No 1981/35 6

☐ NEW PROPOSAL
☐ CONTINUING PROJECT
☐ FINAL REPORT
☐ PROGRESS REPORT

OUT-OF-SESSION - December 1983

FIRC 27

FISHING INDUSTRY RESEARCH TRUST ACCOUNT

TITLE OF PROPOSAL/PROJECT: The Oceanography of a Continental Shelf Section

ORGANISATION: The Flinders University of South Australia

PERSON(S) RESPONSIBLE: Dr G.W. Lennon

FUNDS SOUGHT/GRANTED

YEAR	SOUGHT	GRANTED
1981/82		$21,860
1982/83		36,367

RELATED APPLICATIONS:

RECEIVED ..... Oct ... /1983. DISTRIBUTED ..1..Dec../1983

..... Judith Lee .....
for Secretary
Fishing Industry Research Council

F139—12/81

The Flinders University of South Australia

BEDFORD PARK SOUTH AUSTRALIA 5042
TELEPHONE 275 3911

School of Earth Sciences

The Fishing Industry Research Committee
Department of Primary Industry
Edmund Barton Building
Broughton Street
BARTON ACT 2600

14th October 1983

Reference: F81/221 o333V

Dear Secretary,

In response to your letter of Sept 5, I am now able to forward to you a report on the 1982/3 FIRTA Project: The Oceanography of a Continental Shelf Section.

I regret that this report has been delayed.

I would wish to point out to the Committee that FIRTA support provided the basic facilities for the experimental phase of this programme and that the interpretive procedure will continue over the next year. In consequence the Committee might wish us to report again in 1984.

Yours faithfully,

G.W. Lennon
Professor of Oceanography

FISHING INDUSTRY RESEARCH TRUST ACCOUNT

Project:

The Physical Oceanography of a Continental Shelf Section in South Australia.

G.W. Lennon
Professor of Oceanography
School of Earth Sciences
Flinders University of S.A.

S.D. Hahn
Postgraduate Research Student
School of Earth Sciences
Flinders University of S.A.

This project was supported by FIRTA in two years, 1981/2 and 1982/3.

The research grant made possible the first systematic and longterm attempt to study the physical marine environment of a cross-shelf transect in Australian waters. For the first time, long time series of marine variables were obtained at a single station. Attempts were made to record

(a) temperature at several depths at intervals of 30 minutes
(b) current speed, direction and conductivity at at least two depths every 15 minutes
(c) sea levels based upon a bottom-mounted pressure sensor at 10 minute intervals.

The study area is shown in Figure 1.

Apart from two events beyond our control, one a shark bite and the other a possible interference with our mooring, the experimental record was one of great success. A detailed timetable is given in the attached Appendix.

In addition the water structure was examined across the mouth of the Gulf and along the cross-shelf transect on twelve separate occasions. These exercises served to place the observations in the wider regional context, and three opportunities provided by CSIRO to examine a wider picture extending to Bass Strait, served to increase the scale of awareness considerably.

This exercise should be viewed in the regional context in that the observational sites are strategic in so far as they are arranged so as to monitor the marine features passing through the system from west to east (a shelf-edge jet and shelf-trapped long waves) and also to monitor basic features of Shelf/Gulf exchange processes, notably the means by which the high brine contents of the Gulfs are flushed so as, hopefully, to maintain stability from year to year.

It is a matter of satisfaction to report that the experimental phase of the study has been successfully accomplished and a large data base of relevant information has been assembled. Yet the research project is not

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complete. What now remains is for further progress to be made in the interpretation of the data and of the utilization of the material in modelling relevant processes. This activity will require at least one further year of study so that a final report will not be available for some time. Note that FIRTA support is not required for the ongoing phase. The present report is therefore of interim type dealing primarily with the initial experimental activity.

SUMMARY OF INTERPRETATION TO DATE

1. Temperature and Salinity - Vertical Structure.

Near-continuous time series data of temperatures and salinities at various depths have been observed at a moored station over two years. Seasonal variations were determined as shown in Figs. 2 and 3.

A surface mixed layer down to 25m is always present. The thermocline is seen to develop in November at 30m depth and this becomes stronger and deeper with time, reaching 60m depth in February. As time elapses from this stage,the thermocline continues to deepen though it becomes weaker so that in late April it can just be seen at approximately 100m depth. However in May the thermocline is rapidly destroyed and from May to late October generally vertically-mixed conditions penetrate to the sea bed with a slight indication of a temperature inversion (0.5^{o} warmer on the bottom).

As short term temperature variability is greatest at the thermocline depth, $16.5^{o}C$ isothermal depths were interpolated from thermistor chain data and an example is shown in Fig. 4. The evidence suggests that the thermocline is extremely mobile responding to internal waves, possibly tides. Temperature excursions at this thermocline depth can attain $4^{o}C$ within a few hours and the tracking of temperature contours reveals vertical displacements of the thermocline as much as 20m. Surface waters down to 40m depth show a range from $35.5^{o}/oo$ to $35.8^{o}/oo$ with a minimum in October -November and a maximum in February-March.A much greater range is shown at the bottom ($35.2^{o}/oo$ to $36.1^{o}/oo$) with a minimum in the summer season. During the summer the bottom water has cool and less saline characteristics. These indicate that the bottom water of the continental shelf is supported by intermediate water of the Southern Ocean through coastal slope intrusion processes.

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Seasonal variations of the vertical density structure is shown in Fig. 5 and computed from temperature and salinity.

Since the density structure is dominated by temperature rather than salinity an understanding of the temperature structure and its seasonal variations as shown in Figure 2, provides a ready indicator of the major features of the coastal marine environments.

2. Water Movement through the Station.

Annual mean current speed at the upper layer (about 20m below surface) is 20 cm/sec, though a maximum of 100 cm/sec was recorded, and at the lower layer (20m above bottom) the mean drops by 20% to 16 cm/sec. General current direction is southeast in both layers, however, there is a somewhat complicated eddy-like circulation during September-March. The south-eastward direction is predominant in May and June. The tidal current component is very small having a mean speed of 8.8 cm/sec in the upper layer and 7.4 cm/sec in the lower layer, while its excursion distance may be less than 4 km.

The residual current component, obtained by removing the tidal signal using a numerical filter, has a mean speed of 14.8 cm/sec in the upper layer and 12.5 cm/sec in the bottom layer, nearly twice the magnitude of the tide. Fig. 6 shows a Progressive Vector Diagram of the lower layer from June 1982 to June 1983 indicating the main drift tendency.

In the 1982 winter cruise of RV SPRIGHTLY, two satellite-tracked buoys were released, one in the Great Australian Bight and the other near the mooring station, and their subsequent tracks confirmed the dominant seasonal south-eastward flow as well as maintaining compatibility with moored current meter data.

Coastal water in this area runs primarily along the coast south-eastward, however, during summer, medium scale eddy-like circulation can be identified. The transport of nutrients from the deeper ocean to the surface is inhibited by the dominant south-easterly stream and it is in the ephemeral flow reversals which occur in summer that we see conditions right for upwelling. The episodic character of these events is of vital importance in a Fisheries context.

Fisheries Implications

(a) In the next stage we shall consult Biologists and Fisheries Department personnel. Meanwhile it seems to us:-

(b) The work provides an adequate basis for the determination of the temperature of the shelf edge water column, its seasonal variation and its vertical structure - in particular the strength of the thermocline through its development.

(c) We have identified major vertical displacements of the thermocline in a time scale of hours in response to tidal and other forces. At this stage the tidal part of the signal has been determined and can be predicted.

Whether this proves to be a significant influence on fish behaviour and whether the tidal cycles are sufficiently dominant to indicate that fish behaviour is markedly different at certain parts of the cycle remains to be studied.

The general case is that the project tracks the development and mobility of the thermocline which functions as a marine boundary. Boundaries are zones where materials, including biota accumulate so that the strong link with fisheries interests is forged.

APPENDIX

LISTINGS OF FIELD DATA COLLECTIONS

1. Moored Station

Location: 35^{o} 46'S, 135^{o} 45'E (60 miles south of Pt. Lincoln)

Water Depth: 140 m (near shelf edge)

Period: Preliminary Study, April - June 1981
Main Study, November 1981-June 1983

Instruments Moored: 1 Thermistor chain
2 or more Recording Current Meters
1 or 2 Tide gauges

Data Intervals: Thermistor chain, 30 min.
Current Meter, 15 min.
Tide Gauge, 10 min.

Instruments Used:

Thermistor Chain: Microsystem TR110, 14 sensors
Aanderaa TR692, 10 sensors

Current Meter: Aanderaa RCM-4, 5 sensors
speed, direction, temperature, salinity and depth.

Tide Gauge : Microsystem TG-12A, 2 sensors,depth and temperature

(a) Station VICTOR (April - June 1981)

One thermistor chain (TR110), 2 current meters (RCM-4 5453, 3524) and 1 tide gauge (TG79) were deployed on 6th April and recovered on 2nd July, 1981 as a preliminary study. The thermistor chain exercise proved to be only moderately successful due to manufacturing faults, one sensor was faulty from the beginning and the others from 1st June. Successful data obtained are as follows:-

Current: 2 depths (40 m and 115 m) data
from 6th April to 2nd July, every 15 mins.

Salinity: 2 depths (40 m and 115 m) data
from 6th April to 2nd July, every 15 mins.-

Tide: From 6th April to 2nd July, every 10 mins.

Temperature:
16 depths data from 6th April to 31st May and then 3 depths data up to 2nd July.

(b) STATION ALPHA (November 1981 - January 1982)

One thermistor chain (TR110), 6 current meters (RCM-4, 4234, 5455, 5454, 3524, 3545 and 3523) and 2 tide gauges (TG 79 and 80) were deployed

on 11th November 1981 and recovered on 28th January. Only one current meter (RCM-4 5454) was faulty and this was moored at the depth of 80 metres. Successful data obtained are as follows:-

Current and Salinity:	5 depths (22 m, 48 m, 108 ,, 122 m and 133 m) data from 11th November 1981 to 28th January 1982.
Tide:	From 11th November 1981 to 28th January 1982.
Temperature:	21 depths (22 m, 32 m, 35 m, 39 m, 43 m, 47 m, 48 m, 51 m, 55 m, 59 m, 63 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 108 m, 122 m, 133 m, and bottom) data from 11th November 1981 to 28th January 1982.

(c) STATION BETA (March - May 1982)

One thermistor chain (TR110), 2 current meters (RCM-4 4234 and 3545) and two tide gauges (TG79 and 80) were deployed on 2nd March, however two current meters and one tide gauge (TG80) were replaced by RCM-4 5453, 3524 and TG 59 on 30th April because of a missing surface maker due to heavy weather. They were all recovered on 1st June 1982. In connexion with this problem two current meters became unsupported on May 17th and descended to the sea bed thereby causing a break in the record. Successful data obtained are as follows:-

Current and Salinity:	2 depths (65 m and 125 m) data from 2nd March to 30th April 1982 and the other 2 depths (23 m and 120 m) data from 30th April to 17th May 1982.
Tide:	From 2nd March to 1st June 1982.
Temperature:	17 depths (51 m, 55 m, 59 m, 63 m, 65 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 91 m, 95 m, 99 m, 103 m, 125 m and bottom; from 30th April to 17th May 1982, then 15 depths data (excluding current meters depths) up to 25th May 1982.

(d) STATION GAMMA (June - August 1982)

One thermistor chain (TR 692), 2 current meters (RCM-4 5454 and 3523) and a tide gauge (TG63) were deployed on 1st June and they were recovered on 26th August 1982. One current meter (RCM-4 5454) of 20 m depth was found to be faulty after 17th June, and a tide gauge was also faulty after 5th June. Successful data obtained are as follows:

Current and Salinity:	2 depths (20 m and 120 m) data from 1st to 16th June, then bottom depth only up to 22nd August 1982.
Temperature:	11 depths (24 m, 32 m, 40 m, 47 m, 54 m, 62 m, 70 m, 77 m, 85 m, 93 m, and 120 m) data from 1st June to 26th August 1982.

(e) STATION DELTA (September - November 1982)

One thermistor chain (TR110), 2 current meters (RCM-4 3522 and 5455) and a tide gauge (TG80) were deployed on 26th August and they were recovered on 2nd December 1982. Successful data obtained are as follows:

Current and Salinity:	2 depths (30 m and 125 m) data from 26th August to 2nd December 1982.
Tide:	From 26th August to 2nd December 1982.
Temperature:	17 depths (30 m, 43 m, 47 m, 51 m, 55 m, 59 m, 63 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 91 m, 95 m, 125 m, and bottom) data from 26th August to 12th October 1982 then 3 depths (30 m, 125 m, and bottom) only up to 2nd December, 1982.

(f) STATION EPSILON (December 1982 - February 1983)

One thermistor chain(TR692), 2 current meters (RCM-4 3524 and 3545) and a tide gauge (TG103) were deployed on 2nd December 1982 and they were recovered on 8th March 1983. Three days after deployment the thermistor chain cable was damaged by shark bite. Successful data obtained are as follows:-

Current and Salinity:	2 depths (15 m and 125 m) data from 2nd December 1982 to 8th March 1983.
Tide:	From 2nd December 1982 to 8th March 1983.
Temperature:	3 depths (15 m, 125 m, and bottom) data from 2nd December 1982 to 8th March 1983. In addition 10 more depths only for 2-4th December.

