JOINT COMMITTEE ON OCEANOGRAPHY

WINTER OCEANOGRAPHY OF BAYNES SOUND AND THE LAZO BIGHT

By
R.J.Waldie

Pacific Oceanographic Group
Nanaimo, B.C.
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PACIFIC OCEANOGRAPHIC GROUP

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Introduction

Oceanographic investigations were undertaken during the winter of 1950-51 to assist the Groundfish Investigation of the Pacific Biological Station in obtaining information prerequisite to the study of the spawning migrations of lemon soles in the vicinity of Baynes Sound and the Lazo Bight.

The water temperatures have been examined cursorily during the spawning period, but they are not indicative or conclusive of any limited conditions in the spawning areas or of any gradient in conditions toward the areas.

It was required, therefore, to determine if there were gradients in the oceanographic conditions of temperature, salinity, density, and currents which could be considered as directive factors in this migratory study.

The Area

The area, as shown in Figure 1, is located along the eastern coast of Vancouver Island in the northwestern section of Georgia Strait.

Baynes Sound is a narrow trough separated from Georgia Strait by Denman Island and the shallow Comox Bar, over which the average depth is about one fathom. It is approximately 17 miles long and is connected to the strait by a deeper channel in the southern end.

The Lazo Bight is a shallow tongue-shaped depression in the sea floor of the otherwise quite steep coastal slope of Vancouver Island. It is approximately 1 mile wide and 5 miles long and extends northwestward from the lower central portion of the area toward Cape Lazo.

These regions are both submarine valleys having black mud and sand bottoms rich in organic detritus, which indicates that they are protected from strong currents.

Fresh water from land drainage is supplied by the many small creeks and rivers which empty only into Baynes Sound (Figure 1). The Courtenay River, which flows in the head of Baynes Sound, carries much the greatest proportion of fresh water into the system, and the effect of all other streams may be neglected except in the immediate vicinity of their estuaries.

During all surveys the weather was generally mild and overcast with only slight precipitation. Winds were variable, but usually southeasterlies of varying force prevailed.

The Investigation

Synoptic surveys for the investigation of the physical properties of the water were conducted during November, 1950, January and February, 1951, with the assistance of the oceanographic research vessel, C.N.A.V. "EHKOLI", providing data for the description of the winter state.

The February survey was frequently interrupted due to adverse wind conditions, therefore, it cannot be considered as a synoptic survey in the true sense.

All surveys were conducted during spring tides, as shown in Figure 3. The shaded areas represent the duration of daily observations, which were conducted, in general, during periods of minimum variation of tidal height.

The study involved the sampling of a vertical column of water at 38 strategically located stations, eighteen in Baynes Sound and twenty over the Lazo Bight (Figure 2), so as to give both longitudinal and cross-sectional series throughout the entire area. At each position, ten or more samples were obtained from the water column and analysed for the vertical distribution of temperature, salinity, density, and in some cases dissolved oxygen. Continuous temperature measurements were made by bathythermographs. Salinity and dissolved oxygen were determined at sea, using standard procedures.

The November, 1950 survey was conducted with a view to studying the deep structure, and samples were taken at close intervals, and as near the bottom as safety permitted, (0, 10, 20, 30, 35, 40, 44, 47, 49, 50 yards depth). The data from this survey revealed no anomaly in the deep water structure, so the following two surveys were re-organized to provide data for the study of the entire water mass. Samples were taken at discrete depths from the surface to the bottom, with a typical cast being 0, 2, 4, 6, 10, 15, 20, 30, 40, 50 yards, or at as many of these intervals as the depth of water at each station would permit.

The oceanographic observations consisted of time of observation, location, depth in yards, temperature, salinity, dissolved oxygen, weather, wind and state of sea.

Data

The analysis of all data shows that the structure and distribution of the water properties was similar during each survey, although the water temperature was approximately one degree Centigrade colder in each successive survey. On this basis, and for purposes of simplicity, the data from the January, 1951 investigation are presented as being representative of the winter conditions in this region.

The distribution of surface and bottom temperature is shown in plan in Figures 4 and 5, and the corresponding salinity distribution is shown in Figures 6 and 7.

Longitudinal sections of temperature, salinity, and density along the line of stations in Baynes Sound and the centre line of stations over the Lazo Bight are shown in Figures 8 and 9. The corresponding temperature, salinity, and density-depth profiles are shown in Figures 10 and 11. The cross-sections in Figures 12 and 13 represent the distribution of the water properties at the northern and southern extremities of the area.

The concentration of dissolved oxygen was determined at randomly scattered locations throughout the region as illustrated in Figure 14.

The surface and 90 foot vectors for the observed current determinations are shown in Figure 15.

Discussion

1. Temperature

During all surveys, the surface water over the entire area was colder than that of the underlying deep water (Figure 10), with a maximum temperature-depth increase of approximately three degrees Centigrade. The water in Baynes Sound was generally colder by about one degree than the water in the Lazo Bight region (Figures 4 and 5).

The cold surface water in the upper reaches of Baynes Sound (Figure 4) is associated with the fresh water discharge from the Courtenay River. The cold brackish layer flows south in the sound, and depending upon the state of tide and wind, some intrudes into the Baynes Sound waters over the Comox Bar, while the main flow continues south as a tongue of cold water which is evident for some considerable distance along the Denman Island side of the sound.

The waters along the Vancouver Island side of the sound are warmer, at all depths, than those along the Denman Island side (Figures 4 and 5).

This is probably due to upwelling of the deeper warmer water along this shore in consequence of the prevailing southeasterly winds.

The vertical structure shown in Figure 10 consists of a cold, nearly isothermal surface layer extending to a depth of about 10 feet, which is associated with surface cooling and indicates the depth of wind mixing. Below this layer a thermocline of one degree temperature increase extends to about 30 feet depth, while in the deeper water the temperature increase is very small to an almost constant value at the bottom (Figures 5 and 8).

The surface water in the Lazo Bight region was about one degree warmer than that in Baynes Sound. In general, there is a tendancy toward the formation of a warm-water surface cloud in the northern part of the area, with the colder surface water being confined along the Denman Island shore and in the area just north of Hornby Island (Figure 4). The temperature of the deep bottom water, particularly in the immediate vicinity of the Lazo Bight (Figure 1), is practically constant, but to the east, or seaward from this area, the temperature increases slightly with the fall of the coastal slope (Figure 5).

It is evident from the vertical temperature structure shown in Figure 11, that the maximum temperature difference from surface to bottom is 0.8°C. There is an isothermal surface layer to a depth of about 40 feet, below which the temperature increases very gradually to the constant values in the deeper water as shown in Figures 5 and 9.

2. Salinity

The water in Baynes Sound is considerably less saline than the water in the adjacent Lazo Bight region. There is appreciable vertical structure but very little horizontal salinity variation in Baynes Sound, while the Lazo Bight region is devoid of salinity gradients or structure of any kind.

The low surface salinity water evident in the upper reaches of Baynes

Sound is attributed to the fresh water discharge from the Courtenay River, which flows out over the underlying sea water and mixes with it to form a brackish upper zone about 30 feet deep. This upper zone persists for some distance to the south along the Denman Island side of the sound as shown in Figure 6. As this upper zone, which contains the river water moves seaward, it gets progressively more saline as additional sea water is entrained, and its identity is finally lost in the lower reaches of the sound. The structure of this zone is clearly shown in Figure 10, where it may be noted that the salinity increases by variable gradient to about salinity 26.7 °/oo at a depth of approximately 30 feet, where it intercepts the more uniform gradient of smaller slope denoting the lower zone. In this lower zone, the salinity increases regularly with depth to an almost constant value in the bottom waters (Figure 7).

In the Lazo Bight region, localized areas of low surface salinity are sometimes evident when the brackish upper zone water from Baynes Sound flows out across the Comox Bar, but in general the distribution of surface salinity during this winter period was found to be as shown in Figure 6, with the area of higher surface salinity being in the northern section, and that of lower surface salinity along the Denman Island shore and in the southern section. The salinity of the deep bottom water is almost constant throughout the entire area, particularly in the immediate vicinity of the Lazo Bight (Figure 7), and increases gradually to the east or seaward down the coastal slope as did the temperature.

It may be noted from the vertical structure in Figure 11, that the increase in salinity with depth is very slight. There is an isohaline surface layer to a depth of about 50 feet, below which the salinity increases gradually with depth to a constant value in the deep zone (Figures 9 and 11).

3. Density

During all surveys, the density closely approximated the salinity distribution which may be regarded as being qualitatively synonymous.

The low density of the Courtenay River water contributes to the formation and stability of the upper zone evident in the northern part of Baynes Sound, and in the winter, when this zone is colder than the underlying deep water, the low salinity (salt content) controls its density and ensures that it will float in the sea water (Figures 8 and 10).

There is no distinct upper zone present in the Lazo Bight waters and it is evident from Figure 11 that the increase in density with depth is very slight. Under these conditions the stability is much reduced and strong winter winds may cause mixing to some considerable depth.

