SOUTH PACIFIC COMMISSION

THIRD SOUTH PACIFIC ALBACORE RESEARCH WORKSHOP
(Noumea, New Caledonia, 9–12 October 1990)

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I. INTRODUCTION

The first South Pacific Albacore Research (SPAR) Workshop was held in Auckland in June 1986. It provided a forum to review existing albacore fisheries in the South Pacific, identify types and availability of albacore fishery statistics, review research and research findings on albacore, identify and assign priorities for future albacore research and finally provide for co-ordination of research on albacore in the South Pacific. The first SPAR Workshop took place in an atmosphere of 'development', emphasising exploratory trolling to identify distribution of the resource in time and space, and to assess resource potential. In addition to survey work, studies on age and growth, reproductive biology, mortality rates and stock identity were highlighted as requiring priority attention.

In the years following the first SPAR Workshop, the fishery underwent substantial changes. The troll fishery developed steadily and, in 1988–89, a large fleet of driftnet vessels, primarily from Japan and Taiwan, entered the South Pacific fishery. These developments resulted in the surface catch of albacore reaching an estimated 33,559 mt in 1988–89, doubling the total catch that had been taken by all fisheries at the time of the first SPAR Workshop. Because of these events the second SPAR Workshop, held in Suva, Fiji in June 1989, focused more on the status of the stock and the possible effects of the increase in surface-fishery catches, although research review and co-ordination remained important functions.

Partly because of the uncertainty expressed by the second SPAR Workshop regarding the sustainability of the increased surface catches and their possible effects on the longline fishery, Pacific Island countries and the distant-water fishing nations concerned began a series of consultations on arrangements for management of the South Pacific albacore fishery. At the second of these consultations in Honiara, Solomon Islands in March 1990, it was agreed that the SPAR group would function as an interim Scientific Advisory Group on Albacore (SAGA), advising future management consultations on the status of the stock and other scientific matters.

The third SPAR Workshop was held at South Pacific Commission headquarters in Noumea, New Caledonia from 9 to 12 October 1990. The Workshop was immediately followed by the third Consultation on Arrangements for South Pacific Albacore Fisheries Management.

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1. PRELIMINARIES

1.1 Opening address

1. The Director of Programmes of the South Pacific Commission (SPC), Mrs Hélène Courte, welcomed participants to the third South Pacific Albacore Research (SPAR) Workshop. She noted that recent developments in the fisheries targeting albacore in the South Pacific increased the need for sound scientific advice to assist fisheries management. However, advice required comprehensive data concerning the operations of fleets targeting albacore, together with good information relating to the biology of the fish. The Workshop was required to examine available information, suggest means by which it could be improved and discuss issues that require consideration if management of fisheries targeting South Pacific albacore is to be effective.

1.2 Election of Chairperson and rapporteurs

2. The outgoing chairman, Dr Antony Lewis, called for nominations for a Chairperson, noting that the person elected would serve for a period of two years during the transition of SPAR to SAGA, which would provide scientific advice to the proposed Management Body for South Pacific albacore.

3. Dr Tim Adams, Representative of Fiji, was elected Chairman and Dr Talbot Murray, Representative of New Zealand, was selected as co-ordinating rapporteur.

1.3 Adoption of Agenda

4. The agenda was adopted with the addition of an item on the relationship between SPAR and SAGA.

2. REVIEW OF THE FISHERIES

2.1 Additional information on the 1988–89 fishery

5. The Workshop reviewed developments within the 1988–89 and 1989–90 albacore fisheries exploiting the South Pacific stock. Plans for the upcoming 1990–91 fisheries were also described. The agenda focused on developments and updates of information available since the Second Consultation on Arrangements for South Pacific Albacore Fisheries Management, held in Honiara, Solomon Islands, from 2 to 7 March 1990. A series of working and information papers was tabled for discussion under specific agenda items. For the purposes of the report, summaries of each presentation and the discussion on each agenda item were prepared by a team of appointed rapporteurs.

6. Several participants were able to update or provide provisional estimates of total albacore catches in various fisheries. These corrections are incorporated in the summaries of nominal catch presented in Table 1 for longline fisheries and in Table 2 for the surface fisheries.

2.2 Review of the 1989–90 fishery

7. Results of the joint SPC/New Zealand observer activity for the 1989–90 albacore troll season were presented in Working Paper No. 2. Five observers covered a total of 263 observer days on six vessels between November 1989 and April 1990. They spent 25 observer days in November–December in the Tasman Sea on two vessels; 36 days on two vessels in November–December along the north-east coast of New Zealand; and 202 days from January to April on five vessels in the Subtropical Convergence Zone (STCZ) east of New Zealand.

8. Lengths of 55,715 albacore were measured and a substantial number of fish weighed and their girths measured. Size composition for the 1989–90 season was generally similar to that for the 1988–89 season. Three length modes (about 57 cm, 68 cm and 75 cm) were roughly equally represented in the Tasman Sea, with evidence of a fourth, smaller (<50 cm) mode. North-east of New Zealand, the two modes of larger albacore were dominant. In the STCZ in 1988–89, the mode of about 68 cm had been dominant; in 1989–90, the three modes were about equally represented initially, while the 75 cm mode decreased in representation progressively through to April, when a small (about 50 cm) mode began to be seen.

9. Average catch rates were poor (29 albacore per day) in the Tasman Sea, considerably better (158 per day) off north-east New Zealand, and most successful (336 per day) along the STCZ, where the catch rate was approximately twice the 1988–89 rate.

10. No driftnet-marked albacore were observed in the Tasman Sea and less than one per cent of the catch off north-east New Zealand was marked. However, 4.5 per cent of the STCZ catch exhibited 'recent' damage (mainly to albacore of the smaller modes) and 7.8 per cent (mainly albacore of the two larger modes) exhibited 'healed' marks. 'Healed' marks are attributed to 1988–89 driftnet encounters. No 'healed' marks had been evident in 1988–89 and the 'recent' marks then were more numerous, at 14.5 per cent. The ratio of the 1989–90 percentage of 'healed' marks to the 1988–89 percentage of 'recent' marks was used to provide a preliminary estimate of survival, equivalent to a total mortality rate of 0.58 per year; this includes the influences of M, F, mortality due to driftnet encounter, changing catchability, and emigration. The absence of driftnet-marked trolled albacore in the Tasman Sea may suggest that movement from the SCTZ to the Tasman Sea is minor. This was consistent with the limited number of observations in the south-east Australian longline catch between April and July, when no marked albacore were detected. In contrast, the longline catch off north-east New Zealand in May–June 1990 contained some marked individuals, as did New Zealand domestic catches in the Tasman Sea at the end of the season.

11. Japanese driftnet fishing activity, reviewed in Working Paper No. 8, was conducted in three areas of the South Pacific (the Tasman Sea, an area east of New Zealand from 175° to 155° W, and further east from 155° to 130° W). The Tasman Sea fishing area has been fished each year since the 1983–84 season, with an average CPUE of 609.6 albacore per vessel-day. The area immediately east of New Zealand has been fished during the same years, with the exception of 1987–88, with an average CPUE of 329.6 albacore per day, approximately half that of the Tasman Sea area. The highest CPUE on average was from the area furthest to the east, which has only been fished by driftnet vessels in three of the seven seasons since 1983–84. CPUE in the easternmost area was about 50 per cent higher that that of the Tasman Sea (953.5 albacore per day). Japanese driftnet fishing in the South Pacific was suspended at the end of the 1989–90 fishing season.

12. Average CPUE in the Japanese driftnet fishery increased from 1983–84 to 1987–88, which is attributed to technological refinements in the method. Driftnet CPUE subsequently declined

between 1987–88 and 1988–89. Further catch and effort data from the commercial fleet are expected, as Japanese scientists are making an effort to contact vessel owners directly for data from 1983–88 when the official logbook system was not in effect. The meeting commended these efforts to complete the data compilation on Japanese driftnet fishing.

13. The estimated catches in the 1988–89 and 1989–90 fishing seasons for the Japanese fleet in the South Pacific are 13,263 mt and 5,667 mt respectively. This decline in catch reflects declining vessel numbers.

14. Size composition of the catch from 1988–89 is available for the three areas, but in 1989–90 these data are not available for the area immediately east of New Zealand. While 2–3 modes are evident in most months for all areas sampled, fish in the easternmost area were on average larger than those in the Tasman Sea.

15. With the co-operation of JAMARC, the SPC and New Zealand MAF Fisheries carried out two observer cruises aboard the JAMARC RV *Shinhoyo Maru* (Working Paper No. 3). The purpose of the observer activities was:

- To measure size composition of the catch;
- To estimate by-catch species composition;
- To estimate albacore dropout rates during hauling;
- To estimate fleet aggregation and vessel movements;
- To score fish caught for net damage types.

16. Differences between fishing gear and methods used on the research vessel and on commercial driftnet vessels were described. Differences included fishing different areas and using less driftnet than commercial vessels and limited deployments of an experimental subsurface driftnet set 2 m below the surface.

17. Results of the observer cruises differed in several aspects between the Tasman Sea and STCZ fishing areas, as follows:

- CPUE in the STCZ was about twice that of the Tasman Sea;

- By-catch of skipjack tuna was much higher in the Tasman Sea than in the STCZ and appeared to be related to the higher temperatures there;

- There were differences in the size composition of both albacore and skipjack tuna between the areas (albacore were larger and skipjack smaller in the STCZ);

- Size composition of albacore in the Tasman Sea was divided into three distinct size classes, while modes in the STCZ were much less distinct;

- Albacore from the STCZ were of significantly higher body condition as inferred from length and girth measurements;

- Dropout rates of dead albacore during hauling were higher in the Tasman Sea (8.7%) than in the STCZ (3.7%). The National Research Institute for Far Seas Fisheries (NRIFSF) estimates for the Tasman Sea cruise were slightly lower than SPC estimates (7.3% as opposed to 8.7%);

- By-catch of fish, cephalopods, marine mammals, sea-birds and turtles differed markedly between areas, with 41 species caught in the Tasman Sea as opposed to 19 in the STCZ;

- Marine mammal, sea-bird and turtle by-catch was higher in the Tasman Sea;

- All marine mammals and sea-birds, with the exception of one whale, were dead; turtles were released alive;

- In the Tasman Sea, the by-catch of skipjack was reduced and no marine mammals, sea-birds or turtles were caught in the few deployments of driftnets set 2 m below the surface.

