REPORT OF THE 2011 BLUE MARLIN STOCK ASSESSMENT AND WHITE MARLIN DATA PREPARATORY MEETING

(Madrid, Spain – April 25 to 29, 2011)

1. Opening, adoption of Agenda and meeting arrangements

Mr. Driss Meski, ICCAT Executive Secretary, opened the meeting and welcomed participants.

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

The Agenda (**Appendix 1**) was adopted. 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, 9 and 10
P. Lynch, L. Reynal and P. Bannerman	Item 2
E. Prince and P. Lynch	Item 3
J. Hoolihan	Item 4
G. Díaz	Item 5
C. Brown and D. Die	Item 6
L. Kell and M. Ortiz	Item 7
F. Arocha and J. Santiago	Item 8
F. Arocha	Item 9

2. Update of BUM basic information and review of WHM basic information

2.1 Task I (catches)

The Secretariat provided a detailed report of updated Task I catch statistics (including discards) for the reporting period 1956-2010 (**Table 1**). However, since data from 2010 are preliminary and incomplete, the stock assessment was performed on data for the period 1956-2009. For those CPCs that did not report catches in 2010, these data were carried over from the previous year to support projection analyses. The catches in **Table 1** also include the proportion of catches reported as unclassified billfish that were reclassified as blue marlin in the 2010 Blue Marlin Data Preparatory Meeting. Total Task I catch statistics were also presented in terms of catch or landings, and dead discards (**Figure 1**). Total catches with live and dead discards were also presented for those CPCs that reported these categories separated. It was noted, however, that few CPCs reported live discards corresponding with the ICCAT management recommendation mandating live release from longlines (**Table 2)**. Total catches (including dead discards) were also presented by gear type (**Figures 2** and **3**) with longlines continuing to represent the dominant gear, but the proportion due to artisanal gillnets has been increasing over the last decade. This increase may be due to increased landings, better reporting, or a combination of both. Information on live discards was presented for the CPCs that provided that information (**Table 2**). However, since there is not sufficient information regarding post-release survival of blue marlin released from longlines, potential mortality of the live discard fraction was not incorporated into the total removals input matrix. Landings from FAD fisheries in the area of Martinique and Guadeloupe were also presented during the meeting and incorporated into the Task I table. Catch and fishing effort for these fisheries were estimated using historical effort data derived from interviews with boat captains, while historical landings were estimated using the average CPUE from 2008-2009 for Martinique and the CPUE from 2008 for Guadeloupe (**Figure 4** and **Figure 5**).

2.2 Task II (catch-effort and size samples)

The Secretariat provided a detailed summary of updated Task II catch and effort data, and total available data were presented in the 2010 Blue Marlin Data Preparatory Meeting. For size samples, the size compositions and size frequency analysis reported in the 2010 Blue Marlin Data Preparatory Meeting (Anon. 2011) was reviewed.

Document SCRS/2011/049 presented a detailed analysis of catch data obtained from the National Observer Program database (NOP) from Brazilian chartered longliners. A total of 5,320 blue marlins were measured from 2005 to 2008. Specimens ranged from 89 to 350 cm LJFL, and the sex ratio favored males (1:1.73) in most length classes. Larger individuals tended to be caught below the 5°S latitude. Immature individuals were few and occurred only in two areas (0º, 15ºW and 25ºS, 25ºW). The smallest individuals (<170 cm) occurred offshore mainly in the first quarter. Largest individuals occurred in the south of the study area during austral summertime then moving clockwise towards the north in warmer waters during the wintertime, closing a possible reproductive migratory cycle in the south central Atlantic. These reports agreed with prior observations by Ueyanagi et al. (1970) and Amorim et al. (1998; 1994) that reported aggregations of blue marlin for reproductive purposes, in southern Brazil, between 20°S and 30°S, during the first quarter.

2.3 Other information (tagging)

Conventional tag releases and recaptures were reported in 5x5 degree squares (**Figure 6** and **7**). The highest density of releases is from the western Atlantic and Caribbean. Tag recaptures are also concentrated in the western Atlantic Ocean and Caribbean Sea.

3. Review of WHM/spearfishes catch estimates

Shivji et al. (2006) recently validated the presence of roundscale spearfish (*Tetrapturus georgii*) in the western North Atlantic, a species that is morphologically similar to white marlin, and suggested that some unknown proportion of white marlin catches may actually be roundscale spearfish. This prompted the Group to discuss the possibility of estimating and removing a portion of the reported white marlin catch and reallocating those catches to roundscale spearfish. However, after discussing the results of prior research (Beerkircher et al. 2009, Arocha and Silva 2011), as well as document SCRS/2011/051 presented at this meeting, it was concluded that the amount of variability in the observed ratios between the two species (annual and interannual) and the insufficient spatial sampling coverage would preclude the ability to reliably estimate proportions of roundscale spearfish from white marlin catches at present. Furthermore, it was noted that there is additional confusion in the identification of spearfishes in general among CPCs. Therefore, it is the decision of the Group to treat the upcoming white marlin assessment (2012) as a white marlin/spearfishes species complex. There are ongoing research projects addressing the issue of misidentification of these species; however, it was noted by the Working Group that reliable population-level estimates would require a comprehensive Atlantic-wide sampling program, as well as a large-scale retrospective analysis. Furthermore, it was noted that the Spanish longline fleet may represent an ideal sampling platform for estimating white marlin/roundscale spearfish proportions on broad temporal and spatial scales, particularly for the northeastern and southwestern regions of the Atlantic Ocean (SCRS/2011/035).

3.1 Task I (catches)

The Secretariat provided a detailed report of Task I catch statistics (including discards) for the reporting period 1956-2010 (**Table 3**). However, since very few CPCs reported data for 2010, these catches are preliminary and incomplete. Following the reclassification of unclassified billfish developed in the 2010 Marlin Data Preparatory Meeting, white marlin catches include the proportion of catches that were reclassified as white marlin. Total catches with live and dead discards were also presented for those CPCs that reported these categories separated (**Figure 8**). Total catches (including dead discards) were also presented by gear type (**Figures9** and **10**), with longlines continuing to represent the dominant gear for removals. Information on live discards was presented for the CPCs that submitted this information to the Secretariat (**Table 2**).

Document SCRS/2011/026 provides information obtained from Uruguay's Pelagic Longline Observer Program on the catch of white marlin taken by the Uruguayan fleet operating in the southwestern Atlantic Ocean during the period April 1998 to December 2010, and the Japanese longline fleet that operated in the Uruguayan EEZ from March to September 2009 and from May to September 2010. The largest catches of the Uruguayan fleet were recorded north of 30°S. The highest CPUE values were obtained in areas with sea surface temperature (SST) between 20 and 24°C. Nominal CPUE of the Japanese longline fleet (2009-2010) was lower than the nominal CPUE of the Uruguayan fleet. However, considering the operational depth of this fleet (100-200 m), the area of operation (34-37°S), and the distribution limit of the species, this difference in CPUE was very small. This could be due to different behavior of individuals in areas at higher latitudes, with more time spent at a greater depth and lower temperatures. The mean size of white marlin (by sex) caught by the Japanese fleet was higher than those caught by the Uruguayan fleet (SCRS/2011/026).

3.2 Task II (catch-effort and size samples)

The Secretariat provided a detailed summary of Task II size data for white marlin. In addition to catch and effort data, the size composition data presented for white marlin in the report of the 2010 Marlin Data Preparatory Meeting were updated and presented. Length measurements were standardized to lower jaw fork length (LJFL, cm) using the equations in the ICCAT Manual. Slight differences in data collection methodology were exhibited across the fisheries (i.e. specification of the size intervals used for measurement, and or the size bound reported, mid-point or upper-lower size bin limit). In these instances, no conversions were applied because the differences were minimal. Suspicious length measurements were excluded by restricting the size data to a range of 50 and 400 LJFL cm, respectively. Overall, size data were analyzed from ten flags and three different fishing gears, including new size series of white marlin from Portugal and Ghana. Results were presented as annual mean LJFL (**Figure 11**) and were summarized as: a) size distribution histograms by year for the past ten years (**Figure 12**), for the dominant fishing gears (**Figure 13**), and dominant CPC fleets (**Figure 14**). In general, there was little trend in mean LJFL or in the shape of the frequency histograms. However, catches in the artisanal fisheries off western Africa reported catching larger than average fish. Plots of cumulative probability across the observed range of LJFL by year were generated for the longline and the U.S. sport fisheries combined (**Figure 15**), and a separate plot was created for the gillnet fisheries (**Figure 16**). These figures indicate relatively consistent patterns of size-selectivity for white marlin across fisheries and through time.

3.3 Catalogue of available information

The currently available white marlin Task I and Task II data were presented by flag and fleet for the past two decades (**Table 4**). In the table, the solid color cells represent strata for which data have been reported. It is evident that many CPCs have not fulfilled their reporting obligations for white marlin.

3.4 Other information

Conventional tag releases and recaptures were reported in 5x5 degree squares (**Figure 17** and **18**). The highest density of releases is from the western Atlantic and Caribbean. Tag recaptures are also concentrated in the western Atlantic and Caribbean.

4. Review of biological, habitat, and tagging data for blue marlin and white marlin

4.1 Biological data

4.1.1 Blue marlin

Biological information presented at the 2010 blue marlin data preparatory and 2011 assessment meetings was reviewed, along with relevant peer-reviewed studies published since the previous assessment (2006). Ongoing age and growth analyses were presented for blue marlin (n = 440) sampled from Brazil and Venezuela between December 2004 and December 2006. Transverse fin spine sections from 151 females, 286 males, and 3 unidentified were included. Relative marginal increment analysis was used to determine the periodicity of annulus formation. The effects of so called “false” annuli (e.g. double, triple rings) created uncertainty in some counts. Similarly, obliteration of early formed annuli due to spine core vascularization over time created problems. Failure to account for obliterated annuli may prevent age estimation or result in underestimation of affected spines. Also, lack of adequate sample representation for very large blue marlin hindered accurate growth curve estimates from these samples. Estimated sizes at sexual maturity were 183 cm LJFL (females), and 150 cm LJFL (males).

SCRS/2011/021described the spatial and temporal characteristics of the sex ratios and spawning activity for blue marlin caught in the Venezuelan pelagic longline (n = 1,935) and artisanal drift gillnet (n = 19,037) fisheries for the period 1991-2009. Sex ratio favored males throughout the season in the pelagic longline fishery, but to a lesser extent in the artisanal drift gillnet fishery. Sex ratio at size favored males strongly for specimens <200 cm LJFL in both fisheries. The size of fish caught by the artisanal drift gillnet fishery has remained stable (~200 cm LJFL, females; ~175 cm LJFL, males). However, the number of large males present during the early period in the fishery has been replaced by large numbers of small males in recent years. Large males (>300 cm LJFL), although small in number were present most of the year. The overall sex ratio proportion from the two fisheries was 0.44 female, indicating a dominance of males. Mature males may move north on a seasonal basis for spawning. Mature post-spawned young females (200-275 cm LJFL) move from spawning grounds around Puerto Rico into the southern fishing areas, presumably to replenish energy (i.e. feeding) lost to reproduction.

SCRS/2011/049 described the length composition and spatiotemporal distribution of South Atlantic blue marlin (n = 5,320) from data collected by the Brazilian National Observer Program during 2005-2008. Lengths ranged from 89 to 350 cm LJFL. Of 876 samples sexed, males were more predominant than females (1:1.73). The seasonal distribution of largest individuals suggested a cyclic pattern of migration from the south during the austral summer, then moving clockwise into warmer northern waters during the winter.

Empirical relationships between natural mortality (M) and maximum age, based on Hoenig (1983) were presented to the Group (**Figure 19**). While the limitations of the method are acknowledged, no alternative direct estimates of M were available. Therefore, for the purpose of the 2011 blue marlin assessment an M value of 0.139 was used assuming a maximum age of 30 years.

4.1.2 White marlin

SCRS/2010/042 estimated age and growth for white marlin captured in the commercial and artisanal fisheries in the western Atlantic and Caribbean. For further details see 2010 blue marlin data preparatory meeting report.

Arocha and Silva (2011) examined the spatial and temporal distribution of the proportion of roundscale spearfish relative to white marlin from observed sets in the Venezuelan pelagic longline fleet. For further details see Report of the 2010 Blue Marlin Data Preparatory Meeting.

SCRS/2011/026 presents information from the Uruguayan Observer Program about size composition and sex ratio, in two strata of depth (≤100 m and 100-200 m), for white marlin caught by Uruguayan and Japanese fleets, as well as sea surface temperature (SST) data. A total of 328 individuals were measured in the Uruguayan surface fleet, and an average size of 173.1 cm LJFL (range 120-208 cm) was estimated with males having a lower average size than females. In the Japanese fleet which operated exclusively in the Uruguayan EEZ, the average size was 176 cm LJFL, with males having a higher average size (182 cm) and two of the individuals observed were above 200 cm LJFL (203 and 219 cm). Sex ratio (females:males) observed in the Uruguayan and Japanese fleets was 3:1 and 1.7:1, respectively. Highest catches were observed in areas where SST was between 20 and 24° C. According to the authors, these data suggest a possible higher plasticity for this species which in some areas allows adaptation to increased depths and lower water temperature.

SCRS/2011/051 described the use of genetic analysis to differentiate between white marlin and roundscale spearfish from 212 tissue samples collected at an annual recreational fishing tournament held in Cape May, New Jersey, (U.S.A.) for the period 1992-2010. Results indicated that roundscale spearfish comprised 2.1% of combined species from 1992-2000, but increased to 33.3% from 2002-2010. Considerable year-to-year variation in the relative proportions of the two species was evident over the past decade, suggesting that extensive temporal sampling is warranted to accurately estimate relative proportions for any particular area.

SCRS/2011/035 reported observations of white marlin bycatch (n = 1,385) from the Spanish surface longline fleet targeting swordfish during 1993-2010. At least one white marlin was caught in 18.9% of sets that did catch swordfish. White marlin comprised 12.85% of the total number of istiophorids. Sizes ranged from 130 to 280 cm LJFL for females, and 95 to 285 cm LJFL for males. Size frequencies by year are provided. Of 822 specimens sexed, 42.5% were female and 57.5% male.

4.2 Habitat

4.2.1 Blue marlin

SCRS/2011/052 described preliminary investigation into the possible influence of environmental factors on the catchability of blue marlin off Ghana. Seasonal variation in upwelling and sea surface temperatures in the Gulf of Guinea affected the distribution of blue marlin. The availability of blue marlin decreases during the upwelling period (July-September). This period is also characterized by lower temperatures. Other factors may influence the perceived decrease in abundance, such as a shift in fishing gears to target small pelagics. Further investigation is warranted.

Kell, *et al.* (2011) reported on exploratory CPUE standardization for blue marlin caught inside and outside of the Atlantic oxygen minimum zone. For further details see the Report of the 2010 Blue Marlin Data Preparatory Meeting.

Kraus *et al.* (2011) examined horizontal movements of blue marlin (*n* = 42) monitored with PSATs in the Gulf of Mexico (GOM) during the period 2003-2008. Days at large ranged from 4 to 334. While some fish exhibited egress into the areas of Belize (Caribbean Sea) and U.S. Virgin Islands, most remained in the GOM. Mean displacement ranged between ~300 and 1,200 km. Tracks revealed highly variable movement patterns, regardless of tagging location, season, or egress status. Seasonal changes in distribution suggested a north-south cyclical movement pattern within the GOM. Results support a new perspective of blue marlin in which the GOM provides suitable year-round habitat that is utilized by a subset of the Atlantic population.

Wells *et al*. (2010) investigated regional variation in otolith chemistry of blue marlin from the western North Atlantic. Samples (*n* = 65) originated from the GOM, Straits of Florida, Caribbean Sea, and western North Atlantic. Reduced variability in otolith $\delta^{18}O$ of GOM samples, combined with high classification success of samples from this region, suggests that movement out of the GOM may be more limited compared to the other regions investigated. Although a single Atlantic-wide stock is still supported, these results suggest the possibility that migratory contingents may be present, warranting further investigation.

4.2.2 White marlin

SCRS/2011/035 described the spatial and temporal characteristics of white marlin (*n* = 1,385) captured as bycatch by the Spanish surface longline fleet targeting swordfish during 1993-2010. Plots illustrate the spatial habitat of white marlin for the central and eastern North Atlantic, and South Atlantic. White marlin catch distribution during 1993-2010 is plotted with management zones gridded.

4.3 Tagging

4.3.1 Blue marlin

An update was presented on ICCAT tagging database. For blue marlin, it includes a total of 53,045 releases and 921 (1.74%) recaptures. Snodgrass *et al* (2011) provided an update of the U.S. conventional tagging data base for blue marlin. For further details see 2010 blue marlin data preparatory meeting report.

Other recent PSAT studies have reported movement tracks or displacement vectors of blue marlin in the Atlantic (Goodyear *et al.*, 2008; Kraus *et al.*, 2011; Prince and Goodyear, 2006; Prince *et al.*, 2010).

4.3.2 White marlin

An update was presented on ICCAT tagging database. For white marlin, it includes a total of 46,858 releases and 1059 (2.26%) recaptures. Orbessen *et al* (2011) provided an update of the U.S. conventional tagging data base for white marlin. For further details see the Report of the 2010 Blue Marlin Data Preparatory Meeting.

5. Review of catch per unit effort series: blue marlin and white marlin

5.1 Blue marlin

SCRS/2011/050 presented standardized CPUE series for blue and white marlin for the Brazilian longline fisheries. The authors used three different modeling approaches: zero-inflated negative binomial, delta lognormal, and tweedie GLM. The variables tested in the models were *year, area, quarter*, and *strategy*. This last variable describes the fishing strategy that includes factors such as targeting, gear configuration, etc. Based on model diagnostics, the authors indicated that delta-lognormal model was the most appropriate for the data. The final estimated CPUE had a high degree of interannual variability, but with a strong declining trend in the last five years of the time series. The Group briefly discussed the concept of the variable strategy and its estimation technique. The Group indicated that in the past, Brazilian scientists excluded some of the 'strategies' defined using cluster analyses in their estimation of CPUEs. However, the authors indicated that following the SCRS advice they included all strategies in their analyses.

The Group discussed the differences between the CPUEs presented in the data preparatory and the current estimation with regards to the use of the interactions terms year*quarter and year*strategy that can affect the estimation of the estimate by year. The authors conducted some additional analysis during the meeting and based on the results the authors advised the Group not to include the interaction terms in the final model due to concerns of a fixed year interactions effects. It is noted that the existence of year interactions whether or not it is included in the model may pose difficulties in the estimation of the index values. The Group discussed the high variability of the Brazilian index, the potential reasons of such variability, and if the index might reflect changes more related to the fishery than true population trends. It was also mentioned that the downward trend at the end of the time series might be the result of the implementation of mandatory use of circle hooks in the fleet. However, the Group did not have enough information to evaluate the potential impact of the use of circle hooks on the catch rates.

SCRS/2011/047 presented an evaluation of approaches to estimating relative abundance (i.e., CPUE standardization). A simulation analysis was used to generate catch data with an underlying biomass following the dynamics of the Japanese longline fishery in the Atlantic. A range of biomass trends and patterns in vertical catchability were evaluated, and the models compared included statHBS, GLM, and delta-lognormal GLMs. Overall, the statHBS model provided more accurate estimates of true biomass; however, for simplicity this study did not incorporate spatial and population structure. Also, the statHBS model relied on estimates of hook depth that were assumed without error. In practice, the uncertainty surrounding hook depth may reduce the accuracy of statHBS.

SCRS/2011/048 presented the results of a simulation model (LLSIM) that integrated species distributions with longline-hook distributions of time at depth to predict catch per set. The species' habitat was stratified by month, latitude, longitude and depth. Externally-derived relative abundances by latitude and longitude were inputs to the model and distributed by depth according to the ambient temperature or decay in temperature with depth relative to the temperature of the surface mixed layer. The spatial distributions of longline sets by gear configuration were also model inputs by year (1956-1995), month, latitude and longitude based on the observed effort by the Japanese longline fleet in the Atlantic, or alternatively the same number of sets was randomly assigned to the central tropical Atlantic (CTA) for the same months and years. The stocks were assumed to be either stable or declined with time. The resulting simulated time series were standardized using GLM (Generalized Linear Model) and HBS (deterministically derived standardized abundance incorporating external environmental information) methods. The results were contrasted with the known "true" distributions. Neither the GLM nor HBS consistently accurately recovered the "true" trend in stock abundance when the longline sets mirrored the historical distributions of the Japanese longline sets, presumably because of spatial or other shifts in fishing effort with time. Neither method appeared superior. The Group discussed that an index that includes the entire Atlantic instead of only the Central Tropical Atlantic (e.g., CTA) may be preferable because restricting it to high abundance areas might not reflect the true change in abundance in the entire population. The Group also discussed on the use of the theoretical time spent for each hooks at depth in the simulation study given that studies using TDRs have showed different hook behavior, and also other variables such as the time of longline setting and haulback, and the use of multi and monofilament lines are known to have a strong effect on catch rates. The Group also briefly discussed if spatial changes in the Oxygen Minimum Zone (OMZ) in the CTA would results in a changes of the carrying capacities for the affected species. After a lively discussion, the Group agreed that given the level of information available there was no clear answer to the question.

SCRS/2011/043 presented blue marlin standardized CPUE for the Japanese longline fleet estimated using a GLM lognormal model approach adding a constant value. The CPUE was estimated for two separate periods 1990-2000 and 2001-2009 to accommodate the ICCAT management measure that requires the release from longline vessels of blue and white marlin that are alive at haul back. This was necessary because the estimated CPUE for the period after 2000 was estimated only using kept blue marlin instead of all marlin caught (i.e., kept and released). Note that the authors indicated that there was an error in the estimation used in the CPUE presented in the document and a new estimate (SCRS/2011/043rev) was presented during the meeting. The CPUE was estimated using aggregated catch and effort (i.e. number of hooks) by 5x5 degrees squares and by gear configuration (i.e., hooks per basket). The variables tested in the model were *year¸ quarter, area, hooks per basket* and the interaction terms *quarter*area* and *year*area*. The Group discussed the limitation of using only kept blue marlin to estimate an index of abundance and the validity of assuming a constant rate of released blue marlin after the implementation of the 2001 ICCAT management measure.

The Group noted that document SCRS/2011/052 presented catch and effort (number of trips) information and requested the Secretariat to estimate a standardized index for this fishery (**Appendix 4**).

SCRS/2011/045 presented a standardized blue marlin CPUE series for the Chinese Taipei longline fleet. The index was estimated using the lognormal and GAM model approaches and testing the variables *month, year, latitude,* and *longitude* and the interactions with the *year* term. The authors indicated that the GLM (lognormal) model with interaction terms was the most appropriate as it explained the most deviance. However, all the estimated CPUEs were very similar.

The Group discussed extensively the available CPUE series (both the series presented in the 2010 data preparatory meeting and those presented during the current meeting) and developed a series of criteria to guide the discussion. For the selection of the CPUE series the Group took into consideration the advice from the Report of the 2009 ICCAT Working Group on stock Assessment Methods (Anon. 2010), if the estimated CPUEs had model diagnostics, the level of aggregation of the data used, the length of the time series, if the CPUEs were standardized or not, the modeling approach (lognormal vs. delta-lognormal), if there were gaps in the time series (missing years), if the CPUEs were estimated by national scientist or by the ICCAT Secretariat using Task II data, and if the CPUE were estimated using the entire blue marlin catch or only kept fish. The CPUE series available by the Group were: (1) Japan-LL 1990-2009, (2) Japan-LL 1956-2008 prepared by the Secretariat using Task II data, (3) Japan-LL 1960-1998 used in the 2000 stock assessment, (4) China Taipei-LL1968-2009, (5) China-Taipei 1968-2004 prepared by the Secretariat using Task II data, (6) USA-LL 1986-2009, (6a) USA-recreational 1974-2009, (7) Venezuela-LL 1991-2009, (8) Venezuela-small scale 1991-2009, Venezuela-sport 1961-1995 (historical), (9) Korea-LL 1976-2008, (10) Brazil-LL 1980-2010, and (11) Ghana-gillnet 1997-2010.

The Group agreed to use in the models base case the USA-LL, USA-recreational, Venezuela-LL, Venezuela-small scale (gillnet), and the Venezuela-sport CPUE series that were presented in the 2010 blue marlin data preparatory meeting. The Group agreed on the need to use a time series for longline fisheries that extended back in time to the 1950-1960s. The Group held an extensive discussion with regard to the three available Japanese indexes. It was decided not to include the Japan-LL 1956-2008 CPUE series because it was prepared by the Secretariat using Task II data without input from the Japanese national scientists. The Group agreed to include the Japanese LL CPUE series used in the 2000 stock assessment that covered the period 1960-1998 and the series presented during this stock assessment meeting, but only for the period 2001-2009. This two series were included as separate series because they correspond to two periods of time with different blue marlin management regulations.

Following a similar rationale, the Group chose the Chinese Taipei index prepared by national scientists presented in the meeting over the index prepared by the Secretariat using reported Task II data. Note that although the Chinese Taipei CPUE series was estimated for the entire period 1968-2009, the Group decided to split the series into the periods 1968-2000 and 2001-2009 to account for the changes in management regulations previously mentioned. The Group also included the Ghanaian index that was prepared by the ICCAT Secretariat using data presented by national scientists during the meeting. The entire Group concurred with the decision of not including the Korean LL index that was prepared by the Secretariat. This decision was based mostly on the fact that the time series had gaps (missing years), the uncertainty surrounded the data used in its estimation, and because the index was estimated using reported Task II data it had a relatively high degree of aggregation and poor resolution. In addition, the time period covered by the Korean LL index was already covered by the Japanese and Chinese Taipei indexes. The selected blue marlin indexes used in the 2011 blue marlin stock assessment are presented in **Table 5** and shown in **Figure 20**.

Composite blue marlin CPUE series

The composite blue marlin CPUE for the index series was estimated using a GLM model with three different weighting schemes. The model included *Year* and *Index source* as factors, and the weighting scenarios used were: a) equal weighting, b) catch weight factor, defined as the ratio of the catch by the fleet/gear representing each index to the total catch of all other indices fleets combined, and c) area weighting, defined as the number the 5x5 degree cells fished by the fleet/gear representing each index to the maximum number of 5x5 cells within a year by any given fleet. **Table 5** shows the provided CPUE series. The composite CPUE series were estimated using a Generalized Linear Model, assuming a log-error distribution for the input CPUE series. The formulation of the model was log(CPUE) = year + Source (CPUE index series) + error. Composite CPUE values were back-calculated from the LSMeans of the model fit. Three composite CPUE series were estimated for blue marlin, **Table 6** and **Figure 21** show the resulting composite CPUE values.

5.2 White marlin

SCRS/2011/050rev presented the estimation of white marlin CPUE for the Brazilian longline fishery used the same methodology described in the blue marlin section and no interaction terms were included in the final model. The estimated CPUE, although variable, did not have the large interannual variability observed for blue marlin.

SCRS/2011/044rev presented the white marlin standardized CPUE for the Japanese longline fleet estimated using a GLM (see Section 5.1) lognormal model approach adding a constant value. It used the same methodology described in document SCRS/2011/043rev for blue marlin including the estimation of separate indexes for periods 1990-2000 and 2001-2009 to account for differences in marlin management. The Group inquired about the selection of the areas used in the analysis and requested that in the future Japanese scientists could compared the results of using the old area selection methodology (based in fishing strategies) with the new approach of using a cluster analysis to define fishing areas.

SCRS/2011/033 presented standardized catch rates of white marlin for the Venezuelan longline fishery. The series was estimated with a GLM approach assuming a delta-lognormal distribution and including *year, vessel, bait type, depth of hook, area, and season,* and the interaction terms in the model. Model diagnostics showed no major deviations from the model assumptions. The Group asked why the models included individual vessels instead of grouping the vessels by category. The authors indicated that this approach takes better into account the variability associated to each vessel in those cases where the same vessels do not continuously operate throughout the entire time series.

SCRS/2011/034 presented standardized catch rates of white marlin for a small scale gillnet fishery from Venezuela. The series was estimated with a GLM approach assuming a lognormal distribution and including *year* and *season* and interactions. Model diagnostics showed no major deviations from the model assumptions.

The white marlin CPUE series described above are presented in **Table 7** and shown in **Figure 22**.

6. Stock assessment

6.1 Methods and data used

One document was presented on stock assessment methodology (SCRS/2011/046). This document used the catch and indices of abundance as provided at the 2010 Blue Marlin Data Preparatory Meeting to update the surplus production models conducted in the 2000 blue marlin stock assessment. Three modeling software packages were used in this analysis: ASPIC, Bayesian Surplus Production model, and Stock Synthesis configured as age-structured production model. Model configurations were made to be as close as possible to those of the ASPIC model conducted in 2000. The results of the modeling suggested that the blue marlin stock was closer to the ICCAT management benchmarks than previously estimated. This result held true regardless of which of the two modeling platforms (ASPIC or Stock Synthesis) were used. It was evident, however, that the Brazilian longline and Korean longline CPUE indices presented at the 2010 Blue Marlin Data Preparatory Meeting were the most influential for the estimated differences in B/B_{MSY} and F/F_{MSY}. However, the Brazilian indices available at the data preparatory meeting were revised for the assessment meeting, and during the assessment meeting the Group decided that the Korean longline CPUE should be omitted from further consideration due to the limited detail of the available data (only Task II data were used), and absence of contributed expertise from the CPC scientists in the development of the indices.

The Group agreed to conduct the evaluation of stock status using two models: 1) a non-equilibrium production model (ASPIC) for continuity from the 2000 assessment (the last assessment during which stock status benchmarks were developed), and 2) the fully integrated stock synthesis model described in **Appendix 5**.

The Group also agreed to conduct initial base case runs using the indices as defined in Section 5, applying equal weighting among the indices. The catch series agreed upon included assignments of unspecified billfish to specific species, as calculated by the Secretariat, and an estimated catch series for Martinique and Guadaloupe provided during the meeting. The catch was assigned to 4 gear groupings: longline, gillnet, purse seine, and rod and reel (recreational catches), with all other gears being grouped with longline since it is the least selective gear for blue marlin with respect to size. It was noted that Senegal had been reporting handline and troll catches through 2007, but beginning in 2008 began reporting sport catches and no longer reported handline and troll catches. After reviewing the size frequency distributions for the Senegalese catch series, these were all grouped with longline for the assessment analyses.

As explained in Section 4.1.1, the Group followed the approach developed by Hoenig (1983) using the linear regression parameters developed for fish species to calculate an estimate of natural mortality, so that:

$$\ln(Z) = 1.46 - 1.01 * \ln(t_{max}),$$

where Z is the constant instantaneous rate of mortality and t_{max} is the maximum age. In an unfished state, M = Z. Assuming a maximum age of 30 years (slightly above the 27+ years obtained by Hill *et al.* 1989 through hard part aging of Pacific blue marlin), the resulting natural mortality (M) estimate was 0.139.

6.2 Stock status

6.2.1 Non-equilibrium production model

ASPIC 5.3.4 was used for all model runs and in all cases it was assumed they started at 1956 with the same carrying capacity. All available CPUE indices were scaled to the average of the U.S. recreational CPUE index over the period of overlap of each index. The U.S. recreational index was chosen because it is the only one that has sufficiently long periods of overlap with all other indices. ASPIC 5.3.4 has a limit of 10 CPUE series, so an initial model was set up with ten of the eleven available indices. The only index that was not used was the late period (2001-2009) for the Chinese Taipei longline index. Since it was necessary to exclude at least one index, this particular index was selected for exclusion because the effect on the indices of the implementation of regulations requiring the release of live fish was unclear, since this index was developed from kept fish only, and the time period was covered by other indices (It was noted that other indices, such the Japanese longline index for 2001-2009, may also be affected by implementation of these regulations).

When data were fitted equal weights for these 10 CPUE series, or with weights proportional to the area covered by each fishery, ASPIC could not converge. Combined indices of all series weighted equally, weighted by the area of the fishery, and weighted by the catch of each fishery were also used with ASPIC. In these later cases ASPIC converged to estimates that were deemed unrealistic, with values of r of 0.023 and K of 185,000 tons. This lack of convergence or convergence to unrealistic results is related to the presence of the many conflicting trends found in the CPUE as seen in the correlation matrix for CPUE indices (**Table 8**).

