Original: English

REPORT OF THE 2013 ATLANTIC SWORDFISH STOCK ASSESSMENT SESSION

(Olhão, Portugal, September 2-10, 2013)

1. Opening, adoption of the Agenda and meeting arrangements

The meeting was held at the IPIMA Centre, Olhão, Portugal. Local arrangements were made by Dr. Miguel Neves dos Santos (incoming Swordfish Coordinator), and Dr. R. Coelho. Dr. John Neilson, meeting Chairman, welcomed meeting participants ("the Group") and presented the general arrangements of the meeting. Dr Neilson proceeded to review the Agenda which was adopted with some changes (**Appendix 1**). Dr. Neilson reminded the Group that the agenda was prepared to address the objectives presented in the Swordfish Work Plan for 2013 approved by the SCRS in 2012 (see ICCAT, 2013).

A list of meeting participants is attached as (**Appendix 2)** and the list of scientific documents presented at the meeting is attached as (**Appendix 3)**.

The following participants served as Rapporteurs for various sections of the report:

Section	*Rapporteurs*
1, 9, 10	J. Neilson
2	W. West
3	G. Diaz, H. Hazin
4	C. Brown, M. Neves dos Santos
5	G. Diaz, A. Domingo
6	J. Walter, K. Yokawa, A. Hanke
7	J. Walter, M. Kai, A. Hanke
8	L. Kell, A. Hanke
9	M. Neves dos Santos, J. Neilson
10	M. Neves dos Santos, J. Neilson

2. Review of biological data, including tagging information

Document SCRS/2013/161 presented a hypothesis of a recent poleward shift of swordfish in the North Atlantic. Based on observations of opposing trends in abundance for northern Swordfish, the document suggested the possibility of a shift in abundance from warm, southern latitudes to cooler, more northern latitudes. Several of the observed indices of abundance changed sharply in direction from negative to positive, while others showed an opposite change. The observed changes in the direction of the abundance indices correspond with changes in trends in the size of the Atlantic Warm Pool (AWP), the change in sign of the Atlantic Multidecadal Oscillation (AMO), and the North Atlantic Oscillation (NAO). To quantify a possible relation between the changes in abundance and the various candidate environmental indices, we ran the assessment model without the influence of the environmental data and regressed the residuals of the fit to the CPUEs to the various environmental indices (**Figure 1**). Given the suspected temperature tolerance limits of Swordfish, it is possible that either their preferred habitat has moved north, a preferred prey species, or both. It was further noted that the timing of the annual northward migration of swordfish corresponded with the annual cycle of the Atlantic Warm Pool (**Figure 2**).

Swordfish are generally caught on the cold side of oceanic fronts, in contrast to some pelagic sharks that can be found on the warm side. As oceanic fronts shift, we can assume that the swordfish will either move with the front (horizontal shift) or change their diving patterns (vertical shift) in response. Subsequently, the Group discussed the possibilities of either a shift or an expansion of the stock in response to environmental factors. Further research into the depth to which the Atlantic Warm Pool extends will be a valuable addition, since swordfish dive and can feed deep. The observed changes in the indices of abundance were based on fisheries dependent data which may not accurately indicate changes in stock abundance, but a correlation with an effort shift. This environmental variable hypothesis has implications for and requires consideration in spatial and sex-based stock assessment models, at the abundance indices level or in the model itself.

Document SCRS/2013/151 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. Although movements mainly took place latitudinally, fish tracks showed some connectivity across the north Atlantic. Average estimated daily displacements were 24.68± 19.51 km · day-1, and could eventually average ~ 100 km · day-1. The longest track recorded totaled more than 10,000 km. Preliminary results suggest that swordfish show a remarkable physiological versatility, inhabiting Atlantic waters with SSTs ranging from 10.1 to 28.6ºC, and subject to environmental temperatures from <4ºC to 28º C, with daily shifts frequently over 15ºC (mean 9.25±5.69). Fish showed a clear diel pattern in vertical behavior, and may be feeding at depth during daytime and staying in the mixed layer at night. Statistical analyses showed no spatial-temporal difference in vertical migration behaviour, although this can be partially due to the limitations of the PSAT transmitted data. This information will improve as new PSAT data become available and will help on the formulation of assessment models.

The Group appreciated the retrospective tagging results accompanied by a video depiction of the horizontal movements. The various latitudinal and longitudinal movements were noted in relation to a previous coastal tagging study. Further analyses of the vertical temperature profile will be conducted. The Group enquired on the accuracy of the estimated locations and the possibility of sex identification during tagging. Tagging work was encouraged and has the potential for inclusion in stock assessment models in the future.

Document SCRS/2013/153 presented a study of age and growth of South Atlantic swordfish. A total of 406 anal fins of South Atlantic Swordfish were collected from 2006 to 2013. Fins were classified in three types and the type A was the most common one found. Several biometric relationships between ray section measurements and lower jaw fork length (LJFL) were analysed. A better focus description for swordfish age interpretation has been developed. Mean sizes by age and growth parameters were estimated for this stock ($L\infty$= 358.65, k= 0.092, T0= -1.929) using the Standard Von BertalanFfy model, which showed the better fit in comparison with other VB models. No clear results haves been obtained when indirect validation tests (edge type and MIR) were applied.
The retrospective results reflect the age and growth in North Atlantic swordfish. Splitting the sexes in the plot will be useful to observe the difference in the growth curves. The Group inquired whether there was a significant difference between the male and female growth models, as this would have an implication for sex based stock assessment models that currently aggregate sexes. Additionally, a difference in natural mortality between the sexes would have the same implication. The authors are yet to validate the work done and increase the size ranges.

3. Review of catch data, including catch at size and fisheries trends

The Secretariat indicated that there were no updates to the Task I and II data with the exception of the inclusion in the Task I table of the 2012 catches submitted by the CPCs. The 2012 reported catches for the northern and southern stocks amounted to 13134 and 10392.5 t, respectively (**Table 1**). The Group noted that there were no 2012 catches reported for a few CPCs for both the northern (8 CPCs) and southern stock (1 CPC). For these CPCs, the Group agreed to use the average value of catches reported for 2009-2011 as an estimate for 2012 to use in the projections (**Table 2**). After estimating the 2012 missing catches, total catch amounted to 14038 t for the northern stock and 10393 for the southern stock.

Fishery descriptions

South Africa: Longline fishing in South African waters began in the 1960s by foreign flagged vessels targeting southern bluefin tuna and albacore. Interest to start a local fishery began in 1995 when foreign vessels successfully targeted and caught tuna. An experimental fishery targeting tunas and swordfish began in 1997 which developed into a formal fishery in 2005. The fishery is coastal and swordfish-oriented effort concentrates in the southwest Indian Ocean region (20°-30°S, 30°-40°E) and along the South African continental shelf in the southeast Atlantic (30°-35°S, 15°-18°E). On average, 15 South African vessels are active in a year and target swordfish in 20-30m length vessels. Additionally, foreign flagged vessels catch swordfish as bycatch. Catches peaked in 2001 and 2002 and has been on the decline since then with an average of <200 t per year over the last 5 years. The fishery is effort controlled and restricted to 50 active vessels per year. Of the 50 vessels, fewer permits (20) were made available for swordfish targeting to reduce pressure, particularly in the Indian Ocean.

Fishery descriptions for other CPCs can be found in the 'Report of the 2013 Atlantic swordfish data preparatory meeting'.

4. Relative abundance indices

4.1 Relative abundance indices – North

Available catch per unit effort (CPUE) series were evaluated by the Group during the 2013 Atlantic swordfish data preparatory meeting (SCRS/2013/015), and certain indices were identified as suitable for use in assessment models (Japan, Portugal, Morocco, Canada *1* and 2, Spain age-specific and age-aggregated, and USA 1 and 2). However, in some cases the Group had asked for further clarification or additional analyses. During the data preparatory meeting, the Group had also provisionally decided to exclude the Chinese Taipei indices from use in the assessment models pending further information regarding the standardization calculations and data treatments addressing targeting. Therefore, initial discussions focused on any changes or updates to the indices since the data preparatory meeting, as well as responses to questions arising during the data preparatory meeting.

Spanish, Portuguese, and U.S. scientists confirmed that there were no changes or updates to the indices from their fisheries since the data preparatory meeting. During that meeting, the Group had expressed concern regarding the inclusion of a year*quarter interaction as a fixed effect in the Moroccan indices, as this can affect the estimation of the year effect (which is the proxy for the relative abundance). The Group had recommended that the author explore modeling the interaction as a random effect. No Moroccan scientist was present for the assessment meeting, and no new index had been provided. Nevertheless, the Group agreed provisionally to use the Moroccan indices in the assessment models.

As requested by the Group, the Japanese index for Area 5 was revised to include the earlier time period. During the data preparatory meeting, the Group had noted that Japanese longliners changed their gear configuration frequently in the tropical areas in the 1990s due to the rapid improvement of gear materials, and that gear configuration had not changed greatly in Area 5 (temperate area of the northwest Atlantic). Since the Area 5 indices would not reflect such large influences from changing gear configuration, Area 5 indices were used in the assessment models.

New Canadian indices were presented in response to the Group's request to move all interactions with the year effect to the random component of the mixed effects model and to address possible year by bait interactions. In this iteration, both longitude and latitude were introduced as predictors but only latitude was retained. Area was introduced as a fixed effect and an area-year interaction was introduced in the random component of the model with separate slopes and intercepts estimated for levels of hooks used. A variation of this was also examined involving the estimation of separate slopes and intercepts for each level of bait. The estimates of year effects were similar to those documented in the paper and it was determined that the trends estimated were a function of how we marginalize the effect of predictors that do not index the stock. The method adopted was to set all continuous predictors at their mean value and the categorical predictors at the level associated with swordfish fishing (area=4W; bait=fish; quarter=3; hook=J). The Group recommended that data from 1962 (for which samples sizes are low) be removed from the analysis; this analysis was conducted and the results presented to the Group for inclusion in the assessment models. In addition, the Canadian scientist clarified that the Canadian CPUE data were standardized in a single model, and that the results should be considered as a single index series, with a gap from 1971-1978.

The Group considered whether or not the U.S. indices could be reconstructed as a single series taking into account new information provided by U.S. scientists that analyses of catch rates from observer data and catchabilities estimated in preliminary stock synthesis runs could not detect a significance between the catch rates using J- and circle-hooks (the reason for the construction of separate indices was the introduction of domestic management measures requiring the mandatory use of circle hooks in 2004). However, it was noted that the original conclusion that the use of circle hooks (in combination with squid bait) reduced catch rates emerged from a controlled experiment permitting side-by-side comparisons of hook type. Therefore, the Group decided to maintain the split between USA 1 and USA 2.

Document SCRS/2013/154 presented indices of abundance derived from the Chinese Taipei longline fleet data and the author responded to the concerns/questions raised by the Group during the data preparatory meeting. It was confirmed that the standardized CPUEs of swordfish were calculated using the LSmeans of the modeled YEAR effects. The author also clarified that separate abundance indices were developed for three periods (1967-

1989, 1990-1999 and 2000-2012), and that the reason why the index considering gear configuration (e.g. hooks per basket) began in 2000 (rather than 1995 when such data began to be incorporated in the data base) was that gear configuration data were sparse during the period 1995-1999. The Group appreciated the clarifications and further information, but nevertheless maintained the recommendation that the Chinese Taipei indices not be used for the north Atlantic assessment models considering the relatively small catch levels spatial coverage of this fleet in the north Atlantic especially in recent years.

The final CPUE indices, in biomass, developed by CPC scientists are shown in **Table 3** and in **Figure 3**. To facilitate visual comparison of the annual trends, the plotted values of the indices were rescaled to the mean of the overlapping years; i.e., the individual standardized index trends were adjusted proportionally to have the same average level (1.0) within the period of greatest overlap (2006-2011). As USA 1 does not include these years, its plotted values were rescaled such that its average values during the period 1997-2003 equal the overall average of the plotted (rescaled) values of the Canadian, Portuguese, and Spanish indices during the 1997-2003.

During the data preparatory meeting, the Group had recommended updating the biomass combined index to run the continuity scenario from 2009 stock assessment. CPC scientists from the major longline fleets operating in the North Atlantic (USA, Spain, Canada, Japan, Morocco and Portugal) submitted catch and effort data, at varying levels of aggregation, which the Secretariat used to calculate the combined index (SCRS/2013/139). As in past analyses, main effects included: year, area, quarter, a nation-operation variable reflecting gear and operational differences thought to influence swordfish catchability, and a target variable (based on the percentage of swordfish in the catch) to account for trips where fishing operations varied according to the main target species. The combined index is shown in **Figure 4**, rescaled to the final fishery specific indices.

The Group considered that, conceptually, this approach standardizing across the data from the major fisheries had the potential to better reflect overall stock abundance when compared to indices constructed from data for individual fisheries, given that this global approach would have higher sample sizes and broader spatial coverage, and might better account for changes in local availability. But the potential of this analysis could be hampered by several factors: (1) the observations generally had a higher level of aggregation than the original data that might be available to CPC scientists; (2) level of aggregation was inconsistent across fleets (i.e., by trip/gear category/avg. effort, by trip with detailed gear/effort collected separately, by month/gear category/5X5 degree square), resulting in disproportionate representation in the data and inconsistent levels of effort represented by each data point; and (3) the lack of auxiliary information, which might be available to CPC scientists constructing fleet-specific indices, sometimes at a set level, by virtue of observer programs or logbooks or from outside sources given more precise set location data; such auxiliary information could potentially better account for changes in targeting or the influence of environmental factors.

As had occurred during the data preparatory meeting, there was discussion on the appropriateness of the inclusion of an explanatory variable (in this case, the targeting variable based on categories defined from the proportion of swordfish in the catch) that is derived from (or directly related to) the dependent variable. The concern is that the model will calculate that changes in catch rates are caused by changes in level of target category, when in fact changes in abundance may be reflected in catch levels that in turn change the target category independent of any changes in fishing strategy. In such a case, the standardization model would tend to adjust high catch rates down, and low catch rates up, masking underlying trends. An alternative point of view was that, in the absence of detailed information on changes in fishing strategy (such as gear configuration and bait), the ratio of swordfish in the catch was the best way to discriminate between effort directed at different species. Although the Group did not reach consensus on this point, a new sensitivity standardization analysis conducted removing the target variable resulted in essentially no change to the estimates of the index, and showed some narrowing of the confidence interval .

Considering the influence of the combined index on model results, and the fact that substantial differences from the index calculated for the last assessment are observed for some years, the Group discussed how this apparent uncertainty could be quantified or characterized in the assessment results and resulting management advice. To better understand the source of these differences, the Group requested a plot of the nominal catch rates calculated from the observations used for the combined index calculations in 2009 and for the current assessment (**Figure 5**).

During the data preparatory meeting, the use of the data derived from dealer landings reports was rejected for use in the calculation of USA indices, in favor of data derived from the observer program, despite the shorter time series of data collected by observers. Observer data are available at the set level, and include data on many set-specific variables (e.g. bait, gear configuration, etc.), but there was a change over time in how dealer landings data were collected over time, from a voluntary program with a selection bias (with possible overestimation of fleet catch rates), to a mandatory program, with linkage to logbook information on location and gear only available later in the period. Despite the previous decision that the best, and least biased, catch rate data were from the observer program, USA domestic rules regarding data confidentiality prevented the submission of these landing data (used in the standardization of the USA 1 and USA 2 indices), resulting in potentially biased data from the U.S. CPUE. The potentially biased dealer landings data retained a much higher number of observations following the application of the minimum aggregation criteria, when compared to the observer data, although some data could not be provided due to having to exclude stratum with that did not meet confidentiality requirements. The effect of excluding the stratum with lower number of dealer landings observations is not known. As has been recommended in the past by the SCRS, the Group continues to recommend that some mechanism be developed, either within the current ICCAT confidentiality rules, or through some modification of the system, to enable the sharing of such critical high-resolution (low aggregation) data.

Since the data were not available to calculate a combined index for the south Atlantic swordfish stock, combined indices were developed using an approach that has been employed for several other SCRS stock assessments (e.g. tropical tunas, billfish), in which yearly index values are calculated from the available fishery specific standardized indices, using the natural log of the yearly index values as input to a GLM with the fleet as an effect. The resulting LSmeans are then back-transformed to produce the combined index values. This procedure also permits weighting each index by the area of coverage or catch (**Table 4**).

The differences between combined indices constructed in this manner, and those constructed by standardizing across the catch and effort observations provided by the CPCs, could not be evaluated in the south Atlantic. To aid the interpretation of results in the south Atlantic, in the absence of a combined index constructed from observations, the Group decided to conduct this comparison for the north Atlantic. The indices produced through the GLM approach, unweighted, weighted by area, and weighted by catch, are shown along with the continuity case combined index in **Figure 6**. The various weighting schemes generally had modest effect among GLM combined indices. The GLM and continuity combined indices were similar in some cases, but the GLM values were sensitive to instances when only one index was available, and the continuity combined index estimates a much higher value for 1963. The Group noted that the differences in information provided by the GLM combined indices from the continuity index appeared to mimic the difference in information between the individual indices and the continuity index.

4.2 Relative abundance indices – South

Six data sets of relative abundance indices (Brazil, Spain, Uruguay, Japan, Chinese Taipei and South Africa) were made available to the Group. These CPUE indices were standardized using various analytical approaches, as presented during the Data Preparatory meeting (Madrid, 3-10 June 2013). Details on the data series and methods used were provided in documents: SCRS/2013/098, Brazil; SCRS/2013/108, Spain; SCRS/2013/101, Uruguay; SCRS/2013/109, Japan; SCRS/2013/098, Chinese Taipei. Some of these relative abundance indices were presented in terms of standardized CPUE in number, therefore the Group requested national scientists (Brazil, Japan and Chinese Taipei) to convert these numbers in to biomass. This task was made by multiplying the annual standardized CPUE in number by the mean weight of the catch-at-size as provided by the Secretariat. These standardized CPUE (in weight) series then revised by the Group.

Brazil: Improvements were made to the last CPUE index which resulted in a reduction of the interannual variability in the new index. However, interannual variability still remained (i.e. particularly high in 2010) which might be the result of the very heterogeneous nature of the Brazilian fleet instead of the true trend of biomass. The Group believes that the increase in the abundance index for the species may be an overly optimistic representation of the recent trend in southern Atlantic swordfish biomass. Therefore, the Group decided not to include this series in the stock assessment modelling process.

Spain: The standardized series showed a flat and fairly stable trend over time period (1989-2011). The Group decided to include this series in the stock assessment modelling process.

Uruguay: An update of the standardized catch rate of swordfish caught by the Uruguayan longline fleet in the Southwestern Atlantic Ocean between 1982 and 2012 was presented. As suggested during the data preparatory meeting and used during the previous swordfish stock assessment, the CPUE series was split in two periods (1982-1992 and 1993-2011) due to a change in the target species in 1992. Moreover, as there have been changes in fleet dynamics that occurred after 2010, due to labour conflicts and changes in market demands that resulted in a sharp reduction in the fishing effort, the Group agreed not to include the years 2010 to 2011 on this series for the purpose of the stock assessment modelling process.

Japan: In the last swordfish stock assessment (2009), Japan submitted standardized CPUE for south Atlantic swordfish with the time series broken in two separate series (1975-1989 and 1990-2007) since there had been clear operational changes (changes on gear configuration for deeper setting in the second period) (Yokawa, 2010). In the data preparatory meeting in July 2013, Japan only updated the later part of the CPUE time series (1990-2012) as no new information was available for earlier time series. The Group agreed to also include the earlier time series (1975-1989) for the base case run as it was already reviewed and adopted at the last stock assessment in 2009. National scientists also suggested the removal of the years 1990 and 1991 from the time series, as these years may not be well represented. Because of possible data contamination due to discarding in the North (vicinity of the stock boundary at 5ºN), the Group decided to exclude the data corresponding to the period 2000-2005 and to the area north of 15ºS (northern area) from the standardized CPUE series, for the purpose of the stock assessment modelling process.

Chinese Taipei: – The document SCRS/2013/155 presented an updated version of the standardized catch rate of swordfish caught by the Chinese Taipei longline fleet in the South Atlantic Ocean between 1967 and 2012, as requested by the Group. The series was split into 3 different series corresponding to the periods 1967-1989, 1990-1999 and 2000-2012, due to changes in the fishery (lower depth of setting in the early years; a shift on the fishing ground towards the tropical area as a results of a shift on the target specie to bigeye tuna) and the type of data available (e.g. the number of hooks per basket only available since 2000). The Group decided to use these series as a sensitivity analysis run for the stock assessment modelling process.

South Africa: The document SCRS/2013/159 presented a standardized catch rate of swordfish (in number) caught by the South Africa longline fleet in the South Atlantic Ocean between 1998 and 2012. The analysis used a GLM modelling approach, which used as explanatory variables: year, month, total number of hooks per set, catch location, flag, target species, vessel name size (LOA). The Group acknowledged the effort made and recommended further improvement regarding the model formulation and the predictions for extracting the year effect on the standardized index. Therefore, the Group decided not to include this series in the stock assessment modelling process.

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 summarized in **Table 5** and illustrated in **Figure 7**. To facilitate visual comparison of the annual trends, the indices were scaled to the mean of the overlapping years.

Two combined indices were produced (summarized in **Table 6** and **Figure 8**), one excluding Brazil and the other excluding both Brazil and Chinese Taipei data series. To facilitate visual comparison of the annual trends, the indices were scaled to the mean of the overlapping years. The GLM for the combined CPUE index was weighted by the 5ºx5º of the area fished by each fleet in each year. The index was calculated as the bias-corrected back-transformed LSmean index (estimated on the log-scale). For the combined index which excluded Brazilian data series only, the SE for the back-transformation was taken as the geometric mean of the last three years so that the extremely high SE on the estimate for 1967 has less influence on the mean.

5. Methods and other data relevant to the assessment

At the June 2013 Atlantic swordfish data preparatory meeting, the Swordfish Working Group supported the effort to incorporate more of the available swordfish data into the assessment process by using other assessment platforms besides the surplus production model ASPIC used in previous assessments. The Group reviewed the available data and platforms, and it also considered the necessary expertise required to run the assessment models available. The Group recommended that besides ASPIC, the assessment also use the Stock Synthesis (SS3) and Bayesian Surplus Production (BSP2) models. The incorporation of these 2 models into the assessment process would allow for the use of priors derived from life history information, environmental data, lengths, and age specific CPUEs.

The Group discussed the possibility of including 2012 data to estimate stock status even though the 2012 swordfish Work plan indicated that the stock assessment would be conducted only with data through 2011. It was agreed that the Group should not depart from the 2012 work plan and, hence, conduct the stock assessment with data to 2011. However, the Group also agreed to perform some exploratory runs including 2012 not with the goal of providing management advice but to assess the current stock trend.

5.1 North

5.1.1 ASPIC Production model

The Grouped pointed out that during the 2009 assessment the parameter B_1/K was fixed at the value 0.85 because efforts to estimate this parameter resulted in non-convergence of the model for the northern stock. As part of a continuity case, the Group agreed to fix the B_1/K parameter to the same value used in the last assessment. However, given that preliminary runs reached model convergence while estimating B_1/K, the Group agreed to estimate all parameters in all other ASPIC runs. The Group also agreed to project the ASPIC model used in the 2009 assessment with the 2009, 2010 and 2011 reported catches to compare with the results of the current assessment.

In applying production models to North Atlantic swordfish, the Group used the dynamic (non-equilibrium) model (ASPIC v5.55) adopted previously by the SCRS for several species including swordfish. This version of ASPIC is parameterized in terms of MSY, K, and B1 (first year)/K, the model was formulated as in the 1994, 1996, 1999, 2002, 2006 and 2009 assessments. The initial settings of the models were as follow: (i) 1950 (B_0) biomass constrained to equal 0.875*K (equivalent to 1.75*B_{MSY}) or B_0 be estimated, other parameters MSY, K and catchability coefficients being estimated; (ii) Logistic production model assumption; and (iii) optimize model conditioned on catch. Least absolute values minimization was used. At prior assessments, sensitivity analyses were conducted to evaluate sensitivity to this and other factors. Other model settings such convergence criterion, search solution, restarts during optimization and initial start values for parameters as given in (**Table 7** Input file ASPIC)

The data used in ASPIC production modeling and in the sensitivity analyses were the total North Atlantic reported catch from 1950 to 2011 including estimated dead discards (**Table 7**) and the CPUE combined biomass N-SWO index as described in section 4.1 (**Figure 4**). At this assessment, sensitivity analyses were conducted to evaluate the effect on the model of the different data index input. **Table 8** and **Table 9** summarize the sensitivity scenarios considered during the evaluation, briefly considering a single index or multiple fleet indices, fixing or estimating all parameters. Other sensitivity analyses included standard protocols for retrospective analysis, cross-checking analysis, and evaluation of the shape parameter assumption for the Surplus Production Model.

It should be emphasized that the lumped biomass production models assume that the input CPUE series are proportional to biomass with some degree of random variation and both can give misleading results when this assumption is violated. The indices of biomass were assumed to be lognormally distributed.

Five alternative runs were considered by the Group (**Table 10**): **1)** a run using a single standardized index involving the combined data of Spain, USA, Canada, Portugal and Japan fit with the logistic function to the total catch where B_1/K was freely estimated, **2)** a continuity run configured as in run1 but with B_1/K fixed at 0.85 (as in 2009), **3)** a run1 variant using a Fox surplus production model, **4)** a run1 variant using separate unweighted indices that were standardized together and fit to the respective catch of each flag and **5)** a run using 7 unweighted indices (including Morocco and USA split) standardized by flag and fit to the respective catch by flag using a logistic surplus production model

5.1.2 Bayesian Surplus Production Model

A full description of the BSP methodology applied for North and South Atlantic swordfish was presented in document SCRS/2013/100.

For the BSP base case run for North Atlantic swordfish, all inputs, assumptions, and settings were based on the best available information and most common practice with BSP within the context of fish stock assessment applications of BSP. The following list summarizes the key settings for the North Atlantic swordfish case study applications:

- A Monte Carlo life table/ Leslie Matrix approach was applied to develop a prior for *r* for North Atlantic swordfish using life history data from the 2013 data preparatory meeting and the ICCAT website (see Appendix A in SCRS 2013-100 for details).

- For the north, the stock trend index was the stock trend index produced by the Secretariat using GLM standardization which was consistent with common practice since about 1989.
- Likelihood function of the abundance index data follows a lognormal distribution as in was applied in the BSP run in the 2009 stock assessment of North Atlantic swordfish (ICCAT,2010)
- Schaefer surplus production function (B_{MSY}/K=0.5) (as in ICCAT 2010)
- Prior mean p_0 (B_{1950}/K) for the north was 0.875, prior SD(log(p_0))=0.25 as was applied in the BSP run in the 2009 North Atlantic swordfish assessment ICCAT (2009).
- For North Atlantic swordfish, the standard deviation in process error deviates ($\sigma_{process}$) was set at 0.05 since there were very few deviates from model predictions that were much larger than this for the majority of the time series and apart from the first decade no noticeable serial autocorrelation in deviations in fits of the model to the data.
- A uniform prior on K, and uninformative prior for *q*
- Lag 1 autocorrelation with the autocorrelation coefficient, □, set at 0.5 starts in 2012 (see Stanley et al. 2009 for the equations).
- For the north, the CV for the combined stock trend index was obtained by iterative reweighting, with fixed observation error from survey imprecision and process error components determined by fitting the BSP model to the data to find the parameter values that give the maximum posterior density (mpd).

Sensitivity tests were conducted to evaluate the effect of stock assessment model assumptions on stock status and projection results. A summary of the additional model runs carried out for North Atlantic swordfish is provided in **Table 10**, and a brief description of each analysis is provided below.

Prior distribution for r and *K*: To evaluate the sensitivity of model results to the prior distributions for the key parameters r and *K*, additional runs were conducted: one with a uniform on log K prior and a lognormal prior for K with a mean of 200,000 tons and a SD in the log of *K* of 0.8. Runs were also carried out with a high prior mean for *r* and a low prior mean for r. The low r prior was obtained by applying a prior mean for *r* (0.28) that was two thirds of the reference case prior mean, while the high *r* prior was obtained by using a prior mean (0.56) that was one third higher than the reference case prior mean (0.42). The prior CVs were held constant at 0.39. To evaluate the joint effects of uncertainty in r and K, two other runs were carried out (see **Table 11**).

Uncertainty in the standard deviation (SD) in process error (σ_p) deviates in annual stock biomass – Due to having one only time series of abundance, it is not possible to jointly estimate σ_p and the standard deviation in observation error deviates for the different abundance indices (σ_o). We thus evaluated the sensitivity of results to applying a lower and higher value for σ_p. The values applied in this sensitivity analysis were 0.005, 0.01, 0.05, 0.075, 0.10 and 0.15.

Uncertainty in the form of the surplus production function – It is typically not possible to estimate the third parameter in generalized surplus production functions such as the Fletcher or Pella Tomlinson models (Quinn and Deriso 1999). It is common thus to apply only the Schaefer surplus production model for which B_{msy}/K is fixed at 0.5. McAllister et al. (2000) provide a variant of the Fletcher production function that can incorporate an informative prior for r and avoids the infinite slope at the origin of the Fletcher and Pella Tomlinson functions when B_{msy}/K approaches and drops below 1/e (about 0.368). The original BSP and updated BSP2 software packages include this Fletcher model variant. We evaluated the sensitivity of results to setting B_{msy}/K at 0.1, 0.2, 0.3, 0.4 and 0.6.

For diagnostic analyses three different sets of model runs were carried out. In one set the influence of each CPUE time series was evaluated by leaving out one time series at a time when the model was fitted to the six CPUE series by flag. In a second set of runs, the influence of each recent year of data on results was evaluated by fitting the model to the CPUE data with one year of CPUE data removed at a time. The model was projected to the latest year with data (2011) using the catch removal records to test predictions of the model against those provided when the model was fitted to all years of data. These sets of diagnostics runs were carried out for runs with the combined CPUE index and the set of indices by flag.

For a third set of diagnostic analyses, post model, pre-data runs were carried out using a few different priors for *K*, to evaluate the effect on the model output distributions for key quantities of interest of running the model with the priors and the catch data. The marginal prior and posterior *pdf*s of *r* and *K* are plotted to show the extent to which priors have been updated by fitting the model to data.

The possibility of updating the reference case settings was allowed for based on Bayes factor results obtained after fitting the model to the data in the different sensitivity analyses. We applied conservative criteria for updating the reference case settings to reduce the possibility of making excessively frequent and numerous changes or poorly justified changes that could result from random variation in the data when reference case settings are actually better approximations than the alternative settings. We would consider suggesting a revision of the reference case settings only if there was a very strong weight of evidence (e.g., a Bayes factor of less than 1/50 (see below)) against the reference case setting compared to the most credible alternative setting for some model component) in the posterior results.

5.1.3 Stock Synthesis

Based on data presented at the 2013 Swordfish Data Preparatory Meeting, the SS model was configured using ten longline fisheries and one “other”. The longline fisheries were Spain, United States, Canada, Japan, Portugal, Chinese Taipei, and Morocco (some fisheries were split). These fisheries collectively accounted for 92% of the total northern Swordfish landings, with the other countries and gears making up the remaining 8 percent. The SS configuration uses one season, one area, and two sexes. These dimension decisions were based on addressing the goal of adding completeness but in a “first step” and parsimonious manner so as not to unnecessarily over parameterize the model.

Direct observations of age-at-size provided by Venezuela were used to estimate growth parameters. Natural mortality for females was fixed at 0.20 per year and estimated for males. Maturity was made to be 50% at age-5 and 100% thereafter. Fecundity was made a function of body weight.

Length samples by sex for the eight fisheries were available from about 1978 to 1998. After 1998 only unisex lengths were available for use. Sex ratio by length from Canadian and U.S. observer program was used for those fleets for years without sex specific lengths. Means body weight of fish from Canada and U.S. (observed, retained fish) were used in the fit (those fisheries were all that was available).

Discards were taken from Task I tables provided at the Data Preparatory Meeting. For those CPCs that reported “significant” dead discards (U.S. and Canada) a release mortality of 100% was assumed (to match the discards exactly). For those CPCs that did not report discards to the ICCAT, discards were not considered.

Variance reweighting was used on the CPUE time series as well as the length compositional data according to estimates produced from an initial model run.

Several different model configurations were investigated by the Group. The three model configurations used to depict the range of the possible status of the northern swordfish stock in 2011 were chosen to represent variation in two major assumptions of the base configuration. These were the allowance of dome-shaped selectivity in some fleets versus asymptotic selectivity in for all fleets, the inclusion and exclusion of the environmental covariate (Atlantic Warm Pool) on the catchability of some fleets with regard to the associated CPUE time series, and a fixed or estimated value for steepness.

Selectivity was made to be length based with all ages (0-25) available. Two selectivity configurations were considered: (1) dome-shaped selectivity was allowed for Spain, U.S. and Morocco, and asymptotic selectivity assumed for Canada, Japan, Portugal, Chinese Taipei, and “other”; (2) forced to be asymptotic for all fleets. Spanish age-specific CPUE was modeled as a function with age with all lengths being made fully available. When seemingly dictated by the fit residuals with regard to minimum legal regulations, several fisheries peak selectivity parameter was made time varying by before-and-after 1990, when the 125 cm minimum size regulation was adopted. Fits to length compositions that could obviously benefit from this blocking were Spain, U.S., and Canada.

Annual catchability for the U.S., Canadian, and Japanese fleets as well as the Spanish age-specific CPUEs were modeled with two configurations: (1) forced to be constant every year, (2) made to deviate according to the annual size of the Atlantic Warm Pool (AWP). This decision was based on the conclusions that were drawn from work presented at the meeting (SCRS/2013/161).

A Beverton-Holt stock recruitment relation was either (1) assumed with maximum recruitment and steepness being estimated with a prior of 0.83 and a standard deviation of 0.11 and assuming a full beta distribution, or (2) fixed at a value of 0.83. When estimated, steepness tended to hit the upper bound so it was fixed at 0.83 to remain consistent with the value that was used to develop the prior for other models under consideration.

5.2 South

5.2.1 ASPIC Production model

The Group used an updated version of the non-equilibrium surplus production model ASPIC (version 5.34.6 from the NMFS tool box, note that for projections ASPICP.EXE, version 4.13 was used) adopted by the SCRS for several species including swordfish. Data from 1956 to 2011 were used as input for the model. The fleets included separately in the initial analysis were Brazil, Chinese Taipei (3 separate indices), Japan (2 indices), Spain, and Uruguay (2 indices), (Section 4.2). The index of abundance for the Brazilian fleet was converted from number of fish into weight by using average weight from the catch-at-size files (Task II). The landings for those fleets for which indices of abundances were not estimated were added to the landings of the Japanese longline fleet. The model runs followed the same settings used for the 2006 assessment (Anon. 2007b), B1/K parameter was fixed at the value 0.875 and final values of MSY and K were model estimated. The model was fit by the sum of squares objective function.

The Group also decided to use two combined indices use as input for the ASPIC model as described in section 4. The base cased included the fleets listed above and their associated indices of abundance as described in Section 4.2., **5)** as in run1, but with B_1/K not fixed, and **6)** as in run2, but with B_1/K not fixed. For runs where an index was dropped, the catch was attributed to Japan. The outcomes were not sensitive to this method.

1) Sensitivity run with 8 individual indices of abundance weighted equally including the Chinese-Taipei index
2) Run with 5 individual indices of abundance without including the Chinese Taipei index.
3) Combined biomass index (estimated with Chinese Taipei) weighted by area fished.
4) Combined biomass index (estimated without Chinese Taipei) weighted by area fished.
5) as in run1 but with B_1/K not fixed and
6) as in run2 but with B_1/K not fixed. For runs where an index was dropped, the catch was attributed to Japan.

The rationale for choosing the separate index runs with and without Chinese Taipei was based upon the data preparatory meeting decision that this index should be considered as a sensitivity run. The same rationale was applied to construct the combined index with and without the index from Chinese Taipei. The decision to weight separate indices equally was based upon an *a priori*, but *ad hoc* assumption that each index could equally reflect the stock abundance trends. The decision to fix B1/K was based upon a similar decision for the North Atlantic when B1/K could not be estimated. B1/K was estimated for runs 5 and 6 and likelihood profiles for B1/K were produced. In addition sensitivity of the model results to B1/K values were explored.

5.2.2 Bayesian Surplus Production Model

The reference case run settings for South Atlantic swordfish are listed below:

- A separate prior for r for South Atlantic swordfish, which was different than that for North Atlantic swordfish, was computed based on life history parameters obtained from the data preparatory meeting report for Atlantic swordfish using the same approach as for the north (see SCRS/2013/100).
- Because abundance indices were uninformative with respect to carrying capacity for South Atlantic swordfish, the prior for K for South Atlantic swordfish was formulated using the posterior for K from the base case run for North Atlantic swordfish. A null hypothesis was formulated in which the carrying capacity per unit sea surface area in the range of South Atlantic swordfish was presumed to be the same as that for North Atlantic swordfish. The habitat area in terms of the number of 5x5 squares for North and South Atlantic swordfish was quantified after consultation with swordfish biologists participating in the stock assessment meeting. The number of 5x5 squares was found to be 130 in the N. Atlantic and 130 in the South Atlantic. The prior for K for the South Atlantic swordfish was thus obtained using the posterior for K obtained in the reference case run for North Atlantic swordfish.
- For the south, the reference case set of indices included the Spanish, Japanese early, Japanese late, Uruguay early and Uruguay late indices. Due to the inability to fit the model to any CPUE series that included the Brazilian index, this index was not included in the fitting of the BSP model.
- Prior mean value for B_{1950}/K for the north was 1, prior $SD(\log(B_{1950}/K_0))=0.25$ as in ICCAT (2009).
- The prior mean for South Atlantic swordfish was set at 1 since records of catches in the 1950s were only a few tons and were much less in magnitude than the annual catch biomass values in the North Atlantic Ocean in this early period.

- For the north, the standard deviation (SD) in process error $SD_{process\ error}$ was set at 0.1 since the abundance index data were less informative about stock trends and there was more uncertainty in the annual dynamics of South Atlantic swordfish than for North Atlantic swordfish.
- In all other aspects, the settings for the reference case run for South Atlantic swordfish were identical to base case settings for North Atlantic swordfish.

Sensitivity tests were conducted to evaluate the effect of stock assessment model assumptions on stock status and projection results. A summary of the additional model runs carried out for South Atlantic swordfish is provided in **Table 12**, and a brief description of each analysis is provided below.

Prior distribution for r and *K* - To evaluate the sensitivity of model results to the prior distributions for the key parameters r and *K*, additional runs were conducted: a uniform on K prior was first applied to evaluate the amount of information in the CPUE data for carrying capacity. To evaluate the sensitivity of results to the informative prior for K that was applied for South Atlantic swordfish, the reference cased prior mean for K was adjusted 50% lower and 150% higher. Runs were also carried out with a high prior mean for *r* and a low prior mean for r. The low r prior was obtained by applying a prior mean for *r* (0.28) that was two thirds of the reference case prior mean, while the high *r* prior was obtained by using a prior mean (0.56) that was one third higher than the reference case prior mean (0.42). The prior CVs were held constant at 0.39 (see **Table 12**).

For diagnostic analyses three different sets of model runs were carried out. In one set the influence of each CPUE time series was evaluated by leaving out one time series at a time when the model was fitted to the six CPUE series. In a second set of runs, the influence of each recent year of data on results was evaluated by fitting the model to the CPUE data with one year of CPUE data removed at a time. The model was projected to the latest year with data (2011) using the catch removal records to test predictions of the model against those provided when the model was fitted to all years of data. These sets of diagnostics runs were carried out for runs with the set of indices without the Brazilian index and the Chinese Taipei CPUE series. One set of runs was carried out for the run with a uniform prior on K to evaluate how sensitive results were to removing one data point at a time with no constraint on the K parameter. The second set of retrospective analyses was carried out using the informative prior for K that was formulated using the prior developed from the K per unit area for North Atlantic swordfish (reference case). This was to evaluate whether the use of an informative prior gave rise to retrospective patterns.

For a third set of diagnostic analyses, post model, pre-data runs were carried out using a few different priors for *K*, to evaluate the effect on the model output distributions for key quantities of interest of running the model with the priors and the catch data. The post model, pre-data distributions and marginal prior and posterior *pdf*s of *r* and *K* and some other quantities are plotted to show the extent to which priors have been updated by fitting the model to data.

Tables 13 and **14** present an evaluation of the methods applied for North and South Atlantic swordfish assessments.

6. Stock Status results

Stock status is based on data and indices of abundance up to and including 2011 and stock status is referenced to year 2011.

6.1 Stock status – North

Three stock assessment platforms were used to provide stock status for the north Atlantic swordfish stock, ASPIC, BSP2 and SS3.

6.1.1 Production models

6.1.1.1 ASPIC Diagnostics

Five alternative runs were considered by the Group (**Table 8**). Both run1 and run2 were shown to have similar estimates of the parameters and trends in B, F, B/B_{msy} and F/F_{msy}. These runs gave stock trajectories consistent with the 2009 assessment. Run 4 had stock trajectories (relative fishing mortality and biomass) similar to the runs 1 and 2 (combined versus separate indices), however the endpoints were more optimistic. Run1 and run3 (logistic versus Fox) had similar relative fishing mortality estimates in 2011 but divergent estimates for relative biomass.

In general, residuals exhibited trends or patterns (auto correlation) that will introduce bias in the bootstrap estimates and the bootstrap confidence intervals will be unrealistically narrow. Also a retrospective analysis indicated that there was no strict pattern in the series fit to the catch with terminal years from 2006 to 2011 (**Table 15, Figure 9**). As the catch and CPUE information was successively removed from the latest years (2011 – 2006), the model predicted higher carrying capacity (larger *K* values), and slightly lower stock productivity (lower *r* values) and consequently lower MSY (**Figure 9**). The retrospective results indicated that biomass has been above B_{MSY} since 2008 and fishing mortality below F_{MSY} for the last 5 years. However confidence intervals substantially overlap during the time period evaluated. Compared with the retrospective run from the 2009 assessment, the trends of *r* and *K* in particular were opposite but in 2009 a larger range of variation was observed compared to the 2013 retrospective results.

A jackknife analysis was performed by sequentially giving each index in run 6 zero weight. The most influential indices were Canada and then Spain (**Figure 10**). Removing Canada did not allow the model to converge while only removing Spain impacted on the model's ability to provide realistic biomass estimates. Removing other indices resulted in similar looking trends in biomass.

Figure 11 compares the 2009 assessment model, projected with the report catches up to and including 2011, to run 2 conducted in 2013. The lines show the median and the 5th and 95th percentiles. The plot is intended as a form of quality control test. Gelman and Hill (2007) observed that when learning about a method it is convenient to predict outcomes that have already occurred so that predictions can be compared to reality. Unfortunately, in stock assessments we do not actually know what the reality is since different model assumptions can produce different perceptions of the stock. Therefore, the plot shows the consistency of the advice. It can be seen that the 2009 assessment and projection bounds the 2013 assessment, i.e. the updated assessment is consistent with the advice given in 2009.

The Group concluded that the diagnostics suggested that run 2 should be chosen as the base case model and run 5 a sensitivity run. Run 2 provided the best consistency in the advice relative to the 2009 assessment and perhaps illustrated that a combined index is a good fallback when there are concerns with the diagnostics of models developed on separate indices. The fit of the individual indices to the data showed a trend in the residuals, though the confidence intervals were smaller than in run 2 (**Figures 12** and **13**, **Table 16**). The Group determined that to make run 5 more comparable to run 2, B_1/K should be fixed at 0.85 and this became run 6. Likelihood profiles based on residual sum of squares for K, r and MSY by data compartment (index) yielded conflicting outcomes for run 6 and were better determined for run 2.

An initial run with the logistic SPM (run1) estimated all parameters (B_1/K, K, MSY and the catchability coefficient) and satisfactorily converged. However, after review of the uncertainty and bootstrap results there was clear indication that the initial biomass (B_1/K) parameter was poorly estimated and it had large confidence bounds (**Figure 14**). This indicated that the data was to inform the model of the stock status at the beginning of the series (1950) was insufficient, in part due to the lack of index information for the initial years (1963 first year for index). The mean trend estimate of B_1/K of 0.54 indicated that the stock was relatively highly exploited back in 1950, a result due to both the lack of information and an artifact of the model. Given, this low starting biomass is in contradiction with the history of the fisheries for swordfish in the north Atlantic, the Group decided to continue with the assumption of fixing B_1/K to a value of 0.87 as in previous assessments. It is of note, that this assumption had no impact on the model results regarding the status of the stock in the present time, or estimates of population parameters except B_1. **Table 17** contrasts the estimated parameters by the two models. **Figure 15** shows the annual trends of the relative biomass of the two model formulations; notice the wider confidence bounds in the initial years when the B_1/K is freely estimated.

A diagnostic run, cross-check validation was done using the end points from the retrospective runs and projecting from these points to 2011 using the known catch (Task I) for each of the years removed. The expected results are that the projected trends should fall within the predicted biomass or fishing mortality estimates for the base case. **Figure 16** shows the results from the cross-check validation runs in terms of absolute biomass and overall fishing mortality. The predicted biomass from the cross-check runs were above the median of the base run, but within the predicted 80% confidence bound. This was similar for the fishing mortality, but with predictions below the base model trend. The Group concluded that there were no retrospective patterns to reject the base model, and that the cross-check confirms the robustness of the model.

An additional sensitivity run was done evaluating the shape of the surplus production (run 3) model. The base model, which assumes a logistic function, was contrasted against the Fox surplus production model (**Table 18**). The results indicated that the Fox SPM fit the catch slightly better with the index data (a reduction of less than 0.9% in the objective function), but this was not statistically significant. The parameter that was most uncertain was the B_1/K due to the lack of index of abundance information in the initial years of the time series. Although the parameter estimates were similar between the two alternative shape parameterizations of the production model, the annual trends of relative biomass and fishing mortality showed larger differences (**Figure 17**). The Fox model estimated higher ratios of B/B_{MSY} since 1960, albeit following a similar pattern and an equivalent F/F_{MSY} trend after 1960. The Group concluded that there was not sufficient evidence to change the base assumption of a Logistic SPM.

The Group also reviewed the SPM runs with input from several indices of abundance. For runs 5 and 6, the model used the standardized indices of abundance that were provided by CPCs and discussed during the data preparatory meeting (SCRS/2013/015). Briefly, 7 biomass indices were included in runs 5 and 6; Japan, EU-Spain, EU-Portugal, Morocco, Canada and U.S. The index for the U.S. was split into two time series in response to a change in management regulations that affected catch rates. Each index was associated with their respective catch (Task I); and the catch of others fleets was added to the U.S. fleet series 1 catch data. The only difference between run 5 and 6 was that in run 6 the B_1/K parameter was fixed. Alternative biomass indices were also created from the Year*Fleet interaction of the combined biomass index (see SCRS/2013/139 for further details). For this model run (run 4), only 5 indices were available; Japan, EU-Spain, EU-Portugal, Canada, and U.S. All runs 4 to 6 converged, however diagnostics, particularly of the indices trends exhibited residual trends indicating poor fit and negative correlation among some of the indices (**Figure 18**). It was noted, however, that the general trends of biomass and fishing mortality were similar and gave same general trends overall (**Figure 19**). The Group concluded that based on the diagnostics and performance of the model runs 4, 5, or 6 should not be considered as the base case model.

6.1.1.2 ASPIC Results

Results from the north Atlantic base case ASPIC model, which the Group considered to be the most credible model version, are shown in **Tables 16** and **19** and **Figures 12** and **13**. The estimated relative biomass trend shows a consistent increase since 1997. **Table 16** show**s** the deterministic biomass, fishing mortality and relative biomass and fishing mortality values estimated from the ASPIC base model for the North Atlantic swordfish stock 1950-2012. Biomass values represent estimates at the beginning of the year. The bias corrected deterministic outcome indicates that the stock is at or above B_{MSY} (**Figure 13**). 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 2002-05 period and downward trend since then (**Figure 13)**. 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 (14,038 MT) exceeded the TAC of 13,700 MT. Overall, the stock was estimated to be slightly less productive than in the previous two assessments with the intrinsic rate of increase, r, estimated at 0.42 compared to 0.44 in 2009 and 0.49 in 2006. These differences in r are likely a result of updates in the data and indices because a retrospective analysis provides estimates of r that indicate productivity has been increasing since 2006 (**Table 15**). 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 (**Figure 20**). 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 BSP2 estimating larger stock biomass and lower fishing mortality across the entire time series.

Figures 12 and **13** show the fit of the index of abundance and the trends of the relative biomass (B/B_{MSY}) and fishing mortality (F/F_{MSY}). **Figure 21** shows histograms and scatter plots of bootstrapped estimates of the biomass and F ratios for 2011 from the ASPIC base case model (run2), while **Figure 22** shows the Kobe plot of the predicted stock status at the start of 2012. The spread of the logistic fits suggest that current biomass is above B_{MSY} and below $F_{MSY.}$ Overall, 97% of the bootstrap runs indicated $F < F_{MSY}$ and $B > B_{MSY.}$ **Figure 23** shows the contours of the bootstrap runs and the marginal distributions of the relative indicators. Although the uncertainty around B_{MSY} is considerable, the stock is considered to be continuing with the recovery predicted in the last 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 (**Figure 24**).

6.1.2.1 BSP2 Diagnostics

Two BSP2 models were considered by the Group as a reference case: 1) [runR] a run using a single standardized index involving the combined data of Spain, USA, Canada, Portugal and Japan and 2) [run C] a run using 7 equally weighted indices (including USA split; CV=0.5) standardized by flag and fit to the total catch by flag. These runs are most comparable to ASPIC runs 2 and 6, respectively.

For all BSP2 runs, importance sampling provided numerically stable results and precise approximations of the marginal posterior distributions for parameters. Importance sampling, however, was less efficient for the runs with the largest values for the standard deviation in process error (e.g., when standard deviation (sd) in process error was set at 0.15.). For all runs except those where sd process error was set at 0.15, the maximum weight from any one draw from the importance function dropped rapidly to less than 0.5% within ten minutes of importance sampling (one million draws). In runs with the sd process error set at 0.15 the maximum weight dropped below 1%, after a few hours when importance sampling (36 million draws). For the reference case run, the maximum weight taken by a single draw was about 0.012%. **Figure 25** shows that the maximum weight taken up by any one draw from the importance function drops progressively to a tiny number. In all runs, the CV in the weights (CVw) was less than half of the value for CV in the likelihood times the prior (CVlp) (e.g., for the reference case CVw = 13.3, and CVlp = 482), and the maximum weights were not consistently in the tails of the marginal posterior density functions for key parameters. Importance sampling was thus computationally highly efficient.

Standardized residuals by year were plotted for the combined index of abundance (R.N) to evaluate the extent of serial autocorrelation in the residuals (**Figure 26a**). There was some noticeable serial autocorrelation at lag 1 in the first decade and an apparent decrease in the magnitude of deviates with time. But thereafter the residual pattern showed very little autocorrelation. When the observed CPUE were plotted against the predicted CPUE, there was a well-defined positive correlation, though there was a large positive deviate for the 1963 CPUE (**Figure 26b**). The plot of stock biomass against the combined CPUE index shows a fairly good fit of the model to the data with the model predicted stock biomass trending through the observed CPUE fairly closely (**Figure 27a**). The plot of the estimates of annual process error deviates over time shows a small surge in positive deviates and then a negative series of deviates prior to 1970 but after that shows no discernible patterns after that (**Figure 27b**). This suggests that there are no indications of substantial non-stationarity in the form of the surplus production function over the time series.

In a retrospective-cross validation diagnostics analysis for the reference case BSP run for the north, R.N, the biomass was projected from 2011 to 2020 with constant removals of 10,000 t thereafter and from 2001 to 2011 using the catch data to 2011, fitting the model to the CPUE data with one year removed at a time (**Figure 28a**). In other words, the model was for example fitted to data to 2009 and then projected to 2020 using the catch series mentioned above. The model was then fitted to data to 2008, but then projected to 2020 again using the catch series mentioned again and so on until the model was fitted to data only up to 2001 and then projected again to 2020. The resulting biomass and fishing mortality rate trajectories to 2020 resulting from this set of retrospective runs, were very similar and all predicted stock biomass trajectories passed similarly through the data that were not used to estimate model parameters (**Figure 28b**). There were no apparent retrospective patterns for r, K, F_{MSY}, MSY, F/F_{MSY}, and B/B_{MSY} but the confidence intervals widened as the years were dropped due to the presence of increasing process error (**Table 20a, Figure 29**).

BSP2 run C.1 residuals for the individual indices had trends (**Figure 30**). The magnitude of the standardized residuals had a positive trend for Canada while USA1/USA2, and Portugal exhibited a slight negative trend. The Japanese index had high residuals at the ends while Spain trended negative over the last 10 years. Thus, indices were in conflict with each other making results sensitive to how the different indices could be weighted in the fitting process. The fit of the BSP model to the CPUE data by flag shows individual CPUE series having trends in conflict with the projected stock biomass, e.g., for Spain, Japan and Canada (**Figure 31a**). Process error deviates showed a slight dip in the 1980s followed by a progressively slight increase since the mid-1990s to 2011 (**Figure 31b**). A slight retrospective pattern was detected in in the stock biomass and fishing mortality rate reconstructions (**Figure 32a,b**). Retrospective patterns were also apparent for r (0.41 to 0.45) and F_{MSY} from 2001 to 2011 (**Table 20b**). MSY and K were stable while F/F_{MSY} and B/B_{MSY} exhibited a slight up-tick (**Figure 33**).

In another diagnostic analysis (jackknife), where the model was fitted to the CPUE by flag provided by national scientists (run C.1), the data were removed one time series at a time with replacement. Posterior distributions suggested higher levels of fishing mortality when Portugal was included and lower levels of F when Canada was included (**Figure. 34**). This reflected the opposing tendencies in trend information in these datasets. Given the residual diagnostics, and sensitivity of results to the different CPUE series in run C.1 run R.N performed better than run C.1 and had less retrospective pattern.

In another diagnostic analysis (jackknife), where the model was fitted to the CPUE by flag provided by national scientists (run C.1), the data were removed one time series at a time with replacement. Posterior distributions suggested higher levels of fishing mortality when Portugal was included and lower levels of F when Canada was included (**Figure. 34**). This reflected the opposing tendencies in trend information in these datasets. Given the residual diagnostics, and sensitivity of results to the different CPUE series in run C.1 run R.N performed better than run C.1 and had less retrospective pattern.

A final diagnostic run performed with the BSP model was to run the model with only the catch and the priors without fitting the model to the CPUE data for parameter estimation. This is termed the post-model-pre-data run. This shows the relative amount of information in the priors and also catch data in parameter estimation and estimation of quantities of interest such as replacement yield in recent years. For the BSP run R.N, there was no information in the catch data to update the priors, except to make slightly larger values than considered in the prior for K implausible (**Figure 35**). There appeared to be a very small amount of information about replacement yield, B_{2011}/B_{msy} and F_{2011}/F_{msy} when the model was run with the catch data but the post model pre-data distributions were updated markedly when the model was fitted to the CPUE data (**Figure 35**).

On final review of the runs, the Group was assured that given the lack of trend in the process error deviates for the combined index used for Bayes advice there was no detectable evidence of the presence of non stationary dynamics based on the model. However for the model estimated for the separate indices there was evidence of trend in process error in recent years which could be due to expansion of the Atlantic warm pool leading to higher CPUEs for some of the more northern fleets. The combined GLM analysis modeled the year*area interactions as random effects diminishing the potential effect of different CPUE trends in different areas. In contrast, treating the indices as separate allows introduces these potential environmental affects into the production model likely leading to the process error estimates in the BSP model fits.

The consensus of the Group was that run R.N was an acceptable view of stock status but that the GLM diagnostics from index standardization might be more informative when choosing between the alternate runs using combined or separate indices in the future.

6.1.2.2 BSP2 Results

The estimated stock status results from applying the BSP2 model (run1) are shown in **Table 21**. The posterior results from the BSP reference case run for North Atlantic swordfish suggest that the stock is very close to B_{msy} and that fishing mortality is very close to F_{msy} (**Table 21**).

A number of sensitivity analysis were carried out and results are summarized in **Table 22** and **Figure 36**. By varying the value for Bmsy/K from 0.1 to 0.6, it was determined that this aspect of the production function was an important source of uncertainty. Bayes factors indicated that Bmsy/K = 0.3 was 7.9 times more likely than 0.5 (**Table 22**, **Figure 37**), yet only values greater than 10 would be suggestive of a definitive difference. Sensitivity runs involving contrasting priors on K and r (r = 0.38; high r = 0.58 and low K) made little impact on the reference points due to the compensation occurring within the model (**Table 21**).

Compared to the base ASPIC estimates, the stock productivity is lower, K is higher, and relative measures of stock status are less optimistic, though the stock is estimated to be slightly above B_{MSY}, and current fishing mortality is estimated to be less than F_{MSY} (**Figure 38)**. The uncertainty around B_{MSY} is considerable. **Figure 39** provides the relative biomass and relative fishing mortality trajectories which are less optimistic than those provided by ASPIC. Compared with the comparable ASPIC run, the current value of B/B_{MSY} was similar and F/F_{MSY} was less optimistic. A similar plot is show for run C.1 where the indices were fit by flag which indicates a higher relative biomass status and lower relative fishing mortality rates (**Figure 40**).

