Annex 5

REPORT OF THE BILLFISH WORKING GROUP WORKSHOP

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

3-10 February 2009
Honolulu, Hawaii, USA

1.0 INTRODUCTION

The 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 February 3-10, 2009. The goals of the workshop were 1) to update and adopt fishery statistics, 2) review swordfish stock structure scenarios, 3) concur on standardized swordfish CPUE time series for use in stock assessments, and 4) agree on swordfish stock assessment model structure(s) and input parameters. Gerard DiNardo, Chairman of the BILLWG, welcomed participants from Chinese Taipei, the Inter-American Tropical Tuna Commission (IATTC), Japan, and the United States of America (USA) (Appendix 1). Rapporteuring duties were assigned to Jon Brodziak, Dean Courtney, Michael Hinton, Gakushi Ishimura, Russell Ito, Minoru Kanaiwa, Ai Kimoto, Kevin Piner, Chi-Lu Sun, Lyn Wagatsuma, and Kotaro Yokawa. Wagatsuma served as lead rapporteur with overall responsibility of assembling the workshop report. Working papers (WP) were distributed and numbered (Appendix 2), and the meeting agenda adopted (Appendix 3).

2.0 MEETING SUMMARIES

2.1 8th ISC Plenary

The 8th ISC Plenary meeting was held in Takamatsu, Japan in July 2008. Gerard DiNardo, BILLWG Chairman, presented summaries, and reports of the BILLWG workshops held since the 7th ISC Plenary Meeting, including plans for the October 2008 Billfish habitat requirements session at the 5th World Fisheries Congress and the November 2008 BILLWG Special session on stock structure. DiNardo also provided an update on the status of the upcoming swordfish assessment, sought guidance concerning interactions with the Northern Committee Striped Marlin Working Group (NC-SMWG), submitted a report recommending North Pacific striped marlin as a northern stock, updated catch tables, and discussed a billfish biological research plan at the request of the ISC Chairman. Meeting participants reviewed and adopted analyses recommending striped marlin as a northern stock, and endorsed both the 5th World Fisheries Congress Special Session on habitat requirements, as well as the ISC Billfish Special Session on stock structure. An ISC Biological Research Task Force (BRTF) was established; led by Shui-

Kai (Eric) Chang as Chairman, and assisted by John Holmes. The ISC BRTF is scheduled to convene immediately following the ISC BILLWG in May 2009 in Busan, Korea.

2.2 WCPFC-SC4

The 4th Regular Session of the Western and Central Pacific Fisheries Commission Scientific Committee (WCPFC-SC) was held in Port Moresby, Papua New Guinea in August 2008. Gerard DiNardo updated the WCPFC-SC on the activities of the ISC BILLWG, submitted a blue marlin assessment schedule and proposal, and presented information supporting striped marlin as a northern stock. The WCPFC-SC did not agree with the ISC BILLWG's findings of striped marlin as a northern stock and suggested that catch data from the South Pacific Ocean be included in the BILLWG's analysis. Conversely, the WCPFC-SC accepted the assessment done by Australian scientists assuming a separate South Pacific stock and endorsed the NC-SMWG which assumes a separate North Pacific stock.

Discussion

It was pointed out that the BILLWG completed the requested analyses and that the acceptance and endorsement of contradicting analyses brings into question the scientific credibility of the decision. In order to clarify the issue, the Chairman may want to contact Naozumi Miyabe, WCPFC-SC Chair, regarding how to go forward with this matter, as well as the Australians to discuss a possible collaboration of efforts.

2.3 4th Regular Session of the Northern Committee

The 4th Regular Session of the Northern Committee (NC4) was held in Tokyo, Japan in September 2008. At the 3rd Regular Session of the Northern Committee (NC3) held in September 2007, the Northern Committee was tasked to convene a working group that includes fisheries managers, gear technology experts and fishermen, as well as scientists, in order to identify effective mitigation measures to reduce fishing mortality on striped marlin in the North Pacific Ocean. In reviewing the progress of the working group, the NC4 acknowledged that little progress had been made. It found, however, that the work remained important and that the tasks identified at NC3 were still relevant. The ISC provided a list of fisheries papers containing striped marlin information for use by the striped marlin working group. The NC members agreed to intensify their efforts to contribute to the work of the group, with a view to producing useful results in time to be reviewed at the 5th Regular Session of the WCPFC (WCPFC5) in December 2008. Subsequent to the meeting, the U.S. volunteered Gerard DiNardo to chair the NC-SMWG. A work plan was developed and accepted, and scientific working group members identified. Other working group members (i.e. fisheries managers) still need to be identified.

2.4 5th Regular Session of the WCPFC

The WCPFC5 was held in Busan, Korea in December 2008. The WCPFC agreed that the NC-SMWG's work is still a high priority and endorsed their work plan. It subsequently released a request for proposals to partially fund North Pacific striped marlin research and proposals are due by COB on February 13, 2009.

Discussion

Because many of the members of the ISC BILLWG overlap with members of the NC-SMWG, the BILLWG discussed whether the NC-SMWG should be convened under the umbrella of the ISC, or as a separate entity. It was agreed that these groups will be separate (i.e. will submit separate reports, etc.), but in order to save time and money, will convene in conjunction with the scheduled ISC BILLWG workshops. It was clarified that if a proposal is submitted to the WCPFC, it will be submitted by interested scientists as a group, and not by the ISC BILLWG. It was agreed that the focus of the NC-SMWG should be to identify potential mitigation measures to reduce fishing mortality (i.e. time/space closures, gear modifications, etc.) In the future, the NC-SMWG will need to collaborate with fishermen as well as other countries. This should improve relationships between scientists and fishermen, thus aiding implementation of fishing mortality reduction methods.

It was pointed out that the role of the WCPFC-SC, relative to the tasks of the NC-SMWG is unclear. For example, does the WCPFC-SC have to review and endorse the work of the NC-SMWG before any measures can by presented for adoption at the NC or WCPFC Committee meetings? The Chairman was tasked with contacting the Chairman of the WCPFC-SC to seek clarification.

3.0 ISC BILLFISH WORKING GROUP SPECIAL SESSION ON STOCK STRUCTURE

The ISC BILLWG special session on billfish stock structure was convened in Honolulu, Hawaii, USA from 12-14 November 2008 (Appendix 4). The goal of the special session was to assess billfish stock structure in the North Pacific Ocean and develop plausible stock structure scenarios for populations of swordfish and striped marlin in the North Pacific for use in stock assessments. Participants included scientists from the USA, Japan, and the IATTC, as well as invited geneticists from Texas A&M University and Hopkins Marine Station, Stanford University.

Presentations were made by BILLWG members, as well as the invited geneticists. It was evident that there is insufficient spatio-temporal coverage in the genetic studies of North Pacific swordfish. Studies lacked large sample sizes and samples were collected opportunistically, rather than at according to an established statistical sampling design.

After careful review of available genetic, CPUE, and distributional data, it was agreed that the upcoming swordfish stock assessment would assume two stock structure scenarios: Stock Scenario-1) a single North Pacific stock (Figure 1), and Stock Scenario-2) a two-stock scenario with a diagonal boundary from Baja, California (30ºN x 110ºW) to approximately 170ºW at the equator. The boundary follows a step wise pattern as outlined in Figure 2, inferred from the WP by Ichinokawa and Brodziak (ISC/08/BILLWG-SS/04). The southern boundary in the Western-Central Pacific Ocean is at the equator and in the Eastern Pacific Ocean the southern limit is set at 20ºS.

While data to support a multiple stock scenario for NP striped marlin is weak, the BILLWG recognized that spatial structure is evident and future assessments should at minimum, capture this as a sensitivity run.

Discussion

It was clarified that the southern boundary of Stock Scenario-2 in the Eastern Pacific Ocean at 20ºS was arbitrarily decided by the WG. While there is catch data south of 20ºS, the data is limited, making a choice of a more effective southerly boundary difficult. Also, there was a desire to focus the assessment on the North Pacific and a more southerly boundary could bias results. Additionally, the original boundary suggested by the Ichinokawa and Brodziak document (ISC/08/BILLWG-SS/04) was more complicated (5ºx5º blocks cut diagonally), but because of the resolution of available catch data (5ºx5º), the stepwise boundary was adopted. The WG recognized the possibility of contamination between Sub-Areas (EPO), however sensitivity analyses indicate that the range of the boundary is narrow. It was also clarified that the geneticists agreed that there is a North-South split of the swordfish stock in the Western Pacific at the equator which is consistent with the proposed stock scenarios.

Figure 1. Depiction of boundaries for the single stock scenario.

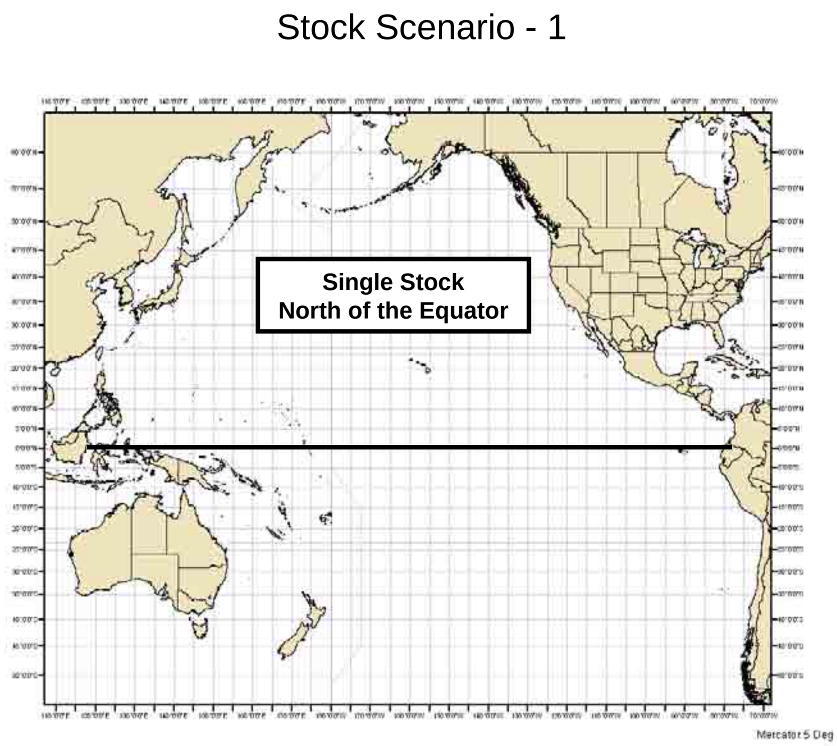
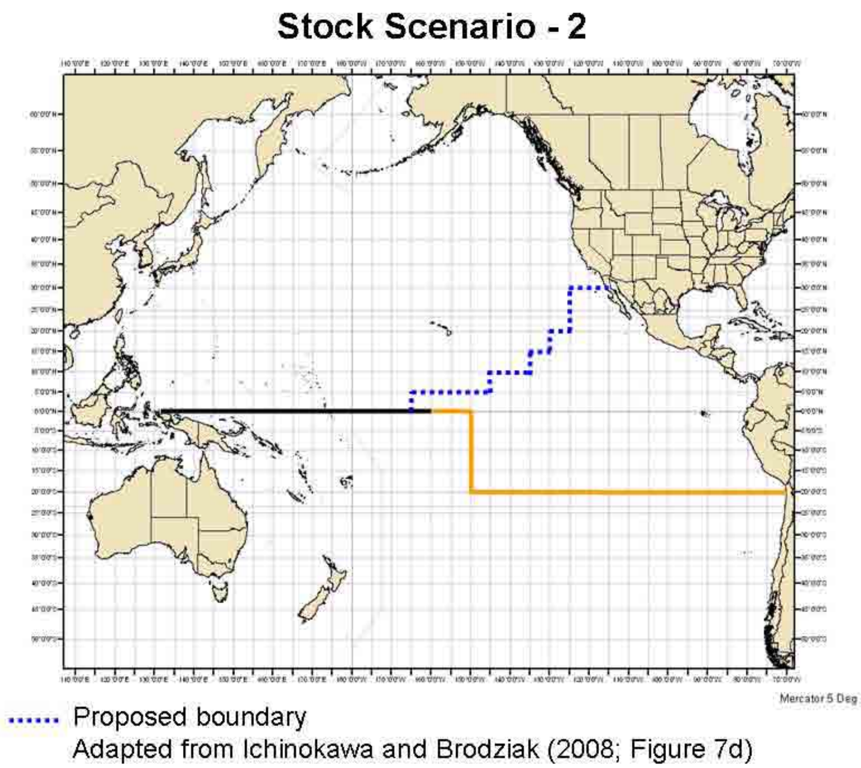


Figure 2. Depiction of proposed boundaries for the two-stock scenario.



4.0 STATUS OF WORK ASSIGNMENTS

The WG was updated on the status of work assignments from the June 2008 ISC BILLWG workshop. BILLWG members were assigned to:

- Complete and submit north Pacific swordfish CPUE time series
- Complete and submit data catalogues
- Submit Category I data for 2000-2007

DiNardo indicated that the North Pacific swordfish CPUE time series should be nearly complete by the adjournment of this meeting for use in the swordfish stock assessment. Data catalogues have been distributed to participants from Chinese Taipei, Japan, Mexico and the USA, with instructions to fill out information on data for striped marlin, swordfish, and blue marlin, and submit completed catalogues to the Chairman as soon as possible. It was noted that information has been submitted from Hawaii, but is still outstanding from Japan, Chinese-Taipei, Mexico, and the USA (California only). Category I data for 2000-2007 has been submitted by most participating member countries and will be reflected in the catch tables (Tables 1 and 2).

Assignments for the Chairman of the BILLWG from the June 2008 ISC BILLWG workshop were:

- ISC Plenary presentations
- WCPFC-SC4 presentations
- Request Category I, II and III data from member countries

The Chairman reported that presentations at the 8th ISC Plenary and the WCPFC-SC4 were made, and requests were sent out for Category I, II, and III data to member countries. The importance of the data catalogues to the activities of the BILLWG was stressed and member countries should submit their completed data catalogues as soon as possible.

5.0 BILLFISH CATCH AND EFFORT DATA

5.1 Catch amount of Swordfish (*Xiphias gladius*) by the Japanese coastal, offshore, and distant-water longline fishery in the Pacific presented by Ai Kimoto (ISC/09/BILLWG-1/16)

Catch associated with the offshore fishery were separated into a North Pacific Ocean (Sub-Area 1) and Eastern Pacific Ocean (Sub-Area 2) stock according to the agreed two stock scenario (Stock Scenario-2) adopted by the BILLWG (see Fig. 2). Catch in numbers is available from 1952 to 2007, catch in weight from 1971 to 2007. Catch statistics from the coastal longline fishery are limited to Sub-Area 1. From 2000 to 2003, swordfish catches were stable. After 2003, catches increased slightly.

