REPORT OF THE 2019 ICCAT YELLOWFIN TUNA STOCK ASSESSMENT MEETING

(*Grand-Bassam, Cote d'Ivoire, 8-16 July 2019*)

"The results, conclusions and recommendations contained in this Report only reflect the view of the Tropical Tuna Working Group. Therefore, these should be considered preliminary until the SCRS adopts them at its annual Plenary meeting and the Commission revise them at its Annual meeting. Accordingly, ICCAT reserves the right to comment, object and endorse this Report, until it is finally adopted by the Commission."

1. Opening, adoption of agenda and meeting arrangements

The meeting was held at Afrikland Hotel Grand-Bassam, Cote d'Ivoire July 8 to 16, 2019. Dr. Shannon L. Cass-Calay (USA), the Yellowfin Tuna Species Group ("the Group") rapporteur and meeting Chair, opened the meeting and welcomed participants. Dr. Justin Amande and Professor Datté J. Yao (Côte d'Ivoire) welcomed the participants and highlighted the importance of the work to be developed by the Group aiming at the preparation for the management advice to the Commission. At the opening of the session, the general inspector, Dr. Diawara Siriman, representing the Ministry of Livestock and Fisheries Resources, stated that the health of the tuna industry in Côte d'Ivoire, which is a flagship of the fisheries industry, is essential as the supply for the tuna companies of the country who depends on it. The Group thanked the Ministry of Animal Resources and Fisheries, supporting staff and Côte d'Ivoire scientist for kindly hosting the meeting and having arranged all necessary logistics for its success. The Chair proceeded to review the Agenda, which was adopted with changes (**Appendix 1**).

The List of Participants is included in **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3**. The abstracts of all SCRS documents and presentations provided at the meeting are included in **Appendix 4**. The following served as rapporteurs:

Sections	*Rapporteur*
Item 1	M. Ortiz,
Item 2	S. Cass-Calay, M. Ortiz, L. Ailloud
Item 3	L. Ailloud, A. Kimoto, S. Cass-Calay, M. Ortiz
Item 4	A. Kimoto, D. Die, C. Brown, M. Narvaez
Item 5	A. Kimoto, J. Walter
Item 6	S. Cass-Calay, G. Melvin, D. Die
Item 7	S. Cass-Calay, D. Die
Item 8	M. Ortiz

And the following served as assessment modelers;

Model	Modelers
Stock Synthesis	J. Walter, A. Kimoto, K. Sato, T. Matsumoto, H. Yokio, H. Winker
JABBA	R. Sant'Ana
MPB	G. Merino

2. Summary of available data for assessment

2.1 Biology

A presentation was made (SCRS_P_2019_037) regarding the age composition of yellowfin tuna captured in the Ascension Islands. Large yellowfin tuna are often observed. Captures (n = 341) were made by rod and reel and spear fishing modes during 2014-2017. Individuals from 50 to 192 cm, and 0 to 18 years were observed (**Figure 1**). Evidence of sexually dimorphic growth was also noted (**Figure 2**).

The group determined that the maximum age of yellowfin observed in this study (18 years) was consistent with a previous study in the Gulf of Mexico and USA Atlantic east coast (SCRS/2019/025), further supporting the change from Max Age = 11 to Max Age = 18 which was recommended at the data preparatory meeting. Furthermore, this study also confirms that individuals as old as 18 occur outside of the US, and closer to the areas where fishing pressure is higher (e.g. Gulf of Guinea).

The Group discussed the available length at age observations from Ascension, USA and South Africa, and noted that the variability in the length at age of young fish appears larger than the variability in the length at age of older fish (**Figure 3**.) The Group suggested that the unusual variability in length at age of young fish could arise as an artifact of birthdate assignment. For example, in the US study, birthdate is assumed to be July 1, but yellowfin born outside US waters may have been sampled in the US study. These fish could have true birthdates much earlier, leading to an error in age assignment. Errors could also occur because spawning season is protracted, so a fish born early in the spawning season would appear much larger at assigned age than a fish born late in the same spawning season. An assumed birthdate was not applied to the Ascension Island data. Therefore, the ages from that study are simply the number of annuli observed, and no adjustment is made to account for birthdate.

The Group also observed that studies in various areas (South Africa, USA, Ascension Island) suggest dissimilar growth patterns (**Figure 3**) but noted that this could arise as a function of differential fishing selectivity. The Group also discussed that there was strong bimodality in the length composition of the Ascension data, and that this data included older fish which were larger, on average, than those sampled in other areas. The Group concluded that the bimodality occurred because two types of sampling gear were used (rod and reel, and spear). The Group also concluded that most of the largest fish were captured by spear fishers, who frequently target the largest fish for sport. If such targeting creates a bias toward larger fish at age, this could explain the differences observed between the US and Ascension Island data.

The Group agreed that the Ascension dataset was appropriate for use in age-structured stock assessments (e.g. stock synthesis) but recommended that age assignment for the Ascension dataset be adjusted to consider birthdate to maximize the comparability of the datasets. Unfortunately, not all samples had edge type, so the adjustment could not be made during the meeting. Should these data be made available, the adjustment could be made. Also, stock synthesis requires age composition data to be assigned to a fleet or survey. The Group noted that the current fleet structure of the stock synthesis model does not include a fleet comparable to the Ascension spear fishery. Therefore, the Group recommended excluding the spear fishing data from the stock synthesis model inputs. The Group agreed that the rod and reel gear could be assumed to have similar selectivity as the longline fleets.

AOTTP Information

The working requested a summary of the information concerning growth from the Atlantic Ocean Tropical tuna Tagging Programme (AOTTP). Two analyses were presented. The first analysis was developed using data from recaptured yellowfin tuna released between 40-90 cm, with length data quality of "MEAS", with 46 to 74 days at sea. Fish were assigned an assumed age according to the Von Bertalanffy equation (Linf = 155.7; k=0.443, t0 = 0.0148). The age was calculated for the midpoint of the length between the release length and the recapture length. For the purposes of visualizing the data, 215 fish were randomly selected from the available observations (**Figure 4**).

The second similar analysis (**Figure 5**) produced a vector plot of the growth increments of AOTTP fish measured upon recovery. The relative age of each fish at the time of tagging was estimated from the length at tagging by inverting the von Bertalanffy (top panel) and Richards (bottom panel) growth equations using parameters estimated by stock synthesis. The age at recapture is then taken to be the age at tagging plus the time at liberty.

The results indicate that tagged fish released with lengths of less than 65 cm tend to grow slower (than the von Bertalanffy equation (Linf = 155.7; k=0.443, t0 = 0.0148) while fish above 65 cm tend to grow faster (**Figure 4**). The results suggest that the growth of yellowfin tuna is better estimated using a Richards function than a von Bertalanffy function. Therefore, the Group recommended that age-structured models use that functional shape (**Figure 5b**).

2.2 Catch, effort, size and CAS estimates

The Secretariat reported on the intersessional work done following the workplan from the data preparatory meeting. Task 1 Nominal Catch (NC) was updated and provided to the modelers ahead of the meeting. Total YFT catch (**Table 1**) included the estimates of the Ghana tropical tunas 2012-2018 (SCRS/2019/124), the data submitted by CPCs until June 26, 2019 and estimated 2018 catches. The 2018 reports of catches by CPC was incomplete, only about 58% of the total (**Table 2**). For those CPCs that did not report catch in

2018, and estimated YFT catch was calculated as the average of the 3 previous years (2015-2017). **Table 3 and Figure 6** show the total catches of YFT 1950-2018 by main gear used as input for the stock assessment models).

Catch distribution (CatDis) was also estimated for YFT extending the distribution to match the fleet distribution for the Stock Synthesis. **Table 6** shows the fleet structure used for the Stock Synthesis model, and **Table 4** shows the catch for each of the fleet as estimated from the CatDis. The Secretariat also provided the size samples composition for each fleet ID base on the Task 2 size data, SCRS/2019/66 document provides details and methods for estimating the size sample frequencies 1968-2017, no sufficient size information was available for 2018. During the meeting, review of preliminary runs and diagnostics were used to correct some of the fleet size information, see section 3.1.4 for further details. At the meeting is was noted that the size data from Venezuela contained in the ICCAT database for the 2006 PS and BB fleets was incorrect. It will be updated after the meeting. For this assessment this size data was excluded.

SCRS/2019/124 presented the estimates of the Ghanaian total tropical tuna catches from the purse seine and baitboat fisheries 2012-2018. These estimates included the catches for YFT, the size composition of the catch (Task 2 SZ), and catch and effort for the tropical tunas (Task 2 CE). The estimates are based exclusively on the AVDTH Ghana database, as it was concluded that sampling and coverage of the two main Ghanaian fleets is sufficient and appropriate to estimates total catch, catch composition, size distribution of catch and catch-effort distribution since 2012. To estimate the catch, catch-effort, and catch composition from the Ghanaian sampling program, the species composition and size sampling by fleet/vessel, year, month, gear, fishing mode and 1x1 lat-lon grid were used. The new estimates for YFT were lower in general compared to previous estimates presented for the bigeye stock assessment in 2018 (**Figure 7**). The differences resulted from the method used to estimate catch composition. In 2018 estimates were based on the EU and Ghana fleet composition data, while in 2019 only the Ghana sampling data was used.

A presentation (SCRS/P/2019/039) reviewed the fisheries trends of the Venezuelan purse seine, longline and baitboat fleets for 1987-2018. Catch and effort trends of these fleets has decreased from peak catches in the early 1990's, from about 8 to 2 thousand tons in recent years, for all three main gears. It was noted that the main fishing grounds are the eastern Caribbean region, with some expansion to the Guyana-Amazon area during the 2010s for the longline fleet only. The size distribution of the catch ranges from 30 to 190 cm FL YFT, with larger fish caught by the longline fleet, and small and medium size caught by the baitboat and purse seine fleets. It was noted that the sampling in all 3 fleets is done by trained observers, for the longline sampling is done by observers onboard, while for purse seine and baitboat is done at port.

Document SCRS/2019/100 was submitted on the EU-Spain Canary Islands fisheries for 1975-2018. During the data preparatory meeting document SCRS/2019/076 with similar information was presented and discussed by the Group, therefore document SCRS/2019/100 was not discussed at this meeting.

2.3 Relative abundance estimates

Three documents describing abundance indicators (CPUE) were submitted that had been previously discussed during the yellowfin tuna data preparatory meeting in April 2019. The changes made to these documents had been recommended by the Group. Therefore, these documents were made available intersessionally for review and were presented at the meeting but were not discussed in detail. These documents included:

- SCRS/2019/066: An index of yellowfin tuna in free schools for the EU purse seine fleet (EUPSFS index).

- SCRS/2019/075: An index of juvenile yellowfin tuna derived from echosounder buoys (BAI index).

- SCRS/2019/122: Regional indices of abundance for the Japanese Longline.

Two new abundance series were presented to the Group, summarizing CPUE series for the Venezuelan and Chinese Taipei longline fisheries. These are described below. The revised and new CPUE series are summarized **Table 5** and **Figure 8**.

SCRS/2019/123 document describes a standardized index of relative abundance for the Venezuelan longline fishery during the period 1991-2018. The index was estimated using generalized linear models and a delta lognormal approach. Two data sources were used, the Venezuelan Pelagic Longline Observer Program (1991-2011) and the National Observer Program (2012-2018). The index showed relatively constant values from 1992-2004, then increased to a maximum in 2007. Thereafter, the index showed a declining trend until 2010, after which it is stable at that level (**Figure 8**).

The Group discussed some technical aspects of the standardization, including the approach used to model a number of influential interaction terms. In the current standardization, the Group noted that year interaction terms were modeled using fixed effects and recommended that these be modeled using random effects. Generally, ICCAT has recommended the use of random effects because it produces expanded confidence intervals that may better represent scientific uncertainty. This change in the calculation of the index was carried out during the meeting and the updated index is shown in **Figure 9** and was provided to the modeling team for use in sensitivity analyses. The Group also noted that there are some important outliers in the lognormal component. These had not been removed because there was no evidence that they were erroneous.

The Group observed that the Venezuelan fleet operations have shifted over time toward the Atlantic Ocean, off the Guianas Shelf (**Figure 10**) and recommended that regional indices could be constructed (i.e. regions 1-3 used for the joint index) to better account for the movement of the fleet over time.

SCRS/2019/120 document describes a development of standardized indices of abundance from the Chinese Taipei distant water longline fishery during the period 1967-2018. Regional abundance indices of yellowfin tuna were developed by period using generalized linear models. The entire period (1967-2018) and three separate periods from 1967-1989, 1990-2005, and 2006-2018 were considered, with information on operation type (i.e., the number of hooks per basket, HPB) available for the latter period. The standardized indices showed almost identical trends between whole and separate periods. However, the trends differed amongst regions, especially since 2010, with an increase for the western tropical Atlantic Ocean but a slight decrease in the eastern tropical waters (**Figure 11**).

The Group observed that the spatial extent of this fishery is large, and that effort and nominal CPUE have shifted between areas over time (**Figures 12 and 13**), in large part due to changes in the target species (**Figure 14**). The author also noted that the substantial increase in the standardized CPUE in the mid 2000s may have resulted from ICCAT regulations to limit the catch of bigeye tuna, which caused some fishermen to target yellowfin tuna (Sun *et al.* 2014). The Group also noted that there are substantial changes in the size composition of the Chinese Taipei longline fishery which may result, in part, from changes in targeting and other fishing behaviors due to regulations imposed to limit the catch of bigeye. Because the joint longline index (SCRS/2019/081) already included the operational level data from the Chinese Taipei longline fleets, the Group had recommended the use of the joint indices in the stock assessment models, rather than the indices developed solely from the data of Chinese Taipei.

Due to changes in targeting, regulations and reporting, the Group expressed some concerns about the use of the Chinese Taipei data in the development of the joint longline CPUE index. Data were presented to the Group which indicated potential high-grading in the Chinese Taipei longline fleets after 2004. This date corresponds to a change in national regulations and the presenter noted that the observed change in the mean size of fish could potentially be due to discarding. The Group noted that discards are not included in the logbooks and that this could cause problems in the standardization of the joint index. For instance, there could be problems if the discard rate changes over time, and the selectivity of the index could be biased.

The Group requested that the author clarify the information used in the development of the joint index. The author responded to this request and following these discussions, the Group generally agreed to use the joint CPUE indices, as recommended by the data preparatory meeting. However, the potential impact of discards on the joint longline index warrants further investigation.

3. Stock assessment methods and other data relevant to the assessment

3.1 Stock Synthesis

3.1.1 Model setup and data inputs

An initial assessment of the Atlantic yellowfin tuna stock using Stock Synthesis 3.3 (Methot and Wetzel, 2013) was conducted prior to the 2019 Yellowfin Tuna Stock Assessment Meeting as agreed in the 2019 Yellowfin Tuna Data Preparatory Meeting. The full assumptions and data inputs to this model are described in SCRS/2019/121. Model inputs were discussed in detail at the 2019 data preparatory meeting (Anon, 2019).

The key assumptions and configurations of the initial "preliminary reference model" were as follows. The preliminary reference model was constructed as a model with 4 seasons and a timeframe from 1950 – 2018. Fleets are partitioned to represent homogenous fishing areas. However, this model does not have explicit movement between the areas and hence functions as a non-spatial, one-area model. The model starts in 1950 and assumes that the stock starts at virgin or near virgin conditions.

3.1.2 Natural mortality

Natural mortality (M) was parameterized by age according to Lorenzen (2005), scaling to the growth curve (section 3.1.3). This was conducted internally to the model to be consistent with the growth treatment in the model by assuming a value of natural mortality of 0.35 assigned to age 5 (baseline M), consistent with the Then et al. (2017) estimator of M, and assuming a maximum age of 18. This treatment differs from the 2016 assessment where growth was scaled externally with a baseline M=0.55 based on a maximum age of 11 and scaled according the Gascuel *et al*. (1992) size at age. The resulting M-at-age vector is defined below:

Age	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
M	1.3	0.66	0.48	0.4	0.37	0.35	0.34	0.34	0.34	0.33

Natural mortality was initially included in the grid of uncertainty, and during the data preparatory meeting two alternative values, upper and lower M vector were proposed (Anon 2019). However, these values were considered very low and high for yellowfin biology dynamics, and during the meeting the Working Group restricted this range to values of 20% above and below the baseline M (0.28 and 0.42, respectively). Still, however, these more extreme values of M were eliminated from the final stock synthesis model uncertainty grid because the low M scenario had poor diagnostic performance, and the high M scenario produced model estimates that were not consistent with the known biology (i.e. maximum age) of yellowfin tuna. The difficultly in using the low and high M may have been in part due to the fact that both steepness (*h*) and M were fixed in stock synthesis. The Group decided to use only the baseline M value (0.35) and recommended that further analyses be done to determine an appropriate range of M values based on simulation analyses and other biological information. A likelihood profile on M suggested that all values of M greater than 0.35 were equally probable.

3.1.3 Growth, morphometric relationships and reproduction

Following an evaluation of the growth of yellowfin recaptured in the AOTTP (**section 2.1**), the Group elected to use a Richards functional form for the growth model but decided to fix the parameters at the values estimated internally by stock synthesis using the US/GOM age data. Parameters were fixed to avoid introducing additional instability in the model. The weight of Atlantic yellowfin tuna in kilograms was estimated from straight fork length in centimeters as:

$$W_L = (2.1527 \times 10^{-5})\ SFL^{2.976} \qquad \text{(Caverivière 1976)}$$

Fecundity was modeled as a direct function of female body weight. The maturity at length was based on Diaha *et al*. (2016), with 50% maturity at 115 cm SFL. The sex ratio was assumed to be 50:50 males-females. Birth date was adjusted to the first month of each season (January, April, July, October).

Growth for yellowfin was estimated using recent otoliths sampling (GOM/US East Coast), that included age validation based on bomb-radiocarbon techniques (see section 2.1 from Anon. 2019 for more details). A major difference in the biological information is the new maximum age assumption of Age 18 for Atlantic yellowfin tuna, compared to the assumptions in previous assessments where maximum age was assumed to be 11. This has important implications for the estimate of natural mortality. Growth was estimated internally in stock synthesis using the US/GOM age data, assuming a Richards growth model, and a given size at minimum size of age sampling (0.38 year) of 25 cm SFL.

Regarding the use of age data for conditional age at length, the Group originally favored its use in stock synthesis, but model diagnostics were poor. A cross sectional catch curve applied to the age data estimated Z at 0.45. It was the Group's feeling that the Z experienced by the large fish found in the GOM and off the Eastern US could be lower and possibly not representative of the bulk of the exploited population. The Group therefore elected not to use the age data for conditional age at length.

3.1.4 Fleet structure

For the 2019 assessment, the model used 25 different fleets (**Table 6)**. Fleet structure was largely the same as in 2016 with some exceptions. First a new fleet was assigned to the emerging handline fishery off northern Brazil. Next, the longline fleet-areas were adjusted to coincide with the geographical areas of the joint longline index (SCRS/2019/121 Figure 2). This change applies to both catch by area/fleet and the size information.

During the meeting, a more detailed review of the size composition of each fleet and feedback from scientists familiar with the fisheries, suggested a need to restructure of some of the fleets. These changes included:

1. Fleet 11_GhanaBB_PS: The Group decided to impose four selectivity time blocks: 1981-1987 (mixed BB and PS), 1988-1995 (mostly BB), 1996-2018 (mixed BB and increasing PS) and prior to 1981 selectivity will match that estimated for 1988-1995 (mostly BB). For the most recent time block 1996-2018 the Group recommended removing the length composition data from 1996-2008 (blue box in **Figure 15**) where sampling for the expanding purse seine fishery was incomplete and likely not representative. These decisions were based on evaluation of the length composition inputs (**Figure 15**) and changes in the relative fraction of the catch landed by BB vs. PS (**Figure 16**).

2. Fleet 12_BB_area2_SDakar: The Group noted an increase in large fish in the size composition of the fleet in the last decade (**Figure 17**, recent years) and upon inspection of the data realized that it was being caused by the South African HL fishery which targets much larger fish than other BB. The decision was therefore taken to move South Africa HL catch and length data from Fleet 12_BB_area2_Sdak to Fleet 25_OTH_OTH.

3. Fleet 13_BB_DAKAR_62_80 and Fleet 14_BB_DAKAR_81+: clear outliers were present in the size data of the Venezuela BB (particularly 2006). The Group decided to remove all size data from Venezuela BB pending a more thorough evaluation of these records.

4. Fleet 24_PS_WEST: This fleet included the US PS and Venezuelan PS. Given that the majority of US PS catches prior to 1990 occurred in the Eastern Tropical Atlantic, the Group proposed to move US catch and size data prior to 1990 from Fleet 24_PS_WEST to Fleet 1_PS_ESFR2_6585 and Fleet 2_PS_ESFR2_8690. As with BB, clear outliers were present in the 2006 size data of the Venezuela PS. Given the limited time available to evaluate the problem, the decision was taken to remove Venezuela PS size data for 2006. The Venezuelan scientist confirmed that their original submission for 2006 by BB and PS was correct, the Group recommended to check and revise the ICCAT database.

5. Fleet 25_OTH_OTH: The length composition of Cabo Verde HL (originally assigned to Fleet 25_OTH_OTH) was similar to the Cabo Verde BB (included in Fleet 14_BB_DAKAR_81_18). The Group therefore decided to move catch and length data from Cabo Verde HL from Fleet 25_OTH_OTH (green line in **Figure 18**) to Fleet 14_BB_DAKAR_81_18. Due to this fleet being a 'catch-all' fleet, the selectivity is not well defined and there is a risk that the model will interpret the occasional spike in catches of 50 cm fish as large recruitment events when in fact the presence of these fish is most likely linked to

internal changes in fleet dynamics and local availability. The Group therefore recommended to down-weight the influence of this data using a much lower lambda (0.001).

6. Fleet 17_Japan_LL_TRO and Fleet 20_Other_LL_TRO: These fleets exhibit a shift in mean size at age through time. The Group discussed the possibility that these shifts in selectivity could be produced by increased discarding or by changes in fleet composition. Time blocks were proposed based on the Hoyle et al. (2019) influence plots which indicate a substantial shift in fleet composition, likely associated with the observed changes in selectivity. Time blocks on selectivity will be as follows 1950-1979 (early shallow sets), 1980-1991 (transition to deeper sets and BET targeting), 1992-2004 (deep sets) and between 2005-2018 to coincide with the apparent change in selectivity to target larger BET. Size composition data from the Chinese Taipei longline fishery was removed from 2005-2018 due to difficulties in interpretation of the increasing mean size (See **section 2.3**).

7. Fleet 22_HL_Braz_N: Lack of size composition data for the BRA HL fishery means the selectivity is poorly informed. The Group elected that selectivity of Brazil HL be estimated using prior distributions derived from the AOTTP tagging estimates, rather than mirrored to the Fleet 14_BB_DAKAR_81_18. Length composition data for 1994 (dominated by larger fish) was removed.

These changes led to a better prediction of mean lengths and improved the Pearson residuals from the fit to the length composition.

3.1.5 Abundance Index inputs

A major advance in this assessment was the development of a joint longline index using high resolution catch and effort information from the main longline fleets operating in the Atlantic (Japan, US, Brazil, Korea and Chinese Taipei). The index was developed for 3 regions; North Atlantic, tropical area and South Atlantic based on the size distribution of the catches for these fleets. This index was linked to the Japan longline fleet composition size data for estimating selectivity, as this fleet represents the majority of the size composition in region 2 after removal of the Chinese Taipei data from 2005-2018, and because it has had consistent size sampling. One index was used in the initial stock synthesis reference run, the Joint LL Region 2 index (SCRS/2019/121). Three time blocks (section 3.1.4) were applied to the selectivity assumed for this index to account for changes in targeting to bigeye tuna. To obtain the interannual variance for the joint index the geometric mean of each seasonal CV was obtained and used as input for the annual index. Indices were input as annual values.

The bouy associated index (BAI) index was modelled as linked to respective seasonal PS FAD fleets, which improved fit to the index. The EUPSFS index was linked to the PS EU FSC 91 season 1 where much of the catch comes from. Indices were input as annual indices, except the BAI index that maintained their seasonal information, with a mean CV=0.2 for the LL indices and 0.3 for the BAI and EUPSFS indices but allowed to vary with the interannual variability in the estimated standard error of the index.

The hindcasting diagnostic indicated better predictions of CPUE trend when the model included all indices of abundance.

3.1.6 Length composition

Length composition data were initially processed by the Secretariat (SCRS/P/2018/46) to remove outlier and to achieve generally homogenous fleet structure. After removal of outliers, no fish above 220 cm remained in the dataset. Size composition data was estimated following the same fleet structure described above (**section 3.2.4**) and it was updated during the meeting to also reflect the changes described in this document in terms of fleet restructuring.

Length composition was input with an initial sample size equal to the ln(N) to decrease the weight of multiple samples within a fleet, season, and year combination. Preliminary results indicated that size composition data has a large influence in the model fit and results. During the meeting further downweighing of the size composition to 0.5*ln(N) resulted in similar results but showed improvement in the fits and diagnostic test results. Thus, a lambda of 0.5*ln(N) was used to weight the size composition data in all accepted runs.

3.1.7 Stock recruitment parameterization

A Beverton-Holt stock recruitment relation was assumed to model the number of recruits as a function of spawning stock biomass. Virgin recruitment (R0) was freely estimated and steepness (h) was fixed at a value of 0.8 for the preliminary reference model and at 0.9 for the uncertainty grid. Profiling on steepness indicated that there was insufficient information in the data to freely estimate it. Annual variation in recruitment (SigmaR) was estimated in the stock synthesis models on the basis of a likelihood profile which supported estimation. The estimated total annual recruitment was distributed across the four seasons according to seasonal allocations estimated in the model. Deviations in annual recruitment were estimated from 1979 to 2017. The lognormal bias correction ($-0.5\sigma^2$) for the mean of the stock recruit relationship was applied during the period 1972 to 2017 with the recommended bias correction ramp applied to each model according to Methot and Taylor (2011).

During the meeting analyses showed that the reference model fit tended to produce unusually large recruitment peaks in 2017 and 2018, due primarily to the information from the BAI index that is treated as a recruitment index. Noting that there is no size composition data in 2018 in this model to corroborate or contrast with these high recruitment estimates, the Group decided to fix the 2018 estimates of recruitment to the stock recruitment curve rather than estimate them. Not estimating the recruitment deviation for 2018 substantially improved the reference model diagnostics.

3.1.8 Selectivity

Length-based selectivity was estimated for the fleets. **Table 7** outlines the functional forms chosen and time blocks imposed on each fleet.

3.1.9 Data weighting

Input variance adjustments were iteratively adjusted according to recommendations in Francis (2011).

3.1.10 Diagnostics

The Group discussed the initial models (SCRS/2019/121, runs 1-23) presented by the authors and a number of additional model runs were proposed, conducted and discussed (**Table 8**). A set of diagnostics were run to evaluate model performance including fits to indices of abundance, length composition residuals, retrospective analysis, hindcasting, likelihood profiling, Age Structured Production Model (ASPM) analysis, jitter analysis and sensitivity runs on influential parameters. The details of these runs are provided in **Table 8** and the following presentations: YFT stock synthesis.2019_Part1.inputs and diagnostics, YFT stock synthesis.2019_Part II reference grid development and sensitivity runs, YFT stock synthesis.2019_Part III reference grid developmentV3. Diagnostics on preliminary runs are available in presentation SCRS/P/2019/043. Diagnostics on the accepted runs are described in **section 4.1**.

3.1.11 Base case and sensitivity runs

The list of accepted runs is detailed in **Table 9**. The following characteristics were common to all runs: the Richards growth function was fixed to parameter values estimated internally by stock synthesis using age data from US/GOM, no conditional age at length data was used, M was scaled according to the growth curve using $M_{age\ 5}$=0.35, recruitment deviations were not estimated for 2018, a lambda of 0.5 was used to downweigh the length composition data. Sensitivity runs tested the influence of h (0.8 vs. 0.9) and the BAI index (including vs. excluding the index).

3.2 Surplus production model MPB

Document SCRS/2019/115 presented preliminary results from fitting the biomass production model mpb (Kell, 2016) to the YFT data using catch data and the joint LL R2 index for 1979-2018 (run 1). Updating the data from what was available in the 2019 Data Preparatory meeting with the most recent catch data made available by the Secretariat caused notable changes in the perception of stock status. Overall, the model had difficulty converging and diagnostics were relatively poor.

The Group expressed concerns over the fact that the model appears unstable. The model finds a solution only if strict constraints are imposed on the search space for *r* (intrinsic growth rate) and *K* (carrying capacity), and when the model did find a solution, that solution does not correspond to the minimum in the likelihood profile, suggesting poor convergence (**Figure 19**).

The Group discussed the following points: a) mpb has difficulty explaining the observed catch given the continuous decline in the CPUE, b) there are population dynamics and selectivity components that a biomass model simply cannot accommodate.

Unconstrained, the model tends to go to values of intrinsic growth rates *r* that are extremely low. It is therefore necessary to impose some level of constraint on the parameters. However, the Group felt that it was more defensible on a biological standpoint to constrain *K* on the left-hand side and leave *r* unconstrained, and expected that would improve the estimation of *r* (**Table 10**, run2). The Group also recommended to free up the B0 parameter as a potential solution for improving the fit (**Table 10**, run3). Freeing up B0 had almost no impact. Another proposal to improve fit was to include the EUPSFS index. Adding the PS index led to a slight improvement in the pattern of residuals for the indices in the most recent years and showed more stability in the jackknife analysis (**Figure 20**), with almost no change to the hindcasting and retrospective analyses. The Group asked to see if the *r* and *K* estimates change a lot retrospectively. The result showed no change in the retrospective pattern for *r* with a slight change for *K* and MSY. The LL region 1 index was later added to see if it would further improve the fit, but the model could not converge.

Finally, the Group agreed on a reference case (run 2) using two indices: Joint LL R2 and EUPSFS, as this was the scenario with better diagnostics.

3.3 Bayesian surplus production model JABBA

Document SCRS/2019/125 presented results from JABBA, a Bayesian surplus production model. Four scenarios were presented: a) base case (joint LL R2 with stock synthesis 2016 r prior), b) run 1 (joint LL R2 with FishLife r prior), c) run 2 (joint LL R2 + BAI with stock synthesis 2016 r prior), d) run 3 (joint LL R2 + BAI with FishLife r prior). FishLife r prior refers to a prior estimated using biological parameters available at FishLife database (www.fishbase.se/yellowfin_tuna) and size composition data used in stock synthesis in a model approach to derive surplus biomass parameters from age structure population dynamic model (Winker et al., 2018). This approach has been used in other ICCAT and tRFMOs assessments previously, with the objective of making comparable the runs between biomass surplus production models and length-age based integrated models such stock synthesis. In all scenarios, the model appeared to converge properly, though the inclusion of the BAI index worsened the diagnostics. Overall, the management quantities estimated were comparable across runs.

During the meeting, the JABBA base case run from SCRS 2019/119 was updated using an *r* prior based on the 2019 stock synthesis run results. The Group decided to exclude the 2 scenarios that use 2016 priors (runs 1 and 3) since they contain outdated information on the biology of the stock. All runs presented at the meeting are listed in **Table 11**.

The Group raised concern that the priors may be having too much influence on the results. Even the "uninformative" prior chosen for run 5 appeared to have information due to its lognormal shape. The Group therefore recommended to create a new run using the FishLife prior but with increased CV (run 14). Increasing the CV from 0.3 to 0.6 allowed the model more freedom to adapt to the data and the model converged on a value of *r* close to the one estimated by stock synthesis (**Figure 21**). This gave the Group confidence that the value estimated for *r* in the JABBA model is consistent with the information present in the integrated assessment. However, noting that this run had a higher RMSE in the fit to the index and a strong retrospective pattern (which is to be expected when giving more flexibility to the prior) the Group elected not to use a CV of 0.6 in the final selection of accepted runs. The Group did discuss the issue of taking results from a model fit and using it as data (as is the case with the stock synthesis prior). However, it considered that comparing JABBA results using FishLife prior with the expanded CV with runs that use the stock synthesis prior was a valuable exercise for checking that the model results are consistent with the data going into the assessment.

Following the observation that *K* and *r* appear highly correlated and that *r* is consistently being estimated at a value that is lower than that indicated by the prior, a question was raised on whether there is something inherent to mbp and JABBA that causes these models to favor lower values of *r*. The Group does not know if this observed propensity to favor lower *r* values is a true property of the model or simply a result of the data. The Group recommended to try a sensitivity run with ASPIC, whose properties are well studied, to check if the model results in similar estimates for *r*. ASPIC is not able to control the estimation of *r* the same way as JABBA or mbp, and when used with the available indices it leads to implausibly low estimates of *r*.

Regarding indices, the Group questioned the appropriateness of using the echosounder CPUE (BAI) in a production model as it reflects only the dynamics of recruits. On this basis, the Group elected to remove this run and instead test the impact of adding three new indices: EUPSFS, joint LL R1 and joint LL R3 over the Joint R2 index. All other indices except for the EUPSFS, showed evidence of lack of randomness of time-series residuals (**Figure 22**). Still, anytime more than one index was used, the conflict between indices consistently translated into a positive trend in the residuals in the earlier years and a negative trend in the residuals in the most recent years. The Group discussed the shortcomings of each index. Both LL and PS indices have shortcomings, such as changes in targeting, and technological advances that are difficult to properly account for. But, based on the diagnostics, the quality of the fit was best when using only the Joint LL R2 index (**Figure 22**) so the Group decided to use run 6 as the base case and include the other indices (except for BAI) in sensitivity analyses (run 13). Two additional sensitivity runs were selected to contrast results using the stock synthesis prior vs. the FishLife prior (runs 16 and 17).

The JABBA runs utilizing the Venezuelan longline index (VEN LL) showed a poor fit to VEN LL index, with a residual trend in the index fit as well as an increase in RMSE for the overall model fit. The Group agreed that runs including the VEN LL index should not be used for the uncertainty matrix. The Group affirmed, however, its recommendation these data should be included, if possible, in the next development of a multi-national joint LL CPUE index.

Another issue common to all runs was the increasing trend observed in the process error over the last decade (**Figure 23**). In state-space models, like JABBA, the observation error is accounted for in the fit to the indices, but the process error component represents all other processes that are not directly controlled or observed in the data used to modelling (e.g. growth, recruitment, catchability, catch, etc.). The Group noted that the increasing trend in the process error occurred the same year that stock synthesis has a selectivity change imposed. If the change in selectivity is indeed causing this pattern in the process error one could attempt to solve this in the production model by accounting for some autoregressive structure in q. Though this issue deserves to be further explored, resolving it is beyond the scope of the current assessment meeting.

Lastly, the Group compared results from mpb and JABBA. Though the Bayesian model showed better model convergence and diagnostics, both models resulted in similar parameter estimates, giving the Group confidence in the population dynamics being estimated.

4. Stock status results

4.1 Stock Synthesis

Following the development of the reference case described in **section 3.1** the Group determined the major axes of uncertainty to develop the uncertainty grid. The axes of uncertainty included:

1. To use/not use the Juvenile Index from Echosounder Buoys (BAI).
2. Steepness (0.8 and 0.9)

In preliminary model runs, the lambda on length composition (1, 0.5) and the natural mortality (0.28, 0.35, 0.42) had also been included as possible axes of uncertainty, but they were ultimately excluded from the final uncertainty grid for reasons indicated in sections 3.1. Briefly, the low natural mortality had poor diagnostic performance, and the high mortality produced results that appeared biologically implausible although the retrospective and hindcast analyses revealed no unusual behavior. The results from weighting the length composition with a lambda set to 1 or 0.5 were nearly identical, but the lambda 0.5 had improved model performance. The final stock synthesis uncertainty grid was composed of the 4 combinations of items above. *Note: the reference case is a member of the uncertainty grid.* The full listing of model runs, likelihoods and some diagnostic criteria are in **Tables 8** and **9**.

Diagnostic performance for the Stock Synthesis runs

All uncertainty grid runs had positive definite hessians and maximum gradient components less than 0.0001. Parameter estimates for the uncertainty grid models are shown in **Table 12,** and had relatively low standard errors except some of the spline parameters, the Richards K parameters and the descending limb of the PS-West, though some of the CVs are misleading as the parameters themselves were estimated to be very close to zero, inflating the CV. Also, there were relatively few highly correlated parameters with a few notable exceptions being K and the Richards growth parameter. There were no bound parameters in the uncertainty grid runs.

A full suite of diagnostic evaluations (likelihood profiles, jitter, retrospective, hindcast) were conducted for each model run. The jitter analyses (n=50) indicated that the models were stable (i.e. all MLE estimates were within one likelihood unit; **Figure 24**). Profiling of the key parameters (R0, steepness, sigmaR and M) for the reference case indicated that R0 was estimable (**Figure 25**) but that steepness was not (**Figure 26**). Regarding R0, there was conflict between the various data components, where the survey data favored a higher value of R0, relative to the length data. However, the survey data had little influence on the maximum likelihood estimate for that parameter. Profiles for natural mortality (M) at age 5 indicated that values of 0.35 and higher are equally probable (**Figure 27**), but that values below 0.35 are not supported. Due to the rather high correlation between steepness and R0, fixing certain values of steepness largely predetermined R0 (**Figure 28**). Hence it was necessary to fix steepness. Sigma R appears estimable (**Figure 29**) using the Methot and Taylor (2011) bias correction ramping. Hence it was considered unnecessary to include different values of sigmaR as part of the uncertainty grid.

Retrospective analyses showed no strong pattern for any uncertainty grid model (**Figure 30**). Hindcasting is a similar approach that can be used to evaluate multiple measures of prediction skill. In a hindcast a model is fit to the first part of a time series and then projected over the period omitted in the original fit. Prediction skill can then be evaluated by comparing the predictions from the projection with the observations (Kell et al. 2016). The hindcast results indicated that the uncertainty grid models had population dynamics that were able to predict the CPUE series used (Joint Longline Area 2, EU_PS_Free School) except for the Echosounder Buoy (BAI) index of juvenile yellowfin, which cannot be hindcast because there is no data in the hindcast to predict deviations from the stock recruitment relationship (**Figure 31**).

An Age Structured Production Model (ASPM) diagnostic was also conducted (**Figure 32**). This analysis was used to determine whether the stock synthesis results were consistent with age-structured production model population dynamics. The treatments for this analysis were: **base case** (the stock synthesis model run), **aspm**: running stock synthesis like ASPM using the selectivity parameters from integrated model, the recruitment deviation is not used, **aspm_est**: same as **aspm** but estimated recruitment deviation, **aspm_fix**: same as **aspm_est** but with fixed recruitment deviation from the integrated model). The results suggest that the Stock Synthesis runs behave much like ASPM when structured similarly.

Model Results

The fits to the indices (**Figure 33 – 36**) and the length composition aggregated by fleet (**Figure 37 – 40**) were examined and were considered acceptable. The Total Biomass, SSB, F and recruitment trends are shown in **Figures 41** to **44** and **Tables 13** and **14**. The recruitment deviations showed little trend in residuals, although some very large recruitment events were noted, including a large recruitment event in 2017 in the runs that included the juvenile index (EUPSFS). The model estimated selectivity values are shown in **Figure 45.**

The estimated stock recruitment relationships showed little evidence of a relationship between SSB and recruits (**Figure 46**) and there was insufficient contrast in the data to estimate steepness from the profiles (see **Figure 26**). Recruitment by season indicates that the highest fraction of recruits was estimated to be born in seasons 1 and 2 (Jan-June) and the lowest in season 4 (Oct-Dec) (**Figure 47**). Time series of the numbers at age shows little evidence of strong cohort structure and a decline in the mean age in the population over time (**Figure 48**).

The estimated maximum sustainable yield (MSY) in 2018 for the uncertainty grid models ranged from 101,779 to 120,468 t (**Table 15**). These values were similar to those reported in the 2016 assessment (123,139 to 123,382). Calculations of the time-varying benchmarks show a long-term increase in SSB_{MSY} and a general long term decrease in F_{MSY} and MSY (**Figure 49**).

In general, the estimated SSB/SSB_{MSY} and F/F_{MSY} trajectories showed very similar trends for all stock synthesis uncertainty grid models (**Figure 50**). The SSB/SSB_{MSY} has shown a significant decreasing trend since the 1960s, and the SSB_{2018}/SSB_{MSY} value was the lowest in the time series, with values that ranged from (1.17 to 1.39). These values were generally higher than the estimated biomass levels estimated in the 2016 stock synthesis model runs (0.81 to 1.38). Fishing mortality (exploitation in biomass) increased to a maximum in the early 1980s and 1990s then declined until the mid 2000s before increasing again to high levels by 2018 (**Figure 50**). Fishing mortality in 2018 was at or near the highest level in the time series. The estimated values of F_{2018}/F_{MSY} ranged from (0.86 to 1.19).

Combined results of the stock synthesis uncertainty grid

A Kobe plot was developed using the stock synthesis results from all uncertainty grid models. According to the Stock Synthesis results, the estimated SSB/SSB_{MSY} indicates that the 2018 stock is not overfished (1.32 with 90% CI: 1.02 – 1.69); **Figure 50**, top and **Figure 51**) The F/FMSY in 2018 varied by model run, but on aggregate suggests that the stock was near the overfishing threshold (0.93 with 90% CI: 0.56 – 1.43) ; **Figure 50**, bottom and **Figure 51**). In 2018, the probability of overfishing and overfished (red) was 3.4% the probability of being overfished but not overfishing (yellow) was 0.5%, the probability of not being overfished but overfishing (orange) was 36.9% and the probability of being neither overfished nor overfishing (green) was 59.3%.

4.2 Surplus production model MPB

After the Group discussed Document SCRS/2019/115, the updated MPB results were provided. For MPB, the Group agreed on a reference case using two indices of abundance: joint longline index Region 02 and EU purse seine free school (EUPSFS) index. 500 bootstraps were run to characterize the statistical uncertainty for this Reference Case. **Table 16** shows the estimated parameters and MSY based benchmarks summarized by means, medians and 90% confidence intervals.

The trajectory of the estimated biomass (**Figure 52**, upper panel) showed a continuous decreasing trend from 1950 to the early 2000s, and a slightly increasing trend afterwards (**Table 17**). The fishing mortality increased gradually from 1950 and reached the historical highest value in early 2000s (**Figure 52**, lower panel, **Table 17**). It was gradually decreased to the late 2000s and remained flat, however some increase was observed in the recent years (2005-2018). The retrospective analysis (**Figure 53**) shows a pattern where the model tends to overestimate biomass and underestimate fishing mortality as a new year of data is added. The retrospective runs were projected forward with catch observations (hindcast diagnostic) and new trends of biomass were compared with the reference case. The results (**Figure 54**) shows relatively good prediction skill, as indicated by predicted biomass falling within the confidence intervals of the bootstrapped estimate, except for the 10-year retrospective case.

Figures 55 and **56** show the estimated trajectory of the stock on a Kobe diagram and the marginal density distributions of the bootstraps for the relative stock status estimates in 2018. **Figure 56** also shows the probabilities of the stock being in the different quadrants of the Kobe plot. According to the estimates of the MPB-Reference Case, Atlantic yellowfin stock is currently not overexploited and not undergoing overexploitation (green area of the Kobe plot) with probability (56%).

4.3 Bayesian surplus production model JABBA

After the Group reviewed Document SCRS/2019/125 and discussed various additional scenarios (**Table 11**), it was agreed that the following 4 scenarios (Base Case, S2, S3, and S5) are the final Reference Cases for JABBA.

- Base Case: Joint longline index Region 02, and use *r* prior from the stock synthesis setting in 2019
- S2: Joint longline index Region 02, and use *r* prior from Generic FishLife

- S3: Joint longline index Regions 02 and 01 and EU purse seine free school (EUPSFS), and use *r* prior from the stock synthesis setting in 2019
- S5: Joint longline index Regions 02 and 01 and EU purse seine free school (EUPSFS), and use *r* prior from Generic FishLife

The Group agreed to carry out two sensitivity runs (S6 and S7) based on the Base Case and S2 scenarios to evaluate the effect of Venezuelan longline index provided during the stock assessment meeting.

- Sensitivity S6: Base Case + Venezuelan longline index
- Sensitivity S7: S2 + Venezuelan longline index

The estimated parameters and values of biomass and fishing mortality for all Reference Cases are shown in **Tables 18** and **19**. The trajectory of B/B_{MSY} in the Reference Base Case showed a continuous decreasing trend from 1950 to 2018 (**Figure 57**, right panel). In the 2010s, the trend of become relatively flat but reached at the historical lowest level and remained below B_{MSY} (base case B_{2018}/B_{MSY} =1.02). The trajectory of F/F_{MSY} (**Figure 57**, left panel) showed an overall increasing trend from the beginning of the time series to its end of the time series, except several years in the mid-2000s. F/F_{MSY} in 2016 was quickly increased to the historical highest value (1.02), and remained at close to 1.0 afterwards but not overfishing (F_{2018}/F_{MSY} = 0.95). A retrospective analysis for eight years was also examined which showed no retrospective patterns and very consistent estimates (**Figure 58**).

All Reference Cases generally showed similar trends in B/B_{MSY} and F/F_{MSY} (**Figure 59**), but the values showed two parallel patterns except B/K; Base Case and S3, and S2 and S5 were very similar. The estimated K values in Base Case and S3 were larger than those in S2 and S5 (**Table 18**), that caused by the different assumption on prior distribution of *r* (use *r* prior from the stock synthesis setting in 2019 or from Generic FishLife). These differences produced the higher B/B_{MSY} values and smaller F/F_{MSY} values in Base Case and S3 compared to those in S2 and S5.

Hindcasting (Kell *et al*., 2016) was conducted for the four Reference Cases by projecting over the period omitting the last 8 years from the time series and comparing to the models that utilized the complete time series (**Figure 60**). The prediction skill of joint longline index Region 02 performs better for the Base Case than for S2 run. When multiple CPUEs were used in S3 and S5, the model did not forecast joint longline index Region 02 well, while the projections for the other indices performed better. All predicted indices remained within the 95% credibility intervals of 10,000 MCMC iterations.

The Group explored the sensitivity analyses including the Venezuelan longline index on the S3 and S5 runs (Sensitivity S6 and S7). Residual diagnostic (**Figure 61**) and the randomness of the time series of CPUE residuals (**Figure 62**) showed strong trend and pattern on the Venezuelan longline index. The RMSE increased from 9% in the Reference Base Case to 47% with this index. Given that the use of the Venezuelan index did not improve the JABBA models, the group did not recommend its use at this time. Instead, the group recommended that the Venezuela longline index data be included in the standardization method of the joint longline index for Atlantic fisheries.

The Group reviewed the trajectories of B_{2018}/B_{MSY} and F_{2018}/F_{MSY} from each JABBA Reference Cases (**Figure 63**). The Group was concerned that some of the Kobe plots did not show a typical anti-clockwise pattern with the stock status moving from underexploited level through a period of unsustainable fishing to the overexploited phase. This could be related to the changes in selectivity over the time series, that surplus production models commonly do not take into account. This pattern is more sensitive in JABBA that estimates the process error (see Section 3.3) which may explain the distinction between JABBA's and MPB models.

The combined posteriors of B_{2018}/B_{MSY} and F_{2018}/F_{MSY} from the four JABBA Reference Cases (**Figure 64**) predicted 48.9% probability that the stock remains overfished and that overfishing is still occurring (red quadrant), while being in the green quadrant with 42.6%, 6% in the yellow quadrant, and 2.5% in the orange quadrant (i.e. overfishing but not overfished).

4.4 Synthesis of assessment results

Data inputs and model structure

During the data preparatory meeting the Group agreed on the data inputs to be used with the two modelling platforms deemed to be appropriate for the evaluation of stock status: production models (JABBA and MPV) and a statistically integrated assessment model (Stock Synthesis). A subset of the data inputs had to be prepared/updated after the data preparatory meeting (e.g. VEN LL, buoy BAI and EU free school (EUPSFS) indices of abundance, catch per fleet, size data). At the data meeting, the Group also agreed on the main axes of uncertainty associated with the different data inputs and model structures: natural mortality, growth, stock productivity (*r* or steepness), sub-sets of indices of abundance, statistical weight of different data inputs.

During the meeting, the Group investigated an initial set of models fitted during the intersessional period together with the appropriate diagnostics (residuals of fit to each data set, hindcast predictions, retrospective analysis, likelihood profiles for each parameter and data input, ASPM diagnostic for stock synthesis, differences between posterior and prior for Bayesian models). Model runs that were deemed to have inappropriate diagnostics, were eliminated from the data set. The failure of the diagnostics of certain model runs was also used to revise the axes of uncertainty and final model specifications.

The following production model runs were retained for management advice:

- JABBA with joint longline index of tropical area (region 2), and *r* prior consistent with Stock Synthesis 2019 estimates
- JABBA with joint longline index of region 2 and *r* prior based on inputs from FISHLIFE
- JABBA with joint longline indices of region 2 and northern area (region 1) and purse seine free school index, and *r* prior consistent with Stock Synthesis 2019 estimates
- JABBA with joint longline index of region 2 and region 1 and purse seine free schools index and *r* prior based on inputs from FISHLIFE
- MPB with joint longline index region 2 and purse seine free school index

Four Stock Synthesis model runs were retained for management advice, obtained by the combination of two valued of steepness and two set of abundance indices:

- without buoy index of abundance (BAI) and with steepness 0.8 (run 1)
- without buoy index of abundance and with steepness 0.9 (run 2)
- with buoy index of abundance and with steepness 0.8 (run 3)
- with buoy index of abundance and with steepness 0.9 (run 4)

All other specifications of Stock Synthesis were the same for the four model runs. The most important specifications of Stock Synthesis that need to be highlighted are:

- natural mortality changes with age, and for age 5 is 0.35
- Richard's growth model was initially estimated with age composition data and its paramenters fixed for the final stock synthesis runs
- all models included the joint longline index for region 2 and the purse seine free school index
- the buoy index (BAI) was used as a quarterly abundance index for FAD fisheries
- the statistical weight of length composition data was fixed to 0.5 for all runs
- a few changes to structure of fleets agreed during the data preparatory meeting, including adding new periods of change in selectivity for some fleets
- eliminated some sets of size data for certain fisheries that could not be accommodated with the final fleet structure of the model
- data is not sufficient to estimate recruitment deviations in 2018, the last year of assessment.

Stock status

The trend in the estimated biomass for all models shows a general continuous decline in biomass through time. Stock Synthesis runs suggest a few periods of large increases in spawning biomass associated with episodes of high recruitment. Such very high recruitments have only happened three times in the period 1960 to 2017. Production models show much less pronounced increases in total biomass at the equivalent times. Note, however, that for all models there are large uncertainties in the value of biomass at any point in the history, including 2018 (**Figure 65**). Most model runs lead to biomasses at the end of 2018 above the level that produces MSY (**Figure 66**).

Estimates of historical fishing mortality show similar trends for all models. For most model runs, fishing mortality increased progressively until the early 1980s, it varied in level until the mid 1990s, after which it declined gradually until the mid 2000s. Since the mid-2000s, the fishing mortality has had a generally increasing trend with fluctuations until 2018. Overall the models estimate that the fishing mortality in 2018 was near the fishing mortality that would produce MSY, with the majority of the models estimating fishing mortality to be below that level. Again, for all models there are large uncertainties in the value of fishing mortality at any point in the history, including 2018 (**Figure 67**).

It is important to note that the Stock Synthesis model is the only one that can provide estimates of recent recruitment. Recruitments were not estimated to vary from the stock-recruit relationship for 2018, due to the large uncertainty in terminal year recruitment estimates. The estimate of recruitment in 2017 is also more uncertain than for previous years, in part because there is no 2018 size frequency data to corroborate or contrast with it. Stock Synthesis models which use the buoy index suggest very high recruitment in 2017, whereas models that do not use the buoy index suggest that recruitment in 2017 was above average but not particularly high. The alternative assumptions about recruitment produce some differences in estimates of historical trends and current status, but the largest differences are seen in the projections, which will be discussed in the next section.

In considering how to synthesize management advice (e.g. current [2018] stock status), the Group considered a number of factors. In a general sense, Stock Synthesis may be considered to be a more appropriate model for the situation observed in the YFT fisheries, where overall selectivity has changed over time mostly towards an increase in the probability of catching small fish. The surplus production models do not take this into account. This was a basis for developing the final status and projection advice for BET in 2018 only with stock synthesis. However, in this YFT assessment, Stock Synthesis results were deemed to be very sensitive to the alternative data inputs and model structures considered. The Group considered that the accepted runs from surplus production models reflected different, reasonable hypotheses for the YFT population dynamics and thus were included in the management advice.

The four Stock Synthesis model runs, were regarded as representing alternative recruitment, and steepness hypotheses. Likewise, the JABBA runs addressed different hypotheses about initial priors for *r*, and about which indices of abundance were representing the population. Finally, the base case selected for MPB estimated biomass and fishing mortality trends that varied somewhat from JABBA. The Group decided that, in order to capture this uncertainty in the population dynamics for developing the management advice, it was best to incorporate results from all of the accepted model runs.

The Group decided to give equal weight to surplus production model and integrated assessment model results. Within surplus production models, JABBA and MPB were also given equal weight. Each run within a modeling platform (JABBA, and Stock Synthesis) were given equal weight. All benchmarks were calculated following this weighting scheme. A distribution of estimates for each benchmark was calculated by combining the following number of random estimates from the various models: 100 for each of the four JABBA models, 400 for the MPB model and 200 for each Stock Synthesis model. This provided a set of 1600 iterations. Median, 5 and 95 percentiles were then calculated from each distribution.

For the combined results (MPB, JABBA, SS) used to develop management advice, the median estimate of B_{2018}/B_{MSY} is 1.17 (0.75, 1.62) and the median estimate of F_{2018}/F_{MSY} is 0.96 (0.56, 1.50). The median MSY estimated is 127,558 tons with 90% confidence intervals of 98,268 and 267,350 tons (**Table 20**). Combining the results of all models provides a way to estimate the probability of the stock being in each quadrant of the Kobe plot in 2018 (**Figure 68**). The corresponding probabilities are 54% in the green (not being overfished not subject to overfishing), 21% in the orange (subject to overfishing but not being overfished) 2% in the yellow (being overfished but not subject to overfishing) and 22% in the red (being overfished and subject to overfishing).

5. Projections

The Group agreed to project each of the models (i.e. stock synthesis, MPB, and JABBA) using the following general specifications.

- Projection interval: The Group agreed to make projections over a 14-year interval, 2020-2033, which corresponds to two generation times of yellowfin tuna.
- 2019 Catch: Fixed at 131,042 t, the same catch as was estimated for 2018.
- Constant catch projections were made at 0 t, and 60,000 – 150,000 t, by 10,000 t intervals: 11 catch scenarios in total.

For stock synthesis setting,

- Recruitment: Based on the estimated stock recruitment relationship with no recruitment deviations.
- Selectivity and fleet allocations: It is necessary to specify the selectivity pattern for projections. The appropriate pattern is model specific. Use average of the last three years of the model (2016-2018).

5.1 Stock synthesis

For stock synthesis uncertainty grid, the statistical uncertainty of catch projections were estimated using 2,500 multivariate normal (MVN) iterations for each model of the grid (run1 (Reference Case), run 2, run 3, and run 4) for each constant catch scenario. Due to the technical problem in MVN approach, the values of F/F_{MSY} more than 4 or B/B_{MSY} less than 0.2 were replaced to 4 or 0.2 (SCRS/2019/145). The trajectories for relative biomass and fishing mortality using the median of MVN iterations are shown in **Figure 69.** The projections in runs 1, 2 and 3, and 4 (**Figure 69**) showed that the median of MVN iterations could maintain the stock above B_{MSY} level and below F_{MSY} by 2033 with the constant catches less than 110,000 t, 120,000 t, and 130,000 t, respecitively. However, the projections in runs 1 and 2 clearly indicate that constant catch higher than 140,000 t leads to population crash in later years.

5.2 MPB

Catch projections from the 5000 iterations developed from the MPB-Reference Case were carried out. The deterministic trajectories for relative biomass and fishing mortality are shown in **Figure 70**. The projections with MPB (**Figure 70**) showed that according to the the median of 5000 bootstrap iterations, constant catches less than 130,000 t could maintain the stock at or above B_{MSY} level and below F_{MSY} though 2033

5.3 JABBA

Catch projections from 36,000 MCMC iterations were conducted for each JABBA Reference Cases (Base Case, S2, S3, and S5). The trajectories for relative biomass and fishing mortality using the median of MCMC iterations are shown in **Figure 71.** The projections with JABBA in Base Case, S3, and S5 (**Figure 71**) showed that according to the the median of MCMC iterations, constant catches less than 130,000 t. could rebuild (S5) or maintain the stock at or above B_{MSY} level and below F_{MSY} through 2033 However, the projection with S2 could rebuild the stock at or above B_{MSY} level and below F_{MSY} by 2033 with the constant catches less than 120,000 t.

5.1 Synthesis of projections

Combined catch projections from 9 runs (JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1, 2, 3 and 4) were provided at constant catches ranging 0 t and from 60,000 to 150,000 t. The method used to combine the projection results is described in section 4.4. In the projections results from the Stock Synthesis and JABBA models, some iterations were predicted with exceptionally small biomass ratios and exteremly high F ratios indicating the potential for stock collapse. Thus, probability of biomass being less than 20% of the biomass that supports MSY was calculated for each projection year and catch scenario (**Table 21**). The probability increased with higher catch levels and in later projected years. The probabilities more than 1% or 10% were observed with the constant catch more than 110,000 t or 140,000 t, respectively. The highest probability was 23.3% with 150,000 t constant catch in 2033. It should be noted that the reference chosen, 20% of biomass that supports MSY, was selected for informational purposes and has not been adopted formally by the SCRS for tropical tunas.

The combined projections show that 120,000 t constant catch will maintain more than 50% probability of being in green quadrant by 2033 (**Figure 72** and **Table 22**: Kobe II matrix).

6. Recommendations

Management

Based on the 2019 stock assessment, the Atlantic yellowfin tuna stock biomass was estimated to be above the biomass that can support MSY on a continuing basis (not overfished; 1.17 B/B_{MSY} in 2018), and that the current fishing mortality was at or near the overfishing threshold (0.96 F/F_{MSY} in 2018). The Group noted that catch reports for 2018 were incomplete, with 42% of the estimated total catch being estimated using the average from the previous three years by CPC and gear type. Furthermore, no size data for 2018 were available at the time of the assessment. This may add uncertainty to the terminal year stock status estimates for 2018, and the Group recommends that final SCRS advice take into consideration any difference between these current estimates and the reported 2018 catches available for the Plenary meeting.

Projections results indicated that catch levels at or below the 120,000 t were expected to maintain healthy stock biomass through 2033. However, the Group noted that the most recent catch estimates suggest that overall catches have exceeded 120,000 t every year since 2015, the Group expressed strong concern that such overages are expected to further degrade the condition of the yellowfin stock if they continue. Furthermore, given that significant overages continue to occur, existing conservation and management measures appear to be insufficient, and the Committee recommends that the Commission strengthen such measures.

