INTER-AMERICAN TROPICAL TUNA COMMISSION

9TH STOCK ASSESSMENT REVIEW MEETING

REVIEW OF 2008 STOCK ASSESSMENTS

La Jolla, California (USA)
12-16 May 2008

MEETING REPORT

Chairman: Dr. Guillermo Compeán

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A. List of attendees

The 9th Stock Assessments Review Meeting was held in La Jolla, California, USA, on 12-16 May 2008. The attendees are listed in Appendix A.

1. Welcome, introductions, meeting arrangements

The meeting was called to order on 12 May 2008, by the Chairman, Dr. Guillermo Compeán, Director of the IATTC, who thanked the attendees for coming to the meeting, and then asked them to introduce themselves. Drs. Robert Olson and Dale Squires were appointed rapporteurs. The Stock Assessment Review Meeting is not a formal subsidiary meeting of the IATTC, but rather an informal working group convened by the Director; it is intended to provide an external peer review of the IATTC staff's stock assessments, to give the scientists of member countries and cooperating non-parties of the IATTC (CPCs) a view of these assessments, to review the advice and recommendations from the staff, and to provide an opportunity to prepare for the formal consideration of the status of the stocks at the upcoming annual meeting in June.

2. Consideration of agenda

Dr. Compeán reviewed the provisional agenda and the documents that pertain to each agenda item. It was decided to omit two items, one on the stock structure of striped marlin, and another to discuss the draft of Fishery Status Report 6, *Tunas and Billfishes in the Eastern Pacific Ocean in 2007*. With these changes, the agenda was approved.

3. Report of the workshop on using tagging data for fisheries stock assessment

Dr. Mark Maunder presented a summary of the IATTC Workshop on Using Tagging Data for Fisheries Stock Assessment and Management, held in La Jolla on 16-19 October, 2007, preceded by a workshop on Stock Synthesis II on 15 October[1]. The topics covered at the workshop included traditional analyses, integrating tagging data into population dynamics models, auxiliary information, advection-diffusion models, archival tag data, mark-recapture analysis, growth, behavior, diagnostics, and designing tagging experiments. Some important aspects of tagging studies and analyzing tagging data that were discussed included: as much effort should be applied to recoveries as to releases, collection of auxiliary information is as important as releases and recoveries (*e.g.* reporting rates, tag loss, tag mortality), computational limitations are often encountered in the application of modern integrated tagging models, appropriate diagnostics are needed for fisheries tagging applications, more attention is needed in the design of tagging programs, and new tagging methods such as archival tags have great potential, but methods need to be developed to make use of this information in stock assessments.

4. The fishery in 2007

Mr. Ed Everett reviewed the information on the fishery for tunas in the eastern Pacific Ocean (EPO) in 2007. He discussed EPO tuna catch statistics, total catches by species and by flag, purse-seine catch

[1] See report at http://www.iattc.org/PDFFiles2/Tagging-WS-Oct-2007-Report-ENG.pdf

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 446,000 metric tons (t), which was about 38% less than in the record catch year of 2003, and about 23% less than the 15-year average of catches of 578,000 t.

Ecuadorian, Mexican, Panamanian, and Venezuelan flag vessels caught about 79% of the yellowfin, skipjack, and bigeye in the EPO during 2007. Mexican, Panamanian, and Venezuelan vessels caught about 70% of the yellowfin; Ecuadorian vessels accounted for about 44% of the total catches of skipjack. The catches of yellowfin associated with dolphins were significantly lower in the Northern areas off Mexico and Central America in both the inshore and offshore areas. The yellowfin catches off South American were also lower in 2007 compared to the average during 1997-2006. The catches of yellowfin in 2007 were 244,000 t lower than the record catch in 2002, and were 123,000 t (42%) lower than the 10-year average. The skipjack catches were slightly higher in the inshore areas off Mexico and in the inshore areas off South America, compared to the 1997-2006 average of catches. The total skipjack catches in 2007 were 87,000 t (29%) lower than the record catch in 2006, and slightly higher (1%) than the 10-year average of catches. The 2007 catch distributions of bigeye showed a reduction of catch in both the coastal and offshore areas. Catches of bigeye in 2007 were about 34,000 t lower than the record catch in 2000, and about 6% lower than the 1997-2006 average. The FAD fishery continued its expansion westward in the equatorial region.

Length-frequency and species composition sampling areas were shown, and areas defined for stock assessments were described. Of the 805 wells sampled for length frequencies and species composition in 2007, 569 contained yellowfin, 602 contained skipjack, and 219 contained bigeye. In 2007 the average size of yellowfin from all sets and areas combined was greater than in 2006, but was considerably lower than during the 2002-2005 period. The average weights of skipjack in 2007 were the same as in 2006, but less than the average weights for the 2002-2005 period. The average weights of bigeye in 2007 were slightly greater than in 2006, but were lower than the average weights observed in 2002-2005.

During 2007, Pacific bluefin tuna were caught from May through August from about 26°N to 32°N. Catches were about 4,000 t in 2007, about 6,000 t less than catches recorded in 2006.

The participants requested clarification about whether the catch reductions were due to reductions in effort, or changes in targeting different set types. There was not less fishing effort overall in 2007, but the fleets of some countries moved some effort from dolphin sets to fishing on floating objects and unassociated schools. Mr. Everett was not prepared to comment on capacity changes of the various fleets.

Mr. Everett mentioned that a new sampling system has been employed as of 2000, and this is detailed in the IATTC Annual Report for that year.

One participant asked whether the decrease in average size of bigeye during 2006 and 2007 was due to an increase in fishing on floating objects or an increase in recruitment. Mr. Everett explained that, during those years, the majority of length-frequency samples came from floating-object sets due to an increase in number of boats fishing on FADs.

It was noted that most of the Pacific bluefin caught in the EPO are delivered to grow-out pens, and the data for those catches are generally not available. Data on the size composition of bluefin delivered to the pens are also lacking. Length-frequency samples for 2007 were low also because the sport catch decreased. One participant noted that the Instituto Nacional de Acuacultura y Pesca (INAP) of Mexico has estimated the average size of bluefin delivered to the Mexican grow-out farms as 80-90 cm. INAP and CONAPESCA are preparing a management plan, which will be published soon and will require the operators of grow-out farms to provide statistics. These data will then be provided to the Commission.

5. Report on the 76th and 77th IATTC meetings on management

No presentation was prepared for this agenda item. Dr. Compeán referred to Document SARM-9-05 for

details.

a. Method for evaluating conservation proposals for yellowfin and bigeye tuna

Dr. Rick Deriso presented the methods and results used for the staff's conservation proposal (Document IATTC-77-04). The proposal is comprised to two components: a closure of the EPO purse-seine fishery for 12 weeks and a closure of the offshore area west of the Galapagos Islands between 94° and 110°W and from 3°N to 5°S during another portion of the year.

