NEW ZEALAND MARINE DEPARTMENT

FISHERIES TECHNICAL REPORT
No. 69

SURVEY OF PELAGIC FISH IN THE NELSON AREA (1968-1969) BY SPOTTER-PLANE

B. F. WEBB

WELLINGTON, NEW ZEALAND
1971

FISHERIES TECHNICAL REPORT

SURVEY OF PELAGIC FISH IN NELSON AREA (1968-1969) BY SPOTTER-PLANE

B. F. WEBB,
FISHERIES DIVISION,
MARINE DEPARTMENT,
WELLINGTON.

Fisheries technical report no. 69 (1971)

CONTENTS

SUMMARY

Results of an aerial spotting survey of pelagic fish in the Tasman Bay area are analysed and discussed. It was found the distribution and abundance of kahawai, horse mackerel, English mackerel and trevally shoals but not of pilchards, anchovies, or sprats changed seasonally. This migration pattern may be used to give a rough estimation of tonnages for pelagic fish. A bi-modal pattern of daily appearance of shoals occurred throughout the year.

INTRODUCTION

A tuna survey along the north-west coast of Australia (F.I.N.S., March 1968) showed that aircraft were approximately 30 times more efficient than fishing boats in locating fish shoals at the surface.

Most fish spotting surveys in New Zealand have been confined to reports within private companies, or to unpublished data on tuna distribution placed in the Marine Department files. These tuna reports were on flights and sightings made principally in the Bay of Plenty area. The only published survey has been that of Tunbridge (1969) who carried out a pilchard study from 14.9.64 to 10.10.64. In this report he discussed the results of a series of flights made from Karamea on the West Coast to Kaikoura on the East Coast.

The present survey took place between May 1968 to April 1969, the fish shoals being principally kahawai (Arripis trutta), horse mackerel (Trachurus declivis), English mackerel (Scomber australasicus), trevally (Caranx lutescens), pilchard (Sardinops neopilchardus), anchovy (Engraulis australis) and sprat (Maugeclupea antipodum). The fish shoals were identified as "kahawai" (kahawai, trevally, horse mackerel, English mackerel) and "pilchard" (pilchard, anchovy, sprat, yellow-eyed mullet) for two reasons:

(1) There occurred times when it was not possible to identify species owing to overcast or partly cloudy conditions.

(2) It was not possible to identify the "pilchard" shoals by species from the air.

The flight path and area covered was from Kahurangi Point (West Coast) to Cape Campbell (East Coast) with extensions to Paraparaumu (Figure 1). In Figure 1 Zones A-F were arbitrary divisions made for ease of data recording. For the analysis in this report the divisions were modified according to topography:

I = zone A plus the area of B above Farewell Spit; II = Tasman Bay including Golden Bay; III = the part of zone E above Marlborough Sounds; IV = area from the Brothers Island to Cape Campbell; V = zone F.

The aims of the project were:

(a) To locate and plot the distribution of fish shoals each week and month.

(b) To find out if there were seasonal changes in distribution.

(c) To identify, as far as possible, the fish species from the air.

(d) To find out if the fish shoals surfaced at different times of the day.

(e) To arrive at some general idea as to the quantity of fish within the area.

METHODS

The types of plane used were:

(a) Initially, from May until the end of October, a Cessna 172 high-winged, single engine, monoplane; and

(b) From the beginning of November, predominantly a Piper Apache twin-engine, low-wing monoplane.

The relative cruising speeds for these two planes were Cessna 100-110 m.p.h., Apache 130-140 m.p.h. Initial spotting and counting of fish shoals took place at altitudes ranging from 600-900 feet. Once the shoals were counted the identification of the shoals was made at 200-300 feet. It was noticed that below 150-200 feet the fish were disturbed by aircraft noise and dived into deeper water. The identification of the fish shoals was based on the colour of the fish as they moved in the water. The following colour pattern was used:

(1) Horse mackerel - reddish-brown colour of the shoals.

(2) Trevally - shoals greenish-yellow; when fish were feeding bellies showed as a silvery colour.

(3) Kahawai - shoals blue; did show a little white when feeding but difficult to separate from English mackerel from the air.

(4) English mackerel - similar to kahawai but smaller; no white when feeding.

(5) Pilchards - cannot see fish but shoals appeared as a ripple on the water.

Points to note from the pattern were, firstly, trevally were very mobile even in warm water and dived more readily when disturbed; secondly, the relative ease with which the various fish species were caught by the purse seine method was as follows: horse mackerel, kahawai and English mackerel, and most difficult trevally; thirdly, it was virtually impossible to distinguish kahawai and English mackerel from the air owing to the similarity in colour and shoaling behaviour.

Since the area covered was so large the flight schedule necessitated dividing the area into two sectors, western and eastern (refer Figure 1). These two sectors were either covered on the same day, or if incelement weather occurred, on separate days within the same week. On a few occasions the complete circuit was covered in one day, a flight of approximately six hours for the Cessna and four and a half hours for the Apache. Refuelling occurred at Paraparaumu Airport for the longer eastern sector.

During the flight data was recorded in table form giving species, grid reference, estimated tonnage, weather, and time of sighting, while the fish shoal numbers were marked on an accompanying map.

RESULTS

General

It was apparent from the beginning that the weather would play an important role in the fish spotting schedule. As was mentioned above a large part of the survey was interrupted by unsuitable weather conditions, the type of weather required being clear skies (or high cloud), wind no more than 15 knots, sea calm or with only a slight-moderate swell, and with no white-caps as these tended to be confused with and to mask the presence of fish shoals. Table 1 below indicates the number of fish spotting flights made per zone compared with the total.

The right-hand column showed the maximum number of complete flights possible. Since there were no flights in the first and last half weeks of October 1968, these were added to the September and November months respectively to make up the full weeks in these months. Similar interchanges occurred between July-August, December-January and March-April.

TABLE 1

Plane Flights made per Zone per Month

Month	Zones						Total Possible
	A	B	C	D	E	F	
May	4	4	4	4	4	4	4
June	1	1	1	2	2	1	4
July	2	4	4	5	5	4	5
August	3	4	4	4	4	2	4
September	4	5	5	4	4	3	5
October	0	3	3	3	2	2	3
November	2½	4½	4	5	4	4	5
December	2½	4	4	4	3½	3	4
January	5	5	5	5	5	5	5
February	3	3	3	3	2½	2	4
March	4	4	4	3	3	3	4
April	3	3	3	4	2	2	5
	34	44½	44	46	41	35	52

Two main points arise from this table. Firstly, although all areas were to some extent affected by inclement weather, June 1968 proved to be the only month where survey flights were seriously curtailed. This was in keeping with the mid-winter weather of the area where 30-50% of the wind direction was from the north-west to north sector and 30-35% from the south to south-west sector, and where 30-40% of the wave heights ranged from 5-20 feet. Secondly, the total flight figures showed that zones A and F were the worst affected by the adverse weather.

The monthly distribution patterns of the fish shoals may be seen in Figures 2 (a - l) and 3 (a - l). Several points are evident:

(a) In June only four shoals of "kahawai" were seen. Being mid-winter, and with water temperatures ranging from 9.6°C in Cloudy Bay to 10.8°C in Tasman Bay, this decrease in surface shoals was to be expected.

(b) During October and November no "pilchard" shoaling fish were seen. This was surprising considering that from July to September a number of small shoals were evident in Tasman Bay. This "absence" was probably caused by the high winds that prevailed in these two months. It was observed from the "W.J. Scott" that 2-3 days of fine weather was needed after a storm to bring the fish shoals up to the sea surface. These adverse conditions probably also accounted for the "absence" of "kahawai" shoals from the West Coast and Cook Strait zones.

(c) Throughout the summer months there occurred a concentration of "pilchard" fish between 173° 00'E and 173° 30'E with decreasing abundance in areas on either side. The reasons for this were unknown.

(d) Analysis of number of fish shoals observed in relation to water depth, showed that in all seasons 80-90% "kahawai" fish were in water deeper than 20 fathoms. This was true even for the area Kahurangi Point to Cape Farewell. The distribution of "pilchard"

shoals in relation to depth varied according to season: in winter 90% of the shoals were seen in water less than 20 fathoms, in spring 55%, in summer 75%, and in autumn 50%. Thus during winter and summer, but not in spring and autumn the "pilchard" shoals were predominantly in the shallower waters and within 10 miles of the shoreline.

(e) A few shoals identified as trevally were seen between December and February. Most of these occurred north of the Marlborough Sounds during February among shoals of kahawai, English mackerel and horse mackerel.

(f) The pattern of shoal distribution and concentration for the "kahawai", taken from June to May, showed a trend towards a seasonal migration in both the eastern and western areas, moving northwards in spring while reverting southwards in autumn.

This migration trend may be seen to greater effect in Figure 4. In the data recorded there were a number of "pilchard" observations written as "numerous scattered shoals" or "dozens of small shoals": these were conservatively estimated and then a + sign placed alongside the number. Thus, the + sign in the figures indicatesthat further shoals were present but actual numbers not known.

From Figure 4 two major patterns emerged:

(1) During winter very little surface fish occur from Kahurangi Point to Cape Campbell. From July there appeared to begin a northward late winter-spring movement of "kahawai", from western and eastern areas of the South Island. Evidence for this was seen in the concentration of fish shoals in Cloudy Bay (Area IV) and Kahurangi Point (Area I) areas during this time. This migration continued until summer with shoal sightings increasing in Tasman Bay (Area II) and north of the Sounds (Area III) as the water temperatures rose from 10.0°C-11.0°C in June to 18.0°C-20.0°C in January. There occurred a corresponding decrease of shoals at the extremities of the survey area. Information gathered on the "W.J. Scott" showed that these shoals stayed in these

summer areas from November to March.

During April the "kahawai" shoals moved out of Tasman Bay and north of the Sounds giving an increase in shoal numbers spotted off Kahurangi Point and Cape Campbell areas. This phenomenon has been observed for many years by fishermen using bottom trawls, the quantities of kahawai , caught in the nets, decreasing rapidly during winter. The shoals were noted to break up, being more inclined to exist as scattered groups rather than as compact shoals.

(2) The seasonal movement for the "pilchard" shoals appeared to be from the sheltered coastline areas during winter into the more open waters during spring, summer and autumn. From December to April "pilchard" shoals increased considerably in Tasman Bay where 95% of the shoals were sighted. During April-May the number of shoals decreased rapidly until in June virtually all "pilchard" fish had moved back to the in-shore area.

Sightings of Fish Shoals in relation to Time of Day:

The occurrence of shoaling fish was further analysed in respect to time in an endeavour to establish whether the number of surface "kahawai" and "pilchard" shoals varied with the time of day. The main pre-requisite for such an investigation was the need for regular observations throughout the daylight hours in each month. Below is a list showing:

(a) The number of flights that took place, and were completed, before 1130 hours or after 1330 hours; and

(b) The percentage number of flights that were completed within the 1130-1330 hour time interval (flights were only accredited into this interval if they were completed or started after 1200 hours or before 1300 hours).