The Commission should also be aware that increased harvests on small yellowfin, and the increased catches of bigeye tuna if such harvests are taken on FADs, could have negative consequences to both long-term sustainable yield and stock status. Should the Commission wish to increase long-term sustainable yield, the Committee continues to recommend that effective measures be found to reduce fishing mortality on small yellowfin and bigeye tuna (e.g. FAD-related and other fishing mortality of small yellowfin tuna).

Research and Statistics

- A number of issues related to discards from the longline fleets of Chinese Taipei, ongoing practices and their impact on the joint longline index were discussed during the assessment meeting. **The Group recommended that the potential impact associated with discards in the joint longline index be further investigated and revisions made as were done for the BET stock assessment.**
- In 2018 there was no funding provided to carry out work on yellowfin tuna MSE in 2019. However, if MSE is going to be used to provide advice on tropical tunas in 2022 it is time to reactivate the process. **The Group recommended that the MSE workplan be revised and requests funding to continue the process.** It was also suggested that other sources of funding for work be explored as well.

- **The Group recommended evaluation of approaches to improve the estimates of M, and to develop uncertainty grids that consider the correlations between key biological parameters for example, M and steepness so that biologically implausible combinations can be identified and eliminated.**

- **The Group recommended increasing the sampling and ageing of small** (≤ 65 SFL, particularly < 30 cm SFL) **yellowfin using daily ring counts and otolith weight to better understand the dynamics of growth for earlier years, and the apparent slow initial growth/two-stanza pattern.**

- **The Group recommended that Venezuela scientist and the Secretariat review the size data for 2006 and other years as outliers were identified for this particular year in several fleets.**

- **The Group recommended that the Venezuela catch and effort data from the longline fisheries should be included, if possible, in the next development of a multi-national joint LL CPUE index.**

- As presentations are an increasingly important part of the SRCS meetings, the Group request that the SCRS discuss possible changes to the process used to manage and storage such presentations during the plenary meeting to:

  - improve the ability of scientists to access such material in the future
  - properly reference the material presented
  - make it clear to presentation authors whether material can or cannot be cited in ICCAT reports

- **It was recommended that the Ghanaian scientists provide a review of the data available through the EMS project, comparing those data with the data coming from at-sea observers and port samplers to the SCRS.**

7. Other matters

The ICCAT Secretariat provided a summary of the active requests from the Commission regarding tropical tunas (**Appendix 5**). During the meeting, information was presented, and discussions ensued related to two of these requests. The following text is a summary of these discussions and is intended to help the Group develop the responses during the September meeting of the species group.

Evaluate the efficacy of the area/time closure referred to in paragraph 13 for the reduction of catches of tropical tuna juveniles. Rec. 16-01, paragraph 15

In 2018, the SCRS recommended that the efficacy of longer and larger closures should be evaluated.

SCRS/2019/107 presents an alternative approach to manage purse seine fisheries for tropical tuna stocks, which uses fisheries closures instead of catch limits for the purse seine fishery. The length of the closures is estimated according to an expected reduction in catch, through a model that uses fisheries data and inputs from the latest assessments of tropical tuna stocks. The proposal is to set two closures to achieve the reduction in activity that is sought, allowing that each fishing unit selects the closure during which it will remain in port, so as to not compromise supply to the market. The approach is similar to the one used at the IATTC, which has proved successful over many years.

It is proposed that full closures are more efficient than TACs, or time-area closures, because: they are fully inclusive in terms of the fishing units and stocks covered (target and bycatch); do not lead to catch misreporting; and are not undermined by changes in targeting or selectivity through effort redistribution or changes in gear configuration or fishing mode. The authors hypothesize that they will be more effective in achieving the targets set by the Commission than stock-based TACs, which have been exceeded for several years in both the ICCAT and IOTC.

The model includes a tool that can express the reduction sought in terms of the number of days of closure required and the number of closures that could be implemented to achieve that target. In addition, the model is multi-species and can be set to achieve targets for both target and bycatch stocks, preventing the detrimental effects that TACs set on individual stocks may have on multi-species fisheries.

During the discussion, it was noted that in SCRS/2019/107 the catches of immature/mature fish by fishing mode estimated by the model for bigeye did not reflect the values calculated from the present fisheries.

The authors pointed out that the purpose of the analysis presented was to demonstrate the tool and to show how achievement of any goal expressed as a percent reduction in catch of immature/mature fish could be evaluated with such tool. The authors intend to modify input values to be more in line with current estimates for the Atlantic fisheries and present the new analysis at the next SCRS plenary.

Various points were discussed regarding the model assumptions in relation to the effort pattern during the open fishing periods. The authors assumed that there was little chance for effort to increase in the open period. Arguments were made that current purse seine operations are already very efficient and there is little room for vessels to increase their efficiency by shortening their periods when they are landing or by timing their maintenance and refit to the closure period. One of the constraints for the latter is the fact that there are limited sites available for vessel maintenance. However, it was noted, that in the case of the IATTC closure at least one fleet was able to increase effort by increasing efficiency and redistributing maintenance to the closed period.

Another question was whether there would be some chance of effort redistribution of purse seine to other oceans (Pacific and/or Indian) during such closures. The perception from authors was that this would be unlikely given the length of closures considered. In the Pacific, such effort distribution from the East to the Central Pacific is constrained by the lack of fishing opportunities provided by PNA countries to access their waters. Most tRFMOs have capacity restrictions that could limit such movement of seiners. Clearly, it is difficult to predict what effects new Atlantic closures may have on trans-oceanic movement of purse seine effort. All tRFMOs should be aware of such possible effects when they make the decisions of imposing new lengthy closures and consider strengthening capacity constraints to such movement.

Part of why catches exceeded TACs in recent times was CPCs exercising their rights to develop purse seine fleets. It was questioned whether closures would affect such pattern or not in the future. The authors responded that the incentive to enter the fishery or increase the catch of new/recent entrants would remain, however, new entrants would have to accept that they would be subject to the closures as well.

The authors also made the point that such closures would have to be reviewed continuously and the allocation of open days should be changed in response to the condition of the stock(s). It was pointed out that the analysis assumes the closures do not impact the potential CPUE in the open period, but such assumption may not be correct. It is possible that the accumulation of biomass during the closures could lead to increases in CPUE once the area is re-opened. It was discussed that seasonal closures in the IATTC have not shown any evidence of substantial increases in CPUE after the opening, although it needs to be noted that IATTC vessels can choose which closure to abide with. Therefore fishing effort never goes to zero during closures, it is only reduced.

One important point made was that closures without some measure of capacity constraints are unlikely to be beneficial in term of economics. It was understood that the closure will also be applied to supply vessels. In the IATTC effort capacity is adjusted with a multiplier that is calculated every year and links the number of fishing days of the closure to the state of stocks. A possible mechanism to control capacity may be requiring CPCs to inform ICCAT of any proposed increase in the number of fishing vessels with enough time so that the allowable days of opening could be recalculated. These closures should have benefits in terms of reductions in bycatch because it is expected that they will reduce overall purse seine effort.

It was noted, that the current system of stock-specific TACs constrains fleets for which the species under a TAC may not be the primary objective but rather a bycatch. Recently, small-scale fleets from some CPCs have had to stop fishing because the national BET catch limit was reached, when in fact BET was not their primary target. Another limitation of the current system is that it requires real time monitoring of catch so as not to exceed quotas. Such monitoring is not always effective, furthermore when it relies on the monitoring of species composition at the landing place, a challenging endeavor.

The Group discussed the fact that such closures can assist in achieving a TAC. The Group agreed that this analysis was informative and that it should be transmitted to the SCRS for their consideration in the September meeting.

Provide performance indicators for skipjack, bigeye and yellowfin tuna, with the perspective to develop management strategy evaluations for tropical tunas. Rec. 16-01, paragraph 49 (b)

Phase one of a research project in support of the MSE process on tropical tunas was completed in 2018 (Merino *et al*., 2018) but no further funding was provided for phases two and three. Phase one included:

- Workplan development
- Initiate design and implementation of MSE
- Participate in workshops

  - Bigeye stock assessment (16-20 July, Pasaia)
  - Panel 1 (23-25 July Bilbao)
  - SCRS species (26-28 September, Madrid)
  - Specific MSE workshop (December, Pasaia)

- Liase with ICCAT experts for stock assessment methods, uncertainties, data formats etc.

The preliminary workplan developed for phases two and three include:

- Develop stock synthesis for eastern SKJ
- Condition OMs
- Develop Observation Error Model
- Identify candidate MPs
- Performance statistics
- Simulations
- Evaluation of MPs
- Summary and presentation of results
- Dissemination to SCRS, WGs, Panel 1 and Commission at request
- Peer review publication of results

The Group reviewed a proposal (**Figure 73**) for activities for phases two and three in order to be ready to implement the project. The initial estimate of such activities is of €250,000. Phase two and three of such project would be completed during 2020 and 2021.

The Group discussed the importance of considering these activities given: the need to maintain the momentum of progress on MSE for tropical tunas and take advantage that 2019 is the beginning of a new budget cycle for ICCAT. Furthermore, the SCRS plans to conduct an assessment of skipjack tuna in 2020, so it would be appropriate to work on MSE in 2020 and 2021 to be in a position to provide advice on MSE to the Commission by 2022. It was pointed out that the proposed budget supports the technical and scientific work related to MSE, and although input from stakeholders is an important part of the process, this proposed budget does not provide support for such activities. It was noted that the FAO ABNJ tuna project and some other funding agencies are in the process of developing activities in support of broader capacity building related to MSE.

The Group recommended that this proposed list of activities and associated budget be considered by the SCRS to be passed to the Commission when needed. The Group was reminded of the benefits of continued Commission discussions regarding operational management objectives for tropical tunas. The more specific these objectives are the easier it will be for the MSE technical group to develop and calculate performance indicators within the MSE. To that end, the calendar and proposed workplan should explicitly indicate that input from the Commission is expected.

8. Adoption of the report and closure

The major part of the report was adopted during the meeting, sections 4.4, 5.3 and 5.4 are pending for adoption. The Group agreed to adopt these sections by correspondence by 2 September 2019. Dr Cass-Calay thanked the Ministry of Fisheries of Côte d'Ivoire for hosting and their logistic and technical support to the meeting as well their attentions and social gatherings provided ot the Group. The meeting was adjourned.

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Table 1. Final YFT Task I nominal catch (T1NC, t) by region, major gear, flag and year.

Catch type	Area	Flag		1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
			TOTAL	1,200	1,358	2,787	3,600	3,407	4,300	6,597	23,698	40,581	57,769	68,493	58,803	57,523	64,598	68,928	67,721	58,736	60,225	84,323	94,591	74,720	74,746	95,462	95,935	107,232	124,515	124,942	131,335	134,017	127,568	130,769
	ATE			1,200	1,200	2,600	3,600	3,400	4,300	5,834	19,857	24,336	38,648	51,978	50,981	28,323	42,408	47,402	54,441	43,651	53,225	74,591	81,370	59,999	58,295	82,139	82,150	92,857	108,489	111,002	117,623	120,199	114,595	117,871
	ATW			-	158	187	-	7	-	763	3,841	16,245	19,121	16,515	7,822	29,200	22,190	21,526	13,281	15,085	7,000	9,732	13,221	14,721	16,451	13,323	13,785	14,375	16,026	13,940	13,712	13,818	12,973	12,898
Landings	ATE		Bait boat	1,176	1,176	2,548	3,528	3,332	4,218	5,723	9,187	10,304	5,775	11,247	9,839	10,557	17,785	21,116	18,486	15,050	16,761	22,135	15,645	9,787	10,701	13,304	14,747	19,699	9,633	12,814	10,949	9,970	14,096	7,763
			Longline	-	-	-	-	-	-	-	10,347	13,987	32,761	40,606	40,940	17,492	23,263	19,027	27,663	12,931	17,741	22,711	21,358	16,572	15,099	18,506	20,629	19,535	15,575	12,837	15,662	11,375	6,970	12,756
			Other surf.	24	24	52	72	68	82	111	323	45	112	125	202	274	60	34	13	12	1	-	5	115	121	110	109	103	59	114	327	503	878	193
			Purse seine	-	-	-	-	-	-	-	-	-	-	-	-	-	1,300	7,225	8,279	15,658	18,722	29,745	44,362	33,525	32,374	50,219	46,665	53,520	83,222	85,237	90,685	98,351	92,651	97,159
	ATW		Bait boat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	1,278	408	-	-	32	736	1,648
			Longline	-	-	-	-	-	-	612	3,539	15,962	19,121	16,515	7,822	29,200	21,991	21,400	13,281	15,085	6,782	9,618	13,221	14,522	16,235	12,314	12,984	12,895	14,263	13,002	12,170	9,862	9,666	7,373
			Other surf.	-	158	187	-	7	-	151	302	283	-	-	-	-	-	-	-	-	-	-	-	199	199	199	202	202	218	304	229	262	242	263
			Purse seine	-	-	-	-	-	-	-	-	-	-	-	-	-	199	126	-	-	218	114	-	-	17	810	573	-	1,137	634	1,313	3,662	2,329	3,614
	ATE		Purse seine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Longline	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Purse seine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ATW		Longline	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Other surf.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Angola	1,200	1,200	2,600	3,600	3,400	4,100	3,734	2,610	2,049	1,387	2,472	2,241	2,065	2,209	3,635	1,941	1,331	885	1,087	390	361	498	611	603	839	55	1,005	2,085	2,296	904	558
		CP	Belize	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45	646	680	655	936	191	44	53	61	-	-	-	-	-	-	-
		CP	Cape Verde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	346	296	455	445	410	360	115	104	470	581	864
		CP	China PR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Curaçao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Côte d'Ivoire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	523	1,296	2,629	2,350	2,968	6,426	7,353	9,465	9,993	8,928	10,970
		CP	EU.Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.España	-	-	-	-	-	-	-	-	-	-	-	-	1,502	3,009	3,256	3,179	1,502	3,124	3,347	5,696	7,087	7,829	9,294	14,055	16,077	24,713	33,423	35,525	34,616	40,383	38,759
		CP	EU.Estonia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.France	-	-	-	-	-	200	2,100	6,900	8,300	4,500	8,900	7,800	6,100	13,050	18,970	18,959	20,678	20,267	28,123	25,973	19,783	19,719	24,318	25,142	31,370	37,589	42,262	39,550	44,169	38,689	43,371
		CP	EU.Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Latvia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Lithuania	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Malta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Poland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	125	185	77
		CP	EU.United Kingdom	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	El Salvador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Gabon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47
		CP	Gambia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Ghana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	112	274	763	945	621	546	1,426	1,974
		CP	Guatemala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Guinea Ecuatorial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Guinée Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Honduras	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Japan	-	-	-	-	-	-	-	10,347	13,987	32,761	40,606	40,940	18,590	23,974	21,062	28,962	15,888	16,664	19,369	12,072	4,421	5,492	8,315	9,051	8,513	3,021	5,238	2,647	1,722	1,241	2,217
		CP	Korea Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	293	365	1,600	4,200	8,020	6,900	7,800	9,008	11,832	10,304	7,636	11,060	8,625	6,449	5,349
		CP	Liberia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Libya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Maroc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	290	1,048	1,574	2,167	3,440	2,986	3,243
		CP	Mauritania	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Namibia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Nigeria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	344	-	-	-	-	-	-	-
		CP	Panama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	510	3,709	3,172	2,016	2,892	1,736	1,477	739	1,661
		CP	Philippines	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Russian Federation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	S. Tomé e Príncipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	15	45	39	28	31
		CP	Senegal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	241	1,272	3,083	3,227	2,520	4,082	5,335	7,278	6,307	4,298	2,813	1,991	925	1,003	296	57
		CP	South Africa	-	-	-	-	-	-	-	-	-	-	-	-	-	71	285	-	-	-	-	-	-	-	54	65	57	18	6	167	281	4,595	540
		CP	St. Vincent and Grenadine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	U.S.A.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	918	5,827	18,791	9,029	3,764	12,021	3,017	5,621	13,960	1,706	6,400	8,131	2,884	1,614
		CP	U.S.S.R.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	535	770	2,680	2,674	1,942	529	1,420	1,104	1,186	2,505	1,856	1,652	1,884	687	806	448
		CP	UK.Sta Helena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	100	100	100	75	52	108	34	37	69	55
		CP	Uruguay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Vanuatu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Venezuela	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCC	Chinese Taipei	-	-	-	-	-	-	-	-	-	-	-	-	66	95	94	44	904	2,147	7,458	7,910	4,407	3,842	3,955	1,695	1,130	1,469	678	208	203	190	71
		NCO	Benin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	95
		NCO	Cambodia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Cayman Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	602
		NCO	Congo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	140
		NCO	Cuba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	535	367	2,412	1,224	940	1,120	1,760	3,640	4,900	3,426	2,000	2,400	3,000	2,339	3,168	5,128
		NCO	Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Georgia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	NEI (ETRO)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	NEI (Flag related)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Seychelles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Ukraine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1 (continuation). Final YFT Task I nominal catch (T1NC, t) by region, major gear, flag and year.

Catch type	Area	Flag		1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	ATW	CP	Barbados	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	79	94	58	67	81	40
		CP	Belize	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Brazil	-	-	-	-	-	-	-	-	1,740	5,920	4,700	4,400	1,400	2,400	1,624	696	464	812	812	464	812	347	233	153	232	260	715	1,302	852	1,353	1,008
		CP	Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	161	240	318	-	-
		CP	Cape Verde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	China PR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Curaçao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	151	151	151	151	151	151	151	151	173	173	173
		CP	EU.España	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	489	-	-	762	-	266	1,049	752	-
		CP	EU.France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	El Salvador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	FR.St Pierre et Miquelon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Grenada	-	-	-	-	-	-	-	-	-	-	-	-	-	100	100	100	100	100	100	100	100	100	100	100	100	100	100	364	166	148	487
		CP	Guatemala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Japan	-	-	-	-	-	-	612	2,851	13,172	11,310	10,216	1,669	24,547	14,620	16,558	10,369	11,757	2,687	4,158	3,600	4,313	9,052	4,155	2,510	3,985	2,756	3,069	1,408	1,647	1,707	1,117
		CP	Korea Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	67	670	1,782	3,486	3,001	3,278	4,547	5,400	7,718	4,574	6,522	4,259	4,414	1,933
		CP	Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
		CP	Panama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28	1,978	1,114	1,191	1,283	582	1,440	102	807
		CP	Philippines	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	St. Vincent and Grenadines	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Trinidad and Tobago	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	U.S.A.	-	158	187	-	7	-	151	302	283	111	-	-	17	207	126	-	-	218	114	-	-	17	321	573	-	375	546	808	1,616	298	553
		CP	UK.Bermuda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	11	10	12	26	35
		CP	UK.British Virgin Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	UK.Turks and Caicos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Uruguay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Vanuatu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Venezuela	-	-	-	-	-	-	-	688	1,050	1,780	1,597	1,728	3,001	2,781	1,787	1,657	1,978	1,637	1,661	2,268	1,748	2,149	2,398	1,921	1,308	662	626	827	1,306	2,811	5,397
		NCC	Chinese Taipei	-	-	-	-	-	-	-	-	-	-	-	-	212	304	302	139	339	876	1,426	4,292	3,583	1,096	1,362	1,305	1,500	1,200	1,284	164	181	848	616
		NCC	Guyana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCC	Suriname	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Argentina	-	-	-	-	-	-	-	-	-	-	2	25	23	78	129	100	-	23	139	100	-	150	400	129	112	108	57	43	4	-	-
		NCO	Colombia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Cuba	-	-	-	-	-	-	-	-	-	-	-	-	-	1,700	900	219	443	580	652	615	480	340	360	367	374	600	1,200	900	661	232	689
		NCO	Dominica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Dominican Republic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	NEI (Flag related)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Saint Kitts and Nevis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Seychelles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Sta. Lucia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	48	48	51	51	54	69	67	67	28	27
Landings(FP)	ATE	CP	Belize	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Cape Verde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Curaçao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Côte d'Ivoire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.España	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Guatemala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Guinée Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Panama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	St. Vincent and Grenadines	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Mixed flags (EU tropical)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Discards	ATE	CP	EU.France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Korea Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	South Africa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCC	Chinese Taipei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ATW	CP	Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Korea Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	U.S.A.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	UK.British Virgin Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCC	Chinese Taipei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1 (continuation). Final YFT Task I nominal catch (T1NC, t) by region, major gear, flag and year.

Catch type	Area	Flag		1981	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	2012	2013	2014	2015	2016	2017	2018
	ATW	CP	Barbados	30	36	51	90	57	39	57	236	62	89	108	179	161	156	255	160	149	150	155	155	142	115	178	211	292	197	154	156	79	129	131	195	188	218	262	324	270	263
		CP	Belize	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	143	1,164	1,160	940	264	42	41	38	33	-	2,163	359	133
		CP	Brazil	2,084	1,979	2,844	2,149	2,947	1,837	2,266	2,512	2,533	1,758	1,838	4,228	5,131	4,169	4,021	2,767	2,705	2,514	4,127	6,145	6,239	6,172	3,503	6,985	7,223	3,790	5,468	2,749	3,313	3,677	3,615	4,639	7,277	11,645	13,643	16,682	18,362	16,214
		CP	Canada	-	-	-	-	-	2	40	30	26	7	29	25	71	52	174	155	100	57	22	105	125	70	73	304	240	293	276	168	53	166	50	93	74	34	59	19	193	15
		CP	Cape Verde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	-	81	86
		CP	China PR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	628	655	22	470	435	17	275	74	29	124	284	248	258	126	94	81	73	91	182	232	168
		CP	Curaçao	173	173	173	173	150	150	160	170	170	170	150	160	170	155	140	130	130	130	130	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	127	107	126	120
		CP	EU.España	-	-	1,957	3,976	1,000	-	-	1	3	2	1,462	1,314	989	7	4	36	34	46	30	171	-	-	-	-	-	1	84	81	69	27	33	32	138	155	105	360	357	207
		CP	EU.France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	122	456	712	412	358	647	632	403	346	345
		CP	EU.Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	-	0	-	-	-	-	-	-	-
		CP	EU.Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	151	60	88	179	260	115	127	92	4	2	-	15	70	505
		CP	El Salvador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	381	91	168
		CP	FR.St Pierre et Miquelon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	-
		CP	Grenada	64	59	169	146	170	506	186	215	235	530	620	595	858	385	410	523	302	484	430	403	759	593	749	460	492	502	633	756	630	673	-	-	-	-	-	-	-	-
		CP	Guatemala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	71	40
		CP	Japan	2,983	3,288	1,218	1,030	2,169	2,103	1,647	2,395	3,178	1,734	1,698	1,591	469	589	457	1,004	806	1,081	1,304	1,775	1,141	571	755	1,194	1,159	437	541	986	1,431	1,539	1,106	1,024	734	465	613	462	416	497
		CP	Korea Rep.	3,325	2,249	1,920	989	1,655	853	236	120	1,055	484	1	45	11	-	-	84	156	-	-	-	-	-	-	-	580	279	270	10	52	56	470	472	115	39	11	12	3	6
		CP	Mexico	42	128	612	1,059	562	658	33	283	345	112	433	742	855	1,093	1,126	771	826	788	1,283	1,390	1,084	1,133	1,313	1,208	1,050	938	890	956	1,211	916	1,174	1,414	1,004	1,045	968	1,279	1,241	891
		CP	Panama	262	675	62	246	-	5,278	3,289	2,192	1,595	2,651	2,249	2,297	-	-	-	-	-	-	5	-	20	28	-	-	-	2,804	227	153	119	2,134	1,126	1,630	1,995	902	1,580	1,863	1,620	1,604
		CP	Philippines	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36	106	78	12	79	145	299	230	234	151	167	-	-	-	30	72	76	-	-	-	-
		CP	St. Vincent and Grenadine	-	-	-	-	-	-	-	-	1	40	48	22	65	16	43	37	35	48	190	1,989	1,365	1,165	568	4,251	3,430	2,680	2,989	2,547	2,274	854	963	551	352	505	153	434	701	429
		CP	Trinidad and Tobago	-	-	232	31	-	-	-	1	11	304	543	4	4	120	79	183	223	213	163	112	122	125	186	224	295	459	615	520	629	788	799	931	1,128	1,141	1,179	1,057	890	1,214
		CP	U.S.A.	1,688	1,095	2,553	2,180	9,735	9,938	9,661	11,064	8,462	5,666	6,914	6,938	6,283	8,298	8,131	7,745	7,674	5,621	7,567	7,051	6,703	5,710	7,695	6,516	5,568	7,091	5,529	2,473	2,788	2,510	3,010	4,100	2,332	2,630	2,074	3,273	3,372	2,894
		CP	UK.Bermuda	21	22	10	11	42	44	25	23	22	15	17	42	58	44	44	67	55	53	59	31	37	48	47	82	61	31	30	15	41	37	100	66	36	12	10	9	25	32
		CP	UK.British Virgin Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	0	-	-	1	1	3	10	5	-	-	-
		CP	UK.Turks and Caicos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	1	0	-	-	-	-	6	2	-	-	-	-
		CP	Uruguay	67	214	357	368	354	270	109	177	64	18	62	74	20	59	53	171	53	88	45	45	91	91	95	204	644	218	35	66	76	122	24	6	7	-	-	-	-	-
		CP	Vanuatu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	681	689	661	555	873	816	720	330	207	124	17	-	-	-	-
		CP	Venezuela	4,500	14,426	26,576	21,879	20,535	11,755	11,137	10,949	15,567	10,556	16,503	13,773	16,663	24,789	9,714	13,772	14,671	13,995	11,187	11,663	18,687	11,421	7,411	5,792	5,097	6,514	3,911	3,272	3,198	4,783	4,419	4,837	5,050	3,772	3,127	4,204	5,059	4,125
		NCC	Chinese Taipei	435	407	87	559	780	1,156	709	1,641	762	5,221	2,009	2,974	2,895	2,809	2,017	2,668	1,473	1,685	1,022	1,647	2,018	1,296	1,540	1,679	1,269	400	240	315	211	287	305	252	236	139	293	181	213	414
		NCC	Guyana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	183	181	126
		NCC	Suriname	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,943	1,829	-	-	-	-	-
		NCO	Argentina	8	7	-	-	44	23	18	66	33	23	34	1	-	-	-	-	-	0	-	-	-	-	-	327	327	-	-	-	5	0	-	-	-	-	-	-	-	-
		NCO	Colombia	-	3	29	-	180	211	258	206	136	237	92	95	2,404	3,418	7,172	238	46	46	46	46	46	46	46	46	46	46	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Cuba	1,997	1,503	793	2,538	1,906	2,081	1,062	98	91	53	18	11	1	14	54	40	40	15	15	-	-	65	65	65	65	65	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Dominica	-	-	-	-	-	-	-	-	-	18	12	23	30	31	9	-	-	-	80	78	120	169	119	81	119	65	103	124	102	110	132	119	120	256	194	179	209	194
		NCO	Dominican Republic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	89	220	226	226	226	226	226	226	226	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	NEI (Flag related)	-	-	651	352	450	806	1,012	2,118	2,500	2,985	2,008	2,521	1,514	1,880	1,227	2,374	2,732	2,875	1,578	2,197	765	14	112	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Saint Kitts and Nevis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	29	-
		NCO	Seychelles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Sta. Lucia	25	26	23	56	79	125	76	97	70	58	49	58	92	130	144	110	110	276	123	134	145	94	139	147	172	103	82	106	97	223	114	98	136	93	175	191	232	199
Landings(FP)	ATE	CP	Belize	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	50	71	27	109	35	-	-	-	-
		CP	Cape Verde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	77	28	39	40	103	152	58	35	82	256	-	-	-	-
		CP	Curaçao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	25	22	16	176	95	89	114	86	78	-	-	-	-
		CP	Côte d'Ivoire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	267	116	24	-	-	-	-
		CP	EU.España	-	-	11	61	36	51	535	307	288	364	940	859	1,149	910	559	87	384	494	733	714	-	-	335	368	142	154	67	270	279	352	358	140	146	353	-	-	-	-
		CP	EU.France	-	145	140	20	4	11	232	350	422	530	982	1,033	1,554	1,461	1,074	472	658	703	832	914	344	309	672	597	244	128	33	52	203	181	344	347	129	115	-	-	-	-
		CP	Guatemala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57	35	17	32	9	34	8	12	13	19	-	-	-	-
		CP	Guinée Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	72	-	66	20	67	95	389	876	487	461	-	-	-	-
		CP	Panama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	155	125	177	114	99	54	101	54	163	59	-	-	-	-
		CP	St. Vincent and Grenadine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
		NCO	Mixed flags (EU tropical)	319	97	87	35	30	11	156	247	259	230	998	571	744	688	876	254	452	291	216	423	42	13	298	570	292	251	416	464	467	857	1,601	-	-	-	1,855	1,691	1,155	1,567
Discards	ATE	CP	EU.France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	137	-	63	-
		CP	Korea Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
		CP	South Africa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
		NCC	Chinese Taipei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	-	-	-	-	-	-
	ATW	CP	Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	0
		CP	Korea Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-
		CP	Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	6	5	9	8	9	7	3	3	3	3	3	4
		CP	U.S.A.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	UK.British Virgin Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
		NCC	Chinese Taipei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-

Table 1 (continuation). Final YFT Task I nominal catch (T1NC, t) by region, major gear, flag and year.

Catch type	Area	Flag		1981	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	2012	2013	2014	2015	2016	2017	2018
			TOTAL	156,031	165,291	165,419	114,491	156,827	146,827	145,698	136,076	162,465	193,584	167,523	163,770	163,447	173,739	154,677	149,187	137,318	144,513	136,154	132,315	153,439	134,770	122,580	119,558	105,067	105,885	100,431	111,868	117,908	118,043	113,599	114,937	106,288	112,861	127,572	148,043	134,800	131,042
	ATE			138,327	139,001	125,102	76,658	114,011	108,993	113,716	101,481	125,544	160,853	130,626	126,058	124,702	125,524	119,404	116,132	104,978	113,594	105,444	96,692	113,123	105,105	97,598	88,303	75,569	77,613	76,264	93,745	99,131	97,189	94,678	91,652	82,848	88,947	102,180	114,057	100,047	100,152
	ATW			17,704	26,290	40,318	37,833	42,815	37,834	31,982	34,594	36,921	32,731	36,897	37,712	38,745	48,215	35,274	33,056	32,341	30,919	30,710	35,623	40,317	29,665	24,982	31,255	29,498	28,272	24,167	18,123	18,777	20,855	18,921	23,285	23,440	23,914	25,392	33,986	34,753	30,890
Landings	ATE		Bait boat	10,018	13,211	11,507	14,757	16,186	15,223	16,713	16,034	12,216	19,625	17,693	15,095	18,467	15,646	13,570	11,401	12,639	14,261	16,558	9,965	14,018	11,488	10,099	14,773	9,770	12,836	12,914	9,553	8,851	9,370	12,382	9,178	6,803	9,450	9,354	10,065	8,065	7,221
			Longline	8,185	10,456	6,143	8,146	9,520	5,779	6,629	8,956	7,566	10,253	9,740	7,171	9,079	14,876	13,935	14,493	10,740	13,872	13,561	11,588	7,576	5,864	9,183	11,537	7,206	7,234	13,437	8,562	7,443	5,161	6,298	5,337	5,657	4,742	4,340	4,860	4,589	4,604
			Other surf.	4,783	3,031	3,710	2,157	1,336	2,112	1,868	2,168	2,107	1,831	2,722	1,519	1,399	1,667	1,658	1,688	1,770	1,571	1,465	2,301	1,951	1,624	2,309	2,661	2,110	2,644	1,951	1,498	1,740	1,688	1,101	1,891	2,979	1,550	1,596	2,470	2,329	2,150
			Purse seine	115,022	112,061	103,504	51,482	86,900	85,806	87,583	73,420	102,686	128,020	97,549	99,810	92,310	90,276	87,732	87,737	78,334	82,401	72,079	70,787	89,191	85,808	74,702	57,798	55,429	54,152	47,126	73,123	79,674	79,102	71,875	73,373	66,076	71,803	84,898	94,971	83,847	84,611
	ATW		Bait boat	1,917	2,970	3,603	3,698	5,478	2,421	5,468	5,822	4,834	4,718	5,359	6,276	6,383	7,094	5,297	4,560	4,275	5,511	5,364	6,753	5,572	6,009	3,764	4,868	3,867	2,695	2,304	886	1,331	1,436	2,311	1,299	1,602	513	743	1,216	866	942
			Longline	11,425	10,036	8,454	10,184	11,281	19,743	14,638	19,863	17,853	19,749	14,967	18,442	13,675	12,626	11,560	12,605	11,896	12,426	13,756	16,163	15,696	11,926	10,166	18,165	18,171	15,463	16,098	13,773	14,650	14,882	11,963	14,933	11,864	8,939	8,803	11,456	10,408	10,591
			Other surf.	1,540	1,172	2,511	748	5,062	5,848	5,210	2,875	2,587	1,464	2,157	1,635	2,606	5,465	4,907	5,107	4,459	3,826	4,900	4,838	5,107	3,763	6,445	5,004	4,826	5,667	3,418	1,392	1,417	1,806	2,381	3,754	6,336	11,878	13,510	15,978	19,347	16,241
			Purse seine	2,822	12,112	25,749	23,203	20,994	9,822	6,665	6,034	11,647	6,800	14,414	11,359	16,081	23,030	13,510	10,784	11,710	9,157	6,523	7,870	13,942	7,966	4,607	3,217	2,634	4,442	2,341	2,067	1,370	2,722	2,256	3,292	3,635	2,581	2,332	5,334	4,129	3,112
	ATE		Purse seine	319	242	238	116	70	73	923	904	969	1,124	2,921	2,463	3,447	3,059	2,509	813	1,495	1,488	1,781	2,051	387	321	1,305	1,534	1,054	747	836	1,008	1,423	1,869	3,021	1,872	1,332	1,401	1,855	1,691	1,155	1,567
			Longline	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	-	0	0	-	-	-
			Purse seine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	137	-	63	-
	ATW		Longline	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	167	-	-	-	-	-	-	5	6	5	9	8	9	7	3	3	3	3	3	4
			Other surf.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
		CP	Angola	959	1,467	788	237	350	59	51	246	67	292	510	441	211	137	216	78	70	115	170	35	34	34	34	34	-	-	23	98	-	-	-	-	-	-	-	-	2	-
		CP	Belize	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	3	963	-	326	406	-	-	-	-	-	-	-	405	1,794	3,172	5,861	5,207	7,036	7,132	3,497	5,811	4,455
		CP	Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Cape Verde	5,281	3,500	4,341	2,820	1,901	3,326	2,675	2,468	2,870	2,136	1,932	1,527	1,612	1,943	1,908	1,518	1,783	1,421	1,663	1,851	1,684	1,953	1,868	3,236	6,019	5,648	4,568	7,905	4,638	5,856	6,002	4,603	7,513	4,507	7,823	6,990	2,756	5,498
		CP	China PR	-	-	-	-	-	-	-	-	-	-	-	-	139	156	200	124	84	71	1,535	1,652	586	262	1,033	1,030	1,112	1,056	1,000	365	214	169	220	170	130	20	78	286	346	237
		CP	Curaçao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,183	6,082	6,110	4,039	5,646	4,945	4,619	6,667	4,747	24	1,939	1,368	7,351	6,293	5,302	4,413	6,792	3,727	5,152	6,140	7,905	6,535	6,860
		CP	Côte d'Ivoire	9,670	8,051	1,143	891	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	673	213	99	302	565	175	482	216	626	573	470	385	1,481	2,077	324	251	315	952	463
		CP	EU.Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.España	51,428	54,164	51,946	40,049	66,874	61,878	66,099	50,167	61,649	68,603	53,464	49,902	40,403	40,612	38,278	34,879	24,550	31,337	19,947	24,681	31,105	31,469	24,884	21,414	11,795	11,606	13,584	24,409	32,793	25,560	21,026	18,854	11,878	14,225	21,094	19,266	12,308	10,712
		CP	EU.Estonia	-	-	-	-	-	-	-	-	-	-	234	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.France	44,787	36,205	38,164	5,954	10,323	16,553	16,610	20,230	30,602	45,572	34,788	33,964	36,064	35,468	29,567	33,819	29,966	30,739	31,246	29,789	32,211	32,753	32,429	23,949	22,672	18,940	11,330	16,115	18,923	20,280	22,037	18,506	20,291	21,087	19,443	26,198	25,831	24,580
		CP	EU.Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Latvia	-	-	-	-	-	-	-	-	-	-	255	54	16	-	55	151	223	97	25	36	72	334	334	334	334	334	-	-	-	200	143	15	-	0	23	-	-	-
		CP	EU.Lithuania	-	-	-	-	-	-	-	-	-	-	332	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Malta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
		CP	EU.Poland	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	EU.Portugal	208	981	1,333	1,527	36	295	278	188	182	179	328	195	128	126	231	288	176	267	177	194	4	6	4	5	16	274	865	300	990	537	452	355	335	69	76	112	67	133
		CP	EU.United Kingdom	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	23	21	22	1	-	0	-	0	-
		CP	El Salvador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	933	-	-	-	-	-	-	-	-	-	-	-	-	-	2,750	8,252	6,227	5,743
		CP	Gabon	1	-	-	-	-	-	-	-	-	-	-	-	12	88	218	225	225	295	225	162	270	245	44	6	2	44	-	1	0	0	-	-	-	-	-	-	-	-
		CP	Gambia	-	-	-	-	-	-	-	-	-	2	16	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Ghana	5,510	9,797	7,689	9,039	12,550	11,821	10,830	8,555	7,035	11,988	9,254	9,331	13,283	9,984	9,268	8,182	15,087	13,850	21,450	12,673	23,845	18,546	15,839	15,444	13,019	14,037	15,570	16,521	15,858	20,252	18,501	16,470	13,921	18,939	19,659	20,218	20,398	23,160
		CP	Guatemala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,207	1,588	2,906	5,265	3,461	3,736	2,603	3,124	2,803	2,949	4,023	3,754	5,200	2,703	3,647	2,499
		CP	Guinea Ecuatorial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	892	892	199	-	2	11	9	6	-	-
		CP	Guinée Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	208	1,956	820	-	-	-	-	-	-	-	-	-	-	-	-	298	292	1,559	1,484	823	-	-	-	-
		CP	Honduras	-	-	-	-	-	-	-	-	-	-	-	2	-	-	4	3	4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Japan	2,863	4,815	3,062	4,344	5,765	3,634	4,521	5,808	5,882	5,887	4,467	2,961	2,627	4,194	4,770	4,246	2,733	4,092	2,101	2,286	1,550	1,534	1,999	5,066	3,088	4,206	8,496	5,266	3,563	3,041	3,348	3,637	3,843	3,358	2,855	2,914	2,715	2,828
		CP	Korea Rep.	4,288	4,010	1,629	1,917	1,668	965	1,221	1,248	1,480	324	259	174	169	436	453	297	101	23	94	142	3	8	209	984	95	4	303	983	381	324	20	26	97	77	36	356	408	449
		CP	Liberia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49	71	89	100	88	76	88	84
		CP	Libya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	208	73	73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Maroc	4,817	4,540	2,331	614	2,270	2,266	1,529	1,331	2,305	5,306	1,799	2,653	2,396	3,017	2,290	3,430	1,947	2,276	2,307	2,441	3,000	2,111	1,675	814	1,940	222	102	110	110	44	272	55	137	107	72	115	113	108
		CP	Mauritania	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-
		CP	Namibia	-	-	-	-	-	-	-	-	-	-	-	-	-	35	14	72	69	3	147	59	165	89	139	85	135	59	28	11	1	9	90	24	6	15	42	53	53	49
		CP	Nigeria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	3	1	-	-	-	-	-	-
		CP	Norway	-	-	-	-	-	813	418	493	1,787	1,790	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Panama	341	5,054	6,956	2,757	3,100	1,944	3,935	3,047	4,032	8,793	7,976	8,338	10,973	12,066	13,442	7,713	4,293	2,111	1,315	1,322	626	1,112	-	1,887	6,170	8,557	9,363	6,175	5,982	5,048	4,358	5,004	3,899	4,587	3,202	4,305	5,073	4,199
		CP	Philippines	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	126	173	86	0	50	9	68	13	30	88	53	152	89	134	5	56	-	-	-	-	-
		CP	Russian Federation	-	-	-	-	-	-	-	-	-	-	3,200	1,862	2,160	1,503	2,936	2,696	4,275	4,931	4,359	737	-	-	-	-	4	42	211	42	33	-	-	-	-	-	-	-	-	-
		CP	S. Tomé e Príncipe	97	193	194	177	180	180	178	298	299	164	187	170	181	125	135	120	109	124	114	122	122	122	122	134	145	137	144	160	165	169	173	177	182	186	301	301	266	289
		CP	Senegal	521	1,509	971	1,536	2,191	1,422	1,222	932	262	182	105	40	15	1	94	77	152	248	663	194	279	558	253	589	1,106	1,347	1,071	720	1,146	939	1,235	1,875	1,081	603	1,883	6,850	3,988	5,073
		CP	South Africa	178	49	456	759	382	55	68	137	671	624	52	69	266	486	199	157	116	261	320	191	342	152	298	402	1,156	1,187	1,063	351	303	235	673	174	440	1,512	925	706	387	389
		CP	St. Vincent and Grenadine	-	-	-	-	-	-	-	-	-	-	510	4,936	5,391	2,476	2,142	2,981	3,146	3,355	2,668	2,113	3,715	189	56	14	-	101	209	83	74	28	-	-	-	-	-	-	71	-
		CP	U.S.A.	1,472	636	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	U.S.S.R.	541	1,004	1,282	2,168	3,768	1,851	1,275	3,207	4,246	3,615	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	UK.Sta Helena	59	97	59	80	72	82	93	98	100	92	100	166	171	150	181	151	109	181	116	136	72	90	158	226	240	344	177	97	104	65	163	149	53	152	178	181	221	199
		CP	Uruguay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CP	Vanuatu	-	-	-	-	-	-	-	-	-	-	869	872	1,624	2,357	2,357	1,130	576	-	228	-	-	-	-	-	24	145	483	450	331	23	10	124	21	-	-	-	-	-
		CP	Venezuela	-	-	-	-	634	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,612	245	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCC	Chinese Taipei	432	203	452	87	146	254	193	207	96	2,244	2,163	1,554	1,301	3,851	2,681	3,985	2,993	3,643	3,389	4,014	2,787	3,363	4,946	4,145	2,327	860	1,707	807	1,180	537	1,463	818	1,023	902	927	761	563	578
		NCO	Benin	100	113	49	65	60	19	3	2	7	1	1	1	1	1	1	1	3	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Cambodia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Cayman Islands	1,460	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Congo	50	-	-	-	11	20	15	15	21	22	17	18	17	14	13	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Cuba	2,945	2,251	1,916	1,467	1,585	1,332	1,295	1,694	703	798	658	653	541	238	212	257	269	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Georgia	-	-	-	-	-	-	-	-	-	-	25	22	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	NEI (ETRO)	-	-	-	-	-	-	-	-	-	-	1,636	2,359	388	477	1,847	-	148	-	-	-	1,510	1,345	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	NEI (Flag related)	-	-	103	54	76	150	285	206	280	1,115	2,310	1,315	1,157	2,524	2,975	3,588	3,368	5,464	5,182	3,072	2,019	43	466	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Seychelles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NCO	Ukraine	-	-	-	-	-	-	-	-	-	-	215	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. YFT reported catches (Report CPC) and estimates for 2018 total catch using the 3 prior years (2015-2018 average).

Catch	**Est 3 yr Avg**	**Report CPC**	**Total**
Flag	**2018**	**2018**	
Barbados	263		
Belize	4,588		
Brazil	16,214		
Canada		15	
Cape Verde		5,584	
China PR	405		
Chinese Taipei		992	
Côte d'Ivoire	463		
Curaçao	6,980		
Dominica	194		
El Salvador	5,911		
EU.España	177	10,742	
EU.France	315	24,611	
EU.Portugal		638	
Ghana		23,160	
Guatemala		2,539	
Guyana	126		
Japan	3,325		
Korea Rep.		455	
Liberia	84		
Maroc		108	
Mexico		895	
Mixed flags (EU tropical)	1,567		
Namibia	49		
Panama	5,803		
S. Tomé e Príncipe	289		
Senegal	57	5,016	
South Africa		389	
St. Vincent and Grenadines	429		
Sta. Lucia	199		
Trinidad and Tobago		1,214	
U.S.A.	2,894		
UK.Bermuda		32	
UK.Sta Helena		199	
Venezuela	4,125		
Total	**54,455**	**76,587**	**131,042**

Table 3. Total nominal catch YFT 1950 – 2018 used as input for the 2019 stock assessment. 2018 is a combination of CPC reported catches and Group estimates.

YearC	Bait boat	Longline	Other surf.	Purse seine	Total
1950	1,176		24		1,200
1951	1,176		182		1,358
1952	2,548		239		2,787
1953	3,528		72		3,600
1954	3,332		75		3,407
1955	4,218		82		4,300
1956	5,723	612	262		6,597
1957	9,187	13,886	625		23,698
1958	10,304	29,949	328		40,581
1959	5,775	51,882	112		57,769
1960	11,247	57,121	125		68,493
1961	9,839	48,762	202		58,803
1962	10,557	46,692	274		57,523
1963	17,785	45,254	60	1,499	64,598
1964	21,116	40,427	34	7,351	68,928
1965	18,486	40,943	13	8,279	67,721
1966	15,050	28,016	12	15,658	58,736
1967	16,761	24,523	1	18,940	60,225
1968	22,135	32,329		29,859	84,323
1969	15,645	34,579	5	44,362	94,591
1970	9,787	31,094	314	33,525	74,720
1971	10,701	31,334	320	32,391	74,746
1972	13,304	30,820	309	51,029	95,462
1973	14,773	33,613	311	47,238	95,935
1974	20,977	32,430	305	53,520	107,232
1975	10,041	29,838	277	84,359	124,515
1976	12,814	25,839	418	85,871	124,942
1977	10,949	27,832	556	91,998	131,335
1978	10,002	21,237	765	102,013	134,017
1979	14,832	16,636	1,120	94,979	127,568
1980	9,411	20,129	456	100,772	130,769
1981	11,935	19,610	6,323	118,163	156,031
1982	16,181	20,492	4,203	124,415	165,291
1983	15,110	14,597	6,221	129,491	165,419
1984	18,455	18,330	2,905	74,801	114,491
1985	21,664	20,801	6,398	107,964	156,827
1986	17,644	25,522	7,960	95,701	146,827
1987	22,181	21,268	7,078	95,171	145,698
1988	21,856	28,819	5,043	80,357	136,076
1989	17,050	25,419	4,695	115,302	162,465
1990	24,343	30,002	3,295	135,944	193,584
1991	23,052	24,707	4,879	114,884	167,523
1992	21,371	25,613	3,154	113,632	163,770
1993	24,850	22,754	4,005	111,838	163,447
1994	22,740	27,502	7,132	116,365	173,739
1995	18,867	25,495	6,564	103,751	154,677
1996	15,961	27,098	6,795	99,334	149,187
1997	16,914	22,637	6,230	91,538	137,318
1998	19,772	26,297	5,397	93,047	144,513
1999	21,922	27,484	6,365	80,383	136,154
2000	16,718	27,751	7,139	80,707	132,315
2001	19,590	23,272	7,058	103,519	153,439
2002	17,497	17,790	5,388	94,096	134,770
2003	13,863	19,349	8,754	80,614	122,580
2004	19,641	29,703	7,665	62,549	119,558
2005	13,637	25,377	6,936	59,117	105,067
2006	15,530	22,702	8,311	59,341	105,885
2007	15,218	29,541	5,370	50,302	100,431
2008	10,439	22,340	2,890	76,198	111,868
2009	10,182	22,102	3,157	82,467	117,908
2010	10,806	20,052	3,494	83,692	118,043
2011	14,694	18,271	3,483	77,152	113,599
2012	10,477	20,278	5,645	78,537	114,937
2013	8,405	17,524	9,315	71,043	106,288
2014	9,963	13,685	13,428	75,785	112,861
2015	10,097	13,147	15,106	89,222	127,572
2016	11,281	16,318	18,448	101,996	148,043
2017	8,931	15,001	21,675	89,193	134,800
2018	8,162	15,200	18,391	89,289	131,042

Table 4. Catch of YFT by fleet ID for input in the stock synthesis model. See Table 6 for the definition of the fleet ID structure and details

Year	Fleet ID 1	Fleet ID 2	Fleet ID 3	Fleet ID 4	Fleet ID 5	Fleet ID 6	Fleet ID 7	Fleet ID 8	Fleet ID 9	Fleet ID 10	Fleet ID 11	Fleet ID 12	Fleet ID 13	Fleet ID 14	Fleet ID 15	Fleet ID 16	Fleet ID 17	Fleet ID 18	Fleet ID 19	Fleet ID 20	Fleet ID 21	Fleet ID 22	Fleet ID 23	Fleet ID 24	Fleet ID 25
1950	-	-	-	-	-	-	-	-	-	-	-	1,176	-	-	-	-	-	-	-	-	-	-	-	-	24
1951	-	-	-	-	-	-	-	-	-	-	-	1,176	-	-	-	-	-	-	-	-	-	-	158	-	24
1952	-	-	-	-	-	-	-	-	-	-	-	2,548	-	-	-	-	-	-	-	-	-	-	187	-	52
1953	-	-	-	-	-	-	-	-	-	-	-	3,528	-	-	-	-	-	-	-	-	-	-	-	-	72
1954	-	-	-	-	-	-	-	-	-	-	-	3,332	-	-	-	-	-	-	-	-	-	-	7	-	68
1955	-	-	-	-	-	-	-	-	-	-	-	4,141	77	-	-	-	-	-	-	-	-	-	-	-	82
1956	-	-	-	-	-	-	-	-	-	-	-	4,911	812	-	-	-	612	-	-	-	-	-	151	-	111
1957	-	-	-	-	-	-	-	-	-	-	-	6,518	2,669	-	-	2	13,196	-	-	688	-	-	302	-	323
1958	-	-	-	-	-	-	-	-	-	-	-	7,094	3,210	-	-	183	26,976	-	-	2,790	-	-	283	-	45
1959	-	-	-	-	-	-	-	-	-	-	-	4,034	1,741	-	-	112	42,936	1,024	111	7,700	-	-	-	-	112
1960	-	-	-	-	-	-	-	-	-	-	-	7,805	3,442	-	-	183	42,344	8,295	-	6,299	-	-	-	-	125
1961	-	-	-	-	-	-	-	-	-	-	-	6,822	3,017	-	-	17	29,501	13,091	-	6,153	-	-	-	-	202
1962	-	-	-	-	-	-	-	-	-	-	-	6,696	2,359	-	1,502	2,433	36,742	2,798	194	4,524	1	-	-	-	274
1963	1,300	-	-	-	-	-	-	-	-	-	-	10,538	4,738	-	2,509	5,484	27,407	4,825	1,687	5,849	1	-	-	199	60
1964	7,225	-	-	-	-	-	-	-	-	-	-	13,754	5,106	-	2,256	5,890	25,348	3,867	1,007	4,314	1	-	-	126	34
1965	8,279	-	-	-	-	-	-	-	-	-	-	10,995	4,912	-	2,579	1,078	28,998	6,842	300	3,725	0	-	-	-	13
1966	15,658	-	-	-	-	-	-	-	-	-	-	9,800	5,048	-	202	3,918	17,380	1,055	655	4,999	8	-	-	-	12
1967	17,804	-	-	-	-	-	-	-	-	-	-	10,987	5,550	-	224	1,088	10,589	1,147	1,220	10,459	20	-	-	1,136	1
1968	23,921	-	-	-	-	-	-	-	-	-	-	14,675	7,213	-	247	1,559	10,070	2,284	840	16,695	881	-	-	5,941	-
1969	25,573	-	-	-	-	-	-	-	-	-	-	9,961	5,415	-	269	723	7,809	1,433	946	22,106	1,561	-	-	18,791	5
1970	24,496	-	-	-	-	-	-	-	-	-	-	6,357	2,729	-	701	2,790	3,406	613	1,619	22,250	416	-	-	9,029	314
1971	28,610	-	-	-	-	-	-	-	-	-	-	6,743	3,538	-	420	7,434	2,726	468	442	20,191	72	-	-	3,781	320
1972	38,687	-	-	-	-	-	-	-	-	-	2	10,094	2,477	-	731	2,470	2,774	1,253	541	22,913	870	-	-	12,342	309
1973	43,648	-	-	-	-	-	-	-	-	-	112	10,693	3,182	-	786	2,299	800	704	886	28,822	102	-	-	3,590	311
1974	47,899	-	-	-	-	-	-	-	-	-	274	13,090	5,581	-	2,032	2,263	1,071	141	813	28,078	64	-	-	5,621	305
1975	69,943	-	-	-	-	-	-	-	-	-	763	5,030	3,300	-	1,029	2,132	1,926	135	1,940	23,561	146	-	-	14,335	277
1976	83,538	-	-	-	-	-	-	-	-	-	945	8,028	3,764	-	231	2,873	468	25	1,933	19,777	763	-	73	2,179	345
1977	84,778	-	-	-	-	-	-	-	-	-	621	6,621	3,446	-	273	1,062	394	11	1,144	25,049	172	-	1	7,207	555
1978	92,041	-	-	-	-	-	-	-	-	-	546	5,155	4,293	-	243	1,534	341	49	984	18,188	142	-	10	9,737	755
1979	90,279	-	-	-	-	-	-	-	-	-	1,426	9,880	3,616	-	150	1,477	400	110	1,591	12,770	290	-	15	4,461	1,105
1980	95,266	-	-	-	-	-	-	-	-	-	1,974	3,559	4,065	-	92	817	1,916	106	703	16,328	259	-	28	5,228	428
1981	110,893	-	-	-	-	-	-	-	-	-	5,510	5,503	-	3,802	96	2,055	1,888	201	461	14,743	261	-	1,321	4,294	5,002
1982	107,476	-	-	-	-	-	-	-	-	-	9,797	4,820	-	5,337	418	359	5,378	325	809	13,329	292	-	948	12,748	3,255
1983	103,138	-	-	-	-	-	-	-	-	-	7,689	4,229	-	5,190	740	393	1,600	76	1,645	10,235	649	-	2,276	23,615	3,945
1984	52,343	-	-	-	-	-	-	-	-	-	9,039	2,674	-	6,600	3,706	222	3,187	558	2,761	11,152	451	-	507	18,894	2,397
1985	83,659	-	-	-	-	-	-	-	-	-	12,550	3,049	-	6,885	2,857	290	4,618	401	3,001	11,964	528	1	4,610	20,628	1,787
1986	-	82,264	-	-	-	-	-	-	-	-	11,821	917	-	6,618	1,903	640	1,896	870	7,271	14,285	562	2	5,316	9,822	2,642
1987	-	86,617	-	-	-	-	-	-	-	-	10,830	1,676	-	8,556	3,008	854	1,890	621	6,860	10,382	660	-	4,691	6,665	2,387
1988	-	74,143	-	-	-	-	-	-	-	-	8,555	2,084	-	8,951	2,446	787	4,032	1,163	9,209	12,191	1,437	1	2,378	6,034	2,664
1989	-	103,475	-	-	-	-	-	-	-	-	7,035	2,265	-	6,785	1,145	715	5,980	275	6,679	11,404	365	-	2,180	11,647	2,514
1990	-	128,964	-	-	-	-	-	-	-	-	11,988	2,652	-	7,473	2,409	601	4,755	563	4,696	18,575	812	-	925	6,800	2,370
1991	-	-	35,133	27,764	14,614	7,212	2,490	2,405	4,925	7,199	9,254	1,924	-	9,510	2,544	689	2,770	1,259	4,798	14,004	1,187	-	1,777	12,963	3,102
1992	-	-	35,657	23,079	13,849	11,885	4,425	3,984	4,780	5,795	9,331	3,542	-	6,930	1,675	850	2,296	569	6,323	14,431	1,144	-	1,225	10,069	1,928
1993	-	-	28,341	19,790	18,861	11,099	6,938	4,954	3,281	5,707	13,283	3,858	-	6,457	1,253	59	2,535	501	5,131	13,256	1,271	-	2,189	12,867	1,815
1994	-	-	35,895	17,754	12,265	6,007	4,080	4,542	7,980	8,231	9,984	3,756	-	7,550	1,450	260	3,183	1,341	4,778	14,959	2,982	60	5,027	19,612	2,045
1995	-	-	36,742	14,971	16,463	6,829	3,417	7,366	3,284	8,341	9,268	3,854	-	4,740	1,005	235	3,547	1,445	5,347	13,979	942	30	4,486	6,338	2,048
1996	-	-	30,190	15,890	13,504	5,866	4,275	5,207	5,362	5,714	8,182	2,688	-	4,735	2,898	149	4,457	643	4,785	15,808	1,255	77	4,418	10,784	2,300
1997	-	-	34,056	14,266	8,007	4,836	2,657	4,192	4,046	2,199	15,087	2,529	-	4,343	582	195	2,549	795	5,101	13,492	504	156	3,901	11,653	2,172
1998	-	-	35,539	18,292	8,727	5,818	939	4,606	3,386	1,873	13,850	1,863	-	5,251	3,519	455	2,631	2,087	4,236	16,225	663	-	3,172	9,157	2,225
1999	-	-	23,866	13,167	7,884	6,663	1,130	3,565	5,438	2,507	21,450	1,901	-	7,511	699	350	2,466	589	6,382	16,553	1,145	-	4,193	6,523	2,172
2000	-	-	18,510	12,166	18,099	5,446	1,535	4,212	3,307	4,637	12,673	3,778	-	5,212	277	451	2,541	1,069	5,575	16,935	1,181	-	4,150	7,572	2,989
2001	-	-	23,507	16,241	14,861	11,631	1,236	3,705	3,292	2,874	23,845	1,876	-	6,091	18	527	1,898	266	4,847	14,465	1,269	-	4,503	13,934	2,555
2002	-	-	26,663	15,807	9,933	8,592	696	2,529	5,227	1,957	18,546	3,335	-	6,643	93	282	1,490	332	4,454	9,217	2,014	-	3,137	11,573	2,250
2003	-	-	15,681	13,396	18,235	6,701	1,745	2,782	5,031	3,062	15,838	2,236	-	4,741	175	410	1,551	792	3,972	11,147	1,476	272	5,531	4,852	2,950
2004	-	-	14,315	14,683	6,705	5,390	1,808	2,847	5,023	3,092	15,444	3,635	-	5,846	218	672	4,686	903	4,785	17,055	1,603	-	4,024	3,185	3,641
2005	-	-	14,238	10,617	7,355	6,785	1,134	3,117	4,150	2,724	13,019	3,067	-	3,800	115	580	3,207	460	4,527	15,480	1,123	-	3,822	2,634	3,114
2006	-	-	6,449	15,977	10,676	6,512	2,128	2,717	3,350	2,228	14,037	2,201	-	3,853	304	330	2,686	1,627	5,916	11,669	475	30	5,081	4,439	3,200
2007	-	-	8,561	9,242	7,112	7,221	1,520	3,033	2,759	3,118	15,570	1,849	-	2,875	320	90	2,127	6,820	5,941	14,334	230	22	3,135	2,341	2,213
2008	-	-	15,384	15,048	12,535	8,397	2,162	2,832	3,608	4,967	16,521	856	-	1,835	424	43	2,495	3,714	4,432	11,488	168	26	1,079	2,067	1,784
2009	-	-	19,401	16,707	16,797	5,727	2,318	3,689	3,362	3,503	15,858	835	-	2,818	272	28	2,321	2,645	5,236	11,666	205	2	1,102	1,363	2,052
2010	-	-	16,736	17,481	9,318	6,079	2,381	4,414	5,544	5,066	20,252	1,022	-	2,632	851	60	1,883	2,636	4,248	11,000	224	61	1,293	2,722	2,140
2011	-	-	13,822	17,362	10,028	3,658	4,051	4,477	4,978	4,791	18,501	2,067	-	4,544	1,311	38	1,771	2,644	4,507	8,969	340	415	1,548	2,253	1,519
2012	-	-	11,079	15,238	5,484	10,110	3,654	5,215	7,044	6,724	16,470	847	-	3,750	108	21	1,587	3,054	5,281	10,138	197	1,570	1,830	3,291	2,245
2013	-	-	13,218	11,880	10,630	3,587	4,058	4,227	6,145	4,263	13,921	1,352	-	2,129	403	36	2,379	2,162	3,262	9,290	396	5,208	787	3,635	3,320
2014	-	-	16,374	9,006	9,333	7,462	2,568	4,915	5,020	5,636	18,939	1,624	-	2,197	94	1	1,750	2,073	3,375	6,322	164	10,415	1,184	2,581	1,829
2015	-	-	20,430	7,694	12,042	9,014	2,985	7,175	8,095	6,599	19,659	1,365	-	2,262	80	1	1,620	1,846	2,659	6,868	153	12,123	1,032	1,920	1,951
2016	-	-	14,089	16,688	13,735	5,807	4,136	11,509	8,406	11,801	20,218	1,865	-	2,426	229	5	2,564	807	3,211	9,636	96	13,658	1,972	2,367	2,817
2017	-	-	11,645	15,413	11,058	8,230	4,401	6,242	6,465	7,628	20,398	1,276	-	1,711	283	4	2,536	591	3,520	8,221	129	16,878	1,941	3,373	2,855
2018	-	-	11,073	17,754	12,422	6,180	4,742	5,033	5,310	6,686	23,160	1,059	-	1,384	95	6	2,331	987	2,893	8,873	109	14,220	1,636	2,553	2,535

Table 5. Recommended annual abundance indices for the Atlantic yellowfin tuna stock assessment reference case. This table reflects revisions made following the data preparatory meeting.

series	Joint LL- Region1		Joint LL- Region2		Joint LL- Region3		FR_PS		Ven_LL	
units	Number		Number		Number				Number	
area	North Temprate		Tropical		South Temprate		Tropical		North Temprate	
method	Delta lognormal		Delta lognormal		Delta lognormal				Delta lognormal	
source	SCRS/2019/081		SCRS/2019/081		SCRS/2019/081		SCRS/2019/066		SCRS/2019/117	
Year	Std. CPUE	CV	Std. CPUE	CV	Std. CPUE	CV	Std. CPUE	CV	Std. CPUE	CV
1979	1.12	0.10	1.29	0.08	1.35	0.20				
1980	0.89	0.10	1.25	0.06	0.62	0.14				
1981	0.81	0.08	1.23	0.05	0.72	0.12				
1982	0.74	0.09	1.18	0.04	0.90	0.10				
1983	1.01	0.09	1.02	0.06	0.85	0.11				
1984	1.12	0.09	1.29	0.05	1.07	0.12				
1985	0.86	0.09	1.15	0.04	0.86	0.10				
1986	1.06	0.08	1.41	0.05	0.99	0.10				
1987	1.06	0.07	1.52	0.04	0.91	0.11				
1988	1.19	0.07	1.37	0.04	1.35	0.10				
1989	1.16	0.06	1.31	0.04	1.00	0.10				
1990	1.36	0.07	1.32	0.04	1.00	0.09				
1991	1.23	0.06	1.11	0.04	1.03	0.07	0.32	0.15	1.03	0.62
1992	1.25	0.06	0.86	0.04	1.07	0.09	0.31	0.14	0.77	0.46
1993	0.96	0.07	1.02	0.04	0.88	0.09	0.98	0.11	0.59	0.50
1994	1.22	0.07	1.07	0.04	1.06	0.07	0.79	0.14	0.55	0.43
1995	1.26	0.06	1.13	0.04	1.22	0.07	1.07	0.11	0.42	0.68
1996	1.01	0.06	0.98	0.04	1.09	0.08	0.93	0.12	0.62	0.43
1997	1.04	0.06	0.88	0.04	0.98	0.08	0.85	0.11	0.51	0.46
1998	1.08	0.06	0.94	0.04	1.15	0.06	1.30	0.10	0.66	0.48
1999	1.10	0.06	0.95	0.04	1.05	0.07	1.07	0.10	0.89	0.35
2000	1.07	0.05	0.94	0.04	1.08	0.06	0.77	0.10	0.59	0.49
2001	1.00	0.05	0.87	0.04	1.11	0.07	1.00	0.10	0.56	0.65
2002	0.86	0.05	0.78	0.04	1.18	0.08	0.97	0.10	0.61	0.72
2003	0.93	0.05	0.82	0.04	1.16	0.07	1.55	0.09	0.73	0.85
2004	1.04	0.05	0.94	0.04	1.13	0.08	1.13	0.08	0.82	0.95
2005	1.34	0.05	1.18	0.03	1.29	0.06	0.80	0.10	1.42	0.76
2006	1.14	0.06	0.98	0.03	1.07	0.05	0.97	0.08	1.02	0.73
2007	0.90	0.06	0.87	0.04	1.02	0.05	0.80	0.09	2.19	0.32
2008	0.69	0.07	0.67	0.04	0.85	0.06	1.03	0.09	1.68	0.24
2009	0.77	0.07	0.69	0.03	0.81	0.06	1.11	0.07	1.41	0.39
2010	0.72	0.07	0.64	0.03	0.90	0.06	0.88	0.10	1.19	0.33
2011	0.79	0.07	0.65	0.03	1.02	0.06	0.81	0.09	1.19	0.12
2012	0.84	0.06	0.66	0.03	1.21	0.06	0.80	0.10	1.13	0.23
2013	0.87	0.06	0.72	0.04	1.24	0.05	0.86	0.08	1.17	0.31
2014	0.80	0.08	0.64	0.04	0.89	0.06	0.84	0.10	1.29	0.17
2015	0.78	0.07	0.67	0.04	0.99	0.06	0.85	0.09	1.35	0.23
2016	0.86	0.07	0.64	0.04	0.98	0.06	1.10	0.11	1.24	0.19
2017	0.92	0.07	0.67	0.04	1.04	0.06	0.87	0.11	1.19	0.06
2018	0.86	0.09	0.55	0.05	0.91	0.09	0.98	0.09	1.17	0.15

series		Buoy-derived Abundance Index	
units			
area		Tropical	
method		Delta lognormal	
source		SCRS/2019/075	
Year	Quarter	Std. CPUE	CV
2010	**1**	0.44	0.15
2010	**2**	0.44	0.15
2010	**3**	0.41	0.16
2010	**4**	0.63	0.16
2011	**1**	0.45	0.16
2011	**2**	0.51	0.15
2011	**3**	0.37	0.16
2011	**4**	0.33	0.16
2012	**1**	0.23	0.15
2012	**2**	0.34	0.15
2012	**3**	0.22	0.16
2012	**4**	0.17	0.15
2013	**1**	0.12	0.14
2013	**2**	0.17	0.14
2013	**3**	0.17	0.13
2013	**4**	0.22	0.13
2014	**1**	0.17	0.13
2014	**2**	0.18	0.13
2014	**3**	0.22	0.12
2014	**4**	0.22	0.12
2015	**1**	0.15	0.12
2015	**2**	0.17	0.12
2015	**3**	0.22	0.09
2015	**4**	0.22	0.10
2016	**1**	0.14	0.11
2016	**2**	0.19	0.12
2016	**3**	0.22	0.12
2016	**4**	0.21	0.11
2017	**1**	0.17	0.12
2017	**2**	0.24	0.11
2017	**3**	0.34	0.11
2017	**4**	0.46	0.11

Table 6. Stock synthesis fleet structure definition for the 2019 YFT stock assessment for catch and size composition.

