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Observations of Currents and Water Properties in Puget Sound, 1972

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OBSERVATIONS OF CURRENTS AND WATER PROPERTIES IN PUGET SOUND, 1972

Glenn A. Cannon and Norman P. Laird

Description is given of the experiment and the current measurements and STD observations made in Puget Sound in February 1972, a particularly cold winter in Puget Sound. Mean flow was observed to reverse from northerly in the surface water to southerly in the deep water at a depth near 50 m, the approximate bottom of the pycnocline. Significant concentration of kinetic energy at the lunar semidiurnal tidal frequency was observed at 41 m in the pycnocline. Relatively large temperature fluctuations which decayed with time and then were absent were observed.

1. INTRODUCTION

During 1972 the Pacific Oceanographic Laboratories (POL) commenced an experimental program to study the dynamics of the Puget Sound system. Experiments to investigate the characteristics of the mean circulation averaged over several tidal cycles and variations caused by important external parameters, such as tide and tidal current, river runoff, winds, and changes in oceanic conditions outside the estuary, are underway or are planned. Initial emphasis is on the direct measurement and description of the horizontal, vertical, and temporal distribution of the mean currents through use of unattended, moored arrays of instruments. These data also will be used to test and refine existing mathematical models appropriate to describe the mean circulation in Puget Sound. This report is intended to provide an initial summary of the experiment and data of February 1972 which may be useful to others.

2. EXPERIMENT DESCRIPTION

A subsurface current-meter mooring was deployed in the central basin of Puget Sound midway between West Point and Point Jefferson in 190 m of water (mean water depth) on 31 January (fig. 1). The mooring was maintained throughout February and was retrieved on 2 March. The location was chosen based on previous, but somewhat limited, studies indicating the two-layer mean flow structure in the region (Barnes, 1953; Collias, 1963). Two kinds of rotor-vane internally recording current meters were used: Braincon meters (model 381), which record on film continuous samples of averages of speed and histograms of direction, and Anderaa meters (model RCM4), which record on magnetic tape continuous samples of averages of speed and instantaneous readings of direction, temperature, and, on one meter pressure. All meters had 10-min sampling intervals. Both types of meters have relatively large vanes making them fairly insensitive to high-frequency direction fluctuations, and in both, the vane and case are free to swivel about the main support rod which is an integral part of the mooring. Table 1 summarizes the distribution of instrumentation on the mooring. Mean depths are given. Buoyancy was provided by two 0.91 m diameter steel spheres (surplus submarine net floats, each providing about 325 lbs, 148 kg, buoyancy shackled together at the top of the mooring. Meters were connected using 1/4-in (6.35 mm) torgue-balanced 3x19 cable, 1/2-in (12.7 mm) shackles, and one swivel (in addition to the meters themselves) with each piece of cable. The mooring was deployed buoy first from the NOS ship McARTHUR, and after streaming it out from the

