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RESEARCH TRUST ACCOUNT

TITLE OF PROPOSAL COMMERCIAL DEVELOPMENT OF THE STRIPED TUNA RESOURCE IN EASTERN AUSTRALIAN WATERS

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CHARTER OF CATRIONA B. FOR THE DETERMINATION OF STRIPED TUNA RESOURCES - N.S.W. EAST COAST

Brief outline and comment by F. Broder - Skipper.
Preliminary to full report being prepared by N. Carrick, Biologist with CSIRO.

See folio 232.

The N.S.W. Bluefin fishery is based on a run of bluefin which begins about September and concludes during the later half of January. Despite a heavy commitment of aircraft searching and or boats ranging across the Bass Straits to Tasmanian waters, the only useful find is a run of Bluefin occurring in the vicinity of Wilsons Promontory - so far it appears to be of a limited nature. Fleet skippers have to choose then between going to Port Lincoln, Wilsons Promontory or reverting to other forms of fishing. To date there has been extreme reluctance exhibited by Tuna Skippers to fish for Striped Tuna as an alternative unless they occurred in heavy quantities close to their operational bases and did not inhibit their capacity to catch Bluefin. However with South Australian catches showing marked seasonal fluctuations and overall a decided decline in catch per boat and bearing in mind the high cost structures inherent in the South Australian fishery apropos of searching, catching, transport etc. interest is turning once more to the possibility of utilising the East Coast Striped Tuna resource.

Over the years the spasmodic attempts to do this have met with limited success due to two factors. Firstly, in a Bluefin oriented fishery, attention has been directed to S/Tuna only when there was no bluefin apparent in N.S.W. or bad seasonal conditions in South

Australia. Secondly, extreme fluctuations in occurrences in conjunction with the first facts has promoted an attitude of uncertainty and frustration on the part of fishermen attempting to develop a tangible income earner. Added to these has been the lower demand price for Striped Tuna as compared to Bluefin, the smaller more delicate units to store and handle.

Catriona B. was chartered at the instigation of Heinz Greenseas Cannery to determine among other things, if there existed a viable economic fishery in Striped Tuna. During the period of the charter, a lot of fish was observed and some caught but whether it constitutes a viable economic fishery is doubtful, given present economic and physical circumstances. However, if the fish that occurred off Port Stephens in February and March is an annual event then it will become a positive and welcome adjunct to the Bluefin season and no doubt some development of this find may be expected.

When formulating the search strategy, a number of factors were taken into account. For a start, the very reason for the charter pre-supposed a lack of continutiy of reliable occurrences of Striped Tuna close to the Bluefin-oriented fishery, even though vast quantities do appear at intervals close to Eden. The prices offering per tonne landed at Eden $280 for fish less than 3 kg. and $410 for fish greater than 3 kg. dictated a polarisation in concept. Fish less than 3 kg. were then declared small and fish greater than 3 kg. large. For short range fishing, the price for small fish is barely adequate unless they are taken either in quantity or as an opportunistic catch. For pole boats there are no economics for long range fishing on small fish.

Very little effort then was directed to the occurrence and catching of small fish and it was decided to put total emphasis on searching for a possible fishery on large fish. As world S/Tuna fisheries favour higher oceanic temperatures than those of southern N.S.W. waters, it was decided to look in areas to the north of Sydney where in terms of search effort in the Bluefin fishery, very little attention has been directed. Extension of the search to Lord Howe Island was prompted by a temporary preponderance of small fish at Port Stephens, also to see if anything was available in the open ocean condition and it was thought it was a logical proposition to expect to find fish around the Island. Although the latter proved true, it was disappointing to find nothing between.

When searching for Striped Tuna in waters warmer than 20°C, a big advantage is the feature that almost invariably they are accompanied by wedge tailed shearwaters and these birds are most reliable indicators as to their presence. Until an area was located in which good schools occurred (greater than 10 tonnes), it was felt that the presence of a spotter plane was not entirely justified. Once it was realised there were large schools in an area then the spotter plane came into its own.

To summarise the results obtained:

1. Despite the failure to catch them, there were good quantities of large fish (greater than 4 kg) evident off the coast between Smoky Cape to Byron Bay during the September-October period. (Whenever weather permitted, numerous schools were found which during summer months can yield up to 15 tonnes daily per boat in ½ - 3 tonne catches per school. These schools are

mostly unsuited to purse seining. The failure to catch them during this period is puzzling but must not be regarded as a criterion of catchability or operational success. Factors of expertise, experience, bait, possibly one peculiar boat noise, each or all can be a major influence. It could be that these fish would have started to bite with the onset of warmer weather and it is unfortunate that lack of funds or time did not allow this feature to be more fully examined.

2. Concurrent with what has been recognised as a very poor season on the Southern N.S.W. coast, there were very good schools of Striped Tuna during February-March between Port Stephens, Sugarloaf Point. These schools apparently occurred almost daily and were talked about by game fishermen as having been seen during January. All size schools were observed from 5 to 500 tonnes and the fish caught from them were mostly of the 3-5 kg range. Eminently suited to purse seining, poling - remarkably free-biting with minimal bait consumption and possibly the area close in, 30-50 fathoms from Port Stephens to Sugarloaf Point, offers one of the best troll line fisheries in Australia during the summer period. There was however, 3 weeks latter February/early March, when it was decided to look at Lord Howe Island and it is not certain these fish were there during the whole of this period. Similar schools of similar size fish occurred at Lord Howe Island but because of bait considerations and problems of catch stowage, it was not possible to spend much time there.

With the onset of bad weather that occurred around Easter, no more fish was observed in the heavy schooling mode. Extensive flooding produced a belt of dirty waters that persisted right through April and may have accounted for the disappearance of these schools.

Although the search was extended to Coffs Harbour, there was no evidence offshore to suggest the presence of Striped Tuna. The fish that was found off Sydney to Kiama appeared to have no substance in terms of a commercial fishery during the time spent looking at them. Continuous bad weather during April precluded any attempts to go offshore where it was felt that larger fish, 8-15 kg. may have occurred.

There were some problems experienced during the Charter and it is suggested that they be given serious consideration. The causative one was storage of catch. Storage in chilled sea water is inadequate. Fish kept in this manner chafe very badly and even if they were pounded to prevent chafe, it becomes critical after 4 days that they be taken to a proper cold storage depot and with distance and weather considerations, this creates serious curtailmemt of fishing time and effort. Of course this applies to fishing on a long range basis anywhere. Spray refrigeration using heavy brine offers a possible solution - that is freezing the catch solid, pumping dry then keep the hold cold with dry refrigeration. Any alternative to adequate refrigeration on board such as road transport, etc. during hot summer months renders the whole exercise uneconomic because of excessive costs.

Bait as always was a problem throughout the year, both volume and type. With the good fishing experienced at Port Stephens and Lord Howe Island, it was found that yellowtail was quite suitable and they did not have to be small, but it would be unwise to regard this as a normal expectation.

In all bait, pilchards, anchovies etc. will always produce much more positive results. This year, very little success was had in locating them. Baiting

along the coast from Sydney north is most unreliable, there being few baiting spots other than around Port Stephens where this year, the predominant specie Maray, a type of pilchard, died immediately on being placed in the tanks.

NC:CJ
20/10/77

COMMERCIAL DEVELOPMENT OF THE STRIPED TUNA *(KATSUWONUS PELAMIS)* RESOURCE IN EASTERN AUSTRALIAN WATERS

REPORT OF PHASE I

Introduction: The chartered vessel *Catriona B* was engaged in Phase 1 of this program from 21 August 1977 to 7 October 1977. Fishing operations were centred about the northern New South Wales coast from north Solitary Island to Crowdy Head and ranged from inside the shelf to 180 miles east of Coffs Harbour, and north Solitary Island. Baiting operations were concentrated on the south coast of NSW owing to a bait shortage in northern NSW waters. During these 49 days of operation 23 days were spent searching and fishing, seven days were spent steaming, 12 days were lost due to bad weather, 4 days were spent purse-seining for bait (day-shots), Twenty nights were spent searching for bait and six night shots were made, yielding only 20 scoops of pilchards and anchovies.

Two hundred and seventy eight skipjack schools were sited during 1,900 nautical miles searched between 0700 - 1700. Attempts were made to fish 96 schools; however only 4 schools responded to pole and line fishing with a total catch only amounting to 3.0 tonnes.

The majority of searching operations were carried out between 0700 and 1700 and throughout this period 15 minute entries were made of the schools of fish sighted, tonnage (where possible), fish size, bird species and their abundance and behaviour, water temperature and water colour were monitored continuously, fish were measured for population size structure, guts and gonads were preserved for later laboratory analyses, and blood and liver collected for racial studies of the skipjack stock. Furthermore, plankton samples were taken inshore at baiting areas in an attempt to identify the presence of larval and post larval bait. In general, within the limits of this survey an ecological tone is apparent in that an understanding of the whole would enable predictions relating to behavioural responses of skipjack to pole and line, and purse seine fishing. Further the various components investigated will be of direct use to the fishermen for strategy in earching and fishing operations.

A school of skipjack was defined as such if it contained greater than 20 fish and/or if there were greater than 20 shearwaters or 5 sooty terns which were working.

Scattered fish were not taken into account nor were bird patches which were not working. An average school size consisted of 13.05 tonnes as derived from 20 random reliable estimates of tonnage. Hence, at least 3,628 tonnes of skipjack were sighted in the searching area between North Solitary Island and Crowdy Head. This figure is an underestimate as bird behaviour indicated that a very large number of schools were moving up and down. These could not be quantified according to the criteria set for a school.

A total of 2,375 tonnes of skipjack were landed during the 1974-75 tuna season with the majority of fish being caught during January. Hence, it is evident that a large skipjack resource exists in the eastern waters of Australia and all we need to do is to learn how to catch them. One should point out that the failure of purse-seiners in subsequent seasons was due to inexperienced crew and skippers. The skipjack fished during Phase I were not vulnerable to pole and line fishing; however they would be vulnerable to skillful purse seining. One should point out that skipjack vary in seasonal abundance and size composition of stock along NSW coastal waters (personal experience). As such the initiation of Phase I of this program was premature and its termination too early.

Section 1: FISH RESPONSE TO POLE AND LINE FISHING

The very low biting response of skipjack may be the result of an interacting set of factors. Firstly, the water conditions were not conducive to pole and line fishing during this period as the water was relatively cold, there were no marked temperature discontinuities and there were no typical small scale temperature oscillations within these water masses. Water colour varied from dirty green to blue. Secondly, the bait used was yellowtail (8-18 cm size). It is unlikely that the bait alone induced this low response as very large schools were fished with completely no response. Furthermore, the increase in biting response during October may be due to oceanographic conditions being more conducive to arousing biting response rather than the bait used. Pilchard bait was used during the October period. Also no tightly aggregated schools were observed during this survey which suggested that environmental conditions were not conducive to pole-and-line fishing. In general, the fish schooling behaviour can be termed very 'wild'. Schools did not aggregate and were: spread out over considerable distances, one-layered in the water column, groups were splitting off from the main part of the patch, were intermittently diving, changing swimming direction and their swimming velocity was estimated to vary from 4-30 knots.

Section 2 : BAIT

The following bait species were captured; pilchard *(Sardinops neopilchardus)*, sandy sprat *(Hyperlophus vittus)*, maray *(Etrumeus jacksoniensis)* southern anchovy *(Engraulis australis)* and yellowtail *(Trachurus mucullochi)*. Yellowtail were used as bait for most of this survey owing to the scarcity of other forms of bait. Most fish did not respond to this bait as indicated by Appendix I, which shows that for 88 schools fished with this bait only one responded. Pilchards appeared to arouse and maintain a higher biting response; however the bait used cannot explain the low school responses as greater than 5 tonnes of skipjack have been taken from relatively small schools using this bait (personal experience).

Section 3: AVAILABILITY OF BAIT

A severe limitation to Phase I of this project was a scarcity of bait in the inshore waters between Port Stephens and Byron Bay. However, this may be a seasonal phenomena as Blackburn (1949) has pointed out that between August-September adult pilchards in these waters occur offshore where they spawn and it is not until late September-October that the post larvae move inshore to take up residence for one year of their life. Plankton sampling showed that this indeed was the case. Plankton samples taken at Byron Bay and Trial Bay contained relatively large numbers of small early post larval pilchards and anchovies. This leads to the prediction that during January to April bait will be available in these areas. Furthermore, postlarval pilchards move into inshore waters earlier in southern waters (e.g. Wreck Bay) This was evident in that pilchards sighted and caught at Wreck Bay were all 0-year class recruits which probably entered these inshore areas 2-3 months earlier than the northern stock.

Section 4: BAITING METHODS

Night shots for bait (pilchards and anchovies) were not successful owing to the scarcity of bait and the presence of predators (barracouta and jack mackerel). However, large schools of pilchards occupied Wreck Bay beach and from 12 bait shots only one was successful yielding 130 scoops. A method was developed for day-shooting whereby a diver using SCUBA prevents bait from escaping from the purse-entrance. In the setting the net boat drops one end of the net which is weighed and shoots around the fish being guided by a spotter in the vessels crows nest. Once the bait net is rounding the bait school the main vessel would position itself for picking up the lampara wings and purse ropes. This method should be tested in Phase II as efficient capture of bait would be vital to such a fishery.

Section 5. SEAWATER SURFACE TEMPERATURE

Surface temperature were continually monitored and related to:

(1) The numbers of skipjack schools

(2) Fish schooling behaviour and biting response

(3) Seabird diversity, abundance and behaviour

(4) Water colour

During the earlier part of this survey it was noticed that the temperature recorder was relatively insensitive to small scale temperature oscillations. The sensitivity was increased and arbitrary temperature units were calibrated with surface temperature measurements taken one metre below the surface. This calibration is shown in Appendix II. The adjustment enabled a high degree of sensitivity and accuracy ($\pm$ 0.12^{o}C) of temperature recordings which could be continuously monitored.

Previous work (Carrick 1977a) has shown that seawater surface temperature is an important factor relating to skipjack abundance, schooling behaviour and biting response. That is, water of relatively high temperature (24-26^{o}C), the appearance of marked temperature discontinuities and small scale temperature oscillations within a water mass were associated with tightly aggregated schools which had a high biting response.

The results obtained from Phase I of this survey have indicated that seawater temperature were not conducive to tight schooling behaviour and fish biting response.

Section 6: WATER COLOUR

In order to identify particular water masses which may be associated with skipjack schools a subjective classification of color scale was constructed and painted in water colours by the skipper Mr Frank Broder. In this scheme two major water groups (A and B) were classified according to their temperature and constituent colour components (blue, green, grey and browns of various shades). Scale A ranged from clear royal blue to dirty green and B ranged from clear blue to green with seven types of water colours in each group viz. scales 1A to 7A and 1B to 7B. The colour scheme was tested 10 times on 4 crew members and was completely consistent.

The colour scheme was used to classify water masses throughout searching courses and was associated with species of fish, numbers of schools, species of birds and numbers, shales, dolphins, sharks etc., and water temperature. The results although not as yet analysed indicate that by using the above associations one can predict whether fish are in the searching area.

Section 7: PLANKTON SAMPLING

Plankton samples were taken using a parachute drop net during lay-out nights and baiting nights. The presence of certain indicators in the plankton may be related to the abundance of skipjack and bait species. Furthermore, plankton sampling has enabled prediction that pilchard bait would be available from summer - autumn (see Section 3).

Bibliography

Carrick, N. (1977a) "Skipjack biting response during the 1974-75 tuna season and the effect of a cyclone on surface water temperature".

Blackburn, M. (1949).- "Age, Rate of Growth and general life-history of the Australian Pilchard (*Sardinops neopilchardus*) in NSW. CSIRO Bulletin No. 242. 1949.

SUMMARY LOG OF PHASE I (21 August, 77 to 7 October, 77

This contains a summarized log of daily operations with Maps 1 to 24 indicating daily steaming, searching and fishing operations plotted at regular time intervals throughout the 24 hour system.

21.8.77 0600 : Departed Sydney Cove. Searched inside the shelf and anchored in Port Stephens at 1630. Sighted only scattered skipjack. Attached bait light to determine whether bait was available and throughout the night only a few scoops of yellowtail were observed under the light.

22.8.77 0700 : Left anchorage at Port Stephens. Searched along the shelf. Anchored in Trial Bay at 0300. Sighted no skipjack schools only a few scattered fish. Water dirty green and cold. No bait available.

23.8.77 0830 : Left anchorage at Trial Bay and arrived in Coffs Harbour 1615. Sighted 2 patches of skipjack. Attempted to fish but no biting response.

24.8.77 0700 : Left Coffs Harbour and searched inside and off the Shelf. Sighted 49 schools of skipjack; attempted to fish 15 schools but did not respond to bait (yellowtail 8-18 cm length). No marked temperature oscillations, water cold with a maximum of 20.5°C and colour grey blue.

25.8.77 Coffs Harbour wharf. Rough sea conditions.

26.8.77 0600 Searched eastwards from Coffs Harbour and layed out at sea from 1630. Sighted 10 schools of skipjack and attempted to fish 6 but no biting response. Water temperature ranged from 20.4°C to 22.2°C.

27.8.77 0700 Searching from layout position. Sighted 14 schools and attempted to fish 8 with no biting response. Water slightly bluer offshore (scale 2A-3A) but not ideal colour of 1A. Water temperature ranged from 21.0 to 21.8°C.

28.8.77 0800 Left lay-out position and searched until 1800. Sighted 12 schools and fished 4. No biting response. Water colour 2A-3A with temperature 21.0-21.8°C. One section of blue blue water (scale 1A).

29.8.77 Searching from 0700 as shown in map 6. Sighted 15 schools. 15 attempts were made to fish these schools but no biting response. One patch contained very large fish of 18 kg size.

29.8.77 Searching from 0700 as shown in map 6. Sighted 15 schools. Fished one. 15 Attempts were made to fish these schools but no biting response. One patch contained very large fish of 18 kg size.

30.8.77 0700 Searching from lay-out position and arrived at Coffs Harbour 2300. Sighted 17 schools of fish. Attempted to fish 3 schools with only one school responding to bait. Landed weight was 640 kg. Water blue, surface temperatures 22.8°C with some temperature oscillation where fish were caught. However, response not high. Could not maintain frenzy and biting response.

31.8.77 Tied up at Coffs Harbour Wharf. Obtained stores, unloaded 640 kg of skipjack and discussed operations with CSIRO officer.

1.9.77 0530 Departed Coffs Harbour wharf. Attempted to search inshore for bait by sounding; however bait relatively scarce and no pilchard or anchovy soundings. Sighted 22 schools of skipjack and attempted to fish 8 with no biting response. Water 22.0°C and colour scale 1A-1B. At 2045 anchored in middle of Coffs Harbour after sounding for bait. Throughout the night and early morning only yellowtail and recently metamorphosed pilchards 2-3 cm in length under the bait light.

2.9.77 0530 : Left anchorage and obtained fuel at Coffs Harbour wharf. Left wharf at 0930. Sighted 60 schools of skipjack; however the majority of these schools consisted of small fish 1-3 kg size. Made 4 attempts to fish large sized fish schools (6-8kg size) with no biting response. From 1800 onwards steaming towards Byron Bay with the objective to catch and identify tuna schools spotted by plane off Fingal Head.

