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# TEMPERATURE STRUCTURE AND SURFACE SALINITY IN THE GULF OF MAINE DURING 1981 AND 1982

by

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## INTRODUCTION

This report presents the monthly temperature and surface salinity data from the Gulf of Maine collected during 1981-1982 by the Ship of Opportunity Program (SOOP). The Ship of Opportunity Program originated in 1975 as part of the joint effort of the Atlantic Environmental Group (AEG) in Narragansett, Rhode Island and the Northeast Fisheries Center (NEFC) laboratory in Woods Hole, Massachusetts.

The program was set up with the main objective to monitor the monthly changes in water temperature and sea surface salinity along designated transect routes in the Gulf of Maine. Reports on results from earlier years of this program are in Wright (1983), Caine (1980), Kirschner (1980), Pawlowski (1979), and Pawlowski (1978).

Observations in 1981 were made by M.V. CARIBOU REEFER II operating between Gloucester, Massachusetts and Cape Sable, Nova Scotia; M.V. MARINE EVANGELINE between Portland, Maine and Yarmouth, Nova Scotia; and the U.S.C.G.C. ACTIVE operating along the 43°00'N latitude between 70°31'W and 66°47'N. Dates of 1981 cruises are listed in Table 1. Observations in 1982 were made by M.V. YANKEE CLIPPER sailing from Boston, Massachusetts to Cape Sable; M.V. MARINE EVANGELINE from Portland to Yarmouth; U.S.C.G.C. DECISIVE operating along the 42°25'N latitude between 70°W and 67°34'W; and U.S.C.G.C. DUANE from 70°05'W, 43°21'N to 66°59'W, 43°07'N. Dates of 1982 cruises are listed in Table 2. Locations of the transects are shown in Figure 1.

# METHODS

Expendable bathythermograph (XBT) probes were dropped at hourly intervals along the transect route. A surface bucket temperature and water sample for salinity analysis were also taken at each XBT station. The salinities were determined by AEG using a conductive salinometer. Bottom depths were read from the XBT traces when possible. In other cases the station positions were plotted on a bathymetric chart and a depth estimate obtained. Distance between the stations were calculated for use in plotting the temperature cross sections. The XBT traces were read to a tenth of a degree resolution and temperature cross sections were drawn with a 1°C contour interval. In areas where data is missing, isotherms were plotted using a dashed line. The surface temperature and surface salinity along the transects were plotted for each occupation of each section. The surface salinity data were also averaged regionally along each transect and the values for each region plotted through each year. On the Portland to Yarmouth transect four regions were used - coastal Maine and coastal Nova Scotian where the water depth was less than 100 m, and the central gulf east and west of 68°30'W. For the Gloucester or Boston to Cape Sable transect, five regions were used - coastal Massachusetts and coastal Nova Scotia with depths less than 100 m, central gulf west of 69°W, the central gulf between 69° and 68°W, and the central gulf east of 68°W. In the five central gulf regions, the area weighted mean temperature of water below 100 m depth was determined by use of a planimeter and the values plotted.

# RESULTS

The contoured temperature sections are presented for each transect in each year by season: winter (January-March), spring (April-June), summer (July-September), and fall (October-December) (Figures 2-17). The surface temperature and salinity values along each section occupation are also grouped seasonally (Figures 18-26). The area averaged surface salinity and bottom water temperature values are plotted by year (Figures 27-32).

## 1981

### Portland-Yarmouth

By late January cooling induced convection had produced nearly isothermal conditions to the bottom at both the eastern and western ends of the transect. Convection, however, had not penetrated below 50 m depth over the central portion of the section. A temperature gradient below 50 m still separated the warmer (>7°C) water of Slope Water origin that filled much of the deeper areas from the surface cooling. By late February continued cooling and convection had resulted in vertically isothermal conditions across the entire section, except for a reduced area of warmer Slope Water over the deep trough in Jordan Basin. The shallow coastal areas were 1-2°C colder than the interior waters.

While little surface warming occurred by early April, by late May the seasonal thermocline had begun to form in the upper

25 m across the transect. Between April and May surface temperatures rose about 4°C. The surface warming isolated a temperature minimum layer between 50-100 m, characteristic of the Maine Intermediate water identified by Hopkins and Garfield (1979). The bottom waters warmed slightly through the spring. As cold (<4°C) layer observed at 50 m in April may have been either an early evidence of intermediate layer formation by slight surface warmining, or due to the advection of cold water from the Scotian Shelf.

Surface warming continued through the summer with the thermocline fully developed in July and with downward penetration of heating evident through September. The temperature minimum layer was eroded by late August and temperatures then generally decreased from surface to the bottom.

Through the fall surface cooling which was first evident in early October steadly broke down the thermocline. By late December near uniform conditions were again being approached. Temperatures in the bottom layer warmed through the fall with little water of less than 6°C being observed in November and little less than 7°C in December.

## Gloucester-Cape Sable

During the winter wind mixing and cooling induced convection progressively cooled the water column. By late March in Wilkenson Basin on the western side of the transect nearly isothermal conditions (4-5°C) extended to at least 200 m depth. Further to the east the isothermal layer extended to about 100 m depth, with warmer (6-8°C) Slope Water filling the deeper layers of both Crowell Basin and the trough east of Browns Bank.

While only slight near surface warming near the coasts was observed in early April, by late May a sharp thermocline had begun to form over the western half of the section. Surface temperatures there rose 5-9° between April and May observations. The onset of the thermocline isolated a mid-depth temperature minimum layer across much of the section. To the east, surface temperatures rose more slowly and a cold (<3°C) layer of water appeared intruding at 50 m depth from the Scotian Shelf. This intrusion may be related to the similar feature observed in the April occupation of the Portland-Yarmouth section.

Through the summer the thermocline continued to develop and by early September extended across the entire section. The mid-depth temperature minimum layer endured at least in small parcels to September. The bottom waters below 100 m continued to cool into the late spring and then began to warm through the summer with an average increase of about 1°C occurring between June and September.

1982

Portland-Yarmouth

The slow cooling that began in the fall of 1981 accelerated in early 1982. In January cooling was concentrated in the upper 50 m where temperatures dropped 2-3°C. During February and March cooling penetrated to the deeper layers such that by late March, isothermal conditions (approximately 3°C) existed to the bottom (approximately 175 m) over the western half of the section. To the east the warmer temperatures associated with the intrusion of Slope Water were still evident (below 100 m) in Jordan Basin with maximum temperatures of 7-8°C.

During the spring, surface warming began with the onset of thermocline formation evident by late May at the western half of the section. A temperature minimum layer was isolated below the thermocline. The bottom waters below the temperature minimum continued to cool until late May.

Through the summer the thermocline intensified with downward penetration of heating continuing to at least 100 m depth into mid-September. While the bottom water temperatures rose in eastern Jordan Basin, the temperature minimum layer was still observed over most of the section through September.

A breakdown in the thermocline occurred during October and resulted in isothermal conditions over at least the upper 50 m of the water column. While the surface temperatures dropped 3°C, the waters that had been below the thermocline exhibited a comparable increase in temperature. This pattern suggests that the breakdown in the thermocline was due to wind induced mixing, rather than cooling induced convection. Slow cooling with nearly isothermal conditions continued through December. Average bottom water temperatures remained fairly constant through the fall.

Boston-Cape Sable

The first 1982 occupation of the Boston-Cape Sable section occurred in late May by which time the seasonal thermocline had begun to form over the western half of the transect, the mid-depth temperature layer had been isolated below the thermocline, and the average bottom layer temperature in Crowell Basin was about 7.5°C and in Wilkenson Basin about 6.5°C. During the summer the thermocline continued to develop and maximum surface temperatures were observed in mid-July. Downward penetration of heating below the thermocline, however, continued into September and the temperature minimum layer gradually warmed. The bottom layer in Wilkenson Basin cooled through August while in Crowell Basin it warmed. An usually warm (>10°C) parcel of water appeared intruding at depth into Crowell Basin in July. The feature was evident as a temperature maximum between 100-150 m on two XBT traces and is believed to be real. While it was not observed in August, the bottom layer temperature to the east warmed by nearly 2°C between July and August indicating a considerable influx of warm water. The warming was short lived with cooler bottom temperatures again observed in September.

During October a breakdown of the thermocline was observed that was similar to that seen in the Portland-Yarmouth section. Surface temperatures decreased 2-4°C, while below 25 m, temperatures increased, again suggesting a wind induced mixing. Cooling continued into December when nearly isothermal conditions existed to 100 m depth across the entire section. The average bottom layer temperatures increased by about 1°C through the fall as the temperature minimum layer eroded and actual bottom temperatures increased slightlty.

Surface Salinity

1981

Along both transects a general decrease in surface salinity through the year was observed in all areas (Figures 27 and 28). The rapid decline of salinity in the coastal Maine areas during the spring was due to local coastal runoff and contributed to the onset of thermocline formation observed in the temperature cross sections. The interior areas of both sections had a more uniform rate of decrease in salinity. Even though some increases did occur, each area showed a drop of nearly $1^{o}/oo$ in salinity between the first and last occupations for the year. The Gloucester to Cape Sable transect was not occupied after September and the trend through the end of the year is not known.

1982

The Portland-Yarmouth section began the year with surface salinity values considerable less than at the beginning of 1981 (Figure 28). West of 68°30'W the spring decrease in surface salinity associated with coastal runoff was observed. East of 68°30'W, however, the salinity remained fairly constant through June. Beginning in June a rise in salinity began in the coastal Nova Scotia area and appeared to progress westward across the section. The maximum salinity at the end of this rising trend also appeared to progress westward from near Nova Scotia in September to coastal Maine in November. At the end of 1982 the salinity in each area was at least 0.75$^{o}$/oo higher than at the end of 1981.

The observations on the Boston to Cape Sable transect began in May (Figure 30). A steady, general increase occurred through the rest of the year in all areas. West of 69°W this increase was greater than 2$^{o}$/oo and further to the east it was about 1$^{o}$/oo.

Bottom Layer Temperatures

The average temperatures below 100 m depth are shown in Figures 31 and 32. At the Portland-Yarmouth section in both years minimum values were observed between February and May. The lack of data in March 1981 prevents identifying the actual time of minimum temperatures. The winter cooling occurred earlier and more rapidly in 1981 than in 1982. From July to December the bottom layer temperatures across the section were fairly similar in both years, with 1982 being slightly warmer than 1981. The seasonal extremes in both years had a range of 5-6°C west of 68°30' and of about 2° east of 68°30'.

The Boston to Cape Sable section was not occupied through the full seasonal cycle of either year and had only a five month period of overlap between the years. 1982 was considerably warmer than 1981 in every area in May and June, with the differences largest on the eastern side of the Gulf. By September the bottom layer temperatures in 1981 and 1982 were quite similar. The higher bottom layer temperatures in 1982 on the Portland to Yarmouth section, particularly west of 68°30'W, suggest that the change in Slope Water characteristics had penetrated throughout the Gulf of Maine by October-November 1982.

## CONCLUSIONS

The temperature cross sections for both transects in both years show the major features of the seasonal cycle commonly observed in the Gulf of Maine. A major difference between the years appears to be a change in the character of Slope Water entering the gulf. In June 1982 Crowell Basin on the eastern side of the Boston-Cape Sable section had water above 9°C at mid-depth and above 10°C in July. These temperatures are more than 2°C warmer than the maximum values observed in 1981 at the same location. A rapid rise in surface salinity also was occurring by June 1982 and at both sections appeared to progress across the entire Gulf of Maine. The higher temperatures and surface salinities suggest the influx of Warm Slope Water in 1982 with colder, fresher Labrador Slope Water being more prevalent in 1981 (see Gatian, 1976 for discussion of Slope Water characteristics). The lack of data from October 1981 to May 1982 in Crowell Basin prevent a full discussion of this change in water characteristics.

# FIGURE CAPTIONS

1. Location of Transects Occupied in 1981 and 1982.

2. 1981 Winter Sections by MARINE EVANGELINE.

3. 1981 Spring Sections by MARINE EVANGELINE.

4. 1981 Summer Sections by MARINE EVANGELINE.

5. 1981 Fall Sections by MARINE EVANGELINE.

6. 1981 Winter Sections by CARIBOU REEFER II.

7. 1981 Spring Sections by CARIBOU REEFER II.

8. 1981 Summer Sections by CARIBOU REEFER II.

9. 1981 Section by U.S.C.G.S. ACTIVE.

10. 1982 Winter Sections by MARINE EVANGELINE.

11. 1982 Spring Sections by MARINE EVANGELINE.

12. 1982 Summer Sections by MARINE EVANGELINE.

13. 1982 Fall Sections by MARINE EVANGELINE.

14. 1982 Spring Sections by YANKEE CLIPPER.

15. 1982 Summer Sections by YANKEE CLIPPER.

16. 1982 Fall Sections by YANKEE CLIPPER.

17. 1982 Sections by U.S.C.G.C. DUANE and U.S.C.G.C. DECISIVE.

18. 1981 Surface Temperatures by MARINE EVANGELINE.

19. 1981 Surface Salinity by MARINE EVANGELINE.

20. 1981 Surface Temperature by CARIBOU REEFER II.

21. 1981 Surface Salinity by CARIBOU REEFER II.

22. 1982 Surface Temperature by MARINE EVANGELINE.

23. 1982 Surface Salinity by MARINE EVANGELINE.

24. 1982 Surface Temperature by YANKEE CLIPPER.

25. 1982 Surface Salinity by YANKEE CLIPPER.

26. 1982 Surface Temperature and Salinity by U.S.C.G.C. DUANE and U.S.C.G.C. DECISIVE.

27. 1981 Area Averaged Surface Salinity by MARINE EVANGELINE.

28. 1982 Area Averaged Surface Salinity by MARINE EVANGELINE.

29. 1981 Area Averged Surface Salinity by CARIBOU REEFER II.

30. 1982 Area Averaged Surface Salinity by YANKEE CLIPPER.

31. Bottom Water Temperatures on the Gloucester to Cape Sable Section for a) 1981 and b) 1982.

32. Bottom Water Temperatures on the Portland to Yarmouth Section for a) 1981 and b) 1982.

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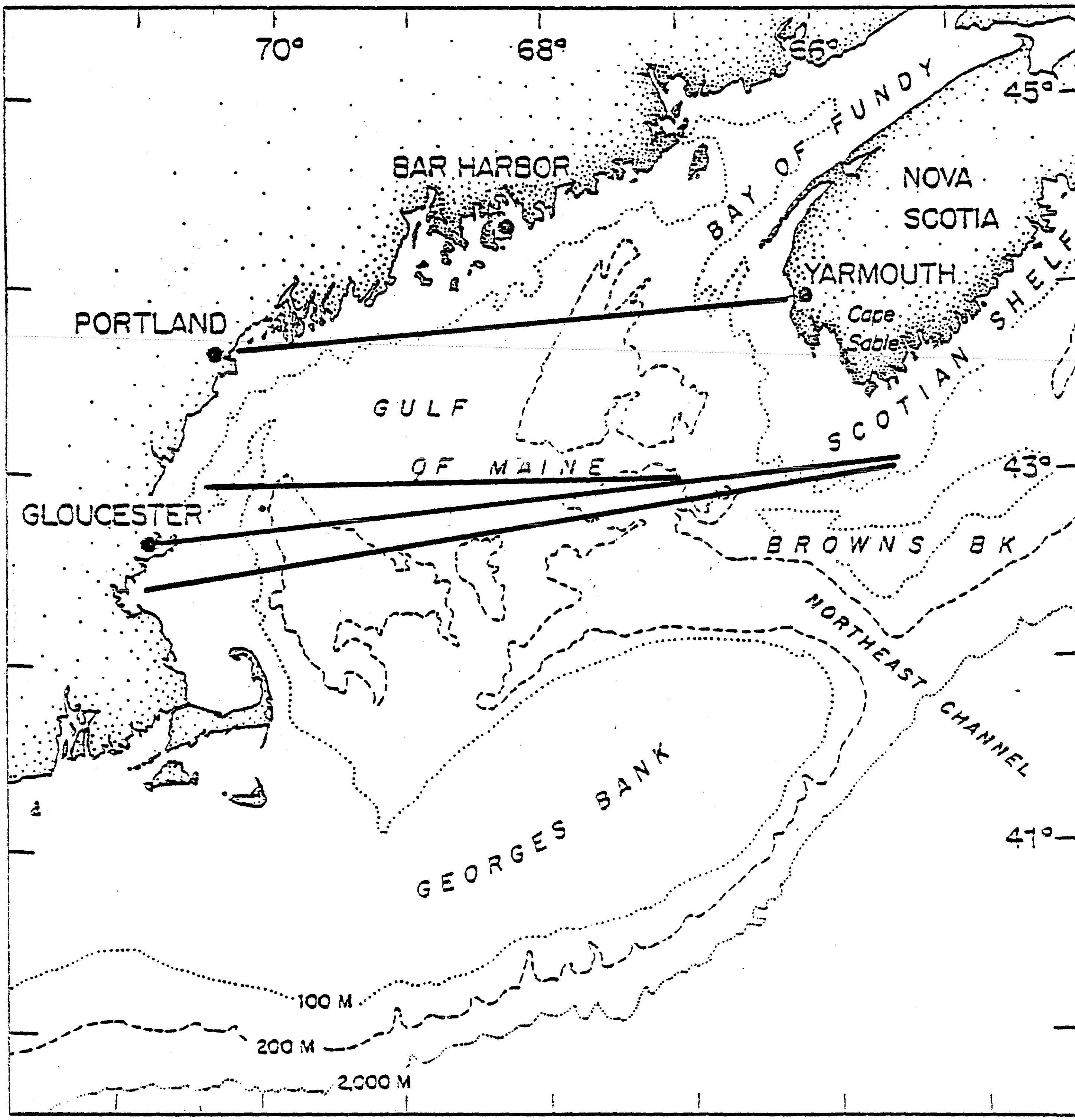
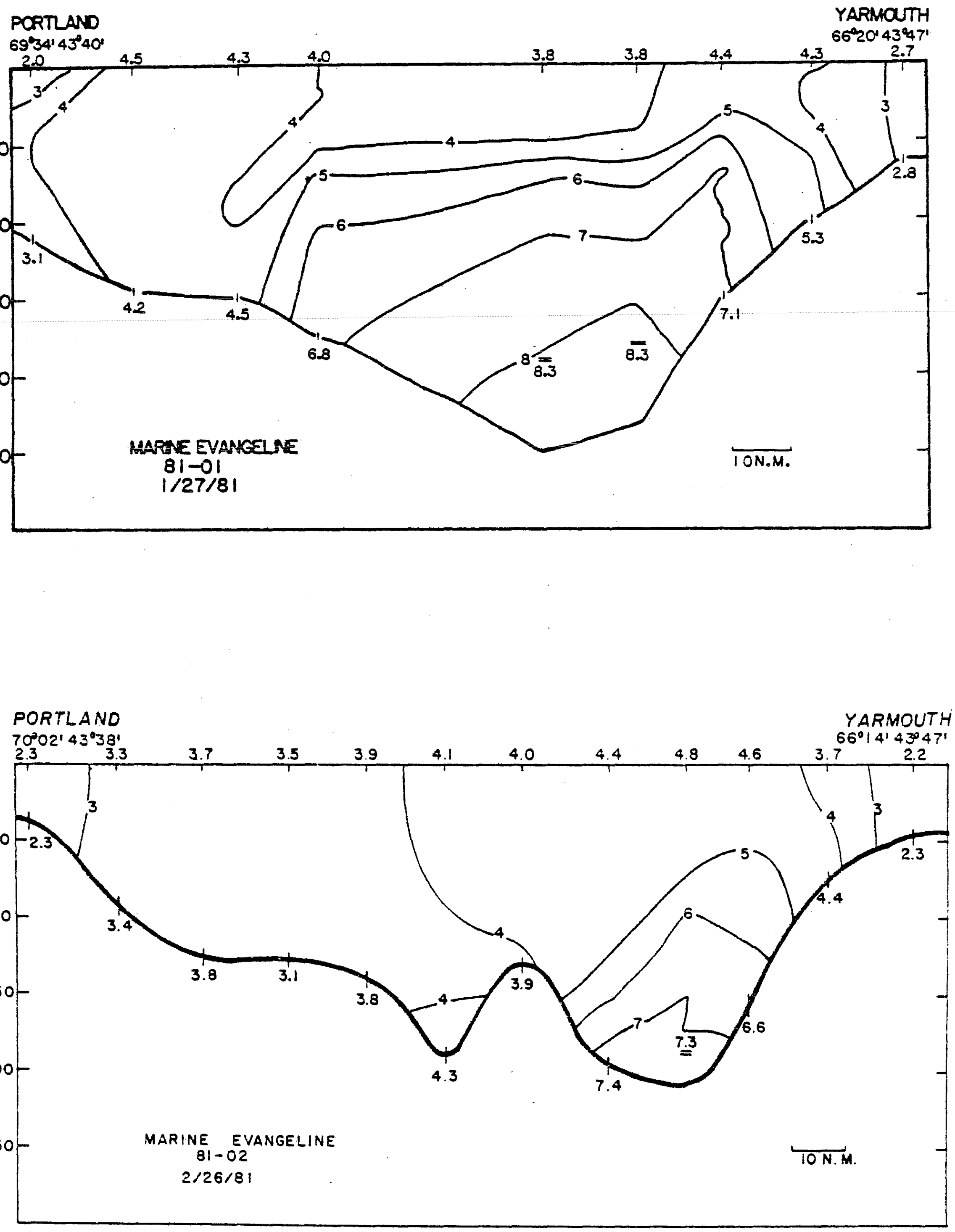

