REPORT OF THE 2012 WHITE MARLIN STOCK ASSESSMENT MEETING

(Madrid, Spain – May 21-25, 2012)

1. Opening, adoption of Agenda and meeting arrangements

Dr. Pilar Pallarés, on behalf of the ICCAT Executive Secretary, opened the meeting and welcomed participants.

The meeting was chaired by Dr. Freddy Arocha (Venezuela). Dr. Arocha welcomed the Working Group participants and reviewed the objectives of the meeting.

During the review of the Agenda, the SCRS Chair called the Group's attention to the structure defined by the Working Group on Stock Assessment Methods for the detailed reports. The Group considered that, at this stage, it would be difficult to adapt the Agenda to the new structure. Nevertheless, the Group recommended the rapporteurs this structure to take into account and to try to include, inasmuch as possible, the information considered by the Methods Working Group into the current Agenda items. The Agenda (**Appendix 1**) was then adopted without changes. The List of Participants is attached as **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3**.

The following participants served as rapporteurs:

P. Pallarés	Items 1, 7 and 8
M. Ortiz, C. Palma, D. Die and K. Ramírez	Item 2
E. Prince, J. Hoolihan and C. Sun	Item 3
G. Díaz, H. Agrelli and P. Travassos	Item 4
C. Brown, M. Schirripa and D. Die	Item 5
F. Arocha and K. Ramírez	Item 6

2. Update of white marlin basic information

2.1 Task I (catches)

The Secretariat provided a detailed report of updated Task I catch statistics (including dead discards) for the reporting period 1956-2011 (**Table 1** and **Figure 1**), data from 2011 are preliminary and incomplete. As agreed in the work plan, the stock assessment was performed on data from the period 1956-2010. For those CPCs that did not report catches in 2010, these data were not carried over from the previous years. Also, catches include the proportion of catches reported as unclassified billfish that were reclassified as white marlin in 2010 (2008-2010 for Brazil) following the same decisions and recommendations adopted by the Working Group during the White Marlin Data Preparatory Meeting in 2011 (Anon. 2012). Total catches (including dead discards) were then also presented by gear type (**Table 2**, **Figures 2** and **3**), with longline continuing to represent the dominant gear. Information on live discards was presented for the CPCs that provided that information (**Table 3**). Information on total live discards and post-release survival of white marlin from longline was not available. Therefore, the Group was unable to estimate post-release mortalities to include in the assessment. The Group decided to update the estimates of white marlin by-catch from the purse-seine tropical fisheries (see section 2.1.1 for further details).

The Group reviewed the catch and effort data and discussed the collection of data provided by the CPCs on marlins catches, following the ICCAT Recommendations [Rec. 98-10, Rec. 00-13, and Rec. 04-09] and how this has impacted the total removals reported in Task I. It was noted that few CPCs currently report dead discards for white marlin. It was recommended that CPCs report discards based on data collected from observers and logbooks, distinguishing between landings, dead discards, and live discards.

The Group noted that there has been a reduction of fishing effort for some fleets (particularly for the longline fleets in the Atlantic), particularly for Chinese Taipei due to reductions of fishing capacity and the effect of ICCAT management measures.

The Group considered the availability of information provided by CPCs in 2012 for the data input and evaluation of white marlin. Several consultations over fishing effort and reported catch were done by the Group.

The reported catches of white marlin had significantly decreased since the years 2000-2002. Overall for the main longline fleets, as the average reductions were over 75% compared to the late 1990s (see **Figure 17**). It is true, however that during this time period there were also significant reductions in the fishing effort for the longline gear, as shown by the estimates of total hooks deployed by these fleets (see **Figure 17**). However, proportionally, the reduction in fishing effort from these longline fleets does not fully account for the reductions of white marlin catches. In addition, the Group noted that the reporting of discards submitted by CPCs is very limited and so far no other information of changes in fishing practices or catchability has been provided that can completely account for the reductions of white marlin catches, since the implementation of management regulations by the Commission in 1998-1999. Therefore, the Group concluded that reported catches after 1998-1999 may not include increased discards at sea particularly from longline fleets as a consequence of the implementation of management recommendations, and thus total removals in Task I statistics may be underestimated since 1998-1999.

To evaluate this uncertainty, the Group produced a range of estimates of the potential total removals (landings + discarded dead) following the implementation of the management regulations. The approach for this estimation was as follows: The lower estimate of the catch was set equal to the reported catch (e.g., Task I) for the major longline fleets, while the upper estimate was calculated from the observed white marlin catch rates from these fleets in the period before implementation multiplied by the annual fishing effort for each given fleet beginning in 1998. The white marlin catch rates were calculated by dividing the total catch of each fleet during 1995-1997 by the total reported hooks fished during the same period. The longline fishing effort (in hooks) was obtained from the 2011 estimates of Eff-Dis (**Figure 4**). If yearly estimates of total catch produced by this approach did not exceed the Task I reported catch for a fleet, the reported catch was maintained. The Group also produced estimated catch series of the mean of the reported Task I and the estimated upper limit. This “middle” scenario would be most appropriate if half of the unreported discards represented in the upper estimates were discarded alive. The Group was unable to quantify the relative likelihood of each scenario. The Group also noted that the scale of the estimates is sensitive to the range of years used to calculate the assumed catch rates.

The list of major longline fleets for which estimates were made, the catch per hook calculated across 1995-1997, and any increase in catch between the reported and upper estimates are shown in **Table 4**. The middle estimates are not shown, as these are simply half the increases of the upper estimates. The catch trends of the major longline fleets under each scenario are shown in **Figure 5**. It should be noted that E.U. Portugal longline catches are included in this summary figure, but there was no information from the 1995-1997 with which to produce estimates of total removals; therefore, reported catches for E.U. Portugal were used. Brazil began reporting discards in 2006, therefore the Brazil reported Task I catches were maintained for 2006 onward. U.S. longline catches are also included in this figure, but no estimates were made for this fleet, as the US reports dead discards in Task I.

2.1.1 Estimation of white marlin by-catch from the tropical tuna purse seine

There have been a few recent studies reporting estimates of billfish by-catch from purse seine, obtained from data collected by on-board observers (Amande et al 2010, Delgado et al 2001, Delgado et al 2005, Gaertner et al 2003) and landings of “faux poisons” in Abidjan (Chavance et al 2011). Only some of the studies based on observer data contain information on the species composition of the billfish by-catch so as to separate white marlin (Amande et al 2010, Chassot et al 2009, Delgado et al 2005,), while Gaertner et al (2003) only separate marlins from sailfish. There is no species specific information on billfish landings contained in the “faux poisson” of Abidjan (Chavance et al 2011, Chassot et al 2009).

Estimates of the amount of billfish by-catch from on-board observer data has been done for different components of the purse seine fleet and for different periods (**Table 5** and **Figure 6**).

A large portion of the billfish by-catch, ranging from 67% (Amande et al 2010) to 70% (Delgado et al 2005) is retained on-board. A large portion of these catches are then landed in Abidjan where it is reported as a component of the “faux poisson” (Chassot et al., 2009, Chavance et al 2009). The majority of the remainder of the by-catch (22%) is discarded dead at sea or retained for consumption on-board (5%), only about 1% is released alive (Delgado et al 2005).

The only studies (Delgado et al 2005, Chassot et al. 2009, Amande et al 2010) that report identification of individual species in the billfish by-catch of purse seiners suggest only a few of the about seven hundred identified billfish observed are white marlin (**Table 6**). This implies that the percentage of billfish caught in purse seine that are white marlin is only of a few percent in numbers and even less in biomass. The estimates of Amande et al 2010 are most useful because they represent both French and Spanish fleets and are separated by fishing mode. The percentage in weight of the billfish by-catch that represents white marlin caught in free schools is estimated by Amande et al (2010) to be 1.8% and for FAD associated schools of 3.3%. In contrast estimates from Delgado et al (2005) for the Spanish purse seine fleet were of 3.1 % for free schools and 11.1 % for FAD associated schools. In their study of the French fleet, Chassot et al (2009) did not identify a single white marlin among the billfish by-catch.

The average weight of individual white marlin identified by Delgado et al (2005) and Amande et al (2010) was surprisingly high. Amande et al (2010) reported six white marlin weighting 600 kg, which gives an average of 100 kg a fish. Delgado et al (2005) do not report weights of the observed catch. However, they do report the relative contributions in weight and numbers of each billfish species. This allows for calculation of relative weights suggesting that the average weight of a white marlin is 0.6-0.7 times the weight of a blue marlin, whereas sailfish are 0.15 times the weight of a blue marlin. Given that the average weight of a blue marlin calculated from the data from Amande et al (2010) is 135 kg, this means that the white marlin observed by Delgado would also be about 100 kg. Such high average weights for white marlin are not common in the catches of any of the other gears that catch this species in the area where the purse seine operate. The length frequency distribution of white marlin obtained from Task II data for the area between 10°N and 10°S and 25°W and 10°E for all gears show a mode at 160 cm which correspond to a weight of 22.4 kg (**Figure 7**). This same data show that the proportion of large fish (> 200 cm and > 44 kg) is only about 3% since the year 2000, although it was about 35% in the 1970s (**Figure 8**). This seems to suggest that 100 kg white marlin are rare. It is therefore critical that future studies on purse seine billfish by-catch confirmed that white marlin are indeed caught on-board these vessels, and that previous reports do not correspond to misidentified blue marlin.

In conclusion, billfish are an important component of the by-catch of purse seiners and many are retained and landed, primarily in Abidjan. The majority of these fish are not white marlin and the percentage in weight of white marlin is only a few percent of the total weight of the billfish by-catch. The Group agreed to use the percentages obtained by Amande et al (2010) of 1.8 % for free schools and 3.3 % for FAD associated schools to calculate the catch of white marlin for the purse seine fleets together with the ratios of billfish by-catch to tuna catch as proposed before by Delgado et al (2001), Delgado et al (2005), Gaertner et al (2003) and Amande et al (2010). Estimates obtained through this process for 2000 to 2010 are shown in **Figure 6** and **Table 7**. Estimates of billfish by-catch here obtained are larger than those provided by Amande et al (2010) but similar to those obtained for an earlier period by Gaertner et al (2003).

2.2 Task II (catch-effort and size samples)

The Secretariat provided summary of updated Task II catch and effort data and Task II size/CAS data. For size samples, the size compositions and size frequency preliminary analysis were presented in document SCRS/2012/062.

Document SCRS/2012/062 presented a detailed analysis of size frequency data submitted to the Secretariat. Over 130000 white marlins were measured from 1970 to 2010. All data were converted to lower jaw-fork length (LJFL cm) measurements using the size and weight-size conversion factors adopted by the SCRS. Samples less than 50 or greater than 400 LJFL cm were considered outliers, and thus excluded from the analyses. A review of frequency samples by fleet, gear, year and quarter highlighted two series that clearly indicated larger departures from the general trend, and likely included either error in the measurement reported or misidentification of the species. These series were the Ghana gillnets size samples for 1999 quarter 2, and also Brazil longline size samples for 1995 quarter 2. These series were excluded from further analyses. The Group reviewed the different size frequencies and requested further analyses. **Figure 9** shows the distribution (mosaic plot) of size samples by year and major longline fleets. It was noted that there is no constant size samples provided by one single fleet. Therefore, it is possible that trends in mean size or size frequency distribution reflect changes in the source fleet, rather than the stock population. An examination of the sizes of fish taken by fleet, however, did not indicate any concerns. No examination of spatial patterns of fish sizes was undertaken but should be done in the future. The size frequency data were aggregated by main gears (longline, gillnet and sport/recreational fisheries) and year, in 5 cm size bins (50-325 LJFL cm) to be used as input for the catch-statistical model.

Document SCRS/2012/062 also presented a standardized median size annual trend for white marlin, based on the size frequency data. The standardization used a GLM with the fleet, gear, year, quarter and sex factors. Major differences were identified within gear-fleet combinations. The standardized mean size series indicated a decrease in size since the 1970, reaching lowest values in 1995. Since then, the mean size has increase slowly. The Group, however noted that changes in mean size may be due to the unbalance sampling from some of the major fisheries, and expressed caution in the interpretation of these results.

2.3 Other information (tagging)

The Secretariat provided updated tables of the conventional tag releases and recaptures reported by CPCs. Tag releases and recaptures are presented in **Figure 10**.

3. Review of biological data

3.1 Biology

For the purpose of this assessment, sizes at age and maturity were based on estimates provided by Die and Drew (2008). Consideration for sex ratio, spawning seasonality, sexual maturity and fecundity were based on the work of Arocha and Bárrios (2009).

A species identification guide for Atlantic istiophorids (authored by Freddy Arocha and Lawrence Beerkircher) was made available at the white marlin assessment meeting. This is an accurate and well written billfish identification guide that communicates to fishermen as well as scientists. As such, the Group suggests that ICCAT distributes this guide to all fleets to avoid the misidentification of istiophorid billfish. This is particularly important to avoid misidentification between roundscale spearfish and white marlin, which has caused the Group concern and resulted in a mixed species white marlin assessment for 2012.

SCRS/2012/040 document addressed sampling of Venezuelan artisanal longline fleets targeting tuna and tuna-like species (e.g., billfish). This is an enhanced species-specific monitoring program that summarizes at-sea sampling protocols and associated activities. It is well illustrated and provides a successful approach for at-sea sampling of artisanal fishing vessels (vessels < 15 m). The Group suggests that this approach be considered for many of the ICCAT Atlantic artisanal fleets that target pelagic species.

3.2 Tagging

SCRS/2012/067 document presented an analysis of capture-recapture data from white marlin to obtain von Bertalanffy growth parameter estimates. Mean asymptotic length and growth rate estimates were obtained by fitting observed growth measurements of recaptured fish from tagging data using the Fabens method. The model demonstrated high sensitivity to data inputs, and reasonable estimates were obtained only when strict filter criteria were applied. Mean asymptotic length from the most appropriate model was estimated at 218 cm with a growth rate constant of 0.33. Potential bias in the estimates may have resulted from imprecise and inaccurate size measurements, lack of contrast in the range of sizes, and the lack of age information on marked fish. Results should be compared with estimates from alternative model frameworks and size-at-age estimation methods.

4. Review of catch per unit effort series

Document SCRS/2012/048 presented standardized CPUE for the Brazilian longline fishery. The Group inquired about the reason the authors choose to use a Poisson distribution instead of a delta-lognormal approach. It was indicated by the authors that 'number of fish' is a discrete variable and, therefore, they felt that the use of a Poisson distribution was more appropriate. The Group also discussed that fishing areas used as a factor in the models might be too large and that the authors might want to consider exploring the use of smaller areas in future analysis. It was also noticed that the nominal and standardized CPUEs were quite different for some years. The Group briefly discussed what factors in the model could produce such differences. There was concern in the Group that the use of 'Flag' as a factor in the model did not entirely captured the variability associated to the high vessel turnover, changes in gear configuration and targeting, etc. In other words, potential changes in catchability might not be entirely accounted for in the model. The Group also showed some concern regarding the definition of 'night' and 'day' as a factor that described the time of setting. That is because the time of day used to define 'day' and 'night' seems to have been defined the same way without taking into consideration time of year and longitude. However, there was a general agreement that the potential effect of using a unique definition of ‘day’ and ‘night’ most probably was very small. One particular point that concerned the Group was the high interannual variability observed in the index which seemed to be not biologically plausible. This particular issue was acknowledged by the author in the document.

Document SCRS/2012/056 presented a standardized CPUE series for the Chinese Taipei longline fleet. The Group noticed a significant CPUE decrease in the last decade of the time series. The Group noticed that this decrease coincided with the adoption of the 1998 ICCAT management regulations for this species. In addition, reductions in fishing capacity of the Chinese Taipei longline contributed to an overall reduction in white marlin catches. The Group also noticed that swordfish catches also declined during the same period. This CPUE was developed using all white marlin catch. The Group observed that, although the nominal CPUE was low for the period 2000-2010, the standardized index for the same period was relatively higher. The Group noted that recent distribution of fishing effort has been in strata which were expected to have low white marlin catch rates.

Document SCRS/2012/060 presented an update of the U.S. longline fishery CPUE index estimated using observer data. The authors indicated that, although during the last years of the time series white marlin and spearfish are recorded separately for the last time of the time series, they were combined for this index because they choose to estimate and index for both species combined because during the earlier part of the time series such differentiation was not available and the Billfish Work Plan called for combining them. The index was estimated using all fish caught (i.e., discarded dead and well as released alive).

Document SCRS/2012/055 presented the results of how the inclusion of catch rates affects the results of a Bayesian state-space version of the Schaefer type. The authors indicated that the inclusion of CPUEs that only covered the last two or three decades of the time series have very limited or no effect on the outcomes of the model and that the landings seemed to be more informative to the model than CPUEs. The Group discussed that the lack of change in the estimated parameters when the different CPUE data points were included in the model might be the result of the lack of a signal in the CPUE series. Alternatively, the Group discussed the possibility that parameters could be estimated with enough precision in the earlier period of the time series so the addition of new CPUE data points did not result in changes in the estimates.

Document SCRS/2012/054 presented a CPUE series for the longline fleet of EU-Spain. The Group acknowledged the difficulties it faced to fully assess this document given that none of the authors attended the meeting. For example, the Group was unable to assess if dead discards and live releases were included in the estimation of the CPUE or the relationship between the two data sets used. In addition, the document did not contain enough information that could explain the differences in the observed proportion positive between the two data sets.

In addition to the three CPUE series described above, there were 6 other CPUE series available for the Group that were either presented at the 2011 white marlin data preparatory meeting (see ‘Report of the blue marlin stock assessment and white marlin data preparatory meeting’) or were used in previous stock assessments.

In summary, the CPUE series available for the Group were (**Table 8** and **Figure 11**):

1) Chinese-Taipei, longline fishery, 1967-2010
2) Brazil, longline, 1978-2011
3) USA, longline, 1992-2010
4) Spain, longline, 1988-2010
5) Venezuela, gillnet, 1991-2010
6) Venezuela, longline, 1991-2010
7) Venezuela, sport, 1961-1995
8) USA, recreational, 1973-2010
9) Japan, longline, 1959-1999
10) Japan, longline, 1990-1999, 2000-2010

Details on the CPUEs for the Venezuela sport fishery and Japan longline fishery (1959-1999) can be found in the Report of the Fourth ICCAT Billfish Workshop (Anon. 2001) details on the US recreational index that can be found in the upcoming 2012 Collect Volume of Scientific Papers series, and for the rest of the indexes that were not presented in the meeting, details can be found in the ‘Report of the Blue Marlin Stock Assessment and White Marlin Data Preparatory Meeting” (Anon. 2012).

The Group agreed that the implementation of [Rec. 98-10], which requires CPCs to reduce their white marlin landing to 1/3 of the 1999 levels and to release white marlin from longlines and purse seines that are alive at haulback, was expected to result in an increase of regulatory discards. Therefore, the Group agreed of the importance of considering if the available CPUEs were estimated using all white marlin catches instead of only data from retained fish.

Following the guidelines (presented in a form of a table) developed by the SCRS Working Group on Stock Assessment Methods (WGSAM), the Group assessed the available CPUE series for their inclusion in the assessment models. The Group decided to modify the table by reducing the scores from 1-5 to 1-3, and by adding one more element to indicate if white marlin discards were included in the data used to estimate the indexes. The Group found some difficulties assessing some of the elements in the table. For example, the fraction of the catch represented by the index with respect to the total catch of the stock, or the trends between the catch and the CPUE series were difficult to assess because that information was not part of the documents. The Group was also unable to quantitatively assess if interannual variability were outside biologically plausible bounds and the severity of these deviations because the R script used in SCRS/2012/039 was not available to the Group at the time of the meeting. **Table 9** shows the scores given to each element in the CPUE series. The use of the score ‘N/A’ (not applicable) was used for some elements in the table. The Group also agreed that given a final score to each CPUE series based on the partial score to each element was difficult because it considered that equal weight should not be given to all elements. Finally, the Group also recognized the difficulties associated with assessing the quality of an index when the author(s) of the document were not present at the meeting. The Group suggested to consider the presence (or absence) of the authors in the meeting as one more element used to assess the index.

After taking into consideration the partial scores assigned to each element in the **Table 9**, the Group made the following decisions with respect to the indices:

1) ***Chinese-Taipei, longline fishery (1967-2010):*** Although this index was estimated from aggregated data and the factors considered for the standardization only included year, month, and latitude and longitude, the Group agreed that this index was valuable because it extended throughout the entire time series used in the assessment, it covered a large geographical area, and it was calculated using all catches. Therefore, the Group agreed it was suitable for inclusion CPUE in the assessment models.

2) ***Brazil longline fisheries (1978-2011):*** The Group felt that, given the high frequency of CPUE values that seemed to have severe deviations from biologically plausible values, as well as concern that changes in targeting may not have been fully accounted for. This CPUE series should not be included in the assessment at this time.

3) ***USA, longline (1992-2011):*** Although this index covered a relatively short time period (1992-2010), the Group considered this index to be valuable because it was constructed using observer data, and included all caught white marlin (i.e., dead discards and live releases).

4) ***Spain, longline (1988-2010):*** The Group expressed some concern about severe deviations from biologically plausible values and the high degree of aggregation of some of the data. Nevertheless, the Group decided to include this index in the assessment models because of the large geographic area covered by the index.

5) ***Venezuela, gillnet fishery:*** Although this index corresponds to a very limited geographical area, the Group agreed to use it in the assessment models because it was the only available gillnet index to accompany the catches from these fisheries used in the models, and because the index comes from a described ‘hot spot’ for white marlin.

6) ***Venezuela, longline:*** The Group included this index in the assessment models because it covered an area in the Caribbean for which there are no other longline CPUE series available. In addition, it was indicated that the area covered by the index includes a described ‘hot spot’ for white marlin, the index was constructed using data from all caught fish (i.e., landed, discarded dead, and released alive from the Venezuelan observer program).

7) ***Venezuela sport fisheries:*** This index was not included in the assessment because it was not standardized, it did not include discards, and the data quality was deemed to be poor.

8) ***USA, recreational (1973-2010):*** The Group decided to include this index because of the geographical extent covered by the index, the fact that it includes all catches (i.e., fish landed, discarded dead, and released alive), the extent of the time series, and because the assessment model included a sport/recreational fishery.

9) ***Japan, longline (1959-1999):*** This historical index was included in the assessment models because the Group agreed on the importance of having more than one index covering the earlier part of the time series. In addition, the index covers a large geographical extent and a large fraction of the total catch of the stock.

10) ***Japan, longline (1990-2000, 2001-2009):*** The Group agreed on the importance of using these two indexes because one of them covers the most recent part of the time series (which is not covered by the other Japanese index). However, the Group recognized that for years 1990-1999 there was an overlap between one of these indexes and the Japanese historical index which should be addressed during the analyses.

5. Stock assessment

5.1 Methods

The Group agreed to conduct the evaluation of stock status using two models: (1) a non-equilibrium production model (ASPIC); and (2) the fully integrated stock synthesis model described in **Appendix 6**. A Bayesian Surplus Model (BSP) was presented to the Group as a third model option. However, the Group was unable to fully evaluate the methods, diagnostics, and results of this model during the meeting. Although the cursory evaluation that was done indicated that the results were generally consistent with the other two models, the results were not formally considered for management advice due to a lack of detailed group evaluation. Details and figures of the BSP are given in **Appendix 4**.

The Group also agreed to conduct model runs using the indices described in section 4. The version of Task I catches developed as described in section 2 was used for base runs (**Table 1**). The two catch series (upper and middle estimates) with alternative potential total removals (catch+discarded dead) following the implementation of the management regulations were used for sensitivity runs.

The catch was assigned to four gear groupings: longline, gillnet, purse seine, and rod and reel (recreational catches), while the catch from all other gears were grouped with the longline catches since this gear is the least selective one for white marlin with respect to size.

After a preliminary run conducted with the Stock Synthesis model, the Group agreed to not include the Spanish longline index in subsequent model runs given the concerns discussed in section 4.

5.2 Stock status

5.2.1 Non-equilibrium production model (ASPIC)

Dynamic production models implemented through the ASPIC software (Prager 1994, 2002) have been used in all recent assessments of billfish. For white marlin, ASPIC was used during the 1994, 1998, and 2000 assessments. In all cases, logistic production functions were used because the data typically does not allow for the estimation of the shape of this function. The ASPIC 5.3.4 version used here allows for the inclusion of separate CPUE indices. Therefore, different CPUE input scenarios were attempted to determine the influence of individual and combinations of CPUE series on model results (**Table 10**). In all these cases, B1/K was fixed to a value of 1.0 and was not estimated by the model. To see the effect of simply updating the same data used in the last assessment to develop the advice, a combined CPUE index was estimated using the method of Conn (2010). In addition to using the Task I reported catch as an estimate of the total catch, two alternative estimates were used representing different levels of unaccounted discards (see Section 2). In a few cases where a scenario with many CPUE indices did not converge, the catchabilities of individual CPUEs were not estimated, but rather were fixed to the value estimated for that series when it was fitted alone to the ASPIC model. Input parameters for the ASPIC model are provided in **Appendix 5**.

Effects of alternative CPUE series

Times series trends for indices that extended for a longer period, such as the Japanese longline and Chinese Taipei longline, provided a signal of the dynamics of the stock. This was different from the dynamic signal provided by the relative abundance indices that started later. The biomass ratios and fishing mortality ratios estimated differed depending on the indices included in the model (**Figure 12).** Recent biomass ratios are lower and fishing mortality ratios are higher for scenarios that included the Japanese and Chinese Taipei relative abundance estimates. All scenarios suggest that the Biomass ratio has increased since 2004, but remained below B_{MSY} in 2010. Fishing mortality has been declining since the late 1990s regardless of the scenarios, but the F/F_{MSY} ratio was generally higher for the scenarios that include both the Japanese and Chinese Taipei relative abundance estimates, but not for other scenarios. The scenario with six indices (Case 1b) is closest to the base case scenario used in the statistically integrated model.

Recent longline catch

Model results obtained using the alternative catch series described in section 2.1 showed that recent fishing mortality was greater than that estimated with Task I reported catches (**Figure 13).** Biomass ratios differed mostly from the mid 1980s to the end of the 1990s, and less so in recent years. Using these higher catch scenarios suggested a slower or eliminated biomass recovery over the last ten years.

Combined index

Fits to the combined index were similar to those obtained with the seven separate indices used in the base case. When alternative catch estimates were used for the recent period, the combined index provided more pessimistic view of the recent trend in biomass and fishing mortality (**Figure 14**). If the recent catch was greater than the Task I, the fits suggest that the recent biomass continues to decline.

Diagnostics of ASPIC fits

In general, there were no great differences in how the various ASPIC scenarios fit the CPUE series. ASPIC fits to the Venezuelan longline, U.S. longline and U.S. recreational indices explained more of the variation in these indices than the fit to the Venezuelan gillnet index (**Figure 15**). That was because they fitted the general decreasing trend observed in these indices, but not the relative flat trend of the later index. There were no obvious large time trends in the residuals of the fits to these indices. The fit to the Chinese Taipei longline index followed the overall decreasing trend in this index, but not the decadal-scale changes observed in the middle of the time series, as a result residuals tend to be positive in the 1980s and negative in the 1990s. The fit to the Japanese index was the poorest of all and could not fit both the initial increase in CPUE and the subsequent decline. Residuals are clearly correlated with time for the Japanese index, and for the recent period of the Chinese Taipei index.

