INTER-AMERICAN TROPICAL TUNA COMMISSION

WORKING GROUP ON STOCK ASSESSMENT

8TH MEETING

REVIEW OF 2007 STOCK ASSESSMENTS

La Jolla, California (USA)
7-11 May 2007

MEETING REPORT

Chairman: Dr. Robin Allen

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http://www.iattc.org/Meetings2007ENG.htm

The 8th Meeting of the Working Group on Stock Assessments was held in La Jolla, California, USA, on 7-11 May 2007. The attendees are listed in Appendix A.

1. Welcome, introductions, meeting arrangements

The meeting was called to order on 7 May 2007, by the Chairman, Dr. Allen, who thanked the attendees for coming to the meeting, and then asked them to introduce themselves. Drs. Olson and Boggs were appointed Rapporteurs. Dr. Allen reviewed the purpose of the meeting, which is not a formal subsidiary meeting of the IATTC, but rather an informal working group convened by the Director. The Stock Assessment Working Group is to provide an external peer review of the staff stock assessments to give the scientists of members and cooperating non-parties of the IATTC (CPCs) an in-depth view of the staff's stock assessments, to review the advice and recommendations from the staff (Agenda Items 16 and 20), and to provide an opportunity to prepare for the formal consideration of the status of the stocks at the upcoming annual meeting in June. In recent years the Commission has asked that various other matters be reviewed by the Working Group. This year, the agenda includes discussion of: 1) the impact of incidental catch of seabirds and identification of geographic areas where there could be interactions with the fisheries, 2) the preparation of a plan for the comprehensive assessment of sharks, in cooperation with scientists of CPCs and the Western and Central Pacific Fisheries Commission (WCPFC), and 3) the ratio of fin weight to body weight of sharks.

2. Consideration of agenda

Dr. Allen reviewed the agenda and documents that pertain to each agenda item. It was decided to discuss Item 8c, *Review of staff management recommendations* for yellowfin with Item 9d, *Review of staff management recommendations* for bigeye. Additional items were added to Agenda Item 19, *Other business*, including a paper on sea turtles and FADs, a discussion about eastern Pacific Ocean data by Dr.

Fonteneau, and a proposal by the Ecuadorian participants. With these changes, the provisional agenda was approved.

3. Report and review of recommendations from 7th meeting

It was agreed to add this agenda item at last year's meeting of the Working Group. Dr. Allen reported that the 74th meeting of the Commission received the report of the 7th meeting of the Working Group and the staff conservation recommendations. After considerable discussion, a proposal for measures along the lines of the staff recommendations was made, but in the end the Commission adopted a resolution for 2007 only, similar to C-04-09. The Commission also agreed to convene a meeting in early 2007 to discuss conservation and management measures for bigeye and yellowfin tuna.

4. Report of the workshop on evaluation of management strategies

Dr. Maunder summarized the report of the workshop on management strategies held in La Jolla on 17-20 October 2006[1]. The topics covered in the workshop included: comprehensive management strategy evaluation (MSE) for tunas and billfishes; evaluation of management strategies that use spatial and temporal closures, gear restrictions, or vessel catch limits; consequences of effort allocation among fishing methods; and multi-species MSE. Comprehensive MSE includes the definition of operating models, data collection, assessment methods, harvest rules, and evaluation criteria. Presentations included an introduction of MSE, information on the operating model used in support of the harvest policy at the International Pacific Halibut Commission, a framework for using the Stock Synthesis II (SS2) model for MSE, use of temporarily or permanently closed areas, methods to analyze the redistribution of effort during fishery closures, analysis of historical catch rates for the purse-seine fishery of the eastern Pacific Ocean (EPO) to search for time-area "hotspots" for bigeye catches and predict the impact of closing these time-area strata, an analysis of IATTC Resolution C-04-09 on the conservation of tuna in the EPO, an approach for modeling tuna movement with Multifan-CL, research on the acoustic detection and behavior of bigeye and skipjack tunas with the objective of reducing the catch of small bigeye tuna, preliminary analysis of the effects of purse-seine gear characteristics on catch of bigeye, analysis of the impact of vessel catch limits for bigeye, analysis of restrictions on bigeye less than 60 cm in length, multi-species yield analysis, and an outline of multi-species management strategy evaluation (msMSE). Several management options were identified at the workshop: closed seasons, spatial closures, catch quotas, size limits, restrictions on number or characteristics of fish-aggregating devices (FADs), individual vessel quotas, and capacity limits. For each of these options the advantages and disadvantages were identified, with particular focus on likely success, effectiveness, effect on bycatch, and practicality in implementation. No attempt was made to weight the importance of each advantage or disadvantage. Research required to assess the potential of each option was also discussed. The most promising management measure was identified. The existing 6-week closure is generally acceptable, but insufficient for yellowfin and bigeye conservation. Other management action, in addition to a seasonal closure, is needed; otherwise the required closure would be too long. It is more promising to develop approaches that involve the industry in a proactive rather than punitive way. Methods should be developed to reduce bigeye catch by permitting some vessels to fish for skipjack associated with FADs during the closed period. This would require a designed program with scientists and observers on board to test methods that catch skipjack without catching bigeye. An alternative is to allow each vessel to continue fishing after the catch limits have been met, provided that its catches of yellowfin or bigeye are kept below acceptable limits. Some of the research recommendations included evaluating the effectiveness of previous closures, use of commercial vessels to conduct research during the closure (*e.g.* on methods to catch skipjack while minimizing catches of bigeye, tagging studies), estimating movement of the fish to improve the analysis of closures, investigating how effort might be reallocated if a spatial closure is implemented, developing tools to conduct comprehensive MSE for the EPO, developing gear that can minimize catches of small fish, investigating acoustic methods to identify small fish before setting, FAD registration and numbering

[1] http://www.iattc.org/PDFFiles2/Management-strategies-WS-Oct-06-ReportENG.pdf

to facilitate research on the FAD fishery, analyze the operations of vessels that capture the most bigeye, or a large proportion of bigeye, in more detail (*e.g.* spatial distribution, gear configuration, and FAD design), prioritizing the observer's duties to provide information that can help address current management problems.

5. Update on data received since preparation of Fishery Status Report 4

Mr. Pérez reviewed Document SAR-8-05, which summarizes the data provided to the IATTC staff by 30 June 2006 pursuant to Resolution C-03-05 on data provision. The types of data provided by each country were described.

A participant sought clarification about the major data sources that are missing. These include longline effort data for bigeye in the most recent years, while the catch and length-frequency data are nearly up to date. Bycatch data are also needed, and species identifications of sharks and seabirds need some improvement. It was noted that the observers from the Mexican national program provide valuable size-composition data by measuring tunas onboard at sea.

6. The fishery in 2006

Mr. Everett reviewed the information on the fishery for tunas in the EPO in 2006. He discussed EPO tuna catch statistics for 2006; total catches by species and by flag, purse-seine catch distributions for yellowfin, skipjack, and bigeye, and size compositions of the three species. The catches of yellowfin, skipjack, bigeye, and Pacific bluefin tuna by purse seine, pole-and-line, and recreational gear in 2006 were about 7% less than the catches in 2005 and about 1% greater than the average for 1996-2005.

Together, Ecuadorian, Mexican, and Panamanian-flag vessels caught about 68% of the total yellowfin, skipjack, and bigeye in the EPO during 2006. Mexican vessels caught about 41% of the yellowfin, and Ecuadorian vessels caught about 46 and 48% of the skipjack and bigeye, respectively. Yellowfin catches in 2006 were the lowest on record since 1984, and 44% below the 1996-2005 average. Lower catches were apparent throughout the EPO. There were extremely high catches of unassociated skipjack in the inshore areas off South America from about 0° to 20°S. Greater catches of skipjack were also evident in floating-object sets offshore to 150°W. The record high 2006 EPO skipjack catches of 308,000 metric tons (t) were 12% greater than the previous record catch in 2003. Bigeye catches in 2006 were similar to the 1996-2005 average, with the exception of greater catches on floating objects west of 130°W.

Length-frequency and species composition sampling areas were shown, and areas defined for stock assessments were described. Of the 1,053 wells sampled for length frequency and species composition in 2006, 739 contained yellowfin, 877 contained skipjack, and 338 contained bigeye. The average sizes of yellowfin, skipjack, and bigeye were less than the previous five-year averages for each species.

The participants noted that species composition changed quite a bit since last year, and size frequency is also changing. Both may be due to changes in recruitment, or they could be due to an altered seasonal pattern of fishing effort, which will be discussed in the agenda items on stock assessment. Size composition data have been provided for 2005 for most longline fisheries.

7. Report on the IATTC *ad hoc* meeting on management, February 2007

Dr. Allen reported that the focus of this meeting was to explore future options for the conservation and management of bigeye and yellowfin tunas. The meeting asked the IATTC scientific staff to provide the following information and analysis:

1) Work to refine critical areas for juvenile bigeye tuna and juvenile yellowfin tuna and consider the conservation value of closing these areas to purse-seine fishing for a period or year-round;

2) produce estimates of total allowable catch (TAC); compile a list of the practical and administrative issues raised regarding potential use of national catch allocations or individual fishing quotas (IFQs) for vessels;

3) estimate the conservation measures that would be necessary if the Commission implemented the *Plan for regional management of fishing capacity*[2] and reduced the purse-seine fleet to the target capacity levels;

4) investigate the impact of fishing effort on adult stocks of yellowfin tuna during recent years;

5) summarize available information on the impacts of the use of FADs, describe areas where FADs should not be placed because of the probability of catching juvenile tunas, determine the increase in vulnerability of tunas since the introduction of the FAD fishery, and determine the number of FADs placed.

