81-11

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Temperature Structure and Surface Salinity in the Gulf of Maine during 1980

by

W. R. Wright

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Signature Paul G Martin

Date 7 April 1981

Northeast Fisheries Center
Woods Hole, MA 02543

Laboratory Reference # 81-11

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INTRODUCTION

Since June 1975, water temperature and sea surface salinity in the Gulf of Maine have been monitored on a monthly basis in a Ship of Opportunity Program (SOOP) carried out cooperatively by the Northeast Fisheries Center (NEFC) laboratory in Woods Hole, Massachusetts, and the Atlantic Environmental Group (AEG) in Narragansett, Rhode Island. Results through 1979 have been reported by Pawlowski (1978a, 1978b), Kirschner (1979a, 1979b, 1979c), and Cain (1980). This report covers the observations made in 1980.

Cruises were made in 1980 by the M.V. MARINE EVANGELINE operating between Portland, Maine and Yarmouth, Nova Scotia; the M.V. CARIBOU REEFER II between Gloucester, Massachusetts and Cape Sable, Nova Scotia; and the U.S.C.G.C. DECISIVE along a line at 42°55'N between 67°W and 70°27'W. The cruises are listed in Table 1 and the tracks are shown in Figure 1. Expendable bathythermograph (XBT) drops, bucket temperatures and surface water samples for salinity were taken hourly during each cruise. The salinities were determined by inductive salinometer at AEG.

WINTER

The seasonal progression of cooler temperatures at the sea surface and in the upper layers is evident in both the Portland-Yarmouth and Gloucester-Cape Sable sections (Figures 2, 6). By March, the low point for the year, the water column east of Portland was mixed to a depth of 150 m at a temperature of about 4°C. Slightly higher temperatures and shallower convective mixing occurred on the more southern route. At greater depths in both locations, there was warmer water up to 9°C, representing Slope Water inflow through Northeast Channel. In the northern Gulf of Maine, the Slope Water temperatures did not follow a seasonal trend, with the deepest values going from 8.8°C in January to 8.0°C in February and 9.6°C in March. The March value may represent northward penetration of the >9° water which was found in Crowell Basin in January but was gone by March.

SPRING

There was a hint of surface warming on the Portland-Yarmouth run in April and by June a strong thermocline existed down to about 30 m (Figure 3), weaker on the Nova Scotia side. On the southern transect the June thermocline was strong at the Gloucester end and absent near Cape Sable (Figure 7). Mid-depth temperatures on both transects were in the 5-6°C range. Deeper observations were inadequate to determine if Slope Water was present, except in Crowell Basin where temperatures exceeded 7°C.

SUMMER

The thermocline reached its peak in July and August and began to weaken in September (Figures 4, 8). The $10^{o}C$ isotherm deepened during the season from about 20-25 m in July to around 50 m in September. Mid-depth waters warmed about $2^{o}C$ during the course of the summer and a mid-depth minimum was noticeable only in the middle of the gulf, much weaker than in previous years. There was very little indication of Slope Water influx except some water warmer than 9° in Crowell Basin in August.

FALL

Stratification broke down more rapidly then usual and by November the water was vertically homogeneous throughout the northern transect except at one station in mid-gulf (Figure 5). In the southern transect, the water was well-mixed by November to above 100 m over Wilkinson Basin and to at least 150 m on the Nova Scotia side (Figure 9). In December, the vertical homogeneity was disturbed by an intrusion of water warmer than $9^{o}C$. This could not be a remnant of the fall overturn because it was overlain by water of $6^{o}C$ and must have been quite saline - i.e. of Slope Water origin - to be dense enough for stability.

SURFACE TEMPERATURE AND SALINITIES

The CARIBOU REEFER surface temperatures (Figure 10) showed a low in March and April (around 2° to $5^{o}C$) and a high (near $20^{o}C$) in September, dropping quickly to $12^{o}C$ in October and around $7^{o}C$ by December. The Cape Sable values were generally lower than those further west, as usual. Surface salinities (Figure 11) were higher in winter in mid-gulf (around $33.5^{o}/oo$), dropped below $33^{o}/oo$ in summer and

increased slightly in the fall except near Cape Sable where values continued to decrease through December.

The MARINE EVANGELINE surface temperatures sequence ran about a month ahead of the southern transect through most of the year, with a minimum in February-March (4-5°C) and a maximum (18°C) in August (Figure 12). However, the drop to cooler fall values occurred in October in both locations. Surface salinity patterns (Figure 13) were similar to those on the Gloucester-Cape Sable run.

SUMMARY

The major difference between 1980 and previous years was the apparent absence of Slope Water in the deeper part of the basin during most of 1980. Slope Water was evident in Crowell Basin in January but did not clearly appear there again until December. On the northern transect, Slope Water was not evident after March.

REFERENCES

Cain, T.E. 1980. Temperature structure and surface salinity in the Gulf of Maine during 1979. Annales Biologiques 36 (in press).

Kirschner, R.A. 1979a. Fall temperature structure in the northern Gulf of Maine: a four-year comparison. Coastal Oceanography & Climatology News 1(2): 16-17.

_____ 1979b. Temperature structure and sea surface salinity conditions in the Gulf of Maine since summer 1975. Proc. Second Informal Workshop in the Oceanography of the Gulf of Maine and Adjacent Seas, Halifax, May 1979 p. 42 (abstract only).

_____ 1979c. Temperature structure and surface salinity in the Gulf of Maine during 1978. Annales Biologiques 35: 30-41.

Pawlowski, R.J. 1978a. The Gulf of Maine temperature structure between Bar Harbor, Maine and Yarmouth, Nova Scotia, June 1975 - November 1976. NOAA Technical Report NMFS SSRF-726, 10 pp.

_____ 1978b. Vertical temperature structure and sea surface salinity in the Gulf of Maine during 1977. Annales Biologiques 34: 27-31.

TABLE 1

SOOP Runs in the Gulf of Maine in 1980

A. Portland - Yarmouth (M.V. MARINE EVANGELINE)

CRUISE NUMBER	DATE
80-01	17 January
80-02	21 February
80-03	20 March
80-04	17 April
80-05	22 May
80-06	26 June
80-07	22 July
80-08	28 August
80-09	23 September
80-10	21 October
80-11	30 November

B. Gloucester - Cape Sable (M.V. CARIBOU REEFER II)

80-01	1-2 January
80-02	19-21 March
80-03	4-5 April
80-05	5-6 May
80-07	5-6 June
80-08	21-22 July
80-09	20-21 August
80-10	2-3 September
80-11	20-21 October
80-13	11-12 November
80-14	13-14 November
80-15	14-15 December

C. 42°55'N Latitude (U.S.C.G.C. DECISIVE)

80-01	9 February

FIGURE CAPTIONS

Figure 1. Chart shows positions of transects occupied in 1980: Portland to Yarmouth, M.V. MARINE EVANGELINE; Gloucester to Cape Sable, M.V. CARIBOU REEFER II; transect along 42°55'N, U.S.C.G.C. DECISIVE.

Figure 2. 1980 winter sections by M.V. MARINE EVANGELINE.

Figure 3. 1980 spring sections by M.V. MARINE EVANGELINE.

Figure 4. 1980 summer sections by M.V. MARINE EVANGELINE.

Figure 5. 1980 fall sections by M.V. MARINE EVANGELINE (top, middle); CARIBOU REEFER section 80-13 (bottom).

Figure 6. 1980 winter sections by M.V. CARIBOU REEFER (top, bottom); U.S.C.G.C. DECISIVE section (middle).

Figure 7. 1980 spring sections by M.V. CARIBOU REEFER.

Figure 8. 1980 summer sections by M.V. CARIBOU REEFER.

Figure 9. 1980 fall sections by M.V. CARIBOU REEFER.

Figure 10. 1980 surface temperatures by M.V. CARIBOU REEFER.

Figure 11. 1980 surface salinities by M.V. CARIBOU REEFER.

Figure 12. 1980 surface temperatures by M.V. MARINE EVANGELINE.

Figure 13. 1980 surface salinities by M.V. MARINE EVANGELINE.

