SOUTH PACIFIC ALBACORE OBSERVER PROGRAMME 1988-89

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Tuna and Billfish Assessment Programme
Technical Report No. 22

South Pacific Commission
Noumea, New Caledonia
1989

Original text: English

South Pacific Commission Cataloguing-in-publication data

Hampton, John
South Pacific albacore observer programme 1988-89 / John Hampton, Talbot Murray and Peter Sharples
(Technical report / Tuna and Billfish Assessment Programme ; no. 22)

1. Tuna fisheries -- Oceania -- Research 2. Albacore -- Research I. Murray, Talbot II. Sharples, Peter III. Tuna and Billfish Assessment Programme IV. New Zealand. Fisheries Research Centre V. Title

639.2758099072 AACR2
ISBN 982-203-130-0

Prepared for publication and printed at
South Pacific Commission Headquarters,
Noumea, New Caledonia, 1989

ABSTRACT

Two observer cruises were undertaken in the Subtropical Convergence Zone in the 1988-89 season, during which over 10,000 albacore were measured for fork length. Samples of these were also measured for girth, weighed and the presence of gillnet marks recorded. At least three age groups were visible in the length frequency data, the sizes of which agreed closely with other samples taken from the surface fisheries. Minor gillnet marks to the body were found on albacore of all sizes, but were most prevalent in fish of 60-75 cm. Minor marks to the head were most common in fish larger than 70 cm, while severe abrasions were found in fish of 60-65 cm. These observations are consistent with small albacore being able to pass easily through the gillnet meshes without injury, albacore of 60-75 cm being most effectively caught and only escaping with sometimes severe injury, and larger albacore not being able to pass completely through the meshes and often escaping with minimal injury to the head. Gillnet-marked albacore were found to be of lower condition than unmarked albacore on the basis of length, weight and girth measurements.

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

CONTENTS

LIST OF TABLES

LIST OF FIGURES

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 up to 2,000 t (Wetherall and Yong 1987; Wang *et al.* 1988).

A small troll fishery for albacore has operated for some years in coastal waters off the west coast 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 - April. Preliminary opinions were that this fishery could support a catch of about 10,000-15,000 t without substantially reducing longline catches.

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 gillnetters caught 1,000 t, and a fleet of Japanese gillnetters 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.

Gillnet fishing in the South Pacific also expanded dramatically in 1988-89. Prior to the exploratory Taiwanese fishing in 1987-88, the only known gillnet activity in the South Pacific has been that of a Japanese fleet, which has fished since at least 1983-84 mainly in the Tasman Sea. The exact number of gillnetters that fished in the South Pacific in 1988-89 is not known with certainty. However, unconfirmed reports suggest that at least 60 Taiwanese, 60 Japanese and 1 South Korean vessels fished. (The Japanese fleet fished mainly in the Tasman Sea. However, some vessels transferred to the STCZ east of New Zealand later in the season). Based on limited catch rate information, the minimum total gillnet catch for the 1988-89 season is estimated to be 25,000 t.

This rapid increase in catch, particularly by the gillnet fishery, has caused much concern throughout the South Pacific, particularly by Pacific Island countries involved in troll and longline fishing, or in the processing/transhipping of albacore catches. As a consequence of this concern, an informal 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 paucity of information available on the surface fishery for albacore, and in particular on the likely level of interaction among the troll, gillnet 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 reconnaissance and placement of observers on board commercial troll vessels.

1.2 Observer programme

In line with the recommendations of the November 1988 consultation, an observer programme was mounted for the 1988-89 season. The programme was coordinated by SPC and the New Zealand Ministry of Agriculture and Fisheries (MAF). Funding for the first observer cruise was provided by the United Nations Development Programme (UNDP), while the second cruise was undertaken voluntarily by Mr Sharples without funding. A third cruise by a second observer, funded by the FAO/UNDP Regional Fisheries Support Programme and New Zealand MAF, had to be aborted because of an unexpected finish to the season.

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

1.3 Other data collected during the 1988-89 season

Various other data were collected from the fisheries during 1988-89, including longline log book and catch length-frequency data in Pago Pago (NMFS), troll catch landings and length-frequency data in Pago Pago (NMFS), Papeete (EVAAM), Levuka (Pacific Fishing Co. and SPC) and New Zealand (MAF), and gillnet transhipment and length-frequency data in Noumea (SPC) and Wellington (MAF). Tagged albacore were also released by MAF and U.S. troll fishermen contracted to NMFS. These data will undergo independent analysis in due course.

2. OBJECTIVES OF THE OBSERVER PROGRAMME

The general objective of the observer programme was to document the fishing activities of troll and drift gillnet vessels along the STCZ in the South Pacific Ocean. The principal activities of the observer were to collect albacore size composition data, estimate by-catch composition in the surface fisheries, estimate the occurrence of net damaged albacore, ranked by severity, and generally to gather information on drift gillnet 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 gillnet marks and ranking their severity.
(c) To observe gillnet 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, and to document characteristics of vessels and gillnet gear in the vicinity of trolling operations, if possible with photographic records.
(d) To record observations on the behaviour of albacore schools and collect oceanographic data where feasible, and to carefully record recapture details of any tagged fish.

3. OPERATIONAL SUMMARY

The observer was offered berths aboard albacore troll vessels from New Zealand and the U.S. on an opportunistic basis. The programme began upon departure from Nelson, New Zealand aboard the M.F.V. *Daniel Solander* on 26 December, 1988 and finished on 30 April, 1989 with his arrival in Pago Pago, American Samoa aboard the F.V. *Barbara H.* The observer was absent from the fishing grounds for 40 days in mid-season from 11 February to 22 March 1989. The programme can therefore be considered to comprise an early-season cruise (M.F.V.s *Daniel Solander* and *Solander II*) and a late season cruise (F.V. *Barbara H*), hereafter referred to as Cruise 1 and Cruise 2, respectively. Apart from the mid-season break in the observer programme, good coverage of the season was obtained, since work began on one of the first boats to start fishing and finished on one of the last boats to leave the fishing grounds at the end of the season. A total of 108 days was spent at sea, 71 of which were spent fishing. The area of activity coincided with the areas of troll and drift gillnet operations, ranging from approximately 36°20'S to 39°00'S and from 168°10'W to 136°10'W. Plots of the cruise tracks, along with positions of gillnet vessel sightings, are shown in Figure 1.