Dates of the purse-seine closures are:

1. Entire EPO from 0000 hours on 20 June to 2400 hours on 11 September (12 weeks);
2. Offshore area from 0000 hours on 12 September to 2400 hours on 31 December. This is a region that was originally proposed by the delegations from Ecuador and Spain in a conservation proposal for the June 2007 IATTC meeting.

For the longline fishery:

> China, Japan, Korea, and Chinese Taipei shall take the measures necessary to ensure that their total annual longline catches of bigeye tuna in the EPO during 2008, 2009, and 2010 do not exceed the following levels:
>
> a. China: 2,190 t; Japan: 28,283 t; Korea: 10,438 t; Chinese Taipei: 6,601 t;
>
> b. Other CPCs shall take the measures necessary to ensure that their total annual longline catches of bigeye tuna in the EPO during 2008, 2009, and 2010 do not exceed the greater of 83% of 2001 catches or 500 t.

Results show that the purse-seine conservation targets of 20% and 30% for yellowfin and bigeye tunas, respectively, would be achieved by the proposal.

Participants requested more details from Dr. Deriso about the proposed offshore closure area. It was commented that the area, also known by some participants as El Corralito, has a large concentration of bigeye juveniles and adults, but the fish move and a static area is not biologically sound. Dr. Deriso acknowledged that the proposal would have been less effective in some years because of differences in spatial distribution of bigeye.

The proposal was considered by some as one of the most viable options for bigeye conservation, justified by a long time series of data. It was suggested that this proposal be discussed further after the stock assessments are presented.

One participant made the argument that, rather than compare fleet capacity to that of previous years, it be compared to the ideal fleet level. Dr. Deriso estimates that the optimum fleet capacity for bigeye in the EPO is 70% of the current capacity.

6. Yellowfin and bigeye tunas

a. Stock assessment of yellowfin

Dr. Maunder presented the stock assessment of yellowfin tuna in the EPO. 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 assessment for 2008 differs from that of 2007 in the following ways: the catch and length-frequency data for the surface fisheries have been updated to include new data for 2007 (except the first quarter) and revised data for 2000-2006 and the first quarter of 2007; new or updated longline catch data are available for Chinese Taipei (2004-2006) and Japan (2003-2006). The analysis indicated that the yellowfin population has experienced two, or possibly three, different productivity regimes (1975-1982, 1983-2001, and 2002-2006) corresponding to low, high, and intermediate levels of recruitment. The productivity regimes correspond to regimes in biomass, higher-

productivity regimes producing greater biomasses. 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 2002-2007. The biomass in 2005-2008 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 sets associated with dolphins, and accordingly, this method has the greatest impact on the yellowfin population, although it has almost the least impact per ton of catch of all fishing methods. Historically, the spawning biomass ratio (ratio of the spawning biomass to that of the unfished population, SBR) of yellowfin in the EPO was below the level corresponding to the maximum sustainable yield (MSY) during the lower productivity regime of 1975-1983, but above that level for most of the following years, except for the recent period (2003-2007). The increase in the SBR in 1984 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 MSY levels and associated SBR levels. The SBR at the start of 2008 is estimated to be above the level corresponding to the MSY. The effort levels are estimated to be less than those that would support the MSY (based on the current distribution of effort among the different fisheries), but recent catches are substantially below the MSY. 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 MSY. Under current levels of fishing mortality, it is predicted that the biomass will increase and then decrease, but remain above the current level, and that the SBR will follow a similar trend, remaining above the level corresponding to the MSY. A comparison of the biomass and SBR predicted with and without the restrictions from Resolutions C-04-09 and C-06-02 suggests that, without the restrictions, they would be at lower levels than at present, and would decline to about the level corresponding to the MSY.

Participants expressed concern that, although the current estimates for yellowfin lie in the management target zone (green area in Figure 5. 1 of Document SARM-9-06a), the low CPUE on fish associated with dolphins and other factors give cause to doubt an optimistic assessment. Dr. Maunder pointed out that the declining number of sets on dolphins and the increasing number of sets on schools associated with floating objects and on unassociated schools can make the stock appear better off than it might be, due to fishing on smaller fish. Changes in size composition are important. One participant noted that the end points frequently appear to be biased upwards because, in the assessments for the following years, the points for the previous year are often lower previously, when they were current. A retrospective analysis of this phenomenon was recommended.

There was discussion of the effects of oceanographic conditions on the tuna stocks. It was pointed out that the three productivity regimes could be partially associated with the Pacific Ocean interdecadal period as well as El Niño and La Niña oceanographic events. It was suggested that oceanographic conditions should be taken into account when modeling tuna time series. The Commission staff takes into account the physical environment in its assessments, but predictions are not possible. Another participant expressed caution that changes in fleet dynamics can be influential beyond changes in oceanographic conditions, and biomass estimates are not independent of the fisheries data.

There was considerable discussion of the fact that the fishery in the EPO has undergone a small expansion west of 150ºW to about 160ºW in 2006 and 2007. Most of the catches in this region have been skipjack. The IATTC's mandate extends to 150ºW.

b. Stock assessment of bigeye

Dr. Alexander Aires-da-Silva presented the current stock assessment of bigeye tuna in the EPO. As in the

last assessment, this assessment was conducted using Stock Synthesis II (SS2). The assessment is based on the assumption that there is a single stock of bigeye in the EPO, and that there is no exchange of fish between the EPO and the western and central Pacific Ocean.

Catch, catch per unit of effort, and length-frequency data for the surface fisheries have been updated to include new data for 2007 and revised data for 2003-2006.

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 were above average since 2000 and were particulaly large in 2005 and 2006. 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 1994-1998 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 626 thousand t in 1986, after which it decreased to an historic low of about 270 thousand t at the beginning of 2007. 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 2008, the spawning biomass of bigeye tuna in the EPO was near the historic low level. At that time the SBR was about 0.17, about 10% less than the level corresponding to the MSY.

Recent catches are estimated to have been about the MSY 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 MSY is about 82% of the current (2005-2007) level of effort. The MSY of bigeye in the EPO could be maximized if the age-specific selectivity pattern were similar to that for the longline fishery 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 MSY was greater than the current MSY and the fishing mortality was less than F_{MSY}.

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 MSY unless fishing mortality levels are greatly reduced or recruitment is above average for several consecutive years.

All four model scenarios considered suggest that, at the beginning of 2008, the spawning biomass was below S_{MSY}. MSY and the $F_{\text{multiplier}}$ 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, fishing mortality is well above F_{MSY}.