6.1.3 Stock Synthesis

6.1.3.1 Stock Synthesis Diagnostics

As the SS model was used for hypothesis testing and corroboration purposes, in an effort to make the best use of the limited meeting time the discussion of model diagnostics was somewhat abbreviated. Nonetheless, they were presented and discussed by the Group. Some of the immediate potential advantages of using an integrated framework is the amount of data that can be incorporated (**Figure 41**). However, these advantages are only as strong as the quality of the data is (i.e. more data does not necessarily result in a more accurate or precise assessment). The integrated approach was capable of using fleet-specific information in terms of selectivity and CPUE-fleet coupling. Because some of the individual fleets fished in specific areas, some of which held different size fish, this made for a pseudo-area specific model. The use of direct observations of sex-specific lengths, age-at-size, and mean body weight are just some examples of data that have existed in the ICCAT database for many years, but until this point have not been formally included in the assessment model.

Fits to the biological observation data of age-at-size and sex ratio were acceptable (**Figure 42**). However, the Group noted that fits to observations of some fleet specific mean size were not as good for some years. Even so, the model seemed to capture the sexual dimorphic nature of the population.

When the selectivities that were allowed to be dome-shaped were made asymptotic the likelihood values (a "goodness of fit" value) for the length compositional data became considerably (**Figure 43**). However, this was not apparent when the fit to the fleet aggregated length compositional data was examined (**Figure 44**). Closer examination of the year/fleet specific length fits did reveal differences, but they were subtle. The drop in likelihood units (over 1000 units out of a total of approximately 6500 units) was likely due to the large number of observational data points included in the model fit. Given that different sized fish are available to the various fleets in different areas and different times of year it seems logical to maintain the dome-shaped selectivity option.

The addition of the Atlantic Warm Pool (AWP) as an environmental covariate on catchability resulted in CPUE residuals that were much less biased then when it was not. Specifically, the fit to the Canadian CPUE was improved considerably (**Figure 45**). The residuals that were previously quite scattered around the 1 to 1 line were made more linear. The same type of improvement was made for the Spanish age-specific CPUEs (**Figure 46**). Previous work by Mejuto (2013) presented at the data preparatory meeting demonstrated a relation between the CPUE time series and the North Atlantic Oscillation (NOA). The NOA and the AWP were highly correlated.

It became apparent during the meeting that the allotted time might not permit a full and detailed analysis of all three of the modeling platforms complete with diagnostics, alternative runs, and projections. Although the SS modeling work was recognized as a very valuable tool and was expected to now be an ongoing part of the swordfish assessment activities, continued and complete examination of all of the critical aspects of the model could not be completed at the meeting given time limitations. Consequently, results of the SS model were not considered to develop the management advice. To further the use of the SS model, the Group made relevant recommendations to ensure the work continued (see recommendation section below).

6.1.3.2 Stock Synthesis Results

Estimates of stock status from the SS modeling effort are shown in **Figure 47**. The three SS models all gave relatively similar results in terms of stock trends. When the Atlantic Warm Pool (AWP) was included in the model it tended to pull down the most recent estimates of stock status as it tempered the large increase in the Canadian CPUE by increasing the catchability. Assuming full selectivity (asymptotic) did little to change the relative trend but it did change the estimates of absolute biomass. Finally, while the general trends agreed reasonably well with the ASPIC and BSP2 base case model results, the SS model estimated a lower B/B_{MSY} and a higher F/F_{MSY} for 2011 (**Figure 47**). This was mostly due to a decrease in recruitment in the most recent years. Estimates of 2011 B/B_{MSY} and F/F_{MSY} with standard deviations are shown in **Figure 48**. All three SS models suggest that the stock is likely overfished and currently undergoing over-fishing.

6.2 Stock status – South

In 2009, evaluation of the status of the South Atlantic swordfish stock was assessed using a 'Catch only' model. It was not possible to replicate or run this model at this meeting, thus other stock assessment platforms were used to provide stock status advice for the South Atlantic swordfish stock (i.e. ASPIC and BSP2). Preliminary ASPIC and BSP2 runs on nine separate indices indicated that the Brazilian index was driving the model lack of fit. In general, the indices were observed to track trends in effort and therefore did not provide independent signals of abundance. It was noted that Brazil accounted for approximately 25% of the total landings and that it was the longest series once the Chinese Taipei index was split into three parts. The Brazilian index was negatively correlated with most of the other indices and the conflicting trends could not be reconciled within either production model platform. Removing the Brazilian index allowed the models to obtain solutions, indicating that the only practical course of action was to drop or down weight the Brazilian index from further modeling.

6.2.1 ASPIC

The Group reviewed 6 alternative ASPIC runs (**Table 23)**: 1) 8 equally weighted indices (Spain, Uruguay1, Uruguay2, Japan1, Japan2, list) fit to their respective catch data and B_1/K fixed at 0.875, 2) as in run1 but without the 3 Chinese Taipei indices, 3) as in run1 with indices combined, 4) as in run2 with indices combined, 5) as in run1 but with B_1/K not fixed, and 6) as in run2 but with B_1/K not fixed. For runs where an index was dropped, the catch was attributed to Japan. The outcomes were not sensitive to this method.

6.2.1.1 ASPIC Diagnostics

1. *Likelihood profiles for key parameters and estimability of parameters*

Objective function profiles of MSY and K indicated that there was very limited ability to estimate K and that the solution surface was extremely flat (**Figure 49**). When viewing separate indices, there were divergent signals in the profiles by data source and erratic behavior of the objective function surface. There was no signal in data to estimate B_1/K, other than a low likelihood that K was less than 100,000 MT (**Figure 50**).

2. *Correlations of CPUEs*

There were strong negative correlations in CPUEs even after removing the Brazil time series. These negative correlations make interpretation of any results problematic and can lead to model instability (**Figure 51**)

3. *CPUE residuals and autocorrelation and qq-normal plots of the residuals*

Residual patterns are shown for model runs 1 to 4 (**Figure 52**). CPUE residuals show autocorrelation, some residual trends and non-constant variance (**Figure 53**). These are likely to violate the assumptions of independent and identically distributed residuals required for unbiased bootstrap confidence intervals. The end result will be that the bootstrap confidence intervals will be likely to underestimate uncertainty.

4. *Jackknife CPUE*

Removing one index at a time indicates that the model is extremely sensitive to the Japanese longline index 2 (**Figure 54**).

5. *Retrospective performance*

The model estimates increasing K (to extremely high values) and decreasing r (to very low values) with subsequent retrospective peels. This can be attributed to instability in the estimate of the parameter or to a situation where the only signal that r is different from very low values is obtained from the data for the most recent years. A retrospective analysis of run2 revealed that the value of r and K were strongly dependent on the last 2 years of data (**Figure 55**). As years were successively dropped, the reconstructed stock biomass showed less depletion from an unfished state and estimates of r dropped while those of K increased.

6. *Quantification of uncertainty and performance*

The model can be bootstrapped, in practice, but autocorrelation in the residuals (**Figure 53**) will likely lead to too narrow confidence intervals. When bootstraps were performed for run2, three out of 500 trials were replaced due to MSY being out of bounds.

7. *General comments*

Both runs 1 and 2 gave the only plausible results. The correlations among the series were improved compared with all indices in, though there were clearly trends in the residuals and the variance was non-constant across the time series. Of note, there were also strong residual patterns in the Japanese longline CPUE for the years 2000-2005 indicating that these years might also be affected by management regulations affecting the Northern stock. This issue was addressed by the new standardization conducted during the meeting. B_1/K was estimated to be 0.84 in run5, but a decision was made to fix B_1/K to 0.875 after viewing the poor estimability of this parameter and the relative insensitivity of the results to this assumption (**Figure 56**).

The combined index runs 3 and 4 did not fit the data even after excluding indices for both Brazil and Chinese Taipei. The model parameters hit upper bounds as the information in the model indicated that K was essentially unbounded (**Table 23**). This is due to substantially divergent signals between the landings and the CPUE and subsequently the combined indices were not considered for further results. However it was noted that the method of combining the indices in the GLM could be explored further, in particular considering a jackknifing approach to creating a combined index. For the separate index models the diagnostic patterns were particularly troublesome. Notably the objective function surface is extremely shallow for K indicating that this key parameter is very poorly determined and may be a spurious result. Second, the severe retrospective pattern indicates that any signal on r is only a product of 2 years of data and potentially renders these results spurious and subsequent considerations of stock status and projections are highly suspect. Third, the autocorrelation in residuals will produce bootstrap confidence intervals that underestimate the true uncertainty.

6.2.1.2 ASPIC Results

The results of the reference case ASPIC model (run 2) indicated that there was a conflicting signal for several of the indices used and substantial conflict in the landings history and the indices (**Figure 57**). The model estimated biomass was relatively stable until the early 1980s when it started declining until the late 1990s and it reversed that trend about 2003. Estimated relative fishing mortality (F_{2011}/F_{MSY}) was 0.8391 indicating that the stock is not undergoing overfishing (**Figure 58, Table 24**). Similarly, estimated relative biomass (B_{2011}/B_{MSY}) was 0.9770, indicating that the stock is slightly overfished (**Figure 58, Figure 71, Table 24**). The time series of relative biomass showed that the stock became overfished in 1997 and has remained in that condition, but it has almost rebuilt. The absolute and relative biomass and fishing mortality trajectories are similar to the 2009 ASPIC model, despite the substantial differences in CPUE index treatment. The 2009 index used continuous Japan and Chinese Taipei indices and the index from Brazil but even with these difference the model similarities are high (**Figure 59**). Given that the realized catches have been well below the TAC since at least 2002, it is possible that this has contributed to the improvement of the relative stock status. **Table 23** shows all estimated benchmarks. The point estimates should be taken with caution as the objective function profile is flat for K and the approximate confidence intervals are unreliable for reasons given above. The replacement yield was estimated by ASPIC to be approximately 14,000 MT.

6.2.2 BSP2

Due to the lack of any consistent depletion signal in most of the standardized CPUE indices, and also in the obtaining of preliminary results in fits of BSP to the CPUE indices by flag that showed no update in the prior distribution for carrying capacity (i.e., the obtaining of a nearly flat posterior for carrying capacity) (see below), an informative prior for carrying capacity for South Atlantic swordfish was developed. It was assumed that the prior for carrying capacity per unit habitat for swordfish could be formed from the posterior distribution for carrying capacity per unit habitat for swordfish in the North Atlantic Ocean. With consultation of the swordfish biologists participating in the 2013 stock assessment meeting in Olhao, the parts of the North and South Atlantic Ocean that were considered to be swordfish habitat were tallied up. In both the North and the South Atlantic Ocean, 130 5x5 squares were counted as swordfish habitat. Therefore the posterior distribution for carrying capacity obtained from the reference case run for North Atlantic swordfish was applied as the reference case prior distribution for swordfish in the South Atlantic Ocean (**Figure 60**).

6.2.2.1 BSP2 Diagnostics

Preliminary model runs involved all available indices (equally weighted) and indicated that the model could not be run with the Brazilian index present as parameter estimates always hit the upper bound. Without the Brazilian index the model produced an infinite estimate of stock size that was largely due to the presence of the three Chinese Taipei indices.

As with the application of BSP to the North Atlantic swordfish stock, the SIR diagnostics for BSP applications to south Atlantic swordfish all indicated very rapid convergence in all runs carried out. The maximum weight in the posterior diminished to less than half a percent within a million draws from the importance function for all runs carried out.

The fitted stock biomass trend to the CPUE data by flag show that some CPUE series show trends that conflict with the estimated trends in stock biomass (**Figure 61a**). The estimated process error deviates show a negative series in the late 1970s, a positive trend in the 1980s and 1990s and a negative dip around 2000 (**Figure 61b**). This suggests some possible non-stationarity in the surplus production function over this period. Strong residual patterns were observed for several but not all of the remaining indices (exhibited by negative correlations) (**Figure 62**). This suggests caution is required when interpreting estimates of trends obtained by fitting models to these data in combination. The biomass trend however was shown to have extremely wide confidence intervals (**Figure. 63a**) so caution is required in interpreting the estimated median trend in stock biomass. The catch data provided was not consistent with the average trend in the abundance indices and consequently there was no information to update the prior for K or r with or without Chinese Taipei in the model.

For the reference case model in which an informative prior for carrying capacity was applied (run R.S) there were no apparent retrospective patterns in the reconstructed and predicted stock biomass and fishing mortality rate by year estimates (**Figure 63b**). There were no retrospective patterns seen in the six variables monitored for the South Atlantic swordfish stock (**Table 25**, **Figure 64**). There were no retrospective patterns either when the uniform prior for K was applied (**Figure 65**). When CPUE indices by flag were removed one at a time, there was some sensitivity of posteriors for r, K, F_{2011}/F_{MSY} and B_{2011} /B_{MSY} to the removal of e.g. the Spanish Index (**Figure. 66**). However, while the posterior distributions shifted slightly, the bulk of the probability still stayed near to the reference case (R.S) central tendencies and did not lead to differences that could be large enough to change perceptions of stock status. The marginal posterior distributions for replacement yield for replacement yield values larger than zero were all centered about 15,000t in the jackknife analysis and when the prior for K was uniform and also for the post model, pre data run (**Figure 66**).

Sensitivity runs were carried out on BSP applied to by flag CPUE for South Atlantic swordfish with a uniform on K prior and variants on the prior for r. Some of these runs included versus excluded the Chinese Taipei index. In all instances, the posteriors for K, MSY and stock biomass in 2011 were not very different from the post model pre-data distribution with the unform on K prior (**Figure 67**) indicating that the model is sensitive to the prior for K and that there is very little signal in the data to determine K. Similar sensitivity to a uniform prior for K were seen for the combined index but are not shown. Thus stock sizes in 2011 of 100,000 t or more were equally likely when a uniform prior for K was applied. However, the posteriors for replacement yield were all had a mode at about 15000 t, except for the posterior computed using also the Chinese Taipei index (**Figure 67**). Runs with the Chinese Taipei index and the uniform on K prior gave results that suggested enormous stock sizes and productivity (**Figure 67**).

Several sensitivity runs were also carried out applying the informative prior for K and excluding the Chinese Taipei index (**Figure 68**). The posteriors for K, r, and stock biomass in 2011, were all quite sensitive to the prior means for r and K that were considered (e.g., prior mean for K 50% and 150% of the reference case prior mean and the prior mean for r at 2/3 and 150% of the reference case prior mean for r) (**Figure 68a-c**). The posterior mode for MSY was largely insensitive however to the settings for the prior mean for r and K (**Figure 68d**). However, as indicated above, the posterior distribution for MSY under a uniform prior for K was quite flat but had a posterior mode at 18,000t, a little higher than the range of 14,000-16000t under different priors for r and different informative priors for K. The posterior mode for replacement yield (for values of replacement yield larger than zero) however was at about 14,000-15,000 tons for all of the different sensitivity runs on r and K and no different from the reference case run (**Figure 68e**). The results excluding the Chinese Taipei index thus all suggest that the estimates of replacement yield were moderately informative with a posterior mode at about 14,000-15,000 tons and this result was insensitive to the apparent conflicts in the CPUE data (excluding Chinese Taipei), and this was the case with and without the informative prior for K.

The estimate of B/B_{MSY} across the time series was consistent with a stock that is in an unfished state or lightly exploited in all sensitivity and diagnostic runs carried out (**Table 27**). It should be noted that the BSP results are contingent upon the assumed prior distribution for carrying capacity. For the reference model the prior for carrying capacity was carried over from the estimated posterior distribution from the North. Hence the productivity estimates for the South are largely constrained by the assumption of informative priors for both r and K. When a completely uninformative prior for K is used (**Figure 67**), the lack of strong signal in the data suggests extremely high values of K deemed unlikely by the Group , hence the decision to use an informative prior for K was made.

It should be noted that for 1950- 2011, the total removals for the South Atlantic stock were 73% of the total removals for the North Atlantic stock for this same period (i.e., 464,000 tons from the South and 637,000 tons from the North Atlantic). Should the carrying capacity per unit habitat be similar between the North and the South Atlantic Ocean, significantly lower total magnitude of removals for the South Atlantic stock, would suggest that the level of depletion for the South Atlantic should be less than that for the North Atlantic Ocean. The BSP results for the South Atlantic population of swordfish that all suggest a lower level of depletion and lower level of fishing mortality rate, are thus consistent with the lower magnitude of removals for the southern stock that is expected to have a similar carrying capacity as the northern Atlantic stock.

6.2.2.2 BSP2 Results

The results of the reference case BSP2 model run for the South Atlantic swordfish stock are provided in **Table 26 and Figure 69**. Estimated relative fishing mortality (F_{2011}/F_{MSY}) was 0.47 (90% interval: 0.18-0.97) indicating that the stock is not undergoing overfishing (**Figure 70**). Similarly, estimated relative biomass (B_{2011}/B_{MSY}) was 1.38 (90% interval: 0.89-1.87), therefore indicating that the stock is unlikely to be overfished (**Figure 71**). **Table 26** shows all estimated benchmarks. However, the Group noted that the status results are sensitive to the choice of prior for K.

6.2.3 Exploration of mean weights and recent landings history

In view of the uncertainty for the south stock evaluation using catch and index of abundances, auxiliary information was reviewed by the Group. The Group explored recent trends in landings and mean weights to determine if there was a signal that fishing mortality might be changing in recent years. On average, the total swordfish catches per year over the last ten years (2001-2011), for flags with the highest average catches for the same time period, show a declining trend (**Figure 72**). However, the average weight per swordfish for the same flags has remained stable over the last 10 years with outliers seen by Senegal and Brazil in 2009 and 2010, respectively (**Figure 73**). It might be expected that the reduction in landings (if commensurate with a reduction in fishing mortality) would lead to increases in the mean size/weight, which are not clearly evident. However, multiple factors can affect mean weight such as recruitment events, changes in fishery selectivity, or changes in growth. Nonetheless, there is a strong signal of decreasing mean weights over a 30 year time period since 1978 (Figure 15 in the Data Preparatory Meeting Report) which corresponds with the increases in landings. This exhibits an expected population level response to fishing which warrants further exploration and potentially incorporating into modeling. However, any changes in size selectivity over time should be carefully considered when evaluating these mean weight trends.

7. Projections

7.1 Projections – North

7.1.1 Production models: ASPIC and BSP2

The ASPIC base model was projected to the year 2022 under constant TAC scenarios of 8 to 20 thousand tones. Catch in year 2012 (14,038 t) was assumed to be the reported catch plus the average of the last three years (2009-11) for those CPCs that have not reported swordfish catches as of September 5, 2013 (**Table 2**). Median trajectories for biomass and fishing mortality rate for all of the future TAC scenarios are plotted in **Figure 74**.

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} (**Figure 21** and **22**) and, thus, the Commission's rebuilding plan goal has been achieved. While there is some uncertainty associated with this conclusion, 93% of the bootstrap estimates of current biomass were greater than or equal to B_{MSY}, while 97% of the bootstrap estimates of current F were less than F_{MSY} (**Figure 21**). Rebuilding was achieved in spite of allowable catch levels agreed in [Rec. 06-02 and Rec. 08-02] which exceeded scientific recommendations, but which were not realized. The 2007 and 2008 catches were 10% and 22% below the estimated MSY level, respectively, thus allowing the stock to grow in biomass. It should also be noted that the 2012 catch levels (14,038 t) were above the TAC (13,700 t).

Future TACs above 15000 t are projected to result in 50% or lower probabilities of the stock biomass remaining above B_{MSY} over the next decade (**Table 28**) as the resulting probability of F exceeding F_{MSY} for these scenarios would trend above 50% over time. The current TAC of 13,700 t would have an 84% probability of maintaining the stock and fishing mortality rates at a level consistent with the Convention Objectives over the next decade.

Projections with BSP also used similar specifications for 2012 and 2013 yields and projected over the same time frame (**Figures 75-76**). Both models provide very consistent advice that TAC levels of 13700 t would maintain the stock at a level consistent with the Convention Objectives over the next decade. When comparing the quantification of uncertainty around stock status under a TAC of 13700 t, the BSB 95% credibility bounds appear diverge into the future whereas the ASPIC 80% confidence intervals are relatively constant. This is due largely to the fact that BSP incorporates process error into projections.

Table 29 gives the estimated probability of B>=BMSY, F<=FMSY, and maintaining the stock in the condition consistent with the Convention objective (B>BMSY and F<FMSY) for the constant catches listed and the times indicated from the BSP base case model for the North Atlantic stock. In contrast to the ASPIC, the BSP results indicate that the current TAC of 13,700 t would have a 50% probability of maintaining the stock and fishing mortality rates at a level consistent with the Convention Objectives by 2021.

7.2 Projections – South

7.2.1 ASPIC and BSP Production models

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. For both BSP and ASPIC projections for the reference case (5 CPUE series, without China Taipei and Brazil) were performed for catch levels from 10,000 t to 20,000 t by increments of 1,000 t for years 2015-2022. For year 2012, projections used the task I estimates available at the meeting (10393t) for 2013, all projection scenarios assumed a catch equal to the TAC (15,000 t). For ASPIC 500 bootstraps were performed and bias-corrected approximate confidence limits at 80% were obtained. For BSP 5000 SIR resamples were obtained and 0.05 and 0.95% credibility intervals obtained.

Figures 77 and **78 (BSP) and Figures 79** and **80 (ASPIC)** show the results of the projections for both models which are in agreement that catch levels of 14000 t result in a stable stock trend and stable fishing mortality. Both models indicate that TAC levels equal to the current TAC 15000 t could lead to declines from 2011 values.

It should be noted that for the BSP model the stock status is higher than B/B_{MSY} so declines in the stock at 15,000t would not lead to an overfished condition. In contrast the ASPIC results indicate that the stock is lower than $B/\ B_{MSY}$ so that catches of 15,000t could further reduce the stock below B_{MSY}. These results are contingent upon the estimates of B_{MSY} which are highly uncertain.

Tables of the estimated probability of B>=BMSY, F<=FMSY, and maintaining the stock in the condition consistent with the Convention objective (B>BMSY and F<FMSY) a series of catches for the ASPIC (**Table 30**) and BSP (**Table 31**) reference case model for the South Atlantic stock are shown for reference purposes but should be interpreted with caution as it is unlikely that MSY reference points are well-estimated. For ASPIC (**Table 30**) the current TAC of 15000 has a 43% chance of maintaining the stock at the convention objectives by 2021 while for BSP the same TAC has a 73% chance (**Table 31**).

8. Limit reference points

The Commission has requested the SCRS to identify limit reference points for North Atlantic albacore (Rec. 11-04) as well as North Atlantic swordfish (Rec 11-02). The 2013 Working Group on Stock Assessment Methods (WGSAM) discussed the implementation of this request and suggested a possible approach for a Harvest Control Rule and Limit Reference Points for North Atlantic swordfish (**Figure 81**; Figure 1 of the Report of the 2013 WGSAM Report).

The Albacore Species Group met prior to the Swordfish Group and proposed an Interim Limit Reference Point (iLRP). For North Atlantic albacore an iLRP of 0.4BMSY was recommended based on the work done to identify candidate limit reference points for tuna stocks in the Pacific (Peerce, 2011). The principles in Rec. 11-13 provide a basis for the design of a Harvest Control Rule (HCR) that uses both target and limit reference points to set catch levels. The SCRS has previously recommended a generic HCR (**Figure 81**), for use with limit and target reference points to set catches. However, before a HCR is adopted stock-specific robustness testing should be performed using Management Strategy Evaluation (MSE). This will allow the iLRP to be evaluated, with respect to meeting management objectives. Evaluation will also be conducted for other candidates, i.e. the reference point is interim until it can be fully evaluated, alongside other alternatives, with respect to its robustness to uncertainty.

SCRS/2013/150 summarised the rational used by the Albacore Group to develop the reference point and its use as part of a HCR. SCRS/2013/033, 034 and 035 provide an example of conducting an MSE to evaluate a HCR for albacore; while SCRS/2011/195 provides an example of a MSE for North Atlantic Swordfish. The Methods Working Group also recognised the need when developing an advice framework based on reference points of enhancing dialogue between SCRS and the Commission and that this would take several years to complete.

The approach taken at the Albacore Species Group allowed advice to be provided in the Kobe Strategy Matrix framework consistent with the Commission's decision making policy for development and application of conservation and management measures (Rec. 11-13). However rather than advice being based on a TAC it was based on a target fishing mortality.

In order to advance the Commission-SCRS dialogue, the Albacore Species Group provided information to the Commission on the basis of a range of interim HCR parameters, i.e. target fishing mortalities and biomass threshold (or buffer which if the stock fell below would result in fishing mortality being reduced). This would meet the Commission's policy objectives based on the assessment outcomes, e.g.

1) For 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.
2) For stocks that are in the upper right yellow quadrant of the Kobe plot (overfishing), the Commission shall immediately adopt management measures designed to result in a high probability of ending overfishing in as short a period as possible.
3) For stocks in the red quadrant of the Kobe plot (overfishing and overfished), the Commission shall immediately adopt management measures, designed to result in a high probability of ending overfishing in as short a period as possible and the Commission shall adopt a plan to rebuild these stocks, and
4) For stocks in the lower left yellow quadrant of the Kobe plot (overfished but no overfishing), the Commission shall adopt management measures designed to rebuild these stocks in as short a period as possible.

Using different methods for quantifying uncertainty in stock assessment can result in different probability expectations (SCRS/2013/117). Also traditional stock assessment methods mainly consider observation and measurement error while uncertainty about the actual dynamics (i.e. model uncertainty) has a larger impact on achieving management objectives. This is an important area of research best considered as part of an MSE. However, the Commission expects management advice based upon the quantified uncertainties in the assessments SCRS conducts (Res. 11-14). **Table 32** provides example probability expectations given the uncertainty in run 2 of the ASPIC assessment. This is based on a range of interim HCR parameter values for the generic HCR to help guide discussion about the policy decisions with regard to what is meant by 'high probability' and 'as short as possible'. A main intention of this table is to help advance the Commission-SCRS dialogue. While it is recognised that different assessment methods will provide alternative estimates of uncertainty it is still possible to provide information to the Commission on the basis of a range of interim HCR parameter values which would meet the Commission's policy based on assessment outcomes as done for North Atlantic albacore.

The construction of Kobe II Strategy Matrices (K2SMs) using a HCR are detailed in SCRS/2013/188 and compared to K2SMs based on constant catch and fishing mortality. Since the stock currently has a high probability of being in the green kobe quadrant (i.e. $B>B_{MSY}$ and $F<F_{MSY}$) projections based on the HCR are equivalent to constant F projections, since the stock is greater than the biomass limit and threshold reference points and so the HCR sets an F equal to the target F. If the target F was chosen based on the recommended TAC then the advice based on the HCR would also be equivalent to current advice. Using a HCR also implies moving away from a TAC to an F based system, which will have economic consequences.

An interim biomass limit reference point of 0.4BMSY was proposed which is consistent with the limit reference point proposed for North Atlantic albacore and robust limits recommended for a number of Pacific tuna stocks (e.g. Preece, et al. 2011). In the future a fuller range of candidate limit reference points can be evaluated, e.g. through MSE testing.

9. Recommendations

9.1 Research and statistics

Stock structure. The Draft Report of the Swordfish Stock Structure workshop (Heraklion, March 2006) recommended intensified collaborative and multi-disciplinary research. In particular, the classification of swordfish caught near the boundaries to their stock of origin is subject to uncertainty and cannot be made accurately without intensified collaborative and multi-disciplinary research taking into account fine-scale (e.g., 1º squares) and quarterly sampling strata.

Catch. All countries catching swordfish (directed or by-catch) should report catch, catch-at-size (by sex) and effort statistics by a small an area as possible, and by month. Recognizing the differential growth and distribution between sexes, collecting catch-at-size information by sex is particularly important.-These data must be reported by the ICCAT deadlines, even when no analytical stock assessment is scheduled. Historical data should also be provided.

Discards. Information on the number of fish caught, and the numbers discarded dead and released alive should be reported so that the effect of discarding and releasing can be fully included in the stock assessment. Observer sampling should be sufficient to quantify discarding in all months and areas in both the swordfish directed fisheries and the tuna fisheries that take swordfish as by-catch. Studies should be conducted to improve estimation of discards and to identify methods that would reduce discard mortality of swordfish. Studies should also be conducted to estimate the subsequent mortality of swordfish discarded alive; these are particularly important given the level of discarding due to the minimum size regulatory recommendation.

Unreported Catches. The 2009 stock assessment report noted that the summarized form in which the swordfish Statistical Document (s.SDS) information is currently reported to ICCAT (bi-annual summaries of direct imports and re-exports) does not give the sufficient detail for improving estimates of potential NEI and volume of Atlantic swordfish in international trade largely due to uncertainty about the year and area of capture for swordfish products in trade, the general lack of product to live weight conversions, , and the potential for double counting catches submitted on the re-export certificates. These estimates could be greatly improved if the corresponding ***individual*** statistical documents and re-export certificates were made available. These detailed data exist at National levels (with identification numbers) and an effort should be made to recover this important information, if the Commission wishes to improve the utility of the s.SDS for validating Task I data. SCRS has reiterated this advice over the past decade (see General Recommendations to the Commission, in the SCRS Reports of 2000, 2001, 2002, 2003 and 2004), but as of yet none of the detailed swordfish s.SDS information has been received by the Secretariat.

Target species. All fleets should record detailed information on log records to quantify which species or species-Group is being targeted. Compilation of detailed gear characteristics and fishing strategy information (including time of set) are very strongly recommended in order to improve CPUE standardization. The recommendations made by the 2002 Working Group on Stock Assessment Methods meeting for looking at diagnostics in this context should be followed. The Group recommended the investigation of alternative forms of analyses in the south that deal with both the By-catch and Target patterns, such as age- and spatially-structured models.

Given the unresolved issue of the performance of catch-based and gear-based methods (preferred method when possible) for evaluating targeting, when it is possible to use both methods for a data series interested parties could construct CPUE indices using both methods to test whether they give similar signals. These results should then be collated in a meta-analysis for a methods meeting so that this issue can be resolved.

Tagging. The Group recommended development of an experimental design for specific tagging applications such as estimating fishing mortality rates and/or migration patterns. A tagging study designed to estimate fishing mortality would be particularly useful for the South Atlantic, given the highly uncertain stock status for that resource.

Pop-up satellite archival tagging studies such as reported in SCRS/2013/151 and in Neilson et al. 2009 are revealing different movement patterns, depending on where the tags were deployed, even within the North Atlantic management unit. Such results suggest that future assessment models should include area-specific structuring of input data.

South Atlantic Swordfish Research Plan. Given the poor understanding of population dynamics of swordfish in the South Atlantic, the Group should develop a long term plan for an enhanced program of research, focussing on independent estimates of fishing mortality, fraction mature by age, growth by sex and stock, movement and migrations, and improving available indices of abundance. Within the context of the SCRS Strategic Plan, this deficiency could be addressed.

CPUE. Future data preparatory meetings should focus on resolving the conflicting indices to the extent possible prior to the next assessment. Consideration should be given to aggregating the CPUE trends by area (rather than the current method of aggregating by nation). For the South Atlantic in particular, some attempt should be made to use stock assessment methods that can reconcile the contradictory trends in the target and by-catch CPUE series for the south (e.g., age/spatially-structured models). Given that no time series reliably spans the key time period before and after the increase and decrease in landings, the Group recommends the exploration of a combined index for the South ATL considering spatial weighting, data imputation (Carruthers et al. 2010) and using raw data with covariates that define targeting similar to the approach in the North.

It is recommended that for the next stock assessment, some sensitivity analysis be carried out for the combined index for the North. One particular set of analyses that would be of interest is to jackknife the catch and effort records by flag and to produce a new set of combined CPUE index data sets with one flag removed at a time. This would show the influence of each flag on the combined index. The simplest approach would be to use the same standardization model as was used for the combined index with all flags included but then to downweight the inputs for each flag one at a time.

Development of Stock Synthesis. The Group agreed that the Stock Synthesis method is an important advance, in that it allows inclusion of a broader range of input data than the surplus production models in current use. The Group recognized the possibility of spatial and environmental effects as perhaps being partially responsible for the conflicting directions of some of the influential indices of abundance. The Group recommended further study into including environmental covariates into the overall assessment process when and where appropriate. To take full advantage of the method, it is recommended that Working Group members take every opportunity to become more familiar with the approach, either through dedicated training or on-site work experience.

Stock Synthesis could also be used to help develop an operating model which will be used to evaluate the interim Limit Reference Point used as part of a Harvest Control Rule. It could also be used to evaluate alternative stock assessment processes, such as Delay-Difference or the Gedamke-Hoenig (2006) method.

The Group also recommended that future development of Stock Synthesis for the North Atlantic stock include incorporation of available PSAT information, as well as season/ area effects.

Model Validation. The Group recommended that methods be developed to evaluate indices of stock abundance based on fisheries dependent data, e.g. by using simulation and cross validation based on detailed data such as log books and sales records.

There is substantial information in the mean weight information that could inform total mortality rates. The WG recommends the further model explorations using delay-difference models or non-equilibrium Gedamke-Hoenig (2006) models mean length estimators of Z may be valuable for South Atlantic swordfish.

Data Sharing and Confidentiality. Confidentiality requirements of individual CPCs sometimes constrain the analyses that are undertaken by the Group. As has been recommended in the past by the SCRS, the Group continues to recommend that some mechanism be developed, either within the current ICCAT confidentiality rules, or through some modification of the system, to enable the sharing of such critical high-resolution (low aggregation) data.

Informative priors for carrying capacity. Given the sensitivity of assessment results in general to prior distributions for carrying capacity in situations where the data are uninformative, the Group recommends that informative priors for K be developed based upon factors such as habitat area, population density and other life history factors. While borrowing a prior based upon the posterior for K from another assessment, e.g., using the posterior for K from the North for the South may be scientifically justified, the Group recommends that future decisions such as this be based upon scientific analyses similar to the development of a prior for r.

9.2 Management

North Atlantic

Table 28 shows the ranges of total catch limits and associated probabilities associated with stock status by year. The current TAC of 13700 has an 84% probability of maintaining the North Atlantic swordfish stock in a rebuilt condition by 2021 while maintaining a level biomass. TACs up to 14300 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 biomass declines.

Should the Commission wish to implement a limit reference point, the current TAC of 13700 t would translate to a target fishing mortality rate of 0.90*Fmsy. Given that the stock is above Bmsy, most biomass thresholds under consideration in a harvest control would have little impact upon management advice in the short term.

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 15,000t.

10. Other matters

To allow sufficient time to advance the understanding of stock status for the North and South Atlantic, the Group recommends that the next Atlantic swordfish assessment will be conducted no sooner than 2016.

11. Adoption of the report and closure

The Chair recognized the hard work of participants during the Data/Methods meeting earlier this year, intersessionally, and also during the stock assessment meeting. The Group thanked the Chair for his work done during the meeting. Dr. Neilson also thanked the Group for their support during his tenure as Swordfish Coordinator, and wished the new Coordinator, Dr. Miguel Neves dos Santos good fortune with his new assignment. The Group and the Chairman also recognized the helpful work of the Secretariat. The Detailed Report was adopted during the meeting.

References

Carruthers, T., et al. 2011.Integrating imputation and standardization of catch rate data in the calculation of relative abundance indices *Fisheries Research*. 109 (2011): 157-167.

Gedamke, T., and J.M. Hoenig. 2006. Estimating Mortality from Mean Length Data in Non-equilibrium Situations, with Application to the Assessment of Goosefish. Trans. Amer. Fish. Soc. 135:476-487.

ICCAT 2013, Report for Biennial Period, 2012-13, Part II, pp: 248-252.

Mejuto, J., B. Garcia-Cortes, A. Ramos-Cartelle. 2013. Standardized catch rates in number of fish by age for the North Atlantic swordfish (*Xiphias gladius*) of the Spanish longline fleet, for the period 1983-2011. Coll. Vol. Sci. Pap. ICCAT. SCRS/2013/107.

Neilson JD., Smith S, Royer F, Paul SD, Porter JM, Lutcavage M. 2009. Investigations of Horizontal Movements of Atlantic Swordfish Using Pop-up Satellite Archival Tags. In: Tagging and Tracking of Marine Animals with Electronic Devices (Eds: Nielsen JL, Arrizabalaga H, Fragoso N, Hobday A, Lutcavage M, Sibert J). Reviews: Methods and Technologies in Fish Biology and Fisheries, Vol. 9, pp 145-159.

Preece, A., R. Hillary, and C. Davies. 2011. Identification of candidate limit reference points for the key target species in the WCPFC. WCPFC-SC7-2011/MI-WP-03.

Yokawa, K. 2010. CPUE standardization of south Atlantic swordfish caught by Japanese longliners in 1975-2007. Collect. Vol. Sci. Pap. ICCAT, 65(1): 241-248.

Table 1 Task I Catch data (t) of Atlantic swordfish (*Xiphias gladius*) by major area, gear and flag.

																																	Sep/13 (Ass)
			1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2011
TOTAL			19662	19929	21953	23969	24380	26266	32685	34305	32976	28826	29207	32868	34459	38803	33511	31567	26251	27123	27180	25139	23758	24075	25252	25643	25718	27932	23596	24761	24209	23898	23888
	ATN		13215	14527	12791	14383	18486	20236	19513	17250	15672	14934	15394	16738	15501	16872	15222	13025	12223	11622	11453	10011	9654	11442	12175	12480	11473	12302	11050	12081	11553	12523	12834
	ATS		6447	5402	9162	9586	5894	6030	13172	17055	17304	13893	13813	16130	18958	21930	18289	18542	14027	15502	15728	15128	14104	12633	13077	13162	14245	15630	12546	12679	12655	11375	11055
Landings	ATN	Longline	13019	14023	12664	14240	18269	20022	18927	15348	14026	14208	14288	15641	14315	15764	13808	12181	10939	10666	9837	8676	8799	10333	11406	11527	10840	11475	10341	11439	10964	11610	12004
		Other surf.	196	504	127	143	217	214	586	1902	1646	511	723	689	478	582	826	393	800	426	478	433	240	487	449	620	409	546	465	485	437	511	516
	ATS	Longline	6344	5307	8920	8863	4951	5446	12404	16398	16705	13287	13176	15547	17387	20806	17799	18239	13748	14823	15448	14302	13576	11712	12485	12915	13723	14967	11761	12106	11920	10817	10497
		Other surf.	103	95	242	723	943	584	768	657	599	606	637	583	1571	1124	489	282	269	672	278	825	527	920	591	248	522	572	779	574	587	488	488
Discards	ATN	Longline	0	0	0	0	0	0	0	0	0	215	383	408	708	526	562	439	476	525	1137	896	607	618	313	323	215	273	235	151	148	392	305
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	12	9	4	1	6	8	5	7	10	8	8	9	7	5	9	9
	ATS	Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	21	10	6	1	0	0	0	1	0	0	91	6	0	147	70	70
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATN	Barbados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	16	16	12	13	19	10	21	25	44	39	27	39	20	13	23	23
		Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	112	106	184	184
		Brasil	0	0	0	0	0	0	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	554	1088	499	585	1059	954	898	1247	911	1026	1547	2234	1676	1610	739	1089	1115	1119	968	1079	959	1285	1203	1558	1404	1348	1334	1300	1346	1551	1551
		China P.R.	0	0	0	0	0	0	0	0	0	0	0	73	86	104	132	40	337	304	22	102	90	316	56	108	72	85	92	92	73	75	75
		Chinese Taipei	260	272	164	152	157	52	23	17	270	577	441	127	507	489	521	509	286	285	347	299	310	257	30	140	172	103	82	89	88	192	192
		Cuba	254	410	206	162	636	910	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	0	0	0	0	0	0	25	30	0	
		Dominica	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	1	0	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	0	0	0	0	0	
		EU.España	4554	7100	6315	7441	9719	11135	9799	6648	6386	6633	6672	6598	6185	6953	5547	5140	4079	3996	4595	3968	3957	4586	5376	5521	5448	5564	4366	4949	4147	4889	4889
		EU.France	0	0	1	4	4	0	0	0	75	75	75	95	46	84	97	164	110	104	122	0	74	169	102	178	92	46	14	15	35	16	16
		EU.Ireland	0	0	0	0	0	0	0	0	0	0	0	7	0	0	15	15	132	81	35	17	5	12	1	1	3	2	2	1	1	2	2
		EU.Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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	0	0	0	0	0	0	
		EU.Portugal	11	9	14	22	468	994	617	300	475	773	542	1961	1599	1617	1703	903	773	777	732	735	766	1032	1320	900	949	778	747	898	1054	1203	1203
		EU.United Kingdom	0	0	0	0	0	0	0	0	0	0	0	2	3	1	5	11	0	2	1	0	0	0	0	0	0	0	0	2	0	0	
		FR.St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	3	36	48	0	82	48	17	90	1	1
		Faroe Islands	0	0	0	0	0	0	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	0	0	0	0	0	0	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	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
		Japan	1755	537	665	921	807	413	621	1572	1051	992	1064	1126	933	1043	1494	1218	1391	1089	161	0	0	0	575	705	656	889	935	778	1062	523	723
		Korea Rep.	198	53	32	160	68	60	30	320	51	3	3	19	16	16	19	15	0	0	0	0	0	0	0	51	65	175	157	3	0	0	
		Liberia	34	53	0	24	16	30	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	0	0	0	0	0	0	2	0	0	0	0	0	
		Maroc	91	129	81	137	181	197	196	222	91	110	69	39	36	79	462	267	191	119	114	523	223	329	335	334	341	237	430	724	963	782	782
		Mexico	0	0	0	0	0	0	0	0	0	0	0	6	14	0	22	14	28	24	37	27	34	32	44	41	31	35	34	32	35	38	38
		NEI (ETRO)	0	0	0	0	0	0	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)	0	0	0	0	14	3	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	0	0	0	0	0	
		Panama	0	0	0	0	0	0	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	0	0	0	0	0	0	1	4	44	5	0	8	0	22	28	0	17	17
		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	
		Russian Federation	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	0	0	0	
		Senegal	0	0	0	0	0	0	0	1	0	6	6	0	0	0	0	0	0	0	0	0	0	0	108	108	0	38	0	28	11	1	1
		Seychelles	0	0	0	0	0	0	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	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	
		St. Vincent and Grenadines	0	0	0	0	0	0	0	0	3	0	3	23	0	4	3	1	0	1	0	22	22	7	7	7	0	51	7	34	13	11	11
		Sta. Lucia	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	3	0	0	2	0	0	0	0
		Trinidad and Tobago	0	21	26	6	45	151	42	79	66	71	562	11	180	150	158	110	130	138	41	75	92	78	83	91	19	29	48	30	21	16	13
		U.S.A.	5410	4820	4749	4705	5210	5247	6171	6411	5519	4310	3852	3783	3366	4026	3559	2987	3058	2908	2863	2217	2384	2513	2380	2160	1873	2463	2387	2730	2274	2551	2752
		U.S.S.R.	69	0	16	13	18	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5	5	3	3	2	0	0	1	1	0	3	4	3	3	3	3
		UK.British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	7	0	3	0	0	4	4
		UK.Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	29	14	0	0	0	10	23	23
		Venezuela	25	35	23	51	84	86	2	4	9	75	103	73	69	54	85	20	37	30	44	21	34	45	53	55	22	30	11	13	24	18	18
	ATS	Angola	0	0	26	228	815	84	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	20	0	0	361	31	351	198	175	230	88	88	14	24	0	0	0	0	38	0	5	10	8	0	0	0	0	0	0	1	0	0
		Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	17	8	0	0	0	0	0	0	120	32	111	121	207	207
		Benin	24	0	86	90	39	13	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	1019	781	468	562	753	947	1162	1168	1696	1312	2609	2013	1571	1975	1892	4100	3847	4721	4579	4082	2910	2920	2998	3785	4430	4153	3407	3386	2926	3033	3033
		Cambodia	0	0	0	0	0	0	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	0	0	0	0	0	0	29	534	344	200	423	353	278	91	300	473	470	291	296	248	248
		Chinese Taipei	520	261	199	280	216	338	798	610	900	1453	1686	846	2829	2876	2873	2562	1147	1168	1303	1149	1164	1254	745	744	377	671	727	612	410	424	424
		Cuba	432	818	1161	1301	95	173	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	0	0	10	10	10	10	12	7	8	18	13	14	20	19	26	18	25	26	20	19	19	43	29	31	39	17	159	100	114	145	145
		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	0	0	0	0	66	0	4393	7725	6166	5760	5651	6974	7937	11290	9622	8461	5832	5758	6388	5789	5741	4527	5483	5402	5300	5283	4073	5183	5801	4700	4700
		EU.Lithuania	0	0	0	0	0	0	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	0	0	0	0	0	0	1	0	0	380	389	441	384	381	392	393	380	354	345	493	440	428	271	367	232	263	263
		EU.United Kingdom	0	0	0	0	0	0	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	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	
		Ghana	55	5	15	25	13	123	235	156	146	73	69	121	51	103	140	44	106	121	117	531	372	734	343	55	32	65	177	132	116	60	60
		Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Honduras	0	0	0	0	0	0	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	3287	1908	4395	4613	2913	2620	4453	4019	6708	4459	2870	5256	4699	3619	2197	1494	1186	775	790	685	833	924	686	480	1090	2155	1600	1340	1314	1233	912
		Korea Rep.	486	409	625	917	369	666	1012	776	50	147	147	198	164	164	7	18	7	5	10	0	2	24	70	36	94	176	223	10	0	0	
		Mixed flags (FR+ES)	0	0	0	0	0	0	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	0	0	0	0	0	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	0	0	0	0	0	0	22	0	0	0	0	730	469	751	504	191	549	832	1118	1038	518	25	417	414	414
		Nigeria	0	83	69	0	0	0	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	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	0	0	0	0	0	0	6	1	8	1	1	4	58	41	49	14	35	35
		S. Tomé e Príncipe	0	0	0	0	0	0	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	0	0	0	0	0	0	77	138	195	180	264	264
		Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	
		South Africa	3	7	23	8	5	5	4	0	0	5	9	4	1	4	1	1	240	143	328	547	649	293	295	199	186	207	142	170	145	97	97
		St. Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	7	16	4	3	3
		Togo	0	0	0	6	32	1	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	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.	26	46	158	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		UK.Sta Helena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	4	0	0	0	0	0	0	0	0	0	
		Uruguay	575	1084	1927	1125	537	699	427	414	302	156	210	260	165	499	644	760	889	650	713	789	768	850	1105	843	620	464	370	501	222	179	179
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	26	6	3	0	3	1	1
Discards	ATN	Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	52	35	50	26	33	79	45	106	38	61	39	9	15	8	8
		Japan	0	0	0	0	0	0	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	0	0	0	0	0	0	170	170
		Mexico	0	0	0	0	0	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	1
		U.S.A.	0	0	0	0	0	0	0	0	0	215	383	408	708	526	588	446	433	494	490	308	263	282	275	227	185	220	205	148	138	223	135
		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	0
	ATS	Brasil	0	0	0	0	0	0	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	0	0	0	0	0	0	147	70	70
		U.S.A.	0	0	0	0	0	0	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**

Table 2 Estimated catch of swordfish north and south by the Group for 2012. Highlighted cells show the catch values by flag that were estimated as the average of the prior three years (2009-11). Total catch by stock for 2012 (14,038 N-SWO and 10,393 S-SWO) was used for projections, for 2013 the TACs (13,700 t and 15,000) were assumed for each stock.

Sum of Qty_t		YearC												
Stock	**Flag**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
ATN	Barbados	13.2	19	10.4	21.43	25.27	44.023	39.36	26.57	38.569	19.753	12.687	23.078	20.974
	Belize								8.725	0.976	112.249	106.4	184.008	140.625
	Brasil	117.3												
	CAN	1017.693	1105.291	992.025	1363.478	1248.113	1664.182	1441.565	1408.987	1372.687	1309.02	1360.76	1558.398	1599.184
	China P.R.	21.6	101.7	90.2	315.8	55.836	107.944	72	85	92	92	73.271	74.705	59.002
	Chinese Tai	347	299	310	257	30	140	172	103	82	89	88	192	166
	Côte D'Ivoire										25	29.94		6.596
	Cuba			9.73	2.5	3.3	2.3	1.5						
	Dominica		1			0.102	0.18	0.364	0.299	0.306	0.73		0.026	0.378
	SPA	4595.01	3967.891	3957.3	4585.7	5376.001	5521.091	5447.907	5564.289	4365.696	4949	4147.1	4888.508	5622.065
	EU.France	121.9		74	169	101.7	177.761	92.333	46.033	13.9957	15.01349	35.26302	15.92826	22.06826
	EU.Ireland	35.1	17.26	5	12	1.46	1.28	2.589	1.82	2.202	0.947	1.499	2.217	5.25
	EU.Netherlands									0.046			0.648	0.648
	POR	731.5	734.55	765.805	1031.973	1319.743	900.476	949.016	777.9743	747.08	897.7491	1054.464	1202.872	882.285
	EU.United K	0.51						0.0075	0.1566		2.2342	0.3255		0.171
	Faroe Islan	4												
	FR.St Pierre et Miquelon			10.2	2.8	35.65	48.4		82.015	47.563	17.093	89.854	0.604	35.85033
	Grenada	84.31		53.807	88.03	73.112	55.528	30.274	26.464	42.737				
	JAP	759	567	319	263	575	705.306	656.181	889.056	935.468	777.537	1062.336	523.338	715.156
	Korea Rep.						51	65	175.171	156.697	3		170.056	97.731
	Libya							2.4						
	MAR	114	523	223	329	335	334	341	237	430	724	963	782	823
	Mexico	37	26.607	33.646	31.956	43.995	41.351	31.451	34.658	33.83	32.424	35.434	38.094	40.516
	Philippines		1.416	4.11	44.015	4.525		8		21.68	27.9		17.22	36.497
	Russian Federation						1							
	Senegal					107.73	107.73		38		28	11	1	44.075
	Seychelles	9.769												
	Sierra Leon	2.246	2.393											
	St. Vincent	0.1	22	22	7.14	7.14	7.14		51.473	7.055	33.651	12.63	10.701	16.335
	Sta. Lucia				0.2	1.603	2.631	0.075	0.356	1.578	0.303	0.033	0.363	0.233
	Trinidad ar	41	75	92	77.733	82.663	90.798	19.277	28.517	48.122	30.179	21.263	15.604	14.073
	USA	3353.26	2524.98	2647.6	2794.55	2654.669	2387.638	2057.848	2682.798	2591.693	2878.031	2411.847	2773.746	3651.03
	UK.Bermud	3	2	0.4	0.45	0.5	0.5		3.131	3.975	3.196	2.817	2.849	1.377
	UK.British Virgin Islands					4.214	4.214	7		3.009			3.753	3.753
	UK.Turks and Caicos								0.217					
	Vanuatu					34.567	29.29	13.828				9.906	23.244	15.476
	Venezuela	44.017	20.7	33.8	44.7	53.438	54.62	21.562	30.276	10.755	13.4	23.637	17.824	18.287
	Total	11452.52	10010.79	9654.023	11442.46	12175.33	12480.38	11472.54	12301.99	11049.72	12081.41	11553.47	12522.78	14038.64
ATS	Angola						3							
	Argentina	0.13	5.406	10.006	7.724	0.12						0.602	0.495	0.5485
	Belize	8.21							119.733	31.957	111.345	120.871	206.617	196.608
	Brasil	4579.3	4081.6	2910	2919.994	2998.064	3785.493	4430.179	4243.484	3412.603	3385.602	2925.609	3033.034	3031.417
	China P.R.	344	200.3	423	353.3	277.766	91.273	300	473	470	291	295.83	247.508	315.504
	Chinese Tai	1303	1149	1164	1254	745	744	377	671	727	612	410	424	379
	Côte D'Ivoi	20	18.9	19	43	28.6	31	39.48	17.41	159	100	113.77	145.44	81.76764
	SPA	6387.996	5788.704	5740.7	4526.9	5483.006	5402.002	5299.997	5283.497	4072.597	5182.994	5800.795	4699.998	4851.58
	POR	391.8	392.5	380	353.883	345.151	492.555	439.581	428.322	270.697	366.8737	231.595	262.5301	184.369
	EU.United Kingdom			0.1				49.04			2.7792			
	Gabon				8.6									
	Ghana	116.54	530.6	371.68	734.28	342.57	54.666	31.873	65	176.869	132.241	116.011	60.143	53.92
	JAP	790	685	832.654	924.052	686	479.629	1089.893	2154.571	1599.56	1339.582	1314.141	1232.529	861.602
	Korea Rep.	9.654	0.1	1.5	24	70	36	94	175.829	223.303	10	147.426	70.172	78.727
	Mixed flags	3.8												
	Namibia	468.738	750.79	503.7	191.47	549.161	831.575	1118.027	1037.575	518.2	25.41	416.77	414.25	84.6625
	Philippines		5.87	0.79	8.05	1	1.016	4	58.404	41.219	49.313	13.559	34.691	15
	S. Tomé e P	119.5	119.5	119.5	119.5	125.9	146.6	138.3	138.3	183	188	193		
	Senegal								77	138.116	195	180.408	264.069	161.833
	Seychelles			5.903										
	South Afric	328.1	547.26	649.2	292.955	294.533	199.317	185.636	206.825	142.052	170.088	144.801	96.57445	50.24514
	St. Vincent and Grenadines								10.176	6.833	16.226	4.459	2.806	3.418
	Togo					9	10	2						
	USA	143.83	43.39	200.3	20.94	15.71						0.256311		
	UK.Sta Helena		20.06	3.91										
	Uruguay	713	789	768	850	1105	843	619.921	463.86	369.726	500.879	222.2981	179.102	40.149
	Vanuatu						11.228	26.111	5.533	3.268		3.193	1.1609	2.737
	Total	15727.6	15127.98	14103.94	12632.65	13076.58	13162.35	14245.04	15629.52	12546	12679.33	12655.39	11375.12	10393.09

Table 3 Final biomass indices considered to be suitable for use in assessment models for North Atlantic swordfish.

YEAR	INDEX	Nominal	Stand.	Rescaled	CV	INDEX	Nominal	Stand.	Rescaled	CV	INDEX	Nominal	Stand.	Rescaled	CV	INDEX	Nominal	Stand.	Rescaled	CV	INDEX	Nominal	Stand.	Rescaled	CV	INDEX	Nominal	Stand.	Rescaled	CV	INDEX	Nominal	Stand.	Rescaled	CV
1963	Canada	3,29	2,02	1,72	0,13																														
1964	Canada	1,17	0,95	0,80	0,09																														
1965	Canada	0,75	0,71	0,60	0,09																														
1966	Canada	0,78	0,72	0,61	0,08																														
1967	Canada	0,95	0,85	0,72	0,08																														
1968	Canada	0,65	0,62	0,52	0,09																														
1969	Canada	0,63	0,59	0,50	0,09																														
1970	Canada	0,76	0,72	0,61	0,08																														
1971																																			
1972																																			
1973																																			
1974																																			
1975																											Japan		27,53	1,31	0,09					
1976																											Japan		18,76	0,90	0,06					
1977																											Japan		20,59	0,98	0,07					
1978																											Japan		5,17	0,25	0,08					
1979	Canada	1,14	0,85	0,72	0,13																						Japan		5,11	0,24	0,06					
1980	Canada	1,16	0,83	0,71	0,11																						Japan		6,28	0,30	0,05					
1981	Canada	1,00	0,72	0,61	0,13																						Japan		7,04	0,34	0,04					
1982	Canada	0,81	0,62	0,53	0,15																						Japan		9,91	0,47	0,07					
1983	Canada	0,60	0,45	0,39	0,13																						Japan		8,49	0,41	0,07					
1984	Canada	0,44	0,36	0,31	0,13																						Japan		11,32	0,54	0,07					
1985	Canada	0,63	0,55	0,47	0,14																						Japan		11,41	0,54	0,07					
1986	Canada	0,84	0,68	0,58	0,16																						Japan		11,92	0,57	0,06	Spain		300,78	1,15	0,03
1987	Canada	0,51	0,40	0,34	0,15																						Japan		7,25	0,35	0,06	Spain		302,80	1,16	0,03
1988	Canada	0,58	0,46	0,39	0,14																						Japan		9,12	0,44	0,06	Spain		257,40	0,98	0,03
1989	Canada	0,57	0,40	0,34	0,13																						Japan		10,20	0,49	0,06	Spain		260,43	1,00	0,03
1990	Canada	0,99	0,70	0,60	0,13																						Japan		8,51	0,41	0,06	Spain		260,62	1,00	0,03
1991	Canada	0,57	0,40	0,34	0,11																						Japan		5,26	0,25	0,06	Spain		265,13	1,01	0,03
1992	Canada	0,63	0,44	0,37	0,11											USA 1	1043,00	1,07	0,83	0,07							Japan		3,86	0,18	0,07	Spain		260,59	1,00	0,03
1993	Canada	0,51	0,44	0,38	0,10											USA 1	985,00	1,03	0,80	0,05							Japan		4,00	0,19	0,08	Spain		230,72	0,88	0,03
1994	Canada	0,43	0,36	0,31	0,09											USA 1	839,00	0,96	0,75	0,06							Japan		4,32	0,21	0,09	Spain		221,32	0,85	0,03
1995	Canada	0,42	0,35	0,29	0,10											USA 1	1007,00	1,13	0,88	0,05							Japan		1,98	0,09	0,16	Spain		244,57	0,93	0,03
1996	Canada	0,26	0,23	0,20	0,10											USA 1	823,00	1,08	0,84	0,06							Japan		1,30	0,06	0,15	Spain		206,45	0,79	0,03
1997	Canada	0,39	0,41	0,35	0,09						Portugal	201,00	211,50	0,58	0,02	USA 1	778,00	0,95	0,74	0,07							Japan		1,63	0,08	0,12	Spain		204,03	0,78	0,03
1998	Canada	0,51	0,57	0,48	0,10						Portugal	261,40	219,60	0,60	0,03	USA 1	929,00	1,28	1,00	0,07							Japan		2,77	0,13	0,10	Spain		219,82	0,84	0,03
1999	Canada	0,71	0,73	0,62	0,09						Portugal	270,30	198,70	0,54	0,03	USA 1	1183,00	1,56	1,22	0,06							Japan		2,78	0,13	0,08	Spain		245,91	0,94	0,03
2000	Canada	0,43	0,43	0,36	0,10						Portugal	385,50	311,60	0,85	0,02	USA 1	934,00	0,86	0,67	0,06							Japan					Spain		309,08	1,18	0,03
2001	Canada	0,58	0,53	0,45	0,10						Portugal	372,10	325,70	0,89	0,02	USA 1	599,00	0,76	0,59	0,07							Japan					Spain		269,71	1,03	0,03
2002	Canada	0,65	0,54	0,46	0,11						Portugal	264,00	257,10	0,70	0,02	USA 1	593,00	0,69	0,54	0,08							Japan					Spain		231,85	0,89	0,03
2003	Canada	0,75	0,89	0,75	0,11						Portugal	339,80	302,50	0,82	0,02	USA 1	577,00	0,63	0,49	0,06							Japan					Spain		265,35	1,01	0,03
2004	Canada	0,70	0,88	0,75	0,10						Portugal	508,90	377,50	1,03	0,02						USA 2	727,00	0,86	0,84	0,05	Japan					Spain		241,23	0,92	0,03
2005	Canada	0,88	0,94	0,79	0,09	Morocco	662,39	449,80	1,08	0,03	Portugal	350,20	293,00	0,80	0,02						USA 2	773,00	1,01	0,99	0,06	Japan					Spain		237,95	0,91	0,03
2006	Canada	0,82	0,97	0,83	0,10	Morocco	283,88	394,47	0,94	0,02	Portugal	377,50	312,80	0,85	0,02						USA 2	821,00	1,04	1,02	0,07	Japan		5,62	0,27	0,09	Spain		221,21	0,85	0,03
2007	Canada	0,81	1,02	0,87	0,10	Morocco	217,04	342,38	0,82	0,04	Portugal	430,70	324,50	0,88	0,02						USA 2	900,00	1,22	1,20	0,06	Japan		7,89	0,38	0,20	Spain		254,16	0,97	0,03
2008	Canada	1,01	1,36	1,15	0,11	Morocco	306,57	369,14	0,88	0,04	Portugal	412,30	337,90	0,92	0,02						USA 2	974,00	1,26	1,24	0,06	Japan		12,63	0,60	0,15	Spain		293,32	1,12	0,03
2009	Canada	1,09	1,18	1,01	0,11	Morocco	307,12	516,49	1,24	0,03	Portugal	530,00	444,40	1,21	0,02						USA 2	929,00	1,03	1,01	0,06	Japan		31,52	1,51	0,18	Spain		269,45	1,03	0,03
2010	Canada	1,26	1,40	1,19	0,12	Morocco	454,49	445,47	1,07	0,03	Portugal	480,90	416,30	1,13	0,02						USA 2	613,00	0,71	0,70	0,05	Japan		26,02	1,24	0,16	Spain		262,05	1,00	0,03
2011	Canada	1,13	1,13	0,96	0,11	Morocco	314,35	437,67	1,05	0,03	Portugal	475,10	367,50	1,00	0,03						USA 2	691,00	0,86	0,84	0,05	Japan		41,94	2,00	0,19	Spain		269,61	1,03	0,03
2012	Canada	1,13	1,15	0,98	0,11	Morocco	324,89	560,02	1,34	0,03	Portugal	623,20	456,80	1,24	0,02											Japan		36,61	1,75	0,23					

NOTE: "Rescaled" refers to the process by which the individual standardized index trends are adjusted proportionally to have the same average level within a chosen overlapping time period as the average level across all other indices for the overlaping time period.