Dr. Deriso presented some analyses that were requested by the Commission. Estimates of spatial distribution of catches (1994-2006) were presented based on data collected aboard purse-seine vessels by observers. The annual average catches of yellowfin and bigeye tuna <2.5 kg are a small fraction of the annual average total catches of all tunas (yellowfin, bigeye, and skipjack combined) in every 2º spatial stratum. The spatial distributions of the catches reflect the spatial distribution of sets. Almost all catches of bigeye <2.5 kg are from floating-object sets, whereas yellowfin <2.5 kg are caught in both floating-object and unassociated sets. Yellowfin <2.5 kg are caught closer inshore than small bigeye in both northern and southern latitudes. The overall spatial separation of catches of yellowfin and bigeye <2.5 kg suggests that there is no single area whose closure would be optimal for reducing the catches of both yellowfin and bigeye. The spatial patterns of the catches of 2.5–12.5 kg and <2.5 kg yellowfin and bigeye are somewhat similar.

Dr. Deriso also showed the average annual purse-seine catches (1994-2006) of yellowfin, bigeye, and skipjack tunas in the EPO, by size category, inside and outside the closed area proposed by the United States (90ºW-120ºW by 6ºN-12ºS). Catches presented were based on observer estimates aboard vessels with fish-carrying capacities greater than 363 t, and include both retained and discarded catch. Overall, 62% of all bigeye catches were made in this proposed closed area, but only about half of the catches of bigeye <2.5 kg. The majority of both yellowfin and skipjack is caught outside the proposed closed area, with only 18% of yellowfin caught in the area, and 44% of skipjack. For all species, retained longline catches are less frequent inside the proposed closed area than outside.

The Working Group suggested that the presentation would show the areas in which the small tunas were caught more clearly if it were by numbers of fish. It was asked how any trends in species compositions over area or time could be concluded, given the inconsistent ability of the observers to distinguish between the yellowfin and bigeye. The clear gradient that was seen is not consistent with misidentification.

It was clarified that the closed area proposed by the United States was not a request for a conservation management measure, but a proposal to investigate the effects of such a closure. In requesting an analysis, the U.S. did not evaluate the area boundaries, but used the area that the IATTC had identified previously. The results of the analysis suggest that it would be very unlikely that a closure of this area would be substantially beneficial to yellowfin and bigeye. In addition, it is uncertain how the fishermen would change their fishing strategies in response to a closed area, or how future environment changes would alter the results.

8. Yellowfin tuna

a. Stock assessment

Dr. Maunder presented the stock assessment of yellowfin tuna (*Thunnus albacares*) in the EPO (Document SAR-8-08a). An age-structured, catch-at-length analysis (A-SCALA) was used in the assessment, which is based on the assumption that there is a single stock of yellowfin in the EPO. The

[2] http://www.iattc.org/PDFFiles2/IATTC-73-EPO-Capacity-Plan.pdf

assessment for 2007 differs from that of 2006 in the following ways. The catch, effort, and length-frequency data for the surface fisheries have been updated to include new data for 2006 and the first quarter of 2007 and revised data for 2000-2005. New or updated longline catch data are available for Chinese Taipei (2002-2005), China (2001-2005), and the Republic of Korea (2003-2005). The analysis indicates that the yellowfin population has experienced two, or possibly three, different recruitment regimes (1975-1982, 1983-2001, and 2002-2006) corresponding to recruitment levels of low, high, and intermediate size. The recruitment regimes correspond to regimes in biomass, higher-recruitment regimes producing greater biomass levels. The analysis indicates that strong cohorts entered the fishery during 1998-2001, and that these cohorts increased the biomass during 1999-2001. However, these cohorts have now moved through the population, so the biomass decreased during 2002-2006. The biomass in 2005-2007 was at levels similar to those prior to 1985. In general, the floating-object, unassociated, and pole-and-line fisheries capture younger, smaller yellowfin than do the dolphin-associated and longline fisheries. The longline fisheries and the dolphin-associated fishery in the southern region capture older, larger yellowfin than do the northern and coastal dolphin-associated fisheries. Significant levels of fishing mortality have been estimated for the yellowfin fishery in the EPO. These levels are highest for middle-aged yellowfin. Most of the yellowfin catch is taken in schools associated with dolphins, and, accordingly, this method has the greatest impact on the yellowfin population, although it has almost the least impact per unit of weight captured by all fishing methods. Historically, the spawning biomass ratio (SBR) of yellowfin in the EPO was below the level corresponding to the average maximum sustainable yield (AMSY) during the lower productivity regime of 1975-1982, but above that level for most of the following years, except for the most recent period (2003-2007). The 1984 increase in the SBR is attributed to the regime change, and the recent decrease may be a reversion to an intermediate productivity regime. The two different productivity regimes may support two different AMSY levels and associated SBR levels. The SBR at the start of 2006 is estimated to be below the level corresponding to AMSY. The effort levels are estimated to be above those that would support the AMSY (based on the current distribution of effort among the different fisheries), but recent catches are substantially below AMSY. Because of the flat yield curve, only substantial changes from the current effort level would reduce average equilibrium yield below the AMSY given, the current recruitment levels.

If a stock-recruitment relationship is assumed, the outlook is more pessimistic, and current biomass is estimated to be below the level corresponding to the AMSY for most of the model period, except for a period from the beginning of 2000 to the end of 2002. Under 2006 levels of effort (2004 for the longline fisheries) the biomass is predicted to increase slightly and then decrease to around the current level. SBR is predicted to follow a trend similar to that of biomass. The SBR is predicted to return to the level corresponding to the AMSY. A comparison of the biomass and SBR predicted with and without the restrictions from Resolution C-04-09 suggests that, without the restrictions, they would be at lower levels than those at present, and would decline a little further in the future.

There was considerable discussion of the yellowfin assessment. Concern was expressed that some patterns could be due to environmental variability, both ENSO-scale and inter-decadal regime changes, and that the recent decline in biomass might be due to entering a cold regime.

Concern was expressed that the results of the analysis shown in Figure 4.10c, biomass trajectories simulated with and without fishing by different fisheries, was misleading. The greatest yield per recruit (YPR) is associated with dolphin sets, and yet the figure shows that the greatest impact on the yellowfin population is due to dolphin sets. The staff noted that the stacked biomass trajectories in the graph should not be interpreted as the effect of sequentially removing fisheries because of interacting effects among the fisheries operating simultaneously.

The participants questioned why the yellowfin assessment did not make use of the older data, from the 1950s onward, instead of only data since the 1970s, and with proper consideration of the changes as is done in the assessments by most commissions. The staff indicated that it was unlikely that the impacts of fishing in the 1950s could be affecting the recent SBR. Alternate approaches to examining the SBR were

suggested. It should be possible with a model that includes spatial analysis to reconstruct what the populations were in the earlier period.

Clarification was provided that the most recent estimates of fishing mortality (*F*) and biomass indicate both that overfishing is now occurring, and that the stock was slightly overfished in 2006, with a 3-year average *F*scale of 0.99.

It was noted that the biomass estimate has increased for the most recent year, but not the estimate of the unexploited biomass. This may be due to the recruitment biomass representing a larger fraction of total biomass than in the past, pointing out that recent recruitment may be critical.

The SBR calculated with the updated data indicates a more substantial decline than before, to below the reference line for the last four years, and a greater cause for concern than was indicated by the assessments for previous years. It was noted that the 2005 assessment was much more similar to the 2007 assessment than was the 2006 assessment, and the estimates have a retrospective pattern, that is, they change a lot from year to year as the most recent data are updated. It was also noted that the catches in recent months have increased somewhat.

There was much discussion regarding the regime-shift hypothesis explaining declining catches of yellowfin. Oceanographic evidence supports the idea that we have entered into a cold period, although evidence in the fish stocks (*e.g.* large skipjack catches) is not apparent. The regime shift hypothesis is being used by the staff only to interpret changes in recruitment, and research efforts at IATTC's Achotines Laboratory in Panama have focused on environmental factors in larval survival. An alternative to the regime-shift hypothesis is that fishing areas have changed, and fishery-wide catch-per-unit-of-effort (CPUE) data may not clearly represent the changing population biomass due to differing catchabilities by area.

The group recommended that the staff make model runs to explore the assessment indication of an increase in biomass (with large uncertainty) in the most recent year. For biomass to increase, while catch and CPUE were declining, would suggest that the biomass increase must have come from recruitment increases in 2005 and/or 2006. The result of this was reported to the meeting; the biomass increase was caused by a statistically-significant increase in recruitment.

b. Effect of Resolution C-04-09

Dr. Maunder presented an evaluation of the Resolution C-04-09 on the conservation of tuna in the EPO with respect to yellowfin tuna. The resolution included a 6-week closure during the third or fourth quarter of the year for purse-seine fisheries, and longline catches are not to exceed 2001 levels. Purse-seine effort for yellowfin tuna increased in 2004 relative to 2003, indicating that the resolution was not effective. However, the dolphin-associated effort decreased in 2005 and 2006 relative to 2003. The stock assessment model was used to project the population forward 8 years, starting in 2004, assuming that the conservation measures were not implemented. The biomass would decline more if the resolution had not been adopted and the SBR would be below that which would support the AMSY. Purse-seine catch would, after several years, be less if the resolution had not been adopted.

The participants noted that the closure did not seem to be long enough to have a comprehensive effect in reducing overall effort. The group speculated whether purse-seine effort that may have been diverted from yellowfin to bluefin tuna due to low yellowfin CPUE may have exacerbated reduced catches.

c. Review of staff management recommendation

Discussion of yellowfin management recommendations was deferred for discussion with the bigeye recommendations.

d. Predicting yellowfin tuna recruitment using oceanographic data

Dr. Maunder presented a paper by Dr. Adam Langley, Secretariat of the Pacific Community. This work

compared recruitment indices from the stock assessment in the western and central Pacific with oceanographic data, finding significant relationships. The modelers then took a similar approach for the yellowfin in the EPO, using generalized linear models to relate recruitment to oceanographic variables. Several key oceanographic variables were highly auto-correlated (wind speed, temperature, current at 45 m depth, depth of 20ºC isotherm). High recruitment that occurred in the late 1990s and early 2000s was correlated with some of these variables.

