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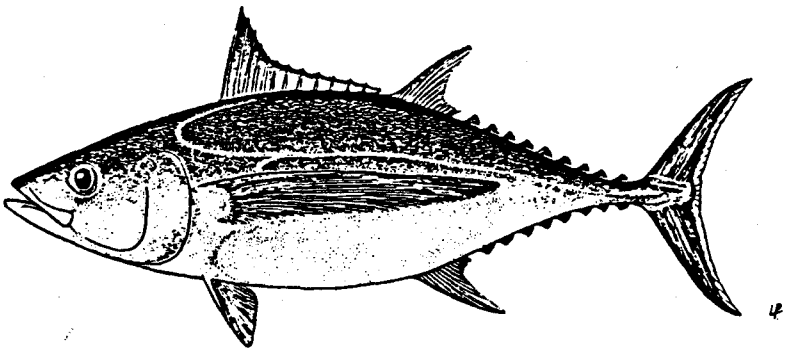

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SOUTH PACIFIC ALBACORE OBSERVER PROGRAMME ON TROLL VESSELS 1989-1990

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ABSTRACT

A series of observer cruises was conducted on six albacore troll vessels covering the entire fishing season between November 1989 and April 1990. A total of 263 observer days were spent at sea. The areas covered include the Tasman Sea (2 vessels, 25 days), the northeast New Zealand coast (2 vessels, 36 days) and the Subtropical Convergence Zone east of New Zealand (6 vessels, 202 days). In total, 55,715 albacore were measured for fork length, many of which were also weighed and their girth measured. All fish sampled were scored for degree of driftnet damage. A new category of driftnet damage that is interpreted as resulting from driftnet escapement in the 1988-89 season was also recorded. None of the albacore examined from the Tasman Sea and only 0.8% of those examined from the northeast 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% of albacore examined from the Subtropical Convergence Zone bore fresh driftnet marks. Old injuries, probably inflicted during the 1988-89 surface fishery season, were observed only in the Subtropical Convergence Zone and were found on 7.8% of albacore examined. The CPUE on observed troll vessels in 1989-90 was 26 fish per day in the Tasman Sea, 158 fish per day off the northeast 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 1988-89 of 175.9 fish per day.

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 longliners 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 coastal waters of New Zealand, usually recording catches of 1,000-3,000 t annually. Exploratory troll fishing in 1985-86 and 1986-87 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) during 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 1987-88, 44 U.S., Canadian and Fijian troll vessels caught about 3,600 t of albacore in the STCZ. In addition, 7 Taiwanese large mesh pelagic driftnet vessels caught 1,000 t, and a fleet of Japanese driftnetters took 4,800 t. During the 1988-89 season, 54 troll vessels from the U.S., 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 1988-89. Prior to the exploratory Taiwanese fishing in 1987-88, the only known driftnet activity in the South Pacific was that of a Japanese fleet, which has fished since at least 1983-84 mainly in the Tasman Sea. Although the exact number of driftnetters that fished in the South Pacific in 1988-89 is not known, reports suggest that at least 60 Taiwanese, 67 Japanese and 1 South Korean vessels 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 1988-89 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 1988-89 season consisting of detailed fishery monitoring, aerial surveillance and placement of observers on commercial troll vessels. The 1988-89 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 1988-89 observer programme reported by Hampton et al. (1989) have proved invaluable in preliminary assessments of the status of the stock.

The rapid increase in catch in 1988-89, 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/transhipping of albacore catches. To address the concern regarding recent levels of exploitation of the albacore stock the albacore observer programme was expanded in 1989-90 to cover the entire season and area of troll vessel operation. Observer coverage for two cruises in 1989-90 on a research driftnet vessel was also negotiated in cooperation with the Government of Japan and is reported separately (Sharples et al. 1990).

1.2 Observer programme

In line with the recommendations of the November 1988 consultation, and building on experience gained during the 1988-89 observer programme, an expanded observer programme on troll vessels was mounted for the 1989-90 season. The programme was coordinated 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 was 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 1989-90 albacore season

Various other data were collected from the fisheries during 1989-90, 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 principle 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 to 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 onboard host vessels.

(b) To routinely record 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 observe driftnet hauling operations on distant-water vessels, recording the approximate number of albacore and other species caught and numbers of fish dropping out during hauling of the net.

(f) To document characteristics of driftnet vessels and gear in the vicinity of trolling operations, if possible with photographic records.

(g) To record observations on the behaviour of albacore schools, collect oceanographic data where feasible, and to carefully record recapture details of any tagged fish.

3. OPERATIONAL SUMMARY

Five observers were offered berths aboard albacore troll vessels from New Zealand and the U.S. at the invitation of the vessel owners and in cooperation with vessel managers and masters. The vessels sampled, areas fished, and the 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 90	A. Allan
Daniel Solander	Tasman Sea	14-29 Nov 89	M. Douglas
	Tasman Sea	19-20 Dec 89	M. Douglas
	E. Coast NZ	30 Nov-19 Dec 89	M. Douglas
	STCZ	1 Jan-16 Mar 90	P. Sharples
Day Star	STCZ	3-5 Mar 90	A. Allan
Kariqa	Tasman Sea	25 Nov-1 Dec 89	G. Williams
	Tasman Sea	18-19 Dec 89	G. Williams
	E. Coast NZ	2-17 Dec 89	G. Williams
	STCZ	18 Mar-8 Apr 90	P. Sharples
Mata Whao Rua	STCZ	17 Mar-14 Apr 90	A. Allan
San Te Maru 18	STCZ	17 Jan-19 Mar 90	R. Stewart

A total of 263 observer days were spent at sea. 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 east coast of New Zealand where U.S. troll vessels were reporting good catch rates. In all, 25 observer days were spent on two vessels in the Tasman Sea while 36 observer days were spent on the same boats fishing the east coast.

During the time troll vessels were in the Tasman Sea only six confirmed sightings of driftnet vessels were made (by 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 6 vessels during the 1 January to 14 April period for a total of 202 observer days in the STCZ.

Plots of the cruise tracks are shown in Figure 1.

3.1 Troll vessel characteristics and fishing strategies

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

TABLE 2. TROLL VESSEL CHARACTERISTICS

Vessel	Length (m)	GRT	Freezer Hold (tonnes)	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	150	10
San Te Maru 18	52.8	345		16

3.1.1 MFV Atu (N.Z.)

The 1989-90 season was the first season this vessel fished in the offshore albacore fishery. However the crew and especially the Captain have had extensive experience in the New Zealand fisheries for albacore and southern bluefin. The Atu trolled 10 lines from outriggers and 4 lines off the stern. Hydraulic haulers hauled the outrigger lines, stern lines were hand hauled. In addition, 4 lines were trolled from a forward starboard outrigger. Forward outrigger lines were hauled by hand through the sea door.