3.9.77 From 0100 steaming towards Byron Bay. Rough sea conditions with wind NNW/30 knots. 1230 anchored at Byron Bay.

4.9.77 0700 : Anchored at Byron Bay. Rough sea conditions offshore. At 1100 left anchorage to investigate tuna schools sighted by spotter aircraft off Fingal Head. Sighted two large schools which appeared to be Northern Bluefin. They did not respont to bait. At 1900 anchored at Byron Bay. Sounded for bait with negative results. No pilchards or anchovies came under bait light. However, plankton samples indicated the presence of post larval pilchards.

5.9.77 0700 : Rough sea conditions prevailed throughout the day. Wind SW 25/30 knots.

6.9.77 0730 : Steaming from Byron Bay and arrived at Coffs Harbour at 2030. Sighted only 5 patches of fish which were SE of North Solitary island. fished with no biting response.

7.9.77 0700 : Tied-up at Coffs Harbour wharf. Bad weather conditions. Obtained stores, maintenance and adjusted thermograph. Liaison with CSIRO Officer.

8.9.77 0700 : Coffs Harbour wharf. Rough sea conditions with wind SW/25 knots. at 1400 left Coffs Harbour with the objective to locate and capture bait in Trial Bay. From 1930 to 2030 sounded areas in Trial Bay for bait with no indication of pilchards or anchovies. At 2030 anchored and throughout the night and early morning only observed 20 scoops of adult pilchards under light. Plankton samples indicated presence of metamorphosing pilchards and anchovies (taken from 2100-0130.)

9.9.77 From 0730 searching and arrived at layout position at 2000. Sighted 25 schools of skipjack. Fished two schools with no biting response. One of these consisted of a 40 tonne school of fish ranging from 6-10 kg size; however no biting response was emitted even after 10 runs. This indicated that the bait (yellowtail 8-18cm and/or environmental conditions were not conducive to emitting a biting response.

10.9.77 Anchored at Trial Bay. Rough sea conditions (wind SSW/20 knots) prevailed throughout the day.

11.9.77 Anchored at Trial Bay. Bad weather prevailed throughout the day. Wind SSW/20 knots changing to NE/20 knots in afternoon.

12.9.77 0630 : Steaming east of Trial Bay. Rough sea conditions. Objective to search outwide and to make our way back to Sydney in an attempt to find pilchards and anchovy bait. Sighted 4 schools and fished 4 with no biting response. At 1730 layed-out. Wind increased in strength and at 2400 changed from SW/25knots to a northerly/30 knots. Rough sea conditions with gale force wind warming. Steamed shorewards from 2400.

13.9.77 0200 to 2400 Steaming shorewards, rough sea conditions with wind change from North/30 knots at 0400 to SW/25 knots.

14.9.77 0200 Anchored at Trial Bay.0900 left Trial Bay searching inshore towards Coffs Harbour as sea conditions rough offshore;sighted no skipjack schools. Water dirty green (colour scale 7A-6A) and cold 17.8°C. 1300 tied-up at Coffs Harbour wharf.

15.9.77 Tied up at Coffs Harbour wharf. Rough Sea conditions prevailed throughout the day. Obtained stores and maintenance.

16.9.77 Tied up at Coffs Harbour wharf. Rough sea conditions.

17.9.77 Tied up at Coffs Harbour wharf. Rough sea conditions.

18.9.77 0700 left Coffs Harbour wharf with searching direction shown in map 15. Steamed throughout the night and early morning in an attempt to find warm blue offshore water. Sighted 6 schools of skipjack and fished 5 with no response.

19.9.77 0600 searching as shown in map 15. Sighted 17 skipjack schools. Fished 10 with no biting response. Water temperature relatively cold 17.6-22.2°C and water colour scale from 1A-6A. Took plankton samples during lay-out.

20.9.77 Steamed throughout early morning and searching course indicated in Map 17. Water dirty green (6A-6B) and cold 16.8-19.5°C. Sighted no skipjack schools. Steaming throughout night towards Port Jackson.

21.9.77 0700 Steaming towards Port Jackson. Sighted no skipjack schools. Water cold 18.9°C and bluer inshore. 11.30 entered Port Jackson and sounded for bait. Soundings were indicative of pilchards and anchovies. At 1230 tied up at Sydney Cove wharf. Obtained stores and maintenance. 1900 moved to Rose Bay for baiting operation. Relative scarcity of bait with only 20 scoops appearing under light at 2200.

22.9.77 0400 Rose Bay shot bait net catching 5 scoops of anchovies and pilchards. Rough sea conditions. 0800 tied-up at Sydney Cove wharf. 1900 left Sydney Cove wharf anchored at Rose Bay at 1930 for baiting operation.

23.9.77 0500 shot net and obtained 5 scoops of anchovies and pilchards. 0630 left Rose Bay with objective to bait in JB where pilchards and anchovies are more abundant. Rough sea conditions and at 1030 Petter engine holed resulted in steaming back to Port Jackson. Sounding for bait in Port Jackson from 1200 to 1230, however sounding indicative of scarce bait supply. At 1245 tied up at Sydney Cove wharf. 1400-1900 maintenance on boat.

24.9. Rough sea conditions. Tied-up at Sydney Cove wharf.

25.9.77 0600 left wharf at Sydney Cove. From 0900 to 1500 searched along shelf but did not sight any schools of skipjack only scattered fish. Water cold (18.0-18.6°C) and green. At 1645 entered Jervis Bay and up to 1830 searched for bait using sounder. Soundings indicative of relatively large pilchard schools. At 2030 large amount of blubber in water and only 20-30 scoops of maray pilchards came under light.

26.9.77 From 0100 to 0300 moved 4 times in Jervis Bay in an attempt to find a larger bait supply. At 0430 shot bait net and obtained 10 scoops of pilchards. C800 steaming towards Wreck Bay with objective to search and sound for bait. From 1100-1400 had two day shots for bait at Wreck Bay, however were unsuccessful. From 1700-2100 sounded for bait and moved twice. At 2300 large amount of bait under light but scared by barracouta.

27.9.77 0100-0230 Took plankton samples at Wreck Bay. Weather conditions became hazardous for a baiting operation with rough sea conditions created by a southerly wind of 20-25 knots. 0530 steaming towards Ulladulla for anchorage and arrived 0830. From 0830-1600 emptied and cleaned bait tanks.

28.9.77 0700 left Ulladulla wharf with objective to capture bait at Wreck Bay during daylight. From 0930-1400 had two bait shots off Wreck Bay beach but were unsuccessful. From 1400-1700 mended and attached Lampara wing to bait net. 1730 moved to Wreck Bay beach area for night shot. At 1900 about 200 scoops of pilchards under light but were scared by barracouta. Moved to another position and at 2030 approximately 50 scoops of pilchards came under light but presence of jack mackerel prevented shooting bait net.

29.9.77 0100 left Wreck Bay due to presence of jack mackerel and barracouta and steamed to Jervis Bay. At 0500 shot bait net; however only obtained 10 scoops of Maray pilchards. At 0820 steamed towards Wreck Bay with the objective to capture bait during daylight hours. From 1030 to 1500 had 6 day shots with bait net, however were only successful in taking 150 scoops from one shot. At 1530 steaming towards Jervis Bay and anchored at 1800 after bait sounding.

30.9.77 From 2400 to 0345 moved five times within Jervis Bay, in an attempt to find a more plentiful bait supply. At 0500 approximately 200 scoops of pilchards under light, however bait shot was unsuccessful. 0700 steamed towards Sydney. Rough sea conditions. Arrived Sydney 1500.

1.10.77 0960 Sydney Cove. Obtained fuel and stores. 1400 left Sydney Cove with objective to fish areas east of Coffs Harbour with pilchards as bait. Searching course as in Map 20. Sighted scattered skipjack to 1800. Steamed throughout night and early morning.

2.10.77 From 0600 searching and arrived at Coffs Harbour 2400. Sighted 5 schools of skipjack. Attempted to fish 3 however only one school responded to live bait fishing - caught approximately 108 kg. Water temperature at this particular area was still cold 22.7°C; however the increased biting response may be due to the pilchard bait.

3.10.77 0645 steaming from Coffs Harbour. Rough sea conditions, wind SW/20 knots. Returned to Coffs Harbour wharf at 1330.

4.10.77 0800 Coffs Harbour wharf. Rough sea conditions. Wind SW/15 knots and expecting Southerly change. At 1200 left Coffs Harbour wharf and searched eastwards. Sighted 1 school of skipjack which did not respond to bait. Previously sighted relatively larger numbers of schools in the area. Predicted that fish more southwards. At 2000 layed-out.

5.10.77 0800 searching as in Map 24. Water conditions observed were better than ones previously encountered. That is ,water temperature 22.4°C, Royal blue (scale 1A), marked frontal boundaries existed and knife edged oscillations throughout in blue sea. Sighted 14 patches of fish. Fished 2 patches and both responded to live bait. Caught approximately 2 tonne. Rough sea conditions in afternoon prevented fishing other schools. At 1600 steaming and anchored at Sugarloaf Point at 2400.

6.10.77 0830 Steaming towards Port Stephens. Rough sea conditions wind SW/20 knots sighted large numbers of scattered fish and small schools inshore. Anchored at Port Stephens 1330. At 2300 a very large amount of recently metamorphosed pilchards and anchovies appeared under light. This indicated that 2.5.4 cm) pilchards and anchovies have marked seasonal changes in abundance in these northern inshore areas as schools of this size were not previously recorded. During January to April one would expect this 0-year class stock to grow to a suitable bait size and to be available in relatively large amounts for baiting operations.

7.10.77 Port Stephens - rough sea conditions, wind SW/15-20 knots. Left Catriona B at 1500 as Phase I of this project terminated.

Acknowledgements

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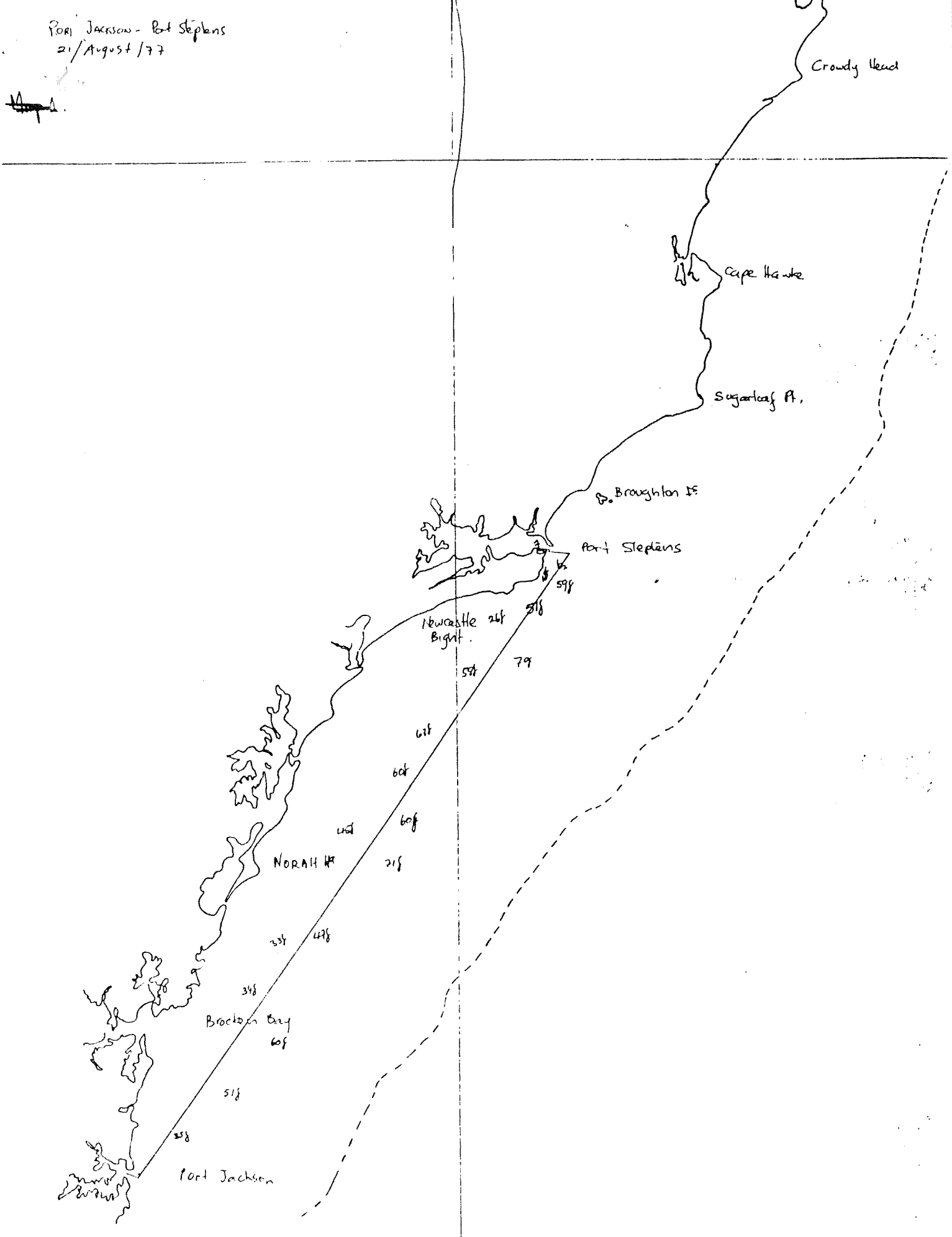
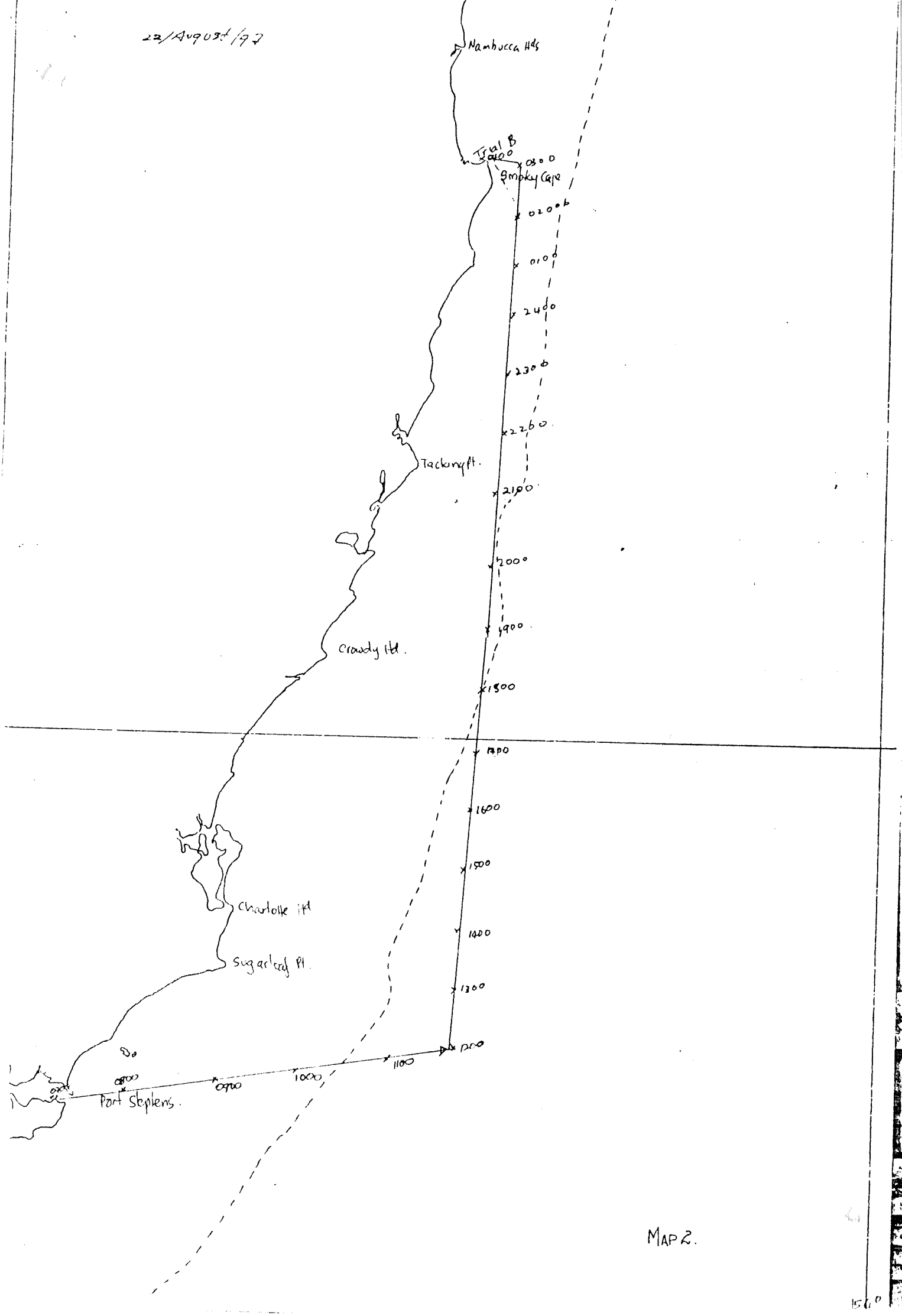
APPENDIX: SIGHTINGS AND RESPONSE OF SKIPJACK TO POLE AND LINE FISHING

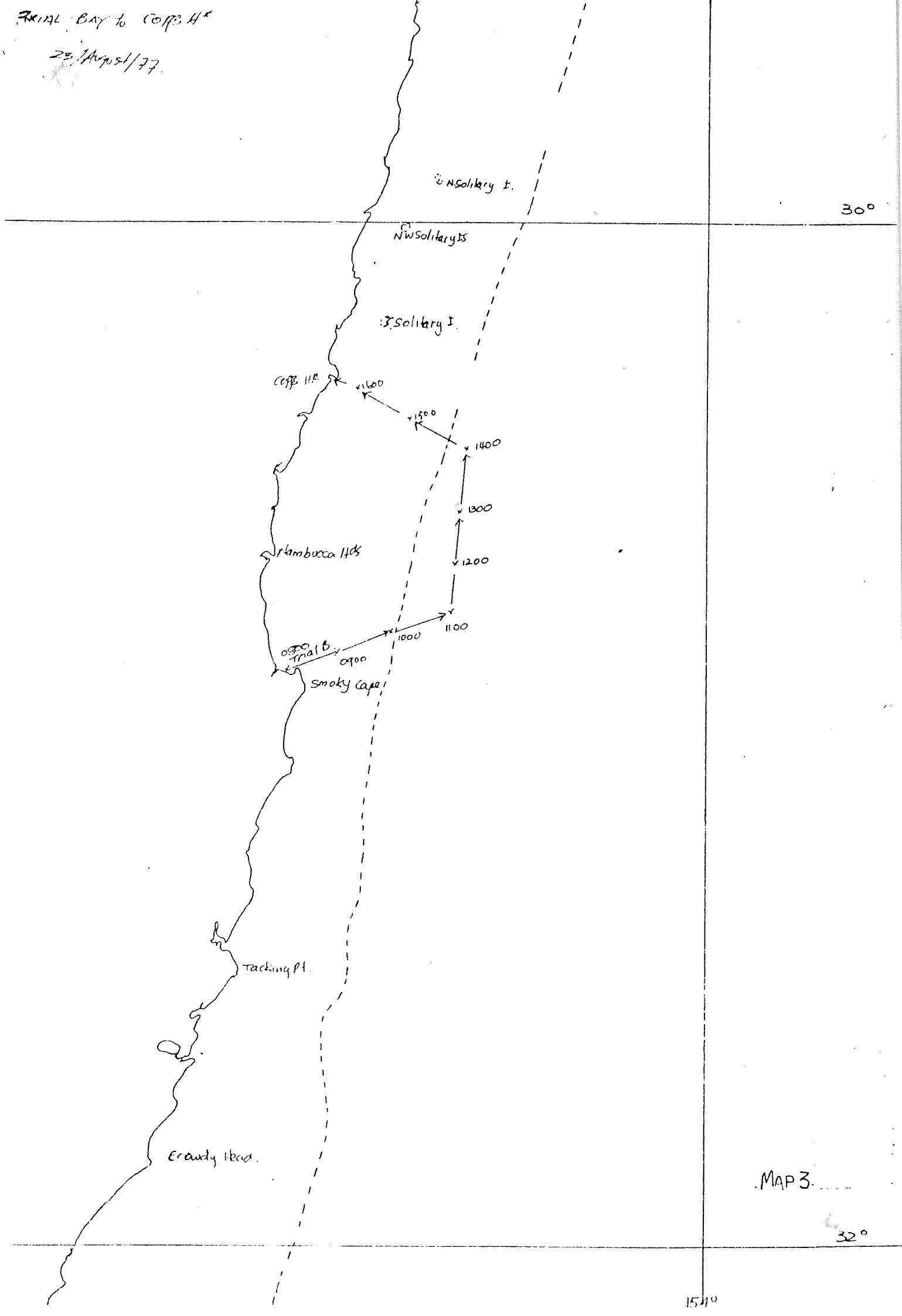
Date	No. skipjack schools sighted	No. schools fished	Response	Bait used
23 August	2	1	- re	yellowtail
24 August	49	15	- re	"
26 August	10	6	- re	"
27 August	14	8	- re	"
28 August	12	4	- re	"
29 August	15	5	- re	"
30 August	17	6	+ re (1 school)	"
1 September	22	7	- re	"
2 September	60	10	- re	"
6 September	5	2	- re	"
9 September	25	5	- re	"
12 September	4	4	- re	"
18 September	6	5	- re	"
19 September	17	10	- re	"
2 October	5	4	+ re (1 school)	pilchard
4 October	1	1	- re	"
5 October	14	3	+ re (2 schools)	"
	278	96		