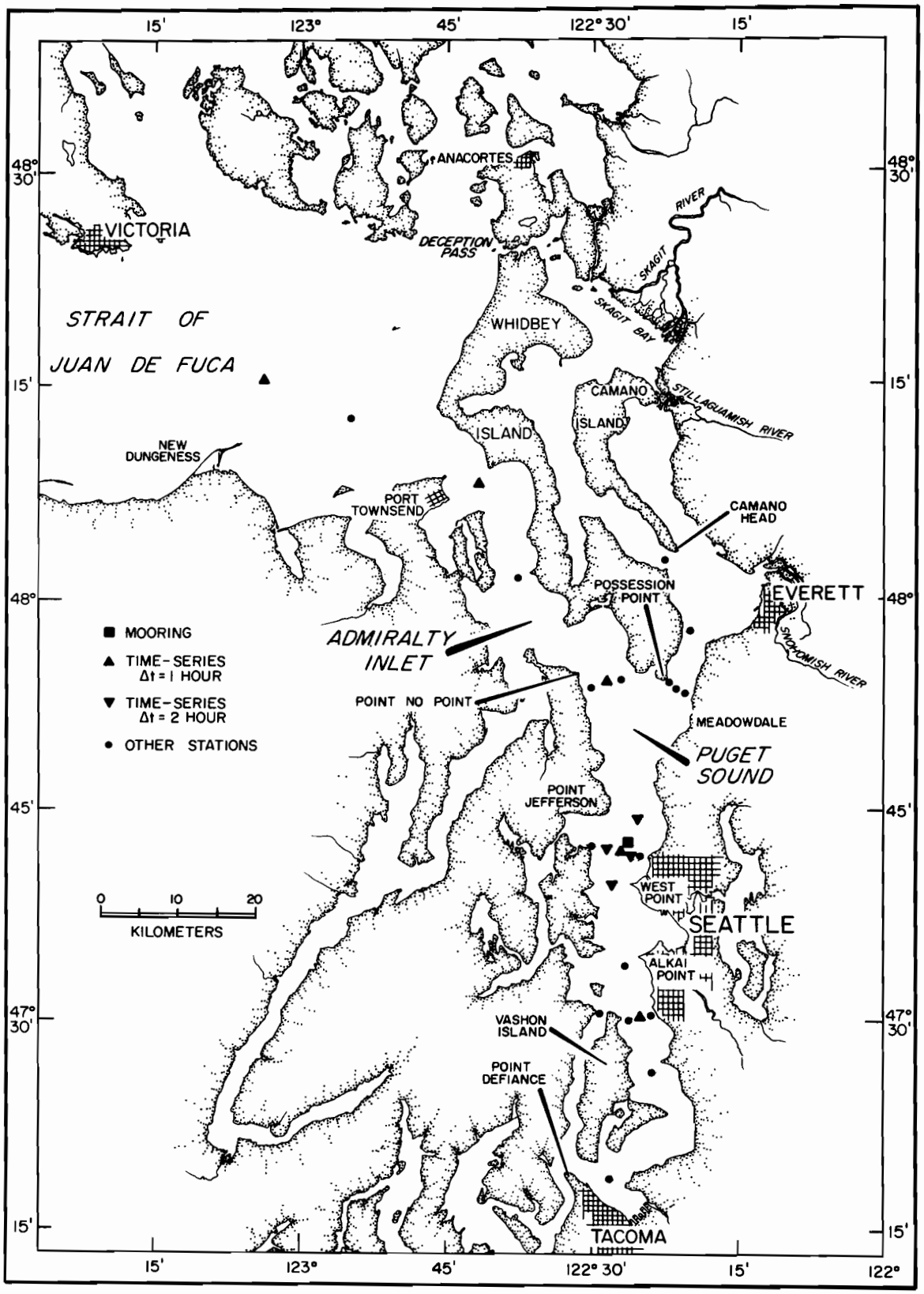


Figure 1. Puget Sound region showing station locations. Scale is about 1 : 8 x 10^5.

Table 1. Summary of Mooring Instrumentation

Meter (#)	Depth (m)	Variables	Length of Records (# points)	(hrs)	Start Times (PST 31 Jan)
A352	16	C,T,P	4468	745	1220
B074	41	C	4008	668	1310
B118	67	C	3754	626	1310
A348	90	C,T	4480	747	1220
B132	127	C	3143	524	1310
A346	171	C,T	----	---	----
B129	187	C	----	---	----

Note: A or B with meter numbers signifies Aanderaa or Braincon, respectively. Variables C, T, and P signify currents, temperature and pressure, respectively. Sampling interval was 10-min.

ship, the anchor (two railroad wheels, total weight about 1500 lbs, 680 kg) was dropped from just beneath the surface. The topmost part of the mooring was about 9 m below the surface at mean lower low water. The mooring was retrieved by acoustic release (AMF, model 242) of the anchor.

A slight premature release of the anchor during deployment resulted in the vane of the bottom Braincon meter being sheared and the inverting of the bottom Aanderaa meter destroying its rotor. This damage, plus internal malfunctions, resulted in no data from the bottom two current meters. In future experiments with these relatively large vane meters, the anchor may be lowered with a pelican hook release all the way to the bottom. This technique of streaming the mooring buoy first from an anchored ship and then lowering the anchor has proved most satisfactory in the past.

A survey of water properties in Puget Sound was made subsequent to deployment of the mooring using a salinity-temperature-depth (STD) recorder (Bissett-Berman, Model 9006) (fig. 1). Stations were occupied to within a few meters of the bottom by use of a Hydro Products pinger attached to the STD. Data were recorded both on a digital data logger and on an analog recorder. Sufficient Nansen bottle samples were obtained to calibrate the STD. The survey commenced near Tacoma and ended off New Dungeness requiring about 19-20 hrs. The occupied stations were chosen because of the existing data base obtained at these sites by the University of Washington on a tri-weekly interval during the previous 2 yrs (Lincoln and Collias, 1970). Following the general survey, time-series stations of hourly STD's were made for the remainder of the first week and all of the second week (fig. 1). During the fifth week before retrieving the mooring, the general survey and the time-series stations near the mooring and near Port Townsend were repeated. Table 2 summarizes the STD data. As far as we know, these are the most comprehensive STD data obtained from the main basin of Puget Sound.

