INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC WORKING GROUP

REVIEW OF THE STATUS OF BIGEYE TUNA IN THE EASTERN PACIFIC OCEAN

23-24 October 2000
La Jolla, California, USA

Chairman: Robin Allen

CHAIRMAN'S REPORT

AGENDA

1. Opening of the meeting
2. Adoption of the agenda
3. Introduction
   i. Terms of reference
   ii. Patterns of catches
   iii. Previous evaluations of interactions of longline and purse-seine fisheries
4. Update of stock assessment for the eastern Pacific Ocean
5. Report on Pacific-wide modeling of bigeye
6. Results from pilot bigeye tagging program in 2000
7. Alternative methods for reducing the catch of juvenile bigeye:
   i. full retention
   ii. sorting grid
   iii. abandoning sets
   iv. other methods
8. Accuracy of estimated catches during the year
9. Other relevant information
10. Future management measures
11. Adjournment

DOCUMENTS

1. Status of bigeye tuna in the eastern Pacific Ocean
2. Geographical distributions of effort and catches of tunas by purse-seine vessels in the eastern Pacific Ocean during 1990-2000
3. A-SCALA: an age-structured statistical catch-at-length analysis for assessing tuna stocks in the eastern Pacific Ocean

APPENDICES

1. List of attendees

Agenda Item 1. Opening of the meeting

The meeting was called to order by the Chairman, Dr. Robin Allen, on October 23, 2000, at 9:45 a.m. The attendees are listed in Appendix 1 of this report.

Agenda Item 2. Adoption of the agenda

Dr. Allen asked for comments on the provisional agenda for the meeting. It was agreed that an additional item, *Accuracy of estimated catches during the year*, would be added after Item 7, and that Items 8, 9, and 10 would be renumbered accordingly.

Agenda Item 3. Introduction

Dr. Allen said that the terms of reference for the meeting are given in the resolution on bigeye adopted at the 66th meeting of the IATTC, held in San Jose, Costa Rica, in June 2000, which states that:

7. The Scientific Working Group shall meet in October 2000 to review the status of the bigeye stock and recommend management measures for 2001. The Group should consider, *inter alia*:
    - the patterns of catches of bigeye tuna;
    - any data available on size composition of the bigeye catches;
    - previous evaluations of the impact of catches by longline and small purse-seine vessels and of interactions between the longline and purse-seine fisheries;
    - alternative methods for reducing the catch of juvenile bigeye tuna; and
    - other relevant information provided for consideration by the IATTC.
8. The Parties shall, taking into consideration the recommendations of the Scientific Working Group, adopt management measures for 2001 before the end of the year 2000.

Dr. Allen then briefly reviewed the fisheries for bigeye in the eastern Pacific Ocean (EPO). For many years nearly all of the catches of bigeye in the EPO were taken by longline vessels. During the early 1990s the longline fishing effort and catch began to decrease. During the mid-1990s the purse-seine catches of bigeye increased and the longline catches continued to decline. The purse-seine catches may have aggravated the decline in longline catches, but any effect would lag behind catches as the fish taken by purse seiners are younger than those taken by longliners. He then reviewed the contents of a Background Paper, *Geographical distributions of effort and catches of tunas by purse-seine vessels in the eastern Pacific Ocean during 1990-2000*, distributed before the meeting. Most of the catches of bigeye by surface gear are made between about 10°N and 10°S, but the distributions vary from year to year. In some years there have been two areas of concentration of catches, one north and one south of the equator, and in other years there has been only one area, formed by the merging of the northern and southern areas. Fish less than 60 cm in length have made up a significant portion of the purse-seine catches, particularly during 1994-1998. The incidence of these small fish decreased in the purse-seine catches during 1999, and even more during 2000.

Dr. Allen then discussed the interactions of the various fisheries, estimated by simulations of the effects on the catches of bigeye, yellowfin, and skipjack tuna of (1) future longline effort of 50, 100, 150, or 200 percent of its present level, with the purse-seine effort at its present level, and (2) future purse-seine effort of 85, 95, 105, or 115 percent of its present level, with the longline effort at its present level. Changes in longline effort would have little effect on the surface catches of bigeye and yellowfin, and no effect on those of skipjack, but they would, of course, have profound effects on the longline catches of bigeye and yellowfin. Changes in the purse-seine effort would have some effect on the longline catches of bigeye and yellowfin, but much greater effects on the surface catches of bigeye and skipjack and, to a lesser extent, yellowfin.