For the 10 days the observer was on the Atu, fishing was generally very good for most vessels in the area. In addition to regular radio contact with other vessels, the captain used radar to identify areas of vessel concentration in picking fishing areas. In locating concentrations of fish the captain relied heavily on a depth sounder to locate sub-surface schools of fish. 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 GPS. During periods of good fishing this involved retracing the same path all day. On one occassion the vessel found a log and circled it for the remainder of the day with good results.

During periods of strong wind (in excess of 25 knots) a strategy ofalternately fishing with and against the weather was adopted. There did not appear to be any difference in catch rate when fishing with or against the weather.

3.1.2. MFV Daniel Solander (N.Z.)

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 that could be lowered from the main deck to water level so fish could be landed easily in any weather. Up to 23 lines were fished, with 4-5 from the stern, 6-7 from each of the two outriggers and 3-4 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 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 MFV Day Star (U.S.)

The observer spent only three days on board the Day Star in transit between vessels. The main fishing strategy was to use the sonar to locate a school of albacore. Having done so the school was circled, with the sonar used to maintain the vessels 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 5 lines from each of two outriggers and 4 or 5 lines from the stern. Hydraulic haulers were used to haul the 10 outrigger lines.

3.1.4 MFV Kariqa (N.Z.)

The Kariqa was on her first trip in the offshore albacore fishery. Up to 23 lines were fished at a time, 8 or 9 from each of two outriggers and 6 from the stern. A depth sounder was used to locate tuna schools, although it was not used to continuously track schools. Sea surface temperature measured on board and satellite derived temperature charts were used to indicate general areas of expected fish concentration.

3.1.5 MFV Mata Whao Rua (N.Z.)

This vessel had not previously participated in any albacore fishery but the captain and crew had considerable experience in the New Zealand albacore and southern bluefin fisheries. The vessel usually towed 27 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 MFV San Te Maru 18 (N.Z.)

This was the first season the San Te Maru fished for albacore although the captain participated in the offshore albacore fishery in 1988-89. Up to 31 lines were fished. The main strategy was 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. Sun fish were also circled and their position marked in case it 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 during 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 an additional 25

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 then 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 1988-89 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 and unmarked albacore through a section of driftnet found at sea. In repeated trials unmarked albacore developed the same categories of damage seen in freshly caught fish.

The driftnet fragment used in the 1988-89 verification experiment was a 200 mm mesh (stretched diagonal measure) piece presumed to be Taiwanese in origin. This driftnet fragment was found to tightly encircle an albacore with a girth of 46-49 cm 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 this size class corresponds to the larger of two size classes observed during transshipments of driftnet caught albacore in 1988-89 in Noumea. Mesh size is reported to vary among vessels with 178 mm mesh believed to have been more common in the 1989-90 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 in interpreting the size selectivity of and escapement from driftnets.

In the 1989-90 season it was found that some fish retained healed driftnet marks probably obtained in the 1988-89 season. This new category of mark was not seen in 1988-89. 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 1989-90) marking pattern along the sides of the fish is presently interpreted as damage incurred in a previous season.

3.4 Gillnet 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 has not been able to pass through the net.

Damage Code 3: The most serious category of net damage. Fish exhibit damage similar to Damage Code 1 and also exhibit 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 previously damaged by a driftnet (Damage Code 1) and to have subsequently recovered after some period at liberty (possibly 1 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 (MV Daniel Solander and Kariqa) carried observers while fishing the Tasman Sea and along the northeast coast of New Zealand in November and December 1989. A further five New Zealand troll vessels (MV Atu, Daniel Solander, Kariqa, Mata Whao Rua and San Te Maru 18) and one U.S troll vessel (MV Day Star) carried observers between January and April 1990 while fishing the STCZ. The composited fishing tracks of the troll vessels carrying observers is shown in figure 1.

A total of 234 observer days were spent at sea, 26 days in the Tasman Sea and 38 days along the northeast coast of New Zealand during November-December. The remaining 170 observer days were spent in the STCZ during January-April 1990. Fishing in the Tasman Sea was poor with an average of 29 albacore caught per day. Fishing along the northeast coast of New Zealand during the same period was considerably better with an average of 158 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 summarises catch and effort data by month and fishing area for the 1989-90 albacore fishing season.

Table 3. Albacore catch and effort summary aboard troll vessels in the Tasman Sea during the 1989-90 South Pacific fishing season.

		Nov 89	Dec 89
Daily sea surface temperature	Avg.	16.7	17.5
	min.	15.5	16.5
	max.	19.6	18.9
Days fished		23	3
Hours fished per day	Avg.	13.5	15.9
	s.d.	5.1	0.4
Number of jigs fished	Avg.	18.2	22.0
	s.d.	1.7	1.4
No. albacore landed per day	Avg.	31.0	22.0
	s.d.	27.8	11.0
No. albacore per 100 hook hrs.	Avg.	12.18	3.96
	s.d.	8.67	2.96

Table 4. Albacore catch and effort summary aboard troll vessels along the northeast coast of New Zealand during the 1989-1989-90 South Pacific fishing season.

		Nov 89	Dec 89
Daily sea surface	Avg.	18.3	18.7
temperature	min.	17.9	14.7
	max.	18.6	20.0
Days fished		1	37
Hours fished	Avg.	14.5	15.1
per day	s.d.	-	2.5
Number of	Avg.	17.0	20.6
jigs fished	s.d.	-	1.7
No. albacore	Avg.	812.0	144.3
landed per day	s.d.	-	129.5
No. albacore	Avg.	329.41	46.20
per 100 hook hrs.	s.d.	-	43.41

Table 5. Albacore catch and effort summary aboard troll vessels along the Subtropical Convergence Zone east of New Zealand during the 1989-90 South Pacific fishing season.

		Jan 90	Feb 90	Mar 90	Apr 90
Daily sea surface	Avg.	18.8	18.2	18.0	17.8
temperature	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	Avg.	15.3	14.5	13.6	12.2
per day	s.d.	1.3	1.4	0.5	2.4
Number of	Avg.	19.1	20.8	22.8	20.0
jigs fished	s.d.	3.1	3.2	4.9	0.0
No. albacore	Avg.	336.5	368.1	312.7	336.3
landed per day	s.d.	195.5	170.5	213.3	139.6
No. albacore	Avg.	113.88	121.47	109.37	148.49
per 100 hook hrs.	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) and short-billed spearfish (Tetrapturus angustirostris).

4.2 Length Composition

The length compositions of albacore are presented for the Tasman Sea, the northeast 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 was 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.

4.3 Incidence of driftnet-marked albacore

The incidence of driftnet-marked albacore for each of the areas by month is given in Table 6.

