IP 2

# REVIEW OF RESEARCH AND OF RECENT DEVELOPMENTS IN SOUTH PACIFIC ALBACORE FISHERIES, WITH EMPHASIS ON LARGE-SCALE PELAGIC DRIFTNET FISHING

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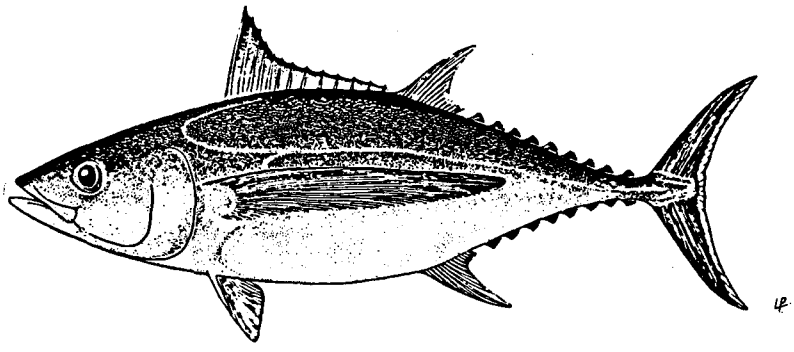

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# Review of Research and of Recent Developments in South Pacific Albacore Fisheries with Emphasis on Large-Scale Pelagic Driftnet Fishing

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## Introduction

Large-scale pelagic driftnet fishing has been widely used in the South Pacific region since 1983, especially in the Tasman Sea east of Australia and the area east of New Zealand. Most driftnet fishing, however, has been experimental, involving relatively few vessels to assess the commercial potential of undeveloped and underdeveloped resources in high seas areas. The commercial potential of a wide variety of pelagic resources have thus far been assessed but access to results of driftnet surveys is extremely difficult. Taiwanese driftnet surveys, conducted largely within Australian and New Zealand waters, for squid (Ommastrephes bartrami and Nototodarus gouldi) in 1981 have been described by Collins and Dunning 1981 and Anon 1981. Large-scale pelagic driftnet fishing by Taiwanese vessels for sharks and mackerel began in 1974 in the waters of the adjacent Arafura Sea north of Australia and is the most extensively studied driftnet fishery in the region. This fishery was closed in 1986 because of the high catch of dolphins (Read and Ward 1986) based on the work of Harwood et

al. (1984), Harwood and Hembree (1987), and Hembree and Harwood (1987). The results of JAMARC driftnet surveys for slender tuna (Allothunnus fallai) since 1983; for pomfrets (three species of Bramidae) since 1984; and for albacore (Thunnus alalunga) since at least 1987 are not readily available.

More recently the rapid development of South Pacific albacore surface fisheries, particularly the driftnet fishery, has raised considerable concern over the potential impacts to the stock and to some components of the incidental catch. The absence of requirements for commercial fishing vessels to provide catch and effort data (changed only in the 1989/90 season for Japanese vessels) and the lack of access to driftnet survey data on catch rates, catch composition, and size composition of target species has severely hampered the assessment of large-scale pelagic driftnet fishing for albacore in the South Pacific.

In order to understand the concerns caused by the expansion of large-scale pelagic driftnet fishing in the South Pacific it is necessary to review both the development of South Pacific albacore fisheries and the research which has been carried out on the stock. From this framework it is also easy to identify research areas that will need to be further developed.

## Development of South Pacific Albacore Fisheries

### Longline Fisheries

South Pacific albacore fisheries began with the expansion of Japans' distant water longline fleet into the South Pacific during the early 1950s. Longliners from the Republic of Korea, following the early success of the Japanese fleet, began targeting albacore in the late 1950s and were followed by longliners from Taiwan in the late 1960s. Since 1985, South Pacific coastal states have also begun fishing for adult albacore. Tonga and New Caledonia have both invested in longliners which solely target albacore and a number of small vessels drop line for adult albacore in French Polynesian waters.

The combined catch by all fleets targeting adult albacore has been at or below the estimated Maximum Sustainable Yield (MSY) of 30-35,000 tonnes (Wang et al. 1988) since the late 1970s. This paper ignores catches in all fisheries other than the asian longline fishery on the basis that these fisheries account for over 90% of all catches. Table 1 summarizes South Pacific longline catches of albacore.

Table 1. Longline catches (tonnes) of South Pacific albacore by country waters. Asterisks indicate estimated catches.

| Year | Japan | Korea | Taiwan | Others | 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 | n/a | 27,614 |
| 1986 | 4,466 | 18,799 | 11,913 | 200 | 35,378 |
| 1987 | 4,085 | 8,646 | 15,009 | 884 | 28,624 |
| 1988 | 4,100* | 6,896 | 17,120 | 866 | 28,982* |

## Surface Fisheries

Trolling for albacore first developed in the South Pacific in New Zealand coastal waters in the late 1960s. This fishery experiences extremely variable landings due to uncertain weather conditions during the short summer season and due to variable climatic effects on the southern extent of the juvenile albacore distribution. In good seasons (warm calm summers) over 200 small vessels may enter this fishery and can be expected to land 2000-4000 tonnes of juvenile albacore. In

bad seasons (cold windy summers) fewer vessels fish and landings can be expected to be less than 1000 tonnes. The troll fishery has expanded since 1986, partly due to perceptions that observed declines in longline fishing might allow increased yields from the surface fishery and partly from results of exploratory fishing along the Subtropical Convergence Zone (STCZ) east of New Zealand. The STCZ albacore troll fishery has continued to develop from 100 tonnes and two vessels in 1985/86 to about 4000 tonnes and 50 vessels in 1988/89.

