Annex 5

REPORT OF THE BILLFISH WORKING GROUP WORKSHOP

International Scientific Committee for Tuna and Tuna-like Species
In the North Pacific Ocean

6-16 December 2011
Honolulu, Hawaii, USA

1.0 INTRODUCTION

An intercessional workshop of the Billfish Working Group (BILLWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) was convened in Honolulu, Hawaii, USA from 6-16 December 2011. The goals of this workshop were to: (1) conduct assessment of the Western and Central North Pacific (WCPO) striped marlin stock, (2) begin preparation for a blue marlin stock assessment, and (3) develop a plan to update North Pacific swordfish stock assessment.

Jon Brodziak, Chairman of the BILLWG, welcomed participants from Chinese Taipei, Japan, Korea, the Secretariat of the Pacific Community (SPC), and the United States of America (USA) (Attachment 1). The Chairman noted that no representatives were present from Canada, China, Mexico, or the Inter-American Tropical Tuna Commission (IATTC).

2.0 ADOPTION OF AGENDA AND ASSIGNMENT OF RAPPORTEURS

Rapporteuring duties were assigned to Yi-Jay Chang, Gerard DiNardo, Simon Hoyle, Russell Ito, Lyn Katahira, Minoru Kanaiwa, Ai Kimoto, Hui-Hua Lee, Jae-Bong Lee, Soo Jeong Lee, Naozumi Miyabe, Kevin Piner, Nan-Jay Su, Chi-Lu Sun, Darryl Tagami, Su-Zan Yeh, and Kotaro Yokawa. Lyn Katahira served as the lead rapporteur with overall responsibility of assembling the workshop report. The meeting agenda was adopted (Attachment 3).

3.0 COMPUTING FACILITIES

Computing facilities included a website for distribution of working papers and other meeting documents and information and also included Wi-Fi wireless network access point to connect to the Internet.

4.0 NUMBERING OF WORKING PAPERS AND DISTRIBUTION POTENTIAL

Working papers were distributed and numbered (Attachment 2). The working papers that were agreed to be posted on the ISC website where they will be available to the public were: ISC/11/BILLWG-3/01, ISC/11/BILLWG-3/02, ISC/11/BILLWG-3/03, ISC/11/BILLWG-3/04, and ISC/11/BILLWG-3/06. The working paper that will not be posted on the ISC website was: ISC/11/BILLWG-3/05 pending approval from the author's organization (Attachment 2). The availability for public posting of ISC/11/BILLWG-3/05 will be revisited at a later date.

5.0 STATUS OF WORK ASSIGNMENTS

The assignments that stemmed from the May 2011 ISC BILLWG workshop were as follows:

- Submit all outstanding catch, standardized catch-per-unit effort (CPUE), and size composition data for the striped marlin stock assessment by June 30, 2011 to the Billfish WG Chair.
- Finalize all working papers submitted at this meeting by June 30, 2011.
- Revise striped marlin catch data table (i.e. Table 1) to reflect new catch data provided at May 2011 BILLWG meeting.

The ISC Chair reported that the BILLWG completed all assignments.

The Chairman was also given an assignment at the May 2011 ISC BILLWG workshop:

- ISC BILLWG Chair will inquire with the STATWG about data for mapping fishing effort.

The ISC Chair reported that he had completed this assignment.

6.0 ANNUAL BILLFISH CATCH AND EFFORT

Three working papers on the topic of annual billfish catch and effort were presented to the WG. The WG reviewed the working papers and discussed the presentations by Ito, Miyabe, and Tagami.

6.1 U.S. Commercial Fisheries for Marlins in the North Pacific Ocean presented by Russell Ito (ISC/11/BILLWG-3/05)

This working paper presents summaries for U.S. commercial fisheries that catch marlins (Istiophoridae) in the North Pacific Ocean. The two largest fisheries for marlins were the Hawaii longline fishery and the small boat troll fishery; primarily located in Hawaii. A brief description of the gear and techniques for each fishery is covered. Blue marlin (*Makaira nigricans*) and striped marlin (*Kajikia audax*) were the dominant components of the commercial marlin catch. Nominal longline CPUEs for both blue and striped marlins were on a declining trend. Though the longline fishery covered a larger area of fishing compared to the troll and handline fisheries, the latter fisheries landed larger marlins than the longline fishery in 2010.

<u>Discussion</u>

The WG noted that the Hawaii longline fishery area of operation is limited due to the vessels being relatively small compared to distant-water longline vessels and because the fishery provides fresh fish, and not frozen product. It was noted that in this working paper, the nominal marlin CPUE time series was produced using the deep-set sector of the Hawaii longline fishery and that a CPUE time series for the shallow-set sector may be produced but there are time periods where data is unavailable due to certain management measures. It was suggested that a table be produced with CPUE values. It was also noted that it is difficult to integrate state catch and dealer data because the troll size data and handline size data is hard to differentiate. The WG noted a strong catch of juvenile striped marlin in the Hawaii longline fishery during early 2011. It was also noted that in general, marlin catches were on a declining trend in the Hawaii longline fleet, while deep pelagic species seemed to be on an increasing trend over time.

6.2 Japanese Longline Catch Distribution of Striped Marlin in the North Pacific between 2001-2009 presented by Naozumi Miyabe *(presentation and maps were distributed)*

Miyabe provided Japanese longline catch distribution in number of fish of striped marlin in the north Pacific by each 10 degree square, between 2001 and 2009. During the early 2000, good catches were recorded in the offshore area between 35° N and 40° N as well as the around 10° N and 20° N. However, as time goes, catches became sporadic and reduced. These distributions information may be important when considering management issues.

Discussion

The presenter noted that the number of small vessels (<10 gross registered tons (GRT)) were increasing in the Japanese longline fishery. The WG noted that the striped marlin catches tended to be high during quarter 4. It was also noted that there was a sudden drop in longline catch from 2005 onward.

6.3 Spatial Distribution of Striped Marlin, Longline Catch and Effort Data from WCPFC presented by Darryl Tagami *(presentation only)*

Spatial distribution of striped marlin catch and effort from longline data was presented through 30 GIS maps of the Pacific Ocean. The plots also separated the data by Areas 1, 2, and 3. The data for Japan (1950-2010), Taiwan (1958-2010), U.S.A. (1994-2010), and Korea (1975-2010) were obtained from the Western and Central Pacific Fisheries Commission (WCPFC). Summary statistics for each map plot provided the total sum of catch and effort, mean annual catch and effort, and nominal CPUE. There was a general decline in catch, effort, and CPUE for the Japanese longline fishery from 1950-2010. It was suggested that there was a similar decline in catch and CPUE for the Taiwanese longline fishery from 1958-2010, except the effort continued to increase over time.

Discussion

The WG questioned the species identification of striped marlin because of the abnormally high striped marlin catches near the equator as well as the high CPUE of striped marlin in the tropical area (<10° N) in the Korean longline fishery. It is possible that blue marlin may be mistaken for striped marlin. It was suggested to contact the WCPFC regarding this issue. It was also suggested to compare logbook data with observer data to resolve this issue. The WG clarified that the Taiwanese longline effort has declined after 2005.

It was suggested that the WG consider examining longline data from Indonesia, Philippines, and Vietnam. However, the Philippine longline fleet is currently very small, and the data from these countries are questionable. Vietnam may be able to provide some useful data when their data collection system improves. Total cumulative catches from the above countries could be in the range of 10-30 mt.

7.0 WCPO STRIPED MARLIN STOCK ASSESSMENT DATA INPUTS

One working paper on the topic of WCPO striped marlin stock assessment data inputs was presented to the WG. The WG reviewed the working paper and discussed the presentation by Brodziak.

7.1 Patterns in Catches, Standardized CPUEs, and Fishery Length Compositions of the Western and Central North Pacific Striped Marlin Stock presented by Jon Brodziak (ISC/11/BILLWG-3/04)

This working paper depicts patterns in the catch of the Japanese distant water longline fleet (JDWLL), the standardized catch per unit effort estimated by fleet and by area where appropriate for the current assessment, and the length composition data available for the current assessment of the western and central North Pacific Ocean striped marlin stock. There were a total of 59 graphs showing the temporal patterns of catch, standardized CPUE, sample sizes of length frequency data, and length composition by fleet. The reported catch of WCPO striped marlin in numbers of fish harvested by the JDWLL fleet in all stock areas showed a declining trend since the 1960s. The reported quarterly catch of WCPO striped marlin in numbers of fish harvested by the JDWLL fleet in also showed variation occurs across quarters of the year. The average quarterly mean fish weights of WCPO striped marlin of fish harvested by the JDWLL fleet in also showed variation occurs across quarters of the year since 1975 when annual estimates of mean weight were available. Trends in standardized JDWLL CPUE showed inter-annual variability and various temporal patterns but the standardized JDWLL CPUE series by assessment area all showed a consistent declining trend in the 2000s. Overall, the number of moderate to strong positive correlations among CPUE time series increased from the 1975-1986 assessment time period to the 2000-2009 assessment time period. Plots of sample size by fleet showed that most of the available data were collected from the JDWLL fleets in areas 2 and 3 and the JCLL fleet with some additional samples collected from JDWLL in all areas during 1970-1974 and in area 1 during 1975-2009, also collected from the USA since the mid-1990s. Overall, the available length compositions showed that the mean length of sampled striped marlin varied on a quarterly and annual basis by fishing fleet.

Discussion

The working group discussed the correlations suggested by the working paper and indicated in the working group document uploaded to the website. The presenter suggested that there were positive correlations between different CPUE time series which indicates a similar pattern of trend in population abundance.

The working group discussed the average fish weight from the Japanese distant-water longline between 1952 and 1975 which appeared constant for all areas combined (WP-4, Figures 17-20). The presenter suggested that the average fish weight during 1952-1970 appeared constant because the estimates were derived from the available data during 1971-1975.

The working group discussed the pattern of increase of the average size of the Japanese longline fisheries in Area 1, which may be due to a change in fishing practice in this area. However, no specific information is available for the argument.

8.0 WCPO STRIPED MARLIN ASSESSMENT MODELING

Four working papers on WCPO striped marlin assessment modeling were presented to the WG. The WG reviewed the working papers and discussed the presentations by Piner and Lee, Su, Chang, and Kanaiwa.

8.1 Preliminary Striped Marlin Stock Assessment presented by Kevin Piner and Hui-Hua Lee (ISC/11/BILLWG-3/01)

This paper takes new life-history parameters and updated data time series of Western Central Pacific Ocean striped marlin data and incorporates that information into a length-based age structured Stock Synthesis model (V.3.20b). Data were available from 19 individual fleets from 1952-2010, however the most reliable data was available from 1975 to present. Major structural assumptions for the model included: single area, annual time-step with observed data fit quarterly, at least one fishery assumed to have asymptotic selectivity, time varying selectivity patterns for Japanese longline fleets, season 3 (summer) spawning with mean recruitment governed by a Beverton-Holt spawner recruit function. The objectives of the paper were to develop a Stock Synthesis model that attempted to reduce data conflict by 1) using appropriate model structure, 2) selective use of consistent CPUE series and 3) iterative re-weighting to model expected variances of composition and CPUE likelihood components, if needed.

Preliminary analyses demonstrated that changing the minimum observation size bin from 55 cm to 120 cm removed the influence of misfit to the size comp of age 0 fish. We also showed that assumptions of a single time invariant growth function and annual variability in recruitment level were not sufficient to explain the variability observed in size information corresponding to age-0 fish. In addition, separating the Japanese harpoon fishery into two seasonal fisheries reduced the influence of a strong seasonal pattern in fish size taken in that fishery. We also performed cross-pair analyses to examine which fishery was most consistent with the assumption of an asymptotic selectivity pattern. This analysis indicated that the early Japanese other and driftnet fisheries consistently produced the best fitting model when specified as asymptotic fisheries. We also separated CPUE series into two groups based on consistency of series determined running the model with each likelihood component sequentially removed from contributing to the fitting. Consistency of CPUE series was evaluated through examining which likelihood components improved or degraded with the removal of another likelihood component. Based on this analysis we postulated that the Japanese distant water longline fisheries from 1975-present and the Hawaiian longline CPUE series were the most consistent abundance indices in the model. Although some CPUE series were available beginning in 1952, the initial year of the preferred model was 1975 when more complete fishery data became available. Starting the model in 1975 also allowed us to examine initializing the model without strong equilibrium assumptions. We showed that starting year and the assumption about the initial equilibrium conditions did not have a strong influence on model results. Profiling across fixed values of unfished recruitment (R0) showed that starting the model in 1975, with internally consistent CPUE, minimum size bins of 120 cm and splitting the Japanese Other fishery into two seasonal fisheries resulted in a model with minimal data conflict and a reasonably well defined solution.

Discussion

Clarification was sought regarding the striped marlin growth model used in the assessment. It was pointed out that the current growth model comes from a recent analysis by Sun et al. (2011) and that this model was reviewed and adopted for use in the assessment at a previous Billfish WG Workshop. There was agreement that sampling of length and weight data, as well as hard parts for aging should continue, and that the growth models should be updated accordingly. The biological studies of striped marlin should cover a large area of the North Pacific to improve the life history information and advance our understanding of the striped marlin population dynamics. It was recommended that additional sampling for biological data be conducted under the umbrella of the ISC Biological Sampling Program. The WG pointed out the need for maps delineating the spatial extent of all fisheries, and map overlays indicating where length samples were collected. CPUE maps would also be helpful to interpret interactions between fisheries. The WG checked the consistency of the data used in the stock assessment, which was clarified using the information from the likelihood profiles. The WG discussed the treatments of the datasets used in the assessment, such as the choice of CPUE series (Set 1 or Set 2) and starting time of the model (1952 or 1975). Clarification on the assumed maturity ogive was provided, and the WG requested to see how changing the maturity ogive would affect the assessment results. The temporal changes in catchability (q) for the some of the fisheries seemed unreasonable (approaching 60%) and further investigation was recommended. For this assessment it was clarified that effective sample size was computed as the input length composition sample size divided by 10 for all longline fisheries, which was suggested by a previous study conducted on the Hawaiian longline fishery (pers. comm. Dean Courtney, PIFSC). Additional testing was requested to understand the sensitivity of model results to this assumption.

8.2 Stock Assessment of Striped Marlin *(Kajikia audax)* in the Western and Central North Pacific Ocean Using an Age-Structured Model presented by Nan-Jay Su (ISC/11/BILLWG-3/02)

Based on the two-stock scenario of population structure, an age-structured population dynamics model was fitted to catch, catch-rate, and length-frequency data for the WCPO stock of striped marlin in the North Pacific Ocean to examine the current status of this population. Striped marlin CPUE and length frequency data from Japanese, Taiwanese, and Hawaiian fisheries were included in the analyses. Results indicated that the current spawning stock biomass (S2009) was at a low fraction of its unfished level and below the MSY level, and that the current fishing intensity (F2009) exceeded the level to maintain MSY. However, there was considerable uncertainty regarding the assessment results because of the conflict between the CPUE series and size composition data when fitting the model using all available data.

Discussion

It was noted that the dynamics of recruitment appeared to be similar to that observed in the SS3 model. It was noted that each of the modeled fisheries was assumed to have asymptotic selectivity and it was suggested that sensitivities assuming dome-shaped fishery selectivity be conducted. It was pointed that the Japanese coastal longline and driftnet fisheries received higher weightings than other fisheries and that this was done to improve the fit to the CPUE trends. The impact of starting the model in 1975 was discussed and recommended to provide a basis for comparisons with the SS3 model. The WG requested to see the effect of changing the starting year of the model to 1975. The requested model run was completed and the presenter showed that the stock assessment results were similar to the results with SS3 when the model was started from 1975.