Auxiliary tide, wind, and runoff data were obtained simultaneously by other organizations and have been made available to us. Tides measured at Meadowdale and Point Defiance and winds measured at West Point were part of a University of Washington (UW) program (Lincoln and Collias, 1970). Tides have been monitored at Seattle by NOS since before 1900. Runoff has been monitored regularly by the U.S. Geological Survey. Additionally, the UW and POL deployed two arrays of thermistors about a week before the retrieval of our mooring. These arrays were

Table 2. STD Summary

Stations (name)	Start-Stop Times (hr,month,day)	Time-Series Interval (hrs)	Number of Stations
General Survey	1730 I31-1230 II 1	-	25
New Dungeness	1200 II 1-1200 II 2	1	24
Port Townsend,1	1400 II 2-1400 II 3	1	24
Point No Point	1600 II 3-1200 II 4	1	21
Vashon Island	1000 II 7-1000 II 8	1	24
Mooring,1	1200 II 8-1200 II 9	1	24
Mooring (east)	1300 II 9-1100 II10	2	12
Mooring (west)	1400 II 9-1200 II10	2	12
Point Jefferson	1400 II10-1200 II11	2	12
West Point	1500 II10-1300 II11	2	12
General Survey	1300 II28-0930 II29	-	25
Port Townsend,2	1100 II29-1100III 1	1	24
Mooring,2	1400III 1-1400III 2	1	24

mooring and near the Vashon Island STD time-series station, and they were maintained for about a month to test the respective equipment. They will not be discussed here.

3. DATA REDUCTION AND PRESENTATION

The Braincon current-meter data were read from the films, digitized, and processed using a data reduction program developed at UW (Hopkins, 1971). The average speed is calculated from the number of rotor revolutions during each 10-min sampling interval, and the direction is chosen as the most frequently occurring direction during each interval. The digitizing process results in a current speed resolution of about $\pm$ 0.3 cm/s. The Aanderaa current-meter data were first translated by the manufacturer and then processed by the UW program. Average speed is determined similarly to the Braincon's, and direction, temperature, and pressure are sampled once during each sampling interval. Digitizing

results in a current speed resolution of about ± 0.2 cm/s, a temperature resolution of about ± 0.02 °C, and a pressure resolution corresponding to about ± 13 cm of water. Calibration curves for the meters were taken from combined sources provided by the manufacturers and those performed by POL and UW in the Bonneville Power Commission tow tank (Braincon meters) and in the Chesapeak Bay Institute circulating test flume (Aanderaa meters). The resulting current-meter data consisted of time series of speed and direction (to which the current is flowing) at 10-min intervals.

The STD data were recorded digitally once per second while the instrument was lowered at a rate of about 30 m/min; thus data were obtained about every half meter of depth. Nansen bottle samples were used to determine corrections of + 0.02 °/oo and - 0.04 °C to salinity and temperature, respectively, for the entire cruise. The data were translated, edited, corrected, and interpolated to provide values of temperature, salinity, and sigma-t (σ_t) at 5-m intervals at UW facilities. Linear interpolations for temperature and salinity were made at the first intersection of a depth. Sigma-t was computed from the interpolated temperature and salinity. These data were used for all subsequent work.

The following presentations of the data have been selected as being the most descriptive for a wide variety of users. Presentation of the current-meter data are grouped so the user may assess variations through-out the water column by examining one kind of information from all instruments. Presentations of the water properties are grouped so the user may assess changes that occurred during the month interval.

3.1 Histograms

The current-meter data have been displayed as histograms of direction (fig. 2) and speed (fig. 3). Directions were grouped in 3° intervals, and speeds were grouped in 1 or 2 cm/s intervals for Braincon or Aanderaa meters, respectively. The data are presented as actual numbers of observations in each group and as a percentage of the maximum number of observations in any one group.

3.2 Progressive Vector Diagrams

Progressive vector diagrams (fig. 4) were constructed by vector addition of hourly vector averages of currents. The diagrams do not represent real particle trajectories, but they give an indication of the longer period fluctuations in the motion at a single point, specifically the mean motion. Because of the complexity of the diagram from data at 41 m, it was replotted on an expanded scale (fig. 5).

