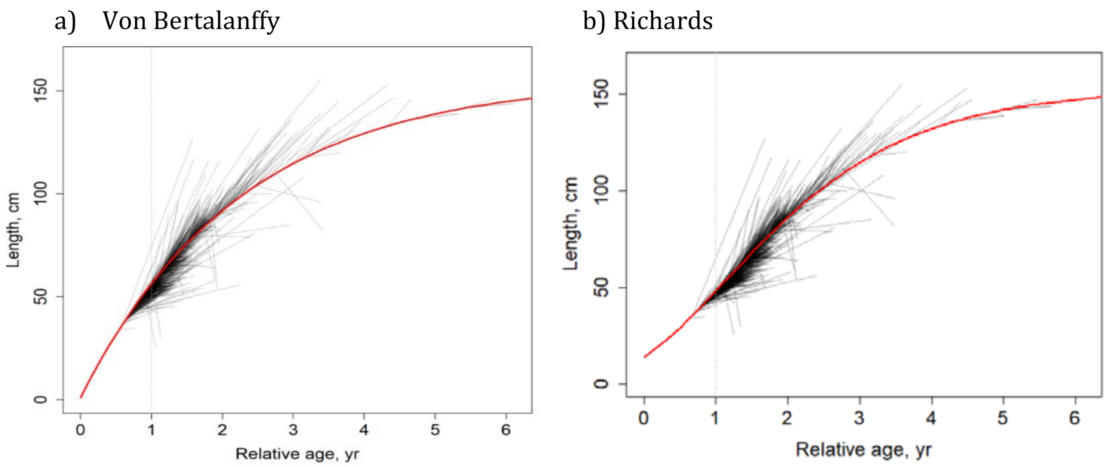
TAC | Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	64	84	95	99	100	100	100	100	100	100	100	100	100	100
60000	64	75	85	92	96	97	98	99	99	99	100	100	100	100
70000	64	74	83	90	94	96	97	98	98	99	99	99	100	100
80000	64	72	79	86	91	94	96	97	97	98	98	99	99	99
90000	64	70	77	82	87	90	92	94	95	96	97	97	98	98
100000	64	68	73	77	82	85	87	89	90	92	93	94	94	95
110000	64	66	69	72	75	77	79	81	82	83	84	85	86	86
120000	63	63	64	65	65	66	66	67	67	68	65	65	66	66
130000	58	57	56	54	52	50	47	46	45	44	43	42	38	38
140000	48	45	42	38	35	31	29	26	24	22	21	20	20	19
150000	39	34	30	25	21	17	15	13	12	12	11	10	9	7



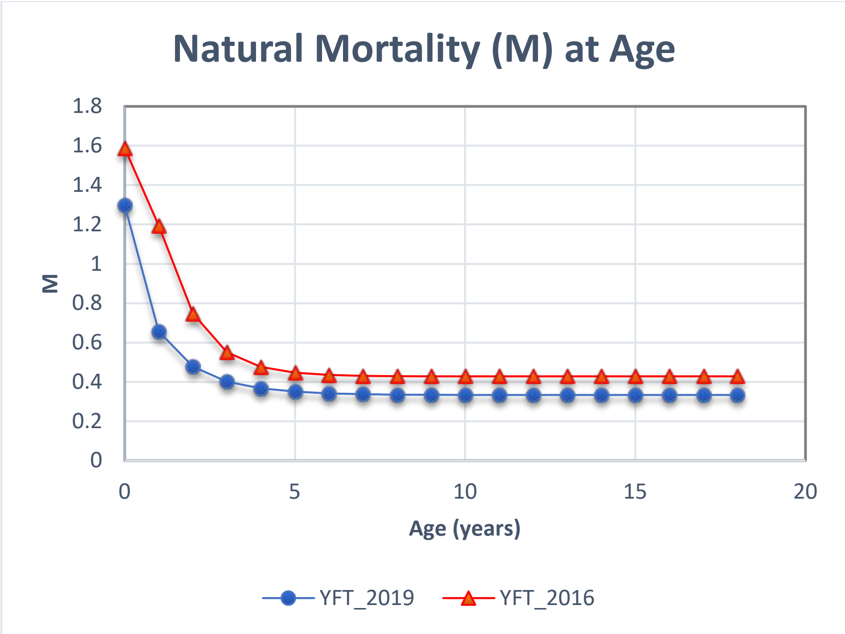
YFT-Figure 1. Apparent movements (straight line distance between the tagging location and that of recovery) calculated from conventional tagging from the historical ICCAT tagging database (top panel) and the current AOTTP activities (bottom panel).



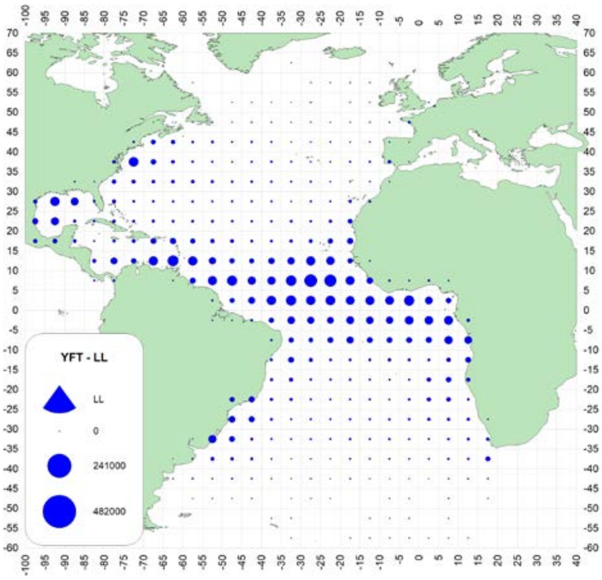
YFT-Figure 2. The size at age of YFT fish sampled off Ascension Island, the USA and South Africa (AOTTP), by gender. Ages of USA and AOTTP samples were assigned based on assumed birthday. No adjustment was made to annulus count for Ascension data.