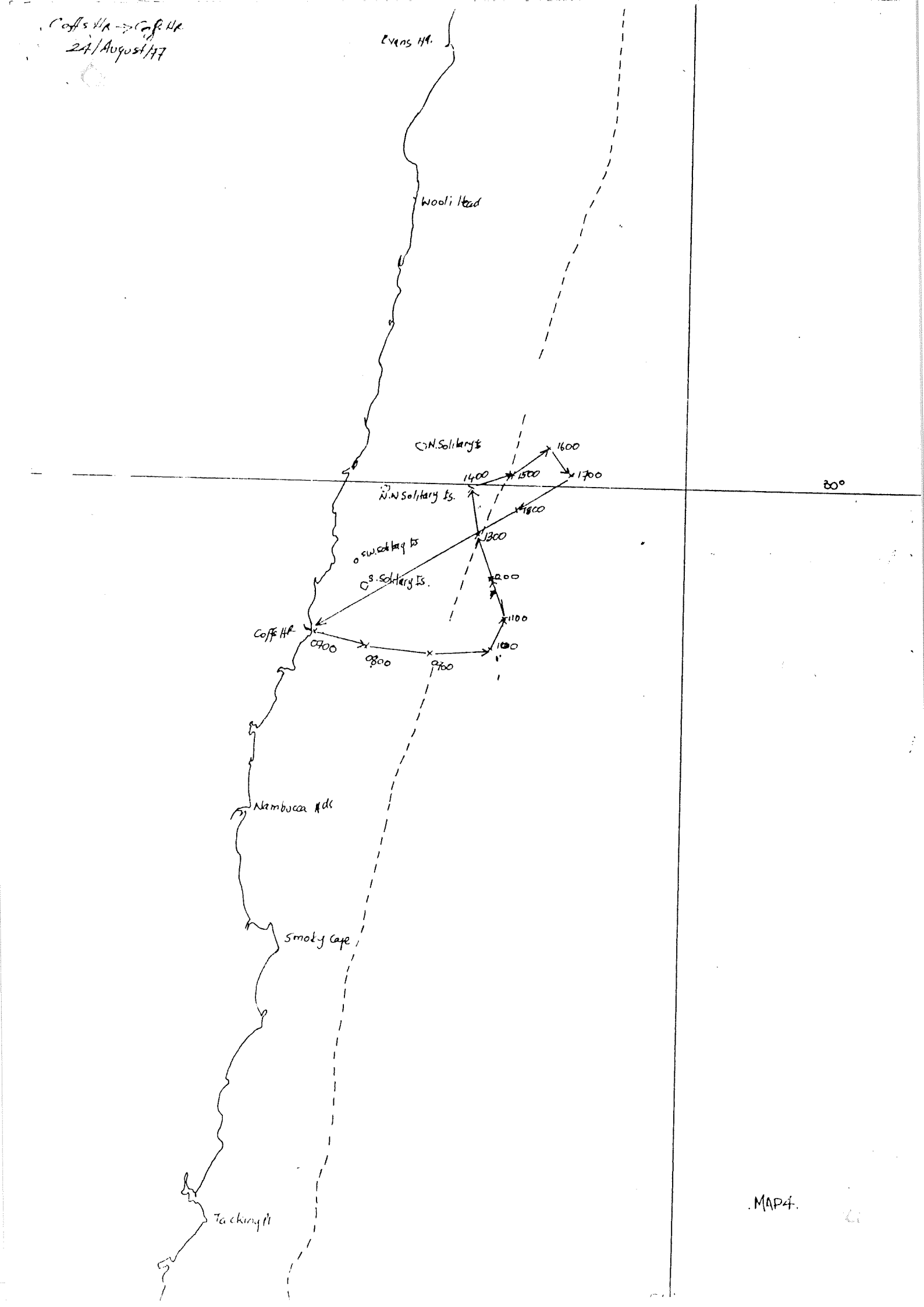
Port Jackson - Port Stephens
21/August/77

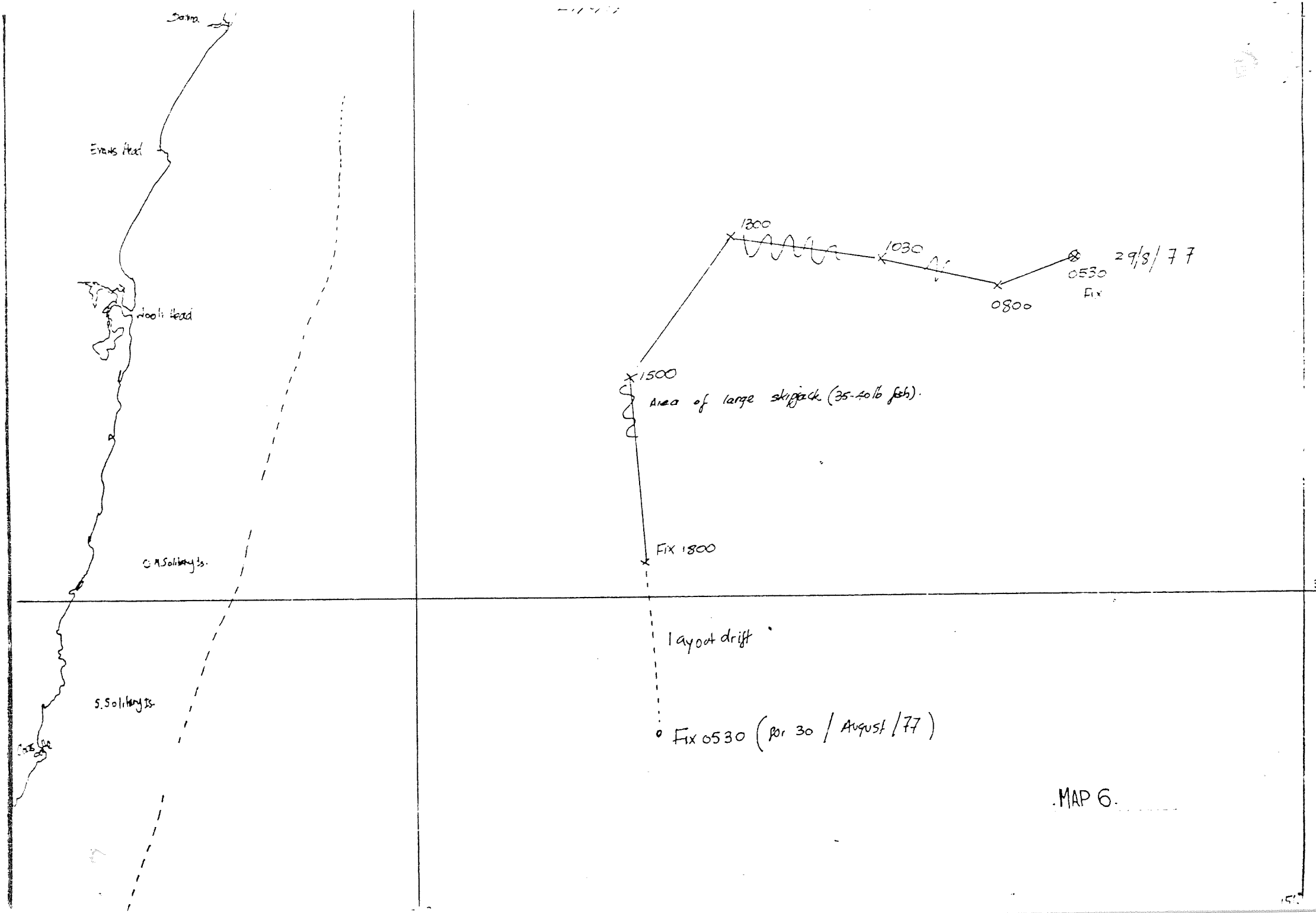


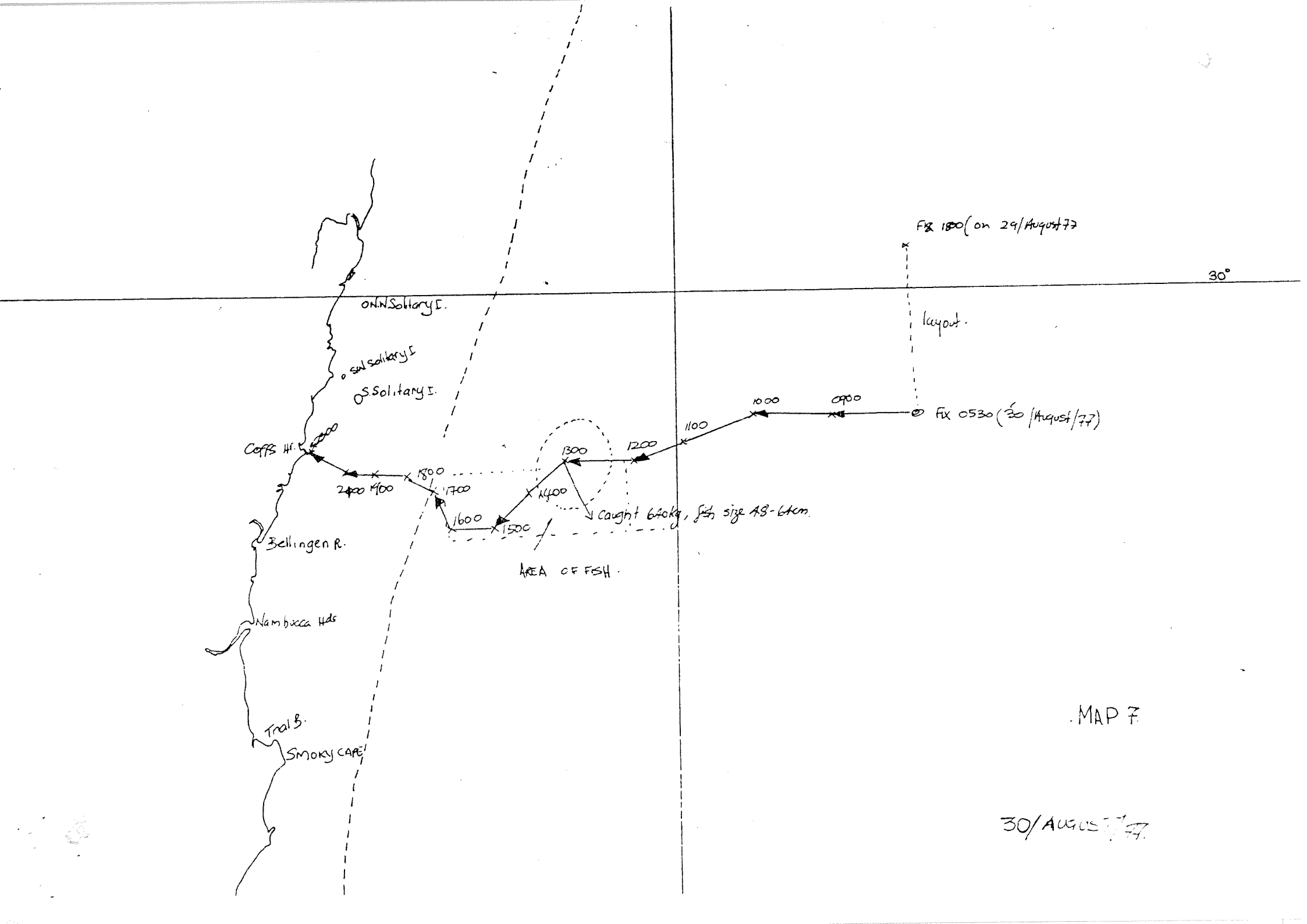
MAP 1.

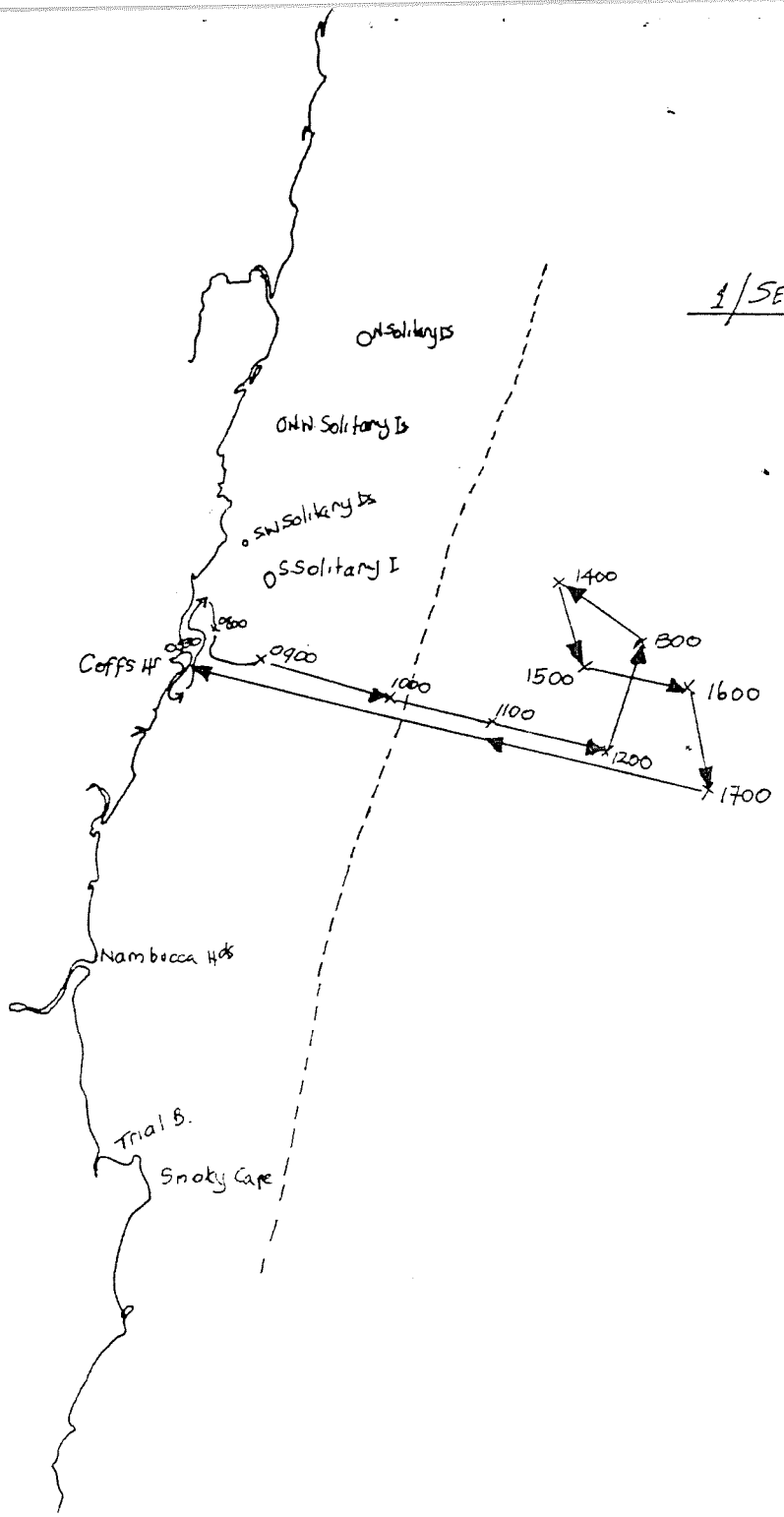

22/August/97
Nambucca Hds
Trial B
0400
0300
Smoky Cape
0200
0100
2400
2300
2200
Tacking Pt.
2100
2000
1900
Crowdy Hd.
1500
1800
1600
1500
Charlotte Pt
1400
Sugarloaf Pt.
1300
1200
1100
1000
0900
0800
Port Stephens.
MAP 2.