<u>Discussion</u>

The discussion included issues of imperfect matching in some data categories. For example, data from the coastal longline (<20 MT) does not have quarterly catch data before 1994. It was pointed out that the log-book system for Japanese coastal longliners commenced in 1994. Before that, only the annual catch by species had been available in Japanese year book of the fishery.

5.2 Catch table updates

Kotaro Yokawa submitted an updated Japanese catch table. In this submission, swordfish catch by the harpoon fishery included trolling catches while catches by other gears included the bait fishing method. Striped marlin catches for the other gear included catches by bait fishing, net fishing, trap net, trolling, and harpoon. It was also pointed out that CPUE time series for swordfish caught in Japanese fisheries have been updated..

The Chairman noted that updates to the catch tables were also submitted by Korea and Mexico (ISC/09/BILLWG-1/14), but scientists from these countries were not present to explain the updates. The information from Korea comprised Category I data, while that of Mexico comprised Category I, II, and III data.

<u>Discussion</u>

The WG accepted these catch table updates, and changes will be reflected in Tables 1 and 2. The BILLWG Chairman thanked all countries for their submissions.

6.0 STRIPED MARLIN

6.1 The spatial distribution of habitat preferences for striped marlin presented by Minoru Kanaiwa (ISC/09/BILLWG-1/03)

Previous analyses using Japanese Training Vessels (JTV) data indicated that ambient temperature is a good indicator for habitat preference. However, the JTV data contains detailed operational data which is generally not available from the commercial fishery. Reported operational data from Japanese longline fisheries is generally limited to hooks per basket (HPB) and our analyses suggested no clear relationship between nominal CPUE (nCPUE) and HPB in the North Pacific. The same was true for nCPUE and sea surface temperature, and nCPUE and depth of the deepest hook (DHT). However, there appears to be a weak relationship between catch rate and HPB, as well as catch rate and DHT in areas adjacent to the US coast. From these results, we conclude there may be some spatially structured habitat preferences for striped marlin, but additional studies are necessary to obtain reasonable areal and seasonal distribution patterns by depth.

Discussion

Because zero catches are prevalent in the commercial data set, it was suggested that a logistic regression, with areas as factors, could also be applied, as well as the delta-model approach. The failure to identify habitat preferences in most areas may be attributed to variation in gear configuration over time and space. This variation is not present in data from training vessels. It was noted that including feeding study data in estimates of habitat preference may not be informative, because ongoing studies suggest striped marlin feed opportunistically.

6.2 Model uncertainty and biological reference points for North Pacific striped marlin presented by Jon Brodziak (ISC/09/BILLWG-1/02)

Model selection and model averaging techniques were applied to estimate biological reference points for North Pacific striped marlin under competing hypotheses about stock-recruitment dynamics and environmental forcing under each stock structure scenario. This analysis was a continuation of research presented at the June 2008 ISC BILLWG meeting. The new analyses explicitly incorporated the recommendations of the ISC BILLWG on the treatment of fishery selectivity. In particular, aggregate fishery selectivity at age was calculated for two selectivity time periods (1965-1979 and 1980-2003) using the same approach as was used in the WG's analysis of the fraction of North Pacific striped marlin biomass north of 20° North. A standard age-structured production model was applied to calculate external estimates of maximum sustainable yield (MSY) based biological reference points using stock-recruitment estimates from the two assessment scenarios for North Pacific striped marlin and a Bayesian model-averaging approach developed by Brodziak and Legault (2005). Spawning biomass (S_{MSY}) and fishing mortality (F_{MSY}) to produce MSY were the focus of this analysis because they are currently used to guide the management of several tuna stocks in the North Pacific and also because they provide a natural biological limit for assessing the issue of overfishing as an indicator for ecosystem-based fishery management. Model averaged estimates of spawning biomass to produce maximum sustainable yield (S_{MSY}) and the associated fishing mortality (F_{MSY}) were used to characterize the relative stock status (S/S_{MSY} and F/F_{MSY}) under each scenario through time. Model averaged estimates of relative status can be averaged across assessment scenarios to reflect the relative credibility of each scenario, despite differences in the scale of absolute estimates of spawning biomass and fishing mortality under each scenario. Implications of these analyses for the North Pacific striped marlin stock were straightforward. First, there was substantial evidence that the stock is depleted or is rapidly approaching a depleted condition. Second, it was highly likely that the stock has been experiencing excessive fishing mortality ($F/F_{MSY} > 1$) since the 1980s. These conclusions about probable stock status suggested that it may be useful to consider how fishing mortality might be reduced through reduction of catch or fishing effort in fisheries that harvest North Pacific striped marlin.

Discussion

The WG agreed that the approach taken has significant utility. Assessments containing data from multiple fleets generally have differing selectivity curves, and coping with this in the development of reference points has been a persistent problem. This approach provides a way to deal with this issue, as well as a way of averaging across competing assessment models. The WG agreed that the three scenarios outlined in the paper may be plausible, and recommended Kobe Plots be developed for each. It was pointed out that choice of reference points and how information of stock status is portrayed has yet to be resolved in most RFMOs.

6.3 Considerations on regions for use in stock assessments of striped marlin presented by Michael Hinton (ISC/09/BILLWG-1/18)

Catch rates of striped marlin taken in longline fisheries of Japan from 1965-1974 were standardized using generalized additive models (GAM), and the model output graphed as contour plots to assist with the identification of potential regions. There was indication of sub-area structure in the population of striped marlin in the Pacific, with regions for stock assessment identified in the northwest, northeast and southeast regions. The findings of the catch rate analyses were consistent with indications of stock structure in the Pacific striped marlin from genetic studies and tagging studies indicating low mixing rates among regions of high abundance of striped marlin.

Discussion

It was recognized that this paper potentially provides a new and interesting approach for analyzing CPUE of billfishes caught by longliners, but caution should be exercised when comparing relatively high CPUEs in the EPO area with those observed in other areas. In the EPO, striped marlin are targeted while they are a bycatch in other areas. This standardization approach does not account for differences in targeting. Concern was raised over combining the relatively high catch rate area in the subtropical north central Pacific with a stock whose spawning area is westward near Chinese Taipei, rather than to the high catch region and spawning ground off Mexico. The distance between the subtropical area in the north central Pacific and waters off Mexico is less than the distance to the area off Chinese Taipei (~2,700nm vs ~3,300 nm). It was pointed out that there is a difference between the genetic structure of striped marlin found off Mexico and Hawaii, but no significant difference between those off Japan/Chinese Taipei and those off Hawaii, which supports the connectance between the Japan/Chinese Taipei area and Hawaii. However, it was noted that this genetic difference is based on a relatively small sample size which could potentially influence the results. Available information suggests that the existence of a large spawning ground of striped marlin in around Hawaiian waters is low. However, it was pointed out that there has been little sampling for striped marlin larvae in the regions of the North Pacific where spawning may be occurring, or in regions of the western Pacific where spawning has been described or believed to be occurring. It was noted that parameters for environmental data examined as part of this work were not significant in the model, which was consistent with results shown in November 2008. It was suggested that a more rigorous model selection process be implemented, such as AIC or BIC values, to which it was pointed out that for the method used, AIC and BIC values are not suitable for selection of final fitted models. It was also suggested that model selection be evaluated from the view point of its consistency with the biology of striped marlin. For comparative purposes, it was suggested that this method be applied to North Pacific swordfish.

7.0 SWORDFISH CPUE TIME SERIES

7.1 Generalized additive model analyses to standardize swordfish (*Xiphias gladius*) catch rates in the Hawaii-based pelagic longline fishery, 1995-2007, for use in stock assessment presented by Dean Courtney (ISC/09/BILLWG-1/04)

In the Hawaii-based longline fishery, shallow-sets generally target swordfish, while deep-sets target bigeye tuna and catch swordfish incidentally. Data used to standardize catch rates included information on environmental conditions and fishing operations. Three GAMs were fit to the data and each GAM included the same response and predictor variables. The first GAM was fit to all observed sets (shallow and deep combined). The second GAM was fit to shallow-sets separately. The third GAM was fit to deep-sets separately. The deviance residuals for the GAM fit to all sets (shallow and deep combined) were heteroskedastic when plotted against the predictors. This was not the case for deviance residuals from the separate deep- and shallow-set GAM fits. As a result, predicted catch rates were estimated from GAMs fit separately to shallow-sets and to deep-sets. Two time series of swordfish CPUE are recommended for consideration in stock assessment: Nominal CPUE from observed plus unobserved shallow-sets, and GAM-predicted CPUE from observed plus unobserved shallow-sets. Two additional time series of swordfish CPUE may be useful for exploratory purposes: 1) nominal CPUE from observed plus unobserved deep-sets, and 2) GAM-predicted CPUE from observed plus unobserved deep-sets.

Discussion

The WG discussed the separation of deep- and shallow-sets using 15 HPB. It was noted that the 15 HPB was a regulation identifying swordfish targeting (sets with <15 HPB are assumed to target swordfish). There was considerable discussion on what factors to use in the final model and what method was best to choose important factors (AIC or BIC). However, it was also noted that once the data set is divided into deep- and shallow-sets the addition of other factors does not greatly affect the trend in the index. The WG recommended that standardized CPUE be used in the upcoming assessment, not nominal metrics. The WG also noted that the time series associated with shallow-sets best represents swordfish abundance for use in the upcoming stock assessment because swordfish are caught incidentally in the deep-sets and the associated CPUE time series does not reflect abundance.

7.2 Preliminary CPUE time series from the California driftnet fishery, 1990-present presented by Kevin Piner (ISC/09/BILLWG-1/05)

Drift gill net fisheries targeting swordfish have operated off the west coast of the United States since the early 1980s. Management regulations have impacted both the method and area of operation in attempts to reduce impact on non-targeted species. The fishery has been somewhat stable in operations since 1990, with observer coverage starting in that year. A CPUE series was derived from 1990-2008 from logbooks recording catch and effort data. The time series show a flat trend, with increase variance post 2000. Effort directed at swordfish has also declined over the same period and the increasing variance reflects a near linear decline in observations. More work is needed to better understand the affects of regulations on the derived CPUE series. With additional work, it may also be possible to extend the time series back to the early 1980s.

Discussion

The utility of the drift gillnet data as the basis for CPUE was discussed. It was noted that the series represents only a small fraction of Sub-Area 1 and catch rates may have been influenced by management actions. Furthermore, the relatively large variance estimates derived from the re-sampling approach and the generally flat trend of the index would diminish its contribution to the stock assessment. In contrast, it was also noted that a flat index may be representative of the population's trend in abundance and that other data sources have been equally affected by management regulation. It was agreed that work on the index should be continued with emphasis on understanding the effect of the recent time area closures on the estimated CPUE with the goal to determine if the introduction of latitude and season blocks in the analysis successfully accounted for the recent time/area closures.

7.3 CPUE distribution of swordfish by the Japanese offshore and distant-water longline fishery in the Pacific Ocean for the two-stock scenarios – a single North Pacific and a two-stock hypothesis presented by Ai Kimoto (ISC/09/BILLWG-1/15)

Standardized CPUE series for the period between 1952 and 2006 were developed using a generalized linear model (GLM) analysis. For the single North Pacific stock (NPO) hypothesis (Stock Scenario-1), CPUE metrics before the early 1980s were lower than the average of the whole period. Highest CPUEs were observed in 1987 and 2001, while the lowest CPUE was observed in 1998. In 2006, higher than average CPUEs were also observed. For the two-stock hypothesis (Stock Scenario-2), the stock in the Sub-Area 1 showed a similar trend to the one in the single stock scenario (Stock Scenario-1) before 1996. Lowest CPUEs were observed in 1997 and 1998. High CPUEs were observed in 2001 and 2006, but the values are not as prominent compared to those observed in the single North Pacific stock hypothesis (Stock Scenario-1). In the Sub-Area 2 (EPO), CPUEs are available from 1955 through 2006. High standardized CPUE was observed in 1970 and decreased thereafter.

Discussion

The BILLWG Chairman noted this was the Dr. Kimoto's first presentation to the WG, and that the WG was appreciative.

7.4 Effects of a change in target species on the CPUE of swordfish caught by Japanese offshore surface longliners operating in the North Pacific presented by Kotaro Yokawa (ISC/09/BILLWG-1/06)

The Japanese offshore surface longline fishery primarily targets swordfish in the northwest and the north central Pacific, and also targets tunas and blue shark seasonally. The analysis of recent set-by-set data from surface operations (sets with 3 and 4 HPB) suggests a declining importance of tuna as a secondary target and an increasing importance of blue shark. This apparent shift in targeting of tuna and blue shark occurred between 1994 and 2007 and could bias swordfish CPUE estimates in the northwest and north central Pacific, which are predominately estimated from data associated with the Japanese offshore and, to a lesser extent, from distant-water longline fisheries. Additional research is needed to assess the impact of shifting targets in an objective way.

Discussion

The WG noted that it was difficult to separate unsuccessful trips targeting swordfish from successful trips targeting sharks. The WG suggested that examining the entire trip to determine when targeting changed may be more successful than examining targeting solely on a set by set basis.

7.5 Standardization of Taiwanese distant-water tuna longline catch rates for swordfish in the North Pacific from 1995-2007 based on the two stock structure scenarios recommended for stock assessment presented by Chi-Lu Sun (ISC/09/BILLWG-1/17)

Catch rates of swordfish for the Taiwanese tuna longline fishery in the North Pacific Ocean were standardized using a GLM. For the two stock hypothesis (Stock Scenario-2), the boundary separation adopted by the WG (see Ichinokawa and Brodziak ISC/08/BILLWG-SS/03) was assumed. Each model included the main variables year, quarter, area, hooks per basket (HPB), and all two-way interactions between quarter, area and HPB. For the single North Pacific stock hypothesis, CPUE increased from 1995 to 2001, declined until 2005, after which CPUE increased. For the two-stock hypothesis, CPUEs in Sub-Area 2 (EPO) were generally higher compared to CPUEs in Sub-Area 1 (NPO). In Sub-Area 1 (NPO), CPUEs increased between 1995 and 2002, declining gradually thereafter. In Sub-Area 2 (EPO), CPUEs increased between 1995 and 2001, declined until 2005, thereafter CPUEs increased.

Discussion

The WG agreed that the incorporation of HPB into the model, instead of the catch of other species as a proxy for target/depth, represents an improvement over past standardization analyses. It was noted that the spatial distribution of Chinese Taipei fishing effort and associated catch is consistent with the stock boundaries proposed in the two-stock hypothesis (Stock Scenario-2). It was also noted that there is historical catch and effort data without HPB and that incorporating these data into the analysis would extend the series further back in time. A proposal was made by Chinese Taipei to extend the HPF series further back in time and would involve a collaborative research project between Chinese Taipei and Japan. In the interim, the WG recommended that catch rate data from the other species remain in the model as a means of incorporating targeting in the analysis.