For the period with the greated overlap between indices (2006-2011), this average level is set to 1.

USA 1 is rescaled to the average levels of the indices it overlaps during 1997-2003 (Canada, Portugal, and Spain).

Table 4 Combined CPUE indices of abundance (biomass) developed for the 2013 North Atlantic swordfish stock assessment.

YEAR	*INDEX*	*Nominal*	*Standardized*	*Rescaled*	*CV*	*Low*	*High*
1963	Combined	3534,43	4,47	5,71	0,30	2,47	8,09
1964	Combined	1210,24	1,58	2,02	0,30	0,88	2,84
1965	Combined	764,27	0,97	1,24	0,30	0,54	1,74
1966	Combined	752,70	0,99	1,26	0,30	0,55	1,77
1967	Combined	966,62	1,17	1,49	0,30	0,65	2,09
1968	Combined	664,62	0,91	1,16	0,30	0,51	1,64
1969	Combined	616,86	0,85	1,08	0,30	0,47	1,51
1970	Combined	738,66	0,97	1,23	0,30	0,54	1,73
1971							
1972							
1973							
1974							
1975	Combined	46,86	1,68	2,14	0,26	1,00	2,83
1976	Combined	35,93	1,37	1,74	0,27	0,81	2,31
1977	Combined	40,07	1,58	2,02	0,27	0,94	2,67
1978	Combined	63,56	1,79	2,28	0,25	1,10	2,93
1979	Combined	928,49	1,39	1,78	0,17	0,99	1,97
1980	Combined	419,80	1,37	1,74	0,18	0,97	1,94
1981	Combined	72,51	0,94	1,20	0,19	0,64	1,37
1982	Combined	122,18	1,15	1,47	0,17	0,83	1,60
1983	Combined	167,04	0,97	1,24	0,16	0,71	1,32
1984	Combined	270,70	0,90	1,15	0,15	0,67	1,21
1985	Combined	248,25	1,04	1,33	0,15	0,78	1,39
1986	Combined	336,97	0,99	1,27	0,15	0,75	1,33
1987	Combined	444,07	0,86	1,10	0,15	0,64	1,15
1988	Combined	472,44	0,82	1,05	0,14	0,62	1,09
1989	Combined	292,08	0,76	0,97	0,14	0,58	1,00
1990	Combined	332,21	0,87	1,11	0,14	0,66	1,14
1991	Combined	353,81	0,88	1,12	0,14	0,67	1,15
1992	Combined	328,20	0,71	0,91	0,14	0,54	0,94
1993	Combined	306,00	0,70	0,90	0,14	0,54	0,92
1994	Combined	281,00	0,60	0,76	0,14	0,45	0,79
1995	Combined	262,88	0,65	0,83	0,14	0,49	0,86
1996	Combined	183,79	0,48	0,61	0,14	0,36	0,63
1997	Combined	207,68	0,55	0,70	0,13	0,42	0,72
1998	Combined	230,39	0,63	0,80	0,13	0,48	0,82
1999	Combined	263,24	0,69	0,87	0,13	0,53	0,89
2000	Combined	236,54	0,46	0,59	0,17	0,33	0,65
2001	Combined	386,48	0,73	0,94	0,15	0,54	0,99
2002	Combined	435,03	0,73	0,94	0,15	0,55	0,99
2003	Combined	442,40	0,69	0,89	0,15	0,52	0,93
2004	Combined	427,61	0,72	0,92	0,15	0,54	0,97
2005	Combined	457,59	0,66	0,85	0,15	0,49	0,90
2006	Combined	324,44	0,56	0,71	0,14	0,42	0,73
2007	Combined	352,86	0,74	0,94	0,14	0,56	0,97
2008	Combined	337,80	0,79	1,01	0,14	0,60	1,03
2009	Combined	378,21	0,86	1,10	0,14	0,66	1,13
2010	Combined	359,23	0,89	1,14	0,14	0,68	1,17
2011	Combined	395,60	0,86	1,10	0,14	0,66	1,14

Table 5 – CPUE indices of abundance (biomass) developed for the 2013 South Atlantic swordfish stock assessment. The series for Uruguay was partitioned in two: 1982-1992 and 1983-2009. The series of Japan was portioned in to two: 1975-1989 and 1992-2012. The Chinese Taipei series, which was used for sensitivity analysis, was portioned in to three: 1967-1989, 1990-1999 and 2000-2012.

Year	Brazil	Spain	Uruguay	Uruguay2	Japan	Japan2	C_TAI1	C_TAI2	C_TAI3
1967							2.361		
1968							1.458		
1969							1.210		
1970							1.455		
1971							1.342		
1972							1.089		
1973							1.154		
1974							1.050		
1975					0.978		0.980		
1976					0.972		0.529		
1977					0.901		0.582		
1978	0.553				0.513		0.697		
1979	0.622				0.743		0.971		
1980	0.872				0.449		0.872		
1981	0.813				0.493		0.926		
1982	0.916		2.592		0.669		0.747		
1983	0.701		1.542		0.652		0.773		
1984	0.492		1.141		0.791		1.001		
1985	0.502		0.683		1.528		0.675		
1986	0.704		0.782		1.355		0.610		
1987	0.676		1.542		1.665		0.719		
1988	0.637		1.049		1.281		0.800		
1989	0.446	1.469	1.261		2.009			0.753	
1990	0.949	1.104	1.049					0.708	
1991	0.880	1.067	0.915					1.366	
1992	0.538	0.973	1.035			1.708		1.541	
1993	0.788	0.846		1.434		1.605		0.996	
1994	0.638	0.968		1.054		1.787		1.315	
1995	1.081	1.104		1.560		1.224		1.012	
1996	0.936	0.998		1.275		1.291		1.161	
1997	0.778	0.931		1.381		1.087		0.849	
1998	1.373	0.908		1.074		0.933		0.478	
1999	0.668	0.974		1.005		0.829		0.573	
2000	0.717	1.175		1.146		0.891			1.217
2001	0.972	1.040		1.039		0.427			1.228
2002	0.751	0.994		0.636		0.551			1.154
2003	1.340	0.874		0.656		0.389			1.017
2004	1.081	0.864		0.991		0.633			0.858
2005	0.947	1.039		0.806		0.608			0.804
2006	1.312	1.049		0.932		0.750			1.290
2007	1.078	1.010		0.844		1.162			0.968
2008	1.622	0.975		0.545		0.921			1.077
2009	1.343	1.063		0.622		1.218			0.946
2010	1.476	1.038				1.068			0.756
2011	0.732	1.006				0.918			0.858
2012	1.357					1.296			0.826

Table 6 Combined CPUE indices of abundance (biomass) developed for the 2013 South Atlantic swordfish stock assessment. The index variability is listed as the coefficient of variation (CV).

	W/o Brazil		W/o Brazil + C_TAI	
Year	Index	CV	Index	CV
1967	1.701	0.832		
1968	1.019	0.322		
1969	0.837	0.282		
1970	1.003	0.272		
1971	0.925	0.271		
1972	0.751	0.273		
1973	0.804	0.308		
1974	0.727	0.286		
1975	0.648	0.251	0.571	0.332
1976	0.422	0.285	0.588	0.441
1977	0.437	0.258	0.536	0.395
1978	0.423	0.245	0.301	0.349
1979	0.585	0.256	0.435	0.344
1980	0.442	0.232	0.259	0.296
1981	0.475	0.224	0.284	0.283
1982	0.482	0.221	0.414	0.275
1983	0.493	0.228	0.429	0.268
1984	0.602	0.221	0.507	0.247
1985	0.602	0.201	0.695	0.214
1986	0.562	0.220	0.722	0.254
1987	0.700	0.227	0.954	0.267
1988	0.671	0.238	0.730	0.269
1989	1.227	0.194	1.184	0.250
1990	1.136	0.235	1.253	0.422
1991	1.918	0.211	1.194	0.409
1992	2.030	0.178	1.799	0.205
1993	1.591	0.164	1.659	0.198
1994	1.974	0.160	1.945	0.184
1995	1.565	0.182	1.582	0.197
1996	1.606	0.173	1.523	0.188
1997	1.337	0.158	1.369	0.177
1998	1.003	0.161	1.223	0.176
1999	1.039	0.163	1.174	0.182
2000	1.306	0.153	1.312	0.175
2001	1.028	0.157	0.865	0.174
2002	1.089	0.154	0.980	0.174
2003	0.874	0.151	0.798	0.154
2004	0.966	0.153	1.002	0.164
2005	0.961	0.158	1.042	0.173
2006	1.253	0.163	1.155	0.186
2007	1.207	0.167	1.346	0.186
2008	1.157	0.158	1.166	0.170
2009	1.233	0.160	1.424	0.177
2010	1.101	0.158	1.344	0.172
2011	1.089	0.159	1.235	0.176

Table 7 ASPIC inputs for the North Atlantic swordfish stock assessment.

```
BOT  ## Run type (FIT, BOT, or IRF)
"SWO Base 2013 Model 1 index"
LOGISTIC  YLD    LAV
102  ## Verbosity
1000  50  ## Number of bootstrap trials, <= 1000
1  500  ## 0=no MC search, 1=search, 2=repeated srch; N trials
1.0000E-09  ## Convergence crit. for simplex
3.0000E-08  25  ## Convergence crit. for restarts, N restarts
1.0000E-06  6  ## Conv. crit. for F; N steps/yr for gen. model
8.0000  ## Maximum F when cond. on yield
10.0  ## Stat weight for B1>K as residual (usually 0 or 1)
1  ## Number of fisheries (data series)
1.0000E+00    ## Statistical weights for data series
0.8500  ## B1/K (starting guess, usually 0 to 1)
1.0276E+01  ## MSY (starting guess)
1.0276E+02  ## K (carrying capacity) (starting guess)
1.3212E-02    ## q (starting guesses -- 1 per data series)
0  1  1  1    ## Estimate flags (0 or 1) (B1/K,MSY,K,q1...qn)
1.0276E+00  2.0552E+02  ## Min and max constraints -- MSY
1.0276E+01  2.0552E+03  ## Min and max constraints -- K
9227323  ## Random number seed
62  ## Number of years of data in each series
"Combined index 2013"
CC
```

1950	-9.999000E+03	3.646000E+00
1951	-9.999000E+03	2.581000E+00
1952	-9.999000E+03	2.993000E+00
1953	-9.999000E+03	3.303000E+00
1954	-9.999000E+03	3.034000E+00
1955	-9.999000E+03	3.502000E+00
1956	-9.999000E+03	3.358000E+00
1957	-9.999000E+03	4.578000E+00
1958	-9.999000E+03	4.904000E+00
1959	-9.999000E+03	6.232000E+00
1960	-9.999000E+03	3.828000E+00
1961	-9.999000E+03	4.381000E+00
1962	-9.999000E+03	5.342000E+00
1963	4.473438E+00	1.019000E+01
1964	1.583060E+00	1.125800E+01
1965	9.714710E-01	8.652000E+00
1966	9.911450E-01	9.349000E+00
1967	1.168751E+00	9.107000E+00
1968	9.121180E-01	9.172000E+00
1969	8.480170E-01	9.203000E+00
1970	9.662130E-01	9.495000E+00
1971	-9.999000E+03	5.266000E+00
1972	-9.999000E+03	4.766000E+00
1973	-9.999000E+03	6.074000E+00
1974	-9.999000E+03	6.362000E+00
1975	1.681189E+00	8.839000E+00
1976	1.367890E+00	6.696000E+00
1977	1.581853E+00	6.409000E+00
1978	1.790089E+00	1.182700E+01
1979	1.392648E+00	1.193700E+01
1980	1.367741E+00	1.355800E+01
1981	9.391720E-01	1.118000E+01
1982	1.148966E+00	1.321500E+01
1983	9.683190E-01	1.452700E+01
1984	8.977420E-01	1.279100E+01
1985	1.043113E+00	1.438300E+01
1986	9.947550E-01	1.848640E+01
1987	8.594920E-01	2.023600E+01
1988	8.229940E-01	1.951340E+01
1989	7.606890E-01	1.725010E+01
1990	8.687960E-01	1.567210E+01
1991	8.766740E-01	1.493370E+01
1992	7.149710E-01	1.539400E+01
1993	7.022890E-01	1.673780E+01
1994	5.994980E-01	1.550130E+01
1995	6.491520E-01	1.687220E+01
1996	4.778280E-01	1.522170E+01
1997	5.522520E-01	1.302470E+01
1998	6.265800E-01	1.222330E+01
1999	6.852570E-01	1.162170E+01
2000	4.598390E-01	1.145250E+01
2001	7.341630E-01	1.001080E+01
2002	7.347170E-01	9.654000E+00
2003	6.946080E-01	1.144250E+01
2004	7.238150E-01	1.217530E+01
2005	6.647820E-01	1.248040E+01
2006	5.551440E-01	1.147250E+01
2007	7.381290E-01	1.230200E+01
2008	7.906940E-01	1.104970E+01
2009	8.622360E-01	1.208140E+01
2010	8.939210E-01	1.155350E+01
2011	8.637880E-01	1.252280E+01

Table 8 Summary of the Surplus Production Model runs (ASPIC) for the North Atlantic swordfish.

Run	Description
1- Run 1	ASPIC 1 index combined biomass index - LOGISTIC SPM - estimate all parameters
2- Run 2 Base	ASPIC 1 index combined biomass index - LOGISTIC SPM - Fixing B1/K 0.85 (continuity case)
3- Run 3	ASPIC 1 index combined biomass index - FOX SPM - estimate all parameters
4- Run 4	ASPIC 5 index estimated from the COMBINED NSWO - LOGISTIC SPM - estimate all parameters
5- Run 5	ASPIC 7 index stdz by the CPCs. LOGISTIC SPM - estimated all parameters
6- Run 6	ASPIC 7 index stdz by the CPCs. LOGISTIC SPM Fixing B1/K

Table 9 Summary of sensitivity and diagnostic runs performed with the ASPIC Surplus Production Model for North Atlantic swordfish.

Run	Description
1- Retrospective	Run 1 Base - Retrospective 2011 – 2006
2- Cross-checking	Run 1 Projections from retrospective end point w/ annual catch Task I
3- Performance	Projections of 2009 SA model with annual catch Task I
4- Jackknife Index	Run 2 removing one index at time from base model

Table 10 Table of ASPIC model alternative runs for the South Atlantic swordfish stock.

			Spain 1989-2011	Uruguay 1982-1992	Uruguay2 1993-2009	Japan 1 1975-1989	Japan 2 1992-2011	C_TAI1 1967-1988	C_TAI2 1989-1999	C_TAI3 2000-2012
1	fix B1/K at 0.875	8 sep indices								
2	fix B1/K at 0.875	5 sep indices	""	""	""	""	""			
								C_TAI1 1967-1988	C_TAI2 1989-1999	
3	fix B1/K at 0.875	Comb index 8 indices	""	""	""	""	""			
4	fix B1/K at 0.875	Comb index 5 indices	""	""	""	""	""			
5	estK	8 sep indices	""	""	""	""	""	""	""	""
6	estK	5 sep indices	""	""	""	""	""			

Table 11 Summary of BSP sensitivity test runs for North Atlantic swordfish.

Code	*Category Description*	*Code*	*Run Description*
R	Base case	R.N	Base case
A	B_{msy}/K	A.1	$B_{msy}/K = 0.1$
		A.2	$B_{msy}/K = 0.2$
		A.3	$B_{msy}/K = 0.3$
		A.4	$B_{msy}/K = 0.4$
		A.5	$B_{msy}/K = 0.6$
B	*r* and K prior	B.1	low *r* (mean = 0.28, CV = 0.39) (equivalent to steepness of 0.71)
		B.3	Uniform on log K prior.
		B.4	Lognormal prior for K with mean of 200,000t, and SD in log(K) of 0.8.

		B.5	low r prior, high K prior
		B.6	high r prior, low K prior
C	CPUE series,	C.1	CPUE by flag provided by national scientists for USA (two series), Canada, Portugal, Spain
		C.2	Leaving out Canadian cpue series
		C.3	Leaving out Japanese cpue series
		C.4	Leaving out Portugese cpue series
		C.5	Leaving out Spanish cpue series
		C.6	Leaving out early USA cpue series
		C.7	Leaving out later USA cpue series
D	Post model, pre-	D.1	Running the model with the priors and catch records but without fitting the model to the cpue
E	Retrospective analysis with cross validation on the combined index	E.1	Base case but with the model fitted to the combined index up to 2010
		E.2	Base case but with the model fitted to the combined index up to 2009
		E.3	Base case but with the model fitted to the combined index up to 2008
		E.4	Base case but with the model fitted to the combined index up to 2007
		E.5	Base case but with the model fitted to the combined index up to 2005
		E.6	Base case but with the model fitted to the combined index up to 2004
		E.7	Base case but with the model fitted to the combined index up to 2003
		E.8	Base case but with the model fitted to the combined index up to 2002
		E.9	Base case but with the model fitted to the combined index up to 2001
F	Retrospective analysis with cross validation on the six cpue series by flag	F.1	Run C.1 but with model fitted to the six cpue series by flag up to 2010
		F.2	Run C.1 but with model fitted to the six cpue series by flag up to 2009
		F.3	Run C.1 but with model fitted to the six cpue series by flag up to 2008
		F.4	Run C.1 but with model fitted to the six cpue series by flag up to 2007
		F.5	Run C.1 but with model fitted to the six cpue series by flag up to 2006
		F.6	Run C.1 but with model fitted to the six cpue series by flag up to 2005
		F.7	Run C.1 but with model fitted to the six cpue series by flag up to 2004
		F.8	Run C.1 but with model fitted to the six cpue series by flag up to 2003
		F.9	Run C.1 but with model fitted to the six cpue series by flag up to 2002
		F.10	Run C.1 but with model fitted to the six cpue series by flag up to 2001
G	Standard deviation in process error	G.1a,b	$\sigma_{process}$ = 0.005 (a=uniform on K prior, b=uniform on logK prior)
		G.2a,b	$\sigma_{process}$ = 0.01
		G.3a,b	$\sigma_{process}$ = 0.05 (reference case)
		G.4a,b	$\sigma_{process}$ = 0.075
		G.5a,b	$\sigma_{process}$ = 0.10
		G.6a,b	$\sigma_{process}$ = 0.15

Table 12 Summary of BSP sensitivity test runs for South Atlantic swordfish.

Code	Category	Code	Run Description
R	Reference case	R.S	Reference run (prior mean r and K at 0.42 and 172213t, CVs 0.39 and 0.3)
H	*K and r priors*	H.1	Prior mean for K set at 0.5 of reference case prior mean
		H.2	Prior mean for K set at 1.5 of reference case prior mean
		H.3	Low *r* (mean = 0.28, CV = 0.39) (equivalent to steepness of 0.71)
I	CPUE series	I.1	CPUE by flag provided by national scientists for Portugal, Uruguay early, Uruguay late, Spanish and
		I.2	Leaving out Spanish cpue series
		I.3	Leaving out Early Uruguay series
		I.4	Leaving out Late Uruguay cpue series
		I.5	Leaving out Japanese early cpue series
		I.6	Leaving out Japanese late cpue series
		I.7a,b,c,d	Combined indices that include Portugese, Uruguay, Spanish, Japanese cpue and include/ exclude Chinese
J	Post model, pre-data	J.1	Running the model with the priors and catch records but without fitting the model to the cpue data, using
		J.2	Running the model with the priors and catch records but without fitting the model to the cpue data, using
K	Retrospective analysis with cross validation on the set of indices by flag, informative prior for K	K.1	Reference case with the model fitted to the combined index up to 2010
		K.2	Reference case with the model fitted to the combined index up to 2009
		K.3	Reference case with the model fitted to the combined index up to 2008
		K.4	Reference case with the model fitted to the combined index up to 2007
		K.5	Reference case with the model fitted to the combined index up to 2006
		K.6	Reference case with the model fitted to the combined index up to 2005
		K.7	Reference case with the model fitted to the combined index up to 2004
		K.8	Reference case with the model fitted to the combined index up to 2003
		K.9	Reference case with the model fitted to the combined index up to 2002
		K.10	Reference case with the model fitted to the combined index up to 2001
L	Retrospective analysis with cross validation on the six cpue series by flag	L.1	Uniform K prior, with the model fitted to the combined index up to 2010
		L.2	Uniform K prior, with the model fitted to the combined index up to 2009
		L.3	Uniform K prior, with the model fitted to the combined index up to 2008
		L.4	Uniform K prior, with the model fitted to the combined index up to 2007
		L.5	Uniform K prior, with the model fitted to the combined index up to 2006
		L.6	Uniform K prior, with the model fitted to the combined index up to 2005
		L.7	Uniform K prior, with the model fitted to the combined index up to 2004
		L.8	Uniform K prior, with the model fitted to the combined index up to 2003
		L.9	Uniform K prior, with the model fitted to the combined index up to 2002
		L.10	Uniform K prior, with the model fitted to the combined index up to 2001

Table 13 Summary table of Methods used in the North Atlantic swordfish stock assessment .

Method	Summary of Diagnostic methods applied for North Atlantic SWO (e.g., residual analyses, retrospective analyses,cross validation, etc.)	Interpretations of diagnostics results obtained for North Atlantic SWO	What assumptions or data inputs are results most sensitive to?	Has the analysis adequately quantified the uncertainty for the results to be applied in Kobe phase plot advice on stock status and projections? Mention any caveats as appropriate.	Other considerations? e.g., ease of application by National Scientists in ICCAT forum
ASPIC	1. analysis of bootstrap performance 2. Cross-check validation 3. CPUE residuals (against years & observed vs fitted) for trend and autocorrelation 4. qq-normal plots of the residuals to index fits 5. Cross-correlations of CPUEs 6. Likelihood profiles, both joint and single 7. Sens to shape 8. retrospective analysis 9. Validation using 2009 assessment model, project forward 10.Jackknife	1. No anomalous residuals of bootstraps of stock trajectories; bias at the beginning of the series. 2. There is not significant retrospective patterns; some deviations but not a pattern and always within the CI 3. Combined: very small standardized residuals and small autocorrelations; some patterns at the beginning. Individual indices: some show clear trends in the residuals (e.g, in run 4 SPA vs US) 4. Residuals were normally distributed 5. some substantial neg. correlation for the sep indices 6. For run 2 the profiles show that MSY and K reach a clear solution. For run 6, profiles show odd patterns in the likelihood (really sum of squares) profiles by fleet for K, which show that some fleets have a two minima (high and low K) which shows divergent signals. JLL and Can have the greatest influence on estimate of K. [still need joint profile] 7. Obj function favors lower Bmsy/K than 0.5. 8. Some retro. pattern in r and K 10. Model cannot estimate K without Canada index	- Separate vs combined index affects the trajectory, especially in the recent years -Model sensitive to shape parameter -Stationarity of population dynamics	Intervals of the estimates if B/Bmsy and F/Fmsy are narrow - Uncertainty estimates are sensitive to assumptions of bootstrapping, violation of IID leads to narrower confidence intervals	-ease of application -used to assess SWO for the past 20 years - included in the ICCAT software catalogue - code currently available to the Group for the projection of HCR - used by the ALBSAWG for projecting HCR
BSP2	1. CPUE residuals (against years & observed vs fitted) 2. Cross-check validation 3. Joint and marginal profiles of fit surface for the parameters (r & K) 4. Posterior, post-model pre-data distributions 5. Bayes factors of Bmsy/K 6. Process error deviates 7. Jacknife of the indices 8. retrospective pattern 9. Cross-correlations of CPUEs	1. Similar to ASPIC. Combined: very small standardized residuals and small autocorrelations; some patterns at the beginning. Individual indices: some show clear trends in the residuals (US, JP, SP) CPUE residuals sensitive process error treatment. 2. There is not significant retrospective patterns 3. negative correlation of -0.89 between r and K, prior on r restricts space for K. 4. Posteriors diverge from prior, indicating signal in CPUE 5. Bmsy/K of 0.5 cannot be rejected but model favors lower values 6. Combined : beginning, up down; but not particular trend towards end of series Individual indices: White noise, then negative then rising, suggesting NS in prod. function. Over-predicting for the most recent period; potential linkage with environmental drivers 7. Posteriors of r & K are very sensitive using combined vs individual indices; benchmarks are also very sensitive. 8. Small retrospective pattern in r and K 9. some substantial neg correlation for the sep indices	- Separate vs combined index affects the trajectory, especially in the recent years - Assumptions of priors: no great impact, compensated with posteriors. - Shape parameter is the main source of uncertainty - sigma on process standard error	Take into consideration process errors More robust way to incorporate uncertainty. Process error not assumed to be independent (has autocorrelation), sigma assumed constant over time, future process error deviates AR(1), rho=0.05. This translates uncertainty in the production dynamics to wider CI in projections. But status is dependent upon assumed process error variance level. The group may need to explain what we mean by "Process Error", i.e. what factors could be causing these residual patterns. *explain in text	Previous version included in catalogue Extensive simulation testing Other versions used in BET, ALB, sharks Small user group No manual

Stock Synthesis	1. Retrospective analysis 2. profiling on steepness 3. CPUE residuals 4. Length, age, sex ratio, mean weight residuals	1. Retrospective pattern was good. 2. steepness was bounded high 3. CPUE residuals reduced by the addition of the environmental covariate 4. Lengths, age, sex ratio fit well; mean weight biased	1. Steepness 2. asymptotic versus dome-shaped selectivity	1.No, as time did not permit this to be completed for all three models	Process error has environmental linkage Can potentially reconcile conflicting indices

Table 14 Summary table of Methods used in the North Atlantic swordfish stock assessment.

Method	Summary of Diagnostic methods applied for North Atlantic SWO (e.g., residual analyses, retrospective analyses,cross validation, etc.)	Interpretations of diagnostics results obtained for North Atlantic SWO	What assumptions or data inputs are results most sensitive to?	Has the analysis adequately quantified the uncertainty for the results to be applied in Kobe phase plot advice on stock status and projections? Mention any caveats as appropriate.	Other considerations? e.g., ease of application by National Scientists in ICCAT forum
ASPIC	1.Likelihood profiles for key parms or Bayes equivalent- estimability of parms. Profiles by data source. 2. Correlations of CPUEs 3. CPUE residuals and autocorrelation and qq-normal plots of the residuals 4. Jackknife CPUE 5. Retrospective performance 6. Quantification of uncertainty (can model bootstrap) and performance (are bootstraps well distributed)	General comments: For the combined indices the model estimated nonsensical parameter estimates due to substantially divergent signals between the landings and the CPUE. Separate index models: For the separate models (Run 1, 8 fleets) and 8 fleets (run2) the models converged on a solution. The stability of that solution problematic. 1. Profiles of MSY and K indicate that there is very limited ability to estimate K and that the solution surface is extremely flat. When viewing separate indices there is divergent signals in the profiles by data source and erratic behavior. No signal in data to estimate B1/K. Low likelihood that K<1E5, differential weighting of the indices could be considered. 2, There were strong negative correlation in CPUEs even after removing Brazil time series. These negative correlations make interpretation of any results difficult 3. CPUE residuals show autocorrelation and trend 4. Jackknife results indicate that sensitivity to JLL2 index 5. retros show strong pattern of increasing K (to extremely high values) and decreasing r (to very low values) with subsequent retrospective. 7. Some bias between estimate and bootstrap median. Likely too narrow CI. Trials replaced for MSY out of bounds: 3	Stationarity of dynamics. Model actually converged on a stable solution	No. Uncertainty in poor model fit not considered. Model does not estimate productivity of the stock	Same as above but ASPIC not used in main advice for SAtl
BSP2	1.Likelihood profiles for key parms or Bayes equivalent (Posterior, post-model pre-data	General comments. For the combined indices the model estimated nonsensical parameter estimates due to substantially divergent signals between the landings and the CPUE.	**Prior on r, due to no updating in posterior** **Model could be sensitive to prior for**	**Uncertainty related to model fit** **Model does not estimate**	**Same as above**

distributions)- estimability of parms 2. Correlations of CPUEs 3. CPUE residual and autocorrelation 4. Jackknife CPUE 5. Retrospective performance 6. Quantification of uncertainty 7. Process error deviates	1.Flat posterior surface for K. Very little information to indicate an upper limit on K. No divergence of posterior from prior (i.e. no signal in the CPUE data) for r. 2. There were strong negative correlation in CPUEs even after removing Brazil time series. These negative correlations make interpretation of any results difficult 3. CPUE residuals show autocorrelation and trend 4. Jackknife results indicate that sensitivity to JLL2 index 5. Slight retrospective pattern 7. Substantial variability 8. Process error, flat in early time series divergent sinusoidal wave pattern in recent years.	**r**	**productivity of the stock**

Table 15 North Atlantic swordfish results from a retrospective analysis of the ASPIC model base case (run2). Biomass values are given in kilograms.

Year	*r*	K	Fmsy	B./Bmsy	F./Fmsy	MSY
2011	0.420	130100	0.210	1.136	0.812	13660
2010	0.413	131800	0.207	1.104	0.779	13620
2009	0.408	133400	0.204	1.077	0.833	13600
2008	0.369	145000	0.185	1.026	0.817	13390
2007	0.349	152200	0.174	0.980	0.953	13260
2006	0.353	150500	0.177	0.973	0.898	13300

Table 16 Northern Atlantic swordfish results for the Base case ASPIC model run2.

```
SWO Base 2013 Model 1 index                                                    Page 1
                                                        Monday, 09 Sep 2013 at 10:55:29
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.34)
                                                               BOT program mode
Author:    Michael H. Prager; NOAA Center for Coastal Fisheries and Habitat Research         LOGISTIC model mode
           101 Pivers Island Road; Beaufort, North Carolina  28516  USA                      YLD conditioning
           Mike.Prager@noaa.gov                                                 LAV optimization

Reference:  Prager, M. H. 1994. A suite of extensions to a nonequilibrium        ASPIC User's Manual is available
           surplus-production model.  Fishery Bulletin 92: 374-389.              gratis from the author.

CONTROL PARAMETERS (FROM INPUT FILE)                   Input file: c:\users\mortiz\desktop\run2\nswo_base.inp
------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization with bootstrap.
Number of years analyzed:                62          Number of bootstrap trials:                1000
Number of data series:                    1          Bounds on MSY (min, max):       1.028E+00   2.055E+02
Objective function:          Least absolute values       Bounds on K (min, max):          1.028E+01   2.055E+03
Relative conv. criterion (simplex):       1.000E-09      Monte Carlo search mode, trials:       1         500
Relative conv. criterion (restart):       3.000E-08      Random number seed:                      9227323
Relative conv. criterion (effort):        1.000E-06      Identical convergences required in fitting:      25
Maximum F allowed in fitting:               8.000


PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS)                                    error code   0
------------------------------------------------------------------------------------------------------------------
Normal convergence


GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)
------------------------------------------------------------------------------------------------------------------
                                         Weighted        Weighted     Current    Inv. var.    R-squared
Loss component number and title                LAV     N        MSE       weight       weight      in CPUE

Loss(-1)  LAV in yield                   0.000E+00
Loss(0)   Penalty for B1 > K                0.000E+00    1        N/A    1.000E+01         N/A
Loss(1)   Combined index 2013                  6.721E+00   45        N/A    1.000E+00         N/A        0.337
.................................................................
TOTAL OBJECTIVE FUNCTION:                     6.72126137E+00
Estimated contrast index (ideal = 1.0):        0.5575        C* = (Bmax-Bmin)/K
Estimated nearness index (ideal = 1.0):        1.0000        N* = 1 - |min(B-Bmsy)|/K


MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
------------------------------------------------------------------------------------------------------------------
Parameter                                  Estimate    User/pgm guess    2nd guess    Estimated    User guess

B1/K      Starting relative biomass (in 1950)      8.500E-01        8.500E-01    4.000E-01          0          1
MSY       Maximum sustainable yield               1.366E+01        1.028E+01    8.731E+00          1          1
K         Maximum population size              1.301E+02        1.028E+02    5.238E+01          1          1
phi       Shape of production curve (Bmsy/K)       0.5000           0.5000         ----          0          1

--------- Catchability Coefficients by Data Series ---------------
q(1)      Combined index 2013                   1.175E-02        1.321E-02    4.750E-01          1          1


ESTIMATES FROM BOOTSTRAPPED ANALYSIS
------------------------------------------------------------------------------------------------------------------
                    Estimated  Estimated      Bias-corrected approximate confidence limits        Inter-
Param         Point   bias in pt   relative     ------------------------------------------------   quartile   Relative
name        estimate    estimate       bias    80% lower    80% upper    50% lower    50% upper       range   IQ range

B1/K      8.500E-01   -1.665E-15     0.00%    8.500E-01    8.500E-01    8.500E-01    8.500E-01   0.000E+00     0.000
K         1.301E+02    1.521E+00     1.17%    1.097E+02    1.572E+02    1.207E+02    1.414E+02   2.069E+01     0.159

q(1)      1.175E-02    1.119E-04     0.95%    9.618E-03    1.435E-02    1.079E-02    1.285E-02   2.065E-03     0.176

MSY       1.366E+01    8.097E-03     0.06%    1.320E+01    1.405E+01    1.346E+01    1.384E+01   3.748E-01     0.027
Ye(2012)  1.341E+01   -9.412E-02    -0.70%    1.324E+01    1.379E+01    1.337E+01    1.361E+01   2.381E-01     0.018
Y.(Fmsy)  1.266E+01   -1.100E-02    -0.09%    1.262E+01    1.275E+01    1.265E+01    1.270E+01   5.502E-02     0.004

Bmsy      6.506E+01    7.603E-01     1.17%    5.487E+01    7.860E+01    6.035E+01    7.069E+01   1.035E+01     0.159
Fmsy      2.100E-01    3.107E-03     1.48%    1.679E-01    2.556E-01    1.904E-01    2.286E-01   3.817E-02     0.182

fmsy(1)   1.787E+01    7.747E-02     0.43%    1.679E+01    1.861E+01    1.740E+01    1.816E+01   7.621E-01     0.043

B./Bmsy   1.136E+00   -1.213E-03    -0.11%    1.036E+00    1.229E+00    1.091E+00    1.178E+00   8.666E-02     0.076
F./Fmsy   8.115E-01    7.101E-03     0.88%    7.320E-01    9.191E-01    7.758E-01    8.591E-01   8.334E-02     0.103
Ye./MSY   9.815E-01   -7.034E-03    -0.72%    9.504E-01    9.975E-01    9.697E-01    9.915E-01   2.178E-02     0.022
```

Table 17 N-SWO A comparison of population parameter estimates from the base run when either estimating initial biomass (B_1/K, run1) or fixing it at a value of 0.87 (run2).

MODEL CONTINUITY WITH B1/K FIXED AT 0.85

Param name	Estimated Point estimate	Estimated bias in pt estimate	relative bias	Bias-corrected approximate confidence limits: 80% lower	80% upper	50% lower	50% upper	Inter-quartile range	Relative IQ range
B1/K	0.85	-1.665E-15	0	0.85	0.85	0.85	0.85	0	0
K	130.1	1.036	0.008	108.9	153.4	120.7	140.4	19.72	0.152
q(1)	0.01175	0.0001602	0.0136	0.009778	0.01441	0.0108	0.01274	0.00194	0.165
MSY	13.66	0.0158	0.0012	13.25	14.08	13.49	13.84	0.3533	0.026
Ye(2012)	13.41	-0.08342	-0.0062	13.23	13.78	13.35	13.58	0.226	0.017
Y.(Fmsy)	12.66	-0.008804	-0.0007	12.63	12.76	12.65	12.7	0.05261	0.004
Bmsy	65.06	0.5182	0.008	54.45	76.7	60.34	70.2	9.859	0.152
Fmsy	0.21	0.003818	0.0182	0.1737	0.2602	0.1925	0.2314	0.03895	0.185
fmsy(1)	17.87	0.07181	0.004	16.85	18.61	17.43	18.2	0.7641	0.043
B./Bmsy	1.136	-0.001071	-0.0009	1.049	1.238	1.098	1.181	0.08399	0.074
F./Fmsy	0.8115	0.006355	0.0078	0.7293	0.9064	0.7708	0.8522	0.08139	0.1
Ye./MSY	0.9815	-0.006817	-0.0069	0.947	0.9968	0.9683	0.9905	0.0222	0.023

MODEL ASPIC RUN 1 ESTIMATING B1/K, K, MSY & q

Param name	Estimated Point estimate	Estimated bias in pt estimate	relative bias	Bias-corrected approximate confidence limits: 80% lower	80% upper	50% lower	50% upper	Inter-quartile range	Relative IQ range
B1/K	0.547	0.02471	0.0452	0.09623	1	0.2261	0.7637	0.5375	0.983
K	130.1	1.062	0.0082	111.9	163.6	121	144.4	23.42	0.18
q(1)	0.01175	0.000253	0.0215	0.009187	0.0139	0.01048	0.01268	0.002205	0.188
MSY	13.66	0.009852	0.0007	13.1	14.03	13.41	13.83	0.4148	0.03
Ye(2012)	13.41	-0.09221	-0.0069	13.2	13.75	13.35	13.59	0.2403	0.018
Y.(Fmsy)	12.66	-0.00902	-0.0007	12.62	12.74	12.65	12.7	0.0533	0.004
Bmsy	65.07	0.5312	0.0082	55.94	81.81	60.52	72.22	11.71	0.18
Fmsy	0.21	0.00468	0.0223	0.161	0.2508	0.1858	0.2286	0.04283	0.204
fmsy(1)	17.86	-0.01446	-0.0008	16.73	18.56	17.32	18.18	0.8586	0.048
B./Bmsy	1.136	-0.00425	-0.0037	1.026	1.242	1.091	1.192	0.1011	0.089
F./Fmsy	0.8115	0.01027	0.0127	0.7259	0.9331	0.7687	0.8605	0.09185	0.113
Ye./MSY	0.9815	-0.007	-0.0071	0.9443	0.998	0.9651	0.9913	0.02623	0.027

Table 18 N-SWO Comparison of the estimated parameters from the Surplus Production model assuming a Logistic (base case run2) or Fox shape parameter model (run3).

Model	Code	Exponent	Bmsy/K	B1/K	MSY	K	q1	Objective fn.
Logistic	0	2	0.5	0.5470	13.660	130.100	0.01175	6.7204
Fox	0	1	0.368	0.0480	13.500	149.500	0.01169	6.6612

Table 19 N-SWO ASPIC base case results. Intervals are based on 1000 bootstraps from ASPIC run2 with the point estimate, median, 10%, and 90% percentiles.

Parameter	Point estimate	Median	Low(10%)	Upp(90%)
B1/K	0.85000			
K	130100	130100	108900	153400
q(1)	0.01175	0.01175	0.00978	0.01441
MSY	13660	13660	13250	14080
Ye(2012)	13410	13410	13230	13780
Y.(Fmsy)	12660	12660	12630	12760
Bmsy	65060	65060	54450	76700
Fmsy	0.21	0.21	0.17	0.26
fmsy(1)	17.87	17.87	16.85	18.61
B./Bmsy	1.1360	1.1360	1.0490	1.2380
F./Fmsy	0.8115	0.8115	0.7293	0.9064
Ye./MSY	0.9815	0.9815	0.9470	0.9968

Table 20 a. N_SWO results from the retrospective analysis of the BSP2 reference case (run R.N). b**.** Retrospective cross-validation analysis for BSP to CPUE by flag (run C.1).

a)

Year	*r*	*K*	*fmsy*	*f2011/fmsy*	*B2011/Bmsy*	*msy*
2011	0.337	162814	0.17	0.87	1.05	13642
2010	0.333	163838	0.17	0.89	1.05	13596
2009	0.328	165790	0.16	0.91	1.02	13520
2008	0.318	169181	0.16	0.94	1.00	13441
2007	0.314	170437	0.16	0.96	0.98	13395
2006	0.316	170077	0.16	0.97	0.96	13411
2005	0.326	165861	0.16	0.91	1.02	13553
2004	0.328	165413	0.16	0.90	1.04	13567
2003	0.331	164549	0.17	0.90	1.04	13574
2002	0.329	164342	0.16	0.89	1.05	13584
2001	0.329	163999	0.16	0.89	1.04	13572

Year	*r*	*K*	*fmsy*	*f2011/fmsy*	*B2011/Bmsy*	*msy*
2011	0.495	120025	0.25	0.55	1.51	15017
2010	0.492	121863	0.25	0.56	1.49	14958
2009	0.476	124687	0.24	0.58	1.46	14862
2008	0.443	132391	0.22	0.61	1.40	14723
2007	0.424	137353	0.21	0.63	1.37	14615
2006	0.419	138637	0.21	0.63	1.37	14537
2005	0.422	137830	0.21	0.62	1.38	14582
2004	0.415	138913	0.21	0.63	1.38	14506

Table 21 Medians and 90% credibility intervals from the posterior distributions from the BSP model applied to data for North Atlantic SWO. Codes used for each run along with a run description can be found in BSP_Table M.1. Biomass values are in tons. The referenced current year is 2011.

Run	r			B_{msy}			$B_{current}$			$RepY_{current}$			$B_{current}/B_{msy}$			$F_{current}/F_{msy}$			$Catch_{curr}/RepY$		
	10%	**Median**	**90%**	**10%**	**Median**	**90%**	**10%**	**Median**	**90%**	**10%**	**Median**	**90%**	**10%**	**Median**	**90%**	**10%**	**Median**	**90%**	**10%**	**Median**	**90%**
Ref.	0.20	0.34	0.51	55197	80919	135094	56824	85720	151039	11843	13432	14812	0.84	1.06	1.29	0.67	0.87	1.16	0.85	0.93	1.06
	B_{msy}/K																				
A.1	0.28	0.51	0.89	34164	56842	89121	112659	222564	454341	7137	10931	14196	2.58	3.99	6.09	0.10	0.22	0.42	0.88	1.15	1.75
A.2	0.27	0.52	0.85	35156	56502	110776	69635	120980	288835	9941	12280	14436	1.56	2.18	3.02	0.23	0.40	0.63	0.87	1.02	1.26
A.3	0.26	0.45	0.69	41621	61974	108805	60498	96342	187271	10944	12648	14239	1.19	1.57	2.04	0.39	0.57	0.83	0.88	0.99	1.14
A.4	0.24	0.40	0.59	47531	69257	113675	57657	88877	153512	11360	13001	14464	0.99	1.29	1.63	0.51	0.71	0.98	0.87	0.96	1.10
A.5	0.17	0.27	0.40	52856	76938	120399	52928	79523	125741	12368	14163	15592	0.78	1.04	1.31	0.64	0.83	1.16	0.80	0.88	1.01
	***r* prior mean, *K* prior mean**																				
B.1	0.15	0.27	0.42	65111	98611	171476	64734	102575	186358	11265	13194	14903	0.82	1.04	1.29	0.67	0.90	1.23	0.84	0.95	1.11
B.2	0.24	0.38	0.55	50948	73266	114123	52561	78921	125858	12161	13526	14775	0.86	1.07	1.29	0.67	0.85	1.10	0.85	0.93	1.03
B.3	0.22	0.36	0.53	52930	75766	119969	55292	80276	129657	11965	13435	14762	0.84	1.06	1.28	0.68	0.86	1.15	0.85	0.93	1.05
B.4	0.23	0.36	0.53	53351	75185	115009	54605	80549	127831	12039	13467	14727	0.86	1.06	1.27	0.68	0.86	1.12	0.85	0.93	1.04
B.5	0.18	0.30	0.46	60461	88869	141543	60816	92363	155780	11523	13203	14689	0.82	1.04	1.27	0.69	0.90	1.22	0.85	0.95	1.09
B.6	0.26	0.40	0.58	49324	68892	104562	52279	75025	117630	12157	13542	14725	0.87	1.08	1.30	0.66	0.84	1.09	0.85	0.93	1.03
	CPUE by flag																				
C.1	0.25	0.50	0.75	40356	60013	125228	59065	90974	200608	5960	10867	13485	1.31	1.51	1.74	0.44	0.55	0.66	0.90	1.14	1.83
	Standard deviation in process error (SD=0.005, 0.01, 0.05, 0.075, 0.1, 0.15)																				
F.1a	0.25	0.36	0.49	56610	74023	101861	59464	76792	103796	12333	13185	13704	0.86	1.04	1.21	0.75	0.91	1.14	0.91	0.95	1.02
F.2a	0.24	0.36	0.49	56569	74527	103437	59178	76953	105580	12296	13201	13757	0.86	1.04	1.21	0.75	0.91	1.14	0.91	0.95	1.02
F.3a	0.20	0.34	0.51	55197	80919	135094	56824	85720	151039	11843	13432	14812	0.84	1.06	1.29	0.67	0.87	1.16	0.85	0.93	1.06
F.4a	0.18	0.32	0.50	55861	88846	166056	57205	95393	194021	11594	13813	16502	0.83	1.07	1.37	0.57	0.83	1.15	0.76	0.91	1.08
F.5a	0.17	0.30	0.51	56924	98532	233301	56664	107927	287208	11462	14399	19887	0.81	1.09	1.45	0.44	0.77	1.14	0.63	0.87	1.09
F.6a	0.15	0.28	0.48	67057	134029	327560	62640	131922	447692	11263	17232	29383	0.78	1.10	1.46	0.27	0.66	1.09	0.42	0.73	1.10

Table 22 Bayes factors for some alternative BSP model runs for North Atlantic swordfish. These reflect the ratio of the probability of the stock assessment data based on a sensitivity run to the probability of the data obtained from the reference case. For runs with alternative process error Bayes factors are shown for runs with uniform on K and uniform on log(K) priors. NA indicates no results produced.

				Bayes factor	
Category Code	*Category Description*	*Code*	*Run Description*	*U(K)*	*U(log(K))*
A	B_{msy}/K	A.1	$B_{msy}/K = 0.1$	7.9	NA
		A.2	$B_{msy}/K = 0.2$	6.7	NA
		A.3	$B_{msy}/K = 0.3$	7.9	NA
		A.4	$B_{msy}/K = 0.4$	6.7	NA
		Ref	$B_{msy}/K = 0.5$	1.0	NA
		A.5	$B_{msy}/K = 0.6$	0.4	NA
B	*r* prior mean	B.1	low *r* (mean = 0.28, CV = 0.49)	1.2	NA
		Ref	ref. prior (mean = 0.42, CV = 0.49)	1.0	NA
		B.2	high *r* (mean = 0.56, SD = 0.49)	0.6	NA
G	Process error SD	G.1a,b	$\sigma_{process\ error}$=0.005	0.8	0.8
		G.2a,b	$\sigma_{process\ error}$=0.01	0.8	0.9
		Ref., G.1	$\sigma_{process\ error}$=0.05	1.0	1.0
		G.3a,b	$\sigma_{process\ error}$=0.075	1.2	1.1
		G.4a,b	$\sigma_{process\ error}$=0.10	1.2	1.1
		G.6a,b	$\sigma_{process\ error}$=0.15	0.8	0.6

Table 23 ASPIC S-SWO results of the model runs. Run2 was chosen as the reference model. Shading indicates where a parameter has hit an upper bound.

	2009 Base model	1	2	3	4	5	6
fit method	SumSq	SumSq	SumSq	SumSq	SumSq	SumSq	SumSq
indices	6 sep CPUE	8 sep CPUE	5 sep indices	Comb 8 indices	Comb 5 indices No Tai	8 sep CPUE	5 sep indices
B1/K	0.875	0.875	0.875	0.875	0.875	3.957	0.8421
MSY	14870	14210	14210	60000	60000	60000	14210
K	95410	176200	116700	7000000	7000000	3151000	116700
Bmsy	47700	88120	58360	3500000	3500000	1576000	58370
Fmsy	0.3118	0.15	0.2436	0.017	0.017	0.038	0.244
r	0.6236	0.3	0.4872	0.034	0.034	0.076	0.487
B/Bmsy	1.04	0.95	0.9770	1.88	1.88	1.916	0.9771
F/Fmsy	0.75	1.09	0.8391	0.10	0.10	0.09894	0.83910
	* bound						

Table 24 S-SWO ASPIC reference case results. Intervals are based on 500 bootstraps from the ASPIC run2 with the point estimate, 20%, 80%, quartiles of the biomass index.

Name	Estimate	Estimated bias in pt estimate	Estimated relative bias	80% lower	80% upper
B1/K	0.875	0	0%	0.875	0.875
K	116700	25560	22%	78170	236700
q(1)	0.000008619	0.000000177	2%	0.000004352	0.00001326
q(2)	0.00001648	7.698E-07	5%	0.000006945	0.0000284
q(3)	0.0000168	7.142E-07	4%	0.000007214	0.00002892
q(4)	0.000009831	1.971E-07	2%	0.000004929	0.00001577
q(5)	0.00001742	8.346E-07	5%	0.000007443	0.00003036
MSY	14210	-119.7	-1%	11980	15030
Replacement Yield (2012)	14210	-396.9	-3%	12800	15130
Yat(Fmsy)	11900	-12.11	0%	11550	12430
Bmsy	58360	12780	22%	39080	118400
Fmsy	0.2436	0.009492	4%	0.1043	0.384
r	0.4872			0.2086	0.768
B./Bmsy	0.977	0.02985	3%	0.7943	1.144
F./Fmsy	0.8391	0.01743	2%	0.6863	1.088
Ye./MSY	0.9995	-0.01938	-2%	0.9992	1
q2/q1	1.912	-0.00543	0%	1.565	2.309
q3/q1	1.949	-0.009282	0%	1.643	2.413
q4/q1	1.141	0.0005229	0%	0.9872	1.36
q5/q1	2.021	-0.01137	-1%	1.69	2.547

Table 25 S-SWO results from a retrospective analysis of the BSP2 model.

Year	*r*	*K*	*fmsy*	*f2011/fmsy*	*B2011/Bmsy*	*msy*
2011	0.388	189316	0.19	0.47	1.38	17735
2010	0.391	190196	0.20	0.46	1.40	17713
2009	0.382	189987	0.19	0.49	1.34	17483
2008	0.376	190360	0.19	0.50	1.32	17213
2007	0.381	188537	0.19	0.48	1.38	17333
2006	0.375	188548	0.19	0.50	1.35	17063
2005	0.373	188446	0.19	0.50	1.34	16997
2004	0.379	187466	0.19	0.50	1.33	17145
2003	0.386	188710	0.19	0.48	1.35	17539
2002	0.407	188565	0.20	0.46	1.34	18438
2001	0.413	190308	0.21	0.46	1.32	18793

Table 26 S-SWO estimated stock status results from the BSP2 model.

Parameter	Mean	SD	CV	5th Percentile	Median	95th Percentile
r	0.415	0.143	0.346	0.2306	0.3878	0.6961
K	196611	49173	0.25	128530	189316	289468
MSY	19808	7552	0.381	12156	17735	35084
Bmsy	98306	24587	0.25	64265	94658	144734
Binit (1950)	200988	79655	0.396	110104	185892	321036
Bcur (2011)	137288	51717	0.377	69480	130465	239805
Bcur (2011)/Bmsy	1.379	0.298	0.216	0.894	1.383	1.873
Bcur (2011)/Binit	0.72	0.226	0.314	0.391	0.702	1.122
Bcur (2011)/K	0.689	0.149	0.216	0.4472	0.6917	0.9363
Fmsy	0.2073	0.0717	0.346	0.1153	0.1939	0.348
Fcur (2011)	0.0948	0.0359	0.378	0.0485	0.0889	0.1626
Fcur (2011)/Fmsy	0.5093	0.2469	0.485	0.1831	0.4674	0.9715
REPYcur (2011)	14253.9	5004.9	0.351	5235.8	14360.9	22056.2
Catcur/REPYcur (2011)	0.7436	0.3166	0.426	0	0.7545	1.2149

Table 27 Medians and 95% credibility intervals from the posterior distributions from the BSP model applied to data for South Atlantic SWO. Codes used for each run along with a run description can be found in Table 5.6. Biomass values are in tons. The referenced current year is 2011.

Run	***r***			***B**$_{msy}$*			***B**$_{current}$*			***RepY**$_{current}$*			***B**$_{current}$/**B**$_{msy}$*			***F**$_{current}$/**F**$_{msy}$*			***Catch**$_{curr}$/**RepY***		
	5%	**Median**	**95%**	**5%**	**Median**	**95%**	**5%**	**Median**	**95%**	**5%**	**Median**	**95%**	**5%**	**Median**	**95%**	**5%**	**Median**	**95%**	**5%**	**Median**	**95%**
R.S	0.23	0.39	0.70	64265	94658	144734	69480	130465	239805	5236	14361	22056	0.89	1.38	1.87	0.18	0.47	0.97	0	0.76	1.22
	***r* prior mean, *K* priors**																				
H.1	0.35	0.55	0.84	42095	60919	89546	43434	76773	137292	8861	14350	18412	0.85	1.26	1.72	0.29	0.57	0.97	0.578	0.78	1.12
H.2	0.19	0.34	0.69	85693	130559	206822	96218	194057	369674	1221	15113	27732.90	0.96	1.51	1.95	0.13	0.35	0.855	0.00	0.67	1.17
H.3	0.19	0.32	0.56	69036	102287	152522	70237	131507	242371	6701	13822	20490	0.85	1.29	1.79	0.25	0.56	1.11	0.43	0.80	1.31
H.4	0.27	0.45	0.82	61442	91987	139833	69216	131408	247128	3574	14851	23128	0.94	1.46	1.90	0.15	0.40	0.87	0.00	0.72	1.13
H.5	0.16	0.33	0.69	98190	269201	468322	124534	455678	905894	0	17439	49244	1.10	1.70	2.12	0.05	0.16	0.65	0.00	0.34	0.96

Table 28 Estimated probability of B>=B_{MSY}, F<=F_{MSY}, and maintaining the stock in the condition consistent with the Convention objective (B>B_{MSY} and F<F_{MSY}) for the constant catches listed and the times indicated from the ASPIC base case model for the North Atlantic stock.

