9.2 SWO-ATL - ATLANTIC SWORDFISH

The status of the North and South Atlantic swordfish stocks was assessed in 2022, by means of applying statistical modelling to the available data up to 2020. Complete information on the data availability and assessment can be found in the Report of the 2022 ICCAT Atlantic Swordfish Data Preparatory Session *(Online, March 21 to 1 April 2022*) (Anon., 2022b) and Report of the 2022 ICCAT Atlantic Swordfish Stock Assessment *(Online, 20-28 June 2022)* (Anon., 2022k). Statistics relevant to Atlantic swordfish is presented in the Report of the Subcommittee on Statistics, included as **Appendix 13** to this SCRS Report, and recommendations pertinent to Atlantic swordfish are presented in Item 16.

SWO-ATL-1. Biology

Swordfish (*Xiphias gladius*) are members of the family Xiphiidae and are in the suborder Scombroidei. They can reach a maximum weight in excess of 500 kg. They are distributed widely in the Atlantic Ocean and Mediterranean Sea. In the ICCAT Convention area, the management units of swordfish for assessment purposes are a separate Mediterranean group, and North and South Atlantic groups separated at 5°N.

Swordfish feed on a wide variety of prey including groundfish, pelagic fish, deep-water fish, and invertebrates. They are believed to feed throughout the water column, and from electronic tagging studies, undertake extensive diel vertical migrations.

Swordfish mostly spawn in the western warm tropical and subtropical waters throughout the year, although seasonality has been reported in some of these areas. They are found in the colder temperate waters during summer and fall months. Young swordfish grow very rapidly, reaching about 140 cm LJFL (lower-jaw fork length) by age three, but grow slowly thereafter. Females grow faster than males and reach a larger maximum size. Tagging studies have shown that some swordfish can live up to 15 years. Swordfish are difficult to age, but about 50% of females were considered to be mature by age five, at a length of about 180 cm. However, the most recent information indicates a smaller length and age at maturity.

The analysis of the horizontal movements shows seasonal patterns, with fish generally moving towards the equator by winter and returning to the temperate foraging grounds in spring and summer. Broader areas of mixing between some eastern and western areas were also suggested. Results obtained by up satellite tags also fully confirm the previous knowledge that was available from fishery data: deep longline settings catch swordfish during the daytime as a by-catch, while shallow setting longliners target swordfish at night closer to the surface.

Beginning in 2018, an ICCAT swordfish biology programme, encompassing all three ICCAT stocks, has been conducting studies on swordfish growth, reproductive biology, and genetic analysis for identification of stock boundaries and mixing. Since programme inception, 4,159 fish have been sampled for otolith, fin spines, gonads and other tissues. The three research areas address key uncertainties important for improving the scientific advice for management of the stocks. Within each of the project areas, important scientific advances have been made:

- Ageing and growth: standards for ageing spines and otoliths; preliminary work on new growth models.

- Reproductive biology: standards for classifying reproductive status of swordfish and preliminary updates to maturity schedules.

- Genetics: identified genetic markers important for stock differentiation; identified key stock mixing areas in the North-East Atlantic; identified sub-populations within the Mediterranean.

These biological studies are ongoing, and the collective work contributes to the next major advance in the assessment of swordfish status.

SWO-ATL-2. Fishery indicators

Due to the broad geographical distribution of Atlantic swordfish (**SWO-ATL-Figure 1**) in coastal and off-shore areas (mostly ranging from 50ºN to 45ºS), this species is available to a large number of fishing countries. **SWO-ATL-Figure 2** shows total estimated catches for North and South Atlantic swordfish. Directed longline fisheries from Canada, EU-Spain, and the United States have operated since the late 1950s or early 1960s, and harpoon fisheries have existed at least since the late 1800s. Other directed swordfish fisheries include fleets from Brazil, Morocco, Namibia, EU-Portugal, South Africa, and Venezuela. The primary bycatch or opportunistic fisheries that take swordfish are tuna fleets from Chinese Taipei, Japan, Korea and EU-France. The tuna longline fishery started in 1956 and has operated throughout the Atlantic since then, with substantial catches of swordfish that are produced as a bycatch of tuna fisheries. The largest proportion of the Atlantic catches is made using surface-drifting longline. However, many additional gears are used, including traditional gillnets off the coast of western Africa.

Trends by area (NE vs. NW Atlantic) in the CPUE indexes were consistent with the seasonal movement patterns observed in the electronic tagging data, as well as in the catches and sex-ratio distributions. Relationships observed for the eastern Atlantic were opposite to those in the western Atlantic. This pattern was correlated with the decadal cycling of the AMO as well as that of the North Atlantic Oscillation (NAO). Including the AMO as a covariate to area specific catchability within the assessment model helped reduce the conflicting directions of the various CPUE trends. Further analysis and hypothesis testing was recommended to determine if the relationship was due to a swordfish temperature preference, a change in prey distribution, or perhaps both. To support this hypothesis testing the Committee encouraged a group of swordfish scientists to work towards uniting the available North Atlantic swordfish CPUE data into a single dataset so that a more refined, area specific CPUE analyses could be conducted.

For both the North and South Atlantic some of the indices of abundance were affected by changes in gear technology and management that could not be accounted for in the CPUE standardization, and therefore some indices had to be split into consistent time periods.

Total Atlantic

The total Atlantic estimated catch (landings plus dead discards) of swordfish (North and South, including reported dead discards) in 2021 (19,214 t) was 8.9% lower than the reported catch of 2015 (21,097 t), the terminal data year in the previous assessment. Catch reports are considered to be nearly complete for 2021, however, few countries, which typically represent a small portion of the catch, have not yet reported their 2021 catches and because of unknown unreported catches, this value should be considered provisional and subject to further revision.

North Atlantic

For the past decade, the North Atlantic estimated catch (landings plus dead discards) has averaged about 11,000 t per year (**SWO-ATL-Table 1**). The catch in 2021 (9,729 t) represents a 51.9% decrease since the 1987 peak in North Atlantic landings (20,238 t). These reduced landings have been attributed to ICCAT management measures, a reduction in total longline effort (Taylor *et al.,* 2020), and shifts in fleet distributions, including the movement of some vessels in certain years to the South Atlantic or out of the Atlantic. In addition, some fleets, including at least the United States, EU-Spain and EU-Portugal have changed operating procedures to opportunistically target tuna and/or sharks, taking advantage of market conditions and higher relative catch rates of these species previously considered as bycatch in some fleets. Recently, socio-economic factors, and oceanography patterns may have also contributed to the decline in catch. Task 1 and 2 data coverage is generally good, however the Committee noted the sparse discarding data for most CPCs as well as gaps in the catch and effort data for some CPCs.

Available longline CPUE series were evaluated by the Committee and certain indices were identified as suitable for use in the assessment models (Canada, Chinese Taipei, EU-Portugal, EU-Spain, Japan, Morocco, and USA). Trends in standardized CPUE series by fleets contributing to the stock assessment models are shown in **SWO-ATL-Figure 3**. Most of the series have an increasing trend since the late 1990s but show a decrease or plateau in the more recent years. There have been some recent changes in United States regulations (such as time-area closures for other species like Atlantic bluefin tuna) that may have impacted catch rates. The combined index used in the biomass models is shown in **SWO-ATL-Figure 4**.

South Atlantic

The historical trend of catch (landings plus dead discards) can be divided in two periods: before and after 1980. The first one is characterized by relatively low catches, generally less than 5,000 t (with an average value of 1,824 t). After 1980, landings increased continuously up to a peak of 21,931 t in 1995, levels that are comparable to the peak of North Atlantic harvest (20,238 t in 1987). This increase of landings was, in part, due to progressive shifts of fishing effort to the South Atlantic, primarily from the North Atlantic, as well as other waters. Expansion of fishing activities by southern coastal countries, such as Brazil and Uruguay, also contributed to this increase in catches. The reduction in catch following the peak in 1995 resulted from regulations and was partly due to a shift to other oceans and target species. In 2021, the reported catch (9,486 t) is 57% lower than the 1995 reported catch (**SWO-ATL-Table 1**).

Available longline CPUE series for South Atlantic swordfish were evaluated by the Committee and certain indices were identified as suitable for use in assessment models (Brazil, Chinese Taipei, EU-Spain, Japan, South Africa, Uruguay). The available indices are illustrated in **SWO-ATL-Figure 5**.

Discards

Since 1991, very few fleets have reported dead discards (see **SWO-ATL-Table 1**). The volume of North Atlantic reported dead discards reached a maximum of 1,138 t in 2000. Recent reported dead discards for the North Atlantic are low (113 t in 2020; 99 t in 2021). For the South Atlantic, the reported discards peaked at 147 t in 2010. In 2021, 128 t of dead discards were reported for the South Atlantic. The Committee continued to express concerns due to the low percentage of fleets that have reported annual dead discards (in t) and that what has been reported is not necessarily scaled to the entire fishery.

SWO-ATL-3. State of the stocks

North Atlantic

Two stock assessment platforms were used to provide estimates of stock status for the North Atlantic swordfish stock as a basis for management advice. There were: a Bayesian surplus production model (JABBA - Just Another Bayesian Biomass Assessment) and the integrated assessment model Stock Synthesis (SS).

The Committee noted that the 2022 assessment represents a significant improvement in the characterization of uncertainty of current stock status for North Atlantic swordfish using updated information and integration of JABBA. The Committee agreed that management advice for North Atlantic swordfish, including stock status and projections, should be based on JABBA and SS models.

There were important developments to the modelling this year. In particular, the SS model provided estimates of the full number of dead discards due to the size limit (i.e., reported and unreported) in the estimation of stock status. This analysis is consistent with the request of the Commission that the SCRS monitor and analyse the effects of the minimum size limit (Rec. 17-02, paragraph 10). This capacity will also be useful in future MSE simulations.

Based on the combined results from the two stock assessment model platforms (Stock Synthesis and JABBA), the North Atlantic swordfish stock biomass was above B_{MSY} (median B_{2020}/B_{MSY} = 1.08 and 95% CI of 0.71 and 1.33) and fishing mortality was below F_{MSY} (median F_{2020}/F_{MSY} = 0.80 and 95% CI of 0.64 and 1.24) in 2020 (**SWO-ATL-Figure 6**). The median MSY was estimated as 12,819 t with 95% CI of (10,864 t and 15,289 t).

The joint Kobe phase plot shows that JABBA model results provide wider range of uncertainty than the Stock Synthesis results. Probabilities of the stock being in each quadrant of the Kobe plot (**SWO-ATL-Figure 9**) are 63% in the green (not overfished not subject to overfishing), 22% in the yellow (overfished but not subject to overfishing) and 15% in the red (overfished and subject to overfishing). The results point to a stock status of not overfished (37% probability of overfished status), with no overfishing (15% probability of overfishing taking place). The estimate of stock status in 2020 is very similar to the estimated status from the previous assessment in the terminal year (2015).

South Atlantic

Two stock assessment platforms were used to assess the South Atlantic swordfish stock. These were a Bayesian surplus production model (JABBA) and Stock Synthesis. While Stock Synthesis was explored in 2022, only the JABBA model was used for providing advice.

The Committee acknowledged the progress made to implement a Stock Synthesis model for the South stock for the first time, but revision of size data and further model development are still required before it can be fully used for management advice. As such, the Stock Synthesis model was considered preliminary, and the Committee agreed that stock status estimates and projections for management advice should be done using only the JABBA model. For the purpose of comparison of model results across platforms only, results from Stock Synthesis are presented in **SWO-ATL-Figure 7** to illustrate the overall consistency among models.

Both models were consistent and suggested a decline in stock biomass as the fishing mortality increased in the 1990s. The final JABBA results estimated that B_{2020} was also below B_{MSY} (median = 0.77, 95% CIs = 0.53-1.13) while F_{2020} was marginally above F_{MSY} (median = 1.03, 95% CIs = 0.67-1.51) (**SWO-ATL-Figure 8**). The JABBA's MSY_{2020} was estimated to be 11,481 t.

