NEW ZEALAND MARINE DEPARTMENT

FISHERIES TECHNICAL REPORT
No. 80

THE ALBACORE (THUNNUS ALALUNGA (BONATERRE)) FISHERY IN NEW ZEALAND COMMERCIAL CATCHES AT NEW PLYMOUTH 1970

E. B. SLACK

WELLINGTON, NEW ZEALAND
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INTRODUCTION

The first wholly commercial fishing operation for albacore in New Zealand was conducted by Mr Dave Baker, owner operator of the 45 foot wooden fishing boat "Sea Bee" which he equipped for trolling by the method described by Scofield (1956) as used in California and the Pacific coast of North America. Slack (1969) has described the fishing operations conducted from the "Sea Bee" in the East Cape to Gisborne area over the period 20 January to 27 March 1968. The boat was based at Whitianga, some 200 miles from the fishing grounds and the operations consisted of five fishing tours of between four and ten days absence from the home port. Catch effort data were recorded in terms of fish caught per hundred hook hours and the catch rate varied from 40 to 130 fish per hundred hook hours throughout the five tours with an average for all trips of 80 albacore.

In these operations on the East Coast measurement of surface seawater temperatures indicated that albacore were seldom caught in water of surface temperature higher than 68°F. (20°C.). Although lures were towed during the transit of the Bay of Plenty on the way to or from the fishing grounds, no strikes of albacore were obtained offshore in the Bay where the temperature remained within the range 20.6-21.7°C. (69° - 71°F). The main catches of albacore were made along the boundary between blue oceanic water and green inshore water in the coastal region between East Cape and the Mahia Peninsula and particularly at the boundary of oceanic water with the run-off attributable to rivers. There was a distant temperature front at all these boundaries of from one to several degrees Farenheit. York (1969) has reported finding temperature fronts at the boundaries of river run-off and oceanic water in the same region and also obtained maximum catches at these fronts during his own trolling trials for albacore.

Fishing Operations from New Plymouth 1970

For personal reasons Mr Baker had moved to New Plymouth during 1969 and at the start of 1970 was fishing solely for crayfish, the outrigger poles for the tuna trolling gear having been left in Whitianga. A cooperative programme with the author was commenced in early February when feather jigs were towed in the immediate vicinity of New Plymouth in the area shown in the map, Figure 1. Initially only three lures were towed, two from the stern quarters and one from the mast. On 11 February whilst visiting craypots off Oakura, a few miles south of New Plymouth, strikes of albacore were obtained and in ten hours fishing with the three lines 384 albacore were landed. This was a total catch for the day almost fifty per cent higher than any made during the 1968 season off East Cape, whilst the catch rate was several times as great as the best on the East Coast grounds. On 12 February and 13 February "Sea Bee" returned to the same locality off Oakura and took 215 and 115 albacore respectively, again in ten hours fishing time towing three hooks. Subsequently two extra lines were towed by setting the boom of the mast out sideways in the manner of an outrigger pole and towing one line from near its outer end and another attached at about half way along its length. On the four days 14 February to 17 February inclusive, after rigging the boat in this way, albacore were encountered just seaward of the Sugar Loaf Islands at the entrance to New Plymouth Harbour, the catches for these days being 231, 178, 27 and 135 fish respectively. The total catch to this date, weighing 12,000 lb. was offloaded.

Fishing was continued on 18 February but the fish had now moved from the near vicinity of the harbour. "Sea Bee" sailed north in search of them and strikes were obtained some 10 to 20 miles out to sea eastwards of the Mokau River mouth, 200 albacore being taken in ten hours fishing time. After one day spent in port, fishing was resumed in the same area and over the next five days the daily catch rates were 61, 25, 250, 253, 230 and 25 respectively. The weight of the total of 1044 fish caught in this period was 13,155 lbs.

By this time a pattern of fishing operations had emerged which showed a significant difference to the East Cape operations in that the trips were day trips only, as compared to the four to ten day tours when fishing out of Whitianga. Sufficient fish were being caught within a close enough distance of port to show a profitable return on a day trip basis. In fact fishing effort had frequently to be restricted below the maximum possible on some days, because either the freezer capacity on the boat or receiving facilities ashore had been overloaded.

The pattern of daily trips was continued throughout March. In the period 1 March to 13 March inclusive, vulnerable concentrations of albacore were encountered off Waitara at a distance offshore varying from one or two to about fifteen miles. During this period, on 3 March, the boat had a record catch of 470 albacore for a single day, and on two other days, 2 and 12 March, the catches were 308 and 338 albacore respectively. The catch taken between 1 and 5 March amounting to 1198 fish was unloaded and weighed in as single batch totalling 14,280 lbs. weight. On 13 March the catch taken between that date and 7 March was weighed in at 10,100 lbs. yielded by a catch of 1082 albacore.

Between 14 and 20 March fishing had to be suspended as the receiving and storage facilities in New Plymouth had been saturated. Fishing recommenced on 21 March when the albacore were found to have moved somewhat to the north. Catches of 258 and 78 fish were made off Mokau on the 21st and 22nd respectively. On 23, 24 and 25 March the albacore had moved still further to the north and catches of 44, 245 and 161 fish respectively were made off Tirau Point. The total catch between 21 and 25 March was 786 albacore which weighed in at 8,100 lbs.

In the last few days of March the fishing area was invaded by schools of barracouta, Thyrsites atun, which proved a great nuisance to the fishermen by attacking the tuna lures in such numbers that the major part of the fishing time was spent in unhooking them. Albacore continued to be present and frequent strikes were obtained and the fish landed, but their access to the lures was so restricted by the barracouta that catches per hook hour ceased to be meaningful as an index of abundance. The

numbers of barracouta and their frequency of attacks upon the lures had increased to such an extent by the end of March that full time fishing for albacore was discontinued. The information on daily catches given above is presented visually in Fig. 2 in which the numbers of fish caught daily and areas of capture are overprinted on the map of the fishing area.

In Table 1 the data for the fishing season are presented on the basis of dividing the catch into the five batches which were weighed in at the shore facility. The number of fish landed in each batch and their total weight allows calculation of an average weight per fish, whilst a record of the number of hook hours required to catch each batch allows the catch rate per hundred hook hours to be derived.