Estimated probabilities (%) that fishing mortality is below F_{MSY}

TAC	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
8000	88	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
9000	88	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
10000	88	99	99	99	99	99	99	100	100	100	100	100	100	100	100	100	100	100
11000	88	98	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99
12000	88	96	96	96	96	97	97	97	97	98	98	98	98	99	99	99	99	99
13000	88	93	93	93	93	94	94	94	94	94	94	94	94	94	94	94	94	94
13200	88	92	92	92	92	92	92	92	92	92	92	91	92	91	91	91	91	91
13400	88	90	90	90	90	90	90	89	89	89	89	88	88	88	88	87	87	87
13600	88	88	88	88	87	87	86	85	85	84	83	83	83	83	83	82	82	81
13700	88	88	88	87	85	84	84	83	82	82	81	81	79	79	78	77	77	77
13800	88	87	86	85	83	82	82	81	79	78	77	76	75	75	74	73	71	70
13900	88	86	84	83	82	80	79	77	75	74	73	71	70	68	66	64	63	61
14000	88	84	82	80	79	77	75	74	72	69	67	65	62	60	57	56	54	51
14100	88	82	80	78	76	74	72	69	66	63	59	57	54	49	47	45	43	40
14200	88	81	79	76	73	71	67	63	59	55	50	46	44	40	37	34	32	31
14300	88	80	76	73	70	65	61	56	50	46	42	36	34	32	30	26	24	22
14400	88	78	74	71	65	60	54	47	42	37	33	30	27	23	21	18	17	16
14600	88	74	69	63	56	47	40	33	30	24	20	17	14	13	12	9	9	8
14800	88	70	62	51	43	34	29	22	17	13	12	9	6	6	5	4	4	4
15000	88	64	55	42	32	25	17	13	11	7	5	4	3	2	2	2	3	3
16000	88	31	17	10	4	2	0	0	0	0	0	0	0	0	0	0	0	0
17000	88	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18000	88	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19000	88	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20000	88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Estimated probabilities (%) that the spawning stock biomass is above SSB_{MSY}

TAC	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
8000	93	92	96	96	99	99	99	99	99	100	100	100	100	100	100	100	100	100
9000	93	92	95	96	98	99	99	99	99	99	99	100	100	100	100	100	100	100
10000	93	92	95	96	96	97	99	99	99	99	99	99	99	99	99	99	99	99
11000	93	92	94	96	96	96	96	97	99	99	99	99	99	99	99	99	99	99
12000	93	92	93	94	95	95	96	96	96	96	97	97	97	97	97	97	98	98
13000	93	92	92	93	93	93	93	93	93	94	94	94	94	94	94	94	94	94
13200	93	92	92	93	92	92	92	92	92	92	92	92	92	92	92	92	92	92
13400	93	92	92	91	91	91	91	91	91	90	90	90	90	89	89	89	89	89
13600	93	92	91	91	90	90	89	88	88	88	87	87	86	85	84	84	83	83
13700	93	92	91	91	90	89	88	88	87	87	85	85	83	83	82	81	81	80
13800	93	92	91	90	89	89	88	87	86	84	83	82	81	80	78	77	76	76
13900	93	92	91	90	89	88	87	85	83	83	80	79	77	75	74	74	72	70
14000	93	92	91	90	88	88	86	84	81	80	78	75	74	72	70	67	65	62
14100	93	92	91	89	88	86	84	81	79	77	74	72	69	66	63	59	57	51
14200	93	92	91	89	87	85	82	80	77	74	70	67	63	58	55	49	46	43
14300	93	92	90	89	86	84	80	78	74	70	65	61	56	49	45	41	35	32
14400	93	92	90	89	86	82	80	74	70	65	59	52	46	41	35	32	29	25
14600	93	92	90	88	84	80	75	67	61	52	45	36	31	26	21	17	14	13
14800	93	92	90	86	81	77	67	60	49	39	31	24	17	14	11	9	7	5
15000	93	92	90	85	80	72	61	49	37	27	19	13	9	7	5	4	3	2
16000	93	92	87	78	61	38	18	8	3	1	0	0	0	0	0	0	0	0
17000	93	92	84	63	31	9	2	0	0	0	0	0	0	0	0	0	0	0
18000	93	92	80	44	9	1	0	0	0	0	0	0	0	0	0	0	0	0
19000	93	92	75	25	1	0	0	0	0	0	0	0	0	0	0	0	0	0
20000	93	92	67	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Estimated probabilities (%) that both the fishing mortality is below F_{MSY} and spawning stock biomass is above SSB_{MSY}

TAC	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
8000	88	92	96	96	99	99	99	99	99	100	100	100	100	100	100	100	100	100
9000	88	92	95	96	98	99	99	99	99	99	99	100	100	100	100	100	100	100
10000	88	92	95	96	96	97	99	99	99	99	99	99	99	99	99	99	99	99
11000	88	92	94	96	96	96	96	97	99	99	99	99	99	99	99	99	99	99
12000	88	92	93	94	95	95	96	96	96	96	97	97	97	97	97	97	98	98
13000	88	91	92	92	92	92	93	93	93	94	94	94	93	93	94	94	94	94
13200	88	91	91	92	92	91	91	91	91	91	91	91	91	91	91	91	91	91
13400	88	90	90	89	89	89	89	89	89	89	89	88	88	87	87	87	87	87
13600	88	88	88	88	87	87	86	85	85	84	83	83	83	83	83	82	82	81
13700	88	88	88	87	85	84	84	83	82	82	81	81	79	79	78	77	77	77
13800	88	87	86	85	83	82	82	81	79	78	77	76	75	75	74	73	71	70
13900	88	86	84	83	82	80	79	77	75	74	73	71	70	68	66	64	63	61
14000	88	84	82	80	79	77	75	74	72	69	67	65	62	60	57	56	54	51
14100	88	82	80	78	76	74	72	69	66	63	59	57	54	49	47	45	43	40
14200	88	81	79	76	73	71	67	63	59	55	50	46	44	40	37	34	32	31
14300	88	80	76	73	70	65	61	56	50	46	42	36	34	32	30	26	24	22
14400	88	78	74	71	65	60	54	47	42	37	33	30	27	23	21	18	17	15
14600	88	74	69	63	56	47	40	33	30	24	20	17	14	13	12	9	8	7
14800	88	70	62	51	43	34	29	22	17	13	12	9	6	6	5	4	3	3
15000	88	64	55	42	32	25	17	13	11	7	5	4	3	2	2	1	1	1
16000	88	31	17	10	4	2	0	0	0	0	0	0	0	0	0	0	0	0
17000	88	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18000	88	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19000	88	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20000	88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 29 Estimated probability of B>=B_{MSY}, F<=F_{MSY}, and maintaining the stock in the condition consistent with the Convention objective (B>B_{MSY} and F<F_{MSY}) for the constant catches listed and the times indicated from the BSP base case model for the North Atlantic stock.

P(By>Bmsy)

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TAC= 8000	67%	63%	69%	78%	84%	87%	90%	92%	94%	94%
TAC= 9000	67%	63%	68%	75%	80%	84%	87%	89%	90%	92%
TAC= 10000	67%	63%	66%	72%	77%	80%	82%	84%	86%	87%
TAC= 11000	67%	63%	65%	70%	73%	75%	77%	79%	80%	81%
TAC= 12000	67%	63%	64%	66%	68%	70%	71%	72%	72%	72%
TAC= 13000	67%	63%	63%	63%	63%	63%	63%	63%	62%	62%
TAC= 13700	67%	63%	62%	60%	59%	58%	57%	55%	54%	53%
TAC= 14000	67%	63%	62%	59%	58%	56%	54%	52%	50%	49%
TAC= 15000	67%	63%	60%	56%	52%	48%	45%	42%	40%	38%
TAC= 16000	67%	63%	59%	52%	47%	41%	37%	33%	30%	27%
TAC= 17000	67%	63%	57%	48%	40%	34%	30%	26%	22%	20%
TAC= 18000	67%	63%	56%	44%	35%	28%	23%	20%	17%	14%

P(Fy<Fmsy)

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TAC= 8000	58%	61%	99%	99%	100%	100%	100%	100%	100%	100%
TAC= 9000	58%	61%	98%	98%	98%	98%	98%	98%	99%	99%
TAC= 10000	58%	61%	95%	95%	95%	95%	95%	96%	96%	96%
TAC= 11000	58%	61%	90%	90%	90%	90%	91%	90%	91%	91%
TAC= 12000	58%	61%	81%	81%	81%	81%	81%	82%	82%	82%
TAC= 13000	58%	61%	69%	69%	69%	68%	67%	68%	68%	67%
TAC= 13700	58%	61%	60%	59%	58%	57%	56%	54%	53%	53%
TAC= 14000	58%	61%	56%	54%	53%	51%	50%	49%	48%	48%
TAC= 15000	58%	61%	42%	39%	36%	34%	33%	32%	31%	32%
TAC= 16000	58%	61%	29%	26%	24%	21%	20%	20%	21%	22%
TAC= 17000	58%	61%	18%	16%	14%	13%	12%	13%	15%	19%
TAC= 18000	58%	61%	12%	9%	8%	7%	8%	10%	15%	22%

P(Fy<Fmsy and By>Bmsy)

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TAC= 8000	56%	57%	69%	78%	84%	87%	90%	92%	94%	94%
TAC= 9000	56%	57%	68%	75%	80%	84%	87%	89%	90%	92%
TAC= 10000	56%	57%	66%	72%	77%	80%	82%	84%	86%	87%
TAC= 11000	56%	57%	65%	70%	73%	75%	77%	79%	80%	81%
TAC= 12000	56%	57%	64%	66%	68%	70%	70%	72%	72%	72%
TAC= 13000	56%	57%	61%	61%	62%	61%	62%	61%	61%	60%
TAC= 13700	56%	57%	57%	55%	55%	54%	53%	51%	50%	50%
TAC= 14000	56%	57%	54%	52%	51%	50%	49%	47%	46%	44%
TAC= 15000	56%	57%	42%	39%	36%	34%	33%	31%	30%	29%
TAC= 16000	56%	57%	29%	26%	24%	21%	19%	18%	17%	16%
TAC= 17000	56%	57%	18%	16%	14%	13%	11%	10%	9%	8%
TAC= 18000	56%	57%	12%	9%	8%	6%	6%	5%	4%	4%

Table 30 Estimated probability of B>=B_{MSY}, F<=F_{MSY}, and maintaining the stock in the condition consistent with the Convention objective (B>B_{MSY} and F<F_{MSY}) for the constant catches listed and the times indicated from the ASPIC reference case model for the South Atlantic stock.

Prob(B>=Bmsy)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
10000	61%	68%	72%	79%	86%	88%	91%	94%	95%	95%
11000	50%	70%	67%	74%	80%	84%	87%	88%	89%	91%
12000	50%	70%	67%	73%	76%	79%	82%	84%	86%	87%
13000	50%	70%	67%	70%	73%	75%	76%	77%	78%	79%
14000	50%	70%	67%	68%	68%	68%	69%	69%	69%	69%
15000	50%	70%	67%	64%	61%	59%	55%	54%	50%	48%
16000	50%	70%	67%	60%	52%	44%	36%	31%	27%	23%
17000	50%	70%	67%	54%	41%	30%	21%	14%	10%	7%
18000	50%	70%	67%	49%	32%	18%	10%	7%	5%	3%
19000	50%	70%	67%	44%	24%	10%	6%	4%	3%	2%
20000	50%	70%	67%	40%	16%	7%	4%	3%	1%	1%

Prob(F<=Fmsy)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
10000	95%	53%	95%	96%	96%	97%	97%	97%	97%	97%
11000	95%	53%	91%	92%	94%	94%	94%	95%	95%	95%
12000	95%	53%	85%	87%	87%	88%	88%	89%	89%	89%
13000	95%	53%	76%	78%	78%	79%	79%	80%	80%	81%
14000	95%	53%	66%	67%	67%	67%	68%	68%	68%	67%
15000	95%	53%	51%	50%	47%	44%	42%	40%	39%	38%
16000	95%	53%	33%	29%	25%	21%	18%	15%	13%	10%
17000	95%	53%	22%	15%	10%	5%	3%	2%	1%	1%
18000	95%	53%	12%	5%	2%	1%	1%	1%	1%	0%
19000	95%	53%	5%	1%	1%	1%	0%	0%	0%	0%
20000	95%	53%	1%	1%	0%	0%	0%	0%	0%	0%

Prob(F<=Fmsy) and Prob(B>=Bmsy)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
10000	73%	62%	79%	83%	87%	89%	91%	91%	92%	93%
11000	73%	62%	79%	83%	87%	89%	91%	91%	92%	93%
12000	73%	62%	76%	80%	82%	84%	85%	86%	87%	88%
13000	73%	62%	72%	74%	76%	77%	78%	78%	79%	80%
14000	73%	62%	67%	68%	67%	68%	68%	69%	68%	68%
15000	73%	62%	59%	57%	54%	52%	49%	47%	45%	43%
16000	73%	62%	50%	44%	38%	33%	27%	23%	20%	17%
17000	73%	62%	45%	35%	26%	18%	12%	8%	5%	4%
18000	73%	62%	40%	27%	17%	9%	5%	4%	3%	2%
19000	73%	62%	36%	23%	12%	5%	3%	2%	1%	1%
20000	73%	62%	34%	20%	8%	4%	2%	2%	1%	1%

Table 31 Estimated probability of B>=B_{MSY}, F<=F_{MSY}, and maintaining the stock in the condition consistent with the Convention objective (B>B_{MSY} and F<F_{MSY}) for the constant catches listed and the times indicated from the BSP reference case model for the South Atlantic stock.

P(By>Bmsy) Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TAC= 12000	90%	89%	87%	87%	86%	86%	86%	85%	85%	85%
TAC= 13000	90%	89%	86%	86%	85%	84%	83%	83%	82%	81%
TAC= 14000	90%	89%	86%	85%	83%	82%	81%	80%	79%	78%
TAC= 15000	90%	89%	86%	84%	82%	80%	79%	77%	76%	75%
TAC= 16000	90%	89%	86%	83%	80%	78%	76%	74%	73%	71%
TAC= 17000	90%	89%	85%	82%	79%	76%	73%	71%	70%	67%
TAC= 18000	90%	89%	85%	81%	77%	74%	71%	68%	66%	64%
TAC= 19000	90%	89%	84%	80%	75%	71%	68%	65%	62%	60%
TAC= 20000	90%	89%	84%	79%	74%	69%	65%	62%	58%	55%

$P(F_y<F_{msy})$

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TAC= 12000	98%	86%	93%	92%	92%	91%	91%	91%	91%	90%
TAC= 13000	98%	86%	90%	90%	89%	88%	88%	88%	87%	87%
TAC= 14000	98%	86%	87%	87%	85%	85%	84%	83%	83%	83%
TAC= 15000	98%	86%	84%	83%	82%	81%	80%	80%	80%	80%
TAC= 16000	98%	86%	81%	79%	78%	77%	76%	76%	75%	75%
TAC= 17000	98%	86%	78%	75%	73%	72%	71%	71%	71%	71%
TAC= 18000	98%	86%	74%	71%	68%	67%	66%	66%	66%	67%
TAC= 19000	98%	86%	70%	66%	64%	63%	61%	62%	63%	63%
TAC= 20000	98%	86%	66%	62%	60%	58%	57%	58%	59%	60%

$P(F_y<F_{msy}$ and $B_y>B_{msy})$

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TAC= 12000	90%	84%	86%	86%	86%	85%	85%	85%	84%	84%
TAC= 13000	90%	84%	85%	85%	84%	83%	83%	82%	81%	81%
TAC= 14000	90%	84%	84%	82%	82%	80%	79%	78%	78%	77%
TAC= 15000	90%	84%	82%	80%	79%	77%	76%	75%	74%	73%
TAC= 16000	90%	84%	79%	78%	75%	74%	72%	71%	69%	68%
TAC= 17000	90%	84%	76%	74%	72%	69%	67%	66%	64%	63%
TAC= 18000	90%	84%	74%	70%	67%	65%	62%	61%	59%	57%
TAC= 19000	90%	84%	69%	66%	63%	60%	58%	56%	54%	52%
TAC= 20000	90%	84%	65%	61%	59%	56%	53%	51%	49%	47%

Table 32 Kobe II Strategy matrix for North Atlantic swordfish derived using harvest control rules.

																				Average catch over *(1000t)*	**Cumulative catch over:**		
Bthreshold	**Ftarget**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	***3 years***	***5 years***	***10 years***	***15 years***
.6Bmsy	*0.75Fmsy*	88	92	95	96	99	99	99	99	100	100	100	100	100	100	100	100	100	100	11.740	59.787	122.391	185.947
.6Bmsy	*0.80Fmsy*	88	92	95	96	97	99	99	99	99	100	100	100	100	100	100	100	100	100	12.402	62.678	127.161	192.322
.6Bmsy	*0.85Fmsy*	88	92	94	95	96	97	99	99	99	99	99	100	100	100	100	100	100	100	13.050	65.448	131.556	198.016
.6Bmsy	*0.90Fmsy*	88	92	94	95	96	96	96	99	99	99	99	99	99	99	100	100	100	100	13.683	68.099	135.588	203.049
.6Bmsy	*0.95Fmsy*	88	92	93	94	95	95	96	96	96	97	99	99	99	99	99	99	99	99	14.302	70.633	139.269	207.438
.6Bmsy	*Fmsy*	88	92	92	0	92	92	0	92	92	0	92	92	0	92	92	0	92	92	14.908	73.054	142.610	211.207
.8Bmsy	*0.75Fmsy*	88	92	95	96	99	99	99	99	100	100	100	100	100	100	100	100	100	100	11.740	59.787	122.391	185.947
.8Bmsy	*0.80Fmsy*	88	92	95	96	97	99	99	99	99	100	100	100	100	100	100	100	100	100	12.402	62.678	127.161	192.322
.8Bmsy	*0.85Fmsy*	88	92	94	95	96	97	99	99	99	99	99	100	100	100	100	100	100	100	13.050	65.448	131.556	198.016
.8Bmsy	*0.90Fmsy*	88	92	94	95	96	96	96	99	99	99	99	99	99	99	100	100	100	100	13.683	68.099	135.588	203.049
.8Bmsy	*0.95Fmsy*	88	92	93	94	95	95	96	96	96	97	99	99	99	99	99	99	99	99	14.302	70.633	139.269	207.438
.8Bmsy	*Fmsy*	88	92	92	0	92	92	0	92	92	0	92	92	0	92	92	0	92	92	14.908	73.054	142.610	211.207
Bmsy	*0.75Fmsy*	88	92	95	97	99	99	100	100	100	100	100	100	100	100	100	100	100	100	11.665	59.581	122.256	185.849
Bmsy	*0.80Fmsy*	88	92	95	97	99	99	100	100	100	100	100	100	100	100	100	100	100	100	12.323	62.457	127.019	192.227
Bmsy	*0.85Fmsy*	88	92	95	96	99	99	99	100	100	100	100	100	100	100	100	100	100	100	12.966	65.209	131.407	197.924
Bmsy	*0.90Fmsy*	88	92	94	96	99	99	99	100	100	100	100	100	100	100	100	100	100	100	13.596	67.841	135.430	202.961
Bmsy	*0.95Fmsy*	88	92	93	95	98	99	99	99	100	100	100	100	100	100	100	100	100	100	14.211	70.354	139.099	207.356
Bmsy	*Fmsy*	88	92	92	0	94	96	5	99	99	2	100	100	1	100	100	0	100	100	14.813	72.744	142.421	211.128

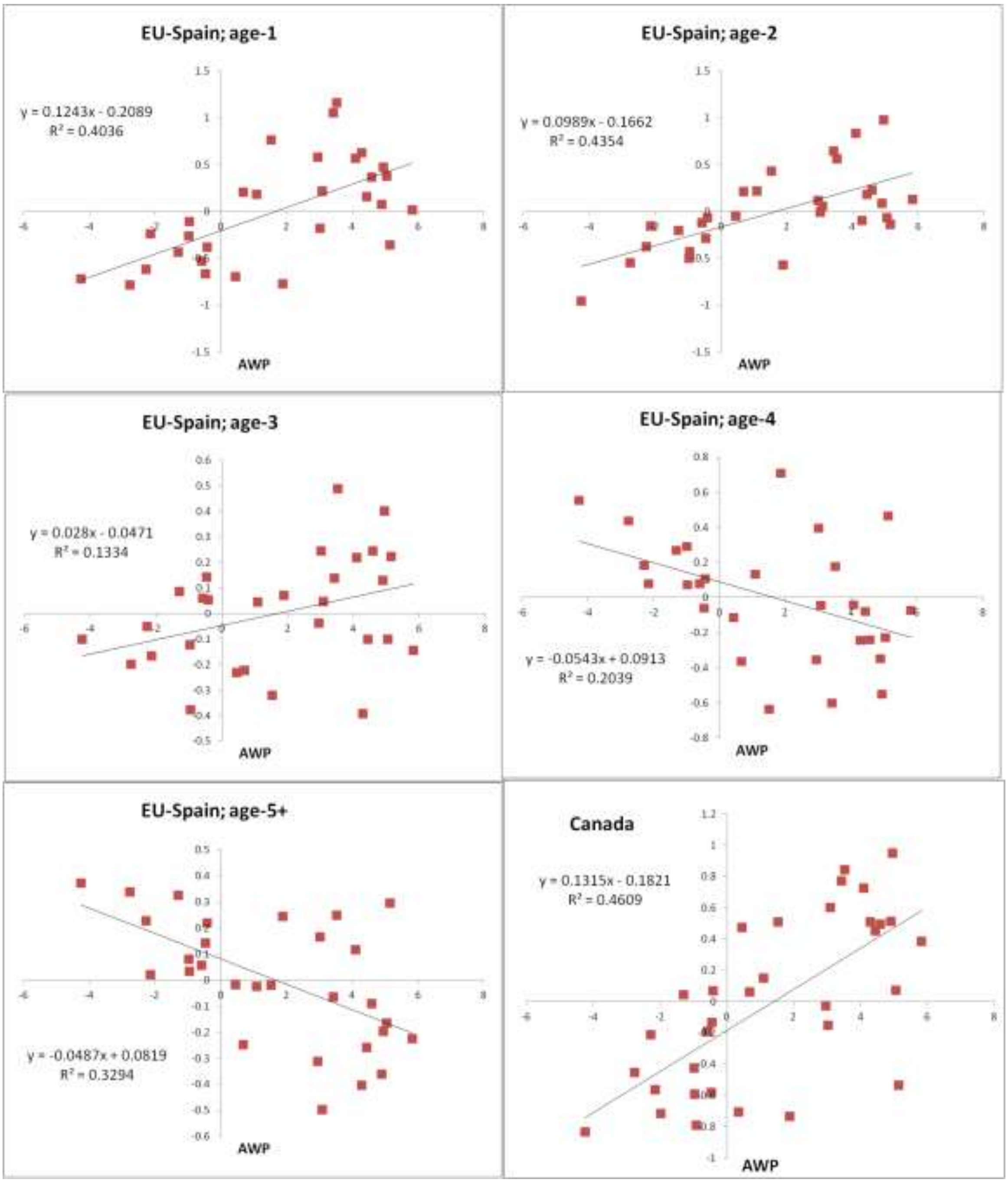


Figure 1. Deviations from the observed and expected (i.e. residuals) for the Spanish age-specific and the Canada CPUEs from the SS model regressed against the annual size of the Atlantic Warm Pool.

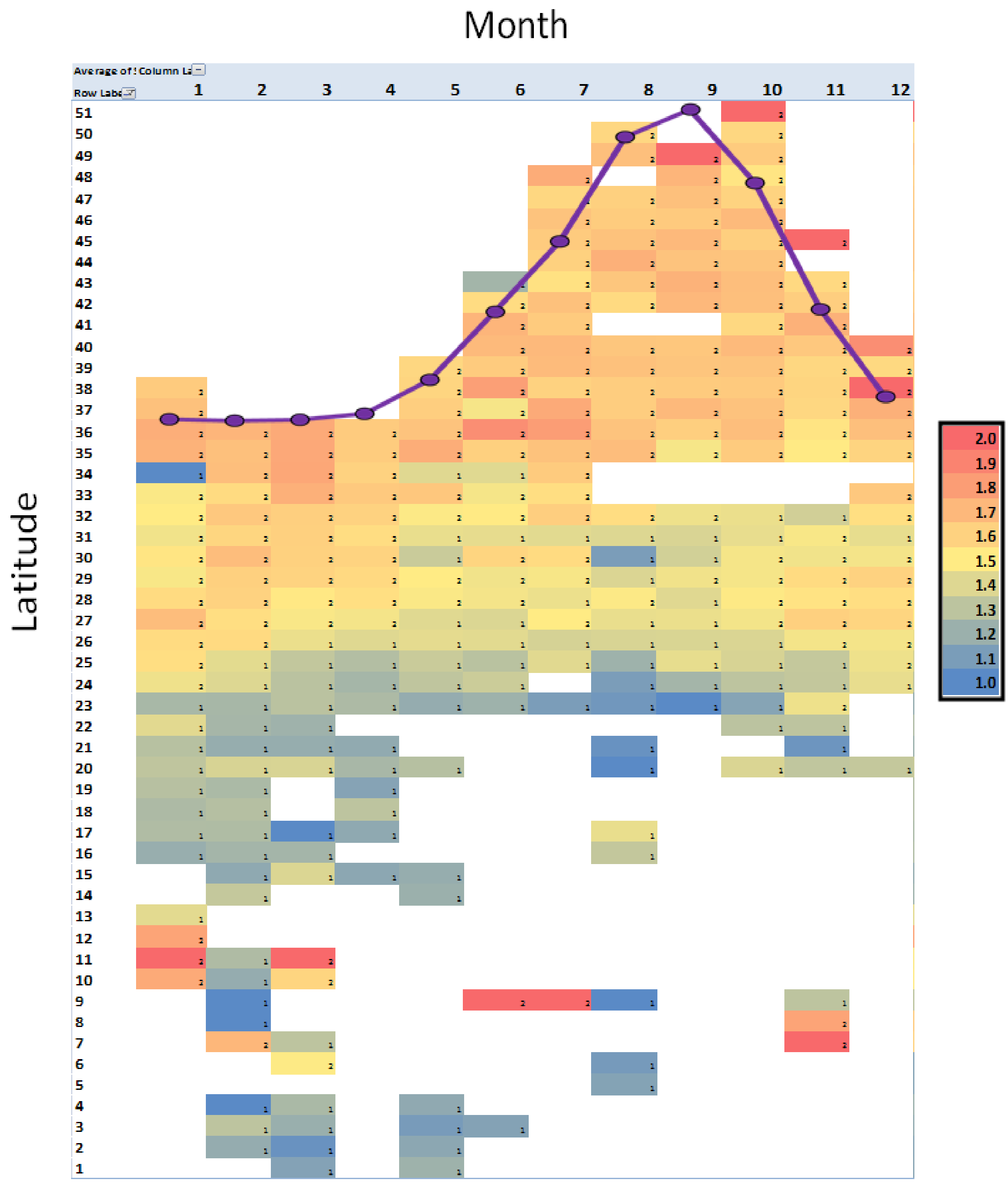


Figure 2. Depiction of the seasonal latitudinal migration of swordfish off the east coast of the United States from the US observer data. The numbers and colors within the grids represent the mean sex ratio (males are blue and 1; females are red and 2). The bolded line represents the monthly climatology of the expansion and contraction (i.e. area) of the Atlantic Warm Pool.

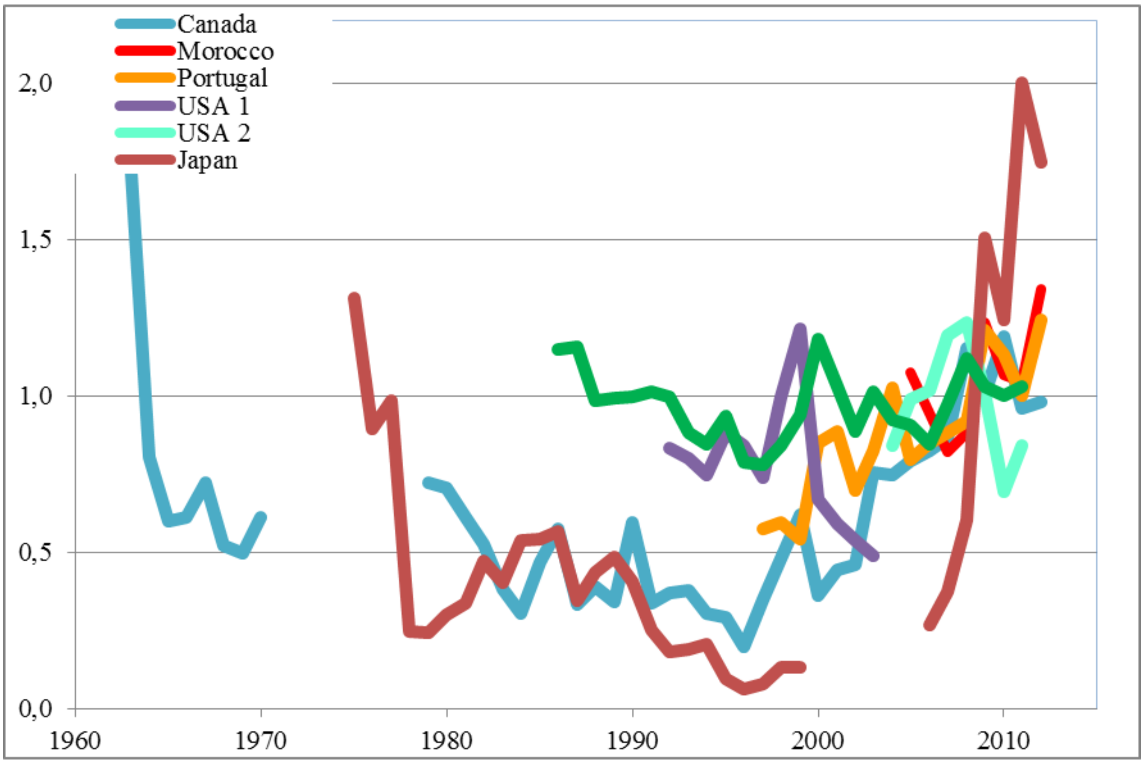


Figure 3. Fleet-specific indices in biomass, standardized by CPC scientists, considered to be suitable for use in stock assessment models.

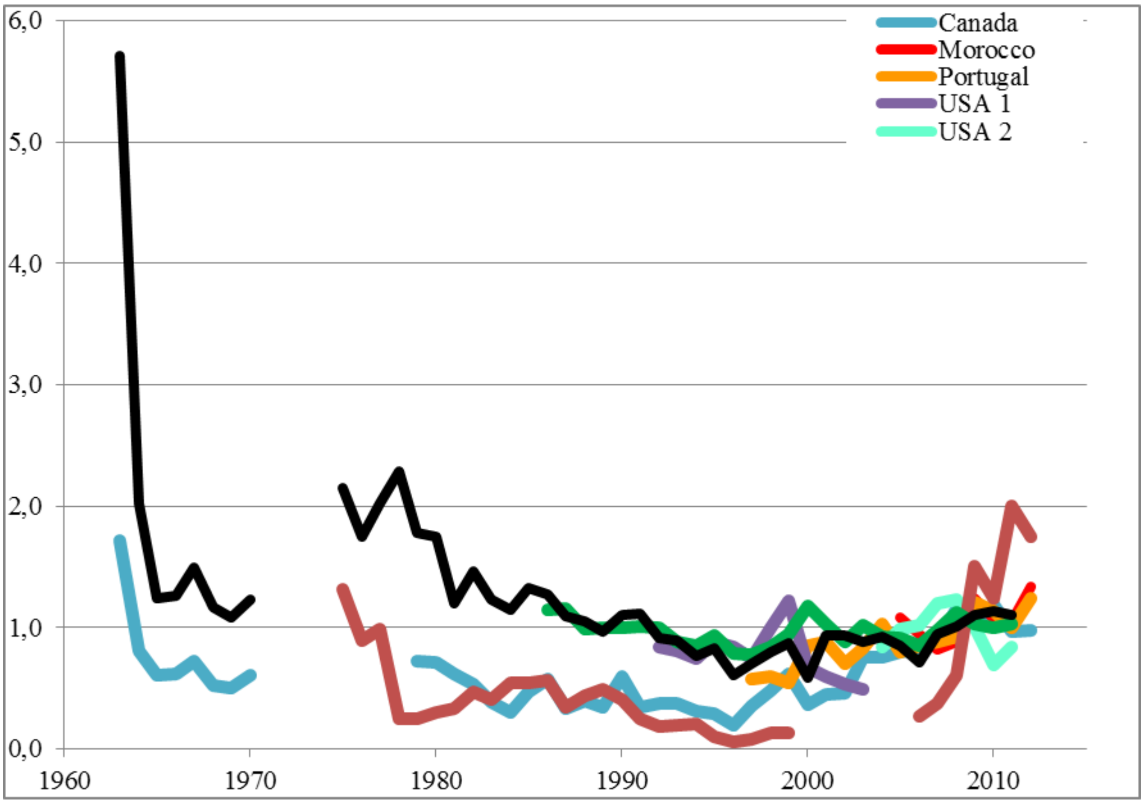


Figure 4. Continuity Case Combined Index compared to Fleet-specific indices in biomass, as standardized by CPC scientists.

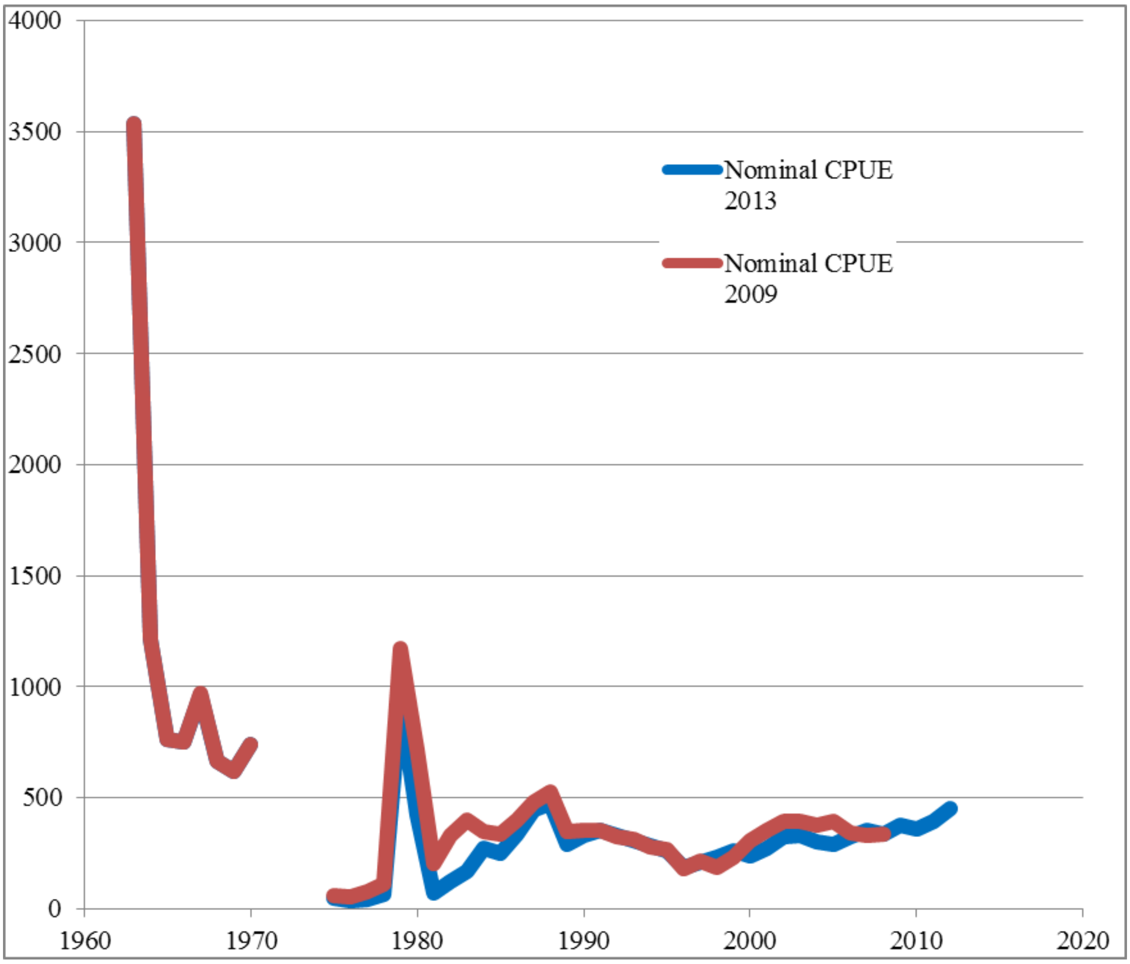


Figure 5. Comparison of the nominal CPUE trends calculated from the catch and effort data used for the calculation of standardized combined indices for the 2009 and 2013 swordfish stock assessment meetings.

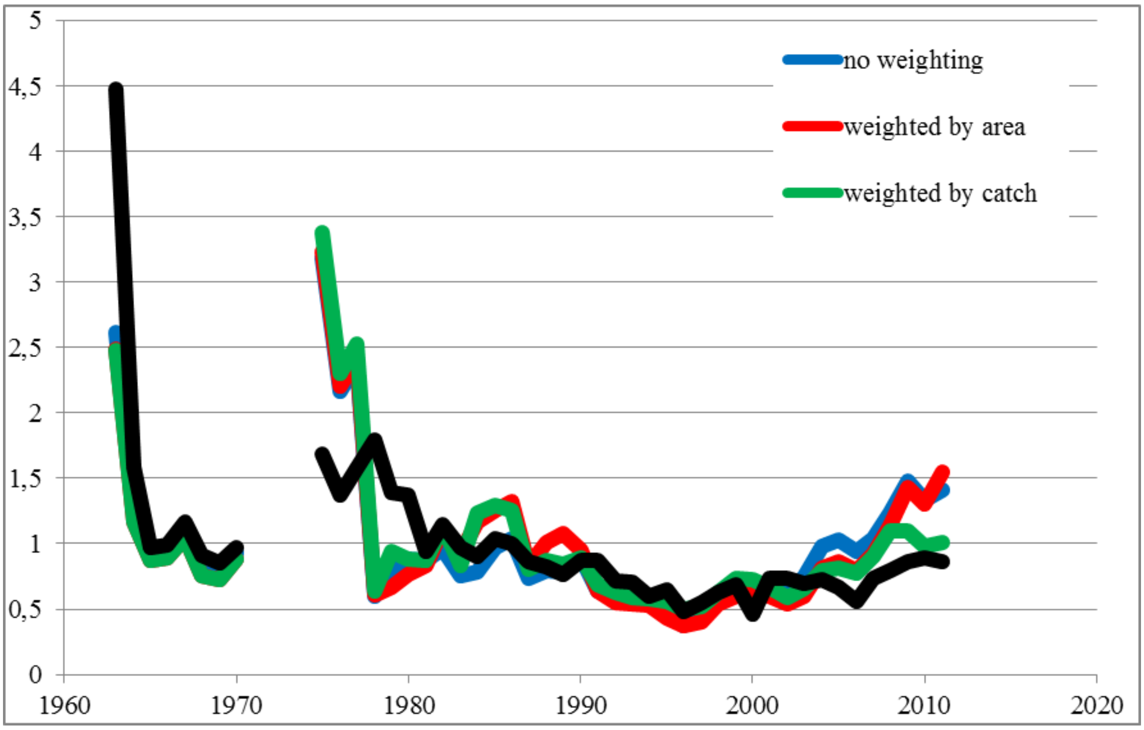


Figure 6 Comparison of Continuity Case Combined Indices to Combined Indices developed using GLM under different weighting schemes (no weighting, weighted by area, weighted by catch).

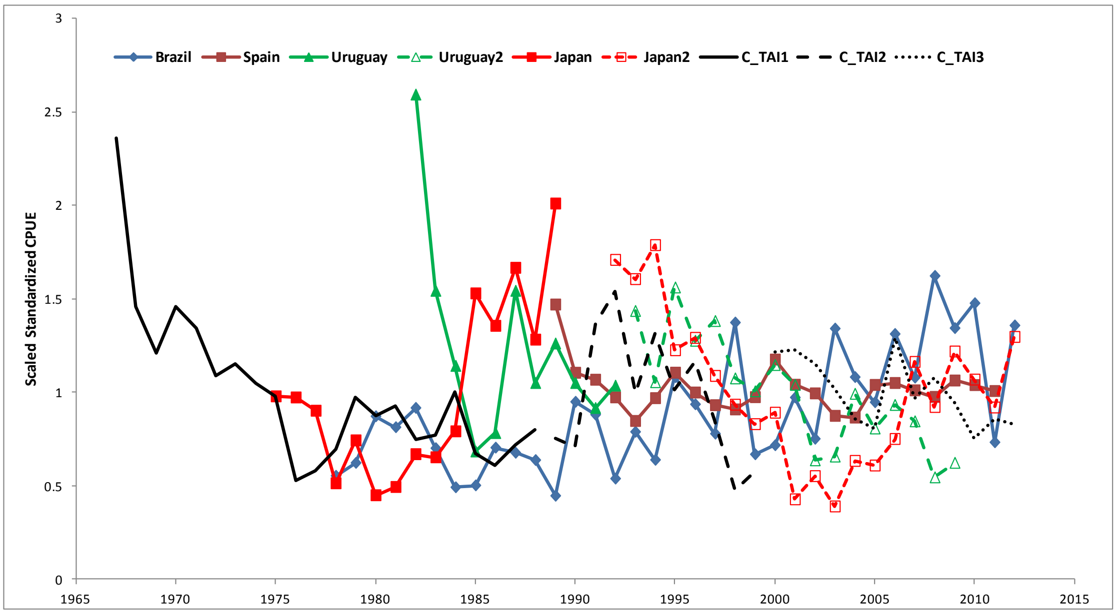


Figure 7. Patterns in standardized catch rates for South Atlantic swordfish across time from nine standardized CPUE series. The CPUE series are scaled to their mean for the overlapping years.

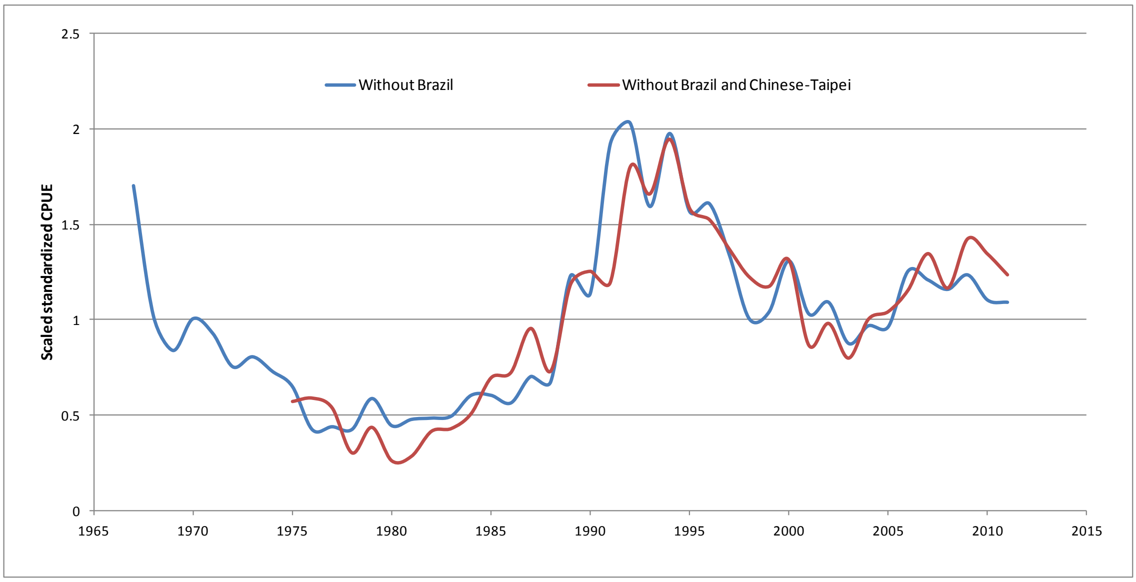


Figure 8. Combined standardized CPUE indices developed for the 2013 South Atlantic swordfish stock assessment.

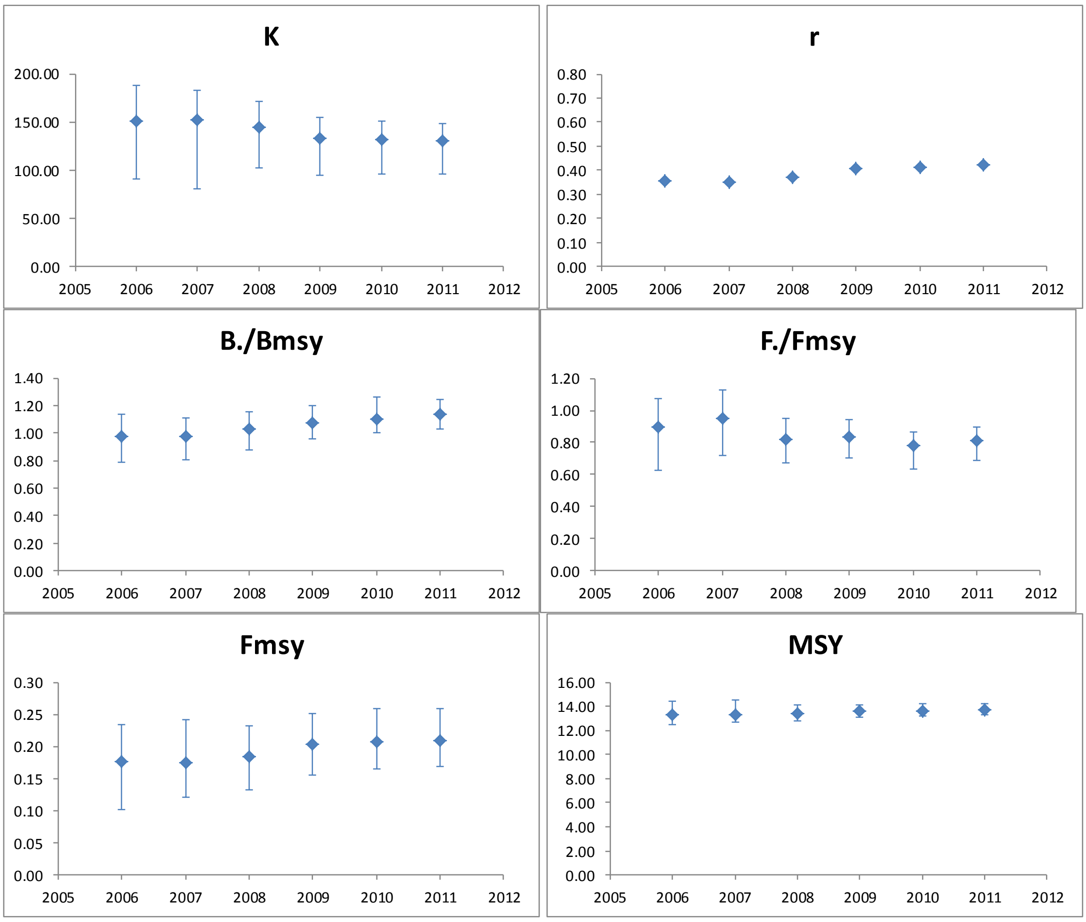


Figure 9 Point estimates of K, r, B/B_{MSY}, F/F_{MSY}, F_{MSY} and MSY resulting from a retrospective analysis of the North Atlantic swordfish ASPIC model.

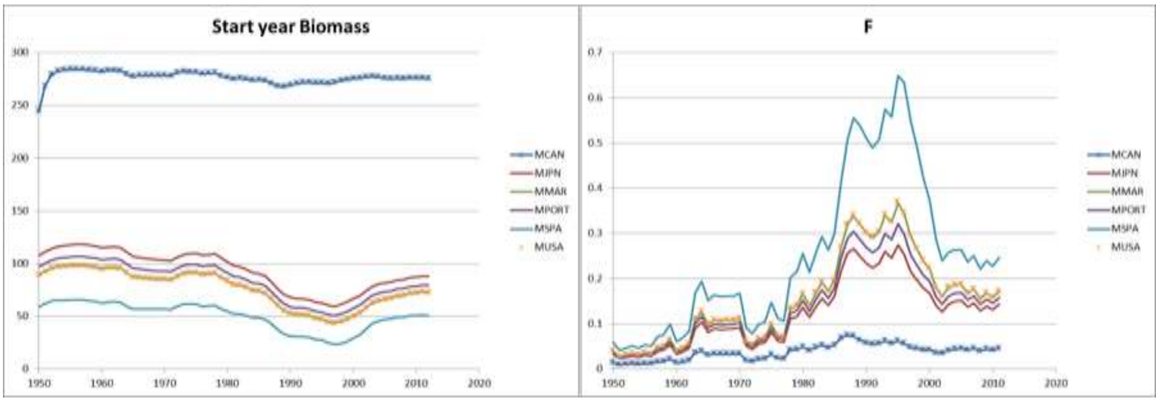


Figure 10 N-SWO Jackknife diagnostics. Trends of biomass (start of year) and fishing mortality estimated when a particular index of abundance was removed from the input of the ASPIC model (run 6). The legend indicates the particular index removed from each run.

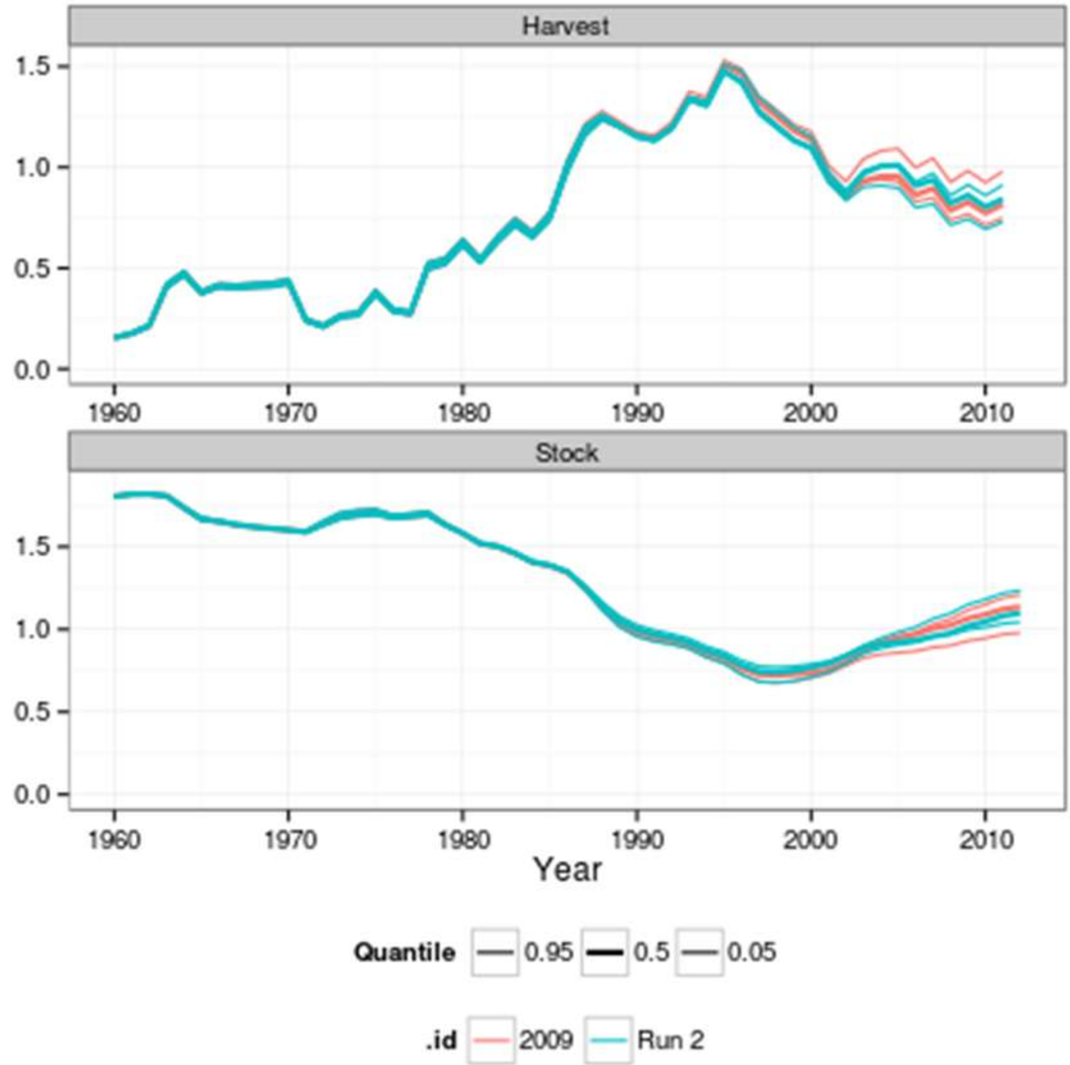


Figure 11 Quality control plot of relative fishing mortality (top) and relative biomass (bottom) trajectories for the 2009 base case model (red) and 2013 base case model (run2) and current 1963-2011 catch data. The lines show the median and the 5th and 95th percentiles.

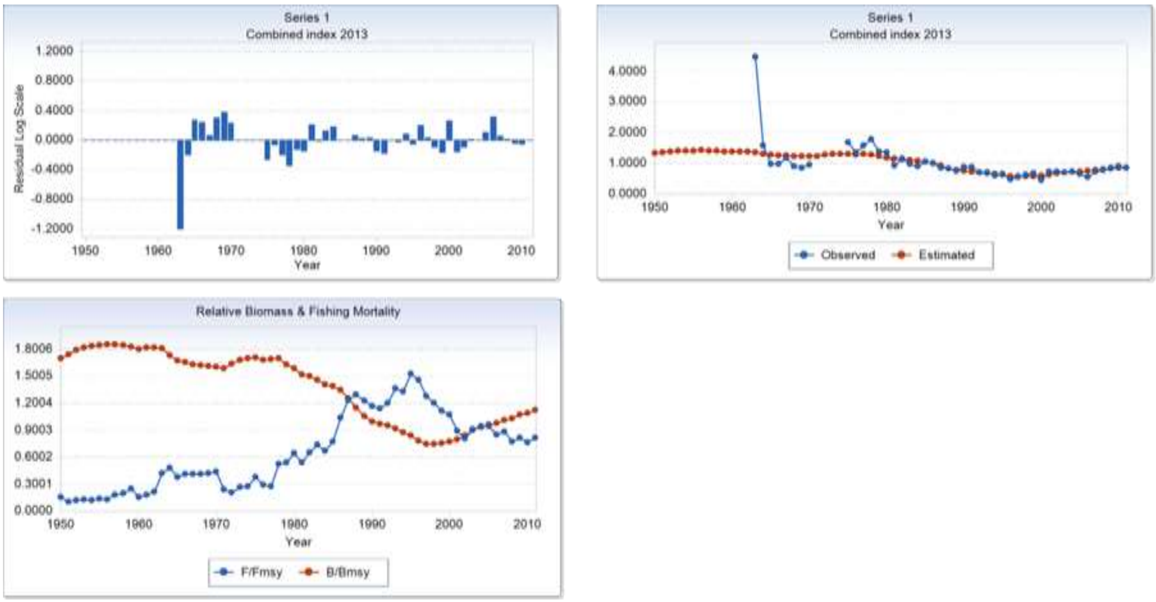


Figure 12 N-SWO ASPIC results Base Run2 model. Combined biomass index residuals (top left) and predicted index (right) and the relative annual trends of biomass (B/B_{MSY}) and fishing mortality (F/F_{MSY}) 1950-2011.

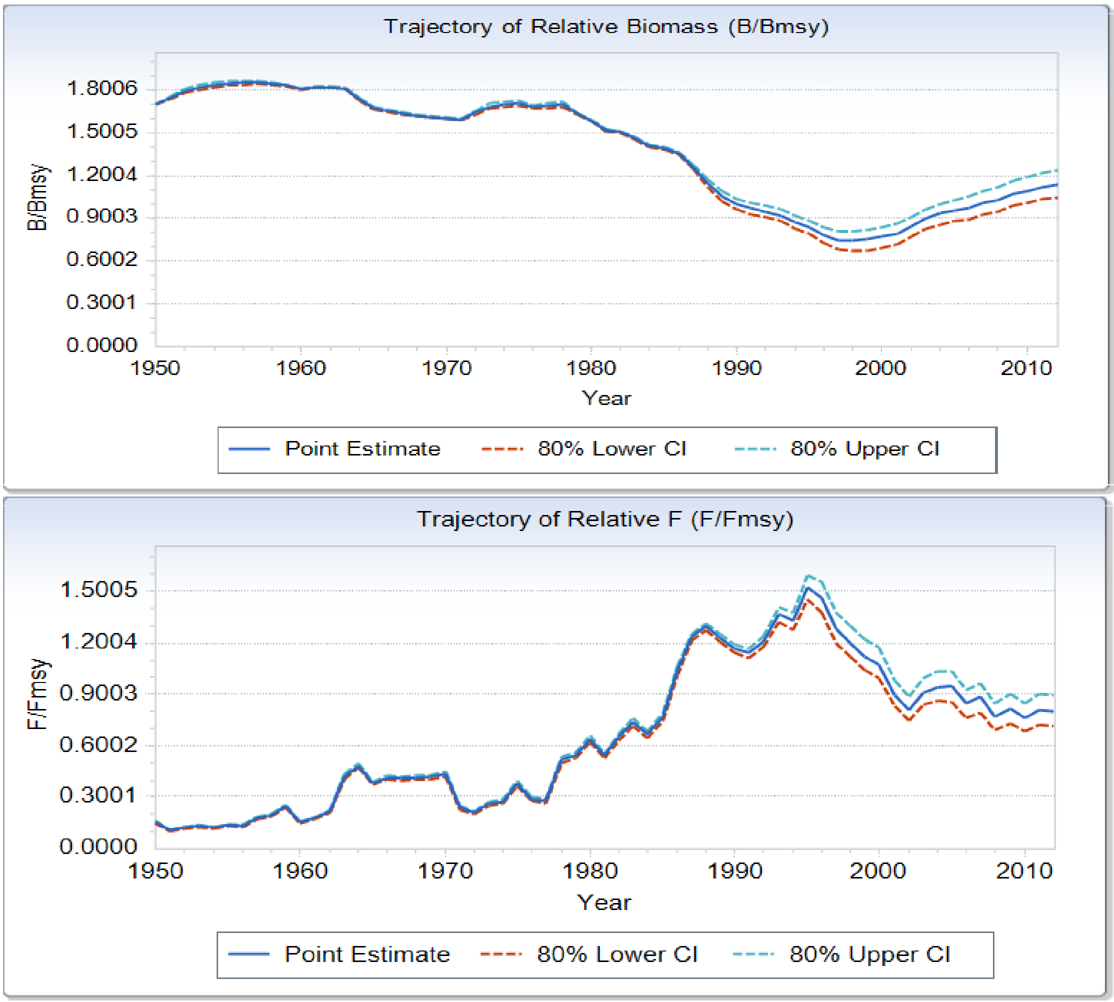


Figure 13 Trends in North Atlantic swordfish relative biomass (top) and fishing mortality (bottom) point estimates from the ASPIC base case (run2) model.