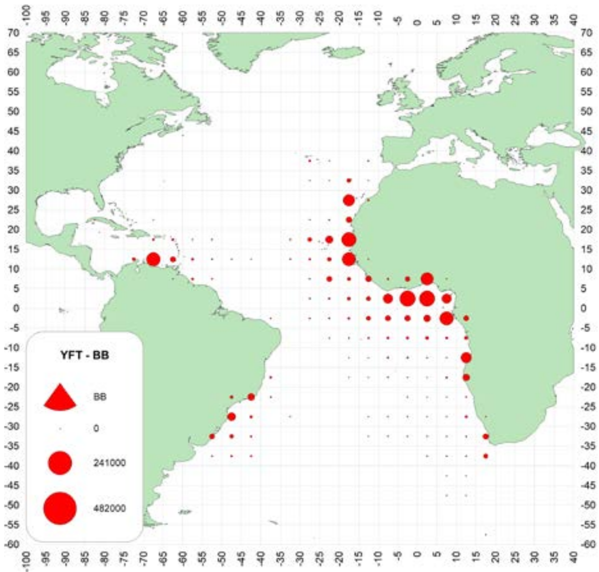
YFT-Figure 3. Vector plot of the growth increments of AOTTP fish measured upon recovery. The relative age of each fish at the time of tagging is estimated from the length at tagging by inverting the von Bertalanffy (left panel) and Richards (right panel) growth equations using parameters estimated by SS. The age at recapture is then taken to be the age at tagging plus the time at liberty. Each growth trajectory (shown in grey) starts on the fitted curve (shown in red).



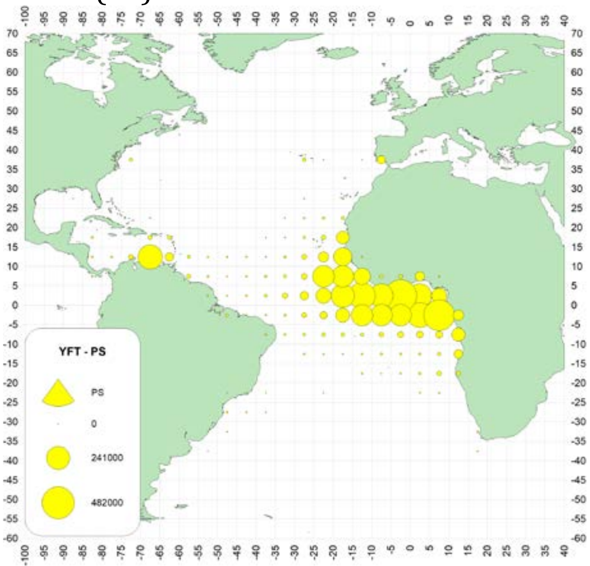
YFT-Figure 4. New information on age and growth supported a Richards growth function, and a change in maximum age from 11 to 18 years which had implications for the estimated (Lorenzen) natural mortality at age which depends on both. The implied 2019 natural mortality based on the t_{MAX} of 18 is 0.35 yr^{-1}, which is lower than the 2016 assessment assumption of 0.54 yr^{-1} based on a t_{MAX} of 11 years.



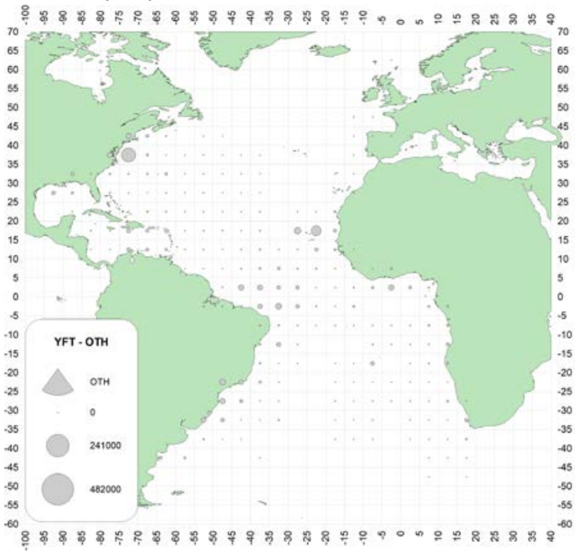
a. YFT (LL)



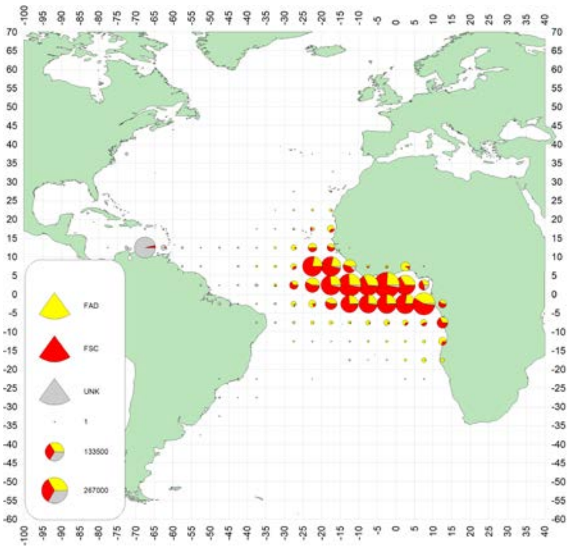
b. YFT (BB)



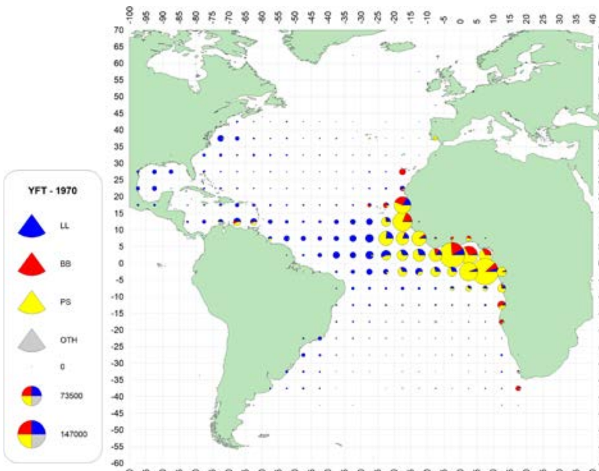
c. YFT (PS)