Two alternative ASPIC runs were made to cope with these problems. First, a run with all 10 indices was prepared where only MSY was estimated and where K was assumed to be 100,000 tons in order to achieve convergence. This assumption produces fits that resemble the fit obtained in 2000, where the estimated K was 85,600 tons and is equivalent to constraining the value of r (**Figure 23**). This run is later referred to as "low productivity". A second run was prepared for ASPIC where a selection of indices was conducted under the premise that some indices reflect abundance more than others. All indices used in this run were weighted by the average area of each fishery. The indices of Ghana and Brazil were excluded because they tend to be negatively correlated with most of the other indices over which they overlap. The Chinese Taipei and Japanese index were split between pre and post 1980 to represent the possibility that the CPUE standardization had not removed the variation in catchability caused by the development of deep water operations for bigeye tuna. The Chinese Taipei index was only used prior to 1980 since the period 1981 to 2000 is negatively correlated with all the other indices with which it overlaps. This left a run with seven indices referred to later as "high productivity" (**Figure 24**). This run did converge to a plausible albeit different result than the "low productivity" run (**Table 9**).

The Group considered that the "low productivity" run was having difficulty reconciling the long term catch trends (with a general pattern of initial large drop in CPUE followed by a long period of relatively leveled catch rates) with the catch trends (initial relatively high catches, followed by somewhat reduced catch levels, and then increased catch levels again. Only when some of the CPUE series are eliminated does the model converge to a solution and the remaining CPUE series become somewhat more informative about stock productivity ("high productivity" run). The current status determinations for these two runs are rather similar (**Table 10**), with the stock biomass in both cases estimated to be below B_{MSY} and the fishing mortality exceeding F_{MSY}. There were considerable differences in the estimates of MSY, 2,700 t and 4,300 t for the low and high productivity runs respectively. The corresponding r values for these two runs were equally different, 0.11 and 0.65, respectively.

These results highlight the fact that there is no information in the relative abundance indices that can be unequivocally used to determine how productive the stock is. The level of productivity does not change the estimated current status of the stock which is assessed to be overfished and suffering overfishing.

6.2.2 Statistically integrated model

The basic structure, assumptions and inputs of the Base Case of the fully integrated model on the stock synthesis platform are described in **Appendix 5**. The configurations and results of specific runs are described below.
<u>Base Case</u>

The estimated growth parameters resulted in male and female growth curves that agreed well with what is believed to be the true biological functions (**Figure 25**, top). The resulting fit to the observed sex ratio observations (**Figure 25**, bottom) were very satisfactory, especially with regard to sexually mature fish. Consequently, the Group adopted a two-sex model approach.

The fit to the CPUE time series demonstrated the inconsistencies between the eleven indices (**Figure 26**). The model was unable to fully capture some of the observed annual variations in the CPUE. This was assumed to be due to the bounds imposed on recruitment deviations (-0.5 and 0.5).

The length composition data was found to provide no 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 and the resulting estimated selectivities (**Figure 27**) posed no meaningful problems. The time varying selectivity for the sport fishery was found to be a satisfactory solution to account for changes in the length frequencies that were due to changes in minimum size regulations. The fit to the estimated post-release mortalities of recreational live discards due to, among other things, the minimum size regulation is shown in **Figure 28**. The fit was deemed by the Group to be satisfactory. The Group discussed as to how best deal with post-release mortality of live discards from longline gear within the assessment modeling framework. The Group recognized the basis of the problem being a lack of reliable estimates of discards both with regard to quantity and length composition. Further discussion followed that emphasized the need for fleet specific discard mortality estimates as well.

Estimated trends in spawning stock biomass were found to be similar to those estimated in previous assessments (**Figure 29**). Estimates of recruitment showed very wide confidence intervals (**Figure 30**). This is due to the fact that nearly all the signal for recruitment was from the CPUE data, as none was found in the lengths data. The CPUE data was mostly an adult index and, as such, cannot provide a clear signal to annual recruitment strengths. Furthermore, given the inconsistencies in the CPUE time series, the model was unable to obtain reliable estimates of annual recruitment. Nonetheless, a trend was evident in estimated trajectories by an increase from 1990 to 2000 followed by a sharp decline afterwards. However, the signal for this trend more likely originated from the landings data, which also showed a drop off at the same time but was probably due to regulatory measures. Given all the above difficulties, estimates of annual recruitment remain highly uncertain.

Uncertainties in recruitment notwithstanding, estimates of the spawning stock-recruitment relationship appeared reasonable (**Figure 31**). However, recruitment deviation bounds were hit for some years (**Figure 32**). The estimate of virgin recruitment was 5.026 (log scale) with a standard deviation of 0.166, and the estimate of steepness was 0.411 with a standard deviation of 0.062 (**Table 11**). This resulted in an estimate of maximum sustainable yield of 2837 t (SD = 246 t). The resulting estimate of stock status from the base case model were that the stock is currently overfished (B/B_{MSY} = 0.670, SD = 0.071) and undergoing overfishing (F/F_{MSY} = 1.633, SD = 0.263). The annual trend in stock status is shown in **Figure 33.**

To better characterize the uncertainty around the parameter and derived quantities estimates, a series of MCMCs were run. These resulted in the distribution of the estimate of B/B_{MSY} and F/F_{MSY} in 2009 (**Figure 34**) as well as the Kobe phase plots (**Figure 35**).

Sensitivity Runs

To examine the sensitivity of results to the assumed value of natural mortality, it was requested that two additional runs be made with the value of natural mortality fixed at the upper and lower values of the 95% confidence intervals assuming a mean of 0.139 and 25% CV (lower value M = 0.07, upper value M= 0.19). The model failed to converge on the lower level of M (**Table 12**). Not until M was raised to M = 0.12 did the model find a satisfactory solution. At M = 0.12, the estimated status of the stock relative to the benchmarks changed very little (B/B_{MSY} = 0.700, SD = 0.077; F/F_{MSY} = 1.499, SD = 0.240). Likewise, for M at the high end of the range the estimate of stock status did not show a significant change (B/B_{MSY} = 0.636, SD = 0.065; F/F_{MSY} = 1.854, SD = 0.312). These results are shown **Figure 36** and **Figure 37**. Consequently, the estimate of current stock status does not seem to be particularly sensitive to assumptions with regard to natural mortality with the bounds explored.

It was noted that during the base case model run, bounds on recruitment deviations were being hit on several years. In order to examine the sensitivity of results to the constraints on recruitment deviations, the bounds were widened to values of -5.0 to 5.0, which are levels that should only rarely be restrictive. The subsequent model fit was very unstable, inconsistent between runs, and would not converge properly. This is very likely due to the fact that the only data signals from which to estimate deviations were coming from the CPUE data. With no other observations to inform the model regarding recruitment variation, experimentation found that, when the recruitment deviations are not bound, the recruitment deviations were used by the model to fit the erratic variations in each of the CPUE time series. An attempt was made to estimate more recruitment deviations further back in time (starting in 1957). While the model was able to converge using this tactic, convergence was inconsistent. This leads to the conclusion of either a very flat response surface, or the occurrence of several local minimums, either of which would deem the model unreliable. As a result, the bounds on the recruitment deviations were maintained as originally configured for the base model. However, it was noted that these bounds may be having a significant influence on the estimate of the steepness parameter.

6.3 Projections

For projections, the Group decided to use the 2010 catches that were estimated during this meeting (3,431 t), in which 2009 catches were carried over to 2010 for CPCs that had not yet reported 2010 catches. The catches for 2011 were also assumed to be identical to those estimated for 2010 since any measures established at the next Commission meeting could only be implemented in 2012 at the earliest.

The Group agreed that projections should be carried out assuming constant catch levels, beginning in 2012, ranging from 0 to 6000 t. However, results show that projections with TAC above 4000 t, did produce collapse of the stock. For presentation purposes, projections were restricted to a TAC range of 0 - 4000 t.

6.3.1 Projections from non-equilibrium production model results

Projections made from the "low productivity" case with future catch levels of 2,000 or more suggests that it is more likely that the biomass of the stock will continue to decline. For catches of 1,500 there is greater likelihood that the stock will increase than it will decline. Projections made from the "high productivity" case with future catch levels of 3,000 or less would allow the stock to recover. Projections with status quo catches of 3,500 suggest the stock would not recover nor decline.

The Group made the determination that estimates of current stock status and subsequent projections should be based on the statistically integrated model rather than the non-equilibrium production model. This determination was based on the fact that the production model was unable to arrive at a satisfactory fit to the data without fixing two of the three parameters, perhaps at somewhat arbitrary values, or by eliminating some of the CPUE series. Although the fully integrated model used some of the same data, the ability of the integrated model to incorporate more of the available data and the fact that it was able to successfully arrive at convergence compelled the Group to choose the fully integrated model for continued consideration and projections. The Group noted that the available data did not provide sufficient information for either model to reliably determine the productivity of the stock. Therefore the projections are uncertain.

*6.3.2 Projections using the statistically integrated mo**del***

To evaluate the implications of future catch levels for rebuilding the stock, projections were conducted with the Stock Synthesis (SS3) software as follows. The status of the blue marlin stock at the end of 2009 (final year of SS3 base model) was projected deterministically assuming different levels of total catch. Projections assumed that for 2010 and 2011 the levels of catch were those estimated by the Group during the review of catch statistics (see Section 2.1.) of 3,431 tons. Future catches, starting in 2012, were projected at constant levels ranging from 0 to 4,000 t per year (with increments of 500 t).

Table 13 and **Figure 37** show the trends of relative biomass (SSB/SSB_{MSY}) of the stock during the period covered by the projections. Overall, total catches above 3,000 t did result in a continued decline of the stock biomass within the projected time period. Total catches at or below 2,000 t did allow the stock to increase in biomass within this time period, catches around 2,500 t will basically maintain the stock at the same depleted level as in 2011. Only catches of 1,500 t or below will allow the stock to recover to biomass levels at or above SSB_{MSY} before 2026. The Group noted that the stock projections behave similarly to those of the surplus production model (ASPIC) "low productivity" case, although recovery is somewhat faster with the fully integrated model base case. As noted previously, due to the uncertainty in estimates of the productivity of the stock, the projections are uncertain (see **Figure 43**).

7. Evaluation of management scenario

Management evaluations were performed to provide advice in the form of a Kobe II strategy matrix (K2SM), following the Guidelines developed by the 2009 Working Group on Stock Assessment Methods (Anon. 2010). The K2SM is a decision table that summarizes the probabilities of achieving within a given time period biomass and fishing mortality rate targets (i.e. related to maintaining stocks at levels that can achieve Maximum Sustainable Yield) under different management regimes such as a TAC levels. The Kobe II strategy matrix is being used by all the tuna RFMOs and its production is a now primary output of assessment working groups. Importantly, this means that the mandate of the species working groups is expanded from simply determining current stock status to providing probabilistic management advice that incorporates uncertainty.

Traditional stock assessments mainly consider only uncertainty in observations and process (e.g. recruitment). However, uncertainty about the actual dynamics (i.e. model uncertainty) has a larger impact on achieving management objectives (Punt 2006). Therefore, when providing management advice it is important to consider appropriate sources of uncertainty. Rosenberg and Restrepo (1994) categorized uncertainties in fish stock assessment and management as:

- Process error: caused by disregarding variability, temporal and spatial, in dynamic population and fisheries processes;
- Observation error: sampling error and measurement error;
- Estimation error: arising when estimating parameters of the models used in the assessment procedure;
- Implementation error: where the effects of management actions may differ from those intended.
- Model error: related to the ability of the model structure to capture the core of the system dynamics;

Sources of uncertainty related to model error include: (i) structural uncertainty, due to inadequate models, incomplete or competing conceptual frameworks, wrongly specified or ignoring key processes and/or relationships, which tend to be underestimated by experts (Morgan et al., 1990); and (ii) value uncertainty, due to missing or inaccurate data or poorly known parameters.

The Guidelines developed by the Working Group on Stock Assessment Methods are:

- Matrices should be presented in both tabular and graphical form
- The model(s), model runs and methodologies used for construction should be clearly documented.
- Matrices should be constructed from the assessment models used to determine stock status.
- Matrices should clearly outline assumptions and uncertainties.
- Methodologies for model averaging, model harmonization and generation of probabilistic statements regarding harvest control rules should be employed.
- Multiple matrices may be necessary to provide advice spanning alternative hypotheses.

Stochastic projections form the basis of the K2SM and therefore full documentation on how these were conducted is provided in Section 6.3. This includes specification of:

- Projection software used
- Recruitment model/recruitment replacement/error structure specifications
- Selectivity/partial F specifications
- Age "plus-group" calculations
- Projection time period
- Management implementation assumptions

Two stock assessment methods were used during the meeting a surplus production model (ASPIC) and age-sex structured catch statistical model (SS3) (see Section 6.1) and projections were performed using both methods (see Section 6.3). The Group decided to use the SS3 as base model, therefore only projections from SS3 were used to produce the K2SM.

Uncertainty in the assessment was characterized by conducting both sensitivity and Markov Chain Monte Carlo (MCMC) runs. The sensitivity runs evaluated uncertainty in the Group's knowledge of natural mortality and the steepness parameter of the stock recruitment relationship (i.e., value uncertainty), while the MCMC runs were conducted to provide uncertainty in parameters and quantities derived from them (i.e. estimation error). The model configuration used in the MCMC analysis was exactly the same as that of the base model. That is, parameter priors and bounds were left unchanged).

The Markov Chain Monte Carlo method (MCMC) is a method for approximating the posterior distribution for parameters of interest within a Bayesian framework. SS3 is based on AD Model Builder and so can use both the mode of the posterior distribution and the Hessian matrix at the mode to implement a version of the Hastings-Metropolis algorithm to obtain a sequence of random samples from a probability distribution. Another advantage is that with AD Model Builder, it is possible to compare the profile likelihood for a parameter of interest and compare it with the MCMC distribution. A large discrepancy may indicate that one or both estimates are inadequate.

Assessment estimates of annual recruitment were highly uncertain and the recruitment deviation bounds were hit for some years. The bounds may have a significant influence on the estimate of the steepness parameter and hence stock productivity and MSY based reference points. However, estimates of stock status and exploitation rate relative to MSY based marks appeared to be robust to the value of M assumed (see Section 6.2.2). There is also a lack of reliable data on post-release mortality of live discards both for use within the stock assessment and importantly for projecting the stock under the different management options (implementation error). However, uncertainty in on post-release mortality of live discards on the implementation of management measures was not considered.

Projections were made using the base case run from 2010 through 2026 (see Section 6.3). For 2010 and 2011 it was assumed a catch of 3,431 t (estimated for 2010 by the Group based on preliminary reports from CPCs) as management regulations should start in 2012 at the earliest. The projections assumed the same biological and fisheries parameters and characteristics as the assessment base model, i.e. parameters were constant across years and MCMC run for biological parameters and across years for fishery parameters. The allocation of TACs between fleets in the projections was based on the average catch proportions by fleets for the last five years (2005-2009).

Performing constant catch projections for more than one fleet with different selection patterns under a fixed allocation key means that a change in population structure (e.g. due to a management plan aimed to recover a stock) will result in the relative partial fishing mortality to vary by year. Since MSY reference points are calculated assuming a selection pattern based on the total fishing mortality, which is a weighted sum of the partial Fs, MSY based reference points will also vary by year. Likewise historical estimates of MSY based reference will also vary where relative partial Fs have varied. However, SS3 assumes that MSY based reference points are fixed within an MCMC run, both historically and into the future, this means that the time series of SSB and harvest rate relative to B_{MSY} and F_{MSY} will be biased in different ways over time and between TAC regimes.

Time series of biomass relative to B_{MSY} and harvest rate relative to F_{MSY} are presented in **Figure 38** (historic period 1957-2009) and **Figures 39** and **40** for the projections (2010 - 2026) used to construct the K2SM **Table 14**). For the historic period lines represents the median and 80% inter quartiles values. Current status of the blue marlin stock is presented in **Figure 41** indicating the level of uncertainty in the base model results.

The KS2M shows the probabilities of being in the Kobe quadrant corresponding to $SSB \geq SSB_{MSY}$ and $F \leq F_{MSY}$ by year for each of the TAC levels (**Figure 42**). Kobe phase plot with individual realisations from several models evaluated is presented in **Figure 43**.

8. Effects of current regulations

Recommendation [Rec. 06-09] placed catch restrictions for blue marlin and white marlin. It established that the annual amount of blue marlin that can be harvested by pelagic longline and purse seine vessels and retained for landing must be no more than 50% for blue marlin of the 1996 or 1999 landing levels, whichever is greater. That recommendation established that: "All blue marlin and white marlin brought to pelagic longline and purse seine vessels alive shall be released in a manner that maximizes their survival. The provision of this paragraph does not apply to marlins that are dead when brought along the side of the vessel and that are not sold or entered into commerce".

The Working Group discussed this recommendation. During these discussions, the Group addressed the issue of documenting the number of live releases and its difficulty to be estimated for the whole fisheries. Apparently, some ICCAT member longline and purse seine observer programs have not been recording this variable, so a quantitative Atlantic-wide assessment of how well this recommendation has been implemented by ICCAT members could not be made. The Group recommended that this situation be rectified so that the Commission recommendation on live releases can be evaluated within the context of the billfish rebuilding plan. The Group recommended that, in addition to recording the number of live billfish releases and the number of dead discards or retentions, CPCs should provide estimates of live discard mortality. Studies with electronic tagging or auxiliary information, such type of terminal gear, degree of injury at release, condition of the fish at release, could help to estimate survival rates of caught and release blue marlin.

Meanwhile, the Group considered that there is not enough information on the proportion of fish being released alive for all fleets to evaluate the effectiveness of this particular regulation. Average catch of pelagic longline and purse seine vessels during the period 2005-2009 was 1,938 t or 51 % of the maximum catch for those same fleets in the years 1996 or 1999 (3,810 t), above the 50% recommended in current recommendation [Rec. 06-09].

9. Recommendations

9.1 Research and statistics

1. The Group recommended on the need to stress that CPCs should report Task I and Task II for inter-sessional meetings by the deadlines provided by the Secretariat.

2. The Group recommended that the study on age and growth of blue marlin continues, stressing the need to include in the study anal spine sections from large specimens in subtropical and temperate areas.

3. The Group recognized the important new catch estimates of blue marlin from FAD fisheries of Martinique and Guadalupe and recommended that detail of estimation be presented as an SCRS document in the next species group meeting. The Group also recommended that other Caribbean countries with FAD fisheries report detail specific billfish catches.

4. The Group encouraged the Secretariat to reach out to other RMFO in the Greater Caribbean to explore sharing data pertinent to ICCAT fisheries.

5. The Group recognized the complexity of white marlin reported catches where historical catches may comprise a mixture of species, like roundscale spearfish (RSP) and longbill spearfish (SPF) in addition to white marlin. Therefore, the Group recommended that the white marlin stock assessment to be conducted in 2012 be considered as mix species stock assessment.

6. Noting the misidentification problems between white marlin, roundscale and longbill spearfishes, the Group recommended conducting an Atlantic-wide survey of WHM-RSF-SPF distribution and abundance with the collaboration of CPCs with fleets covering the entire Atlantic, particularly in the eastern and southwestern Atlantic fishing areas.

7. The Group strongly recommended that the Commission provide additional funding (50K euros) to the Enhanced Billfish Research Program for a genetic study in order to accelerate the data acquisition and analysis for separating white marlin from spearfishes to be undertaken in the immediate future.

8. In noting that estimation of relative abundance indices is always best done at the highest spatio-temporal resolution warranted by the available data, the Group recommended that all CPCs, and especially those that have important catches of white marlin, provide updated relative abundance indices obtained from such high resolution CPUE data and also to take into consideration the effect of current regulations in the standardization process. 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-after implementation.

9. The Group recommended that the surplus production models conducted in the 2000 white marlin stock assessment be updated in the 2012 stock assessment meeting.

9.2 Management

The current blue marlin stock assessment indicates that the stock is below B_{MSY} and the fishing mortality above F_{MSY} (2009). Unless the current catch levels (3,431 t, 2010) are substantially reduced, the stock will likely continue to decline. The Commission should adopt a rebuilding plan for the stock of Atlantic blue marlin.

The Commission should implement management measures to immediately reduce fishing mortality on blue marlin stock by adopting a TAC that allow the stock to increase (2000 t or less, including dead discards)

1. To facilitate the implementation of the TAC, the commission may consider the adoption of measures such as, but not limited to:

   a) Total prohibition of landings of blue marlin from pelagic longline and purse seine fisheries to improve the effectiveness of current management measures.
   b) Encouraging the use of alternative gear configurations that reduce the likelihood of deep hooking therefore increasing the post-release survival (for example, circle hooks).
   c) Broader application of time-area closures.
   d) Consider adopting measures to reduce fishing mortality of blue marlin from small-scale fisheries.

2. Noting the misidentification problems between white marlin and spearfishes, the Group recommended that management recommendations combine these species as a mixed stock until more accurate species identification and differentiation of species catches are available.

3. The Commission should require the reporting of catches of white marlin and roundscale spearfish separated.

10. Other matters

The Group discussed extensively the complexity of identifying accurately white marlin from roundscale and longbill spearfishes. It acknowledged that the most accurate way to separate the species was by genetic analysis but well experienced and trained scientific observers and fishers can accurately separate the species using anatomical features. Following the recommendation from the Blue Marlin Data Preparatory Meeting that stated that the chapter on spearfishes in the *ICCAT Manual* be updated to consider the misidentification problems between roundscale and longbill spearfishes and white marlin, as well as the need to have field identification sheets for all species of billfish, similar to those prepared for sharks and small tunas, but with key features to accurately separate white marlin from spearfish species. In order for all CPCs to be able to accurately separate white marlin from the spearfishes, instruments such as those mentioned above need to be updated and developed by the Secretariat and funds need to be allocated for the development of such identifications instruments.

11. 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. Total removals of blue marlin 1956-2010. Values included the estimated BUM component from the unclassified billfish catches, the revised catch series from the French West Indies FAD fisherеis estimates, and Working Group estimates for 2010.

Gear SS3	Catch t / Flag	Year Cal 1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GN	Benin																										5	7		8	10	7	4	12		6	6	6	6	5	5	5	5	5	5	5										
	Brasil																															3										21														
	Côte D'Ivoire																																	130	82	88	105	79	139	212	177	157	222	182	275	206	196	78	109	115	107	178	150	991	440	440
	Dominica																																																					0		
	EU.España																																	2																						
	EU.France																																																					0		
	Gabon																																						1	2		304	5				1		3							
	Ghana																									119	129	52	216	166	150	16	5	7	430	324	126	123	236	441	471	422	491	447	624	639	795	999	415	470	759	405	683	191	140	116
	Liberia																																								87	148	148	701	420	712	235	158	115							
	NEI (BIL)																													128	78	68	94	74	103	18	20	38																		
	Senegal																																			1		0												0	0					
	Togo																																										23		73	53	141	103	775							
	Venezuela																																	20	99	13	13	21	24	58	48	71	86	175	190	80	57	50	55	57	110	118	184	105	69	94
LL	Barbados																			183	150	120	81	72	51	73	117	99	126	126	10	14	13	46	3	18	12	18	21	19	31	25	30	25	19	19	18	11	11			25				9
	Belize																																																				4			3
	Benin																										1	1		1																										
	Brasil						41	24	12	12	12	12	6	15	17	38	14	17	4	15	15	41	99	47	33	21	26	28	27	31	32	42	51	73	59	50	60	125	146	79	178	308	165	486	509	467	780	387	577	195	610	299	253	160	149	149
	Canada																																1																		0					
	China P.R.																																							62	73	62	78	120	201	23	92	88	89	58	96		65	13	77	77
	Chinese Taipei							20	48	13	4	69	291	803	1364	929	935	928	692	552	527	409	171	258	190	289	202	250	172	172	313	215	317	292	473	1704	1672	824	685	663	467	660	1478	578	486	485	240	294	319	315	151	99	233	148	195	153
	Côte D'Ivoire																													100	100	100	100																						23	23
	Cuba								145	154	176	118	444	280	165	149	166	89	298	686	789	409	320	210	336	349	286	436	396	373	451	214	205	285	151	202	189	204	69	39	85	43	53	12	38	55	56	34	3	4	7	7				
	Dominica																																														64	69	75	36	44	55	58	106	76	76
	Dominican Republic																																										41	71	29	19	23		207							
	EU.España																													3	4	1		6	23	6	14	47	44	55	40	158	122	195	125	140	94	28	12	51	24	91	38	55	60	60
	EU.France																														28	28	92	92	107	140	159	181	265	284	291	369	448	507	565	608	659	687	687	701	738	738	724	752	434	498
	EU.Portugal																											1	2	1	1	1	1	0	1	1	4	2	5	6	5	2	3	47	8	22	18	6	32	27	48	105	135	158	106	104
	Grenada																									1	1	12	6	8	11	36	33	34	40	52	64	52	58	52	50	26	47	60	100	87	104	69	72	45	42	33	49	54	45	45
	Jamaica																																										24													
	Japan	39	764	772	841	2712	3768	7044	8600	7590	5751	3370	1073	946	960	1005	1395	420	346	284	608	264	135	69	134	308	468	1132	440	833	1100	509	440	823	1555	1217	900	1017	926	1523	1409	1679	1349	1185	790	883	335	267	442	540	442	490	920	1028	822	1261
	Korea Rep.									2	7	93	145	186	312	488	479	466	989	834	658	566	663	325	145	94	126	50	131	344	416	96	152	375	689	324	537	24	13	56	56	144	56	2	3	1	1		0	1	6	33	64		8	8
	Maroc																																																		12					
	Mexico																																						3	13	13	13	13	27	35	68	37	50	70	90	86	65	91	82	93	93
	NEI (BIL)																																													53	184	258	167	89	7	160	209	205	177	
	NEI (ETRO)																																						174	326	362	435	548	803	761	492	274	17	14							
	Netherlands Antilles																							50	50	50	50	50	50	50	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40										
	Panama																	22	452	134	95	154	190	74	13																					41										
	Philippines																																											7	71	38								8		
	Russian Federation																																																		1					
	S. Tomé e Príncipe																																	28	19	17	18	21	25	28	33	36	35	33	30	32	32	32	32	9	21	26				
	Senegal																																		1		4	7		9		2	5				11	24	32	11	1	5	91	18	24	24
	South Africa																																												0	0	1	4					2			
	St. Vincent and Grenadines																																		1	0	0	1	2	2	2		1					20					1	3	2	2
	Sta. Lucia																																										4	1		10	5		18	17	21	53	46	70	72	72
	Trinidad and Tobago																												15	19	2	42	92	45	12	9	4		2	16	28	12	49	15	20	51	14	16	9	10	7	14	16	34	26	22
	U.S.A.																								17	18	47	34	28	93	148	86	268	172	194	163	145	148	130	112	153	205	139	52	83	60	22	49	19	35	25	36	42	38	42	17
	U.S.S.R.									1	4	6	16	15	16	14	17	43	62	9	18	1	10	5			1				7	23	45	32	5																					
	UK.British Virgin Islands																																																			1				
	UK.Sta Helena																																														0									
	Ukraine																																				15																			
	Uruguay																																							3	1	1	26	23				1	5	3	2	8	5		6	
	Vanuatu																																																	2	1	0				
	Venezuela						152	99	101	74	36	35	62	96	43	30	178	188	124	83	82	78	79	93	132	79	102	81	167	107	214	214	55	53	45	52	31	33	40	59	53	61	44	30	30	28	15	26	30	26	29	12	21	15	38	42
PS	Mixed flags (FR+ES)								1	1	1	4	6	12	15	22	31	48	49	79	86	109	134	136	126	144	169	174	167	118	122	135	132	137	144	199	137	116	146	133	126	96	82	80	83	79										
	U.S.A.																																														2									
RR	Brasil														1	1							1	2	1	2	2	2		1	1	1	0	1	1	2	1	0	1	2	2	2	28								2	1	9	1		
	EU.Portugal																														7	11	7	2	4				10	5	5	5						2								
LL	Senegal																																																					96	37	37
	Trinidad and Tobago																												0	1	0	0	1	0	1	1	2	1	0			2					3		0	1	0	0	1	1	1	
	U.S.A.					103	116	115	128	161	163	149	197	168	207	204	179	191	209	234	241	265	295	295	295	295	295	295	187	187	147	187	161	173	121	25	30	49	77	87	43	35	46	50	37	24	16	17	19	26	16	17	9	13	6	4
	UK.Bermuda																				1	2	2	5	2	4	1	2	7	8	9	11	6	8	15	17	18	19	11	15	15	15	3	5	1	2	2	2	2	2	2	2	2	2	2	2
	UK.Turks and Caicos																																																	0		2		0		
	Venezuela						6	6	3	3	2	7	6	6	6	6	4	2	1	2	1	1	1	1	2	2	4	2	5	10	5	4	5	3	5	5	5	12	10	5	5	5														
Total		39	764	772	841	2,815	4,083	7,308	9,038	8,011	6,156	3,863	2,246	2,527	3,106	2,886	3,398	2,414	3,226	3,095	3,271	2,419	2,181	1,642	1,527	1,848	2,032	2,708	2,142	2,888	3,416	2,114	2,330	2,974	4,432	4,705	4,330	3,208	3,309	4,410	4,353	5,568	5,937	5,964	5,651	5,520	4,526	3,846	4,416	2,934	3,416	3,079	4,106	4,345	3,170	3,431

Table 2. Total Task I data reported as live discards for blue marlin and white marlin from the CPCs that submitted this information to the Secretariat.

Catch t						*Year C*		
Species	*Stock*	*Flag*	*Gear*	*2004*	*2006*	*2007*	*2008*	*2009*
BUM	ATN	Mexico	LL		0.426	0.75	0.93	1.08
		UK.Turks and Caicos	RR	2.339				
	ATS	Brazil	LL		46.52	57.9	19.48	
			SP		0.396			
BUM Total				**2.339**	**47.35**	**58.6**	**20.41**	**1.08**
WHM	ATN	Mexico	LL		0.025	0.43	0.3	0.291
	ATS	Brazil	LL		14.78	24.4	5.84	
			SP		0.052			
WHM Total					**14.86**	**24.9**	**6.14**	**0.291**

Table 3. Total removals of white marlin 1956 - 2010. Values included the estimated white marlin component from the unclassified billfish catches.