3.3 Time Series

A selection of the original time-series data at the mooring, tides, wind and runoff all have been plotted on a common time scale (fig. 6). There is an uncertainty of about $\pm$ 1/2 hr in the beginning times of the Braincon records. The +u direction is taken, roughly, along the axis of the estuary toward the ocean (northerly) and +v is 90° to the left. Because tidal motion dominates the currents, a consistent method of choosing the u axis is along the direction of maximum variance (Cannon, 1969). Table 3 summarizes some of the statistics. The means ($\bar{u}$ and $\bar{v}$) and variances are calculated for maximum number of

Table 3. Summary Statistics of the Current-Meter Records

Depth (m)	Direction of +u (°T)	$\bar{u}$ (cm/s)	Variance (cm^2/s^2)	$\bar{v}$ (cm/s)	Total Variance (cm^2/s^2)	Lunar Days (#)
16	24	10.1	194	-1.3	222.	29
41	31	2.9	530.	2.4	594.	26
67	46	- 8.3	206.	2.5	238.	25
90	42	-11.9	165.	4.9	201.	30
127	48	- 9.9	236.	4.0	280.	21

Note: Values are for the maximum number of lunar days in the total records.

lunar days in the records. The pressure guage malfunctioned causing the flattening of extremes, thus pressure data should be used with caution. Because of an error in data reduction, 1.5 °C should be added to temperatures in fig. 6.

The wind observations were reduced from analog recordings of speed and direction by estimating hourly averages of the two variables separately. The north-south component is plotted with positive representing flow toward the north (opposite to conventional weather direction) and is consistent with current records. The winds also are presented as a progressive vector diagram (fig. 7). Runoff data were obtained from U.S. Geological Survey weekly reports of daily averages for the Skagit River near Concrete, Washington. The Skagit is the largest river entering Puget Sound and supplies about 36 percent of the fresh water (Roden, 1967).

Tides were recorded digitally at 6-min intervals. They are presented relative to mean lower low water. Gaps in the records occurred during instrument malfunctions.

