INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS

COMMISSION INTERNATIONALE POUR LA CONSERVATION DES THONIDES DE L'ATLANTIQUE

COMISIÓN INTERNACIONAL PARA LA CONSERVACIÓN DEL ATÚN ATLÁNTICO

REPORT OF THE STANDING COMMITTEE ON RESEARCH AND STATISTICS (SCRS)

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BLUEFIN TUNA - WEST

BFTW-2. Fishery indicators

The total catch for the West Atlantic peaked at 18,671 t in 1964, mostly due to the Japanese longline fishery for large fish off Brazil (that started in 1962) and the U.S. purse seine fishery for juvenile fish **(BFT-Table 1, BFTW-Figure 1)**. Catches dropped sharply thereafter with the collapse of the bluefin tuna by-catch longline fishery off Brazil in 1967 and decline in purse seine catches, but increased again to average over 5,000 t in the 1970s due to the expansion of the Japanese longline fleet into the northwest Atlantic and Gulf of Mexico and an increase in purse seine effort targeting larger fish for the sashimi market. The total catch for the West Atlantic including discards has been relatively stable since 1982 due to the imposition of quotas. However, since a total catch level of 3,319 t in 2002 (the highest since 1981, with all three major fishing nations indicating higher catches), total catch in the West Atlantic declined steadily to a low of 1,638 t in 2007 and then increased in 2008 and 2009 to 2,000 t and 1,980 t, respectively. The catch in 2012 was 1,750 t **(BFTW-Figure 1).** The decline through 2007 was primarily due to considerable reductions in catch levels for U.S. fisheries. Since 2002, the Canadian annual catches have been relatively stable at about 500-600 t (735 t in 2006); the 2006 catch was the highest recorded since 1977 (972 t). The 2012 Canadian catch (including dead discards) was 493 t. Japanese catches have generally fluctuated between 300-500 t, with the exception of 2003 (57 t), which was low for regulatory reasons, and 2009 (162 t). Japanese landings for 2011 were considerably higher than previous at 578 t, while catch in 2012 was 289 t.

The average weight of bluefin tuna taken by the combined fisheries in the West Atlantic were historically low during the 1960s and 1970s **(BFTW-Figure 2)**, for instance showing an average weight of only 33 kg during the 1965-1975 period. However, since 1980 they have been showing a quite stable trend and at a quite high average weight of 93 kg.

The overall number of Japanese vessels engaged in bluefin fishing has declined from more than 100 vessels to currently less than 10 vessels in the West Atlantic. After reaching a catch level of 2,014 t in 2002 (the highest level since 1979), the catches (landings and discards) of U.S. vessels fishing in the northwest Atlantic (including the Gulf of Mexico) declined precipitously during 2003-2007. The United States did not catch its quota in 2004-2008 with catches of 1,066, 848, 615, 858 and 922 t, respectively. However, in 2009 the United States fully realized its base quota with total catches (landings including dead discards) of 1,272 t and since that time catches have remained around 900 t with a catch in 2012 of 915 t.

The indices of abundance used in the 2012 assessment were updated through 2012 **(BFTW-Figure 3)**. The catch rates of juvenile bluefin tuna in the U.S. rod and reel fishery fluctuate with little apparent long-term trend, but exhibit a pattern that is consistent with the strong year-class estimated for 2003 and showed small increases in 2010 and 2011, but declined in 2012. The catch rates of adults in the U.S. rod and reel fishery remain low, but increased in 2010 to the highest level since 2002, showed a small decrease in 2011 and 2012. The catch rates of the Japanese longline fishery north of 30°N fluctuated significantly since 2007, showing considerably high values for 2007, 2009, 2011, and 2012 fishing years. These high indices might be related to an increase in abundance of relatively small (135-150cm, 50-60 kg) and medium (180-200 cm, 115-165 kg) sized bluefin. The catch rates from the U.S. Gulf of Mexico longline fishery showed a gradual increasing trend from 1996 to 2008, a slight decrease afterwards, and a sharp increase in 2012. The nominal catch rates in the Gulf of St. Lawrence have increased steadily since 2004 and the catch rates in 2011 were the highest in the time series considered in the 2012 assessment, and further increased in 2012. The nominal catch rates in southwest Nova Scotia have continued to follow a general increasing trend since 2000. The Gulf of Mexico larval survey (the only fishery independent indicator) continues to fluctuate around the low levels observed since the 1980s. In view of these trends, there is no indication of a change in stock status sufficient to warrant advancing the scheduling of the next stock assessment.

BFTW-3. State of the stock

The most recent assessment was conducted in 2012 and included information through 2011 (Anon. 2013). The SCRS cautions that the conclusions of that assessment do not capture the full degree of uncertainty in the assessments and projections. An important factor contributing to uncertainty is mixing between fish of eastern and western origin. Based on earlier work, the estimates of stock status can be expected to vary considerably depending on the type of data used to estimate mixing (conventional tagging or isotope signature samples) and modeling assumptions made. Mixing models will be further investigated prior to the next assessment. Another important source of uncertainty is recruitment, both in terms of recent levels (which are estimated with low precision in the assessment), and potential future levels (the "low" vs. "high" recruitment hypotheses which affect management benchmarks). Improved knowledge of maturity at age will also affect the perception of changes in stock size. Finally, the lack of representative samples of otoliths requires determining the catch at age from length samples, which is imprecise for larger bluefin tuna. Many of these deficiencies are being addressed by current research programs.

The 2012 assessment estimated trends that are consistent with previous analyses in that spawning stock biomass (SSB) declined steadily from 1970 to 1992 and has since fluctuated between 25% and 36% of the 1970 level (**BFTW-Figure 4**). In recent years, however, there appears to have been a gradual increase in SSB from 27% in 2003 to an estimated 36% in 2011. Since 1998, when the rebuilding plan was adopted, the SSB has increased by 19%. The stock has experienced different levels of fishing mortality (F) over time, depending on the size of fish targeted by various fleets (**BFTW-Figure 4**). Fishing mortality on spawners (ages 9 and older) declined markedly after 2003.

Estimates of recruitment were very high in the early 1970s (**BFTW-Figure 4**), and previous analyses involving longer catch and index series suggest that recruitment was also high during the 1960s. Since 1977, recruitment has varied from year to year without trend with the exception of a strong year-class in 2003. The previous assessment estimated that the 2003 year-class was the largest since 1974, but the current assessment estimates two somewhat smaller year classes (2002 and 2003) instead. The Committee continues to believe the 2003 year class was large based on the progression of size classes through various fisheries; and the estimate of two adjacent but smaller year classes is likely an artifact of the lack of direct observations of the age of fish in the catch and recent regulations in the United States that limited the take of fish in that size range. In 2012, the 2003 year class has started to contribute to the spawning biomass.

A key factor in estimating MSY-related benchmarks is the highest level of recruitment that can be achieved in the long term. Assuming that average recruitment cannot reach the high levels from the early 1970s, recent F (2008-2010) is 61% of F_{MSY} and SSB_{2011} is about 140% of SSB_{MSY} (**BFTW-Figure 5, BFTW-Figure 6**). Estimates of stock status are more pessimistic if a high recruitment scenario is considered (F =160% of F_{MSY}, SSB =19% of SSB_{MSY}).

The Committee recognizes that the large uncertainty in stock status is exacerbated by the lack of appropriate information/data and scientific surveys, and suggests using a scientific research quota (as recommended previously by the SCRS) to help support the improvement of stock abundance indices for western Atlantic bluefin tuna and overcome this standstill situation. However, the Committee also points out that the collection of the information mentioned above is a long-term endeavor.

BFTW-4. Outlook

A medium-term outlook evaluation of changes in spawning stock size and yield over the remaining rebuilding period under various management options was conducted in 2012. Future recruitment was assumed to fluctuate under two scenarios: (i) average levels observed for 1976-2008 (87,000 fish, the low recruitment potential scenario) and (ii) levels that increase as the stock rebuilds (MSY level of 280,000 fish, the high recruitment potential scenario). The Committee has no strong evidence to favor either scenario over the other and notes that both are plausible (but not extreme) lower and upper bounds on rebuilding potential.

The outlook for bluefin tuna in the West Atlantic is summarized in **BFTW-Figure 7 and BFTW-Tables 1-3**. The low recruitment scenario suggests the stock is above the MSY level with greater than 60% probability and catches of 2,500 t or lower will maintain it above the MSY level. Constant catches of 2,000 t would result in 2019 SSB nearly equal to that in 2012. If the high recruitment scenario is correct, then the western stock will not rebuild by 2019 even with no catch, although catches of 1,200 t or less are predicted to have a 60% chance to immediately end overfishing and initiate rebuilding.

The Committee notes that considerable uncertainties remain for the outlook of the western stock, including the effects of mixing and management measures on the eastern stock.

BFTW-5. Effect of current regulations

The Committee previously noted that Recommendation 08-04, which was implemented in 2009, was expected to result in a rebuilding of the stock towards the convention objective, but also noted that there has not yet been enough time to detect with confidence the population response to the measure. This statement is also true for

Recommendation 10-03, which was implemented in 2011, and Recommendation 12-02, which was implemented in 2013. Nevertheless, the available fishery indicators **(BFTW-Figure 3)** as well as the 2012 assessment suggest the spawning biomass of western bluefin tuna continues to increase.

BFTW-6. Management recommendations

In 1998, the Commission initiated a 20-year rebuilding plan designed to achieve SSB_{MSY} with at least 50% probability. In response to recent assessments, the Commission recommended a total allowable catch (TAC) of 1,900 t in 2009, 1,800 t in 2010 [Rec. 08-04] and 1,750 t in 2011, 2012 and 2013 [Rec. 10-03, Rec. 12-02].

The most recent (2012) assessment indicates similar historical trends in abundance as in previous assessments. The strong 2003 year class has contributed to stock productivity such that total biomass has been increasing in recent years.

Future stock productivity, as with prior assessments, is based upon two hypotheses about future recruitment: a ‘high recruitment scenario” in which future recruitment has the potential to achieve levels that occurred in the early 1970s and a “low recruitment scenario” in which future recruitment is expected to remain near present levels (even if stock size increases). The results of this assessment have shown that long term implications of future biomass are different between the two hypotheses and the issue of distinguishing between them remains unresolved.

Probabilities of achieving SSB_{MSY} within the Commission rebuilding period were projected for alternative catch levels **(BFTW-Table 1)**. The "low recruitment scenario" suggests that biomass is currently sufficient to produce MSY, whereas the "high recruitment scenario" suggests that SSB_{MSY} has a very low probability of being achieved within the rebuilding period. Despite this large uncertainty about the long term future productivity of the stock, under either recruitment scenario current catches (1,750 t) should allow the biomass to continue to increase. Larger catches in excess of 2,000 t will prevent the possibility of the 2003 year class elevating the productivity potential of the stock in the future. Maintaining catch at current levels (1,750 t) is expected to allow the spawning biomass to increase, which may help resolve the issue of low and high recruitment potential. Analyses conducted in SCRS/2013/191 predict that maintaining catches of 1,750 t could allow the more correct recruitment scenario to be identified with reasonable confidence (statistical power of 70-80%) by the year 2024 and maintaining a catch of 1,000 t or less could allow the spawning biomass to rebuild enough to do so by the end of the rebuilding period (2018).

The Commission should decide the TAC, which should include the scientific research quota (such as proposed by Japan, see SCRS/2013/200, SCRS/2013/203) if it is implemented. The Committee notes that TAC should be decided considering the alternative catch levels shown above and the priority placed on protecting 2003 year class, continued stock growth, and the future ability to discriminate the recruitment hypothesis.

As noted previously by the Committee, both the productivity of western Atlantic bluefin tuna and western Atlantic bluefin tuna fisheries are linked to the eastern Atlantic and Mediterranean stock. Therefore, management actions taken in the eastern Atlantic and Mediterranean are likely to influence the recovery in the western Atlantic, because even small rates of mixing from East to West can have considerable effects on the West due to the fact that eastern plus Mediterranean resource is much larger than that of the West.

WEST ATLANTIC BLUEFIN TUNA SUMMARY (Catches and Biomass in t)		
Current (2012) Catch (including discards)	1,750 t	
Assumed recruitment	Low potential	High potential
Maximum Sustainable Yield (MSY)	2,634 (2,452-2,834)[1]	6,472 (5,736-7,500)[1]
SSB_{MSY}	12,943 (12,717-13,268)[1]	93,621 (77,288-116,679)
SSB_{2011}/SSB_{MSY}	1.4 (1.14-1.72)[1]	0.19 (0.13-0.29)[1]
F_{MSY}	0.17 (0.14-0.19)[1]	0.064 (0.056-0.074)[1]
$F_{0.1}$	0.11 (0.10-.12)[1]	0.11 (0.10-.12)[1]
$F_{2008-2010}/F_{MSY}$[2]	0.61 (0.49-0.74)[1]	1.57(1.24-1.95)[1]
$F_{2008-2010}/F_{0.1}$	0.92 (0.77-1.12)[1]	0.92 (0.77-1.12)[1]
Stock status	Overfished: NO	Overfished: YES
	Overfishing: NO	Overfishing: YES
Management Measures:	[Rec. 08-04] TAC of 1,900 t in 2009 and 1,800 t in 2010, including dead discards.	
	[Rec. 10-03, Rec. 12-02] TAC of 1,750 t in 2011-2013, including dead discards.	

[1] Median and approximate 80% confidence interval from bootstrapping from the assessment.
[2] $F_{2008-2010}$ refers to the geometric mean of the estimates for 2008-2010 (a proxy for recent F levels).

BFTW-Table 1. Kobe II matrices (updated during the 2012 stock assessment) giving the probability that the spawning stock biomass will exceed the level that will produce MSY ($B>B_{MSY}$, not overfished) in any given year for various constant catch levels under the low recruitment, high recruitment, and combined scenarios. The current TAC of 1,750 t [Rec. 10-03] is indicated in bold.

Low Recruitment

TAC	2012	2013	2014	2015	2016	2017	2018	2019
0	98%	98%	99%	100%	100%	100%	100%	100%
1600	98%	97%	96%	96%	96%	97%	99%	99%
1750	98%	97%	94%	96%	94%	97%	97%	98%
1900	98%	97%	94%	95%	93%	95%	96%	97%
2100	98%	97%	94%	94%	91%	92%	93%	94%
2300	98%	96%	93%	93%	87%	87%	90%	89%
2500	98%	96%	92%	92%	84%	84%	84%	84%
2600	98%	96%	91%	90%	82%	82%	80%	80%
2700	98%	96%	91%	89%	80%	78%	77%	76%
2800	98%	96%	90%	88%	78%	76%	75%	72%
2900	98%	96%	90%	87%	77%	73%	70%	67%
3000	98%	96%	89%	85%	74%	70%	67%	62%
3100	98%	96%	87%	83%	70%	68%	61%	56%
3200	98%	95%	87%	82%	67%	63%	57%	52%
3300	98%	95%	86%	81%	66%	58%	53%	47%

High Recruitment

TAC (t)	2012	2013	2014	2015	2016	2017	2018	2019
0	0%	0%	0%	0%	0%	0%	0%	0%
500	0%	0%	0%	0%	0%	0%	0%	0%
1000	0%	0%	0%	0%	0%	0%	0%	0%
1500	0%	0%	0%	0%	0%	0%	0%	0%
1750	0%	0%	0%	0%	0%	0%	0%	0%
2000	0%	0%	0%	0%	0%	0%	0%	0%

Combined

TAC (t)	2012	2013	2014	2015	2016	2017	2018	2019
0	49%	49%	49%	50%	50%	50%	50%	50%
100	49%	49%	49%	50%	50%	50%	50%	50%
200	49%	49%	49%	50%	50%	50%	50%	50%
300	49%	49%	49%	50%	50%	50%	50%	50%
400	49%	49%	49%	50%	50%	50%	50%	50%
500	49%	49%	49%	50%	50%	50%	50%	50%
600	49%	49%	49%	50%	50%	50%	50%	50%
700	49%	49%	49%	50%	50%	50%	50%	50%
800	49%	49%	49%	50%	50%	50%	50%	50%
900	49%	49%	48%	50%	50%	50%	50%	50%
1000	49%	49%	48%	49%	50%	50%	50%	50%
1100	49%	48%	48%	49%	49%	50%	50%	50%
1200	49%	48%	48%	49%	49%	50%	50%	50%
1300	49%	48%	48%	49%	49%	50%	50%	50%
1750	49%	48%	47%	48%	47%	48%	49%	49%
1800	49%	48%	47%	48%	47%	48%	48%	49%
1900	49%	48%	47%	48%	47%	48%	48%	49%
2000	49%	48%	47%	47%	46%	47%	47%	48%
2500	49%	48%	46%	46%	42%	42%	42%	42%

BFTW-Table 2. Kobe II matrices (updated during the 2012 stock assessment) giving the probability that the fishing mortality rate (F) will be less than the level that will produce MSY ($F<F_{MSY}$, no overfishing) in any given year for various constant catch levels under the low recruitment, high recruitment, and combined scenarios. The current TAC of 1,750 t [Rec. 10-03] is indicated in bold.