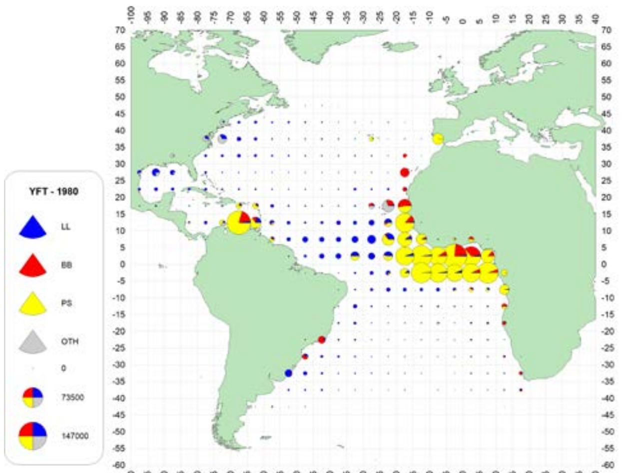
d. YFT (oth)



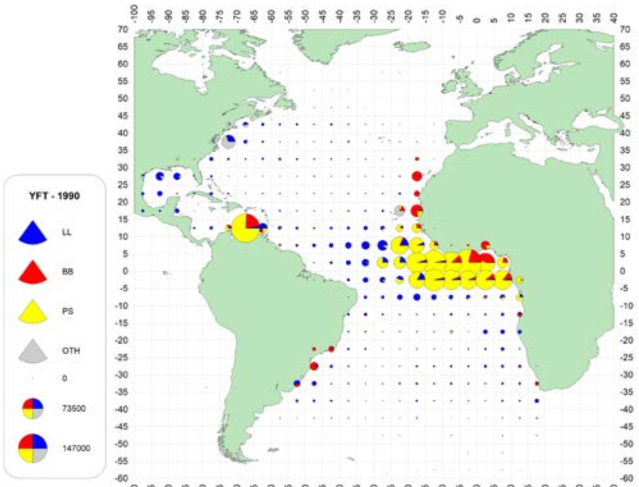
e. YFT (FAD/FREE 1991-2021)



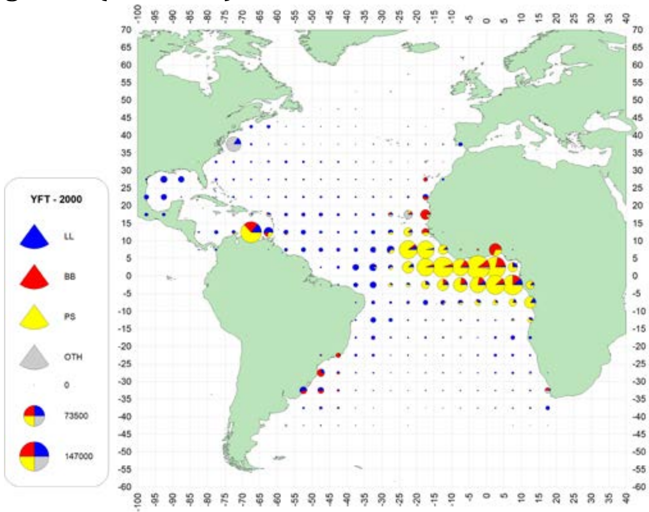
f. YFT (1970-79)



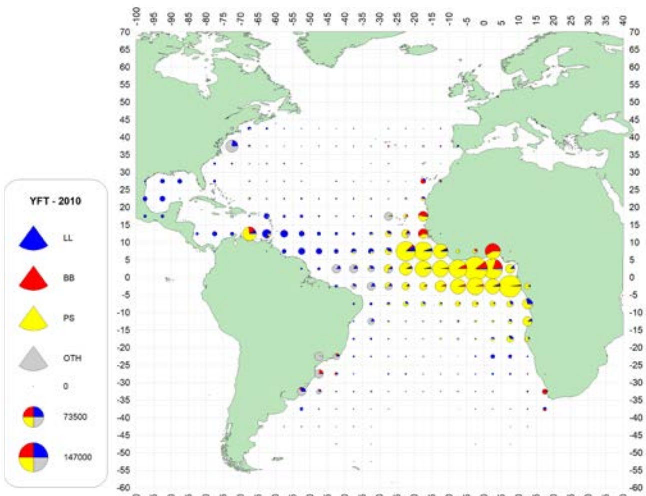
g. YFT (1980-89)



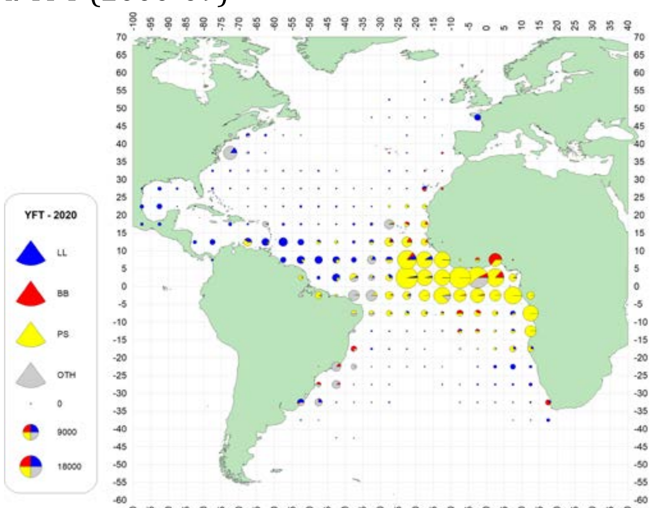
h. YFT (1990-99)



i. YFT (2000-09)

