iotc ctoi Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien

# Report of the Sixth Session of the Scientific Committee

**Victoria, Seychelles, 3-6 December 2003**

**IOTC-SC-06-03R[E]**

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IOTC. Report of the Sixth Session of the Scientific Committee. Victoria, Seychelles, 3-6 December 2003. *IOTC-SC-06-03R[E]. 83 pp*

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# 1. OPENING OF THE SESSION

1. The Sixth Session of the Scientific Committee of the Indian Ocean Tuna Commission (IOTC) was held at the Victoria Conference Centre in Victoria, Seychelles, from the 3rd to the 6th of December 2003. It was attended by 46 delegates from 13 IOTC Members and Cooperating Non-Member Parties, as well as two observers from member countries of FAO or other UN agencies and intergovernmental organizations. Dr Shui-Kai Chang attended as an invited expert. The list of participants is reproduced in Appendix I.

2. Dr. Geoffrey Kirkwood of the United Kingdom, Chairman of the Scientific Committee, chaired the Session. Dr. Kirkwood welcomed the delegates and noted the large amount of work to be done in the short time available.

# 2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

3. The Scientific Committee adopted the Agenda as presented in Appendix II of this report. The documents available are listed in Appendix III.

# 3. ADMISSION OF OBSERVERS

4. In conformity with the decision of the Third Session of the Commission on the admission of observers, the delegates of South Africa (FAO Member Country), Russian Federation and ICCAT[1] (international organization) were admitted. The Chairman then invited the delegates to introduce themselves.

# 4. PROGRESS REPORT OF THE SECRETARIAT

5. The Secretariat presented IOTC-SC-03-02, outlining staff changes, the core activities of acquisition, processing and dissemination of information pertinent to the tuna fisheries of the Indian Ocean, as well as a work-plan for the year 2004.

6. The Commission, at its Fifth Session, approved the creation of a new post: a Management Officer at a P-4 level, to be recruited in the second half of 2003. It was decided to restructure the responsibilities of the Management Officer and the Data Manager posts by establishing a Data Coordinator post (P-4 level) and a Field Data Manager (P-3 level). The former Data Manager, Miguel Herrera, was selected for the post of Data Coordinator, and Mr. François Poisson was hired as the Field Data Manager.

7. The System Manager, Mrs. Viveca Nordstrom, seconded by the Seychelles Fishing Authority, resigned to her post in July 2003. Her replacement, Mr. Nishan Sugathadasa, started in November 2003. The Secretariat also benefited from the assistance of Mr. Julien Million, who spent six months at the Secretariat providing technical support to the activities related to the Indian Ocean Tuna Tagging Programme (IOTTP).

8. The acquisition of information remained the main focus of the Secretariat's activities throughout the year. Requests for submission of the mandatory data were sent to all Member and non-Member countries and new data were entered in the databases. Additional data validation procedures were developed.

9. The execution of the IOTC-OFCF[2] project, with sampling programmes in Thailand, Malaysia and Indonesia continued during 2003, and were extended with programmes conducted in Oman, and Maldives. More details on these programmes are given under point 5.

10. The development of specific procedures for data entry and validation continued during 2003. New procedures were also created for the preparation of reports and datasets for the Working Parties. The preparation and processing of historical information continued, including major reviews concerning the

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[1] International Commission for the Conservation of Atlantic Tunas

[2] Overseas Fishery Cooperation Foundation, Japan

vessel record database and re-estimation of catches of non-reporting fleets. The Secretariat also carried out statistical analyses and data modeling to assist the work of the Working Parties. In addition, the Secretariat developed databases for maintaining the IOTC Vessel Record (Resolution 02/05), as well as a database of authorized signatures and seals for the Bigeye Tuna Statistical Document.

11. The development of the IOTC statistical software, WinTuna, continued during 2003, with new modules added to facilitate several data-entry and analysis tasks, as well as integration of a database for tagging data. The software is fully operational and has been deployed in several countries and institutions.

12. The Secretariat has been increasingly involved in a number of activities related with coordination, technical support and field work for the Indian Ocean Tagging Program. The extent of this involvement is described in more details under point 8.

13. Activities related to the dissemination of information were carried out as in previous years with the publication and diffusion of data products, proceedings and reports of all meetings that took place during the year. The IOTC website has been updated to include electronic versions of most scientific papers presented to the Working Parties and recent Expert Consultations. These papers have also been published as the Proceedings of the IOTC Working Parties in a CD-ROM format. The secretariat has also continued partnership with FIGIS, sponsored by FAO.

14. The Secretariat presented its work plan for 2004, noting that, in addition to the core activities, the start of the main phase of the Indian Ocean Tagging Program, and the continuation and/or extension of the IOTC/OFCF project will impose considerable workloads of the current staff.

15. The Committee congratulated the Secretariat on the amount and quality of the work performed during the last year and endorsed the plan of work for the year 2004.

16. The Committee noted with concern that next year, in addition to a very high workload; the Secretariat might also be subject to senior level staff changes, in the view of the imminent retirement of the Executive Secretary. In this sense, the Committee recommends that the Secretariat must be careful to give the highest priority to its core activities.

17. The Committee also recommends that any additional burdens on the Secretariat be carefully decided and prioritized.

18. The Committee recognizes that the implementation of the next phase of the Indian Ocean Tagging Program will have a noticeable impact of the workload of the Secretariat’s staff, in particular, during the first half of next year, before the Program’s Chief Coordinator and Program Manager Unit are selected and become fully operational. In this context the Committee recommends that a junior professional post be created to assist in the implementation of the small-scale tagging programmes in the region.

## 5. DATA COLLECTION AND STATISTICS

### Report of the Working Party on Data Collection and Statistics

19. The Fourth Meeting of the Working Party on Data Collection and Statistics took place in Mahé, Seychelles on December 1st and 2nd, 2003.

20. The WPDCS reviewed the situation of the data holdings at the Secretariat, noting improvement in several areas, including the retrieval of important historical datasets from several countries, better estimation of the catches of fresh-tuna IUU vessels, progress in the sampling programmes under the scope of the IOTC-OFCF Project. The scarcity of size-frequency data from the longline and artisanal fisheries continues to be a major impediment for the application of rigorous stock assessment.

21. It was noted that current IOTC standards for data collection and reporting are minimum requirements to be met by member and cooperating parties. The Secretariat has the necessary mechanisms to deal with confidential data, and the Committee recommends that, when required, confidential information should be available to the working parties.

22. The Scientific Committee noted with satisfaction that a number of national observer programs have started operation. The Committee also welcomed the news that China has started an observer program.

23. The Scientific Committee endorsed the activities proposed concerning data dissemination, including:

a. The preparation of a detailed plan for an Atlas of Indian Ocean Tuna Fisheries

b. The development of a proposal for the preparation of an IOTC Field Manual.

c. Further efforts to extend a database of original biological data.

All these activities are to be conducted by national scientists in cooperation with the Secretariat.

## Establishment of a Sub-Committee on Data Collection and Statistics

24. The Committee agreed with the suggestion of transferring the activities of the Working Party in Data Collection and Statistics to a sub-committee of the Scientific Committee. The likely benefits of doing this would include: improved assistance of participants to the working group and more efficient use of resources. Nevertheless, it was agreed that special sessions of the WPDCS could be convened to deal with subjects not relevant to the Scientific Committee.

## Progress Report of the IOTC-OFCF Project

25. The Secretariat informed the Committee on the activities carried out under the scope of the IOTC-OFCF Project during its second year of operation.

26. The first IOTC-OFCF joint committee meeting was held at the IOTC Secretariat in May, 2003. During that meeting the current achievements of the project were evaluated and considered highly satisfactory, and a work plan for the next year was agreed.

27. During this year, a number of consultancies were conducted to important fishing nations in the region, combining fact-finding missions and the preparation of country reports. These reports will be reviewed during the Regional Workshop on Data Collection and Processing Systems, which is scheduled to be held in Seychelles in March 2004. The countries covered by the consultants or staff from the Project, included India, Iran, Maldives, Mauritius, Thailand, Sri Lanka, Mozambique, Seychelles and Oman.

28. The Project showed important advances in the sampling programmes implemented in Indonesia through collaboration between the IOTC-OFCF project, national Indonesian institutions (DGCF[3], RIMF[4]) and the activities under the ACIAR[5]-CSIRO[6] project. The successful implementation of the activities in Indonesia was highlighted in the second meeting of the Steering Committee, in which also was agreed that the IOTC-OFCF Project will begin to phase out its involvement during 2004-2005, transferring responsibilities to the Indonesian authorities.

29. The IOTC-OFCF project also continued funding and technical assistance for the sampling programme in Phuket, Thailand, provided support to extend the sampling programmes in Oman and the Maldives artisanal fisheries.

30. In 2003, three persons from Sri Lanka and Thailand attended a training course provided by OFCF named "Fishery Resources Management Course (FRMC)" to learn fishery resource management and to compile the country reports under the supervision of NRIFSF[7]. This course is funded by a source different from the Project.

31. The preliminary plan for 2004-2005 includes continued support for the Indonesian project, the sampling programs in Phuket, Thailand and the Maldives, as well as the celebration of the Regional Workshop on Data Collection and Processing Systems.

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[3] Directorate General for Capture Fisheries

[4] Research Institute for Marine Fisheries

[5] Australian Council for Industrial and Agricultural Research

[6] Commonwealth Scientific and Industrial Research Organization (Australia)

[7] National Research Institute of Far Sears Fisheries in Japan

32. It was noted that the sampling activities in Indonesia produced information that is critical for the stock assessments of tunas and billfishes in the Indian Ocean, and concerns were raised regarding the continuity of this information once the project phases out in 2004-2005. The Secretariat indicated that case-specific steps are being taken to ensure that the data collection continues after the support of the project is completed. These steps have included meetings with industry representatives (which have been receptive and positive), and the plan of maintaining the sampling teams as units independent from government agencies.

33. It was also noted than in addition to collecting current data, during the many missions to the areas covered by the IOTC-OFCF project, the Project staff has collected historical data from processing plants and port landing records, in some cases with series as long as 20 years. In addition, it was indicated that the ACIAR[8]-CSIRO[9] project is involved in recovering information from older observer programs in Indonesia and it is possible that these programs be expanded in the future.

34. The Committee commended the Secretariat and OFCF for the considerable progress achieved by the Project, noting that the data collected in the scope of the Project was of utmost importance, and has already shown its worth for the work of the Working Parties on Tropical Tunas and Billfish. In this sense, the Committee strongly recommends the continuation of the Project.

### Progress on a survey of predation of longline-caught fish

35. The Fourth Session of the Commission approved a research recommendation for the initiation of a predation survey by Members and Cooperating Non-Members. Japan initiated a survey starting in September 2000 that will end in August 2005. Seychelles also has initiated predation surveys on their longline fleet. A workshop to discuss the results of these surveys was scheduled for 2004.

36. It was suggested that it might take from one to one and a half years to recover survey data, since longliners can send data forms only when they arrive to port. Under such circumstances, the Committee endorsed a proposal that the workshop, originally scheduled for 2004, be postponed until 2006, to ensure availability of all data necessary.

37. The Scientific Committee also recommends that all countries with information about predation should submit data to the Secretariat at least six months in advance to the date of the workshop, and that the Secretariat should make this data available to the appropriate working groups.

## 6. PRESENTATION OF NATIONAL REPORTS

38. The following National Reports were presented to the Scientific Committee and discussed (abstracts of the documents and verbal updates are included in Appendix IV.): IOTC-SC-03-Inf2 (EC-France), IOTC-SC-03-Inf10 (EC-Spain), IOTC-SC-03-Inf6 (India), IOTC-SC-03-Inf4 and IOTC-SC-03-Inf3 (Japan), IOTC-SC-03-Inf12 (Republic of Korea), IOTC-SC-03-Inf1 (UK), IOTC-SC-03-Inf13 (Australia), IOTC-SC-03-Inf5 (South Africa). A national report from China (IOTC-SC-03-Inf8) was submitted to the Committee, but was not discussed.

39. In addition, Thailand and Sri Lanka provided the Scientific Committee with verbal updates of their National Reports. Document IOTC-SC-03-Inf11 provided information about GLOBEC project CLIOTOP.

40. To a question regarding the relatively large catches of the only Japanese research purse seiner fishing in the Indian Ocean, it was indicated that the vessel also engaged in commercial activity.

41. To several questions regarding information presented in the national report of the Republic of Korea, it was indicated that the country currently has two data acquisition systems in place, which has resulted in some discrepancies. The country expects to solve these discrepancies in the future. It was also suggested that a corrected data set be provided to the Secretariat. It was also clarified that the reported decrease since 1991 in vessels operating in the Indian Ocean was due to the fleet moving to other areas.

[8] Australian Council for Industrial and Agricultural Research

[9] Commonwealth Scientific and Industrial Research Organization (Australia)

42. It was noted that the UK reported a low total catch for the purse seine activity in the BIOT (Chagos Archipelago) for years 2002/2003. It was suggested that a possible explanation for this was that effort in the area was also low. It was also noted that the observer program initiated by the UK is providing valuable information on bycatch and discards.

43. The Committee welcomed the reported initiative of Sri Lanka to improve their fishery data collection and statistics system. It was indicated that although there are only about 30 offshore longline vessels registered in the country, it is possible there is a number of vessels operating illegally in its EEZ, however, the country does not have resources to control these operations. It was suggested that foreign vessels landing fish in the country's ports, whether licensed or not, must be reported to the Secretariat.

44. The Scientific Committee also welcomed the initiative of the CLIOTOP project, noticing that it is in line with recommendations made by the Working Parties and the Scientific Committee.

## 7. STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN

### Report of the Working Party on Tropical Tunas (WPTT)

45. The Fifth Meeting of the Working Party on Tropical Tunas (WPTT) took place in Victoria, Seychelles on June 3, 2003, chaired by Mrs. Pilar Pallarés. Aware of the request from the Commission to provide technical advice in relations to Resolution 02/08: On the conservation of bigeye and yellowfin tuna in the Indian Ocean, the WPTT gave priority to the analyses required to provide such advice. After this, priority was given to a consideration of the status of skipjack tuna. The Chairperson of the WPTT introduced the report and executive summaries presenting the situation of the three species under its mandate.

46. The Committee commended the WPTT for the amount of work done, particularly considering the reduced time available for the meeting.

47. The Scientific Committee endorsed the research recommendations of the WPTT and recommended that the WPTT (and other Working Parties as well) should strive to improve the presentation of the research recommendations, by separating general recommendations from those directed to specific members, and indicating those that are being implemented and the responsible party for its execution. The Scientific Committee also recommended that the various tasks recommended for future implementation be prioritized.

48. The Scientific Committee noted that efforts should continue to resolve the technical problems affecting the estimation of fishing capacity and, in this respect, noted the work being conducted by an FAO project aiming at estimating global fishing capacity.

49. The Scientific Committee endorsed the recommendations of the WPTT and added two additional tasks:

- Analysis and evaluation of the impact of the activities of supply vessels on the efficiency of purse-seine vessels.
- Recalculate assessments incorporating the most complete 2003 data, to the extent possible according to the priorities to be assigned by the Commission.

50. The EC reported on the progress in the development of an operational model for the bigeye tuna in the Atlantic that could be adapted to the Indian Ocean to be reported at the World Bigeye Meeting to be held in Madrid, Spain in March 2004. This initiative complements similar developments by Australian scientists. The Scientific Committee congratulated these delegations for the progress in this important initiative.

51. Concerning the arrangements for next meeting, the Scientific Committee endorsed the plan of requesting the Secretariat to produce, in advance of the next meeting of the WPTT, a document showing traditional stock status indicators for the species of interest.

52. Executive Summaries prepared by the WPTT for yellowfin, bigeye and skipjack tunas, as amended to reflect the views of the Scientific Committee, are listed in Appendices V to VII.

## Technical Advice in relation to Resolution 02/08: On the conservation of bigeye and yellowfin tuna in the Indian Ocean

*53.* At its 7th Session, the Commission adopted Resolution 02/08, the main operative paragraphs of which include "*The IOTC … resolves to seek technical advice from the Scientific Committee for the next session of the Commission on:*

- *Potential management measures designed to reduce the fishing mortality on juvenile bigeye and yellowfin tuna. The measures to be investigated should include, but not be restricted to, time and/or area closures on purse seine fishing on floating objects, and other forms of effort reduction or alternative fishing strategies.*
- *Other potential management measures aimed at maintaining or reducing the effective fishing effort and catches of yellowfin and bigeye tunas by all gears.*
- *The likely effect of these measures on the future productivity of the stocks of bigeye and yellowfin tunas and their consequences on catches of skipjack tuna.*

*On the basis of the updated scientific advice, the Commission will seek to adopt appropriate measures to address the recommendations of the Scientific Committee at the 2003 Session of the Commission".*

54. The evaluation of the potential effects of reduction in fishing mortality of both purse-seine and longline were examined. This was based on short-term and long-term calculations. Short-term calculations were based on recent catch rates by species and sizes and, therefore, these applied to all three tropical tuna species. In contrast, the long-term calculations (Tables 3, 4 and 5) could only be conducted for bigeye tuna, as this is the only species for which estimates of fishing mortality at age are available.

55. The Scientific Committee evaluated a number of potential management measures that could lead to a reduction in the fishing mortality on bigeye and yellowfin tunas. The specific management measures discussed are relevant to the purse-seine fishery only. Specific management measures for reducing longline fishing mortality were not considered. Those management measures considered are listed in Tables 1 and 2, which summarize their likely effects and advantages and disadvantages. A more detailed discussion of each of the measures considered can be found in Appendix IX.

56. Various analyses were conducted in order to assess the effects of the measures considered. In several cases, it was not possible to conduct a quantitative assessment of the effects of a particular measure due to the absence of data pertinent to that measure. In some cases, the likely response of the fishing fleets to the measures is difficult to quantify. In these cases, estimates of the effects of management measures given in Table 1 are maximum achievable numbers since they essentially assume perfect implementation of the measure, or in the case of a time-area closure, that purse seiners that normally fish in the moratorium area do not fish elsewhere during the moratorium period. In other cases, such as the reduction in the number of purse-seine vessels, the effect of the measure can be more accurately predicted, as it is unlikely to be compensated for by a change in fishing strategy.

***Table 1**. Summary evaluation of potential effects of the management measures considered (see text for details).*

| **Management measure** | **Comment** | **Likely effect on juvenile bigeye mortality** | **Likely effect on juvenile yellowfin mortality** | **Likely effect on bigeye catches** | **Likely effect on yellowfin catches** | **Likely effect on skipjack catches** |
|---|---|---|---|---|---|---|
| **Time-area closure to purse seine fishing** | A spatial-temporal closure has been applied in the Atlantic, and considered by the IOTC in 2000 | 12-31% reduction depending on scenario | 15-38% reduction depending on scenario | Short term: 6000-15000t loss of large BE+YF to PS<br>Long term: 2 - 6% increase in total yield | short term: 6000-15000t loss of large BE+YF to PS<br>long term: not available | 20,000- 50,000t reduction |
| **Reduction in overall purse seine effort** | Reducing the number of vessels | 10% reduction in no. of vessels: 4-18% reduction | 10% reduction in no. of vessels: 4-18% reduction | Short term: 10% reduction in no. of vessels: 4-17% reduction<br>Long term: <2.2% increase in overall yield | short term: 10% reduction in no. of vessels: 5-17% reduction in catch<br>long term: not available | 10% reduction in no. of vessels: 4-17% reduction in catch |
| | Increasing days in port when unloading | 2-4 days: 5-11% reduction (2nd semester only)<br>2-4 days: 7-15% reduction (whole year) | 2nd semester only,<br>2-4 days:5-10% reduction<br>whole year,<br>2-4 days: 7-15% reduction | Short term:<br>2-4 days:5-11% catch reduction (2nd semester only)<br>2-4 days: 7-15% catch reduction (whole year)<br>Long term: <3% increase in overall yield | Short term:<br>2-4 days:4-9% catch reduction (2nd semester only)<br>2-4 days: 7-15% catch reduction (whole year)<br>Long term: not available | 2nd semester only<br>2-4 days:5-11% reduction in catch<br>whole year<br>2-4 days: 7-15% reduction in catch |
| **Limitations on the number of FADs and/or their electronic equipment** | Should potentially reduce the fishing mortality due to FADs | Reduction; not enough information to quantify | Reduction; not enough information to quantify | Uncertain, but even total ban is unlikely to increase yield by more than 13-24% depending on scenario | Reduction; not enough information to quantify | Reduction, with amount depending on extent of the limitation |
| **Ban of supply vessels** | Supply vessels are important only for some PS vessels (9 supply vessels operating) | Reduction; not enough information to quantify | Reduction; not enough information to quantify | Uncertain | Uncertain | Reduction; not enough information to quantify |
| **Limits on skipjack catches by trip for purse seiners** | Recommended in 2001 by various tuna boat owner associations in order to improve the SKJ market prices | Reduction; not enough information to quantify | Reduction; not enough information to quantify | Uncertain | Uncertain | Reduction depending on extent of limitation |
| **Size Limit** | Such measures have commonly been adopted by various fisheries agencies; used for tunas by ICCAT | Uncertain, depending on success of implementation | Uncertain, depending on success of implementation | Uncertain, depending on success of implementation | Uncertain, depending on success of implementation | Uncertain, depending on success of implementation |

***Table .2**. Summary evaluation of advantages and disadvantages of the management measures considered.*

| **Management measure** | **Advantages** | **Disadvantages** |
|---|---|---|
| **Time-area closure to purse seine fishing** | • Improve the long-term yield per recruit. (It was noted that, in case of stocks that are heavily exploited a reduction in the catch of juveniles would lead to an increase in yield per recruit and spawning stock size. In the case of yellowfin tuna, the benefits would flow to the purse seine, driftnet and longline fisheries. For bigeye tuna the only beneficiary would be the longline fishery).<br>• Possible decrease in the total discards from the fishery. | • Loss of catch of skipjack to purse seine fleet<br>• Likely difficulties with compliance; lack of compliance would reduce the benefits of the measure<br>• Likely redirection of effort to other areas within the Indian Ocean |
| **Reduction in overall purse seine effort** | Reduction in number of vessels:<br>• Could reduce the catches of bigeye and yellowfin taken in association with FADs<br>• Reduced effort cannot be redirected to another area/time within the Indian Ocean | Reduction in number of vessels:<br>• May be difficult to implement<br>• Given the differences in efficiency between vessels, different implementations (choice of vessels to exclude from the fleet) would lead to different levels of effectiveness of this measure |
| | Increase in the number of days in port:<br>• Could reduce the catches of bigeye and yellowfin taken in association with FADs | Increase in number of days in port:<br>• May be difficult to implement, particularly in case of transshipping at sea |
| **Limitations on the number of FADs and/or their electronic equipment** | • Addresses problem directly<br>• Reduction in the number of FAD-associated sets | • Monitoring the number of drifting objects deployed by purse seiners would imply having inspectors on board permanently, including on supply vessels.<br>• At this stage there is no information about the relation between the number of drifting objects deployed and the resulting catches. |
| **Ban of supply vessels** | Could lead to a reduction in the number of FAD-associated sets. | • Difficult to quantify at this stage<br>• Only some vessels use supply vessels<br>• May be difficult to implement |
| **Limit on skipjack catches by trip for purse seiners** | Could lead to a reduction in the number of FAD-associated sets. | • Difficult to implement<br>• Decrease in catch of skipjack<br>• Possible increase in discards |
| **Size limit** | Currently none - cannot be implemented | It is not possible to implement this measure effectively given current technology. |

57. The Committee noted that the intended benefits of any of the measures considered would be fully attained only to the extent that fleets comply with the measures. IUU fleets might not comply with the measures. However, the estimated catches of tropical tunas by purse-seine vessels that would probably comply represent a substantial proportion of the total purse-seine catch of tropical tunas.

***Table 3.*** *Long-term effects of reduction in PS fishing mortality on total catch of bigeye tuna.*

| Reduction in PS fishing mortality | Change in PS catch | Change in LL catch | Change in Total catch |
|---|---|---|---|
| 5% | -3.8% | +1.9% | +0.6% |
| 10% | -7.7% | +3.8% | +1.2% |
| 15% | -11.8% | +5.8% | +1.8% |
| 20% | -15.9% | +7.8% | +2.4 |

***Table 4.*** *Long-term effects of changes in both PS and LL fishing mortality on total catch of bigeye tuna.*

| | 10% reduction in PS fishing mortality | 20% reduction in PS fishing mortality |
|---|---|---|
| 0% reduction in LL fishing mortality | PS: -8%<br>LL: +4%<br>Total: +1% | PS: -16%<br>LL +8%<br>Total: +2% |
| 10% reduction in LL fishing mortality | PS: -6%<br>LL: +1%<br>Total: -1% | PS: -14%<br>LL: +5%<br>Total: +0.4% |
| 20% reduction in LL fishing mortality | PS: -3%<br>LL: -3%<br>Total: -3% | PS: -11%<br>LL: +0.5%<br>Total: -2.1% |

***Table 5.*** *Changes in spawning stock biomass (SSB) for reductions in PS and LL fishing mortality*

| | 10% reduction in PS fishing mortality | 20% reduction in PS fishing mortality |
|---|---|---|
| 0% reduction in LL fishing mortality | +4% | +8% |
| 10% reduction in LL fishing mortality | +15% | +20% |
| 20% reduction in LL fishing mortality | +27% | +33% |

***Table 6.*** *Potential benefits (in percent reduction of juvenile mortality) for three options for the moratorium. Large tunas: bigeye > 10 kg + yellowfin > 5 kg.*

| *Area* | *Months* | *Benefits (reduction of juvenile mortality)* | | *Maximum costs (loss of catches in t)* | |
|---|---|---|---|---|---|
| | | *Bigeye* | *Yellowfin* | *Large tunas* | *Skipjack* |
| 0°- 5°N; Coast – 60° E | Sep through Oct | 12% | 15% | 5,900 | 19,500 |
| 0°- 10°N; Coast – 60° E | Aug through Nov | 31% | 38% | 14,800 | 49,400 |
| 0°- 5°N; Coast – 55° E | Jan through Dec | 20% | 26% | 10,400 | 31,600 |

***Table 7.*** *Reduction in annual catch for two level of reduction in the number of purse-seiners, estimated from the average annual catch rates. UL represents an upper limit based on the average plus one standard error; LL represents the lower limit calculated as the average minus one standard error.*

| | | ***Effort*** | ***Total catch*** | ***YFT > 10kg*** | ***SKJ*** | ***BET > 10kg*** | ***YFT < 10kg*** | ***BET < 10kg*** | ***Number of sets*** |
|---|---|---|---|---|---|---|---|---|---|
| Current catch in tons | | 15,406 | 354,487 | 143,677 | 180,807 | 30,003 | 45,946 | 21,609 | 11,150 |
| | | ***Percent changes*** | | | | | | | |
| 5% reduction in number of vessels (3) | UL | 6% | 8% | 8% | 9% | 9% | 9% | 9% | 8% |
| | mean | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% |
| | LL | 4% | 2% | 2% | 2% | 2% | 2% | 2% | 3% |
| 10% reduction in number of vessels (6) | UL | 13% | 17% | 17% | 17% | 17% | 18% | 18% | 16% |
| | mean | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| | LL | 7% | 5% | 5% | 4% | 4% | 4% | 4% | 5% |

## Report of the Working Party on Billfish (WPB)

58. The report of the third meeting of the Working Party on Billfish, held in Perth, Australia on November 10-12th, was introduced by its Chair, Dr John Gunn. As instructed by the Commission, the WPB gave priority to the assessment of the status of swordfish. The status of other species of billfish will be reviewed in future meetings of the WPB.

59. The Scientific Committee congratulated the WPB for the amount of work completed in such a short time.

60. On the reduction of catches in recent years, the invited expert confirmed, after contacts with the fishing fleet operators, that the reduction can be explained by changes in targeting of the Taiwanese fleet for commercial reasons.

61. The Scientific Committee noted that the results of any assessment will depend on the effectiveness of the CPUE standardization and encouraged the WPB to continue with the collaborative work in order to improve the standardization of the Taiwanese CPUE series.

62. The Committee endorsed the research recommendations proposed by the WPB.

63. An executive summary on the status of the swordfish resource was prepared by the Chairperson of the WPB, and is listed in Appendix VIII.

### Report on albacore tuna

64. The Secretariat presented a report describing the current status of IOTC databases for albacore (IOTC-SC-03-07). This report was complemented with a set of figures presented in document IOTC-SC-03-Inf.14.