TRIAL BAY to COFFS H^R
25/1/August/77.
N Solitary I.
30°
NW Solitary Is
S Solitary I.
Coffs Hr
1600
1500
1400
1300
1200
1100
1000
0900
0800
Trial B
Smoky Cape
Tacking Pt
Crowdy Head
MAP 3.
32°
154°

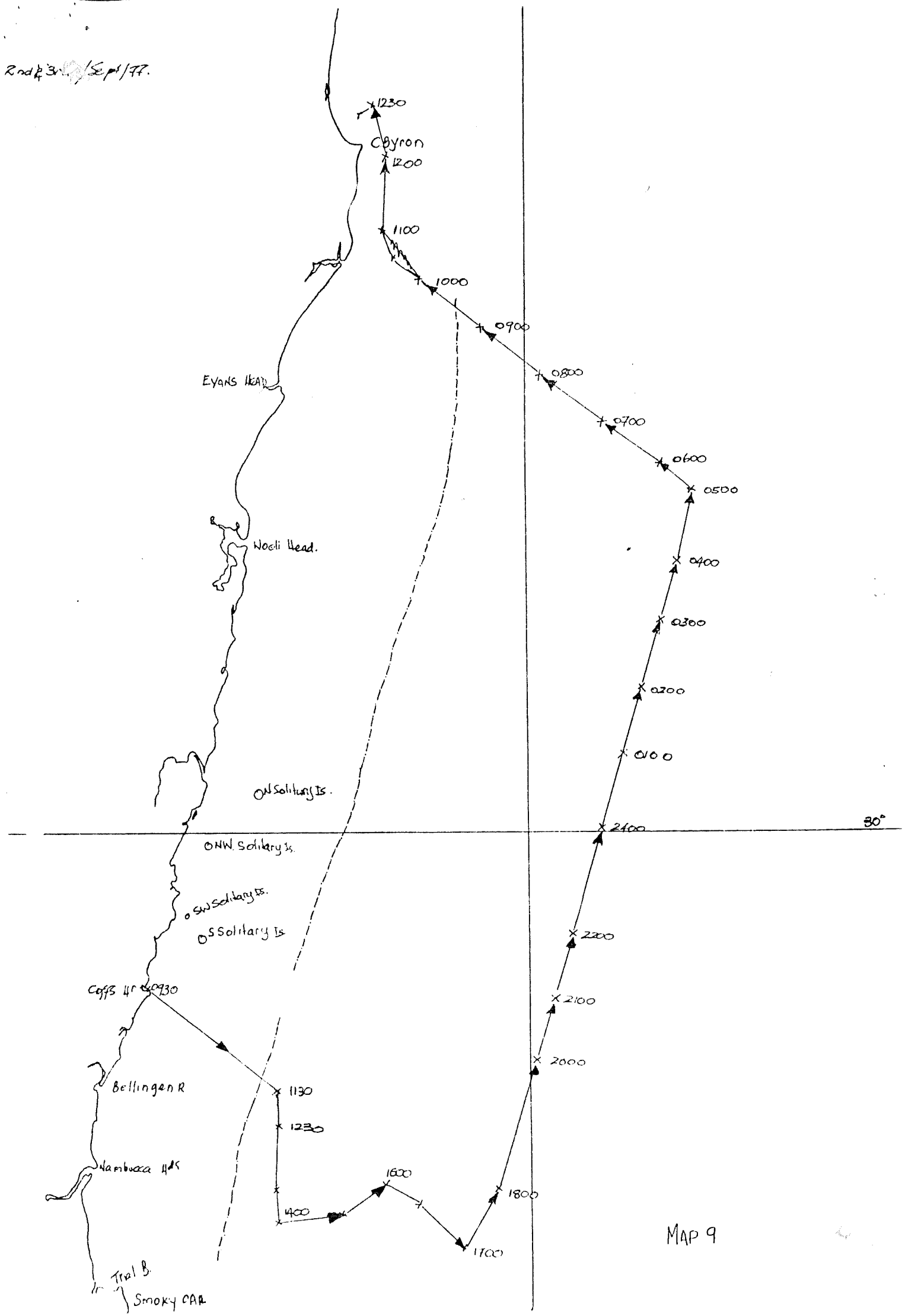

Coffs Hr -> Coffs Hr
24/August/77
Evans Hd.
Wooli Head
N.Solitary Is
1600
1400
1500
1700
N.N Solitary Is.
1800
1300
W.Solitary Is.
S. Solitary Is.
2000
1100
Coffs Hr
0700
0800
0900
1000
Nambucca Hds
Smoky Cape
Tacking Pt
80°
MAP 4.


Darwin
Evans Head
Iluka
Woolgoolga
Woolgoolga Head
C. M Solitary Is.
S. Solitary Is.
Coffs Hbr
1300
1030
0800
0530
Fix
29/8/77
1500
Area of large skipjack (35-40lb fish).
Fix 1800
layout drift
Fix 0530 (for 30 / August / 77)
MAP 6.

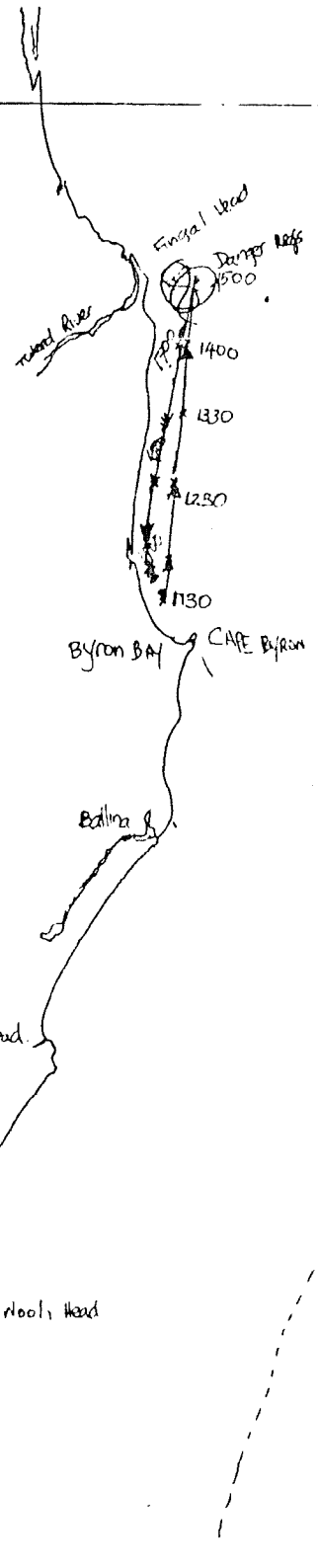

Fix 1800 (on 29/August/77
30°
layout.
ON.N.Solitary I.
S.Solitary I.
Coffs Hr.
Bellingen R.
Nambucca Hds
Trial B.
SMOKY CAPE
2000
2400
0100
0800
0900
1000
1100
1200
1300
1400
1500
1600
1700
Fix 0530 (30/August/77)
caught 640kg, fish size 48-64cm
AREA OF FISH
MAP 7
30/AUGUST/77


1/SEPTEMBER/77.
NSolitary Is
ONW Solitary Is
SW Solitary Is
SSolitary I
Coffs Hr
0800
0900
1000
1100
1200
1400
800
1500
1600
1700
Nambucca Hds
Trial B.
Smoky Cape

MAP 8.


2nd & 3rd/Sept/77.
1230
Cbyron
1200
1100
1000
0900
0800
0700
0600
0500
0400
0300
0200
0100
2400
2200
2100
2000
1800
1700
1600
1400
1130
1230
0930
Evans Head
Woodi Head.
ONSolitary Is.
ONW. Solitary Is.
OSW Solitary Is.
OS Solitary Is
Coffs Hr
Bellingen R
Nambucca Hds
Trial B.
Smoky CAR
30°
MAP 9

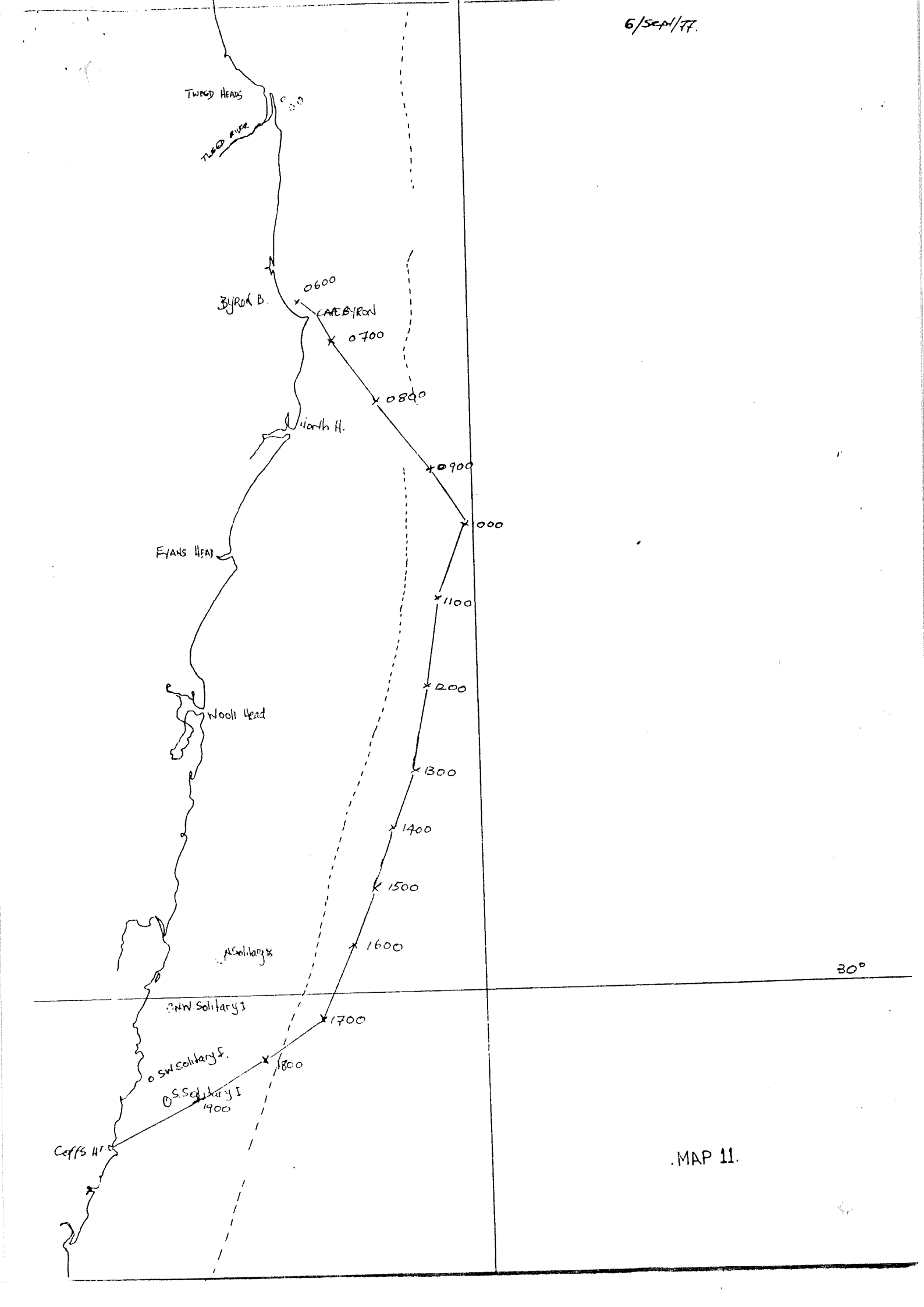
4/Sept/77.

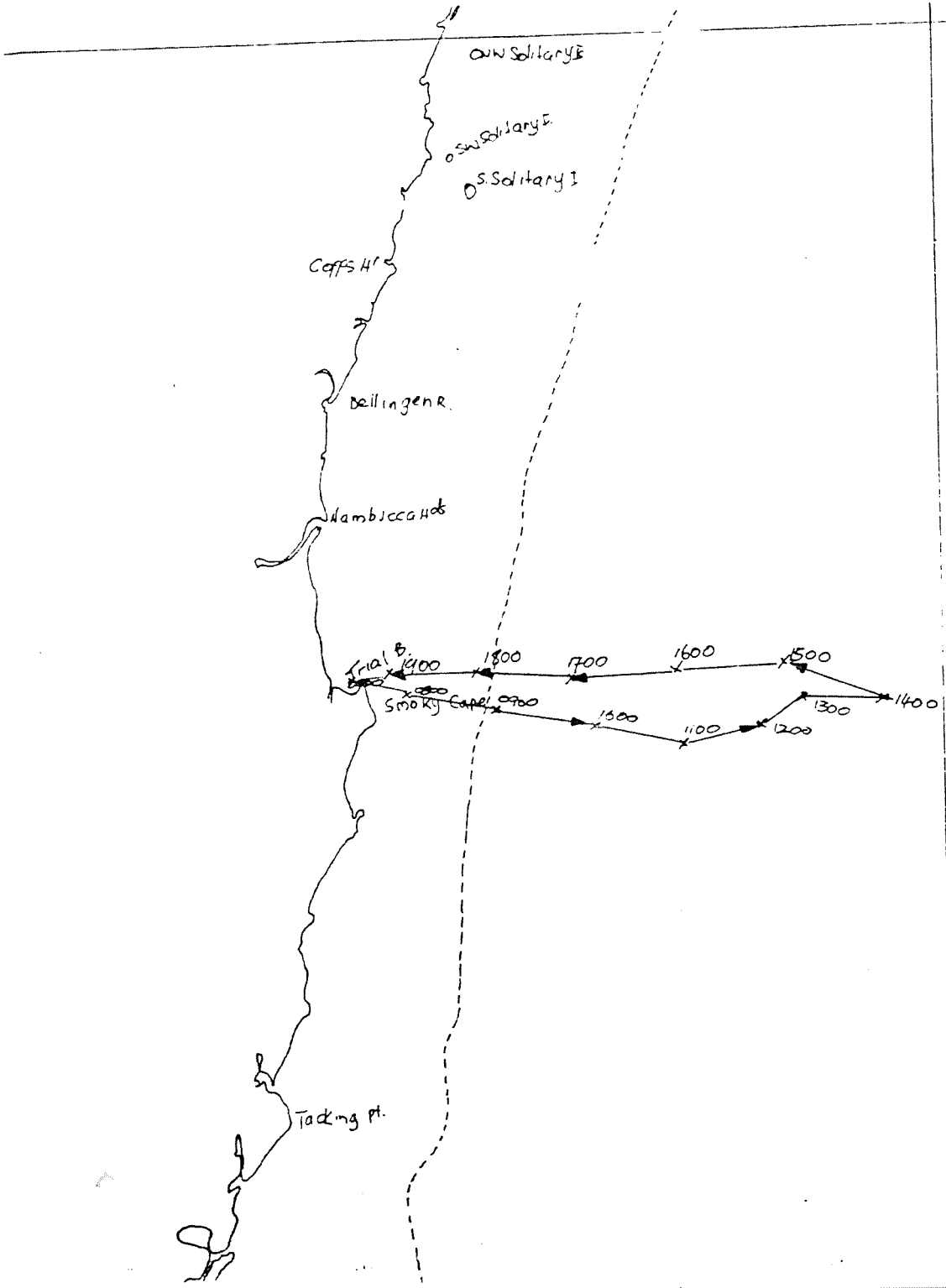


28°

MAP 10.

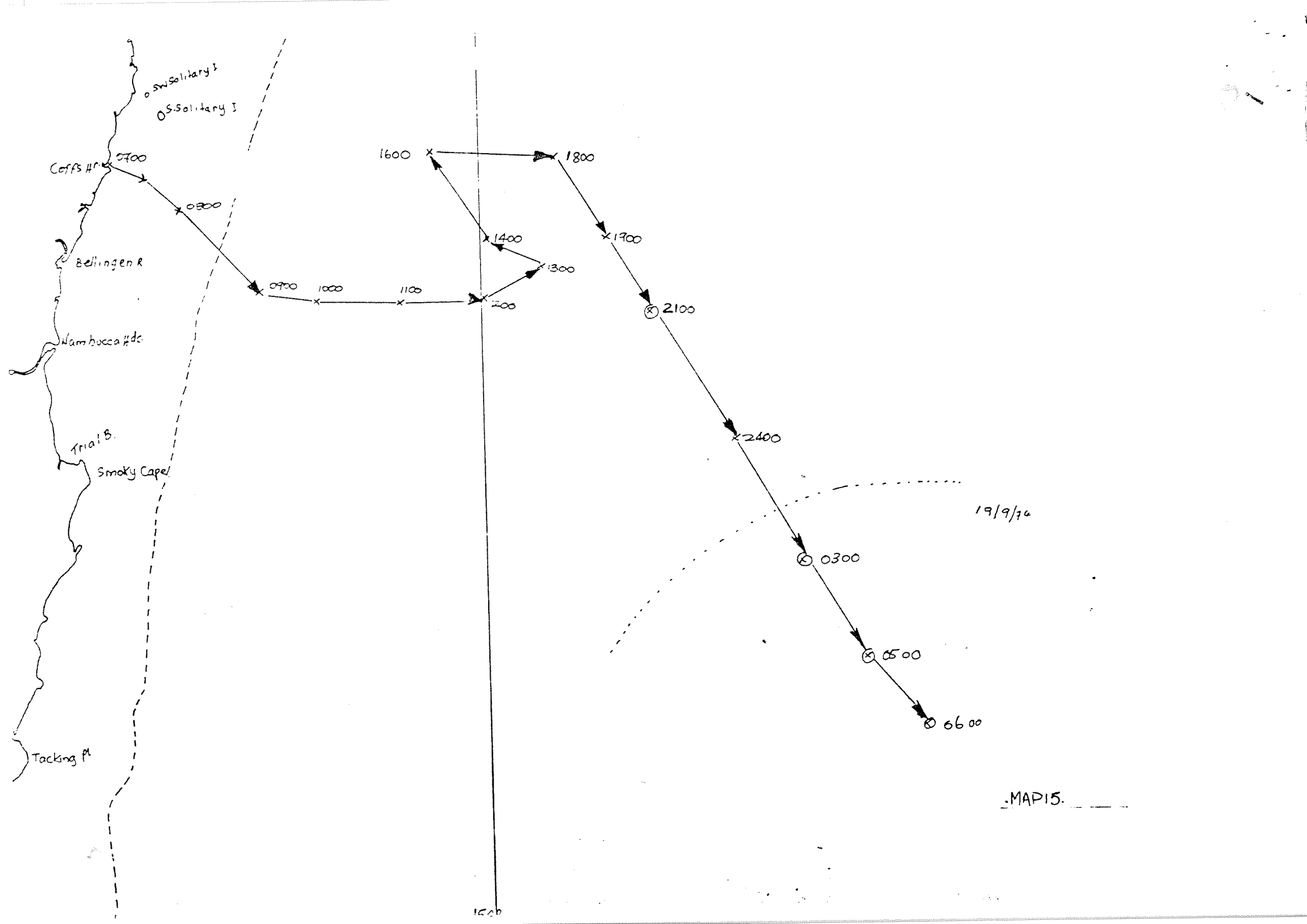
154°

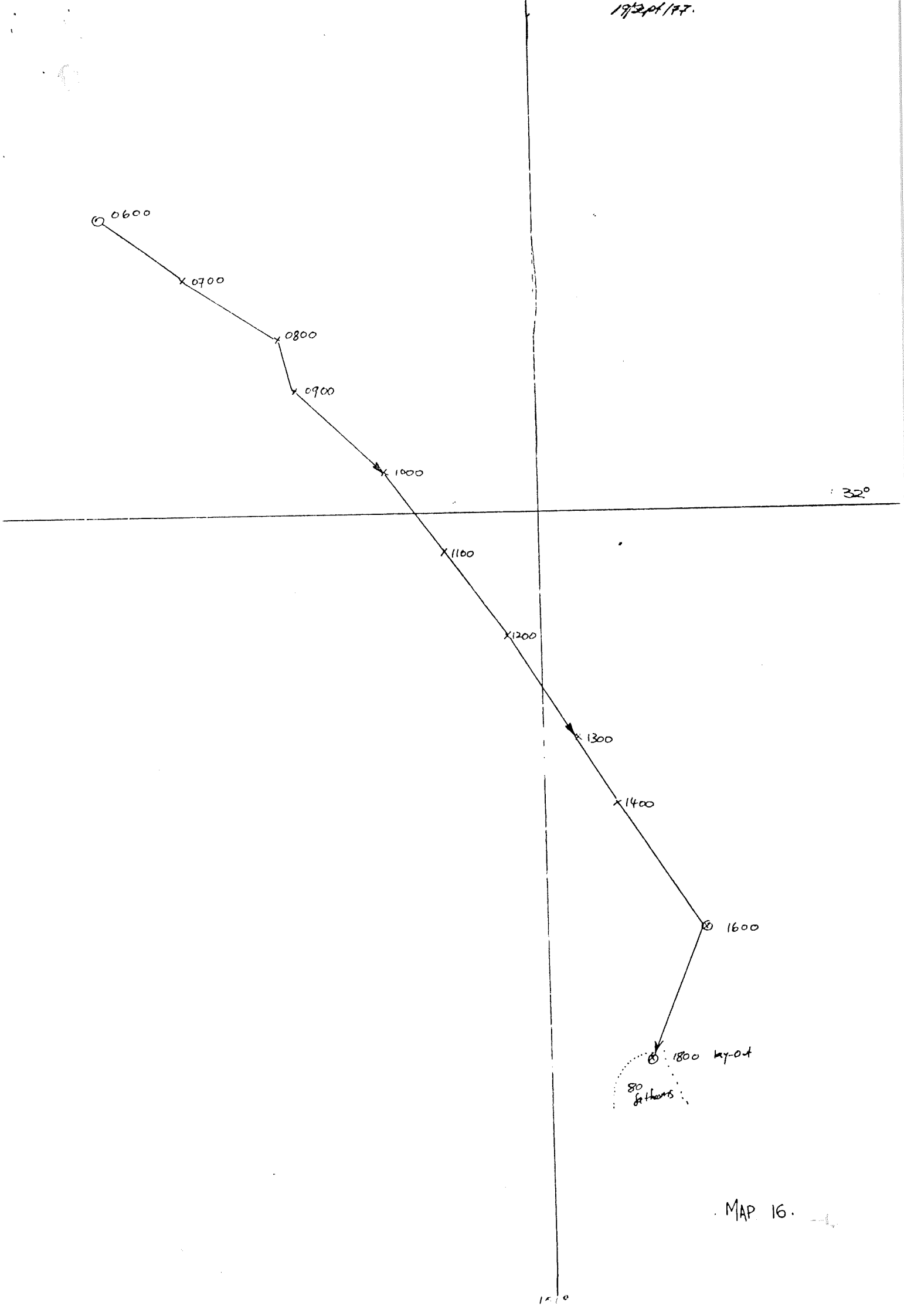

6/SEPT/77.
TWEED HEADS
TWEED RIVER
BYRON B.
CAPE BYRON
0600
0700
0800
North H.
0900
000
EVANS HEAD
1100
200
Wooli Head
1300
1400
1500
1600
Solitary Is
30°
NW Solitary I
1700
SW Solitary Is.
1800
S. Solitary I
1900
Coffs Hr
MAP 11.