Stock Synthesis ID	Name	Season	Gear	Area_ID_TT	Yr_Start	Yr_End
1	PS EU 63-85		PS	1, 2n, 2s, 3	1963	1985
2	PS EU 86-90		PS	1, 2n, 2s, 3	1986	1990
3	PS EU FSC 91	1	PS	1, 2n, 2s, 3	1991	2018
4	PS EU FSC 91	2	PS	1, 2n, 2s, 3	1991	2018
5	PS EU FSC 91	3	PS	1, 2n, 2s, 3	1991	2018
6	PS EU FSC 91	4	PS	1, 2n, 2s, 3	1991	2018
7	PS EU FAD 91	1	PS	1, 2n, 2s, 3	1991	2018
8	PS EU FAD 91	2	PS	1, 2n, 2s, 3	1991	2018
9	PS EU FAD 91	3	PS	1, 2n, 2s, 3	1991	2018
10	PS EU FAD 91	4	PS	1, 2n, 2s, 3	1991	2018
11	PSBB Ghana		PS+BB	1, 2n, 2s, 3	1972	2018
12	BB South Dakar		BB	2n, 3	1950	2018
13	BB Dakar 62-80		BB	2n	1955	1980
14	BB Dakar 81+		BB	2n	1981	2018
15	BB North 25 lat		BB	1	1962	2018
16	LL JPN North 25		LL	North_LL	1957	2018
17	LL JPN Trop		LL	Trop_LL	1956	2018
18	LL JPN South		LL	South_LL	1959	2018
19	LL North Oth		LL	North_LL	1959	2018
20	LL Trop Oth		LL	Trop_LL	1957	2018
21	LL South Oth		LL	South_LL	1962	2018
22	HL Brazil		HL	1	1985	2018
23	RR USA		RR	1	1951	2018
24	PS West		PS	2n	1979	2018
25	Others		OTH	1, 2n, 2s, 3	1950	2018

Table 7. Description of selectivity shapes, time blocks and data decisions for the accepted runs. Time blocks are described as the beginning and ending years for blocks.

Fleet	Selectivity	Time block(s)	Note
1	5 node cubic spline		Include US PS Catch and Size
2	5 node cubic spline		Include US PS Catch and Size
3	5 node cubic spline		
4	mirrored to 3		
5	mirrored to 3		
6	mirrored to 3		
7	5 node cubic spline	2003 2018 (switch to FADs)	
8	mirrored to 7	2003 2018 (switch to FADs)	
9	mirrored to 7	2003 2018 (switch to FADs)	
10	mirrored to 7	2003 2018 (switch to FADs)	
11	5 node cubic spline	1981 1987 1988 1995 1996 2018 (selex change)	Exclude Size 1996-2008
12	double normal, smooth inc/dec	2010 2018 (selex change)	Exclude South Africa Catch and Size
13	double normal, smooth inc/dec		Exclude Venezuela BB Size
14	double normal, smooth inc/dec		Exclude Venezuela BB Size
15	mirrored to 14		
16	double normal, smooth increase		
17	logistic	1979 1991 1992 2004 2005 2018 (selex change)	
18	mirrored to 16		
19	double normal, smooth increase	2003 2018	Exclude Chinese Taipei Size after 2005
20	logistic	1979 1991 1992 2004 2005 2018 (selex change)	Exclude Chinese Taipei Size after 2005
21	mirror 19		Exclude Chinese Taipei Size after 2005
22	double normal with AOTTP tagging estimates as priors		Exclude 1994 Brazil HL Size
23	double normal, smooth inc/dec	1998 2018 (69 cm size limit)	
24	double normal		Exclude US PS Catch and Size before 1990, remove 2006 Size from Venezuelan PS
25	double normal		Include South Africa Catch and Size, exclude Cabo Verde Catch and Size. Lower lambda (0.001).

Table 8. Description of reference and sensitivity runs carried out prior to and at the 2019 stock assessment meeting. Runs 29 and up use the data decisions listed in section 3.2.4.

Run	Description
1	Growth fit internally (Richards), Joint LL R2, Conditional Age at Length (CAL), $M_{age\ 5}$=0.35 with Lorenzen scaling, *h* fixed at 0.8
2	Like 1 but with von Bertalanffy form
3	**No CAL, fixed growth to estimates from 1 (preliminary reference run)**
4	No CAL, convert to Lorenzen scaling of M ($M_{age\ 5}$=0.318)
5	Like 3 but ASPM, fix all selectivity parameters, estimate R_0, σ_R, recruitment deviations
6	Like 3 but no recruitment deviations
7	Like 3 but with continuity M from 2016 assessment
8	Like 3 but with reduce weight on length composition (0.5)
9	Like 3 + BAI (CV 0.3, scaled as above)
10	Like 3 + EUPSFS + BAI (CV 0.3, scaled as above)
11	Like 3 + EUPSFS (CV 0.3, scaled according to interannual variability in precision)
12	Like 3 + 3 Joint LL indices
13	Like 3 but *h* fixed at 0.7
14	Like 3 but *h* fixed at 0.9
15	Like 3 but *h* fixed at 0.99
16	Like 3 but estimate M, fix growth no CAL
17	Like 3 but estimate M, fix growth, CAL
18	Like 3 but Low $M_{age\ 5}$=0.28; or other low M
19	Like 3 but High $M_{age\ 5}$ = 0.42, or other high M
20	Like 3 but with CAL
21	Like 5 but with 2016 new M
22	Like 5 but with 2016 + only joint LL
23	Like 3 but time block LL JPN and LL tropical at 1979
24	Like 3 but fix 2017 recruitment deviations at zero
25	Like 23 but split JLL and Trop at 2004, downweigh OTHER_OTHER length composition data
26	Like 25 but with new data file
27	Like 25 same data file, but control file mods
28	Like 27 but removing BR HL prior to 1992 and Ghana BB/PS 1996-2008
29	**no CAL, M=0.35, Lorenzen scaled (final reference run)**
30	Like 29 + EUPSFS and BAI
31	Like 29 but with CAL
32	Like 29 + EUPSFS and BAI
33	Like 30 but with M and growth like 2016 assessment
34	Like 30 but with low $M_{age\ 5}$=0.28
35	Like 30 but with high $M_{age\ 5}$=0.42
36	Like 29 but ASPM, fix all selectivities, estimate R_0, σ_R, recruitment deviations
37	Like 30 but with λ on length composition (0.5)
38	Like 30 but *h*=0.7
39	Like 30 but *h*=0.9
40	Like 29 + all indices
41	Like 29 but with only the 3 LL indices (region 1,2,3)
42	Like 29 but with only EUPSFS index
43	Like 30 but no recruitment deviations in 2017 and 2018
44	Like 30 but no recruitment deviation in 2018

Table 9. Characteristics of the reference and sensitivity runs from stock synthesis model used for the uncertainty grid and management advice.

Run	Indices	*h*
1 (Reference)	joint LL R2 + EUPSFS	0.8
2	joint LL R2 + EUPSFS	0.9
3	joint LL R2 + EUPSFS + BAI linked to seasonal fleets	0.8
4	joint LL R2 + EUPSFS + BAI linked to seasonal fleets	0.9

Table 10. List of model runs carried out in *MPB*.

Run	Indice(s)	Other assumptions/restrictions
1	Joint LL R2 (1979-2018)	Search space constrained for r and k
2	Joint LL R2 (1979-2018) + EU PS (1993-2018)	Unconstrained search space
3	Joint LL R2 (1979-2018) + EU PS (1993-2018)	Unconstrained search space Free B0

Table 11. List of model runs carried out in JABBA. Runs 1-4 were presented in the submitted SCRS document. All other runs were conducted during the assessment meeting. Models in **bold** were used for projections and stock status.

Run	Indice(s)	Prior on r	Reference
1	Joint LL R2	SS3 2016	Base Case in SCRS/2019/119; S1 in YFT_JABBA2019_v3 slides 2 and 29
2	Joint LL R2	FishLife (CV = 0.3)	S1 in SCRS/2019/119; S2 in YFT_JABBA2019_v3 slides 2 and 29
3	Joint LL R2 + BAI	SS3 2016	S2 in SCRS/2019/119
4	Joint LL R2 + BAI	FishLife (CV = 0.3)	S3 in SCRS/2019/119
5	Joint LL R2	Uninformative lognormal	S3 in YFT_JABBA2019_v3 slide 2
6 (base)	**Joint LL R2**	**SS3 2019**	**Base case in YFT_JABBA2019_v3 slides 2, 14, 29, 61 and 68**
7	Joint LL R2 + Joint LL R1	SS3 2019	S1 in YFT_JABBA2019_v3 slide 14
8	Joint LL R2 + Joint LL R3	SS3 2019	S2 in YFT_JABBA2019_v3 slide 14
9	Joint LL R2 + EUPSFS	SS3 2019	S3 in YFT_JABBA2019_v3 slide 14
10	Joint LL R2 + Joint LL R1 + Joint LL R3	SS3 2019	S4 in YFT_JABBA2019_v3 slide 14
11	Joint LL R2 + Joint LL R1 + Joint LL R3 + EUPSFS	SS3 2019	S5 in YFT_JABBA2019_v3 slide 14
12	Joint LL R2 + Joint LL R1 + Joint LL R3 + EUPSFS + BAI	SS3 2019	S6 in YFT_JABBA2019_v3 slide 14
13	**Joint LL R2 + Joint LL R1 + EUPSFS**	**SS3 2019**	**S3 in YFT_JABBA2019_v3 slides 29, 61 and 68**
14	Joint LL R2	FishLife (CV = 0.6)	S2 in YFT_JABBA2019_v3 slide 68
15	Joint LL R2 + Joint LL R1 + EUPSFS	FishLife (CV = 0.6)	S5 in YFT_JABBA2019_v3 slide 68
16	**Joint LL R2**	**FishLife (CV = 0.3)**	**S2 in YFT_JABBA2019_v3 slide 61**
17	**Joint LL R2 + Joint LL R1 + EUPSFS**	**FishLife (CV = 0.3)**	**S5 in YFT_JABBA2019_v3 slide 61**
18	Joint LL R2 + Joint LL R1 + EUPSFS	SS3 2016	S4 in YFT_JABBA2019_v3 slide 29
19	Joint LL R2 + Ven LL	SS3 2019	S6 in YFT_JABBA2019_v3 slide 69
20	Joint LL R2 + Ven LL	FishLife (CV=0.3)	S7 in YFT_JABBA2019_v3 slide 69

Table 12. Stock synthesis parameter estimates of the for the reference model Run 1. Most parameter estimates are similar. Recruitment deviations not shown for brevity.

Name	Value	Phase	Min	Max	CV	Grad	Pr type	Prior	Pr SD
NatM_p_1_Fem_GP_1	0.35	-4				-			
L_at_Amax_Fem_GP_1	153.0	-2	120	190	-	-	no	-	-
VonBert_K_Fem_GP_1	0.67	-4	0.1	0.9	-	-	no	-	-
Richards_Fem_GP_1	0.11	-4	-2	2	-	-	no	-	-
CV_young_Fem_GP_1	0.21	-4	0.1	0.3	-	-	no	-	-
CV_old_Fem_GP_1	0.07	-5	0.1	0.3	-	-	no	-	-
RecrDist_month_4	-0.06	3	-4	4	-509.6%	-2E-05	Sbet	0.17	2.00
RecrDist_month_7	-0.41	3	-4	4	-35.8%	2E-05	Sbet	-0.72	2.00
RecrDist_month_10	-1.81	4	-4	4	-39.6%	1E-05	Sbet	-0.23	2.00
SR_LN(R0)	11.33	1	9	13	0.6%	8E-05	no	-	-
SR_BH_flat_steep	0.80	-3	0.2	1	-	-	no	-	-
SR_sigmaR	0.35	6	0.2	1	15.6%	4E-06	no	-	-
SizeSpline_Val_2_1_PS_ESFR2_6585(1)	0.01	5	-2	2	324.9%	1E-05	Sbet	0.18	2
SizeSpline_Val_4_1_PS_ESFR2_6585(1)	0.06	4	-2	2	268.8%	2E-06	Sbet	-0	2
SizeSpline_Val_5_1_PS_ESFR2_6585(1)	0.80	4	-2	2	17.7%	1E-05	Sbet	0.68	2
SizeSpline_Val_2_2_PS_ESFR2_8690(2)	-0.01	2	-3	3	-907.6%	3E-08	no	-	-
SizeSpline_Val_4_2_PS_ESFR2_8690(2)	-0.44	2	-3	3	-95.6%	-3E-06	no	-	-
SizeSpline_Val_5_2_PS_ESFR2_8690(2)	1.88	2	-2	5	17.5%	7E-06	no	-	-
SizeSpline_Val_2_3_PS_ESFR2_9118_S1(3)	0.07	5	-2	2	116.8%	2E-07	Sbet	0.38	2
SizeSpline_Val_4_3_PS_ESFR2_9118_S1(3)	-0.39	4	-2	2	-70.8%	-3E-06	Sbet	-0.8	2
SizeSpline_Val_5_3_PS_ESFR2_9118_S1(3)	2.46	4	-2	5	8.1%	6E-06	Sbet	1.79	2
SizeSpline_Val_2_7_ESFR_FADS_PS_9118_S1(7)	0.92	5	-2	2	3.0%	3E-06	no	-	-
SizeSpline_Val_4_7_ESFR_FADS_PS_9118_S1(7)	-1.11	4	-5	2	-14.9%	5E-06	no	-	-
SizeSpline_Val_5_7_ESFR_FADS_PS_9118_S1(7)	-0.77	5	-5	2	-20.8%	9E-06	no	-	-
SizeSpline_Val_1_11_BB_PS_Ghana_6518(11)	-8.00	4	-10	7	-14.1%	5E-07	no	-	-
SizeSpline_Val_2_11_BB_PS_Ghana_6518(11)	0.77	5	-1	1	5.0%	2E-06	Sbet	0.24	1
SizeSpline_Val_4_11_BB_PS_Ghana_6518(11)	-4.92	4	-10	2	-17.1%	2E-07	Sbet	-5.7	1
SizeSpline_Val_5_11_BB_PS_Ghana_6518(11)	-4.26	4	-10	2	-27.2%	-7E-08	Sbet	-3	1
Size_DblN_peak_12_BB_area2_Sdak(12)	46.08	3	30	180	3.9%	6E-06	Sbet	46.5	0.5
Size_DblN_ascend_se_12_BB_area2_Sdak(12)	3.74	5	-5	9	11.8%	7E-07	Sbet	3.78	1
Size_DblN_descend_se_12_BB_area2_Sdak(12)	7.66	4	-5	9	2.0%	1E-05	no	0	0
Size_DblN_ascend_se_13_BB_DAKAR_62_80(13)	4.46	5	-5	9	3.6%	-3E-06	Sbet	4.39	1
Size_DblN_descend_se_13_BB_DAKAR_62_80(13)	7.33	4	-5	9	1.4%	4E-06	no	-	-
Size_DblN_ascend_se_14_BB_DAKAR_81_18(14)	4.61	5	-5	9	2.3%	-7E-06	Sbet	4.81	1
Size_DblN_descend_se_14_BB_DAKAR_81_18(14)	8.81	5	-5	9	1.6%	4E-06	Sbet	6.76	0.2
Size_DblN_peak_16_Japan_LL_N(16)	118.9	3	70	130	1.7%	8E-06	Sbet	119	0.5
Size_DblN_ascend_se_16_Japan_LL_N(16)	6.35	5	-5	9	2.1%	-1E-05	Sbet	6.49	0.5
Size_DblN_descend_se_16_Japan_LL_N(16)	5.14	4	-5	10	8.5%	9E-06	no	-	-
Size_DblN_end_logit_16_Japan_LL_N(16)	-1.43	4	-9	15	-18.5%	1E-05	no	-	-
Size_inflection_17_Japan_LL_TRO(17)	118.1	3	70	180	2.5%	2E-05	no	-	-
Size_95%width_17_Japan_LL_TRO(17)	29.33	3	10	60	12.0%	-3E-06	no	-	-
Size_DblN_peak_19_Other_LL_N(19)	125.4	3	70	150	0.8%	3E-05	Sbet	125	1
Size_DblN_ascend_se_19_Other_LL_N(19)	6.89	5	-5	9	0.7%	-4E-05	Sbet	6.49	1
Size_DblN_descend_se_19_Other_LL_N(19)	5.06	4	-5	10	3.9%	3E-05	no	-	-
Size_DblN_end_logit_19_Other_LL_N(19)	-2.27	4	-9	15	-11.2%	2E-05	no	-	-
Size_inflection_20_Other_LL_TRO(20)	85.93	3	40	180	2.4%	1E-05	Sbet	85.9	0.2
Size_95%width_20_Other_LL_TRO(20)	14.01	3	10	60	18.6%	2E-07	Sbet	13.5	0.2
Size_DblN_peak_22_HL_Braz_N(22)	54.47	5	40	100	3.4%	-2E-06	Norm	60	10
Size_DblN_descend_se_22_HL_Braz_N(22)	5.88	5	-5	9	7.9%	6E-07	Norm	4.5	2
Size_DblN_ascend_se_23_US_RR(23)	4.95	5	-5	9	2.7%	-6E-06	Sbet	5.64	1
Size_DblN_descend_se_23_US_RR(23)	7.02	4	-5	9	1.8%	7E-06	no	-	-
Size_DblN_ascend_se_24_PS_WEST(24)	4.96	4	-5	9	4.4%	3E-06	Sbet	5.34	2
Size_DblN_descend_se_24_PS_WEST(24)	5.13	4	-5	10	15.1%	5E-07	Sbet	5.18	2
Size_DblN_end_logit_24_PS_WEST(24)	-0.98	6	-9	15	-61.1%	2E-06	Sbet	-0.5	2
Size_DblN_peak_25_OTH_OTH(25)	78.33	3	50	130	8.3%	-6E-06	Sbet	71.2	0.2
Size_DblN_descend_se_25_OTH_OTH(25)	8.93	4	-5	10	12.8%	-8E-06	Sbet	8.06	0.2
SizeSpline_Val_1_7_ESFR_FADS_PS_9118_S1(7)_BLK1repl_2003	-6.70	6	-10	7	-7.1%	2E-06	no	-	-
SizeSpline_Val_4_7_ESFR_FADS_PS_9118_S1(7)_BLK1repl_2003	-2.44	6	-5	2	-9.3%	6E-07	no	-	-
SizeSpline_Val_5_7_ESFR_FADS_PS_9118_S1(7)_BLK1repl_2003	-3.12	6	-5	2	-10.3%	-1E-06	no	-	-
SizeSpline_Val_1_11_BB_PS_Ghana_6518(11)_BLK3repl_1981	-8.51	6	-10	7	-8.3%	5E-07	Sbet	-7.8	0.2

Name	Value	Phase	Min	Max	CV	Grad	Pr type	Prior	Pr SD
SizeSpline_Val_1_11_BB_PS_Ghana_6518(11)_BLK3repl_1988	-8.36	6	-10	7	-6.9%	-4E-07	Sbet	-7.8	0.2
SizeSpline_Val_1_11_BB_PS_Ghana_6518(11)_BLK3repl_1996	-7.87	6	-10	7	-12.9%	-5E-08	Sbet	-7.8	0.2
SizeSpline_Val_4_11_BB_PS_Ghana_6518(11)_BLK3repl_1981	-2.07	6	-5	2	-21.1%	-1E-06	Sbet	-0.3	0.1
SizeSpline_Val_4_11_BB_PS_Ghana_6518(11)_BLK3repl_1996	0.28	6	-5	2	80.5%	5E-07	Sbet	-0.3	0.1
SizeSpline_Val_5_11_BB_PS_Ghana_6518(11)_BLK3repl_1981	-0.77	6	-2	2	-43.7%	4E-07	Sbet	-1.4	0.2
SizeSpline_Val_5_11_BB_PS_Ghana_6518(11)_BLK3repl_1988	-2.83	6	-3	2	-11.7%	7E-07	Sbet	-1.4	0.2
SizeSpline_Val_5_11_BB_PS_Ghana_6518(11)_BLK3repl_1996	-0.78	6	-2	2	-35.7%	-3E-06	Sbet	-1.4	0.2
Size_inflection_17_Japan_LL_TRO(17)_BLK7add_1979	2.67	6	-10	30	147.6%	-1E-06	no	-	-
Size_inflection_17_Japan_LL_TRO(17)_BLK7add_1992	13.04	6	-10	30	29.4%	4E-06	no	-	-
Size_inflection_17_Japan_LL_TRO(17)_BLK7add_2005	20.86	6	-10	30	20.9%	2E-06	no	-	-
Size_95%width_17_Japan_LL_TRO(17)_BLK7add_1979	-3.43	6	-15	25	0.0%	4E-06	no	-	-
Size_95%width_17_Japan_LL_TRO(17)_BLK7add_1992	-2.96	6	-15	25	0.0%	-3E-06	no	-	-
Size_95%width_17_Japan_LL_TRO(17)_BLK7add_2005	8.27	6	-15	25	0.0%	-2E-07	no	-	-
Size_DblN_peak_19_Other_LL_N(19)_BLK1repl_2003	130.4	6	30	180	0.0%	3E-05	no	-	-
Size_inflection_20_Other_LL_TRO(20)_BLK7add_1979	15.51	6	-10	30	0.0%	2E-06	no	-	-
Size_inflection_20_Other_LL_TRO(20)_BLK7add_1992	4.93	6	-10	30	0.0%	-3E-06	no	-	-
Size_inflection_20_Other_LL_TRO(20)_BLK7add_2005	24.47	6	-10	30	0.0%	-2E-07	no	-	-
Size_95%width_20_Other_LL_TRO(20)_BLK7add_1979	14.27	6	-15	25	0.0%	-2E-06	no	-	-
Size_95%width_20_Other_LL_TRO(20)_BLK7add_1992	9.10	6	-15	25	0.0%	2E-07	no	-	-
Size_95%width_20_Other_LL_TRO(20)_BLK7add_2005	20.57	6	-15	25	0.0%	3E-06	no	-	-

Table 13. Estimates of SSB relative to SSB_{MSY}, and fishing mortality relative to F_{MSY} between 1951 and 2018 from SS Grid runs 1-4. Confidence intervals are 95% and based on the hessian standard errors.

	SSB/SSBmsy												F/Fmsy											
		Run 1			Run 2			Run 3			Run 4			Run 1			Run 2			Run 3			Run 4	
Year	MLE	lci	uci	MLE	lci	uci	MLE	lci	uci	MLE	lci	uci	MLE	lci	uci	MLE	lci	uci	MLE	lci	uci	MLE	lci	uci
1951	3.39	3.34	3.45	3.82	3.72	3.91	3.38	3.33	3.42	3.79	3.71	3.86	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1952	3.39	3.34	3.44	3.81	3.72	3.90	3.37	3.33	3.42	3.78	3.71	3.85	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1953	3.38	3.33	3.43	3.80	3.71	3.89	3.37	3.32	3.41	3.77	3.70	3.85	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1954	3.37	3.32	3.43	3.79	3.70	3.88	3.36	3.31	3.40	3.76	3.69	3.84	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1955	3.36	3.31	3.41	3.78	3.69	3.87	3.35	3.30	3.39	3.75	3.68	3.82	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1956	3.35	3.30	3.40	3.76	3.67	3.86	3.34	3.29	3.38	3.74	3.66	3.81	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
1957	3.33	3.28	3.39	3.75	3.65	3.84	3.32	3.28	3.37	3.72	3.65	3.80	0.08	0.07	0.09	0.07	0.06	0.08	0.07	0.06	0.08	0.06	0.06	0.07
1958	3.29	3.23	3.34	3.69	3.60	3.79	3.28	3.23	3.33	3.67	3.59	3.75	0.14	0.12	0.16	0.12	0.10	0.14	0.12	0.11	0.14	0.11	0.10	0.12
1959	3.21	3.15	3.27	3.60	3.50	3.70	3.20	3.15	3.26	3.58	3.50	3.67	0.20	0.17	0.23	0.18	0.15	0.20	0.18	0.16	0.20	0.16	0.14	0.18
1960	3.10	3.04	3.17	3.48	3.37	3.58	3.11	3.04	3.17	3.47	3.37	3.56	0.25	0.21	0.28	0.21	0.18	0.24	0.22	0.19	0.25	0.19	0.17	0.22
1961	3.01	2.93	3.08	3.36	3.25	3.48	3.02	2.95	3.09	3.36	3.26	3.46	0.22	0.19	0.25	0.19	0.16	0.22	0.19	0.17	0.22	0.17	0.15	0.19
1962	2.94	2.86	3.03	3.29	3.17	3.41	2.96	2.88	3.04	3.29	3.18	3.40	0.22	0.19	0.25	0.19	0.16	0.22	0.19	0.17	0.22	0.17	0.15	0.20
1963	2.85	2.69	3.01	3.19	2.99	3.38	2.88	2.73	3.03	3.21	3.03	3.39	0.25	0.21	0.30	0.22	0.18	0.26	0.23	0.19	0.26	0.20	0.16	0.23
1964	2.73	2.43	3.04	3.05	2.70	3.40	2.78	2.49	3.07	3.09	2.76	3.42	0.28	0.23	0.34	0.25	0.19	0.30	0.25	0.20	0.30	0.22	0.18	0.26
1965	2.60	2.20	2.99	2.90	2.45	3.35	2.66	2.28	3.04	2.96	2.53	3.39	0.29	0.22	0.36	0.26	0.19	0.32	0.26	0.20	0.31	0.23	0.18	0.28
1966	2.45	2.00	2.89	2.73	2.23	3.24	2.53	2.10	2.95	2.81	2.33	3.29	0.26	0.20	0.33	0.23	0.17	0.29	0.23	0.18	0.28	0.20	0.15	0.25
1967	2.39	1.92	2.86	2.67	2.14	3.19	2.47	2.02	2.92	2.75	2.24	3.25	0.28	0.20	0.35	0.24	0.18	0.31	0.24	0.18	0.30	0.21	0.16	0.26
1968	2.33	1.85	2.82	2.61	2.06	3.15	2.42	1.95	2.89	2.69	2.16	3.21	0.40	0.29	0.50	0.34	0.25	0.44	0.34	0.26	0.43	0.30	0.22	0.38
1969	2.22	1.73	2.70	2.48	1.93	3.02	2.31	1.84	2.78	2.57	2.04	3.09	0.45	0.33	0.58	0.40	0.28	0.51	0.39	0.29	0.49	0.35	0.26	0.44
1970	2.17	1.68	2.67	2.42	1.87	2.98	2.26	1.79	2.74	2.51	1.98	3.05	0.36	0.26	0.46	0.31	0.22	0.40	0.31	0.23	0.39	0.27	0.20	0.35
1971	2.15	1.65	2.65	2.41	1.84	2.97	2.24	1.76	2.73	2.50	1.96	3.04	0.32	0.24	0.41	0.28	0.20	0.35	0.28	0.21	0.35	0.25	0.18	0.31
1972	2.40	1.89	2.90	2.69	2.12	3.26	2.46	1.98	2.95	2.75	2.21	3.30	0.35	0.26	0.44	0.30	0.22	0.38	0.31	0.23	0.38	0.27	0.20	0.34
1973	2.99	2.40	3.58	3.37	2.70	4.05	3.01	2.44	3.57	3.38	2.74	4.02	0.31	0.23	0.39	0.27	0.20	0.34	0.28	0.21	0.35	0.24	0.18	0.30
1974	3.43	2.78	4.09	3.89	3.15	4.64	3.42	2.79	4.04	3.86	3.14	4.57	0.34	0.25	0.42	0.29	0.21	0.36	0.30	0.23	0.38	0.26	0.20	0.33
1975	3.50	2.86	4.15	3.98	3.24	4.72	3.48	2.85	4.10	3.93	3.23	4.64	0.40	0.30	0.50	0.34	0.26	0.43	0.36	0.27	0.45	0.31	0.24	0.39
1976	3.33	2.73	3.94	3.79	3.10	4.49	3.31	2.72	3.90	3.75	3.08	4.41	0.43	0.32	0.53	0.37	0.28	0.46	0.39	0.29	0.48	0.33	0.25	0.41
1977	3.06	2.51	3.61	3.49	2.85	4.12	3.05	2.51	3.58	3.45	2.84	4.06	0.49	0.37	0.61	0.42	0.32	0.52	0.44	0.34	0.55	0.38	0.29	0.48
1978	2.74	2.26	3.23	3.13	2.57	3.69	2.74	2.26	3.22	3.10	2.57	3.64	0.56	0.43	0.70	0.48	0.36	0.60	0.51	0.39	0.62	0.44	0.33	0.54
1979	2.43	2.00	2.86	2.77	2.27	3.26	2.44	2.01	2.87	2.76	2.28	3.24	0.61	0.46	0.76	0.52	0.39	0.65	0.55	0.42	0.68	0.47	0.36	0.59
1980	2.09	1.71	2.47	2.38	1.95	2.82	2.12	1.74	2.50	2.39	1.97	2.82	0.71	0.54	0.88	0.60	0.46	0.75	0.63	0.48	0.78	0.54	0.41	0.67
1981	1.80	1.46	2.13	2.04	1.66	2.43	1.83	1.49	2.17	2.07	1.69	2.45	0.93	0.71	1.16	0.79	0.60	0.99	0.82	0.62	1.02	0.71	0.54	0.88
1982	1.59	1.27	1.90	1.80	1.45	2.16	1.63	1.31	1.95	1.83	1.48	2.19	1.08	0.81	1.34	0.92	0.69	1.15	0.95	0.71	1.18	0.82	0.61	1.02
1983	1.42	1.12	1.73	1.62	1.27	1.96	1.47	1.16	1.78	1.66	1.31	2.01	1.14	0.85	1.43	0.97	0.72	1.23	1.00	0.74	1.26	0.87	0.64	1.09
1984	1.33	1.03	1.63	1.51	1.17	1.85	1.38	1.07	1.69	1.55	1.21	1.90	0.79	0.58	0.99	0.67	0.49	0.85	0.69	0.51	0.87	0.60	0.44	0.76
1985	1.40	1.10	1.71	1.60	1.25	1.95	1.45	1.13	1.77	1.64	1.28	1.99	0.95	0.72	1.19	0.81	0.61	1.01	0.84	0.63	1.05	0.73	0.54	0.91
1986	1.59	1.26	1.92	1.81	1.44	2.19	1.62	1.28	1.97	1.84	1.46	2.22	0.84	0.63	1.05	0.71	0.53	0.89	0.75	0.56	0.93	0.64	0.48	0.80
1987	1.78	1.41	2.14	2.03	1.61	2.45	1.81	1.43	2.18	2.05	1.63	2.47	0.81	0.61	1.01	0.69	0.51	0.86	0.72	0.54	0.90	0.62	0.46	0.77
1988	1.81	1.44	2.17	2.07	1.65	2.49	1.84	1.46	2.21	2.09	1.67	2.51	0.75	0.57	0.93	0.63	0.48	0.79	0.67	0.50	0.83	0.57	0.43	0.71
1989	1.84	1.48	2.19	2.11	1.70	2.52	1.87	1.50	2.23	2.13	1.72	2.53	0.90	0.69	1.11	0.76	0.58	0.94	0.80	0.61	0.99	0.68	0.52	0.85
1990	1.79	1.45	2.13	2.06	1.67	2.45	1.82	1.47	2.17	2.07	1.68	2.46	1.12	0.86	1.39	0.95	0.72	1.18	1.00	0.76	1.24	0.85	0.65	1.06
1991	1.62	1.29	1.95	1.86	1.48	2.24	1.66	1.32	1.99	1.89	1.51	2.26	1.03	0.79	1.28	0.87	0.66	1.08	0.92	0.70	1.14	0.79	0.60	0.98
1992	1.53	1.22	1.84	1.75	1.40	2.10	1.56	1.24	1.88	1.78	1.42	2.13	1.02	0.78	1.26	0.87	0.66	1.07	0.91	0.69	1.13	0.78	0.59	0.97
1993	1.54	1.24	1.84	1.76	1.42	2.11	1.56	1.25	1.87	1.78	1.44	2.12	1.02	0.79	1.26	0.87	0.66	1.07	0.91	0.70	1.13	0.78	0.60	0.97
1994	1.54	1.25	1.83	1.77	1.43	2.10	1.56	1.26	1.87	1.78	1.44	2.12	1.09	0.84	1.34	0.92	0.71	1.14	0.97	0.75	1.20	0.83	0.64	1.03
1995	1.52	1.22	1.81	1.74	1.41	2.08	1.54	1.24	1.84	1.76	1.42	2.09	1.00	0.76	1.23	0.84	0.64	1.04	0.89	0.67	1.10	0.76	0.58	0.94
1996	1.51	1.21	1.80	1.73	1.40	2.07	1.53	1.23	1.84	1.75	1.41	2.09	0.99	0.75	1.23	0.84	0.63	1.04	0.88	0.66	1.10	0.75	0.57	0.94
1997	1.46	1.16	1.76	1.68	1.34	2.01	1.49	1.18	1.79	1.69	1.35	2.03	0.95	0.71	1.18	0.80	0.60	1.00	0.84	0.63	1.05	0.72	0.54	0.90
1998	1.41	1.11	1.70	1.62	1.28	1.95	1.44	1.13	1.74	1.64	1.30	1.98	1.01	0.76	1.27	0.86	0.64	1.08	0.90	0.67	1.13	0.77	0.57	0.97
1999	1.35	1.05	1.64	1.55	1.20	1.89	1.38	1.07	1.69	1.57	1.23	1.92	0.92	0.69	1.16	0.78	0.58	0.98	0.82	0.61	1.03	0.70	0.52	0.88
2000	1.40	1.09	1.71	1.61	1.26	1.96	1.44	1.12	1.75	1.64	1.28	1.99	0.82	0.61	1.03	0.69	0.52	0.87	0.73	0.54	0.91	0.62	0.46	0.78
2001	1.61	1.28	1.94	1.85	1.47	2.24	1.64	1.30	1.98	1.87	1.49	2.25	0.89	0.67	1.11	0.75	0.56	0.94	0.79	0.59	0.99	0.67	0.50	0.84
2002	1.74	1.38	2.10	2.01	1.59	2.42	1.77	1.40	2.14	2.02	1.61	2.43	0.77	0.57	0.96	0.65	0.48	0.81	0.68	0.51	0.85	0.58	0.43	0.73
2003	1.77	1.40	2.14	2.04	1.62	2.46	1.80	1.43	2.17	2.06	1.64	2.47	0.69	0.52	0.86	0.58	0.43	0.73	0.61	0.46	0.77	0.52	0.39	0.66
2004	1.82	1.46	2.19	2.10	1.68	2.52	1.84	1.48	2.21	2.11	1.70	2.52	0.68	0.51	0.85	0.57	0.43	0.72	0.61	0.45	0.76	0.52	0.39	0.65
2005	1.81	1.45	2.17	2.09	1.67	2.50	1.83	1.46	2.19	2.09	1.69	2.50	0.63	0.47	0.79	0.53	0.39	0.66	0.56	0.42	0.70	0.48	0.36	0.60
2006	1.70	1.35	2.05	1.97	1.57	2.36	1.73	1.38	2.08	1.98	1.58	2.37	0.65	0.49	0.81	0.55	0.41	0.69	0.58	0.43	0.72	0.49	0.37	0.62
2007	1.64	1.31	1.98	1.89	1.51	2.28	1.66	1.33	2.00	1.90	1.53	2.28	0.63	0.47	0.79	0.53	0.40	0.67	0.56	0.42	0.70	0.48	0.36	0.60
2008	1.63	1.30	1.96	1.88	1.51	2.26	1.65	1.32	1.98	1.89	1.52	2.26	0.73	0.55	0.91	0.62	0.46	0.77	0.65	0.49	0.81	0.56	0.42	0.70
2009	1.54	1.23	1.86	1.78	1.42	2.14	1.56	1.25	1.88	1.79	1.43	2.14	0.81	0.61	1.01	0.68	0.51	0.86	0.72	0.54	0.90	0.62	0.46	0.77
2010	1.43	1.12	1.73	1.65	1.30	2.00	1.46	1.15	1.76	1.66	1.32	2.01	0.84	0.63	1.06	0.71	0.53	0.89	0.74	0.55	0.93	0.63	0.47	0.80
2011	1.37	1.07	1.67	1.58	1.24	1.92	1.40	1.10	1.70	1.60	1.26	1.94	0.82	0.61	1.03	0.69	0.51	0.87	0.70	0.53	0.88	0.60	0.45	0.75
2012	1.37	1.07	1.68	1.59	1.24	1.93	1.44	1.14	1.75	1.64	1.30	1.99	0.81	0.60	1.02	0.68	0.50	0.86	0.69	0.52	0.86	0.59	0.44	0.74
2013	1.41	1.10	1.72	1.63	1.27	1.98	1.52	1.21	1.83	1.73	1.38	2.09	0.73	0.54	0.92	0.62	0.46	0.78	0.64	0.48	0.80	0.55	0.41	0.68
2014	1.47	1.15	1.79	1.70	1.33	2.07	1.54	1.23	1.85	1.76	1.41	2.11	0.76	0.56	0.95	0.64	0.47	0.80	0.69	0.52	0.86	0.59	0.44	0.74
2015	1.51	1.18	1.85	1.75	1.37	2.13	1.48	1.18	1.79	1.69	1.35	2.03	0.86	0.64	1.09	0.73	0.53	0.92	0.81	0.60	1.01	0.69	0.52	0.87
2016	1.48	1.14	1.82	1.71	1.32	2.10	1.40	1.09	1.70	1.59	1.25	1.93	1.07	0.77	1.36	0.90	0.65	1.15	1.00	0.73	1.27	0.86	0.63	1.09
2017	1.35	1.01	1.69	1.56	1.17	1.95	1.28	0.98	1.59	1.45	1.11	1.80	1.09	0.74	1.43	0.91	0.62	1.20	1.00	0.71	1.29	0.86	0.61	1.12
2018	1.198	0.848	1.549	1.39	0.99	1.79	1.17	0.86	1.48	1.32	0.97	1.67	1.19	0.74	1.63	1.00	0.62	1.37	1.00	0.68	1.32	0.86	0.59	1.14

Table 14. Estimates of SSB 1950 – 2018 from the stock synthesis grid runs 1-4. Confidence intervals are 95% and based on the Hessian standard errors.

		Run 1			Run 2			Run 3			Run 4	
Year	MLE	lci	uci	MLE	lci	uci	MLE	lci	uci	MLE	lci	uci
1950	1,433,860	1,244,168	1,623,552	1,370,660	1,178,805	1,562,515	1,527,430	1,313,853	1,741,007	1,452,100	1,241,978	1,662,222
1951	1,433,100	1,243,401	1,622,799	1,369,910	1,178,048	1,561,772	1,526,680	1,313,095	1,740,265	1,451,340	1,241,212	1,661,468
1952	1,431,490	1,241,803	1,621,177	1,368,290	1,176,440	1,560,140	1,525,060	1,311,487	1,738,633	1,449,720	1,239,602	1,659,838
1953	1,428,550	1,238,884	1,618,216	1,365,360	1,173,531	1,557,189	1,522,100	1,308,546	1,735,654	1,446,770	1,236,672	1,656,868
1954	1,424,420	1,234,795	1,614,045	1,361,240	1,169,452	1,553,028	1,517,950	1,304,433	1,731,467	1,442,620	1,232,559	1,652,681
1955	1,419,730	1,230,171	1,609,289	1,356,560	1,164,838	1,548,282	1,513,210	1,299,754	1,726,666	1,437,910	1,227,910	1,647,910
1956	1,414,770	1,225,276	1,604,264	1,351,630	1,159,973	1,543,287	1,508,220	1,294,823	1,721,617	1,432,950	1,223,009	1,642,891
1957	1,408,500	1,219,062	1,597,938	1,345,410	1,153,808	1,537,012	1,501,910	1,288,562	1,715,258	1,426,690	1,216,798	1,636,582
1958	1,388,390	1,199,007	1,577,773	1,325,370	1,133,823	1,516,917	1,481,740	1,268,443	1,695,037	1,406,600	1,196,757	1,616,443
1959	1,355,210	1,165,932	1,544,488	1,292,300	1,100,861	1,483,739	1,448,480	1,235,277	1,661,683	1,373,450	1,163,705	1,583,195
1960	1,310,960	1,121,851	1,500,069	1,248,210	1,056,945	1,439,475	1,404,110	1,191,060	1,617,160	1,329,240	1,119,651	1,538,829
1961	1,270,380	1,081,389	1,459,371	1,207,850	1,016,712	1,398,988	1,363,410	1,150,468	1,576,352	1,288,770	1,079,297	1,498,243
1962	1,243,510	1,054,362	1,432,658	1,181,390	990,145	1,372,635	1,336,710	1,123,633	1,549,787	1,262,480	1,052,911	1,472,049
1963	1,205,240	1,005,300	1,405,180	1,144,730	944,126	1,345,334	1,302,020	1,079,229	1,524,811	1,229,200	1,011,048	1,447,352
1964	1,153,670	921,061	1,386,279	1,095,730	865,994	1,325,466	1,255,230	1,001,043	1,509,417	1,184,840	938,417	1,431,263
1965	1,096,870	837,821	1,355,919	1,041,430	787,949	1,294,911	1,201,810	921,426	1,482,194	1,133,900	863,849	1,403,951
1966	1,033,980	762,508	1,305,452	981,260	716,911	1,245,609	1,141,820	848,622	1,435,018	1,076,590	795,277	1,357,903
1967	1,009,050	729,458	1,288,642	957,558	685,973	1,229,143	1,117,190	815,550	1,418,830	1,053,220	764,471	1,341,969
1968	985,510	699,981	1,271,039	935,303	658,455	1,212,151	1,093,250	785,783	1,400,717	1,030,630	736,793	1,324,467
1969	936,854	655,341	1,218,367	888,915	616,097	1,161,733	1,043,550	740,242	1,346,858	983,444	693,776	1,273,112
1970	917,664	632,731	1,202,597	870,518	594,252	1,146,784	1,022,840	716,092	1,329,588	963,698	670,700	1,256,696
1971	909,130	622,370	1,195,890	863,759	585,598	1,141,920	1,014,340	705,709	1,322,971	957,127	662,259	1,251,995
1972	1,011,860	710,506	1,313,214	966,014	672,839	1,259,189	1,113,380	788,843	1,437,917	1,055,670	745,135	1,366,205
1973	1,261,610	901,979	1,621,241	1,211,210	859,876	1,562,544	1,358,180	972,628	1,743,732	1,295,230	925,211	1,665,249
1974	1,449,720	1,046,479	1,852,961	1,397,390	1,002,446	1,792,334	1,543,650	1,111,509	1,975,791	1,478,150	1,062,740	1,893,560
1975	1,480,160	1,074,436	1,885,884	1,430,050	1,032,103	1,827,997	1,571,560	1,135,648	2,007,472	1,508,340	1,089,139	1,927,541
1976	1,408,370	1,022,644	1,794,096	1,362,130	983,423	1,740,837	1,495,600	1,079,617	1,911,583	1,436,750	1,036,765	1,836,735
1977	1,293,290	939,436	1,647,144	1,251,510	903,857	1,599,163	1,376,970	993,467	1,760,473	1,323,200	954,546	1,691,854
1978	1,159,460	842,408	1,476,512	1,122,150	810,471	1,433,829	1,238,930	892,943	1,584,917	1,190,330	857,847	1,522,813
1979	1,026,490	743,354	1,309,626	993,301	714,924	1,271,678	1,101,760	790,459	1,413,061	1,057,950	759,003	1,356,897
1980	884,225	636,028	1,132,422	855,263	611,394	1,099,132	956,096	680,745	1,231,447	917,259	653,204	1,181,314
1981	759,276	541,324	977,228	733,965	520,002	947,928	827,903	583,632	1,072,174	793,424	559,549	1,027,299
1982	669,706	470,374	869,038	646,785	451,201	842,369	734,806	509,414	960,198	703,253	487,710	918,796
1983	600,930	412,549	789,311	579,840	395,066	764,614	664,392	450,019	878,765	635,013	430,144	839,882
1984	562,215	378,923	745,507	542,440	362,617	722,263	623,862	414,446	833,278	596,104	395,978	796,230
1985	593,061	405,237	780,885	573,845	389,378	758,312	655,341	440,903	869,779	628,164	423,015	833,313
1986	671,442	466,442	876,442	651,382	449,647	853,117	734,064	500,951	967,177	705,837	482,466	929,208
1987	750,207	524,146	976,268	729,436	506,694	952,178	816,312	560,632	1,071,992	786,929	541,555	1,032,303
1988	762,763	535,191	990,335	742,736	518,404	967,068	829,607	572,090	1,087,124	801,017	553,794	1,048,240
1989	776,761	552,862	1,000,660	757,497	536,734	978,260	843,599	590,014	1,097,184	815,868	572,371	1,059,365
1990	756,827	539,988	973,666	738,274	524,467	952,081	821,477	575,519	1,067,435	794,688	558,518	1,030,858
1991	685,668	480,293	891,043	668,273	465,852	870,694	748,259	514,845	981,673	722,921	498,844	946,998
1992	644,989	452,334	837,644	628,819	438,983	818,655	704,623	484,901	924,345	680,831	470,000	891,662
1993	648,847	459,810	837,884	633,086	446,736	819,436	705,673	490,293	921,053	682,395	475,737	889,053
1994	650,386	463,151	837,621	634,947	450,308	819,586	706,127	492,959	919,295	683,194	478,686	887,702
1995	640,529	454,147	826,911	625,316	441,525	809,107	695,720	483,462	907,978	672,993	469,402	876,584
1996	637,080	449,676	824,484	621,905	437,112	806,698	692,249	478,852	905,646	669,479	464,790	874,168
1997	616,345	430,200	802,490	601,384	417,837	784,931	671,557	459,430	883,684	649,004	445,515	852,493
1998	594,285	410,688	777,882	579,737	398,699	760,775	649,264	439,897	858,631	627,224	426,346	828,102
1999	568,665	386,370	750,960	554,615	374,845	734,385	624,232	416,376	832,088	602,763	403,264	802,262
2000	591,719	402,955	780,483	577,583	391,341	763,825	649,503	434,711	864,295	627,743	421,441	834,045
2001	680,132	471,337	888,927	664,922	458,777	871,067	741,079	504,875	977,283	717,651	490,560	944,742
2002	735,881	510,383	961,379	720,209	497,547	942,871	799,681	545,749	1,053,613	775,269	530,984	1,019,554
2003	748,127	519,319	976,935	733,031	507,141	958,921	812,618	555,386	1,069,850	788,613	541,096	1,036,130
2004	769,542	538,609	1,000,475	754,795	526,827	982,763	833,251	574,272	1,092,230	809,332	560,094	1,058,570
2005	763,959	534,492	993,426	749,629	523,100	976,158	826,826	570,111	1,083,541	803,069	555,972	1,050,166
2006	719,032	500,619	937,445	705,636	490,001	921,271	780,020	535,741	1,024,299	757,318	522,171	992,465
2007	693,117	482,864	903,370	680,181	472,582	887,780	752,231	517,147	987,315	729,957	503,673	956,241
2008	688,492	482,106	894,878	675,614	471,835	879,393	746,075	515,422	976,728	723,688	501,702	945,674
2009	651,183	453,541	848,825	638,771	443,647	833,895	706,712	485,440	927,984	684,949	472,054	897,844
2010	603,356	415,579	791,133	591,594	406,218	776,970	657,759	446,845	868,673	636,866	433,988	839,744
2011	578,770	395,844	761,696	567,404	386,806	748,002	633,549	427,820	839,278	613,038	415,168	810,908
2012	580,649	396,257	765,041	569,394	387,324	751,464	651,616	442,680	860,552	630,404	429,461	831,347
2013	595,234	405,565	784,903	584,038	396,743	771,333	687,554	471,303	903,805	665,017	457,069	872,965
2014	621,142	424,915	817,369	610,082	416,317	803,847	697,100	480,085	914,115	674,080	465,428	882,732
2015	639,491	437,368	841,614	628,665	429,135	828,195	670,885	459,858	881,912	648,133	445,269	850,997
2016	624,059	420,286	827,832	613,782	412,739	814,825	630,732	425,512	835,952	608,194	410,936	805,452
2017	569,324	369,135	769,513	559,988	362,645	757,331	579,610	378,545	780,675	557,280	364,022	750,538
2018	506,273	308,672	703,874	498,006	303,393	692,619	528,253	330,142	726,364	506,320	315,853	696,787

Table 15. Stock synthesis grid runs 1 – 4 estimated benchmarks for Atlantic YFT stock.

		Run 1			Run 2	
Benchmark	**MLE**	**lci**	**uci**	**MLE**	**lci**	**uci**
SSB_unfished	1,433,860	1,244,168	1,623,552	1,370,660	1,178,805	1,562,515
Totbio_unfished	1,847,760	1,603,285	2,092,235	1,766,280	1,519,006	2,013,554
SmryBio_unfished	1,847,500	1,603,061	2,091,939	1,766,040	1,518,802	2,013,278
Recr_unfished	83,296	71,503	95,089	79,580	67,712	91,447
SSB_Btgt	430,157	373,249	487,065	411,199	353,643	468,755
SPR_Btgt	0.344	0.344	0.344	0.319	0.319	0.319
Fstd_Btgt	0.161	0.148	0.175	0.175	0.161	0.189
Dead_Catch_Btgt	101,768	88,245	115,291	106,738	92,164	121,312
SSB_SPR	363,244	315,189	411,299	383,785	330,066	437,504
Fstd_SPR	0.186	0.171	0.201	0.187	0.172	0.202
Dead_Catch_SPR	101,030	87,609	114,451	107,170	92,537	121,803
SSB_MSY	422,487	367,459	477,515	359,054	310,133	407,975
SPR_MSY	0.339	0.334	0.343	0.282	0.276	0.289
Fstd_MSY	0.164	0.151	0.177	0.198	0.183	0.213
Dead_Catch_MSY	101,779	88,255	115,303	107,301	92,650	121,952
Ret_Catch_MSY	101,779	88,255	115,303	107,301	92,650	121,952
B_MSY/SSB_unfished	0.295	0.290	0.299	0.262	0.256	0.268
		Run 3			**Run 4**	
Benchmark	**MLE**	**lci**	**uci**	**MLE**	**lci**	**uci**
SSB_unfished	1,527,430	1,313,853	1,741,007	1,452,100	1,241,978	1,662,222
Totbio_unfished	1,966,670	1,691,521	2,241,819	1,869,710	1,599,012	2,140,408
SmryBio_unfished	1,966,420	1,691,309	2,241,531	1,869,480	1,598,820	2,140,140
Recr_unfished	86,978	73,715	100,241	82,734	69,744	95,723
SSB_Btgt	458,229	394,156	522,302	435,629	372,592	498,666
SPR_Btgt	0.344	0.344	0.344	0.319	0.319	0.319
Fstd_Btgt	0.169	0.158	0.180	0.184	0.172	0.195
Dead_Catch_Btgt	114,826	102,512	127,140	119,899	106,601	133,197
SSB_SPR	386,949	332,843	441,055	406,587	347,753	465,421
Fstd_SPR	0.195	0.183	0.207	0.196	0.184	0.208
Dead_Catch_SPR	113,930	101,649	126,211	120,353	106,974	133,732
SSB_MSY	452,022	389,789	514,255	383,482	329,596	437,368
SPR_MSY	0.340	0.336	0.344	0.285	0.280	0.289
Fstd_MSY	0.171	0.160	0.182	0.206	0.193	0.219
Dead_Catch_MSY	114,833	102,513	127,153	120,468	107,048	133,888
Ret_Catch_MSY	114,833	102,513	127,153	120,468	107,048	133,888
B_MSY/SSB_unfished	0.296	0.292	0.300	0.264	0.259	0.269

Table 16. MSY based benchmarks, stock status and estimated model parameters for the MPB-Reference Case for Atlantic yellowfin tuna.