8.3 A Sensitivity Study of Age-Structured Production Model (ASPM) for Striped Marlin *(Kajikia audax)* in the Western and Central North Pacific Ocean presented by Yi-Jay Chang (ISC/11/BILLWG-3/06)

This working paper evaluated the impacts of uncertainty about recruitment variation, size-at-age, maturity, natural mortality rate, and stock–recruitment steepness on the population dynamics and management-related quantities for striped marlin (*Kajikia audax*) in the western and central North Pacific Ocean using an age-structured production model. The results suggested that annual recruitment variation was important for characterizing the temporal trend of population abundance. Incorporation of recruitment variation led to a better fit of the assessment data. Estimates of virgin biomass and biological reference points were found to be more sensitive to the uncertainty in natural mortality and steepness in comparison to other life history parameters such as age-at-length and the maturity ogive.

Discussion

It was clarified that the value of steepness (h) used in the sensitivity analyses was h=0.87; this value was adopted at a previous Billfish WG Workshop. It was pointed out that the analyses appeared to rely on a single CPUE series from the JDWLL, despite the fact that three were provided. It was pointed out that the JDWLL CPUE series from Area 3 was used in this model because the catchability was high for that series.

8.4 Estimated Stock Dynamics of North West Pacific Striped Marlin by Using a Stock Production Model Incorporating Covariates (ASPIC) presented by Minoru Kanaiwa (ISC/11/BILLWG-3/03)

An analysis of striped marlin stock dynamics in the North West Pacific Ocean by using A Stock Production Model Incorporating Covariates (ASPIC, Prager 1994) was conducted. Five time series of stock abundance and fishery catches were used in the analysis. These were the Japanese distant water longline, the Japanese coastal longline (JCLL), the Japanese driftnet (JDN), the Taiwanese longline (TWLL) and the Hawaii longline (HWLL). Negative correlations between the JDWLL, JCLL and HWLL series and the JDN and TWLL series were detected. Three assessment model scenarios were constructed; each scenario assumed a different set of weighting factors for CPUE. Under the equal weights model, the estimated time series of stock biomass decreased from an initial value of 2.5 times of Bmsy to 0.8 times Bmsy, while estimated fishing intensity increased from 1.4 times of Fmsy to 2 times Fmsy. Under the down-weighting of JDWLL, JCLL and HWLL CPUE scenario, the results became more optimistic with higher biomasses and lower fishing mortality rates than under the equal weighting scenario. In contrast, the results under the down-weighting of JPDN and TWLL CPUE scenario were more pessimistic. In conclusion, there were two sets of relative abundance indices whose annual trends were contradictory to each other. Thus, estimated striped marlin biomass was strongly influenced by the choice of weighting factors for the CPUE time series.

Discussion

The presenter noted that the decreasing biomass trend was similar with estimated biomass trends from other models. The WG sought clarification on the CPUE series used in the analysis and how they were derived. The WG noted that area-weighting factors were used to combine the CPUE series for the Japanese distant-water longline fishery. It was recommended that observed and predicted values of standardized CPUE be provided and that residual plots be constructed. The WG requested that the estimated values intrinsic growth rate and carrying capacity be provided. It was clarified that data were fit using a Pella-Tomlinson model.

It was noted that the estimated value of the shape parameter was not provided and the WG requested estimates of B_{MSY} and carrying capacity be provided to allow its computation. The presenter subsequently provided the requested information to the WG for review.

8.5 Model Sensitivity Analyses and Model Selection

The WG developed a set of questions and associated model sensitivity analyses by consensus to select a base case, or most reliable, stock assessment model configuration. A suite of model sensitivity runs were conducted to gauge the influence of various parameter estimates and assumptions on model fits. Each sensitivity model run addressed a specific question and model runs were prioritized based on importance. It should be noted that the vast majority of model sensitivity runs focused on the SS3 model, as this was the agreed modeling platform for the assessment. The sensitivities were used to identify the structure of the base case model (i.e., which CPUE series to include) for deriving stock status and conservation advice. The requested model sensitivity runs and associated results in the order they were requested follow. The ordering of these analyses reflected the WG’s prioritization.

8.5.1 Model Sensitivity Analyses – Initial Set

1. What CPUE series should be included in base case, or set of base case models?

   Assuming that CPUE set 1 (JDWLL CPUE in areas 1, 2, and 3, and Hawaii longline CPUE) is the initial set of CPUE indices for assessment, sequentially add in additional CPUE. Model diagnostics included goodness of fit to CPUE series and length compositions as well as likelihood profiles. Results of this analysis indicated that the addition of more CPUE series to set 1 produced no measureable improvements to the fits in CPUE and length composition data (Appendix 1).

2. Are the observed changes in the JDWLL catchability coefficients (q) from the model 4 scenario in WP-1 plausible? If not what can be done to improve the model fit to the data (WP-1; Figure 10)? Would the estimation of a more flexible time-varying selectivity process for JDWLL Areas 1 and 2 alter the interpretation of q in those fisheries?

   The WG discussed possibilities for the large temporal changes in q and identified potential causes. In particular, the WG believed that there were changes in fishing practices within area 3 that were not being accounted for. An analysis of CPUE data at finer spatiotemporal resolutions would provide insight for likely changes in q. Providing more flexibility in the estimation of q via time-varying selectivity showed improvements in the fit to length composition data but produced no measurable improvements in fits to CPUE series. Observed changes in q within an Area (1-3) were smaller than changes in q across Areas over time indicating there was significant spatial structure within each Area. This was consistent with the WGs prior expectations. Area 3 had the smallest relative changes in q over time which suggested that CPUE in this Area was probably more representative of changes in population abundance and was not as strongly affected by changes in fishing strategy as CPUE in Areas 1 and 2.

3. What is coefficient of variation (CV) of the length at age relationship for the youngest reference age fish and the oldest reference age fish?

   Additional analyses were conducted to determine the CVs on the youngest and oldest fish based on the aging study of Sun et al. (2011). The empirical size at age CVs were consistent with the values used in the assessment (i.e., WP-6); the CVs were larger for younger fish (8%) and the CVs were smaller for older fish (4%).

4. Should the base case model use alternative assumptions about the error variances of observed data? Should iterative re-weighting (IR) of CPUE and length composition variance based on an initial run of the base case model configuration be applied to produce the final base case model run?

   IR was applied to evaluate its influence on variance estimation and the model fits to CPUE series and length composition data. Better fits to the TWLL-late CPUE series were observed after IR. In contrast, fits to the recent portion of the JDWLL were worse when

IR was applied. There was little improvement in fits to the length composition data when IR was applied. The WG discussed the benefits of applying IR and the WG reached a consensus that the base model would include IR.

The following items were considered to be of low priority by the WG and were not addressed in the initial set of sensitivity analyses:

5. What time period should be used for the estimation of recruitment deviations?

6. What equilibrium catch assumptions should be used to start the model (year, initial age distribution and equilibrium catch)?

7. What length composition data should be included (especially relevant for fisheries with few length data and small catches)?

8. Is the split of the Japan other fishery into two seasonal components appropriate?

9. Is the assumed spawning season appropriate?

10. Consider a different selectivity pattern model to match the missing age-1 in some length composition data sets.

11. Is the use of a minimum length bin of 55 cm or 120 cm appropriate?

Based on results of the initial set of sensitivity runs, consensus agreement was reached on the following:

- Use the model-based estimate of the variability of the CPUE indices from IR to set the CV for the CPUE indices.

- Do not change the weighting of length composition data except where the model indicates that the weighting should be decreased as indicated by a lower estimated effective sample size.

- The base case model was defined to include CPUE series from JDWLL (1975-2009, Area 1-3), HWLL, TWLL (late), and JCLL.

8.5.2 Model Sensitivity Analyses – Second Set

Following the WG agreement on the selection of the CPUE series to be included in the base case model, the WG requested to see the results of a set of 10 sensitivity runs (Second Set). These runs were conducted to empirically evaluate how sensitive the base case model configuration was to alternative model assumptions or configurations that might be considered to be plausible.

In particular, the WG requested to see the following output from each of the 10 sensitivity runs: spawning biomass (female only), fits to the CPUE data, fits to the time-aggregated length composition data, recruitment (pooled sexes), total biomass (pooled sexes), and changes in the fitted negative log likelihood value (a.k.a., likelihood) by model likelihood component (i.e., CPUE and length composition).

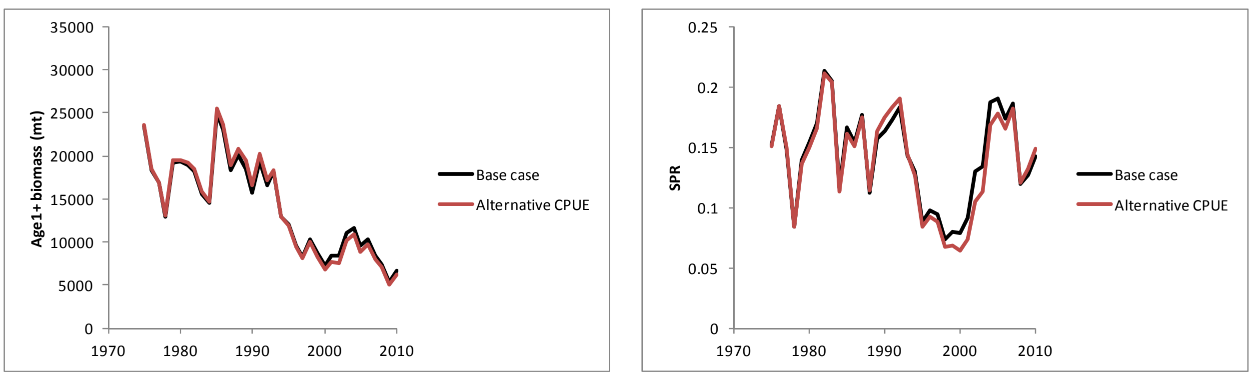
1. <u>Alternative distant-water longline CPUE sensitivity analysis</u>

Question: What would be the effect of using a single JDWLL CPUE time series, instead of separate indices by Area and for 3 time periods?

Request: Run the base case model without JDWLL Areas 1-3 CPUE data, and instead use the estimated single JDWLL CPUE time series (for all areas combined) using estimated selectivity for Areas 2 and 3 and using 2 time periods as assumed in the estimated series.

Results: There was some degradation to the model fits of the CPUE series, especially in middle and late time periods. The trends in total biomass and spawning potential ratio were similar for the base case and alternative CPUE models (Figure 8.5.2.1). The relative changes in total biomass and spawning potential ratios from the base case to the alternative were -4.8% and 4.4% in 2009.

Figure 8.5.2.1. Alternative distant-water longline CPUE sensitivity analysis fits to total biomass (left panel) and spawning potential ratio (right panel).



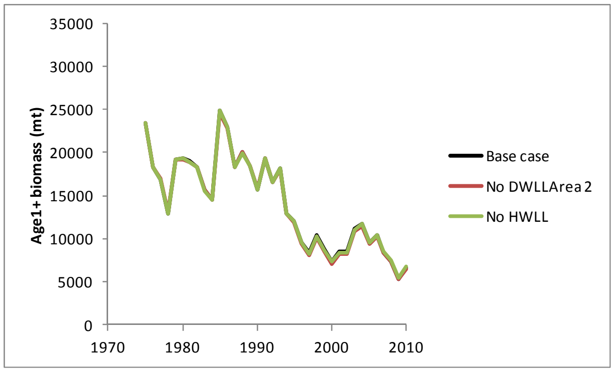
2. <u>Base case model without Hawaii Longline CPUE sensitivity analysis</u>

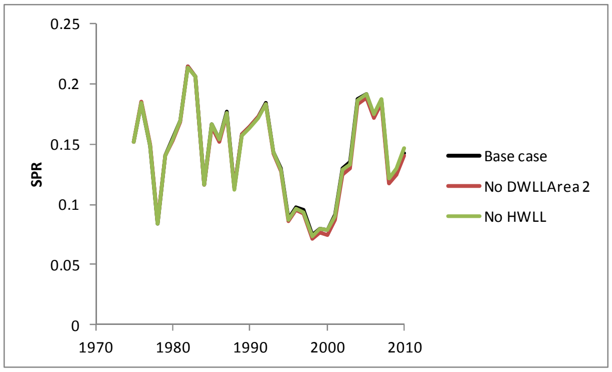
Question: What would be the effect of excluding the Hawaii longline CPUE series?

Request: Run the base case model without the HWLL CPUE series.

Results: There was very little difference in the fitting of length compositions and CPUE trends. The trends in total biomass and spawning potential ratio were very similar for the base case and without HWLL models (Figure 8.5.2.2). The relative changes in total biomass and spawning potential ratios from the base case to the without HWLL were 1.6% and 2.4% in 2009.

Figure 8.5.2.2. Base case model without Hawaii longline CPUE and without Japanese distant-water longline Area 2 time series sensitivity analyses with fits to total biomass (left panel) and spawning potential ratio (right panel).





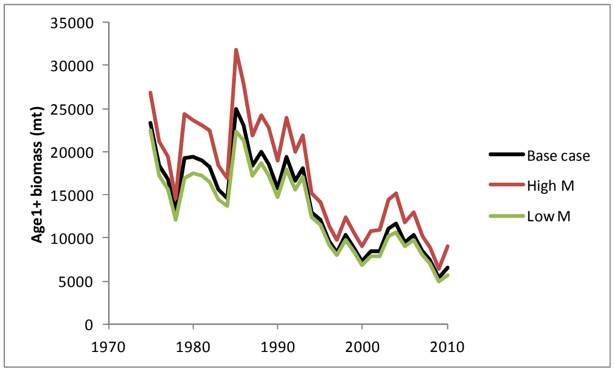
3. <u>Natural mortality rate sensitivity analysis</u>

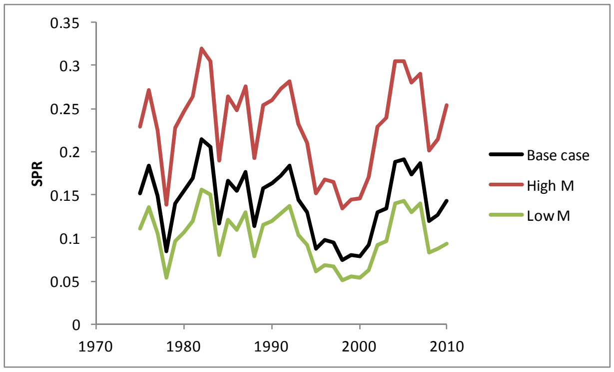
Question: What would be the effect of using a lower or higher adult natural mortality rate?

Request: Run the base case model with adult M=0.3 and 0.5, with juvenile M scaled as in the base case.

Results: Both natural mortality rate sensitivity runs fit worse by a moderate amount. Biomass changed as expected, with relatively large changes. Fits to CPUE series appeared similar, however. While the pattern in trends in total biomass and spawning potential ratio were relatively similar for the base case and alternative M models, the changes in biomass and spawning potential ratio were substantial (Figure 8.5.2.3). The relative changes in total biomass and spawning potential ratios from the base case for the lower M model were -5.8% and -30.7% in 2009 and were 21.6% and 69.4% for the higher M model.

Figure 8.5.2.3. Natural mortality rate sensitivity analyses using lower (M=0.3) and higher (M=0.5) adult natural mortality rates with fits to total biomass (left panel) and spawning potential ratio (right panel).