Management benchmarks

Estimated management benchmarks differed between cases (**Table 11, Figure 16**). Benchmarks for case 1b suggested a median MSY of 874 t with 10 and 90 percentiles of 795 - 976 t generated by a low productivity stock (F_{MSY} = 0.03) that has been slowly declining from its virgin state (K = 54,480 t). The median biomass ratio in 2011 of 0.50, with 10 and 90 percentiles of 0.42-0.60, clearly suggested that the stock remains overfished. The median fishing mortality ratio was 0.99 with 10 and 90 percentiles of 0.75 and 1.27 suggesting that overfishing was probably not occurring in 2010.

If recent catches were to be greater than those reported in Task 1 (cases 1c and 1d), the estimated MSY would be at around 1000 t. Current fishing mortality ratios, however, would be greater than 1 which indicates that overfishing was still occurring. Estimates of the biomass ratio in 2011 did not change and suggested that the stock remains overfished regardless of the level of catches used in the model runs (**Table 11**). Alternative model runs that used fewer CPUE series (cases 15, 17 and 18d) provided more optimistic results than the case that used all available indices, with estimated MSYs around 1,100-1,200 t, and biomass ratios in 2011 between 0.7 and 0.8, so the stock still remains overfished.

All these model fits suggested a low productivity stock with F_{MSY} at about 0.05 or less, that has been slowly declining from the beginning of the fishery. It has to be noted that cases 1b, 1c and 1d had values of q for Chinese Taipei and Japanese longline that were fixed and not estimated by the model to allow model convergence. Benchmarks were, therefore, constrained (**Figure 16**).

Results for the cases that excluded the Chinese Taipei and the Japanese longline indices (Cases 15, 17 and 18d) resulted in estimates of benchmarks with higher uncertainty (**Figure 16**) than the other cases which confirmed the importance of the relative abundance signal for the years prior to 1975.

5.2.2 Statistically integrated model

The basic structure, assumptions, inputs, and full diagnostics of the fully statistically integrated base case model on the stock synthesis platform are described in **Appendix** 6. The configurations and results of specific runs are described below. The Group agreed that RUN_1 would be the base case.

Base Case

A graphical display of all data available for analysis is shown in **Appendix 6, Figure 1**. An effort was made to use as much of the available data as possible. This was in response to previous recommendations made by the Billfish Working Group to try and utilize as much of the ICCAT data as possible and to include it, where appropriate, in the stock assessment model. Arguably, the most important difference between the ASPIC model and the SS fully integrated model is the fact that the SS model can estimate annual recruitment deviations. The estimation of annual recruitment deviations led to the perception that the white marlin stock was more productive and would recover faster than estimated by the ASPIC model.

The fit to the CPUE time series showed inconsistencies between the nine indices (**Appendix 6, Figures 2A-C and Figure 3**). The model was unable to fully capture some of the observed annual variations in the CPUE. The issues associated with the CPUE time series are discussed in Section 4.

It was found that the length composition data did not provide any meaningful signal with regard to annual variation in recruitment. Given this, and the annual consistencies in the length frequency data, the fit to the lengths (**Appendix 6, Figures 4-6**) and the resulting estimated selectivities (**Appendix 6**, **Figure 7**) posed no meaningful problems.

The Group discussed how to best deal with post-release mortality of live discards from longline gear within the assessment modeling framework. The Group was left with the basis of the problem being a lack of reliable estimates of discards both with regard to quantity and length composition. **Figure 17** shows how white marlin catches and longline effort (measured in number of hooks) followed the same trend from 1980 to 1996, the first year of managed landings. After 1996 reported white marlin catches declined at a faster rate than the reported longline effort. Since white marlin is primarily a by-catch species, this suggests that white marlin catches may have been under reported. The Group emphasized the need for fleet specific discard mortality estimates as well. Given the potential importance of unreported catches, the Group chose to consider two levels of potential landings as the basis to conduct sensitivity runs (**Figure 18**).

Estimates of the spawning stock-recruitment relationship appeared plausible (**Appendix 6, Figure 8**). The estimate of virgin recruitment was 5.327 (log scale) with a standard deviation of 0.055, and the estimate of steepness was 0.654 with a standard deviation of 0.032 (**Appendix 6, Table 1**). This resulted in an estimate of MSY of 1604 t (SD = 28 t). The resulting estimate of stock status from the base case model is that the stock is currently overfished (B/B_{MSY} = 0.322; SD = 0.046), but not undergoing overfishing (F/F_{MSY} = 0.720; SD = 0.105).

Estimates of annual recruitment showed very wide confidence intervals (**Appendix 6, Figure 9**). This was due to the fact that nearly all the signal for recruitment was coming from the CPUE data, as none was found in the length data. The CPUE data was mostly an adult index and as such, cannot give a clear signal to the strength of annual recruitments. Furthermore, given the inconsistencies in the CPUE time series, the model was not able to arrive at reliable estimates of annual recruitment. Nonetheless, a negative change in the average recruitment was evident for the time periods 1977-1998 and 1999-2010. However, the signal for this trend very likely came from the landing data, which also showed a decline at the same time, but most likely due to regulatory measures. Given all the above difficulties, estimates of annual recruitment remain highly uncertain. The estimated time series of spawning stock biomass with approximate 95% confidence intervals is shown in **Appendix 6, Figure 10**. Estimated fishing mortality followed a pattern similar to that of the reported landings (**Appendix 6, Figure 11**).

To better characterize the uncertainty around the parameter and derived quantities estimates, a series of Markov Chain Monte Carlo (MCMC) were run. The resulting posteriors are shown in **Appendix 6, Figures 12A-D**.

Nearly all of the posteriors resulted in normal or nearly normal distributions with one exception which was the second parameter of the gillnet selectivity. The posteriors of the derived quantities F/F_{MSY} and $B/_{MSY}$ were bimodal, suggesting that perhaps a global minimum was not found. One possible cause for this is the lack of agreement between the CPUE time series. Further detailed results and discussion regarding model diagnostics are provided in **Appendix 6**.

Sensitivity runs

In order to examine the sensitivity of results to (a) the possibility of cryptic and/or release mortality (as discussed), and (b) various CPUE time series, the Working Group requested that five additional runs be made (**Table 12**).

Generally speaking, the sensitivity runs were relatively consistent in their depiction of the overall trends in the management benchmarks, although Run 4 was unable to converge. This was due to removal of the longest time series of CPUE (i.e. the early Japanese CPUE time series). Estimates of F/F_{MSY} in 2010 ranged from 0.683 to 1.350, while estimates of B/B_{MSY} in 2010 ranged from 0.293 to 0.390 (**Figure 19**). Estimates of steepness were similar between model runs ranging between 0.65 and 0.71, as were estimates of the log of virgin recruitment, which ranged between 5.15 and 5.32. As a result of steepness of virgin recruitment being relatively consistent, estimates of MSY were also consistent, ranging from 1,604 to 1,712 t. (**Figure 20**).

5.2.3 Comparison between ASPIC and SS Base Models

Comparisons between the two base case models were made in terms of estimated management benchmarks as well as estimated productivity. In terms of estimated management benchmarks, the two models performed similarly with estimates of F/F_{MSY} and B/B_{MSY} in 2010 being fairly similar (**Figure 21**). However, the estimates of productivity between the two models were very different with the ASPIC model estimating much lower productivity than the SS model. The ASPIC model depicts a stock that started out at a higher biomass, is less productive, and has a lower MSY than the SS model (**Figure 22**). Furthermore, results of the SS age structured production model (ASPM) also depicted a low productivity stock (SCRS/2012/061). This is most likely due to the fact that the SS fully integrated model was configured to estimate annual recruit deviations. Unlike with the ASPIC model, the freedom to estimate recruitment deviations gave the SS model another way in which to account for the variations in CPUE and landings. Allowing the estimation of recruitment deviations in the SS model resulted in the estimation of a more productive stock and, consequently, a higher MSY. Given the data at hand, it is not possible to determine which of the two models depictions is better, only that they two are different.

5.3 Projections

For projections, the Group assumed that the 2011 and 2012 catches were identical to those estimated for 2010. The Group also agreed that projections should be carried out beginning in 2013, and assumed constant catch levels ranging from 0 to 1600 t at 200 t increments.

However, in view that these tasks would have to be conducted post-meeting it was agreed that the scientists involved in producing the projections will collaborate with ICCAT Secretariat's population dynamics expert in elaborating an SCRS document (PROJ) that will address the projections based on the models selected for management advise, and provide the necessary information characterizing the robustness of the methods applied to assess stock status of white marlin and to develop scientific advise; this document is to be presented at the SCRS-Species Group meeting. During the SCRS Species Group meeting, the Group will analyze the convenience of considering the SCRS document as part of the detailed report as an Appendix or an independent document.

The management advice will be considered on the basis of the detailed report and the SCRS document (PROJ) and will be stated in the Executive Summary report for white marlin.

6. Recommendations

6.1 Research and Statistics

1) The Working Group recommended that CPCs should report Task I and Task II for inter-sessional meetings by the deadlines provided by the Secretariat.

2) The Working Group recommended that white marlin age and growth studies continues, encouraging the evaluation of tag-recapture data available in the ICCAT data base as a suitable compliment to age and growth studies.

3) The Working Group encourages the Secretariat to reach out to other RMFOs in the Greater Caribbean to explore sharing data pertinent to ICCAT fisheries.

4) Noting the misidentification problems between white marlin, roundscale and longbill spearfishes identified by the Working Group, a species identification guide for Atlantic istiophorids was made available at the white marlin assessment meeting. The Working Group recommends that ICCAT distributes this guide to all fleets to avoid future misidentification of istiophorid species.

5) In noting that estimation of relative abundance indices is always best done at the highest spatio-temporal resolution warranted by the available data, the Working Group recommends that all CPCs, and especially those that have important catches of white marlin, provide updated relative abundance indices obtained from such high resolution catch rate data. In addition, consideration of the effect of current regulations in the standardization process needs to be addressed. For instance, when only information on kept fish is available, the effect of implementing regulations requiring the release of live fish from longlines should be accounted for, such as by developing separate indices before and after implementation.

6) The Working Group recommends that an objective protocol to evaluate standardized catch rates be provided to all Working Groups to expedite the process for selecting indices of abundance time series to be used in model runs This protocol should be developed during data preparatory meetings prior to the assessment meeting.

6.2 Management

No management recommendations were considered during the meeting, as they are to be discussed when the Executive Summary is prepared during the SCRS-Species Group meeting.

7. Other matters

None were considered.

8. Report adoption and closure

The report was adopted during the meeting.

The Chairman thanked participants for their hard work.

The meeting was adjourned.

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Table 1. Estimated catches (t) of Atlantic white marlin (*Tetrapturus albidus*) by area, gear and flag.

			1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
TOTAL			1627	1462	1544	2114	1761	1573	1430	1682	1569	1368	978	905	732	742	655	447	601	634	656	434	57
	ATN		239	610	543	660	639	669	483	529	492	484	431	293	253	257	287	196	162	136	203	220	30
	ATS		1,388	853	1,002	1,454	1,122	905	947	1,152	1,077	883	547	612	478	485	368	251	438	498	453	213	27
Landings	ATN	Longline	108	466	413	531	473	554	431	475	399	408	381	230	204	204	252	161	123	105	164	194	30
		Other surf.	21	35	34	57	48	31	10	17	29	34	30	24	32	24	17	23	30	19	23	12	
		Sport (HL+RR)	19	21	30	30	18	20	9	6	6	2	4	6	1	1	1	2	1	2	2	6	
	ATS	Longline	1,328	805	950	1,420	1,086	860	853	979	1,021	827	475	497	425	454	325	202	404	417	381	159	27
		Other surf.	60	48	52	33	31	40	57	173	55	56	71	116	53	31	43	48	15	80	72	53	
		Sport (HL+RR)	0	0	0	0	4	4	0						0				0				
Discards	ATN	Longline	90	88	66	42	100	64	33	31	57	41	16	29	17	27	17	9	8	9	13	8	0
		Other surf.								1	0		1	4	0	0	0	0	0	0	2	0	
	ATS	Longline						0	37	1	0		1					2	19	1		2	
Landings	ATN	Japan	45	180	33	41	31	80	29	39	25	66	15	10	21	23	28	27	10	22	27	34	
		Venezuela	47	187	226	148	171	164	90	80	61	25	72	110	55	55	60	26	52	26	70	54	
		Chinese Taipei	13	92	123	270	181	146	62	105	80	59	68	61	15	45	19	16	1	0	1	1	1
		Cuba												7									
		U.S.A.	13	11	19	13	7	12	8	5	5	1	3	6	1	1	1	1	0	2	2	2	
		Korea Rep.	1	9	4	23	3	7	5								4				8	19	
		EU.España	9	18	15	25	17	97	89	91	74	118	43	4	19	19	48	28	32	10	8	50	
		NEI (ETRO)			23	43	47	57	72	105	100	64	36	2	2								
		Barbados	17	24	29	26	43	15	41	33	25	25	24	15	15			33				6	
		Trinidad and Tobago	3		1	11	18	8	32	10	13	4	2	5	12	6	6	5	12	10	11	15	
		Mexico			2	8	8	3	5	6	11	18	44	15	15	28	25	16	13	14	19	20	28
		NEI (BIL)	0	0								34	72	4	8		26	9	14	18	20		
		Grenada										1	15	8	14	33	10	12	11	17	14		
		Panama																					
		China P.R.				6	7	6	7	10	20	1	7	4	2	1	4	1	0	1	3	4	
		Canada				4	4	8	8	8	5	5	3	2	1	2	5	3	2	2	1	2	1
		EU.Portugal												1	5	11	30	3	2	0	1	2	
		St. Vincent and Grenadines		0	1	0								0	44							0	
		Mixed flags (FR+ES)										3	5	3	3	5	3	2	2	2	3	3	

	Liberia						1	1	3	8	4	3	4	3								
	UK.Bermuda	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	
	Costa Rica									3	14			1								
	U.S.S.R.																					
	Philippines								0	4									1			
	EU.France															0			1	0	0	
	Brasil										1											
	UK.British Virgin Islands																1					
	Sta. Lucia																0		0	0	0	
	Vanuatu															0						
ATS	Chinese Taipei	790	506	493	1,080	726	420	379	401	385	378	84	117	89	127	37	28	53	38	27	19	27
	Japan	77	68	49	51	26	32	29	17	15	17	41	5	12	13	6	11	11	12	16	10	
	Brasil	377	211	301	91	105	75	105	217	158	105	172	407	266	80	244	90	52	55	53	36	
	Korea Rep.	56	1	4	20	20	52	18			0			11	40	3		113	96	70	24	
	NEI (ETRO)			91	171	190	228	288	421	399	258	144	9	7								
	Cuba	10	10																			
	NEI (BIL)										0	5	0	21	134	16	27	156	186	179		
	S. Tomé e Príncipe	26	24	17	21	21	30	45	40	36	37	37	37	37	21	33	29		36	37	38	
	Mixed flags (FR+ES)	11	10	12	11	9	7	7	9	8	9	8	9	10	8	8	8	7	8	9	9	
	Ghana	17	14	22	1	2	1	3	7	6	8	21	2	1	1	1	0		4	4		
	EU.España	17	6	12	2	19	54	4	10	45	68	18	2	3	45	10	23	14	21	8	62	
	Uruguay	1	3		3	0	1	24	22				1	9	2	5	9	3		5		
	Argentina	6																				
	Panama																					
	EU.Portugal														8		19	0	35	39	9	
	China P.R.				3	4	3	4	5	10	1	13	19	6	6	4	5	10	3	5	4	
	U.S.S.R.																					
	Côte D'Ivoire						1	2	1	5	1	2	2	3	1	1	1	1	3	2		
	Philippines								1	8									1			
	Togo							0		1	1	2	0	2								
	Belize					0		1		1	0											
	South Africa												2									
	Cambodia									1												
	Honduras						0	0	0	0												
	Gabon			0	0		1	0				0		0								

Discards	ATN	U.S.A.	90	88	66	42	100	64.49	33.46	32	57.06	40.75	17.37	32.78	16.71	27.42	17.347	9.513	7.722	9.702	14.484	8.26	
		Mexico																0.064	0.06	0.02	0.197	0.093	0.138
	ATS	U.S.A.						0.19	37	1	0.45		0.59										
		Brasil																1.564	18.757	0.78			
		Korea Rep.																				1.583	

Table 2. Total catches (including dead discards) were then also presented by gear type.

tones	Main gear types		
Year	Longline	Other surf.	Sport (HL+RR)
1956	19.00		
1957	160.00		
1958	161.00		
1959	112.00		
1960	253.00		60.00
1961	763.00		67.00
1962	1985.00		79.00
1963	2548.00		66.00
1964	3661.00		74.00
1965	4827.00		79.00
1966	3425.00	1.00	87.00
1967	1335.00	1.00	91.00
1968	1949.00	2.00	98.00
1969	2171.00	3.00	98.00
1970	2027.00	4.00	116.00
1971	2153.00	6.00	107.00
1972	2171.00	9.00	109.00
1973	1750.00	9.00	109.00
1974	1645.00	15.00	115.00
1975	1634.00	16.00	111.00
1976	1680.00	45.00	114.00
1977	1011.00	28.00	111.30
1978	837.00	27.00	111.20
1979	900.10	28.00	111.00
1980	822.00	42.36	112.00
1981	1011.00	157.90	71.90
1982	990.00	64.82	45.40
1983	1512.47	188.80	78.50
1984	1053.59	94.35	65.50
1985	1614.57	71.63	43.00
1986	1494.06	112.43	32.20
1987	1425.93	88.41	37.60
1988	1088.27	278.36	29.00
1989	1681.59	130.56	16.60
1990	1498.65	135.74	24.50
1991	1526.37	81.69	19.10
1992	1358.28	82.67	21.50
1993	1429.23	85.16	29.70
1994	1993.26	90.36	30.10
1995	1659.50	79.46	22.00
1996	1478.39	70.86	24.00
1997	1354.58	66.57	9.00
1998	1485.25	190.26	6.20
1999	1478.25	84.58	6.20
2000	1276.61	89.61	1.70
2001	872.76	101.59	3.50
2002	756.06	143.23	6.15
2003	646.09	84.99	0.78
2004	685.15	55.89	1.25
2005	593.97	59.99	1.43
2006	373.38	71.15	2.14
2007	553.48	45.76	1.27
2008	532.68	99.13	2.04
2009	557.61	96.73	2.02
2010	363.09	64.76	5.77
2011	57.11		

Table 3. Information on white marlin live discards by CPC.

Year				*2004*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Species	*Stock*	*Flag*	*GearGrp*							
BUM	ATN	Mexico	LL		0.426	0.747	0.93	1.08	0.65	0.935
		U.S.A.	LL					58.327	29.328	
		UK.Turks and Caicos	RR	2.339						
	ATS	Brasil	LL		46.524	57.863	19.48			
			SP		0.396					
BUM Total				2.339	47.346	58.61	20.41	59.407	29.978	0.935
SAI	ATW	Brasil	LL		10.68	5.102	2.31			
			SP		2.058					
		Mexico	LL		0.065	0.088	0.07	0.058	0.087	0.129
SAI Total					12.803	5.19	2.38	0.058	0.087	0.129
WHM	ATN	Mexico	LL		0.025	0.428	0.3	0.291	0.227	0.16
		U.S.A.	LL						14.763	
			UN					5.781	0.057	
	ATS	Brasil	LL		14.779	24.428	5.84			
			SP		0.052					
		Korea Rep.	LL						0.198	
WHM Total					14.856	24.856	6.14	6.072	15.245	0.16

Table 4. Catch rates (tons per million hooks) for major longline fleets calculated across 1995-1997, and the resulting tonnage increases from reported Task I when multiplying these catch rates by the reported yearly effort (in millions of hooks), by fleet.

1995-1997 catch per hook	*Brasil*	*Chinese Taipei*	*EU.España*	*Japan*	*Korea Rep.*	*Uruguay*	*Venezuela*	
	9.72	6.03	1.61	0.69	9.43	12.51	35.74	
Year	*Estimated INCREASE in total removals, in tons (upper estimate - reported Task I catch)*							*Total Increase*
1998	11	131	0	16	9	0	97	264
1999	0	372	0	23	11	12	12	430
2000	91	447	0	0	53	15	78	684
2001	108	680	0	0	0	15	27	830
2002	0	628	26	31	2	23	0	710
2003	0	845	13	30	0	25	47	960
2004	71	552	0	27	0	35	84	769
2005	0	470	0	23	29	34	0	556
2006	0	315	0	12	33	10	52	422
2007	0	373	0	31	0	8	84	496
2008	0	315	0	25	12	10	45	406
2009	0	377	16	3	14	23	74	507
2010	0	385	0	1	90	29	80	584

Table 5. Previously published studies that estimate the tropical purse seine by-catch.

Study	*Period of observation*	*Number of observer days (trips)*	*Number of sets*	*Observed fleet*	*Period of estimation*
Delgado el al 2001	1997-1999	2,706 (62)	1191 FS 693 FAD	EU-Spain EU-France	1991-1999
Gaertner et al 2002	1997-1999	2,706 (62)	859 FS 379 FAD 40 Other	EU-Spain EU-France	1991-2000
Delgado et al 2005	2001-2004	2,049	1495	EU-Spain	2001-2003
Amande et al 2011	2003-2007	(27)	301 FS 297 FAD	EU-Spain EU-France	2003-2007

Table 6. Summary of data on species composition of billfish by-catch from published studies.

			Delgado et al 2005	*Chassot 2009*	*Amande 2010*
Free Schools	Number billfish	Observed			429
		Identified			415
	Number WHM			0	2
	% WHM	Number		0	0.5
		weight	0.3	0	1.8
FAD Schools	Number billfish	Observed			152
		Identified			133
	Number WHM			0	4
	% WHM	Number		0	3.0
		weight	11.3	0	3.3
Total	Number billfish	Observed	208		681
		Identified	161		548
	Number WHM		23	0	6
	% WHM	Number		0	
		weight	3.1	0	
Weight of billfish sampled				9.3	26.6
Average WHM weight					

Table 7. Estimated catches of billfish and white marlin from the purse seine fishery for the period 2000-2010.

	Year	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
All billfish	FAD											
	Free School											
	Total	512	564	508	575	520	424	421	349	399	484	455
WHM	FAD											
	Free School											
	Total	12	13	12	13	13	11	10	9	10	10	12

Table 8. White marlin indexes of abundance. Refer to text for detailed explanation of each index.

	SPAIN-LL		TAI-LL	JPN-LL	JPN-LL	USA-LL				VEN-Gill		VEN-LL		USA-Rec				BRA-LL		VEN-Sport
	# fish		# fish	# fish	# fish	# fish		Biomass		Biomass		# fish		# fish		Biomass		# fish		# fish
	CPUE	SE	CPUE	CPUE	CPUE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	CV	CPUE	CV	CPUE	SE	CPUE
1959					0.394															
1960					0.663															
1961					1.545															1.194
1962					3.279															0.826
1963					3.120															0.61
1964					2.461															1.272
1965					2.213															1.18
1966					2.628															0.925
1967			0.165		2.259															1.148
1968			0.304		1.861															0.646
1969			0.311		1.897															0.296
1970			0.324		1.521															0.496
1971			0.345		1.056															2.433
1972			0.214		1.355															0.797
1973			0.259		0.778									1.560	0.620	41.500				1.399
1974			0.317		1.009									1.400	0.570	35.300				0.357
1975			0.249		0.667									1.260	0.470	31.400				1.34
1976			0.094		0.766									1.280	0.440	31.600				0.853
1977			0.094		1.030									0.870	0.480	21.000				0.355
1978			0.099		1.082									1.310	0.430	32.600		0.589	0.091	0.175
1979			0.119		1.317									1.810	0.440	42.800		1.103	0.151	0.387
1980			0.178		0.704									2.560	0.420	61.100		0.518	0.078	1.152
1981			0.187		0.674									2.110	0.390	50.500		0.501	0.073	0.692
1982			0.147		0.484									2.010	0.400	46.900		0.151	0.025	0.744
1983			0.171		0.439									1.770	0.400	40.800		0.211	0.039	0.644
1984			0.141		0.519									1.690	0.380	40.000		0.182	0.029	0.442
1985			0.142		0.399									1.110	0.390	27.000		0.156	0.031	0.445
1986			0.186		0.458									0.940	0.430	22.800		0.416	0.055	0.208
1987			0.210		0.466									1.010	0.420	24.600		0.258	0.035	0.23
1988	0.121	0.039	0.178		0.465									0.960	0.430	23.200		0.238	0.033	0.246
1989	0.118	0.043	0.190		0.464									0.740	0.460	16.500		0.151	0.026	0.158
1990	0.049	0.017	0.128	0.011	0.278									0.820	0.420	21.800		0.526	0.093	0.051
1991	0.045	0.014	0.084	0.012	0.250					2.542	0.742	0.689	0.524	0.810	0.460	19.700		0.305	0.050	0.056
1992	0.014	0.006	0.108	0.007	0.302	0.722	0.286	13.669	5.171	1.456	0.470	0.451	0.284	0.730	0.460	18.900		0.531	0.084	0.028
1993	0.016	0.006	0.226	0.007	0.373	0.688	0.227	11.896	3.702	1.936	0.590	0.636	0.356	0.610	0.500	15.800		0.194	0.048	0.015
1994	0.021	0.006	0.332	0.004	0.253	0.307	0.121	6.811	2.553	7.172	1.904	0.588	0.356	0.620	0.490	16.100		0.195	0.038	0.127
1995	0.039	0.010	0.219	0.001	0.182	0.736	0.243	14.864	4.600	3.627	1.014	0.960	0.412	0.900	0.450	23.200		0.431	0.065	1.08
1996	0.113	0.029	0.214	0.001	0.152	0.403	0.152	8.866	3.183	1.297	0.453	0.352	0.197	0.670	0.460	18.100		1.232	0.183	
1997	0.150	0.337	0.199	0.002	0.137	0.450	0.167	9.452	3.334	1.225	0.412	0.499	0.261	0.660	0.480	17.900		0.541	0.069	
1998	0.200	0.042	0.134	0.001	0.099	0.415	0.169	9.920	3.849	3.099	0.882	0.573	0.292	0.690	0.480	20.600		0.302	0.041	
1999	0.029	0.010	0.131	0.003		0.836	0.273	18.645	5.721	5.394	1.457	0.449	0.294	0.600	0.490	15.800		0.707	0.085	
2000	0.029	0.010	0.122	0.002		0.528	0.194	10.141	3.529	3.704	1.034	0.197	0.137	0.360	0.550	10.400		0.577	0.067	
2001	0.051	0.017	0.128	0.001		0.286	0.113	6.454	2.442	2.298	0.681	0.136	0.106	0.460	0.510	12.800		0.172	0.022	
2002	0.002	0.001	0.137	0.000		0.530	0.189	10.151	3.415	3.225	0.913	0.196	0.129	0.660	0.480	19.100		0.110	0.021	
2003	0.046	0.018	0.109	0.000		0.244	0.094	3.787	1.389	3.511	0.985	0.459	0.216	0.200	0.580	6.400		0.094	0.025	
2004	0.035	0.010	0.090	0.001		0.535	0.181	9.843	3.118	5.275	1.428	0.417	0.233	0.720	0.450	21.500		0.277	0.035	
2005	0.038	0.011	0.099	0.000		0.658	0.218	12.317	3.819	5.343	1.445	0.342	0.196	0.760	0.470	22.600		0.291	0.033	
2006	0.035	0.013	0.111	0.001		0.359	0.133	7.285	2.544	5.124	1.390	0.276	0.165	0.870	0.470	26.800		0.286	0.032	
2007	0.046	0.013	0.095	0.003		0.294	0.107	5.895	2.021	5.858	1.574	0.597	0.355	0.440	0.520	13.100		0.965	0.115	
2008	0.026	0.139	0.084	0.001		0.290	0.104	6.410	2.154	4.205	1.159	0.651	0.435	0.590	0.500	18.900		0.418	0.079	
2009	0.003	0.001	0.082	0.001		0.526	0.171	11.583	3.496	3.580	1.002	0.204	0.200	0.760	0.500	23.700		0.149	0.021	
2010	0.008	0.003	0.083			0.322	0.115	6.926	2.331	2.293	0.680	0.608	0.350	0.700	0.520	22.000		0.620	0.084	
2011						0.890	0.272	17.883	5.054									0.507	0.059	

Table 9. Elements for assessing CPUE series for their inclusion in assessment models and scores assigned.