Variable	Mean	Median	90%LCI	90%UCI
MSY (x 1,000 t)	128.06	128.09	121.79	134.16
B_{MSY} (x 1,000 t)	814.42	757.20	690.75	1065.76
F_{MSY}	0.16	0.17	0.11	0.19
F_{2018}/F_{MSY}	0.981	0.979	0.776	1.194
B_{2018}/B_{MSY}	1.060	1.057	0.844	1.287
B_{2018}/K	0.390	0.389	0.321	0.464
r (yr-1)	0.162	0.169	0.115	0.188
K (x 1,000 t)	2212.708	2057.258	1876.713	2895.589

Table 17. The MPB-Reference Case estimates of biomass, fishing mortality, biomass relative to B_{MSY}, and fishing mortality relative to F_{MSY} between 1950 and 2018 for Atlantic yellowfin tuna.

mpb	Biomass			Fishing mortality			B/Bmsy			F/Fmsy		
Year	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI
1950	1954396	1782878	2750810	0.001	0.000	0.001	2.581	2.581	2.581	0.004	0.003	0.004
1951	1970173	1798648	2765402	0.001	0.000	0.001	2.602	2.594	2.606	0.004	0.004	0.004
1952	1983247	1811471	2778282	0.001	0.001	0.002	2.619	2.605	2.625	0.008	0.008	0.009
1953	1992766	1820578	2788354	0.002	0.001	0.002	2.632	2.614	2.639	0.011	0.010	0.011
1954	1999915	1827237	2796531	0.002	0.001	0.002	2.641	2.622	2.649	0.010	0.010	0.011
1955	2006083	1832889	2804019	0.002	0.002	0.002	2.649	2.628	2.657	0.013	0.012	0.013
1956	2010341	1836626	2809804	0.003	0.002	0.004	2.655	2.634	2.662	0.019	0.018	0.021
1957	2011598	1837388	2812664	0.012	0.008	0.013	2.657	2.637	2.663	0.070	0.066	0.074
1958	1995546	1820910	2798113	0.020	0.015	0.022	2.635	2.624	2.639	0.120	0.115	0.127
1959	1965258	1790529	2768256	0.029	0.021	0.032	2.596	2.591	2.601	0.174	0.166	0.183
1960	1922716	1748380	2724420	0.036	0.025	0.039	2.540	2.527	2.561	0.210	0.201	0.220
1961	1876246	1702868	2674506	0.031	0.022	0.035	2.478	2.459	2.518	0.185	0.177	0.193
1962	1846707	1674781	2639476	0.031	0.022	0.034	2.440	2.418	2.487	0.184	0.176	0.192
1963	1822950	1652636	2609309	0.035	0.025	0.039	2.409	2.386	2.460	0.209	0.200	0.218
1964	1795681	1627031	2575112	0.038	0.027	0.042	2.374	2.349	2.430	0.226	0.216	0.235
1965	1768106	1601205	2539987	0.038	0.027	0.042	2.338	2.312	2.399	0.226	0.216	0.234
1966	1745736	1580655	2509512	0.034	0.023	0.037	2.309	2.283	2.371	0.198	0.190	0.206
1967	1735542	1572273	2490965	0.035	0.024	0.038	2.297	2.272	2.355	0.205	0.195	0.213
1968	1725296	1563687	2472700	0.049	0.034	0.054	2.284	2.262	2.338	0.288	0.275	0.300
1969	1692387	1532309	2432066	0.056	0.039	0.062	2.241	2.215	2.302	0.329	0.314	0.342
1970	1653771	1495363	2384955	0.045	0.031	0.050	2.191	2.161	2.260	0.266	0.254	0.276
1971	1640365	1483670	2362016	0.046	0.032	0.050	2.173	2.146	2.239	0.268	0.256	0.279
1972	1628632	1473619	2341107	0.059	0.041	0.065	2.158	2.133	2.221	0.345	0.329	0.359
1973	1597714	1444272	2301336	0.060	0.042	0.066	2.118	2.090	2.185	0.354	0.337	0.367
1974	1570445	1418525	2264790	0.068	0.047	0.076	2.082	2.053	2.153	0.402	0.383	0.418
1975	1535362	1384964	2221370	0.081	0.056	0.090	2.036	2.004	2.113	0.478	0.454	0.496
1976	1487214	1338529	2164513	0.084	0.058	0.093	1.973	1.935	2.061	0.495	0.470	0.512
1977	1444320	1297518	2112116	0.091	0.062	0.101	1.917	1.875	2.012	0.535	0.508	0.553
1978	1399645	1255032	2057671	0.096	0.065	0.107	1.859	1.813	1.962	0.563	0.533	0.582
1979	1356756	1214705	2004898	0.094	0.064	0.105	1.804	1.755	1.914	0.552	0.522	0.571
1980	1325627	1185176	1962632	0.099	0.067	0.110	1.762	1.713	1.875	0.579	0.547	0.600
1981	1293539	1155472	1920296	0.121	0.081	0.135	1.721	1.671	1.836	0.708	0.667	0.733
1982	1238810	1103413	1855727	0.133	0.089	0.150	1.650	1.595	1.777	0.782	0.736	0.810
1983	1179763	1046858	1786305	0.140	0.093	0.158	1.574	1.512	1.713	0.820	0.769	0.853
1984	1125458	994829	1721197	0.102	0.067	0.115	1.504	1.436	1.654	0.594	0.554	0.620
1985	1127973	997502	1712203	0.139	0.092	0.157	1.506	1.444	1.641	0.813	0.759	0.849
1986	1088515	957657	1662174	0.135	0.088	0.153	1.452	1.386	1.592	0.790	0.734	0.827
1987	1060481	930383	1625081	0.137	0.090	0.157	1.414	1.346	1.555	0.805	0.746	0.845
1988	1035072	905820	1591174	0.131	0.086	0.150	1.380	1.310	1.521	0.771	0.712	0.811
1989	1023121	892177	1568679	0.159	0.104	0.182	1.360	1.291	1.499	0.934	0.861	0.983
1990	982900	852813	1520933	0.197	0.127	0.227	1.308	1.234	1.454	1.158	1.062	1.225
1991	913633	784038	1442336	0.183	0.116	0.214	1.218	1.134	1.381	1.075	0.975	1.150
1992	874662	744859	1397446	0.187	0.117	0.220	1.165	1.075	1.336	1.099	0.990	1.184
1993	841042	710377	1356128	0.194	0.121	0.230	1.118	1.023	1.296	1.144	1.023	1.240
1994	807006	676654	1316508	0.215	0.132	0.257	1.073	0.972	1.258	1.269	1.122	1.386
1995	764337	632920	1267441	0.202	0.122	0.244	1.015	0.905	1.211	1.194	1.042	1.319
1996	741322	607963	1234478	0.201	0.121	0.245	0.981	0.866	1.184	1.191	1.030	1.328
1997	722623	588037	1207383	0.190	0.114	0.234	0.954	0.834	1.163	1.127	0.967	1.268
1998	717898	579399	1192339	0.201	0.121	0.249	0.943	0.817	1.154	1.201	1.027	1.360
1999	705715	561881	1170273	0.193	0.116	0.242	0.922	0.789	1.137	1.157	0.981	1.323
2000	701040	550804	1156990	0.189	0.114	0.240	0.912	0.773	1.129	1.137	0.960	1.314
2001	696741	541807	1149188	0.220	0.134	0.283	0.907	0.761	1.125	1.325	1.114	1.547
2002	675290	512077	1118405	0.200	0.121	0.263	0.875	0.719	1.098	1.208	1.003	1.433
2003	671290	500865	1105525	0.183	0.111	0.245	0.864	0.702	1.089	1.110	0.915	1.335
2004	675615	501411	1106003	0.177	0.108	0.238	0.868	0.701	1.089	1.075	0.884	1.307
2005	686515	504423	1109501	0.153	0.095	0.208	0.879	0.703	1.091	0.938	0.765	1.141
2006	711581	523033	1126842	0.149	0.094	0.202	0.906	0.728	1.114	0.918	0.747	1.115
2007	734550	542354	1144888	0.137	0.088	0.185	0.934	0.751	1.148	0.845	0.683	1.027
2008	761720	568172	1167575	0.147	0.096	0.197	0.968	0.785	1.178	0.907	0.737	1.099
2009	778988	583397	1178649	0.151	0.100	0.202	0.986	0.806	1.198	0.937	0.760	1.134
2010	791869	593075	1183579	0.149	0.100	0.199	0.999	0.816	1.211	0.927	0.751	1.123
2011	803064	602653	1188322	0.141	0.096	0.188	1.012	0.827	1.225	0.880	0.712	1.068
2012	817450	614444	1199918	0.141	0.096	0.187	1.031	0.842	1.244	0.874	0.706	1.060
2013	830928	625287	1213851	0.128	0.088	0.170	1.047	0.853	1.263	0.798	0.641	0.963
2014	852928	645437	1233107	0.132	0.092	0.175	1.075	0.877	1.297	0.830	0.663	0.992
2015	867225	660881	1239565	0.147	0.103	0.193	1.092	0.894	1.319	0.922	0.737	1.102
2016	866504	659255	1231154	0.171	0.120	0.225	1.092	0.889	1.321	1.071	0.854	1.286
2017	845982	638368	1205832	0.159	0.112	0.211	1.066	0.859	1.295	0.999	0.794	1.208
2018	838353	629487	1194778	0.156	0.110	0.208	1.057	0.844	1.287	0.979	0.776	1.194

Table 18. Summary, including MSY based benchmarks, of posterior quantiles denoting the median and the 95% credibility intervals of parameter estimates for the JABBA Reference Cases for Atlantic yellowfin stock.

Model	**Base Case**			**S2**		
Estimates	Median	2.50%	97.50%	Median	2.50%	97.50%
K	2272092	1602534	4512552	1736979	1098577	3350110
r	0.154	0.112	0.211	0.229	0.141	0.369
ψ (psi)	0.992	0.817	1.197	0.993	0.820	1.194
σ_{proc}	0.084	0.045	0.134	0.089	0.055	0.145
m	0.867	0.867	0.867	1.127	1.127	1.127
F_{MSY}	0.178	0.129	0.244	0.203	0.125	0.327
B_{MSY} (t)	776970	548006	1543123	677555	428529	1306801
MSY (t)	134815	108978	267350	134429	111991	245473
B_{1950}/K	0.987	0.761	1.242	0.99	0.754	1.258
B_{2018}/K	0.343	0.195	0.599	0.324	0.195	0.583
B_{2018}/B_{MSY}	1.003	0.571	1.753	0.830	0.499	1.495
F_{2018}/F_{MSY}	0.977	0.297	1.915	1.190	0.368	2.112

Model	**S3**			**S5**		
Estimates	Median	2.50%	97.50%	Median	2.50%	97.50%
K	2146591	1541241	3417437	1591346	1017798	2965343
r	0.161	0.117	0.221	0.255	0.153	0.400
ψ (psi)	0.995	0.819	1.197	0.994	0.82	1.197
σ_{proc}	0.077	0.045	0.122	0.089	0.055	0.134
m	0.867	0.867	0.867	1.127	1.127	1.127
F_{MSY}	0.186	0.135	0.254	0.226	0.136	0.354
B_{MSY} (t)	734053	527046	1168635	620747	397019	1156712
MSY (t)	135118	111155	205339	136810	115105	222251
B_{1950}/K	0.991	0.768	1.246	0.99	0.757	1.256
B_{2018}/K	0.371	0.227	0.564	0.365	0.228	0.603
B_{2018}/B_{MSY}	1.085	0.665	1.649	0.936	0.585	1.547
F_{2018}/F_{MSY}	0.901	0.409	1.619	1.035	0.393	1.772

Table 19. Estimates of biomass, fishing mortality, biomass relative to B_{MSY}, and fishing mortality relative to F_{MSY} between 1950 and 2018 from JABBA Reference Cases (a: Base Case, b: S2, c: S3, and d: S5) for Atlantic yellowfin tuna with 95% credibility intervals.

Base Case

JABBA	Biomass			Fishing mortality			B/Bmsy			F/Fmsy		
Year	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI
1950	2260547	1441730	4535648	0.001	0.000	0.001	2.885	2.225	3.631	0.003	0.002	0.004
1951	2250309	1426115	4536344	0.001	0.000	0.001	2.875	2.181	3.644	0.003	0.002	0.005
1952	2240517	1413573	4529405	0.001	0.001	0.002	2.866	2.137	3.647	0.007	0.004	0.010
1953	2228794	1398683	4513944	0.002	0.001	0.003	2.858	2.102	3.641	0.009	0.005	0.013
1954	2220862	1383577	4492138	0.002	0.001	0.002	2.850	2.086	3.636	0.009	0.004	0.013
1955	2217873	1371496	4514154	0.002	0.001	0.003	2.840	2.064	3.624	0.011	0.006	0.016
1956	2218129	1376886	4505434	0.003	0.001	0.005	2.839	2.056	3.637	0.017	0.008	0.025
1957	2207412	1367964	4483919	0.011	0.005	0.017	2.832	2.043	3.642	0.061	0.030	0.091
1958	2190205	1348194	4454079	0.019	0.009	0.030	2.804	2.019	3.619	0.105	0.052	0.157
1959	2158370	1323503	4423292	0.027	0.013	0.044	2.764	1.986	3.593	0.152	0.075	0.228
1960	2113355	1279972	4360039	0.032	0.016	0.054	2.708	1.936	3.553	0.184	0.090	0.280
1961	2071155	1241169	4289917	0.028	0.014	0.047	2.648	1.891	3.501	0.162	0.078	0.247
1962	2041807	1210113	4239868	0.028	0.014	0.048	2.615	1.840	3.479	0.160	0.078	0.247
1963	2020354	1201827	4249408	0.032	0.015	0.054	2.586	1.817	3.453	0.182	0.087	0.281
1964	1992917	1179027	4221892	0.035	0.016	0.058	2.554	1.782	3.427	0.197	0.093	0.306
1965	1967143	1151778	4219707	0.034	0.016	0.059	2.520	1.752	3.389	0.196	0.091	0.307
1966	1942848	1133700	4196913	0.030	0.014	0.052	2.491	1.730	3.382	0.172	0.080	0.270
1967	1939109	1128034	4166031	0.031	0.014	0.053	2.484	1.723	3.387	0.177	0.082	0.278
1968	1926912	1122391	4201239	0.044	0.020	0.075	2.472	1.708	3.372	0.250	0.114	0.392
1969	1893179	1091387	4192196	0.050	0.023	0.087	2.431	1.671	3.337	0.285	0.129	0.451
1970	1856254	1062376	4185264	0.040	0.018	0.070	2.388	1.632	3.294	0.230	0.102	0.367
1971	1844014	1059786	4166807	0.041	0.018	0.071	2.377	1.631	3.289	0.231	0.102	0.370
1972	1836333	1053753	4193798	0.052	0.023	0.091	2.364	1.630	3.282	0.298	0.129	0.473
1973	1805291	1032418	4201286	0.053	0.023	0.093	2.328	1.602	3.265	0.304	0.130	0.485
1974	1777462	1015018	4227944	0.060	0.025	0.106	2.300	1.577	3.254	0.344	0.144	0.550
1975	1746785	989494	4245721	0.071	0.029	0.126	2.261	1.541	3.236	0.408	0.168	0.654
1976	1702495	950056	4275713	0.073	0.029	0.132	2.208	1.491	3.215	0.419	0.167	0.682
1977	1660918	916821	4293143	0.079	0.031	0.143	2.158	1.442	3.176	0.452	0.175	0.745
1978	1616287	884491	4283439	0.083	0.031	0.152	2.104	1.396	3.139	0.474	0.178	0.786
1979	1575025	852265	4306768	0.081	0.030	0.150	2.055	1.350	3.110	0.463	0.169	0.775
1980	1546965	834861	4325359	0.085	0.030	0.157	2.025	1.321	3.114	0.484	0.170	0.812
1981	1523867	824591	4344908	0.102	0.036	0.189	2.000	1.301	3.105	0.584	0.203	0.983
1982	1486440	794718	4290605	0.111	0.039	0.208	1.949	1.251	3.063	0.636	0.218	1.085
1983	1454307	769122	4270412	0.114	0.039	0.215	1.908	1.213	3.052	0.649	0.219	1.118
1984	1459065	762753	4376217	0.078	0.026	0.150	1.918	1.202	3.124	0.447	0.147	0.783
1985	1508104	797776	4474920	0.104	0.035	0.197	1.976	1.262	3.184	0.594	0.198	1.028
1986	1544213	814993	4690763	0.095	0.031	0.180	2.029	1.285	3.320	0.542	0.178	0.943
1987	1569723	831390	4764419	0.093	0.031	0.175	2.062	1.301	3.387	0.529	0.174	0.920
1988	1551248	822740	4681014	0.088	0.029	0.165	2.038	1.292	3.332	0.501	0.164	0.867
1989	1523239	816061	4542365	0.107	0.036	0.199	2.005	1.275	3.252	0.608	0.201	1.046
1990	1460996	781343	4384973	0.133	0.044	0.248	1.922	1.228	3.125	0.755	0.250	1.302
1991	1341161	704571	4057427	0.125	0.041	0.238	1.763	1.113	2.889	0.713	0.233	1.236
1992	1259706	658946	3777001	0.130	0.043	0.249	1.657	1.039	2.701	0.741	0.244	1.289
1993	1245272	655173	3780443	0.131	0.043	0.249	1.638	1.034	2.690	0.749	0.244	1.302
1994	1238612	652808	3794566	0.140	0.046	0.266	1.632	1.029	2.693	0.798	0.257	1.380
1995	1211532	634458	3779383	0.128	0.041	0.244	1.596	0.994	2.674	0.728	0.231	1.279
1996	1167449	606964	3598673	0.128	0.041	0.246	1.535	0.960	2.555	0.729	0.233	1.285
1997	1126149	586414	3461920	0.122	0.040	0.234	1.478	0.924	2.457	0.696	0.223	1.223
1998	1120400	587629	3444571	0.129	0.042	0.246	1.474	0.921	2.451	0.735	0.236	1.293
1999	1105791	577796	3415179	0.123	0.040	0.236	1.457	0.904	2.422	0.701	0.225	1.236
2000	1090981	571567	3381162	0.121	0.039	0.231	1.436	0.894	2.389	0.691	0.223	1.220
2001	1068095	560038	3297793	0.144	0.047	0.274	1.405	0.881	2.325	0.818	0.267	1.442
2002	1033797	533983	3193281	0.130	0.042	0.252	1.358	0.839	2.258	0.744	0.239	1.323
2003	1042583	535456	3255014	0.118	0.038	0.229	1.370	0.837	2.291	0.671	0.214	1.204
2004	1084357	557225	3389672	0.110	0.035	0.215	1.422	0.873	2.400	0.629	0.199	1.130
2005	1114626	576820	3528600	0.094	0.030	0.182	1.469	0.894	2.499	0.536	0.168	0.969
2006	1072684	557605	3351941	0.099	0.032	0.190	1.410	0.867	2.367	0.563	0.178	1.006
2007	995677	519848	3079430	0.101	0.033	0.193	1.311	0.810	2.186	0.574	0.183	1.020
2008	919109	481752	2790038	0.122	0.040	0.232	1.208	0.754	1.971	0.694	0.225	1.225
2009	875449	457039	2646128	0.135	0.045	0.258	1.148	0.716	1.876	0.771	0.250	1.356
2010	836480	434925	2521217	0.141	0.047	0.271	1.100	0.682	1.791	0.807	0.263	1.424
2011	819645	424596	2483110	0.139	0.046	0.268	1.078	0.667	1.765	0.791	0.257	1.400
2012	816444	426217	2487244	0.141	0.046	0.270	1.073	0.669	1.769	0.803	0.258	1.415
2013	819753	427737	2537758	0.130	0.042	0.248	1.080	0.672	1.800	0.738	0.236	1.303
2014	818750	427449	2516596	0.138	0.045	0.264	1.077	0.670	1.790	0.785	0.252	1.383
2015	819250	429728	2502837	0.156	0.051	0.297	1.077	0.673	1.783	0.887	0.285	1.563
2016	804313	418182	2479273	0.184	0.060	0.354	1.060	0.658	1.759	1.045	0.335	1.864
2017	780734	388563	2472886	0.173	0.055	0.347	1.027	0.612	1.751	0.981	0.307	1.827
2018	762050	362706	2492665	0.172	0.053	0.361	1.003	0.571	1.753	0.977	0.297	1.915

Table 19. Continued.

S2												
JABBA	**Biomass**			**Fishing mortality**			**B/Bmsy**			**F/Fmsy**		
Year	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI
1950	1725687	1008159	3378993	0.001	0.000	0.001	2.539	1.934	3.226	0.003	0.002	0.005
1951	1719686	1001763	3368642	0.001	0.000	0.001	2.529	1.905	3.216	0.004	0.002	0.006
1952	1715496	995396	3358613	0.002	0.001	0.003	2.525	1.886	3.207	0.008	0.004	0.011
1953	1709704	987871	3336217	0.002	0.001	0.004	2.517	1.870	3.191	0.011	0.006	0.015
1954	1703882	989348	3323107	0.002	0.001	0.003	2.511	1.862	3.188	0.010	0.005	0.014
1955	1700106	985716	3307008	0.003	0.001	0.004	2.506	1.857	3.189	0.013	0.007	0.018
1956	1701436	990332	3314908	0.004	0.002	0.007	2.507	1.855	3.194	0.019	0.011	0.027
1957	1698517	979969	3327567	0.014	0.007	0.024	2.502	1.849	3.197	0.070	0.038	0.099
1958	1678775	966808	3315795	0.024	0.012	0.042	2.476	1.825	3.167	0.121	0.065	0.172
1959	1646900	939697	3322509	0.035	0.017	0.061	2.430	1.787	3.132	0.175	0.094	0.251
1960	1609612	906172	3276369	0.043	0.021	0.076	2.372	1.735	3.086	0.213	0.112	0.306
1961	1566235	873837	3249632	0.038	0.018	0.067	2.310	1.673	3.033	0.188	0.098	0.272
1962	1542816	855346	3202200	0.037	0.018	0.067	2.275	1.646	3.014	0.186	0.096	0.271
1963	1524335	845778	3193869	0.042	0.020	0.076	2.252	1.616	2.993	0.212	0.108	0.310
1964	1504924	831647	3180098	0.046	0.022	0.083	2.220	1.602	2.962	0.229	0.115	0.336
1965	1482241	819161	3190911	0.046	0.021	0.083	2.189	1.576	2.946	0.228	0.113	0.336
1966	1466628	810865	3158764	0.040	0.019	0.072	2.168	1.549	2.917	0.200	0.099	0.297
1967	1463592	812491	3191311	0.041	0.019	0.074	2.163	1.547	2.925	0.205	0.101	0.305
1968	1461130	810510	3184853	0.058	0.026	0.104	2.155	1.542	2.926	0.289	0.142	0.430
1969	1432695	790884	3154678	0.066	0.030	0.120	2.119	1.501	2.898	0.330	0.160	0.493
1970	1400539	763486	3134739	0.053	0.024	0.098	2.071	1.457	2.853	0.267	0.128	0.402
1971	1394753	763116	3121430	0.054	0.024	0.098	2.063	1.451	2.852	0.268	0.127	0.404
1972	1392749	759490	3117373	0.069	0.031	0.126	2.059	1.456	2.848	0.343	0.161	0.517
1973	1366869	749624	3108017	0.070	0.031	0.128	2.022	1.428	2.822	0.352	0.163	0.528
1974	1346622	735087	3121077	0.080	0.034	0.146	1.993	1.404	2.795	0.400	0.183	0.604
1975	1317946	719872	3095313	0.094	0.040	0.173	1.952	1.375	2.760	0.475	0.211	0.716
1976	1277970	689920	3091135	0.098	0.040	0.181	1.892	1.327	2.711	0.492	0.213	0.747
1977	1241243	666521	3097258	0.106	0.042	0.197	1.841	1.291	2.674	0.533	0.223	0.806
1978	1203452	641578	3122272	0.111	0.043	0.209	1.790	1.246	2.642	0.562	0.227	0.852
1979	1173206	624968	3138196	0.109	0.041	0.204	1.742	1.213	2.622	0.552	0.213	0.837
1980	1148390	614939	3213199	0.114	0.041	0.213	1.710	1.193	2.611	0.576	0.216	0.871
1981	1131239	608829	3200550	0.138	0.049	0.256	1.686	1.175	2.600	0.698	0.256	1.053
1982	1093884	581282	3172072	0.151	0.052	0.284	1.636	1.128	2.565	0.763	0.272	1.161
1983	1067475	559029	3166863	0.155	0.052	0.296	1.595	1.084	2.539	0.784	0.276	1.206
1984	1069148	557832	3218253	0.107	0.036	0.205	1.597	1.076	2.603	0.542	0.185	0.843
1985	1111332	595742	3284122	0.141	0.048	0.263	1.663	1.138	2.658	0.714	0.248	1.098
1986	1145242	612020	3423828	0.128	0.043	0.240	1.715	1.157	2.799	0.648	0.222	1.011
1987	1169291	629867	3512256	0.125	0.041	0.231	1.748	1.181	2.879	0.629	0.214	0.984
1988	1152945	622220	3457783	0.118	0.039	0.219	1.728	1.171	2.840	0.595	0.203	0.927
1989	1134701	619909	3409011	0.143	0.048	0.262	1.704	1.168	2.777	0.720	0.247	1.109
1990	1085502	593691	3298946	0.178	0.059	0.326	1.629	1.122	2.659	0.898	0.306	1.374
1991	985023	525807	3015279	0.170	0.056	0.319	1.475	1.008	2.432	0.857	0.290	1.318
1992	922593	487614	2800519	0.178	0.058	0.336	1.380	0.941	2.256	0.897	0.309	1.376
1993	917386	488737	2797416	0.178	0.058	0.334	1.373	0.936	2.263	0.899	0.305	1.384
1994	916576	491913	2823230	0.190	0.062	0.353	1.375	0.934	2.293	0.956	0.323	1.479
1995	897219	475420	2811658	0.172	0.055	0.325	1.343	0.901	2.266	0.871	0.288	1.363
1996	861586	453817	2678540	0.173	0.056	0.329	1.289	0.865	2.155	0.876	0.290	1.372
1997	828546	435844	2570128	0.166	0.053	0.315	1.242	0.830	2.061	0.837	0.280	1.314
1998	827192	437255	2558718	0.175	0.056	0.331	1.240	0.833	2.066	0.881	0.295	1.376
1999	815977	430987	2552323	0.167	0.053	0.316	1.225	0.815	2.053	0.840	0.279	1.323
2000	807038	426671	2497019	0.164	0.053	0.310	1.210	0.810	2.015	0.826	0.277	1.298
2001	790407	420356	2430293	0.194	0.063	0.365	1.186	0.796	1.959	0.977	0.328	1.530
2002	757558	395201	2341912	0.178	0.058	0.341	1.137	0.756	1.898	0.898	0.298	1.418
2003	765157	398485	2404632	0.160	0.051	0.308	1.150	0.758	1.937	0.807	0.268	1.285
2004	801931	421118	2526340	0.149	0.047	0.284	1.205	0.791	2.044	0.750	0.247	1.207
2005	833460	441252	2675900	0.126	0.039	0.238	1.255	0.812	2.166	0.635	0.204	1.038
2006	798418	423337	2511103	0.133	0.042	0.250	1.198	0.788	2.039	0.668	0.217	1.075
2007	739295	390497	2299075	0.136	0.044	0.257	1.110	0.735	1.866	0.685	0.226	1.087
2008	677963	358531	2073733	0.165	0.054	0.312	1.016	0.682	1.673	0.834	0.281	1.303
2009	644267	339661	1966666	0.183	0.060	0.347	0.964	0.645	1.587	0.925	0.312	1.443
2010	612472	323331	1876944	0.193	0.063	0.365	0.920	0.617	1.518	0.971	0.329	1.511
2011	600172	314834	1862014	0.189	0.061	0.361	0.901	0.603	1.502	0.955	0.318	1.492
2012	601560	317064	1872946	0.191	0.061	0.363	0.902	0.603	1.505	0.965	0.319	1.510
2013	606391	317013	1894105	0.175	0.056	0.335	0.906	0.604	1.536	0.887	0.290	1.399
2014	604886	319628	1877876	0.187	0.060	0.353	0.907	0.607	1.515	0.943	0.313	1.474
2015	605845	322950	1886315	0.211	0.068	0.395	0.909	0.611	1.518	1.062	0.354	1.661
2016	593877	315224	1854800	0.249	0.080	0.470	0.893	0.595	1.495	1.254	0.415	1.985
2017	571764	290697	1848171	0.236	0.073	0.464	0.859	0.548	1.489	1.186	0.378	1.969
2018	553023	267607	1851323	0.237	0.071	0.490	0.830	0.499	1.495	1.190	0.368	2.112

Table 19. Continued.

S3												
JABBA	**Biomass**			**Fishing mortality**			**B/Bmsy**			**F/Fmsy**		
Year	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI
1950	2135155	1396645	3556330	0.001	0.000	0.001	2.899	2.245	3.643	0.003	0.002	0.004
1951	2129638	1375634	3557076	0.001	0.000	0.001	2.888	2.208	3.643	0.003	0.002	0.005
1952	2120792	1364357	3572352	0.001	0.001	0.002	2.881	2.172	3.646	0.007	0.004	0.010
1953	2112268	1355829	3577818	0.002	0.001	0.003	2.874	2.151	3.647	0.009	0.006	0.013
1954	2105654	1346635	3576145	0.002	0.001	0.003	2.866	2.132	3.632	0.009	0.005	0.013
1955	2100989	1350556	3548849	0.002	0.001	0.003	2.863	2.129	3.643	0.011	0.007	0.016
1956	2094229	1345309	3546890	0.003	0.002	0.005	2.854	2.123	3.638	0.017	0.011	0.024
1957	2088726	1333572	3552029	0.011	0.007	0.018	2.845	2.101	3.628	0.061	0.038	0.089
1958	2069874	1317580	3544255	0.020	0.011	0.031	2.819	2.076	3.606	0.105	0.066	0.154
1959	2036554	1286016	3500677	0.028	0.017	0.045	2.773	2.039	3.582	0.152	0.095	0.224
1960	1993248	1243030	3454199	0.034	0.020	0.055	2.712	1.981	3.527	0.185	0.114	0.273
1961	1946439	1202158	3411689	0.030	0.017	0.049	2.646	1.925	3.467	0.163	0.099	0.242
1962	1914844	1170017	3387173	0.030	0.017	0.049	2.605	1.876	3.432	0.162	0.097	0.244
1963	1891436	1157232	3355931	0.034	0.019	0.056	2.574	1.844	3.408	0.184	0.110	0.279
1964	1863999	1137736	3309070	0.037	0.021	0.061	2.536	1.811	3.372	0.199	0.118	0.304
1965	1832685	1113114	3272889	0.037	0.021	0.061	2.498	1.774	3.334	0.199	0.117	0.303
1966	1811505	1097319	3266255	0.032	0.018	0.054	2.465	1.753	3.313	0.175	0.102	0.268
1967	1799813	1094202	3241426	0.033	0.019	0.055	2.451	1.744	3.303	0.181	0.105	0.276
1968	1785007	1087145	3228916	0.047	0.026	0.078	2.435	1.724	3.280	0.254	0.149	0.390
1969	1752644	1061145	3201540	0.054	0.030	0.089	2.388	1.689	3.241	0.291	0.169	0.450
1970	1711245	1031409	3150852	0.044	0.024	0.072	2.335	1.644	3.189	0.235	0.135	0.364
1971	1700215	1023967	3119065	0.044	0.024	0.073	2.313	1.630	3.166	0.237	0.136	0.369
1972	1684582	1016747	3100855	0.057	0.031	0.094	2.296	1.617	3.143	0.306	0.173	0.473
1973	1650025	990679	3071442	0.058	0.031	0.097	2.252	1.577	3.108	0.314	0.175	0.486
1974	1619638	966691	3055651	0.066	0.035	0.111	2.211	1.554	3.060	0.358	0.198	0.555
1975	1577512	932068	3031201	0.079	0.041	0.134	2.158	1.506	2.991	0.426	0.231	0.665
1976	1526496	893054	2983720	0.082	0.042	0.140	2.091	1.452	2.906	0.442	0.237	0.693
1977	1476670	861859	2908340	0.089	0.045	0.152	2.029	1.396	2.823	0.480	0.252	0.757
1978	1429410	832039	2872038	0.094	0.047	0.161	1.965	1.348	2.750	0.506	0.261	0.808
1979	1378997	792567	2822442	0.093	0.045	0.161	1.907	1.293	2.680	0.499	0.252	0.798
1980	1349894	767273	2792558	0.097	0.047	0.170	1.864	1.249	2.624	0.523	0.261	0.848
1981	1324108	755508	2759376	0.118	0.057	0.207	1.832	1.219	2.584	0.635	0.315	1.034
1982	1299481	729601	2733464	0.127	0.060	0.227	1.800	1.183	2.553	0.685	0.337	1.130
1983	1283323	715494	2727499	0.129	0.061	0.231	1.779	1.157	2.555	0.693	0.337	1.157
1984	1295934	715976	2786065	0.088	0.041	0.160	1.797	1.162	2.613	0.476	0.228	0.800
1985	1344466	761087	2846141	0.117	0.055	0.206	1.860	1.225	2.675	0.628	0.306	1.040
1986	1381830	777541	2938804	0.106	0.050	0.189	1.910	1.258	2.770	0.573	0.274	0.953
1987	1412490	794786	3013540	0.103	0.048	0.183	1.953	1.281	2.847	0.556	0.266	0.924
1988	1414549	799601	3008657	0.096	0.045	0.170	1.957	1.285	2.840	0.518	0.249	0.859
1989	1408077	806604	2978265	0.115	0.055	0.201	1.952	1.295	2.812	0.621	0.300	1.022
1990	1373841	783184	2910259	0.141	0.067	0.247	1.900	1.258	2.749	0.759	0.365	1.248
1991	1269784	712780	2722157	0.132	0.062	0.235	1.756	1.152	2.555	0.712	0.340	1.184
1992	1196711	668739	2574789	0.137	0.064	0.245	1.656	1.083	2.410	0.738	0.353	1.227
1993	1170652	656291	2512373	0.140	0.065	0.249	1.623	1.066	2.357	0.751	0.361	1.244
1994	1175451	662142	2526568	0.148	0.069	0.262	1.628	1.071	2.368	0.797	0.380	1.323
1995	1155500	647428	2481040	0.134	0.062	0.239	1.603	1.044	2.344	0.720	0.340	1.204
1996	1107954	618157	2387220	0.135	0.062	0.241	1.535	1.000	2.236	0.725	0.344	1.213
1997	1072939	597343	2307210	0.128	0.060	0.230	1.488	0.965	2.169	0.689	0.327	1.158
1998	1079825	606053	2324477	0.134	0.062	0.238	1.497	0.979	2.178	0.721	0.344	1.203
1999	1068562	597245	2299347	0.127	0.059	0.228	1.482	0.964	2.156	0.686	0.327	1.150
2000	1049966	588484	2258098	0.126	0.059	0.225	1.457	0.951	2.126	0.679	0.324	1.129
2001	1030508	577326	2195389	0.149	0.070	0.266	1.427	0.931	2.065	0.802	0.384	1.343
2002	991426	549291	2141602	0.136	0.063	0.245	1.377	0.887	2.005	0.731	0.349	1.230
2003	1014394	565224	2205785	0.121	0.056	0.217	1.408	0.914	2.065	0.649	0.307	1.090
2004	1056566	591955	2290426	0.113	0.052	0.202	1.467	0.952	2.155	0.608	0.288	1.022
2005	1092220	617017	2369031	0.096	0.044	0.170	1.515	0.989	2.246	0.517	0.242	0.870
2006	1041295	585966	2249367	0.102	0.047	0.181	1.441	0.940	2.123	0.549	0.260	0.916
2007	956359	532222	2060782	0.105	0.049	0.189	1.323	0.859	1.939	0.566	0.270	0.952
2008	880802	490484	1892146	0.127	0.059	0.228	1.222	0.789	1.772	0.684	0.327	1.150
2009	844744	472029	1809781	0.140	0.065	0.250	1.171	0.760	1.701	0.752	0.359	1.256
2010	806537	446777	1736425	0.146	0.068	0.264	1.118	0.723	1.625	0.788	0.377	1.328
2011	794650	442143	1709954	0.143	0.066	0.257	1.104	0.712	1.604	0.768	0.366	1.295
2012	801946	445002	1727209	0.143	0.067	0.258	1.111	0.718	1.619	0.772	0.367	1.295
2013	810539	452193	1750477	0.131	0.061	0.235	1.124	0.725	1.637	0.705	0.335	1.189
2014	809968	450345	1738767	0.139	0.065	0.251	1.124	0.727	1.634	0.748	0.356	1.259
2015	815620	455882	1744260	0.156	0.073	0.280	1.131	0.734	1.644	0.841	0.404	1.412
2016	812450	452773	1754677	0.182	0.084	0.327	1.128	0.734	1.648	0.979	0.464	1.651
2017	794315	435242	1752839	0.170	0.077	0.310	1.103	0.699	1.640	0.912	0.422	1.576
2018	781455	413616	1760998	0.168	0.074	0.317	1.085	0.665	1.649	0.901	0.409	1.619

Table 19. Continued.

S5												
JABBA	**Biomass**			**Fishing mortality**			**B/Bmsy**			**F/Fmsy**		
Year	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI	Median	90%LCI	90%UCI
1950	1576025	925558	3040825	0.001	0.000	0.001	2.537	1.942	3.221	0.003	0.002	0.005
1951	1573176	925921	3033786	0.001	0.000	0.001	2.533	1.929	3.207	0.004	0.002	0.005
1952	1570018	922601	3026898	0.002	0.001	0.003	2.533	1.916	3.201	0.008	0.005	0.011
1953	1566861	923280	3018663	0.002	0.001	0.004	2.527	1.911	3.205	0.010	0.006	0.014
1954	1563437	916429	3021698	0.002	0.001	0.004	2.521	1.908	3.193	0.010	0.006	0.014
1955	1560773	918256	2981636	0.003	0.001	0.005	2.520	1.900	3.191	0.012	0.007	0.017
1956	1555468	914922	3003404	0.004	0.002	0.007	2.516	1.896	3.191	0.019	0.011	0.027
1957	1552159	914170	2968619	0.015	0.008	0.026	2.511	1.890	3.179	0.068	0.041	0.096
1958	1532691	898078	2976895	0.026	0.014	0.045	2.478	1.858	3.157	0.118	0.071	0.167
1959	1503041	872241	2946378	0.038	0.020	0.066	2.427	1.817	3.115	0.172	0.102	0.245
1960	1462405	838269	2903194	0.047	0.024	0.082	2.362	1.766	3.061	0.210	0.122	0.300
1961	1421166	804781	2862925	0.041	0.021	0.073	2.296	1.696	2.998	0.185	0.106	0.267
1962	1403732	791024	2866983	0.041	0.020	0.073	2.264	1.667	2.983	0.184	0.104	0.266
1963	1385717	781967	2872044	0.047	0.022	0.083	2.240	1.651	2.959	0.209	0.118	0.302
1964	1366599	772724	2835786	0.050	0.024	0.089	2.208	1.623	2.927	0.226	0.127	0.329
1965	1347539	763426	2808916	0.050	0.024	0.089	2.179	1.593	2.891	0.225	0.126	0.330
1966	1332528	755505	2825470	0.044	0.021	0.078	2.155	1.574	2.871	0.197	0.109	0.290
1967	1330175	755310	2801951	0.045	0.021	0.080	2.148	1.567	2.878	0.203	0.111	0.298
1968	1326259	756771	2789536	0.064	0.030	0.111	2.146	1.562	2.876	0.285	0.155	0.419
1969	1299487	732280	2734580	0.073	0.035	0.129	2.098	1.516	2.829	0.326	0.175	0.486
1970	1268370	708115	2702401	0.059	0.028	0.106	2.045	1.464	2.781	0.265	0.141	0.397
1971	1260155	707875	2677736	0.059	0.028	0.106	2.037	1.461	2.770	0.266	0.141	0.398
1972	1252967	709766	2664922	0.076	0.036	0.134	2.028	1.452	2.765	0.342	0.179	0.512
1973	1226089	691009	2598836	0.078	0.037	0.139	1.987	1.421	2.719	0.351	0.182	0.527
1974	1204103	675850	2561173	0.089	0.042	0.159	1.952	1.387	2.676	0.400	0.205	0.605
1975	1170935	657746	2524141	0.106	0.049	0.189	1.900	1.348	2.633	0.478	0.239	0.724
1976	1129519	621621	2496168	0.111	0.050	0.201	1.831	1.288	2.563	0.498	0.242	0.761
1977	1091529	599492	2458864	0.120	0.053	0.219	1.766	1.244	2.521	0.544	0.256	0.831
1978	1048273	573930	2470255	0.128	0.054	0.234	1.703	1.194	2.463	0.577	0.262	0.881
1979	1010434	549590	2456262	0.126	0.052	0.232	1.644	1.146	2.400	0.572	0.250	0.875
1980	984662	532695	2442772	0.133	0.054	0.245	1.605	1.110	2.373	0.602	0.258	0.921
1981	968749	522326	2461271	0.161	0.063	0.299	1.579	1.084	2.343	0.731	0.312	1.125
1982	947051	504775	2438577	0.175	0.068	0.327	1.542	1.054	2.327	0.793	0.332	1.225
1983	932824	490904	2415454	0.177	0.068	0.337	1.519	1.027	2.316	0.806	0.332	1.255
1984	941867	491627	2483236	0.122	0.046	0.233	1.534	1.031	2.382	0.553	0.225	0.870
1985	985302	527328	2554195	0.159	0.061	0.297	1.603	1.093	2.457	0.724	0.299	1.123
1986	1016986	543099	2658223	0.144	0.055	0.270	1.655	1.121	2.562	0.657	0.267	1.028
1987	1042124	557676	2729757	0.140	0.053	0.261	1.694	1.150	2.632	0.636	0.257	0.994
1988	1045266	559513	2725542	0.130	0.050	0.243	1.697	1.155	2.624	0.593	0.241	0.924
1989	1044747	568663	2708546	0.156	0.060	0.286	1.699	1.167	2.609	0.709	0.291	1.092
1990	1017234	553584	2692740	0.190	0.072	0.350	1.653	1.139	2.546	0.867	0.353	1.334
1991	929894	492854	2460972	0.180	0.068	0.340	1.511	1.026	2.345	0.821	0.331	1.277
1992	874648	460617	2304207	0.187	0.071	0.356	1.419	0.962	2.192	0.856	0.346	1.329
1993	857254	456785	2250347	0.191	0.073	0.358	1.395	0.950	2.160	0.868	0.350	1.351
1994	864818	462980	2277272	0.201	0.076	0.375	1.406	0.958	2.190	0.915	0.366	1.420
1995	851257	451640	2273860	0.182	0.068	0.342	1.383	0.938	2.182	0.827	0.330	1.298
1996	812146	428709	2167524	0.184	0.069	0.348	1.320	0.891	2.075	0.837	0.333	1.315
1997	786801	412721	2106802	0.175	0.065	0.333	1.275	0.860	2.003	0.796	0.316	1.253
1998	794983	421205	2124714	0.182	0.068	0.343	1.294	0.872	2.027	0.826	0.329	1.299
1999	787033	417291	2114457	0.173	0.064	0.326	1.282	0.864	2.020	0.787	0.311	1.236
2000	773101	410288	2054826	0.171	0.064	0.322	1.259	0.852	1.974	0.778	0.312	1.221
2001	757767	404518	1988165	0.202	0.077	0.379	1.230	0.837	1.910	0.922	0.372	1.438
2002	724425	380622	1933092	0.186	0.070	0.354	1.177	0.793	1.841	0.846	0.338	1.333
2003	744874	390565	2007980	0.165	0.061	0.314	1.211	0.815	1.912	0.749	0.297	1.178
2004	781627	416305	2109742	0.153	0.057	0.287	1.272	0.854	2.013	0.695	0.275	1.098
2005	816306	438908	2209590	0.129	0.048	0.239	1.329	0.886	2.126	0.585	0.231	0.935
2006	772331	414164	2066331	0.137	0.051	0.256	1.258	0.841	2.002	0.623	0.248	0.990
2007	704305	374222	1868855	0.143	0.054	0.268	1.147	0.767	1.806	0.649	0.259	1.026
2008	645499	341512	1719975	0.173	0.065	0.328	1.049	0.702	1.635	0.790	0.315	1.246
2009	620643	326239	1660110	0.190	0.071	0.361	1.008	0.676	1.577	0.866	0.343	1.367
2010	590430	308970	1573415	0.200	0.075	0.382	0.959	0.641	1.505	0.913	0.362	1.444
2011	581981	304889	1570840	0.195	0.072	0.373	0.947	0.634	1.491	0.890	0.353	1.402
2012	587861	308860	1576097	0.196	0.073	0.372	0.956	0.641	1.510	0.892	0.352	1.410
2013	596108	313614	1614968	0.178	0.066	0.339	0.970	0.649	1.536	0.812	0.322	1.285
2014	598202	316749	1602024	0.189	0.070	0.356	0.972	0.651	1.533	0.859	0.342	1.357
2015	603302	322400	1586562	0.211	0.080	0.396	0.982	0.664	1.535	0.961	0.385	1.509
2016	602183	321310	1600199	0.246	0.093	0.461	0.980	0.660	1.535	1.118	0.444	1.770
2017	585402	303424	1603922	0.230	0.084	0.444	0.954	0.622	1.534	1.047	0.404	1.708
2018	574586	287700	1606970	0.228	0.082	0.455	0.936	0.585	1.547	1.035	0.393	1.772

Table 20. Combined estimates of Atlantic YFT stock benchmarks from the uncertainty grid.

Estimates	Mean (90% lower and upper confidence intervals)
Maximum Sustainable Yield (MSY)	127,558 t (98,268-267,350 t) *
Relative Biomass**: B_{2018}/B_{MSY}	1.17 (0.75 - 1.62)
Relative Fishing Mortality: F_{2018}/F_{MSY}	0.96 (0.56 - 1.50)

*minimum and maximum values of 90%LCI and 90%UCI among all runs by the Stock Synthesis, JABBA, and MPB

**SSB (Stock Synthesis) or exploited biomass (production models)

Table 21. Estimated probabilities of biomass the Atlantic YFT stock levels < 20% of BMSY in the combined projections of JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1-4) in a given year for a given catch level (0, 60,000 – 150,000 t). This result was used to develop the management advice of Atlantic YFT stock.

TAC	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
60000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
70000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
80000	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
90000	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%
100000	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%	0.3%	0.3%	0.4%	0.4%	0.5%	0.5%	0.6%	0.6%
110000	0.0%	0.0%	0.1%	0.1%	0.2%	0.4%	0.6%	0.7%	0.8%	0.9%	1.0%	1.2%	1.4%	1.5%
120000	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	1.0%	1.2%	1.5%	1.8%	2.1%	2.4%	2.6%	2.9%
130000	0.0%	0.1%	0.2%	0.5%	0.8%	1.2%	1.6%	2.1%	2.6%	3.0%	3.5%	3.9%	4.3%	4.7%
140000	0.0%	0.1%	0.3%	0.7%	1.2%	1.8%	2.6%	3.2%	4.0%	4.8%	10.4%	12.2%	12.9%	13.4%
150000	0.0%	0.1%	0.3%	1.0%	1.7%	2.7%	3.7%	4.8%	11.9%	12.7%	15.9%	21.3%	22.1%	23.3%

Table 22. Estimated probabilities of the Atlantic YFT stock (a) being below F_{MSY} (overfishing not occurring), (b) above B_{MSY} (not overfished) and (c) above B_{MSY} and below F_{MSY} (green zone) in a given year for a given catch level (0, 60,000 – 150,000 t), based upon the combined projections of JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1-4). This result was used to develop the management advice of Atlantic YFT stock.

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

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

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

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

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

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

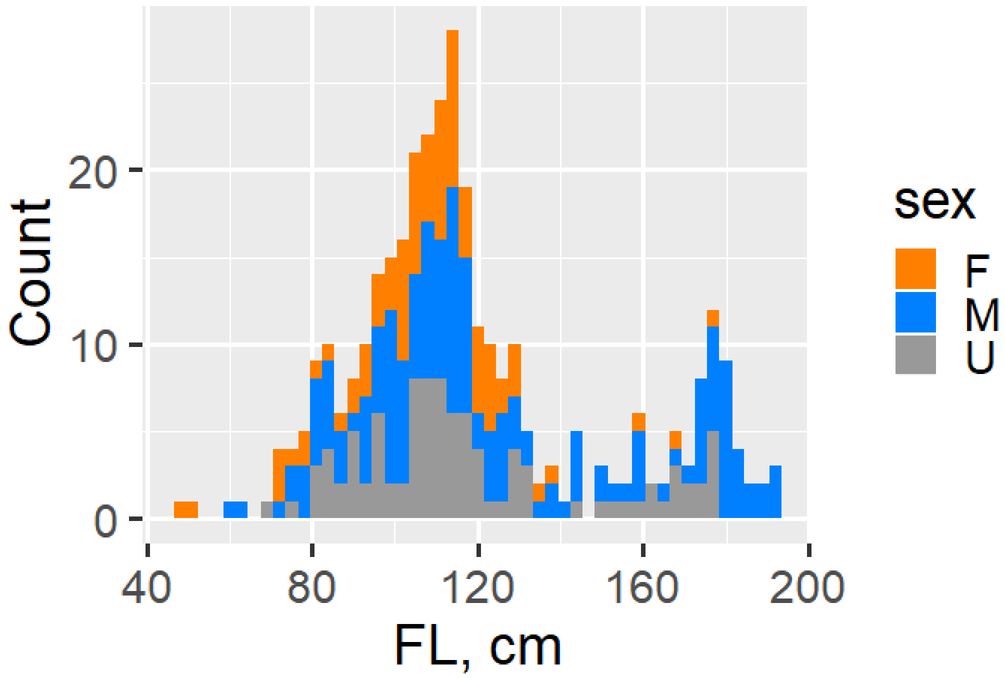


Figure 1. The size composition of YFT fish sampled off Ascension Island, by gender.

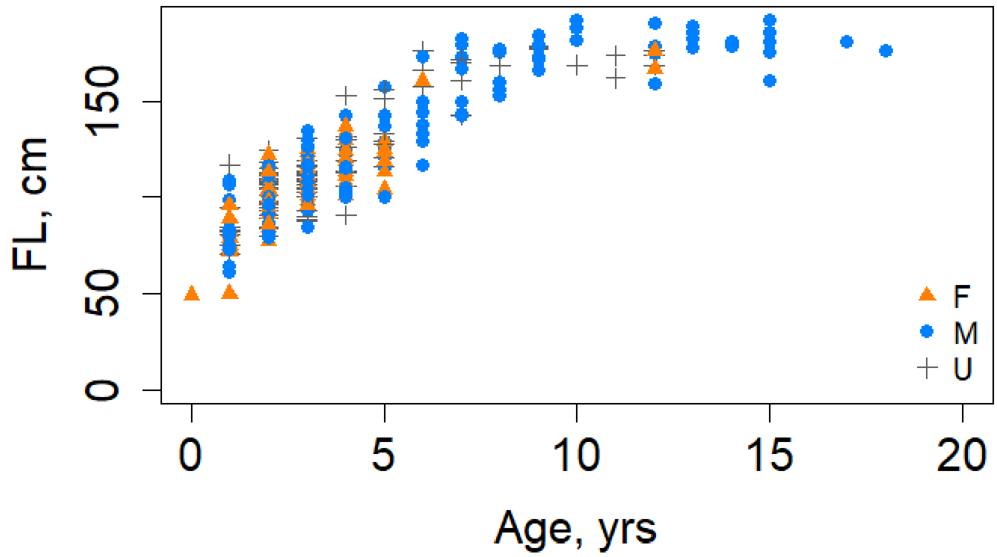


Figure 2. The size at age of YFT fish sampled off Ascension Island, by gender. Some evidence of sex-specific growth is noted. No adjustment was made to annulus count for Ascension data.

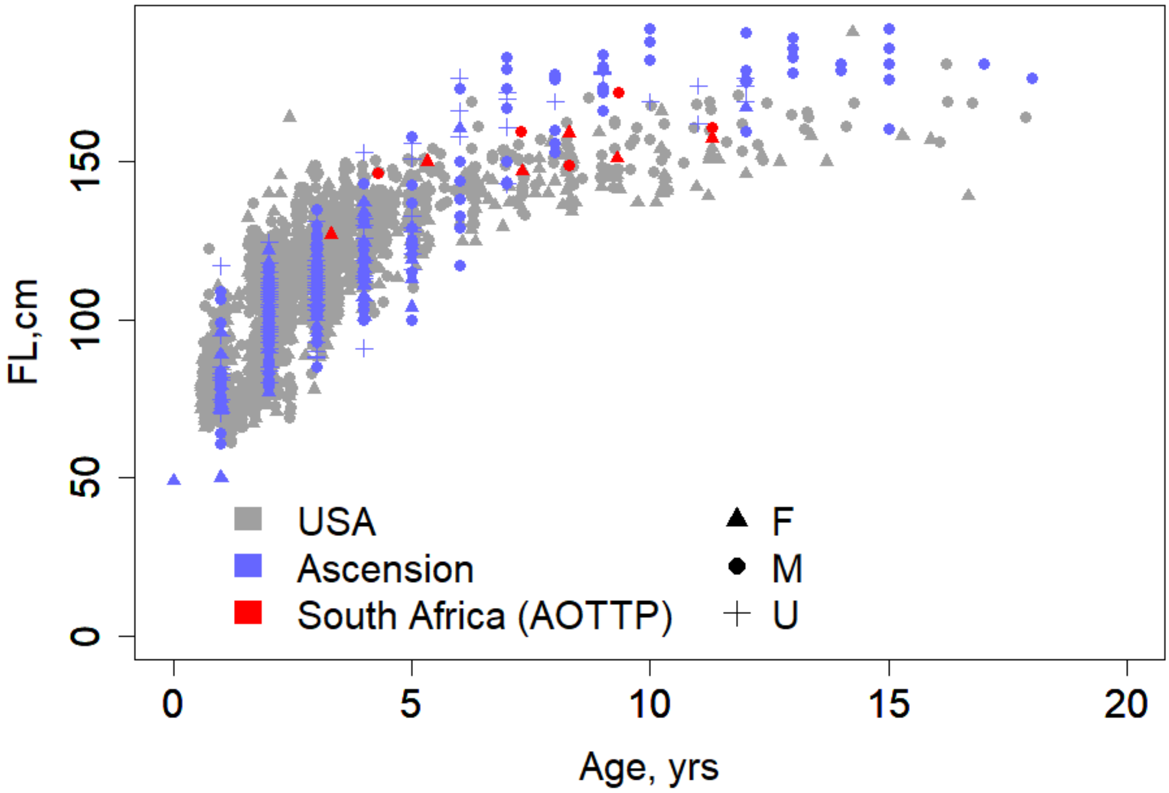


Figure 3. The size at age of YFT fish sampled off Ascension Island, the USA and South Africa (AOTTP), by gender. No adjustment was made to annulus count for Ascension data.

•

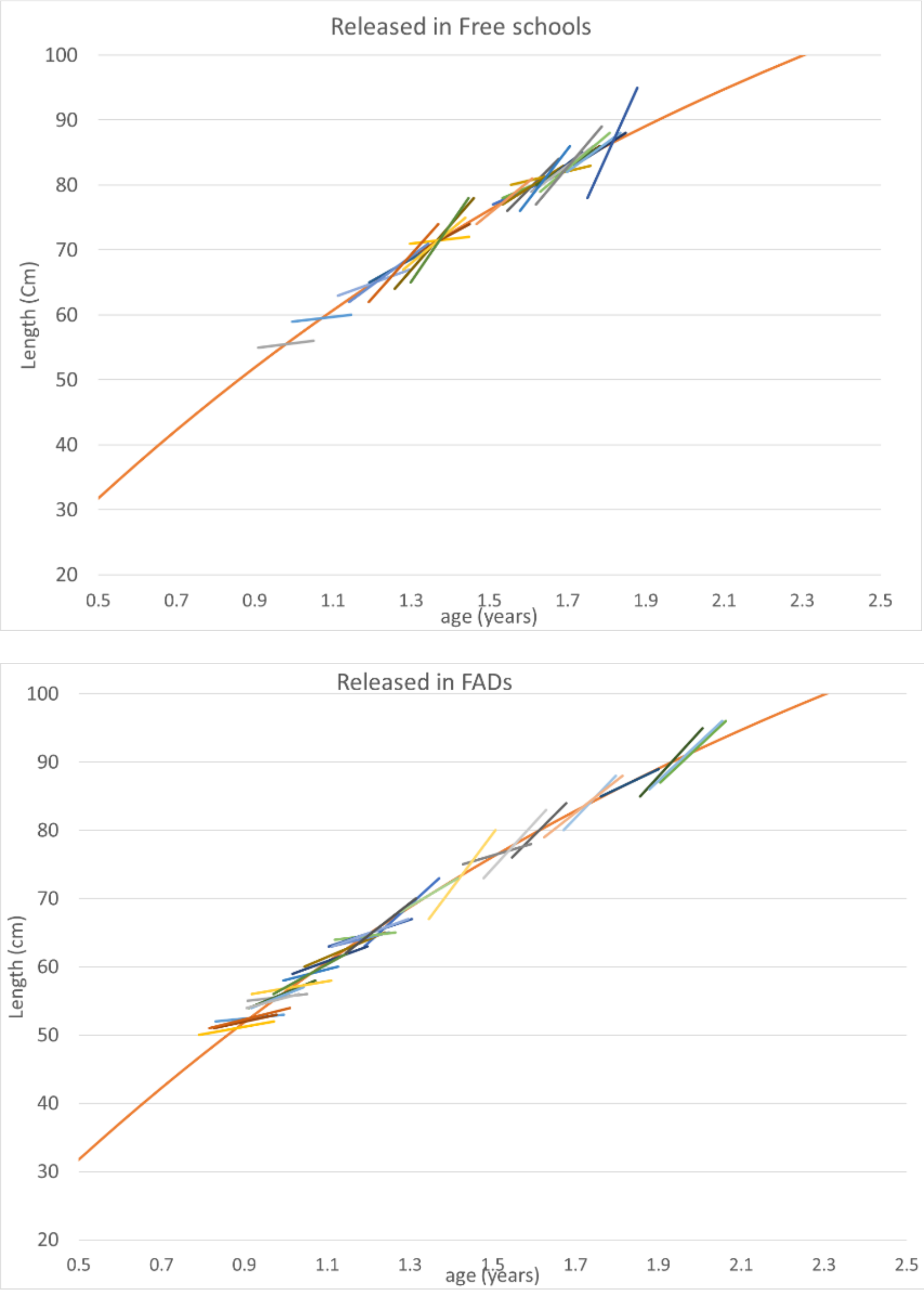
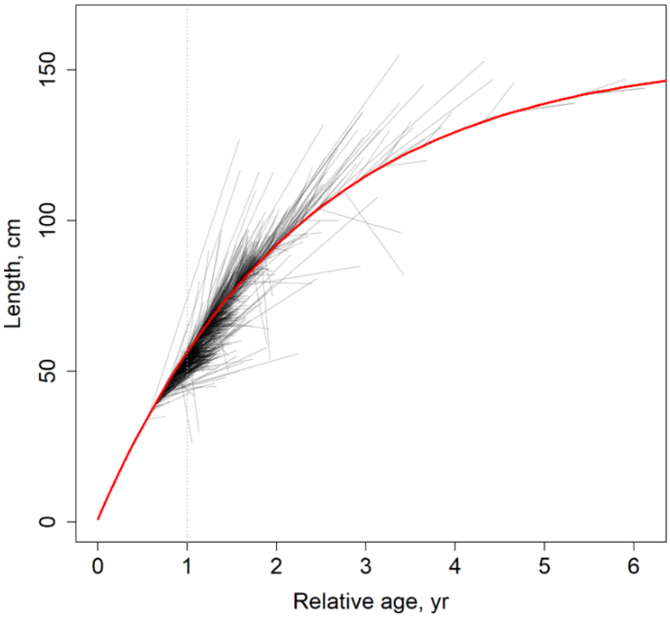


Figure 4. Fit to an assumed von Bertalannfy growth function for recaptured yellowfin tuna in the AOTTP ICCAT database.

a) Von Bertalanffy



b) Richards

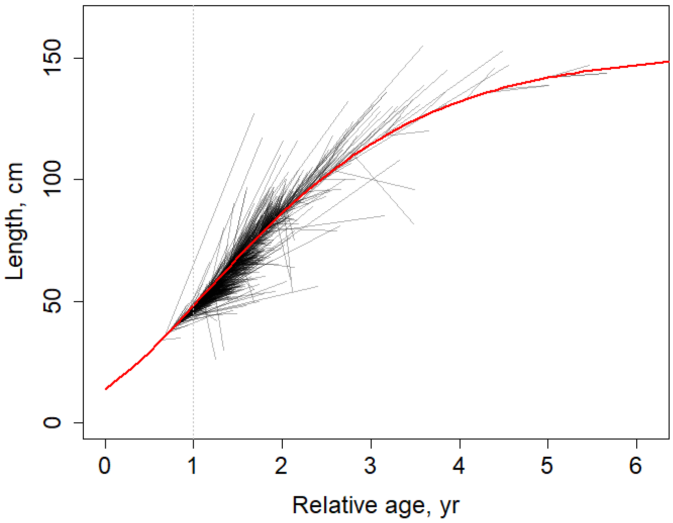


Figure5. Vector plot of the growth increments of AOTTP fish measured upon recovery. The relative age of each fish at the time of tagging is estimated from the length at tagging by inverting the von Bertalanffy (top panel) and Richards (bottom panel) growth equations using parameters estimated by SS. The age at recapture is then taken to be the age at tagging plus the time at liberty. Each growth trajectory (shown in grey) starts on the fitted curve (shown in red).