(g) STATION ZETA (March - June 1983)

One thermistor chain (TR110), two current meters (RCM-4 5455 and 6583) and a tide gauge (TG65) were deployed on 8th March and they were recovered on 14th June 1983. There were no instrument faults. Successful data obtained are as follows:-

Current and Salinity:	2 depths (15 m and 125 m) data from 8th March to 14th June 1983.
Tide:	From 8th March to 14th June 1983.
Temperature:	17 depths (15 m, 47 m, 51 m, 55 m, 59 m, 63 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 91 m, 95 m, 99 m, 125 m, and bottom) data from 8th March to 14th June 1983.

2. CTD (Conductivity/Temperature/Depth) OBSERVATION

To examine the water structure across the mouth of Spencer Gulf and along a shelf transect directed as an extension of the Gulf axis, CTD (Conductivity/Temperature/Depth) observations at several stations were carried out 12 times during the period April 1981 to June 1983, as follows:

5-6 April 1981 (SE5): 13 stations occupied
30th June - 2nd July 1981 (SE6): 12 stations + Sprightly Data
10 - 11th November 1981 (SE7): 13 stations
27-28th January 1982 (SE8): CTD faults, surface data for 9 stations only + Sprightly data
1-2nd March 1982 (SE9) : 14 stations
29-30th April 1982 (SE10): 8 stations
30th May - 1st June 1982 (SE11): 8 stations + 6 stations
28-29th June 1982 (SP6/82): 12 stations + Sprightly data
25-26th August 1982 (SE12): 15 stations
30th November - 2nd December 1982 (SE13): 11 stations + 5 stations
7-8th March 1983 (SE14)); 12 stations, temperature data only (salinity faults)
14-15th June, 1983 (SE15): 15 stations

Most frequently occupied CTD stations are shown in Fig. 1.

3. REGIONAL CTD OBSERVATION

To support an understanding of ocean-shelf interaction near the shelf break area and the continuity of shelf edge current in the vicinity of the study area, regional oceanographic observations were made on board R/V SPRIGHTLY through the courtesy of CSIRO, three times during the study period, Flinders Staff participated.

(a) Bass Strait to Great Australian Bight
Period: 14th June - 2nd July 1981 in water depths down to 1000 m.

(b) Bass Strait to Kangaroo Island
Period: 22-31st January 1982 in water depths down to 1500 m.

(c) Fremantle, W.A. to Portland, Vic.
Period: 18th June - 4th July 1982 in water depths down to 2000m.

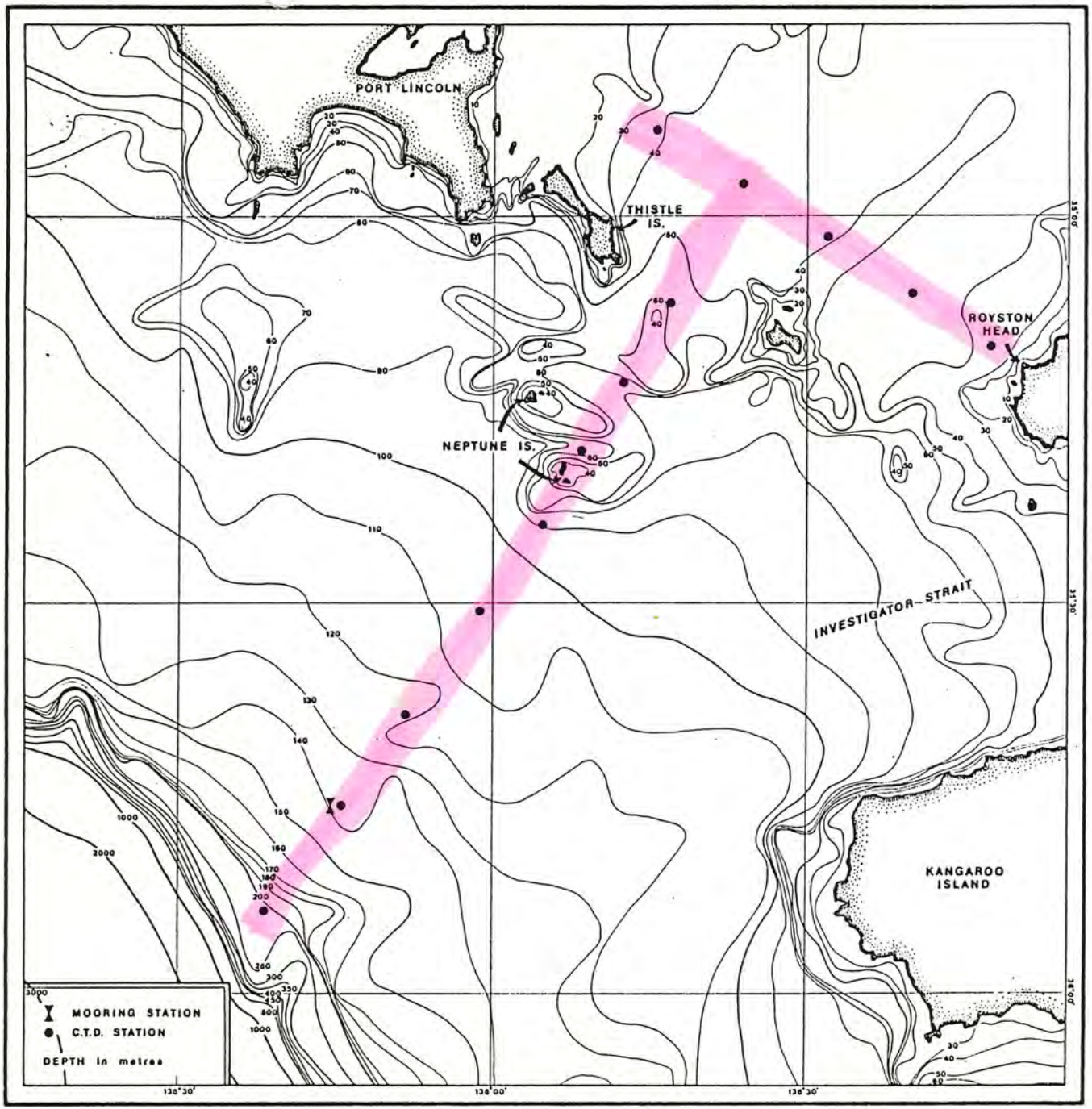


Fig. 1. STUDY AREA

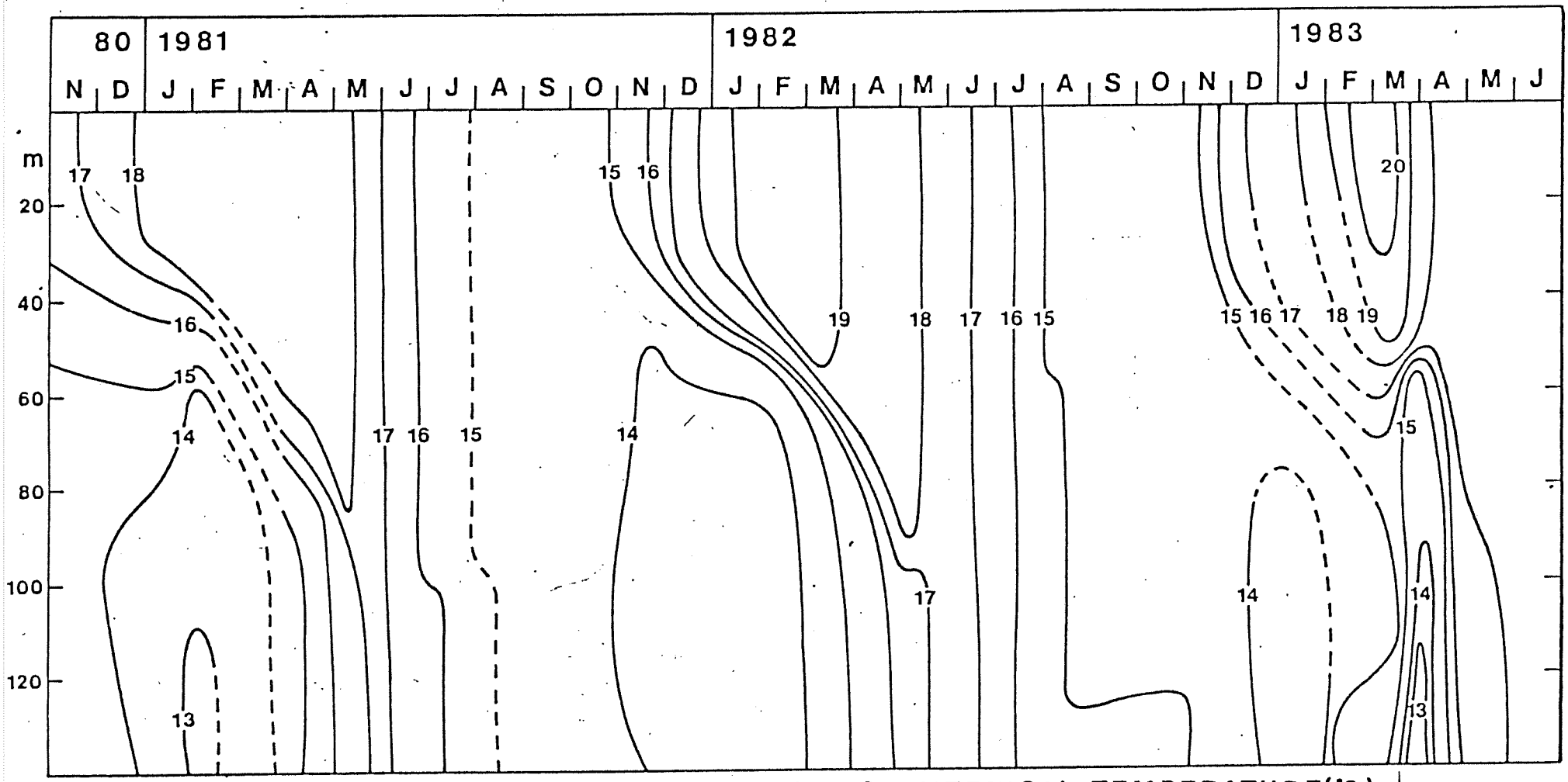


Fig. 2. SEASONAL VARIATION OF VERTICAL TEMPERATURE(°C).