TABLE 6. INCIDENCE OF DRIFTNET-MARKED ALBACORE

	Tasman Sea		NZ		STCZ	
Month	New	Old	New	Old	New	Old
Nov 89	0.0	0.0	0.0	0.0		
Dec 89	0.0	0.0	0.8	0.0		
Jan 90					0.1	8.7
Feb 90					1.7	9.0
Mar 90					8.7	7.4
Apr 90					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 0.8% of those examined from the NZ 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% 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°E. Significantly, driftnet vessels were not sighted in the STCZ by observers until this time. Old injuries, probably inflicted during the 1988-89 surface fishery season, were observed only in the STCZ but throughout the whole area, and were found on 7.8% of albacore examined.

During the 1988-89 season, 14.5% of albacore examined by observers bore new marks. If the old marks observed during 1989-90 were inflicted during 1988-89, the ratio of the percentages, i.e. 7.8/14.5, is an estimate of the survival from 1988-89 to 1989-90 and is equivalent to a total mortality rate of 0.58 yr^{-1}.

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 suport the assumption that old marks were acquired during the 1988-89 season.

4.4 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. Shin-Hoyo 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 1988-89, 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 1989-90 are presented in Figure 8.

Driftnet vessels (approximately 20 Japanese and at least 2 Taiwanese vessels) were sighted in the Tasman Sea from October 1989 through February 1990. The area of Japanese driftnet fishing in 1989-90 was further west than in 1988-89, reportedly due to restrictions imposed by the Japanese government (P. Sharples, pers. comm.). Surveillance flights of the Tasman Sea indicated that the arrival of the Japanese fleet was later in 1989-90 than in 1988-89.

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 the few reports of vessel registration numbers but appears to have been fewer than 20 vessels.

5. MAJOR CONCLUSIONS

The major conclusions of the 1989-90 observer programme on troll vessels are as follows:

(a) Fishing in the Tasman Sea was poor with an average of 29 albacore caught per day. Fishing along the northeast coast of New Zealand during the same period was considerably better with an average of 158 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 1988-89.

(b) The size composition of albacore measured during the 1989-90 observer programme is similar in basic appearance to those from previous seasons. For the STCZ area, catches were more evenly spread over the three modes in 1989-90 than in 1988-89, when the second mode was most dominant.

(c) The incidence of albacore caught in the STCZ bearing recent driftnet marks was much lower in 1989-90 (4.5%) compared to 1988-89 (14.5%). However, 7.8% of the catch in the STCZ bore marks that probably were inflicted by driftnet encounter in 1988-89. Driftnet-marked abacore were not observed in the Tasman Sea or off the northeast coast of New Zealand.

(d) On the basis of observations of driftnet marks assumed to have been inflicted during 1988-89, an estimate of average total mortality during the 1988-89 and 1989-90 seasons is 0.58 yr^{-1}. 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 of albacore bearing such marks in the Tasman Sea would suggest that emigration in that direction at least is minor.

(e) Areas of driftnet fishing in the Tasman Sea and STCZ albacore fishing areas in 1989-90 were similar to those in 1988-89. Driftnet fleet distributions were reported to be similar to those last year, although the Japanese fleet was reported to have arrived in the Tasman Sea later than in 1988-89. Fleet

sizes of Taiwanese and Japanese driftnet vessels were dramatically reduced in 1989-90 relative to 1988-89.

ACKNOWLEDGEMENTS

The following observers participated in the 1989-90 observer programme: Alistair Allan, Martin Douglas, Peter Sharples, Ramari Stewart and Greg Williams. We are grateful for their thorough work under difficult conditions. Thanks also for the cooperation and hospitality of the owners, skippers and crews of the Atu, Daniel Solander, Day Star, Kariqa, Mata Whao Rua and San Te Maru 18, without which this work would not have been possible. The 1989-90 observer programme was funded by the British Development Division in the Pacific, the European Community European Development Fund and the New Zealand Ministry of Agriculture and Fisheries.

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Appendix

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'S	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

Figure 1. Cruise tracks of vessels participating in the 1989-90 observer programme. The symbol '+' marks noon position.