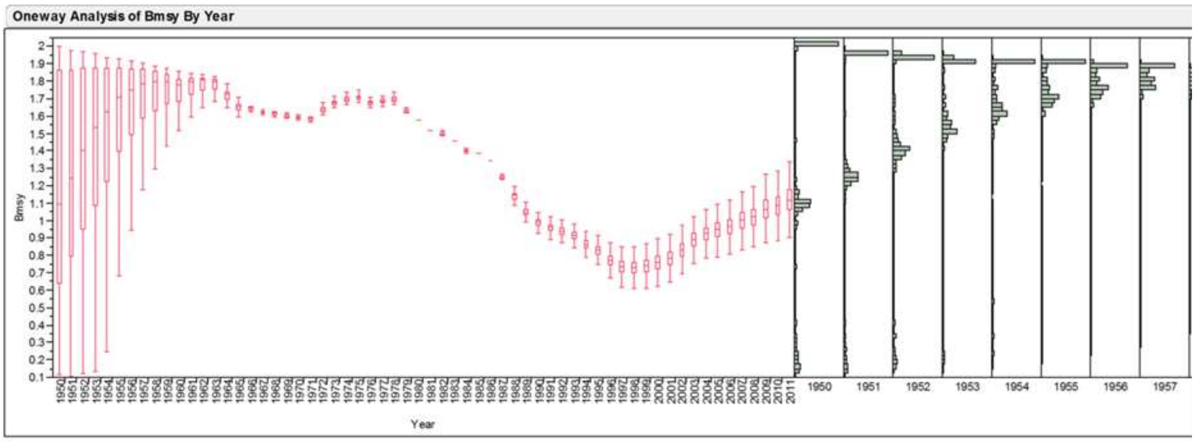


Figure 14 N-SWO. Distribution of bootstrap runs for the ASPIC base run model (run2) when estimating B_1/K. The right plot shows the box plots of 1000 boots and the left the corresponding histograms.

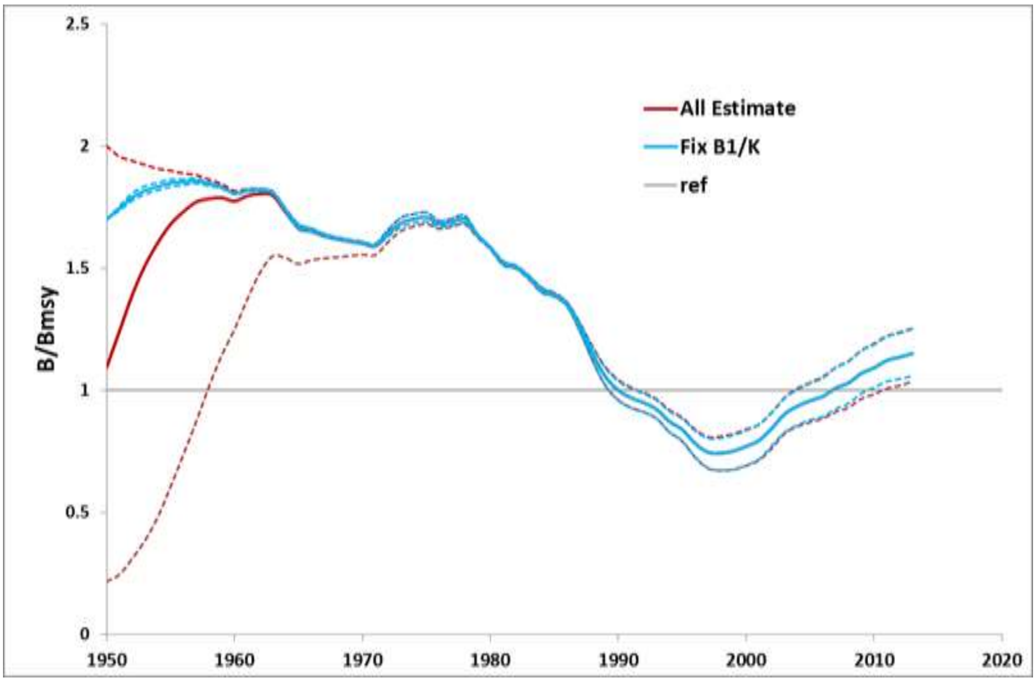


Figure 15 N-SWO. Annual trends of relative biomass (B/B_{MSY}) with 80% estimated confidence bounds for the base case model with either estimating (run2) all initial parameters (B_1/K, K, MSY, q) or fixing B_1/K at 0.875 (run2).

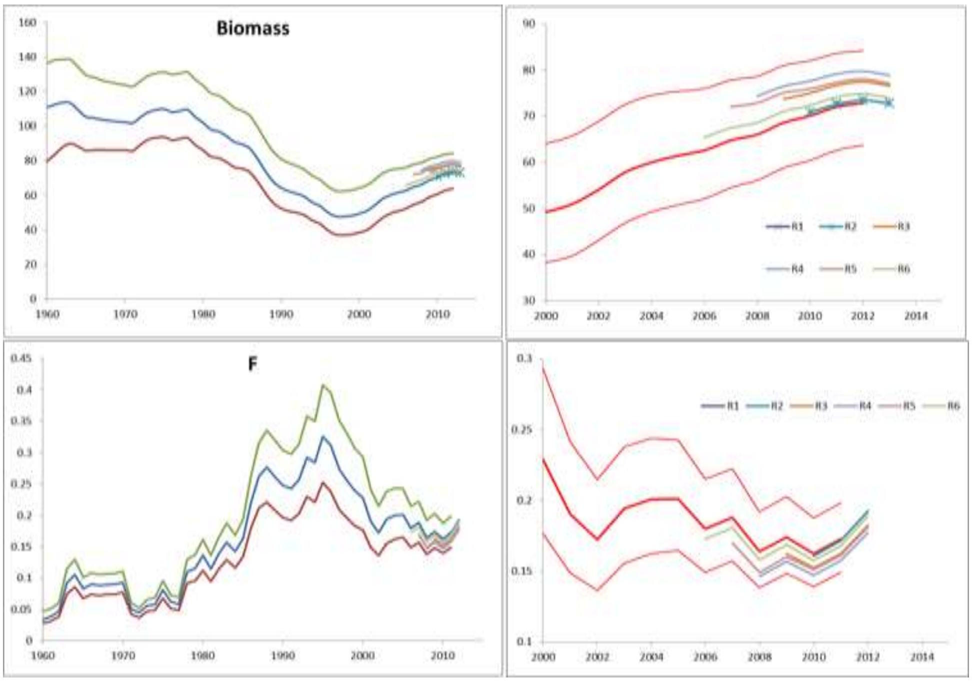


Figure 16 N-SWO. Cross-check validation run as projected from the retrospective scenarios using the known catch (Task I). Upper and lower curves represent 80% confidence bounds.

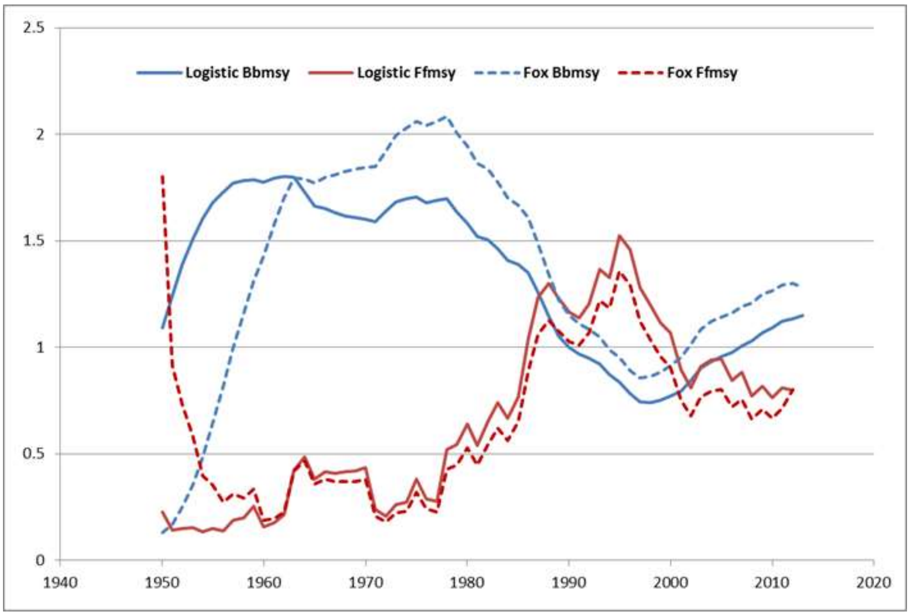


Figure 17 N-SWO. Relative trends in biomass (B/B_{MSY}) and fishing mortality (F/F_{MSY}) estimated by the Logistic (ASPIC base case run2) and the Fox surplus production model (ASPIC run3).

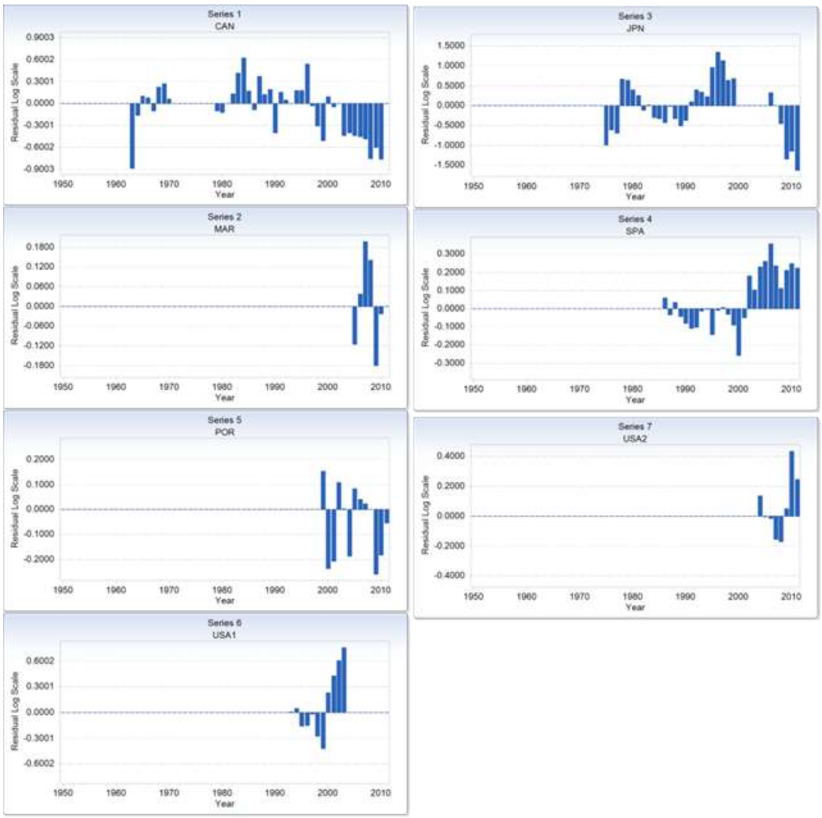


Figure 18 N-SWO Diagnostic plots. An example of the residual patterns for the indices of abundance by fleet predicted by the ASPIC SPM run 5.

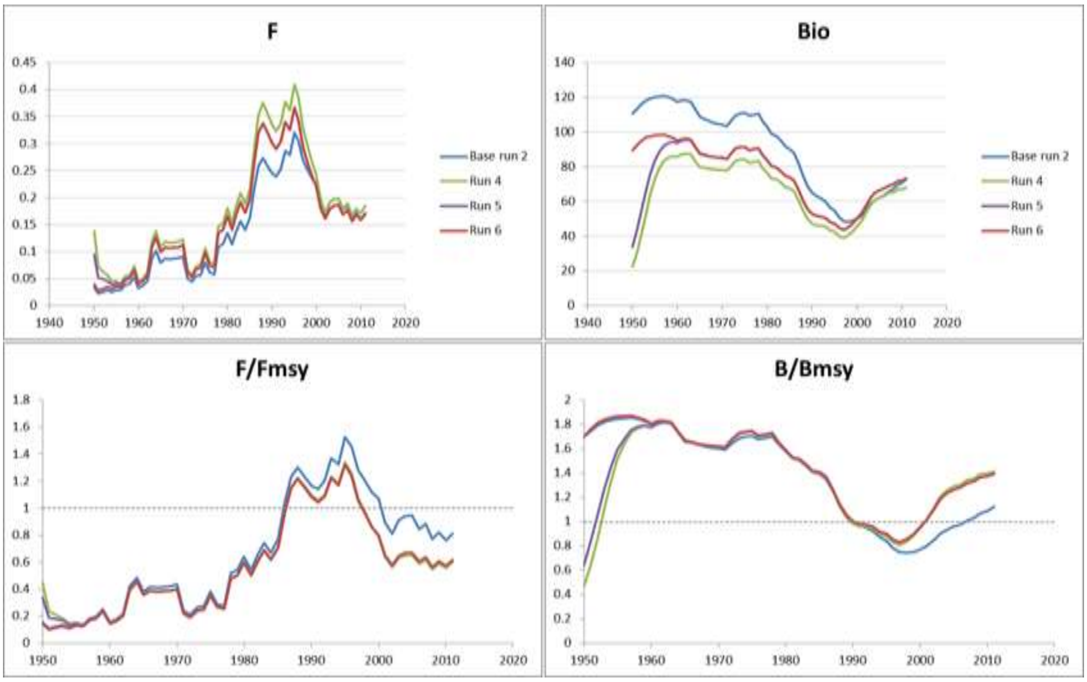


Figure 19 N-SWO Trends in fishing mortality, total biomass, relative F and relative biomass for the base case (run2) and runs with multiple indices of abundance (runs 4 to 6) from a Surplus Production Model for north Atlantic swordfish.

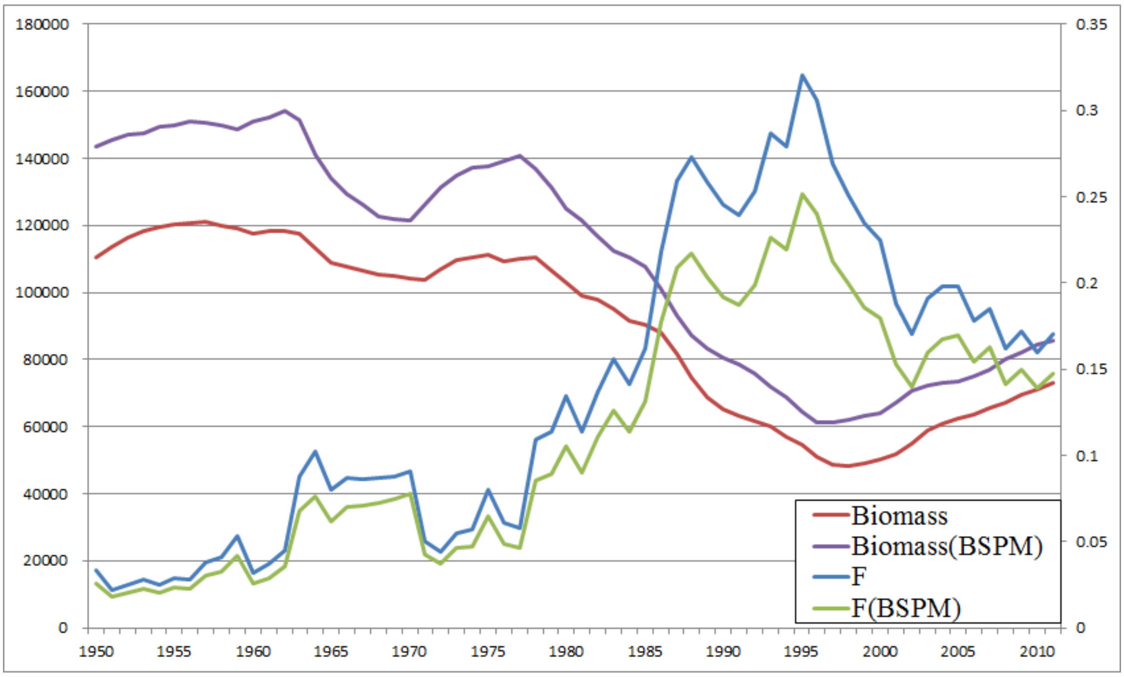


Figure 20 Trends in North Atlantic swordfish absolute biomass and fishing mortality estimates from the ASPIC base case (run2) and BSP2 reference case (run1) models.

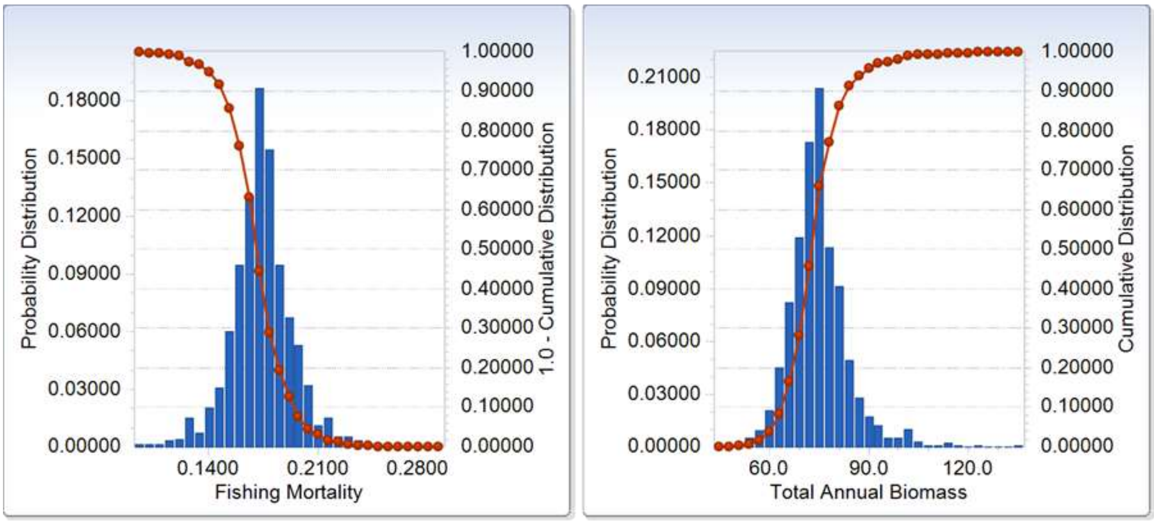


Figure 21 Histograms of predicted absolute fishing mortality (2011) and total biomass (start 2012) from the north Atlantic swordfish ASPIC base case run2 model.

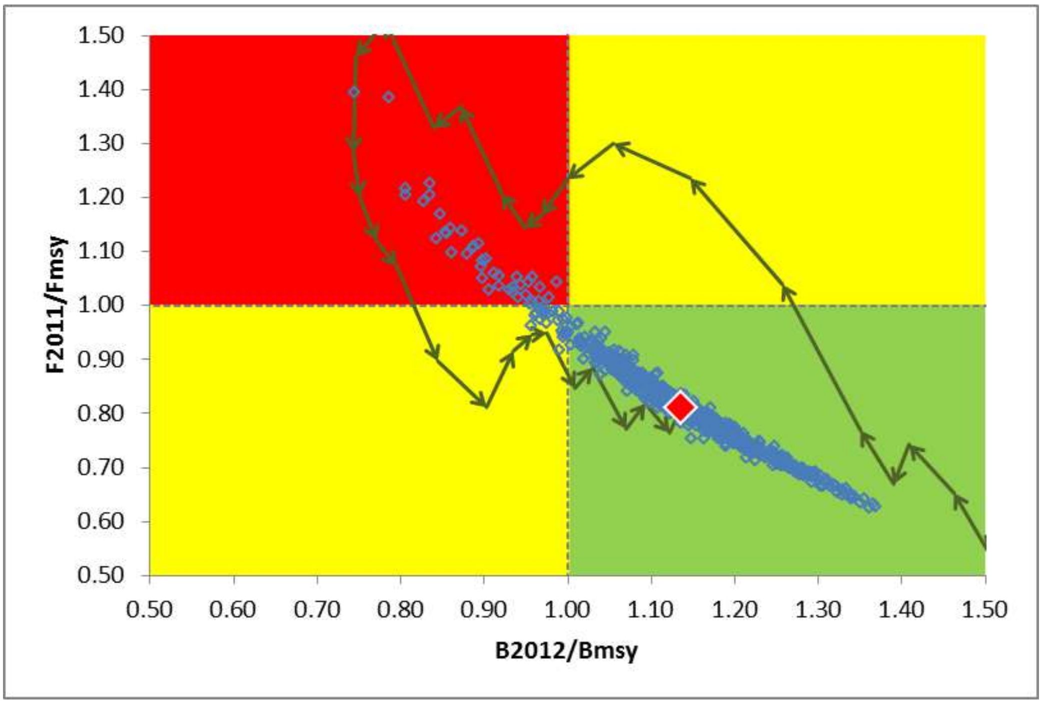


Figure 22 N-SWO Kobe plot for north Atlantic swordfish status at the start of 2012. Points show the results from 1000 bootstrap runs, solid diamond the estimated median point and the solid line the track of the stock status since 1950. (ASPIC base case north run2).

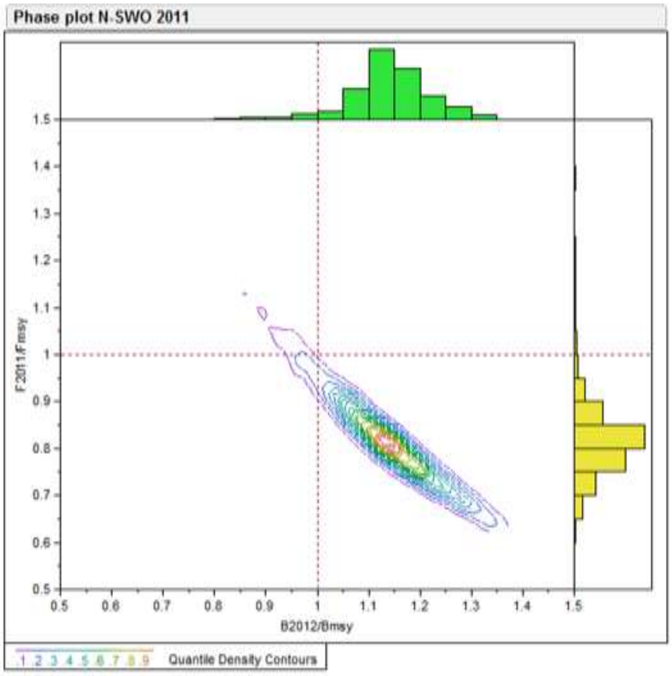


Figure 23 N-SWO A phase plot of relative biomass and fishing mortality from the ASPIC base model (run2). Areas depict the estimated non parametric quantile density contours (by 0.05 increments) of 1000 bootstrapped runs. Histograms show the marginal distribution for each variable.

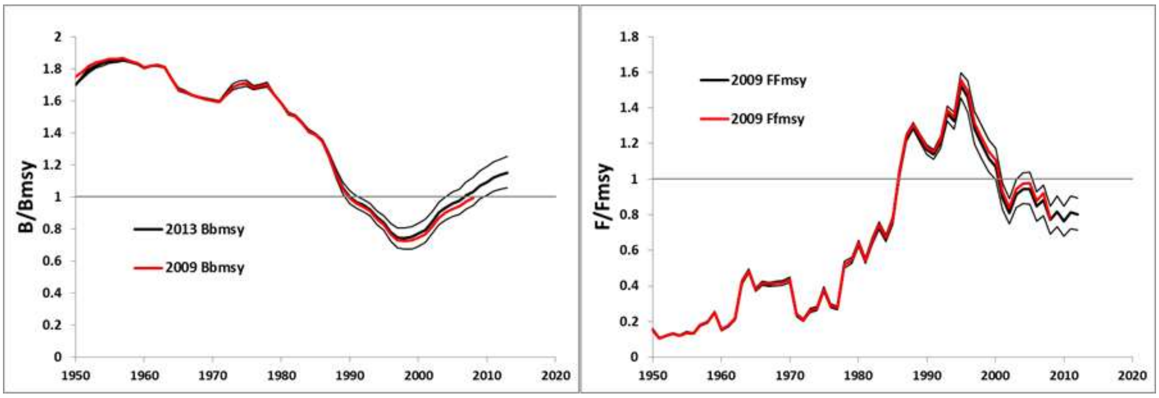


Figure 24 N-SWO. A comparison of the relative biomass (left) and fishing mortality (right) estimated by the base case models in 2009 and 2013 assessments. Thin lines indicate the 80% confidence bounds for the 2013 estimates.

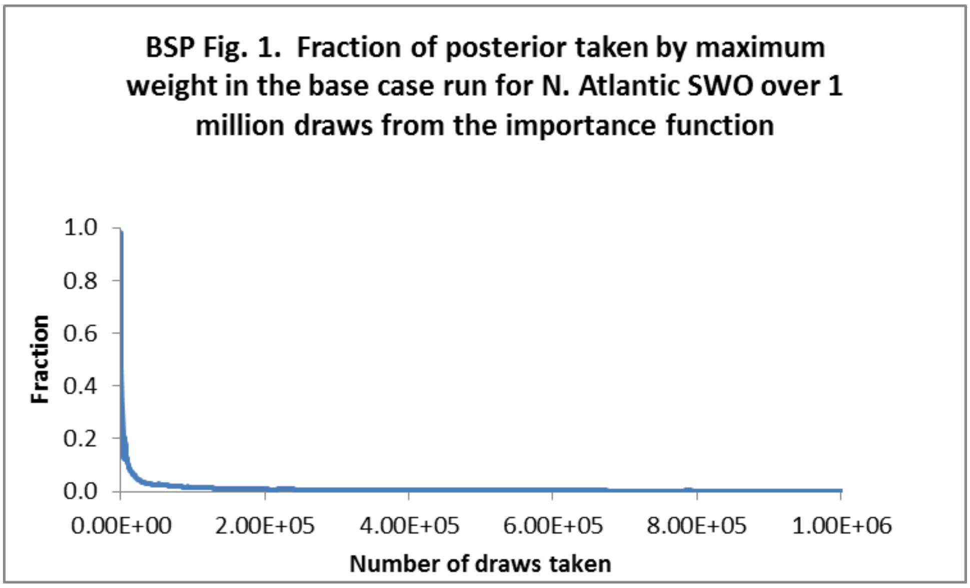
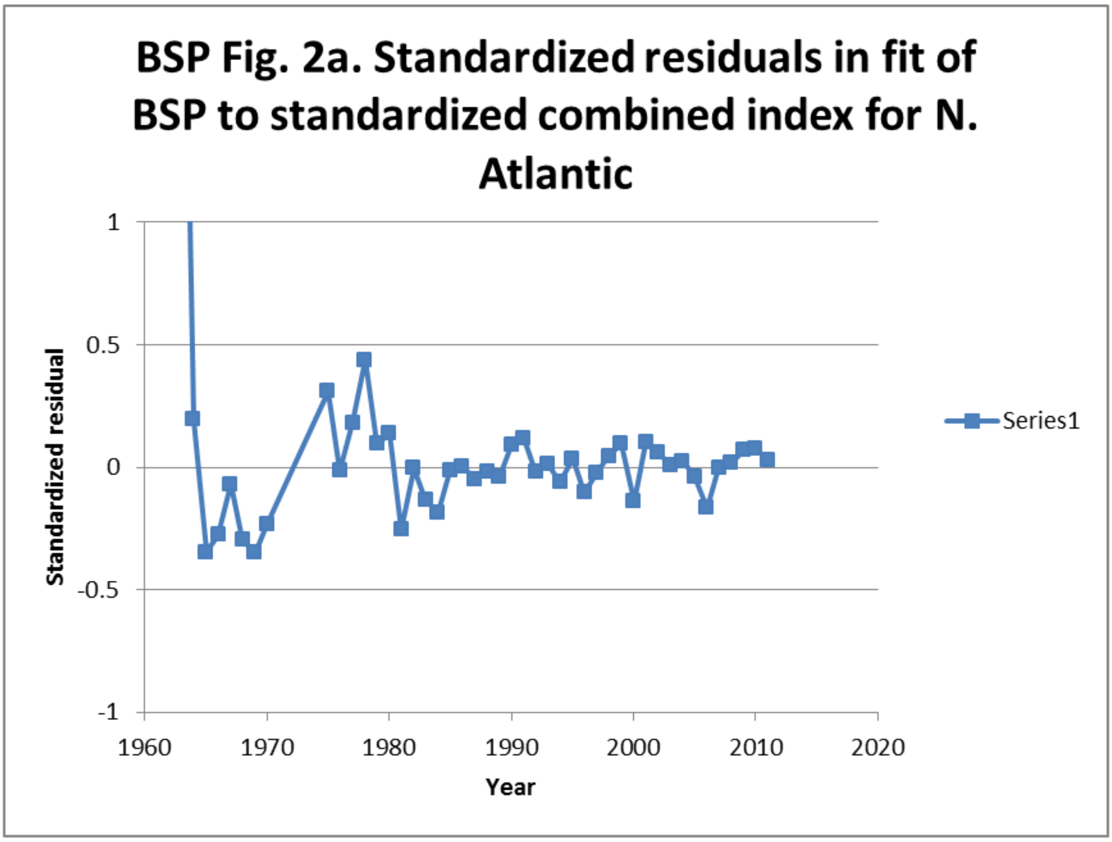


Figure 25 Plot of the fraction of the posterior taken by the maximum weight drawn in the base case BSP run for North Altantic swordfish.



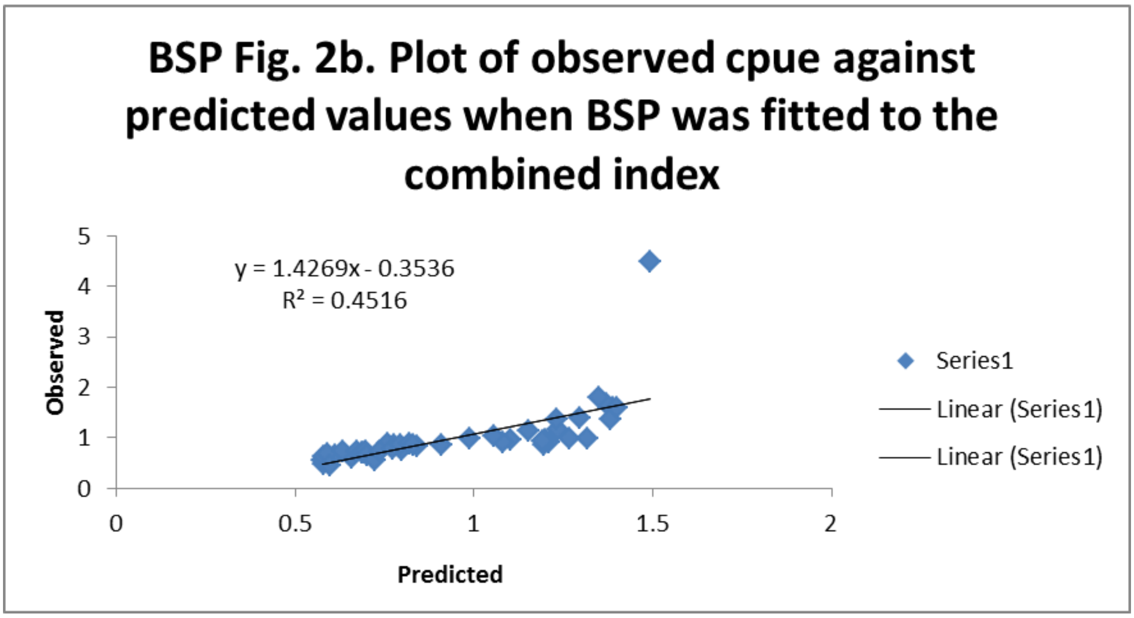


Figure 26. Plots of a. residuals for the by flag CPUE data, and b. observed versus predicted SPUE with the BSP model run R.S applied to North Atlantic swordfish.

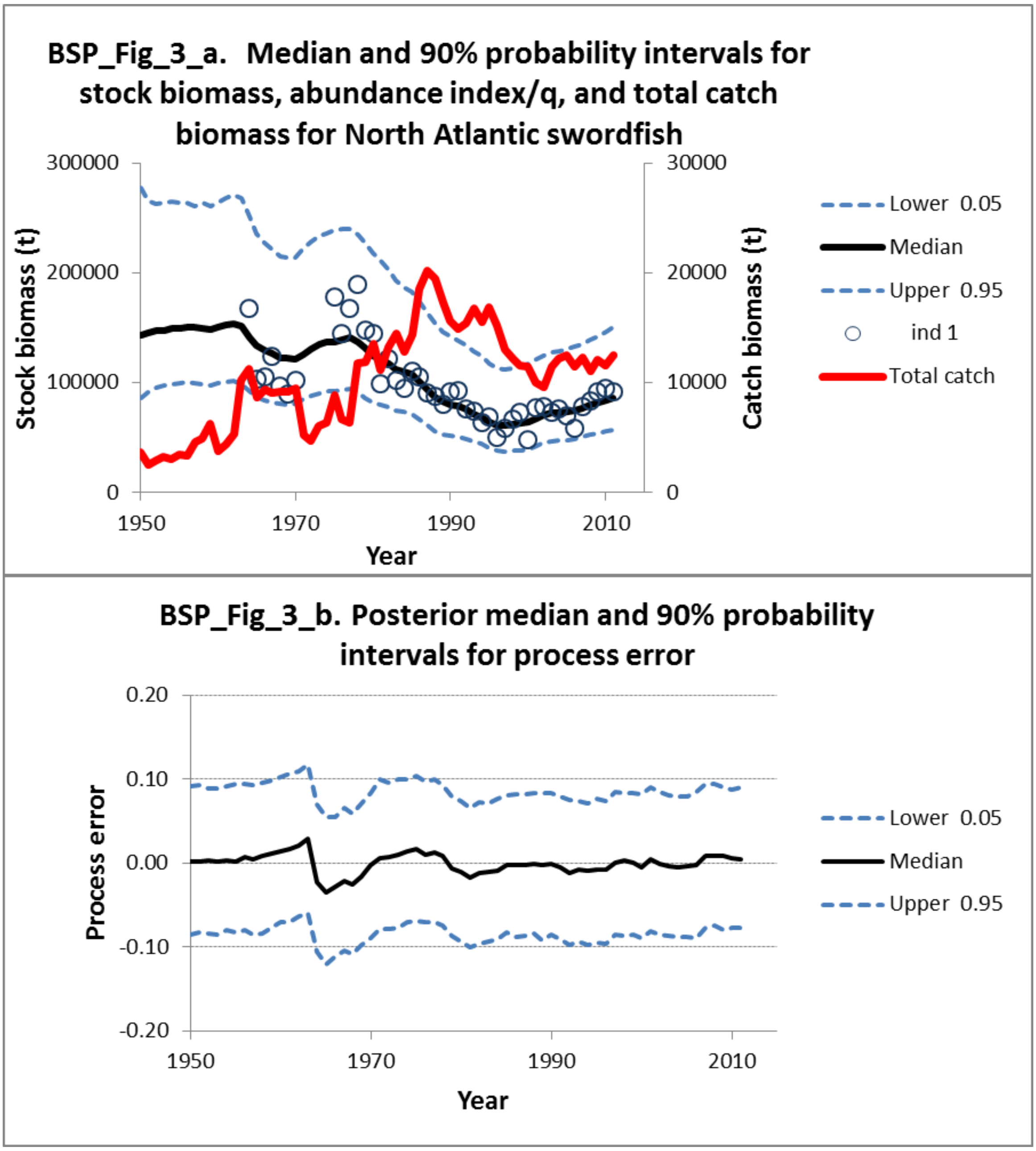


Figure 27 a. Plots of estimated swordfish stock biomass and b. process error deviates for the reference case BSP model (R.N) application to the combined CPUE index in the North Atlantic Ocean.

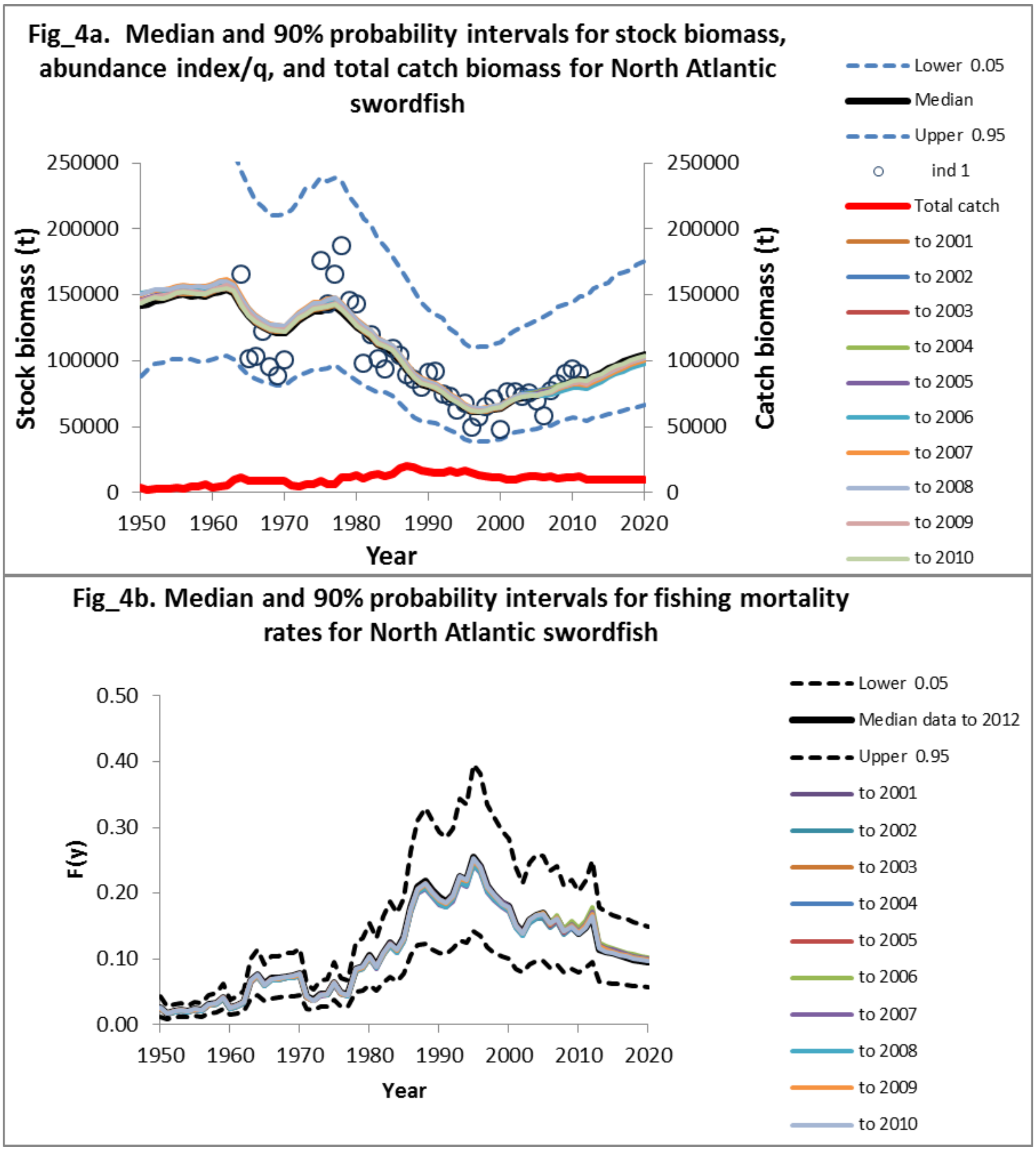


Figure 28 Plots of a. stock biomass and b. fishing mortality rate estimates and predictions from a retrospective cross-validation analysis with the BSP model runs for North Atlantic swordfish.

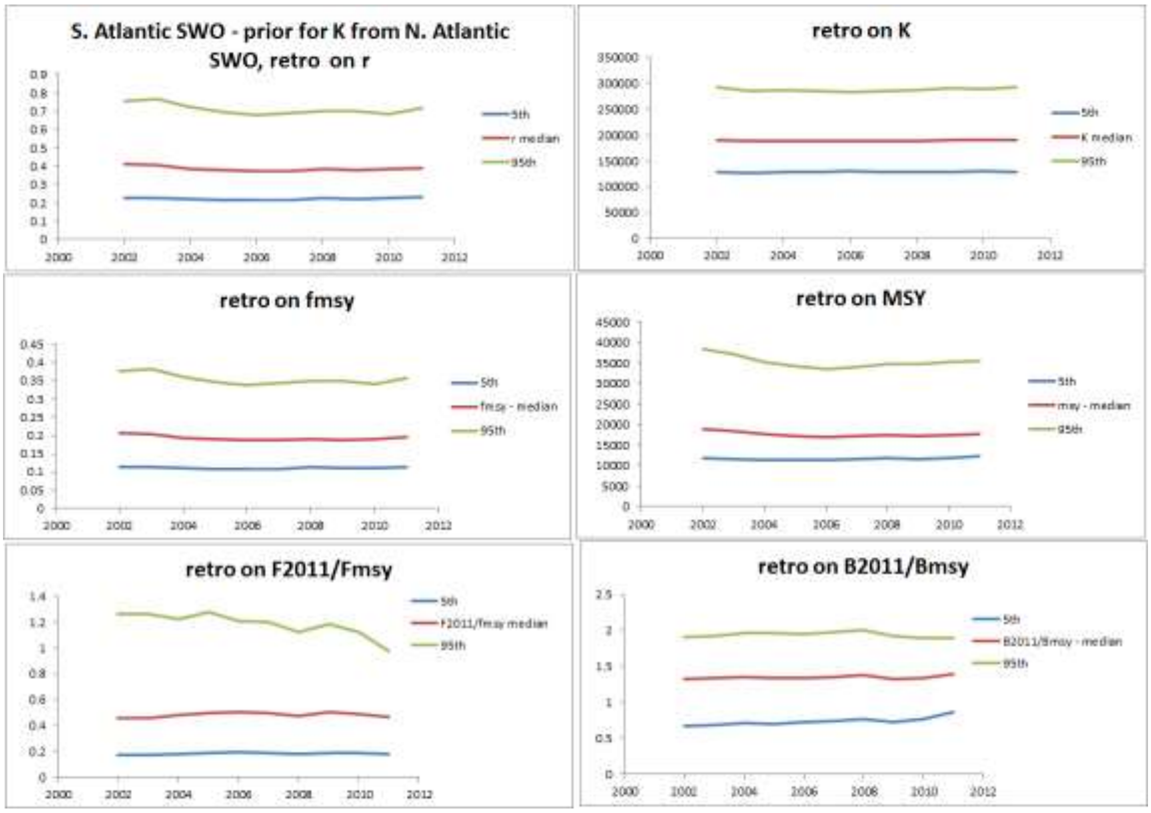


Figure 29. Point estimates of K, r, B/B_{MSY}, F/F_{MSY}, F_{MSY} and MSY resulting from a retrospective analysis of the North Atlantic swordfish BSP2 reference case (runR.N).

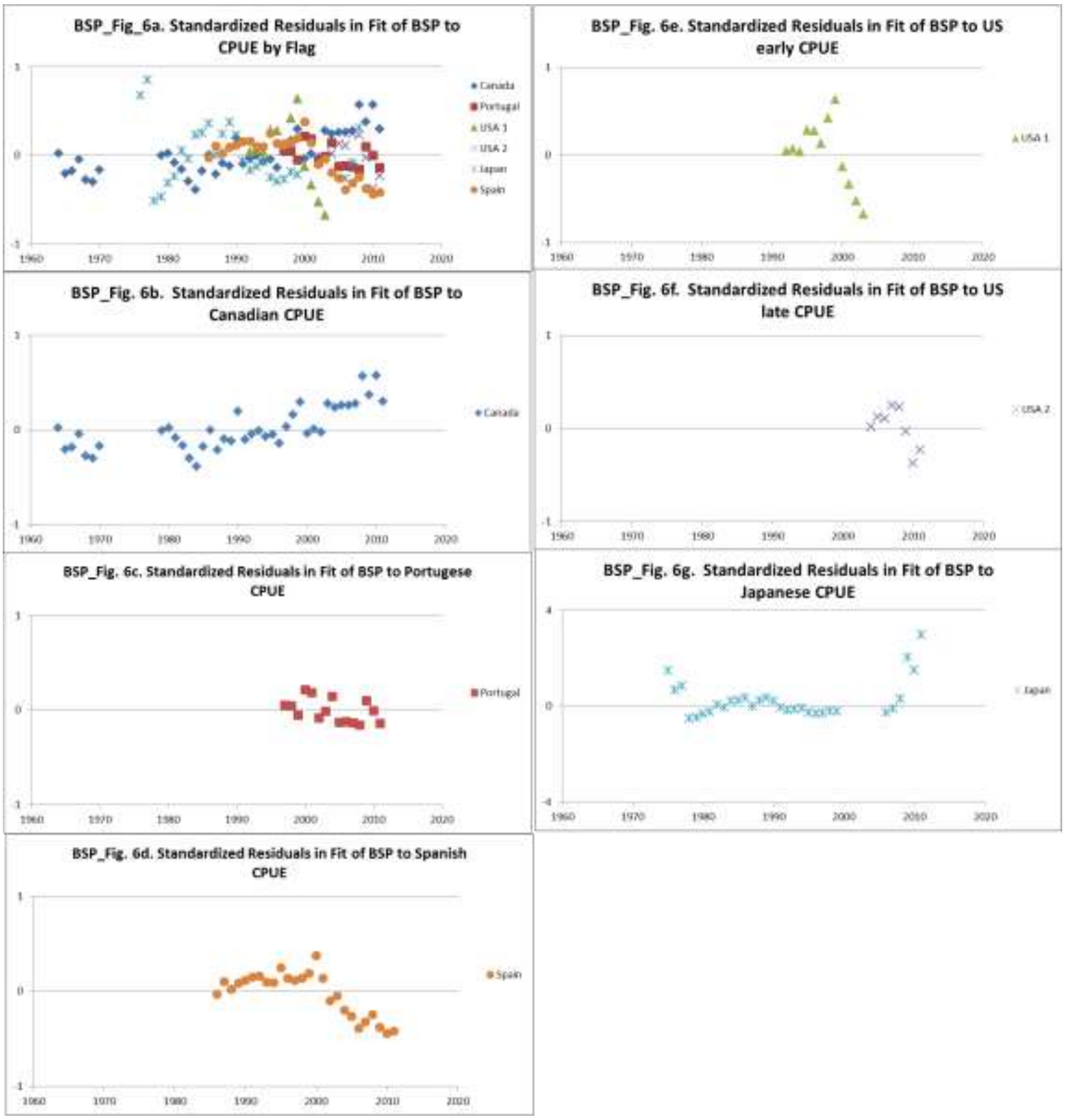


Figure 30 Standardized residuals plotted against year for the fit of the BSP model to the cpue indices by flag for North Atlantic Swordfish.

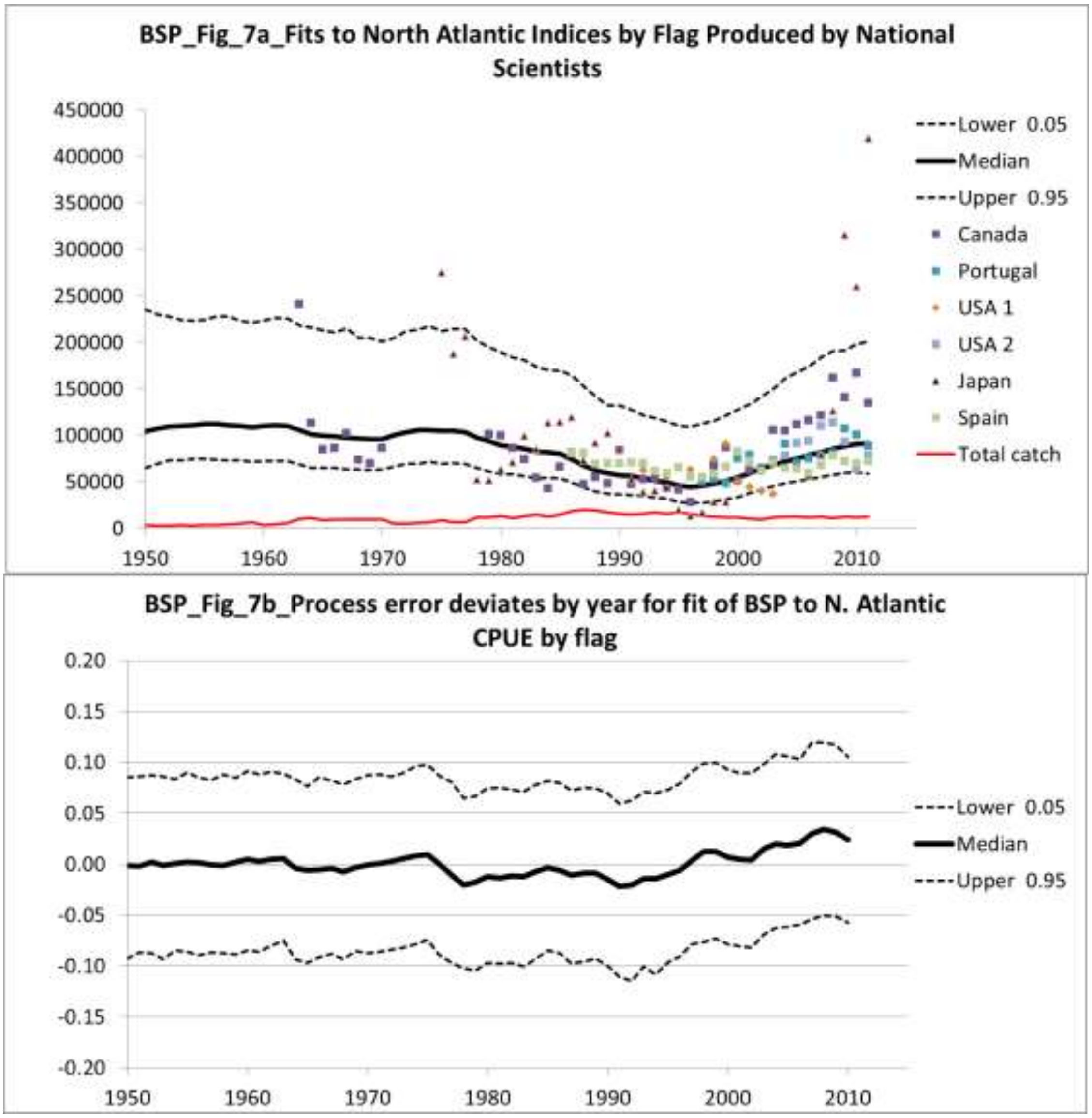


Figure 31 Plots of a) the fit of the BSP model to the standardized cpue data by flag and b) the associated annual process error deviates.

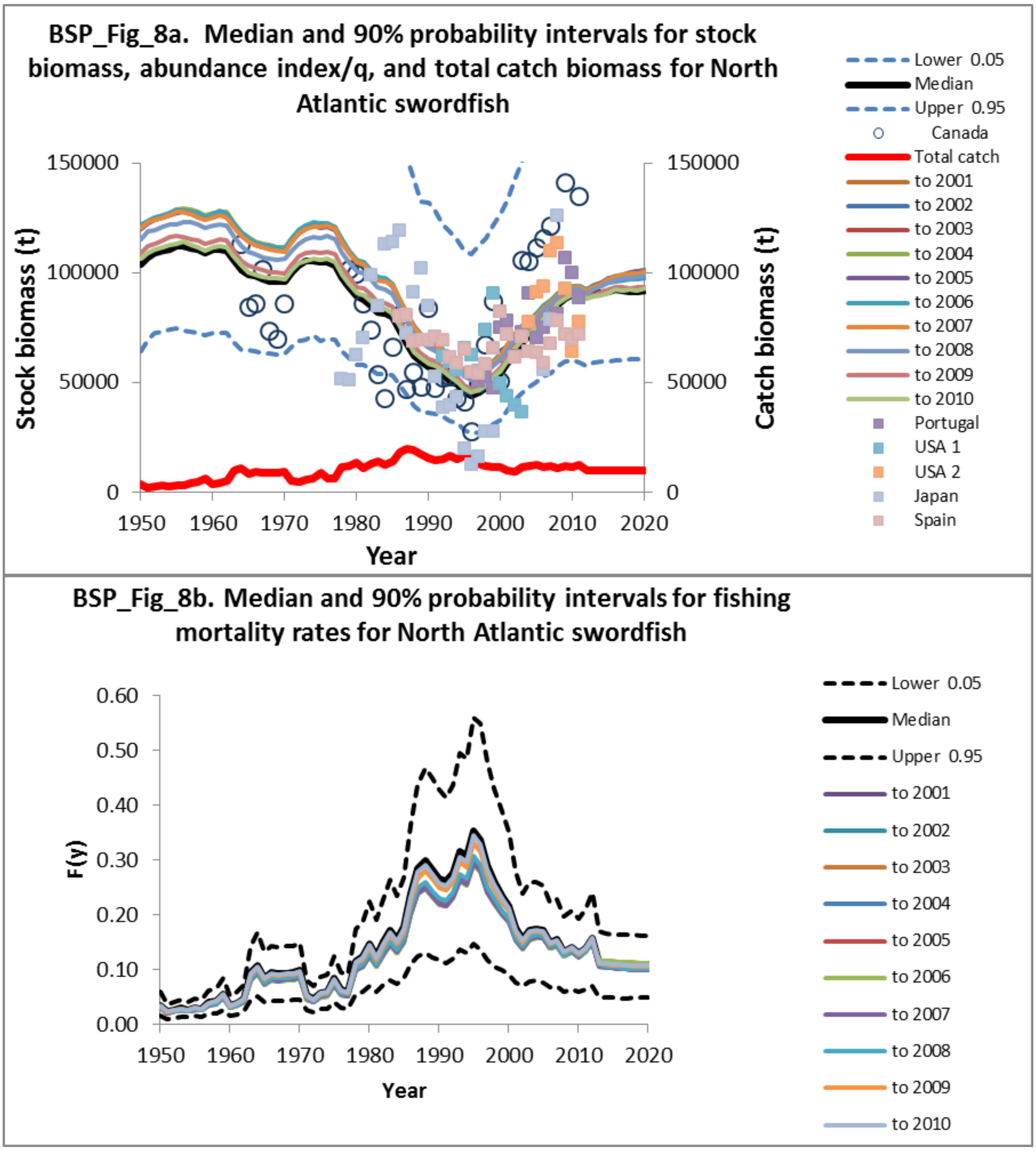


Figure 32 Stock biomass and b. fishing mortality rate estimate trajectories from a retrospective – cross validation analysis with the fitting of BSP to the cpue data by flag with equal weighting (run C.1) for North Atlantic swordfish.

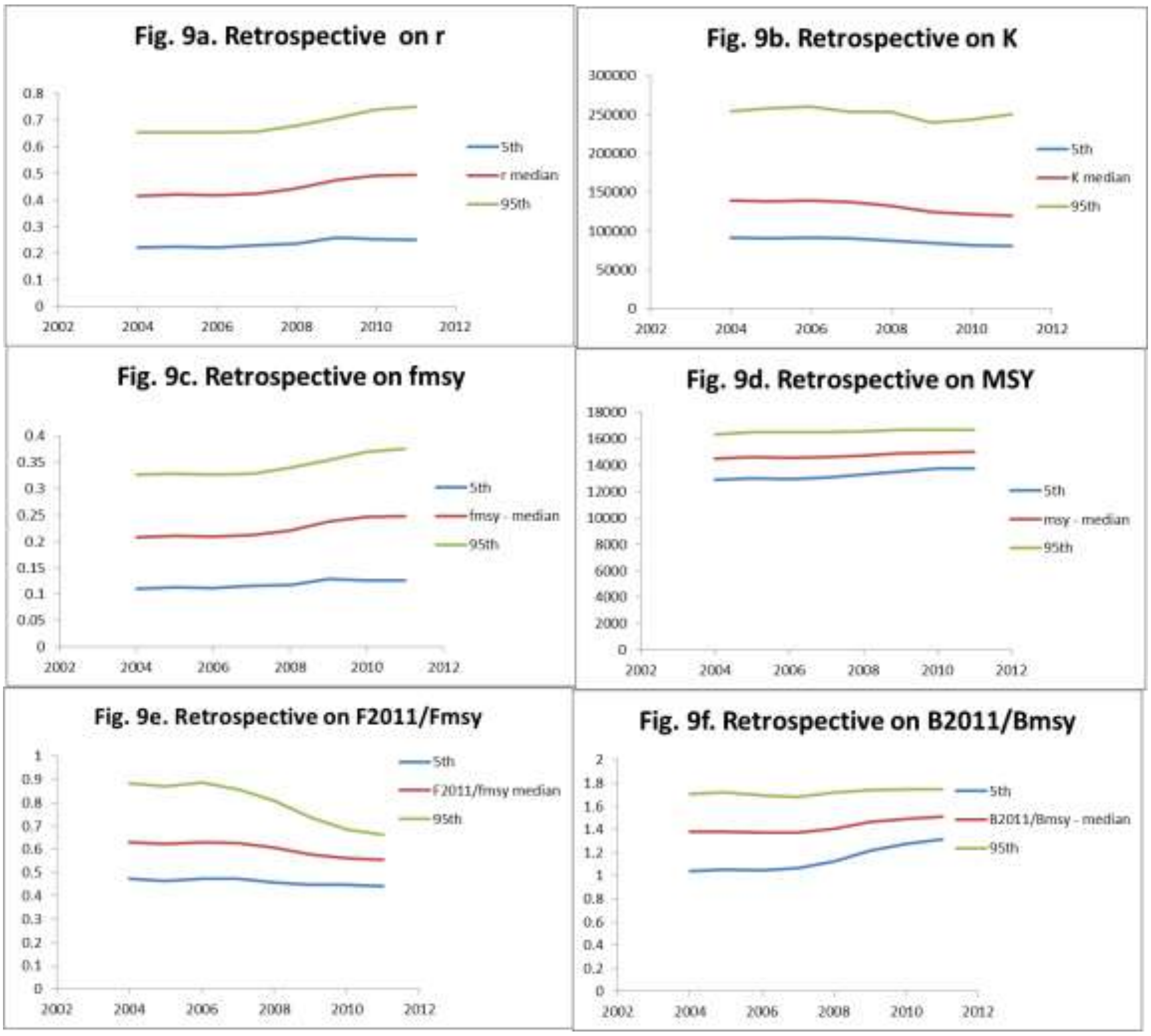


Figure 33 Plots of retrospective patterns in estimates of a. r, b. K, c. Fmsy, d. MSY, e. F2011/F_{msy} and f. B2011/B_{msy} in the BSP model run C.1 in which BSP was fitted to cpue by flag with equal weighting to the different cpue series for North Atlantic swordfish..