TABLE 1

Date	Hook Hours	Albacore caught and weighed in	Average catch per 100 hook hours	Weight of batch (lbs.)	Average weight per fish
11-17 Feb.	225	1285	566	12,000	10.7
18-25 Feb.	345	1044	305	13,155	10.3
1-5 March	165	1198	726	14,280	11.9
7-13 March	215	1082	503	10,100	9.4
21-25 March	266	786	295	8,100	10.3

DISTRIBUTION OF VULNERABLE ALBACORE IN RELATION TO HYDROGRAPHIC CONDITIONS

In the fishing trials on the East Coast described by Slack (1969) and York (1969) the vulnerable concentrations of albacore were found almost exclusively at the well defined boundaries between blue oceanic and green inshore water, particularly that originating as river run-off water. There was a well marked drop in temperature across the boundary of blue and green water, and the largest catches were made where the discontinuity in temperature was most marked. Few of the catches on the East Coast were made in water of surface temperature higher than 68°F. (20°C.). In the fishing off the Taranaki coast major concentrations of albacore were also found at the boundary between blue oceanic water and river run-off water, particularly that arising from the Waitara River, but other small fishable schools of albacore were found scattered throughout the Taranaki Bight in blue water of surface temperature up to 72°F. (22.2°C.). The quantity of freshwater shed by the rivers was very much less than that of the East Coast rivers and the freshwater influence in lowering sea surface temperature was undetectable by unsophisticated mercury in glass thermometer at more than a mile or two offshore. Some readily striking small concentrations of albacore were found where there was no apparent local discontinuity in either water colour or temperature. Since between one third and one half of the season's catch here described was caught under such conditions, it became important to find an additional indicator of vulnerable albacore concentrations. Included in this requirement was a need to avoid feeding schools of kahawai *Arripis trutta* and barracouta, *Thyrsites atun* which, if encountered, attacked the lures, wasted much of the fishermen's time in unhooking these unwanted species and greatly accelerated the wear on the feather jigs.

Fish Sea-Bird Associations as an Indicator for Vulnerable Albacore Concentrations

Observations on the association between fish species and sea-bird species were made both from the boat and from aircraft in radio contact with the boat. One type of association detected

was that between large schools of kahawai or barracouta and dense flocks of white fronted terns, Sterna striata and, or, red billed gulls Larus scopulinus novaehollandiae. This type of school formation was readily seen from a considerable distance from the boat or from the air. When observed from vertically above the school from a height of 1100ft. the silver shapes of individual fish in these schools could clearly be seen and when the boat was directed into fishing contact with the schools by radio the fish could be seen to strike the lures; capture of the fish thus hooked confirmed the identity of fish in such schools as either kahawai or barracouta. Albacore were only rarely taken from the vicinity of such a school.

The other bird and fish association recorded in the operations presently described was between shearwaters of the genus Puffinus and albacore tuna. The shearwaters most commonly encountered were the flesh-footed shearwater, Puffinus carneipes, fluttering shearwater, Puffinus gavia gavia and Buller's shearwater, Puffinus bulleri. Although the author has seen P. gavia aggregated into large flocks in Tasman Bay during the winter, on the Taranaki tuna grounds in late summer the birds were usually dispersed into small groups of between 10 and 50 birds. P. carneipes and P. bulleri were usually encountered in much smaller groups of from 2 to 10 birds. When the boat was directed to fish amongst such small flocks, seen to be actively feeding, strikes of albacore were frequently obtained. It is a characteristic of the albacore associated with the shearwaters that the individual fish cannot be seen from the air until they strike a lure and are dragged along at or close to the surface. Unlike kahawai or barracouta a hooked albacore can dive quite deeply and even hooked fish may not be seen to be caught from the air until hauled over the side of the boat.

A complication of this neat distinction between albacore and kahawai/barracouta schools is that occasionally a mixed type of bird flock is encountered in which a few terns and red billed gulls are feeding along with small numbers of the shearwaters. From the vicinity of such a mixed feeding flock of gulls and shearwaters, trolling frequently produced a mixed catch of kahawai and albacore.

The fishermen roughly estimated that the proportion of kahawai to albacore taken from such schools was in approximately the same ratio as the number of gulls and terns to the shearwaters.

An interesting feature of the feeding patterns of the sea birds and predator fish was that in the fishing presently described the prey was identical for all species of fish and birds throughout the area, whether offshore or close inshore, whether in blue water or in green, and consisted exclusively of anchovies, Engraulis australis in the length range of 30 to 70 mm.

The association of the kahawai and barracouta with gulls and terns and albacore with shearwaters can be explained by the different feeding patterns of the various species concerned. Kahawai and barracouta hunt in large packs and feed ferociously, driving concentrations of anchovies right up to and even through the surface where they are picked up by the gulls and terns. The albacore encountered during the present operations do not school in dense packs and do not remain at the surface for any length of time. They appear to frequent a lower level, probably at the thermocline and make occasional forays to the surface but not in sufficient numbers to drive large numbers of anchovies before them. The anchovies on which they do feed are not therefore harried so closely to the surface, that they become vulnerable to the terns and gulls which cannot dive to take them. On the other hand the bait fish is driven close enough to the surface for it to be taken by the shearwaters which are able to both dive and swim under water in pursuit of prey. According to this theory the gannet, Sula serrator serrator should also be associated with schools of albacore, and this bird is occasionally seen diving amongst the shearwaters. The gannet can, however, dive quite deeply, and is not dependent on predator fish to drive its prey to the surface. Gannets can frequently be seen searching independently over a wide area and can detect and dive with great accuracy on individual fish. When gannets are very numerous in a district they will often fish in packs and are then attracted to schools of fish. York, (1971) has recorded the underwater noises made by diving gannets which can be heard over a distance of several miles. He has

suggested that tuna are attracted to the vicinity of a diving flock of gannets by this underwater noise. In this case, therefore, the tuna profit by the feeding activity of the gannet, whereas the gulls, terns and shearwaters profit by that of the tuna.

In dealing with the subject of bird and fish associations it is necessary to recognise that some sea-birds are attracted to and follow fishing boats in the expectation of scavenging garbage and fish offal. The best known of these is probably the black-backed gull Larus dominicanus. Although this bird has been observed by the author to scoop up anchovies from a surface school, its presence at the site of a fishing operation is usually due to the operation itself so that it is not an indicator of tuna concentrations.