Following Dr. Aires-da-Silva's presentation, there was discussion about the selectivity pattern assumed for bigeye in SS2. Selectivity issues peculiar to yellowfin are not an issue for bigeye. A simple assumption of double normal selectivity for bigeye work well in SS2, and the staff felt it was not necessary to repeat the assessments using A-SCALA, the previous model. Some participants requested that the staff continue making comparisons of assessment results using A-SCALA and SS2, as was done last year. Previous analyses showed that A-SCALA and SS2 gave similar results.

Further recommendations were made to include historical data back to the 1950s in the assessments,

because large longline catches were taken, there are good data, and at the beginning the fishery was exploiting a virgin stock. However, it was pointed out that the surface fishery was not fully developed at that time, and the Japanese longline fishery did not use deep longlines to target bigeye until after the 1960s. A request was also made to include the absolute estimates of spawning biomass and total biomass, in addition to the ratios.

A cautionary comment was made, similar to a comment made about the yellowfin assessment, that although we are "within striking distance" with respect to MSY, it is important to remember that the MSY itself is dependent on the current mixture of effort by gear types, and the calculated MSY is sub-optimal in terms of what could be obtained from a mixture of gear types that increased longline effort and decreased purse-seine effort. It was recommended that the Commission staff consider optimality.

It was pointed out that the physical environment, particularly the depth of the thermocline and oxycline, should affect the availability of bigeye to capture with surface gear. The depths of the thermocline and oxycline are related to decadal-scale environmental regimes. One participant encouraged the Commission staff to undertake retrospective analysis of environmental influences on bigeye catches.

In response to a question about whether the staff incorporated changing selectivity patterns in the assessment projection, it was pointed out that only average conditions for the most recent period were used.

c. Effect of Resolution C-04-09

Dr. Maunder presented an evaluation of the 2004 Resolution on the conservation of tuna in the eastern Pacific Ocean (Resolution C-04-09) with respect to yellowfin and bigeye tuna. The resolution included a 6-week closure during the third or fourth quarter of the year for purse-seine fisheries, and limited longline catches to 2001 levels. In 2004 there was a reduction of effort in the floating-object fisheries, particularly in the third quarter. However, in 2005, 2006, and 2007 the floating-object effort was greater than in 2003. Effort in the unassociated fisheries was reduced in the fourth quarter of 2004, but this was more than offset by increased effort in the second and third quarters. In 2005, 2006, and 2007, the unassociated fishing effort was greater than in 2003. Effort in the dolphin-associated fisheries fell in the fourth quarter of 2004, but increases in the first through third quarters resulted in an overall increase in days fished in 2004. Dolphin-associated effort in 2005, 2006, and 2007 was lower than in 2003. The capacity of the purse-seine fleet, in cubic meters of well volume, increased steadily during 2003-2007. This growth in capacity, together with the operational adjustments to the closures made by the fleet, is constraining the effect of the management measures. A comparison of changes in effort over time, by purse-seine set type, indicates that the majority of this increase in capacity is directed at tuna associated with floating objects or unassociated schools. The nominal longline effort and catch of bigeye have decreased substantially since 2002. The stock assessment model was used to project the population forward 9 years, starting in 2004, assuming that the conservation measures were not implemented. The biomass of yellowfin and bigeye tuna would have decline more if the resolution had not been adopted.

7. Assessment of skipjack tuna

Dr. Maunder presented the indicators of stock assessment for skipjack tuna in the EPO. Skipjack tuna is a notoriously difficult species to assess. Due to its high and variable productivity, it is difficult to detect the effect of fishing on the population with standard fisheries data and stock assessment methods. Since the stock assessments and reference points for skipjack in the EPO are so uncertain, developing alternative methods to assess and manage the species that are robust to these uncertainties would be beneficial. Maunder and Deriso (2007) investigated some simple indicators of stock status based on relative quantities. Rather than using reference points based on MSY, they compared current values of indicators to the distribution of indicators observed historically. They also developed a simple stock assessment model to generate indicators for biomass, recruitment, and exploitation rate. We update their results to include data for 2007. To evaluate the current values of the indicators in comparison to historical values,

we use reference levels based on the 5th and 95th percentiles, as the distributions of the indicators are somewhat asymmetric. The purse-seine catch has been increasing since 1985, and is currently above the upper reference level. Except for a large peak in 1999, the floating-object CPUE has generally fluctuated around an average level since 1990. The unassociated CPUE has been higher than average since about 2003. The standardized effort indicator of exploitation rate has been increasing since about 1991, and in 2007 is on the upper reference level. The average weight of skipjack has been declining since 2000, and the 2007 average weight is approaching the lower reference level. The biomass, recruitment, and exploitation rate have been increasing over the past 20 years. The main concern with the skipjack tuna stock is the constantly increasing exploitation rate. However, the data- and model-based indicators have yet to detect any adverse consequence of this increase. The average weight is near its lower reference level, which can be a consequence of overexploitation, but it can also be caused by recent recruitments being stronger than past recruitments.

There was discussion of how fishing effort of the purse-seine fleet is allocated to different tuna species, when one species is the target and another is a bycatch. Dr. Deriso explained that a regression model is used to allocate effort to gear types, but not species. If the biological information indicates the species do not mix randomly, then information on the spatial structure will improve the assessments. It was also pointed that methods of standardization was the subject of a previous IATTC workshop. To improve effort allocation estimates, the IATTC staff has recommended marking FADs so they can be identified by fishermen and observers. This would allow the staff to build a model of FAD dynamics to derive a standardized index. A model needs three components: 1) FAD dynamics, 2) fish dynamics, and 3) fleet dynamics.

8. Stock structure of bigeye, yellowfin, and skipjack tunas

Mr. Kurt Schaefer presented scientific information available to elucidate stock structure of bigeye, yellowfin, and skipjack tunas in the EPO. It was initially pointed out that regional fidelity has been demonstrated for bigeye, yellowfin, and skipjack tunas in the EPO, with low levels of mixing expected with stocks in the central and western Pacific Ocean. The existing information on catch distributions, spawning, tagging, morphometrics and meristics, genetics, and biological markers for these species in the EPO was reviewed.

It was concluded that the evidence indicates there are probably northern and southern sub-stocks of bigeye (with separation at about 10°N), based on tagging data; northern and southern sub-stocks of yellowfin (with separation at about 15°N), based on tagging, length-at-maturity, morphometric, and stable nitrogen isotope data; and northern and southern sub-stocks of skipjack (with separation at about 15°N), based on tagging and length-at-maturity data.

It was also concluded in this presentation that: 1) the spatial extent of those stocks and the levels of mixing are not yet well defined, 2) the stock boundaries most likely oscillate within a few degrees of latitude relative to seasonal and annual variability in oceanographic conditions and 3) further tagging experiments are required throughout the EPO to elucidate the extents and interactions of the sub-stocks.