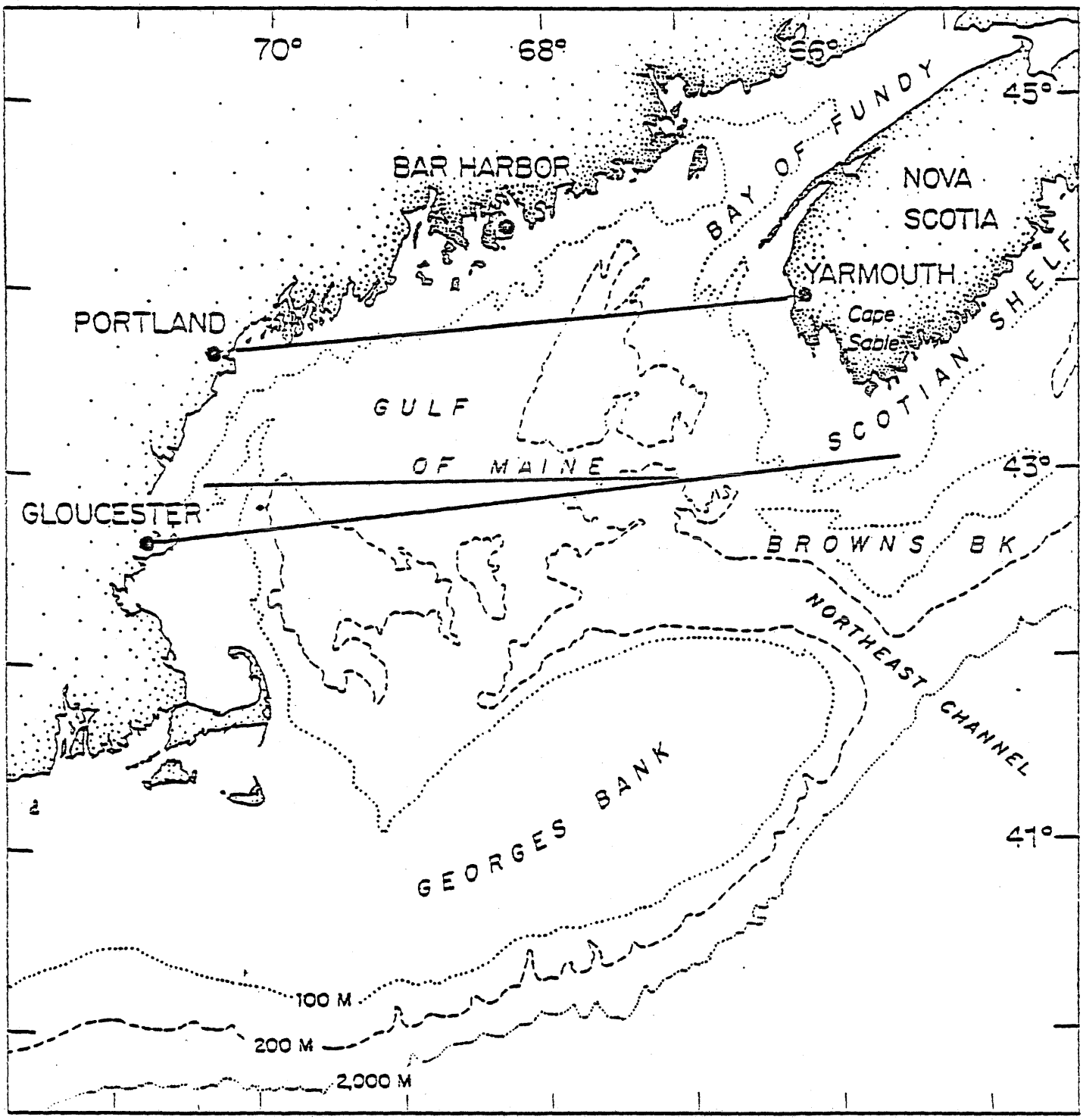

70°
68°
66°
45°
43°
41°
BAR HARBOR
BAY OF FUNDY
NOVA
SCOTIA
YARMOUTH
Cape
Sable
SCOTIAN SHELF
PORTLAND
GULF
OF MAINE
GLOUCESTER
BROWNS BK
NORTHEAST CHANNEL
GEORGES BANK
100 M
200 M
2,000 M

FIGURE 1

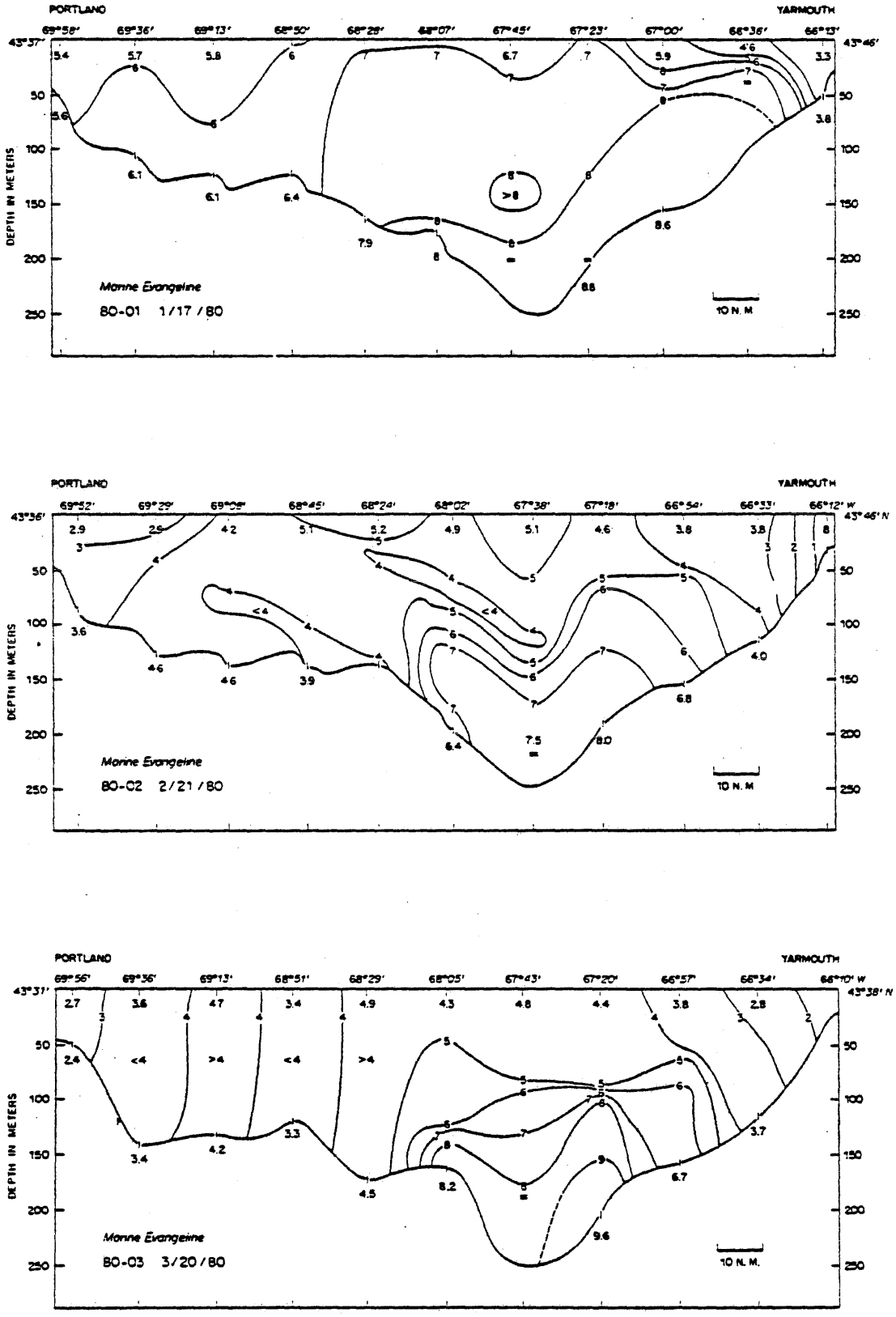
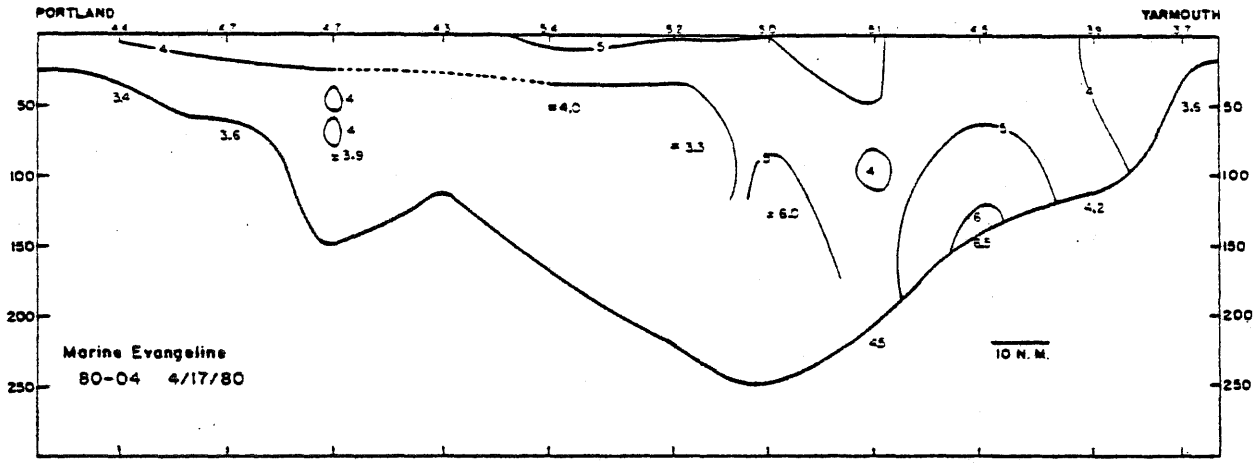
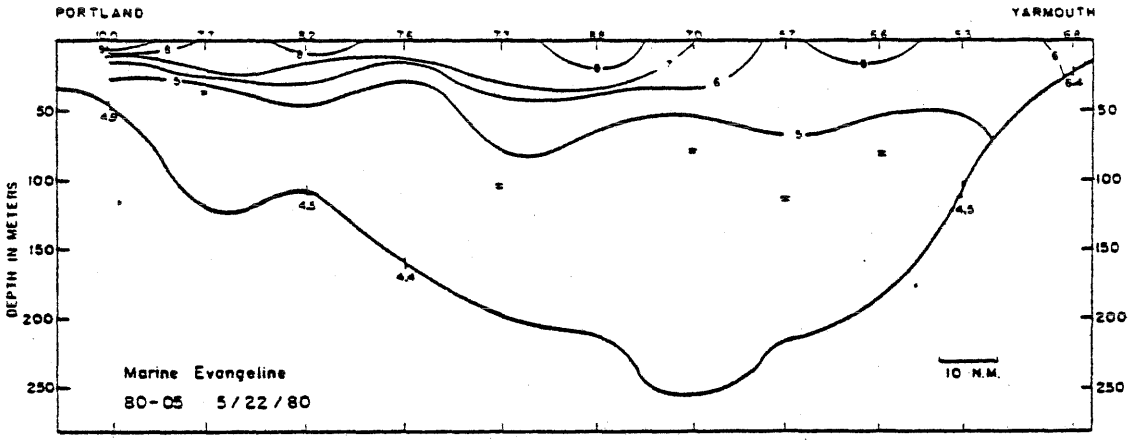

PORTLAND
YARMOUTH
DEPTH IN METERS
Monne Evangeline
80-01 1/17/80
10 N. M
Monne Evangeline
80-02 2/21/80
10 N. M
Monne Evangeline
80-03 3/20/80
10 N. M.

FIGURE 2


PORTLAND
YARMOUTH
Marine Evangeline
80-04 4/17/80
10 N.M.


PORTLAND
YARMOUTH
DEPTH IN METERS
Marine Evangeline
80-05 5/22/80
10 N.M.

