INTER-AMERICAN TROPICAL TUNA COMMISSION

THIRD MEETING OF THE SCIENTIFIC WORKING GROUP
REVIEW OF STOCK ASSESSMENTS

CHAIRMAN'S REPORT (REVISED)

La Jolla, California (USA)
May 6-8, 2002

Chairman: Robin Allen

AGENDA

1. Welcome, introductions, consideration of agenda
2. The fishery in 2001
3. Progress report on sampling of catches for species composition
4. Review of stock assessments
   i. Yellowfin
   ii. Skipjack
   iii. Bigeye
   iv. Striped marlin
   v. Pacific bluefin, albacore, swordfish and blue marlin
5. Ecosystem modeling
6. Summary and recommendations
7. Other business
8. Adjournment

DOCUMENTS

- A1 Draft: The fishery for tunas and tuna-like fishes in the eastern Pacific Ocean in 2001, and outlook for 2002
- A2 Draft: Status of yellowfin tuna in the eastern Pacific Ocean in 2001 and outlook for 2002
- A3 Draft: Status of skipjack tuna in the eastern Pacific Ocean in 2001 and outlook for 2002
- A4 Draft: Status of bigeye tuna in the eastern Pacific Ocean in 2001 and outlook for 2002
- A5 Draft: Fisheries for Pacific bluefin tuna, albacore tuna, swordfish, and blue marlin in the Pacific Ocean, and assessments of these species
- A11 Draft: Status of striped marlin in the eastern Pacific Ocean in 2001 and outlook for 2002
- A22 Draft: Ecosystem modeling of the pelagic eastern tropical Pacific Ocean

APPENDICES

A. List of attendees
B. Intermediate results and diagnostics commonly used in reviewing stock assessment modeling results

The 3rd Meeting of the IATTC Scientific Working Group was held in La Jolla, California (USA) on May 6-8, 2002. The attendees are listed in Appendix A.

1. Welcome, introductions, consideration of agenda

The meeting was called to order on May 6, 2002, by the Chairman, Dr. Robin Allen, Director of the IATTC, who thanked everyone for coming to the meeting, and then asked the attendees to introduce themselves. After a brief discussion, the provisional agenda was approved without change.

2. The fishery in 2001

Dr. Allen summarized the information in Document A1 on the surface fishery for tunas in the eastern Pacific Ocean (EPO).

3. Progress report on sampling of catches for species composition

A new system for sampling surface-caught tunas in the EPO was adopted by the IATTC staff in 2000. Briefly, the fish in a well of a purse seiner or pole-and-line vessel are selected for sampling only if all the fish in the well were caught during the same calendar month, in the same type of set (floating-object, unassociated school, or dolphin), and in the same sampling area. These data are then categorized by fishery.

4. Review of stock assessments

The assessments of yellowfin, skipjack, and bigeye were performed with A-SCALA (*Age-Structured Statistical Catch-at-Length Analysis*).

4.1. Yellowfin

Yellowfin in the EPO are considered to constitute a single, separate stock. It appears that the yellowfin population has experienced two different recruitment and biomass regimes (1975-1983 and 1984-2001), with the second regime having greater recruitment and biomass than the first. The spawning biomass ratio (the ratio of the spawning biomass in a given year to that for the equilibrium unfished stock; SBR) of yellowfin in the EPO was below the level that will support the average maximum sustainable yields (AMSYs) during the low-recruitment regime period, but above that level during the high-recruitment regime period. The two different productivity regimes may support two different levels of AMSY and associated SBRs.

The current SBR for yellowfin in the EPO is above the SBR level at AMSY. The standardized fishing effort levels are estimated to be less than the levels that will support the AMSY (based on the current distribution of effort among the different fisheries). However, due to the large recruitment that entered the fishery in 1998, the catch levels are greater than the corresponding values at the AMSY. Because of the flat yield curve, current effort levels are estimated to produce, under average conditions, catch that is only slightly less than the AMSY.