Low Recruitment

TAC (t)	2012	2013	2014	2015	2016	2017	2018	2019
0	100%	100%	100%	100%	100%	100%	100%	100%
1600	100%	100%	100%	100%	100%	100%	100%	100%
1750	100%	100%	100%	100%	100%	100%	100%	100%
1900	100%	99%	100%	100%	100%	100%	100%	100%
2100	100%	99%	99%	98%	98%	99%	99%	99%
2300	100%	96%	96%	95%	94%	96%	95%	95%
2500	100%	91%	90%	86%	85%	87%	86%	84%
2600	100%	87%	85%	82%	81%	81%	81%	79%
2700	100%	83%	81%	76%	74%	75%	72%	70%
2800	100%	79%	76%	69%	67%	68%	65%	61%
2900	100%	74%	70%	62%	58%	59%	56%	53%
3000	100%	67%	63%	53%	51%	51%	48%	45%
3100	100%	60%	55%	46%	43%	44%	40%	35%
3200	100%	52%	48%	39%	36%	36%	31%	28%
3300	100%	45%	42%	33%	29%	29%	26%	23%

High Recruitment

TAC (t)	2012	2013	2014	2015	2016	2017	2018	2019
0	8%	100%	100%	100%	100%	100%	100%	100%
700	8%	100%	100%	100%	100%	100%	100%	100%
800	8%	99%	99%	100%	100%	100%	100%	100%
900	8%	95%	97%	98%	99%	100%	100%	100%
1000	8%	89%	92%	94%	97%	98%	99%	100%
1100	8%	80%	85%	87%	90%	95%	97%	98%
1200	8%	67%	75%	78%	83%	88%	91%	93%
1300	8%	52%	62%	66%	72%	81%	83%	86%
1400	8%	39%	48%	52%	60%	70%	74%	79%
1500	8%	30%	38%	41%	47%	57%	64%	68%
1600	8%	19%	28%	30%	38%	46%	53%	57%
1700	8%	13%	18%	21%	28%	37%	42%	46%
1750	8%	12%	15%	17%	23%	32%	38%	42%
1900	8%	6%	9%	10%	12%	20%	24%	28%
2100	8%	2%	3%	4%	5%	9%	11%	13%
2300	8%	1%	2%	2%	3%	3%	5%	6%

Combined

TAC (t)	2012	2013	2014	2015	2016	2017	2018	2019
0	54%	100%	100%	100%	100%	100%	100%	100%
900	54%	98%	99%	99%	100%	100%	100%	100%
1000	54%	95%	96%	97%	98%	99%	100%	100%
1100	54%	90%	93%	93%	95%	98%	98%	99%
1200	54%	83%	88%	89%	91%	94%	96%	97%
1300	54%	76%	81%	83%	86%	90%	92%	93%
1400	54%	70%	74%	76%	80%	85%	87%	90%
1500	54%	65%	69%	71%	73%	79%	82%	84%
1600	54%	59%	64%	65%	69%	73%	77%	78%
1700	54%	57%	59%	60%	64%	69%	71%	73%
1750	54%	56%	57%	59%	61%	66%	69%	71%
1800	54%	54%	56%	57%	60%	64%	66%	68%
1900	54%	53%	54%	55%	56%	60%	62%	64%
2000	54%	51%	52%	53%	54%	56%	59%	60%
2100	54%	50%	51%	51%	52%	54%	55%	56%
2200	54%	50%	50%	50%	50%	52%	53%	53%
2300	54%	49%	49%	48%	49%	50%	50%	51%
2400	54%	47%	47%	46%	46%	48%	47%	47%
2500	54%	46%	45%	44%	43%	45%	44%	43%

BFTW-Table 3. Kobe II matrices (updated during the 2012 stock assessment) giving the joint probability that the fishing mortality rate will be less than the level that will produce MSY ($F<F_{MSY}$) and the spawning stock biomass (SSB) will exceed the level that will produce MSY ($B>B_{MSY}$) in any given year for various constant catch levels under the low recruitment, high recruitment, and combined scenarios. The current TAC of 1,750 t [Rec. 10-03] is indicated in bold.

Low Recruitment

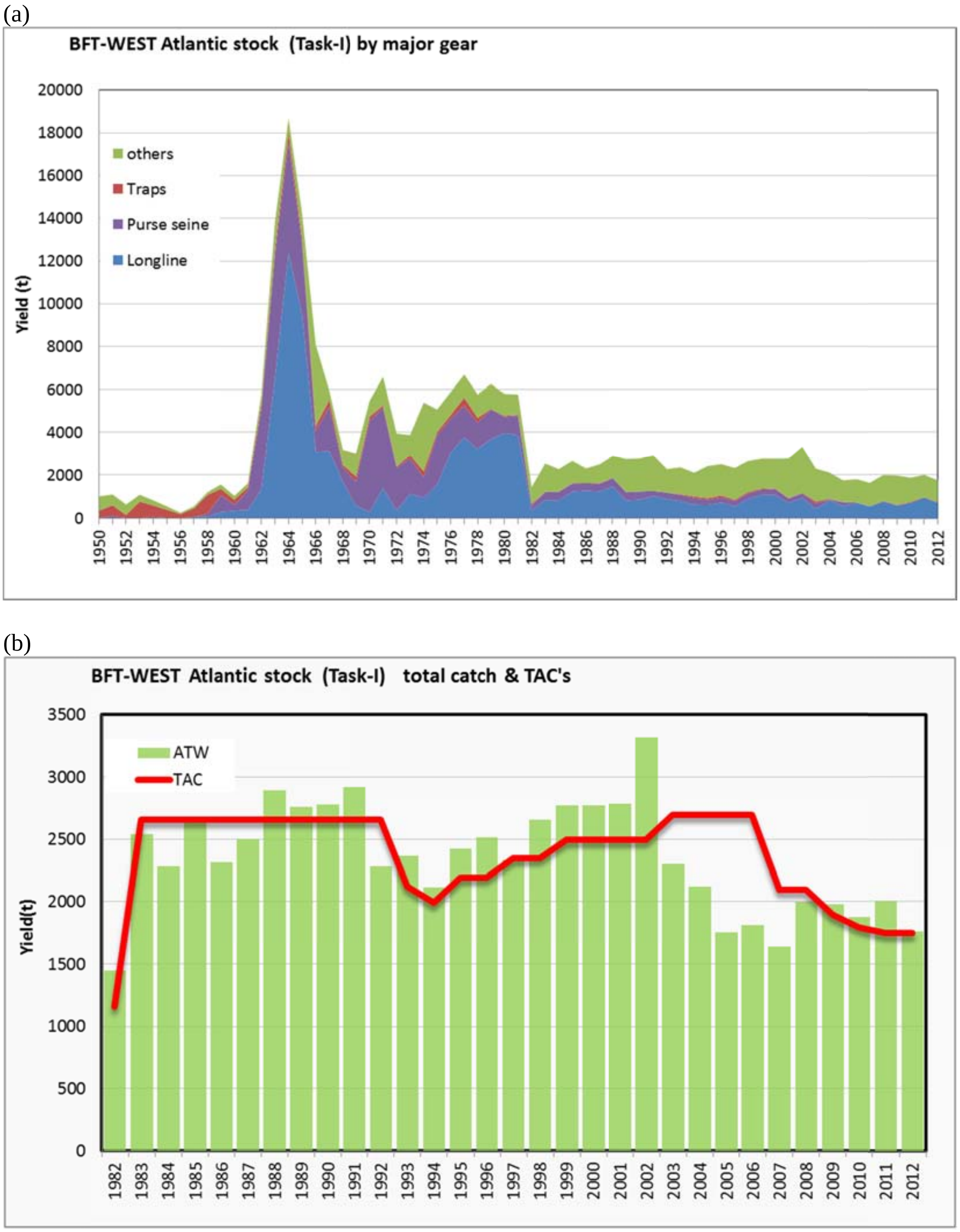
TAC	2012	2013	2014	2015	2016	2017	2018	2019
0	98%	99%	100%	100%	100%	100%	100%	100%
1600	98%	97%	96%	96%	96%	97%	99%	99%
1750	98%	97%	94%	96%	94%	97%	97%	98%
1900	98%	97%	94%	95%	93%	95%	96%	97%
2100	98%	97%	94%	94%	91%	92%	93%	94%
2300	98%	95%	93%	92%	87%	87%	90%	89%
2500	98%	91%	89%	85%	83%	83%	84%	83%
2600	98%	87%	85%	82%	79%	80%	79%	77%
2700	98%	83%	81%	76%	74%	74%	72%	70%
2800	98%	79%	76%	69%	67%	68%	65%	61%
2900	98%	74%	70%	62%	58%	59%	56%	53%
3000	98%	67%	63%	53%	51%	51%	48%	45%
3100	98%	60%	55%	46%	43%	44%	40%	35%
3200	98%	52%	48%	39%	36%	36%	31%	28%
3300	98%	45%	42%	33%	29%	29%	26%	23%

High Recruitment

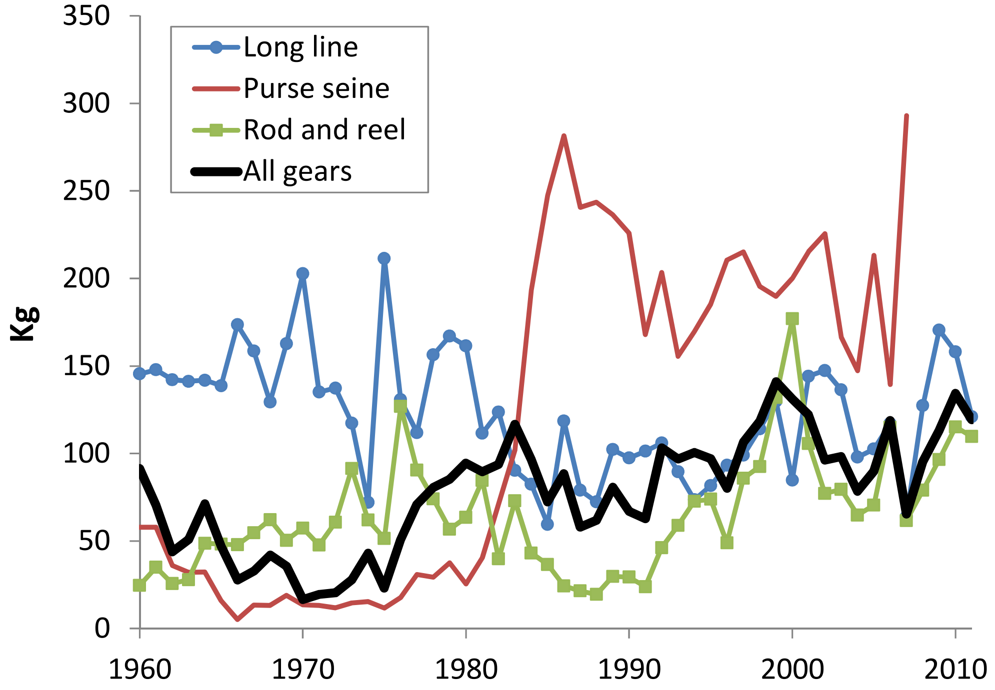
TAC (t)	2012	2013	2014	2015	2016	2017	2018	2019
0	0%	0%	0%	0%	0%	0%	0%	0%
500	0%	0%	0%	0%	0%	0%	0%	0%
1000	0%	0%	0%	0%	0%	0%	0%	0%
1500	0%	0%	0%	0%	0%	0%	0%	0%
1750	0%	0%	0%	0%	0%	0%	0%	0%
2000	0%	0%	0%	0%	0%	0%	0%	0%

Combined

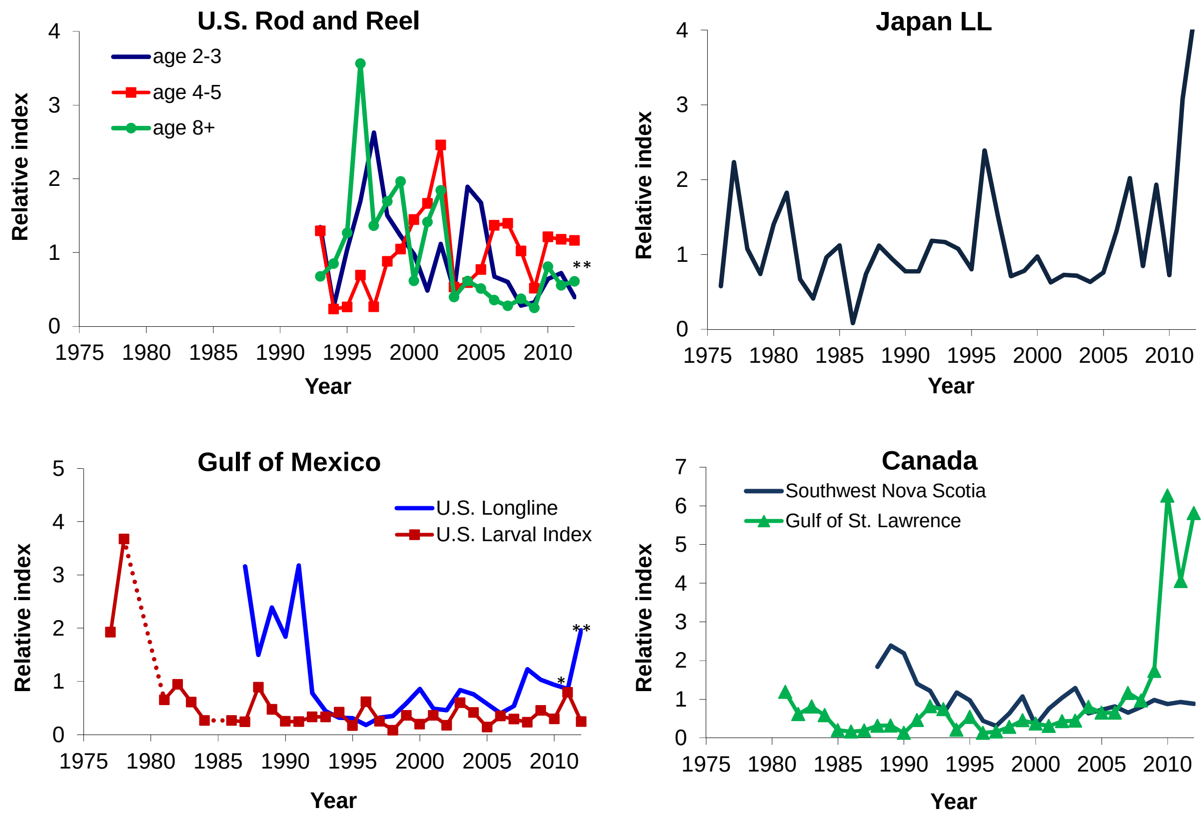
TAC (t)	2012	2013	2014	2015	2016	2017	2018	2019
0	49%	49%	49%	50%	50%	50%	50%	50%
100	49%	49%	49%	50%	50%	50%	50%	50%
200	49%	49%	49%	50%	50%	50%	50%	50%
300	49%	49%	49%	50%	50%	50%	50%	50%
400	49%	49%	49%	50%	50%	50%	50%	50%
500	49%	49%	49%	50%	50%	50%	50%	50%
600	49%	49%	49%	50%	50%	50%	50%	50%
700	49%	49%	49%	50%	50%	50%	50%	50%
800	49%	49%	49%	50%	50%	50%	50%	50%
900	49%	49%	48%	50%	50%	50%	50%	50%
1000	49%	49%	48%	49%	50%	50%	50%	50%
1100	49%	48%	48%	49%	49%	50%	50%	50%
1200	49%	48%	48%	49%	49%	50%	50%	50%
1300	49%	48%	48%	49%	49%	50%	50%	50%
1750	49%	48%	47%	48%	47%	48%	49%	49%
1800	49%	48%	47%	48%	47%	48%	48%	49%
1900	49%	48%	47%	48%	47%	48%	48%	49%
2000	49%	48%	47%	47%	46%	47%	47%	48%
2500	49%	46%	44%	43%	41%	42%	42%	41%