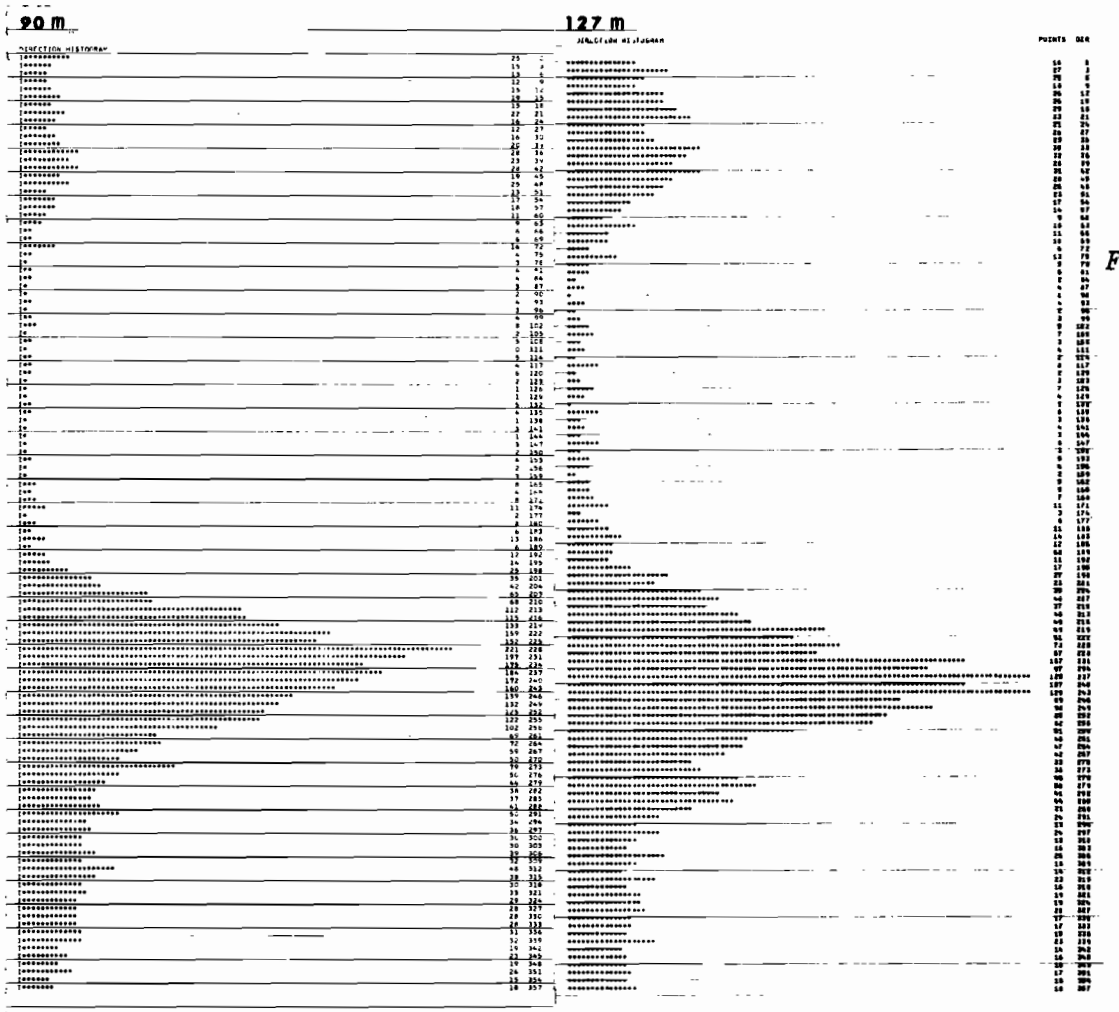


*Figure 2. Histograms of directions (°T). On each diagram the depth is given at the top. The middle direction of each 3° group is given in the right-hand column, and the number of observations in each group is given in the left-hand column. The percentage distribution is represented by 100 *'s for the group with the maximum number of observations and by a number of *'s for each of the other groups equal to the ratio of the number of observations in the group to the maximum number.*