Projections of the future status of the yellowfin stock in the EPO with the current effort levels and average recruitment indicate that the population will decline to an SBR level lower than the current level, but will remain above the level that will support the AMSY. These simulations were carried out using the average recruitment for the 1975-2001 period. If the average recruitment for the 1984-2001 period had been used, it is likely that the estimates of SBR and catches would be higher. If a stock-recruitment relationship is assumed, the results are more pessimistic, and the current biomass is estimated to be below the level that would support AMSY for most of the model time frame, except for the last few years.

The average weight of fish in the catch of all fisheries combined has been well below the critical weight (49.5 kg), suggesting that the recent age-specific pattern of fishing mortality is not satisfactory from a yield-per-recruit standpoint. The AMSY calculations indicate that the catches could be greatly increased if the fishing effort were directed more toward longlining and purse-seine sets on yellowfin associated with dolphins. This would also increase the SBR levels.

4.2. Skipjack

The current stock assessment of skipjack tuna is considered preliminary because: (1) it is not known whether the catch per day of fishing for the purse-seine fisheries is proportional to the abundance of the fish; (2) it is possible that there is a population of large skipjack that is invulnerable to the fisheries; (3) the stock structure in relation to the western and central Pacific is uncertain; and (4) the estimates of absolute biomass have changed by more than an order of magnitude since the previous assessment.

The recruitment of skipjack tuna to the fisheries in the EPO is highly variable. The fishing mortality is estimated to be about the same or less than the natural mortality. These estimates of mortality from A-SCALA are supported by independent estimates from tagging data. The biomass fluctuates mainly in response to the variations in recruitment, except for the low biomass levels in the early 1980s that appear to be the consequence of high fishing mortality rates.

The analysis indicates that a group of cohorts with very high biomass entered the fishery during 1998-1999 and that these cohorts increased the catches during 1999 and 2000. There is also an indication that the most recent recruitments have been low, which may lead to lower biomasses and catches. However, these estimates of low recruitment are based on limited information and are therefore very uncertain.

There is considerable variation in the SBR for skipjack tuna in the EPO. In 2002 the SBR is at a low level (about 0.23). AMSY and yield-per-recruit calculations estimate that the maximum yields are achieved with infinite fishing mortality because the critical weight is less than the average weight at recruitment to the main fisheries. This is uncertain, however, due to uncertainties in the estimates of natural mortality and growth.

4.3. Bigeye

At the beginning of January 2002 the spawning biomass of bigeye tuna in the EPO was at a low level. At that time the SBR was about 0.28, with lower and upper confidence limits (±2 standard deviations) of about 0.15 and 0.41. The estimate of the upper confidence bound is close to the estimate of SBR_{AMSY} (0.38), suggesting that at the start of January 2002 the spawning biomass of bigeye in the EPO was less than the level that is required to produce the AMSY. However, the spawning biomass appears to have been above this level throughout most of the July 1980-January 2001 period. The stochastic projections indicate that within the next three years the SBR is likely to continue to decline to well below the level that would be expected if the population were producing the AMSY. This decline is likely to occur regardless of the environmental conditions and the amount of fishing that occur in the near future because the projected estimates of SBR are driven by the small cohorts that were produced during 1999-2001. The projected SBR may increase by 2006, but the timing and rate of this increase would be dependent on future levels of recruitment (which may be driven by future environmental conditions) and fishing mortality.

The average weight of fish in the catch of all fisheries combined has been below the critical weight (about 35.5 kg) since 1993, suggesting that the recent age-specific pattern of fishing mortality is not satisfactory from a yield-per-recruit standpoint.

The distribution of effort among fishing methods affects both the equilibrium yield per recruit and the equilibrium yield. When floating-object fisheries take a large proportion of the total catch, the maximum possible yield per recruit is less than that when longline catches are dominant. Also, if the longline catches are dominant, the maximum yield per recruit (or a value close to it) can be obtained over a wide range of fishing mortality (*F*) multipliers. When floating-object fisheries take a large proportion of the total catch, a more narrow range of F multipliers produces a yield per recruit that is close to the maximum. When floating-object fisheries take a large proportion of the total catch and a stock-recruitment relationship exists, extremely large amounts of fishing effort would cause the population (and therefore the yield) to decline significantly. When longline catches are dominant, the population can sustain substantially higher fishing mortality rates. These conclusions are valid only if the age-specific selectivity pattern of each fishery is maintained.