During the same period that the STCZ troll fishery was developing east of New Zealand, a large-scale pelagic driftnet fishery for albacore was also developing in high seas areas east and west of New Zealand. The rapid expansion of this driftnet fishery from 10 vessels in 1986/87 to perhaps as many as 198 in 1988/89 and the magnitude of driftnet catches (estimated conservatively) resulted in considerable concern amongst coastal states of the region over the sustainability of continued harvests of juveniles at 1988/89 levels. Table 2 summarizes the catches in surface albacore fisheries in the South Pacific by country and fishing method.

Table 2. Surface fishery catches (tonnes) of South Pacific albacore since 1970 by country and gear. Asterisks indicate estimated catch.

| Year | Australia Various* | Total Gillnet* | N Z Troll | STCZ Troll | Total* |
|---|---|---|---|---|---|
| 1967 | n/a | | 5 | | 5 |
| 1968 | n/a | | 14 | | 14 |
| 1969 | n/a | | n/a | | n/a |
| 1970 | 500 | | 50 | | 550 |
| 1971 | 500 | | n/a | | 500 |
| 1972 | 500 | | 268 | | 768 |
| 1973 | 500 | | 484 | | 984 |
| 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 | 5,801 | 330 | 3,600 | 10,000 |
| 1989 | 200-400 | 25-49,000 | 4,801 | 4,100* | 34-59,000 |

In addition to concerns of overfishing, albacore catch levels by driftnet fleets have raised concern related to the potential for economic impacts which could range from diminished landings at regional canneries, reduced catches in regional fisheries, loss of fisheries development opportunities, reductions in foreign longline catches with resultant effects on regional support bases and fishing license fees. Concern over direct competition between driftnet and troll fleets also arises since both surface fisheries catch the same sizes of fish in the same area at the same time.

The rapid development of the driftnet fishery without adequate information on the population dynamics of South Pacific albacore and without collecting fisheries statistics from this fleet has made impact assessment extremely difficult. However, the reductions in driftnet fleet size in 1989/90 and the commitment to stop driftnet fishing by July 1991 must reduce the threat posed by the 1988/89 catch levels and increase confidence that it will be possible to manage the resource effectively.

## Albacore Research Programmes in the South Pacific

The general features of the biology, ecology, and distribution of Pacific albacore are well known (Foreman 1980). It is clear from this synopsis that there are differences in fisheries operating on the stocks and in the population structure of albacore stocks between the North and South Pacific and that less is known about the South Pacific stock.

The distribution of the South Pacific albacore stock is imprecisely known from egg and larval surveys (Nishikawa et al. 1985), research surveys for juveniles (Roberts 1977 and 1980; Ichikawa 1981; Iwasa et al. 1982; Le Gall et al. 1982; Laurs et al. 1986 and 1987; Murray and Bailey 1987; Watanabe et al. 1989), and historical catch and effort data from commercial fisheries (Foreman 1980; Polacheck 1987; Wang 1988). Based on these sources the approximate geographical limits for the South Pacific stock are believed to extend from the equator to 50° S and from the east coast of Australia to the west coast of South America. At present there no information which demonstrates that there is more than one albacore stock in the South Pacific. However, the possibility of mixing between stocks, either between the South Pacific and Indian Oceans around southern Australia or between the North and South Pacific has not been ruled out.

## An Overview of New Zealand Albacore Research Programmes

### South Pacific Albacore Research linkages

New Zealand MAF Fisheries has maintained an active field research programme to study the distribution, growth, and movement of albacore in the southwestern Pacific since 1984. This research has been closely integrated with other research programmes on the South Pacific stock through the South Pacific Albacore Research (SPAR) group. Research planning has also been done in consultation with the SPAR group. Where possible joint programmes have been developed (e.g., a scientific observer programme with the SPC, development of ageing techniques with the U.S. National Marine Fisheries Service, a tagging programme with SPC, NMFS, and France). Continuation of an active research programme to provide data for stock assessment (including driftnet impacts) and which is integrated with other research initiatives in the South Pacific is planned.

### Observer Programmes

Observers have been placed on troll vessels during the 1988/89 and 1989/90 seasons to assess the size composition of the troll catch, hook drop off rates, catch composition, catch rates, and the incidence of recent versus old driftnet damage. The results are to be published annually by the SPC.

In the 1989/90 season an observer was allowed to board the JAMARC research driftnet vessel Shin-hoyo maru for one month in the Tasman Sea and for one month south of Tahiti. The activities of the observer were similar to those of observers on troll vessels. The results of this work will be jointly published.

A small observer programme is also conducted onboard longline vessels fishing within the New Zealand EEZ. This programme ensures that the size composition of adult albacore are censused annually.

### Research Surveys

Research surveys to assess catch rate and size composition of troll caught albacore in relation to oceanography are conducted annually. These surveys have provided data on relative abundance of albacore in high seas areas relative to shelf-slope areas fished by the New Zealand domestic fleet.

Research surveys to assess the frequency of recent driftnet damaged albacore in relation to the geographical distribution of the driftnet fleet are being conducted to determine patterns of short-term movement.

Commercial Catch Sampling

Port and vessel sampling of the New Zealand albacore catch is conducted several times each year during the summer season to provide a regular series of length frequencies. The incidence of driftnet damage is also estimated onboard troll vessels.

Tagging Studies

Tagging is conducted annually during dedicated research cruises east and west of New Zealand as part of a regional study of movements coordinated by SPC. The majority of albacore are also injected with oxytetracycline as part of an age validation experiment.

Age Determination

A rapid method for age determination is being evaluated by comparing the banding sequences in caudal centra with those in otoliths. The banding sequence in caudal centra appears to provide a rapid method for ageing albacore up to 10 years old. Studies are currently underway to try and decrease the variance in the fitted growth curve by stratifying samples by sex. The validation of this method is part of a joint study with U.S. scientists and has been underway for several years awaiting recoveries of whole oxytetracycline injected tagged fish.