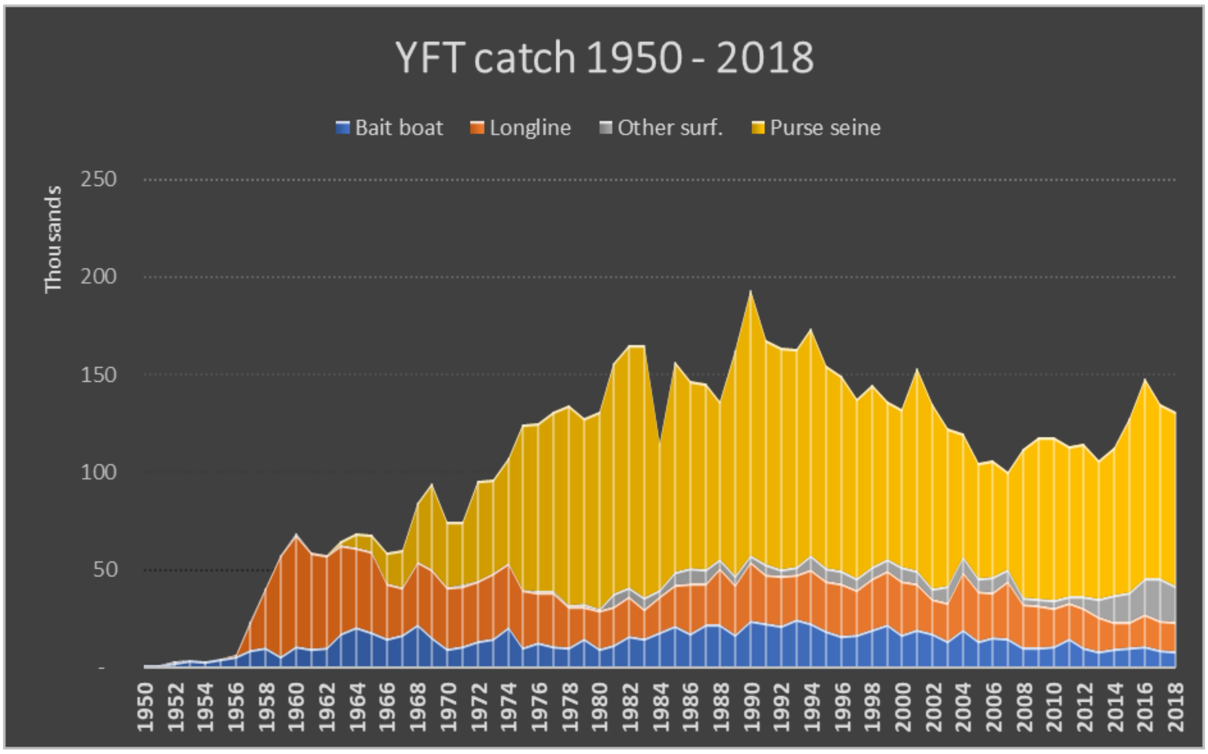


Figure 6. Yellowfin tuna total catch 1950 – 2018 by main fishing gear group. 2018 catch es preliminary**.**

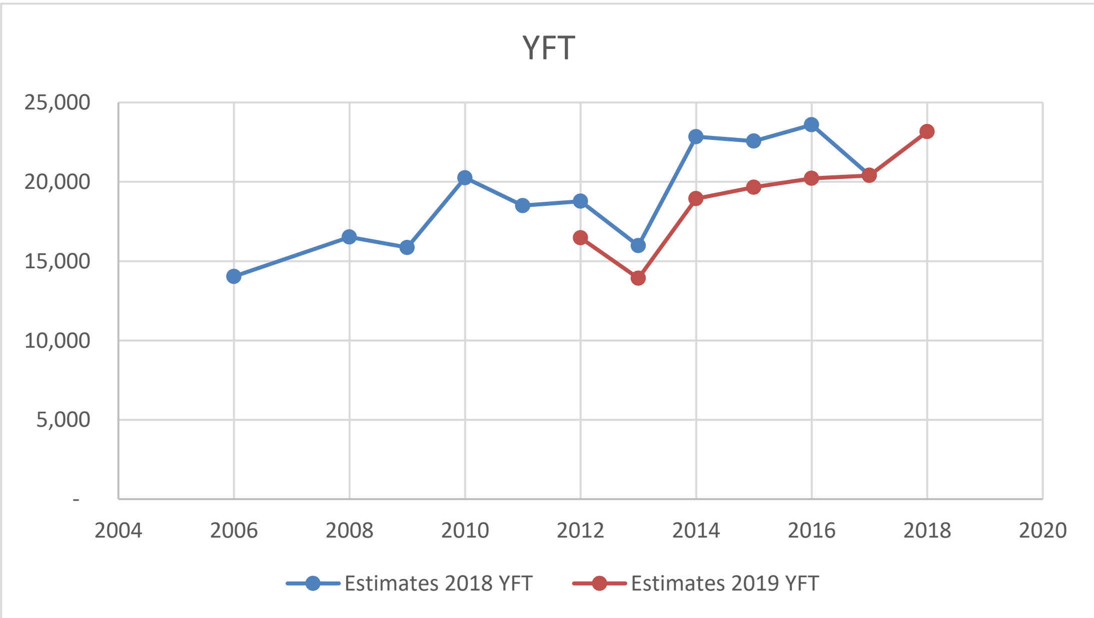


Figure 7. Comparison of YFT estimates of catch by the Ghana tropical fisheries PS and BB for 2018 (2006-2017) and the 2019 YFT stock assessment (2012-2018).

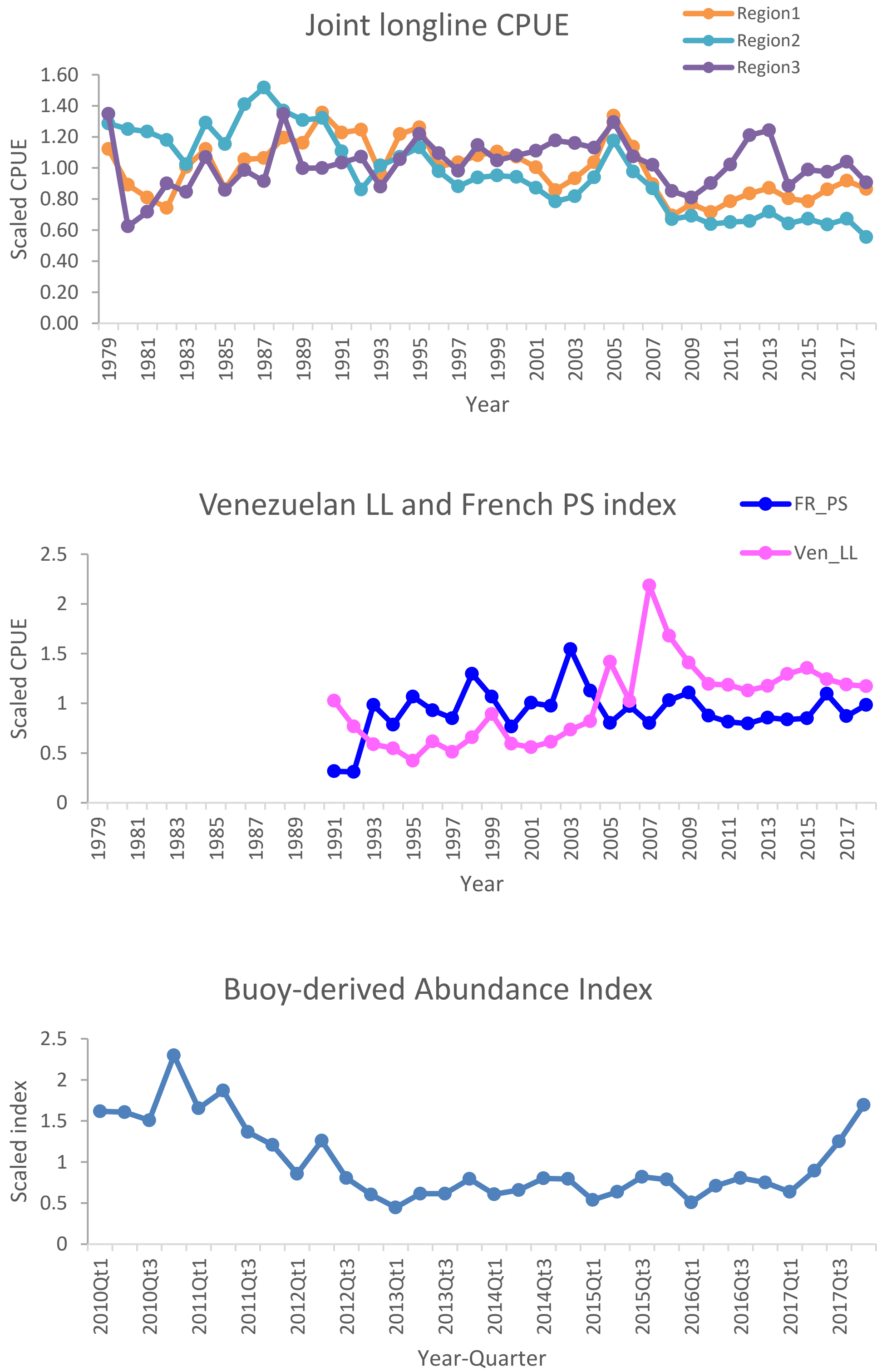


Figure 8 Recommended annual abundance indices for the Atlantic yellowfin tuna stock assessment reference case. This figure reflects revisions made following the data preparatory meeting.

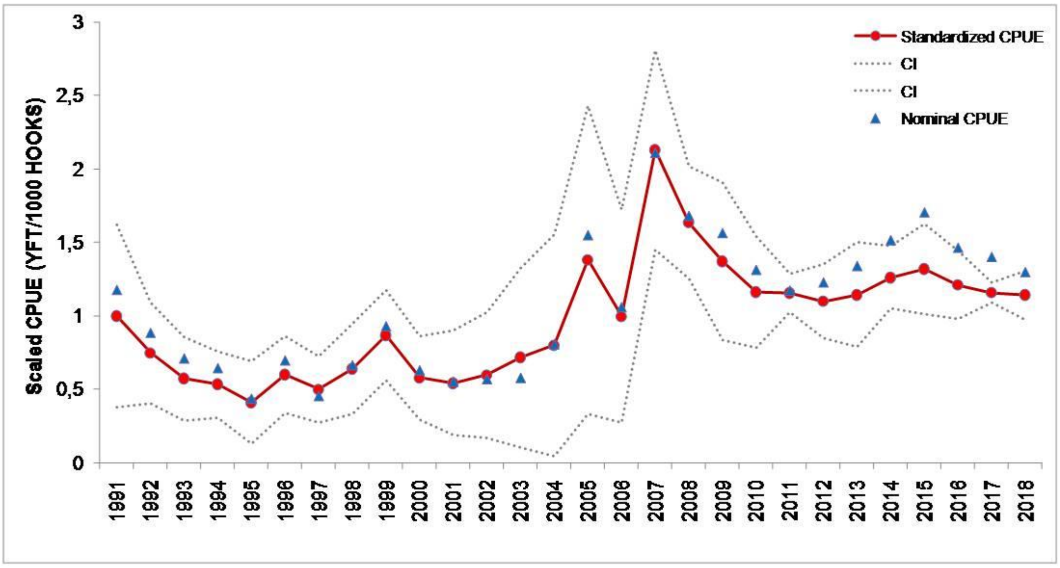


Figure 9. Scaled nominal (blue triangles) and standardized (red circles) CPUE in numbers of yellowfin tuna caught by the Venezuelan longline fleet during the period 1991-2018. The dotted lines represent the 95% confidence intervals.

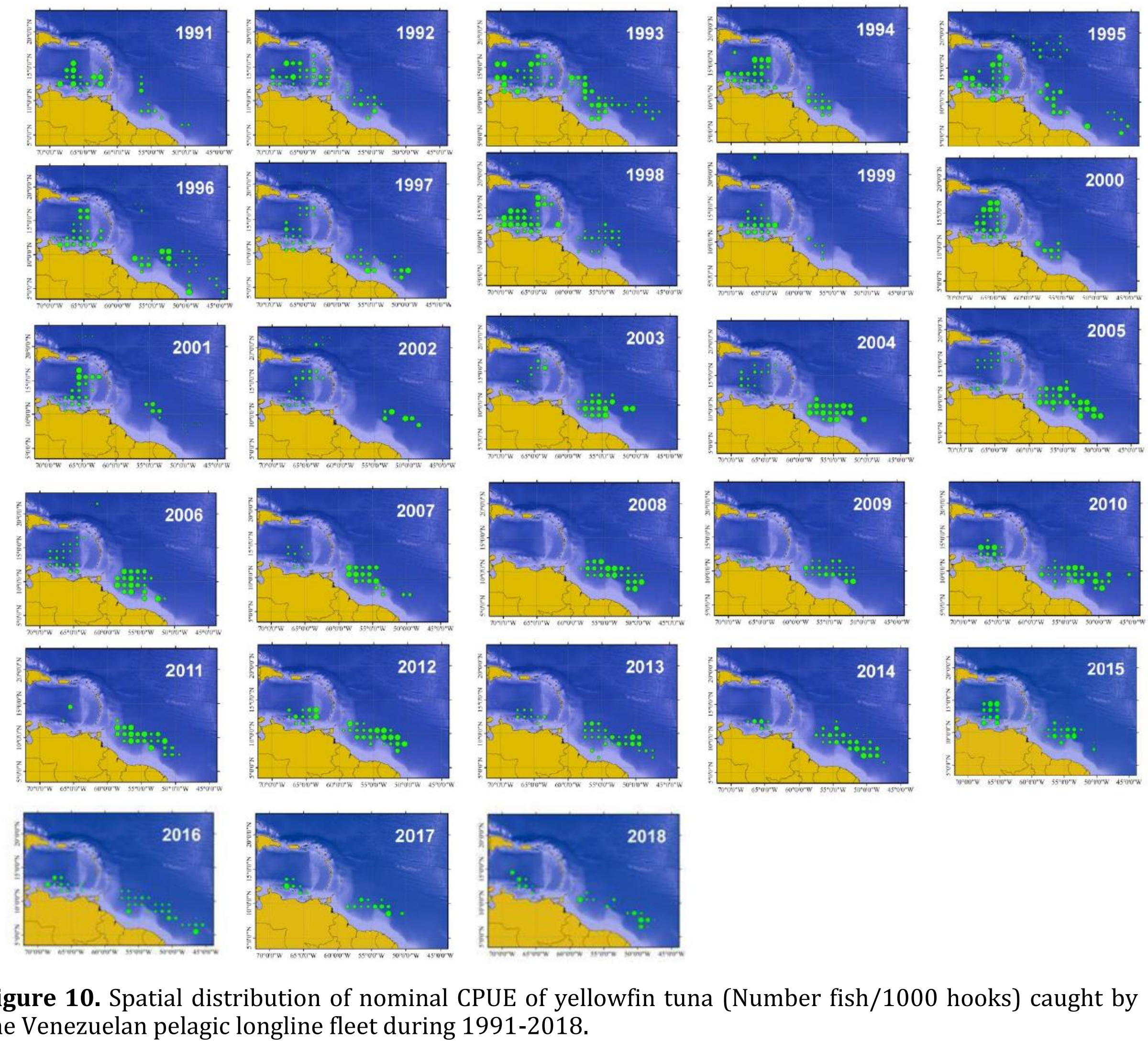


Figure 10. Spatial distribution of nominal CPUE of yellowfin tuna (Number fish/1000 hooks) caught by the Venezuelan pelagic longline fleet during 1991-2018.

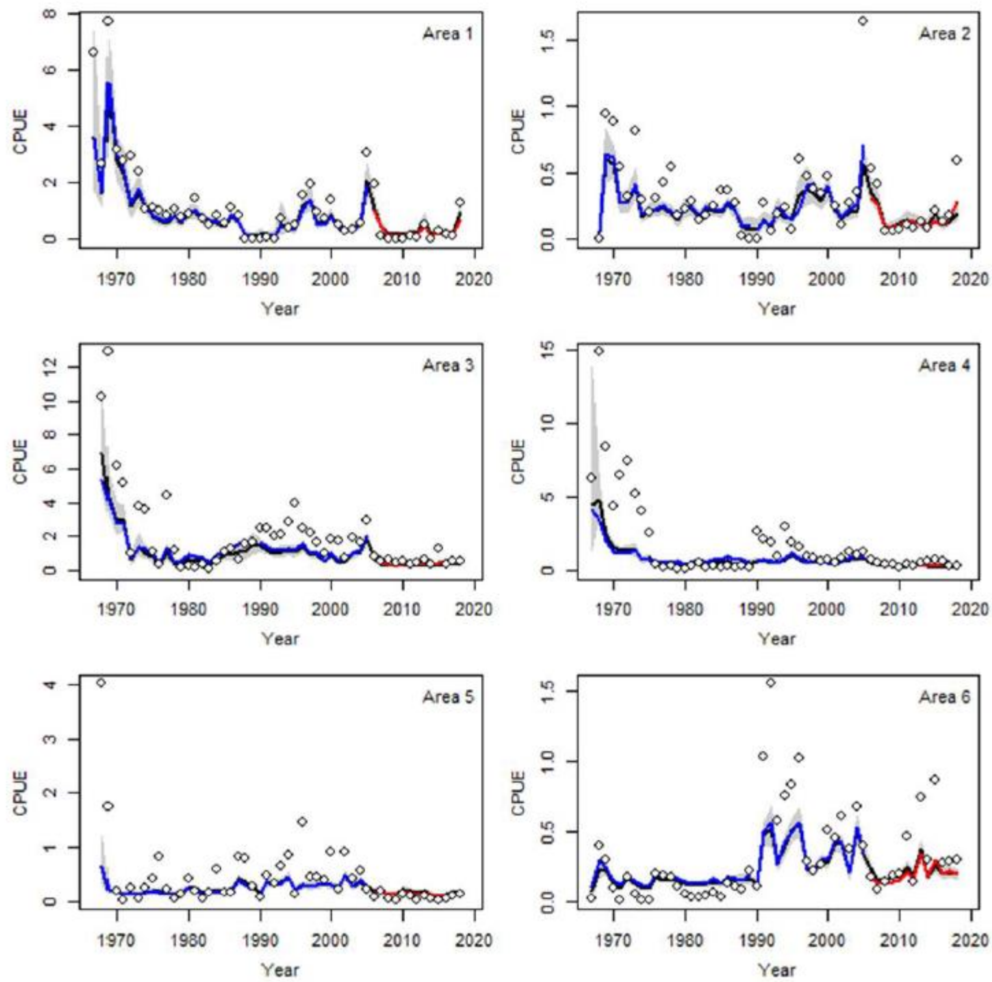


Figure 11. Indices of abundance from the Chinese Taipei distant water longline fishery. Nominal (open circles) and standardized (solid lines) CPUE of yellowfin tuna by period 1967-2018 (black lines), 1967-1989, 1990-2005 (blue lines) and 2006-2018 (red lines). Hooks-per-basket information was available for the latter period. The shaded areas represent the 95% confidence intervals for the entire period (1967-2018).

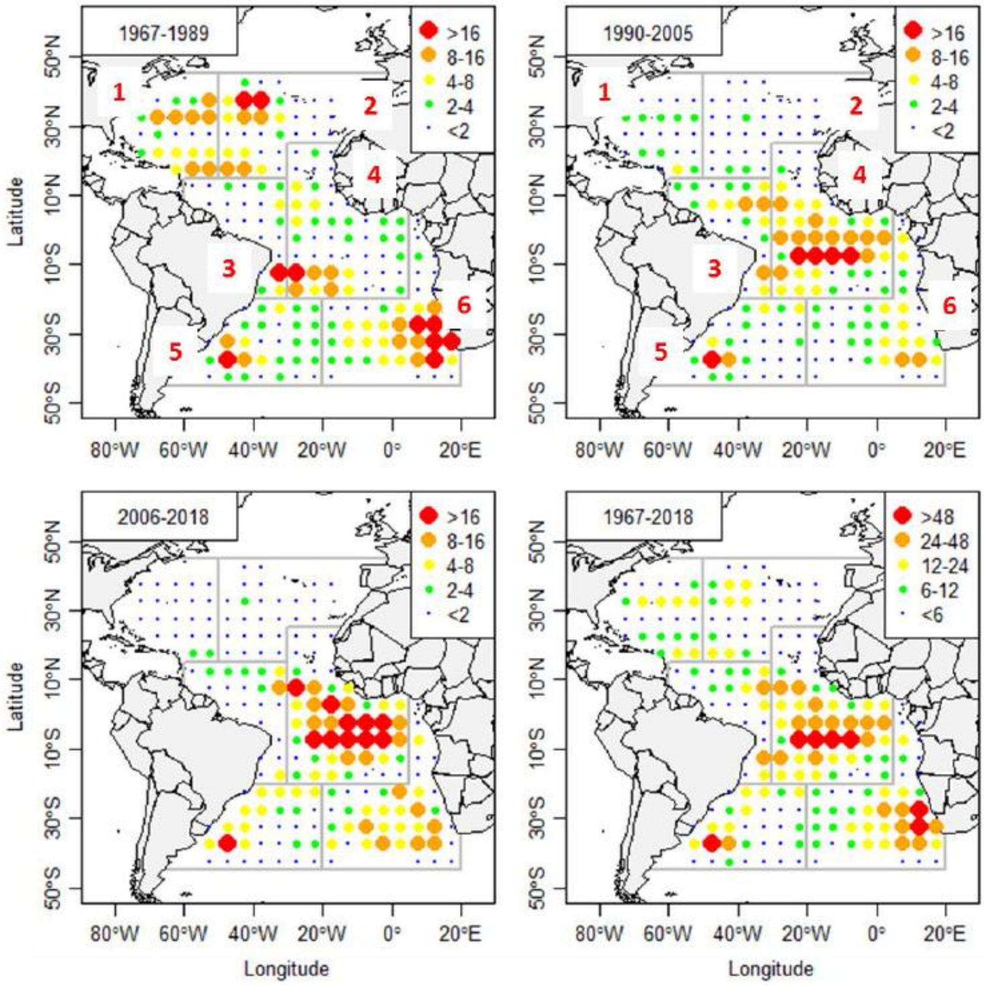


Figure 12. Distributions of fishing effort (million hooks) for the Chinese Taipei distant-water tuna longline fishery for the periods 1967-1989, 1990-2005, 2006-2018 and 1967-2018.

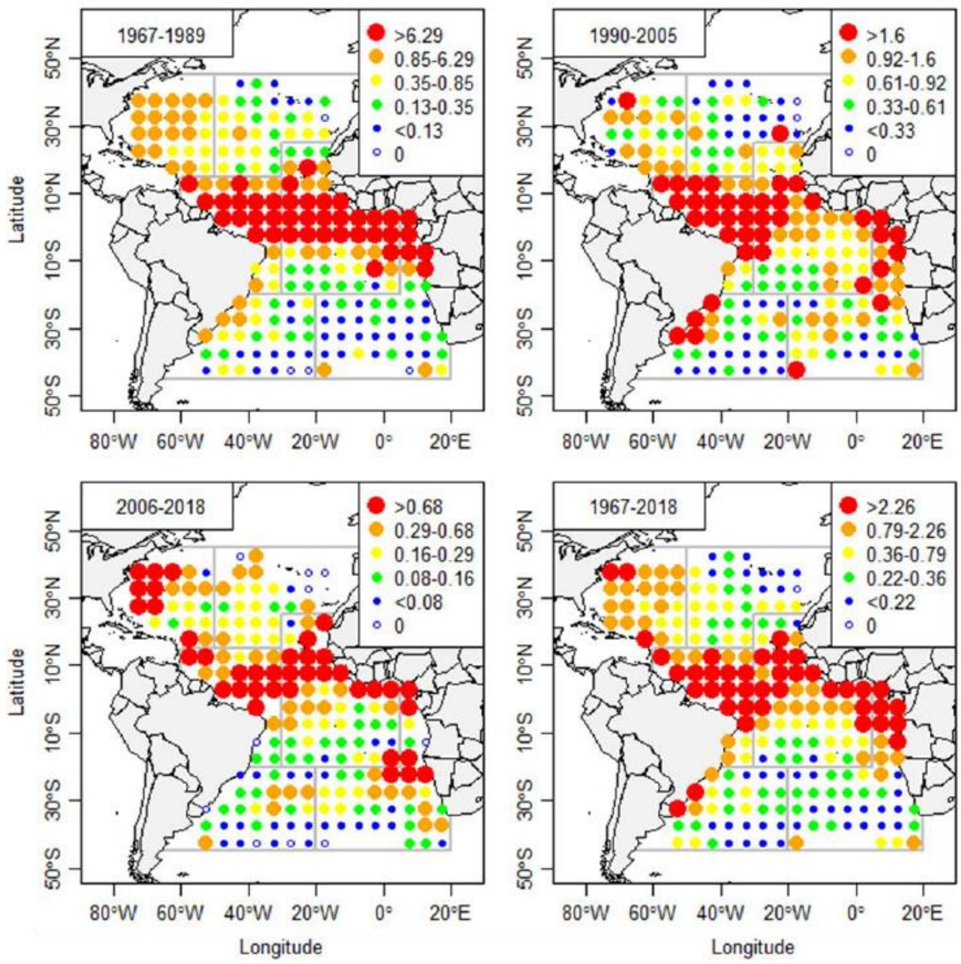


Figure 13. Distribution of nominal CPUE (number of fish caught per 1000 hooks) for yellowfin tuna caught in the Chinese Taipei distant-water tuna longline fishery for the periods of 1967-1989, 1990-2005, 2006-2018 and 1967-2018.

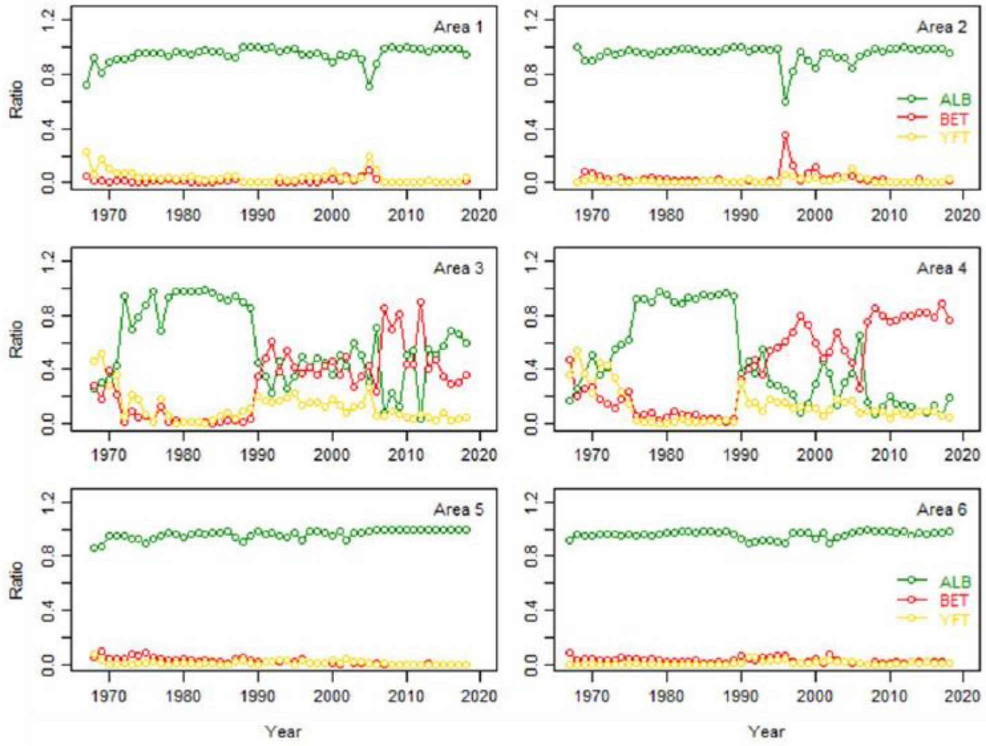


Figure 14. Catch ratios of albacore (ALB), bigeye (BET) and yellowfin tuna (YFT) by area for the China-Taipei distant-water tuna longline fishery. Changes in catch ratio are typically the result of a change in targeting.

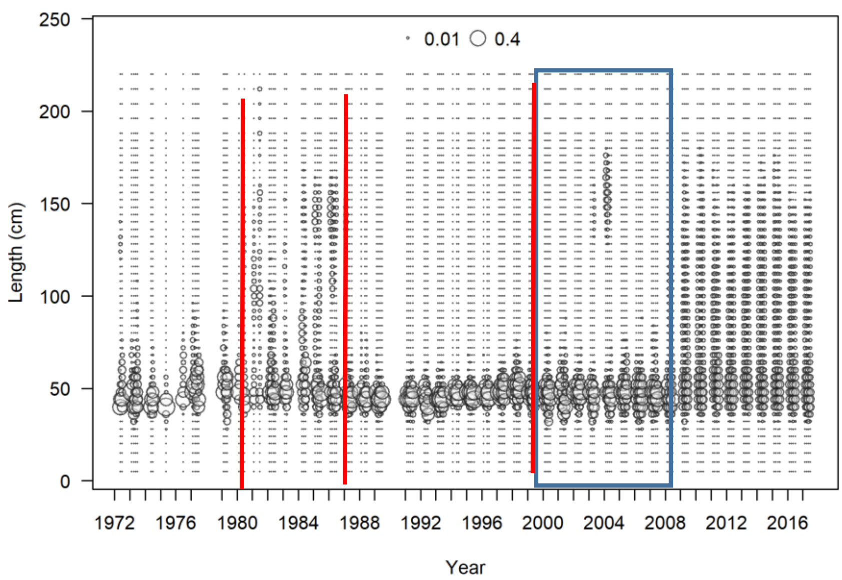


Figure 15. Length composition input for Fleet 11 Ghana BB_PS

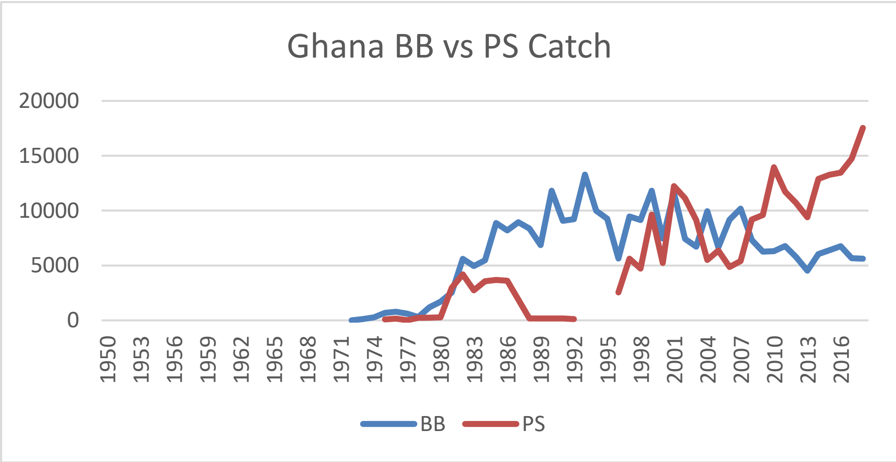


Figure 16. Distribution of catch between PS and BB from Fleet 11 Ghana BB_PS

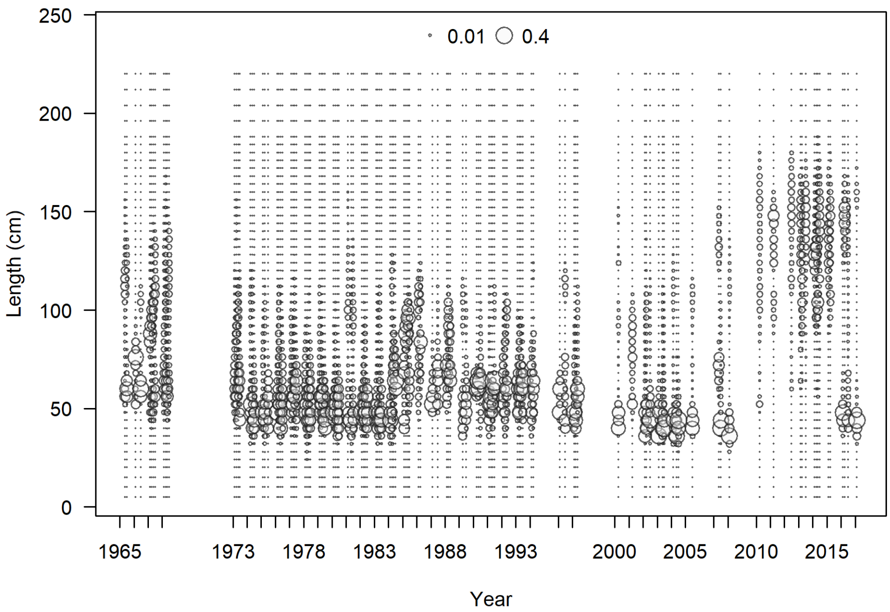


Figure 17. Length composition input for Fleet 12 BB_area2_Sdak before South Africa size data were removed.

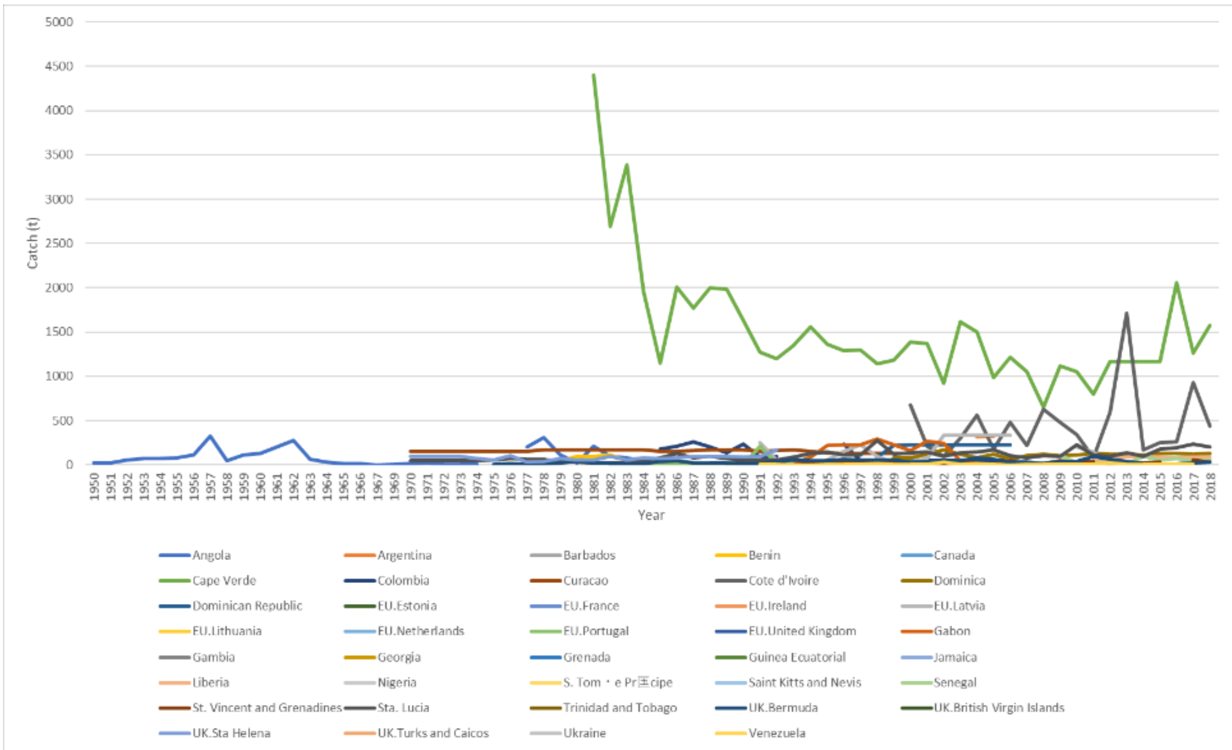


Figure 18. Catch in Fleet 25 other by country before Cape Verde data were removed.

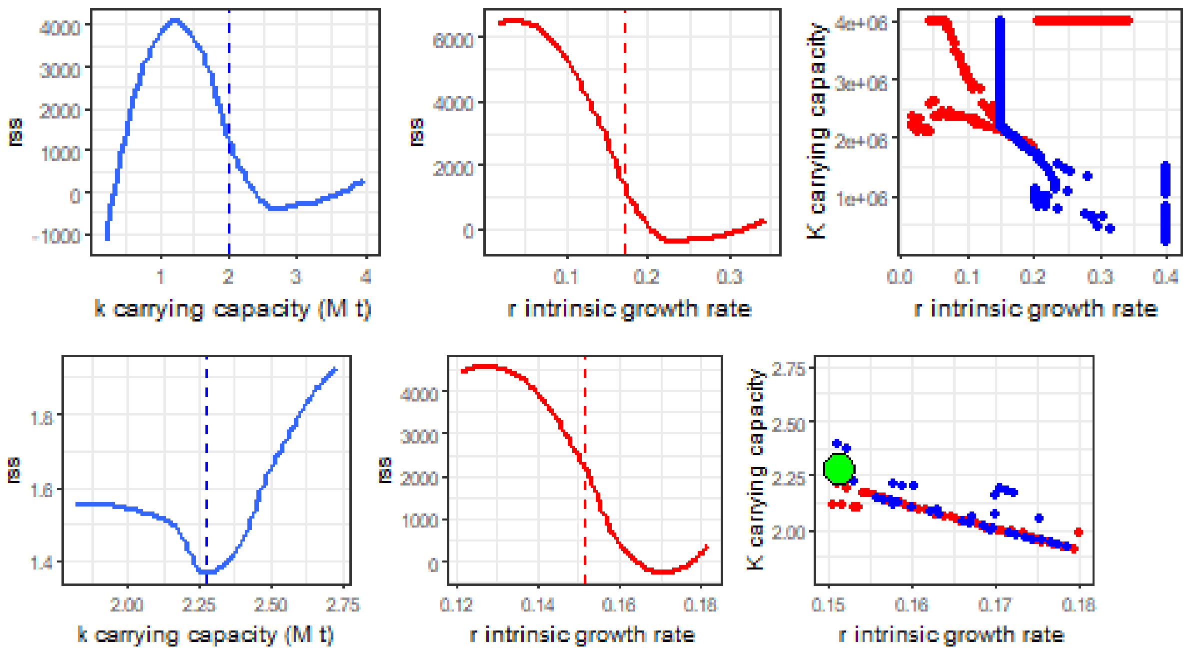


Figure 19. Likelihood profiles for *r* and *K* resulting from run 1 of the *mpb* model (top) vs. run 2 (bottom).

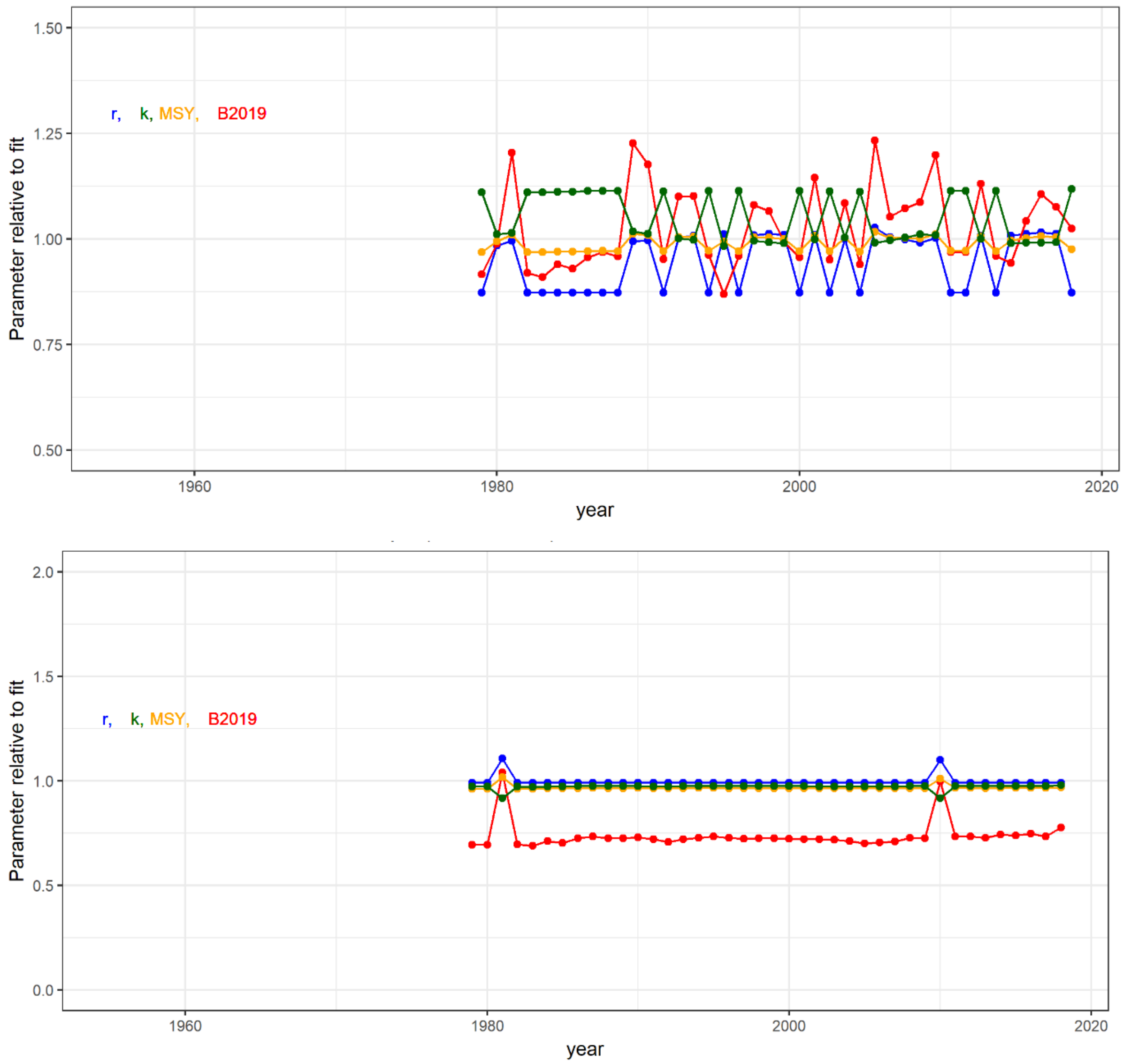


Figure 20. Improvements in the jackknife between run 1 (top) and run 2 (bottom) of *mpb*. Each point represents the change in the parameter estimate resulting from removing that year's data.

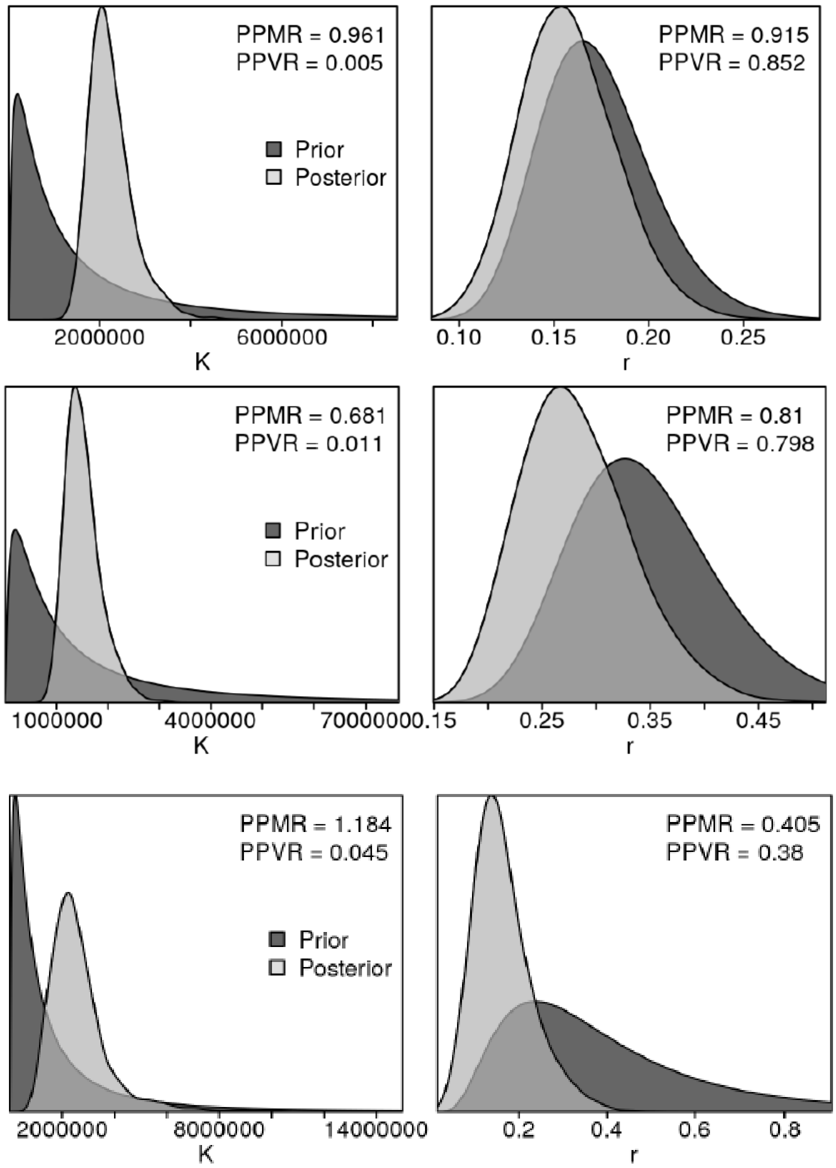


Figure 21. Prior and posterior distributions for *K* and *r* resulting from JABBA using an SS3 2019 prior (run 6, top), FishLife prior with a CV = 0.3 (run 2, middle), FishLife prior with a CV = 0.6 (run 14, bottom).

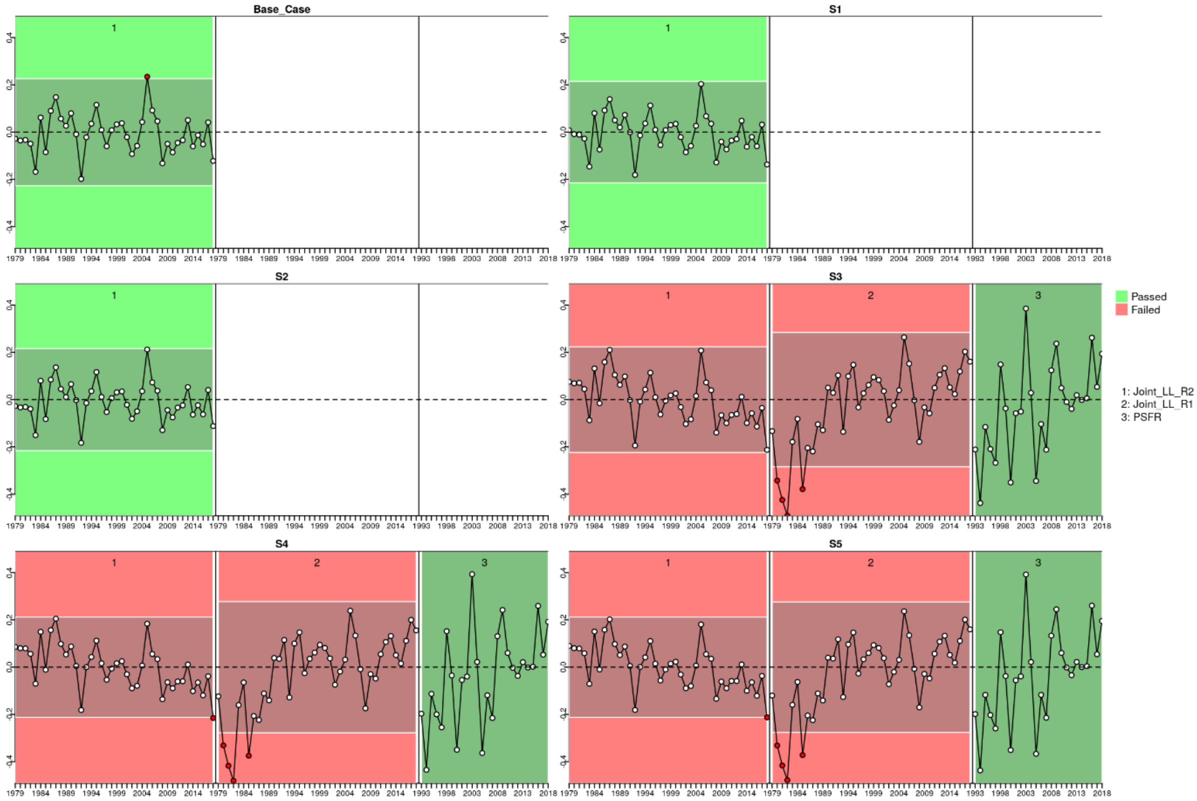


Figure 22. Diagnostic test, quantitative evaluation of the randomness of the time series of CPUE residuals by fleet for runs 6, 1, 16, 13, 18, 17 (from top left to bottom right). Green panels indicate no evidence of lack of randomness of time-series residuals (p>0.05) while red panels indicate the opposite. The inner shaded area shows three standard errors from the overall mean and red circles identify a specific year with residuals greater than this threshold value (3x sigma rule).

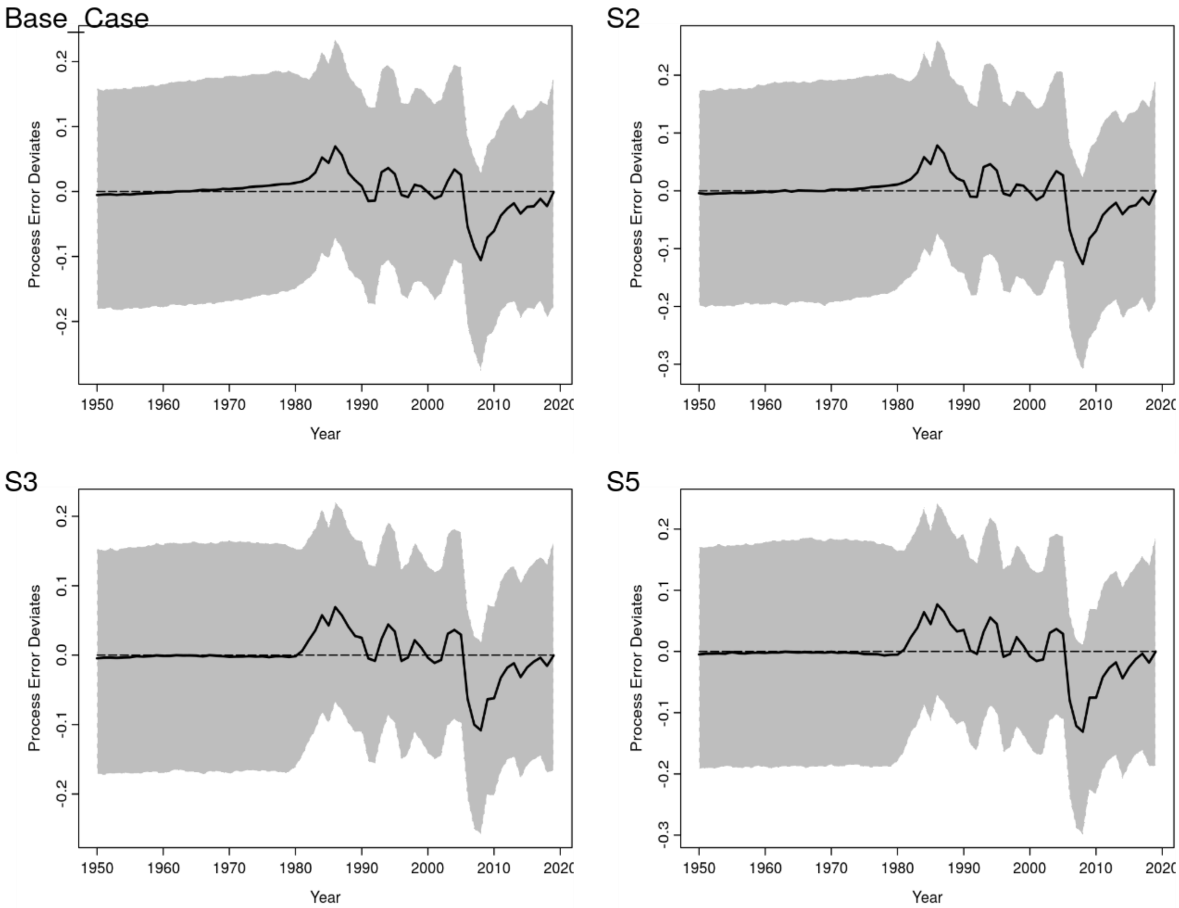


Figure 23. Process error deviations (median: solid line) for the 4 reference runs: (from top left to bottom right) runs 6, 16, 13, 17. Shaded grey area indicates 95% credibility intervals.

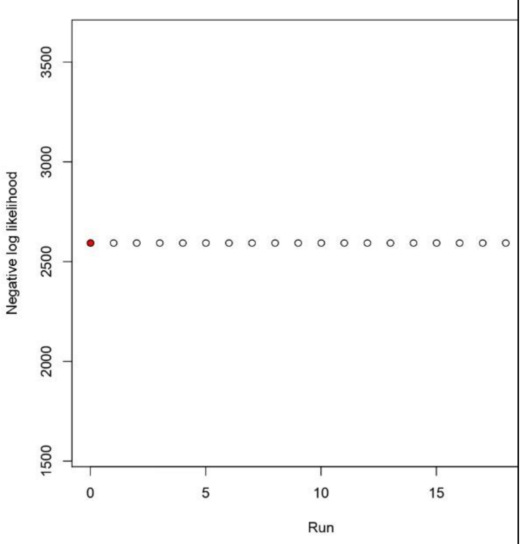
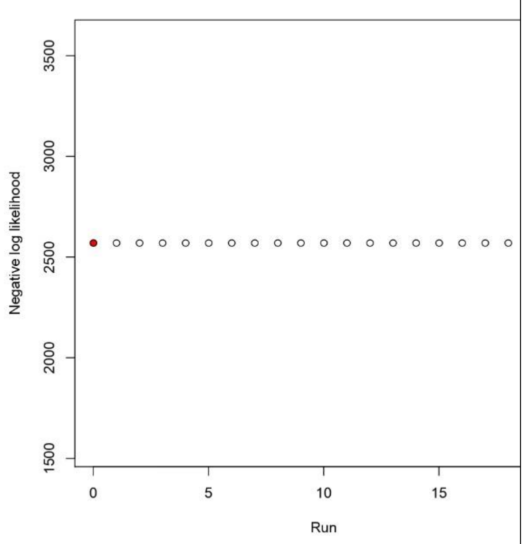
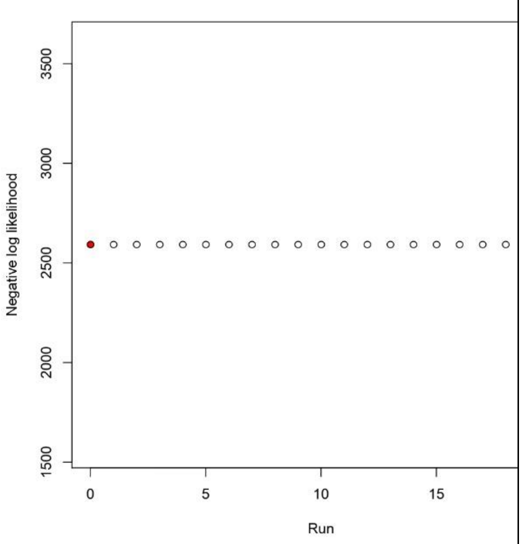
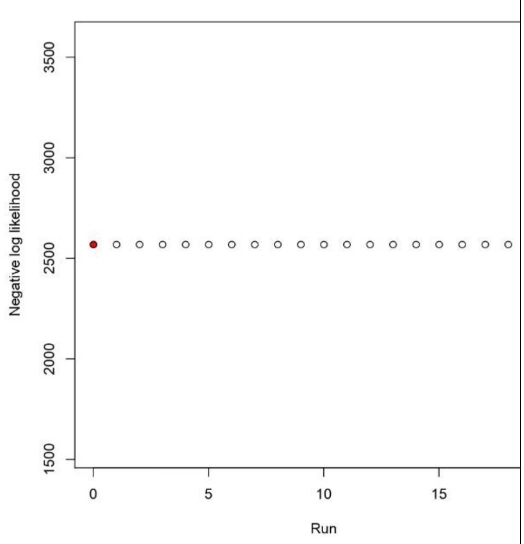
model		model	
1		3	
2		4	
1. Ref Run; h=0.8; Lambda=0.5, m=0.35, no 2018 rec devs; 2. h=0.9; Lambda=0.5, m=0.35, no 2018 rec devs; 3. new h=0.8; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs; 4. new h=0.9; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;			

Figure 24. The jitter analysis for the Stock Synthesis runs.