65. It was noted that the quality of the reporting of catches and effort for albacore has been declining since the mid-eighties. Nevertheless, the completeness of the catch and catch-and-effort data is still good. In contrast, the size frequency statistics are poorly represented.

66. The Committee recommended that the Working Party on Temperate Tunas be activated and meet next year. The main activities of this WP should be reviewing the data situation for albacore tunas in the Indian Ocean, and if possible assess the status of the stock. Additionally the WP should identify research needs for the species.

67. Since there is evidence of migration patterns for albacore tunas between the Indian Ocean and the Atlantic Ocean, it is recommended that an invitation to the Working Party meeting is sent to ICCAT. The Committee also recommended that the Secretariat or national scientists from the Working Party on Temperate Tunas attend the ICCAT Working Party relevant for this species. The Secretariat will contact ICCAT to request the data that is available for the Atlantic Ocean.

## Management recommendations

**Yellowfin tuna**

**Considering all the stock indicators and assessments, as well as the recent trends in effort and total catches of yellowfin, the Scientific Committee considered that:**

**Total catches under current fishing patterns are close to, or possibly above MSY. In these circumstances, any further increase in both effective fishing effort and catch above levels in 2000 should be avoided. The large increase in catch in 2003 reinforces the importance of this recommendation.**

**The current trend for increasing fishing pressure on juvenile yellowfin by purse seiners fishing on floating objects is likely to be detrimental to the stock if it continues, as fish of these sizes are well below the optimum size for maximum yield per recruit.**

**The Scientific Committee also noted that juvenile yellowfin tuna are caught in the purse-seine fishery that targets primarily skipjack tuna. Some measures to reduce the catches of juvenile yellowfin tuna in the FAD fishery will be accompanied by a decrease in the catches of skipjack tuna.**

**Skipjack tuna**

**The Working Party on Tropical Tunas has not made any specific management recommendations for the skipjack stock. However, the life history characteristics of skipjack tuna, the information presented in the documents reviewed, and the information in the stock status indicators prepared during the meeting suggests that there is no need for immediate concern about the status of skipjack tuna.**

**Bigeye tuna**

**The results of further assessments of the bigeye tuna stock using age-structured production models presented in 2002 to the WPTT confirmed and reinforced the assessment agreed at the 2001 meeting. The WPTT therefore reiterated the technical advice on bigeye tuna given last year.**

**The Scientific Committee had already noted with concern the rapid increase of catches of bigeye tuna at its meeting in 1999. Since then, catches have remained high. The current high level in catch in numbers of juvenile bigeye tuna by purse seiners fishing on floating objects is likely to be detrimental to the stock if it continues, as fish of these sizes are well below the optimum size for maximum yield per recruit.**

**The Scientific Committee also noted that juvenile bigeye tuna are caught as bycatch in the FAD purse-seine fishery that targets primarily skipjack tuna. Some measures to reduce the catches of bigeye tuna in this fishery could be expected to result in a decrease in the catches of skipjack tuna.**

**Taking into account the results of the current assessments, which represent the best effort to date to analyze the available data in a formal context, it is likely that current catches are well above MSY. Therefore, the Committee recommends that a reduction**

**in catches of bigeye tuna from all gears, eventually to the level of MSY, be started as soon as possible.**

**Swordfish**

**On the basis of the production models and the stock indicators, the Scientific Committee concluded that the current level of catch (about 30,000 t) is unlikely to be sustainable. Of particular concern are the trends in abundance of swordfish in the SW Indian Ocean, where the highest catches are currently taken.**

**The Committee considered that any further increase in effort in the Western Indian Ocean (particularly in the southwest) would increase the risk of overfishing the swordfish stock. Thus, the Committee considered that any increase in the catch of, or fishing effort on, swordfish should not be allowed.**

**The indicators suggest that a comprehensive assessment of swordfish stocks in the Indian Ocean should be conducted as soon as possible.**

## 8. ACTIVITIES IN RELATION WITH THE INDIAN OCEAN TUNA TAGGING PROGRAMME (IOTTP)

### Report of the Working Party on Tagging (WPT)

68. The report of the WPT (IOTC–SC-03-05) was presented by the Chair, Dr. Alain Fonteneau. Significant progress has been achieved on a number of elements of the program and full-scale tagging is expected to start in the second half of 2004.

69. The WP Chair reported that tagging trials conducted to date as part of the IOTTP have had mixed success. The Scientific Committee was informed that simulation studies suggested in the WPT report have been postponed until January due to conflicting schedules of ad hoc working group members.

70. The WPT noted that plans already in place within the IOTTP are expected to lead to adequate releases of tags in all three target species across the Western and Central Indian Ocean. Plans and prospects for tag releases in the Eastern Indian Ocean are much less clear. As releases in the Eastern Indian Ocean are seen as critical for the IOTTP, the Scientific Committee discussed plans for pilot projects aimed at determining the best way to release significant numbers of tags in this area.

71. Australia reported that they had developed a proposal for a pilot tagging study in collaboration with Indonesia, but a funding source has yet to be identified... The Secretariat noted that $200-300K US would be available to assist with charters, if Australia could assist with manpower.

72. Japan reported that they will be conducting a tagging cruise in the Eastern Indian Ocean in January 2004 using IOTTP tags.

73. Thailand expressed its desire to participate in tagging activities in the eastern Indian Ocean provided that support and materials are available.

74. SEAFDEC conducted a tagging program in Thailand using IOTTP tags in October 2003. However, at this stage the Scientific Committee has received no reports on the success of this program.

75. The Bureau of Fisheries, Ministry of Agriculture, People's Republic of China reported that they would be contributing $25,000 US to the IOTTP.

### Current status of the Regional Tuna Tagging Program –Indian Ocean (RTTP-IO) arrangements

76. The IOTC Secretariat reported that the EU has approved expenditure of 14 million Euros for the main phase of the IOTTP, the RTTP-IO. However, the project agreement has yet to be signed. A draft

Memorandum of Understanding (MOU) between Commission de l' Océan Indien (COI) and the IOTC has been developed and will be presented to IOTC Commission in 2003. The MOU sees IOTC as the supervisor of project, which in practice means that the IOTC will have technical responsible/control of project, but will not be responsible for finances. The COI will have responsibility for the financial control of the project. Recruitment, tendering and review of potential tagging vessels will begin as soon as possible, and it is likely that the vessels and staff will be in place ready to start tagging in October/November 2004.

### Report on recent activities related to the IOTTP

77. The IOTC Secretariat reported on a broad range of activities relating to the IOTTP undertaken over the last 12 month. These include design of posters, T-shirts, development of a network of National Correspondents to assist with tag recovery, examination of options for estimating tag reporting rate, planning for a limited tag seeding experiments using Spanish observers, plans for bait surveys in the Seychelles Plateau. The work conducted during 2003 was possible largely through the efforts of a consultant to the IOTC. As it is not possible to extend the term of the consultant past April 2004, the Secretariat proposed the addition of a junior post within the Secretariat for two years starting in 2004 to facilitate continuation of the IOTTP support efforts. This proposal was supported by the SC as the work on pilot projects was seen as indispensable to the overall IOTTP.

### Small-scale tagging projects in the Republic of Maldives and India

78. Concerning the plans for small-scale tagging in Maldives and India (IOTC-SC-03-Inf.7) to start in the near future, the Scientific Committee supported these initiatives noting that they provide important information for those areas.

### Progress Report on FADIO and TAGFAD activities

79. A report of current tagging operations in the Western Indian Ocean was presented in document (IOTC-SC-03-Inf.9). These are small-scale tagging activities taking place in collaboration to the IOTTP. The main objectives are tagging of tunas normally not available to the pole-and-line gear, which is the primary gear that will be used by the IOTTP and tagging of tunas associated to Fish Aggregating Devices (FAD).

80. In 2003, three operations were conducted: (i) A trip to Oman to identify and test tagging opportunities in artisanal fisheries; (ii) the first FADIO trip in September to test and calibrate their echo sounder and sonars and to implant the first sonic tags on tunas associated to FADs; and (iii) the first TAGFAD cruise in October for archival tags released on medium size yellowfin and bigeye tuna associated to FADs and some dart-tagging on the same species plus skipjack tunas.

## 9. SCHEDULE OF WORKING PARTY MEETINGS IN 2004

81. The Committee recommended that the Working Party on Tropical Tunas should meet in June 2004 in Seychelles. Priority should be given to review the assessment of either bigeye or yellowfin tuna, pending a final decision of the Commission on the priorities.

82. The Committee recommended that the Working Party on Tagging should meet for two days immediately after the Working Party on Tropical Tunas, also in Seychelles.

83. The Committee recommended that the Working Party in Methods should meet in June of 2004, just before the Working Party in Tropical Tunas.

84. The Scientific Committee recommended that the Working Party on Billfish should meet again for five days in September and/or October of 2004.

85. The Scientific Committee indicated its desire to for a meeting of the Working Party in Neritic Tunas. Two Members, India and Iran, have expressed their interest in hosting this meeting. It was noted that previous meetings have not taken place mainly dues to lack of expression of interest in participation. The Committee recommends that any countries with data on neritic tuna fisheries should contact the Secretariat with this information. The date and venue of the meeting will be determined at a later date after consultations with the interested parties.

86. The Scientific Committee recommended that the Working Party on Temperate Tunas should meet in 2004, with date and venue to be determined at a later date, to consider the situation of the albacore tuna.

87. The Secretariat will contact CCSBT[10] to request an executive summary of the situation of the southern bluefin tuna.

### Progress in the establishment of a Working Party on Bycatch

88. Concerning the activities in relation to the Working Party on Bycatch, it was agreed that Dr. John Kalish, from Australia, will act as Chairman of a small group that would start the activities assigned by the Scientific Committee as listed in last year's report.

## 10. ANY OTHER BUSINESS

### Preparation of a Glossary of fisheries terms

89. A proposal to create a glossary of fisheries terms was discussed by the Scientific Committee. It was noted that other Commissions have developed similar publications which have shown to be useful for scientists and Commissioners. In particular, it was indicated that ICCAT has a glossary, mainly oriented towards assessment and management terms and FAO, through its FIGIS project, has also produced a general glossary.

90. The Scientific Committee considered that a glossary of fisheries term would be a useful tool, and it recommends that this could be done through a short term consultancy organized and supervised by the Secretariat. Collaboration with the above organizations to maximize resources and avoid duplication of effort is suggested.

### Preparation of an annotated bibliography on Indian Ocean Tuna

91. The Scientific Committee noted that the IOTC publications were not currently listed in the Aquatic Sciences and Fisheries Abstracts (ASFA). The Secretariat confirmed that it has submitted to the FAO the information necessary to incorporate the IOTC publications in the ASFA.

92. The Scientific Committee noted that the IOTC is producing a small number of printed documents and it considered a proposal to increase the amount of printed material produced by the Secretariat. The reviews of tuna fisheries and stocks that are published yearly by the other tuna Commissions were quoted as being publications potentially interesting for the IOTC. It was indicated that currently all the proceedings, reports from the Working Parties, Committees and expert Consultations, as well as most of the scientific and informative documents presented in these working groups, are published in electronic format through the Secretariat and the Commission's web site. Some Members expressed their wish that at least a limited number of paper copies be produced, for distribution of libraries in the region. However, it was noted that the Commission has issued instructions to restrict the production of such material for budgetary reasons.

## 11. ADOPTION OF THE REPORT

93. The Report of the Sixth Session of the Scientific Committee was adopted on December 6th, 2003

[10] Commission for the Conservation of Southern Bluefin Tuna

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# APPENDIX II. AGENDA OF THE MEETING

1. ***Opening of the Session***
2. ***Adoption of the Agenda and arrangements for the Session (IOTC-SC-03-01)***
3. ***Admission of observers***
4. ***Progress Report of the Secretariat (IOTC-SC-03-02)***
5. ***Data Collection and Statistics***
    - *5.1 Report of the Working Party on Data Collection and Statistics (IOTC-SC-03-03)*
    - *5.2 Progress Report of the IOTC-OFCF project (IOTC-SC-03-09)*
    - *5.3 Progress on a survey of predation of longline-caught fish (IOTC-SC-03-10)*
    - *5.4 Establishment of a Sub-Committee on Data Collection and Statistics*
6. ***Presentation of National Reports***
7. ***Status of Tuna and Tuna-like resources in the Indian Ocean***
    - *7.1 Report of the Working Party on Tropical Tunas (WPTT) (IOTC-SC-03-04) and presentation of the Executive Summaries*
        - ***7.1.1 Executive Summary of the status of the yellowfin tuna.***
        - ***7.1.2 Executive Summary of the status of the skipjack tuna.***
        - ***7.1.3 Executive Summary of the status of the bigeye tuna.***
        - ***7.1.4 Technical Advice in relation to Resolution 02/09: On the conservation of bigeye and yellowfin tuna in the Indian Ocean.***
    - *7.2 Report of the Working Party on Billfish (WPB) (IOTC-SC-03-06)*
        - ***7.2.1 Executive Summary on the status of swordfish resource***
    - *7.3 Availability of information on albacore tuna (IOTC-SC-03-07)*
8. ***Activities in relation with the Indian Ocean Tuna Tagging Programme (IOTTP)***
    - *8.1 Report of the Working Party on Tagging (WPT) (IOTC-SC-03-05)*
    - *8.2 Current status of the RTTP-IO arrangements*
    - *8.3 Report on recent activities related to the IOTTP (IOTC-SC-03-08)*
    - *8.4 Small-scale tagging projects in the Republic of Maldives and India*
    - *8.5 Progress Report on FADIO and TAGFAD activities*
    - *8.6 Progress on a tag seeding experiment*
9. ***Schedule of Working Party meetings in 2004***
    - *9.1 Progress in the establishment of a Working Party on Bycatch*
10. ***Any other business***
    - *10.1 Preparation of a Glossary of fisheries terms*
    - *10.2 Preparation of an annotated bibliography on Indian Ocean Tuna*
11. ***Adoption of the Report***

# APPENDIX III. List of documents.

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|---|---|
| IOTC-SC-03-01 | Provisional Agenda. |
| IOTC-SC-03-02 | Progress Report of the Secretariat. |
| IOTC-SC-03-03 | Report of the Permanent Working Party on Data Collection and Statistics (WPDCS). |
| IOTC-SC-03-04 | Report of the Working Party on Tropical Tunas (WPTT). |
| IOTC-SC-03-05 | Report of the Working Party on Tagging (WPT). |
| IOTC-SC-03-06 | Report of the Working Party on Billfish (WPB). |
| IOTC-SC-03-07 | Review of available information on albacore tuna |
| IOTC-SC-03-08 | Progress report on recent tagging activities |
| IOTC-SC-03-09 | Progress Report of the IOTC-OFCF project. |
| IOTC-SC-03-10 | Proposal to postpone the predation workshop and call for cooperation to build the predation survey database. |
| IOTC-SC-03-inf1 | UK National Report 2003 |
| IOTC-SC-03-inf2 | EU National Report |
| IOTC-SC-03-inf3 | Progress report on predation surveys for tuna longline-caught fish (Japan) |
| IOTC-SC-03-inf4 | Japan National Report |
| IOTC-SC-03-inf5 | National Report of South Africa |
| IOTC-SC-03-inf6 | National Report of India |
| IOTC-SC-03-inf7 | Tagging Of Tunas In The Lakshadweep Island Waters |
| IOTC-SC-03-inf8 | National Report of China |
| IOTC-SC-03-inf9 | Tagging operations conducted in 2003 in the Western Indian Ocean |

# APPENDIX IV. NATIONAL REPORT ABSTRACTS

## AUSTRALIA

The principal gears used by Australian vessels catching tuna and billfish in the IOTC area of competence are longline and purse seine. Total longline effort in 2002 was 6.0 million hooks, down from more than 6.2 million hooks in 2001. The longline fishery targets swordfish (2000 mt in 2002), but also takes significant catches of yellowfin (354 mt), and bigeye (418 mt). Catches of swordfish and yellowfin were slightly lower than in 2001, but bigeye catches were slightly higher than in 2001 (385 mt). There were 40 domestic longliners fishing in this region in 2002, a decline from 50 vessels in 2000. The purse seine fishery targets southern bluefin tuna which are towed to cages near shore for fattening. Late season catches of skipjack are taken by purse seiners in some years. In 2002, 1144 mt of skipjack was caught by purse seine (up from 897 mt in 2001). About 5000 mt of southern bluefin has been caught and towed to fattening cages by domestic purse seiners in each of the past four years. A scientific observer program commenced in 2003 on Australian longline vessels operating in the Indian Ocean. Australia is engaged in a range of research activities among which is a project to develop a robust set of stock status indicators for species targeted by the Australian fishery.

## CHINA

93 fishing vessels of Chinese tuna longliners were operating between 40 - 95°E, 10°N -15°S in the Indian Ocean in 2002, with the total nominal catch of 4922MT, 800MT or 14 percent less than the previous year. Bigeye and Yellowfin are the two main targeting species, accounting for 56.7 % and 26.9% of the total tuna catch respectively. Total fishing effort in 2002 was 13,343 thousand hooks, about 33.2% less than the previous year. CPUE varied from 212 to 509gk/l000hooks, with the mean value 351 kg/l000hooks. Catch statistics including FORM 1, FORM 3 and vessel information have been routinely reported to the IOTC Secretariat. New fishing licenses will be issued to all fishing vessels operated on high seas at the end of December 2003. A scientific observer program was carried out in 2002 and will be continued in 20O3.Tuna Statistical Documents program on Bigeye was carried out since July 1 2002 according to Resolutions adopted by IOTC.

## EC-SPAIN

Two fleets are operating in the Indian Ocean: the purse seine fleet targeting tropical tuna (yellowfin, skipjack and bigeye) and the longline fleet targeting swordfish. In 2002 a total of 18 purse seiners and 10 longliners (2 during the whole year and 8 partially) were operating. Most of the purse seiners are between 800 and 2,000 t of carrying capacity. Longliners vessels ranged from 27 to 42 meters in length. Spanish catches in 2002 were: 53,205 t (yellowfin), 91,462 t (skipjack), 11,096 t (bigeye), 217 t (albacore) and 3,502 t (swordfish), resulting a total of 159,888 t, the most important catches from the beginning of the fishery. Purse seine catch in 2002 increased a 26% as a consequence of the important increase (34%) of catch of skipjack. Tropical tuna sampling in 2002 has considerably increased (1,028 samples against 850 in 2001 and 160,894 against 136,719 in 2001 fish measured) because the full implementation of the new sampling method and the improvement of the sampling structure. Together with than 28,000 swordfish have been measured (45% of the total landings) and sex at age for temporal-spatial strata has been obtained by biological sampling.

Regarding research, two Spanish Research Institutes (IEO and AZTI) are involved in the tropical tuna researches and the IEO is also involved in the swordfish research. Since the beginning of the 90’s Spanish expert on fisheries has been permanently based in Mahé. Scientists involved in these fisheries have actively participated in the works of the WPTT, WPT and the SC. This year 9 documents have been presented. Research programs are or will be conducted in order to implement the Scientific recommendations, in particular: plan for collecting information on supplies and fishing on FADs, jointed (IEO-AZTI) observer program to estimate discards and by-catch (8 trips in 2003), jointed (IRD-IEO-AZTI) tagging program on tropical tuna fishing on FADs (2 cruises in 2003) and opportunistic tagging of swordfish and by-catch of longline catch.

## EC-FRANCE

GENERAL FISHERIES STATISTICS

Regarding French fisheries, two fleet are actively fishing for tuna in the Indian Ocean: seiners mostly based in Seychelles and longliners operating from La Réunion. The fisheries statistics for the latter are not currently available.

Total French tuna and tuna-like catches in the Indian Ocean accounted for 98,165 t in 2002, slightly more than in 2001 (79,133 t) and the previous years, while the number of boats remained stable.

SEINERS

After a decline in catches from 1994 to 1998, mainly due to a decrease in the number of boats, total catches have regularly increased. This increase is particularly obvious in 2002 (+26%), with a relatively stable fishing effort (-3%) and a slight increase in the number of sets (+5%). Skipjack and bigeye catches respectively increased by 51% and 33% while yellowfin catches remained stable (+2%). Most of the increase comes from catches on floating objects with +53% for the three species and +30% in the number of sets, while catches on free schools dropped by 10% along with -28% of sets.

Nominal effort (16 seiners) and total number of sets have remained stable while fishing effort (days of fishing) decreased slightly. The trend of the recent years, with a regular decrease in the number of sets on floating objects which was partially compensated for by an increase of the sets on free schools, have been dramatically reversed in 2002.

Total CPUE (in tons by fishing day) have reached an exceptionally high all-time record in 2002. This is particularly true for skipjack, while yellowfin and bigeye remained at a stable high level. The main reason for that exceptional catch is the increase of catches on floating objects, since the free school values have remained stable.

Generally speaking, fishing has remained concentrated in its usual area in 2002, although it extended slightly more eastward than in 2001. Unlike the previous years, relatively high catches have been recorded in the area between Seychelles and the Mozambique Channel, on floating objects as well as free schools.

Mean weight in yellowfin catches has continued to increase for free schools while decreasing for floating objects, reaching its lowest value ever. It remained stable for bigeye tuna and decreased for skipjack. Finally, mean weights of albacore have slightly increased, after the low but steady decline recorded since 1991. Overall, mean weights in 2001 have increased for free schools and decreased for floating objects, for all species.

Sampling and catch monitoring procedures have been described and reported on during the meetings of the Data collection and Statistics Working Party in 1999 (WPDCS-99-09) and 2000 (WPDCS-00-10), while the data processing workflow (T3: Traitement des Thons Tropicaux) is detailed in its user’s manual, which is available on request. Changes are ongoing and 2004 should see an actualization of the time series as well as the publication of a synthetic document.

LONGLINERS

The activity of the longline fleet has been studied by the IFREMER Laboratoire Ressources Halieutiques in La Réunion, between 1993 and 2000 (Poisson & Taquet, 2001.) It allowed collecting and processing accurate data on activity and catches until December 2000. Since then, only data submitted by local armaments to the Affaires Maritimes are available. IFREMER has started a new voluntary data collection scheme, until the implementation of a Fisheries Information System in La Réunion.

While the number of longliners longer than 16 meters has strongly decreased since 1998 to 7 boats in 2002, the number of boats shorter than 16 m (9-14 m) has dramatically increased to 17. Swordfish remains the target species for that fleet, but catches have decreased following a yield drop. Catches of main tuna species (yellowfin, bigeye and albacore) have all declined in 2002.

Between 1994 and 2000, only swordfish sizes have been recorded. A new collection of sizes of swordfish from the La Réunion longline fleet has been initiated in early 2002, and was extended to cover all species under IOTC mandate, as well as the dolfinfish.

Regarding longline fishing in La Réunion, 2001 is a year that will remain way less documented than other years, because of the end of the Programme Palangre Réunionais (PPR.) The implementation of a regional fisheries monitoring system (SIHR) should lead to a perceptible improvement during 2004 and should, thus, participate to a better management of fisheries resources.

2- IMPLEMENTATION OF THE SCIENTIFIC COMMITTEE ADVICES

Most the recommendations made by the various Working Parties and regarding France have been or will be soon implemented. More details can be found in the EC-France national report (CTOI-CS-03-Inf2.)

3- RESEARCH PROGRAMMES

IRD

The programs presented during the second session of the Scientific Committee in 1999 (IOTC-SC-99-10) are evolving well. A number of publications have been made (see bibliography in CTOI-CS-03-Inf2), including 11 documents presented to IOTC. Of particular interest this year are:

- the initiation of the TAGFAD and FADIO programs;

- the continuation of studies on biotic interactions in high-seas ecosystems and on large predators' trophodynamism;

- collection and analysis of data from the European tuna fisheries, in relation with an important involvement with the works of the various IOTC Working Parties.

IRD also actively took part in IOTC activities regarding the Working Party on Tagging (CTOI-SC-03-Inf9, Hallier, 2003), chaired by Alain Fonteneau.

IFREMER

In La Réunion, IFREMER continues its works on the swordfish biology, especially on validating yearly growth increments.

A new fisheries monitoring system is under development and should allow to enhance the quality and perpetuate the collection of statistical data from mid-2004 onwards.

The DORADE research program, aiming at better understanding aggregation amongst epipelagic fish (mainly dolfinfish) was initiated in early 2001.

Finally, IFREMER-La Réunion also takes part in the IRD-led FADIO programme.

## JAPAN

As the general fisheries statistics, statistical of Japanese longline and purse seine fisheries were summarized up to 2002 although the data of 2002 is preliminary. The number of vessel operating in the Indian Ocean has been les than 200 since 2000, and their catch for each species in 2002 (2001) were 3,139 (4,850MT) for southern bluefin, 3,182MT (3,006MT) for albacore, 13,955MT (12,779MT) for bigeye and 15,162MT (14,029MT) for yellowfin using about 110 million hooks as the effort. In the purse seine fishery, the last commercial purse seiner retreated from this Ocean in 2001 then only one research vessel, Nippon-Maru is operating thereafter. Purse seine catch in weight of skipjack, yellowfin and bigeye in 2002 (2001) was 1,160MT (1,830MT), 182MT (603MT) and 328MT (592MT), respectively, by the effort (operation days + searching days) of 134 (262) fishing days. Progress on the implementation of recommendations of the past Scientific Committees relating to Japan were explained, i.e., (a) Collection of more size data, (b) Search for the historical weight data, (c) Tagging in the eastern Indian Ocean, (d) Investigation of the status of the live bait for the tagging experiments, (e) Continuation of the predation survey and (f) Improvement of the CPUE Standardization. Regarding the national research programs, research of behavior of fishing group around FAD by Shoyo-Maru, tagging on small tunas in eastern Indian Ocean by No.2 Taikei-Maru and tagging on sub-adult bigeye by No.21 Fukuryu-Maru were introduced. During the period from October to December in 2003, 144 sub-adult bigeye tunas were tagged and released at South-East off Cape Town.

### KOREA

The Korean tuna longline fishery has shown a decreasing trend from the late 1970s to recent years in both number of fishing vessels and annual catches. In 2002, total catch amounted to 1,259 mt by 11 longliners, which was the record low in Korean longline fishery in this area. Catch consists of 649 mt of southern bluefin tuna, 332 mt of yellowfin tuna, 186 mt of bigeye tuna and some minor catches of other tunas and billfishes. Compared to 2001, catches of yellowfin and bigeye tuna decreased remarkably by more than 70% and 80%, respectively. This was mainly due to the shift of many longliners from the Indian Ocean to the Pacific. National Fisheries Research and Development Institute (NFRDI) has maintained a small scale tagging project through which it encourages fishermen to have voluntary tagging practices during their fishing operation. This voluntary tagging program will be continued until a bigger-scale tagging program has been initiated in the future. Korean government initiated fisheries observer program in 2002 to monitor its distant water fisheries including those for tunas and to meet the requirements of regional fisheries bodies. At the initial stage, size of the observer program will be fairly small to cover only for the fisheries to be urgently implemented but will be gradually developed to cover all required areas of tuna fisheries.

### SOUTH AFRICA

Towards the end of 2001 the tuna longline fishing grounds were expanded to include the area east of South Africa. Consequently, fishing effort and catches in the Indian Ocean rose sharply in 2002, reaching approximately 1 100 MT compared to only 400 MT in 2001. In 2002, the longline catch consisted of swordfish (591.9 MT), bigeye tuna (202.9 MT), yellowfin tuna (144.7 MT) and albacore (64.9 MT). Of the remaining 98 MT reported catch, blue sharks accounted for 33 MT and unidentified tuna 10 MT. Twenty-three vessels were actively fishing in 2002. This fleet will be expanded in 2004 when long-term commercial fishing rights are allocated. Albacore catches are seldom made by the pole and line sector in the Indian Ocean, with annual catches averaging less than 10 MT. Skiboats, using rod and reel, catch significant quantities of king mackerel, queen mackerel and juvenile yellowfin tuna, but due to under-reporting catches have steadily been declining in recent years with only 7.4 MT of king mackerel, 3.6 MT of queen mackerel and 4 MT of yellowfin tuna reported. No catches were reported for pelagic shark longline, and this sector will be terminated in 2005.

Fisheries research is mainly focused on swordfish and aims to elucidate the life history and stock delineation of swordfish in South African waters. In 2004, genetic and heavy metal analysis of swordfish tissue samples as well as a tagging programme will be implemented.

South Africa has implemented ICCAT management and control measures for her fleets, including measures to combat IUU fishing, mandatory VMS, 20% onboard scientific observer coverage for longline vessels, full port inspection scheme, minimum size limits and a daily logbook system. South Africa also provides fishery statistics according to IOTC specifications on an annual basis.