Catch t		Year Cal																																																				
Stock	Flag	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
ATN	Barbados																																	117	11	39	17	24	29	26	43	15	41	33	25	25	24	15	15			33				6
	Brasil																																													1										
	Canada																																1							4	4	8	8	8	5	5	3	2	1	2	5	3	2		1	
	China P.R.																																							6	7	6	7	10	20	1	7	4	2	1	4	1	0	1	3	
	Chinese Taipei							1	4	3	2	32	47	58	135	104	178	244	135	252	125	142	44	79	62	105	174	134	203	96	128	319	153		4	85	13	92	123	270	181	146	62	105	80	59	68	61	15	45	19	16	1	0	1	1
	Costa Rica																																												3	14			1							
	Cuba								35	45	69	118	127	103	58	61	45	34	112	256	294	68	67	43	68	70	189	205	728	241	296	225	30	13	21	14												7								
	EU.España																													9	14			61	12	12	9	18	15	25	17	97	89	91	74	118	43	4	19	19	48	28	32	10	8	
	EU.France																																																		0			1	0	
	EU.Portugal																																															1	5	11	30	3	2	0	1	1
	Grenada																																													1	15	8	14	33	10	12	11	17	14	
	Japan	4	25	62	16	25	30	271	754	1,493	1,913	1,417	174	273	451	419	915	339	328	381	404	540	80	27	42	99	118	84	27	52	45	56	60	68	73	34	45	180	33	41	31	80	29	39	25	66	15	10	21	23	28	27	10	22	27	100
	Korea Rep.									1	1	51	44	52	204	340	219	213	106	90	71	64	71	33	16	18	49	12	6	18	147	37	2	2	82	39	1	9	4	23	3	7	5								4				8	
	Liberia																																									1	1	3	8	4	3	4	3							
	Mexico																																						2	8	8	3	5	6	11	18	44	15	15	28	25	16	14	14	19	
	NEI (BIL)																													1	0	0	0	0	0	0	0	0								34	72	4	8		26	9	14	18	20	
	NEI (ETRO)																																						23	43	47	57	72	105	100	64	36	2	2							
	Panama																	10	48	14	10	17	20	8	1																															
	Philippines																																											0	4									1		
	St. Vincent and Grenadines																																					0	1	0								0	44							
	Sta. Lucia																																																			0		0	0	
	Trinidad and Tobago																												8	13	2	28	61	29	7	6	3		1	11	18	8	32	10	13	4	2	5	12	6	6	5	12	10	11	12
	U.S.A.					60	60	74	64	70	76	76	81	87	76	104	95	99	104	108	107	109	109	109	110	116	78	57	81	81	75	116	186	102	117	98	103	99	85	55	107	76	41	37	62	42	21	38	17	28	18	11	8	11	16	10
	U.S.S.R.												1	1	1		1	1	2		1																																			
	UK.Bermuda																												1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	
	UK.British Virgin Islands																																																			1				
	Vanuatu																																																		0					
	Venezuela						18	35	57	82	66	104	114	118	290	27	94	268	175	121	117	112	110	129	183	113	142	113	234	155	155	151	154	42	47	79	47	187	226	148	171	164	90	80	61	25	72	110	55	55	60	26	52	26	70	46
ATN Total		**4**	**25**	**62**	**16**	**85**	**108**	**381**	**914**	**1,694**	**2,127**	**1,798**	**588**	**692**	**1,215**	**1,055**	**1,547**	**1,208**	**1,010**	**1,222**	**1,129**	**1,052**	**501**	**428**	**482**	**521**	**750**	**605**	**1,288**	**666**	**862**	**933**	**648**	**436**	**376**	**407**	**239**	**610**	**543**	**660**	**639**	**669**	**483**	**529**	**492**	**482**	**426**	**290**	**250**	**252**	**284**	**194**	**160**	**133**	**200**	**176**
ATS	Argentina												3	14			20	100	57		2	2	2								4	4			8	9	6																			
	Belize																																								0		1		1	0										
	Brasil						60	34	17	17	17	17	9	21	24	54	17	33	18	32	32	68	275	175	133	58	100	76	81	61	87	143	93	149	204	205	377	211	301	91	105	75	105	217	158	105	172	407	266	80	244	91	71	47	52	
	Cambodia																																												1											
	China P.R.																																							3	4	3	4	5	10	1	13	19	6	6	4	5	10	3	5	
	Chinese Taipei							5	10	3	2	29	134	327	448	508	260	469	464	285	382	377	119	198	155	145	136	227	87	124	172	196	613	565	979	810	790	506	493	1,080	726	420	379	401	385	378	84	117	89	127	37	28	53	38	27	19
	Côte D'Ivoire																																									1	2	1	5	1	2	2	3	1	1	1	1	3	2	
	Cuba								9	17	33	23	67	15	7	8	4	6	21	48	55	38	57	127	205	212	116	45	112	153	216	192	62	24	22	6	10	10																		
	EU.España																																	1	1	0	17	6	12	2	19	54	4	10	45	68	18	2	3	45	10	23	14	21	8	
	EU.Portugal																																																	8		19	0	35	39	6
	Gabon																																						0	0		1	0				0		0							
	Ghana																									6	45	21	142	54	15	22	6	88	68	31	17	14	22	1	2	1	3	7	6	8	21	2	1	1	1	0		4	4	
	Honduras																																									0	0	0	0											
	Japan	15	135	99	96	228	662	1,644	1,664	2,002	2,718	1,585	494	815	392	284	65	101	27	9	14	3	26	14	15	7	25	27	17	24	81	73	74	76	73	92	77	68	49	51	26	32	29	17	15	17	41	5	12	13	6	11	11	12	16	9
	Korea Rep.									2	7	58	125	157	177	230	341	332	165	139	109	220	111	5	24		36	57	9	44	225	34	25	17	53	42	56	1	4	20	20	52	18			0			11	40	3		113	96	70	
	Mixed flags (FR+ES)											1	1	2	3	4	6	9	9	15	16	20	25	25	23	27	31	32	31	22	23	25	25	25	27	37	11	10	12	11	9	7	7	9	8	7										
	NEI (BIL)																																													0	5	0	21	134	16	27	156	186	179	
	NEI (ETRO)																																						91	171	190	228	288	421	399	258	144	9	7							
	Panama																	16	75	22	16	59	31	1	2																															
	Philippines																																											1	8									1		
	S. Tomé e Príncipe																																	14	16	19	26	24	17	21	21	30	45	40	36	37	37	37	37	21	33	29				
	South Africa																																															2								
	Togo																																										0		1	1	2	0	2							
	U.S.A.																																									0	37	1	0		1									
	U.S.S.R.										2	2	6	6	6	4	6	15	22	3	6		3	2			1																													
	Uruguay																										1	10	13	65	44	16	6	1	1	1	1	3		3	0	1	24	22				1	9	2	5	9	3		5	
ATS Total		**15**	**135**	**99**	**96**	**228**	**722**	**1,683**	**1,700**	**2,041**	**2,779**	**1,715**	**839**	**1,357**	**1,057**	**1,092**	**719**	**1,081**	**858**	**553**	**632**	**787**	**649**	**547**	**557**	**455**	**491**	**495**	**492**	**548**	**867**	**705**	**904**	**960**	**1,453**	**1,252**	**1,388**	**853**	**1,002**	**1,454**	**1,122**	**905**	**947**	**1,152**	**1,077**	**881**	**539**	**604**	**469**	**478**	**360**	**243**	**432**	**445**	**407**	**35**
Grand Total		**19**	**160**	**161**	**112**	**313**	**830**	**2,064**	**2,614**	**3,735**	**4,906**	**3,513**	**1,427**	**2,049**	**2,272**	**2,147**	**2,266**	**2,289**	**1,868**	**1,775**	**1,761**	**1,839**	**1,150**	**975**	**1,039**	**976**	**1,241**	**1,100**	**1,780**	**1,213**	**1,729**	**1,639**	**1,552**	**1,396**	**1,829**	**1,659**	**1,627**	**1,462**	**1,544**	**2,114**	**1,761**	**1,573**	**1,430**	**1,682**	**1,569**	**1,363**	**965**	**894**	**719**	**730**	**645**	**436**	**591**	**578**	**607**	**210**

* Values from 2010 are provisional as they represent a low percentage of CPC's reports at the time of the meeting.

Table 4. Catalog of Task I (t1 tones, numbers) and Task II (t2 availability: where yellow cells = t2ce only; green cells = t2ce & t2sz, red cells = not t2) for white marlin between 1990 and 2010.

Status	Flag	GearGrp	DS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CP	Barbados	HL	t1																					3
			t2																					
		LL	t1								41	33	25	25	24	15	15			33				3
			t2																					
		UN	t1	39	17	24	29	26	43	15														
			t2																					
	Belize	LL	t1						0		1		1	0										
			t2																					
	Brasil	BB	t1													65								
			t2																					
		GN	t1							1														
			t2																					
		HL	t1														0							
			t2																					
		LL	t1	201	377	211	301	91	101	70	105	102	158	106	172	342	266	80	243	87	63	41	32	
			t2																					
		SP	t1	4	0	0	0	0	4	4	0										0			
			t2																					
		SU	t1															0	0					
			t2																					
		UN	t1									115								4	8	7	21	
			t2																					
	Canada	GN	t1									0												
			t2																					
		HP	t1								0						0	0	0	0	0			
			t2																					
		LL	t1					4	4	8	8	8	5	5	3	2	1	1	4	3	2		1	
			t2																					
		RR	t1													0			0		0			
			t2																					
		TL	t1												0	0								
			t2																					
		TR	t1																					
			t2													b							b	
	China P.R.	LL	t1					9	11	9	11	15	30	2	20	23	8	6	9	6	10	5	9	
			t2																					
	Côte D'Ivoire	GN	t1							1	2	1	5	1	2	2	3	1	1	1	1	3	2	
			t2													b	b	b		b				
	EU.España	LL	t1	12	26	15	26	7	36	141	93	101	119	186	61	6	22	64	58	51	46	32	16	
			t2						b	b		b	b	b	b	b	b	b	b	b				
		UN	t1			8		19		10														
			t2																					
	EU.France	GN	t1																			0		
			t2																					
		LL	t1																			0		
			t2																					
		TN	t1																				0	
			t2																					
		UN	t1																0			1		
			t2																					
	EU.Portugal	BB	t1																					0
			t2																					
		LL	t1														5	19	30	22	2	35	40	6
			t2																					
		SU	t1																				1	0
			t2																					
		TP	t1																0					0
			t2																					
		UN	t1													1								
			t2																					
	Gabon	GN	t1				0	0		1	0				0		0							
			t2																					
	Ghana	GN	t1	31	17	14	22	1	2	1	3	7	6	8	21	2	1	1	1	0		4	4	
			t2								b		b	b				b	b					
	Honduras	LL	t1							0	0	0	0											
			t2																					
	Japan	LL	t1	126	122	248	82	92	57	112	58	56	40	83	56	16	33	36	34	39	21	34	43	109
			t2																					
	Korea Rep.	LL	t1	81	57	10	8	43	23	59	23			0			11	40	7		113	96	78	
			t2																					
	Mexico	LL	t1				2	8	8	3	5	6	11	18	44	15	15	28	25	16	14	14	19	
			t2																					
	Philippines	LL	t1									1	12									1		
			t2																					
	S. Tomé e Príncipe	TR	t1						21	30	45	40	36	37	37	37	37	21	33	29				
			t2																					
		UN	t1	19	26	24	17	21																
			t2																					
	South Africa	LL	t1													2								
			t2																					
	St. Vincent and Grenadines	LL	t1													0	44							
			t2																					
		UN	t1			0	1	0																
			t2																					
	Trinidad and Tobago	LL	t1	6	3		1	11	18	8	32	10	13	4	2	5	12	6	6	5	12	10	11	12
			t2																					
	U.S.A.	GN	t1																					
			t2																					
		LL	t1	82	90	88	66	44	100	65	70	32	57	41	17	29	17	27	17	9	8	9	13	8
			t2																					
		PS	t1												1									
			t2																					
		RR	t1	15	13	11	19	11	7	9	8	5	5	1	3	6	1	1	1	1	0	2	2	2
			t2																					
		SP	t1																					
			t2	b	b																			
		TW	t1																					
			t2																					
		UN	t1	1						3		1	0			4	0	0	0	0	0	0	2	0
			t2																					
	UK.Bermuda	RR	t1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	
			t2																					
	UK.British Virgin Islands	LL	t1																	1				
			t2																					
	Uruguay	LL	t1	1	1	3		3	0	1	24	22				1	9	2	5	9	3		5	
			t2																					
	Vanuatu	LL	t1																0					
			t2																					
	Venezuela	GN	t1		4	3	4	12	5	2	3	13	18	12	7	17	10	19	13	21	28	16	19	
			t2													b	b	b	b	b	b	b	b	
		LL	t1	74	38	175	213	118	156	152	82	67	43	13	66	93	45	36	47	6	24	10	52	46
			t2		b										b									
		RR	t1	5	5	9	10	18	10	10														
			t2																					
		UN	t1								5													
			t2																					
NCC	Chinese Taipei	LL	t1	895	803	598	616	1350	907	566	441	506	465	437	152	178	104	172	56	44	54	38	28	20
			t2																					
NCO	Argentina	UN	t1	9	6																			
			t2																					
	Cambodia	LL	t1										1											
			t2																					
	Chinese Taipei (foreign obs.)	LL	t1																					
			t2																					
	Costa Rica	UN	t1										3	14			1							
			t2																					
	Cuba	LL	t1	20	10	10										7								
			t2																					
	Grenada	LL	t1													8		33	10	12	11	17	14	
			t2																					
		UN	t1											1	15		14							
			t2																					
	Japan (foreign obs.)	LL	t1																					
			t2																					
	Liberia	GN	t1							1	1	3	8	4	3	4	3							
			t2																					
	Mixed flags (FR+ES)	PS	t1	37	11	10	12	11	9	7	7	9	8	7										
			t2																					
	NEI (BIL)	GN	t1	0	0	0																		
			t2																					
		LL	t1											34	77	4	30	134	42	31	170	189	199	
			t2																					
		UN	t1												0					6		15		
			t2																					
	NEI (ETRO)	LL	t1				114	214	237	285	359	526	498	322	180	11	9							
			t2																					
	Sta. Lucia	TR	t1																			0	0	
			t2																					
		UN	t1																	0				
			t2																					
	Togo	GN	t1								0		1	1	2	0	2							
			t2																					

Table 5. Blue marlin standardized CPUE indices used in the 2010 stock assessment. Note the Chinese Taipei index for the period 2001-2009 (shaded cells) was included in the model as a separate index (see text for explanation).

Fleet	*JAP*	*JAP*	*TAI*	*USA*	*USA*	*VEN*	*VEN*	*VEN*	*BRA*	*GHANA*
Gear	*LL*	*LL*	*LL*	*LL*	*Rec*	*LL*	*GIL*	*Rec*	*LL*	*GIL*
Units	*Num.*	*Num.*	*Num.*	*Wt.*	*Num.*	*Wt.*	*Wt.*	*Num.*	*Num.*	*Wt.*
1959	2.221		0.293							
1960	1.964		0.317							
1961	3.820		0.273					0.169		
1962	3.465		0.182					0.253		
1963	2.777		0.144					0.112		
1964	1.776		0.099					0.087		
1965	1.216		0.103					0.065		
1966	1.005		0.099					0.187		
1967	0.974		0.071					0.128		
1968	1.176		0.070					0.119		
1969	1.299		0.053					0.136		
1970	1.048		0.054					0.123		
1971	0.652		0.058					0.065		
1972	0.747		0.080					0.032		
1973	0.579		0.070					0.024		
1974	0.966		0.072					0.047		
1975	0.699		0.064					0.016		
1976	0.485		0.065					0.011		
1977	0.558		0.063					0.021		
1978	0.590		0.064		0.746			0.020		
1979	0.601		0.070		0.566			0.047		
1980	0.733		0.073		0.762			0.043	0.248	
1981	0.651		0.081		0.837			0.068	0.299	
1982	0.827		0.097		0.650			0.031	0.202	
1983	0.741		0.050		1.089			0.072	0.595	
1984	0.828		0.070		1.022			0.140	0.213	
1985	0.873		0.097		1.152			0.061	0.117	
1986	0.605		0.139	1.838	1.051			0.054	0.142	
1987	0.663		0.100	1.297	0.870			0.064	0.664	
1988	0.640		0.098	1.327	1.016			0.038	0.249	
1989	0.674		0.099	1.905	0.884			0.066	0.388	
1990	0.524		0.293	1.819	0.763			0.017	0.245	
1991	0.358		0.317	1.239	1.360	0.630	10.920	0.040	0.322	
1992	0.366		0.273	1.869	1.188	0.340	12.590	0.052	0.570	
1993	0.479		0.182	2.060	1.123	0.230	15.700	0.039	0.337	
1994	0.503		0.144	1.610	1.166	0.430	32.340	0.108	0.229	
1995	0.472		0.099	1.229	1.202	0.380	31.480	0.094	0.390	
1996	0.513		0.103	1.252	1.209	0.310	25.070		0.366	
1997	0.459		0.099	0.743	1.067	0.330	30.470		0.663	
1998	0.475		0.070	0.694	1.088	0.310	40.840		0.724	
1999			0.071	0.589	1.361	0.220	68.120		0.401	
2000			0.069	0.539	1.133	0.300	24.920		0.620	1.941
2001		0.012	***0.083***	0.380	0.724	0.220	18.240		0.961	2.648
2002		0.009	***0.086***	0.490	0.724	0.210	16.810		0.411	1.869
2003		0.011	***0.054***	0.282	0.686	0.130	20.130		0.223	1.303
2004		0.018	***0.041***	0.433	0.936	0.110	23.380		0.528	0.540
2005		0.014	***0.044***	0.486	0.937	0.110	25.500		0.529	1.102
2006		0.024	***0.057***	0.345	0.988	0.330	28.570		0.313	0.658
2007		0.057	***0.054***	0.446	0.987	0.250	33.000		0.204	0.502
2008		0.033	***0.041***	0.669	0.818	0.350	25.510		0.236	0.116
2009		0.021	***0.041***	0.460	1.146	0.200	17.960		0.150	0.121

Table 6. Blue marlin standardized combined CPUE indices estimated using equal weighting for all CPUE series (EQW), weighting the CPUE series by area (ARW) and by catch (CAW).

Year	*EQW*	*ARW*	*CAW*
1959	1.593	1.762	1.929
1960	1.409	1.558	1.706
1961	2.120	2.998	3.315
1962	2.470	2.744	3.009
1963	1.472	2.185	2.412
1964	1.037	1.402	1.542
1965	0.742	0.961	1.056
1966	1.144	0.802	0.875
1967	1.106	0.813	0.988
1968	1.180	1.177	1.354
1969	1.213	1.248	1.398
1970	0.954	0.917	0.991
1971	0.609	0.629	0.669
1972	0.444	0.577	0.607
1973	0.376	0.509	0.574
1974	0.470	0.615	0.591
1975	0.284	0.474	0.465
1976	0.253	0.388	0.412
1977	0.295	0.351	0.407
1978	0.278	0.357	0.346
1979	0.401	0.402	0.478
1980	0.405	0.488	0.535
1981	0.449	0.451	0.532
1982	0.367	0.489	0.621
1983	0.496	0.456	0.531
1984	0.488	0.484	0.613
1985	0.359	0.455	0.607
1986	0.386	0.425	0.456
1987	0.550	0.494	0.538
1988	0.421	0.472	0.514
1989	0.537	0.555	0.571
1990	0.391	0.495	0.526
1991	0.379	0.325	0.316
1992	0.436	0.413	0.391
1993	0.414	0.492	0.477
1994	0.550	0.541	0.525
1995	0.525	0.465	0.452
1996	0.450	0.470	0.464
1997	0.465	0.442	0.485
1998	0.458	0.402	0.463
1999	0.454	0.382	0.439
2000	0.458	0.401	0.533
2001	0.387	0.308	0.631
2002	0.328	0.282	0.442
2003	0.251	0.215	0.253
2004	0.281	0.272	0.254
2005	0.309	0.260	0.350
2006	0.336	0.320	0.300
2007	0.346	0.402	0.375
2008	0.275	0.316	0.300
2009	0.219	0.245	0.217

Table 7. White marlin standardized CPUE indices presented in this meeting.

Fleet	*JAP*	*JAP*	*VEN*	*VEN*	*BRA*
Gear	*LL*	*LL*	*LL*	*GIL*	*LL*
Units	*Num.*	*Num.*	*Wt.*	*Wt.*	*Num.*
1980					0.75
1981					0.31
1982					0.14
1983					0.24
1984					0.15
1985					0.15
1986					0.32
1987					0.38
1988					0.38
1989					0.46
1990	0.011				0.67
1991	0.012		0.69	2.54	0.58
1992	0.007		0.45	1.46	0.59
1993	0.007		0.64	1.94	0.45
1994	0.004		0.59	7.17	0.38
1995	0.001		0.96	3.63	0.33
1996	0.001		0.35	1.3	1.34
1997	0.002		0.50	1.22	0.84
1998	0.001		0.57	3.1	0.66
1999	0.003		0.45	5.39	0.82
2000	0.002		0.20	3.7	0.81
2001		0.00067	0.14	2.3	0.44
2002		0.00030	0.20	3.22	0.24
2003		0.00040	0.46	3.51	0.19
2004		0.00067	0.42	5.28	0.20
2005		0.00046	0.34	5.34	0.16
2006		0.00085	0.28	5.12	0.16
2007		0.00327	0.60	5.86	0.21
2008		0.00092	0.65	4.21	0.17
2009		0.00075	0.20	3.58	0.12
2010			0.61	2.29	0.57

Table 8. Correlations between CPUE indices used in ASPIC runs. Also shown below each correlation the number of years of overlap for the two correlated indices.

Series index name	*id*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Longline Japan period 1959-98	**1**	1.00									
		40									
Longline Japan period 2001-2009	**2**	0.00	1.00								
		0	9								
Longline Venezuela 1991-2009	**3**	-0.56	0.49	1.00							
		8	9	19							
Longline Chi. Taipei 1967-2000	**4**	0.69	0.00	-0.15	1.00						
		32	0	10	34						
Longline Brazil 1980-2009	**5**	-0.41	-0.46	-0.13	-0.07	1.00					
		19	9	19	21	30					
Longline US 1986-2009	**6**	0.18	0.29	0.48	0.22	-0.23	1.00				
		13	9	19	15	24	24				
US recreational 1974-2009	**7**	-0.39	0.43	0.49	0.28	0.04	0.39	1.00			
		25	9	19	27	30	24	36			
Venezuela Gillnet 1991-2009	**8**	0.69	0.81	-0.11	0.06	0.01	-0.23	0.41	1.00		
		8	9	19	10	19	19	19	19		
Venezuela recreational 1961-1995	**9**	0.70	0.00	0.01	0.68	0.03	-0.26	0.40	0.96	1.00	
		35	0	5	29	16	10	22	5	35	
Ghana artisanal 2000-2009	**10**	0.00	-0.56	-0.11	0.00	0.80	-0.25	-0.41	-0.43	0.00	1.00
		0	9	10	1	10	10	10	10	0	10

Table 9. Degree of fit of CPUE data to alternative ASPIC models (low productivity and high productivity) as measured with the partial r square for each index. Note that some indices are used in both models others not. Shaded colors denote high positive (green), medium positive (cyan) , medium negative (yellow) and high negative (red).

		Partial r square	
CPUE series	*Period*	*Low Prod.*	*High Prod.*
Longline Japan	1959-1998	0.22	
Longline Japan	2001-2009	-0.23	
Longline Japan	1959-1980	¤	0.67
Longline Japan	1981-1998		-0.58
Longline Venezuela	1991-2009	0.36	0.38
Longline Chi. Taipei	1967-2000	0.02	
Longline Chi. Taipei	1967-1980		-0.10
Longline Brazil	1980-2009	-0.40	
Longline US	1986-2009	0.50	0.65
US recreational	1974-2009	-1.40	-2.37
Venezuela Gillnet	1991-2009	-0.36	
Venezuela recreational	1961-1995	0.04	-0.17
Ghana artisanal	2000-2009	-0.01	

Table 10. Management benchmarks resulting from two alternative ASPIC models. * Values were fixed, not estimated to help model to converge. In parenthesis are 80% from bootstrap runs. ** r is calculated from the values of K and MSY.

	Low productivity	*High productivity*
K	100,000*	26,400 (26,140 – 26,665)
r	0.11 **	0.65**
MSY	2,700 (2,559-2,874)	4,300 (4,240 – 4,305)
B_{2010}/B_{MSY}	0.52 (0.37-0,67)	0.57 (0.35 – 0.81)
F_{2009}/F_{MSY}	2.19 (1.63-3.15)	1.33 (0.94 -1.99)
B_{MSY}	50,000*	13,220 (13,070 – 13,320)
F_{MSY}	0.054 (0.051-0.057)	0.32 (0.318 – 0.33)

Table 11. Estimated and derived quantities from the fully integrated base case model. F values are the ratio of total F to the F_{MSY}.

		Fully Integrated Model		
Parameter/Quantity		**Estimate**	**SD**	**CV**
R0		5.026	0.166	0.033
steepness		0.411	0.062	0.151
F_2005		1.376	0.212	0.154
F_2006		1.231	0.183	0.149
F_2007		1.770	0.267	0.151
F_2008		2.102	0.322	0.153
F_2009		1.633	0.263	0.161
Bratio_2005		0.844	0.079	0.093
Bratio_2006		0.857	0.074	0.086
Bratio_2007		0.835	0.072	0.086
Bratio_2008		0.746	0.070	0.094
Bratio_2009		0.670	0.071	0.106
Fstd_MSY		0.07	0.02	0.292
TotYield_MSY		2837.30	246.87	0.087

Table 12. Output table to sensitivity runs at various fixed rates of natural mortality requested by the Working Group. Highlighted row indicated the base case model.

M	Hessian?	-LL	steep	SD		B/Bmsy	SD		F/Fmsy	SD
0.07	NO	382.125	0.995 (H)	N/A		1.745	N/A		0.558	N/A
0.10	NO	385.478	0.543	N/A		0.733	N/A		1.496	N/A
0.11	NO	385.594	0.497	N/A		0.698	N/A		1.600	N/A
0.12	YES	424.772	0.482	0.078		0.700	0.077		1.499	0.240
0.139	YES	425.266	0.411	0.062		0.670	0.070		1.633	0.263
0.19	YES	425.474	0.324	0.0393		0.636	0.065		1.854	0.312
REC DEV										
0.139	YES	1937.68	0.980	0.050		0.199	0.158		2.386	0.432

Table 13. Biomass ratio (SSB/SSB_{MSY}) trends for projections of blue marlin stock at different levels of total annual catch. For 2010 and 2011 it was assumed a catch of 4,341 t as estimated by the Working Group

Year	*Catch 0*	*500*	*1000*	*1500*	*2000*	*2500*	*3000*	*3500*	*4000*
2010	0.730019	0.730019	0.730019	0.730019	0.730019	0.730019	0.730019	0.730019	0.730019
2011	0.705949	0.705949	0.705949	0.705949	0.705949	0.705949	0.705949	0.705949	0.705949
2012	0.684518	0.684518	0.684518	0.684518	0.684518	0.684518	0.684518	0.684518	0.684518
2013	0.747284	0.735067	0.722912	0.710816	0.69857	0.6866	0.674937	0.662819	0.650665
2014	0.807427	0.78413	0.759727	0.73593	0.711736	0.687999	0.663826	0.638816	0.614842
2015	0.869686	0.832156	0.795515	0.759411	0.722677	0.686481	0.650552	0.61429	0.578451
2016	0.929767	0.880576	0.832159	0.784004	0.734573	0.686935	0.638708	0.590197	0.540989
2017	0.994037	0.932765	0.872557	0.810334	0.748807	0.687464	0.626182	0.564506	0.503026
2018	1.05914	0.98465	0.91065	0.839011	0.764148	0.689571	0.614619	0.53965	0.464618
2019	1.121755	1.03784	0.951883	0.866153	0.779697	0.691005	0.60246	0.513194	0.42396
2020	1.18609	1.089965	0.993575	0.894843	0.794923	0.690961	0.587983	0.485334	0.379811
2021	1.245605	1.139545	1.03127	0.919711	0.807669	0.691898	0.572685	0.455044	0.334358
2022	1.3056	1.18798	1.06985	0.948173	0.82092	0.691317	0.5583	0.425262	0.289528
2023	1.36488	1.239005	1.108815	0.972672	0.837039	0.691292	0.543366	0.391995	0.241419
2024	1.421225	1.285975	1.146675	1.001305	0.851388	0.692626	0.529049	0.358837	0.194934
2025	1.47461	1.334295	1.18296	1.02989	0.865275	0.696268	0.513041	0.325652	0.14728
2026	1.525875	1.377005	1.22217	1.05738	0.884099	0.696307	0.496624	0.28923	0.10432

Table 14. Kobe II Strategy Matrix (K2SM) Percent values indicate the probability of achieving the goal of $SSB_{yr} >= SSB_{MSY}$ AND $F_{yr} < F_{MSY}$ for each year (yr) under different constant catch scenarios (TAC tons).

	TAC								
Year	0	500	1000	1500	2000	2500	3000	3500	4000
2012	0%	0%	0%	0%	0%	0%	0%	0%	0%
2013	2%	2%	1%	1%	1%	1%	0%	0%	0%
2014	9%	6%	4%	3%	2%	1%	1%	0%	0%
2015	19%	13%	9%	6%	3%	2%	1%	0%	0%
2016	33%	23%	15%	9%	5%	3%	1%	0%	0%
2017	49%	35%	22%	13%	7%	3%	2%	0%	0%
2018	63%	47%	31%	18%	10%	4%	2%	0%	0%
2019	74%	58%	40%	24%	12%	5%	2%	1%	0%
2020	81%	67%	49%	30%	16%	6%	2%	1%	0%
2021	87%	74%	56%	36%	18%	7%	2%	0%	0%
2022	92%	80%	63%	41%	21%	8%	3%	0%	0%
2023	94%	84%	68%	46%	24%	9%	3%	0%	0%
2024	96%	88%	73%	50%	27%	10%	3%	0%	0%
2025	97%	91%	77%	55%	29%	11%	3%	0%	0%
2026	98%	93%	81%	59%	32%	12%	3%	0%	0%

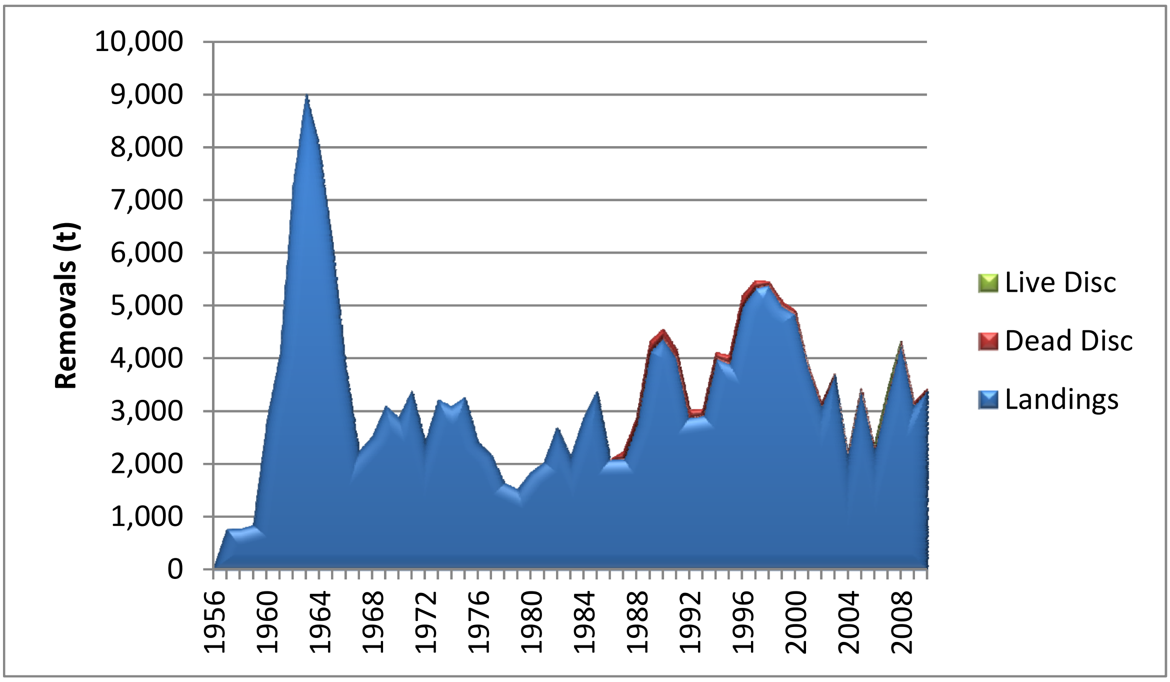


Figure 1. Blue marlin total catches with live and dead discards between 1956 and 2010. Data for 2010 were estimated by the Working Group during the meeting and should be considered provisional.

