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SOUTH PACIFIC ALBACORE OBSERVER PROGRAMME ON TROLL VESSELS, 1989–1990

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ABSTRACT

A series of observer cruises, covering the entire fishing season between November 1989 and April 1990, was conducted on six albacore troll vessels. A total of 231 searching/fishing days was observed. The areas covered included the Tasman Sea (2 vessels, 25 searching/fishing days), the north-east New Zealand coast (2 vessels, 36 days) and the Subtropical Convergence Zone to the east of New Zealand (6 vessels, 170 days). The CPUE on observed troll vessels in 1989–1990 was 31 fish per searching/fishing day in the Tasman Sea, 167 fish per day off the north-east coast of New Zealand and 336 fish per day in the Subtropical Convergence Zone. This compares with a CPUE in the Subtropical Convergence Zone in 1988–1989 of 176 fish per day. In total, 55,715 albacore were measured for fork length; many of these were also weighed and their girths measured. All fish sampled were scored for degree of driftnet damage. A new category of driftnet damage, interpreted as resulting from driftnet escapement in the 1988–1989 season, was also recorded. None of the albacore examined from the Tasman Sea and only 0.7 per cent of those examined from the north-east New Zealand coast had marks that seemed to have been acquired in the current season (as evidenced by the freshness of the wounds). On the other hand, 4.5 per cent of albacore examined from the Subtropical Convergence Zone bore fresh driftnet marks. Old injuries, probably inflicted during the 1988–1989 surface fishery season, were observed only in the Subtropical Convergence Zone and were found on 7.8 per cent of albacore examined. As with findings in the 1989–1990 season, marked albacore caught in the STCZ were in significantly lower condition than unmarked fish. There was evidence, however, that albacore that survived encounters with driftnets in the previous season regained condition between fishing seasons.

RESUME

Plusieurs sorties d'observation ont été réalisées à bord de six ligneurs au cours de la campagne de pêche du germon entre novembre 1989 et avril 1990. Elles correspondent au total à 231 jours de repérage et de pêche. Les zones qui ont été couvertes sont la mer de Tasman (pour 2 navires et 25 jours de repérage et de pêche), le nord-est de la côte néo-zélandaise (pour 2 navires et 36 jours) et la zone de convergence subtropicale à l'est de la Nouvelle-Zélande (pour 6 navires et 170 jours). La prise par unité d'effort et par jour constatée à bord de ces ligneurs en 1989–1990 est de 31 captures en mer de Tasman, de 160 au large de la côte nord-est de la Nouvelle-Zélande et de 336 dans la zone de convergence subtropicale. Ces chiffres sont à comparer à la PUE de 176 captures par jour constatée en 1988–1989 dans la zone de convergence subtropicale. Au total, on a relevé la longueur à la fourche de 55 715 germons ainsi que le tour de corps et le poids de beaucoup d'entre eux. Tous les spécimens échantillonnés ont été répertoriés en fonction des lésions imputables aux filets dérivants qu'ils présentaient. On a également constaté un nouveau type de lésions, que l'on a imputées à des tentatives de fuite pour s'extraire des mailles des filets dérivants au cours de la campagne 1988–1989. Aucun des spécimens capturés en mer de Tasman et seuls 0,7% de ceux provenant de la côte nord-ouest de Nouvelle-Zélande présentaient des lésions semblant avoir été infligées pendant la campagne de pêche en cours (à en juger par le degré de cicatrisation). En revanche, 4,5% des germons échantillonnés dans la zone de convergence subtropicale présentaient des lésions récentes imputables à des filets dérivants. Ce n'est également que dans cette zone que l'on a constaté des lésions anciennes, probablement infligées au cours de la campagne de pêche de surface de 1988–1989 et ce, sur 7,8% des poissons examinés. Comme on l'avait déjà constaté en 1989–1990, les germons présentant des lésions et capturés dans la zone de convergence subtropicale étaient, de toute évidence, en moins bonne santé que les poissons indemnes. On a pu cependant aussi constater que les germons qui survivent blessés par des filets dérivants se rétablissent d'une campagne à l'autre.

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1. BACKGROUND

1.1 South Pacific albacore fisheries

Albacore (*Thunnus alalunga*) have been exploited in the South Pacific by Asian longliners since 1952, first by the Japanese and subsequently by Koreans and Taiwanese. As the longline fishery developed, catch rates fell and targeted albacore fishing by Japanese vessels declined. Catches have fluctuated between 25,000 t and 40,000 t since 1960, with production model estimates indicating a maximum sustainable yield for the longline fishery of 35,000 t, assuming a minor surface fishery of about 2,000 t (Wetherall and Yong, 1987; Wang et al., 1988).

A small troll fishery for albacore has operated since 1974 in the coastal waters of New Zealand, usually recording catches of 1,000–3,000 t annually. Exploratory troll fishing in 1985–1986 and 1986–1987 suggested that a viable surface fishery could be developed in the offshore waters of the Subtropical Convergence Zone (STCZ) (35–40°S, 170–130°W) from December to April. Preliminary opinions were that this fishery could support a catch of about 10,000–15,000 t without substantially reducing longline catches (SPC, 1986).

Since these surveys, the surface fishery has developed rapidly. During 1987–1988, 44 U.S., Canadian and Fijian troll vessels caught about 3,600 t of albacore in the STCZ. In addition, seven Taiwanese large mesh pelagic driftnet vessels caught 1,000 t, and a fleet of Japanese driftnetters took 4,800 t. During the 1988–1989 season, 54 troll vessels from the United States, Canada, New Zealand and French Polynesia caught about 3,700 t of albacore in the STCZ, while nearly 5,000 t was caught by some 200 trollers in inshore waters off the west coast of New Zealand, resulting in a total troll catch of about 9,000 t.

Driftnet fishing in the South Pacific also expanded dramatically in 1988–1989. Prior to the exploratory Taiwanese fishing in 1987–1988, the only known driftnet activity in the South Pacific was that of a Japanese fleet, which has fished since at least 1983–1984 and mainly in the Tasman Sea. Although the exact number of driftnetters that fished in the South Pacific in 1988–1989 is not known, reports suggest that at least 60 Taiwanese, 67 Japanese vessels and one South Korean vessel fished. The Japanese fleet fished mainly in the Tasman Sea, with most vessels transferring to the STCZ east of New Zealand in the middle of the season. Taiwanese and Korean driftnetters primarily fished the STCZ east of New Zealand. Based on limited catch rate information, the minimum driftnet catch for the 1988–1989 season is estimated to be 25,000 t (SPC, 1989).

As early as 1988 South Pacific Island countries began to express concern regarding the potential for overfishing the South Pacific albacore stock. A consultation, sponsored by the Forum Fisheries Agency (FFA), the South Pacific Commission (SPC) and the Food and Agriculture Organization of the United Nations (FAO), took place in Suva, Fiji on 3–4 November 1988. The consultation noted the lack of information available on the surface fishery for albacore, and in particular the likely level of interaction among the troll, driftnet and longline fisheries. As a consequence, it strongly endorsed a proposal for data collection during the 1988–1989 season, consisting of detailed fishery monitoring, aerial surveillance and placement of observers on commercial troll vessels. The 1988–1989 observer programme, while limited to a single observer working consecutively on three vessels, provided the first documentation of driftnet escapement and provided a large body of data on the STCZ troll fishery. The results of the 1988–1989 observer programme reported by Hampton et al. (1989) have proved invaluable in preliminary assessments of the status of the albacore stock.

The rapid increase in catch in 1988–1989, particularly by the driftnet fleets, reinforced concerns throughout the South Pacific, particularly by Pacific Island countries involved in troll and longline fishing, or in the processing/trans-shipping of albacore catches. To address the concern regarding recent levels of exploitation of the albacore stock, the albacore observer programme was expanded in 1989–1990 to cover the entire season and area of troll vessel operation. Observer coverage for two cruises in 1989–1990 on a research driftnet vessel was also negotiated, in co-operation with the Government of Japan, and is reported separately (Sharples et al., 1991).

1.2 Observer programme

In line with the recommendations of the November 1988 consultation, and building on experience gained during the 1988–1989 observer programme, an expanded observer programme on troll vessels was mounted for the 1989–1990 season. The programme was co-ordinated by SPC and the New Zealand Ministry of Agriculture and Fisheries (MAF Fisheries). Observers were all trained personnel recruited from the MAF Fisheries Scientific Observer Programme. Briefing and debriefing were conducted by scientific staff of MAF Fisheries Pelagic Research Group.

Programme objectives and sampling protocols were developed jointly by scientists from the SPC's Tuna and Billfish Assessment Programme, the New Zealand MAF Fisheries Pelagic Research Group in Wellington, and the U.S. National Marine Fisheries Service (NMFS) Southwest Fisheries Center in Hawaii.

1.3 Other data collected during the 1989–1990 albacore season

Various other data were collected from the fisheries during 1989–1990, including longline log book and catch length-frequency data in Pago Pago (NMFS), Levuka (Pacific Fishing Co. and SPC), Noumea (SPC) and New Zealand (MAF Fisheries); troll catch landings and length frequency data in Pago Pago (NMFS), Papeete (EVAAM), Levuka (Pacific Fishing Co. and SPC) and New Zealand (MAF Fisheries). The spatial pattern of driftnet-damaged albacore in relation to the driftnet fleet was determined and damaged fish biopsied by MAF Fisheries. Tagged albacore were released by MAF Fisheries and U.S. troll fishermen contracted to NMFS. SPC began collecting gonad samples to determine the seasonality of spawning. These data will undergo independent analysis in due course.

2. OBJECTIVES OF THE OBSERVER PROGRAMME

The general objectives of the observer programme were to collect biological data relevant to stock assessment of South Pacific albacore and to document the fishing activities of troll and driftnet vessels in the Tasman Sea and along the STCZ. The principal observer activities were to collect albacore length, weight and girth data; estimate by-catch composition in the surface fisheries; estimate the occurrence of net-damaged albacore, ranked by severity, and gather information on driftnet fishing in the South Pacific. The specific daily activities of the observer were:

(a) To record the daily catch of albacore and troll by-catch on board host vessels;

(b) To record routinely length, weight and girth of albacore, recording also the presence of driftnet marks ranked by their severity;

(c) To record the frequency of shark damage to landed fish;

(d) To record the frequency of escapement from troll hooks;

(e) To document occurrence of driftnet vessels, recording vessel characteristics and operations if possible;

(f) To record observations on the behaviour of albacore schools, and to record recapture details of any tagged fish.