The southern swordfish stock biomass is overfished, and overfishing is occurring. The JABBA base case assessment indicates a 56% probability that the stock is within the red quadrant of the Kobe plot (**SWO-ATL-Figure 10**).

SWO-ATL-4. Outlook

North Atlantic

Based on the currently available information to the Committee, both the JABBA and Stock Synthesis base models were projected to the year 2033 under constant TAC scenarios of 9,000 to 16,000 t, as well as a zero-catch scenario.

For the projections, catches for 2021 and 2022 are assumed to be constant at 10,476 t (the catch value for 2020 at the time of the assessment). Different levels of constant catch are projected for the period 2023-2033 (**SWO-ATL-Table 2**). The combined Stock Synthesis and JABBA projections show that a 13,200 t constant catch, which is the current TAC level (Rec. 21-02), will have a 60% probability of being in green quadrant in 2033. However, given that the estimated MSY (that is inclusive of dead discards) is 12,819 t and B_{2020}/B_{MSY}=1.08, catches above MSY will results in biomass declines over the projection period (**SWO-ATL-Figure 11**). Under 2021 catch (9,729 t), there is an 84-87% probability of the stock being in green quadrant by 2033 (**SWO-ATL-Table 2**).

South Atlantic

The 2022 assessment stock status results are similar to the 2017 assessment, but updated information used in the 2022 assessment resulted in estimates of a less productive stock (MSY_{2020} = 11,481 t; MSY_{2015} = 14,570 t). Specifically, a new surplus production function was objectively derived using biological information, and updated CPUE indices.

Results of projections from the 2017 assessment indicated that if catches remained below 11,000 t, there was a 60% chance of the stock falling within the green quadrant by 2020. The average catch for the period 2016-2020 was 10,125 t, yet the assessment still indicates a 56% probability that the stock is within the red quadrant in 2020 (**SWO-ATL-Figure 10**). The Committee notes that this apparent inconsistency can be explained by the lower productivity (see above) of the stock determined in the 2022 assessment.

Projections were conducted for the base case JABBA model under constant TAC scenarios of 6 to 15 thousand tons, as well as a zero-catch scenario (**SWO-ATL-Figure 12**). Projections were implemented in 2023 and catches for 2021 and 2022 were assumed to remain constant (9,826 t) at the average from the previous three years. Under current catch levels (9,826 t), the South Atlantic swordfish stock has a 55% probability of being in the green quadrant of the Kobe plot by 2033 (**SWO-ATL-Table 3**).

SWO-ATL-5. Effect of current regulations

For the North and South Atlantic, the most germane recommendations can be found in Recs. 21-02 and 21-03, modifying Recs 17-02 and 16-04, respectively.

Catch limits

The total allowable catch in the North Atlantic during the 2007 to 2009 period was 14,000 t per year. The reported catch during that period averaged 11,811 t and did not exceed the TAC in any year. In 2010, the TAC was reduced to 13,700 t. The reported mean catch from 2010-2017 was 11,576 t and exceeded the TAC in 2012 (13,868 t). In 2018, the TAC was reduced to 13,200 t. The reported catch from 2018-2021 has averaged 9,862 t and has not exceeded the TAC in any year.

The TAC in the South Atlantic for the years 2007 through 2009 was 17,000 t. The reported catch during that period averaged 13,674 t and did not exceed the TAC in any year. In 2010, the TAC was reduced to 15,000 t. The reported catch from 2010-2017 averaged 10,644 t and did not exceed the TAC in any year. In 2018, the TAC was reduced to 14,000 t. The reported catch from 2018-2021 averaged 9,719 t and did not exceed the TAC in any year.

Minimum size limits (Rec. 17-02)

There are three minimum size options that are applied to the entire Atlantic: 125 cm LJFL/25 kg with a 15% tolerance (of the number of swordfish *per landing*); or 119 cm LJFL/15 kg with zero tolerance and evaluation of the discards; and for dressed fish, cleithrum to keel length of 63 cm.

Since the implementation of the minimum landing sizes in 2000, the estimated proportion of swordfish less than 125 cm LJFL reported in the landings (in numbers) has been generally decreasing in the North Atlantic and stable in the South. In the North Atlantic, the estimate was 33% in 2000 and decreased to 23% in 2015. In the South Atlantic the estimate was 18% in 2000, had a maximum of 19% in 2006 and decreased to 13% in 2015. The Committee notes that these estimates are based on low sample sizes, are uncertain and may be biased. They will remain uncertain until CPCs fully report size samples from the entire catch. A figure of the estimated absolute biomass and numbers of fish as well as estimated proportions of undersized fish in the catch that are discarded in the North Atlantic is shown in **SWO-ATL-Figure 13**. The decreasing trend can be due to a decrease in encounter rate of undersized fish due to changes in fleet behaviour, or a decrease in recruitment over time, or a combination of both.

The Committee also noted high values of hooking mortality (ranging between 78-88%) on small swordfish (<125 cm LJFL) by surface longline fisheries targeting swordfish (**SWO-ATL-Figure 14**). The post-release mortality of specimens discarded alive from commercial fishing gear is unknown. Evaluating other strategies to reduce fishing mortality on juvenile swordfish will need complete datasets on fishing effort and size data over the entire Atlantic and should take into account the effects of these strategies on other species. In view of the Commission objective to reduce fishing mortality on small swordfish, the Committee therefore recommends that future work should be carried out to determine more precisely the spatial distribution and magnitude of fishing effort, the size and sex distribution of undersized swordfish in the Atlantic, using high resolution observer data.

SWO-ATL-6. Management Recommendations

North Atlantic

SWO-ATL-Table 2 shows the probabilities of maintaining B>B_{MSY}, maintaining F<F_{MSY}, and maintaining the stock in the green quadrant of the Kobe plot over a range of TAC options for North Atlantic swordfish over a period of 10 years. The combined Stock Synthesis and JABBA projections show that a 13,200 t constant catch, which is the current TAC level (Rec. 21-02), will result in a 60% probability of being in the green quadrant in 2033 (**SWO-ATL-Table 2**). However, given that the estimated MSY (that is inclusive of dead discards) is 12,819 t, catches above MSY will results in biomass declines over the projection period (**SWO-ATL-Figure 11**).

The Committee also recognizes that the above advice does not fully account for removals associated with the actual mortality of unreported dead and live discards, quota carryovers (15% in the North Atlantic), quota transfers across the North, and South stock management boundaries nor the total cumulative quota, which includes catch allocated to "other CPCs" and would fall above the TAC if achieved. The Committee emphasizes that the importance of this uncertainty be taken into consideration by the Commission when adopting a TAC.

South Atlantic

SWO-ATL-Table 3 shows the probabilities of maintaining B>B_{MSY}, maintaining F<F_{MSY}, and maintaining the stock in the green quadrant of the Kobe plot over a range of TAC options for South Atlantic swordfish over a period through 2033. The current TAC of 14,000 t (Rec. 21-03) is unlikely (3% probability) to result in the stock being in the green quadrant of the Kobe plot by 2033. The reported catch for 2021 was 9,454 t. Catch levels less than 10,000 t will accelerate rebuilding.

The Committee also recognizes that as was the case for the northern stock, the above advice does not fully account for removals associated with the actual mortality of unreported dead and live discards, quota carryovers (30% in the South Atlantic) nor quota transfers across the North and South stock management boundaries. The Committee emphasizes the importance of these uncertainties and recommends that the stock be closely monitored in the upcoming years to confirm rebuilding.

ATLANTIC SWORDFISH SUMMARY TABLE		
	North Atlantic	***South Atlantic***
Maximum Sustainable Yield	12,819 t (10,864 t-15,289 t)[1]	11,481 t (9,793 t-13,265 t)[2]
Current (2022) TAC	13,200 t	14,000 t
Current (2021) Yield[3]	9,729 t	9,454 t
Yield in last year used in assessment (2020)[4]	10,668 t	9,020 t
B_{MSY} (CI)	57,919 t (23,666 t-153,156 t)[5]	74,641 t (60,179 t-92,946 t)[2]
F_{MSY}	0.15 (0.08-0.23) [5]	0.15 (0.12-0.19) [2]
Relative Biomass (B_{2020}/B_{MSY})	1.08 (0.71-1.33) [5]	0.77 (0.53-1.11)[2]
Relative Fishing Mortality (F_{2020}/F_{MSY})	0.80 (0.64-1.24)[5]	1.03 (0.67-1.51)[2]
Stock Status (2020)	Overfished: NO	Overfished: YES
	Overfishing: NO	Overfishing: YES
Management Measures in Effect	Country-specific TACs [Rec. 21-02]; Minimum size 125/119 cm LJFL[6]	Country-specific TACs [Rec. 21-03]; Minimum size 125/119 cm LJFL[7]

[1] Median from base case JABBA and Stock Synthesis models; range corresponding to the lowest and highest 95% CIs from the two models.
[2] Median and 95% CIs from base case JABBA model.
[3] Provisional and subject to revision.
[4] Based on catch data available in July 2021 for the stock assessment session.
[5] Median and 95% quantiles from base case Stock Synthesis and JABBA models.
[6] Associated alternatives listed in Rec. 17-02.
[7] Associated alternatives listed in Rec. 17-03.

SWO-ATL-Table 1. Estimated catches (t) of Atlantic swordfish (*Xiphias gladius*) by area, gear and flag.