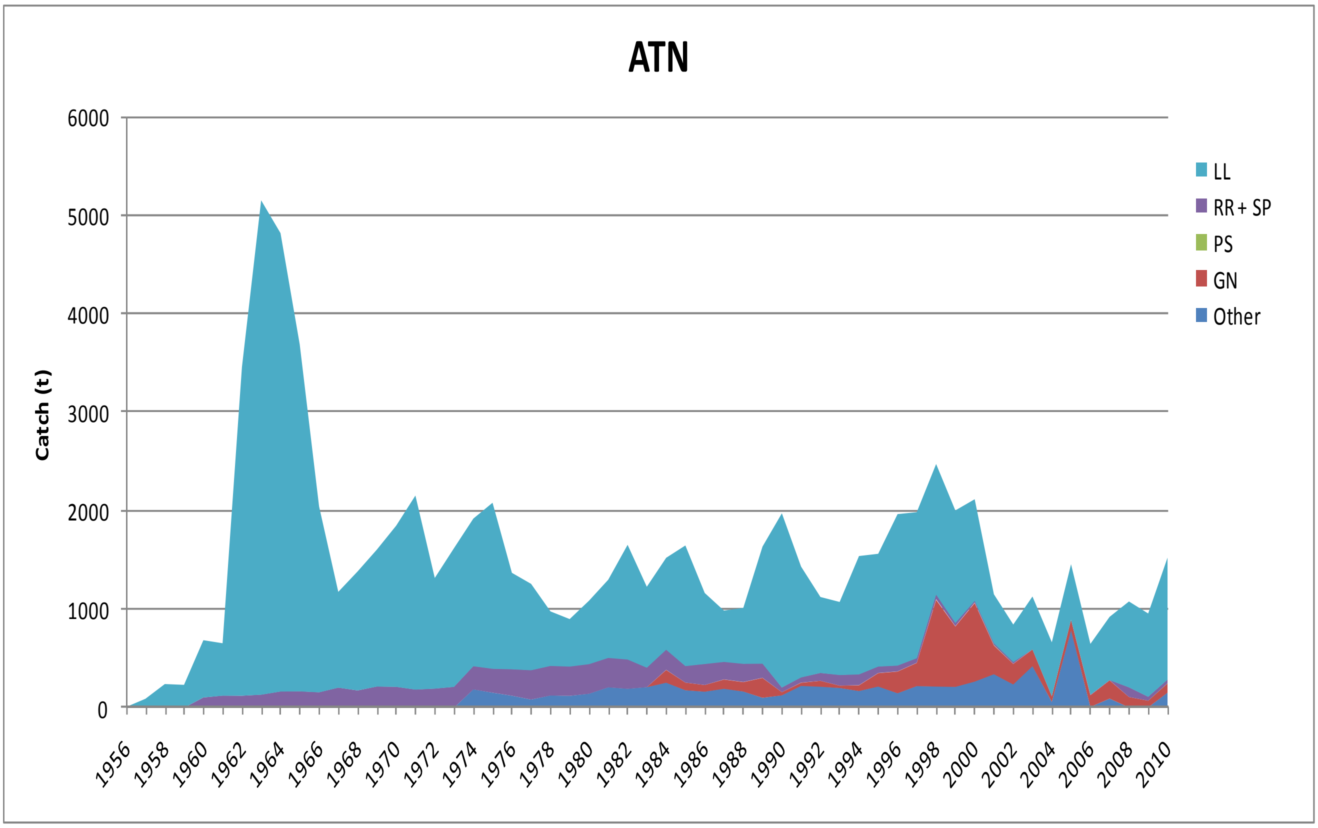


Figure 2. Blue marlin total catches with live and dead discards between 1956 and 2010 for the North Atlantic.

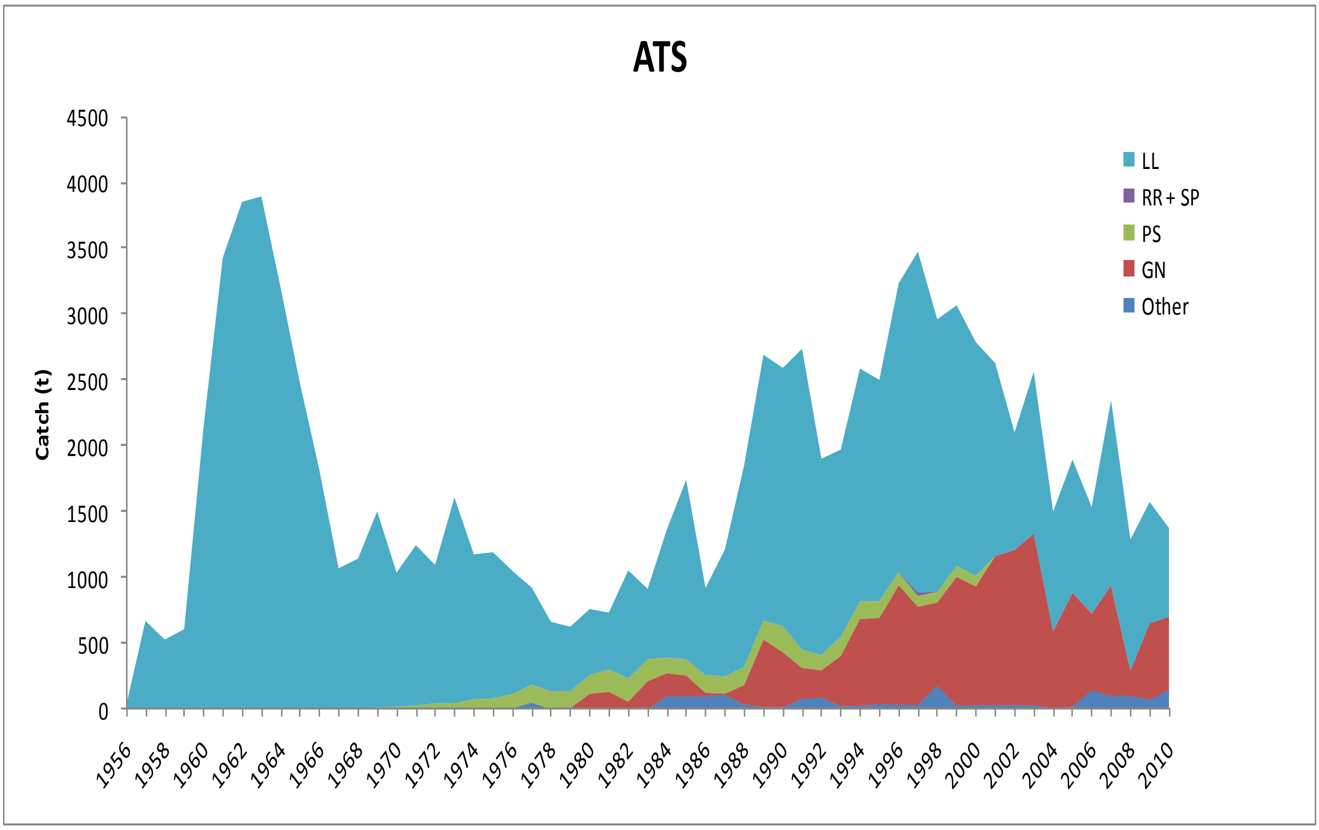


Figure 3. Blue marlin total catches with live and dead discards between 1956 and 2010 for the South Atlantic.

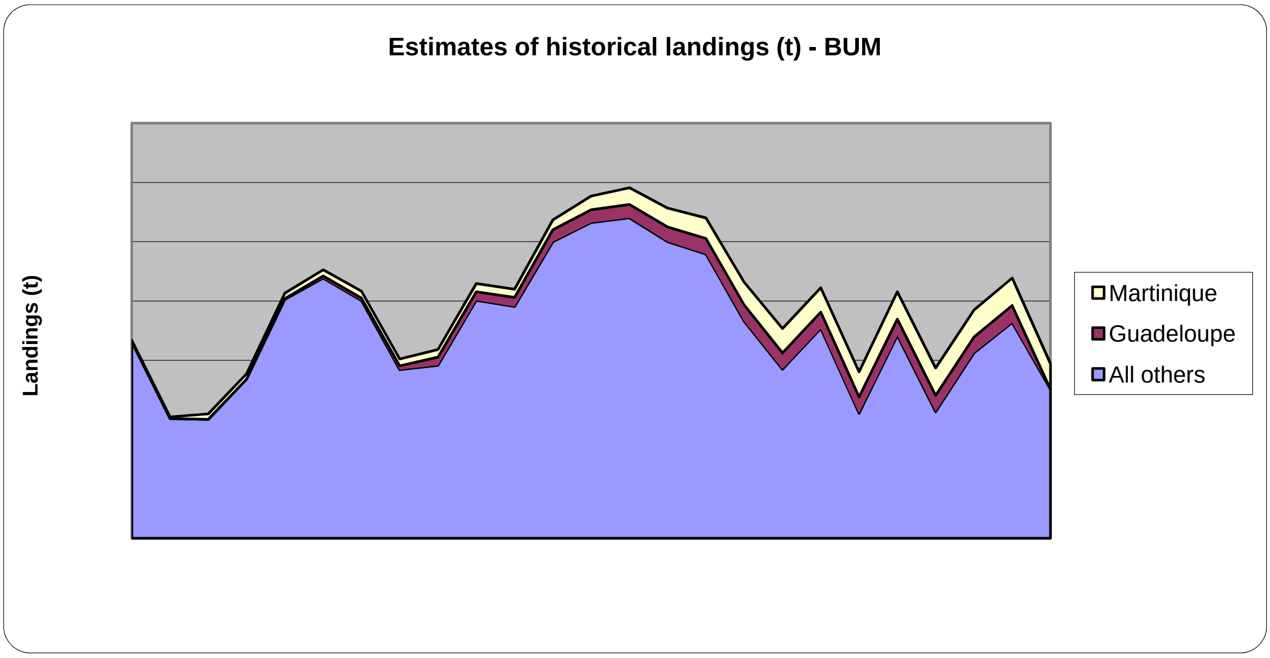


Figure 4. Blue marlin estimates of historical landings from FAD fisheries in the area of Martinique and Guadeloupe (1985-2009).

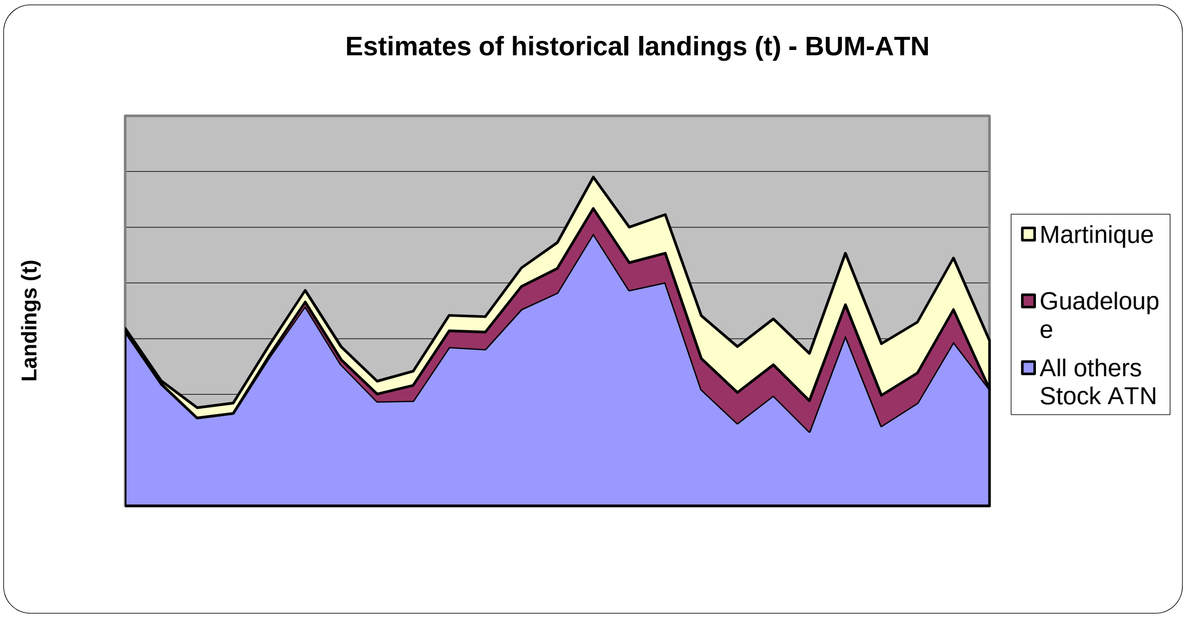


Figure 5. Blue marlin estimates of historical landings from FAD fisheries in the area of Martinique and Guadeloupe in the North Atlantic (1985-2009).

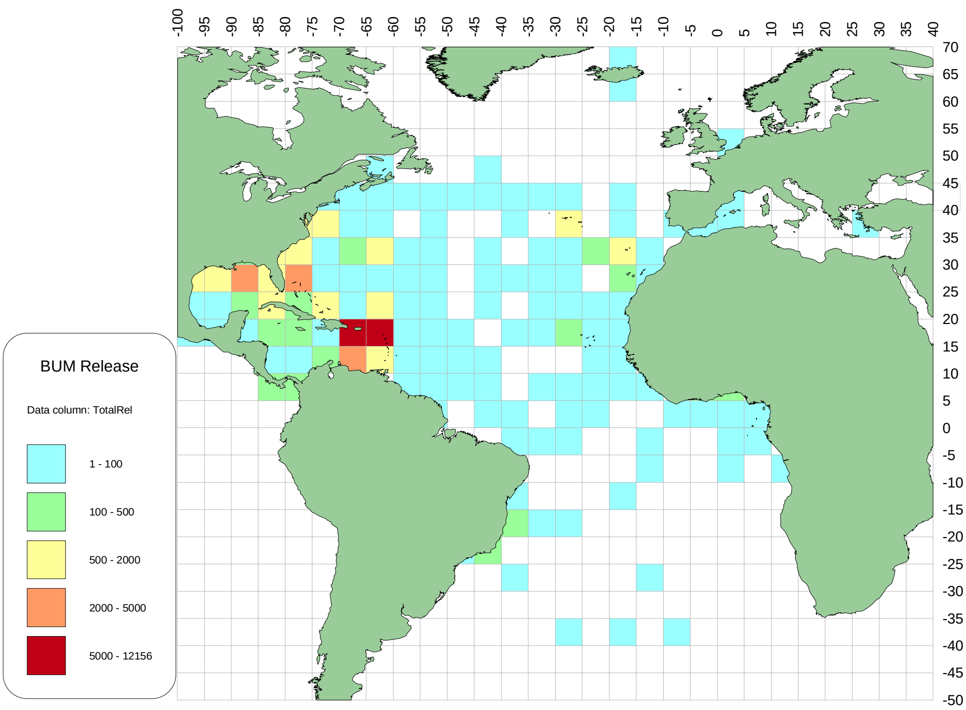


Figure 6. Density plots of conventional tag releases of blue marlin by 5x5 square areas for all years.

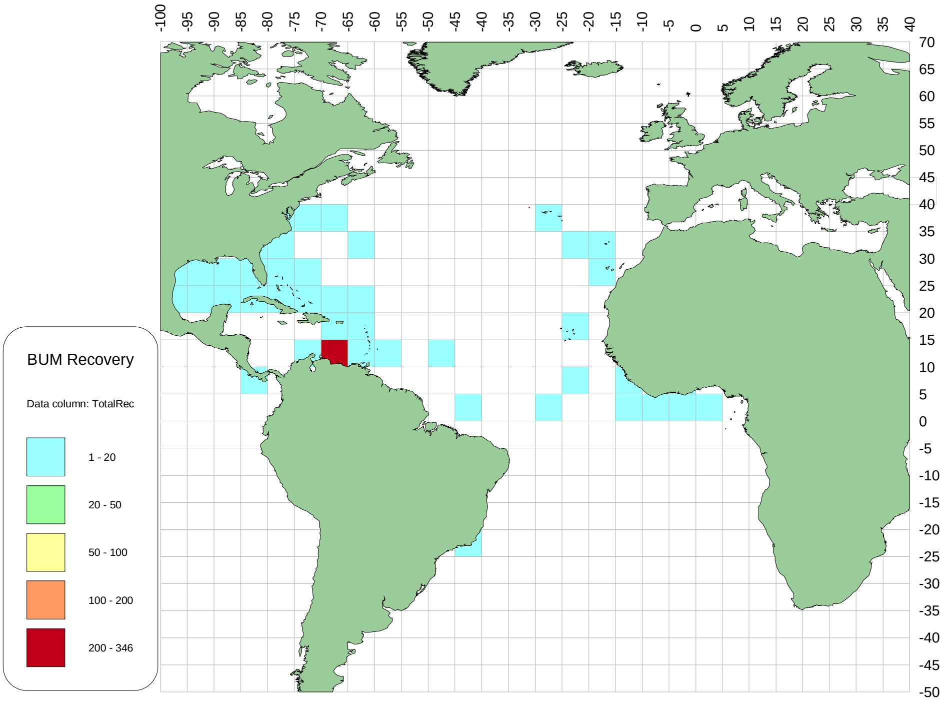


Figure 7. Density plot of conventional tag recaptures of blue marlin by 5x5 square areas all years.

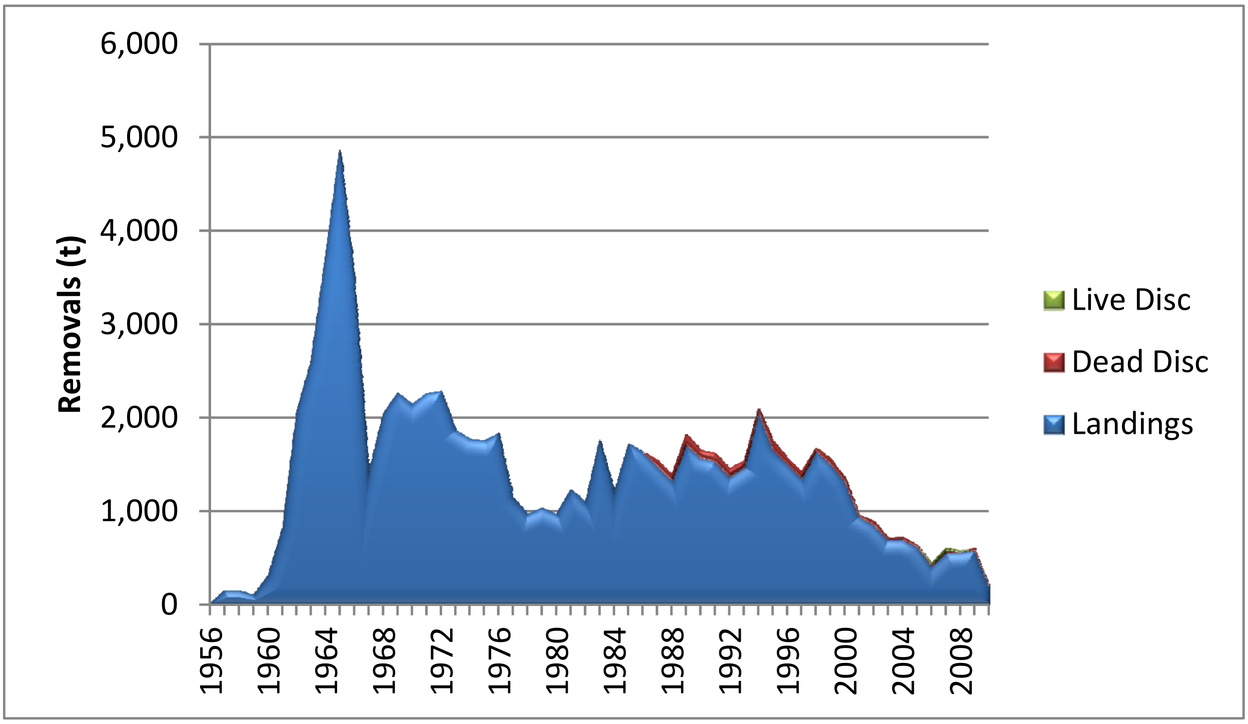


Figure 8. White marlin total catches with live and dead discards between 1956 and 2010.

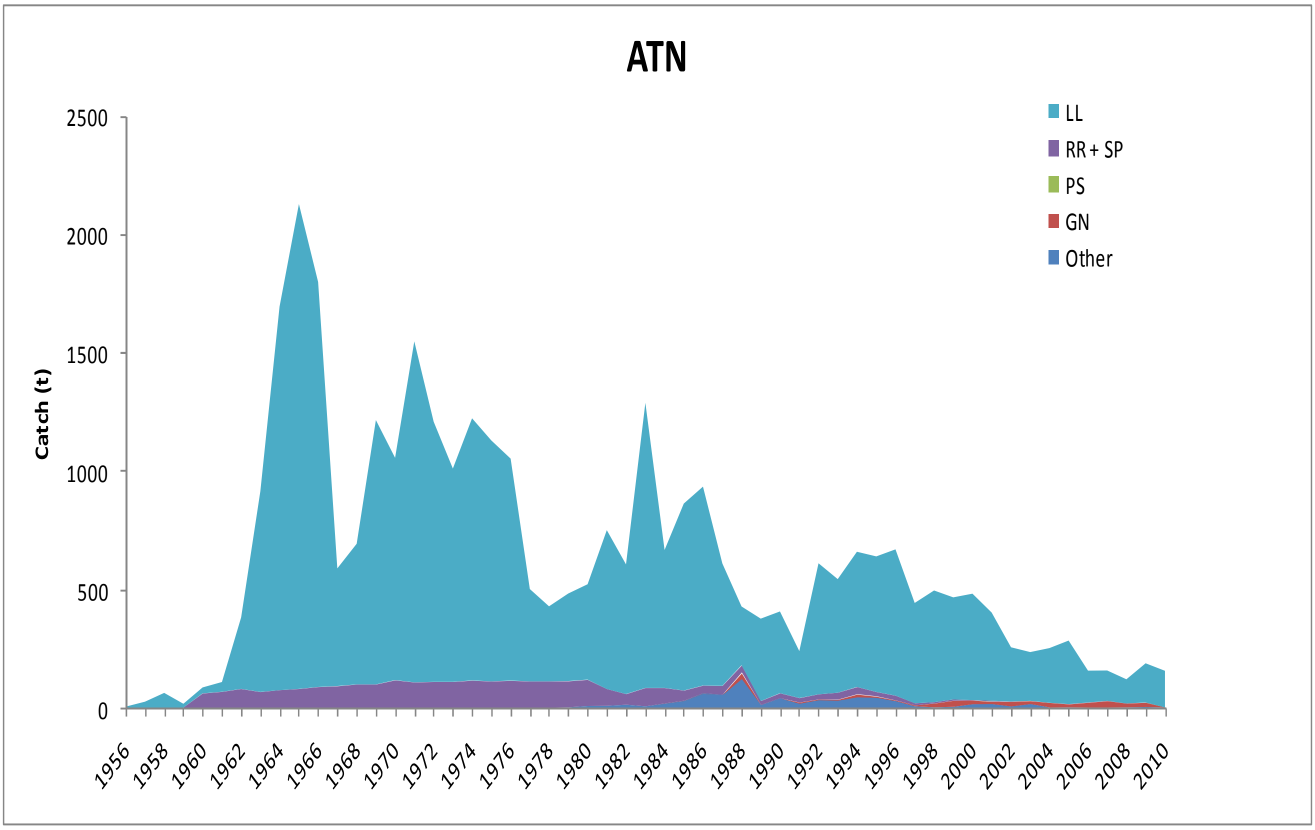


Figure 9. White marlin total catches with live and dead discards between 1956 and 2010 for the North Atlantic.

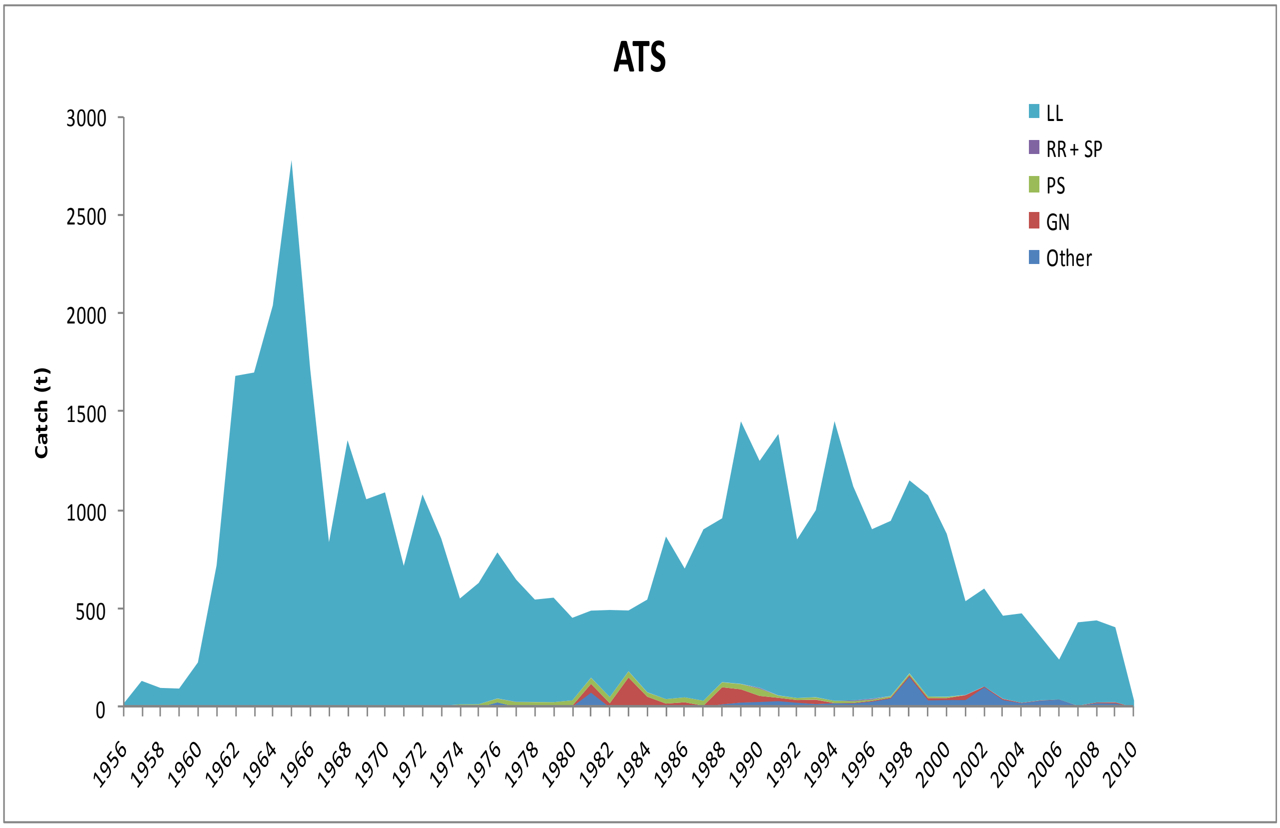


Figure 10. White marlin total catches with live and dead discards between 1956 and 2010 for the South Atlantic**.**

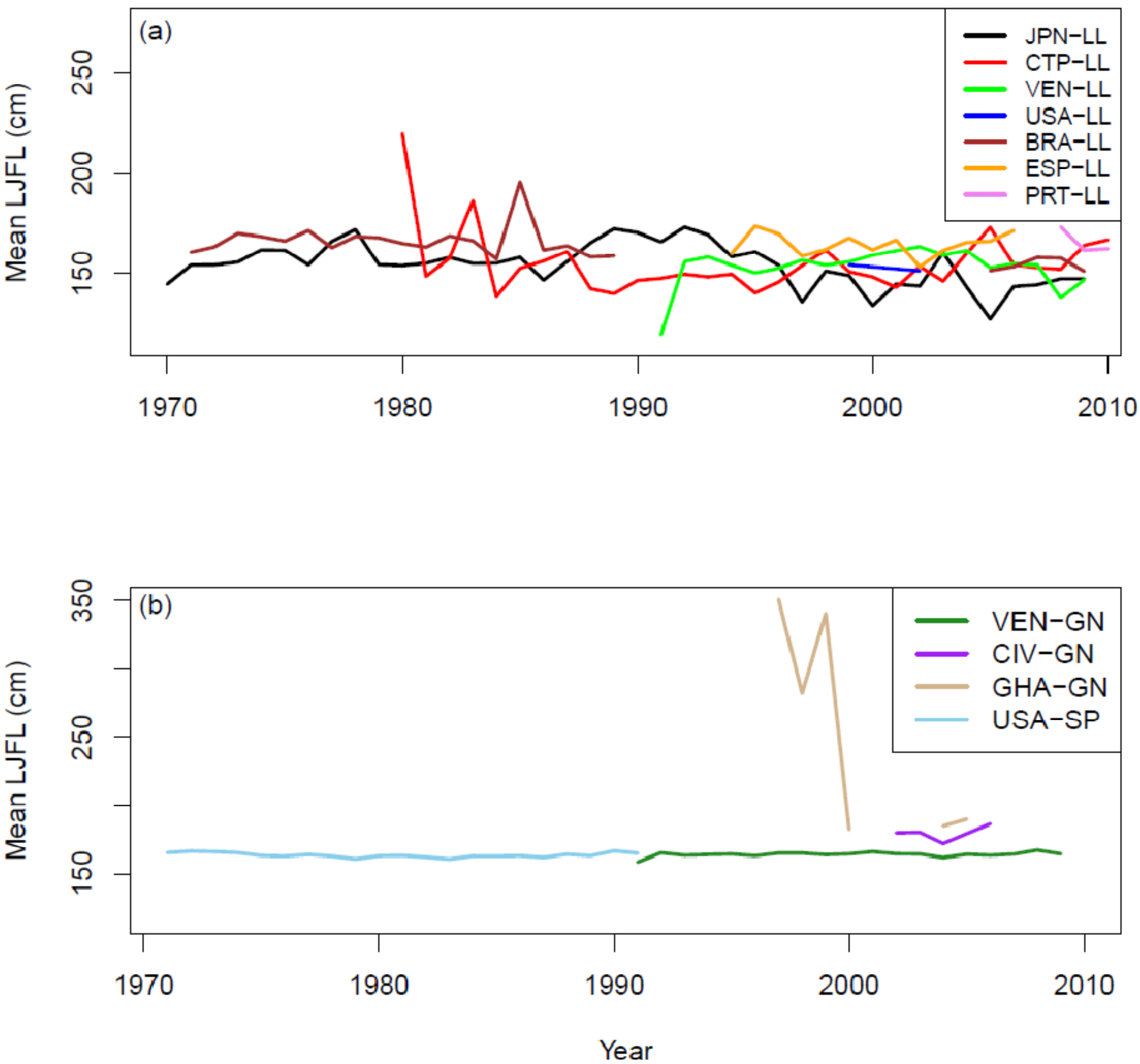


Figure 11. Annual mean size, lower jaw fork length (LJFL) cm of white marlin observed in various longline (LL) fisheries (a) and in gillent (GN) and U.S. sport (SP) fisheries (b).