Marine and Coastal Management, which is South Africa’s Fisheries Authority, has initiated the process with Foreign Affairs and International Liaison to endorse the application for Cooperating Contracting Party status with IOTC. In the interim South Africa is seeking Cooperating Non-contracting Party status.

## THAILAND

According to the IOTC Record of vessels over 24 meters authorized to operate in the IOTC area, only 5 Thai vessels are operating in the Indian Ocean, of which 3 are research vessels. Normally, vessels with the smaller sizes are fishing neritic tunas in the Andaman Sea within the Thai jurisdiction. The main species of small tunas caught are frigate tuna, kawakawa, and longtail tuna. The tuna industry of Thailand relies tremendously on the importing of raw material. Three main species of imported tunas are skipjack, albacore and yellowfin. In the practice of combating IUU fishing, Thailand is planning to modify some trawlers fishing illegally in the waters of its neighboring countries to engage in either longliners or purse seiners in the deep-sea areas within the Thai jurisdiction as well as in the international waters of the Indian Ocean. In addition, prior to importing of yellowfin tunas and their processed products into the Thai territory, the importers need to obtain letter of recommendation from the Department of Fisheries to verify that the imported products are not unlawfully caught by purse seiners in the Eastern Pacific Ocean.

## UK

The UK National Report summarizes tuna fishing in the British Indian Ocean Territory (Chagos Archipelago) Fisheries Conservation and Management Zone (FCMZ) during the 2002I2003 fishing season (April 2002 to March 2003). During this season, 37 longline vessels (mainly from Japan and Taiwan, China) caught a total of 1467 t, mainly of yellowfin and bigeye tuna, and 52 purse seine vessels (Spanish and French operated) caught 722 t of skipjack, yellowfin and bigeye tuna. An observer programme was again conducted in 2002/2003, with observations on 2 Japanese and 4 Taiwanese longliners. In this programme, biological sampling is carried out and data collected on target tuna, bycatch and discard species. In addition, complete hook-by-hook surveys are carried out of selected longline sets, for which all fish caught were landed. Collection of these observer data fulfils recommendations made by the WPDCS and WPTT.

# APPENDIX V. EXECUTIVE SUMMARIES ON THE STATUS OF SPECIES

# 1. EXECUTIVE SUMMARY OF THE STATUS OF THE YELLOWFIN TUNA RESOURCE

## BIOLOGY

Yellowfin tuna is a cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three oceans, where it forms large schools. The sizes exploited in the Indian Ocean range from 30 cm to 170 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack and juvenile bigeye tuna and are mainly limited to surface tropical waters, while larger fish are found in surface and sub-surface waters. Intermediate age yellowfin are seldom taken in the industrial fishery, but are abundant in some artisanal fisheries, mainly in the Arabian Sea.

Stock structure is unclear, and a single stock is usually assumed for stock assessment purposes. Longline catch data indicates that yellowfin are distributed continuously throughout the entire tropical Indian Ocean, but some more detailed analysis of fisheries data suggests that stock structure may be more complex. A study of stock structure using DNA was inconclusive.

Spawning occurs from December to March in the equatorial area (0-10°S), but the main spawning grounds seem to be between 50° and 70°E. Yellowfin size at first maturity has been estimated at 110 cm, and recruitment occurs in July. Newly recruited fish are primarily caught by the purse seine fishery on floating objects. Males are predominant in the catches of larger fish, but apparently at a larger size (150 cm) than in other oceans.

Several new growth studies were presented to the WPTT. The Working Party identified two hypotheses regarding growth curves: a “slow-growth” hypothesis, assuming a two-stanza growth curve, and a “fast-growth” hypothesis, assuming a constant growth rate. The two-stanza growth curve is in good agreement with growth curves estimated from size frequencies and tagging studies in the Atlantic and western Pacific Oceans.

There are no direct estimates of natural mortality (M) for yellowfin in the Indian Ocean. In stock assessments, estimates from other oceans have been used, mainly based on results from the western Pacific tagging programme. These indicated a higher M on juvenile fish than for older fish.

There is little information on yellowfin movement patterns in the Indian Ocean, and what information there is comes from analysis of fishery data, which can produce biased results because of their uneven coverage. However, there is good evidence that medium sized yellowfin concentrate for feeding in the Arabian Sea. Feeding behavior is largely opportunistic, generally aimed at large concentrations of crustacea in the tropical areas or small mesopelagic fishes in the Arabian Sea.

## FISHERY

Catches by area, gear, country and year from 1950 to 2002 are shown in Table 1 and illustrated in Figure 1. Contrary to the situation in other oceans, the artisanal fishery component in the Indian Ocean is substantial, taking approximately 20-25% of the total catch.

The geographical distribution of yellowfin tuna catches in the Indian Ocean in recent years by the main gear types (purse-seine, longline and artisanal) is shown in Figure 2. Most yellowfin tuna are caught in Indian Ocean north of 10°S and in the Mozambique Channel (north of 25°S).

Purse seine currently takes the most catch, with a catch of 142,000 t in 2002 coming mostly from the western Indian Ocean. Although some Japanese purse seiners have fished in the Indian Ocean since 1977, the purse seine fishery developed rapidly with the arrival of European vessels between 1982 to 1984. Since then, there has been an increasing number of yellowfin tuna caught (*Figure 3*) although a larger proportion of the catches is made of adult fish, when compared to the case of the bigeye tuna purse-seine catch. Purse seine catches of yellowfin with fork lengths between 30 and 180 cm increased rapidly to some 130,000 t in 1993, after which they have fluctuated around that level.

The purse seine fishery is characterized by the use of two different fishing modes: the fishery on floating objects (FADs), which catches mainly small yellowfin in association with skipjack and juvenile bigeye, and a fishery on free swimming school, which catches larger yellowfin on mixed or pure sets. Between 1995 and 2000, the FAD component of the purse seine fishery represented 50-66% of the sets undertaken (65-80% of the positive sets) and took 46-63% of the yellowfin catch by weight (63-76% of the total catch).

The longline fishery started in the beginning of the 1950's and expanded rapidly over the whole Indian Ocean. It catches mainly large fish, from 80 to 160 cm fork length. The longline fishery targets several tuna species in different parts of the Indian Ocean, with yellowfin and bigeye being the main target species in tropical waters. The longline fishery can be subdivided into an industrial (deep-freezing longliners operating on the high seas from Japan, Korea and Taiwan,China) and an artisanal component (ice longliners operating more in coastal waters). The longline catch of yellowfin reached a maximum in 1993, after which it declined to a level of 86,000 t in 2002.

Artisanal catches, taken by baitboat, gillnet, troll, handline and other gears, have increased steadily since the 1980s. In 2002, the total artisanal yellowfin catch was 85,000 t, while the catch by the dominant artisanal gear, gillnets, was 54,000 t.

Annual mean weights of yellowfin caught by different gears and by the whole fishery are shown in Figure 3. After an initial decline, mean weights in the whole fishery remained quite stable from the 1970s to the early 1990s. After 1993, mean weights in the catches in the industrial fisheries have declined. Although total catch in biomass has been stable for several years, catches in numbers have continued to increase, as there has been more fishing effort directed towards smaller fish, as illustrated in Figure 10.

### AVAILABILITY OF INFORMATION FOR ASSESSMENT PURPOSES

The reliability of the estimates of the total catch has continued to improve over the past few years, on one hand as a result of the catch sampling program being fully operational now, and on the other hand because several national sets of data have recently become available (Oman, Sri Lanka, Iran).

A number of papers dealing with fisheries data, biology, CPUE trends and assessments were discussed by the WPTT in 2002, and additional data analyses were performed during that meeting. In particular, estimates of annual catches at size for yellowfin were calculated using the best available information. Estimated catches at age calculated using the catch-at-size data and the two hypotheses regarding growth curves (fast vs. slow growth) are shown in Figure 5. Two sets of natural mortality at age schedules were agreed, both assuming a higher M on juvenile fish.

Standardized CPUE analysis using both Japanese and Taiwanese data were presented and discussed. New analyses were also carried out on these data sets during the meeting, estimating standardized CPUEs for both the whole Indian Ocean and the tropical area (10N – 15S), where the bulk of the catch is taken. All resulting standardized CPUE series are similar. These showed an initial steep decline, over a period when catches were relatively low and stable, followed by stable standardized CPUEs since the late 1970s, a period during which catches have increased strongly following the development of the purse seine fishery. This is illustrated in Figure 4 for the tropical area. The observed pattern of standardized CPUE does not correspond well with the expected response of CPUE to changes in catch and biomass. There are several possible explanations for this, such as changes in catchability or behavior, or the population existing in two fractions with differential availability to purse seine and longline gears. However, there is no scientific information to judge which, if any, of these explanations is correct.

### STOCK ASSESSMENT

A full assessment was attempted for yellowfin tuna in 2002. Several papers presenting assessment results were discussed by the WPTT, and additional assessments were carried out during the meeting using agreed data sets.

No new stock assessment methods were presented to the WPTT, and assessments were carried out using methods used at previous meetings, including the modified Grainger and Garcia index, the PROCEAN method, ASPM, a multi fleet statistical catch at age model, sequential population analysis (VPA) and a multigear yield-per-recruit analysis. Many new analyses based on agreed sets of data and hypothesis were performed and discussed during the meeting.

Although there were differences in the details of results from the different assessments, the overall picture is consistent. This can be seen in Figures 6 to 9, which illustrate some of the results from the assessments, expressed in relative units to make them directly comparable. There has been a large and steady increase in fishing mortality since the early 1980s, while there is indication that there has been a substantial decline in biomass since the mid-1980s. Estimates of catchability both for purse-seine and longline fleets show a strong increasing trend since the mid-1980s, especially for the purse-seine fleet, as illustrated in Figures 8 and 9. It should be noted that these figures are intended to illustrate general trends, and should not be viewed as depicting precise estimates of changes in efficiency.

It is not currently possible to obtain a reliable estimate of the fishing mortality at MSY (Fmsy), and some assessment runs were unable to produce plausible estimates of MSY. However, in those cases where plausible estimates or indicators of MSY could be obtained, they consistently indicated that current catches are in the vicinity of, or possibly above, MSY. Even if current catches are below MSY, a continuation of the recent rapid increase in catches and effort would mean that the fishery could very soon reach or exceed MSY.

It is also clear from the basic data that, during the early period of the fishery (from the 1950s to the start of the 1980s), the catches were relatively low and stable around 40,000 t. Since the 1980s there has been a rapid increase in the longline and purse seine effort and the total catch reached over 300,000 t in 1992. Since the mid-1990s there has also been an increase in purse seine fishing on floating objects which has led to a rapid increase in the catch of juvenile yellowfin. The rapid expansion, particularly on juvenile fish, is cause for concern, since it displays all the symptoms of a potentially risky situation. The increases in catches in general has not been as a result of geographic expansion to previously unfished areas, but rather as a result of increased fishing pressure on existing fishing grounds.

The SC received information that, based on the landing data collected in Seychelles, large catches of large yellowfin tuna were taken by purse-seine fleets on free-swimming schools during 2003 in the western Indian Ocean. By the end of 2003, the catch of yellowfin tuna by purse seiners is likely be up to 50% larger that the catches in recent years. Subsequently, the total catch of yellowfin tuna in the Indian Ocean could reach during 2003 between 400 and 500 thousand metric tons, depending on the catches by other gears. Notably, this catch was taken by a purse-seine fishing fleet of the same size, and fishing in an area similar to, that in previous years.

This catch will be well above the range of MSYs estimated by the WPTT. The SC was not able to explain these large catches but, at this stage, an increase in the catchability of the stock (e.g.: increase in fishing efficiency, changes in fish behavior, changes in fleet targeting, etc.) seems a more likely explanation than a sudden increase in the adult stock biomass.

The SC noted that it has recommended in earlier years that the catches and the fishing effort should not exceed the 2000 levels. However, considering that nominal effort has been maintained at levels comparable to those of 2000 and that analyses suggest that the fishing efficiency has increased in recent years, effective fishing effort probably has exceeded the effort exerted in the year 2000. The large catches in 2003 taken by the same nominal effort of last year suggest that effective fishing effort might have increased substantially in 2003.

### MANAGEMENT RECOMMENDATIONS

Considering all the stock indicators and assessments, as well as the recent trends in effort and total catches of yellowfin, the Scientific Committee considered that:

1) Total catches under current fishing patterns are close to, or possibly above MSY. In these circumstances, any further increase in both effective fishing effort and catch above levels in 2000 should be avoided. The large increase in catch in 2003 reinforces the importance of this recommendation.
2) The current trend for increasing fishing pressure on juvenile yellowfin by purse seiners fishing on floating objects is likely to be detrimental to the stock if it continues, as fish of these sizes are well below the optimum size for maximum yield per recruit.
3) The Scientific Committee also noted that juvenile yellowfin tuna are caught in the purse-seine fishery that targets primarily skipjack tuna. Some measures to reduce the catches of juvenile yellowfin tuna in the FAD fishery will be accompanied by a decrease in the catches of skipjack tuna.

*Yellowfin Tuna Summary*

| | |
|---|---|
| Maximum Sustainable Yield (MSY) | 280,000 - 350,000 t |
| Current (2002) Catch | 312,000 t |
| Current Replacement Yield | |
| Relative Biomass $B_{cur}$/ Bmsy | |
| Relative Fishing Mortality $F_{cur}$/Fmsy | |
| Management Measures in Effect | None |

*Table 1 – Yellowfin catches by area, gear and countries from 1950 to 1976.*

| Gear | Fleet | Av98/02 | Av50/02 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Purse Seine | Other Fleets | 2.2 | 1.1 | | | | | | | | | | | | | | 0.0 | 0.0 | 0.0 | | | | | | | | | 0.0 | 0.0 | 0.1 |
| | ***Total*** | ***133*** | ***119*** | | | | | | | | | | | | | | ***0*** | ***0*** | ***0*** | | | | | | | | | ***0*** | ***0*** | ***0*** |
| Baitboat | Maldives | 11.9 | 5.3 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 | 1.5 | 1.5 | 1.5 | 1.5 | 1.0 | 1.5 | 1.7 | 1.7 | 1.8 | 2.3 | 1.4 | 2.5 | 6.9 | 5.0 | 4.6 | 5.2 |
| | Other Fleets | | 0.1 | | | | | | | | | | | | | | | | | | | | | | | | 0.6 | 1.2 | 0.2 | |
| | ***Total*** | ***13*** | ***7*** | ***2*** | ***2*** | ***2*** | ***2*** | ***2*** | ***2*** | ***2*** | ***2*** | ***2*** | ***2*** | ***1*** | ***2*** | ***2*** | ***2*** | ***2*** | ***1*** | ***2*** | ***2*** | ***2*** | ***2*** | ***2*** | ***1*** | ***3*** | ***7*** | ***6*** | ***5*** | ***5*** |
| Longline | Indonesia | 34.7 | 6.0 | | | | | | | | | | | | | | | | | | | | | | | | 0.1 | 0.3 | 0.7 | 1.0 |
| | China (Taiwan,China) | 19.1 | 12.7 | | | | | 0.2 | 0.7 | 1.1 | 1.3 | 1.8 | 2.4 | 2.2 | 2.9 | 3.5 | 3.4 | 2.9 | 2.2 | 4.4 | 3.4 | 22.6 | 21.1 | 14.9 | 11.8 | 11.8 | 5.7 | 4.4 | 4.6 | 3.4 |
| | Japan | 15.3 | 15.4 | | | 3.7 | 6.8 | 21.7 | 44.2 | 59.5 | 31.9 | 22.6 | 22.2 | 36.1 | 32.7 | 44.2 | 22.0 | 22.2 | 24.9 | 40.8 | 30.2 | 48.3 | 23.1 | 10.3 | 13.4 | 7.9 | 3.9 | 4.9 | 6.4 | 2.8 |
| | Korea, Republic of | 1.9 | 6.0 | | | | | | | | | | | | | | | | | 0.1 | 0.2 | 4.6 | 8.0 | 4.1 | 6.5 | 9.6 | 9.9 | 11.6 | 11.7 | 12.8 |
| | Other Fleets | 2.8 | 1.9 | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.9 |
| | ***Total*** | ***100*** | ***98*** | | | ***4*** | ***7*** | ***22*** | ***45*** | ***61*** | ***33*** | ***24*** | ***25*** | ***38*** | ***36*** | ***48*** | ***25*** | ***25*** | ***27*** | ***45*** | ***34*** | ***76*** | ***52*** | ***29*** | ***32*** | ***29*** | ***20*** | ***21*** | ***23*** | ***21*** |
| Gillnet | Pakistan | 4.9 | 2.5 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | 0.5 | 1.4 | 0.7 | 0.7 | 0.8 | 0.8 | 1.2 | 1.8 | 2.4 | 2.6 | 3.5 | 3.4 | 3.4 | 3.1 | 2.8 | 2.3 | 2.8 | 2.2 | 3.0 | 3.3 | 3.1 |
| | ***Total*** | ***55*** | ***43*** | ***0*** | ***0*** | ***0*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***2*** | ***2*** | ***3*** | ***4*** | ***3*** | ***3*** | ***3*** | ***3*** | ***2*** | ***3*** | ***2*** | ***3*** | ***3*** | ***3*** |
| Line | Maldives | 1.1 | 0.3 | | | | | | | | | | | | | | | | | | | | | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.5 |
| | France-Reunion | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.4 | 0.4 | 0.3 | 0.4 | 0.3 | 0.3 |
| | ***Total*** | ***7*** | ***6*** | ***0*** | ***0*** | ***0*** | | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** |
| Other | Indonesia | 0.3 | 0.9 | 0.1 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.8 | 0.6 | 0.6 | 1.0 | 1.0 | 0.8 | 0.3 | 0.7 |
| | Sri Lanka | 0.0 | 2.7 | | | | | | | 1.2 | 3.1 | 2.0 | 2.2 | 2.9 | 3.2 | 4.7 | 7.8 | 5.4 | 6.0 | 5.8 | 8.5 | 9.0 | 6.8 | 5.8 | 4.7 | 6.5 | 5.1 | 6.1 | 6.6 | 6.9 |
| | Other Fleets | 0.2 | 0.1 | | | | | | | | | | | | | | | | | | | | | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 |
| | ***Total*** | ***4*** | ***10*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***2*** | ***4*** | ***2*** | ***3*** | ***3*** | ***4*** | ***5*** | ***8*** | ***6*** | ***7*** | ***7*** | ***9*** | ***10*** | ***8*** | ***7*** | ***6*** | ***8*** | ***6*** | ***7*** | ***7*** | ***8*** |
| **ALL** | **TOTAL** | **312** | **282** | **2** | **2** | **6** | **9** | **24** | **48** | **65** | **40** | **30** | **30** | **44** | **42** | **56** | **37** | **35** | **38** | **57** | **48** | **91** | **65** | **41** | **41** | **43** | **36** | **38** | **39** | **38** |
| Gear | Fleet | Av98/02 | Av50/02 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |

***Table 1(cont.)** – Yellowfin catches by area, gear and countries from 1977 to 2002.*

| Gear | Fleet | Av98/02 | Av50/02 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Purse Seine | Spain | 50.2 | 15.2 | | | | | | | | 11.5 | 18.4 | 20.0 | 26.3 | 44.9 | 41.1 | 43.7 | 44.0 | 37.8 | 47.8 | 43.1 | 65.1 | 59.4 | 61.0 | 38.6 | 51.9 | 52.1 | 47.7 | 53.2 |
| | France | 30.7 | 14.0 | | | | | 0.2 | 1.0 | 10.5 | 36.7 | 39.1 | 43.3 | 46.8 | 59.9 | 38.4 | 45.3 | 38.1 | 45.3 | 39.5 | 35.8 | 39.6 | 35.6 | 31.2 | 22.4 | 30.8 | 37.7 | 31.4 | 35.1 |
| | NEI-Other | 22.9 | 5.3 | | | | | | | 0.7 | 8.4 | 9.4 | 6.3 | 5.2 | 7.9 | 4.5 | 11.9 | 11.9 | 8.1 | 15.5 | 19.7 | 19.3 | 16.7 | 21.9 | 20.3 | 25.8 | 27.1 | 19.4 | 19.1 |
| | NEI-Ex-Soviet Union | 10.9 | 2.2 | | | | | | | | | | | | | | 0.8 | | 5.1 | 8.1 | 5.8 | 16.3 | 13.2 | 10.2 | 7.3 | 12.1 | 14.0 | 10.7 | 10.7 |
| | Seychelles | 8.9 | 1.2 | | | | | | | | | | | | | | | 0.4 | 0.2 | | | | | 2.8 | 7.4 | 9.8 | 11.6 | 12.9 | 16.6 |
| | France-Territories | 3.1 | 0.1 | | | | | | | | | | | | | | | | | | | | | | | | | 3.1 | 1.3 |
| | Iran, Islamic Republic | 2.4 | 0.6 | | | | | | | | | | | | | | | | 2.1 | 3.4 | 2.7 | 4.3 | 1.6 | 1.9 | 3.3 | 2.5 | 2.2 | 2.2 | 5.0 |
| | Japan | 1.5 | 1.0 | 0.0 | 0.2 | 0.1 | 0.1 | 0.0 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.3 | 0.4 | 0.9 | 3.0 | 5.1 | 11.9 | 10.9 | 5.3 | 4.8 | 3.9 | 2.6 | 1.9 | 1.5 | 1.0 | 0.6 | 0.2 |
| | Other Fleets | 2.2 | 1.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 1.4 | 1.6 | 1.9 | 3.8 | 5.4 | 5.6 | 5.1 | 4.1 | 6.3 | 2.4 | 3.4 | 3.0 | 2.8 | 1.9 | 2.1 | 2.4 | 2.0 | 1.8 | 1.4 | 1.2 |
| | ***Total*** | ***133*** | ***41*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***1*** | ***13*** | ***58*** | ***69*** | ***74*** | ***84*** | ***119*** | ***90*** | ***109*** | ***106*** | ***113*** | ***129*** | ***115*** | ***152*** | ***132*** | ***134*** | ***104*** | ***136*** | ***147*** | ***129*** | ***142*** |
| Baitboat | Maldives | 11.9 | 5.3 | 4.9 | 3.8 | 4.4 | 4.4 | 5.6 | 4.5 | 7.7 | 8.2 | 6.9 | 6.2 | 7.4 | 5.9 | 5.5 | 4.9 | 7.0 | 8.0 | 9.3 | 12.4 | 11.8 | 11.5 | 12.2 | 13.0 | 13.0 | 10.1 | 11.5 | 20.5 |
| | India | 0.6 | 0.0 | | | | | | | | | | | | | | | | | | | | | | | 0.6 | | | |
| | Other Fleets | | 0.1 | | | | | 0.4 | 0.5 | 0.5 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | | | | | | | | |
| | ***Total*** | ***13*** | ***5*** | ***5*** | ***4*** | ***4*** | ***4*** | ***6*** | ***5*** | ***8*** | ***8*** | ***7*** | ***6*** | ***7*** | ***6*** | ***6*** | ***5*** | ***7*** | ***8*** | ***9*** | ***12*** | ***12*** | ***12*** | ***12*** | ***13*** | ***14*** | ***10*** | ***11*** | ***21*** |
| Longline | Indonesia | 34.7 | 6.0 | 1.3 | 1.3 | 1.4 | 2.1 | 2.6 | 2.7 | 0.8 | 0.8 | 0.8 | 0.7 | 1.3 | 2.3 | 3.8 | 4.6 | 5.5 | 9.3 | 10.8 | 14.8 | 16.7 | 31.8 | 38.2 | 35.7 | 41.7 | 29.6 | 28.4 | 28.4 |
| | China | 1.5 | 0.2 | | | | | | | | | | | | | | | | | | | 0.1 | 0.5 | 0.8 | 0.4 | 2.3 | 2.4 | 1.8 | 1.3 |
| | (Taiwan,China) | 19.1 | 12.7 | 8.1 | 4.2 | 3.7 | 3.8 | 4.1 | 4.7 | 5.6 | 5.8 | 7.3 | 16.2 | 22.3 | 22.7 | 22.4 | 31.6 | 30.7 | 56.0 | 88.0 | 34.0 | 23.1 | 27.9 | 18.4 | 23.4 | 17.7 | 17.4 | 18.9 | 27.7 |
| | NEI-Fresh Tuna | 15.5 | 4.5 | | | | | | | | | | | | | 11.9 | 16.6 | 14.4 | 16.7 | 19.5 | 27.6 | 25.7 | 24.7 | 25.1 | 22.1 | 14.8 | 10.8 | 4.6 | 5.1 |
| | Japan | 15.3 | 15.4 | 2.1 | 4.6 | 3.3 | 3.2 | 4.9 | 7.3 | 7.8 | 7.9 | 9.5 | 10.7 | 8.3 | 9.3 | 4.6 | 6.3 | 4.4 | 5.7 | 5.7 | 9.7 | 8.0 | 12.8 | 15.6 | 16.8 | 14.7 | 15.5 | 14.0 | 15.2 |
| | NEI-Deep-freezing | 8.0 | 2.6 | | | | | | | | | 0.1 | 1.1 | 1.2 | 3.4 | 3.2 | 6.7 | 5.9 | 10.2 | 27.0 | 11.2 | 7.8 | 13.5 | 6.5 | 11.3 | 8.5 | 9.0 | 4.7 | 4.7 |
| | Korea, Republic of | 1.9 | 6.0 | 31.4 | 25.2 | 17.8 | 12.5 | 11.8 | 18.7 | 15.3 | 9.9 | 12.0 | 14.9 | 12.6 | 13.4 | 8.1 | 7.0 | 3.0 | 4.1 | 4.7 | 3.6 | 2.4 | 3.4 | 3.6 | 2.3 | 0.9 | 1.1 | 1.4 | 0.3 |
| | NEI-Indonesia Fresh Tuna | 1.5 | 1.9 | | | | | | | | | | 0.1 | | 2.7 | 10.3 | 12.6 | 12.9 | 15.6 | 12.6 | 16.3 | 8.9 | 3.7 | 4.0 | 0.3 | 0.0 | | | |
| | Pakistan | 0.2 | 1.1 | | | | | | | | | | | | | | | 1.7 | 19.5 | 28.2 | 2.2 | 3.0 | 2.5 | 0.1 | 0.1 | 0.1 | 0.2 | | |
| | Other Fleets | 2.8 | 0.8 | 0.7 | 0.0 | 0.4 | 0.4 | 0.2 | 1.1 | 1.3 | 0.8 | 0.5 | 1.2 | 0.7 | 0.7 | 1.2 | 0.8 | 3.0 | 20.5 | 34.7 | 9.0 | 4.8 | 3.4 | 1.3 | 2.4 | 2.2 | 2.5 | 3.1 | 3.0 |
| | ***Total*** | ***100*** | ***51*** | ***44*** | ***35*** | ***27*** | ***22*** | ***24*** | ***34*** | ***31*** | ***25*** | ***30*** | ***45*** | ***46*** | ***54*** | ***65*** | ***86*** | ***81*** | ***158*** | ***231*** | ***128*** | ***101*** | ***124*** | ***114*** | ***115*** | ***103*** | ***88*** | ***77*** | ***86*** |
| Gillnet | Sri Lanka | 19.7 | 4.6 | | | | | | 6.7 | 7.2 | 5.2 | 6.1 | 6.9 | 6.7 | 8.1 | 9.3 | 7.2 | 11.0 | 10.0 | 10.4 | 11.1 | 7.8 | 12.7 | 15.5 | 19.3 | 27.1 | 21.7 | 14.7 | 17.4 |
| | Iran, Islamic Republic | 18.6 | 4.0 | | | | | | | | | | | | | 1.0 | 2.3 | 3.2 | 12.1 | 13.3 | 19.5 | 22.5 | 28.5 | 19.1 | 18.0 | 24.3 | 13.5 | 18.0 | 19.0 |
| | Oman | 9.3 | 3.8 | | | | | | | | | 2.2 | 2.5 | 5.8 | 15.5 | 16.0 | 14.1 | 9.0 | 13.4 | 11.4 | 18.9 | 21.3 | 11.6 | 9.8 | 11.3 | 7.4 | 7.0 | 11.0 | 11.0 |
| | Pakistan | 4.9 | 2.5 | 2.7 | 1.6 | 2.8 | 1.3 | 2.0 | 2.5 | 0.8 | 0.9 | 1.5 | 2.5 | 2.3 | 3.7 | 8.6 | 3.2 | 4.8 | 3.9 | 2.6 | 2.4 | 2.1 | 2.8 | 3.7 | 3.7 | 8.7 | 4.7 | 3.6 | 2.9 |
| | India | 1.7 | 0.2 | | | | | | | | | | | | | | | | | | | | | | 2.0 | 0.9 | 1.2 | 2.6 | 2.6 |
| | Other Fleets | 0.8 | 0.2 | | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 0.3 | 0.7 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 | 0.9 | 0.7 | 0.7 |
| | ***Total*** | ***55*** | ***15*** | ***3*** | ***2*** | ***3*** | ***1*** | ***2*** | ***9*** | ***8*** | ***6*** | ***10*** | ***12*** | ***15*** | ***27*** | ***35*** | ***27*** | ***29*** | ***40*** | ***38*** | ***53*** | ***54*** | ***56*** | ***49*** | ***55*** | ***69*** | ***49*** | ***51*** | ***54*** |
| Line | Comoros | 5.3 | 1.3 | | | | | | | | | | | | | 3.3 | 3.3 | 3.3 | 4.7 | 4.7 | 5.6 | 5.6 | 5.5 | 5.3 | 5.3 | 5.2 | 5.6 | 5.2 | 5.2 |
| | Maldives | 1.1 | 0.3 | 0.4 | 0.5 | 0.7 | 0.7 | 0.7 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.3 | 0.6 | 0.7 | 1.6 | 2.5 | 0.2 |
| | India | 0.3 | 0.0 | | | | | | | | | | | | | | | | | | | | | | 0.3 | 0.5 | 0.2 | 0.4 | 0.4 |
| | France-Reunion | 0.3 | 0.2 | 0.3 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.3 | 0.4 | 0.4 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 |
| | Mauritius | 0.2 | 0.0 | | | | | | | | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| | Other Fleets | 0.1 | 0.1 | | | | | | 0.4 | 0.5 | 0.4 | 0.4 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| | ***Total*** | ***7*** | ***2*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***0*** | ***1*** | ***1*** | ***4*** | ***4*** | ***4*** | ***6*** | ***6*** | ***6*** | ***6*** | ***6*** | ***6*** | ***7*** | ***7*** | ***8*** | ***9*** | ***6*** |
| Other | India | 1.9 | 0.3 | | | | | | | | | | | | | | | | | | | | 7.2 | 4.0 | 1.2 | | 0.7 | 1.6 | 1.6 |
| | Yemen | 0.8 | 0.3 | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 2.4 | 0.8 | 0.5 | 1.6 | 0.7 | 0.7 | 0.8 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| | Tanzania | 0.6 | 0.1 | | | | | | | | | | | | | | | | | | | | | | | 0.4 | 0.7 | 0.8 | 0.8 |
| | Indonesia | 0.3 | 0.9 | 1.9 | 3.6 | 4.0 | 2.8 | 0.2 | 1.5 | 1.2 | 0.7 | 2.8 | 4.7 | 2.6 | 2.4 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 |
| | Sri Lanka | 0.0 | 2.7 | 5.7 | 5.4 | 6.2 | 6.9 | 7.7 | | | | | | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Other Fleets | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.5 | 1.1 | 0.6 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.2 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 |
| | ***Total*** | ***4*** | ***4*** | ***8*** | ***9*** | ***10*** | ***10*** | ***9*** | ***2*** | ***2*** | ***1*** | ***5*** | ***6*** | ***3*** | ***4*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***8*** | ***5*** | ***2*** | ***2*** | ***3*** | ***5*** | ***4*** |
| **ALL** | **TOTAL** | **312** | **119** | **60** | **51** | **45** | **39** | **42** | **53** | **63** | **101** | **122** | **143** | **156** | **211** | **201** | **232** | **228** | **325** | **414** | **316** | **327** | **339** | **320** | **296** | **331** | **305** | **282** | **312** |
| Gear | Fleet | Av98/02 | Av50/02 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 |