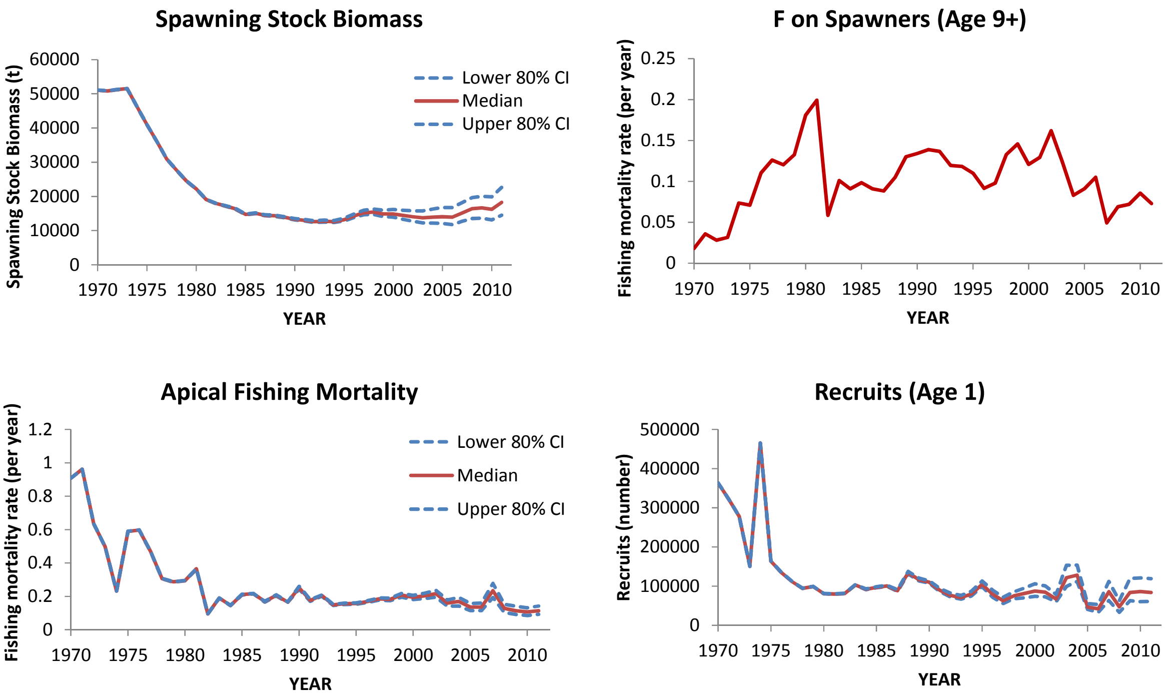
BFTW-Figure 1. Historical catches of western bluefin tuna: (a) by gear type and (b) in comparison to TAC levels agreed by the Commission.



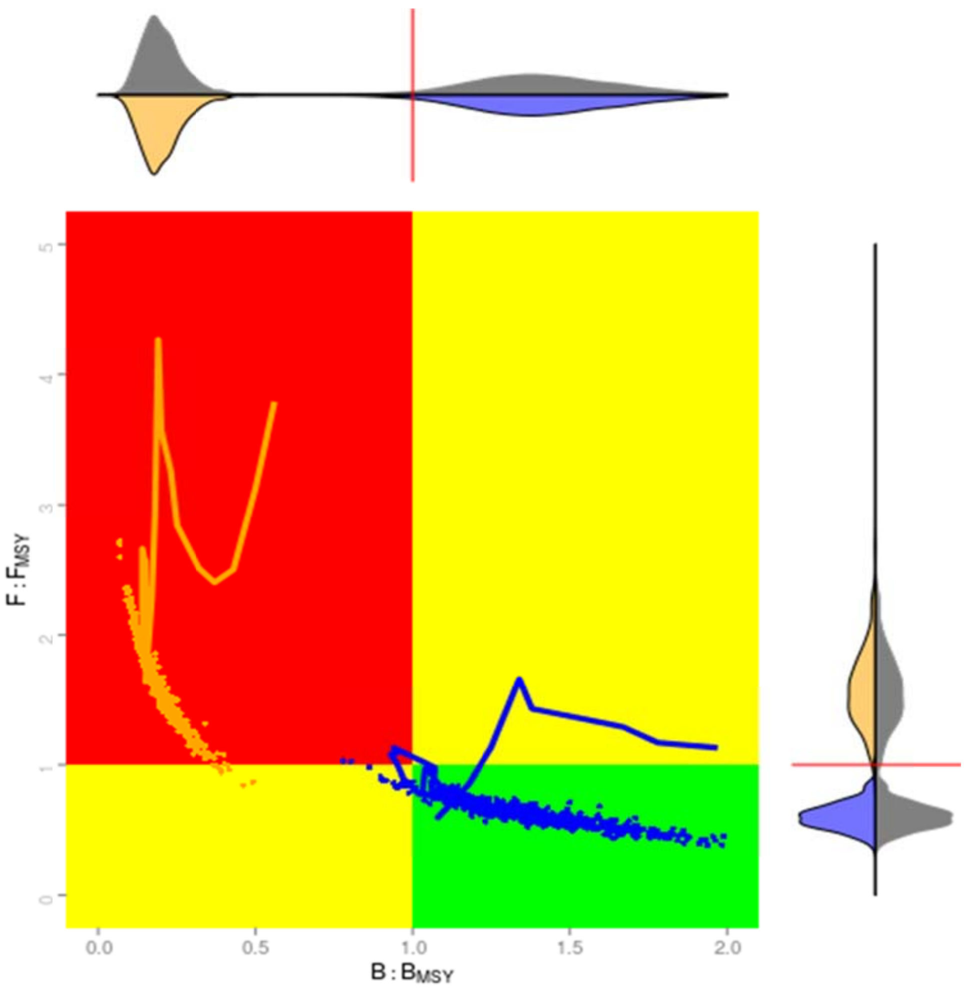
BFTW-Figure 2. Mean weight of western bluefin tuna catches by purse seine, longline, rod and reel, and all gears combined (estimated from the catch-at-size compiled information).



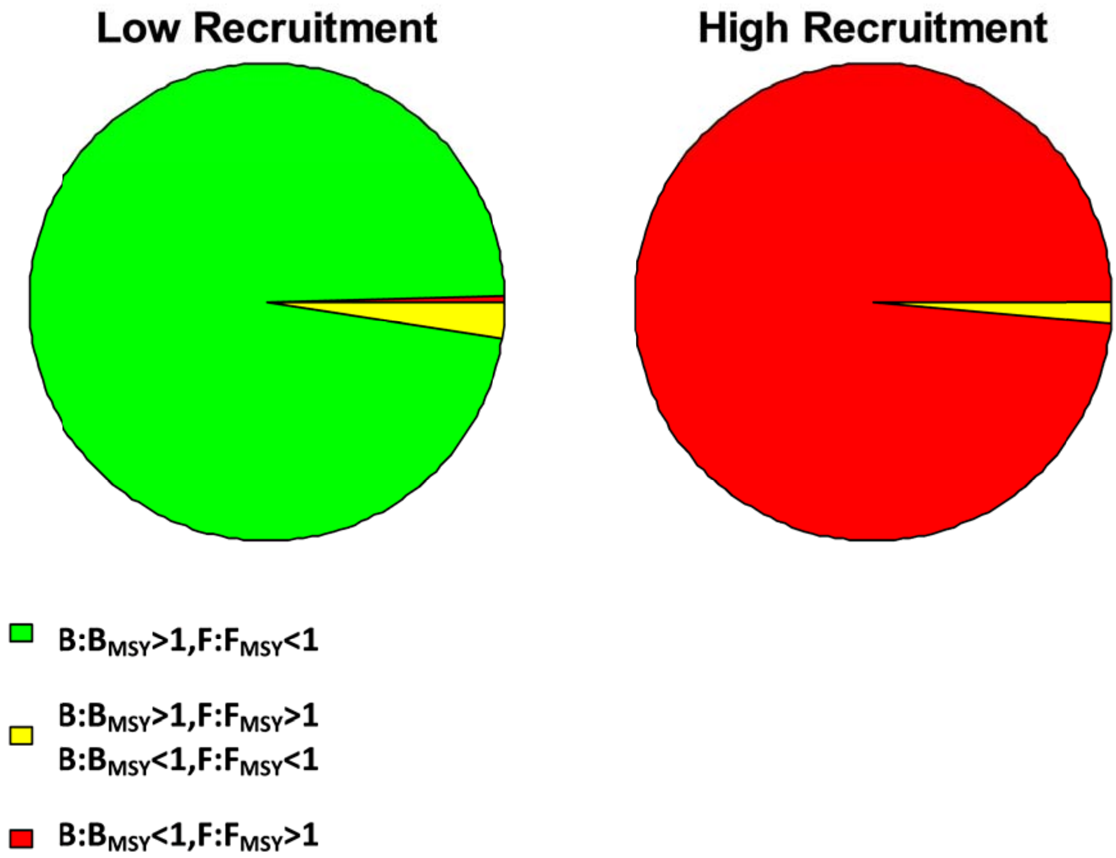
BFTW-Figure 3. Updated indices of abundance for western bluefin tuna. The dashed portions of the larval survey bridge the gaps between years where data were missing or otherwise considered unreliable by the 2012 SCRS (and not used in the base assessment). The Canadian indices represent nominal catch rates, all others are standardized indices. *The value for 2011 in the U.S. Gulf of Mexico longline index was not used in the 2012 assessment. **2012 U.S. Rod and Reel and Gulf of Mexico longline data are preliminary and subject to revision.



BFTW-Figure 4. Median estimates of spawning biomass (age 9+), fishing mortality on spawners, apical fishing mortality (F on the most vulnerable age class) and recruitment for the base VPA model. The 80% confidence intervals are indicated with dotted lines. The recruitment estimates for the last three years of the VPA are considered unreliable and have been replaced by the median levels corresponding to the low recruitment scenario.

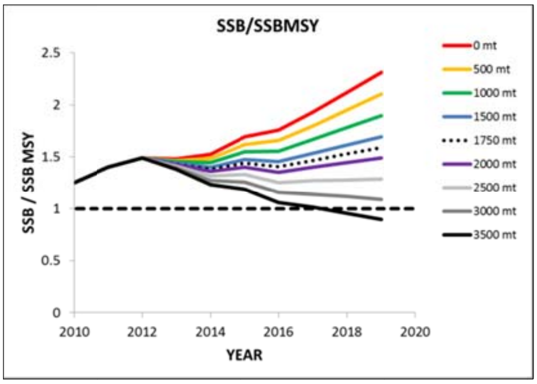


BFTW-Figure 5. Estimated status of stock relative to the Convention objectives (MSY) by year (1973 to 2011) and recruitment scenario (black=high recruitment potential, blue=low recruitment potential). The light blue dots represent the status estimated for 2011 and the clouds of symbols depict the corresponding bootstrap estimates of uncertainty..The lines give the historical point estimates. The marginal density plots shown above and to the right of the main graph reflect the frequency distribution of the bootstrap estimates of each model with respect to relative biomass (top) and relative fishing mortality (right). The frequency distributions of the combined model bootstraps are shown in light blue. The red lines represent the benchmark levels (ratios equal to 1.0)

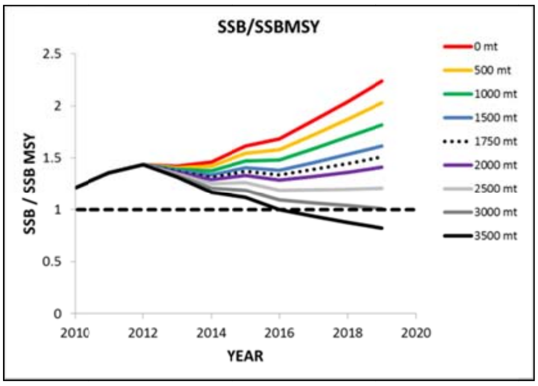


BFTW-Figure 6. Pie chart summarizing stock status, showing the proportion of model outputs that are not overfished and not undergoing overfishing (green), either overfished or undergoing overfishing (yellow) and both overfished and undergoing overfishing (red).

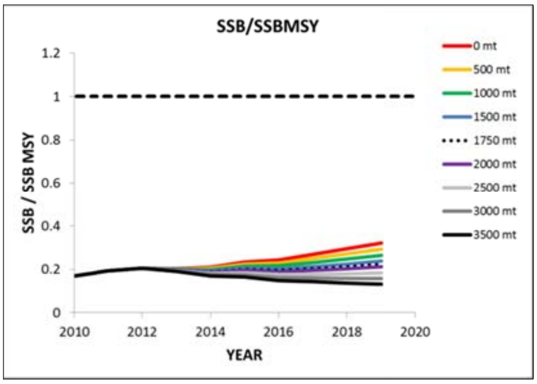
A) 50% probability
Low recruitment potential



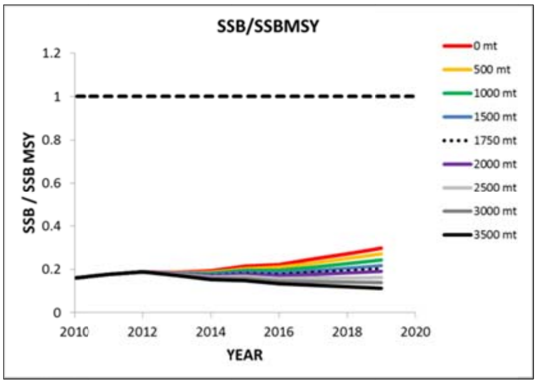
B) 60% probability
Low recruitment potential



C) 50% probability
High Recruitment potential



D) 60% probability
High recruitment potential



BFTW-Figure 7. Projections of spawning stock biomass (SSB) for the Base Case assessment under low recruitment potential (top panels) and high recruitment potential (bottom panels) and various levels of constant catch. The labels "50%" and "60%" refer to the probability that the SSB will be greater than or equal to the values indicated by each curve. The curves corresponding to each catch level are arranged sequentially in the same order as the legends. A given catch level is projected to have a 50% or 60% probability of meeting the convention objective (SSB greater than or equal to the level that will produce the MSY) in the year that the corresponding curve meets the dashed horizontal line.