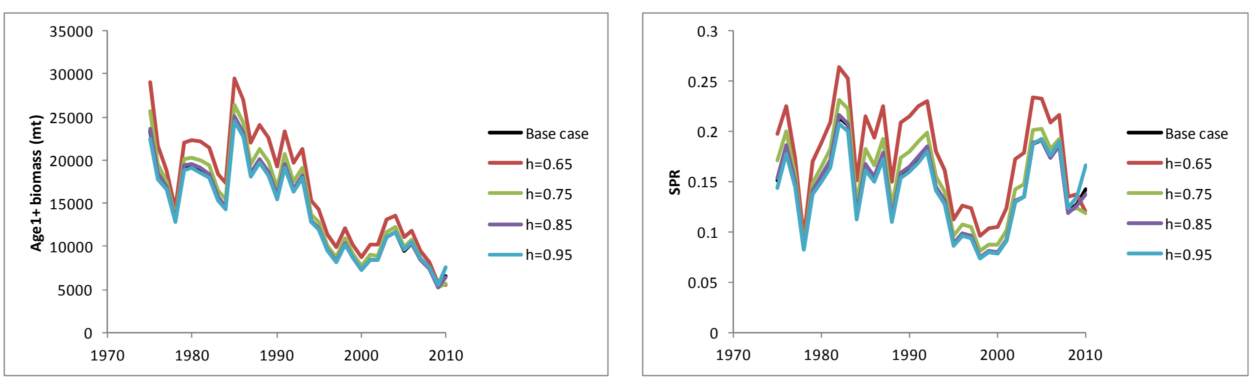
4. <u>Stock-recruitment steepness sensitivity analysis</u>

Question: What would be the effect of using a lower or higher stock-recruitment steepness ?

Request: Run the base case model with stock-recruitment steepness values of h=0.65, 0.75, 0.85, 0.95. These values bracket the range of potentially credible values of steepness.

Results: Changing the value of steepness changed the total likelihood substantially because the variance of recruitment deviates was 0.6. Biomass trends has a similar patterns but had different scales between steepness runs. Lower steepness values produced higher biomass estimates compared to the base case. The differences in the fits to the CPUE data among steepness runs were minor, however. In general, using a higher steepness implied a more resilient but smaller and more productive stock. In the previous assessment the steepness was assumed to be h=0.7. In the current assessment, the maximum likelihood estimate of steepness derived from life history parameters was h=0.87. As a result, it was expected that the stock would be more productive in the current stock assessment. While the pattern in trends in total biomass and spawning potential ratio were relatively similar for the base case and alternative steepness models, the changes in biomass and spawning potential ratio were notable (Figure 8.5.2.4). The relative changes in total biomass and spawning potential ratios from the base case for the lowest steepness model (h=0.65) were 6.4% and 8.4% in 2009 and were 4.3% and 6.3% for the highest steepness model (h=0.95) model.

Figure 8.5.2.4. Stock-recruitment steepness sensitivity analyses with fits to total biomass (left panel) and spawning potential ratio (right panel).



5. <u>Base case model without Japanese DWLL Area 2 CPUE sensitivity analysis</u>

Question: What would be the effect of excluding the Japanese distant-water longline CPUE series?

Request: Run the base case model without the JDWLL Area 2 CPUE series for all time periods.

Results: There were small changes in both fits to CPUE and length composition data and minor differences in biomass trends. The trends in total biomass and spawning potential ratio were very similar for the base case and without JDWLL Area 2 CPUE models (Figure 8.5.2.2). The relative changes in total biomass and spawning potential ratios from the base case to the without JDWLL CPUE were -1.2% and -1.7% in 2009.

6. <u>Catch penalty sensitivity analyses</u>

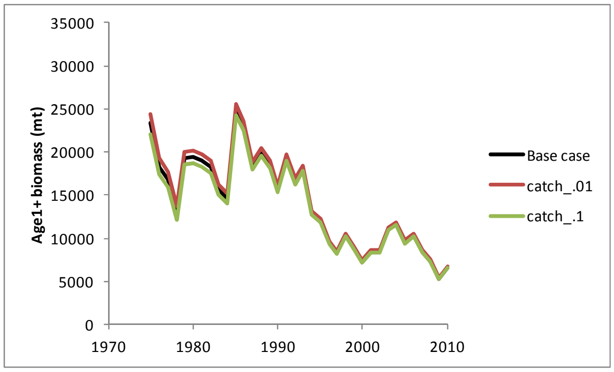
Question: What is the effect of assuming different penalties for fitting the observed time series of fisheries catches?

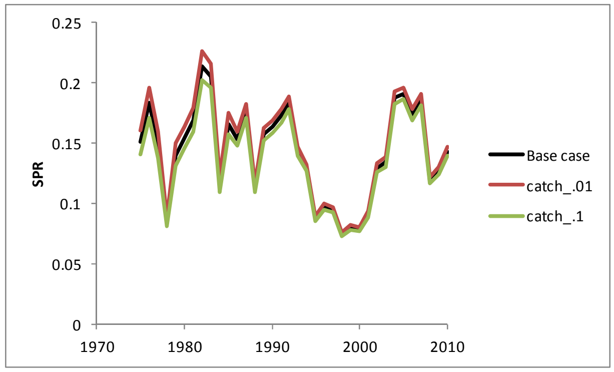
Request: Run the base case model with the CV penalty for fitting the time series of fisheries catches set to be to 1% and 10%

Results: Total model likelihood changes were relatively small for both of the catch penalty changes. The largest discrepancies between predicted and observed catches occurred for the Japanese other gears combined fishery. Overall, the biomass trends showed some moderate changes across penalties with greater differences from the base case occurring in the 1970s and 1980s. Overall, the changes in biomass and spawning potential ratio were minor (Figure 8.5.2.6). The relative changes in total biomass and spawning potential ratios from the base case for the lower penalty (CV=10%) model were -1.5% and -2.2% in 2009 and were 2.1% and 2.9% for the higher penalty (CV=1%) model.

Comment: Concern was raised by the WG about the historical change of the reliability of annual catches, especially for recent years when sightings of illegal drift netters were reported, but due to the lack of the quantitative information, the sensitivities for the historical change of CV of reported catch was not conducted.

Figure 8.5.2.6. Catch penalty sensitivity analyses using lower (CV=10%) and higher (CV=1%) penalties with fits to total biomass (left panel) and spawning potential ratio (right panel).





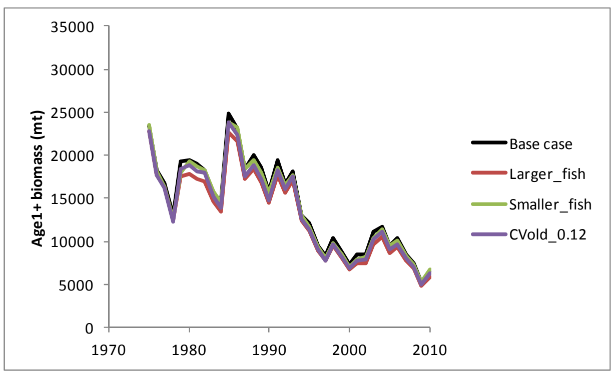
7. Growth curve sensitivity analysis

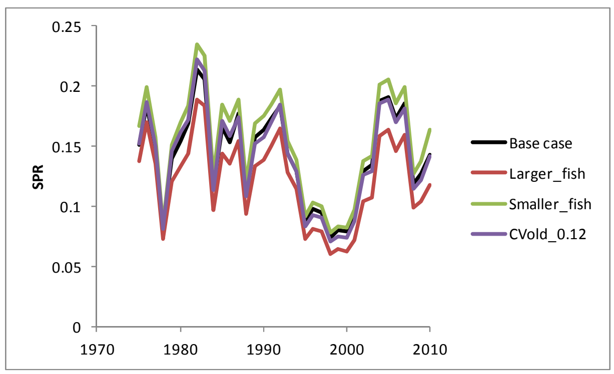
Question: What would be the effect of assuming a different growth curve?

Request: Run the base case model with the length at maximum reference age to be A_{max} = 205 and A_{max} = 225. Use a Brody growth coefficient K that is consistent with the first four ages of the Sun et al. (2011) growth curve.

Results: Assuming different lengths at maximum reference age produced substantial degradations to some CPUE fits. Trends in biomass had similar patterns but somewhat different scales than the base case. While the pattern in trends in total biomass and spawning potential ratio were relatively similar for the base case and the larger and smaller fish size models, the changes in the scale of spawning potential ratio were notable (Figure 8.5.2.7). The relative changes in total biomass and spawning potential ratios from the base case for the larger fish model were -9.1% and -17.9% in 2009 and were -0.2% and 8.5% for the smaller model.

Figure 8.5.2.7. Base case model with larger and smaller maximum size and higher assumed variability (CV=12%) on size at maximum reference age sensitivity analyses with fits to total biomass (left panel) and spawning potential ratio (right panel).





8. Growth variability sensitivity analysis

Question: What would be the effect of assuming higher variability in the length at age of older fish?

Request: Run the base case model with the CV of the length at age of older fish (age A_{max}) set to be CV=12%.

Results: There was very little difference in the fitting of length compositions and CPUE trends. The trends in total biomass and spawning potential ratio were very similar for the base case and with the higher length-at-age CV model (Figure 8.5.2.7). The relative changes in total biomass and spawning potential ratios from the base case to the higher length-at-age CV model were -6.0% and -3.9% in 2009.

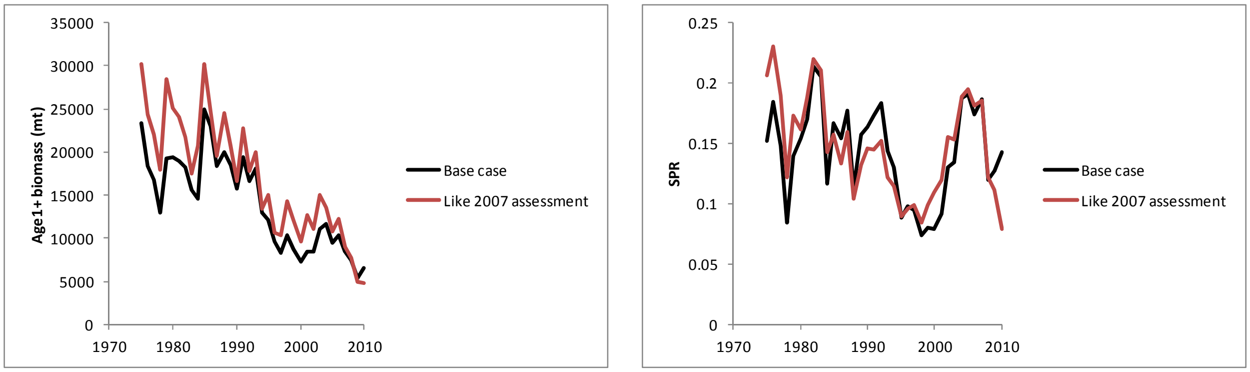
9. Comparison to previous assessment sensitivity analysis

Question: What would be the effect of using the model assumptions from the previous assessment conducted in 2007 with the catch, CPUE, and length composition data from the current stock assessment?

Request: Run the base case model with the following changes. Use the previous stock assessment structure to the extent possible. Set adult natural mortality rate to be M=0.3. Set steepness to be h=0.7. Set all fishery selectivities to be asymptotic. Set maturity to be knife-edged with full maturity at 155 cm. Use the Melo-Barrera growth curve (Melo-Barrera et al. 2003).

Results: The changes in the fits to the CPUE and length compositions with the 2007 model assumptions were substantially poorer than the fits for the base case. The biomass trends had a similar pattern of decline but showed a larger decline with the 2007 model assumptions (Figure 8.5.2.9). Similarly, the patterns in spawning potential ratio were similar but showed a very substantial decline in recent years under the 2007 model assumptions (Figure 8.5.2.9). Overall, the relative changes in total biomass and spawning potential ratios from the base case to the 2007 assumptions model were -7.0% and -11.9% in 2009.

Figure 8.5.2.9. Comparison to previous assessment conducted in 2007 sensitivity analyses using base case model data and model assumptions from 2007 assessment with fits to total biomass (left panel) and spawning potential ratio (right panel).



10. <u>Start catch in 1952 sensitivity analysis</u>

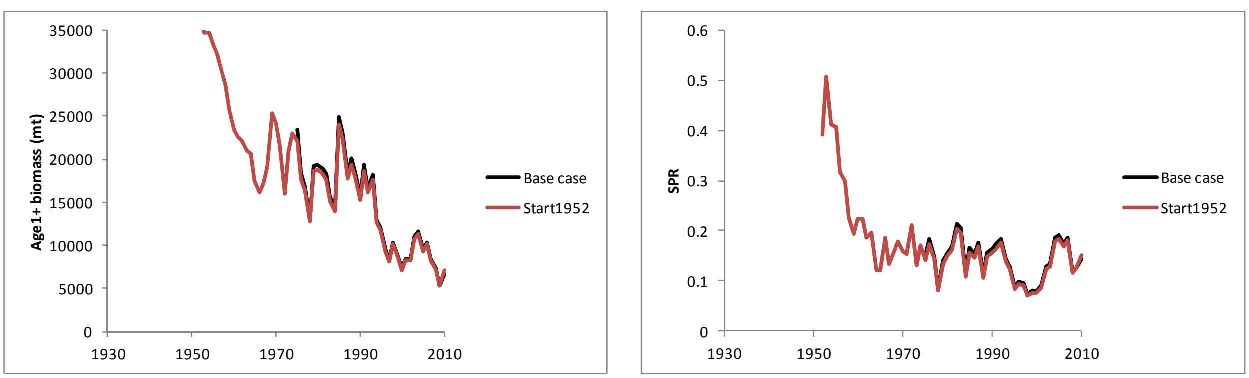
What is the effect of including the catch from 1952-1974 on model outputs?

Question: What would be the effect of starting the base case model in 1952 and fitting the 1952-1974 catch data as was done in the 2007 stock assessment ?

Request: Run the base case model including the catch from 1952-1974 and fitting a single aggregated fishery selectivity based on the JDWLL length composition data from 1970-1974.

Results: There was very little difference in the fitting of CPUE trends. The trends in total biomass and spawning potential ratio were very similar for the base case and the model including the 1952-1974 catch (Figure 8.5.2.10). The relative changes in total biomass and spawning potential ratios from the base case to the model including the 1952-1974 catch were -0.1% and -0.5% in 2009.

Figure 8.5.2.10. Effect of starting the base case model in 1952 and including the 1952-1974 catches sensitivity analysis with fits to total biomass (left panel) and spawning potential ratio (right panel).



8.5.3 Model Sensitivity Analyses – Third Set

The WG made three other requests for information to clarify the results of the base case model. Each of these requests was addressed during the meeting.

1. Produce a plot of the selectivity curves for the JDWLL fleets in Areas 1, 2, and 3 along with the TWLL by time period.
2. Produce a time series of exploitation rates for the aggregate fishery and a time series of adult fishing mortality rates that are comparable to what was presented in the 2007 assessment.
3. Provide a spreadsheet with the base case estimates of spawning biomass and the recruitment that was produced by that spawning biomass in the same row.

8.5.4 Summary of Sensitivity Analyses

The base case model was not sensitive to most factors except for natural mortality rate and steepness, and moderately to growth. Further research on striped marlin life history and growth may help to improve the stock assessment. In addition, future research on detailed fishery data may help to improve the reliability of CPUE indices and better understand patterns in selectivity.

9.0 ADOPTION OF THE BASE CASE ASSESSMENT MODEL FOR WCPO STRIPED MARLIN

The WG adopted a base case assessment model for WCPO striped marlin after conducting a suite of sensitivity runs. The structure, input data and assumptions for the consensus base case model were summarized (Tables 3.1, 3.2, 3.3, and 3.4).

9.1 Base Case Assessment Model

The WG noted that the base case stock assessment model was fit using the Stock Synthesis (V3.20b, SS3) software. The likelihood components for the base case model included catch, proportion-at-size and catch-per-unit effort series from all fisheries (Table 3.1). Information to parameterize the biology and life history of the species (Table 3.2) was taken from ISC Billfish working group papers as previously agreed. Growth was modeled with a von Bertalanffy growth curve, recruitment was modeled with a Beverton-Holt stock-recruit curve and the natural mortality rate was age-specific. The base case model structure allowed for the estimation of domed shaped selectivity patterns for all fisheries except the Japanese driftnet and other-early fishery; selectivities for these two fisheries were assumed to be asymptotic (Table 3.3). Fishery selectivity patterns were also allowed to vary in time for the JDWLL fleet. Variances for likelihood components were rescaled to match the output model predictions. That is, IR was used for the base case. The base case model was started in 1975 and it was assumed that the combined fisheries were in equilibrium in 1975 with an assumed equilibrium catch of 5,000 mt. There were

5 initial recruitment deviations estimated prior to the start of model dynamics in 1975 and these were used to initialize the population age structure in 1975 (Table 3.4). Likelihood components of the base case model were also summarized (Table 3.5). The base case model fits to length compositions and CPUE along with model results were also summarized (Figures 9.1, 9.2 and 9.3).