9/SEPT/77.

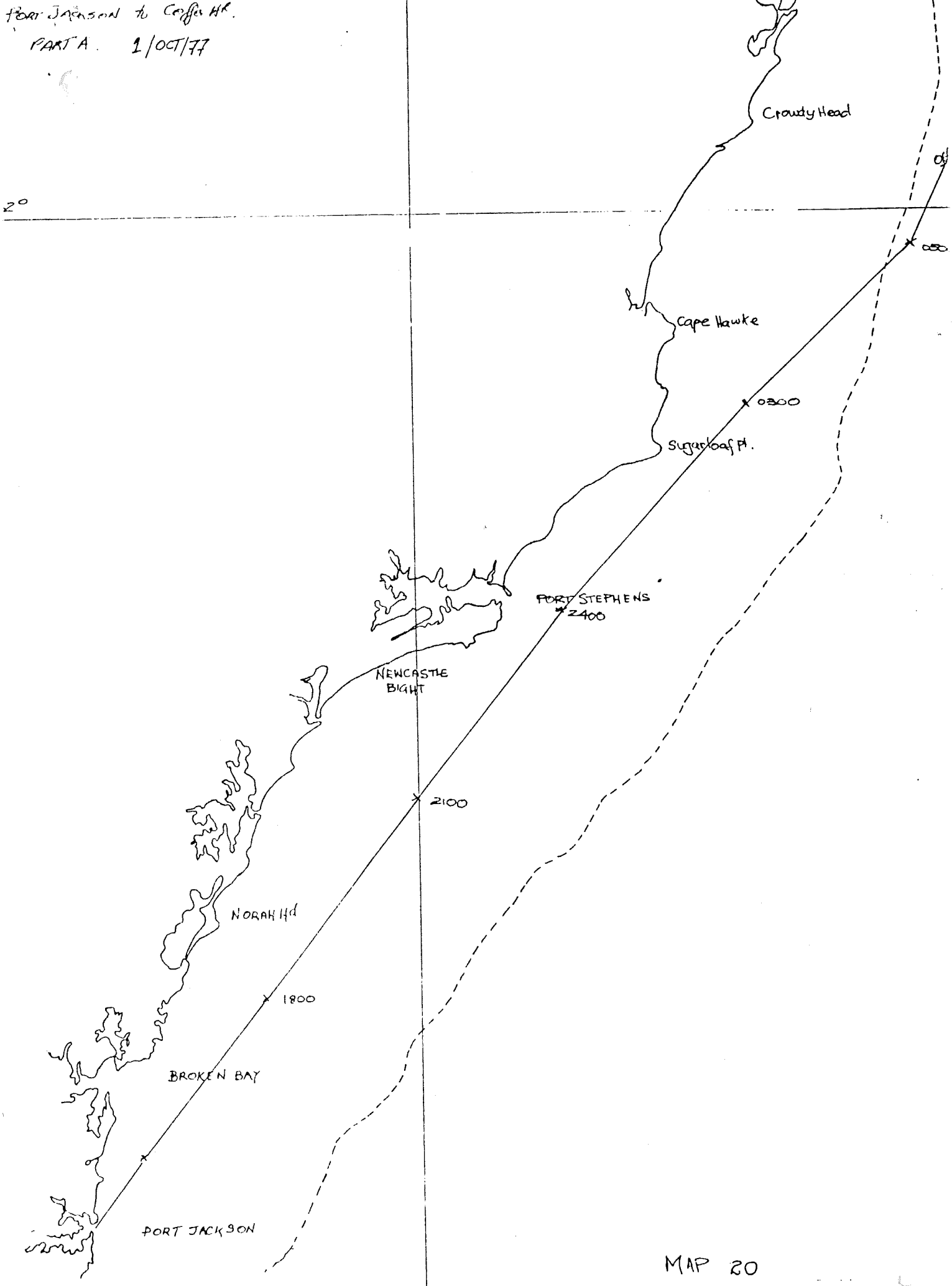
MAP 12.


SW Solitary I
S. Solitary I
Coffs Hr
0700
0800
0900
1000
1100
1200
1300
1400
1600
1800
1900
2100
2400
0300
0500
0600
Bellingen R
Nambucca Hds
Trial B.
Smoky Cape
Tacking Pt
19/9/74
MAP 15.

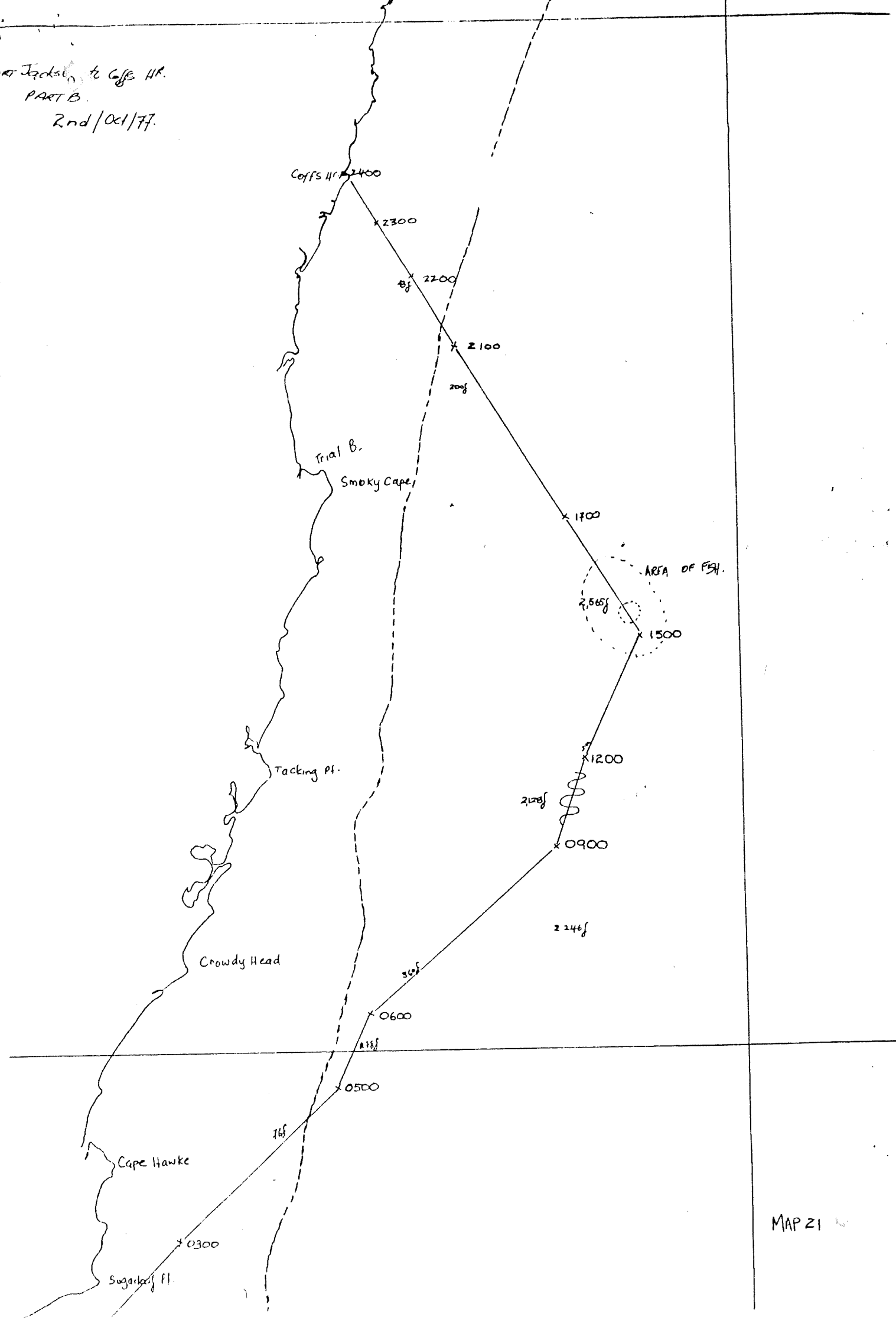

1952/04/17.
0600
0700
0800
0900
1000
32°
1100
1200
1300
1400
1600
1800 lay-out
80 fathoms

MAP 16.

Port Jackson to Coffs Hr.
PART A. 1/OCT/77



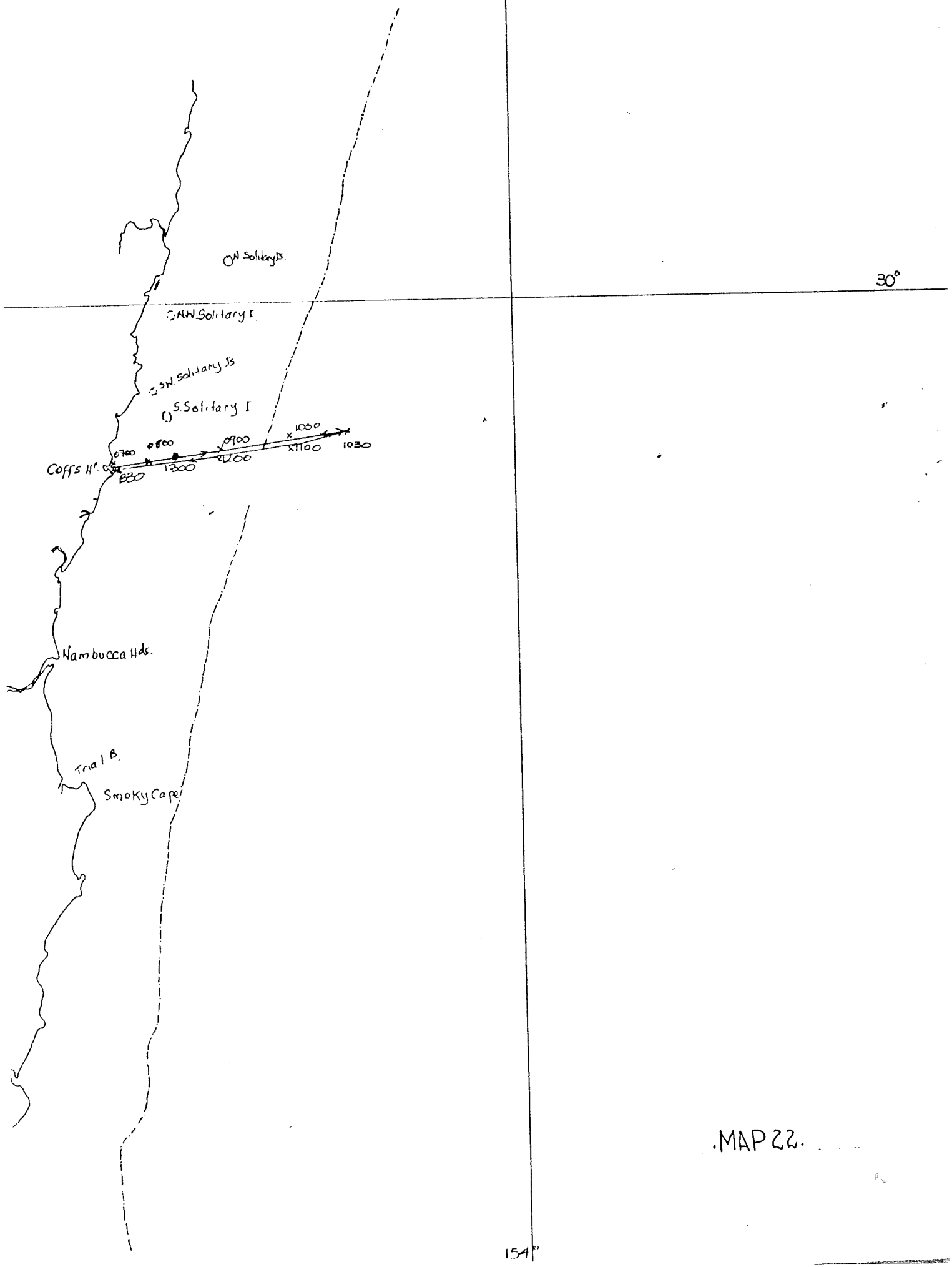
Port Jackson to Coffs Hr.
PART B.
2nd/Oct/77.



MAP 21

3/Oct/73

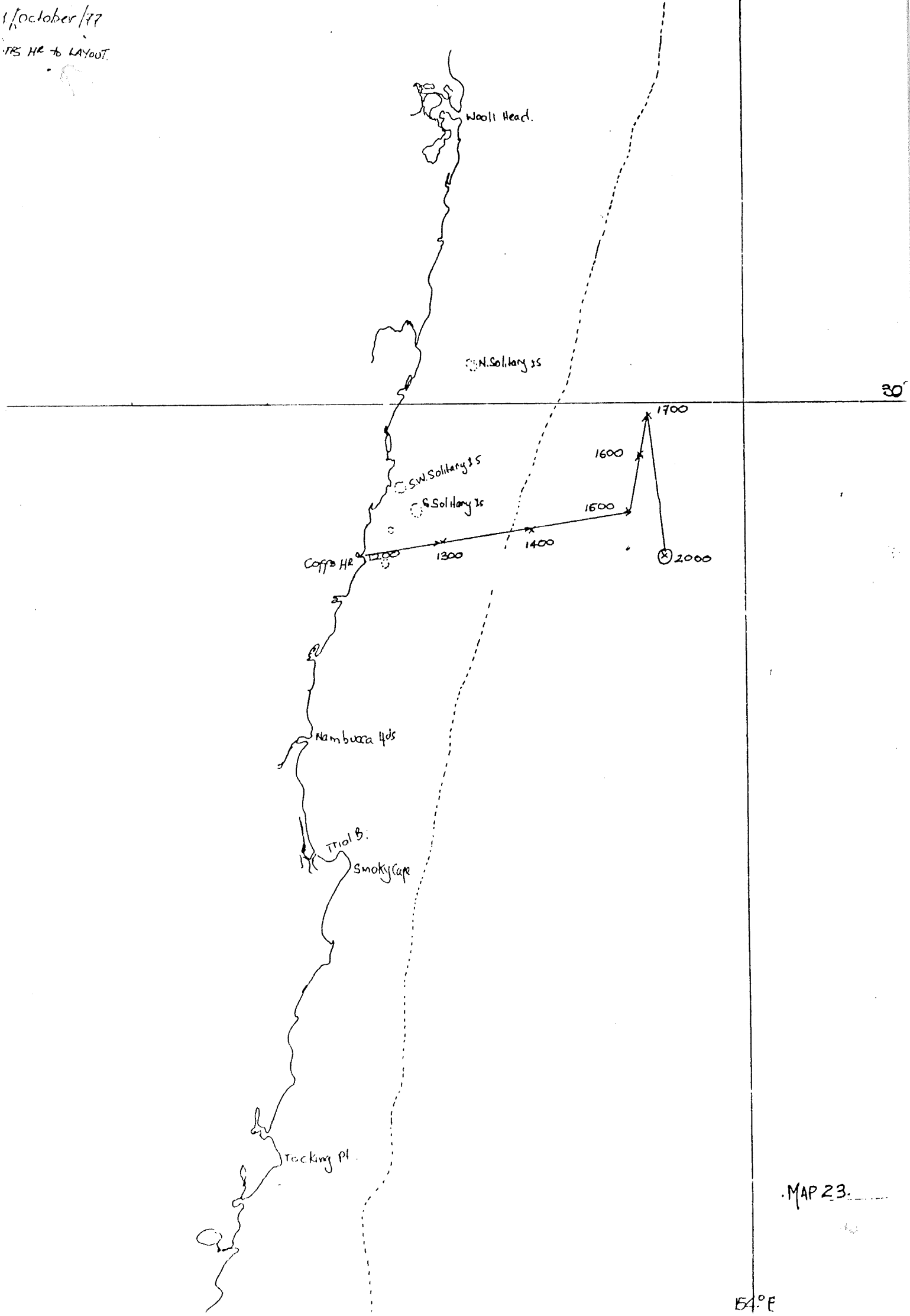
Coffs Hr to Coffs Hr.