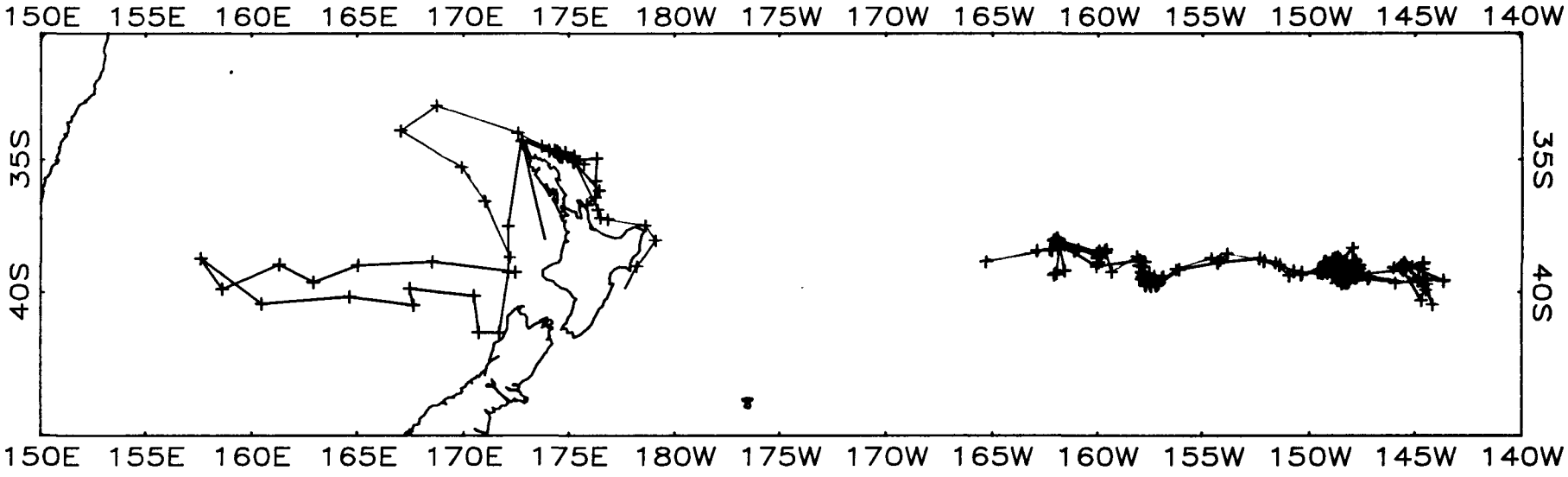
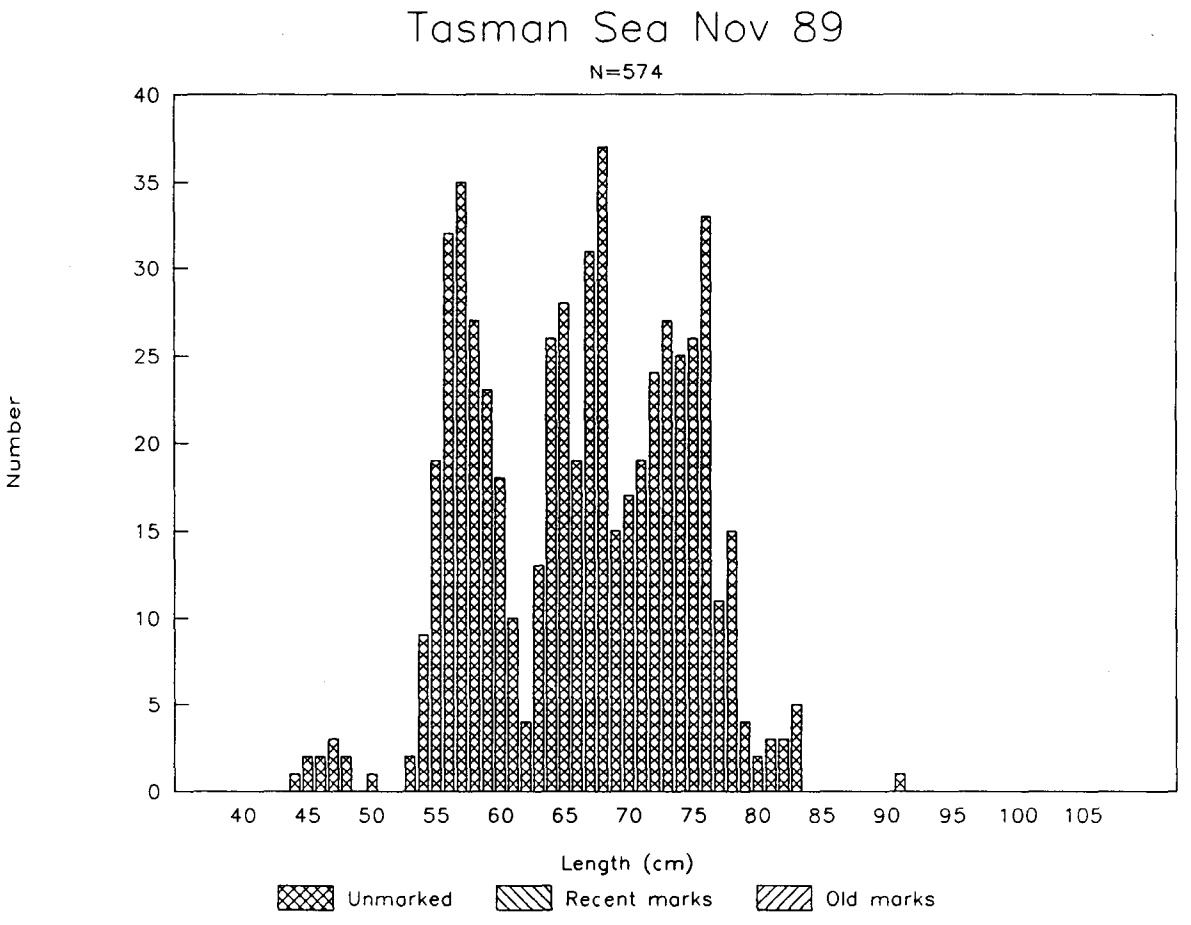

150E 155E 160E 165E 170E 175E 180W 175W 170W 165W 160W 155W 150W 145W 140W
35S
40S
150E 155E 160E 165E 170E 175E 180W 175W 170W 165W 160W 155W 150W 145W 140W
35S
40S

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


Tasman Sea Nov 89
N=574
Number
0
5
10
15
20
25
30
35
40
40 45 50 55 60 65 70 75 80 85 90 95 100 105
Length (cm)
Unmarked
Recent marks
Old marks