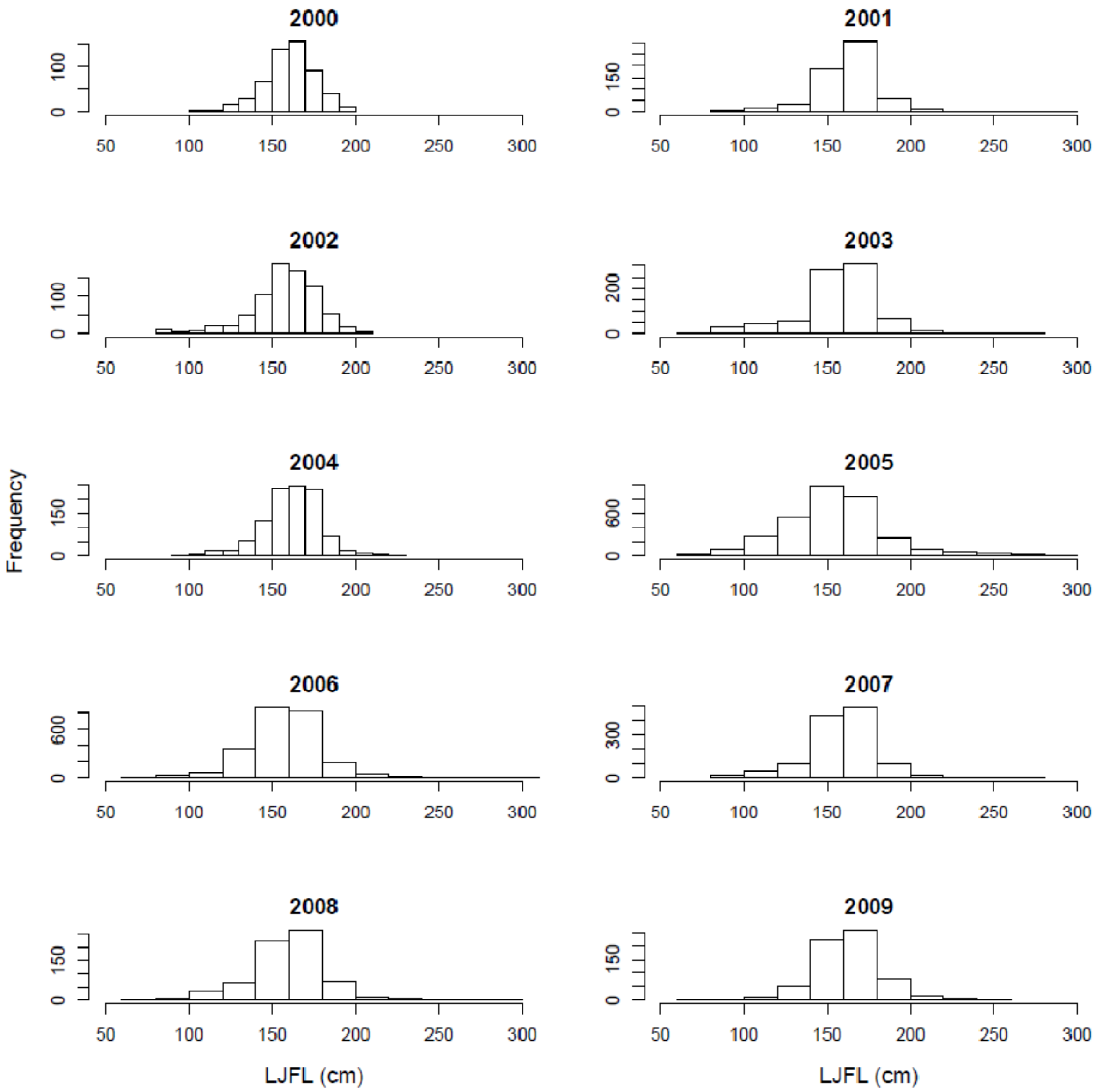


Figure 12. Size frequency histograms of white marlin (LJFL cm), combined across all fisheries and reported from 2000-2009.

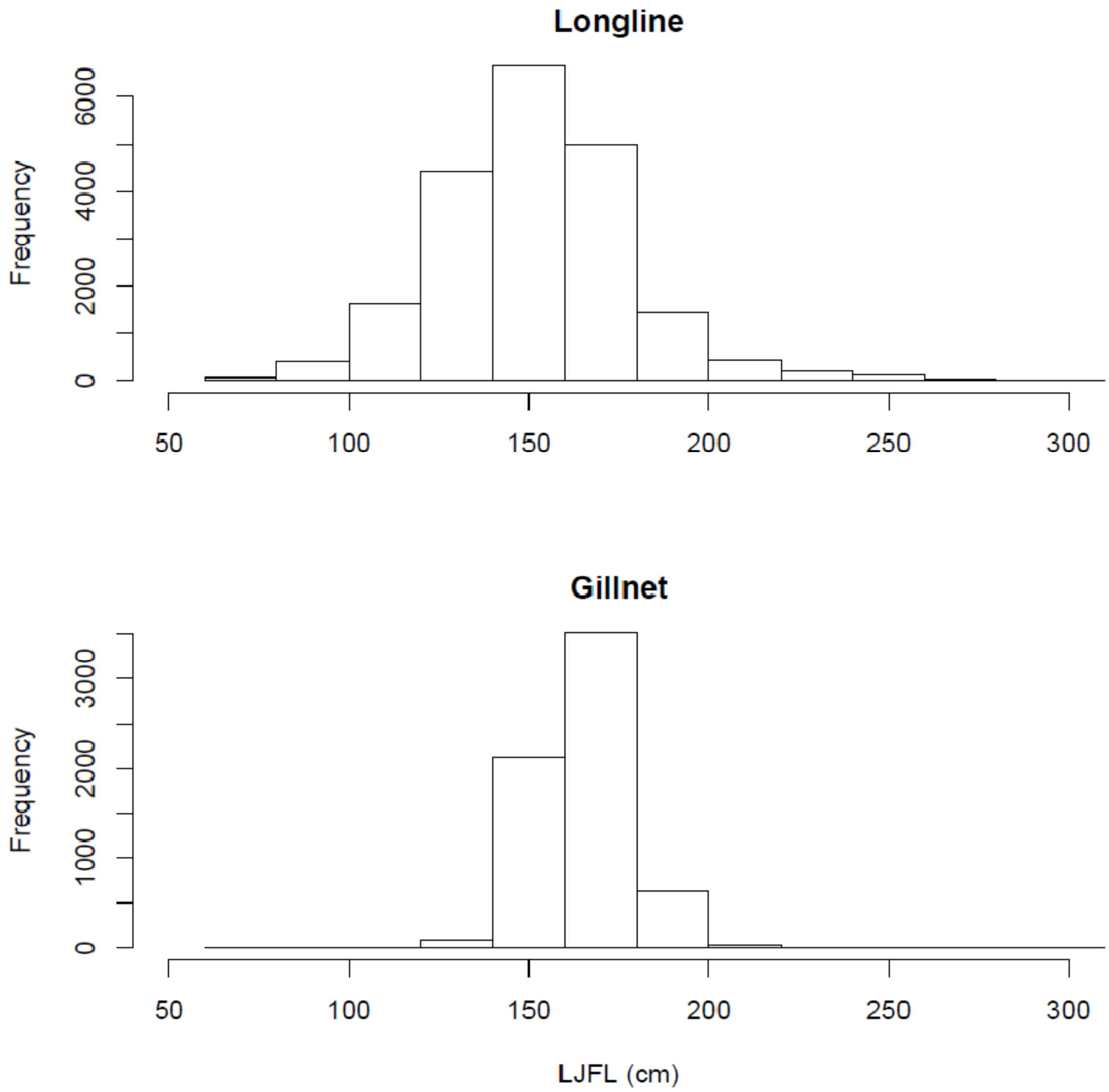


Figure 13. Size frequency histograms of white marlin (LJFL cm) combined over time and reported for the two most dominant gears in terms of catch.

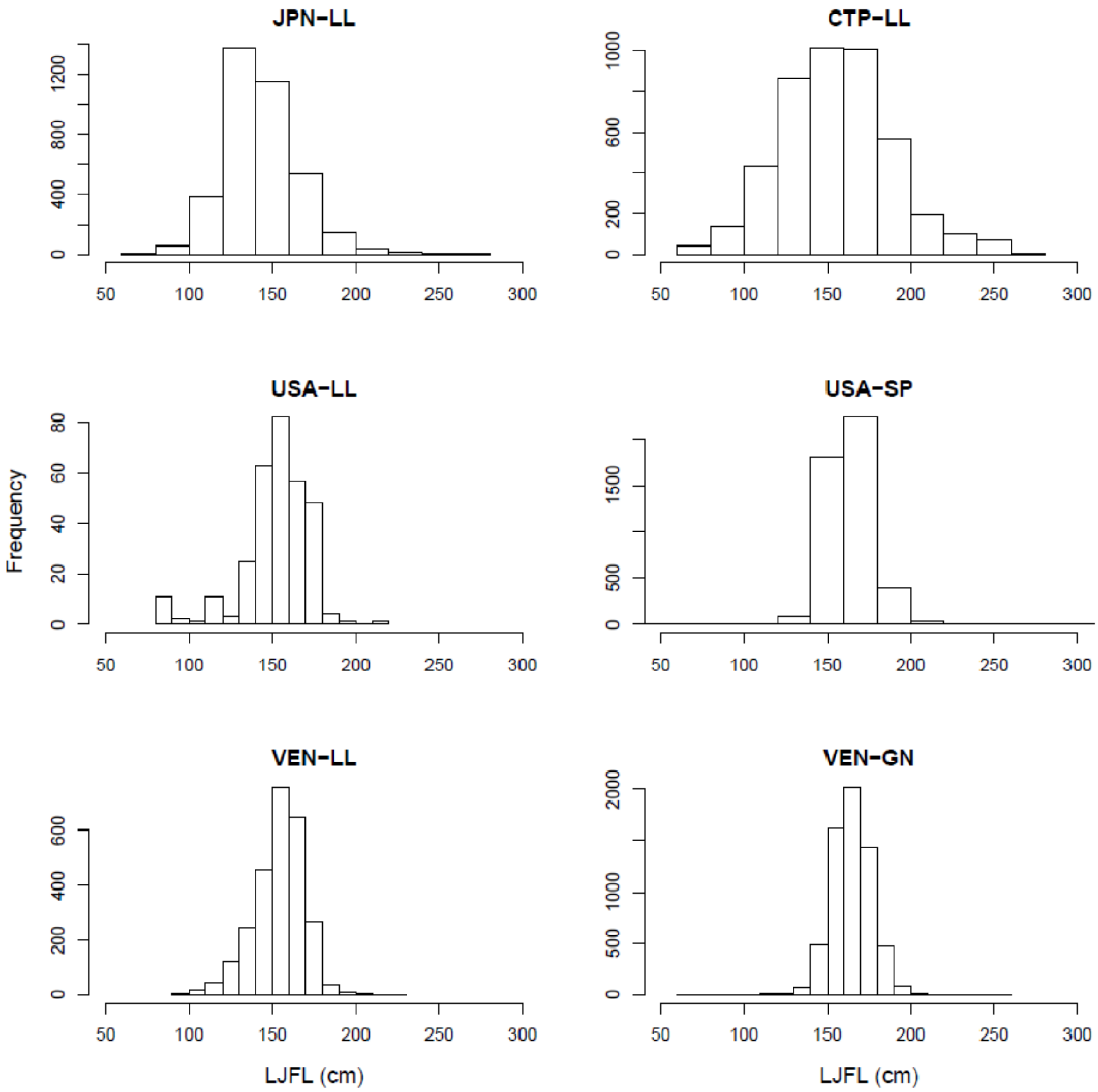
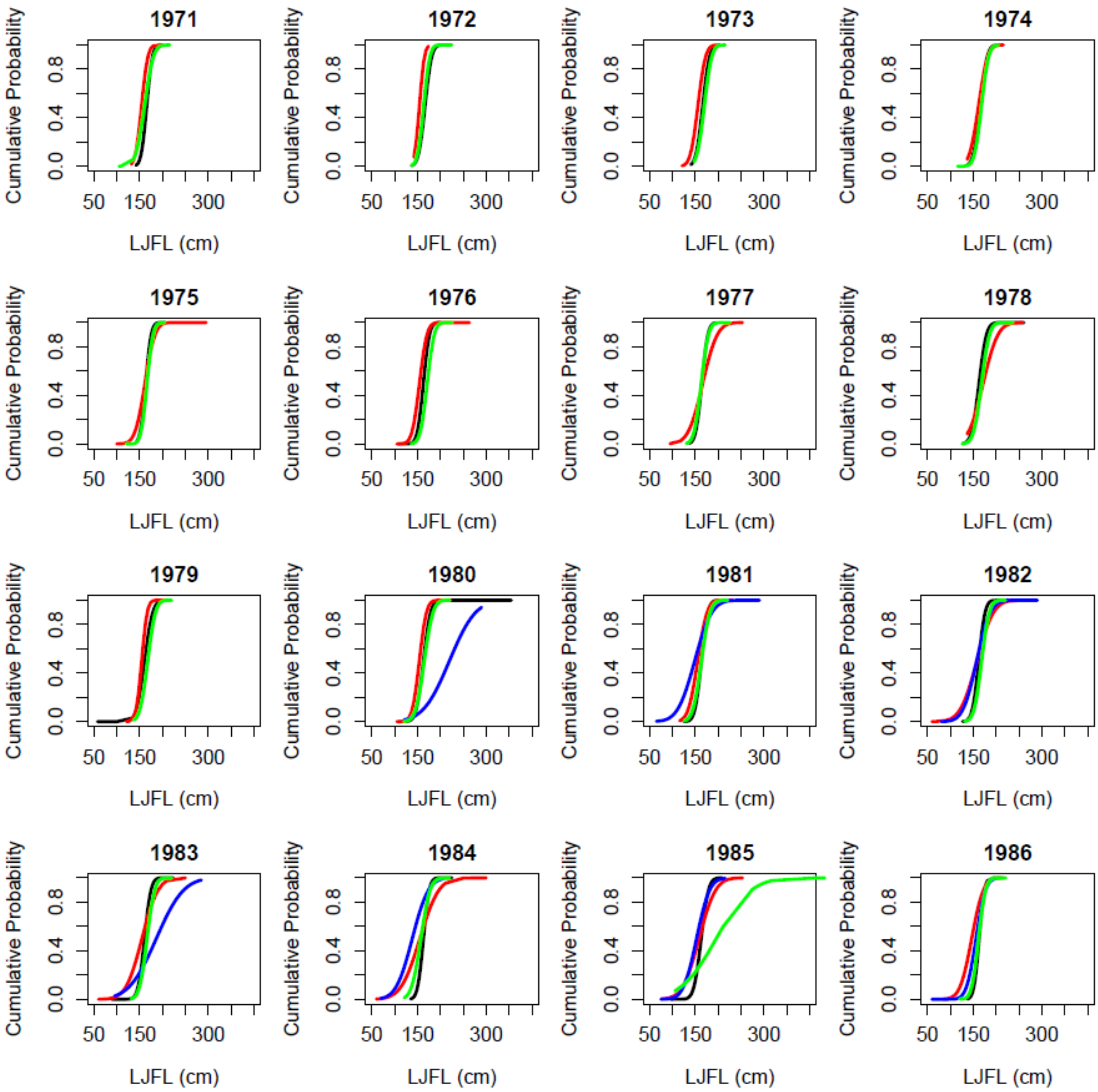


Figure 14. Size frequency histograms of white marlin (LJFL cm) combined over time and reported for the longline (LL), gillnet (GN), and sport (SP) flag-fisheries that comprise the large proportion of white marlin catch.


1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
Cumulative Probability
LJFL (cm)
0.0
0.4
0.8
50
150
300

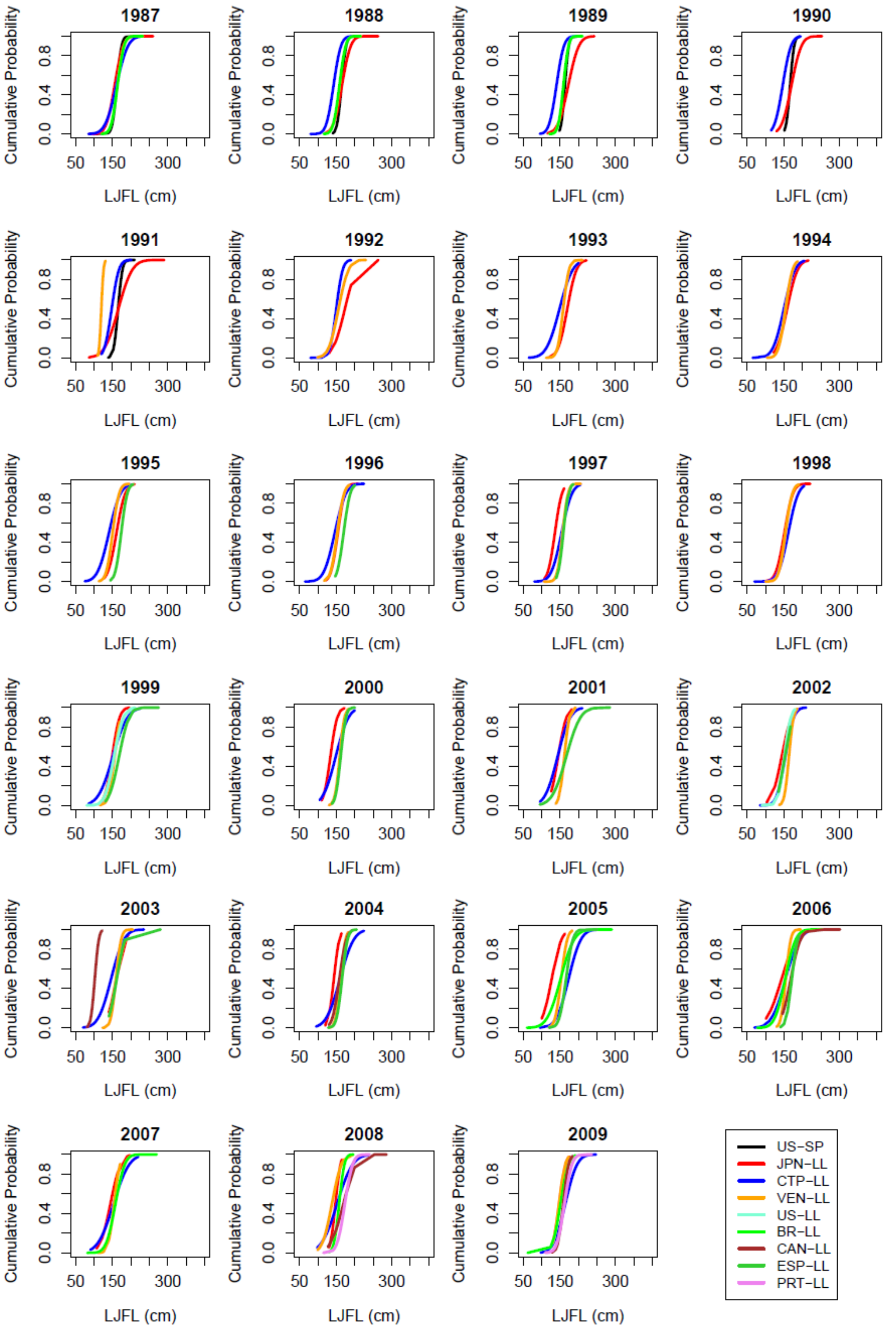


Figure 15. Annual cumulative probability of white marlin size distributions (LJFL) reported by the sport fishery from the US and several large-scale longline (LL) fisheries.

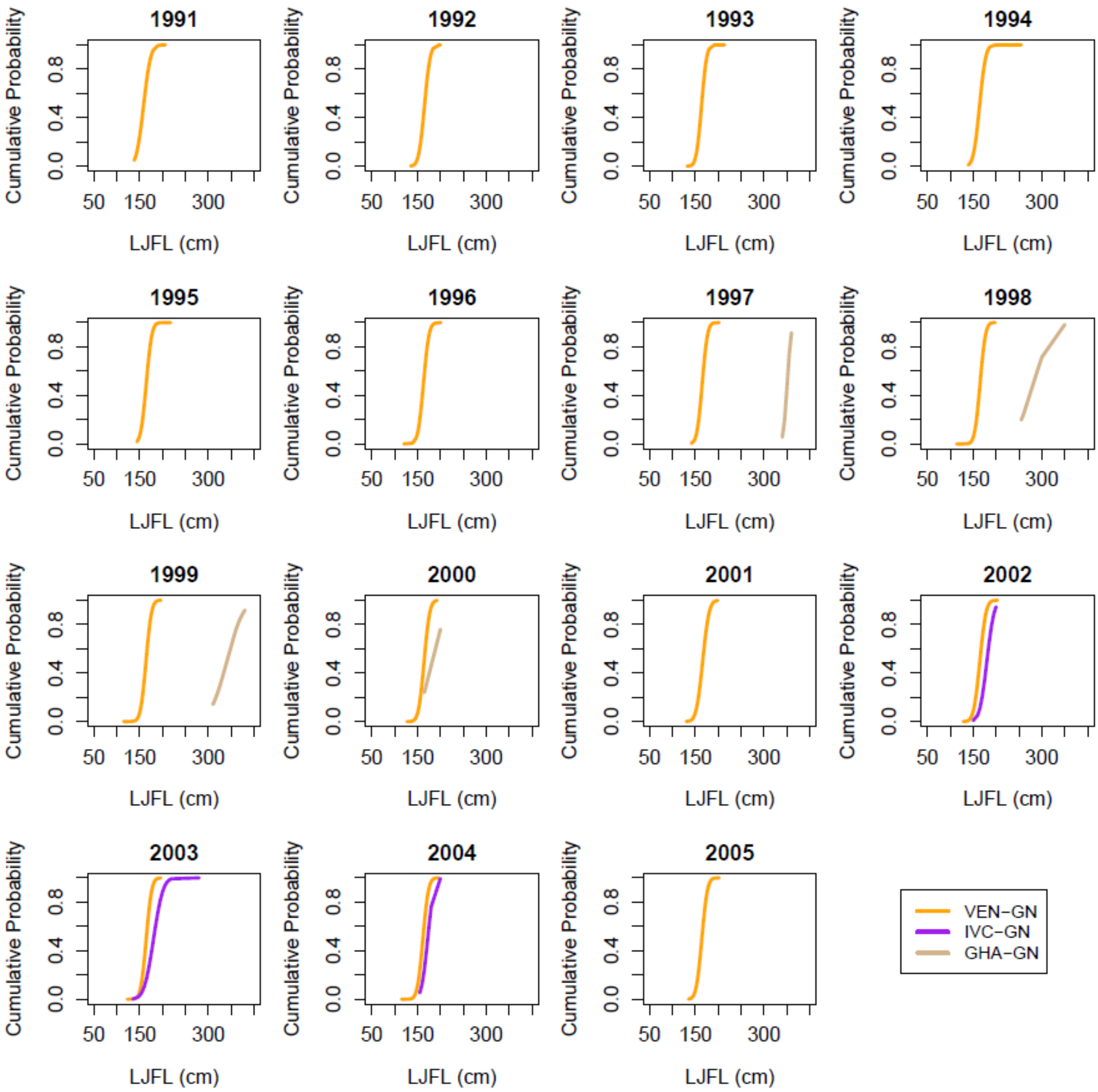


Figure 16. Annual cumulative probability of white marlin size distributions (LJFL cm) reported by several gillnet (GN) fisheries.

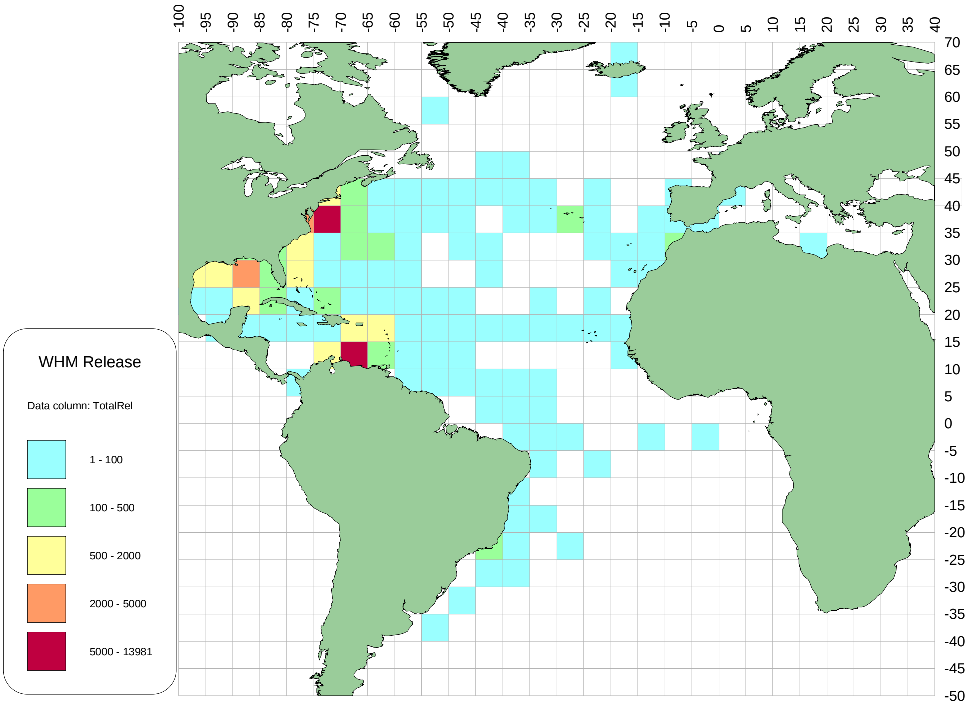


Figure 17. Density plot of conventional tag releases of white marlin by 5x5 square areas.

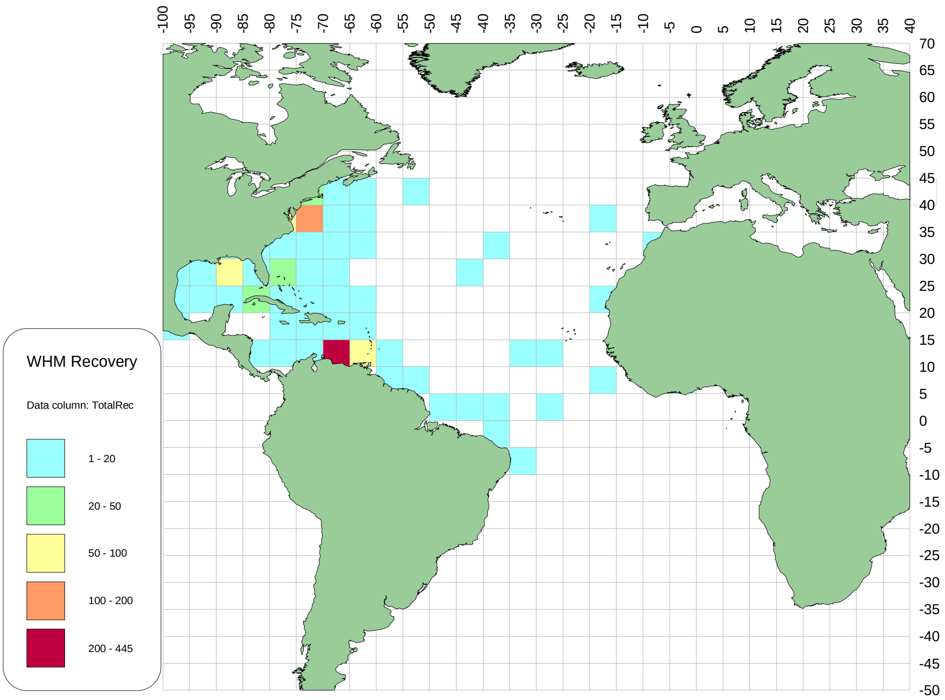


Figure 18. Density plot of conventional tag recaptures of white marlin by 5x5 square areas.

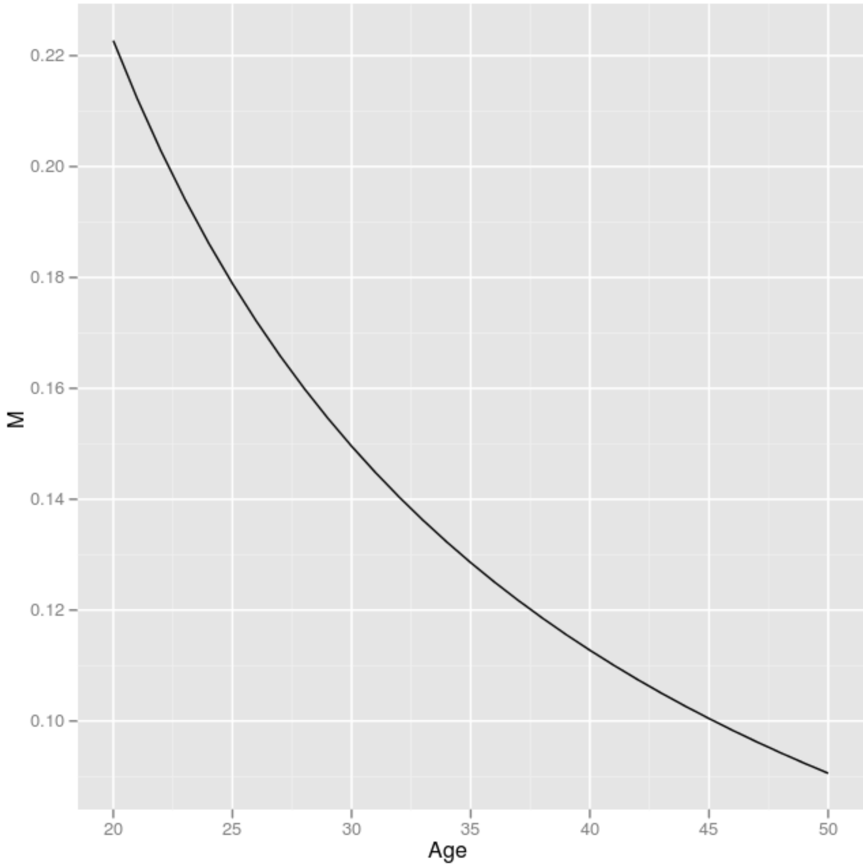


Figure 19. Relationship between natural mortality (M) and longevity (age).

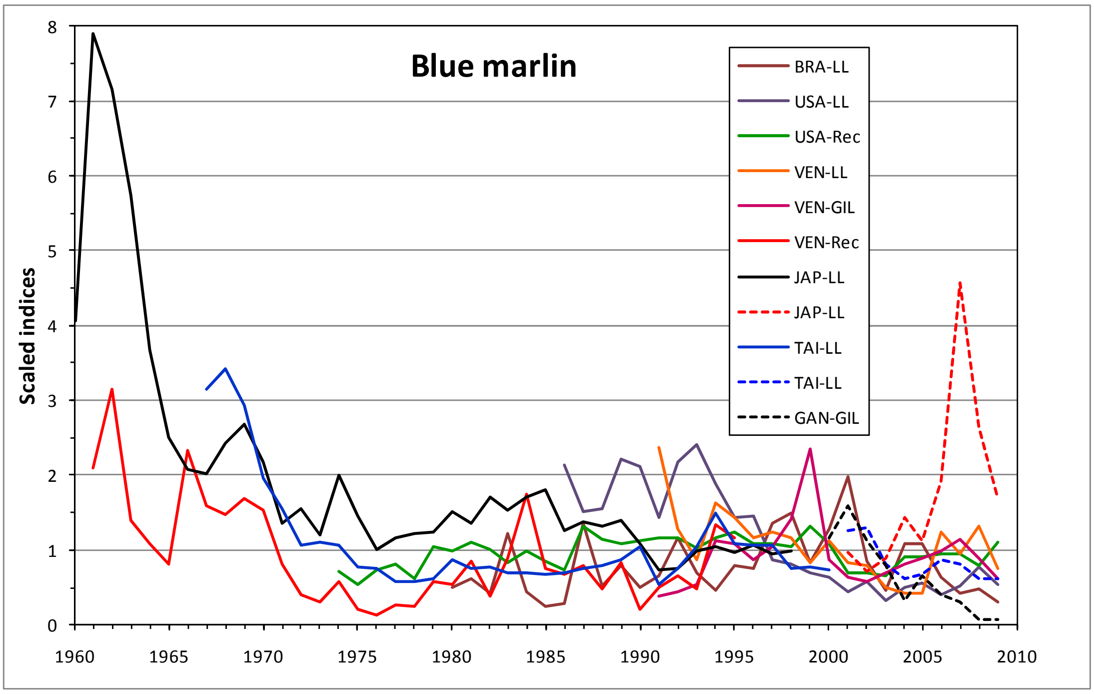


Figure 20. Indices of abundance used in the 2011 blue marlin stock assessment. For graphing purposes the indices were scaled to their respective mean value for the period 1993-2004.