The participants congratulated Mr. Schaefer and the Commission on a good summary of the current state of knowledge on stock structure. However, concern was expressed about the lack of tagging data for adult bigeye, the lack of tag returns from longline vessels, and the lack of tagging data in the western part of the EPO and west of the EPO. Mr. Schaefer pointed out that the IATTC has tagged considerable numbers of bigeye (1,351 tagged, 312 recovered) greater than 100 cm, up to 150 cm using plastic dart tags (PDTs). Archival tags, which yield better movement information than PDTs, were deployed in 117 large bigeye, with a 36% recovery rate. Some were at liberty for 1.5 to over 2.5 years. There are also tag return data from the longline fleets of Japan, Korea, and Chinese Taipei, and the return rates of archival tags are consistent with return rates from the purse-seine fleet, but those of PDTs are less than expected. Bigeye up to 180cm in length were returned by longline vessels. Tagging has been restricted to the eastern part of the EPO due to limited funding.

There was also concern that theoretical north-south movements corresponding to spawning-feeding migrations are not represented in the tagging data. It was pointed out that this hypothesis is contrary to reproductive biology data, and there is no evidence in support of this hypothesis. The Commission hopes to continue tagging, including higher latitude areas, if the budget becomes available.

There was discussion about the stock structure of bigeye in the Pacific, with a question about the existence of separate stocks in the east and west due to low mixing rates. The population structure is probably more complicated than a simple two-stock model, and there was speculation on plausible stock structure in the Pacific. However, for management purposes, the current assumption of one bigeye stock in the EPO is suitable, and consistent with the current state of knowledge. It was pointed out that there is a tendency for fish to stay in a certain area in all oceans, but there is also mixing at a larger scale. The mixing rate is an important matter, which is currently being taken into account in the assessments. Stock structure is a concern, and an IATTC workshop will be proposed later this year to discuss spatial considerations.

Discussion ensued about the need to formulate a large-scale tagging program, such as ICCAT and the IOTC have done in the past. A joint tagging program with the Western and Central Pacific Fisheries Commission (WCPFC) and the IATTC was mentioned. A delegate from Ecuador expressed support for a tagging study, and the Director reiterated the IATTC staff's intention to continue tagging studies.

The representative from Chinese Taipei informed the meeting that they currently have a small-scale tagging program for bigeye, operating between 136º and 167ºW during 2006-2008. Thirty-five archival tags and 2 pop-up tags have been deployed in bigeye tuna (12-35 kg) by experienced observers. A request was made for the delegates to inform the fishermen in their countries to watch for tag returns.

9. Method for in-season update of stock abundance

The observation of within-year declines in CPUE for yellowfin tuna suggested that a within-year depletion estimator may be applicable to the estimation of yellowfin tuna biomass. A simple population dynamics model using a weekly time step was developed and applied to yellowfin tuna catch and effort data. The catchability coefficient was shared among years. The estimates of start-of-year biomass are similar to those estimated in the full stock assessment. The start-of-year biomasses are also well estimated if only a quarter of a year's data is available for the year of interest. These results suggest that the method could be used as an in-season estimator of biomass. The most up-to-date data available for the purse-seine fleet is at-sea reports of catch and capacity at sea. The method was modified to include autocorrelated random effects for catchability and start-of-year biomass to share information from completed years with the year for which the in-season estimate is being conducted. The model is coded in AD Model Builder, and the random effect is implemented using the Laplace approximation method. The in-season estimator is applied to data for yellowfin and bigeye tunas in the EPO during 1991-2006 and 1995-2006, respectively. In addition to the within-year population dynamics model, a linear model was also applied. Model selection was used to select the best model and cross-validation tests were used to determine the performance of the in-season estimator for different fractions of a year's data. The model estimates the abundance well, using either the full, quarter or half year of data. The model estimates that the bigeye tuna biomass increases during the year and decreases substantially from the end of one year to the start of the next. Therefore, a linear model is favored for this species. The 2008 start-of-year biomass estimates from the in-season estimator are very similar to those estimated by the full stock assessment models. The in-season estimation procedure performs well for both yellowfin and bigeye. However, care should be taken when applying the method to bigeye, due to the limited contrast in abundance under which the method has been tested. A harvest rate could be applied to the in-season estimates of abundance to set annual quotas.

There were some questions about technical issues, such as whether parameters are estimated inside the model or passed to the model as independent estimates, and Dr. Maunder addressed the questions.

10. Presentation of contributed papers

a. An overview of ten years of IATTC bigeye stock assessments in the eastern Pacific Ocean

Dr. Alain Fonteneau reviewed Document SARM-9-11d, authored by him and Dr. Javier Ariz. The paper examines and discusses the bigeye stock assessment results obtained by the IATTC staff since the year 2000. It first makes a retrospective review of the quite large variability and uncertainties in the basic data and hypotheses used in these assessments, for instance, the year-to-year variability in catch levels, growth patterns, sex ratio at size, natural mortality, and spawning potential as a function of age. The paper also discusses the validity of the 150°W frontier assumed for this stock. The structural problems faced in the past and present bigeye stock assessments are also discussed, for instance trying to explain the increase of estimated MSY and estimated recruitment during recent years (when FADs were increasingly used by purse seiners and reducing the average weight of the fish caught and the yield per recruit of the combined fisheries). The paper recommends that these basic uncertainties and problems should not remain cryptic, and that they should be better discussed in the yearly assessment reports. It also concludes that their potential impact on the stock assessment results should be better evaluated by the IATTC staff, for instance the effect of assuming a higher natural mortality for juvenile bigeye. The paper also makes a series of research recommendations that could improve future bigeye stock assessments in the EPO, for instance in the field of improving biological parameters and on the urgent need to conduct a large-scale tagging program fully coordinated between the eastern and western Pacific.

b. Comments by IATTC staff on Document SARM-9-11d

Dr. Deriso reviewed Document SARM-9-INF-B, which presents comments by the IATTC staff on Drs. Fonteneau and Ariz' paper.

The IATTC staff disagrees with many of these conclusions and recommendations, which were summarized by Dr. Deriso in his presentation.

There were a number of recommendations with which the IATTC staff agrees:

1. Higher natural mortality for young bigeye in our assessments; this is being done in our current assessment, and has been done in previous assessments except those completed in 2000 and 2007.
2. Improve estimates of age-specific natural mortality of bigeye by analyzing the tagging data and other information, and incorporate tagging data in future assessments.
3. Encourage scientists involved with longline fisheries to increase the sample sizes with regard to sex ratios and maturity.
4. Continue collaboration with the WCPFC on an Secretariat of the Pacific Community (SPC) project proposal for a regional, or possibly Pacific-wide, investigation of age-specific reproductive parameters for bigeye tuna.
5. Recommend a large-scale tagging project, as proposed in the past.
6. Continue biological research on bigeye.
7. Continue to discuss uncertainties; we will endeavor to improve our presentation.