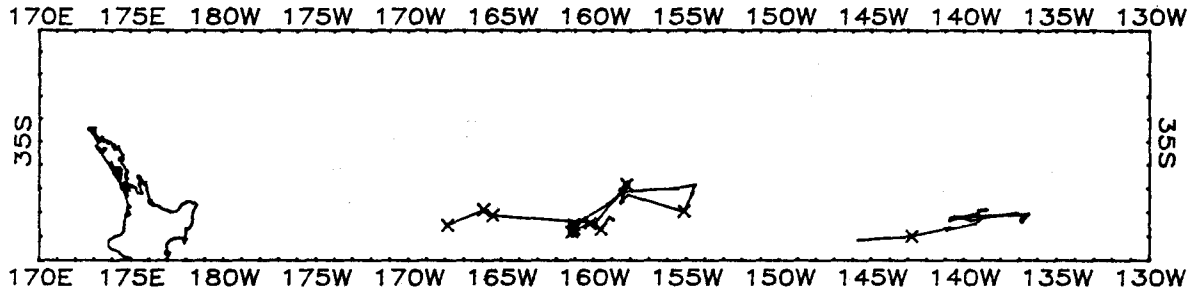

Figure 1: Cruise tracks of the 1988-89 South Pacific albacore observer programme. (Cruise 1 is the more westerly of the two. Positions of gillnet vessel sightings are marked by X.)

3.1 Vessels sampled and visited at sea

Due to initial uncertainty by the troll boat skippers as to the role of an observer on board their vessels, the opportunity to collect data was limited to relatively few vessels. The vessels that were visited or from which data were collected were as follows:

M.F.V.*Daniel Solander**	26 December - 16 January and 19 January - 10 February
F.V. *Nightwind*	A visit on 11 January
M.F.V. *Solander II**	16 - 19 January
F.V. *Royal Dawn*	A visit on 10 February
F.V. *Bald Eagle*	For transit to Pago Pago 10 - 20 February
F.V. *Barbara H**	11 March - 30 April

* albacore sampling on these vessels only

3.2 Troll vessel characteristics and fishing strategies

M.F.V. *Daniel Solander*: Radio Call Sign ZMCH

Length	53.6 metres
Breadth	8.5 metres
Gross tonnage	345
Freezer hold capacity	300 tonnes
Owner	Solander Fisheries
Master	John Bennett
Crew no.	10
Nationality	New Zealand

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*). It was converted for the South Pacific offshore albacore fishery in late 1988 with the addition of an adjustable stern platform that could be lowered from the main deck level to any height above the water, thus enabling fish to 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 fronts, using a sea surface temperature recorder. Satellite sea surface temperature charts were also available on a regular basis. After locating a front the vessel would then hunt in the vicinity of the front for sub-surface fish schools, using a depth sounder. The *Daniel Solander* did not have sonar. 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 fish. 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.

M.F.V. *Solander II*: Radio Call Sign ZMFH

Length	34.0 metres
Breadth	5.8 metres
Gross tonnage	79
Freezer hold capacity	64 tonnes
Owner	Solander Fisheries
Master	Carl Fry
Crew no.	8
Nationality	New Zealand

Originally built in Japan as a combination salmon gillnet and squid-jig vessel, the *Solander II* has regularly been used for squid jigging and albacore trolling in New Zealand domestic fisheries. More recently it has been used in the development of longlining for southern bluefin tuna in winter months. The *Solander II* was equipped for the offshore albacore fishery with two outriggers. It pulled up to 19 lines, with 4-5 from the stern and 6-7 from each outrigger.

All fish were pulled by hand. Fish had pectoral fins removed, but were not spiked when landed. Fish were blast frozen and were periodically transhipped, after freezing, to the *Daniel Solander*'s larger freezer hold.

The fishing strategy was the same as on board the *Daniel Solander*, with the exception that the *Solander II* was equipped with sonar. Sonar enabled the *Solander II* to stay circling on a school of fish once it was located and increased the effective search radius of the vessel.

F.V. *Barbara H*: Radio Call Sign WYU9637

Length	23.7 metres
Breadth	7.4 metres
Gross tonnage	?
Freezer hold capacity	84 tonnes
Owner	Art Haworth
Master	David Haworth
Crew no.	4
Nationality	U.S.

Designed and built as an albacore troll-boat, the *Barbara H* has been modified as a swordfish gillnet boat for the North Pacific fishery. The *Barbara H* did not carry gillnet gear in the South

Pacific and fished only by trolling, using up to 15 lines with up to 3 from the stern and 5-6 from each outrigger. Hydraulic gurdies were used to haul outrigger lines, with one man working each side. The stern lines were pulled by hand. Fish were frozen whole under a brine spray.

The fishing strategy was to search for temperature fronts and to use a combination of depth sounder and sonar to hunt for and stay with fish schools. During the period the observer was on board the *Barbara H*, the satellite sea surface temperature charts, which were available to the vessel earlier in the season, could not be received.

3.3 Sampling procedures for length, girth and weight

Generally an attempt was made to measure all fish caught. However, this was not feasible during periods of high catch rates. 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 a further 25 albacore were subsequently taken. All fish sampled after 7 January were graded for net 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 nearest whole centimetre. The fork lengths of albacore measured during Cruise 1 were 42-103 cm. However, after the first few days, all fish smaller than about 55 cm were released. Fish this small were rare, and usually fewer than 2 per day were caught. Occasionally these small albacore were damaged during hauling and would be kept for the galley. These damaged fish were measured and included in the sample. Albacore caught during Cruise 2 were larger, and hence all fish landed were kept.

Girth measurements were made by passing a plastic measuring tape around the fish beneath the pectoral fins, 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 during Cruise 1 (*Daniel Solander* and *Solander II*), when pectoral fins were removed after fish were landed. During Cruise 2 (*Barbara H*), when 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 method used on Cruise 1. Girth measurements were rounded down to the nearest 0.5 cm.

Albacore were weighed during Cruise 1 with a 15 kg hand-held beam balance, suspended from an overhang. Weight was recorded to the nearest 0.1 kg. Albacore were not weighed during Cruise 2.

3.4 Scoring of gillnet damage

Prior to 7 January, over 2,000 albacore were examined and measured. Gillnet damage scores were not kept for these fish. This pre-scoring period was used to ensure that the damage codes developed did not include damage that might have resulted from capture by trolling or damage incurred after landing. The pre-scoring period was prior to encounter with the gillnet fleet.

Codes were developed to describe various types of gillnet damage. These were later verified by pushing unmarked fish of different sizes through a piece of gillnet recovered at sea from a stray buoy. In this experiment, unmarked fish were dropped head first through the suspended net segment. Those large enough to be forced through the mesh all bore the characteristic longitudinal stripes of net marked fish, either on the trunk or the head, depending on fish size.

Gillnet mesh size obviously determines the size class(es) of tuna that are captured. The piece of gillnet recovered had a 20 cm stretch diagonal mesh, which was found to tightly encircle an albacore with a girth of 46-49 cm at a position just posterior to the gills. This girth is equivalent to a fork length of 65-75 cm, which coincides with the larger of two size classes sampled from gillnet vessels transhipping in Noumea during January - February (see section 4.2).