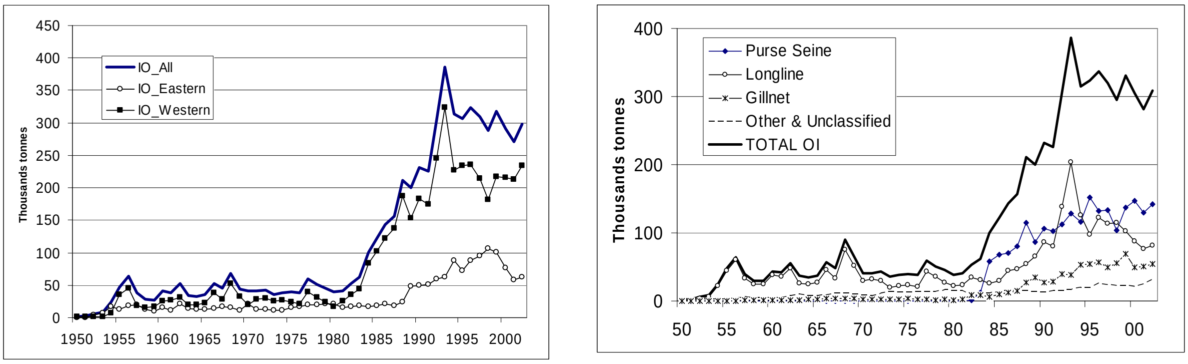



***Figure 1.*** *Yearly catches (thousand of metric tones) of yellowfin by area (Eastern and Western Indian Ocean, left) and by gear (longline, purse-seine, artisanal and unclassified, right) from 1950 to 2002.*

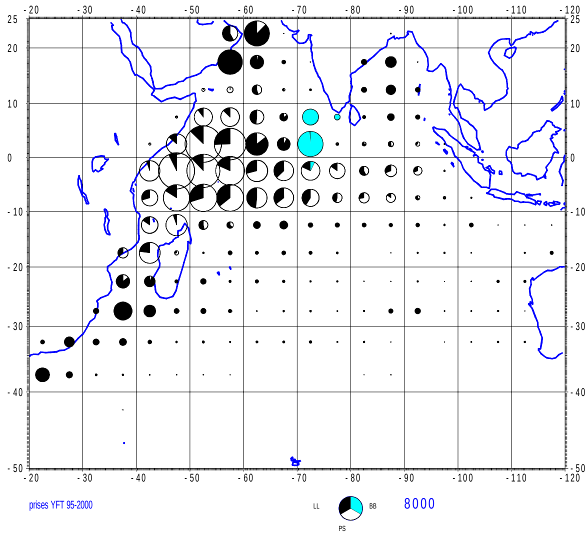



***Figure 2.*** *Average (1995-2000) geographical distribution of yellowfin catches according to the gear (longline, purse-seine and baitboat). The figure is based on available data only, and it does not include catches of important fleets for which spatial distribution is not available.*

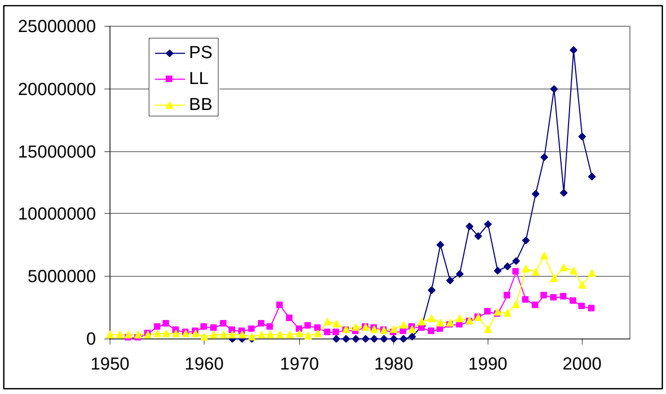



***Figure 3***. *Catch in numbers of yellowfin tuna by gear (PS: purse seine; LL: longline; BB: baitboat).*

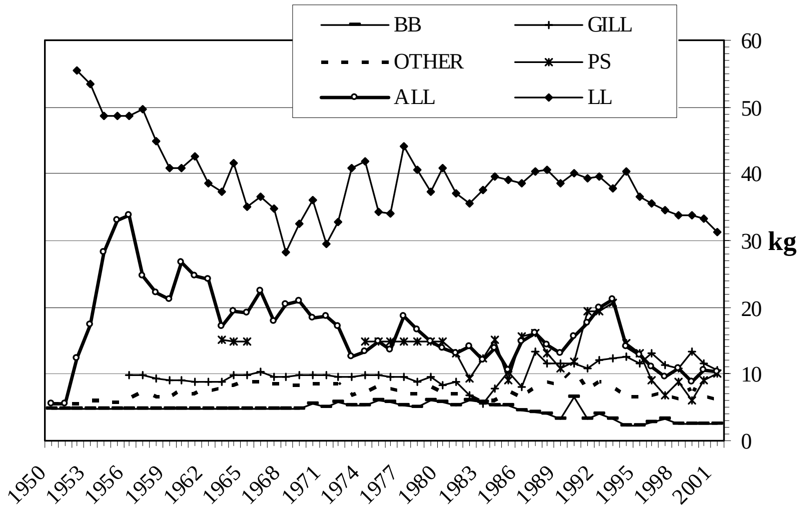



***Figure 4.*** *Yellowfin average weight in the catch by gear (from size-frequency data) and for the whole fishery (estimated from the total catch at size).*

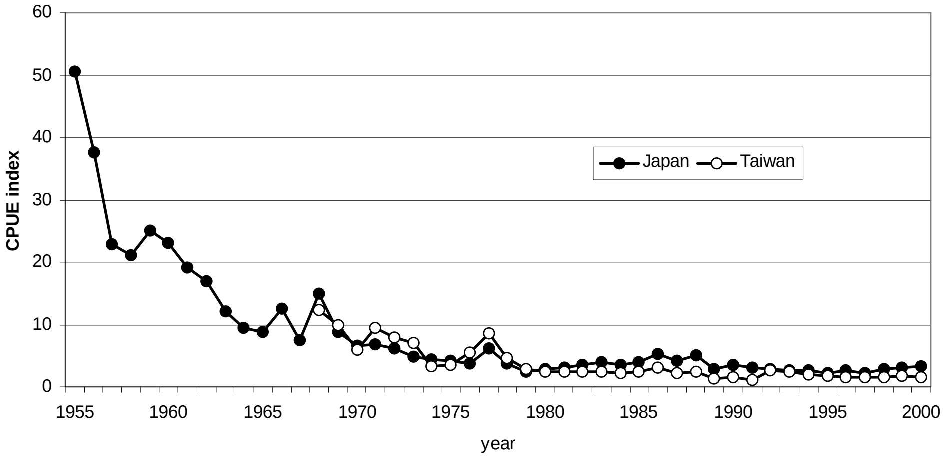



***Figure 5.*** *Yearly standardized CPUE indices based on the Japanese and Taiwan, China longline yellowfin CPUEs in the tropical area (10°N-15°S).*

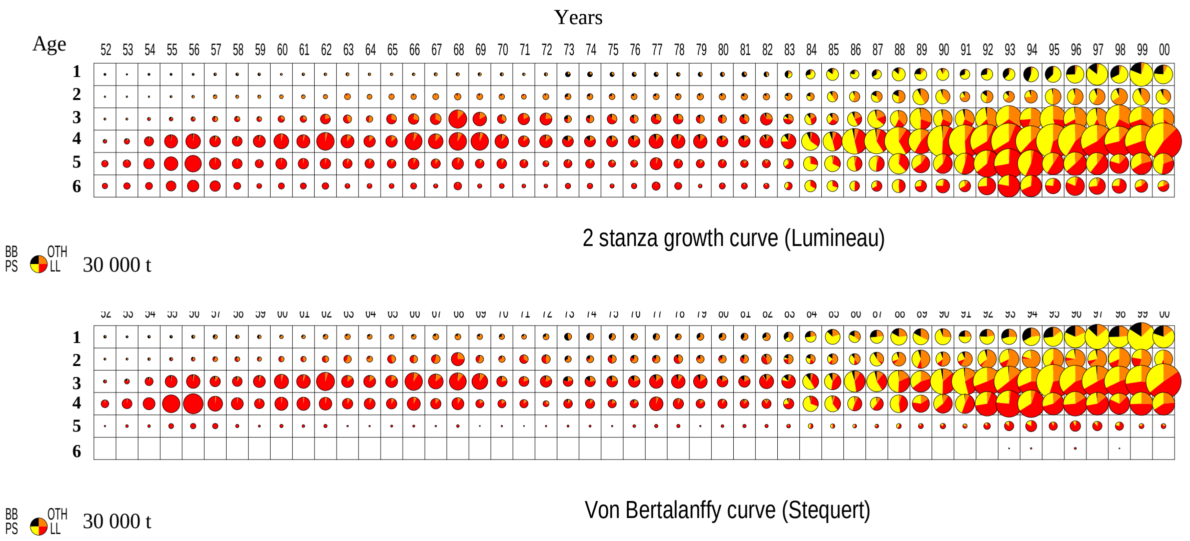



***Figure 6.*** *Catch at age by gear (in weight) according to the two growth hypothesis used by the WPTT: "slow", assuming a two stanzas growth curve (above) and "fast", assuming a constant growth rate (below).*

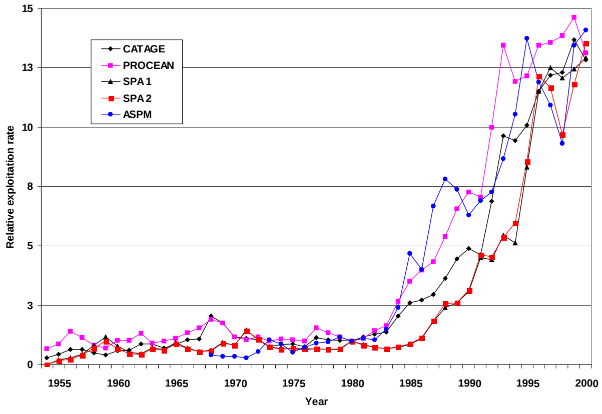



*Figure 7.* Relative exploitation rates estimated from the five assessments ran by the WPTT (all have been set at 1 in 1980 selected as the reference year).

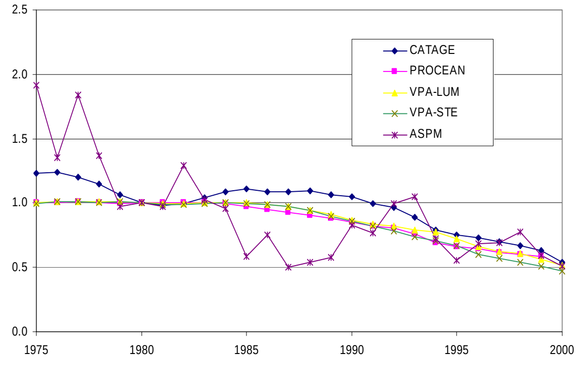



***Figure 8.*** *Trend of the relative biomass estimated from the five assessments ran by the WPTT.*

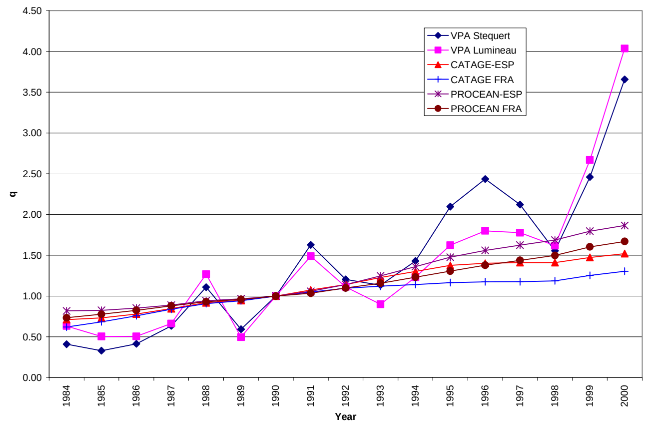



*Figure 9.* *Average yearly relative catchability coefficients for purse seine fleets estimated from the assessments ran during the meeting; all have been set at one in 1990 selected as the reference year.*

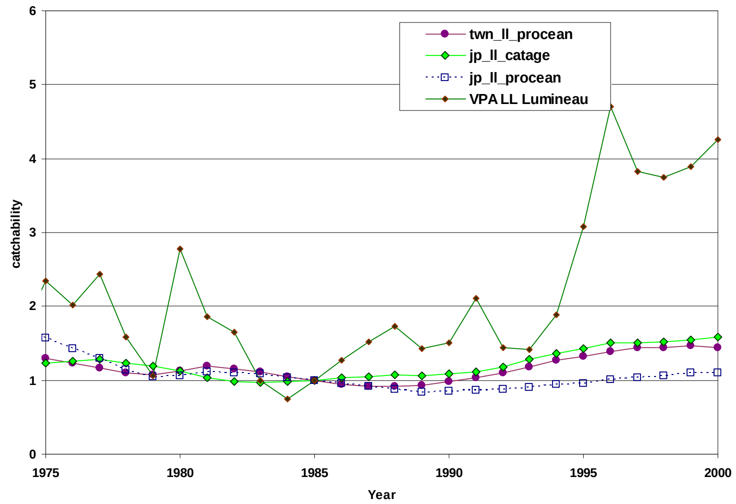



*Figure 10. Average yearly relative catchability coefficients for longline fleets estimated from the assessments ran during the meeting; all have been set at 1 in 1985, selected as the reference year.*

## 2. EXECUTIVE SUMMARY OF THE STATUS OF THE BIGEYE TUNA RESOURCE

### *Biology*

Bigeye tuna is a tropical tuna species occurring in surface waters down to about 300 m depth or more. Juveniles of this species frequently school at the surface underneath floating objects in single-species groups or in aggregations with yellowfin and skipjack tunas. Association with floating objects appears less common as they grow older.

Currently a single stock is assumed for the Indian Ocean, based on circumstantial evidence. The range of the stock (as indicated by the distribution of catches) includes tropical areas, where reproductively active individuals are found, and temperate waters, usually considered to be feeding grounds.

Of the three tropical tuna species, bigeye tuna lives the longest (more than ten years) and that makes it the species most vulnerable, in relative terms, to over-exploitation. Bigeye tuna start reproducing when they are approximately three years old, at a length of about 100cm.

### *Fishery*

*Bigeye tuna is predominantly caught by industrial fisheries and appears only occasionally in the catches of artisanal fisheries. Bigeye tunas have been caught by industrial longline fleets since the early 1950's, but before 1970 they only represented an incidental catch. After 1970, the introduction of fishing practices that improved the access to the bigeye resource and the emergence of a sashimi market made bigeye tuna a target species for the main industrial longline fleets. More recently (since the early 1990s) bigeye tunas have been caught by purse seine vessels fishing on tunas aggregated on floating objects in increasingly large numbers* (Figure 3). *Most of the bigeye catches reported under purse seiners are juveniles. Large bigeye tuna are primarily caught by longlines, and in particular deep longliners* (Table 1 and Figures 1 and 2).

*In contrast with yellowfin and skipjack tunas, for which the major catches take place in the western Indian Ocean, bigeye tuna is also exploited in the eastern Indian Ocean* (Figure 2). *Catches of bigeye have decreased in 2000 and 2001 relative to earlier years, in the eastern and western parts of the Indian Ocean, but have increased slightly in 2002 in the western Indian Ocean. The increase in catches in the eastern Indian Ocean is mostly due to increased activity of small longliners fishing for fresh tuna. This fleet started operating around 1985. In the western Indian Ocean, the catches of bigeye are mostly the result of the activity of large longliners and purse seiners.*

An important part of the longline catch is taken by longliners from non-reporting flags (see Table 1). The Commission has initiated sampling programmes in various ports in the Indian Ocean to better estimate catches from this component.

### *Availability of information for assessment purposes*

The reliability of the total catches has continued to improve over the past years. The fact that most of the catch of bigeye tuna comes from industrial fisheries has facilitated the estimation of total catches. Catch and effort data, potentially useful to construct indices of abundance, is also considered to be of good overall quality. Size-frequency information is considered to be relatively good for most of the purse-seine fisheries, but insufficient for the longline fisheries. This is due primarily to a lack of reporting from the Korean fleets in the 1970's, lack of reporting from Taiwanese fleets since 1989 and insufficient sample sizes in recent years in the Japanese fishery.

Information on biological parameters is scarce and improvements are needed in particular concerning growth and natural mortality. Current proposals for an Indian Ocean tagging programme are oriented towards improving knowledge of these biological characteristics. A new growth curve was presented in 2003 which was considered to be an important improvement over previously existing information.

In the case of the purse-seine fishery, it was not possible to derive indices of abundance from catch-and-effort information, because the interpretation of nominal fishing effort was complicated by the use of FADs and increases in fishing efficiency that were difficult to quantify. In the case of the longline fisheries, indices of abundance were derived, although there still remain uncertainties whether they fully take into account targeting practices on different species *(Figure 4)*. A new CPUE analysis that incorporates consideration to the habitat of bigeye tunas was presented in 2003 *(Figure 5)*.The new CPUE index shows differences with the one used in the last agreed assessment and, therefore, results from future assessment could be markedly different from the current assessment.

***Stock assessment***

*In 2001, the WPTT conducted a stock assessment on the basis of the best available information at the time using age-structured production models (ASPM). Maximum sustainable yield (MSY) was estimated to be about 89,000 t, from the results considered to be the most reliable. In 2002, the estimate of MSY was updated to 102,000 t, with a confidence interval of 73,000 – 129,000 t.*

*The assessments suggest that the population is currently above the MSY level but has been declining since the late 1980s (*Figure 6*). The overall fishing mortality is estimated to be currently below that expected at the MSY level, but recent catches have considerably exceeded the estimated MSY and, therefore, they do not appear sustainable. This apparent paradox can be explained by noting that, according to the results of the assessment, the current biomass is more than twice the biomass at MSY. In this case, even a fishing mortality rate less than that at MSY can produce a catch which is greater than MSY, at least temporarily. However, it should also be noted that considerable uncertainty remains around the estimates of current fishing mortality and the estimated fishing mortality at MSY.*

The present situation is linked to the rapid increase in both fishing mortality and catches over the last ten years. If current catches are maintained, the population will fall soon to levels below those of MSY.

*The recruitment parameters estimated by the model suggest a very weak dependency of the recruitments on the spawning biomass level. There is an increasing trend in the estimated recruitments in recent years, although it was noted that this might actually be due to a trend in catchability not accounted for in the model formulation.*

*In 2001, the WPTT conducted forward projections for the period 2000-2010 on the basis of the results of the ASPM assessment conducted at that meeting, assuming two different scenarios:*

- *A constant fishing mortality (F) scenario, in which the fishing mortality is assumed to remain constant at the levels estimated for 1999.*
- *An increasing fishing mortality scenario, in which fishing mortality is assumed to continue to increase at a rate of 6 % per year during the projected period.*

*These projections are presented in Figure 7.*

*Projections under the constant F scenario indicate that the population would be reduced to a level slightly above MSY, with catches being reduced over time and reaching an equilibrium slightly below the MSY of about 100,000 t. This is a direct consequence of the assumed fishing mortality for the projected period.*

*Projections assuming an increasing F at an annual rate of 6 % (the average rate of increase in overall fishing mortality in the late 1990s as estimated in the assessment) suggest that a decline in the total catch over the projected period would be slightly less than that under the constant F scenario. However, the decline in longline catches is more pronounced in this scenario, while catches in the purse-seine fishery actually increase during the period. This latter projection depends strongly on the assumption that recruitment is almost independent of spawning stock. Of particular concern is the predicted reduction by the year 2010 of the spawning stock biomass to about 20 % of its virgin level, a value that is often considered as a limit reference point.*

*Given that the current assessment suggests that recruitment is almost independent of spawning stock biomass, the results of the projections reflect mostly yield-per-recruit effects, which could also be evaluated using a multi-gear yield-per-recruit analysis such as the one depicted in Figure 8. This calculation was done on the basis of the results and assumptions on input values from the 2001 assessment.*

*A number of uncertainties in the assessments conducted have been identified. These uncertainties include:*

- *The lack of a growth curve for the Indian Ocean that adequately represents growth for fish of all sizes caught by longline and purse-seine fisheries.*
- *Insufficient size information for the catches of longline fisheries, especially in recent years.*
- *Uncertainty about the natural mortality at various life stages.*
- *Uncertainty about the increase in efficiency of the different fisheries involved, especially in the purse-seine fishery. Future consideration of an increase in efficiency could result in a more pessimistic appraisal of the stock status. For example, it is possible that the fishing mortality that would result in the MSY has already been exceeded.*
- *There are still unresolved questions in the current index of abundance.*

Although there is scope for improvement in the current assessment, it is unlikely that these uncertainties will be substantially reduced for the next assessment cycle.

***Management recommendations***

The results of further assessments of the bigeye tuna stock using age-structured production models presented in 2002 to the WPTT confirmed and reinforced the assessment agreed at the 2001 meeting. The WPTT therefore reiterated the technical advice on bigeye tuna given last year.

The Scientific Committee had already noted with concern the rapid increase of catches of bigeye tuna at its meeting in 1999. Since then, catches have remained high. The current high level in catch in numbers of juvenile bigeye tuna by purse seiners fishing on floating objects is likely to be detrimental to the stock if it continues, as fish of these sizes are well below the optimum size for maximum yield per recruit.

The Scientific Committee also noted that juvenile bigeye tuna are caught as bycatch in the FAD purse-seine fishery that targets primarily skipjack tuna. Some measures to reduce the catches of bigeye tuna in this fishery could be expected to result in a decrease in the catches of skipjack tuna.

Taking into account the results of the current assessments, which represent the best effort to date to analyze the available data in a formal context, it is likely that current catches are well above MSY. Therefore, the Committee recommends that a reduction in catches of bigeye tuna from all gears, eventually to the level of MSY, be started as soon as possible.