Agenda Item 4. Update of stock assessment for the eastern Pacific Ocean

This item was presented by Dr. George M. Watters, who was chiefly responsible for the analyses described in the Background Paper, *Status of bigeye tuna in the eastern Pacific Ocean*, distributed before the meeting. This was an update of Background Paper A4, presented at the 66th meeting of the IATTC in June 2000. Dr. Watters said that A-SCALA (*Age-Structured Catch-at-Length Analysis*) had been used to perform the calculations, and that the methods were described in another Background Paper, also distributed before the present meeting. He described the revisions that had been made since the June meeting, and then discussed the material in the Background Paper on the status of bigeye in the EPO.

During the ensuing discussion the following points were made: (1) better estimates of the age-specific natural mortality rate are needed; (2) comparison of the average weight of fish in the catch and the critical weight can be misleading, as different distributions of the sizes of fish caught can produce similar average weights of fish caught; (3) the decreased catches of small bigeye during 1999 and 2000 could be the result of low recruitment, but this is not certain; (4) it was unexpected that medium-sized fish (about 90 to 120 cm) would be attracted to fish-aggregating devices (FADs) to the extent observed during 2000. It was noted that the changes in the fishery during recent years, in particular the expansion of the area exploited by the fishery, made assessment difficult. Also, this analysis assumed a single stock in the EPO, whereas an analysis was being developed for a more complicated mixing model for the entire Pacific (see next agenda item).

Dr. Alain Fonteneau shared some information on the situation in the Atlantic and Indian Oceans, where bigeye catches have recently shown spectacular increases with fishing effort, and seem to have exceeded the levels corresponding to the average maximum sustainable yields, a matter of considerable concern. Dr. Naozumi Miyabe said that the National Research Institute of Far Seas Fisheries (NRIFSF) of Japan planned to tag bigeye in the Atlantic Ocean. Dr. Richard B. Deriso noted that one of the recommendations of the world meeting on bigeye held in La Jolla in 1996 was that "a workshop on stock assessment of bigeye involving about four to eight participants, all with experience and expertise in stock assessment, should be held in the near future," and suggested that the time was ripe for such a workshop.

Agenda Item 5. Report on Pacific-wide modeling of bigeye

Dr. John Hampton discussed this agenda item. The modeling project involved scientists from the IATTC, the NRIFSF, and the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC), and was funded partially by the Pelagic Fisheries Research Program of the University of Hawaii. MULTIFAN-CL, which is similar to A-SCALA, was used for these analyses. The analysis presented by Dr. Watters assumed a single stock of bigeye in the EPO, whereas these analyses assumed mixing among different groups of fish in the Pacific. The Pacific Ocean was divided into the four areas, delimited by boundaries at 20°N and 160°W. The principal differences between the Pacific-wide analyses and those described by Dr. Watters are that: (1) it includes provision for different levels of recruitment and for movement of fish between areas, whereas Dr. Watters' does not; (2) it does not incorporate the possible effects of environmental variation, whereas Dr. Watters' does. Length-frequency data were used to estimate the movements of fish from one area to another. It appeared that the fish tended to move from the western Pacific Ocean to the EPO, especially the part of the EPO south of 20°N. In general, the results of the two analyses were similar.

The ensuing discussion included some of the topics discussed relative to Dr. Watters' presentation. It was agreed that estimates of movements based on length-frequency data alone are unreliable without tagging data. However, large numbers of fish would have to be tagged in many different locations throughout the year to get reliable estimates of the movement of bigeye in the Pacific Ocean. Dr. Hampton pointed out that the return data for the first month after release may be unusable, as tagging is usually conducted where there is a concentration of fishing vessels. Also, the fish may be especially vulnerable to capture at that time. Substantial numbers of bigeye have been tagged in the Coral Sea, and a few of them have been

recaptured east of 160°W.

Agenda Item 6. Results from bigeye tuna pilot-tagging project in 2000

Mr. Kurt M. Schaefer presented this agenda item. He explained that Phase 1 of a proposed multi-year bigeye tuna-tagging project was conducted from March 1 to May 29, 2000. The primary objective was to establish whether live-bait, pole-and-line fishing is a practical technique for tagging, using conventional dart tags, of large numbers of small bigeye (<100 cm) associated with FADs in the EPO. The secondary objective was to tag bigeye with archival tags.