70°
68°
66°
45°
43°
41°
BAR HARBOR
BAY OF FUNDY
NOVA SCOTIA
YARMOUTH
Cape Sable
PORTLAND
GLOUCESTER
GULF OF MAINE
SCOTIAN SHELF
BROWNS BK
NORTHEAST CHANNEL
GEORGES BANK
100 M
200 M
2,000 M

Figure 1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69°34' 43°40'
YARMOUTH
66°20' 43°47'
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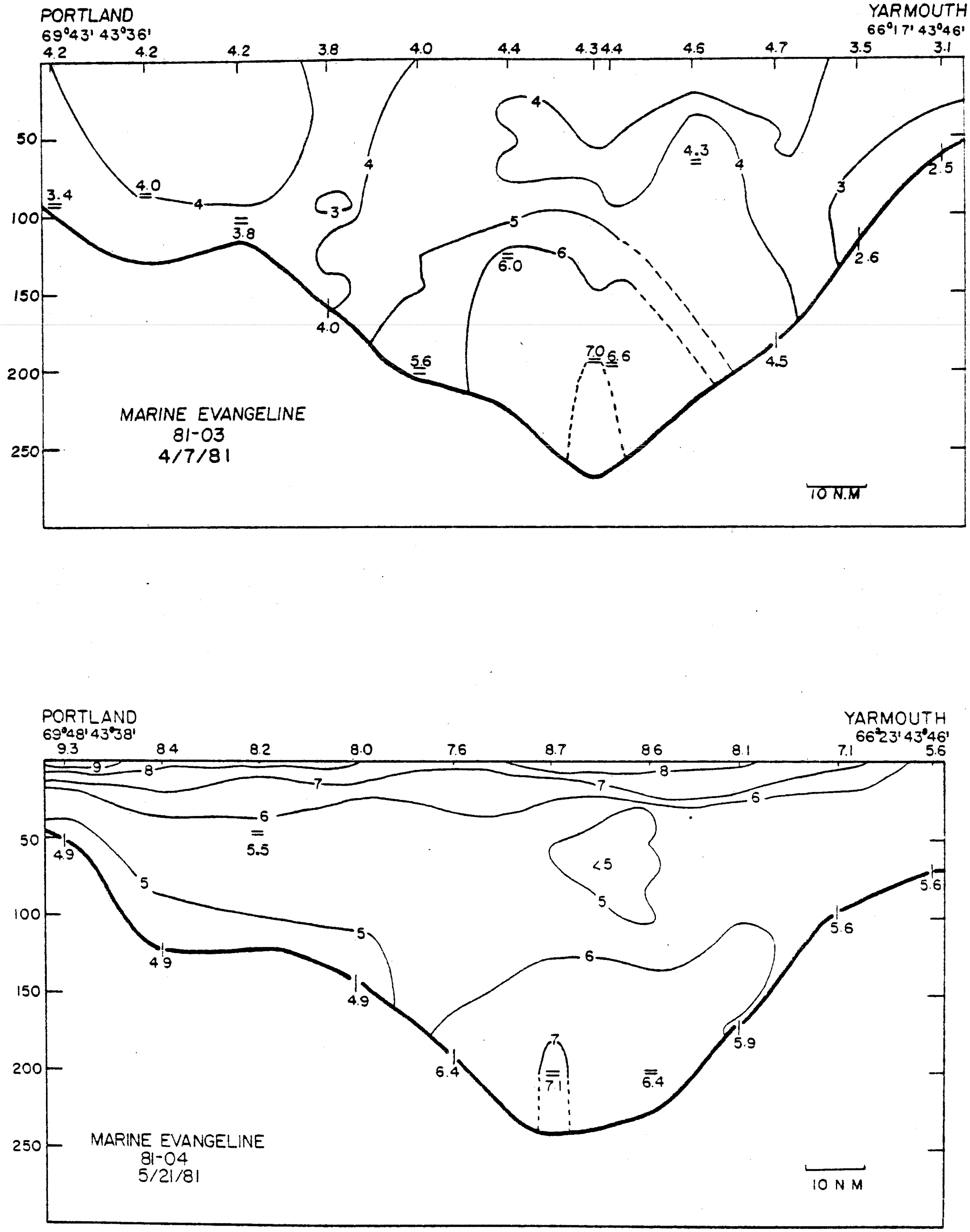
4.5
4.3
4.0
3.8
3.8
4.4
4.3
2.7
50
100
150
200
250
3.1
4.2
4.5
6.8
8.3
8.3
7.1
5.3
2.8
MARINE EVANGELINE
81-01
1/27/81
10N.M.
PORTLAND
70°02' 43°38'
YARMOUTH
66°14' 43°47'
2.3
3.3
3.7
3.5
3.9
4.1
4.0
4.4
4.8
4.6
3.7
2.2
2.3
3.4
3.8
3.1
3.8
4.3
3.9
7.4
7.3
6.6
4.4
2.3
MARINE EVANGELINE
81-02
2/26/81
10 N.M.

Figure 2



PORTLAND
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YARMOUTH
66°17' 43°46'
4.2
4.2
4.2
3.8
4.0
4.4
4.3
4.4
4.6
4.7
3.5
3.1
50
100
150
200
250
MARINE EVANGELINE
81-03
4/7/81
10 N.M
PORTLAND
69°48' 43°38'
YARMOUTH
66°23' 43°46'
9.3
8.4
8.2
8.0
7.6
8.7
8.6
8.1
7.1
5.6
50
100
150
200
250
MARINE EVANGELINE
81-04
5/21/81
10 N M


Figure 3

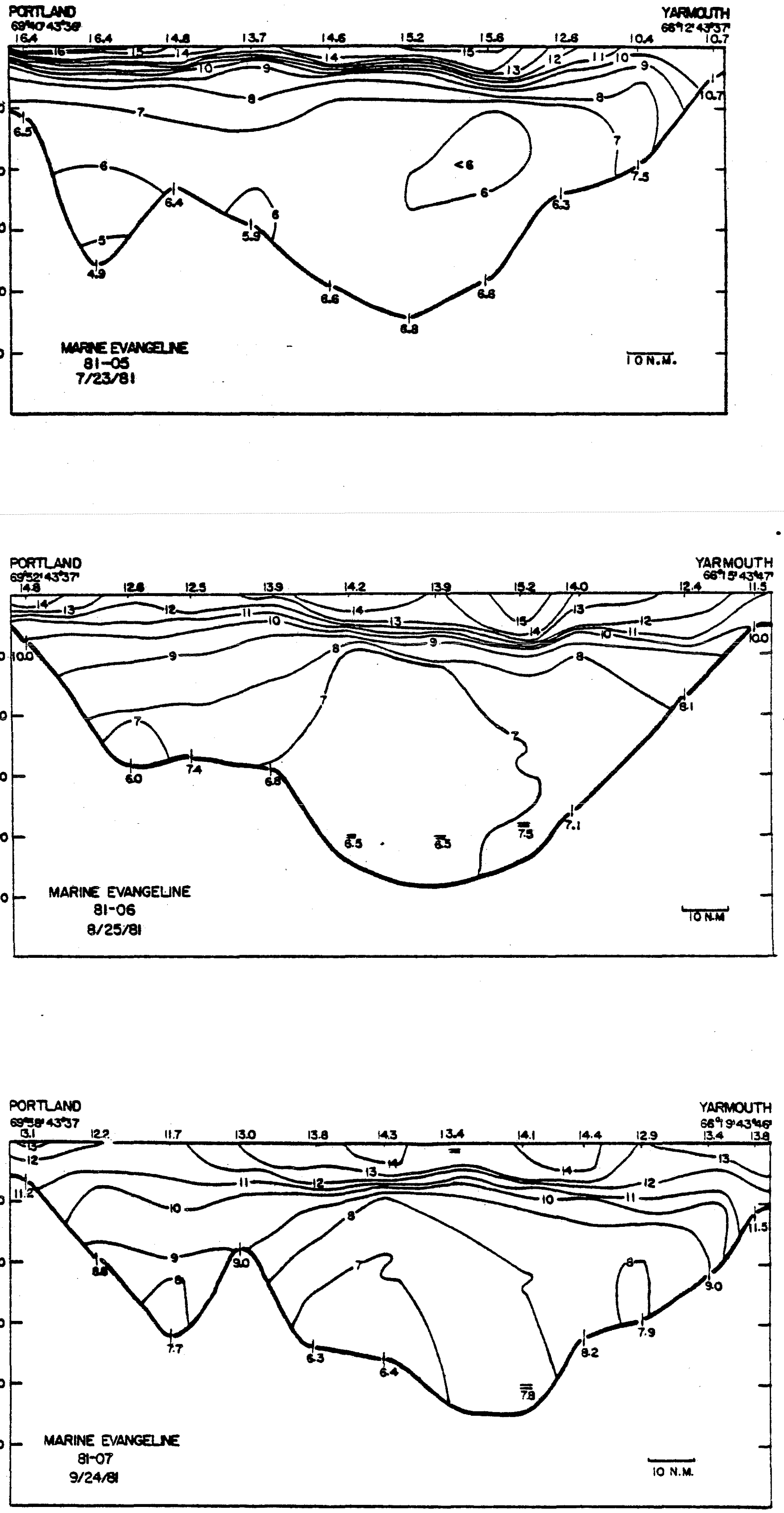
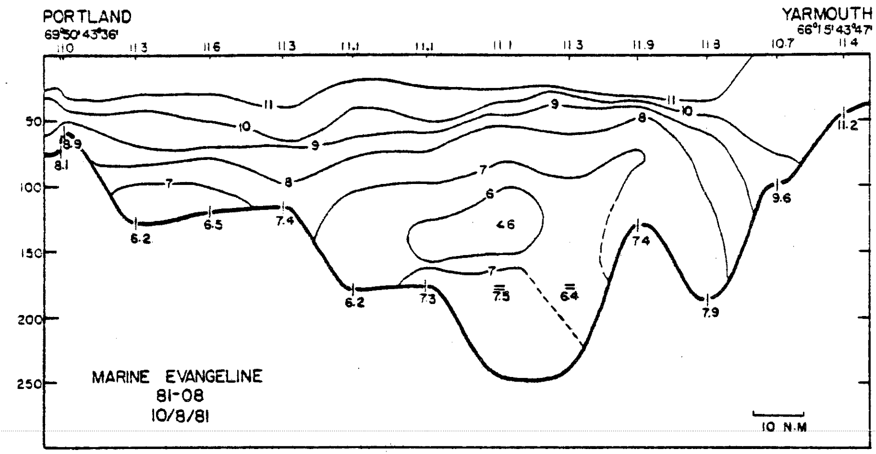

PORTLAND
YARMOUTH
50
100
150
200
250
MARINE EVANGELINE
81-05
7/23/81
10 N.M.
PORTLAND
YARMOUTH
50
100
150
200
250
MARINE EVANGELINE
81-06
8/25/81
10 N.M.
PORTLAND
YARMOUTH
50
100
150
200
250
MARINE EVANGELINE
81-07
9/24/81
10 N.M.

Figure 4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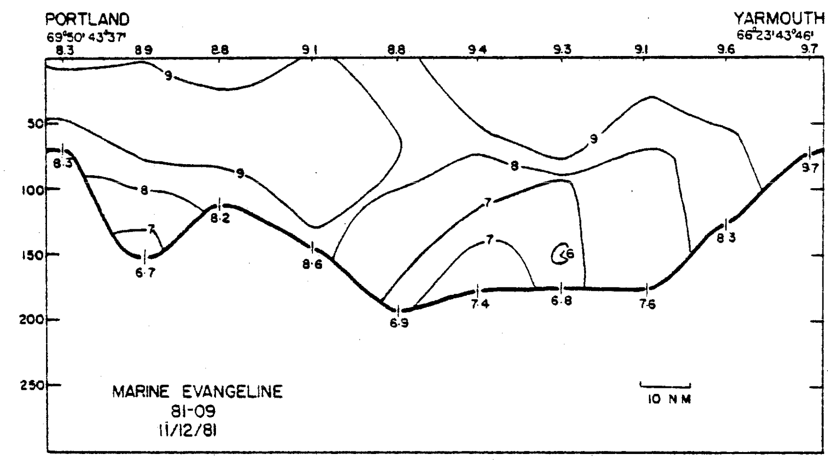
81-08
10/8/81
10 N.M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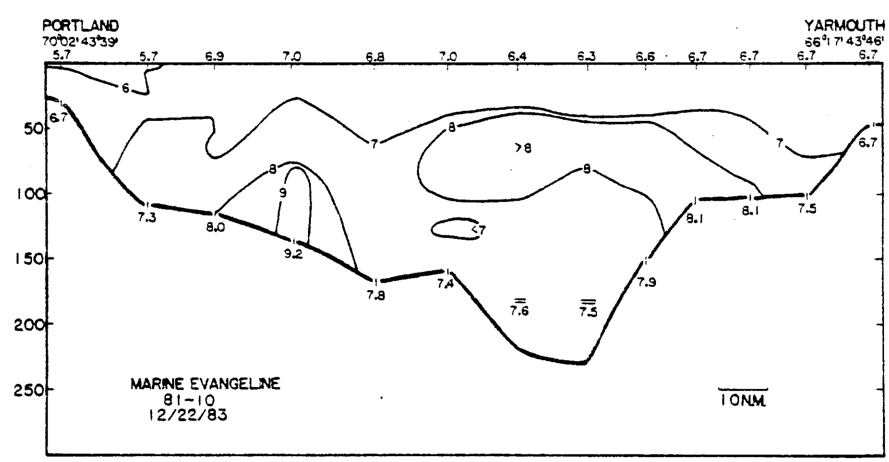
YARMOUTH
66°23' 43°46'
MARINE EVANGELINE
81-09
11/12/81
10 NM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12/22/83
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Figure 5