## *BIGEYE TUNA SUMMARY*

| | |
|---|---|
| Maximum Sustainable Yield : | 102,000 t (73,000 – 129,000 t) |
| Current (2002) Catch: | 128,000 t |
| Current Replacement Yield | |
| Relative Biomass ($B_{2000}/B_{msy}$) | 2.15 |
| Relative Fishing Mortality ($F_{2000}/F_{MSY}$) | 0.66 |
| Management Measures in Effect | None |

***Table 1**. Catches of bigeye tuna by gear and main fleets for the period 1950-2002 (in thousands of tones)*

| Gear | Fleet | Av98/02 | Av50/02 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baitboat | ***Total*** | ***1*** | ***0*** | | | | | | | | | | | | | | | | | | | | | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| Longline | China | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | (Taiwan,China) | 36.9 | 12.4 | | | | | 0.1 | 0.2 | 0.6 | 0.9 | 1.5 | 1.5 | 1.3 | 1.9 | 1.2 | 1.7 | 1.8 | 1.4 | 2.2 | 2.3 | 7.2 | 8.0 | 10.0 | 5.5 | 5.5 | 4.0 | 6.0 | 5.3 | 4.2 |
| | Indonesia | 25.3 | 4.5 | | | | | | | | | | | | | | | | | | | | | | | | 0.0 | 0.2 | 0.4 | 0.3 |
| | Japan | 15.3 | 11.3 | | | 0.3 | 1.7 | 6.8 | 9.5 | 12.2 | 11.1 | 10.2 | 8.4 | 14.8 | 13.0 | 17.3 | 11.6 | 16.0 | 17.6 | 21.4 | 21.8 | 23.6 | 14.4 | 12.7 | 11.2 | 8.3 | 5.2 | 6.9 | 5.5 | 2.1 |
| | Korea, Republic of | 3.6 | 7.3 | | | | | | | | | | | | | | 0.1 | 0.1 | 0.4 | 6.3 | 6.6 | 2.6 | 4.1 | 4.3 | 6.6 | 13.4 | 24.7 | 21.0 | | |
| | ***Total*** | ***107*** | ***42*** | | | ***0*** | ***2*** | ***7*** | ***10*** | ***13*** | ***12*** | ***12*** | ***10*** | ***16*** | ***15*** | ***18*** | ***13*** | ***18*** | ***19*** | ***24*** | ***25*** | ***37*** | ***29*** | ***25*** | ***21*** | ***18*** | ***16*** | ***27*** | ***36*** | ***28*** |
| **ALL** | **TOTAL** | **138** | **49** | | | **0** | **2** | **7** | **10** | **13** | **12** | **12** | **10** | **16** | **15** | **18** | **13** | **18** | **19** | **24** | **25** | **37** | **29** | **25** | **21** | **18** | **16** | **27** | **36** | **28** |
| Gear | Fleet | Av98/02 | Av50/02 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |

| Gear | Fleet | Av98/02 | Av50/02 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Purse Seine | Spain | 12.4 | 2.7 | | | | | | | | 0.8 | 1.3 | 1.8 | 5.0 | 6.8 | 5.9 | 4.9 | 6.0 | 3.6 | 5.4 | 5.9 | 12.2 | 11.4 | 15.9 | 11.2 | 16.0 | 10.8 | 7.9 | 11.1 |
| | France | 6.9 | 2.1 | | | | | 0.0 | 0.0 | 0.2 | 2.3 | 4.3 | 7.1 | 7.0 | 6.2 | 3.6 | 4.6 | 5.4 | 3.8 | 5.0 | 5.4 | 7.3 | 6.9 | 7.8 | 6.4 | 8.5 | 6.7 | 5.1 | 7.4 |
| | NEI-Other | 5.6 | 1.0 | | | | | | | 0.0 | 0.5 | 0.6 | 1.0 | 0.8 | 0.8 | 0.5 | 1.0 | 1.5 | 0.9 | 1.9 | 2.5 | 3.4 | 3.4 | 6.2 | 5.2 | 7.5 | 6.0 | 3.1 | 4.1 |
| | Seychelles | 2.1 | 0.3 | | | | | | | | | | | | | | | 0.0 | 0.0 | | | | | 0.9 | 2.0 | 3.0 | 1.8 | 2.8 | 3.7 |
| | NEI-Ex-Soviet Union | 1.1 | 0.2 | | | | | | | | | | | | | | 0.0 | | 0.4 | 1.0 | 0.3 | 1.4 | 1.1 | 1.2 | 0.9 | 1.6 | 1.2 | 0.8 | 0.8 |
| | Japan | 0.9 | 0.4 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.3 | 0.6 | 1.1 | 1.3 | 1.8 | 2.0 | 4.2 | 3.6 | 1.3 | 1.3 | 0.9 | 0.9 | 0.7 | 0.6 | 0.3 |
| | Other Fleets | 1.2 | 0.3 | | | | 0.0 | | 0.1 | 0.3 | 0.2 | 0.7 | 0.5 | 0.6 | 1.0 | 1.4 | 1.0 | 1.3 | 0.7 | 0.6 | 0.6 | 0.6 | 0.4 | 0.7 | 0.6 | 0.8 | 0.5 | 1.0 | 0.2 |
| | ***Total*** | ***30*** | ***7*** | | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***1*** | ***4*** | ***7*** | ***11*** | ***13*** | ***15*** | ***12*** | ***13*** | ***16*** | ***11*** | ***16*** | ***19*** | ***28*** | ***25*** | ***34*** | ***27*** | ***38*** | ***28*** | ***21*** | ***28*** |
| Baitboat | ***Total*** | ***1*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***1*** | ***1*** | ***0*** | ***1*** | ***1*** | ***1*** | ***1*** | ***0*** | ***1*** | ***1*** |
| Longline | China | 2.3 | 0.3 | | | | | | | | | | | | | | | | | | | 0.1 | 0.5 | 1.7 | 2.2 | 2.2 | 2.7 | 3.0 | 2.8 |
| | (Taiwan,China) | 36.9 | 12.4 | 6.2 | 4.9 | 7.4 | 8.9 | 6.8 | 11.3 | 11.3 | 10.9 | 12.2 | 16.8 | 17.6 | 19.4 | 19.9 | 20.7 | 29.0 | 24.0 | 39.5 | 27.7 | 32.6 | 29.8 | 34.1 | 39.7 | 37.1 | 36.4 | 37.0 | 44.3 |
| | Indonesia | 25.3 | 4.5 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.8 | 1.9 | 2.4 | 2.4 | 0.7 | 2.4 | 3.2 | 4.5 | 4.5 | 4.5 | 7.6 | 7.9 | 10.8 | 12.2 | 23.2 | 27.9 | 26.1 | 30.5 | 20.9 | 21.1 | 21.1 |
| | NEI-Deep-freezing | 15.4 | 2.9 | | | | | | | | | 0.1 | 1.1 | 0.9 | 2.9 | 2.8 | 4.4 | 5.5 | 4.3 | 12.1 | 9.2 | 11.0 | 14.5 | 11.9 | 19.1 | 17.8 | 18.8 | 9.2 | 9.2 |
| | Japan | 15.3 | 11.3 | 3.1 | 10.9 | 4.2 | 5.9 | 7.8 | 11.4 | 18.3 | 14.0 | 17.2 | 15.8 | 15.5 | 12.3 | 7.7 | 8.2 | 7.8 | 5.6 | 8.3 | 17.5 | 17.2 | 16.5 | 18.8 | 17.1 | 14.0 | 13.6 | 12.8 | 14.0 |
| | NEI-Fresh Tuna | 4.5 | 1.0 | | | | | | | | | | | | | 1.9 | 2.6 | 2.3 | 2.6 | 3.4 | 5.3 | 5.5 | 5.8 | 6.2 | 6.1 | 4.8 | 3.7 | 1.5 | 2.6 |
| | Korea, Republic of | 3.6 | 7.3 | 24.6 | 32.9 | 21.2 | 18.7 | 18.9 | 18.9 | 16.7 | 11.5 | 12.4 | 11.4 | 13.9 | 16.5 | 11.7 | 10.3 | 2.1 | 4.5 | 7.1 | 8.2 | 6.2 | 10.8 | 10.2 | 3.2 | 1.3 | 1.8 | 1.4 | 0.2 |
| | Other Fleets | 3.9 | 1.9 | | | | 0.2 | 0.2 | 0.2 | 0.3 | 0.1 | 0.1 | 0.3 | 0.1 | 2.0 | 7.6 | 9.2 | 9.5 | 11.8 | 11.6 | 14.1 | 8.5 | 3.1 | 3.4 | 2.5 | 3.3 | 3.1 | 3.2 | 4.5 |
| | ***Total*** | ***107*** | ***42*** | ***34*** | ***49*** | ***33*** | ***34*** | ***34*** | ***43*** | ***49*** | ***39*** | ***44*** | ***46*** | ***50*** | ***56*** | ***56*** | ***60*** | ***61*** | ***61*** | ***90*** | ***93*** | ***93*** | ***104*** | ***114*** | ***116*** | ***111*** | ***101*** | ***89*** | ***99*** |
| Gillnet | ***Total*** | ***0*** | ***0*** | | | | | | | | | ***0*** | ***0*** | ***0*** | ***2*** | ***1*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***1*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| Line | ***Total*** | ***0*** | ***0*** | | | | | | | | | | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| Other | ***Total*** | | ***0*** | | | | | | | ***0*** | ***0*** | | | | | | | | | | | | | | | | | | |
| **ALL** | **TOTAL** | **138** | **49** | **34** | **49** | **33** | **34** | **34** | **43** | **49** | **43** | **52** | **57** | **64** | **74** | **69** | **73** | **77** | **72** | **106** | **112** | **124** | **130** | **149** | **144** | **150** | **129** | **111** | **128** |
| Gear | Fleet | Av98/02 | Av50/02 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 |

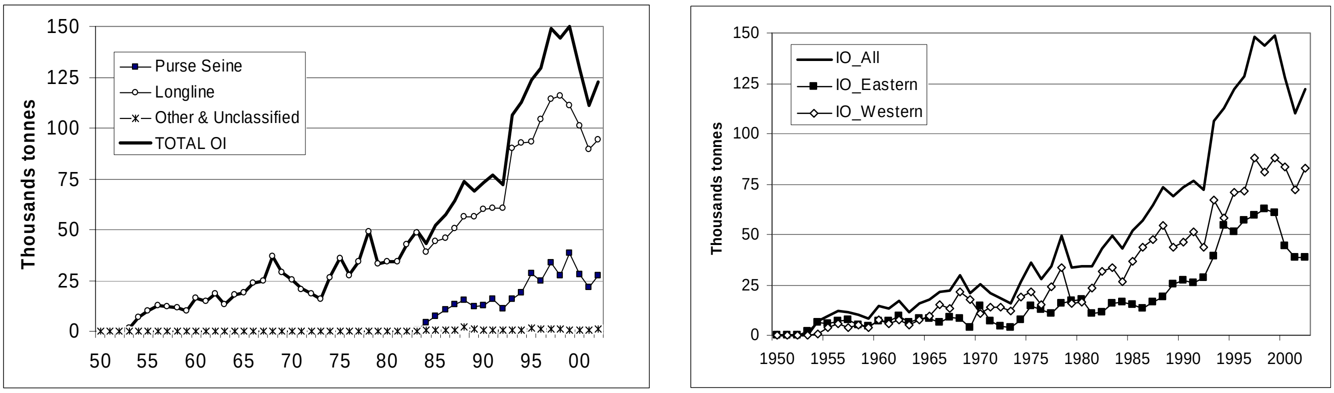



***Figure 1** – Yearly catches (thousand of metric tones) of bigeye tuna by area (Eastern and Western Indian Ocean, left) and by gear from 1950 to 2002 (right).*

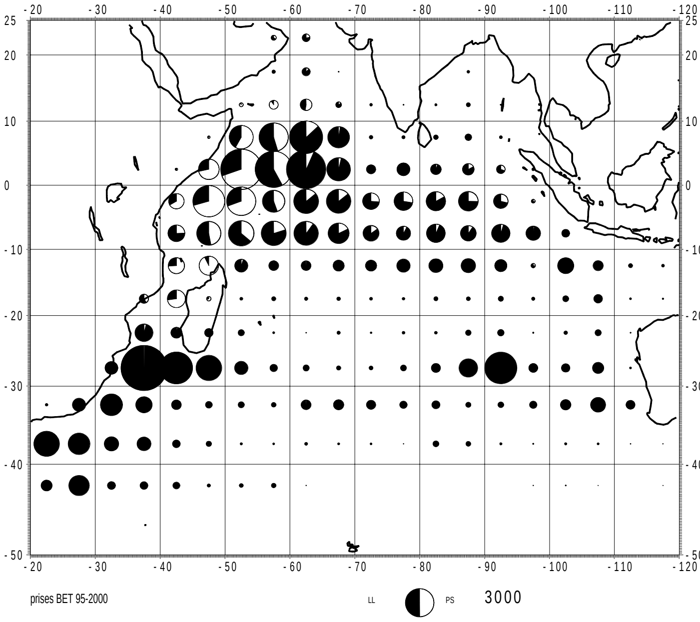



***Figure 2** – Average (1995-2000) geographical distribution of bigeye tuna catches according to gear (longline in black, purse-seine in white). The figure is based on available data only, and it does not include catches of important fleets for which spatial distribution is not available.*

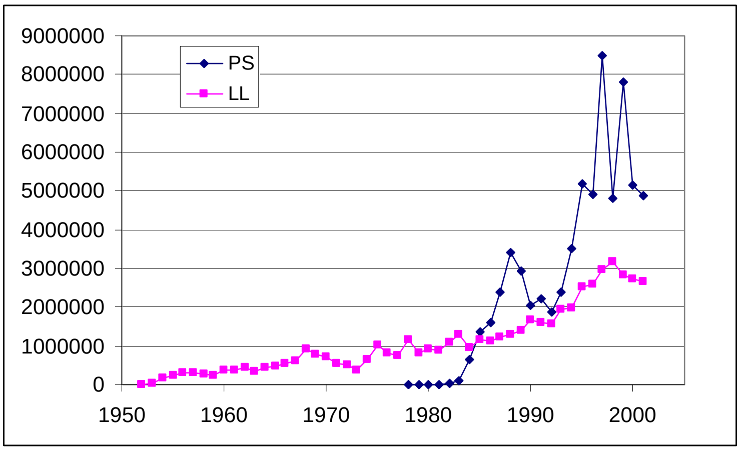



*Figure 3. Catch in numbers of yellowfin tuna by gear (PS: purse seine; LL: longline).*

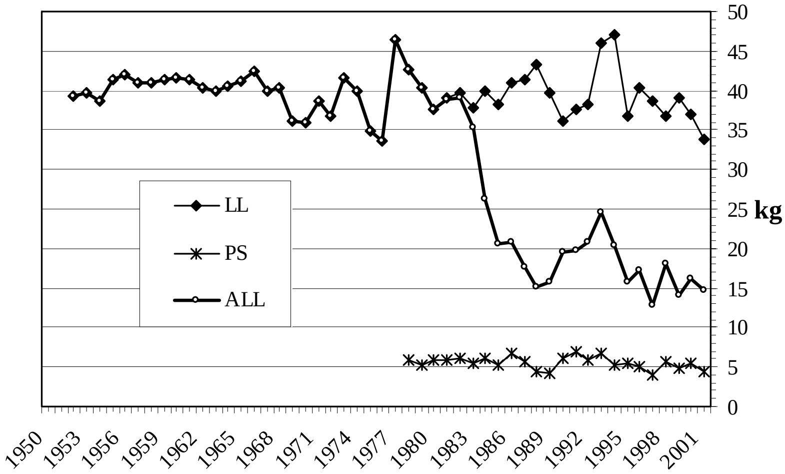



***Figure 4**. Average weight in the catch by gear for the period 1950-2001.*

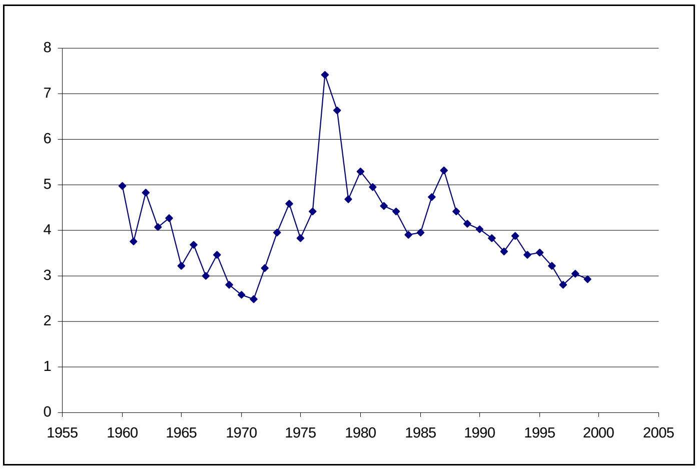



***Figure 5.*** *Yearly abundance index based on Japanese longline bigeye CPUE as used in the 2001assessment.*

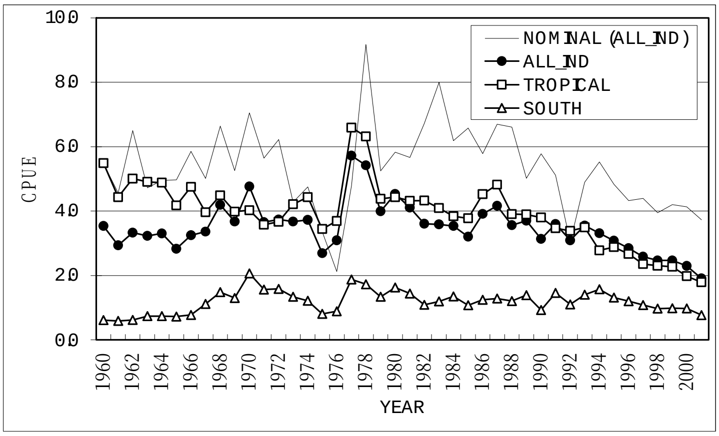



***Figure 6.*** *Yearly abundance index based on Japanese longline bigeye CPUE presented to the 2003 WPTT meeting.*

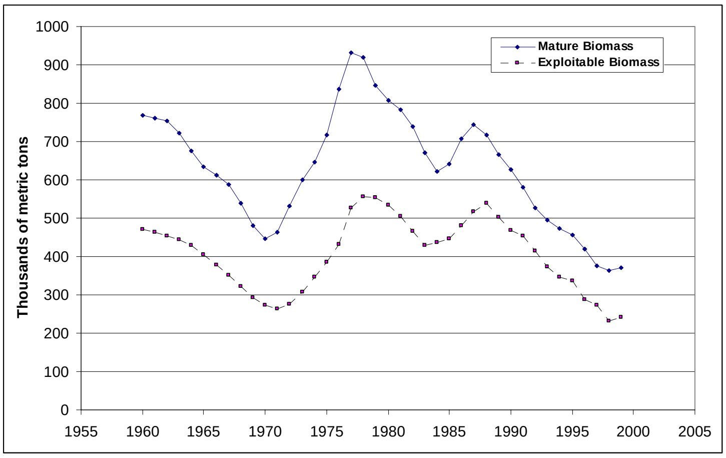



***Figure 7.*** *Trends of the mature and exploitable biomass of bigeye tuna, as estimated by the WPTT in 2001*

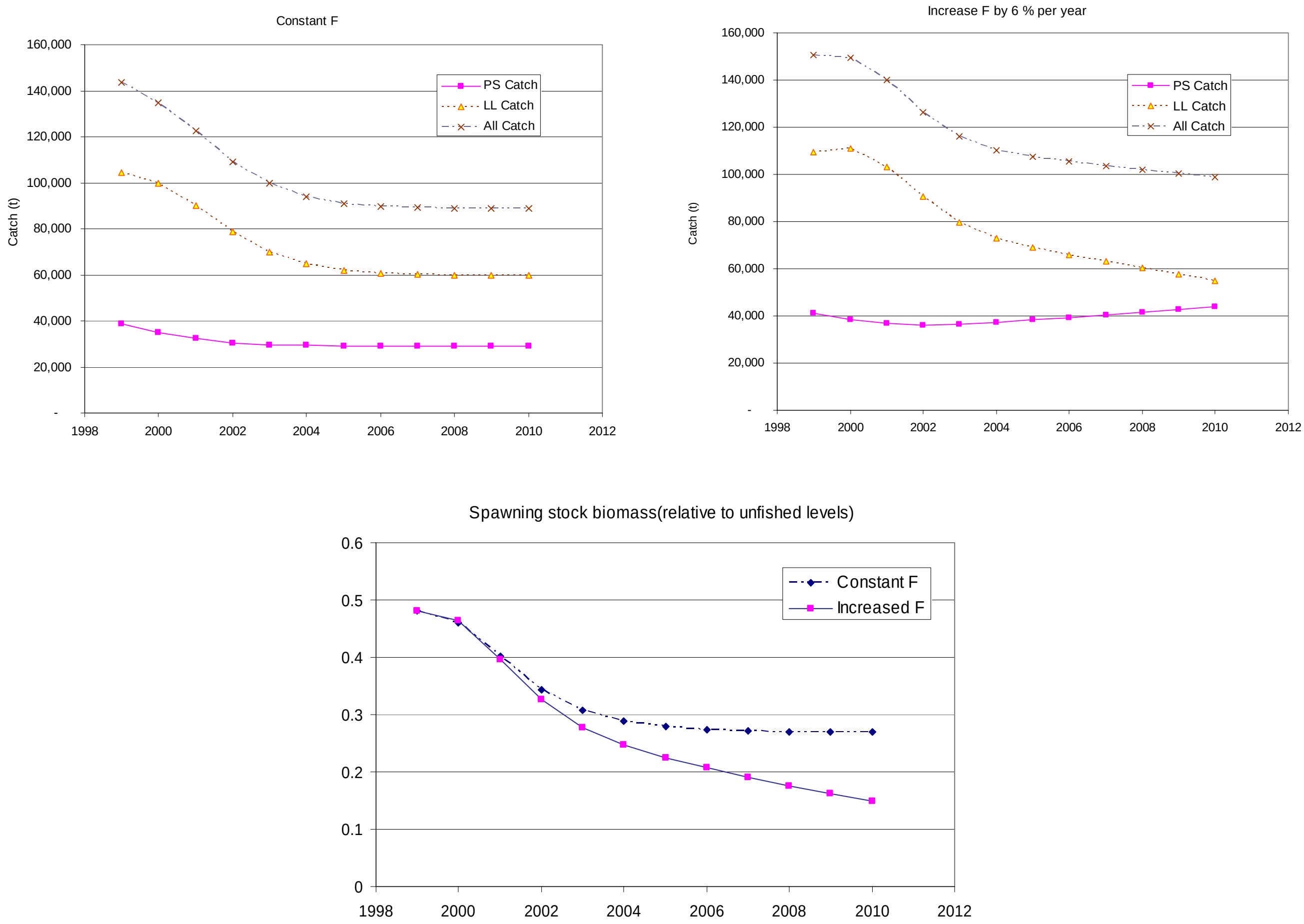
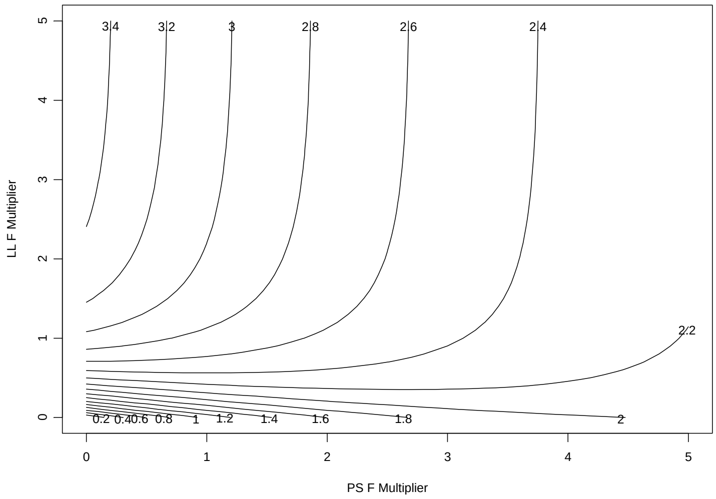



***Figure 8**. Results of the projections under different scenarios, as calculated by the WPTT in 2001.*

***Figure 9.** Multi-gear yield-per-recruit analysis, as estimated by the WPTT in 2001.*



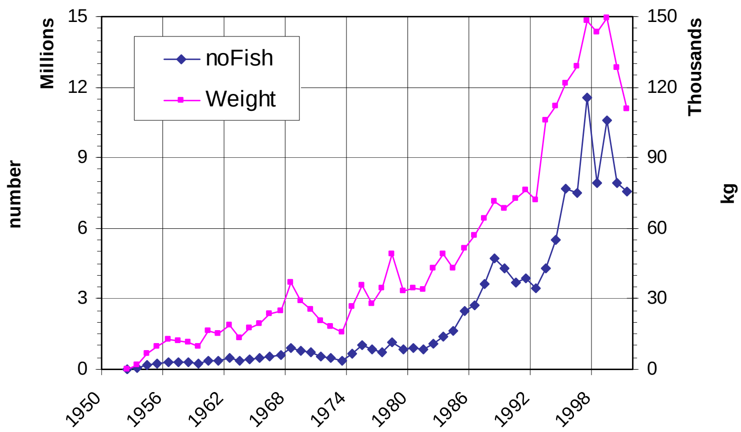




***Figure 10. Total catch of bigeye tuna in weight and numbers.***

## 3. EXECUTIVE SUMMARY OF THE STATUS OF THE SKIPJACK TUNA RESOURCE

*BIOLOGY*

Skipjack tuna (*Katsuwonus pelamis*) is a cosmopolitan species forming schools in the tropical and subtropical waters of the three oceans. It generally makes large mixed schools in association with other tunas having a similar size as juveniles of yellowfin and bigeye. This is specially the case with FADs associated schools exploited by the purse seine fishery where skipjack is largely dominant (60-70% of the total catch).

The skipjack tuna resource exhibits characteristics that result in a higher productivity when compared to other tuna species. This species has a short lifespan, and they are exploited during a short period (probably less than 3 years). The species shows high fecundity and spawns opportunistically throughout the year in the whole interequatorial Indian Ocean (north of 20°S, with surface temperature greater than 24°C) when conditions are favorable. As the size at first maturity is about 41-43 cm for both males and females for skipjack, the bulk of their catch is made on fishes that have already spawned.

Although three documents were presented on the skipjack growth, it is still uncertain, mainly because its apparent seasonal and geographical variability. However it seems to be closer to the Atlantic estimates than those from the Pacific Ocean. Consequently, it is still a priority to gain more knowledge on the skipjack time-and-space variability in growth patterns.

In the absence of any stock structure estimate, a single Indian Ocean stock is assumed. However, it appears to be less migratory than the other tunas; taking into account the biological characteristics of this species and the different areas where fishing takes place, smaller management units could be considered.

Because of these characteristics, skipjack tuna resources are considered to be resilient stocks which are not easily over fished.

*FISHERIES*

Catches increased slowly from the 1950s, reaching some 50,000 t at the end of the 1970s, mainly caught by baitboats and gillnets. The catches increased rapidly with the arrival of the purse seiners in the early 1980s, to become the most important tuna species in the Indian Ocean catches since 1999 with catches exceeding 400,000 t yearly (*Figure 1 and Table 1*).

Catches reached a peak in 2002 with a preliminary estimate of over 460,000 t: 190,000 t from the main purse-seine fishery, 115,000 t for the Maldivian baitboat fishery and some 160,000 t for the other fisheries, assuming in 2002 the same catch than in 2001. The increase in 2002, relative to the previous year, was observed at least for both the purse seine (35%, mainly due to a larger catch on FADs) and the Maldivian baitboat (31%, essentially from an increase in CPUE) fisheries.

In recent years, skipjack catches were shared in similar proportions between the industrial purse seine fishery and the different artisanal ones (baitboat, gillnets and others), the majority of this catch originating in the western Indian Ocean (*Figure 1*). In general, there is low inter-annual variability when compared with similar fisheries in other oceans.

The increase of skipjack catches by purse seine fisheries is related to the development of a fishery in association with Fish Aggregating Devices (FAD); currently, 80% of the skipjack tuna caught by purse-seine is taken under FADs. Catch rates by purse seiners show an increasing trend (*Figure 3 and 5*) possibly due to an increase in fishing power and to an increase in the number of FADs (and the technology associated with them) in the fishery.

The Maldivian fishery has increased regularly its effort with the mechanization of its pole and line since 1974, and then the use of anchored FADs since 1981. Skipjack represents some 75% of its total catch, and catch rates have regularly increased since the beginning of the 80s (*Figure 4*).

Few information is available on the gillnet fisheries (mainly from Sri Lanka, Iran, Pakistan, India and Indonesia) which represents an important component of the skipjack fishery (20%, close to 90,000 t in 2001).

The average size of skipjack caught in the Indian Ocean remains relatively large (greater than in the Atlantic, but lower than in the Pacific) with 2.5 kg for purse-seine, 3.0 kg for the Maldivian baitboats and 4-5 kg for the gillnet (Figure 5).

*Stock Status*

The assessment of skipjack tuna was a priority for the WPTT in 2003. The group analyzed the information available for stock assessment and considered that there were large uncertainties in the information needed to conduct a complete assessment of the Indian Ocean skipjack tuna. As an alternative, the group decided to analyze different fishery indicators that provide a general understanding of the estate of the stock.

1. **Trends in catches**: The trend in catches indicate a large and continuous increase in the catches of skipjack tuna since the mid-1980's (*Figure 1*), particularly due to an expansion of the FAD-associated fishery in the western Indian Ocean. There is no sign that the rate of increase is diminishing in recent years.

2. **Nominal CPUE Trends:** *Figure 3* shows the nominal CPUE trends of the purse seine fishery for three major areas: Somalia area, Western Seychelles area and Mozambique Channel. In the Somalia and Western Seychelles area catches have been increasing recently. In each of these areas, with the exception of west Seychelles in 2002 the nominal CPUE has been relatively stable since the late 1980's. Since this is a period during which is believed that effective purse-seine effort has increased substantially it is likely that the true abundance in these areas has decreased. In itself, this is not unexpected given the large increase in catches over that period. However, as these areas may be source of skipjack recruitment to the Maldives artisanal fishery, there is the potential for an interaction to be occurring between these fisheries.

3. **Average weight in the catch by fisheries:** The Working Party noted that the average weights of the skipjack taken from various areas have been more or less the same since 1991 (*Figure 6*). Figure 5 shows catches at size expressed as average weight from three major gears; purse seine, baitboat and gillnet. The purse seine and the baitboat fisheries take the greatest catch around 40-50 cm while catches taken from gillnet fisheries ranges from 70-80 cm.

4. **Number of squares fished:** The trend in the number of one-degree squares visited and with catches of skipjack tuna by the main purse-seine fleets suggests that, after the late 1990's, the spatial distribution of the main purse-seine has remained at the same average level. In 1998, a particularly strong El Niño episode resulted in a much wider spatial distribution of the catches.

**Length-based cohort analyses.** The WPTT did not develop a formal stock assessment for skipjack tuna. However, a length-based cohort analysis was carried during the meeting to analyze skipjack catches and length frequencies (*Figure 7*). The recent period is characterized by a dramatic increase of catches of smaller size fish due to the development of the purse seine FAD fishery and the largest mode reflects the artisanal (essentially Maldives's pole-and-line) fishery.