3.5 Gillnet damage codes

Early in the trip a scale of gillnet damage codes was established. Initially '0' to '3', the final scale was expanded to '4', with '0' representing undamaged fish. Albacore with damage types '1' and '4' were at first all categorised under '1', indicating minor damage to fish (7-19 January only). It became apparent by 20 January that there was minor damage found in larger fish (type '4') that was distinct from the minor damage seen in small fish (type '1'); hence the introduction of the new category. For ease of data presentation, it is assumed that all albacore 68 cm and larger coded '1' during the period 7-19 January should actually be coded '4'. This is in agreement with the size of fish having minor damage of the two types observed after 19 January. Descriptions of the gillnet damage categories are as follows:

Category 0: Fish without gillnet damage.

Category 1: By far the majority of fish were scored with this grade. Usually the fish had multiple lateral stripes that appeared as slight skin discoloration spaced 5-10 mm apart. These stripes were continuous along the thickest part of the body, starting anywhere from just forward of the gill operculae to just forward of the largest girth measurement, and running to the equivalent girth measurement at the posterior part of the fish.

Category 2: Similarly to category '1', these fish also had a patch where skin and scales had been scraped away, leaving a raw area in the region of greatest girth. Typically this raw area was 2.5-5.0 cm wide and 5.0-10.0 cm in length and located 1.0-2.5 cm below the first dorsal fin on both sides of the fish. Accompanying damage to the second dorsal, anal and caudal fins was common. Occasionally, damage to the first dorsal and pectoral fins was also observed. A few category '2' fish had the scraped portion located dorsally across the first dorsal fin groove. This damage generally seemed a little more severe than typical type '2' damage. A few fish lacked the raw patches described above but the fish were scored as category '2' because of type '1' damage and badly damaged fins. Several fish recorded as type '1' appeared as if they might have had the more serious type '2' damage earlier, but this had now healed and was evident only as a slight discoloration of the skin.

Category 3: This was reserved for badly lacerated or bleeding fish damaged by the mesh cutting into the flesh. Albacore with this type of damage were not caught during either cruise.
Category 4: Prior to 20 January, fish with this damage type were scored as '1'. Category '4' was recognised as a distinct damage type only after the frequency of fish larger than 68 cm fork

length increased. Albacore with this damage type typically bore the longitudinal stripes and skin discoloration of type '1' fish. However, because the large girth of these fish prevented them going further into the mesh, the marks were restricted to the head and gill operculae. Type '4' marks began well forward of the operculae, usually stopping abruptly at or just beyond the operculae, but anterior to the pectoral fins. This type of damage was consistent with a fish swimming into a net until the mesh tightened around its head. Lateral banding appeared to result from large fish having been caught, struggled enough for the mesh to slip fractionally, then swimming into the mesh again. All previous damage categories appeared to result from fish passing through the mesh.

4. RESULTS AND OBSERVATIONS

4.1 Albacore catch, effort and CPUE

Albacore catch and effort data were collected early in the season aboard the *Daniel Solander* from 27 December 1988 to 9 February 1989 (Cruise 1) and at the end of the season aboard the *Barbara H* from 22 March to 17 April 1989 (Cruise 2). The only trolling by-catch on either vessel was skipjack tuna (*Katsuwonis pelamis*) which comprised a very small fraction of the total catch by number. Catch and effort are summarised in Table 1.

4.2 Length composition

The overall length composition of albacore measured during both cruises is shown in Figure 2. Three modes are apparent in the data: 57-58 cm, 67-68 cm and 77-78 cm. These modes appear to be the result of discrete spawnings, the periodicity of which is unclear at this time. Previous data suggest some variation in the positioning of modes, which could imply year-to-year variation in growth rate or time of spawning (or differences in sampling times). For example, clear modes in the 1987-88 U.S. troll catch were found at 62 and 72 cm (Majors and Coan 1989), which correspond to the troughs in Figure 2. This is in agreement with the sampling carried out in Papeete, where the two dominant modes (corresponding to the first two modes in Figure 2) are 2-3 cm smaller than in the previous year (Yen *et al.* 1989).

Length frequencies broken down by cruise and by the presence or absence of external marks produced by entanglement and escapement from gillnets are shown in Figure 3. There is little difference in the positioning of modes for the unmarked and marked albacore measured during each cruise. The modes show a progression of 1-3 cm from the first to the second cruise, which is probably due to growth (although geographical differences could also be present). The Cruise 2 length frequency agrees well with that presented by Yen *et al.* (1989) for the same period. There are, however, some differences in the size compositions of unmarked and marked fish. The first and third modes appear to be under-represented in the marked length frequencies, possibly indicating size selection effects of gillnets. This is discussed further in later sections.

Table 1: Catch and effort statistics collected on board albacore troll vessels

		Cruise 1	Cruise 2
Vessel		*Daniel Solander*	*Barbara H.*
Dates sampled		27 December - 9 February	22 March - 17 April
Areas sampled		40°56'-36°20'S 176°27'E-158°57'W	39°00'-37°54'S 145°53-136°06'W
Daily sea surface temperature	av.	17.7	18.5
	min.	15.7	17.5
	max.	19.0	19.5
Days fished		44	25
Hours fished per day	av.	15.3	12.0
	s.d.	1.2	2.0
Number of jigs fished	av.	20.9	10.4
	s.d.	1.6	3.0
No. of albacore landed per day	av.	215.0	107.0
	s.d.	247.1	106.9
No. of albacore per 100 hook hrs	av.	67.51	76.10
	s.d.	82.78	76.60

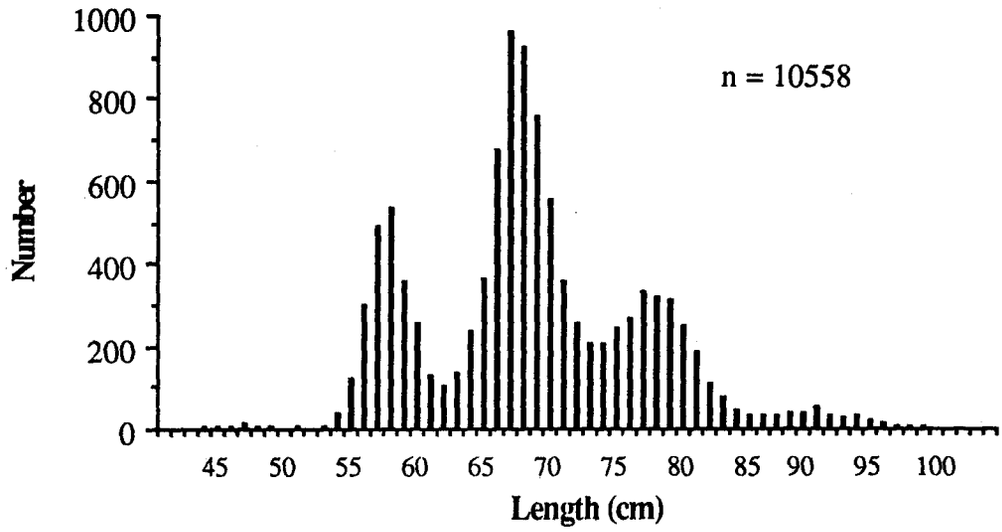

Figure 2: Length-frequency distribution of all albacore sampled during the observer programme