3. OPERATIONAL SUMMARY

Five observers were offered berths aboard albacore troll vessels from New Zealand and the United States at the invitation of the vessel owners and in co-operation with vessel managers and masters. The vessels sampled, areas fished and periods of observer coverage are listed in Table 1.

Table 1. Operational summary of troll vessels covered by the 1989–1990 observer programme

Vessel	Area	Dates	Observer
Atu	STCZ	7–17 Mar.1990	A. Allan
Daniel Solander	Tasman Sea	14–29 Nov.1989	M. Douglas
	Tasman Sea	19–20 Dec.1989	M. Douglas
	NE Coast NZ	30 Nov.–19 Dec.1989	M. Douglas
	STCZ	1 Jan.–16 Mar.1990	P. Sharples
Day Star	STCZ	3–5 Mar.1990	A. Allan
Kariqa	Tasman Sea	25 Nov.–1 Dec.1989	G. Williams
	Tasman Sea	18–19 Dec.1989	G. Williams
	NE Coast NZ	2–17 Dec.1989	G. Williams
	STCZ	18 Mar.–8 Apr.1990	P. Sharples
Mata Whao Rua	STCZ	17 Mar.–14 Apr.1990	A. Allan
San Te Maru 18	STCZ	17 Jan.–19 Mar.1990	R. Stewart

Observers were at sea from mid-November 1989 to mid-April 1990. Fishing was divided between three areas: the Tasman Sea, the east coast of New Zealand north of 40°S and the STCZ east of New Zealand.

Fishing in the Tasman Sea was generally poor, causing troll vessels to change their fishing area after only a brief period of exploratory fishing. These vessels moved to the north-east coast of New Zealand where U.S. troll vessels were reporting good catch rates. Observers were on two vessels in the Tasman Sea from mid- to late November and for a brief period in mid-December, and on the same vessels fishing the north-east coast of New Zealand from early to mid-December.

During the time troll vessels were in the Tasman Sea only six confirmed sightings of driftnet vessels were made (confirmation was from aerial surveillance and merchant shipping reports). The nearest that troll vessels got to the driftnet fishing area during this period was approximately 100 n.mi.

Observer coverage of the STCZ began in January, when New Zealand troll vessels moved east to enter the fishery. Three observers covered six vessels fishing in the STCZ from early January to mid-April.

Plots of the cruise tracks are shown in Figure 1.

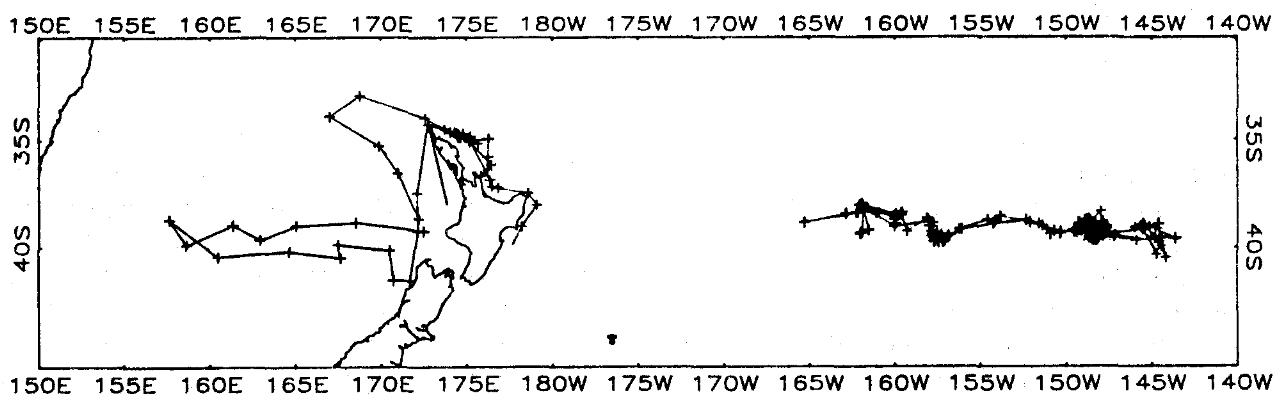


Figure 1. Cruise tracks of vessels participating in the 1989–1990 observer programme. (The symbol '+' marks noon position.)

3.1 Troll vessel characteristics and fishing strategies

The troll vessels on which observers worked varied in size and fishing strategy. A summary of the troll vessel characteristics is given in Table 2.

Table 2. Troll vessel characteristics

Vessel	Length (m)	GRT (t)	Freezer hold (t)	No. crew
Atu	28.0	144	70	8
Daniel Solander	53.6	345	300	10
Day Star	22.2	?	45	3
Kariqa	32.7	143	?	8
Mata Whao Rua	51.0	298	158	10
San Te Maru 18	52.8	345	?	16

3.1.1 M.F.V. Atu

This New Zealand vessel had not fished in the offshore albacore fishery until the 1989–1990 season. However its crew, and especially the captain, had had extensive experience in the New Zealand fisheries for albacore and southern bluefin. The *Atu* trolled ten lines from outriggers and four lines off the stern. Hydraulic haulers hauled the outrigger lines, while stern lines were hand-hauled. In addition, four lines were trolled from a forward starboard outrigger. Forward outrigger lines were hauled by hand through the sea-door.

For the 10 days during which the observer was on the *Atu*, fishing was generally very good for most vessels in the area. To find fishing areas, the captain was in regular radio contact with other vessels and also used radar to identify areas of vessel concentration. In locating concentrations of fish, he relied heavily on a depth sounder to locate sub-surface schools. When good sounder marks were encountered, the area was circled until the fishing dropped off. A set course was then resumed. To stay near productive fishing areas, the captain made extensive use of the course plotter interfaced with a Global Positioning System (GPS) navigation unit. During periods of good fishing this involved retracing the same path all day. On one occasion the *Atu* found a floating log with a school of albacore aggregating underneath it. The vessel trolled around the log for the remainder of the day, with good results. During periods of strong wind (over 25 knots) a strategy of fishing alternately with and against the weather was adopted, but there did not appear to be any difference in catch rate when fishing either way.

3.1.2. M.F.V. Daniel Solander

Originally built as a Japanese longliner, the *Daniel Solander* was bought by Solander Fisheries (NZ) and used for trolling and handlining southern bluefin tuna (*Thunnus maccoyii*) within the New Zealand EEZ. It was converted for the South Pacific offshore albacore fishery in late 1988. An adjustable stern platform was added which could be lowered from the main deck to water level so that fish could be landed easily in any weather. Up to twenty-three lines were fished, with four to five from the stern, six to seven from each of the two outriggers and three to four from the starboard HIAB deck crane located on the bow. Fish on the HIAB lines were hauled through the starboard sea-door. Once landed, all fish had their pectoral fins removed and most were spiked in the head to minimise damage on deck before being blast frozen. Measurements were made after fin removal and spiking.

The *Daniel Solander*'s main fishing strategy along the STCZ was to search for temperature gradients, using a sea-surface temperature recorder. Satellite sea-surface temperature charts were also available on a regular basis as an aid to locating surface temperature fronts. After locating a front, the vessel would then concentrate trolling in the vicinity, while using a depth sounder to locate sub-surface fish schools. If fish were present and weather permitted, the vessel would circle while fishing. A second strategy was to circle any logs or sunfish (*Mola mola*) encountered, which usually resulted in the capture of a few albacore. The vessel would also circle stray buoys encountered. If a school of fish was found in an otherwise quiet fishing period, the *Daniel Solander* would release its own buoy to mark the spot and begin circling.

3.1.3 M.F.V. Day Star

The observer spent only three days on board the U.S. vessel *Day Star*, in transit between other vessels. The main fishing strategy was to use the sonar to locate a school of albacore. The school was then circled, with the sonar used to maintain the vessel's proximity to the school. Anchovies and pilchards were thrown liberally amongst the lines to encourage the albacore to stay with the vessel. When a school was located, its position was also recorded in the course plotter interfaced with the GPS so that these positions could be revisited later. The vessel usually towed five lines from each of two outriggers and four or five lines from the stern. Hydraulic haulers were used to haul the ten outrigger lines.

3.1.4 M.F.V. Kariqa

The New Zealand vessel *Kariqa* was on her first trip in the offshore albacore fishery. Up to twenty-three lines were fished at a time, eight or nine from each of two outriggers and six from the stern. A depth sounder was used to locate tuna schools, although it was not used to track schools continuously. Sea-surface temperature measured on board and satellite-derived temperature charts were used to indicate general areas of expected fish concentration.

3.1.5 M.F.V. Mata Whao Rua

This New Zealand vessel had not previously participated in any albacore fishery but its captain and crew had considerable experience in the New Zealand albacore and southern bluefin fisheries. The vessel usually towed twenty-seven lines which were all hand-hauled. The vessel maintained good catch rates by staying with other vessels, fishing along temperature gradients, and circling areas whenever albacore were caught. Other strategies included fishing around logs, stationary vessels and areas of bird activity.

3.1.6 M.F.V. San Te Maru 18

This was the first season during which the New Zealand vessel *San Te Maru* had fished for albacore although the captain participated in the offshore fishery in 1988–1989. Up to thirty-one lines were fished. The main strategies were to search for strong temperature gradients using a sea-surface temperature recorder, or to fish in areas where other vessels were fishing. The vessel also used a colour depth sounder to look for sub-surface schools. When schools were located they were marked. Sunfish were also circled and their positions marked in case they submerged.

3.2 Sampling procedures for length, girth and weight

Observers generally attempted to measure all fish caught. However, this was not possible during periods of high catch rates or bad weather. In these circumstances, four periods during the day were chosen to collect lengths, girths and weights of at least 25 randomly chosen fish. Lengths of at least 25 additional albacore were also measured. All fish sampled were graded for driftnet marks.

Fork length was measured from the tip of the snout with the mouth closed to the end of the median caudal fin ray and rounded down to the previous whole centimetre.

Girth measurements were made by passing a plastic measuring tape around the fish, perpendicular to the long axis, at a point just posterior to the tip of the pelvic fins when folded flush with the body. This was the only measure possible when pectoral fins were removed after fish were landed, as was routinely done on several vessels. On vessels where pectoral fins were not removed, the tape was passed over one pectoral fin folded flush against the body and under the other. This proved to be an easier method of measuring girth with the pectoral fins intact, and gave identical results to the previously described method. Girth measurements were rounded down to the previous 0.5 cm.

Some vessels carried motion-compensated electronic scales which were used to weigh fish. On vessels without scales albacore were weighed with a 15 kg hand-held beam balance, suspended from an overhang. Weight was recorded to the nearest 0.1 kg. On a few vessels weights were not recorded since neither scales nor balances were available.