The fishing pattern is shown in *Figure 8*. They reflect the evolution of the fishery and in particular the increased mortality on both purse seine and the artisanal components. In particular they represent increase of purse seine fishery in the eighties and of the FAD fishery in the nineties.

**Interaction between fisheries and species.** A potential problem in the skipjack fisheries is the interaction between industrial and artisanal fisheries, and more particularly between the western Indian Ocean purse-seine fishery and the Maldivian baitboat fishery.

Due to the fact that the purse-seine fishery is a multi-species fishery large numbers of juvenile bigeye and yellowfin tuna are caught in the course of purse-seine sets on FADs that target skipjack tuna.

*Skipjack tagging and IOTTP*

The analysis of skipjack tuna stock status conducted by the WPTT indicates significant uncertainties in key parameters for the stock assessment, this reinforces the previous recommendation that the results of the large scale tagging programme planned by the IOTC will allow to estimate for skipjack tuna:

- stock structure,
- variability of growth in time and space,
- natural mortality at age,
- stock size,
- as well as the potential interactions between skipjack tuna fisheries.

Subsequently, the Scientific Committee recommended to fully incorporate skipjack tuna in the tagging operations that will be planned for the incoming large scale IOTTP tagging programme

STOCK ASSESSMENT

The Scientific Committee recognized that, in spite of not having a full stock assessment for skipjack, the analysis of the stock status indicators provided by the WPTT does not show reasons for concern.

The SC noted two additional arguments in favor of this conclusion. First, in most fisheries, declining catches combined with increasing effort are usually indicators that a stock is being exploited close or above its MSY. In the case of skipjack tuna, catches have continued to increase as effort increased. Second, the majority of the catch comes from fish that is already sexually mature (greater than 40 cm), as the fishing pattern by size indicates.

The SC noted that, although there might be no reason for concern, it is clear that the catches cannot be increased at the current rate indefinitely. Therefore, it recommends that the situation be monitored closely and be reviewed in the WPTT.

*MANAGEMENT RECOMMENDATIONS*

The Working Party on Tropical Tunas has not made any specific management recommendations for the skipjack stock. However, the life history characteristics of skipjack tuna, the information presented in the documents reviewed, and the information in the stock status indicators prepared during the meeting suggests that there is no need for immediate concern about the status of skipjack tuna.

## *Skipjack Tuna Summary*

| | |
|---|---|
| Maximum Sustainable Yield : | |
| Current (2002) Catch: | 482,000 t |
| Current Replacement Yield : | |
| Relative Biomass ($B_{cur}/B_{MSY}$) : | |
| Relative Fishing Mortality ($F_{cur}/F_{MSY}$): | |
| Management Measures in Effect : | None |

| Gear | Fleet | Av98/02 | Av50/02 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Purse Seine | Indonesia | 3.4 | 0.8 | | | | | | | | | | | | | | | | | | | | | | | | | 0.1 | 0.2 | 0.3 |
| | Other Fleets | 1.8 | 0.6 | | | | | | | | | | | | | | 0.0 | 0.2 | 0.0 | | | | | | | | | | | |
| | ***Total*** | ***181*** | ***51*** | | | | | | | | | | | | | | ***0*** | ***0*** | ***0*** | | | | | | | | | ***0*** | ***0*** | ***0*** |
| Baitboat | Maldives | 80.8 | 32.4 | 8.0 | 0.8 | 8.0 | 9.0 | 9.0 | 9.0 | 9.0 | 10.0 | 10.0 | 10.0 | 9.0 | 8.0 | 8.0 | 8.0 | 8.0 | 14.1 | 16.9 | 18.9 | 17.5 | 19.6 | 27.6 | 28.0 | 17.5 | 19.5 | 22.5 | 14.9 | 18.6 |
| | Other Fleets | 0.0 | 1.3 | 0.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.6 | 1.7 | 1.6 | 1.7 | 1.6 | 1.6 | 2.1 | 2.1 | 2.2 | 2.3 | 2.6 | 2.8 | 2.7 | 2.9 | 3.1 | | 0.0 | 0.0 | 5.0 | 10.5 | 1.8 | 0.1 |
| | ***Total*** | ***89*** | ***34*** | ***8*** | ***2*** | ***9*** | ***11*** | ***11*** | ***11*** | ***11*** | ***12*** | ***12*** | ***12*** | ***11*** | ***10*** | ***10*** | ***10*** | ***10*** | ***17*** | ***20*** | ***22*** | ***20*** | ***23*** | ***28*** | ***28*** | ***17*** | ***25*** | ***33*** | ***17*** | ***19*** |
| Longline | ***Total*** | ***0*** | ***0*** | | | | | | | | | | | | | | | | | | | | | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| Gillnet | Pakistan | 4.2 | 3.4 | 0.5 | 0.5 | 0.5 | 0.7 | 0.8 | 0.8 | 0.7 | 1.9 | 0.9 | 0.9 | 1.1 | 1.0 | 1.6 | 2.4 | 3.3 | 3.6 | 4.8 | 4.7 | 4.7 | 4.2 | 3.9 | 3.1 | 3.7 | 2.9 | 4.0 | 4.5 | 4.2 |
| | ***Total*** | ***71*** | ***17*** | ***0*** | ***0*** | ***0*** | ***1*** | ***1*** | ***1*** | ***1*** | ***2*** | ***1*** | ***1*** | ***1*** | ***1*** | ***2*** | ***2*** | ***3*** | ***4*** | ***5*** | ***5*** | ***5*** | ***4*** | ***4*** | ***3*** | ***4*** | ***3*** | ***4*** | ***4*** | ***4*** |
| Line | Comoros | 2.1 | 0.7 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | |
| | Other Fleets | 1.5 | 0.5 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.6 | 0.4 | 0.5 | 0.5 | 0.3 | 0.5 |
| | ***Total*** | ***4*** | ***1*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***1*** | ***1*** | ***0*** | ***1*** | ***0*** | ***0*** | ***1*** |
| Other | Indonesia | 38.0 | 11.6 | | | | | | | | | | | | | | | | | | | | | 2.3 | 2.4 | 3.7 | 4.1 | 4.4 | 6.7 | 8.9 |
| | Sri Lanka | 0.0 | 6.6 | 4.3 | 4.1 | 7.9 | 5.1 | 6.6 | 7.0 | 10.0 | 10.0 | 9.7 | 10.0 | 10.0 | 15.0 | 9.4 | 15.5 | 11.0 | 10.0 | 11.6 | 16.4 | 20.7 | 14.6 | 11.8 | 9.5 | 13.2 | 10.4 | 12.3 | 15.2 | 12.2 |
| | Other Fleets | 0.1 | 0.6 | | | | | | | | | | | | | | | | | | | | | 1.1 | 1.2 | 1.3 | 1.3 | 1.4 | 1.8 | 1.7 |
| | ***Total*** | ***41*** | ***21*** | ***4*** | ***4*** | ***8*** | ***5*** | ***7*** | ***7*** | ***10*** | ***10*** | ***10*** | ***10*** | ***10*** | ***15*** | ***9*** | ***16*** | ***11*** | ***10*** | ***12*** | ***16*** | ***21*** | ***15*** | ***15*** | ***13*** | ***18*** | ***16*** | ***18*** | ***24*** | ***23*** |
| **ALL** | **TOTAL** | **386** | **124** | **13** | **7** | **18** | **16** | **18** | **19** | **22** | **24** | **22** | **23** | **22** | **26** | **21** | **28** | **25** | **30** | **36** | **43** | **46** | **42** | **47** | **45** | **40** | **44** | **56** | **46** | **46** |
| Gear | Fleet | Av98/02 | Av50/02 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |

***Table 1**. Catches of skipjack tuna by gear and main fleets for the period 1950-2002 (in thousands of tones).*

| Gear | Fleet | Av98/02 | Av50/02 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Purse Seine | Spain | 68.3 | 18.7 | | | | | | | | 6.4 | 18.6 | 19.1 | 27.9 | 39.7 | 63.9 | 47.9 | 41.8 | 46.7 | 51.3 | 61.6 | 69.6 | 66.3 | 62.9 | 58.6 | 74.3 | 77.2 | 68.4 | 91.5 |
| | France | 35.2 | 14.3 | | | | | 0.2 | 1.0 | 9.4 | 27.3 | 29.8 | 36.1 | 35.6 | 36.1 | 43.1 | 29.0 | 39.4 | 45.0 | 48.2 | 58.4 | 48.7 | 40.1 | 31.3 | 30.3 | 42.7 | 39.9 | 32.0 | 54.0 |
| | NEI-Other | 31.3 | 6.5 | | | | | | | 0.4 | 8.2 | 8.4 | 6.4 | 4.8 | 7.0 | 7.9 | 11.0 | 10.8 | 10.8 | 17.4 | 24.5 | 22.3 | 18.4 | 24.3 | 31.2 | 33.4 | 40.8 | 26.5 | 31.9 |
| | NEI-Ex-Soviet Union | 15.6 | 3.0 | | | | | | | | | | | | | | 0.7 | | 10.0 | 8.0 | 8.2 | 20.6 | 16.4 | 11.6 | 11.9 | 19.1 | 20.3 | 15.1 | 15.1 |
| | Seychelles | 13.9 | 1.9 | | | | | | | | | | | | | | | 1.8 | 0.6 | | | | | 4.9 | 10.7 | 15.8 | 11.6 | 26.2 | 29.9 |
| | Japan | 4.2 | 3.1 | 0.1 | 0.9 | 0.6 | 0.4 | 0.0 | 0.5 | 0.6 | 0.7 | 0.3 | 0.6 | 0.9 | 2.3 | 3.4 | 10.9 | 15.9 | 31.5 | 31.3 | 20.1 | 16.1 | 7.0 | 6.7 | 5.7 | 4.6 | 2.3 | 1.8 | 1.2 |
| | France-Territories | 3.8 | 0.1 | | | | | | | | | | | | | | | | | | | | | | | | | 3.8 | 0.2 |
| | Indonesia | 3.4 | 0.8 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.6 | 0.7 | 0.1 | 1.1 | 0.9 | 0.9 | 1.0 | 0.9 | 1.0 | 0.9 | 1.4 | 2.1 | 2.2 | 2.2 | 2.9 | 3.5 | 3.2 | 3.3 | 3.3 | 3.9 | 3.9 |
| | Iran, Islamic Republic | 2.0 | 0.3 | | | | | | | | | | | | | | | | | | | | 0.8 | 1.0 | 2.0 | 2.7 | 1.6 | 2.9 | 6.7 |
| | Mauritius | 1.7 | 1.3 | | | 0.0 | 1.0 | 1.7 | 2.4 | 1.4 | 2.5 | 2.0 | 1.9 | 4.4 | 5.0 | 5.6 | 4.1 | 6.5 | 6.0 | 6.9 | 5.1 | 3.8 | 1.9 | 2.9 | 1.2 | 2.4 | 0.3 | | |
| | Other Fleets | 1.8 | 0.6 | | | | | 0.0 | 0.3 | 0.1 | 0.6 | 1.1 | 2.5 | 5.5 | 2.7 | 2.7 | 4.5 | 6.5 | 0.3 | 0.0 | 1.2 | | | 0.0 | 0.0 | | 1.1 | 2.6 | 1.2 |
| | ***Total*** | ***181*** | ***51*** | ***0*** | ***1*** | ***1*** | ***2*** | ***2*** | ***5*** | ***13*** | ***46*** | ***61*** | ***67*** | ***80*** | ***94*** | ***128*** | ***109*** | ***124*** | ***152*** | ***165*** | ***181*** | ***183*** | ***154*** | ***149*** | ***155*** | ***198*** | ***198*** | ***183*** | ***236*** |
| Baitboat | Maldives | 80.8 | 32.4 | 13.7 | 13.2 | 17.3 | 22.2 | 19.6 | 15.3 | 19.3 | 32.3 | 42.2 | 45.1 | 42.6 | 58.2 | 57.8 | 60.7 | 58.3 | 57.6 | 58.0 | 68.7 | 69.9 | 66.2 | 68.1 | 77.8 | 92.3 | 78.8 | 86.8 | 113.7 |
| | India | 5.7 | 0.1 | | | | | | | | | | | | | | | | | | | | | | | 5.7 | | | |
| | Australia | 2.7 | 0.2 | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | | 0.0 | | 0.1 | 0.5 | 0.2 | 0.9 | 2.2 | 5.0 | 2.9 | | |
| | Other Fleets | 0.0 | 1.3 | 0.6 | 0.8 | 0.4 | 0.0 | 0.2 | 2.1 | 2.1 | 1.5 | 1.8 | 0.4 | 0.4 | 0.5 | 1.8 | 0.1 | 0.2 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | ***Total*** | ***89*** | ***34*** | ***14*** | ***14*** | ***18*** | ***22*** | ***20*** | ***17*** | ***21*** | ***34*** | ***44*** | ***46*** | ***43*** | ***59*** | ***60*** | ***61*** | ***59*** | ***58*** | ***58*** | ***69*** | ***70*** | ***66*** | ***69*** | ***80*** | ***103*** | ***82*** | ***87*** | ***114*** |
| Longline | ***Total*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***1*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| Gillnet | Sri Lanka | 42.7 | 10.1 | | | | | | 10.6 | 11.2 | 8.7 | 10.1 | 16.7 | 16.3 | 19.6 | 22.6 | 25.0 | 27.9 | 23.8 | 24.1 | 21.5 | 18.2 | 22.7 | 27.8 | 34.6 | 51.9 | 51.9 | 47.2 | 42.9 |
| | Iran, Islamic Republic | 13.0 | 2.1 | | | | | | | | | | | | | 0.3 | 0.8 | 1.1 | 4.3 | 4.4 | 7.4 | 1.1 | 2.5 | 5.0 | 4.7 | 13.9 | 18.5 | 23.2 | 23.1 |
| | Indonesia | 7.7 | 1.6 | | | | | | 0.6 | 1.1 | 1.3 | 0.1 | 0.5 | 0.5 | 1.0 | 1.1 | 2.8 | 4.6 | 4.4 | 4.8 | 5.0 | 4.8 | 6.6 | 7.8 | 7.2 | 7.4 | 7.4 | 8.9 | 8.9 |
| | Pakistan | 4.2 | 3.4 | 3.7 | 2.2 | 3.8 | 1.7 | 2.7 | 3.3 | 1.1 | 1.2 | 2.0 | 1.5 | 3.7 | 5.5 | 7.5 | 7.6 | 7.4 | 6.1 | 6.9 | 8.1 | 7.1 | 4.1 | 4.5 | 4.4 | 4.5 | 4.3 | 3.4 | 3.1 |
| | India | 2.7 | 0.2 | | | | | | | | | | | | | | | | | | | | | | 0.6 | | 3.4 | 4.1 | 4.1 |
| | Oman | 0.4 | 0.1 | | | | | | | | | | | | | | | | | | 0.4 | 0.8 | 0.4 | 0.7 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 |
| | ***Total*** | ***71*** | ***17*** | ***4*** | ***2*** | ***4*** | ***2*** | ***3*** | ***15*** | ***13*** | ***11*** | ***12*** | ***19*** | ***20*** | ***26*** | ***32*** | ***36*** | ***41*** | ***39*** | ***40*** | ***42*** | ***32*** | ***36*** | ***46*** | ***52*** | ***78*** | ***86*** | ***87*** | ***82*** |
| Line | Comoros | 2.1 | 0.7 | | | | | | | | | | | | | 3.8 | 3.8 | 3.8 | 1.8 | 1.8 | 2.2 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.2 | 2.0 | 2.0 |
| | Other Fleets | 1.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.9 | 0.9 | 1.8 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.8 | 1.2 | 1.1 | 1.2 | 0.6 | 0.6 | 0.5 | 1.2 | 1.3 | 0.7 | 1.5 | 1.9 | 2.3 |
| | ***Total*** | ***4*** | ***1*** | ***0*** | ***0*** | ***0*** | ***1*** | ***0*** | ***1*** | ***1*** | ***2*** | ***1*** | ***1*** | ***0*** | ***1*** | ***4*** | ***5*** | ***5*** | ***3*** | ***3*** | ***3*** | ***3*** | ***3*** | ***3*** | ***3*** | ***3*** | ***4*** | ***4*** | ***4*** |
| Other | Indonesia | 38.0 | 11.6 | 6.6 | 6.3 | 9.6 | 10.6 | 10.7 | 15.1 | 17.5 | 15.1 | 16.9 | 15.9 | 19.9 | 20.2 | 24.0 | 19.0 | 18.8 | 19.9 | 23.7 | 24.7 | 23.7 | 32.5 | 38.4 | 35.4 | 36.4 | 36.2 | 43.5 | 43.5 |
| | India | 2.7 | 1.7 | | | | | 1.8 | 2.4 | 2.8 | 3.6 | 3.3 | 4.3 | 5.9 | 5.1 | 6.4 | 5.8 | 4.6 | 4.9 | 5.0 | 9.3 | 6.6 | 6.8 | 6.1 | 0.4 | | 2.1 | 2.5 | 2.5 |
| | Sri Lanka | 0.0 | 6.6 | 11.4 | 11.0 | 8.3 | 12.7 | 13.8 | | | | | | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Other Fleets | 0.1 | 0.6 | 1.4 | 1.4 | 1.4 | 1.3 | 1.4 | 1.5 | 1.7 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| | ***Total*** | ***41*** | ***21*** | ***19*** | ***19*** | ***19*** | ***25*** | ***28*** | ***19*** | ***22*** | ***21*** | ***22*** | ***22*** | ***27*** | ***27*** | ***30*** | ***25*** | ***24*** | ***25*** | ***29*** | ***34*** | ***30*** | ***39*** | ***45*** | ***36*** | ***37*** | ***38*** | ***46*** | ***46*** |
| **ALL** | **TOTAL** | **386** | **124** | **38** | **36** | **42** | **51** | **53** | **57** | **70** | **113** | **140** | **154** | **172** | **206** | **254** | **236** | **252** | **277** | **296** | **330** | **319** | **299** | **312** | **326** | **419** | **408** | **407** | **482** |
| Gear | Fleet | Av98/02 | Av50/02 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 |

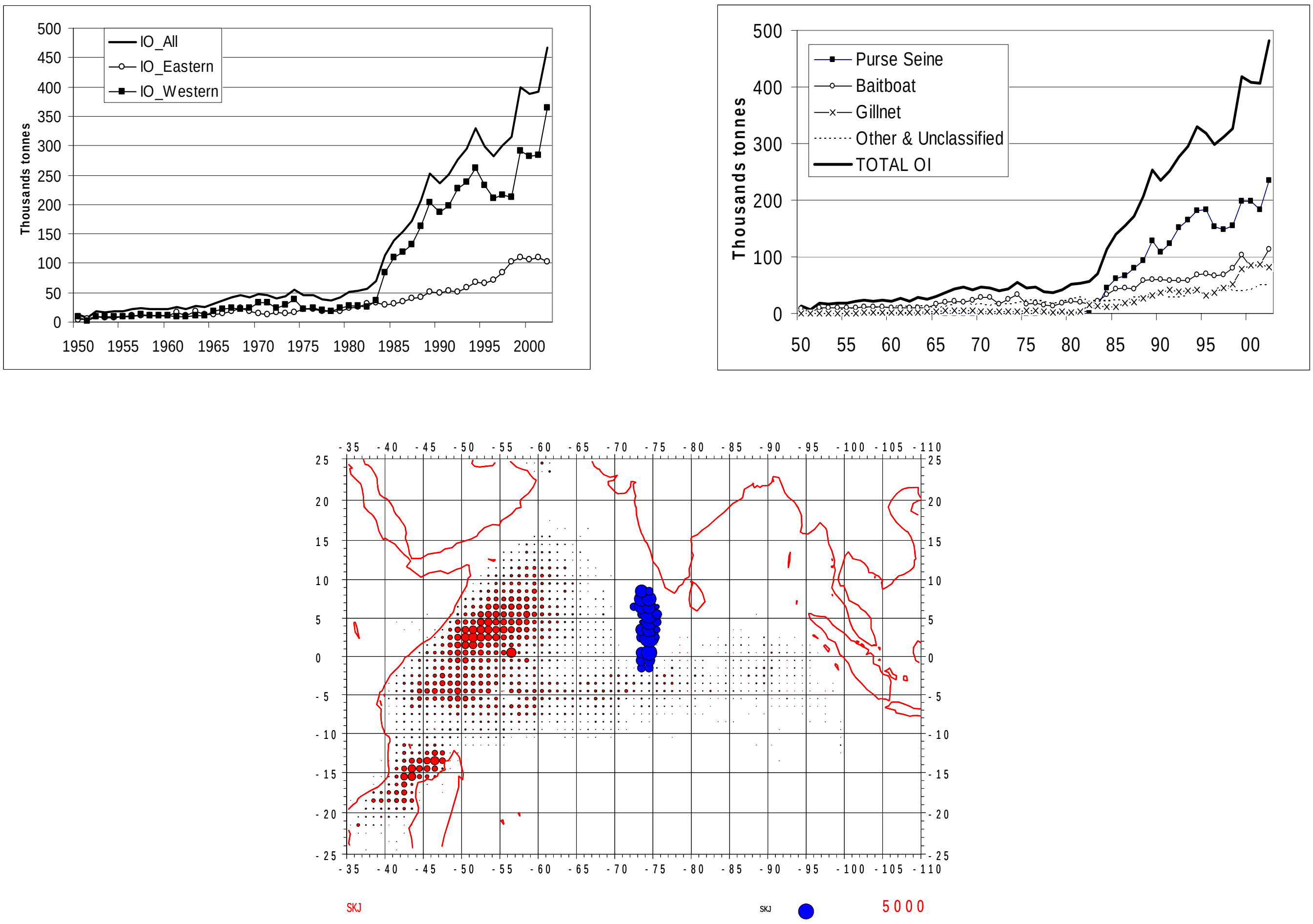



***Figure 1**. (a) Yearly catches (thousand of metric tones) of skipjack tuna by area (Eastern and Western Indian Ocean, top left) and by gear (top right) from 1950 to 2002 (right). (b) Average spatial distribution of Indian Ocean skipjack catches for 1995—2001 for purse-seine (red/light) and baitboat (blue/dark).*

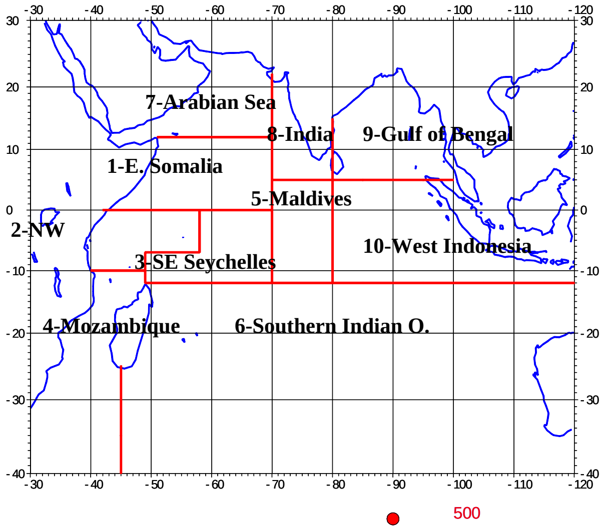



***Figure 2***. *Areas used for the calculation of the CPUE trends shown in Figure 4*

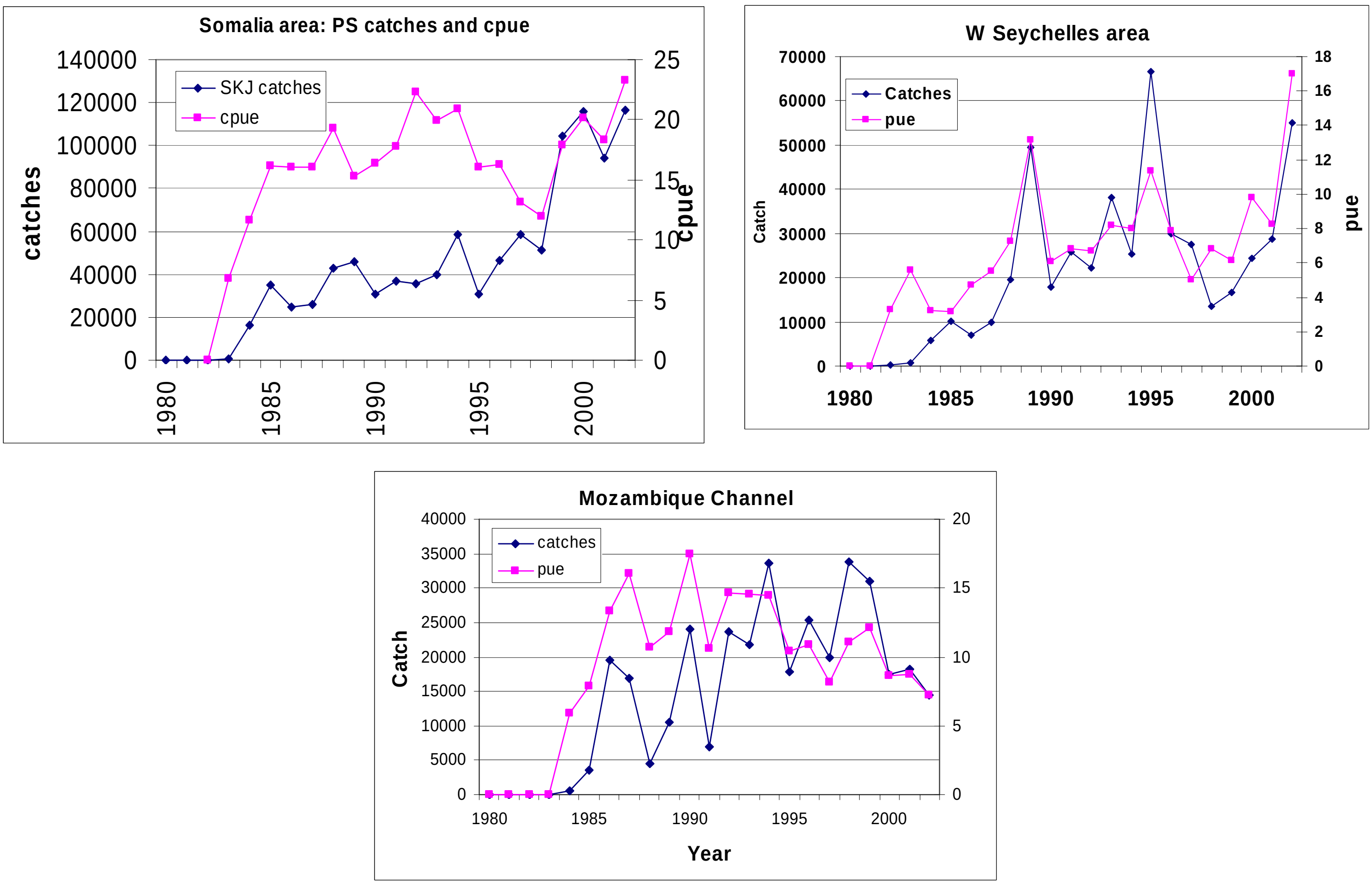



***Figure 3.*** *Nominal CPUEs for three important purse seine fishing ground areas: Somali Basin (top left panel); Mozambique Channel top right panel) and Western Seychelles (bottom panel).*

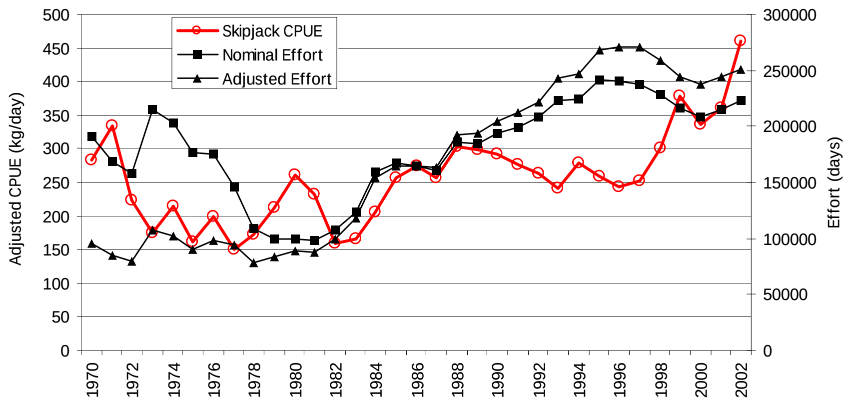



***Figure 4.*** *Time series of Maldives CPUE and the nominal and adjusted effort (WPTT-03-23).*

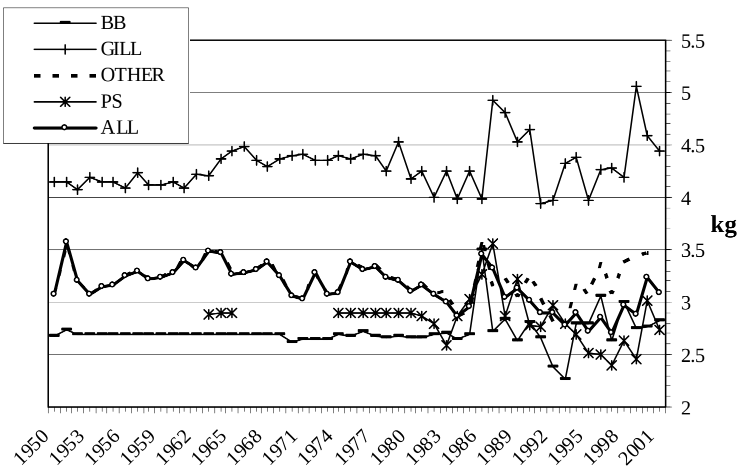



***Figure 5.*** *Skipjack tuna average weight in the catch by gear (from size-frequency data) and for the whole fishery (estimated from the total catch at size).*

