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FOREWORD

The first South Pacific Albacore Research (SPAR) Workshop was held in Auckland in June 1986. It provided a forum to review existing albacore fisheries of 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 to provide for co-ordination of research on albacore in the South Pacific. The 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 rate and stock identity were highlighted as requiring priority attention. Unbeknown to participants at the first meeting a major change in the albacore fishery was building. A drift gillnet fishery developed following exploratory and experimental cruises by Japan. By 1987 the growing Japanese gillnet fleet was joined by Taiwanese gillnet vessels. The rapid expansion of the fishery resulted in at least a doubling (and possibly a tripling) of catch in the three years between the first and this second South Pacific Albacore Research Workshop. As a consequence the second workshop was faced with an urgent need to re-orient the direction and priorities of studies on the albacore resource. It also saw the need to comment on the broader implications of the expansion.

Once again, the South Pacific Commission acted as sponsor for the meeting. The Government of Fiji generously offered to be the host. The meeting was held in June 1989 in Suva, with participants from South Pacific Island countries, as well as from Australia, New Zealand, France, Japan, the Republic of China and the United States. Regional organisations represented were SPC, FFA, ORSTOM, and FAO. The South Pacific Commission expressed its special gratitude to Japan and the Republic of China for their participation and the opportunity provided for the exchange of information on their fisheries. Special thanks are extended to the FAO/UNDP Regional Fisheries Support Programme for its invaluable assistance during the duration of the workshop.

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REVIEW OF RECENT DEVELOPMENTS IN THE ALBACORE FISHERY AND OF RECENT RESEARCH ACTIVITY

1. Participants at the workshop (Annex I) were requested to prepare brief country summaries of the present fishery for albacore in their waters or carried out by their vessels, including historical records of catch and effort and plans for future involvement in the albacore fishery. The agenda (Annex II) also offered scope for the presentation of summaries of research activity. The various documents submitted as working papers and information papers are listed in Annex III. For the purpose of the report, participants provided the following summaries of their presentations.

FIJI (SPAR 2/WP.9)

2. Albacore has been landed in Fiji, for canning in Levuka, since 1975. Previously Levuka was a transhipment base for longliners. A fleet of large Taiwanese longliners is chartered by PAFCO and the number of vessels unloading each year has ranged from five to thirty. Thirty longliners are projected for 1990 and the number of US troll vessels from the southern albacore fishery is expected to increase over the six unloaded in 1989. A port sampling operation is planned, gathering both length frequency samples and gonad samples from longliners and troll vessels unloading at the cannery. Foreign vessels fishing in the Fiji EEZ are required by statute to make their logbooks available, and it is planned to institute a logbook system for the growing local fleet of sashimi tuna vessels.

AUSTRALIA (SPAR 2/WP.4)

3. Albacore are an incidental catch in the Australian 200 mile fishing zone, most strongly represented (1,300 tonnes annually) in Japanese longlining but also (100 tonnes) in domestic longliners' catches. Surface (pole and purse seine) catches of about 100 tonnes and recreational catches (perhaps 200-400 tonnes) also occur.

4. Japanese longline catch rates increased steadily in the north-east during the 1980s to 10 fish per 1,000 hooks, while declining in the south-east from 18 fish per 1,000 hooks in 1985 to less than 8 per 1,000 hooks in 1988. Virtually no biological research has been directed at albacore in Australia. Several surveys indicated promising albacore resources off south-eastern Australia. Sixty-five albacore were single tagged during the 1960s and 38 double tagged in 1984 with no recaptures reported, but three recoveries have been reported from releases of tagged albacore in the 1970s and 1980s by the New South Wales Game Fish Tagging Program.

FRENCH POLYNESIA (SPAR 2/WP.3)

5. Albacore longline fishing is practised mainly by Korean, but also by Japanese vessels in the EEZ. Japanese vessels mainly fish north of 12°S and Korean vessels cover an area between 5°S and 30°S. Total annual albacore catches ranged from 800 to 1,000 mt recently. Figures for CPUE obtained in 1987 and 1988 between 13°S and 30°S, which is the albacore habitat in French Polynesia, are the highest for the concerned period. This seems to show an increase of abundance for the last two years. An increase of CPUE when moving to the south is observed. Maximum CPUE is obtained from April to September. The average weight is 15.6 kg, for both Japanese and Korean catches.

6. Surface trolling vessels have unloaded almost 3,000 mt of albacore in Papeete since 1987. The individual fishing effort (no. of fishing days/boat) increased in 1989 but the catch rate was two times lower than in 1988. Best fishing is obtained in January and February and between 37°S and 40°S. The 1989 season stopped earlier than previous years. The size composition shows clearly two modes, with an average of 62 cm and 71 cm, decreasing in 1989. Observations of gillnet damaged fishes suggest an average of 12 per-cent for the observed vessels. Size of damaged fishes ranges from 50 cm to 80 cm.

NEW CALEDONIA (SPAR 2/WP.7)

7. Albacore is caught as a by-catch of Japanese and domestic longline fisheries targeting for the Japanese sashimi market and operating within the EEZ of New Caledonia.

8. During the years 1986, 1987 and 1988, Japanese longliners caught 444 mt of albacore (26% of their total catch), and domestic longliners (3 units fished each year) caught 1,314 mt (42% of their total catch).

9. The following has been noted :

- a lower CPUE in June and July,
- an increase in the CPUE each year,
- an average weight of fish caught of 14 to 21 kg with smaller values for the Japanese vessels.

NEW ZEALAND

Review of fisheries (SPAR 2/WP.21)

10. New Zealand vessels participated in two surface albacore fisheries in 1988/89. The most valuable was the West Coast South Island fishery. Albacore concentrations off this coast fluctuate annually with oceanographic conditions and, since the vessels in the fishery remain close to home port, the catches also fluctuate. The 1988/89 season was the best on record, with 4,800 mt landed. The fishery is important to this economically depressed region and also serves to divert fishing pressure from more heavily stressed fish stocks.

11. Three New Zealand vessels also participated for the first time in the surface troll fishery for albacore in the waters to the east of the New Zealand EEZ, catching about 360 mt.

12. Approximately 1,500 mt of albacore are also caught by Korean and Japanese longline vessels licenced to fish inside the New Zealand EEZ.

Age determination based on caudal vertebrae (SPAR 2/WP.20)

13. Preliminary results suggest that ages of albacore can be easily determined from vertebral rings for fish up to 10 years old. High variance of fork lengths for intermediate ages and the poor representation of older fish in the present sample may account for the poor parameter estimates obtained. Further study, in particular study of tetracycline injected fish, is required.

Movements of albacore tuna *(Thunnus alalunga)* in the South Pacific: evidence from parasites (SPAR 2/WP.17)

14. Parasites were collected from albacore caught by surface trolling and longlining in the south-west Pacific. Parasite data show a decrease in prevalence of didymozoid parasites with increasing fish length up to a fork length of 85-90 cm, followed by a subsequent increase in prevalence in large longline caught fish from temperate waters. This pattern in older fish is consistent with fish returning from spawning in tropical waters, assuming they have been reinfected by didymozoids.

15. Albacore of 50-70 cm fork length collected at widely separate locations in the south-west Pacific exhibit differences in parasite prevalence which, together with tagging and fishery data, support an hypothesis that juvenile albacore migrate to New Zealand from the tropics and then move east along the Sub-tropical Convergence Zone (STCZ).

SOLOMON ISLANDS (SPAR 2/WP.8)

16. Albacore catches in the Solomon Islands EEZ are mainly by licensed foreign longline vessels, namely Taiwanese, Korean and Japanese. Taiwanese vessels target on albacore and they operate from September to March in response to the effect of the southern winter. Considerable quantities (around 1,500 mt per annum) were taken by a Taiwanese fleet based at Santo, Vanuatu before its withdrawal in 1981/82. Japanese and Korean longliners also took albacore from Solomon Island waters as incidental catches. Currently only Japanese longline vessels are licensed to operate there.