				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	2020	2021
TOTAL				29207	32868	34460	39036	33511	31567	26356	27124	27181	25139	23758	24078	25153	25544	25724	27935	23472	24814	24267	23914	24576	21282	20678	21097	21112	20833	19403	20325	19415	19214
	ATN			15394	16738	15501	17105	15222	13025	12329	11622	11453	10011	9654	11444	12071	12380	11528	12306	11102	12146	11672	12709	13890	12078	10708	10752	10501	10295	9025	10244	10451	9729
	ATS			13813	16130	18958	21931	18289	18542	14027	15502	15728	15128	14104	12634	13082	13163	14196	15629	12370	12668	12596	11205	10686	9204	9970	10345	10611	10537	10378	10081	8964	9486
Landings	ATN	Longline		14356	15804	14365	15864	13822	12204	11062	10717	9922	8678	8799	10334	11410	11531	10896	11478	10394	11504	11077	11796	12976	11366	10089	10194	9913	9462	8401	9340	9752	9118
		Other surf.		655	526	428	715	812	370	782	376	393	432	240	486	341	516	409	546	465	485	441	511	512	513	463	391	483	684	472	600	587	512
	ATS	Longline		13422	15739	17839	21584	17859	18299	13748	14823	15448	14302	13576	11714	12558	12915	13984	15318	11980	12301	12087	10854	10255	8958	9736	10047	10461	10281	10323	9975	8814	9325
		Other surf.		391	391	1119	347	429	222	269	672	278	826	527	920	523	248	212	221	384	368	361	277	291	246	189	254	148	145	27	57	93	33
Discards	ATN	Longline		383	408	708	526	562	439	476	525	1137	896	607	618	313	323	215	273	235	151	148	392	391	199	156	167	105	149	152	304	113	97
		Other surf.		0	0	0	0	26	12	9	4	1	6	8	5	7	10	8	8	9	7	5	9	10	0	0	0	0	0	0	0	0	1
	ATS	Longline		0	0	0	0	1	21	10	6	1	0	0	0	1	0	0	91	6	0	147	74	140	0	46	43	2	111	26	50	57	128
		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	1	0	0	
Landings	ATN CP	Barbados		0	0	0	0	33	16	16	12	13	19	10	21	25	44	39	27	39	20	13	23	21	16	21	29	20	21	18	10	12	13
		Belize		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	112	106	184	141	142	76	1	3	59	145	117	111	121
		Brazil		0	0	0	0	0	0	0	0	117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Canada		1547	2234	1676	1610	739	1089	1115	1119	968	1079	959	1285	1203	1558	1404	1348	1334	1300	1346	1551	1489	1505	1604	1579	1548	1188	782	995	1334	1377
		China PR		0	73	86	104	132	40	337	304	22	102	90	316	56	108	72	85	92	92	73	75	59	96	60	141	135	81	86	92	96	44
		Curaçao		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Côte d'Ivoire		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	30	0	0	0	0	0	0	0	0	0	26	**0**
		EU-Denmark		0	0	0	0	0	0	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-España		6672	6598	6185	7176	5547	5140	4084	3996	4595	3968	3957	4586	5376	5521	5448	5564	4366	4949	4147	4889	5622	4084	3750	4013	3916	3586	3186	3112	3587	3235
		EU-France		75	95	46	84	97	164	110	104	122	0	74	169	102	178	92	46	14	15	35	16	94	44	28	66	90	79	80	82	90	103
		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	**0**
		EU-Ireland		0	7	0	0	15	15	132	81	35	17	5	12	1	1	3	2	2	1	1	2	5	2	3	15	15	10	13	3	24	9
		EU-Netherlands		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**
		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		542	1961	1599	1617	1703	903	773	777	732	735	766	1032	1320	900	949	778	747	898	1054	1203	882	1438	1241	1420	1460	1871	1691	2392	2070	2165
		EU-Rumania		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		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	**0**
		FR-St Pierre et Miquelon		0	0	0	0	0	0	0	0	0	0	10	3	36	48	0	82	48	17	90	1	0	18	3	0	0	0	0	0	0	**0**
		Great Britain		0	2	3	1	5	11	0	2	1	0	0	0	0	0	49	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
		Grenada		3	13	0	1	4	15	15	42	84	0	54	88	73	56	30	26	43	0	0	0	0	0	0	39	29	36	36	22	15	
		Guatemala		0	0	0	0	0	0	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	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Japan		1064	1126	933	1043	1494	1218	1391	1089	161	0	0	0	575	705	656	889	935	778	1062	523	639	300	545	430	379	456	325	355	412	274
		Korea Rep		3	19	16	16	19	15	0	0	0	0	0	0	0	51	65	175	157	3	0	0	0	64	35	0	9	19	9	9	14	13
		Liberia		7	14	26	28	28	28	28	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	95	5	7	3	8
		Maroc		69	39	36	79	462	267	292	119	114	523	223	329	335	339	341	237	430	724	968	782	770	1062	1062	850	900	900	950	950	936	955
		Mexico		0	6	14	10	22	14	28	24	37	27	34	32	44	41	31	35	34	32	35	38	40	33	32	31	36	64	44	30	21	25
		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		0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Philippines		0	0	0	0	0	0	0	0	0	1	4	44	5	0	8	0	22	28	0	17	36	9	14	0	0	0	0	0	0	**0**
		Russian Federation		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	0	0	**0**
		Senegal		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	41	87	113	148	44	43	49	78	146	112	89	121	33	6
		Sierra Leone		0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	
		St Vincent and Grenadines		3	23	0	4	3	1	0	1	0	22	22	7	7	7	7	51	7	34	13	11	8	4	40	102	33	46	26	12	7	**0**
		Trinidad and Tobago		562	11	180	150	158	110	130	138	41	75	92	78	83	91	19	29	48	30	21	16	14	16	26	17	13	36	3	6	8	6
		UK-Bermuda		0	0	0	1	1	5	5	3	3	2	0	0	1	1	0	3	4	3	3	3	1	1	1	1	2	1	2	2	6	5
		UK-British Virgin Islands		0	0	0	0	0	0	0	0	0	0	0	0	4	4	7	0	3	0	0	4	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	13	17	0	0	0	0	0	0	**0**
		USA		3852	3783	3366	4026	3559	2987	3058	2908	2863	2217	2384	2513	2380	2160	1873	2463	2387	2730	2274	2551	3393	2824	1809	1581	1408	1294	1135	1449	1351	1137
		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**
		Venezuela		103	73	69	54	85	20	37	30	44	21	34	45	53	55	22	30	11	13	24	18	25	24	24	34	56	58	36	35	16	13
	NCC	Chinese Taipei		441	127	507	489	521	509	286	285	347	299	310	257	30	140	172	103	82	89	88	192	166	115	78	115	148	78	162	115	144	66
		Costa Rica		0	0	0	0	0	0	0	1	1	0	0	1	4	3	2	4	11	6	11	23	21	22	30	34	26	44	43	23	19	51
		Guyana		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10	5	2	5	5	3		
	NCO	Cuba		27	16	50	86	7	7	7	7	0	0	10	3	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Dominica		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	
		Faroe Islands		0	0	0	0	0	0	0	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NEI (Flag related)		35	111	0	0	0	0	0	0	0	0	0	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	0	0	0	0	2	0	1	
		Seychelles		0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Sta Lucia		0	0	1	0	0	0	0	0	0	0	0	0	2	3	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	
		Vanuatu		0	0	0	0	0	0	0	0	0	0	0	0	35	29	14	0	0	0	10	23	15	2	4	7	0	0	0	0	0	
	ATS CP	Angola		0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	18	0	0	13	0	0	0		
		Belize		0	0	0	1	0	0	0	17	8	0	0	0	0	0	0	120	32	111	121	207	197	136	45	111	176	166	115	55	2	2
		Brazil		2609	2013	1571	1975	1892	4100	3847	4721	4579	4082	2910	2920	2998	3785	4430	4153	3407	3386	2926	3033	2833	2384	2892	2599	2938	2410	2798	2863	2110	2823
		China PR		0	0	0	0	0	0	29	534	344	200	423	353	278	91	300	473	470	291	296	248	316	196	206	328	222	302	355	211	89	37
		Curaçao		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Côte d'Ivoire		13	14	20	19	26	18	25	26	20	19	19	43	29	31	39	17	24	145	156	58	89	133	68	48	58	41	57	123	19	22
		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	**0**
		EU-España		5651	6974	7937	11290	9622	8461	5832	5758	6388	5789	5741	4527	5483	5402	5300	5283	4073	5183	5801	4700	4852	4184	4113	5059	4992	4656	4404	4224	4442	4470
		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	4	0	0	**0**
		EU-Lithuania		0	0	794	0	0	0	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		1	0	0	380	389	441	384	381	392	393	380	354	345	493	440	428	271	367	232	263	184	125	252	236	250	466	369	323	335	224
		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	**0**
		Gabon		0	0	0	0	0	0	0	0	0	0	0	9	2	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	**0**
		Ghana		69	121	51	103	140	44	106	121	117	531	372	734	343	55	32	65	177	132	116	60	54	37	26	56	36	55	6	32	31	19
		Great Britain		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	**0**
		Guatemala		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Guinea Ecuatorial		0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	**0**
		Honduras		3	0	0	6	4	5	2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Japan		2870	5256	4699	3619	2197	1494	1186	775	790	685	833	924	686	480	1090	2155	1600	1340	1314	1233	1162	684	976	659	637	915	640	647	552	484

				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	2020	2021
			Korea Rep	147	198	164	164	7	18	7	5	10	0	2	24	70	36	94	176	223	10	0	0	42	47	53	5	19	11	18	9	15	6
			Namibia	0	0	22	0	0	0	0	730	469	751	504	191	549	832	1118	1038	518	25	417	414	85	129	395	225	466	600	881	811	789	623
			Nigeria	3	0	0	0	9	0	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	0	0	0	0	0	0	29	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Philippines	0	0	0	0	0	0	0	0	0	6	1	8	1	1	4	58	41	49	14	35	15	35	58	0	0	0	0	0	0	**0**
			S Tomé e Principe	177	202	190	178	166	148	135	129	120	120	120	120	126	147	138	138	183	188	193	60	84	60	94	145	77	65	1	3	30	32
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	97	137	78	117	162	178	143	97	90	112	65	116	38	**0**
			South Africa	9	4	1	4	1	1	240	143	328	547	649	293	295	199	186	207	142	170	145	97	50	171	152	218	164	189	189	251	149	179
			St Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	7	16	4	3	2	2	19	0	5	9	4	15	9	32
			UK-Sta Helena	0	0	0	0	0	0	0	0	0	20	4	2	2	0	0	0	0	0	0	0	0	5	6	2	0	0	0	0	0	**0**
			USA	0	0	0	0	171	396	160	179	142	43	200	21	15	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	210	260	165	499	644	760	889	650	713	789	768	850	1105	843	620	464	370	501	222	179	40	103	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	1686	846	2829	2876	2873	2562	1147	1168	1303	1149	1164	1254	745	744	377	671	727	612	410	424	379	582	406	511	478	416	446	346	296	406
		NCO	Argentina	88	14	24	0	0	0	0	38	0	5	10	8	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
			Benin	26	28	25	24	24	10	0	3	0	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	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	246	192	452	778	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Mixed flags (FR+ES)	0	0	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	0	0	
			NEI (Flag related)	0	0	0	0	0	0	0	0	0	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	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Togo	5	8	14	14	64	0	0	0	0	0	0	0	9	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	11	26	6	3	0	3	1	3	0	1	1	0	0	0	0	0	
Discards	ATN	CP	Canada	0	0	0	0	0	5	52	35	50	26	33	79	45	106	38	61	39	9	15	8	111	59	12	8	11	21	5	2	2	3
			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**
			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	1
			Japan	0	0	0	0	0	0	0	0	598	567	319	263	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	6	3
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	170	46	19	0	2	0	0	0	0	0	**0**
			Mexico	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
			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
			USA	383	408	708	526	588	446	433	494	490	308	263	282	275	227	185	220	205	148	138	223	217	120	137	137	90	111	140	287	91	89
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	7	18	4	18	7	7	14	2
	ATS	CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	91	6	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	1	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	2
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	147	70	23	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**
			USA	0	0	0	0	1	21	10	6	1	0	0	0	1	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	4	117	0	45	43	2	111	26	49	57	126

SWO-ATL-Table 2. Joint probabilities of the North Atlantic swordfish stock being below F_{MSY} (top, overfishing not occurring), above B_{MSY} (middle, not overfished) as well as the joint probability of being above B_{MSY} and below F_{MSY} (bottom, green zone) in a given year for a given catch level based on 30,000 iterations of the MVLN approximation for Stock Synthesis and JABBA MCMC iterations.