Month	Number of flights before 1130 hours or after 1330 hours		Number of flights made	% Number of flights completed or started between 1200-1300 hours
	Before	After		
May	1	2	7	50
June	-	-	2	100
July	1	2	7	55
August	2	1	8	58
September	2	4	10	37
October	1	1	4	43
November	1	2	7	55
December	2	4	7	14
January	-	-	5	100
February	1	1	4	33.3
March	3	1	8	44
April	3	0	6	50

The flights took place between 0830-1830 hours with variations owing to different take off and landing times.

There was very little overall difference between the spotting time spent outside the 1130-1330 hour time period with that utilised during the 1130-1330 hour period. With the exception of June, which had only two flights, most of the months had an approximate 50:50 ratio, with the number of flights ranging from 4-10 per month. This indicated a relatively unbiased time schedule although obvious seasonal bias away from sunrise and sunset in summer, and closer to sunrise and sunset in winter, did occur. This would lead to truncating of the total fish shoal numbers observed, more during early morning than late afternoon. No fish shoals were sighted after 1630 hours even on the occasions when spotting ended at 1800 hours.

Figure 5 illustrates the number of shoals observed plotted against one hourly time intervals for each month. The following points are evident:

(1) The midday decrease of fish shoals was an actual occurrence and not one that could be attributed to flight-time bias. The general trend of the sightings was for a morning and afternoon peak appearance decreasing between approximately 1130-1330 hours. The morning peak was generally higher than the afternoon peak. Why this should be is unknown.

(2) A further dearth of shoals occurred during early morning and late afternoon, from July through to October. From December to April this variation in shoal numbers was not so noticeable.

(3) The reasons for the bi-modal distribution in sightings are unknown although it is well known that planktonic crustacea, such as euphausids and copepods, make marked vertical migrations related to light intensity and temperature, both seasonally and daily. The low light intensity plus the moderate temperatures in August and April, may explain the presence of the large numbers of fish shoals plotted over the midday period, since kahawai, English mackerel, horse mackerel and pilchards all feed extensively on plankton. This apparent optimum combination of the two physical factors was not evident during winter when fish shoals were few or absent.

DISCUSSION

It became obvious from the results of the survey that the distribution of the fish shoals changed through the seasons.

From observations made from the "W.J. Scott" it was evident that the kahawai spawned in this area north of the South Island. Spawning was seen to occur in the whole shoal rather than as individual fish. Locating the breeding kahawai shoals was fairly simple owing to the behaviour of the fish: the fish curved half out of the water with the tail and head only submerged, and with the actual spawning taking place by a series of pumping motions of the tail. Shoals of kahawai were observed to spend 2-3 minutes spawning on the surface before diving for 5-10 minutes, then re-appearing to continue spawning. This pattern continued for some time with one shoal being timed for 45 minutes. Breeding shoals observed varied in size from 10-35 tons.

In most instances the estimation of fish tonnages from plane spotting gives no absolute indication as to the quantity of fish present owing to:

(a) The possibility of counting the same shoal several times each month.

(b) Uncertainty whether the estimated tonnages from the air were accurate, although they were considered to be fairly close in this survey; and

(c) The uncertainty of knowing what proportion of the shoals were on the surface.

For these two latter reasons it is preferable to coordinate, as far as possible, the plane spotting activities with a fishing vessel so that the accuracy of tonnage estimations can be determined. However, the estimates made during the survey are recorded in Appendix 1.

A geological survey explosion by an oil company was observed on 1.4.69. Prior to the explosion two shoals of "kahawai" were noted in the area; after the explosion a further 14 shoals came up to the surface, apparently stimulated by the shock-waves, but otherwise unaffected. These shoals made no attempt to move away from the area nor were there any dead fish on the surface. This incident gave rise to an important question: How much of the total fish population do the surface fish shoals represent? This incident showed that possibly only 1/7th of the shoals are at the surface at one time; this portion may vary during the day and with the seasons.

ACKNOWLEDGEMENTS

Thanks are owing to Mr Bill Little, Fisheries Inspector, Nelson, for carrying out the majority of the plane spotting flights, for recording basic data and for helpful discussion; Mr A.R. Brown, Mate of the "W.J. Scott" until October 1968, for instruction of fish spotting methods; Mr G. Freeman, Administration Officer, Nelson, for his help over the 12 month period; the Nelson Aero Club for their enthusiasm and help throughout the survey; and to the Paraparaumu Aero Club for their hospitality. Dr D. Eggleston criticised the manuscript.

REFERENCES

F.I.N.S. (Fishing Industry News Service), Western Australia. Vol. 1(1), March 1968: 7-11.

TUNBRIDGE, B.R. 1969 Pilchard survey, Nelson, 1964. N.Z. Mar. Dept. Fish. Tech. Rept No. 32 : 41 pp.

LIST OF FIGURES

FIGURE 1. FISH SURVEY AREA, FLIGHT PATHS, and RECORDING ZONES

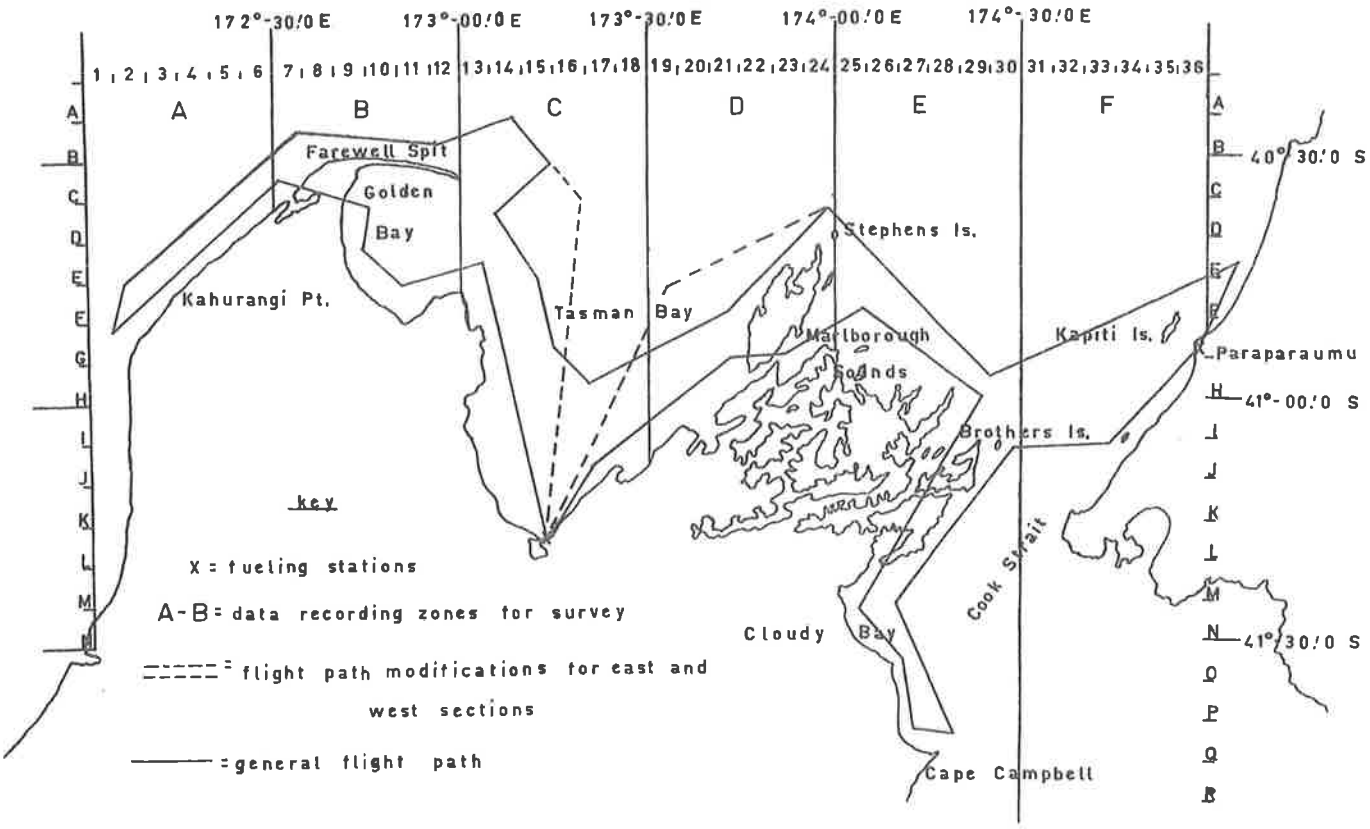


FIGURE 2. FISH SHOAL DISTRIBUTION by PLANE SURVEY (Kahawai-type)