17. Although very little is known about the abundance, distribution and population dynamics of the albacore resource, the Fisheries Division, in the interest of sound fisheries management, has adopted the policy of issuing catch quotas to the major fisheries and by specific area where possible. The total allowable catch for longlining in the Solomon Islands EEZ is 8,500 mt.

18. The National Fisheries Development Co. Ltd. of Solomon Islands used to operate two sashimi longline vessels, but these have been sold due to their uneconomic operations.

JAPAN (SPAR 2/WPs 5, 10, 15 & 16)

19. Catch statistics of South Pacific albacore by the Japanese large-mesh driftnet fishery, 1983/84-1987/88, were estimated using a limited number of samples from commercial fishermen. Total catch of albacore in each season ranged from 590 mt to 4,800 mt, and average albacore catch number was 451.1 fish per day per boat. There were two main fishing grounds, namely the Tasman Sea and east of New Zealand.

20. Catch trends of South Pacific albacore by Japanese longline fishing from 1952 to 1987 were described, along with fishing effort. Recently, the catch of albacore has ranged from 3,600 mt to 4,900 mt and has been stable. Fishing effort continued at a high level of 110 million hooks.

21. JAMARC pole-and-line and gillnet surface fisheries survey activities in the South Pacific, 1981-1987, were reviewed. Albacore were distributed over a wide area from east to west in the South Pacific, and their density was high east of New Zealand, in the central South Pacific and off Chile. By examination of position along the body where fish were enmeshed, 180 mm mesh size gillnet was considered suitable for capturing 65 cm to 79 cm albacore.

22. Results of the 1988/89 JAMARC drift gillnet survey season in the South Pacific were also reviewed. The total catch during the period was 191 mt, of which albacore comprised 102 mt. The length frequency distribution of albacore by gillnet was almost the same as that for U.S. jigboat catch in the same season.

REPUBLIC OF CHINA (SPAR 2/WP.6)

Fisheries activities

23. Taiwan has three types of far seas tuna fisheries operating in the South Pacific Ocean. Until the end of 1988, almost all vessels were longliners targeting albacore. Gillnet vessels entered the South Pacific Ocean in December 1987. From about 1983, purse seine vessels started to operate in the south-western Pacific, but they target skipjack and yellowfin tuna.

Catch statistics

24. Long-term catch data of the longline fishery by species, by month and by 5-degree squares are published annually. Estimated total catch of South Pacific albacore was about 17,120 mt in 1988. Rapid development of a gillnet fishery has resulted in 18,000-39,000 mt total catch (estimated by SPC) in the 1989 fishing season (November 1988 -May 1989). Both catch statistics and biological data (mainly length composition) collection systems for gillnet and large purse seine fisheries are being organised.

Research

25. Seasonal variation of fishing grounds and index of abundance has revealed that the South Pacific albacore stock might consist of two subgroups. Maximum sustainable yield (MSY) was estimated at 31-33,000 mt based on overall tuna longline catch.

Future research

26. Four proposals are considered:

(a) Research on growth, based on length composition data and/or age- determination methods;

(b) Estimating the recruitment to the tuna longline fishery to detect the influence of surface fisheries;

(c) To standardise the fishing effort of different fishing types;

(d) To find the optimal combination of fishing efforts of various fishing types in exploitation of the South Pacific albacore stock.

UNITED STATES OF AMERICA

Age and growth of South Pacific albacore (SPAR 2/WP.18)

27. An analysis of otolith increments and fork length measurements on 144 albacore was carried out to estimate a model of age and growth. Based on experience with albacore in the North Pacific, the otolith increments were assumed to have a daily frequency. The results suggest that South Pacific albacore growth rates are faster than expected, and imply that the modes typically seen in the surface fishery catches are separated by an interval of six months, rather than one year as is usually assumed. If this is true, then spawning would either be semestral, or there could be two stocks with spawning seasons six months apart. The growth model based on daily increments is inconsistent with information from four tag recoveries to date, and may also be at variance with estimates of growth based on the progression of length frequency modes. The possibility of biases in otolith increment counting will therefore be investigated.

Use of longlining catch rate statistics to monitor South Pacific albacore abundance (SPAR 2/WP.11)

28. Historical catch and effort data from logbooks of Taiwanese and Korean longliners based at Pago Pago were analysed to elicit information on changes in abundance of albacore exploited by the longline fleets. The analysis showed that trends in mean catch rate were consistent among the fleets and over the range of latitudes covered by the fleets. The data also indicate consistent seasonal patterns of effort distribution in the South Pacific. Abundance indices computed by month and 5-degree bands of latitude provide a basis for monitoring the abundance of the larger, mature segment of the albacore stock, and measuring the impact of the expanding surface fisheries harvesting smaller, younger albacore. Provisional indices of abundance for the STCZ (35-40°S), calculated up to May 1989, suggest that mean catch rates of albacore by the longliners in this area were lower in April and May 1989 than in previous years. Continued updating and monitoring of these indices is a high priority.

South Pacific albacore catch made by U.S. jigboats during the 1987-1988 and 1988-1989 fishing seasons (SPAR 2/WP.1)

29. A new troll fishery for albacore has been developed in the central South Pacific Ocean. Forty-three vessels, mainly U.S. but also including several from Canada, Tahiti and Fiji, participated in the fishery during the 1987-1988 season; slightly over 4,000 short tons of albacore were caught. Fifty vessels operated in the South Pacific albacore fishery in 1988-1989, with 48 from the U.S., Canada and Tahiti, and 2 from New Zealand. The vessels caught about 4,100 short tons (3700 metric tons).

30. The fishery takes place primarily within a zonal band between 35°S and 40°S, between about longitude 160°W and 135°W. The season extends between December and April, with peak catches made during January and February. The fishery harvests primarily pre-spawning fish with fork lengths between 60 cm and 80 cm. Some smaller and some larger fish, up to 105 cm, are also taken. There was an unexplained shift in size composition modes between the 1987-1988 and 1988-1989 seasons. The average number of albacore caught/boat/day was 304 and 253 in the 1987-1988 and 1988-1989 fishing seasons, respectively.

Relationships between South Pacific albacore troll fishing success and oceanographic conditions (SPAR 2/IP.19)

31. Research surveys were conducted in 1986 and 1987 by U.S. scientists to evaluate relationships between the availability of albacore caught by trolling and the oceanography of the STCZ in the central South Pacific. Oceanographic measurements were made from a research vessel working in conjunction with U.S. fishing vessels conducting exploratory troll fishing for albacore. The results demonstrated that the distribution and availability of albacore, indicated by troll fishing success, were correlated with mesoscale variations in boundary features marking the STCZ waters. Catch rates were highest where the gradients were prominent and lowest where gradients were diffused.

Testes morphology, histology and spermatogenesis in South Pacific albacore (SPAR 2/WP.19)

32. Results from an examination of approximately 200 fish show that a substantial portion of male albacore caught by surface trolling in mid-ocean areas of the South Pacific STCZ may be sexually mature when they attain a fork length of 71-80 cm and that the proportion of mature fish increases with increasing length. Males caught by subsurface longline fishing in coastal waters off New Zealand also showed development in sexual maturity, but in lower proportions and not as accelerated as males caught by surface trolling in the mid-ocean region. Female fish caught in both regions, which ranged between 55 and 95 cm fork length, showed little sign of advancement in sexual maturity. South Pacific albacore are believed to spawn generally in the region of the Southern Convergence waters between about 10°S and 20°S.