8.0 SWORDFISH LENGTH DATA

8.1 Length Distributions of male and female swordfish captured in the directed Hawaii pelagic longline fishery during 1994-2008 presented by Jon Brodziak (ISC/09/BILLWG-1/07)

Age and growth studies of swordfish captured in the Hawaii-based pelagic longline fishery have shown that swordfish in this fishery region exhibit sexual dimorphism, with females growing faster and attaining larger sizes than males (DeMartini et al. 2007). This WP examines whether sexual dimorphism of swordfish catches were consistently observed in the Hawaii-based longline fishery. Quarterly length distributions of swordfish captured in Hawaii's shallow-set longline fishery (a swordfish directed fishery) during 1994-2008 are described using data collected by fishery observers. Differences in quarterly mean lengths of female and male swordfish were analyzed using the two-sample T-test to discern whether sexual dimorphism was apparent in the swordfish fishery catch data. This test procedure is robust to departures from normality. T-test results indicated that there were 30 significant comparison-wise differences between female and male mean lengths out of a total of 43 quarterly comparisons. On average, female mean length at capture was 16 cm greater than the male mean length in the quarters where a significant difference was detected. The observed percentage of significant comparisons (70%) was substantially higher than expected due to random sampling (5%). Overall, the analysis provided strong evidence that sexual dimorphism typically exists in the swordfish captured by the directed Hawaii longline fishery. This suggests that sex-specific fishery catch statistics need to be collected on an ongoing basis to account for expected differences in female and male size at capture.

<u>Discussion</u>

The WG questioned whether the current level of sampling of catch-at-length data is sufficient. It was suggested that the issue could be addressed in a separate analysis to determine optimum sample sizes. The WG also noted that it is important to understand if the difference in mean size between sexes is indicative of a fundamental difference in the age-at-size. It was also noted that there is some indication of seasonal growth in the quarterly mean size data. These effects should be considered in the development of the stock assessment model.

8.2 Length Frequency of swordfish (*Xiphias gladius*) in the catch of Hawaii-based pelagic longline fishery during the years 1994-2008 presented by Dean Courtney (ISC/09/BILLWG-1/08)

In the Hawaii-based longline fishery, shallow-sets generally target swordfish, while deep-sets target other species and catch swordfish incidentally. Between 2001 quarter 1 and 2004 quarter 2, and again between 2006 quarter 2 and 2006 quarter 4, management restrictions prohibited swordfish targeted sets in the Hawaii-based longline fishery and length sample sizes for shallow-sets were small. In general, patterns of swordfish length frequency differed between shallow- and deep-sets with smaller swordfish being captured in the deep-set sector. As a result, swordfish length frequency should probably be analyzed separately for shallow- and deep-sets for use in stock assessments. Within the shallow-set swordfish target sector, female swordfish were larger than males. As a result, it may also be appropriate to analyze swordfish length frequency separately for males and females for use in stock assessments. Three time series of swordfish length frequency from the shallow-set sector are presented for consideration in stock assessments: shallow-set combined sex, shallow-set females, and shallow-set males. An additional time series of swordfish length frequency from the deep-set sector is provided for consideration that may be useful for exploratory purposes, perhaps as a pre-recruit index.

Discussion

The WG discussed whether the difference in length composition between deep- and shallow-set was the result of the targeted depth or the spatial location of fishing. It was clarified that in quarter 2, the fisheries overlap spatially and that the size compositions are more similar. This was thought to indicate that spatial area and not depth may be more influential in size of swordfish caught. It was also suggested that a comparison of the aggregated sex-specific length composition data be compared to the full (sexed and unsexed) size composition, or to weight data available from the commercial fisheries landings. If the distributions are markedly different it would indicate that the sex-specific size data may not be representative of the length distribution of the fishery. It was also noted that data from deep-sets have very little sex-specific information. However, the deep-set catch is made up primarily of age 0 fish and growth differences should not greatly affect the interpretation of age-at-size.

9.0 BILLFISH ECONOMIC ANALYSES

9.1 Recreational fisheries for tuna and billfish in Baja California Sur (BCS), Mexico and the potential for interaction with commercial fisheries presented by Gakushi Ishimura (ISC/09/BILLWG-1/09)

In recent years, recreational fishing in BCS has grown along with tourism in the region and has developed into a large industry that plays a significant role in the local economy. Blue marlin, striped marlin, and sailfish make up 99% of billfish captures, which total about 23,000 fish a year. Mexican fishing regulations only allow targeted fisheries for billfish to be conducted by recreational fisheries. However, because of billfish are taken as bycatch in the commercial fisheries, these two sectors have been in conflict over the use of billfish resources.

Discussion

It was noted that the number of reported Baja California licenses may reflect purchases for trips arriving and returning to U.S. ports (San Diego, California) rather than trips originating from solely Baja California ports. It was further noted that the variation in annual catch in the recreational fishery may reflect local variation rather than indication of overall stock condition.

It was pointed out that many scientific organizations, as well as RFMOs, do not conduct economic studies or routinely collect economic data as part of their operational plan. However, economic information and studies are useful for understanding changes in catch rates. Collection of economic dada and studies on the economics of the fisheries are encouraged.

9.2 Observations from a Japanese swordfish and blue shark market presented by Gakushi Ishimura (ISC/09/BILLWG-1/10)

While fishery regulations targeting harvest activities have an immediate effect on fishers' behaviour, the responses of the seafood market are usually not straightforward due to globally available substitute commodities, or because of responses by fishers that change the nature of the fishing effort. This study examined the market structure change response to the changes in fishery regulations. The swordfish and blue shark market data at the port of Kesen-numa were analyzed with a fishery regulation change for the off-shore longline fishery. With changes in available quantities, price elasticity was found significant for both swordfish and blue shark, while changes in the price-trend, resulting from changes in regulations, was found significant only for blue shark.

Discussion

It was clarified that adjustments for inflation had not been made at this point, but will be at a later date. It was also noted that there are different indices for price change by landing region in the U.S. There was some discussion on cross-market analyses, and it was indicated that much more will be done on this aspect of the study. Seasonality was handled using a time series filter. There was a discussion that seasonality in the economics analysis consists of two components, price- and supply-side driven fluctuations. The filter accounts for both. It was noted that the increase in landing value of blue shark from 1997 resulted principally from increased supply due to the expansion of the fishing ground.

9.3 Overview of economics and operations of the longline fisheries in Kesen-numa, Japan presented by Gakushi Ishimura (ISC/09/BILLWG-1/11)

Kesen-numa City is the principal port for swordfish landings in Japan, receiving approximately 80% of the total annual landings to Japan in recent years. The off-shore longline fishery provides most (~ 75%) of the total landings. This paper presents an overview of the economics and operations of the swordfish longline fishery in Kesen-numa City, as well as descriptive data on the swordfish longline fishery. While the total number of fishing vessels and reported fishing effort has declined, it was found that the total trip length (days at sea) increased during the 1994-

2006 period. The increased days-per-trip appeared to increase actual revenue, and will be investigated in a formal cost analysis to examine the "true" value of additional days of operation.

Discussion

The WG noted the preliminary nature of this study and looks forward to its completion.

9.4 Preliminary evidence of the market value of freshness in the Japanese swordfish and blue shark longline fishery presented by Gakushi Ishimura (ISC/09/BILLWG-1/12)

When markets value product freshness, and assign a higher premium on these items, producers (fishermen) may have an incentive to differentiate their products by freshness. This study outlines a robust statistical method to estimate freshness premium revealed by auction participants. Detailed logbook records and daily auction price data are combined to construct a unique panel data set. A significant freshness premium is found in the swordfish market but not in the blue shark market. This is because the majority of demand for swordfish is for raw products, while most blue shark is sold as processed products.

Discussion

There was a discussion on the use of "Total Days" (length of fishing trip) as a proxy for freshness. In this fishery the general operation is to move to the most distant fishery ground and to then fish while returning to port. With this operation, it might be considered that the length of the fishing trip might provide a sufficient measure. As the study continues, it will be possible to look at other freshness proxies, such as "day-fish-caught". For the principal species in this study (swordfish and blue shark) there are two different expectations of freshness or shelf-life. Swordfish enters the fresh fish market, and freshness is a significant concern, but blue shark enters markets which do not place significant value on freshness. This means that while fish may be fresh, value loss due to slight "loss" of freshness may not be considered significant. As a result, fishermen make changes in trip length to address freshness, as well as economic efficiency, with various approaches to vessel operations to optimize economic return. In this discussion of factors impacting market price (e.g. total catch) it was pointed out that it is difficult to identify the capacity of the daily market. It was noted that there is only one landing each day, so there is no effect due to being first to land. Future work will try to identify if prices are influenced most by demand or supply.

10.0 SWORDFISH BIOLOGICAL DATA

10.1 Available swordfish biological data for the North Pacific Ocean, including length-at-age, growth curves and size-at-maturity (length at 50%) schedules reviewed by Robert Humphreys

Three swordfish growth curves are available for males and females separately from the Western North Pacific, Central North Pacific, and Eastern North Pacific. Because swordfish age determination techniques have been cross-validated for ages used in growth curves developed for the Western North Pacific, Central North Pacific, and Eastern North Pacific, differences in growth curves between the Western North Pacific and Central North Pacific probably represented real differences in growth rate rather than methodological differences in age determination technique. It was also noted that age determination has not been cross-validated for ages used in the Western South Pacific, and that recent comparative work suggests that there may be methodological differences in swordfish age determination among laboratories in the North Pacific and Western South Pacific. As a result, caution should be used when interpreting regional differences in swordfish growth curves between the North Pacific and Western South Pacific.

Size-at-maturity estimates (length at 50% maturity) for specimens collected in two regions (the Western North Pacific and the Central North Pacific) were presented. It was noted that length at 50% maturity only differed by 4 cm between the Central and Western North Pacific regions.

Discussion

The WG noted that the length-at-age curves presented for the Eastern North Pacific lacked an asymptote in length at age at larger sizes; probably as a result of limited sample size from large swordfish, and that large swordfish were probably not being represented in the growth curve for the Eastern North Pacific. Because of the lack of cross-validation, the WG did not consider growth curves from the Western South Pacific. It was noted that confidence intervals should be provided.

The WG reviewed data associated with each study and concluded that the maturity schedule stemming from the Hawaii study represents the best available science.

10.2 Potential natural mortality rates of north Pacific swordfish presented by Jon Brodziak (ISC/09/BILLWG-1/13)

Natural mortality rates (M) were estimated using seven empirical and four theoretical approaches that depended on estimates of swordfish life history parameters. Empirical approaches to estimating M due to Alverson and Carney (1975), Pauly (1980), Hoenig (1983), Lorenzen (1996), and Hewitt and Hoenig (2005) were applied to North Pacific swordfish. Theoretical approaches developed by Peterson and Wroblewski (1984), Jensen (1996), and Chen and Watanabe (1989) were also considered. Sex-specific estimates of M were developed to account for sexual dimorphism in swordfish growth based on life history data from the Central North Pacific data along with a sensitivity analysis using data from the Eastern North Pacific. Age-dependent estimates of M were also evaluated to account for changes in survival rates as fish age. Overall, the Hoenig (1983), Alverson and Carney (1975), Pauly (1980), and Beverton-Holt invariant 2 (Jensen 1996) provided consistent estimates of constant natural mortality of female and male swordfish in the Central North Pacific with M ranging from roughly M=0.35 to M=0.41 y-1. Of the age-dependent M estimators, the Lorenzen (1996) tropical system estimator appeared to provide the most plausible results that were consistent with the central tendency of the constant M estimators. Alternative estimates of female and male swordfish natural mortality at age based on Eastern North Pacific life history parameters exhibited a greater range of values and were more variable than those based on the Central North Pacific data.

Discussion

The WG concluded that tying the estimation of M to recent data as done in the WP represented the best available scientific information on natural mortality rates for North Pacific swordfish.

11.0 BLUE MARLIN ABUNDANCE INDEX

11.1 Preliminary results of collaborative research to develop one standardized index of blue marlin catch per unit effort (CPUE) from two distant water longline fleets; the Japanese distant water longline fleet, and the Taiwanese distant water longline fleet presented by Kotaro Yokawa

It was pointed out that the number of vessels in the Japanese distant water longline fleet has declined during recent years. As a result, the geographic coverage of the Japanese distant water longline fleet in the Pacific has been reduced. During the same time period, the spatial coverage in the Pacific by the Taiwanese distant water longline fleet has increased. Collaborative research has begun to compare the spatial distribution of the two fleets, and that the spatial coverage of the two fleets in the Pacific appeared to be complimentary. The complimentary nature of the data may allow estimation of a single standardized CPUE index representing a wider geographic range. Additional analyses are planned as part of an expanding collaborative research effort.

Discussion

The WG pointed out that the time-series might also be improved by including data from the Hawaiian pelagic longline fleet in future studies. Chi-Lu Sun thanked Gerard DiNardo and Kotaro Yokawa for their assistance on the collaborative study. It was also noted that the collaborative research was made possible by the effective efforts of Mr. Nan-Jay Su, a PhD candidate of National Taiwan University who spent three weeks in Japan working on the project. A WP may be available for review at a later date. The BILLWG Chairman stressed the importance of scientific collaborations and encouraged others to develop such relationships.

12.0 SWORDFISH STOCK ASSESSMENT WORKPLAN

It was agreed that the swordfish assessment would be conducted using a Bayesian production model, as well as Stock Synthesis 2 or 3 (SS2 or SS3). It was also clarified that Dean Courtney (PIFSC) will conduct the SS2 or SS3 model runs and that Japan would take the lead on developing the production model.

12.1 Background information on swordfish, previous assessments, and input data requirements for the current swordfish assessment reviewed by Dean Courtney

A previously presented ISC working document from the November 2008 at the ISC BILLWG special session on swordfish stock structure was presented (ISC/08/BILLWG-SS/05). The WP includes a bibliography and review of previous Pacific swordfish stock assessments and concluded that gains in North Pacific swordfish stock assessment model performance could be possible by including the following: identification of population structure, including sex-specific data (e.g., Wang et al. 2005, 2007), and updating time-series of data to include potential contrast in reduced catch and CPUE during the Hawaii longline (HLL) swordfish moratorium 2000 – 2004. Two modeling options for the current assessment were described: Bayesian surplus production (BSP) model and Stock Synthesis (SS) length-based model. Both assessment approaches would require catch data and relative abundance indices (CPUE series) for estimating time series of swordfish biomass and fishing mortality by Sub-Area.