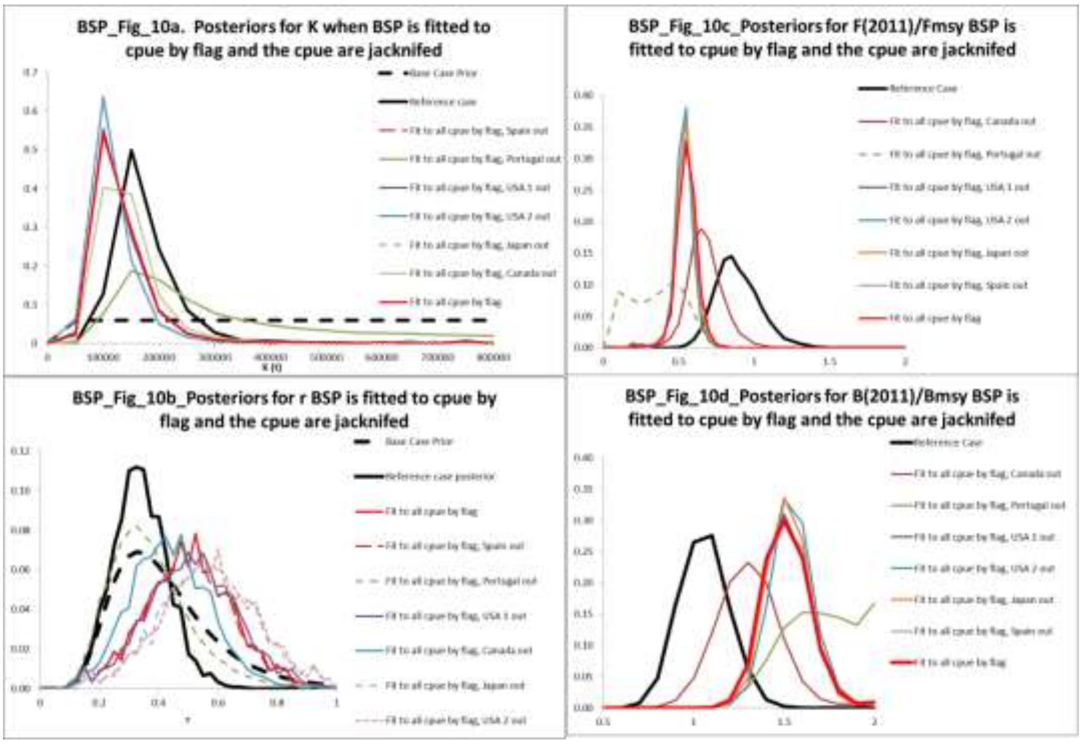


Figure 34 Marginal posteriors for a. carrying capacity (K), b. r, c. fishing mortality rate in 2011/ F_{msy}, and d. stock biomass in 2011/ B_{msy}. Diagnostic runs were carried out leaving out one cpue series at a time for North Atlantic swordfish.

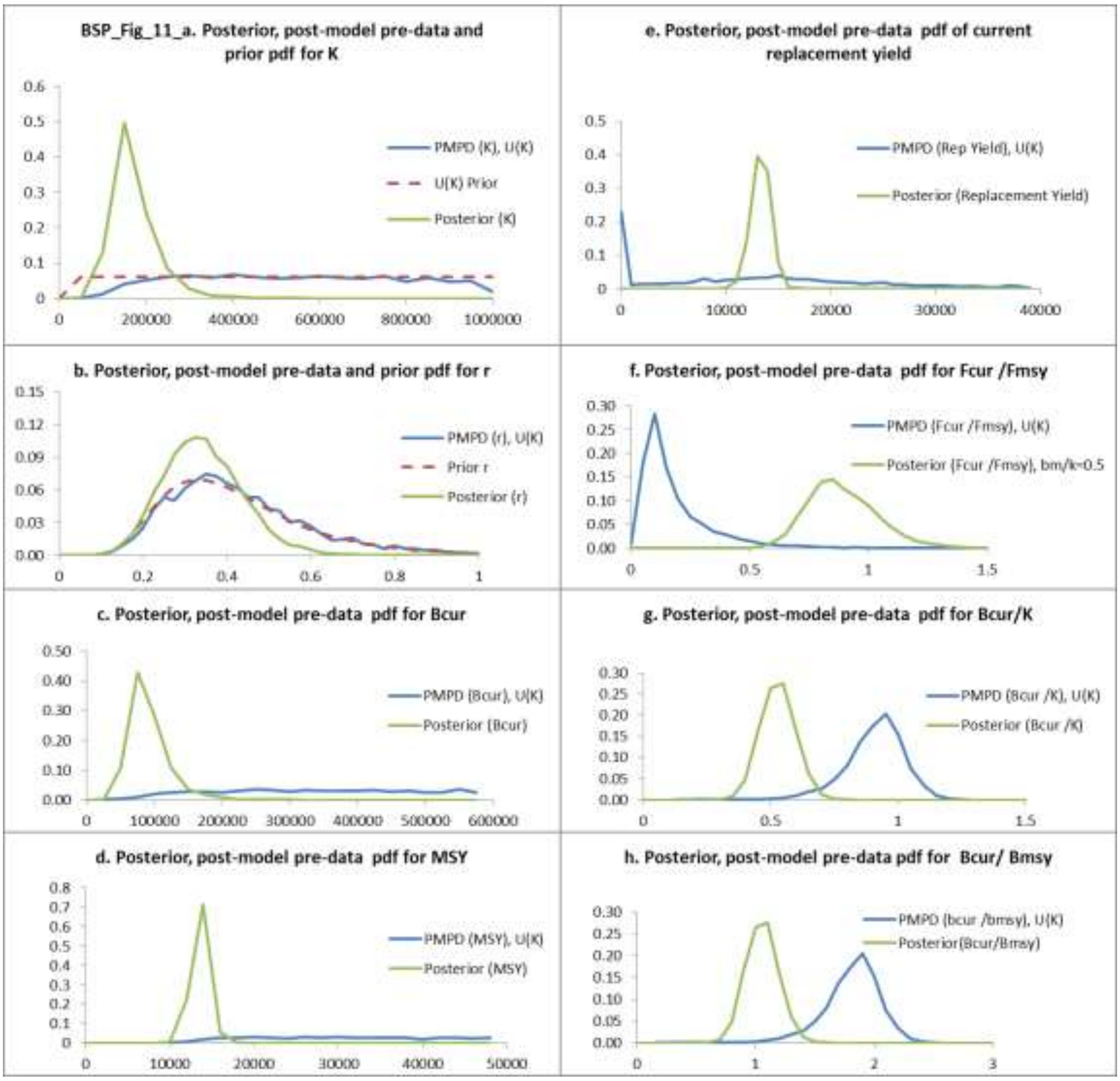


Figure 35 Marginal posterior distributions and post-model-pre-data distributions for the reference case run of BSP for North Atlantic swordfish.

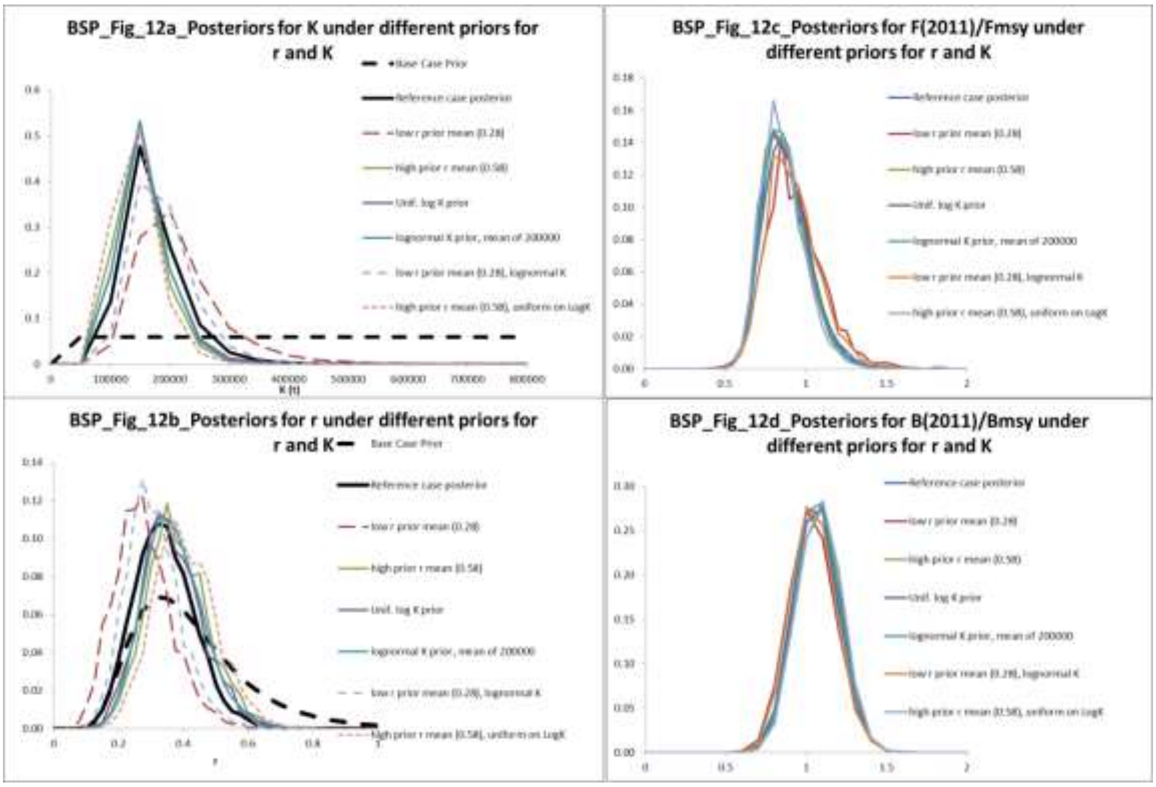


Figure 36 Marginal posterior distributions for K, r, F(2011)/Fmsy, B(2011)/$_{Bmsy}$ for North Atlantic swordfish under different priors for r and K, with the BSP model fitted to the combined index for North Atlantic swordfish.

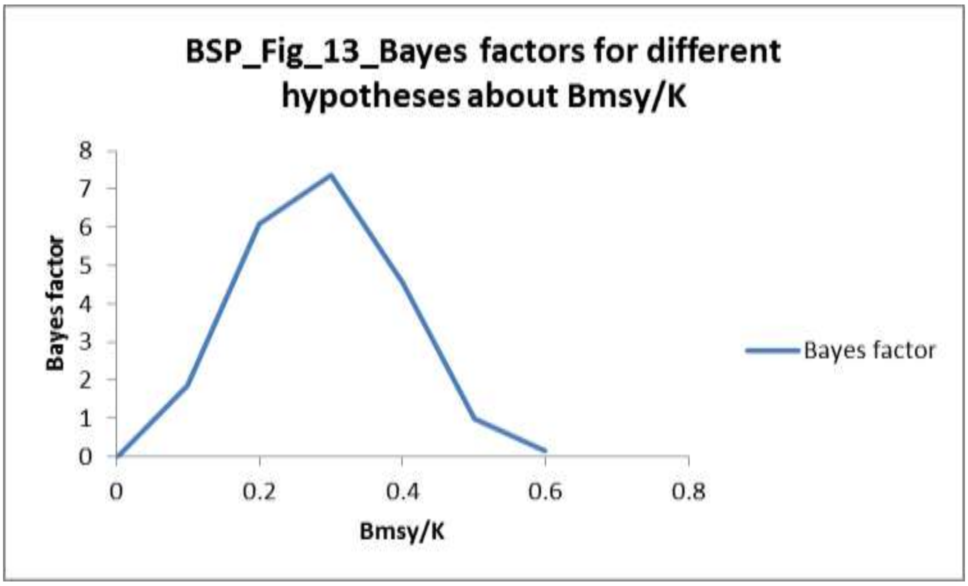


Figure 37 Bayes factors computed for the BSP model when applied to the combined index and run with values for Bmsy/K ranging from 0.1 to 0.6 (BSP runs B.1-B.5 and R.N).

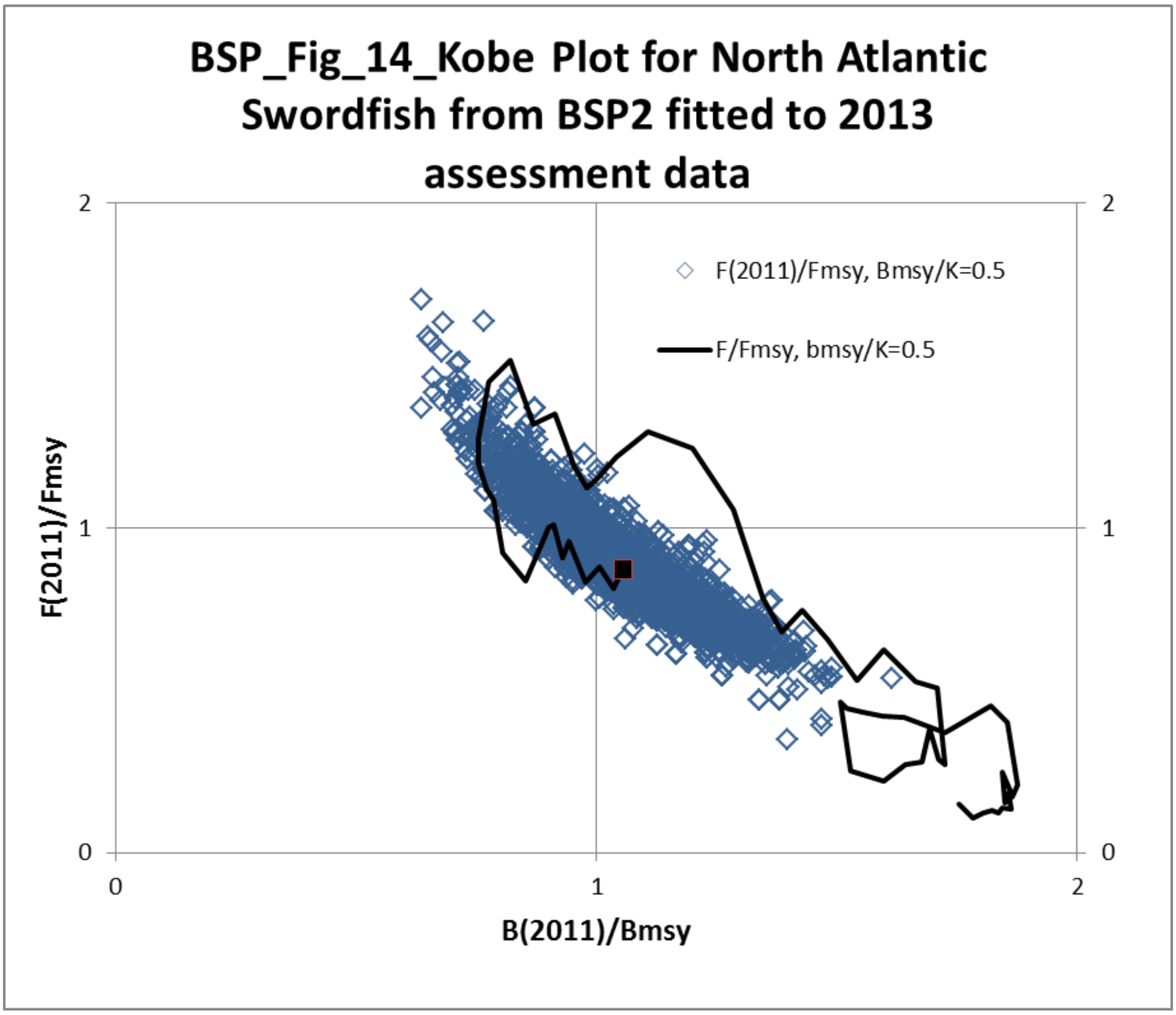
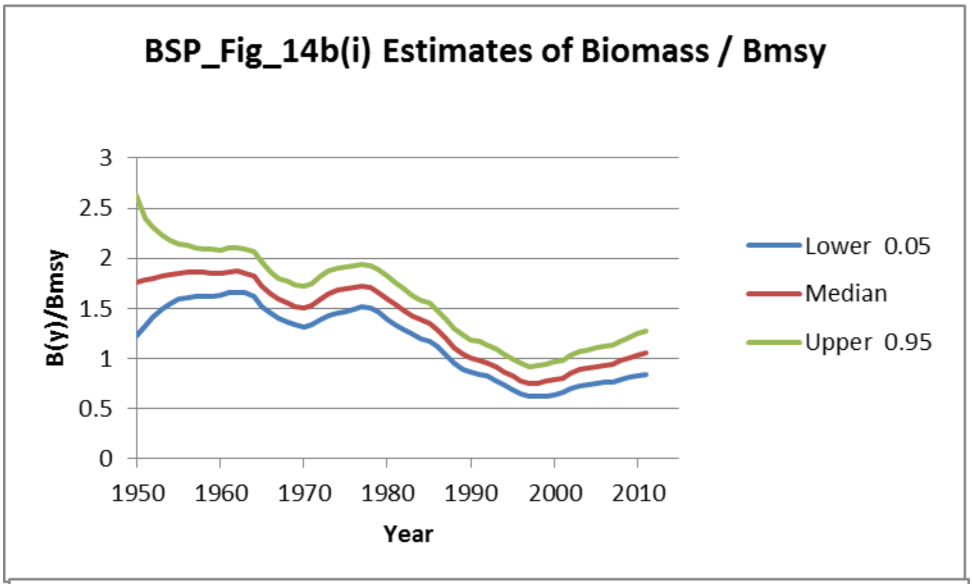


Figure 38 Kobe phase plot from fit of BSP to the combined index (run R.N) for North Atlantic swordfish.. The diamonds show individual draws from the posterior while the trajectory shows the posterior median values of F/Fmsy and B/Bmsy running from 1950-2011.



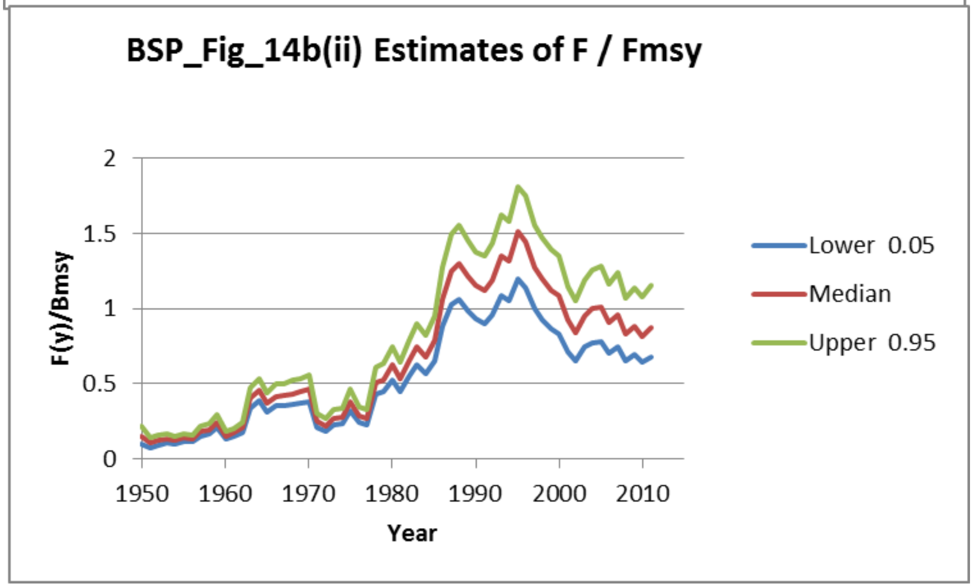


Figure 39 Plots of the ratios of i) stock biomass to Bmsy and ii) fishing mortality rate to Fmsy from the reference case BSP run for North Atlantic swordfish.

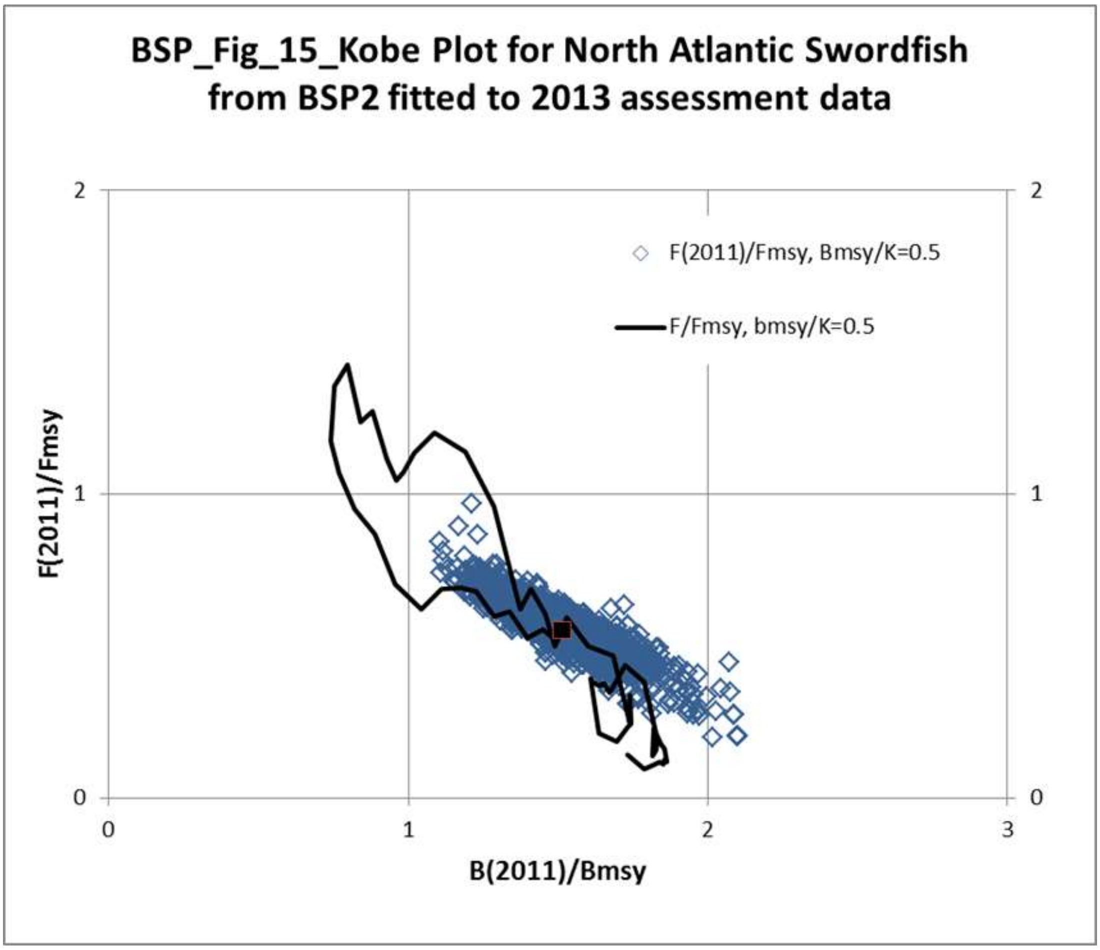


Figure 40 Kobe phase plot from fit of BSP to cpue indices by flag (run C.1) for North Atlantic swordfish.. The diamonds show individual draws from the posterior while the trajectory shows the posterior median values of F/Fmsy and B/Bmsy running from 1950-2011.

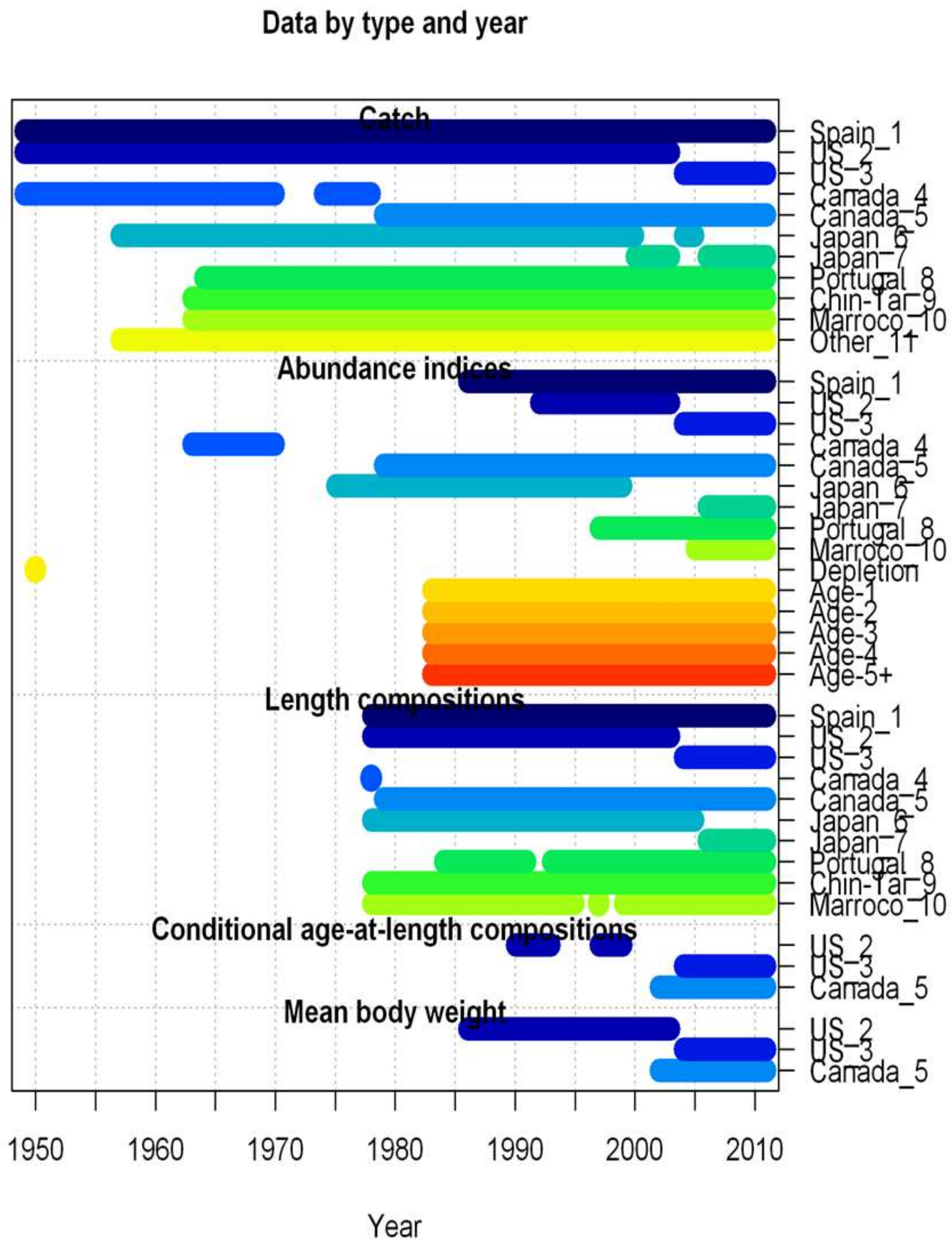


Figure 41 Data type and year used in the northern Swordfish SS model.

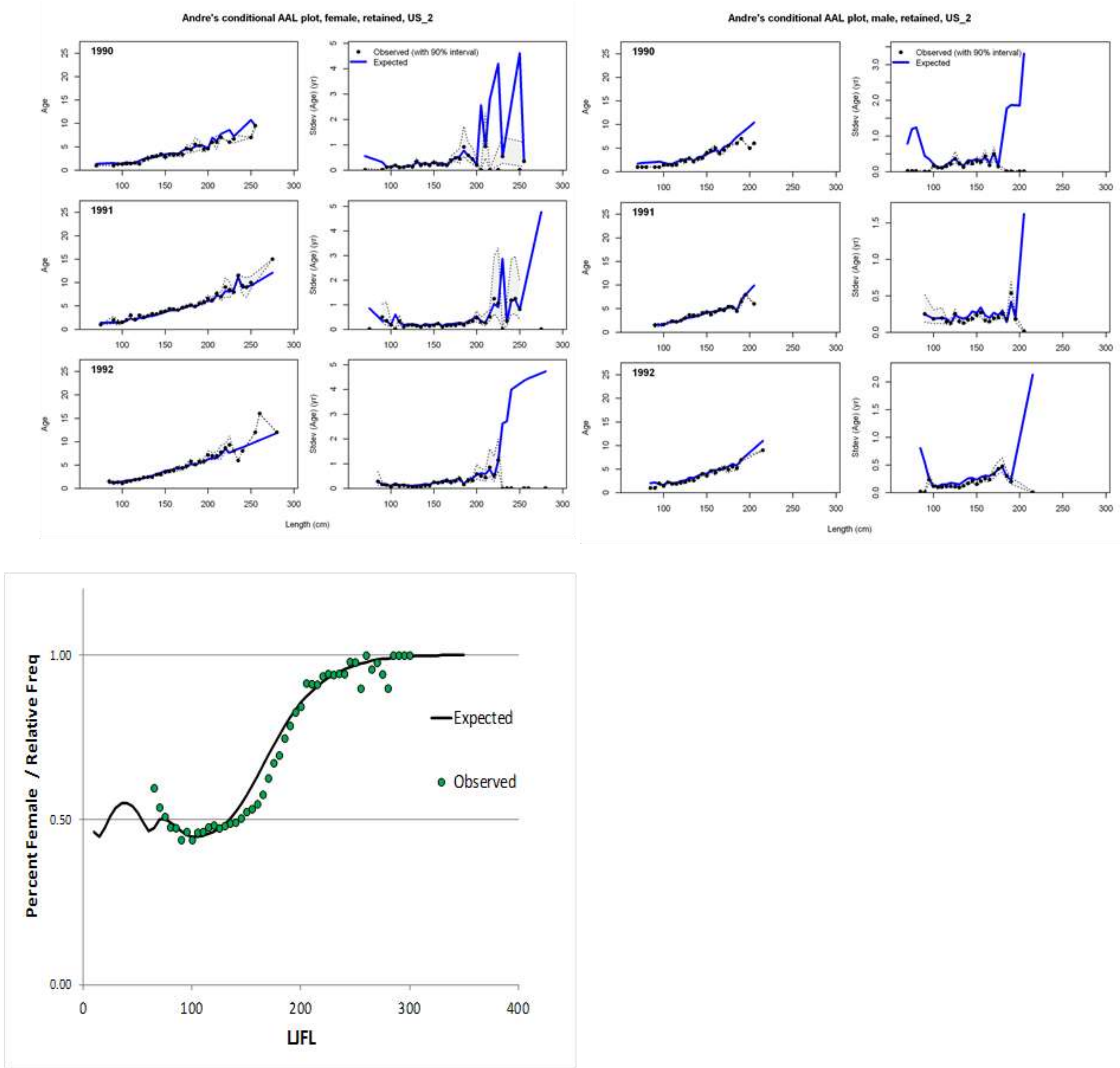


Figure 42 Observed and fitted size at age for female (upper left) and male (upper right) with associated standard deviations; and the expected (line) and observed (dots) sex ratio as observed from the US observer data (bottom) for the northern Swordfish 2011.

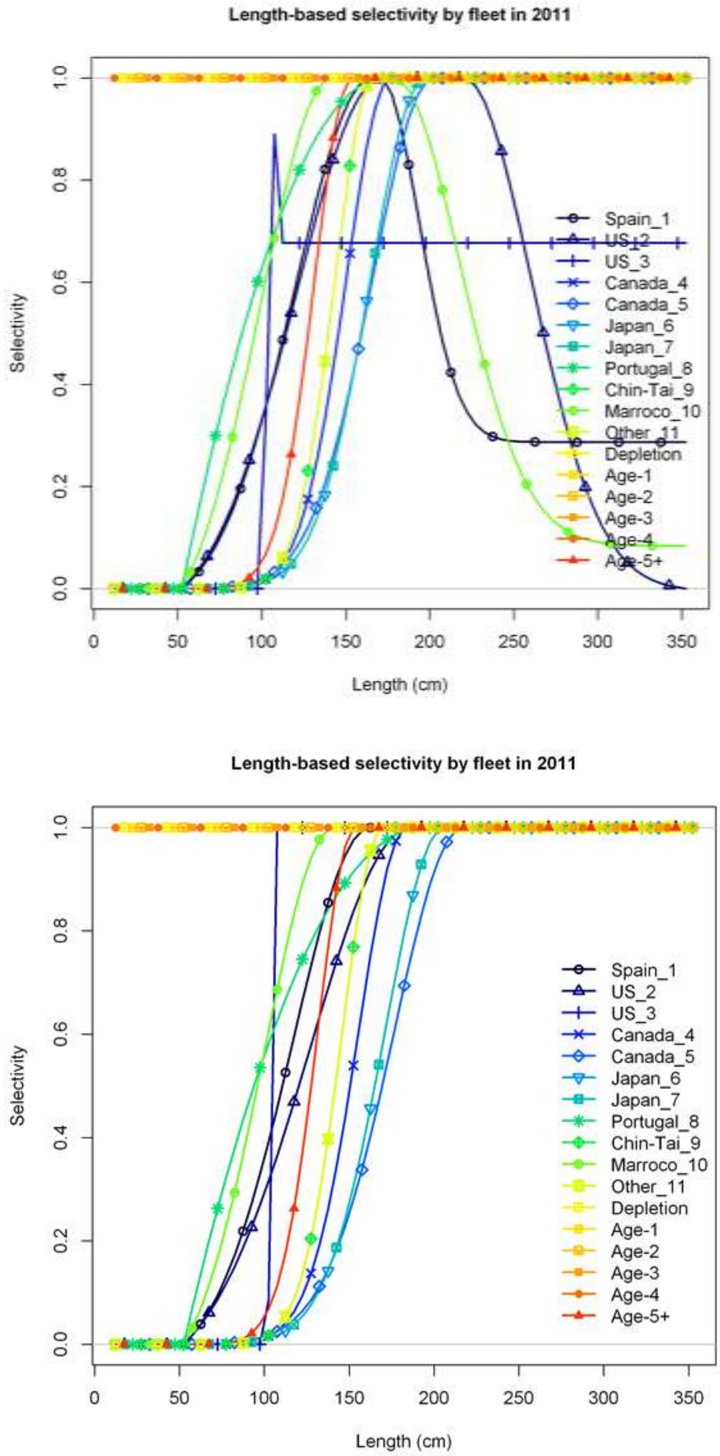
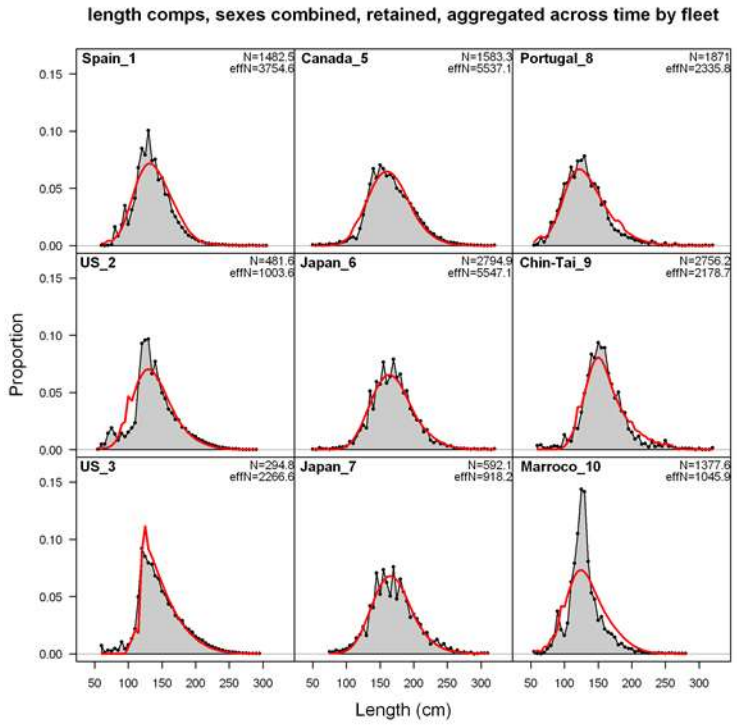


Figure 43 Length-based selectivity by fleet for the configuration that allowed for dome-shaped (top) and the configuration that forced asymptotic for northern Swordfish.



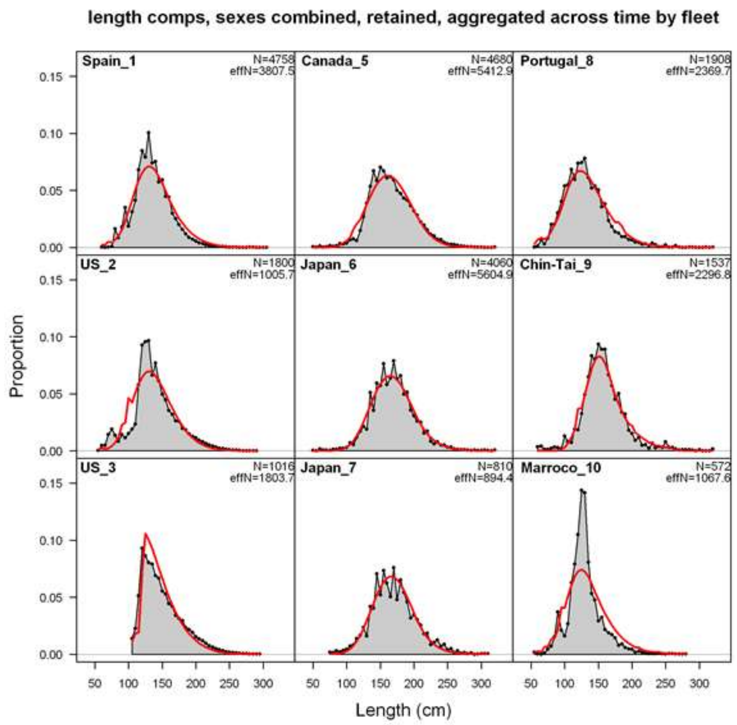


Figure 44 Fit to sexes combined length compositions aggregated by fleet for the configuration that allowed for dome-shaped (top) and the configuration that forced asymptotic for northern Swordfish 2011.

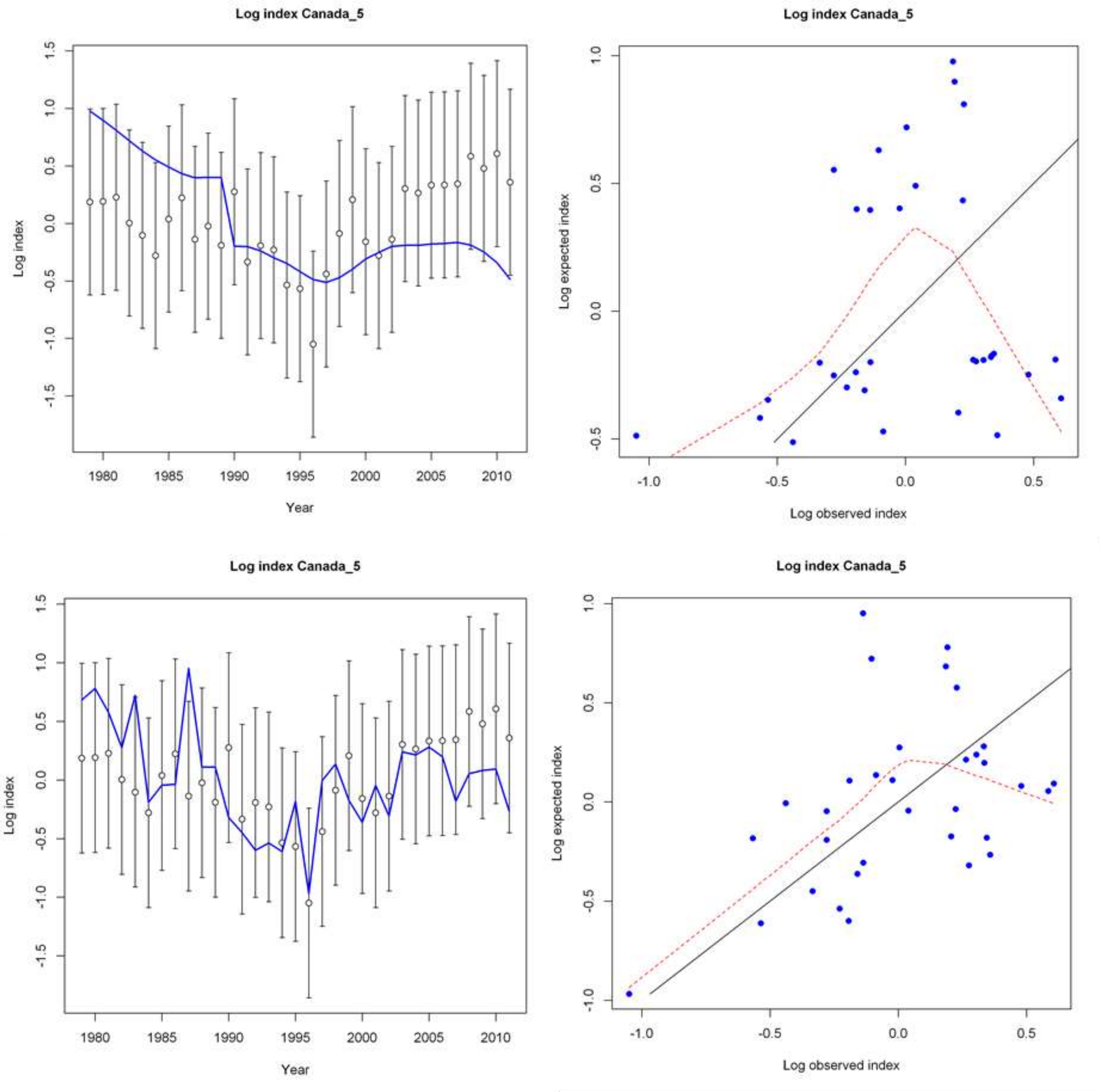


Figure 45 Residuals to the fit to the Canadian CPUE without the Atlantic Warm Pool included (top row) and with it included (bottom row) for northern Swordfish 2011.

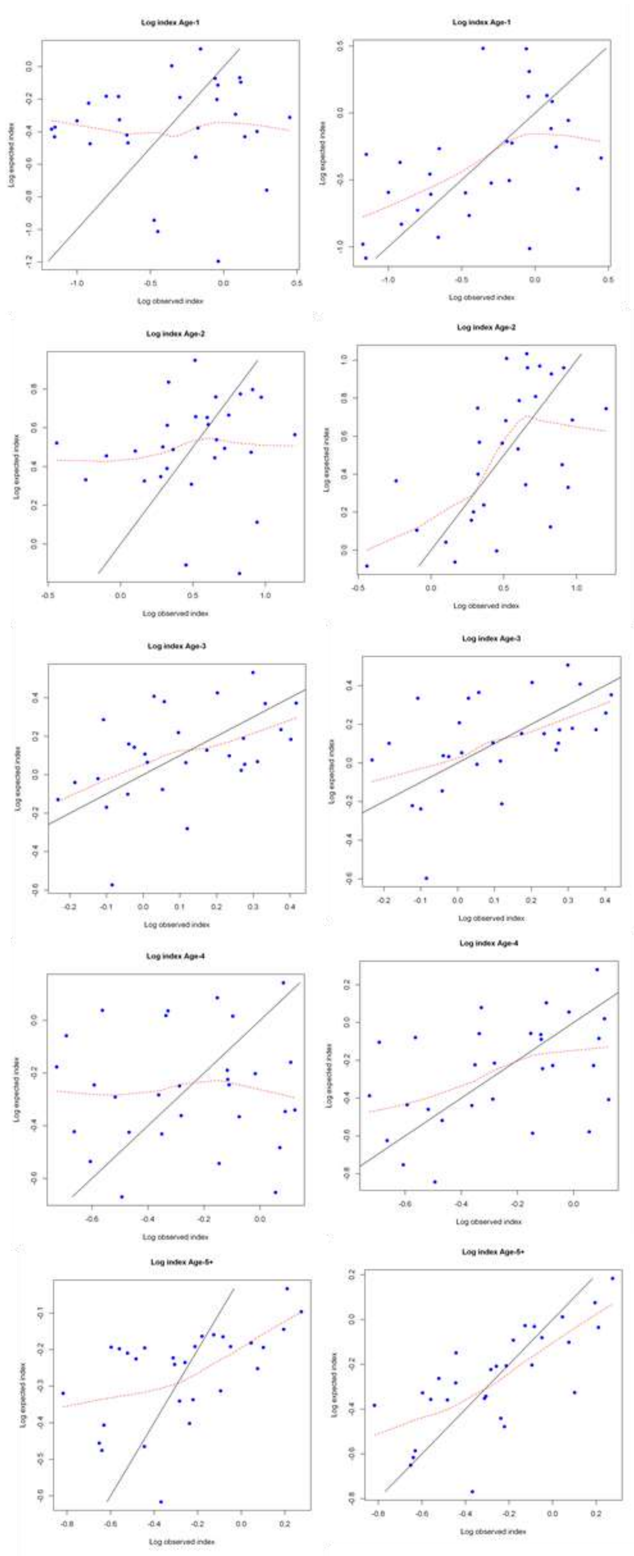


Figure 46 Residuals to the fit to the Spanish age-specific CPUE without the Atlantic Warm Pool included (left column) and with it included (right column) for northern Swordfish 2011.

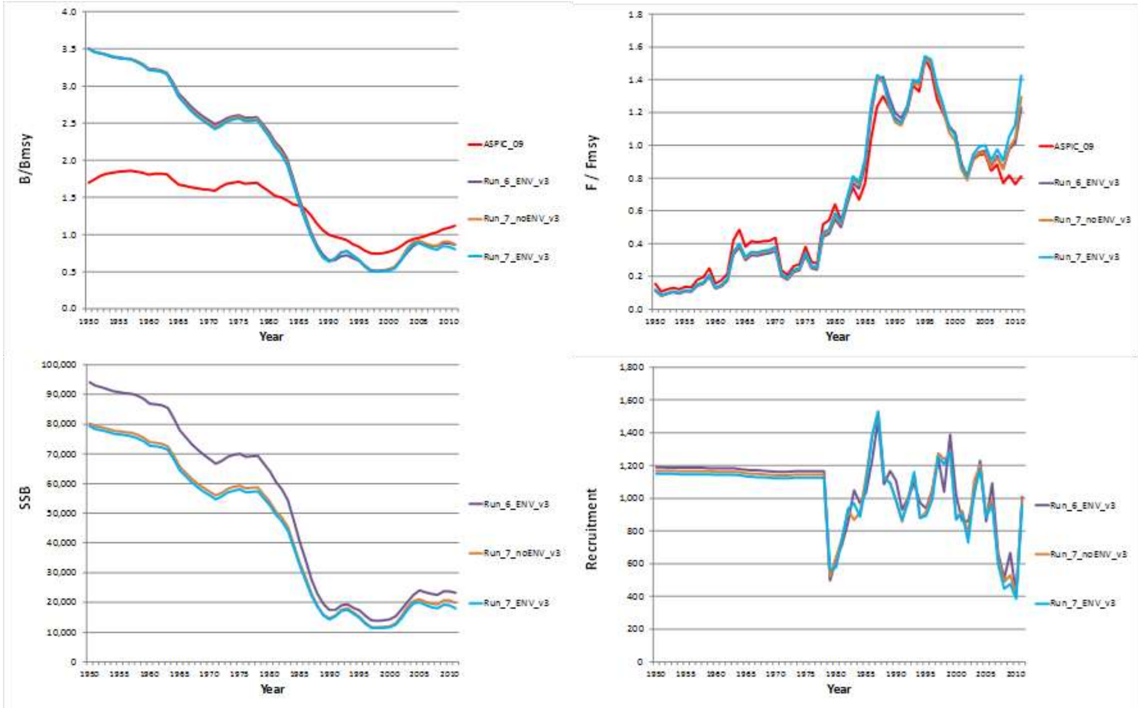


Figure 47 Estimates of B/Bmsy (upper left), F/Fmsy (upper right), spawning stock biomass (lower left), and recruitment for the estimates from the 2009 ASPIC estimate and the three final SS model configurations considered for northern Swordfish 2011.

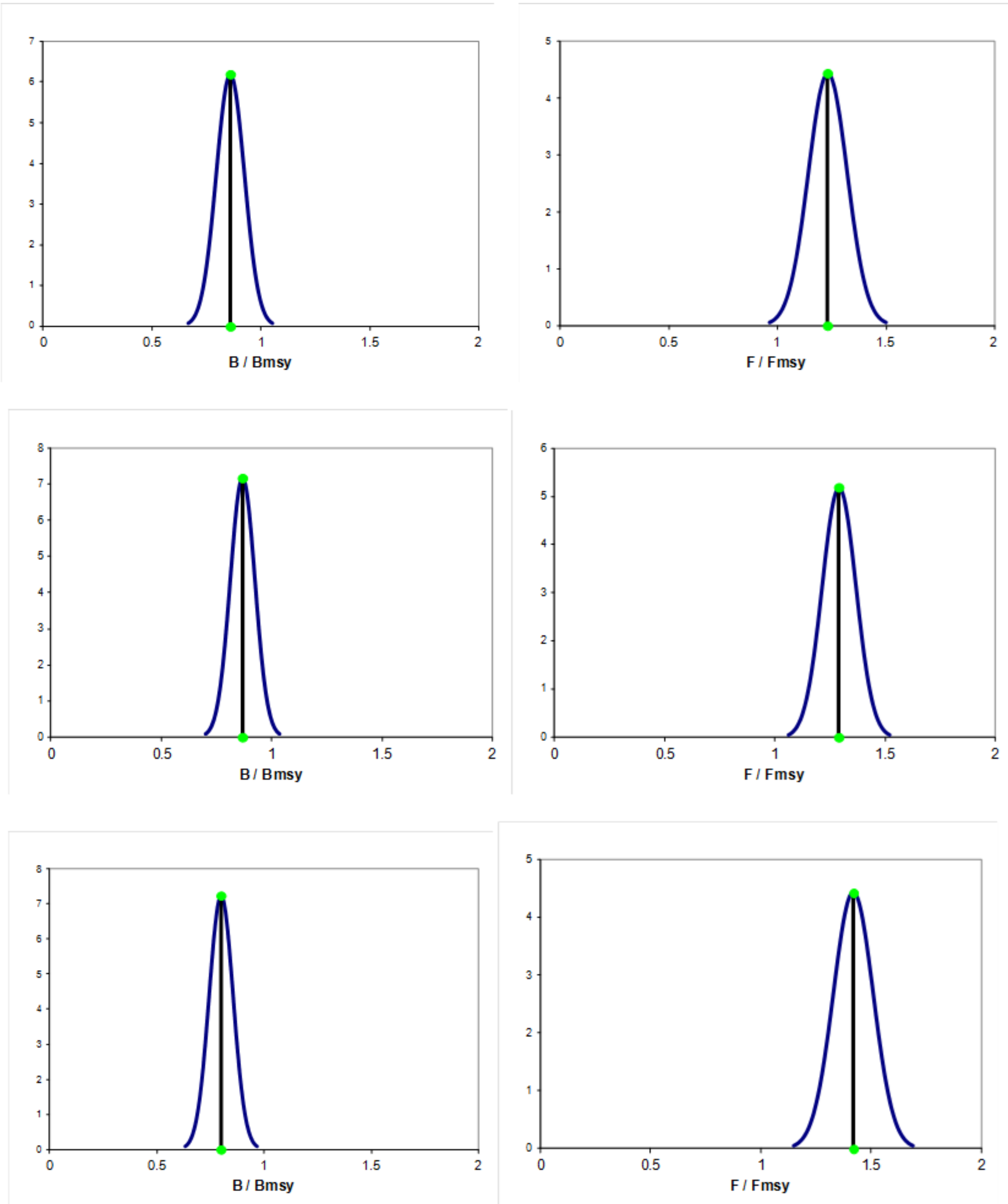


Figure 48 Estimates of B/Bmsy and F/Fmsy and standard deviations in 2011 for the SS model configuration with allowed dome-shaped selectivity and environmental covariate (top row), with forced asymptotic selectivity and no environmental covariate (middle row), and forced asymptotic selectivity with environmental covariate (bottom row) for northern Swordfish 2011.

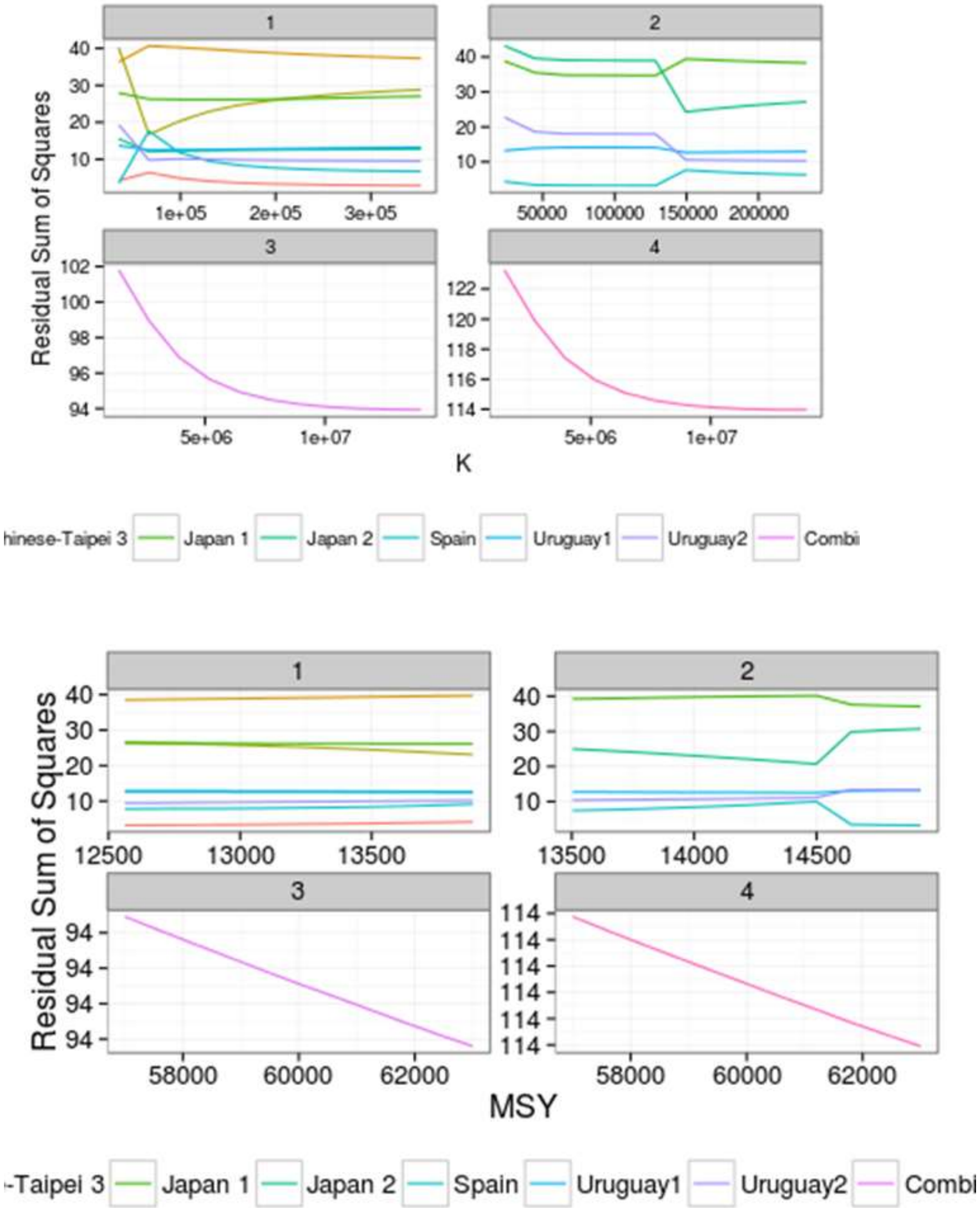


Figure 49 Likelihood profiles for K (top) and MSY (bottom) by data component for south Atlantic swordfish ASPIC runs 1, 2, 3 and 4.