Following Dr. Deriso's presentation, Dr. Aires-da-Silva presented and discussed two aspects of the research conducted as part of preparing Document SARM-9-INF-B. Drs. Fonteneau and Ariz identified two distinct stanzas of recruitment estimates,; especially, a period of lower estimates for 1975-1993, prior to the expansion of the FAD fishery into the region west of the Galapagos Islands, precedes a period of higher estimates (1994-2007). A possible explanation of the lower recruitment estimates for 1975-1993 is that M is grossly underestimated in the bigeye assessments for tuna less than 70 to 90 cm in length. A series of sensitivity analysis was conducted to evaluate the impact of the stock assessment results from assuming a wide range of natural mortality curves.

Management quantities showed varying levels of sensitivity that depended on both the level of M and the

number of ages involved. The management quantities showed little sensitivity when higher levels of M were assumed for young fish 0-5 quarters of age. Specifically, the $F_{multiplier}$ estimates are all below 1 (overfished status) for all reference points considered. In contrast, the management quantities showed higher sensitivity to the assumption made about the oldest of the young ages included in the early higher levels of M. The $F_{multiplier}$ was greater than 1 (stock underfished) for 9 out of 24 cases (37%) of the analyses of the sensitivity to the M assumptions made for the young fish. The more optimistic evaluations ($F_{multiplier}$ >1) all assumed high levels of M that are unrealistic for bigeye 5-12 quarters old (80-110 cm). Furthermore, they do not consider that a stock-recruitment relationship could exist.

Sensitivity analyses to investigate the effect on the management quantities from considering the natural mortality curves assumed by other RMFOs (IOTC, ICCAT, and SPC) were also conducted. In general, the bigeye stock evaluation results showed low sensitivity to assuming the M curves used in the most recent bigeye stock assessments by other RFMOs. The exception is a curve used as a sensitivity analysis in the IOTC assessments. In this case, $F_{multiplier}$ is estimated to be at 1.2 and 1.0 for the MSY and MSY proxy at 20% S_0 reference points, respectively. However, if the same IOTC reference points are taken (S_{MSY}/S_0 = 0.31-0.47), $F_{multiplier}$ is at a much lower level (0.80).

Following a technical question for Dr. Aires-da-Silva, more discussion ensued regarding the recommendation to include the early data, back to the 1950s, in the stock assessments. The IATTC staff is not averse to including the early data, but much uncertainty would be added by using those data. For example, as seen in other fisheries, the initial catch rates are high and not proportional to biomass. Shallow longlines were used in those early years, which did not target bigeye like the deep longlines presently do. Thus, the early longline data would introduce more uncertainty. The opinion of the staff is that including early data in the assessments would not alter the current management recommendations. However, it could be done as a sensitivity analysis, focusing on the effects on management conclusions. Dr. Maunder mentioned that the staff did an analysis back to 1950, but it was not included in the assessment reports. The informal analysis produced the same result as the assessments without the old data, unless the analysis included the assumption that longline CPUE was proportional to abundance back to 1950. Starting in 1975, the longline fishery expanded into the EPO and began targeting bigeye using a deep longline configuration.

One participant expressed the opinion that comparing the trends of biomass among models is more important than comparing absolute biomass estimates. More discussion about a single-stock hypothesis for bigeye ensued. The results of the Pacific-wide bigeye assessment were consistent with the results for the EPO. It should be emphasized that uncertainty in science does not imply that management recommendations can be freely modified. Management recommendations are made based on the best available scientific information.

One participant noted that management advice is very consistent with the model when a stock-recruitment relationship is used. He offered the opinion that the base case for the bigeye and yellowfin assessments should be the one including the stockrecruitment relationship as a precautionary measure; it should at least be highlighted during the presentation to the Commission

The participants expressed appreciation to Drs. Fonteneau and Ariz for their report, which they found interesting and constructive. All the biological parameters in the models are the results of consecutive discussions by many scientists over time, and changes are made when appropriate. The parameters in use represent the best scientific estimates currently available. It is worthwhile looking into the concerns expressed by the meeting participants, but this does not reduce the value of the work that has been done to date.

11. Effects of the tuna fisheries on the ecosystem of the EPO

Dr. Olson presented an overview of the Document SARM-9-12 on ecosystem considerations, focusing on trophodynamics studies and estimates of average trophic level of the catches. It is widely recognized that

management measures can have implications for other components of the food web, in addition to the target species. Bottom-up forces caused by environmental variability and top-down effects of fisheries removals act in concert through the food web. A greater understanding of the trophic links and biomass flows in the food web are necessary. The GLOBEC Climate Impacts on Oceanic Top Predators (CLIOTOP) program is an international effort focused on improving knowledge of the effects of fishing over a backdrop of variable physical processes.

The STAR Project of the SWFSC is instrumental in ecosystem studies of the EPO, and the STAR cruises have provided samples for studies of stable isotope ecology, and students have contributed much to our studies of trophodynamics.

The approach used in the recent research on trophodynamics was to examine broad-scale spatial relationships among copepods and yellowfin tuna, using stable isotope and stomach-contents analyses, to infer information about the trophic position of yellowfin tuna in the food web. Using a generalized additive model fitted to abundance-weighted average $\delta^{15}N$ values of several omnivore copepod species, isotopic spatial relationships among the yellowfin and the copepods were examined. We found a broad-scale, uniform gradient in $\delta^{15}N$ values of the copepods increasing from south to north in a region encompassing the eastern Pacific warm pool and parts of several current systems. Over the same region, a similar trend was observed for the $\delta^{15}N$ values in the white muscle of yellowfin tuna caught by the purse-seine fishery, implying limited movement behavior. Assuming the omnivore copepods, primary-secondary consumers, represent a proxy for variations in $\delta^{15}N$ values at the base of the food web, the isotopic difference between these two taxa was interpreted as a trophic-position offset. An apparent inshore-offshore gradient in yellowfin trophic position was not explained by the distribution of yellowfin of different sizes, by typical ambit distances (*i.e.* movements), or by seasonal variability (although the limited data were inadequate to thoroughly evaluate temporal factors).

Trophic levels (TLs) are used in food-web ecology to characterize the functional role of organisms, to facilitate estimates of energy or mass flow through communities, and for elucidating trophodynamics aspects of ecosystem functioning. The mean TL of the organisms taken by a fishery is a useful metric of ecosystem change and sustainability because it integrates an array of biological information about the components of the system. TLs were estimated for a time series of annual catches and discards by species from 1993 to 2006 for three purse-seine fishing modes and the pole-and-line fishery in the EPO. The estimates were made by applying the nominal TL values from the EPO ecosystem model, weighted by the catch data by fishery and year for all model groups from the IATTC tuna, bycatch, and discard data bases. The TLs of the summed catches of all purse-seine and pole-and-line fisheries were fairly constant from year to year, varying by less than 0.1 TL, and there was no indication of declining trends over the 14-year period.