The spatial structure proposed for the current ISC BILLWG swordfish assessment (Stock Scenario-1 and Stock Scenario-2) was reviewed in relation to previous Pacific swordfish assessments. Summary tables of available CPUE and catch time-series (years of data availability within stock scenario Sub-Areas) were presented. It was noted that both BSP and SS assessment models will require catch time-series to be compiled within the spatial structure of the Sub-Areas identified for the current ISC BILLWG swordfish assessment. It was requested that catch time-series data be compiled within stock scenario Sub-Areas before the end of the meeting so that BSP stock assessment modeling could commence immediately following the meeting.

Available length time-series for the current ISC BILLWG swordfish assessment (Stock Scenario-1 and Stock Scenario-2) were reviewed in relation to previous Pacific swordfish assessments. The review of available length data indicated that swordfish length frequency differed at a finer geographic spatial resolution than captured by Stock Scenario-1 and Stock Scenario-2. For example, in the Hawaiian pelagic longline fishery, relatively larger swordfish are captured in swordfish targeted sets which occur in more northern latitudes. It was noted that differences in swordfish length frequency by geographic region have also been observed in the Atlantic where only female swordfish appear to make long distance migrations to feeding areas, while males appear to stay near spawning areas throughout the year. It was noted that as a result of differences in swordfish length frequency by geographic region, the SS assessment model will require length time series to be compiled within a finer spatial resolution than the Sub-Areas identified for the current ISC BILLWG swordfish assessment (Stock Scenario-1 and Stock Scenario-2). The proposed length time series included quarterly length frequency data from the Hawaii longline shallow- and deep-set fisheries, the Japanese distant water longline fishery, and the Chinese Taipei distant water longline fishery in recent years. In some cases, time-varying selectivity estimates may be needed to account for changes in fishery operations. For Stock Scenario-1, it was requested that length time-series be compiled within the finer spatial resolution identified in ISC/09/BILLWG-1/17, Figure 1. Similarly, for Stock Scenario-2, it was requested that length time-series, be compiled within the finer spatial resolution identified in ISC/09/BILLWG-1/17, Figure 2.

Available life history information to characterize swordfish growth for stock assessments was described. It was noted that age determination techniques developed for swordfish in the Western, Central, and Eastern Pacific were calibrated between the laboratories. However, growth curves presented for the Eastern Pacific lacked an asymptote in length at age at larger sizes, likely as a result of large swordfish not being represented in the growth curve. It was concluded that growth rates from Central Pacific (DeMartini et al. 2007), and associated natural mortality (ISC/09/BILLWG-1/13), would be used as a "base case" for SS in both Stock Scenario-1 and Stock Scenario-2. Growth rates from the Northwest Pacific (Sun et al. 2002), and associated natural mortality, will be included as a sensitivity analysis for SS in both Stock Scenario-1 and Stock Scenario-2. The growth rates from the Central Pacific (DeMartini et al. 2007) was chosen for the base case because of the relatively larger sample size of large swordfish which resulted in a more clearly defined asymptote in the growth curve.

Two regional maturity ogives are available: one for the Northwest Pacific (Wang et al. 2003) and one for the Central North Pacific (DeMartini et al. 2000). Lengths at 50% maturity were nearly identical for the Central and Western Pacific. Under both stock scenarios, the WG concluded that it would use the Central North Pacific maturity at length curve for the baseline assessment. The Northwest Pacific maturity ogive would be used in an alternative sensitivity analysis.

Available CPUE time series for stock assessments were identified and described including: 1) the Japanese distant water longline fleet standardized CPUE fit in two time periods for the North Pacific and for the two Sub-Areas; 2) the Taiwanese distant water longline fleet standardized CPUE for the North Pacific and for the two Sub-Areas; and 3) the Hawaii-based pelagic longline fleet standardized shallow-set CPUE for the North Pacific and for Sub-Area 1. Alternative indices that might be considered for use in the stock assessment modeling were: the Taiwanese distant water longline fleet CPUE standardized using yellowfin and bigeye tuna catch as explanatory variable for set type; the Hawaii-based pelagic longline fleet standardized deep-set CPUE; and the California drift net standardized CPUE.

Discussion

The WG discussed the probable relationship between growth and natural mortality rates and proposed that swordfish life history information from the Central North Pacific be used to estimate the natural mortality rate under both stock structure scenarios. The WG concluded that it would be appropriate to estimate the swordfish natural mortality rate using life history parameters as described in ISC/09/BILLWG-1/13.

The WG discussed the data requirements for applying the SS model to North Pacific swordfish under the two scenarios for stock structure. The lack of sex-specific length frequency data for most fisheries except in recent years suggested that there would be little or no consistent signal to fit a two-sex model. This led the WG to conclude that it would be prudent to consider the development of a pooled-sex model before attempting to fit a two-sex model for swordfish. As a result, it was agreed that the baseline SS configuration would be a pooled-sex model.

The WG discussed the input data and model structure for applying the SS model to assess swordfish under the single and two-stock scenarios. It was agreed that the baseline model for the Stock Scenario-1 would use the growth and maturity information for the Central North Pacific along with an associated estimate of the swordfish natural mortality rate. The WG also agreed to use the area stratification from ISC/09/BILLWG-1/17 to define spatial units (e.g., fisheries) for fitting quarterly fishery length frequency distributions (units are cm of eye-fork length) and catches by fishing fleet. Model structure and input data for Stock Scenario-2 were also discussed. The baseline two-stock scenario would include no movement between stocks under the hypothesis that mixing rates between stocks were negligible, on average. An alternative sensitivity analysis would explore the effects of potential movement rates between stocks.

The WG concluded that growth curves from the Central North Pacific represented the best available scientific information for North Pacific swordfish growth rates as a practical use for stock assessment models because of the relatively large sample size of larger swordfish which resulted in a clearly defined asymptote in length at age for larger sizes. The WG concluded that growth curves from the Western North Pacific should also be considered for use in stock assessment as a sensitivity analysis.

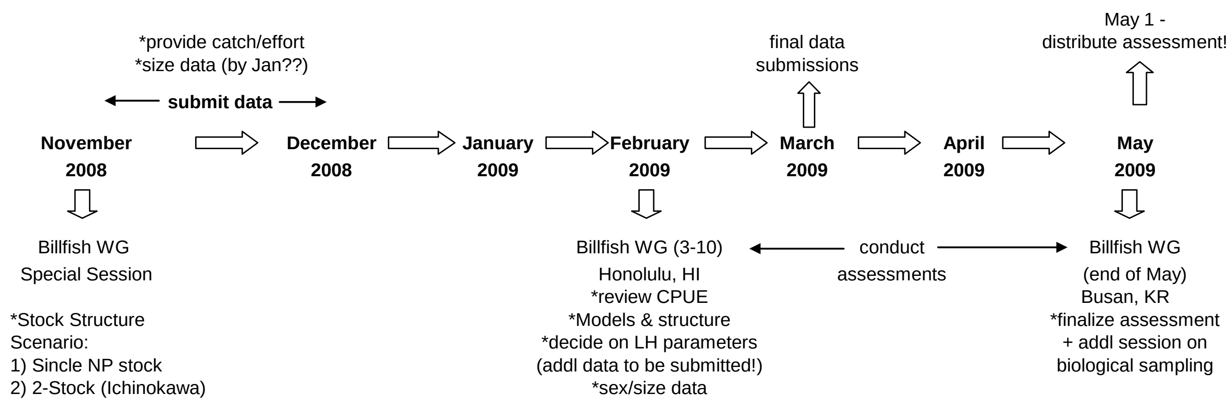
The WG concluded that size-at-age maturity schedules from the Central North Pacific and Western North Pacific represented the best available scientific information for North Pacific swordfish growth rates.

For this assessment, the WG agreed to use the following biological parameters which were estimated independently from swordfish life history data from the Central North Pacific for input into SS: Von Bertalanffy growth parameters (cm of eye-fork length), T_{MAX} (y), and Max eye fork length (cm) (DeMartini et al. 2007, Uchiyama and Humphreys 2007); length-weight relationship pooled sexes (cm of eye fork length, kg) (Uchiyama et al. 1999, Uchiyama and Humphreys 2007); and maturity probability (p(L) at length (cm of eye fork length) (DeMartini et al. 2000)

Life History Parameter	Female Value	Male Value	Equation/Source
Central North Pacific Von Bertalanffy growth parameters (cm of eye-fork length)	K = 0.246 ± 0.019 LINF = 230.5 ± 3.94 T0 = -1.24 ± 0.167	K = 0.271 ± 0.034 LINF = 208.9 ± 5.60 T0 = -1.37 ± 0.259	$EFL_t = EFL_\infty\left(1-e^{-k(t-t_0)}\right)$ Uchiyama and Humphreys (2007), DeMartini et al (2007)
Central North Pacific maximum observed age TMAX (y), and Max eye frok length (cm)	TMAX (y) = 12 Max (EFL) = 259	TMAX (y) = 11 Max (EFL) = 229	Uchiyama and Humphreys (2007), DeMartini et al (2007)
Central North Pacific length-weight relationship pooled sexes (cm of eye fork length, kg)	a = 1.2988x10^{-5} b = 3.0738		$W(kg) = aEFL^b$ Uchiyama and Humphreys (2007), Uchiyama et al. (1999)
Central North Pacific maturity probability (p(L) at length (cm of eye fork length)	L50 = 143.6 σ = 9.67	L50 = 102.0 σ = 7.08	$p(EFL) = \left(1+\exp\left(\frac{-(EFL-L_{50})}{\sigma_m}\right)\right)^{-1}$ De Martini et al. (2000)

12.2 Work plan, Assignments, and Timeline

A work plan for the completion of the swordfish stock assessment by the July 2009 ISC Plenary Session was outlined:



13.0 BILLFISH COLLABORATIVE RESEARCH (BIOLOGICAL RESEARCH TASK FORCE)

At the 8th ISC Plenary meeting in July 2008, an ISC Biological Research Task Force (BRT) was established and tasked with designing a multi-species, large-scale biological sampling program to obtain the data needed for age and growth, and maturity studies. Shui-Kai (Eric) Chang (Chinese Taipei) was appointed BFT Chairman and John Holmes (Canada) vice Chairman. The BRT is scheduled to convene immediately following the next ISC BILLWG workshop in May 2009.

In order to assist the BRT in completing its task at the May meeting, each WG is asked to map the following information (one map per species and per following items):

1. Spatial distribution of catch by fleet (defined as nation/gear combinations, e.g., Japan-LL, USA-troll) by season;

2. Spatial distribution of size categories by fleet and by season. Each WG should define 3-4 (the fewer the better) size categories for each species, and provide information on the distribution of these size categories by fleet and season, so that requests for samples in a certain size category in a specified region and time (season) can be matched to fleets and season in the multi-species plan;

3. Spatial distribution of existing sampling programs by size category/fleet/season, e.g., observer, port sampling, fishermen;

4. Spatial distribution of fisheries targeted for sampling;

5. Spatial distribution of areas targeted for sampling but not currently sampled by existing programs for that species; and

6. Spatial strata for sampling and the number of fish sampled per stratum.

Unlike the other ISC WGs, the BILLWG will need to submit a sampling plan that incorporates the biological data needs for all species of billfish that are studied, rather than just one species. In order to develop and submit the BILLWG sampling plan by the due date of 1 May 2009, the appropriate data will need to be submitted from all ISC member countries by 30 March 2009 to the BILLWG Chairman.

Discussion

The appropriate size categories in which the data will be submitted were discussed, with no conclusion. To determine the appropriate size categories for billfish, the Chairman is tasked with contacting other ISC WG chairs, as well as Robert Humphreys to discuss which size categories would be optimal. The Chairman will notify the WG members as soon as possible what is decided.

It was clarified that the purpose of the BRT is to compile data from all ISC WGs, and propose a multi-species sampling design to the WCPFC for possible funding with an initial focus on age and growth, and maturity studies. It may be possible that the BILLWG can request the BRT to focus on other biological sampling program needs, such as recruitment, at a later date.

14.0 OTHER BUSINESS

14.1 ISC Report and Working Paper Guidelines

A handout was distributed in January 2009 to ISC WG Chairmans from the ISC Chairman regarding guidelines for WG reports. The WGs were assigned to review the handout, and to apply the guidelines to rapporteured WG report sections as well as WP reports for all future ISC BILLWG workshops. The guidelines that applied to the format of tables and figures were highlighted. It was also noted that the timeline for the finalization and submission of WG reports to the ISC Chairman was decreased from three months to one month following the adjournment of all WG workshops, with the exception of workshops held less than a month preceding ISC Plenary meetings.

Discussion

The WG discussed the future implementation of an updated ISC webpage that will include downloadable files of submitted WPs, with the permission of the lead author, as well as WG reports. Individual authors will have the option of having their submitted WPs available for download directly from the ISC website, or to have their email and contact information available for the public who are interested. When WPs are submitted to WG workshops, authors should indicate whether or not they would like their WP(s) available for download from the website. Additionally, the Chairman would like to have abstracts included in all future WPs.

The launch date of the updated webpage is to be determined; however, the BILLWG should start implementation of the new WP format beginning with the May 2009 ISC BILLWG workshop. The Chairman stressed that preliminary WP titles should be submitted at least two weeks before the start date of WG workshops.

Uniformity of WP format was discussed. The WG was instructed to follow the guidelines outlined in the distributed handout, and an official coversheet and template for WPs will be distributed before every future WG workshop.

14.2 Assignments

14.2.1 Assignments for BILLWG Members

Members of the ISC BILLWG were given a number of assignments, including:

- Complete and submit data catalogues (U.S. California, Japan, Chinese Taipei, Mexico) as soon as possible.
- Submit spatio-temporal data outlined by BRT (all ISC member countries) by 30 March 2009.

The data catalogue from the U.S. California was submitted during the workshop and will be reviewed before acceptance.

14.2.2 Assignments for BILLWG Chairman

The ISC BILLWG Chairman was tasked with a single assignment:

- Contact other ISC WG chairs, as well as Robert Humphreys to discuss which size categories would be optimal for the data submission into the BILLWG sampling plan. Relay decision to BILLWG as soon as possible.

15.0 FUTURE MEETINGS

The next BILLWG workshop is scheduled for 19-26 May 2009 in Busan, Korea. The BRT meeting will immediately follow. The location of the meetings is not definitive, but should be finalized by the Chairman by February 27, 2009. Other location options for the May BILLWG and BRT meeting, such as Vancouver, Canada and Victoria, Canada were suggested. The Chairman will discuss these possibilities with John Holmes, a member of the BRT. It was noted that the May BILLWG coincides with the 60th Tuna Conference in Lake Arrowhead, California.

Currently, there is no BILLWG workshop scheduled immediately preceding the ISC Plenary meeting in July 2009.

The following BILLWG workshop is tentatively scheduled for 20-27 October 2009 in Hawaii, USA. The Chair will try to coordinate these dates so not to overlap with the PICES meeting or the IATTC workshop in October 2009. The pan-Pacific blue marlin assessment will be the next focus of the BILLWG, following the finalization of the swordfish stock assessment.