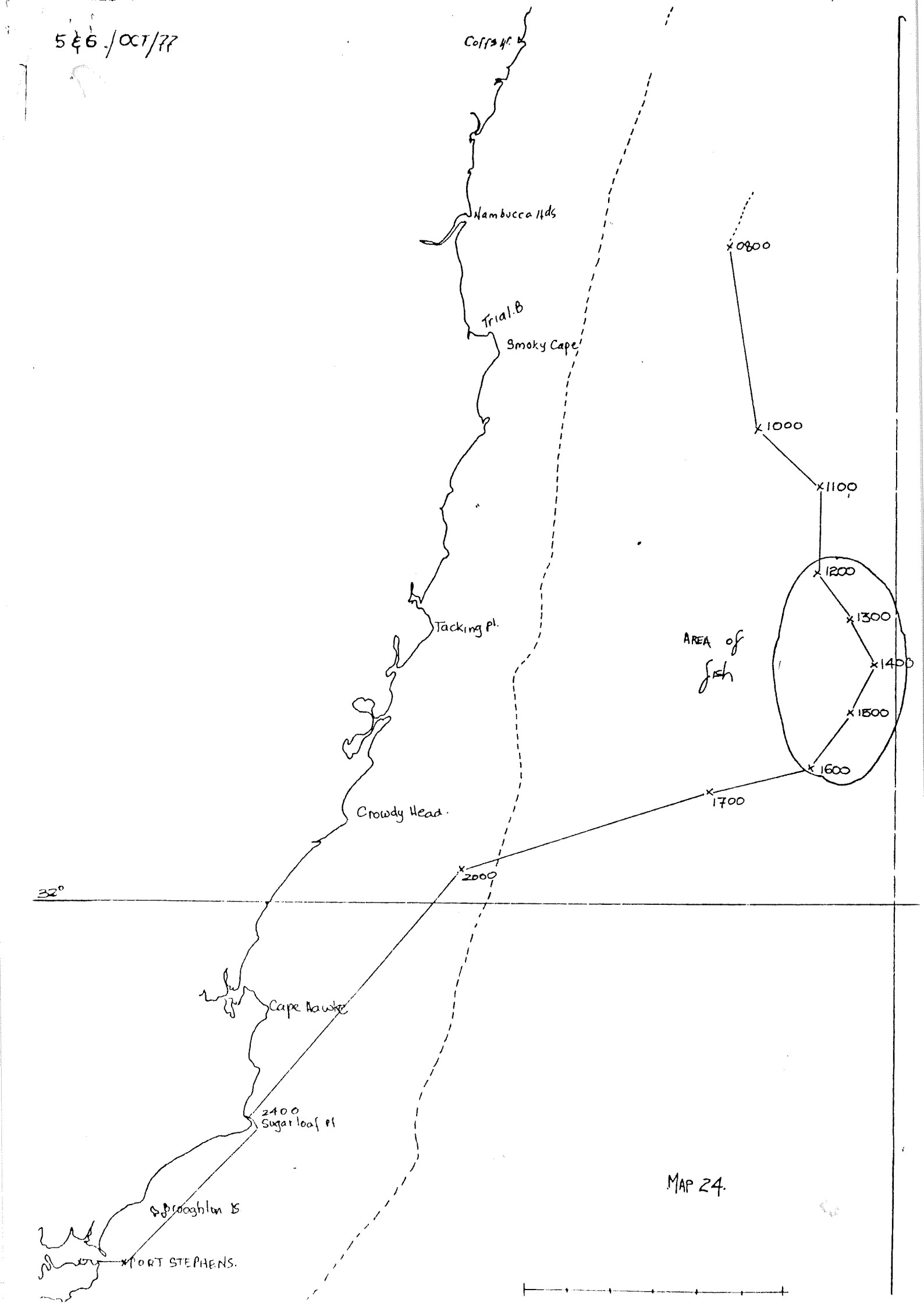


.MAP 22.

1/October/77

TBS HR to LAYOUT




5 & 6 / OCT / 77
Coffs H.
Nambucca Hds
Trial B
Smoky Cape
Tacking Pt.
Crowdy Head
Cape Hawke
2400
Sugarloaf Pt
Broughton Is
PORT STEPHENS.
32°
0800
1000
1100
1200
1300
1400
1500
1600
1700
2000
AREA of fish
MAP 24.

25·0
24·0
23·0
22·0
21·0
20·0
19·0
18·0
17·0
16·0
15·0
14·0
13

30 35 40 45 50 55 60 65 70 75 80 85

$y = mx + c$

Centigrade = 0·2096 × Thermo. units + 8·3909

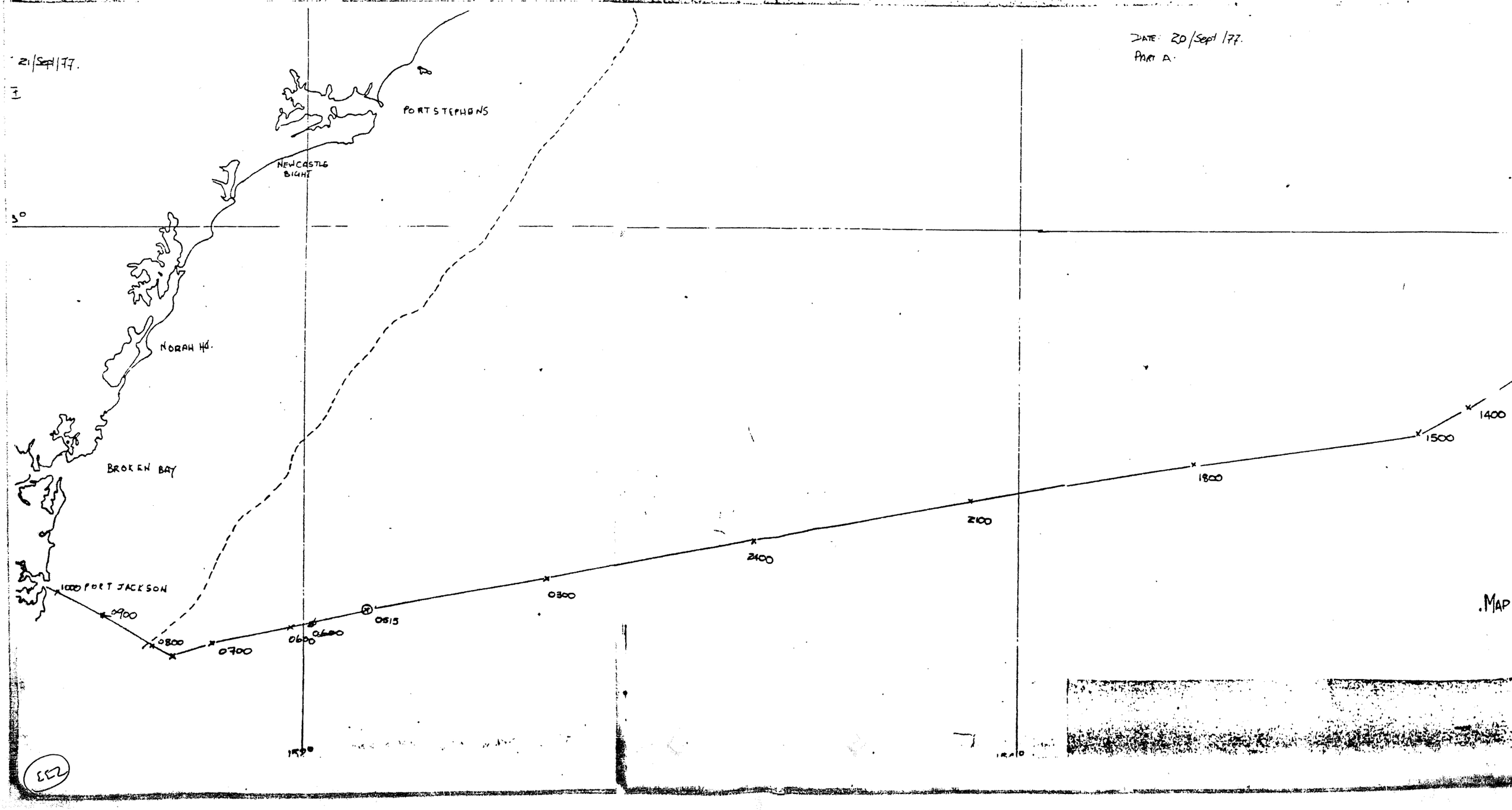
$t_{0.001}$

No. of readings (N) = 83

Degrees of freedom = 81

DATE: 20/Sept 177.
PART A.

21/Sept/77.



MAP 1

COMMERCIAL DEVELOPMENT OF THE STRIPED TUNA *(KATSUWONUS PELAMIS)* RESOURCE IN EASTERN AUSTRALIAN WATERS

The chartered tuna fishing vessel *Catriona B* was engaged in phase II of this survey from 16 January to 26 April, 1978. Fishing operations extended from Eden to Coffs Harbour with brief survey of the waters adjacent to Lord Howe Island. The fishing nucleus was centred about Port Stephens. During a total of 98 days of operation 56 were spent searching and fishing; eleven days were spent steaming, twenty three days were lost due to bad weather and eight days lost due to maintenance problems. Thirty seven nights were spent searching for bait from which 14 night-shots were made. Seven hundred and fifty seven schools of skipjack were sighted and from 301 attempts to "fish" these schools only 49 responded to pole-and-line fishing yielding a total catch of approximately 136 tonnes.

From an estimated total catch of 140.38 tonnes February constituted 68.85 tonnes (49.05%), March 57.4 tonnes (40.8%), January 7.23 (5.15%), September-October 3.25 tonnes (2.33%), April 3.1 tonnes (2.3%) while August contributed 0.5 tonnes (0.36%) to total catch. (Phase I and II).

The Sugarloaf Point - Port Stephens area contributed to over 74% of the total catch. Some catches exceeded 10 tonnes from schools and as such the catch rate (fish per hook-minute) exceeded the highest catch rates of most foreign skipjack fisheries. Mean catch/fishing day rose from 0.9 tonnes/day in January 1978 to 11.48 tonnes/day in March and fell to 0.78 tonnes/day in April. Similarly, mean catch/school rose from 0.72 tonnes/school in January and rose to 4.78 tonne/school in March with a subsequent fall to 0.39 tonne/school in April.

Modal size classes in phase I were evident at 50-51, 54-55 and 56-57 cm class intervals. However, in phase II a large variety of modes existed between the schools ranging from 38-39 cm to 56-57 cm. The most frequently occurring modal size classes within the schools of phase II were the 46-47 and 48-49 class intervals. Schools fished at Lord Howe Island during January 1978 contained a modal size class of 56-57 cm and this class interval was dominant in some schools fished in the mainland waters during March and April.

Most schools sighted were small fish schools (<45 cm) characterised by being of small tonnage (< 10 tonnes). Daily school sightings were higher than most documented foreign fisheries, Appendix 1. The number of schools sighted per month -hour were highest in April 2.15 schools/hr, followed by January 2.11, March 1.81, August 1.72, February 1.28 and September-October 1.23 schools/hr.

Average daily density (no. schools/hr/day) varied largely between days and between months with the highest value of 2.03 schools/hr occurring in January and the lowest value of 1.4 schools/hr occurring in September-October 77. From a total number of 757 schools sighted during the entire survey, March contributed 233 schools (22.02%), followed by April 213 schools (20.13%), February 177 schools (16.73%), Sept-October 172 schools (16.26%), January 134 schools (12.67%) and August 129 schools (12.19%).

The objectives of the fishing operation were to maximise catches of fish larger than 3 kg and to find suitable bait supplies along the coast. This survey was successful in that the "fishery" was expanded in latitude resulting in sightings and catches of skipjack which previously were neither sighted nor caught in such quantity. Furthermore, potentially "good" baiting areas were found to exist north of Sydney. Unfavourable weather conditions, the lack of

small bait (anchovies and small pilchards), the low bait-tank capacity, the inefficient holding tanks aboard the *Catriona B* and the overall shortage of large fish (> 3 kg) were a drawback to this operation.

The results of this survey indicate that a large skipjack resource exists in Eastern Australian waters which could be caught in "fishable" quantities from August to March. Unfortunately, the skipjack resource as well as the availability of small bait may be grossly unpredictable in quantity from year to year. The present attitude of Australian tuna fisherman towards development of a skipjack fishery is unfavourable and is due to the existing price structure of skipjack, the lack of shore facilities and the occurrences of lengthy periods of bad weather. Overall, the financial return per tonne for equivalent units of effort (baiting, searching, catching etc) in skipjack fishing falls far below that of bluefin and this is the single most important factor hindering the development of such a fishery.

New Zealand has recently "developed" a skipjack fishery largely based on foreign purse-seine expertise. During the 1977-78 season the New Zealand skipjack catch exceeded nine and a half thousand tonnes with the bulk of this catch being made by five purse seiners exceeding 1000 tonne holding capacity. It is evident that the development of a skipjack fishery requires purse-seine methods with experienced foreign fishing crew.

CATCH, FISH SIZE AND SCHOOL SIGHTINGS OVER PHASE I (AUG.-OCT, 1977) and PHASE II (JANUARY-APRIL 1978)

CATCH: From an estimated total catch of 140.38 tonnes February contributed 68.85 tonnes (49.05%), March 57.4 tonnes(40.9%, January 7.23 tonnes (5.15%), September-October 3.28 tonnes (2.33%), April 3.1 tonnes (2.2%) while August contributed 0.5 tonnes (0.36%) to total catch, Fig. 1, Table 1A. Of the areas fished the zones between Sugarloaf Point and Newcastle (9/1,10/3) contributed over 74% to the total catch. While Lord Howe Island (zones 8/14, 8/13) contributed 13% to total catch, Fig. 2 c,d,e. At these high yielding zones catches in excess of 10 tonnes were caught from individual schools which in consideration of the number of polers (4-5) exceeds the highest catch rates of most documented foreign pole-and-line fisheries, Figure 3. Mean catch/fishing day rose to a maximum of 11.48 tonnes in March and fell to a low of 0.78 tonnes/fishing day during April. Similarly, mean catch/school rose to a maximum of 4.78 tonnes in March and fell to 0.39 tonnes in April, Fig.1,2;Table 1B.

FISH SIZE: Modal size classes of fish caught in Phase I were 50-51 cm (2.6 - 2.8 kg), 54-55 cm (3.4 - 3.6 kg) and 56-57 cm (3.8 - 4.1 kg) of which the latter size class was the strongest, Fig. 2a, b, Table 1A, Fig. 4. During phase II a variety of modal size classes existed between the schools ranging from 38-39 cm (1.0-1.1kg) to 56-57 cm (3.8 - 4.1 kg) with the most frequent modal size classes being the 46-47 cm (1.9-2.1 kg) and 48-49 (2.2-2.4 kg) size classes, Table 1A, Appendix 1.

Over the six survey periods size histograms of monthly catches have been constructed for each month and indicate to a limited degree the modes existing within the populations, Fig. 2(a) to (f). Further analyses have been carried-out in an attempt to separate groups from these polymodal size frequency distributors. Initial investigations of school size structure over phase II indicate: the size of fish within schools which were more accessible to fishing and the size differences of schools between areas and times (Fig. 5).

Observations indicate that the majority of schools sighted were small fish (< 45 cm) schools which were characterised by forming large numbers of small schools (<5 tonnes). The large fish (>10kg) sighted during phase I, were not observed within the areas searched during phase II.

Our fishing technique was selectively biased towards fish greater than 45cm, as such, the relatively low frequency of smaller size classes within the sampled population would be a reflection of this bias. Small fish schools could have been successfully fished over the survey if we were able to obtain large quantity of small bait.

NUMBER OF SCHOOLS: On seven occasions the number of schools sighted per day exceeded 50, Appendix 1. The average number of schools/month/hr was highest in April with a value of 2.15 schools and was followed by January 2.11, March 1.81, August 1.72, February 1.28, and Sept-October 1.23 schools/month/hr, Fig. 1. Average daily school density (schools/hr/day) was highest in January 2.03, and lowest in September-October 1.40, Figure 1, Table 1A. Preliminary analyses indicates that catch is not related to school density, Fig.6, this is realized by the large numbers of wild small schools which did not significantly contribute to the catch. However, catch tended to increase in relation to increasing frequency of larger sized schools(> 20 tonnes), Fig. 7. Overall, tightly aggregated large schools tended to be under-dispersed and a bite better in that a relatively higher biting response was maintained over a greater period, Fig. 3.

Large school aggregations (> 20 tonnes) were more frequent between Sugarloaf Pt and Port Stephens. Furthermore, the daily catch and the numbers of schools greater than twenty tonnes was found to be related to the number of manta rays, Fig. 8,9.

Skipjack searching relies more on seabirds than that of bluefin (personal experience). Some bird species numerical abundances are reliable indicators of skipjack presence while others have negative relationship. For example the wedgetail shearwater tends to increase as the numbers of schools of skipjack increases, Fig.10. Furthermore, spatial pattern (and behaviour) of sets of bird species can be used to home-in on skipjack (published elsewhere).

AREAS OF FISH CONCENTRATION:

August '77 - Only scattered fish were observed from the inshore waters from Sydney to zone8/2, Fig. 2a. The offshore waters between Wooli and Tacking point contained the largest aggregations of skipjack with concentration centred in the zones 4/2, 5/2, 6/3, 4/5, 3/4 and 4/3. The largest fish (> 10 kg) schools sighted over the entire survey occurred in the zones 3/4, 4/3. Fish were caught at zone 5/2, Appendix 1. Larger fish occurred further offshore.

SEPTEMBER-OCTOBER '77 - Areas of largest concentration occurred at the following zones: east of Smoky Cape (6/2, 6/1), east of Tacking Point (7/3, 8/3), east of Coffs Harbour (5/2) the far offshore waters east of Crowdy Head (8/6, 8/7) and a large concentration of small skipjack (< 45 cm) at 10/1 and 9/1. At zone 9/6 a very strong current line was encountered with a temperature drop of 4.6^{o}C. Northwards from the current line the water was warm, blue and contained skipjack; whereas southwards it was green, relatively cold and no skipjack schools were observed, Fig. 2b and Appendix 1.

JANUARY: Largest school concentration occurred between Ulladulla and Jervis Bay (15/3, 15/2), between Moruya and Ulladulla (16/2, 17/1) and Tathra-Bermagui (18/2, 17/1). Largest catch occurred at 13/4.

FEBRUARY: Searching ranged from inshore waters from Ulladulla to Sugarloaf Point and offshore waters from Jervis Bay to Lord Howe Island. Areas of largest school concentration occurred at the zones adjacent to Lord Howe Island (8/14, 7/13, 7/14) and zones between Sugarloaf Pt and Port Stephens (10/3, 9/1). Largest catches occurred at 9/1, 10/3 and 8/13. The largest school sighted (> 500 tonne) was situated in the Lord Howe Island zone, 8/13. The offshore waters between Lord Howe Island and Jervis Bay were relatively scarce in skipjack.

MARCH: Searching was restricted to inshore areas between Eden and Coffs Harbour with greatest cover given to areas between Sydney and Sugarloaf Pt. Areas of greatest fish concentration occurred at the following zones: 16/2; 15/2; 11/2,3; 12/2,3; 9/1 and 10/3. In contrast to August-October'77 relatively few skipjack schools were sighted between Crowdy Head and Coffs Harbour. Large school catches (e.g. 14,16 tonnes) occurred at zone 9/1 directly east of Sugarloaf Pt. At least 14 schools sighted at 9/1 exceeded fifty tonnes and one was in excess of 1000 tonnes, Fig. 2e, Appendix 1.

APRIL: Areas searched ranged from inshore waters from Sugarloaf Point to Montague Island. Schools were very "patchy" with occurrences being characterised by large numbers of wild small schools. Areas of greatest fish concentration occurred between Sydney-Wollongong and Sugarloaf Pt-Port Stephens. Large numbers of schools sighted over this period were "sized-mixed". The largest school catch was 1.0 tonne, Fig. 2F.

The richest water observed (plankton samples, birds, sharks, manta rays, marlin etc) between Coffs Harbour and Montague Island occurred in zones 9/1 and 10/2. It was at these zones, characterised by the presence of very strong current lines, temperature discontinuities and large water colour changes where large schools of skipjack occurred. In fact, the Sugarloaf Pt area is a biologically enriched zone and as such within optimum temperature regimes is a nucleus for skipjack aggregation.

TROLL LINE FISHING:

Trolling was carried out in conjunction with searching operations and the areas of greatest strikes are indicated in Appendix 1. Troll line fish caught in phase II tended to be larger than poled fish, Figure 11. No relationship was found between skipjack abundance (based on numbers of schools) and troll line strikes, Figure 12.