4. Dissolved Oxygen.

In general the dissolved oxygen concentration in both areas decreased regularly with depth from saturation at the surface to between 50% and 60% of saturation at the bottom. In Baynes Sound there was a small area of supersaturation in the central region, and in the Lazo Bight area there was some evidence of supersaturation at the southern limits. In both regions the high oxygen concentrations occurred in the upper 30-50 feet of the water column as shown in Figure 14.

These occurrences cannot be explained from the data, but may be associated with the history of the water mass.

5. Currents

Current observations were conducted at Station B and D in Baynes Sound and at Station 8 in the Lazo Bight region on February 17 and 18, 1951. Current drags were constructed from a pair of sheet-metal vanes about 18 x 24 inches set at right-angles and suspended on a line which passed through the centre of an ellipsoidal metal buoy. Two current drags were released on four occasions to obtain a direct measure of the current velocity at the same time as obtaining several serial stations. One drag was set with its vanes at a mean depth of about 1 1/2 feet below the surface, while the other was set at a depth of 90 feet.

The procedure was to release the two drags before starting to occupy a group of stations e.g. a 3-station cross-section, and to recover them on completion of these stations. The progress of the floats during this interval was taken as an indication of the velocity of the current at the two depths.

From the observed currents as shown in Figure 15, it is evident that the principal movement in Baynes Sound was to the south or seaward with a velocity of approximately 0.4 knots, while in the Lazo Bight region it was westward or anti-clockwise around the area with a belocity of approximately 0.1 knots.

These data are not adequate for a discussion of the circulation in this region, but indicate that the currents are very weak and probably variable, as the entire region is influenced by the reversing tidal currents in Georgia Strait.

Conclusions

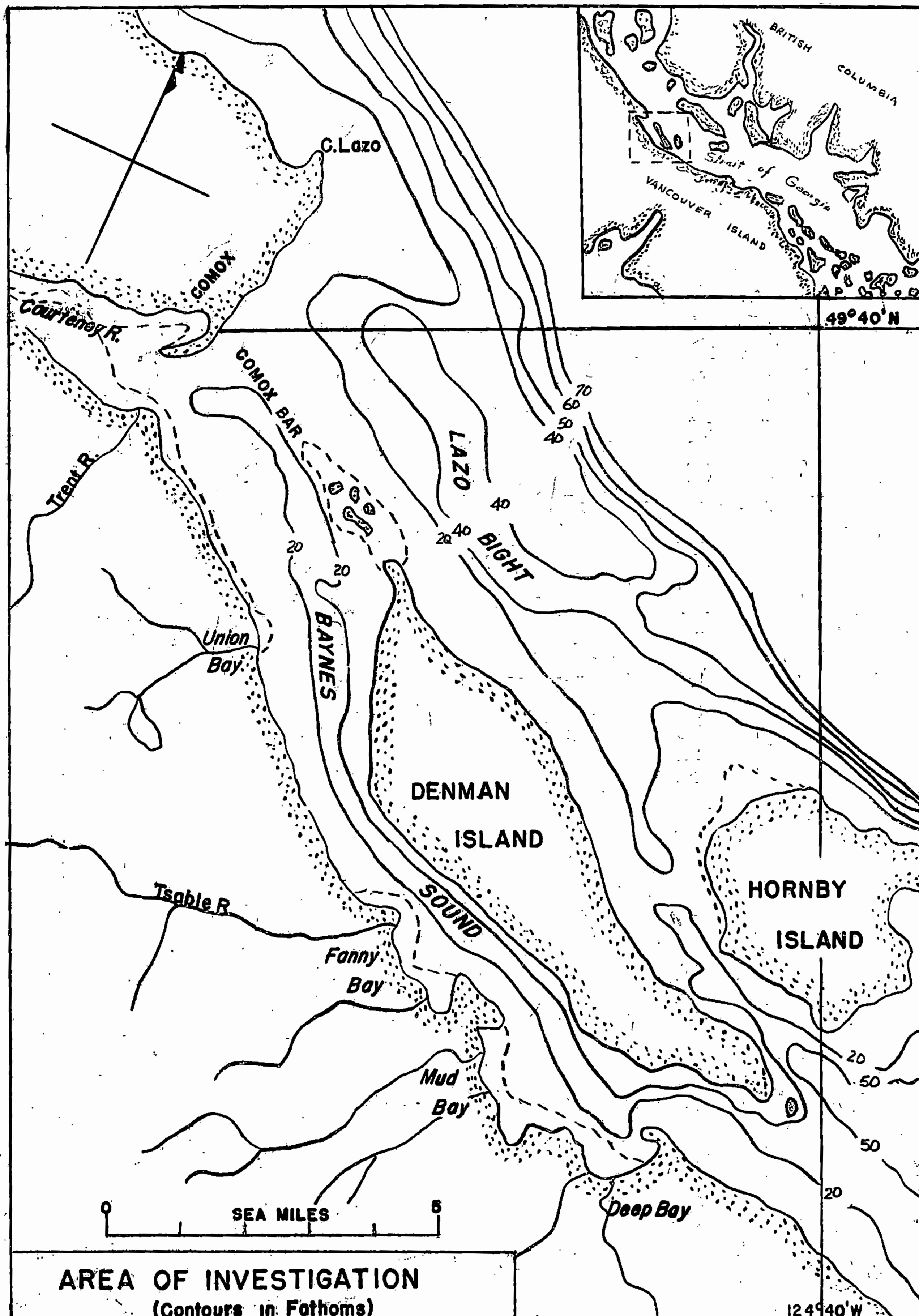
1. There is appreciable vertical structure but very little horizontal variation in Baynes Sound (Figure 10), while in the Lazo Bight area the distribution of properties is almost uniform (Figure 11).

During the winter season of 1950-51, the temperature and salinity of the waters in Baynes Sound varied between 5.8°C (42.5°F) and 25.0 °/₀₀ salinity at the surface to 7.8°C (46.0°F) and 28.5 °/₀₀ salinity at the bottom. In the

Lazo Bight region the variation was from 7.0°C (44.5°F) and 27.0 ‰ salinity at the surface to 8.4°C (47.0°F) and 30.0 ‰ at the bottom.

2. There was no evidence of oxygen depletion in any of the waters.

3. Current velocities and water movements are small.



AREA OF INVESTIGATION
(Contours in Fathoms)

Figure 1.