33. It is not clear what advantage there is for male albacore in being sexually mature at times, locations and ages when females are not in spawning condition. Sampling of both males and females over the entire spawning cycle and in the localities where albacore are believed to spawn will be required to understand the reproductive biology of the South Pacific albacore population.

Summary of South Pacific albacore tagging conducted during 1986-1989 (SPAR 2/WP.13)

34. The first SPAR workshop recommended that an international co-operative tag and release programme be established to acquire knowledge needed to fully develop the albacore fisheries in the South Pacific and to measure the viability of the resource. Information on migratory patterns, age and growth, and fisheries interactions was identified as especially important.

35. Through the 1988-1989 fishing season 5,839 albacore have been tagged and released by fishery scientists and fishermen from the U.S., and by fishery scientists from New Zealand and French Polynesia. About two-thirds of the tagged fish have been released in the region east of 170°W in a zonal band between 35°S to 40°S, and about one-third in coastal waters around New Zealand. The size composition of the fish released is representative, for the most part, of fish taken by the troll fisheries operating in the areas of release. About 40 percent of the fish that have been released were injected with oxytetracycline.

36. Only five of the tagged fish have been recovered, all by longliners. The results are consistent with the hypothesis that pre-adult fish move eastward across the central South Pacific in STCZ waters during austral summer months and that adult fish move northward into sub-tropical waters.

ORSTOM

N/O *Coriolis* Prosgermon 1987 cruise report (SPAR 2/WP.12)

37. This cruise was part of the SPAR research programme, and took place during the 1987 austral summer, from mid-February to mid-March, in the eastern part of the Central Pacific (125-140°W). Expendable bathythermograph (XBT) launches and surface observations (sea surface temperature, salinity, chlorophyll content and meteorology) were achieved each half-degree during the outward and return route as well as within the convergence area; continuous sea surface temperature and bathymetry by echo-sounding were also recorded; plankton hauls (0-200 and 0-500 m) were done during the outward route each half-degree.

38. On the whole, the cruise progressed quite well, despite breakdown of the conductivity-temperature-depth profiles (CTD) probe which prevented hydrological study of the subtropical convergence. The transition zone preceding the subtropical convergence, as identified from XBT and surface data, was observed to have a general direction west-south-west/ east-north-east from 33°S-140°W to 34°S-125°W. The whole area, including the convergence, was considered relatively poor regarding phyto- and zooplankton.

39. It was demonstrated that surface albacore stocks extend at least towards 125°W, while most of the present exploratory fishery takes place further westward (around 155°W). A total of 140 trolling hours with 10 lines out gave a catch of 496 albacore, 190 of them subsequently tagged and released, and biological samples were taken from 61. Yields were high for a research vessel (average catch of 44 albacore/day, 60 to 90 including lost fishes, 130 for the best catch); sizes ranged between 40 and 97 cm; most of the catches were from sub-surface fish with no surface sightings. Four age classes (50, 61, 71 and 80 cm) were represented in the catch.

Overview of the Atlantic albacore fisheries (SPAR 2/IP.1)

40. This paper gives a short overview of the Atlantic albacore fishery, based on ICCAT SCRS/87 information. The albacore resource is traditionally shared between a northern and a southern stock, separated at 5°N. A distinct Mediterranean stock may exist, and relationships between the southern stock and the Indian Ocean stock cannot be excluded.

41. The northern stock has been exploited for a long time by surface fisheries, the longline fishery appearing in the sixties. Catches ranged from 30,000 to 60,000 mt (10,000 to 20,000 mt for longline, 10,000 to 20,000 mt for pole-and line and 10,000 to 40,000 mt for trollers). The surface fishery has declined regularly since 1965. Production model MSY estimates give a 50,000 to 70,000 mt range, significantly more than the present catch of 40,000 mt. Consequently, the stock is considered moderately exploited. The southern stock has been exploited by longline since the sixties, with a 10,000 to 30,000 mt/year catch; the surface fishery is recent and remains at a relatively low level. Estimates from production modelling give a 25,000 mt MSY. The possibility of a relationship with the Indian Ocean albacore stock should be examined.

New albacore fishing techniques in the north-east Atlantic (gillnet and pelagic trawl): description and incidence on the albacore stock (SPAR 2/IP.10)

42. Since the sixties, the French albacore surface fishery has declined dramatically, mainly due to an old and not renewed fleet and outdated fishing techniques. The northern Atlantic

albacore stock was underexploited and a good potential market existed for the species. The fishing industry and IFREMER set up research into new fishing gears.

43. Drift gillnets, made of panels 50 m long and 20-36 m drop, with 80-180 mm mesh size, were used; these were neutrally buoyant so could be adjusted to the desired depth; usually total length of nets ranged from 2.5 to 6 km. Gillnetting was done during the night (set at dusk, hauled during the night) and, additionally, trolling was undertaken during the day. Twenty boats used this technique in 1988, catching some 500 mt. Their yields were about twice those of trollers (190 versus 95 fish/day), with a higher maximum (1,500 fish in one set, compared to 800 in a day by trolling); sizes of gillnetted fish were similar to those obtained from trolling during the day, as well as those from other trollers (mean weight 5.7 kg for gillnet, 5.4 for trollers).

44. Pelagic pair trawling experiments were carried out, with tows lasting some 5 hours during the night at a speed of 3.5 to 4 knots. These trawls have a vertical opening of 40 m, a lateral opening of 70 m, wide meshes at the mouth, and a belly longer than in conventional trawls. Twenty-seven pairs of trawlers were operating in 1988, catching 1,100 mt of albacore in 60 fishing trips. As for gillnetting, complementary trolling was undertaken during the day. Yields were quite variable, triple that of trollers on the mean (but for 2 boats), and reaching some 3,000 fish in a single set for the best observed catch. They caught larger fish in greater number (average weight 6.4 kg), but also somewhat more smaller fishes than trollers.

SPC/NZ

South Pacific albacore observer programme 1988/89 (SPAR 2/WP.14)

45. Two observer cruises were undertaken in the STCZ on the New Zealand troll vessel *Daniel Solander* and U.S. troll vessel *Barbara H.* During the cruises, over 10,000 albacore were measured for fork length; samples of these were also measured for girth, weighed and the presence of gillnet marks recorded. At least three age groups were visible in the length frequency data, the sizes of which agreed closely with other samples taken from the surface fisheries. Minor gillnet marks to the body were found on albacore of all sizes, but were most prevalent in fish of 60-75 cm. Minor marks to the head were most common in fish larger than 70 cm, while severe abrasions were found in fish of 60-65 cm. These observations are consistent with small albacore being able to pass easily through the gillnet meshes without injury, albacore of 60-75 cm being most effectively caught and only escaping with sometimes severe injury, and larger albacore not being able to pass completely through the meshes, therefore often escaping with minimal injury to the head. Gillnet marked albacore were found to be of lower condition than unmarked albacore, on the basis of length, weight, and girth measurements.

46. The incidence of gillnet marked albacore was 12.4 and 19.0 percent of the total troll catch inspected on the first and second cruises, respectively. The percentages varied from about 3 to 30 per cent on individual days. This suggests that the exploitation rate of albacore by the surface fishery may be high, possibly up to 50 per-cent, particularly if the rate of escapement from gillnets is low (about 10%). More information is needed if accurate estimates are to be obtained.

DEVELOPMENT OF A 'BEST ESTIMATE' OF THE STATUS OF THE SOUTH PACIFIC ALBACORE FISHERY

LIFE HISTORY

47. Albacore are distributed throughout the South Pacific, occurring as larger individuals at depth in tropical and sub-tropical waters and, during the summer months, as smaller, juvenile fish in the surface layer of the STCZ.