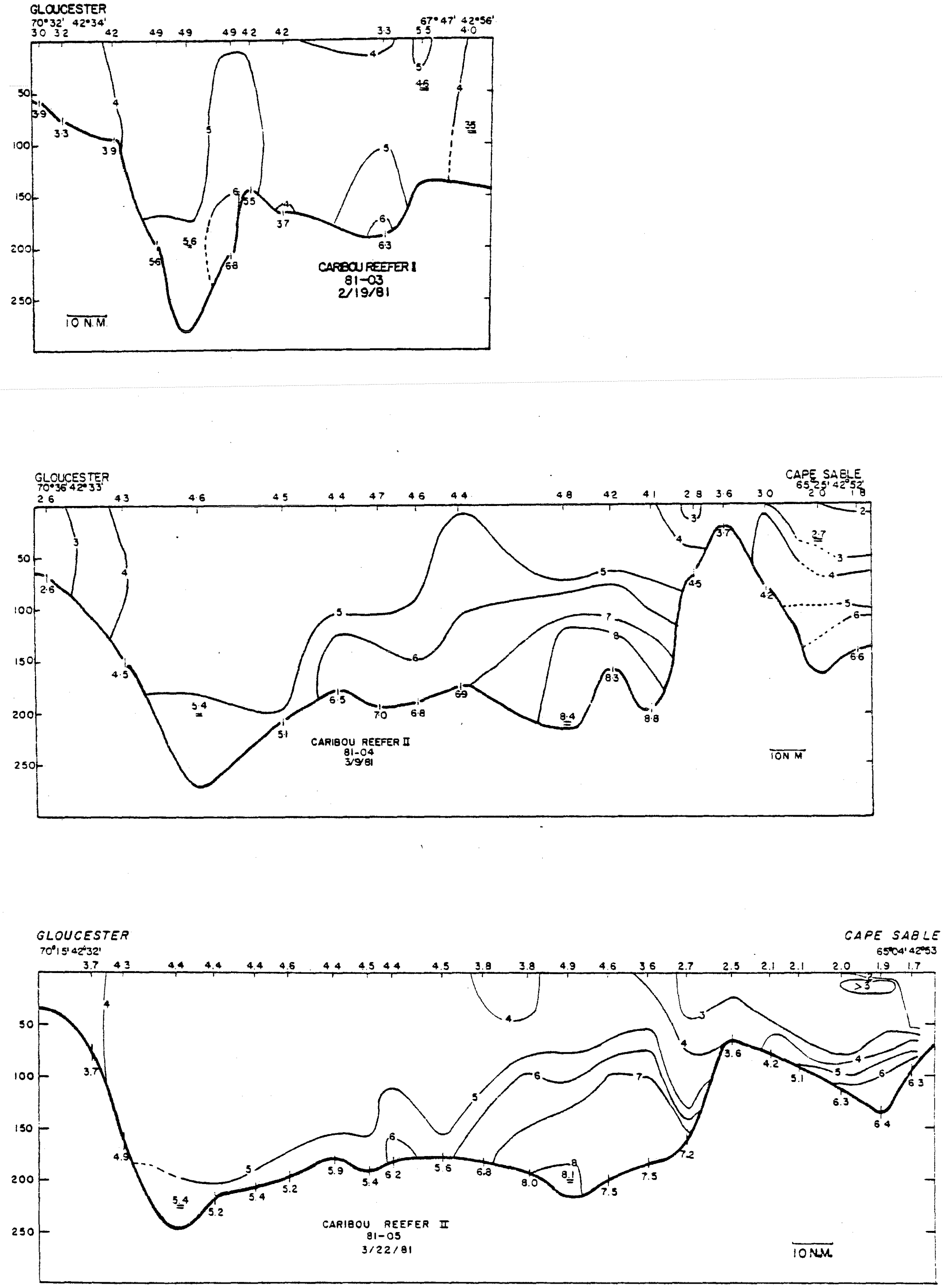

GLOUCESTER
70°32' 42°34'
67°47' 42°56'
CARIBOU REEFER II
81-03
2/19/81
10 N.M.
GLOUCESTER
70°36' 42°33'
CAPE SABLE
65°25' 42°52'
CARIBOU REEFER II
81-04
3/9/81
10 N.M.
GLOUCESTER
70°15' 42°32'
CAPE SABLE
65°04' 42°53
CARIBOU REEFER II
81-05
3/22/81
10 N.M.

Figure 6

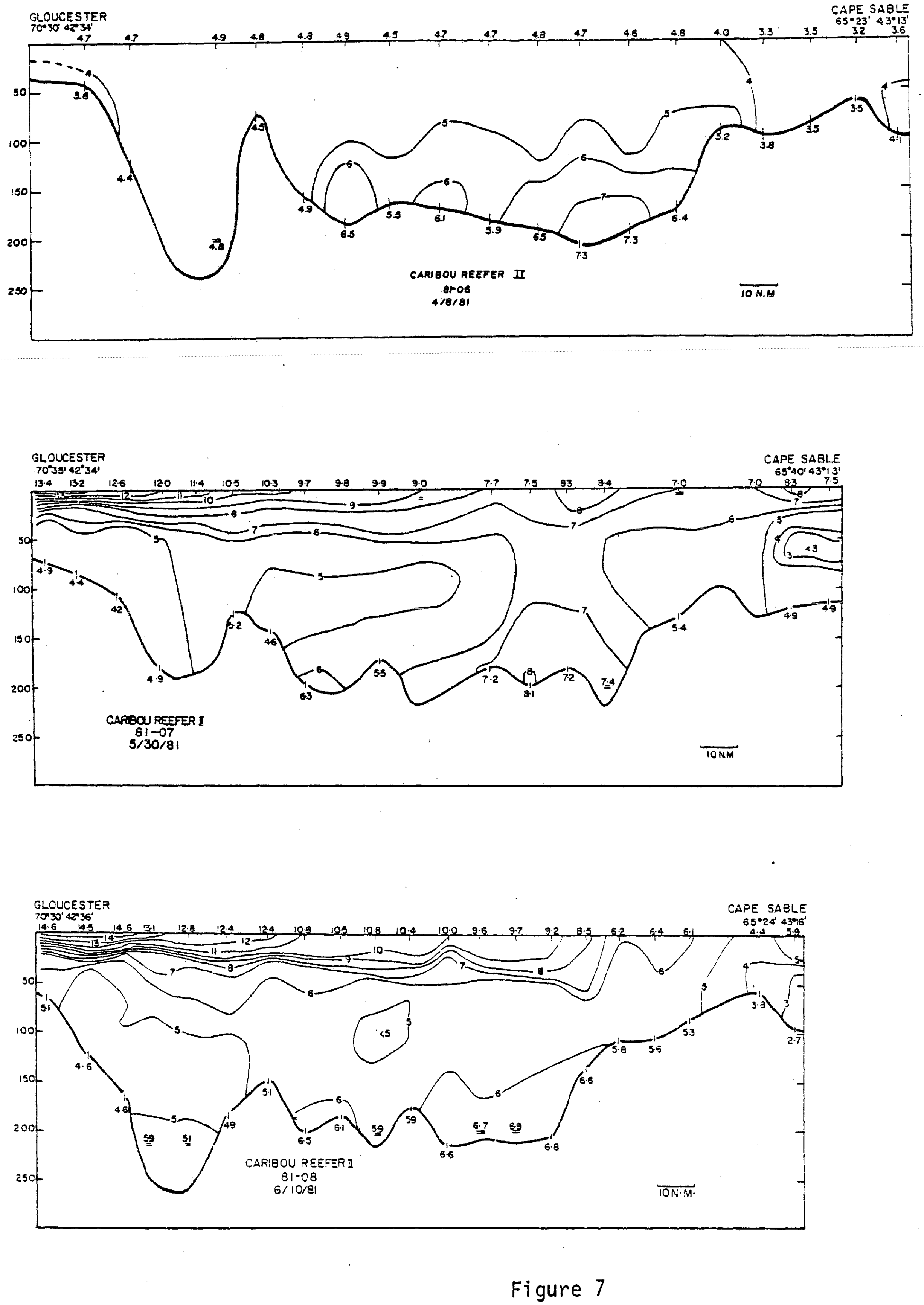

GLOUCESTER
CAPE SABLE
CARIBOU REEFER II
81-06
4/8/81
10 N.M
GLOUCESTER
CAPE SABLE
CARIBOU REEFER II
81-07
5/30/81
10NM
GLOUCESTER
CAPE SABLE
CARIBOU REEFER II
81-08
6/10/81
10N·M·

Figure 7

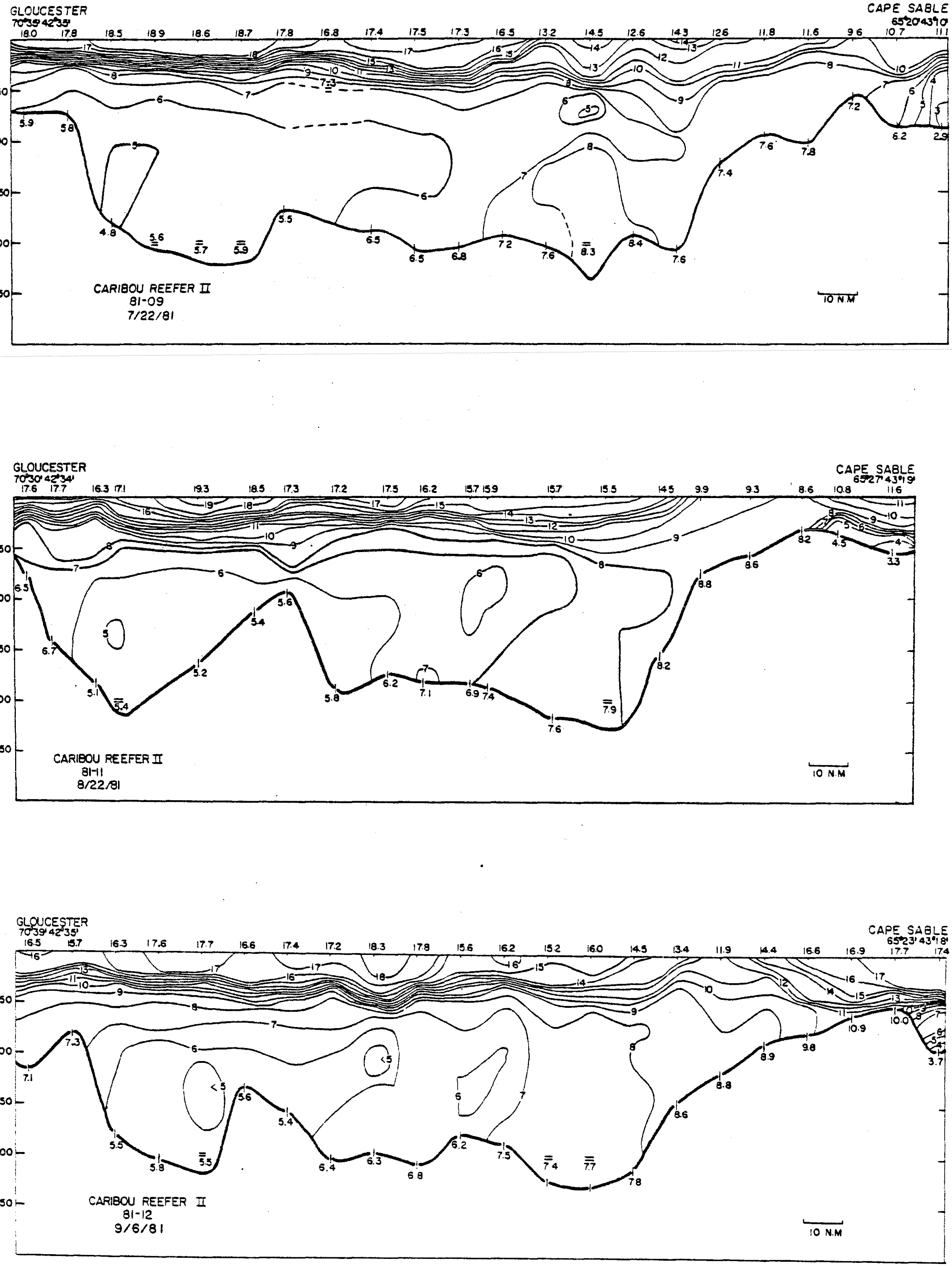
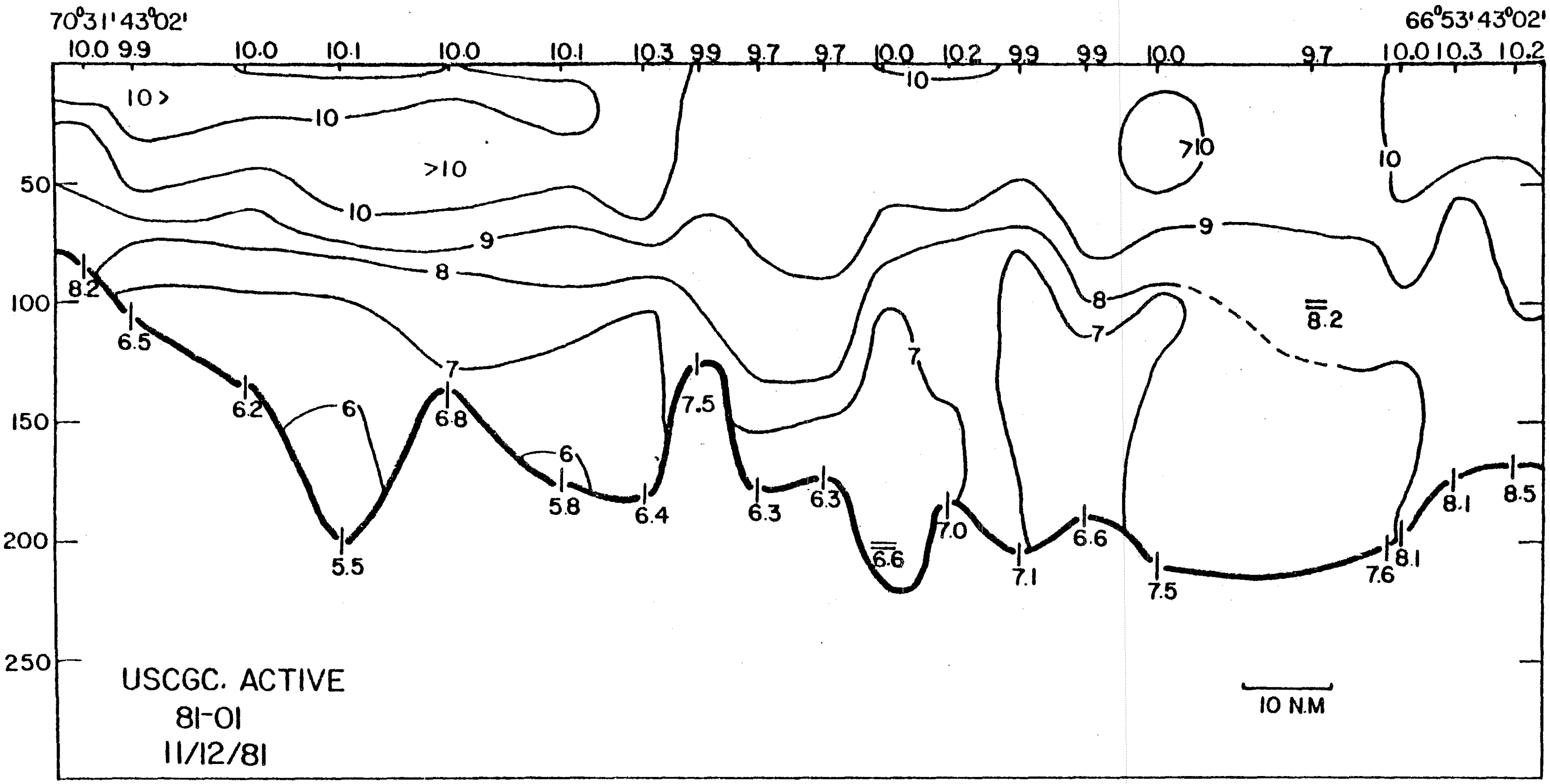

GLOUCESTER
70°39' 42°35'
CAPE SABLE
65°20' 43°10'
CARIBOU REEFER II
81-09
7/22/81
10 N.M
GLOUCESTER
70°30' 42°34'
CAPE SABLE
65°27' 43°19'
CARIBOU REEFER II
81-11
8/22/81
10 N.M
GLOUCESTER
70°39' 42°35'
CAPE SABLE
65°23' 43°18'
CARIBOU REEFER II
81-12
9/6/81
10 N.M

Figure 8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50
100
150
200
250
10>
>10
9
8
7
6
8.2
6.5
6.2
5.5
6.8
5.8
6.4
7.5
6.3
6.3
6.6
7.0
7.1
6.6
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7.6
8.1
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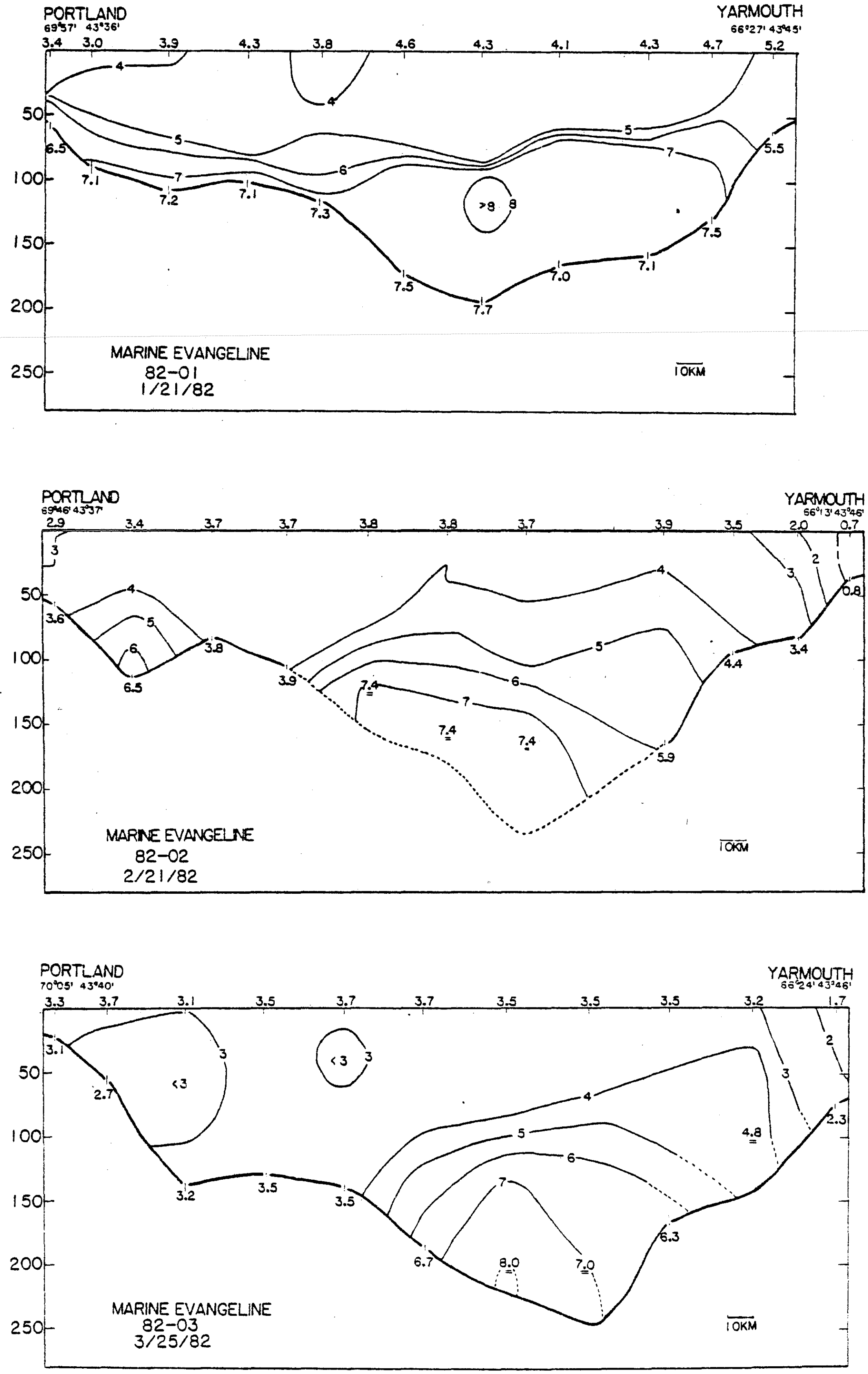
8.5
USCGC. ACTIVE
81-01
11/12/81
10 N.M