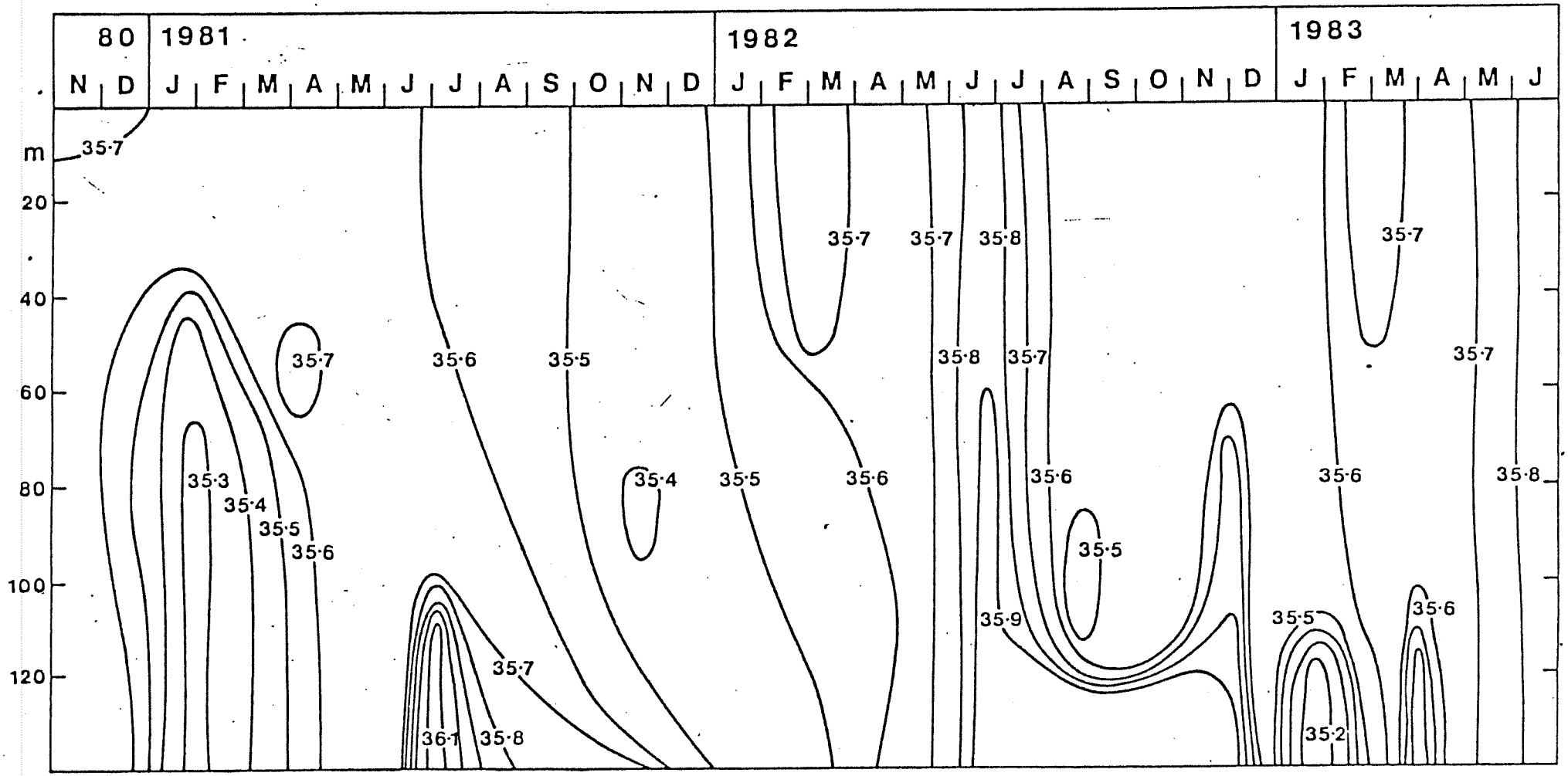
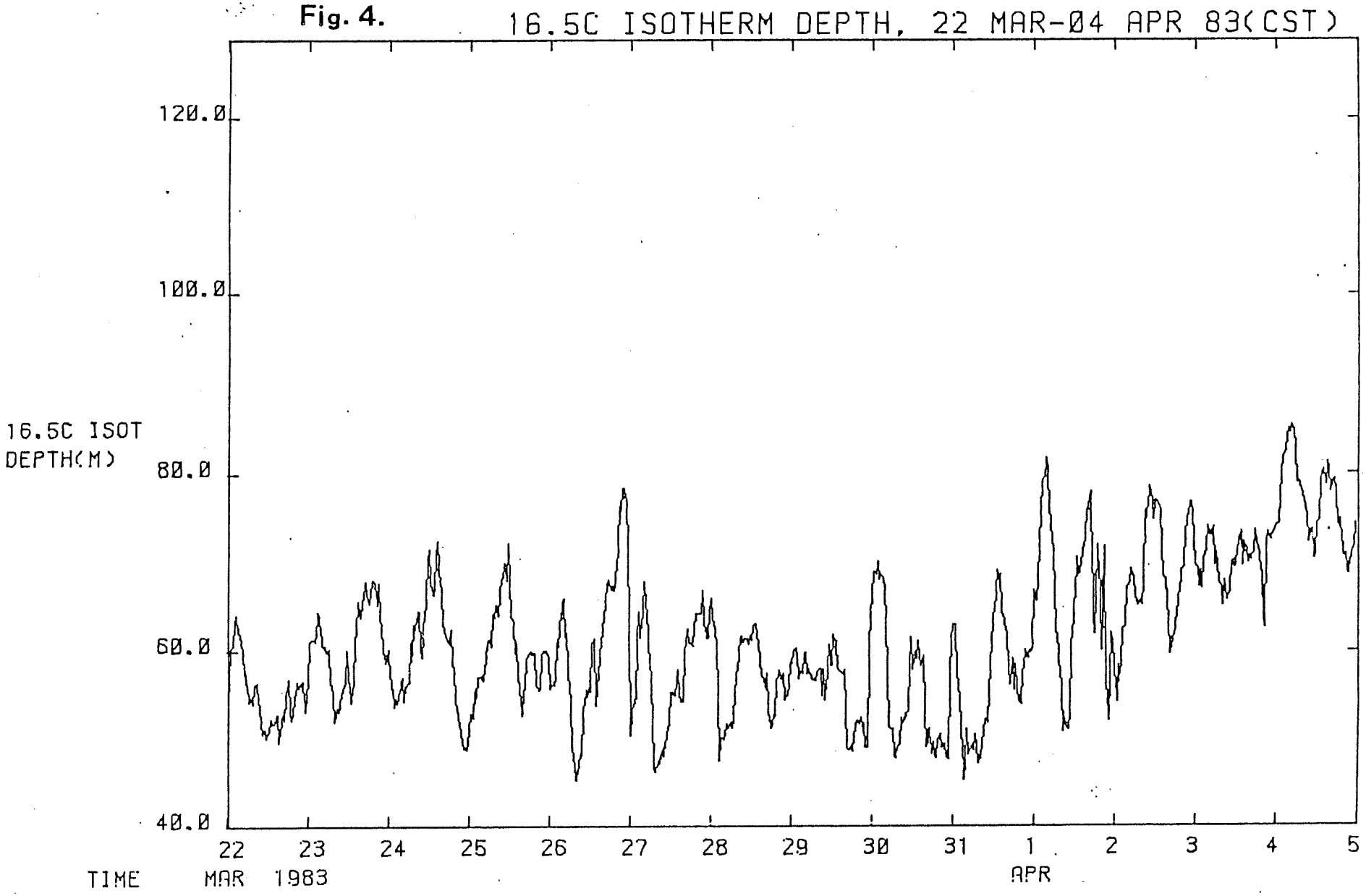


Fig. 3. SEASONAL VARIATION OF VERTICAL SALINITY (‰)

Fig. 4.


16.5C ISOTHERM DEPTH, 22 MAR-04 APR 83(CST)
16.5C ISOT DEPTH(M)
120.0
100.0
80.0
60.0
40.0
22
23
24
25
26
27
28
29
30
31
1
2
3
4
5
TIME
MAR 1983
APR

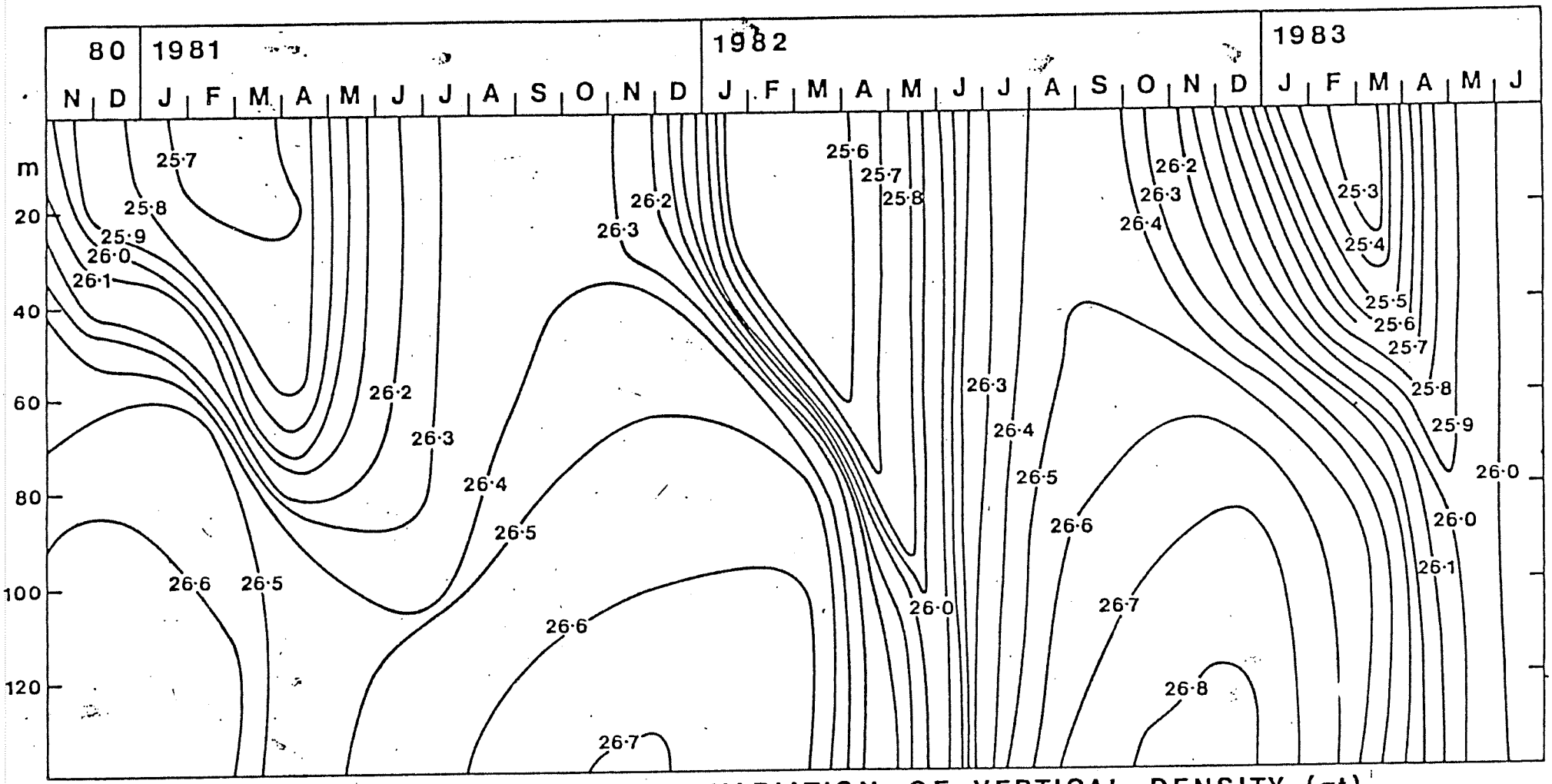


Fig. 5. SEASONAL VARIATION OF VERTICAL DENSITY (σt)

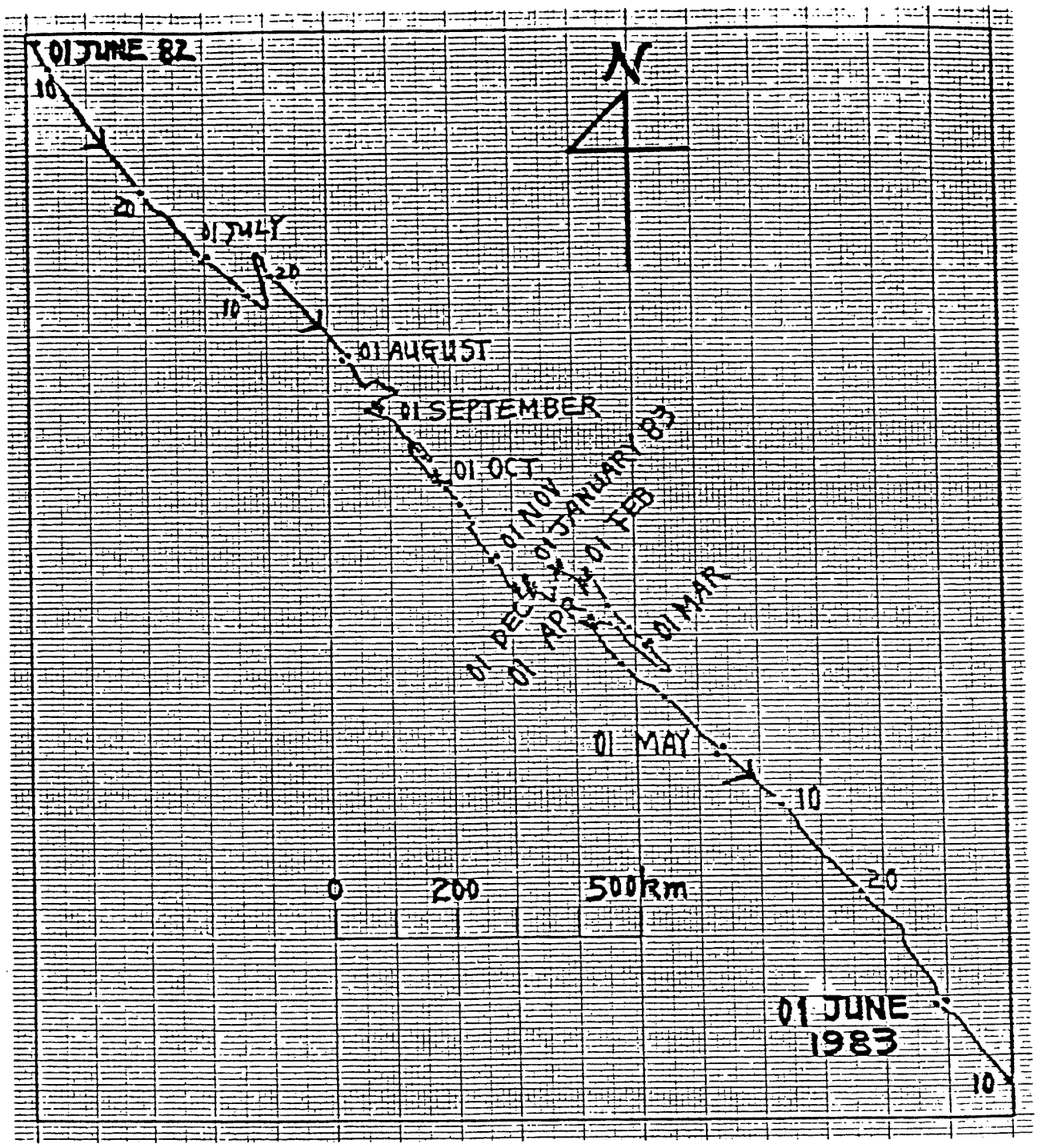


Fig. 6. PROGRESSIVE VECTOR DIAGRAM

(20 m up from bottom, from June 82 to June 83)

D6

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.....Judith Lee.....
for Secretary
Fishing Industry Research Council

F139—12/81

The Oceanography of a Continental Shelf Section (1981/35)

Objectives:

(i) To observe the temperature and salinity structure along a section at the mouth of Spencer Gulf, South Australia, from Rosalind Shoal via Neptune Island to the edge of the continental shelf.

(ii) To design a mooring, for deployment near the shelf edge on the above section, containing a thermistor chain of 14 temperature sensors and two Aanderaa current meters, the latter capable of logging conductivity and temperature in addition to current speed and direction.

Organisation:

Flinders University

Supervisors:

Professor G.W. Lennon
and Dr D.G. Provis,
Meteorology and Oceanography,
School of Earth Sciences,
Flinders University,
BEDFORD PARK SA 5042

Grants:

1981/82	1982/83	Total
$21,860	$36,367	$58,227

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Tide: From 6th April to 2nd July, every 10 mins.