18. The observed differences between the two cruises are likely to be the result of differences in proximity to large land masses and to timing of the cruises (Tasman Sea in November– December, STCZ in February–March).

19. Working Paper No. 7 presented a review of Japanese albacore fisheries in the South Pacific. Targeting for albacore by Japanese longliners has decreased since the 1960s, when fishing for yellowfin and southern bluefin tuna increased. Therefore CPUE trends may not reflect abundance trends in this fishery accurately since albacore is essentially a by-catch. In general, however, albacore catch increased over the period 1977–82 and declined subsequently. Nominal CPUE parallels the trend in catch, except for the 1986–87 period, when CPUE increased while catch decreased. The trend in CPUE is confounded by changes in fishing areas, gear innovations, and probably other factors not discussed. Although the number of Japanese longliners operating in the South Pacific is unknown, data assembled by the SPC from vessels operating in the EEZs of SPC member countries indicate that 443 vessels fished during 1989.

20. The Taiwanese and Korean albacore longline fleets have been monitored regularly at their base in Pago Pago (Working Paper No. 9). CPUE in these fisheries increased during the 1970s and subsequently decreased during the 1980s. Of particular relevance to the development of the surface fishery are longline CPUE trends in the area which coincides with the STCZ troll fishery (35–40°S). In this area, higher catches are made than in other areas, but fish, on average, are smaller than those caught in lower latitudes. This suggests that there is potential for interaction between surface and longline fisheries in the same year. In the STCZ, both Taiwanese and Korean longline CPUE declined in the first two quarters of 1988–89 (Korean CPUE reached an all-time low), continuing a decline that seems to have been in progress since about 1986. These data suggest a reduction in albacore abundance in the STCZ, the causes of which are not yet known.

21. Three other countries have also been collecting information to detect interactions between surface and longline fisheries. New Caledonia has been monitoring the percentage of albacore in the total catch (Information Paper No. 4, Figure 1) and average weight (Information Paper No. 4, Figure 2) in longline fisheries in its waters. The observed trends appear to be seasonal, possibly due to immigration. Australia and New Zealand have been monitoring longline fisheries in their waters for the frequency of recent driftnet damage in albacore caught, as an indicator of driftnet escapement. Australia has not seen driftnet-damaged fish in longline albacore catches along the south-east coast of Tasmania, but New Zealand reported that driftnet-marked fish were a significant proportion of smaller albacore in longline catches along its east coast.

Review of fisheries in other oceans

22. The possibility of exchange of albacore between the Indian Ocean and South Pacific stocks prompted a review of recent trends in Indian Ocean fisheries. Several participants had attended the

recent Consultation on Stock Assessment of Tunas in the Indian Ocean held in Bangkok from 2 to 6 July 1990. They gave a brief overview of information presented during that meeting.

23. The major albacore fishing nation in the Indian Ocean is Taiwan, which uses both driftnet and longline fishing gears. CPUE data, based on effective effort in all longline fisheries (Taiwan, Korea and Japan combined), show a declining trend from 1964 (hook rate about 2.5 per cent) to 1971 (hook rate about 1.5 per cent). The rate had fallen to about 0.5 per cent in 1988. Data on longline fishing by both Taiwan and Japan show a recent trend towards increased targeting of yellowfin, bigeye and southern bluefin tuna for the sashimi market. Total catches by all fleets increased steadily from 67 mt in 1952 to 18,000 mt in 1964, fluctuating thereafter between 10,000 and 22,000 mt, except in 1974, when the catch reached 27,250 mt. The high exploitation of young albacore by the Taiwanese driftnet fishery in recent years does not appear to have affected the longline fishery yet.

24. Since 1986, and continuing through the 1988–89 fishing season, Taiwanese driftnet vessels have increased effort and catches of albacore from about 17,000 mt in 1986 to 19,000 mt in 1988–89. One hundred and forty-nine Taiwanese driftnet vessels were operating in the Indian Ocean in 1987–88, fishing mostly in the central Indian Ocean in a well-defined latitudinal band from 25 to 40° S. Anecdotal reports of increased activity by Taiwanese driftnet vessels operating from Cape Town in the Indian Ocean and the South Atlantic Ocean may explain where Taiwanese vessels displaced from the South Pacific will go.

2.3 Plans for the 1990–91 fishery

25. The driftnet fleet of Taiwan is expected to remain at 11 vessels, while the Japanese and Korean fleets have announced that they will not fish with driftnets in the coming season. The offshore troll fleet is expected to increase, primarily through increased numbers of smaller U.S. trollers, which will be serviced at sea. In addition, New Zealand and French Polynesian vessel numbers are expected to increase. Taiwanese and Korean longline activity, which had been expected to increase, because of rising oil prices may not do so. However, an increase in small nearshore domestic longliners targeting albacore and bigeye tuna is expected in New Zealand. The number of vessels likely to be operating in these fisheries is unknown.

3. REVIEW OF RECENT RESEARCH ACTIVITIES ON ALBACORE

3.1 South Pacific

Analysis of length-frequency data

26. During the second SPAR Workshop, the first information on the age and growth of South Pacific albacore was presented (SPAR 2/WP.18). This information, based on otolith increments, suggested that albacore grow faster than first thought, and that the modes seen in length-frequency data represent biannual cohorts rather than annual cohorts. To determine whether this interpretation is sound, an analysis of length-frequency data from the troll fishery was undertaken using the MULTIFAN software package (Fournier et al., 1990[1]). This analysis, presented in Working Paper

1. Fournier, D.A., J.R. Sibert, J. Majkowski and J. Hampton. 1990. MULTIFAN a likelihood-based method for estimating growth parameters and age composition from multiple length-frequency data sets illustrated using data for southern bluefin tuna *(Thunnus maccoyii). Can. J. Fish. Aquat. Sci. 47:* 301-317.

No. 1, incorporated annual and biannual models, but was not conclusive as to which model provided the better fit to the data. However, an extremely good fit of the annual model to data from four of the five recoveries of tagged South Pacific albacore that had useful recovery lengths was obtained, suggesting that the annual model was appropriate. Further analysis is warranted, particularly in incorporating length-frequency data from the longline fishery. The further development of MULTIFAN leading to an integrated age-structured analysis of South Pacific albacore was suggested as a promising stock assessment approach.

Seasonality of spawning

27. Preliminary results of three TBAP gonad sampling projects in the region (the PAFCO cannery at Levuka, Fiji; Noumea port; and on board the Tongan longliner MV *Lofa*) support the standard hypotheses that albacore reach maturity at about 90 cm fork length and spawn in the austral summer (Working Paper No. 6). In addition, albacore of both sexes may employ an 'opportunistic' reproductive strategy during the spawning season, with one gonad of each pair being considerably reduced in size and perhaps kept in reserve. Histological examination of the gonads will be undertaken to determine at what stage spawning occurs, but this will depend on locating a suitable laboratory to do the work.

Fiji

28. The Fisheries Division plans to become more involved in the TBAP-instigated sampling project at Levuka by placing at the cannery a full-time Research Officer who will be responsible for length-frequency sampling of all tuna species landed and will also collect albacore gonads. An annual licensing system for the growing domestic longline fishery (targeting bigeye and yellowfin but with a substantial albacore by-catch) will soon be introduced and this will involve compulsory submission of daily log books, which will consequently increase the amount of data available next year. Fijian observers from the FFA/US purse seine observer programme will be able to undertake trips on the domestic longliners and will be able to collect length data and gonad samples.

Australia

29. The possibility of Australian observers collecting gonad samples on Japanese longliners operating in the Australian Fishing Zone has been investigated but may be impractical as the Japanese fishermen do not want the albacore damaged in any way; however, length data are currently being collected.

New Caledonia

30. It is not possible to place observers on the longline vessels operating out of Noumea as there is no room for extra people on board. A routine port sampling programme could be set up if necessary. The TBAP, however, is currently sampling the catch of this fleet.

Tonga

31. Research presently undertaken in Tonga consists of albacore gonad sampling on board the longliner MV *Lofa* in collaboration with the TBAP. Length-frequency data are also collected to coincide with the gonad samples.

New Zealand

32. Two research cruises are planned for the coming season, one of which will concentrate on tagging albacore in the New Zealand EEZ. Observer coverage is proposed for domestic troll vessels, a portion of the United States troll fleet planning to fish in the zone in the coming season and on the growing domestic longline fleet. The observer programme on Japanese southern bluefin tuna longliners, which covers the entire season, will be continued and hopefully extended.

French Polynesia

33. French Polynesia noted no change in present research activities, with ORSTOM continuing to collect length data on foreign licensed longliners (published in an annual report), and EVAAM continuing to measure troll-caught fish being landed in Papeete and assessing driftnet damage where possible. EVAAM plans to assess the artisanal albacore fishery, to determine the size of the catch.

U.S.A.

34. The National Marine Fisheries Service (NMFS) has continued its monitoring programme in American Samoa, collecting log books and length data from Taiwanese and Korean longliners and U.S. trollers that land to the two canneries situated in Pago Pago. There are plans to investigate the possibility of obtaining time- and area-specific length data but this may be limited by available funds.

35. Otolith interpretation work is ongoing, but during 1990 has tended to concentrate on North Pacific albacore, particularly large fish (110 cm) being landed in Hawaii, because of the current crisis status of that stock.

3.2 Other areas

36. During the second or third quarter of 1991 a workshop on albacore will be held in Japan to address the status of the North Pacific albacore stock, which is currently thought to be at a low level. Scientists from Japan, U.S.A., Canada, and possibly Taiwan will co-operate on a wide-ranging research programme that includes:

- Analyses of CPUE by size categories to track different year classes in the various fisheries;

- Ageing studies, particularly of large albacore to determine whether there is an unfished, residual population of spawning fish;

- Gonad sampling to determine the location, seasonality, frequency and duration of spawning (Information Paper No. 3).

37. Japan, Canada and USA have begun a large-scale observer programme on Japanese driftnet vessels in the North Pacific; this programme will provide valuable data on the stock. In addition, the USA is carrying out observer programmes on Taiwanese and Korean driftnet vessels, in co-operation with those countries. In all of these observer programmes, information on North Pacific albacore catch and by-catch is being obtained.

38. A Taiwanese research vessel will be undertaking a six-week cruise from late October 1990 in the Indian Ocean to determine the differences in catch rates between driftnet and longline gear set

in the same area. The vessel will also collect biological samples for age and growth studies, and for genetic identification of albacore stock structure in the southern hemisphere.