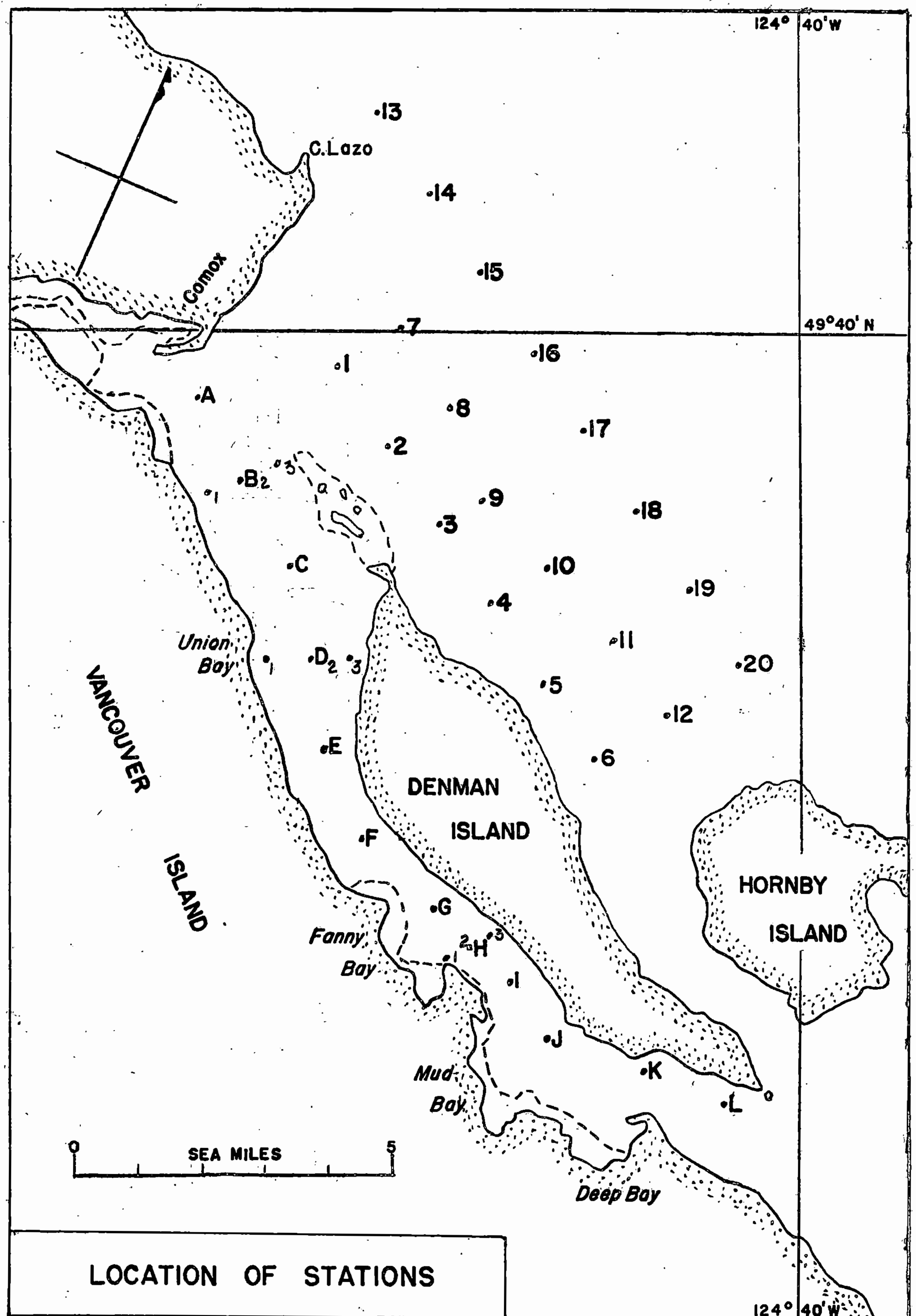
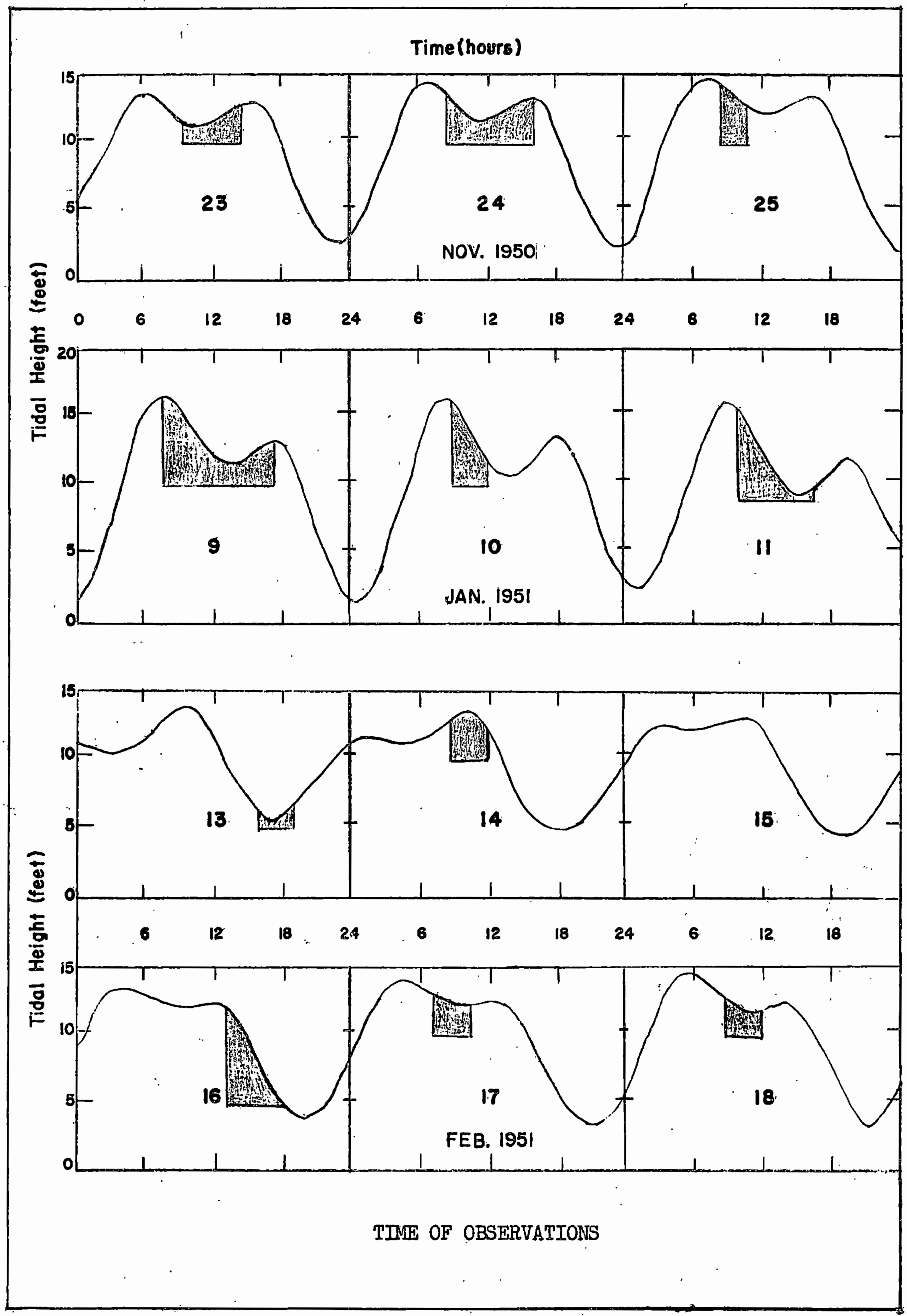
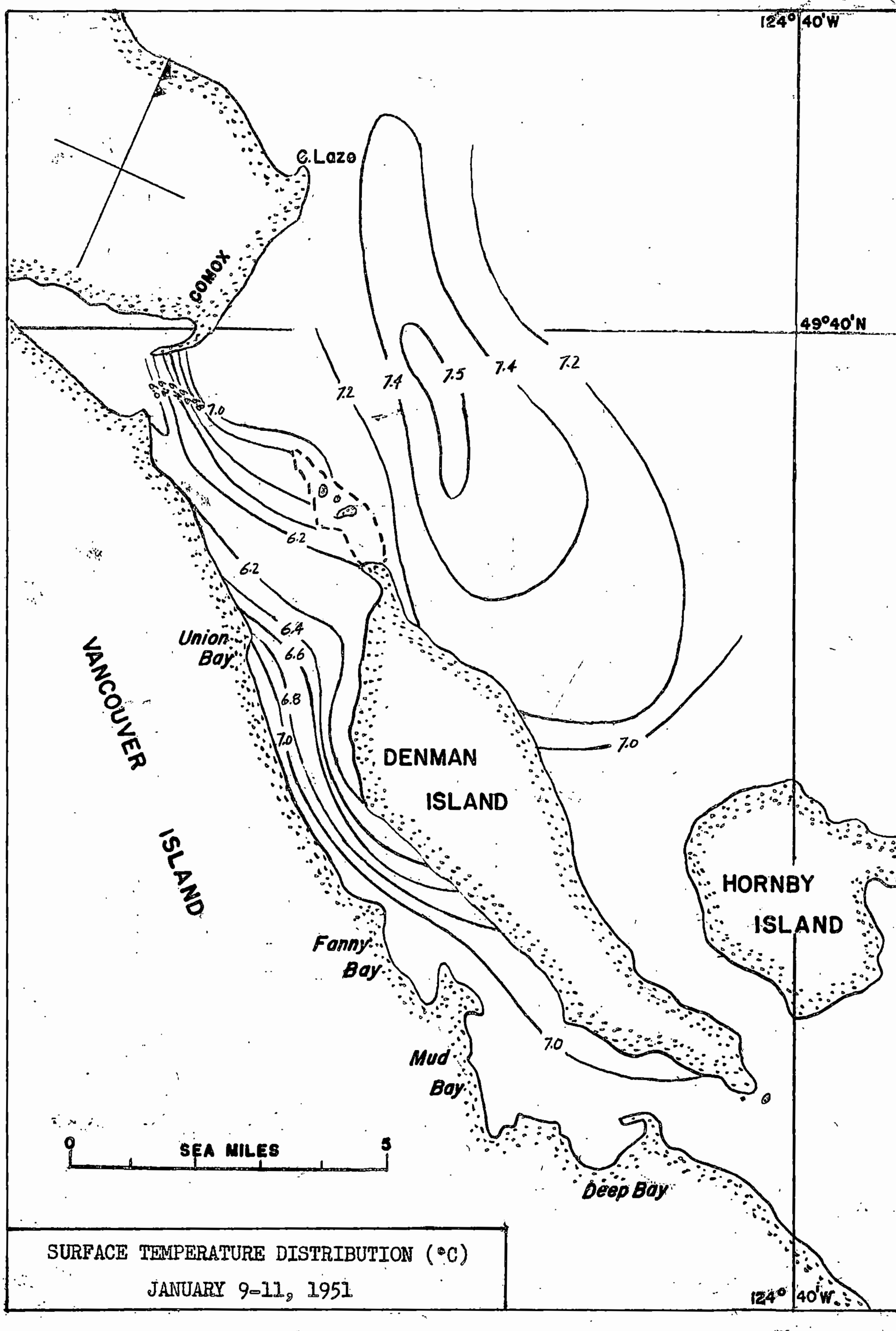

124° 40'W
49°40' N
C.Lazo
Comox
13
14
15
7
16
1
A
8
17
2
B2
18
9
3
C
10
19
4
11
20
Union Bay
D2
5
12
VANCOUVER ISLAND
E
6
DENMAN ISLAND
F
HORNBY ISLAND
G
Fanny Bay
H
I
J
K
Mud Bay
L
SEA MILES
0
5
Deep Bay
LOCATION OF STATIONS
124° 40'W

Figure 2.