One participant cautioned against considering the analysis to have specific input value for the stock assessments or management recommendations. This is due to the host of variables used to derive the relationship and the very short testing period during which the model's predictions are compared with recent data not used in its fitting.

9. Bigeye tuna

a. Stock assessment

Dr. Aires da Silva presented the current stock assessment of bigeye tuna (*Thunnus obesus*) in the EPO. Unlike previous assessments, which used A-SCALA, this assessment was conducted using SS2. The assessment is based on the assumption that there is a single stock of bigeye in the EPO, and that there is no significant net exchange of fish between the EPO and the western and central Pacific Ocean.

Catch, CPUE, and length-frequency data for the surface fisheries have been updated to include new data for 2006 and revised data for 2000-2005.

There have been important changes in the amount of fishing mortality caused by the fisheries that catch bigeye tuna in the EPO. On average, the fishing mortality on bigeye less than about 15 quarters old has increased substantially since 1993, and that on fish more than about 15 quarters old has increased slightly since then. The increase in fishing mortality on the younger fish was caused by the expansion of the fisheries that catch bigeye in association with floating objects.

There are several important features in the estimated time series of bigeye recruitment. First, estimates of recruitment before 1993 are very uncertain, as the floating-object fisheries were not catching significant amounts of small bigeye. There was a period of above-average recruitment in 1995-1998, followed by a period of below-average recruitment in 1999-2000. The recruitments have been above average since 2000, and were particularly large in 2005. The most recent recruitment is very uncertain, due to the fact that recently-recruited bigeye are represented in only a few length-frequency samples. The extended period of relatively large recruitments in 1995-1998 coincided with the expansion of the fisheries that catch bigeye in association with floating objects.

The biomass of 3+-quarter-old bigeye increased during 1983-1984, and reached its peak level of about 614,898 t in 1986, after which it decreased to an historic low of about 278,962 t at the beginning of 2005. Spawning biomass has generally followed a trend similar to that for the biomass of 3+-quarter-olds, but lagged by 1-2 years.

At the beginning of January 2007, the spawning biomass of bigeye tuna in the EPO was near the historic low level. At that time the SBR was about 0.20, about 10% less than the level corresponding to the AMSY.

Recent catches are estimated to have been at about the AMSY level. If fishing mortality is proportional to fishing effort, and the current patterns of age-specific selectivity are maintained, the level of fishing effort corresponding to the AMSY is about 77% of the 2004-2006 average fishing effort, based on the most recent three-year average *F*scale. The AMSY of bigeye in the EPO could be maximized if the age-specific selectivity pattern were similar to that for the longline fishery that operates south of 15ºN because it catches larger individuals that are close to the critical weight. Before the expansion of the floating-object fishery that began in 1993, the AMSY was greater than the current AMSY and the fishing mortality was less than F_{AMSY}.

Recent spikes in recruitment are predicted to result in increased levels of SBR and longline catches for the next few years. However, high levels of fishing mortality are expected to subsequently reduce SBR. Under current effort levels, the population is unlikely to remain at levels that support AMSY unless fishing mortality levels are greatly reduced or recruitment is above average for several consecutive years.

Analyses were carried out to assess the sensitivity of results to: 1) sensitivity to the stock–recruitment relationship, which would provide more pessimistic results; 2) use of the southern longline CPUE data only; 3) estimating growth and assuming estimates for the asymptotic length parameter of the von Bertalanffy growth curve; 4) fitting to initial equilibrium catch; 5) iterative reweighing; and 6) using two time blocks for selectivity and catchability of the southern longline fishery. The base case was more optimistic than the sensitivity case that did not use the purse-seine CPUE index.

All analyses, except that incorporating the low assumed value for the asymptotic length parameter of the von Bertalanffy growth curve, suggest that at the beginning of 2007 the spawning biomass was below F_{AMSY}. AMSY and the *F* multiplier are sensitive to how the assessment model is parameterized, the data that are included in the assessment, and the periods assumed to represent average fishing mortality, but under all scenarios considered, except that incorporating the time blocks for the selectivity and catchability for the southern longline fishery without iterative re-weighting or low assumed value for the asymptotic length, fishing mortality is well above F_{AMSY}.

Discussion followed Dr. Aires da Silva's presentation. The pattern of natural mortality (*M*), with low values for small fish, was criticized as biologically inconsistent. It was noted that bigeye tagging studies show the smallest fish have much higher natural mortality rates. The staff acknowledged that the pattern of *M* is an assumption forced by the SS2 software, but pointed out that the assessment results are not very sensitive to the low estimates of *M* in the early ages that are hardly selected at all in the fisheries. The SS2 model re-scales the recruitment to a different level to accommodate that error. Parallel runs between the SS2 and A-SCALA model runs are fairly consistent. There are, however, some very important differences between the results of the two models, mainly the last (2006) estimate of spawning biomass. The staff believes that difference in the last year is due in large part to the A-SCALA model including CPUE from the coastal floating-object fishery (Fishery 4), while these data are not included in the SS2 model. Longline CPUE data are not available for 2006, but those data would indicate if the last SBR point was reliable or not. Furthermore, the need for timely data underscores the subsidiary benefit of deploying a vessel monitoring system (VMS) for real-time reporting, which could hasten the submission of longline statistics to the regional fisheries management organizations (RFMOs).

Another topic of discussion was the hypothesis that a cold phase, possibly indicative of a regime shift, is possibly having a positive influence on bigeye recruitment, and hence biomass. The staff was encouraged to consider the oceanographic conditions in the assessments.

Discussion turned to the summary illustration of stock status in relation to a vertical *F* scale and a horizontal biomass scale showing the final (2006) point in the upper left red quadrant that indicates that overfishing is underway (*F* too high) and that the stock is overfished (biomass too far to the left). This same summary figure, or one like it, has been requested of all the tuna commissions, to arrive at a standard in presenting stock status.

Actions that could be taken to improve the CPUE data were discussed. Data quality is very important, and better CPUE data from the FAD fisheries could be achieved by identifying (numbering) individual FADS and maintaining logbook records on how frequently FADS are visited and sets are made on them. This was a previous recommendation.

b. Effect of Resolution C-04-09

Dr. Aires da Silva presented an evaluation of Resolution C-04-09 on the conservation of tuna in the EPO with respect to bigeye tuna. The resolution included a 6-week closure during the third or fourth quarter of the year for purse-seine fisheries and longline catches are not to exceed 2001 levels. In 2004 there was an

overall 22% reduction of effort in the floating-object fisheries, with a 46% reduction in the third quarter. However, for 2005 and 2006, respectively, the third-quarter effort was only 27% and 9% less, and the total effort was 7% and 21% greater than in 2003. With respect to the longline fisheries, catches of bigeye have decreased substantially since 2001. In 2006, it was only 44% of that in 2001 and 52% of the combined catch cap for Chinese Taipei, China, Korea, and Japan.

The stock assessment model was used to project the population forward 8 years, beginning in 2004, assuming that the conservation measures were not implemented. The spawning biomass of bigeye tuna at the end of 2006 with the management restrictions is about 56% greater than it would be if no restrictions had been implemented. The spawning biomass is still below the level required to support the AMSY, except 2008 and will, under average conditions, remain below that level. It will decline even further if no restrictions are implemented.

Discussion included a request for a clearer summary of how much reduction in effort was accomplished. New vessels were not prohibited from entering the fishery, so the target was not achieved. It was noted that there has been a drastic decline in longline catches in the EPO, but an increase in the western and central Pacific Ocean (WCPO), and the total bigeye catch in the Pacific Ocean is relatively stable. It was stated that some longline fleets have installed VMS on all their large vessels to enhance monitoring of the fleets, and have reduced their fishing capacity, which has resulted in declines of their catches in the most recent years, both in the EPO and the WCPO. This led to a discussion of VMS technology. It was stated that most of the longline fleets already have VMS and there is no reason to doubt compliance.

A discussion ensued regarding whether the closure had been designed to address mostly yellowfin fishing or yellowfin and bigeye fishing. The staff recommendations have been for both species, but the measures adopted by the Commission have addressed more aspects that affect yellowfin rather than adopting the full recommendations.

It was asked if the staff has looked into a possible effect between bigeye recruitment and oceanographic factors. The staff had previously seen an effect of zonal current velocities at depth, but the relationship was not persistent in subsequent assessments. Recruitment estimates for bigeye before 1993 are very uncertain because the purse-seine FAD fishery was not yet developed, so it is difficult to correlate recruitment with environmental factors before that year.

c. Presentation on AMSY under different purse seine and longline effort allocation levels

Dr. Maunder presented the results of some model runs done during the meeting. The presentation illustrated the reductions in harvest rate that would be required by both longline and purse seine gear to achieve AMSY of bigeye) (2004-2006). The presentation illustrated the modification also provided a view of the harvest rate over time by longline and purse seine from 1970 to present, showing the recent reduction in longline effort.

d. Factors affecting purse-seine catches on FADs

Dr. Lennert-Cody presented a summary of a study of gear effects on the presence of bigeye tuna catches in floating-object sets for vessels with fish-carrying capacity greater than 363 t. Among the gear characteristics studied that directly relate to the vertical stratification of tuna species around floating objects, it was found that the maximum depth of the object below the water's surface and the hanging depth of the purse-seine net had the most affect on whether bigeye tuna were caught, with catch more likely on deeper objects and in deeper nets (actual fishing depths are not known). These gear effects were found to vary spatially, with the greatest increases in the probability of catching bigeye tuna on deeper objects and in deeper nets in the southern area of the fishery. Nonetheless, the location of the set (latitude, longitude) was the strongest determinant with this data set for the presence of bigeye tuna catch. Sets in which bigeye tuna was caught, but none was predicted, were found to occur most frequently for certain vessels, suggesting that some vessels may also catch bigeye tuna in ways different from those employed by most of the fleet, *i.e.*, in ways poorly described by the predictors included in this analysis. This

represents a form of a vessel effect that could be amenable to further study. Results of this study indicate that fishermen have several options available to them to try to avoid catching bigeye tuna, including: changing the depth of the material hanging underneath the floating object and the actual fishing depth of the net when they intend to fish in certain areas of the fishery, and changing their overall fishing location.