Use of Aircraft in Support of Fishing Operations

The association of albacore with shearwaters allows detection of vulnerable concentrations of the tuna from the air whilst at the same time concentrations of kahawai and barracouta, which have a similar association with gulls and terns, can also be detected and avoided. During the 1970 season a light aircraft chartered from the Taranaki Aero Club was employed on several of the fishing days to "spot" and direct the "Sea Bee" on to albacore associated with feeding shearwaters. Insufficient flights were made for the results to be submitted to precise statistical analysis, but the observers and fishermen concluded, subjectively, that searching time to find the tuna could be reduced by one third to one half and daily catch rates increased proportionately when location of schools and direction of the boat was conducted from a "spotter" aircraft. The use of an aircraft was found to be particularly advantageous when a locality which had been yielding good catches for a number of consecutive days suddenly became barren of tuna, indicating that the fish had temporarily left that locality. In several such instances the tuna were readily located again in a locality some thirty to fifty miles distant from the previous area of good catches. Pilots of the aero-club who had flown on the fish spotting flights readily learnt to detect the biological indicators of tuna concentrations and willingly agreed to report such sightings

when flying along the coastline during ordinary business of the club. If the pattern of distribution of albacore off the Taranaki Coast is repeated in subsequent seasons and if a fleet of fishing boats engages in trolling, the employment of an aircraft for searching and directing operations will probably become an accepted part of the fishery.

Length and Age Composition of the Catch

Age determinationsby annual markings in scales and other structures has not been found a particularly satisfactory method for albacore. Clemens (1961) made age and growth studies based on data obtained by tagging experiments and after fitting his data to von Bertallanffy's growth equation concluded that in the North Pacific stock of albacore, fork lengths of 52, 65 and 76 cm. corresponded with fish of age groups I, II and III respectively.

Bell (1962) reported being able to detect annuli in the scales of the caudal peduncle of albacore taken on the Californian Coast and on the basis of aging by this method concluded that a mode at 57.3 cm. which appeared in the autumn Californian catch consisted of fish in their second year of life, whilst a mode at 65.7 was due to an age group in their third year of life. Since the fish are taken in the autumn the length at time of capture is greater than that at the time of deposition of the last annulus. By back calculation from the annulus he calculated that the modal length in the winter at time of formation of the first annulus would be 49.5 cm.

A number of scales were taken from the albacore in the present catch and examined for evidence of annular markings. Most of the scales were thick, blistered and impregnated with oil as described in the literature, Nose et al (1955) and Otsu and Ochida (1959). Scales taken from the caudal peduncle in the vicinity of the fifth dorsal finlet were free from oil and disfigurement and had clear circuli as reported by Bell (op. cit.) but no markings could be detected with any degree of consistency to suggest the presence of annual rings.

A table showing the length frequency distribution of five hundred of the albacore taken in the present fishing is given in Table 2 and the corresponding length frequency polygon is presented in Fig. 3. From this data there appears to be a modal length at about 51 cm., and another at about 61 cm. A few fish at about 35 cm. L.C.F. were also taken in the catch. Other fish were taken at a length up to 78 cm. but not in such proportions as to indicate other modal lengths.

It seems reasonable to suppose that the fish of modal length 51 cm. and 61 cm. in the New Zealand catch correspond with those of 52 cm. and 65 cm. reported by Clemens (op. cit.) and with those of 57.3 cm. and 65.7 cm. reported by Bell respectively, that is the two groups are in their second and third years of life. The fish at 35 cm. would be in their first year of growth. Yoshida and Otsu (1963) pointed out that a group of fish 35 cm. L.C.F. occasionally enter the North Pacific commercial catches, particularly in the Japanese live bait fishery and these authors also concluded that these were fish in their first year of growth.

Significance of Length Composition of Catch for the Fishery

There is an important relationship between the length and age of albacore and their vulnerability to various fishing methods in the northern hemisphere stock. Tagging programmes, (Clemens (op. cit.)), Otsu and Uchida (1963) established that the North Pacific albacore form a unit stock which is exploited in three regional fisheries; these are the U.S. West Coast troll and live bait fishery, the Japanese coastal live bait fishery and the Japanese mid-ocean long line fishery.

Recruitment into all these fisheries is from a common reproductive part of the population which spawns in sub-tropical waters under the influence of the North Equatorial Current, Ueyanagi (1957), Yabe et al (1958), Otsu and Uchida (1959). It is now generally accepted, following Suda (1958), that the young albacore remain in sub-tropical waters until about one year old and then migrate into temperate waters, featuring significantly in

the commercial catches from age 2 to age 8. A greater proportion of the older, larger fish is taken in the long line than in the live bait fishery which in turn yields more fish of older age groups than does the troll fishery. If a similar pattern of distribution of age classes obtains in the Southern Hemisphere we should expect to find that in addition to the summer troll fishery for the younger year classes there will be a winter offshore long line fishery for older fish.

The Japanese Long Line Fishery

Nishimura (1963) describes experiments in August 1960 in which fish detected by echo-sounder off north eastern New Zealand were shown, by capture, to be albacore of length 90 to 102 cm. and Suda, Koto, and Kume (1963) report that by 1960 a commercial long line fishery for albacore had been established between 170°E. and 170°W. and 30°S. and 40°S, that is in the waters offshore of North Island, New Zealand.

Records of the Research Division of the Fisheries Agency of Japan (1965 to 1970) show that this long line fishery for albacore continues. The main season seems to occur between April and June with smaller catches being made between July and September.

Cowper (1970) and pers. comm. has given details of a cruise during June-July/1965 by the "Fukushima Maru", a fisheries training vessel operated by the Onahama Fisheries High School of Fukushima Prefecture Japan in which about 1,100 albacore were taken by long line between 1770°E. and 1770°W. and between 35°S. and 40°S.

The length frequency composition of this catch of albacore is given in Table 3. Comparison with the length frequency of the catch taken in the inshore troll fishery, given in Table 2, shows the same difference in age groups between the two fisheries as in the northern hemisphere albacore fisheries. The troll fishery takes mainly juvenile fish in their second and third years of age; only about 9 per cent of the catch exceeded 65 cm. in length, whereas in the long line fishery over 90 per cent of the catch exceeded this length. 17 per cent were in the length range 60 - 69 cm., 40.5 per cent in the range 70 - 79 cm., 19.5 per cent in

the range 80 - 89 cm., 17.5 per cent in the range 90 - 99 cm., whilst the remaining 5.5 per cent were in a length range of 100 - 109 cm.