The WG agreed on 8-15 March 2010 for the subsequent BILLWG workshop. The location is to be determined.

16.0 ADJOURNMENT

The ISC BILLWG intercessional workshop was adjourned at 12:01pm on February 10, 2009. The Chairman expressed his appreciation to all participants for their contributions and cooperation in completing a successful meeting.

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Table 1. Striped marlin catches (in metric tons) by fisheries, 1952-2005. Blank indicates no effort. - indicates data not available. 0 indicates less than 1 metric ton. Provisional estimates in ( ).

	Japan							Chinese Taipei[1]												Costa Rica[1]	Korea			Mexico			United States					
Year	Distant-water and Offshore Longline	Coastal Longline	Other Longline	Small Mesh Gillnet	Large Mesh Gillnet	Other[2]	Total	Distant-water Longline	High-seas Drift Gillnet	Offshore Longline	Offshore Gillnet	Offshore Others	Coastal Harpoon	Coastal Setnet	Coastal Gillnet & Other net	Coastal Longline	Coastal others	Other	Total	Sport	Longline	High-seas Drift Gillnet	Total	Longline	Sport[1]	Total	Longline	Troll	Handline	Sport[1]	Total	Grand Total
1952	2,901	-	722	-	0	1,564	5,187												-		-		0			0				23	23	5,210
1953	2,138	-	47	-	0	954	3,139												-		-		0			0				5	5	3,144
1954	3,068	-	52	-	0	1,088	4,207												-		-		0			0				16	16	4,223
1955	3,082	-	28	-	0	1,038	4,148												-		-		0			0				5	5	4,153
1956	3,729	-	59	-	0	1,996	5,785												-		-		0			0				34	34	5,819
1957	3,189	-	119	-	0	2,459	5,767												-		-		0			0				42	42	5,809
1958	4,106	-	277	-	3	2,914	7,300			543								387	930		-		0			0				59	59	8,289
1959	4,152	-	156	-	2	3,191	7,501			391								354	745		-		0			0				65	65	8,311
1960	3,862	-	101	-	4	1,937	5,904			398								350	748		-		0			0				30	30	6,682
1961	4,420	-	169	-	2	1,797	6,388			306								342	648		-		0			0				24	24	7,060
1962	5,739	-	110	-	8	1,912	7,769			332								211	543		-		0			0				5	5	8,317
1963	6,135	-	62	-	17	1,910	8,124			560								199	759		-		0			0				68	68	8,951
1964	14,304	-	42	-	2	2,344	16,692			392								175	567		-		0			0				58	58	17,317
1965	11,602	-	19	0	1	2,794	14,416			355								157	512		-		0			0				23	23	14,951
1966	8,419	-	112	0	2	1,570	10,103			370								180	550		-		0			0				36	36	10,689
1967	11,698	-	127	0	3	1,551	13,379	2		385								204	591		-		0			0				49	49	14,019
1968	15,913	-	230	0	0	1,043	17,186	1		332								208	541		-		0			0				51	51	17,778
1969	8,544	600	3	0	3	2,668	11,818	2		571								192	765		-		0			0				30	30	12,613
1970	12,996	690	181	0	3	1,032	14,902	0		495								189	684		-		0			0				18	18	15,604
1971	10,965	667	259	0	10	2,042	13,943	0		449								135	584		0		0			0				17	17	14,544
1972	7,006	837	145	0	243	993	9,224	9		380								126	515		0		0			0				21	21	9,760
1973	6,357	632	118	0	3,265	702	11,074	1		568								139	708		0		0			0				9	9	11,791
1974	6,700	327	49	0	3,112	775	10,963	24		650								118	792		0		0			0				55	55	11,810
1975	5,281	286	38	0	6,534	686	12,825	64		732								96	892		0		0			0				27	27	13,744
1976	5,136	244	34	0	3,561	585	9,560	32		347								140	519		0		0			0				31	31	10,110
1977	3,019	256	15	0	4,424	547	8,261	17		524								219	760		43		43			0				41	41	9,105
1978	3,957	243	27	0	5,593	546	10,366	0		618								78	696		28		28			0				37	37	11,127
1979	5,561	366	21	0	2,532	526	9,006	26		432								122	580		-		0			0				36	36	9,622
1980	6,378	607	5	0	3,467	536	10,993	61		223								132	416		37		37			0				33	33	11,479
1981	4,106	259	12	0	3,866	542	8,785	17		491								95	603		-		0			0				60	60	9,448
1982	5,383	270	13	0	2,351	656	8,673	7		397								138	542		39		39			0				41	41	9,295
1983	3,722	320	10	22	1,845	827	6,746	0		555								214	769		19		19			0				39	39	7,573
1984	3,506	386	9	76	2,257	719	6,953	0		965								330	1,295		23		23			0				36	36	8,307
1985	3,897	711	24	40	2,323	733	7,728	0		513								181	694		16		16			0		18		42	60	8,498
1986	6,402	901	33	48	3,536	577	11,497	0		179								148	327		61		61	-		0		19		19	38	11,923
1987	7,538	1,187	6	32	1,856	513	11,132	31		383								151	565		1		1	-		0	272	30	1	28	331	12,029
1988	6,271	752	7	54	2,157	668	9,909	7		457								169	633		11		11	-		0	504	54		30	588	11,141
1989	4,740	1,081	13	102	1,562	537	8,035	8		184								157	349		26		26	-		0	612	24	0	52	688	9,098
1990	2,368	1,125	3	19	1,926	545	5,986	2		137								256	395		315		315	-	181	181	538	27	0	23	588	7,465
1991	2,845	1,197	3	27	1,302	507	5,881	36		254								286	576	106	141		141	-	75	75	663	41	0	12	716	7,495
1992	2,955	1,247	10	35	1,169	303	5,719	1		219								197	417	281	318		318	-	142	142	459	38	1	25	523	7,400
1993	3,476	1,723	1	-	828	708	6,736	5		221								142	368	438	388		388	-	159	159	471	68	1	11	551	8,640
1994	2,911	1,284	1	-	1,443	383	6,022	1		137								196	334	521	1,045		1,045	-	179	179	326	35	0	17	378	8,479
1995	3,494	1,840	3	-	970	283	6,590	27		83								82	192	153	307		307	-	190	190	543	52	0	14	609	8,041
1996	1,951	1,836	4	-	703	152	4,646	26		162	8	6	30	3	-	-	-		235	122	429		429	-	237	237	418	54	1	20	493	6,162
1997	2,120	1,400	3	-	813	163	4,499	59		290	9	-	33	3	-	2	-		396	138	1,017		1,017	-	193	193	352	38	1	21	412	6,655
1998	1,784	1,975	2	-	1,092	304	5,157	90		205	15	-	19	6	1	9	-		345	144	635		635	-	345	345	378	26	0	23	427	7,053
1999	1,608	1,551	4	-	1,126	184	4,473	66		128	7	-	26	5	1	3	-		236	166	433		433	-	266	266	364	28	1	12	405	5,979
2000	1,152	1,109	8	-	1,062	297	3,628	153		161	17	1	29	6	1	1	-		369	97	537		537	-	312	312	200	14	1	10	225	5,168
2001	985	1,326	11	-	1,077	237	3,636	121		129	16	-	30	5	-	-	-		301	151	254		254	-	237	237	351	42	2		395	4,974
2002	764	796	5	-	1,264	290	3,119	251		226	14	-	6	8	1	-	-		506	76	188		188	-	305	305	226	30	0		256	4,450
2003	1,013	842	3	-	1,064	203	3,124	241		91	26	-	11	5	1	-	-		375	79	206		206	-	322	322	552	29	0		581	4,687
2004	699	1,000	2	-	1,339	92	3,130	261		95	8	1	7	5	2	-	1		380	(19)	75		75	-	-	0	376	34	1		411	(4,015)
2005	(562)	(668)	(1)	-	(1,214)	(98)	(2,543)	176		76	1	-	5	9	9	-	8		284	-	141		141	-	-	0	493	20	0		513	(3,481)
2006	(642)	(538)	(1)	-	(1,190)	(95)	(2,466)														56		56				609	21	0		630	(3,152)
2007	313						(313)														28		28				265	13	0		278	(619)
2008																																

[1] Estimated from catch in number of fish

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

Table 2. Swordfish catches (in metric tons) by fisheries, 1952-2005. Blank indicates no effort. - indicates data not available. 0 indicates less than 1 metric ton. Provisional estimates in ( ).

	Japan								Chinese Taipei[5]											Korea			Mexico	United States[6]						
																								Hawaii	California					
Year	Distant-water and Offshore Longline[2]	Coastal Longline	Driftnet	Harpoon[3]	Other Bait Fishing	Trapnet	Other[4]	Total	Distant-water Longline	Offshore Longline	Offshore Gillnet	Offshore Others	Coastal Harpoon	Coastal Setnet	Coastal Gillnet & other net	Coastal Longline	Coastal Others	Other	Total	Longline	High-seas Drift Gillnet	Total	All Gears	Longline	Longline	Gill Net	Harpoon	Unknown[7]	Total	Grand Total
1952	8,890	152	0	2,569	6	68	6	11,691	-	-									-	-			-	-	-	-	-	-	-	11,691
1953	10,796	77	0	1,407	20	21	87	12,408	-	-									-	-			-	-	-	-	-	-	-	12,408
1954	12,563	96	0	813	104	18	17	13,610	-	-									-	-			-	-	-	-	-	-	-	13,610
1955	13,064	29	0	821	119	37	41	14,111	-	-									-	-			-	-	-	-	-	-	-	14,111
1956	14,596	10	0	775	66	31	7	15,486	-	-									-	-			-	-	-	-	-	-	-	15,486
1957	14,268	37	0	858	59	18	11	15,251	-	-									-	-			-	-	-	-	-	-	-	15,251
1958	18,525	42	0	1,069	46	31	21	19,734	-	-									-	-			-	-	-	-	-	-	-	19,734
1959	17,236	66	0	891	34	31	10	18,267	-	427								91	518	-			-	-	-	-	-	-	-	18,785
1960	20,058	51	1	1,191	23	67	7	21,400	-	520								127	647	-			-	-	-	-	-	-	-	22,047
1961	19,715	51	2	1,335	19	15	11	21,147	-	318								73	391	-			-	-	-	-	-	-	-	21,538
1962	10,607	78	0	1,371	26	15	18	12,115	-	494								62	556	-			-	-	-	-	-	-	-	12,671
1963	10,322	98	0	747	43	17	16	11,244	-	343								18	361	-			-	-	-	-	-	-	-	11,605
1964	7,669	91	4	1,006	40	16	26	8,852	-	358								10	368	-			-	-	-	-	-	-	-	9,220
1965	8,742	119	0	1,908	26	14	182	10,991	-	331								27	358	-			-	-	-	-	-	-	-	11,349
1966	9,866	113	0	1,728	41	11	4	11,763	-	489								31	520	-			-	-	-	-	-	-	-	12,283
1967	10,883	184	0	891	33	12	5	12,008	-	646								35	681	-			-	-	-	-	-	-	-	12,689
1968	9,810	236	0	1,539	41	14	9	11,649	-	763								12	775	-			-	-	-	-	-	-	-	12,424
1969	9,416	296	0	1,557	42	11	14	11,336	0	843								7	850	-			-	-	-	-	-	-	-	12,186
1970	7,324	427	0	1,748	36	9	3	9,547	-	904								5	909	-			-	5	-	-	612	10	627	11,083
1971	7,037	350	1	473	17	37	31	7,946	-	992								3	995	0			-	1	-	-	99	3	103	9,044
1972	6,796	531	55	282	20	1	2	7,687	-	862								11	873	0			2	0	-	-	171	4	175	8,737
1973	7,123	414	720	121	27	23	2	8,430	-	860								119	979	0			4	0	-	-	399	4	403	9,816
1974	5,983	654	1,304	190	27	16	2	8,176	1	880								136	1,017	0			6	0	-	-	406	22	428	9,627
1975	7,031	620	2,672	205	58	18	2	10,606	29	899								153	1,081	0			-	0	-	-	557	13	570	12,257
1976	8,054	750	3,488	313	170	14	12	12,801	23	613								194	830	0			-	0	-	-	42	13	55	13,686
1977	8,383	880	2,344	201	71	7	2	11,888	36	542								141	719	219			-	17	-	-	318	19	354	12,961
1978	8,001	1,031	2,475	130	110	22	1	11,770	-	546								12	558	68			-	9	-	-	1,699	13	1,721	14,049
1979	8,602	1,038	983	161	45	15	4	10,848	7	661								33	701	-			7	7	-	-	329	57	393	11,949
1980	6,005	849	1,746	398	29	15	1	9,043	10	603								76	689	64			380	5	-	160	566	62	793	10,905
1981	7,039	727	1,848	129	58	9	3	9,813	2	656								25	683	-			1,575	3	0	473	271	2	749	12,820
1982	6,064	874	1,257	195	58	7	1	8,456	1	855								49	905	48			1,365	5	0	945	156	10	1,116	11,842
1983	7,692	999	1,033	166	30	9	2	9,931	0	783								166	949	11			120	5	0	1,693	58	7	1,763	12,763
1984	7,177	1,177	1,053	117	98	13	0	9,635	-	733								264	997	48			47	3	12	2,647	104	75	2,841	13,520
1985	9,335	999	1,133	191	69	10	0	11,737	-	566								259	825	24			18	2	0	2,990	305	104	3,401	15,981
1986	8,721	1,037	1,264	123	47	9	0	11,201	-	456								211	667	9			422	2	0	2,069	291	109	2,471	14,761
1987	9,495	860	1,051	87	45	11	0	11,549	3	1,328								190	1,521	44			550	24	0	1,529	235	31	1,819	15,439
1988	8,574	678	1,234	173	19	8	0	10,686	-	777								263	1,040	27			613	24	0	1,376	198	64	1,662	14,001
1989	6,690	752	1,596	362	21	10	0	9,431	50	1,491								38	1,579	40			690	218	0	1,243	62	56	1,579	13,279
1990	5,833	690	1,074	128	13	4	0	7,742	143	1,309								154	1,606	61			2,650	2,436	0	1,131	64	43	3,674	15,672
1991	4,809	807	498	153	20	5	0	6,292	40	1,390								180	1,610	5			861	4,508	27	944	20	44	5,543	14,306
1992	7,234	1,181	887	381	16	6	0	9,705	21	1,473								243	1,737	8			1,160	5,700	62	1,356	75	47	7,240	19,842
1993	8,298	1,394	292	309	43	4	1	10,341	54	1,174								310	1,538	15			812	5,909	27	1,412	168	161	7,677	20,368
1994	7,366	1,357	421	308	37	4	0	9,493	-	1,155								219	1,374	66			581	3,176	631	792	157	24	4,780	16,228
1995	6,422	1,387	561	423	34	7	0	8,834	50	1,135								225	1,410	10			437	2,713	268	771	97	29	3,878	14,559
1996	6,916	1,067	428	597	45	4	0	9,057	9	701	2	-	19	10	-	-	-		741	15		15	439	2,502	346	761	81	15	3,705	13,957
1997	7,002	1,214	365	346	62	5	0	8,994	15	1,358	1	1	27	8	-	24	-		1,434	100		100	2,365	2,881	512	708	84	11	4,196	17,089
1998	6,233	1,190	471	476	68	2	0	8,440	20	1,178	8	-	17	15	1	-	-		1,239	153		153	3,603	3,263	418	931	48	19	4,679	18,114
1999	5,557	1,049	724	416	47	5	0	7,798	70	1,385	4	-	51	5	1	-	-		1,516	132		132	1,136	3,100	1,229	606	81	27	5,043	15,625
2000	6,180	1,121	808	497	49	5	0	8,660	325	1,531	5	-	74	5	1	1	-		1,942	202		202	2,216	2,949	1,885	646	90	9	5,579	18,599
2001	6,932	908	732	230	30	15	0	8,847	1,039	1,691	17	-	64	8	1	1	-		2,821	438		438	780	220	1,749	375	52	5	2,401	15,287
2002	6,230	965	1,164	201	29	11	0	8,600	1,633	1,557	7	1	1	16	1	1	-		3,217	439		439	465	204	1,320	302	90	3	1,919	14,640
2003	5,376	1,063	1,198	149	28	4	0	7,818	1,084	2,196	3	-	-	8	-	-	-		3,291	381		381	671	147	1,812	216	107	0	2,282	14,443
2004	5,395	1,509	1,062	229	30	4	0	8,229	884	1,828	5	-	-	7	1	-	3		2,728	410		410	270	213	898	169	62	37	1,379	13,016
2005	(5,359)	(1,294)	(956)	(187)	(337)	(3)	(0)	(8,136)	437	1,813	1	-	-	5	2	-	18		2,276	434		434	235	1,475		220	76	0	1,771	(12,852)
2006	(6,261)	(1,505)	(796)	(244)	(342)	(5)	(1)	(9,154)												477		477	347	1,175		444	71	2	1,692	(11,670)
2007	6,499							(6,499)												452		452		1,444		484	58	0	1,986	(8,937)
2008																														