Pole-and-line and handline fishing techniques were used to catch tunas for tagging with conventional and archival tags. The releases took place during mid-April to mid-May between 1° to 3°N and 95° to 97°W. Unfortunately, small bigeye were not located in significant numbers. The scarcity of small bigeye in the area of operation was confirmed by radio reports from purse-seine vessels operating in the area and the size compositions of the fish landed by those vessels.

The numbers of returns of tags received to date are as follows:

Species	Tag type	Released	Returned	Percent returned
Bigeye	Conventional	101	13	12.9
Bigeye	Archival	96	21	21.9
Skipjack	Conventional	1,238	251	20.3
Yellowfin	Conventional	71	7	9.9

All except one of the bigeye recaptures have been by purse seine vessels fishing around FADs, with the one exception recaptured by a longline vessel. There is a decreasing trend observed in the percentage of tag returns for bigeye after 2 months at liberty.

There is an increasing relationship between the number of days at liberty for bigeye and displacement, in nautical miles, between the release and recapture positions. The data indicate the potential for movements in excess of several hundred nautical miles for bigeye recaptured after 60 days at liberty.

Four different patterns recorded by archival tags, normal, abnormal, FAD-associated, and deep diving have been observed in the vertical movements data for bigeye tuna. Mr. Schaefer presented estimates of the percentage of days classified as "FAD-associated" and the residency times at FADs for the 3 bigeye at liberty for the longest periods, for a total of 335 days.

Mr. Schaefer presented the apparent environmental preferences of bigeye for depth, temperature, and light levels, by time of day. The fish are found at shallow depths above 50 m (the depth of the thermocline) in temperatures of 24° to 27°C at night, with a increasing trend in depth at sunrise; during the day the fish are distributed either in the upper 50 m or at depths of about 200 to 300 m in temperatures of 12° to 14°C. The daytime light levels in the 200 to 300 m depth interval and the nocturnal light levels above 50 m overlap, and are much closer than the daytime values above 50 m. The diel cycle of sunrise and sunset has a significant effect on the activity patterns of bigeye.

The meeting expressed satisfaction with this very interesting and valuable project. In answer to a question, Dr. Allen said that the IATTC hoped to do further tagging in the near future, but that outside funding would be necessary to accomplish this. In response to another question, Mr. Schaefer said that geolocation estimates had been calculated based on the archival tag light intensity data for all fish, and presented a slide of the geolocation estimates and the tracks for the 3 bigeye at liberty for the longest periods and discussed the positional errors associated with those estimates. He also said that the environmental preferences data presented could be used for adjusting the catch per unit of effort for gear vulnerability. However, although the preferences in temperature at depth relative to time can probably only be used for adjusting the catchability of the fish, light levels have a profound effect on the behavior and distribution of bigeye and their activity patterns, which are strongly influenced by their prey. The

estimates of time bigeye spent at FADs derived from the archival tag data should be of considerable value in evaluating the vulnerability of bigeye to capture at FADs. The numbers of tagged fish recaptured per month had declined steeply, but that this did not necessarily reflect high mortality of the fish, as it was likely that they were moving out of the area of the fishery to some extent.

Agenda Item 7. Alternative methods for reducing the catch of juvenile bigeye

Dr. Allen said that there were several initiatives underway to reduce the catch of juvenile bigeye. In a resolution adopted at the 66th meeting of the IATTC in June 2000, the Commission agreed "to implement, as of 1 January 2001, a one-year pilot program to require all purse-seine vessels to first retain on board and then land all bigeye, skipjack, and yellowfin tuna caught, except fish considered unfit for human consumption for reasons other than size, in order to provide a disincentive to the capture of these small fish."

He said that there were a number of questions that needed to be answered, such as: the point during the set after which the fish would have to be retained; the criteria, other than size, that would make a fish unfit for human consumption; and how the fish too small for canning would be utilized. He said that retaining fish that would ordinarily be discarded at sea would affect the stock assessment, as the discard categories would no longer exist.

A prototype sorting grid was tested with captive yellowfin at the IATTC's Achotines Laboratory in Panama during 1998. This modest experiment provided evidence that yellowfin would swim through a grid, and that their subsequent mortality would not be excessive. A sorting grid would be difficult to use, however, as it would have to be incorporated into the net and then taken out again during each set. Dr. Martín Hall said that a flexible, diamond-shaped grid that could be passed through the power block and thus avoid this difficulty had been developed in the Canadian salmon fishery.