ELEMENT	DESCRIPTION	SUFFICIENCY SCORE (1 is poor, 3 is best)											
		1	2	3	TAI-LL	VEN - GILL	VEN-LL	VEN-Sport	US-LL	US-Rec	JP-LL	JP-LL	BR-LL
1	Diagnostics	No Diagnostics or assumptions clearly violated		Full Diagnostics and assumptions fully met.	2	3	2	1	2	2	1	1	2
2	Appropriateness of data exclusions and classifications (e.g. to identify targeted trips).	Not approriate		Fully Appropriate	N/A	N/A	N/A	N/A	N/A	3	2	2	N/A
3	Geographical Coverage	Small localized fishery/survey		Represents geographic range of population	3	1	2	1	2	2	2	3	2
4	Catch Fraction relative to the total catch of the stock	Small		Large	3	1	2	1	2	1	3	3	2
5	Length of Time Series relative to the history of exploitation.	Short		Long	3	2	2	2	2	2	1	2	2
6	Are other indices available for the same time period?	Many		It is the only available index	2	1	1	1	1	1	1	3	2
7	Does the index standardization account for known factors that influence catchability/selectivity?	No		Fully	2	N/A	2	1	2	1	2	1-2	2
8	Are there conflicts between the catch history and the CPUE response?	Yes		No	2	3	?	3	3	3	3	2	2
9	Is the interannual variability outside biologically plausible bounds (e.g. SCRS/2012/039)	Frequently		Seldom	3	2	1	1	2	3	3	2	1
10	Are biologically implausible interannual deviations severe? (e.g. SCRS/2012/039)	Very Severe		Minimal	?	?	?	?	?	?	?	1	1
11	Assessment of data quality and adequacy of data for standardization purposes (e.g. sampling design, sample size, factors considered)	Low		High	1	2	2	1	3	2	1	1	2
12	Is this CPUE time series continuous?	Very Discontinuous		Completely	3	3	3	3	3	3	3	3	3
13	Were all catches (retained and not retained fish) included in the estimation of the CPUE?	No		Dead/live accounted for	3	3	3	1	3	3	1 and 3*	3	1

* a score of 3 was assigned to the period 1999-2000 and a score of 1 to the period 2001-2009

Table 10. Description of ASPIC Cases attempted. Cases in grey boxes were run with the ASPIC bootstrap routine.(*) cases that required fixing parameters to help convergence.

Case number	*Parameters fixed*	*Catch series*	*Converged*	*(Number of indices); abundance indices used*
1b	q Japan q Taiwan	Task 1	Y(*)	(6) Longline Japan early, Longline Taiwan, Longline US, Longline Venezuela, Recreational US, Gillnet Venezuela
1c	q Japan q Taiwan	Upper estimate		
1d	q Japan q Taiwan	Lower estimate		
18d	q Taiwan	Task 1	Y(*)	(5) Longline Taiwan, Longline US, Longline Venezuela, Recreational US, Gillnet Venezuela
7	none	Task 1	Y	(5) Longline Japan early , Longline US, Longline Venezuela, Recreational US, Gillnet Venezuela
17	none	Task 1	Y	(4) Longline US, Longline Venezuela, Recreational US, Gillnet Venezuela
15	none	Task 1	Y	(3) Longline Venezuela, Longline US, Gillnet Venezuela
13	none	Task 1	Y	(2) Longline Venezuela, Gillnet Venezuela
2	none	Task 1	N	(1)Longline Japan early
3	none	Task 1	Y	(1)Recreational US
4	none	Task 1	N	(1)Longline Taiwan
5	none	Task 1	N	(1) US Longline
11	none	Task 1	N	(6) Longline Japan early, Longline Taiwan, Longline US, Longline Brasil, Longline Venezuela, Gillnet Venezuela
16	none	Task 1	y	Ven LL, US Br LL and GILLnet
C1	none	Task 1	Y	Combined (1)
C2	none	Upper estimate		
C3	none	Lower estimate		

Table 11. Management benchmark for the different ASPIC cases from 500 bootstraps. Estimates represent median and in parenthesis are shown 10 and 90 percentiles. Estimates for base case are shaded.

	Case 1b		*Case 1c*		*Case 1d*	
MSY (MT)	874	(795-976)	1,082	(994-1,169)	979	(873-1,058)
K (MT)	58,480	(54,530-61,440)	54,870	(51,550-58,700)	56,540	(53,270-60,930)
BMSY (MT)	29,240	(27,260-30,720)	27,440	(25,770-29,350)	28,270	(26,630-30,470)
FMSY	0.030	(0.027-0.035)	0.039	(0.034-0.045)	0.035	(0.029-0.040)
B2011/BMSY	0.50	(0.42-0.60)	0.51	(0.42-0.62)	0.50	(0.41-0.60)
F2010/Fmsy	0.99	(0.75-1.27)	1.85	(1.41-2.36)	1.47	(1.15-1.95)
Y eq. (MT)	659	(541-813)	817	(668-997)	737	(583-888)
Y fmsy (MT)	441	(438-444)	1004	(989-1169)	727	(718-733)
	Case 15		*Case 17*		*Case 18d*	
MSY (MT)	1,105	(261-1,353)	1,162	(579-1,350)	1,040	(952-1,118)
K (MT)	54,000	(34,940-148,300)	44,560	(33,450-89,150)	52,270	(48,730-55,870)
BMSY (MT)	27,000	(17,470-74,160)	22,280	(16,720-44,580)	26,130	(24,360-27,940)
FMSY	0.041	(0.004-0.072)	0.052	(0.014-0.081)	0.040	(0.034-0.046)
B2011/BMSY	0.86	(0.61-1.62)	0.66	(0.54-0.82)	0.66	(0.57-0.76)
F2010/Fmsy	0.46	(0.24-0.90)	0.57	(0.43-0.83)	0.64	(0.53-0.80)
Y eq. (MT)	1,084	(541-1,353)	1,029	(666-1,241)	917	(789-1,051)
Y fmsy (MT)	446	(435-465)	452	(436-465)	446	(443-448)
	Case c1		*Case c2*		*Case c3*	
MSY (MT)	853	(241-1,153)	633	(129-940)	806	(203-1,124)
K (MT)	60,410	(43,140-95,180)	81,410	(61,440-114,300)	66,830	(45,960-103,600)
BMSY (MT)	30,210	(21,570-47,590)	40,710	(30,720-57,150)	33,420	(22,980-51,790)
FMSY	0.028	0.005-0.054)	0.015	(0.002-0.029)	0.024	(0.004-0.048)
B2011/BMSY	0.53	(0.44-0.63)	0.49	(0.41-0.63)	0.50	(0.41-0.64)
F2011/Fmsy	0.97	(0.69-2.98)	3.24	(2.26-16.1)	1.79	(1.27-5.1)
Y eq. (MT)	665	(206-921)	468	(94-686)	606	(176-830)
Y fmsy (MT)	440	(430-452)	990	(969-1,004)	721	(710-734)

Table 12. Differences in SS model setup between base case (Run 1) and sensitivity runs.

	Catch scenario	*CPUE series*	*CPUE weight*
RUN 1	Task 1	All except JP short	CV = 0.3
RUN 2	Highest	All except JP short	CV = 0.3
RUN 3	Middle	All except JP short	CV = 0.3
RUN 4	Task 1	All except JP long	CV = 0.3
RUN 5	Task 1	All except JP short	Temporal weights

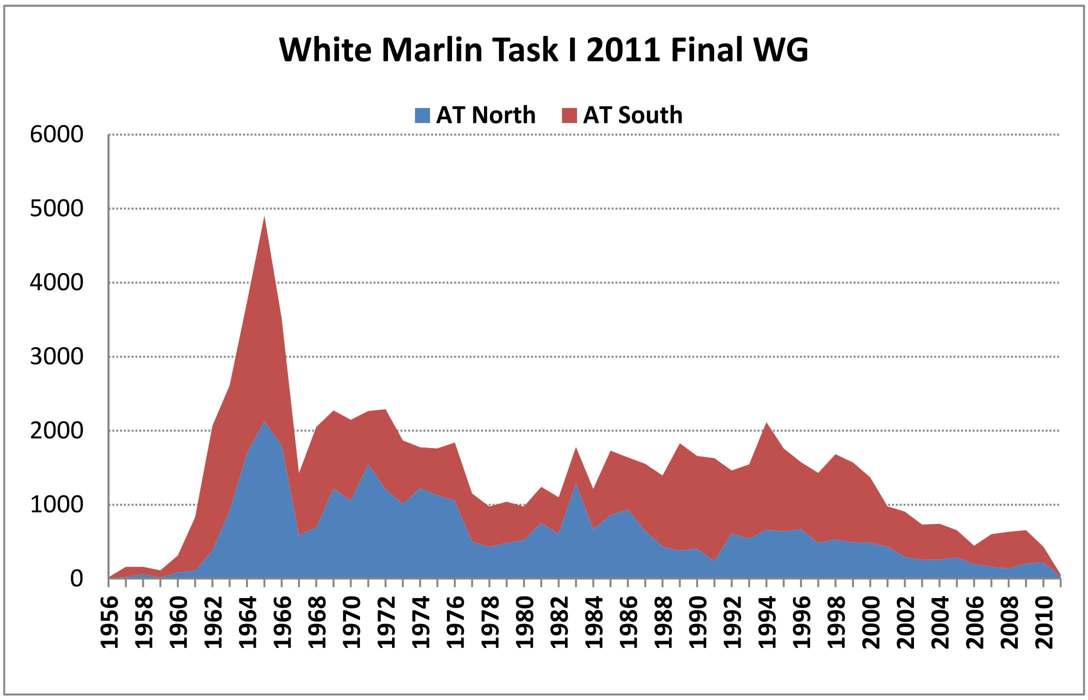


Figure 1. White marlin total catch (including dead discards) by North and South Atlantic.

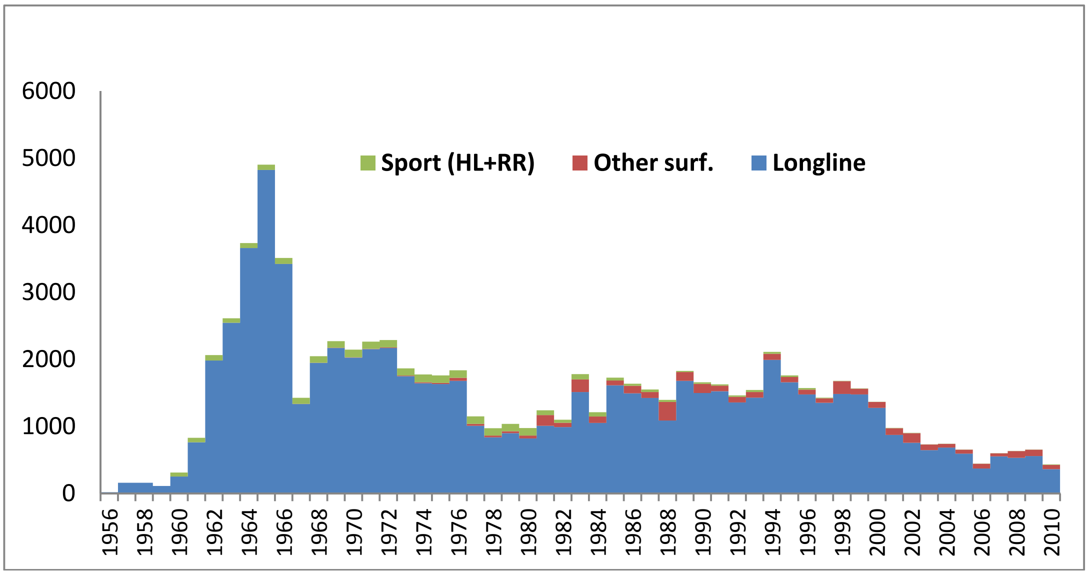


Figure 2. White marlin total catch (including dead discards) by main gears.

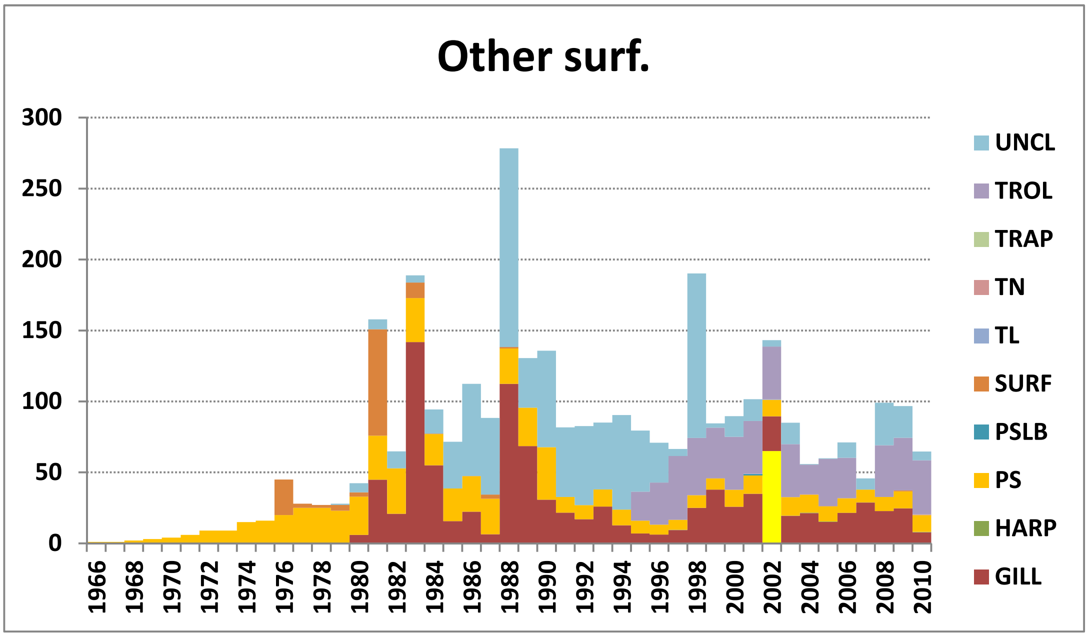


Figure 3. White marlin total catch (including dead discards) by other surface gears.

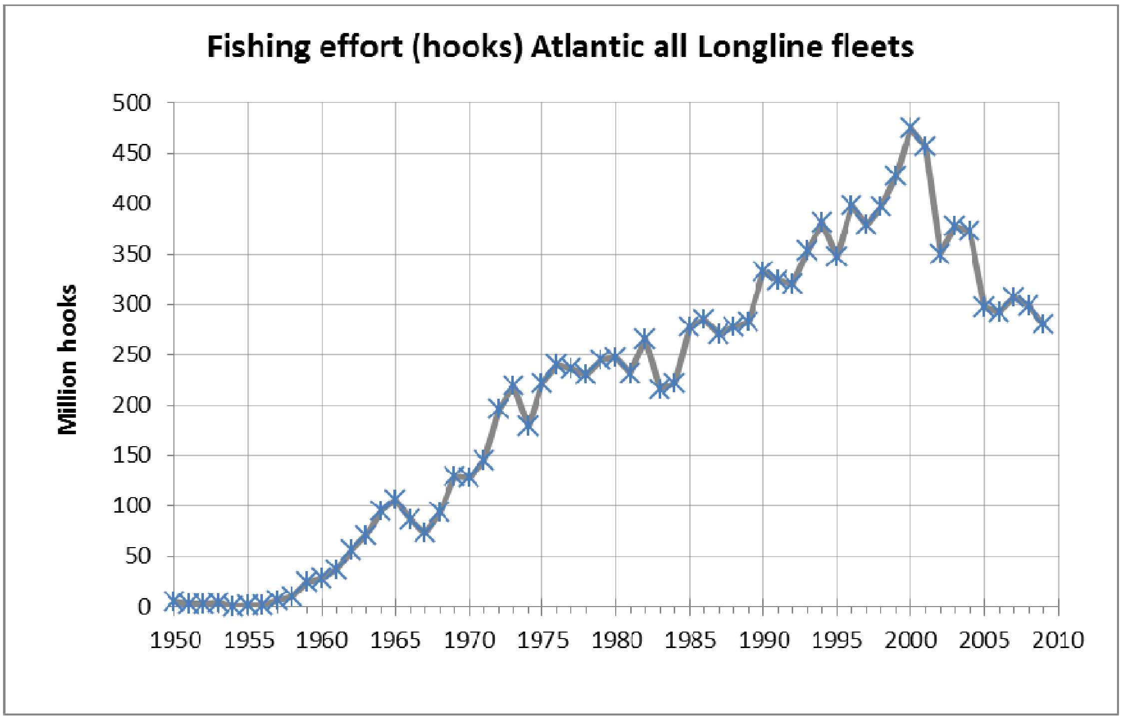


Figure 4. Estimated total Atlantic fishing effort (millions of hooks) by year for the longline fleet. These estimates do not include the Mediterranean fisheries.

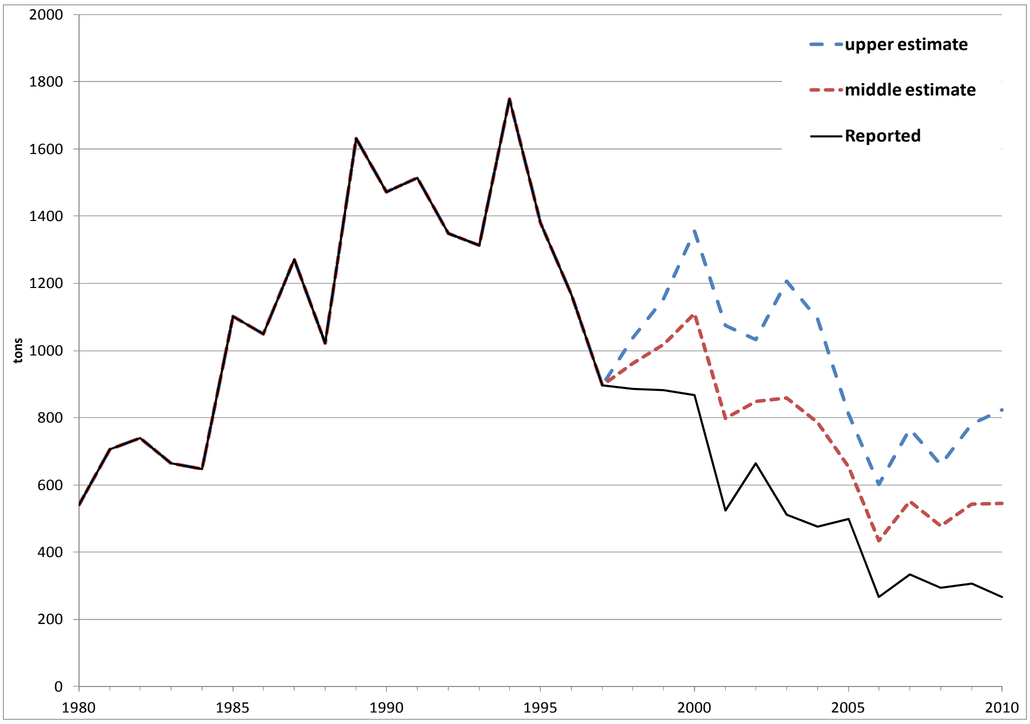


Figure 5. Catch of the major longline fleets (Brazil, Chinese Taipei, EU. Spain, EU. Portugal, Japan, Korea Rep., U.S.A., Uruguay and Venezuela) under each scenario (reported Task I, an upper estimated calculated from 1995-1997 catch rates and reported effort for each year after 1997, and a middle estimate which is the mean of reported Task I and the upper estimate).

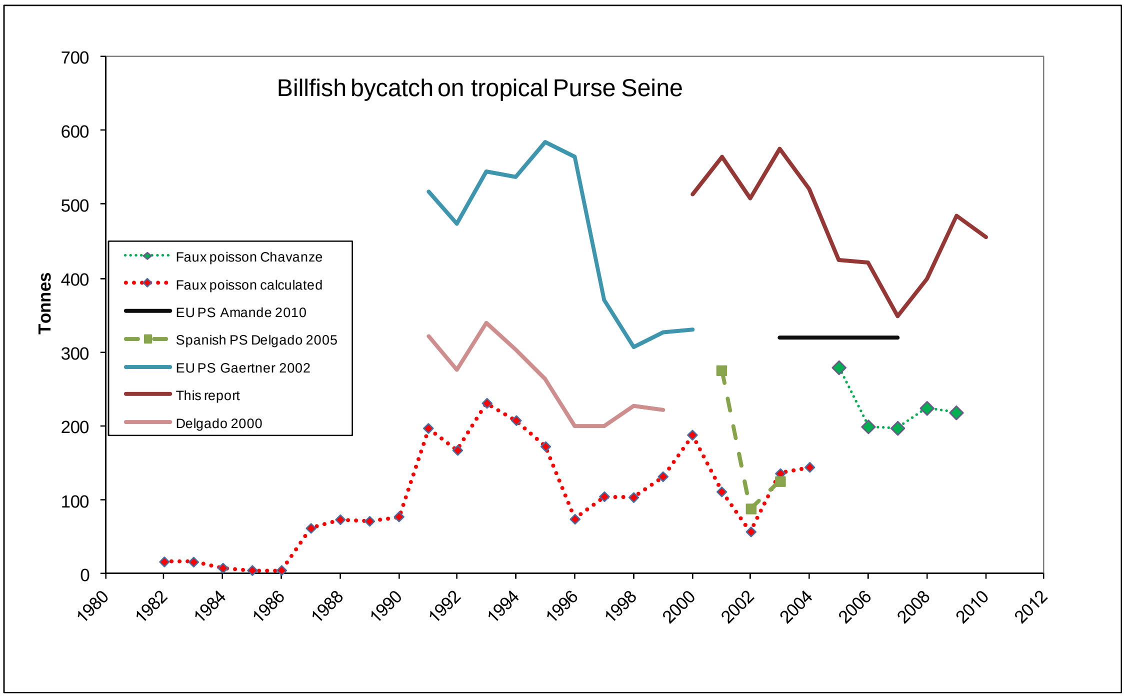


Figure 6. Estimated billfish bycatch in the tropical purse seine fishery from various studies and from current report. Note that "faux poisson" estimates represent landings in Abidjan only and the other estimates represent all billfish caught, retained and discarded.

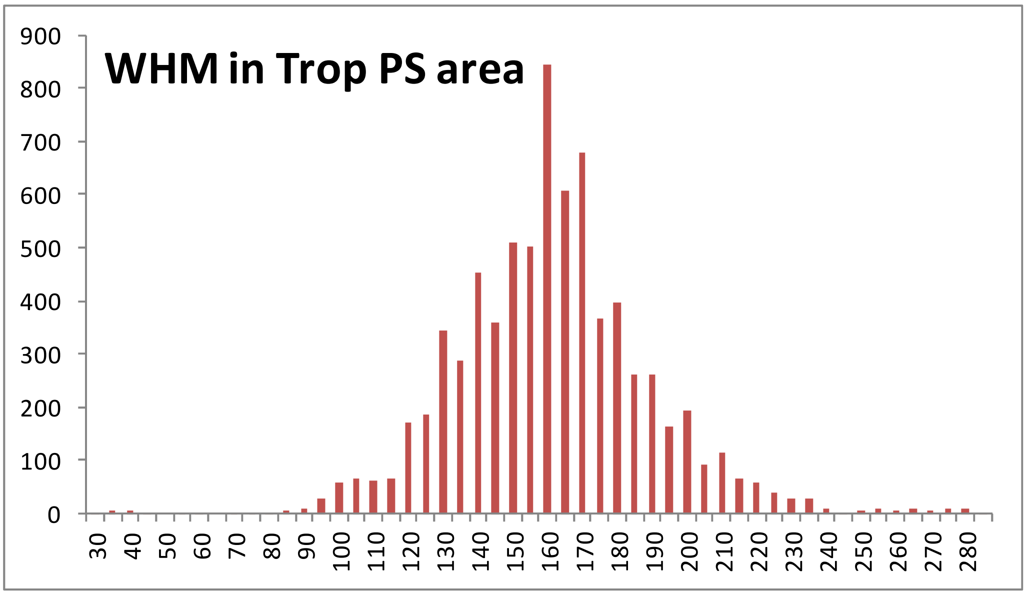


Figure 7. Length frequency distribution of white marlin for all years and all gear combined obtained from task II for the region between 10N and 10 S and 25W and 10E .

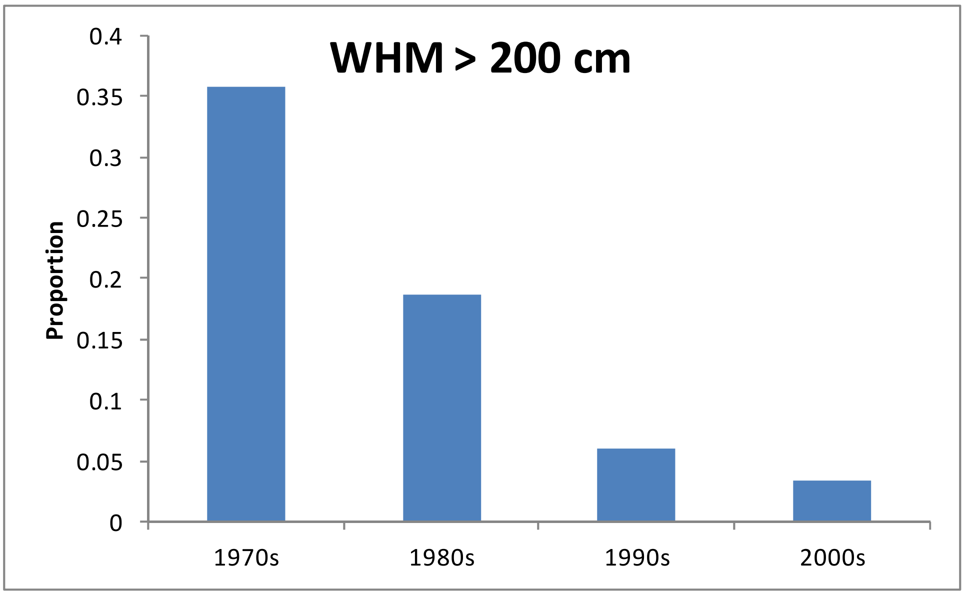


Figure 8. Proportion of white marlin that are were greater than 44 Kg (LJFL > 200 cm) by decade for all gear combined obtained from task II for the region between 10N and 10 S and 25W and 10E .