FUTURE OF THE FISHERY

Whilst tagging experiments on the albacore which visit our coastal waters have yet to show that members of the same stock are taken in the Japanese long line fishery, there seems little reason to doubt that such will prove to be the case. A management objective of taking the maximum sustainable yield is hardly likely to serve the New Zealand interest as there seems little doubt that a greater yield would be taken by allowing the juveniles taken by trolling at an average weight of about 10.5 lbs. to survive to approximately double this average weight by leaving them for capture in the long line fishery. It is assumed, on the basis of Australian experience, that New Zealand would find it difficult to develop an offshore long line fishery. Beare, Hynd and Lorrimer (1963) concluded on the basis of secio-economic and cost price relationship factors that there was a negligible feasability of Australian fishermen entering into such a fishery in competition with the Japanese.

A recent discovery by York (1971) that large albacore can be taken seasonally in New Zealand coastal waters by long lining, suggests that this method should be encouraged as both adding to the total New Zealand catch and increasing the efficiency of utilisation of the resource.

In the meantime the hooking rates reported in this paper for the inshore troll fishery substantiate the opinion expressed in the author's previous paper (op. cit.) that a viable troll fishery for albacore can be established in New Zealand. This view is shared by tuna canning interests in California, who have offered (Star-Kist Foods) (pers. comm.) to provide a market at predetermined agreed upon prices for next season's albacore catch, to provide trolling gear to those fishermen interested, and to pay for an air-spotting service during the albacore season to improve the catch rates and

productivity of the fishermen. The stage would therefore appear to be well set for a fully commercial feasability trial of the inshore albacore troll fishery in the coming season.

TABLE 2 ALBACORE CATCH - NEW PLYMOUTH 1970

LENGTH FREQUENCY TABLE

SAMPLE OF 500 FISH

L.C.F. CM.	No. of Fish
34.1 - 35.0	2
35.1 - 36.0	2
46.1 - 47.0	4
47.1 - 48.0	17
48.1 - 49.0	32
49.1 - 50.0	51
50.1 - 51.0	56
51.1 - 52.0	54
52.1 - 53.0	40
53.1 - 54.0	23
54.1 - 55.0	8
55.1 - 56.0	6
56.1 - 57.0	12
57.1 - 58.0	9
58.1 - 59.0	18
59.1 - 60.0	32
60.1 - 61.0	33
61.1 - 62.0	30
62.1 - 63.0	15
63.1 - 64.0	6
64.1 - 65.0	6
65.1 - 66.0	7
66.1 - 67.0	2
67.1 - 68.0	4
68.1 - 69.0	3
69.1 - 70.0	4
70.1 - 71.0	2
71.1 - 72.0	3
72.1 - 73.0	4
73.1 - 74.0	3
74.1 - 75.0	6
75.1 - 76.0	3
76.1 - 77.0	2
77.1 - 78.0	1

TABLE 3 ALBACORE CAUGHT BY FUKUSHIMA MARU

8 JUNE - 19 JULY 1965

L.C.F. cm.	No. of Fish
60	18
61	18
62	20
63	19
64	16
65	31
66	15
67	17
68	16
69	19
70	52
71	51
72	52
73	31
74	45
75	63
76	28
77	58
78	42
79	25
80	42
81	27
82	33
83	22
84	8
85	24
86	16
87	22
88	14
89	6
90	24
91	23
92	22
93	15
94	21
95	28
96	13
97	14
98	20
99	13
100	16
101	13
102	10
103	2
104	6
105	4
106	5
107	1
108	2
109	2

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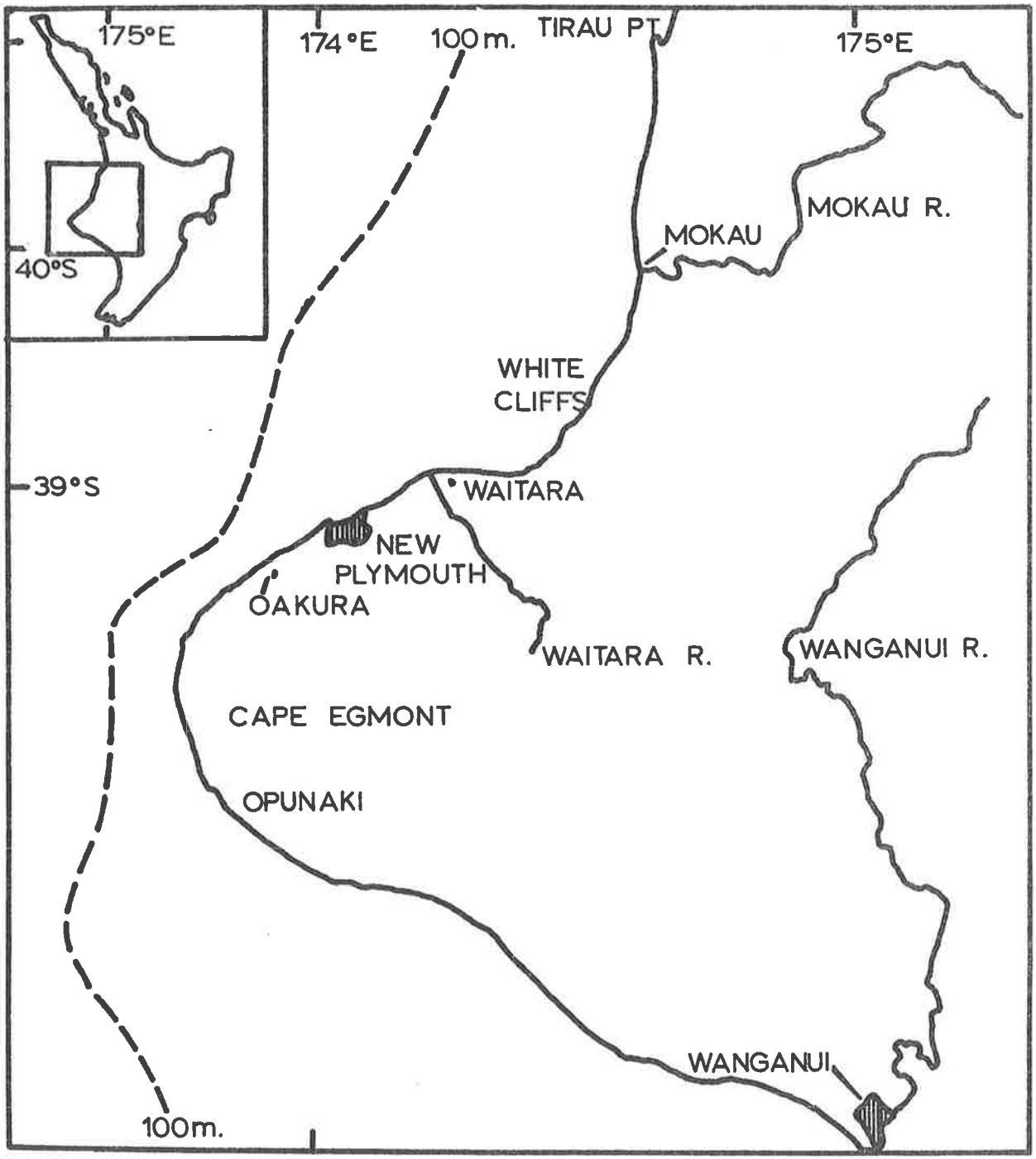


FIG. 1 New Plymouth and Cape Egmont area and the Taranaki Coastline northwards to Tirau Point off which fishing was conducted.