Probability $F<F_{MSY}$

TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0t	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
9000t	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%
10000t	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
11000t	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
12000t	79%	79%	79%	79%	79%	80%	80%	80%	79%	79%	79%
12500t	76%	76%	76%	76%	76%	76%	76%	76%	76%	76%	76%
12600t	75%	75%	75%	75%	75%	75%	75%	76%	75%	75%	75%
12700t	74%	74%	74%	74%	74%	74%	74%	74%	74%	74%	74%
12800t	74%	73%	73%	73%	73%	73%	73%	73%	73%	73%	73%
12900t	73%	72%	72%	72%	72%	72%	72%	72%	71%	71%	71%
13000t	72%	71%	71%	71%	71%	70%	70%	70%	69%	69%	68%
13100t	71%	70%	70%	69%	69%	68%	68%	67%	66%	66%	65%
13200t	70%	69%	69%	68%	67%	66%	65%	64%	63%	62%	61%
13300t	69%	68%	67%	66%	65%	63%	62%	61%	59%	58%	56%
13400t	68%	66%	65%	64%	62%	60%	59%	57%	55%	53%	51%
13500t	66%	65%	63%	61%	59%	57%	55%	53%	51%	48%	46%
13600t	65%	63%	61%	59%	56%	54%	51%	49%	46%	43%	41%
13700t	63%	61%	59%	56%	53%	50%	47%	44%	41%	38%	36%
13800t	62%	59%	56%	53%	50%	46%	43%	40%	37%	34%	32%
14000t	58%	55%	51%	47%	43%	39%	35%	32%	29%	27%	25%
15000t	38%	31%	25%	21%	25%	32%	32%	31%	31%	30%	29%
16000t	20%	15%	12%	11%	10%	10%	10%	9%	9%	9%	9%

Probability $B>B_{MSY}$

TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0t	75%	84%	90%	94%	96%	97%	98%	98%	99%	99%	99%
9000t	75%	78%	80%	82%	83%	84%	85%	86%	86%	87%	87%
10000t	75%	77%	79%	80%	81%	82%	83%	83%	83%	84%	84%
11000t	75%	76%	77%	78%	79%	79%	80%	80%	81%	81%	81%
12000t	75%	75%	76%	76%	77%	77%	77%	77%	77%	77%	77%
12500t	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
12600t	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
12700t	75%	75%	74%	74%	74%	74%	74%	74%	74%	74%	74%
12800t	75%	74%	74%	74%	74%	74%	74%	74%	74%	73%	73%
12900t	75%	74%	74%	74%	73%	73%	73%	73%	73%	72%	72%
13000t	75%	74%	74%	73%	73%	73%	72%	72%	72%	71%	71%
13100t	75%	74%	73%	73%	72%	72%	72%	71%	70%	70%	69%
13200t	75%	74%	73%	72%	72%	71%	71%	70%	69%	68%	67%
13300t	75%	74%	73%	72%	71%	70%	69%	68%	67%	66%	65%
13400t	75%	74%	73%	72%	70%	70%	68%	67%	65%	64%	62%
13500t	75%	74%	72%	71%	70%	68%	67%	65%	63%	61%	59%
13600t	74%	74%	72%	71%	69%	67%	65%	63%	61%	58%	55%
13700t	74%	73%	72%	70%	68%	66%	64%	61%	58%	55%	52%
13800t	74%	73%	71%	70%	67%	65%	62%	59%	55%	52%	48%
14000t	74%	73%	71%	68%	65%	62%	58%	54%	50%	45%	41%
15000t	74%	71%	66%	59%	47%	44%	42%	41%	39%	38%	36%
16000t	74%	69%	59%	48%	36%	27%	21%	18%	16%	15%	14%

Probability $F<F_{MSY}$ and $B>B_{MSY}$

TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0t	75%	84%	90%	94%	96%	97%	98%	98%	99%	99%	99%
9000t	75%	78%	80%	82%	83%	84%	85%	86%	86%	87%	87%
10000t	75%	77%	79%	80%	81%	82%	83%	83%	83%	84%	84%
11000t	75%	76%	77%	78%	79%	79%	80%	80%	80%	81%	81%
12000t	74%	75%	75%	76%	76%	76%	77%	77%	77%	77%	77%
12500t	73%	73%	74%	74%	74%	74%	74%	75%	75%	75%	75%
12600t	73%	73%	73%	73%	74%	74%	74%	74%	74%	74%	74%
12700t	72%	72%	73%	73%	73%	73%	73%	73%	73%	73%	73%
12800t	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%
12900t	71%	71%	71%	71%	71%	71%	71%	71%	70%	70%	70%
13000t	70%	70%	70%	70%	70%	69%	69%	69%	68%	68%	67%
13100t	70%	69%	69%	69%	68%	67%	67%	66%	66%	65%	64%
13200t	69%	68%	68%	67%	66%	65%	64%	63%	62%	61%	60%
13300t	68%	67%	66%	65%	64%	63%	61%	60%	59%	57%	56%
13400t	67%	66%	64%	63%	61%	60%	58%	56%	54%	53%	51%
13500t	66%	64%	62%	61%	59%	57%	55%	53%	50%	48%	46%
13600t	64%	62%	60%	58%	56%	53%	51%	48%	46%	43%	40%
13700t	63%	61%	58%	55%	53%	50%	47%	44%	41%	38%	36%
13800t	61%	59%	56%	53%	49%	46%	43%	40%	37%	34%	32%
14000t	58%	55%	51%	47%	43%	39%	35%	32%	29%	27%	25%
15000t	38%	31%	25%	21%	22%	32%	30%	29%	27%	26%	25%
16000t	20%	15%	12%	11%	10%	10%	10%	9%	9%	9%	9%

SWO-ATL-Table 3. Estimated projection probabilities (%) for the reference case model for South Atlantic swordfish. Projection probabilities are provided for $F<=F_{MSY}$ (top); $B>=B_{MSY}$ (middle); $F<=F_{MSY}$ and $B>=B_{MSY}$ (bottom). Stochastic projections were conducted over the period 2023-2033 with a range of fixed TACs (6,000 – 15,000 t), including a zero catch-scenario. The 2021 and 2022 catches are assumed to be 9,826 t, which is the mean of the 2018-2020 reported catch.

Probability $F<=F_{MSY}$

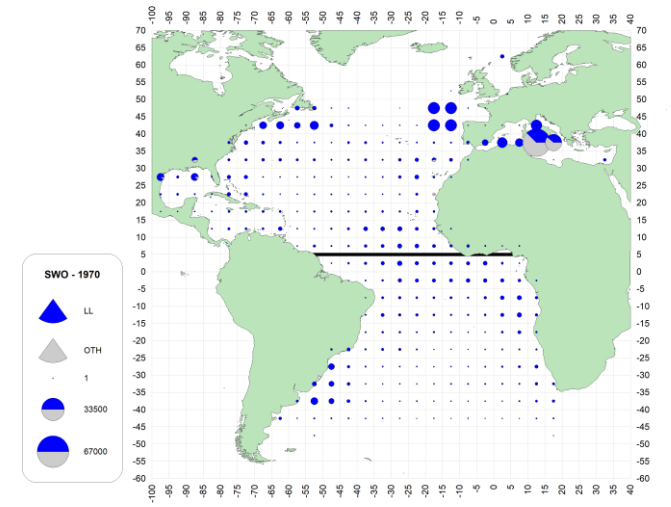
TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
6000	95%	97%	98%	98%	99%	99%	99%	99%	100%	100%	100%
6500	92%	94%	96%	97%	98%	98%	99%	99%	99%	99%	99%
7000	88%	91%	93%	95%	96%	97%	97%	98%	98%	98%	98%
7500	82%	86%	89%	91%	93%	94%	95%	96%	96%	97%	97%
8000	75%	80%	83%	86%	88%	90%	91%	92%	93%	94%	95%
8500	68%	72%	76%	79%	82%	84%	85%	87%	88%	89%	90%
9000	59%	64%	68%	71%	74%	76%	78%	80%	81%	83%	84%
9500	51%	55%	59%	62%	65%	67%	69%	71%	72%	74%	75%
9826	46%	50%	53%	56%	58%	60%	62%	64%	65%	67%	68%
10000	43%	47%	49%	52%	54%	57%	59%	60%	62%	64%	65%
10500	35%	38%	40%	42%	44%	46%	48%	49%	50%	52%	53%
11000	29%	31%	32%	33%	35%	36%	37%	38%	39%	40%	40%
11500	23%	24%	25%	25%	26%	27%	27%	28%	28%	29%	29%
12000	18%	18%	19%	19%	19%	19%	19%	20%	20%	20%	20%
12500	13%	14%	14%	14%	14%	14%	14%	13%	13%	13%	13%
13000	11%	10%	10%	10%	10%	10%	9%	9%	9%	9%	9%
13500	8%	8%	7%	7%	7%	6%	6%	6%	6%	6%	5%
14000	6%	6%	5%	5%	5%	4%	4%	4%	4%	3%	3%
14500	5%	4%	4%	3%	3%	3%	3%	2%	2%	2%	2%
15000	4%	3%	3%	2%	2%	2%	2%	2%	1%	1%	1%

Probability $B>=B_{MSY}$

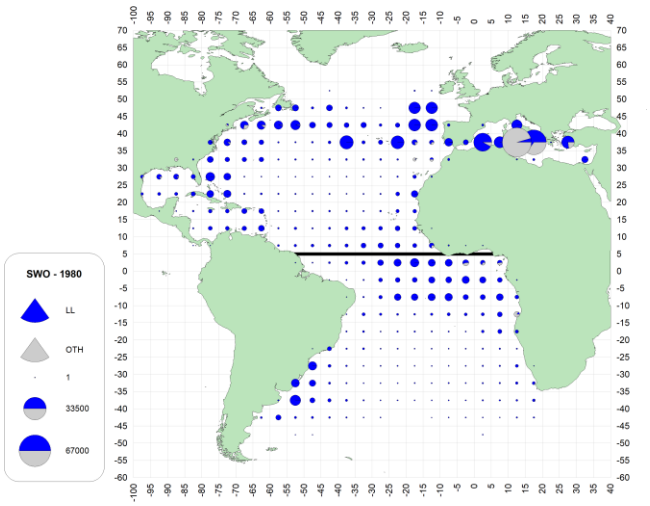
TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	21%	48%	74%	90%	96%	99%	99%	100%	100%	100%	100%
6000	21%	33%	46%	59%	70%	77%	83%	88%	92%	94%	95%
6500	21%	32%	44%	56%	66%	74%	80%	85%	88%	91%	93%
7000	21%	31%	41%	52%	62%	70%	75%	80%	85%	88%	90%
7500	21%	30%	39%	48%	57%	65%	70%	76%	80%	83%	86%
8000	21%	29%	37%	45%	53%	60%	65%	70%	74%	78%	81%
8500	21%	28%	34%	41%	48%	54%	59%	64%	68%	72%	75%
9000	21%	27%	32%	38%	44%	49%	53%	58%	61%	65%	68%
9500	21%	26%	31%	35%	39%	44%	48%	51%	55%	58%	60%
9826	21%	25%	29%	33%	36%	40%	43%	47%	50%	52%	55%
10000	21%	25%	29%	32%	35%	39%	41%	45%	47%	49%	52%
10500	21%	24%	27%	29%	31%	34%	36%	38%	40%	41%	43%
11000	21%	23%	25%	26%	28%	29%	30%	32%	33%	34%	35%
11500	21%	22%	23%	24%	24%	25%	25%	26%	26%	27%	27%
12000	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%
12500	21%	20%	19%	19%	18%	18%	17%	17%	16%	16%	16%
13000	21%	19%	18%	17%	16%	15%	14%	13%	13%	12%	12%
13500	21%	18%	17%	15%	14%	12%	11%	10%	10%	9%	9%
14000	21%	18%	15%	13%	12%	10%	9%	8%	7%	7%	6%
14500	21%	17%	14%	12%	10%	8%	7%	6%	6%	5%	4%
15000	21%	16%	13%	10%	8%	7%	6%	5%	4%	3%	3%