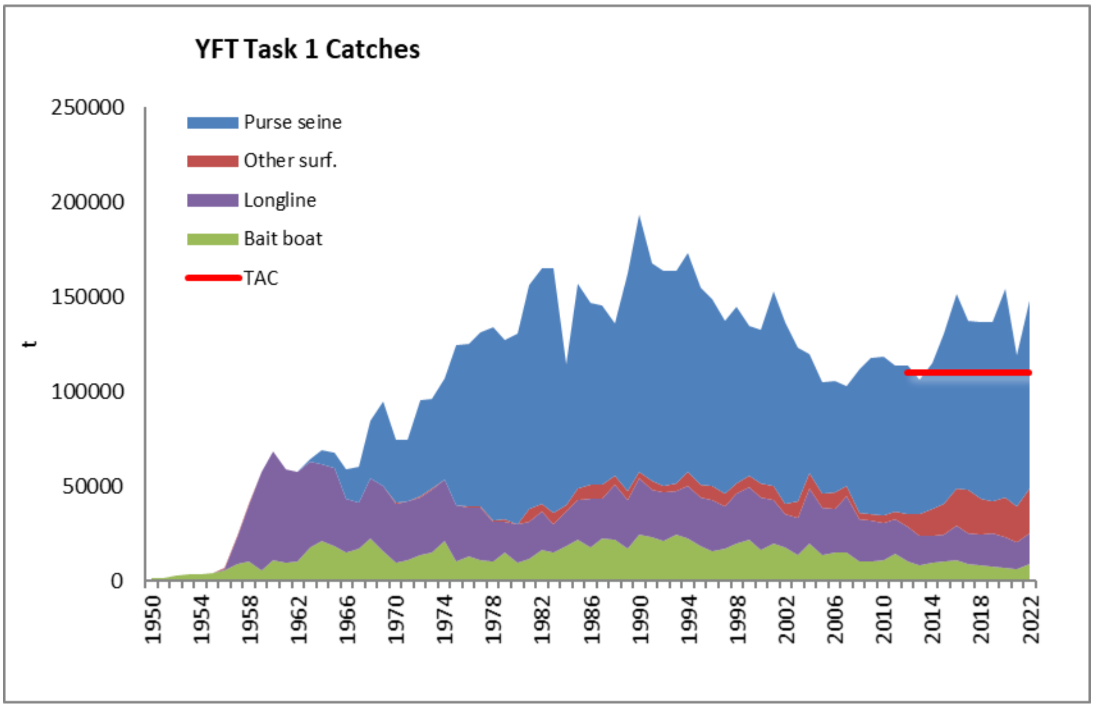


j. YFT (2010-19)

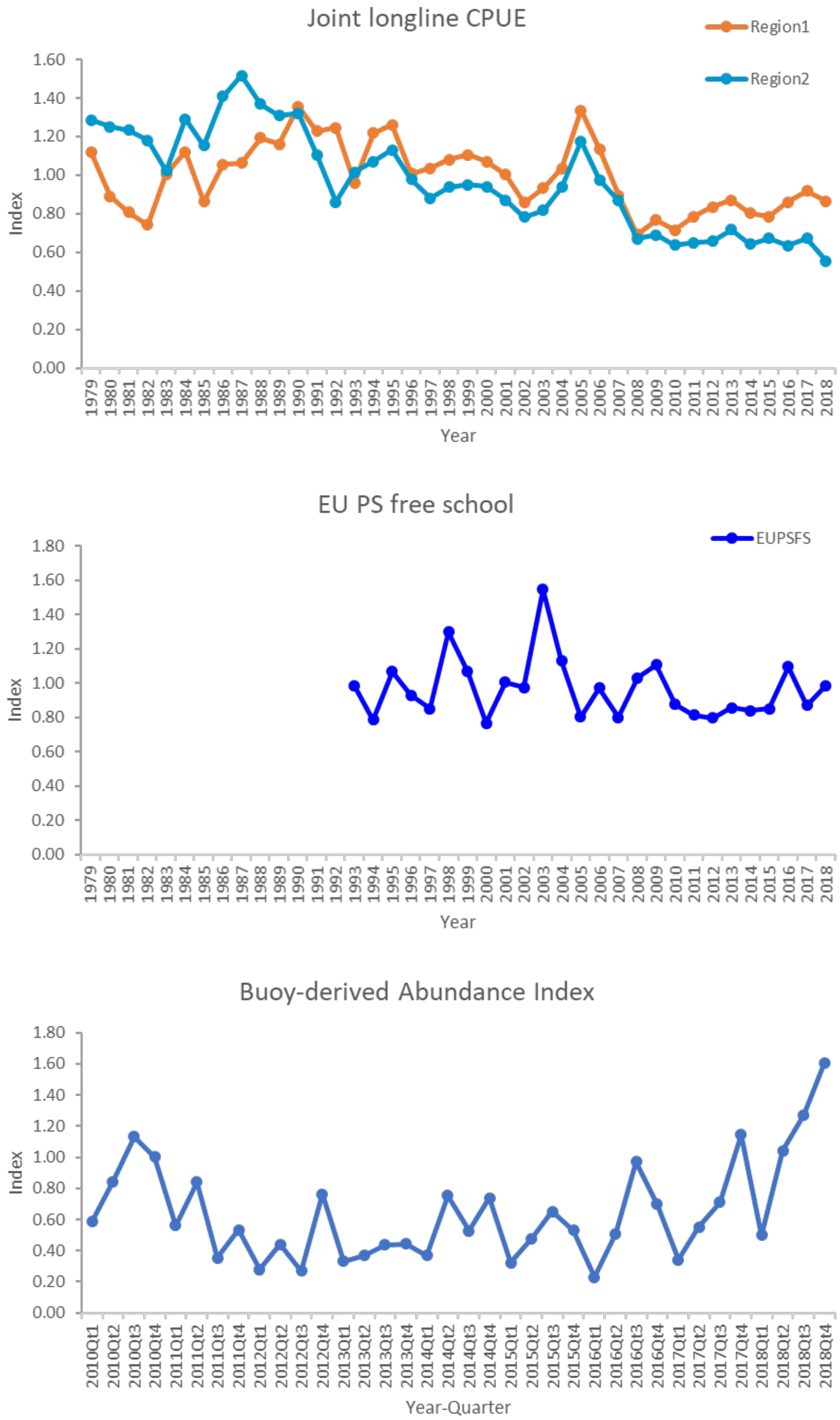


k. YFT (2020-21)