Figure 9


PORTLAND
69°57' 43°36'
YARMOUTH
66°27' 43°45'
MARINE EVANGELINE
82-01
1/21/82
10KM
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69°46' 43°37'
YARMOUTH
66°13' 43°46'
MARINE EVANGELINE
82-02
2/21/82
10KM
PORTLAND
70°05' 43°40'
YARMOUTH
66°24' 43°46'
MARINE EVANGELINE
82-03
3/25/82
10KM

Figure 10

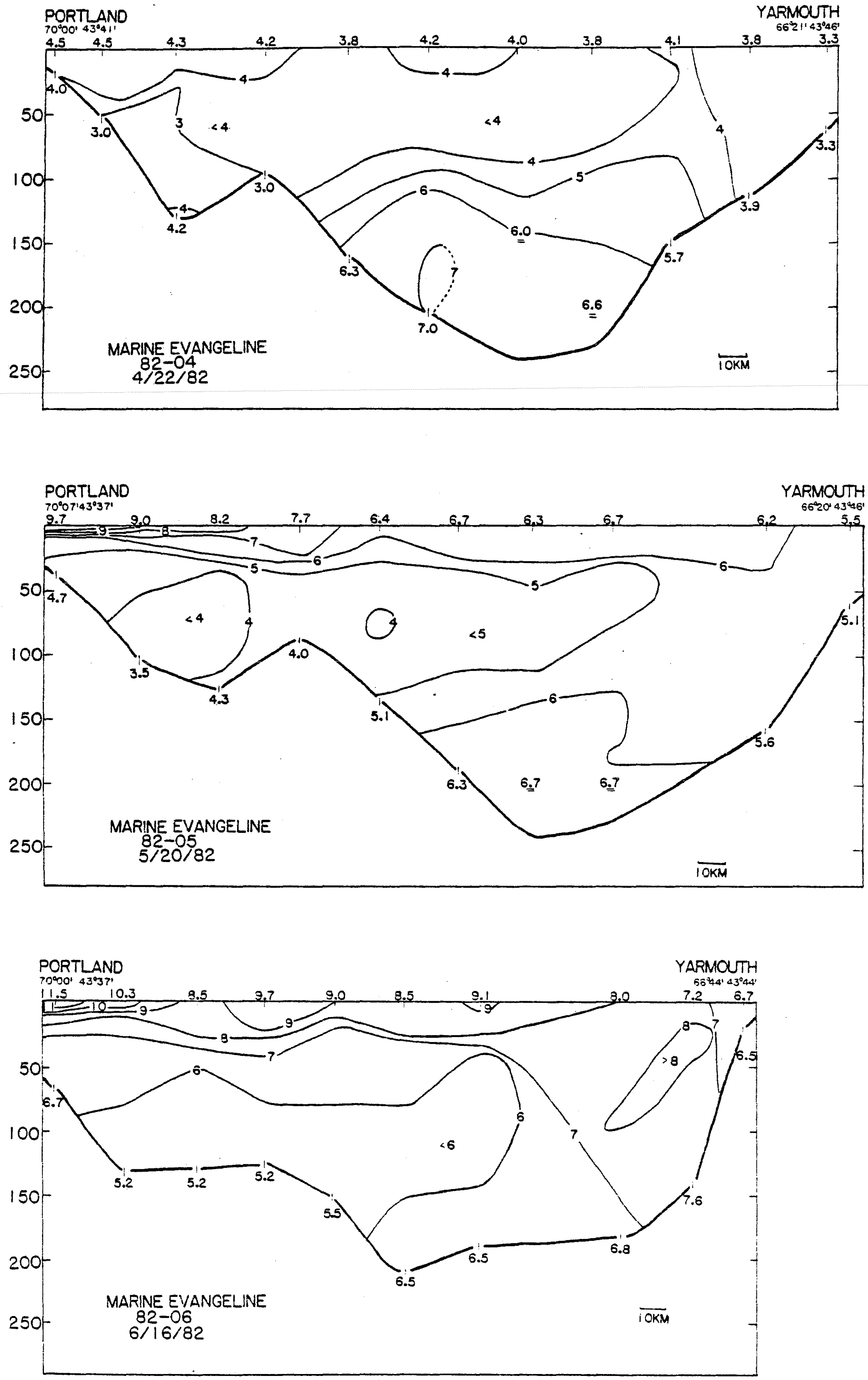
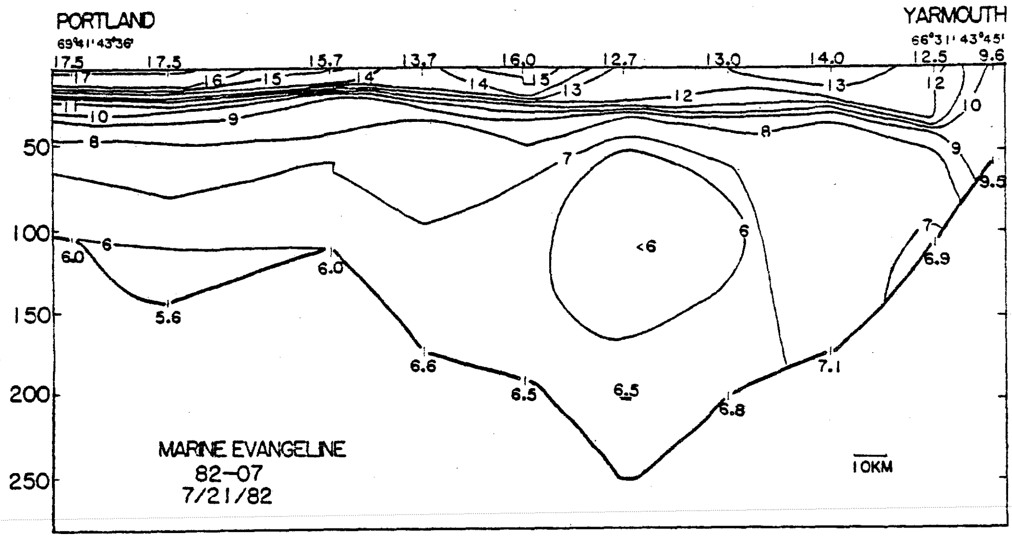

PORTLAND
YARMOUTH
MARINE EVANGELINE
82-04
4/22/82
10KM
PORTLAND
YARMOUTH
MARINE EVANGELINE
82-05
5/20/82
10KM
PORTLAND
YARMOUTH
MARINE EVANGELINE
82-06
6/16/82
10KM

Figure 11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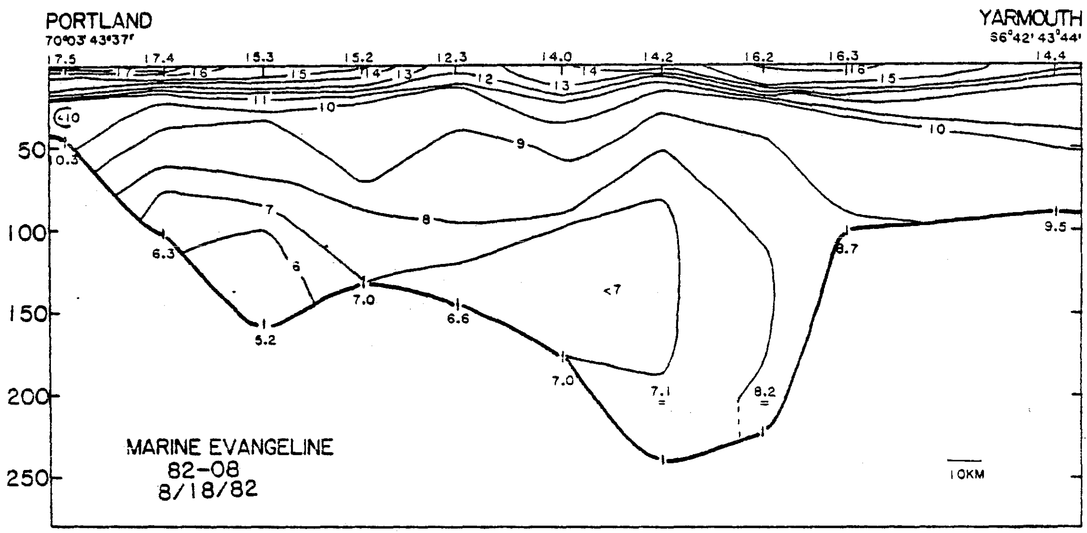
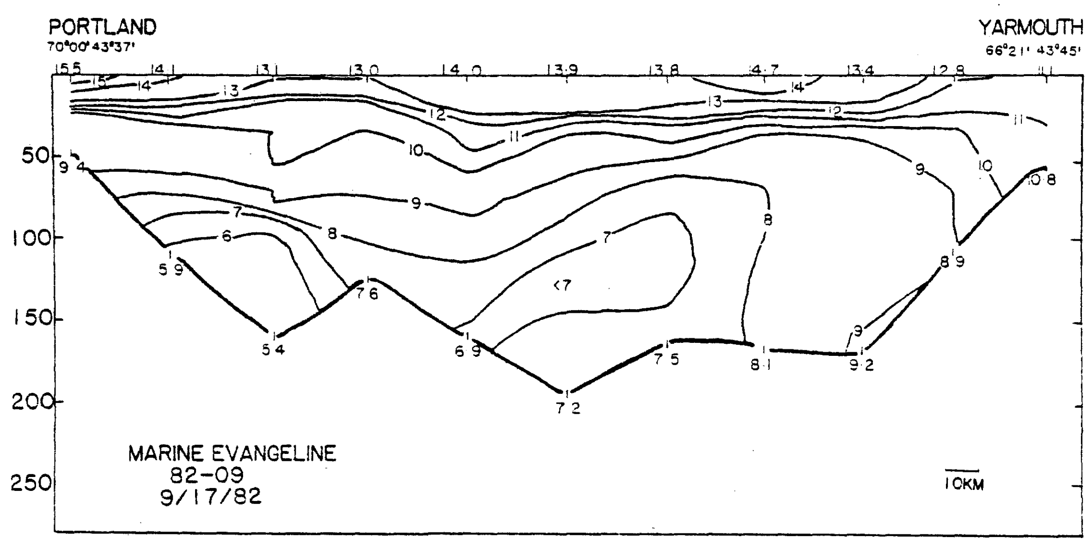
YARMOUTH
66°31' 43°45'
MARINE EVANGELINE
82-07
7/21/82
10KM


PORTLAND
70°03' 43°37'
YARMOUTH
66°42' 43°44'
MARINE EVANGELINE
82-08
8/18/82
10KM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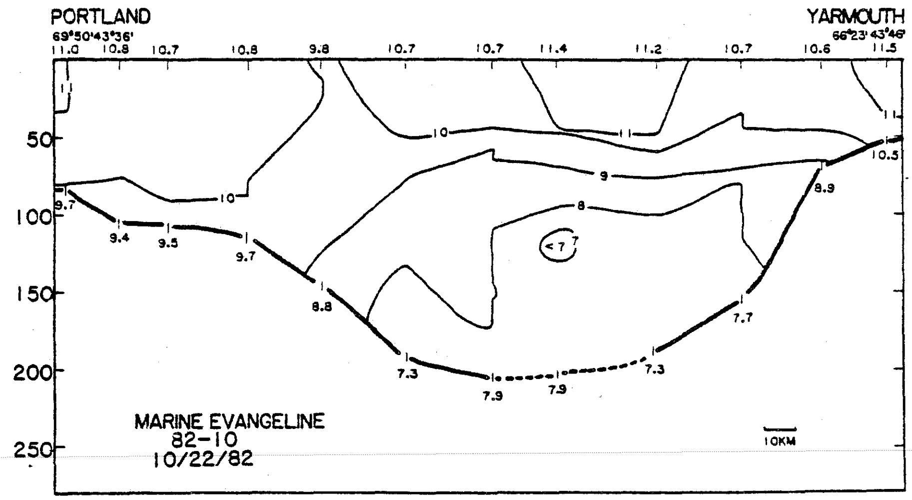
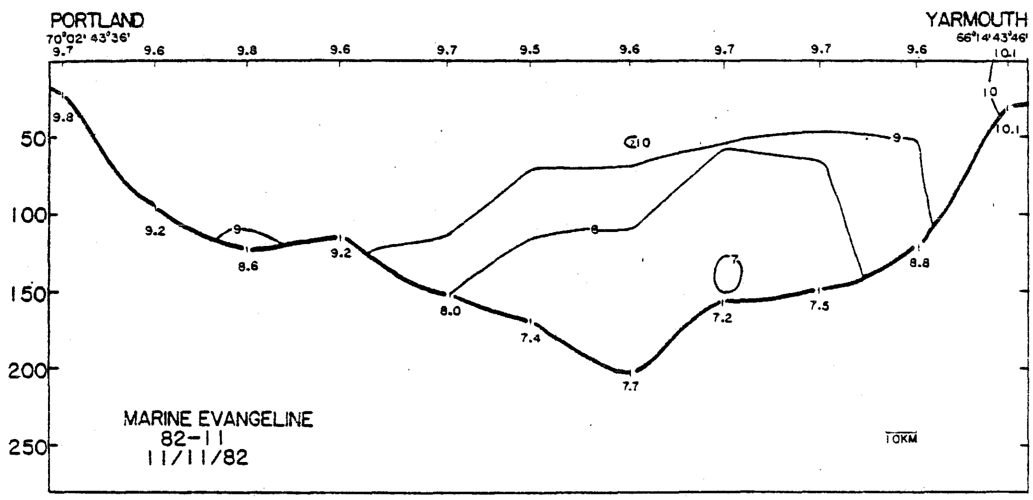
YARMOUTH
66°21' 43°45'
MARINE EVANGELINE
82-09
9/17/82
10KM