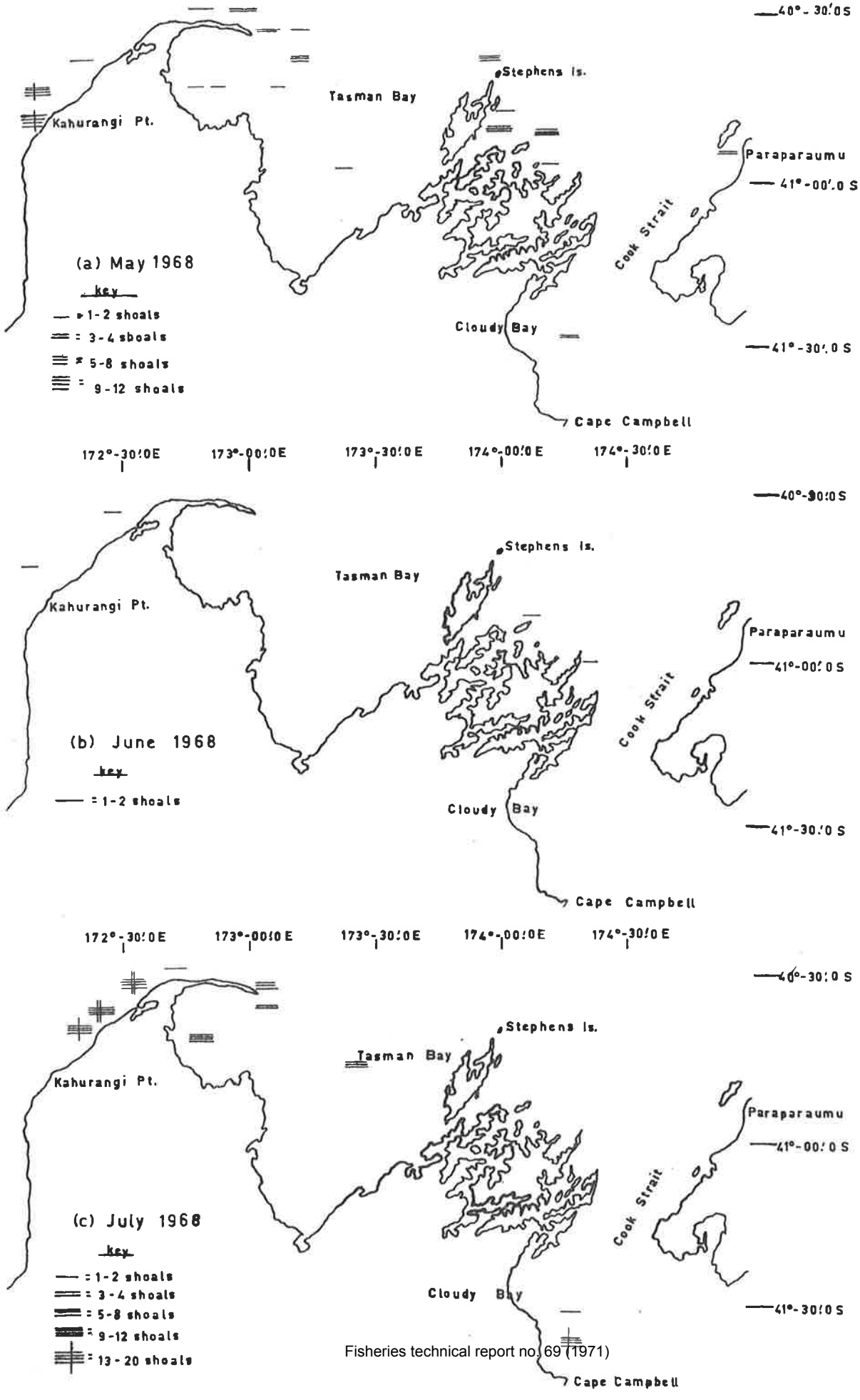
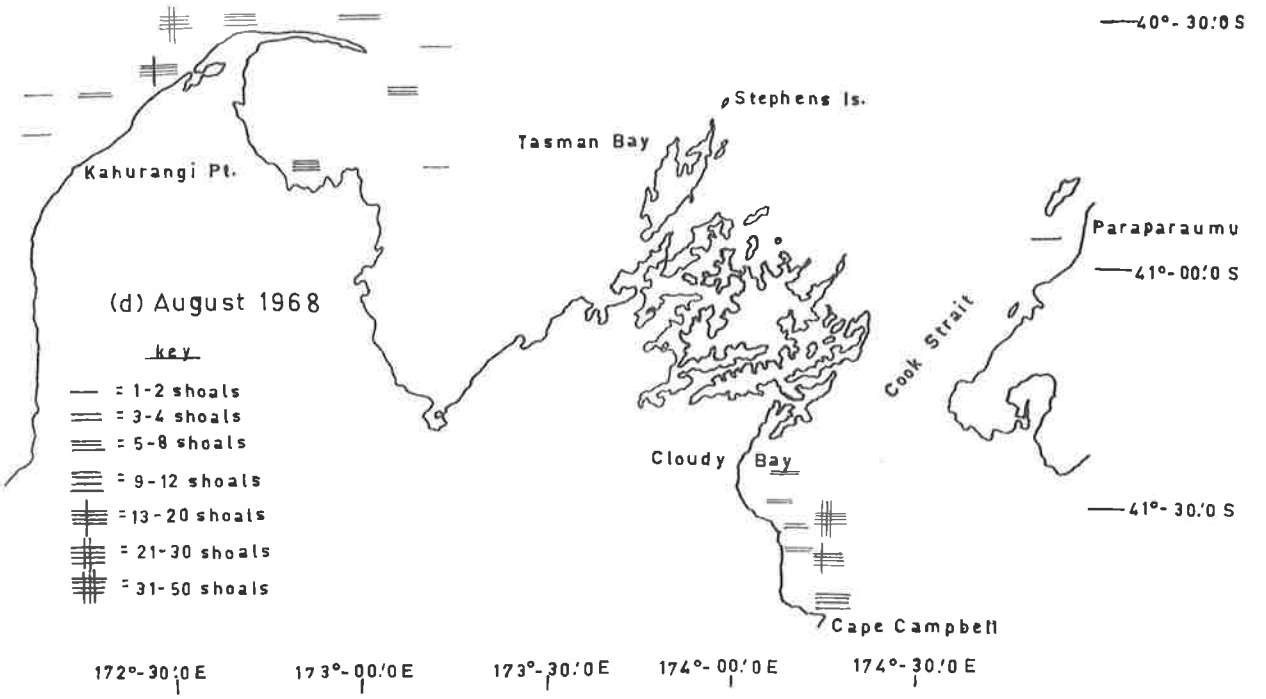
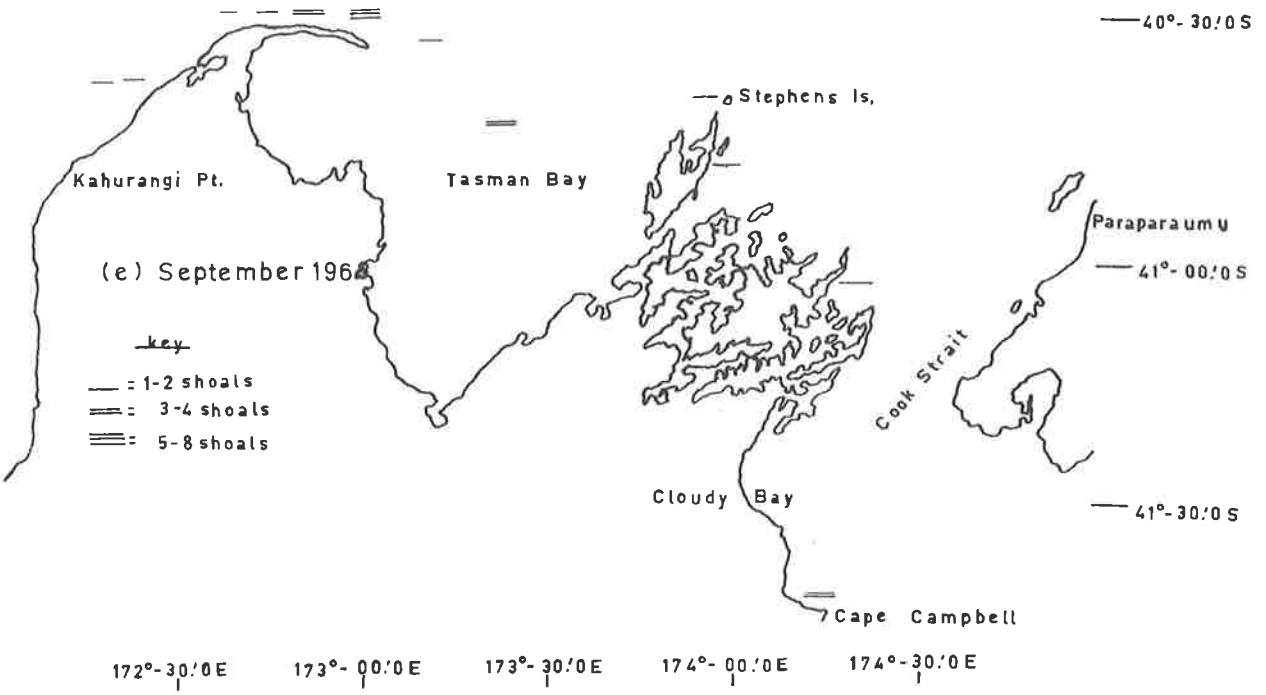


FIGURE 2. (continued)





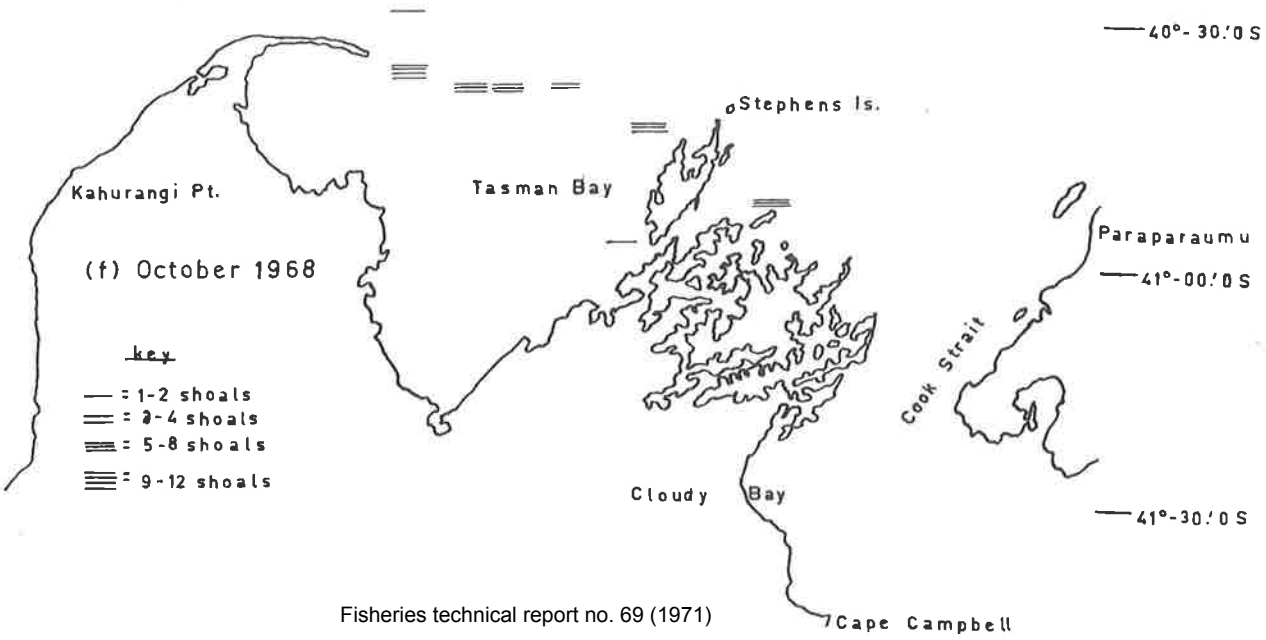


FIGURE 2. (continued)