3.3 Scoring of driftnet damage

Early in the 1988–1989 South Pacific albacore observer programme, large numbers of troll-caught fish were seen exhibiting distinct patterns of skin and scale loss. Damage which had a fresh appearance was frequently seen when both troll and driftnet vessels were fishing in the same areas. These observations suggested that this damage was caused during escapement from a driftnet. This assumption was subsequently verified by dropping freshly caught unmarked albacore through a section of driftnet found at sea. In repeated trials unmarked albacore developed the same categories of marks as those seen in freshly caught damaged fish.

The driftnet fragment used in the 1988–1989 verification experiment was a 200 mm mesh (stretched diagonal measure) piece presumed to be Taiwanese in origin. This driftnet fragment was found to encircle an albacore with a girth of 46–49 cm tightly at a point just posterior to the gills. This girth is approximately equivalent to a fork length range of 65–75 cm. Hampton et al. (1989) reports that this size class corresponds to the larger of two size classes observed during trans-shipments of driftnet-caught albacore in 1988–1989 in Noumea. Mesh size is reported to vary among vessels, with 178 mm mesh believed to have been more common in the 1989–1990 season, especially in the Japanese fleet. Mesh size obviously influences the size composition of the driftnet catch and of the fish which escape. A mixture of mesh sizes increases the difficulty of interpreting the size selectivity of and escapement from driftnets.

In the 1989–1990 season it was found that some fish retained healed driftnet marks probably obtained in the 1988–1989 season. This new category of mark was not seen in 1988–1989. It suggests that at least some albacore survive driftnet encounters while retaining visible evidence of driftnet escapement for considerable periods. Although possibly a more subjective category (since it is not possible to tell precisely how old the net marks are) the appearance of this new (in 1989–1990) marking pattern along the sides of the fish is presently interpreted as damage incurred in a previous season.

3.4 Driftnet damage codes

In the South Pacific the following categories of driftnet damage have been developed:

Damage Code 0: No loss of skin or scales on landing, fins entire.

Damage Code 1: Continuous multiple stripes appearing as slight skin discolorations running laterally along the thickest part of the body about 5–10 mm apart. On close examination the discoloured striping results from skin loss. **Contrast with Damage Code 4.**

Damage Code 2: Minor damage similar to Damage Code 1. Damage restricted to a brush-like pattern of skin abrasion, always with a **very distinct** vertical termination anterior to the point of maximum girth, suggesting the fish was not able to pass through the net.

Damage Code 3: The most serious category of net damage. Fish exhibit damage similar to Damage Code 1 together with areas of exposed muscle with a 'raw' appearance where skin and scales have been scraped away. Exposed patches are typically 25–50 mm wide and 50–100 mm long and usually located within 30 mm of the dorsal or ventral mid-line in the area of maximum girth. Accompanying damage to the second dorsal, anal and caudal fins is common. The first dorsal and pectoral fins are also occasionally damaged.

Damage Code 4: Identical to Damage Code 1 **except** that the stripes are much less distinct and are somewhat interrupted. These fish appear to have been damaged by a driftnet previously (Damage Code 1) and to have recovered after some time at liberty (possibly one year).

4. RESULTS AND OBSERVATIONS

4.1 Albacore catch, effort and CPUE

Albacore catch and effort data were collected aboard New Zealand and U.S. albacore troll vessels during the period November 1989 to April 1990. Two New Zealand troll vessels (M.F.V. *Daniel Solander* and *Kariqa*) carried observers while fishing the Tasman Sea and along the north-east coast of New Zealand in November and December 1989. Five New Zealand troll vessels (M.F.V. *Atu, Daniel Solander, Kariqa, Mata Whao Rua* and *San Te Maru 18*) and one U.S. troll vessel (M.F.V. *Day Star*) carried observers between January and April 1990 while fishing the STCZ. The composite fishing tracks of the troll vessels carrying observers are shown in Figure 1.

A total of 231 searching and fishing days were observed, including 25 days in the Tasman Sea and 36 days along the north-east coast of New Zealand during November–December. The remaining 170 days were spent in the STCZ during January–April 1990. Fishing in the Tasman Sea was poor, with an average of 31 albacore caught per searching/fishing day. Fishing along the north-east coast of New Zealand during the same period was considerably better, with an average of 167 albacore caught per day. The most successful albacore fishing of the entire season was along the STCZ, where observer vessels caught 336 albacore per day. Tables 3–5 summarise catch and effort data by month and fishing area for the 1989–1990 albacore fishing season.

Table 3. Summary of albacore catch and effort aboard troll vessels in the Tasman Sea during the 1989–1990 South Pacific fishing season

		Nov.1989	Dec.1989
Daily sea surface	Avg.	16.7	17.5
temperature	min.	15.5	16.5
	max.	19.6	18.9
Days fished		22	3
Hours fished	Avg.	14.1	15.9
per day	s.d.	4.4	0.4
No. of jigs	Avg.	18.1	22.0
fished	s.d.	1.7	1.4
No. of albacore	Avg.	32.4	22.0
landed per day	s.d.	28.3	11.0
No. of albacore	Avg.	12.40	3.96
per 100 hook-hrs.	s.d.	9.03	2.96

Table 4. Summary of albacore catch and effort aboard troll vessels along the north-east coast of New Zealand during the 1989–1990 South Pacific fishing season

		Nov.1989	Dec.1989
Daily sea surface temperature	Avg.	18.3	18.7
	min.	17.9	14.7
	max.	18.6	20.0
Days fished		1	35
Hours fished per day	Avg.	14.5	15.4
	s.d.	-	1.9
No. of jigs fished	Avg.	17.0	20.6
	s.d.	-	1.8
No. of albacore landed per day	Avg.	812.0	148.1
	s.d.	-	131.7
No. of albacore per 100 hook-hrs.	Avg.	329.41	46.50
	s.d.	-	43.71

Table 5. Summary of albacore catch and effort aboard troll vessels along the Subtropical Convergence Zone during the 1989–1990 South Pacific fishing season

		Jan.1990	Feb.1990	Mar.1990	Apr.1990
Daily sea surface temperature	Avg.	18.8	18.2	18.0	17.8
	min.	17.1	16.9	17.4	17.5
	max.	20.2	19.4	18.9	18.4
Days fished		31	56	75	8
Hours fished per day	Avg.	15.3	14.5	13.6	12.2
	s.d.	1.3	1.4	0.5	2.4
No. of jigs fished	Avg.	19.1	20.8	22.8	20.0
	s.d.	3.1	3.2	4.9	0.0
No. of albacore landed per day	Avg.	336.5	368.1	312.7	336.3
	s.d.	195.5	170.5	213.3	139.6
No. of albacore per 100 hook-hrs.	Avg.	113.88	121.47	109.37	148.49
	s.d.	64.87	54.97	87.31	73.22

By-catch on troll vessels was limited to relatively few skipjack tuna (*Katsuwonus pelamis*), yellowtail kingfish (*Seriola lalandi*), shortbill spearfish (*Tetrapturus angustirostris*) and blue shark (*Prionace glauca*).

4.2 Length Composition

The length compositions of albacore are presented for the Tasman Sea, the north-east coast of New Zealand (NZ) and the STCZ east of New Zealand (STCZ) by month in Figures 2–7. General categories of driftnet marks are also indicated on the histograms. Three distinct modes are visible in the histograms, most likely representing separate cohorts. In January 1990 in the STCZ, the approximate length ranges of the modes were 54–61 cm, 62–71 cm and 72–83 cm. Evidence of a smaller mode is seen for the Tasman Sea in November 1989 (at 44–50 cm) and for the STCZ in April 1990 (at 48–55 cm). Each of the three prominent modes was about equally represented in the Tasman Sea in November 1989. In the NZ area, the second and third modes were dominant in November and December 1989, with the first mode representing a very minor portion of the catch. In the STCZ, the three modes were about equally represented in January 1990, but the third mode decreased progressively in importance through to April as the fishery moved to the east.

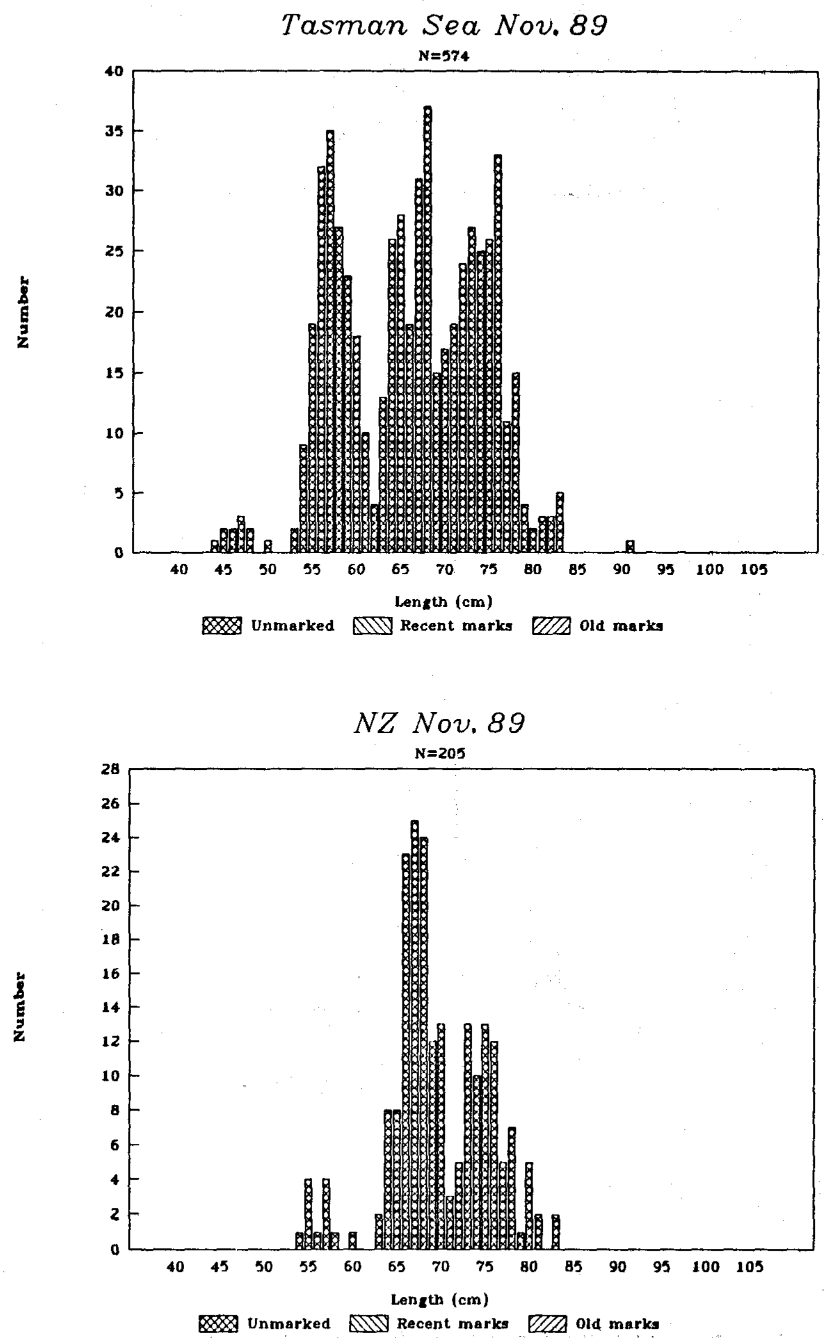
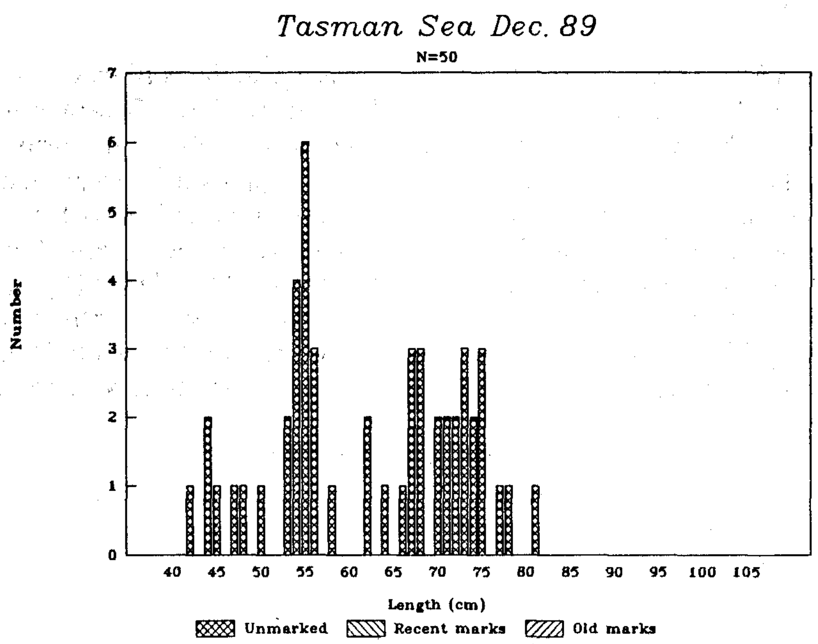