48. They spawn mainly in sub-equatorial waters between 10°S and 20°S after attaining approximately 90 cm in length. Juveniles move southward and appear in surface fisheries in the Tasman Sea, around New Zealand and further to the east in the central South Pacific between 35° and 40°S. The frequency and timing of their STCT return to tropical waters is uncertain; however the few tag returns available suggest northerly movement could occur seasonally (SPAR 2/WP.13). This is also supported by available survey data (SPAR 2/WP.15).

49. The clarity and separation of length frequency modes from the surface fishery indicate that well defined spawning seasons exist (SPAR 2/WP.1, WP.3, WP.14, WP.15, WP.16). The existing biological data are somewhat inconsistent, in that growth rates derived from daily increments on otoliths suggest that spawning is semestral, whereas length-increment data from four tag returns are more consistent with annual spawning (SPAR 2/WP.18). A detailed modal progression analysis of all length-frequency data would help clarify this issue, which has important implications for the determination of growth rates and productivity.

50. Albacore stock structure in the South Pacific is presently ill-defined. As noted above, it is possible that the stock in the STCZ is comprised of two groups with birthdate distributions about six months apart. These groups could arise from a single population with semestral spawning, or from two populations with annual spawning cycles six months out of phase. Other albacore populations, particularly that in the North Pacific, show considerable complexity in their geographical distribution and hence availability to the various fishing gears (SPAR 2/IP.2). It is certainly possible that the South Pacific population could be similarly complex, which would have important stock assessment implications. On the other hand, there is no obvious discontinuity in albacore distribution from the Tasman Sea, across the southern coast of Australia, and into the Indian Ocean (SPAR 2/WP.4). Therefore the relationship between South Pacific and Indian Ocean populations is unknown at this time. A combination of large-scale tagging, population genetics study and/or micro constituent analysis of hard parts, and gonad sampling is required to clarify the issue of stock structure.

CATCHES

51. The catches of albacore for the principal surface (Table 1) and longline fisheries (Table 2) of the South Pacific were tabulated. For missing data, estimates were computed from available information on fleet activities (Table 3).

52. Before 1983, the major component of the surface fishery was the New Zealand troll fleet, which produced less than 3,000 mt annually from waters around New Zealand. In 1983, Japanese gillnet vessels started their operations in the Tasman Sea and east of New Zealand. More recently, U.S. troll (1986) and Taiwanese gillnet (1987) vessels have also entered this fishery. The fishing area has expanded to include the Tasman Sea and the STCZ as far eastward as 120°W and the catch has increased markedly. A record surface fishery high catch of 34,000 to 59,000 mt is estimated for the 1988-89 season.

Table 1: Surface fishery catch (mt) of South Pacific albacore by country and gear (Estimates are shown in parentheses)

YEAR	Australia p/l & sport	Japan gillnet	Korean gillnet	New Zealand troll	Taiwan gillnet	USA troll	TOTAL
1979	(500)						(500)
1971	(500)						(500)
1972	(500)						(500)
1973	(500)						(500)
1974	(500)			898			(1,400)
1975	(500)	?		646			(1,100)
1976	(500)	?		25			(500)
1977	(500)	?		621			(1,100)
1978	(500)	?		1,686			(2,200)
1979	(500)	?		814			(1,300)
1980	(500)	?		1,468			(2,000)
1981	(500)	?		2,085			(2,600)
1982	(500)	?		2,434			(2,900)
1983	(500)	?		744			(1,200)
1984	(200-400)	1,563		2,773			(4,600)
1985	(200-400)	1,905		3,253			(5,500)
1986	(200-400)	1,919		1,911		100	(4,200)
1987	(200-400)	587		1,227		750	(2,900)
1988	(200-400)	4,801		330	1,000	3,600	(10,000)
1989	(200-400)	(7-10,000)	184	5,161	(18-39,000)	(3,700)	(34-59,000)

NOTES

1. Japan 1984-88 figures are rough estimates obtained from interview of a small sample of vessels (SPAR 2/WP.5); 1989 figure is a rough estimate obtained by interview of fishermen.

2. New Zealand 1989 figure is preliminary catch and includes catch of three vessels that fished offshore, outside the EEZ.

3. Taiwan figures are preliminary catch (SPAR 2/WP.6). Estimate for 1989 based on catch rate of 300 mt/vessel for 60-130 vessels.

4. USA troll catches include small amounts caught by Canadian, French Polynesian and Fijian troll vessels.

5. All Australian catches are rough estimates. The 1989 catch is assumed to be the same as for 1988 (SPAR 2/WP.4).

6. Troll and gillnet figures are for the year in which the season finished e.g. the 1988 line is for the 1987/88 season.

7. The Korean gillnet figure for 1989 includes 112 mt taken by purse seiners.

53. The longline fishery, in contrast, has remained relatively unchanged since the 1980s. The catch averaged about 30,000 mt annually and the 1988 catch is estimated to be 29,000 mt.

54. A total of 63,000-88,000 mt of albacore is projected to be taken from the South Pacific in 1989 (assuming that the longline catch in 1989 is the same as that in 1988). The catch of the surface fisheries has overtaken that for the longline fishery. As a consequence, the size composition of fish in the overall catch has changed markedly. Whereas large fish (>70 cm FL) taken by longliners (Figure 1a) once dominated the catch, currently smaller fish (50-70cm FL) taken by troll and gillnet gear make up a major part of the overall catch (Figures 1b and 1c).

55. As a note of caution, it should be emphasised that the catches outlined above have included a range of estimates when accurate data have been unavailable. Furthermore, for the

drift gillnet fishery no estimate is incorporated for damage and subsequent mortality associated with albacore escapement from fishing gear; nor is there an adjustment for albacore entangled and killed but lost during net retrieval ('dropouts' - possibly of the order of 5-10 per-cent).

Table 2: Longline fishery catch (mt) of South Pacific albacore by country (Estimates are shown in parentheses)

YEAR	Australia	Japan	Korea	New Caledonia	Taiwan	Tonga	TOTAL
1952		210					210
1953		1,091					1,091
1954		10,200					10,200
1955		8,420					8,420
1956		6,220					6,220
1957		9,764					9,764
1958		21,558	146				21,704
1959		19,344	456				19,800
1960		23,756	610				24,366
1961		25,628	330				25,958
1962		38,880	599				39,479
1963		33,500	1,367				34,867
1964		21,435	2,911				24,346
1965		19,305	6,405				25,710
1966		23,401	10,817				34,218
1967		16,640	13,717		11,751		42,108
1968		7,707	10,138		12,424		30,269
1969		5,559	9,963		9,595		25,117
1970		6,560	11,599		14,689		32,848
1971		4,339	14,482		15,887		34,708
1972		2,796	14,439		(16,814)		(34,049)
1973		2,381	17,452		17,742		37,575
1974		1,847	12,194		17,283		31,324
1975		1,045	9,015		17,071		27,131
1976		1,906	12,212		13,700		27,818
1977		2,240	13,176		21,932		37,348
1978		2,520	10,989		20,942		34,451
1979		2,350	8,682		15,086		26,118
1980		2,488	10,852		18,180		31,520
1981		4,856	14,793		14,595		34,244
1982		4,900	12,586		12,689		30,175
1983		4,928	6,669		12,119		23,716
1984		3,607	5,730		11,155		20,492
1985		3,746	14,267		9,601		27,614
1986	15	4,466	18,799	185	11,913	166	35,544
1987	94	4,085	8,646	563	15,009	227	28,624
1988	78	(4,100)	6,896	567	17,120	212	(28,973)

NOTES

1. Japan estimate for 1988 is the average of 1985-1987 catches (SPAR 2/WP.10).

2. Taiwan data source is landings stated by Taiwan Deepsea Tuna Boatowners and Exporters Association.

3. The 1972 Taiwanese catch is estimated as the average of the 1971 and 1973 catches.

Table 3: Number of fishing vessels by country and gear fishing for South Pacific albacore

Country, gear	1987	1988	1989
Surface Fishery			
Australia, pole & line	?	?	?
Japan, gillnet	(9)	(20)	(60)
Korea, gillnet		1	1
New Zealand, troll	(100)	(25)	(200)
Taiwan, gillnet	0	7	(60-130)
USA, troll (including Canada, USA, France)	7	43	48
Longline Fishery			
Australia	47	27	?
Japan	(min 307)	(min 344)	?
Korea	(min 99)	(min 90)	?
New Caledonia	3	3-4	3-4
Taiwan	53	63	(75)
Tonga	1	1	1

NOTES

1. Japan and Korea longline figures based on SPC coverage under access agreements for all Western and Central Pacific.

2. Taiwan longline figure includes Pago and Kaohsiung vessels. Does not include Tong Kang vessels, although SPC coverage of all Taiwan longliners was 109 in 1987 and 124 in 1988.