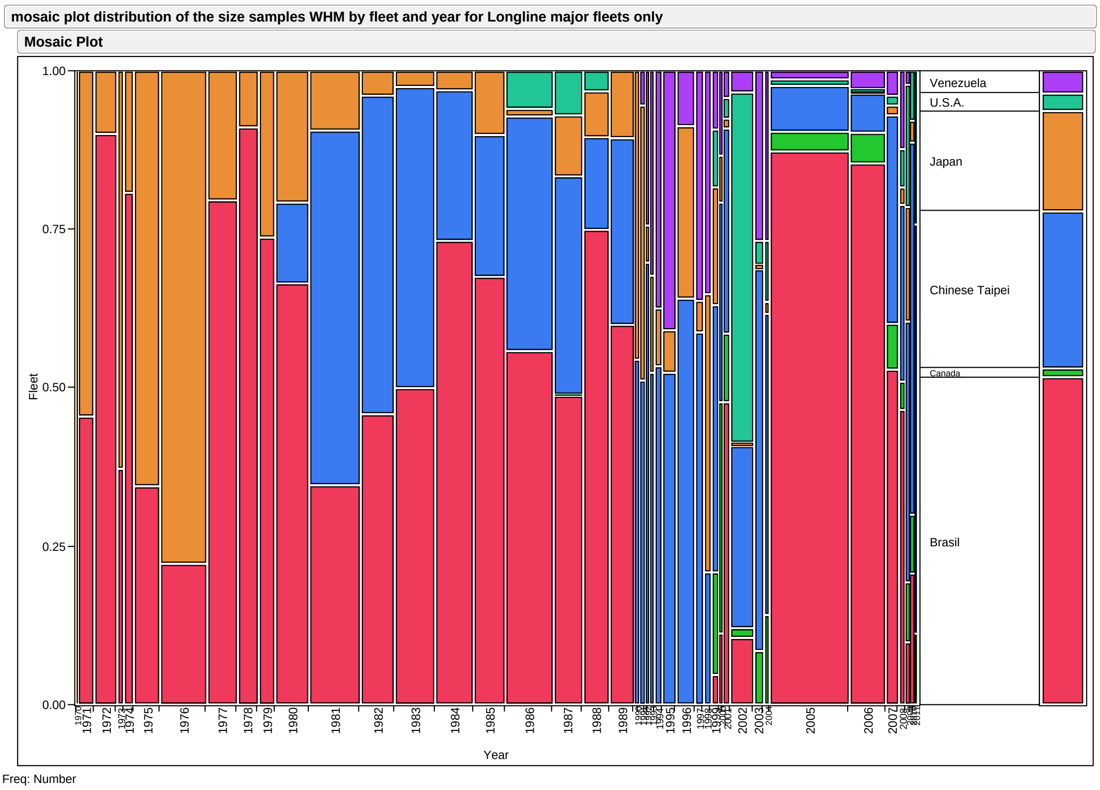


Figure 9. Mosaic plot of the distribution of size samples for white marlin by year and major fleet.

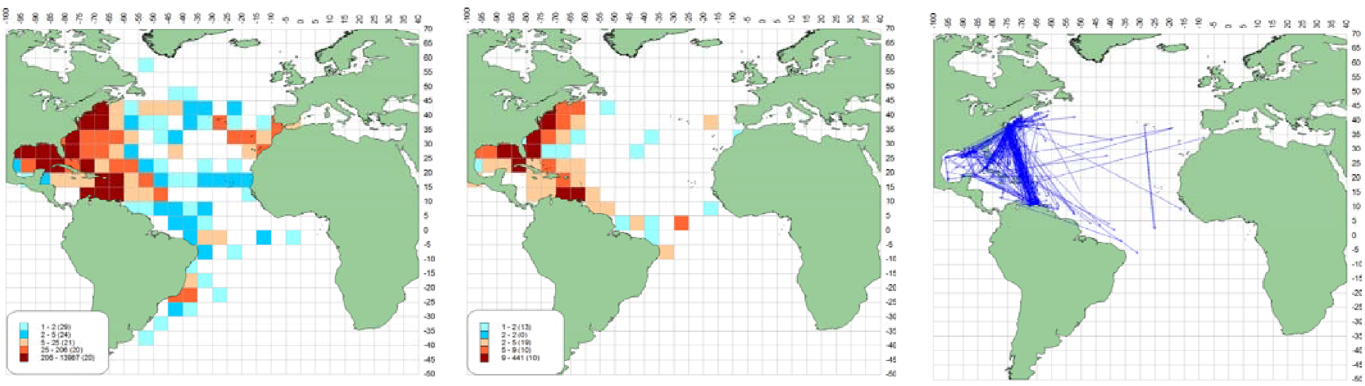


Figure 10. White marlin tag releases and recaptures.

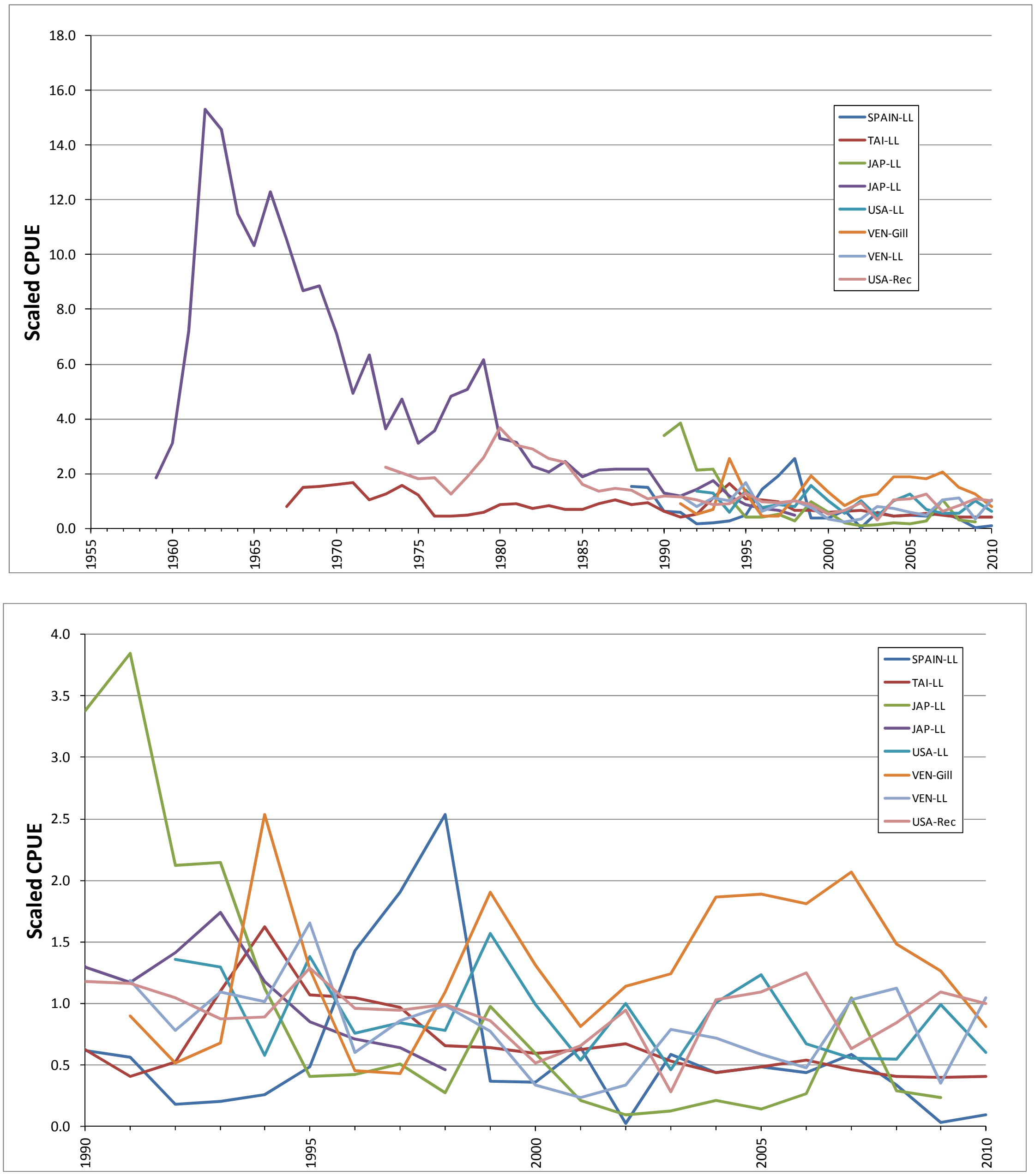


Figure 11. Standardized CPUE series for the white marlin assessment. Upper panel shows the entire time series 1959-2010; while lower panel shows the latest period of the time series (1990-2010).

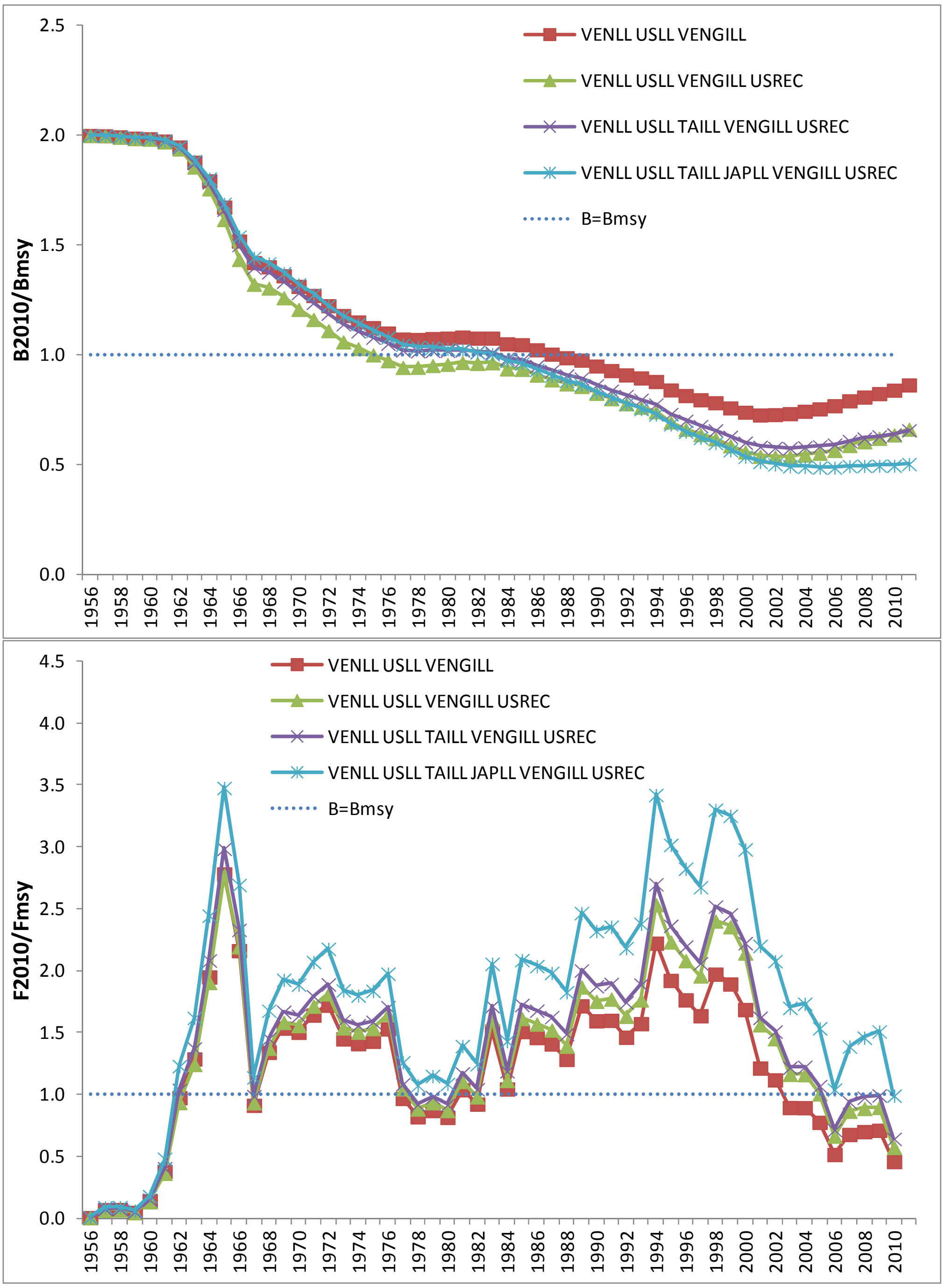


Figure 12. Upper panel, Biomass ratio (B/B_{MSY}); lower panel, Fishing mortality at MSY ratio (F/F_{MSY}) for white marlin depending on the combination of CPUE indices used in ASPIC (cases 1b, 15, 17 and 18d).

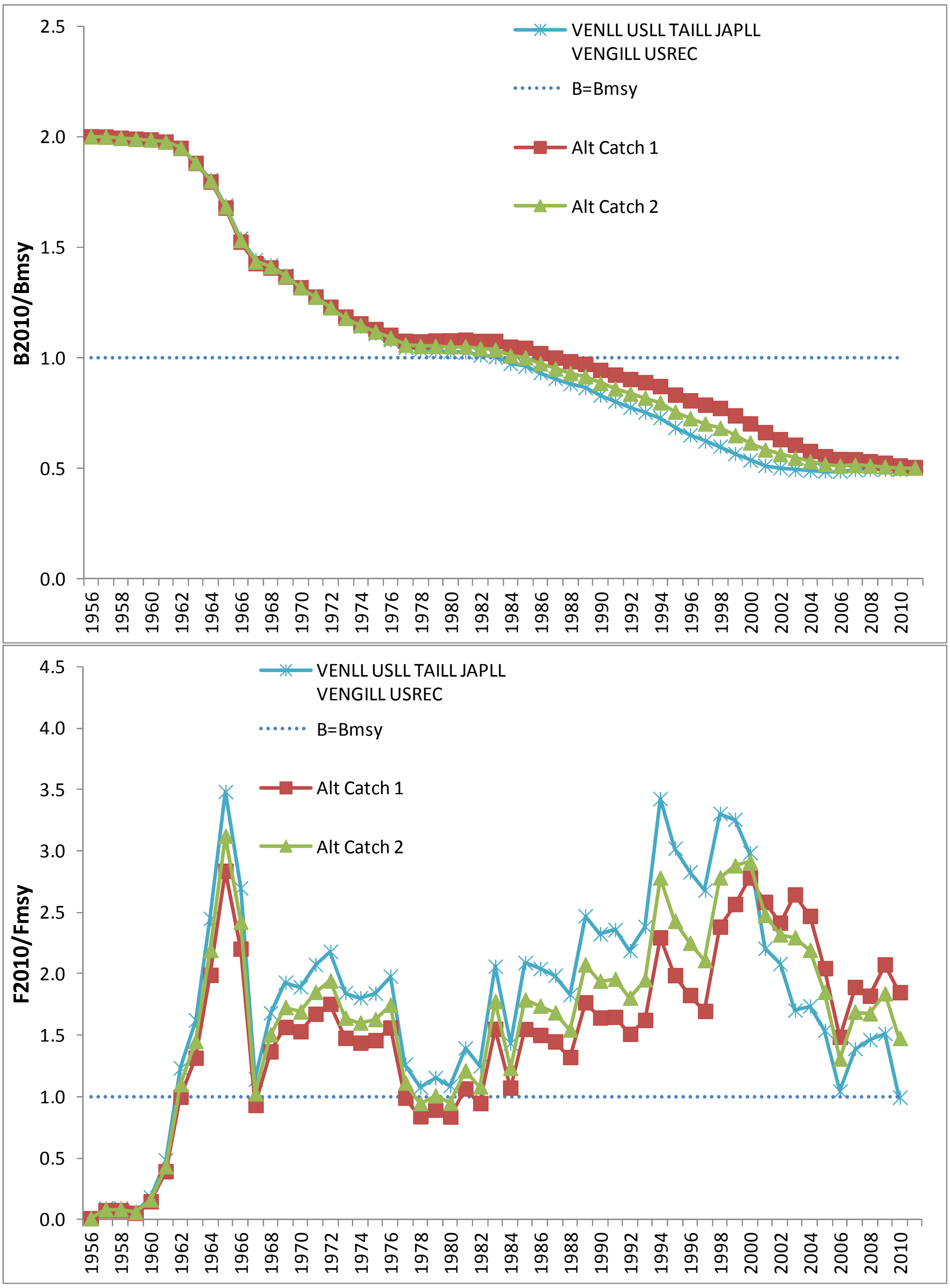


Figure 13. ASPIC fits considering different alternative estimates of the recent catch from longlines (Cases 1b, 1c and 1d). Upper panel, Biomass ratio (B/B_{MSY}); lower panel, Fishing mortality at MSY ratio (F/F_{MSY}).

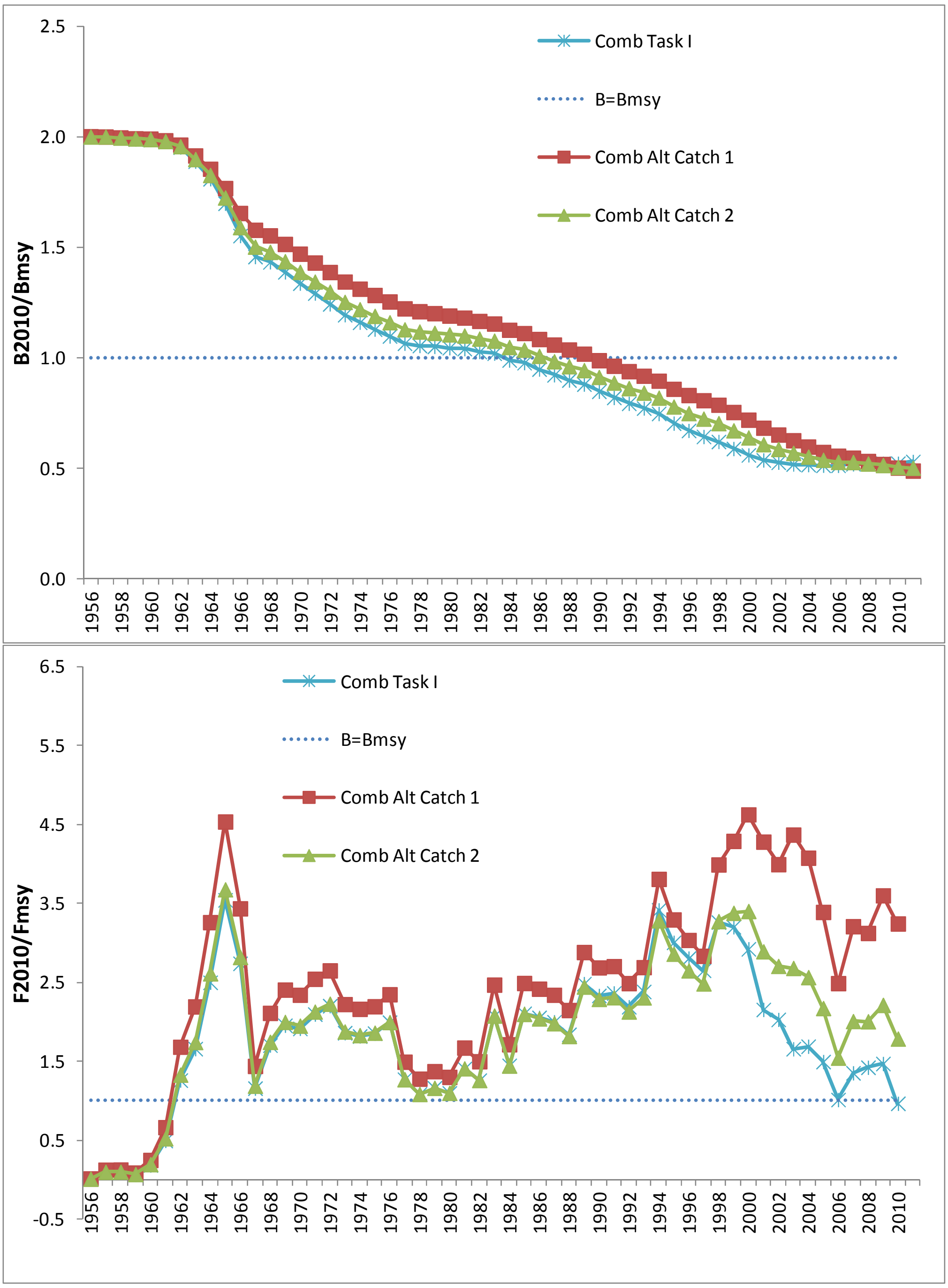


Figure 14. ASPIC fits to the combined index and considering different alternative estimates of the recent catch from longlines (Cases c1, c2 and c3). Upper panel, Biomass ratio (B/B_{MSY}); lower panel Fishing mortality at MSY ratio (F/F_{MSY}).

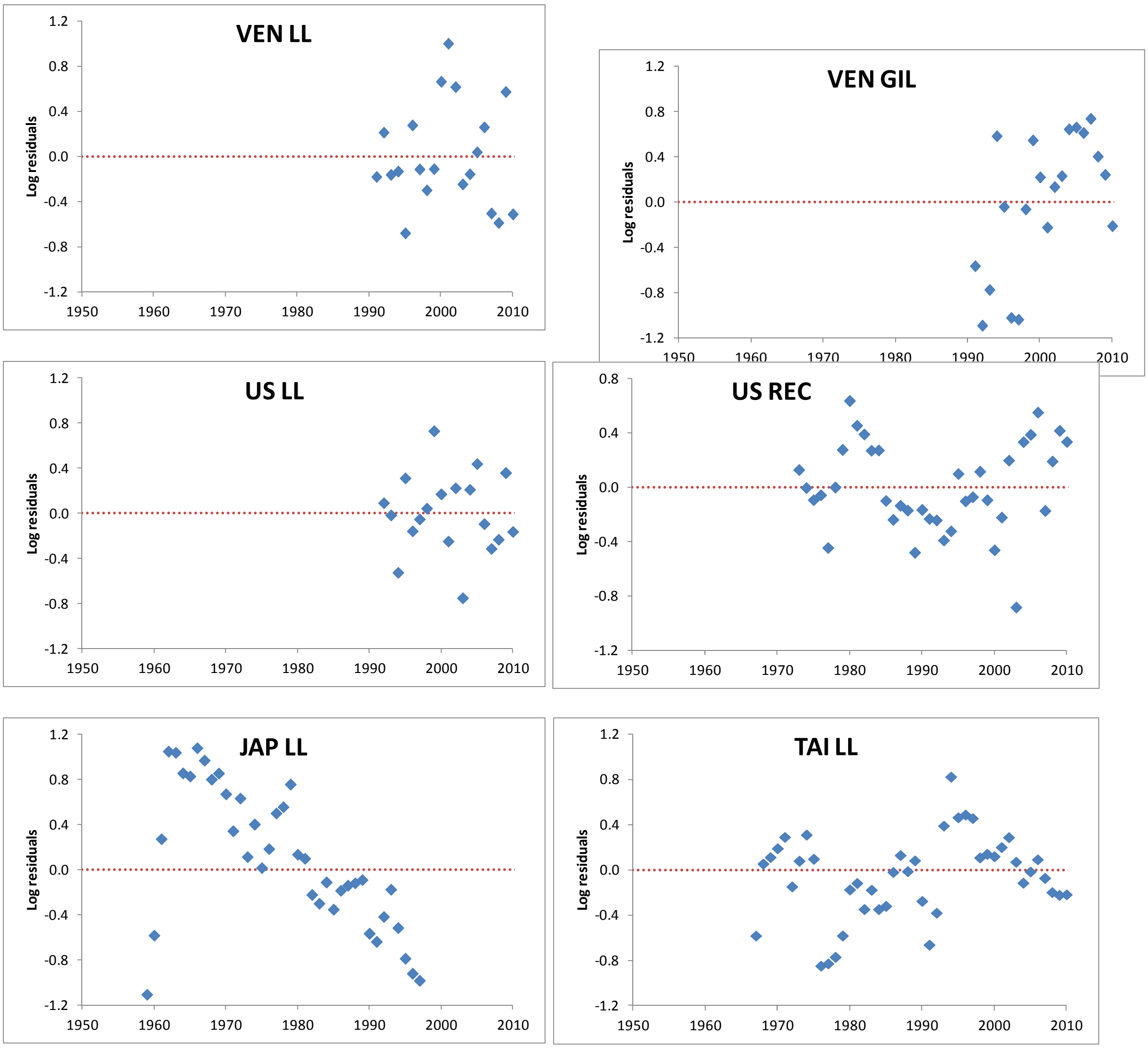


Figure 15. Residuals (log scale) of the ASPIC fit for each of the six CPUE indices used in case 1b.

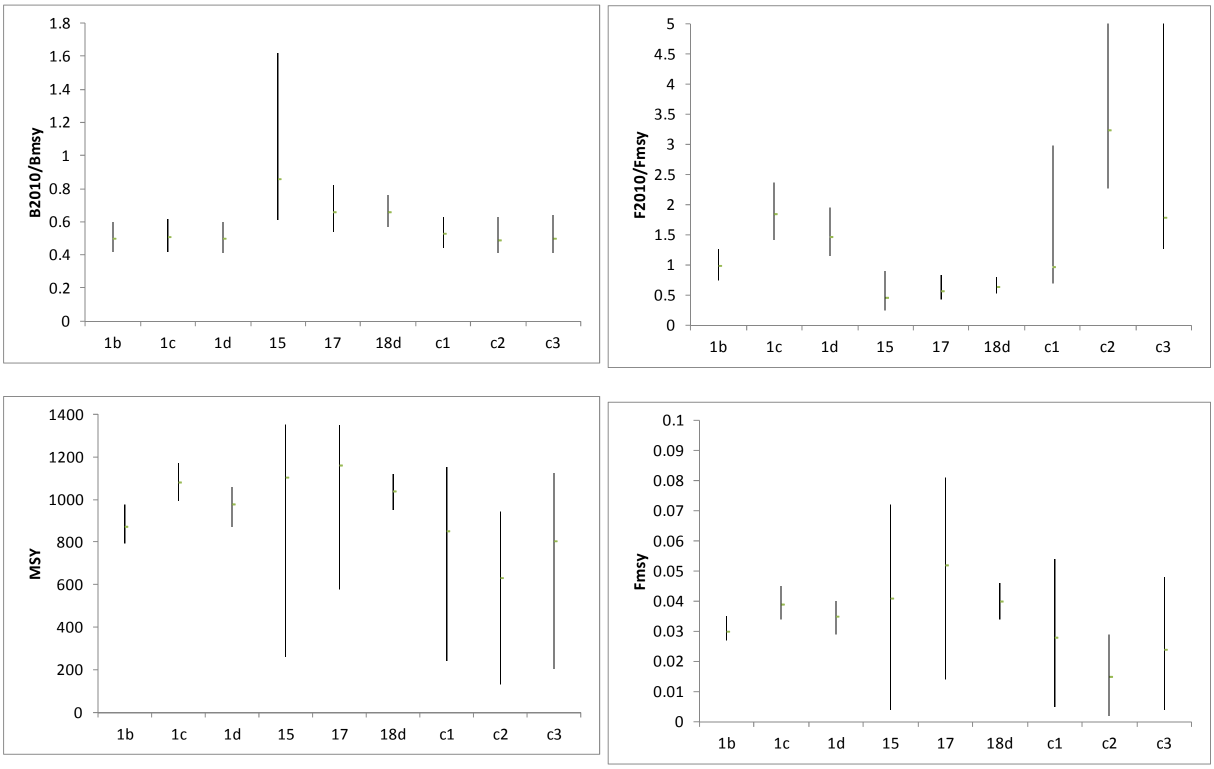


Figure 16. Management benchmark estimates for the different ASPIC cases. Upper left panel, Biomass ratio (B/B_{MSY}); upper right panel Fishing mortality at MSY ratio (F/F_{MSY}); lower left panel MSY (MT) and lower right panel F_{MSY}. Vertical lines represent 10 and 90 percentiles and horizontal line the median. Note that the 90 percentile for the overfishing ratio of case c2 (16.1) is truncated in the figure to facilitate the view of the ratios for other cases.