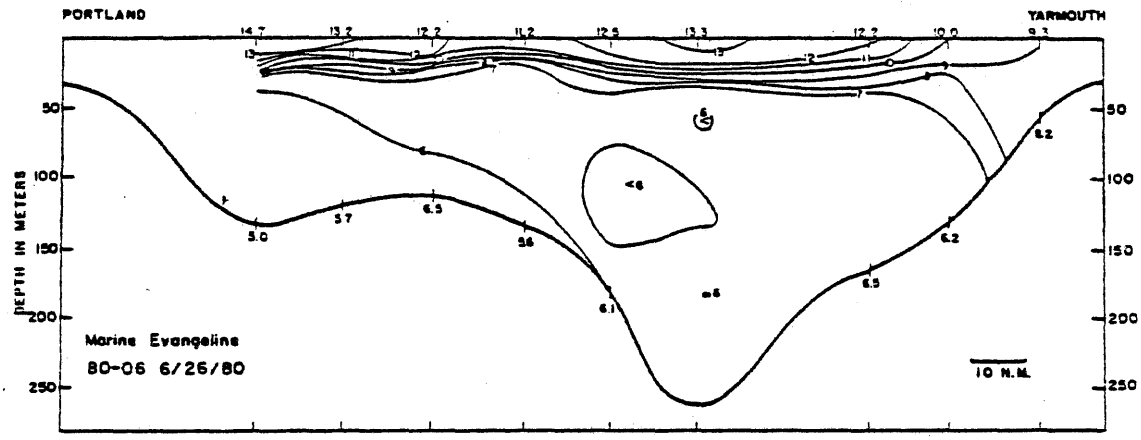

PORTLAND
YARMOUTH
DEPTH IN METERS
Marine Evangeline
80-06 6/26/80
10 N.M.

FIGURE 3

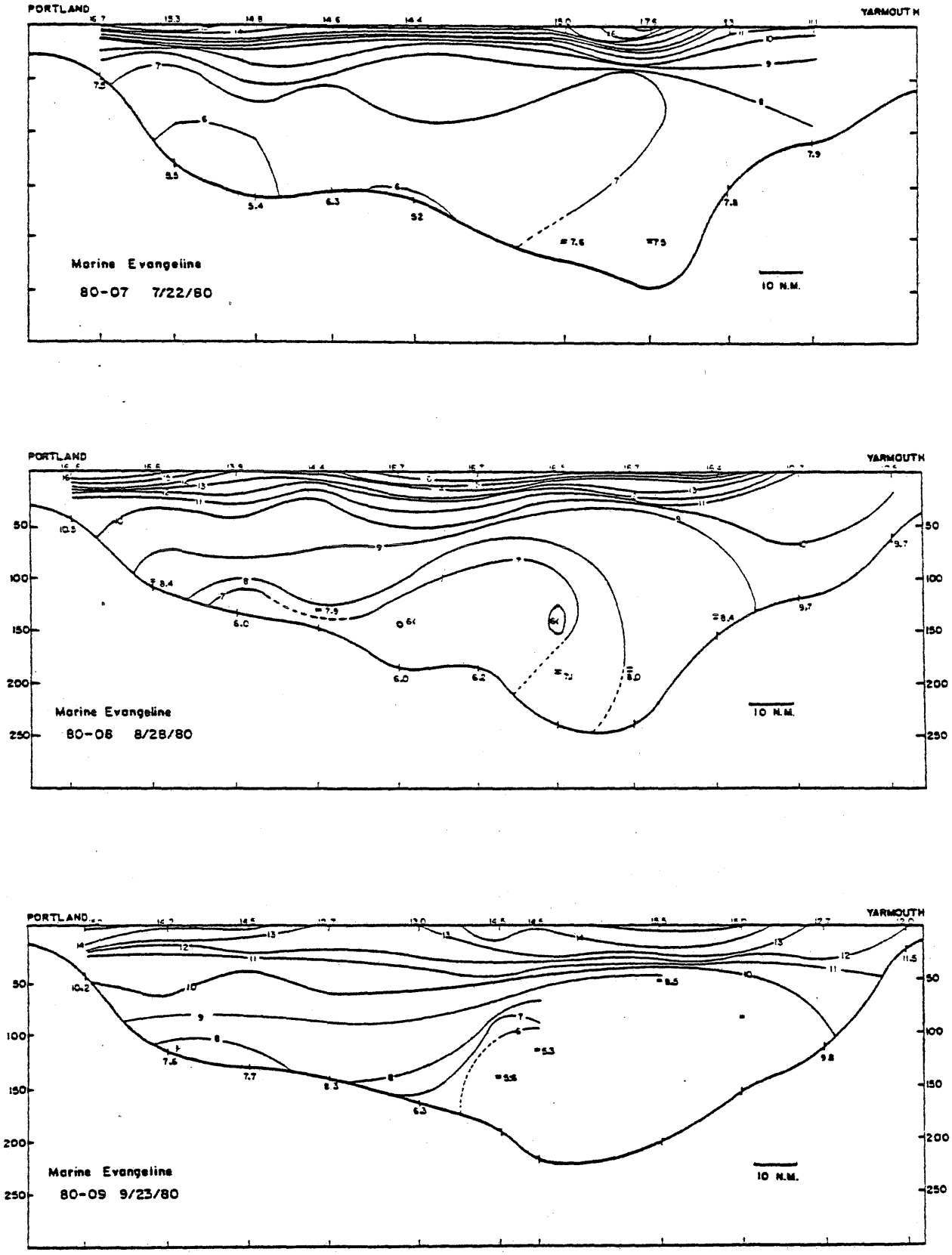
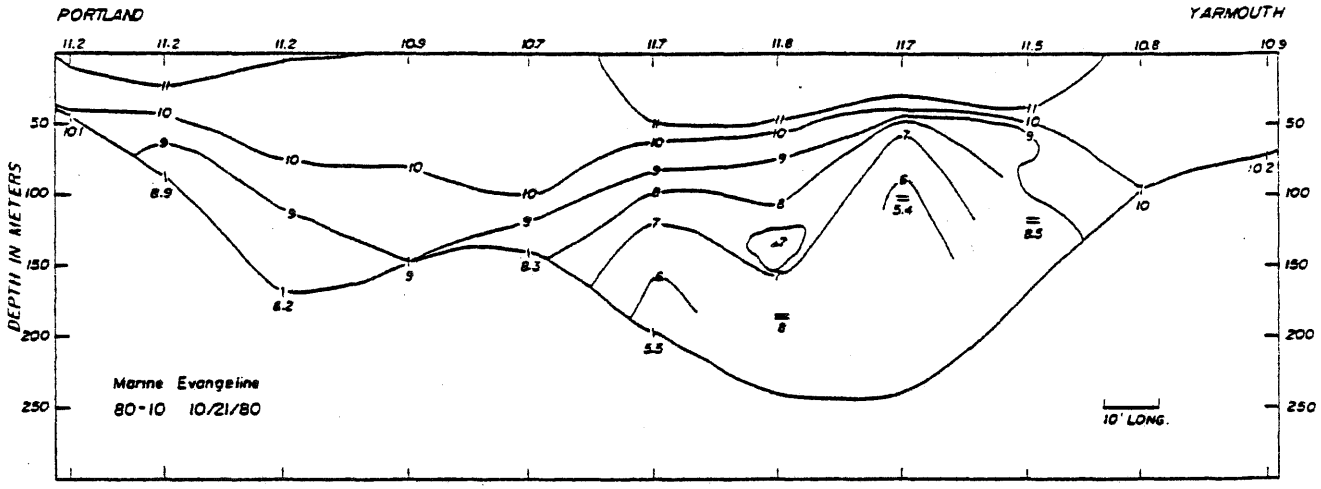
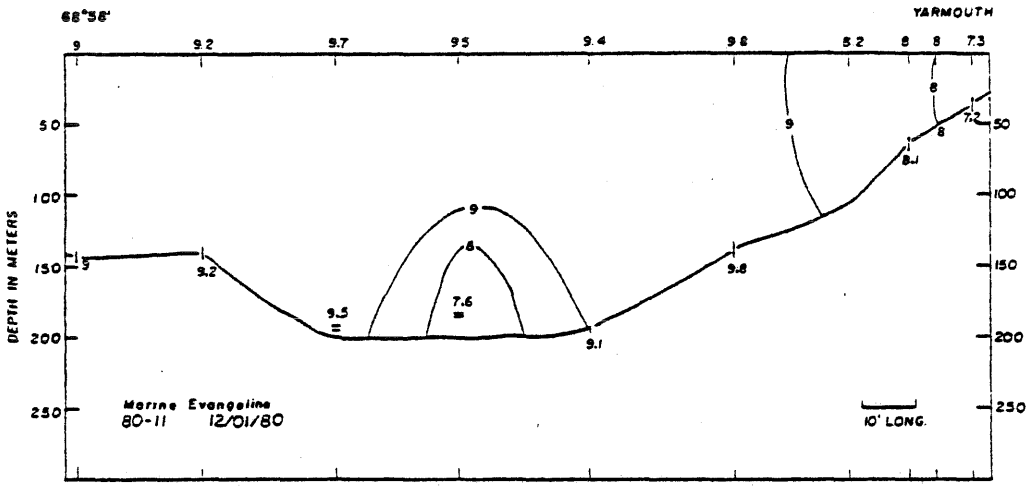

PORTLAND
YARMOUTH
Marine Evangeline
80-07 7/22/80
10 N.M.
PORTLAND
YARMOUTH
Marine Evangeline
80-08 8/28/80
10 N.M.
PORTLAND
YARMOUTH
Marine Evangeline
80-09 9/23/80
10 N.M.

FIGURE 4


PORTLAND
YARMOUTH
DEPTH IN METERS
Marine Evangeline
80-10 10/21/80
10' LONG.


68°58'
YARMOUTH
DEPTH IN METERS
Marine Evangeline
80-11 12/01/80
10' LONG.