39. In the Atlantic Ocean, research on albacore continues, and is presently being reviewed at a meeting of ICCAT member countries in Madrid. Results of this meeting will be made available at the next SPAR meeting.

4. REVIEW OF AVAILABLE FISHERY DATA

4.1 Update of best estimates of historical catch and effort

40. The meeting revised and updated details of catch and vessel numbers for the various components of the South Pacific albacore fisheries, adding annotations on sources of data and the areas to which they related (Tables 1, 2 and 3). South Pacific albacore fisheries have been subject to rapid change in the significance of surface components in recent years. There were indications that this would continue for some time with uncertain consequences for the stock. This highlighted the need for prompt availability of catch, size composition, and effort data. Where detailed data for a component of the fishery would be unavoidably delayed, it was important to develop preliminary estimates, perhaps taking advantage of the usually more timely availability of trend indicators to industry. The meeting recognised that obtaining such information could be time-consuming but urged all countries to facilitate this where necessary by the provision of appropriate resources.

41. The meeting agreed that provisional estimates of most recent catches and fisheries trends should be available to each SPAR meeting. Provisional data, which could be expected to be made available for the next meeting of the SPAR group, and their sources, are outlined in Table 4.

4.2 SPAR database arrangements

42. The status and coverage of the SPAR database were reviewed in Working Paper No. 4. Provision of additional information, just prior to the meeting, necessitated revision of the tables describing the database; the revised tables are included here for reference (Tables 5 and 6). The meeting noted that, for most components of the fishery and countries involved, data in some form was either available on the database, or to SPC, or was expected to be forthcoming during 1990.

43. In reviewing the status of the database, the meeting drew attention to several aspects requiring specific comment. The delay in processing New Zealand troll fishery catch and effort data was again noted with growing concern; the meeting emphasised the importance of timely availability of the information and urged prompt action to reduce the backlog. The delay in processing albacore length-frequency data gathered by Australian observers during Japanese longlining in adjacent waters was also noted; the meeting emphasised the importance of the information and urged prompt attention to the matter.

44. Japan's provision of albacore catch, size composition and effort data to SPC for South Pacific driftnet operations for 1986–88 and for 1981–88 longline operations was commended. It was noted that 1983–85 driftnet data were in preparation and would be forwarded to SPC in due course. While availability of the data to SPC would facilitate assessment work, it was noted that Japan specified that their incorporation in the SPAR database, and hence distribution to other members, was not permitted. The meeting recommended that Japan be requested to reconsider the question

of inclusion of the data in the SPAR database, given that data for all other countries had either been provided already or were about to be.

45. As a sign of good faith and to provide an illustration of the scope and nature of the aggregation of the data, the meeting agreed that a summary of the SPAR database should be distributed to all potential contributors, with advice that subsequent access would only be available to contributors to the database.

46. In general discussion, the meeting noted that the key issues relating to data exchange for the workings of SPAR are: data submission should be timely, incorporating preliminary estimates to ensure completeness, and that the data should be available for co-operative exchange with interested researchers. The time and area aggregation previously specified had been selected to ensure confidentiality and so encourage co-operation and exchange. Continued co-operation by those who had already provided data would only be fostered if they could be shown that reciprocal availability of data, at a similar level of aggregation to their own, could be anticipated.

5. STATUS OF THE SOUTH PACIFIC ALBACORE STOCK

5.1 Trends in fisheries indices

47. After a rapid increase in driftnet fishing effort in the South Pacific to at least 130 vessels in 1988–89, the fleet was reduced to 30 vessels in 1989–90 and will be further reduced to a maximum of 11 vessels in 1990–91. The troll fleet on the other hand continued to increase at a moderate rate. These changes are reflected in the total surface fishery catch which declined markedly from 33,500 mt in 1988–89 to about 16,000 mt in 1989–90 (Table 2).

48. Abundance indices suggest that the stock is responding to this trend of reduced exploitation. For example, CPUE for the troll fleet recovered in 1990 after declining since 1987; CPUE for the driftnet fleet also increased following the significant reduction in the fleet's size (Figure 1). CPUE for the longline fleet, although fluctuating historically, declined steadily since 1986, particularly in the higher latitudes (Figure 2), but is expected to improve beginning about 1992 when year classes not exposed to the high driftnet fishing effort begin recruiting to the longline fishery.

5.2 Best estimate of stock limits

49. The question of stock structure was deliberated at length. In particular, the group sought to define a unit stock for purposes of biological modelling and stock assessment. Available information on albacore stock structure in the South Pacific, North Pacific, and Indian Ocean was reviewed in Working Paper No. 5. The review encompassed results of catch rate distributions, genetic research, migration (tag recovery data), the geographical and temporal distribution of spawning, and other factors.

50. Additional information on albacore physiology and its relationship to the environmental requirements of albacore was also presented. These environmental requirements (mainly temperature and dissolved oxygen minima) are age-dependent and shown in Figure 3 for albacore larvae, juveniles and adults. The latitudinal distributions of the critical temperature and dissolved oxygen concentrations (Figure 4) clearly demonstrate the separation between the North and South Pacific stocks, although some exchange between the adult components of the stocks is possible. The available evidence indicates that albacore in the North and South Pacific constitute discrete stocks.

The exchange of albacore which might occur between the South Pacific and Indian Oceans is not known but is believed to be low.

51. South Pacific albacore range approximately from equatorial waters to the southern extremity of the STCZ, and from the South American coast westward into waters south of Australia. The SPAR group accepts these as the biological limits of the stock. Most of the catch of South Pacific albacore, however, is taken from a more restricted area within this broad region (Figure 5). Accordingly, barring a significant area expansion of the fisheries, the effective fishing area for South Pacific albacore stock can be defined as the area between the equator and 50° S, and between 90° W and 140° E.

52. As more information is gathered about the biology and habitat of South Pacific albacore, the definition of unit stock limits may have to be revised. For example, as in the North Pacific, further research may indicate the existence of subpopulation structure (two or more stocks) within the broad region now defined for a single stock.

5.3 Best estimate of current status of the stock

53. Before the recent expansion of surface fisheries, the maximum sustainable yield of the longline fisheries for South Pacific albacore had been estimated using surplus production models. These analyses, based on historical longline catch and effort statistics, suggested that the longline fleets could take a sustained catch of about 35,000 mt per year in the presence of the small troll fishery operating at the time (about 2,000 mt per year). The average longline catch during the mid-1980s, before the expansion of surface fisheries, was about 30,000 mt.

54. The longline fishery harvests primarily large, mature albacore. On average, the troll and driftnet fisheries catch smaller, younger albacore (Figure 6). Yield-per-recruit considerations suggest that the aggregate yield from the stock would be maximised by expanding the surface fisheries over their levels in the early 1980s to increase the harvest of smaller albacore. However, it is not known exactly how large a catch can be sustained in the surface fisheries, or in the combined surface and longline fisheries. Nor can these maximum sustainable yield levels be determined from the longline fishery surplus production models. As noted at the second SPAR Workshop, assessment of yield potentials in the multi-gear fishery harvesting both older and younger age classes will require additional information on the size and age composition of catches from all fisheries over a period of years, and information on growth rates, mortality rates, and other factors.

55. Considerable progress in estimating these critical parameters has been made during the past year. Nevertheless, there is still an insufficient basis for estimating safe catch levels for surface fisheries, or for all fisheries combined.

56. At the time of the second SPAR Workshop in June 1989, an explosive increase in the harvest of smaller albacore was unfolding, primarily due to expansion of the driftnet fisheries. Concerns were raised about potential overfishing, heightened by the uncertainty over maximum sustainable yield levels. The best data available at the time suggested that the combined troll and driftnet fleets caught between 34,000 mt and 59,000 mt during the 1988–89 fishing season. More recent statistics presented at this workshop (Table 2) suggest that the 1988–89 surface catch was at the lower end of this range, i.e. about 33,500 mt.

57. Concerns about driftnet fishery expansion resulted in a significant reduction of Japan and Taiwan's South Pacific driftnet fleets during the 1989–90 fishing season. Preliminary data indicate

that in 1989–90 the total surface fishery catch was reduced to about 16,000 mt and that the catch by driftnet vessels may be slightly less than that of troll vessels.

58. The reduction in driftnet catch clearly lessens the risk of overfishing the albacore stock. However, even a relatively modest expansion of the surface fisheries will reduce potential yields in the longline fishery. Because the longline fishery catches older albacore, on average, than the surface fisheries, in most longline fishing areas it will take two or three years before the impact of the higher surface fishery catches can be directly measured.

59. Given the reductions in the driftnet fleets and the total surface catch in the 1989–90 fishing season, and the expectation of further significant reductions in the number of driftnet vessels operating during the upcoming 1990–91 season, there appears to be no immediate need for management action to reduce fishing effort further. However, there is still great uncertainty about South Pacific albacore yield potentials and fishery interactions. Accordingly, there is a critical need to continue the careful monitoring of all South Pacific albacore fisheries and to continue research as a basis for sound management advice.

60. Plans to improve fishery monitoring and analyse stock dynamics should be fully implemented. Reliable monitoring and assessment will require greater attention to the collection of accurate and timely statistics on catch and effort in all the fisheries, and improved data on the size composition of the catch. Biological studies on growth, reproduction and other critical parameters for stock assessment should be accelerated and numerical models for estimation of population dynamics and assessment of fishery interactions should be expanded.

6. FUTURE RESEARCH PLANS AND REVIEW OF STRATEGIC RESEARCH PLAN

61. The meeting reviewed progress on each component of the Strategic Research Plan for South Pacific albacore developed at the second SPAR Workshop. Following discussion on these, further elements of a revised strategic plan were elaborated and specific organisational commitments agreed. A summary of the organisations and their responsibility for each strategic plan component, as agreed at the meeting, is given in Table 7.

6.1 Tagging studies

62. Tagging has been recognised as a useful technique for the estimation of vital population parameters and interaction between gear types in the South Pacific albacore fisheries. Tagging studies have been co-ordinated by the SPAR group since 1986, with well over 7,000 troll-caught albacore tagged. Most tagged albacore have also been injected with oxytetracycline for age validation studies. Discussion of tagging centred on the SPC albacore tagging programme to be initiated this December. Of concern were the possible reasons for the low recovery rates in previous albacore tagging. SPC cited experience in the North Pacific on albacore which suggests that significantly more tag recoveries can be expected in tagged fish initially caught by pole-and-line fishing as opposed to trolling. Preliminary results with a coastal pelagic species in New Zealand were reported which suggest that the use of oxytetracycline may also have lowered tag recoveries of albacore. In the experiments cited, approximately 25 per cent of fish injected with the same dose of oxytetracycline per kg body weight as in the South Pacific albacore fishery died within two weeks of injection.