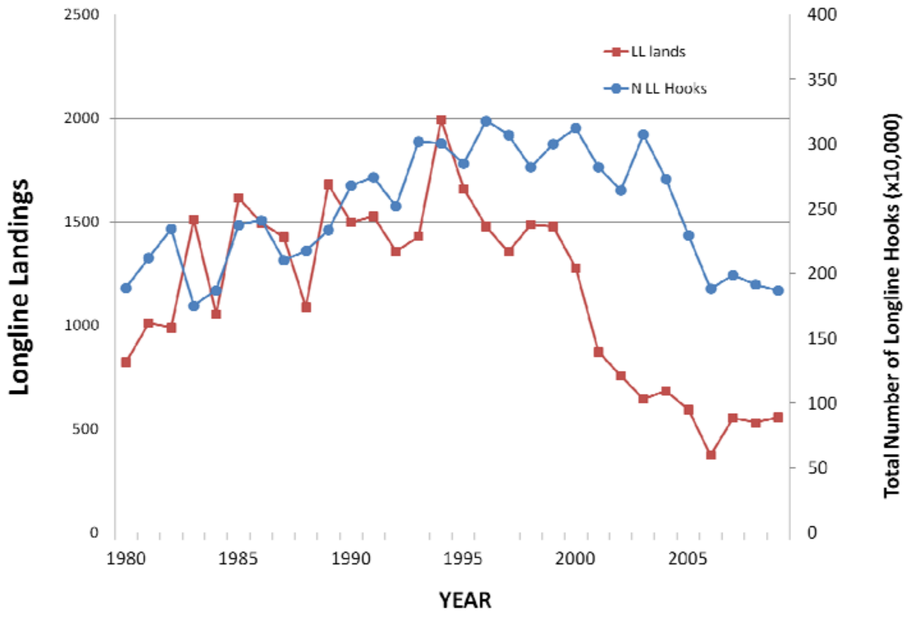


Figure 17. Task I landings of white marlin and the sum of the number of longline hooks reported by Brazil, Chinese Taipei, Spain, Portugal, Japan, Korea, USA, Uruguay, and Venezuela, 1980-2009.

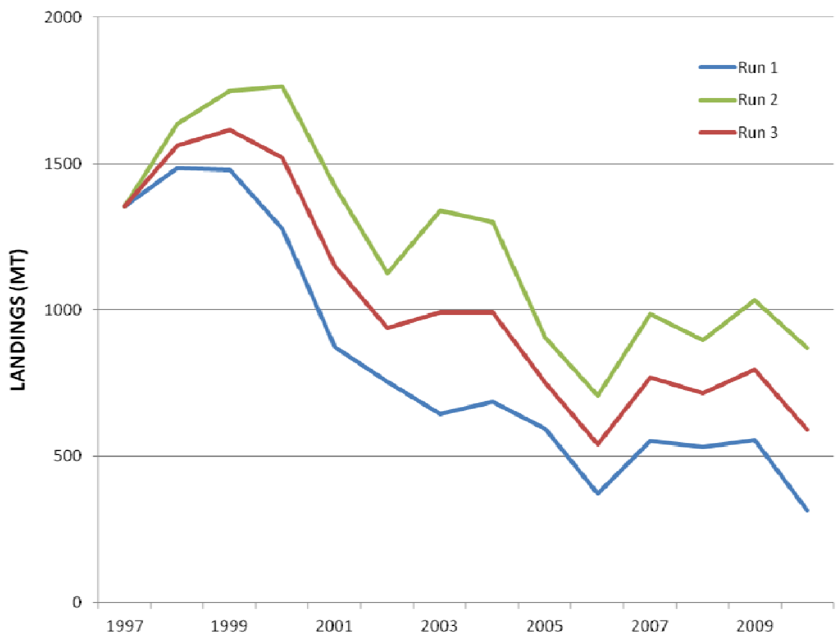


Figure 18. The three levels of estimated cryptic landings for 1997-2010 used in the assessment model sensitivity runs.

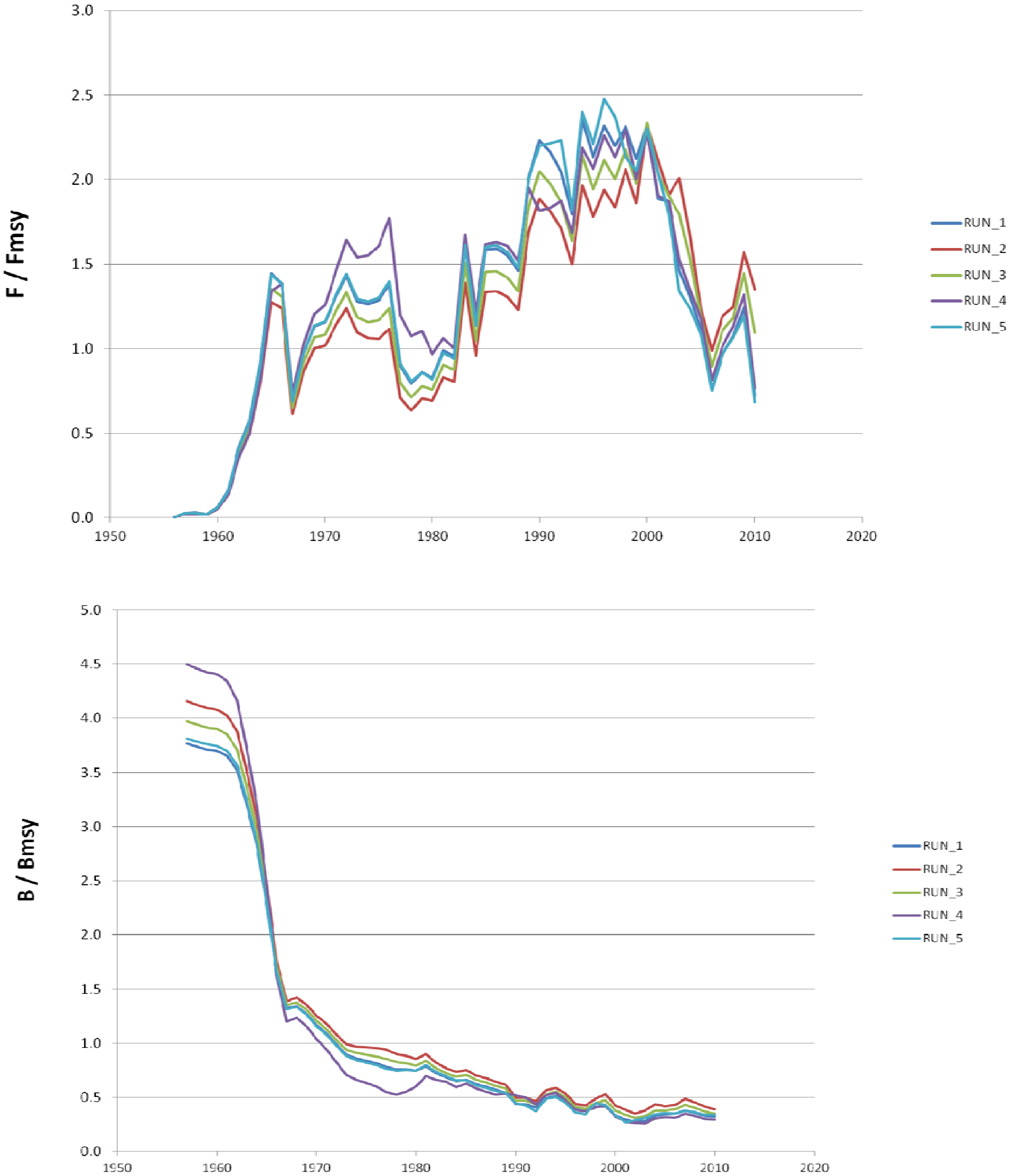


Figure 19. SS estimates of F/F_{MSY} (top) and B/B_{MSY} (bottom) from the base case (Run 1) and four sensitivity runs outlined in Table 12.

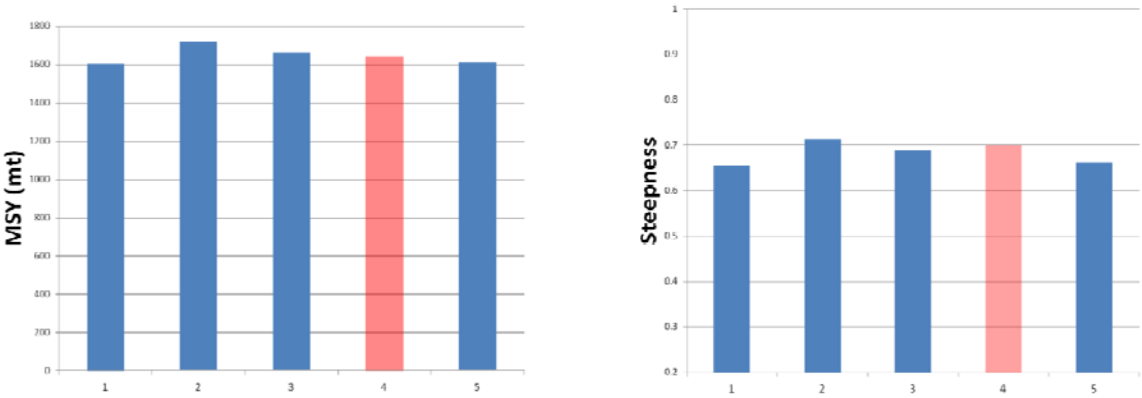
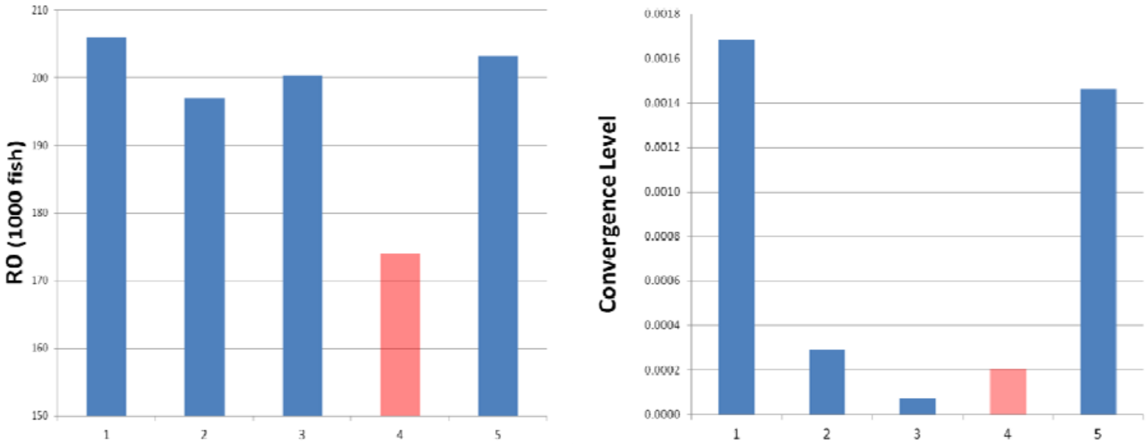
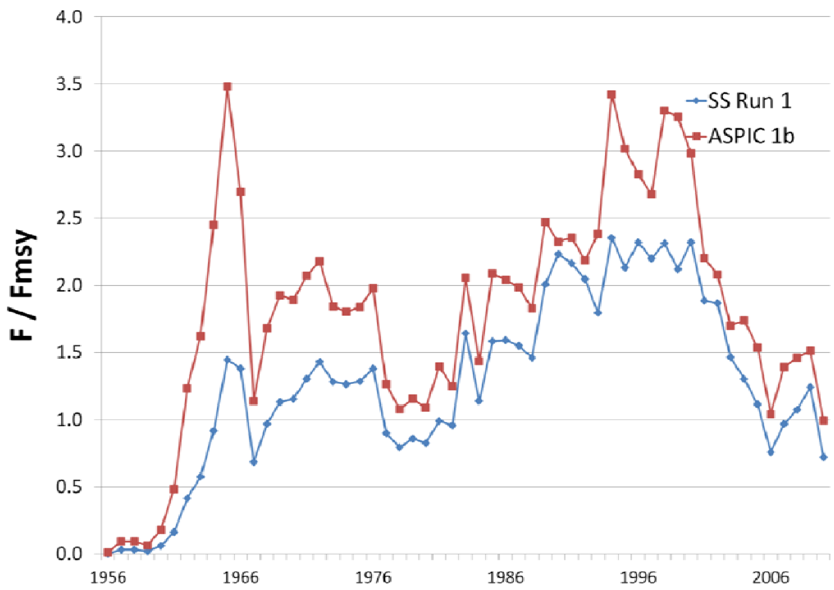


Figure 20. Estimates of MSY (upper left), steepness (upper right), log of virgin recruitment (lower left), and virgin recruitment (lower right) for the five sensitivity runs using SS Run 1 (Run 4 did not properly converge).





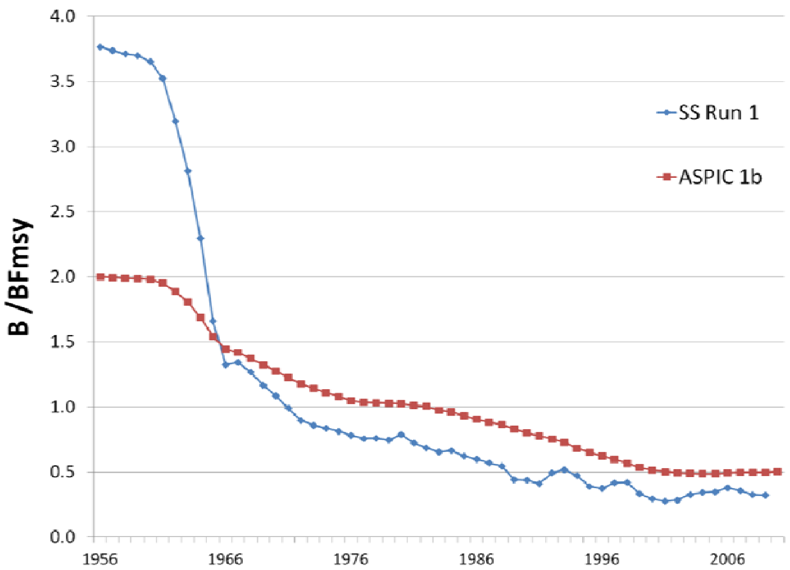
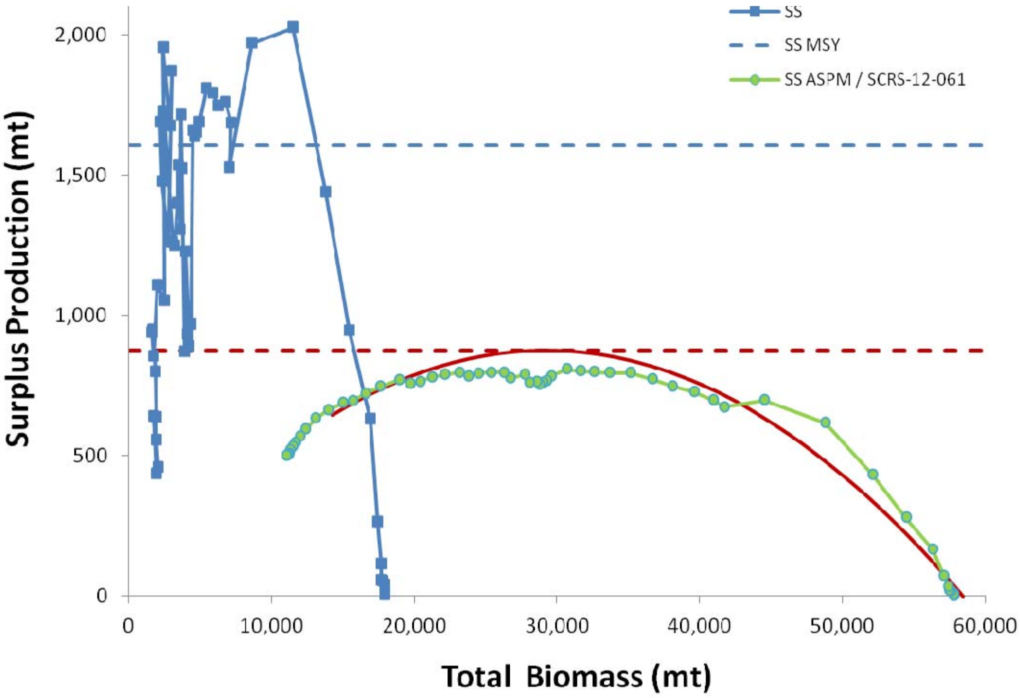


Figure 21. Estimates of F/F_{MSY} (top) and B/B_{MSY} (bottom) for the ASPIC and SS base case models.

Figure 22. Surplus production curves for the ASPIC and SS base case models and the SS age structured production model presented during the meeting via SCRS-12-061. Note that the SS age structured production model was based on unrevised landings data and CPUE indices.



Appendix 1

AGENDA

1. Opening, adoption of agenda and meeting arrangements

2 Update of WHM basic information
   2.1 Task I (catches)
   2.2 Task II (catch-effort and size samples)
   2.3 Other information (tagging)

3. Review of biological data (including steepness)

4. Review of catch per unit effort series

5. Stock assessment
   6.1 Methods and other data relevant to the assessment production models and other models
   6.2 Stock status
   6.3 Projections

6. Recommendations
   6.1 Research and Statistics
   6.2 Management

7. Other matters

8. Adoption of the report and closure

Appendix 2

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Kell, Laurie
Ortiz, Mauricio
Palma, Carlos

Appendix 3

LIST OF DOCUMENTS

SCRS/2012/040	Enhanced monitoring of large pelagic fishes caught by the Venezuela Artisanal Off-shore Fleet targeting tuna and tuna-like species in the Caribbean Sea and adjacent northwestern Atlantic waters: A preliminary Analysis. Arocha, F., Pazos, A., Larez, A., Marcano J., and Gutierrez, X.
SCRS/2012/048	Standardized catch rates of white marlin (*Tetrapturus albidus*) caught by Brazilian tuna longline fleet (1978-2011). Andrade H.A.
SCRS/2012/054	Aplicación de zero-inflated models sobre las tasas de captura de la aguja blanca (*Tetrapturus albidus*) a partir de datos de la pesquería española de palangre de superficie dirigida al pez espada en el Océano Atlántico. Ortiz de Urbina J., García-Costés B., Ramos-Cartelle A. and Mejuto J.
SCRS/2012/055	How much we are learning about the production model's parameter when using standardized catch rates as input data? Andrade H.A.
SCRS/2012/056	Standardized catch-rates of white marlin (*Kajikia albida*) for the Taiwanese distant-water tuna longline fishery in the Atlantic ocean, 1967-2010. Sun C.L., Su N.J., and Yeh S.Z.
SCRS/2012/057	Length-based catch curve analysis for white marlin. Kell L and Palma C.
SCRS/2012/058	An evaluation of the relative importance of the assumed biological parameters when providing management advice for white marlin. Kell L and de Bruyn P.
SCRS/2012/059	A Stock Recruit Meta-Analysis for Scombridae, Istiophoridae and Xiphiidae. Kell L, Jordá M.J., Mosquera I., Harley S. and de Bruyn P.
SCRS/2012/060	White marlin (*Tetrapturus albidus*) and roundscale spearfish (Tetrapturus georgii) standardized catch rates from the U.S. pelagic longline fishery pelagic observer program in the northwest Atlantic and Gulf of Mexico 1992-2011. Karnauskas M., Hoolihan J.P. and Walter J.F.
SCRS/2012/061	Estimates of the status of Atlantic white marlin using ASPIC and Stock Synthesis. Schirripa M.J.
SCRS/2012/062	Review of size frequency samples of white marlin (*Tetrapturus albidus*) 1970-2010. Ortiz, M.
SCRS/2012/065	Estimation of total mortality from size data; An example based on white marlin. Kell L and Ortiz M.
SCRS/2012/067	White marlin (*Tetrapturus albi*dus) growth parameters estimated from capture-recapture data. Lauretta M.V. and Brown B.
SCRS/2012/068	A hierarchical framework for analysing multiple indices; A white marlin example. Kell L and de Bruyn P.

Appendix 4

BAYESIAN PRODUCTION MODEL

A logistic Bayesian surplus production model (Schaefer type) similar to those used in the sailfish assessment in 2009 (Anon. 2010) and in bigeye assessment in 2010 (Anon. 2011) was also fitted to the separated white marlin CPUE time series and to a composite time series. The time series considered are described in Table XX. Posterior distributions were computed based on an Adaptive Importance Sampling (AIS) - Sampling Importance Resampling (SIR) algorithm (Andrade and Kinas 2007). Two sets of prior distributions were used for intrinsec growth rate (r), carrying capacity (k) and coefficient of catchability (q). One less informative (r~U(0,2), k~U(5000,600000), q~U(1E-12,1E-3)) and another more informative especially on r (r~lognomal(log(0.42),0.5), k~U(5000,600000), q~U(1E-12,1E-3)). That restrictive prior for r is equal to the informative prior used in the last two white marlin stock assessment meetings.

Results

Only the models fitted to composite, TAI and USA.RR.n datasets with informative priors resulted in meaningful estimations of the parameters. Hence, only the calculations for those three datasets are showed below. One critical key when using importance sampling algorithms to obtain a sample from the posterior is the choice of the importance function. In the adaptive importance sampling framework one starts with a first importance density distribution (e.g. multidimensional student) and update it a couple of times in order to obtain a final importance density close to the true posterior density, hence a sample is draw from the importance funcion. One way to assess if the importance function is close to the true posterior density is to calculate the *relative entropy* (RE). If RE is close to one the importance function is close to the true posterior. If we rely on this criterion all the models are acceptable in the sense the posteriors samples were draw from a density distribution similar to the true posterior distribution though the samples for "TAI" should be carefully considered (**Figure 1**).

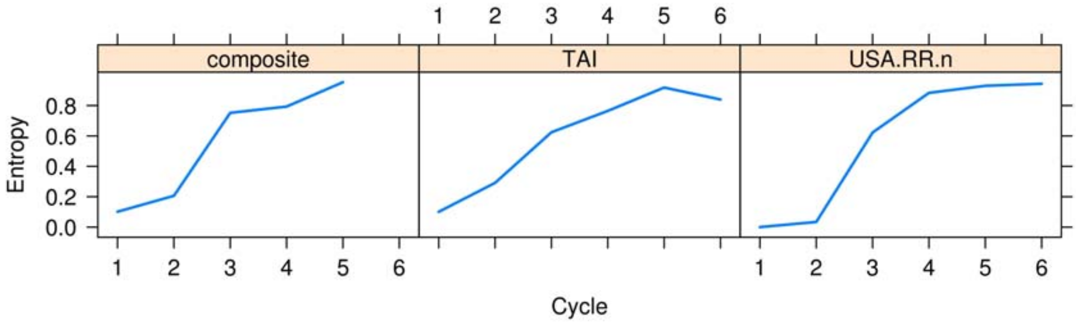


Figure 1. Entropy calculations for the models fitted to catch rate series.

The fittings of the models might be checked. The fittings of the models show decreasing trends for the three datasets until 2000. In the 2000's the model fitted to "TAI" dataset show an increasing trend stronger than those showed by the models fitted to the other two datasets (**Figure 2**). Nevertheless, the predictions of the model fitted to TAI dataset are biased for all the time series as suggested by the standard residuals calculations (**Figure 3**). While the data show a decreasing trend in 2000's, the model fitted to TAI dataset shows an increasing trend (**Figure 2**). The model fitted to the composite time series is not that biased for the more recent years.

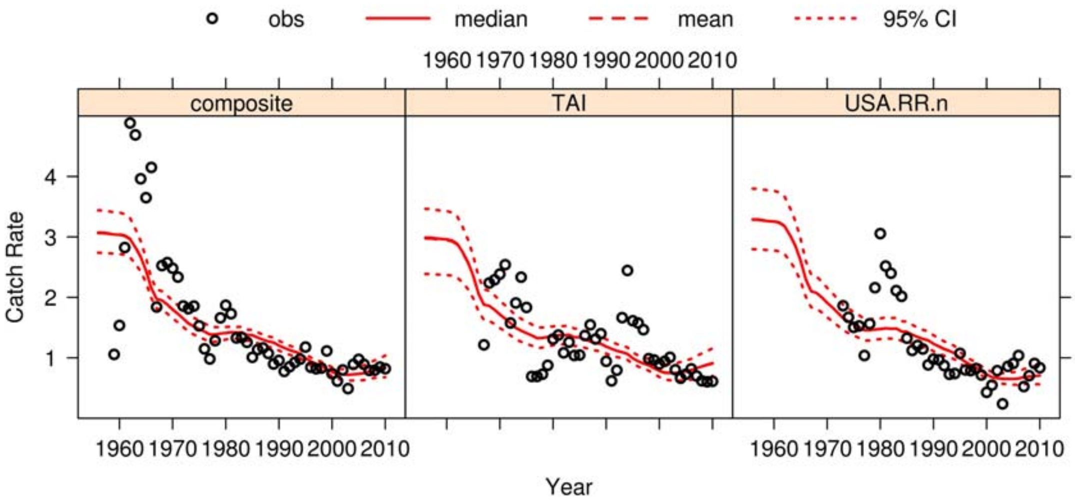


Figure 2. Fittings of the models for the entire datasets.

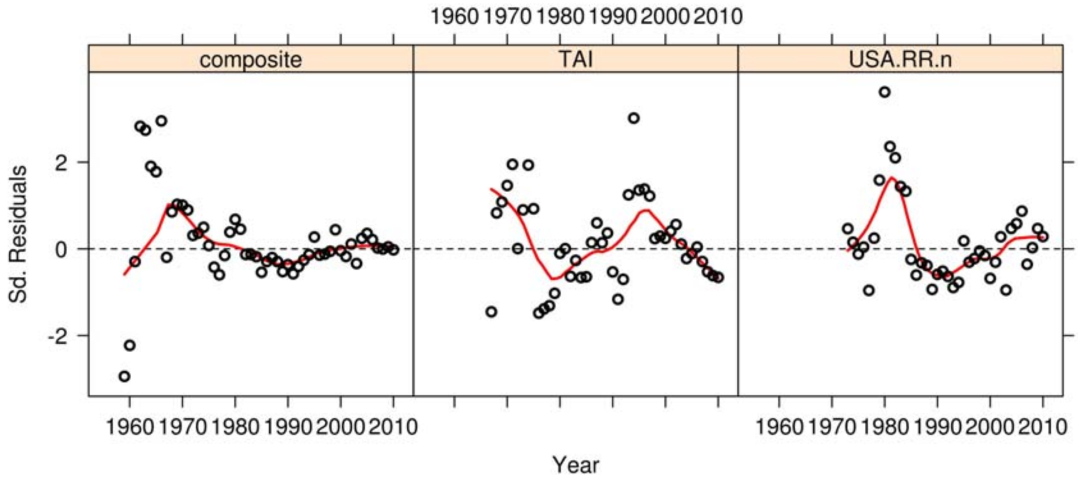


Figure 3. Residuals of the models fitted to composite indices and to indices calculated based on Chinese Taipei longline and on U.S. recreational fisheries.