Temperature:
16 depths data from 6th April to 31st May and then 3 depths data up to 2nd July.

(b) STATION ALPHA (November 1981 - January 1982)

One thermistor chain (TR110), 6 current meters (RCM-4, 4234, 5455, 5454, 3524, 3545 and 3523) and 2 tide gauges (TG 79 and 80) were deployed

on 11th November 1981 and recovered on 28th January. Only one current meter (RCM-4 5454) was faulty and this was moored at the depth of 80 metres. Successful data obtained are as follows:-

Current and Salinity:	5 depths (22 m, 48 m, 108 ,, 122 m and 133 m) data from 11th November 1981 to 28th January 1982.
Tide:	From 11th November 1981 to 28th January 1982.
Temperature:	21 depths (22 m, 32 m, 35 m, 39 m, 43 m, 47 m, 48 m, 51 m, 55 m, 59 m, 63 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 108 m, 122 m, 133 m, and bottom) data from 11th November 1981 to 28th January 1982.

(c) STATION BETA (March - May 1982)

One thermistor chain (TR110), 2 current meters (RCM-4 4234 and 3545) and two tide gauges (TG79 and 80) were deployed on 2nd March, however two current meters and one tide gauge (TG80) were replaced by RCM-4 5453, 3524 and TG 59 on 30th April because of a missing surface maker due to heavy weather. They were all recovered on 1st June 1982. In connexion with this problem two current meters became unsupported on May 17th and descended to the sea bed thereby causing a break in the record. Successful data obtained are as follows:-

Current and Salinity:	2 depths (65 m and 125 m) data from 2nd March to 30th April 1982 and the other 2 depths (23 m and 120 m) data from 30th April to 17th May 1982.
Tide:	From 2nd March to 1st June 1982.
Temperature:	17 depths (51 m, 55 m, 59 m, 63 m, 65 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 91 m, 95 m, 99 m, 103 m, 125 m and bottom; from 30th April to 17th May 1982, then 15 depths data (excluding current meters depths) up to 25th May 1982.

(d) STATION GAMMA (June - August 1982)

One thermistor chain (TR 692), 2 current meters (RCM-4 5454 and 3523) and a tide gauge (TG63) were deployed on 1st June and they were recovered on 26th August 1982. One current meter (RCM-4 5454) of 20 m depth was found to be faulty after 17th June, and a tide gauge was also faulty after 5th June. Successful data obtained are as follows:

Current and Salinity:	2 depths (20 m and 120 m) data from 1st to 16th June, then bottom depth only up to 22nd August 1982.
Temperature:	11 depths (24 m, 32 m, 40 m, 47 m, 54 m, 62 m, 70 m, 77 m, 85 m, 93 m, and 120 m) data from 1st June to 26th August 1982.

(e) STATION DELTA (September - November 1982)

One thermistor chain (TR110), 2 current meters (RCM-4 3522 and 5455) and a tide gauge (TG80) were deployed on 26th August and they were recovered on 2nd December 1982. Successful data obtained are as follows:

Current and Salinity:	2 depths (30 m and 125 m) data from 26th August to 2nd December 1982.
Tide:	From 26th August to 2nd December 1982.
Temperature:	17 depths (30 m, 43 m, 47 m, 51 m, 55 m, 59 m, 63 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 91 m, 95 m, 125 m, and bottom) data from 26th August to 12th October 1982 then 3 depths (30 m, 125 m, and bottom) only up to 2nd December, 1982.

(f) STATION EPSILON (December 1982 - February 1983)

One thermistor chain(TR692), 2 current meters (RCM-4 3524 and 3545) and a tide gauge (TG103) were deployed on 2nd December 1982 and they were recovered on 8th March 1983. Three days after deployment the thermistor chain cable was damaged by shark bite. Successful data obtained are as follows:-

Current and Salinity:	2 depths (15 m and 125 m) data from 2nd December 1982 to 8th March 1983.
Tide:	From 2nd December 1982 to 8th March 1983.
Temperature:	3 depths (15 m, 125 m, and bottom) data from 2nd December 1982 to 8th March 1983. In addition 10 more depths only for 2-4th December.

(g) STATION ZETA (March - June 1983)

One thermistor chain (TR110), two current meters (RCM-4 5455 and 6583) and a tide gauge (TG65) were deployed on 8th March and they were recovered on 14th June 1983. There were no instrument faults. Successful data obtained are as follows:-

Current and Salinity:	2 depths (15 m and 125 m) data from 8th March to 14th June 1983.
Tide:	From 8th March to 14th June 1983.
Temperature:	17 depths (15 m, 47 m, 51 m, 55 m, 59 m, 63 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 91 m, 95 m, 99 m, 125 m, and bottom) data from 8th March to 14th June 1983.

2. CTD (Conductivity/Temperature/Depth) OBSERVATION

To examine the water structure across the mouth of Spencer Gulf and along a shelf transect directed as an extension of the Gulf axis, CTD (Conductivity/Temperature/Depth) observations at several stations were carried out 12 times during the period April 1981 to June 1983, as follows:

5-6 April 1981 (SE5): 13 stations occupied
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27-28th January 1982 (SE8): CTD faults, surface data for 9 stations only + Sprightly data
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29-30th April 1982 (SE10): 8 stations
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25-26th August 1982 (SE12): 15 stations
30th November - 2nd December 1982 (SE13): 11 stations + 5 stations
7-8th March 1983 (SE14)); 12 stations, temperature data only (salinity faults)
14-15th June, 1983 (SE15): 15 stations

Most frequently occupied CTD stations are shown in Fig. 1.

3. REGIONAL CTD OBSERVATION

To support an understanding of ocean-shelf interaction near the shelf break area and the continuity of shelf edge current in the vicinity of the study area, regional oceanographic observations were made on board R/V SPRIGHTLY through the courtesy of CSIRO, three times during the study period, Flinders Staff participated.

(a) Bass Strait to Great Australian Bight
Period: 14th June - 2nd July 1981 in water depths down to 1000 m.

(b) Bass Strait to Kangaroo Island
Period: 22-31st January 1982 in water depths down to 1500 m.

(c) Fremantle, W.A. to Portland, Vic.
Period: 18th June - 4th July 1982 in water depths down to 2000m.

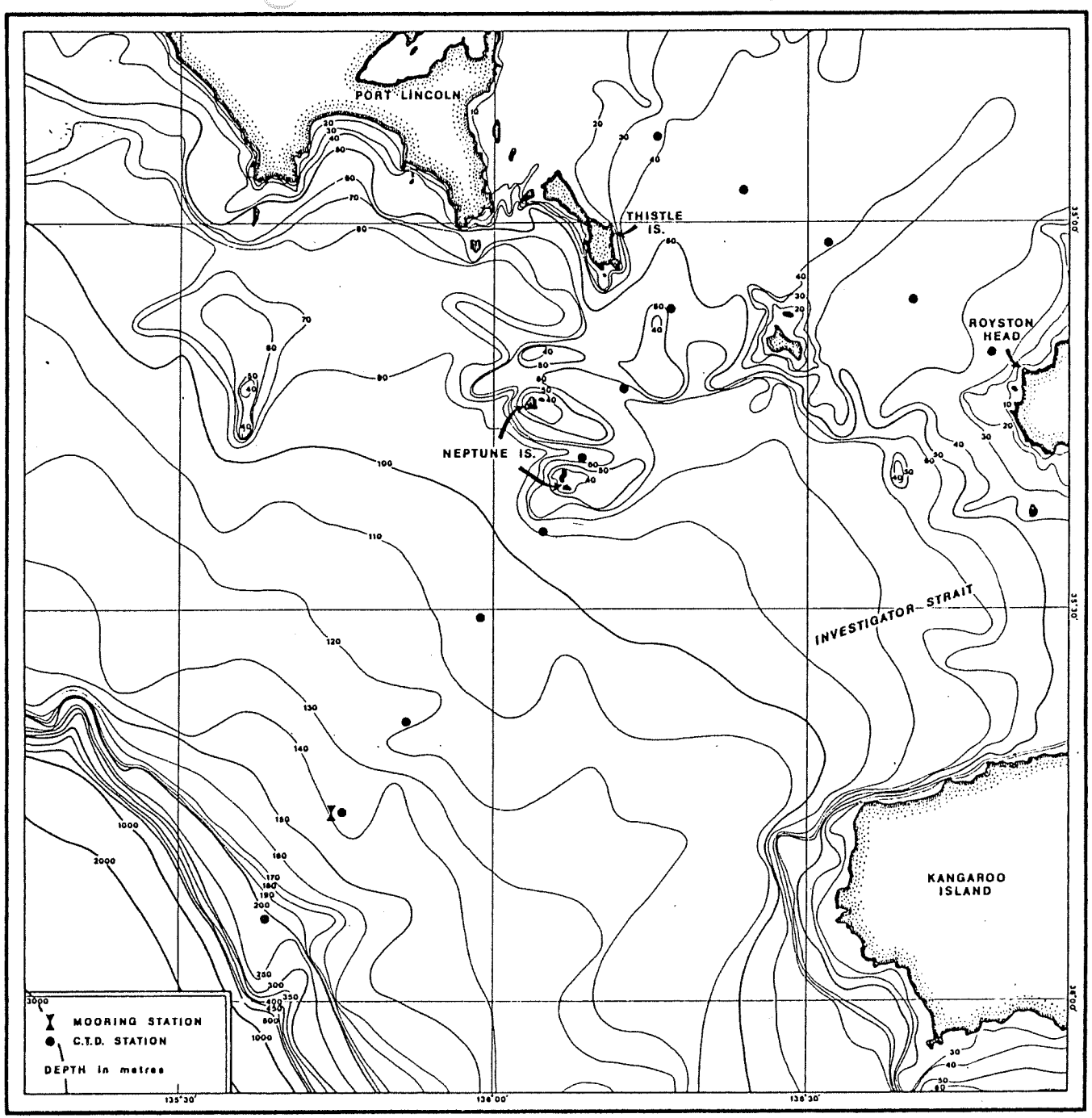


Fig. 1. STUDY AREA

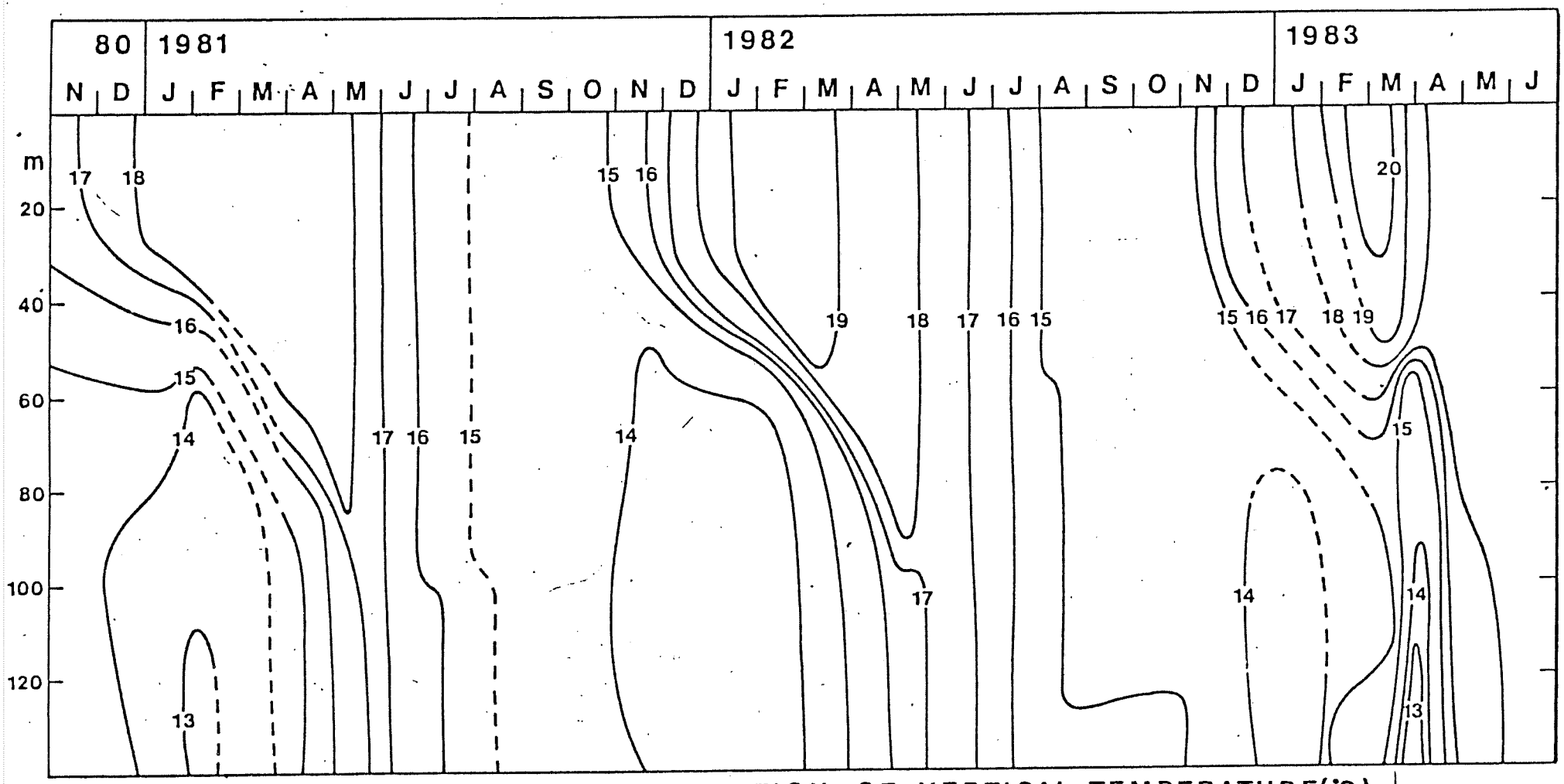


Fig. 2. SEASONAL VARIATION OF VERTICAL TEMPERATURE(°C).