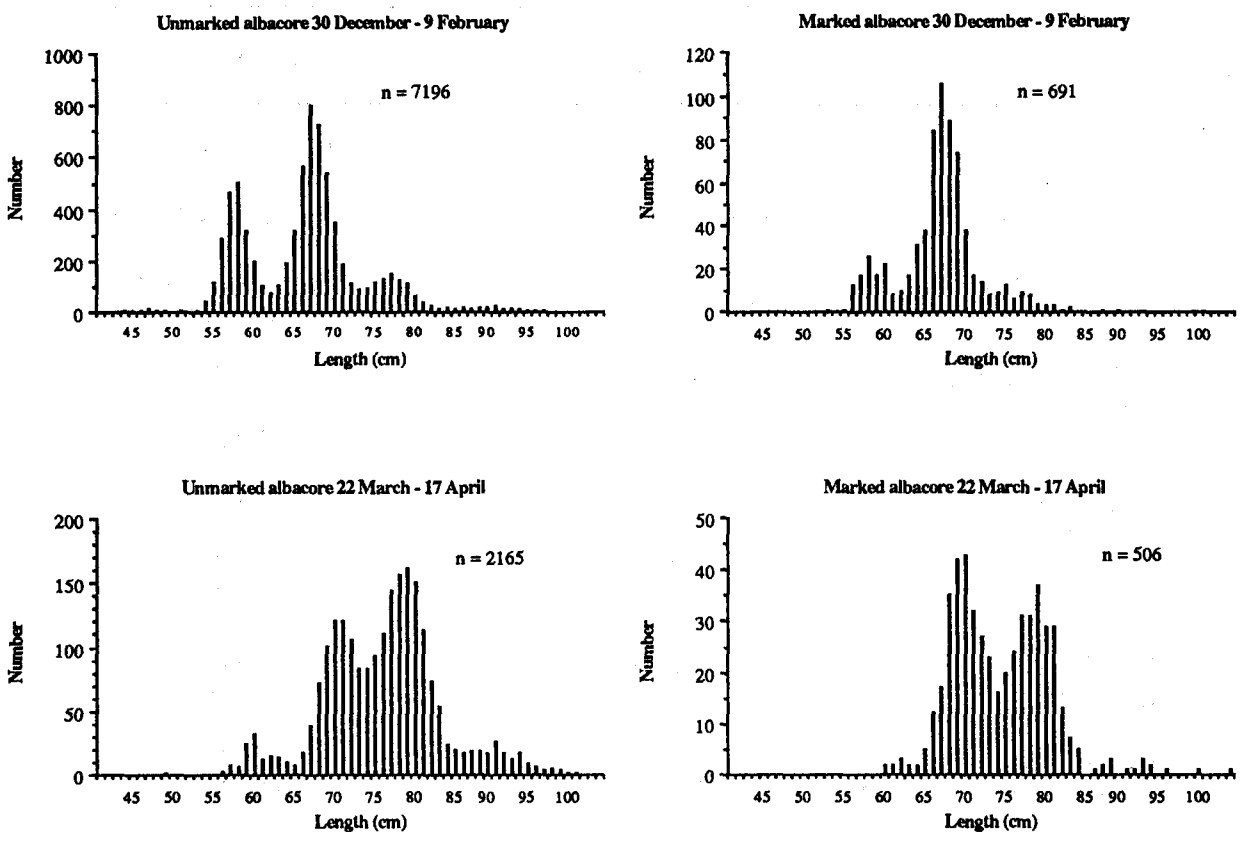

Figure 3: Length-frequency distributions of unmarked and gillnet-marked albacore sampled during Cruise 1 (30 December - 9 February) and Cruise 2 (22 March - 17 April)

The size composition of albacore sampled from Japanese gillnetters transhipping in Noumea is shown in Figure 4. These fish were caught exclusively in the Tasman Sea during December - January. The two prominent modes in these data are 2-3 cm larger than the corresponding modes in the data from the first observer cruise, indicating slight geographical variation in modal structure.

4.3 Incidence of gillnet-marked albacore

A record of the occurrence of gillnet-marked albacore was kept from 7 January. During the first cruise, 12.4 per cent of albacore sampled were marked by previous encounter(s) with gillnets. The percentage of marked albacore increased to 19.0 per cent during the second cruise. Claims of a higher incidence of marked fish in mid-season, when the observer was not on the grounds, could not be verified (claims of 40-50 per cent were common, with some reports as high as 90 per cent). The impression from interviews with some troll boat captains was that the reported period of increased incidence of net damage coincided with a period when troll and gillnet boats were fishing adjacent to each other. Gillnet marks were classified as being minor (head), minor (body) or severe. Most marks were minor during both cruises; however, a larger incidence of head marks was observed during Cruise 2 (Table 2).

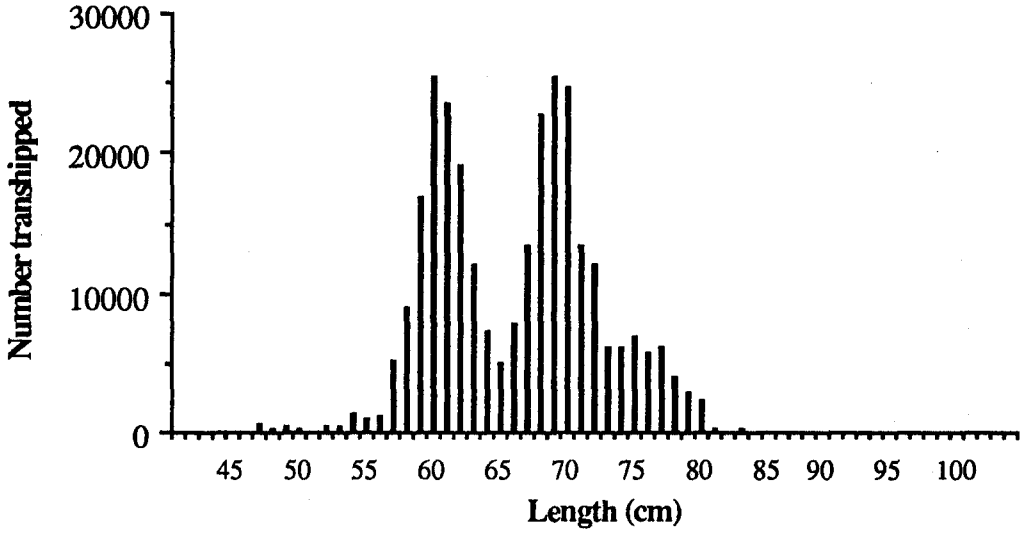

Figure 4: Length-frequency distribution of albacore sampled from Japanese gillnet vessels transhipping in Noumea, 12 January - 8 February