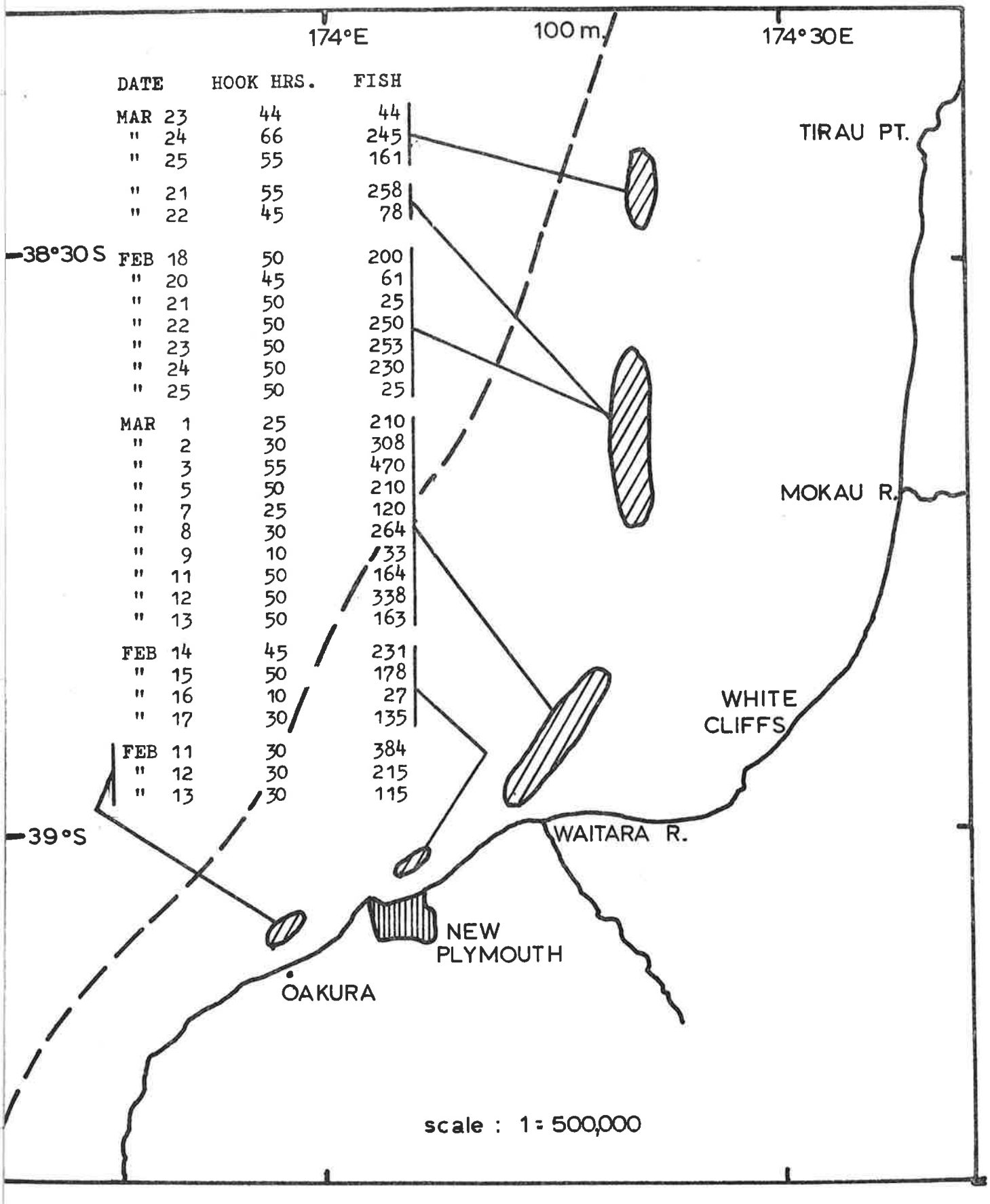


FIG. 2 Hook hours fished and location and quantity of daily catch of albacore taken by "Sea Bee" during February and March 1970. Catches were made in shaded areas.

FIG. 3. LENGTH FREQUENCY Histogram of 472 Albacore taken in the Taranaki Coastal troll Fishery 1970

(Length measured to Caudal Fork)