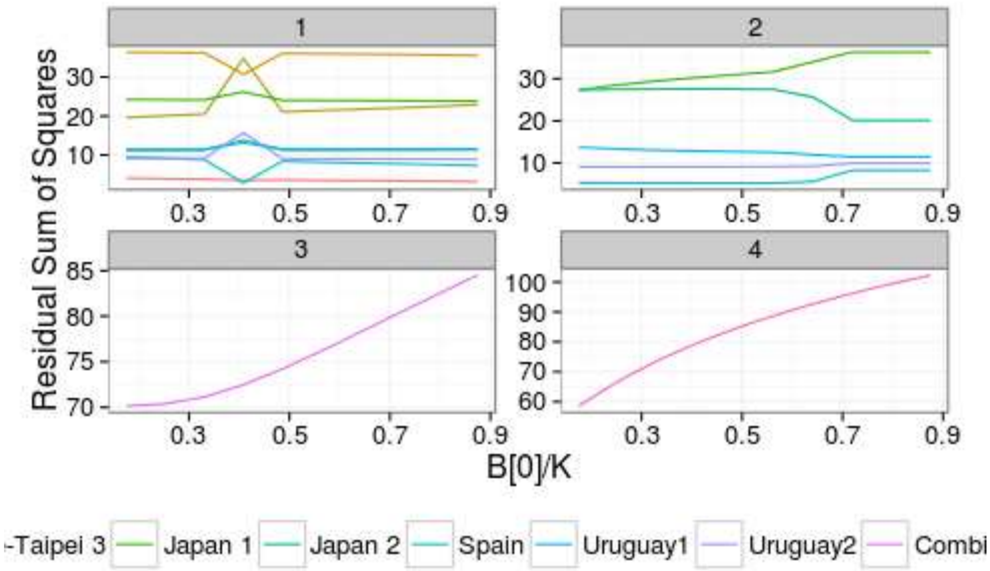


Figure 50 Likelihood profiles for B_1/K by data component for south Atlantic swordfish ASPIC runs 1, 2, 3 and 4.

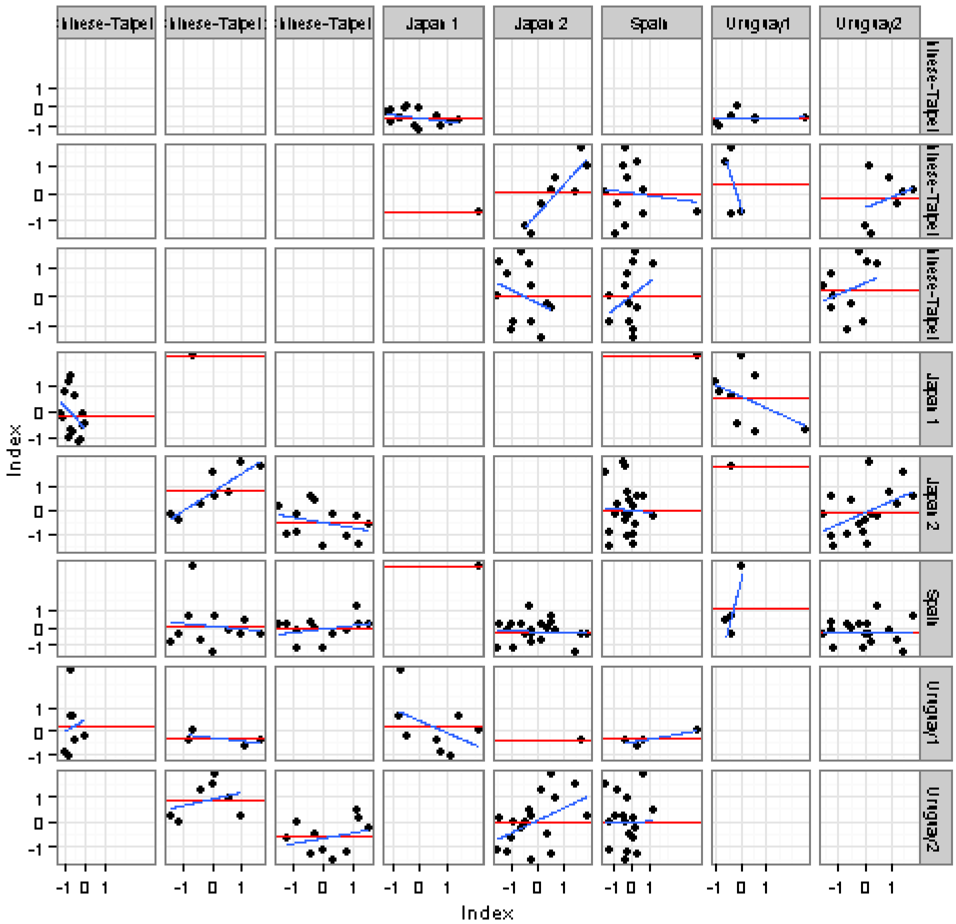


Figure 51 Scatter plots between the indices of abundance for the south Atlantic swordfish stock demonstrating the degree of correlation between index values.

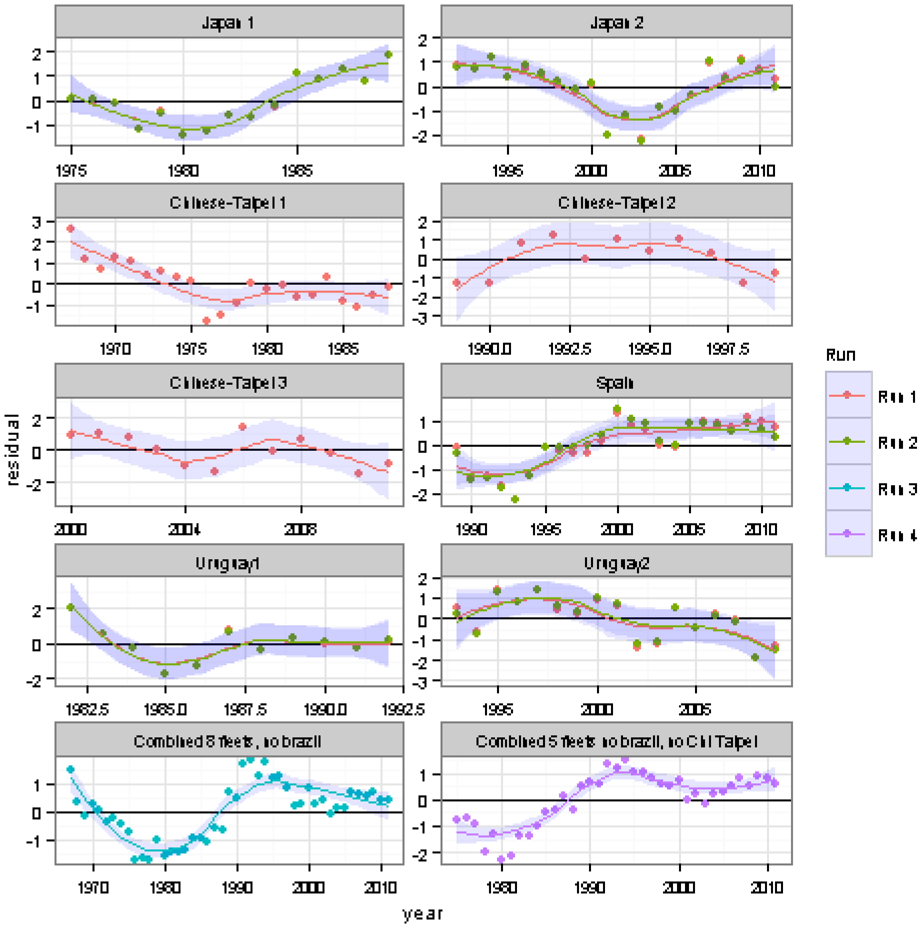


Figure 52 Residuals from the fit of the separate south Atlantic swordfish stock indices to the catch data for ASPIC runs 1, 2, 3 and 4.

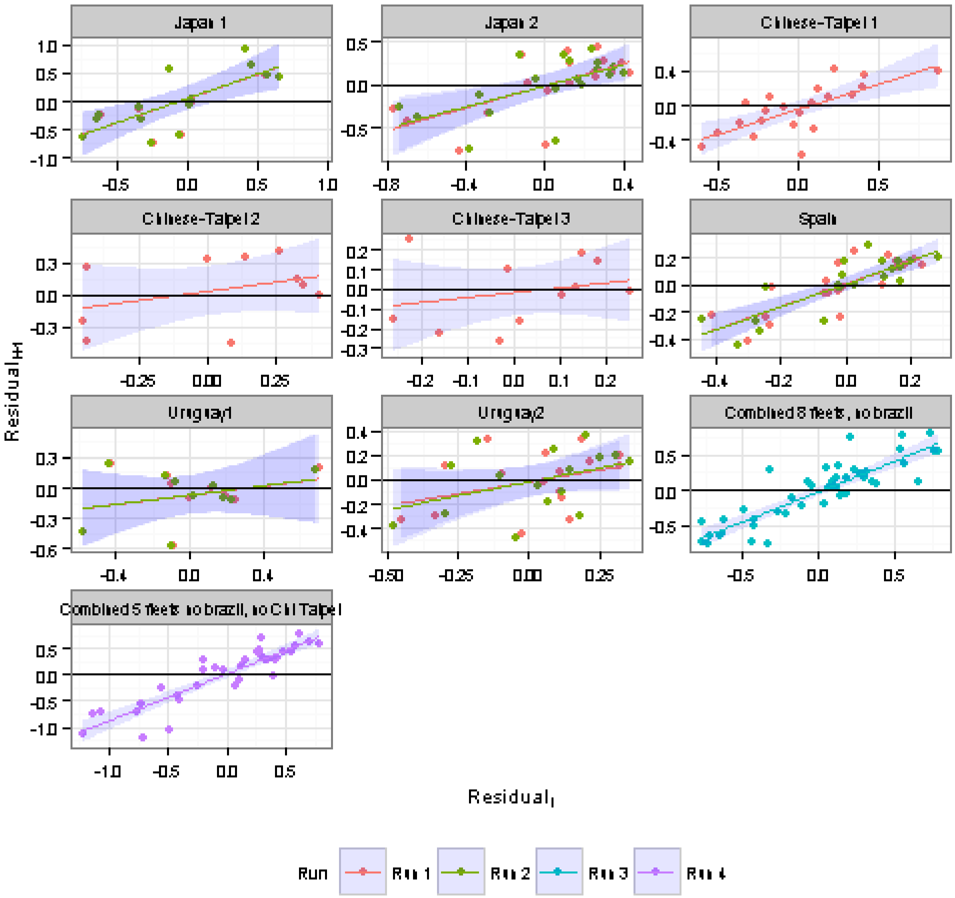


Figure 53 Lag plots of the residuals from the fit of the separate south Atlantic swordfish stock indices to the catch data for ASPIC runs 1, 2, 3 and 4. These plots demonstrate autocorrelation in residuals.

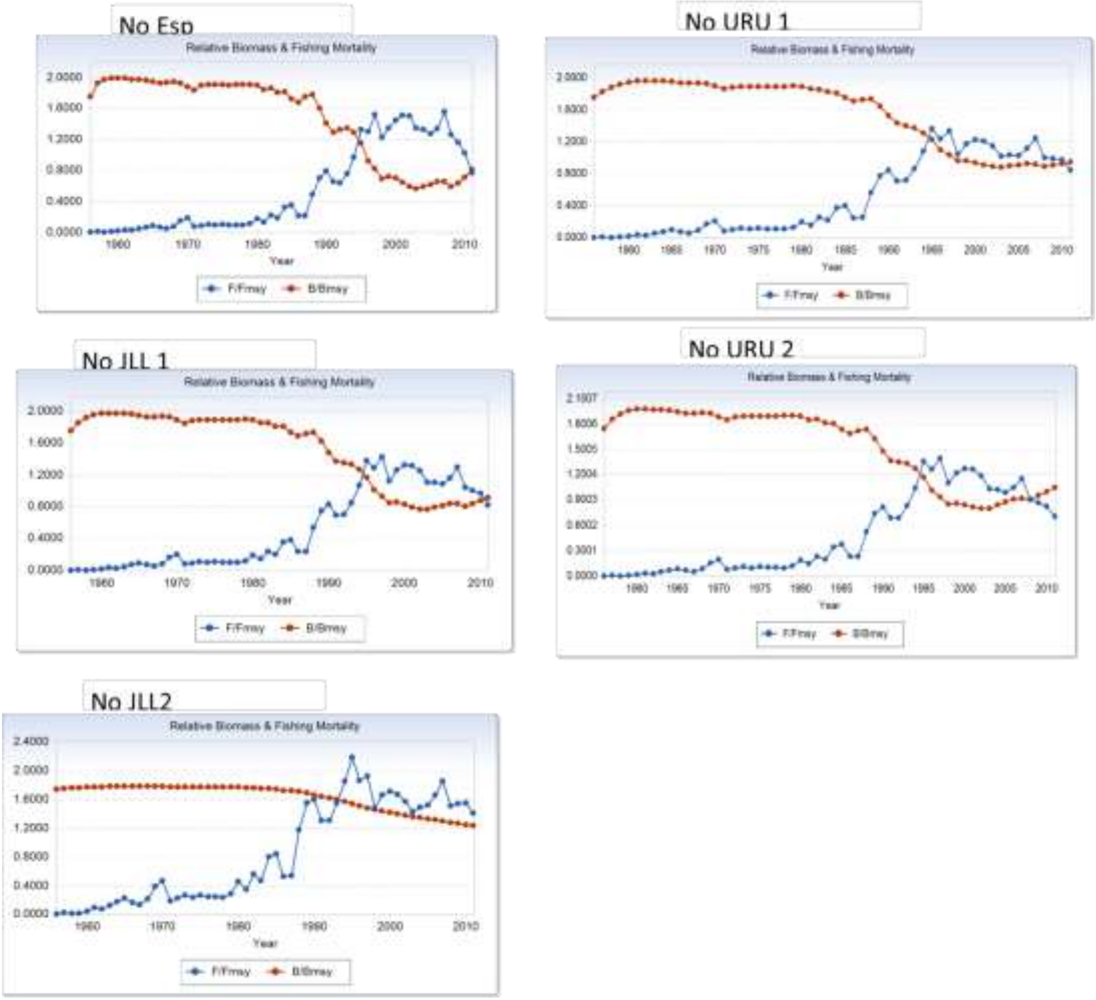


Figure 54 Jackknife sensitivity analysis of a south Atlantic swordfish ASPIC model where indices are removed one at a time.

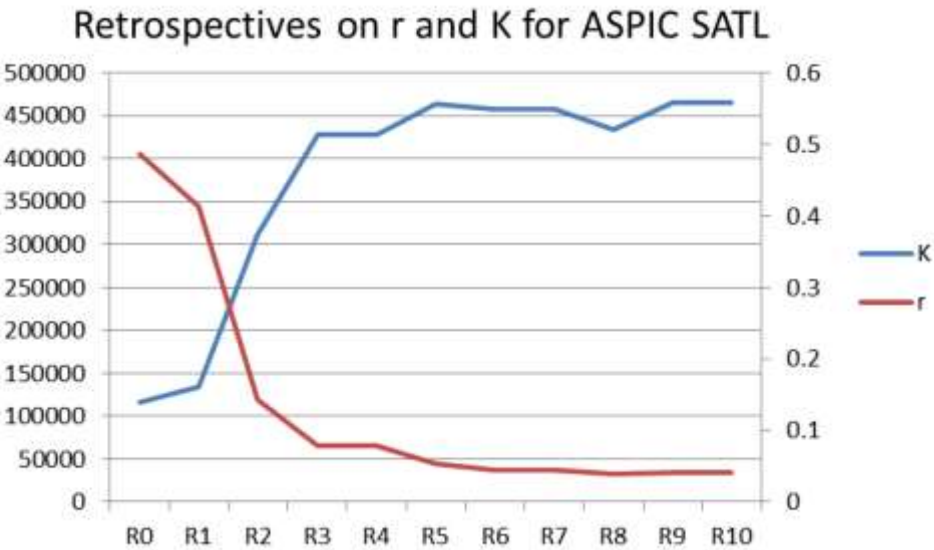


Figure 55 South Atlantic swordfish results from the retrospective analysis of the ASPIC reference case.

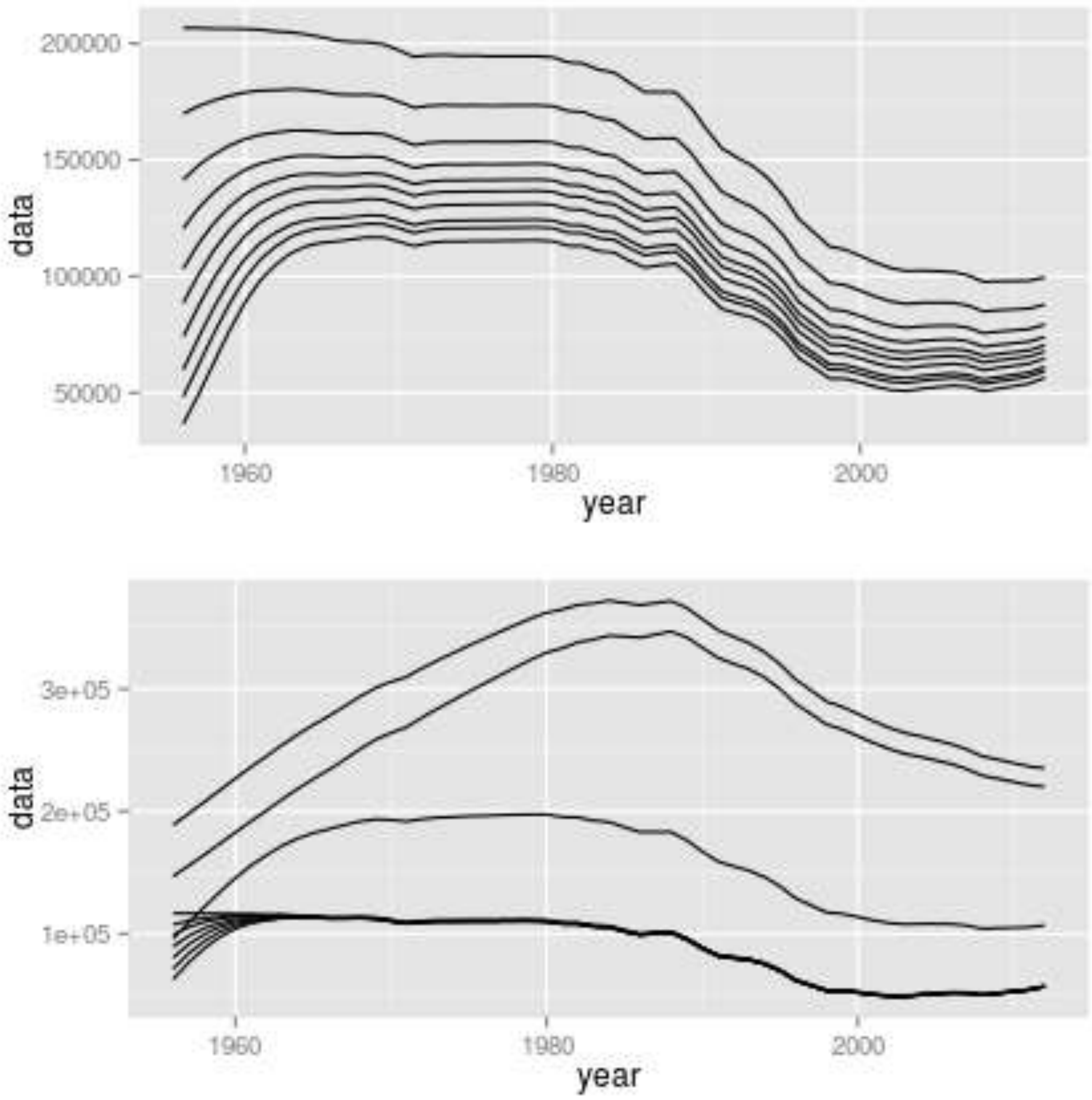


Figure 56 Sensitivity of biomass trends to alternative values for B_1/K. K was held constant and B_1 was allowed to vary in the south Atlantic swordfish ASPIC model run1 (top) and run2 (bottom).

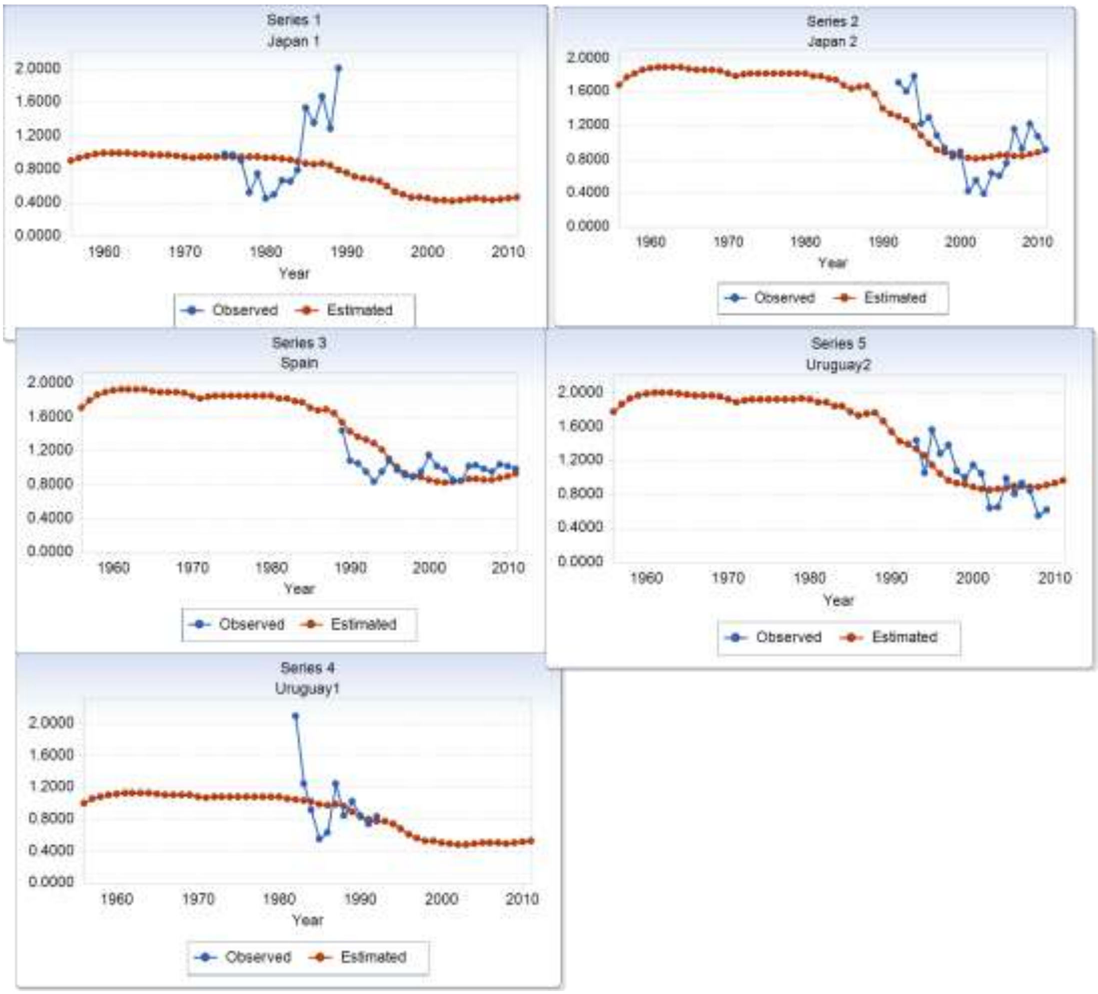


Figure 57 South swordfish: Observed indices of abundance (blue line) and estimated index (red line) by the surplus production model (ASPIC) for South Atlantic swordfish reference case model.

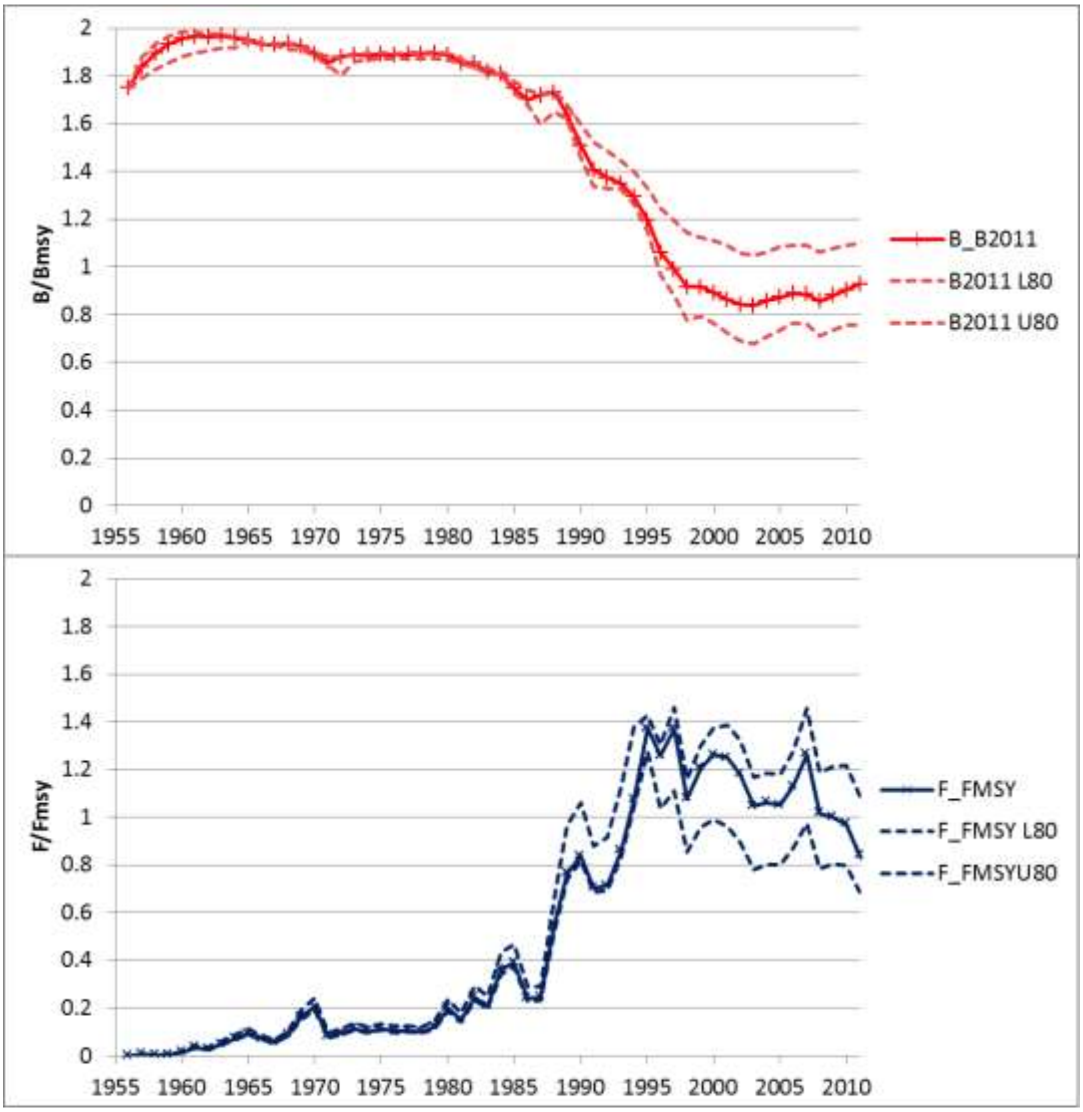


Figure 58 South Atlantic swordfish B/B_{MSY} and F/F_{MSY} estimated by ASPIC, dashed lines are the lower and upper 80 percentiles of the bootstrap runs.

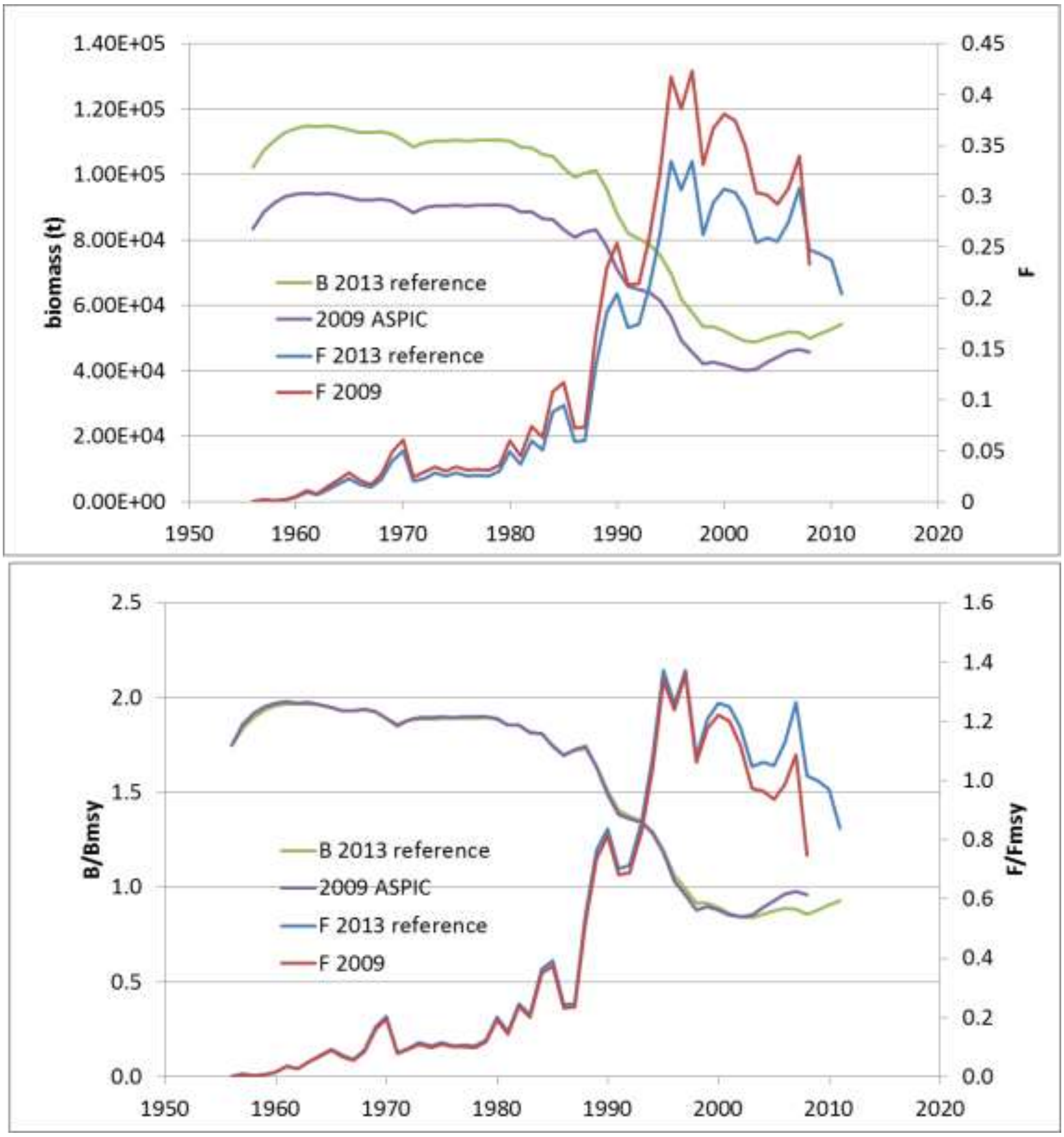


Figure 59. Comparison of the ASPIC 2009 with the 2013 ASPIC run with separate indices, no Brasil and no China-Taipei. Upper figure shows trends in absolute biomass and fishing mortality estimates. Lower figure shows relative plots.

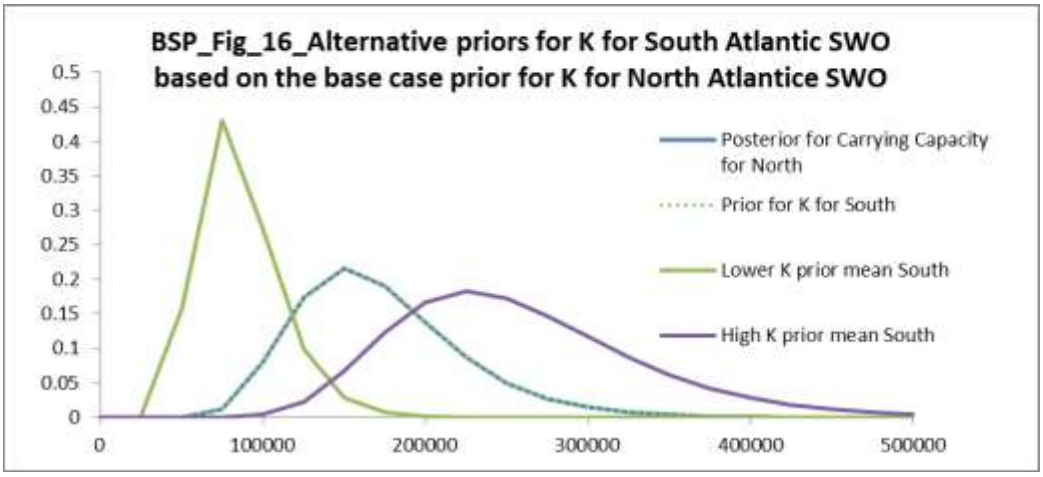


Figure 60. Plots of the reference case prior for K for south Atlantic swordfish. Also shown are priors for K with the prior mean at 50% and 150% of the reference case prior mean that were applied in sensitivity analyses.

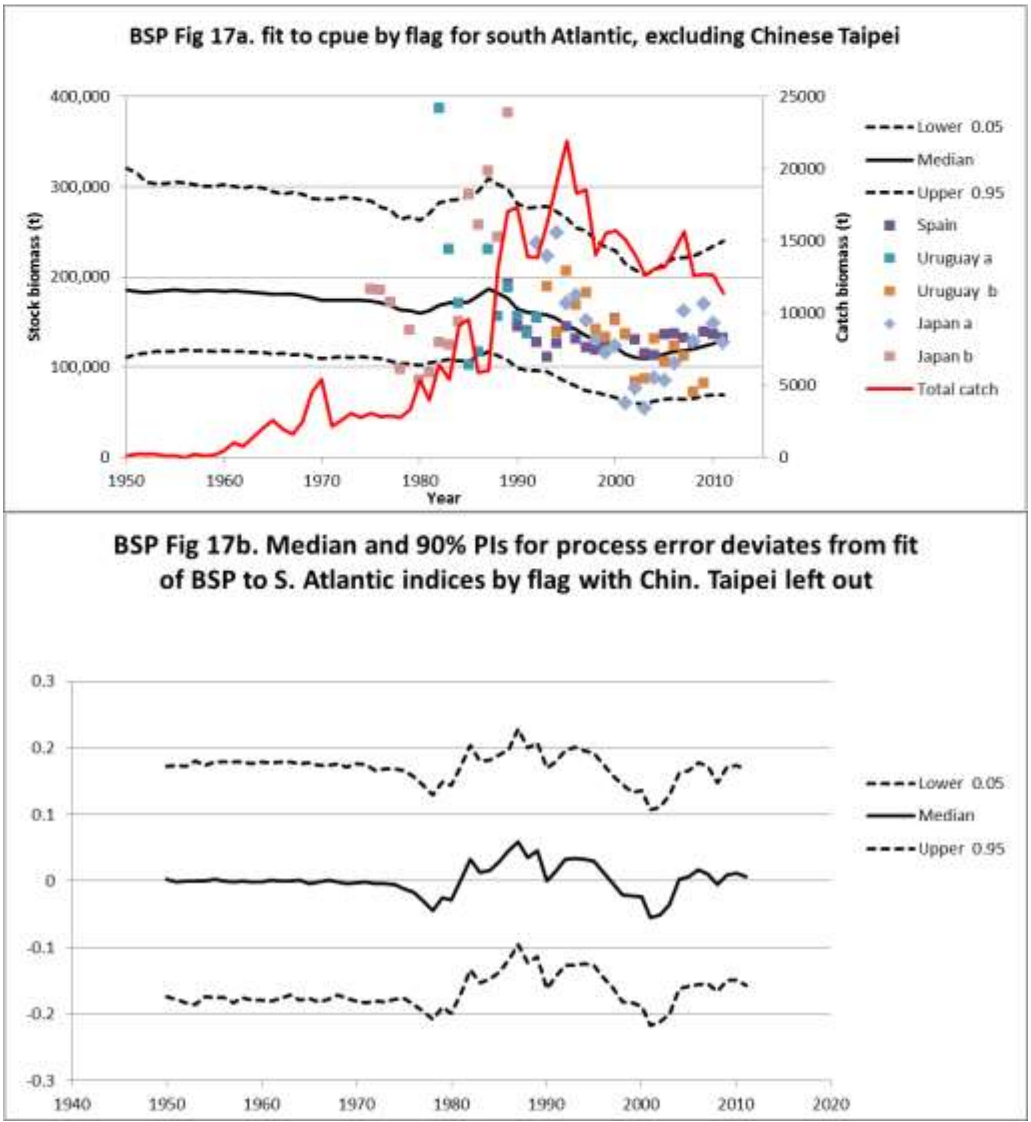


Figure 61. Plots of estimated swordfish stock biomass and process error deviates for the reference case BSP model (R.S) application to cpue by flag excluding the Chinese Taipei index in the south Atlantic Ocean.

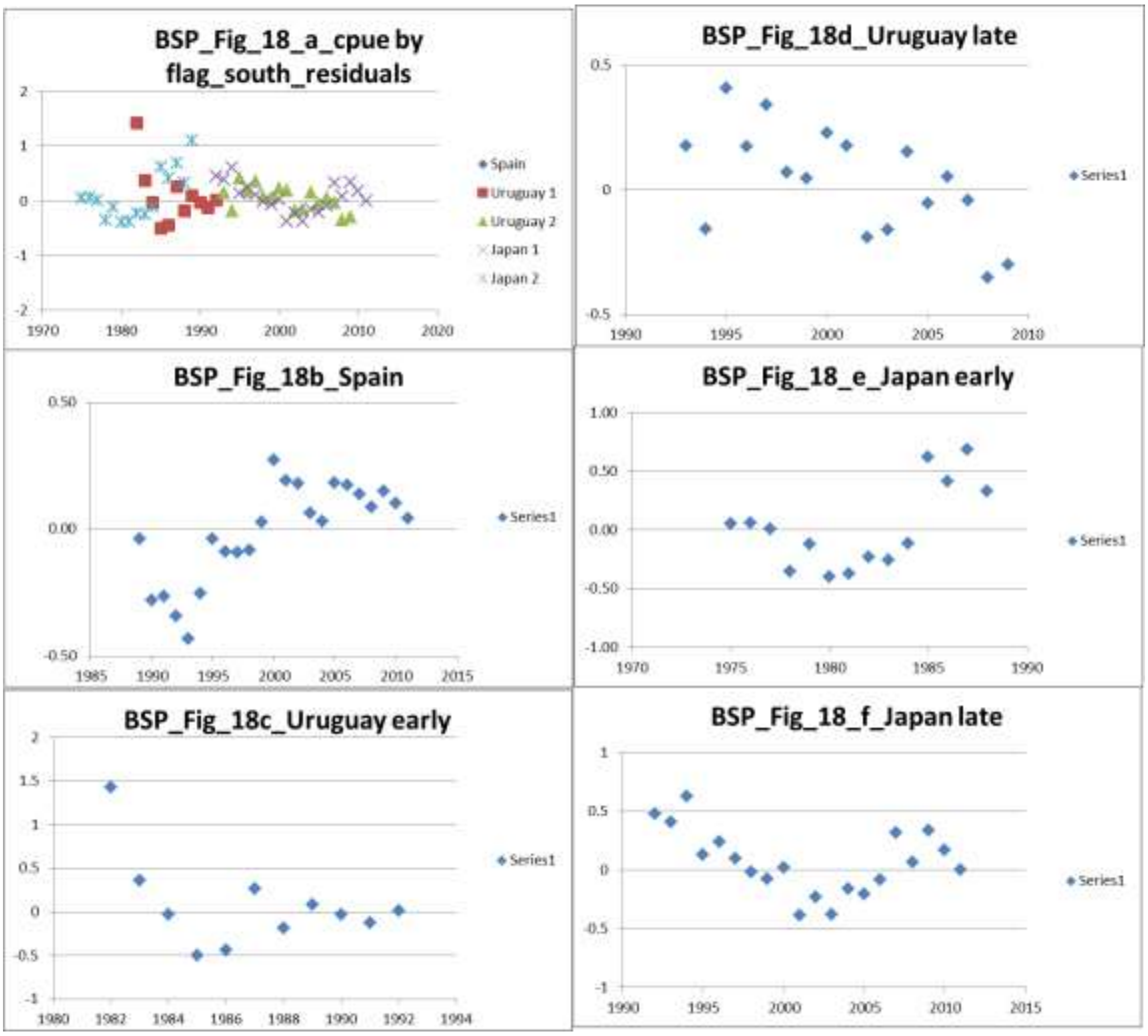


Figure 62. Plots of residuals for the by flag cpue data with the BSP model run R.S applied to South Atlantic swordfish.

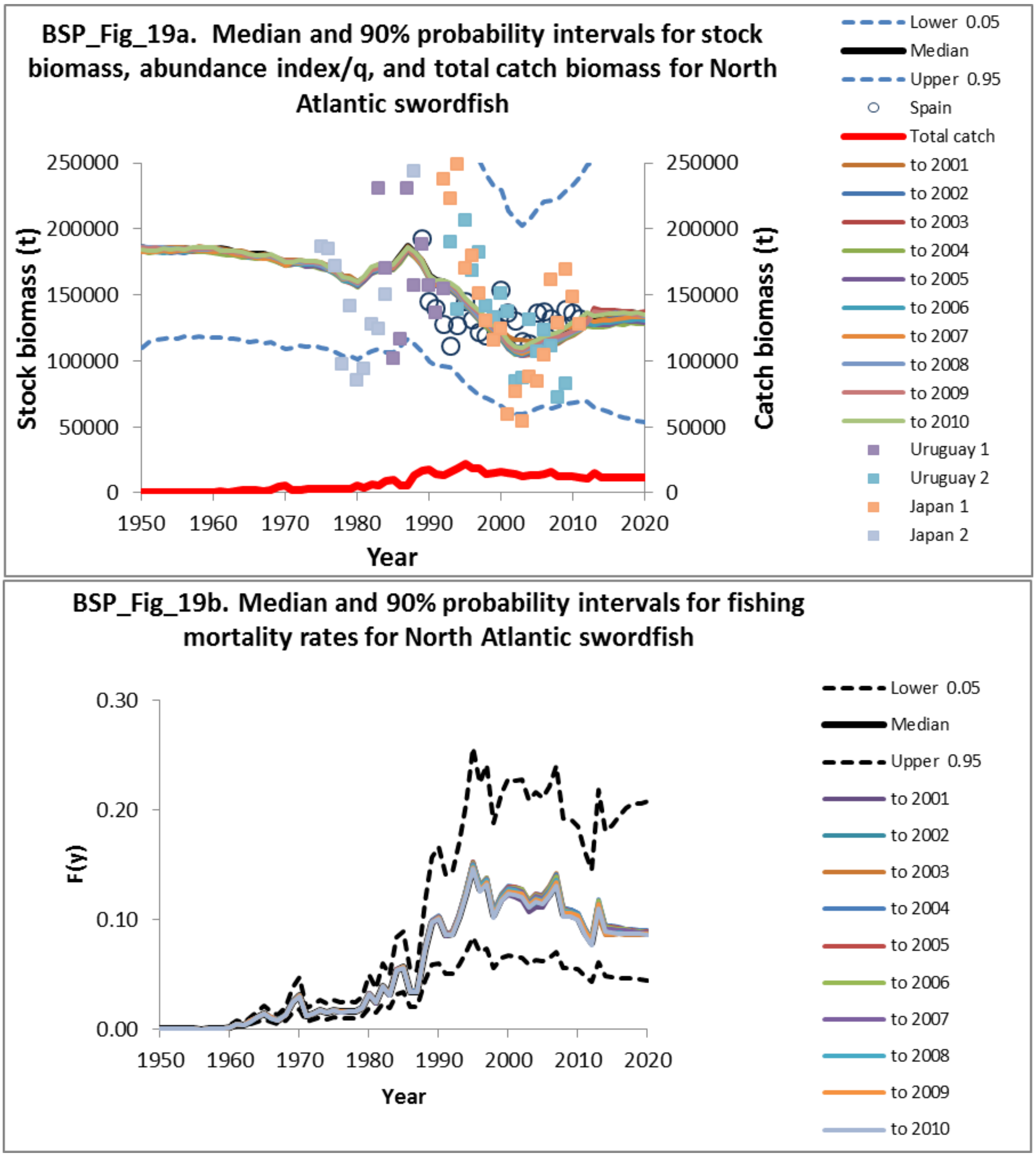


Figure. 63 Plots of a. stock biomass and b. fishing mortality rate estimates and predictions from a retrospective cross-validation analysis with the BSP model runs for south Atlantic swordfish.

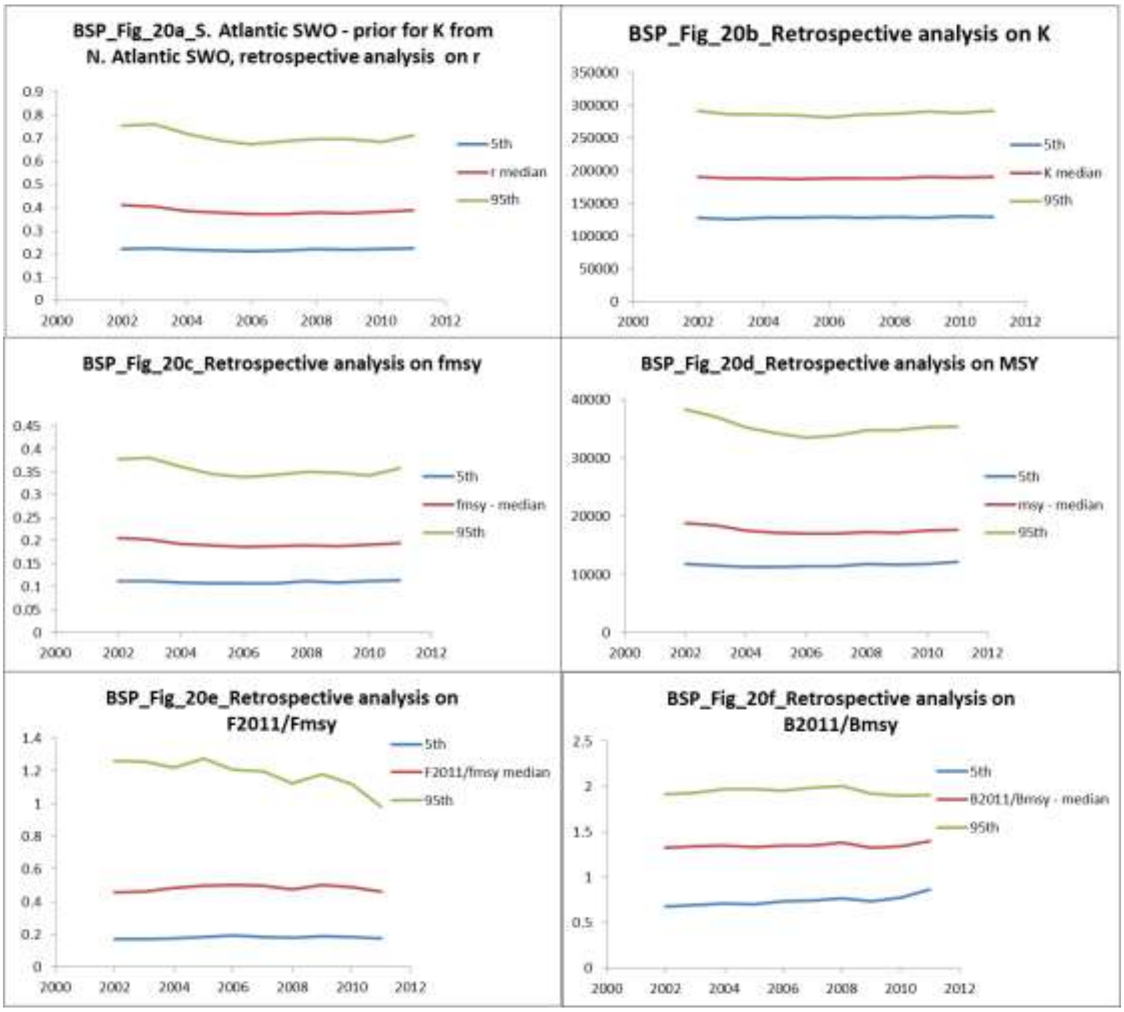


Figure. 64 Plots of a. r, b. K, c. fmsy, d. MSY, e. f2011/fmsy, and b2011/bmsy estimates and predictions from a retrospective cross-validation analysis with the BSP model runs for south Atlantic swordfish with the informative prior for K.

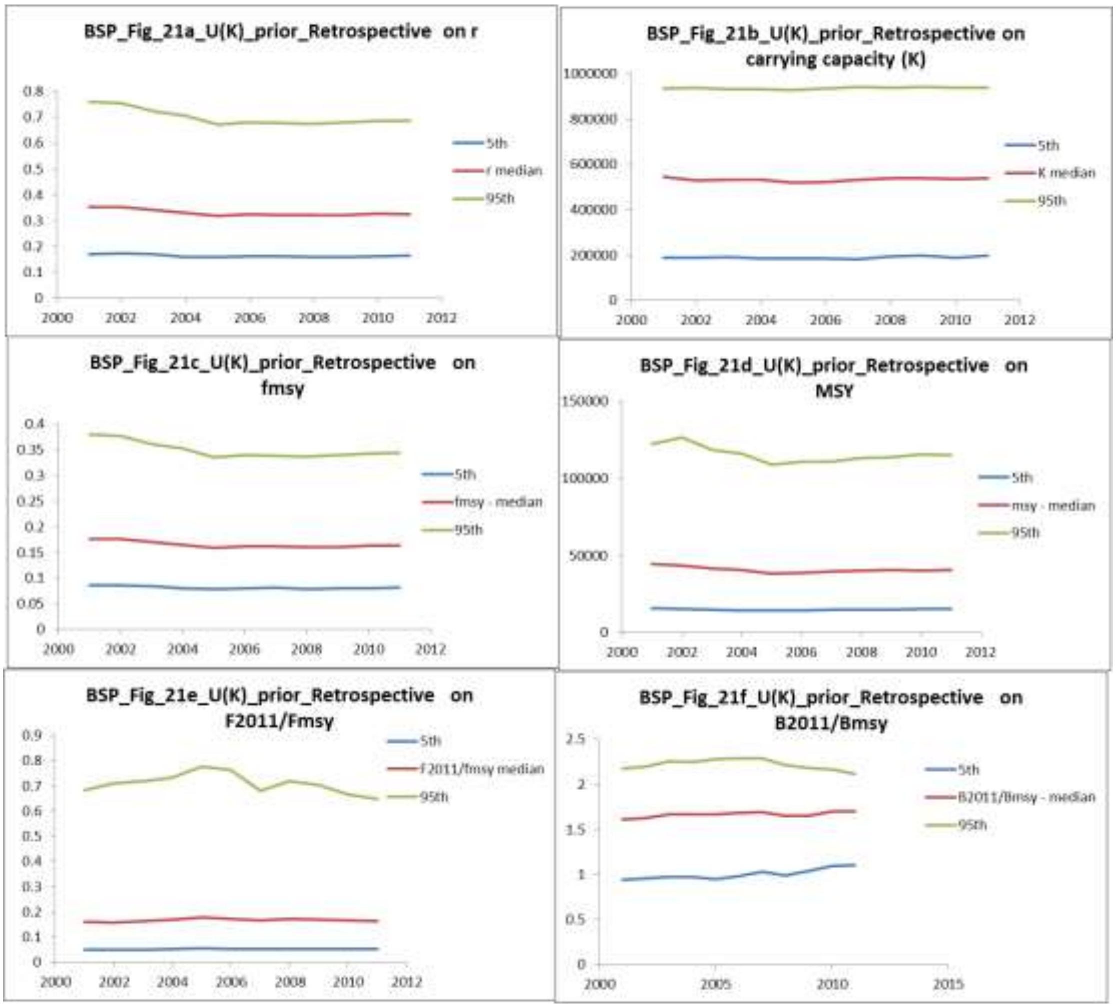


Figure 65 Plots of a. r, b. K, c. fmsy, d. MSY, e. f2011/fmsy, and b2011/bmsy estimates and predictions from a retrospective cross-validation analysis with the BSP model runs for south Atlantic swordfish, with uniform on K prior.

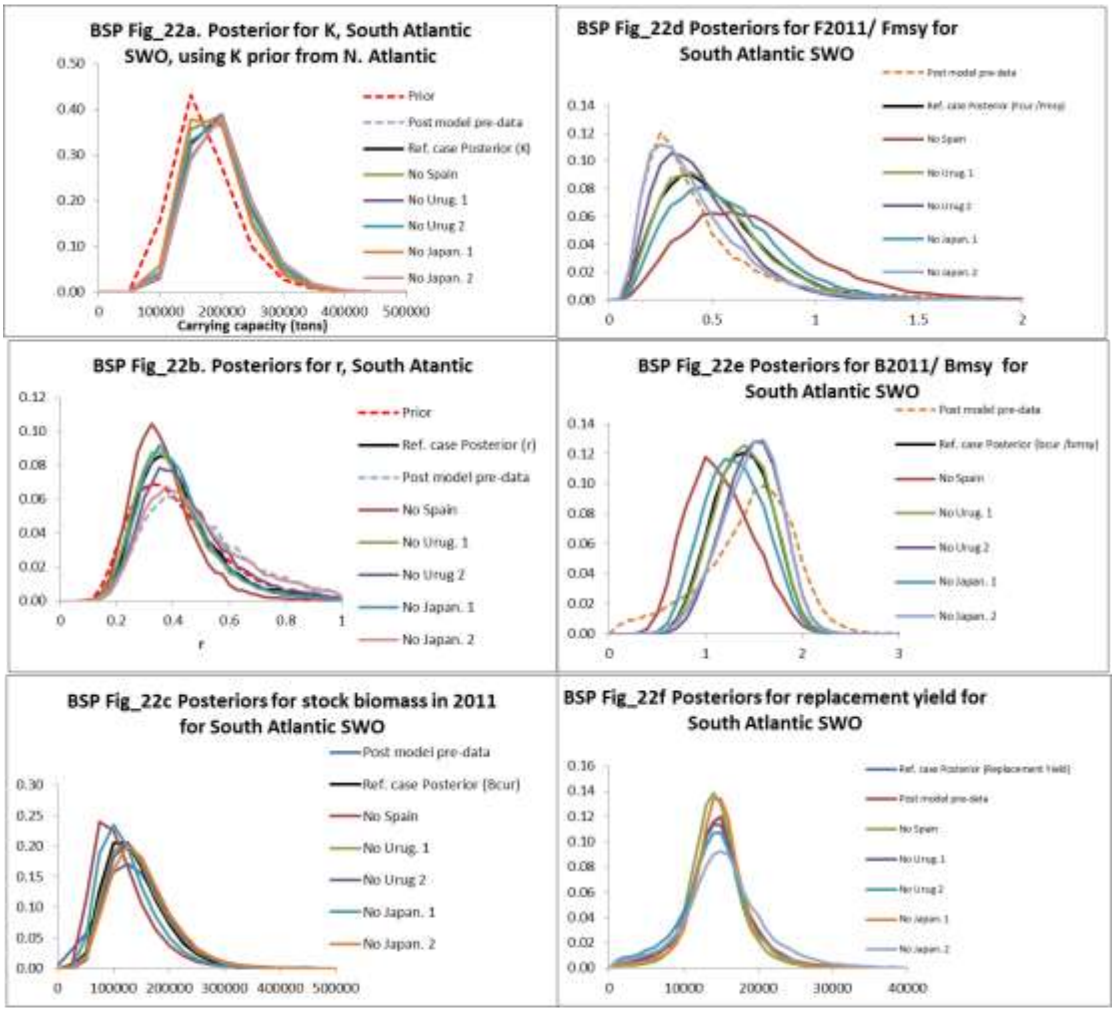


Figure. 66 Posterior results from a jackknife analysis of the cpue by flag data in the BSP application to south Atlantic swordfish.