Figure 2. Length frequency histograms of albacore sampled during November 1989



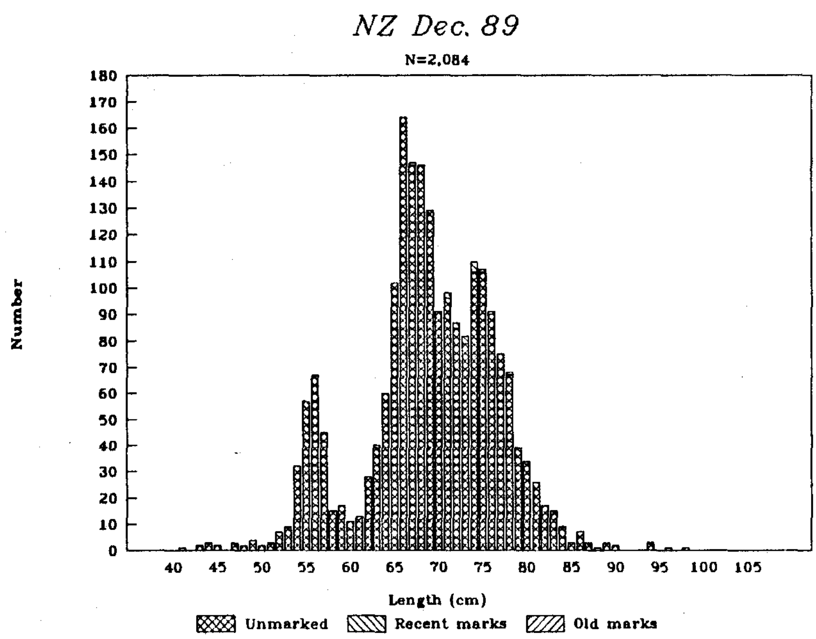


Figure 3. Length frequency histograms of albacore sampled during December 1989

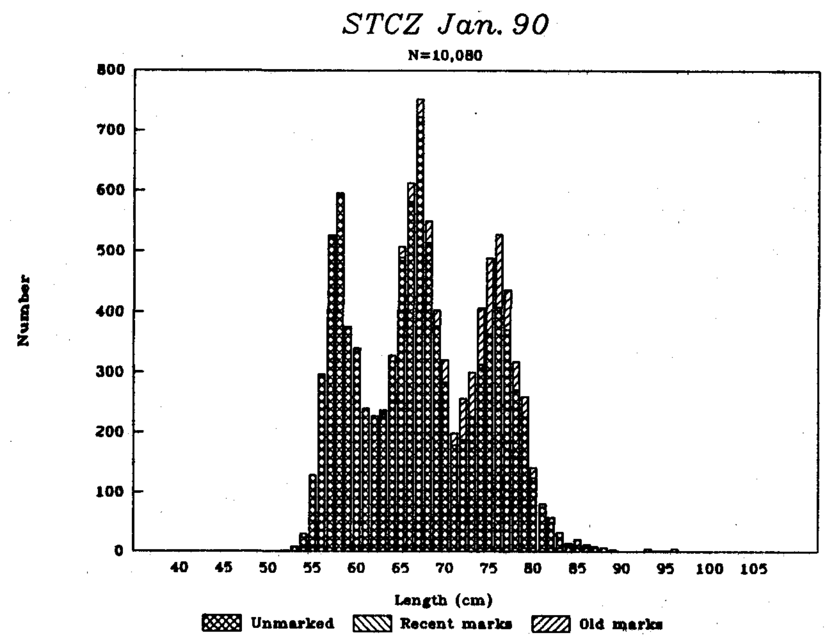


Figure 4. Length frequency histogram of albacore sampled during January 1990

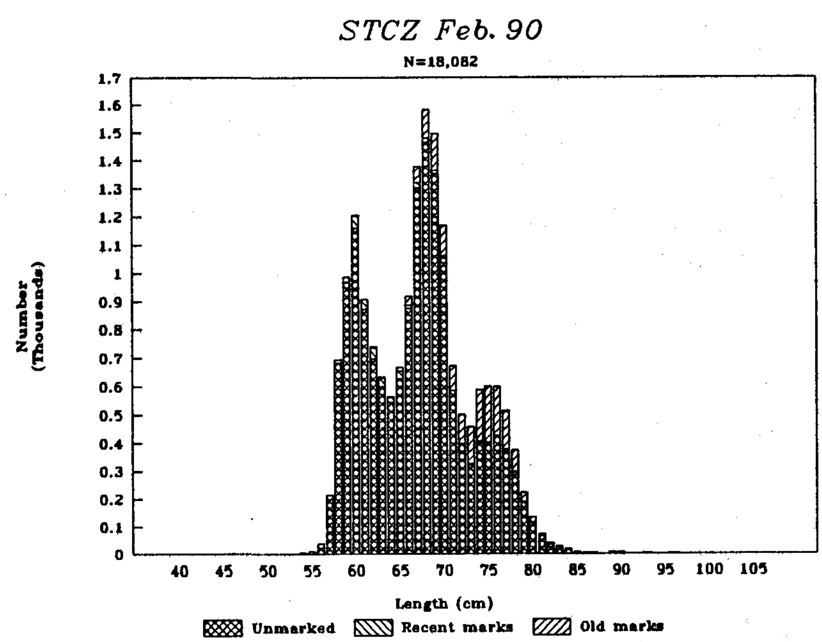


Figure 5. Length frequency histogram of albacore sampled during February 1990

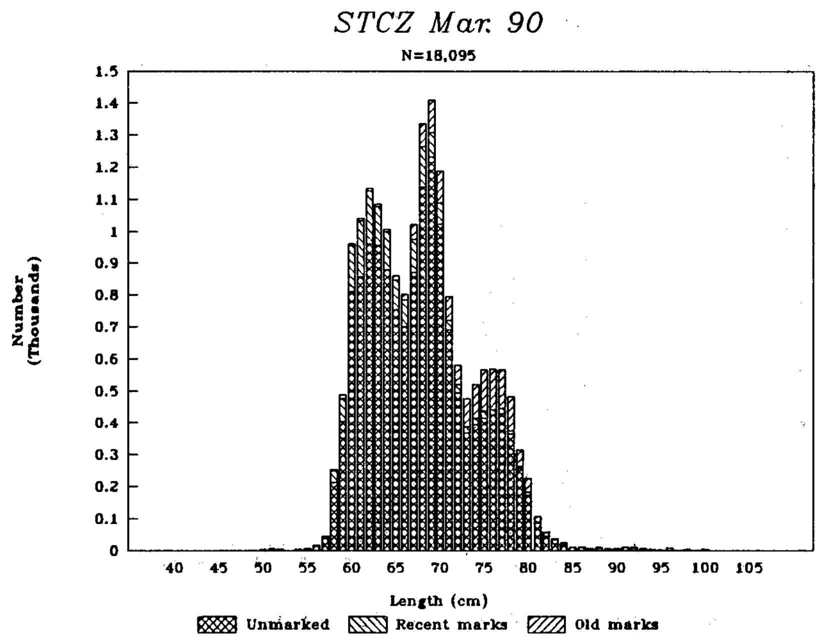


Figure 6. Length frequency histogram of albacore sampled during March 1990

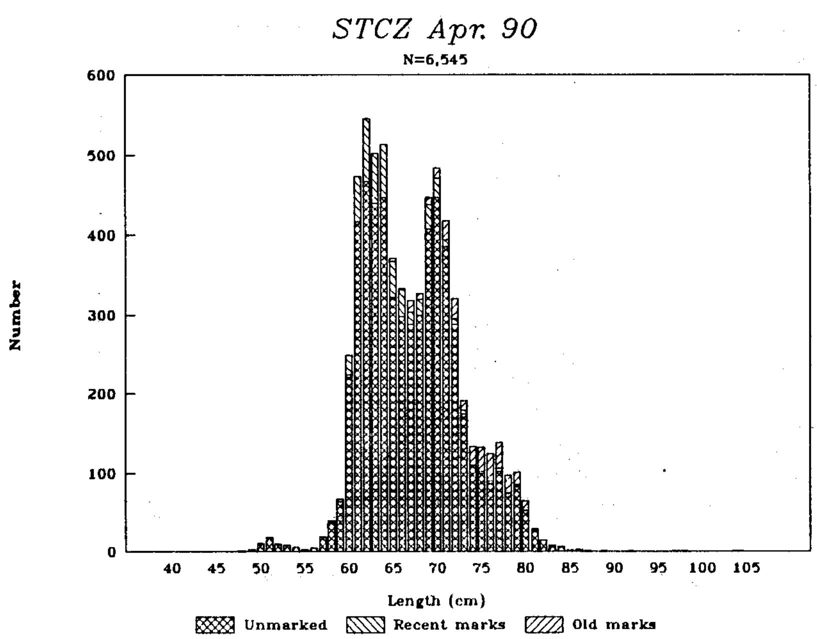


Figure 7. Length frequency histogram of albacore sampled during April 1990

4.3 Incidence of driftnet-marked albacore

The incidence of driftnet-marked albacore from the three fishing areas by month is given in Table 6.