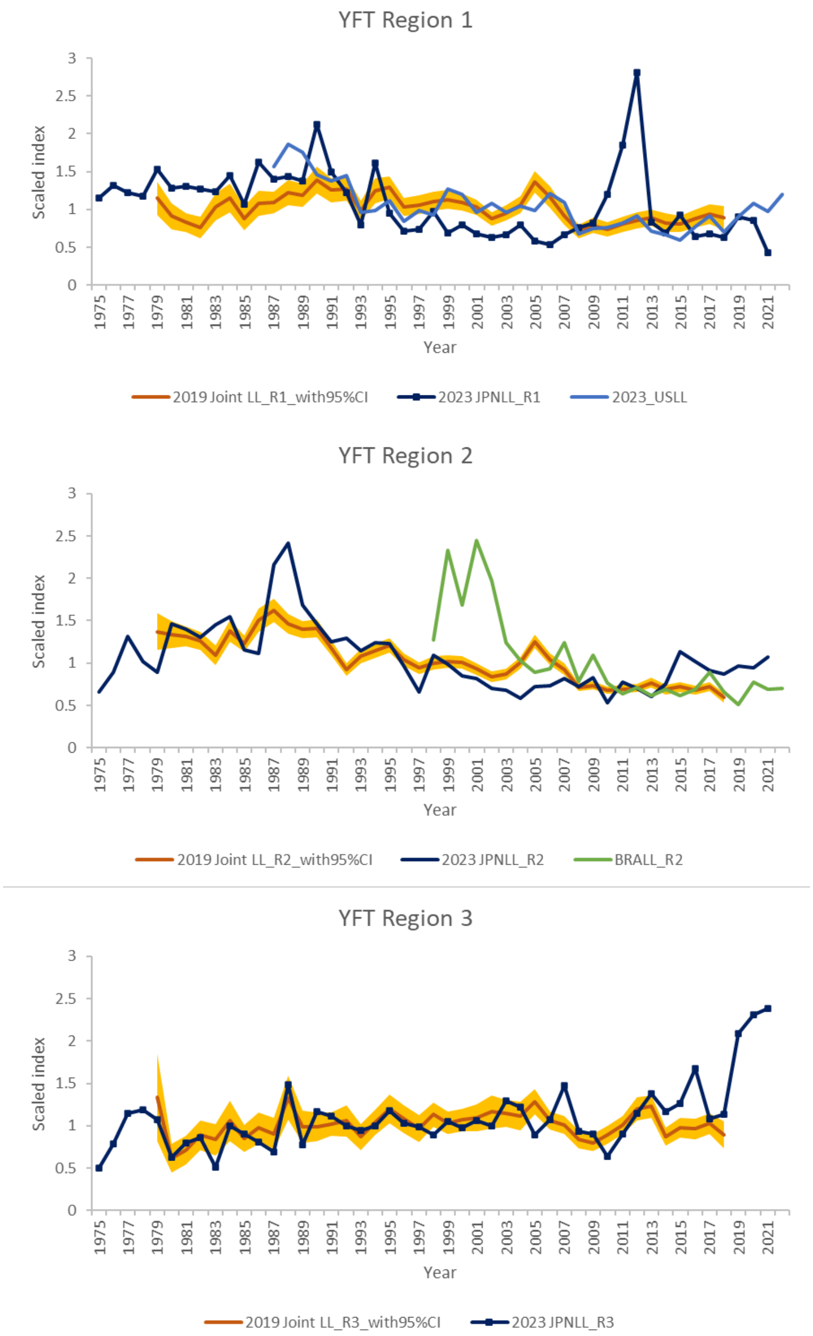
YFT-Figure 5. Geographical distribution of yellowfin tuna total catches by major gears [a-e] and by decade [f-k]. The maps are scaled to the maximum catch observed during 1970-2021. Note: the last panel (k) shows only 2 years of information. Thus, apparent changes in the size of the pie charts (in k) should not be interpreted as a reduction in catch during 2020-2021.



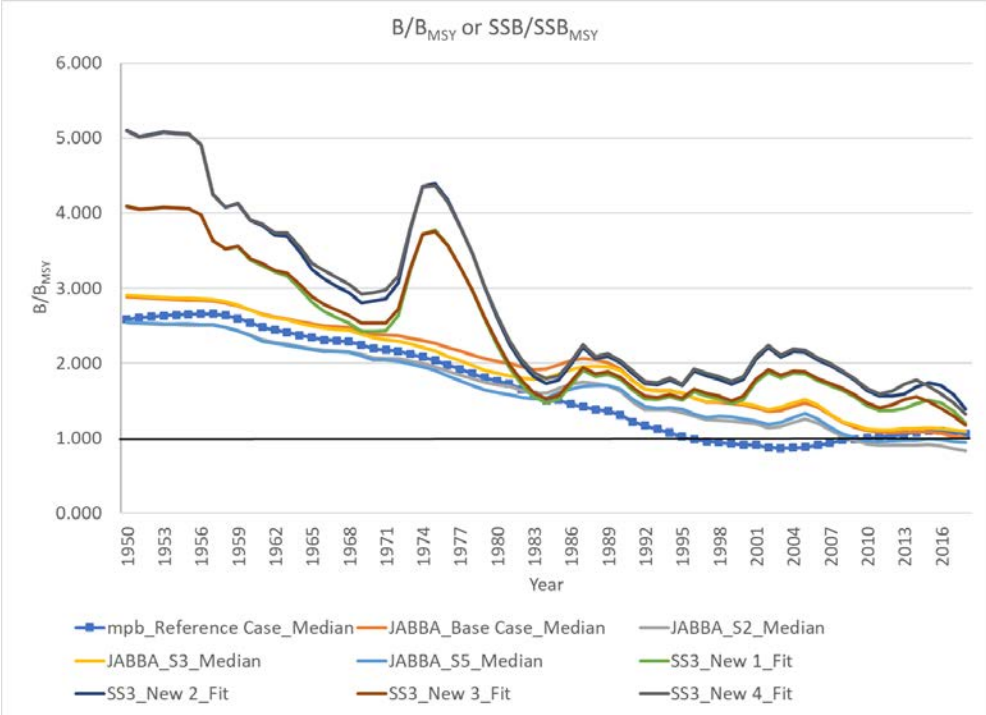
YFT-Figure 6. Yellowfin tuna total catch 1950 – 2022 by main fishing gear group.