CPUE TRENDS

56. Three sets of CPUE time series were made available. They are U.S. jigboat (SPAR 2/WP.1), Japanese drift gillnet (SPAR 2/WP.5) and longline fisheries (SPAR 2/WP.11, IP.7). Excepting one CPUE for the longline fisheries (SPAR 2/IP.7), nominal effort was used for CPUE calculation.

57. Two sets of CPUE for surface fisheries, one for U.S. jigboat, the other for Japanese drift gillnet fisheries, showed decreasing and increasing trends, respectively, for the period 1987-1989 and for the period 1984-1988 (Table 4).

Table 4: CPUE trends for surface fisheries

	U.S. jigboat Catch (No. of fish/ boat/day)	Japanese drift gillnet Average catch (No. of fish/boat/day)
1984		253.3
1985		452.0
1986		516.6
1987	330.2	473.9
1988	303.8	937.0
1989	283.3	

NOTE: figures are for the year in which the season finished

58. The increasing trend of CPUE for Japanese drift gillnet appears to reflect a shift of fishing effort towards the peak of the season rather than a change in abundance. The shortness of the time series makes this apparent discrepancy in surface fishery CPUEs difficult to interpret.

59. The longline CPUE for the whole South Pacific albacore stock based on effective effort showed a moderate decreasing trend to about one half from 1971 to 1985 (Fig. 1 of SPAR 2/ IP.7). Another set of annual longline CPUE for the area between 35 and 40°S, including all longitudes, was calculated from the early 1970s to 1989, stratified by month based on nominal effort. No consistent decreasing or increasing trends were observed for April data, while the series for May showed a decreasing trend, especially marked from 1986 to 1989 (Figs. 9 and 10 of SPAR 2/WP.11). However, it is not possible to give any single definitive explanation for this sharp drop, due to preliminary nature of 1988 and 1989 data.

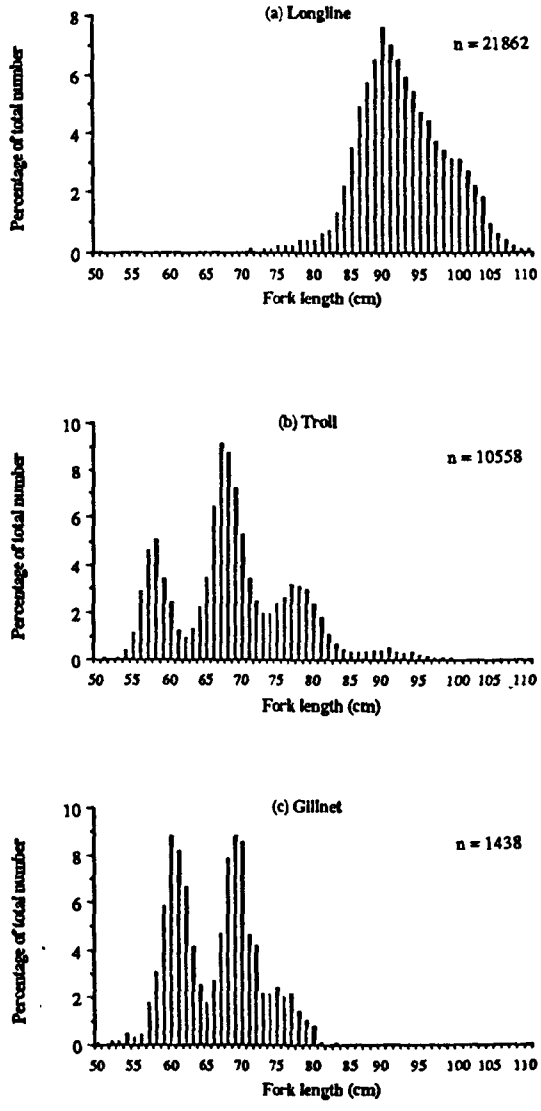

Figure 1: South Pacific albacore length-frequency distributions for (a) the longline fishery (adapted from Otsu and Sumida 1968), (b) the troll fishery (from the 1988/89 observer programme SPAR 2/WP.14) and (c) the gillnet fishery (from 1988/89 Noumea transshipment sampling - SPAR 2/IP.11).

EXPERIENCE IN OTHER ALBACORE FISHERIES

60. In addition to the expanding South Pacific fishery, albacore are taken in the North Pacific, North Atlantic, South Atlantic and Indian Oceans (Table 5). While the Atlantic fisheries seem stable, the build up of South Pacific gillnetting has largely resulted from a seasonal movement of vessels from the North Pacific and a transfer of vessels from the Indian Ocean because of poor catch rates there. The Indian Ocean decline has been quite rapid, as the gillnet fishery there commenced only in the early 1980s. In the North Pacific, after a peak catch of 120,000 mt, recent total catches have been of the order of 42,000 mt, compared with an estimated MSY of 60-110 mt. But there are concerns that the fishery is declining.

61. The decline of the catch in the North Pacific and Indian Ocean would suggest the need for caution in relation to further expansion of surface fisheries, including gillnetting, for albacore in the South Pacific.

Table 5: Global comparison of albacore fisheries

Area	Extent	--Fisheries-- LL	PL	TR	GL		--Catch-- 86	87	88	89	Maximum Catch	MSY	Status of fishery	Source
North						LL	17	15*			25			IP1, IP10
Atlantic	60 deg	+	+	+	+	PL	12	12*			22	50-70	STABLE	*est/1986
	6,700 km					TR	11	11*			40	(from		GL=GL+Trawl
						GL	0	2			2	SURF+LL)		
						TOT	40	40*			65			
North						LL	13	15*			29			IP2,Summary 86
Pacific	100 deg	+	+	+	+	PL	16	7			88	60-110	CONCERN?	GL=GL+Other
	11,000 km					TR	5	4			25	(from		
						GL	12	16			15	SURF+LL)		
						TOT	46	42*			157			
South						LL	23	23*			33			IP1
Atlantic	80 deg	+		+?		TR	5	5*			6	24-25	STABLE	*est/1986
	8,900 km					TOT	28	28*			33	(from LL)		
Indian						LL	10	?			27			TSW 88/82
Ocean	95 deg	+			+	GL	15	?			15	16-18	CONCERN?	WP10
	10,500 km					TOT	25	?			27	(from LL)		
South						LL	27*	31	30*	47				
Pacific	130 deg	+		+	+	TR	2	3	10			30-35	?	
	14,400 km					GL	2	6	27-50			(from LL)		

STATUS OF STOCK

62. The maximum sustainable yield of the longline fisheries for South Pacific albacore has been estimated using surplus production models. These analyses, based on historical longline catch and effort statistics, suggest that the longline fleets can sustain a catch of about 35,000 mt per year in the presence of a small surface fishery (about 2,000 mt per year). Although information on the current total longline catch is incomplete, the average longline catch during the mid-1980s was about 30,000 mt.