Table 6. Percentages of driftnet-marked albacore in catches of observer vessels

Month	Tasman Sea		New Zealand		STCZ	
	New	Old	New	Old	New	Old
Nov. 1989	0.0	0.0	0.0	0.0		
Dec. 1989	0.0	0.0	0.8	0.0		
Jan. 1990					0.1	8.7
Feb. 1990					1.7	9.0
Mar. 1990					8.7	7.4
Apr. 1990					7.7	4.3
Total	0.0	0.0	0.7	0.0	4.5	7.8

New marks are assumed to have been inflicted during the present season. Old marks are assumed to have been inflicted during the 1988–1989 season.

None of the albacore examined from the Tasman Sea and only 0.7 per cent of those examined from the New Zealand area had marks that seemed to have been acquired in the current season (as evidenced by the freshness of the wounds). On the other hand, 4.5 per cent of albacore examined from the STCZ bore fresh driftnet marks. Significant numbers of albacore with new marks were not observed in the STCZ until March 1990, when the troll vessels were fishing east of 150°W. Significantly, driftnet vessels were not sighted in the STCZ by observers until this time. Old injuries, probably inflicted during the 1988–1989 surface fishery season, were observed only in the STCZ (but throughout the whole area), and were found on 7.8 percent of albacore examined.

During the 1988–1989 season, 14.5 per cent of albacore examined by observers bore new marks. If the old marks observed during 1989–1990 were inflicted during 1988–1989, the ratio of the percentages, i.e. 7.8:14.5, is an estimate of the survival from 1988–1989 to 1989–1990 and is equivalent to a total mortality rate of 0.58 per year.

The incidence of recent and old driftnet marks by size is shown in Figures 2–7. In March and April 1990 (Figures 6–7), recent marks were observed on albacore from the first and second modes, but not on those from the third mode. In contrast, old marks were seen mainly in the third mode and also to some extent in the second mode, but never in the first mode (Figures 4–7). These observations support the assumption that old marks were acquired during the 1988–1989 season.

4.4 Albacore condition

Length–weight and length–girth measurements were taken from driftnet-marked and unmarked albacore caught in the Tasman Sea, around northern New Zealand and in the STCZ to test for the effects of driftnet encounter on fish condition and to compare condition between the areas. Marked fish were further separated into those with new marks, attributable to the present season, and those with old marks, probably inflicted during the previous season.

4.4.1 Comparisons between marked and unmarked albacore

The length–weight and length–girth relationships for unmarked albacore from the three areas combined are shown in Figures 8 and 9 respectively. The residuals of the weight and girth measurements, relative to the regression curves fitted to the combined data sets, provide measures of the differences in albacore condition.

The residuals of girth measurements for all marked and unmarked albacore are plotted in Figure 10 as examples. Table 7 compares the condition of marked and unmarked fish sampled in the STCZ; the low numbers of marked fish encountered in the Tasman Sea and northern New Zealand preclude any valid comparisons for these areas. With regard to the length–weight relationship, STCZ albacore with new and old marks appear to be in significantly better condition than unmarked fish. A similar result is seen when comparing the length–girth relationship of old marked fish with unmarked fish, although albacore with new marks were not significantly different in length–girth condition from the unmarked sample. In contrast, Hampton et al. (1989) reported that the condition of marked albacore examined during the 1988–1989 troll season was significantly lower than that of unmarked fish.

Table 7. Condition comparisons of unmarked and driftnet-marked albacore from the STCZ based on length–weight and length–girth measurements

	Subtropical Convergence Zone (STCZ)			
	n	**Mean residual**	**s.d.**	**P**
Length–weight				
Unmarked	7,063	0	0.049	-
New marks	596	0.172	0.050	0.0001
Old marks	549	0.180	0.053	0.0001
Length–girth				
Unmarked	14,410	0	1.246	-
New marks	885	0.010	1.336	0.8166
Old marks	1,314	0.119	1.312	0.0009

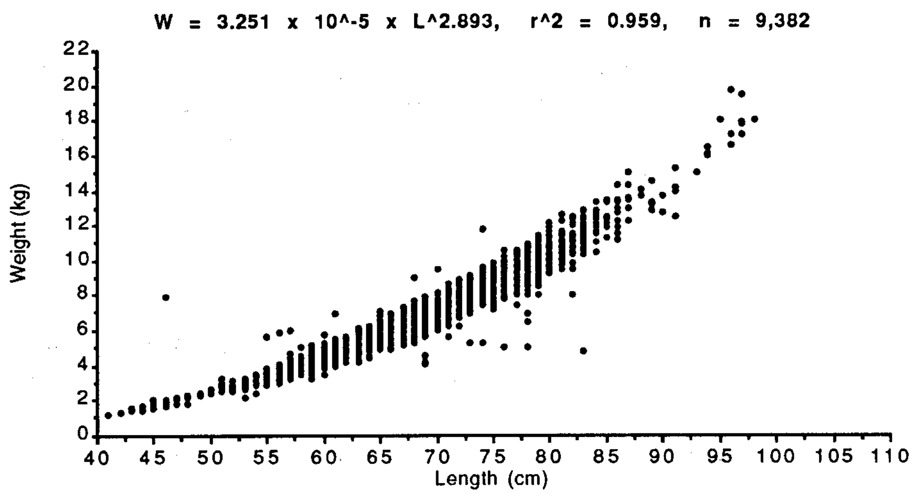


Figure 8. Length–weight observations of unmarked albacore sampled during the 1989–1990 season

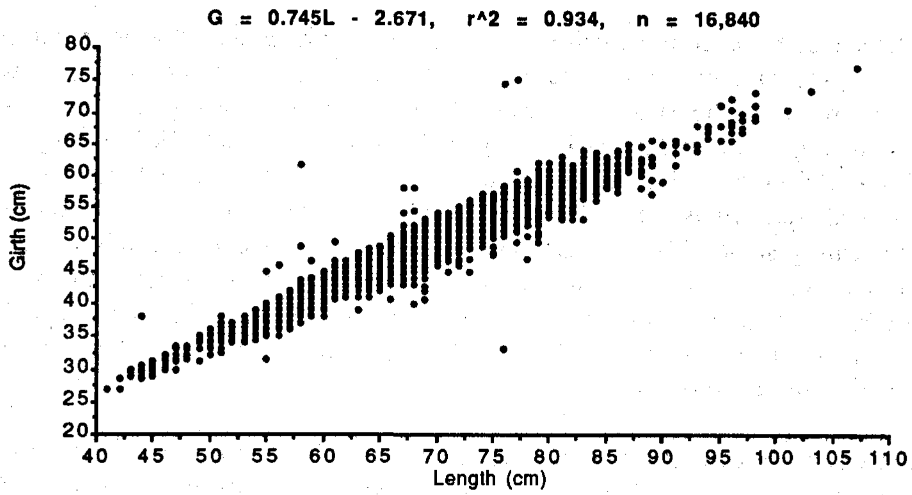


Figure 9. Length–girth observations of unmarked albacore sampled during the 1989–1990 season

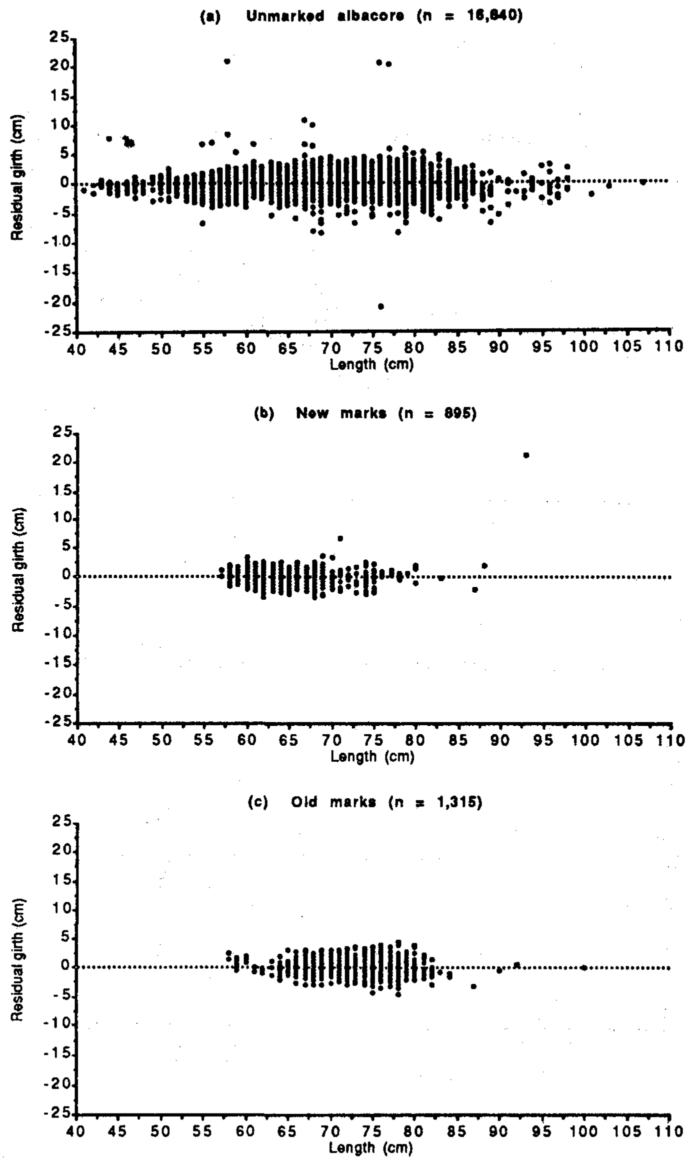


Figure 10. Length–girth residuals of marked and unmarked albacore sampled during the 1989–1990 season, based on the relationship between length and girth of all unmarked fish

The apparent inconsistency between the condition of marked and unmarked albacore from the two seasons can be explained by the fact that most newly marked fish from the 1989–1990 season were taken late in the second half of the season toward the eastern extremity of the fishing area. The plots of length–girth residuals for both newly marked (Figure 11) and unmarked (Figure 12) albacore from the STCZ suggest that condition improved as the 1989–1990 season progressed and as the fishery moved further to the east. Therefore, the sample of newly marked albacore used in the test in Table 7 is not representative of the entire STCZ during the majority of the fishing season, and in fact favours albacore with higher condition. A test of newly marked and unmarked fish after day 45, when new marks were first seen in any numbers, showed that unmarked fish were in significantly better condition (Students t test, $P < 0.0001$, df = 9,462). This finding supports the view expressed by Hampton et al. (1989) that albacore are traumatised by encounters with driftnets and lose condition as a result.