Joint marginal posteriors for r and k are negatively correlated and show the usual “banana type” shape (**Figure 4**). All the posteriors samples give weight to small values of r (0.10 – 0.15) and to values for k close to 40000 t. The estimations are consistent in the sense the three posterior samples converged to similar estimations.

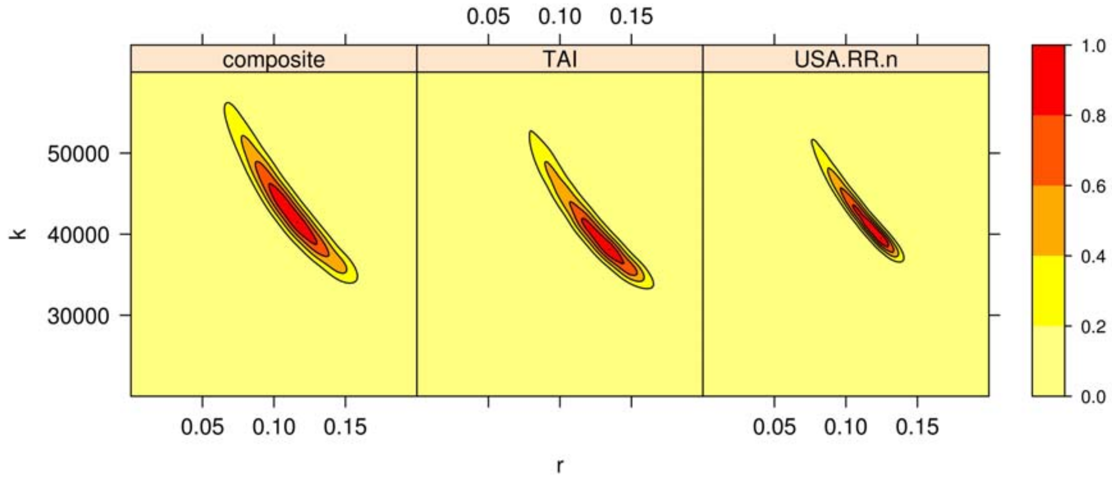


Figure 4. Joint marginal posteriors for r and k as calculated based on composite indices and on longline China Taipei and U.S. recreational datasets.

Overall time trends of ratios Y/Ymsy, F/Fmsy and B/Bmsy as calculated for composite, Chinese Taipei and U.S. recreational datasets are similar until 1990's (**Figure 5**). Nevertheless there are important differences in the end of 2000's. The calculations for TAI suggest an optimistic scenario for the more recent years in the sense there is a high probability that F/Fmsy is bellow 1 and B/Bmsy show an increasing trend. In opposition the calculations for USA recreational dataset suggest that the probability that F/Fmsy is below 1 is not large and that B/Bmsy does not show a sound increasing trend.

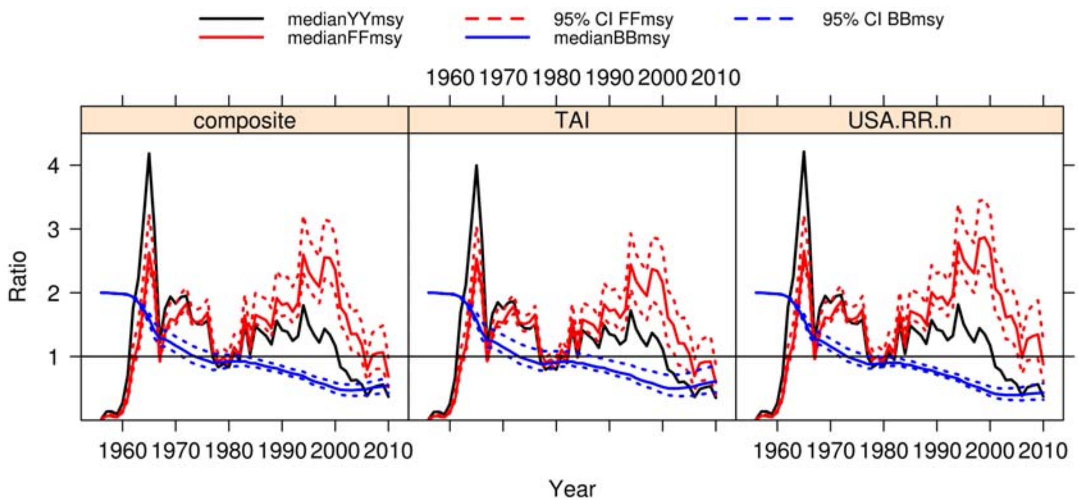


Figure 5. Median of posterior ratios Y/Ymsy, F/Fmsy and B/Bmsy (solid lines). Dashed lines stand for 95% confidence intervals.

The balance between the rations F/Fmsy and B/Bmsy in the very last year of the dataset is showed as phase/kobe plot in **Figure 6**. Calculations for the longline Chinese Taipei dataset clearly suggest that the scenario in the last two or three years can not be classified as one of the red zone (F/Fmsy > 1 and B/Bmsy < 1), though the B/Bmsy is still bellow 1. In opposition if we rely in the calculations for the USA recreational dataset it is not clear that the fishery scenario was not in the red zone in the last years. Estimations for composite indices are in between the estimations calculated for longline Chinese Taipei and U.S. recreational datasets.

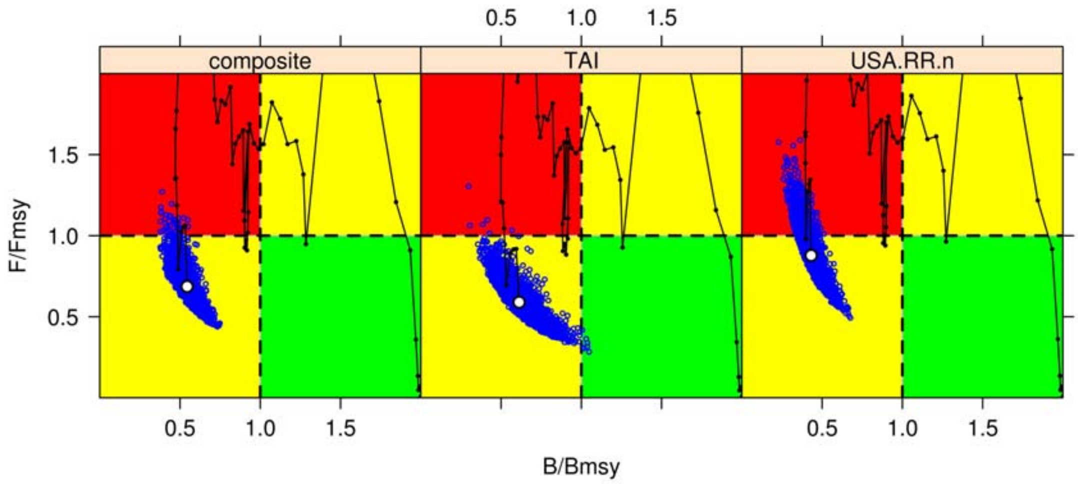


Figure 6. Phase plot as calculated for the composite and longline Chinese Taipei and recreational U.S. datasets.

Median of the predictions of B/Bmsy for the next twenty years under different TAC regulations are in **Figure7**. All the predictions suggest that the increasing trend of the ratio B/Bmsy will be positive as far as the catches are lower 600 t. Nevertheless only calculations for longline Chinese Taipei dataset suggest that the ratio B/Bmsy can achieve a value higher than one in the next twenty year and only if the catches are equal or lower than 400 t. Calculations for USA recreational dataset point for a much more pessimistic scenario. The increasing trend of B/Bmsy will be positive if the catches are equal or lower than 600 t but the B/Bmsy will not achieve a value equal or higher than one in the next twenty years. Predictions for composite datasets are intermediate between those calculated for longline Chinese Taipei dataset and recreational U.S. dataset. If we rely in the composite dataset B/Bmsy can achieve a value higher than one if the catches would be lower than 200 t.

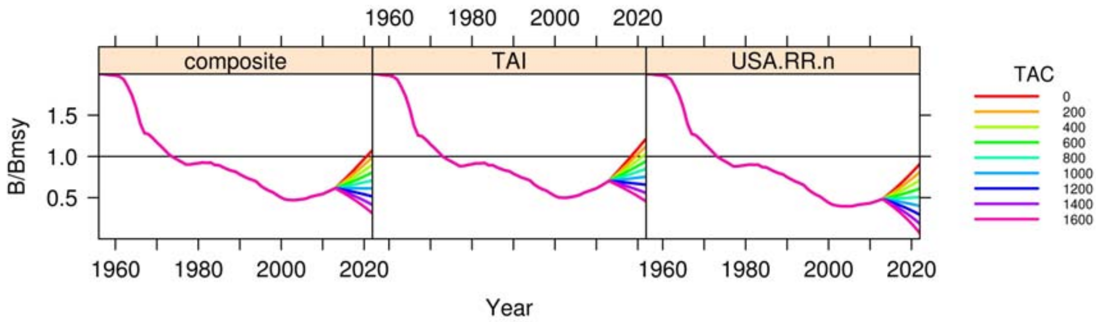


Figure 7. Predictions of B/Bmsy for the next twenty years under different TAC regulations.

Similarly median of the predictions of F/Fmsy for the next twenty years under different TAC regulations are in **Figure 8**. Overall the ratios F/Fmsy will remain lower than one as far as catches are lower than 600 t. Again the more optimistic fishery scenario is the one calculated for longline China Taipei dataset while the more pessimistic scenario arise in the calculations for the recreational U.S. dataset.

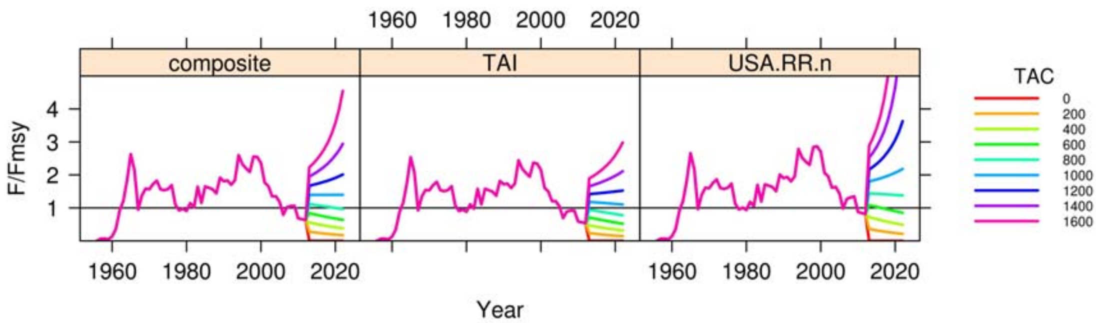


Figure 8. Predictions of F/Fmsy for the next twenty years under different TAC regulations.

Finally, it is important to remind that the model fitted to longline Chinese Taipei dataset is biased for the very last years to show up in the time series, hence all the future predictions for the other two datasets are, at a first glance, more realistic.

Appendix 5

ASPIC INPUTS

Inputs shown are for run 1b. Values used are shown in bold italics. Other runs differ in the number of indices used or catch used. Those differences are noted in table ASPIC1 of section 5 of this report.

Model type ***LOGISTIC*** conditioning type ***YLD*** objective function ***SSE***

Number of bootstrap trials ***501***[1] MC search ***1*** (yes) N trials for MC search ***100000***

[1] In ASPIC 5.34 this number represents the number of bootstrap trials plus one because the first bootstrap data set fitted is not a bootstrap sample and represents the deterministic solution

Convergence crit. for simplex **1.00000d-08** Convergence crit. for restarts ***3.00000d-08*** N restarts ***6***

Convergence crit. for est.effort; ***1.00000d-04*** N steps/yr ***0*** Max. F allowed in est. effort ***8.00000d00***

Weighting for B1 > K ***0d0***

Number of fisheries (data series) ***6*** (VenLL, VenGil, USLL, USREC,JAPLL, TAILL)

Statistical weights for data series ***1d0 1d0 1d0 1d0 1d0 1d0***

B1/K (starting guess) ***1d0*** MSY (starting guess) ***1000*** K (carrying capacity) (starting guess) ***10000***

q (starting guesses)

VenLL,***2.35d-05*** VenGil, ***1.82d-04*** USLL ***5.21d-04*** USREC ***1.11d-03*** JAPLL ***2.05d-05*** TAILL ***7.050E-06***

Estimate flags (0 or 1) (B1/K,MSY,K,q1...qn) ***0 1 1 1 1 1 1 1 0 0***

Min and max constraints – MSY ***100 10000*** Min and max constraints K ***2000 1000000***

Random number seed ***5103079*** Number of years of data in each series ***55 55 55 55 55 55***

Appendix 6

A DETAILED DESCRIPTION OF THE 2012 STATISTICAL INTEGRATED ASSESSMENT MODEL FOR WHITE MARLIN IN THE ATLANTIC OCEAN

Justification

Traditionally the Atlantic white marlin has been assessed using variations on stock-production models. Generally, this was because very little data on this species has been available and these types of models are often times appropriate for data limited situations. Furthermore, although age-structured models, such as virtual population analysis (VPA), were available there are no age data available to estimate catch at age to populate the model. Although some length data from several fisheries has been available, reliable growth curves from which to estimate annual catch-at-age matrices were lacking. However, data on this species has accumulated over the years and in 2010 the ICCAT Billfish Working Group recommended that blue marlin should progress towards the potential application of a statistically integrated assessment model. A similar situation exists for white marlin, so a similar approach was taken here for white marlin. The adoption of a statistically integrated model not only allows for the full utilization of existing data, but also it provides the possibility to evolve in complexity as new data and hypotheses are accumulated. Furthermore, the integrated modeling approach allows for the identification of the sensitivity of the assessment outcome to the various input parameters, biological as well as fishery based.

The objectives of this work are to provide a detailed description of the 2012 model used to evaluate the stock status of Atlantic white marlin using data that heretofore has not been used in a statistically integrated manner. This appendix provides greater detail on the model structure than was able to be given within the stock assessment report itself as well as to present this information is a manner that will allow for replication in the future.

Data

Landings and CPUE time series data for the four gear types considered in this assessment were those reported by the ICCAT Secretariat during the meeting (**Figure 1**). Length compositions for the gear types were those reported by the ICCAT Secretariat during the assessment meeting and revising by the Group.

Estimates of growth were obtained from K. Drew (unpublished data), which was based on hard part analysis. Most other biological parameters, including female maturity, were either taken from the ICCAT manual, white marlin chapter or communicated by F. Arocha (from Arocha and Barrios, 2009).

Configuration and Assumptions

White marlin observational data were fitted using the Stock Synthesis III (SS3, version 3.23b) stock assessment framework. This framework uses a statistical catch-at-age approach to create a population time-series that best fits the given observations using maximum likelihood as the fitting objective. Details of the modeling approach are given in Methot (2009).

Four fleets were defined for inclusion in the model according to gear type: gillnet, longline, purse seine, and sport (recreational, rod-and-reel) fisheries. The SS3 model was configured for one area, one season, and two sexes with dimorphic growth. Natural mortality for both sexes and all ages was fixed at 0.20.

Recruitment was assumed to follow a Beaverton-Holt recruitment function. Virgin recruitment and steepness were freely estimated and recruitment deviations were estimated from 1977-2009. The recruitment time series was assigned a standard deviation (sigma-r) of 0.60. The sock was assumed to be unfished at the beginning of the time period considered.

The descending limb of the selectivity for longline and sport was fixed asymptotic, while gillnet was estimated. Because length compositional data were not available for the purse seine gear, this fleet was configured to have the same selectivity pattern as that estimated for the longline fleet.

Lambda on catch, discards, and CPUE and length data were set to a value of 1.0.

Results and diagnostics

A total of 44 parameters were estimated in the model. The fixed and estimated parameters and their associated coefficients of variation are given in **Table 1**. In general, estimates of gillnet selectivity were estimated with the greatest CV's with the remaining parameters being estimated with CV's less than five percent. The likelihood values for each of the observational time series are given in **Table** 2.

Of the 44 parameters modeled, 8 (4 pairs) had correlation coefficients greater than 70 percent (**Table 3**). Most notable is the high correlation between virgin recruitment and the stock-recruitment steepness parameter. These parameters dictate the overall size and productivity of the stock, two of the most important parameter estimates. The steepness parameter is often times estimated with a relatively informed prior, but not so in this case. The estimated value for steepness was approximately 0.65, which is biologically plausible.

Fits and residuals to the CPUE time series considered are shown in **Figure 2A-C**. Of the surveys used to fit the model, the Japanese early CPUE series had the highest residual mean square error (27.593) and the U.S. sport had the lowest (-7.904). All indexes (standardized) are shown in **Figure 3**.

The integrated model fitted the length compositions from the three fisheries relatively well (Figure 4-6). No effort was made to model the minimum size of white marlin for the US because no other country observes this regulation.

The stock-recruitment function estimated for white marlin is shown in **Figure 7** (top). It is difficult to judge the reliability of the virgin recruitment parameter, although the estimate of 206 million recruits did have a relatively small CV (1.014 percent, **Table 1**). Furthermore, the estimate of the steepness parameter (0.65) seemed very plausible and had a CV of 4.5 percent. However, the high correlation between these two parameters (-0.968) suggests that neither one can be said to be estimated with a great deal of certainty.

Estimates of annual recruitment with approximate 95 percent confidence intervals are shown in **Figure 10**. It should be noted that, in great part, the recruitment signal comes from the observations of landings and general trends in the CPUE time series as the length compositions provide very little information in this regard. Estimates of recruitment deviations showed somewhat of a pattern; however, only one of the estimated deviations (1992) could be said to be statistically different from zero (**Figure 7**, bottom). Annual estimates of recruitment (number of age-0 fish) are shown in Figure 8. Estimates of spawning stock biomass with 95% asymptotic intervals are shown in **Figure 10**.

Estimates of annual fishing mortality by gear showed a relatively steady increasing trend (**Figure 11**). Most of the mortality is due to the longline gea; however, the gillnet fishery also makes up a significant portion of it. The sharp decline in fishing mortality observed after year 2000 is due to the sharp decrease in landings reported after that year. Management benchmarks and associated errors are given in **Table 3**.

Further analysis was carried out by running 501,000 mcmc runs, removing the first 1000 runs, and thinning every 5th run, for a total of 100,000 runs. Frequency plots and trace plots of the estimated parameters are shown in Appendix 1, **Figure 12**. For nearly all parameters, the frequency plots look very well shaped with the exception of the second parameter of the gillnet selectivity (labeled "SizeSel. 1P.2.Gill.Net.1"). Parameters with correlations above 0.70 are shown in **Figure 13**.

References

Arocha, F., and A. Bárrios. 2009, Sex ratios, spawning seasonality, sexual maturity, and fecundity of white marlin (*Tetrapturus albidus*) from the western central Atlantic. Fisheries Research, 95:98-111.

Methot, R. D. 2009, Stock assessment: operational models in support of fisheries management. *In* The Future of Fishery Science in North America, pp. 137–165. Ed. by R. J. Beamish, and B. J. Rothschild. Fish and Fisheries Series, 31. 736 pp.

Table 1. Parameter values for the base case model of Atlantic white marlin.

PARAMETER	VALUE	MIN	MAX	FIXED	ESTIMATED	SD	CV(%)
Natural Mortality							
Female	0.2			X			
Male	0.2			X			
Growth							
Female							
Size (cm) at age 1	117.540			X			
Size (cm) at age 20	172.100	200	300	X			
K	0.320			X			
CV in size at age 1	33.077			X			
CV in size at age 20	22.760	30	60	X			
Male							
Size (cm) at age 1	105.300			X			
Size (cm) at age 20	162.200	150	200	X			
K	0.540			X			
CV in size at age 1	21.258			X			
CV in size at age 20	22.240	20	40	X			
Biological parameters							
Female							
Coefficient to convert L(cm) to Wt (kg)	5.20E-06			X			
Exponent to convert L(cm) to Wt (kg)	3.01E+00			X			
Maturity Logistic inflection	132.000			X			
Maturity slope	-0.125			X			
eggs/gram intercept	1			X			
eggs/gram slope	0			X			
Male							
Coefficient to convert L(cm) to Wt (kg)	5.20E-06			X			
Exponent to convert L(cm) to Wt (kg)	3.01E+00			X			
Stock-Recruitment							
Log of Virgin Recruitment	5.328	4	7		X	0.054	1.014
steepness	0.654	0.2	1		X	0.030	4.534
sigma-r	0.600			X			
Size selectivity parameters							
Gillnet							
Peak	167.740	185	280		X	1.026	0.612
Top	-12.081	-7	6		X	50.122	414.891
Ascending slope	5.076	5	10		X	0.120	2.374
Descending slope	5.010	0	12		X	0.342	6.828
Selectivity at first bin	-15.000			X		_	
Selectivity at last bin	-1.868	-5	5		X	0.421	22.515
Longline							
Peak	181.358	50	280		X	2.604	1.436
Top	_	-15	3	X		_	
Ascending slope	7.347	0	20		X	0.084	1.137
Descending slope	_	-2	25	X		_	
Selectivity at first bin	_	-15	5	X		_	
Selectivity at last bin	_	-5	18	X		_	
Sport							
Peak	166.009	180	300		X	1.520	0.915
Top	-1.509	-15	3	X		_	
Ascending slope	5.269	0	12		X	0.167	3.162
Descending slope	3.259	-2	25	X		_	
Selectivity at first bin	-15.000	-15	5	X		_	
Selectivity at last bin	15.000	-5	18	X		_	

Table 2. Likelihood values for each of the observational data components used to fit the white marlin model. Total likelihood was 494.073 units.

		Gill Net	LongLine	Purse Seine	Sport	Jp_LL_early	Jp_LL_mid	Jp_LL_late	Ven_LL	Ven_GN	US_LL	US_Sport	Spain_LL	Chin-Tai_LL
Fleet:	ALL	1	2	3	4	5	6	7	8	9	10	11	12	13
Catch_lambda:	_	1	1	1	1	1	1	1	1	1	1	1	1	1
Catch_like:	0.021	0.005	0.005	0.005	0.006	0	0	0	0	0	0	0	0	0
Surv_lambda:	_	0	0	0	0	1	0	1	1	1	1	1	0	1
Surv_like:	-13.805	0	0	0	0	27.593	29.737	4.388	-6.391	2.091	-8.763	-27.904	118.453	-4.819
Surv_R.M.S.E.		0	0	0	0	0.584	0.839	0.552	0.399	0.485	0.366	0.291	1.069	0.444
Length_lambda:	_	1	1	0	1	0	0	0	0	0	0	0	0	0
Length_like:	518.415	55.722	328.457	0	134.236	0	0	0	0	0	0	0	0	0

Table 3. Parameter correlations greater than 70% for the base case model of Atlantic white marlin

Parameter 1	Parameter 2	Correlation
S-R steepness	Virgin Recruitment	-0.968
Gillnet Selectivity, descending slope	Gillnet Selectivity, peak	0.869
Longline Selectivity, descending slope	Longine Selectivity, peak	0.779
Sport Selectivity, descending slope	Sport Selectivity, peak	0.876

Table 4. Derived quantities from the white marlin base case model configuration.

Derived Quantity	Estiamte	SD	CV(%)
F/Fmsy			
2006	0.757	0.070	0.092
2007	0.967	0.075	0.078
2008	1.075	0.090	0.084
2009	1.241	0.126	0.102
2010	0.720	0.105	0.146
B/Bmsy			
2006	0.348	0.034	0.098
2007	0.377	0.031	0.083
2008	0.358	0.032	0.088
2009	0.327	0.034	0.104
2010	0.322	0.046	0.141
F at MSY	0.295	0.032	0.110
Yield at MSY	1604	28.74	0.018

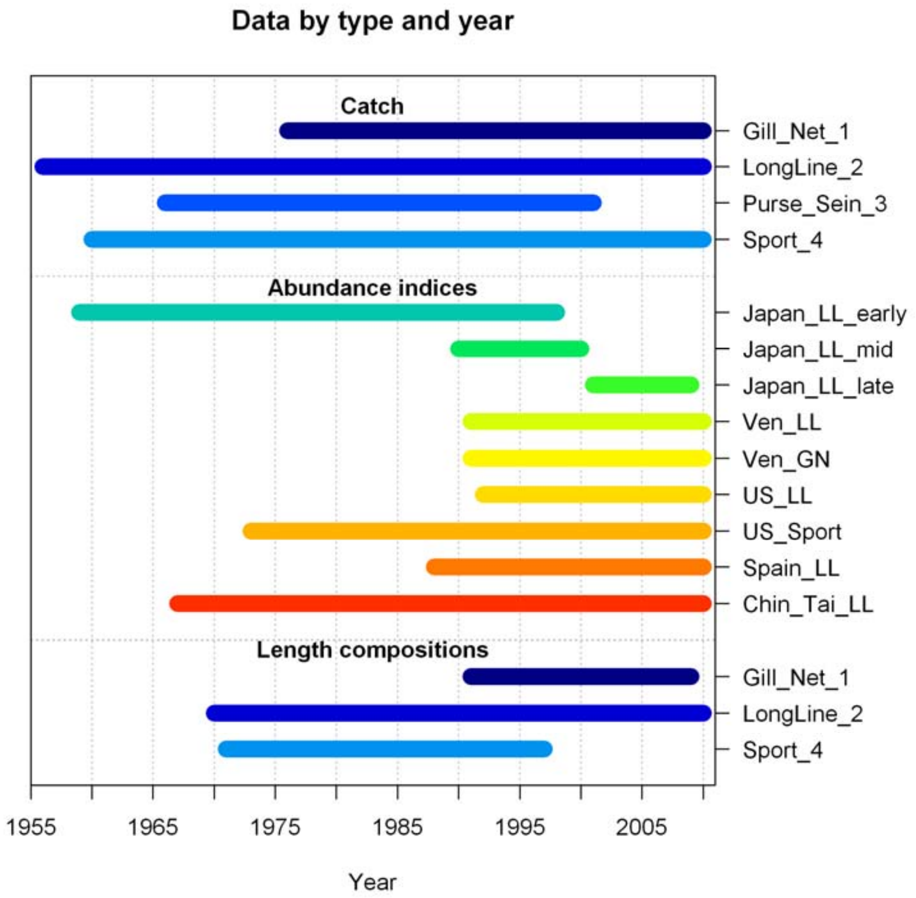


Figure 1. Overview of observational data used in the 2012 white marlin stock assessment model.