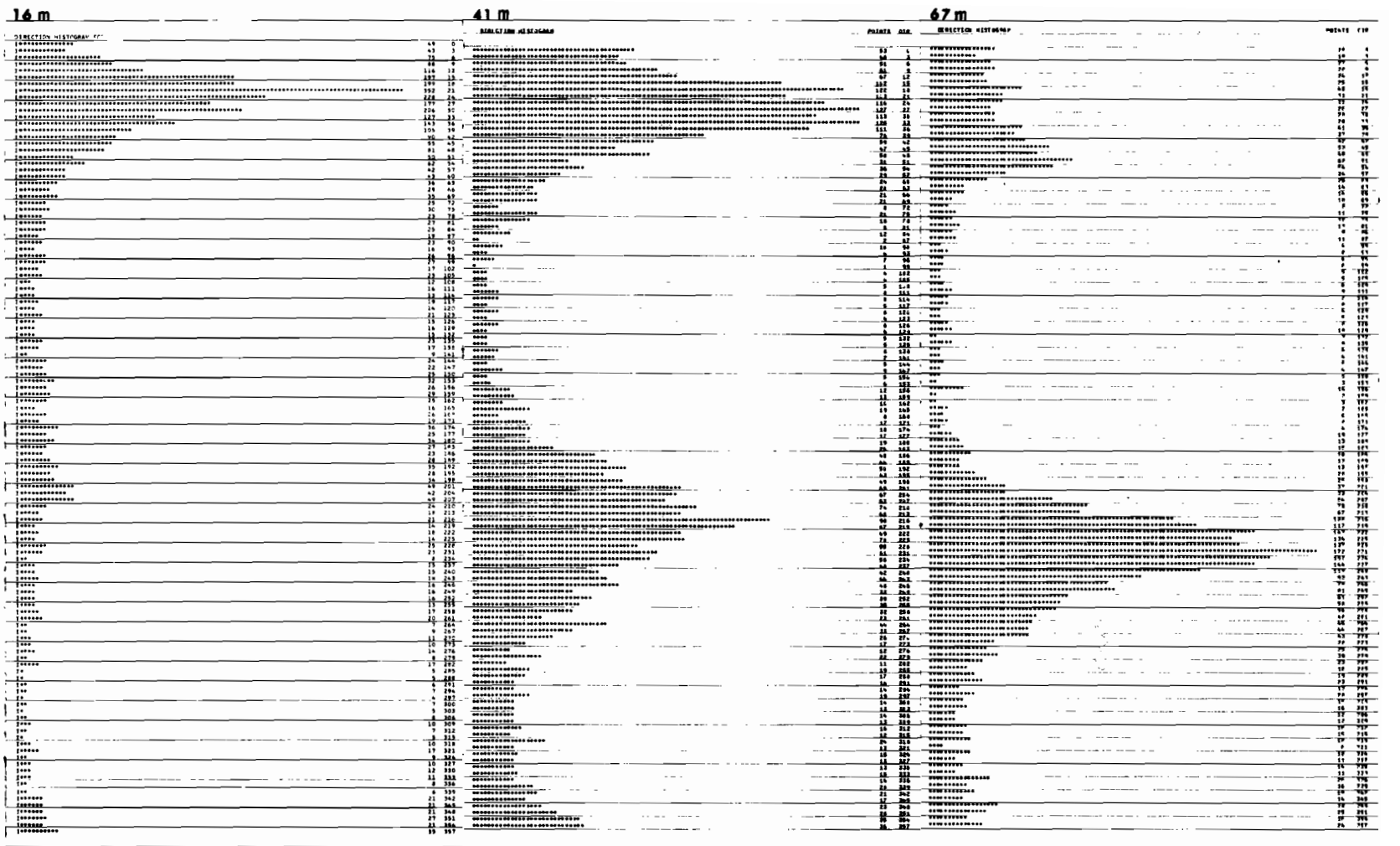


Figure 2.(continued)

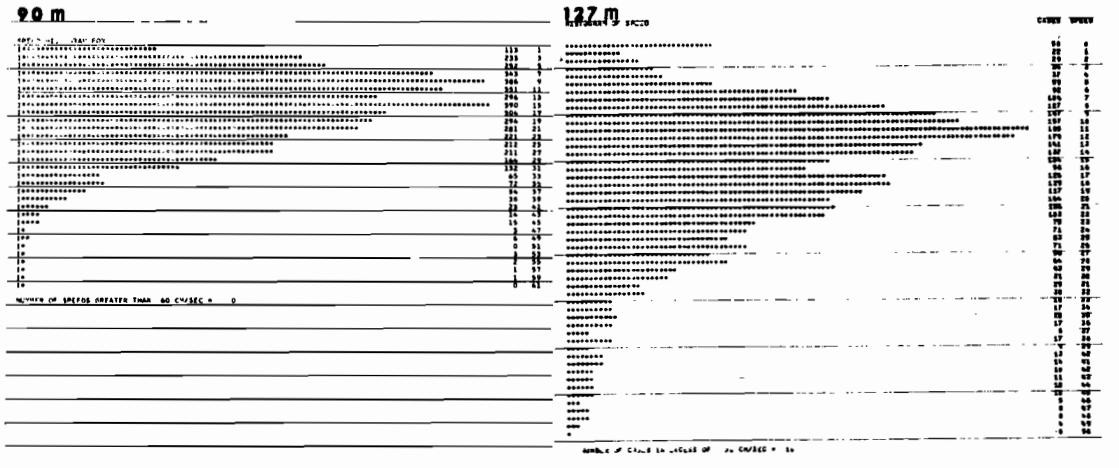


Figure 3. Histograms of speeds (cm/sec). The middle speed of each 1 or 2 cm/s group is given in the right-hand column. The number of cases exceeding the maximum speed is given on the bottom line. See Figure 2 caption.