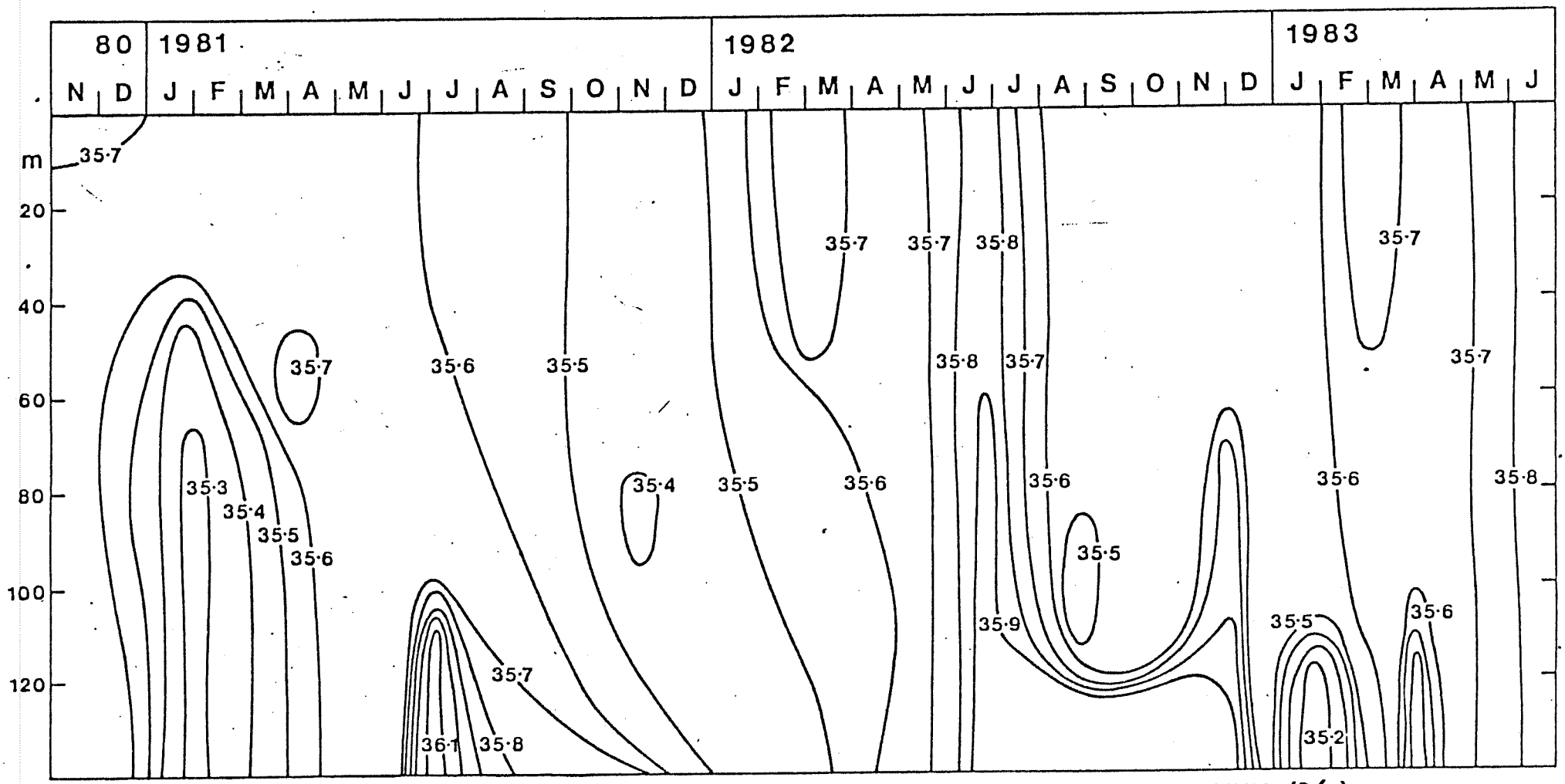
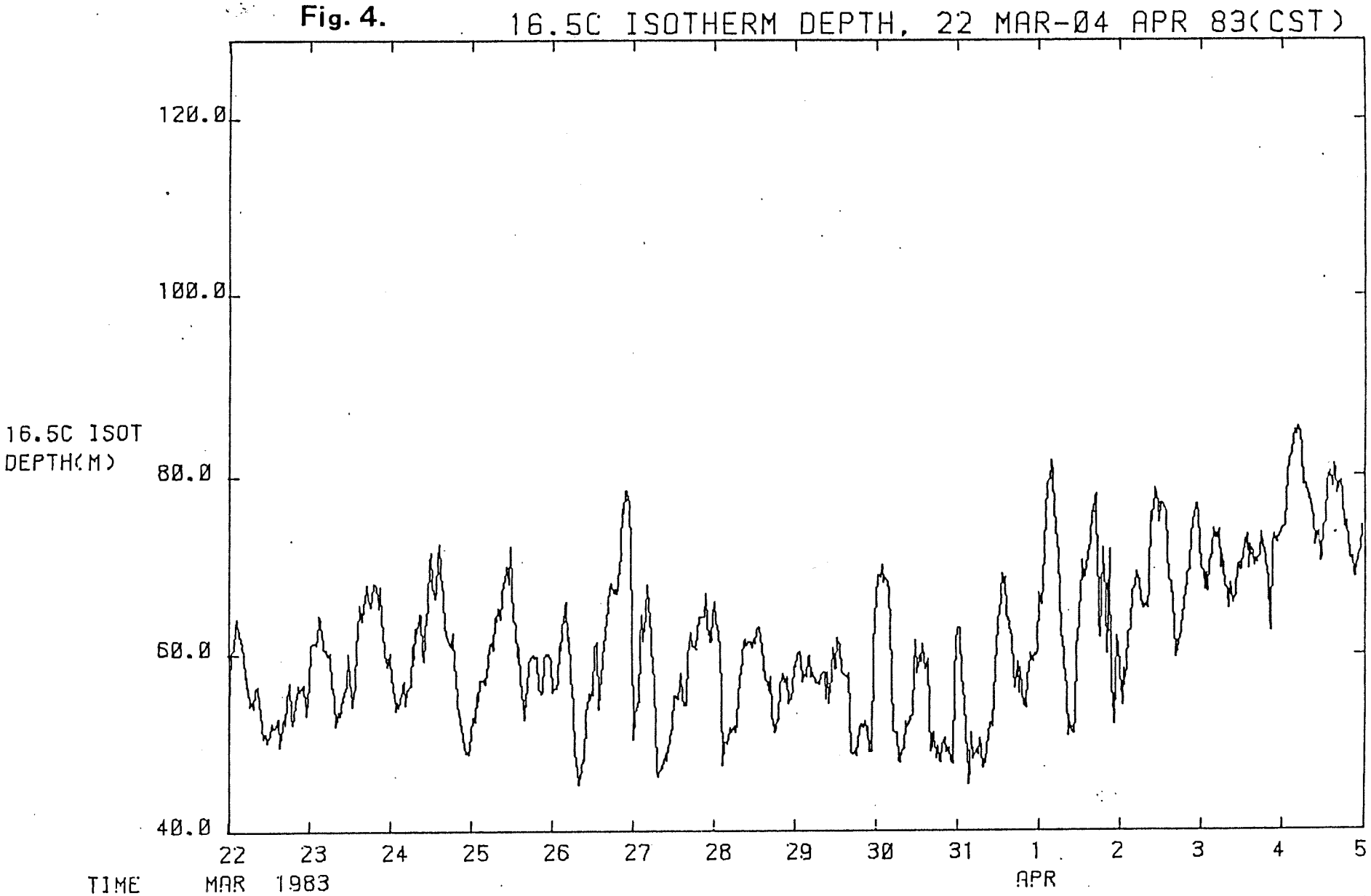


Fig. 3. SEASONAL VARIATION OF VERTICAL SALINITY (‰)

Fig. 4.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16.5C ISOT DEPTH(M)
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100.0
80.0
60.0
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TIME
MAR 1983
APR

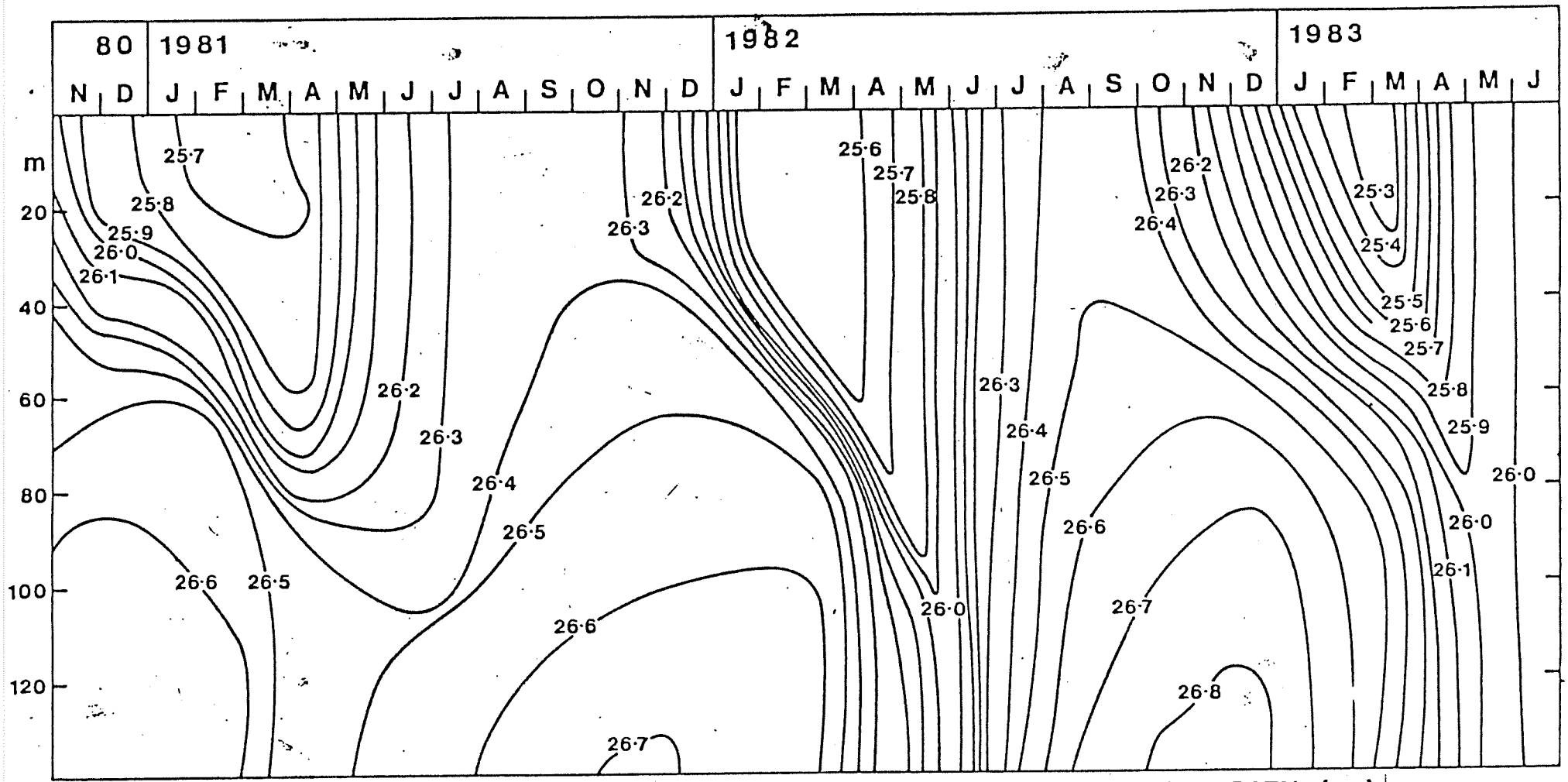

Fig. 5. SEASONAL VARIATION OF VERTICAL DENSITY (σt)