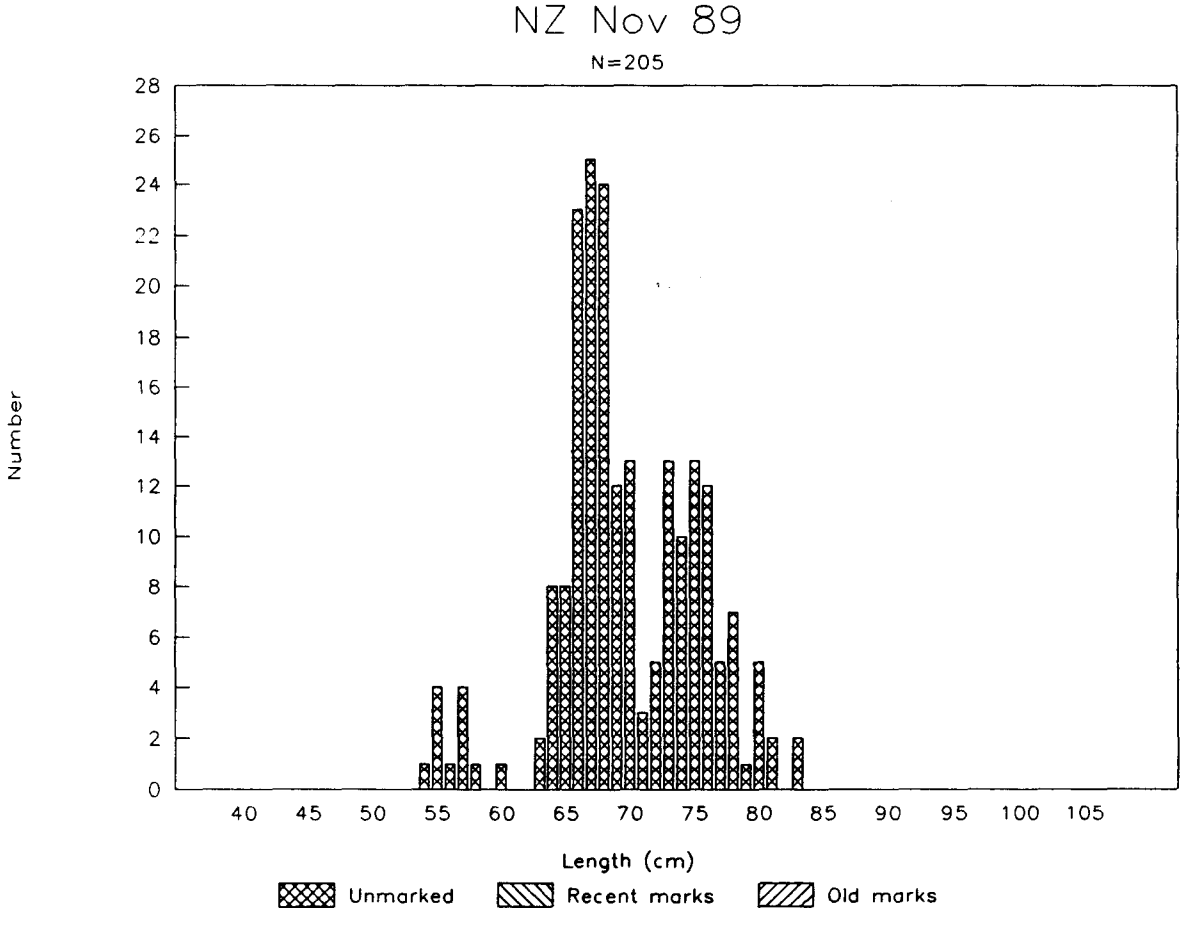
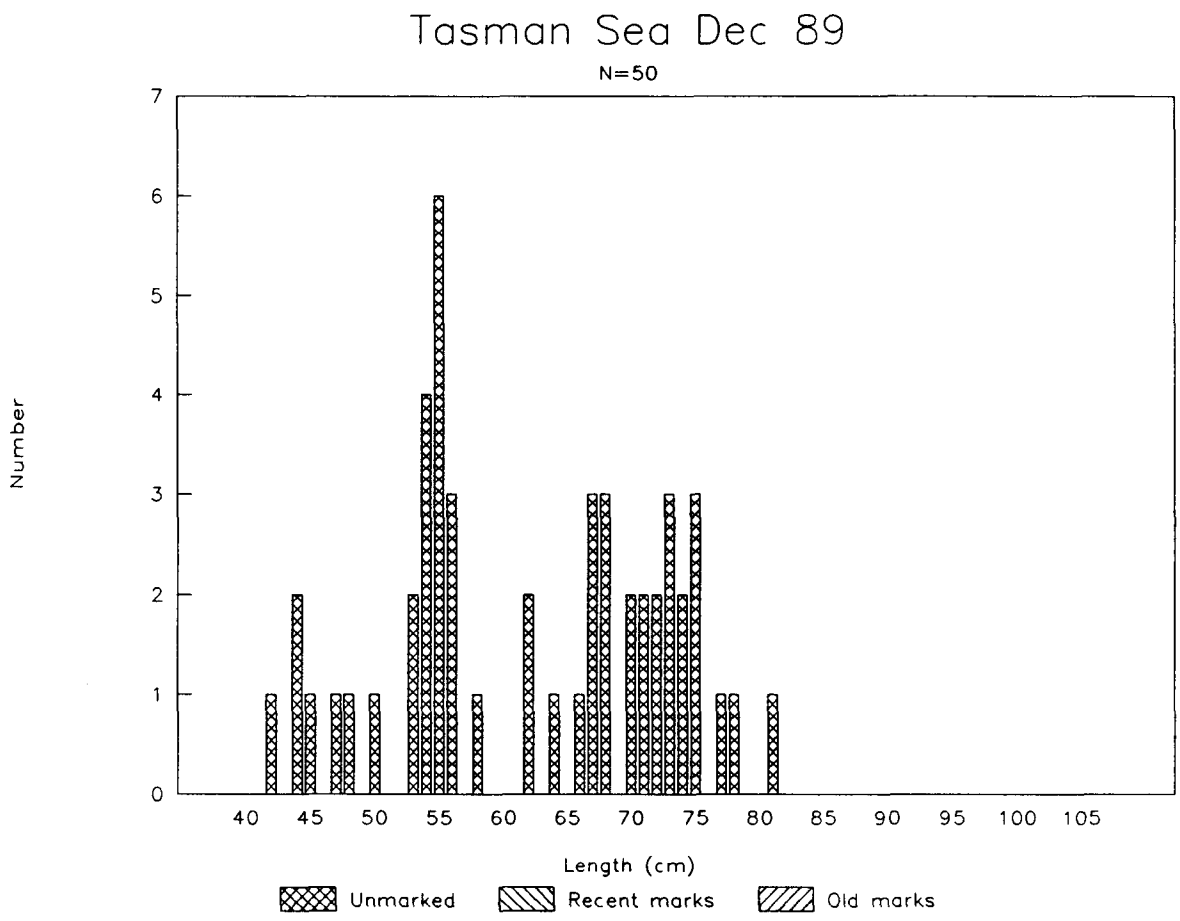

NZ Nov 89
N=205
Number
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
40 45 50 55 60 65 70 75 80 85 90 95 100 105
Length (cm)
Unmarked
Recent marks
Old marks

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


Tasman Sea Dec 89
N=50
Number
0
1
2
3
4
5
6
7
40 45 50 55 60 65 70 75 80 85 90 95 100 105
Length (cm)
Unmarked
Recent marks
Old marks