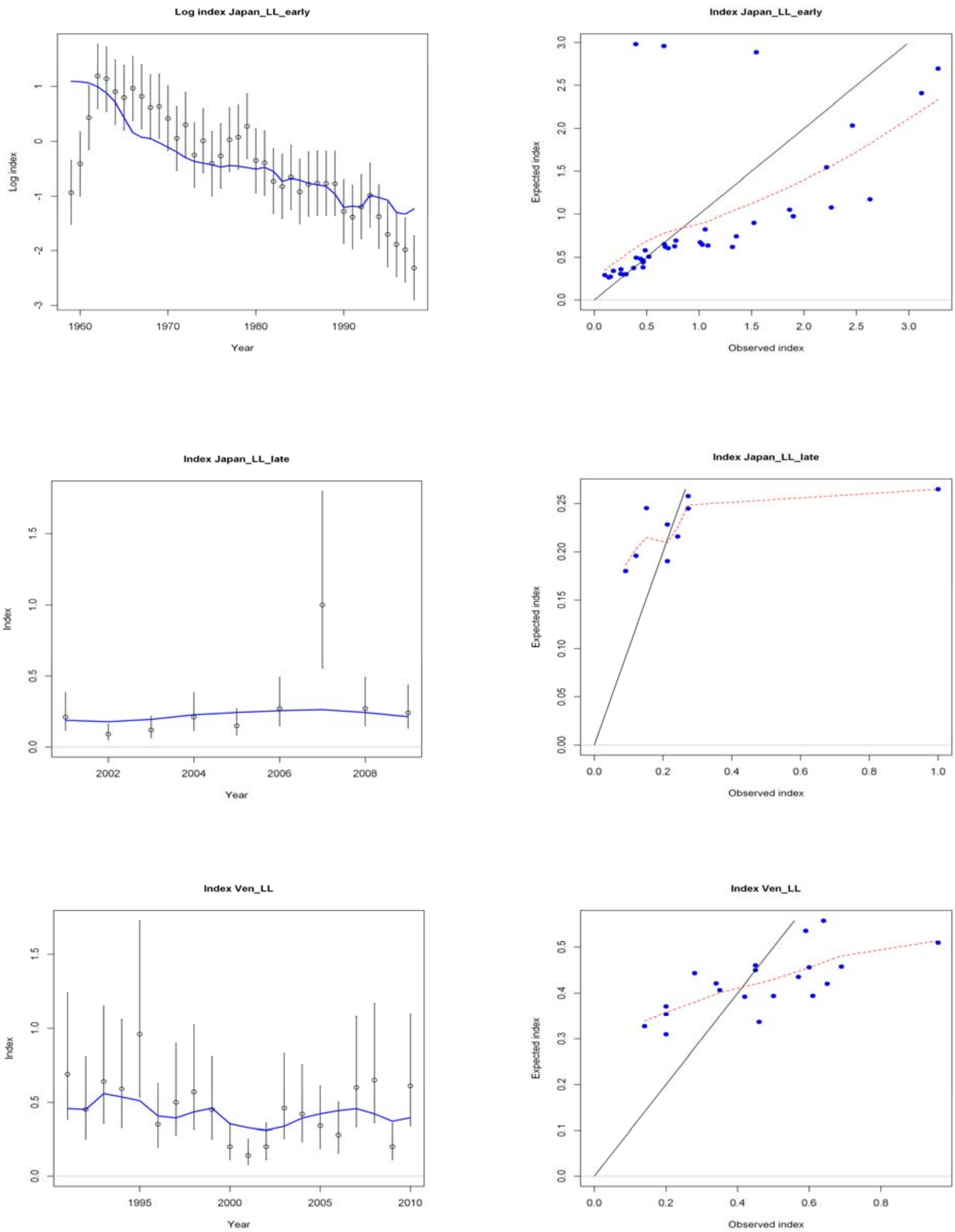


Figure 2A. Observed and predicted indices of abundance used in the 2012 white marlin stock assessment model.

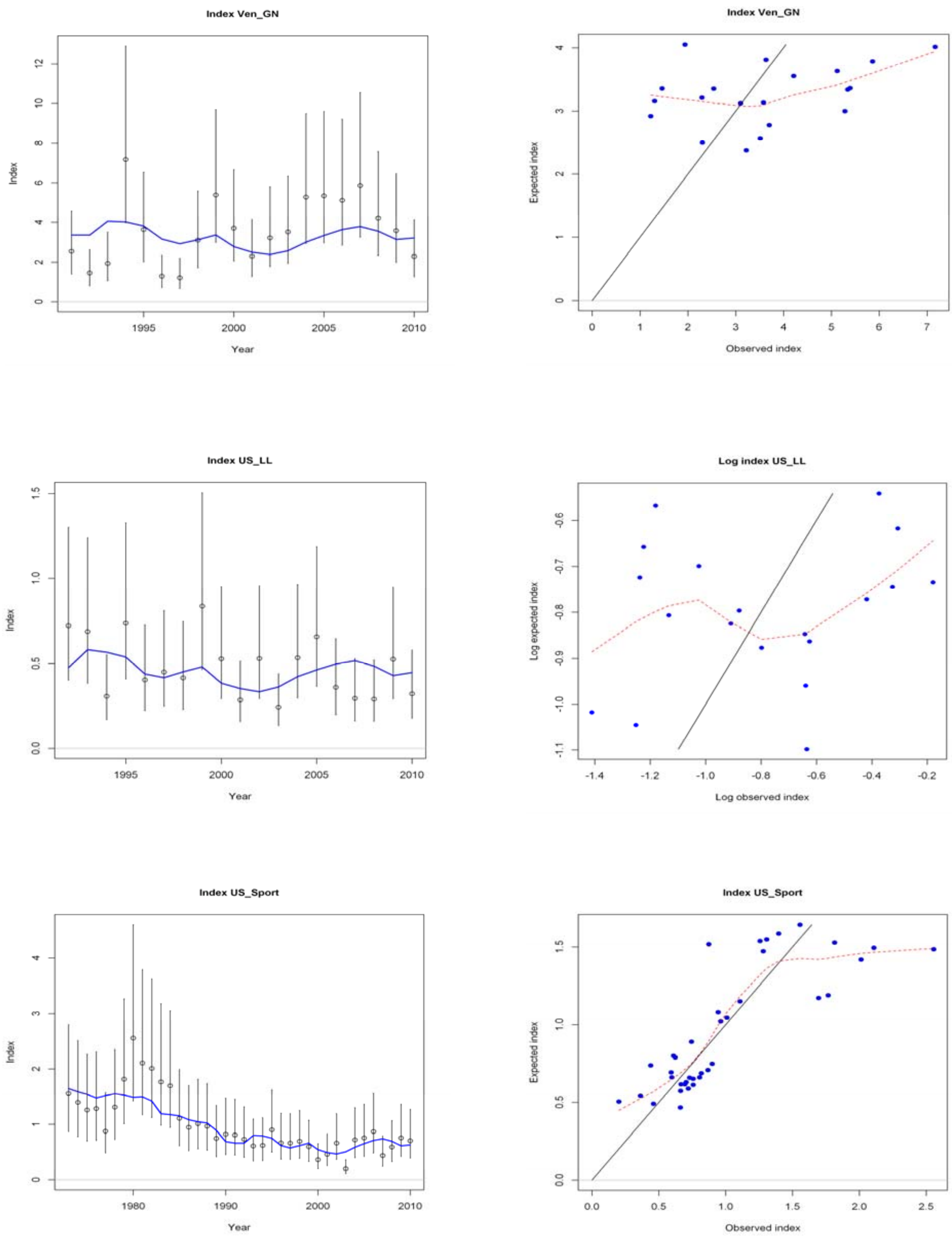


Figure 2B. Observed and predicted indices of abundance used in the 2012 white marlin stock assessment model.

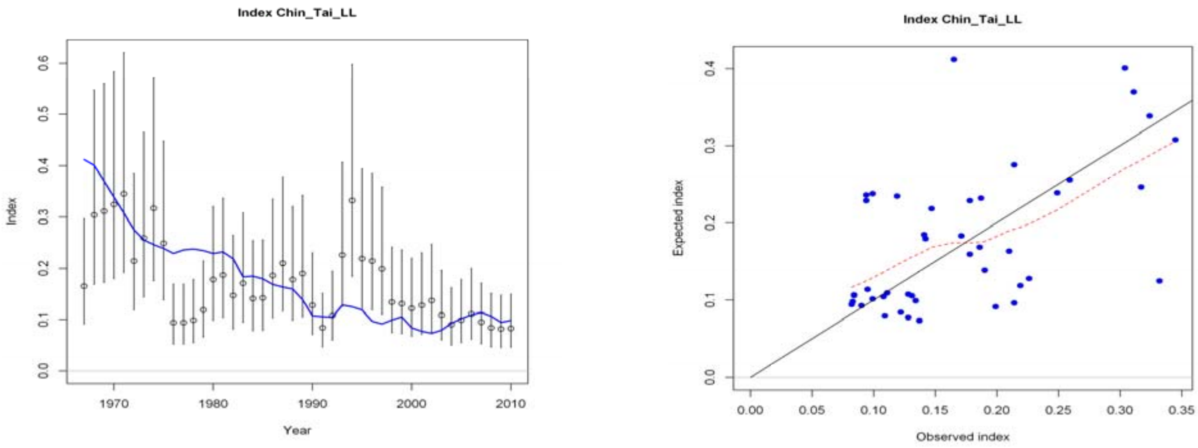


Figure 2C. Observed and predicted indices of abundance used in the 2012 white marlin stock assessment model.

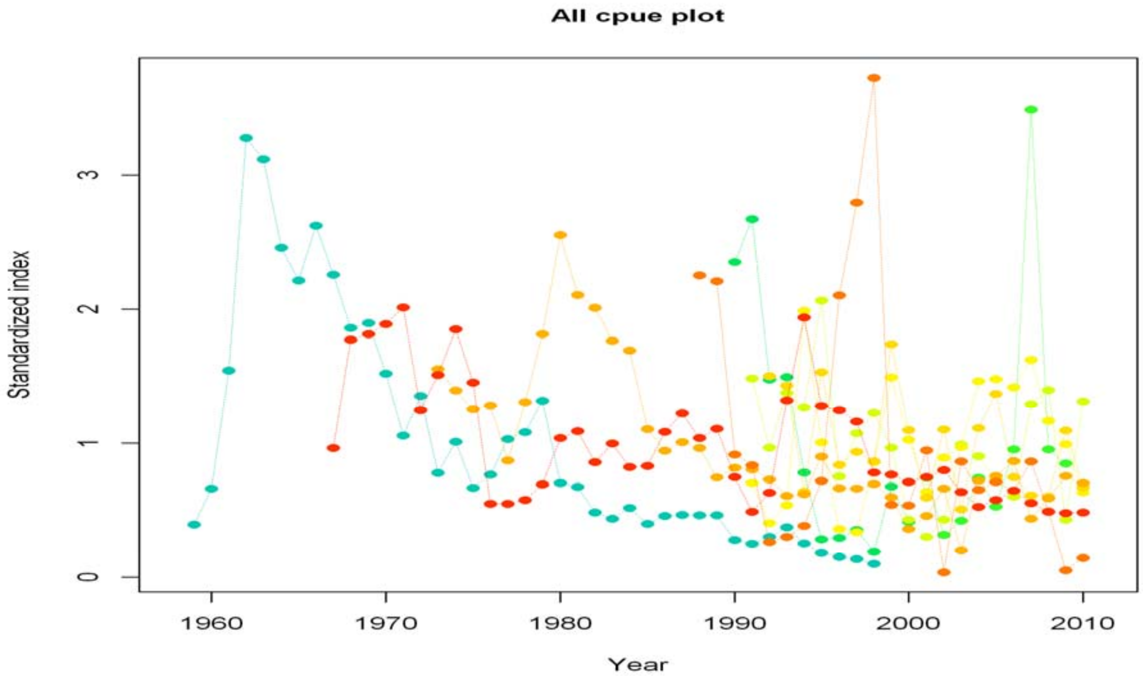


Figure 3. All CPUE time series for white marlin considered in the 2012 white marlin stock assessment model (standardized to 1.0).

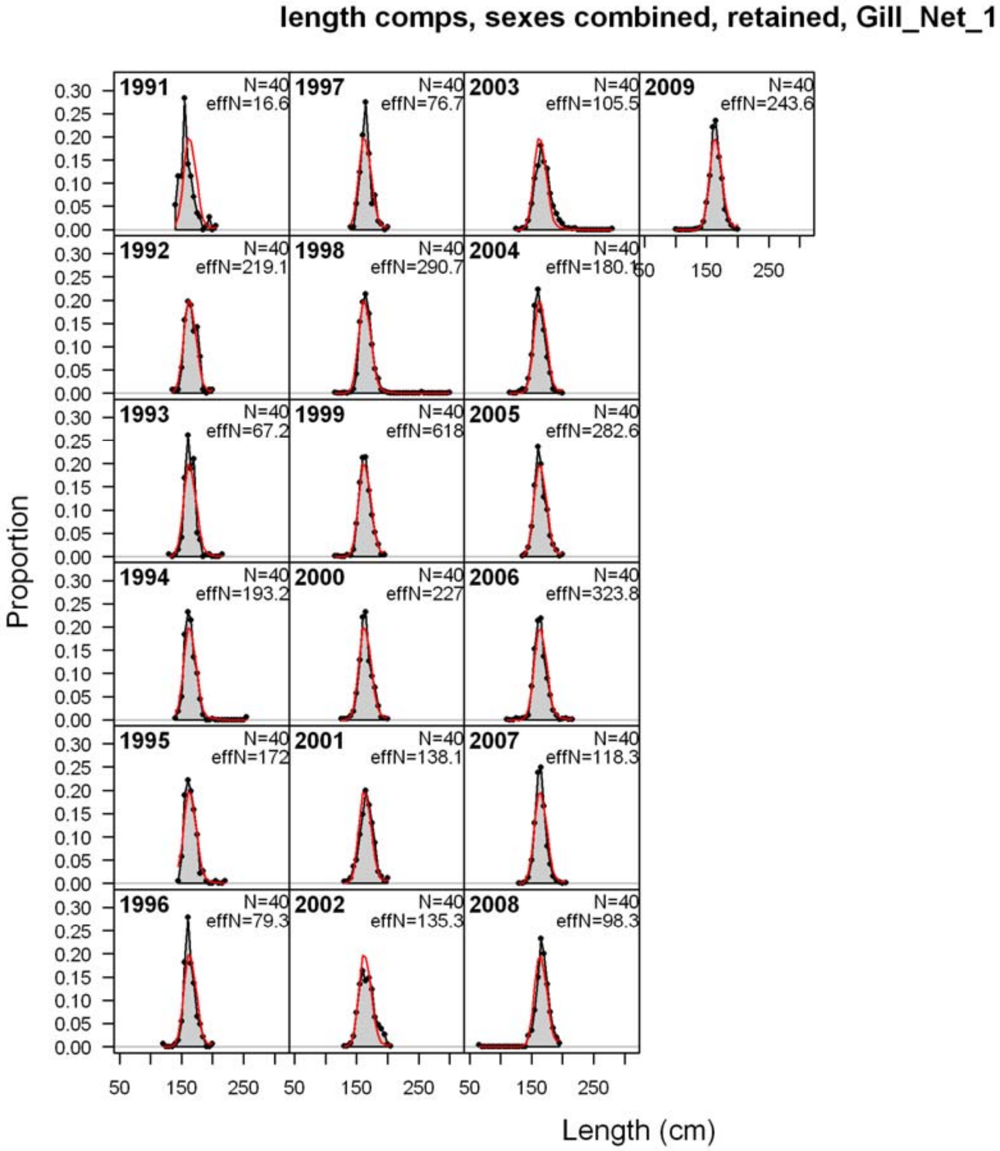


Figure 4. Observed and predicted annual length composition from the white marlin gillnet fishery.

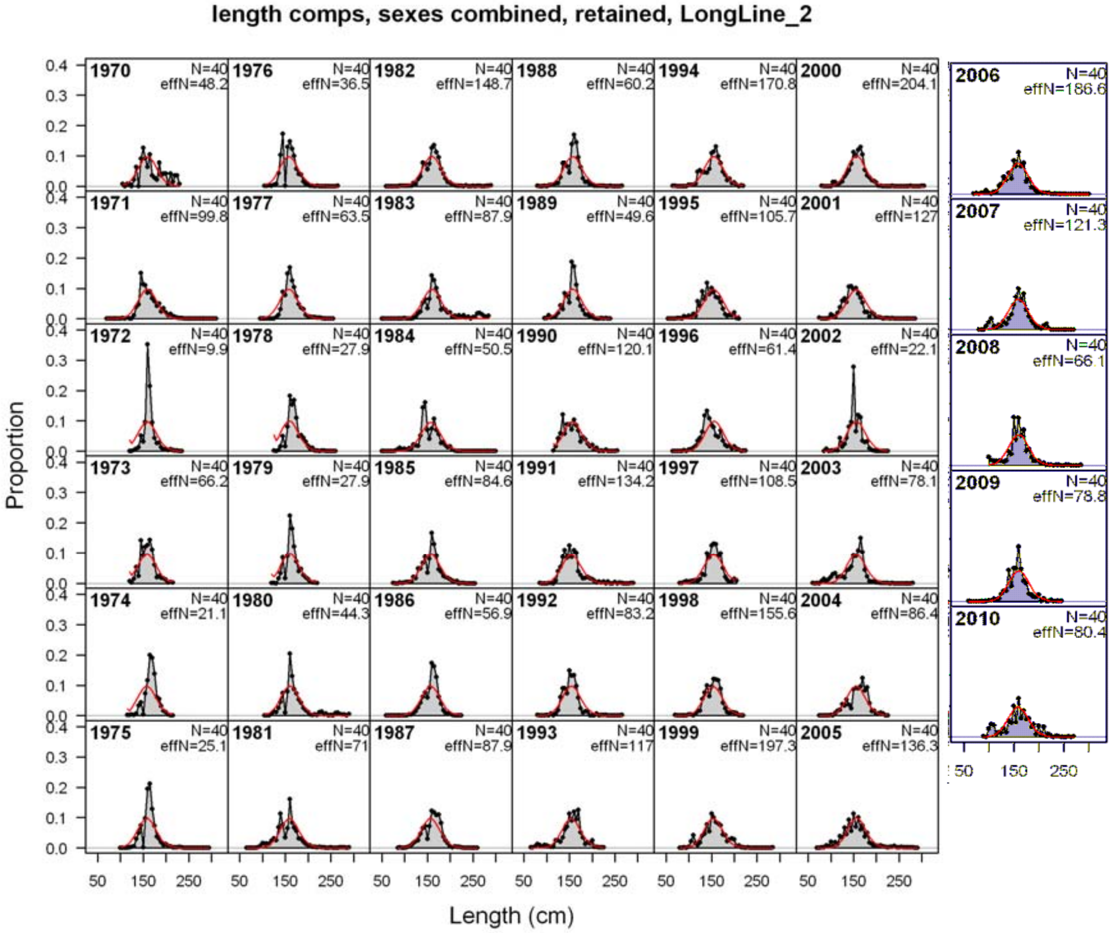


Figure 5. Observed and predicted annual length composition from the white marlin longline fishery.

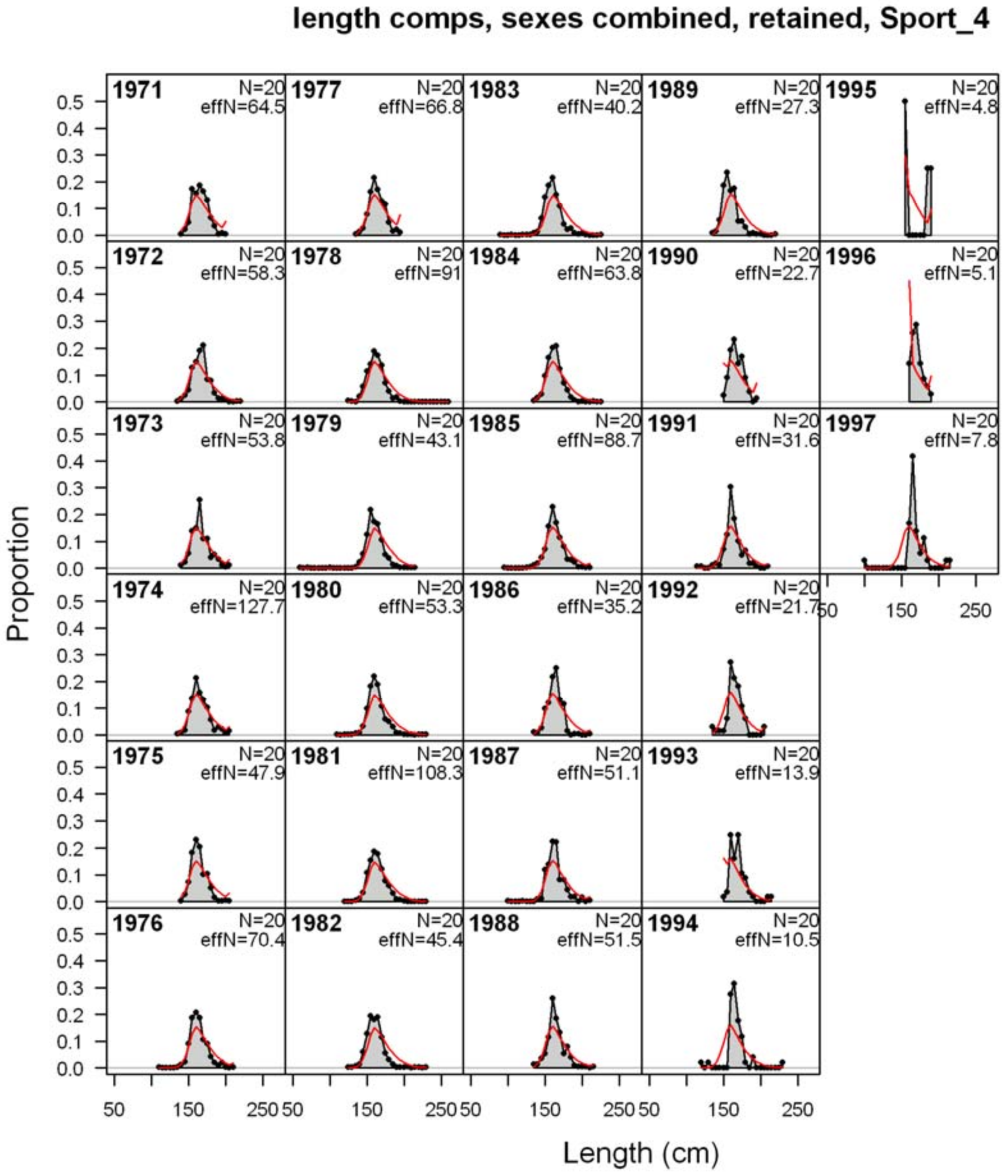


Figure 6. Observed and predicted annual retained length composition from the white marlin sport fishery.

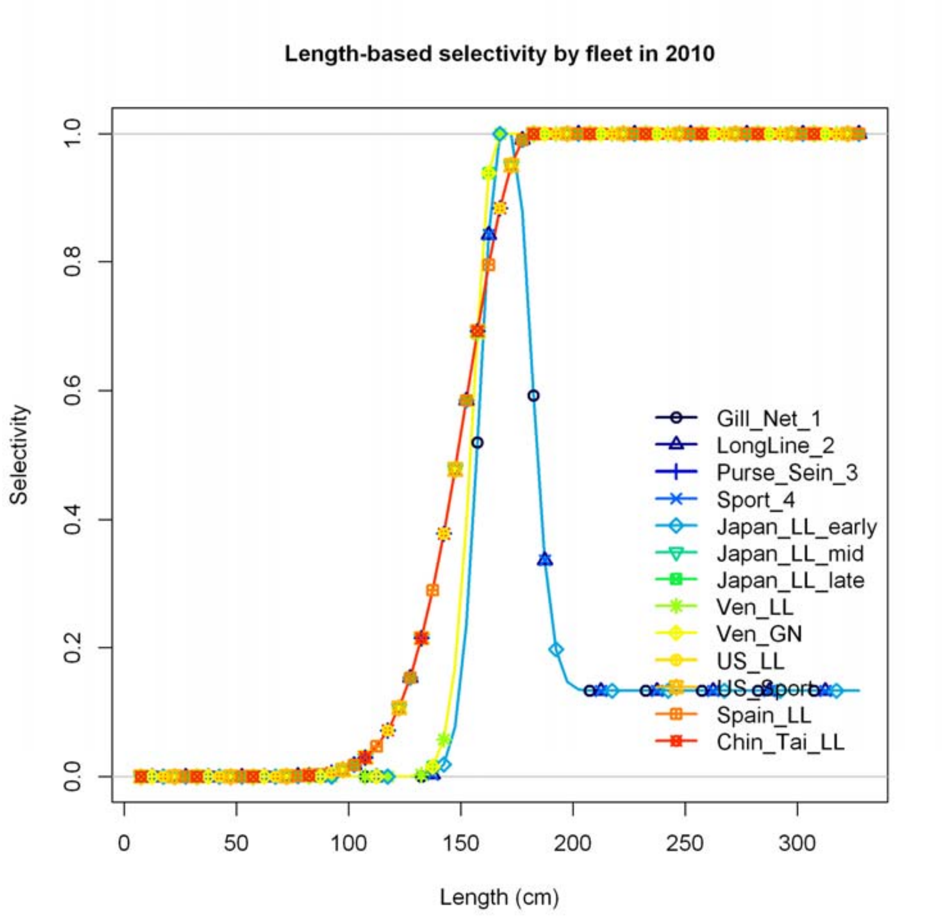
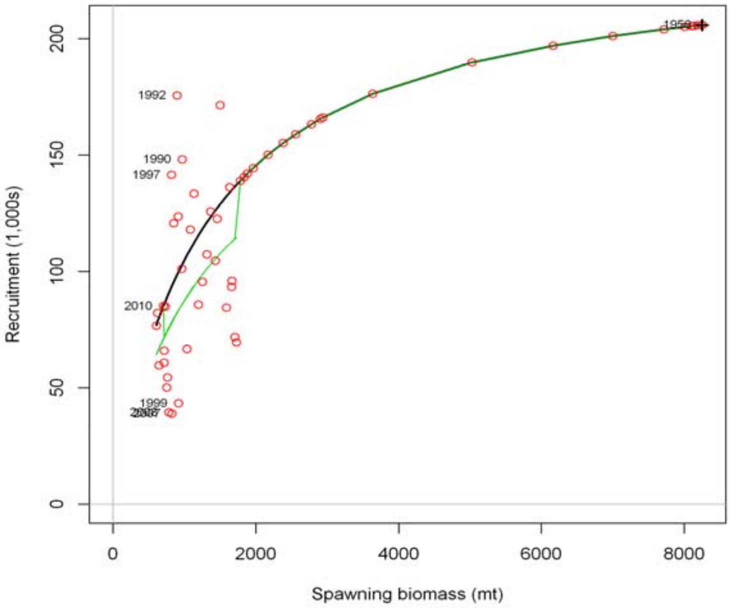


Figure 7. Estimated selectivities for all fleets/surveys modeled in the SS RUN_1 model.