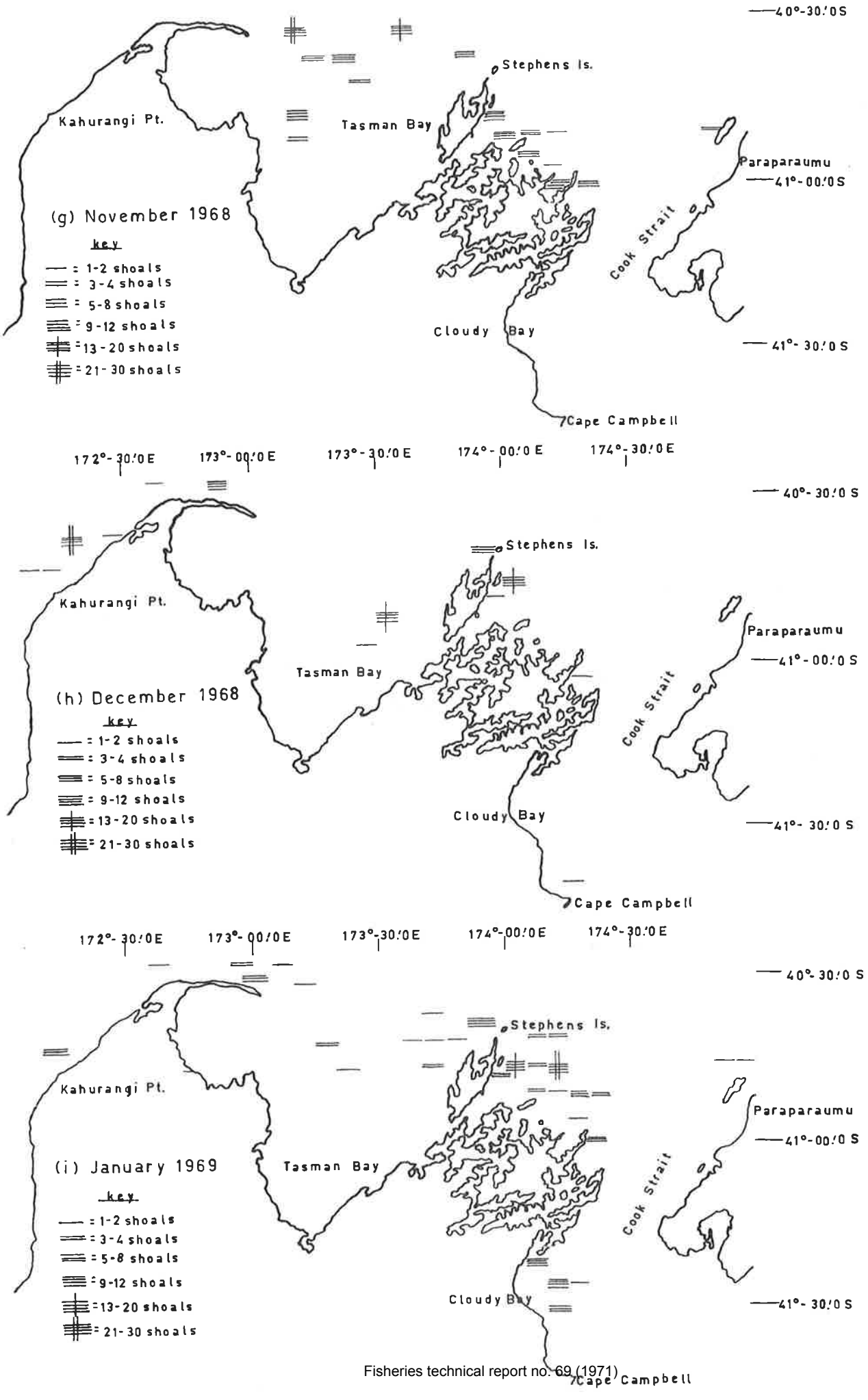


FIGURE 2. (continued)

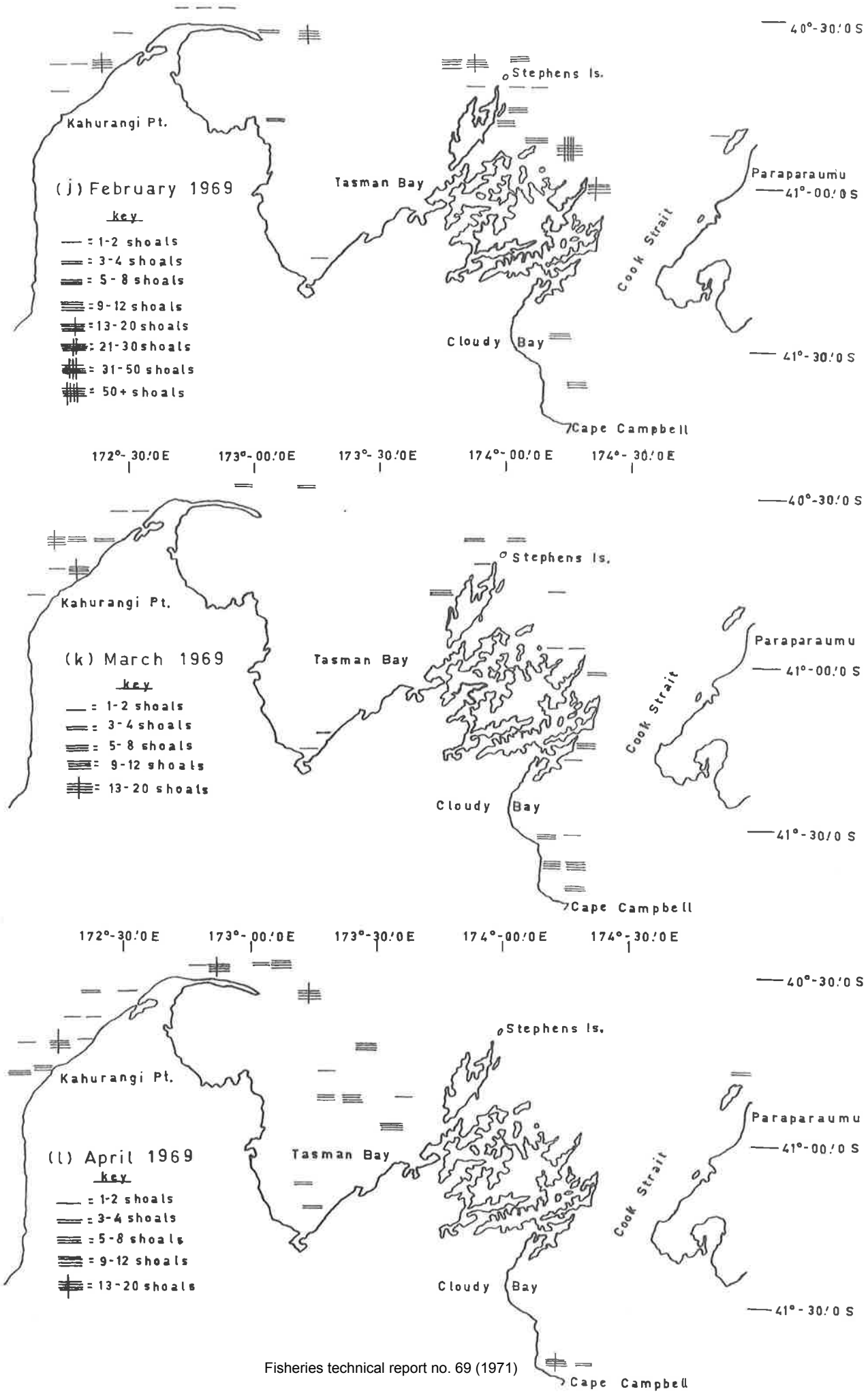
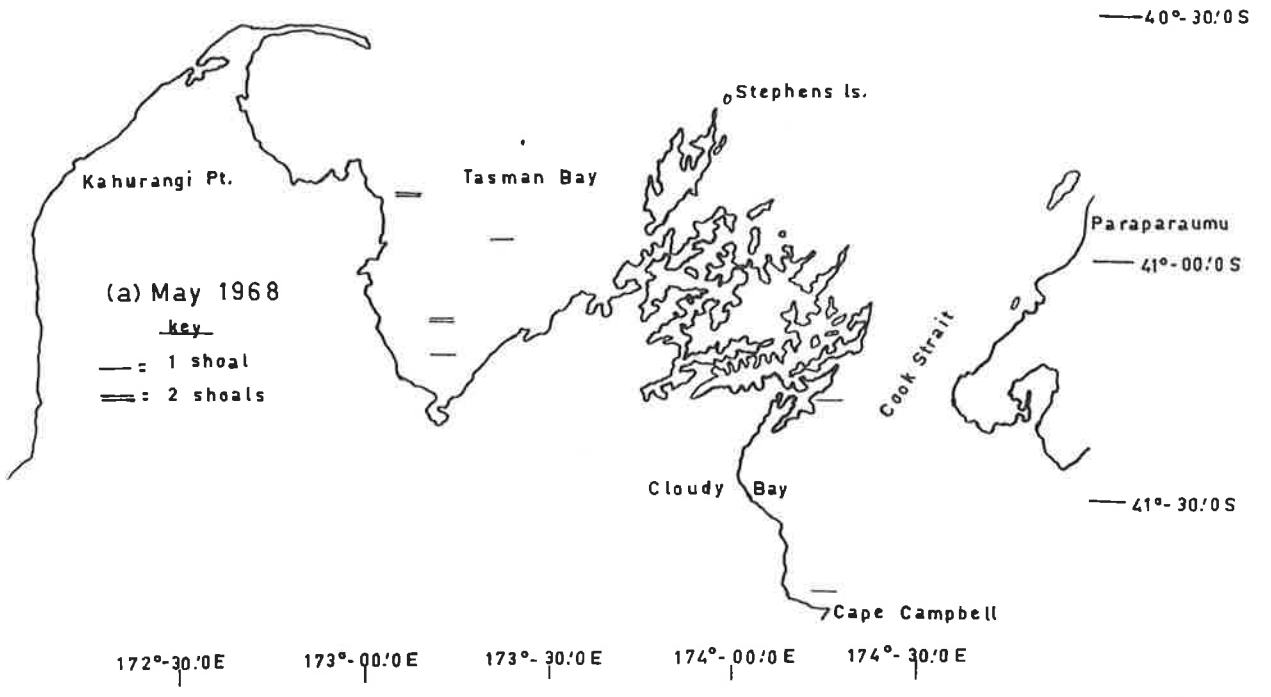
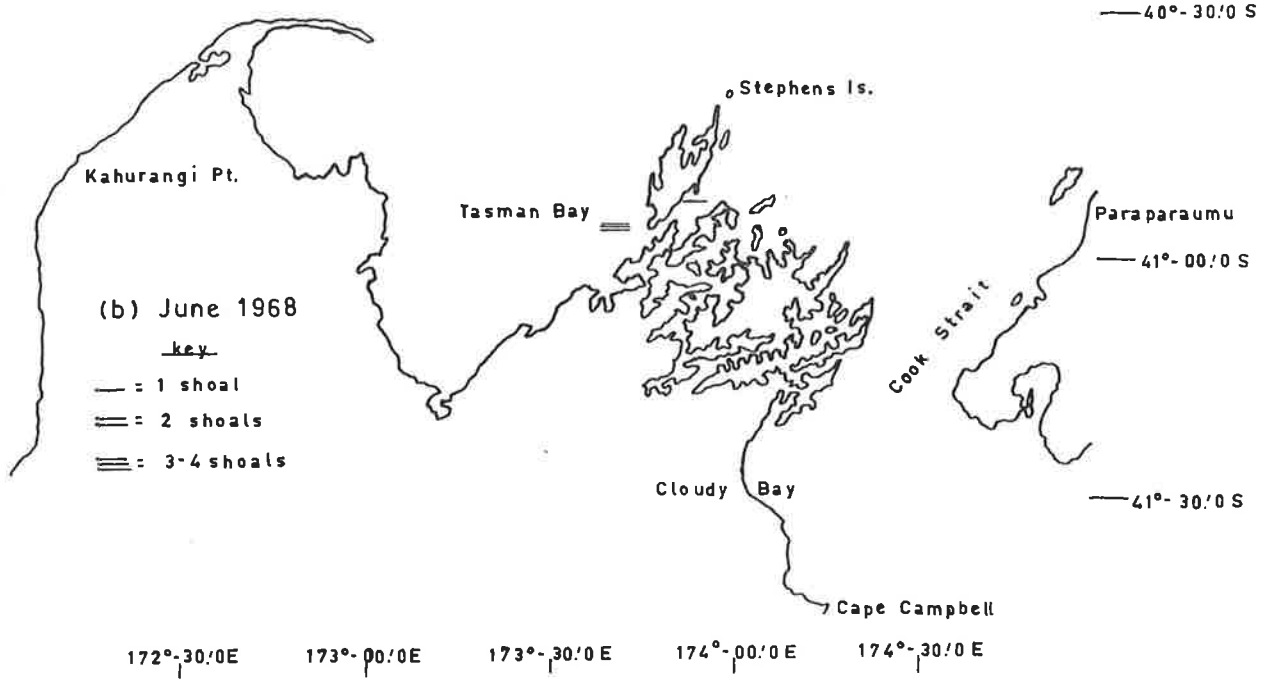