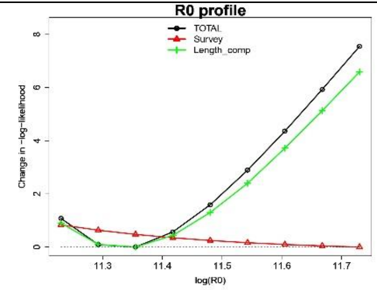
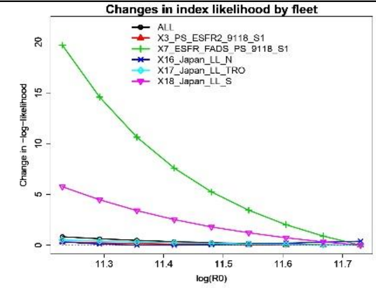
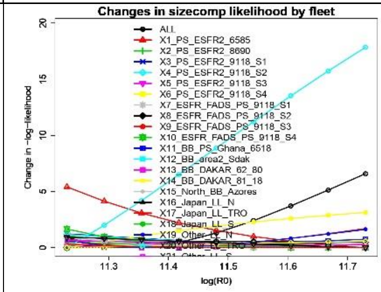
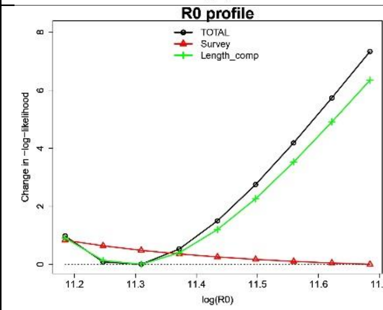
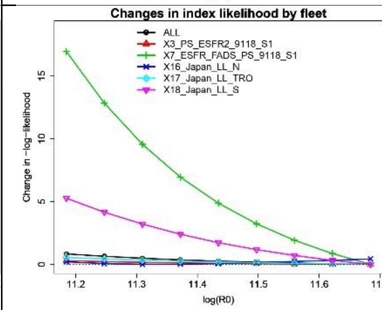
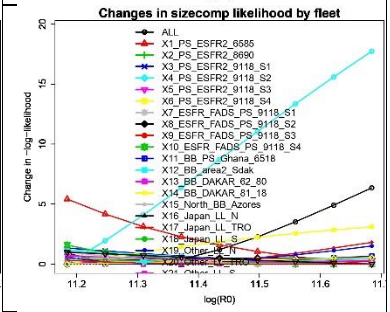
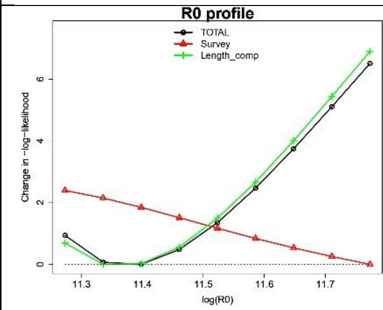
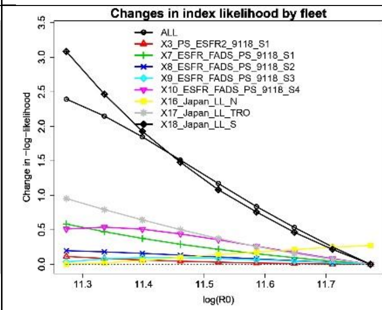
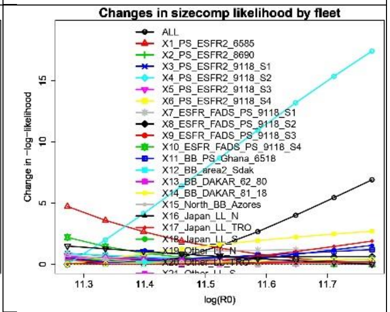
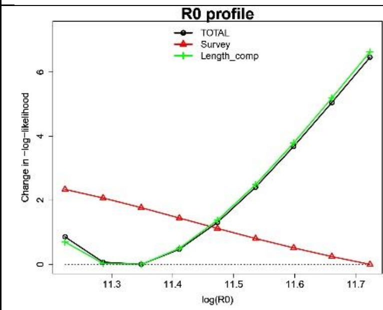
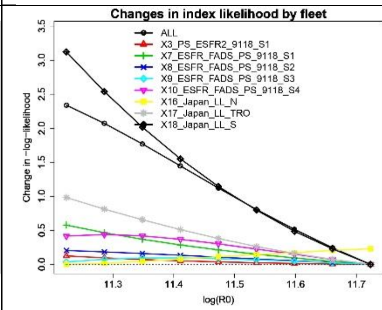
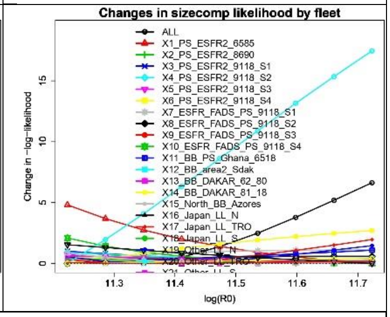
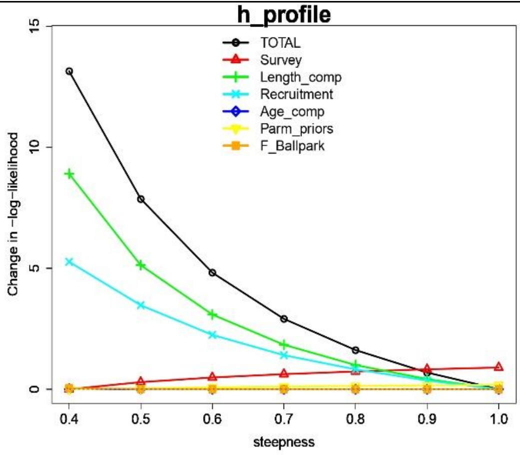
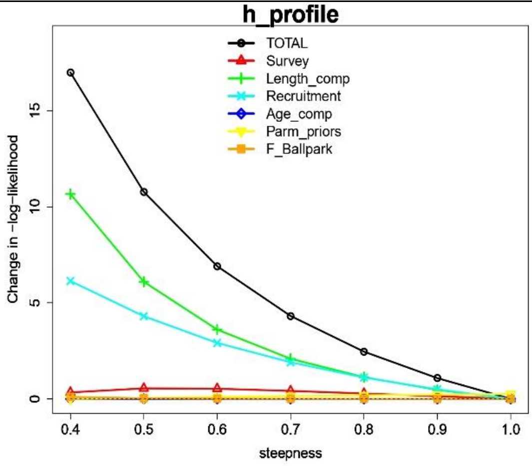
<table>
<tr><th>Model</th><th>Total, survey, size composition</th><th>Survey by fleet</th><th>Size composition by fleet</th></tr>
<tr><td>1</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">1. Ref Run; h=0.8; Lambda=0.5, m=0.35, no 2018 rec devs;
2. h=0.9; Lambda=0.5, m=0.35, no 2018 rec devs;
3. new h=0.8; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;
4. new h=0.9; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;</td></tr>
</table>

Figure 25. The likelihood profile of R0 for the Stock Synthesis runs.

<table>
<tr><td>model</td><td></td><td>model</td><td></td></tr>
<tr><td>1</td><td>
</td><td>3</td><td>
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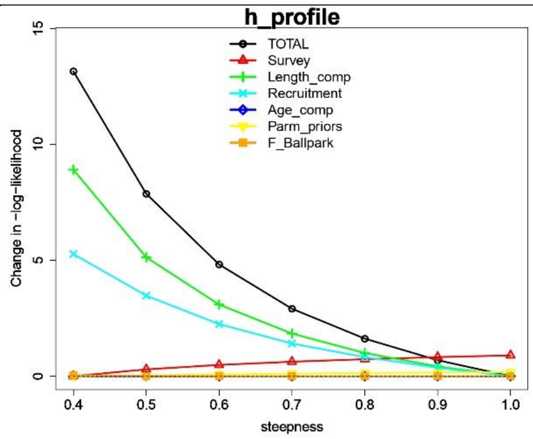
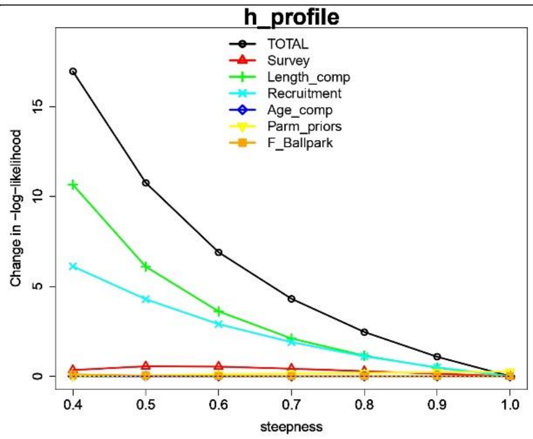
<tr><td>2</td><td>
</td><td>4</td><td>
</td></tr>
<tr><td colspan="4">1. Ref Run; h=0.8; Lambda=0.5, m=0.35, no 2018 rec devs;
2. h=0.9; Lambda=0.5, m=0.35, no 2018 rec devs;
3. new h=0.8; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;
4. new h=0.9; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;</td></tr>
</table>

Figure 26. The likelihood profile of steepness (h) for the Stock Synthesis runs.

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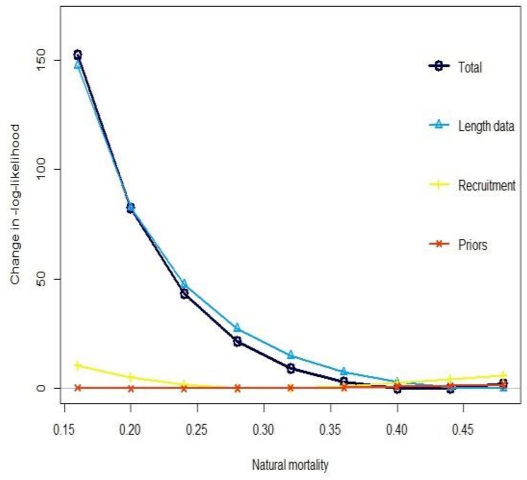
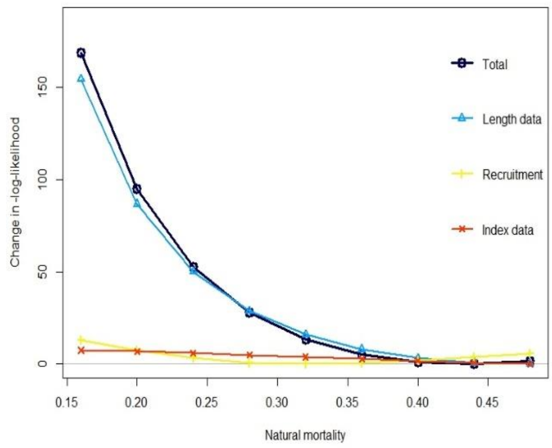
<tr><td>1</td><td>
</td><td>3</td><td>
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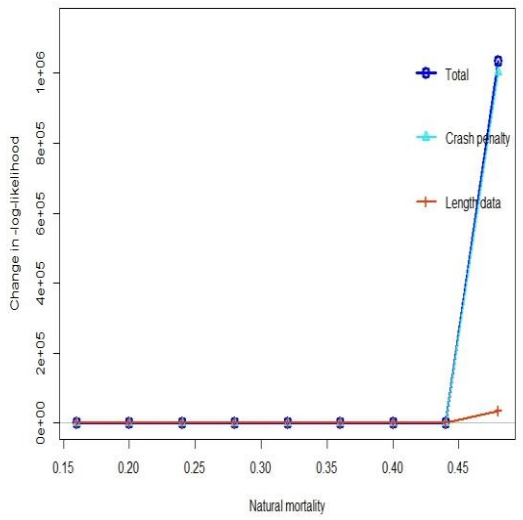
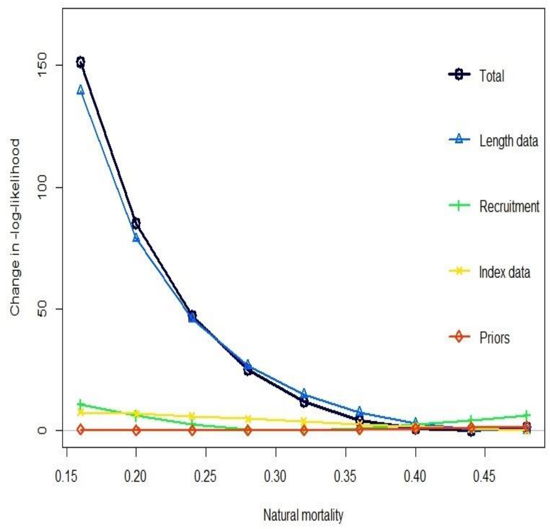
<tr><td>2</td><td>
</td><td>4</td><td>
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<tr><td colspan="4">1. Ref Run; h=0.8; Lambda=0.5, m=0.35, no 2018 rec devs;
2. h=0.9; Lambda=0.5, m=0.35, no 2018 rec devs;
3. new h=0.8; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;
4. new h=0.9; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;</td></tr>
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Figure 27. The likelihood profile of natural mortality (M) for the Stock Synthesis runs.

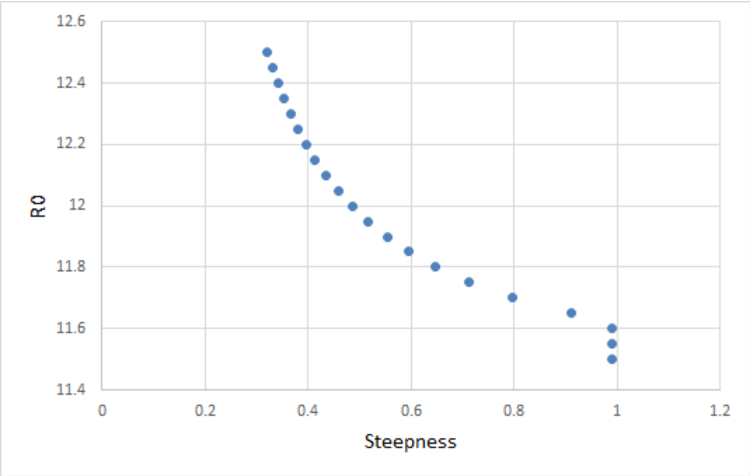


Figure 28. The high correlation between steepness and R0. Fixing certain values of steepness largely predetermined R0, therefore while R0 was estimated in the model, steepness was fixed.

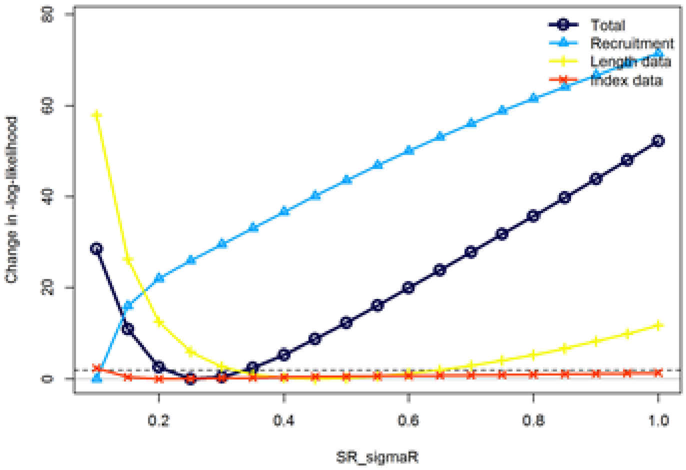
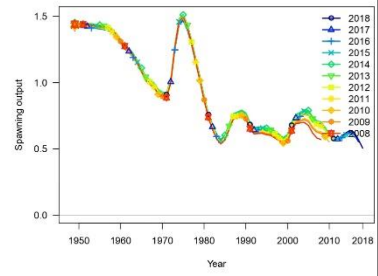
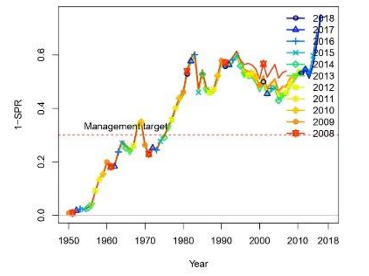
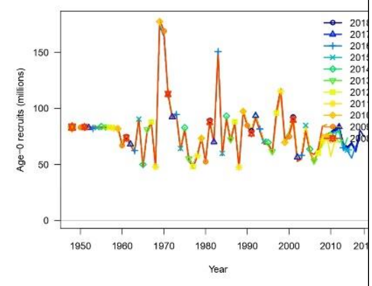
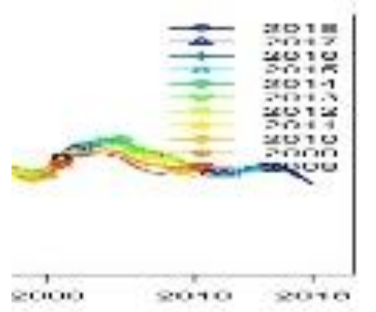
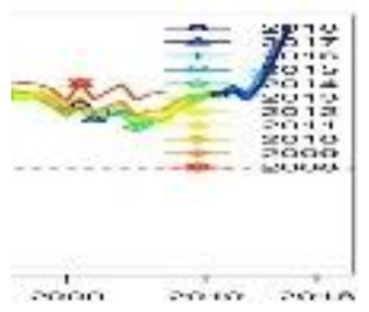
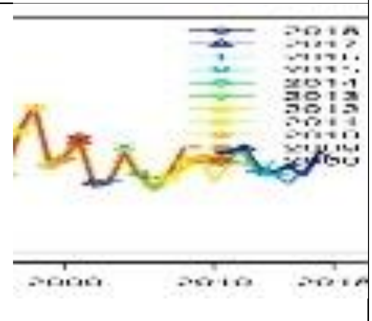
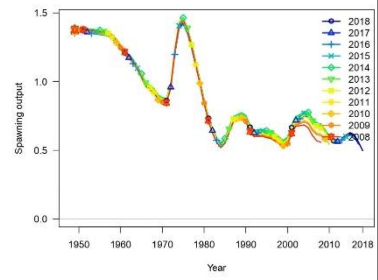
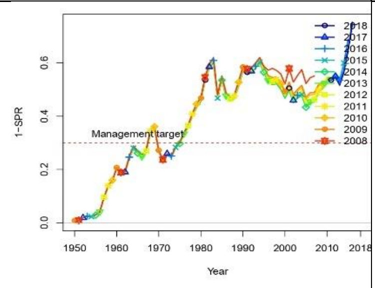
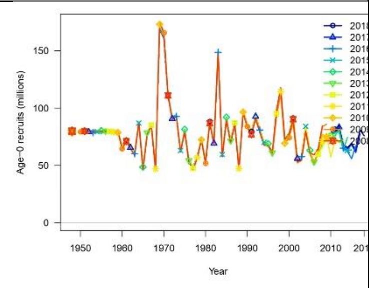
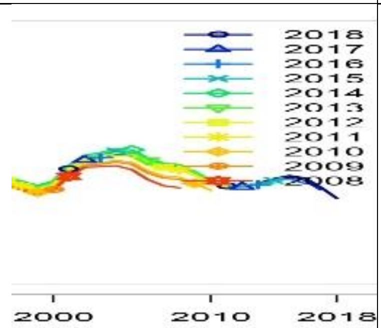
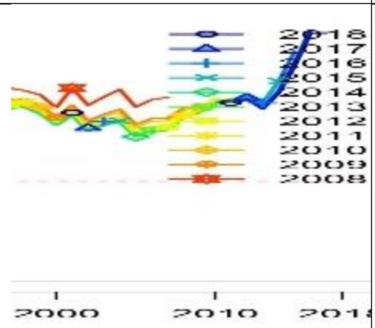
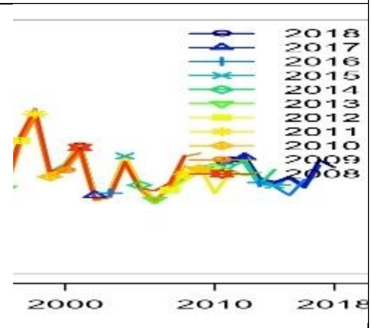


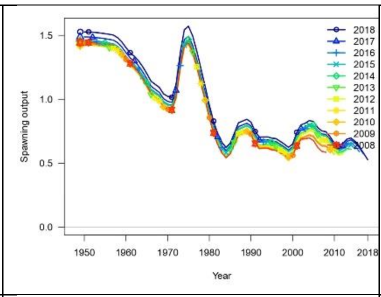
Figure 29. Likelihood profile of the annual variance in recruitment (SigmaR) from the reference case.

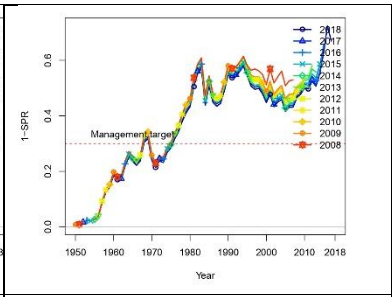
model	Spawning output	1 – SPR (proxy of F)	Recruitment
1			
(enlarge after 2000)			
2			
(enlarge after 2000)			

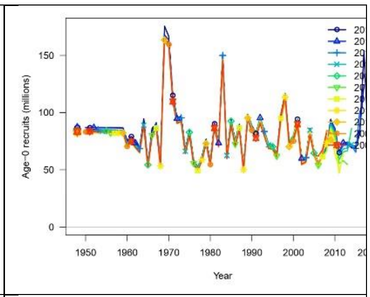
1. Ref Run; h=0.8; Lambda=0.5, m=0.35, no 2018 rec devs;
2. h=0.9; Lambda=0.5, m=0.35, no 2018 rec devs;
3. new h=0.8; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;
4. new h=0.9; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;

Figure 30. Retrospective analyses on the Stock Synthesis models.

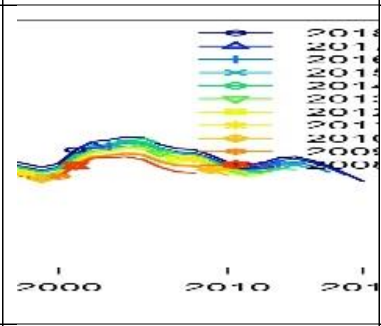
3

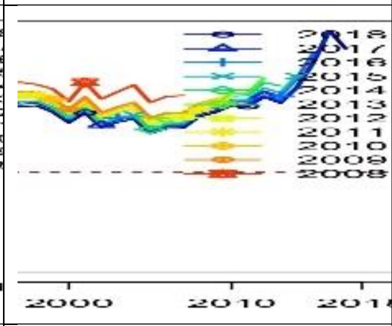


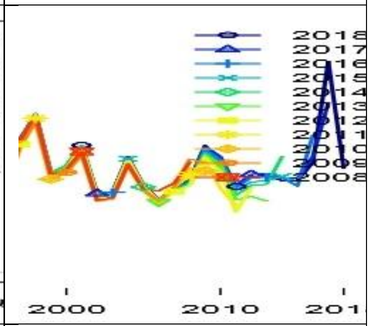




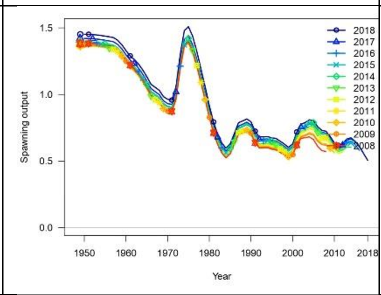
(enlarge after 2000)

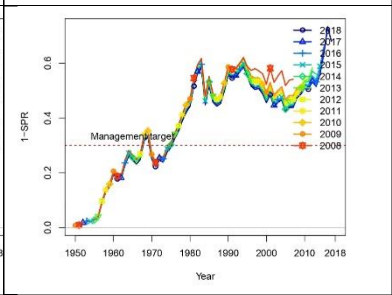


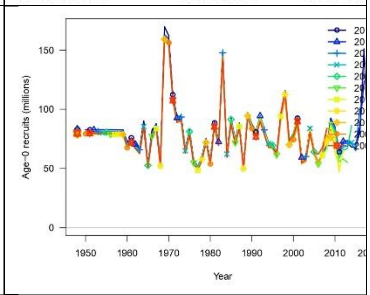




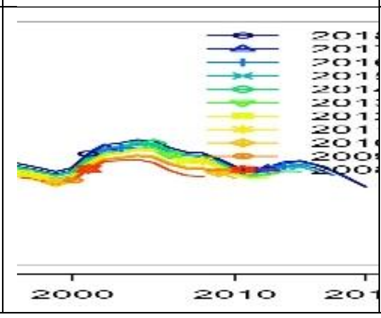
4

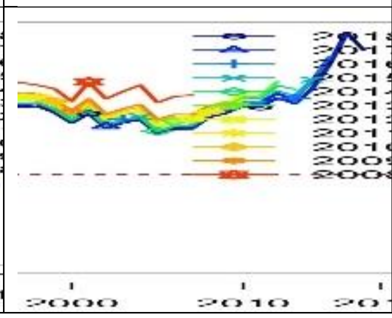






(enlarge after 2000)





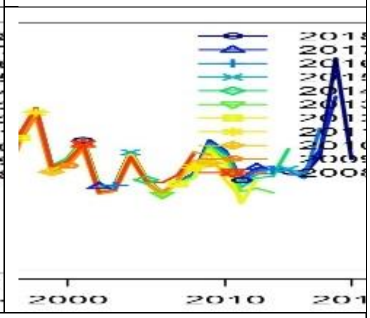
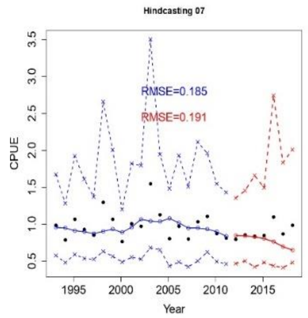
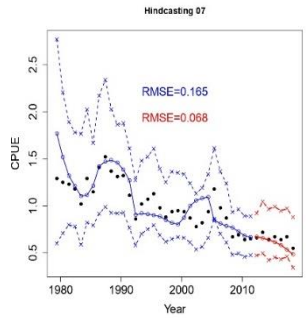
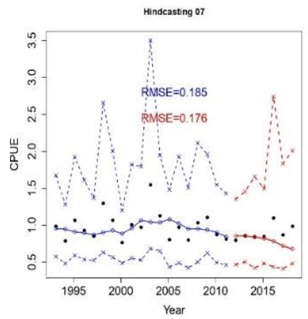
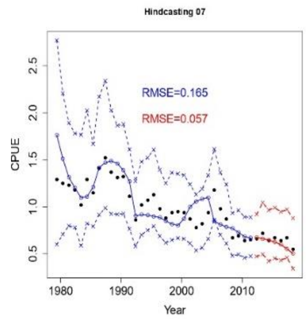
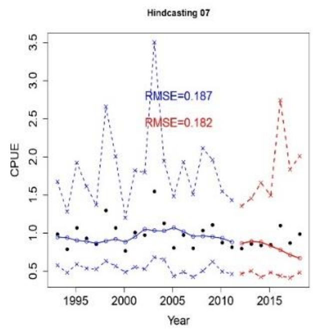
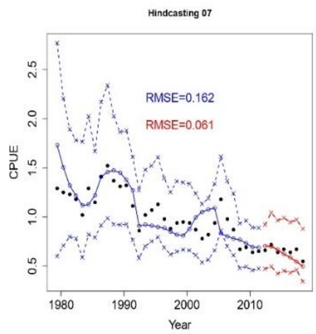
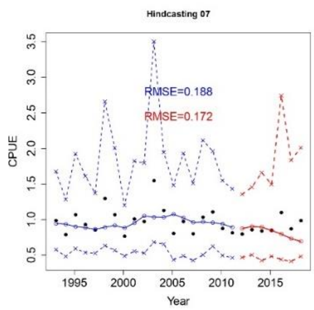
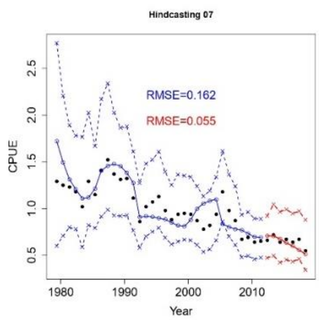


Figure 30 – continued from previous page. Retrospective analyses on the Stock Synthesis models.

model	Fleet 3	Fleet 17
1		
2		
3		
4		

1. Ref Run; h=0.8; Lambda=0.5, m=0.35, no 2018 rec devs;
2. h=0.9; Lambda=0.5, m=0.35, no 2018 rec devs;
3. new h=0.8; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;
4. new h=0.9; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;

Figure 31. The hindcasting analysis for the Stock Synthesis model runs.

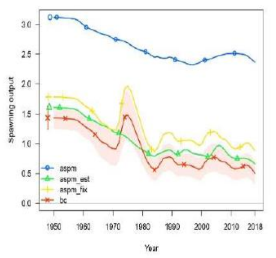
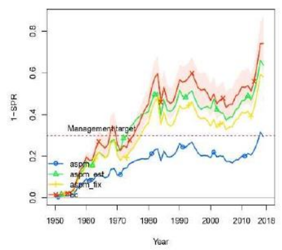
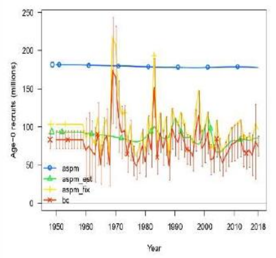
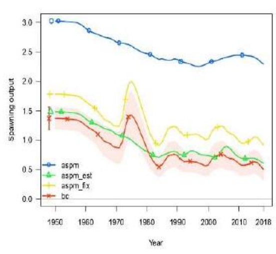
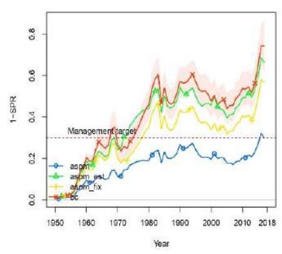
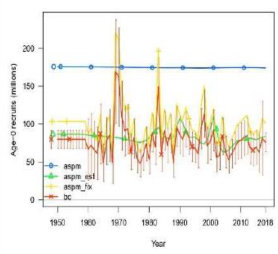
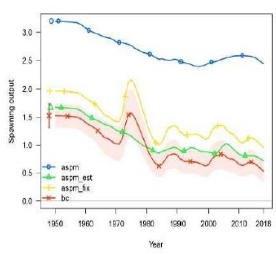
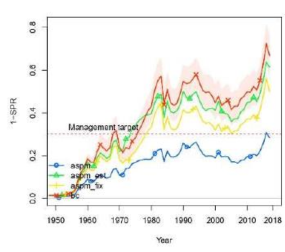
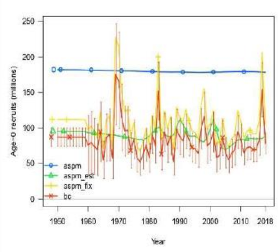
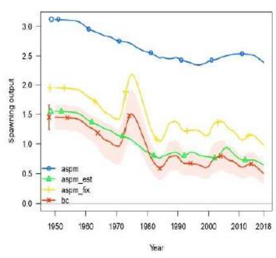
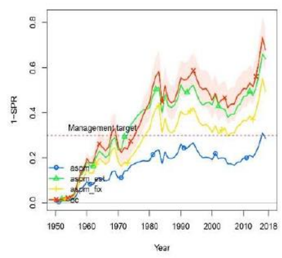
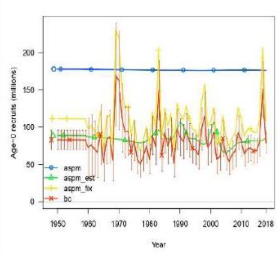
model	SSB	1 - SPR	Recruitment
1			
2			
3			
4			

Fig. 8 ASPM analysis for uncertainty grid analysis

(bc: base case (integrated model), aspm: using the selectivity parameters from integrated model, the recruitment deviation is not used, aspm_est: using the selectivity parameters from integrated model, but estimated recruitment deviation, aspm_fix: using the selectivity parameters and recruitment deviation from integrated model).

1. Ref Run; h=0.8; Lambda=0.5, m=0.35, no 2018 rec devs;
2. h=0.9; Lambda=0.5, m=0.35, no 2018 rec devs;
3. new h=0.8; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;
4. new h=0.9; Lambda=0.5, bouy index linked to seasonal fleets, no 2018 rec devs;

Figure 32. Age Structured Production Model (ASPM) analysis for Stock Synthesis model. Note: bc: base case (integrated model), aspm: using the selectivity parameters from integrated model, the recruitment deviation is not used, aspm_est: using the selectivity parameters from integrated model, but estimated recruitment deviation, aspm_fix: using the selectivity parameters and recruitment deviation from integrated model).

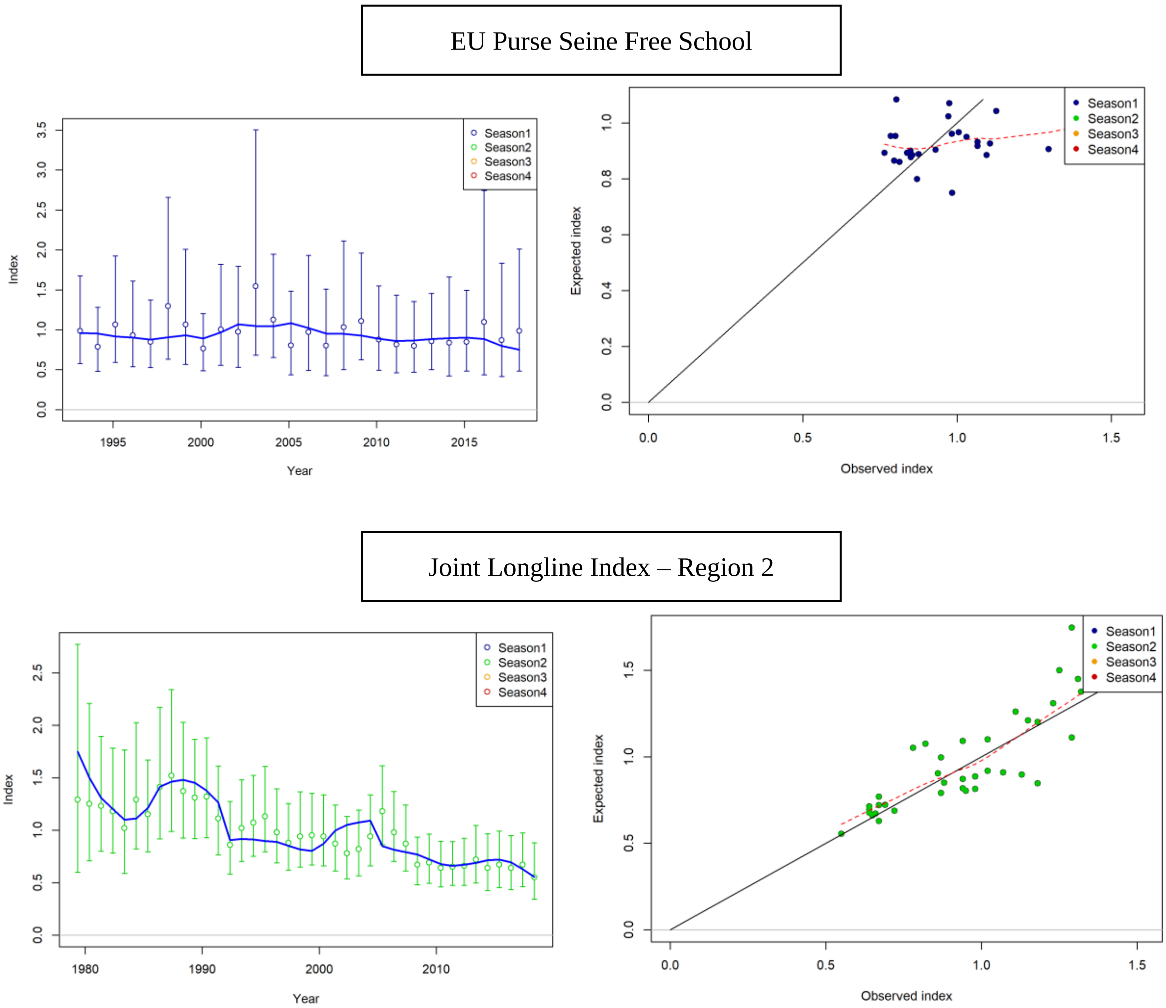
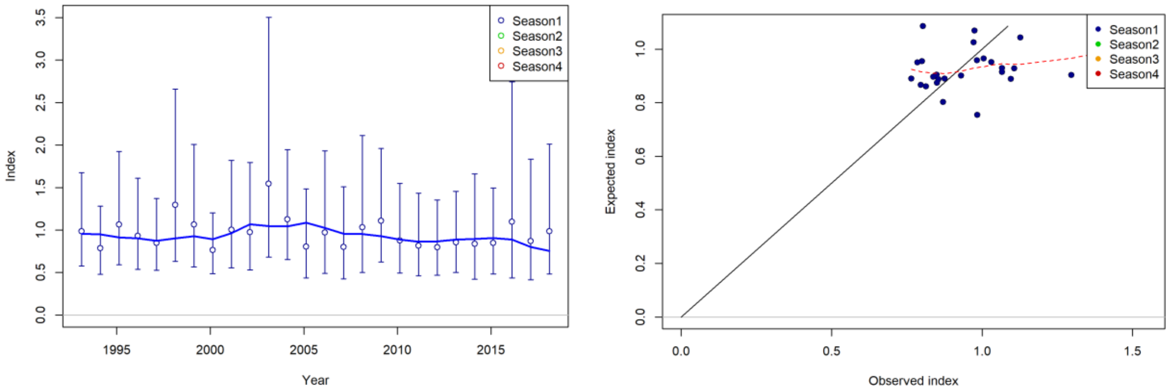


Figure 33. Fits to indices of abundance for Stock Synthesis Run 1.

EU Purse Seine Free School



Joint Longline Index – Region 2

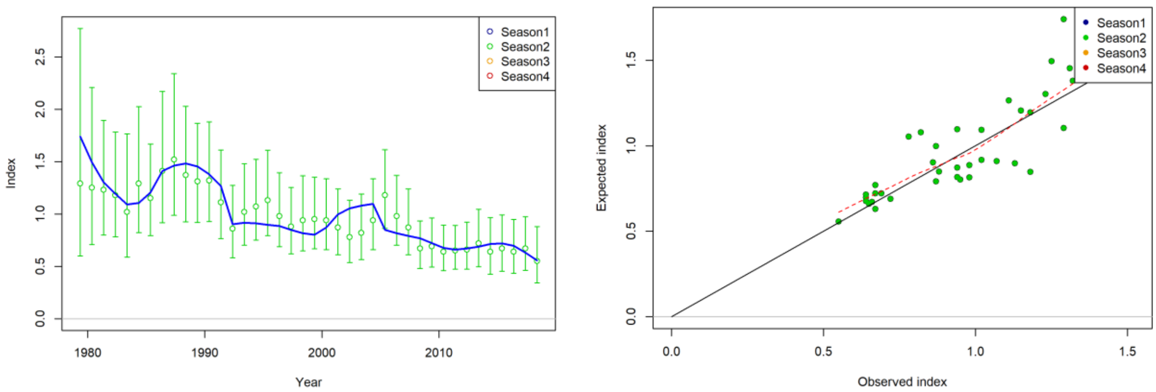


Figure 34. Fits to indices of abundance for Stock Synthesis Run 2.

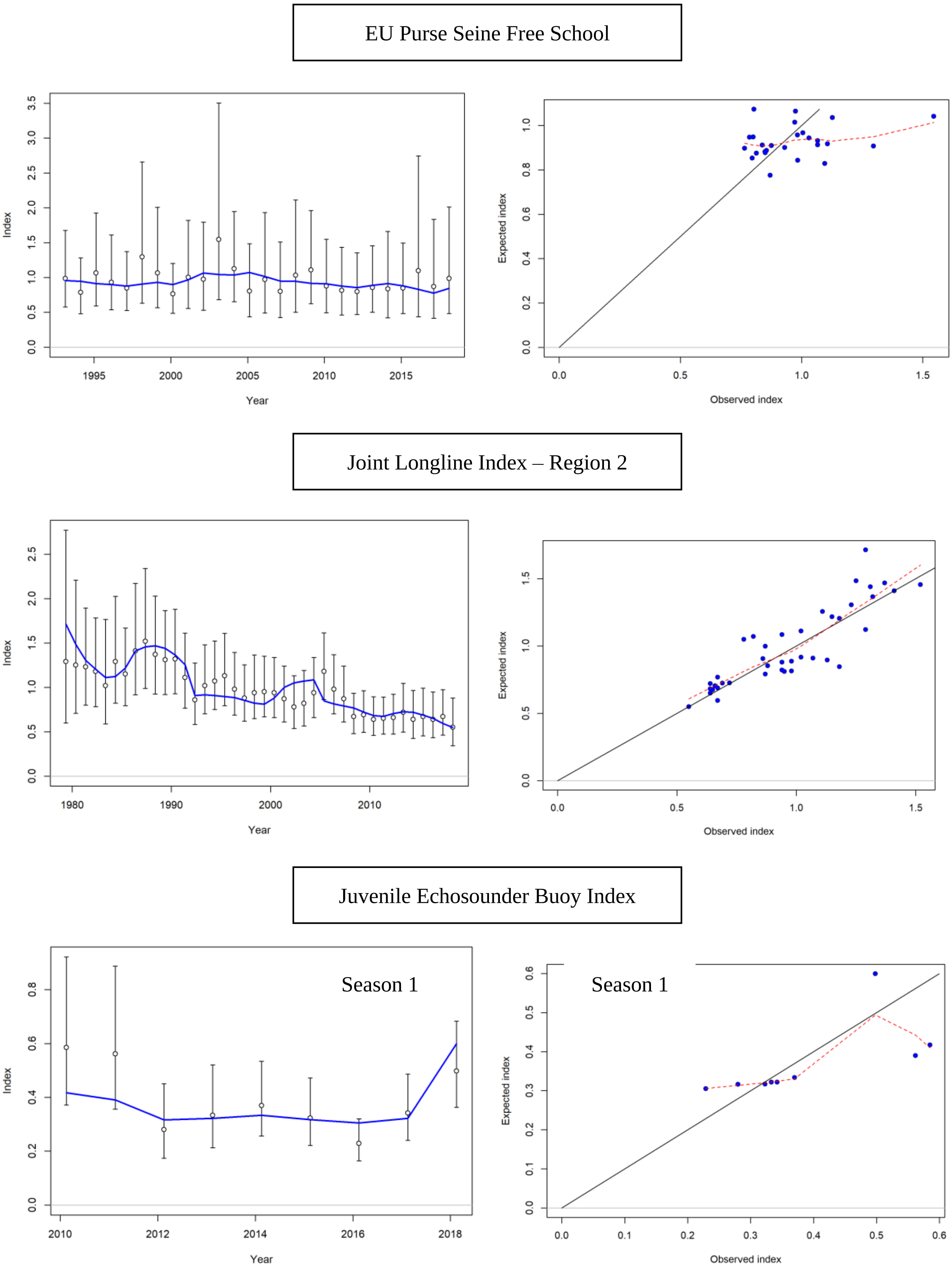


Figure 35. Fits to indices of abundance for Stock Synthesis Run 3 (*continues on next page*).

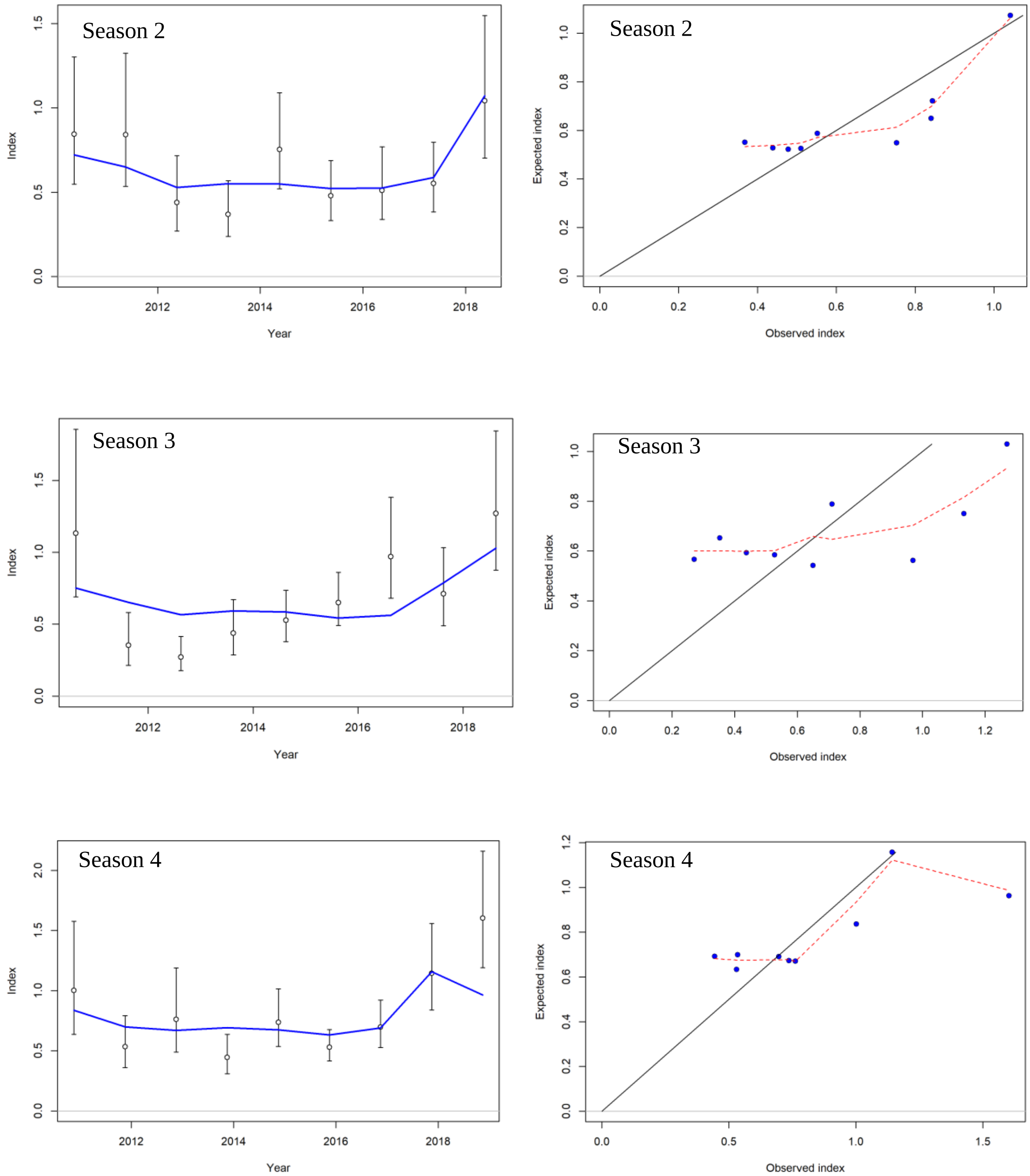
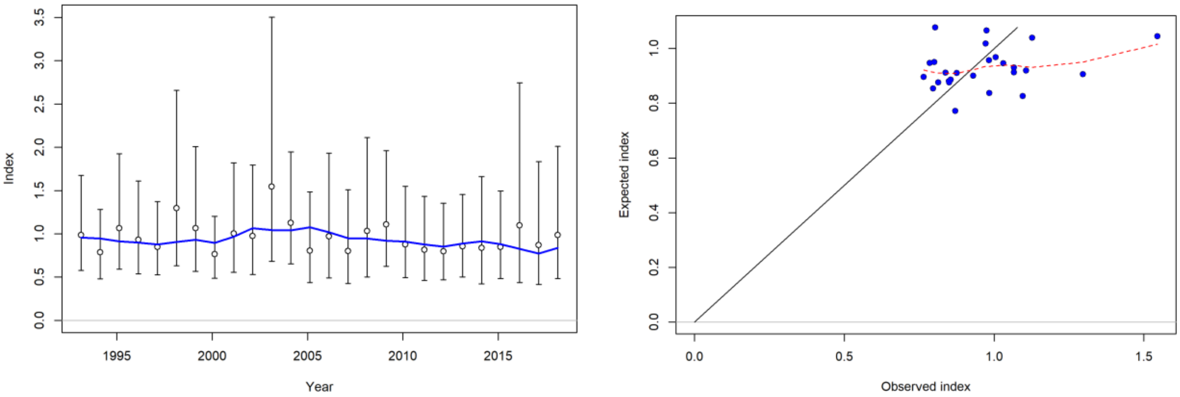
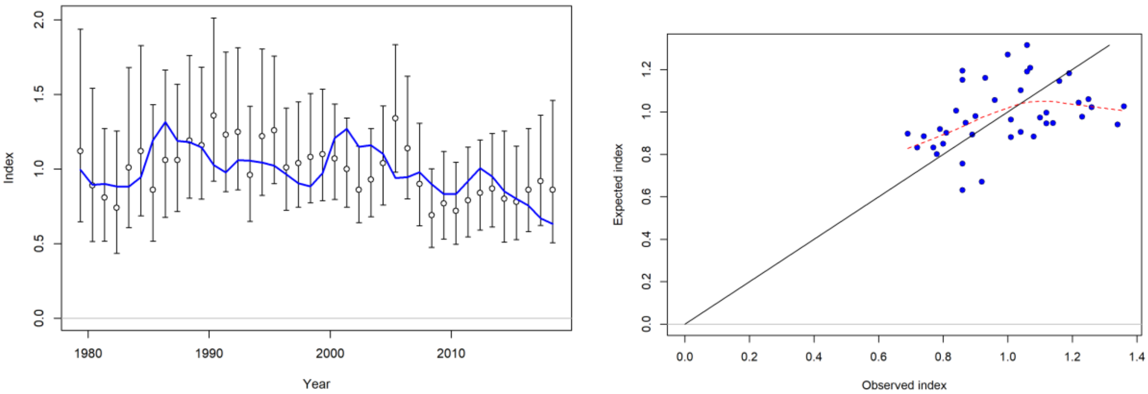


Figure 35 – *continued from previous page***.** Fits to indices of abundance for Stock Synthesis Run 3.

EU Purse Seine Free School



Joint Longline Index – Region 2



Juvenile Echosounder Buoy Index

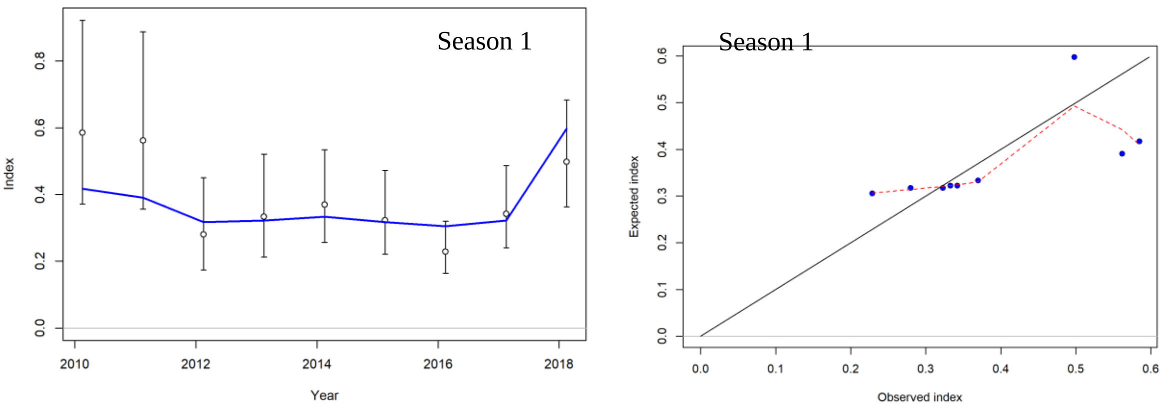


Figure 36. Fits to indices of abundance for Stock Synthesis Run 4 (*continues on next page*).

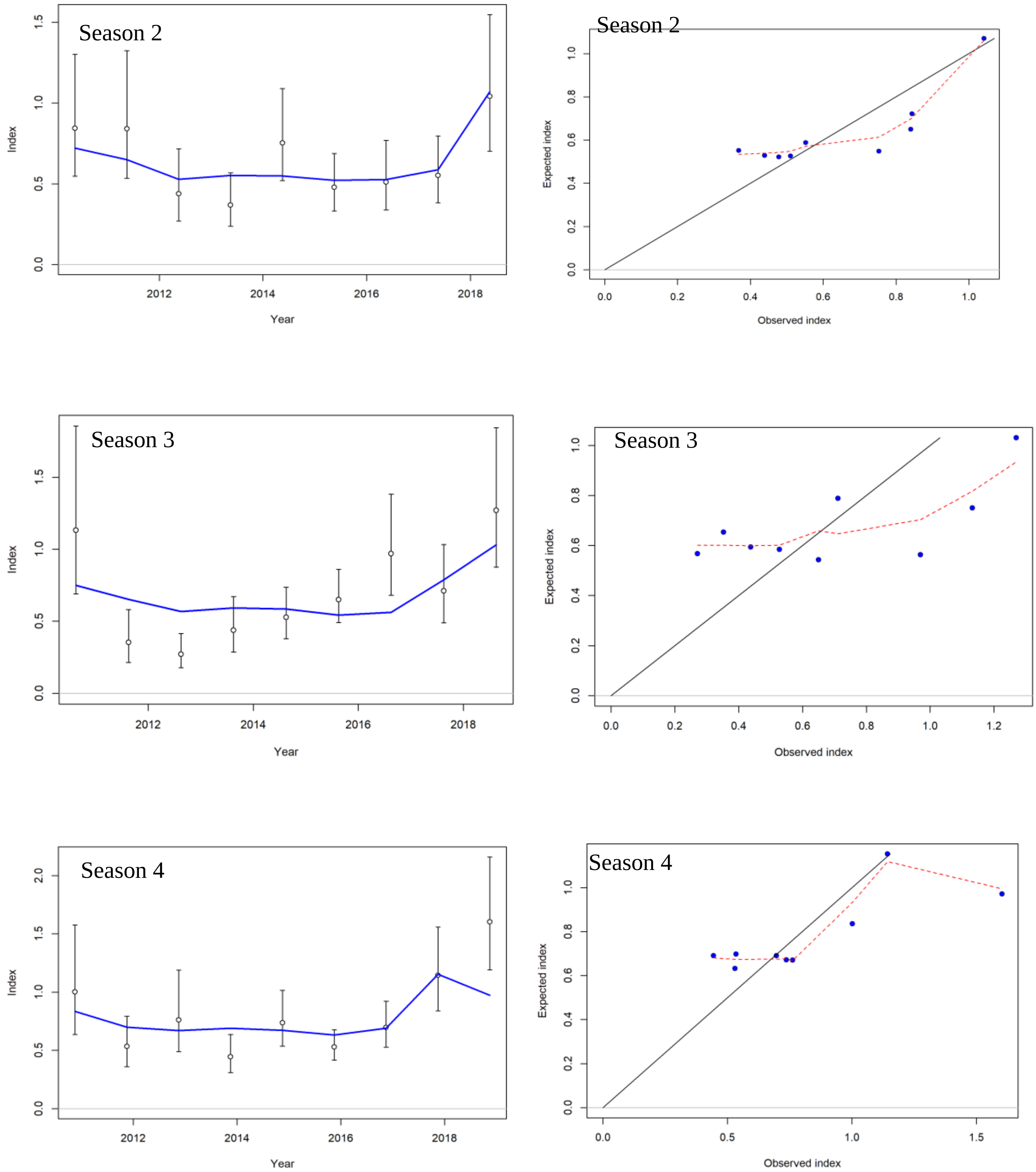


Figure 36– *continued from previous page***.** Fits to indices of abundance for Stock Synthesis Run 4.

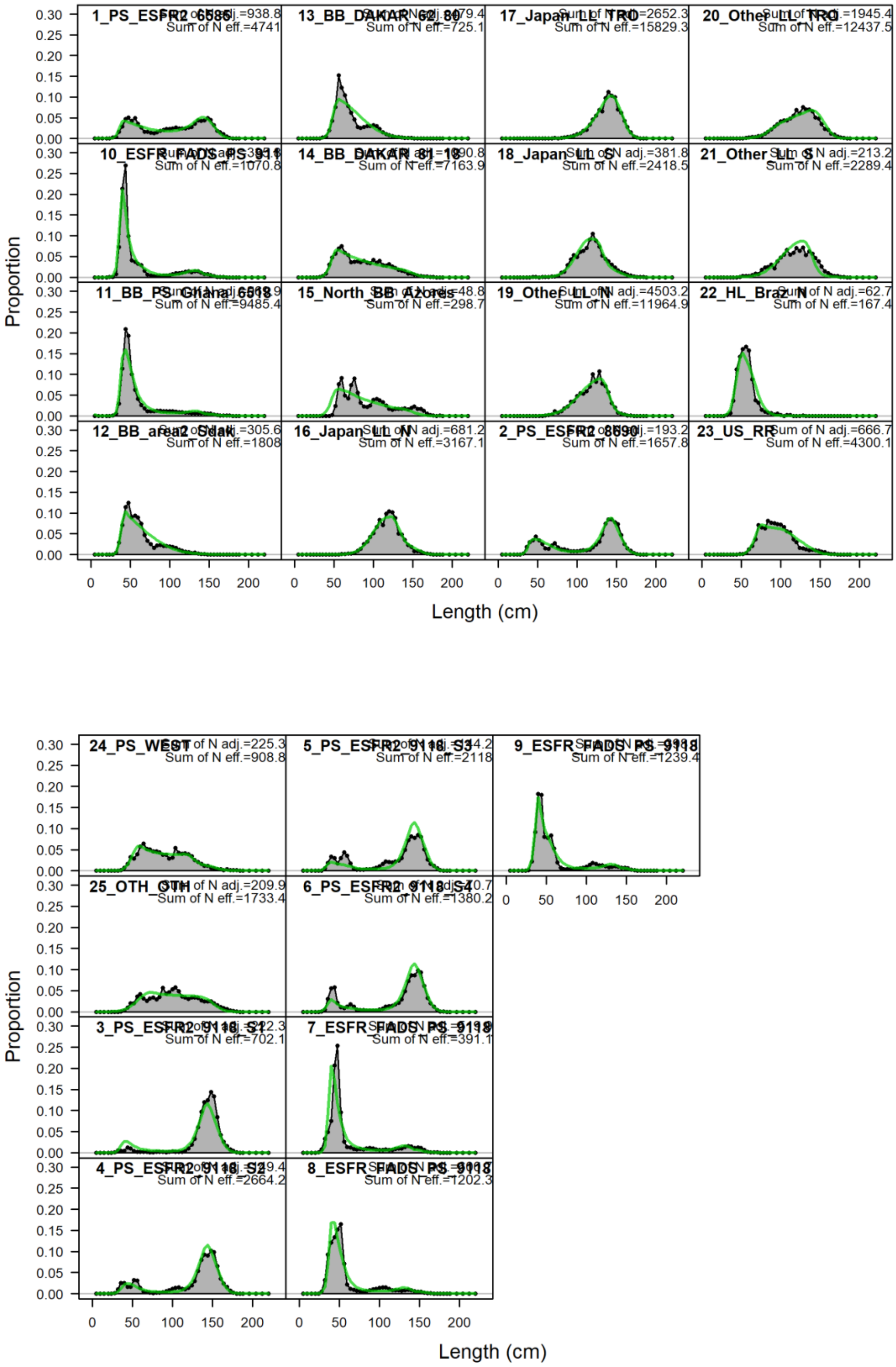


Figure 37. The fits to the length composition, aggregated by fleet for Stock Synthesis Run 1.