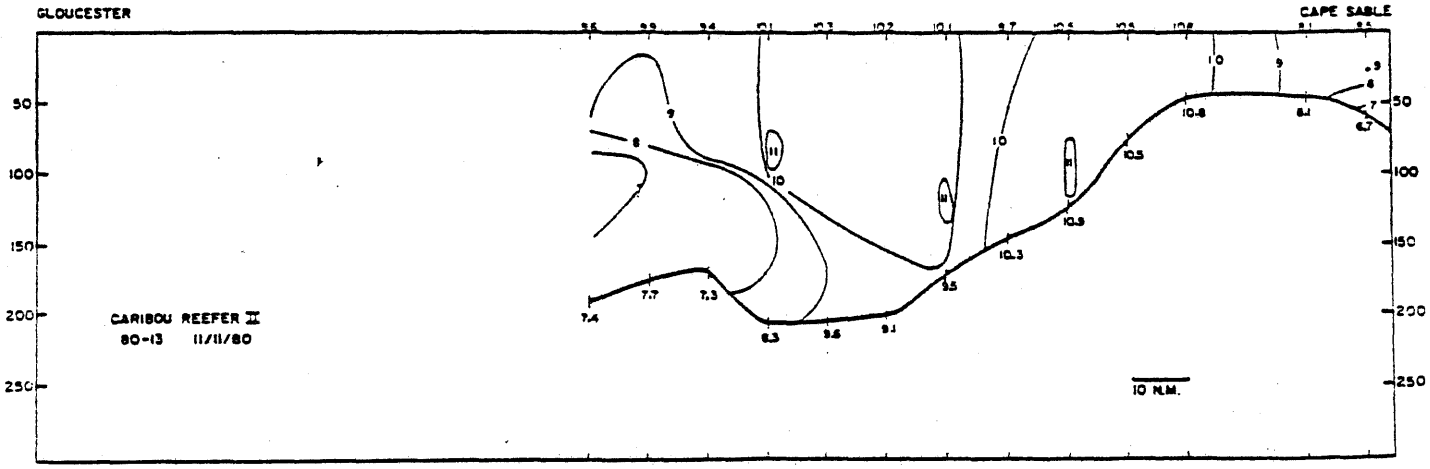
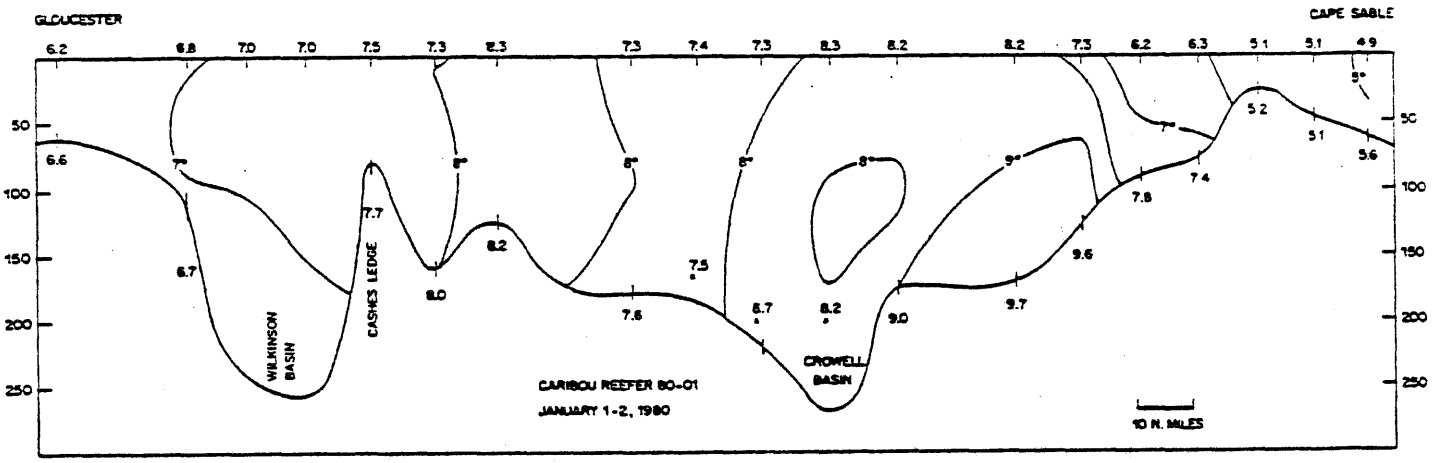
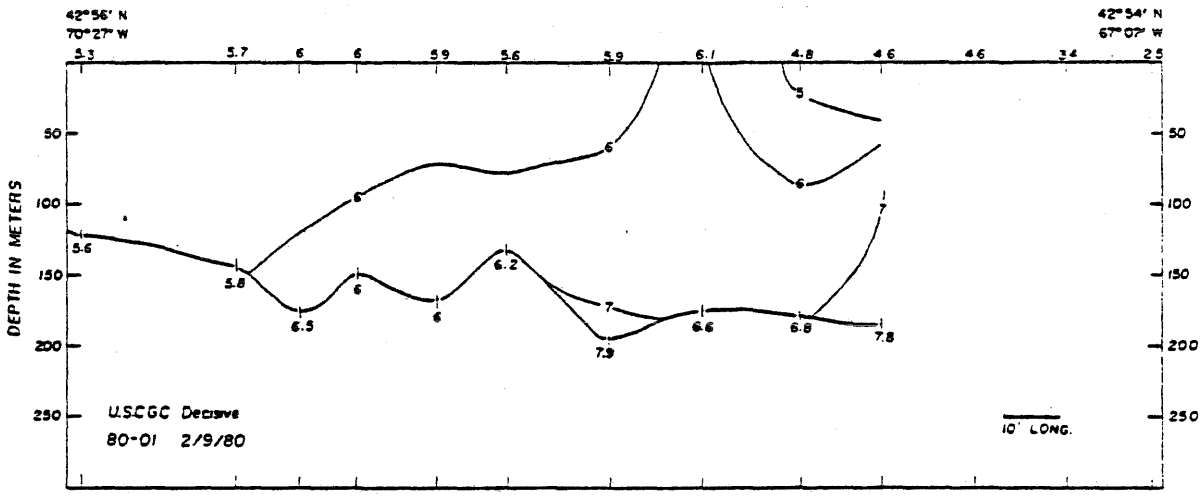

GLOUCESTER
CAPE SABLE
CARIBOU REEFER II
80-13 11/11/80
10 N.M.

FIGURE 5


GLOUCESTER
CAPE SABLE
WILKINSON BASIN
CASHES LEDGE
CROWELL BASIN
CARIBOU REEFER 80-01
JANUARY 1-2, 1980
10 N. MILES


42°56' N
70°27' W
42°54' N
67°07' W
DEPTH IN METERS
U.S.C.G.C. Decisive
80-01 2/9/80
10' LONG.

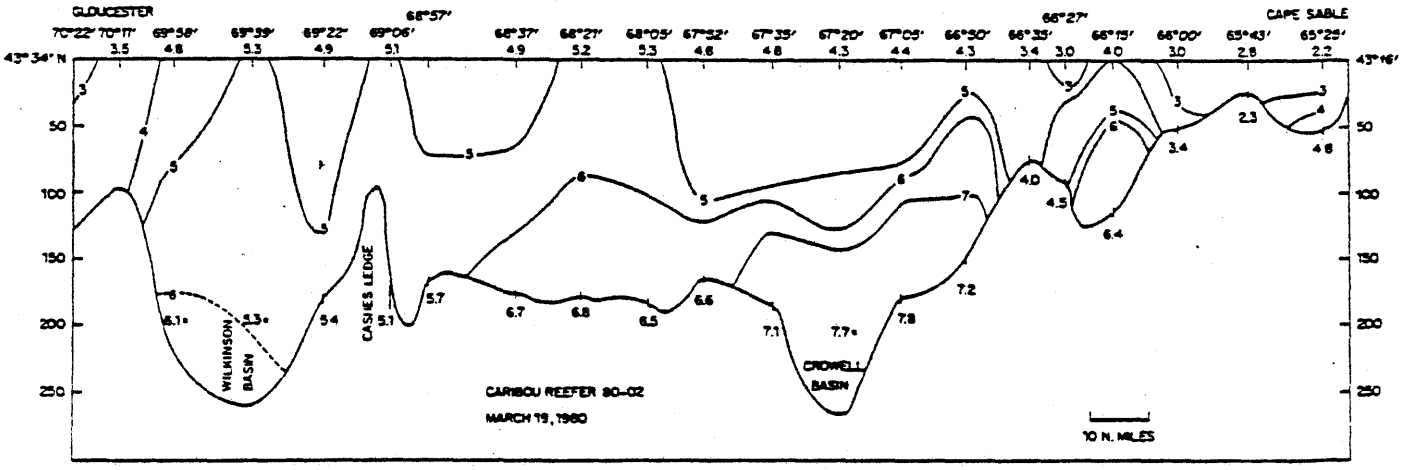
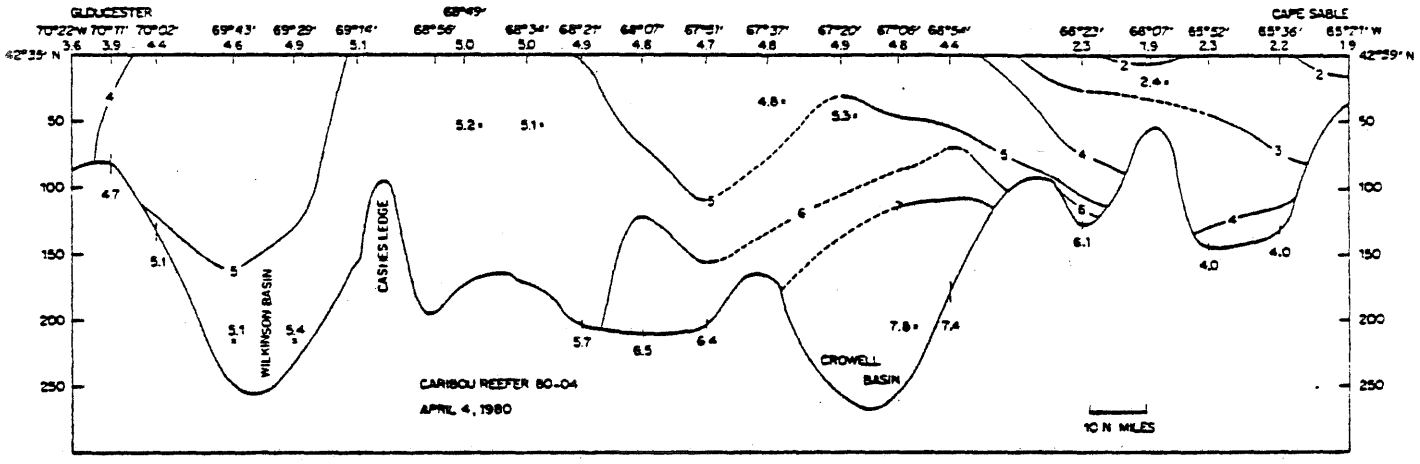
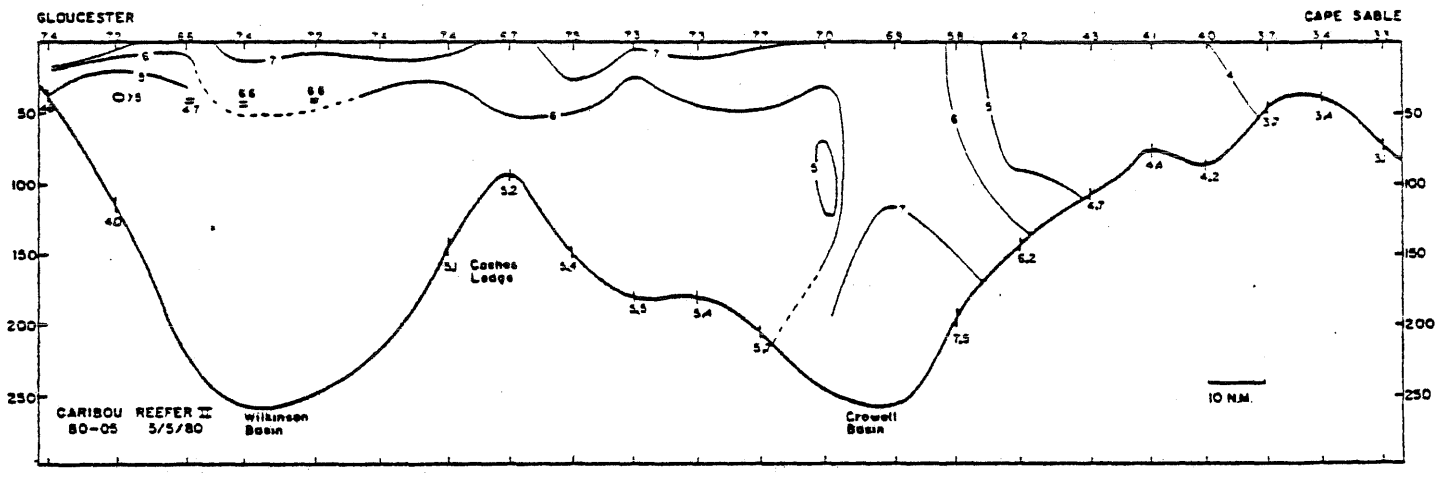