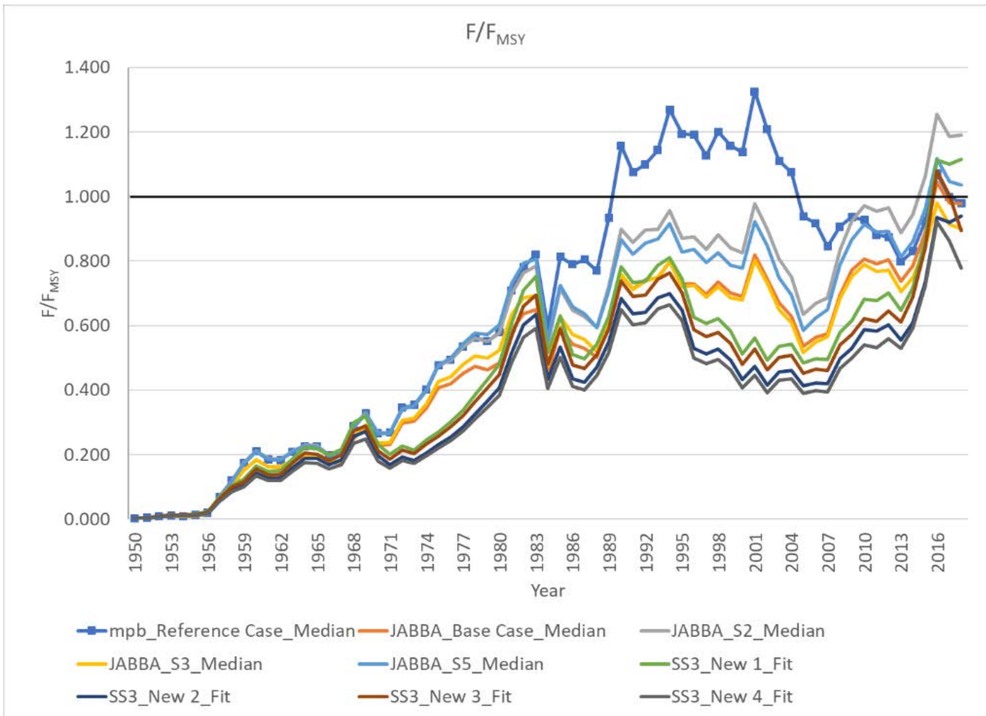
YFT-Figure 7. Annual abundance indices used for the Atlantic yellowfin tuna stock assessment reference cases. Regions 1 and 2 for joint longline mean the area of index that are northern and tropical areas, respectively. Buoy-derived abundance index was used only in Stock Synthesis and joint longline index in region 1 only for JABBA.



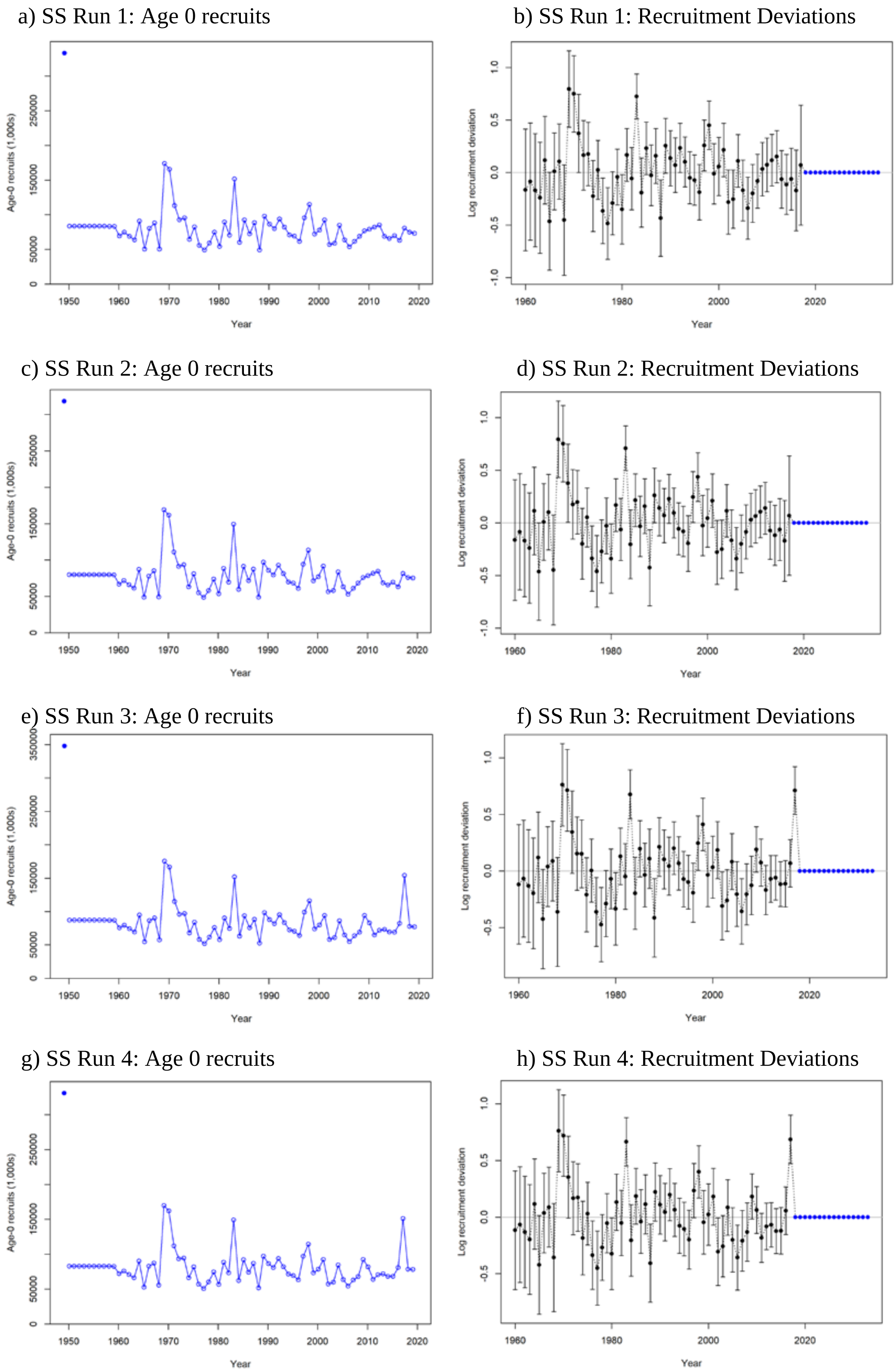
YFT-Figure 8. Comparisons of abundance indices updated in 2023, and the joint longline index used in the2019 stock assessment of Atlantic yellowfin tuna, by region. The Brazilian longline index includes information for both regions 2 and 3.