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

(grey cell) only one vessel fished so combined with Hawaii longline

[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] Contains 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.

Appendix 1

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Appendix 2

Working Papers and Background Papers

WORKING PAPERS

ISC/09/BILLWG-1/01	Billfish Catch Tables. BILLWG. (Gerard.DiNardo@noaa.gov)
ISC/09/BILLWG-1/02	Model Uncertainty and biological reference points for North Pacific striped marlin. Jon Brodziak. (Jon.Brodziak@noaa.gov)
ISC/09/BILLWG-1/03	The spatial distribution of habitat preferences for striped marlin. Minoru Kanaiwa. (m3kanaiw@bioindustry.nodai.ac.jp)
ISC/09/BILLWG-1/04	Generalized additive model analyses to standardize swordfish (*Xiphias gladius*) catch rates in the Hawaii-based pelagic longline fishery, 1995-2007, for use in stock assessment. Dean Courtney, William Walsh, and Jon Brodziak. (Dean.Courtney@noaa.gov)
ISC/09/BILLWG-1/05	Preliminary CPUE Time Series from the California Driftnet Fishery, 1990-present. Kevin Piner and Amy Betcher. (Kevin.Piner@noaa.gov)
ISC/09/BILLWG-1/06	The effect of change of target species on the CPUE of swordfish caught by Japanese offshore surface longliners operating in the north Pacific. Kotaro Yokawa. (yokawa@fra.affrc.go.jp)
ISC/09/BILLWG-1/07	Length distributions of female and male swordfish, X*iphias gladius*, captured in the directed Hawaii pelagic longline fishery during 1994-2008. Jon Brodziak and Dean Courtney. (Jon.Brodziak@noaa.gov)
ISC/09/BILLWG-1/08	Annual and Quarterly Length Frequency of Swordfish (*Xiphias gladius*) Catch in the Hawaii-based Longline Fishery, 1994-2008, for use in Stock Assessment. Dean Courtney, Jon Brodziak, and Eric Fletcher. (Dean.Courtney@noaa.gov)
ISC/09/BILLWG-1/09	Preliminary overview of the Recreational Billfish Fishery in the Eastern Coast of Baja California Sur, Mexico.

	Andres M. Cisneros-Montemayor, Gakushi Ishimura, and German Ponce. (Gakugaku@aol.com)
ISC/09/BILLWG-1/10	Market response to a fishery regulation change: Preliminary observations from a Japanese swordfish and blue shark market. Takanori Minamikawa, Gakushi Ishimura, and Kotaro Yokawa. (Gakugaku@aol.com)
ISC/09/BILLWG-1/11	An Overview of Economics and Operations of the Longline Fisheries in Kessen-numa Japan. Gakushi Ishimura and Kotaro Yokawa. (Gakugaku@aol.com)
ISC/09/BILLWG-1/12	The market value of freshness: Preliminary evidences from swordfish and blue shark market for a pelagic longline fishery. Koichiro Ito, Gakushi Ishimura, Kotaro Yokawa, and Koshiro Ishida. (Gakugaku@aol.com)
ISC/09/BILLWG-1/13	Potential natural mortality rates of North Pacific swordfish. Jon Brodziak. (Jon.Brodziak@noaa.gov)
ISC/09/BILLWG-1/14	Mexican Progress Report on the Marlin and Swordfish Fishery. Luis A. Fleischer, Alexander Klett Traulsen, Pedro A. Ulloa Ramirez. (lfleischer21@yahoo.com)
ISC/09/BILLWG-1/15	Update of the Catch per Unit Effort (CPUE) trend of Swordfish (Xiphias gladius) by the Japanese offshore and distant-water longline fishery in the Pacific. Ai Kimoto and Kotaro Yokawa. (aikimoto@affrc.go.jp)
ISC/09/BILLWG-1/16	Catch amount of Swordfish (Xiphias gladius) by the Japanese coastal, offshore, and distant-water longline fishery in the Pacific. Ai Kimoto and Kotaro Yokawa. (aikimoto@affrc.go.jp)
ISC/09/BILLWG-1/17	Standardization of Taiwanese distant water tuna longline catch rates for swordfish in the North Pacific, 1995-2007, based on two stock structure scenarios. Chi-Lu Sun, Su-Zan Yeh, and Nan-Jay su. (chilu@ntu.edu.tw)
ISC/09/BILLWG-1/18	Preliminary Considerations on Regions for use in Stock Assessment Modeling of Striped Marlin. Michael Hinton. (mhinton@iattc.org)

BACKGROUND PAPERS

ISC/08/BILLWG-SS/05 Review and bibliography of recent swordfish stock assessment methods and available data for the North Pacific Ocean. Dean Courtney, Gakushi Ishimura, and Lyn Wagatsuma. (Dean.Courtney@noaa.gov)

Bigelow, K.A., Boggs, C.H., and He, X. 1999. Environmental effects on swordfish and blue shark catch rates in the US North Pacific longline fishery. Fish. Oceanogr. 8(3):178-198.

Draft ISC BILLWG Special Session Report, 12-14 November 2008. (Gerard.DiNardo@noaa.gov)

DeMartini, E.E., Uchiyama, J.H, Humphreys Jr., R.L., Sampaga, J.D., and Williams, H.A. 2007. Fish. Bull. (105):356-367.

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Summary Report of the 4th Regular Session of the Northern Committee, Tokyo, Japan, 9-11 September 2008.

Uchiyama, J.H, and Humphreys Jr., R.L. Revised Review Table of Vital Rates and Life History Parameters for Striped Marlin, Swordfish, and Blue Marlin in the North Pacific Ocean (February 2007).

Walsh, W.A., Howell, E.A., Bigelow, K.A., and McCracken, M.L. 2006. Analyses of Observed Longline Catches of Blue Marlin, *Makaira nigricans,* Using Generalized Additive Models with Operational and Environmental Predictors. Bull.Mar. Sci. 79(3): 607-622.

Summary Report of the 4th Regular Session of the WCPFC Scientific Committee, Port Moresby, PNG, 11-22 August 2008.

Appendix 3

Agenda

BILLFISH WORKING GROUP (BILLWG)

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

INTERCESSIONAL WORKSHOP AGENDA

Meeting Site: Hawaii Imin International Conference Center @ Jefferson Hall
Kamehameha Room
1777 East-West Road
Honolulu, HI 96822

Meeting Dates: February 3-10, 2009

Goals: 1) to update and complete compilation of fishery statistics, 2) review swordfish stock structure scenarios, 3) agree on a standardized CPUE time series in preparation for future use of fully integrated models to assess the status of swordfish in the North Pacific, and 4) agree on swordfish stock assessment model structure(s) and input parameters.

Draft Agenda:

February 3 (Tuesday), 0930-1000 – Registration

February 3 (Tuesday), 1000-1600

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

2. Adoption of Agenda & Assignment of Rapporteurs

3. Computing Facilities
    a. Access
    b. Security Issues

4. Meeting Summaries (relating to billfish)
    a. 8th ISC Plenary

   b. WCPFC SC4
   c. 4th Regular Session of the Northern Committee
   d. 5th Regular Session of the WCPFC

5. Summary of Nov. 2008 ISC Billfish Special Session on Stock Structure

6. Status of Work Assignments from June 2008 ISC BILLWG workshop

7. Billfish Catch & Effort Data
   a. Data catalogues (Category I, II, and III)
   b. Update Catch tables
   c. Adoption of catch tables

8. Striped Marlin
   a. Habitat needs
   b. Reference Points

February 4 (Wednesday), 0930-1600

9. Swordfish CPUE Time Series
   a. Single stock scenario
   b. 2-stock scenario

10. Swordfish Length Data
    a. Single stock scenario
    b. 2-stock scenario

11. Billfish Economic Analyses

February 5 (Thursday), 0930-1600

12. Swordfish Biological Data
    a. Review of growth curve
    b. Review of size-at-maturity schedules

13. Blue Marlin
    a. Japan-Taiwan collaboration study
    b. Workplan

14. Swordfish Assessment Model
    a. Review available information
    b. Review assessment schedule and workplan

February 6 (Friday), 0930-1200 – Blue Marlin Steering Committee Meeting

February 6 (Friday), 1330-1600 – Northern Committee Striped Marlin Working Group

February 7 (Saturday), 0900-1200

15. Billfish Collaborative Research
    a. Biological Research Task Force
    b. Other

16. Other Business

17. Future Meetings

February 7 (Saturday), 1330-1600 – Rapporteurs complete sections

February 8 (Sunday), No Meeting – Complete Report and Circulate

February 9 (Monday) – WG Reviews Report

February 10 (Tuesday), 0900-1200

18. Finalize Report

18. Adjournment

ISC Billfish Working Group: 1) Gary Sakagawa, 2) Lyn Wagatsuma, 3) Minoru Kanaiwa, 4) Michael Hinton, 5) Ai Kimoto, 6) Dean Courtney, 7) Russell Ito, 8) Jon Brodziak, 9) Chi-Lu Sun, 10) Kevin Piner, 11) Gakushi Ishimura, 12) Kotaro Yokawa, 13) Gerard DiNardo.

Appendix 4

REPORT OF THE BILLFISH WORKING GROUP SPECIAL SESSION

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

12-14 November 2008
Honolulu, Hawaii, USA

1.0 INTRODUCTION

The special session on stock structure 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 November 12-14, 2008. The goal of the special session was to develop plausible stock structure scenarios for populations of swordfish and striped marlin in the North Pacific for use in stock assessments. Gerard DiNardo, Chair of the BILLWG, welcomed participants from the Inter-American Tropical Tuna Commission (IATTC), Japan, and the United States of America (USA) (Attachment 1). Lyn Wagatsuma was assigned lead rapporteuring responsibilities. Documents were distributed and numbered, and the meeting agenda adopted (Attachment 2 and 3).

2.0 EXPANDING OUR APPROACH TO FUTURE STOCK STRUCTURE AND HABITAT STUDIES

Robert Humphreys discussed ways in which new sampling approaches can be brought to bear on future studies of population genetics and Pop-up Satellite Archival Tag (PSAT) tagging that would best help to improve our understanding of swordfish stock structure in the Pacific Ocean. Previous work on stock structure has been primarily focused on areas of highest relative abundance in the fishery which are associated with adult feeding grounds in temperate latitudes. The areas of lower swordfish abundance are generally found in warm waters of the subtropical-equatorial region, and associated with spawning and the early life history. Elucidating the connections between higher latitude feeding areas and lower latitude spawning areas requires new approaches in sampling tissues for DNA analysis and new tactics for tagging fish. The central premise to this approach is that stock separation is maintained by spawning site fidelity, while feeding/fishing grounds may or may not be a mixture of stocks. For genetic studies, this will require more geographically extensive sampling of larvae from surface plankton tows and the collection of YOY juveniles (50-80cm EFL) incidentally captured by tuna longline vessels fishing. Future PSAT tagging needs to be re-directed toward elucidating the migratory link between feeding/fishing areas and presumed spawning areas. On temperate fishing grounds, tagging should target large adults prior to seasonal departure from their respective fishing grounds. Tagging efforts should also be increased around known spawning areas (Hawaii) and other presumed spawning areas (Tahiti, Fiji, southern islands of Japan, etc.). These efforts will require long tag deployments and it is critical that the problems causing premature PSAT tag deployments be resolved. Longer-term efforts will also need to be undertaken in order to 1) develop an archived tissue bank and associated collection metadata to aid future genetic researchers, 2) develop molecular markers for gender identification, and 3) to apply additional techniques (trace element/stable isotope signatures, pollutant loads, parasite tags and genetic tagging) to help elucidate stock structure and movement patterns.

Discussion

There was significant discussion and agreement that premature PSAT deployments on billfish are a continuing problem facing researchers in the Pacific Ocean region. Better success has been achieved by researchers in the Atlantic Ocean with deployments occurring up to 1 year after attachment on swordfish. The Chairman will contact scientists in the Atlantic Ocean to determine why their times to deployment are so much greater than those observed in the Pacific Ocean and report back to the to the WG at the next workshop. It was noted that a number of billfish PSAT tagging projects, and to a lesser extent conventional tagging projects, are occurring across the North Pacific (as well as South Pacific), but at present there is little if any collaboration between the projects. It was agreed that the projects should be integrated and the WG endorsed the development of a multinational collaborative North Pacific billfish tagging project. This project would include electronic, as well as conventional tags and provide information of habitat requirements, growth, movement and harvest rates. The WG also agreed on the need for a reliable gender identification marker, particularly as more and more fisheries land billfish that have been dressed (headed, gilled, gutted, and fins and tail removed). It was noted that research on a gender identification marker is progressing at Texas A&M University, but the work is still preliminary.