GLOUCESTER
CAPE SABLE
WILKINSON BASIN
CASHES LEDGE
CROWELL BASIN
CARIBOU REEFER 80-02
MARCH 19, 1980
10 N. MILES

FIGURE 6


GLOUCESTER
CAPE SABLE
WILKINSON BASIN
CASHES LEDGE
CROWELL BASIN
CARIBOU REEFER 80-04
APRIL 4, 1980
10 N MILES


GLOUCESTER
CAPE SABLE
Cashes Ledge
CARIBOU REEFER II
80-05 5/5/80
Wilkinson Basin
Crowell Basin
10 N.M.

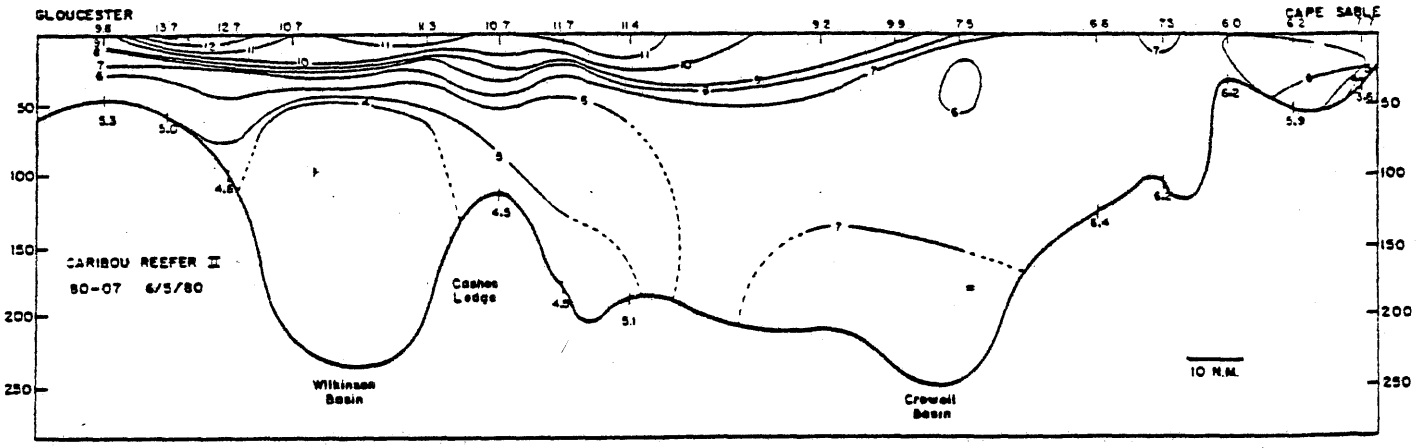
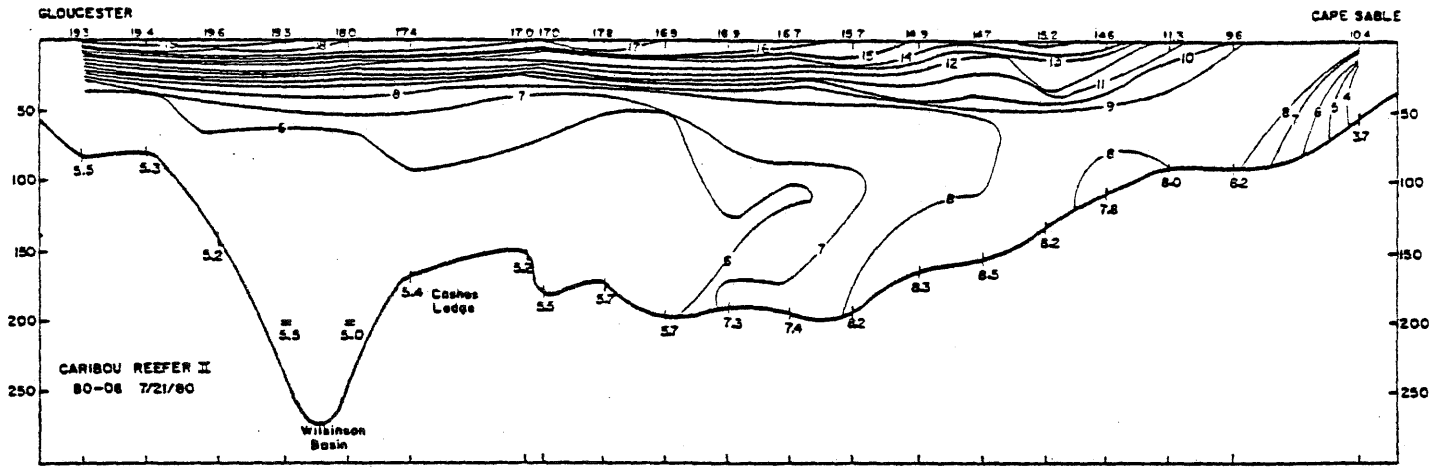
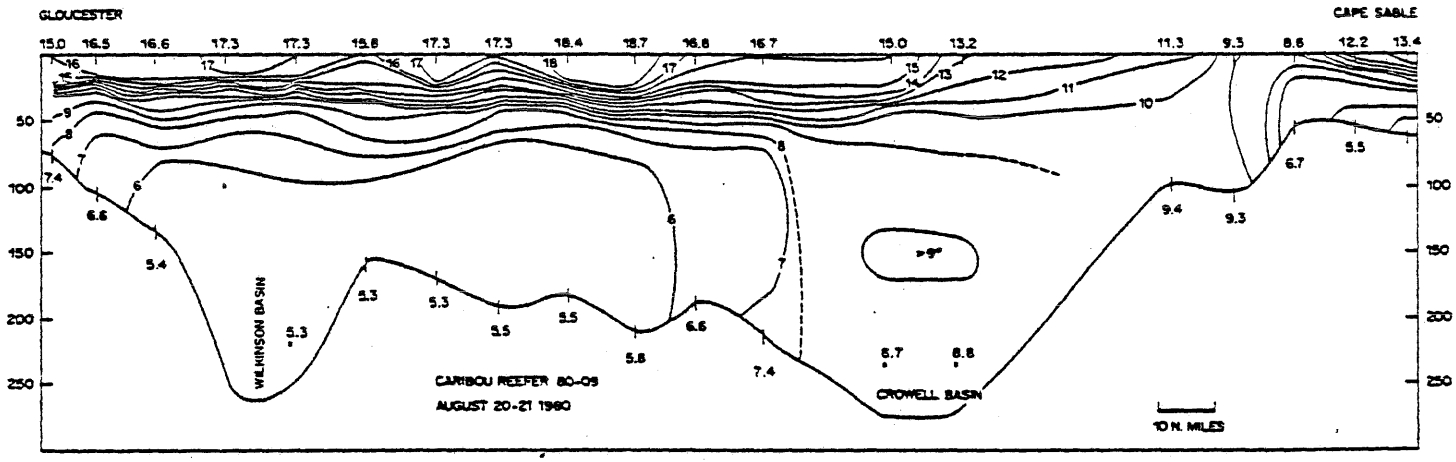

GLOUCESTER
CAPE SABLE
CARIBOU REEFER II
80-07 6/5/80
Cashes Ledge
Wilkinson Basin
Crowell Basin
10 N.M.