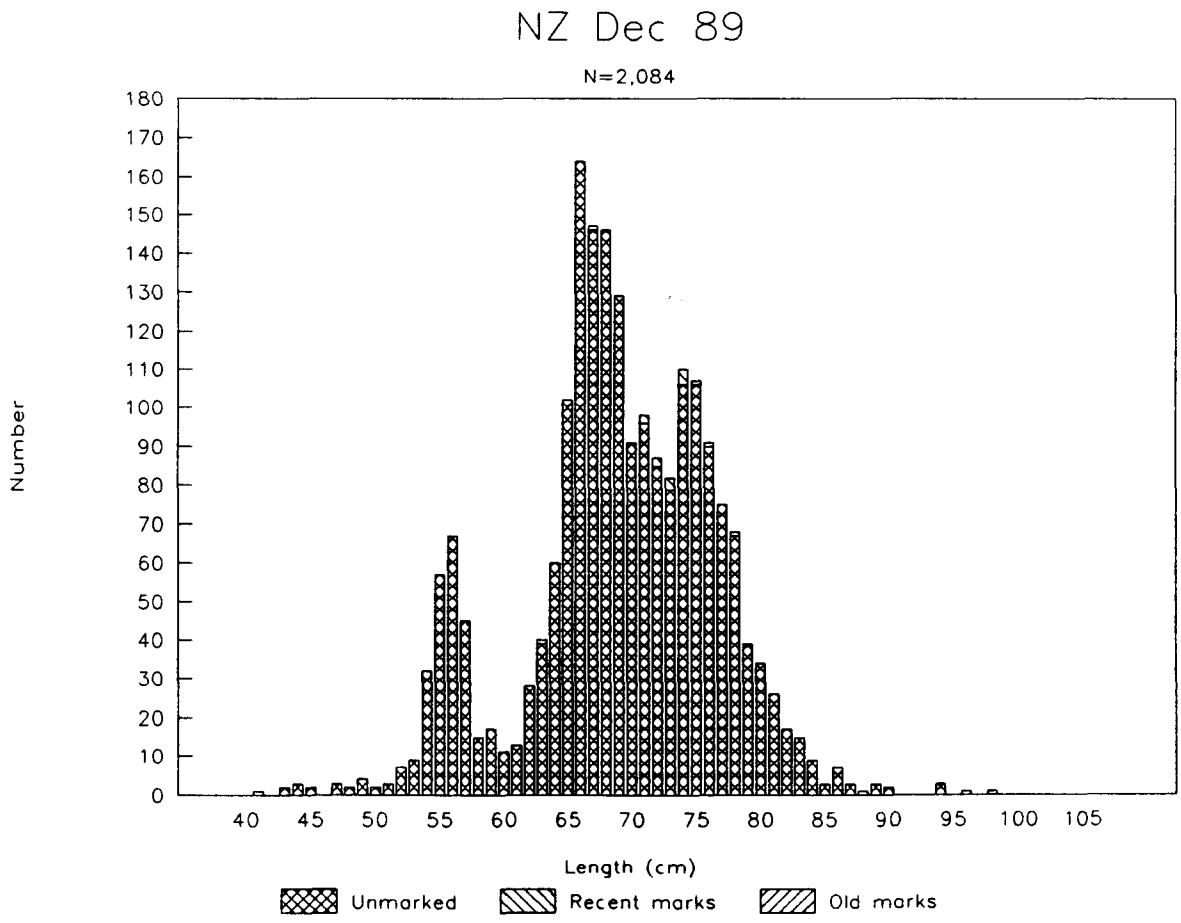
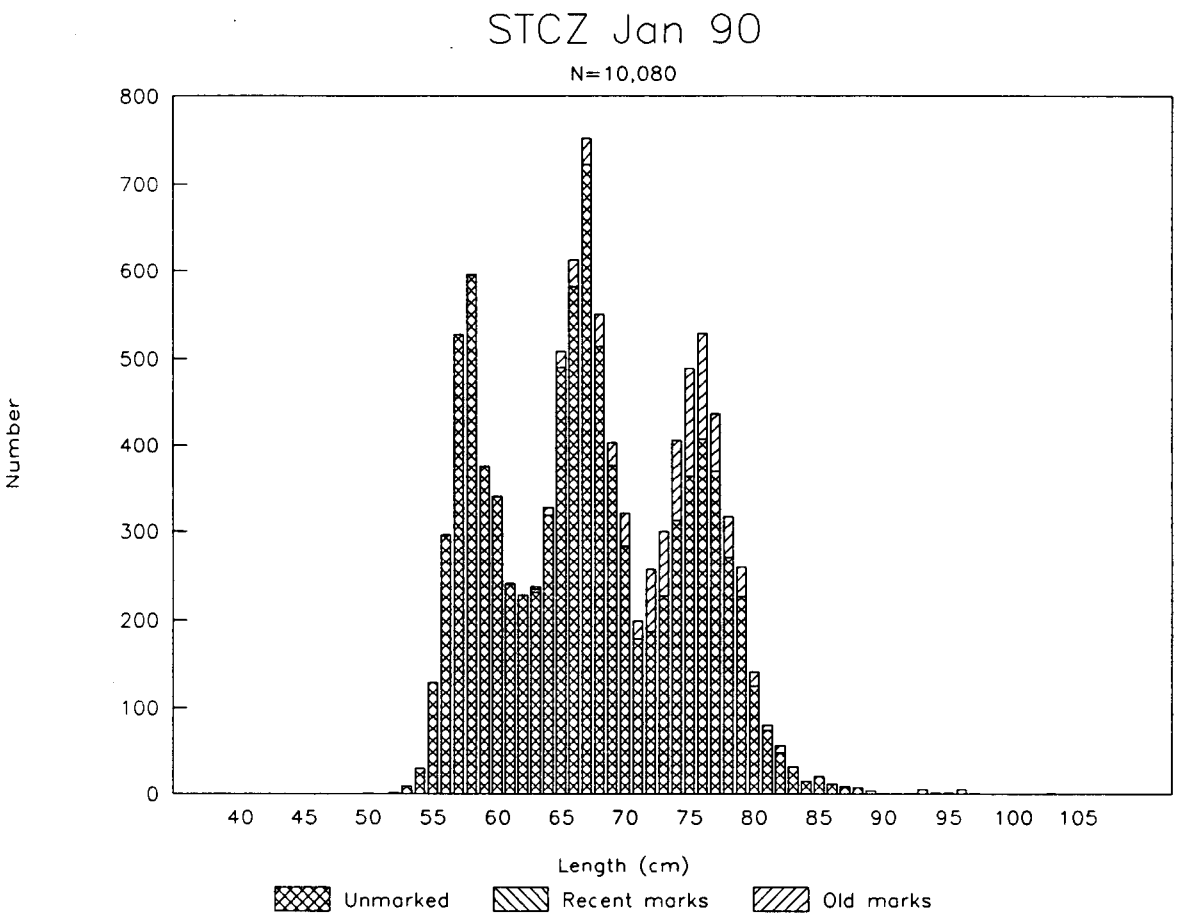

NZ Dec 89
N=2,084
Number
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
40 45 50 55 60 65 70 75 80 85 90 95 100 105
Length (cm)
Unmarked
Recent marks
Old marks

Figure 4. Length-frequency histograms of albacore sampled during January 1990.

Figure 5. Length-frequency histograms of albacore sampled during February 1990.


STCZ Jan 90
N=10,080
Number
800
700
600
500
400
300
200
100
0
40 45 50 55 60 65 70 75 80 85 90 95 100 105
Length (cm)
Unmarked
Recent marks
Old marks