63. The South Pacific longline fishery harvests primarily large, mature albacore. Studies of yield-per-recruit for North Pacific albacore indicate that maximum yield might be achieved by targeting four-to-five year old fish, which would be intermediate in age between the longline and surface fishery age groups. If similar population characteristics hold for South Pacific albacore, a higher aggregate yield might be expected by developing surface fisheries to increase the catch of the smaller, younger albacore. How large a catch could be sustained in the surface fisheries, and in the combined surface and longline fisheries, is unknown, and cannot be determined from the surplus production models. Assessment of potential yields in a multi-gear fishery harvesting both older and younger age classes will require additional information on size and age composition of the catches, growth rates, and mortality rates.

64. Studies of some of these critical parameters are already underway, and others are planned.

65. In view of the considerable uncertainty about the population dynamics of South Pacific albacore, the rapid increase in surface fishery yields, due principally to the drift gillnet fleets, is a cause for concern. The increase, to a total surface catch estimated at 34,000-59,000 mt, has occurred without the concurrent collection of quantitative scientific information that would permit evaluation of its impact and its appropriateness. It is far from clear that this catch is sustainable.

66. In any event, it is reasonable to expect that a sustained surface catch at the level currently realised would markedly reduce potential yields in the longline fishery. Because the longliners catch larger, older fish on average, it will take perhaps two or three years before such impacts can be directly assessed. The surface fishery appears to target two age classes; heavy exploitation of the younger may cause a measurable decrease in the older age class in the subsequent year's catch. These changes will provide valuable information for estimating exploitation rates in the surface fisheries.

67. Plans to carefully monitor all of the fisheries and to analyse the stock dynamics should be developed and implemented immediately. The monitoring and assessment will require greater attention to collection of accurate statistics on catch and effort in all the fisheries, and improved data on the size composition of the catch. Biological studies on growth and other critical parameters for stock assessment should be accelerated and numerical models for stock monitoring and simulation of yield potentials and fishery interactions should be developed without delay.

MANAGEMENT CONSIDERATIONS

68. Recent expansion of the surface fisheries has produced a total South Pacific albacore catch at least double and perhaps triple the maximum sustainable yield estimates for the longline fishery operating with only a minor surface fishery (pre-1986). The total MSY might be increased by increasing the proportion of younger fish in the catch; however, the extent of the increase is unknown.

69. There is a lack of representative data, especially on the gillnet fishery but also on other components of the fishery. Reliable stock assessments will not be possible without these data, so short-term quantitative advice on the stock and on the impact of catch levels will necessarily be provisional and uncertain.

70. Yellowfin tuna, a relatively fast-growing tuna with a moderately fast population turn-over, provides examples of sustained yield increases that have been achieved by re-directing fishing effort towards younger ages. On the other hand, in the case of southern bluefin tuna,

a slow-growing tuna with a low mortality rate, there has been a severe stock decline because of an inappropriate balance between juvenile and adult catches. Albacore are intermediate in population characteristics to the examples above, suggesting the need for caution in the extent to which juvenile catches are increased.

71. The following issues are relevant when management options are considered:

- surface fishery effort and catches have increased rapidly to an alarming level; any further increases would worsen the situation;
- catch estimates take no account of mortality caused by escapement from net and hook and dropout from net;
- reliable quantitative stock assessment advice will not be available in the short term;
- continued harvests of small fish of 34-59,000 mt with the current fishery pattern, will reduce recruitment to the spawning stock and longline catch rates;
- reduced recruitment to the spawning stock could result in reduced recruitment to the surface fisheries;
- if declines in recruitment to the surface fishery occur, stock (and yield) recovery could take many years because of lag effects.

DATA REQUIREMENTS

72. Data collection, and data availability and exchange, are important considerations. Early availability of catch and effort data is particularly important. Delay can prevent early recognition of fishery trends. Changes in longline catch rate or size composition may be the first indicators of population response to changed fishing levels. Changes in troll fishery catch rate and size composition may, in the longer term, reflect variability in recruitment. In the short term, changes in size composition may be the best indication of the effects of interaction between the troll and gillnet fisheries.

73. Collection of catch data needs to account for the total albacore removals from the region. Next, some long term series of catch rate information, broken down by area and time, from major albacore target fisheries is necessary to monitor abundance trends. Finally, details of catch size composition, by area and time, and for the various fisheries is required.

74. The most urgently required data are those describing catch, effort, species composition and size composition in the albacore drift gillnet fisheries carried out by Taiwanese, Japanese and, to a much lesser extent, Korean vessels in the South Pacific. The introduction of data collection procedures for future Taiwan drift gillnet activity in the South Pacific is of paramount importance because no such collection system exists. Japan has arranged voluntary provision of catch and effort information from co-operating gillnetters but, because the data are quite limited in coverage, it has decided to make data provision compulsory.

75. Efforts should also be made to supplement collection of future data with historical data on the fishery. The very recent establishment of the fishery suggests that scope probably still

exists to assemble historical data from current operators. This may require approaches to vessel owners, fishing companies or vessels direct, and could be a difficult task. Nevertheless, the information available is so sparse that special attention to the matter is warranted. For example, data for the 1988-89 season are limited to those from two vessels of the perhaps 120-190 vessels that fished during the season.

76. Participants indicated that efforts will be made to improve size composition data collections. Japan will request co-operation of gillnetters to measure fish on board. It already receives albacore size composition data from longliners and, with the caution that longliners targeted species other than albacore, indicated that it is prepared to make albacore catch and size composition data available, extending this to include gillnet data as the collection system develops. While Taiwan publishes monthly 5-degree square longline catch data and makes them available, the quality of longline catch size composition data provided by fishermen requires validation. Consideration will be given to the introduction of port monitoring of longline and gillnet albacore landings, but staff shortage presents a problem in this regard. The Chairman indicated that SPC will write to Taiwan explaining the urgent and important nature of obtaining data on Taiwanese albacore activity in the South Pacific. New Zealand, French Polynesia, the United States, Fiji, Tonga, New Caledonia and Australia indicated that they will maintain size monitoring programmes or seek to strengthen them where they are unrepresentative.

77. Participants prepared an inventory of South Pacific albacore fisheries statistics (Table 6).

78. In relation to the availability and exchange of data, SPC offered, and participants accepted, its services as a 'clearing house' for receival of data and distribution of them among scientists. It was agreed that monthly catch and effort data by 5-degree square will be exchanged for longline fisheries. In particular, Japan indicated it would provide South Pacific albacore data on a reciprocal basis from 1981 to the present. Taiwan and Korea already publish longline data on this basis so it is assumed that the data will continue to be available.

79. For surface fisheries it was agreed that monthly 5-degree square data will be exchanged. However, the participant from Taiwan explained that no surface fishery data collection system by 5-degree square and month has been established, so he could make no commitment. Japan's contribution would improve with the formal establishment of a collection system for the gillnet fishery.

80. Catch size composition data require separation by latitude and longitude because of the change in size composition by area. It was agreed that size composition data to be exchanged will include monthly breakdown on a 5-degree latitude by 10-degree longitude basis. However, Japan has additional information suitable only for breakdown by quarter on a 10-degree latitude by 20-degree longitude grid, so it will also include this. The participant from Taiwan reiterated his concern about the quality of current Taiwanese length composition data and its unsuitability for distribution pending consideration of an alternative monitoring arrangement.

81. It will be important to standardise definition of 5-degree squares, 5-degree x 10-degree grids or 10-degree x 20-degree grids so that geographic reference to data is consistent among scientists. Timing of updates of data holdings must also be determined. SPC will follow this up by correspondence so that procedures can be finalised by 31 October 1989, in time for the next surface fishery season.