8.9 SWO-ATL-ATLANTIC SWORDFISH

The status of the North and South Atlantic swordfish stocks was assessed in September 2013, by means of applying statistical modelling to the available data up to 2011. Complete information on the assessment can be found in the Report of the 2013 ICCAT Swordfish stock assessment meeting (Anon. 2013). Other information relevant to Atlantic swordfish is presented in the Report of the Sub-Committee on Statistics, included as **Appendix 7** to this SCRS Report, and recommendations pertinent to Atlantic swordfish are presented in Item 17.

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. This stock separation is supported by recent genetic analyses. However, the precise boundaries between stocks are uncertain. 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 recent 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 180cm. However, the most recent information indicates a smaller length and age at maturity.

New length-weight relationships were proposed for both the North and South Atlantic, but these will be considered interim solutions until further analysis is conducted with new and more recent data.

The Group reviewed document SCRS/2013/151 which presented the horizontal tracking of 21 swordfish tagged with pop-up satellite tags in the central and eastern North Atlantic. The analysis of the horizontal movements evidenced seasonal patterns with fish generally moving south by winter and returning to the temperate foraging grounds in spring. Broader areas of mixing between some eastern and western areas were also suggested. These new results obtained by pop-up satellite tags fully confirm the previous knowledge that was available from fishery data: deep longline catch swordfish during the day time as a by-catch, while shallow longliners target swordfish at night in very shallow waters.

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, Uruguay, and Venezuela. The primary by-catch 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 by-catch 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.

The Group reviewed document SCRS-2013-161 that demonstrated a significant relation between temperate fishery CPUE residuals and the size of the Atlantic Warm Pool (AWP), which was shown to be highly correlated with the Atlantic Multidecadal Oscillation (AMO). This supported the information provided on document SCRS/12/022, that described the occurrence of swordfish (1.5 to 2.65 m) off the Norwegian coast (58 to 70ºN latitude) from 1967 to 2011. The effect of AWP was thought to be responsible for conflicting signals in the CPUEs from the northern temperate and tropical regions. Further analysis and hypothesis testing was recommended to determine if this relationship was due to a swordfish temperature preference, a change in prey distribution, or perhaps both.

For both the North and South Atlantic many 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 had to be split. Splitting the indices reduces the abundance signal and, to the degree possible continuity of the indices can be maintained, it will increase the reliability of the assessment results.

Total Atlantic

The total Atlantic estimated catch (landings plus dead discards) of swordfish (North and South, including reported dead discards) in 2012 (24,152 t) is close to the reported catch in 2011 (23,914 t). As a small number of countries have not yet reported their 2012 catches and because of unknown unreported catches, this value should be considered provisional and subject to further revision.

The trends in mean fish weight taken in the North and South Atlantic fisheries is shown in **SWO-ATL-Figure 3**.

North Atlantic

For the past decade, the North Atlantic estimated catch (landings plus dead discards) has averaged about 11,500 t per year (**SWO-ATL-Table 1** and **SWO-ATL-Figure 4**). The catch in 2012 (13,972 t) represents a 31 % decrease since the 1987 peak in North Atlantic landings (20,236 t). These reduced landings have been attributed to ICCAT regulatory recommendations 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, EU-Portugal and Canada, 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 by-catch in some fleets. Recently, socio-economic factors may have also contributed to the decline in catch.

Available catch per unit effort (CPUE) series were evaluated by the Group and certain indices were identified as suitable for use in assessment models (Japan, Portugal, Morocco, Canada, Spain and USA). Trends in standardized CPUE series by fleets contributing to the production model are shown in **SWO-ATL-Figure 5**. Most of the series have an increasing trend since the late 1990s, but the U.S. catch rates remained relatively flat. There have been some recent changes in United States regulations that may have impacted catch rates, but these effects remain unknown. The combined index is shown in **SWO-ATL-Figure 6**, rescaled to the final fishery specific indices.

The most frequently occurring ages in the catch include ages 2 and 3 (**SWO-ATL-Figure 6**).

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 2,300 t). After 1980, landings increased continuously up to a peak of 21,930 t in 1995, levels that are comparable to the peak of North Atlantic harvest (20,236 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 partly due to a shift to other oceans and target species. In 2012, the 10,180 t reported catches were about 54 % lower than the 1995 reported level (**SWO-ATL-Figure 4**). The SCRS received reports from Brazil and Uruguay that those CPCs have reduced their fishing effort directed towards swordfish in recent years. Uruguay recently received increased albacore quotas that may allow increased effort for swordfish in the near future.

Six data sets of relative abundance indices (Brazil, Japan, Spain, Uruguay, South Africa and Chinese Taipei) were made available to the Group. These CPUE indices were standardized using various analytical approaches. The standardized CPUE series presented show different trends and high variability which indicates that at least some are not depicting trends in the abundances of the stock. The available indices are illustrated in Figure **SWO-ATL-Figure 6**. Two combined indices were produced (**SWO-ATL-Figure 7**), one excluding Brazil and the other excluding both Brazil and Chinese Taipei data series.

Discards

Since 1991, several fleets have reported dead discards (see **SWO-ATL-Table 1**). The volume of Atlantic-wide reported discards since then has ranged from 215 t to 1,139 t per year. Reported annual dead discards (in tonnes) have been declining in recent years.

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, non-equilibrium surplus production model (ASPIC) and Bayesian Surplus Production Model (BSP2).

Results from the North Atlantic base case ASPIC model are shown in **SWO-ATL-Figure 8**. The estimated relative biomass trend shows a consistent increase since 1997. The bias corrected deterministic outcome indicates that the stock is at or above B_{MSY} (**SWO-ATL-Figure 9**). The relative trend in fishing mortality shows that the level of fishing peaks in 1995, followed by a decrease until 2001, followed by small increase in the 2002-2005 period and downward trend since then (**SWO-ATL-Figure 8)**. Fishing mortality has been below F_{MSY} since 2000. The estimate of stock status in 2011 is relatively similar to the estimated status in the 2009 assessment, and suggests that there is greater than 90% probability that the stock is at or above B_{MSY}. However, it is important to note that for the first time since 2002 the reported catches in 2012 (13,972 t) exceeded the TAC of 13,700 t. The most recent estimate of stock productivity is very consistent with previous estimates. The absolute biomass trajectory showed a consistent upturn from the estimated 1997 value, and the biomass values for the most recent years are near the level estimated in the mid-1980s (**SWO-ATL-Figure 10**). The high value in 1963 is not well fit as in prior evaluations. Trends in both fishing mortality and biomass are consistent with those produced by the BSP2 model, with the latter model estimating larger stock biomass and lower fishing mortality across the entire time series (**SWO-ATL-Figure 10**). Estimates of stock status from the BSP2 model are consistent with ASPIC results (**SWO-ATL-Figure 11**).

The stock is considered rebuilt, consistent with the 2009 evaluation. Compared with the 2009 ASPIC base case model, the trajectory of biomass and F ratios are similar until the late 1990s, thereafter the current model predicted slightly lower fishing mortality rates and higher relative biomass, but certainly within the estimated 80% confidence bounds (**SWO-ATL-Figure 12**).

South Atlantic

In 2009, evaluation of the status of the South Atlantic swordfish stock was assessed using a 'Catch only' model. During the 2013 stock assessment two platforms were used to provide stock status advice for the South Atlantic swordfish stock (i.e. ASPIC and BSP2).

The results of both models indicated that there was a conflicting signal for several of the indices used and substantial conflict between the landings history and the indices. Consequently the Group had low confidence in the estimation of the absolute productivity level of the stock or on MSY-related benchmarks. Both models had similar difficulties estimating these quantities but both offered useful status advice. Consequently each platform provided a reference model on which the stock status was based.

Both models had similar trajectories of fishing mortality and biomass (**SWO-ATL-Figure 13 and 14**) but differed in their absolute levels and their status relative to benchmarks (**SWO-ATL-Figure 15**). Hence the two models differ in their view of current stock status, with ASPIC estimating the stock to be overfished (B_{2011}/B_{MSY} =0.98) but not undergoing overfishing (F_{2011}/F_{MSY} =0.84), and BSP, neither overfished (B_{2011}/B_{MSY} =1.38), nor overfishing (F_{2011}/F_{MSY} =0.47). Though, it should be noted that there is considerable uncertainty around any of these point estimates.

The groups choose to base stock status determination on a combination of model output and ancillary information, of which two pieces of information are informative. First, total removals (1950-2011) for the South Atlantic stock have been only 73% of the total removals for the North Atlantic stock for the same time period. Second the mean weight for the South (**SWO-ATL-Figure 16**) is larger than for the North. Assuming similar production dynamics, both indicators would suggest a lower exploitation rate for the South stock than for the North. Hence, while the Group does not believe it can estimate the absolute productivity of the stock without improved scientific information, the Group believes that the stock is not overfished.

SWO-ATL-4. Outlook

North Atlantic

Based on the currently available information to the Group, the ASPIC base model was projected to the year 2021 under constant TAC scenarios of 8 to 20 thousand tones. Projections used reported catch as of September 5, 2013 for 2012. For those CPCs whose reported catch was not yet available, their catch was assumed to be the average of the last three years (2009-2011), giving a total catch of 14,038 t. Median trajectories for biomass and fishing mortality rate for all of the future TAC scenarios are plotted in **SWO-ATL-Figure 17**. Results from the 2013 assessment indicated that there is greater than 90% probability that the northern swordfish stock has rebuilt to or above B_{MSY} (**SWO-ATL-Figure 9**), therefore the Commission's rebuilding plan goal has been achieved.

Future TACs above 15,000 t are projected to result in 50% or lower probabilities of the stock biomass remaining above B_{MSY} over the next decade (**SWO-ATL-Table 2**) as the resulting probability of F exceeding F_{MSY} for these scenarios would trend above 50% within four years. A TAC of 13,700 t would have an 83% probability of maintaining the stock and fishing mortality at a level consistent with the Convention objective over the next decade. Projections with BSP also used similar specifications for 2012 and 2013 yields and projected over the same time frame. Both models provide very consistent advice that TAC levels of 13,700 t would maintain the stock at a level consistent with the Convention Objectives over the next decade.

South Atlantic

The Group considered that the ASPIC and BSP estimated benchmarks were unreliable due to the conflicting signal between the catch data and the CPUE time series available to the Group. Hence, it is unknown whether it is possible to obtain substantially higher yields from the stock as BSP suggests or whether the stock is fully exploited as suggested by ASPIC. Until improved scientific information is available in the form of more consistent indices, tagging studies to estimate fishing mortality or abundance or other improved information, this uncertainty may remain.

SWO-ATL-5. Effect of current regulations

In 2006, the Committee provided information on the effectiveness of existing minimum size regulations. New catch regulations were implemented on the basis of Rec. 06-02, which entered into effect in 2007 (Rec. 08-02 extended the provisions of Rec. 06-02 to include 2009). Rec. 09-02 came into effect in 2010 and extended most of the provisions of Rec. 06-02 for one year only. Rec. 10-02 came into effect in 2011, and again extended those provisions for one year only, but with a slight reduction in total allowable catch (TAC).

For the South Atlantic, the most recent recommendation can be found in Rec. 09-03, which establishes a three year management plan for that stock.

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 11,969 t and did not exceed the TAC in any year. In 2010, the TAC was reduced to 13,700 t, compared with 2012 catches of 13,972 t. Reports for 2012 are considered provisional and subject to change.

The total allowable catch in the South Atlantic for the years 2007 through 2009 was 17,000 t. The reported catch during that period averaged 13,482 t, and did not exceed the TAC in any year. In 2010, the TAC was reduced to 15,000 t, compared with 2012 catch of 10,180 t. Reports for 2012 are considered provisional and subject to change.

Minimum size limits

There are two minimum size options that are applied to the entire Atlantic: 125 cm LJFL with a 15% tolerance, or 119 cm LJFL with zero tolerance and evaluation of the discards.

For the 2006-2008 period, the estimate of the percentage of swordfish reported landed (throughout the Atlantic) less than 125 cm LJFL was about 24% (in number) overall for all nations fishing in the Atlantic (28% in the northern stock and 20% in southern stock). If this calculation is made using reported landings plus estimated dead discards, then the percentage less than 125 cm LJFL would be of the same order given the relatively small amount of discards reported. These estimates are based on the overall catch at size, which have high levels of substitutions for a significant portion of the total catch.

Other implications

The Committee is concerned that in some cases national regulations have resulted in the unreported discarding of swordfish caught in the North stock and, to a certain extent, could have influenced similar behavior of the fleet that fishes the South Atlantic swordfish stock. The Committee considers that these regulations may have had a detrimental effect on the availability and consistency of scientific data on catches, sizes and CPUE indices of some of the Atlantic fleets. The Committee expressed its serious concern over this limitation on data for future assessments.

SWO-ATL-6. Management recommendations

North Atlantic

For continuity of advice relative to previous assessments, ASPIC results are provided in **SWO-ATL-Table 2**, which shows the ranges of total catch limits and associated probabilities associated with stock status by year. The current TAC of 13,700 t has an 83% probability of maintaining the North Atlantic swordfish stock in a rebuilt condition by 2021 while maintaining nearly level biomass. This TAC would be in accordance with [Rec. 11-13], adopted by the Commission that indicates that 'For stocks that are not overfished and not subject to overfishing (i.e., stocks in the green quadrant of the Kobe plot), management measures shall be designed to result in a high probability of maintaining the stock within this quadrant'. However, the Committee acknowledges that without better direction from the Commission with regard to what constitutes a 'high probability', it cannot provide more specific advice. TACs up to 14,300 t would still have a higher than 50% probability of maintaining the stock in a rebuilt condition by 2021 but would be expected to lead to greater biomass declines.

South Atlantic

Considering the unquantified uncertainties and the lack of signal in the data for the southern Atlantic swordfish stock, and until sufficiently more research has been conducted to reduce the high uncertainty in stock status, the Committee did not have sufficient confidence in the assessment results to change the previous recommendation to limit catches to no more than 15,000 t.

ATLANTIC SWORDFISH SUMMARY

	North Atlantic	***South Atlantic***
Maximum Sustainable Yield[1]	13,660 t (13,250-14,080)[3]	Unknown
Current (2012) TAC	13,700 t	15,000 t
Current (2012) Yield[2]	13,972 t	10,180 t
Yield in last year used in assessment (2011)	12,834 t[4]	11,055 t[4]
B_{MSY}	65,060 (54,450-76,700)	Unknown
F_{MSY}	0.21 (0.17-0.26)	Unknown
Relative Biomass (B_{2011}/B_{MSY})	1.14 (1.05-1.24)	Unknown, but likely above 1[5]
Relative Fishing Mortality (F_{2011}/F_{MSY}[1])	0.82 (0.73-0.91)	Unknown, but likely below 1[5]
Stock Status	Overfished: NO Overfishing: NO	Overfished: NO[5] Overfishing: NO
Management Measures in Effect:	Country-specific TACs [Rec. 11-02]; 125/119cm LJFL minimum size	Country-specific TACs [Rec. 12-01]; 125/119cm LJFL minimum size

[1] Base Case production model (Logistic) results based on catch data 1950-2011.
[2] Provisional and subject to revision.
[3] Point estimate, 80% bias corrected confidence intervals are shown.
[4] As of 5 September 2013.
[5] This determination is based on the models and the ancillary information (e.g. catch trends, mean weight trends).