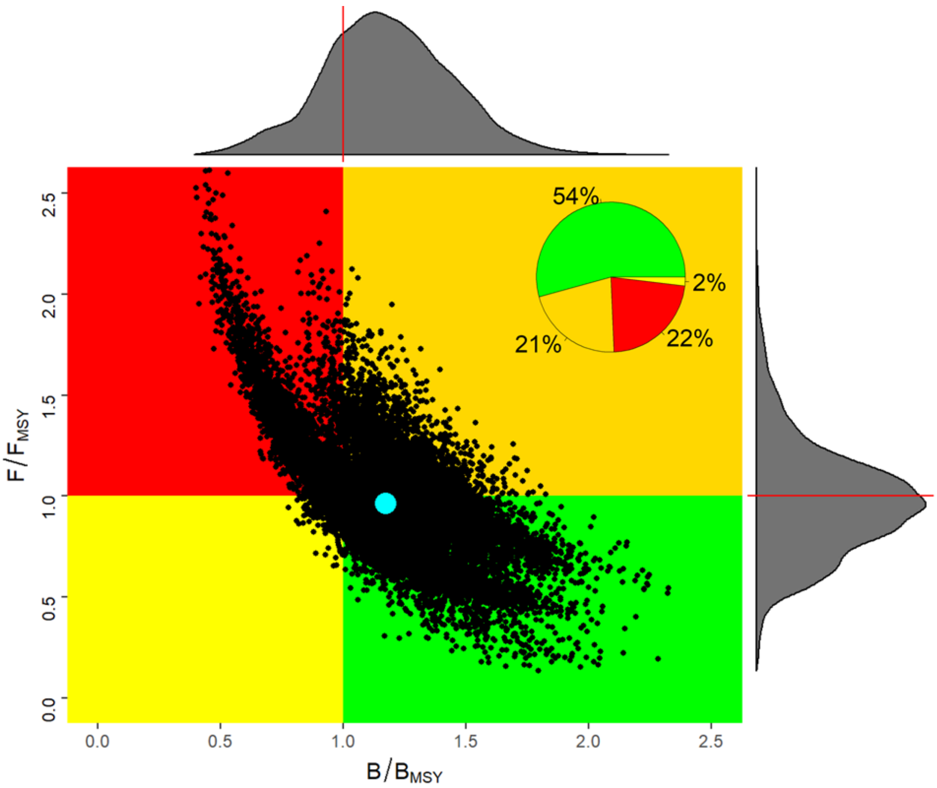
YFT-Figure 9. Estimates of relative biomass (B/B_{MSY}) obtained for all model runs used to develop the management advice.



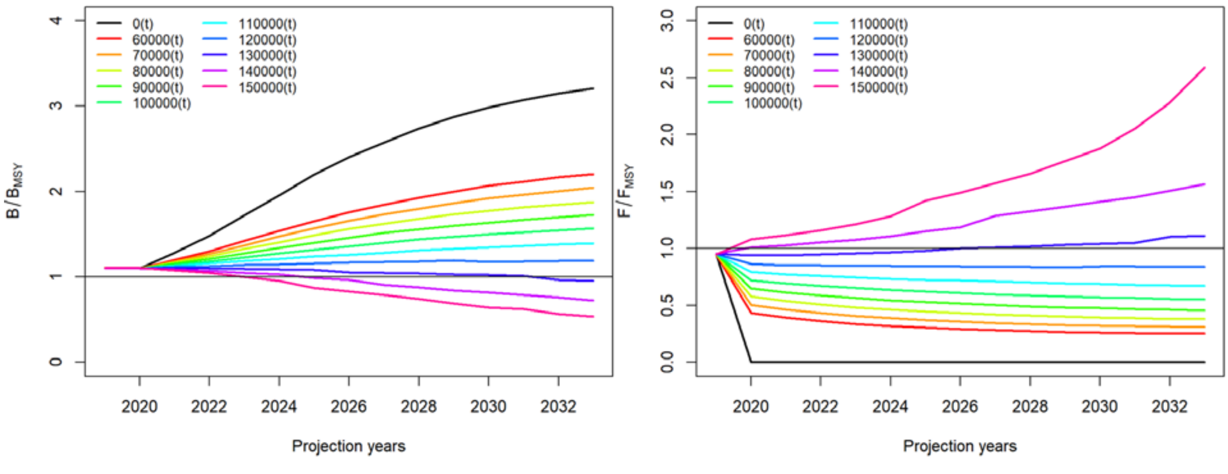
YFT-Figure 10. Estimates of relative fishing mortality (F/F_{MSY}) obtained for all model runs used to develop the management advice.