Probability $F<=F_{MSY}$ and $B>=B_{MSY}$

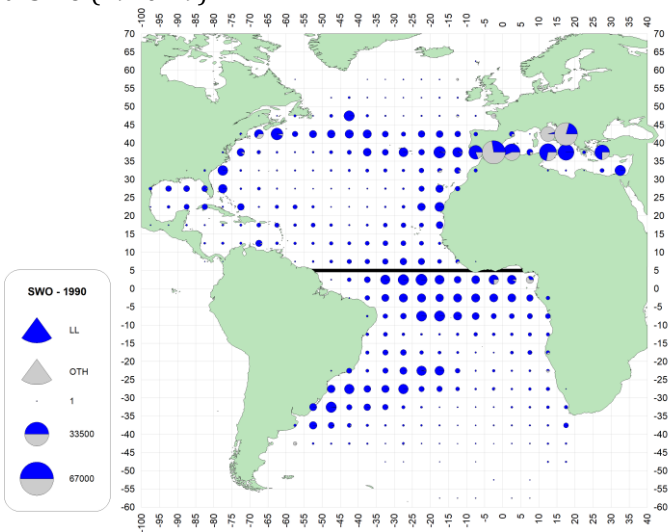
TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	21%	48%	74%	90%	96%	99%	99%	100%	100%	100%	100%
6000	21%	33%	46%	59%	70%	77%	83%	88%	92%	94%	95%
6500	21%	32%	44%	56%	66%	74%	80%	85%	88%	91%	93%
7000	21%	31%	41%	52%	62%	70%	75%	80%	85%	88%	90%
7500	21%	30%	39%	48%	57%	65%	70%	76%	80%	83%	86%
8000	21%	29%	37%	45%	53%	60%	65%	70%	74%	78%	81%
8500	21%	28%	34%	41%	48%	54%	59%	64%	68%	72%	75%
9000	21%	27%	32%	38%	44%	49%	53%	58%	61%	65%	68%
9500	21%	26%	31%	35%	39%	44%	48%	51%	55%	58%	60%
9826	21%	25%	29%	33%	36%	40%	43%	47%	50%	52%	55%
10000	20%	25%	28%	32%	35%	39%	41%	45%	47%	49%	52%
10500	20%	23%	26%	29%	31%	33%	35%	38%	40%	41%	43%
11000	20%	22%	24%	25%	27%	28%	30%	31%	32%	33%	35%
11500	18%	19%	21%	22%	23%	23%	24%	24%	25%	26%	26%
12000	16%	16%	17%	18%	18%	18%	18%	18%	19%	19%	19%
12500	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
13000	10%	10%	10%	10%	9%	9%	9%	9%	9%	9%	8%
13500	8%	8%	7%	7%	7%	6%	6%	6%	6%	5%	5%
14000	6%	6%	5%	5%	5%	4%	4%	4%	4%	3%	3%
14500	5%	4%	4%	3%	3%	3%	3%	2%	2%	2%	2%
15000	4%	3%	3%	2%	2%	2%	2%	2%	1%	1%	1%



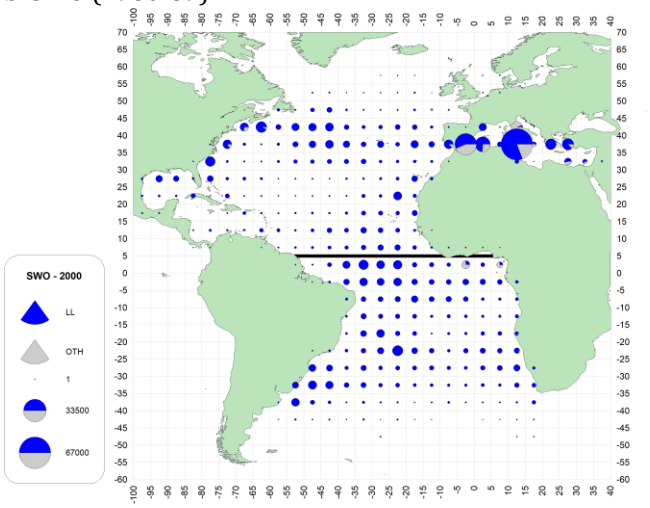
a. SWO (1970-79)



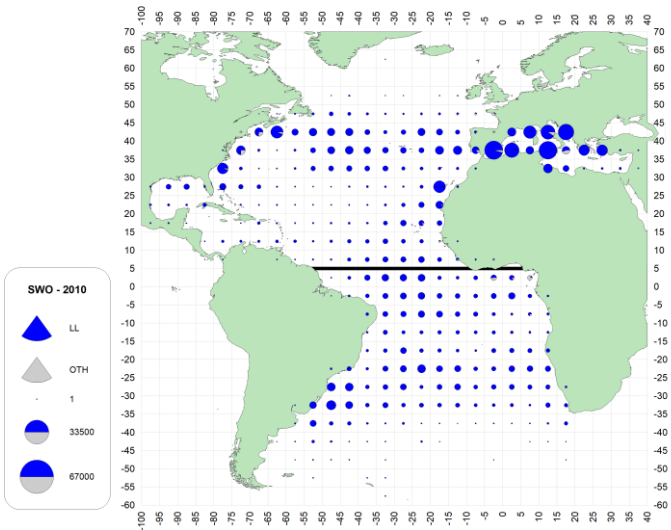
b. SWO (1980-89)



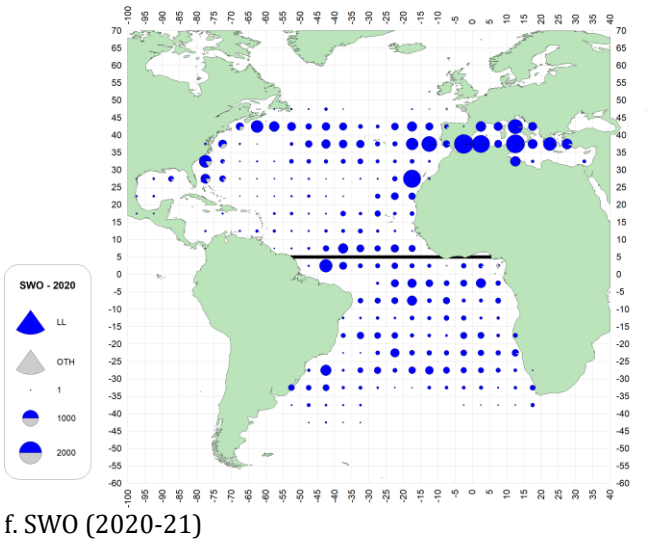
c. SWO (1990-99)



d. SWO (2000-09)

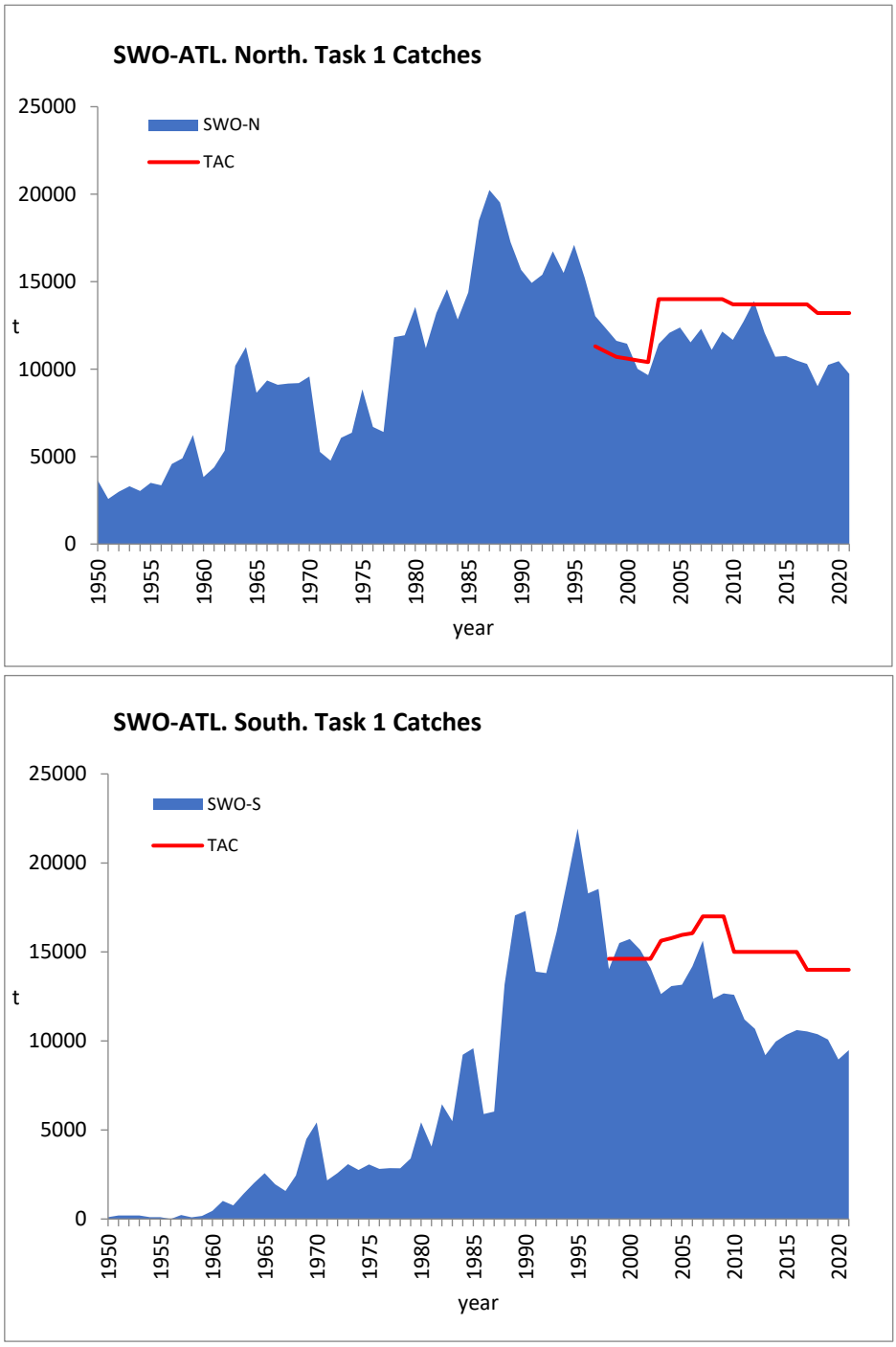


e. SWO (2010-19)

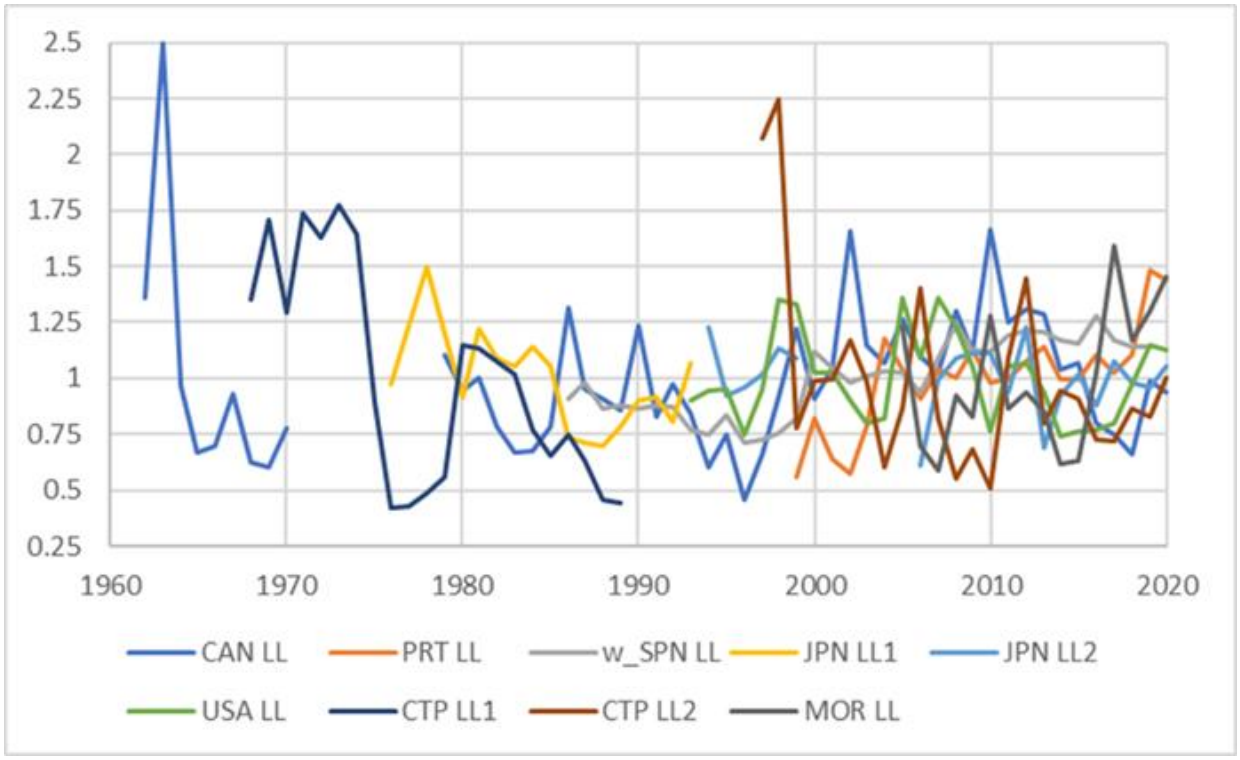


f. SWO (2020-21)