A similar test between unmarked and old-marked albacore after day 45 for fish over 69 cm in fork length (which includes most old-marked fish from the season) showed no significant difference (Students t test, $P = 0.5294$, df = 3,362). This suggests that any condition lost because of driftnet encounter in the previous season can be regained between fishing seasons.

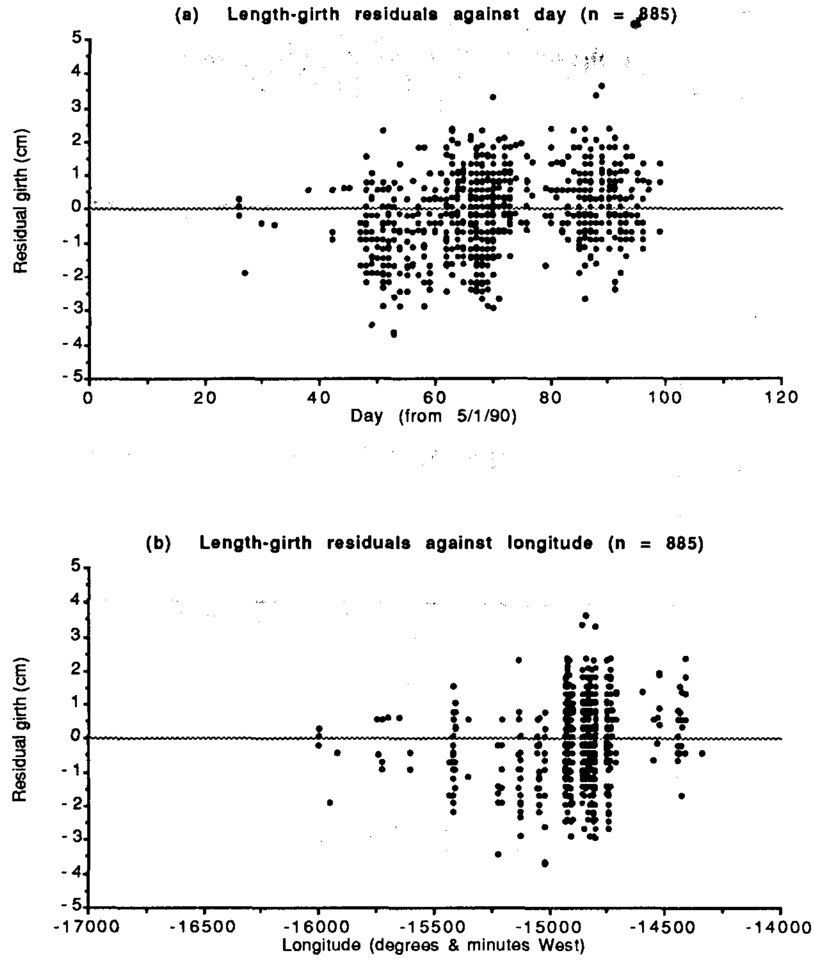


Figure 11. Length–girth residuals of newly marked albacore from the STCZ against day and longitude

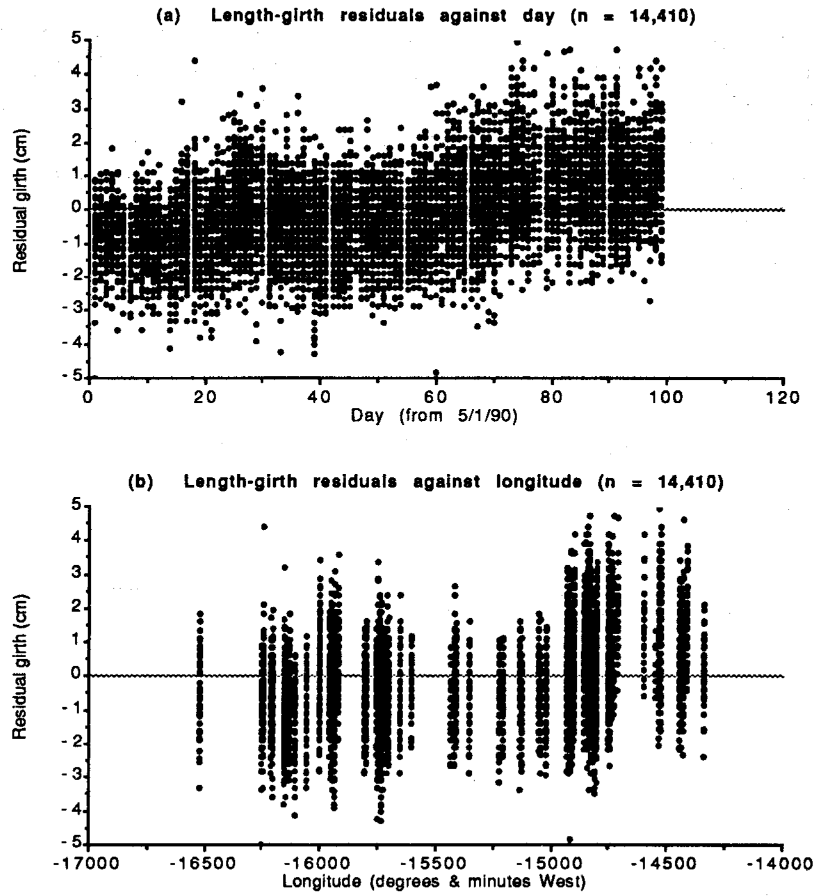


Figure 12. Length–girth residuals of unmarked albacore from the STCZ against day and longitude

4.4.2 Comparisons of unmarked albacore from different fishing areas

Significant differences were found when comparing unmarked albacore from the three fishing areas. As shown in Table 8 and Figure 13, albacore from the STCZ appeared to be in significantly better condition than fish caught in the north of New Zealand and the Tasman Sea. The differences between the Tasman Sea and New Zealand fish are not consistent, however, as Tasman Sea fish were in slightly better length–weight condition than New Zealand fish but in poorer length–girth condition. These differences may be due to the small sample sizes from the Tasman Sea and the greater number of small fish measured from New Zealand.

Table 8. Condition comparisons between areas of unmarked albacore based on length–weight and length–girth measurements

	n	(P < 0.0001 for all comparisons) Mean residual	s.d.
Length–weight			
Tasman Sea	495	-0.024	0.068
NE coast, NZ	1,824	-0.043	0.071
STCZ	7,063	0.013	0.049
Length–girth			
Tasman Sea	519	-1.059	1.347
NE coast, NZ	1,911	-0.753	1.515
STCZ	14,410	0.138	1.246

The relatively good condition of albacore in the STCZ was also observed in fish trolled during the 1988–1989 season (Hampton et al., 1989) and during the 1989–1990 season in driftnet-caught fish (Sharples et al., 1991), and is possibly related to the productivity of the convergence zone that is enhanced by upwellings and shear zones between the subtropical and subantarctic water masses (Laurs et al., 1986). This productivity is reflected in the large concentrations of juvenile Peruvian jack mackerel (*Trachurus murphyi*) present in the zone and their predominance in the diet of albacore (Bailey, 1989).

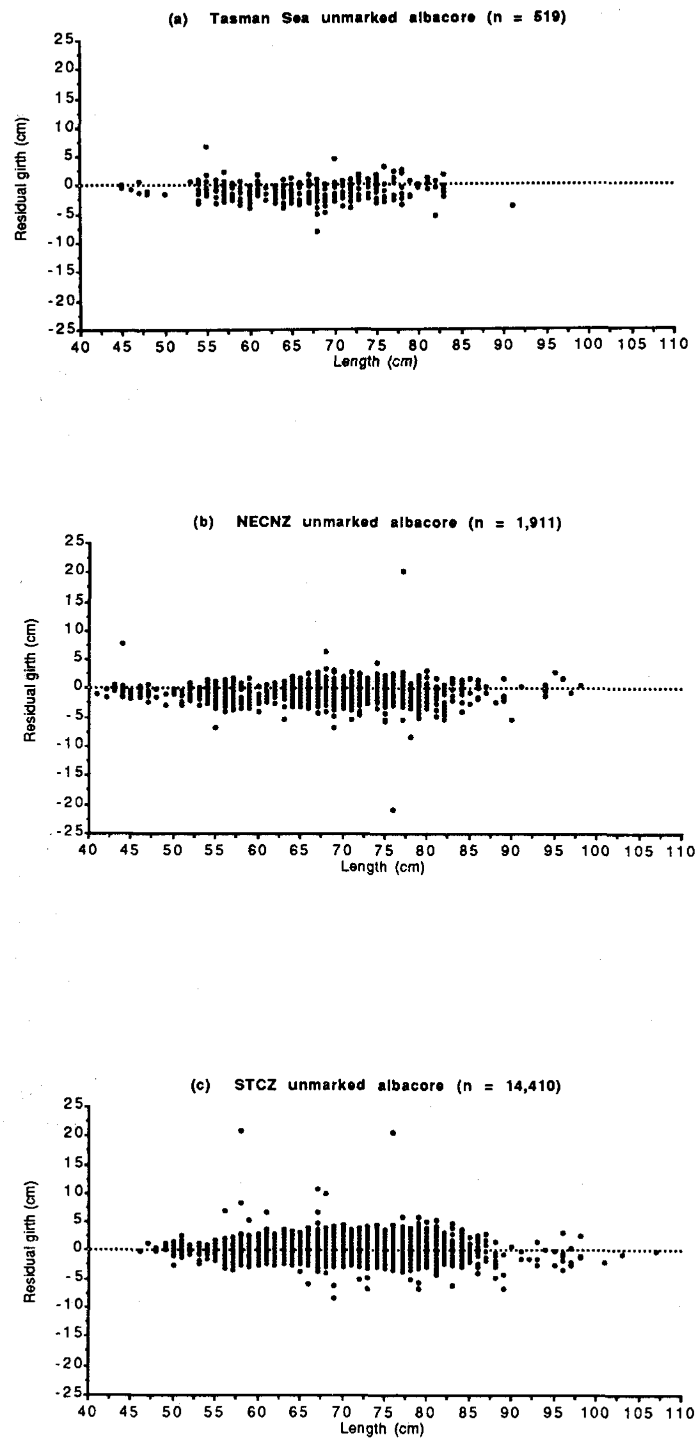


Figure 13. Length–girth residuals of unmarked albacore sampled from the Tasman Sea, the north-east coast of New Zealand and the STCZ during the 1989–1990 season, based on the relationship between length and girth, for all areas combined, of all unmarked fish

4.5 Frequency of shark damage

While examining albacore for driftnet marks, the observers also noted the incidence of damage inflicted by sharks to determine what percentage of the catch was rejected because of this damage. Two forms of shark damage were observed; small, concave bites made by the mesopelagic cookie cutter shark (*Isistius brasiliensis*), and substantial rips and bites made by large pelagic sharks, such as the blue shark. Albacore with cookie cutter bites were usually retained, because of the limited damage, while those damaged by larger sharks were rejected.