One participant underscored Dr. Olson's supposition that seasonal changes in the oceanography are likely to influence the $\delta^{15}N$ patterns at the base of the food web. Another congratulated this approach, and offered a detailed explanation of the physical processes underlying trophodynamics in the ocean. Nutrient dynamics related to current patterns and upwelling explain why the open-ocean "El Corralito" area west of the Galápagos Islands is so productive.

Clarification was requested about the justification for a higher TL estimate for longline catches and for bigeye relative to yellowfin. The longline catches are comprised of larger individuals and different species (*e.g.* billfishes) than those of purse-seine and pole-and-line gear, and bigeye eat more cephalopods at depth than yellowfin do.

This was followed by a discussion of cannibalism by yellowfin tuna, which is not apparent from stomach-contents analyses. Small frigate and bullet tuna, *Auxis* spp., however, are common in the diet of yellowfin, and cannibalism in skipjack is well known in the western Pacific.

One participant made the point that squid as predators should be more prominent in the ecosystem

models, *i.e.* occupying higher TL. Pelagic squid are highly piscivorous and feed over a large depth range. The diet composition of the Humboldt squid is well described in coastal areas, but not in the open ocean. A new ecosystem model for the pelagic EPO will soon be developed using diet and isotope data for 2003-2005, and squid will be parameterized better in that model.

A discussion ensued about FADs and their effect on productivity, whether they "generate" biomass, and whether they concentrate biomass. The attendees encouraged further research on FADs and the FAD fishery.

12. Seabirds

a. Seabirds and fisheries in the IATTC area: an update

Ms. Kim Rivera reviewed Document SARM-9-11a. Several seabird-related topics were addressed at IATTC meetings in 2007 (recommendations to the Commission by the Bycatch Working Group and Stock Assessment Working Group, and proposals to the Commission for mandatory seabird avoidance measures in the longline fisheries and observer coverage). Updates on U.S. seabird-related activities in the IATTC area included: 1) Hawaii-based pelagic longline fishery annual seabird bycatch estimates and 2) Laysan albatross studies on Guadalupe Island, Mexico.

Hawaii-based Pelagic Longline Fishery Although most of this fishery occurs west of 150°W, portions of the fishery overlap with the IATTC Area. Observer coverage is required for both the fishery that targets swordfish (shallow-sets) and tuna (deep-set). Coverage levels are 100% and 20% in these respective fisheries. In addition to information on the target catch, observers collect data on seabird bycatch. The number of birds by species is basic important information necessary to undertake an assessment on potential population-level impacts on the seabirds. NOAA Fisheries recently began collecting information about whether the bycaught albatross are hooked or entangled by the fishing line as well as information about probable time of capture (during set/soak or haul) and release condition (alive, injured, dead). Such information may assist in mitigation efforts to reduce interactions with fishing gear. Seabird bycatch has been reduced substantially since 2001. Seabird avoidance measures were first required in 2001 and were revised in 2006 to allow side-setting is a mitigation measure. Annual seabird bycatch estimates in 2007 continue to remain low (estimated total of 173 albatross). Species composition of the bycatch is black-footed albatross and Laysan albatross. The 2007 annual bycatch rate in the tuna sets is 0.003 albatross/1,000 hooks and the rate in the swordfish sets is 0.035 albatross/1,000 hooks. NOAA Fisheries' Pacific Island Regional Office makes its annual seabird reports available at http://www.fpir.noaa.gov/SFD/SFD_seabirds.html

Laysan Albatross Studies on Guadalupe Island, Mexico NOAA Fisheries is working with the U.S. Fish & Wildlife Service in its implementation of "A Conservation Action Plan for black-footed albatross and Laysan albatross". Consistent with this Action Plan, NOAA Fisheries is working with scientists at the University of California, Santa Cruz (UCSC) to learn more about the at-sea utilization and bycatch interactions of the Laysan Albatross that breed on Guadalupe Island, Mexico in the eastern Pacific. Laysan Albatrosses recently underwent a major range expansion, colonizing Guadalupe and other islands in the eastern Pacific in the 1980s. The Guadalupe Island population has established rapidly underscoring a growing need to ensure that this breeding population is maintained. Future and potential impacts of climate change with predicted increases sea levels and coastal marine hazards (peak wave events, storm surges, and high tides) threaten to inundate important breeding colonies for this and other albatross species of low-lying islands of the Hawaiian Archipelago.

A possible seabird mitigation area identified by the Secretariat in 2007 (IATTC Document 75-07c) likely suggested a 23°N boundary because: a) it has been identified in the Hawaii longline fishery as a potential area of overlap between albatrosses and the Hawaii-based pelagic longline fishery, and b) it would also allow for protective measures around the Guadalupe Island breeding colony. Smaller colonies located south of Guadalupe Island were not considered when the 23°N boundary was suggested in the IATTC

documents in 2007. It is reasonable to consider that necessary protections of these Laysan albatross breeding colonies south of Guadalupe Island would require some boundary south of the suggested 23°N boundary.

Following Ms. Rivera's presentation, several points of clarification about Guadalupe Island and other Mexican islands were made. It was underscored that the Gulf of California is not to be included in the proposed mitigation area. Regarding bird bands, it is important to prepare written materials to disseminate to fishermen in the EPO because they are accustomed to tagging programs of fishes, in which substantial monetary rewards are offered for the return of tags.

A concern was expressed that the main issues of seabird protection were not consistent with the fact that high-seas areas are included in the proposed mitigation area. Of primary conservation concern are the breeding birds on the nursery ground, and second is interactions with fisheries in the EEZs of coastal nations. There are fishery-seabird interactions, however, on the high seas as well as in coastal areas.