Biological Studies

Ancillary studies have also been carried out on albacore forage items (Bailey and Habib 1982, Bailey 1987), on albacore parasites (Jones 1987, 1989), proximate composition (Vlieg and Murray 1988), and on albacore maturation (Ross 1987). These studies are a by-product of major albacore programme and are helping to increase our understanding of South Pacific albacore.

## Results of South Pacific Albacore Research

Albacore studies undertaken by New Zealand and others in the South Pacific provides a reasonable basis for understanding the nature of albacore fisheries and which portions of the stock they operate on. The information which recent research has provided is discussed below while the information which still largely remains to be gathered is identified in a later section.

Fleet Composition, Seasonality and Areas of Operation

The number of vessels by gear type and nationality is given in Table 3 for South Pacific albacore surface and longline fisheries. In many cases the number of vessels represents only a rough estimate of what may be a larger fleet. Surface

fisheries, targeting juvenile albacore in the surface mixed layer, have a limited fishing season corresponding to the austral summer months of December to March. Surface fisheries are further restricted to a relatively narrow latitudinal band between approximately 37 and 41° S during this period and extend from the Australian coast eastwards to approximately 130° W. Longline fisheries in contrast, target deeper dwelling adult albacore and operate throughout the year moving southwards from the equator between February and August and then contracting equatorward from September to January. According to Wang et al. (1988) fishing concentrates north of 20° S from October through March and is broadly distributed as far south as 40° S in other months with most fishing south of 20° S from May to July. This results in a seasonal segregation of surface and longline fisheries.

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 |
|---|---|---|---|
| Australia, pole-and-line | ? | ? | ? |
| Japan, driftnet | (9) | (20) | 67 |
| Korea, driftnet | 0 | 1 | 1 |
| New Zealand, troll | (100) | (25) | (200) |
| Taiwan, driftnet | 0 | 7 | (60-130) |
| U.S., troll | 7 | 43 | 48 |

| Longline Fishery | 1987 | 1988 | 1989 |
|---|---|---|---|
| Australia | 47 | 27 | ? |
| Japan (minimum no.) | 307 | 344 | ? |
| Korea (minimum no.) | 99 | 90 | ? |
| New Caledonia | 3 | 3-4 | 3-4 |
| Taiwan | 53 | 63 | (75) |
| Tonga | 1 | 1 | 1 |

CPUE Trends

Three sets of CPUE time series are readily available and reviewed in SPC (1989). They are the U.S. troll (Laurs and Nishimoto 1989), Japanese driftnet (Hideki et al. 1989) and longline fisheries (Wetherall and Yong 1989, Wang et al. 1988). In modelling the longline fisheries Wang et al. (1988) used effective effort and Wetherall and Yong (1989) used nominal effort for CPUE calculations.

Two sets of surface fisheries CPUE estimates are shown in Table 4, one for the U.S. troll, the other for the Japanese driftnet fishery. These fisheries show decreasing and increasing trends, respectively, for the period 1986/87 to 1988/89 and for the period 1983/84 to 1987/88.

Table 4. CPUE trends in South Pacific albacore surface fisheries.

| Year | U.S. Troll Vessel Catch (no. fish per vessel day) | Japanese Driftnet Vessel Catch (no. fish per vessel day) |
|---|---|---|
| 1983/84 | | 253.3 |
| 1984/85 | | 452.0 |
| 1985/86 | | 516.6 |
| 1986/87 | 330.2 | 473.9 |
| 1987/88 | 303.8 | 937.0 |
| 1988/89 | 283.3 | |

The increasing trend of CPUE for the Japanese driftnet fishery 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 the apparent discrepancy between surface fisheries difficult to interpret.

The longline CPUE for the entire South Pacific albacore stock based on effective effort showed a moderate decreasing trend to about one half from 1971 to 1985 (Wang et al. 1988). The set of annual longline CPUE based on nominal effort for the area between 35 and 40° S, over all longitudes, was calculated from the early 1970s to 1989, stratified by month. 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 (Wetherall and Yong 1989). However, it is not possible to give an unequivocal single explanation for this sharp drop due to preliminary nature of 1988 and 1989 data.

## Size Composition of the Catch

The size compositions of commercial albacore troll catches from the Tasman Sea and east coast of New Zealand are shown in Figure 1. Albacore in the Tasman Sea ranged in size from 44-91 cm. fork length with three equal modes at 56-57 cm, 67-68 cm, and at 76 cm. Along the east coast of the North Island albacore ranged in size from 41-98 cm with slight (about 1 cm) shifts to the right in the three modes. The modes in the east coast fishing area were at 55-56 cm, 66-68 cm, and at 74-75 cm. Differences between fishing areas and changes in size composition throughout a fishing season are well known. However, the differences between fishing areas is not

consistent with the general pattern within the New Zealand EEZ of larger fish on the east coast of the North Island than in the Tasman Sea.

The size composition of the albacore catch by the research driftnet vessel operating in the Tasman Sea reported by the SPC/NZ observer is compared with troll vessel catch in Table 4. Despite the area differences in the troll catch it is clear from Table 4 that both driftnet and troll vessels catch similar sized fish primarily intermediate and large size juveniles.