63. Although no clear reason for low tag recoveries can be determined at present, the upcoming SPC tagging experiment should provide an answer to the effect of method of capture on fish

survival, since fish will be caught by trolling and by pole-and-line fishing. As in previous years New Zealand scientific staff will carry out at least one tagging cruise in 1990–91 and will also contribute one staff member to assist SPC during December. Tagging in December will take place in the New Zealand EEZ and in the Tasman Sea, with a further 1–3 months planned for the STCZ if the first two months are successful. The SPC albacore tagging programme will use SPC tags and as of this year New Zealand tag releases will also use SPC tags. This change in tagging protocol will allow advantage to be taken of the increased awareness, in and outside the region, of SPC's tagging programmes, resulting from the Regional Tuna Tagging Project (RTTP) in tropical waters.

64. Funding for the tagging programme is from the EC, with additional funds from ICOD to recruit an albacore scientist within SPC. The EC funding also ensures continuance of the highly successful scientific observer programme which has been operating over the past two years.

65. The involvement of the United States in the 1990–91 tagging experiment is at present uncertain and is awaiting the annual general meeting of the albacore trollers association to decide on their ability to tag fish this coming season. Other supplementary tagging programmes included JAMARC/CSIRO plans to tag small southern bluefin tuna this November–December while also tagging any albacore they catch. If tagging can be undertaken in this area it may indicate the direction of movement of albacore in the waters south of Australia where exchange between the Indian Ocean and South Pacific stocks may occur.

66. Tagging will be the primary task of SPC, with collaboration from the Department of Primary Industries and Energy of Australia, MAF Fisheries of New Zealand, and NMFS (United States).

6.2 Reproductive studies

67. Preliminary results of studies on seasonality of spawning have already been described. NMFS has established the capability to analyse gonad samples which is primarily focused on studies of North Pacific albacore. The possibility of NMFS assisting with the analysis of South Pacific albacore was discussed; samples collected with the assistance of Fiji, New Caledonia, Tonga and Cook Islands will be analysed as of this year. Australian and New Zealand scientists offered to assist with gonad collections in more southern waters if samples were desired. Discussion regarding the collection of sex ratio data highlighted the fact that gonad sampling was also providing useful information in other areas as well. Data on sex ratio in relation to size will be an additional benefit from these studies and should provide insights into differential mortality and growth between sexes.

68. Discussion at the second SPAR Workshop suggested that it may be possible to collect regular samples of tuna eggs and larvae during oceanographic cruises of TOGA and SURTROPAC. Reports this year indicated that this was not feasible due to other programme priorities. Directed studies of tuna larval distributions, however, are planned in the future when the new NRIFSF research vessel is launched. At present Japan is the only SPAR participant capable of undertaking this work.

6.3 Age and growth studies

69. The growth increments in otoliths and caudal vertebrae are yet to be validated but the recovery in 1989 of one whole albacore that was tagged and injected with oxytetracycline in 1987 shows promise of changing this in the near future. Age validation has been a co-operative programme between New Zealand and NMFS participants and will be completed in 1991. Research institutes in Taiwan expressed interest in extending current age and growth studies in the Indian Ocean, using

using hard parts, to the South Pacific, provided material could be collected by SPC and other SPAR participants, and subject to other commitments. Australia, SPC, Fiji, New Caledonia and Tonga have assisted in previous hard part studies and will assist where possible in future studies. It was suggested that although existing techniques were yet to be developed for microchemical analysis, it would be useful to begin routine collection of otoliths. For instance, in other tuna fisheries it has been shown that when stock abundance is lowered significantly the growth rates can change. Such information may be detected in otoliths in a comparison of growth increments before and following the high levels of driftnet fishing in 1988–89.

70. The programme of port and vessel sampling for length frequency of the catch will be ongoing. These data, especially those collected by observers, have provided extremely valuable information for estimating growth. SPC will continue to be the main agency responsible for this programme, with collaboration from Australia, New Zealand, NMFS, Fiji, French Polynesia, New Caledonia and Tonga.

6.4 Scientific observer programme

71. The information gathered by observers on catch rates, size composition, loss rate, etc., has been essential for developing stock status reports and for collecting information for future stock assessments. Observer deployments have thus far been restricted primarily to troll vessels but two driftnet areas were also covered in 1989–90. Observers are the only reliable way to gather consistent, specific data for the time–area strata required to detect changes in abundance and changes in fishing strategy needed to help interpret CPUE data.

72. Continuation of the observer programme is essential to provide data for albacore stock assessments and particularly to assess interactions between fisheries. SPC indicated that it would continue to support some observers with EC funding of the albacore project. The meeting strongly endorsed the SPC's observer programme and recommended that it be augmented by other agencies in the region. Australia, New Zealand and NMFS participants all promised to do whatever they could to contribute to this programme which they see as critical to the success of albacore fisheries assessments. In discussion, the prospects of expanding observer coverage to include longline vessels, particularly in the areas adjacent to troll fishery grounds, was explored. NMFS plans to assess the feasibility of placing observers on Pago Pago-based longliners in 1991. Placement of observers on longline vessels may be logistically difficult but the possibility of contracting ni-Vanuatu and Tuvaluan crew on Taiwanese and Korean longliners will be explored by SPC.

6.5 Albacore fisheries monitoring

73. Most participants have plans to continue close monitoring of fisheries indicators like CPUE, size composition, incidence of driftnet marks, etc., as input to stock status reports and for future stock assessments. SPC, NTU and NMFS will focus on longline CPUE while NRIFSF and NTU will focus on driftnet CPUE. Interaction between surface and longline fisheries will be the primary responsibility of SPC with collaboration from Australia, NRIFSF, New Zealand, NTU, NMFS, Fiji, French Polynesia, New Caledonia, and Tonga. The focus of this work, and that of the observer programme, will be to provide data for modelling stock dynamics so that stock assessments can be made. In addition to improving data reliability and coverage there is also a need to continue development of population dynamics models and stock assessment methods for albacore. This work will be undertaken by NTU, SPC and NMFS.

6.6 Driftnet dropout rates and troll fishery escapement

74. While Japan has completed its experiments in the South Pacific, the meeting expressed particular interest in any experiments planned by Japan or NTU in other areas. NMFS participants also pointed out that they planned a series of experiments on driftnet dropout in the North Pacific, both at sea and in laboratory wave tanks; these results would be fully available to SPAR.

75. The meeting also noted the need to estimate troll fishery escapement, and some of the complicating factors in estimating this were reviewed. New Zealand scientists will undertake a review of the existing data and present best estimates of loss rate of troll-caught albacore to the next SPAR meeting.

6.7 Oceanography

76. Satellite sea-surface temperature charts produced during 1988–89 and 1989–90 were considered extremely useful for interpreting fishing success. New Zealand has provided these charts on a cost recovery basis to fishing industry groups and plans to produce charts for the 1990–91 season. The desirability of providing these charts to SPC in support of its tagging programme was noted and agreed.

7. OTHER BUSINESS

7.1 Structure and function of the Scientific Advisory Group on Albacore (SAGA)

77. At the Second Consultation on Arrangements for South Pacific Albacore Fisheries Management, a group of scientists representing countries present drafted the structure and functions of a scientific advisory group, herein referred to as SAGA, that could be associated with a management regime for South Pacific albacore (Working Paper No. 10, Attachment N). SPAR endorsed this draft on the basis that the following points required further consideration:

- the submission of data concerning all fisheries harvesting South Pacific albacore was required, including those in which albacore are not the primary target;

- SAGA would require adequate funding (including the possibility of interim funding prior to the establishment of a management regime) to ensure that the research required for management is done;

- timing for submission of data to SAGA should be structured on the basis of the completion of fishing seasons and the anticipated scheduling of meetings of the scientific group. There are practical reasons why it would be most appropriate for SAGA to convene annually in October, prior to the start of the surface fishing season. The secretariat would require data at least one month in advance of that meeting and September 1 was agreed as an acceptable guideline. However, it was also agreed that it would be desirable to submit data to the secretariat in time for it to be circulated to all contributing members of SAGA, so that at least preliminary analysis and documentation could be completed prior to the meeting. The following guidelines for data submission were proposed:

  (a) Catch and effort data for surface fisheries aggregated by 5° square and month for the fishing season should be made available on or before September 1 following the end of the most recent fishing season.

(b) Catch and effort data for longline fisheries aggregated by 5° square and month for each calendar year should be available on September 1, 20 months following the end of the calendar year.

(c) Provisional estimates of total annual catch for longline fisheries should be made available on September 1, 8 months following the end of the calendar year.

(d) Length-frequency data stratified by 5° latitude by 10° longitude by month should be available at the same time as aggregated catch and effort data;

– that SAGA should have an obligation to provide advice to the management body as issues or information arise once the management body is established.

78. Timely submission of information appropriate for consideration by a scientific advisory body was considered essential. In addition, it was agreed that arrangements for the storage and distribution of information submitted to SPAR should be formalised.

79. SPAR agreed that the chairperson would be available as the linkage between SPAR and the Third Consultation on Arrangements for South Pacific Albacore Fisheries Management.

7.2 Report on the FAO Expert Consultation on Interactions of Pacific Ocean Tuna Fisheries

80. The representative of FAO reported that the consultation planned for the first quarter of 1991 in Noumea had been delayed due to difficulties in securing funding. As a consequence the consultation had been rescheduled to begin on the first Tuesday in December 1991, and was planned as an eight-day meeting. The consultation would consist of a set of working groups for the major species of Pacific Ocean tunas, each with a chairperson responsible for preparing a report on interactions between various fisheries prosecuting a particular stock. In addition each chairperson was required to update the status of knowledge for each stock. The chairperson of the South Pacific albacore working group (Dr Talbot Murray) briefly outlined his plans for integrating the work of SPAR into the report to the consultation.

7.3 Prospects for future synoptic research surveys by SPAR

81. The scientists from NMFS raised for discussion the prospects of co-ordinated multi-institution research surveys to improve knowledge of albacore ecology in the South Pacific. The benefits of co-ordinated synoptic surveys similar to those planned and implemented through the first SPAR Workshop in 1986 were recalled. It was suggested that, given the amount of planning required for research of this scale, participants consider the issue for further discussion at the next meeting of SPAR and if possible bring forward research proposals for discussion at that time.