Table 2: Numbers of unmarked and marked albacore recorded during the observer programme (beginning 7 January 1989)

Unmarked	4878	(87.6)	2163	(81.0)	7041	(85.5)
Minor (head)	107	(1.9)	204	(7.6)	311	(3.8)
Minor (body)	496	(8.9)	297	(11.1)	793	(9.6)
Severe	88	(1.6)	5	(0.2)	93	(1.1)
Total marked	691	(12.4)	506	(19.0)	1197	(14.5)
Grand total	5569		2669		8238	

Parentheses contain percentages of each category within cruises

The category of gillnet damage was related to fish size, with minor damage to the head tending to be found in albacore larger than 68 cm while minor damage to the body was found mainly in albacore smaller than 75 cm (Figure 5). Severe damage was found mostly in albacore of 63-71 cm, which have a body size that tightly fits the standard 18-20 cm gillnet stretched mesh.

Relatively few albacore less than 60 cm were observed to be marked (Figure 6). During Cruise 1, occurrence of marked albacore (of all damage types) was highest for the 61-65 cm size class and fell for progressively larger size classes. A similar pattern was observed on the second cruise, although the most marked size class in this case was 66-70 cm.

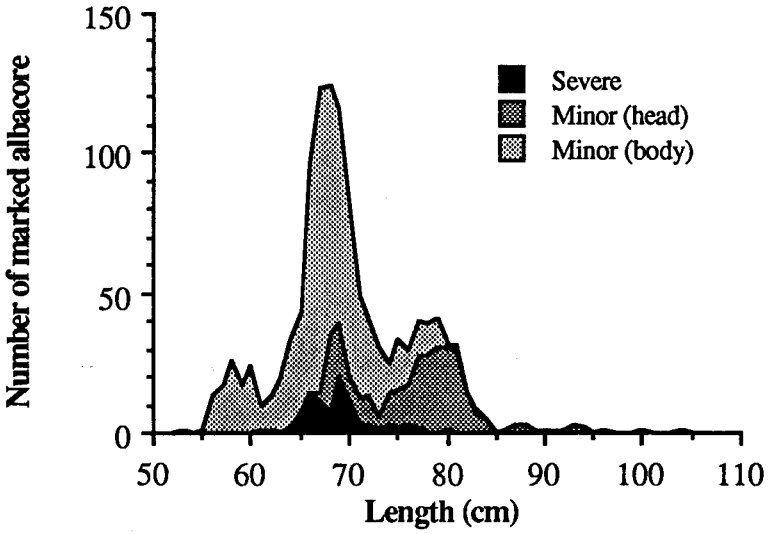

Figure 5: Length-frequency distribution of gillnet-marked albacore, by type of damage

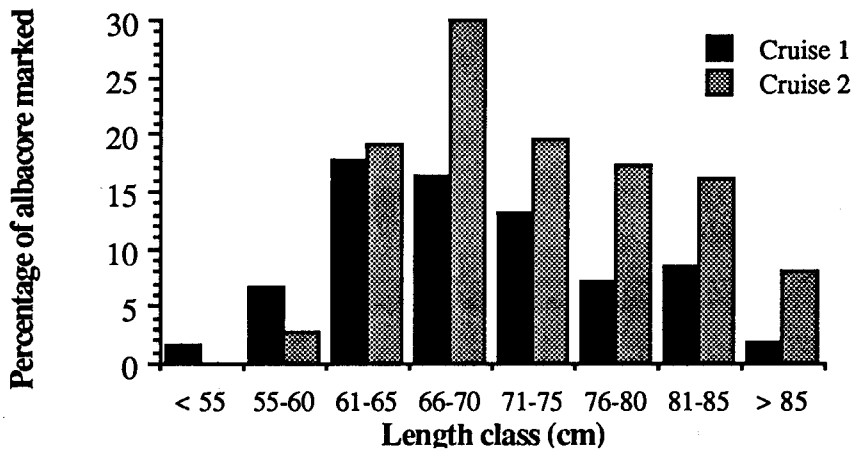

Figure 6: Percentage of gillnet-marked albacore sampled, by 5 cm length classes

The percentage of albacore with gillnet marks varied substantially from day to day. For days when at least 10 albacore were caught, the percentage ranged from less than 5 per cent to about 30 per cent (Figure 7).

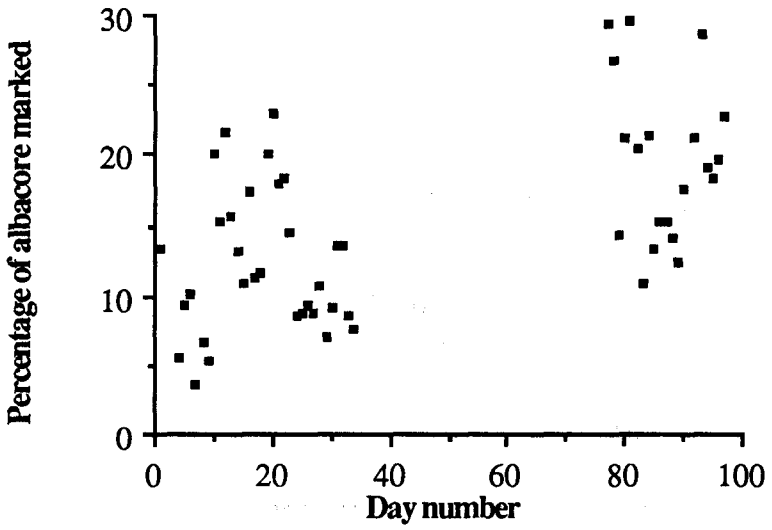

Figure 7: Percentage of gillnet-marked albacore caught on days when ten or more albacore were sampled (day 1 is 7 January)

Several months after the completion of this programme, observer work was conducted aboard a Japanese longliner from 4-28 June 1989 off the east coast of New Zealand's North Island (37°01'-40°31'S, 178°19'E-179°41'W) by New Zealand MAF (observer Peter Sharples). Of the 332 albacore sampled (49-108 cm fork length) 14 were found to be damaged by gillnets (all minor body damage). All damaged albacore were 64-74 cm, representing 25 per cent of fish sampled from this length class. The incidence of damage to longline caught albacore was thus similar to that for the same sized fish caught by trolling.

4.4 Albacore condition

Length-weight and length-girth measurements of marked and unmarked albacore were taken, to test for negative effects of gillnet encounter on albacore condition. These relationships for unmarked albacore sampled are shown in Figures 8 and 9, respectively.