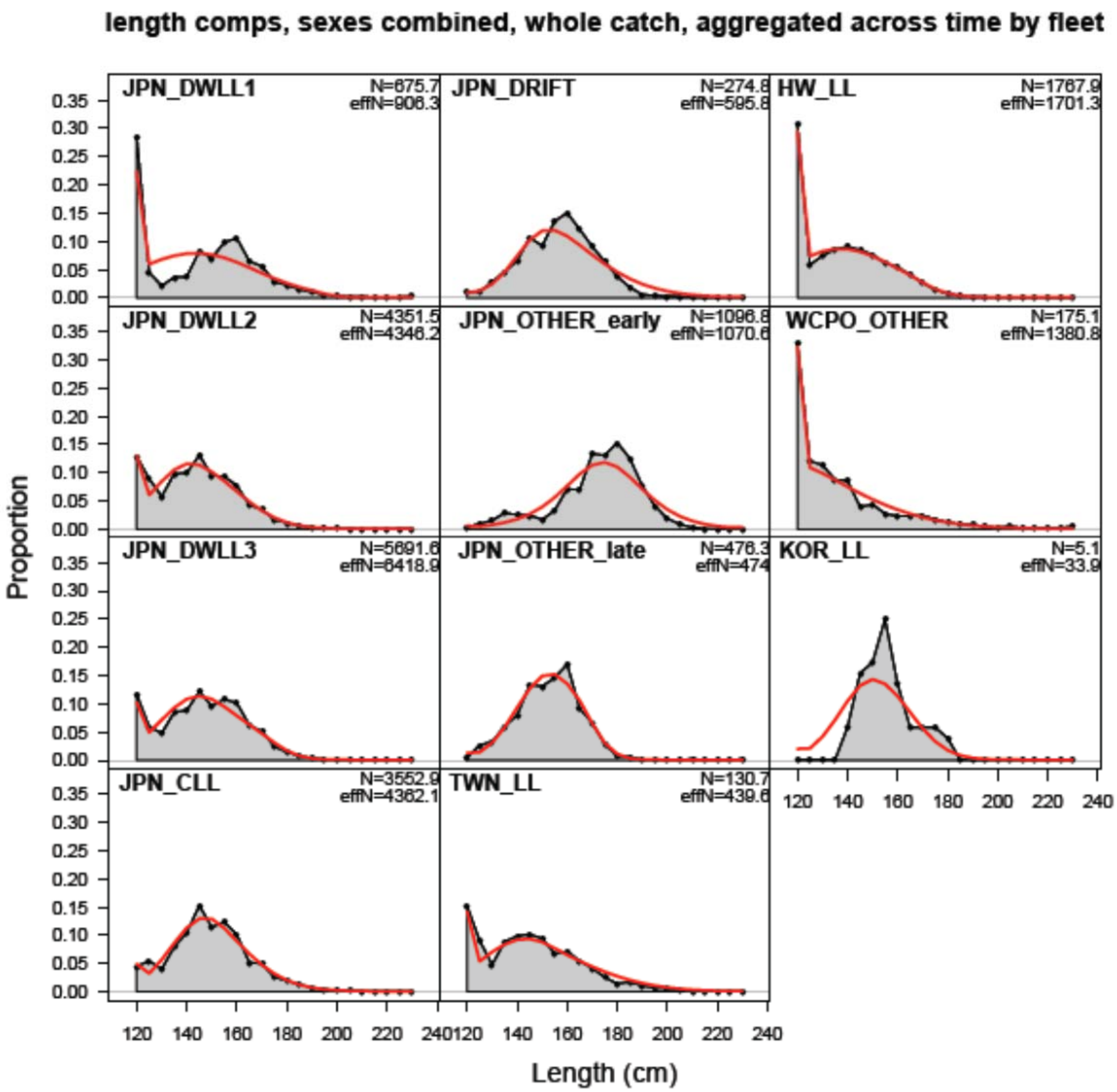


Figure 9.1. Aggregated (across season and years) fits to the proportion-at-length likelihood component by fishery for the base case model.

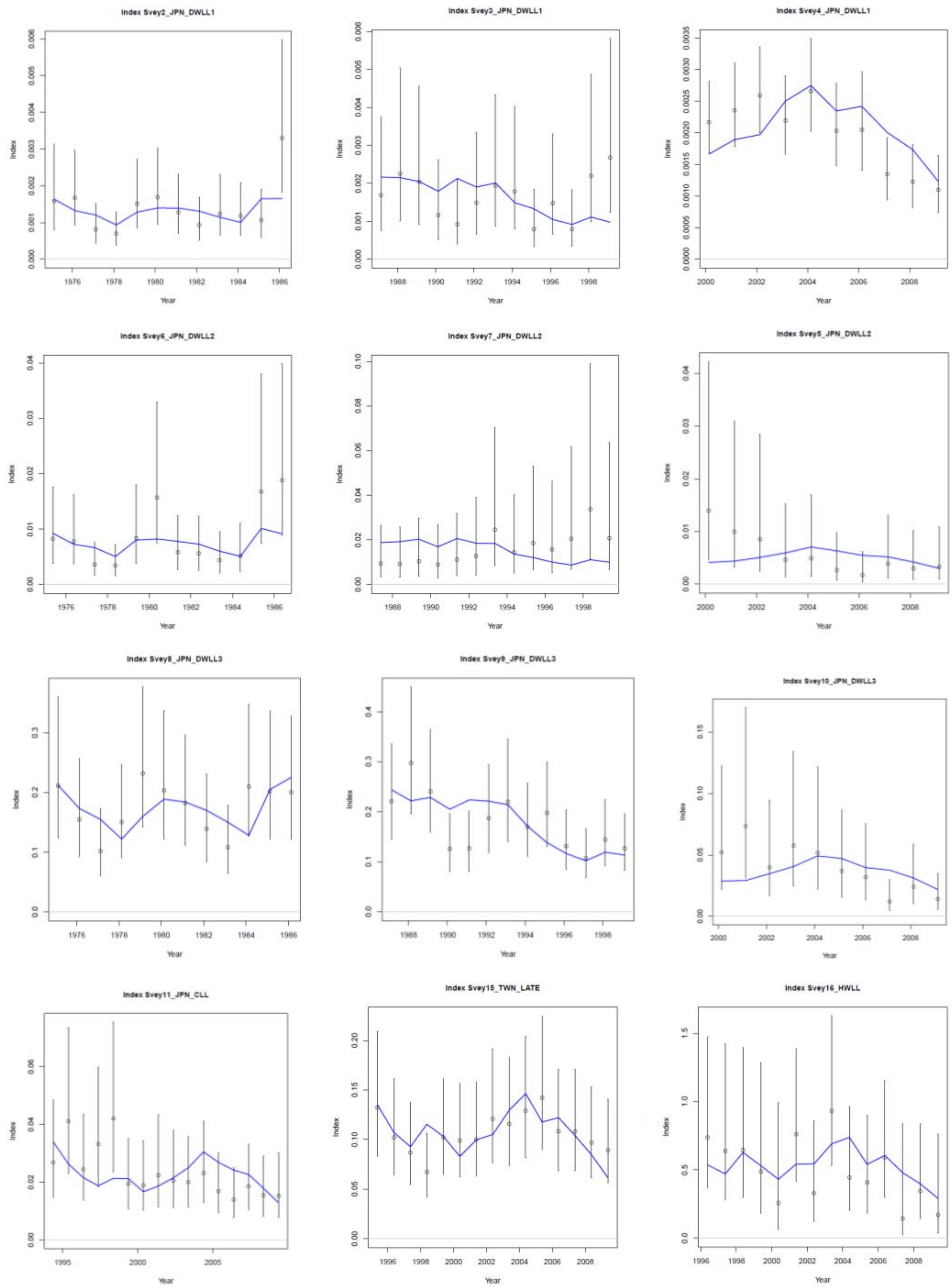
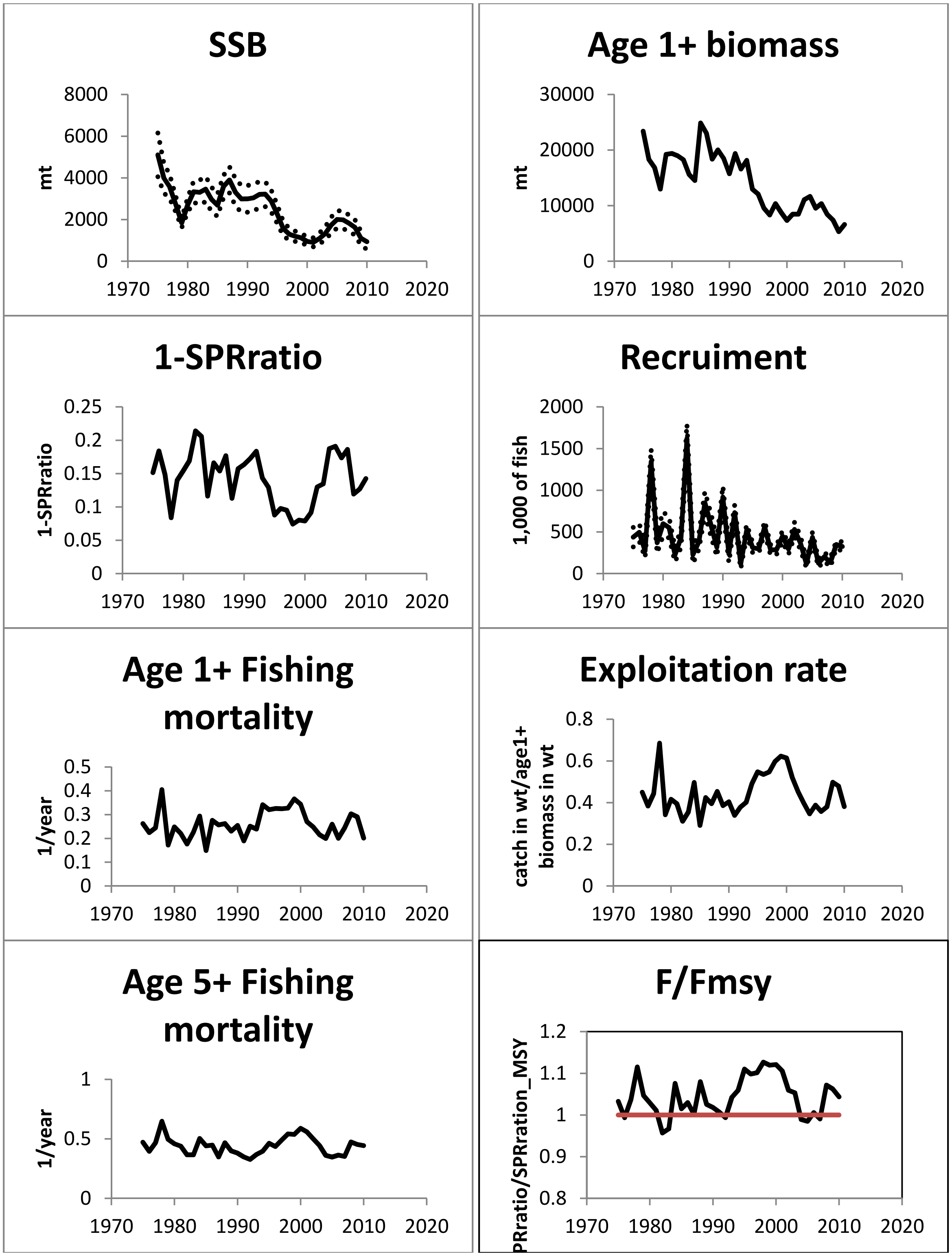
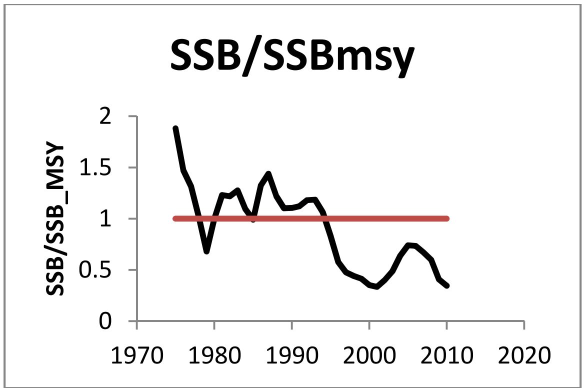


Figure 9.2. Observed and predicted fishery CPUE for the base case model.


SSB
mt
8000
6000
4000
2000
0
1970 1980 1990 2000 2010 2020
Age 1+ biomass
mt
30000
20000
10000
0
1970 1980 1990 2000 2010 2020
1-SPRratio
1-SPRratio
0.25
0.2
0.15
0.1
0.05
0
1970 1980 1990 2000 2010 2020
Recruiment
1,000 of fish
2000
1500
1000
500
0
1970 1980 1990 2000 2010 2020
Age 1+ Fishing mortality
1/year
0.5
0.4
0.3
0.2
0.1
0
1970 1980 1990 2000 2010 2020
Exploitation rate
catch in wt/age1+ biomass in wt
0.8
0.6
0.4
0.2
0
1970 1980 1990 2000 2010 2020
Age 5+ Fishing mortality
1/year
1
0.5
0
1970 1980 1990 2000 2010 2020
F/Fmsy
PRratio/SPRration_MSY
1.2
1.1
1
0.9
0.8
1970 1980 1990 2000 2010 2020



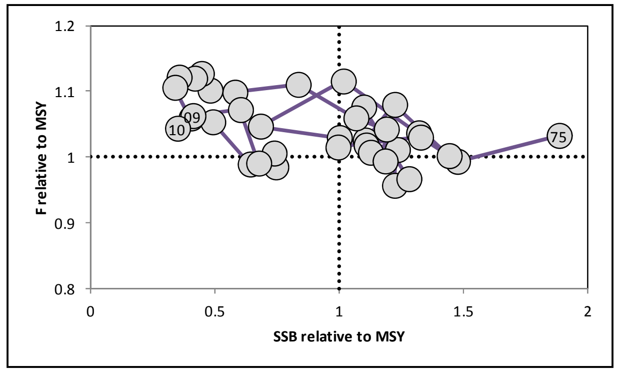


Figure 9.3. Maximum likelihood estimates of assessment outputs for the base case model including spawning biomass (SSB), age-1 and older biomass (Age 1+ biomass), spawning potential ratio (1-SPRratio), recruitment of age-0 fish (Recruitment), an index of average age-1 and older fishing mortality (Age 1+ Fishing mortality), exploitation rate (Exploitation rate), an index of average adult fishing mortality (Age 5+ Fishing mortality), average adult fishing mortality relative to FMSY (F/Fmsy), female spawning biomass relative to BMSY (SSB/SSBmsy), and a Kobe plot relative to MSY-based reference points.