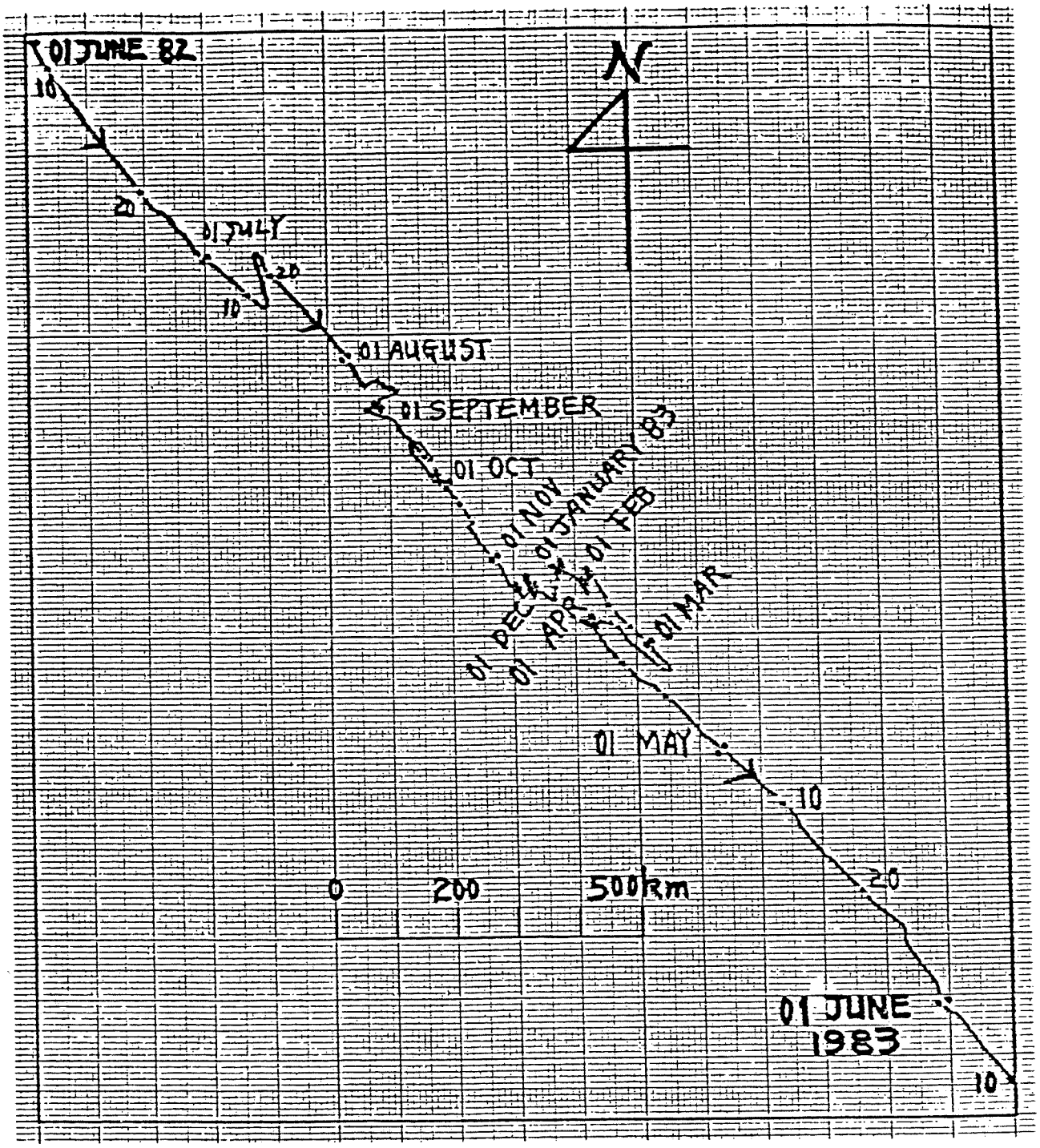

Fig. 6. PROGRESSIVE VECTOR DIAGRAM

(20 m up from bottom, from June 82 to June 83)

No 19.81../.35.....

- ☐ NEW PROPOSAL
- ☐ CONTINUING PROJECT
- ☐ FINAL REPORT
- ☐ PROGRESS REPORT

OUT-OF-SESSION - December 1983

FISHING INDUSTRY RESEARCH TRUST ACCOUNT

TITLE OF PROPOSAL/PROJECT: The Oceanography of a Continental Shelf Section

ORGANISATION: The Flinders University of South Australia

PERSON(S) RESPONSIBLE: Dr G.W. Lennon

FUNDS SOUGHT/GRANTED

YEAR	SOUGHT	GRANTED
1981/82		$21,860
1982/83		36,367

RELATED APPLICATIONS:

RECEIVED ..... Oct ../1983 DISTRIBUTED ..1..Dec../1983

..... Judith Lo .....
for Secretary
Fishing Industry Research Council

F139—12/81

The Flinders University of South Australia

BEDFORD PARK SOUTH AUSTRALIA 5042
TELEPHONE 275 3911

School of Earth Sciences

The Fishing Industry Research Committee
Department of Primary Industry
Edmund Barton Building
Broughton Street
BARTON ACT 2600

14th October 1983

Reference: F81/221 o333V

Dear Secretary,

In response to your letter of Sept 5, I am now able to forward to you a report on the 1982/3 FIRTA Project: The Oceanography of a Continental Shelf Section.

I regret that this report has been delayed.

I would wish to point out to the Committee that FIRTA support provided the basic facilities for the experimental phase of this programme and that the interpretive procedure will continue over the next year. In consequence the Committee might wish us to report again in 1984.

Yours faithfully,

G.W. Lennon
Professor of Oceanography

FISHING INDUSTRY RESEARCH TRUST ACCOUNT

Project:

The Physical Oceanography of a Continental Shelf Section in South Australia.

G.W. Lennon
Professor of Oceanography
School of Earth Sciences
Flinders University of S.A.

S.D. Hahn
Postgraduate Research Student
School of Earth Sciences
Flinders University of S.A.

This project was supported by FIRTA in two years, 1981/2 and 1982/3.

The research grant made possible the first systematic and longterm attempt to study the physical marine environment of a cross-shelf transect in Australian waters. For the first time, long time series of marine variables were obtained at a single station. Attempts were made to record

(a) temperature at several depths at intervals of 30 minutes
(b) current speed, direction and conductivity at at least two depths every 15 minutes
(c) sea levels based upon a bottom-mounted pressure sensor at 10 minute intervals.

The study area is shown in Figure 1.

Apart from two events beyond our control, one a shark bite and the other a possible interference with our mooring, the experimental record was one of great success. A detailed timetable is given in the attached Appendix.

In addition the water structure was examined across the mouth of the Gulf and along the cross-shelf transect on twelve separate occasions. These exercises served to place the observations in the wider regional context, and three opportunities provided by CSIRO to examine a wider picture extending to Bass Strait, served to increase the scale of awareness considerably.

This exercise should be viewed in the regional context in that the observational sites are strategic in so far as they are arranged so as to monitor the marine features passing through the system from west to east (a shelf-edge jet and shelf-trapped long waves) and also to monitor basic features of Shelf/Gulf exchange processes, notably the means by which the high brine contents of the Gulfs are flushed so as, hopefully, to maintain stability from year to year.

It is a matter of satisfaction to report that the experimental phase of the study has been successfully accomplished and a large data base of relevant information has been assembled. Yet the research project is not

.../2

complete. What now remains is for further progress to be made in the interpretation of the data and of the utilization of the material in modelling relevant processes. This activity will require at least one further year of study so that a final report will not be available for some time. Note that FIRTA support is not required for the ongoing phase. The present report is therefore of interim type dealing primarily with the initial experimental activity.

SUMMARY OF INTERPRETATION TO DATE

1. Temperature and Salinity - Vertical Structure.

Near-continuous time series data of temperatures and salinities at various depths have been observed at a moored station over two years. Seasonal variations were determined as shown in Figs. 2 and 3.

A surface mixed layer down to 25m is always present. The thermocline is seen to develop in November at 30m depth and this becomes stronger and deeper with time, reaching 60m depth in February. As time elapses from this stage,the thermocline continues to deepen though it becomes weaker so that in late April it can just be seen at approximately 100m depth. However in May the thermocline is rapidly destroyed and from May to late October generally vertically-mixed conditions penetrate to the sea bed with a slight indication of a temperature inversion (0.5^{o} warmer on the bottom).

As short term temperature variability is greatest at the thermocline depth, 16.5^{o}C isothermal depths were interpolated from thermistor chain data and an example is shown in Fig. 4. The evidence suggests that the thermocline is extremely mobile responding to internal waves, possibly tides. Temperature excursions at this thermocline depth can attain 4^{o}C within a few hours and the tracking of temperature contours reveals vertical displacements of the thermocline as much as 20m. Surface waters down to 40m depth show a range from 35.5^{o}/oo to 35.8^{o}/oo with a minimum in October -November and a maximum in February-March.A much greater range is shown at the bottom (35.2^{o}/oo to 36.1^{o}/oo) with a minimum in the summer season. During the summer the bottom water has cool and less saline characteristics. These indicate that the bottom water of the continental shelf is supported by intermediate water of the Southern Ocean through coastal slope intrusion processes.

.../3

Seasonal variations of the vertical density structure is shown in Fig. 5 and computed from temperature and salinity.

Since the density structure is dominated by temperature rather than salinity an understanding of the temperature structure and its seasonal variations as shown in Figure 2, provides a ready indicator of the major features of the coastal marine environments.

2. Water Movement through the Station.

Annual mean current speed at the upper layer (about 20m below surface) is 20 cm/sec, though a maximum of 100 cm/sec was recorded, and at the lower layer (20m above bottom) the mean drops by 20% to 16 cm/sec. General current direction is southeast in both layers, however, there is a somewhat complicated eddy-like circulation during September-March. The south-eastward direction is predominant in May and June. The tidal current component is very small having a mean speed of 8.8 cm/sec in the upper layer and 7.4 cm/sec in the lower layer, while its excursion distance may be less than 4 km.

The residual current component, obtained by removing the tidal signal using a numerical filter, has a mean speed of 14.8 cm/sec in the upper layer and 12.5 cm/sec in the bottom layer, nearly twice the magnitude of the tide. Fig. 6 shows a Progressive Vector Diagram of the lower layer from June 1982 to June 1983 indicating the main drift tendency.

In the 1982 winter cruise of RV SPRIGHTLY, two satellite-tracked buoys were released, one in the Great Australian Bight and the other near the mooring station, and their subsequent tracks confirmed the dominant seasonal south-eastward flow as well as maintaining compatibility with moored current meter data.

Coastal water in this area runs primarily along the coast south-eastward, however, during summer, medium scale eddy-like circulation can be identified. The transport of nutrients from the deeper ocean to the surface is inhibited by the dominant south-easterly stream and it is in the ephemeral flow reversals which occur in summer that we see conditions right for upwelling. The episodic character of these events is of vital importance in a Fisheries context.

Fisheries Implications

(a) In the next stage we shall consult Biologists and Fisheries Department personnel. Meanwhile it seems to us:-

(b) The work provides an adequate basis for the determination of the temperature of the shelf edge water column, its seasonal variation and its vertical structure - in particular the strength of the thermocline through its development.

(c) We have identified major vertical displacements of the thermocline in a time scale of hours in response to tidal and other forces. At this stage the tidal part of the signal has been determined and can be predicted.

Whether this proves to be a significant influence on fish behaviour and whether the tidal cycles are sufficiently dominant to indicate that fish behaviour is markedly different at certain parts of the cycle remains to be studied.

The general case is that the project tracks the development and mobility of the thermocline which functions as a marine boundary. Boundaries are zones where materials, including biota accumulate so that the strong link with fisheries interests is forged.

APPENDIX

LISTINGS OF FIELD DATA COLLECTIONS

1. Moored Station

Location: 35^{o} 46'S, 135^{o} 45'E (60 miles south of Pt. Lincoln)

Water Depth: 140 m (near shelf edge)

Period: Preliminary Study, April - June 1981
Main Study, November 1981-June 1983

Instruments Moored: 1 Thermistor chain
2 or more Recording Current Meters
1 or 2 Tide gauges

Data Intervals: Thermistor chain, 30 min.
Current Meter, 15 min.
Tide Gauge, 10 min.

Instruments Used:

Thermistor Chain: Microsystem TR110, 14 sensors
Aanderaa TR692, 10 sensors

Current Meter: Aanderaa RCM-4, 5 sensors
speed, direction, temperature, salinity and depth.

Tide Gauge : Microsystem TG-12A, 2 sensors,depth and temperature

(a) Station VICTOR (April - June 1981)

One thermistor chain (TR110), 2 current meters (RCM-4 5453, 3524) and 1 tide gauge (TG79) were deployed on 6th April and recovered on 2nd July, 1981 as a preliminary study. The thermistor chain exercise proved to be only moderately successful due to manufacturing faults, one sensor was faulty from the beginning and the others from 1st June. Successful data obtained are as follows:-

Current: 2 depths (40 m and 115 m) data
from 6th April to 2nd July, every 15 mins.

Salinity: 2 depths (40 m and 115 m) data
from 6th April to 2nd July, every 15 mins.-

Tide: From 6th April to 2nd July, every 10 mins.

Temperature:
16 depths data from 6th April to 31st May and then 3 depths data up to 2nd July.

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One thermistor chain (TR110), 6 current meters (RCM-4, 4234, 5455, 5454, 3524, 3545 and 3523) and 2 tide gauges (TG 79 and 80) were deployed

on 11th November 1981 and recovered on 28th January. Only one current meter (RCM-4 5454) was faulty and this was moored at the depth of 80 metres. Successful data obtained are as follows:-

Current and Salinity:	5 depths (22 m, 48 m, 108 ,, 122 m and 133 m) data from 11th November 1981 to 28th January 1982.
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One thermistor chain (TR110), 2 current meters (RCM-4 4234 and 3545) and two tide gauges (TG79 and 80) were deployed on 2nd March, however two current meters and one tide gauge (TG80) were replaced by RCM-4 5453, 3524 and TG 59 on 30th April because of a missing surface maker due to heavy weather. They were all recovered on 1st June 1982. In connexion with this problem two current meters became unsupported on May 17th and descended to the sea bed thereby causing a break in the record. Successful data obtained are as follows:-

Current and Salinity:	2 depths (65 m and 125 m) data from 2nd March to 30th April 1982 and the other 2 depths (23 m and 120 m) data from 30th April to 17th May 1982.
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(d) STATION GAMMA (June - August 1982)

One thermistor chain (TR 692), 2 current meters (RCM-4 5454 and 3523) and a tide gauge (TG63) were deployed on 1st June and they were recovered on 26th August 1982. One current meter (RCM-4 5454) of 20 m depth was found to be faulty after 17th June, and a tide gauge was also faulty after 5th June. Successful data obtained are as follows:

Current and Salinity:	2 depths (20 m and 120 m) data from 1st to 16th June, then bottom depth only up to 22nd August 1982.
Temperature:	11 depths (24 m, 32 m, 40 m, 47 m, 54 m, 62 m, 70 m, 77 m, 85 m, 93 m, and 120 m) data from 1st June to 26th August 1982.