A participant from Chinese Taipei asked Ms. Rivera for posters and other materials to inform fishermen in that country about the need to return bird bands from seabird mortalities for scientific purposes. He also informed the meeting that some bird bands had been recovered by observers in early 2006 and 2007.

b. Albatross and petrel distribution within the IATTC area

Ms Rivera presented Document SARM-9-11b, submitted by the Agreement for the Conservation of Albatrosses and Petrels (ACAP), on albatross and petrel distribution in the eastern Pacific, based on remote tracking data. Three species (the critically endangered waved albatross and Chatham albatross, and the endangered black-footed albatross) have a high overlap with the IATTC Area. At a colony level, the IATTC Area also has a high overlap with black-browed albatross from Chile and Laysan albatross from Isla Guadalupe. No remote tracking data are currently available for Buller's and Salvin's albatross in the south-east Pacific, but at-sea observations indicate the importance of the IATTC area for these species. The analysis indicates that the mitigation areas suggested in IATTC-75-07c incorporate a high proportion of the distribution of albatrosses, petrels and shearwaters in the eastern Pacific, the species considered most at risk of bycatch in longline fisheries, however this needs to be kept under review as further information becomes available. Ms. Rivera also noted that a second waved albatross workshop recently concluded in Guayaquil, Ecuador, in May 2008 (the first workshop was held in Lima, Peru in June 2007). Representatives from ACAP, Ecuador and Peru government agencies, scientists, the IATTC staff, fishermen, and non-governmental organizations attended the meeting to discuss further development of an Action Plan to address both colony-based and at-sea threats, including fisheries bycatch. A population modeling exercise discussed at the workshop indicated that relatively few additional adult extractions (in the hundreds) from the population could hasten the extinction of this critically endangered species.

Clarification was requested about how the mitigation area was defined, and why it is so large. There does not appear to be much overlap between the distributions of the seabirds and the longline fisheries. No birds were shown in the previous presentation south of the 28ºN parallel. Also, there is no fishing by small-scale longline vessels in that area. Ms. Rivera explained that this is a precautionary measure because the birds are capable of flying into fishing areas, and the maps represent the potential for interaction. Clarification was also requested about the method of estimating catch rates. These are extrapolations to the entire population based on tag returns in the banded population. Another clarification was sought as to the presence of diving species among the seabirds of the EPO, because non-diving species are less likely to interact with longlines. It was pointed out that even non-diving species may interact with the fisheries.

The chairman reminded the meeting participants that the IATTC has a resolution (C-05-01) to reduce seabird bycatch, and to encourage members and cooperating non-members to provide information. The Director will ask all members and cooperating non-members to share the data with IATTC.

c. Seabird bycatch of the Chinese Taipei longline fishery

Ms. Yeh presented Document SAR-9-11c, *Preliminary estimation of seabird bycatch of Taiwanese longline fisheries in the Pacific Ocean*. Noting the increasing global attention on the conservation of the ecosystem, the issue of incidental catches of ecological related species in fishing operations has been of great concern. Taiwan made the first attempt to estimate seabird incidental catch of Taiwan longline fisheries in the Pacific Ocean. To collect scientific information for target species as well as incidental catch species, Taiwan has launched observer programs since 2002. There were 23 observer trips from 2002 to 2006 in the Pacific Ocean large-scale tuna longline fleets. The coverage rate by trips was 3.5% in average. The observed days were 1590. According to the data collected, the seabird incidental catch rate (BPUE) in each 5x5 degree grid square varied from 0 to 0.76 per 1000 hooks with the average BPUE of 0.054 per 1000 hooks. As for the seabird incidental catch distribution, the BPUE was the highest in the areas between 25-40ºN and 165ºW to 165ºE and between 25-35ºS and 165-180ºW. On the contrary, the BPUE was low in tropical area. By using the total efforts data estimated from logbooks and the seabird BPUE from observers, the preliminary estimated average number of seabird incidental catch was around 1500 per year. The observer data showed the set up of bird-scaring lines could reduce the incidental catch of seabirds effectively.

One participant commended Chinese Taipei for undertaking this program. Another participant requested clarification on the species composition of the seabirds, especially in the tropical areas. It was responded that the major seabird bycatch in the North Pacific were identified by observers as Laysan and black-footed albatross. Some birds were unidentified due to the obervers' limited competence in distinguishing seabird species. In the area off Ecuador and Peru, near the Galapagos Islands, Buller's albatross were taken by some of the vessels in the Chinese Taipei program. Species information for the area near New Zealand was not available.

Further details on bird-scaring lines (or tori lines) were requested. The effect of tori lines was seen on two observed trips by a decreased bird bycatch after employing tori lines. Ms. Rivera explained how the seabird-scaring lines are used at sea. A resolution adopted by the WCPFC in 2006 made it mandatory for all large-scale tuna longline vessels to set tori lines, starting in 2007.

13. Assessments by Working Groups of the International Scientific Committee (ISC)

a. North Pacific albacore

Dr. Ray Conser presented a summary of the ISC Albacore Working Group stock assessment. No written summary was provided for the minutes.

Following Dr. Conser's presentation, there was discussion about the preference for doing dynamic scenario predictions with the assessment model, in addition to displaying the static probabilities. Dr. Conser discussed the difficulties involved, in terms of the number of management scenario permutations that would be required and other issues, and concluded that it is impractical to do this adequately without further guidance from the managers. He mentioned the need for a small task force involving members of the Working Group and managers to promote exchange of ideas toward developing guidelines for the scientists to use.

A participant commented that further refinement can be made on the north Pacific albacore assessment, but due to the fact that the Japanese scientist who specializes in albacore is not present, discussion of these items is better left for the ISC. There was a question about the division between the east and west regions of the northern albacore fishery, given the current assumption of a single stock in the North Pacific with a view to ensuring the North Pacific-wide management of this species, encompassing both the Western and Central Pacific Ocean and the EPO. The Working Group's assumption of a single stock is relatively clear, given that the research suggests spawning occurs only in the western Pacific and none in the EPO. Tagging shows regular seasonal movements of young fish from the west to the east. The size-frequency data show that Japan and the United States are fishing on the same fish.

There was discussion of the IATTC's role in North Pacific albacore management. Resolution C-05-02 on northern albacore tuna established a series of obligations for parties and cooperating non-parties, including a recommendation that they provide all information on catches every six months to the IATTC. The IATTC, in coordination with the WCPFC, would have similar recommendations for all parties involved in the fishery on both sides of the Pacific. The IATTC staff, in coordination with other scientific bodies, would develop an estimate of annual stock status. The IATTC staff has asked countries to report catch by gear by semester and biological information corresponding to the fisheries, and some information had been received. One participant expressed concern that neither RFMO has reported on how well the countries are complying with the resolution to freeze fishing effort at recent levels and to provide information. However, "recent levels" at the time of the resolution was not defined. The IATTC has historical data, and staff scientists participate in the ISC working groups. The IATTC will ask the countries to take action.

There was discussion on improving dissemination of the results of the ISC albacore Working Group to the IATTC for review. Currently, these results require approval by the ISC Plenary before being finalized and made available for distribution. The Plenary meets annually, usually in July, which is after the IATTC stock assessment review meeting and annual meeting. The ISC results, therefore, are not officially available for IATTC consideration on a timely basis.