Time(hours)
Tidal Height (feet)
NOV. 1950
23
24
25
JAN. 1951
9
10
11
FEB. 1951
13
14
15
16
17
18
TIME OF OBSERVATIONS

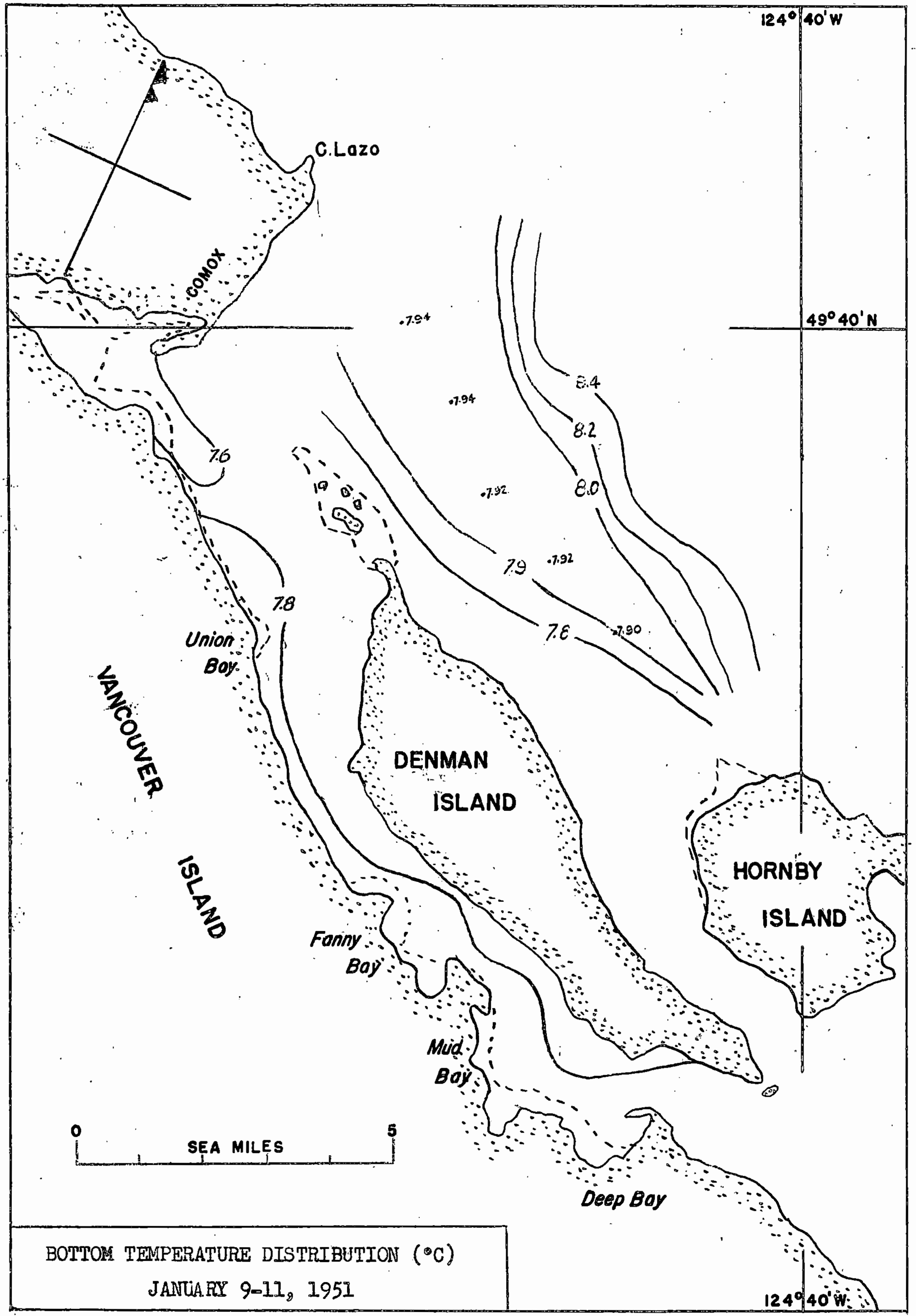
Figure 3.



SURFACE TEMPERATURE DISTRIBUTION (°C)

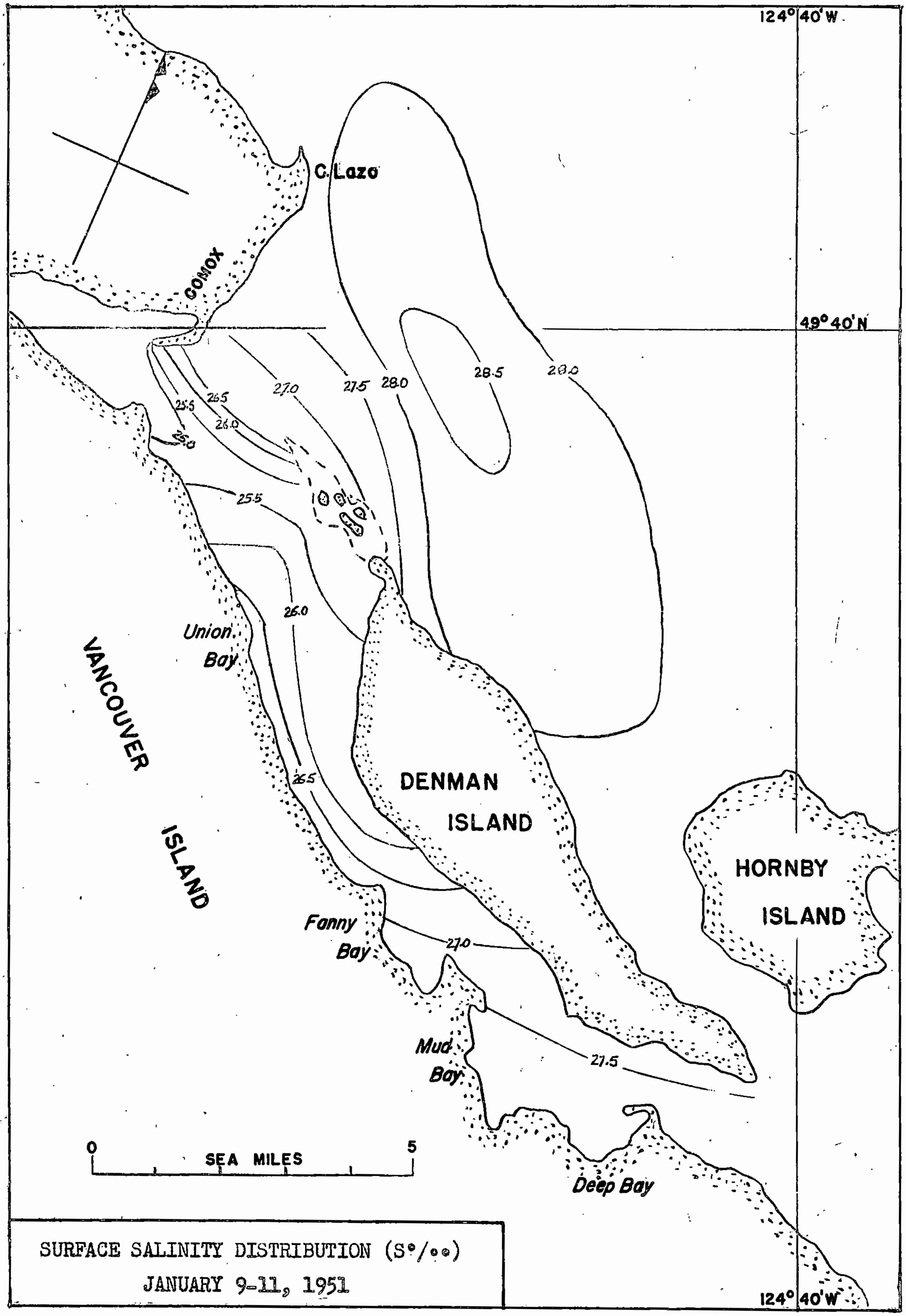
JANUARY 9-11, 1951

Figure 4.