(e) STATION DELTA (September - November 1982)

One thermistor chain (TR110), 2 current meters (RCM-4 3522 and 5455) and a tide gauge (TG80) were deployed on 26th August and they were recovered on 2nd December 1982. Successful data obtained are as follows:

Current and Salinity:	2 depths (30 m and 125 m) data from 26th August to 2nd December 1982.
Tide:	From 26th August to 2nd December 1982.
Temperature:	17 depths (30 m, 43 m, 47 m, 51 m, 55 m, 59 m, 63 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 91 m, 95 m, 125 m, and bottom) data from 26th August to 12th October 1982 then 3 depths (30 m, 125 m, and bottom) only up to 2nd December, 1982.

(f) STATION EPSILON (December 1982 - February 1983)

One thermistor chain(TR692), 2 current meters (RCM-4 3524 and 3545) and a tide gauge (TG103) were deployed on 2nd December 1982 and they were recovered on 8th March 1983. Three days after deployment the thermistor chain cable was damaged by shark bite. Successful data obtained are as follows:-

Current and Salinity:	2 depths (15 m and 125 m) data from 2nd December 1982 to 8th March 1983.
Tide:	From 2nd December 1982 to 8th March 1983.
Temperature:	3 depths (15 m, 125 m, and bottom) data from 2nd December 1982 to 8th March 1983. In addition 10 more depths only for 2-4th December.

(g) STATION ZETA (March - June 1983)

One thermistor chain (TR110), two current meters (RCM-4 5455 and 6583) and a tide gauge (TG65) were deployed on 8th March and they were recovered on 14th June 1983. There were no instrument faults. Successful data obtained are as follows:-

Current and Salinity:	2 depths (15 m and 125 m) data from 8th March to 14th June 1983.
Tide:	From 8th March to 14th June 1983.
Temperature:	17 depths (15 m, 47 m, 51 m, 55 m, 59 m, 63 m, 67 m, 71 m, 75 m, 79 m, 83 m, 87 m, 91 m, 95 m, 99 m, 125 m, and bottom) data from 8th March to 14th June 1983.

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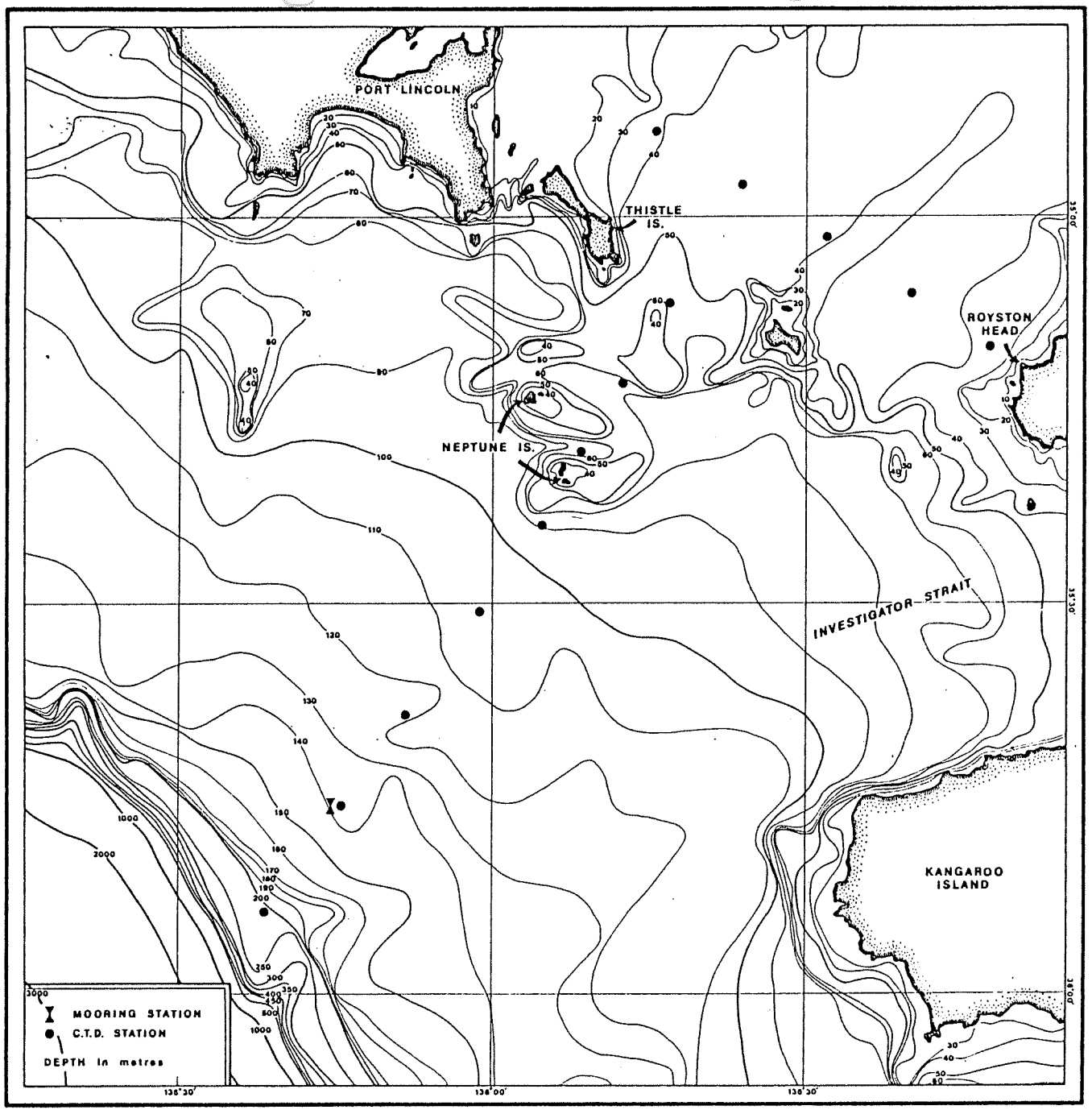


Fig. 1. STUDY AREA

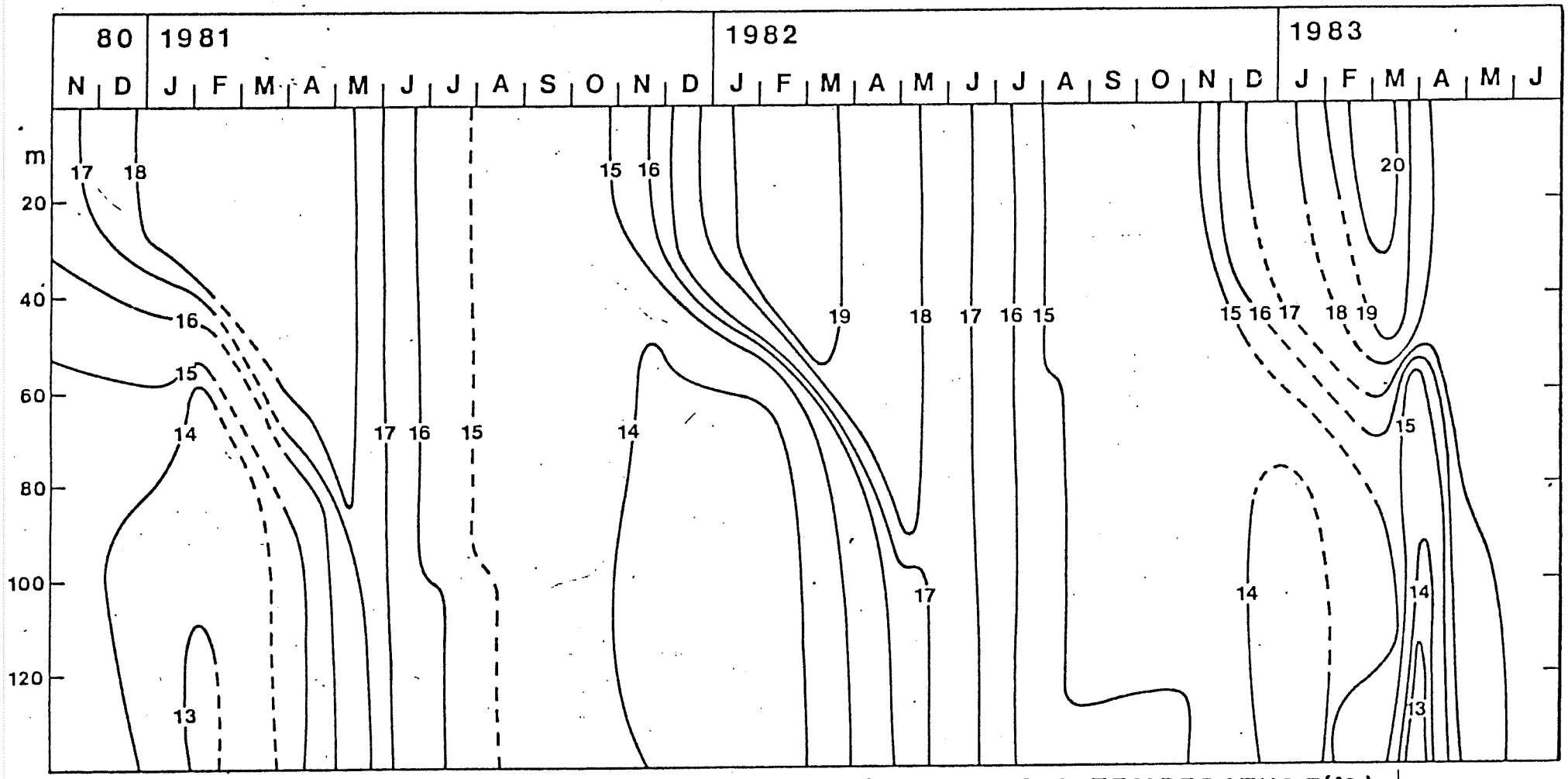


Fig. 2. SEASONAL VARIATION OF VERTICAL TEMPERATURE(°C).