WATER TEMPERATURE AND COLOUR:

Although water colour was based on a subjective colour scheme results clearly showed that there was a strong relationship between colour and temperature. That is, blue water was warmer and greener water colder. Within the areas searched skipjack schools occurred more frequently in water from 22-25°C, Figure 13. Preliminary investigations of water colour-temperature phenomenon and the relationship to skipjack abundance suggest that water colour changes are more highly correlated with skipjack abundance than water temperature and water temperature differences, Table 2.

BAITFISH:

The following bait fish were caught during the survey: the southern anchovy, pilchard, sandy sprat, blue sprat, maray and yellowtail. Of these only the anchovy, pilchard and yellowtail are suitable for pole-and-line fishing.

The availability of small bait (small pilchards and anchovies) is a major problem associated with skipjack pole-and-line fishing along the east coast of New South Wales. During phase II no anchovies were observed and on only two occasions did small pilchards come under the bait-light. However, yellowtail of varying size are available in relatively large quantity from Eden to Trial Bay. At only two areas were small yellowtail caught, Broulee and Sydney Harbour, (Fig. 14). Observations indicated a large supply of small yellowtail at Trial Bay, Appendix II. Maray are abundant at Port Stephens but their exceedingly high bait-tank mortality warrants them unsuitable for skipjack fishing. Baitfish were not found at Lord Howe Island and intensive reef fish survey (B. Russel, personal comm) did not reveal presence of a suitable bait supply.

TABLE 2: CORRELATION MATRIX INDICATING THE RELATIONSHIP BETWEEN WATER TEMPERATURE, WATER TEMPERATURE DIFFERENCES (ΔT), WATER COLOUR CHANGES AND THE ABUNDANCE OF SKIPJACK

No. skipjack schools	1.0000			
Water temperature	0.2689	1.0000		
Water temp. diff.	0.0398	0.1167	1.0000	
No. water colour changes	0.7195	0.2353	0.2874	1.0000

The following biological investigations were carried out to varying stages of completion:

(1) Skipjack race investigation (Liver and blood samples, 1000 each Mr A. Lewis).

(2) Population structure of schools, areas and periods.

(3) Sex-ratio and gonad development (250)

(4) Length-weight relationship.

(5) Optimum sampling size for reliable estimation of population parameters.

(6) Feeding ecology of skipjack (400 guts).

(7) Fish response. Nos. fish poled/standard time intervals.

(8) Environmental relationships with the objective to develop an optimum searching strategy for skipjack.

   (i) Water temperature and colour phenomena in relation to skipjack abundance.

   (ii) Seabird species and pattern (49 species x 110 SITES, MULCLAS)

   (iii) Skipjack associations (birds, manta rays, marlin etc.)

   (iv) Seabird spatial pattern and behaviour in relation to skipjack.

   (v) Relationships between troll line fish and skipjack abundance.

TABLE 1A: SUMMARY SIGHTINGS AND CATCH RECORDS, SKIPJACK SURVEY, AUG.-OCT. 1977 and JAN.-APRIL 1978

Period	Total no. schools	% no. schools (ea.phase)	% no. schools phase I + II	Total no. effective search.hrs	% no. effective search.hrs each phase	% no. effective search hrs Phase I+II	Total schools Total monthly E.S.T.	Average daily school density (no/hr)	S.D.	No. school > 20 tonne	Catch tonnes	School modal size classes (cm)	% catch each phase	% catch I & II
PHASE I														
Aug.77	129	42.86	12.19	75	34.97	11.65	1.72	1.78	2.01	4	0.50	?50-51, 54-55, 56-57	13.23	0.36
Sep-Oct 77	172	57.14	16.26	139.5	65.03	21.66	1.23	1.40	2.21	13	3.28		86.77	2.33
Total Phase I	301			214.5						15	3.78			
PHASE II														
Jan.78	134	17.7	12.67	63.5	14.78	9.86	2.11	2.03	1.68	11	7.23	46-47, 48-49, 52-53	5.29	5.15
Feb.78	177	23.38	16.73	138.5	32.25	21.51	1.28	1.68	2.27	38	68.85	46-47, 48-49, 50-51, 52-53, 54-55, 56-57.	50.40	49.05
Mar.78	233	30.78	22.02	128.5	22.92	19.95	1.81	1.90	2.62	17	57.40	46-47, 48-49, 50-51, 54-55, 56-57	42.03	40.89
Apr.78	213	28.14	20.13	99.0	23.05	15.37	2.15	1.97	2.90	1	3.12	38-39, 48-49, 54-55, 56-57.	2.28	2.22
TOTAL PHASE II	757			429.5						67	136.60			
TOTAL PHASE I & II	1058			644							140.38			

E.S.T. = Effective searching time Fished** = Where schools responded to pole-and-line fishing

TABLE 1B: MONTHLY CATCH, AVERAGE CATCH/SCHOOL, AVERAGE CATCH/DAY AND AREAS OF LARGEST CATCH

Month	Monthly catch (tonnes)	% Total catch (Phase II)	No. schools fished**	Average catch per school (tonnes)	S.D.	No. Fishing days	Average catch per fishing day (tonnes)	S.D.	Areas of largest catch	Zone(s)% of monthly catch	Zone(s)% of catch for Phase II	Zones(s)% of catch for Phase I & II	Three largest school catches (tonnes)
January/78	7.23	5.29	10	0.72	0.87	8	0.90	0.99	13/3,13/4	56.71	3.0	2.92	3.0,1.0,1.0
February/78	68.85	50.40	23	2.99	3.43	11	6.53	5.68	9/1 10/3 8/14,8/13,7/14	34.13 35.22 26.72	17.20 17.75 13.47	16.74 17.27 13.11	12.0,10.0,10.0
March/78	57.40	42.03	12	4.78	5.80	5	11.48	7.42	9/1 10/3	76.13 22.30	31.99 9.37	31.12 9.12	16.0,14.0,12.0
April/78	3.12	2.28	8	0.39	0.45	4	0.78	0.84	12/2,12/3,13/2 9/2,10/3	59.29 33.65	1.35 0.77	1.32 0.75	1.0,1.0,0.8

E.S.T. = Effective searching time
Fished** = Where schools responded to pole-and-line fishing

SUMMARY LOG OF PHASE II (16 January to 25 April, 1978)

This log summarises daily operations over Phase II of this survey, with Fig. 2 indicating areas of operation and Appendix 1 records sightings and catch records from Phase I (August-September 1977) and Phase II (January-April, 1978).

16. 1.78 1030 Departed Eden, weather NE/12-14. Searching inshore anchored at Brush Is., 2100. Objective to catch small bait. No anchovies or pilchards under light.

17. 1.78 0300 Only yellowtail under light. 0400 shot net and caught 50 scoops. 0700 left Brush Is., weather SW/15k and goggly. 0800 N/16-18k. Chummed a patch of small fish (< 2 kg) with no response. At 1500 arrived Jervis Bay and sighted 20 ripplers of bait. From 1600-1800 had day-shot; missed. 1800-1900 sounded for bait. Moved and sounded for bait three times from 2000 but bait relatively scarce.

18. 1.78 0100 Jervis Bay, pilchards under light. 0230 shot-net, caught 200 scoops. Overcast SSW/18k, rough sea. 0600 left J.B. Worked a patch at 1230 for approximately 1 tonne. Southerly gale from 1400. Tied up to Kiama wharf at 1530.

19. 1.78 0700 Kiama wharf, bad weather, NE/18-20k, rough sea. 2200 Left wharf and 2230 anchored at Bass Pt for baiting operation.

20. 1.78 0300 Bass Pt. 30 scoops pilchards under light. At 0500 approximately 500 scoops under light; but daylight. Sighted 21 schools skipjack with some mixed with small yellowfin. Chummed 10 schools with only 1 responding. From 1730 steaming and 2230 anchored Sydney Harbour for bait shot.

21. 1.78 0500 Sydney Harbour, shot net caught 120 scoops of yellowtail. 0830 left Sydney Harbour, NE/8k. Sighted 26 schools of skipjack most small schools. Fished a school at 1830 for 3 tonne. From 2000 steaming.

22. 1.78 0700 Searching from offshore position, NE/8k, 1300 NE/14-16k. Sighted 23 skipjack schools. Bait too large and no biting response from 9 of the 10 schools chummed. Anchored at Wreck Bay 1600 and from 2030 sounded for bait. Moved and sounded 3 times during early morning as could not find suitable bait supply.

23. 1.78 0400 Wreck Bay only large yellowtail and tailor under light, did not shoot. 0800 left Wreck Bay, NE/8 k. Sighted 25 skipjack patches. Most did not respond and consisted mostly of small fish and very wild mixed feeding schools. 1030 bird patch (20-30 tonne) polled 1 tonne and size ranged from 39-61 cm size. At 1600 Navy plane kept on circling low upon us and put schools down. At 1715 poled fish from small patch. From 2200 steaming and arrived at Merimbula at 2230 for bait shot.

24. 1.78 0200-0500 Merimbula. Moved and sounded three times. No bait (i.e. pilchards, anchovies or small yellowtail). 0700 left Merimbula and arrived Eden wharf 0815. Southerly/30-35 k. Bad weather conditions. From 0700-1700 maintenance on boat.

25. 1.78 0700 Steaming from Eden. SSW/8-10 k and 1500 S/30 k. Sighted 4 patches from 0900-1100. At 1430 poled approximately 60 fish. From 1500 steaming towards Eden for bait shot, anchored at 1900. At 2300 no bait under light only large yellowtail. Fish caught ranged from 44-62 cm.

26. 1.78 0300 Moved as no bait and sounded for bait until 0430. Relative lack of bait. At 0500 shot net and caught 30 scoops of yellowtail. 0700 left Eden and steaming NE. Morning NE/12-14 and afternoon NE/16-18 k. From 0800-1400 sighted 30 schools. 0900-0915 fished one for 200 kg (43-61 cm). Steamed. From 1900 searching for bait inside Tolgates (sounding and sighting). Counted 5 bait ripplers but could not identify. Anchored at 2000. At 2030 sea conditions worsening and moved to Pt Upright for more shelter, anchored 2100.

27. 1.78 Pt Upright throughout morning (0100-0500) no pilchards or anchovies. Shot net at 0500 and caught 150 scoop of yellowtail. No pilchards or anchovies. 0800 departed Pt Upright, NE/14 k. Rough seas. 1700 poled 500 kg (42-56 cm) from a patch. 1700, SW/16-18. Rough seas from 1830 steaming. 2230 arrived Sydney Harbour and anchored.

28. 1.78 Bad weather conditions. Tied-up, Sydney Harbour.

29. 1.78 Bad weather conditions. " "

1. 2.78 Bad weather conditions. " "

2. 2.78 0530 Left Watsons Bay. SE/12 k, goggly sea conditions. At 1545 fished a path for 2 tonne (38-54 cm size). From 1700 steaming and arrived Cabbage Tree Is. 2130.

3. 2.78 0530 Left Cabbage Tree Is. NE/10 k. Approx. 500 scoops of Maray and 'bastard' yellowtail under light.
No pilchards or anchovies or small yellowtail. 0745 Left Cabbage Tree Is. From 0945 onwards 18 troll line strikes. Fished two patches for 4½ tonne with size range 36-59 cm and 42-59 cm. 1900 steaming towards Sugarloaf Point and anchored at 2130.

4. 2.78	0200-0500	Sugarloaf Pt . No bait under light only large yellowtail. 0800 Left Sugarloaf Pt and fished two ripplers (> 300 tonnes) for 18 tonne (size ranged 46-48 cm). Sighted 14 other ripplers in area. Very high biting response. From 1800 steaming towards Broughton Is., anchored at 2200.
5. 2.78	0100	Broughton Is. shot bait net, caught 300 scoops of bait (Maray, yellowtail and large pilchards. Ratio of Maray to pilchards 7:1 scoops. 90% mortality of Maray bait in bait tanks from 0200-0900. 0700 left Broughton Is. Sighted 4 bird patches and 3 ripplers. Ripplers sinking. Fished one for 1½ tonne (37-56 cm size range). From 1600 steaming to Sydney.
6. 2.78	0200	Arrived Sydney Harbour. Bad weather conditions S/25-30 k. Maintenance, stores and fuel.
7. 2.78		Sydney Harbour unloading. Bad weather conditions till 1400, S/25-30 k. At 1900 left wharf to sound for bait at Quarantine Bay. At 2030 anchored for bait shot.
8. 2.78	0200-0400	Small yellowtail under light. 0530 shot bait net at Quarantine Bay caught 40 scoops yellowtail and 200 scoops of sandy sprats which meshed. From 0730-0900 unmeshing sandy sprats. 0900 left Sydney Harbour W/6-8. Caught 3/4 tonne skipjack 44-46 cm size). Counted 4 bird patches for the day. Anchored at Broughton Is. at 2100.
9. 2.78	0400	Broughton Is. Shot net and caught 200 scoops of Maray, and 150 scoops of large yellowtail. ENE/10-12 k. Fished three patches. 1130 patch - 2½ tonne (44-54 cm), 1500 patch - 10 tonne (43-57 cm size) and 1830 - 2½ tonne (45-58 cm). From 2000 steaming towards Cabbage Tree Island and anchored at 2200. Southerly (25 - 30 k) came away at 2200 and moved closer ashore.
10. 2.78	0200	Left anchorage at Cabbage Tree Is. as southerly 25-30k and too rough to shoot bait net. At 0800 pulled anchor and steamed into Port Stephens, rough sea conditions. 0900 anchored at Nelsons Bay. S/25-30K.
11. 2.78	0700	Left Nelsons Bay. Bad weather conditions NE 16-18 k. Spray over bridge reduced visibility, searched until 1130 as sea increased with N/18-20 k. Steamed to Broughton Is. and anchored at 1200. At 2200 moved to Cabbage Tree Is. for baiting.
12. 2.78	0100	Cabbage Tree Is. S/20 k, rough sea conditions. 0400 only maray and large yellowtail under light. 0800 Departed Cabbage Tree Is. SW/6 k. From 1545-1620 poled 3/4 tonne (42-50 size). At 1830 worked large bird patch for only 400 kg (42-60 cm, size) although school greater than 30 tonne. Fish tend to be surfacing late in afternoon. From 1900 steaming towards Broughton Is. where anchored at 2100 for bait shot.

13. 2.78 0200 Broughton Is. only maray, large yellowtail, tailor and slimy mackerel under light. 0730 Left Broughton Is. From 0730-0830 intense troll line strikes of fish 50-54 cm cm size. From 1145-1230 fished large bird patch for 5 tonne (45-58 cm size) and counted two other patches in this area while fishing. At 1305 fished another bird patch for 3 tonne (46-63 cm size). From 1700-1900 sighted 6 bird patches and worked them for no response. From 1900 steaming S with objective to search wide and to obtain small bait in Jervis Bay.

14.2.78 0830 Searching offshore, N/8-10 k. From 0700-1800 only sighted 3 bird patches, did not respond. At 1515 arrived Ulladulla wharf and unloaded fish.

15. 2.78 0700 Ulladulla wharf SSW/16 knots. Rough seas. Obtained fuel, stores and maintenance. 1700 left Ulladulla wharf and steaming to Jervis Bay, arrived 2100.

16. 2.78 0100 Jervis Bay pulled anchor, no bait sounded until 0145. From 0200 blue sprats and medium small yellowtail under light. Shot net at 0530 and caught approx. 100 scoops of blue sprats and 120 scoops of yellowtail; however, meshed about 60 scoops of blue sprats. Unmeshing blue sprats from 0600-0830. 0830 left Jervis Bay, N/6-8 k. Sighted 2 bird patches which did not respond to bait. Searched until 1900 and steaming from 2200.

17. 2.78 0500 Searching offshore. N/8 k. Sighted 2 schools of yellowfin. Did not respond. Saw no skipjack schools. Searched until 1900 then steaming towards Lord Howe Island.

18. 2.78 0700 Searching course to Lord Howe Island SE/8-10 k. At 1530 on shelf at Lord Howe Is. sighted 5 bird patches within approx. 14 sq. miles. Attempted to fish 5 but moving very fast. 1830 anchored at Lord Howe Is. SE/14-16 k. Put bait light out for bait observations through night and morning. No bait.

19. 2.78 0700 Lord Howe Is., SE/14 - 16 k. Expecting bad weather so went ashore for inquiries (anchorage, water etc). At 1600 wind increased to 18 k. Put bait light out at 1900 and made observations throughout night and morning - no reliable bait source.

20. 2.78 0700 Left Lord Howe anchorage. SE/6-8 k in morning and changed to E/12-14 k in afternoon. Counted 25 patches. Worked three patches for 5-6 tonne. Patches in area (> 100 ton) but with low response. Searched until 2000 and anchored at 2030.

21. 2.78 0100-0500 No bait. 0600 left anchorage E/8 - 10 k. From 0730 to 1800 sighted 68 schools all > 50 cm size, most ranging from 2 to 300 tonnes. Worked twenty with only four responding to pole and line fishing. Patch 1 poled 300 kg; patch 2 poled 100; patch 2 poled 100; patch 3, 2 tonne and patch 4,500 kg. Searched from 0700-1800 and anchored at Lord Howe Is. at 2000.

22. 2.78 0530 Left anchorage Lord Howe Is. E/ 8-10 k. Sighted 19 patches from 1100-1900. Fished six with one responding, caught 10 tonne. This was bird patch rippler and > 500 tonne. From 1850 steaming towards mainland. Steaming throughout night.

23. 2.78 0600 Steaming offshore. N/16k. Visibility reduced by 0800 with ENE/15-18k and by 1400 ENE/18-25k, spray over bridge.

24. 2.78 Offshore searching. E/12k from 07-2000. Sighted 9 bird patches; however only 3 identified as skipjack. At 1800 wind changed to ENE/10-12k and 1600 SE/18-20k. At 1900 steering malfunction ram broke, spent 2 hrs at sea maintaining. Sea conditions worsening from 2000.

25. 2.78 0200 Steaming, SSE/20 k and rough sea conditions. At 0230 major steering problems and rough sea conditions. Arrived Eden at 1000. Unloaded fish and maintenance.

26. 2.78 Alongside wharf, Eden. Bad weather conditions, S/25-30 k. Maintenance.

27. 2.78 Alongside wharf, Eden. Bad weather conditions S/25-30 k. Maintenance.

28. 2.78 Alongside wharf, Eden, Bad weather conditions S/18-20 k. Maintenance.

1. 3.78 0700 Eden alongside wharf; 1200 went on slipway for rudder maintenance.

2. 3.78 0800 Vessel on slipway, maintenance. At 1400 came-off slipway. At 1930 left Eden wharf for bait shot. SSW/18-20 k, rough sea conditions.

3. 3.78 Twofold Bay. No suitable bait from 2400 to 0500. Pulled anchor at 0700 and tied-up to Eden wharf at 0720. SSW/18-20 and rough seas. Obtained stores, maintenance and fuel. At 1130 left Eden. Searched inshore and visibility reduced. Sighted 7 small bird patches, could not identify 2 fish schools, no response. SE/18 k and very goggly. Searched until 1900, 2030 anchored at Broulee for bait shot.

4. 3.78 0500 Broulee bait shot, 150 scoops of yellowtail. No pilchards or anchovies. 0845 left Broulee. SE/10-14 K. Sighted 62 small bird patches most < 2 ton. At 1100 caught ≑ 200 kg. Most schools small fish 30-48 cm and bait too large to hold them. 1700 steaming towards Currarong for bait shot, NE/18 k. 2000 arrived Currarong and wind NW/20 k and at 2400 sea conditions rough so steamed to Jervis for bait shot.