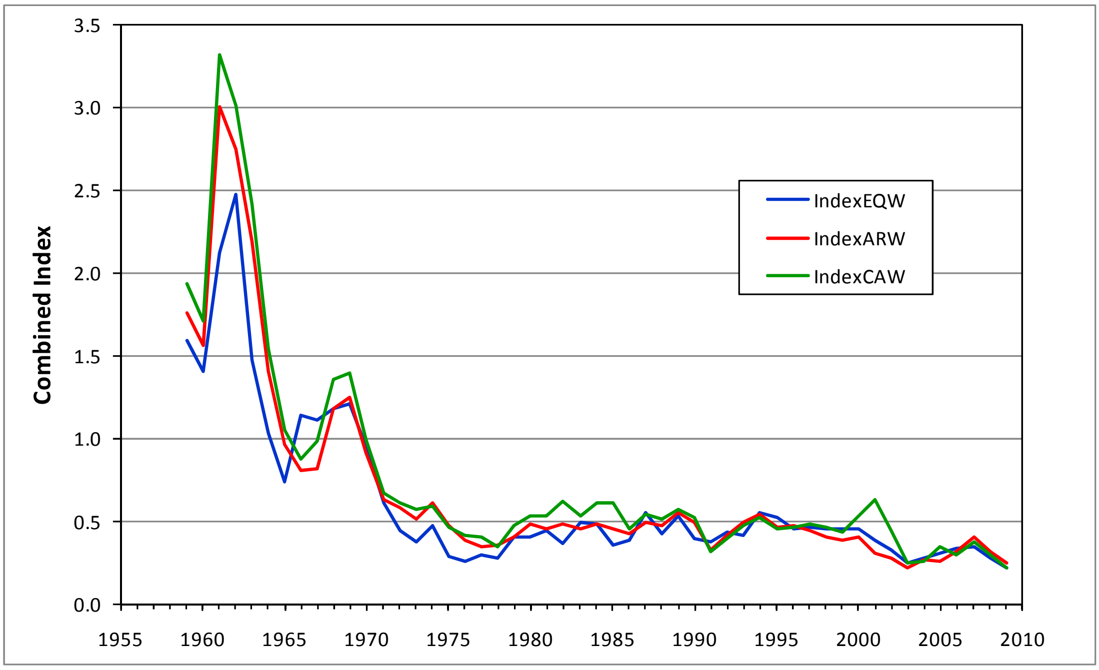


Figure 21. Blue marlin standardized combined CPUE indices estimated using equal weighting for all CPUE series (EQW), weighting the CPUE series by area (ARW) and by catch (CAW).

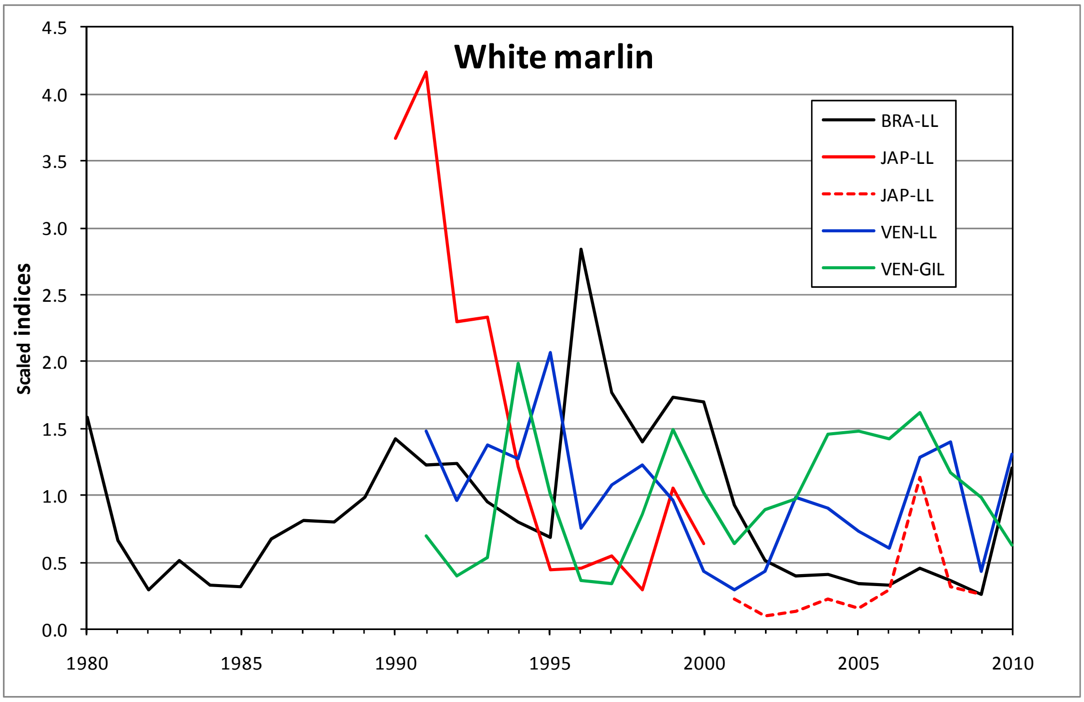
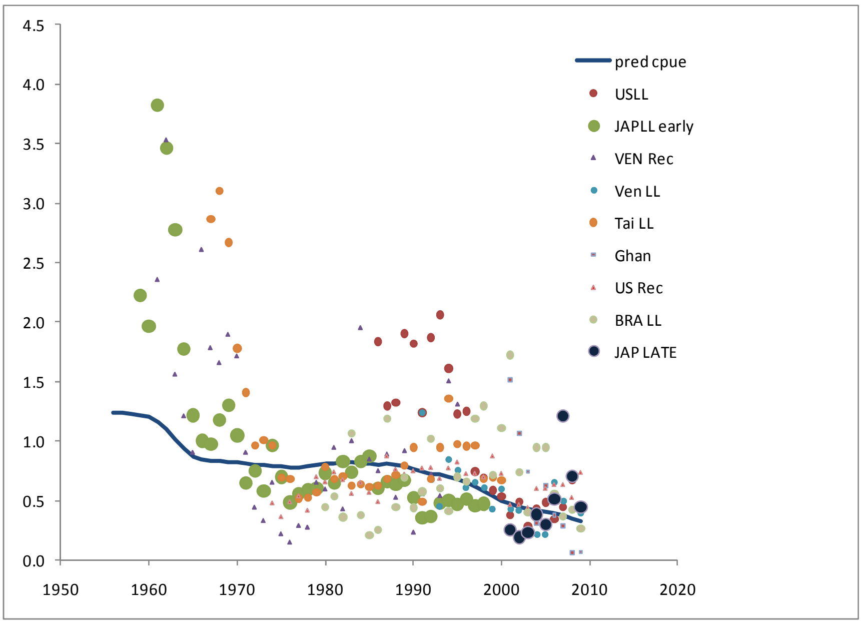


Figure 22. White marlin indices of abundance presented during the meeting. For graphing purposes the indices were scaled to their respective mean value for the period 1990-2010.



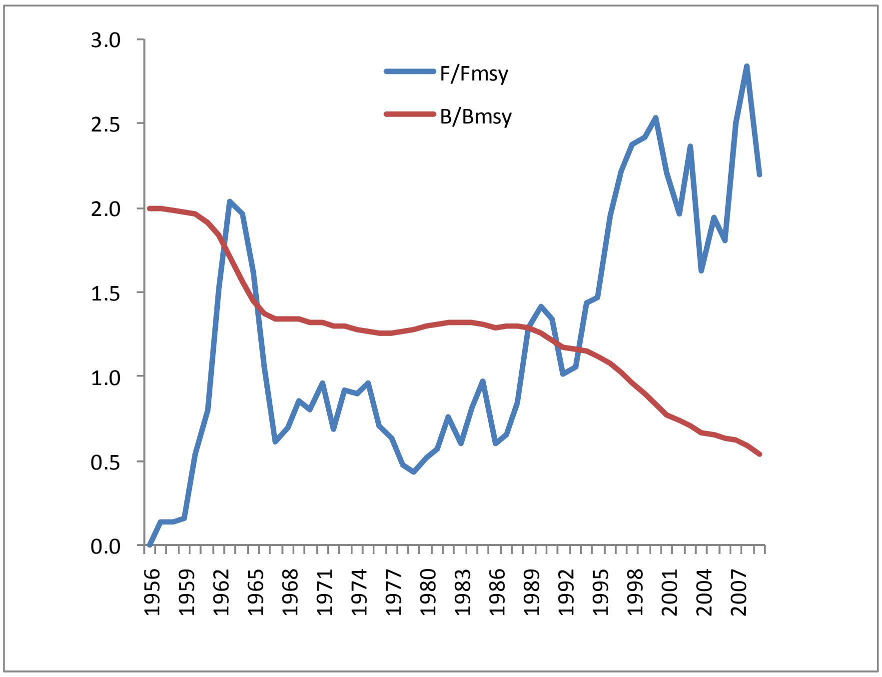


Figure 23. Low Productivity Scenario: (top) Predicted CPUE (blue continuous line) and observed CPUE indices scaled according to the catchability estimated for each index. Symbols are sized proportional to the weights they were assigned in the ASPIC fit. Weights for each index were proportional to the area occupied by each fishery. (bottom) Time trends of B/B_{MSY} and F/F_{MSY} with 80% percentiles based on 1000 ASPIC bootstraps.

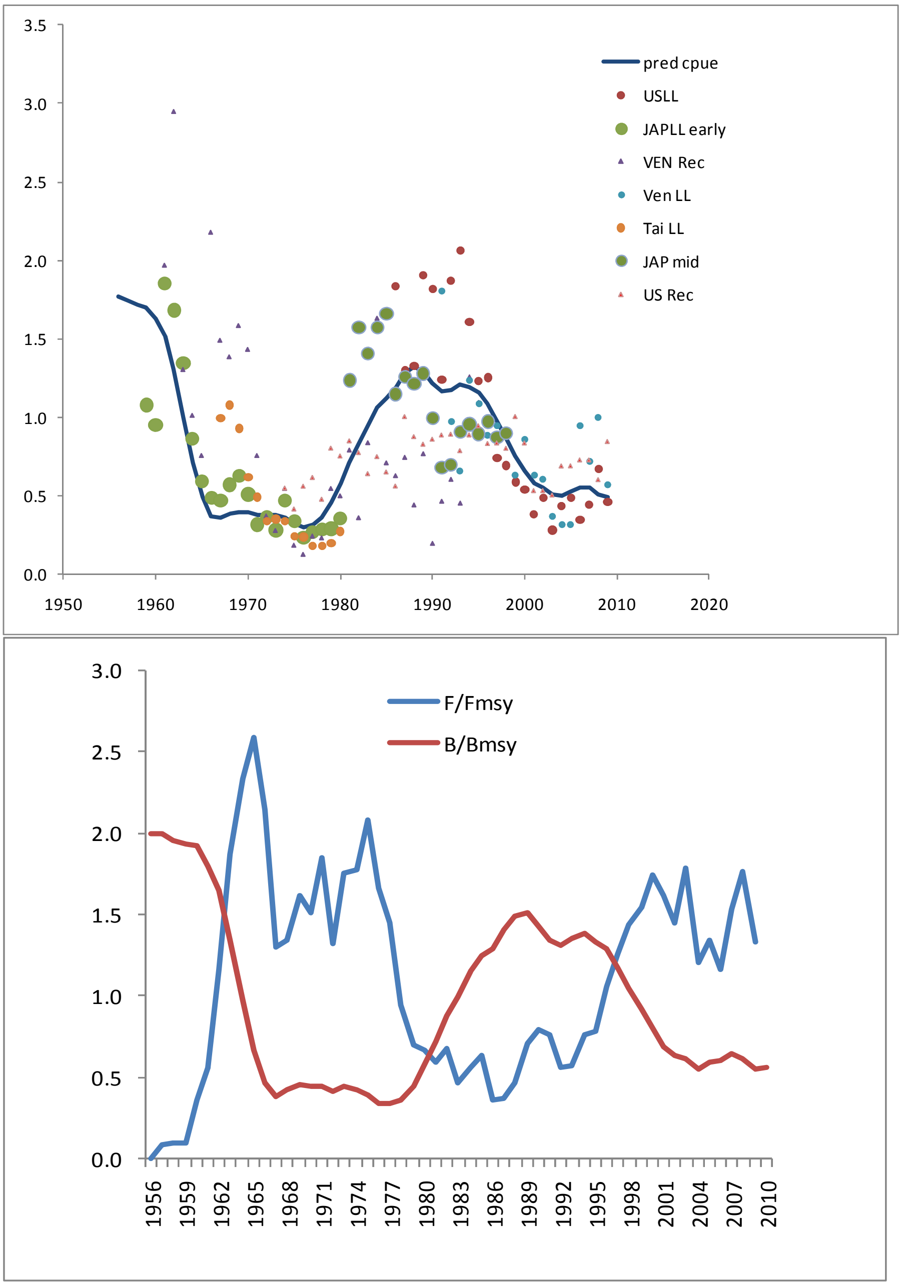


Figure 24. High Productivity Scenario: (top) Predicted CPUE (blue continuous line) and observed CPUE indices scaled according to the catchability estimated for each index. Symbols are sized proportional to the weights they were assigned in the ASPIC fit. Weights for each index were proportional to the area occupied by each fishery. (bottom) Time trends of B/B_{MSY} and F/F_{MSY} with 80% percentiles based on 1000 ASPIC bootstraps.

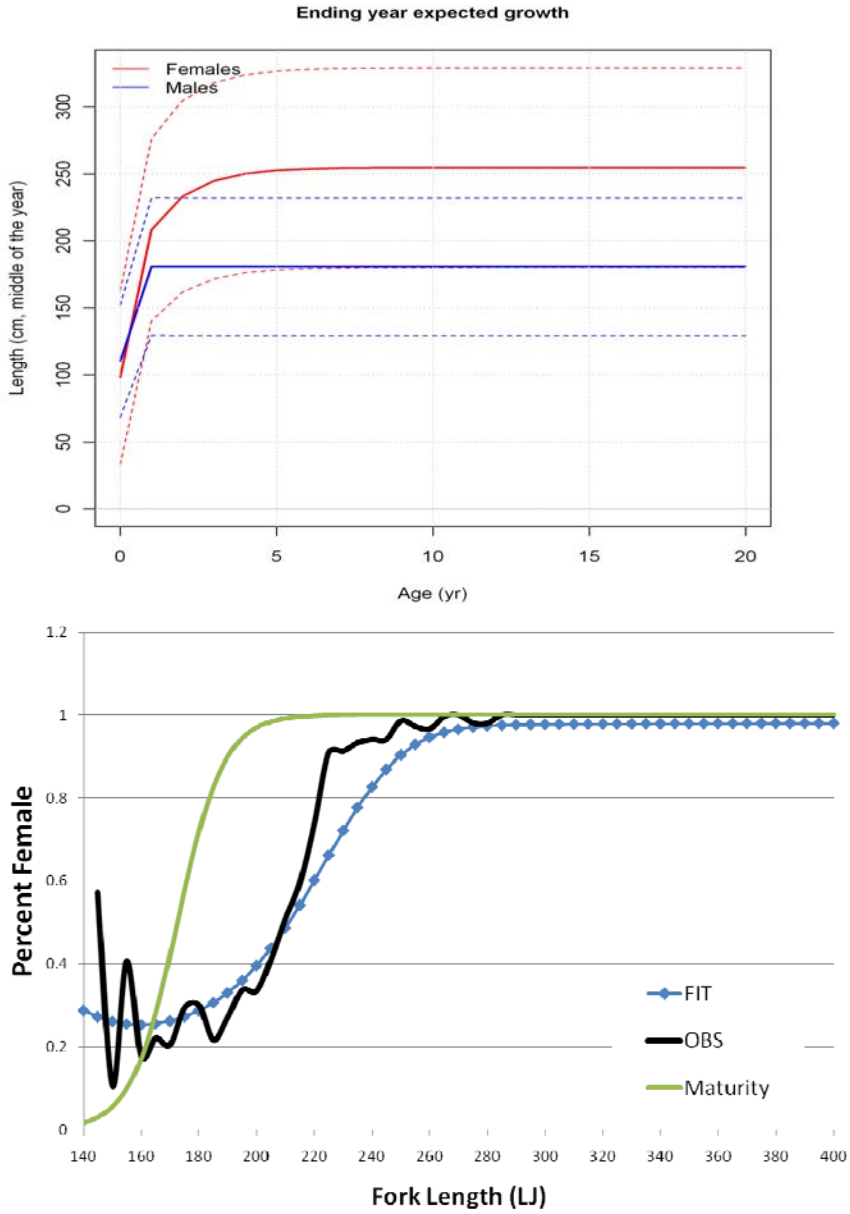


Figure 25. Estimated growth by sex (top). Percentage of maturity by length (green line) and sex ratio (percentage of females) observed and fit by sizes (bottom).

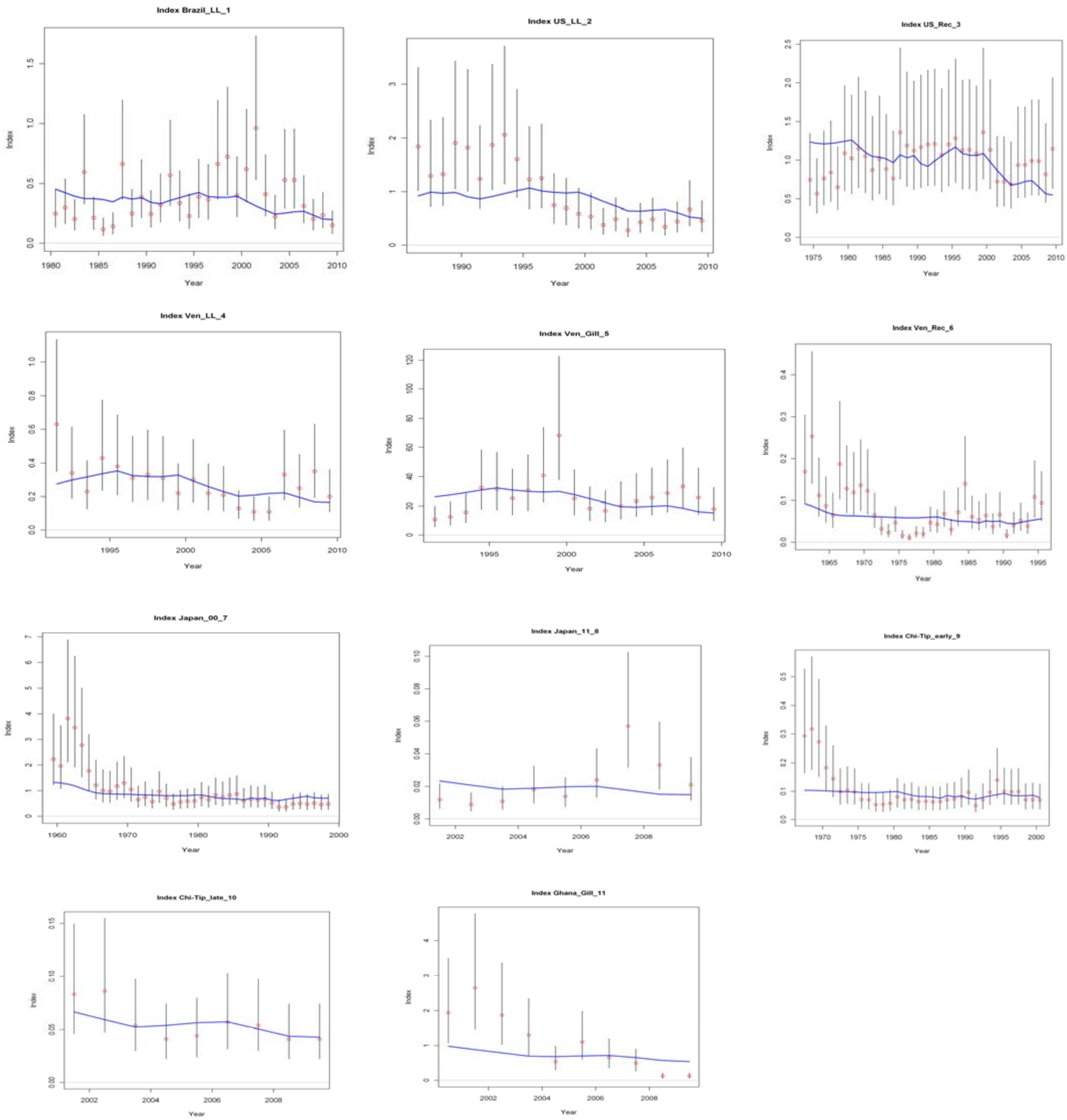


Figure 26. Fit to the CPUE time series used in the fully integrated model.

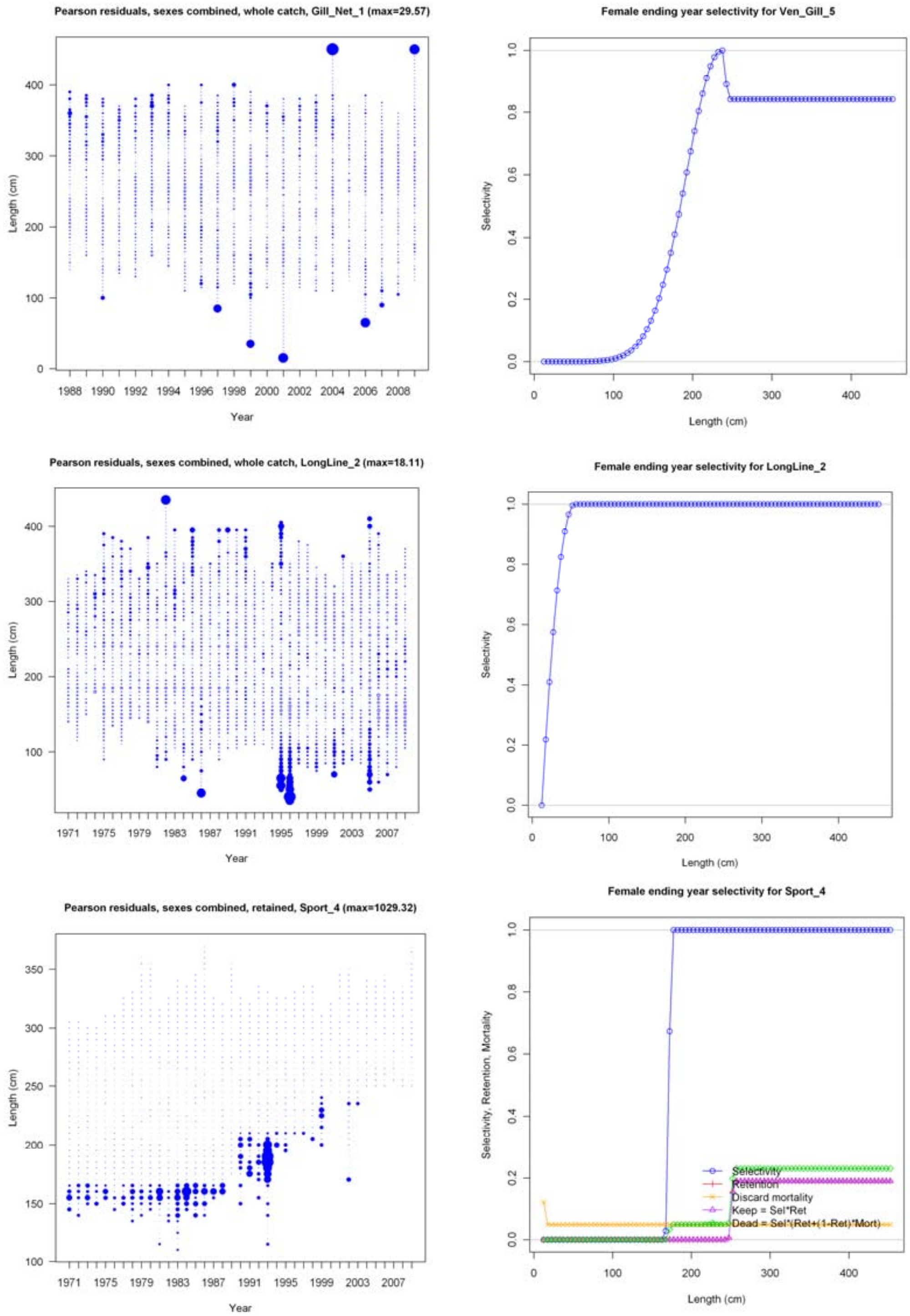


Figure 27. Pearson residuals for fit to length data (left column) and estimated selectivities (right column) for the three gears with length data.

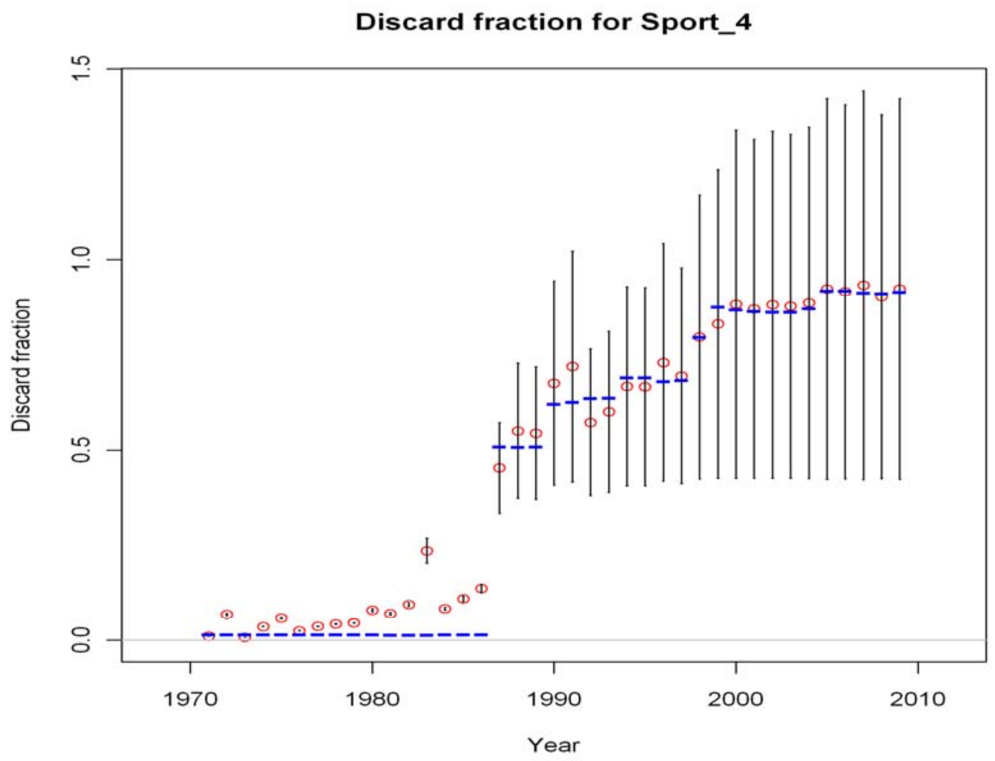


Figure 28. Fit to the estimated discard fraction from the U.S. sport fleet.

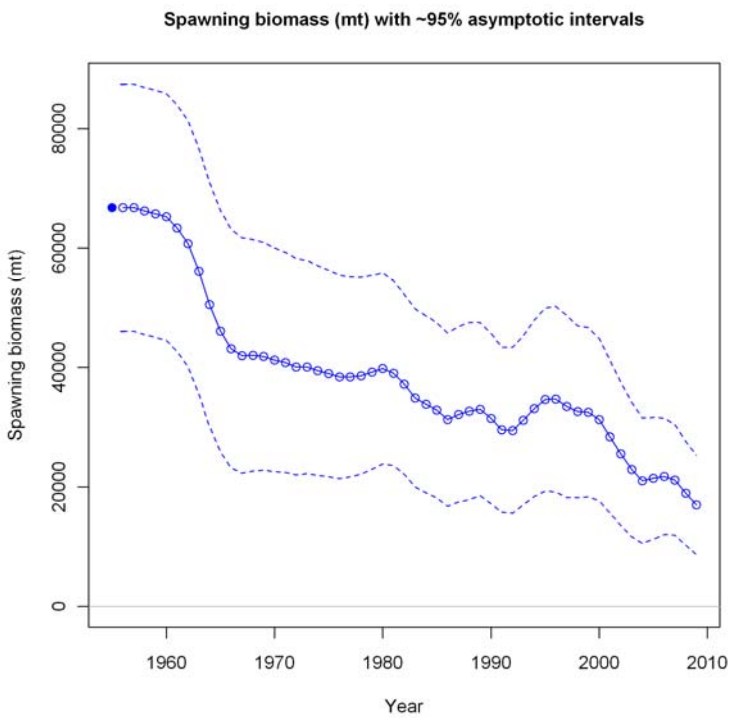


Figure 29. Estimated trend in spawning biomass with 95% confidence intervals from the fully integrated model.

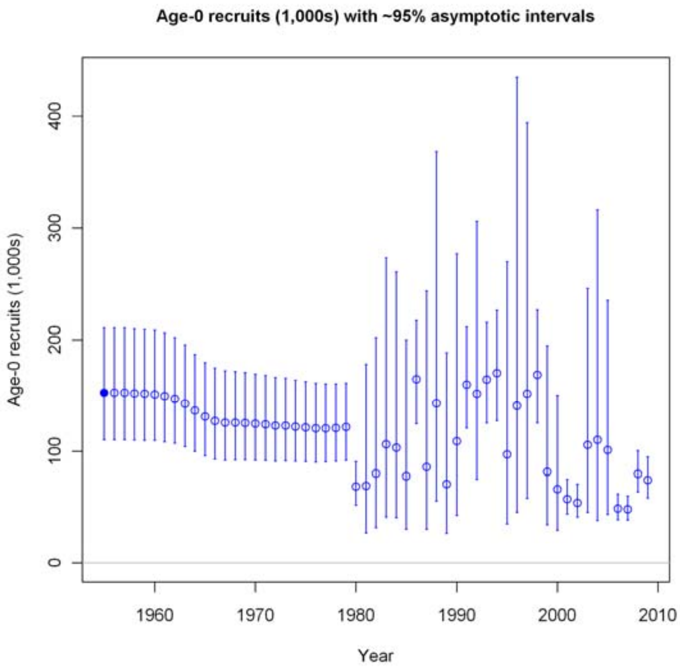


Figure 30. Estimated trend in recruitment with 95% confidence intervals from the fully integrated model.

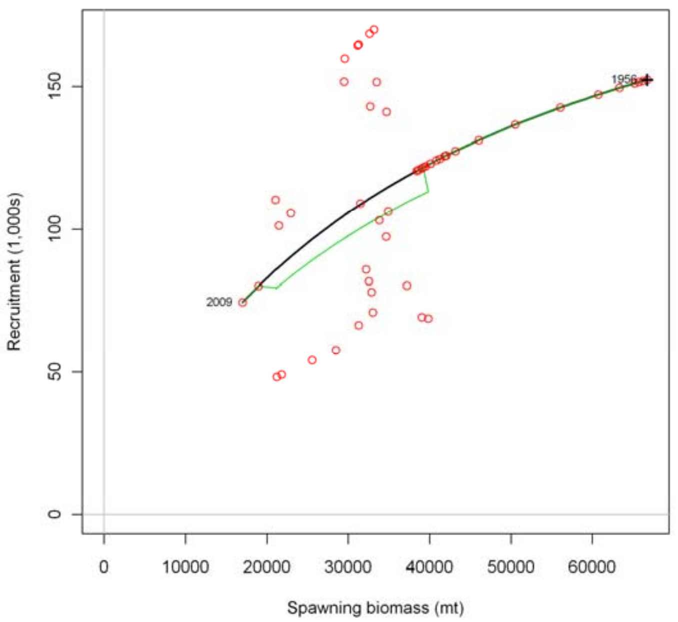


Figure 31. Estimated stock-recruitment function from the fully integrated model.

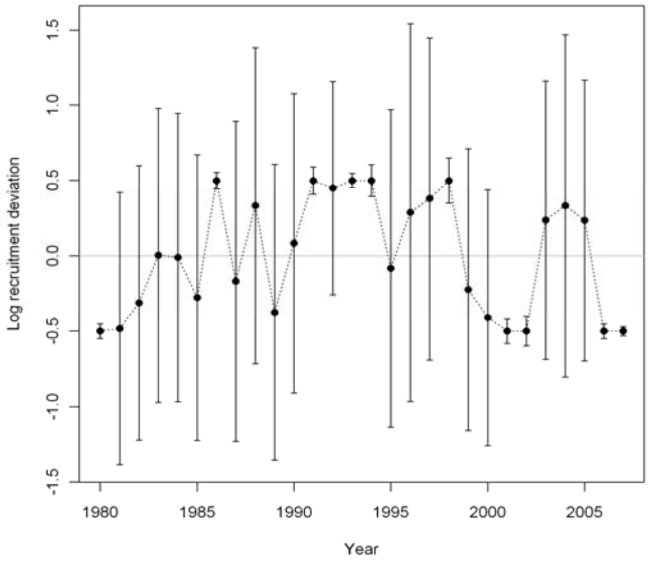


Figure 32. Estimated annual recruitment deviation from the stock-recruitment relationship.