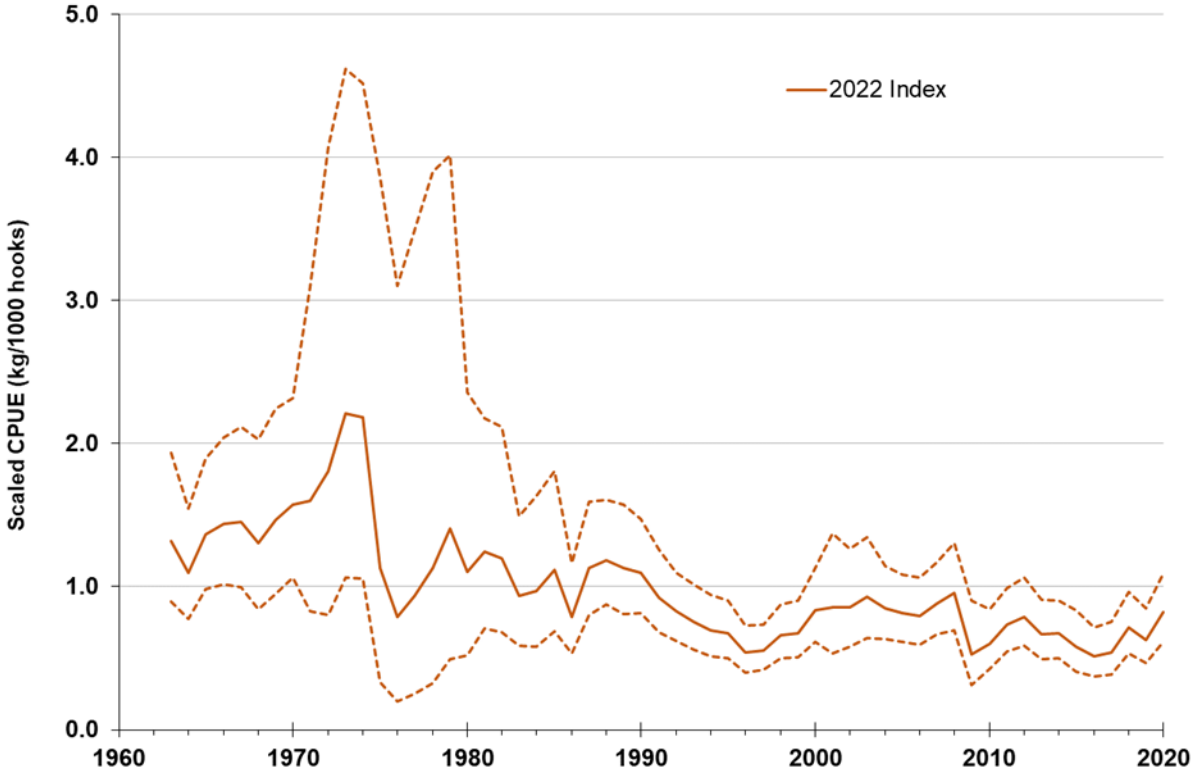
SWO-ATL-Figure 1. Geographic distribution of swordfish cumulative catch (t) by gear, in the Convention area, shown on a decadal scale. The maps are scaled to the maximum catch observed during 1970-2021 (the last decade only covers 2 years).



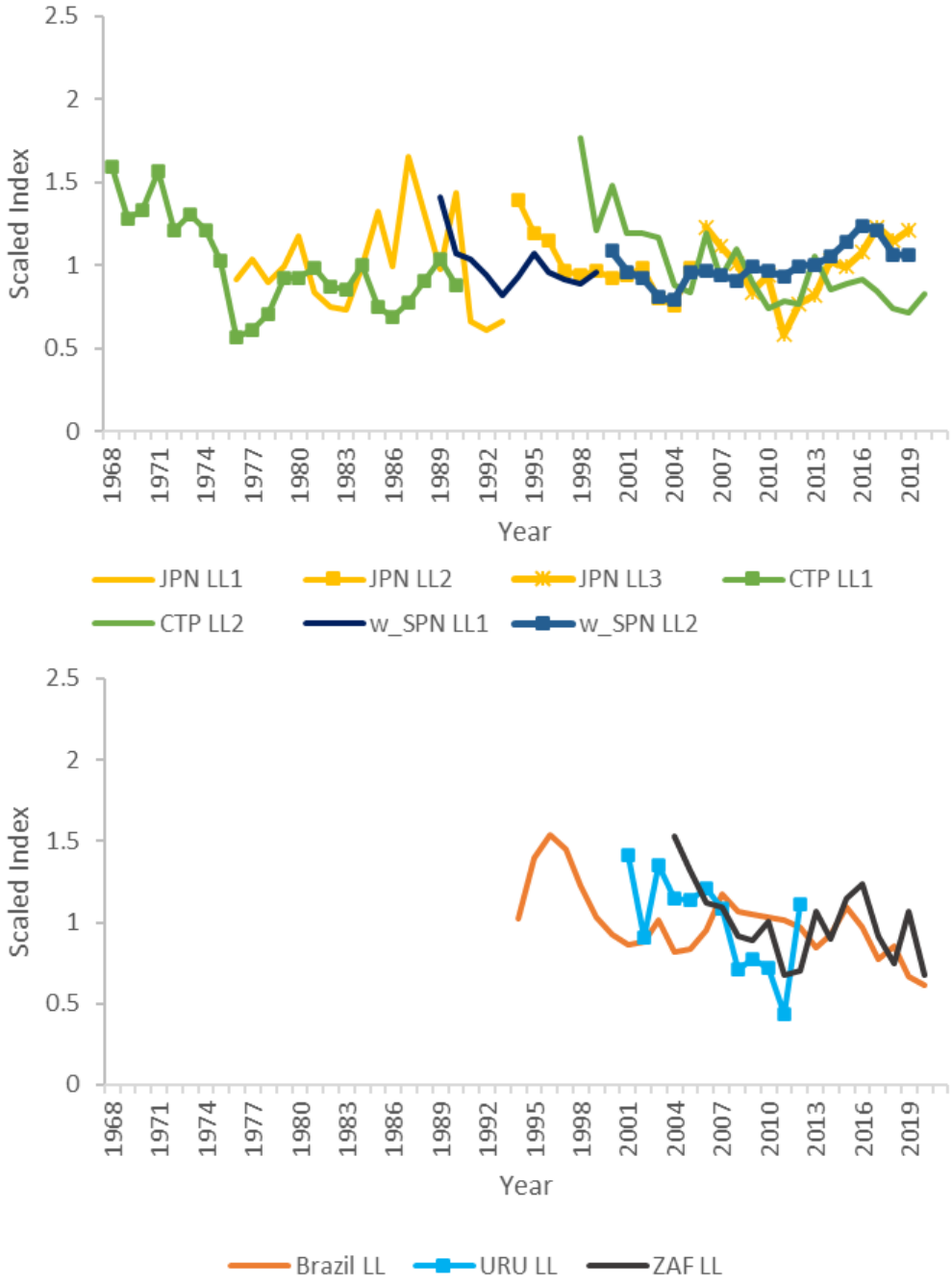
SWO-ATL-Figure 2. North (top) and South (bottom) Atlantic swordfish catches (t, landings and dead discards) and TAC (t), for the period 1950-2021.



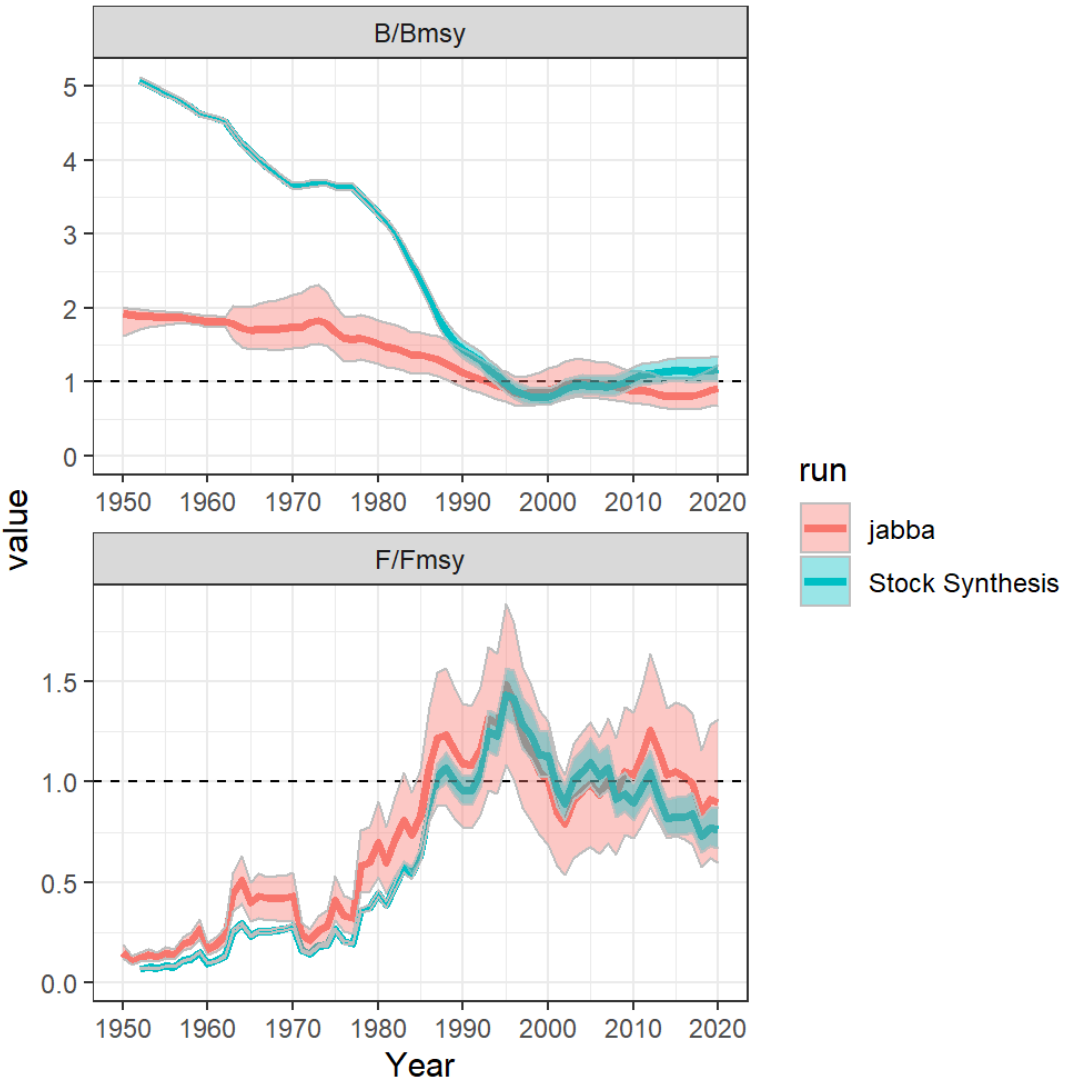
SWO-ATL-Figure 3. Standardized CPUEs series provided by CPCs for the North Atlantic swordfish and the combined index for the base continuity production model. The CPUE series were scaled to their mean for comparison purposes.