3.0 STRIPED MARLIN

3.1 Ranges of Stocks

Work-in-progress on analysis of stock structure of swordfish and striped marlin was presented by Michael Hinton (ISC/08/BILLWG-SS/01). At this point the analyses were restricted to simple generalized additive models (GAMs) and Delta-GLM models. The modeling results of either approach were found to be very similar. Models examined for stock area determination were structured as standardization models for catch rates of longline fisheries. They included factors and interactions for location (latitude and longitude), time (bimonthly period) and a number of environmental indices. Year was not included in interactions, since the factor year provides the basis for one of the indicators (differences in relative abundance trends by area) for confirmation of stock boundaries. Analyses were made using S-PLUS® 8.0 for Windows (TIBCO, Palo Alto, California: http://www.tibco.com/). Modeling will continue and additional results presented at the next full working group meeting. Results were not proposed for use as delimiters of stock area boundaries for upcoming stock assessments of swordfish or striped marlin.

Discussion

There was significant discussion regarding the adequacy of the approach to account for known changes in hooks-per-float (HPF) configurations that occurred in the Japanese Distant Water Longline fishery, which can affect catch-per-unit-effort (CPUE). It was noted that model runs were conducted assuming a change in HPF in 1976 and the results indicated no significant effect. It was recommended that year be explicitly included in the model (presently it is not), as well as HPF in an effort to address changes in HPF.

There was concern that the targeting of striped marlin by the Japanese distant-water longline fishery was not adequately addressed in this approach. Japanese distant-water longline fishermen actually target striped marlin during certain segments of a fishing trip (e.g., when the vessel is returning to port) or throughout the entire trip but only a portion of the hooks on a longline set are fished shallow to target striped marlin. It was pointed out that such fishing practices are not limited to the Japanese fishery and that similar strategies have been adopted by many longline fisheries. Further understanding of fishing practices and fishermen behavior will be necessary if we are to advance or understanding of CPUE.

3.2 Habitat Preferences

Minoru Kanaiwa presented preliminary results of estimated and observed habitat preferences for striped marlin by using data from the longline operations of Japanese training vessels (ISC/08/BILLWG-SS/02). The longline fishery data of Japanese training vessels was analyzed to clarify the habitat preferences of striped marlin. Depth-specific CPUE was used as a metric of habitat preference (higher CPUE = increased preference). Estimated habitat preference was provided by using the statistical application of the habitat-based standardization (statHBS). The ambient temperature was used as an environmental covariate and was provided by the Global Ocean Data Assimilation System (GODAS). StatHBS can utilize habitat preference patterns and determine the importance of temperature to the striped marlin fishery. This type of analysis provides a useful tool to assess the importance of environmental covariates on fishing and should be expanded to include other covariates.

Discussion

While the approach shows promise, the WG noted that the results are not applicable to the commercial fishery. The results are based on data from training vessels which operate differently from the commercial fishery.

4.0 SWORDFISH

4.1 Ranges of Stocks

Michael Hinton re- reviewed his striped marlin presentation in reference to swordfish (ISC/08/BILLWG-SS/03).

Discussion

Because much of the data used in the analyses were pooled, it was difficult for the WG to interpret the results. This could result in downwardly biased estimates of variance. More data associated with individual vessels would be beneficial and the WG recommended that the availability of such data be determined, and if deemed sufficient, the analyses be re-run. Future analyses would also need to address the fact that not all vessels target swordfish equally, which was an explicit assumption in this analysis.

4.2 Genetic Evidence

4.2.1 Mitochondrial DNA

Carol Reeb provided genetic information that recommended that two scenarios be considered for North Pacific stock assessment (presentation only, no WP). The first scenario should comprise only a single stock in the northern Pacific. The second scenario should consider two stocks with separation in the eastern Pacific Ocean (EPO).

Sequencing maternally inherited, mitochondrial DNA (mtDNA) control region shows female swordfish comprise two main populations in the western and central Pacific significantly divergent north and south across the equator (Reeb et al. 2000, Ward et al. 2001). Significant pairwise F_{st}'s in Table 3 of Reeb et al. (uncorrected $p < 0.05$) can be used to draw a pattern of genetic connectivity (Figure 2) illustrating zonal, trans-basin migration/gene flow. Bonferroni correction for simultaneous pairwise tests leaves only the divergence between Japan and Australia as statistically significant. However, application of the Mantel test to the pattern of genetic connectivity shows a highly significant correlation of genetic divergence with geographic distance which is to be expected if populations are indeed structured (Wright 1951). This has been called Isolation by Distance, or the IBD model, commonly employed in the field of landscape genetics. Such trans-Pacific connection has also been seen in CPUE in the Northern Pacific (Sosa-Nishizaki and Shimizo 1991).

Most larval production in the Pacific appears to be restricted to tropical waters west of 140° W longitude (Nishikawa and Ueyanagi 1974, Nishikawa et al. 1985). Because cooler waters of the eastern Pacific are presumed too cold for larval production, the EPO is generally not considered to be a major spawning zone (but see Hinton, unpublished for an argument supporting the presence of Young of Year swordfish in the EPO). Given this, the lack of differentiation in mtDNA along the eastern Pacific could be interpreted as a region of overlap of the northern and southern populations. MtDNA does not detect any further genetic structuring of female swordfish populations in the eastern Pacific.

To date, 540 fish from seven regions (including Western Australia) have been analyzed. These data come from samples collected from seven locals during the years 1990 to 1999 (see Table 1, Reeb et al. 2000 and Table 4, Ward et al. 2001).

As regards the issue of stock assessment in the North Pacific, mtDNA (Reeb et al. 2000; Ward et al. 2001) provides the best genetic data to date showing a pattern of population structure across the entire Pacific. These two studies provide highly significant statistical support for the presence of two stocks. Furthermore, Hinton cites Alvarado-Bremer et al. (unpublished) as having verified these mtDNA results (see Hinton, Marine Freshwater Research 2003 54:393-399).

Studies on nuclear genes also do not clearly show this pattern (Reeb et al. unpublished microsatellites). It is thought that male gene flow and sex distributional differences may explain this discrepancy. Furthermore, there might be additional population structure not yet detected. Certainly, DeMartini et al. clearly show differences in the distribution of males and females in the Pacific. Since our genetic samples came primarily from fisheries dominated by females (with a few exceptions), we believe the pattern detected by maternally inherited mtDNA represents female stock structure. Hence, assessments relying on this data should take gender into account.

Discussion

The WG reviewed the sampling protocols used in the analyses and agreed that sufficient spatio-temporal coverage was lacking. This is a persistent problem facing all genetic studies. Sample sizes in any year are generally small and collected opportunistically. Spatial extent of collected samples is generally limited to a specific local, which is influenced by market demands. The development and implementation of a rigorous North Pacific wide sampling design to collect requisite genetic samples would benefit interpretation of future results. The WG endorsed such an approach and encourages geneticists working on billfish stock structure in the Pacific Ocean to discuss and develop a more statistically sound approach.

In the interim it is recommended that two scenarios be considered for North Pacific stock assessment. The first scenario should comprise only a single stock in the northern Pacific. The second scenario should consider two stocks with the awareness that the eastern Pacific may have a heterogeneous signal due to the apparent mixture of a second population overlapping in the Eastern Pacific. The further south in the eastern Pacific one samples swordfish, the stronger this signal is expected to become. In terms of catch, this second scenario might better explain the CPUE data, especially if assessments go as far south as 20° latitude. At some point, a basin-wide assessment of multiple stock scenarios should be undertaken which might better explain the fluxes of catch in fisheries in Pacific. Possible boundaries of the two stock scenario were discussed but no decision was rendered. The issue will be revisited and resolved after all WPs have been presented.

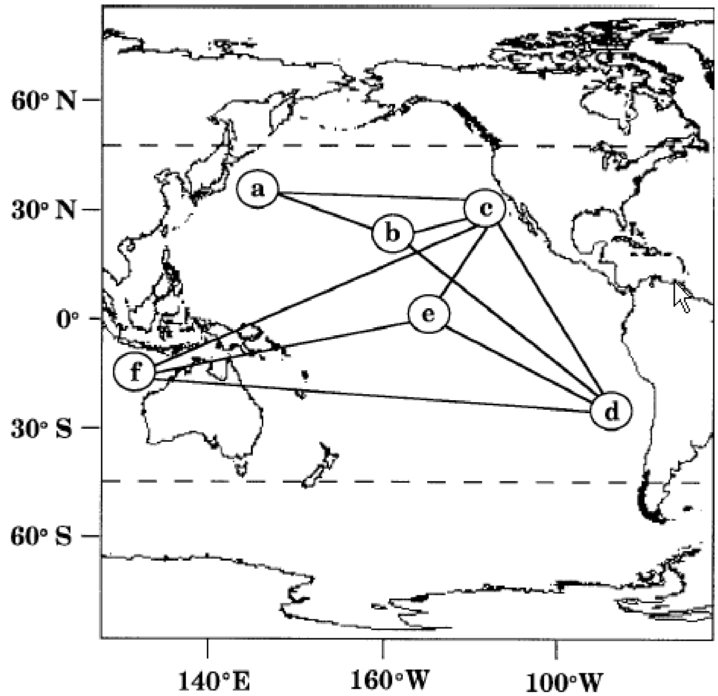


Fig. 2 *Xiphias gladius*. Map of Pacific basin showing U-shape pattern of genetic connectivity [*lines* connect pairs of demes not significantly different from each other as indicated in Table 3; demes are *a* Japan; *b* Hawaii; *c* California–Mexico; *d* Chile; *e* Central Equatorial Pacific; *f* Australia; *dashed lines* show latitudinal distribution of swordfish (Palko et al. 1981)]

4.2.2 Microsatellites

Carol Reeb presented microsatellite information that again, advised the assessment to consider one and two stock scenarios, similar to that for mtDNA (presentation only, no WP). Unlike mtDNA, microsatellites are biparentally inherited. For swordfish, this is important as males and females have different distributions in the Pacific (DeMartini et al. 2000). Thus the genetic signal in microsatellites could be complicated compared to mtDNA if the sexes have different population structures.

Unlike haploid mtDNA which only has one allele acquired from the mother, diploid microsatellites have two alleles, one from the mother, one from the father. This data becomes very useful to determine whether sampled populations are in Hardy-Weinberg equilibrium. Random, mating, self-sustaining populations are in equilibrium. Furthermore, a measure of inbreeding, called F_{is}, would show a value of zero in this case. When differentiated stocks overlap such as has been proposed by Reeb et al. (2000) in the eastern Pacific, HW would be rejected and F_{is} would be have positive value.

Microsatellites show interesting patterns of barriers, gene flow, and gender differences which are relevant to the Northern Pacific stock assessment. Like mtDNA, analysis of the same samples in

Reeb et al. (2000) for 10 microsatellite loci again suggests a continuous trans-Pacific pattern across the Northern Pacific which breaks down as one travels south along the eastern Pacific.

Microsatellites show unique genotypes from samples in the EPO. However, the data is out of Hardy Weinberg equilibrium in our study, as well as in Alvarado-Bremer et al. (2006, Bull. Mar. Sci. 79:493-504). Grouping samples to increase sample size makes this (F_{is}) worse, especially if no attention is paid to gender and time of year fish were sampled. This suggests overlap of additional stocks in the region and is highly suggestive of a mixed stock fishery. It has long been assumed that large females arrive to highly productive EPO waters to feed and grow and that conditions are not optimal for maintenance of large stable spawning grounds capable of supporting a fishery (Sagawa 1989). However, more recent information revealed at this meeting from the Spanish fleet suggests the possibility of spawning in the region. It is clear that the EPO is a feeding zone into which migratory fish move. Heterogeneity caused by mixed stocks, dominance of females in the EPO fishery, and the potential of a seasonal spawning population which typically skews the sex ratio in favor of males, makes characterizing this region as a discrete genetic stock from opportunistically collected samples problematic (see below.

When possible, we separated some of our samples into males and female groups for analysis. When this was done for Chilean, Hawaiian, and Central Pacific swordfish, the F_{is} value approached zero. Furthermore, additional sub-structuring was detected supporting that males and females not only have different distributions, but different patterns of genetic structuring and population origin based on phylogenetic analysis.

Discussion

Regarding stock structure in the North Pacific, it was again advocated for assessments to consider one and two stock plans similar to that for mtDNA. Also, sex differences should be considered. For Japanese fisheries to the west, microsatellites suggest further subdivision away from the Central Pacific. This has been noted in data in DeMartini et al. (2006) showing growth differences between western and eastern North Pacific swordfish.

4.2.3 Methodology

Jaime Alvarado-Bremer presented information on the methodology of assessing genetic differences in Pacific swordfish (presentation only, no WP). Several genetic markers and methodological approaches have been used to study the population structure of swordfish. Regardless of the method or marker employed, all these studies face the challenge of finding differentiation in a highly migratory species, under the expectation that even moderate gene flow (e.g., few individuals exchanged per generation) could prevent the fixation of genetic polymorphisms in subpopulations. Despite of this, population structure studies on swordfish using both mtDNA and nuclear DNA markers have successfully detected significant inter-ocean population differentiation including differences between North and South Atlantic. In the Pacific, the signal of genetic differentiation among regions is considerably less pronounced, yet evidence of genetic heterogeneity has been found using allozymes, mtDNA control region (=D-loop) data, microsatellites, and lastly using lactate dehydrogenase A (ldhA) intron-6 sequence data. Specifically, global exact tests of genic and genotypic differentiation were significant using ldhA data, and the global fixation index was more than six orders of magnitude larger (F_{st} = 0.013) than similar estimates using microsatellites (F_{st}=0.0002). Furthermore, the pair-wise comparisons between the south-eastern Pacific Ocean (SEPO) sample from Chile and all other regions were significant with F_{st} values ranging between 0.013–0.110. The results using ldhA data, coupled with a similar success to detect differentiation within the Atlantic using other exon-primed-intron-crossing (EPIC) markers (e.g., CaM and aldolase B), prompted us to generate additional markers. However, a major challenge associated to score polymorphisms in such loci, is that often direct sequencing is necessary, with the associated higher costs and longer times to score alleles as compared to other methodologies (e.g., PCR-RFLP). As a faster, inexpensive and efficient alternative for genotyping we have successfully employed high resolution melting (HRM) analysis. This technology can be used to score muti-allelic systems, defined by polymorphisms contained in short segments of PCR-amplified DNA. The comparison of samples from Hawaii and Chile using locus (Olb03.10) characterized with HRM resulted in highly significant differentiation (F_{st} = 0.05), a value of this index similar to that obtained with ldhA. These results confirm the difference between SEPO and the NWPO. We have a battery of 10 additional polymorphic EPICs to test the levels of genetic differentiation among Pacific swordfish stocks. We plan to continue working on Pacific swordfish population structure using this methodological approach to further test the robustness of the current genetic perspective that can be summarized as follows: 1) the differentiation of SEPO from North Pacific, 2) the differentiation of Australia versus NWPO, and 3) the distinct signal of the Mexican samples potentially indicative of a mixed stock in agreement with fisheries data.