Table 6: Inventory of fishery statistics for South Pacific albacore

Country, gear	Years	Scale: Time	Scale: Area	Wt/No/ length	Port	Remarks
Catch-effort data (Logbook) for surface fishery						
Japan, gillnet	1983-88	month	1 deg	No	Japan	FSFRL
New Zealand, troll	1974-	month	port	No/av wt	Various	MAFFish
Taiwan, gillnet						
USA, troll	1986-	month deg	1 & 5	No	Pago Pago	NMFS
Catch-effort data (Logbook) for longline fishery						
Australia	1985-	month	region	No/wt	Australia	DPI
Japan (1)	1952-86	month	5 deg	No	Japan	FSFRL
Japan (2)	1978-89	month	1 deg	No/wt	Various	SPC
Japan (3)	1960-72	month	10 deg	No	Pago Pago	NMFS
Korea (1)	1963-87	month	10 deg	No	Pago Pago	NMFS
Korea (2)	1975-	month	5 deg	No	Korea	
Korea (3)	1979-89	month	1 deg	No/wt	Various	SPC
New Caledonia	1983-	month		No/wt	Noumea	
Taiwan (1)	1971-	month	5 deg	No	Taiwan	Taiwan
Taiwan (2)	1964-87	month	10 deg	No	Pago Pago	NMFS
Taiwan (3)	1980-89	month	1 deg	No/wt	Various	SPC
Size-frequency (sample) for surface fishery						
Japan, gillnet (1)	1989	month	1 deg	FL	Japan	FSFRL
Japan, gillnet (2)	1989	trip	region	FL	Noumea	SPC
New Zealand, troll	1974-	season	port	FL	Various	MAFFish
Taiwan, gillnet						
USA, troll (1)	1986-	trip	region	FL	Pago Pago	NMFS
USA, troll (2)	1986-	month	region	FL	Papeete	EVAAM
Size-frequency (sample) for longline fishery						
Australia	1985-	month	region	FL	Australia	some gaps
Japan (1)	1952-86	quarter	10 x 20	FL	Japan	FSFRL
Japan (2)	1962-72	trip	various	FL	Pago Pago	NMFS
Korea	1962-87	trip	various	FL	Pago Pago	NMFS
New Caledonia						
Taiwan	1964-87	trip	various	FL	Pago Pago	NMFS

NOTES

1. SPC data has 10-50% coverage from access agreements.
2. MAFFish refers to New Zealand MAFFish Pelagic Research Group.
3. Size frequency data for New Zealand is missing for some years.

STOCK ASSESSMENT METHODS

82. It is important to identify appropriate methods for South Pacific albacore stock assessment and monitoring, and to specify the corresponding data requirements. Before the recent

development of surface fisheries, the status of the traditional longline fishery was adequately assessed with a surplus production model based on longline catch rates and total catch statistics. It is essential to continue collection of the catch and effort data, but other methods are now needed to assess yield potentials in the surface fisheries and in the aggregate. In particular, age- and/or size-structured methods are needed to analyse the relationships between yield-per-recruit and size-specific fishing mortality, and to assess impacts of the surface fishery developments. These methods require extensive data on size composition of the catch and means to compute the growth and mortality rates.

83. Growth rates can be derived from size frequency data, tagging, and studies of hard parts (otoliths, vertebrae). Mortality rates can be estimated from changes in the size of cohorts over time. The age-specific cohort analyses will require estimation of age composition of the catches from each fishery. For the longline fishery this will be difficult, as age groups are not clearly separated in the catches.

84. In addition to the usual cohort models to estimate mortality and recruitment, it would be useful to develop models which account for spatial variation in population abundance and the distribution of fishing effort. These models can be age- and/or size-specific.

85. Besides the analytical and empirical models just described, there is a need for numerical simulation models. These will allow assessments and projections to be made under complex sets of assumptions on the stock dynamics and exploitation patterns. Indeed, until solid data are available to support the age-specific empirical models, the simulations will likely be the best means of providing provisional assessments. They will be particularly valuable for evaluating the implications of growth in the surface fishery effort, and for assessing the effects of uncertainty in parameters estimates and structural assumptions.

DEVELOPMENT OF A STRATEGIC RESEARCH PLAN

86. A number of priority research areas were identified by the workshop as being critical for stock assessment and the evaluation of interactions.

TAGGING STUDIES

87. Tagging was recognised as a useful technique for the estimation of vital population parameters and interaction among gear types. SPC summarised its plans to undertake a tagging programme in the STCZ in 1989/90, with funding from the European Community. Three month-long tagging cruises are planned, using a chartered pole-and-line/troll boat.

88. Discussion centred on the possible reasons for the very low recovery of tagged albacore achieved in previous experiments, both in the STCZ and in New Zealand inshore waters. In all previous experiments, trolling was the fishing method used; however albacore tagged by this method in the North Pacific had only one quarter the recovery rate of those tagged using pole-and-line fishing.

89. The meeting agreed that highest priority should be given initially to release of the greatest possible number of tags to enhance prospects for recovery; this would mitigate against use of oxytetracycline experiments. Although the tagging techniques used in previous experiments in the South Pacific were considered sound, it was strongly recommended by the meeting that,

if possible, the SPC tagging programme use a pole-and-line vessel that could convert to trolling if necesary.

90. The potential problem of recovering recaptured tags was also highlighted. The United States, Japan and Taiwan all indicated their willingness to co-operate in return of tags. There was some discussion of the experimental design and objectives of the programme, with some concern that the stock assessment and interaction objectives might conflict. SPC pointed out that the general strategy would be to tag over as wide an area as possible and in a size range representative of the surface fisheries, i.e. there would be no preferential selection of fish on the basis of size.

91. In addition to the SPC programme, both the United States (supported by the U.S. fishing industry) and New Zealand confirmed that they would continue to tag albacore during 1989/90. Japan also indicated the possibility of its undertaking albacore tagging in the South Pacific in the future. It was stressed that these programmes should use the same techniques, tags, reward payment and tag collection system.

SEASONALITY OF SPAWNING

92. In earlier sessions, the possibility of semestral spawning had been raised, based on growth rates obtained from analysis of daily otolith increments and the positioning of length-frequency modes in surface catches. Given the stock assessment implications of this tentative finding, the workshop strongly supported a programme to determine seasonality of spawning by sampling gonad indices. Sampling of longline catches could take place at Pago Pago (NMFS) and Levuka (Fiji and SPC). Also, onboard sampling of longliners from Tonga and Fiji, and possibly from a research longlining operation in New Caledonia, could provide a continuous time series of samples of known capture time and location. Fresh material thus collected could be used for microscopic examination to determine precise individual spawning times and periodicities. The National Marine Fisheries Service (Laurs) will investigate the possibility of undertaking the laboratory analyses in the United States.

93. In support of the gonad sampling, it may be possible to investigate opportunities for larval sampling in the presumed spawning area by way of the TOGA and SURTROPAC programmes; however responsibility for processing such samples, if collected, was not discussed.

AGE AND GROWTH STUDIES

94. The growth increments observed in otoliths and vertebrae have not been validated. The rapid growth indicated by analysis of otoliths may result from undercounting rings, but the procedures used are identical to those employed in the North Pacific, where the daily frequency of the increments has been validated. SEM study of otoliths will be considered by NMFS and comparison of otolith and vertebral growth increments from the same fish is planned between New Zealand and NMFS scientists. For the present no further collection of hard parts is planned.

95. There is an urgent need to corroborate the results of otolith and vertebral studies using other methods. NMFS scientists have undertaken to analyse length frequency data to see if modal progression can corroborate growth rates inferred from hard parts.

96. Microconstituent analysis of albacore otoliths and vertebrae may provide an insight into the frequency of increment formation.