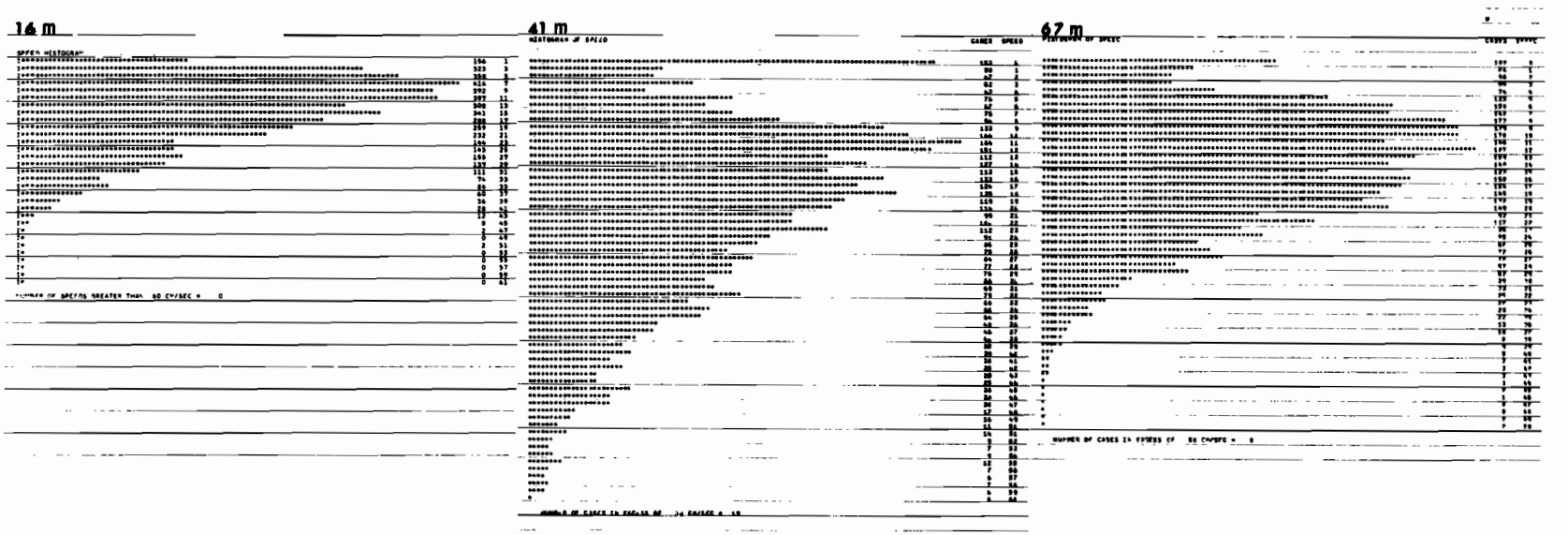
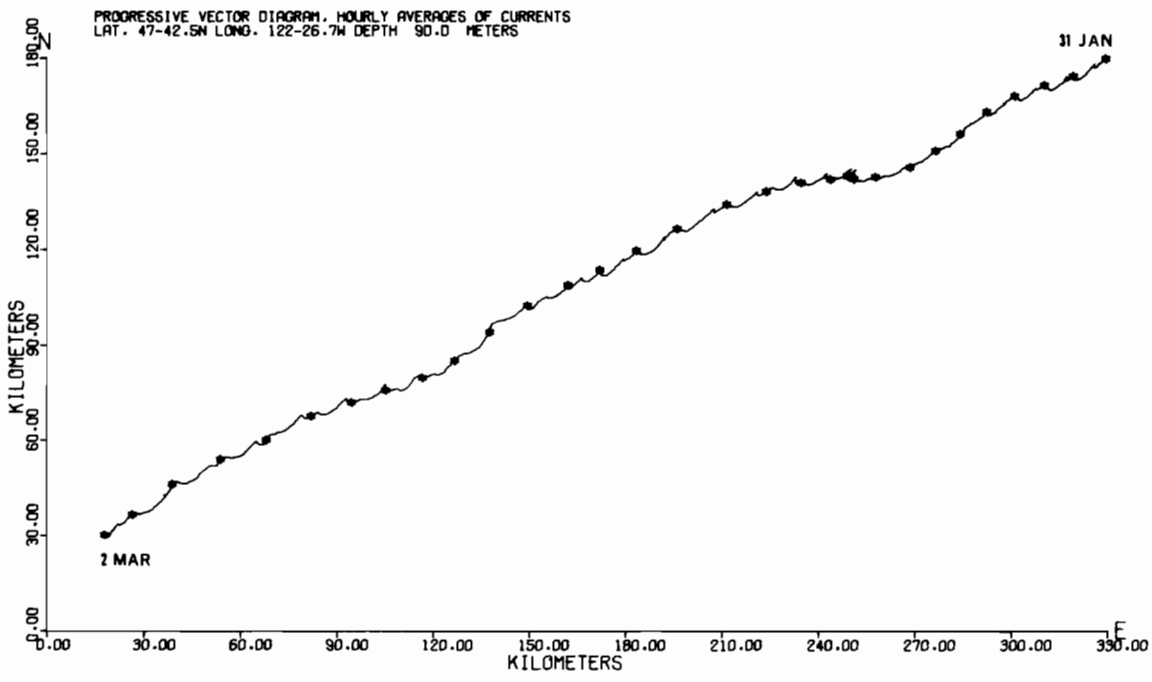


Figure 3. (continued)



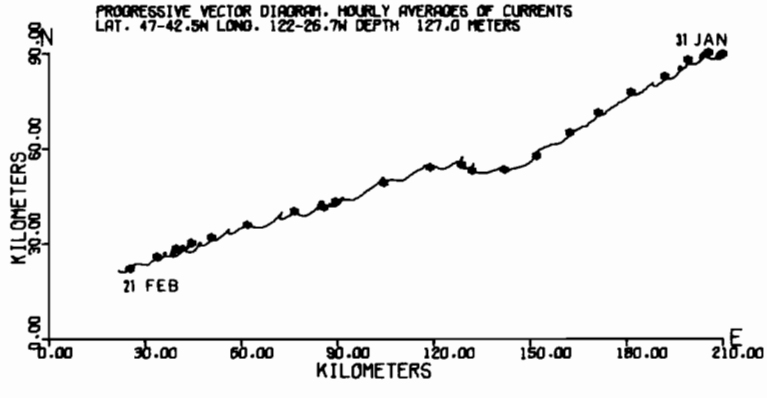


Figure 4. Progressive vector diagrams. Start times differ by about an hour (Table 1), and end times differ by several days. Stars are at 24-hr intervals. Horizontal scales are the same, and north and east directions are shown on the axes.