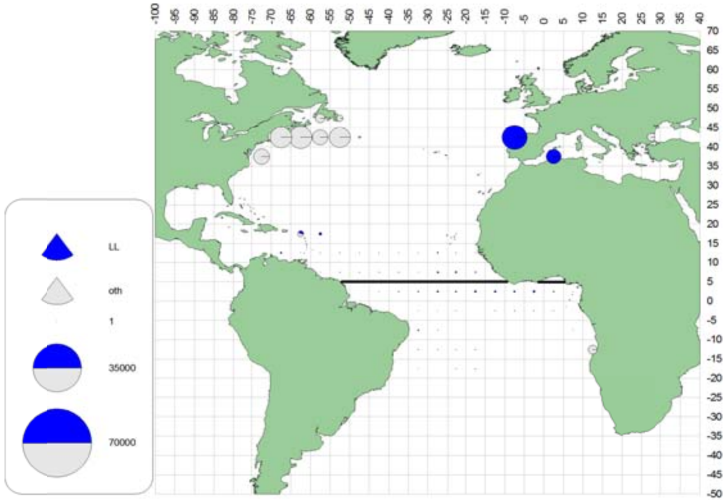
SWO-ATL-Table 1. Estimated catches (t) of Atlantic swordfish (*Xiphias gladius*) by gear and flag.

			1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
TOTAL			32685	34305	32976	28826	29207	32868	34459	38803	33511	31567	26251	27123	27180	25139	23758	24075	25252	25643	25718	27932	23596	24761	24209	23914	24152
	ATN		19513	17250	15672	14934	15394	16738	15501	16872	15222	13025	12223	11622	11453	10011	9654	11442	12175	12480	11473	12302	11050	12081	11553	12523	13972
	ATS		13172	17055	17304	13893	13813	16130	18958	21930	18289	18542	14027	15502	15728	15128	14104	12633	13077	13162	14245	15630	12546	12679	12655	11391	10180
Landings	ATN	Longline	18927	15348	14026	14208	14288	15641	14315	15764	13808	12181	10939	10666	9837	8676	8799	10333	11406	11527	10840	11475	10341	11439	10964	11610	13037
		Other surf.	586	1902	1646	511	723	689	478	582	826	393	800	426	478	433	240	487	449	620	409	546	465	485	437	511	562
	ATS	Longline	12404	16398	16705	13287	13176	15547	17387	20806	17799	18239	13748	14823	15448	14302	13576	11712	12485	12915	13723	14967	11761	12106	11920	10833	9943
		Other surf.	768	657	599	606	637	583	1571	1124	489	282	269	672	278	825	527	920	591	248	522	572	779	574	587	488	214
Discards	ATN	Longline	0	0	0	215	383	408	708	526	562	439	476	525	1137	896	607	618	313	323	215	273	235	151	148	392	362
		Other surf.	0	0	0	0	0	0	0	0	26	12	9	4	1	6	8	5	7	10	8	8	9	7	5	9	10
	ATS	Longline	0	0	0	0	0	0	0	0	1	21	10	6	1	0	0	0	1	0	0	91	6	0	147	70	23
		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	
Landings	ATN	Barbados	0	0	0	0	0	0	0	0	33	16	16	12	13	19	10	21	25	44	39	27	39	20	13	23	21
		Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	112	106	184	141
		Brasil	0	0	0	0	0	0	0	0	0	0	0	0	117	0	0	0	0	0	0	0	0	0	0	0	
		Canada	898	1247	911	1026	1547	2234	1676	1610	739	1089	1115	1119	968	1079	959	1285	1203	1558	1404	1348	1334	1300	1346	1551	1489
		China P.R.	0	0	0	0	0	73	86	104	132	40	337	304	22	102	90	316	56	108	72	85	92	92	73	75	59
		Chinese Taipei	23	17	270	577	441	127	507	489	521	509	286	285	347	299	310	257	30	140	172	103	82	89	88	192	166
		Cuba	832	87	47	23	27	16	50	86	7	7	7	7	0	0	10	3	3	2	2	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	0	0	0	0	25	30	0	7
		Dominica	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	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**
		EU.España	9799	6648	6386	6633	6672	6598	6185	6953	5547	5140	4079	3996	4595	3968	3957	4586	5376	5521	5448	5564	4366	4949	4147	4889	5622
		EU.France	0	0	75	75	75	95	46	84	97	164	110	104	122	0	74	169	102	178	92	46	14	15	35	16	94
		EU.Ireland	0	0	0	0	0	7	0	0	15	15	132	81	35	17	5	12	1	1	3	2	2	1	1	2	5
		EU.Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
		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	
		EU.Portugal	617	300	475	773	542	1961	1599	1617	1703	903	773	777	732	735	766	1032	1320	900	949	778	747	898	1054	1203	882
		EU.United Kingdom	0	0	0	0	0	2	3	1	5	11	0	2	1	0	0	0	0	0	0	0	0	2	0	0	0
		FR.St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	3	36	48	0	82	48	17	90	1	**0**
		Faroe Islands	0	0	0	0	0	0	0	0	0	0	0	5	4	0	0	0	0	0	0	0	0	0	0	0	
		Grenada	56	5	1	2	3	13	0	1	4	15	15	42	84	0	54	88	73	56	30	26	43	0	0	0	
		Iceland	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
		Japan	621	1572	1051	992	1064	1126	933	1043	1494	1218	1391	1089	161	0	0	0	575	705	656	889	935	778	1062	523	715
		Korea Rep.	30	320	51	3	3	19	16	16	19	15	0	0	0	0	0	0	0	51	65	175	157	3	0	0	0
		Liberia	19	35	3	0	7	14	26	28	28	28	28	28	0	0	0	0	0	0	0	0	0	0	0	0	
		Libya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	
		Maroc	196	222	91	110	69	39	36	79	462	267	191	119	114	523	223	329	335	334	341	237	430	724	963	782	770
		Mexico	0	0	0	0	0	6	14	0	22	14	28	24	37	27	34	32	44	41	31	35	34	32	35	38	40
		NEI (ETRO)	76	112	529	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NEI (MED)	131	190	185	43	35	111	0	0	0	0	0	0	0	0	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**
		Panama	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	
		Philippines	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	44	5	0	8	0	22	28	0	17	36
		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	
		Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
		Senegal	0	1	0	6	6	0	0	0	0	0	0	0	0	0	0	0	108	108	0	38	0	28	11	1	44
		Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	
		Sierra Leone	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	
		St. Vincent and Grenadines	0	0	3	0	3	23	0	4	3	1	0	1	0	22	22	7	7	7	0	51	7	34	13	11	16
		Sta. Lucia	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	3	0	0	2	0	0	0	
		Trinidad and Tobago	42	79	66	71	562	11	180	150	158	110	130	138	41	75	92	78	83	91	19	29	48	30	21	16	14
		U.S.A.	6171	6411	5519	4310	3852	3783	3366	4026	3559	2987	3058	2908	2863	2217	2384	2513	2380	2160	1873	2463	2387	2730	2274	2551	3435

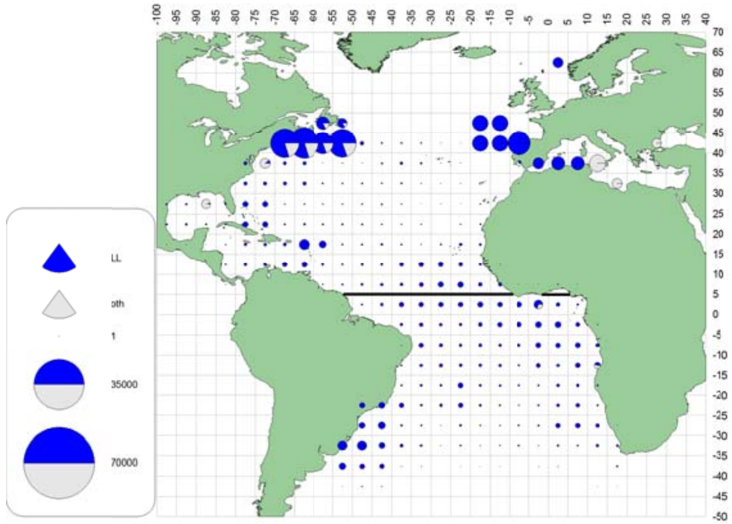
		U.S.S.R.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		UK.Bermuda	0	0	0	0	0	0	0	1	1	5	5	3	3	2	0	0	1	1	0	3	4	3	3	3	1
		UK.British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	7	0	3	0	0	4	**0**
		UK.Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	29	14	0	0	0	10	23	15
		Venezuela	2	4	9	75	103	73	69	54	85	20	37	30	44	21	34	45	53	55	22	30	11	13	24	18	25
	ATS	Angola	84	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	
		Argentina	198	175	230	88	88	14	24	0	0	0	0	38	0	5	10	8	0	0	0	0	0	0	1	0	
		Belize	0	0	0	0	0	0	0	1	0	0	0	17	8	0	0	0	0	0	0	120	32	111	121	207	197
		Benin	19	26	28	28	26	28	25	24	24	10	0	3	0	0	0	0	0	0	0	0	0	0	0	0	
		Brasil	1162	1168	1696	1312	2609	2013	1571	1975	1892	4100	3847	4721	4579	4082	2910	2920	2998	3785	4430	4153	3407	3386	2926	3033	2833
		Cambodia	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	
		China P.R.	0	0	0	0	0	0	0	0	0	0	29	534	344	200	423	353	278	91	300	473	470	291	296	248	316
		Chinese Taipei	798	610	900	1453	1686	846	2829	2876	2873	2562	1147	1168	1303	1149	1164	1254	745	744	377	671	727	612	410	424	379
		Cuba	159	830	448	209	246	192	452	778	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Côte D'Ivoire	12	7	8	18	13	14	20	19	26	18	25	26	20	19	19	43	29	31	39	17	159	100	114	145	82
		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	
		EU.España	4393	7725	6166	5760	5651	6974	7937	11290	9622	8461	5832	5758	6388	5789	5741	4527	5483	5402	5300	5283	4073	5183	5801	4700	4852
		EU.Lithuania	0	0	0	0	0	0	794	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		EU.Portugal	0	0	0	0	1	0	0	380	389	441	384	381	392	393	380	354	345	493	440	428	271	367	232	263	184
		EU.United Kingdom	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	0	0	3	0	0	
		Gabon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	
		Ghana	235	156	146	73	69	121	51	103	140	44	106	121	117	531	372	734	343	55	32	65	177	132	116	60	54
		Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Honduras	0	0	0	0	3	0	0	6	4	5	2	8	0	0	0	0	0	0	0	0	0	0	0	0	
		Japan	4453	4019	6708	4459	2870	5256	4699	3619	2197	1494	1186	775	790	685	833	924	686	480	1090	2155	1600	1340	1314	1233	862
		Korea Rep.	1012	776	50	147	147	198	164	164	7	18	7	5	10	0	2	24	70	36	94	176	223	10	0	0	42
		Mixed flags (FR+ES)	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	
		NEI (ETRO)	0	856	439	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Namibia	0	0	0	0	0	0	22	0	0	0	0	730	469	751	504	191	549	832	1118	1038	518	25	417	414	85
		Nigeria	0	0	0	0	3	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Panama	0	0	0	0	0	0	0	0	0	0	29	105	0	0	0	0	0	0	0	0	0	0	0	0	
		Philippines	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	8	1	1	4	58	41	49	14	35	15
		S. Tomé e Príncipe	216	207	181	179	177	202	190	178	166	148	135	129	120	120	120	120	126	147	138	138	183	188	193	0	
		Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	138	195	180	264	162
		Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	
		Sierra Leone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	
		South Africa	4	0	0	5	9	4	1	4	1	1	240	143	328	547	649	293	295	199	186	207	142	170	145	97	50
		St. Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	7	16	4	3	3
		Togo	0	2	3	5	5	8	14	14	64	0	0	0	0	0	0	0	9	10	2	0	0	0	0	0	
		U.S.A.	0	0	0	0	0	0	0	0	171	396	160	179	142	43	200	21	15	0	0	0	0	0	0	0	**0**
		U.S.S.R.	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	20	4	0	0	0	0	0	0	0	0	0	
		Uruguay	427	414	302	156	210	260	165	499	644	760	889	650	713	789	768	850	1105	843	620	464	370	501	222	179	40
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	26	6	3	0	3	1	3
Discards	ATN	Canada	0	0	0	0	0	0	0	0	0	5	52	35	50	26	33	79	45	106	38	61	39	9	15	8	111
		Japan	0	0	0	0	0	0	0	0	0	0	0	0	598	567	319	263	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	170	46
		Mexico	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
		U.S.A.	0	0	0	215	383	408	708	526	588	446	433	494	490	308	263	282	275	227	185	220	205	148	138	223	216
		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	
	ATS	Brasil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	91	6	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	147	70	23
		U.S.A.	0	0	0	0	0	0	0	0	1	21	10	6	1	0	0	0	1	0	0	0	0	0	0	0	**0**

SWO-ATL-Table 2. Estimated probabilities (%) that both the fishing mortality is below F_{MSY} and spawning stock biomass is above SSB_{MSY} for North Atlantic Swordfish from ASPIC base model.