FIGURE 3. FISH SHOAL DISTRIBUTION by PLANE SURVEY (Pilchard - type)





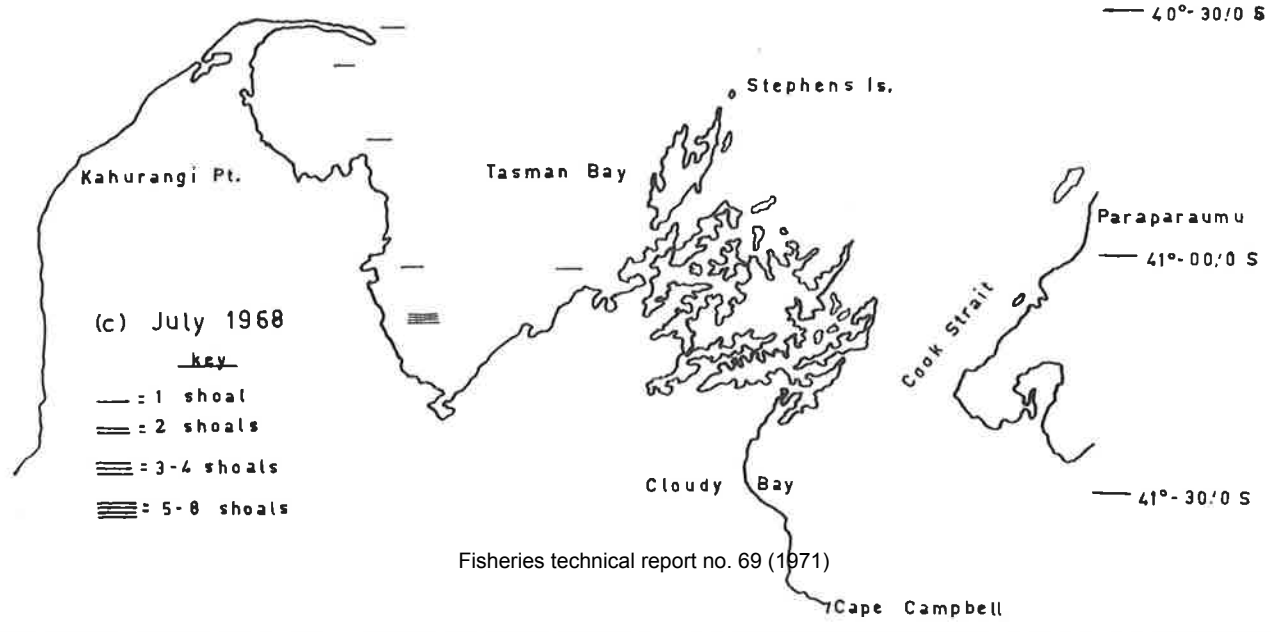
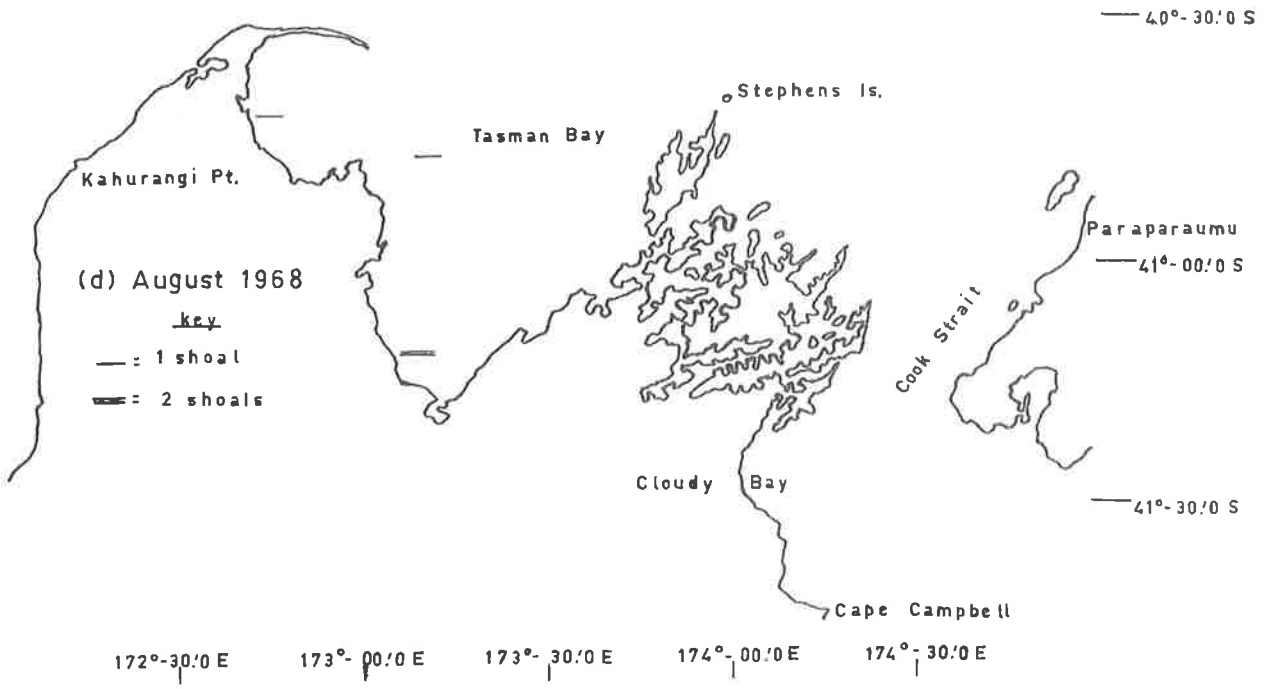
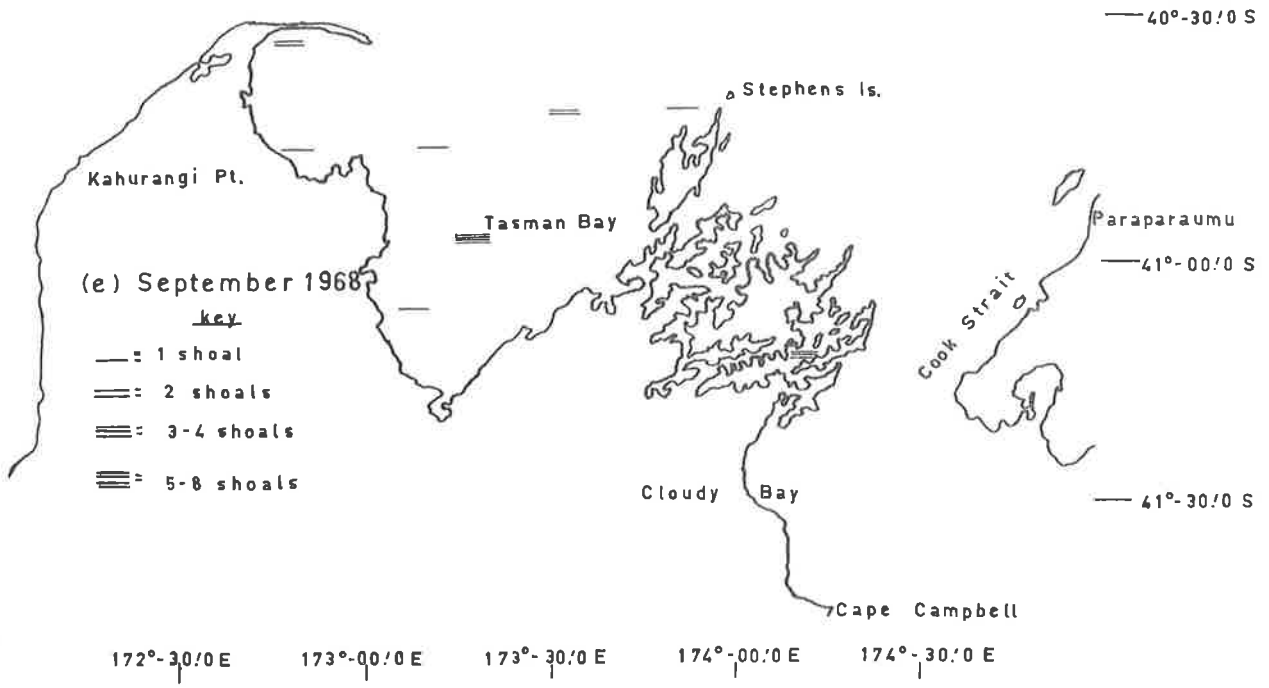


FIGURE 3. (continued)