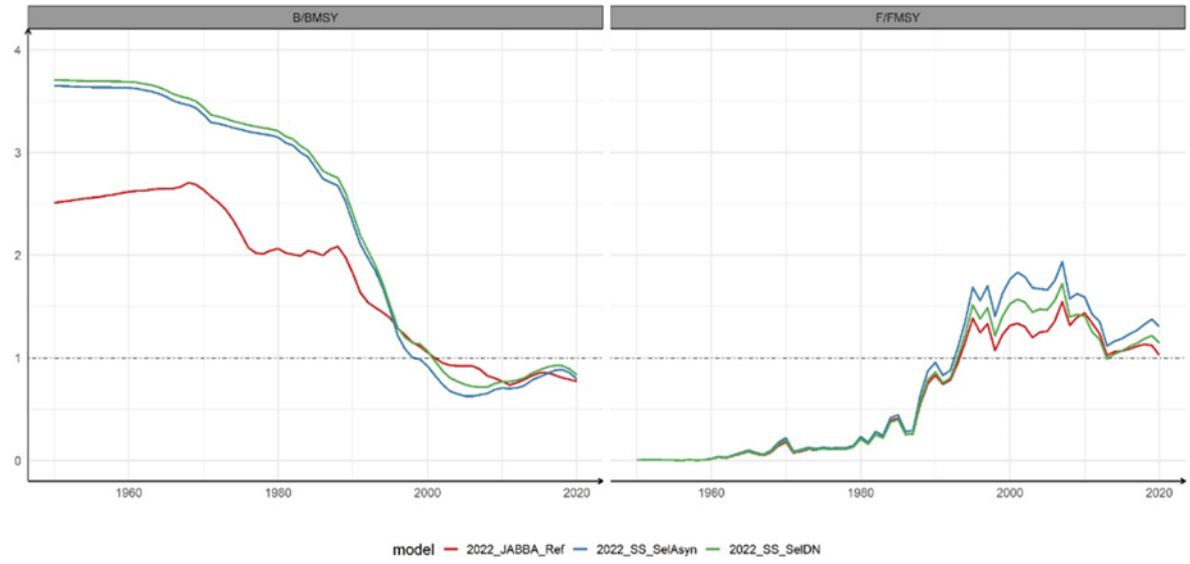
SWO-ATL-Figure 4. Standardized combined biomass CPUE index for North Atlantic and 95% confidence intervals, used as the continuity run for the production models.



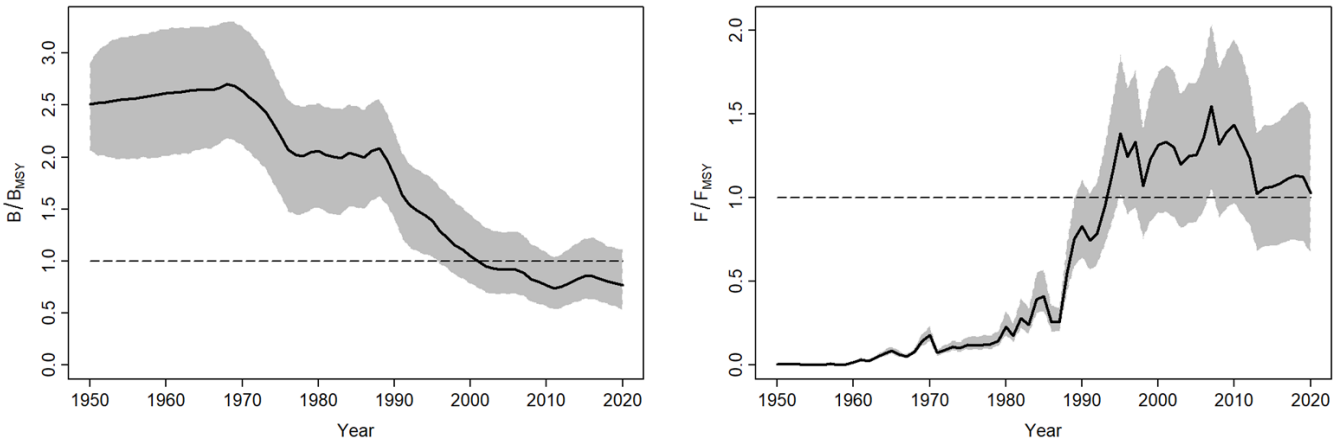
SWO-ATL-Figure 5. Standardized CPUEs series for that were used in the assessment of the South Atlantic swordfish, Indices that were split (JPN, EU-SPN and CTP) are shown on the top, and the rest (BRA, URU and ZAF) are shown at the bottom. The CPUE series were scaled to their mean for comparison purposes.



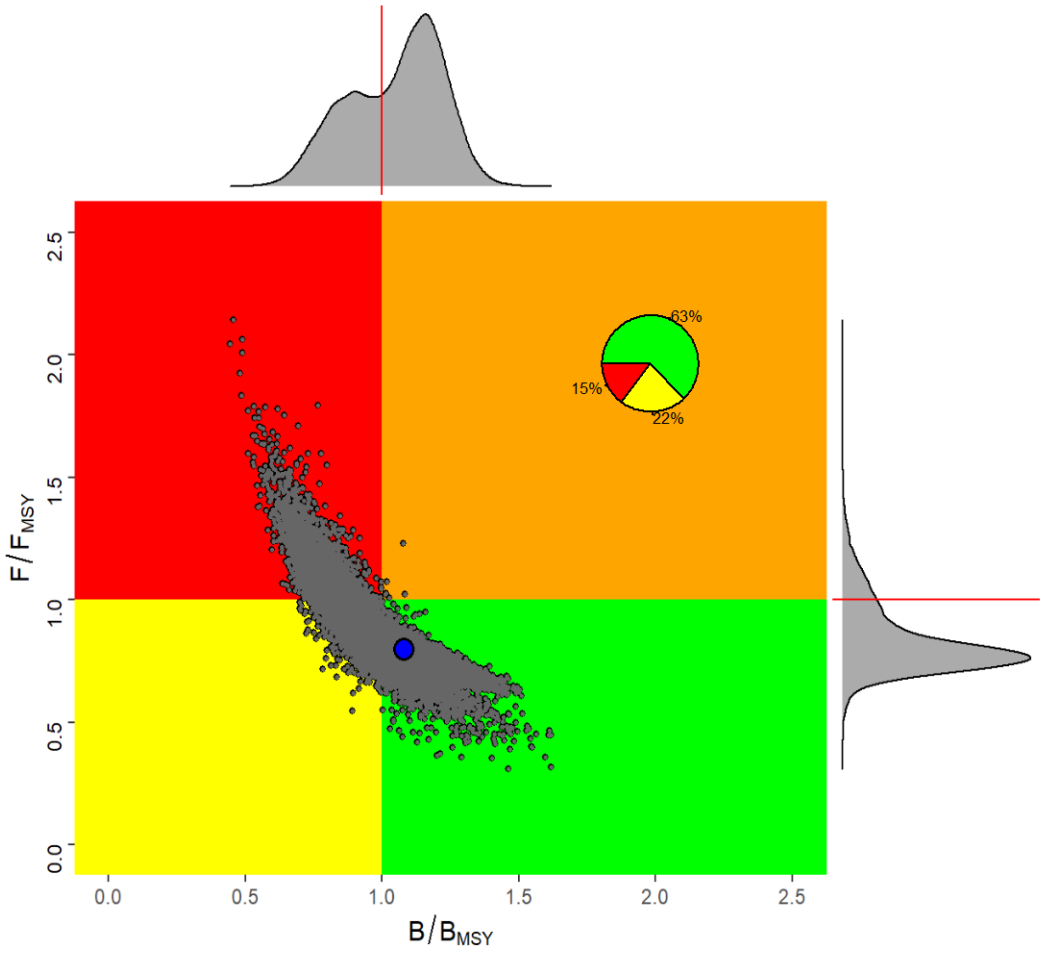
SWO-ATL-Figure 6. Results from the two models used for management advice in the North Atlantic swordfish assessment: JABBA and Stock Synthesis. Trends in relative biomass (top) and fishing mortality (bottom). Uncertainty intervals are approximations of 95% credibility intervals.



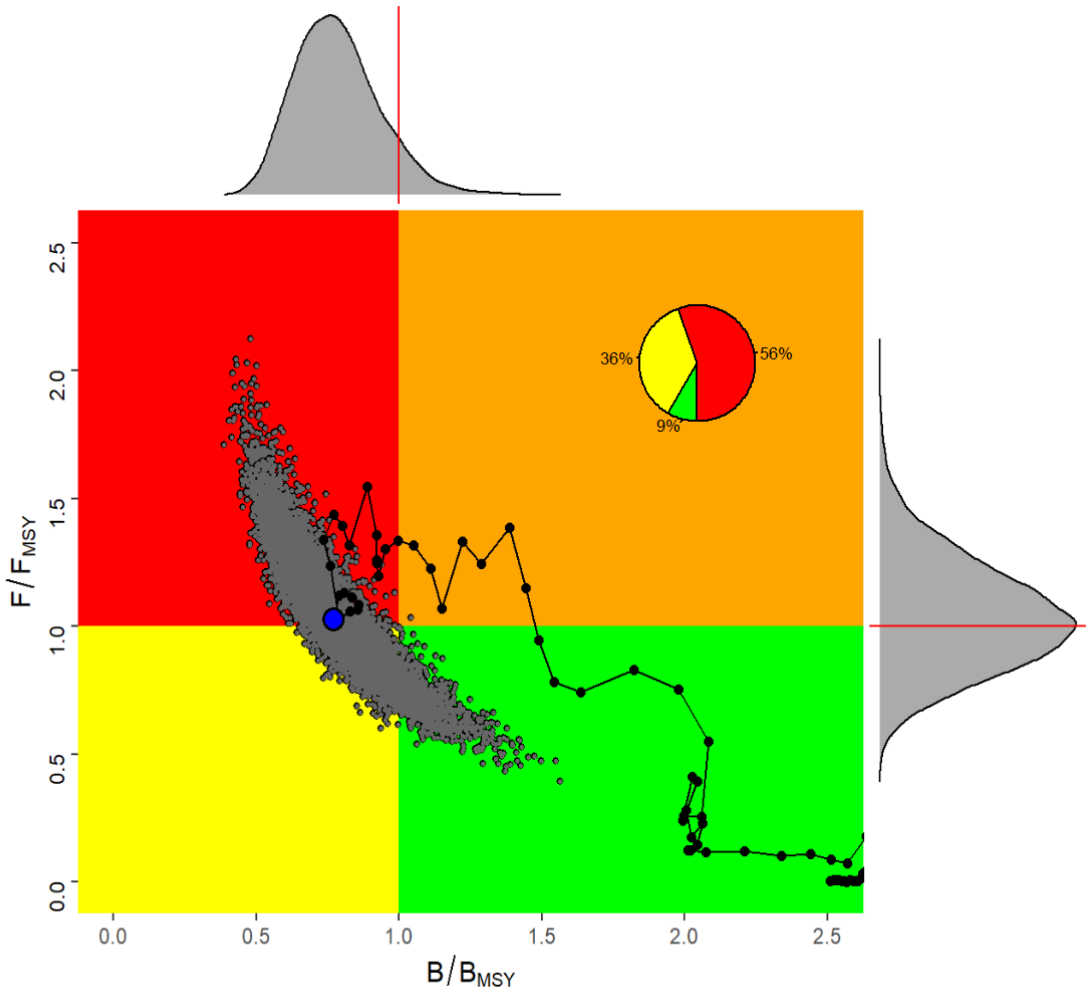
SWO-ATL-Figure 7. Comparisons of B/B_{MSY} and F/F_{MSY} between JABBA base case and two SS runs for the South Atlantic swordfish stock.