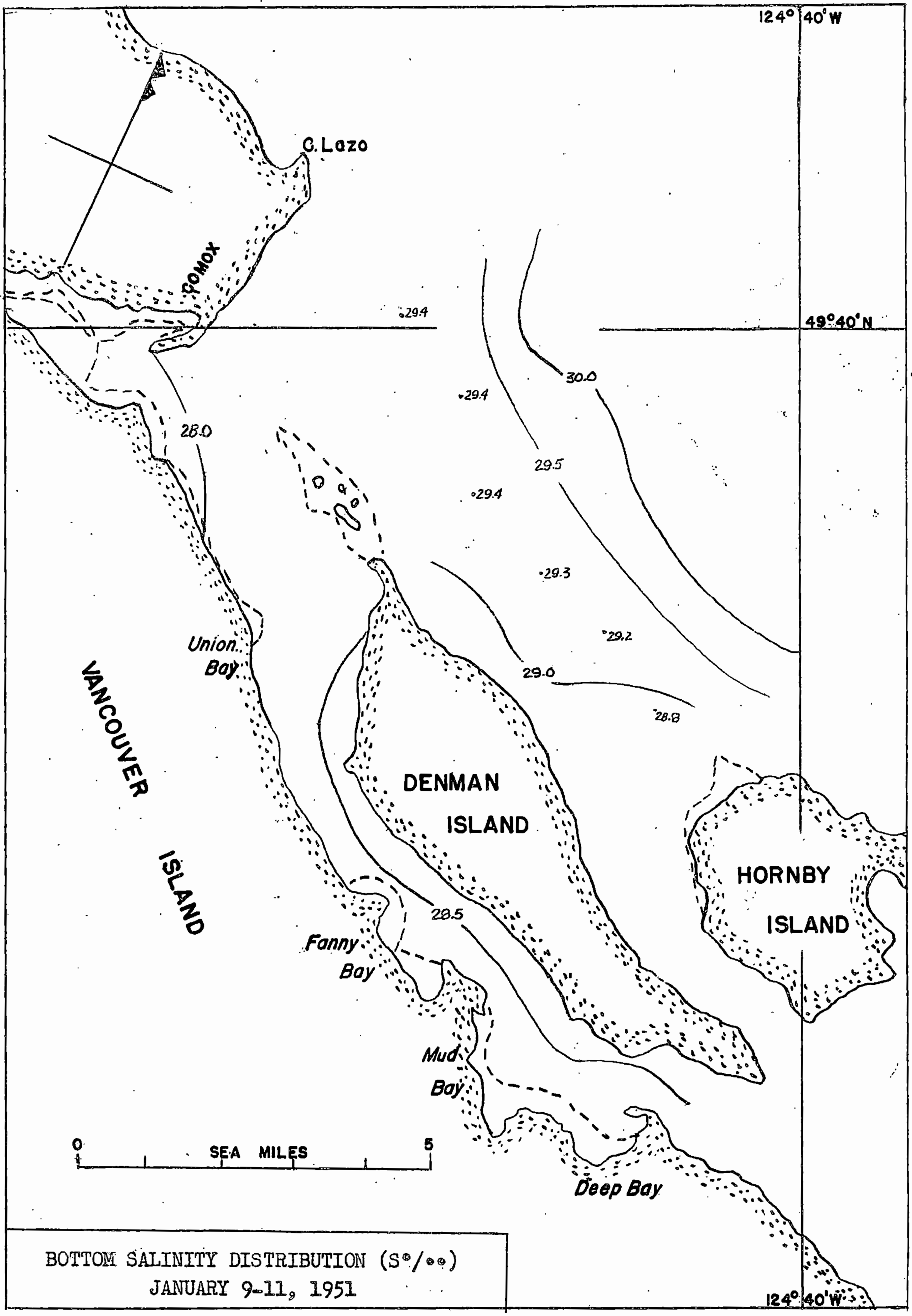
BOTTOM TEMPERATURE DISTRIBUTION (°C)
JANUARY 9-11, 1951

Figure 5.



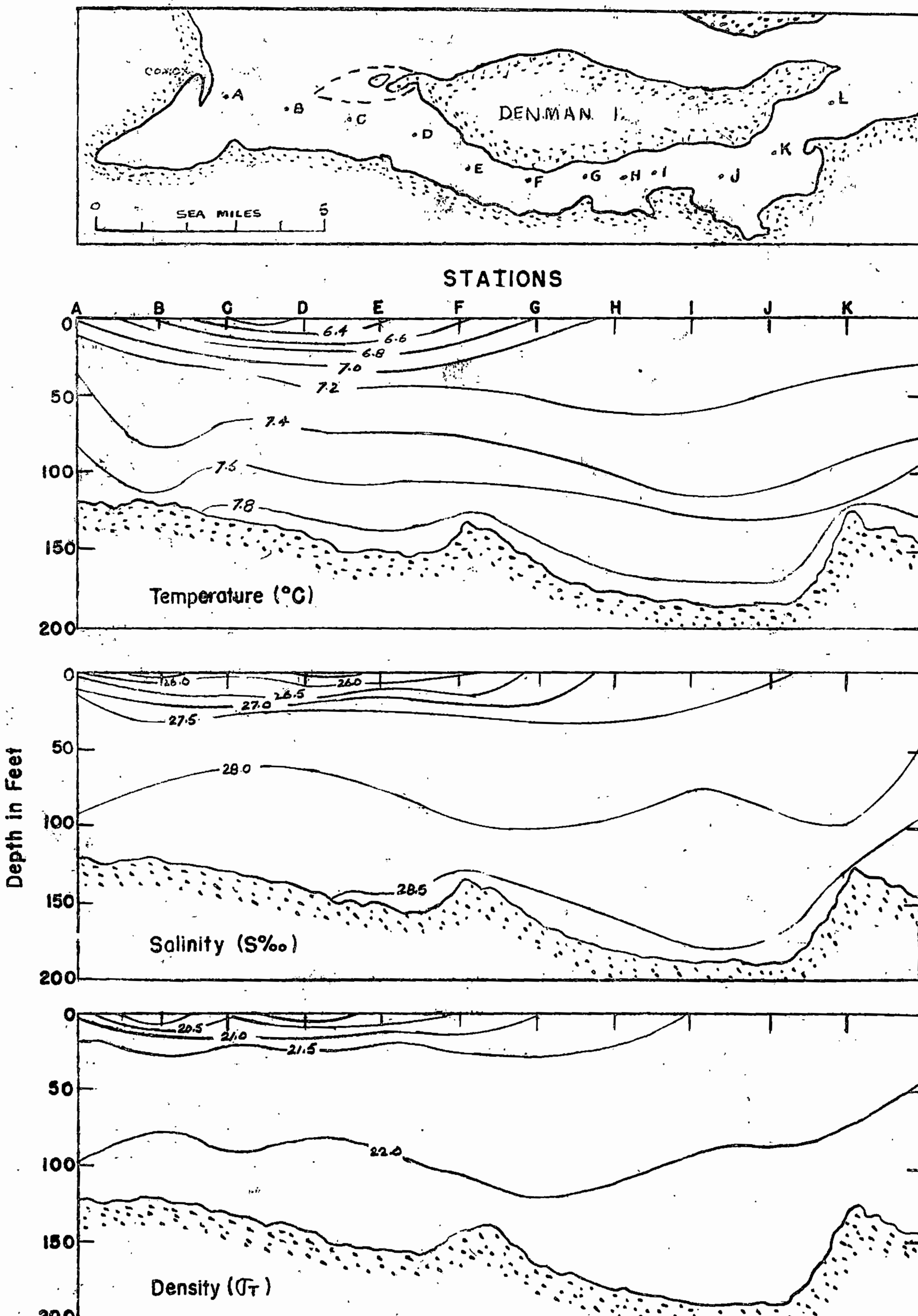
SURFACE SALINITY DISTRIBUTION (S°/oo)
JANUARY 9-11, 1951

Figure 6.