9.2 Stock Status

Results from the base case assessment model were used to determine trends in population biomass, female spawning biomass, and harvest rate of the WCPO striped marlin stock during 1975-2010. Estimates of population biomass (age-1 and older) showed a long-term decline (Figure 9.4). Population biomass averaged roughly 18,200 mt during 1975-1979 (42% of unfished biomass) and declined to an average of 6,500 mt during 2008-2010 (15% of unfished biomass). Reported catches of WCPO striped marlin also declined from an average of 8,100 mt during 1975-1979 to an average of 2,900 mt during 2008-2010 (Figure 9.4). Adult female biomass also exhibited a declining trend during 1975-2010 (Figure 9.5). Estimates of female spawning biomass averaged roughly 3,500 mt during 1975-1979 (127% of BMSY, the biomass to produce maximum sustainable yield [MSY]) and declined to an average of roughly 1,200 mt during 2008-2010 (45% of BMSY). Fishing mortality rates fluctuated at or above FMSY, the fishing mortality to produce MSY, during 1975-2010 (Figure 9.6). Estimates of annual fishing mortality averaged roughly $F_{1975\text{-}1979} = 0.90$ during 1975-1979 (47% above FMSY) and declined by about 10% to average roughly $F_{2008\text{-}2010} = 0.82$ during 2008-2010 (33% above FMSY). If the status of the WCPO striped marlin stock was evaluated relative to MSY-based reference points using the average estimates during 2008-2010 to measure current status with the minimum stock size threshold set to be 50% of BMSY, then the stock would currently be considered to be depleted and would currently be experiencing overfishing, as shown in the Kobe plot (Figure 9.7).

Figure 9.4. Trends in population and catch biomasses of Western and Central North Pacific striped marlin (*Kajikia audax*) during 1975-2010.

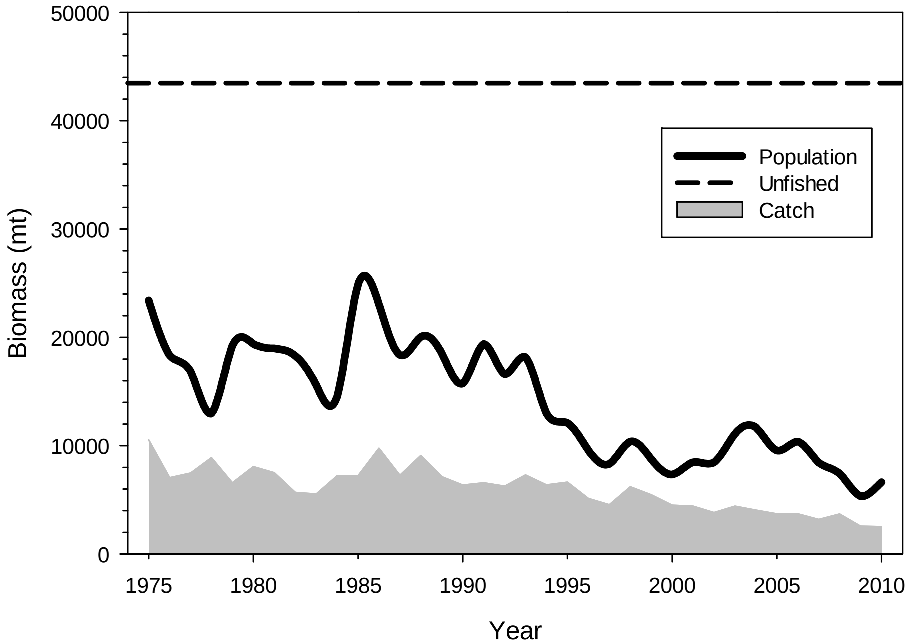


Figure 9.5. Trends in estimates of female spawning biomass of Western and Central North Pacific striped marlin (*Kajikia audax*) during 1975-2010 along with 80% confidence intervals.

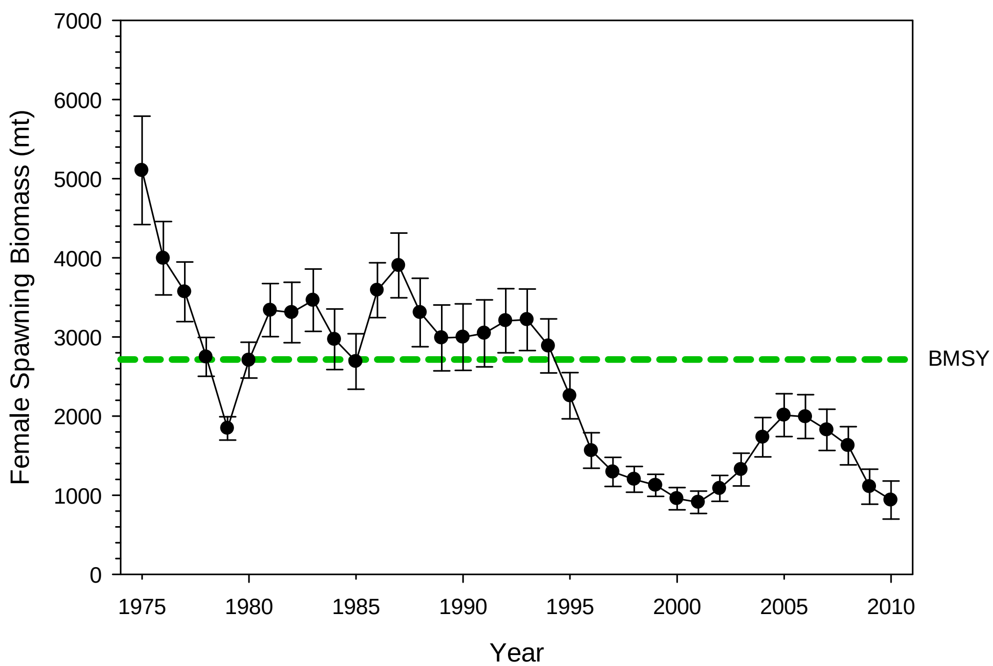


Figure 9.6. Trends in estimates of fishing mortality of Western and Central North Pacific striped marlin (*Kajikia audax*) during 1975-2010 along with 80% confidence intervals.

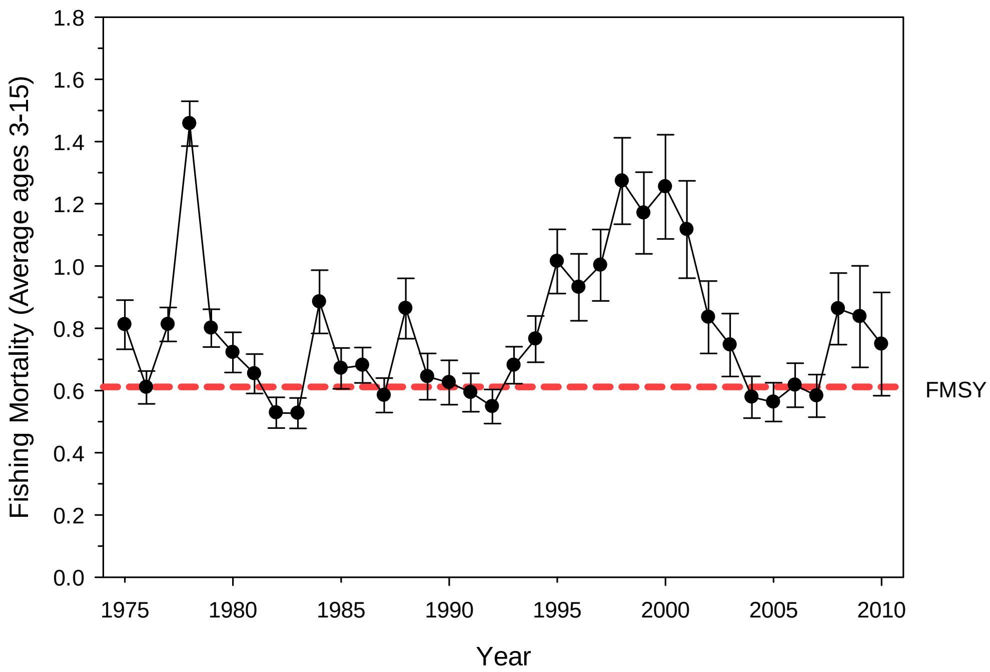
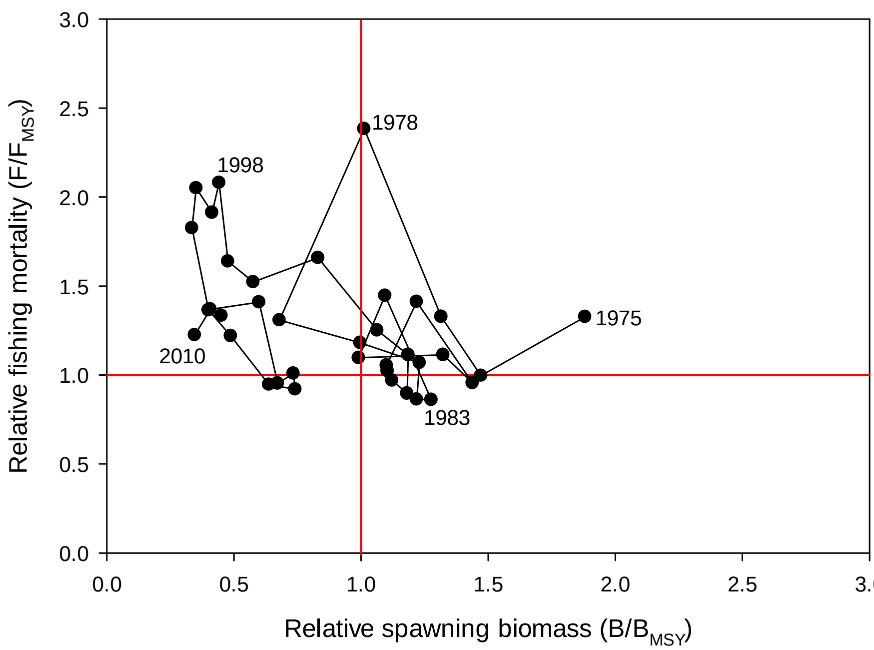


Figure 9.7. Kobe plot of the trends in estimates of relative fishing mortality and spawning biomass of Western and Central North Pacific striped marlin (*Kajikia audax*) during 1975-2010.



9.3 Projections

The working group discussed methods to conduct stock projections based on the assessment results. Stochastic projections were recommended for risk analyses, such as the consideration of the relative probability of exceeding a limit reference point in a given year. Discussion focused on what levels of exploitation to use in the projections, methods to re-sample recruitment, sources of uncertainty to be considered, and the outputs needed from the projections. Some of the options are summarized below.

Harvest scenario options for projections:

- Use average fishing Mortality (2001-2003) F-based, SPR-based (CMM level from WCPFC SC)
- Use average fishing Mortality (2007-2009) F-based, SPR-based (recent level)
- Use F_{MSY}
- Use various SPR ratios (F10%, F20%, F30%)
- Use catch based on a recent average

Recruitment for projections:

- Resample recruitment (whole series vs. more recent series (or early series). The recruitment time series appears to consist of two groups of recruitments with different means and variances for each group. The groups may be consistent with the hypothesis that there was a change in Pacific Ocean regime and productivity in the late 1990s.
- Resample deviations from the estimated stock-recruitment curve.
- Resample recruits per spawner

The working group also noted that it would be useful to assess whether recruitment patterns were autocorrelated and to assess whether alternative assumptions about steepness were warranted.

Sources of uncertainty for projections:

- Estimated initial population numbers at age and size distribution
- Growth
- Selectivity
- Natural mortality rate
- Stock-recruitment steepness

Some potential output distributions from projections

- Catch by fishery
- Spawning biomass
- Exploitable biomass
- Exploitation rate
- Relative biomass
- Relative exploitation rate
- Spawning potential ratio

The Working group recommended that the Billfish Chair put together a small intercessional WG to develop a paper on projections to be presented at the next meeting.

10.0 PACIFIC BLUE MARLIN STOCK ASSESSMENT WORK PLAN

Gerard DiNardo, the ISC Chairman, discussed the work plan for the upcoming Pacific blue marlin stock assessment. Due to the postponement of the North Pacific striped marlin stock assessment by the BILLWG, the completion date of the Pacific blue marlin stock assessment, which was originally scheduled to be presented to the ISC Plenary in July 2012, was also pushed back one year. The BILLWG will plan on completing the blue marlin assessment in April 2013 with presentation to the ISC Plenary in July 2013. With that completion date in mind, one of the goals at the April 2012 intercessional BILLWG workshop will be to begin data preparation. The BILLWG intercessional meeting in Fall 2012 will be used to review estimates of standardized CPUE time series and to make decisions on the input parameters for the stock assessment model. The Pacific blue marlin stock assessment will be completed and finalized at the Spring 2013 workshop.

The WG recognized that because blue marlin is considered a pan-Pacific stock, other countries (other than ISC countries) and organizations will need to contribute data in order to provide a comprehensive picture of the stock status. The WG agreed that collaborations with the WCPFC (SPC) and IATTC would be greatly beneficial in the successful completion of a blue marlin stock assessment. The WG also recognized the need to acquire blue marlin data from the South Pacific.

The last stock assessment of Pacific blue marlin was conducted by Kleiber et al. (2003) and the WG will review this assessment. The WG recognized that the review of each fishery catching blue marlin is very important as this is the first time a blue marlin stock assessment will be conducted by the ISC.

The WG was tasked with presenting working papers on blue marlin nominal reported catch, length composition and size data, and summaries of the history of each fishery at the next intercessional BILLWG workshop in April 2012. The BILLWG Chair also requested that each country provide information and maps of the spatial extent of their blue marlin fisheries.
The BILLWG Chair was tasked with contacting the WCPFC (SPC) and IATTC for data.

10.1 Collaborative Partners

The WG reviewed the potential available information and collaborative partners to conduct a blue marlin stock assessment.

10.1.1 SPC

Dr. Peter Williams manages the data collections for blue marlin and BILLWG Chairman will contact him to make a request for blue marlin data.

10.1.2 Chinese Taipei

National Taiwan University has recently published new research on the reproductive biology of blue marlin (Sun et al., 2009). The NTU research has led to the development of preliminary estimates of von Bertalanffy growth parameters from MULTIFAN. Blue marlin was found to exhibit sexual dimorphism in size. Females grow faster than males. The estimates of Brody growth coefficients K were similar for both sexes but the asymptotic length L_{inf} differed between sexes. It was noted that there is ongoing tagging research on blue marlin being conducted by the Eastern Marine Biology Research Center, Fisheries Research Institute, Taiwan with partial support from NOAA PIFSC.

10.1.3 USA

NOAA PIFSC submitted a working paper on the life history parameters of billfishes, including blue marlin, to the BILLWG in 2007 (pers. comm. Robert Humphreys, PIFSC). The WG noted that Humphreys intends to collect blue marlin samples in 2012 for age and growth studies. There are three major fisheries catching blue marlin; these are longline and recreational fisheries in Hawaii, Guam and California. NOAA PIFSC is currently compiling Hawaiian recreational fishery data and it was expected that these data would be reported in a working paper at the next BILLWG meeting. Some recent information on the estimation of post release mortalities of blue marlin from electronic tagging was also expected to be introduced into the next BILLWG meeting.

10.1.4 Japan

NRIFSF conducted an age and growth study of blue marlin with the support of NOAA PIFSC. This study produced results that were similar to the results of the study conducted by the National Taiwan University. NRIFSF also examined data on the general distribution pattern of blue marlin in the North Pacific. NRIFSF found that blue marlin exhibit sex-specific growth and have sex-specific migration patterns, which were similar to those of the North Pacific swordfish. The WG also noted that there were fewer samples of sex-specific size composition data for blue marlin in comparison to North Pacific swordfish and that this lack of size data may be problematic for fitting a length-based stock assessment model.

10.1.5 Discussion

The WG also discussed other sources of information and fishery data that were may be important for conducting a blue marlin stock assessment. The WG noted that recreational fisheries catch blue marlin in a number of countries, such as Mexico, Australia and New Zealand. The WG recognized that information from these recreational fisheries should also be incorporated into the stock assessment wherever possible. The WG also noted that traditional tagging studies have been conducted in some recreational fisheries in the Pacific. Although these recreational tagging data may be opportunistically, such data may provide some useful information on the general migration patterns and growth of blue marlin. The WG agreed to investigate the possibilities of reviewing such traditional tagging information at the next BILLWG meeting.