Table 5. Albacore fork length modes in troll and driftnet fisheries operating in the western South Pacific in the 1989/90 fishing seasons.

| Fishery | Small | Intermediate | Large |
|---|---|---|---|
| Tasman Sea Troll | 56-57 cm | 67-68 cm | 76 cm |
| east coast NZ Troll | 55-56 cm | 66-68 cm | 74-75 cm |
| STCZ Troll | ? | 67 cm | 75-76 cm |
| Tasman Sea Driftnet | 59-61 cm | 66-67 cm | 74-76 cm |

The 59-61 cm mode in the driftnet fishery in 1989/90 was also present in last years catch but is much reduced this year. The difference between fisheries with regard to the small size classes may be due to a combination of mesh size selectivity and differences in the proportions of small fish recruiting to different parts of the western South Pacific early in the season.

A total of 12,364 fish have been measured during the first segment (January-March 1990) of an observer cruise on troll vessels east of New Zealand along the STCZ, 8.3% of these were smaller than 58 cm and 0.2% were larger than 90 cm. None of these small or large size classes contained fish with old driftnet marks. Old driftnet marks were confined to fish between 63 cm and 87 cm in size.

The size composition of the 1989/90 STCZ troll catch is contrasted with the same period in 1988/89 in Figure 2. The troll catch exhibits clear modes at 67 cm and at 75-76 cm, the lesser mode is less well characterized because of the aggregation of small size classes but is likely to be at about 58 cm. This size composition is very similar to that of troll catches in the Tasman Sea and along the east coast of New Zealand this season. The albacore which showed old driftnet damage exhibited modes which coincide with the intermediate and large size classes in the troll catch. Compared with troll catches during the same period last year (1988/89 season) the modes are at approximately the same sizes but the relative magnitude of small, intermediate, and large size classes are quite different. This year there appears to be a reduction in the small size classes and an apparent

increase in the relative abundance of larger albacore. This pattern is also evident in the size frequency distribution of albacore with old driftnet marks seen this year.

Catch Composition in South Pacific Albacore Fisheries

It is readily acknowledged that in all fisheries there is an incidental or by-catch of other species. It is also recognized that the extent to which by-catch must be considered in managing a fishery depends on how selective the fishing method is and on the vulnerability of species associated with the target species.

Three very different fishing methods are used in the South Pacific to target albacore. The large-scale pelagic driftnet fishery sets its gear in the top 10-15 m at night when juvenile albacore and associated species are feeding at or near the surface. The troll fishery operates from pre-dawn to just after dark drawing juvenile albacore to the surface from as deep as 70 m using artificial lures which imitate small fish. Longliners set baited hooks for deeper dwelling adult albacore from droplines along a submerged mainline at depths of 100-300 m (Suzuki et al. 1977), although albacore can be caught by longline from 50-500 m (Grandperrin and Le Guen 1986).

In order to demonstrate the relative selectivity of the three major target fisheries for South Pacific albacore I have compiled estimates of catch composition for the driftnet fishery (based on research survey catch reports) in Table 6, for the longline fishery in Table 7, and for the troll fishery in Table 8. For the driftnet and longline fisheries the non-fish by-catch (marine mammals, sea birds, and turtles) which is known to occur, although to a much greater extent in the driftnet fishery than the longline fishery, has not been recorded. The troll fishery statistics represents the total catch of all species based on observer data. It is immediately apparent that trolling as a method is the most selective of the currently practised fishing methods followed by longlining. Driftnet fishing even based solely on fish by-catch is clearly the least selective of all oceanic pelagic fishing methods.

Table 6. Catch composition as percent by weight reported by Japanese driftnet research vessels in the South Pacific, data from Watanabe et al. (1989).

| | albacore target | slender tuna target | pomfret target |
|---|---|---|---|
| albacore | 20.0 | 4.5 | 2.7 |
| skipjack | 1.6 | 1.4 | 0.6 |
| yellowfin tuna | 0.2 | 0.1 | < 0.1 |
| slender tuna | 42.5 | 70.5 | 54.1 |
| other tunas | 0.3 | 0.6 | 0.8 |
| billfish | 7.7 | 2.4 | 0.4 |
| sharks | 26.1 | 11.0 | 14.2 |
| pomfrets | 0.4 | 8.1 | 26.4 |
| squids | 0.8 | 0.4 | 0.2 |
| other fish | 0.4 | 0.9 | 0.6 |
| % target | 20.0 | 70.5 | 26.4 |
| % non-target | 80.0 | 29.5 | 73.6 |
| total tonnes | 188.4 | 1453.9 | 1822.4 |
| total tans set | 60104 | 218798 | 237618 |
| years fished | 87/88 | 82/83-86/87 | 84/85-86/87 |

Table 7. Catch composition (as percentage by weight) of albacore longline fisheries operating within the N.Z. EEZ.

| | Japan | Korea |
|---|---|---|
| albacore | 31.4 | 81.7 |
| bigeye tuna | 22.0 | 6.4 |
| butterfly tuna | <0.1 | 14.9 |
| no. bluefin tuna | 0.1 | <0.1 |
| so. bluefin tuna | 0.3 | 0.0 |
| yellowfin tuna | 8.0 | 5.3 |
| swordfish | 19.3 | 0.7 |
| black marlin | 0.2 | 1.1 |
| blue marlin | 0.2 | 1.3 |
| striped marlin | 9.4 | 0.7 |
| sailfish | <0.1 | 0.1 |
| spearfish | 0.1 | <0.1 |
| sharks | 9.1 | 2.7 |
| % target | 31.4 | 81.7 |
| % non-target | 68.6 | 18.3 |
| total tonnes | 562202 | 3437324 |
| years fished | 1985-1988 | 1981-1988 |

Table 8. Catch composition (as number caught) in the albacore troll fishery in the southwestern South Pacific.

| | Daniel Solander Nov/Dec 1989 | Kariqa Nov/Dec 1989 |
|---|---|---|
| albacore | 4499 | 2270 |
| skipjack tuna | 19 | 71 |
| yellowfin tuna | 15 | 6 |
| yellowtail kingfish | 0 | 10 |