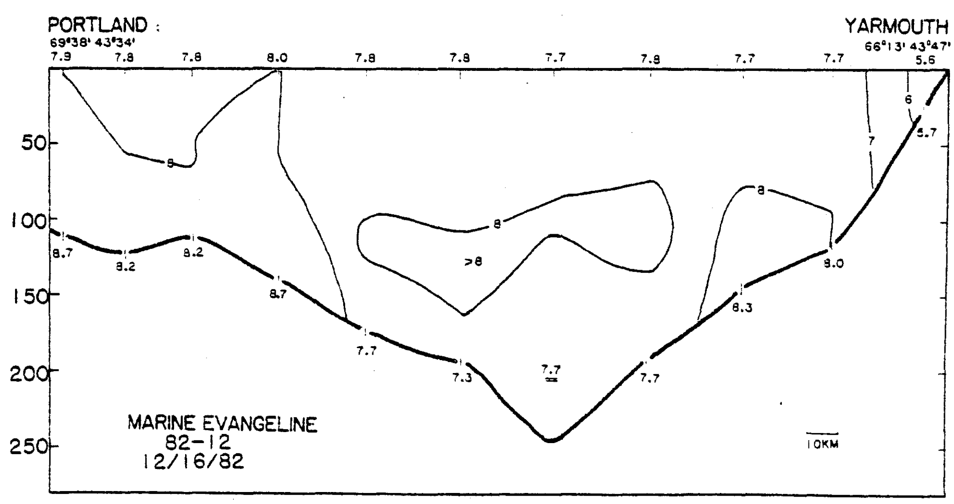
Figure 12



PORTLAND
69°50' 43°36'
YARMOUTH
66°23' 43°46'
MARINE EVANGELINE
82-10
10/22/82
10KM

PORTLAND
70°02' 43°36'
YARMOUTH
66°14' 43°46'
MARINE EVANGELINE
82-11
11/11/82
10KM

PORTLAND
69°38' 43°34'
YARMOUTH
66°13' 43°47'
MARINE EVANGELINE
82-12
12/16/82
10KM


Figure 13

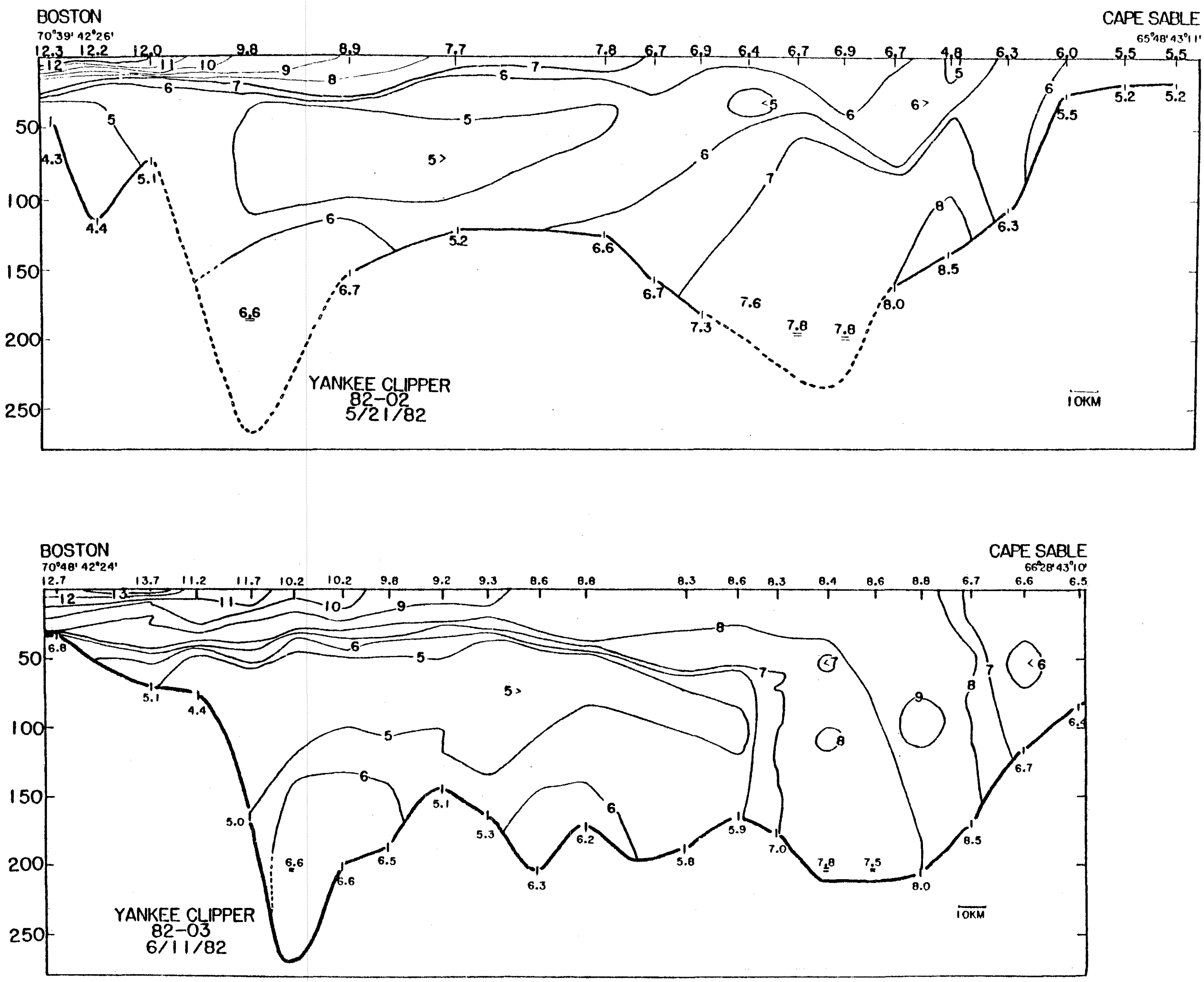
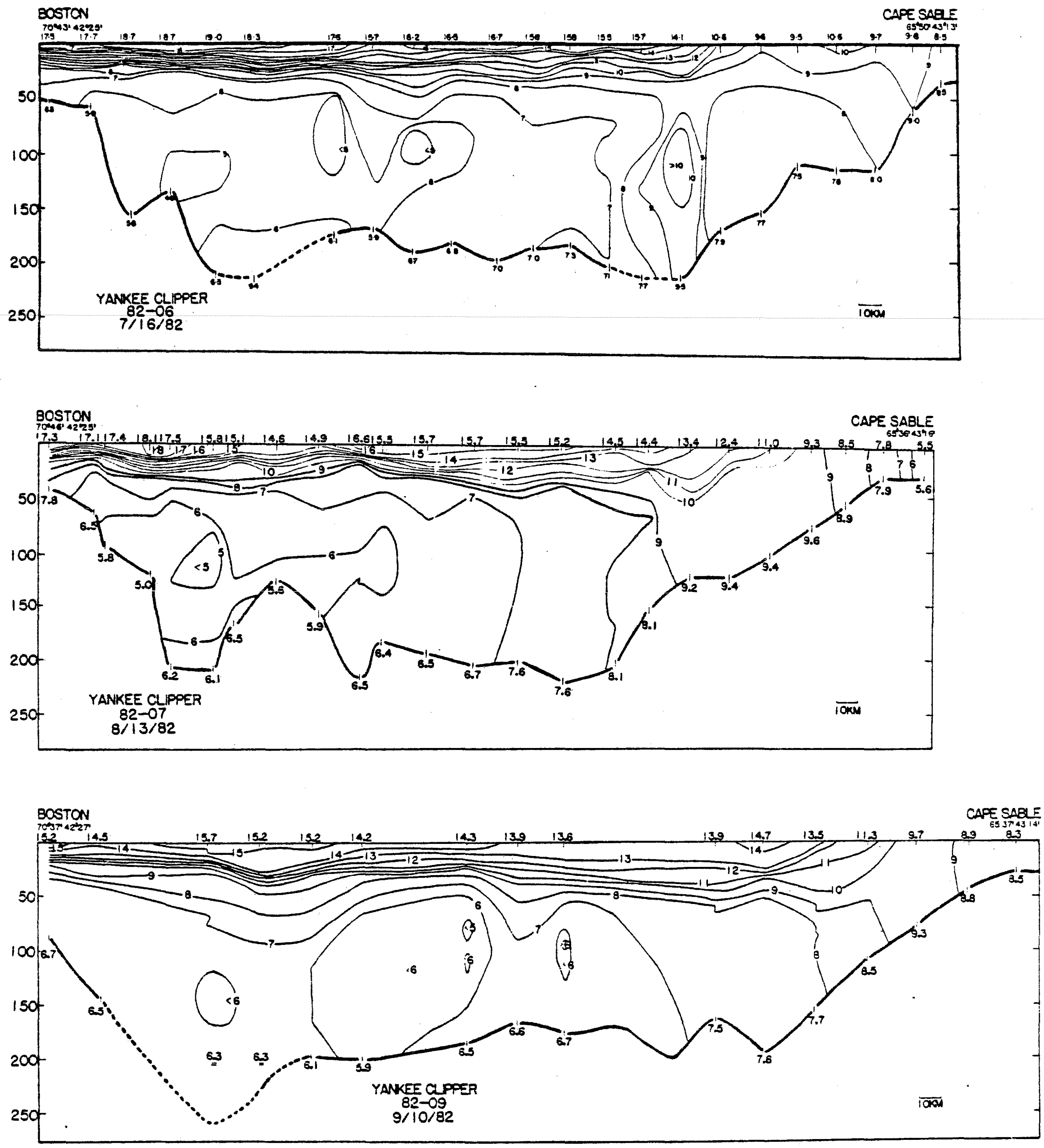

BOSTON
70°39' 42°26'
CAPE SABLE
65°48' 43°11'
50
100
150
200
250
YANKEE CLIPPER
82-02
5/21/82
10KM
BOSTON
70°48' 42°24'
CAPE SABLE
66°28' 43°10'
50
100
150
200
250
YANKEE CLIPPER
82-03
6/11/82
10KM

Figure 14



BOSTON
CAPE SABLE
YANKEE CLIPPER
82-06
7/16/82
10KM
BOSTON
CAPE SABLE
YANKEE CLIPPER
82-07
8/13/82
10KM
BOSTON
CAPE SABLE
YANKEE CLIPPER
82-09
9/10/82
10KM


Figure 15

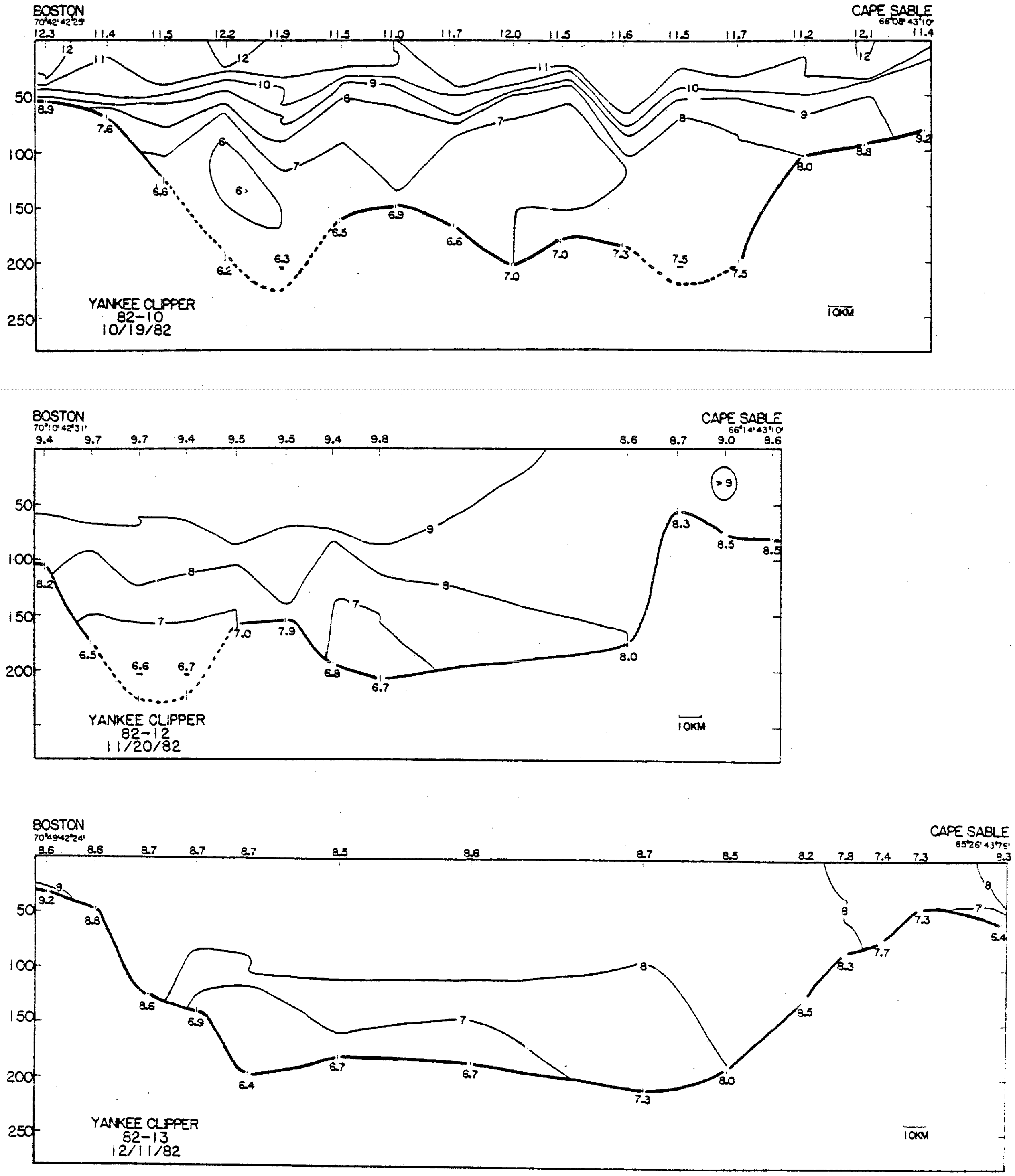

BOSTON
CAPE SABLE
YANKEE CLIPPER
82-10
10/19/82
10KM
BOSTON
CAPE SABLE
YANKEE CLIPPER
82-12
11/20/82
10KM
BOSTON
CAPE SABLE
YANKEE CLIPPER
82-13
12/11/82
10KM

Figure 16

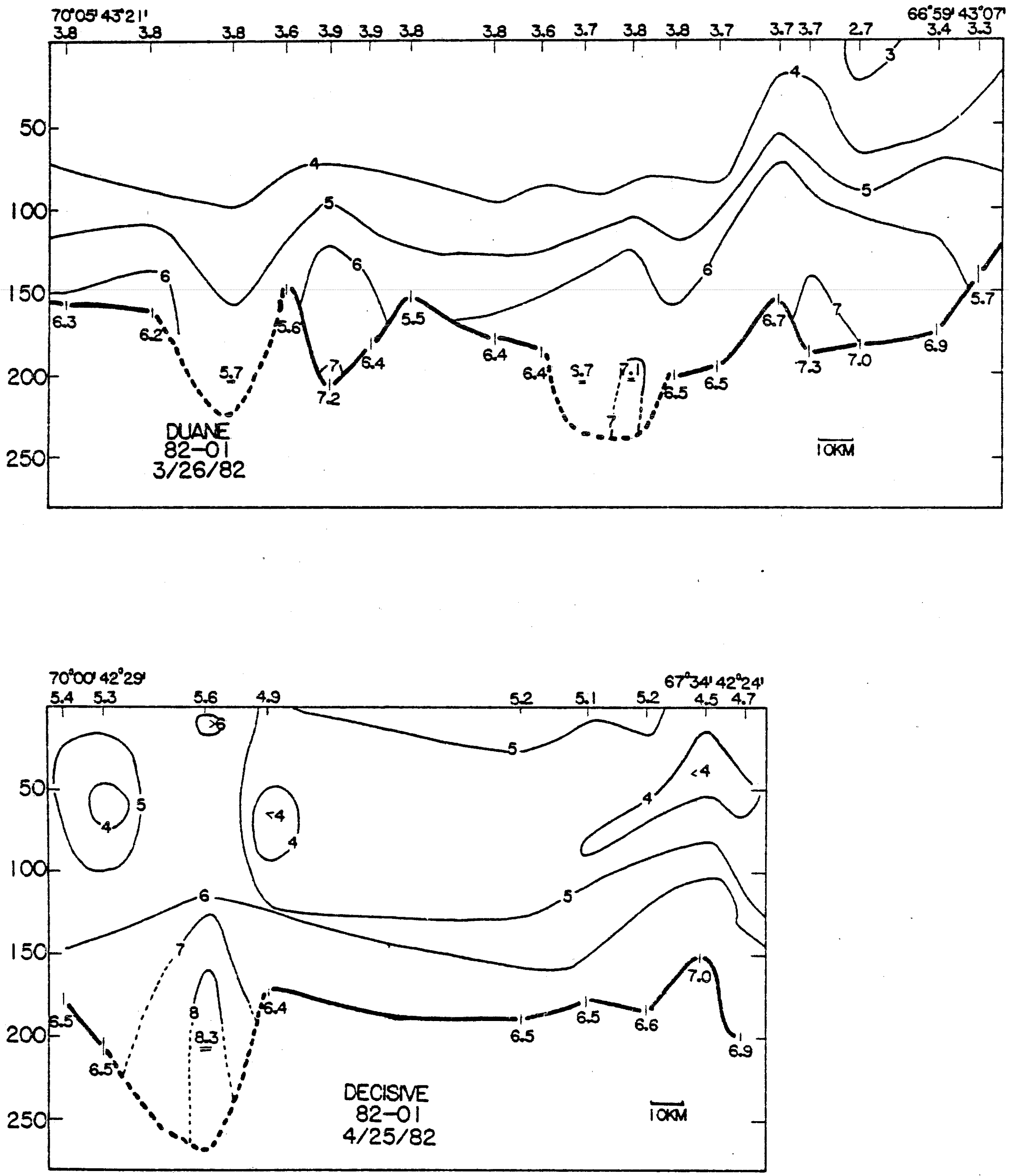
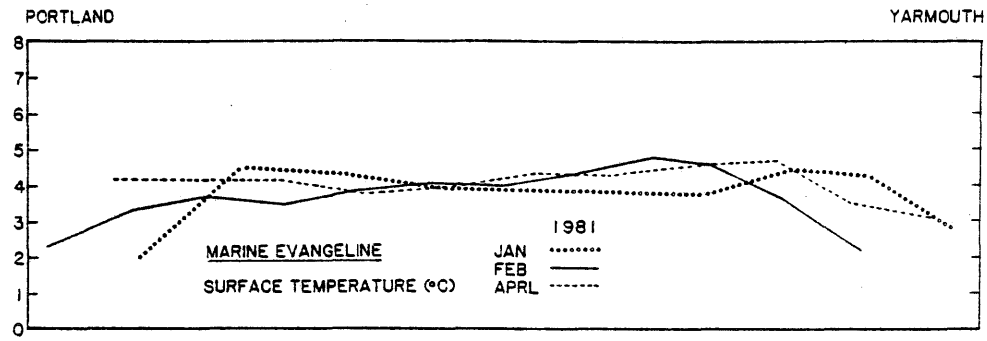
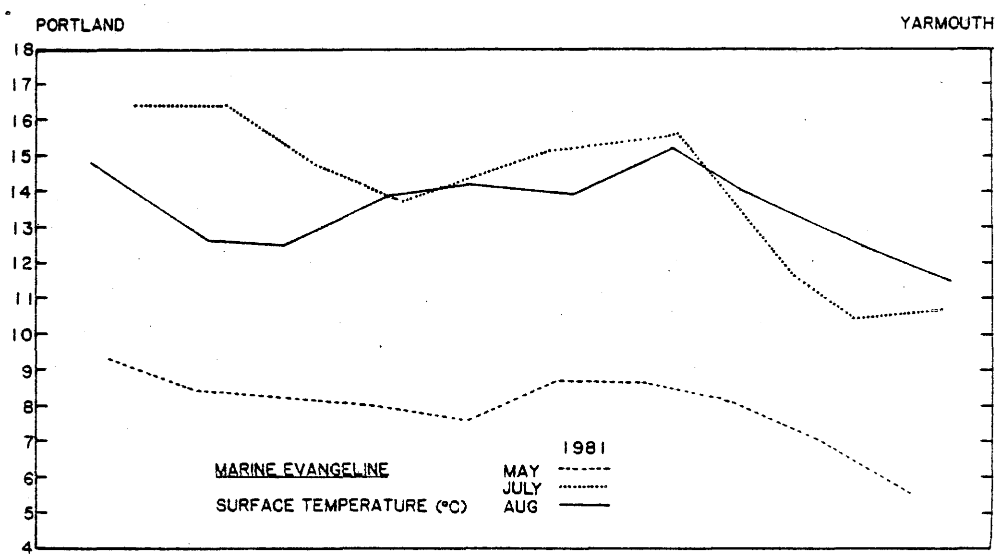