Following the presentation, discussion focused on whether avoiding catching bigeye would affect the target catch. The target catch is skipjack, and previous analyses suggested that the deeper nets that catch bigeye more frequently than shallower nets, catch more skipjack. Dr. Lennert-Cody explained that the actual fishing depth depends on weight of chain and mesh size, and other factors, so a simple regulation limiting net depth is oversimplified, and fishery-wide gear regulations would be ineffective. Moreover, because area has a greater effect that gear variation, area closures would be more effective than gear restrictions.

There was discussion of the depth of the mixed layer or the thermocline possibly being very important. Many suggestions were made regarding how better mixed layer depth estimates could be acquired, and that the differences between thermocline depth and net dimensions should be examined.

e. Review of staff management recommendations

Dr. Allen presented the IATTC staff recommendations on management measures for yellowfin and bigeye, which are found in Document SAR-8-REC (Annex B).

Following Dr. Allen's presentation, Dr. Deriso presented a very simple evaluation of the effect of closing coastal areas (that is the 5-degree strata that intersect coastlines in areas where small yellowfin tuna are caught). The absolute effects of the closure are uncertain because the response of fishermen cannot be predicted. Qualitatively, the closure would likely lead to a reduction of the catch of small yellowfin and an increase in the catches of larger yellowfin in dolphin-associated sets. A potentially negative feature of the closure could be increased catches of both skipjack and bigeye tuna if the fishermen from closed coastal areas switch to fishing on floating objects, particularly in the offshore area west of the Galapagos Islands.

It was noted that variability of stocks and the environment and other factors also make it difficult to predict the effect of closed areas.

The following discussion centered on the impacts on fleets that are not able to move outside a coastal closure. The IATTC staff has not done analyses of the economics or the mobility of the fleets, especially the fleets of smaller vessels that are not considered in the analyses leading to the recommendation. It was recommended that the staff present simple calculations to indicate possible effects of each measure, to be listed along with each of the proposals, and that consideration be given to closures covering part of the year in addition to the entire year. A comment was made that a coastal-area closure should not include fishing for bluefin tuna.

It was suggested that measures restricting areas and seasons would require VMS technology to be utilized, and several members mentioned that their fleets already employ VMS. This technology also opens the door to more real-time reporting with verified location accuracy, which could enhance rapid data processing and reporting to RFMOs. Small vessels may not be able to move outside of coastal areas, but the proposal is meant to apply only to vessels with fish-carrying capacities greater than 363 t (class-6 vessels).

Concern was expressed about the continuing increase in fishing capacity, and it was suggested that capacity limits be recommended. This aspect will be reported to the Commission from the February capacity meeting as well. Some participants urged stronger, less-conservative management recommendations related to capacity restrictions to bring the populations toward AMSY. Controls on fishing capacity were seen as a more effective solution than season or area closures.

Concern was expressed that previous management recommendations for bigeye were only partially met.

Longline effort in the EPO was reduced, but purse-seine capacity in 2007 was 7% greater than in 2004-2006 and the catch of small bigeye has not been reduced substantially. It was pointed out that the task of the working group and staff is to present scenarios to the Commission, rather than to decide on a balance between longline and purse-seine effort. The growth in fishing capacity was taken into account in making the staff recommendations.

Clarification was requested concerning whether the recommendations are for small boats or large boats. The staff's recommendations will apply to class-6 vessels only, and the document will be changed accordingly.

Discussion moved to the staff's recommendations for albacore. The resolution was left vague so that countries could develop their individual approaches to the resolution, but it was suggested that the Commission staff request the individual countries to provide information as to how they are defining "current levels of fishing effort" so that the staff can evaluate whether the countries are complying with the resolution. It was noted that the northern albacore assessment of International Scientific Committee for Tuna and Tuna-like species in the North Pacific Ocean was updated, but the report has not been completed.

Regarding swordfish, it was noted that there has been additional relevant scientific research in Chile and Spain, but not a new assessment.

It was clarified that the suggested precautionary measure in the swordfish recommendation regarding the annual catches refers to the southeastern Pacific Ocean area of unit stock 4, which is the Commission area south of 5º S.

10. Skipjack assessment

Dr. Maunder reviewed the current skipjack assessment. In previous assessments it has been difficult to determine the absolute levels of biomass and exploitation rates, due to the possibility of a dome-shaped selectivity curve. In addition, it is not known whether catch per day fished for purse-seine fisheries is proportional to abundance, the levels of age-specific natural mortality are uncertain, and current YPR calculations estimate that YPR would be maximized by catching the youngest skipjack in the model. Therefore, neither the biomass- or fishing mortality-based reference points nor the indicators to which they are compared are available for skipjack tuna in the EPO.

Simple indicators of stock status based on relative quantities were investigated. Rather than using reference points based on AMSY, we compare current values of indicators to the distribution of indicators observed historically. The indicators, which are based on data, are catch, catch per day fished for each of the floating-object and unassociated purse-seine fisheries, average weight, and standardized effort. The indicators were compared to the relative exploitable biomass and relative exploitation rates from the most recent stock assessment. The indicators were consistent with the stock assessment. The average weight for skipjack has been declining since 2000, and the 2006 average weight is approaching the lower reference level. The CPUEs for both floating-object and unassociated fisheries have generally been increasing since 2000. The standardized effort indicator of exploitation rate has been increasing since about 1991, and in 2006 is above the upper reference level. The purse-seine catch has been increasing since 1985, and is currently above the upper reference level.

There is an apparent contradiction between the recent CPUE increase and the changes in the standardized effort (increase) and average weight (decrease) indicators. We develop a simple stock assessment model to investigate the contradiction in the data. The model is fitted to the two CPUE time series and to the average weight data. The results suggest that the inconsistency can be explained by a parallel increase in both exploitation rate and abundance. An alternative explanation is an increase in the catchability of the skipjack to the purse-seine fisheries. This hypothesis is consistent with the flat index of abundance developed based on ratios of skipjack to bigeye in catch from the floating-object fisheries, which may be robust to changes in catchability.

Discussion following the presentation focused initially on increasing catchability of skipjack due to technical improvements. The staff mentioned that, in general, it is very difficult to find effects of gear changes in the analyses.

It was mentioned that other analyses have suggested that skipjack are underexploited Pacific-wide, and the opinion of the staff was requested regarding whether the analysis suggests that the exploitation is nearing the maximum sustainable rate in the coming years. Given that it is not known if the population has ever gotten close to AMSY levels in the past, it is not possible to know from the relative reference points if skipjack are currently close to AMSY.

The working group noted that the WCPFC assessment was facilitated by tagging data. It was suggested that the benefits of tagging skipjack need to be clearly explored and stated.

11. Swordfish stock structure

Dr. Hinton reviewed Document SAR-8-11 on swordfish stock structure. At this time, the best scientific evidence indicates that there are four stocks of swordfish in the Pacific Ocean, centered in the northwestern, northeastern, southwestern and southeastern Pacific. The IATTC is continuing investigations of stock structure of swordfish in the Pacific Ocean and stock assessments for eastern Pacific swordfish stocks.

A study published in 2006 presented results from 305 swordfish sampled from various localities in the Pacific Ocean, and obtained a statistically-significant ($p < 0.009$) fixation index (F_{ST}) value of 0.013. This result was driven primarily by heterogeneity in distribution of ldh-A alleles in the southeastern Pacific Ocean compared to three other areas (northeastern, southwestern, and the northwestern-central Pacific Ocean). Noise from intra-locus sampling was less than 8% of the signal, and it did not play an important role in explaining F_{ST}.

The stock structure from by the 2006 study was compared with those obtained from previously hypothesized alternative models of population structure for Pacific swordfish. The ldh-A allele frequency data from the 2006 study was pooled to correspond to the alternative two- and three-stock structure hypotheses, and computations of F_{ST} and checks of Hardy-Weinberg Equilibrium (HWE) were made. Estimates of F_{ST} were in all cases lower when samples were pooled to correspond with the alternative models than when they were in the original results, and the alternative models were not in HWE ($p <= 0.0002$ for all applicable tests). These results were consistent with studies in 1998 and 2003 which had statistically-significant differences in trends in relative abundance and changes in size distributions for identified stocks in the northern and southern EPO.

Stock boundaries in the Pacific Ocean do not imply that swordfish do not move across the lines, and although the genetic information is of value in analysis of stock structure and distribution, some of the attendees doubted the necessity of assuming that there are very clear biological boundaries for the stocks. Some participants expressed the opinion that tagging data could be more useful in this regard.