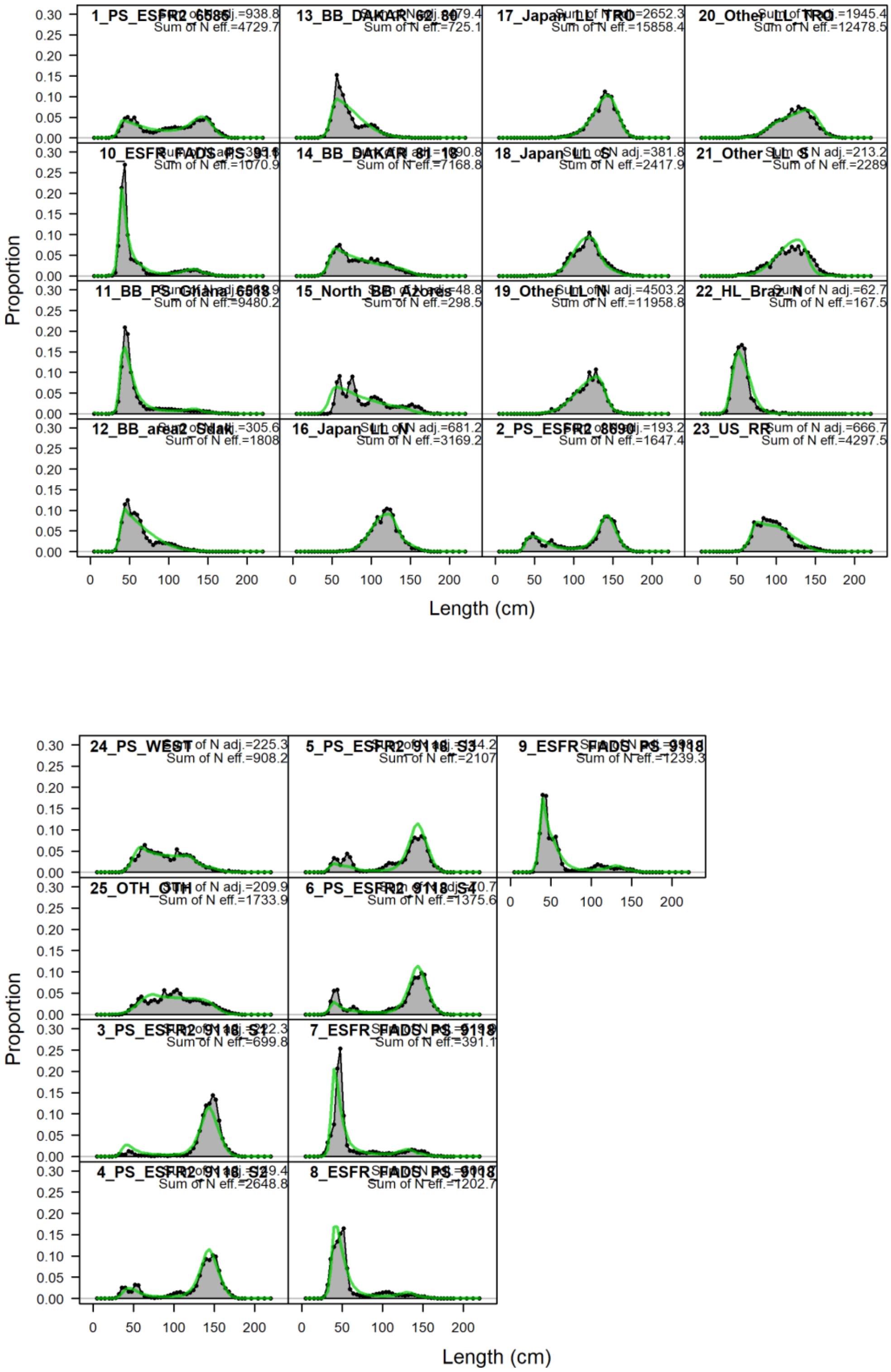


Figure 38. The fits to the length composition, aggregated by fleet for Stock Synthesis Run 2.

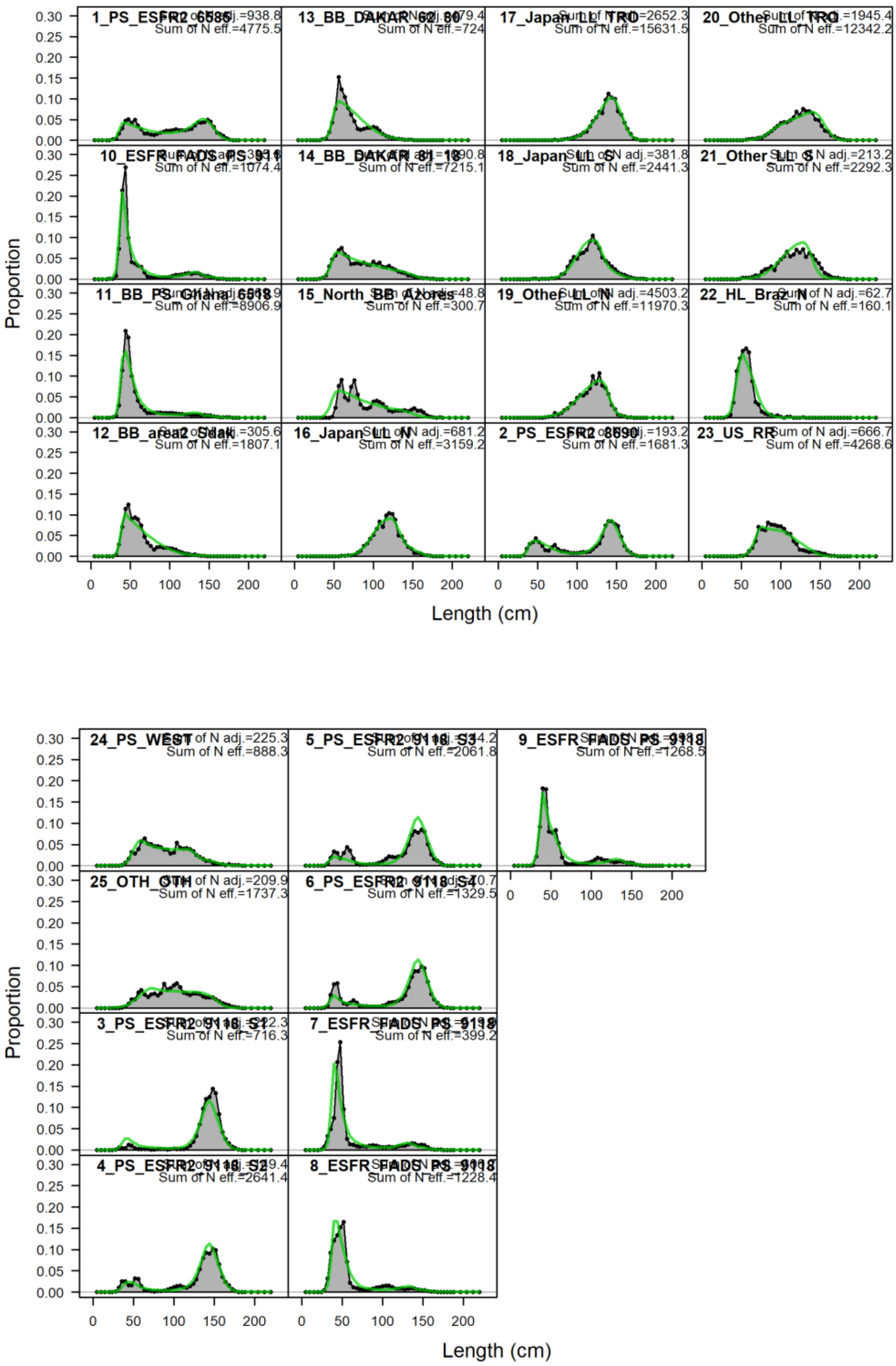


Figure 39. The fits to the length composition, aggregated by fleet for Stock Synthesis Run 3.

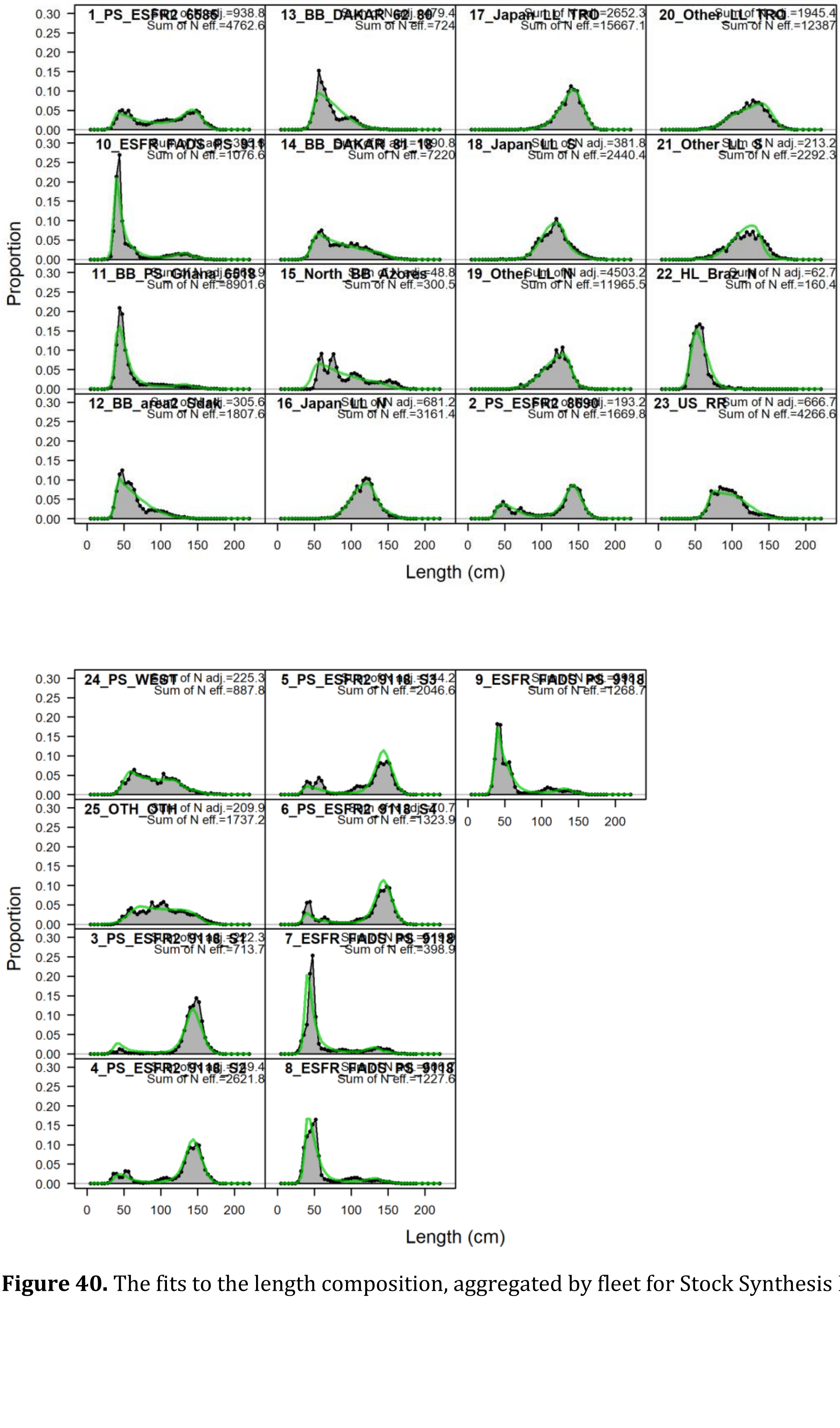


Figure 40. The fits to the length composition, aggregated by fleet for Stock Synthesis Run 4.

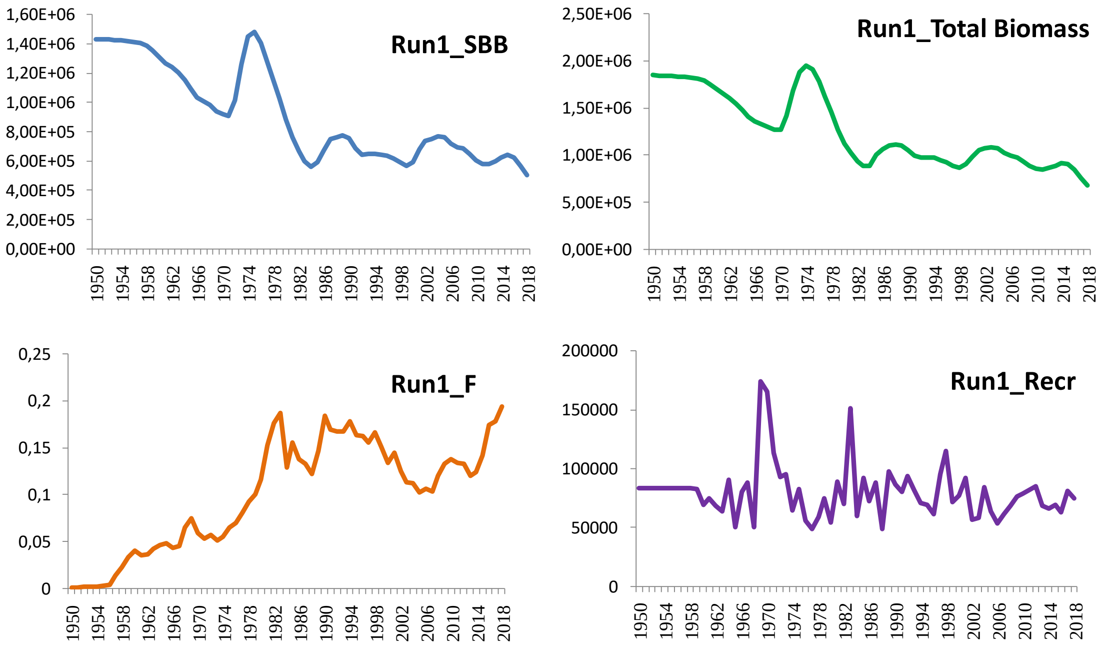


Figure 41. Trends in spawning biomass, total biomass, fishing mortality and recruitment for Stock Synthesis model Run 1.

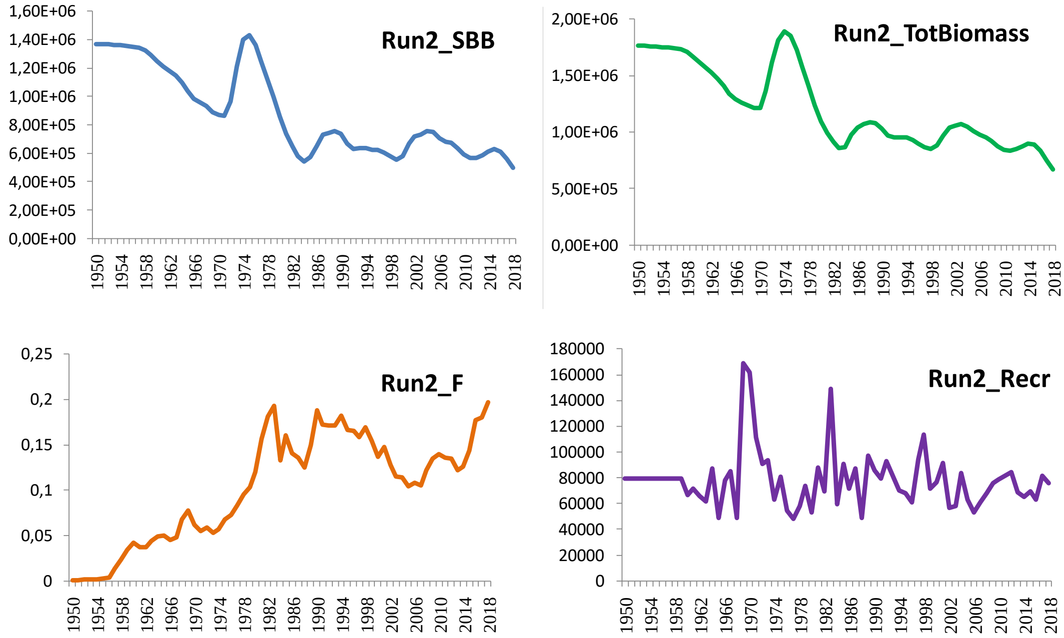


Figure 42. Trends in spawning biomass, total biomass, fishing mortality and recruitment for Stock Synthesis model Run 2.

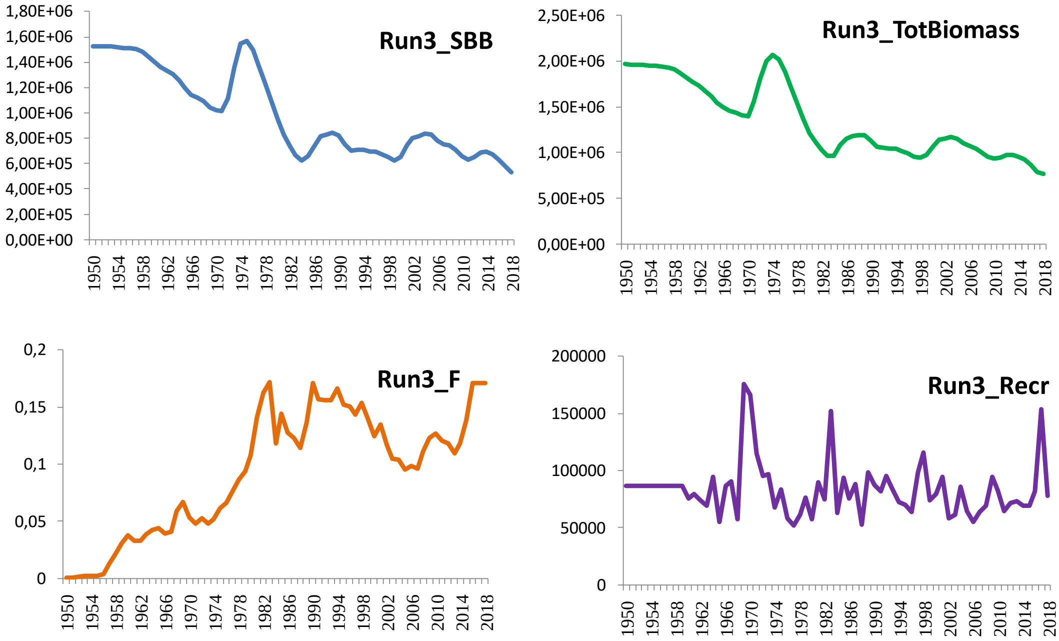


Figure 43. Trends in spawning biomass, total biomass, fishing mortality and recruitment for Stock Synthesis model Run 3.

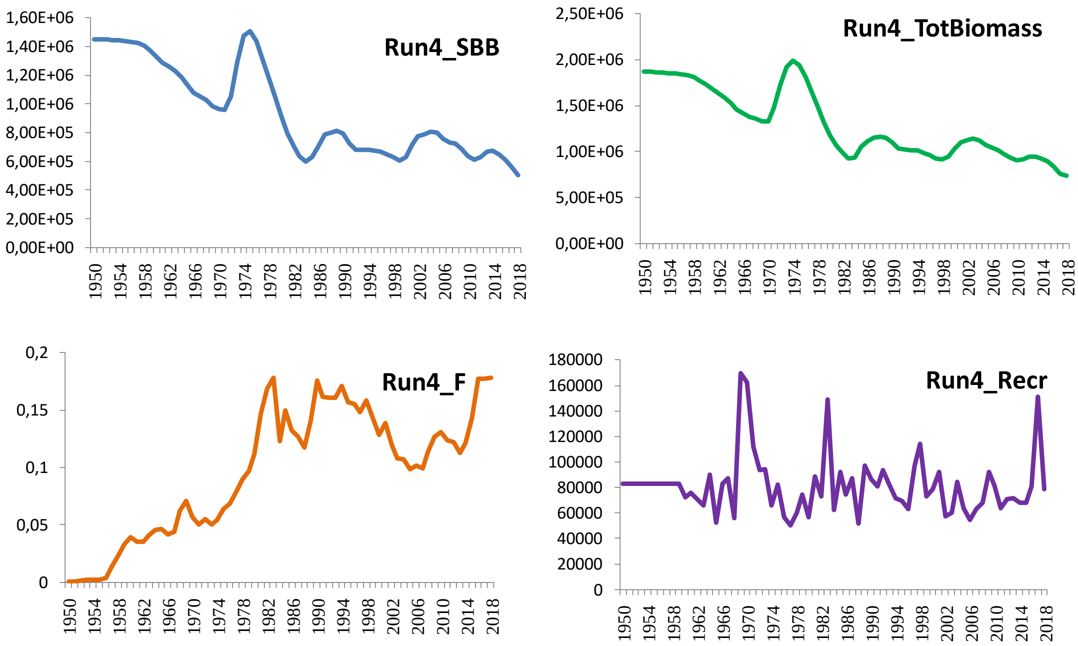


Figure 44. Trends in spawning biomass, total biomass, fishing mortality and recruitment for Stock Synthesis model Run 4

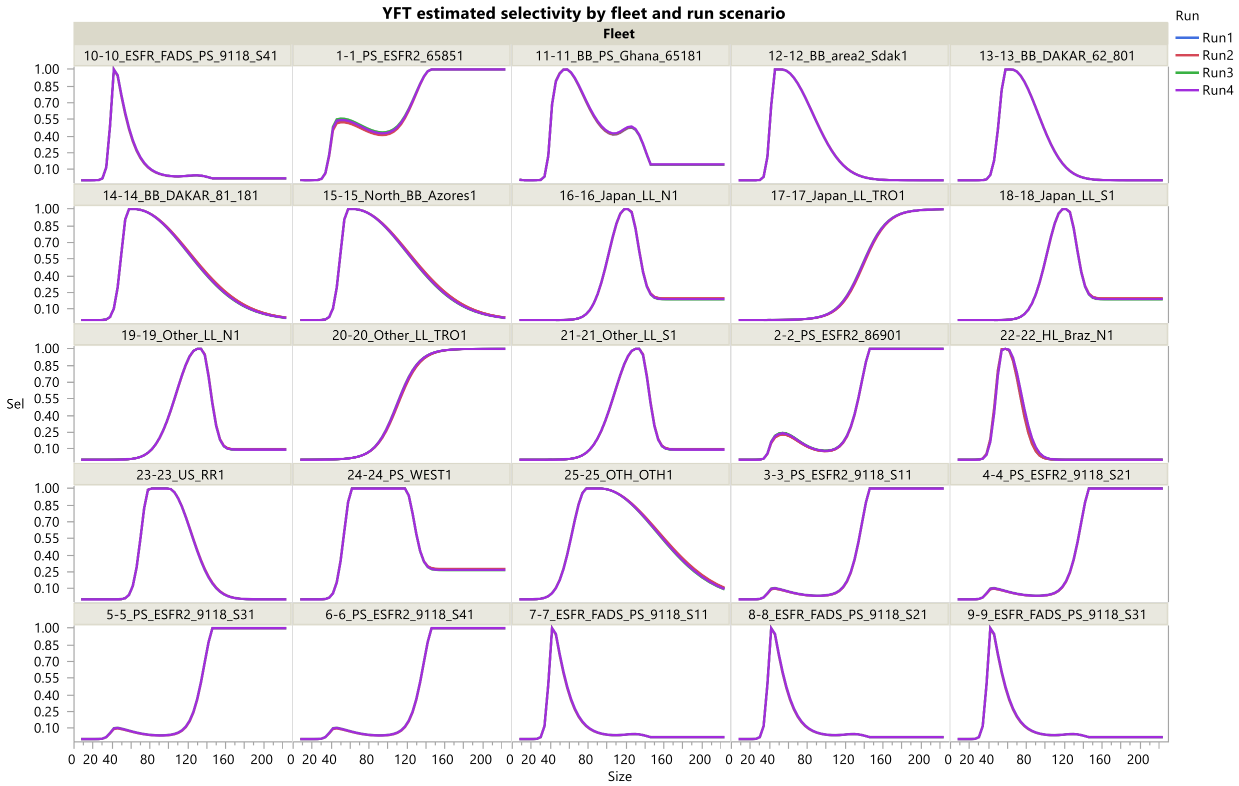
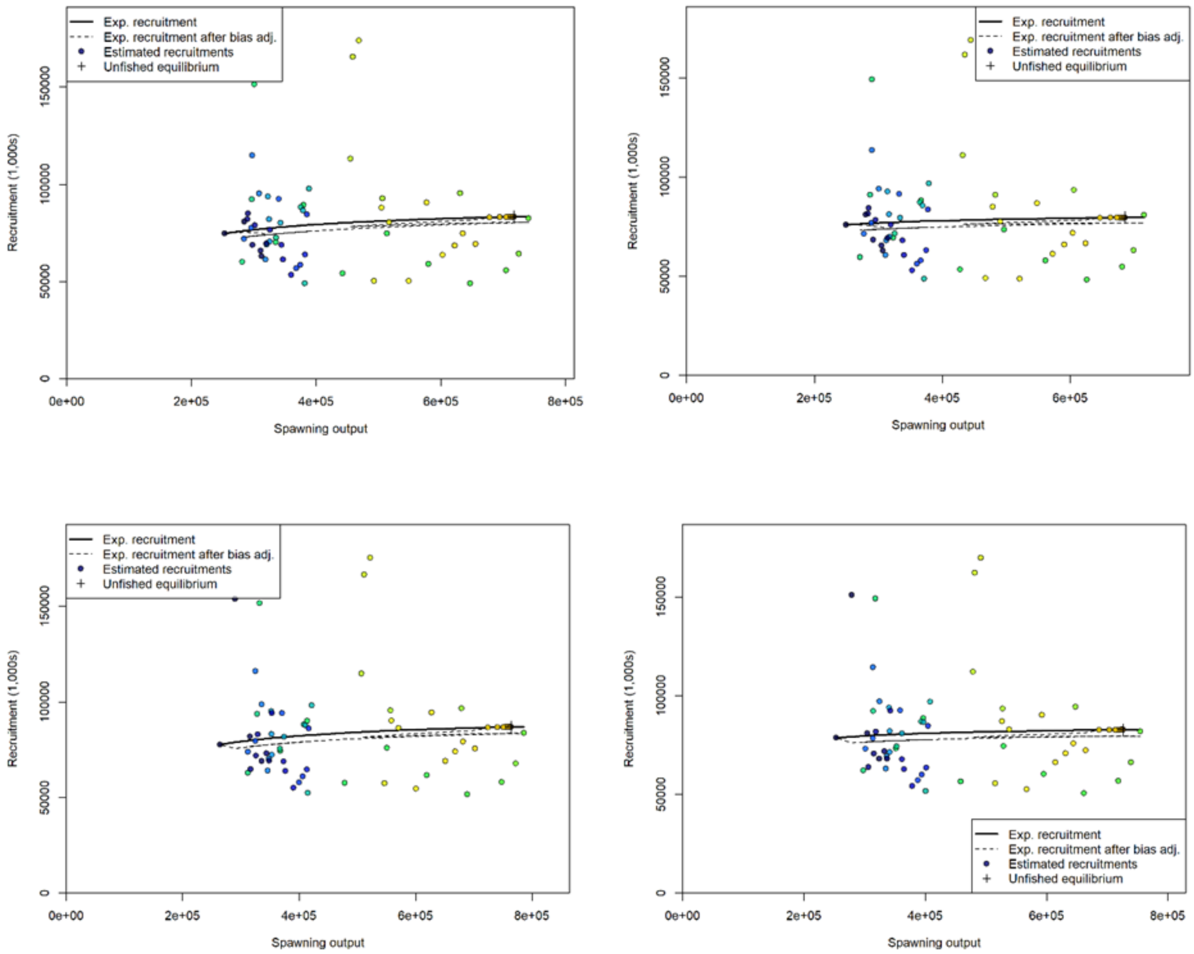


Figure 45. The model estimated selectivity values by fleet ID for the Stock Synthesis runs.

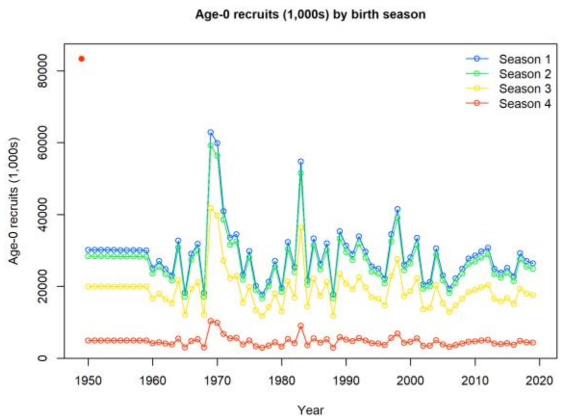
Run 1 Run 2



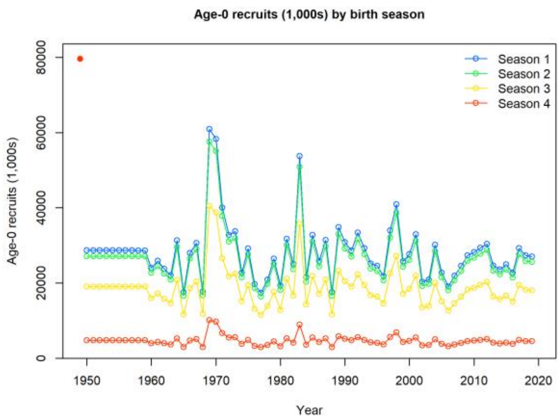
Run 3 Run 4

Figure 46. The estimated stock recruitment relationships showed little evidence of a relationship between SSB and recruits for the Stock Synthesis runs.

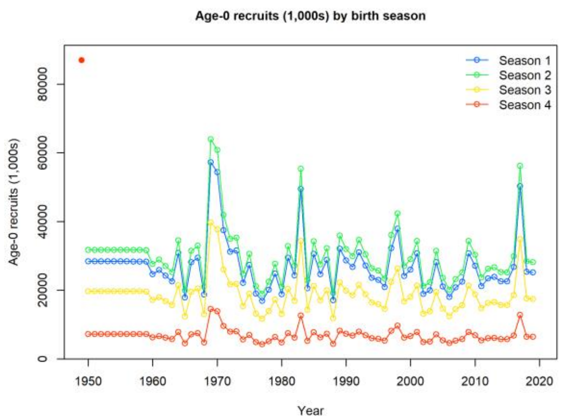
Run 1



Run 2



Run 3



Run 4

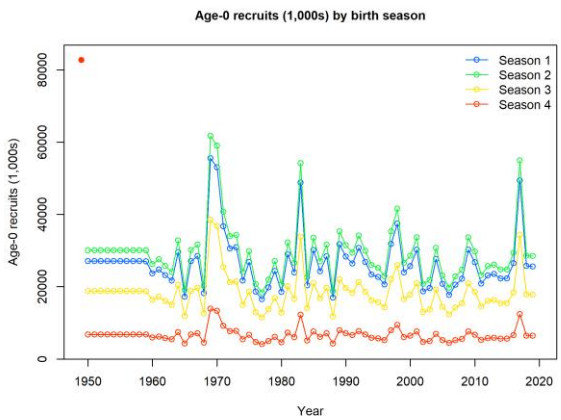
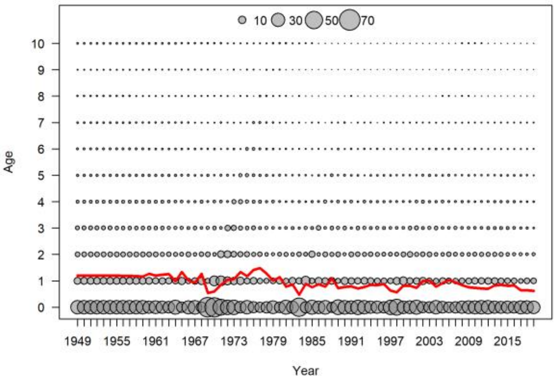
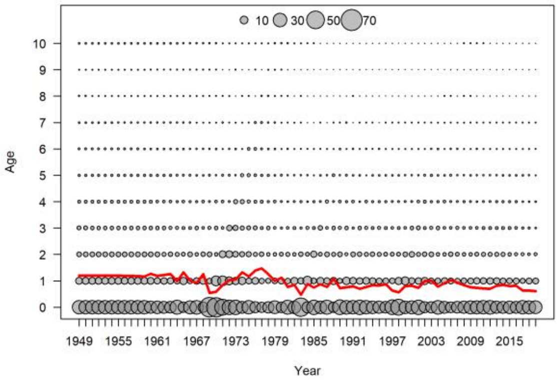


Figure 47. Recruitment by season for the Stock Synthesis runs indicates that the highest fraction of recruits was estimated to be born in seasons 1 and 2 (Jan-June) and the lowest in season 4 (Oct-Dec).

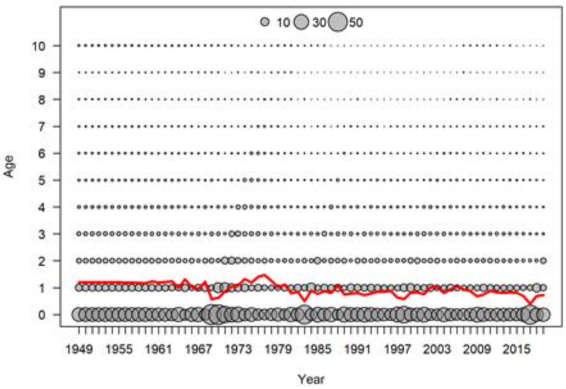
Run 1



Run 2



Run 3



Run 4

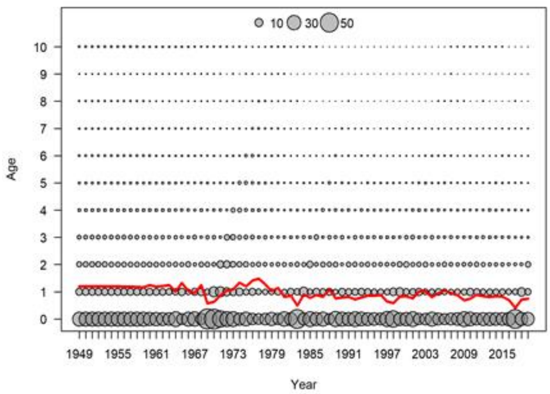
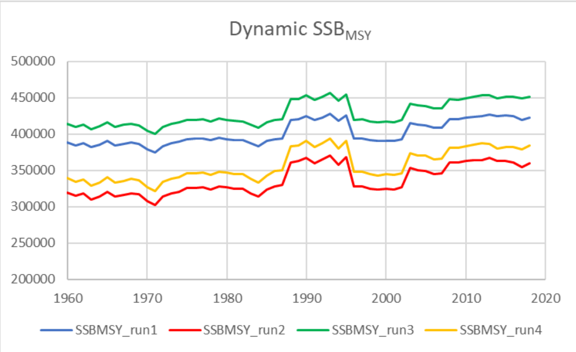
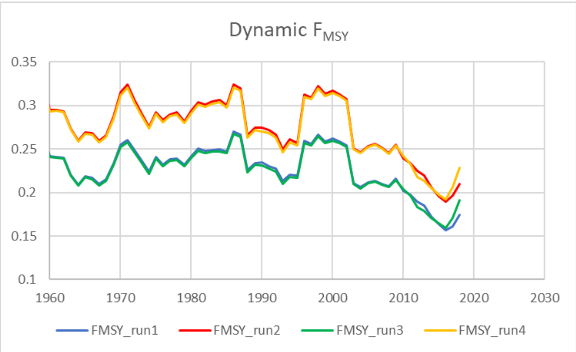


Figure 48. Time series of the numbers at age from Stock Synthesis runs shows little evidence of strong cohort structure and a decline in the mean age in the population over time.





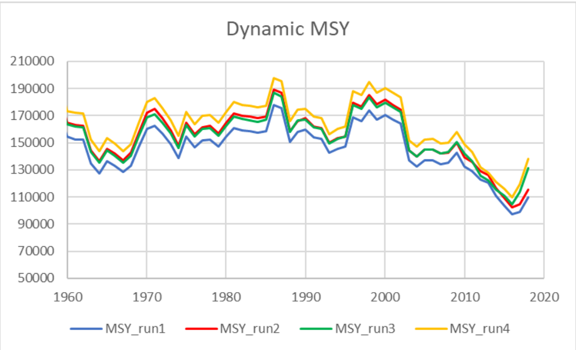
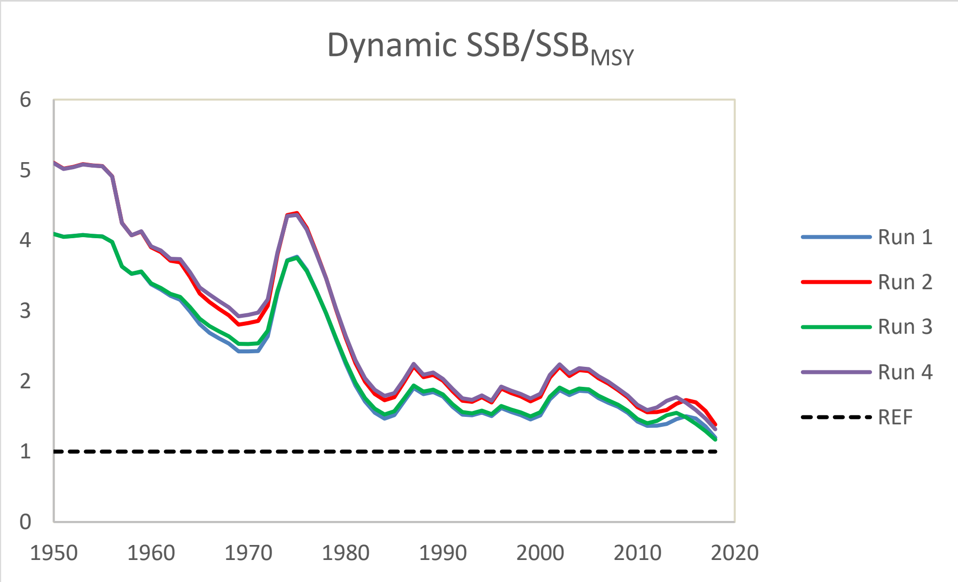


Figure 49. Dynamic SSB_{MSY}, F_{MSY} and MSY for the Stock Synthesis runs.



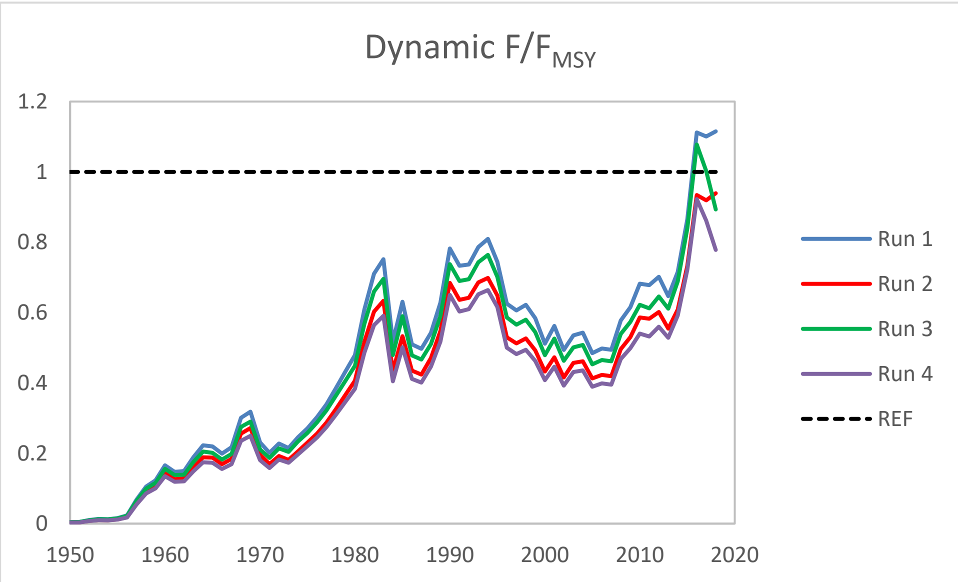


Figure 50. The dynamic SSB/SSBMSY and F/FMSY for the Stock Synthesis runs.

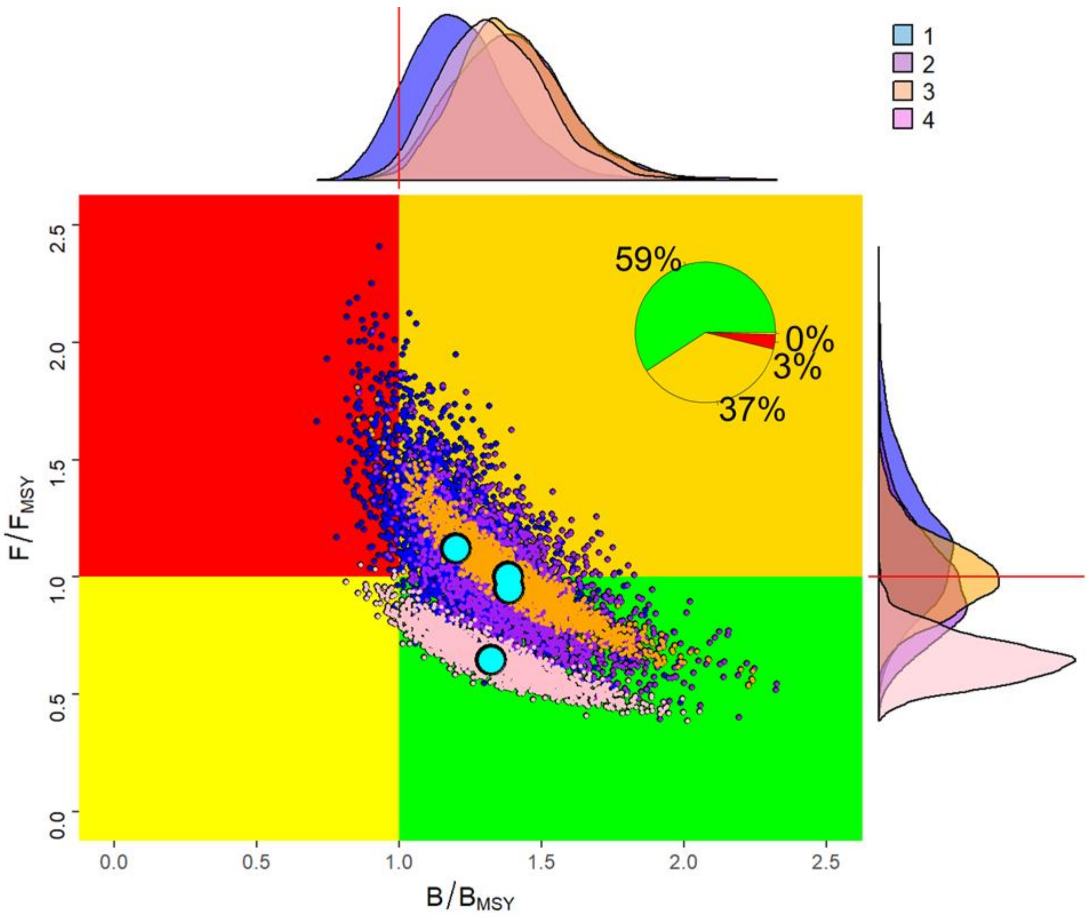


Figure 51. Estimates for 2018 biomass and fishing mortality relative to B_{MSY} and F_{MSY} using 2500 MVN iterations from the Stock Synthesis runs for Atlantic yellowfin stock.

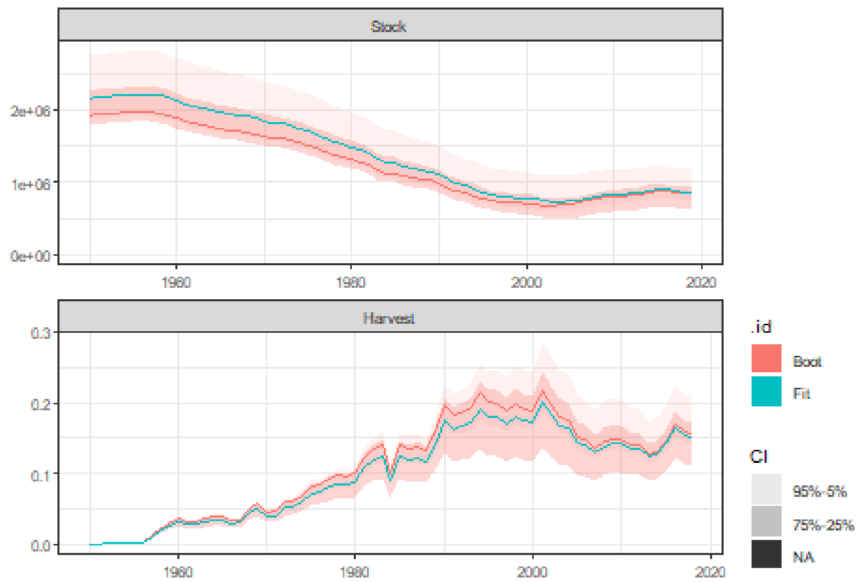


Figure 52. Trajectories of biomass (t) and F for the Atlantic yellowfin tuna Reference Case from MPB. Green and red lines show the model fit and the median of 500 bootstrapped iterations, respectively. The shade areas represent the 95% confidence interval.

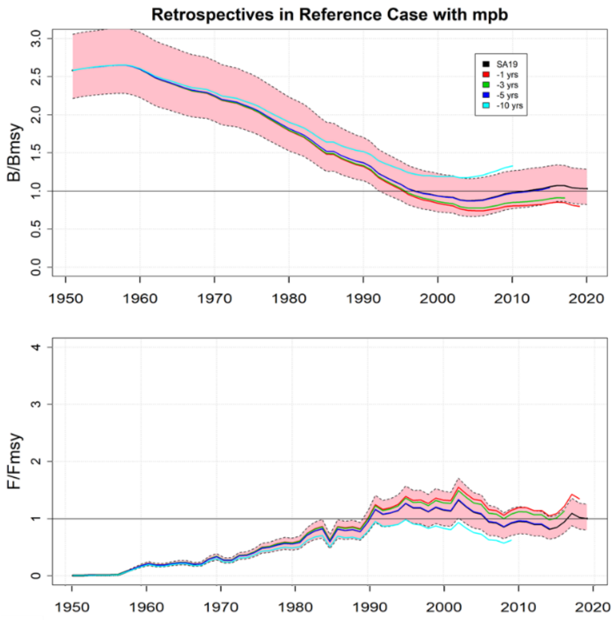


Figure 53. Retrospective analysis. Trajectories of B/B_{MSY} and F/F_{MSY} from the Atlantic yellowfin tuna for the Reference Case and retrospective analysis. Black, red, green, blue, and skyblue lines show the Reference Case, retrospective -1, -3, -5, and -10 years, respectively. The shade areas represent the 95% confidence interval.

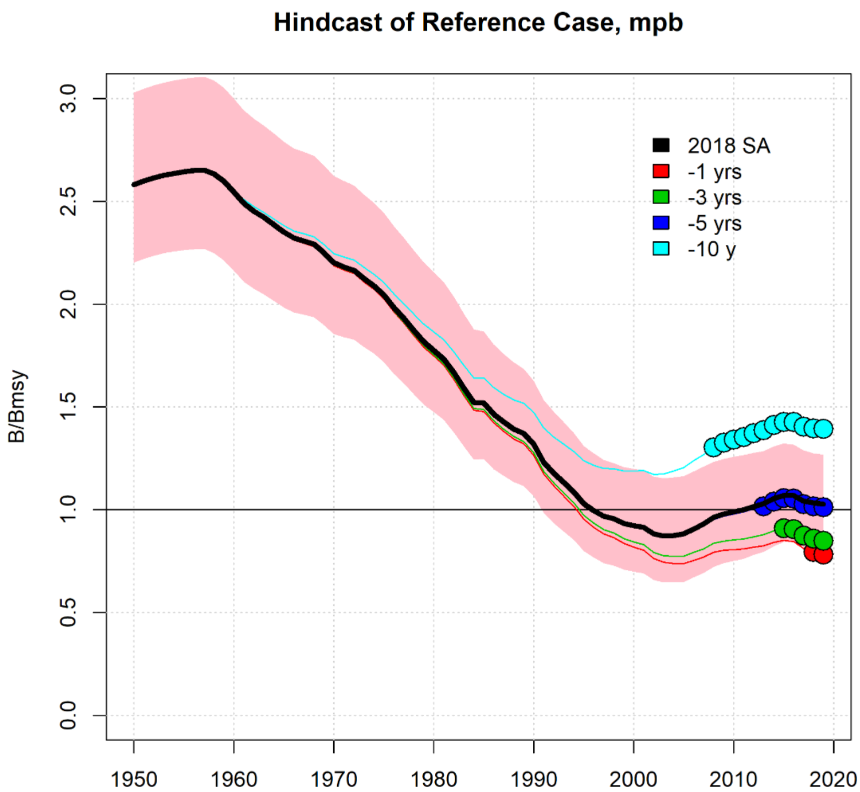


Figure 54. Forward projection of relative biomass from the retrospective runs for the MPB model compare to the reference case (2018 SA, terminal year of stock assessment) including the 80% confidence bounds (shade area).

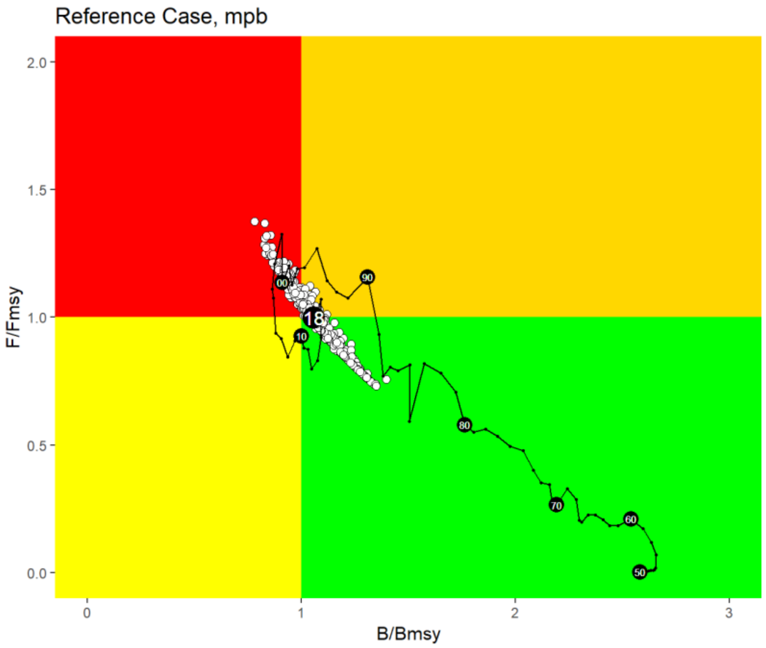


Figure 55. Estimated median historical trend of Atlantic yellowfin stock using the MPB-Reference Case (black line). 500 bootstraps for 2018 of biomass and fishing mortality relative to B_{MSY} and F_{MSY}. Top-right panel: Estimated probabilities of the stock in 2018 being in each of the Kobe plot quadrants estimated from the 500 bootstrapped iterations.

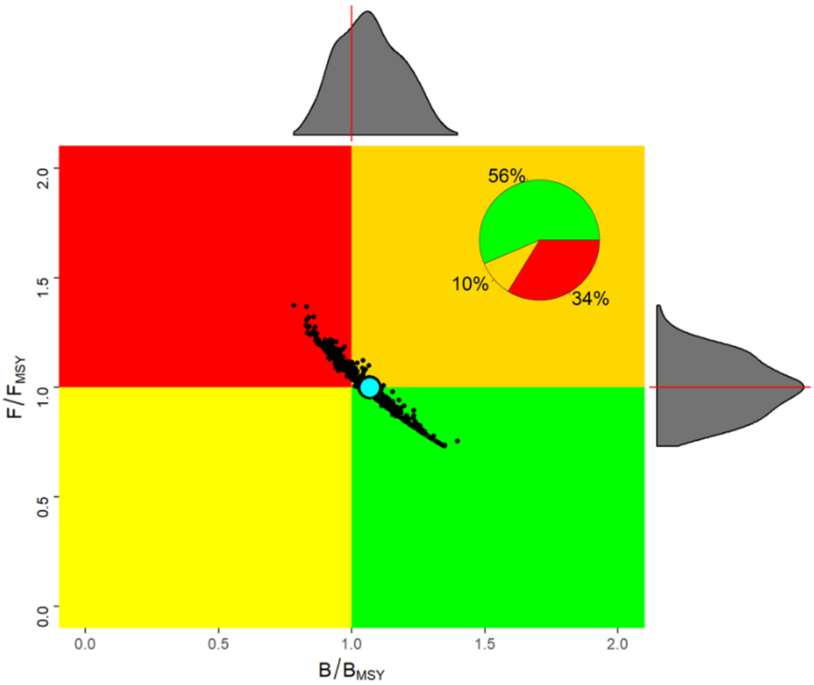


Figure 56. Estimated for 2018 biomass and fishing mortality relative to B_{MSY} and F_{MSY} using 500 bootstrapped iterations from MPB for Atlantic yellowfin stock showing the marginal density of the estimates.

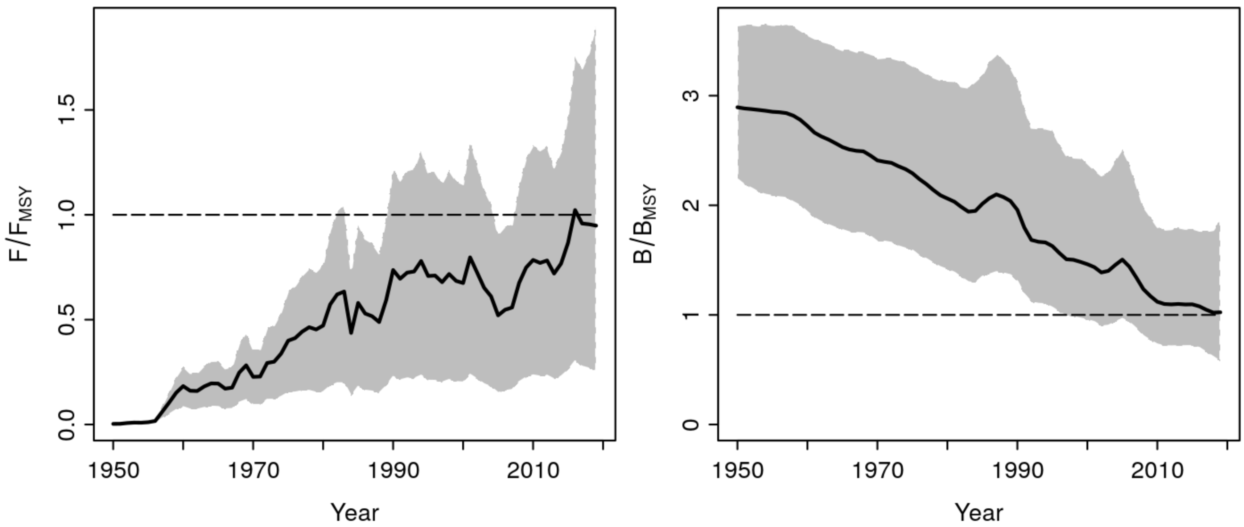


Figure 57. Trajectories of B/BMSY and F/FMSY predicted from posteriors from the JABBA Reference Base Case for Atlantic yellowfin stock. Grey shade areas represent the 95% credibility interval.

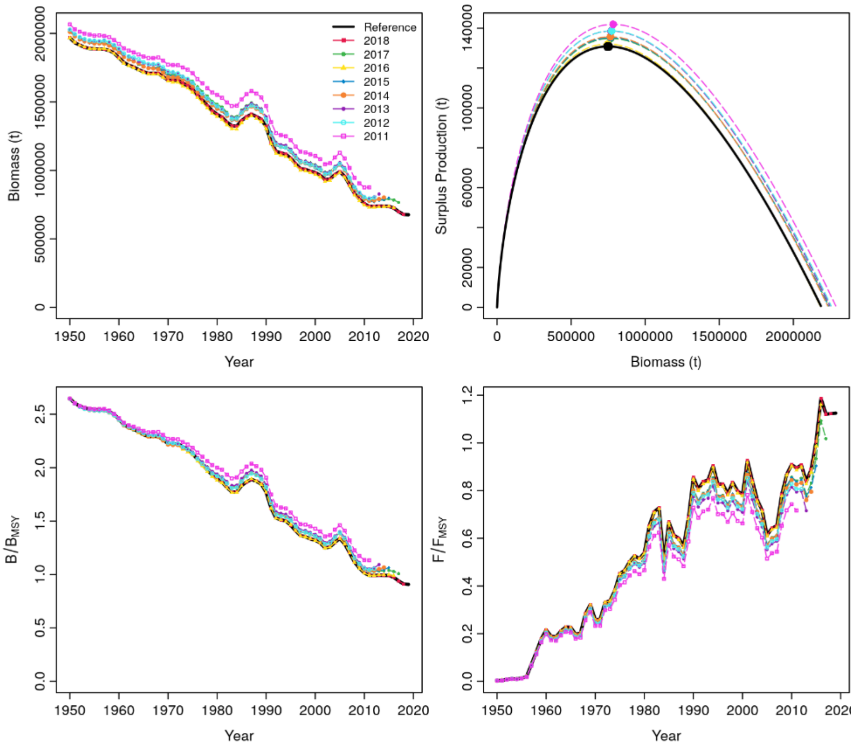


Figure 58. Retrospective analysis for stock biomass (t), surplus production function (maximum = MSY), B/BMSY and F/FMSY shown for the JABBA Reference Base Case. The label "Reference" indicates the model fits and associated 95% CIs. The numeric year label indicates the retrospective results, sequentially excluding CPUE data back to 2011.