BOTTOM SALINITY DISTRIBUTION (S°/°°)
JANUARY 9-11, 1951

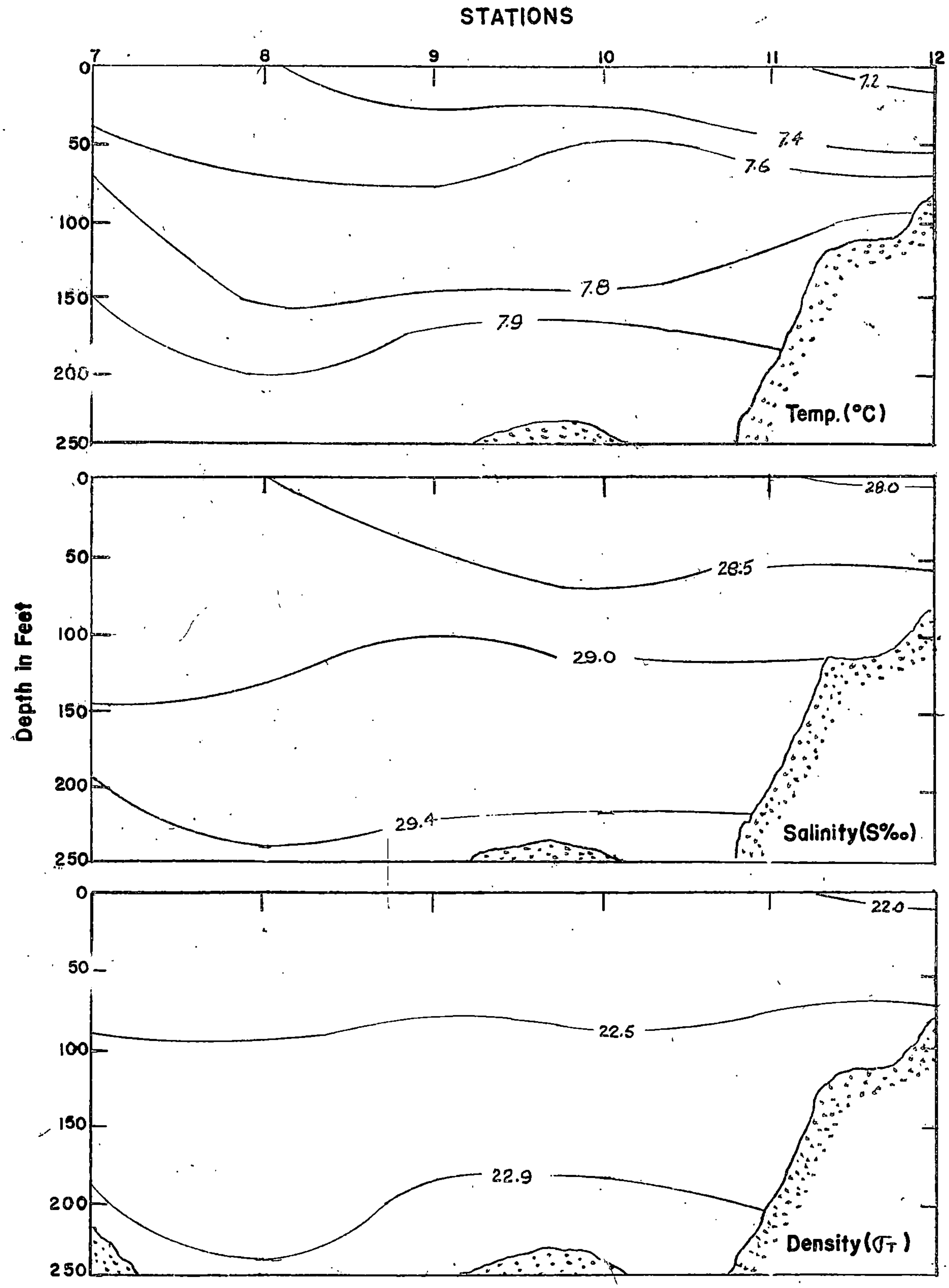
Figure 7.



LONGITUDINAL SECTION THROUGH BAYNES SOUND

JANUARY 9-11, 1951

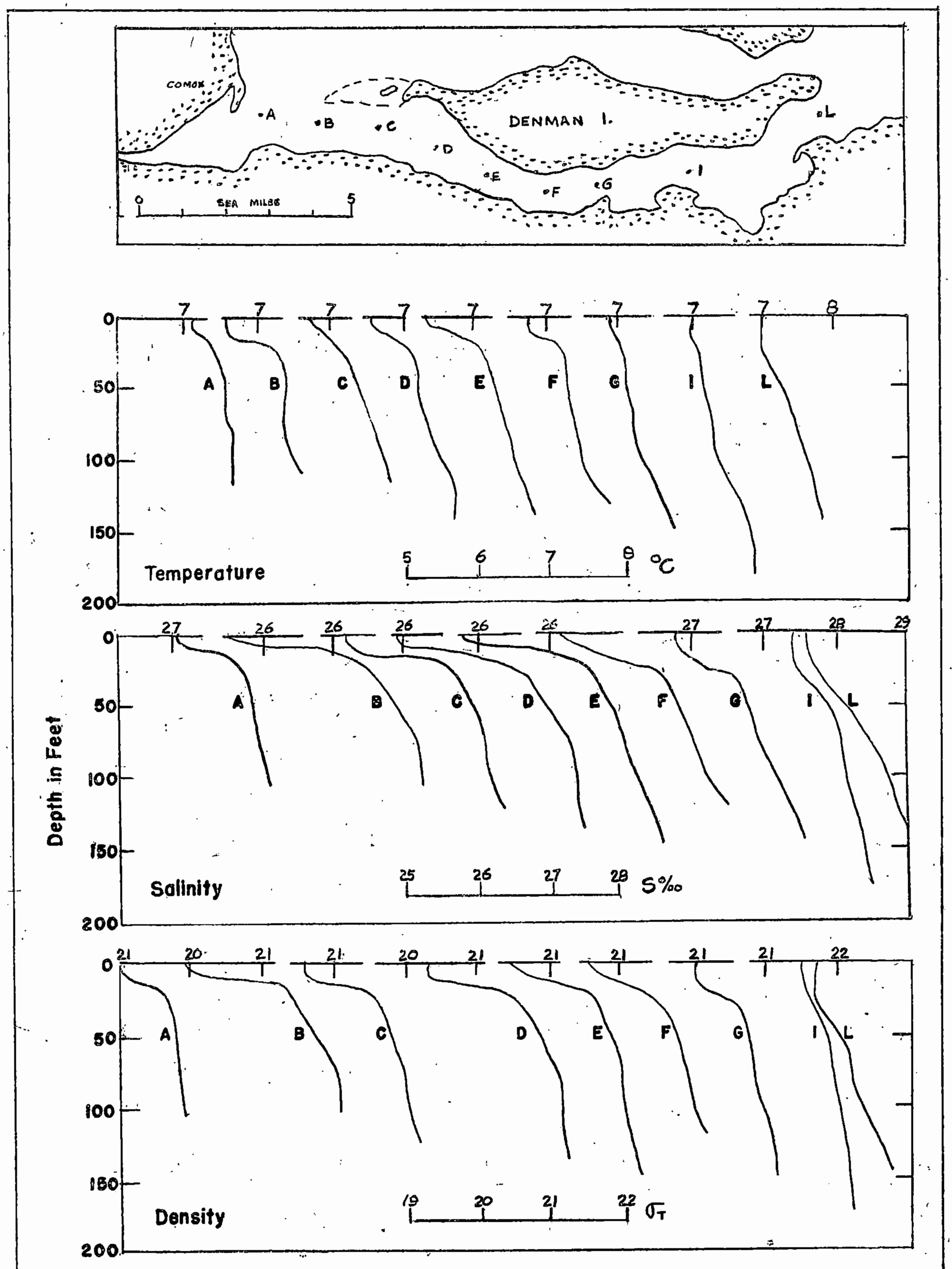
Figure 8.



LONGITUDINAL SECTION THROUGH MIDDLE LINE OF

STATIONS IN LAZO BIGHT REGION - JANUARY 9-11, 1951

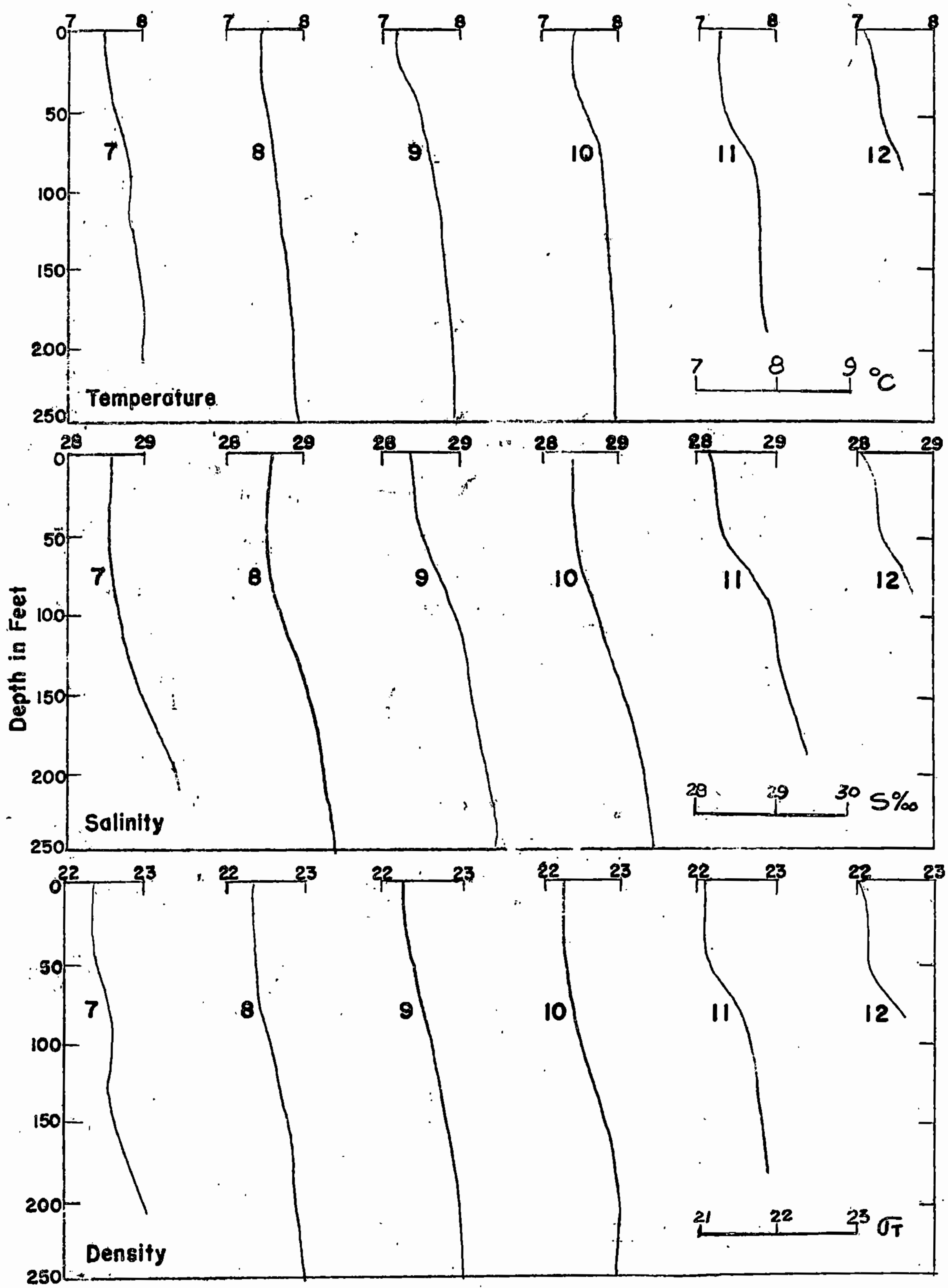
Figure 9.