During the 1989–1990 season, 0.04 per cent of all examined albacore had some form of shark damage (Table 9). The frequency of albacore damaged by large sharks ranged from zero in the Tasman Sea to 0.17 per cent for fish caught off the north-east coast of New Zealand. These figures indicate that the proportion of albacore rejected because of shark damage is negligible. Although no albacore examined from the Tasman Sea were damaged by large sharks, Sharples et al. (1991) noted that 0.6 per cent of the albacore caught by the driftnet vessel *Shinhoyo Maru* in the same area showed signs of such injuries and were rejected.

Table 9. Incidence of shark-damaged albacore in catches of observer vessels

Area	No. of albacore examined	No. of albacore with damage from large sharks (%)	No. of albacore with cookie cutter bites (%)
Tasman Sea	624	0	3 (0.48)
NE coast, NZ	2,289	4 (0.17)	9 (0.39)
STCZ	52,802	6 (0.01)	0
Total	55,715	10 (0.02)	12 (0.02)

4.6 Frequency of albacore escapement

Over a three week-period and for about one hour per day, the observer on the *Daniel Solander* counted the numbers of albacore that escaped from the troll lures after being hooked. These counts did not include 'strikes', where albacore nibbled on the lures in a tentative manner but were not effectively hooked. Escapement occurred within seconds of a fish being hooked, if the vessel was trolling too fast, as the fish was hauled to the boat, or as it was lifted out of the water and on to the deck.

A total of 190 escapements was noted from the 745 occasions when lures were observed to have caught albacore. This gives an overall escapement rate of 25.5 per cent. This figure is probably higher than average because the *Daniel Solander* cannot steam as slowly as the smaller, purpose-built trollers of the fishery. The *Daniel Solander* also has a considerably higher stern than the other vessels, making it easier for fish to drop off the hooks as they are lifted out of the water.

4.7 Driftnet vessel sightings

Driftnet vessel identities and positions were reported by observers on U.S. and New Zealand troll vessels, observers on the JAMARC research driftnet vessel R.V. *Shinhoyo Maru*, officers aboard merchant ships (Union Steamship Co.) and RNZAF fisheries surveillance aircraft. Two driftnet fishing areas, coinciding with the general areas of activity by the Taiwanese and Japanese fleets in 1988–1989, were observed. Most driftnet vessel sightings were north of 40°S, with vessels in the Tasman Sea fishing a broader latitudinal band than driftnet vessels fishing the STCZ. Taiwanese and Japanese driftnet vessel sightings in 1989–1990 are presented in Figure 14 and listed in Appendix I.

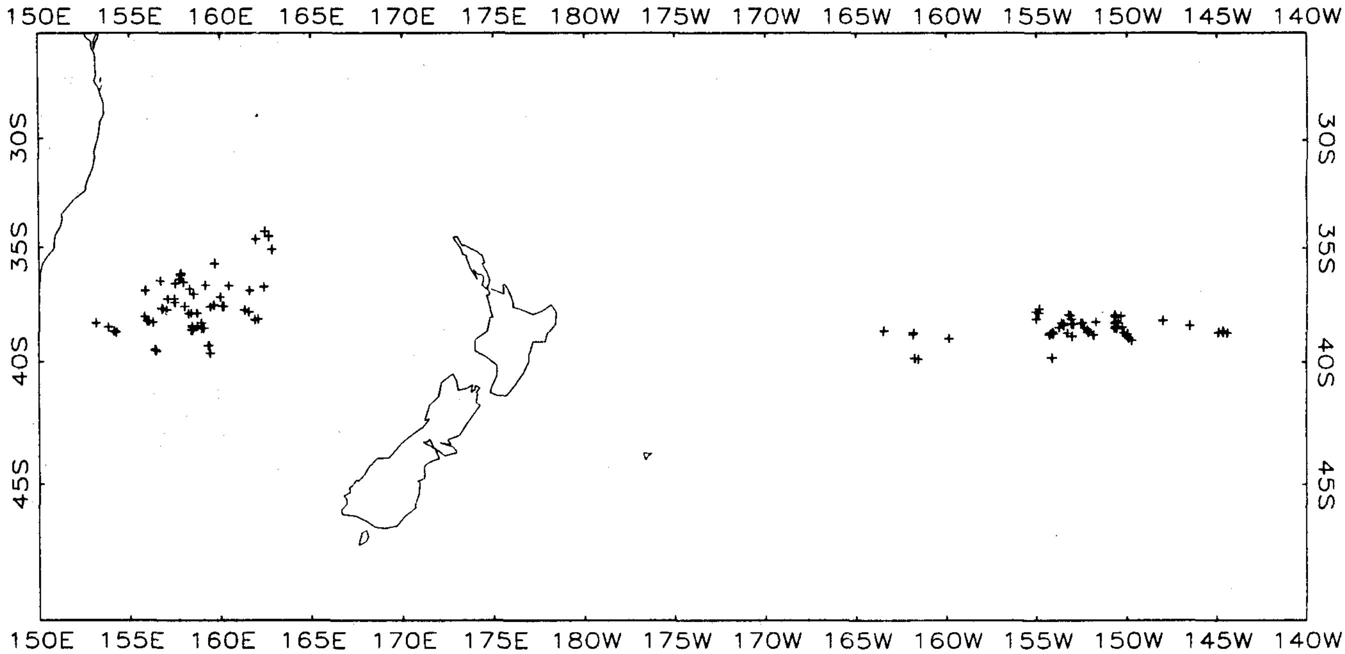


Figure 14. Positions of driftnet vessel sightings during the 1989–1990 season

Driftnet vessels (approximately twenty Japanese and at least two Taiwanese vessels) were sighted in the Tasman Sea between October 1989 and February 1990. The area of Japanese driftnet fishing in 1989–1990 was further west than in 1988–1989. This was reportedly due to restrictions imposed by the Japanese Government (P. Sharples, pers. comm.). Surveillance flights over the Tasman Sea indicated that the arrival of the Japanese fleet was later in 1989–1990 than in 1988–1989.

Driftnet vessels fishing east of New Zealand were observed primarily by U.S. and New Zealand troll vessels east of 174° W from mid-January to early March. Nearly all of the vessels sighted in the STCZ fishing area were Taiwanese, although the Tasman Sea Japanese fleet was reported to have entered the western part of the STCZ fishing area in February (A. Allan, pers. comm.). The size of the Taiwanese fleet could not be estimated from the sightings by troll vessels, due to few reports of vessel registration numbers, but appears to have been less than 20 vessels.

4.8 Behaviour of albacore schools

Troll fishermen interviewed during previous seasons often stated that schools of albacore altered their behaviour and went 'off the bite' if a driftnet vessel deployed its net amongst troll vessels engaged in fishing. One objective of the present season was therefore to determine if this actually happened. Unfortunately, the observers found this a difficult objective to meet because the trollers usually stopped fishing and left the area whenever a driftnet vessel came in sight. This was primarily because the trollers did not want to risk their gear, boats or lives, by fishing near the nets.

4.9 Recovery of tagged albacore

Between the 1985–1986 and 1989–1990 seasons, 6,807 albacore were tagged and released in the STCZ and the waters surrounding New Zealand, under the auspices of the South Pacific Albacore Research (SPAR) group (Lewis, 1990). Seven of these tagged albacore have been recaptured to date, including three in New Zealand waters and four in the STCZ. No recoveries were made during the 1989–1990 season.

5. CONCLUSIONS

The major conclusions of the 1989–1990 observer programme on troll vessels are as follows:

(a) Fishing in the Tasman Sea was poor, with an average of 31 albacore caught per day. Fishing along the north-east coast of New Zealand during the same period was considerably better, with an average of 167 albacore caught per day. The most successful albacore fishing of the entire season was along the STCZ where observer vessels caught 336 albacore per day, approximately twice the CPUE of 1988–1989.

(b) The size composition of albacore measured during the 1989–1990 observer programme is basically similar to those of previous seasons. For the STCZ area, catches were more evenly spread over the three modes in 1989–1990 than in 1988–1989, when the second mode was most dominant.

(c) The incidence in the STCZ of albacore bearing recent driftnet marks was much lower in 1989–1990 (4.5%) than in 1988–1989 (14.5%). However, 7.8 per cent of the catch in the STCZ bore marks that were probably inflicted by driftnet encounters in 1988–1989. Driftnet-marked albacore were not observed in the Tasman Sea and only in small numbers (0.7%) off the north-east coast of New Zealand.

(d) On the basis of observations of driftnet marks assumed to have been inflicted during 1988–1989, average total mortality during the 1988–1989 and 1989–1990 seasons is estimated at 0.58 per year. This estimate includes natural mortality, fishing mortality, mortality due to injuries received during escapement from driftnets, changing vulnerability to troll fishing and emigration out of the STCZ troll fishery area. The absence in the Tasman Sea of albacore bearing such marks would suggest that emigration in that direction at least is minor.

(e) As in the 1988–1989 season, marked albacore caught in the STCZ were in significantly poorer condition than unmarked fish. This further supports the view that albacore are traumatised by driftnet encounter, and lose condition as a result. There was evidence that albacore (particularly those over 69 cm in length) that encountered driftnets in the previous season and survived regained condition between fishing seasons. The significant differences in condition between unmarked fish from the STCZ, the Tasman Sea and northern New Zealand suggest that the convergence zone is a particularly productive area.