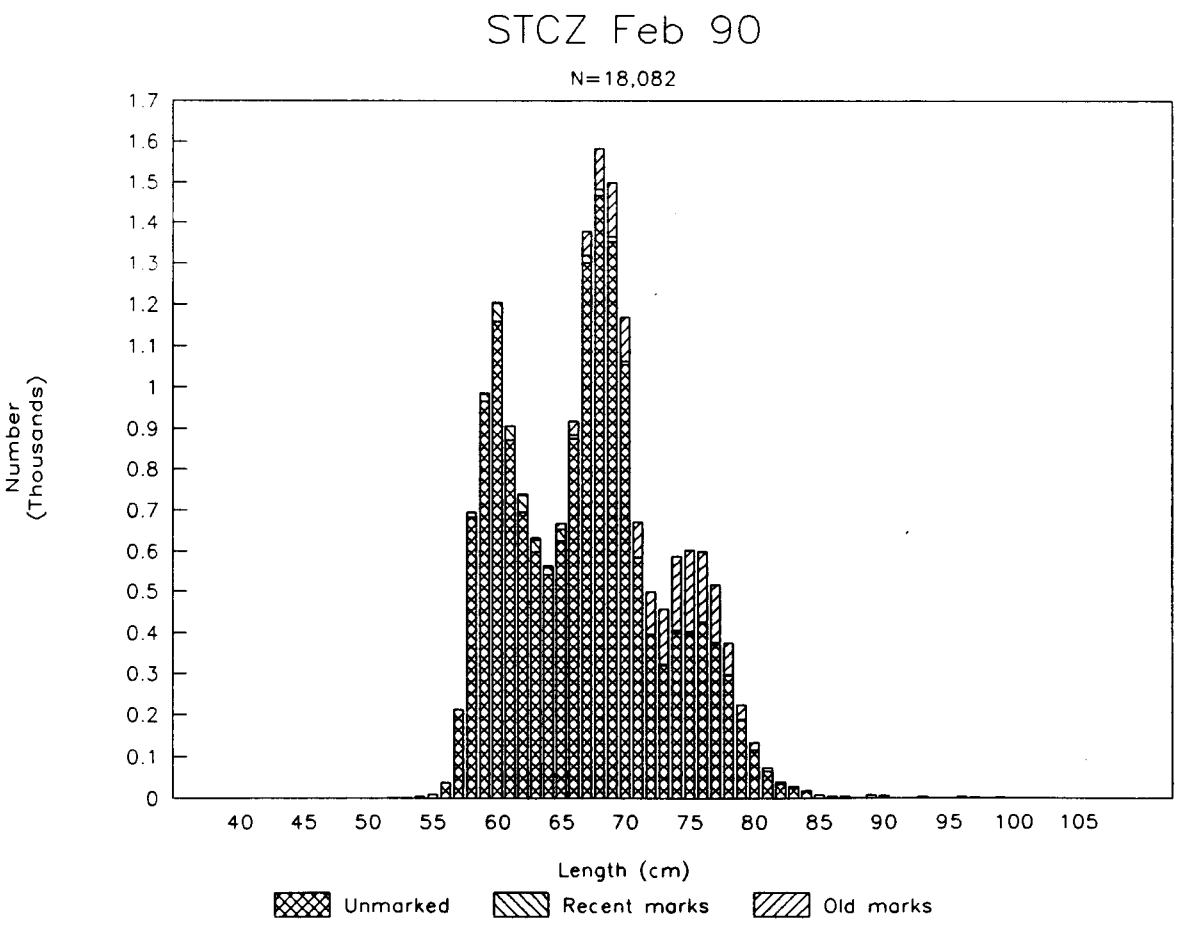
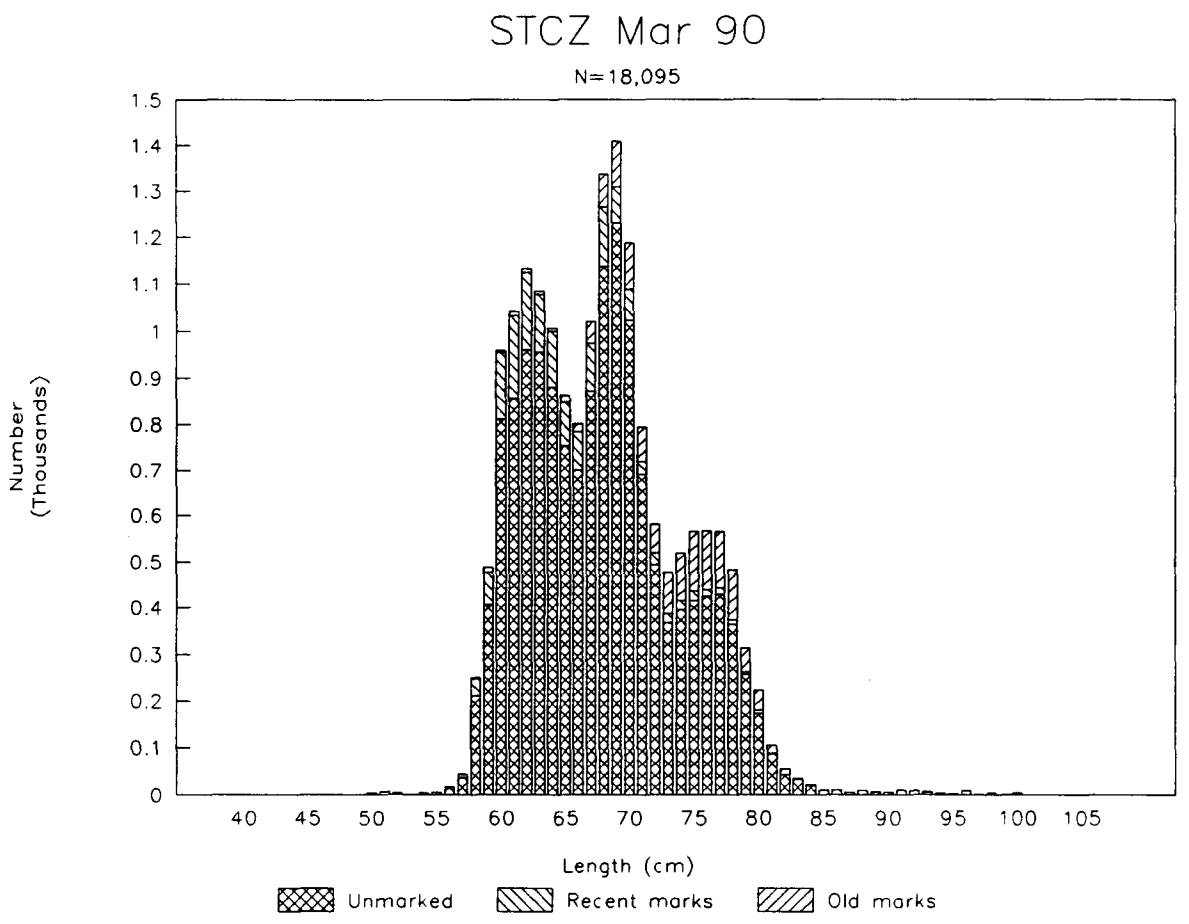

STCZ Feb 90
N=18,082
Number (Thousands)
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
40 45 50 55 60 65 70 75 80 85 90 95 100 105
Length (cm)
Unmarked
Recent marks
Old marks

Figure 6. Length-frequency histograms of albacore sampled during March 1990.

Figure 7. Length-frequency histograms of albacore sampled during April 1990.