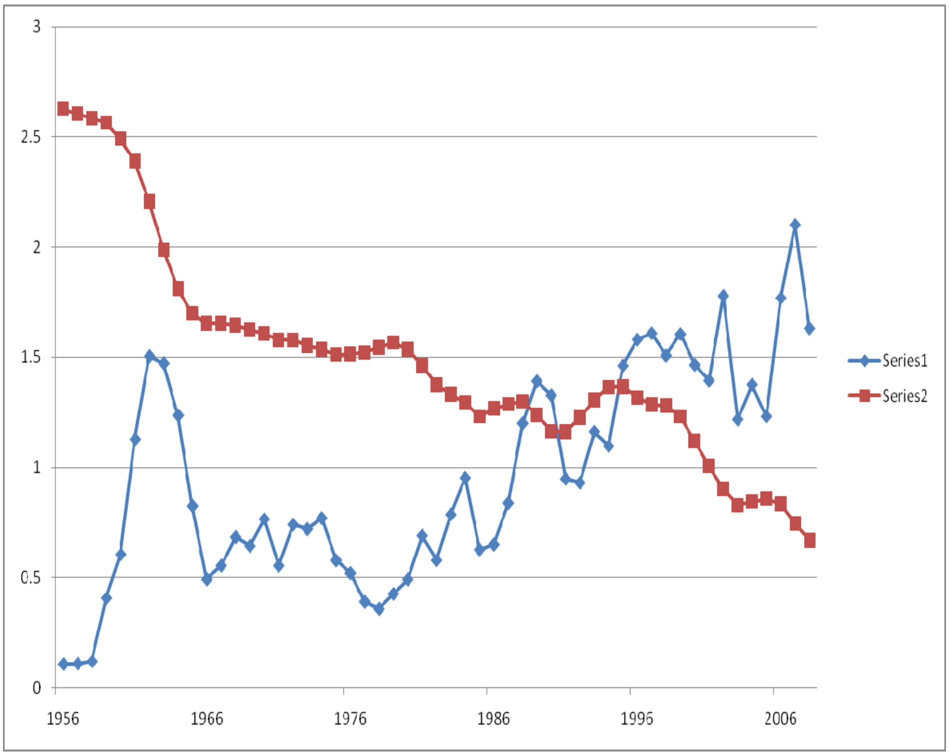


Figure 33. Estimated trends in B/B_{MSY} and F/F_{MSY} from fully integrated model.

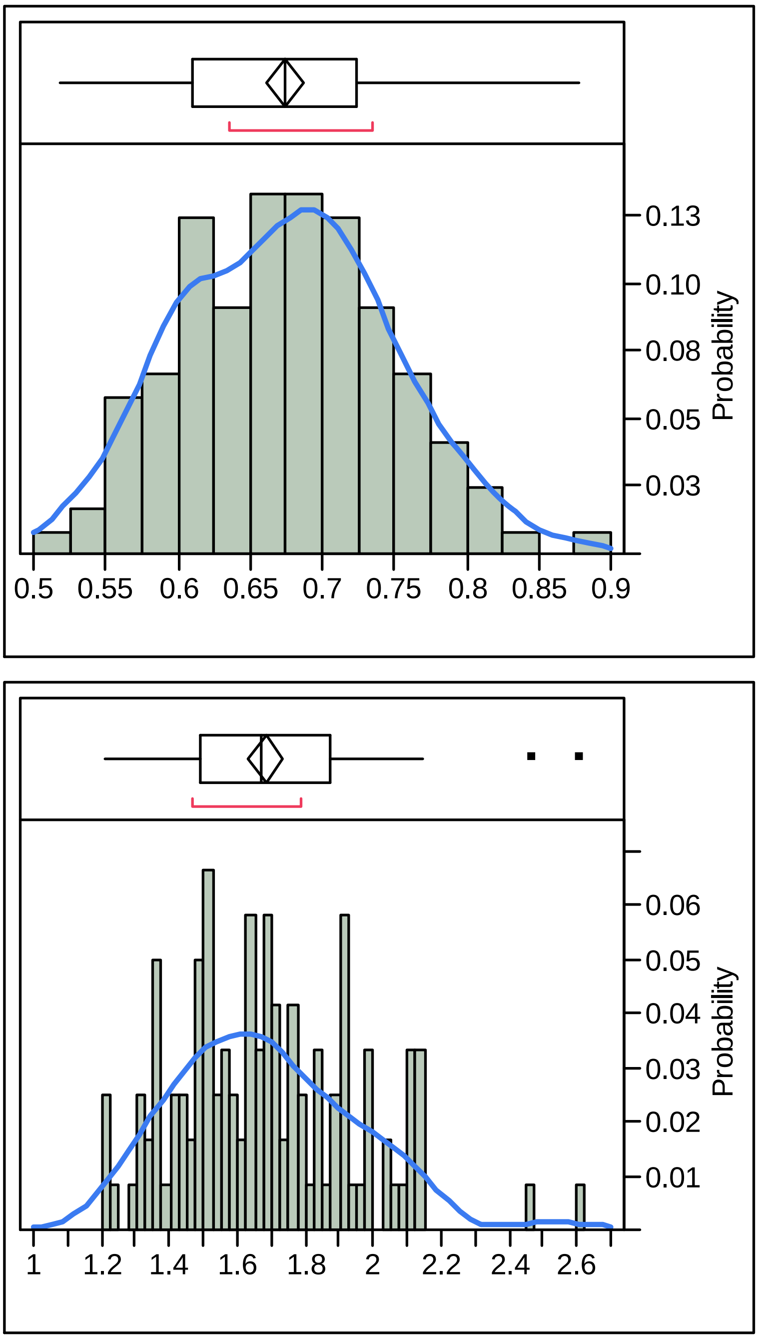


Figure 34. Results of MCMC runs for B/B_{MSY} (top) and F/F_{MSY} (bottom) for 2009.

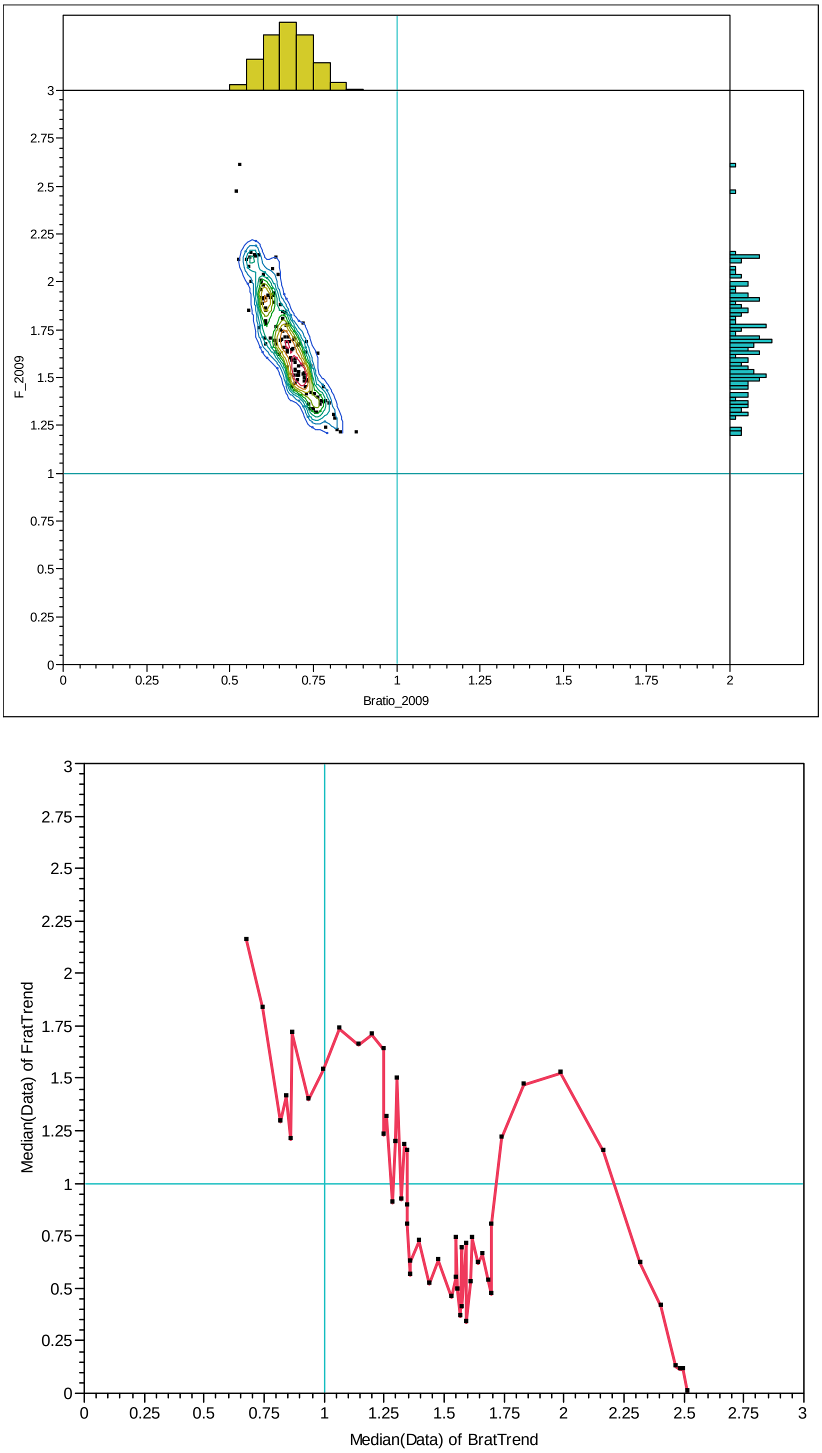


Figure 35. Kobe phase plots from fully integrated base case model.

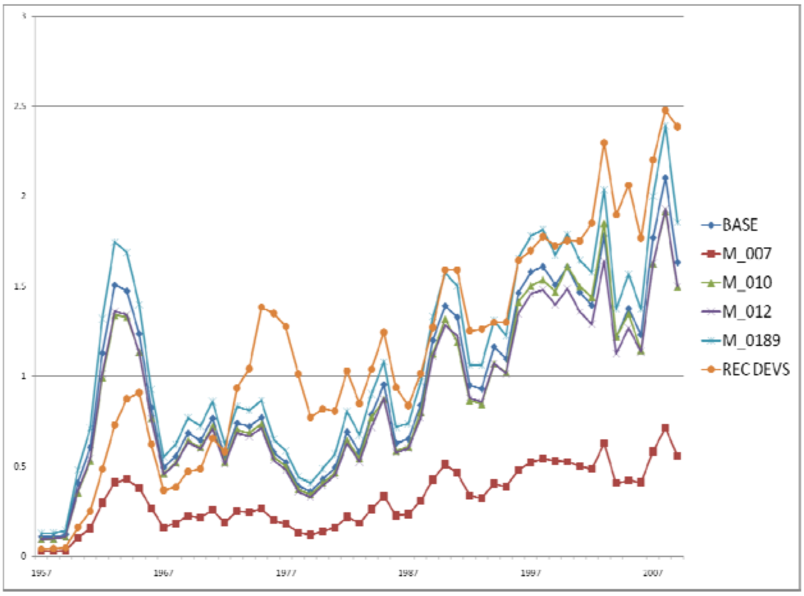


Figure 36. Estimates of F/F_{MSY} for the sensitivity runs.

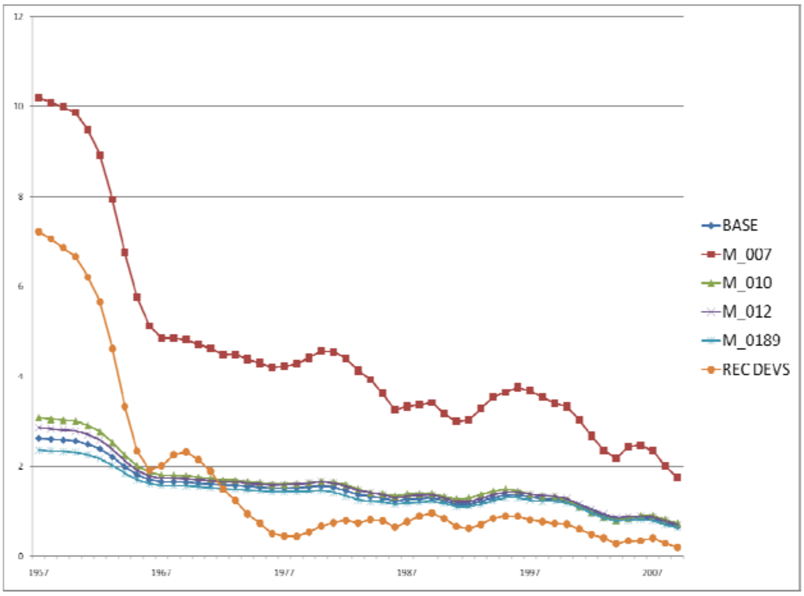


Figure 37. Estimates of B/B_{MSY} for the sensitivity runs.

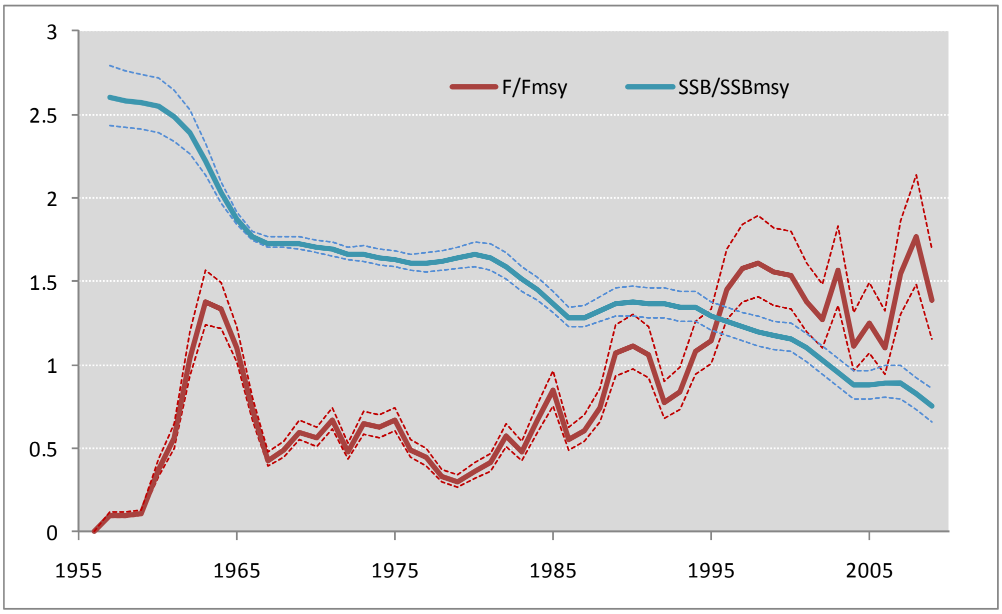


Figure 38. Trends of F/F_{MSY} and SSB/SSB_{MSY} ratios for blue marlin from the base model (SS3). Solid lines represent median from MCMC runs, and broken lines the 10% and 90% percentiles, respectively.

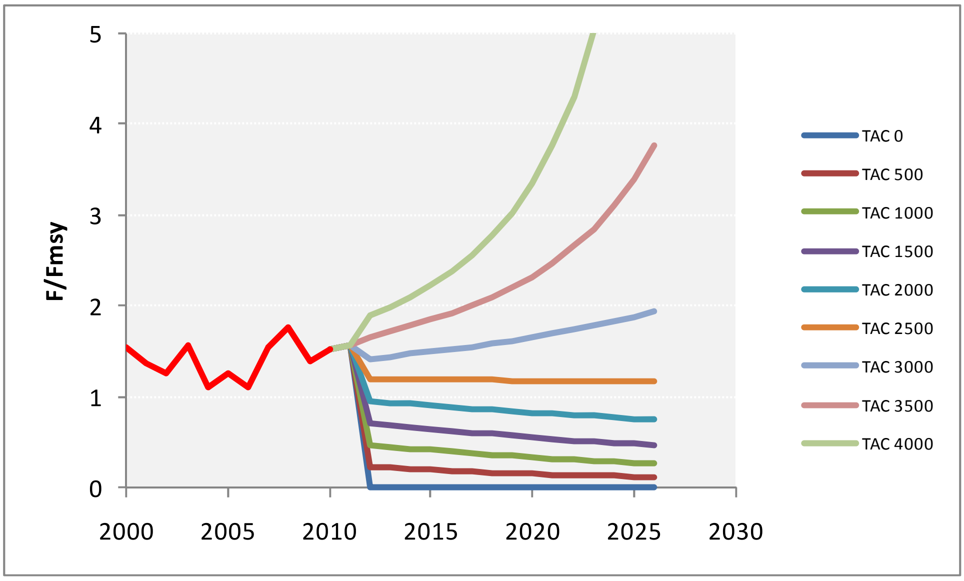


Figure 39. Trends of F/F_{MSY} ratios under different scenarios of constant catch projections (TAC tons) for blue marlin from the base model. Projections start in 2010, for 2010/11 it was assumed a catch of 3,341 t.

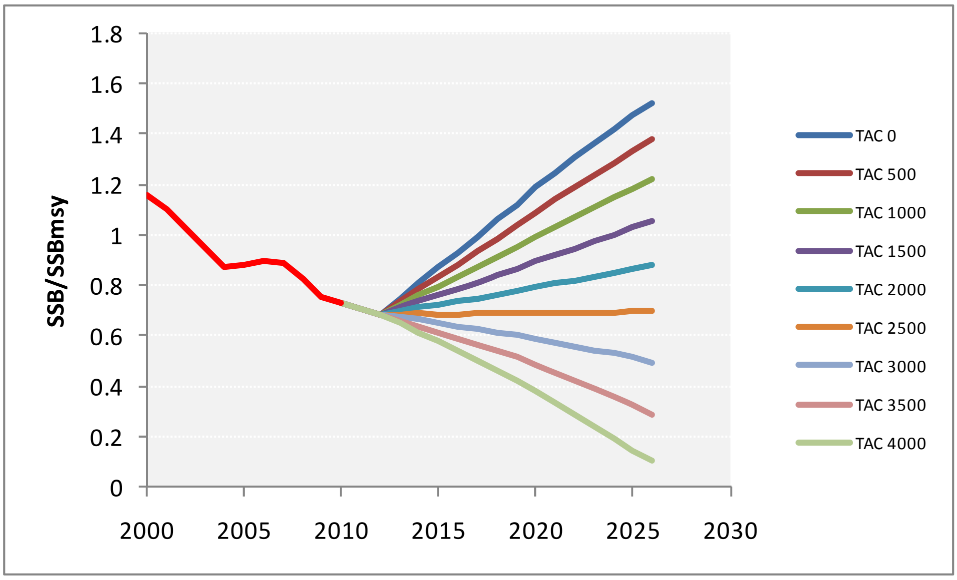


Figure 40. Trends of SSB/SSB_{MSY} ratios under different scenarios of constant catch projections (TAC tons) for blue marlin from the base model. Projections start in 2010, for 2010/11 it was assumed a catch of 3,341 t.

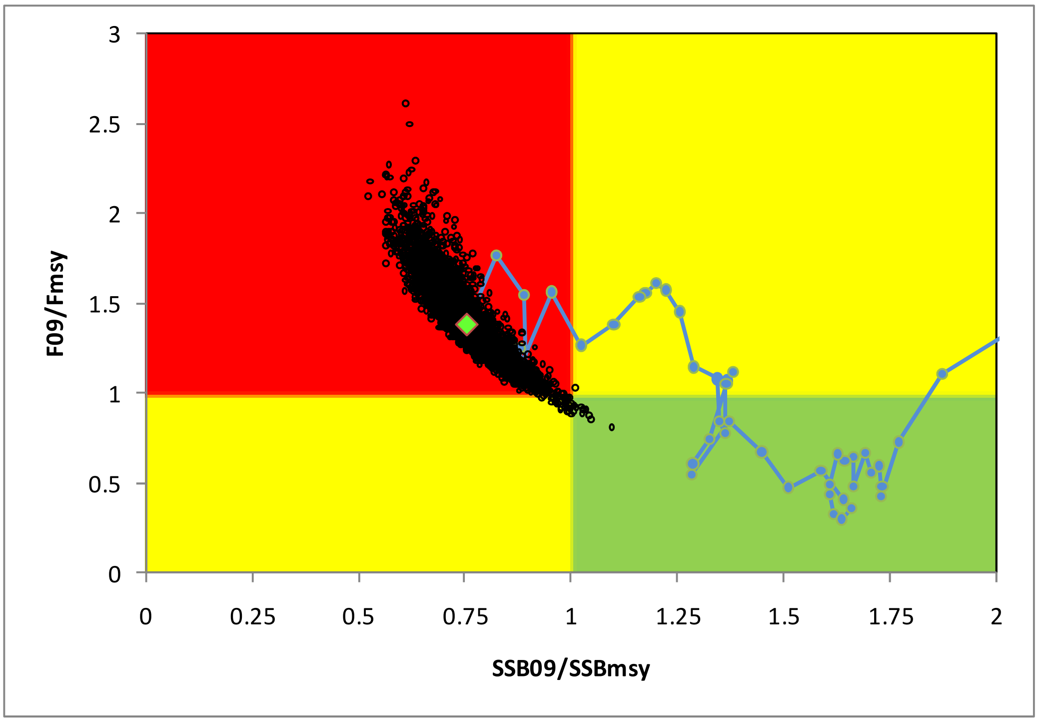


Figure 41. Phase plot for blue marlin from the base model in final year model assessment (2009). Individual points represent MCMC iterations, large diamond the median of the series. Blue circles with line represent the historic trend of the median F/F_{MSY} vr SSB/SSB_{MSY} 1965-2008.

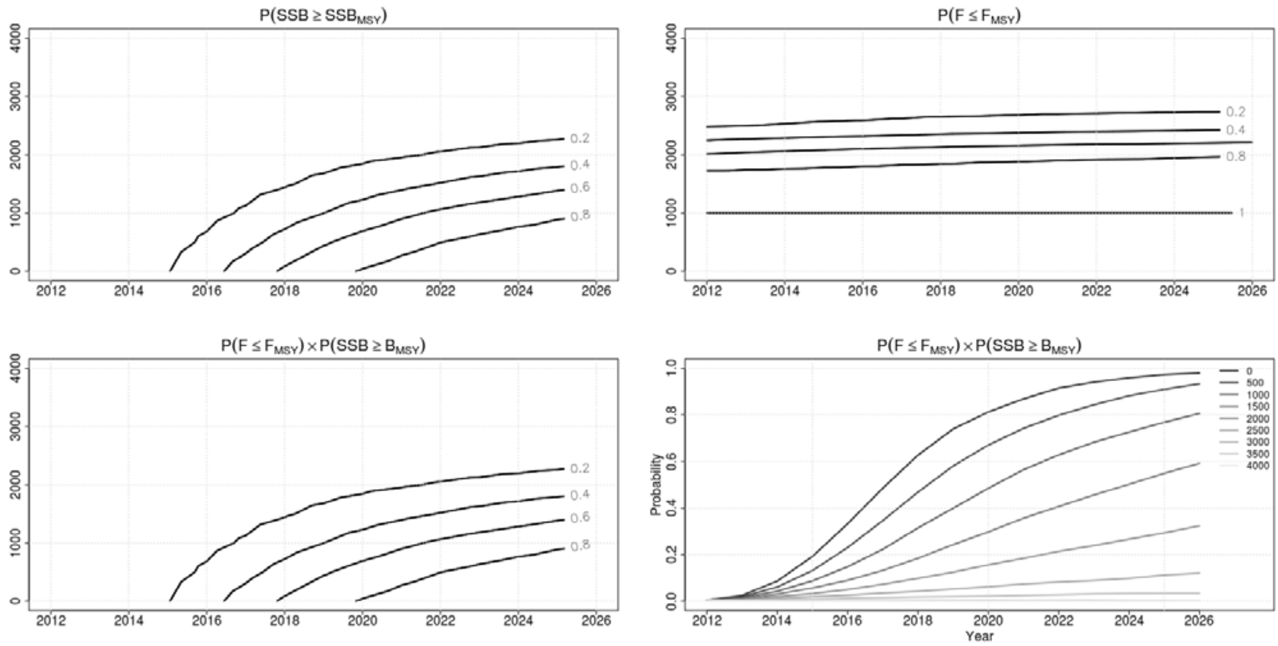


Figure 42. The probabilities of being in the quadrants of figure 7.4. Top left panel summaries by year and TAC the probability of the stock being not overfished (SSB≥SSB_{MSY}); top right the probability of not overfishing (F≤F_{MSY}), and the bottom left figure is the Kobe Strategy Matrix (K2SM) showing probability of the stock both being not overfished and overfishing not occurring. The final panel shows the same information as the K2SM but with TACs as lines and probability on the Y-axis.

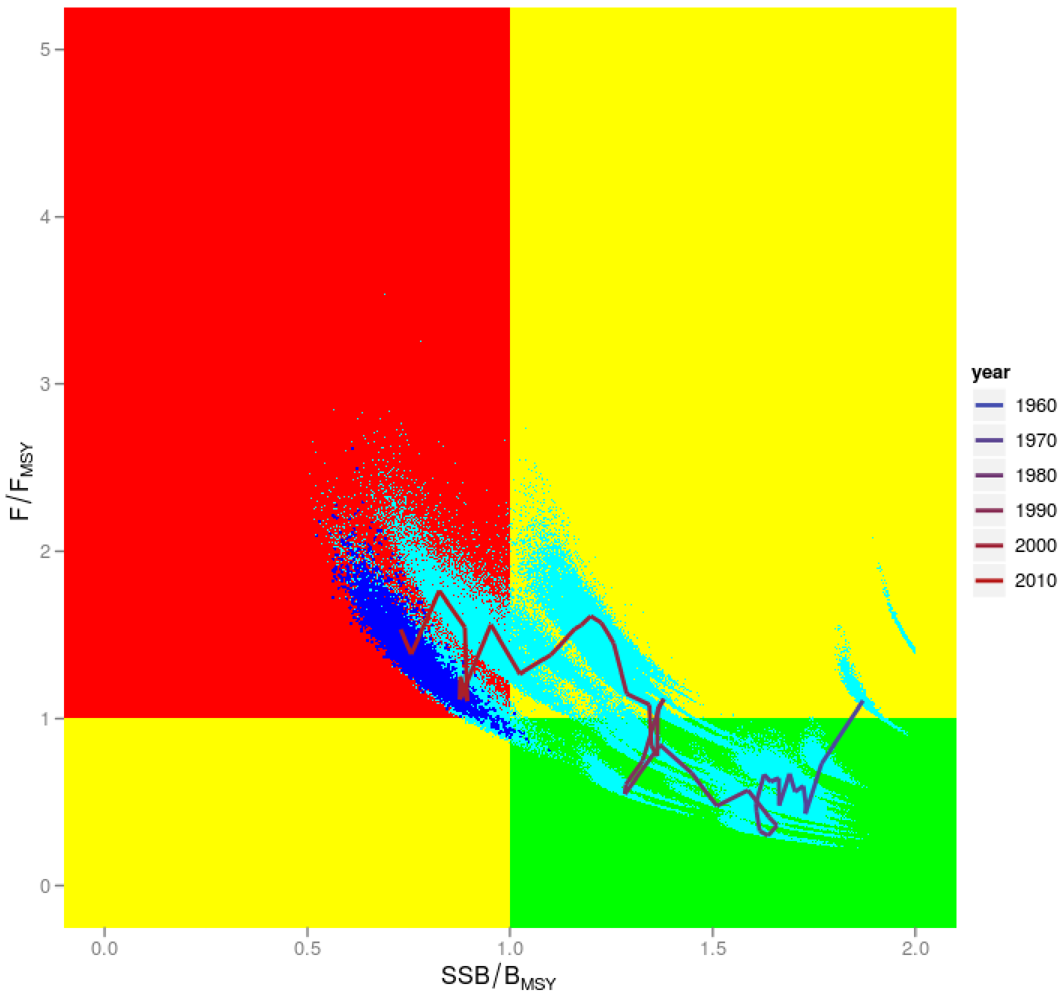


Figure 43. Kobe phase plot points show individual realisations from several models evaluated. Dark blue dots are the MCMC results from the SS3 base model, light blue dots represent bootstrap results from the surplus production models (ASPIC) under different assumptions of stock productivity. The line represents the median trend of the F/F_{MSY} *vs* SSB/SSB_{MSY} from the base model.

Appendix 1

AGENDA

1. Opening, adoption of agenda and meeting arrangements

2. Update of BUM basic information and review 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 WHM/spearfishes catch estimate
   3.1 Task I (catches)
   3.2 Task II (catch-effort and size samples)
   3.3 Catalogue of available information
   3.4 Other information

4. Review of biological, habitat, and tagging data for blue marlin and white marlin
   4.1 Biological data
   4.2 Habitat
   4.3 Tagging

5. Review of catch per unit effort series: blue marlin and white marlin
   5.1 Blue marlin
   5.2 White marlin

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

7. Evaluation of management scenario

8. Effects of current regulations

9. Recommendations
   9.1 Research and statistics
   9.2 Management

10. Other matters

11. Adoption of the report and closure

Appendix 2

LIST OF PARTICIPANTS

CONTRACTING PARTIES

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Appendix 3

LIST OF DOCUMENTS

SCRS/2011/021	Sex ratio at size of blue marlin (*Makaira nigricans*) from the Venezuelan fishery off the Caribbean sea and adjacent waters Arocha, F., Marcano, L., and Silva, J.
SCRS/2011/026	Captura, distribucion y composicion de tallas del aguja blanca, *Tetrapturus albidus*, observada en la flota de palangre uruguaya (1998-2010). Domingo, A., Forselledo R. and Pons, M.
SCRS/2011/033	Standardized catch rates for white marlin (*Tetrapturus albidus*) from the Venezuelan pelagic longline fishery off the Caribbean sea and the western central Atlantic: Period 1991-2010 Arocha, F. and Ortiz, M.
SCRS/2011/034	Catch rates for white marlin (*Tetrapturus albidus*) from the small scale fishery off La Guaira, Venezuela: period 1991-2010. Arocha, F, Barrios, A. and Marcano, L.A.
SCRS/2011/035	Observaciones sobre la aguja blanca (*Tetrapturus albidus*) a bordo de la flota española de palangre de superficie dirigida al pez espada, durante el periodo 1993-2010. Mejuto, J., García-Cortés, B. and Ramos-Cartelle, A.
SCRS/2011/043	Standardized CPUE of blue marlin caught by Japanese longliners in the Atlantic Ocean using GLM model. Kimooto, Ai and Yokawa K.
SCRS/2011/044	Standardized CPUE of white marlin caught by Japanese longliners in the Atlantic Ocean using GLM model. Kimooto, Ai and Yokawa, K.
SCRS/2011/045	Standardization of blue marlin (Makaira nigricans) CPUE for Taiwanese longline fishery in the Atlantic Ocean. Sun, C-L, Su, N-J and Yeh, S-Z.
SCRS/2011/046	Possible stock production models for blue marlin in the Atlantic Ocean up to 2009. Schirripa, M. and Babcock, E.
SCRS/2011/047	An evaluation of methods for standardizing catch rates of highly migratory bycatch species. Lynch, P.D., Shertzer, K.W., and Latour, R.J.
SCRS/2011/048	Preliminary analyses of simulated longline Atlantic blue marlin CPUE with HBS and generalized linear models. Goodyear, C.P. and Bigelow, K.A.
SCRS/2011/049	Length composition and spatiotemporal distribution of blue marlin *Makaira nigricans* in the South Atlantic Ocean. Frédou, T., Frédou, F.L., Hazin, F.H.V. and Travassos, P.
SCRS/2011/050	Standardized CPUEe series of blue and white marlins caught by Brazilian tuna longline fisheries in the southwestern Atlantic ocean (1980-2010). Hazin, H.G., Mourato, B., Hazin, F., Carvalho, F., Frédou, T., Travassos P. and Pacheco J.C.