Another question involved southern albacore. One participant commented that information on southern albacore is not included in the IATTC reports, but it should be. Also, he suggested that the staff make a comparison of northern and southern albacore results. The lead on this work has normally been taken by the SPC. Chile has a large fishery, but Chile is not a member of the IATTC. An IATTC staff member clarified that data on southern albacore are indeed included in IATTC reports.

b. North Pacific striped marlin

Dr. Kevin Piner presented a summary of the stock assessment of the ISC Striped Marlin Working Group. No written summary was provided for the minutes.

Following Dr. Piner's presentation, a participant ask when the separate assessments for the hypothesized east and west stocks will be done. The Chairman responded that the IATTC was committed to perform an assessment by its June 2009 meeting. A participant asked whether the IATTC and the ISC would be able to work together on this, and the Chairman indicated that this would be possible and encouraged. Dr. Piner indicated that an outstanding issue was determining demarcation lines for stocks, which may not correspond to the IATTC-WCPFC boundary: these will need to be worked out.

14. Draft research plan for evaluation of technology used in the purse-seine fishery on floating objects

Mr. Schaefer presented Section 2.4 of Document SARM-9-15, and background material. The presentation focused on an approach to reduce the fishing mortality of bigeye tuna in the purse-seine fishery of the EPO by avoiding their capture, through using advanced detection technology and modifications to fishing methods when bigeye are present in large quantities in mixed-species aggregations associated with floating objects.

Two complementary field studies designed to evaluate the feasibility of this approach were proposed, to determine: 1) the fine-scale spatial and temporal dynamics of mixed-species aggregations associated with floating objects by means of ultrasonic telemetry, and 2) the species and size composition of these aggregations before a set, using acoustic imaging and complementary techniques, coupled with validation after the set.

Some preliminary observations and research regarding the first study revealed that skipjack commonly move significant distances away from floating objects, typically just after dawn, in single-species schools. It was suggested that further investigation and validation of the frequency of this behavior through this

first study, and evaluations of the feasibility, in the second study, of catching those schools with purse-seine vessels when they are separated from the bigeye schools, could provide an option for reducing the fishing mortality of bigeye and other species.

Some preliminary research regarding the second study indicates that the application of tuna species identification and estimation of quantities and sizes, using acoustic imaging, provides some potential for avoiding sets on floating objects when large quantities of bigeye tuna are present.

A participant expressed caution that differing environmental conditions, *e.g.* vertical temperature profiles and gradients, in different ocean areas are expected to affect the behavior of fish associated with FADs. He expressed the opinion that one experiment is not enough for the entire EPO. Another participant suggested the use of a scientific sounder in addition to the equipment on the fishing vessels. It is a problem to sort out species and size composition in mixed schools.

Dr. Ariz mentioned that the Instituto Español de Oceanografia and the Spanish fishing industry were recently awarded a grant to conduct a similar study in EPO. He briefly described the upcoming study and what was learned during a previous study in the Indian Ocean, and offered to keep the IATTC informed of progress. Also, Dr. Soh reported that the WCPFC has contracted with a researcher to characterize species composition and distribution around FADs in the western Pacific, and suggested collaboration between the WCPFC and IATTC. An Ecuadorian participant asked for the proposal as soon as possible, and suggested Ecuador would likely support the initiative.

A short discussion ensued regarding the fact that a discussion of FAD research is not appropriate for this meeting, which is focused on stock assessments. The meeting could, however, make a recommendation for funding this project. Dr. Compeán explained that this preliminary proposal was brought to this meeting because the scientific committees should review research proposals before bringing them to the IATTC meetings.

15. Review of staff management recommendations

The assessment results for bigeye tuna indicate an $F_{multiplier}$ similar to the one calculated for the 2007 assessment. Therefore, the management recommendations made to the 77th Meeting of the IATTC in March 2008 are still appropriate for bigeye tuna. The assessment results for yellowfin tuna are more optimistic, but for operational reasons, as well as for a precautionary approach, the staff reiterates the March 2008 conservation proposal.

16. Date and topic for October workshop

The proposed date and topic for the October workshop were 14-17 October 2008 and "Spatial analysis for stock assessment". Perhaps a workshop on software (*e.g.* Arcview) could be held on 13 October for those who choose to come early.

17. Other business

Dr. Fonteneau noted that none of the recommendations he had proposed at the meeting in May 2007 for changing the content and presentation of the IATTC's stock assessment reports had been implemented. IATTC staff members described which of the proposed changes had been implemented, and indicated that improvements were incorporated in the bigeye assessment using SS2. Recommendations from individuals often are contradicted by recommendations by other individuals, but all the recommendations are being taken into account, and it has not been possible to implement them all.

Discussion ensued about the availability of public domain data on the IATTC website. A website interface that can be quieried is being developed. It was suggested that it would be interesting to publish a yearly IATTC statistical booklet showing the yearly catches of all the tuna fisheries since 1950.

Another participant requested that incidental catches of non-target species be presented at the stock assessment review meetings. The Director said that this is included in Resolution C-04-05 on bycatch,

and those data will be presented next year.

A staff member reminded the participants of the proposals for stock assesments of sharks presented at the 2007 meeting. No funding has yet been obtained. The staff has continued working with the existing budget, but it is difficult to develop the work without additional funds.

18. Recommendations from the meeting

1. Formulate a large-scale tagging program for tropical tunas in the EPO, to augment existing tagging studies. This recommendation underscores the recommendation of the 8th Stock Assessment Review Meeting in 2007, to develop solid proposals for conducting tagging research on tropical tunas.
2. Develop a program for marking FADs to monitor individual FADs, to identify repeated sets, and to measure FAD density, for a better understanding of FAD dynamics with a general goal of improving stock assessments of tropical tunas.
3. Develop a funding proposal for research on mitigation measures to reduce catches of juvenile bigeye and yellowfin on FADs, taking into account the specific research projects under agenda item 14.
4. Consider the possibility of using a higher natural mortality rate for young bigeye in the assessments.
5. Improve estimates of age-specific natural mortality of bigeye by analyzing the tagging data and other information, and incorporate tagging data in future assessments.
6. Ask scientists involved with longline fisheries to increase the sample sizes with regard to sex ratios and maturity.
7. Continue collaboration with the WCPFC on an SPC project proposal for a regional, or possibly Pacific-wide, investigation of age-specific reproductive parameters for bigeye tuna.
8. Continue biological research on bigeye.
9. Continue to incorporate uncertainties in the analyses and to consider the consequences of the uncertainties to the assessment results.
10. Recommend scheduling a meeting of the Working Group on Bycatch in the near future.
11. Encourage the parties to provide bycatch information related to the fisheries of all tuna and tuna-like species, in addition to that collected for the large purse-seine vessels.

19. Meeting report

The meeting report was adopted.

20. Adjournment

The meeting was adjourned at 15:30 on 16 May 2007.

Appendix A.

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