12. Presentation of contributed papers

12a. Proposal targeting a better understanding of the IATTC stock assessment results

Dr. Fonteneau presented various proposals (Document SAR-8-12a) concerning the content and presentation of the future IATTC stock assessment reports, widely based on the yearly reports done by the other tuna RFMOs. The recommendation included increasing the figures and tables showing the basic data used in the stock assessment (*e.g.* total catches by gear, fishing zones, yearly CPUEs, and yearly catches at size taken by each gear). Dr. Fonteneau also recommended showing in these reports a series of external information and indicators, such as the sizes of the area fished, the average sizes of active vessels, and the changes in the AMSY estimated during the previous stock assessment. There was also a firm recommendation that all the results from the models should be presented in a more comprehensive way, for instance on a yearly scale (instead of quarterly scales) and showing the total yearly levels of the

major parameters (such as recruitment levels, fishing effort, and catchability by gear. Dr. Fonteneau said that these proposed changes in the content of the yearly assessment reports would greatly improve the communication of the IATTC assessment results to both scientists and Commissioners.

There were many comments in support of the suggestions, in particular the use of annual summaries or smoothed data as opposed to the quarterly data in graphical presentations. The Commission staff is moving in that direction. It was also suggested that standardizing the intervals used for size data could be useful, but may be difficult due to the different fisheries concentrating on different size ranges of fish.

12b. Acoustic selectivity in tropical tunas (experimental purse-seine fishing in the Indian Ocean)

Dr. Ariz presented the results of a pilot action conducted in the Indian Ocean in 2005 (paper IOTC-2006-WPTT-06). Four Spanish boats, two purse seiners and two supply vessels of the company ALBACORA S.A., and the Spanish Oceanographic Institute (IEO) participated in a pilot project that aimed to reduce the impact of FAD fishing on the stocks of the most sensitive species (bigeye and yellowfin) and on the ecosystem by reducing bycatches. Acoustic data were collected using up-to-date devices (sonar and echosounders) and subsequently analyzed to establish criteria that will enable a reduction in catches of juvenile tropical tunas, based on acoustic selectivity.

It was suggested that the size of swim bladders be investigated to see how the allometry of swim bladder development with fish size may affect differences in species signatures. The study will use some different frequencies to better improve the species differentiation. It was pointed out that this type of research will be expanded in the next iteration to be conducted in the Pacific as well, where there is a much higher incidence of bigeye associated with floating objects.

12c. Sea turtles: protection measures in coastal areas

Dr. Hall reviewed Document SAR-8-13. The sea turtle populations present in the region were reviewed, including the status of some on nesting beaches across the farthest reaches of the Pacific. This was presented to show the dynamics that are driving abundance trends, sometimes in very different directions than might be expected if pelagic fishing mortality were an important influence. Some life history information was also reviewed to suggest the lags that might be expected between changing impacts at sea and mature nester abundance.

Next the bycatch reduction research and outreach program in the region was reviewed. This work is focused on exchanging the J and tuna hooks that prevail in most fisheries with circle hooks, in collaboration with many non-governmental organizations (NGOs), the U.S. National Oceanic and Atmospheric Administration (NOAA), and the Overseas Fishery Cooperation Foundation (OFCF) of Japan, industry and fishers groups, and government fisheries agencies. The program consists of voluntary exchanges of hooks to test circle hooks in the fishing boats, distribution of dehooking tools, an observer program to document the results, and fisher's workshops throughout Latin America to improve species handling protocols. The tests of circle hooks versus the predominant J or tuna hooks are carried on in the artisanal fleets of the coastal nations of the eastern Pacific, from Mexico to Peru, in experimental designs which alternate hook types along the line.

One approach that is being tested as an alternative to circle hooks in the dorado fisheries of Ecuador and Peru is the use of hooks with an added wire appendage opposite from the hook point. The tests in Ecuador and Peru had very good results, with a significant reduction in interaction rates with appendage hooks (53% and 80% reduction in Peru and Ecuador, respectively). Hook swallowing was also greatly reduced among the turtles that were caught. Subsequently more testing was conducted with hooks modified by the addition of a ring (at the request of the fishers), and (lacking the original type) also using a weaker wire appendage. The results were still a very significant reduction in sea turtle hooking rates, but quite higher than in the same hooks without rings.

Other tests were conducted in Ecuador by the OFCF, and in Peru with support from NOAA, to find ways to reduce turtle entanglements, and these tests were highly successful.

Due to lack of time discussion was deferred to informal discussion during a break.

12d. Research on circle hooks in the Korean tuna longline fishery

Dr. An presented information from Document SAR-8-12g, in which the performance of J and circle hooks was compared. Highlights of the results indicated that the catch rates of target fishes were not significantly different, but those of the bycatch species were. Circle hooks tended to hook turtles in the lower jaw, whereas J hooks lodged in the mouth, and turtle mortality rates were higher for J hooks. There were no real differences in the sizes of yellowfin and bigeye tuna caught by the different hooks.

Discussion ensued about circle hooks versus J hooks, in general. It was mentioned that the diversity of circle hook styles in studies is increasing. It was also pointed out that in both turtle presentations, much diversity of hook shapes were lumped under the general nomenclature of "J" hooks, including both straight J and tuna hooks (see illustration in NC2-2006-26 Scientific research on circle hooks[3]).

In many fisheries, circle hooks significantly reduce sea turtle hooking rates in comparison with traditionally-used straight-shank "J" or bent-shank "tuna" hooks. In other fisheries, there were no differences in this respect. In all fisheries examined circle hooks result in different location of hooks in turtles, with significantly fewer circle hooks swallowed than J or tuna hooks, and it is expected that this would translate into higher survival rates of hooked turtles when circle hooks are used. Removal of hooks from the mouth is considerably easier than removal from locations further inside the turtle.

12e. Seabirds

Ms. Rivera presented a combined report for Documents SAR-8-12b (*Best Practices for the Collection of Longline Data to Facilitate Research and Analysis to Reduce Bycatch of Protected Species: Report of a workshop held at the International Fisheries Observer Conference, Sydney, Australia, November 8, 2004*), SAR-8-12c (*Summary Report: Seabird Bycatch Mitigation in Pelagic Longline Fisheries Workshop*), and SAR-8-12d (*Seabirds and Fisheries in the IATTC Area: Assessment, Data Collection, Mitigation*). Recent recommendations from the Working Groups on Stock Assessment (7th meeting, 2006) and on Bycatch (6th meeting, 2007) call for IATTC to coordinate with other tuna RFMOs, particularly WCPFC, and develop a seabird bycatch mitigation strategy that could include standardization of seabird bycatch data, effective seabird mitigation measures, and to identify possible areas within IATTC where mitigation measures would be appropriate. IATTC's Resolution C-05-01 also calls for Working Group on Stock Assessment to conduct an assessment on the impacts of the longline fisheries in the EPO on seabirds. In response to these recommendations, four key areas were discussed: assessment of impacts of fisheries on seabirds, geographic areas of overlap between IATTC fisheries and seabirds, observer data collection, and effective seabird mitigation devices and methods.

Assessment. In addition to assessing the direct impacts of IATTC fisheries on seabirds, the assessment should also consider the indirect interactions that are known to occur. Seabird assessments being planned or conducted by WCPFC (Ecological Risk Assessment using a Productivity-Susceptibility Analysis) and ICCAT were discussed.

Geographic Areas of Overlap with Seabird Species. Data were presented from NOAA Fisheries Cetacean and Ecosystem Assessment cruises conducted by the Southwest Fisheries Science Center, providing another source of information on seabird distribution in the EPO. Data from these cruises corroborate the potential for both direct and indirect interactions of some seabird species of concern with IATTC fisheries.

Observer 'Best Practice' Data Collection. A summary was provided of a NOAA Fisheries workshop

[3] http://www.wcpfc.int/nc2/pdf/WCPFC-NC2-Tokyo.zip

held in conjunction with the International Fisheries Observer Conference to address the development of best practices for the collection of longline data to facilitate research and analysis to reduce bycatch of protected species (seabirds, sea turtles, marine mammals). The executive summary and the full report[4] identify reasons for and the challenges of standardized data collections for longline fishery observer programs.

Effective seabird mitigation devices and methods. Recent reviews of seabird mitigation measures were discussed in an FAO document and in a pelagic longline mitigation workshop of invited experts in 2006. They all identified how mitigation technologies typically work, and stressed that no single mitigation technique achieves maximum success and that seabird conservation in longline fisheries is best achieved through a suite of mitigation measures or best management practices. In addition to reducing bird interactions with fishing gear, mitigation measures must be practical and safe to use, be available at minimal cost, not decrease the catch of target species and/or increase the bycatch of other taxa, be enforceable, and ideally will provide fishermen with an incentive to use them. Ms. Rivera concluded with a summary of seabird priorities for consideration by the working group: 1) continued improvements and progress on an assessment of IATTC fishery impacts on seabirds, including both direct and indirect ecosystem effects; 2) 'best practice' seabird bycatch data collection on industrial and artisanal longliners; 3) continued coordination with other tuna RFMOs and gear mitigation scientists at identifying appropriate and effective technical specifications for seabird mitigation measures; 4) circle hook research that focuses on measures of the impacts of circle hooks vs. other hook types on seabird bycatch levels; and 5) requiring effective seabird mitigation measures on industrial longliners in IATTC areas of greatest likelihood for interactions.

There was discussion of data collection standards for recording seabird bycatch. The paper identified the importance of information on the species, age, and sex of the birds, but given that this kind of information is hard for non-specialists to collect, the best method is to return carcasses to port for biologists to examine. Photographs are an alternative. It would also be very valuable to know more about fleet and vessel characteristics, such as time of set and deck height above water. It was noted that seabird bycatch mitigation in the EPO may be simpler than in other regions due to the presence of fewer deep-diving petrels.