FIGURE 7


GLOUCESTER
CAPE SABLE
Cashes Ledge
Wilkinson Basin
CARIBOU REEFER II
80-08 7/21/80


GLOUCESTER
CAPE SABLE
WILKINSON BASIN
CROWELL BASIN
CARIBOU REEFER 80-09
AUGUST 20-21 1980
10 N. MILES

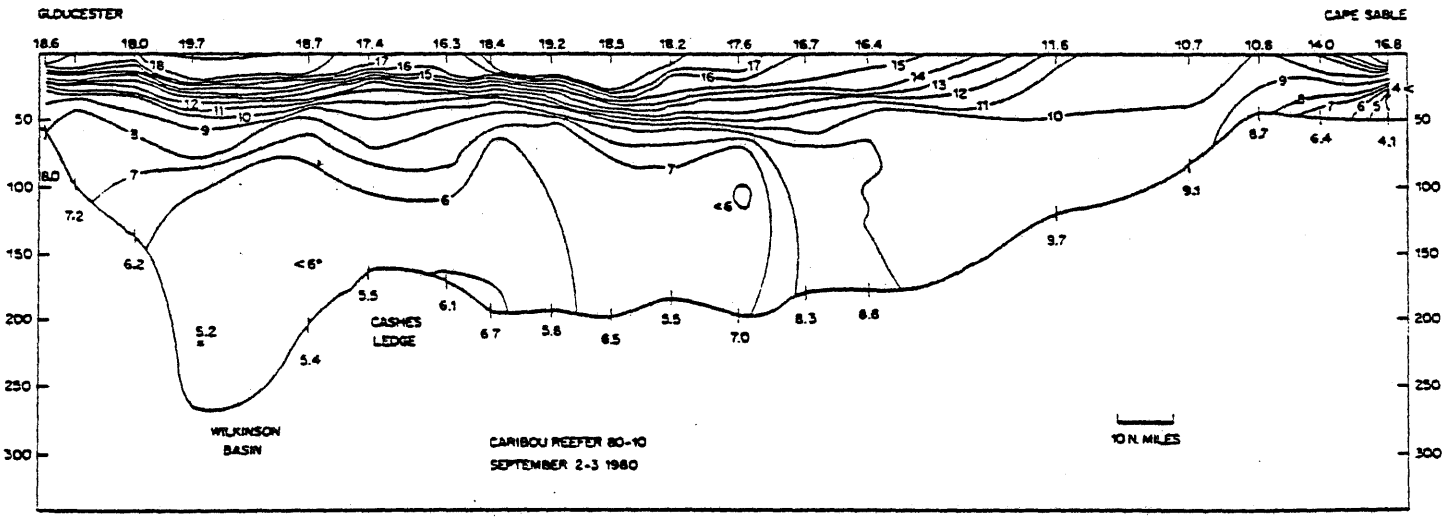
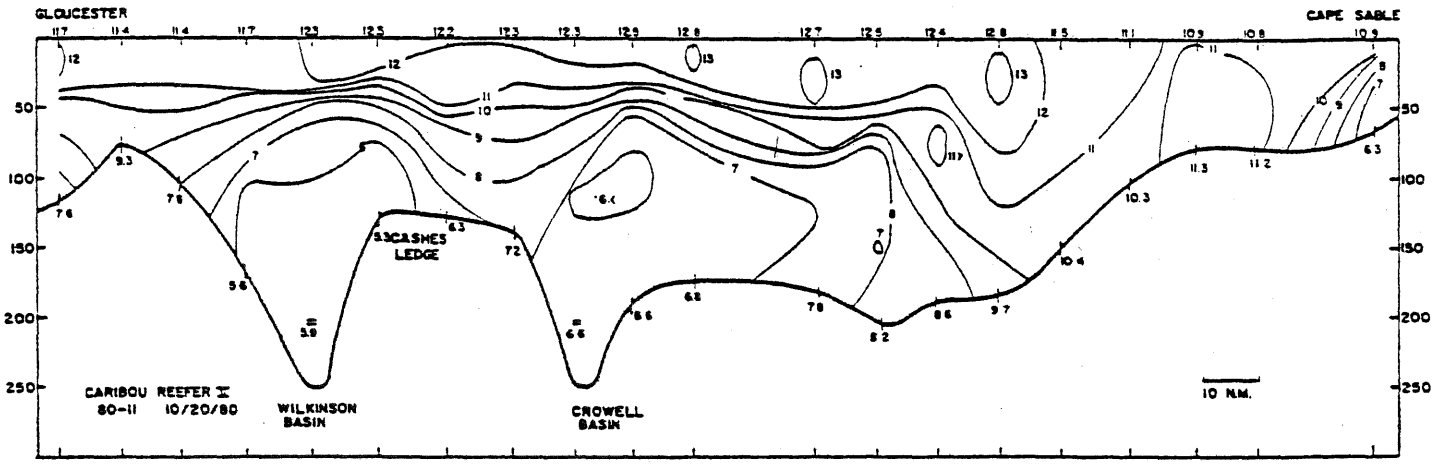
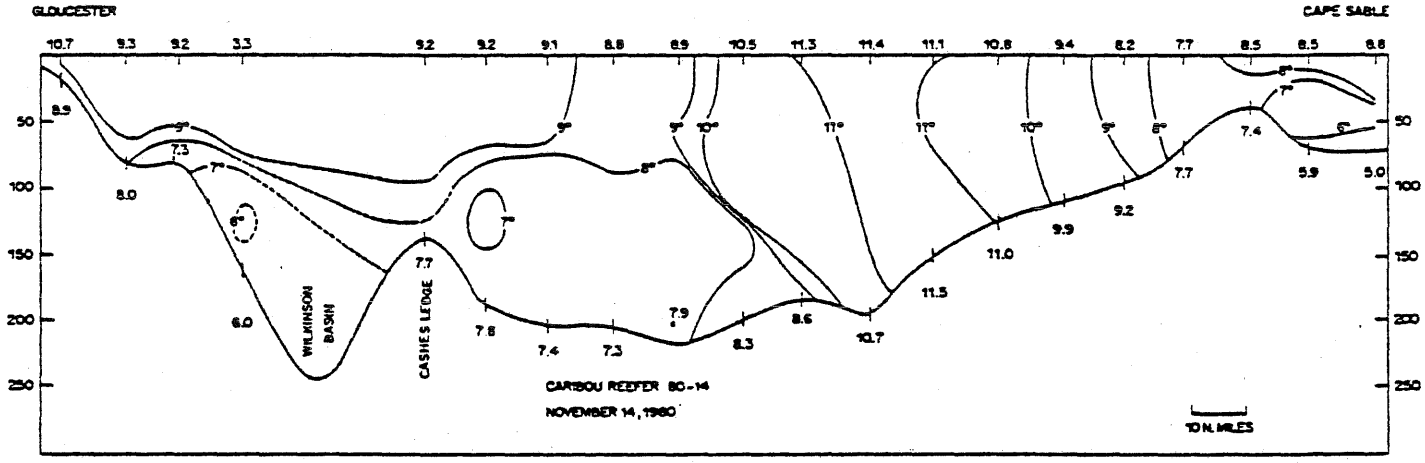

GLOUCESTER
CAPE SABLE
CASHES LEDGE
WILKINSON BASIN
CARIBOU REEFER 80-10
SEPTEMBER 2-3 1980
10 N. MILES

FIGURE 8


GLOUCESTER
CAPE SABLE
CASHES LEDGE
CARIBOU REEFER X
80-11 10/20/80
WILKINSON BASIN
CROWELL BASIN
10 N.M.


GLOUCESTER
CAPE SABLE
WILKINSON BASIN
CASHES LEDGE
CARIBOU REEFER 80-14
NOVEMBER 14, 1980
10 N. MILES

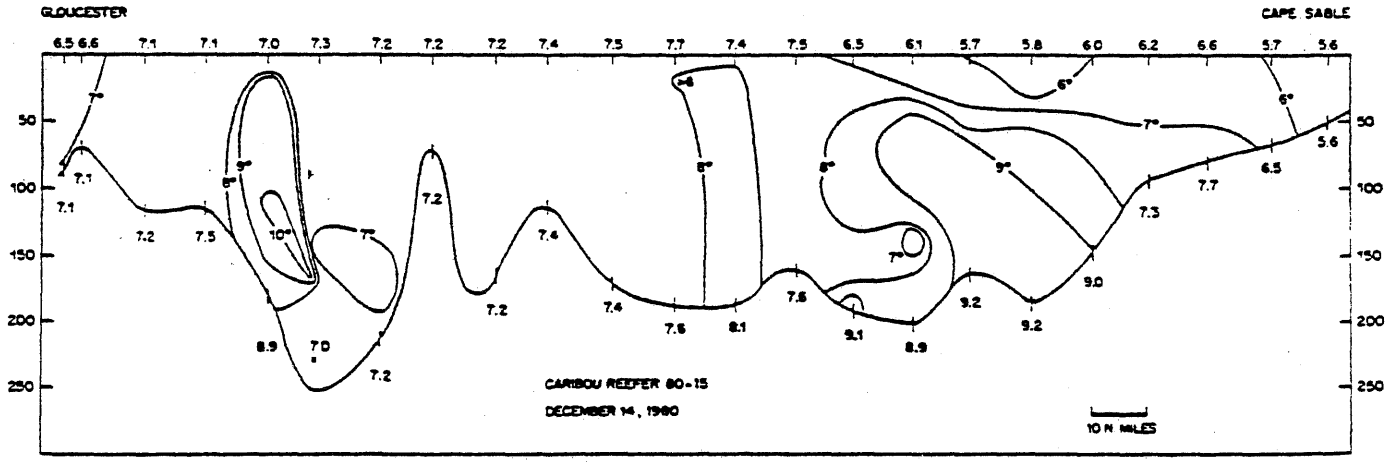
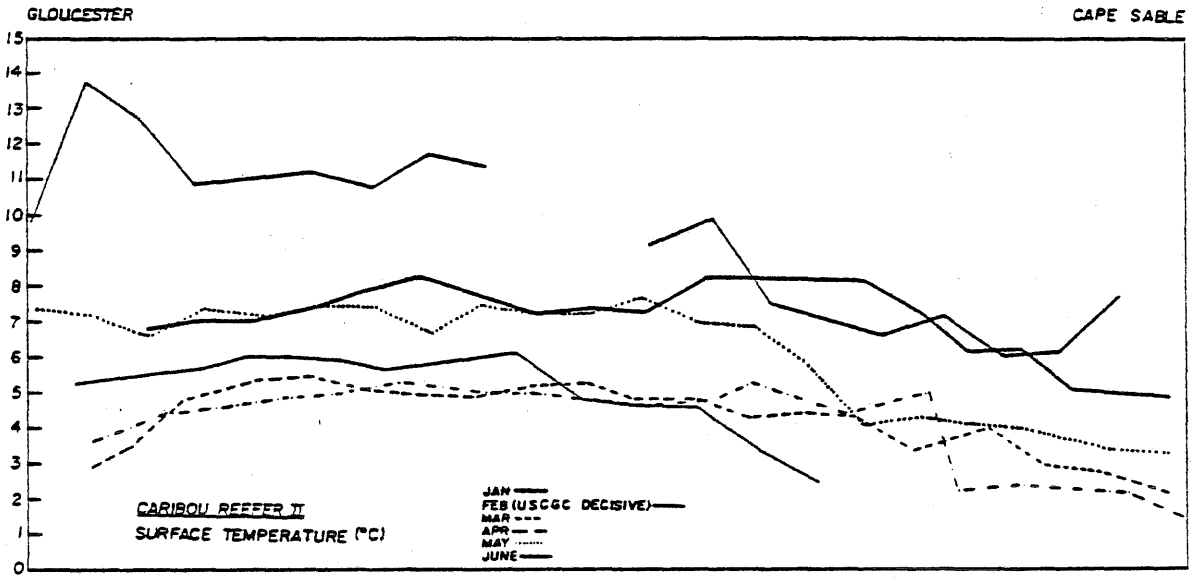