70°05' 43°21'
66°59' 43°07'
3.8 3.8 3.8 3.6 3.9 3.9 3.8 3.8 3.6 3.7 3.8 3.8 3.7 3.7 3.7 2.7 3.4 3.3
50
100
150
200
250
6.3 6.2 5.7 5.6 7.2 6.4 5.5 6.4 6.4 5.7 7.1 6.5 6.5 6.7 7.3 7.0 6.9 5.7
DUANE
82-01
3/26/82
10KM
70°00' 42°29'
67°34' 42°24'
5.4 5.3 5.6 4.9 5.2 5.1 5.2 4.5 4.7
<4
6.5 6.5 8.3 6.4 6.5 6.5 6.6 7.0 6.9
DECISIVE
82-01
4/25/82
10KM

Figure 17


PORTLAND
YARMOUTH
1981
MARINE EVANGELINE
SURFACE TEMPERATURE (°C)
JAN
FEB
APRL


PORTLAND
YARMOUTH
1981
MARINE EVANGELINE
SURFACE TEMPERATURE (°C)
MAY
JULY
AUG

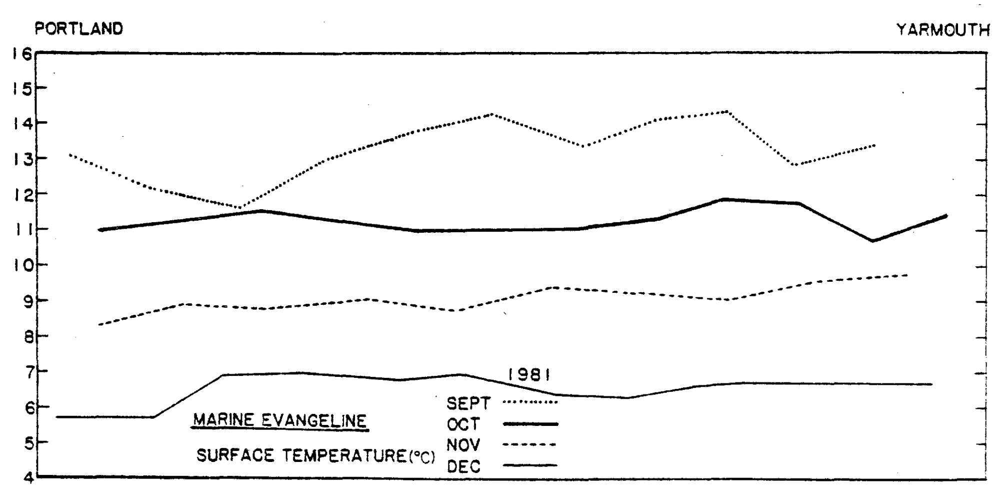
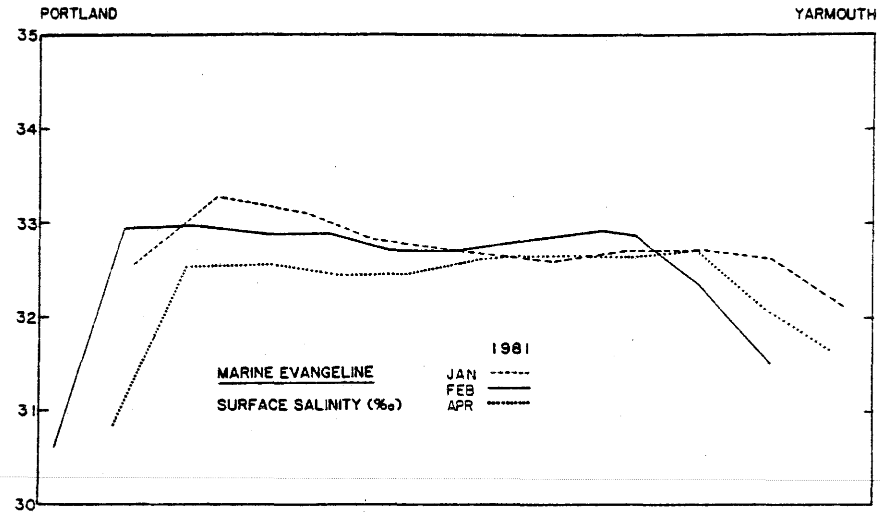
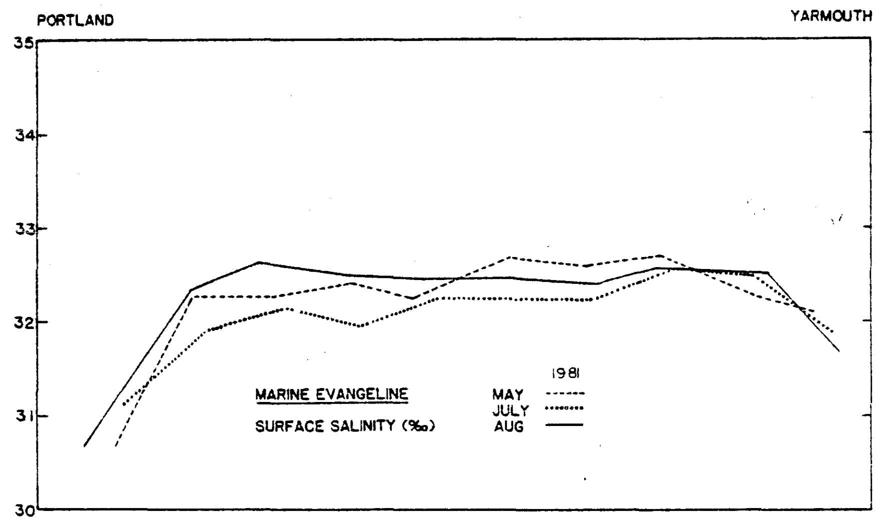

PORTLAND
YARMOUTH
1981
MARINE EVANGELINE
SURFACE TEMPERATURE (°C)
SEPT
OCT
NOV
DEC

Figure 18


PORTLAND
YARMOUTH
35
34
33
32
31
30
1981
MARINE EVANGELINE
SURFACE SALINITY (‰)
JAN
FEB
APR


PORTLAND
YARMOUTH
35
34
33
32
31
30
1981
MARINE EVANGELINE
SURFACE SALINITY (‰)
MAY
JULY
AUG

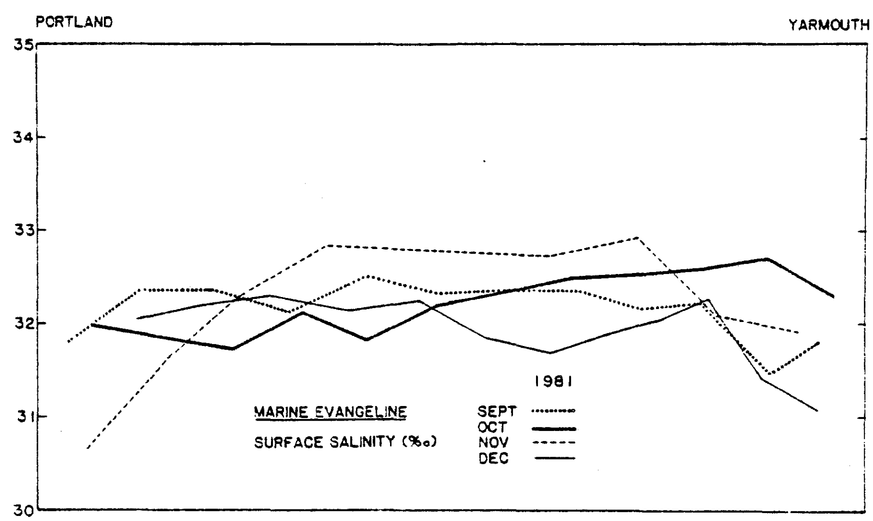

PORTLAND
YARMOUTH
35
34
33
32
31
30
1981
MARINE EVANGELINE
SURFACE SALINITY (‰)
SEPT
OCT
NOV
DEC

Figure 19

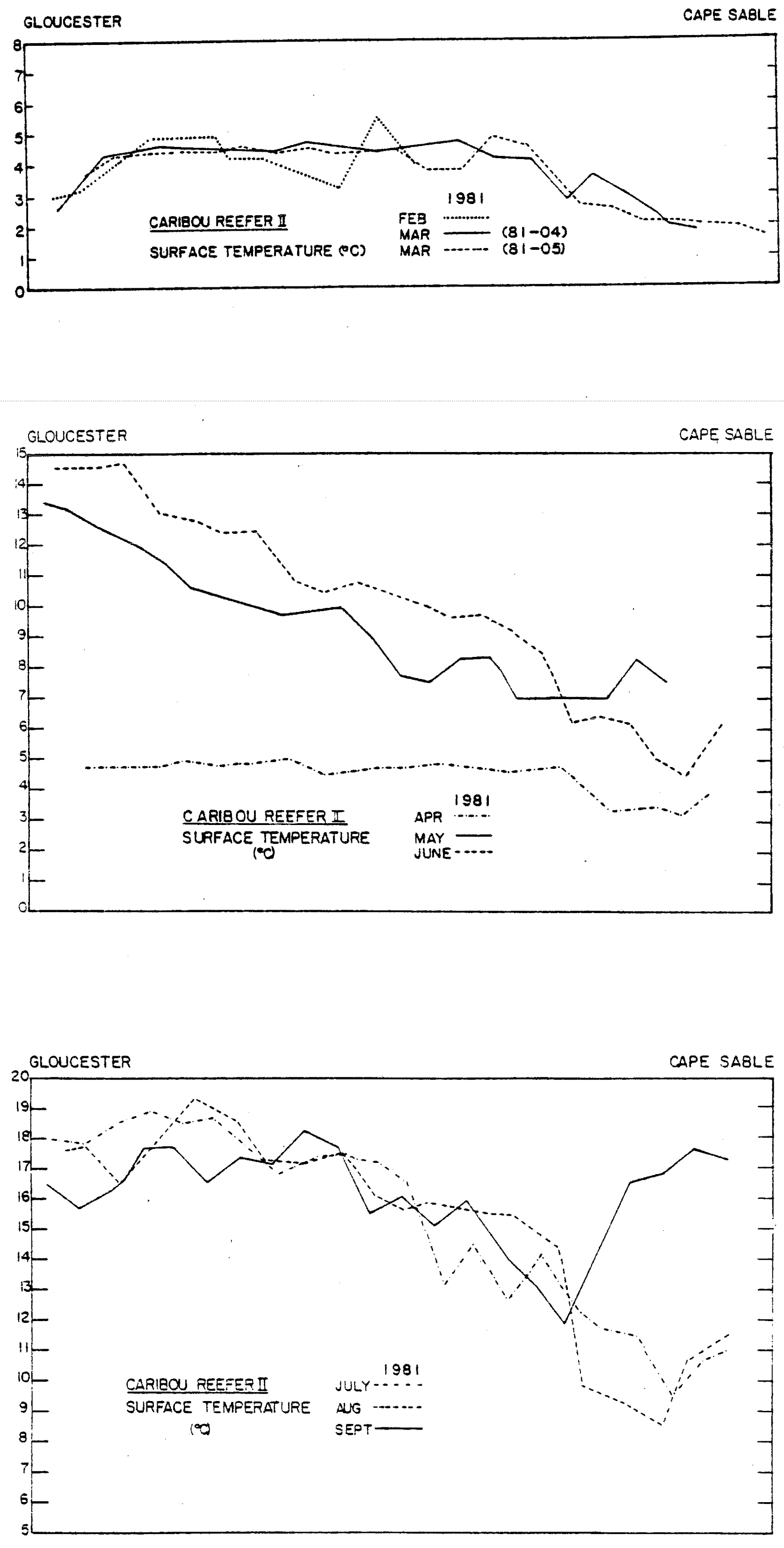
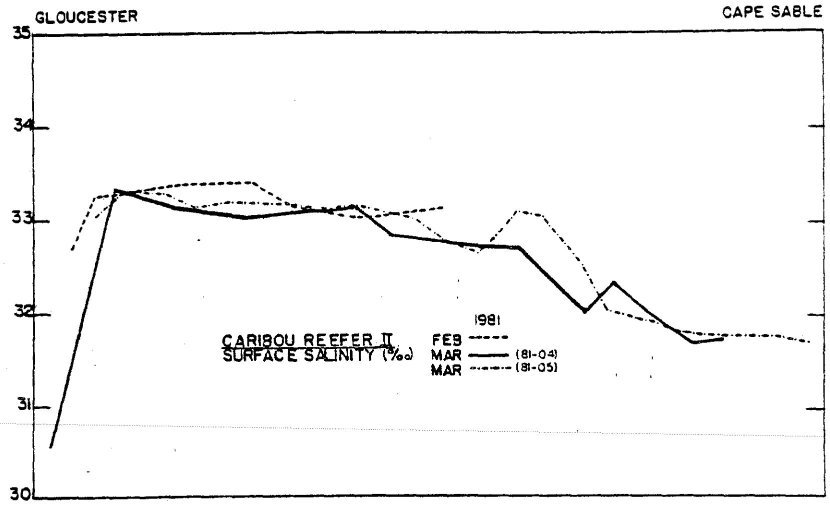
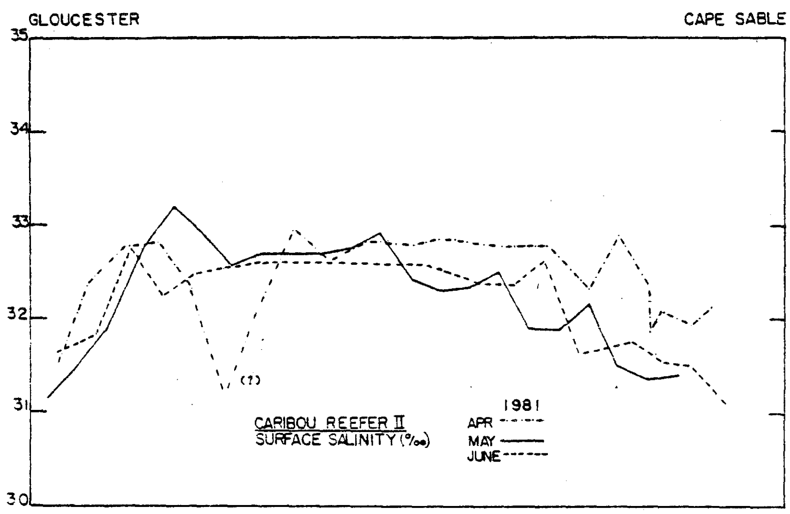

GLOUCESTER
CAPE SABLE
CARIBOU REEFER II
SURFACE TEMPERATURE (°C)
1981
FEB
MAR (81-04)
MAR (81-05)
GLOUCESTER
CAPE SABLE
CARIBOU REEFER II
SURFACE TEMPERATURE (°C)
1981
APR
MAY
JUNE
GLOUCESTER
CAPE SABLE
CARIBOU REEFER II
SURFACE TEMPERATURE (°C)
1981
JULY
AUG
SEPT

Figure 20


GLOUCESTER
CAPE SABLE
35
34
33
32
31
30
1981
CARIBOU REEFER II
SURFACE SALINITY (‰)
FEB
MAR (81-04)
MAR (81-05)