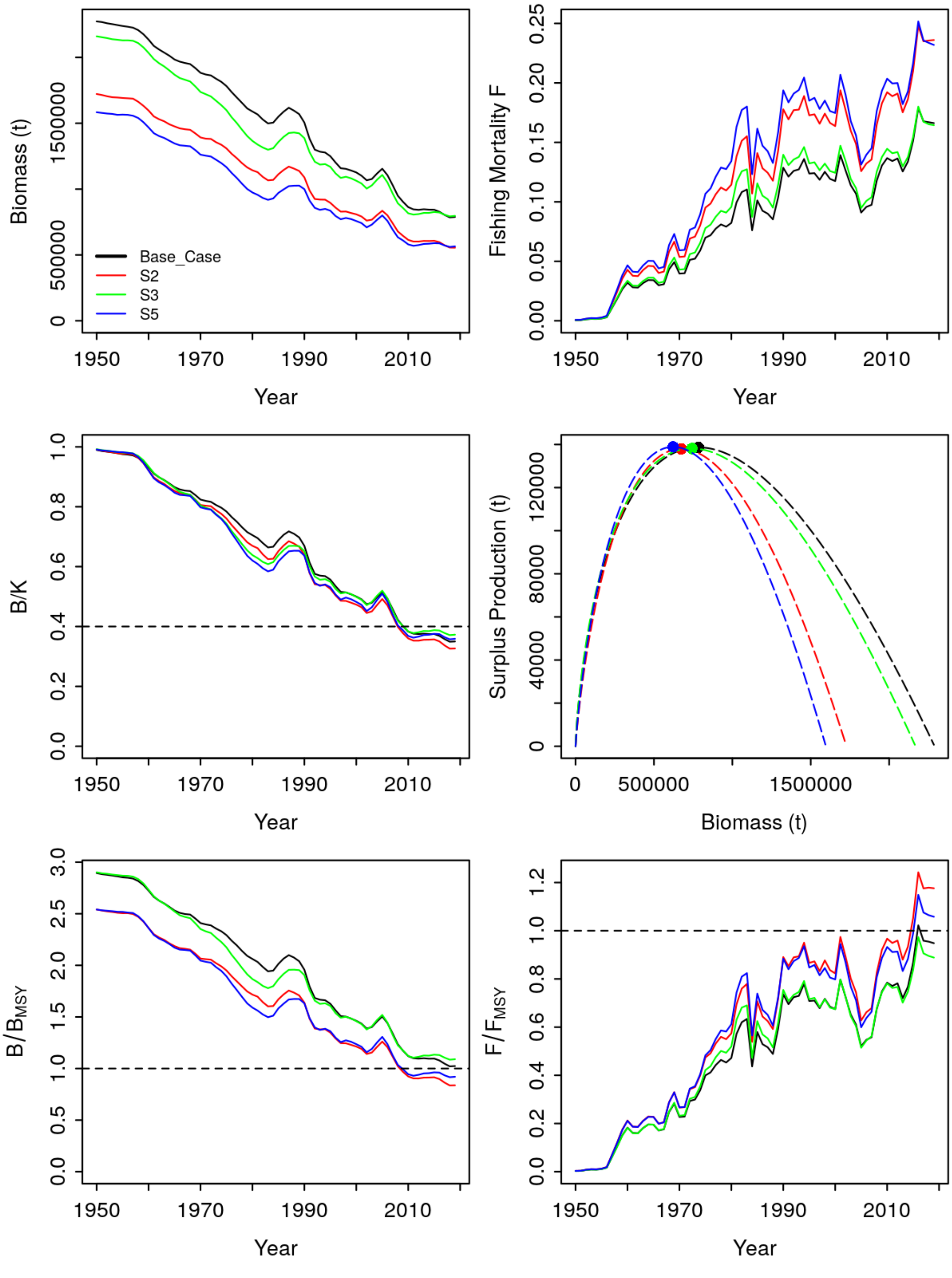


Figure 59. Trends in biomass and fishing mortality (upper panels), biomass relative to K (B/K) and surplus production curve (middle panels) and biomass relative to B_{MSY} (B/B_{MSY}) and fishing mortality relative to F_{MSY} (F/F_{MSY}) (bottom panels) for each scenario from the JABBA Reference Base Case (black), S2 (red), S3 (green), and S5 (blue) for Atlantic yellowfin tuna.

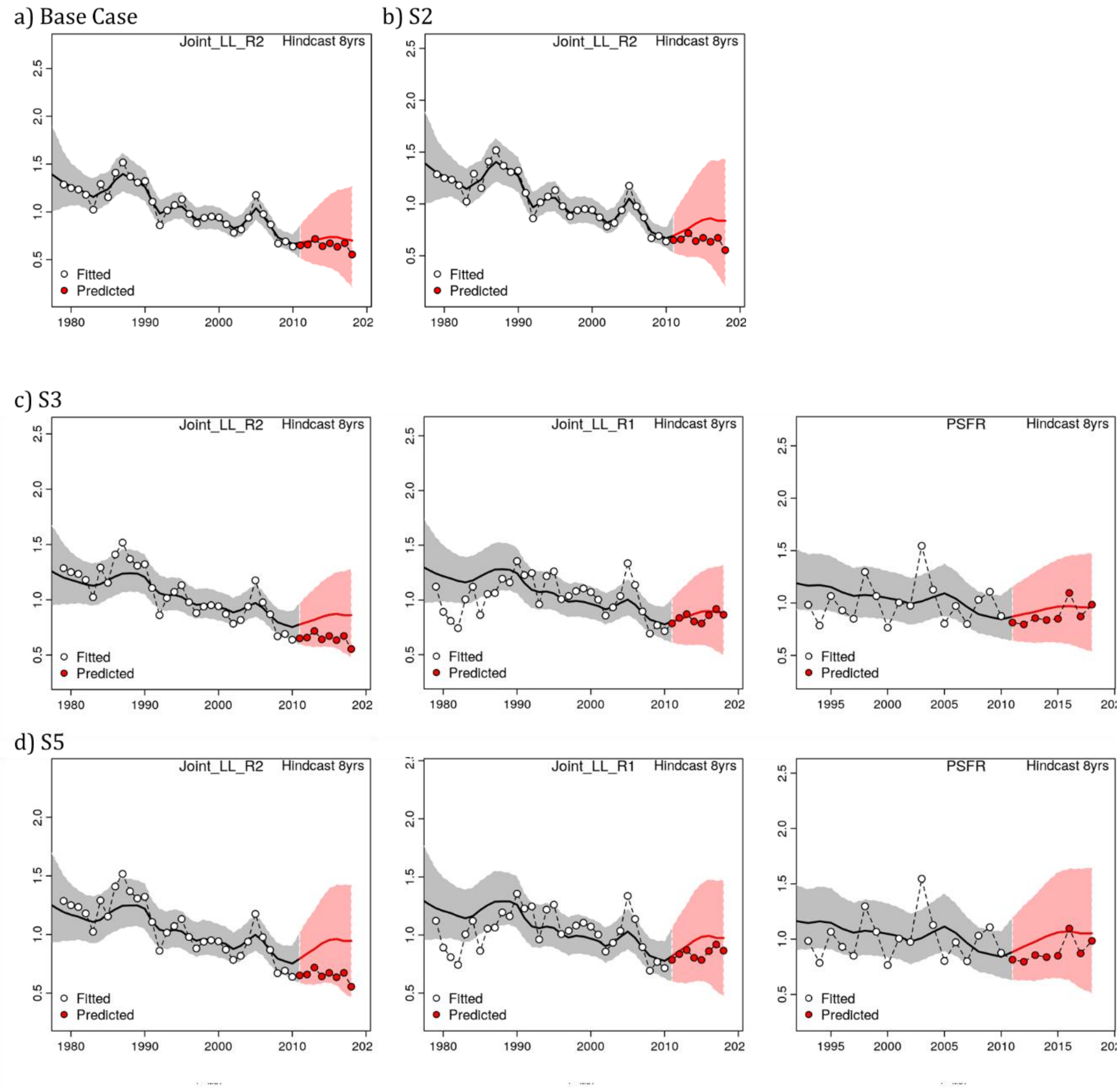


Figure 60. The predicted abundance indices for (none fitted) hindcasting periods of 8 years fitted for the four JABBA Reference Cases (a: Base Case, b: S2, c: S3, and d: S5) for Atlantic yellowfin stock. Predicted mean CPUE and 95%CIs are denoted by black lines with grey shaded area and red lines with red shaded areas for the fitted and hindcasting years, respectively.

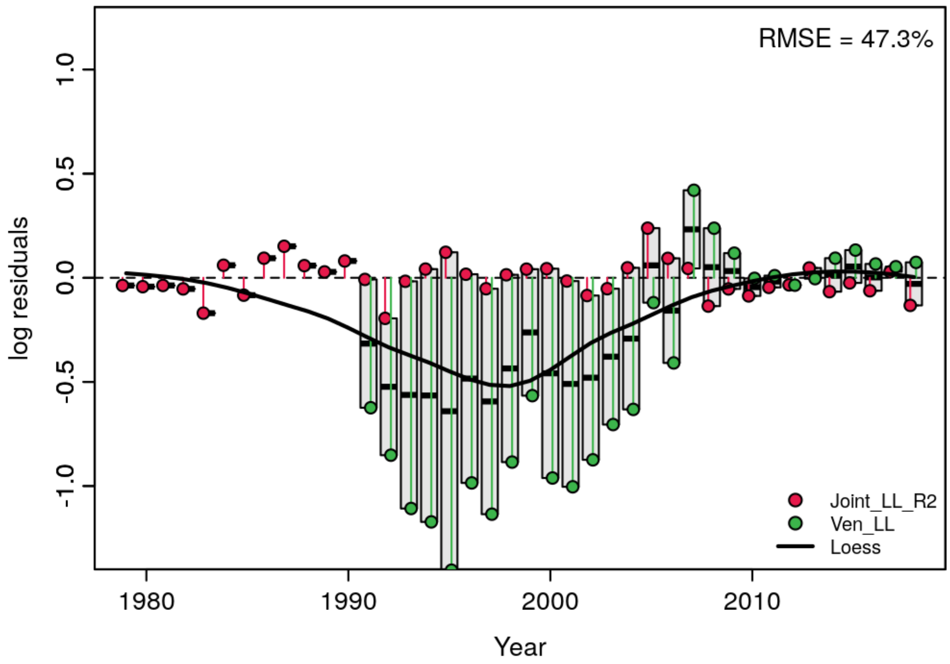


Figure 61. JABBA residual diagnostic plots for sensitivity analysis of Venezuelan longline index examined for each scenario for Atlantic yellowfin tuna. Boxplots indicate the median and quantiles of all residuals available for any given year, and solid black lines indicate a loess smoother through all residuals.

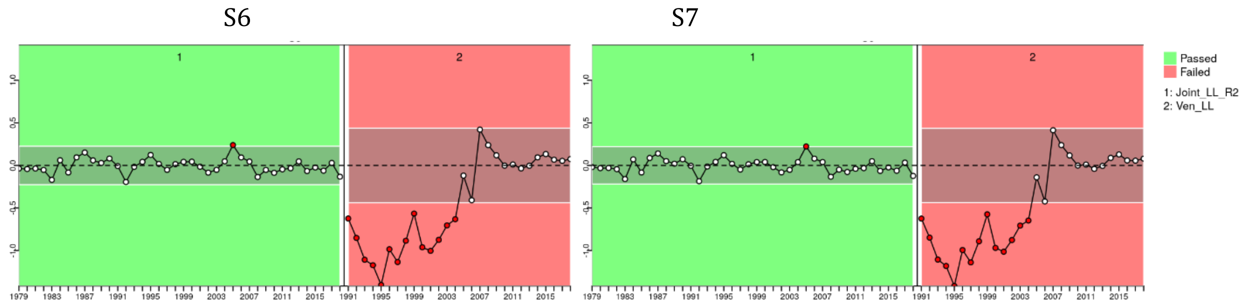


Figure 62. Runs tests to quantitatively evaluate the diagnostic test of randomness for the time series of CPUE residuals by fleet for each scenario. Red panels indicate the lack of randomness for the time-series residuals ($p<0.05$) while green panels indicate the opposite. The inner shaded area shows three standard errors from the overall mean and red circles identify a specific year with residuals greater than this threshold value (3x sigma rule).

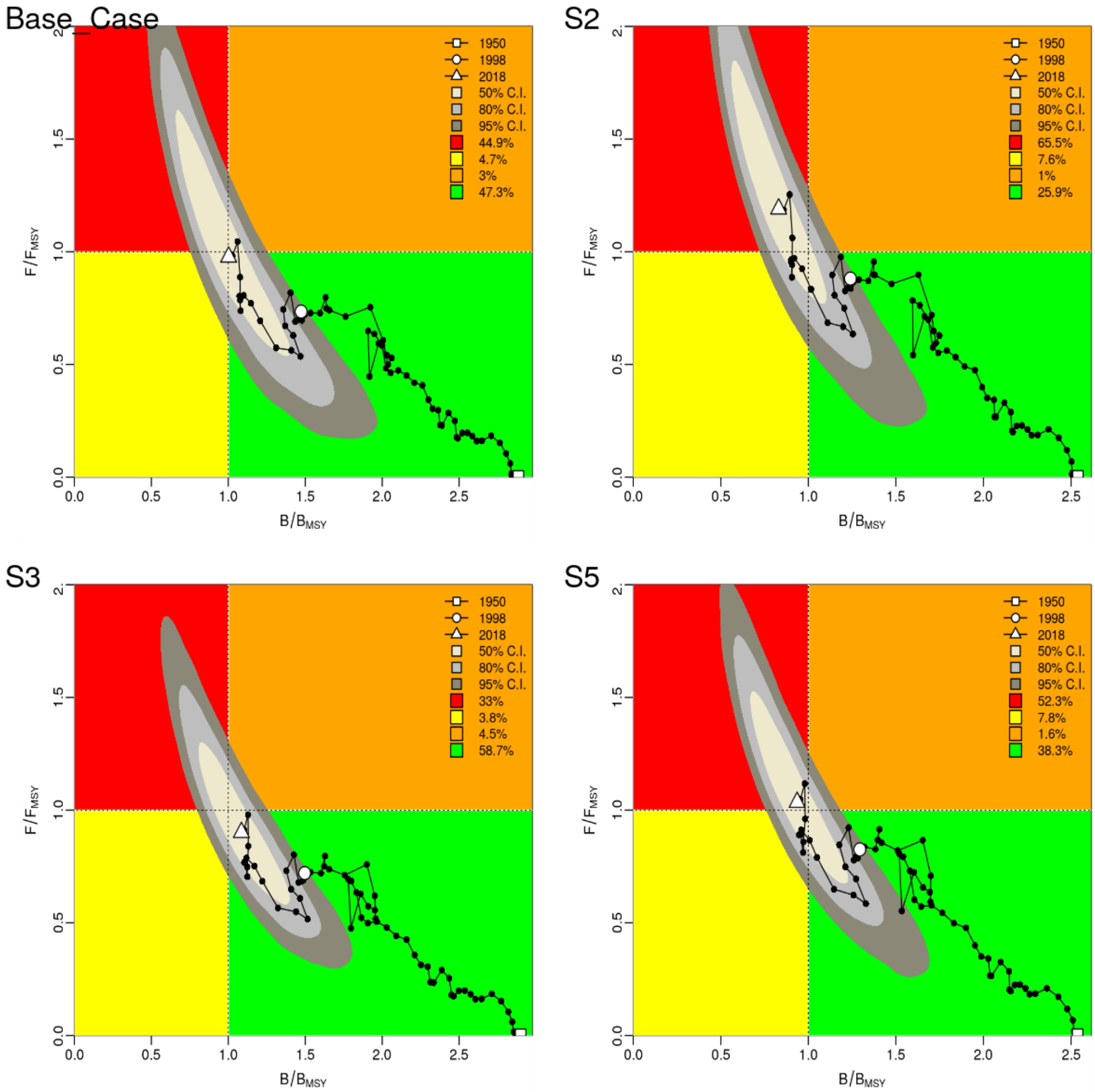


Figure 63. Kobe phase plot of B/B_{MSY} and F/F_{MSY} for the terminal assessment year 2018 for Atlantic yellowfin stock from each JABBA Reference Case (Base Case, S2, S3, and S5) showing the marginal density of the estimates from 10000 MCMC iterations. The probability of the terminal year points falling within each quadrant is indicated in the figure legend.

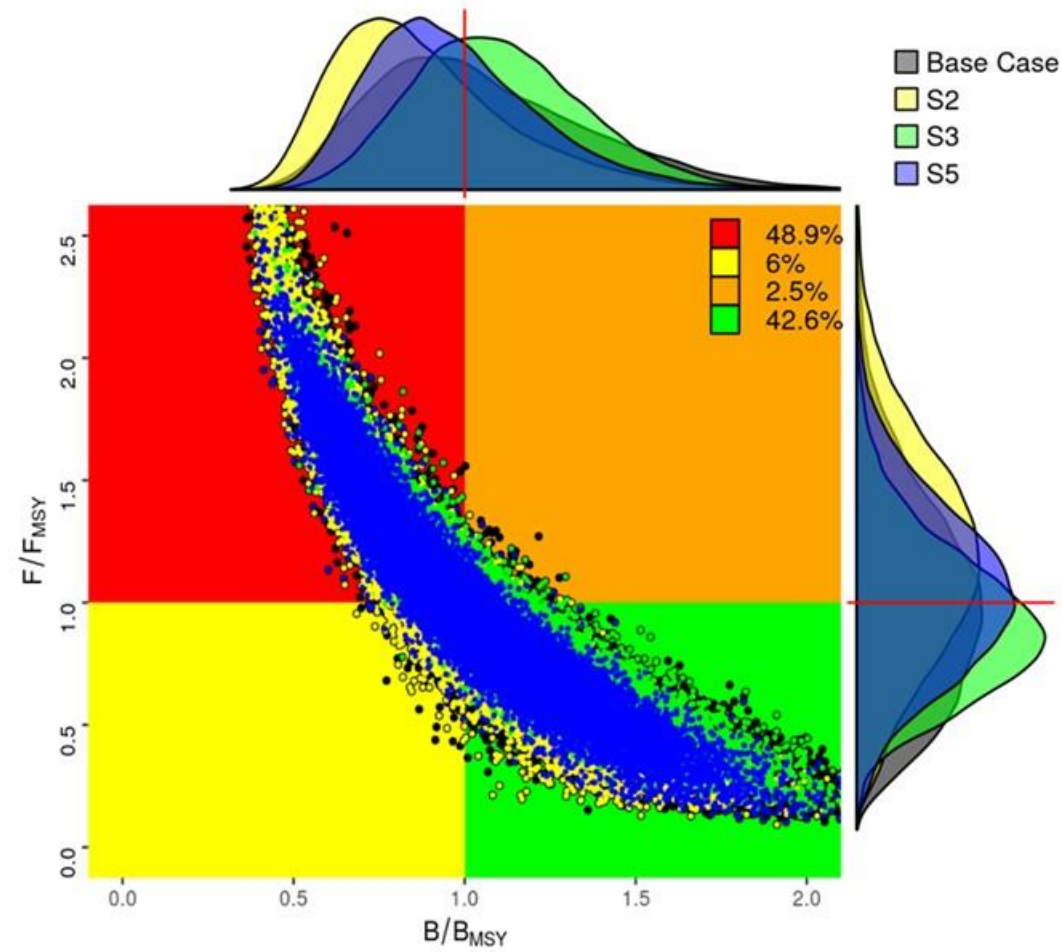


Figure 64. Combined Kobe phase plot of B/B_{MSY} and F/F_{MSY} for the terminal assessment year 2018 for Atlantic yellowfin stock from the JABBA all Reference Cases (gray: Base Case, yellow: S2, green: S3, and blue: S5) showing the marginal density of the estimates from 10000 MCMC iterations in each model. The probability of the terminal year points falling within each quadrant is indicated in the figure legend.

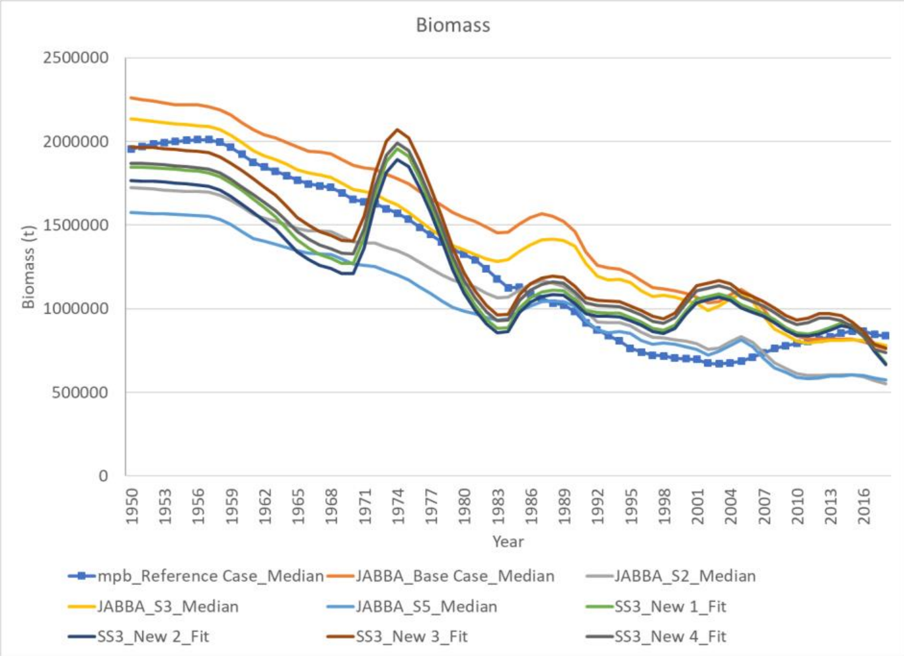


Figure 65: Estimates of total biomass obtained for all model runs used to develop the management advice.

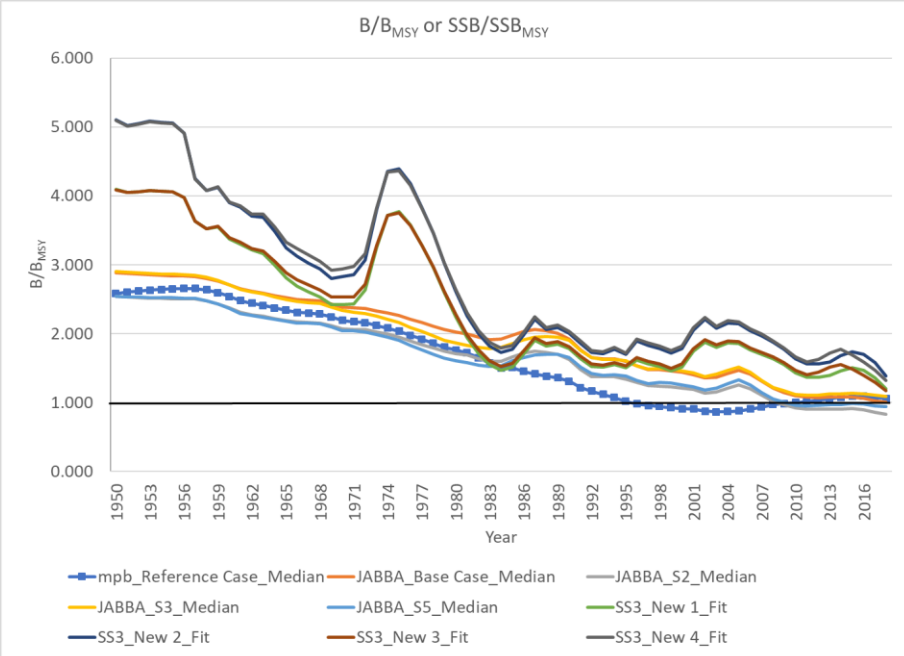


Figure 66. Estimates of relative Biomass B/Bmsy obtained for all model runs used to develop the management advice.

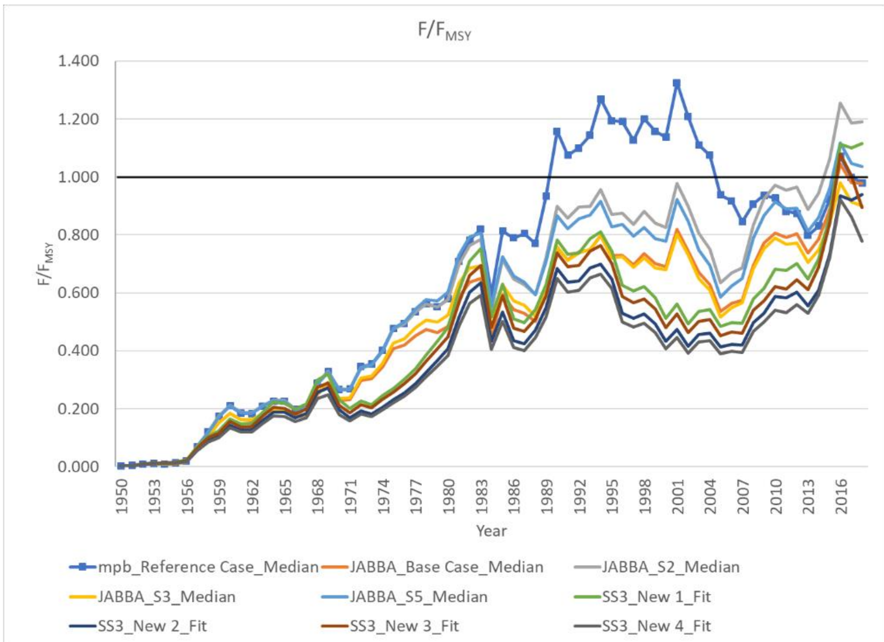


Figure 67. Estimates of relative fishing mortality F/F_{MSY} obtained for all model runs used to develop the management advice.

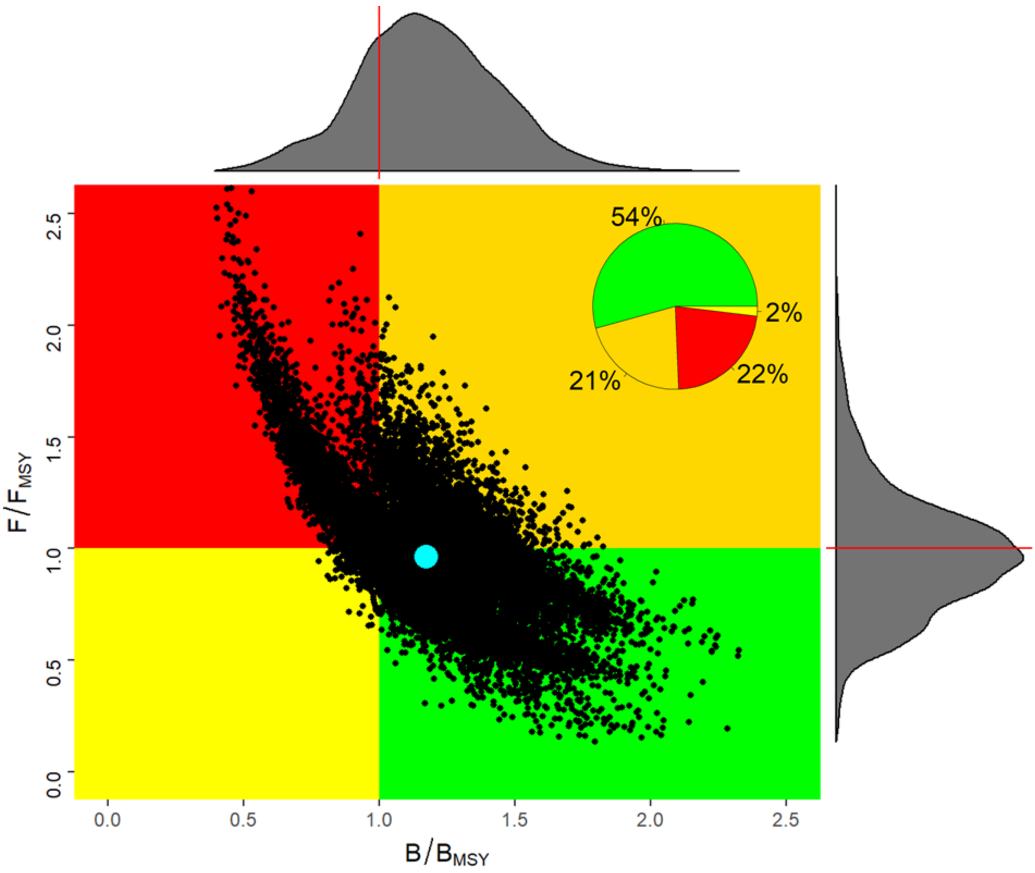


Figure 68. Kobe plot estimated from the combination of stock synthesis, JABBA and MPB model runs chosen to develop the management advice.

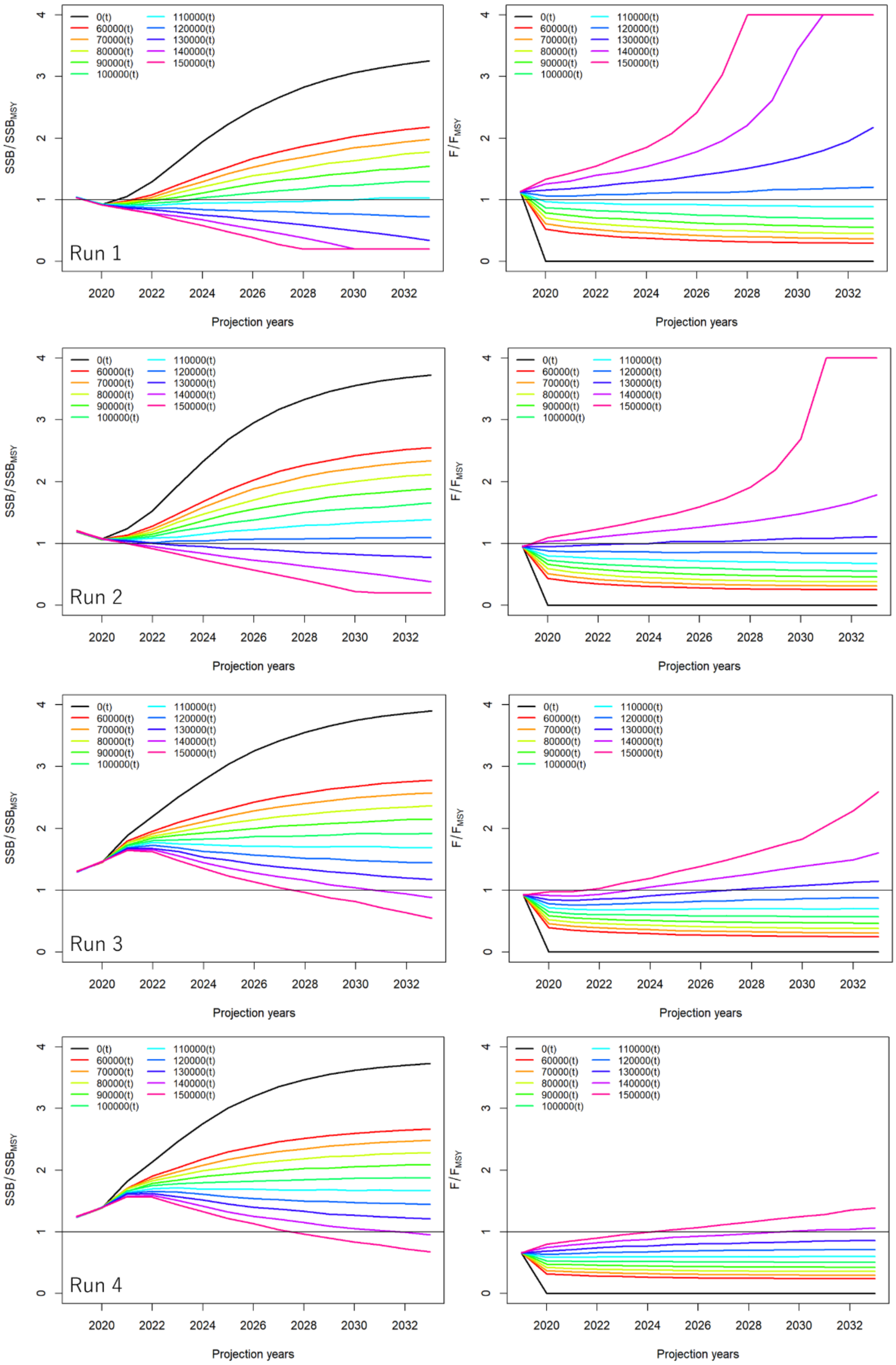


Figure 69. Trends of projected relative biomass (left panel, B/B_{MSY}) and fishing mortality (right panel, F/F_{MSY}) of Atlantic yellowfin stock under different TAC scenarios (0, 60000 – 150000 t) from SS3 uncertainty grid runs (Run 1, Run 2, Run 3, and Run 4). Each line represents the median of 10000 MVN iterations by projection year.

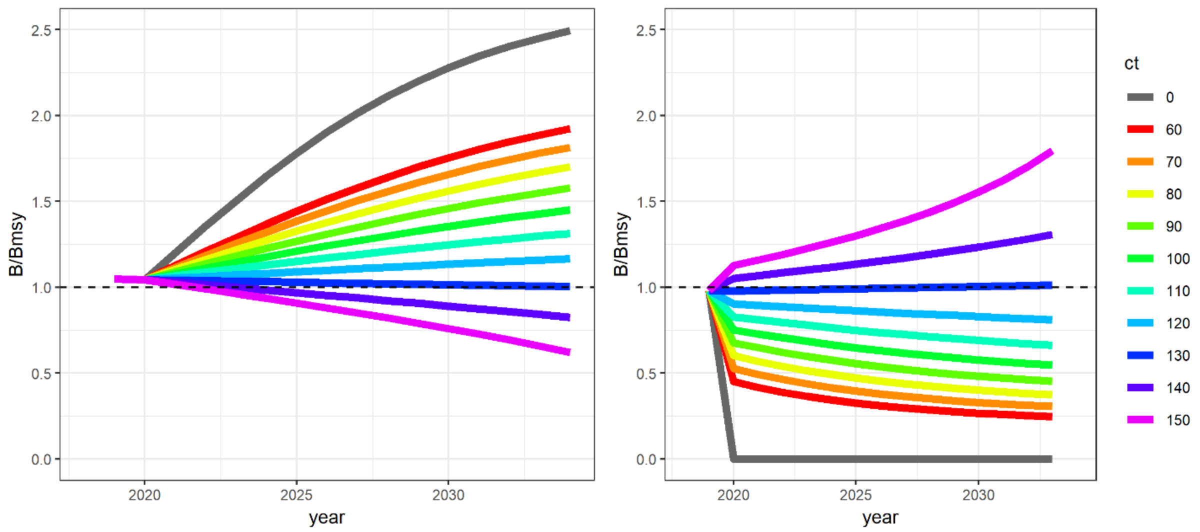


Figure 70. Trends of projected relative biomass (left panel, B/B_{MSY}) and fishing mortality (right panel, F/F_{MSY}) of Atlantic yellowfin stock under different TAC scenarios (0, 60,000 – 150,000 t) from MPB Reference Case. Each line represents the median of 500 bootstrap iterations by projected year.

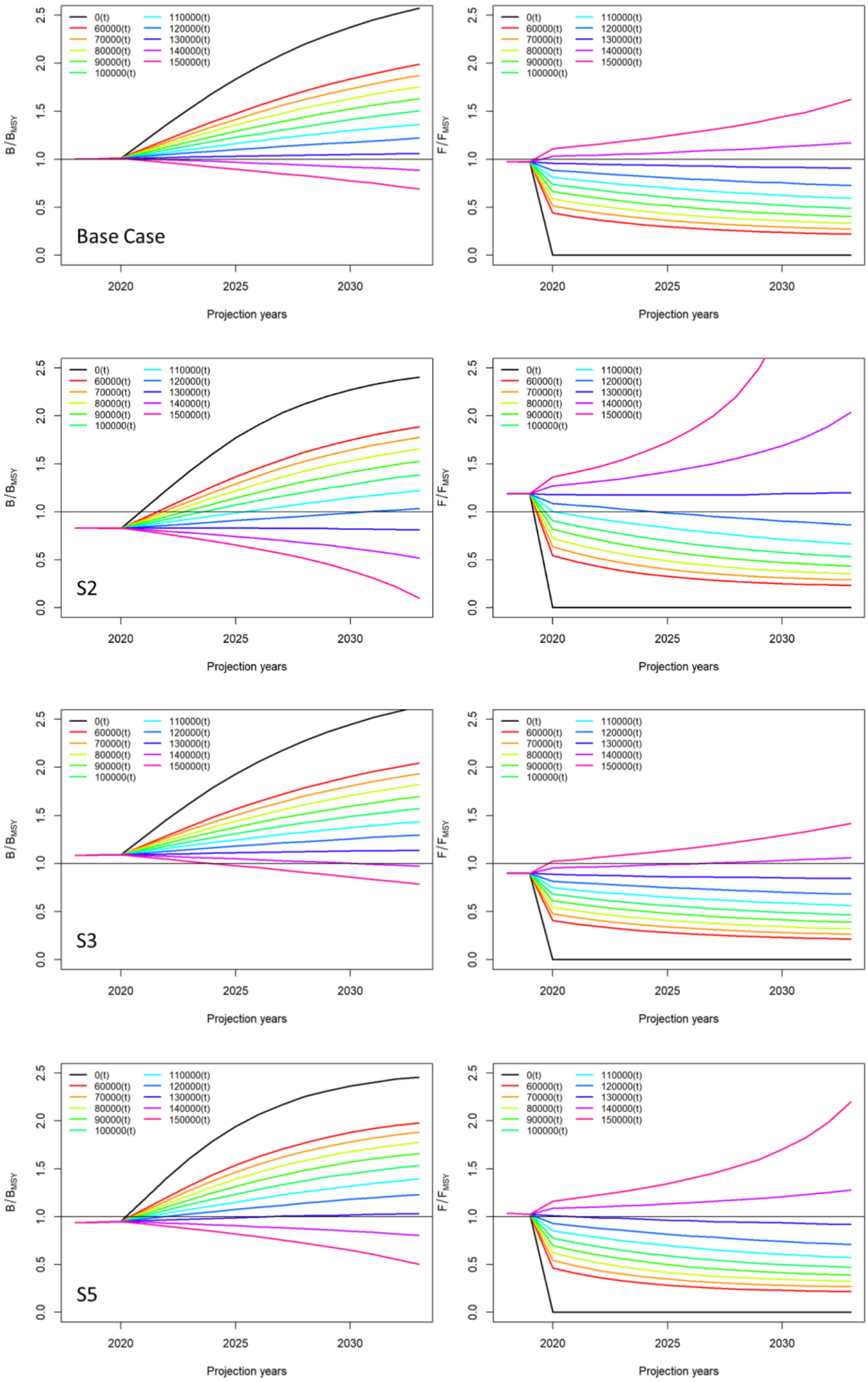


Figure 71. Trends of projected relative biomass (left panel, B/B_{MSY}) and fishing mortality (right panel, F/F_{MSY}) of Atlantic yellowfin stock under different TAC scenarios (0, 60,000 – 150,000 t) from JABBA Reference Cases (Base Case, S2, S3, and S5). Each line represents the median of 36000 MCMC iterations by projected year.

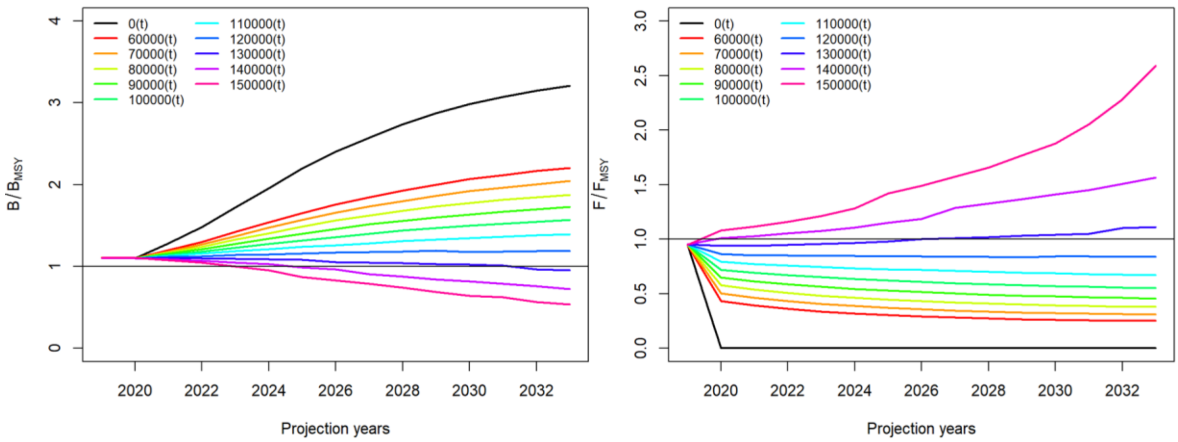


Figure 72. Trends of projected relative biomass (left panel, B/B$_{MSY}$) and fishing mortality (right panel, F/FMSY) of Atlantic yellowfin stock under different TAC scenarios (0, 60000 – 150000 t) from JABBA, MPB, and SS3 using 9 runs (JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1-4)). Each line represents the median of 20000 iterations by projected year. <u>This result was used to develop the management advice of Atlantic YFT stock.</u>

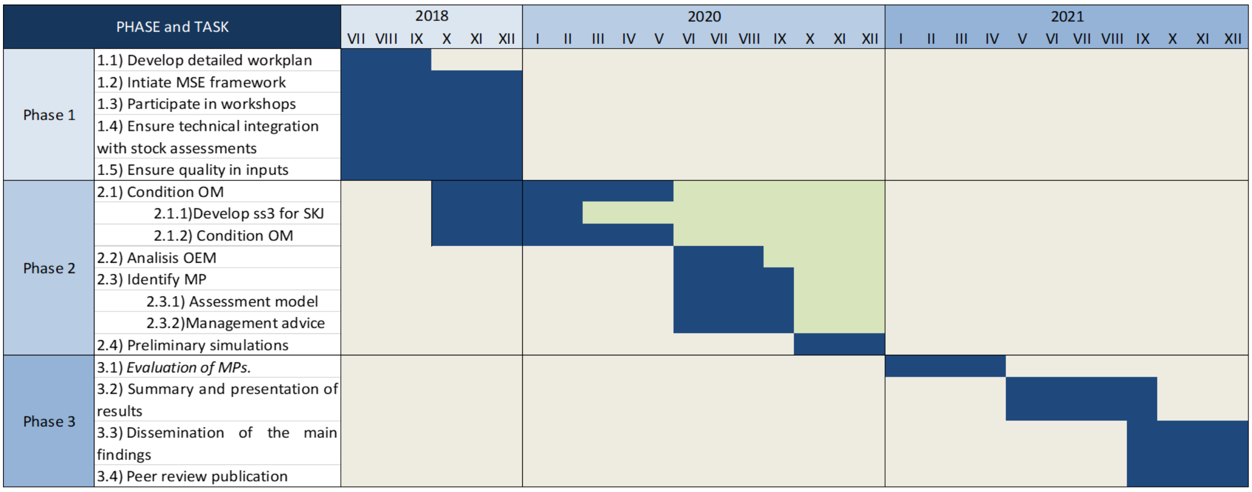


Figure 73. Calendar and list of activities proposed for phase two and three for the research project in support of the MSE for tropical tunas

Appendix 1

Agenda

1. Opening, adoption of Agenda and meeting arrangements

2. Summary of available data for assessment
   2.1 Biology
   2.2 Catch, effort, size and CAS estimates
   2.3 Relative Abundance estimates

3. Stocks Assessment Methods and other data relevant to the assessment
   3.1 Stock Synthesis
   3.2 Surplus production model MPB
   3.3 Bayesian Surplus Production Models

4. Stock status results
   4.1 Stock Synthesis
   4.2 Surplus production model MPB
   43 Bayesian Surplus Production Models
   4.4 Synthesis of assessment results

5. Projections

   5.1 Projections JABBA
   5.2 Projections MPB
   5.3 Projections Stock Synthesis
   5.4 Kobe matrix for yellowfin tuna [to be adopted by correspondence Sep 2, 2019]

6. Recommendations
   6.1 Research and statistics
   6.2 Management

7. Other matters

8. Adoption of the report and closure

Appendix 2

List of Participants

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Appendix 3

List of Papers and Presentations

Reference	*Title*	*Authors*
SCRS/2019/011	Report of the Yellowfin tuna stock assessment session	Anon.
SCRS/2019/100	Datos estadísticos de la pesquería de túnidos de las Islas Canarias durante el periodo 1975 a 2018	Delgado R.
SCRS/2019/107	Using effort control measures to implement catch capacity limits in ICCAT PS fisheries: an update	Sharma R., and Herrera M.
SCRS/2019/115	Stock assessment for Atlantic yellowfin using a biomass production model	Merino G., Murua H., Urtizberea A., Santiago J., Andonegi E., and Winker H.
SCRS/2019/120	Regional abundance indices of yellowfin tuna (*Thunnus albacares*) inferred from data based on the Taiwanese distant-water longline fishery in the Atlantic Ocean	Sung YF., Lin WR., Su NJ., and Lu YS.
SCRS/2019/121	Stock synthesis model for Atlantic yellowfin tuna	Walter J., Urtizberea A., Hiroki Y., Satoh K., Ortiz M., Kimoto K, and Matsumoto T.
SCRS/2019/122	Standardization of yellowfin tuna CPUE in the Atlantic Ocean by the Japanese longline fishery which includes cluster analysis	Matsumoto T., Yokoi H., and Hoyle S.
SCRS/2019/123	Standardized catch rates for yellowfin tuna (*Thunnus albacares*) from the Venezuelan pelagic longline fishery in the Caribbean Sea and adjacent waters of the western central Atlantic for the period of 1991-2018.	Narvaez M., Alarcon J., Evaristo E., Gutierrez X., and Arocha F.
SCRS/2019/124	Estimation of Ghana tasks I and II purse seine and baitboat catch 2012 – 2018: data input 2019 yellowfin stock assessment	Ortiz M., Palma C., Ayivi S., and Bannerman P.
SCRS/2019/125	Atlantic Yellowfin tuna stock assessment: an implementation of Bayesian state-space surplus production model using JABBA	Sant'Ana R., Mourato B., Kimoto A., Walter J., and Winker H.

Reference	Title Presentation	Authors
SCRS/P/2019/037	Age Estimates of Yellowfin Tuna Caught near Ascension Island	Downes K., Pacicco A., and Ailloud L.
SCRS/P/2019/039	Catch, effort, size and weight of yellowfin tuna (*Thunnus albacares*) from the Venezuelan purse seine and baitboat fleets operating in the Caribbean Sea and the western central Atlantic	Narváez M., Alarcón J., Evaristo, E., Marcano J., and Arocha F.
SCRS/P/2019/043	Diagnostics for stock synthesis model SS3	Yokoi H., Satoh K., Walter J., and Matsumoto T.

Appendix 4

SCRS Document and Presentations Abstracts as provided by the authors

SCRS/2019/100. - This document presents a summary of the development and current composition of the Canary Islands baitboat fleet and the catches made between 1975 and 2018. This paper also presents size histograms of the different species caught in 2018 and the average between 2013 and 2017. An estimate of fishing effort was made, differentiating between vessels lesser than and greater than 50 GRT, taking into account that the former (vessels less than 50 GRT) carry out daily trips, with an average of 9 hours at sea, whereas the latter carry out trips lasting more than a day.

SCRS/2019/107 - Total Allowable Catches (TAC's) have been implemented for numerous stocks by ICCAT. However, catch controls, while ensuring that overall fishing mortalities are not exceeded, are not implemented properly because some ICCAT CPCs exceed targets on a regular basis or are not covered by the measures. This is an issue in multi-species fisheries where monitoring of catch in near-real time is complex, especially for industrial tuna purse seine and pole-and-line fisheries, that very often catch juvenile yellowfin tuna and bigeye tuna when targeting skipjack tuna, as those species tend to aggregate forming mixed schools. Also, discards of tropical tunas are usually not reported to the ICCAT and may be important in industrial purse seine and longline fisheries. In other multi-species fisheries, the adoption of measures on one stock may prompt changes of target to other stocks, with a potential to undermine the status of those, -e.g. longline fisheries changing gear configuration, purse seine fisheries shifting from free-school to associated sets, or the contrary, and multi-gear fisheries moving from a gear targeting a stock (pole-and-line targeting skipjack tuna) to another (handline targeting yellowfin tuna).

We examined the historic data series of catch and effort for the Purse seine fleet on tropical tuna in the Atlantic Ocean. Based on the information numerous models were developed to predict how much would be caught at a particular effort target. While these catch targets may vary by time and area, the implementation of time-area closures by the ICCAT has not been successful, mostly due to effort redistribution and catches in areas outside the closure making up for the catch reduction expected from it or an unwanted increase in the catches of other stocks (ICCAT 2016). The purpose of this study is to explore how full seasonal closures (monthly measures), where vessels remain in port, may better assist surface fisheries in achieving the targets set by the ICCAT. We developed a model based on parameter estimates of individual models to estimate catches by time as a function of available biomass for BET, effort by strata (month), and month-effort interactions to estimate BET catch targets (and associated YFT and SKJ as a result). While these models are subject to some uncertainty, they provide managers with the ability to predict catches over a time-period, thereby facilitating monitoring and the use of a more precautionary adaptive approach in attaining conservation targets with a desired precision level. In addition, the implementation of seasonal fishery closures has proved successful at the IATTC, which has been using a control rule based on this principle for over fifteen years with stocks maintained by the target reference level throughout that period. Management systems based on seasonal fishery closures have also proved to be more efficient than those based on TACs, due to the latter leading to underreporting unless extensive monitoring is in place. Some examples of how the control rule may be implemented are provided. A decision support tool is developed based on the data and proposed season closures to implement an overall target catch on Bigeye tuna, one of the stocks managed to a TAC by ICCAT.

SCRS/2019/115. - In this paper we present a stock assessment for Atlantic Ocean yellowfin using a biomass dynamic model. Overall, using the Joint Longline CPUE index presented to the data preparatory meeting and the catch series made available by ICCAT Secretariat, we estimate that the stock is not overfished and not undergoing overexploitation with a 43.4% of probability. However, the initial set of diagnostics calculated with the best fit to the available data suggest that these results need further analysis. This could be refining the space of parameters to facilitate model estimates and to try alternative CPUE indices. These results are a start point for the stock assessment of yellowfin and will be further explored during the stock assessment session in July 2019.

SCRS/2019/116 - Standardization of yellowfin tuna CPUE by Japanese longline in the Atlantic Ocean was conducted using generalized linear models (GLM). The models incorporated fishing power based on vessel ID where available, and used cluster analysis to account for targeting. The variables year-quarter, vessel ID, latlong5 (five-degree latitude-longitude block), cluster, number of hooks per basket and number of hooks per set were used in the standardization. The numbers of clusters selected were 4 for all the regions.

Dominant species differed among clusters. The effects of each covariate varied by region and period. The CPUE trends differed among regions, and were similar to those estimated using the 'traditional method' (without vessel ID and cluster analysis), though with some differences probably due to the inclusion of vessel effects and cluster variables.

SCRS/2019/117 - Standardized index of relative abundance for yellowfin tuna (*Thunnus albacares*) was estimated using Generalized Linear Models approach assuming a delta lognormal model distribution. For this, a combination of data sources (the Venezuelan Pelagic Longline Observer Program 1991-2011 and the National Observer Program 2012-2018) was used, considering as categorical variables year, season/quarter, condition and type of bait, vessel type, depth of fishing, and area. As indicators of overall model fitting, diagnostic plots were evaluated. The standardized yellowfin tuna catch rate index show relatively stable values through 2004 subsequently catch rates increased to a maximum in 2007. Thereafter, standardized catch rates showed a declining trend that appears to be stabilized during the last four years (2015-2018).

SCRS/2019/118 - Information from the AVDTH Ghana fisheries and other sources was used to estimate the task I and II for the Ghanaian tuna baitboat and purse seine fisheries during 2012 – 2018. Catch and landing data collected and managed by the Marine Fisheries Research Division (MRFD) of Ghana included both landings and logbook information from 2005 up to 2017. The estimation of total Ghana catches, catch composition and quarterly-spatial (1°x1°) distribution followed the recommendations from the SCRS Tropicals working group agreed during the yellowfin data preparatory meeting. Sampling for species composition and size distribution were reviewed to determine appropriate sampling for the different components of the Ghana fleets by major gear type. In summary, estimates of total yellowfin catch from the AVDTH database were lower compared to prior reports.

SCRS/2019/119 - Tropical tunas, including bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*), are major target species for the Taiwanese distant-water tuna longline fishery, with the main fishing ground occurring in tropical waters of the Atlantic Ocean. Regional abundance indices of yellowfin tuna were developed by period using generalized linear models (GLMs). A whole period (from 1967-2018) and three separate periods from 1967-1989, 1990-2005, and 2006-2018 with the information on operation type (i.e., the number of hooks per basket, HPB) available for this late period were considered in the standardization models of yellowfin tuna CPUE (catch per unit effort). Standardized CPUE of yellowfin tuna showed almost identical trends between whole and separate periods. However, the trends differed among regions especially in recent years from 2010, with an increase for the western tropical Atlantic Ocean but slightly decrease in the eastern tropical waters.

SCRS/2019/121 - This paper represents a stock assessment of Atlantic yellowfin tuna using the age and length structured integrated assessment model Stock Synthesis version 3.30.09 (SS). The model configuration is largely similar to that of the 2016 assessment and benefits from a joint longline index rather than several separate longline indices with conflicting trends. Additionally, the model benefits from substantially revised length composition input which has reduced conflicting length data and homogenized the fleet structure. Initially we constructed a reference model and tested its performance across a suite of standard model diagnostic tests which indicated decent model performance. Then we produced a series of sensitivity models that evaluated different model formulations. After evaluation of the sensitivity runs, a structured uncertainty grid across multiple model assumptions and structures may be developed. This uncertainty grid is designed to capture much of the key uncertainties in model inputs and parameter assumptions and represents the basis for quantification of Kobe management advice.

Appendix 5

Summary of active Commission requests and previous SCRS responses for tropical tunas

Ghana's comprehensive and detailed capacity management plan on the level of catches. Rec. 16- 01, paragraph 12c:

Background: (Rec. 16-01), paragraph 12c. *Ghana shall be allowed to change the number of its vessels by gear type within its capacity limits communicated to ICCAT in 2005, on the basis of two baitboats for one purse seine vessel. Such change must be approved by the Commission. To that end, Ghana shall notify a comprehensive and detailed capacity management plan to the Commission at least 90 days before the Annual Meeting. The approval is notably subject to the assessment by the SCRS of the potential impact of such a plan on the level of catches.*

The SCRS has not yet provide a response to this request because it has not received the information required to evaluate the impact of changes in the Ghana capacity management plan.

Evaluate the efficacy of the area/time closure referred to in paragraph 13 for the reduction of catches of tropical tuna juveniles. Rec. 16-01, paragraph 15

Background: (Rec. 16-01), paragraph 15. *As soon as possible and at the latest by 2018, the SCRS shall evaluate the efficacy of the area/time closure referred to in paragraph 13 for the reduction of catches of juvenile bigeye and yellowfin tunas. In addition the SCRS shall advise the Commission on a possible alternative area/time-closure of fishing activities on FADs to reduce the catch of small bigeye and yellowfin tuna at various levels*.

In 2017 the SCRS was not able to respond to this request, however, in 2018 it did provide a response building on a number of moratorium analyses that were conducted by the SCRS in previous years. Although the SCRS conducted a preliminary analysis, it reiterated that additional years of data (beyond 2017) would be required to adequately assess the result of the new closure, and those data will not be available until after the deadline provided by the Commission.

The Committee noted that preliminary results indicate that further increases in the number of purse seiners and relocation of effort to areas outside the moratorium has undermined the effectiveness of the moratorium in achieving the objective set by the Commission.

The Committee noted that while more time is needed to be able to answer the request from the Commission to evaluate de current moratorium, preliminary results show that FAD effort relocation to areas outside the moratorium and/or future increases of the effort (number of purse seiners, number of FADs sets, etc.) may render this measure ineffective unless additional measures are adopted to address these impacts.

The Committee considered that a larger area, possibly combined with a longer closure, may address the issue of redistribution of effort. Along with a thorough analysis of the AOTTP data and of the interplay between fishing capacity, fishing effort and fishing mortality, these considerations will allow the further exploration of the effectiveness of any time/area closures within a much broader management context.

Recommendations made by the FAD Working Group (Annex 8) and develop a work plan. Rec. 16-01, paragraph 49 (a)

Background: [Rec. 16-01] paragraph 49(a). *At its 2017 meeting the SCRS shall address to the extent possible the Recommendations made by the FAD Working Group in 2016 (Annex 8) and for the remaining ones develop a work plan to be presented to the Commission at its 2017 Annual meeting.*

In 2017 the SCRS started incorporating some of the actions recommended by the FAD working group in 2016 as part of the group's workplan. During 2018 the SCRS made progress on some of these actions including definitions of FAD related terms, which were presented to the tRFMO FAD working group in early 2019, reporting requirements and data submission forms (i.e. ST08). Other recommended actions are still to be considered by the tropical working group and have to be developed as part of the Tropical tuna working group working plan and the plans of other SCRS working groups related to FAD fishing.

Provide performance indicators for skipjack, bigeye and yellowfin tuna, with the perspective to develop management strategy evaluations for tropical tunas. Rec. 16-01, paragraph 49 (b)

Background: [Rec. 16-01] paragraph 49(b). *At its 2017 meeting the SCRS shall provide performance indicators for skipjack, bigeye and yellowfin tuna as specified in Annex 9, with the perspective to develop management strategy evaluations for tropical tunas*.

In 2017 the SCRS recommended and performance indicators developed for North albacore (see Report of the Second Intersessional meeting of Panel 2, Anon. 2017b) can be used as an initial list to be used for MSE simulations. The SCRS conducted phase one of a project on tropical tuna MSE ((Merino et al 2018)).

Develop a table that quantifies the expected impact on MSY, BMSY, and relative stock status for both bigeye and yellowfin resulting from reductions of the individual proportional contributions of major fisheries to the total catch. Rec. 16-01, paragraph 49 (c)

Background: [Rec. 16-01] paragraph 49(c). *At its 2017 meeting the SCRS shall develop a table for consideration by the Commission that quantifies the expected impact on MSY, BMSY, and relative stock status for both bigeye and yellowfin resulting from reductions of the individual proportional contributions of longline, FAD purse seine, free school purse seine, and baitboat fisheries to the total catch*.

In 2017 and 2018 the SCRS provided extensive responses to this request which were considered but the Commission in the respective annual meetings.

Evaluate the contribution of by-catches and discards to the overall catches in ICCAT tropical tuna fisheries, on a fishery by fishery basis. Rec. 16-01, paragraph 53

Background: [Rec. 16-01] paragraph 53. The SCRS shall evaluate the contribution of by-catches and discards to the overall catches in ICCAT tropical tuna fisheries, on a fishery by fishery basis.

The SCRS provided a response to the Commission on this matter in 2017.

Advise the Commission on possible measures allowing to reduce discards and to mitigate onboard post-harvest losses and by-catch in ICCAT tropical tuna fisheries. Rec. 16-01, paragraph 53

Background: [Rec. 16-01] paragraph 53. *The SCRS shall advise the Commission on possible measures allowing to reduce discards and to mitigate onboard post-harvest losses and by-catch in ICCAT tropical tuna fisheries.*
The SCRS provided a response to the Commission on this matter in 2017.