GLOUCESTER
CAPE SABLE
CARIBOU REEFER 80-15
DECEMBER 14, 1980
10 N MILES

FIGURE 9


GLOUCESTER
CAPE SABLE
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
CARIBOU REEFER II
SURFACE TEMPERATURE (°C)
JAN
FEB (USCGC DECISIVE)
MAR
APR
MAY
JUNE

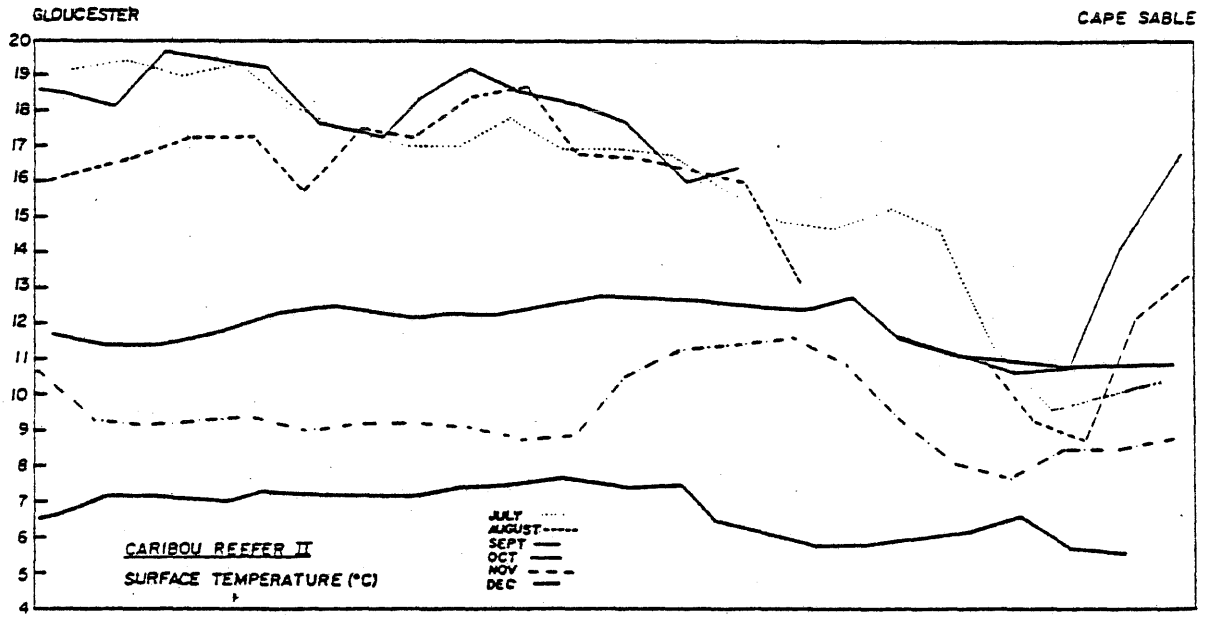

GLOUCESTER
CAPE SABLE
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
CARIBOU REEFER II
SURFACE TEMPERATURE (°C)
JULY
AUGUST
SEPT
OCT
NOV
DEC

FIGURE 10

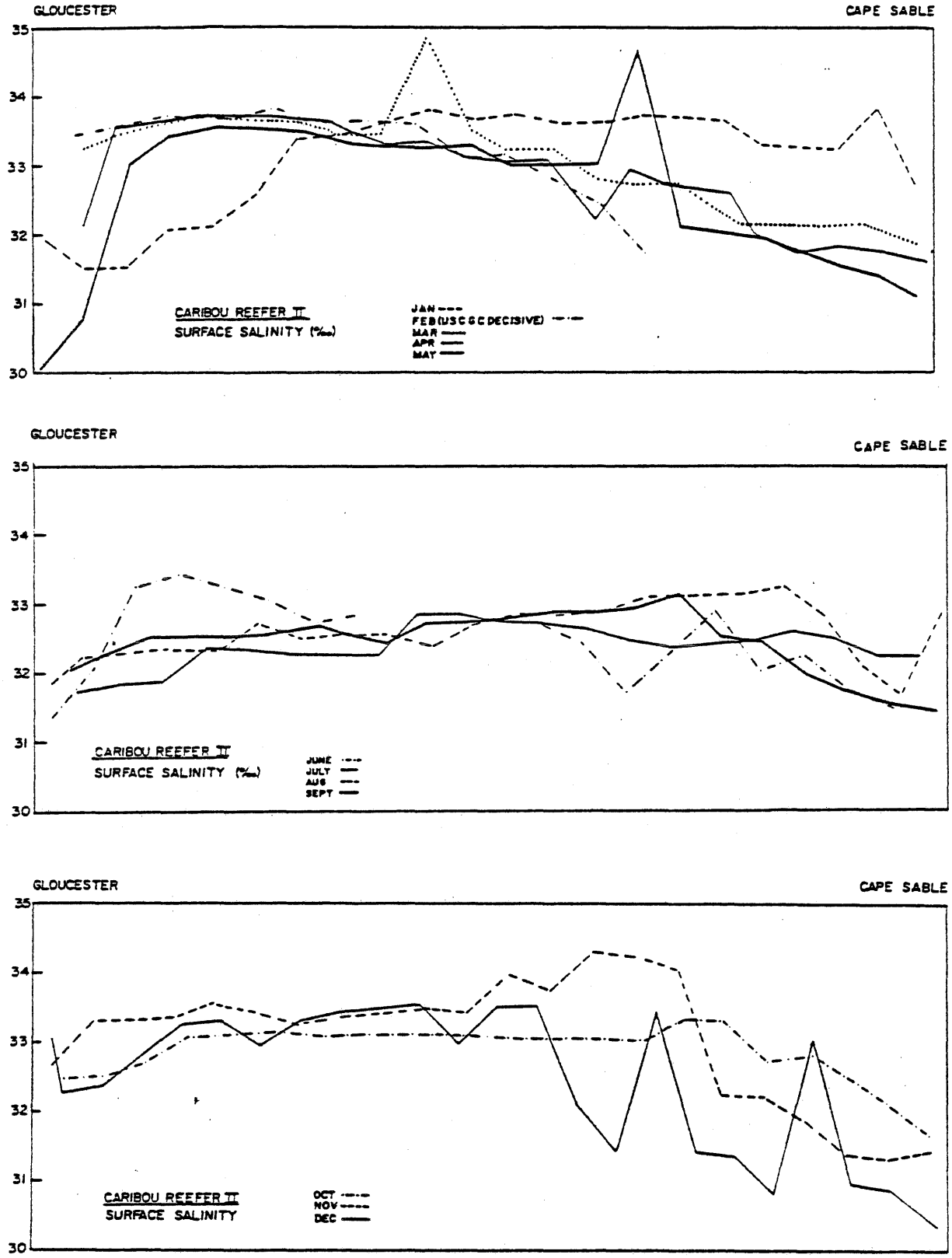
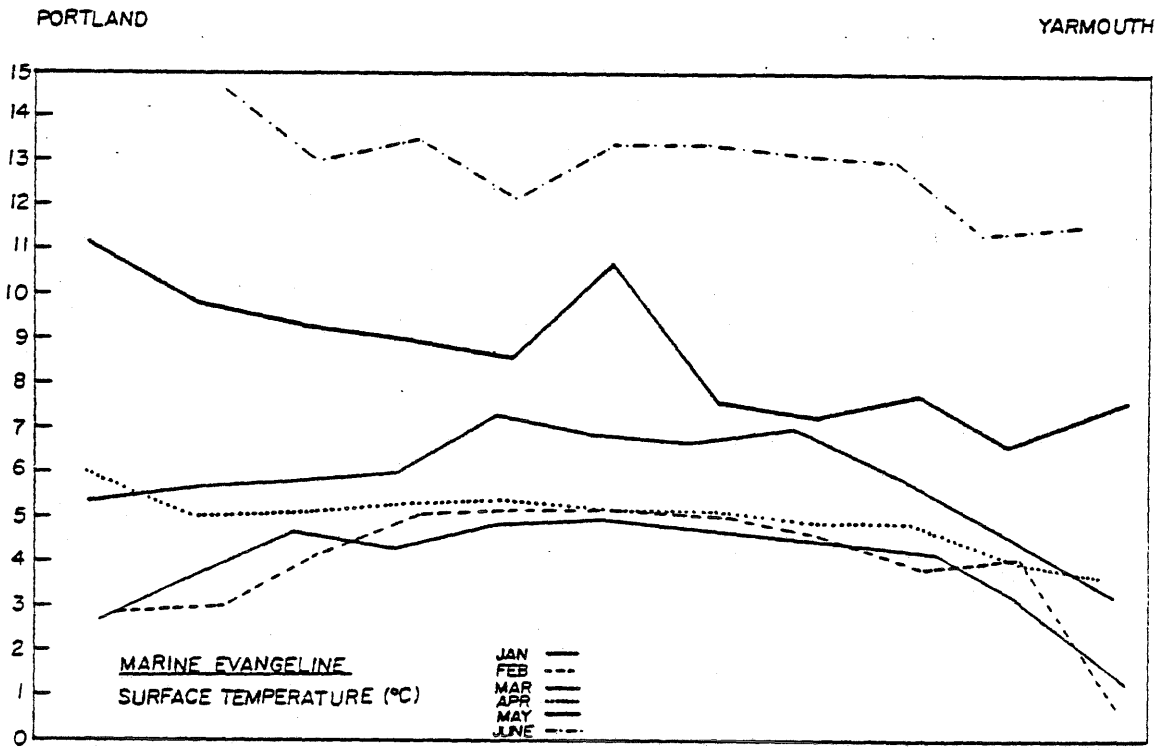