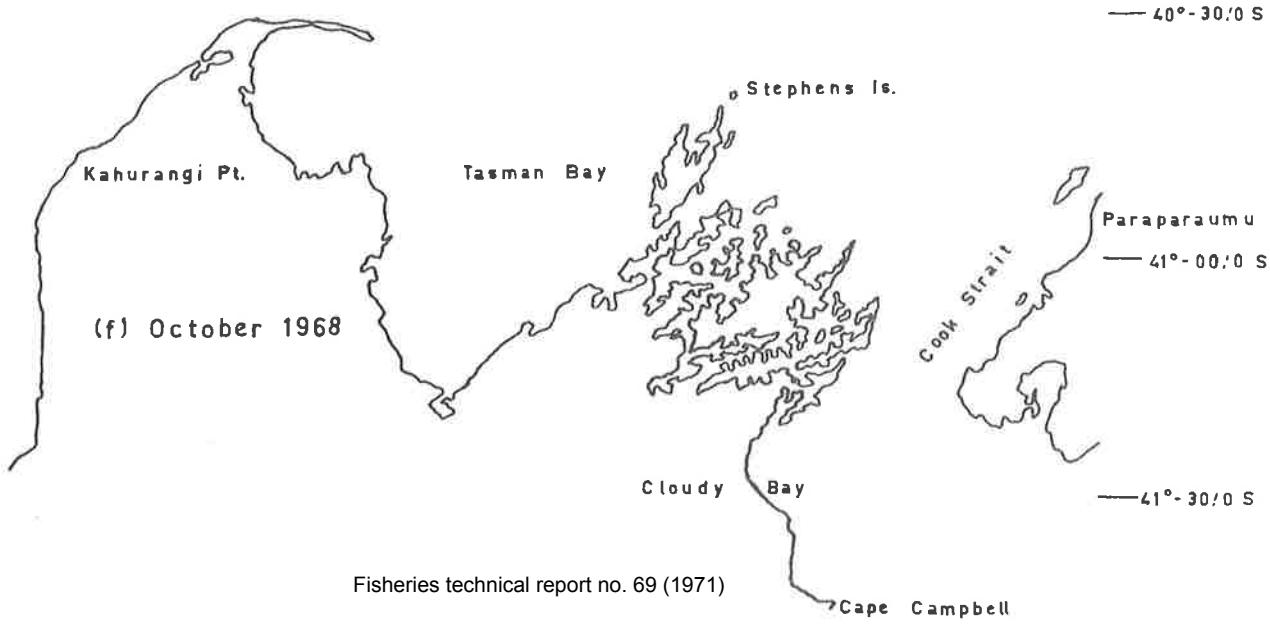
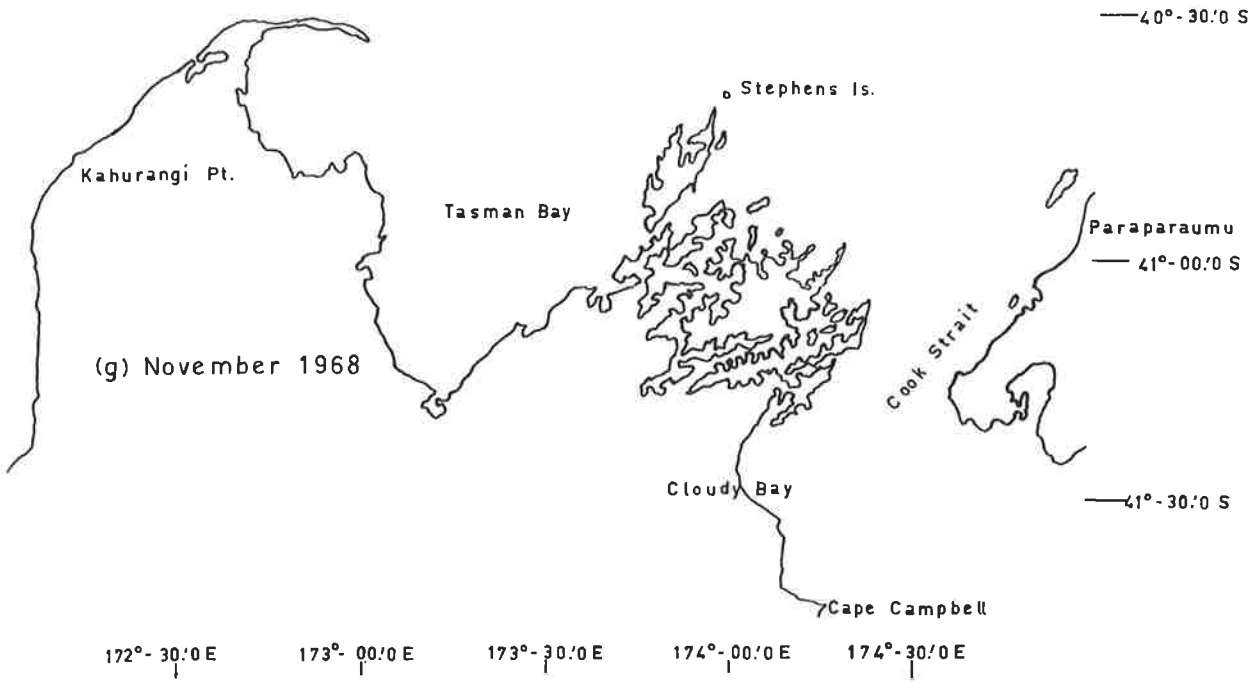
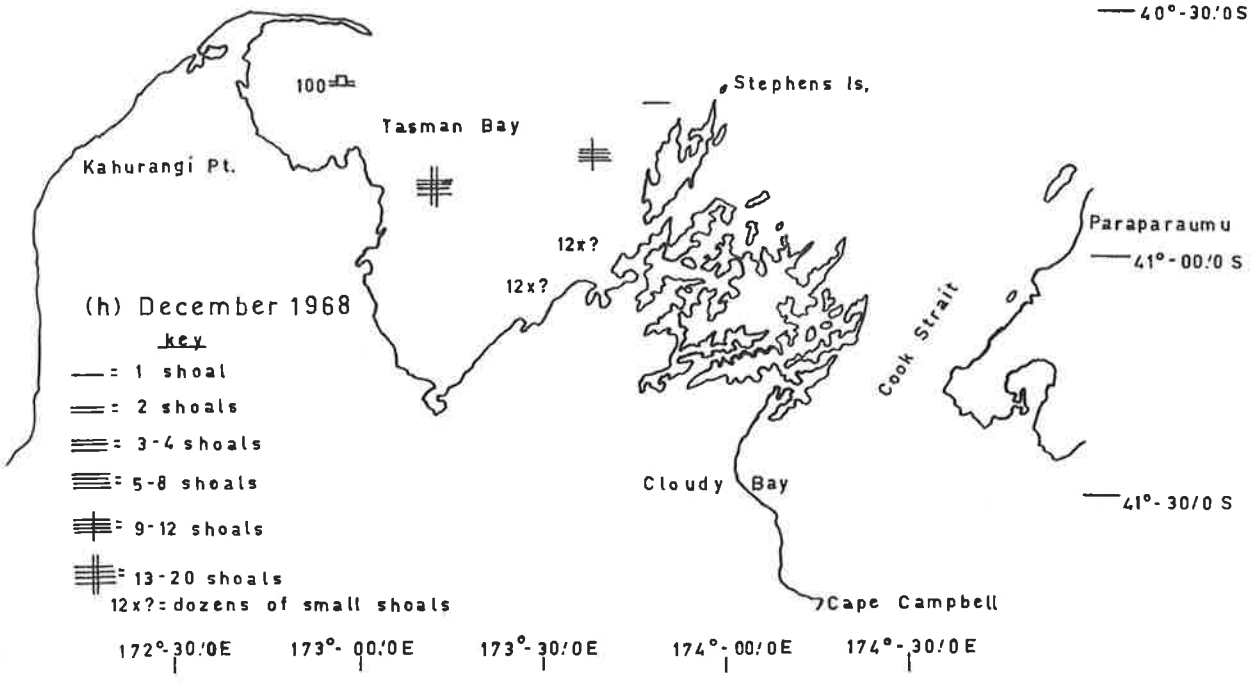


FIGURE 3. (continued)