VERTICAL DISTRIBUTION OF PROPERTIES IN BAYNES SOUND

JANUARY 9-11, 1951

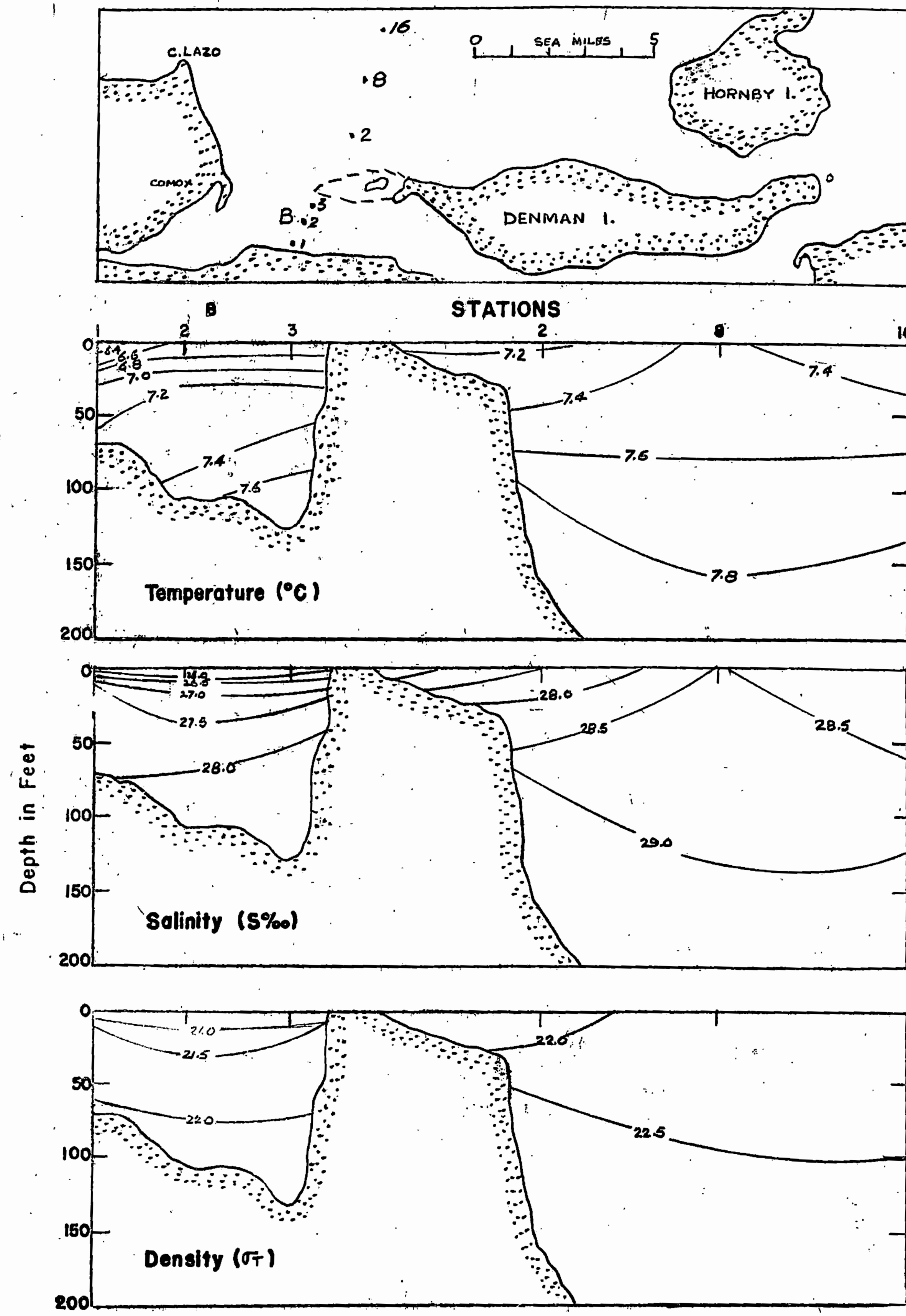
Figure 10.



VERTICAL DISTRIBUTION OF PROPERTIES ALONG MIDDLE LINE

OF STATIONS IN LAZO BIGHT REGION - JANUARY 9-11, 1951

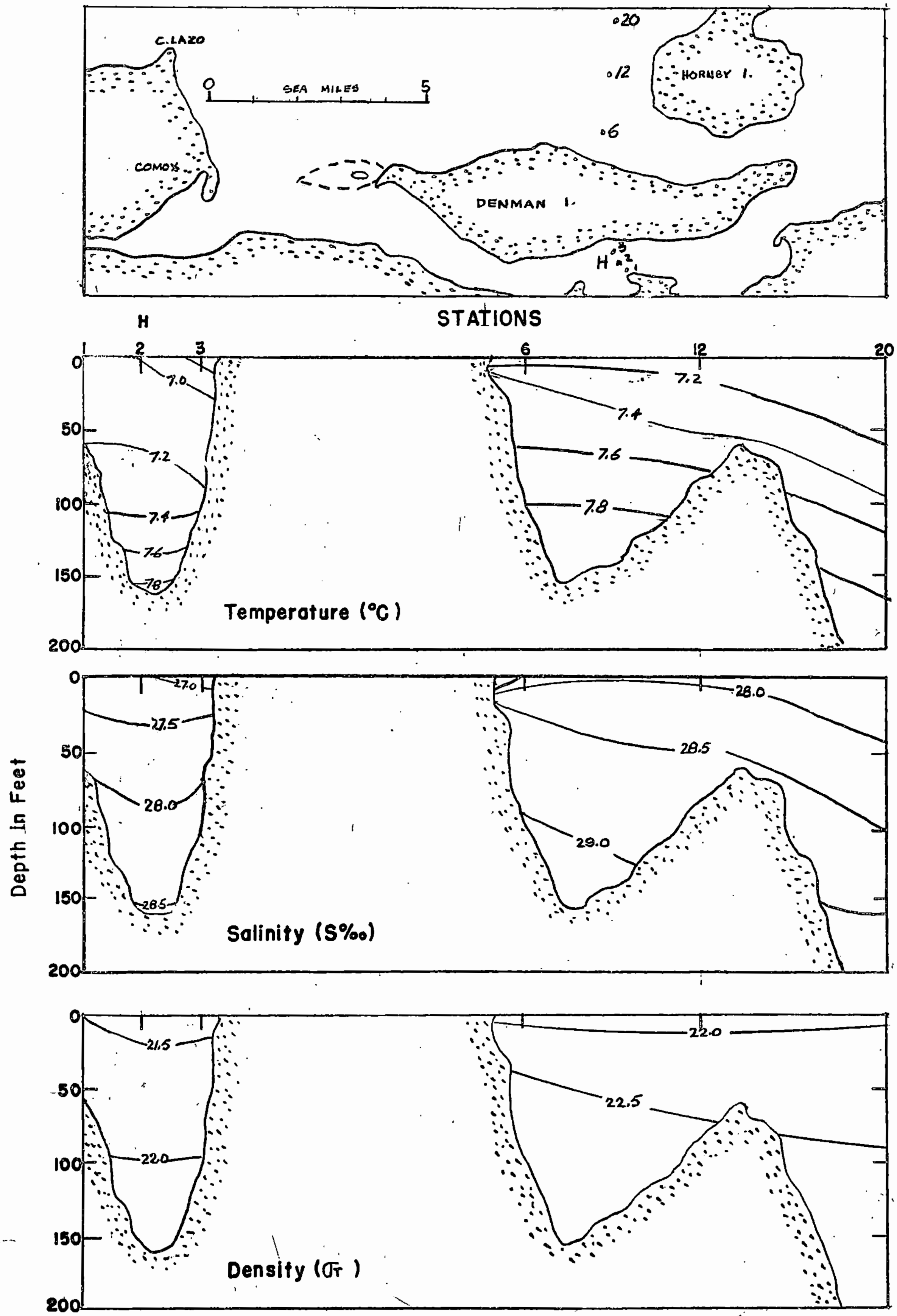
Figure 11.