STCZ Mar 90
N=18,095
Number (Thousands)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
40 45 50 55 60 65 70 75 80 85 90 95 100 105
Length (cm)
Unmarked
Recent marks
Old marks

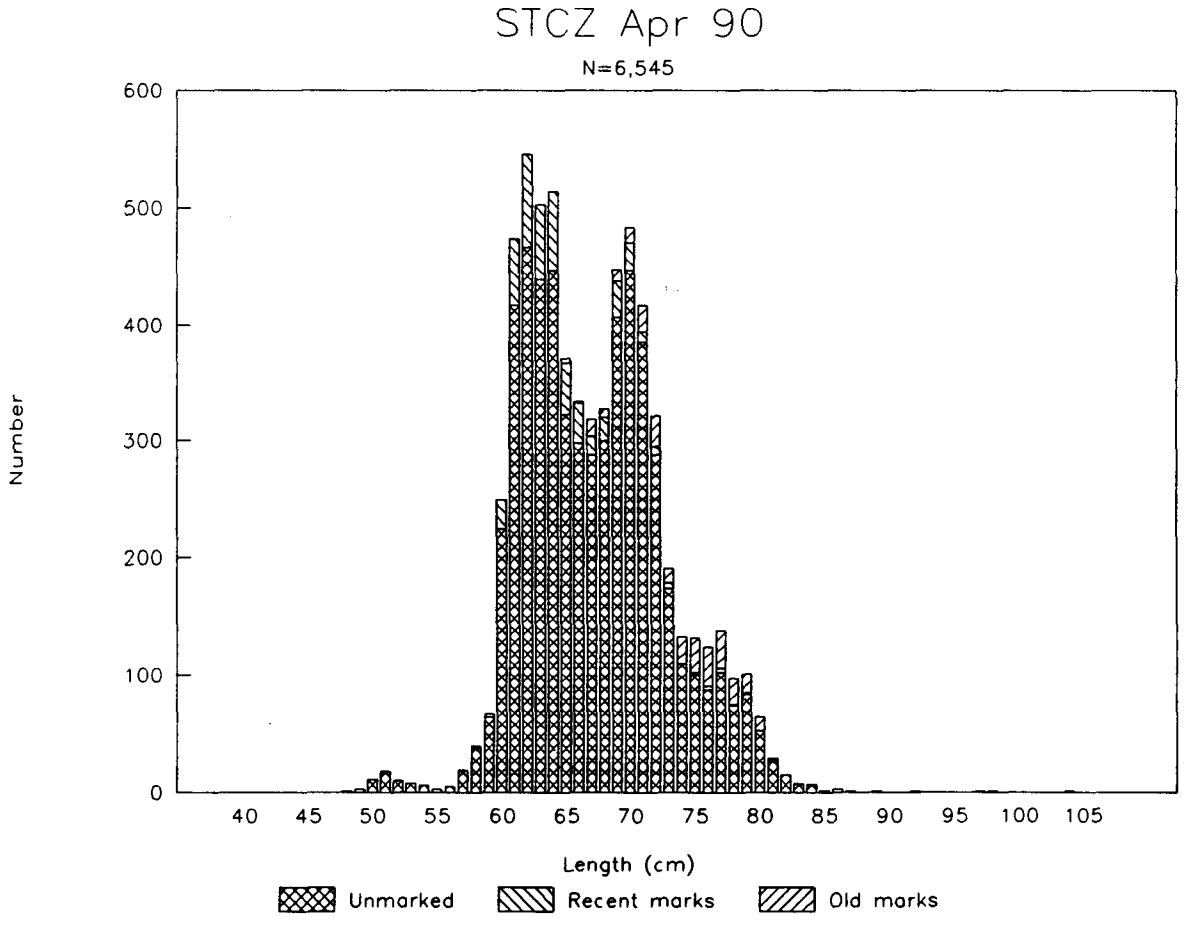
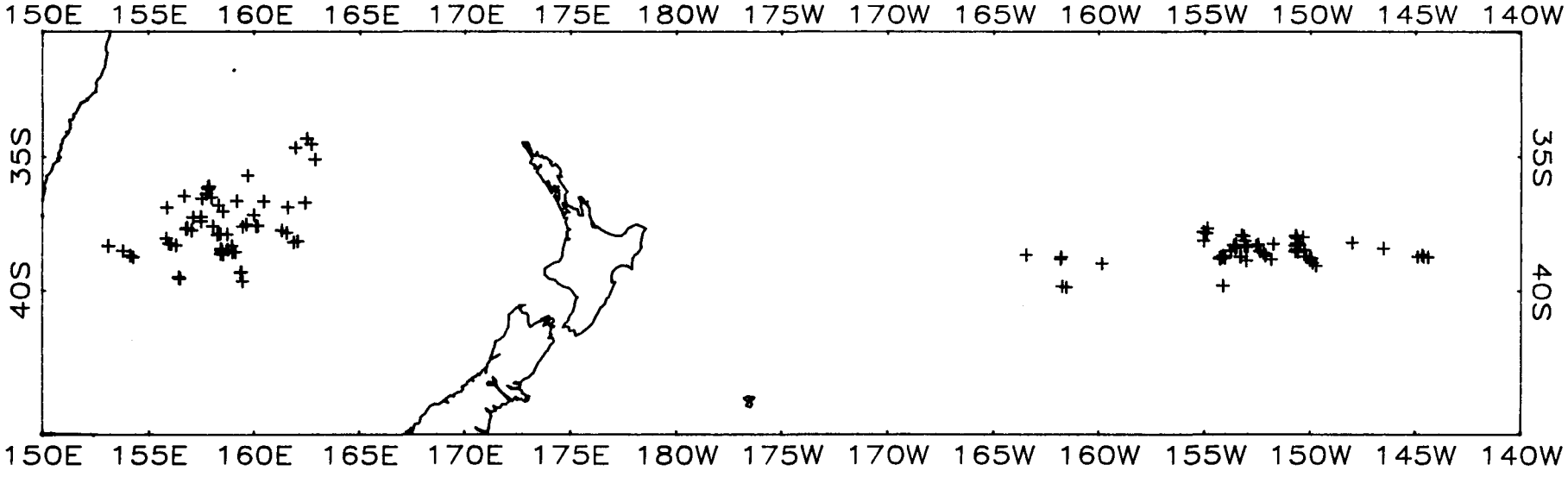

STCZ Apr 90
N=6,545
Number
600
500
400
300
200
100
0
40 45 50 55 60 65 70 75 80 85 90 95 100 105
Length (cm)
Unmarked
Recent marks
Old marks

Figure 8. Positions of driftnet-vessel sightings made during the 1989-90 season.


150E 155E 160E 165E 170E 175E 180W 175W 170W 165W 160W 155W 150W 145W 140W
35S
40S
150E 155E 160E 165E 170E 175E 180W 175W 170W 165W 160W 155W 150W 145W 140W
35S
40S