GLOUCESTER
CAPE SABLE
35
34
33
32
31
30
CARIBOU REEFER II
SURFACE SALINITY (‰)
JAN
FEB (USCGC DECISIVE)
MAR
APR
MAY
GLOUCESTER
CAPE SABLE
35
34
33
32
31
30
CARIBOU REEFER II
SURFACE SALINITY (‰)
JUNE
JULY
AUG
SEPT
GLOUCESTER
CAPE SABLE
35
34
33
32
31
30
CARIBOU REEFER II
SURFACE SALINITY
OCT
NOV
DEC

FIGURE 11


PORTLAND
YARMOUTH
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
MARINE EVANGELINE
SURFACE TEMPERATURE (°C)
JAN
FEB
MAR
APR
MAY
JUNE

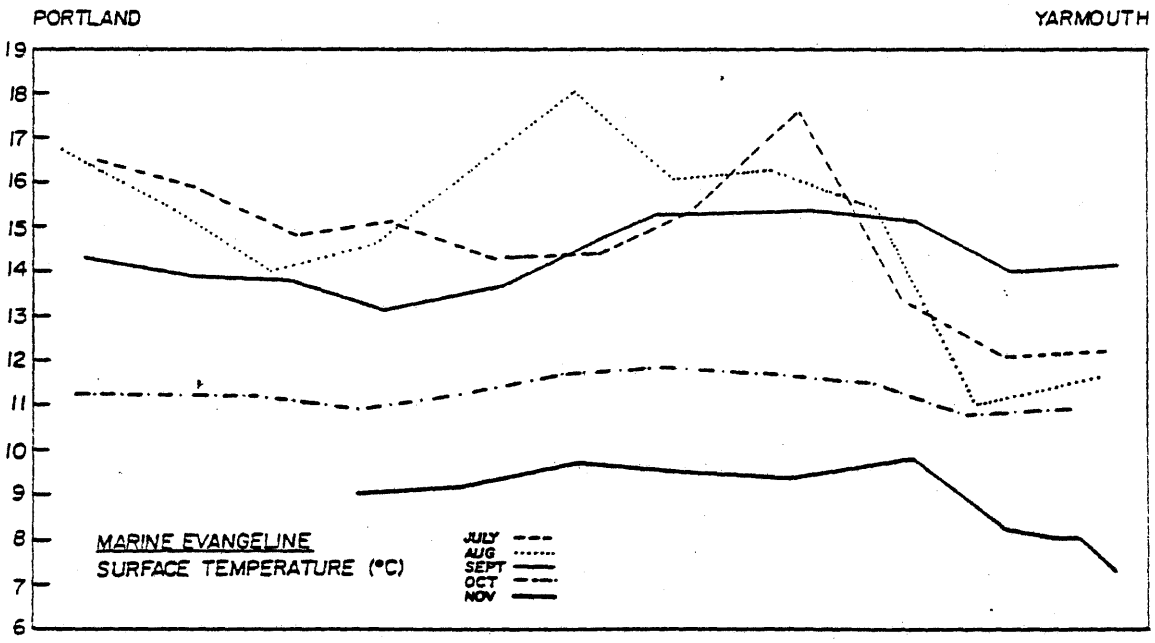
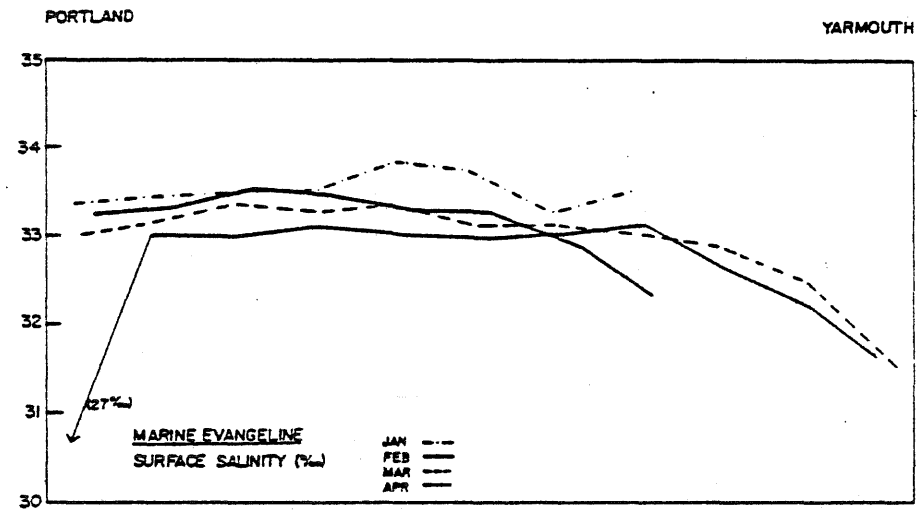
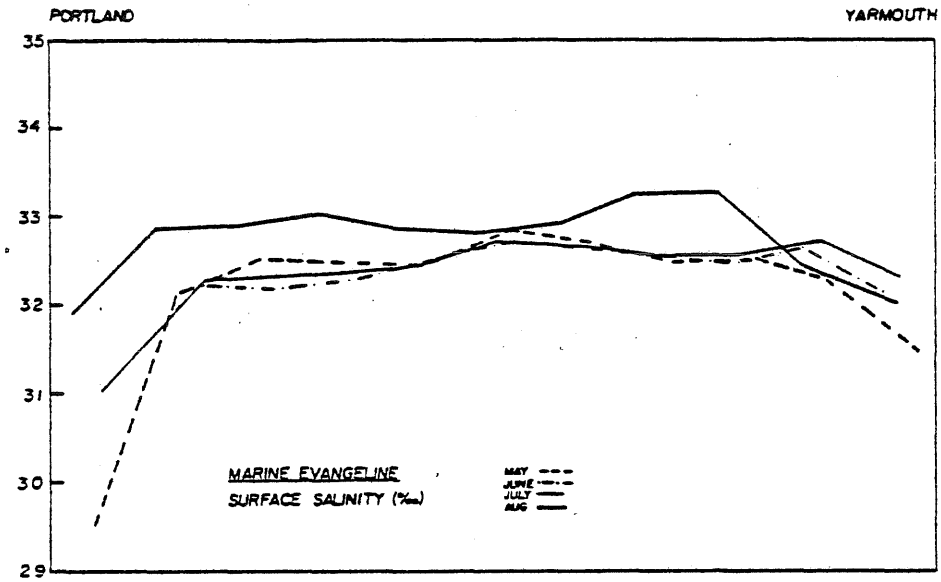

PORTLAND
YARMOUTH
19
18
17
16
15
14
13
12
11
10
9
8
7
6
MARINE EVANGELINE
SURFACE TEMPERATURE (°C)
JULY
AUG
SEPT
OCT
NOV

FIGURE 12


PORTLAND
YARMOUTH
35
34
33
32
31
30
(27‰)
MARINE EVANGELINE
SURFACE SALINITY (‰)
JAN
FEB
MAR
APR


PORTLAND
YARMOUTH
35
34
33
32
31
30
29
MARINE EVANGELINE
SURFACE SALINITY (‰)
MAY
JUNE
JULY
AUG

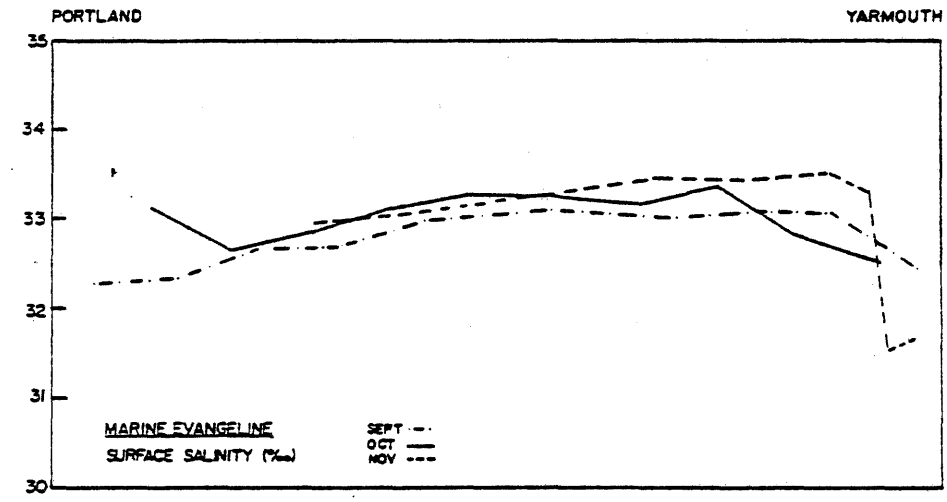

PORTLAND
YARMOUTH
35
34
33
32
31
30
MARINE EVANGELINE
SURFACE SALINITY (‰)
SEPT
OCT
NOV

FIGURE 13