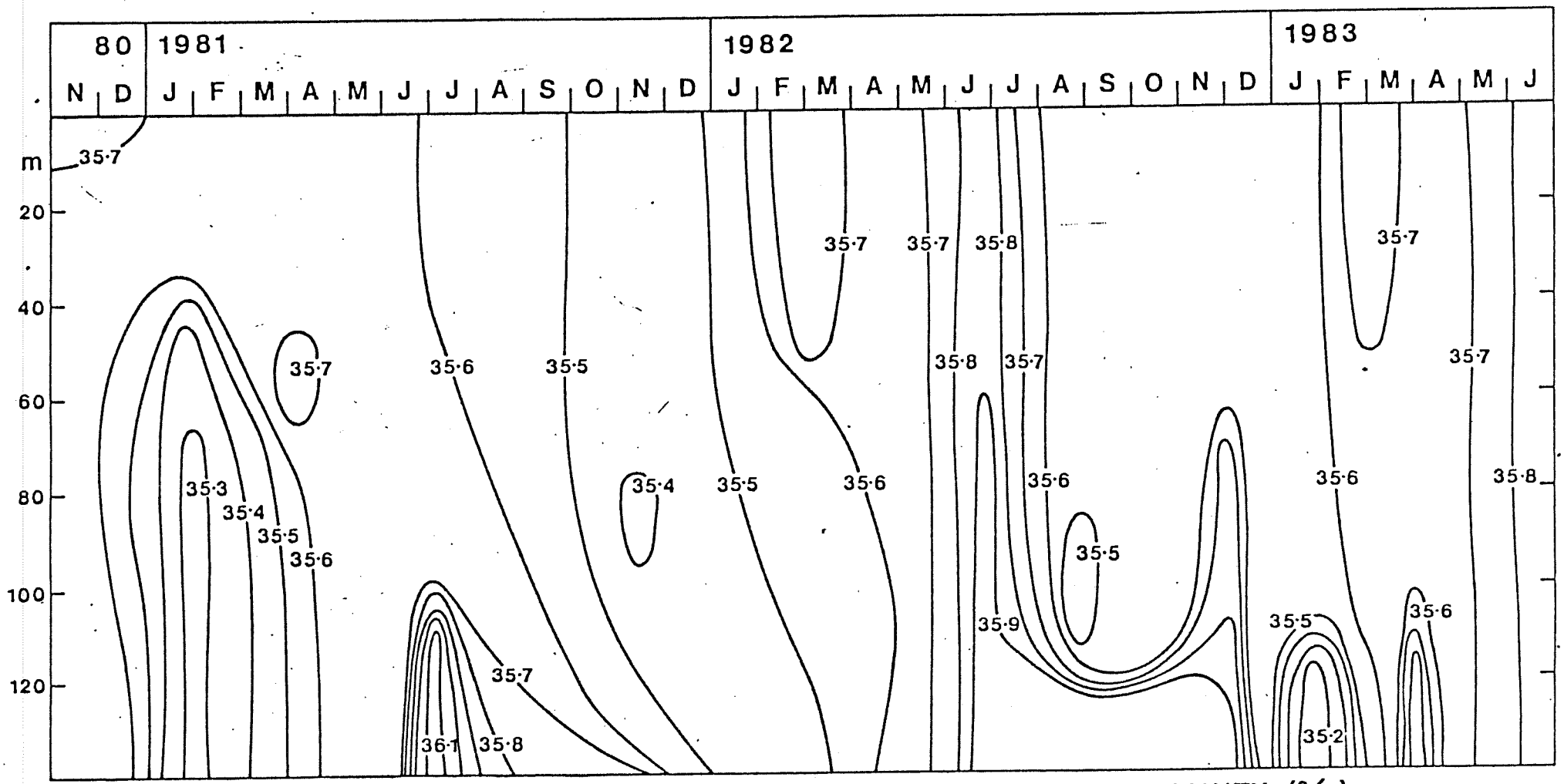
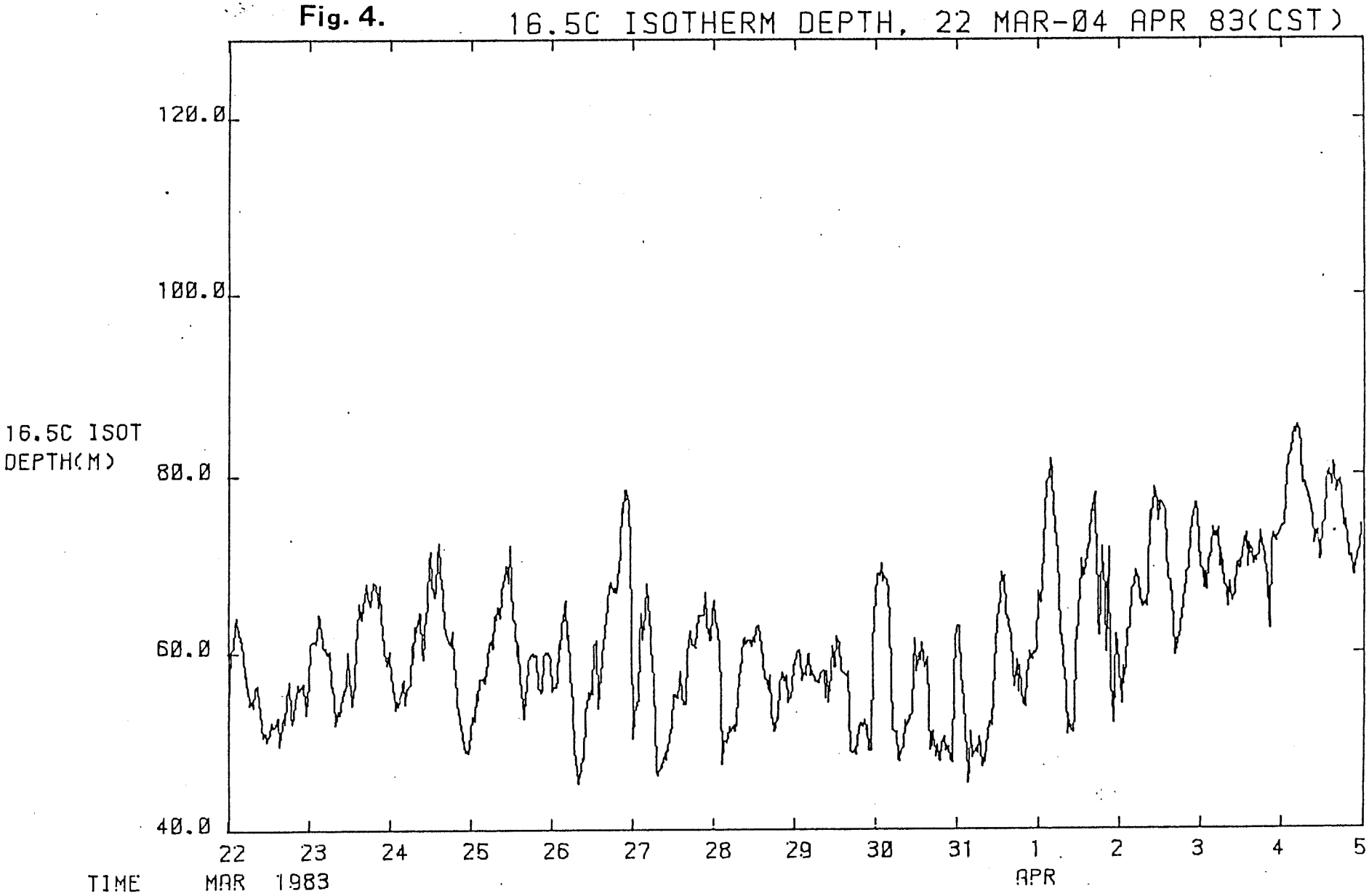


Fig. 3. SEASONAL VARIATION OF VERTICAL SALINITY (‰)

Fig. 4.


16.5C ISOTHERM DEPTH, 22 MAR-04 APR 83(CST)
120.0
100.0
80.0
60.0
40.0
16.5C ISOT DEPTH(M)
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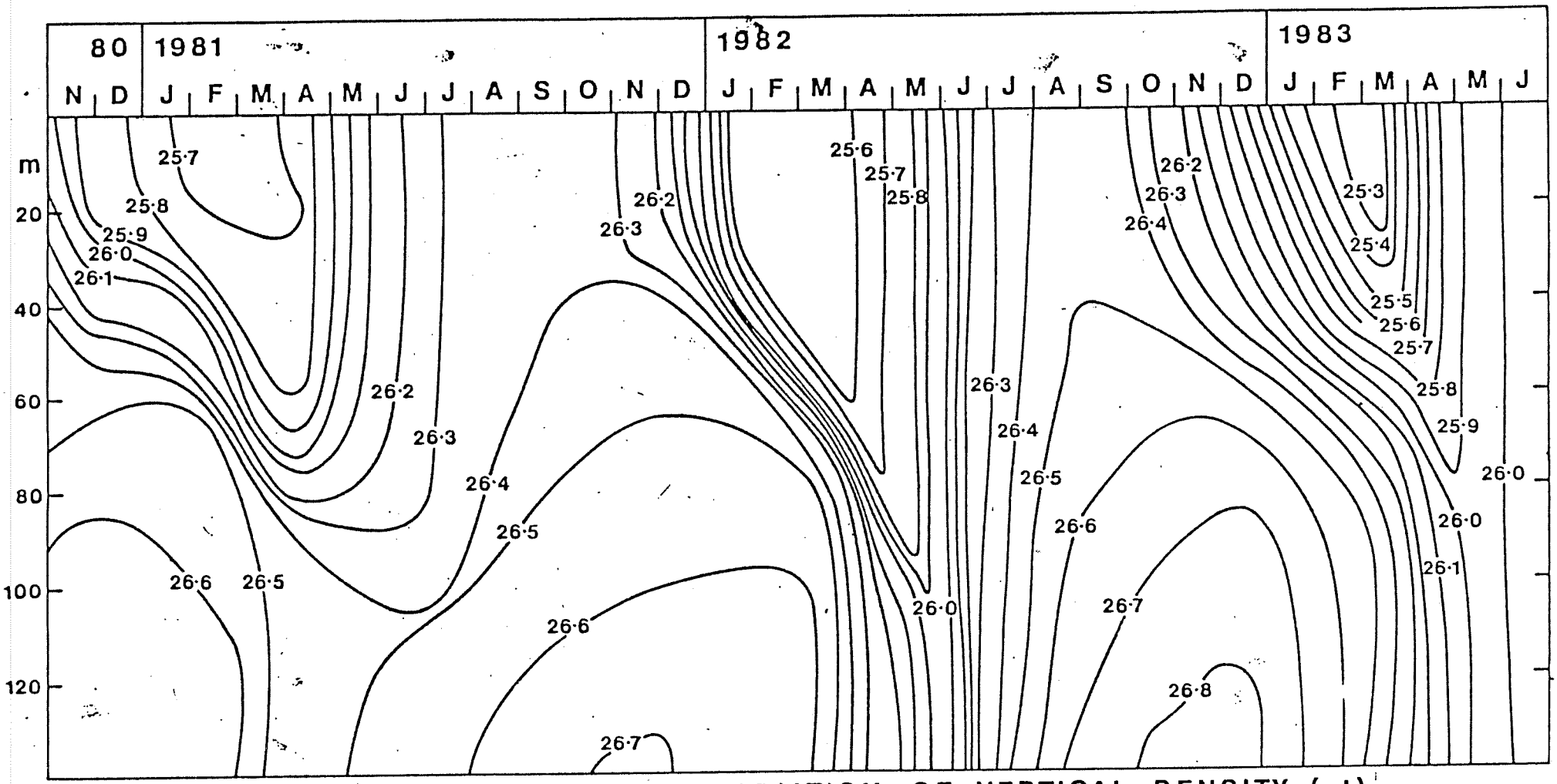

Fig. 5. SEASONAL VARIATION OF VERTICAL DENSITY (σt)

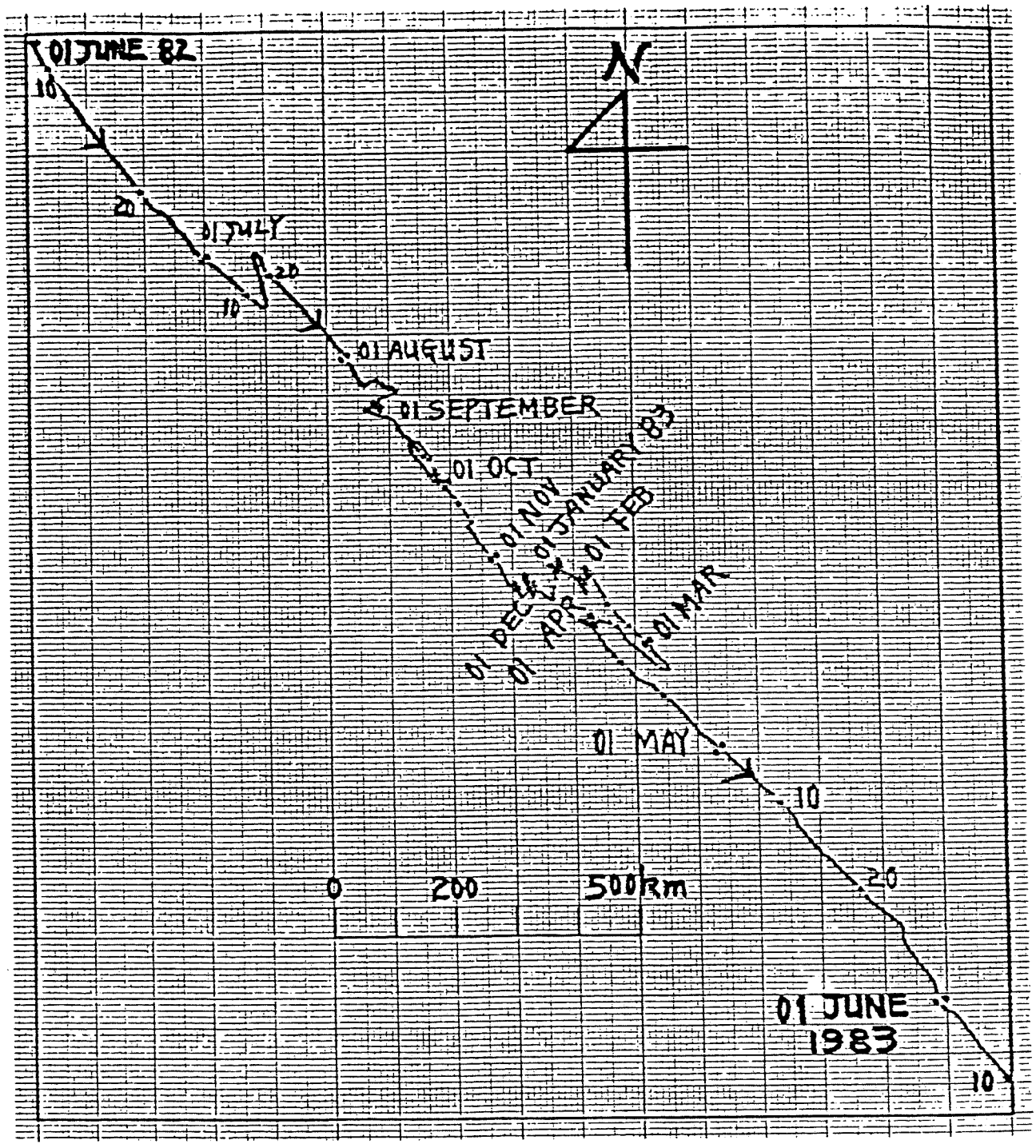

Fig. 6. PROGRESSIVE VECTOR DIAGRAM

(20 m up from bottom, from June 82 to June 83)

81/35

The Oceanography of a Continental Shelf Section (1981/35)

Objectives:

(i) To observe the temperature and salinity structure along a section at the mouth of Spencer Gulf, South Australia, from Rosalind Shoal via Neptune Island to the edge of the continental shelf.

(ii) To design a mooring, for deployment near the shelf edge on the above section, containing a thermistor chain of 14 temperature sensors and two Aanderaa current meters, the latter capable of logging conductivity and temperature in addition to current speed and direction.

Organisation:

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Supervisors:

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Grants:

1981/82	1982/83	Total
$21,860	$36,367	$58,227