8. ADOPTION OF THE REPORT

82. The meeting adopted the report by consensus.

IV. LIST OF PAPERS PRESENTED AT THE MEETING

Working Papers

1. MULTIFAN analysis of South Pacific albacore length-frequency data collected by observers, 1989–1990. *Hampton, J., D.A. Fournier and J.R. Sibert.*

2. South Pacific Albacore Observer Programme on troll vessels, 1989–1990. *Hampton, J. and T. Murray.*

3. Report of observer activity on board JAMARC driftnet vessel R.V. *Shinhoyo Maru* fishing for albacore in the South Pacific Ocean, 22 November – 23 December 1989 and 10 February – 3 March 1990. *Sharples, P., K. Bailey, P. Williams and A. Allan.*

4. Availability of South Pacific albacore data. *Lawson, T.*

5. South Pacific albacore stock structure: a review of available information. *Lewis, A.D.*

6. Sampling of South Pacific albacore gonads by the Tuna and Billfish Assessment Programme, November 1989 – October 1990. *Bailey, K.*

7. A review of Japanese albacore fisheries in the South Pacific. *Watanabe, Y. and Y. Nishikawa.*

8. Catch trends and length frequency of southern albacore caught by Japanese driftnet fishery. *Watanabe, Y.*

9. South Pacific albacore longline CPUE monitoring. *Wetherall, J.A. and M.Y.Y. Yong.*

10. Record of Proceedings of the Second Consultation on Arrangements for South Pacific Albacore Fisheries Management.

11. Review of Garcia's estimators and step by step stock assessment of South Pacific albacore. *Wang, C.H. and J.F. Yao.*

Information Papers

1. Simulation of the South Pacific albacore population: effects of rapid developments in the surface fishery. *Hampton, J.*

2. Review of research and of recent developments in South Pacific albacore fisheries, with emphasis on large-scale pelagic driftnet fishing. *Murray, T.*

3. Pacific albacore reproductive biology sampling instructions. *Bartoo, N.*

4. Characteristics of catches of albacore *(Thunnus alalunga)* in the Exclusive Economic Zone of New Caledonia from 1986–1989. *Etaix-Bonnin, R.*

5. Report on drop-out observations in driftnet fishing. *Watanabe, Y.*

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ANNEX 1

Action Items for 1990–91

1. Tagging studies

- SPC to carry out a tagging programme in 1990–91 in troll fishery areas using a combination of pole-and-line and trolling.
- New Zealand to provide one staff member for the SPC tagging programme during December.
- New Zealand to assist SPC with access formalities for albacore, other tuna fishing and for baitfishing in the New Zealand EEZ.
- New Zealand to conduct a tagging cruise in January–February period using trolling.
- CSIRO to tag all albacore caught during JAMARC/CSIRO tagging cruise south of Australia starting November 1989.
- NMFS to investigate possibilities of tagging from US troll vessels.
- All SPAR participants to assist SPC with tag recoveries.

2. Reproductive studies

- SPC to continue gonad sampling with the assistance of Fiji, New Caledonia, Tonga, Cook Islands, Australia and New Zealand.
- NMFS to assist SPC with analysis of gonad samples.

3. Age and growth studies

- All agencies currently collecting length frequency data (SPC, Fiji, French Polynesia, Tonga, New Caledonia, NMFS, New Zealand, and Australia) to continue port and vessel sampling and where possible increase coverage.
- New Zealand and NMFS to analyse hard parts from tetracycline-injected fish recovered in 1989.
- NMFS to initiate otolith microstructure studies.
- NMFS to initiate otolith ageing studies of large albacore.

4. Scientific observer programme

- SPC to fund two observers for the 1990–91 albacore season.

- NMFS to carry out an observer feasibility study for the longline fishery based in Pago Pago.

- SPC to investigate the possibility of contracting ni-Vanuatu and Tuvaluan crew on DWFN longline vessels to collect size frequency and other fisheries data.

- New Zealand and Australia to investigate the possibilities for observer coverage by their observer programmes within the Australian AFZ and New Zealand EEZ in 1990–91 on troll and longline vessels.

5. Fisheries monitoring

- DPIE to provide provisional estimates of Australian longline and pole–and-line catches and effort for 1990 before the next SPAR meeting.

- EVAAM to provide provisional estimates of longline, handline and troll catches and effort by French Polynesia for 1990 before the next SPAR meeting.

- Marine marchande to provide provisional estimates of New Caledonian longline catches and effort for 1990 before the next SPAR meeting.

- NRIFSF to provide provisional estimates of longline catches and effort by Japan for 1990 before the next SPAR meeting.

- SPC to provide provisional estimates of longline catches and effort by Korea for 1990 before the next SPAR meeting.

- MAF Fisheries to provide provisional estimates of troll and longline catches and effort by New Zealand for 1990–91 before the next SPAR meeting.

- NTU to provide provisional estimates of longline catches and effort for 1990 and driftnet catches and effort by Taiwan for 1990–91 before the next SPAR meeting.

- Fisheries Division, Tonga MAFF, to provide provisional estimates of longline catches and effort by Tonga for 1990–91 before the next SPAR meeting.

- NMFS to provide provisional estimates of troll catches and effort by USA for 1990–91 before the next SPAR meeting.

- All participants will maintain and where possible improve fisheries monitoring programmes and report the extent and type of sampling coverage during the year at the next SPAR meeting.

6. Driftnet dropout rates and troll fishery escapement

- NMFS to report on results of North Pacific experiments conducted in 1990–91.

- Japan and Taiwan to report on results of experiments conducted in 1990–91.

- New Zealand to estimate the loss rate of albacore in the troll fishery.

7. Oceanography

- New Zealand to provide satellite-derived sea-surface temperature (SST) summary at the next SPAR meeting.

- New Zealand to provide SST charts in support of the SPC tagging cruise.

Key to acronyms

AFZ	Australian Fishing Zone
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
DPIE	Department of Primary Industries and Energy (Australia)
DWFN	Distant-water fishing nation
EEZ	Exclusive Economic Zone
EVAAM	Etablissement pour la valorisation des activités aquacoles et maritimes (French Polynesia)
JAMARC	Japan Marine Fishery Resource Research Center
MAF	Ministry of Agriculture and Fisheries (New Zealand)
MAFF	Ministry of Agriculture, Forestry and Fisheries (Tonga)
NMFS	National Marine Fisheries Service (United States)
NRIFSF	National Research Institute of Far Seas Fisheries (Japan)
NTU	National Taiwan University (Republic of China)
SPAR	South Pacific Albacore Research Group
SPC	South Pacific Commission
SST	Sea-surface temperature

ANNEX 2

Table 1. Longline catches (mt) of South Pacific albacore by country and calendar year (estimates and provisional totals are shown in parentheses; estimates do not include research or training vessel catches)

Year	Australia	French Polynesia	Japan	Korea	New Caledonia	Taiwan	Tonga	TOTAL
1952			210					210
1953			1091					1091
1954			10200					10200
1955			8420					8420
1956			6220					6220
1957			9764					9764
1958			21558	146				21704
1959			19344	456				19800
1960			23756	610				24366
1961			25628	330				25958
1962			38880	599				39479
1963			33500	1367				34867
1964			21435	2911				24346
1965			19305	6405				25710
1966			23401	10817				34218
1967			16640	13717		11751		42108
1968			7707	10138		12424		30269
1969			5559	9963		9595		25117
1970		+	6560	11599		14689		32848
1971		+	4339	14482		15887		34708
1972		+	2796	14439		16814		34049
1973		+	2381	17452		17742		37575
1974		+	1847	12194		17283		31324
1975		+	1045	9015		17071		27131
1976		+	1906	12212		13700		27818
1977		+	2240	13176		21932		37348
1978		+	2520	10989		20942		34451
1979		+	2350	8682		15086		26118
1980		+	2488	10852		18180		31520
1981		+	4856	14793		14595		34244
1982		+	4900	12586		12689	95	30270
1983		+	4928	6669		12119	125	23841
1984		+	3607	5730		11155	152	20644
1985		+	3746	14267		9601	253	27867
1986	40	+	4466	18799	185	11913	230	35633
1987	200	+	4085	8646	563	15009	267	28770
1988	200	+	6894	6896	567	17120	230	31907
1989	(590)	(<100)	(5100)	(9000)	(500)	(14000)	196	(29486)

+ denotes small catches of unknown size.

Source of estimates for 1952-1988 = SPAR 2 Report
Estimates for French Polynesia = S. Yen
Estimates for 1989 New Caledonia catch = R. Etaix-Bonnin
Estimates for Tonga = V. Fakalolo
Estimate for 1989 Taiwanese catch = C.H. Wang

Australian catches are by-catch in a yellowfin fishery.

Japanese catch in 1989 is average of 1986-88 catches.

Korean catch in 1989 is the difference between known landings (22,500 mt) sum and estimated catches of DWFN nations.

1989 Australian catch includes 530 mt taken by Australia/Japan joint venture longline and provisionally 60 mt from the domestic longline fishery. Source: A. Caton.

1986-88 Australian catch derived from logbook returns raised to take account of limited coverage prior to 1989. Source: A. Caton.

ANNEX 3

Table 2. Surface fishery catch (mt) of South Pacific albacore by country and gear (estimates and provisional totals are shown in parentheses; estimates include catch by JAMARC research vessels)

Year	Australia p/l & sport	Japan p/l	Japan driftnet	Korea driftnet	Taiwan driftnet	NZ troll	USA troll	TOTAL
1960		45						45
1961								0
1962								0
1963		16						16
1964								0
1965								0
1966								0
1967								0
1968								0
1969								0
1970	(200)							200
1971	(200)							200
1972	(200)							200
1973	(200)							200
1974	(200)					898		1098
1975	(200)					646		846
1976	(200)					25		225
1977	(200)					621		821
1978	(200)					1686		1886
1979	(200)					814		1014
1980	(200)	19				1468		1687
1981	(200)	8				2085		2293
1982	(200)	1				2434		2635
1983	(200)	2	32			744		978
1984	(100)		1581			2773		4454
1985	(100)		1928			3253		5281
1986	(100)		1936			1911	89	4036
1987	(100)		919			1227	748	2994
1988	(100)		4271		1000	330	3527	9228
1989	(100)		13263	184	11000	5202	3810	33559
1990	(100)		5667	0	(2000)	(4371)	(4637)	(16775)

Estimates for Australian p/l & sport catch from A. Caton; uncertainty in these figures suggests annual sport catch may be in the range of 75-150 mt for 1984-90.