CROSS SECTION THROUGH NORTHERN PART OF AREA

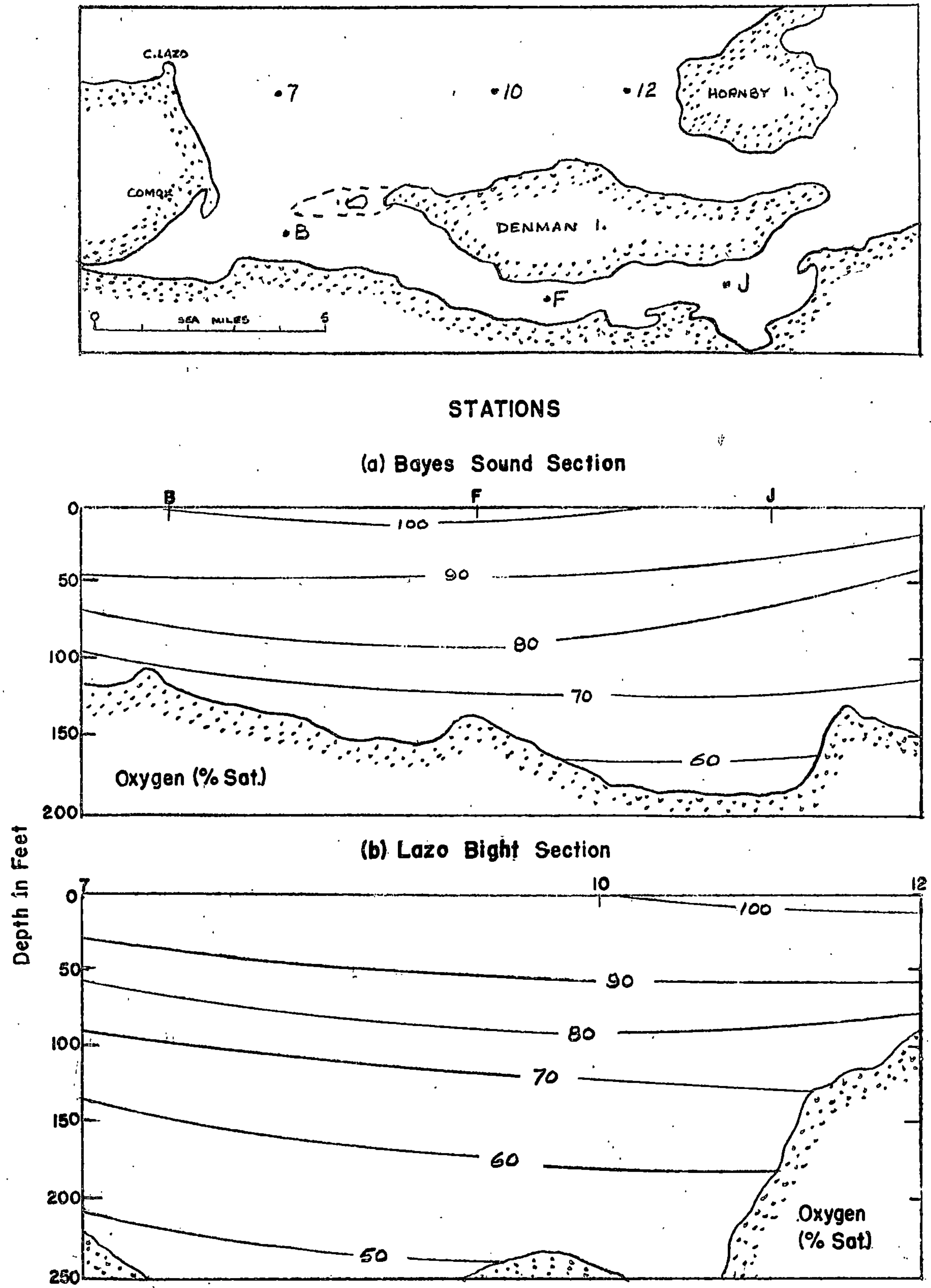
JANUARY 9-11, 1951

Figure 12.



CROSS SECTION THROUGH SOUTHERN PART OF AREA
JANUARY 9-11, 1951

Figure 13.



DISTRIBUTION OF DISSOLVED OXYGEN

JANUARY 9-11, 1951

Figure 14.

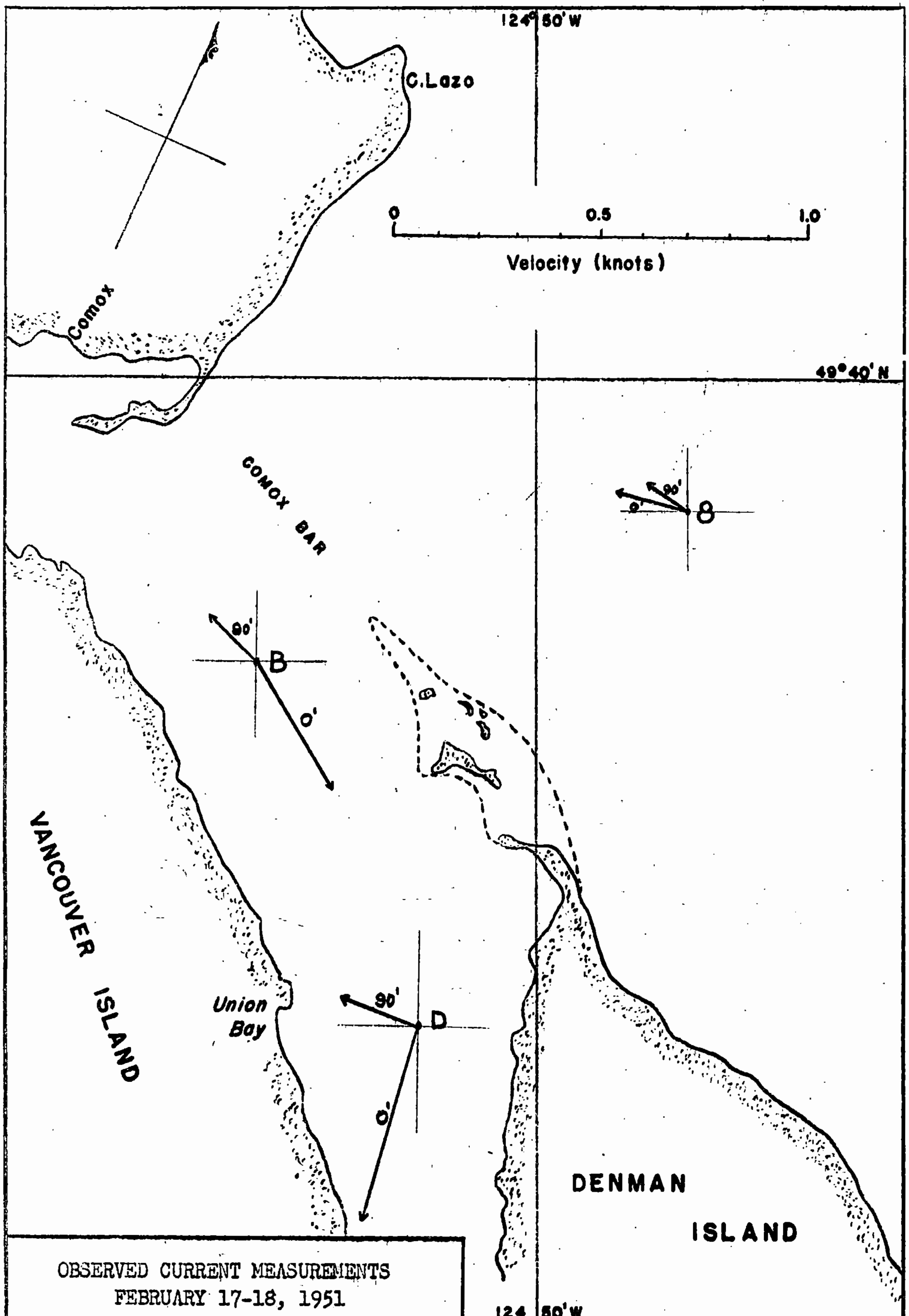

124° 50' W
C.Lazo
0
0.5
1.0
Velocity (knots)
Comox
49° 40' N
COMOX BAR
90'
0'
8
90'
B
0'
VANCOUVER ISLAND
Union Bay
90'
D
0'
DENMAN ISLAND
OBSERVED CURRENT MEASUREMENTS
FEBRUARY 17-18, 1951
124 50' W

Figure 15