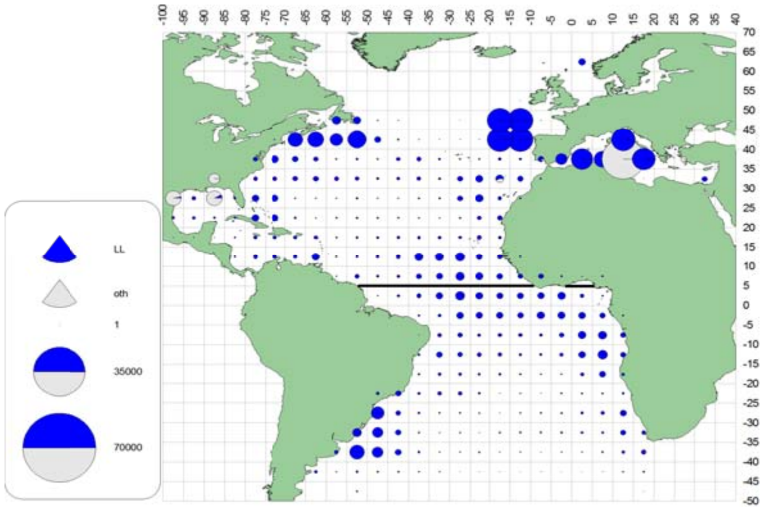
TAC	2014	2015	2016	2017	2018	2019	2020	2021
13000	88	91	92	92	92	92	93	93
13200	88	91	91	92	92	91	91	91
13400	88	90	90	89	89	89	89	89
13600	88	88	88	88	87	87	86	85
13700	88	88	88	87	85	84	84	83
13800	88	87	86	85	83	82	82	81
13900	88	86	84	83	82	80	79	77
14000	88	84	82	80	79	77	75	74
14100	88	82	80	78	76	74	72	69
14200	88	81	79	76	73	71	67	63
14300	88	80	76	73	70	65	61	56
14400	88	78	74	71	65	60	54	47
14600	88	74	69	63	56	47	40	33
14800	88	70	62	51	43	34	29	22
15000	88	64	55	42	32	25	17	13



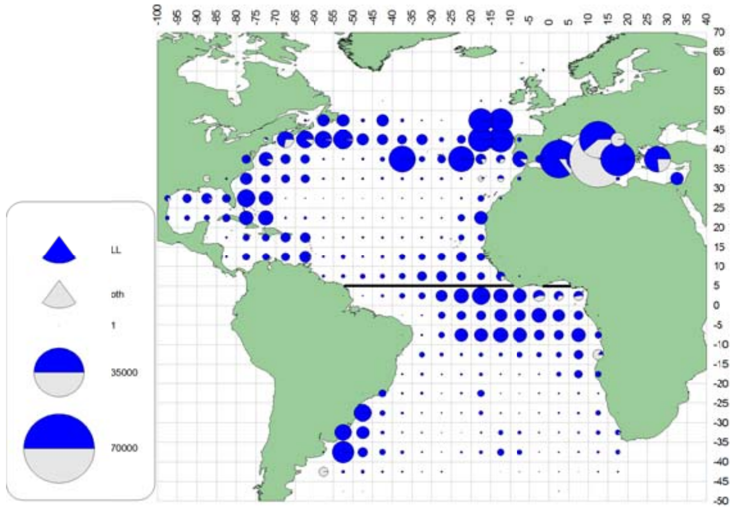
a. SWO (1950-59)



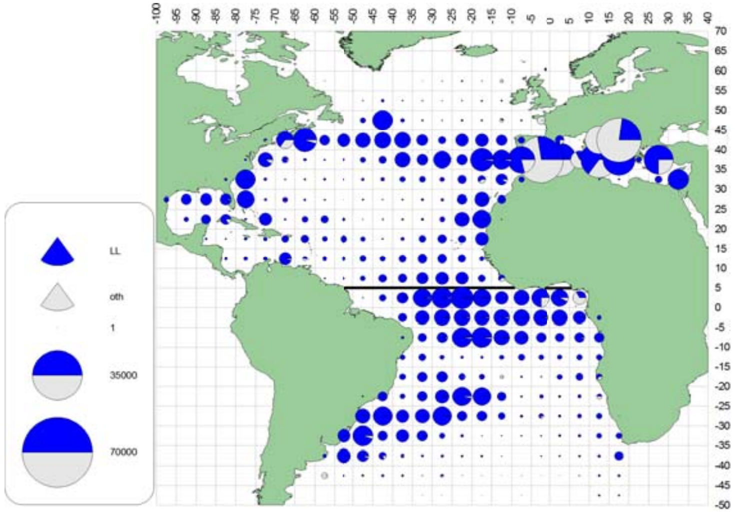
b. SWO (1960-69)

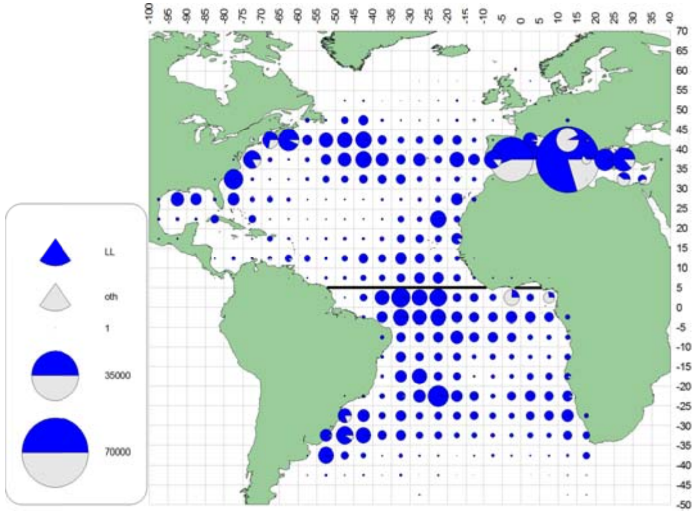


c. SWO (1970-79)



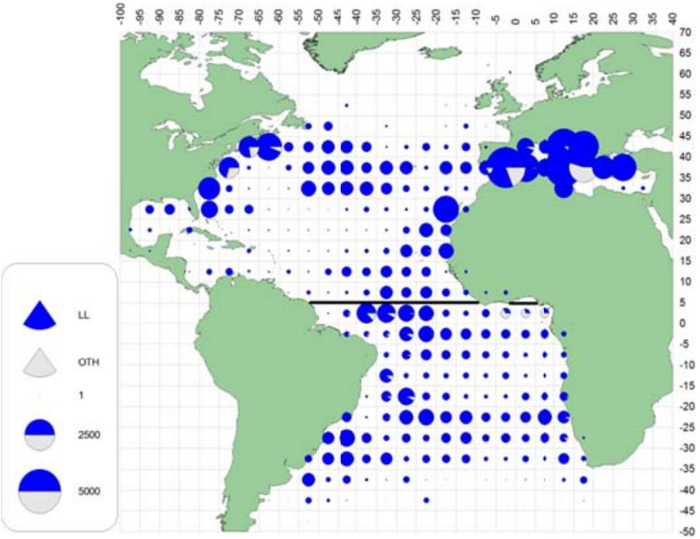
d. SWO (1980-89)





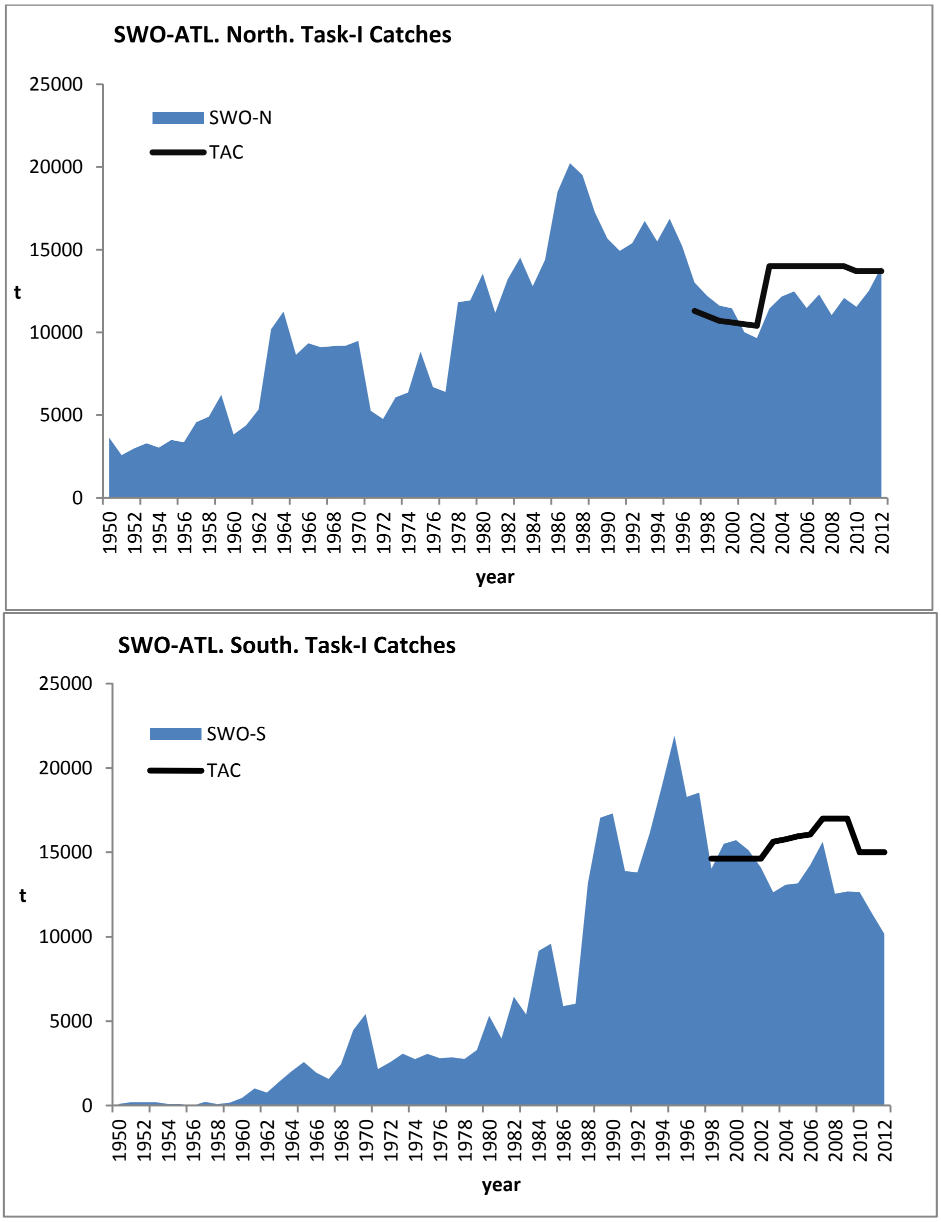
e. SWO (1990-99)

f. SWO (2000-09)

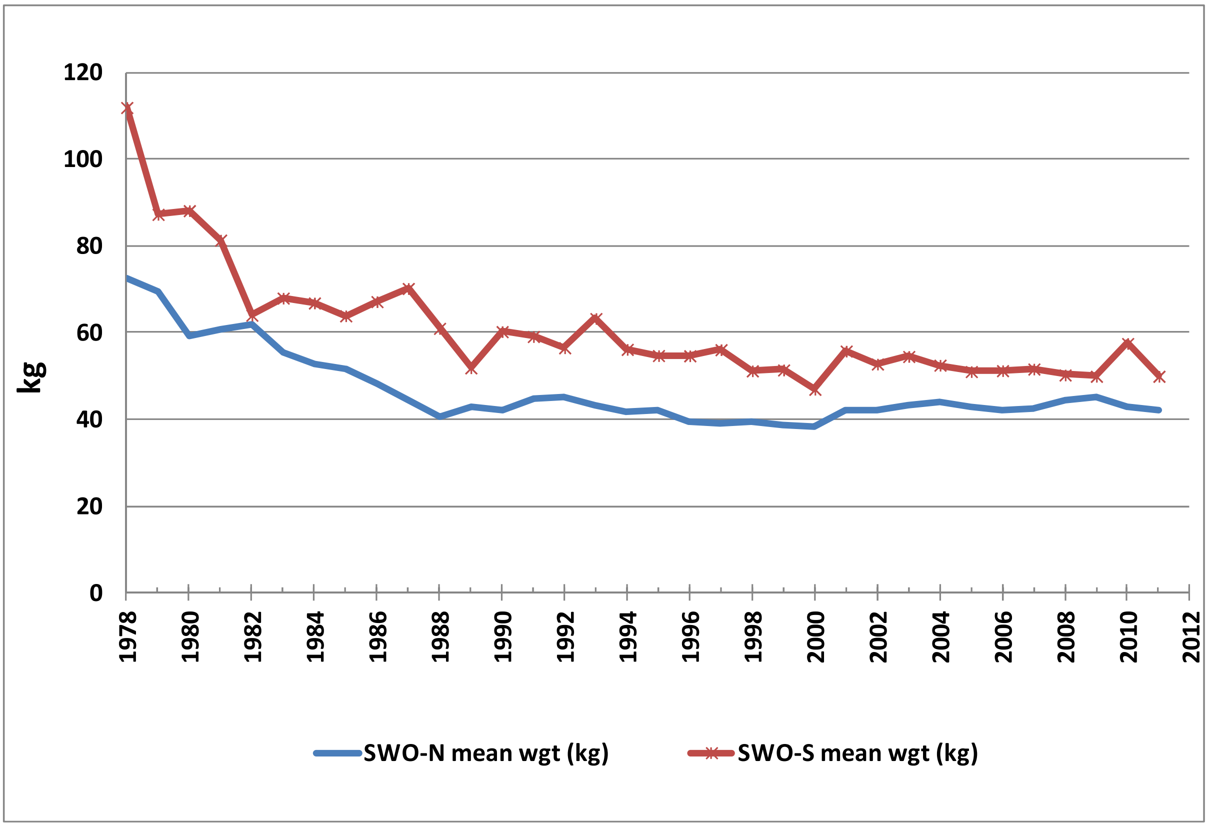


g. SWO (2010-11)

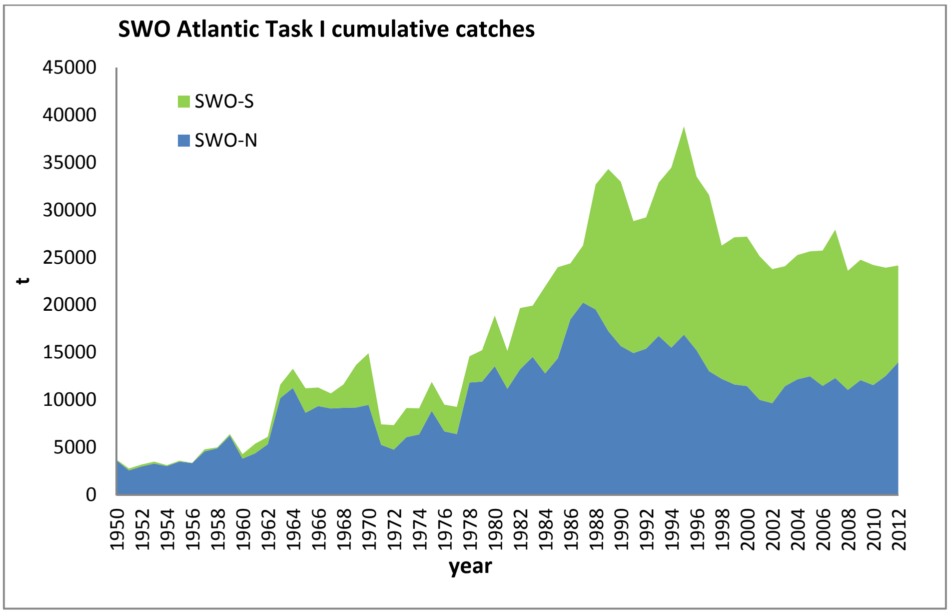
SWO-ATL-Figure 1. Geographic distribution of swordfish cumulative catch (t) by gear, in the Convention area, shown on a decadal scale. The maps (a-f) are scaled to the maximum catch observed during 1950-2009. Map g is scaled to the maximum catch observed from 2010-2011.