Estimates for Japan p/l and driftnet catches from Y. Watanabe.

Estimates of Taiwanese driftnet catch provided to A.D. Lewis (SPC) sourced from the Taiwanese driftnet industry (see note in text regarding data uncertainties). 1990 Taiwanese estimate based on the 1988-89 catch per vessel.

Estimate of 1990 NZ troll catch includes the catches by 6 vessels fishing the STCZ area.

USA troll includes catches by Canadian and French Polynesian vessels. New Zealand catches from the STCZ area are excluded.

ANNEX 4

Table 3. Fleet size for countries fishing for albacore in the South Pacific during the period 1987–1989, by fishery. Estimated vessel numbers are enclosed in parentheses. Information from SPC 1989 and other sources.

SURFACE FISHERIES	1986/87	1987/88	1988/89	1989/90
Australia, pole-and-line	(3)	(3)	(3)	(3)
Japan, driftnet	11	21	65	20
Korea, driftnet	0	1	1	0
Taiwan, driftnet	0	7	64	11
New Zealand, troll	(100)	(25)	(200)	(125)
U.S., troll	7	43	46	49
LONGLINE FISHERY	**1987**	**1988**	**1989**	
Australia	65	63	113	
Japan (minimum no.)	307	344	?	
Korea (minimum no.)	99	90	?	
New Caledonia	3	3-4	3-4	
Taiwan	53	63	45	
Tonga	1	1	1	

1989 Australian vessel numbers, includes 93 domestic vessels and 20 Australian/Japanese joint venture vessels. Source: A. Caton.

Japanese driftnet vessel numbers include 1 or 2 research vessels. Source: Y. Watanabe.

Table 4. Provisional catch and effort data to be supplied prior to the next SPAR meeting

COUNTRY	GEAR TYPE	PERIOD	ORGANISATION
Australia	Longline	1990	DPIE, Canberra
Australia	Pole-and-line	1990	DPIE, Canberra
Fr. Polynesia	Longline	1990	ORSTOM
Japan	Longline	1990	NRIFSF
Korea	Longline	1990	Korea FRDA or SPC
New Caledonia	Longline	1990	Marine marchande
New Zealand	Troll	1990-91	MAF Fisheries
Taiwan	Driftnet	1990-91	NTU
Taiwan	Longline	1990	NTU
Tonga	Longline	1990	Fisheries Division
USA	Troll	1990-91	NMFS

Table 5. SPAR catch and effort database

COUNTRY	VESSEL NATIONALITY	GEAR TYPE	TIME PERIOD	STATUS	COMMENTS
AUSTRALIA	AUSTRALIA	L	1985-1989	√	Authorisation for transfer from SPC/FFA Database received on Oct 20/90.
JAPAN	JAPAN	G	1983/84-1987/88	•	Requested of NRIFSF on Oct 2/89.
JAPAN	JAPAN	G	1988/89-1989/90	√	Provided during SPAR 3, Oct/90. Not available for distribution.
JAPAN	JAPAN	L	1952-1961	•	
JAPAN	JAPAN	L	1962-1980	√	Published by the Fisheries Agency of Japan.
JAPAN	JAPAN	L	1981-1988	√	Provided during SPAR 3, Oct/90. Effort data forthcoming. Not available for distribution.
JAPAN	JAPAN	L	1989	•	
KOREA	KOREA	G	1988/89	•	Requested of FRDA on Mar 1/90. Only one vessel active.
KOREA	KOREA	L	1958-1974	•	Requested of FRDA on Mar 1/90.
KOREA	KOREA	L	1975-1980	√	Published by the Fisheries Research and Development Agency.
KOREA	KOREA	L	1981-1982	•	Requested of FRDA on Oct 2/89.
KOREA	KOREA	L	1983-1985	√	Published by the Fisheries Research and Development Agency.
KOREA	KOREA	L	1986-1988	•	Data for 1986-87 to be published by FRDA in 1990.
KOREA	KOREA	L	1989	•	
NEW CALEDONIA	NEW CALEDONIA	L	1983-1989	√	Authorisation for transfer from SPC/FFA Database received on Oct 19/89.
NEW ZEALAND	NEW ZEALAND	T	1968-1989/90	•	Catch data only for 1968-1985. Recent data being processed at MAFFISH.
TONGA	TONGA	L	1982-1989	•	Request for transfer from SPC/FFA Database of Mar 1/90 acknowledged by fax on Mar 9/90.
TAIWAN	TAIWAN	G	1987/88	•	Data are unavailable at Tuna Research Center.
TAIWAN	TAIWAN	G	1988/89-1989/90	•	Requested of TRC on Mar 1/90. Acknowledged Mar 29/90. Currently being processed.
TAIWAN	TAIWAN	L	1961-1987	√	Published by the Tuna Research Center, National Taiwan University.
TAIWAN	TAIWAN	L	1988-1989	•	Requested of TRC on Mar 1/90. Data currently being processed at TRC.
UNITED STATES	KOREA	L	1987-1988	√	Data for Pago-based vessels aggregated by 10° square by month.
UNITED STATES	TAIWAN	L	1987-1988	√	Data for Pago-based vessels aggregated by 10° squate by month.
UNITED STATES	UNITED STATES	T	1986/87-1989/90	√	Data distributed to SPAR group by NMFS.

KEY: L = longline, G = drift gillnet, T = troller, • = unavailable, √ = available.

Table 6. SPAR size frequency database

COUNTRY	VESSEL NATIONALITY	GEAR TYPE	TIME PERIOD	STATUS	COMMENTS
AUSTRALIA	JAPAN	L	19??-1989	▪	Requested of Bureau of Rural Resources on Nov 29/89.
FIJI	TAIWAN	L	1990	√	Port sampling in Levuka.
FIJI	TONGA	L	1990	√	Port sampling in Levuka.
FIJI	NEW ZEALAND	T	1989/90	√	Port sampling in Levuka.
FIJI	UNITED STATES	T	1989/90	√	Port sampling in Levuka.
FRENCH POLYNESIA	UNITED STATES	T	1986/87-1989/90	√	Port sampling in Papeete. Area missing. Weights available. Number of fish injured available.
JAPAN	JAPAN	G	1988/89-1989/90	√	JAMARC research vessel. Data provided to SPAR 3, Oct/90. Not available for distribution.
JAPAN	JAPAN	L	1952-1985	▪	Requested of NRIFSF on Oct 2/89.
JAPAN	JAPAN	L	1986-1988	√	Provided to SPAR 3, Oct/90. Not available for distribution.
NEW CALEDONIA	NEW CALEDONIA	L	1983-1989	▪	Request acknowledged Oct/89. Data being processed by Marine marchande.
NEW ZEALAND	NEW ZEALAND	T	1972/73-1989/90	▪	Request of MAFFISH acknowledged on Nov 3/89.
SPC	JAPAN	G	1988/89	√	Port sampling in Noumea by SPC staff.
SPC	JAPAN	G	1989/90	√	Sampled by SPC observers on JAMARC vessel.
SPC	NEW CALEDONIA	L	1990	√	Port sampling in Noumea by SPC staff.
SPC	NEW ZEALAND	T	1988/89-1989/90	√	Sampled by SPC observers.
SPC	UNITED STATES	T	1988/89-1989/90	√	Sampled by SPC observers.
TAIWAN	TAIWAN	G	1988/89-1989/90	▪	Data requested of Tuna Research Center on Oct 2/89.
UNITED STATES	JAPAN	L	1962-1972, 1987	√	Annual data. No area. Sex available.
UNITED STATES	KOREA	L	1962-1989	√	Annual data. No area. Sex available.
UNITED STATES	TAIWAN	L	1964-1989	√	Annual data. No area. Sex available.
UNITED STATES	UNITED STATES	T	1986/87-1989/90	√	5° square by month.

KEY: L longline, G drift gillnet, T troller; ▪ unavailable, √ available

Table 7: Albacore research commitments of SPAR member countries and organisations (X = collaborator; XX = principal investigator)

Research activity	Australia DPIE	Japan NRIFSF	New Zealand MAF	China-Taiwan NTU	U.S.A. NMFS	SPC TBAP	France ORSTOM	Fiji FD	French Polynesia EVAAM	New Caledonia MMAM	Tonga FD	Cook Islands
Age and Growth												
(a) Length frequency	X		X		X	XX		X	X	X	X	
(b) Hard parts	X		XX	XX	XX	X		X		X	X	
Reproductive biology	X		X		XX	XX		X		X	X	X
Larval distribution		XX										
Stock boundaries	X						XX					
Population dynamics models & stock assessment methods				XX	X	XX						
Tagging	(X)		X		X	XX						
Oceanography			XX									
Longline CPUE				XX	XX	XX						
Driftnet CPUE		XX		XX								
Longline/surface fishery interaction	X	X	X	X	X	XX		X	X	X	X	
Dropout & escapement			XX									
Observer activity	X		XX		X	XX						