12f. Seabird incidental catches and shark bycatch

Dr. Chang presented information from Document SAR-8-12e, which provides summary information on the interactions with seabirds and sharks from 13 observation trips in the Pacific Ocean on longliners of Chinese Taipei during 2002-2005. Among the observation trips, four were made on albacore vessels in the temperate regions and the rest were on bigeye vessels in the tropical region. The interactions in percentage during the period were 0-0.11% for seabirds and 2.7-5.2% for sharks, with catch rates in the ranges of 0-0.23 individuals/1000 hooks for seabirds (higher in temperate regions) and 0.44-0.89 for sharks (higher in tropical regions). Albatrosses and blue sharks composed most of the interactions. Several mitigation measures have been adopted by vessels operating in the temperate regions to reduce seabird incidental catch, including night setting, adding weight to branch lines, using thawed baits and occasionally throwing baits near the side of boat to attract birds away from the line setting operation. Additional information on bird band collection, visual surveys for seabirds, and data for ratios of weights of shark fins to weights of sharks was also provided.

Also, Dr. Chang informed the working group that a workshop on reducing sea turtle incidental catch was held in Taiwan during late 2006, to introduce to the industry about the world trend on sea turtle conservation, information on endangered sea turtles, results from circle hook experiments, and usage of de-hookers. Besides educational purposes, boat owners were invited to join circle-hook experiments that are going to be conducted in 2007.

[4] http://www.fakr.noaa.gov/protectedresources/seabirds/llreport0307.pdf

The reduced bird bycatch during night fishing was discussed, and it was asked if there was much variation in the time of sets in this fishery that could be useful for investigating such effects. The answer was that the time of setting is quite stereotypical, with setting for albacore in the middle of the night and for bigeye mostly in the early morning. It was noted as also important that the fishermen return ID bands from dead birds. Care should be taken not to offer incentives for these bands, however, as this might cause the intentional killing of the birds.

It was suggested that the deck height of the vessels may be an important kind of information to collect regarding the bycatch of seabirds and other species. Deck height seems to have an important effect, with the low deck height of some vessels resulting in rapid submersion of baits and less opportunity for birds to reach them.

12g. Report of the Chinese observer program in the tropical eastern Pacific

Dr. Dai presented the results of a longline survey in February-December 2006, in which 223 sets were made in the EPO.

A query regarding the size of the juvenile bigeye discarded indicated they were less than 10 kg. Most of these juvenile fish were released to the sea alive. The number seemed high, and it was asked if a peculiar aspect of the operations could have resulted in this anomaly. The answer was that there may have been some small yellowfin included in this number. It was asked if the sets were always deep, as indicated by the hooks depths presented, because the species composition data tend to indicate at least some shallow setting. It was explained the setting operations were completely under the control of the commercial longline vessel, but the observers did keep track of the hook positions that caught fish, and most bigeye were caught on hooks 4 to 9, at depths of approximately 200-300 m (the deeper hooks in the catenary). The working group said it would like to see the complete observer report on these fishing operations, and not just the logbook information.

12h. Albatross and petrel distribution in the EPO

Dr Small, BirdLife International, presented an update on albatross and petrel distribution in the EPO, based on tracking data held by the Global Procellariiform Tracking Database. Since last year, remote tracking data have been added, which have improved understanding of albatross distribution in the North Pacific Ocean.

The northern IATTC area is important for black-footed albatross. Laysan and short-tailed albatrosses are also found within the northern IATTC area at low densities. The small Laysan albatross colony breeding on Isla Guadalupe, Mexico (c. 350 pairs) forages entirely within the EPO. In the southern hemisphere, waved albatrosses from the Galapagos Islands are distributed entirely within the IATTC area. The west coast of South America is highly important for non-breeding black-browed albatross from Chile and for non-breeding Chatham, Salvin's and Buller's albatross from New Zealand. Additional albatross species forage within the far southern portion of the IATTC area, but tracking data indicate relatively little overlap with IATTC longline fishing effort (grey-headed, wandering, northern royal, southern royal, Antipodean albatross). The area proposed by the IATTC staff in Document SAR-8-14 is a good depiction of the area of high density of albatross distribution in the IATTC area. Fewer tracking data are available for Procellaria petrels (white-chinned, grey, Westland, black petrel), which are species also susceptible to bycatch. Range data indicate that the majority are distributed within the area identified in SAR-8-14, with the exception of black petrel.

It was clarified that the increased range shown for black-footed albatross in the most recent results was due to increased sample size, and not due to an oceanographic change during the most recent period.

13. Seabirds: Interactions with longline fisheries – areas and mitigation tools

Dr. Scott presented information from Document SAR-8-14 on seabird interactions with the longline fishery. He reviewed areas in which seabird bycatch may occur, and mitigation measures that can be used

to reduce seabird bycatch. The paper offered a range of potential management and research options to be reviewed by the Working Group and presented at the June 2007 meeting of the IATTC. These options included 1) collection of information on the vessels, gear, and fishing operations of all artisanal and industrial longline fisheries under the purview of the IATTC; 2) observer programs to collect seabird bycatch data and to monitor the effectiveness of mitigation measures; 3) research on mitigation measures; and 4) requiring industrial longliners to adopt mitigation measures to reduce seabird bycatch, following the approach of the WCPFC.

There was a discussion of what is required for tracking data samples to be considered representative, which indicated that variables such as bird age, sex, breeding condition, etc. are much more important influences on ranges and areas than inter-annual variation. It was clarified that the reason for looking at the birds in the EPO was not because it includes the most important breeding areas for most birds, but because it is important to birds for foraging, and the IATTC is concerned about possible bycatch issues. Although there are several species in the area, most are far to the south and only a few have distributions that overlap with the areas in which fishing takes place. One purpose of the presentation was to show these areas of overlap. It was noted that albatross do not often occur in the Gulf of California, so it should not be included in the mitigation area.

14. Sharks

14a. Draft research plan for comprehensive assessment of shark stocks

Resolution C-05-03 on the conservation of sharks requires that the IATTC, in cooperation with scientists of CPCs and, if possible, the WCPFC, shall propose a research plan for a comprehensive assessment of key shark stocks. Dr. Lennert-Cody presented the research proposal contained in Document SAR-8-15 that includes: 1. identification of key species; 2. compilation of available life-history data; 3. compilation and standardization of CPUE and length-frequency data; and 4. population dynamics modeling. A series of actions was proposed, along with the required funding and resources; these include salary for a 14-month research position, catch and effort data for fisheries that take sharks in the EPO, and unpublished life history data.

It was noted that the recommendation from the working group last year was to coordinate with national experts. No discussion of this took place at the 74th Commission meeting in 2006, so the proposal is being reintroduced for consideration at the 75th Commission meeting.

A workshop on bycatch reduction was hosted by the U.S. Southwest Fisheries Science Center (SWFSC) in 2006, which identified a series of research proposals on mitigation methods. Tagging of animals released alive from the decks of boats was identified as necessary. Work is being conducted with observers on artisanal longline fisheries to improve species and sex identifications and measurements. IATTC observers are beginning to collect samples for genetics studies of sharks to be conducted by scientists at the SWFSC. It was pointed out that data on sharks are problematic world wide, and the use life tables and demographic (life history) information to get preliminary information for assessments is desirable.

In general, the participants viewed the recommendations in the paper positively. Additions to the recommendations included using demographic methods and investigating outside funding sources.

14b. Estimation of fin weight to body weight ratios of sharks in the EPO

Dr. An reported on a survey by the National Fisheries Research and Development Institute (NFRDI), Republic of Korea, to collect shark data and to estimate the ratio of fin weight to body weight of sharks during the circle hook experiment survey which was conducted in the EPO between 9°13'S-1°36'N and 126°00'-38°21'W from 20 September to 23 October 2006. The catches of nine species of sharks taken on 62,464 hooks were 413 in number and 11,093 kg in weight. The ratio of wet fin weight to body round weight of sharks by species ranged from 4.1 to 8.1%, and the mean was 5.08%. The total ratio of wet fin

weight to weight of the fins dried on vessels ranged from 0.38 to 0.70, and mean ratio was 0.53.

During the discussion period, it was pointed out that one main difference between the Spanish and Korean studies was that the former used dressed weight of the fins and the latter used round weight. The proportion would be considerably greater if compared to the dressed weight of the shark. A conversion factor can be applied, and then the results made available to the Commission. Another possible source of variability in comparisons among studies is that the fins may not have been totally dry. It was pointed out that IATTC Resolution C-05-03, paragraphs 3 and 4 may need clarification to specify dressed weight. The staff will incorporate the results from the Republic of Korea in its report to the Commission, which was not considered last year due to shortage of time, and suggested the 5% ratio should be further examined.

15. Evaluation of Pacific-wide management strategy

The consultation committee regarding coordination between the IATTC and WCPFC on Pacific-wide management strategies has in its work plan a request that the IATTC, via a meeting of its Working Group on Stock Assessments, address this issue and provide ideas that may be reviewed at the third meeting of the Scientific Committee of the WCPFC. The staff has not had time to address this issue yet, so this agenda item is just to let the participants know that the staff will be developing input on this issue. It was pointed out that one issue of particular importance is the development of reference points, with some specific interest in integrating this into possible future work on MSE. Further discussion was invited, but none was provided by the group. The next action on this will be at the third meeting of the Scientific Committee of the WCPFC in August in Honolulu.

16. Fishery Status Report

A draft of this report is in Document SAR-8-17. The advice the staff provides to the Commission in its Fishery Status Report (FSR) contains the description of the EPO fisheries and also includes summaries of the stock assessments for yellowfin, skipjack, bigeye, Pacific bluefin, and albacore tunas, swordfish, and blue and striped marlin. There is also a chapter on ecosystem considerations. For yellowfin and bigeye, the papers are updated to reflect the new stock assessment information. For skipjack, the staff will update the chapter including information from the analysis presented at this meeting. For Pacific bluefin, albacore, swordfish, and striped and blue marlin, the chapters will be updated, including current fishery data.