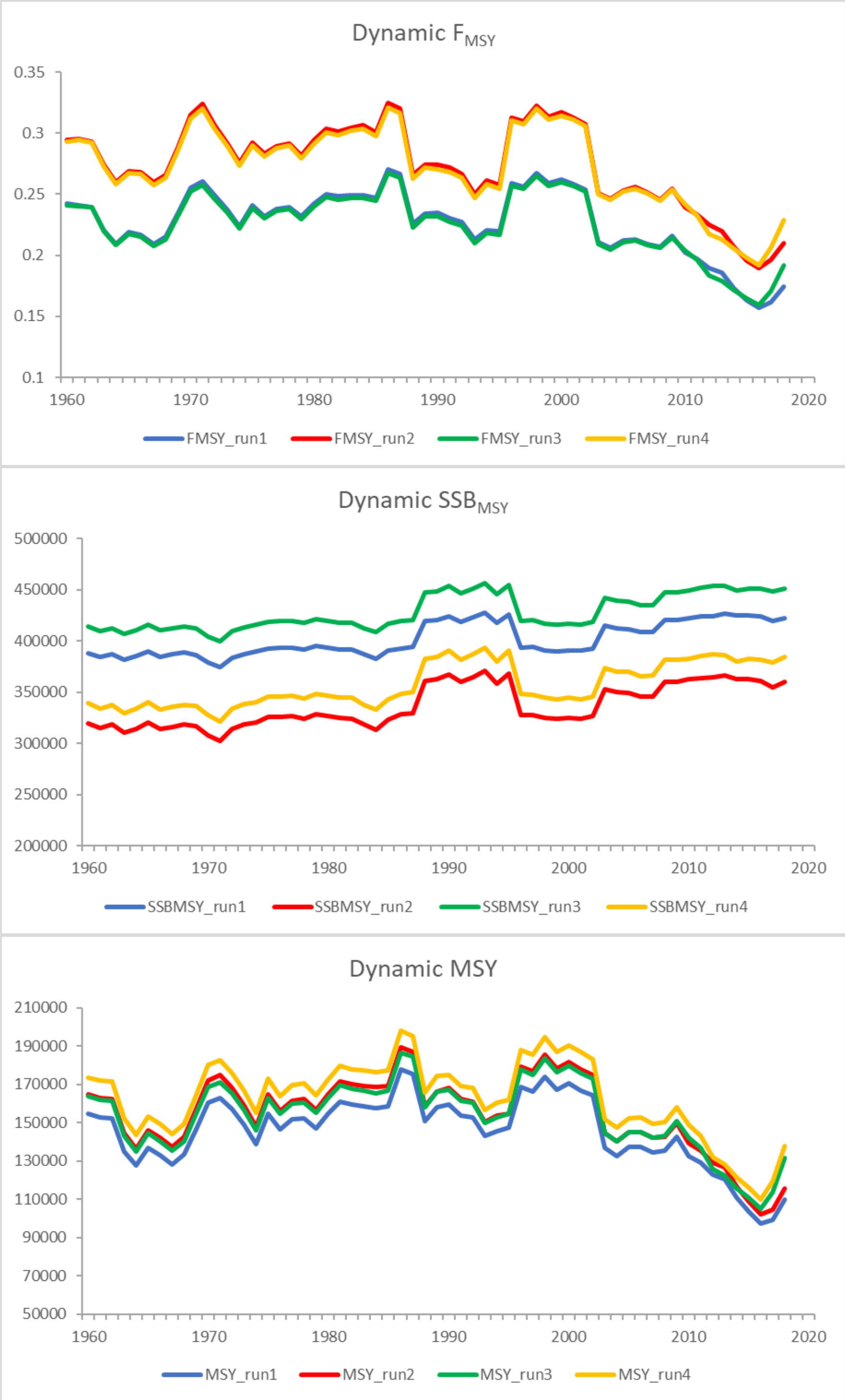
YFT-Figure 11. Annual estimates of Age-0 recruits (left panels) and recruitment deviations with 95% confidence intervals (right panels) for Stock Synthesis model runs. Models which used the buoy index suggest very high recruitment in 2017, whereas models that do not use the buoy index suggest that recruitment in 2017 was not particularly high. Note: Production models (JABBA, MPB) do not produce estimates of recruitment.



YFT-Figure 12. Kobe plot estimated from the combination of Stock Synthesis, JABBA and MPB model runs chosen to develop the management advice. The trajectory of individual runs are shown in the detailed report, and in **Figures 9 and 10** above.



YFT-Figure 13. Trends of projected relative biomass (left panel, B/B$_{MSY}$) and fishing mortality (right panel, F/F$_{MSY}$) of Atlantic yellowfin stock under different TAC scenarios (0, 60000 – 150000 t) from JABBA, MPB, and SS3 using 9 runs (JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1-4)). Each line represents the median of 20000 iterations by projected year. In 2019, the catch was assumed to be 131,042 t, equal to the 2018 estimated landings, which have since been revised upwards to 136,530 t after additional reporting.



YFT-Figure 14. Effect of changes in overall fisheries selectivity on estimate of MSY and reference points used for the determination of stock status (Dynamic SSB_{MSY}, F_{MSY} and MSY for the Stock Synthesis runs). For each year, reference points are calculated with the selectivity of each gear for that year, and relative yearly catch of each fleet.