It may be possible to minimize the non-fish by-catch in these fisheries. Japanese longliners operating within New Zealand waters often employ a line of artificial squid lures without hooks above the longline as it is being baited and set. The lures tend to scare away the sea birds when they dive on the baited hooks thus reducing the by-catch of seabirds. Marine mammals are only occasionally caught on longlines and it is not clear how it could be lowered. In the driftnet fishery this year JAMARC regularly tried an experimental net deployment at 2 m below the surface. These experimental driftnets are reported to have had the same catch rates for albacore but significantly lower catches of skipjack. In particular, no marine mammals, sea birds or turtles were caught in the nets set 2m below the surface. Unfortunately it is not clear whether this experiment is representative of the commercial fleet since the research driftnet vessel did not fish in the same areas at the same times as the other driftnet vessels. It is also unclear why subsurface deployments have not been carried out in the commercial fleet since they have been used by other JAMARC driftnet cruises in the South Pacific in the past (e.g., Ibaraki Maru during January-February 1987).

In Australian experiments with modified driftnets conducted in 1984-1986 (Hembree and Harwood 1987) setting driftnets below the surface reduced the marine mammal by-catch by 50% but also reduced the target species (shark and mackerel) catch by up to 25%. Other experiments by Hembree and Harwood (1987) to increase the accostic target strength of the driftnets with metallic beaded chains and air filled plastic tubes did not reduce the marine mammal by-catch of the driftnets.

In monitoring the catches of fisheries one of the easiest ways of assessing by-catch is with an appropriately designed catch and effort form. These forms usually are restricted in their scope to commercial fish species. At present the only data routinely collected in the South Pacific is from the Japanese longline fleet wherever it fishes, all fisheries operating within Exclusive Economic Zones (primarily through the SPC), and beginning in 1989/90 from the Japanese driftnet fishery. The U.S. high seas troll fishery, the Taiwanese and Korean longline fisheries are covered less well with a voluntary catch and effort form. The data supplied through all of these schemes suffer to varying degrees from error. From independant observer verification of catch and effort accuracy in New Zealand waters we have found that generally the less valuable the species the greater the under-reporting error. We have also determined that only the fish which are landed are recorded, fish which are caught but discarded are not recorded.

The only way to surmount the problem of non-reporting of discards and under-reporting of lesser valued species is through an observer programme. An observer programme is also the only means of assessing non-fish by-catch problems.

Driftnet Dropout Rates of Albacore

One point of concern in assessing the impact of driftnet fishing on the target species is incidental mortality which is not reflected in the nominal catch estimates currently available. There are two components to incidental mortality, one resulting from escapement and another due to fish dropping out of the net during hauling (termed dropout rate). We know from the observer programme that escapement is high (Hampton et al. 1989) but estimates of driftnet damage in the troll catch only reflects the portion of driftnet escapees which survive. We have as yet been unable to devise a method for estimating incidental mortality due to escapement. On the otherhand it has been simple to estimate the dropout rate of dead albacore during a series of driftnet hauling operations. This work has been done separately by both Japanese and SPC scientists. Based on independent visual counts by the two scientists, the dropout rate of dead albacore during hauling was estimated to be approximately 7 to 9 percent. Data on dropout of dead albacore from driftnets while soaking were not collected nor has it yet been possible to determine if dropout rate is higher during rough weather as might be expected.

Interactions Between South Pacific Albacore Fisheries

The nature of interactions between South Pacific albacore fisheries is presently known in qualitative terms from data collected by scientific observers and from New Zealand research cruises. Size composition of albacore in driftnet, troll and longline fisheries together with the incidence of recent driftnet damage in the troll catch has been described in Hampton et al. (1989). These data show clearly that interactions between troll and driftnet fisheries and between combined surface and longline fisheries exist for some size classes. In particular, in the troll catch in 1988/89 the incidence of recent driftnet damage varied from 3% to 30% on individual days where reasonable numbers of fish were caught. Few fish smaller than 60 cm fork length or larger than 70 cm were driftnet marked although substantial numbers of albacore in these size classes were caught by trolling. The high incidence of net marks in 60-75 cm albacore suggests that escapement is high. The observation that the size composition of both troll and driftnet catches is the same and that troll and driftnet vessels fish the same areas at the same time indicates that interaction is likely to be high. Since most driftnet escapement is of fish 60-75 cm fork length suggests that fisheries interactions may be especially intense for intermediate sized juveniles.

In addition, approximately 25% of albacore in the size range 60-75 cm fork length caught in the longline fishery off New Zealand last June were net marked. This observation clearly suggests that albacore in this size range are available to all fisheries and hence interactions between all three fisheries probably occurs. It also suggests that effects of large surface catches may be detected in the longline fishery with a relatively short time lag.

The incidence of driftnet damaged fish in research troll survey catches this year was found to decrease rapidly with increasing distance from the area of driftnet fishing activity in the Tasman Sea this year. The geographical pattern of recent net marked albacore was consistent with the hypothesis that albacore in the western Tasman Sea at mid-latitudes (38° to 41° S) move eastwards towards New Zealand during early summer. The observed increase in net marked albacore in commercial catches from 0.5% to 3.0% between late December 1989 and early March 1990 suggests that the effects of driftnet fishing on troll catches reported by Hampton et al. (1989) may extend to fisheries operating over 1000 km apart.