(f) Areas of driftnet fishing in the Tasman Sea and STCZ albacore fishing areas in 1989–1990 were similar to those in 1988–1989. Driftnet fleet distributions were reported to be similar to those in the previous year, although the Japanese fleet was reported to have arrived in the Tasman Sea later than in 1988–1989. Fleet sizes of Taiwanese and Japanese driftnet vessels were dramatically smaller in 1989–1990 than in 1988–1989.

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Appendix I

Driftnet vessel sightings

Date	Latitude	Longitude	Nationality	Source
26/10/89	34°30´S	162°39´E	Taiwanese	MAF Fish
09/11/89	34°17´S	162°27´E	Taiwanese	MAF Fish
09/11/89	35°05´S	162°50´E	Japanese	MAF Fish
09/11/89	34°38´S	161°56´E	Taiwanese	MAF Fish
23/11/89	36°45´S	162°22´E	Japanese	JAMARC
24/11/89	36°14´S	157°48´E	Japanese	MAF Fish
24/11/89	35°43´S	159°40´E	Taiwanese	MAF Fish
24/11/89	36°55´S	161°35´E	Japanese	MAF Fish
24/11/89	36°42´S	160°26´E	Japanese	MAF Fish
24/11/89	36°09´S	157°50´E	Japanese	MAF Fish
24/11/89	36°36´S	157°30´E	Taiwanese	MAF Fish
25/11/89	36°56´S	155°50´E	Japanese	JAMARC
26/11/89	36°30´S	156°41´E	Japanese	JAMARC
27/11/89	36°09´S	157°50´E	Japanese	MAF Fish
27/11/89	36°11´S	157°47´E	Japanese	JAMARC
28/11/89	36°41´S	159°09´E	Japanese	JAMARC
29/11/89	36°51´S	158°17´E	Japanese	JAMARC
30/11/89	36°25´S	157°43´E	Japanese	JAMARC
01/12/89	37°18´S	157°05´E	unknown	MAF Fish
01/12/89	36°33´S	157°57´E	Japanese	JAMARC
03/12/89	37°05´S	158°30´E	Japanese	JAMARC
04/12/89	37°38´S	158°01´E	Japanese	JAMARC
05/12/89	38°29´S	158°42´E	Japanese	JAMARC
06/12/89	38°21´S	158°55´E	Japanese	JAMARC
07/12/89	38°35´S	158°56´E	Japanese	JAMARC
08/12/89	37°55´S	158°22´E	Japanese	JAMARC
09/12/89	37°57´S	158°14´E	Japanese	JAMARC
10/12/89	37°47´S	157°01´E	Japanese	JAMARC
12/12/89	37°27´S	157°28´E	Japanese	JAMARC
13/12/89	37°17´S	157°27´E	Japanese	JAMARC
17/12/89	37°56´S	158°41´E	Japanese	JAMARC
18/12/89	38°35´S	159°04´E	Japanese	JAMARC
19/12/89	39°19´S	159°22´E	Japanese	JAMARC
20/12/89	39°20´S	159°19´E	Japanese	JAMARC
25/12/89	37°13´S	159°58´E	Japanese	JAMARC
29/12/89	37°37´S	160°09´E	Japanese	JAMARC
30/12/89	37°37´S	160°04´E	Japanese	JAMARC
01/01/90	37°47´S	161°18´E	Japanese	MAF Fish
01/01/90	38°11´S	162°03´E	Japanese	MAF Fish
01/01/90	39°33´S	156°28´E	Japanese	JAMARC
02/01/90	37°52´S	161°32´E	Japanese	MAF Fish
02/01/90	39°30´S	156°24´E	Japanese	JAMARC
03/01/90	39°32´S	156°24´E	Japanese	JAMARC
03/01/90	37°39´S	159°25´E	Japanese	MAF Fish
03/01/90	37°34´S	159°36´E	Japanese	MAF Fish
03/01/90	39°39´S	159°25´E	Japanese	MAF Fish

03/01/90	38°13´S	161°52´E	Japanese	MAF Fish
04/01/90	37°44´S	156°45´E	Taiwanese	MAF Fish
04/01/90	37°43´S	156°48´E	Japanese	MAF Fish
04/01/90	37°43´S	156°48´E	Japanese	MAF Fish
05/01/90	38°32´S	158°26´E	Japanese	JAMARC
06/01/90	38°28´S	158°24´E	Japanese	JAMARC
07/01/90	38°39´S	158°23´E	Japanese	MAF Fish
07/01/90	38°40´S	158°29´E	Japanese	MAF Fish
09/01/90	38°05´S	155°48´E	Japanese	JAMARC
10/01/90	38°16´S	155°55´E	Japanese	JAMARC
11/01/90	38°20´S	156°16´E	Japanese	JAMARC
12/01/90	38°17´S	156°01´E	Japanese	JAMARC
18/01/90	39°52´S	161°33´W	Taiwanese	US troll
19/01/90	39°50´S	161°45´W	unknown	NZ troll
24/01/90	38°10´S	155°02´W	Japanese	JAMARC
26/01/90	37°51´S	155°03´W	Japanese	JAMARC
27/01/90	37°58´S	153°16´W	Japanese	JAMARC
29/01/90	37°43´S	154°52´W	Japanese	JAMARC
30/01/90	37°54´S	154°54´W	Japanese	JAMARC
31/01/90	38°54´S	153°03´W	Japanese	JAMARC
31/01/90	38°46´S	161°49´W	unknown	NZ troll
31/01/90	38°41´S	163°29´W	unknown	JAMARC
01/02/90	38°10´S	153°07´W	Japanese	JAMARC
02/02/90	38°00´S	153°10´W	Japanese	JAMARC
02/02/90	39°00´S	159°52´W	Taiwanese	US troll
02/02/90	38°50´S	161°51´W	unknown	NZ troll
03/02/90	38°17´S	151°45´W	Japanese	JAMARC
04/02/90	38°02´S	150°21´W	Japanese	JAMARC
05/02/90	38°05´S	150°38´W	Japanese	JAMARC
06/02/90	38°16´S	150°38´W	Japanese	JAMARC
07/02/90	37°59´S	150°41´W	Japanese	JAMARC
08/02/90	38°21´S	150°43´W	Japanese	JAMARC
09/02/90	38°01´S	150°42´W	Japanese	JAMARC
09/02/90	38°23´S	153°05´W	Taiwanese	JAMARC
09/02/90	38°23´S	153°05´W	Taiwanese	JAMARC
11/02/90	38°34´S	150°43´W	Japanese	JAMARC
12/02/90	38°30´S	150°40´W	Japanese	JAMARC
13/02/90	38°20´S	150°30´W	Japanese	JAMARC
14/02/90	38°29´S	150°37´W	unknown	JAMARC
15/02/90	38°31´S	150°17´W	Japanese	JAMARC
16/02/90	38°45´S	150°12´W	Japanese	JAMARC
19/02/90	38°14´S	148°01´W	Japanese	JAMARC
20/02/90	38°27´S	146°32´W	Japanese	JAMARC
21/02/90	38°21´S	153°06´E	Japanese	MAF Fish
21/02/90	38°22´S	153°06´E	Japanese	MAF Fish
21/02/90	38°45´S	144°55´W	Japanese	JAMARC
21/02/90	38°22´S	153°06´W	Japanese	NZ troll
21/02/90	38°32´S	153°47´W	Taiwanese	NZ troll
22/02/90	38°43´S	154°07´E	Taiwanese	MAF Fish
22/02/90	38°21´S	153°08´W	Taiwanese	MAF Fish
22/02/90	38°23´S	153°00´W	Taiwanese	US troll
22/02/90	38°20´S	152°35´W	Taiwanese	US troll
22/02/90	38°19´S	152°29´W	Taiwanese	US troll
22/02/90	38°47´S	154°11´W	unknown	NZ troll

22/02/90	38°44´S	154°08´W	Taiwanese	NZ troll
22/02/90	38°48´S	154°04´W	unknown	US troll
22/02/90	38°50´S	154°17´W	unknown	NZ troll
22/02/90	38°50´S	154°17´W	unknown	NZ troll
22/02/90	38°50´S	154°17´W	unknown	NZ troll
22/02/90	38°50´S	154°17´W	unknown	NZ troll
22/02/90	38°50´S	154°17´W	unknown	NZ troll
22/02/90	38°50´S	154°17´W	unknown	NZ troll
22/02/90	38°45´S	144°38´W	Japanese	JAMARC
23/02/90	38°46´S	154°15´E	Japanese	MAF Fish
23/02/90	38°46´S	144°25´W	Japanese	JAMARC
23/02/90	38°47´S	154°15´W	Japanese	NZ troll
23/02/90	39°49´S	154°09´W	unknown	NZ troll
23/02/90	38°41´S	144°42´W	unknown	JAMARC
23/02/90	38°20´S	153°40´W	unknown	JAMARC
24/02/90	38°32´S	153°47´E	Taiwanese	MAF Fish
24/02/90	38°32´S	153°47´W	Taiwanese	NZ troll
24/02/90	38°26´S	153°33´W	unknown	NZ troll
24/02/90	38°26´S	153°33´W	unknown	NZ troll
24/02/90	38°24´S	153°32´W	unknown	NZ troll
24/02/90	38°33´S	152°24´W	unknown	NZ troll
24/02/90	38°33´S	152°24´W	unknown	NZ troll
25/02/90	38°35´S	150°35´W	Japanese	JAMARC
25/02/90	38°37´S	152°14´W	unknown	NZ troll
25/02/90	38°51´S	151°51´W	unknown	NZ troll
25/02/90	38°48´S	150°00´W	unknown	JAMARC
25/02/90	38°48´S	150°00´W	unknown	JAMARC
25/02/90	38°46´S	153°20´W	unknown	JAMARC
25/02/90	38°46´S	153°20´W	unknown	JAMARC
25/02/90	38°46´S	153°20´W	unknown	JAMARC
25/02/90	38°46´S	153°20´W	unknown	JAMARC
26/02/90	38°20´S	153°34´W	Taiwanese	US troll
26/02/90	38°20´S	153°34´W	Taiwanese	US troll
26/02/90	38°49´S	149°58´W	Japanese	JAMARC
27/02/90	38°43´S	152°09´W	Taiwanese	JAMARC
27/02/90	38°43´S	152°09´W	Taiwanese	JAMARC
27/02/90	38°59´S	149°54´W	Japanese	JAMARC
28/02/90	39°05´S	149°44´W	Japanese	JAMARC
02/03/90	38°52´S	150°02´W	Japanese	JAMARC