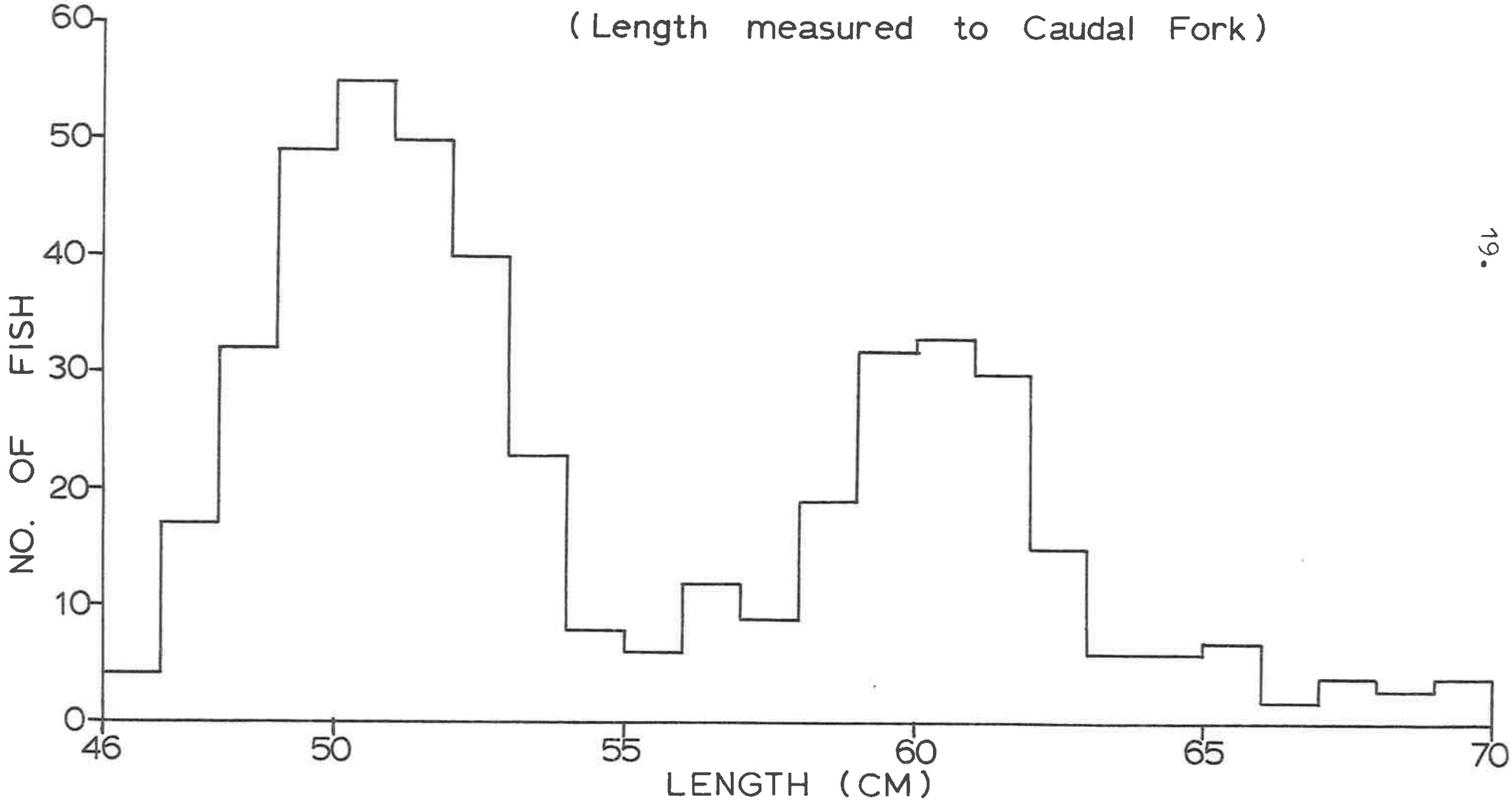
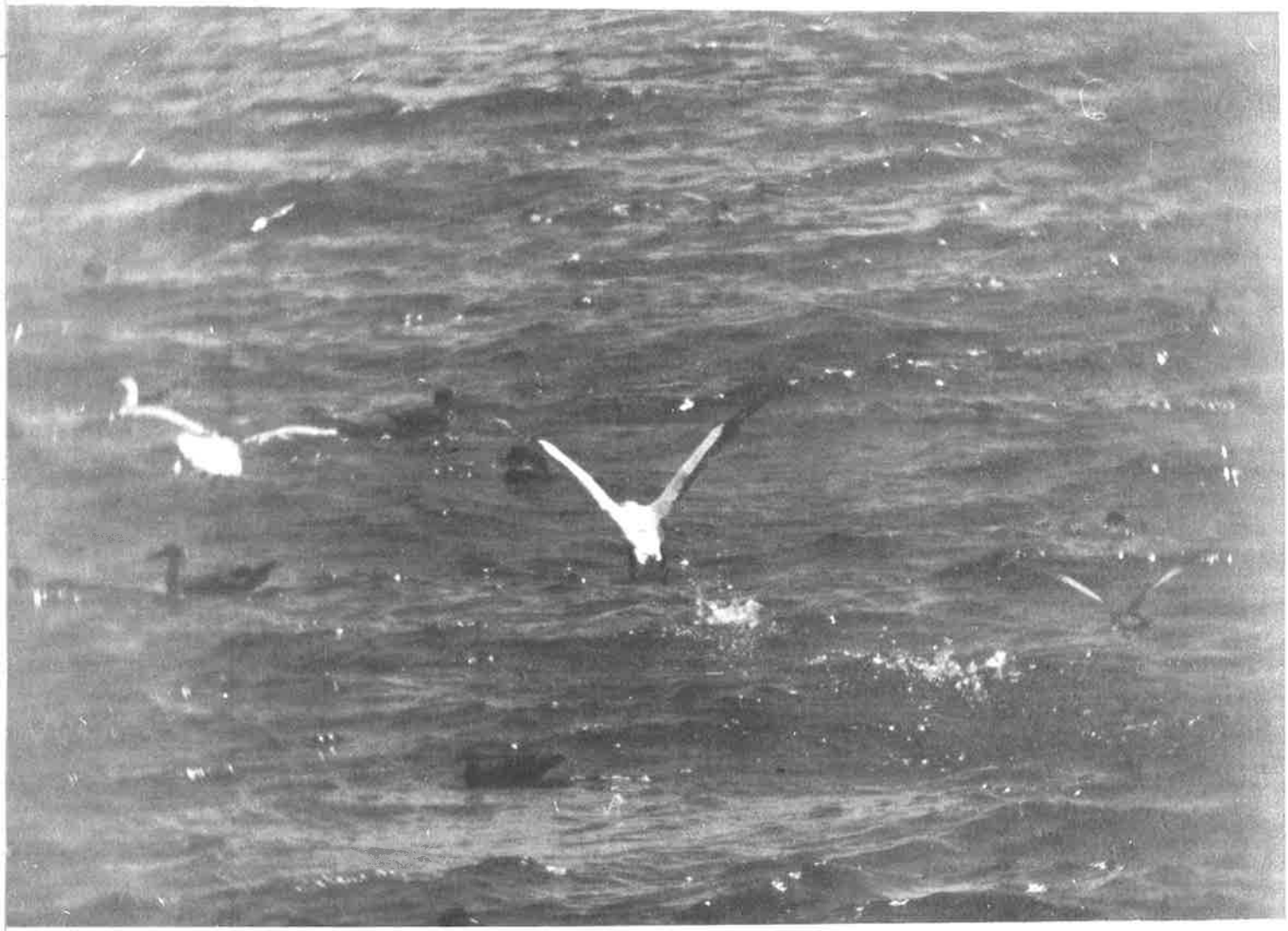
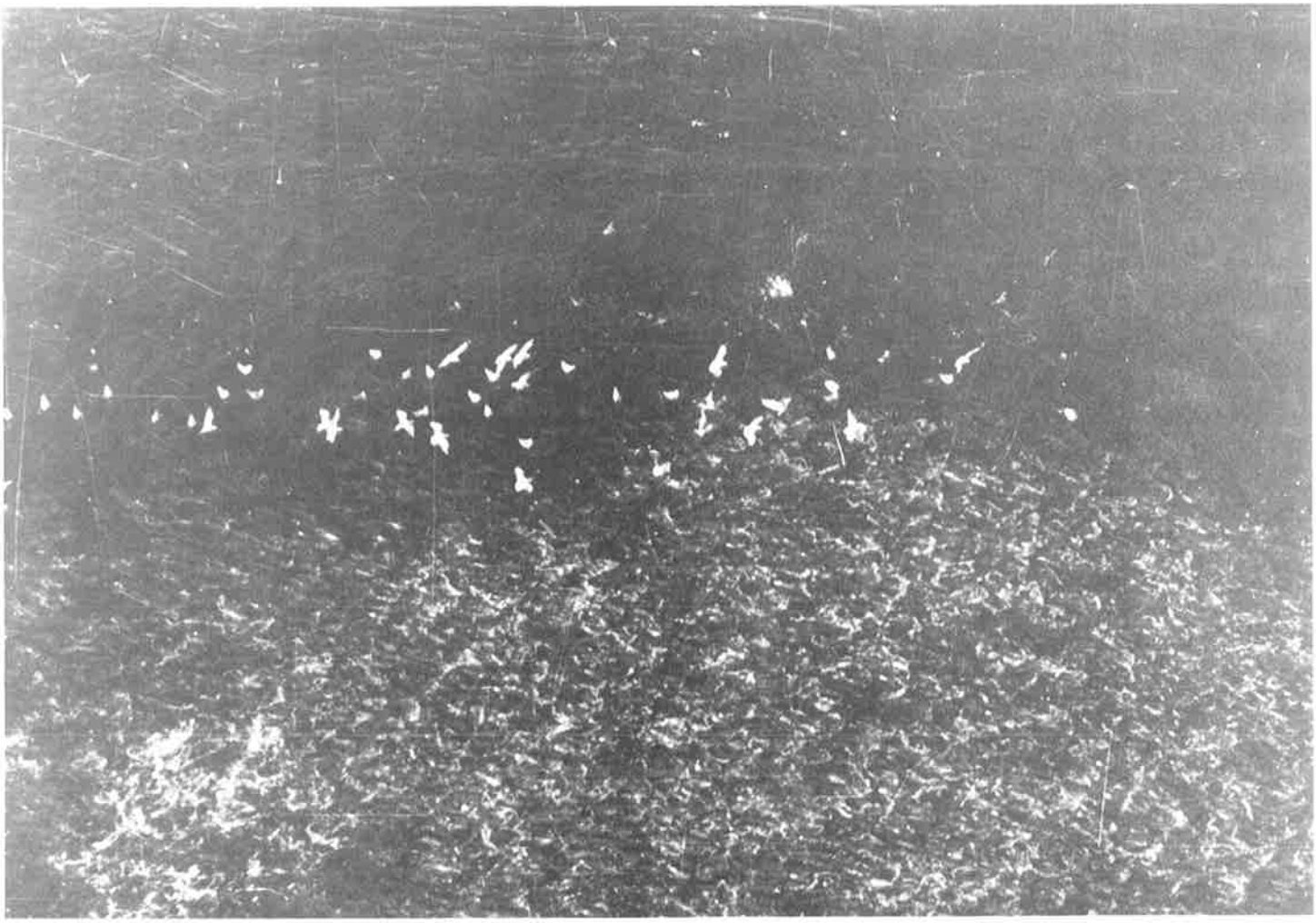