**Preliminary Research Results from the 1989/90 Season**

Since the First Consultation on Arrangements for South Pacific Albacore Fisheries Management held in Wellington in November 1989, additional information has been collected. A research cruise was undertaken by the Japan Marine Fishery Resource Research Center (JAMARC) research driftnet vessel Shin-hoyo Maru. The results of leg 1 of the cruise (Tasman Sea area) have been discussed among scientists attending the Second Consultation on Arrangements for South Pacific Albacore Fisheries Management held in Honiara, Solomon Islands 28 February to 7 March 1990. The results of leg 2 (in the Sub-tropical Convergence Zone east of New Zealand) will be available for the next consultation scheduled for Noumea, New Caledonia in October.

The preliminary findings of leg 1, as reported by both the Japanese and SPC scientists were as follows:

- Based on independent visual counts by the two scientists, the dropout rate of dead albacore during hauling was estimated to be approximately 7 to 9 percent. Data on dropout of dead albacore from driftnets while soaking were not collected.

- Relatively few small albacore (<65cm) were caught during the cruise compared with observed sizes of albacore caught by the commercial Japanese fleet operating in the same area last year. The average albacore catch was 293 fish per set.

- The fish catch other than albacore was comprised primarily of skipjack (353 per set) and pomfret (331 per set). On average 2.3 common dolphins and 0.5 striped dolphins per set were incidently taken. In addition, one pilot whale, one southern bottlenose whale and two unidentified whales were incidentally taken during the cruise. Three leatherback turtles were caught, but were all released in healthy condition. Seabird mortality (four) was minor.

- Experiments were conducted by JAMARC in which one net from most sets was suspended 2m below the surface. There was no difference in the albacore catch between the experimental and commercially deployed nets. However, the by-catch was substantially reduced in the experimental net. In particular, no marine mammals, turtles or seabirds were caught in the

experimental nets. Although this method appears to be effective in reducing by-catch, further trials are desirable to ensure the results obtained are representative of commercial driftnet operations.

A research cruise to the Tasman Sea was conducted by New Zealand MAF Fisheries on the FRV Kaharoa from late December 1989 to mid January 1990. The purposes of the cruise were to estimate the incidence of recent driftnet damage in albacore caught by trolling; map the distribution of recent driftnet damaged albacore in relation to the area fished by the driftnet fleet; determine the size composition and troll catch rate of albacore in the central and western Tasman Sea at mid-latitudes in early summer.

The main findings include:

- incidence of driftnet damage for the entire cruise was about 27%. No driftnet damage was observed in catches west of the area fished by the driftnet fleet.

- the geographical distribution of driftnet damage is consistent with the hypothesis that albacore move eastwards from western mid-latitude areas of the Tasman Sea during early summer. Further analysis and study of this hypothesis is required;

- troll catch rates were several times higher than those of commercial troll vessels fishing in the eastern Tasman Sea and equivalent to catch rates immediately east of New Zealand;

- results of an observer programme by SPC and MAF Fisheries onboard troll vessels indicate that driftnet damage to fish (when driftnet vessels were not fishing in the same area as troll vessels) had occurred in previous seasons;

- in the eastern Tasman Sea and along the east coast of New Zealand, the incidence of old driftnet damage was 0.5%, further to the east along the Subtropical Convergence Zone, the incidence of old driftnet damage was over 9%;

- no freshly damaged fish were observed east of New Zealand before troll vessels entered the area of driftnet fishing south of French Polynesia in late February;

- length frequency distributions from the Tasman Sea and from areas east of New Zealand relative to last year, show a reduction in smaller size classes and an increase in larger size classes.

Recent South Pacific research initiatives, coordinated by the South Pacific Albacore Research (SPAR) group, and the opportunity to place a South Pacific observer onboard a JAMARC research driftnet vessel in 1989/90 has considerably added to the data available to assess the albacore stock and the fisheries operating on it. However, the preliminary nature of the

information available at this time (the first half of the 1989/90 surface fishery season) constrains interpretation of the data at present.

## Future Research Needs

### Stock Assessment Needs

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 the 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 structured and/or size structured methods are needed to analyze the relationships between yield per recruitment 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.

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

In addition to using 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.

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

### Data Requirements

Various data are required for stock assessments of South Pacific albacore in support of management. Data for other purposes (e.g., economic data, fleet composition, vessel location, observer data, etc.) are also necessary for effective fisheries management.

The data for stock assessment purposes may be classified as fisheries data (catch, effort, etc) and data on various biological processes (growth,

mortality, recruitment, etc). Although in some situations more precise data will be needed, minimum requirements for assessments of the South Pacific albacore stock include both fisheries data and biological data.

The fisheries data required include:

- effort and catch by species (including non-target species) for the longline and all surface fisheries in the South Pacific, stratified by 5 degree square and by month;

- size composition of albacore for each gear type, stratified by 5 degrees latitude and 10 degrees longitude areas and by month;

- estimates of incidental mortality (dropout, discards, etc) of albacore associated with all fisheries.

The biological data that are required relate to:

- growth rates

- natural mortality rates

- recruitment

- seasonality of spawning

- stock structure and migration

- distribution in relation to oceanographic features

The collection, early availability, and timely exchange of catch and effort data from all fisheries catching significant numbers of albacore is critical to the success of stock assessment. Delays can interfere with early recognition of fishery trends. For example, changes in longline catch rate or size composition may be the first indicators of population response to changed fishing levels while 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 only indication of the effects of interaction between the troll and gillnet fisheries.

Collection of catch data needs to account for the total albacore removals from the region. In addition, time series of catch rate stratified by area and time for major albacore target fisheries are necessary to monitor abundance trends. Finally, details of catch size composition, by area and time, and for the various fisheries is required.

The most urgently required data are those describing catch, effort, species composition and size composition in the South Pacific driftnet fisheries of Taiwan and Japan. The introduction of data collection procedures for Taiwanese driftnet activity in the South Pacific is of paramount importance because no such collection system exists. Japan introduced mandatory provision of catch and effort information from driftnetters beginning in 1989/90.