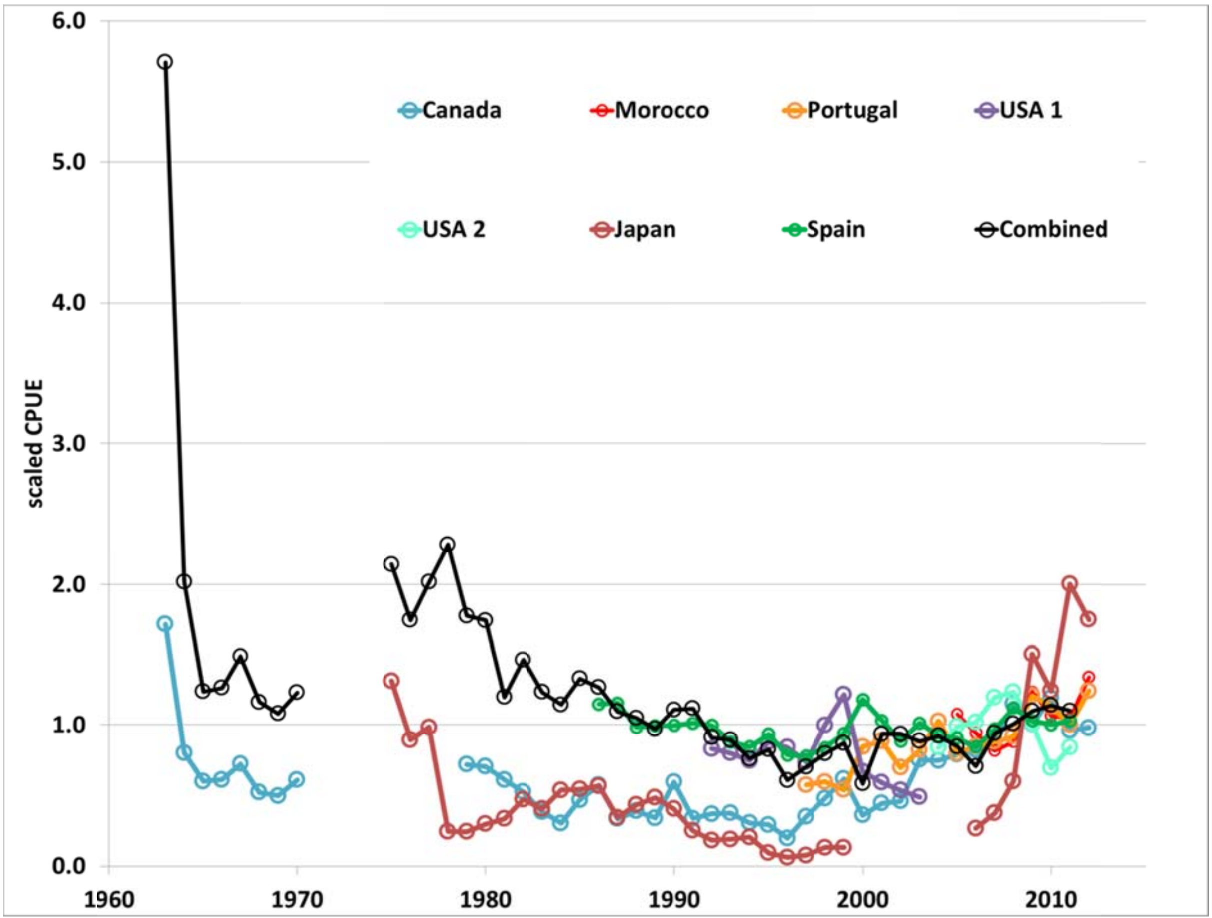
SWO-ATL-Figure 2. North and South Atlantic swordfish catches and TAC (t).



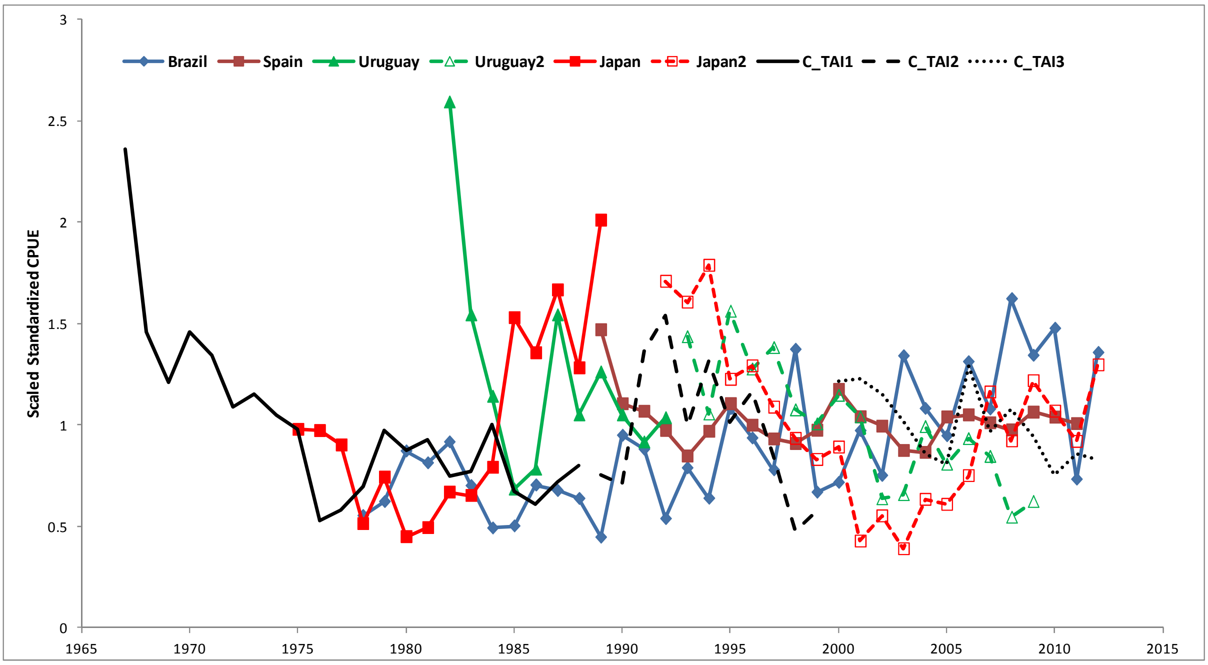
SWO-ATL-Figure 3. Trends in mean weight (kg) for the entire north and south Atlantic swordfish stocks. The information for 2010 is being reviewed and should be considered preliminary.



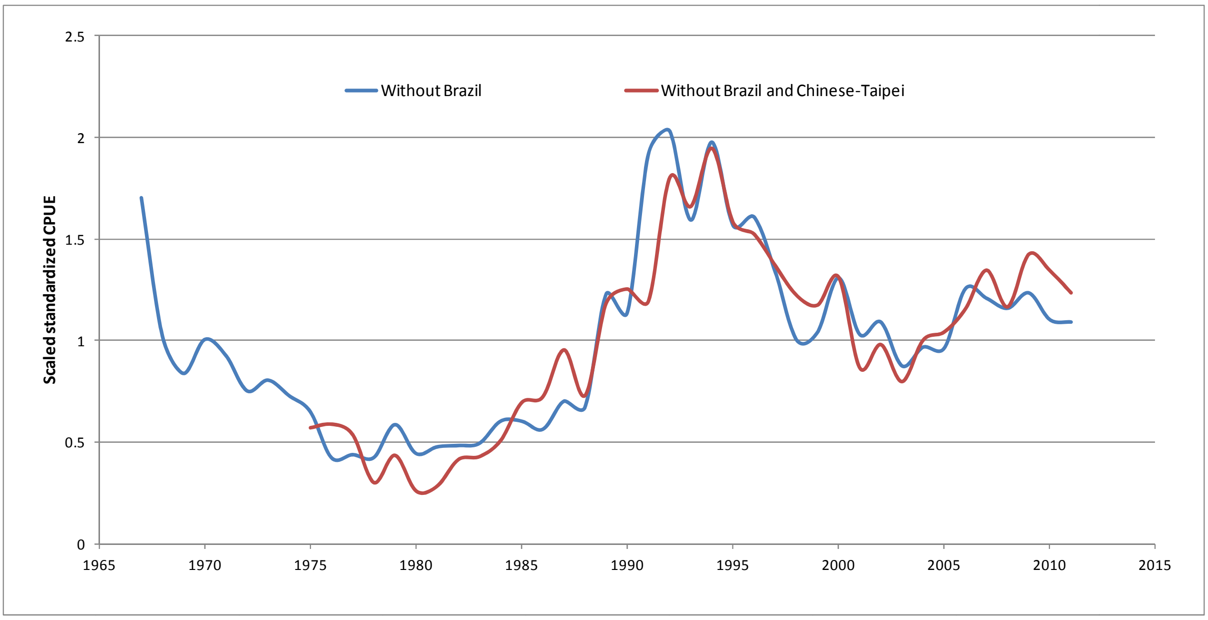
SWO-ATL-Figure 4. Swordfish reported catches (t) for North and South Atlantic, for the period 1950-2012.



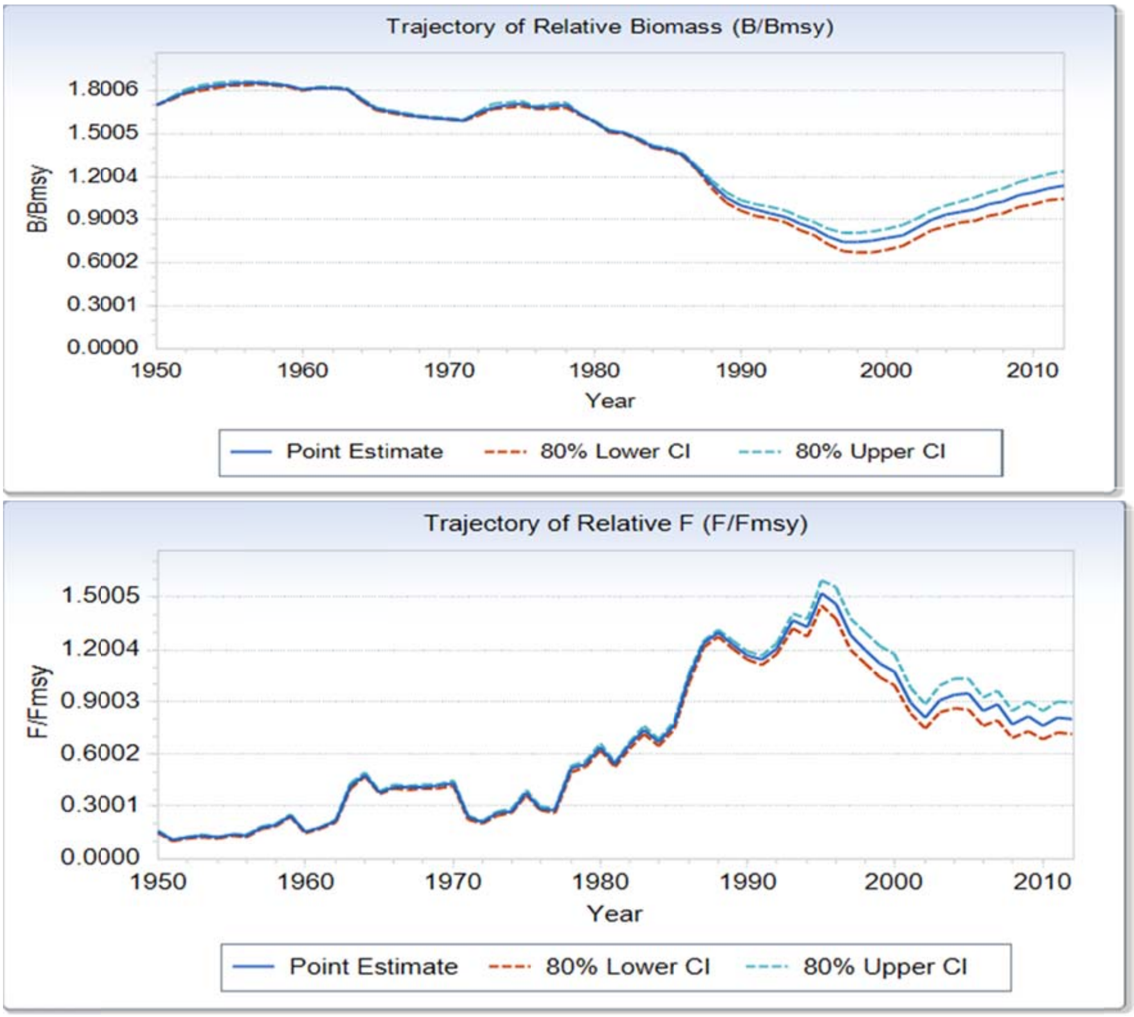
SWO-ATL-Figure 5. Standardized CPUEs series provided by CPCs for the North Atlantic swordfish and the combined index of the base production model. The CPUE series were scaled to their mean for the overlapping years.



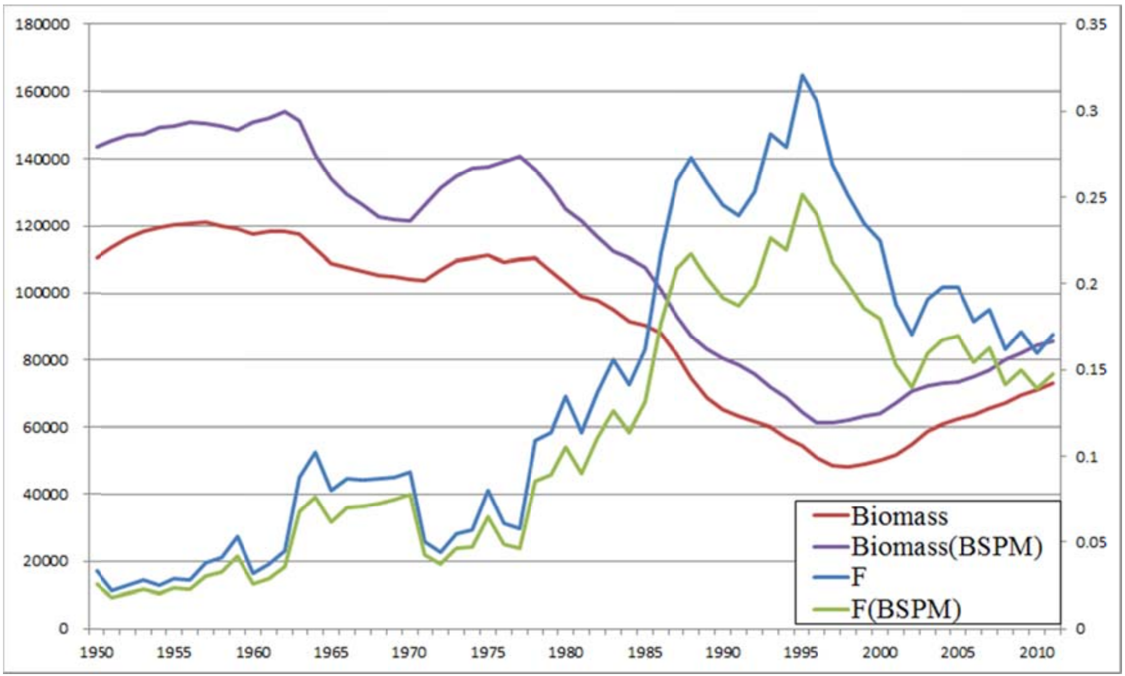
SWO-ATL-Figure 6. Standardized CPUEs series provided by CPCs for the for South Atlantic swordfish, The CPUE series were scaled to their mean for the overlapping years.