Fig. 4



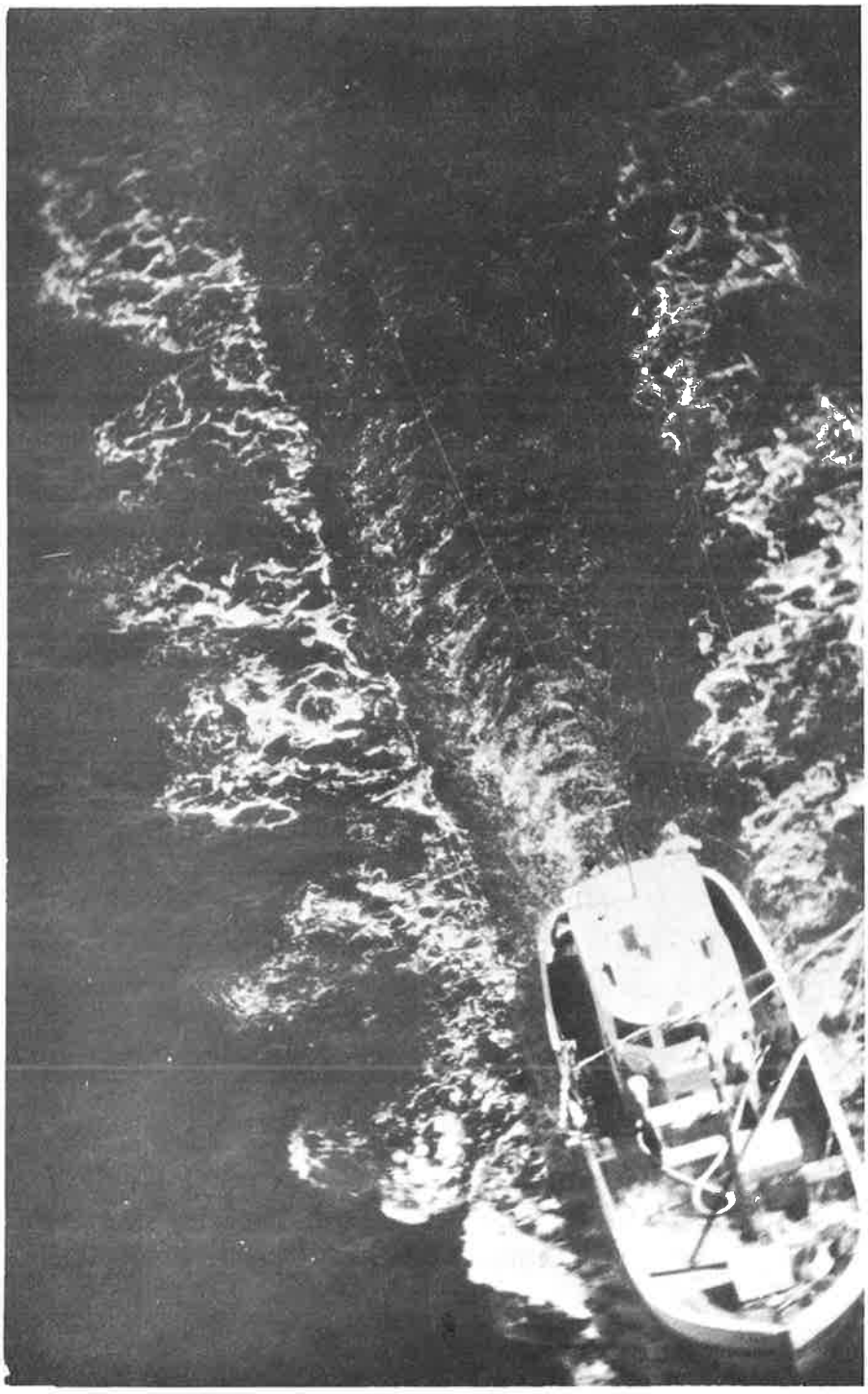
Ten albacore were taken by trolling from the vicinity of this aggregation of sea-birds. The bird flying on the right is a Buller's shearwater, Puffinus bulleri; that flying centre is a gannet, Sula serrator serrator; and that flying to the left of the picture is a black backed gull, Larus dominicanus. An additional black backed gull (adult) is sitting on the water by the left wing tip of the flying bird and a juvenile of the same species is sitting on the water beneath it. The remaining birds in the picture are flesh-footed shearwaters, Puffinus carneipes. All these birds, with the exception of the black backed gulls, which had been attracted to the boat itself, are indicators for the likely presence of albacore.