GLOUCESTER
CAPE SABLE
35
34
33
32
31
30
(?)
1981
CARIBOU REEFER II
SURFACE SALINITY (‰)
APR
MAY
JUNE

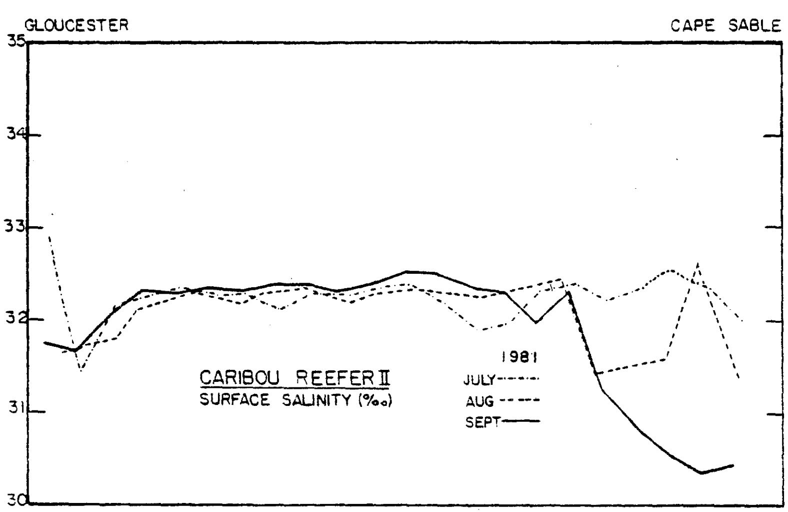
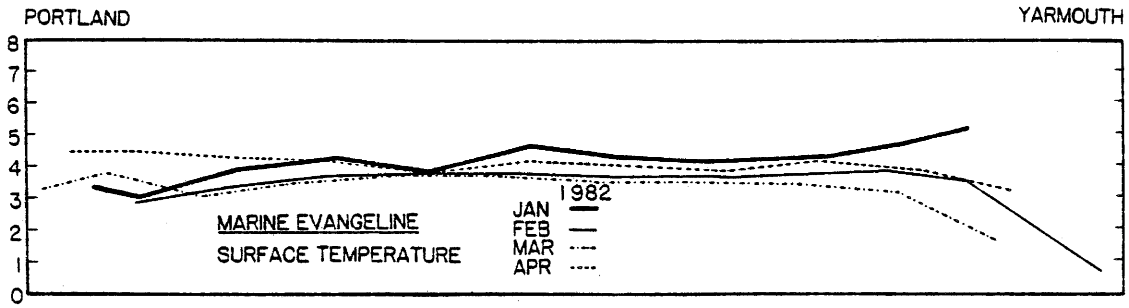
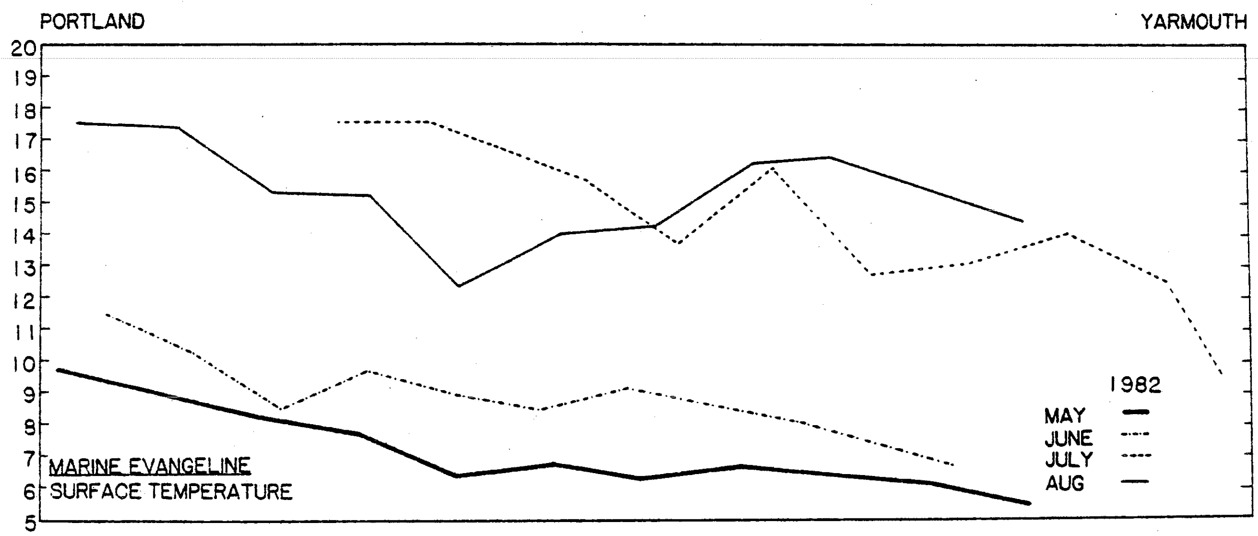

GLOUCESTER
CAPE SABLE
35
34
33
32
31
30
1981
CARIBOU REEFER II
SURFACE SALINITY (‰)
JULY
AUG
SEPT

Figure 21


PORTLAND
YARMOUTH
8
7
6
5
4
3
2
1
0
1982
JAN
FEB
MAR
APR
MARINE EVANGELINE
SURFACE TEMPERATURE


PORTLAND
YARMOUTH
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
1982
MAY
JUNE
JULY
AUG
MARINE EVANGELINE
SURFACE TEMPERATURE

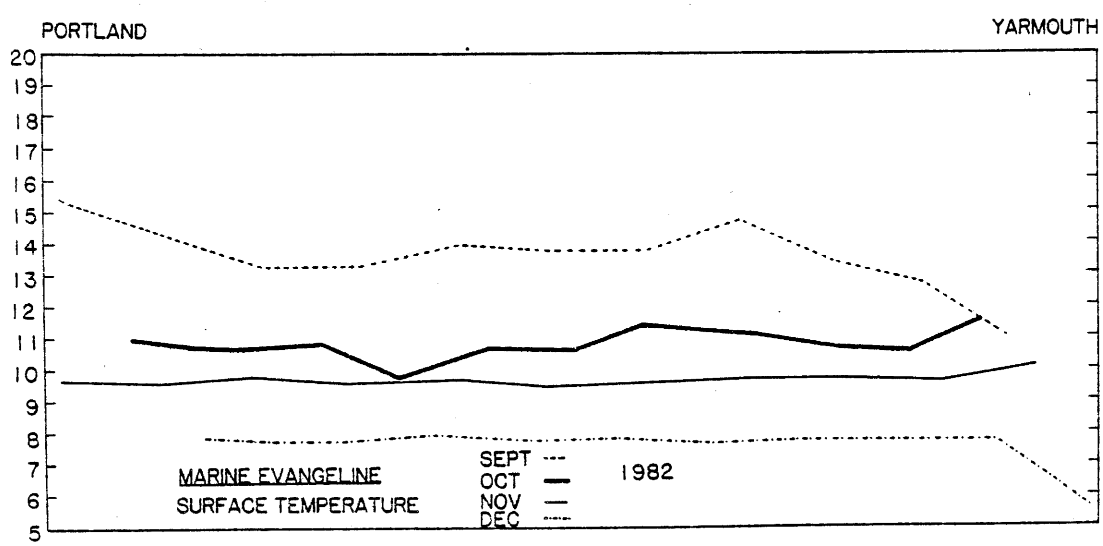

PORTLAND
YARMOUTH
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
SEPT
OCT
NOV
DEC
1982
MARINE EVANGELINE
SURFACE TEMPERATURE

Figure 22

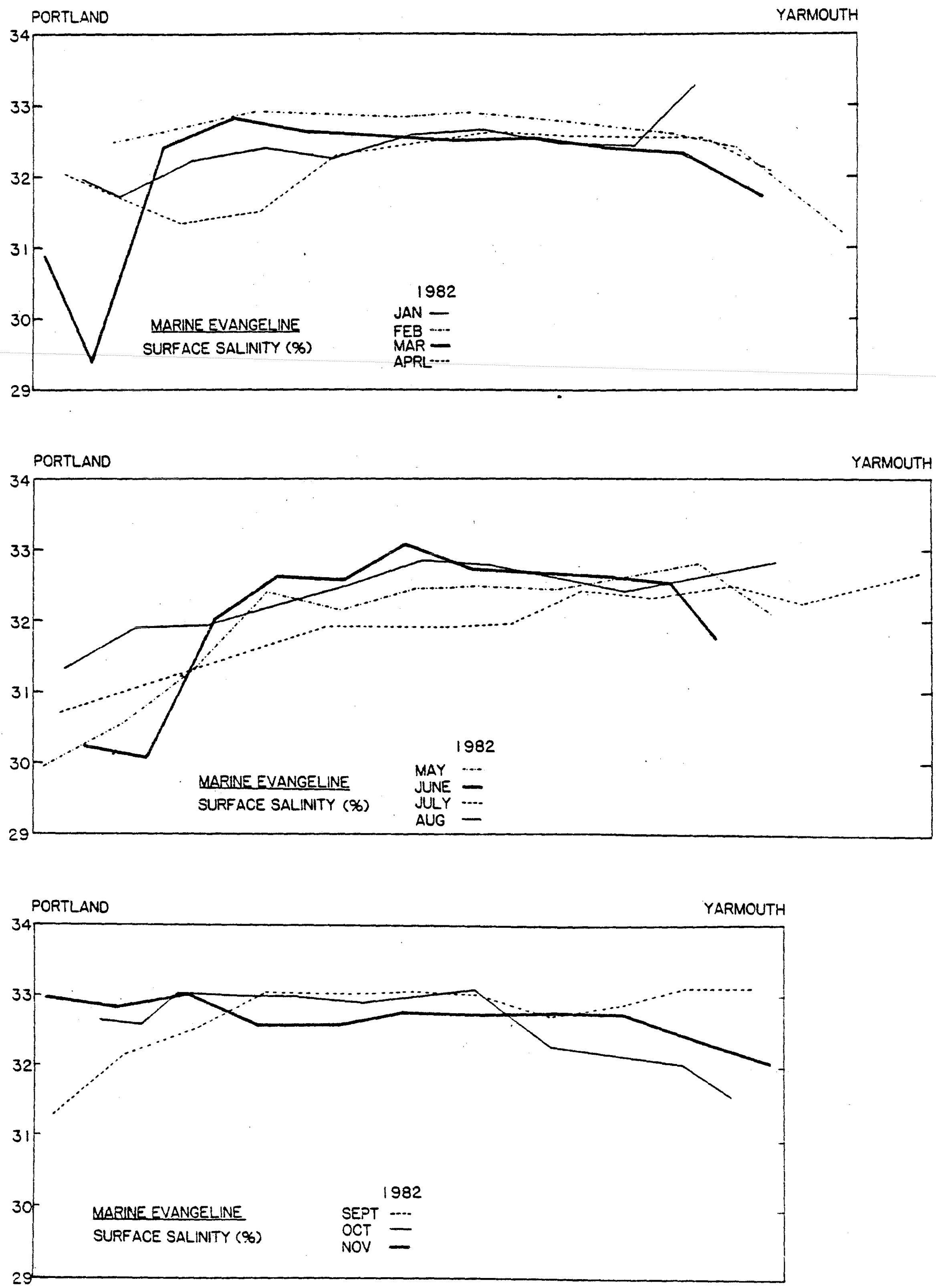
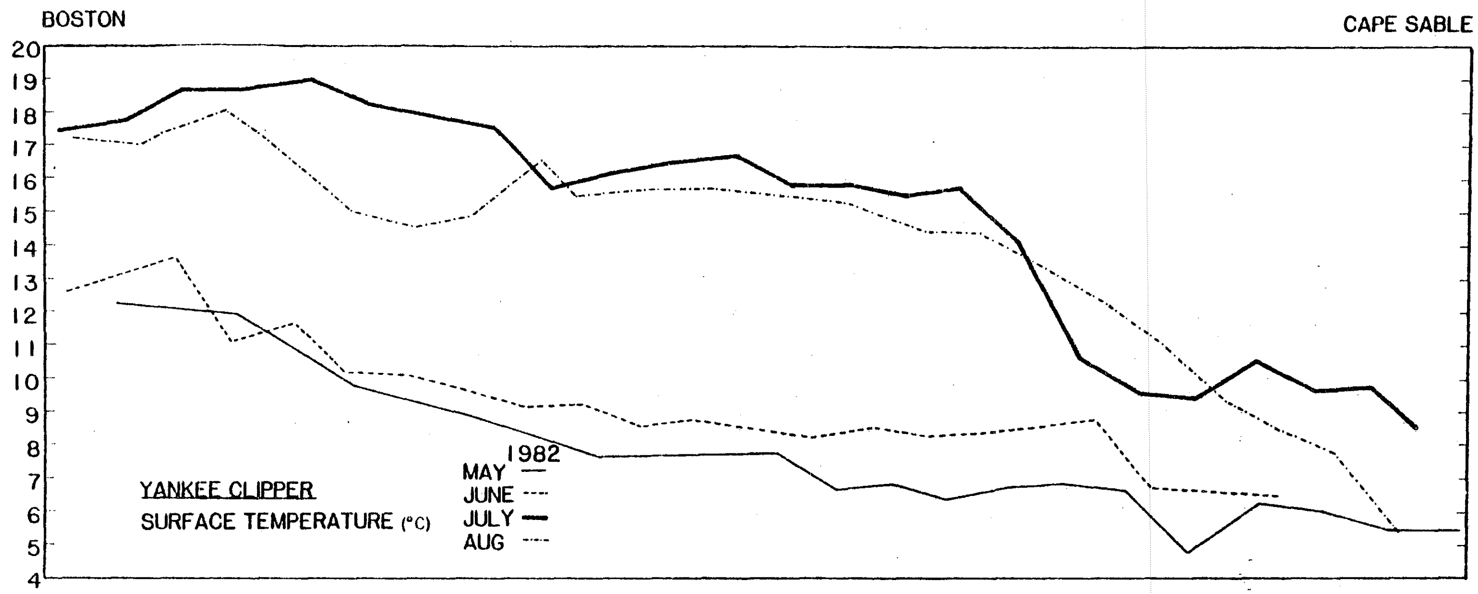
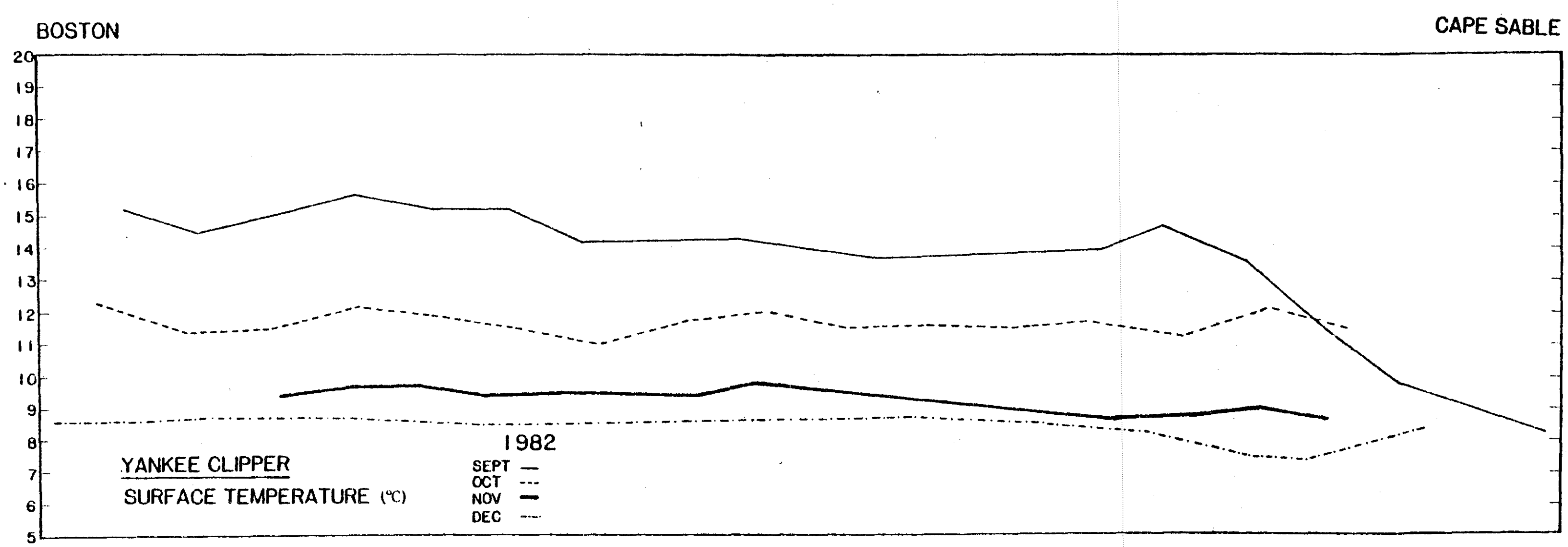
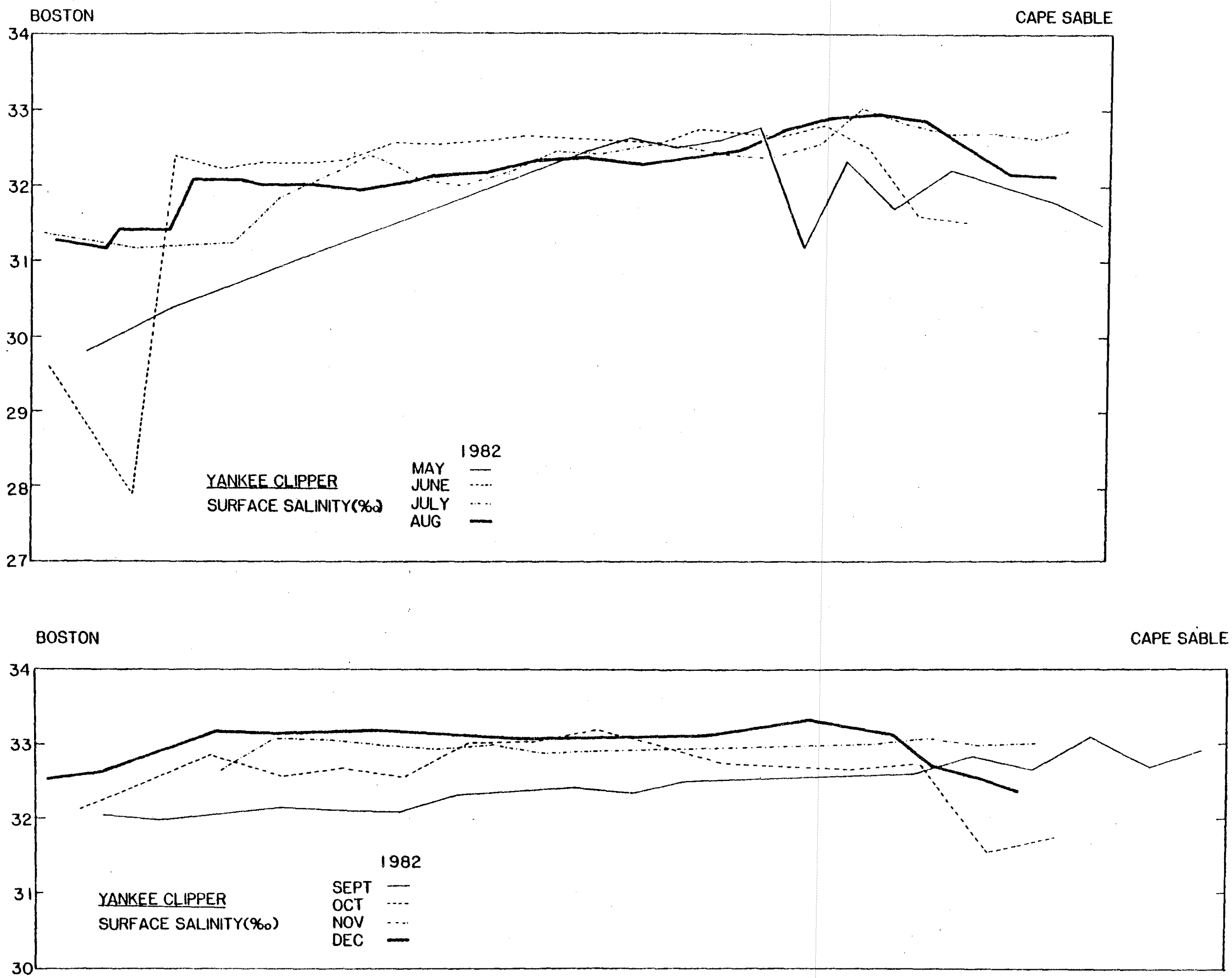