10.2 Assessment Modeling Approaches

The following models were proposed as potential assessment modeling approaches. The strengths and weaknesses of using these assessment models for blue marlin will be discussed at the next BILLWG meeting:

- Age-Structured National Taiwan University Model. This is an approach based on Wang et al (2007).
- Stock Synthesis 3 length-based model for pooled or separate sexes. This is an approach that would be similar to that in Courtney and Piner (2010).
- Bayesian Surplus Production Model. This is an approach that would be similar to that in Brodziak and Ishimura (2011).
- MULTIFAN-CL. This is an approach that would be similar to that in Kleiber et al. (2003).

11.0 OTHER BUSINESS

The WG discussed other business, including a North Pacific swordfish assessment update, ISC BILWG participation, future meetings, and work assignments.

11.1 North Pacific Swordfish Assessment Update

The BILLWG was tasked to update North Pacific swordfish catch by stock area in anticipation of the completion of a full stock assessment in 2013 by the April 2012 intercessional BILLWG workshop.

11.2 ISC Billfish Working Group Participation

The Chair acknowledged the importance of participation from both the IATTC and the SPC in the completion of a blue marlin assessment and expressed hope that their active participation will continue. It was noted that the SPC has been participating in BILLWG meetings at the WCPFC's request and will continue to do so if the request is continued.

11.3 Future Meetings and Timeline

Shanghai Ocean University has agreed to host the next intercessional BILLWG workshop which is tentatively scheduled for 2-9 April 2012 in Shanghai, China. The goals of this workshop will be to finalize the North Pacific striped marlin stock assessment, as well as to prepare data for the Pacific blue marlin stock assessment. BILLWG members should prepare catch and nominal CPUE time series by fishery, as well as descriptions of each fishery by country for presentation in working papers. Following the BILLWG workshop, the ISC, jointly with the Shanghai Ocean University, the Chinese Academy of Fisheries Sciences, and NOAA Fisheries will host a 2-3 day seminar on various fisheries related issues and research. The BILLWG Chair encouraged members to present their research at this seminar as an opportunity to showcase the work that is completed by the BILLWG. Gerard DiNardo will be putting together a seminar agenda and will be distributing more information at a later date.

Preceding the ISC12 in Sapporo, Japan, the BILLWG will meet from 16-17 July 2012 to prepare the conservation advice and information needed to present to the ISC Plenary.

In November-December 2012, the BILLWG will meet to continue data preparation for the blue marlin assessment including CPUE standardization and modeling setup.

11.4 Assignments

11.4.1 BILLWG Assignments

The BILLWG members were assigned a number of tasks. These tasks include:

- Submit finalized copies of all working papers presented at this meeting to the BILLWG Chair by 15 January 2011.

- At the April 2012 meeting, U.S. scientists will catalog data availability from the blue marlin recreational fishery and present it to the BILLWG.

- At the April 2012 meeting, each country will present working papers on blue marlin nominal reported catch, length composition and size data, and summaries of the history of each fishery. The BILLWG Chair also requested that each country provide information and maps of the spatial extent of their blue marlin fisheries.

- Complete a review of the past blue marlin stock assessment (Kleiber et al, 2003) and other relevant research.

- At the April 2012 meeting, update North Pacific swordfish catch by stock area in anticipation of the completion of a full stock assessment in 2013.

- Update North Pacific striped marlin and swordfish catch tables (Tables 1 and 2).

11.4.2 Chairman Assignments

The BILLWG Chairman was also assigned a number of tasks. These tasks include:

- Contact Peter Williams at the SPC regarding blue marlin data holdings and submit a data request.

- Contact IATTC about sending a participant to the BILLWG.

- Contact SWFSC for blue marlin tagging data.
- Contact Mike Musyl (Pelagic Fisheries Research Program) regarding blue marlin tagging data and a summary on his post-release survival research.
- Request blue marlin data from the WCPFC.
- Request blue marlin recreational catch data from New Zealand.
- Provide a template/outline for fishery description working papers for BILLWG members by January 2012.
- Form a sub-group to address recruitment modeling in North Pacific striped marlin projections and develop a paper on projections to be presented at the April 2012 meeting.

11.4.3 Future Work

It was recommended that biological samples be collected under the umbrella of the ISC Biological Sampling Program. The WG recognized that the ISC Biological Sampling Program has yet to be funded, however, in the meantime, biological sampling needs to be conducted and research efforts need to be coordinated within the BILLWG.

It was suggested that the WG consider examining longline data from Indonesia, Philippines, and Vietnam for striped marlin.

The WG pointed out the need for maps delineating the spatial extent of all fisheries capturing billfish and for map indicating where length samples were collected. Spatio-temporal and sex-specific analysis of catch, effort, and length distribution data for all billfish species was also recommended.

12.0 ADJOURNMENT

The workshop was adjourned at 1:00 PM on 16 December 2011. The BILLWG Chairman expressed his appreciation to the rapporteurs and to all participants for their contributions and cooperation in completing a successful meeting. The Chairman also expressed his appreciation of the diligent effort and hard work by Kevin Piner and Hui-Hua Lee to complete the stock assessment modeling during the workshop.

13.0 REFERENCES

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Courtney, D., and Piner, K. 2010. Age structured stock assessment of North Pacific swordfish (*Xiphias gladius*) with Stock Synthesis under a two stock scenario. ISC/10/BILLWG-1/01.

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Table 1. Striped marlin catches (in metric tons) by fisheries, 1952-2010. Blank (" ") indicates no effort. Dash ("–") indicates data not available. Zero ("0") indicates a catch of less than 1 metric ton.

	Japan							Mexico			United States					Costa Rica	
Year	Distant-water and Offshore Longline	Coastal Longline	Other Longline	Small Mesh Gillnet	Large Mesh Gillnet	Other[3]	Japan Total	Longline	Sport[2]	Mexico Total	Longline	Troll	Handline	Sport[2]	US Total	Sport	**WCPFC non-ISC Countries[4]**
1951	2,494	-	673	-	0	1,281	4,448										
1952	2,901	-	722	-	0	1,564	5,187							23	23		
1953	2,138	-	47	-	0	954	3,139							5	5		
1954	3,068	-	52	-	0	1,088	4,207							16	16		
1955	3,082	-	28	-	0	1,038	4,148							5	5		
1956	3,729	-	59	-	0	1,996	5,785							34	34		
1957	3,189	-	119	-	0	2,459	5,767							42	42		
1958	4,106	-	277	-	3	2,914	7,300							59	59		
1959	4,152	-	156	-	2	3,191	7,501							65	65		
1960	3,862	-	101	-	4	1,937	5,904							30	30		
1961	4,420	-	169	-	2	1,797	6,388							24	24		
1962	5,739	-	110	-	8	1,912	7,769							5	5		
1963	6,135	-	62	-	17	1,910	8,124							68	68		
1964	14,304	-	42	-	2	2,344	16,692							58	58		
1965	11,602	-	19	0	1	2,794	14,416							23	23		
1966	8,419	-	112	0	2	1,570	10,103							36	36		
1967	11,698	-	127	0	3	1,551	13,379							49	49		
1968	15,913	-	230	0	0	1,043	17,186							51	51		
1969	8,544	600	3	0	3	2,668	11,818							30	30		
1970	12,996	690	181	0	3	1,032	14,902							18	18		11
1971	10,965	667	259	0	10	2,042	13,943							17	17		12
1972	7,006	837	145	0	243	993	9,224							21	21		13
1973	6,357	632	118	0	3,265	702	11,074							9	9		15
1974	6,700	327	49	0	3,112	775	10,963							55	55		17
1975	5,281	286	38	0	6,534	686	12,825							27	27		18
1976	5,136	244	34	0	3,561	585	9,560							31	31		15
1977	3,019	256	15	0	4,424	547	8,261							41	41		21
1978	3,957	243	27	0	5,593	546	10,366							37	37		21
1979	5,561	366	21	0	2,532	526	9,006							36	36		26
1980	6,378	607	5	0	3,467	536	10,993							33	33		32
1981	4,106	259	12	0	3,866	542	8,785							60	60		43

[1] Provisional data

[2] Estimated from catch in number of fish

[3] Contrains bait fishing, net fishing, trapnet, trolling, harpoon, etc.

[4] Contains catches reported to the WCPFC by the Philippines, Indonesia, China, Vanuatru, Federated States of Micronesia, and Belize, totaled with the estimated unreported catch by the Philippines, Indonesia, Vanuatu, Federated States of Micronesia, and Be

[5] From Appendix

Table 1. (Continued) Striped marlin catches (in metric tons) by fisheries, 1952-2010. Blank (" ") indicates no effort. Dash ("–") indicates data not available. Zero ("0") indicates a catch of less than 1 metric ton.

	Japan							Mexico			United States					Costa Rica	
Year	Distant-water and Offshore Longline	Coastal Longline	Other Longline	Small Mesh Gillnet	Large Mesh Gillnet	Other[3]	Japan Total	Longline	Sport[2]	Mexico Total	Longline	Troll	Handline	Sport[2]	US Total	Sport	WCPFC non-ISC Countries[4]
1982	5,383	270	13	0	2,351	656	8,673							41	41		61
1983	3,722	320	10	22	1,845	827	6,746							39	39		59
1984	3,506	386	9	76	2,257	719	6,953							36	36		36
1985	3,897	711	24	40	2,323	733	7,728					18		42	60		51
1986	6,402	901	33	48	3,536	577	11,497	-				19		19	38		62
1987	7,538	1,187	6	32	1,856	513	11,132	-			272	30	1	28	331		137
1988	6,271	752	7	54	2,157	668	9,909	-			504	54		30	588		129
1989	4,740	1,081	13	102	1,562	537	8,035	-			612	24	0	52	688		101
1990	2,368	1,125	3	19	1,926	545	5,986	-	181	181	538	27	0	23	588		50
1991	2,845	1,197	3	27	1,302	507	5,881	-	75	75	663	41	0	12	716	106	61
1992	2,955	1,247	10	35	1,169	303	5,719	-	142	142	459	38	1	25	523	281	66
1993	3,476	1,723	1	-	828	708	6,736	-	159	159	471	68	1	11	551	438	60
1994	2,911	1,284	1	-	1,443	383	6,022	-	179	179	326	35	0	17	378	521	72
1995	3,494	1,840	3	-	970	283	6,590	-	190	190	543	52	0	14	609	153	68
1996	1,951	1,836	4	-	703	152	4,646	-	237	237	418	54	1	20	493	122	73
1997	2,120	1,400	3	-	813	163	4,499	-	193	193	352	38	1	21	412	138	55
1998	1,784	1,975	2	-	1,092	304	5,157	-	345	345	378	26	0	23	427	144	69
1999	1,608	1,551	4	-	1,126	184	4,473	-	266	266	364	28	1	12	405	166	68
2000	1,152	1,109	8	-	1,062	297	3,628	-	312	312	200	14	1	10	225	97	41
2001	985	1,326	11	-	1,077	237	3,636	-	237	237	351	42	2	-	395	151	50
2002	764	796	5	-	1,264	290	3,119	-	305	305	226	30	0	-	256	76	88
2003	1,013	842	3	-	1,064	203	3,124	-	322	322	552	29	0	-	581	79	105
2004	699	1,000	2	-	1,339	92	3,132	-	-	0	376	34	1	-	411	19 [1]	137
2005	562	668	1	0	1,214	98	2,543	-	-	0	511	20	0	-	531	- [1]	66
2006	623	539	1	0	1,190	95	2,448	-	-	-	611	21	0	-	632	-	42
2007	306	860	5	-	970	79	2,220	-	-	-	276	13	0	-	289	-	31
2008	390 [1]	609 [1]	10 [1]	- [1]	1,302[1]	97 [1]	2,408 [1]	-	-	-	426	14	0	-	440	-	154
2009	166 [1]	606 [1]	21 [1]	- [1]	821 [1]	90 [1]	1,704 [1]	-	-	-	256 [1]	10 [1]	0 [1]	-	266 [1]	-	41
2010	-	-	-	-	-	-	109 [5]	-	-	-	158 [1]	5 [1]	0 [1]	-	163 [1]	-	16
2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Provisional data
[2] Estimated from catch in number of fish
[3] Contrains bait fishing, net fishing, trapnet, trolling, harpoon, etc.
[4] Contains catches reported to the WCPFC by the Philippines, Indonesia, China, Vanuatru, Federated States of Micronesia, and Belize, totaled with the estimated
[5] From Appendix

Table 1. (Continued) Striped marlin catches (in metric tons) by fisheries, 1952-2010. Blank (" ") indicates no effort. Dash ("–") indicates data not available. Zero ("0") indicates a catch of less than 1 metric ton.

Year	Chinese Taipei[2]												Korea			
	Distant-water Longline	High-seas Drift Gillnet	Offshore Longline	Offshore Gillnet	Offshore Others	Coastal Harpoon	Coastal Setnet	Gillnet & Other net	Coastal Longline	Coastal Others	Other	Chinese Taipei Total	Longline	High-seas Drift Gillnet	Korea Total	Grand Total
1951														-		4,448
1952												-	-	-	-	5,210
1953												-	-	-	-	3,144
1954												-	-	-	-	4,223
1955												-	-	-	-	4,153
1956												-	-	-	-	5,819
1957												-	-	-	-	5,809
1958			543								387	930	-	-	-	8,289
1959			391								354	745	-	-	-	8,311
1960			398								350	748	-	-	-	6,682
1961			306								342	648	-	-	-	7,060
1962			332								211	543	-	-	-	8,317
1963			560								199	759	-	-	-	8,951
1964			392								175	567	-	-	-	17,317
1965			355								157	512	-	-	-	14,951
1966			370								180	550	-	-	-	10,689
1967	2		385								204	591	-	-	-	14,019
1968	1		332								208	541	-	-	-	17,778
1969	2		571								192	765	-	-	-	12,613
1970	0		495								189	684	-	-	-	15,615
1971	0		449								135	584	0	-	0	14,556
1972	9		380								126	515	0	-	0	9,773
1973	1		568								139	708	0	-	0	11,806
1974	24		650								118	792	0	-	0	11,827
1975	64		732								96	892	0	-	0	13,761
1976	32		347								140	519	0	-	0	10,125
1977	17		524								219	760	43	-	43	9,126
1978	0		618								78	696	28	-	28	11,149
1979	26		432								122	580	-	-	-	9,648
1980	61		223								132	416	37	-	37	11,512
1981	17		491								95	603	-	-	-	9,490

1 Provisional data

2 Estimated from catch in number of fish

3 Contrains bait fishing, net fishing, trapnet, trolling, harpoon, etc.

4 Contains catches reported to the WCPFC by the Philippines, Indonesia, China, Vanuatru, Federated States of Micronesia, and Belize, totaled with the estimated unreported catch by the Philippines, Indonesia, Vanuatu, Federated States of Micronesia, and Be

5 From Appendix

Table 1. (Continued) Striped marlin catches (in metric tons) by fisheries, 1952-2010. Blank (" ") indicates no effort. Dash ("–") indicates data not available. Zero ("0") indicates a catch of less than 1 metric ton. "Appendix" refers to the BILLWG report from the May 2011 workshop.