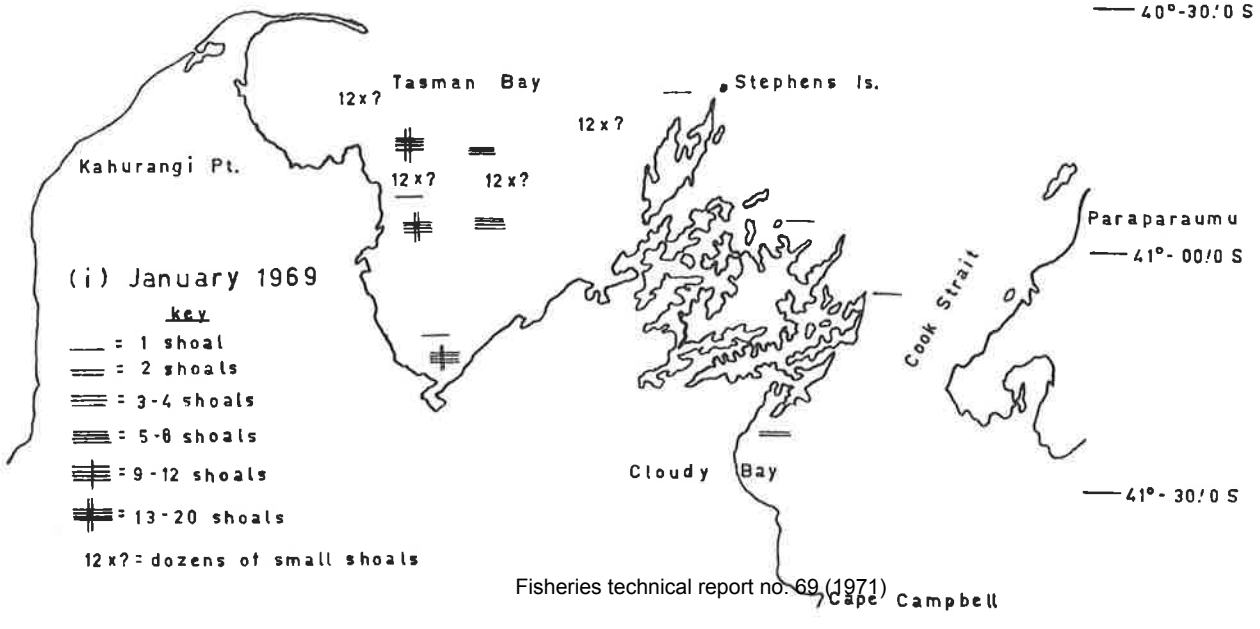
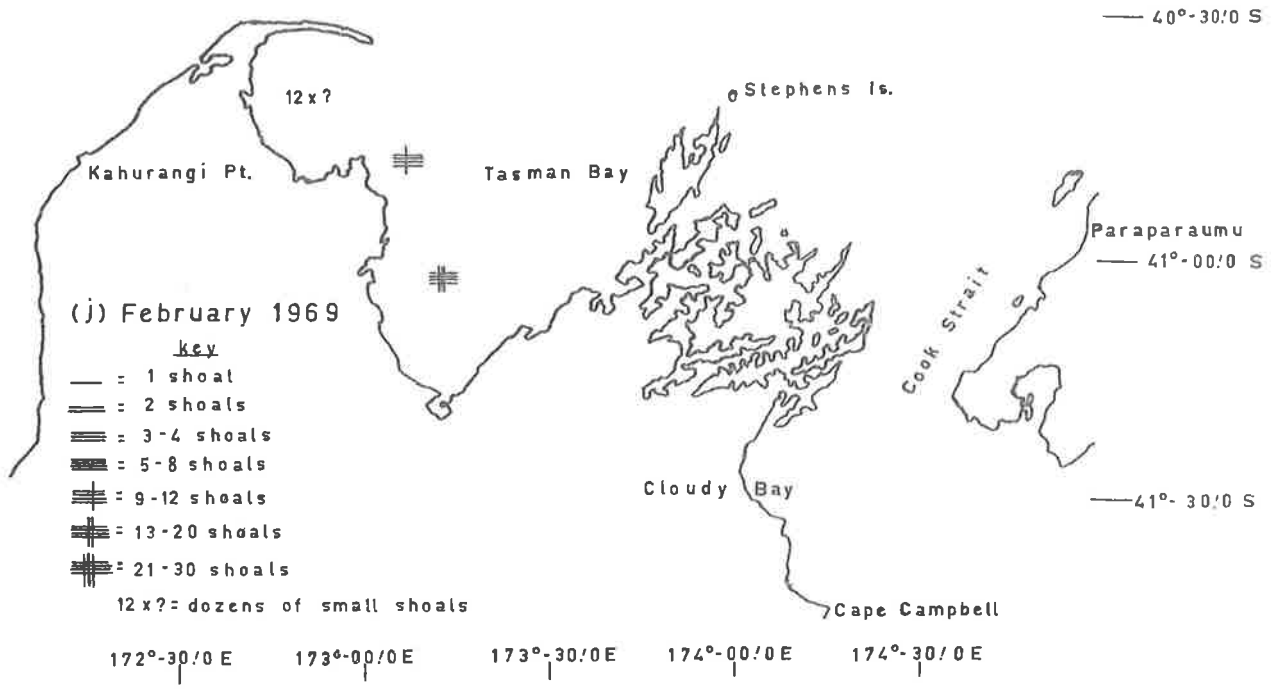
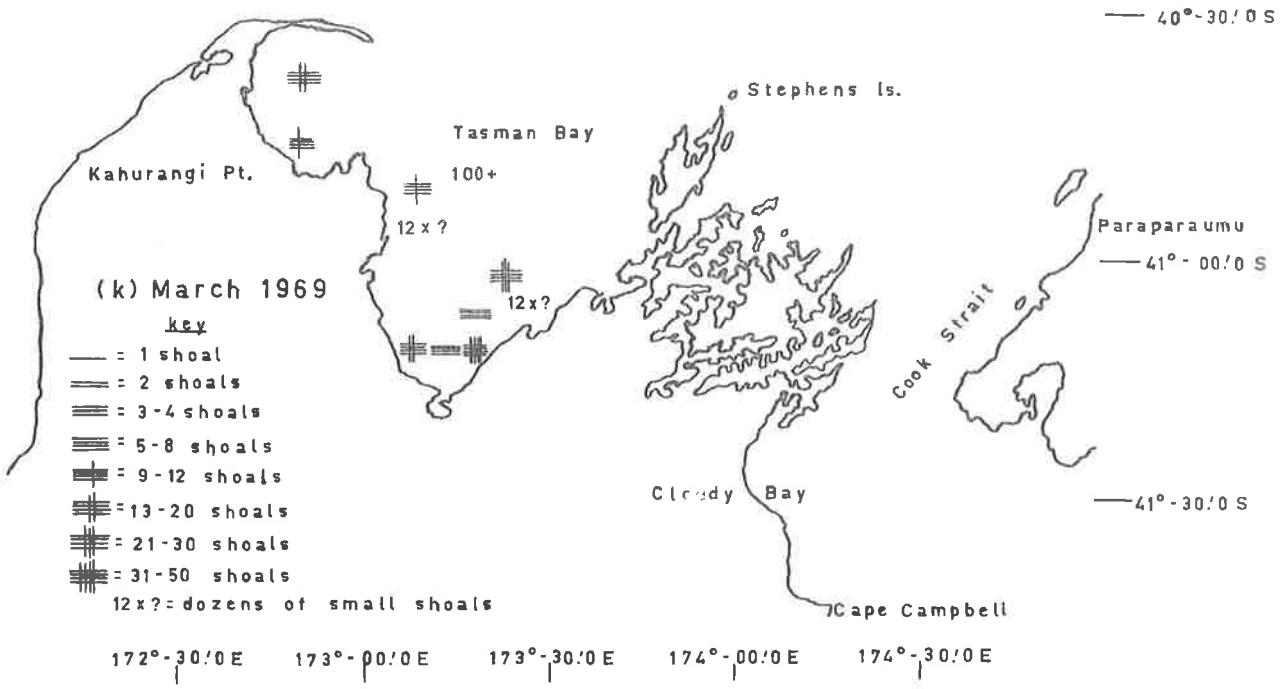


FIGURE 3. (continued)