The residuals, relative to the fitted curves, of the marked albacore provide a measure of the reduction in condition attributable to the trauma of gillnet encounter and the physical injury subsequently inflicted. The residuals of weight and girth both indicate that the condition of marked albacore was significantly lower than that of unmarked albacore (Table 3).

There was also a significant difference in condition, as indicated by the length-girth relationship, between Cruise 1 (155°-168°W) and cruise 2 (137°-146°W), with albacore caught during Cruise 2 being of significantly higher condition (Table 4).

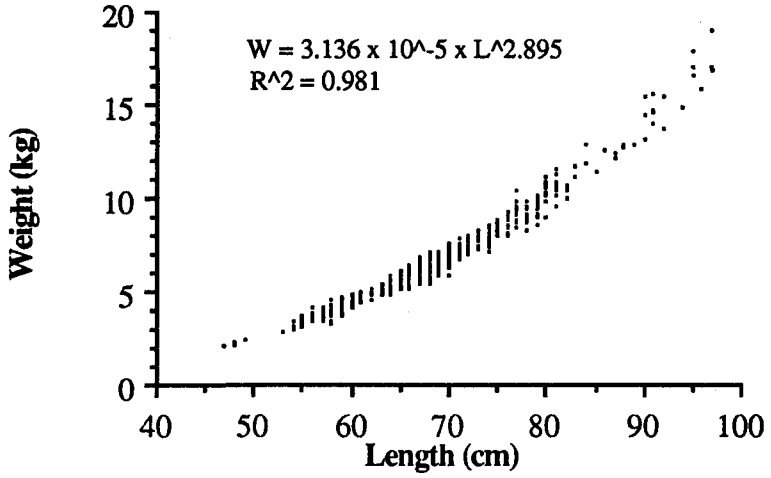

Figure 8: Length-weight observations of sampled albacore

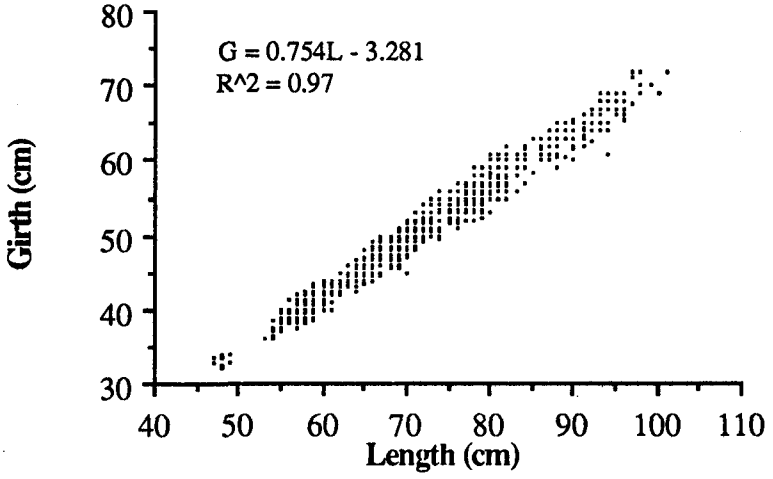

Figure 9: Length-girth observations of sampled albacore

Table 3: Condition comparisons of unmarked and gillnet-marked albacore based on length-weight and length-girth measurements

	Cruise 1			Cruise 2		
Length-weight		(P=0.0005)				
	n	Mean residual	s.d.			
Unmarked	1104	-0.001	0.046			
Marked	164	-0.013	0.045			
Length-girth		(P=0.0014)			(P=0.0016)	
	n	Mean residual	s.d.	n	Mean residual	s.d.
Unmarked	1104	-0.314	1.056	1586	0.262	1.160
Marked	164	-0.580	1.056	398	0.069	1.230

No length-weight measurements were taken on cruise 2

Table 4: Condition comparisons between cruises of unmarked albacore based on length-girth measurements

		(P=0.0001)	
	n	Mean residual	s.d.
Cruise 1	1104	-0.314	1.058
Cruise 2	1586	0.262	1.160

4.5 Gillnet vessel sightings

Reports during the 1987-88 albacore season suggested that gillnet vessels compete directly with troll fishermen for fishing space and interfere with troll vessel activities. Such direct interaction was not observed on either of the observer cruises. Troll vessel captains commented that gillnet vessels now seemed to be keeping away more, and suggested that they might be endeavouring to keep a low profile in order to avoid criticisms of interfering with trolling.

Despite a lack of direct interaction, gillnet vessels were sighted sporadically by the observer while on board the *Daniel Solander* and other troll vessels, and were regularly reported by other troll vessels. Gillnet vessels were usually seen while travelling to new fishing areas or while searching for fish, rather than while fishing. When possible, they were approached in order to identify the vessel name and registration numbers.

There were two periods when gillnet vessels were seen in concentrations. During the period 1–4 January, while the *Daniel Solander* was travelling east from New Zealand to join the the troll fleet at 158°W, eight gillnet vessels were seen between 38°00'S and 38°37'S from 166°00'W to 159°30'W. Nets that were seen ran from ESE to WNW. To avoid entanglement on one occasion, one net had to be skirted by the *Daniel Solander* for 11 miles.

During this same period the *Solander II* and *Day Star*, while steaming on a southerly but parallel course, reported encountering up to 17 gillnet vessels and nets, making night-time steaming very difficult. The *Day Star* inadvertently crossed one net, entangling the vessel by its propeller.

The second concentration was encountered on 27 January by the *Daniel Solander* while fishing at 38°20'S 161°05'W. Here, we successfully fished a small area with up to 7 gillnet vessels in the vicinity. During the next day several troll vessels joined the *Daniel Solander* while the gillnet vessels moved further south. The *Karen Kristie*, fishing at 39°S, 161°W, reported seeing the lights of 30 gillnet vessels on 29 January.

When not fishing in concentrations, gillnet vessels were usually seen in pairs. Identification could be obtained from only eight gillnet vessels and one carrier vessel on the grounds. Difficulty in identification was due to both distance between the observer and gillnet vessel and poor legibility of vessel markings. All vessels for which a home port could be established were from Taiwan (Kaoshung). Only five vessels were sighted during Cruise 2, and only one was close enough to identify.

Comments from various troll boat captains suggested that most of the gillnet vessel activity encountered by the troll fleet this season was during the period that the observer was off of the grounds (10 February - 22 March). More details of gillnet vessel sightings are provided in Appendices 1 and 2.

4.6 Marine mammal sightings

Marine mammals were not observed in the main area of troll fishing and were only encountered twice in the same areas as gillnet vessels. Several sightings of marine mammals were made while the observer was aboard the *Daniel Solander* travelling towards the albacore fishing grounds. The easternmost sighting was at approximately 38°S between 155-156°W while on board the *Solander II*. About 50 small dark dolphins were also sighted on the same day to the east of the gillnet vessel *No. 1 Fuh Kuo* (out of Kaoshung). All other sightings of marine mammals were prior to 7 January and west of 159°W.