Recent retained catches of bigeye from the EPO are estimated to have been about 12% above 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 that is estimated to produce the AMSY is about 185% of the current level of effort. However, increasing the effort to 185% of its present level would increase the long-term average yield by only about 11%, while at the same time decreasing the spawning potential of the stock by about 42%.

The catch of bigeye by the surface fleet may be determined largely by the strength of the cohorts recruited the the fishery. If this is the case, that catch will probably decline when the large cohorts recruited during 1995-1998 are no longer vulnerable to the surface fisheries. 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 15°N.

The sensitivity analyses support the view that, at the start of 2002, the spawning biomass was below the level at which it would be if the stock were producing the AMSY. However, the sensitivity analyses in this years assessment, those presented in IATTC Stock Assessment Report 2, and the stochastic analyses indicate that there is uncertainty in the estimate of the AMSY and the amount of fishing mortality that is required to achieve this yield. Both of these quantities are sensitive to how the assessment model is parameterized and to the data that are included in the assessment. It is important to understand that the estimates of the status of the stock are highly dependent on the method used to calculate the fishing mortalities used in the yield calculations. If the catchabilities remain as high as during the most recent years, and the effort continues at its recent levels, the bigeye population is estimated to be overexploited with respect to producing the AMSY.

Some participants in the Working Group thought that the review highlighted uncertainties in several parameters (longline catch statistics, spawner-recruit relationship, stock structure, and life history parameters) used in the bigeye tuna stock assessment that warrant further evaluation. Some participants believed that the uncertainties were significant, and may cumulatively influence the assessment results. Accordingly, they suggested that fishery management recommendations be developed after completion of the evaluation, and an analysis be conducted on the impacts of the recommendations on the various sectors of the fishery, especially since the measures adopted in response to the recommendations would likely remain in place for a reasonably long period to achieve the predicted outcomes.

4.4. Striped marlin

Alternative hypothesis concerning the stock structure of striped marlin were considered. Differences in the genetic composition of samples from different areas have suggested that there is more than one stock in the EPO. However, the fishery data and analyses indicate that the striped marlin in the EPO are from a single stock. The status of the species was evaluated using the Deriso-Schnute delay difference population dynamics model fitted to catch-per-unit-of-effort (CPUE) data that had been standardized using a general linear model (GLM). The effective fishing effort for striped marlin included in CPUE was estimated using habitat-based standardization. The results indicate that the AMSY of striped marlin in the EPO is about 4,500 mt (range: 4,300 to 4,700 mt) and that the 1998 stock biomass was about that expected at AMSY. During 1991-1998 the average annual retained catch was about 3,100 mt (range: 2,600 to 3,900 mt). Preliminary estimates of the retained catch in 1999-2000 of about 1,800 to 2,000 mt are on the order of one-half the estimated AMSY. During the 1991 to 1998 period (1998 was the last year for which standardized effort data were available for this analysis), the ratio of observed standardized effort to that effort expected to yield AMSY at B_{AMSY} (F_{AMSY}: about 1.8 million standardized hooks) steadily decreased from about 1.4 to 0.7. During this period the ratio of the estimated annual biomass to the biomass that would support the AMSY increased at an average annual rate of about 0.064 from about 0.62 to 1.07. Preliminary estimates of the nominal fishing effort for 2000-2001 show continuing decreases in nominal hooks fished in the EPO, which may lead to continuing decreases in effective effort for striped marlin in the region and continuing increases in the B/B_{AMSY} ratio. Due to the large amount of information on stock dynamics contained in the standardized trend of annual abundance, sensitivity analyses indicated that these results were stable to perturbations across the entire range of natural survival rates (0.2 to 0.8) and Brody growth coefficients (0.40 to 0.95) tested.