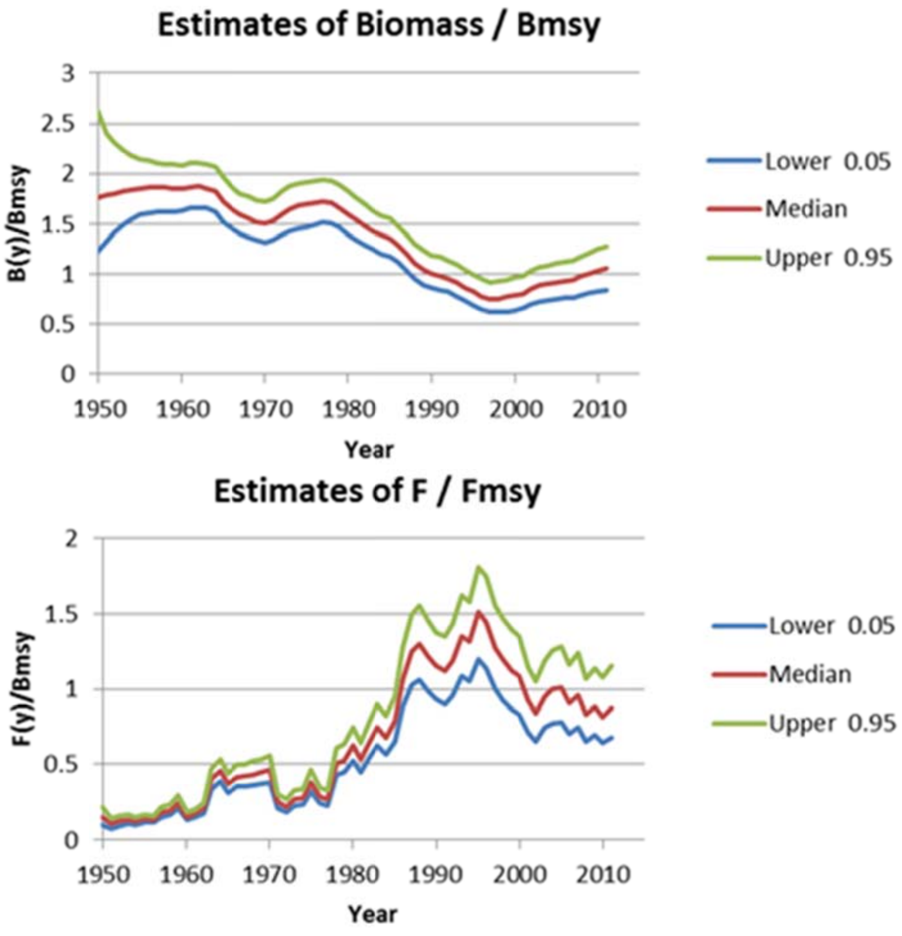
SWO-ATL-Figure 7. South Atlantic swordfish combined standardized CPUE indices.



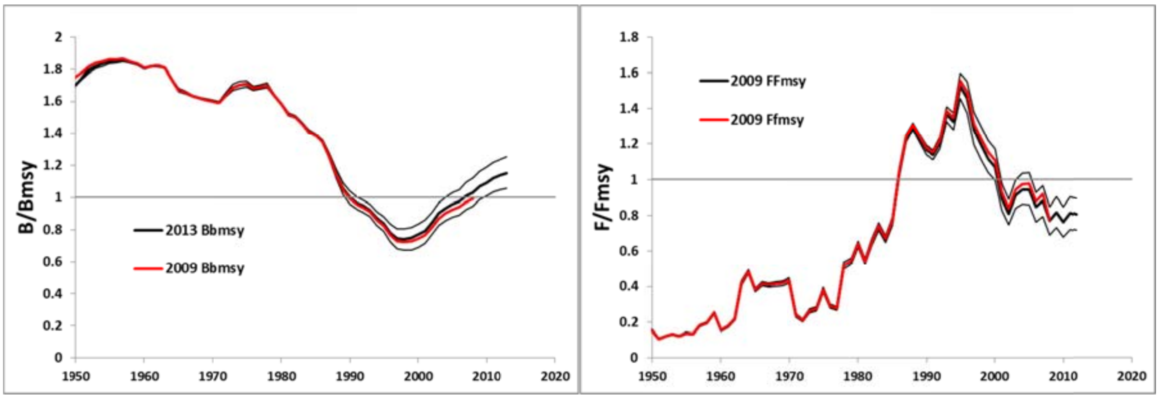
SWO-ATL-Figure 8. Results from the North Atlantic base case ASPIC model: trends in swordfish relative biomass (top) and fishing mortality (bottom) point estimates.



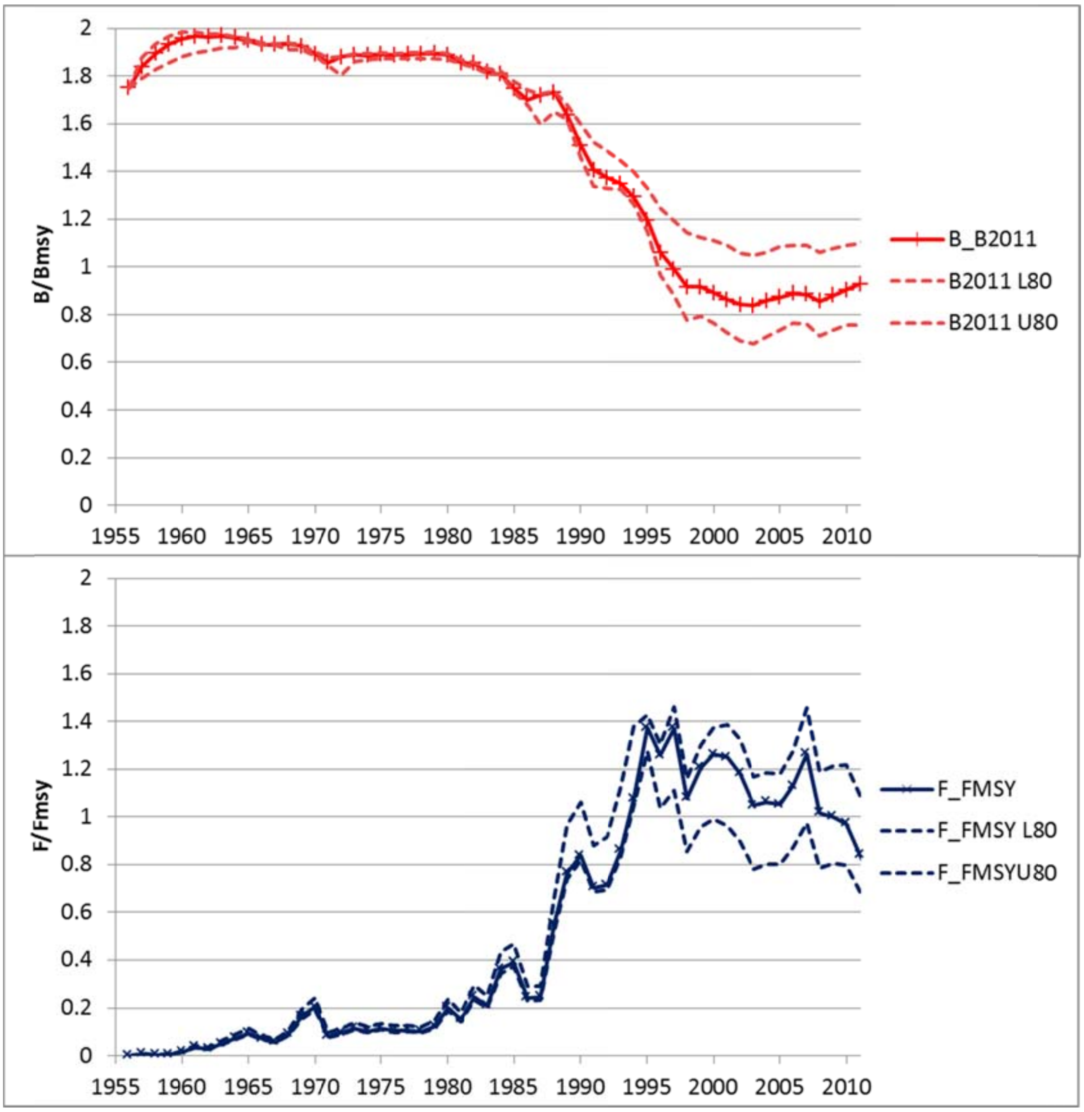
SWO-ATL-Figure 10.Trends in North Atlantic swordfish absolute biomass and fishing mortality estimates from the ASPIC and BSP2 base case models.



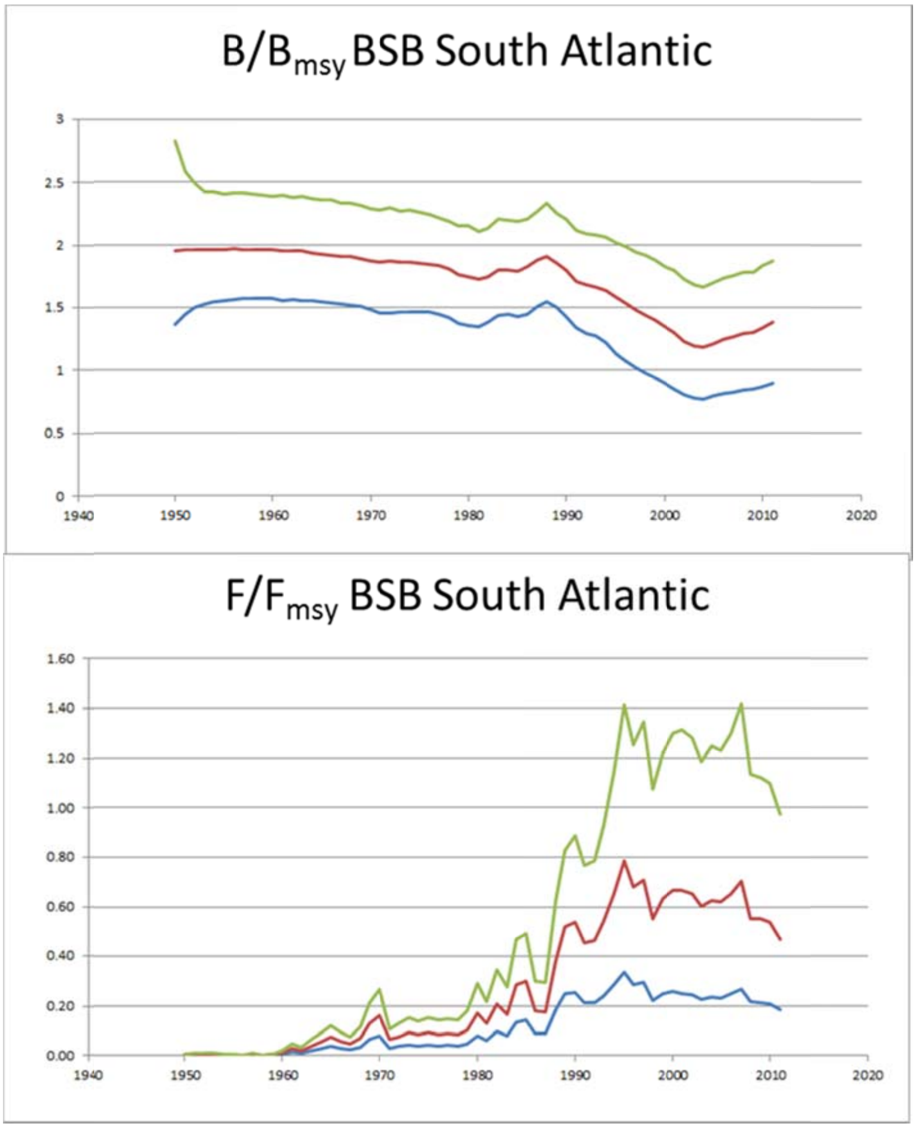
SWO-ATL-Figure 11. Plots of the ratios of i) stock biomass to B_{MSY} and ii) fishing mortality rate to F_{MSY} from the base case BSP for North Atlantic swordfish.



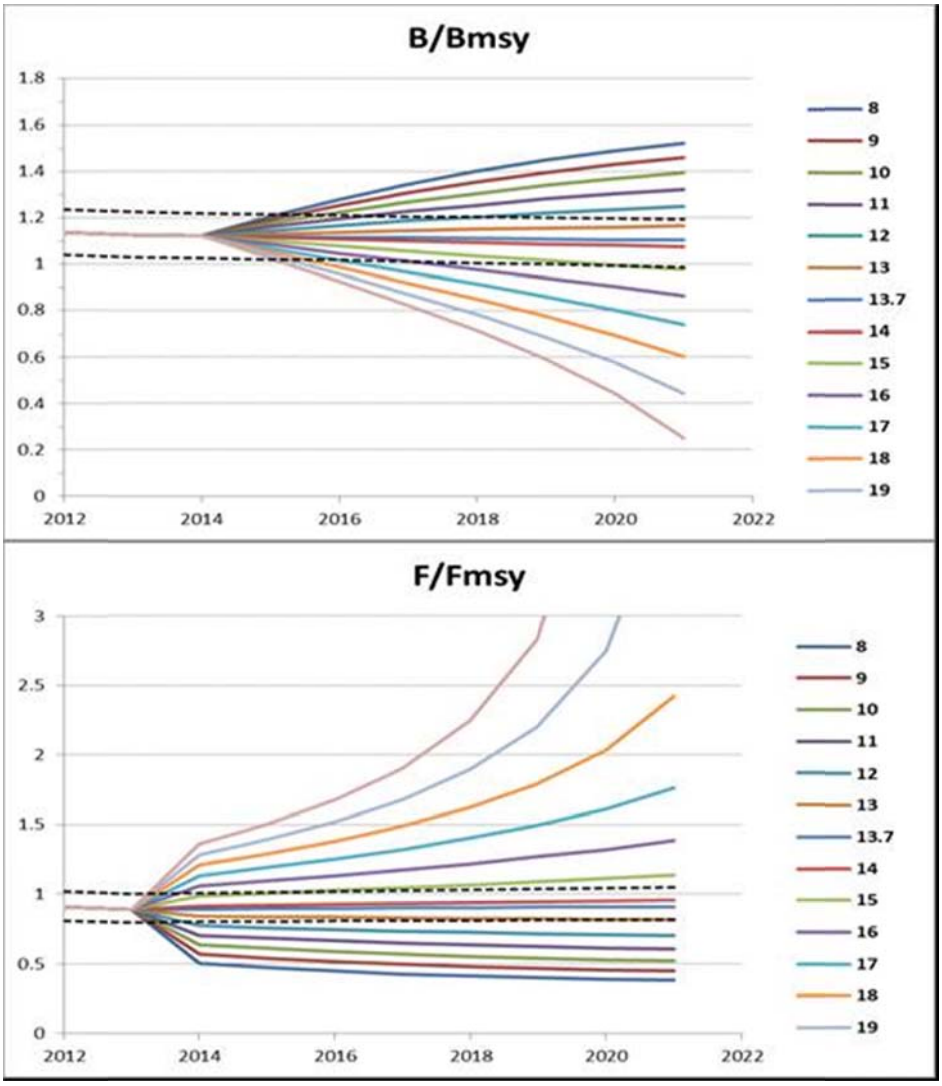
SWO-ATL-Figure 12. Comparison of the relative biomass (left) and fishing mortality (right) estimated by the North Atlantic ASPIC base case models in 2009 and 2013 assessments. Thin lines indicate the 80% confidence bounds for the 2013 estimates.



SWO-ATL-Figure 13. South Atlantic swordfish B/B$_{MSY}$ and F/F$_{MSY}$ estimated by ASPIC, dashed lines are the lower and upper 80 percentiles of the bootstrap runs.



SWO-ATL-Figure 14. South Atlantic swordfish B/B_{MSY} and F/F_{MSY} estimated by BSP2. Posterior median and 90% intervals are plotted.



SWO-ATL-Figure 17. Median trends of the relative biomass (B/B_{MSY}) and fishing mortality (F/F_{MSY}) for the projected North Atlantic swordfish stock based on the ASPIC SP model base under different constant catch scenarios (thousand tons). The lines show the median value of bootstrap runs and the dashed lines are 80% confidence intervals around projection at 13,700 t in the projection time period and the observed catch in the historical time period. The TAC in 2012 is 13,700 t.