PORTLAND
YARMOUTH
34
33
32
31
30
29
1982
JAN
FEB
MAR
APRL
MARINE EVANGELINE
SURFACE SALINITY (%)
PORTLAND
YARMOUTH
34
33
32
31
30
29
1982
MAY
JUNE
JULY
AUG
MARINE EVANGELINE
SURFACE SALINITY (%)
PORTLAND
YARMOUTH
34
33
32
31
30
29
1982
SEPT
OCT
NOV
MARINE EVANGELINE
SURFACE SALINITY (%)

Figure 23

Figure 24

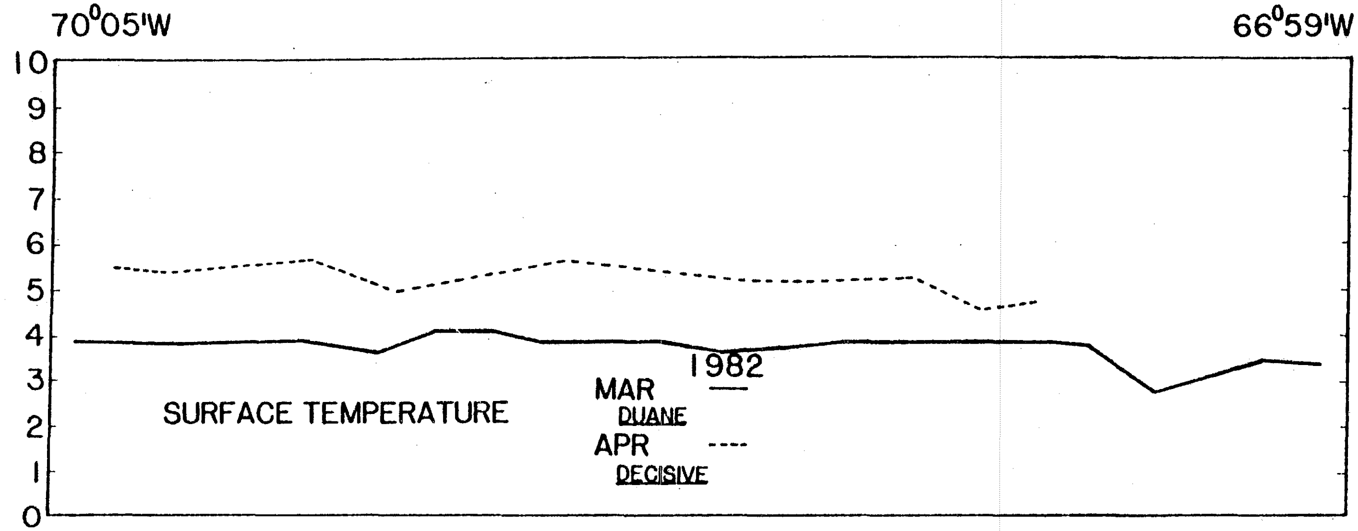

BOSTON
CAPE SABLE
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
1982
MAY
JUNE
JULY
AUG
YANKEE CLIPPER
SURFACE TEMPERATURE (°C)


BOSTON
CAPE SABLE
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
1982
SEPT
OCT
NOV
DEC
YANKEE CLIPPER
SURFACE TEMPERATURE (°C)



BOSTON
CAPE SABLE
34
33
32
31
30
29
28
27
1982
YANKEE CLIPPER
SURFACE SALINITY(‰)
MAY
JUNE
JULY
AUG
BOSTON
CAPE SABLE
34
33
32
31
30
1982
YANKEE CLIPPER
SURFACE SALINITY(‰)
SEPT
OCT
NOV
DEC


Figure 25


70°05'W
66°59'W
10
9
8
7
6
5
4
3
2
1
0
SURFACE TEMPERATURE
1982
MAR
DUANE
APR
DECISIVE

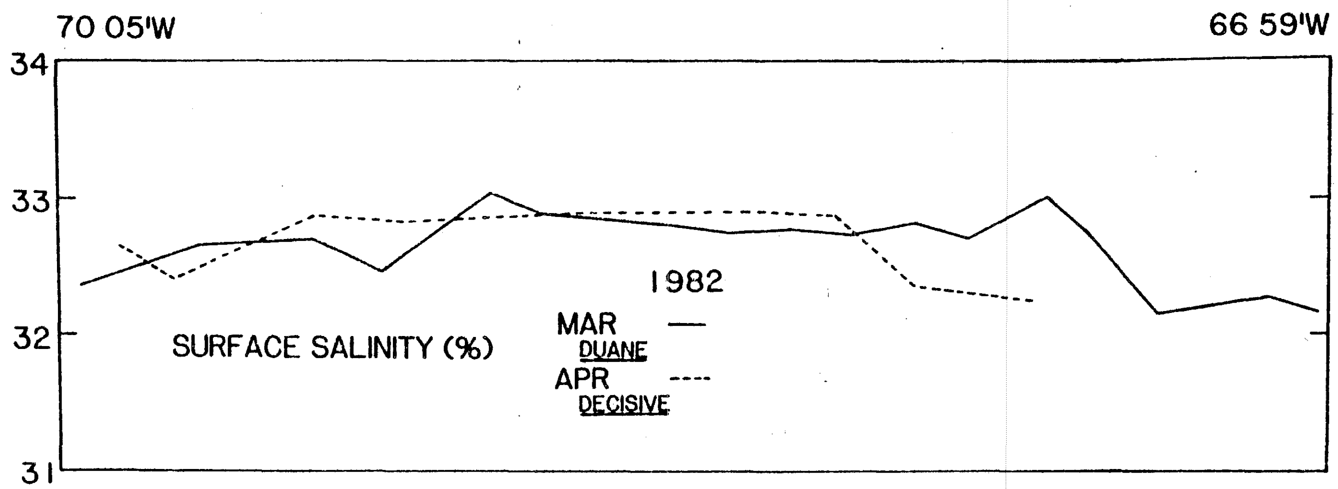

70 05'W
66 59'W
34
33
32
31
SURFACE SALINITY (%)
1982
MAR
DUANE
APR
DECISIVE

Figure 26

Figure 29

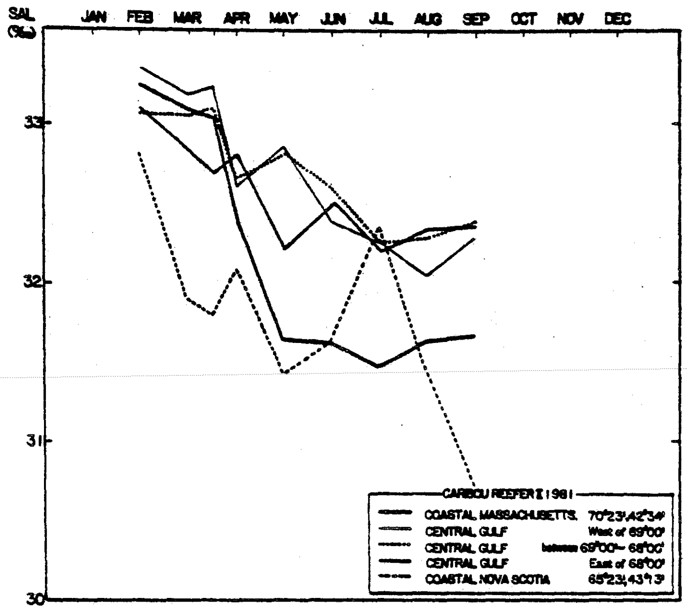
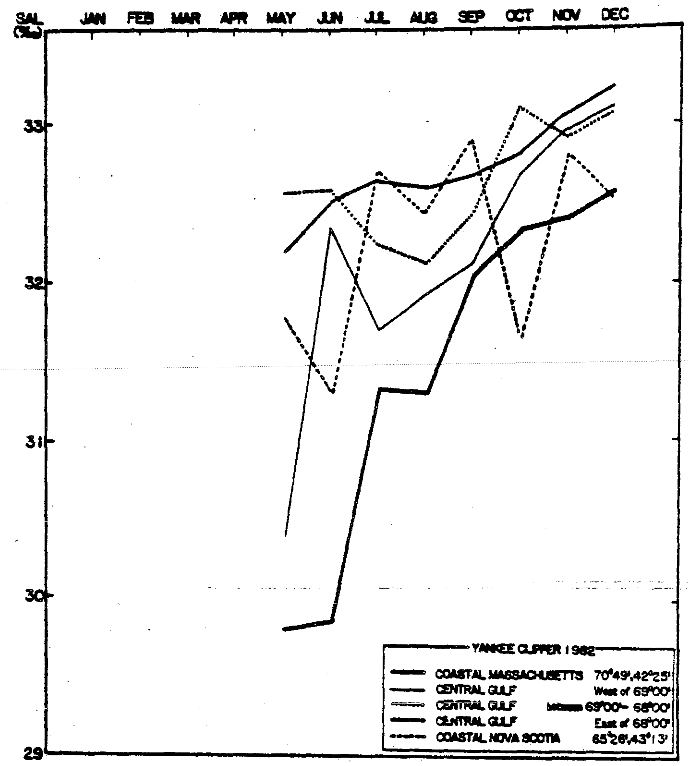



Figure 30



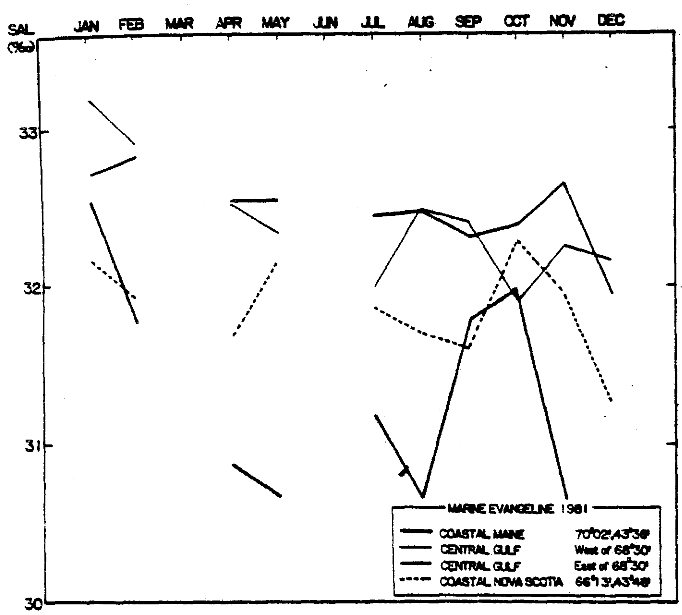




Figure 27

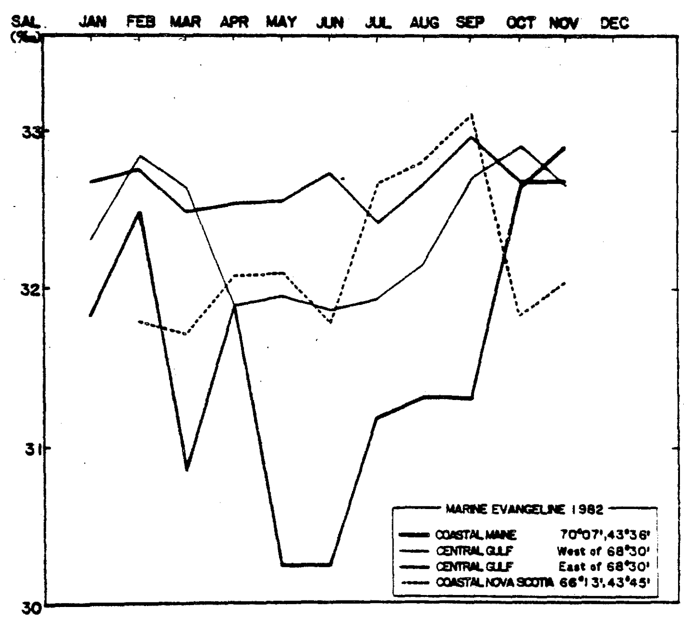



Figure 28

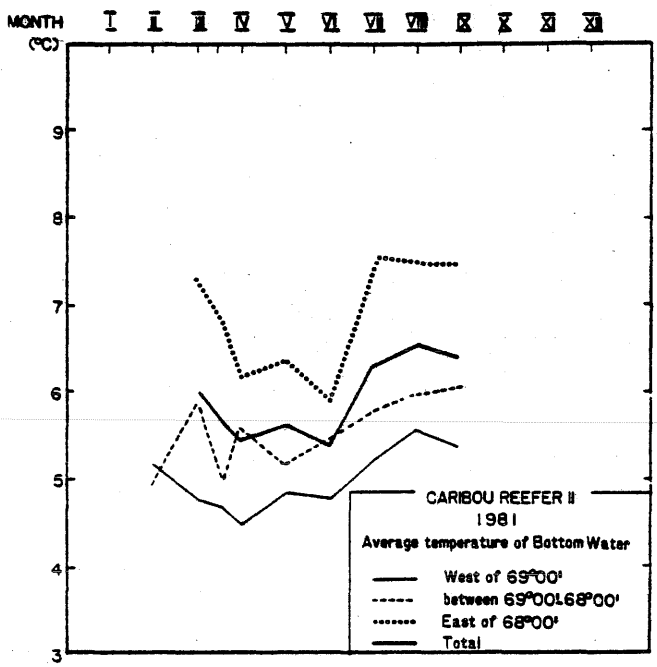



Figure 31a

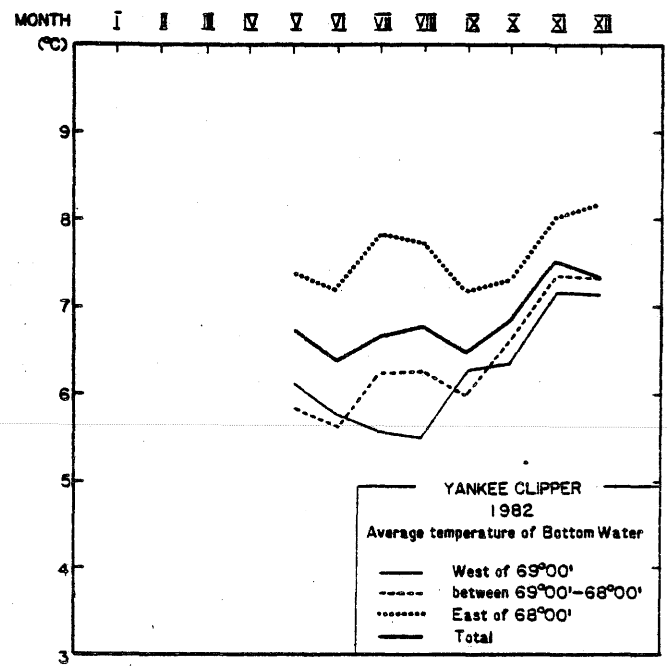



Figure 31b

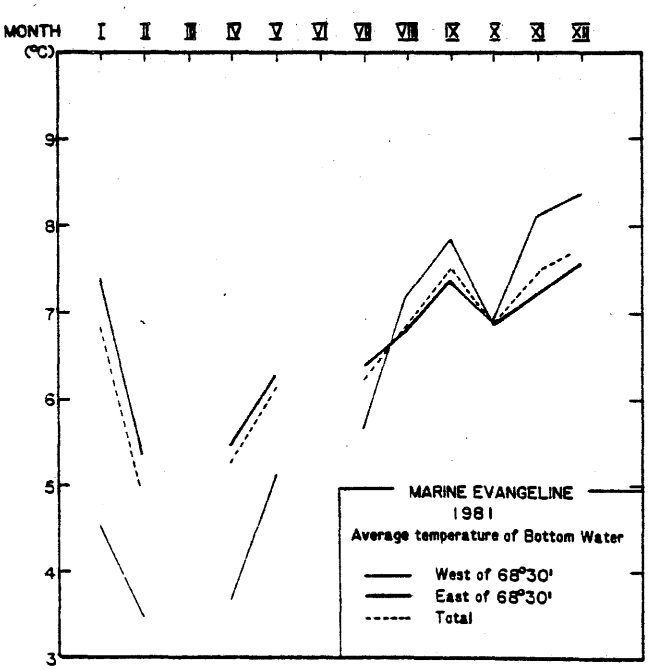



Figure 32a

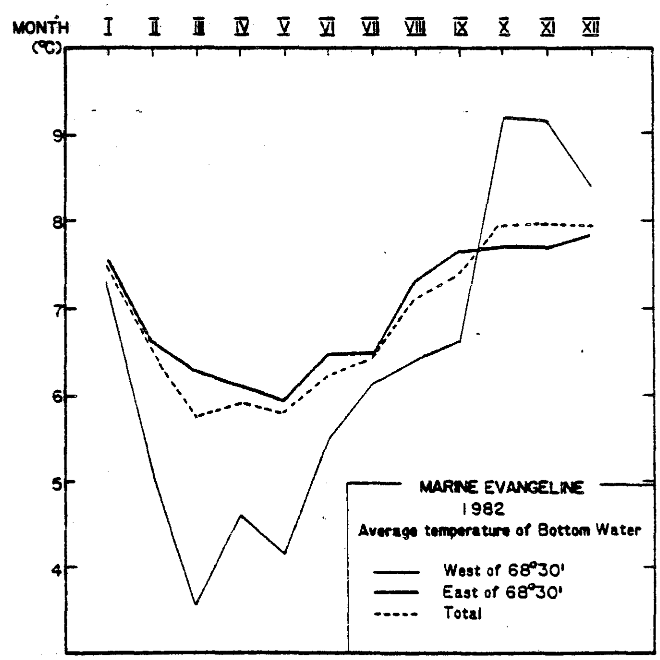



Figure 32b