During the meeting it was mentioned that, though the two-stock hypothesis was not considered plausible, given available data and analyses of catch rates, very preliminary results of analyses of stock status assuming the north and south stock hypothesis indicated that the B/B_{AMSY} ratio for the putative northern stock was on the order of 0.2. On checking these results, it was found that this was not the case: the ratio would be on the order of 0.5, with F/F_{AMSY} averaging about 0.76 during 1993-1998.

Several participants in the meeting asked that further attempts should be made to learn more about stock structure of striped marlin, and recommended that there should be no increase in fishing effort directed at striped marlin until after the results of the analyses of stock structure, growth, and mortality rates are available and the results of a stock assessment incorporating these results are presented.

4.5. Pacific bluefin, albacore, swordfish, and blue marlin

A review of the most recent assessments of these species was presented for consideration. No additional recommendations for actions or additional analysis prior to the upcoming 69th Meeting of the IATTC were made.

5. Ecosystem modeling

The Commission staff has developed a multispecies mass-balance model for the pelagic eastern tropical Pacific (ETP) in an attempt to learn more about how the ecosystem functions and to investigate the relative ecological implications of alternative fishing strategies. The ecosystem model was developed using Ecopath with Ecosim (EwE). The mass balance was generated from estimates of the abundance of the resources (biomasses), the productivity or mortality rates of the resources, how they interact (diet compositions and food consumption rates), and how efficiently the resources are utilized in the ecosystem.

The species components, scope, geographic extent, and parameter requirements of the model were briefly reviewed. The average retained and discarded catches of the model components by five fisheries during 1993-1997 were used in the model. Sensitivity analyses have been performed, both for the Ecopath mass-balance and the dynamic trajectories predicted by Ecosim.

In the pelagic ETP, the fisheries can be viewed as the apex predators of the ecosystem. The trophic level of each fishery was computed based on the catch-weighted average trophic levels of the components of the retained and discarded catches for each fishery, plus 1.0. The trophic levels for the base model, *i.e.* averaged over 1993-1997, from smallest to largest, were 4.72, 4.72, 4.77, 4.78, and 5.19 for pole-and-line vessels, unassociated purse-seine sets, floating-object sets, dolphin sets, and longlining, respectively. The year-to-year variation in trophic level, *i.e.* the "trophic status" of each fishery, may hold promise as a metric for evaluating the relative interannual effects of the fisheries on the ecosystem. The trophic status was estimated for 1993-2001, based on the retained and discarded catches per year for the surface fisheries, by applying the trophic levels estimated by the base model weighted by the catch data by fishery and year for all model groups. The trophic status of the discarded catches varied considerably, but no clear trend was evident.

6. Summary and recommendations

6.1. General recommendations

Assessments of tunas in the Atlantic and Indian Oceans are generally carried out assuming that catchability has increased over time. It was recommended that alternative models be examined to test the recent estimates for yellowfin, which show no changes in catchability but marked increases in recruitment in recent years, and the recent estimates of declining recruitment and increasing catchability for bigeye. The staff would endeavor to do so before the 69th Meeting of the Commission in June 2002.

The critical examination of the residuals in the bigeye assessment was welcomed as a diagnostic tool, and the meeting recommended that a broader suite of diagnostics be examined in future assessments. The diagnostic results, which in some cases are too voluminous to include in the assessment documents, should be posted to the IATTC's web site and become part of the permanent record associated with the assessment documents. In addition, the staff should organize a workshop in the fall of 2002 to further consider diagnostics; it was agreed that the yellowfin tuna assessment model would be used for this initial workshop. Appendix B, provided by one of the participants at the second meeting of the Scientific Working Group, shows a list of examples of possible diagnostics for complex models. The group endorsed the plans to further reduce the number of parameters used in A-SCALA.

The group requested that more detail be added to the striped marlin assessment report to document the basis for use of the single-stock hypothesis, including more details on the published genetic analyses. The group also indicated a desire for more information on the habitat-based standardization method.