Year	Chinese Taipei[2]												Korea			
	Distant-water Longline	High-seas Drift Gillnet	Offshore Longline	Offshore Gillnet	Offshore Others	Coastal Harpoon	Coastal Setnet	Gillnet & Other net	Coastal Longline	Coastal Others	Other	Chinese Taipei Total	Longline	High-seas Drift Gillnet	Korea Total	Grand Total
1982	7		397								138	542	39	-	39	9,356
1983	0		555								214	769	19	-	19	7,632
1984	0		965								330	1,295	23	-	23	8,342
1985	0		513								181	694	16	-	16	8,550
1986	0		179								148	327	61	-	61	11,985
1987	31		383								151	565	1	-	1	12,166
1988	7		457								169	633	11	-	11	11,270
1989	8		184								157	349	26	-	26	9,199
1990	2		137								256	395	315	-	315	7,515
1991	36		254								286	576	141	-	141	7,556
1992	1		219								197	417	318	-	318	7,466
1993	5		221								142	368	388	-	388	8,700
1994	1		137								196	334	1,045	-	1045	8,552
1995	27		83								82	192	307	-	307	8,109
1996	26		162	8	6	30	3	-	-	-	-	235	429	-	429	6,236
1997	59		290	9	-	33	3	-	2	-	-	396	1,017	-	1017	6,710
1998	90		205	15	-	19	6	1	9	-	-	345	635	-	635	7,122
1999	66		128	7	-	26	5	1	3	-	-	236	433	-	433	6,047
2000	153		161	17	1	29	6	1	1	-	-	369	537	-	537	5,209
2001	121		129	16	-	30	5	-	-	-	-	301	254	-	254	5,024
2002	251		226	14	-	6	8	1	-	-	-	506	188	-	188	4,539
2003	241		91	26	-	11	5	1	-	-	-	375	206	-	206	4,792
2004	261		95	8	1	7	5	2	-	1	-	380	75	-	75	4,154 [1]
2005	176		76	1	-	5	9	9	-	8	-	284	141	-	141	3,565 [1]
2006	-	-	-	-	-	-	-	-	-	-	-	123 [5]	56	-	56	3,301 [1]
2007	-	-	-	-	-	-	-	-	-	-	-	260 [5]	28	-	28	2,828 [1]
2008	-	-	-	-	-	-	-	-	-	-	-	196 [5]	-	-	56 [5]	3,254 [1]
2009	-	-	-	-	-	-	-	-	-	-	-	198 [5]	-	-	44 [5]	2,253 [1]
2010	-	-	-	-	-	-	-	-	-	-	-	183 [5]	-	-	30 [5]	501 [1]
2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Provisional data
[2] Estimated from catch in number of fish
[3] Contrains bait fishing, net fishing, trapnet, trolling, harpoon, etc.
[4] Contains catches reported to the WCPFC by the Philippines, Indonesia, China, Vanuatru, Federated States of Micronesia, and Belize, totaled with the estimated
[5] From Appendix

Table 2. Swordfish catches (in metric tons) by fisheries, 1952-2010. Blank (" ") indicates no effort. Dash ("–") indicates data not available. Zero ("0") indicates a catch of less than 1 metric ton.

	Japan								Mexico	United States[6]					
										Hawaii	California				
Year	Distant-water and Offshore Longline	Coastal and Other Longline	Squid Driftnet and Driftnet	Harpoon[3]	Bait Fishing	Trapnet	Other[4]	Japan Total	All Gears	Longline	Longline	Gill Net	Harpoon	Unknown[7]	US Total
1951	7,246	115	10	4,131	88	78	10	11,678	-	-	-	-	-	-	-
1952	8,890	152	0	2,569	6	68	6	11,691	-	-	-	-	-	-	-
1953	10,796	77	0	1,407	20	21	87	12,408	-	-	-	-	-	-	-
1954	12,563	96	0	813	104	18	17	13,610	-	-	-	-	-	-	-
1955	13,064	29	0	821	119	37	41	14,111	-	-	-	-	-	-	-
1956	14,596	10	0	775	66	31	7	15,486	-	-	-	-	-	-	-
1957	14,268	37	0	858	59	18	11	15,251	-	-	-	-	-	-	-
1958	18,525	42	0	1,069	46	31	21	19,734	-	-	-	-	-	-	-
1959	17,236	66	0	891	34	31	10	18,267	-	-	-	-	-	-	-
1960	20,058	51	1	1,191	23	67	7	21,400	-	-	-	-	-	-	-
1961	19,715	51	2	1,335	19	15	11	21,147	-	-	-	-	-	-	-
1962	10,607	78	0	1,371	26	15	18	12,115	-	-	-	-	-	-	-
1963	10,322	98	0	747	43	17	16	11,244	-	-	-	-	-	-	-
1964	7,669	91	4	1,006	40	16	26	8,852	-	-	-	-	-	-	-
1965	8,742	119	0	1,908	26	14	182	10,991	-	-	-	-	-	-	-
1966	9,866	113	0	1,728	41	11	4	11,763	-	-	-	-	-	-	-
1967	10,883	184	0	891	33	12	5	12,008	-	-	-	-	-	-	-
1968	9,810	236	0	1,539	41	14	9	11,649	-	-	-	-	-	-	-
1969	9,416	296	0	1,557	42	11	14	11,336	-	-	-	-	-	-	-
1970	7,324	427	0	1,748	36	9	3	9,547	-	5	-	-	612	10	627
1971	7,037	350	1	473	17	37	31	7,946	-	1	-	-	99	3	103
1972	6,796	531	55	282	20	1	2	7,687	2	0	-	-	171	4	175
1973	7,123	414	720	121	27	23	2	8,430	4	0	-	-	399	4	403
1974	5,983	654	1,304	190	27	16	2	8,176	6	0	-	-	406	22	428
1975	7,031	620	2,672	205	58	18	2	10,606	-	0	-	-	557	13	570
1976	8,054	750	3,488	313	170	14	12	12,801	-	0	-	-	42	13	55
1977	8,383	880	2,344	201	71	7	2	11,888	-	17	-	-	318	19	354
1978	8,001	1,031	2,475	130	110	22	1	11,770	-	9	-	-	1,699	13	1,721
1979	8,602	1,038	983	161	45	15	4	10,848	7	7	-	-	329	57	393
1980	6,005	849	1,746	398	29	15	1	9,043	380	5	-	160	566	62	793
1981	7,039	727	1,848	129	58	9	3	9,813	1,575	3	0	473	271	2	749

[1] Catch data are currently unavailable for Republic of Korea, Philippines, and some other countries catching swordfish in the North Pacific.
[2] Catches by gear for 1952-1970 were estimated roughly using FAO statistics and other data. Catches for 1971-2002 are more reliably estimated.
[3] Contrains trolling and harpoon but majority of catch obtained by harpoon.
[4] For 1952-1970 "Other" refers to catches by net fishing and various unspecified gears.
[5] Offshore longline category includes some catches from harpoon and other fisheries but does not include catches unloaded in foreign ports.
[6] Estimated round weight of retained catch. Does not include discards.
[7] Unknown includes pole and line, purse seine, troll and troll/handline, half ring, and unspecified gears.

only one vessel fished so combined with Hawaii longline

Table 2. (Continued) Swordfish catches (in metric tons) by fisheries, 1952-2010. Blank (" ") indicates no effort. Dash ("–") indicates data not available. Zero ("0") indicates a catch of less than 1 metric ton.

	Japan								Mexico	United States[6]					
										Hawaii	California				
Year	Distant-water and Offshore Longline	Coastal and Other Longline	Squid Driftnet and Driftnet	Harpoon[3]	Bait Fishing	Trapnet	Other[4]	Japan Total	All Gears	Longline	Longline	Gill Net	Harpoon	Unknown[7]	US Total
1982	6,064	874	1,257	195	58	7	1	8,456	1,365	5	0	945	156	10	1,116
1983	7,692	999	1,033	166	30	9	2	9,931	120	5	0	1,693	58	7	1,763
1984	7,177	1,177	1,053	117	98	13	0	9,635	47	3	12	2,647	104	75	2,841
1985	9,335	999	1,133	191	69	10	0	11,737	18	2	0	2,990	305	104	3,401
1986	8,721	1,037	1,264	123	47	9	0	11,201	422	2	0	2,069	291	109	2,471
1987	9,495	860	1,051	87	45	11	0	11,549	550	24	0	1,529	235	31	1,819
1988	8,574	678	1,234	173	19	8	0	10,686	613	24	0	1,376	198	64	1,662
1989	6,690	752	1,596	362	21	10	0	9,431	690	218	0	1,243	62	56	1,579
1990	5,833	690	1,074	128	13	4	0	7,742	2,650	2,436	0	1,131	64	43	3,674
1991	4,809	807	498	153	20	5	0	6,292	861	4,508	27	944	20	44	5,543
1992	7,234	1,181	887	381	16	6	0	9,705	1,160	5,700	62	1,356	75	47	7,240
1993	8,298	1,394	292	309	43	4	1	10,341	812	5,909	27	1,412	168	161	7,677
1994	7,366	1,357	421	308	37	4	0	9,493	581	3,176	631	792	157	24	4,780
1995	6,422	1,387	561	423	34	7	0	8,834	437	2,713	268	771	97	29	3,878
1996	6,916	1,067	428	597	45	4	0	9,057	439	2,502	346	761	81	15	3,705
1997	7,002	1,214	365	346	62	5	0	8,994	2,365	2,881	512	708	84	11	4,196
1998	6,233	1,190	471	476	68	2	0	8,440	3,603	3,263	418	931	48	19	4,679
1999	5,557	1,049	724	416	47	5	0	7,798	1,136	3,100	1,229	606	81	27	5,043
2000	6,180	1,121	808	497	49	5	0	8,660	2,216	2,949	1,885	646	90	9	5,579
2001	6,932	908	732	230	30	15	0	8,847	780	220	1,749	375	52	5	2,401
2002	6,230	965	1,164	201	29	11	0	8,600	465	204	1,320	302	90	3	1,919
2003	5,376	1,063	1,198	149	28	4	0	7,818	671	147	1,812	216	107	0	2,282
2004	5,395	1,509	1,062	229	30	4	0	8,229	270	213	898	169	62	37	1,379
2005	5,359	1,294	956	187	337	3	0	8,136	235	1,622		220	76	0	1,918
2006	6,181	1,507	796	244	342	5	1	9,076	347	1,211		444	71	2	1,728
2007	6,109	2,016	829	122	367	2	1	9,446	383	1,735		484	58	0	2,277
2008	4,402 [1]	1,780 [1]	648 [1]	173 [1]	349 [1]	3 [1]	0 [1]	7,355 [1]	84	1,980		280	33	1	2,294
2009	4,400 [1]	1,548 [1]	682 [1]	239 [1]	249 [1]	3 [1]	0 [1]	7,121 [1]	-	1,813 [1]		172 [1]	34 [1]	1 [1]	2,020
2010	-	-	-	-	-	-	-	-	-	1,654 [1]		33 [1]	22 [1]	4 [1]	1,713
2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Catch data are currently unavailable for Republic of Korea, Philippines, and some other countries catching swordfish in the North Pacific.
[2] Catches by gear for 1952-1970 were estimated roughly using FAO statistics and other data. Catches for 1971-2002 are more reliably estimated.
[3] Contrains trolling and harpoon but majority of catch obtained by harpoon.
[4] For 1952-1970 "Other" refers to catches by net fishing and various unspecified gears.
[5] Offshore longline category includes some catches from harpoon and other fisheries but does not include catches unloaded in foreign ports.
[6] Estimated round weight of retained catch. Does not include discards.
[7] Unknown includes pole and line, purse seine, troll and troll/handline, half ring, and unspecified gears.

only one vessel fished so combined with Hawaii longline

Table 2. (Continued) Swordfish catches (in metric tons) by fisheries, 1952-2010. Blank (“ “) indicates no effort. Dash (“–“) indicates data not available. Zero (“0”) indicates a catch of less than 1 metric ton.

	Chinese Taipei[5]											Korea			
Year	Distant-water Longline	Offshore Longline	Offshore Gillnet	Offshore Others	Coastal Harpoon	Coastal Setnet	Coastal Gillnet & Other Net	Coastal Longline	Coastal Others	Other	Chinese Taipei Total	Longline	High-seas Drift Gillnet	Korea Total	Grand Total
1951												-	-	-	11,678
1952	-	-									-	-	-	-	11,691
1953	-	-									-	-	-	-	12,408
1954	-	-									-	-	-	-	13,610
1955	-	-									-	-	-	-	14,111
1956	-	-									-	-	-	-	15,486
1957	-	-									-	-	-	-	15,251
1958	-	-									-	-	-	-	19,734
1959	-	427								91	518	-	-	-	18,785
1960	-	520								127	647	-	-	-	22,047
1961	-	318								73	391	-	-	-	21,538
1962	-	494								62	556	-	-	-	12,671
1963	-	343								18	361	-	-	-	11,605
1964	-	358								10	368	-	-	-	9,220
1965	-	331								27	358	-	-	-	11,349
1966	-	489								31	520	-	-	-	12,283
1967	-	646								35	681	-	-	-	12,689
1968	-	763								12	775	-	-	-	12,424
1969	0	843								7	850	-	-	-	12,186
1970	-	904								5	909	-	-	-	11,083
1971	-	992								3	995	0	-	0	9,044
1972	-	862								11	873	0	-	0	8,737
1973	-	860								119	979	0	-	0	9,816
1974	1	880								136	1,017	0	-	0	9,627
1975	29	899								153	1,081	0	-	0	12,257
1976	23	613								194	830	0	-	0	13,686
1977	36	542								141	719	219	-	219	13,180
1978	-	546								12	558	68	-	68	14,117
1979	7	661								33	701	-	-	-	11,949
1980	10	603								76	689	64	-	64	10,969
1981	2	656								25	683	-	-	-	12,820

[1] Catch data are currently unavailable for Republic of Korea, Philippines, and some other countries catching swordfish in the North Pacific.
[2] Catches by gear for 1952-1970 were estimated roughly using FAO statistics and other data. Catches for 1971-2002 are more reliably estimated.
[3] Contrains trolling and harpoon but majority of catch obtained by harpoon.
[4] For 1952-1970 "Other" refers to catches by net fishing and various unspecified gears.
[5] Offshore longline category includes some catches from harpoon and other fisheries but does not include catches unloaded in foreign ports.
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Table 2. (Continued) Swordfish catches (in metric tons) by fisheries, 1952-2010. Blank (“ “) indicates no effort. Dash (“–“) indicates data not available. Zero (“0”) indicates a catch of less than 1 metric ton.

	Chinese Taipei[5]											Korea			
Year	Distant-water Longline	Offshore Longline	Offshore Gillnet	Offshore Others	Coastal Harpoon	Coastal Setnet	Coastal Gillnet & Other Net	Coastal Longline	Coastal Others	Other	Chinese Taipei Total	Longline	High-seas Drift Gillnet	Korea Total	Grand Total
1982	1	855								49	905	48	-	48	11,890
1983	0	783								166	949	11	-	11	12,774
1984	-	733								264	997	48	-	48	13,568
1985	-	566								259	825	24	-	24	16,005
1986	-	456								211	667	9	-	9	14,770
1987	3	1,328								190	1,521	44	-	44	15,483
1988	-	777								263	1,040	27	-	27	14,028
1989	50	1,491								38	1,579	40	-	40	13,319
1990	143	1,309								154	1,606	61	-	61	15,733
1991	40	1,390								180	1,610	5	-	5	14,311
1992	21	1,473								243	1,737	8	-	8	19,850
1993	54	1,174								310	1,538	15	-	15	20,383
1994	-	1,155								219	1,374	66	-	66	16,294
1995	50	1,135								225	1,410	10	-	10	14,569
1996	9	701	2	-	19	10	-	-	-		741	15	-	15	13,957
1997	15	1,358	1	1	27	8	-	24	-		1,434	100	-	100	17,089
1998	20	1,178	8	-	17	15	1	-	-		1,239	153	-	153	18,114
1999	70	1,385	4	-	51	5	1	-	-		1,516	132	-	132	15,625
2000	325	1,531	5	-	74	5	1	1	-		1,942	202	-	202	18,599
2001	1,039	1,691	17	-	64	8	1	1	-		2,821	438	-	438	15,287
2002	1,633	1,557	7	1	1	16	1	1	-		3,217	439	-	439	14,640
2003	1,084	2,196	3	-	-	8	-	-	-		3,291	381	-	381	14,443
2004	884	1,828	5	-	-	7	1	-	3		2,728	410	-	410	13,016
2005	437	1,813	1	-	-	5	2	-	18		2,276	434	-	434	12,999
2006	-	-	-	-	-	-	-	-	-	-	-	477	-	477	11,629
2007	-	-	-	-	-	-	-	-	-	-	-	452	-	452	12,558
2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9,733
2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9,141
2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,713
2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Catch data are currently unavailable for Republic of Korea, Philippines, and some other countries catching swordfish in the North Pacific.