Effort should also be made to supplement the collection of catch and effort data from the driftnet fishery with historical data on the fishery. The very recent establishment of the driftnet fishery suggests that scope probably still exists to assemble historical data from current operators. Regardless of the potential difficulties in collecting historical data, the information currently available on large-scale pelagic driftnet fishing in the South Pacific is so sparse that special attention to the matter is warranted. For example, data for the 1988/89 season is limited to two vessels of the estimated 128-198 driftnet vessels that fished during the season. Data availability for the 1989/90 season is presently unknown.

Efforts to improve the collection of size composition data were instituted for the 1989/90 season. Albacore size composition data is generally available from Japanese longliners which target species other than albacore and from Taiwanese and Korean longliners targeting albacore and landing at American Samoa. Albacore size composition data has been collected since the start of each fishery but the size composition of albacore caught by driftnet vessels remains very limited.

At the Second Consultation on Arrangements for South Pacific Albacore Fisheries Management agreement was reached for data to be provided to SPC by all fishing parties in an agreed format. SPC, on behalf of the recently constituted scientific advisory group, will compile all data and make it available for distribution to nominated members of the scientific advisor group on request.

The specific data required now and the time of data submission has been agreed as follows:

- Monthly catch and effort data by 5 degree square will be provided for longline fisheries for each calendar year to be submitted by 30 June, 18 months after the completion of the fishing year. Provisional estimates of total catch and effort will be provided by 1 January, 6 months prior to the submission of detailed data.

- For surface fisheries monthly catch and effort data by 5 degree square will be provided for the 12 month period 1 July to 30 June, by 1 September of that year. Provisional estimates of total catch and effort will be provided by 1 July.

- Size composition data will be provided on a 5 degree latitude by 10 degree longitude by month basis at the same time as detailed catch and effort statistics are submitted.

Strategy for South Pacific Albacore Research

Consultations among scientists working on South Pacific albacore have identified a number of priority research areas they feel are critical for stock assessment and for evaluating fisheries interactions.

1. Tagging Studies.

Tagging has been identified as a useful technique for estimating vital population parameters and interaction among gear types. A cooperative tagging programme has been underway since 1986 by the U.S. and N.Z. This programme uses the same tags and tagging protocols and is coordinated by the SPC. In addition, SPC plans to expand this tagging programme in the STCZ in 1990/91, with three month-long tagging cruises aboard a combination pole-and-line and troll vessel. To date because of vessel availability, albacore tagging has been done from troll vessels. The use of a pole-and-line vessel is expected to increase the recovery rate of tagged fish.

Initially the highest priority will continue to be given to the release of the greatest number of tags to enhance prospects for recovery. Later plans may include the use of oxytetracycline and double tagging.

The objectives of tagging programmes for stock assessment and fisheries interaction studies may conflict. There is a continuing need therefore, to define the objectives and experimental design of tagging programmes as well as ensuring that specific tagging and fishing methods do not introduce bias.

2. Seasonality of spawning.

The possibility of semestral spawning in South Pacific albacore has 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, it is important to determine the seasonality of spawning by way of sampling gonad indices. Onboard sampling of commercial longliners from Tonga and Fiji and from research longlining operations 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.

In addition to gonad sampling, it may be desirable to initiate larval sampling in the presumed spawning areas in conjunction with existing programmes like TOGA and SURTROPAC.

3. Age and Growth Studies

There is an urgent need to corroborate growth increments using other methods.

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 at the focus although there is general agreement between otolith counts of South Pacific albacore and validated increments in the North Pacific. SEM study of otoliths are being initiated by NMFS and comparison of otolith and vertebral growth increments from the same fish is planned between N.Z. and NMFS scientists. NMFS scientists have begun to analyze length frequency data to see if modal progression can corroborate growth rates inferred from hard parts.

4. Oceanography

Satellite sea surface temperature charts have been produced jointly by MAF Fisheries and the N.Z. Meteorological Service during the 1988/89 and 1989/90 albacore seasons to give a synoptic time series of sea surface temperature of fishing areas. These charts can also be used to interpret fishing success.

Subsurface temperature and salinity profiles using XBT's and some form of towed CTD data logger is also very desirable in a region as complex as the STCZ for studies of catch rate in relation to the STCZ and its associated fronts.

5. Scientific Observer Programme

The regular placement of scientific observers onboard commercial driftnet, troll, and longline vessels in the South Pacific is a high priority for future fishing seasons. The placement of observers is the only way to verify the catch and effort statistics upon which stock assessments depend. Observers are also ideally placed to provide catch composition estimates and size composition data of very high quality. In addition, observers can provide estimates of incidental mortality associated with fish dropping off hooks, dropping out of driftnets, and due to discards.

All these data will be needed for stock assessments.

## Summary of Scientific Concerns in the South Pacific

Scientists present at the First Consultation on a Regime for South Pacific Albacore Fisheries Management, held in Wellington in November 1989, provided a summary on the current state of knowledge of the South Pacific albacore stock. To reiterate, the major points highlighted at the Wellington Consultation were:

- "A longline fishery operating in the presence of a small surface fishery was estimated to have a maximum sustainable

yield (MSY) of 35,000 tonnes. When recent expansion of the surface fisheries began, the longline catch was close to its MSY level.

- The potential for increasing the total yield from the resource by increasing the harvest of juveniles in surface fisheries has been recognised. An initial development target of 10,000 tonnes for surface fisheries does not represent the MSY. The combined MSY for surface and longline fisheries cannot be estimated at present.

- Continuation of surface fishing at 1988/89 levels will reduce longline catch rates. The extent of the reduction is unknown.