The group discussed the suggestion of management schemes based on reference points, sustainability indicators, and the precautionary approach, and considered that it was worthy of further consideration. The group considered that the development and additional fine-tuning of existing reference points are appropriate for management. Further development of the ecosystem model as a tool to understand dynamics of the EPO ecosystems, continued bycatch and discard monitoring, and an integrated approach in the multi-species tuna fisheries context would add to ecosystem considerations in fisheries management.

6.2. Advice from the IATTC staff to the Commission for the management of the fisheries

Following the review of the assessments, additional work will be carried out, and the results will be taken account of in the advice provided at the 69th Meeting of the IATTC in June 2002. The conclusions reported here are, of course, subject to change as a result of that work.

6.2.1. Yellowfin

The basecase estimates indicate that the biomass of yellowfin is at a relatively high level, following strong recruitment during the late 1990s. The strong recruitments have allowed catches above the AMSY without depressing the stock size below the AMSY level. The spawning biomass is above the level at which the AMSY would be achieved, and the current fishing effort is estimated to be less than the effort required to produce the AMSY. However, the yield curve is fairly flat at its maximum, and there would be little to gain from allowing effort to increase to the AMSY level.

There have apparently been two different productivity regimes, with different levels of AMSY, and the biomass required to produce the AMSY may differ between the regimes. The average weight of the yellowfin in the catch is much less than the critical weight, so increasing the average weight of the fish caught could substantially increase the AMSY.

An alternative assessment, using a stock-recruit relationship with a steepness of 0.75, was conducted. In this case the current effort exceeds the level that would produce the AMSY. While this alternative was thought to be less likely than the basecase, it is generally acknowledged that some relationship must exist between stock and recruitment, and thus the best estimates are likely to lie between the basecase and the alternative.

The conclusion is that current fishing mortality should not be allowed to increase.

6.2.2. Skipjack

The analysis is still preliminary; however, while the 2002 assessment differs significantly from that of 2001 in terms of estimates of biomass, the overall picture, that the fishery is having little effect on the stock, remains the same. High recruitment during 1998 increased the biomass and catches, but recent lower recruitment caused the biomass to decline in 2000 and 2001. The estimates of fishing mortality are similar to or less than those of the natural mortality. The biomass is highly variable, and is driven by fluctuations in recruitment. There is little evidence of the fishery causing a major decline in the biomass, and no management action is recommended.

6.2.3. Bigeye

The status of bigeye tuna is uncertain because the stock has been highly vulnerable to the purse-seine fishery only since about 1994, and because the fishery has been in a state of rapid change since then. It was emphasized that the assessment of bigeye is more difficult and uncertain than that of yellowfin. The purse-seine fishery has changed rapidly since fish-aggregating devices (FADs) were introduced, and the recruitment has apparently fluctuated considerably. The estimates of the life history parameters are not as reliable as those for yellowfin. The stock structure remains uncertain, with the possibility that there are interactions between bigeye of the eastern and western Pacific.

The biomass of bigeye declined into 2002, as predicted in 2001, after reaching a recent peak during 2000. The spawning biomass is now below the level that supports the AMSY. Weak recruitment has been a recent concern, with below-average recruitment occurring each quarter since mid-1998. The spawning biomass is expected to continue to decline for the next year, with a muted recovery expected afterward, provided that recruitment returns to average levels. The level of fishing effort required to produce the AMSY is estimated to be either at (99%) or above (185%) the current level of effort, depending on whether the catchability of the floating-object fishery remains at the high levels of the last two years or returns to its post-1993 average. If the recruitment is more strongly related to spawning biomass (steepness = 0.75), as considered in a plausible alternative presented in the Document A4, the stock status is more pessimistic, and the chances of recovery at the current levels of fishing effort are reduced or improbable.

Near-term caution is recommended in the management of bigeye tuna because the spawning biomass has recently reached the lowest levels ever estimated (covering years of analysis for 1980-present) and because a recent series of weak recruitment has occurred. The analysis does not suggest that there is a need for drastic management actions, but a reduction in fishing effort on FADs for three months in offshore waters (west of 95°W) or for two months in the eastern Pacific would be a precautionary approach. Recent measures for management of bigeye tunas based on holding catches of small bigeye tunas (those <60cm) below peak levels reached in 1999 are not likely to be adequate for currently managing the bigeye resource: those catch constraints work well only with large recruitments, which have not occurred during the last two years.