[2] Catches by gear for 1952-1970 were estimated roughly using FAO statistics and other data. Catches for 1971-2002 are more reliably estimated.

[3] Contrains trolling and harpoon but majority of catch obtained by harpoon.

[4] For 1952-1970 "Other" refers to catches by net fishing and various unspecified gears.

[5] Offshore longline category includes some catches from harpoon and other fisheries but does not include catches unloaded in foreign ports.

[6] Estimated round weight of retained catch. Does not include discards.

[7] Unknown includes pole and line, purse seine, troll and troll/handline, half ring, and unspecified gears.

Table 3.1. Data used in the stock assessment model. Column labels are Fishery which defines a gear and area operation, Catch in either metric tons (mt) or thousands of fish (#'s), Composition information which are quarterly observations of the proportion-at-length, and CPUE which defines the number of CPUE series derived from that fishery. CPUE number of series in parentheses indicates the number used in the fitting of the model. 2010 estimates of catch are assumed the same as 2009 estimates in most cases.

Fishery	Catch (units)	Composition information years	CPUE (number of series)
Japan DWLL area 1	1975-2010 (#'s)	1975-2006	3 (3)
Japan DWLL area 2	1975-2010 (#'s)	1975-2009	3 (3)
Japan DWLL area 3	1975-2010 (#'s)	1975-2009	3 (3)
Japan Coastal LL	1952-2010 (mt)	1986-2009	1 (1)
Japan Driftnet	1952-2010 (mt)	1980-1983,91,00,05,08,09	2 (0)
Japan OLL	1952-2010 (mt)		0
Japan Squid	1952-2010 (mt)		0
Japan Bait	1952-2010 (mt)		0
Japan Net	1952-2010 (mt)		0
Japan Trap	1952-2010 (mt)		0
Japan Other	1952-2010 (mt)	1972-2000	0
Taiwan Longline	1952-2010 (mt)	2006-2009	2 (1)
Taiwan OSLL	1952-2010 (mt)		0
Taiwan Coastal	1952-2010 (mt)		0
Hawaii LL	1952-2010 (mt)	1994-2010	1 (1)
WCPO others	1952-2010 (mt)	1993-2009	0
Korea LL	1952-2010 (mt)	2005 (not used)	0

Table 3.2. Key Life History parameters used in the stock assessment.

Parameter (units)	value	Fixed or Estimated
Natural mortality (age-specific^{-yr})	0.54-0.38 (specify per age)	fixed
L_at_Amin (EFL cm) (0.3 yr)	104	fixed
L_at_Amax (EFL cm) (15 yr)	214	fixed
VonBert_K	0.24	fixed
CV_Amin (%)	0.14	fixed
CV_Amax (%)	0.08	fixed
Wtlen_1 (kg)	4.68E-06	fixed
Wtlen_2	3.16	fixed
Mat_inflection (EFL cm)	177	fixed
Mat_slope	-0.064	fixed
SR_R0	6.31642	estimated
SR_steep	0.87	fixed
SR_sigmaR	0.6	fixed
Initial age structure	(5 years)	estimated
Recruitment deviations	1975-2008	estimated

Table 3.3. Key fishery parameters used in the stock assessment. The equilibrium F is the estimate of fishing mortality in equilibrium condition required to harvest a fixed striped marlin catch of 5,000 mt given the initial estimates of fishing selectivity patterns by fleet. Mirrored selectivity pattern indicates that another fishery selectivity pattern was used to describe that fisheries removals because of the lack of biological sampling.

Equilibrium F	estimate	Equilibrium Catch	
JPN_DRIFT	1.56763	5,000 mt	
Selectivity			
Fishery	assumption	# parameters estimated	notes
JPN_DWLL1	domed	4	
JPN_DWLL2	domed	10	time varying (3 periods)
JPN_DWLL3	domed	10	time varying (3 periods)
JPN_CLL	domed	4	
JPN_DRIFT	asymptotic	2	
JPN_OLL	mirrored	0	same as CLL
JPN_SQUID	mirrored	0	same as CLL
JPN_BAIT	mirrored	0	same as CLL
JPN_NET	mirrored	0	same as CLL
JPN_TRAP	mirrored	0	same as CLL
JPN_OTHER_early	asymptotic	2	
JPN_OTHER_late	domed	4	
TWN_LL	domed	4	
TWN_OSLL	mirrored	0	same as TWN LL
TWN_CF	mirrored	0	same as TWN LL
HW_LL	domed	4	
WCPO_OTHER	domed	4	

Table 3.4. Likelihood component data variances used in the stock assessment. N indicates the number of observations. q is the analytical solution of the catchability coefficient. Inputted and model expected variances (SE and effN) are given. Input variances reflect a single iterative re-scaling of estimates to be consistent with model expectations. Input effN was only re-scaled if the model prediction of effN was smaller.

CPUE series	N	q	input_SE	r.m.s.e.
JPN_DWLL1_early	12	5.65E-06	0.306767	0.313622
JPN_DWLL1_middle	13	9.01E-06	0.414506	0.476571
JPN_DWLL1_late	10	1.86E-05	0.163003	0.236056
JPN_DWLL2_early	12	2.46E-05	0.390439	0.410733
JPN_DWLL2_middle	13	6.81E-05	0.546912	0.643616
JPN_DWLL2_late	10	4.47E-05	0.616454	0.699129
JPN_DWLL3_early	12	0.000686	0.257767	0.255444
JPN_DWLL3_middle	13	0.000785	0.222406	0.260008
JPN_DWLL3_late	10	0.000374	0.445173	0.54941
JPN_CLL	16	0.000209	0.307211	0.340951
JPN_DFT	17	0.000799	0.449941	0.449158
JPN_DFT	9	0.01038	0.268863	0.270924
TWN_EARLY	16	0.000303	0.466	0.4528
TWN_LATE	15	0.000693	0.234	0.198357
HWLL	14	0.003293	0.478402	0.46803
Size composition	N		Input_effN	mean_effN
JPN_DWLL1	69		9.79275	13.1349
JPN_DWLL2	131		33.2174	33.1769
JPN_DWLL3	135		42.16	47.5473
JPN_CLL	91		39.0429	47.9348
JPN_DRIFT	15		18.32	39.7174
JPN_OTHER_early	34		32.2596	31.4876
JPN_OTHER_late	14		34.0183	33.8602
TWN_LL	13		10.0538	33.8169
HW_LL	66		26.7864	25.7773
WCPO_OTHER	53		3.30377	26.0528
KOR_LL	1		5.1	33.9381

Table 3.5. Negative log likelihood values for the base case assessment model (right column) summarized for the total model likelihood and by likelihood components (rows).

		Base
	TOTAL	3949.55
	Catch	0.47
	Equil_catch	0.54
	CPUE	-73.03
	Length_comp	4020.27
	Recruitment	1.29
Length_comp	JPN_DWLL1	306.28
	JPN_DWLL2	971.37
	JPN_DWLL3	1103.22
	JPN_CLL	572.30
	JPN_drift	59.03
	JPN_other_early	452.49
	JPN_other_late	123.12
	TW_LL	28.11
	HW_LL	343.60
	WCPO	60.77
CPUE	JPN_DWLL1	-7.79
		-2.68
		-7.68
	JPN_DWLL2	-4.58
		1.07
		1.75
	JPN_DWLL3	-10.38
		-10.88
		-0.70
	JPNCLL	-8.57
	TWLL_late	-16.40
	HWLL	-6.20

Attachment 1. List of Participants

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Attachment 2. Working Papers

ISC/11/BILLWG-3/01	Preliminary Striped Marlin Stock Assessment. Kevin Piner, Hui-Hua Lee, Ian Taylor, and Gerard DiNardo. (Kevin.Piner@noaa.gov)
ISC/11/BILLWG-3/02	Stock Assessment of Striped Marlin *(Kajikia audax)* in the western and central North Pacific Ocean Using an Age-Structured Model. Chi-Lu Sun, Nan-Jay Su, Su-Zan Yeh, and Yi-Jay Chang. (chilu@ntu.edu.tw)
ISC/11/BILLWG-3/03	Estimated Stock Dynamics of North West Pacific Striped Marlin by Using a Stock Production Model Incorporating Covariates (ASPIC). Minoru Kanaiwa and Kotaro Yokawa. (m3kanaiw@bioindustry.nodai.ac.jp)
ISC/11/BILLWG-3/04	Patterns in Catches, Standardized CPUEs, and Fishery Length Compositions of the Western and Central North Pacific Striped Marlin Stock. Jon Brodziak and Lyn Katahira. (Jon.Brodziak@noaa.gov)
ISC/11/BILLWG-3/05	U.S. Commercial Fisheries for Marlins in the North Pacific Ocean. Russell Ito. (Russell.Ito@noaa.gov)
ISC/11/BILLWG-3/06	A Sensitivity Study for Striped Marlin *(Kajikia audax)* in the Western and Central North Pacific Ocean using an age-structured Model (ASPM). Chi-Lu Sun, Yi-Jay Chang, Nan-Jay Su, and Su-Zan Yeh. (chilu@ntu.edu.tw)

Attachment 3. Agenda

INTERNATIONAL SCIENTIFIC COMMITTEE FOR TUNA AND TUNA-LIKE SPECIES IN THE NORTH PACIFIC

BILLFISH WORKING GROUP (BILLWG)

INTERCESSIONAL WORKSHOP ANNOUNCEMENT

Meeting Site: Hawaii Imin International Conference Center at Jefferson Hall
Kamehameha Room
1777 East-West Road
Honolulu, HI 96848

Meeting Dates: Dec 6-16, 2011

Goals: Conduct assessment of the Western and Central North Pacific striped marlin stock. Begin preparation for blue marlin stock assessment. Develop plan to update North Pacific swordfish stock assessment.

<u>DRAFT AGENDA</u>

December 6 (Tuesday), 1000-1030 – Registration

December 6 (Tuesday), 1030-1700

1. Opening of Billfish Working Group (BILLWG) Workshop
    a. Welcoming Remarks
    b. Introductions
    c. Standard Meeting Protocols

2. Adoption of Agenda and Assignment of Rapporteurs

3. Computing Facilities
    a. Access
    b. Security Issues

4. Numbering Working Papers and Distribution Potential

5. Status of Work Assignments

6. Annual Billfish Catch/Effort (Category I, II, & III data)
    a. Review of Recent Fishery Information and Available Catch Projections (through

2011)

7. Western and Central Pacific Striped Marlin Stock Assessment Data Inputs
    a. Life History Information Sources
    b. Catch
    c. CPUE Time Series
    d. Size Compositions

8. Western and Central Pacific Striped Marlin Stock Assessment Modeling (if time permits)
    a. Use of Life History Information
    b. Fishery Definitions and Selectivity Modeling
    c. Catch Time Series
    d. Fitting CPUE Time Series

December 7 (Wednesday), 930-1700

8. Assessment Modeling: Continued
    a. Use of Life History Information
    b. Fishery Definitions and Selectivity Modeling
    c. Catch Time Series
    d. Fitting CPUE Time Series
    e. Fitting Size Compositions
    f. Model Runs
    g. Model Diagnostics
    h. Model Results
    i. Biological Reference Points
    j. Sensitivity Analyses
    k. Stock Projections

December 8 (Thursday), 930-1700

8. Assessment Modeling: Continued
    a. Use of Life History Information
    b. Fishery Definitions and Selectivity Modeling
    c. Catch Time Series
    d. Fitting CPUE Time Series
    e. Fitting Size Compositions
    f. Model Runs
    g. Model Diagnostics
    h. Model Results
    i. Biological Reference Points
    j. Sensitivity Analyses
    k. Stock Projections

December 9 (Friday), 930-1700

8. Assessment Modeling: Continued
    a. Use of Life History Information
    b. Fishery Definitions and Selectivity Modeling
    c. Catch Time Series
    d. Fitting CPUE Time Series
    e. Fitting Size Compositions
    f. Model Runs
    g. Model Diagnostics
    h. Model Results
    i. Biological Reference Points
    j. Sensitivity Analyses
    k. Stock Projections

December 10 (Saturday), 930-1300

8. Assessment Modeling: Continued
    a. Use of Life History Information
    b. Fishery Definitions and Selectivity Modeling
    c. Catch Time Series
    d. Fitting CPUE Time Series
    e. Fitting Size Compositions
    f. Model Runs
    g. Model Diagnostics
    h. Model Results
    i. Biological Reference Points
    j. Sensitivity Analyses
    k. Stock Projections

December 11 (Sunday), No Meeting

December 12 (Monday), 930-1700

8. Assessment Modeling: Continued
    a. Use of Life History Information
    b. Fishery Definitions and Selectivity Modeling
    c. Catch Time Series
    d. Fitting CPUE Time Series
    e. Fitting Size Compositions
    f. Model Runs
    g. Model Diagnostics
    h. Model Results
    i. Biological Reference Points
    j. Sensitivity Analyses
    k. Stock Projections

December 13 (Tuesday), 930-1700

9. Adoption of Base Case Assessment Model for WCPO Striped Marlin
   a. Use of Life History Information
   b. Fishery Definitions and Selectivity Modeling
   c. Catch Time Series
   d. Fitting CPUE Time Series
   e. Fitting Size Compositions
   f. Model Runs
   g. Model Diagnostics
   h. Model Results
   i. Biological Reference Points
   j. Sensitivity Analyses
   k. Stock Projections

10. Pacific Blue Marlin Stock Assessment Work Plan
    a. Collaborative Partners
    b. Preparation of Assessment Data
    c. Assessment Modeling Approaches

11. Other Business
    a. North Pacific Swordfish Assessment Update
    b. ISC Billfish Working Group Participation
    c. Future Meetings and Timeline
    d. Assignments

December 14 (Wednesday), 930-1300

12. Rapporteurs and Participants Complete Report Sections

December 15 (Thursday), 930-1700

13. Complete Workshop Report and Circulate; WG Reviews Report

December 16 (Friday), 930-1200

14. Clearing of Report

15. Adjournment

Appendix 1. Likelihood Table

		Set 1	Set 1 + JPN_CLL	Set 1 + JPN_Drift	Set 1 + TW_LL
	Total	4452.56	4439.26	4447.00	4425.72
	Catch	2.06	1.89	1.39	1.67
	CPUE	12.60	5.52	18.25	-0.13
	Length_comp	4437.97	4432.80	4428.87	4425.53
	Recruitment	-0.07	-0.96	-1.53	-1.35
Size composition	JPN_DWLL1	305.32	305.17	306.50	305.22
	JPN_DWLL2	1171.91	1171.85	1171.19	1169.33
	JPN_DWLL3	1129.25	1123.86	1124.03	1117.89
	JPN_CLL	582.91	586.38	583.72	583.42
	JPN_drift	61.53	60.04	60.62	61.46
	JPN_other_early	604.50	607.56	602.09	608.04
	JPN_other_late	136.12	135.96	137.31	135.67
	TW_LL	29.21	28.50	29.14	29.46
	HW_LL	355.37	352.40	352.56	353.42
	WCPO	61.85	61.08	61.71	61.60
CPUE		-4.92	-4.93	-4.41	-4.73
	JPN_DWLL1	6.15	6.79	6.61	6.35
		-12.91	-13.12	-12.40	-12.18
		5.64	5.51	7.28	6.18
	JPN_DWLL2	26.57	25.67	26.80	26.75
		15.90	15.58	15.86	17.02
		-9.26	-9.32	-9.31	-9.43
	JPN_DWLL3	-12.73	-12.95	-12.10	-12.76
		4.47	5.23	6.60	7.25
	JPN_CLL	0	-6.00	0	0
	JPN_drift	0	0	5.83	0
	JPN_drift	0	0	-6.77	0
	TWLL_early	0	0	0	-4.32
	TWLL_late	0	0	0	-14.88
	HW_LL	-6.33	-6.93	-5.73	-5.40