5. 3.78 0500 Jervis Bay. Baitshot 250 scoops of yellowtail and 75 scoops of pilchards. Filled up. Problems with bait shot. Left J.B. 0830 NW/10-12 in morning and NE/14-16 k and increased to 18 k in afternoon. Visibility after 1200 reduced. Searched until 1700. Sighted one bird patch and did not respond. Visibility hindered searching operations. From 1700 steaming towards Port Stephens.

6. 3.78 Steamed throughout early morning, NW/10 k. From 0700 to 1900 sighted 30 bird patch schools of skipjack and 4 ripplers (20-30 tonne) two of which sunk. Fished patch 1 for 3 tonne, patch 2 for 2 tonne and, patch 3 for 500 kg and patch 4 for 3 tonne. Worked 14 schools for no response. From 1900 steaming. 2200 anchored at Broughton Is. for baitshot. From 0200-0400 only maray and large yellowtail under light.

7. 3.78 0700 left Broughton Island, NE/12 k. Area of troll line strikes inshore. By 0900 NE increased to 15 k and spray over bridge reduced visibility. By 1200 working conditions impossible as NE/18 k and very goggly. Searched until 1400 and anchored at Broughton Is. at 1600. From 2200 to 0300 only large yellowtail under light.

8. 3.78 0845 Left Broughton Is. , NNW/16-18 and increased to N/20k at 1100. Searched eastwards for 1 hour. Bad weather conditions. Anchored at Nelson's Bay 1200. From 1230-1700 obtained stores, water and maintenance. At 1730 left Nelson's Bay and sounded for bait around Salamander Bay, at 1830. At 2200 only a few scoops of hardyheads under light. No anchovies.

9. 3.78 From 0300-0500. No bait under light. 0530 left anchorage at Salamander Bay, wind N/10-12 k. Relatively calm sea conditions. At 1115 went into large rippler ($\geq$ 1000 tonne) and poled 5-6 tonne. Marlin put rippler down. At 1200 went into large rippler $\geq$ 300 tonne) and poled 4 tonne. Sighted 2 other ripplers which sunk. At 1500 went into bird patch and poled 200 kg; response strong; but fish too small, discontinued fishing it. Searched until 1800. Anchored at Broughton Is. at 2100 for baitshot.

10. 3.78 0300 Only maray and large yellowtail under light. 0500 steaming N/14-16 k. At 1535 went into rippler ($\doteq$ 300 tonne) poled 16 tonne, very high biting response. Sighted 3 other ripplers while fishing but subsequently sunk. At 1800 steaming towards Broughton Is., anchored at 2030.

11. 3.78 0300 No bait only maray under light. 0600 left Broughton Is., ENE/10-12k in morning increasing to 16-18 k in afternoon. Searched until 1600; however reduced visibility. 1730 anchored at Nelsons Bay. Sighted 3 bird patches.

12. 3.78 0600 Left Nelson's Bay. ENE/10-12 increasing to 16-18 k NE in afternoon. Fished 2 ripplers ($\geq$ 30, $\geq$ 50 tonne respectively) for approximately 1½ tonne. Poled $\doteq$ 12 tonne for 3rd rippler. From 1600 to 1800 worked two bird patches but did not respond. From 1900 steaming. 2415 anchored at Sydney Harbour for bait shot.

13. 3.78 0430 Sydney Harbour, baitshot, 200 scoops of yellowtail NE/12 k. At 0800 moved to Watson's Bay then arrived Sydney Cove 0930 for unloading and fuel. Unloaded approx. 50 tonne from 1030-1930. Maintenance.

14. 3.78 0800 Sydney Cove wharf. NE/16-18 k. Obtained fuel, stores, water and carried out maintenance.

15. 3.78 0000 Departed Sydney Cove to steam through early morning with objective to fish Port Stephens area. Searched from 0600 to 1630 only sighted 2 skipjack patches, no response. Steamed into Cabbage Tree Is., and anchored at 1745. From 0000 to 0300 only Maray and large yellowtail under light.

16. 3.78 0630 Left Cabbage Tree Island. E/14-16 k, goggly sea conditions. Searched southwards and sighted 60 bird patches, very wild and scattered, no response from 19. From 1600-1800 area of troll line strikes but troll patches would not respond, feeding deep and no aggregated schooling. 1800 easterly increased to 18-20 k and rough sea conditions. 1800 onwards steaming to Sydney to investigate patches sighted previously. 2000 arrived Watson's Bay. Expecting easterly gales.

17. 3.78	0700	Left Watson's Bay. E/16-18 k. Rough seas. Steamed east until 0930 too rough, no visibility, turned back at 1000. 1145 Arrived Sydney Harbour and tied up at Sydney Cove.
18. 3.78	0700	Sydney Cove. Bad weather conditions E/20-30 k. Maintenance, stores, water.
19. 3.78	0700	Sydney Cove. Bad weather conditions E/20-30k.
20. 3.78	0700	Sydney Cove. Bad weather conditions E/20-30k.
21. 3.78	0700	Sydney Cove. Bad weather conditions. Very large sea, NE/16-18 k.
22. 3.78	0700	Sydney Cove. NE/10-12 k. Crew member delayed departure. Departed Sydney Cove at 1800. Fresh N/18-20 k.
23. 3.78	0200	Steaming. From 0600-1800 did not sight any skipjack schools. Morning WSW/12-14 k changing to ESE/12-14 k in afternoon. From 1800 layed-out.
24. 3.78		From lay-out position at 0700 searched until 1500. Morning ESE/12-14 k and increased to SE/18 k by 1500. Sighted and worked 3 schools of yellowfin, no response on two and poled 3 fish from one. Sighted no skipjack schools. Steamed to Coffs Harbour, and tied up at wharf 2345.
25. 3.78	0730	Left Coffs Harbour. From 0730 to 1230 SE/10-12 k and large roll. From 1230 NE came away to reach 25-30 k by 1300. Sighted 2 small bird patches from 0700-1330, no response. From 1330 to 1530 sighted very large area of birds, 20 patches. Too rough to fish. Did not troll fish and no response. Steaming from 1430 and arrived Coffs Harbour at 1530.
26. 3.78	0700	At Coffs Harbour wharf. Weatherbound NE/20-25k. Rough sea conditions. Obtained stores, maintenance and water.
27. 3.78	0715	Left Coffs Harbour, N/14-16 k and dropped to 10 k till 1230 then SE/18-20 k and rough sea conditions. Searched from 0730 to 1300, sighted no skipjack schools. After 1200 visibility reduced. From 1230 steaming towards Trial Bay. Anchored Trial Bay 1545. Put bait light out. At 2100 medium-small yellowtail came under light (> 5000 scoops). Potential bait area identified.
28. 3.78	0630	Left Trial Bay SW/14-16 k. From 1000-1230 area of intense troll line strikes. 1015 wind changed to ENE/12-14 k. Sighted 4 bird patches from 1500-1545. Searched until 1630 and arrived and anchored Broughton Is. 2015.
29. 3.78	0730	Left Broughton Is. From 1145-1500 sighted 15 skipjack schools 30-48 cm size and from 1500-1700 sighted 13; however visibility reduced by 1700. Attempted to catch small fish but no response. Bait too large. Need anchovies or small pilchards. From 1700 steaming and anchored at Quarantine Bay 2300.
30. 3.78	0800	Left Quarantine Bay. NW/14-16 k. Sighted 15 patches from 1100-1230. Sea conditions becoming rough from 1230 with NW/18-20k. Fished 3 patches, no response. Arrived and anchored at Taylors Beach, Sydney Harbour 1600. 1900 moved to Sydney Cove Wharf.
31. 3.78		Sydney Cove wharf. Bad weather. SSW/28-30 k.
1. 4.78		Sydney Cove. Bad weather S/20-30 k.

2. 4.78	0600	Left Sydney Cove, NW/10-12. Sighted 28 small schools from 0700-0900, very wild and would not respond. At 0915-0945 fished bird patch for 800 kg. At 1245 poled 10 fish. From 1330 to 1600 sighted 35 bird patches; however no response, fish wild. From 1625-1640 went into 2 patches and poled approx. 500 kg. Sighted one school of large fish (> 65 cm) but too wild. Steamed into Kiama and tied-up at wharf 1900.
3. 4.78	0700	Kiama. SW/18-25 k. Rough sea. Alongside wharf. At 2300 attempted to depart; however engine malfunction (heat exchange component).
4. 4.78		Kiama. Bad weather. S/25-30 k. Rough seas. Engine maintenance.
5. 4.78	0430	Left Kiama wharf. SSW/20 k large sea. Visibility reduced. Saw no fish. Areas of troll line strikes 1200 and from 1545-1600. At 2000 anchored at Fingal Bay.
6. 4.78	0700	Left Fingal Bay. SW/14 k. Sea conditions rough, visibility reduced. 1300 SW/16-18 k. At 1400 went into bird patch (10-20 tonne) pole 1 tonne; however school wild and left us. At 1530 went into another patch (5-10 tonne) poled only 20 fish, wild. steaming from 1600 and anchored Broughton Is. 1630. Wind at 1600 20 k southerly and rough seas.
7. 4.78	0400	Small-medium yellowtail underlight (2000 scoops); bad weather conditions E/15-20. 1000 departed Broughton Is. visibility reduced. Anchored at Port Stephens 1430.
8. 4.78		Nelsons Bay wharf. Southerly/20 k. Rough sea conditions.
9. 4.78	0800	Left Port Stephens, SE/12-14 k. Moderating sea conditions. From 0800 to 1700 sighted 24 schools of small skipjack (30-40 cm size). Fished 12, no response, bait too large. From 1245-1315. Troll line strikes of larger fish. From 1200 ENE/14 k and at 2030 anchored at Cabbage Tree Is 2030.
10. 4.78	0700	Left Cabbage Tree Is. NE/18-20 k with large easterly slop. From 0700-1700 sighted 17 patches; however visibility reduced. Most schools appeared to be small fish (30-45 cm size) and worked ten, no response, bait too large. At 1800 severe thunderstorms and rain and NNW/20-25 k. Arrived Sydney Harbour, 2000.
11. 4.78	0900	Left Sydney Cove. NW/8-10 k. From 1030-1050 troll line strikes. From 1030-1730 sighted 30 skipjack schools most of which were small fish (30-48 cm size). At 1725 poled 24 fish and 1430-1730 area of troll line strikes of larger fish (54 cm size) 2000. Arrived at Kiama and tied-up.
12. 4.78	0630	Departed Kiama. SW/14-16 k which increased to 20 k by 1000. Rough sea conditions. Visibility completely reduced. At 1000 steaming towards Kiama and tied-up at wharf at 1330.
13. 4.78		Kiama wharf. Bad weather conditions SW/18-20 k.
14. 4.78		Kiama wharf. Bad weather conditions SW/20 k
15. 4.78		Kiama wharf until 1130. Bad weather conditions SSW/20-25 k. Very large surge. Left Kiama wharf 1130 due to strong surge. Arrived Ulladulla, 1640.
16. 4.78		Ulladulla wharf. Bad weather conditions. SW/20k.
17. 4.78		Ulladulla wharf. Bad weather conditions. SW/16-18 k.

18. 4. 78	0630	Left Ulladulla wharf. N/10-12 k. At 0815 sighted one school of yellowfin. 0800 wind changed to SW/14-16 k and increased to 16-18 k in afternoon. Rough seas. From 0730-1700 no patches sighted. Anchored at Montague Island 1730, wind SE/14-16 which increased to SE/2--25 k by 2100. Rough seas. Left Montague Island at 2215 and steaming towards Ulladulla.
19. 4.78	0500	Arrived Ulladulla. Wind south/20 k, large sea. Stayed alongside wharf.
20. 4.78	0600	Left Ulladulla wharf SW/12-14 k, large sea with easterly roll. Two toll line strikes (49 cm size) at 0756 and 3 at 1010 (57 cm size). No skipjack schools sighted from 0600-1730. At 1300 conditions bettered with SW/8-10 and decreasing to 6-8 by 1700. Searched until dark 1730. From 1700 visibility reduced from 2100 layed-out.
21. 4.78	0700	SE/8k calm and sunny. Breaking fish (45 cm size) to 1030. sighted 3 bird patches with very low response. 1445 patch poled 10 fish. From 1700 steaming and arrived Cabbage Tree Island 2000.
22. 4.78	0800	Left Cabbage Tree Island. SW/6-8 k up to 1200 then SE/6-8 until 1500 changing to NE/6-8, thereafter. From 0800 to 1500 sighted and worked 2 patches, no response. All 1500 hit "upwelling" area and sighted 70 skipjack schools (30-40 cm size, 40-45 cm size) from 1500-1700 worked 10 with no response, bait too large. From 1515-1730 three troll line strikes (48-60 cm size). Visibility reduced by 1700; however we literally steamed through schools for 1700-1730. School size ranged from 1-10 tonne. Steamed into Port Stephens and anchored at 2030.
23. 4.78	0700	Left Port Stephens NW/18-20 k. Rough sea conditions. Searched until 1100 then turned-back and anchored at Fingal Bay 1230 Wind changed to SE/18-20 k at 1400, moved to Nelsons Bay, anchored 1445 with southerly/28-30 k.
24. 4.78		Port Stephens. Bad weather SSW/20 k all day. Stores water and maintenance.
25. 4.78		Departed Port Stephens 0600. NNW/10-15 k. Rough sea with spray over bridge reduced visibility. Sighted no schools. From 1200 blew fresh E. Force 5. Steaming from 1700 and arrived Sydney Harbour at 2000.
26. 4.78	0800	At Sydney Cove. Rough sea conditions. Fresh westerly 25-30 k, with strong gale force wind warning. Terminated survey. Catriona left Sydney Cove at 1900.

APPENDIX II: AVAILABILITY OF BAIT DURING PHASE II (JAN-APRIL 1978)

ATE	AREA	BAIT PRESENT	APPROX. NO. SCOOPS UNDER LIGHT	NO.SCOOPS SHOT-IN	COMMENTS
'. 1.78	Brush I.	Yellowtail	100	50 yellowtail	No anchovies or pilchards. Bait too large
7. 1.78	Jervis Bay	20 Pilchard ripplers,S ?	>1000	MISSED	Day shot unsuccessful; > 1000 scoops in school.
3. 1.78	Jervis Bay	Pilchards,L	500	200 pilchards L	Bait too large. Average size 16.54 cm. Large numbers predators(slimy mackerel,tailor)
). 1.78	Bass Pt	Pilchards,Ms	>500	-	Bait came to light too late (0100-0400) large numbers of predators
'. 78	Sydney Hbr	Yellowtail,Sm.	400	120 yellowtail Sm.	Baited near Quarantine Bay, good soundings.This bait aroused v.high biting respons on 4/2/78.
2.1.78	Wreck Bay	Yellowtail,L	100	-	Bait too large.Predators abundant.
4.1.78	Merimbula	Yellowtail,Lm	20	-	Not worth shooting
5.1.78	Eden	Yellowtail,Lm	30	30 yellowtail Lm	No bait, large nos predators (tailor,slimy mackerel)
6.1.78	Tolgates	> 8 bait ripplers ?? Yellowtail or pilchards			Bad sea conditions and tide, moved to Pt Upright. No small bait
7.1.78	Pt Upright	Yellowtail, Lm	>200	150 yellowtail, Lm	No small bait
3.2.78	Cabbage Tree I.	Maray S,mS,L, Yellowtail L, Lm,mL	>1000 >500	Missed	Rings caught
4.2.78	Sugarloaf Pt	Yellowtail,L	500	-	Bait too large
5.2.78	Broughton Is.	Maray,Pilchards, L,mS; Yellowtail L,mS.	>500	300 yellowtail L;Maray L,mS; Pilchard,L,mS	No small bait. Ratio of Maray to pilchards calculate 7:1, 0200-0900 > 90% Maray mortality in tank.
8.2.78	Sydney Hbr	Yellowtail,Sm Sandy sprats	300 yellowtail 400 Sandy sprats	40 yellowtail Sm.	Meshed 150-200 scoops sandy sprats. Predators abundant (tailor,slimies and pike)
9.2.78	Broughton Is.	Maray,L Yellowtail,L	>500 >200	200 Maray,L 150 Yellowtail L	High Maray mortality.Predator extremely abundant (tailor & slimies)
2.2.78	Cabbage Tree I.	Maray,L Yellowtail,L	>2000 >500		V.large amount bait.Too large & sea conditions too rough to shoot

L = large; Lm = Large -med; mL = med. large; Sm = small med.; Ms = med.small; s = small

	AREA	BAIT PRESENT	APPROX. NO. SCOOPS UNDER LIGHT	NO. SCOOPS SHOT-IN	COMMENTS
2.78	Broughton I.	Maray,L Yellowtail	>1000 150-200	-	Bait too large
2.78	Jervis Bay	Blue sprats,S Yellowtail, m,L	200 200-150	60 S 120,mL	Meshed 40-60 scoops blue sprat High tank mortality in sprats for 07-1200 > 30%
.2.78	Lord Howe Is.	no bait	-	-	
.2.78	Lord Howe Is.	no bait	-	-	Only 1/3 scoop blue hardyhead
.2.78	Lord Howe Is.	Blue hardyhead S	1-2	-	No bait. size range 3.4-4.5 too small
.2.78	Lord Howe Is.	"	<2		No bait
.3	Eden	Yellowtail,L	50	-	Bait too large. Large no. predators
..3.78	Broulee	Yellowtail,S	200	150,S	Smallest size bait caught during survey. Average size 8.14 cm. No anchovies or pilchards
).3.78	Currarong Jervis B.	Sea conditions rough Yellowtail;Ms, Pilchards,L	 300 200	 250,Ms 75,L	No anchovies or small pilchard
7.3.78	Broughton Is.	Yellowtail,L Maray,L,mL	1000 5000	-	Bait too large;although plentiful supply
3.3.78	Broughton Is. Salamander Bay	Yellowtail,L Maray,L,mL, no surface ripplers & no soundings	>500 >2000	-	Bait too large searched for bait using sound & visual; (ripplers,gannets working etc). However,no bait in Salamander Ba
. 3.78	Salamander Bay	Silver hardyheads + rubbish		-	No bait came under light
0.3.78 & 1.3.78	Broughton Is.	Yellowtail,L Maray,L	>300 >500	-	Bait too large. no anchovies
3.3.78	Sydney Hbr	Yellowtail ML	300	200,ML	Baited in same spot where previously got small bait. No anchovies or pilchards.
6.3.78	Cabbage Tree I.	Yellowtail,L Maray,L	>200 1000	-	Bait too large
7.3.78	Trial Bay	Yellowtail, Ms,S	>5000	-	Found large bait supply of small bait.Anchored nearer reef;previously further away from reef
30.3.78	Sydney Hbr	Yellowtail,sM	200	-	Large no.tailor & slimey mackerel
6.4.78	Fingal Bay	Yellowtail,L	100	-	Bait too large

	AREA	BAIT PRESENT	APPROX. NO. SCOOPS UNDER LIGHT	NO.SCOOPS SHOT-IN	COMMENTS
1.78	North side Broughton I.	Yellowtail,Ms	>2000		Smallest bait found within th vicinity of Pt Stephens. Smaller bait on northern side than the southern side.
.4.78	Cabbage Tree Is.	Yellowtail Ms+L Maray,L,Ms	>300 >2000	-	Bait too large
.4.78	Cabbage Tree Is	Yellowtail,Ms+L Maray	>1000	-	Bait too large. No small pilchards or anchovies