OCEANOGRAPHY

97. Satellite sea surface temperature charts produced during the 1988/89 albacore season were considered an extremely useful and cost-effective tool for interpreting fishing success. Hope was expressed that New Zealand would continue to produce this information. New Zealand expressed its intention to do so, if funds are available, and described a SST mosaic they propose to initiate next season. That would give a synoptic portrayal of the STCZ from NZ east to 150°W.

98. The need for subsurface temperature and salinity profiles was expressed. The use of XBTs and of a towed CTD data logger, similar to one developed at CSIRO Hobart, was described. The commercial version of this machine is available for about $8,000. The view was expressed by ORSTOM and NMFS scientists that this information was very desirable in a region as complex as the STCZ.

'DROPOUT' ESTIMATION IN DRIFT GILLNET FISHERY

99. Japan advised that its planned observer operation on a commercial gillnet vessel in the South Pacific during the 1989/90 surface fishery season would include an examination of drop-out rate during hauling.

INFORMATION COMMUNICATION

100. SPC agreed to produce an annual summary of South Pacific albacore catches from information supplied by participants and the agencies they represented. Methods of distributing information led to a discussion of electronic mail and communication packages. SPC continues to pay subscription costs for all the nodes on the tuna network. The number of packet switching systems in the SPC region limits the utility of EIES within the region and the use by SPC and outside agencies is lower than originally anticipated. SPC suggests consideration of alternative electronic information systems that are either more commonly used or less expensive. The BIX and OMNET systems were mentioned and SPC will circulate information on them and seek advice on the most appropriate way to maintain communication.

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ANNEX I

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ANNEX II

AGENDA

Day 1

1. Preliminaries

   1.1 Opening address
   1.2 Election of Chairman and Rapporteurs

2. Review of recent developments in the albacore fishery

   2.2 South Pacific
   2.2 Other areas

3. Review of recent research activity on albacore

   3.1 South Pacific
   3.2 Other areas

Day 2

4. Review of available data

   4.1 Compilation of an agreed 'best estimate' of historical fishery data
   4.2 Development of a 'best estimate' of the status of the South Pacific albacore fishery

5. Requirements for stock assessment and fishery interaction studies

   5.1 Determination of the most appropriate models to be employed
   5.2 Data requirements
   5.3 Future data collection and protocols for data exchange

Day 3

6. Development of a strategic research plan for South Pacific albacore

   6.1 Tagging experiments
   6.2 Biological/tuna oceanography studies
   6.3 Stock assessment and interaction

7. Other business

8. Arrangements for next meeting

Day 4

9. Adoption of the report

ANNEX III

LIST OF WORKING PAPERS/INFORMATION PAPERS

SPAR 2/WP.1: South Pacific albacore catch made by U.S. jig boats during the 1987/88 and 1988/89 fishing seasons - M. Laurs and R. Nishimoto

" WP.2: Situation et perspectives de la pêche des germons en Polynésie française

" WP.3: La pêche des germons en Polynésie française - S. Yen, J. Chabanne and L. Wrobel

" WP.4: Albacore tuna and its fisheries in the Australian Fishing Zone - A. Caton, P. Ward

" WP.5: Preliminary report of albacore catch by Japanese large-mesh driftnet fishery in the South Pacific, 1983/84-1987/88 - H. Nakano, Y. Watanabe and Y. Nishikawa

" WP.6: Taiwanese tuna fisheries in the South Pacific Ocean - C. H. Wang

" WP.7: La pêche au germon dans la zone économique exclusive de la Nouvelle Calédonie (1986-1988)

" WP.8: Solomon Islands Country Statement - S. Diake

" WP.9: Notes on the Fiji albacore fishery - Fiji Fisheries Division

" WP.10: A review of Japanese albacore fisheries in the Pacific and Indian Oceans - Y. Nishikawa, Y. Watanabe and H. Nakano

" WP.11: Use of longline catch rate statistics to monitor the abundance of South Pacific albacore - J. Wetherall and M. Yong

" WP.12: N.O. *Coriolis* Prosgermon 1987 Cruise Report. 27/2-20/3/1987 - R. Pianet

" WP.13: Summary of South Pacific albacore tagging conducted during 1986-1989 - M. Laurs and R. Nishimoto

" WP.14: South Pacific albacore observer programme 1988/89 - J. Hampton, T. Murray and P. Sharples

" WP.15: South Pacific albacore survey by surface fisheries organized by JAMARC, 1981-1987 - Y. Watanabe, H. Nakano and Y. Nishikawa

" WP.16: Summary of feasibility survey for albacore and billfish by drift gillnet carried out by JAMARC in the Southern part of the South Pacific Ocean during 1988-1989 - JAMARC

" WP.17: Movements of albacore tuna *(Thunnus alalunga)* in the South Pacific: evidence from parasites - B. Jones

SPAR 2/WP.18: Age and growth of South Pacific albacore determined from daily otolith increments - J. Wetherall, R. Nishimoto and M. Yong

" WP.19: Testes morphology, histology and spermatogenesis in South Pacific albacore tuna - F. Ratty, R. Kelly & R. M. Laurs

" WP.20: Preliminary report on age determination of South Pacific albacore using caudal vertebrae - T. Murray and K. Bailey

" WP.21: New Zealand country report. The development of albacore fisheries in New Zealand waters with a summary of recent developments - T. Murray

" WP.22: Tagging albacore in New Zealand waters - K. Bailey

SPAR 2/IP.1: Overview of the Atlantic albacore fisheries - R. Pianet

" IP.2: Current outlook of stock condition and fisheries for North Pacific albacore - G. Sakagawa

" IP.3: Current status of South Pacific albacore data on SWFC data bases - A.Coan and D. Prescott

" IP.4: Pêche aux germons de surface dans le Pacifique Sud - Bilan de la campagne de pêche commerciale effectuée par les germoniers U.S. de décembre 1987 à avril 1988 - S. Yen and L. Wrobel

" IP.5: Pêche des germons de surface dans le Pacifique Sud - Bilan de la première campagne de pêche effectuée par les thoniers américains de décembre 1986 à avril 1987

" IP.6: Observations on drift gillnet selectivity for albacore inferred from various surveys - N. Bartoo and D. Holta

" IP.7: Estimating the MSY of South Pacific albacore 1971-1985 - C. H. Wang, M. S. Chang and M. L. Lin

" IP.8: Seasonal changes of the distribution of South Pacific albacore based on Taiwan's tuna longline fisheries, 1971-1985 - C. H. Wang

" IP.9: Some problems in catch statistics of tuna longline fishery - C. H. Wang

" IP.10: New albacore fishing techniques in the north-east Atlantic (gillnet and pelagic trawl). Description and incidence on the albacore stock - IFREMER.

" IP.11: Sampling of Japanese gillnetters in Noumea, January - February 1989 - Tuna and Billfish Assessment Programme, SPC

" IP.12: South Pacific Albacore Tagging Project

" IP.13: Incidental catch of small Cetaceans in a gillnet fishery in Northern Australian waters - M. B. Harwood, K. J. McNamara and G. R. V. Anderson

" IP.14: Incidental catch of small Cetaceans in the offshore gillnet fishery in Northern Australian waters: 1981-85 - M. B. Harwood and D. Hombree

" IP.15: Pelagic gillnet modification trials in Northern Australian seas - D. Hombree and M. B. Harwood

" IP.16: Data Catalogue - Tuna and Billfish Assessment Programme, SPC (Revised May 1989)

" IP.17: *Regional Tuna Bulletin*, Fourth Quarter 1988 Tuna and Billfish Assessment Programme, SPC

" IP.18: Estimates of catch and effort for tuna fisheries in the Central and Western Pacific Ocean for 1987 and 1988 - Tuna and Billfish Assessment Programme, SPC

" IP.19: Relationships between South Pacific albacore troll fishing success and oceanographic conditions - R. M. Laurs