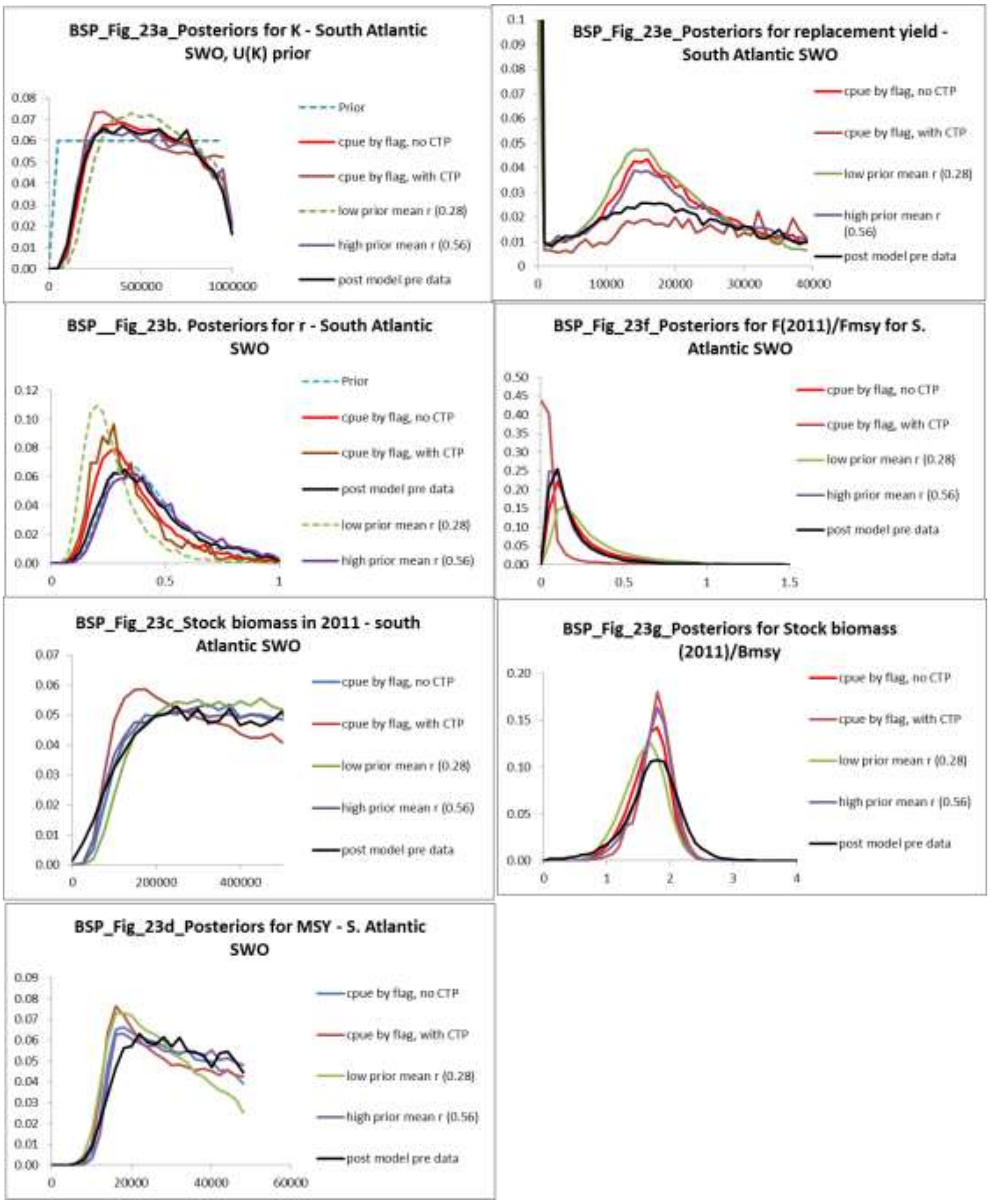


Figure. 67 Sensitivity analysis results for south Atlantic swordfish showing posteriors for BSP model parameters and variables when a uniform on K prior is applied, different prior means for r are applied, and Chinese Taipei (CTP) cpue are either included or left out.

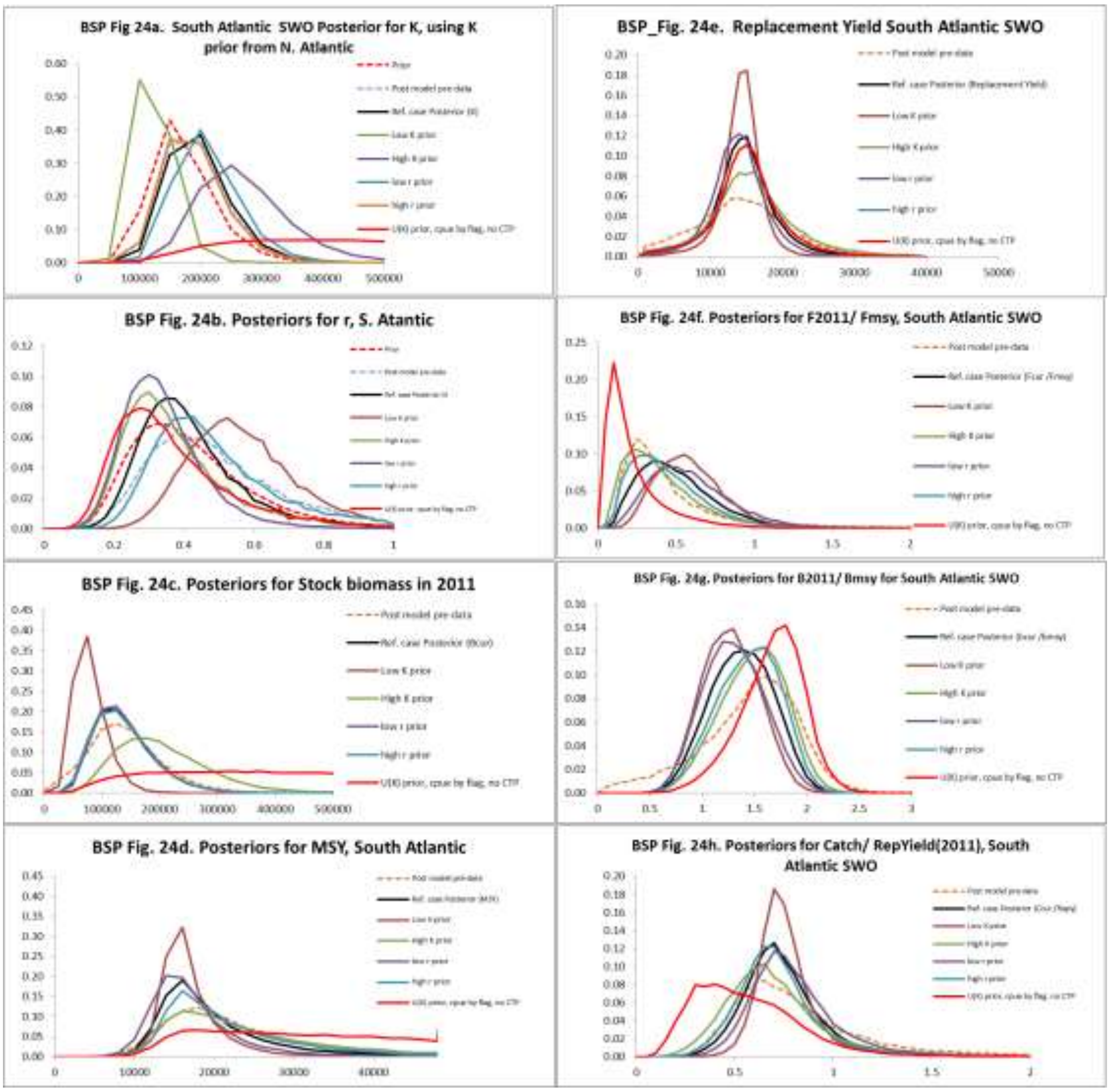


Figure 68 Posterior results for different parameters and variables of interest in a sensitivity analysis of BSP applied to south Atlantic swordfish under different priors for K and r but mostly with informative priors for K applied.

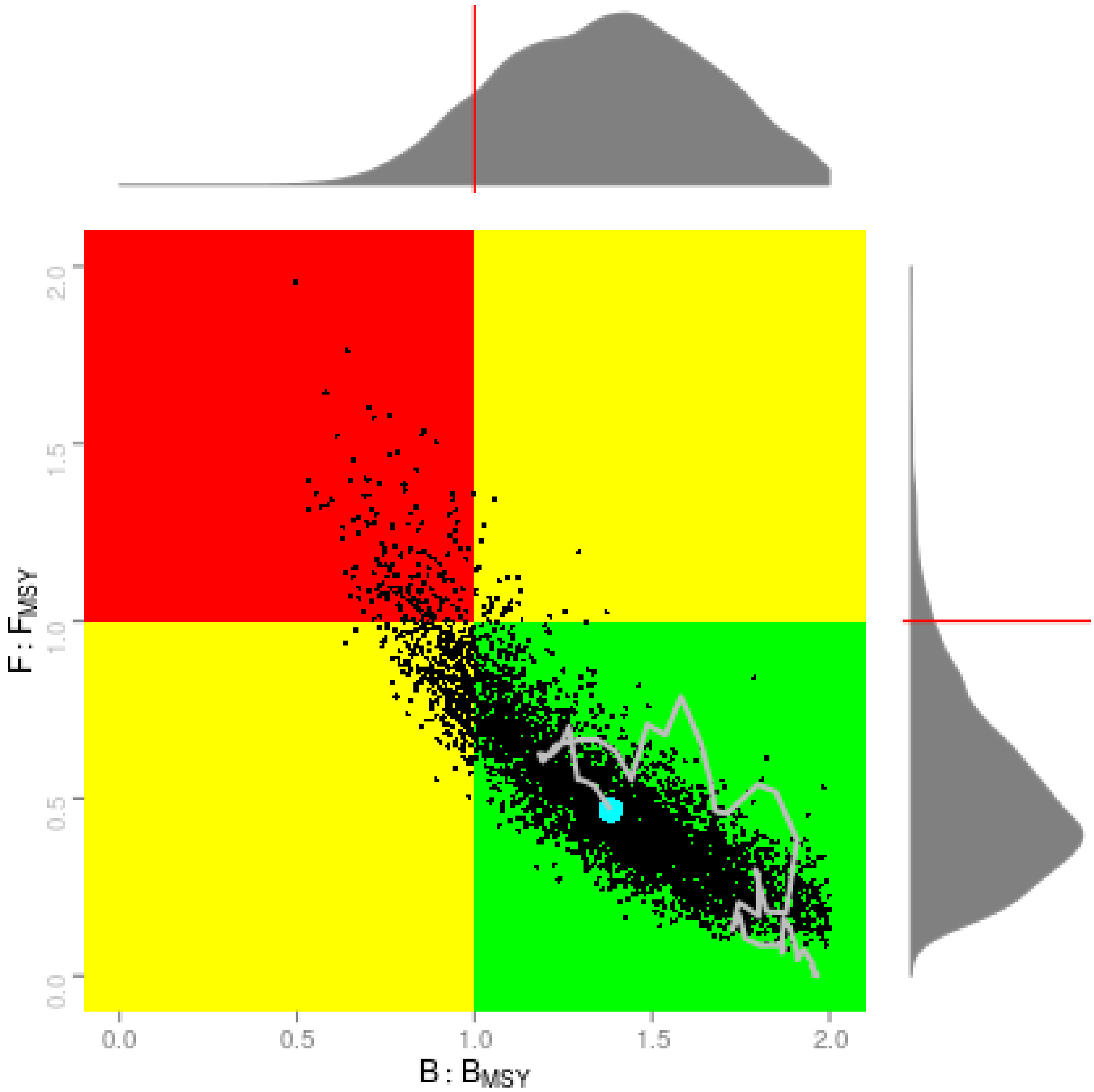


Figure 69 Kobe plot for BSP run R.S for south Atlantic swordfish.

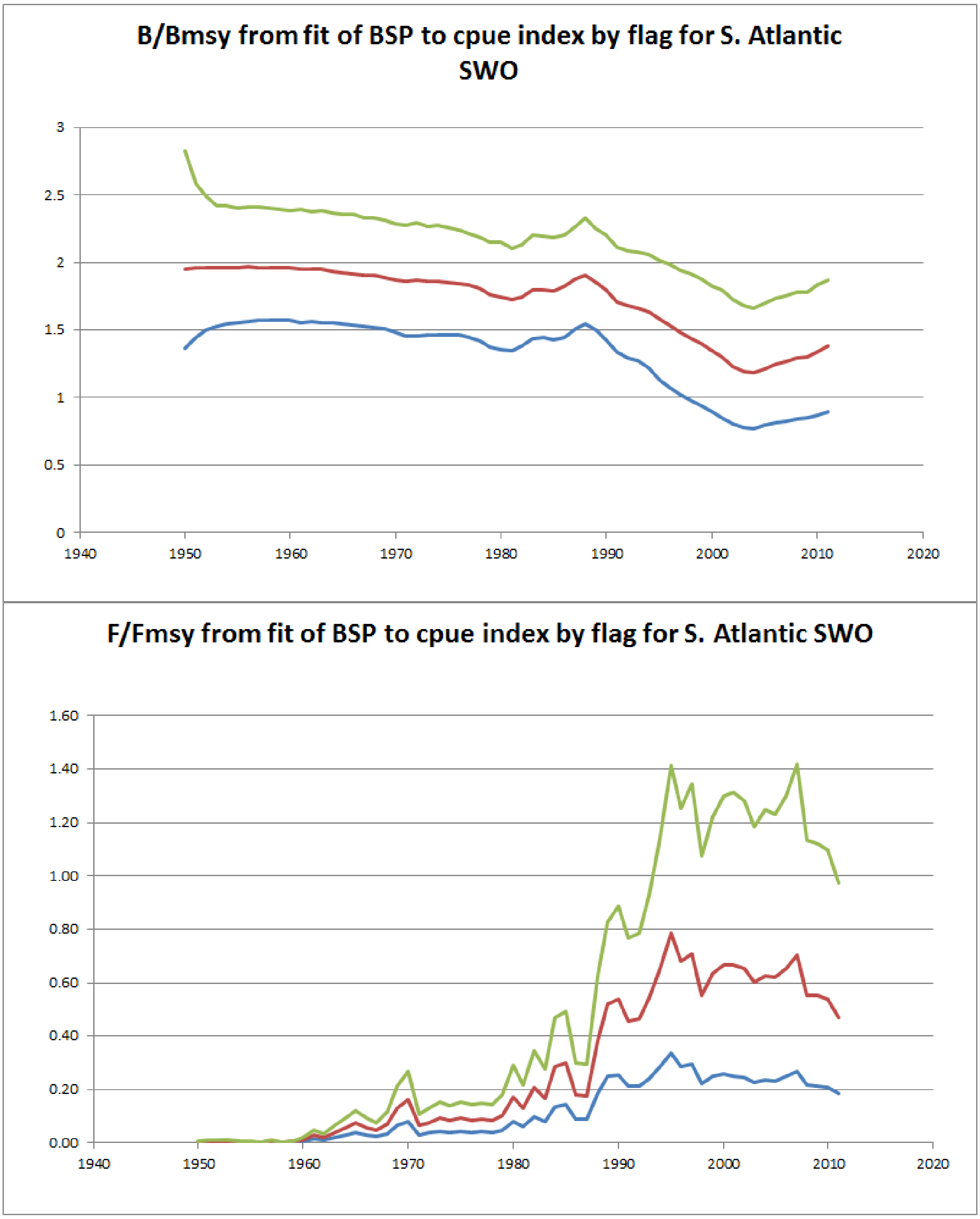


Figure 70 South Atlantic swordfish B/B_{MSY} (top) and F/F_{MSY} (bottom) estimated by BSP2. Posterior median and 90% intervals are plotted.

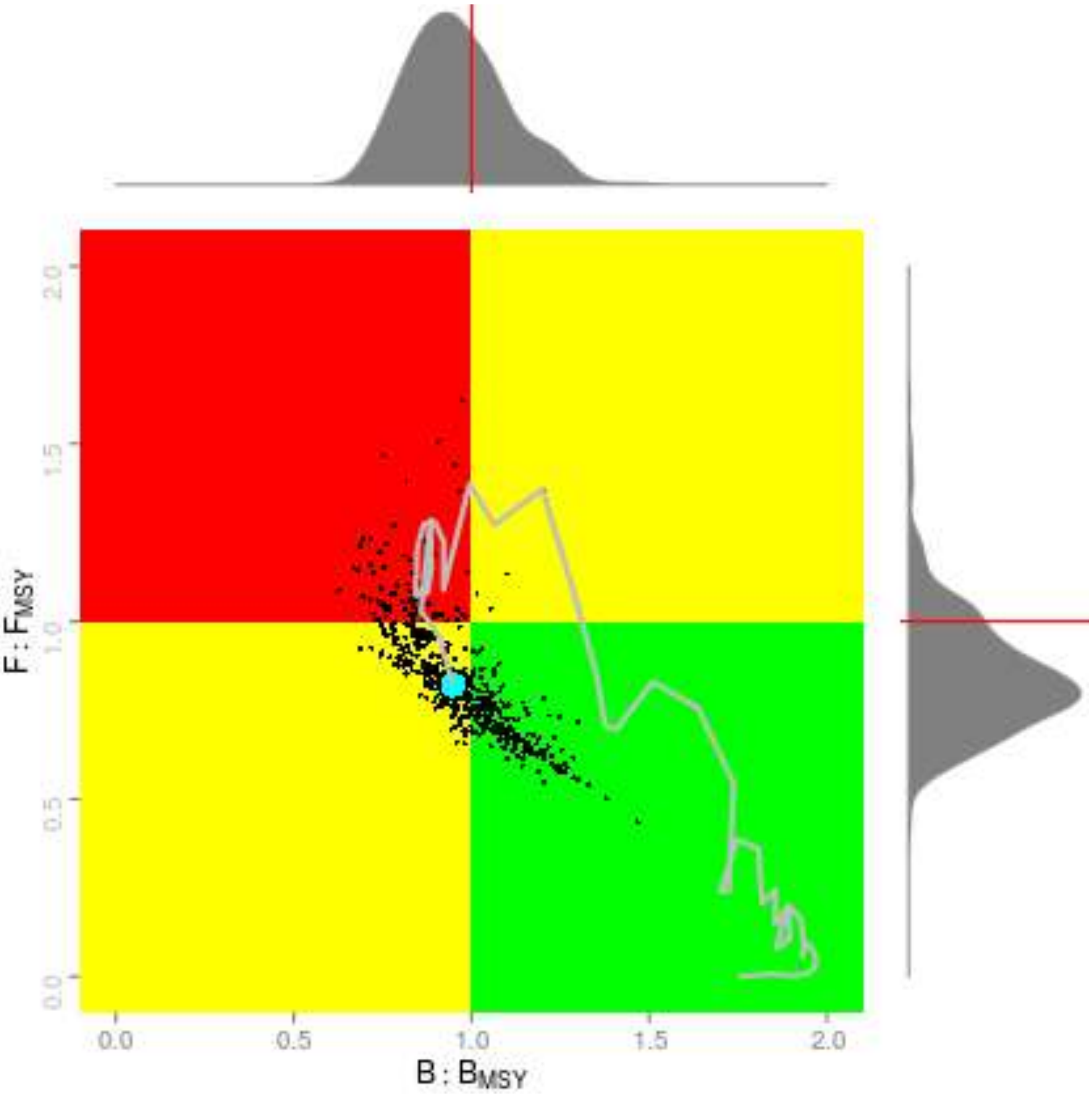


Figure 71 Kobe plot for ASPIC South Atlantic swordfish reference model.

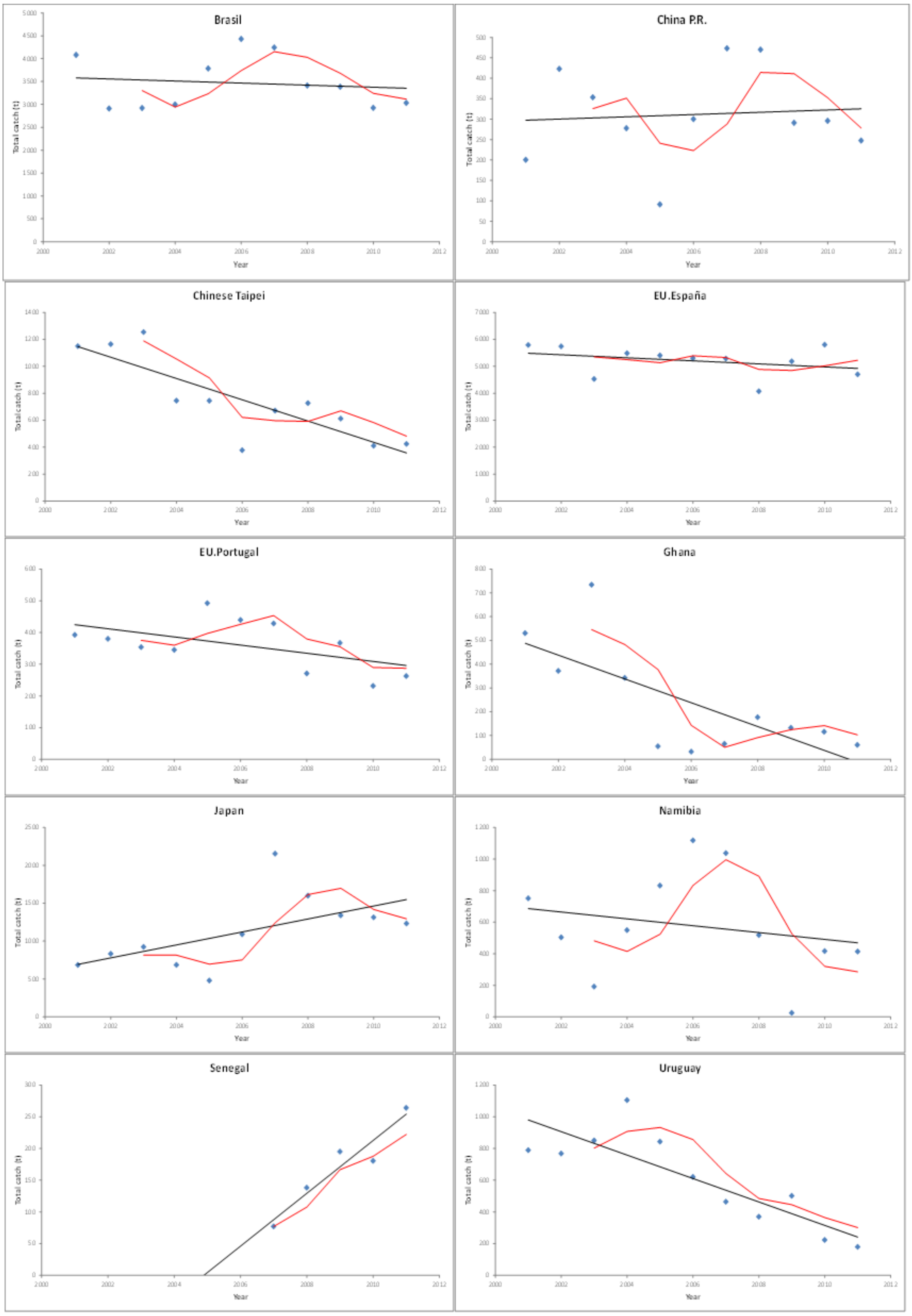


Figure 72 The total catch (MT) per year for the ten flags with the highest average catch from 2001 – 2011, in the South Atlantic. A linear regression (black line) and moving average (red line, 3 point moving average) describe the trends

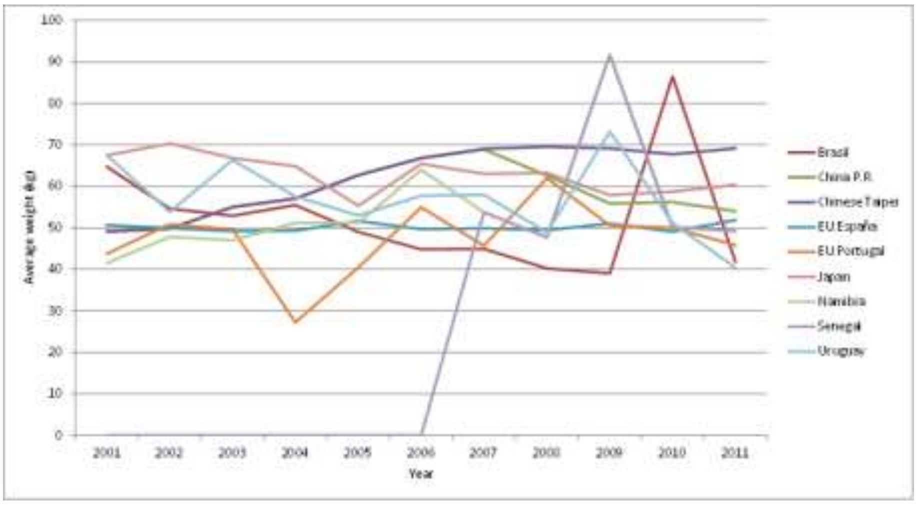


Figure 73 The average weight (kg) per swordfish per year (2001 – 2011) for the ten flags with the highest average catch from 2001 – 2011, in the South Atlantic.

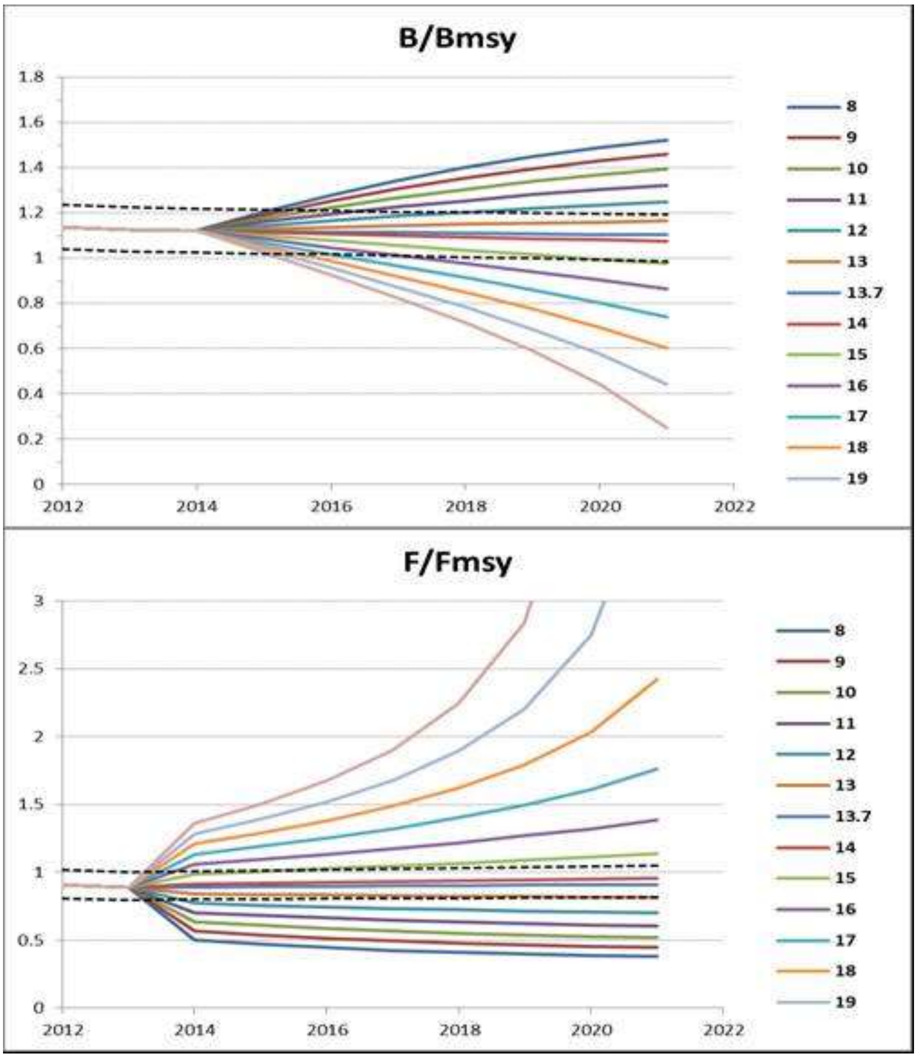
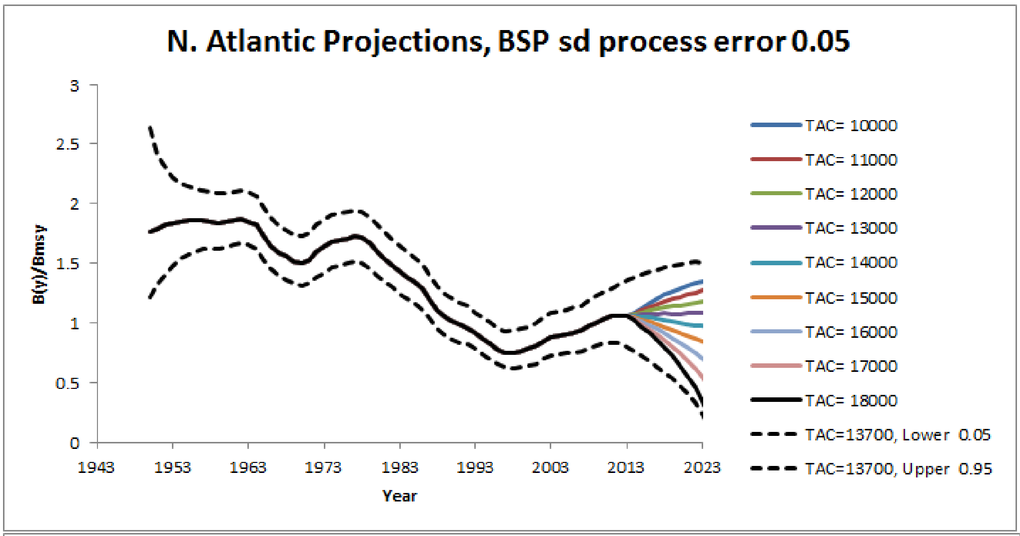


Figure 74 N-SWO Median trends of the relative biomass (B/Bmsy) and fishing mortality (F/Fmsy) for the projected north Atlantic swordfish stock based on the ASPIC SP model base run 2 under different constant catch scenarios (thousand tons). The lines show the median value of bootstrap runs and the dashed lines are 80% confidence intervals around projection at 13.7 thousand t in the projection time period and the observed catch in the historical time period. 13.7 thousand tons is the 2012 TAC.



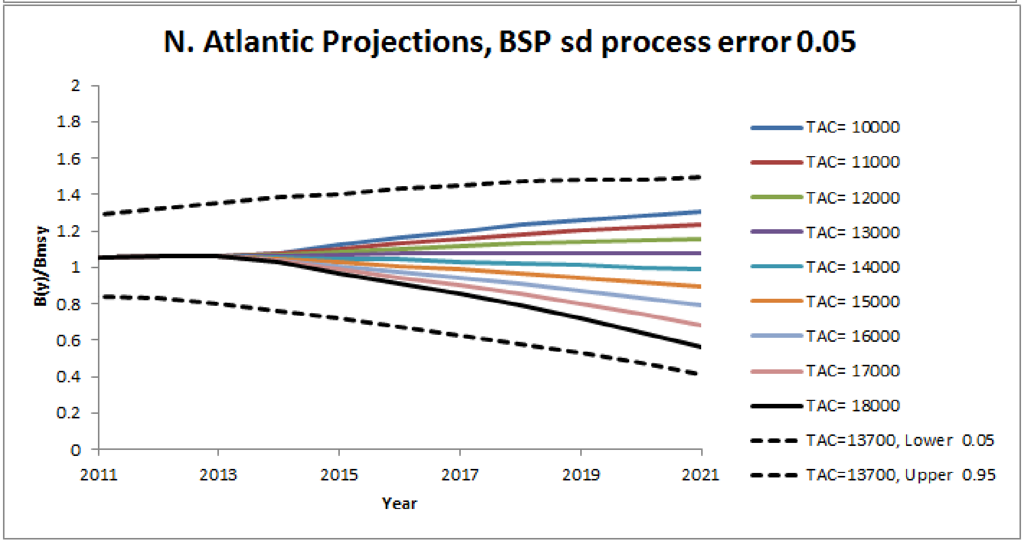


Figure 75. North Atlantic swordfish future projection of biomass/Bmsy from the BSP model with sigma on process error of 0.05. Dashed lines are 95% credibility intervals around a TAC of 13700t.

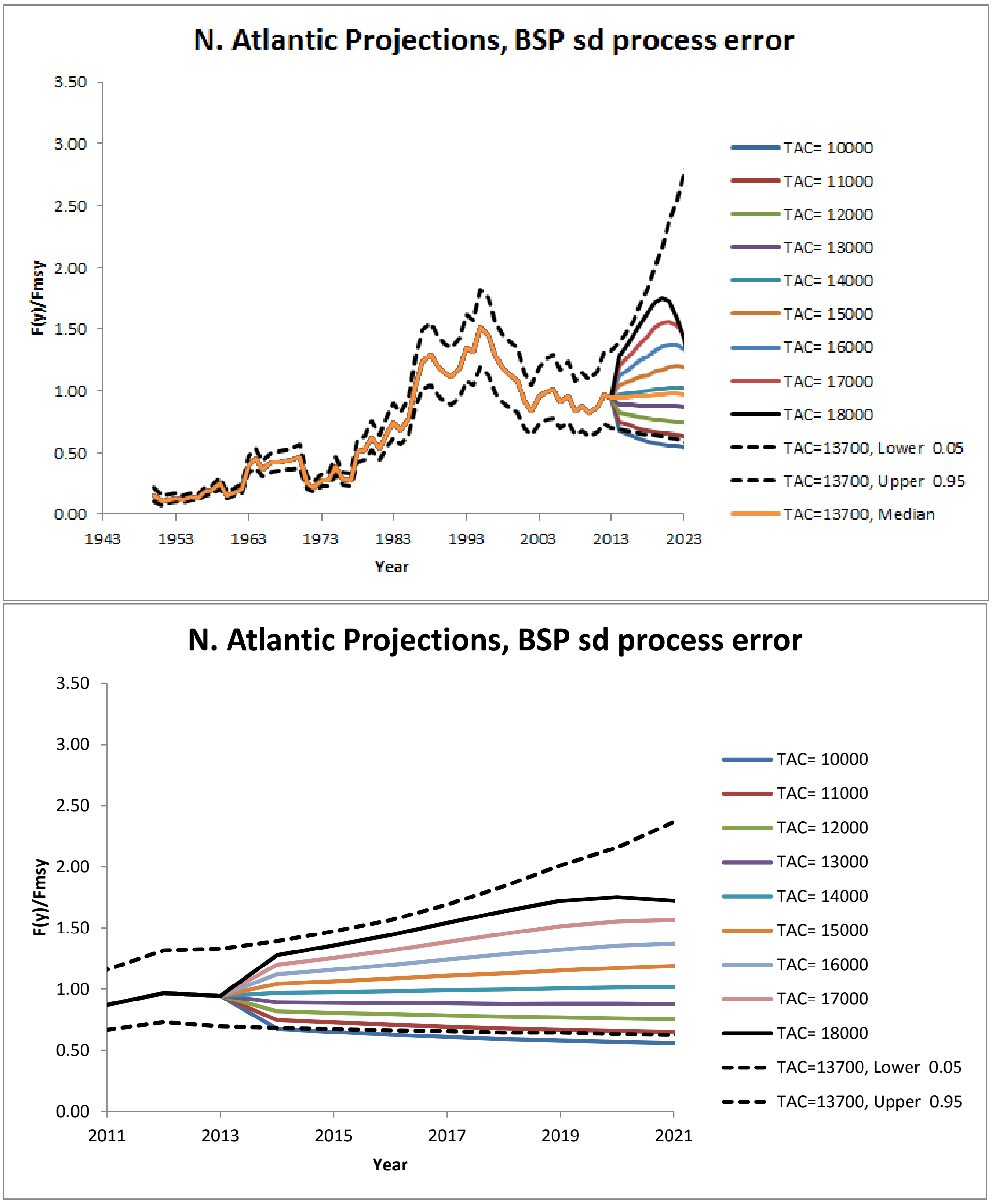
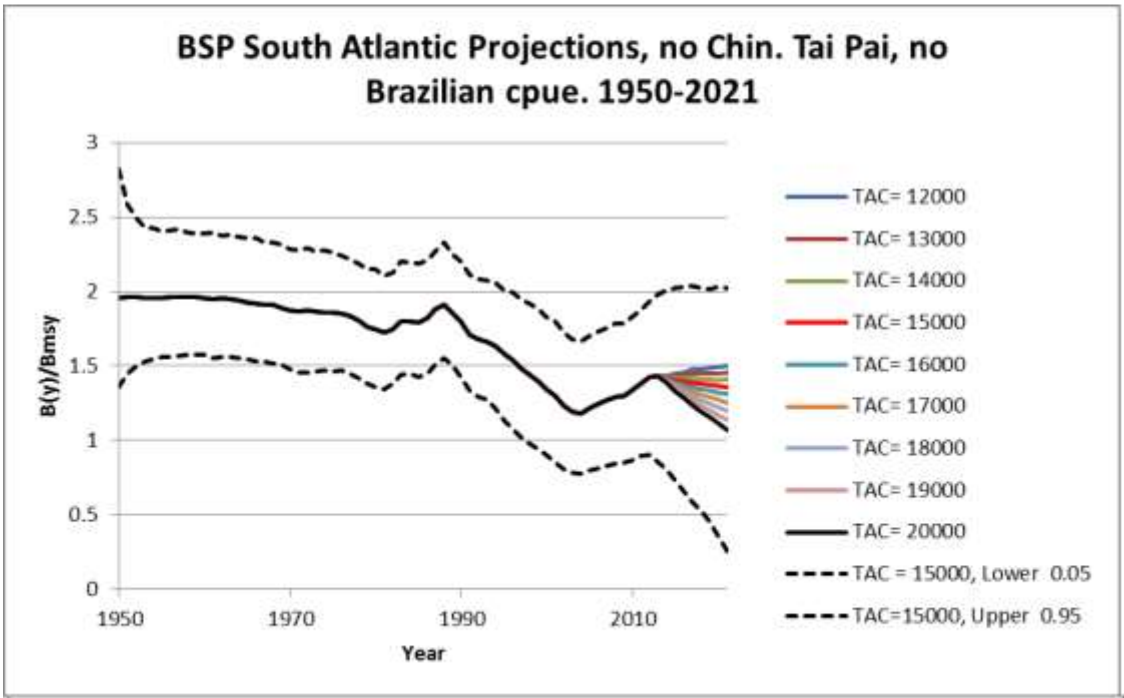


Figure 76 North Atlantic swordfish future projection of fishing mortality/Fmsy from the BSP model with 0.05 values for sigma on process error. Dashed lines are 95% credibility intervals around a TAC of 13700t.



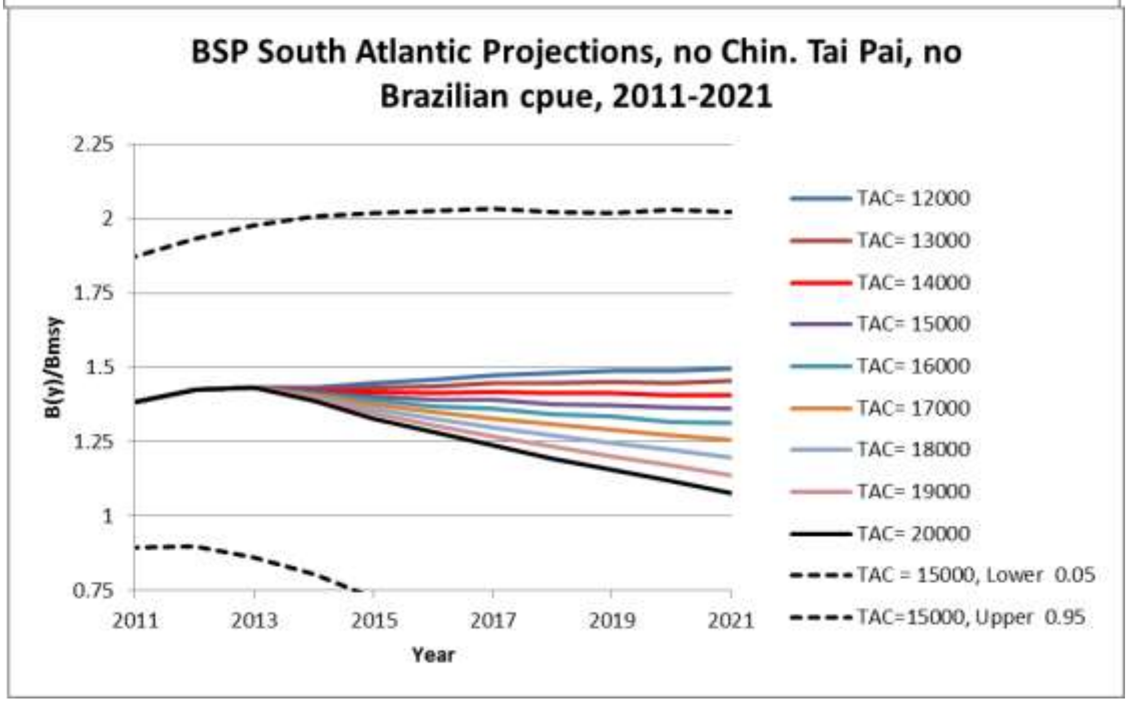


Figure 77. South Atlantic swordfish future projection of biomass/Bmsy from the BSP model. Dashed lines are 95% credibility intervals around a TAC of 13700t.

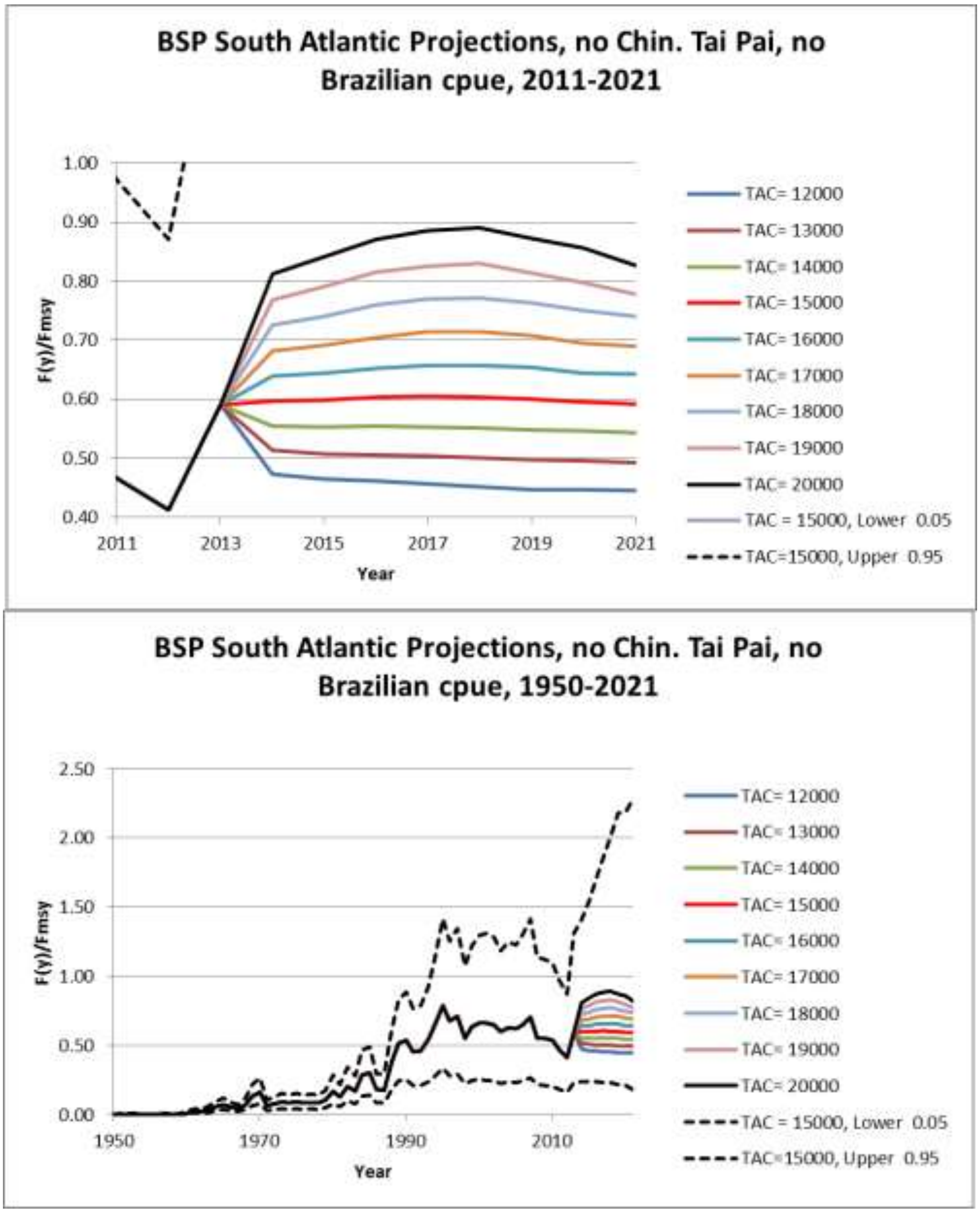


Figure 78 South Atlantic swordfish future projection of fishing mortality/Fmsy from the BSP model. Dashed lines are 95% credibility intervals around a TAC of 13700t.

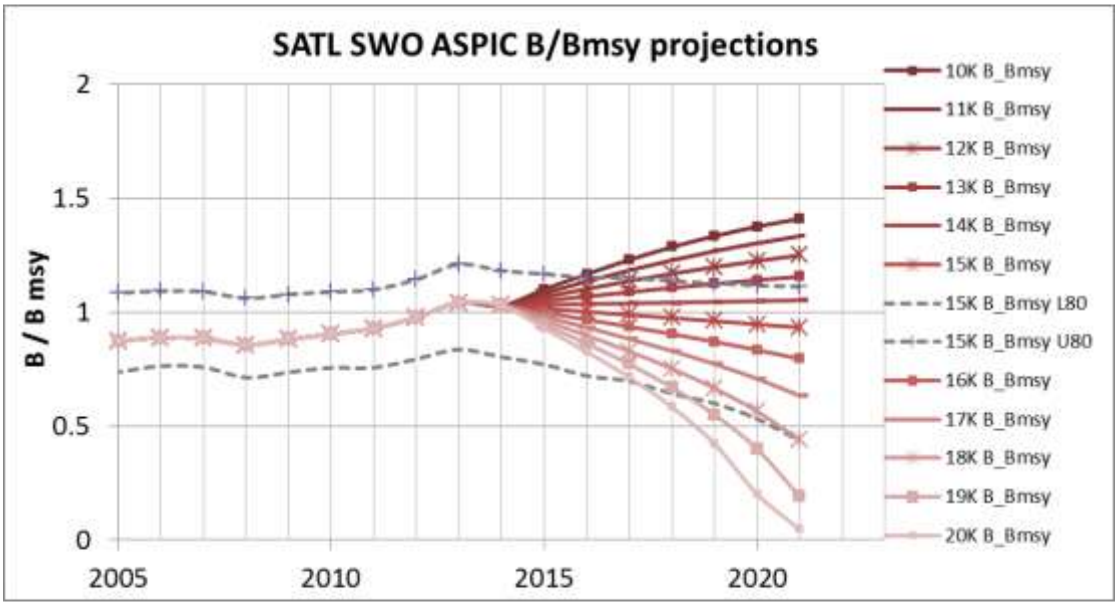


Figure 79 South swordfish projected biomass relative to Bmsy for different levels of catch from ASPIC model excluding Chinese Taipei longline indices.

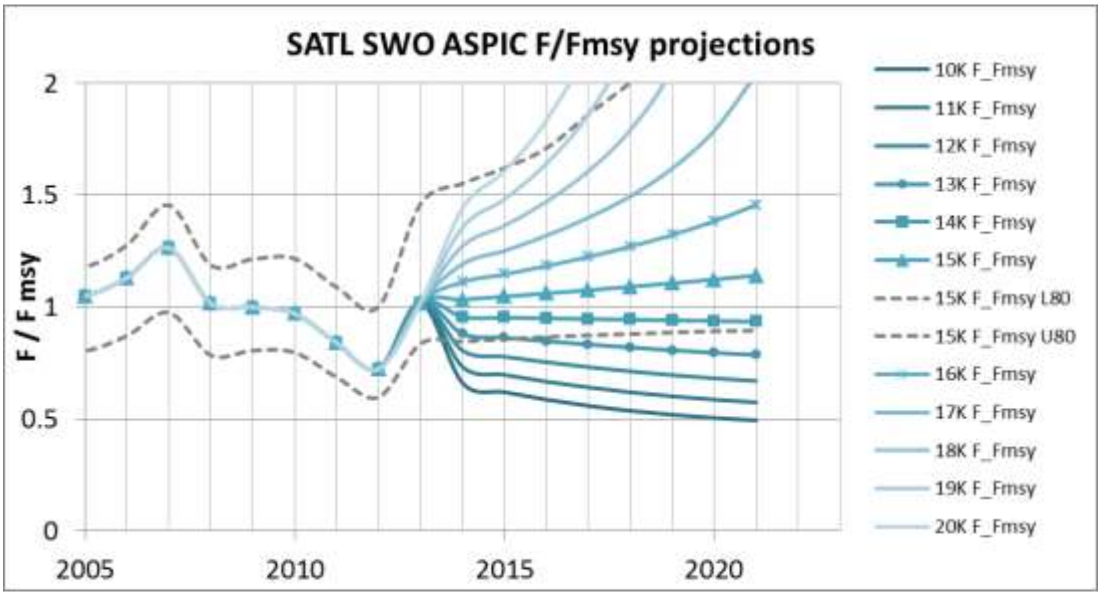


Figure 80 South swordfish projected fishing mortality relative to Fmsy for different levels of catch from ASPIC model excluding Chinese Taipei longline indices.

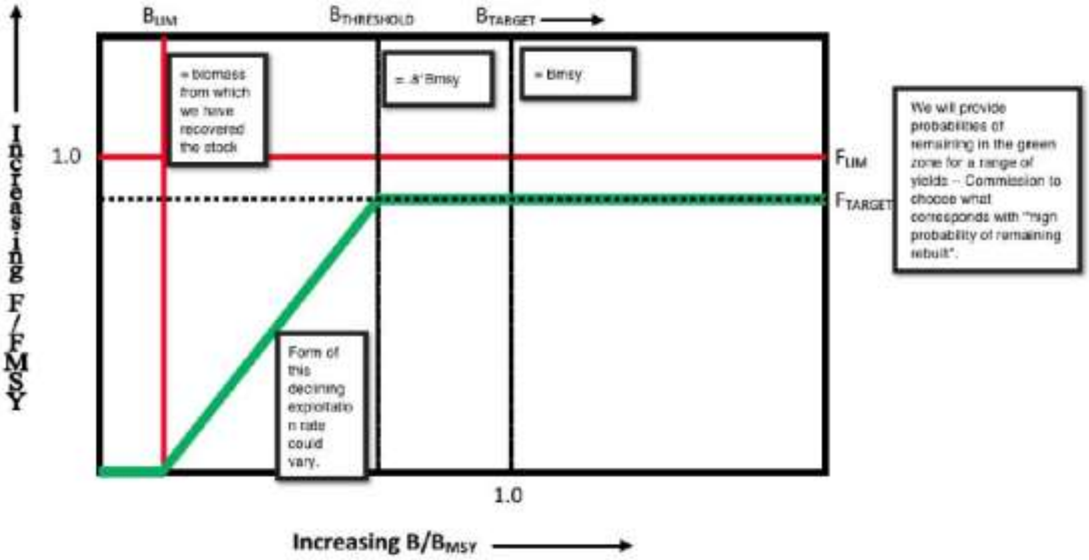


Figure 81 Harvest Control Rule and Limit Reference Points for North Atlantic swordfish that uses the template developed by the Stock Assessment Methods Working Group.

Appendix 1

AGENDA

1. Opening, introductions, adoption of the Agenda and meeting arrangements
2. Biological data, including tagging information
3. Catch data, including catch at size and fisheries trends
4. Relative abundance indices
   4.1 Relative abundance indices – North
   4.2 Relative abundance indices – South
5. Methods and other data relevant to the assessment
   5.1 Methods – North
   5.2 Methods – South
6. Stock status results
   6.1 Stock status – North
   6.2 Stock status – South
7. Projections
   7.1 Projections – North
   7.2 Projections – South
8. Limit reference points
9. Recommendations
   9.1 Research and Statistics
   9.2 Management
10. Other matters
11. Adoption of the report and closure

Appendix 2

LIST OF PARTICIPANTS

SCRS CHAIRMAN

Santiago Burrutxaga, Josu
Head of Tuna Research Area, AZTI-Tecnalia, Txatxarramendi z/g, 48395 Sukarrieta (Bizkaia) País Vasco, Spain
Tel: +34 94 6574000 (Ext. 497); 664303631, Fax: +34 94 6572555, E-Mail: jsantiago@azti.es; flarrauri@azti.es

COORDINATOR OF SWORDFISH SPECIES GROUP

Neilson, John D.
10 Moss Drive, Chamcook, New Brunswick Canada E5B 3G7
Tel: +1 506 529 5913, Fax: +1 506 529 5862, E-Mail: john.neilson@dfo-mpo.gc.ca

CONTRACTING PARTIES

CANADA

Hanke, Alex
Scientific, St. Andrews Biological Station/ Biological Station, Fisheries and Oceans Canada531 Brandy Cove Road, St. Andrews New Brunswick E5B 2L9
Tel: +1 506 529 4665, Fax: +1 506 529 5862, E-Mail: alex.hanke@dfo-mpo.gc.ca

EUROPEAN UNION
Neves Santos, Miguel
Instituto Portugues do Mar e da Atmosfera -I.P./IPMA, Avenida 5 Outubro s/n, 8700-305 Olhão, Portugal
Tel: +351 289 700 504, Fax: +351 289 700 535, E-Mail: mnsantos@ipma.pt

Ortiz de Urbina, José María
Ministerio de Economía y Competitividad, Instituto Español de Oceanografía, C.O de Málaga, Puerto Pesquero s/n, 29640 Fuengirola Málaga, Spain
Tel: +34 952 197 124, Fax: +34 952 463 808, E-Mail: urbina@ma.ieo.es

JAPAN
Kai, Mikihiko
Tuna Fisheries Resources Group, Tuna and Skipjack Resources Division, National Research Institute of Far Seas 5-7-1, Orido, Shimizu, Shizuoka 424-8633
Tel: +81 54 336 6039, Fax: +81 54 335 9642, E-Mail: kaim@affrc.go.jp

Yokawa, Kotaro
Chief, Tuna Fisheries Resources Group, Tuna and Skipjack Resources Division, National Research Institute of Far Seas Fisheries5-7-1 Orido, Shimizu-ku, Shizuoka-City Shizuoka 424 8633
Tel: + 81 543 36 6046, Fax: + 81 543 35 9642, E-Mail: yokawa@fra.affrc.go.jp

MOROCCO
Ayoub, Mohamed
Biologiste au Centre Régional de Dakhla, Institut National de Recherche Halieutique
E-Mail: ayoub.mohamed555@gmail.com

UNITED STATES
Brown, Craig A.
NOAA Fisheries Southeast Fisheries Center, Sustainable Fisheries Division75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 361 4590, Fax: +1 305 361 4562, E-Mail: Craig.brown@noaa.gov

Díaz, Guillermo
NOAA-Fisheries, Southeast Fisheries Science Center, 1315 East-West Highway # 13562, Silver Spring, Maryland 20910
Tel: +1 301 427 8589, Fax: +1 301 713 1875, E-Mail: guillermo.diaz@noaa.gov

Schirripa, Michael
NOAA Fisheries, Southeast Fisheries Science Center75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 361 4568, Fax: +1 305 361 4562, E-Mail: michael.schirripa@noaa.gov

Walter, John
NOAA Fisheries, Southeast Fisheries Center, Sustainable Fisheries Division, 75Virginia Beach Drive, Miami, Florida 33149
Tel: +305 365 4114, Fax: +1 305 361 4562, E-Mail: john.f.walter@noaa.gov

SOUTH AFRICA
Siyema, Tandiwe
Assistant Director, Department of Agriculture, Forestry and Fisheries, Private Bag X 02,
Tel: +27 793 360595, E-Mail: TandiweS@daff.gov.za
West, Wendy
Inshore Resources Research, Department of Agriculture, Forestry and FisheriesFore trust Building, 9 Martin Hammerschlag Way, Foreshore, Cape Town
Tel: +27 21 4023120, E-Mail: WendyW@daff.gov.za

URUGUAY
Domingo, Andrés
Dirección Nacional de Recursos Acuáticos-DINARA, Laboratorio de Recursos Pelágicos, Constituyente 1497, 11200 Montevideo
Tel: +5982 400 46 89, Fax: +5982 41 32 16, E-Mail: adomingo@dinara.gub.uy

EXTERNAL EXPERT
McAllister, Murdoch K.
Fisheries Centre, University of British Columbia, AERL, 2202 Main Mall, Vancouver, B.C. Canada
Tel: +1 604 822 3693, Fax: +1 604 822 8934, E-Mail: m.mcallister@fisheries.ubc.ca

****

ICCAT SECRETARIAT
C/ Corazón de María, 8 – 6/7 planta, 28002 Madrid
Tel: +3491 416 5600; Fax: +34 91415 2612; E-mail: Info@iccat.int

Ortiz, Mauricio
Kell, Laurence

Appendix 3

LIST OF DOCUMENTS

SCRS/2013/139	An Updated biomass index of abundance for North Atlantic swordfish 1963-2012. Ortiz M., Mejuto J., Andrushchenko I., Yokawa K., Walter J., Neves N. and Abid N.
SCRS/2013/151	Tracking of broadbill swordfish, Xiphias gladius, in the Central and eastern North Atlantic Abascal et al.
SCRS/2013/153	An aproach to age and growth of South Atlantic swordfish (*Xiphias gladius*) stock Quelle P. ,González F. , Ruiz M. , Valeiras X. and Gutierrez O.
SCRS/2013/154	Standardized CPUE of swordfish (*Xiphias gladius*) caught by the Taiwanese longline fishery in the North Atlantic ocean for 1967-2012, addressing the targeting change Sun C., Su N., and Yeh S.
SCRS/2013/155	Standardized CPUE of swordfish (*Xiphias gladius*) caught by the Taiwanese longline fishery in the South Atlantic ocean for 1967-2012, addressing the targeting change Sun C., Su N., and Yeh S.
SCRS/2013/157	Stock Assessment Diagnostics for South Atlantic Swordfish. Kell, L., Ortiz de Urbina J.M. and de Bruyn P.
SCRS/2013/158	Stock Assessment Diagnostics for North Atlantic Swordfish. Kell, L., Ortiz de Urbina J.M. and de Bruyn P.
SCRS/2013/159	Standardisation of the catch-per-unit-effort for swordfish (*Xiphias gladius*) caught by the South African pelagic longline fleet (1998-2012). West, W., Kerwath, S. Winker, H., and Smith, C.
SCRS/2013/160	North Atlantic swordfish 2013: stock synthesis configuration version 1.0. Schirripa M.J.
SCRS/2013/161	A hypothesis of a recent poleward shift in the distribution of North Atlantic swordfish (version 1.0). Schirripa M.J.
SCRS/2013/162	Likelihood Profiling by Data Components for the North Atlantic Swordfish ASPIC Assessment. Kell L., Ortiz de Urbina J.M. and De Bruyn P.