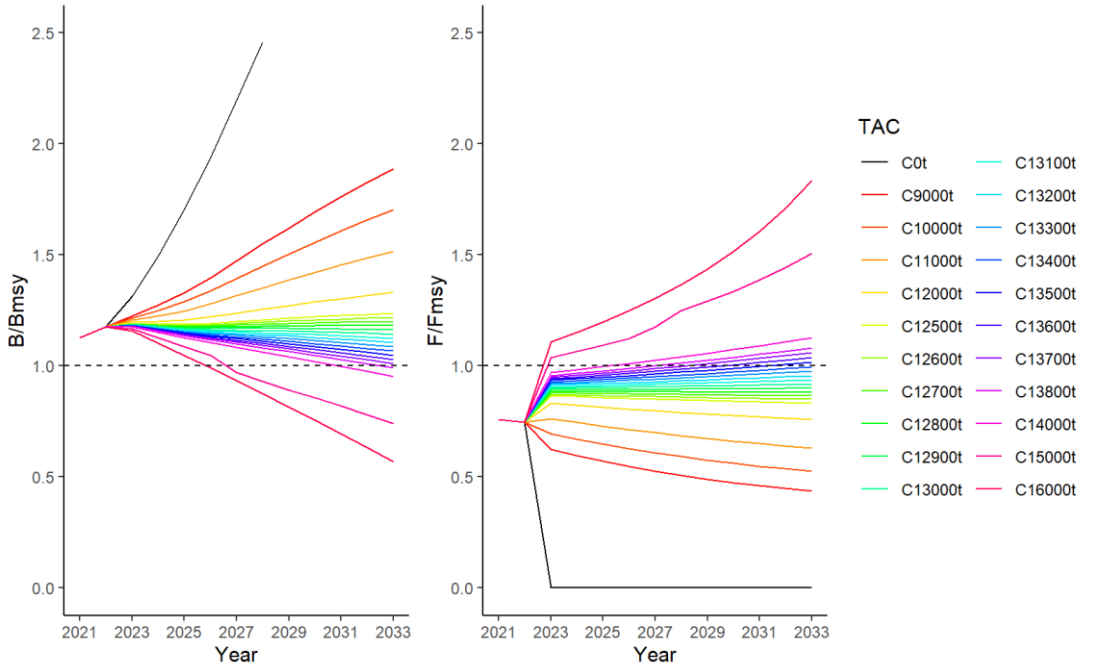
SWO-ATL-Figure 8. South Atlantic swordfish biomass and fishing mortality rates relative to MSY levels, from the JABBA base case model. Grey areas represent 95% credibility intervals.



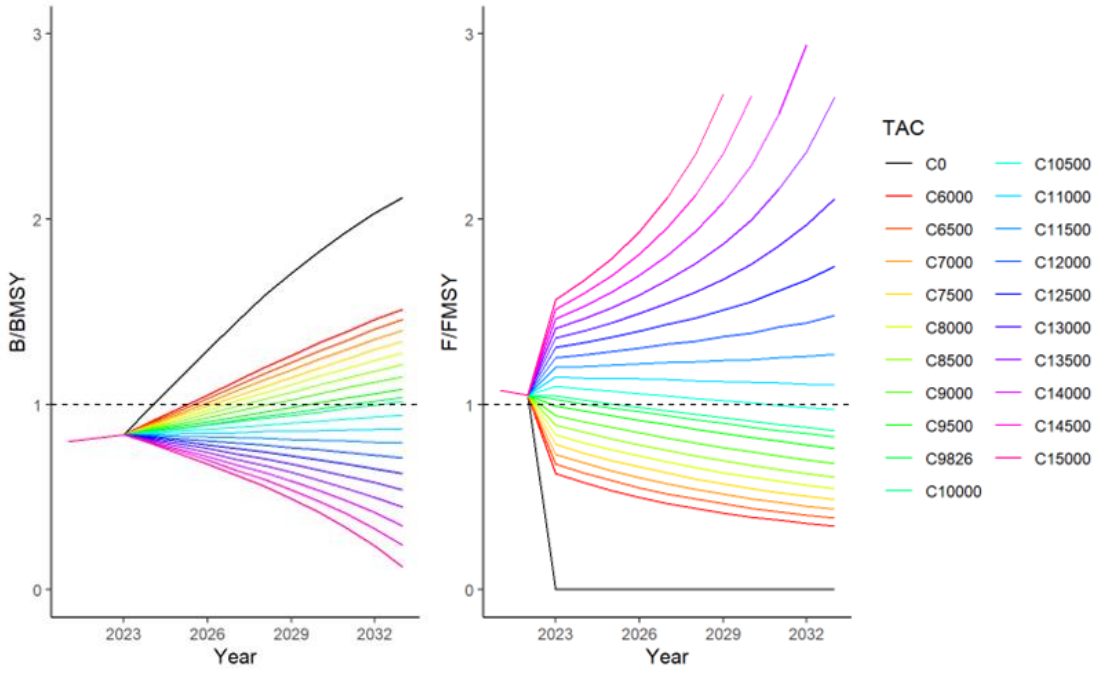
SWO-ATL-Figure 9. Joint Kobe plot for the Stock Synthesis and the JABBA reference case models for the North Atlantic swordfish stock. For the Stock Synthesis run, the benchmark is calculated from the year-specific selectivity and fleet allocations and based on 15000 MVLN iterations for Stock Synthesis and 15000 MCMC iterations for JABBA. The blue point shows the median of 30,000 iterations for SSB_{2020}/SSB_{MSY} or B_{2020}/B_{MSY} and F_{2020}/F_{MSY} for the entire iterations from Stock Synthesis and JABBA. Grey points represent the 2020 estimates of relative fishing mortality and relative spawning stock biomass for 2020 for each of the 30,000 iterations. The upper graph represents the smoothed frequency distribution of SSB_{2020}/SSB_{MSY} or B_{2020}/B_{MSY} estimates. The right graph represents the smoothed frequency distribution of F_{2020}/F_{MSY} estimates. The inserted pie graph represents the percentage of each 2020 estimate that fall in each quadrant of the Kobe plot. All SSB for Stock Synthesis showed the values at the end of years. The blue dot is the median of the 2020 stock status.



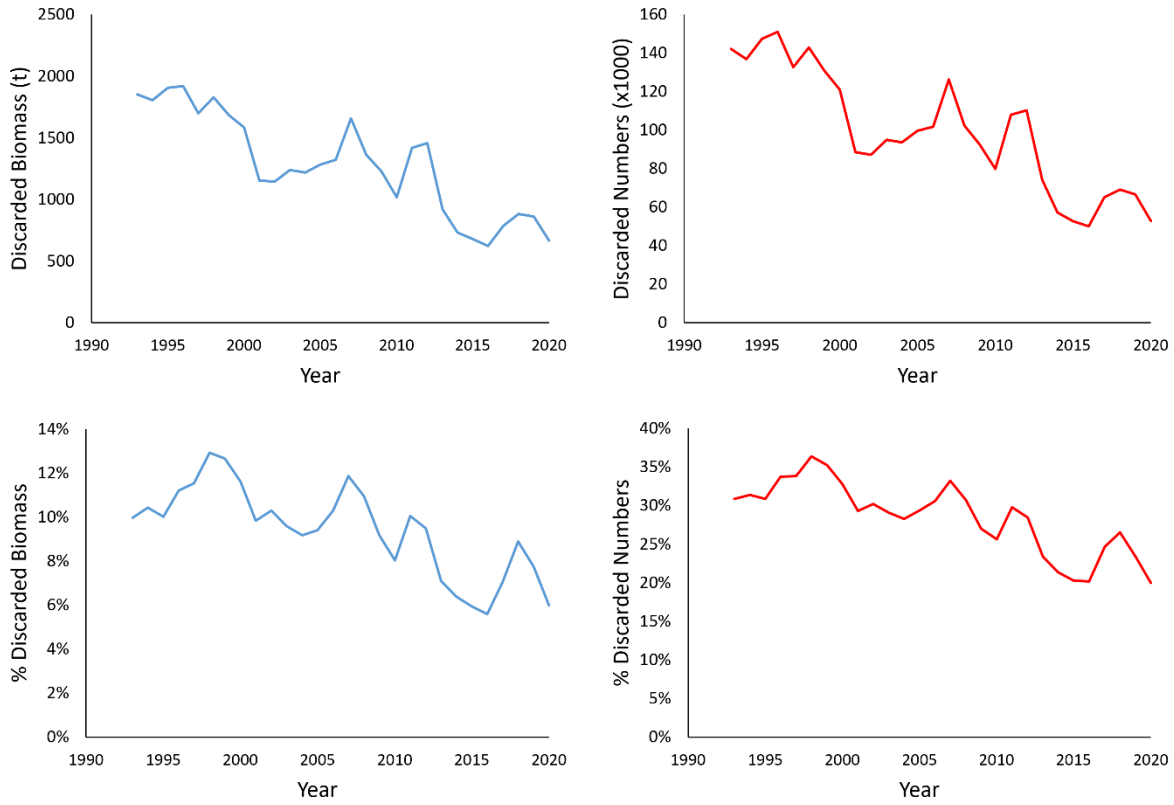
SWO-ATL-Figure 10. Kobe plot for the JABBA reference base case model for southern Atlantic swordfish. The solid blue circle is the estimated median point with the respective uncertainties in the terminal year (2020). The pie chart represents the probabilities of stock being in the different colour quadrants (red 56%, yellow 36%, green 9%). The blue dot represents the 2020 stock status.



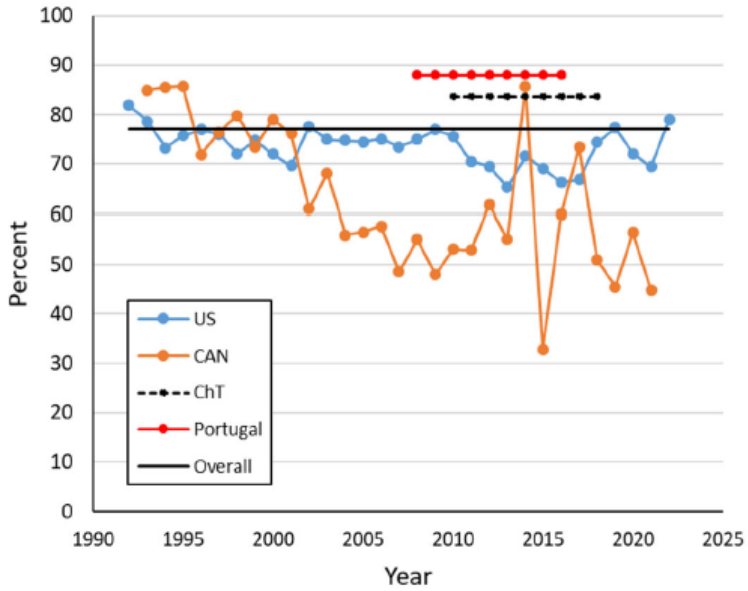
SWO-ATL-Figure 11. Joint projections from Stock Synthesis and JABBA of biomass (or spawning stock biomass) at 0, 9-16 thousand t constant TACs for the North Atlantic swordfish stock.



SWO-ATL-Figure 12. Median trends of relative biomass (B/B_{MSY}) for the projected South Atlantic swordfish stock derived from the JABBA base case model at 0, 6-15 thousand t constant TACs for the period 2023-2033.



SWO-ATL-Figure 13. Estimated total discards due to the minimum size regulation in absolute biomass and numbers (top row) and in biomass and numbers as a proportion of the catch (bottom row) for years 1992 to 2020, as estimated by Stock Synthesis.



SWO-ATL-Figure 14. Direct observations of at-haulback mortality of fish below the minimum size limit in four longline fleets operating in the North Atlantic.