6.2.4. Striped marlin

The basecase assessment of striped marlin assumed a single stock in the eastern Pacific. The catches have decreased over recent years, and currently the stock is at about the level that will provide the AMSY, and the fishing effort is below the level required to produce the AMSY. As more data become available, these analyses should be updated to ensure that, if indications develop that the condition of the stock(s) of striped marlin has deteriorated, action could be considered in a timely manner.

6.2.5. Pacific bluefin, albacore, swordfish, and blue marlin

No recommendations for management are being made for the fisheries for these species in the EPO at this time.

7. Other Business

No other business was discussed.

8. Adjournment

The meeting was adjourned on May 8, 2002.

Appendix A.

ATTENDEES—ASISTENTES

MEMBER COUNTRIES—PAISES MIEMBROS

ECUADOR

FRANKLIN ORMANZA
Instituto Nacional de Pesca

JAPAN—JAPON

NAOZUMI MIYABE
MIKI OGURA
National Research Institute of Far Seas Fisheries
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GUILLERMO COMPEAN JIMENEZ
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UNITED STATES OF AMERICA—ESTADOS UNIDOS DE AMERICA

DAVID AU
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PAUL CRONE
STEVEN REILLY
GARY SAKAGAWA
National Marine Fisheries Service

NON-MEMBER COUNTRIES—PAISES NO MIEMBROS

ESPAÑA—SPAIN

JAVIER ARIZ TELLERIA
Instituto Español de Oceanografía
JULIO MORON
OPAGAC

EUROPEAN UNION—UNION EUROPEA

ALAIN FONTENEAU
Institut de Recherche pour le Developpement (IRD)

PERU

GLADYS CARDENAS
Instituto del Mar del Peru

TAIWAN

CHI-LU SUN
National Taiwan University
REN-FEN WU
Overseas Fisheries Development Council

NON-GOVERNMENTAL ORGANIZATIONS

RUSSELL NELSON
The Billfish Foundation

IATTC—CIAT

ROBIN ALLEN, Director
PABLO ARENAS
WILLIAM BAYLIFF
RICHARD DERISO
MARTIN HALL
SHELTON HARLEY
MICHAEL HINTON
MARK MAUNDER
ASHLEY MULLEN
ROBERT OLSON
JENNY SUTER
PATRICK TOMLINSON

Appendix B.

INTERMEDIATE RESULTS AND DIAGNOSTICS COMMONLY USED IN REVIEWING STOCK ASSESSMENT MODELING RESULTS

1. Matrix of predicted catch numbers by age and time period. Similar matrices for stock numbers and instantaneous fishing mortality rates.
2. Table of parameters estimated, values at the global solution, CVs, flags identifying parameters that hit constraints or significant penalties.
3. Details of the phased estimation of parameters. Trace of initial parameter values at the beginning of each phase plus values of parameters (estimated and fixed) and likelihood components at the end of each stage of estimation (including at the global solution).
4. Correlation among selected parameter estimates, namely those directly related to management advice, *e.g.* recent-period estimates of recruitment, catchability, selectivity, spawning biomass, *etc*.
5. Examination of the response surface at the global solution—especially with respect to changes in key management parameters. For example, convergence checks using different initial value vectors. Likelihood profiling on key management parameters can also be informative here.
6. Residuals summarized and plotted by various types (including, but not limited to, size-composition residuals).
7. Influence of priors. Plot priors *vs*. their respective posterior, including implied priors for key management parameters.
8. Predictive capability of environmental factors. Develop predictive relationships and appropriate lags (*e.g.* for recruitment) using half of the available time series. Examine the utility of environmental factors when applied to the other half of the time series.
9. Compare and contrast results obtained from other assessment methods, *e.g*. by applying commonly-used age-structured models to the predicted catch-at-age data from the A-SCALA model.