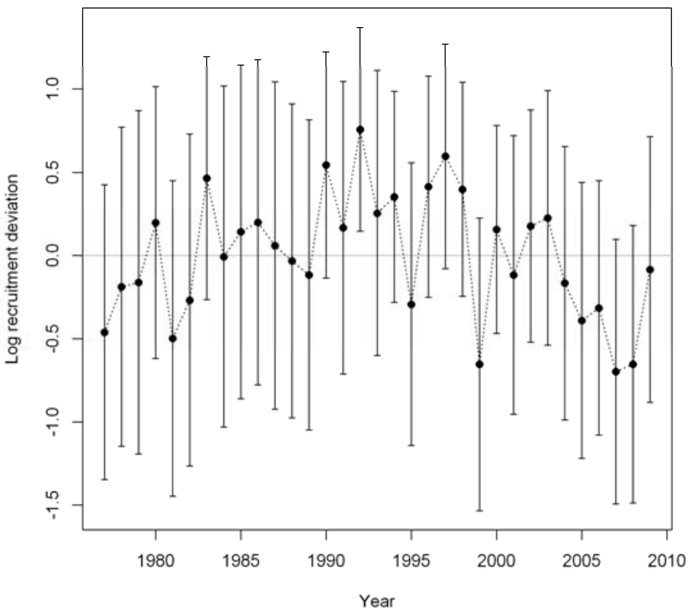


Figure 8. Estimated stock-recruitment function (top) and annual recruitment deviations for the white marlin stock assessment model.

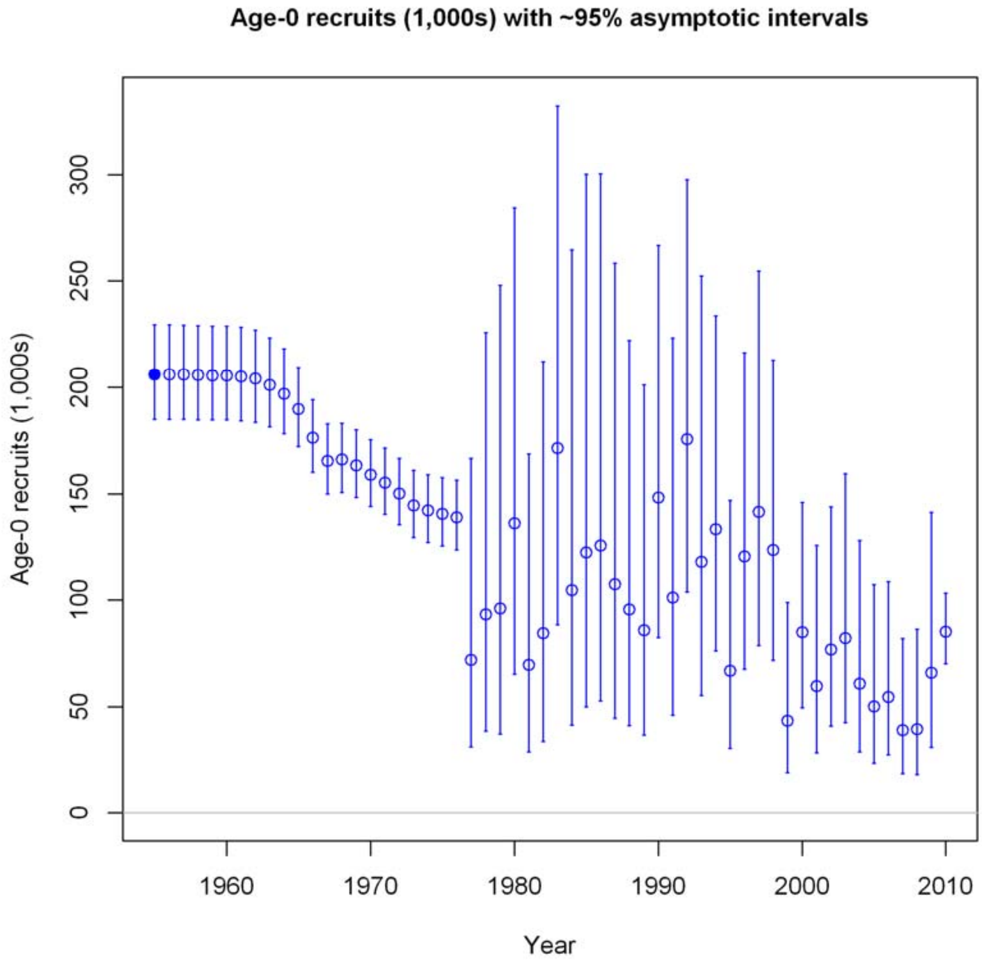


Figure 9. Estimated recruitment with 95% asymptotic intervals for the white marlin stock assessment model.

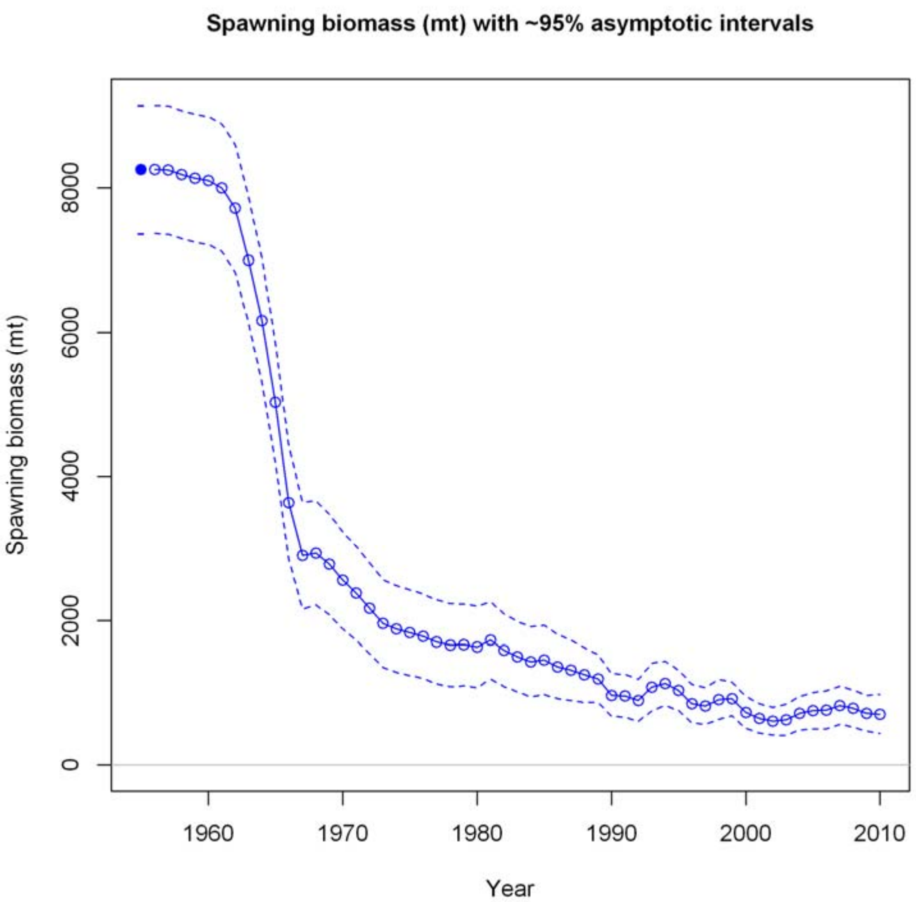


Figure 10. Estimated spawning stock biomass with 95% asymptotic intervals for the white marlin stock assessment model.

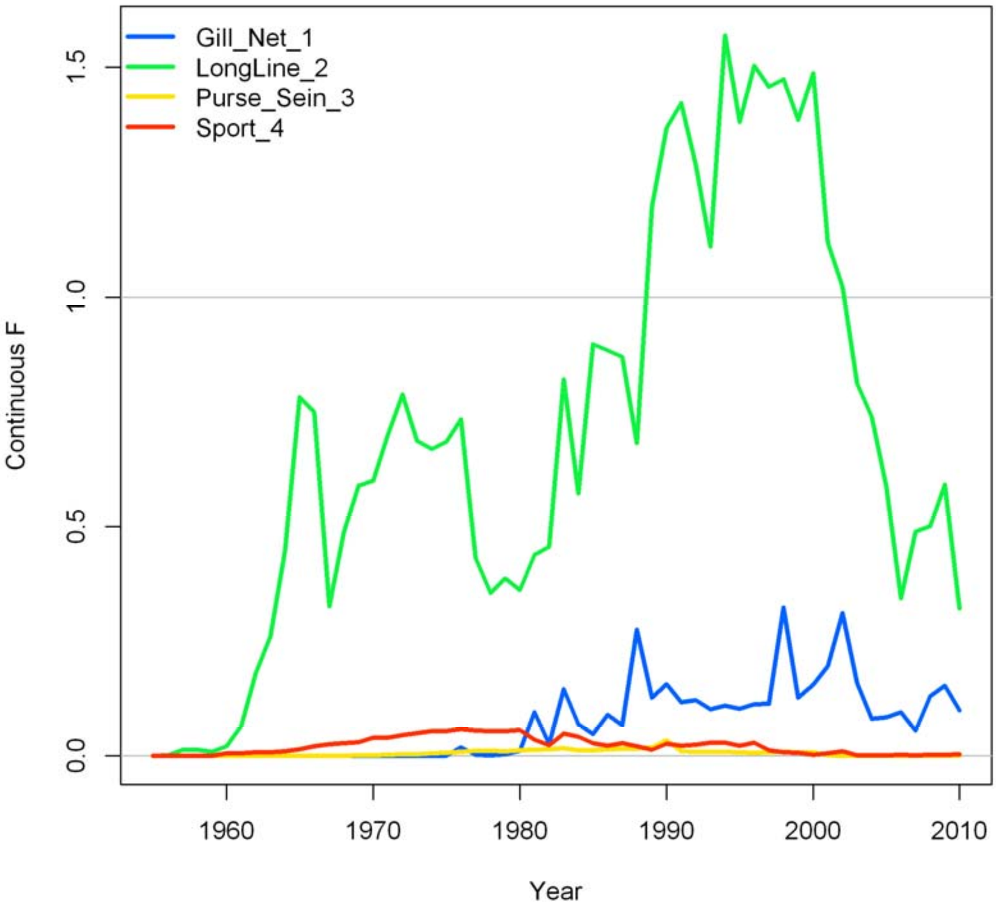


Figure 11. Continuous fishing mortality by gear for the white marlin stock assessment model.

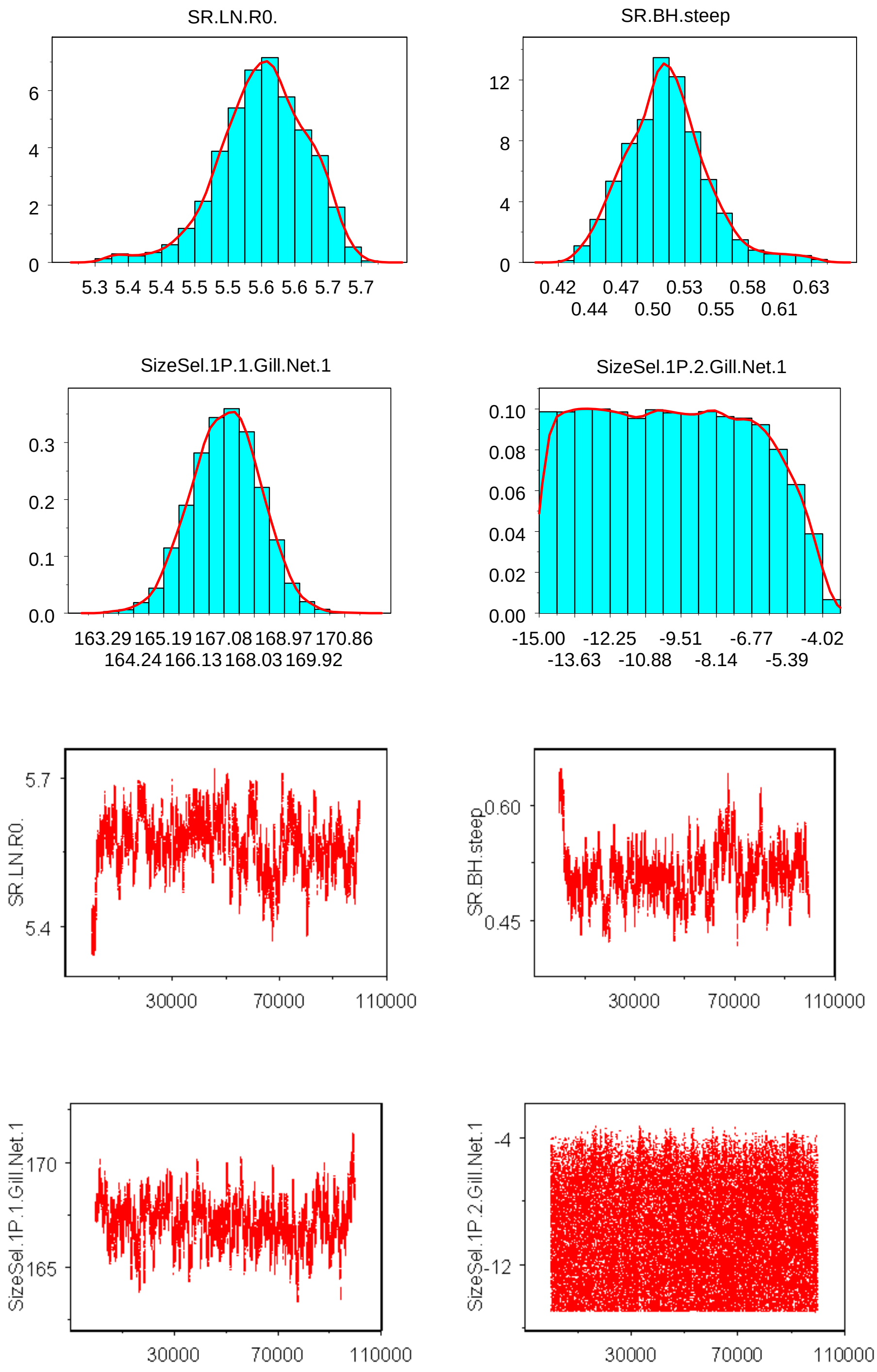


Figure 12A. Frequency histograms (top) and estimation trace plots (bottom) of the posteriors from mcmc analysis for the SS RUN_1 white marlin model.

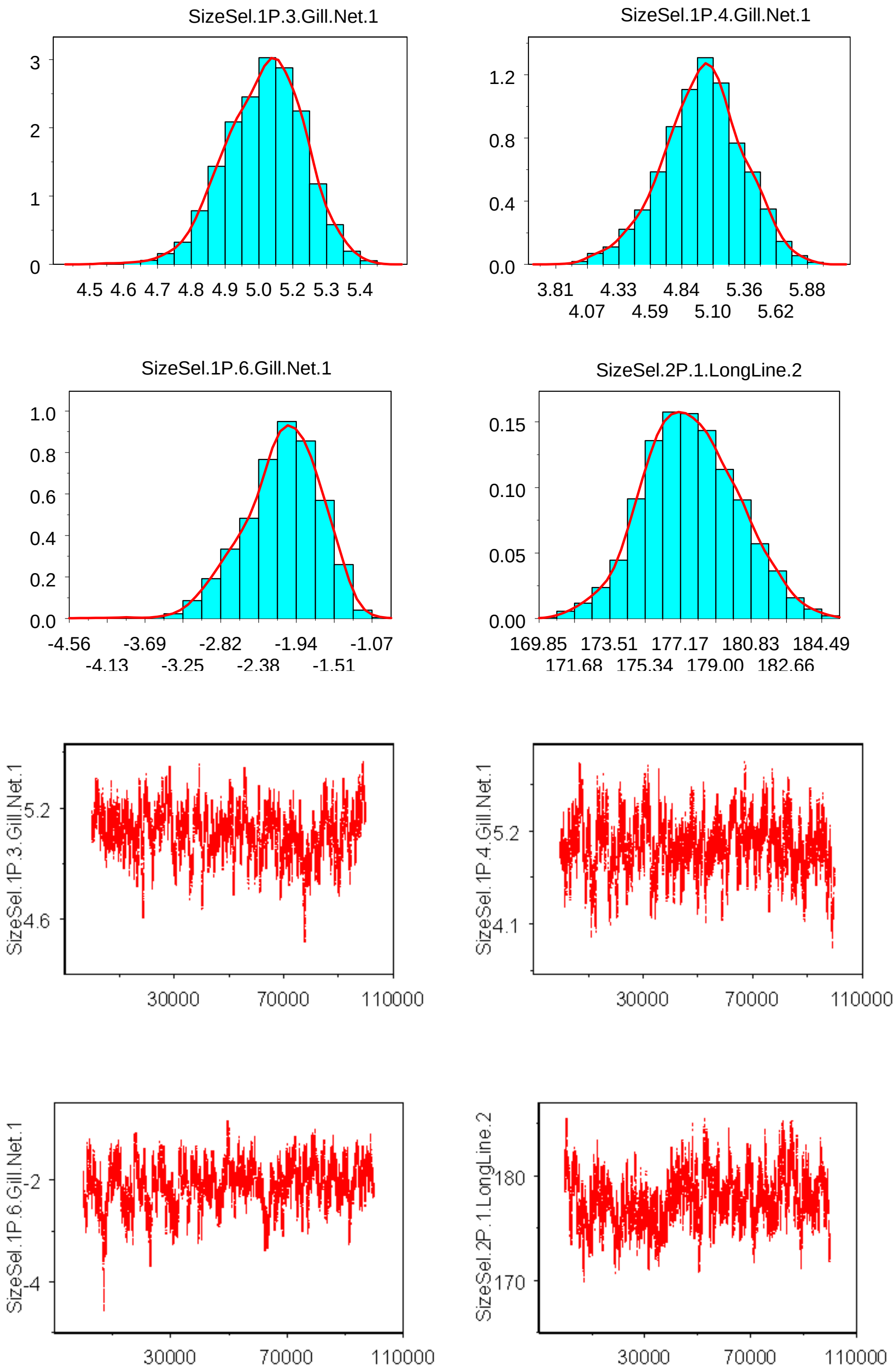


Figure 12B. Frequency histograms (top) and estimation trace plots (bottom) of the posteriors from mcmc analysis for the SS RUN_1 white marlin model.

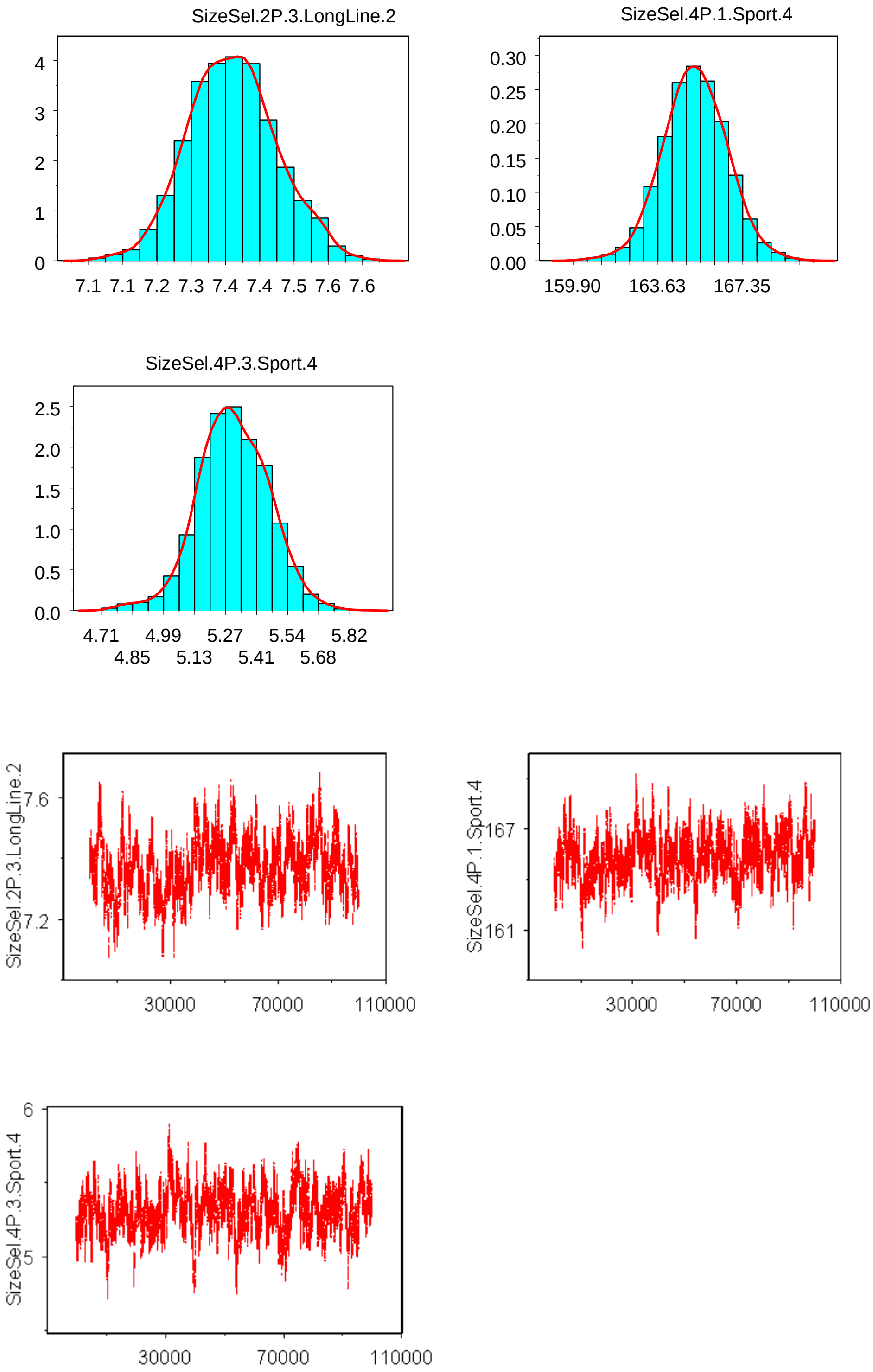


Figure 12C. Frequency histograms (top) and estimation trace plots (bottom) of the posteriors from mcmc analysis for the SS RUN_1 white marlin model.

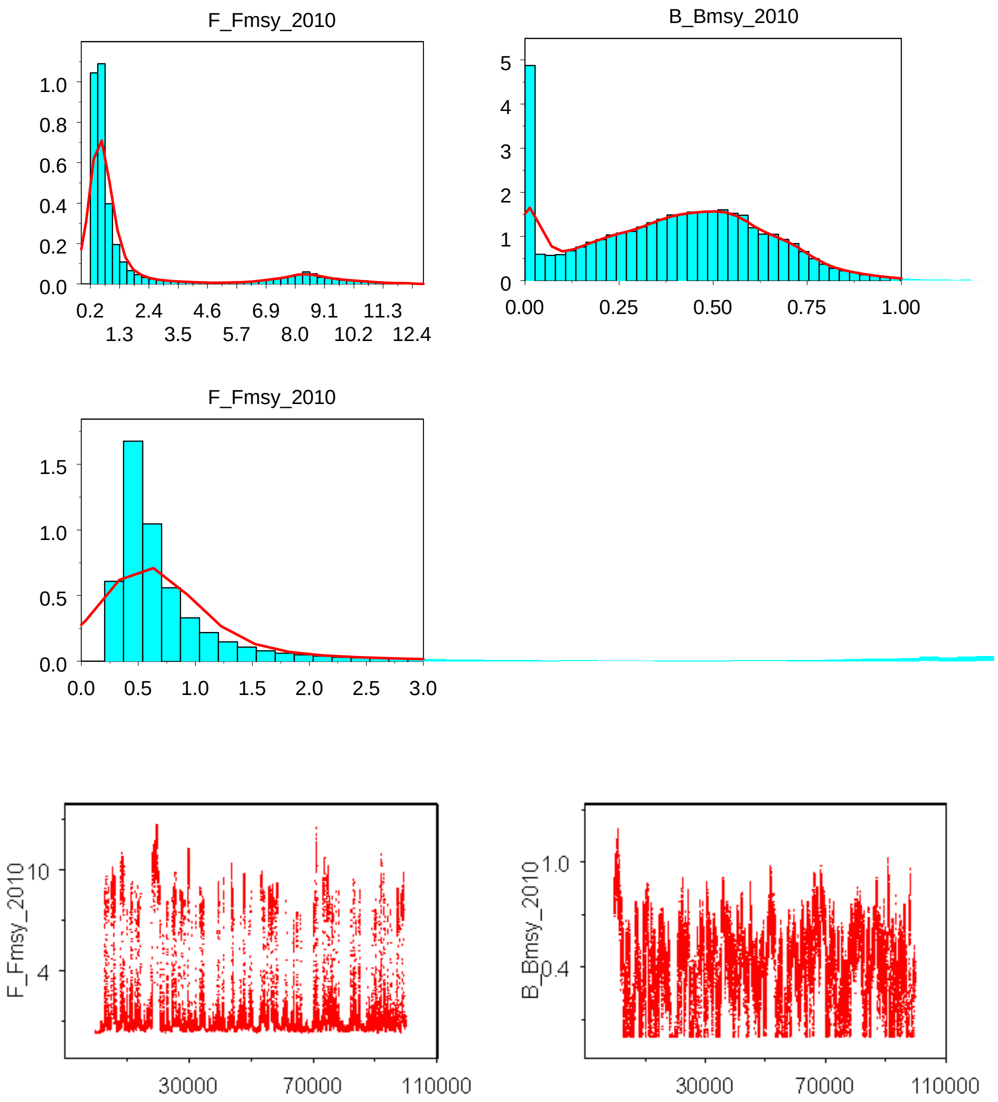


Figure 12D. Frequency histograms (top) and estimation trace plots (bottom) of the posteriors from mcmc analysis for the SS RUN_1 white marlin model.

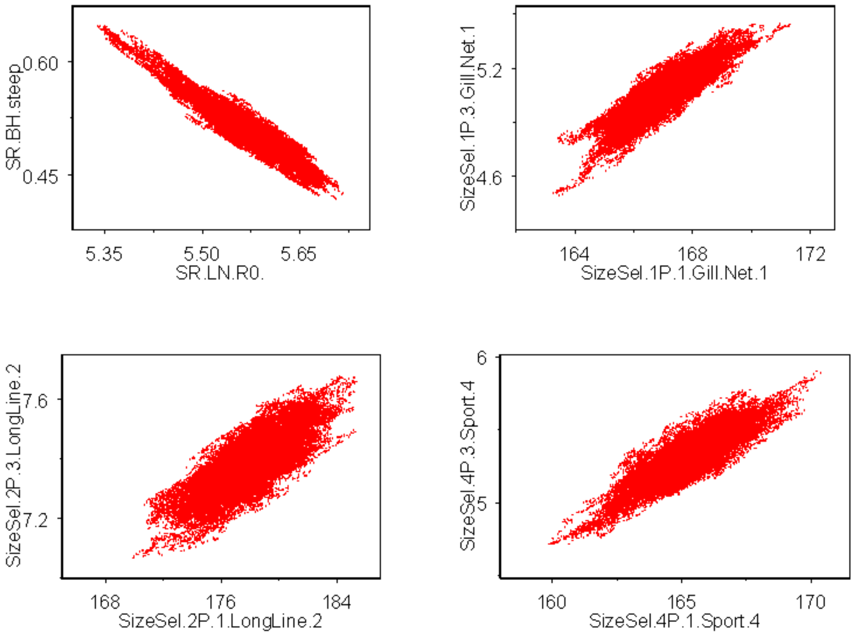


Figure 13. Scatter plots of parameters with correlations greater than 0.70, SS RUN_1 white marlin model.