Dr. Olson presented an overview of the Ecosystem Considerations section of the FSR. The presentation was intended to familiarize the group with the contents of the report, and highlight some recent research. One focus is to address the effects of removals of target species and incidental species and groups. The status of other ecosystem components, such as seabirds, forage taxa, and larval fishes and plankton, is summarized to the level of the available information. The STAR Project of the SWFSC is instrumental in ecosystem studies of the EPO. Brief mention was made of the apparent increasing importance of cephalopods (squid) in the ecosystem, and recent work on trophic interactions and stable isotopes, the physical environment, aggregate indicators (average trophic levels of the catch), and ecosystem modeling was briefly described.

There was brief discussion of a special project for sampling recent yellowfin diets, which was initiated in late 2006 to look at possible evidence for changes in the trophic structure, reflected in food habits, which might explain the reduced catches of yellowfin. It was hypothesized that yellowfin were feeding on deeper-dwelling organisms, and therefore schooling less with the dolphins.

It was also noted that the chapter evaluated the marine mammal abundance surveys of the U.S. NMFS, and that the population of sperm whales had been declining while that of pilot whales was increasing. Also it was noted that dolphin mortality in the purse-seine fishery had reached the lowest level on record.

It was noted that the seabird discussion mentioned indirect impact of fisheries on seabirds, and since

Ecopath includes seabirds as predators and competitors with other predators in the model, some mention should be made of the seabird role in the ecosystem considerations chapter of the FSR.

It was noted that the summary of fisheries trophic levels did not include marine mammals, and that one would probably see a large decline in the trophic level (TL) of the purse-seine fishery with the elimination of the high incidental catches made in the past. Marine mammals have a smaller effect on the TLs of the catch now than they had in the 1970s. This illustrates the ambiguity of broad generalizations such as average trophic level as indicators of ecosystem health. The group asked the staff to consider the inclusion of TL estimates of the catch of the longline fishery.

The work of IATTC in collaboration with the GLOBEC Climate Impacts on Oceanic Top Predators (CLIOTOP) program's worldwide approach was appreciatively noted, and further and more comprehensive collaboration was recommended. The staff indicated that a reference to the collaboration would be included in the FSR.

17. Antigua Convention Article 11, Scientific Advisory Committee

This agenda item anticipated the entry into force of the Antigua Convention, specifically Article 11 and Annex 4, which deal with the Scientific Advisory Committee (SAC). Dr. Allen explained that the IATTC is still waiting for ratification from four members, and when these are received the SAC will become a formal subsidiary body to the IATTC, and will review scientific information and advise the Commission.

It was suggested that it might be time to start developing protocols and procedures for this, and that the staff should start to prepare this material for the working group to review next year. It was assumed that since sufficient remaining members are expected to ratify in the next 6 months, it would very likely be about 2 years until establishment, and thus preparation by the staff of such information for the next meeting would be timely.

18. Date and topic for October workshop

The group discussed the topics suggested by the staff, tagging studies and tagging data analysis for improved stock assessments, and spatial modeling for improved stock assessments. It was noted that large-scale tagging programs are essential tools for tuna stock assessments, given that they are the only source of scientific information that is independent of fisheries data. Such programs play, for tunas, the role of routine research cruises commonly used in the assessment of coastal resources, providing information to tune the assessment models and to better estimate the status of tuna stocks.

There was broad consensus that it might be a good time for the former, since the WCPFC is planning in that direction, and that it might be a good time to establish some formal connection and role in this process. It was noted that as it now stands Stock Synthesis II (SS2) does not allow incorporation of tagging data, although it has the required ability to incorporate spatial analysis. WCPFC will work on its plan for the central Pacific this August, and after that would consider collaborating in a Pacific-wide program.

It was suggested that the tagging workshop include consideration of management strategy advice developed through an enhanced understanding by both scientists and managers of what could realistically be derived from such tagging studies. The workshop should bring together the specialists and modelers to focus on technical abilities, realistic opportunities, and limitations of what they could hope to accomplish with tagging studies, given the field logistics and the tools available and under development (*e.g.* the issue of enhancing and using SS2 for applications of tagging data). The dates for the workshop are during the week of 15 October 2008.

19. Other business

19a. Alternative models of artificial floating objects for tuna fisheries

Dr. Ariz presented the results of experiments conducted in the Indian Ocean, in a Spanish Pilot Action, to

evaluate several prototype artificial floating objects (Document SAR-8-12i). The purpose was to find a FAD typology that will result in fewer bycatches, particularly focusing on the exclusion of sea turtles, without reducing catches of the target species. Data were collected for six months, from May to November 2005, and the results are described in document IOTC-2006-WPBy-05.

The group wondered if the work would continue, and learned that the initiative needs funding to be continued. The group is very interested in the application of these alternative designs, since they appear to offer a simple solution to some of the purse-seine bycatch problems.

It was suggested that the opportunistic observation in this study, where fishermen controlled the frequency of visits to the two FAD types, should be replaced in future by a controlled experimental design.

19b. Proposal of Ecuador

A request was made by Dr. Cedeño on the evaluation of the impacts of the fleet and the potential for excluding the small vessels from the management resolutions affecting yellowfin and bigeye tuna. The analysis of class 2, 3, and 4 vessel catch compositions in 2005, based on IATTC data, implied very limited impact on yellowfin and bigeye tuna. It is extremely important to Ecuador that the analysis be expanded over other years, at least from 1995 through 2006 and that consideration be given to the development of criteria for possibly excluding the small vessels from the management resolutions for yellowfin and bigeye.

Dr. Allen indicated that this could be done fairly quickly, provided that there are vessels from at least three countries represented in the data, due to IATTC confidentiality requirements.

19c. Data problems

A participant suggested a review of issues such as the species composition sampling and related data issues, and also comparisons between oceans. This was done in the past, and there would be interest in returning to this topic at the next meeting of the working group.

Another request was to increase the priority for producing updated IATTC catch data by gear and country for the 1950-1959 period.

20. Recommendations to the Commission

The following recommendations will be made to the Commission:

1. Consider ways to reduce the time lag of the submission of data from the CPCs to the Commission, to provide timely and accurate stock assessments. In order for the CPCs to verify the information submitted to the Commission, it could be useful to obtain information from fishing vessels in the EPO through the use of available technologies.
2. Rigorously control the fishing capacity in the EPO, particularly of the purse seiners, to better achieve target levels of exploitation and to achieve management stability. Target levels have not been achieved by the current management measures, due in part to the lack of management of the entry of additional vessels. Without capacity limitation, achievement of management objectives will require stronger measures and frequent modification of them.
3. Continue to support the staff's participation in activities to develop and evaluate the concept of regional economic and technical cooperation under the auspices of the IATTC. A regional economic cooperation may allow the Commission to address the conservation issues that it faces in a win-win manner.
4. Develop solid proposals for conducting tagging research on tropical tunas. The IATTC should bring together specialists and modelers at the October scientific workshop to review and summarize what could be accomplished with the tools and technology available, in order to evaluate the management

value of such an enterprise and to provide supplemental funding in time to be ready to collaborate actively with WCPFC in a tagging program on a Pacific-wide basis.

5. Convene a working group of both managers and scientists to examine and demonstrate the capability of the assessment techniques and to more narrowly define the scope of analyses of management options that meet the Commission's expectations.

6. Recommendations on seabirds:

    a. Develop a standard format for reporting seabird bycatch information that CPCs are required to provide, in accordance with Resolution C-05-01.

    b. Request that publicity materials be developed for fishermen that describe the disposition of bird bands collected on seabirds killed as bycatch, within appropriate IATTC areas, and advise that care should be taken not to offer incentives for these bands, however, as this might cause the intentional killing of the birds.

    c. Note that, in addition to direct impacts, there are indirect impacts on seabirds of the fisheries under the purview of IATTC, which are included in the IATTC ecosystem model (IATTC Bulletin 22: 133-218).

    d. Continue to examine the effectiveness of measures to reduce seabird interactions with fishing gear. This should include technologies that are under development and technologies currently in use.

21. Meeting report

The meeting report was adopted.

22. Meeting dates for next year

The dates for next year's meeting of the Working Group on Stock Assessments were discussed and 12-16 May 2008 was agreed upon.

23. Adjournment

In recognition of the fact that Dr. Allen had announced his retirement as Director of the IATTC, the meeting participants expressed their appreciation for his service as Chairman of the Stock Assessment Working Group. The meeting was adjourned at 6 p.m. on 11 May 2007.

Appendix A.

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Appendix B.

DOCUMENT SAR-8-REC

DRAFT FOR STOCK ASSESSMENT REVIEW GROUP

STAFF CONSERVATION RECOMMENDATIONS

Resolutions C-04-09 and C-06-02 on the conservation of tunas in the eastern Pacific Ocean (EPO) provide measures for the conservation of yellowfin and bigeye tuna in 2004-2007. This paper makes recommendations for 2007-2009 for yellowfin and bigeye and for an annual limit on the catch of swordfish in the southeastern Pacific Ocean, and clarifies Resolution C-05-02 concerning northern albacore. Summaries of the stock assessments for all species are provided in Document IATTC-75-04, *Tunas and billfishes in the eastern Pacific Ocean in 2006*.

The *ad hoc* meeting of the Commission in February 2007 asked the staff to provide information on possible area closures that would reduce catches of juvenile yellowfin and bigeye tuna, and to estimate the total allowable catches for the fisheries. These recommendations therefore include those measures, in addition to the seasonal closure that has been in effect during 2004-2007. Two points suggested by individual delegations at the February meeting, a closure of a large area to all fishing and measures affecting fish-aggregating devices (FADs), are also addressed.

1. YELLOWFIN TUNA

The stock assessment for yellowfin is similar to that of 2006. The base case assessment indicates that the spawning stock size has declined from a high point in 2001 to about 94% of the level corresponding to the average maximum sustainable yield (AMSY). The fishing mortality corresponding to the AMSY is 0.97 (F_{scale}) times the average fishing mortality rate for the last three years. The base case assessment did not include a stock-recruitment relationship; if that were incorporated (the alternative assessment), F_{scale} would be 0.66.