ANNEX 8

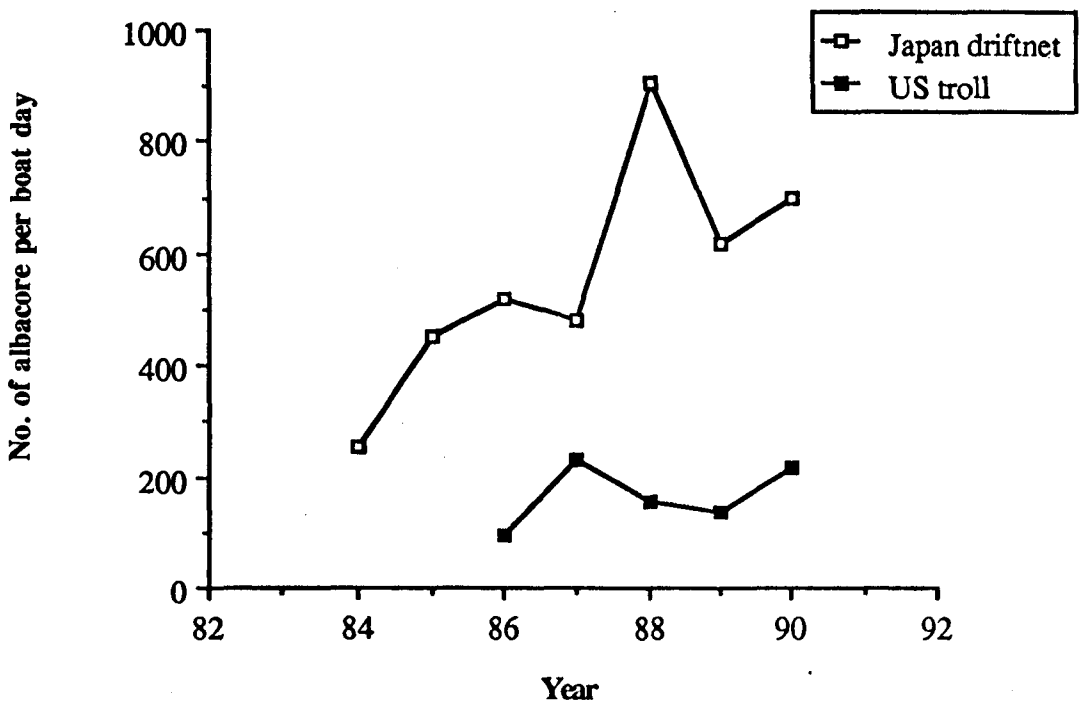

Figure 1. Comparison of surface fishery CPUE trends in South Pacific albacore

ANNEX 9

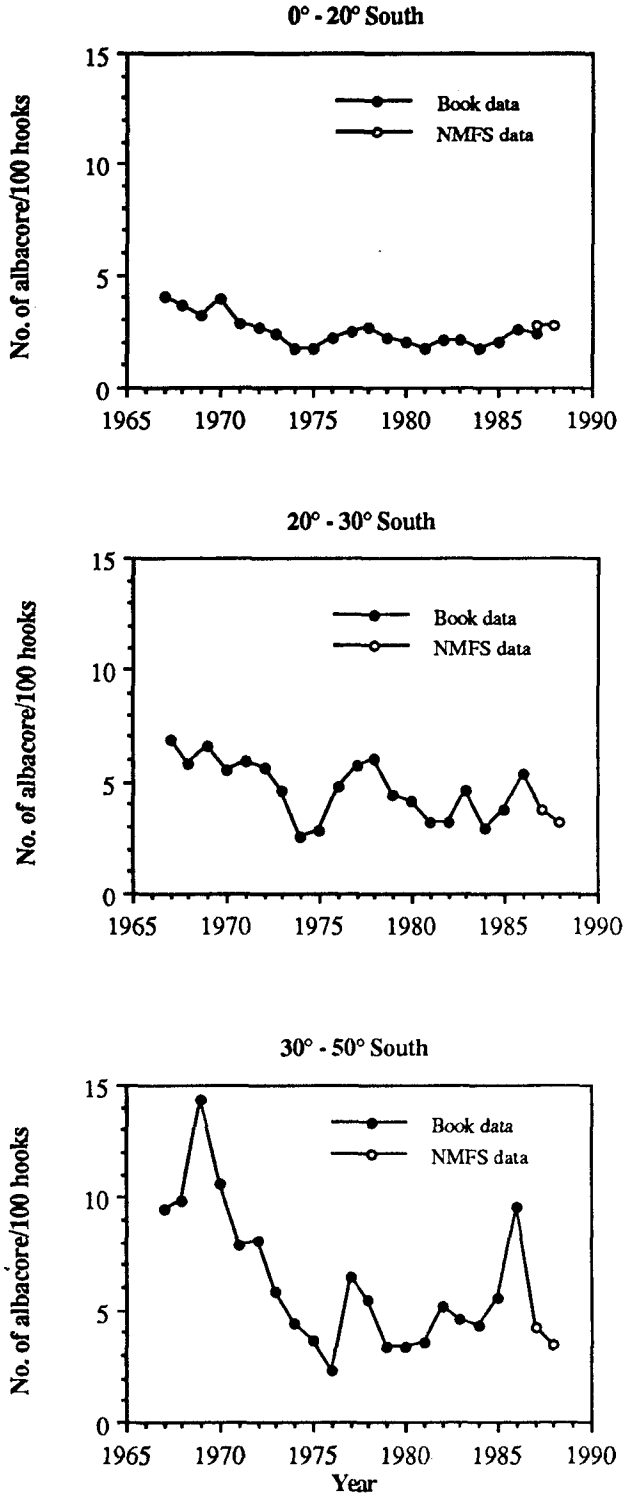

Figure 2. CPUE for Taiwanese longline vessels

'Book data' refers to statistics published by the Tuna Research Center, Institute of Oceanography, National Taiwan University. 'NMFS data' refers to log book data collected by the U.S. National Marine Fisheries Service from vessels unloading in Pago Pago, American Samoa.

ANNEX 10

I - LARVAE

* Temperature range : > 24°C

* 24°C Isotherm position (1)
  J = January
  A = August

* Spawning area (2) :

  May-October

  November-April

  All year round

II - IMMATURES (50-80 cm)

* Temperature range : 16-20°C

* 16 and 20°C isotherm position (1), this range representing their "potential" living area.

  J = January

  A = August

III - ADULTS (> 80 cm).

* Temperature range : 13-25°C

*Fishing area (3) :

(Averaged catch rates, 1952-1976)

  Catch rate / 100 hooks = 7-12

  Catch rate / 100 hooks = 0.5-7

  Incidental catches (4)

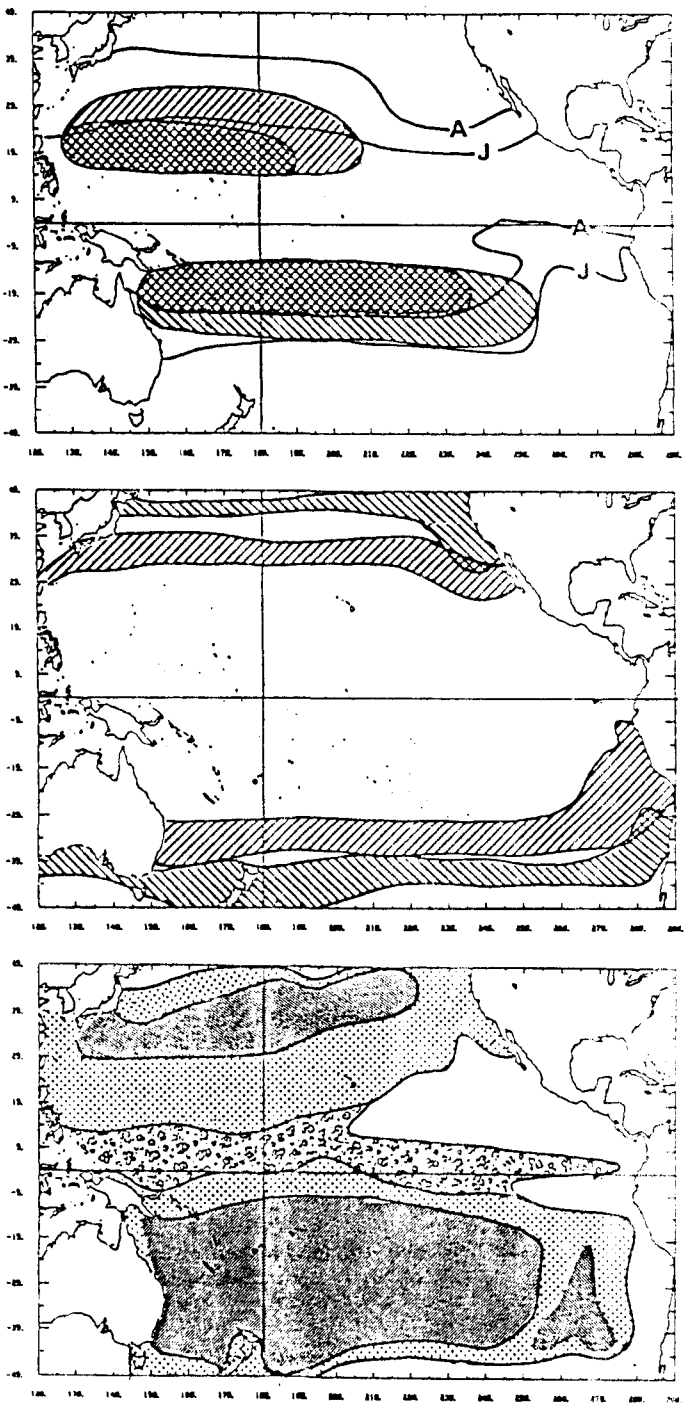

Figure 3. Oceanographical conditions related to the different components of the Pacific Ocean albacore stocks

(1) From Reynolds, R.W., 1982. A monthly average climatology of sea-surface temperature. *NOAA Tech. Rep.*, NWS, 31 : 35p.

(2) From Ueyanagi, 1969. Observations on the distribution of tuna larvae in the Indo-Pacific Ocean with emphasis on the delineation of the spawning areas of albacore, *Thunnus alalunga. Bull. Far Seas Fish. Res. Lab.*, 2 : 177-256.

(3) Adapted from Wetherall, J.A., F.V. Riggs and Y.Y. Yong., 1979. *NOAA, US Nat. Mar. Fish. Serv., South-west Fish. Center, Adminis. Rep.* 16H : 41p.

(4) Adapted from Otsu, T. and R.N. Uchida, 1966. Distribution and migration of albacore *(Thunnus alalunga)* in the Pacific Ocean. *Indo-Pacif. Fish. Coun. Proc.*, 12 (2) : 49-64.