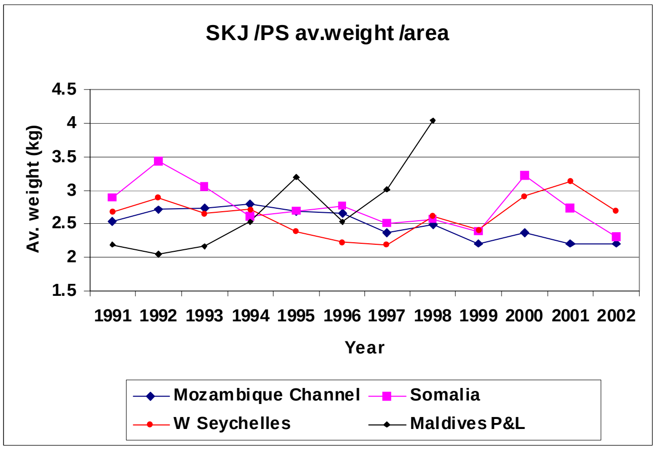



***Figure 6.*** *Time series of average weight of skipjack caught by the purse seine and pole and line by major areas. (1991 - 2002)*

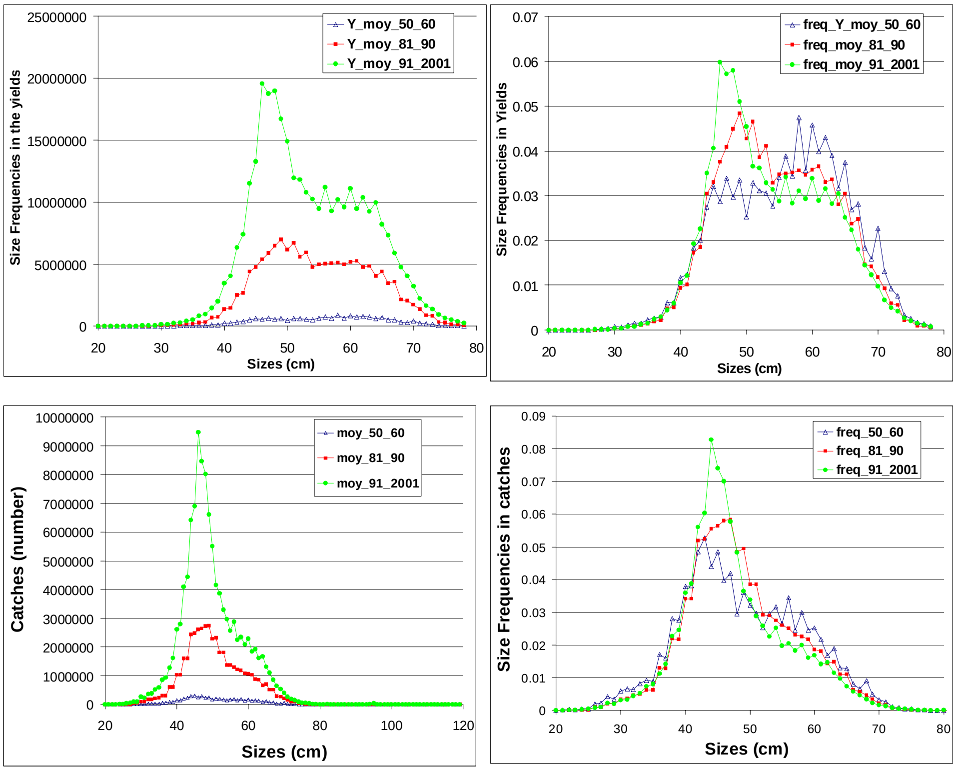



***Figure 7.*** *Size frequencies of the yield (top panels) and catch by numbers (bottom panels) for three time periods: 1950-1960 (green), 1981-1990 (red) and 1991-2001 (blue). Left panels are actual numbers and right panels are in proportions. Note the two modes (40-50 and 55-65 cm) that appear in the yield frequencies but which are less visible in the number frequencies.*

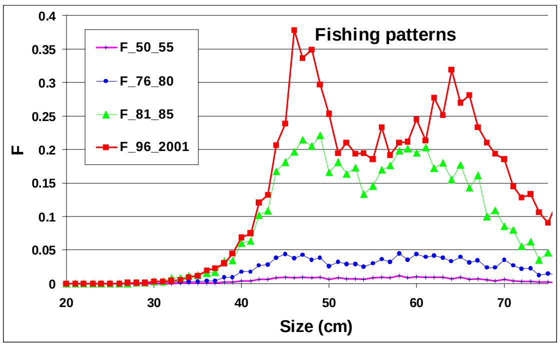



***Figure 8****. Estimated fishing mortality by size for four five-year mean periods : (1950-1955, 1976-1980, 1981-1985, and 1996-2001)*

# 4. EXECUTIVE SUMMARY OF THE STATUS OF THE INDIAN OCEAN SWORDFISH RESOURCE.

## BIOLOGY

Swordfish (Xiphius gladius) is a large oceanic apex predator that inhabits all the world's oceans. They are one of the most widely distributed pelagic fish species and in the Indian Ocean range from the northern coastal state coastal waters to 50°S. The species is known to undertake extensive diet vertical migrations, from surface waters during the night to depths of up to 1000 m during the day, in association with movements of the deep scattering layer and cephalopods, their preferred prey. Although there is no evidence that the species schools, it occurs in local aggregations most commonly in association with oceanic fronts and seamounts.

Genetic studies of the stock structure of swordfish in the Indian Ocean have failed to reveal spatial heterogeneity, and for the purposes of stock assessments one pan-ocean stock has been assumed. However, spatial heterogeneity in stock indicators (CPUE trends), indicate the potential for localized depletion of swordfish in the Indian Ocean, suggesting that mixing across the ocean basin may be limited.

As with many species of billfish, swordfish exhibit sexual dimorphism in maximum size, growth rates and size and age at maturity – females reaching larger sizes, growing faster and maturing later than males. Length and age at 50% maturity in SW Indian Ocean swordfish is 170cm (maxillary-fork length = lmf) for females and 120 cm for males. These sizes correspond to ages of 3-5 years and 1-3 years for females and males, respectively.

Swordfish are highly fecund, batch spawners with large females producing many millions of eggs per spawning event. One estimate for Pacific populations suggests that a female swordfish in equatorial waters may spawn as frequently as once every three days over a period of seven months.

The species is also long lived – reaching maximum ages of more than 30 years. However, the species also exhibits phenomenal growth in the first year of life - by one year of age, a swordfish may reach 90 cm (~15 kg). The average size of swordfish taken in Indian Ocean longline fisheries is between 40kg and 80kg (depending on latitude).

The species life history characteristic of relatively late maturity, long life and sexual dimorphism make it vulnerable to over exploitation.

## FISHERIES

Swordfish are taken as a target or by-catch of longline fisheries throughout the Indian Ocean, are rarely caught by purse seines, but are thought to be a component of the "unidentified Billfish" catch by Sri Lankan gill net fisheries in the central northern Indian Ocean.

Exploitation of swordfish in the Indian Ocean was first recorded by the Japanese in the early 1950's as a by-catch in their tuna longline fisheries. Over the next thirty years, catches in the Indian Ocean increased slowly as the level of coastal state and distant water fishing nation longline effort targeted at tunas increased. In the 1990's, exploitation of swordfish increased by over 500%, peaking in 1998 at around 40,000 tones (Figure 1). By 2002, twenty countries were reporting catches of swordfish (Figure 2), and the total catch had decreased to a little over 30,000 tones.

Since the early 1990's China,Taiwan has been the dominant catcher of swordfish in the Indian Ocean (41-60 % of total catch). Taiwanese longliners, particularly in the south western and equatorial western Indian Ocean, target swordfish using shallow longlines at night. The night sets for swordfish contrast with the daytime sets used by the Japanese and Taiwanese longline fleets when targeting tunas.

During the 1990's a number of coastal and island states, notably Australia, La Reunion/France, Seychelles and South Africa have developed longline fisheries targeting swordfish, using monofilament gear and light sticks set at night. This gear achieves significantly higher catch rates than traditional Japanese and Taiwanese longlines. As a result, coastal and island fisheries have rapidly expanded to take over 10,000 tones of swordfish per annum in the late 1990's.

## STOCK STATUS

Stock assessments of Indian Ocean swordfish stocks are preliminary, and rely heavily on indicators of abundance and stock status such as trends in CPUE and size composition of the catch.
In 2003, fine scale catch and effort data, and associated size composition data for the Taiwanese fishery were provided to the IOTC Working Party on Billfish for the first time. This effort was acknowledged and allowed improved analyses of indicators of abundance and development of more rigorous production models than had been possible previously.
With both Japanese and Taiwanese data available the WPB was able to compare two standardized CPUE series for Indian Ocean swordfish. As both the Japanese and Taiwanese fleets have operated continuously in the Indian Ocean since the 1950's these time series include the periods before and after targeting of swordfish began.
The standardized CPUE series for the Japanese fleet (Figure 4) show relatively large declines since 1990 : 50% decline in the equatorial western (Area 3), 30-50% decline in the tropical western and central ( Areas 5&6) and a 90% decline in the south western (Area 7). There is also evidence of recent declines in Area 4 in the north eastern Indian Ocean. The declines in CPUE in the Japanese series coincide with the timing of 500% increases in swordfish catches by the Taiwanese and other fleets in the areas concerned.
The standardized CPUE series for the Taiwanese fleet (Figure 4) either show no trends or less marked declines than those seen in the Japanese series in the same areas. The exception is in the south western Indian Ocean (Area 7), where the Taiwanese index has declined by 50% since 1991.
The differences between the two standardized CPUE series result from the differences in targeting of the two fleets – the Japanese target tuna and catch swordfish as a by-catch, whereas since 1991 the Taiwanese fleet, particularly in the western Indian Ocean, have targeted swordfish on a seasonal basis and caught tuna as a by-catch. As a result of targeting, the nominal CPUE for the Taiwanese fleet has increased dramatically since then. As it is very unlikely that increasing nominal CPUE reflects increasing abundance, WPB analyses have focused on removing the effect of targeting from the Taiwanese series. At this stage, the WPB are not satisfied that they have successfully accomplished this objective. For this reason, at this stage the WP supports use of the Japanese series as the most appropriate indicator of abundance in Indian Ocean swordfish.

A large number of assessment runs with the 'ASPIC' software, which fits the Schaefer production model to data, were made at the 2003 WPB meeting using the different CPUE indices. Runs were based on the Japanese or Taiwanese series alone, or on the combined Japanese series with the Taiwanese split into two time-periods, one prior to 1992 and one from 1992 (when targeting switched to swordfish). As anticipated, runs based on flat or on contradictory CPUE indices did not converge. Of the runs that converged, most estimated MSY-levels below the current catches, and indicate that the biomass is near or below Bmsy. As a caveat – the WPB noted that there are still many weaknesses in the model analyses which need to be considered and it is planned to address these in a more complete stock assessment at the next WPB meeting.

There are no clear signals of declines in the size-based indices (Figure 5), but these indices should be carefully monitored. It was noted that since females mature at a relatively large size, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.

After reaching a peak of 40,000t in 1998, total catches have decreased slightly over the last five years. However, the effective effort (estimated as the catch divided by the standardized Japanese CPUE) has continued to increase over this period. This might suggest that the decrease in the catch is not as a result of a reduction in effective effort, but more likely to be as a result of a decrease in the swordfish biomass. There is some evidence that some of the Taiwanese fleet has shifted away from swordfish targeting in the last two years, which would explain the drop in swordfish catches recently.

In summary, the stock indicators and the assessments suggest that the stock is likely to be near or below the Bmsy level. This is indicated by some of the assessment runs, but can also be concluded from the relative change in the standardized Japanese CPUE series since the 1990s. Although there is high uncertainty, the indicators and assessments suggest that the situation may be more serious in the Western Indian Ocean than the Eastern Indian Ocean.

## MANAGEMENT RECOMMENDATIONS

On the basis of the production models and the stock indicators, the WPB concluded that the current level of catch (about 30,000 tones) is unlikely to be sustainable. Of particular concern are the trends in abundance of swordfish in the SW Indian Ocean, where the highest catches are currently taken.

The WP considered that any further increase in effort in the Western Indian Ocean (particularly the SW) would increase the risk of overfishing the swordfish stock. Thus, the Working Party considered that any increase in the catch of, or fishing effort on, swordfish should not be allowed.

The indicators suggest that a comprehensive assessment of swordfish stocks in the Indian Ocean should be conducted as soon as possible.

## SWORDFISH SUMMARY

| | |
|---|---|
| Maximum Sustainable Yield : | |
| Current (2002) Catch: | 30,400t |
| Current Replacement Yield | |
| Relative Biomass ($B_{2000}/B_{msy}$) | |
| Relative Fishing Mortality ($F_{2000}/F_{MSY}$) | |
| Management Measures in Effect | None |

***Table 1**. Catches of swordfish by gear and main fleets for the period 1950-2002 (in thousands of tones)*

| Gear | Fleet | Av98/02 | Av50/02 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Longline | China | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | (Taiwan,China) | 14.4 | 3.9 | | | | | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.6 | 0.8 | 1.2 | 0.9 | 0.9 | 0.6 | 1.0 | 0.9 | 0.9 |
| | Japan | 1.6 | 1.0 | | | 0.0 | 0.0 | 0.2 | 0.2 | 0.5 | 0.3 | 0.5 | 0.5 | 0.6 | 0.7 | 0.8 | 0.6 | 0.8 | 1.0 | 1.1 | 1.6 | 1.1 | 1.1 | 1.2 | 1.1 | 0.9 | 0.8 | 0.8 | 0.8 | 0.4 |
| | Indonesia | 0.9 | 0.2 | | | | | | | | | | | | | | | | | | | | | | | | | 0.0 | 0.0 | 0.0 |
| | Korea, Republic of | 0.1 | 0.1 | | | | | | | | | | | | | | | | | | | | | | | | | | 0.2 | 0.4 |
| | Total | 31 | 8 | | | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| ALL | TOTAL | 31 | 8 | | | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| Gear | Fleet | Av98/02 | Av50/02 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |

| Gear | Fleet | Av98/02 | Av50/02 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Longline | China | 0.3 | 0.0 | | | | | | | | | | | | | | | | | | | 0.1 | 0.2 | 0.3 | 0.1 | 0.3 | 0.4 | 0.3 | 0.4 |
| | (Taiwan,China) | 14.4 | 3.9 | 0.9 | 0.6 | 1.1 | 1.3 | 1.1 | 1.5 | 1.9 | 1.7 | 2.0 | 3.2 | 3.8 | 5.4 | 4.1 | 3.8 | 4.7 | 9.0 | 15.3 | 12.5 | 18.3 | 17.6 | 17.3 | 16.8 | 14.7 | 15.2 | 12.3 | 12.9 |
| | NEI-Deep-freezing | 5.8 | 1.2 | | | | | | | | | 0.0 | 0.2 | 0.2 | 0.8 | 0.6 | 0.8 | 0.9 | 1.6 | 4.7 | 4.1 | 6.2 | 8.5 | 6.1 | 8.1 | 7.1 | 7.8 | 3.1 | 3.1 |
| | Japan | 1.6 | 1.0 | 0.3 | 0.9 | 0.6 | 0.6 | 0.8 | 1.0 | 1.2 | 1.3 | 2.2 | 1.3 | 1.4 | 1.5 | 1.0 | 1.0 | 0.9 | 1.7 | 1.4 | 2.6 | 1.7 | 2.1 | 2.8 | 2.2 | 1.5 | 1.6 | 1.2 | 1.4 |
| | France-Reunion | 1.6 | 0.2 | | | | | | | | | | | | | | | 0.0 | 0.1 | 0.3 | 0.7 | 0.8 | 1.3 | 1.6 | 2.1 | 1.9 | 1.7 | 1.3 | 0.8 |
| | Spain | 2.0 | 0.2 | | | | | | | | | | | | | | | | | 0.2 | 0.7 | 0.0 | 0.0 | 0.5 | 1.4 | 2.0 | 1.0 | 1.9 | 3.5 |
| | Australia | 1.7 | 0.2 | | | | | | | | | | | | | 0.0 | | 0.0 | 0.0 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.3 | 1.4 | 1.8 | 2.9 | 2.0 |
| | Indonesia | 0.9 | 0.2 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.5 | 0.5 | 1.0 | 1.2 | 1.1 | 1.3 | 0.7 | 0.6 | 0.6 |
| | NEI-Fresh Tuna | 0.8 | 0.2 | | | | | | | | | | | | | 0.5 | 0.7 | 0.6 | 0.7 | 0.9 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 0.9 | 0.7 | 0.3 | 0.6 |
| | France-Territories | 0.5 | 0.0 | | | | | | | | | | | | | | | | | | | | | | 0.6 | 0.3 | | | |
| | Seychelles | 0.4 | 0.0 | | | | | | | | | | | | | | | | | | | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.6 | 0.6 |
| | Portugal | 0.4 | 0.0 | | | | | | | | | | | | | | | | | | | | | | 0.1 | 0.2 | 0.2 | 0.6 | 0.8 |
| | Philippines | 0.2 | 0.0 | | | | | | | | | | | | | | | | | | | | | | 0.3 | 0.3 | 0.2 | 0.1 | 0.3 |
| | South Africa | 0.2 | 0.0 | | | | | | | | | | | | | | | | | | | | | | 0.2 | 0.0 | 0.0 | 0.2 | 0.6 |
| | Korea, Republic of | 0.1 | 0.1 | 0.4 | 0.6 | 0.5 | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.1 | 0.0 | 0.0 | | 0.0 |
| | Other Fleets | 0.2 | 0.1 | | | | 0.0 | 0.0 | 0.0 | 0.0 | | 0.1 | 0.0 | 0.0 | 0.1 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.5 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 |
| | Total | 31 | 8 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 5 | 6 | 8 | 7 | 7 | 8 | 14 | 24 | 23 | 29 | 33 | 32 | 35 | 32 | 32 | 25 | 28 |
| Gillnet | Sri Lanka | 3.7 | 0.7 | | | | | | | | | 0.4 | 0.3 | 0.3 | 0.4 | 0.3 | 0.6 | 0.9 | 0.8 | 4.5 | 2.2 | 2.3 | 2.5 | 3.1 | 3.9 | 2.1 | 5.5 | 4.7 | 2.4 |
| Line | Total | 0 | 0 | | | | | | | | 0 | 0 | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other | Total | 0 | 0 | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | | 0 | 0 | 1 | 1 | | | | |
| ALL | TOTAL | 35 | 8 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 5 | 5 | 6 | 8 | 7 | 8 | 9 | 15 | 28 | 25 | 32 | 35 | 36 | 40 | 35 | 37 | 30 | 30 |
| Gear | Fleet | Av98/02 | Av50/02 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 |

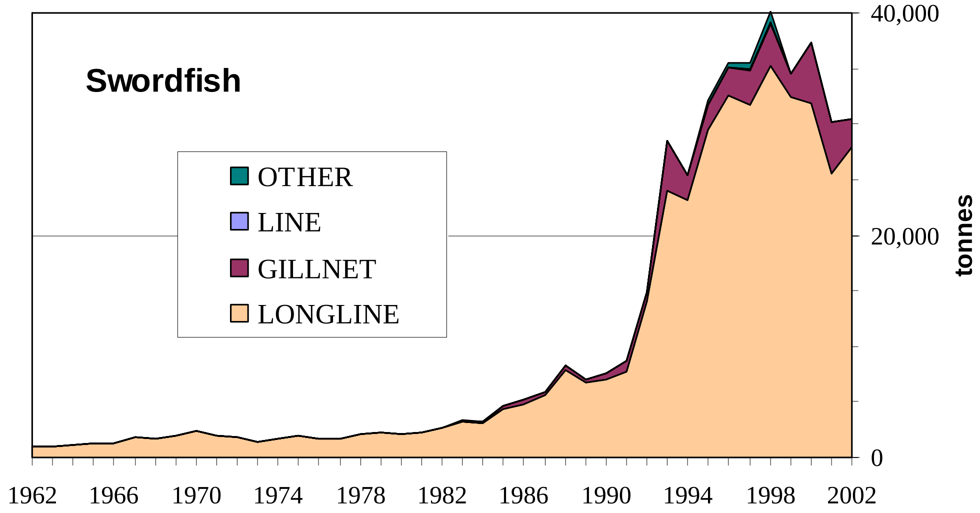



*Figure 1: Catches of Swordfish per gear and year recorded in the IOTC Database (1962-2002).*

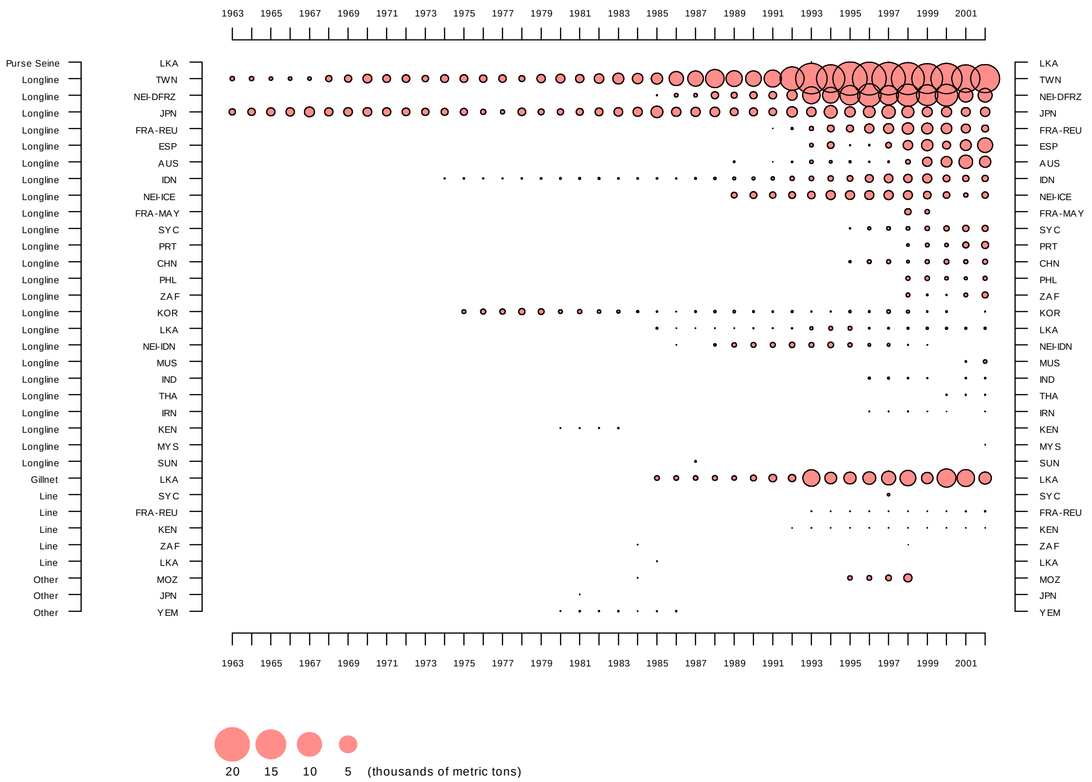



*Figure 2: Catches of swordfish in the Indian Ocean for the period 1963-2002, in thousands of metric tons by gear and country/fleet*

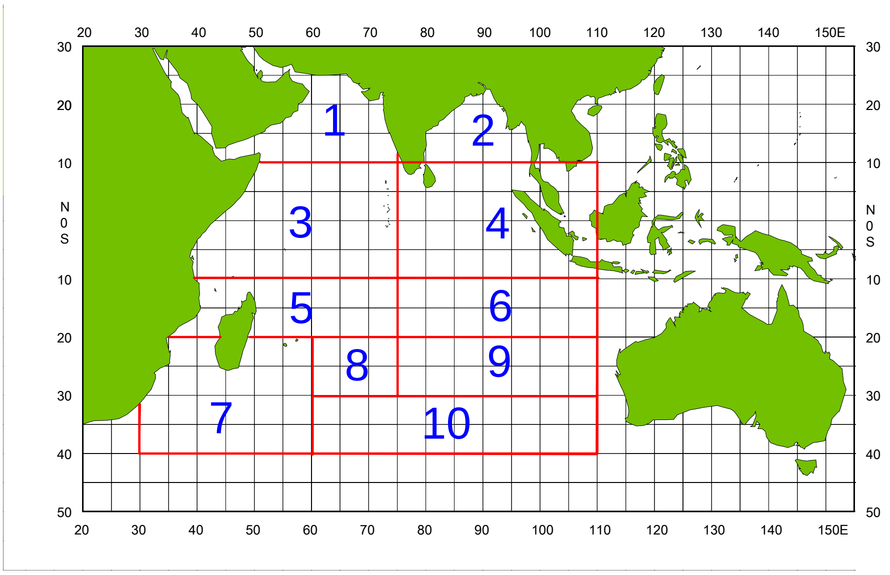



*Figure 3: Areas used in the CPUE standardization for the Japanese and Taiwanese fleets.*

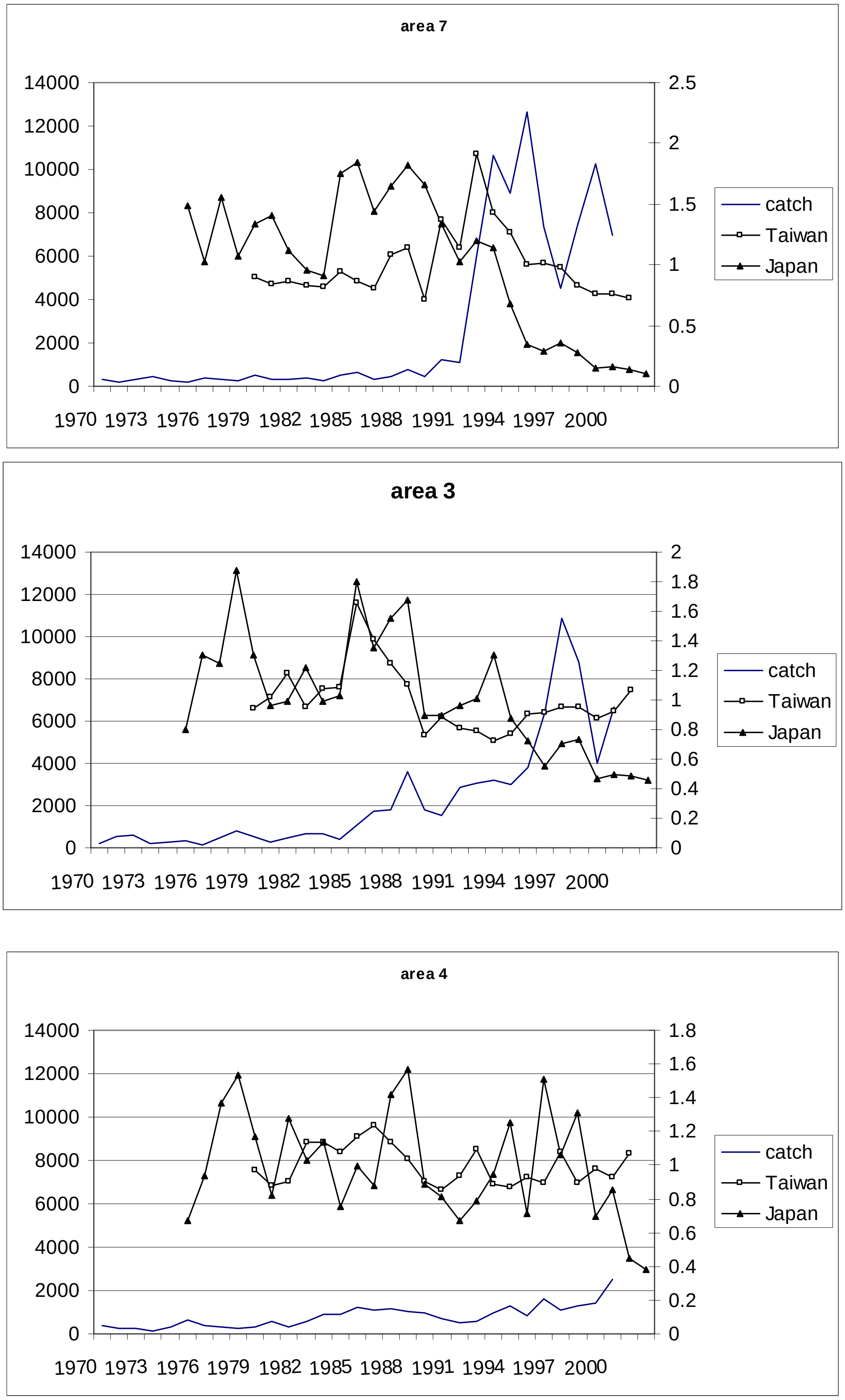



*Figure 4. Total catch and standardized CPUE trends (rescaled to their average) for the Japanese and Taiwanese fleets in areas 3 (equatorial western), 7 (south western) and 4 (equatorial eastern).*