Fig. 5



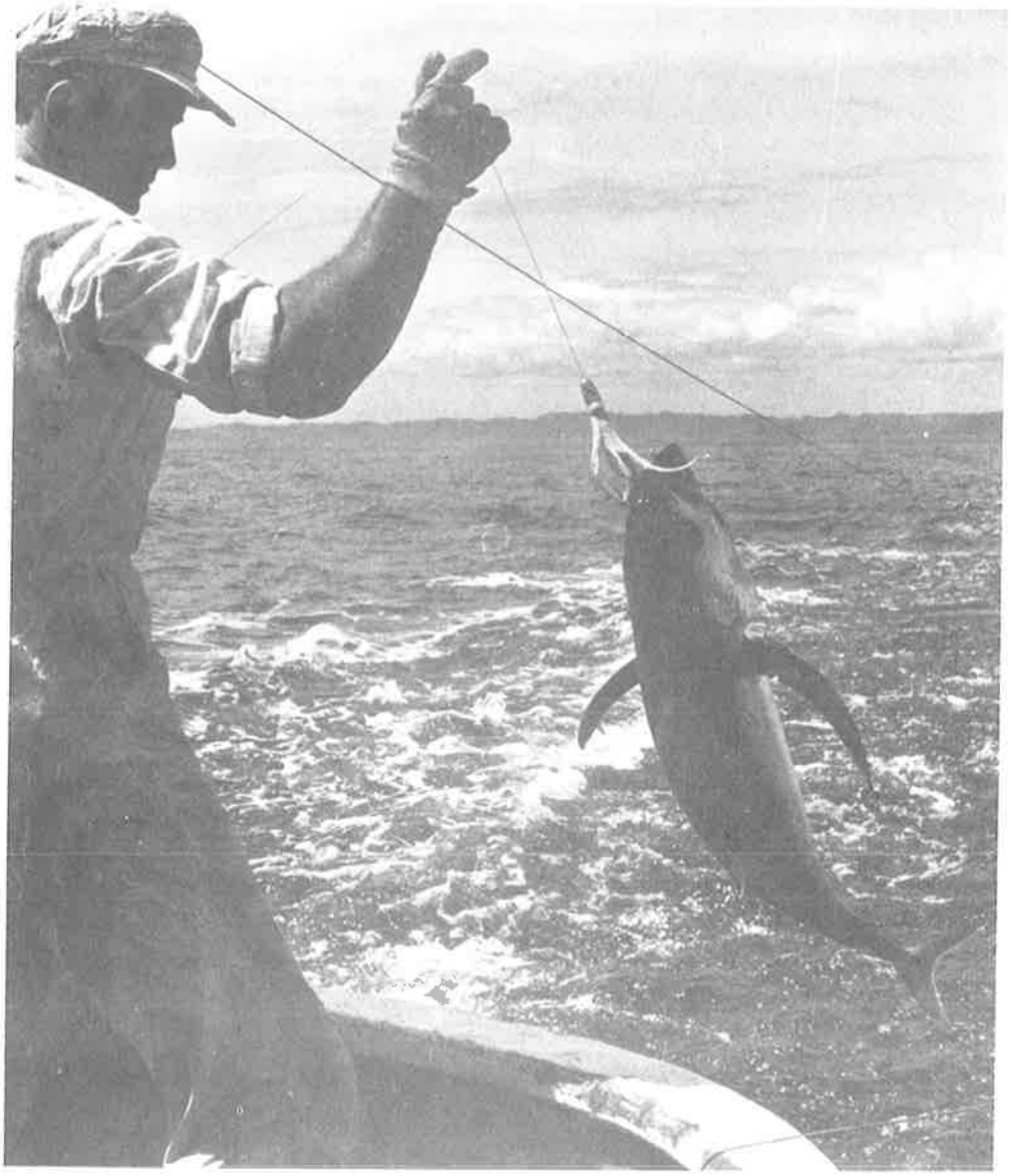
This type of school of individually visible fish with attendant red-billed gulls and terns, invariably yielded kahawai and barracouta rather than tuna in the fishing season off Taranaki reported in this paper.

Fig. 6



The "Sea Bee" trolling in productive albacore water. No tuna can be seen from the air though strikes were being obtained as this picture was taken.

Fig. 7



Mr T. Harvey, crewman on the "Sea Bee" hauls in one of a day's catch of 470 albacore.

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WELLINGTON, NEW ZEALAND
1972