ANNEX 11

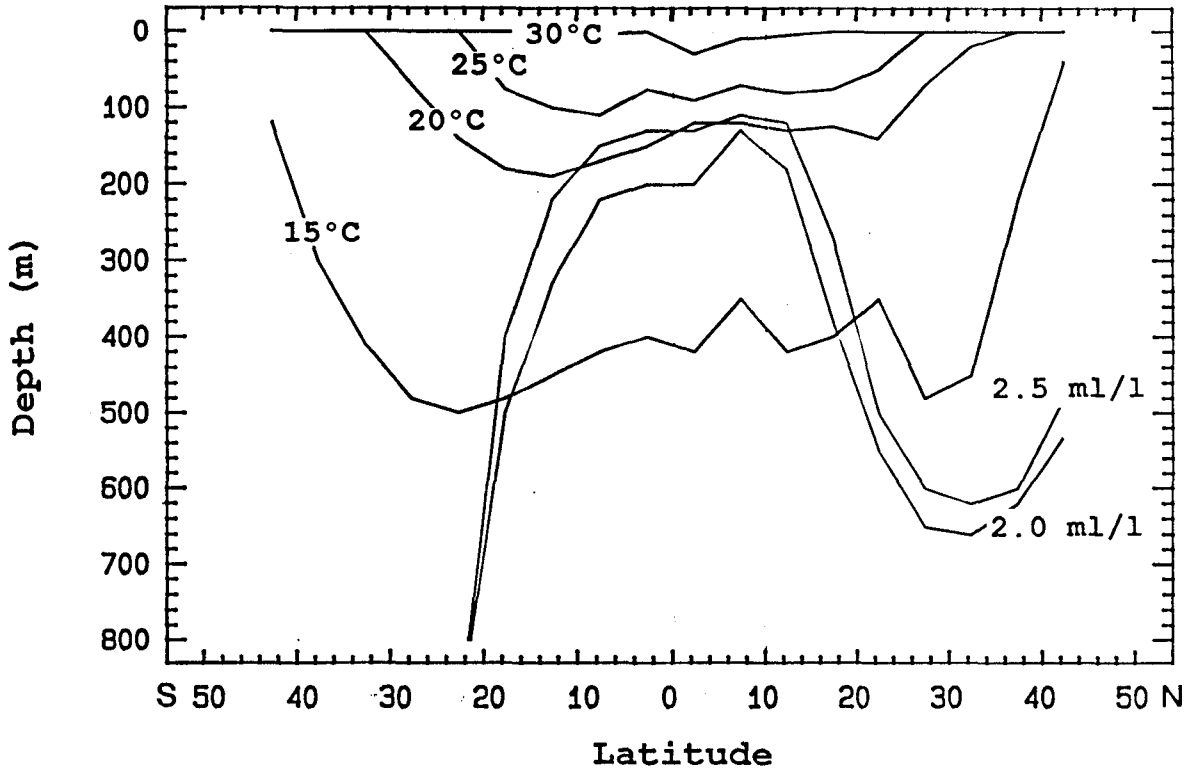

Figure 4. **Annual mean latitudinal distribution over five-degree latitude belts of the Pacific Ocean as a function of depth: main isotherms (15°, 20°, 25° and 30°C) and dissolved oxygen content (2.0 and 2.5 ml/l) (from Levitus, 1982[1])**

[1] Levitus, 1982. Climatological atlas of the world ocean. *U.S. Department of Commerce, NOAA Prof. Paper,* 13 : 173p.

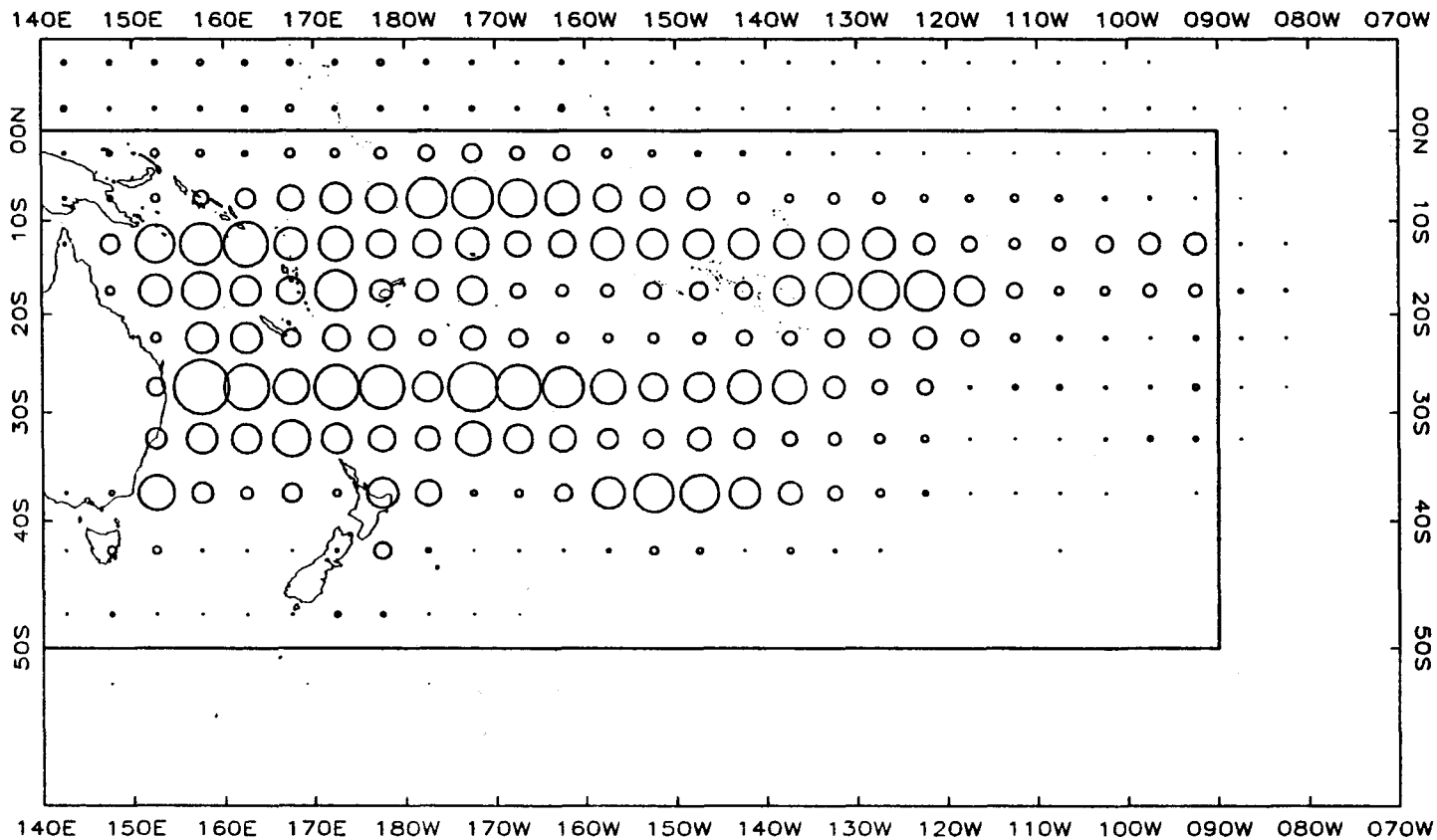

Figure 5. **Aggregate albacore longline catch in numbers for years 1962–1990. The areas of the circles are proportioned to the total catches recorded.**

ANNEX 13

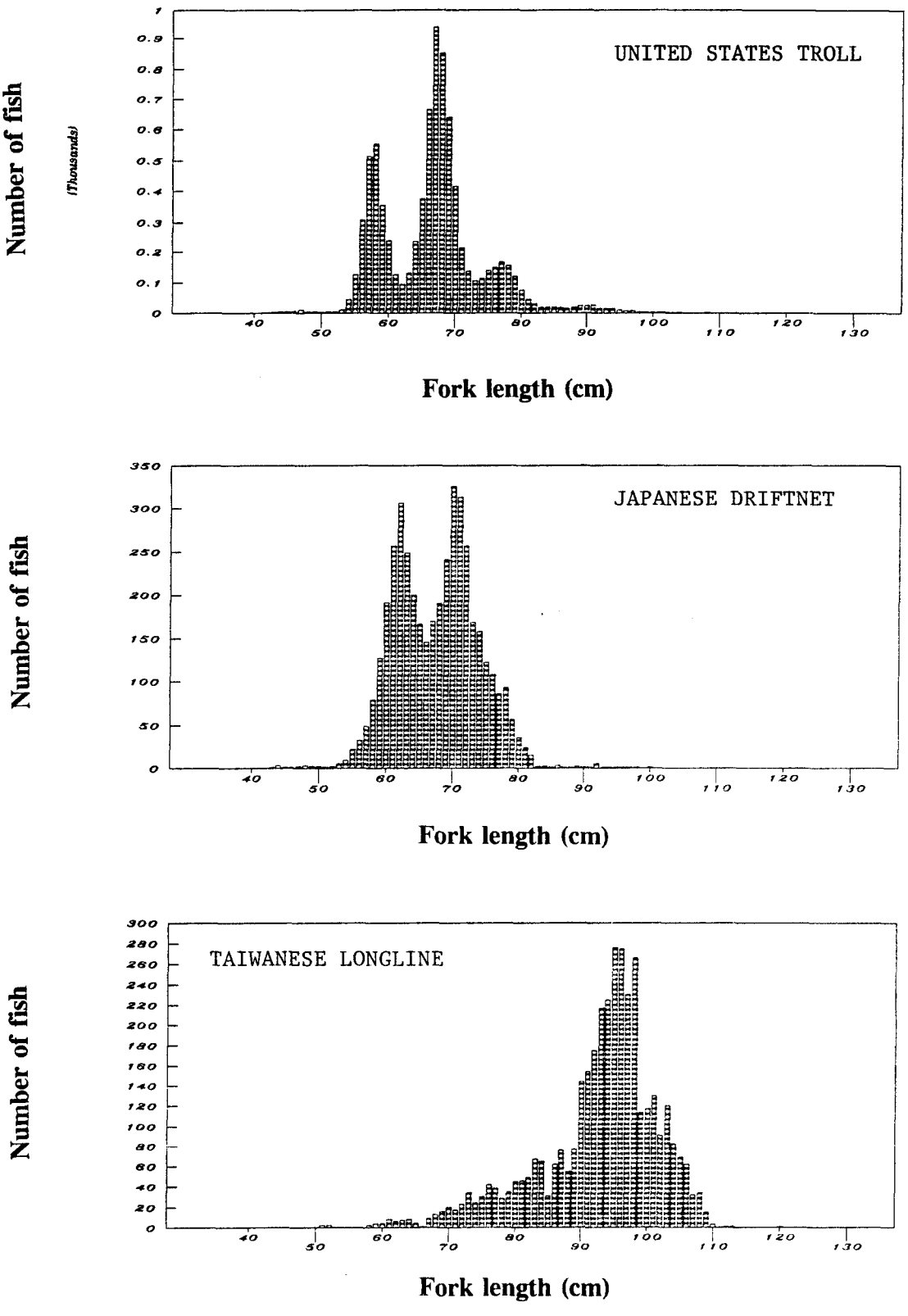

Figure 6. Size frequency distribution of albacore caught by longline, troll and driftnet fisheries in 1989