Discussion

The ISC Billfish Chairman thanked Drs. Reeb and Alvarado-Bremer for their thorough and insightful presentations. Based on the data presented the EPO likely represents a mixing area, and may need to be considered a separate area in future assessments.

4.3 Stock Boundaries

Momoko Ichinokawa presented results for identifying a single boundary of swordfish stocks between the northwest and southeast Pacific using fishery data from Japanese longliners (ISC/08/BILLWG-SS/04). In this study, a computer intensive algorithm was used to identify the single boundary that achieved an optimal fit for GLM analyses to standardize swordfish CPUE where it was assumed that the spatial domain could be separated into two potential stock regions. In addition, sensitivity and bootstrap analysis were used to evaluate uncertainty about the determined boundary. The estimated boundary with the minimum AIC was diagonal, starting from near the coast of Baja California (120°W 30°N, approximately) to the equatorial region around 170°W. The selected boundaries were robust for the model structure among 4 models with more than 1 interaction term. Deviance profiles decomposed by period, quarter and gear suggested that the diagonal boundary was determined by the data from the deepest sets of >14 hooks per basket at 1st, 3rd and 4th quarters during 1999-2007 and at 4th quarter during 1991-1998. This is because target species with deepest sets are relatively consistent (bigeye tuna) compared to the shallower sets, which often switch target species from swordfish in night sets to other species in day sets. In addition, the relative CPUE trends show clear differences between the two regions especially after 1990. Considering the fact that the boundary is corresponding to the area between the oceanographic regions of the California Current System, the North Pacific Equatorial Countercurrent, and the North Pacific Tropical Gyre, the putative stock boundary can be interpreted in relation to large scale currents.

Discussion

The WG endorsed the approach as a tool for identifying potential boundaries. The sensitivity analysis provides a mechanism to assess the “correctness” of boundary choices. The WG recommends that for the two-stock scenario the boundary will be a diagonal from Baja, California (25ºN x 110ºW) to approximately 170ºW at the equator. The boundary follows a step wise pattern as outlined in Fig. 9 of Ichinokawa and Brodziak (ISC/08/BILLWG-SS/04). While the southern boundary in the Western-Central Pacific Ocean was initially determined to be 5ºS (not at the equator), this limit was arbitrarily chosen by the authors. To promote efficiency, the WG recommended establishing the southern boundary in the Central-Western Pacific at the equator. In the EPO the southern limit is set at 20ºS. The results from this analysis are consistent with the (1) finding based on genetics and (2) large scale oceanographic feature in the region, in particular the California Current System, North Pacific Equatorial Countercurrent, and North Pacific Tropical Gyre.

4.4 Review of Recent Assessment Methods and Available Data

Dean Courtney reviewed the spatial structure and data requirements of recent swordfish stock assessments in the Pacific (ISC/08/BILLWG-SS/05). MULTIFAN-CL size/age structured assessments have been conducted in the North Pacific Ocean (NPO) (Kleiber and Yokowa 2004; Wang et al. 2005, 2007) and in the South-West Pacific (SWP) (Kolody et al 2006, 2008). A size/age-structured version of Stock Synthesis II (SS2) (Methot 2000) has been implemented for stock assessment of swordfish in the EPO (Hinton and Maunder 2006).

5.0 GENETIC RESEARCH NEEDS

Because of insufficient sample sizes (both spatially and temporally) and lack of a statistical sampling design, current billfish genetic research programs in the Pacific Ocean provide marginal information for use in stock assessments. To advance the utility of genetic research in future stock assessments, geneticists participating in the workshop were asked to (1) identify potential research projects that would provide requisite data to delineate stock structure and (2) provide a cost estimate to complete the research.

It was recommended that a Pacific-wide biological sampling and tagging study, utilizing conventional tags and PSATs, be developed and implemented. The biological sampling program would provide Pacific-wide samples for genetic analysis, as well as biological parameter estimation (e.g., growth), and results from the tagging study would provide information to verify stock structure. It was also agreed that hypothesis testing for the different stock structure scenarios is needed. The different hypotheses for the stock structure of swordfish in the North Pacific are: 1) a single North Pacific stock, 2) separate north and south stocks in the EPO, 3) separate north and south stocks in the Western Central Pacific, and 4) equatorial linkage. Ideally, it was proposed that quarterly genetic sampling of all life history stages (larvae, juvenile, and adults) occur, with focus in the spawning grounds. It was estimated that approximately $200,000-$300,000 would be required to process all samples.

Discussion

The Chairman thanked Drs. Reeb and Alvarado-Bremer for their input. It was pointed out that the ISC is currently developing biological research plans for billfish and albacore tuna in the North Pacific Ocean, and if that occurs, tissue samples for genetic analysis could also be collected.

6.0 JAPANESE RECENT SIZE DATA

Kotaro Yokawa presented recent length and weight data for swordfish caught by Japanese longline vessels operating in the North Pacific Ocean, and reviewed their utility for use in stock assessments. Size data in recent years was generally obtained from subtropical and temperate areas of the northwest Pacific, the main fishing ground of Japanese surface longliners. Available length and weight data from other areas is insufficient to estimate catch at size.

Comparisons of length frequencies by year, area and quarter indicate that catch in the subtropical area tends to be smaller than that in the temperate area, with higher variability. The observed high variability in the subtropical area likely reflects sex-specific seasonal migration patterns, as well as the annual changes in recruitment.

Because of the paucity of size data, we may want to explore the application of simpler assessment models (e.g., production model) in addition to an age structured type of analysis for North Pacific swordfish.

7.0 SUMMARY OF THE 5TH WFC SPECIAL SESSION STOCK STRUCTURE AND HABITAT OF SWORDFISH AND BILLFISHES WITH COMPARATIVE APPROAHES AMONG OCEANS

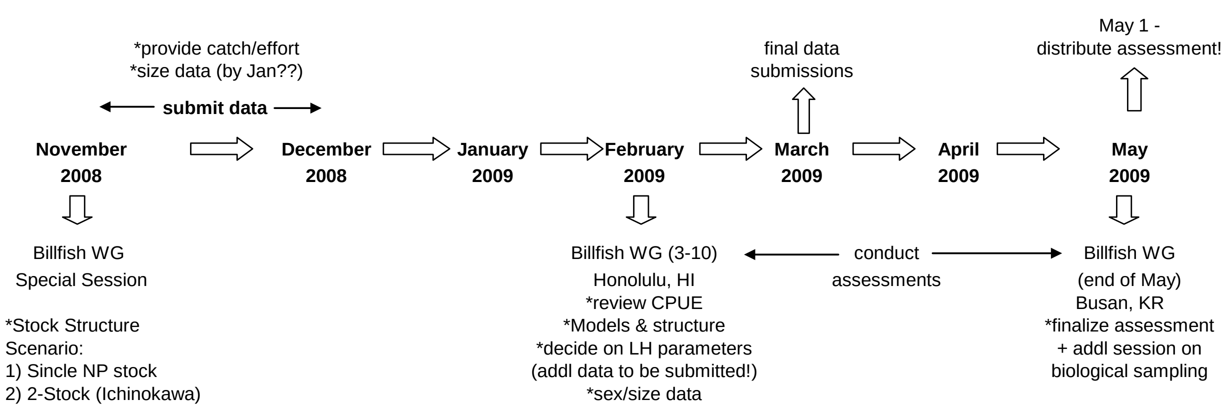
The 5th World Fisheries Congress (WFC) was held October 20-24, 2008 in Yokohama, Japan. The special session entitled “Stock Structure and Habitat of Swordfish and Billfishes with Comparative Approaches Among Oceans: was combined with a theme on adaptive management. Four speakers presented information on billfish stock structure and habitat requirements, and presentation summaries will be published as part of the WFC proceedings.

Robert Humphreys delivered a compelling presentation on swordfish stock structure in the Pacific Ocean, summarizing present knowledge and associated problems. Insufficient sample size and spatiotemporal coverage were highlighted as persistent bottlenecks with current genetic studies, as well as inadequate sampling on associated spawning ground. The need for a Pacific-wide cooperative tagging program was recommended as a way to verify stock structure hypotheses. Momoko Ichinokawa presented a robust statistical approach to determine the optimal number of strata for use in CPUE standardization. This approach clearly represents a more defensible process, which previously was done in ad hoc fashion. The approach will be applied to swordfish catch rates in the North Pacific to assess its utility in defining stock structure. Catherine Purcell presented provisional striped marlin stock structure scenarios based on recent genetic studies. The findings diverge from current stock structure hypotheses and are currently under review. John Neilson presented results from a pop-up satellite tagging study to assess migration rates and possible residence times for swordfish in the western North Atlantic Ocean. Some of the satellite tags remained attached to the fish for up to 411 days, among the longest periods of attachment of pop-up satellite tags reported for any fish species. The results to date challenge the assumption employed in current stock assessments that swordfish move freely from the western North Atlantic to the eastern North Atlantic, as no such movement has been found. The results also demonstrate a consistent pattern of movement with residence in temperate waters from June to October, followed by migration to the south into the Caribbean Sea, with fish remaining there until April.

8.0 STOCK STRUCTURE SCENARIOS AND WORK PLAN

It was agreed that the swordfish stock assessment would assume two stock structure scenarios: 1) a single North Pacific stock, and 2) a two-stock scenario with a diagonal boundary from Baja, California (25ºN x 110ºW) to approximately 170ºW at the equator. The boundary follows a step wise pattern as outlined in Fig. 9 of Ichinokawa and Brodziak (ISC/08/BILLWG-SS/04). The southern boundary in the Western-Central Pacific Ocean is at the equator and in the EPO the southern limit is set at 20ºS.

A work plan for the completion of the swordfish stock assessment by the 2009 ISC Plenary Session was outlined:



Each participating organization should submit catch and effort data, standardized CPUE, and sex-specific size frequency data before January 2009. The PIFSC will submit growth (length at age and weight at length) and maturity information.

It was agreed that the swordfish assessment should utilize a Bayesian production model as well as SS2 or SS3. It was also clarified that Dean Courtney will be conducting the model runs for the swordfish stock assessment.

9.0 ADJOURNMENT

The ISC BILLWG special session on stock structure was adjourned at 1:25pm on November 14, 2008. The Chairman expressed his appreciation to all participants for their contributions and cooperation in completing a successful meeting.

Attachment 1

List of participants

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Attachment 2

List of Documents

WORKING PAPERS

ISC/08/BILLWG-SS/01	Ranges of stocks of striped marlin in the Pacific Ocean: How well can they be known? M. Hinton. (mhinton@iattc.org)
ISC/08/BILLWG-SS/02	Preliminary results of estimated and observed habitat preferences for Striped Marlin by using Japanese training vessels. M. Kanaiwa, K. Yokawa, and K. Bigelow. (m3kanaiw@bioindustry.nodai.ac.jp)
ISC/08/BILLWG-SS/03	A bit more on swordfish stocks in the Pacific Ocean. M. Hinton. (mhinton@iattc.org)
ISC/08/BILLWG-SS/04	Stock boundary between possible swordfish stocks in the northwest and southeast Pacific judged from fisheries data of Japanese longliners. M. Ichinokawa and J. Brodziak. (ichimomo@fra.affrc.go.jp)
ISC/08/BILLWG-SS/05	Review and Bibliography of Recent Swordfish Stock Assessment Methods and Available Data for North Pacific Ocean. D. Courtney, G. Ishimura, and L. Wagatsuma. (Dean.Courtney@noaa.gov)

BACKGROUND PAPERS

DeMartini, E.E., Uchiyama, J.H., Humphreys Jr., R.L., Sampaga, J.D., and Williams, H.A. 2007. Age and growth of swordfish (*Xiphias gladius*) caught by the Hawaii-based pelagic longline fishery. Fish. Bull. (105):356-367.

Hinton, M.G., and Deriso, R.B. 1998. Distribution and stock assessment of swordfish, *Xiphias gladius*, in the eastern Pacific Ocean from catch and effort data standardized on biological and environmental parameters. U.S. Dep. Commer., NOAA Technical Report NMFS 142: 161-179.

Humphreys Jr., R.L., Campana, S.E., and DeMartini, E.E. 2005. Otolith elemental fingerprints of juvenile Pacific swordfish *Xiphias gladius*. Jour. Fish. Biol. (66):1660-1670.

Ichinokawa, M., and Brodziak, J. 2008. Possible substock boundaries of swordfish, *Xiphias gladius*, population in the Pacific Ocean judged from annual CPUE trends by Japanese longliners. Document submitted to 5th World Fisheries Congress, Yokohama, Japan.

Reeb, C.A., Arcangeli, L., and Block, B.A. 2000. Structure and migration corridors in Pacific populations on the Swordfish *Xiphias gladius*, as inferred through analyses of mitochondrial DNA. Mar. Biol. (136):1123-1131.

Sosa-Nishizaki, O. and Shimizu, M. 1991. Spatial and temporal CPUE trends and stock unit inferred from them for the Pacific swordfish caught by the Japanese tuna longline fishery. Bull. Nat. Res. Inst. Far Seas Fish. (28):75-89.

Ward, R.D., Reeb, C.A., and Block, B.A. April 2001. Population Structure of Australian Swordfish, *Xiphias gladius*. Final Report to AFMA.

Attachment 3

Agenda

BILLFISH WORKING GROUP (BILLWG) SPECIAL SESSION

International Scientific Committee for Tuna and Tuan-like species in the North Pacific Ocean

Meeting Site: NOAA Pacific Islands Regional Office (PIRO)
1601 Kapiolani Boulevard, Suite 1110
Honolulu, HI 96814

Meeting Dates: November 12-14, 2008

Goal: Develop plausible stock structure scenarios for populations of swordfish and striped marlin in the North Pacific for use in stock assessments.

November 12 (Wednesday), 0930-1000 – Registration

November 12 (Wednesday), 1000-1630

1. Opening of Billfish Working Group (BILLWG) Special Session on Stock Structure
    a. Welcoming Remarks
    b. Introductions

2. Adoption of Agenda & Assignment of Rapporteurs

3. Computing Facilities
    a. Access
    b. Security Issues

4. Presentations
    a. General
        - Humphreys
    b. Striped Marlin
        - Hinton
        - Kanaiwa

    c. Swordfish

- Reeb
- Reeb
- Alvarado-Bremer
- Ichinokawa
- Courtney

November 13 (Thursday), 0930-1630

4. Presentations (con't)

5. Discussion

6. Plausible Stock Structure Scenarios

November 14 (Friday), 0930-1630

7. Clearing of Report

8. Adjournment