Dr. Allen asked for comments on abandonment of sets before they were completed. Dr. Fonteneau said that new sonars that tell the fishermen the size of the fish in the net are currently being tested in the Atlantic Ocean, and that the results appear encouraging.

Dr. Allen asked for comments on other methods for reducing the catch of juvenile bigeye. The proposals included modifying FADs to attract more medium and larger fish and fewer smaller ones, and various area and time closures.

Agenda Item 8. Accuracy of estimated catches during the year

Dr. Allen said that estimates of the amounts of each species retained aboard the vessels are available from various sources during the year. When a vessel is at sea, estimates made by the observer and/or the crew are often available. When it returns to port, data from the vessel logbook and the observer's records are available. When the fish are unloaded they are weighed by the canneries, and these weights are furnished to the IATTC staff. During the course of the year the at-sea estimates are replaced by logbook data, and these, in turn, are replaced by the unloading weight data. The unloading weight data are usually taken to be correct. Because the landings of yellowfin are much greater than those of bigeye, any misidentification of yellowfin as bigeye, or the reverse, would cause greater percentage errors in the estimates of the total catches of bigeye than those of yellowfin. He said that during 2001 the IATTC staff will carry out a special project which will involve the monitoring the entire unloadings of several vessels. During the ensuing discussion it was suggested that the observers might be able to do more, but Dr. Hall pointed out that their time was limited and that their primary mission was to gather data on marine mammals. In addition, the observers get to see the fish for only a short time as they are loaded aboard the vessel. Furthermore, it is not possible for many of the observers to report their observations to shore facilities at frequent intervals. Dr. Allen said that the IATTC staff is giving consideration to testing photogrammetric techniques at sea for obtaining information on the species and size composition of the fish caught.

Agenda Item 9. Other relevant information

Dr. Watters reviewed work in progress on the relationship between bigeye tuna and the environment in the EPO. He discussed, among other things, the relationship of the estimated recruitment of bigeye to (1) sea-surface temperature anomalies in a rectangle bounded by 5°N, 90°W, 5°S, and 150°W, (2) temperature anomalies at 0°-100°W at 240 m, (3) zonal velocities at the same location at 25 m, and (4) zonal velocities at the same location at 240 m. The relationships were not good, with the possible exception of the last one. Dr. Watters emphasized the fact that it is important to try to understand why the recruitment is related to one or more variables, if such is the case. During the ensuing discussion Mr. Patrick K. Tomlinson pointed out that the estimates of recruitment might be erroneous due to (1) differences among years in the behavior and/or distribution of the fish and to (2) erroneous estimates of the natural mortality rate of the fish. Dr. Miyabe said that he had found a correlation between recruitment of bigeye and the Southern Oscillation Index.

Agenda Item 10. Future management measures

Dr. Allen referred to the pertinent parts of the resolution on bigeye reproduced under Agenda Item 3, and opened the floor for discussion. Dr. Gary Sakagawa said that it is hard to decide on management measures when the objectives of management are not clearly defined. The views expressed ranged from no management measures being necessary to a combination of measures which should, independent of anything else, include a limit on the catch of bigeye less than 60 cm in length, as in the resolution. It was noted that the catch rates of bigeye by longliners increased during 1998, but then apparently decreased during 1999. The assessment showed that during 1994-1996 the fishery had reduced the stock to near the level associated with maximum catches. Dr. Allen suggested the following points as a summary that reflected most of the views expressed as recommendations to the Commission:

1. There is no evidence that bigeye are severely overfished, so immediate action is not necessary.
2. The catches of bigeye less than 60 cm in length should be monitored, and these catches should not be allowed to exceed the limit established in the resolution of June 2000.
3. The fishery during 1994-1996 was apparently sufficient to reduce the spawning stock to levels corresponding to maximum catches, and the corresponding fishing mortalities may be useful as a reference point.

Agenda Item 11. Adjournment

The meeting was adjourned on October 24, 2000, at 5:00 p.m.

Appendix 1.

INTER-AMERICAN TROPICAL TUNA COMMISSION
COMISION INTERAMERICANA DEL ATUN TROPICAL

SCIENTIFIC WORKING GROUP
GRUPO DE TRABAJO CIENTÍFICO

REVIEW OF THE STATUS OF BIGEYE TUNA IN THE EASTERN PACIFIC OCEAN
ANALISIS DE LA CONDICION DEL PATUDO EN EL OCEANO PACIFICO ORIENTAL

October 23-24, 2000 – 23-24 de octubre de 2000
La Jolla, California, USA

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