SCRS/2011/051 Inter-annual variability in the proportion of roundscale spearfish (*Tetrapturus georgii*) and white marlin (*Kajikia albida*) in the western North Atlantic Ocean. Graves, J.E. and McDowell, J.R.

SCRS/2011/052 Preliminary studies on the possible influence of environmental factors on the catchability of the Blue marlins off the western coast of Ghana. Bannerman, P.

Appendix 4

STANDARDIZATION OF CATCH AND EFFORT DATA FROM THE ARTISANAL GILLNET FISHERY IN GHANA FOR BLUE MARLIN

During the meeting, the scientist from Ghana provided catch and effort information from the artisanal fishery that operates primarily with gillnets. The data included catch in tons of fish by month and the corresponding effort (number of day-trips) aggregated by month and year from 2000 to 2010. It also provided the average sea surface temperatures for the same period for the region where the fishery operates.

The Working Group suggested standardizing this catch and effort data. The standardization was done assuming a lognormal error distribution of the nominal catch rates. Initial plots indicated a no clear relationship between catch rates and month or season, neither with sea surface temperature (SCRS/2011/052). In the GLM model the seasonal information was included (quarter factor) and temperature as a continuous variable. The deviance table of the model (**Table APP 4.1**) shows that season and the interaction Year*season had no real statistical significance. The final model included the year, season and temperature as covariate. The diagnostic plots show not major departure from the GLM assumptions. The standardized index is shown in **Table APP 4.2** and **Figure APP 4.1** with estimated 80% confidence intervals.

Table APP 4.1. Deviance analysis table for explanatory variables in the GLM model for blue marlin catch rates from the GHANA small scale fishery. Percent of total deviance refers to the deviance explained by the full model; *p* value refers to the probability Chi-square test between two nested models.

Blue marlin Ghana Artisanal CPUE Index

Model factors positive catch rates values	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	.	172.927891			
Year	10	77.6956625	95.23	81.7%	< 0.001
Year Season	3	75.6611127	2.03	1.7%	0.565
Year Season Year*Season	30	56.33688	19.32	16.6%	0.933

Table APP 4.2. Nominal and standardized (with GLM) CPUE for blue marlin landed by the Ghanaian fishery.

Year	N Obs	Nominal C	Standard	Low	Upp	coeff var	std error
2000	12	4.42	4.06	2.48	6.63	24.9%	1.01
2001	11	4.57	5.54	3.34	9.19	25.7%	1.42
2002	12	3.36	3.91	2.39	6.39	25.0%	0.98
2003	12	2.86	2.73	1.65	4.51	25.6%	0.70
2004	12	1.31	1.13	0.65	1.96	28.0%	0.32
2005	12	2.21	2.31	1.39	3.83	25.8%	0.59
2006	12	1.46	1.38	0.80	2.36	27.6%	0.38
2007	12	1.92	1.05	0.60	1.84	28.7%	0.30
2008	12	0.16	0.24	0.11	0.56	44.0%	0.11
2009	12	0.21	0.25	0.11	0.58	43.1%	0.11
2010	12	0.45	0.42	0.21	0.83	35.7%	0.15

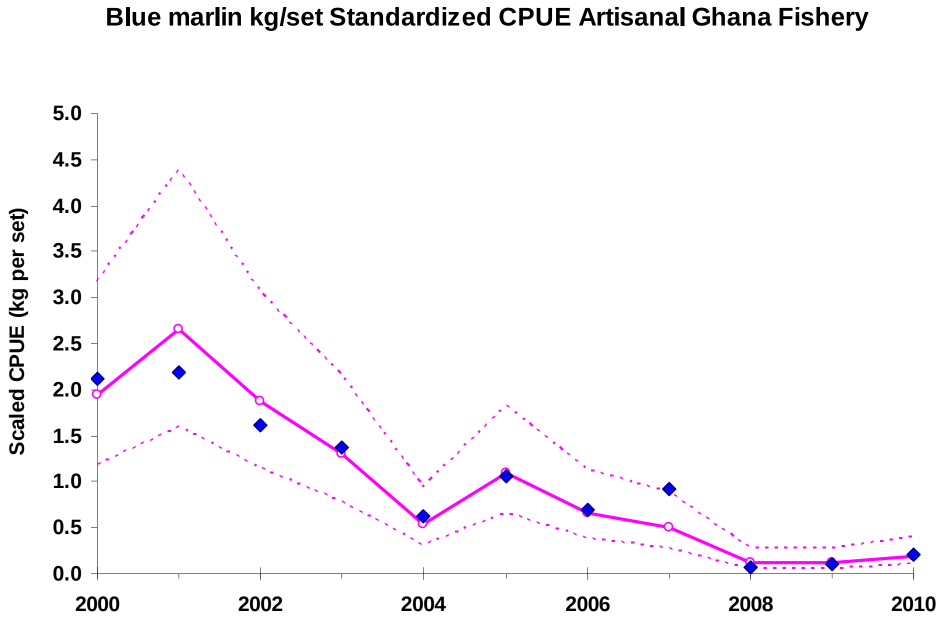

Figure APP 4.1 Nominal (filled diamonds) and standardized CPUE for blue marlin landed by the GHANA fishery. Dashed lines indicate 95% confidence limits of standardized values.

Appendix 5

DESCRIPTION OF THE BLUE MARLIN FULLY INTEGRATED MODEL

Introduction

In May 2010, the ICCAT Blue Marlin Data Preparatory Meeting was held in Madrid, Spain with the goal of updating the various data sets necessary to conduct a stock assessment the following year. The results of this meeting were summarized by the participants ("the Working Group") and are documented in Anon. (2011). The Working Group (WG) made a total of eleven recommendations, one of which will be addressed in this document:

> *5. The Working Group recommended to establish a protocol (web based) to continue progressing with the application of a statistically integrated assessment model that would take into consideration, seasonal catch, effort, size information for all gears, and the new geographical stratification proposed during the blue marlin data preparatory meeting.*

The model used catch, CPUE as revised during the meeting, and length data and where configured with four gear types, one area, and one season. Estimated parameters included virgin recruitment, stock-recruitment steepness, annual recruitment deviations, fishery and survey catchabilities, and gear specific selectivity parameters. This document will attempt to address Recommendation No. 5 and provides information on the fully integrated model configuration and results.

Data used in the fully integrated model assessment process (Figure APP 5.1)

- Catch partitioned into 4 gears (gill net, longline, purse seine, sport) (**Figure APP 5.2**).
- Estimates of growth (**Figure APP 5.3**)
- Maturity function (**Figure APP 5.4**)
- Sex ratio-at-length information from various studies (**Figure APP 5.5**)
- Length compositions for the gear types (**Figure APP 5.6**)
- Recreational releases (**Figure APP 5.7**)

Model configuration

The outline below is for the baseline model after group discussion and modification.

- Stock Synthesis version 3.20b
- Annual time step, 1 area, 2 sexes
- Natural mortality fixed at to 0.139
- Linf and CV of size-at-age of older fish (male and female) was freely estimated
- Virgin recruitment and steepness were freely estimated
- Recruitment deviations were estimated from 1980-2007 with constraints at -0.5 to 0.5
- Catchability for each of the four gears was assumed constant
- The descending limb of the selectivity for longline and sport was fixed asymptotic, while gillnet was estimated
- Inflexion point of the ascending limb of the sport selectivity was time varying and fixed to match the regulations, but the asymptote was freely estimated
- Release mortality for the discarded fish from the sport fishery was assumed to be 5 percent.
- Lambda on catch, discards, and CPUE were set to 1.0; lambdas on the length compositions and sex ratio data were set to 0.1.

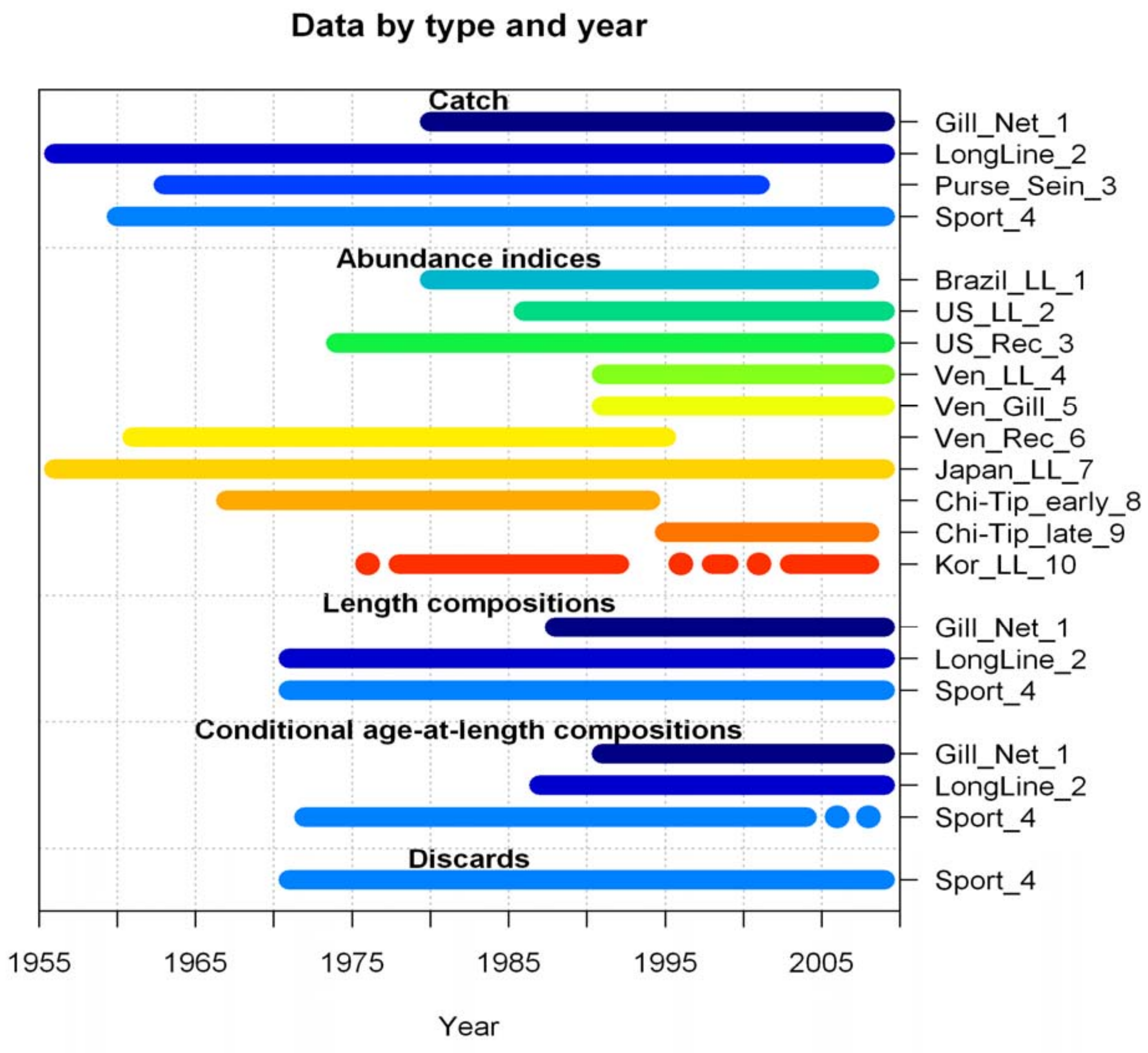

Figure APP 5.1. Data sets by type and gear considered in the statistically integrated model for Atlantic blue marlin**.**

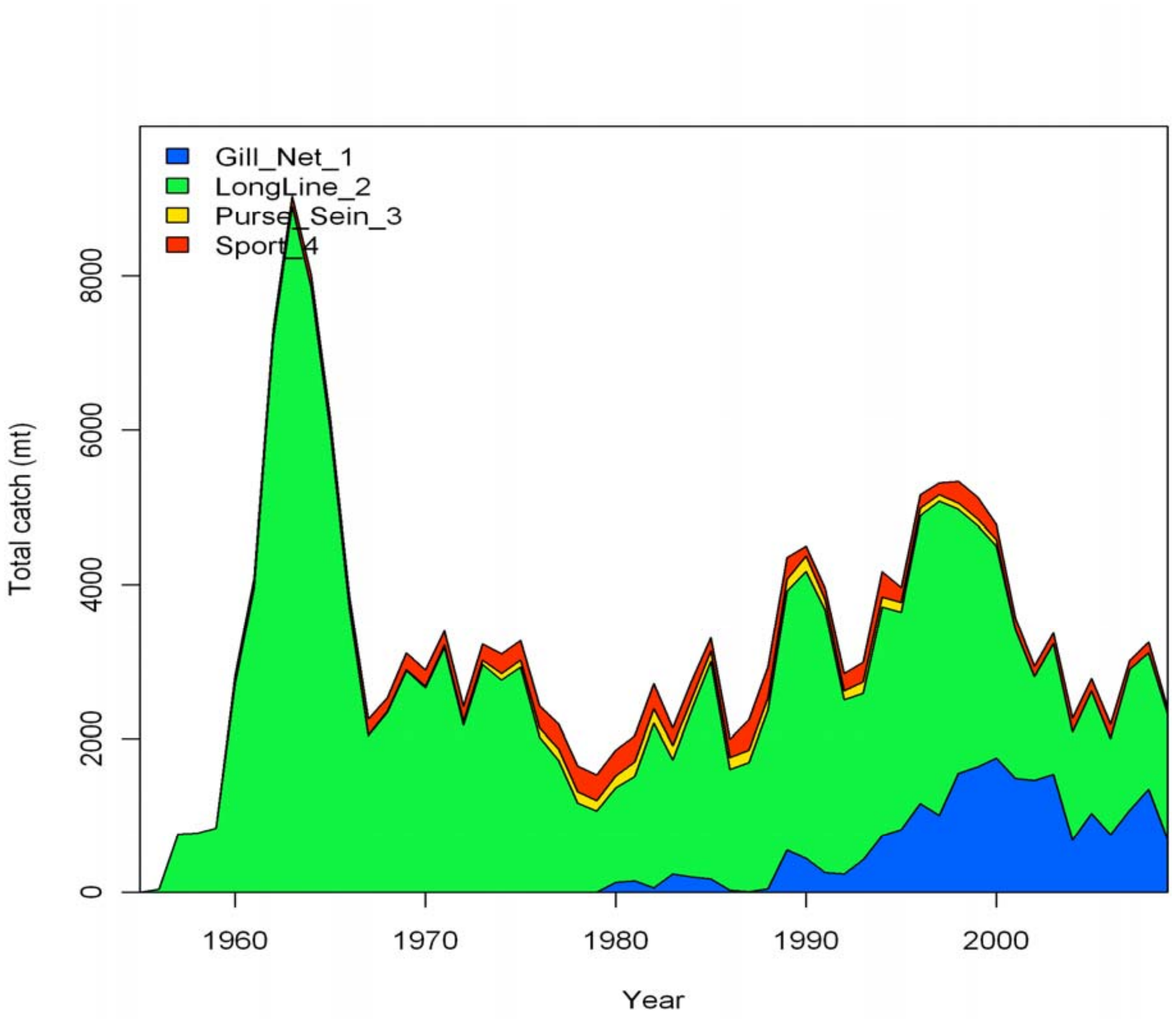

Figure APP 5.2. Landings by the four different gear types considered in the statistically integrated model for Atlantic blue marlin.

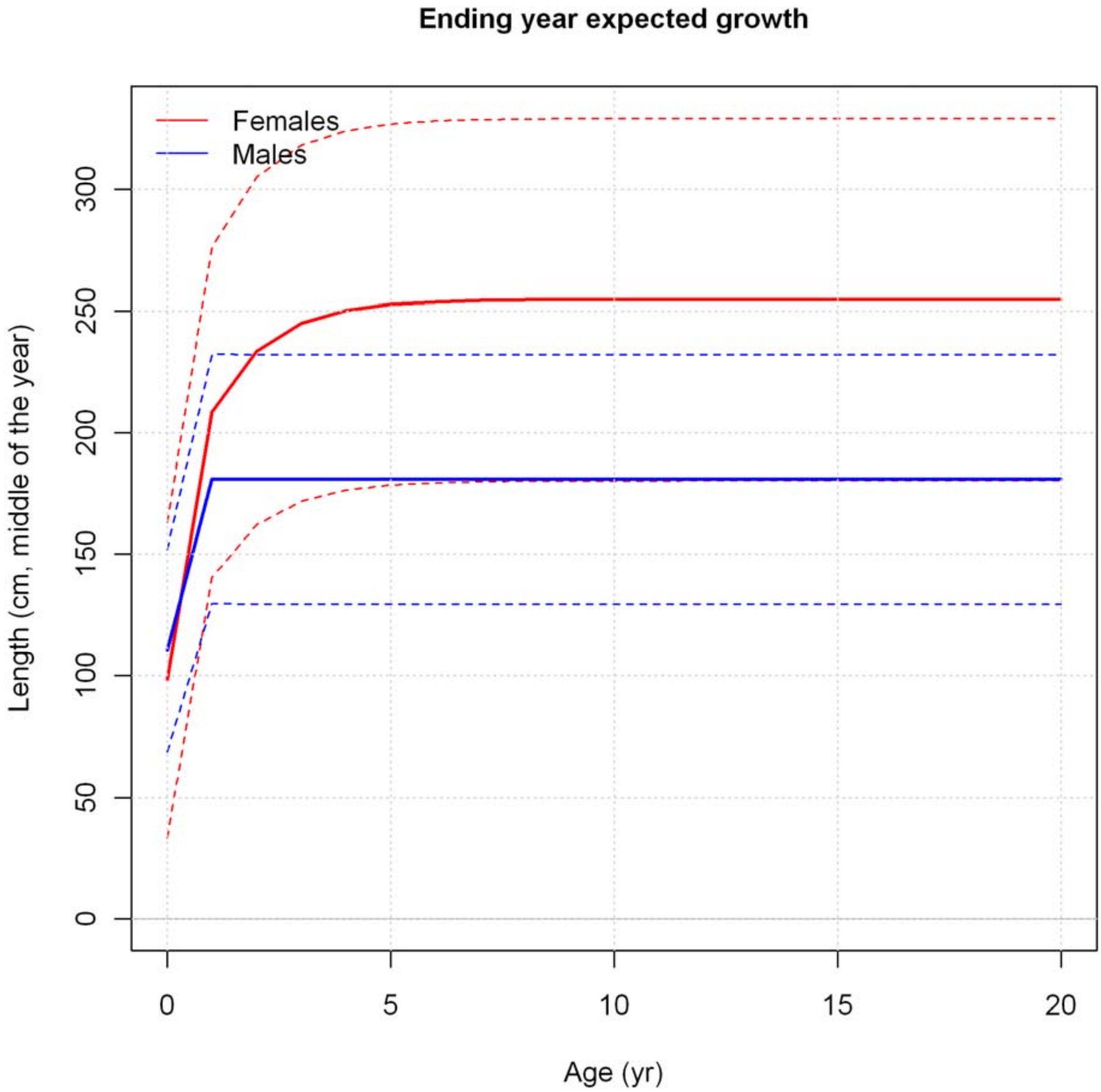

Figure APP 5.3. Sex specific growth curves used and estimated in the statistically integrated model for Atlantic blue marlin.

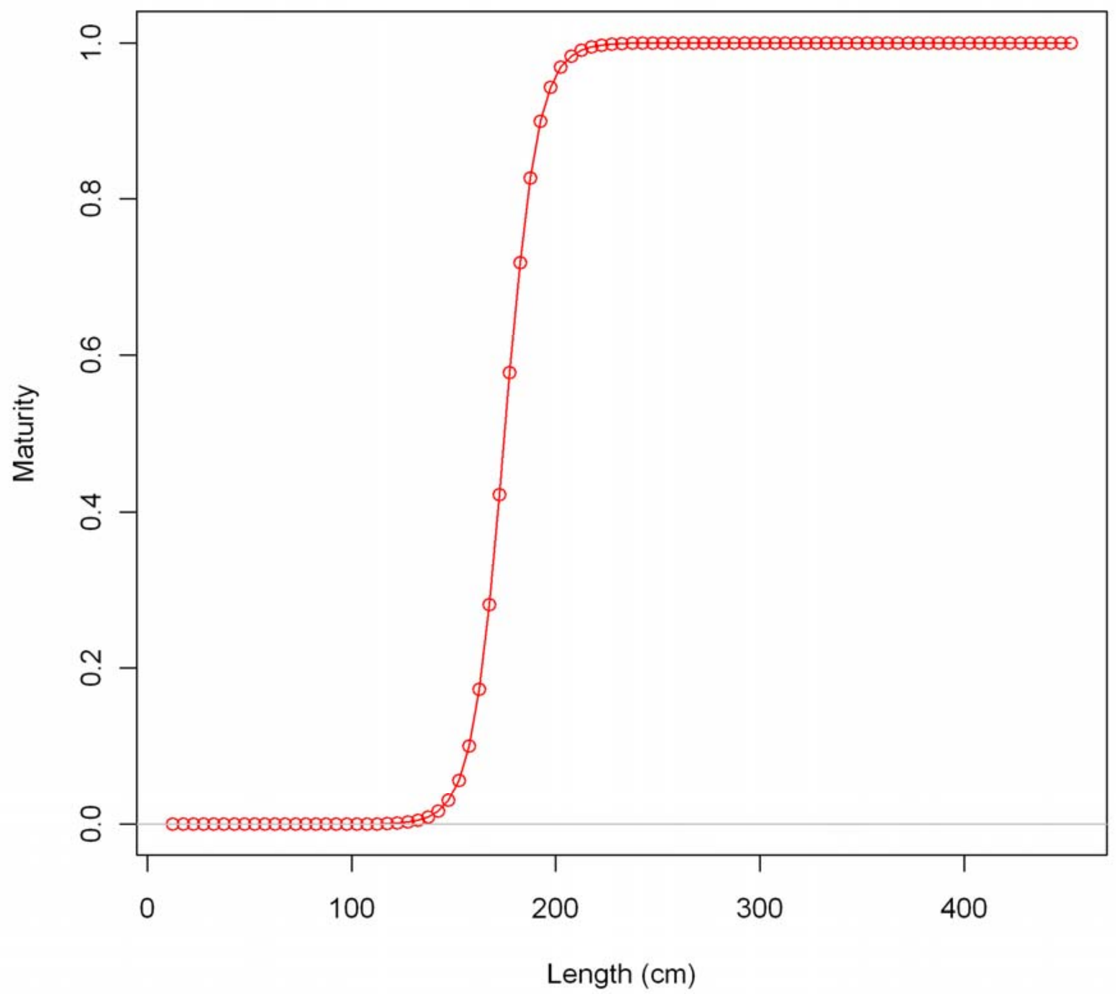

Figure APP 5.4. Female maturity function used in the statistically integrated model for Atlantic blue marlin.

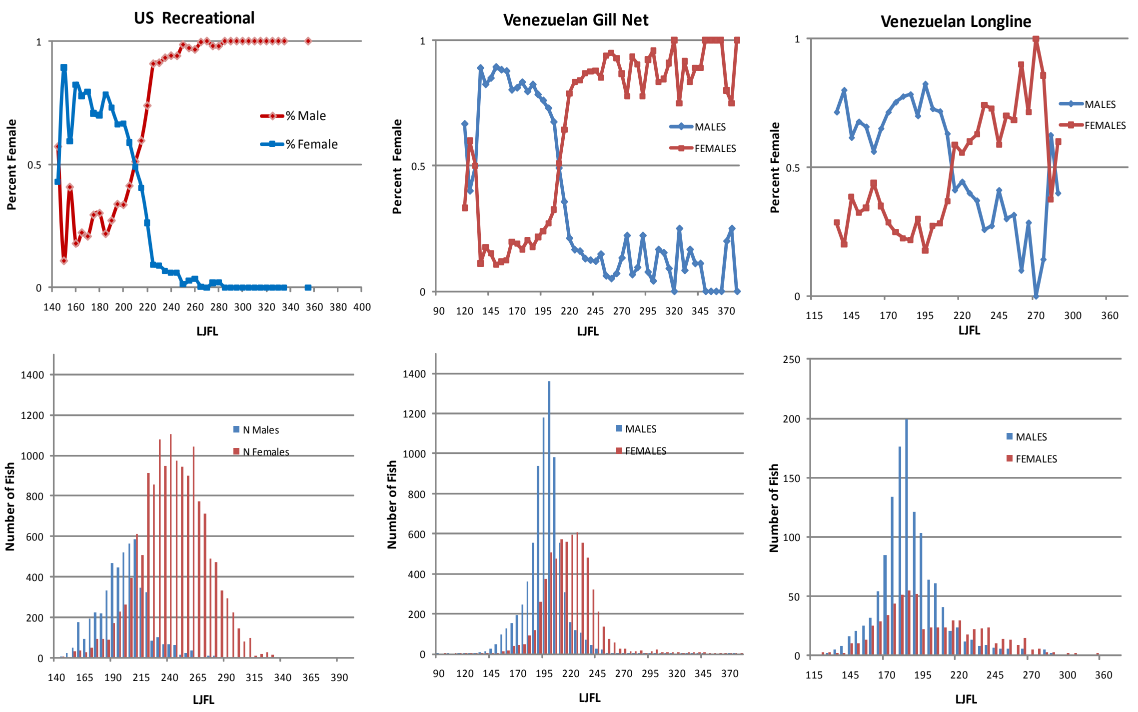

Figure APP 5.5. Observed sex ratios by length (top row) and associated sample size (bottom row) considered in the statistically integrated model for Atlantic blue marlin**.**

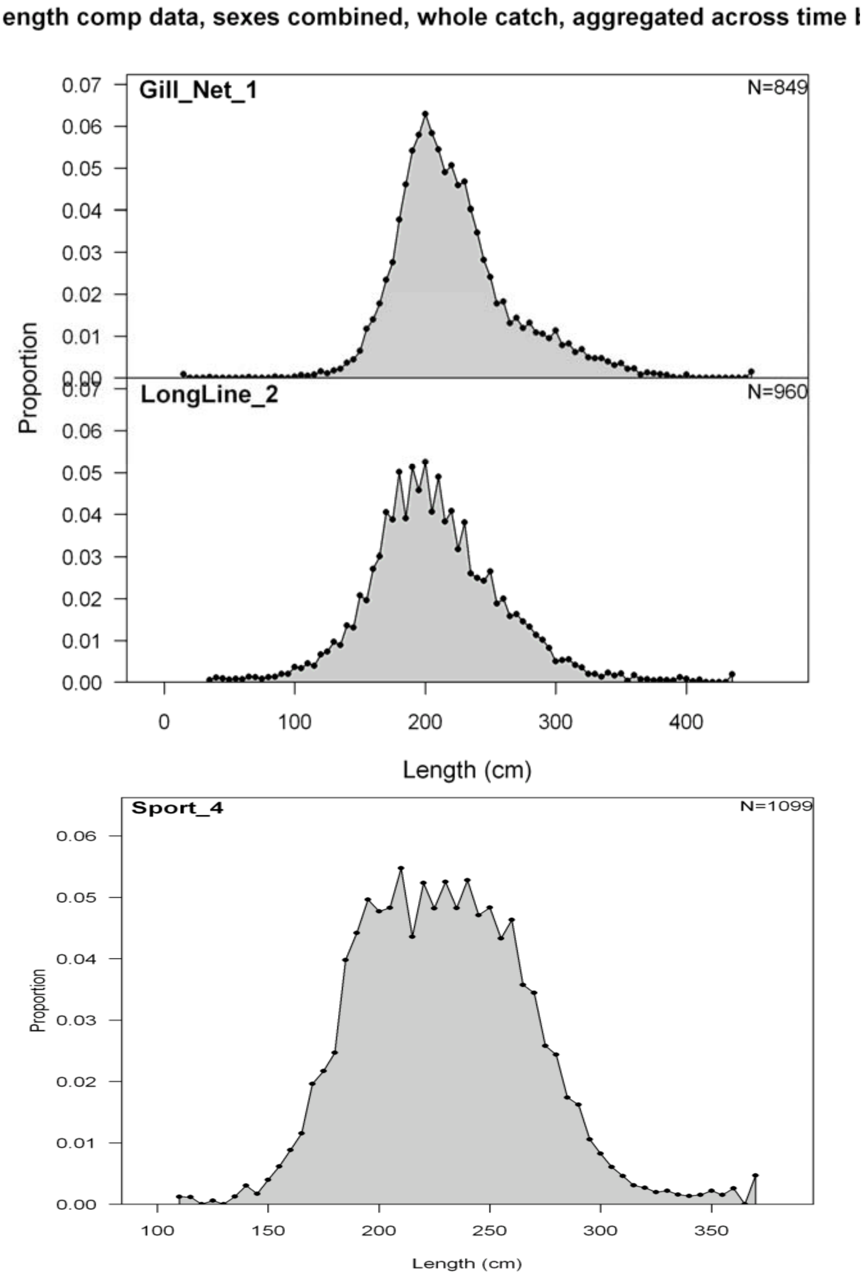

Figure APP 5.6. Length compositional data for three of the four gears considered in the statistically integrated model for Atlantic blue marlin. No lengths were available for purse seine gear.

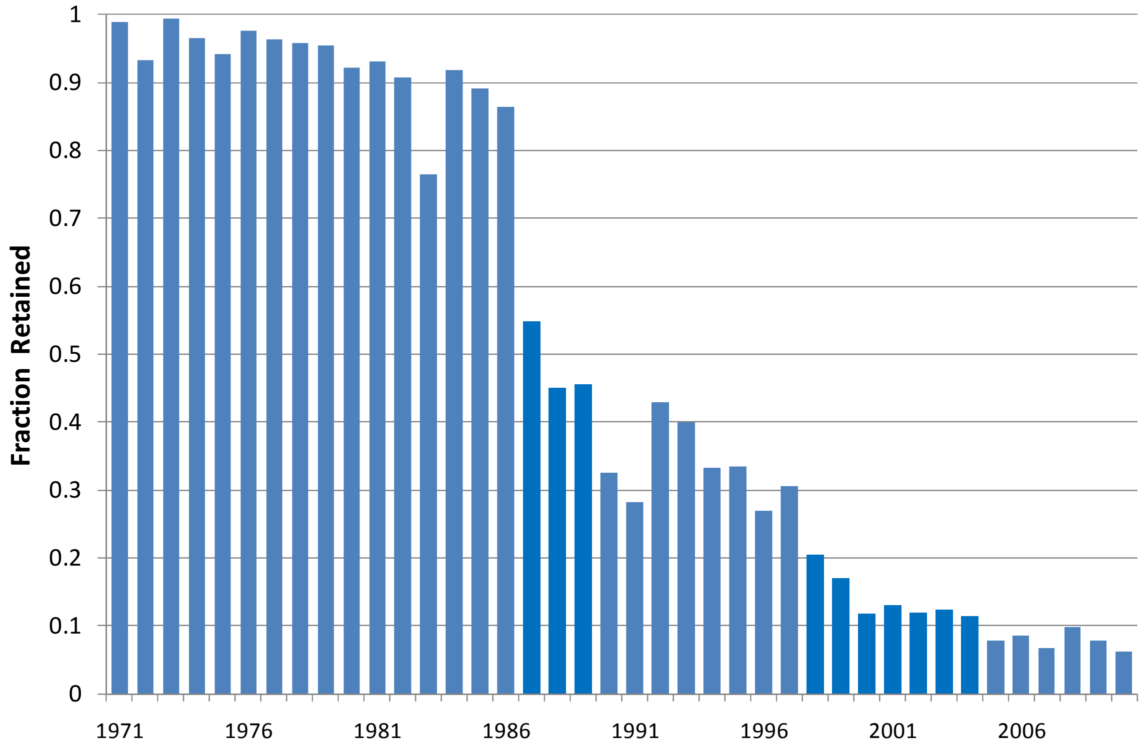

Figure APP 5.7. Fraction of blue marlin retained from the US recreational fleet for Atlantic blue marine according to the Recreational Billfish Survey**.**