- Uncontrolled and rapid expansion of the surface fishery is dangerous and poses a risk of overfishing the stock. Until the stock dynamics are better understood, the impacts cannot be quantified, nor is it possible to predict the time frame in which impacts may be clearly evidenced. Previous media reports of albacore stock collapse in two years are not based on assessments by scientists. This, however, does not lessen the concern expressed by scientists regarding the 1988/89 catch levels.

- Similarly, there are insufficient data available to thoroughly assess the driftnet fleet reductions [for the 1989/90 season] announced by Japan and Taiwan. Reduced surface catches will lessen impacts on the albacore stock and, therefore, on the longline fisheries, however, the effectiveness of these measures cannot be determined at this time."

There is concern regarding the threat large-scale pelagic driftnet fishing poses to the South Pacific albacore stock. There is also a need to immediately improve data collection and to direct future research to ensure we can conduct stock assessments and evaluate interactions between fisheries at the earliest time possible.

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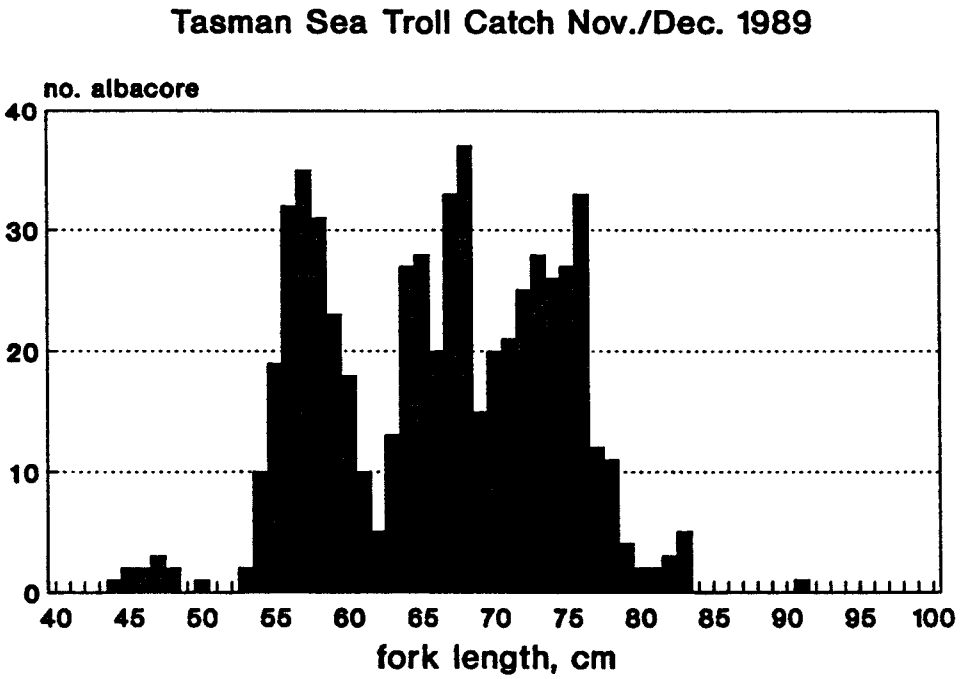
Figure 1. Length frequencies for troll caught albacore in the Tasman Sea (589 fish measured) and east coast of New Zealand (3106 fish measured).



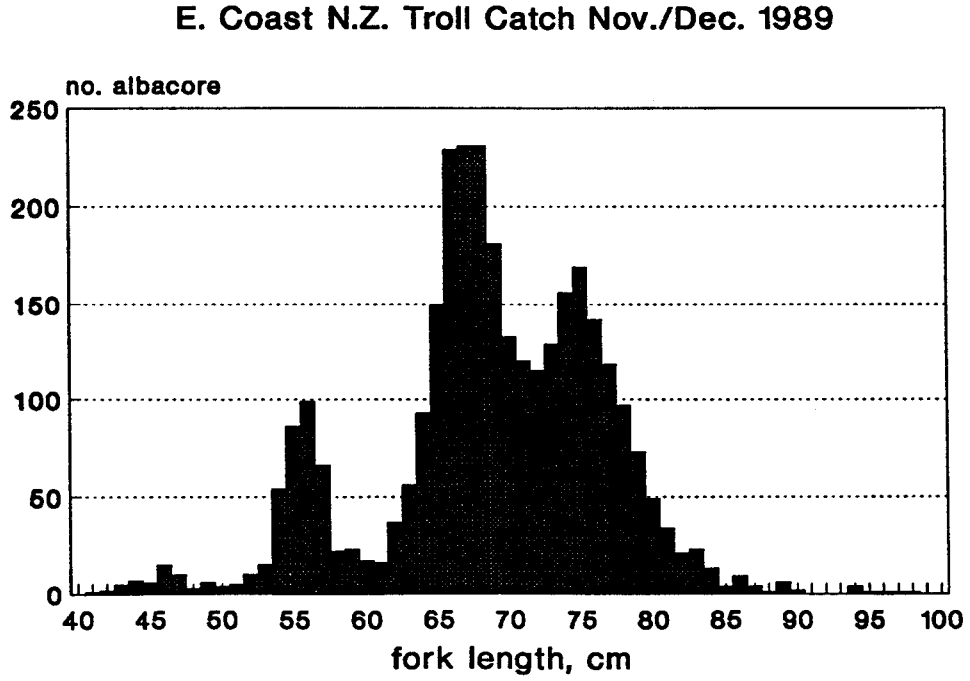



Figure 2. Length frequencies of troll caught albacore from the Subtropical Convergence Zone east of New Zealand in the January-February period of the 1988/89 (7096 fish measured) and the 1989/90 (12,364 fish). Approximately 8% of the fish measured were either smaller than 59 cm or larger than 90 cm and are not shown in the histograms.