5. MAJOR CONCLUSIONS

The major conclusions drawn from the analyses of data collected during the 1988-89 observer programme are as follows:

(a) Catch rates of albacore on vessels used during the observer programme were somewhat lower than overall catch rates by the troll fleet in the previous season. Analysis of log

book data for the troll fleet is required to confirm this observation. There was little evidence that catch rates declined when in the vicinity of gillnet vessels; however the data are limited in this respect.

(b) The size composition of albacore sampled during the observer programme showed a slightly different pattern from those of previous seasons, with the modal sizes of the two most prominent size groups being several cm smaller during the 1988-89 season. Slight differences in the positions of the modes were also apparent from data collected from Japanese gillnet vessels fishing in the Tasman Sea.

(c) The analysis of gillnet-marked albacore provides some information on the size selectivity of gillnets. There were few net-marked fish less than 60 cm fork length, despite substantial numbers of these fish being caught by trolling. Length-frequency data collected from Japanese gillnet vessels working in the Tasman Sea suggest that few fish less than about 58 cm are caught in gillnets. This would suggest that escapement of small albacore from gillnets is high, and occurs with little physical damage to the fish. The highest incidence of net-marked albacore was observed in albacore of 60-75 cm, which coincides with the size range of most of the albacore caught by gillnet. This would suggest that gillnets of the mesh size used in the South Pacific are most effective for albacore of this size. Substantial numbers still manage to escape, but are marked by the net, sometimes severely, in the process. On the other hand, albacore larger than 70 cm are less frequently caught by gillnet. The marks observed on fish of this size suggest that they are too large to enter the mesh fully, and are often able to escape before becoming entangled.

(d) Escapement from gillnets appears to have a statistically significant effect on the condition of albacore, as measured by the relationships between length and weight, and length and girth. This suggests that albacore are traumatised by gillnet encounter, and loss of condition results. While a significant reduction in condition was observed, the sample of marked albacore observed is biased in that each fish had recovered to the extent that it was able to resume feeding; hence the magnitude of the effect on condition was not particularly striking.

(e) The incidence of gillnet-marked albacore in troll catches, while not as high on the observer vessels as reported by fishermen, is nevertheless indicative of a high exploitation rate by the gillnet fleet of albacore in the STCZ. Because the observer vessels did not generally fish in the immediate vicinity of gillnetters, the incidence of marked albacore observed in the troll catches may be indicative of their incidence in the population as a whole in this area. This is supported by the observation of gillnet-marked albacore in Japanese longline catches near New Zealand, which suggests that the albacore population within the size range of about 60-75 cm is available to all three gear types over a large area. This means that almost immediate effects of large gillnet catches might be expected on catches of albacore of this size by both troll and longline gears.

(f) It might be possible to use the incidence of marked albacore in the troll catch as a crude tagging experiment. However, the rate of escapement from gillnets (analogous to release numbers) and drop-out mortality (analogous to tagging mortality) would need to be known, in addition to details of the gillnet and troll catches. If escapement is in fact low,

simple (and somewhat crude) calculations indicate that the exploitation rate by the gillnet fleet could approach 50 per cent. If escapement is high, lower exploitation rates are obtained.

ACKNOWLEDGEMENTS

This programme would not have been possible without the generous help offered by many individuals throughout the South Pacific region interested in the offshore troll fishery for albacore. The co-operation of Solander Fisheries Ltd, the help and friendship of numerous troll fishermen, and the assistance provided in American Samoa by both the Department of Marine and Wildlife Resources and Samoa Packing Company Ltd are gratefully acknowledged. Special thanks are extended to John Bennett, Charles Hufflett, Peter Ballantyne and the crew of the *Daniel Solander*, and to David Howarth and the crew of the *Barbara H* for their co-operation and assistance. Thanks are also due to Carl Fry of the *Solander II* and to Terrance Hornidge of the *Bald Eagle* and their crews for sharing their knowledge of the fishery and for their hospitality. Financial assistance for the programme was provided by the United Nations Development Programme.

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APPENDIX 1

MISCELLANEOUS OBSERVATIONS AND REPORTS

(1. Gillnet setting

On 4 January, *Daniel Solander* encountered a recently set drift gillnet, which we followed for 11 miles before reaching the end (we've no knowledge of how far the net extended in the opposite direction). The net was set downwind towards the NW; orange buoys (about 54 l in size) were spaced approximately 200 m apart, with small white headline floats (about 0.5 l in size) approximately every 2 m. A separately buoyed radio beacon was attached to about every 20th buoy. The net was at the surface and made a distinct navigation barrier. Although it was daylight at the time, no lights or radar reflectors could be seen on any of the buoys.

(2. Refueling of gillnet vessels

The following information was obtained from the purser rescued from the stricken tanker *Delima 120*, which sank, empty, after refueling several gillnet vessels in the South Pacific. The observer interviewed him in Pago Pago. He reported that his company had contracts to refuel most of 130 Taiwanese gillnet vessels in the South Pacific. He was upset that after refuelling a group of these vessels, the *Delima 120* had been denied assistance by these same vessels. The request had been made separately to 16 separate gillnet vessels that he said were close enough to give assistance. Although the *Delima 120* notified them that she was without steerage and rolling in very heavy seas, the vessels denied assistance. The crew of 16 was taken off by the U.S. troll boat F.V. *Royal Dawn*. The *Delima 120* sank within a few days.

The following addresses were obtained from the purser of the tanker *Delima 120*:

Golden Key Petroleum Pty Ltd (only South Pacific)
10, Anson Road #02-38
International Plaza
Singapore 0410
Directors: Mr. Albert Oon, Mr. Raymond Low, Mr. Seo Sang Il (Korean)
Telephone: 223-0010 or 223-0014
Telex No: 24458 Goldky
Fax No: 223-064

The parent company of Golden Key Petroleum Pty Ltd is:
King State Oil
Los Angeles, California
Cable: KINGOIL, L.A.

(3. Reports by troll vessel captains

F.V. *Pursuit* (Kyle van der Pool)

31 Jan. The vessel ran over a net in the fog and dark. The captain almost circled on the net, thinking it was a bite when it caught on his jigs. Fortunately he realised in time and proceeded on his way. This occurred at 38°12'S 160°06'W. Eight miles further North at about 38°04'S 160°06'W he came across a gillnet vessel setting a net. It was proving difficult to get around the net; however the gillnetter stopped setting, then recommenced quarter to half a mile further on. *Pursuit* was able to slip through the gap. *Pursuit* was within 30 metres of the stern of this vessel but the name was too obscured to be legible, despite the close proximity. The net was being set NE to SW.