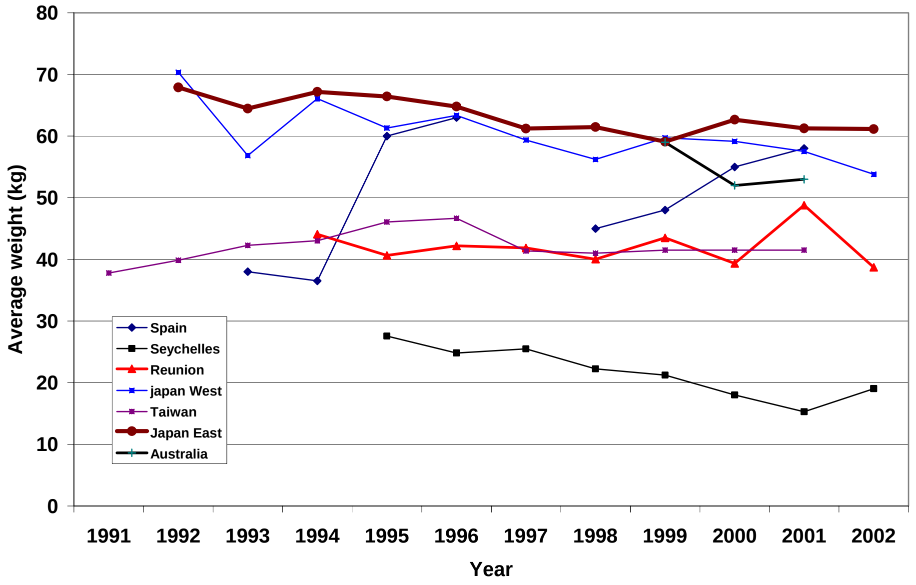



*Figure 5. Trends in average size of swordfish in Indian Ocean fisheries.*

# APPENDIX IX. TECHNICAL ADVICE ON RESOLUTION 02/08: ON THE CONSERVATION OF BIGEYE AND YELLOWFIN TUNA IN THE INDIAN OCEAN

At its 7th Session, the Commission adopted Resolution 02/08, the main operative paragraphs of which include "*The IOTC … resolves to seek technical advice from the Scientific Committee for the next session of the Commission on:*

- *Potential management measures designed to reduce the fishing mortality on juvenile bigeye and yellowfin tuna. The measures to be investigated should include, but not be restricted to, time and/or area closures on purse seine fishing on floating objects, and other forms of effort reduction or alternative fishing strategies.*

- *Other potential management measures aimed at maintaining or reducing the effective fishing effort and catches of yellowfin and bigeye tunas by all gears.*

- *The likely effect of these measures on the future productivity of the stocks of bigeye and yellowfin tunas and their consequences on catches of skipjack tuna.*

*On the basis of the updated scientific advice, the Commission will seek to adopt appropriate measures to address the recommendations of the Scientific Committee at the 2003 Session of the Commission".*

## BACKGROUND AND NEW OR UPDATED INFORMATION

The Committee considered new and updated information with regard to this issue.

Document WPTT/03/04 presents an overview of the FAD fishery in the Indian Ocean since the early eighties. Comparisons are made between FAD and free school fisheries. The difference between size distributions from catches on free schools and catches on FADs, particularly for bigeye, is shown. Maps identify the area with highest catches from FADs in recent years as the region off Somalia. Fishing on FADs in this area occurs in all months, but catches peak between July and November. This reconfirms the findings on appropriate areas and times of the Working Party meeting in 2000. The document also lists potential management measures for FAD fishing; these are further addressed below. During discussion, it was noted that the spatial and temporal distribution of peak catches on FADs has been reasonably consistent in the recent past.

Document WPTT/03/12 evaluates the effect of different purse seine fishing effort reduction scenarios. This document also provides an analysis of data on catches on FADs by time of day, which suggest that particularly high catches are obtained at sunrise, and they contain a high proportion of bigeye. The data do not, however, allow distinction between a first or subsequent set on the same FAD.

Information on FAD fishing activity, based on observations on one Spanish vessel, was presented in WPTT/03/24. The number of retrieved, recycled and newly deployed FADs was monitored, as well as the number of visits to FADs and random encounters with "natural" FADs. The type of equipment associated with FADs had an effect on the number of visits and the catches obtained under the FADs. It was also noted that although GPS-equipped FADs may appear to be inefficient because many visits were made with relatively low catch, this may be misleading because it is very easy to visit a GPS-equipped FAD. FADs with echosounders were also sometimes visited without sets being made because the echosounder only provides information about fish right underneath the FAD, and not about fish in a wider area around the FAD.

It is essential to obtain more information on the characteristics of the FAD-associated fishery, in particular, the overall number of FADs in operation in the Indian Ocean, noting that this could vary greatly within a year. In order to correctly estimate the effects of the FAD other information will also be necessary, such as the effective 'lifespan' of FADs.

MANAGEMENT MEASURES TO REDUCE THE FISHING MORTALITY OF JUVENILE BIGEYE AND YELLOWFIN TUNAS

As requested by the Commission, the Scientific Committee evaluated a number of potential management measures that could lead to a reduction in the fishing mortality on juvenile bigeye and yellowfin tunas. These are listed in Tables 1 and 72in the main report, which summarize the management measures, their likely effects and advantages and disadvantages. A more detailed discussion of each of the measures considered can be found in the following sections.

Various analyses were conducted in order to assess the effects of the measures considered. These are described in detail under the relevant sections. In several cases, it was not possible to conduct a quantitative assessment of the effects of a particular measure due to the absence of data pertinent to that measure. In some cases, the likely response of the fishing fleets to the measures is difficult to quantify. In these cases, estimates of the effects of management measures given in Table 6 are maximum achievable numbers since they essentially assume perfect implementation of the measure, or in the case of a time-area closure, that purse seiners that normally fish in the moratorium area do not fish elsewhere during the moratorium period. In other cases, such as the reduction in the number of purse-seine vessels, the effect of the measure can be more accurately predicted, as it is unlikely to be compensated for by a change in fishing strategy.

**Short-term vs. long-term effects.** A distinction needs to be made between the immediate losses that would come from the application of a management measure (short-term effects) in terms of lost catches of the three species of tuna, and the beneficial effects that are to be expected from improved productivity of the stocks (long-term effects). The procedures used to estimate short-term effects differ in detail among the management measures considered, so they are described under the pertinent sections. However, in general short-term calculations were based on recent catch rates by species and sizes and, therefore, these applied to all three tropical tuna species. In contrast, the long-term calculations could only be conducted for bigeye tuna, as this is the only species for which estimates of fishing mortality at age are available. To estimate long-term effects on total catch of bigeye tuna, where it was possible to estimate the potential reduction in fishing mortality, the Scientific Committee used two approaches: **stock projections** and **per-recruit analyses**. As these approaches were used in the evaluation of several of the options, they are reviewed next.

**Long-term effects using stock projections.** Stock projections were conducted only for bigeye tuna, as there are no reliable estimates of the required parameters for the other tropical tuna species. The projections done in 2001 were updated with new information, including a revised and updated catch series, a new growth curve, and the standardized longline CPUE for the most recent years. The projections cover a period of ten years, during which both annual catches and sizes of the spawning stock of bigeye can be estimated. To explore the effect of the uncertainty on the natural mortality by age, the projections were done based on three different assumed patterns:

The Scientific Committee reiterates the uncertainties and caveats noted in its reports of 2001 and 2002 with respect to the bigeye assessment (on which the stock

***Table 1.*** *Long-term effects of reduction in PS fishing mortality on total catch of bigeye tuna.*

| Reduction in PS fishing mortality | Change in PS catch | Change in LL catch | Change in Total catch |
|---|---|---|---|
| 5% | -3.8% | +1.9% | +0.6% |
| 10% | -7.7% | +3.8% | +1.2% |
| 15% | -11.8% | +5.8% | +1.8% |
| 20% | -15.9% | +7.8% | +2.4 |

projections are based), including uncertainty about the natural mortality at age and about the increase in efficiency of the different fisheries involved, lack of adequate size-frequency data for longline fisheries, especially in recent years and unresolved questions about how well the longline-based standardized CPUEs reflect abundance.

As previously, it was stressed that the caveats and uncertainties expressed about the assessment apply even more strongly to the results of the projections. These calculations are meant to be interpreted as an example of what are possible trends in the fishery if the current status of the resource is well approximated by the results of the assessment. As such, the predictions regarding actual catch levels and their changes over time should be taken with considerable caution.

**Long-term effects using per-recruit analyses.** As in the case of the projections, this approach was only applied to bigeye tuna, since fishing mortality at age is not available for the other tropical tuna species. The analyses allow quantification of the likely long-term effects on the yield per recruit and spawning stock per recruit. Given that estimates of the fishing mortality at age of bigeye tuna come from the assessment, the same uncertainties and caveats apply to the per-recruit analyses.

**Long-term effects of reductions in fishing mortality of bigeye tuna.** The management options considered were designed to result in a reduction in fishing mortality. In order to evaluate the likely long-term effects (ten years of those management options, first the extent to which they would reduce fishing mortality has to be estimated. Then, this reduction is applied to estimates of current fishing mortality which are then used as inputs for both projections and per-recruit analyses.

Both the projections of the total yield of bigeye tuna and the yield-per-recruit analyses provide very similar results for the long-term effects. Considering that the current assessment suggests that there is only a very weak relationship between the size of the spawning stock biomass and the recruitment, both analyses are essentially the same. Therefore, only the results of the projections were used for assessing long-term effects.

The main feature shared by these analyses is that, according to the current assessment of the bigeye tuna, the likely long-term benefits in total catch of any level of reduction in the purse-seine fishing mortality are at best moderate. This is illustrated by estimating the improvement in yields arising from a hypothetical measure that would result in a 100% reduction in fishing mortality of juvenile bigeye tuna (fish younger than two-years old). Such a measure would result in an improvement of about 13-24% (depending on the assumed patterns of juvenile natural mortality and according to the results of the current assessment).

The projections also indicate that the effects will be different for the purse-seine and the longline fisheries. The purse-seine fishery would suffer losses of catches. There would be, however, long-term increases in the catches of longline fishery, as more fish become available to the latter. The Table 1 illustrates the long-term effects on bigeye catches of a reduction in purse seine fishing mortality compared to current levels of fishing mortality. Estimates are based on the current assessment and a juvenile natural mortality value of 0.8. Estimates are very similar for the two alternative assumptions about juvenile natural mortality.

The Scientific Committee also investigated the possible long-term effects of reductions in fishing mortality of both the purse seiner and longliner fleets, and compared results to the case where there is no reduction in the LL fishing mortality. The table below shows that a reduction in PS fishing mortality, combined with a reduction in LL fishing mortality generally leads to a reduction in overall (total) yield. An increase in total yield is only obtained for a relatively large reduction in PS fishing mortality and a small (or no) reduction in the LL fishing mortality.

***Table 2.*** *Long-term effects of changes in both PS and LL fishing mortality on total catch of bigeye tuna.*

| | 10% reduction in PS fishing mortality | 20% reduction in PS fishing mortality |
|---|---|---|
| 0% reduction in LL fishing mortality | PS: -8%<br>LL: +4%<br>Total: +1% | PS: -16%<br>LL +8%<br>Total: +2% |
| 10% reduction in LL fishing mortality | PS: -6%<br>LL: +1%<br>Total: -1% | PS: -14%<br>LL: +5%<br>Total: +0.4% |
| 20% reduction in LL fishing mortality | PS: -3%<br>LL: -3%<br>Total: -3% | PS: -11%<br>LL: +0.5%<br>Total: -2.1% |

The situation is different concerning the spawning stock biomass. A decrease in the catches of any of the gears leads to an increase in the long-term spawning stock biomass. Although the current assessment indicates that spawning stock biomass is above the MSY level, there is considerable uncertainty about the estimation of the level of stock size that would produce the MSY.

***Table 3.*** *Changes in spawning stock biomass (SSB) for reductions in PS and LL fishing mortality*

| | 10% reduction in PS fishing mortality | 20% reduction in PS fishing mortality |
|---|---|---|
| 0% reduction in LL fishing mortality | +4% | +8% |
| 10% reduction in LL fishing mortality | +15% | +20% |
| 20% reduction in LL fishing mortality | +27% | +33% |

- **Time-area closure to purse seine fishing**

If a closure to all purse seine fishing were to be implemented in an area for a specified time period, then this could be enforced through a VMS system, without placement of inspectors, on all vessels that have a VMS system installed. Such a closure would, however, impose a restriction on fishing free schools, which is not necessary to achieve a reduction in fishing mortality on juvenile bigeye tuna. An alternative option would be to apply the closure only to fishing on floating objects, with no restrictions being placed on fishing on free schools. In principle, this would allow fishermen to fish on free-swimming schools in the closed area, as such schools do not contain small fish. However, existing data on purse-seine fishing in the proposed moratorium area and period indicate that only a very small proportion of the catches have been taken from free-swimming schools. Further, enforcement of this measure would require the presence of inspectors on board all vessels. In the calculations that follow, only the first option, that is, a closure to all purse-seine fishing was considered.

Options for a time-area closure of the purse-seine fishery have been already considered and its short-term effects assessed by the Scientific Committee in 2000, following a request from the Commission. During the current meeting, an analysis of the most recent data concerning the spatial and temporal distribution of the purse-seine bigeye catches did not reveal any major changes in the patterns identified in the 2000 meeting (Figure 1). Therefore, the Scientific Committee retained the options presented at that time, and updated the calculations concerning the effects in juvenile mortality and short-term effects on catches of tunas. The areas and times considered are (see Figure 2):

- An area extending from 60°E to the African coast and from the equator to 5°N, closed from September to October (two months)

- A larger area extending from 60°E to the African coast and from the equator to 10°N, closed from August to November (four months)

- An area extending 55°E to the African coast and from the equator to 5°N, closed from January to December (twelve months)

Short-term consequences of the different options for the moratorium were assessed in terms of the following species and size categories, based on historical size-frequency distributions for yellowfin and bigeye tunas taken on drifting objects:

- Yellowfin tuna (below and above 5 kg)

- Bigeye tuna (below and above 10 kg),

- Skipjack (all sizes)

The results of the calculations concerning the options presented (listed in Table 4) are similar to those obtained previously. The Scientific Committee was unable to predict the catches resulting from fishing outside the moratorium area, so the results presented are based in the extreme assumption that the loss of the catch in the moratorium area will not be offset by catches in other areas (i.e. all vessels that previously had fished on drifting objects in the defined region stop fishing for the period of the moratorium). In practice there would be, almost certainly, less loss of catch and a lower reduction in juvenile fishing mortality than that suggested by the current calculations, but it was unable to estimate their extent.

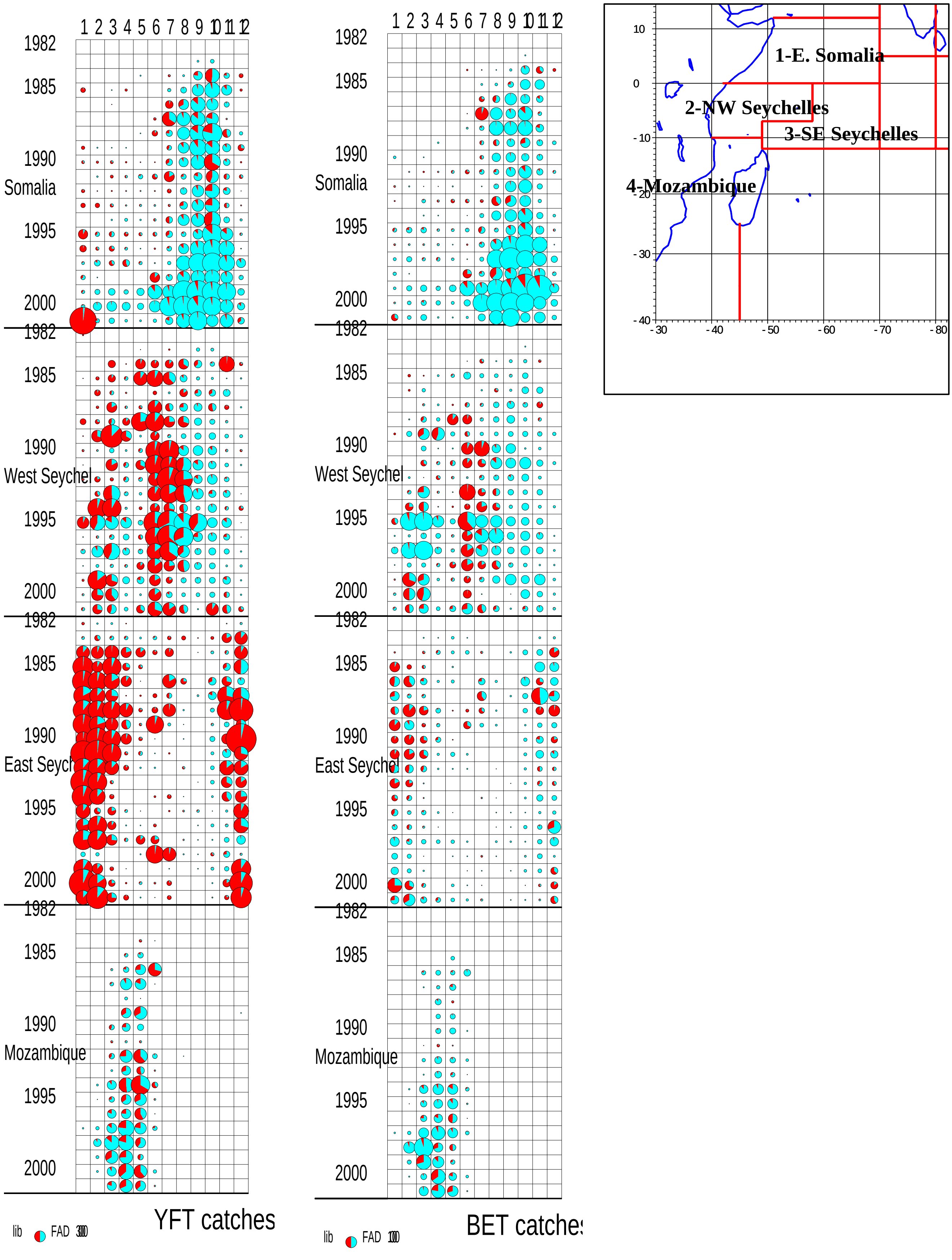
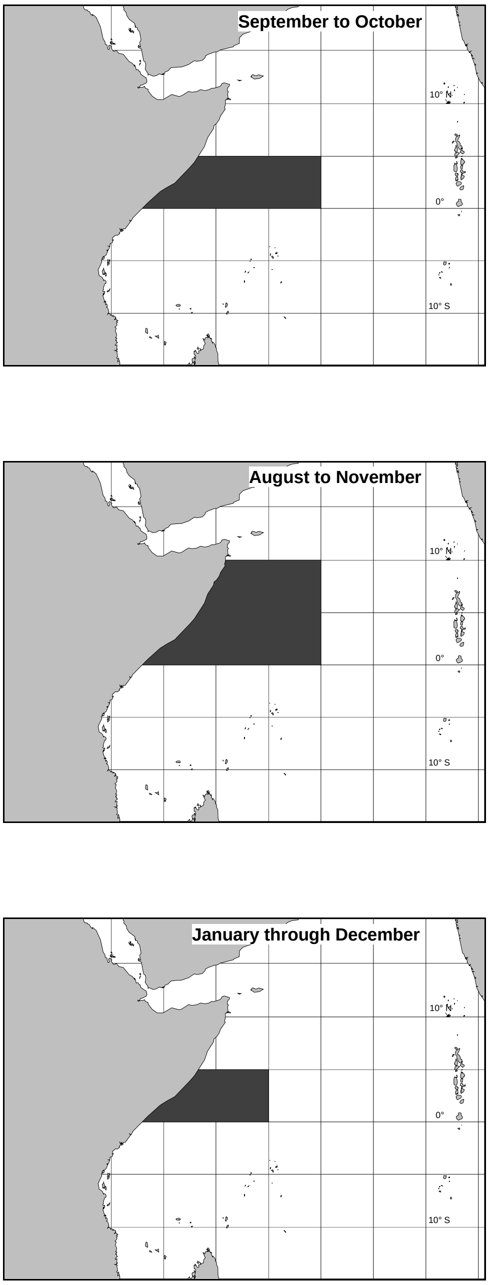



*Figure 1. Monthly catches of yellowfin (left) and of bigeye (right) taken by area under FADs (grey) and on free schools (dark) by Indian Ocean purse seiners (from WPTT-03-04)*

***Figure 2.*** *Areas and periods considered in the assessment of options for a time-area closure.*




- **Reduction in overall purse seine effort**

A reduction in overall purse seine effort could be implemented in different ways, for example, a reduction in the number of vessels, or an increase in the number of days in port. With regard to an increase in the number of days in port, the idea is that after a purse seiner has unloaded following a fishing trip, the vessel would be forced to remain in port for an additional specified number of days. Two options for a measure requiring increased number of days in port were considered: a) the measure is applied only in the second semester (July to

December) when most catches are taken on FADs, and b) the measure is applied over the whole year (see Table 5). The latter option would apply to vessels even during those periods when the fishing is primarily on free-swimming schools.

***Table 4.*** *Potential benefits (in percent reduction of juvenile mortality) for three options for the moratorium. Large tunas: bigeye > 10 kg + yellowfin > 5 kg.*

| | *Months* | *Benefits (reduction of juvenile mortality)* | | *Maximum costs (loss of catches in t)* | |
|---|---|---|---|---|---|
| *Area* | | *Bigeye* | *Yellowfin* | *Large tunas* | *Skipjack* |
| 0°- 5°N; Coast – 60° E | Sep through Oct | 12% | 15% | 5,900 | 19,500 |
| 0°- 10°N; Coast – 60° E | Aug through Nov | 31% | 38% | 14,800 | 49,400 |
| 0°- 5°N; Coast – 55° E | Jan through Dec | 20% | 26% | 10,400 | 31,600 |

The approach to evaluate the likely effects of a reduction in overall purse seine effort uses the average catch rates by species across vessels to infer the likely losses of catches for assumed reductions in purse seine effort. Information on individual size in the catch is used to separately infer the effects on catches of juvenile (< 10kg) bigeye and (< 10kg) yellowfin and on total catches (all sizes) of bigeye and yellowfin. Catch rates vary between vessels and this was taken into account in the calculations in order to estimate a range of likely effects. This approach allows quantification of likely effects on catches in the short term for yellowfin, bigeye and skipjack.

- **Limitations on the number of FADs and/or their electronic equipment**

Limiting the total number of FADs deployed would directly address the problem of reducing fishing mortality on juvenile bigeye and yellowfin tunas. However, monitoring the number of drifting objects deployed by purse seiners or supply vessels would imply having inspectors on board permanently. Furthermore, at this stage there is no information about the current number of drifting objects deployed or about the relation between the number of drifting objects and the resulting catches.

- **Ban on supply vessels**

There was no new information on this possible management measure, but a comparison of the catches of Spanish and French purse seiners on drifting objects was presented to the WPTT in 2000. This emphasized the difference in bigeye tuna catch rates of the Spanish and French purse seiners since 1994, the year when a supply vessel first operated in the fishery. It was suggested that the higher catch rates obtained by the Spanish fleet were associated with the use of supply vessels. Catch rates during the years before 1994 were similar for the Spanish and French boats, as both fleets were operating in a similar manner.

The current information is too limited to properly quantify the effect of the supply vessels.

***Table 5.*** *Reduction in annual catch for two level of reduction in the number of purse-seiners, estimated from the average annual catch rates. UL represents an upper limit based on the average plus one standard error; LL represents the lower limit calculated as the average minus one standard error.*

| | | *Effort* | *Total catch* | *YFT > 10kg* | *SKJ* | *BET > 10kg* | *YFT < 10kg* | *BET < 10kg* | *Number of sets* |
|---|---|---|---|---|---|---|---|---|---|
| Current catch in tons | | 15,406 | 354,487 | 143,677 | 180,807 | 30,003 | 45,946 | 21,609 | 11,150 |
| | | | | | *Percent changes* | | | | |
| 5% reduction in number of vessels (3) | UL | 6% | 8% | 8% | 9% | 9% | 9% | 9% | 8% |
| | mean | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% |
| | LL | 4% | 2% | 2% | 2% | 2% | 2% | 2% | 3% |
| 10% reduction in number of vessels (6) | UL | 13% | 17% | 17% | 17% | 17% | 18% | 18% | 16% |
| | mean | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| | LL | 7% | 5% | 5% | 4% | 4% | 4% | 4% | 5% |

- **Limits on skipjack catches by purse seiners**

Early in 2001, a voluntary restriction on the landings of skipjack tuna was agreed among tuna boat owners as a response to the oversupply of skipjack tuna in the worldwide market. As a consequence, there was a reduction in the number of FAD-associated sets. Such a reduction probably led to a decrease in the catches of juvenile bigeye and yellowfin tuna. However, such a measure would be difficult to implement in the form of a management measure, and would probably lead to increased discards of skipjack tunas.

- **Size Limit**

As was demonstrated by ICCAT's experience with similar regulations, the Working Party believed that it is not possible to implement this management measure effectively. If a size limit on bigeye and yellowfin could be implemented in such a way that all fish below size are returned to sea alive, then the effect would be 100% reduction in fishing mortality on juvenile bigeye and yellowfin. In practice, this is impossible in the purse seine fishery.

### Other considerations

One additional measure, namely preventing setting at sunrise, was considered because catches on FADs appear to be highest at sunrise, and also contain high proportions of bigeye, based on data collected by observers. Implementing and enforcing such a measure is considered to be highly impractical.

The intended benefits of any of the measures considered would be fully attained only to the extent that fleets comply with the measures. IUU fleets might not comply with the measures. However, the estimated catches of tropical tunas by vessels that would probably comply represent a substantial proportion of the total catch of tropical tunas.

### REDUCING THE EFFECTIVE FISHING EFFORT AND CATCHES OF YELLOWFIN AND BIGEYE TUNAS BY ALL GEARS

In 2001, the Scientific Committee noted with concern that catches of bigeye tuna had been increasing up to 1999, the last year with data available for analyses. Taking this into account, the Committee concluded that it was likely that current catches were well above MSY and recommended that a reduction in catches of bigeye tuna from all gears be effected as soon as possible.

Since then, catches of bigeye tuna have decreased and current catches are closer to estimated MSY levels. However, there is uncertainty about the level of the spawning stock biomass corresponding to MSY as a result of the caveats that applied to the 2001 assessment.

An evaluation of the likely long-term effects of a reduction of fishing effort or catch in both purse-seine and longline fishery was presented in Table 3.

As noted above, reductions in purse-seine fishing effort or controls on the catch of yellowfin or bigeye tuna would result in important losses of skipjack tuna, the main target species of this fishery. Similarly, effort or catch controls on longline fisheries could negatively affect those fleets that, while targeting other species, still catch bigeye tuna in small quantities as an incidental catch.