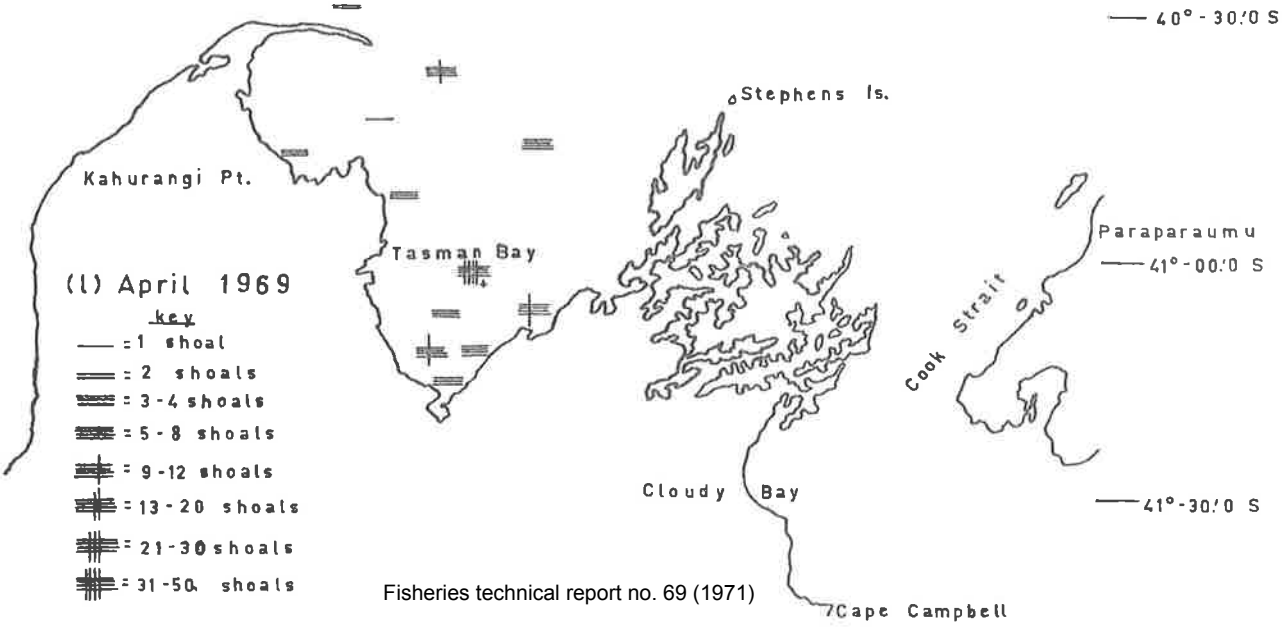


FIGURE 4. TOTAL NUMBER of FISH SHOALS per MONTH per AREA

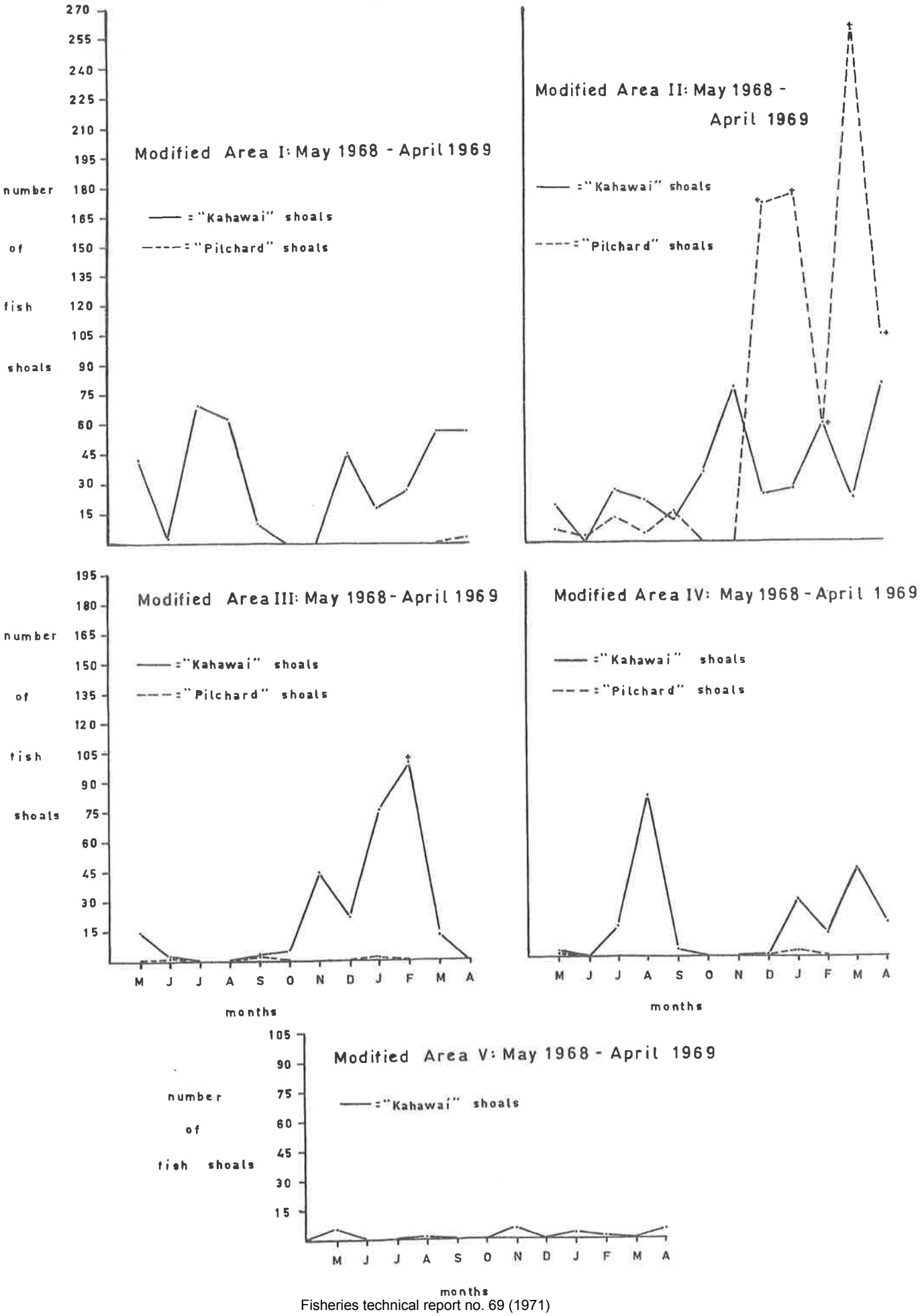


FIGURE 5. TOTAL NUMBER of FISH SHOALS SIGHTED per HOUR, EACH MONTH

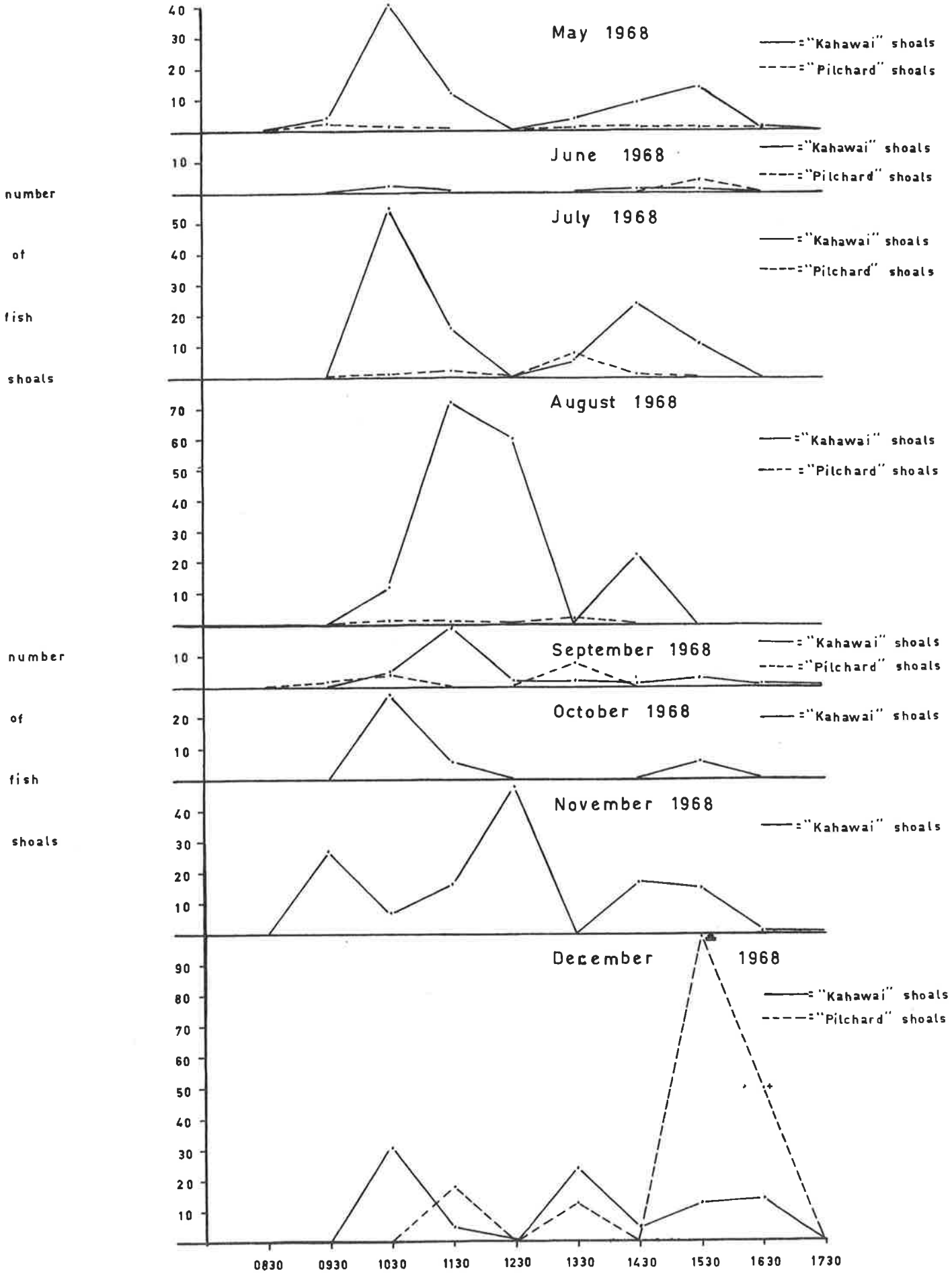
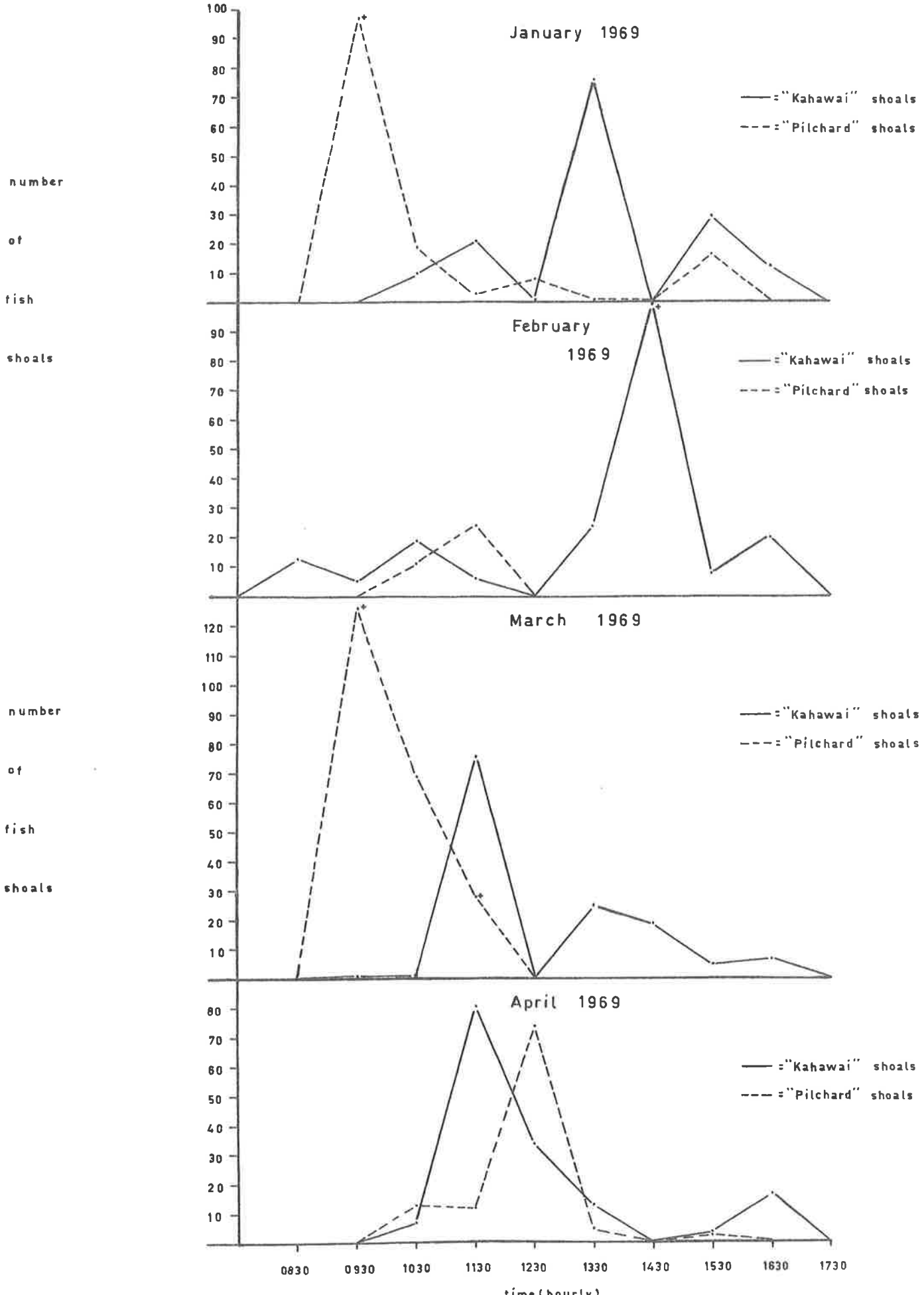


FIGURE 5. (continued)



Appendix 1: Total Estimated Tonnage of "kahawai" and "pilchard" shoals observed each month per modified area

Month	Modified Areas (Tonnages) "kahawai"						"pilchard"					
	I	II	III	IV	V	Total	I	II	III	IV	V	Total
May	496	222	137	30	20	905	-	19	-	12	-	31
June	15	-	13	-	-	28	-	9	5	-	-	14
July	1002	85	-	1127	-	2214	-	57	-	-	-	57
August	260	49	-	284	4	597	-	8	-	-	-	8
September	32	15	8	14	-	69	-	37	-	-	-	37
October	-	185	20	-	-	205	-	-	-	-	-	-
November	-	127	103	-	2	232	-	-	-	-	-	-
December	69	61	42	1	-	173	-	218+	-	-	-	218+
January	166	191	656	437	7	1457	-	220+	3	7	-	230+
February	30	256	210+	33	1	539+	-	59+	-	-	-	59+
March	374	58	175	535	-	1142	-	286+	-	-	-	286+
April	298	415	-	51	12	766	2	191+	-	-	-	193+

Total number of shoals: "kahawai" = 1299; "pilchard" - 917.

Average weight of shoals: "kahawai" = 6.4 tons over the year; "pilchards" = 1.3 tons over the year.

Maximum weight seen in one day: "kahawai" = 83 shoals totalling 1208 tons (30.1.69); 20 shoals totalling 1125 tons (2.7.68).

"pilchard" = 130 shoals totalling 136+ tons (1.4.69); 125 shoals totalling 133 tons (2.1.69)

NEW ZEALAND MARINE DEPARTMENT

FISHERIES TECHNICAL REPORT
No. 69

SURVEY OF PELAGIC FISH IN THE NELSON AREA (1968-1969) BY SPOTTER-PLANE

B. F. WEBB

WELLINGTON, NEW ZEALAND
1971