F.V. *Pacific Warwind*

27 Jan. Reported picking up a bundle of net that contained the remains of 1 porpoise, 2 sharks and 6 albacore. The position was 37°47'S 155°W.

M.F.V. *Solander II* (Carl Fry)

10 Feb. Spotted 2 gillnet vessels south of him at 1900 hrs. His position 38°15'S 158°55'W. At 2005 hrs the gillnet vessels started setting in a WSW direction.

F.V. *Mercator*

27 Jan. Sighted *Champion No. 1* (CT6-0816) near 38°31'S 161°14'W. Took some video footage of her hauling and observed crew trying to gaff fish which had fallen from the net.

F.V. *Robin Ann*

3-7 Jan. Fishing at about 36°-37°S 158°W. Reported large numbers of net-marked fish.

27 Jan. Saw 3 gillnet vessels at about 36°15'S 163°31'W setting their nets at night.

10 Feb. Left the rest of the fleet at 38°05'S 158°52'W and heard reports that several gillnet vessels moved into that area almost immediately. Also mentioned a time when he was fishing in fog with another boat on radar that he presumed to be fishing with him. The fog lifted momentarily and there was a gillnet vessel about half a mile away laying her net. Could not recall the date.

F.V. *Karen Kristie*

29 Jan. Reported seeing the lights of 30 gillnet vessels at about 39°S 161°W. These were just to the south of the *Robin Ann, Judy S* and a few other troll vessels.

F.V. *Judy S*

28 Jan. Ran over 2 gillnets running parallel 1-2 miles apart at 38°30'S 161°28'W. Fortunately the vessel did not become entangled.

APPENDIX 2

GILLNET VESSEL SIGHTINGS

Vessel Sighted Date	Time	Vessel Activity	Name	Observer Vessel Position
30-12-88	1130	steaming	?	38°30'S, 167°55'W
01-01-89	1400	transhipping	*Yung Pang*	38°00'S, 166°02'W
01-01-89	1400	transhipping	*Chiu - Fu*	38°00'S, 166°02'W
03-01-89	1000	hauling	*Yung Pang*	38°18'S, 165°06'W
04-01-89	1610	steaming	?	38°37'S, 159°38'W
04-01-89	1610	steaming	?	38°37'S, 159°38'W
04-01-89	1840	setting	?	38°24'S, 160°08'W
04-01-89	1840	setting	*Jin Hong Shinn*	38°24'S, 160°08'W
16-01-89	1010	hauling	*No.1 Fuh Kuo*	37°57'S, 155°06'W
16-01-89	1010	hauling	?	37°57'S, 155°06'W
27-01-89	1430	none	*Champion No.1*	38°25'S, 161°10'W
27-01-89	1430	?	?	38°25'S, 161°10'W
27-01-89	1430	?	?	38°25'S, 161°10'W
27-01-89	1430	?	?	38°25'S, 161°10'W
27-01-89	1430	?	?	38°25'S, 161°10'W
27-01-89	1430	?	?	38°25'S, 161°10'W
27-01-89	1430	?	?	38°25'S, 161°10'W
27-01-89	1430	?	?	38°25'S, 161°10'W
27-01-89	1430	?	?	38°25'S, 161°10'W
30-01-89	1500	steaming	?	38°47'S, 161°05'W
30-01-89	1730	none	?	38°45'S, 161°03'W
30-01-89	1730	none	?	38°45'S, 161°03'W
04-02-89	0720	hauling	?	38°49'S, 161°19'W
04-02-89	1615	?	?	38°16'S, 159°55'W
04-02-89	1615	?	?	38°16'S, 159°55'W
05-02-89	0645	hauling	*Der Fu No.6*	38°49'S, 161°14'W
06-02-89	1930	transhipping	?	38°46'S, 159°39'W
23-03-89	1130	hauling	?	39°01'S, 142°49'W
23-03-89	1130	steaming	?	39°01'S, 142°49'W
23-03-89	1635	setting	?	38°54'S, 142°30'W
27-03-89	0745	hauling	*San Yu No.11*	38°58'S, 141°28'W
27-03-89	1115	steaming	?	38°53'S, 141°18'W

APPENDIX 3

OBSERVER'S ITINERARY

22 Dec. Observer arrived Wellington for final briefing and gearing up for departure on 26 December.

26 Dec. Flew to Nelson to board *Daniel Solander*. Vessel departed 1300 hrs, bound for fishing grounds and looking for fish along the way. Encountered mixed fishing success and several gillnet vessels during this portion of the trip, as did the *Solander II* travelling a similar route.

5 Jan. Reached the bulk of the troll-fishing fleet at about 1800 hr. Position: 36°52'S, 158° 12'W. Continued to fish with them.

11 Jan. Visited *Nightwind* for the morning for general discussion with Stan Davis, president of Western Fishboat Owners Association (WFOA).

12 Jan. *Daniel Solander* and the *Solander II* broke from the fleet after fishing slowed up and headed generally eastwards searching for fish, with little success. Travelled as far east as 154°W.

16 Jan. Boarded *Solander II* to travel with her as we travelled west to rejoin the fleet.

19 Jan. Rejoined *Daniel Solander.*

10 Feb. Visited *Royal Dawn* in the morning for discussion with Brent Bixler. Transhipped from *Daniel Solander* to *Bald Eagle* for passage to Pago Pago. Ran into a storm on the way north which claimed 2 other vessels and hindered our progress by at least 2 days.

20 Feb. Arrived in port Pago Pago. Spent week visiting the jig boat captains as they arrived in Pago Pago, and visiting the Starkist and Samoa Packing canneries to obtain catch data and discuss attitudes towards gillnet vessels.

27 Feb. Flew to Suva to deliver data to SPC scientist and to attend the Second Consultation on South Pacific Albacore Fisheries Interaction.

1 Mar. Helped prepare data for presentation at meeting.

2 Mar. Attended Second Consultation on South Pacific Albacore Fisheries Interaction.

3 Mar. Flew to Apia on route to Pago Pago to rejoin fishing fleet. Air Pacific mislaid baggage resulting in a one week delay while baggage was recovered and a new boat could be identified to carry observer back to the fishing grounds.

10 Mar. Flew Apia to Pago Pago to join *Barbara H.*

11 Mar. Sailed on *Barbara H* at 1300 hrs bound for fishing grounds.

22 Mar. Started fishing 39° 10'S, 145° 45'W.

24 Mar. Rejoined remaining fleet 38° 45'S 140° 38'W.

18 Apr. With two other remaining vessels, left fishing grounds to head to Pago Pago. 1988–89 South Pacific albacore fishing season now over.

30 Apr. Arrived Pago Pago.

1 May Flew from Pago Pago to Auckland (arrived 2 May 1989).

8 May Wellington for debriefing.