INSERT *F*/S Diagram

The staff recommendation is based on the base case assessment. The staff has attributed the increase in recruitment and stock size after 1985 to a regime change that led to greater spawning biomasses, rather than to dependence of recruitment on spawning stock size. Nevertheless, it is possible that this interpretation is wrong, and that the increase in recruitment after 1985 was related to a stock-recruit relationship with steepness significantly less than 1. If that were the case, the stock would currently be overfished, and the fishing mortality would have to be reduced by about 34% to bring it to the level corresponding to the AMSY.

Since 2002 recruitment has been less than the average for 1985-2001. It is possible that this lesser recruitment will persist in future, with reduced catches relative to those possible during 1987-2003.

In April 2007 the carrying capacity of the purse-seine fleet was about 7% greater than the average for the 2004-2006 period. To simply maintain the effect of Resolution C-04-09, the period during which purse-seining was permitted (46 weeks) should be reduced.

Regardless of the recruitment, the total catch and stock size could be increased if the average size of the yellowfin in the catch were increased. The longline fishery catches the largest fish, but takes less than 5% of the total catch. The purse-seine fishery takes yellowfin of a wide range of sizes, depending on set type. Increasing the proportion of the catch made by longlines or by purse-seine sets on tunas associated with dolphins, particularly offshore, would increase the sustainable yields and the biomass. Area closures might be used to increase the yield per recruit of yellowfin, but their effect cannot be precisely forecast.

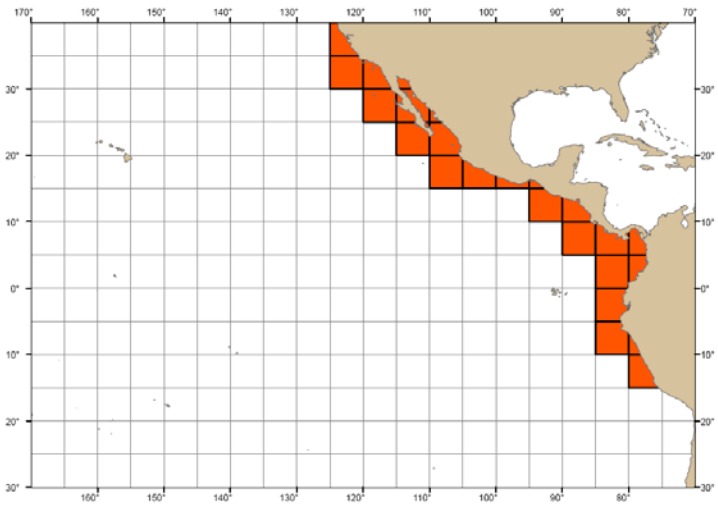

FIGURE 1.

Small yellowfin tuna are taken mostly in inshore areas, and restricting fishing in an area such as that shown in Figure 1 would increase the yield per recruit of yellowfin tuna.

The staff **recommends that:**

1. The closure periods for the purse-seine fishery in Resolution C-04-09 be extended by an additional 31 days, to 73 days, and that the closure period be extended further if the carrying capacity of the purse-seine fleet continues to increase; or
2. A total allowable catch of 200,000 metric tons (t) be adopted for yellowfin taken by purse seine in the eastern Pacific, but that the Director be authorized to increase the limit by up to four increments of 30,000 t each if he concludes from examination of available data that such increases will pose no significant risk to the stock. If the limit, including any increments authorized by the Director, is reached, purse-seining, for tunas will cease, and
3. The Commission consider closing the area shown in Figure 1 to fishing by purse seine, with the objective of improving the yield per recruit of yellowfin tuna.

In case of Option 2 above, the Director should give CPCs one month's notice of the date on which he estimates that the catch limit will be reached.

2. BIGEYE TUNA

The stock assessment results are generally similar to those of previous assessments, except that the recruitment in 2001 and 2002 is now estimated to be less than it was estimated to be in 2006.

INSERT *F*/S Diagram

The stock remains below the AMSY level, but if recruitment is maintained at the levels estimated for the last 30 years, it is expected to approach the level corresponding to the AMSY in 2010, and subsequently to decline. The fishing mortality corresponding to the AMSY is 0.85 (F_{scale}) times the average fishing mortality rate in for the last three years. The base case assessment did not include a stock-recruitment relationship; if that were incorporated (the alternative assessment), F_{scale} would be 0.53.

The staff recommendation is based on the base case assessment. In contrast to yellowfin, there is no information in the history of the fishery that supports a stock-recruit relationship with steepness significantly less than 1. Nevertheless, steepness is difficult to estimate, and there remains a possibility that inferences made using the base case assessment underestimate the extent to which the stock is overfished.

Longline catches have declined to less than the levels allowed by Resolution C-04-09, making the impact of this fishery less than envisaged in the Resolution. On the other hand, the growth in the carrying capacity of the purse-seine fleet has militated against the effect of the Resolution.

Further measures are necessary to allow the stock to be maintained at or above the AMSY level.

The AMSY has been significantly reduced by purse-seine catches of small bigeye, and measures that encourage purse-seine vessels to avoid catching bigeye while fishing for skipjack would be beneficial. The aggregation of fish by FADs is a major part of the fishing effort for that fishery, yet there is little information available about deployment and disposition of FADs. Such information is critical as a basis for any decisions about management of the use of FADs.

The combined fishing effort (longline and purse-seine) should be reduced to 85%. Reductions of differing amounts for each of the two fleets could also achieve the goal of providing the AMSY.

The staff **recommends** that the Commission**:**

1. determine the appropriate adjustments to the balance of the longline and purse-seine fisheries, and,
2. if it wishes to make equal reductions compared to the 2004-2006 average for both purse-seine and longline:
   2.1. Set the following catch limits for longline fishing,

China	2240
Japan	28926
Korea	10675
Chinese Taipei	6751

   and, for other CPCs, to the greater of 85% of the 2001 catches or 500 t,, and

   2.2. In addition to the yellowfin closure above, close the purse-seine fishery on floating objects in the eastern Pacific Ocean for an additional 35 days, or

   2.3. Set a total allowable catch (TAC) for bigeye tuna taken by purse-seine, and prohibit sets on floating objects after the catch limit has been reached. The TAC would initially be 55,000 t, but the Director would be authorized to increase the limit by up to four increments of 4,000 t each, if he concludes, from examination of available data, that such increases will pose no significant risk to the stock, or

   2.4. Limit the total annual catch of bigeye tuna by each purse-seine vessel in such a way that the sum of the individual-vessel limits equals 63,000 t, and prohibit further sets on floating objects by any vessel that reaches its limit. A vessel's catch of bigeye would be estimated either by the observer or, at the request of the captain, by sampling of the vessel's catch conducted by IATTC staff members at the time of unloading. If the latter option is chosen, the vessel would be responsible for reasonable costs of the sampling. Should the total purse-seine catch reach the 63,000 t, all sets on floating objects would be prohibited for the remainder of the year.
3. Require that vessels that use FADs mark the FADs in accordance with international standards for marking fishing gear, and maintain a record of the numbers of FADs on board at the beginning an end of each fishing trip and of the numbers and positions of FADs deployed at sea, and make this information available to the Commission; and
4. Note that the staff has made an evaluation the effect of closing the area shown in Figure 2. The absolute effect is uncertain because the response of fishermen cannot be predicted, but it would be likely to lead to a reduction of bigeye catches and to increased catches of yellowfin. If that were coupled with restrictions in fishing inshore (Figure 1), at least some of the increase in yellowfin catches would probably be made up of large fish taken in sets associated with dolphins.

The estimates of the bigeye catches referred to in 2.3 and 2.4 above should be calculated on the basis of species composition sampling of unloadings, and the Director should give the CPCs one month's notice of the date on which he estimates that the catch limit will be reached.

3. SOUTHEASTERN PACIFIC SWORDFISH

The stock assessment for southeastern Pacific swordfish indicates that the stock is currently above the level corresponding to the AMSY, but that the current catches are slightly above the AMSY level. The staff assessment for 2004 suggested that the stock was overfished. As a precautionary measure, the staff

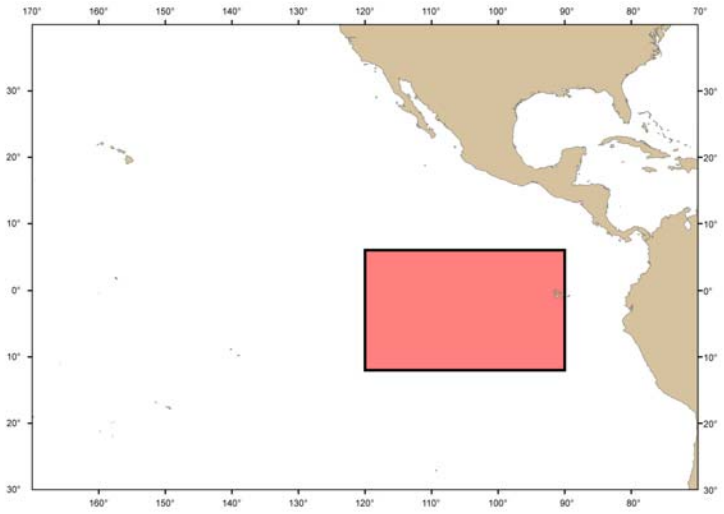

FIGURE 2.

recommends that the annual catches be limited 12,000 t, by allocating limits to the CPCs involved in the fishery.

4. NORTHERN ALBACORE TUNA

The stock assessment for northern albacore has not been updated. For clarity, the staff **recommends** that meaning of the word "current" in paragraph 1 of Resolution C-05-02 should be specified.