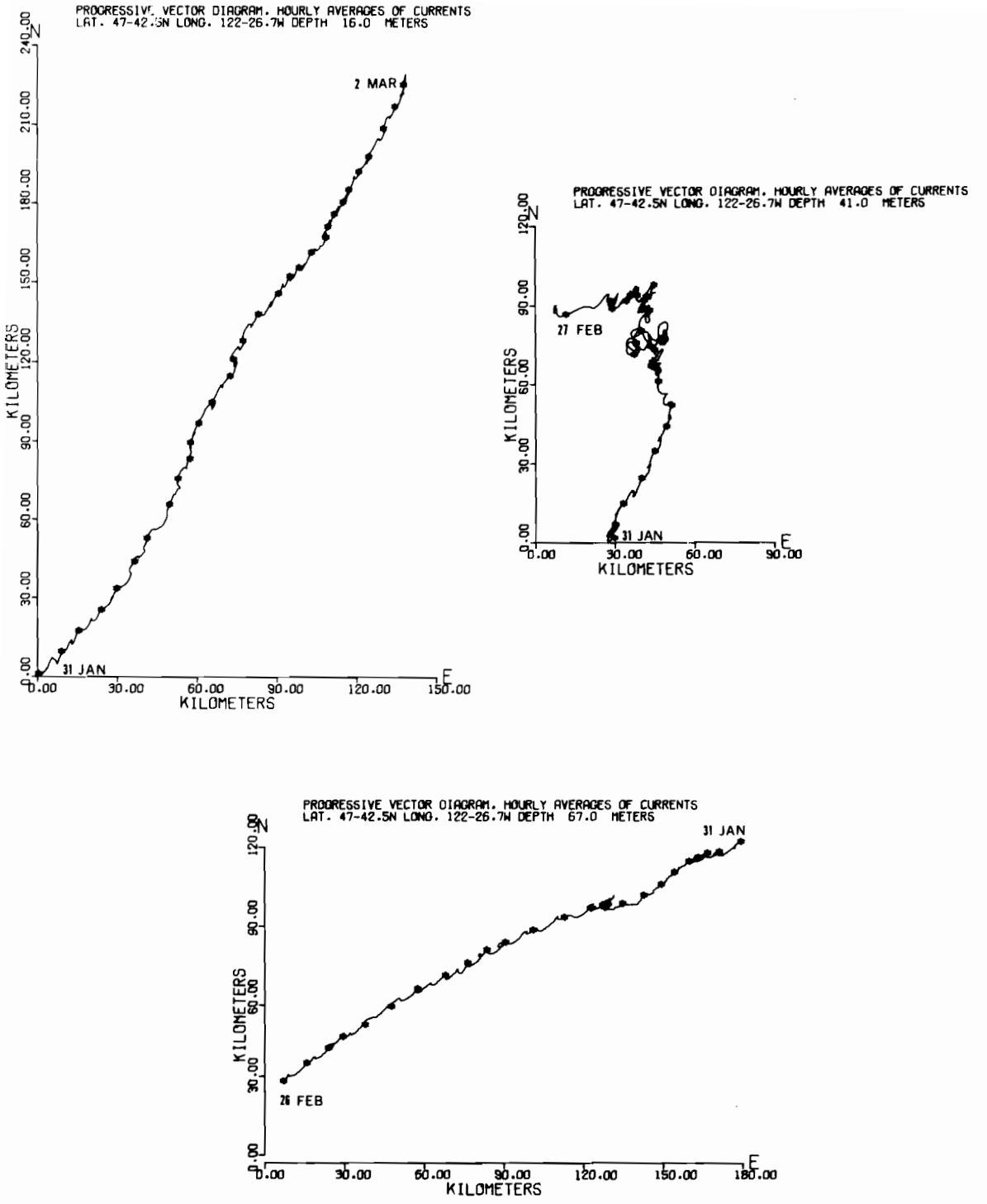


Figure 4.(continued)

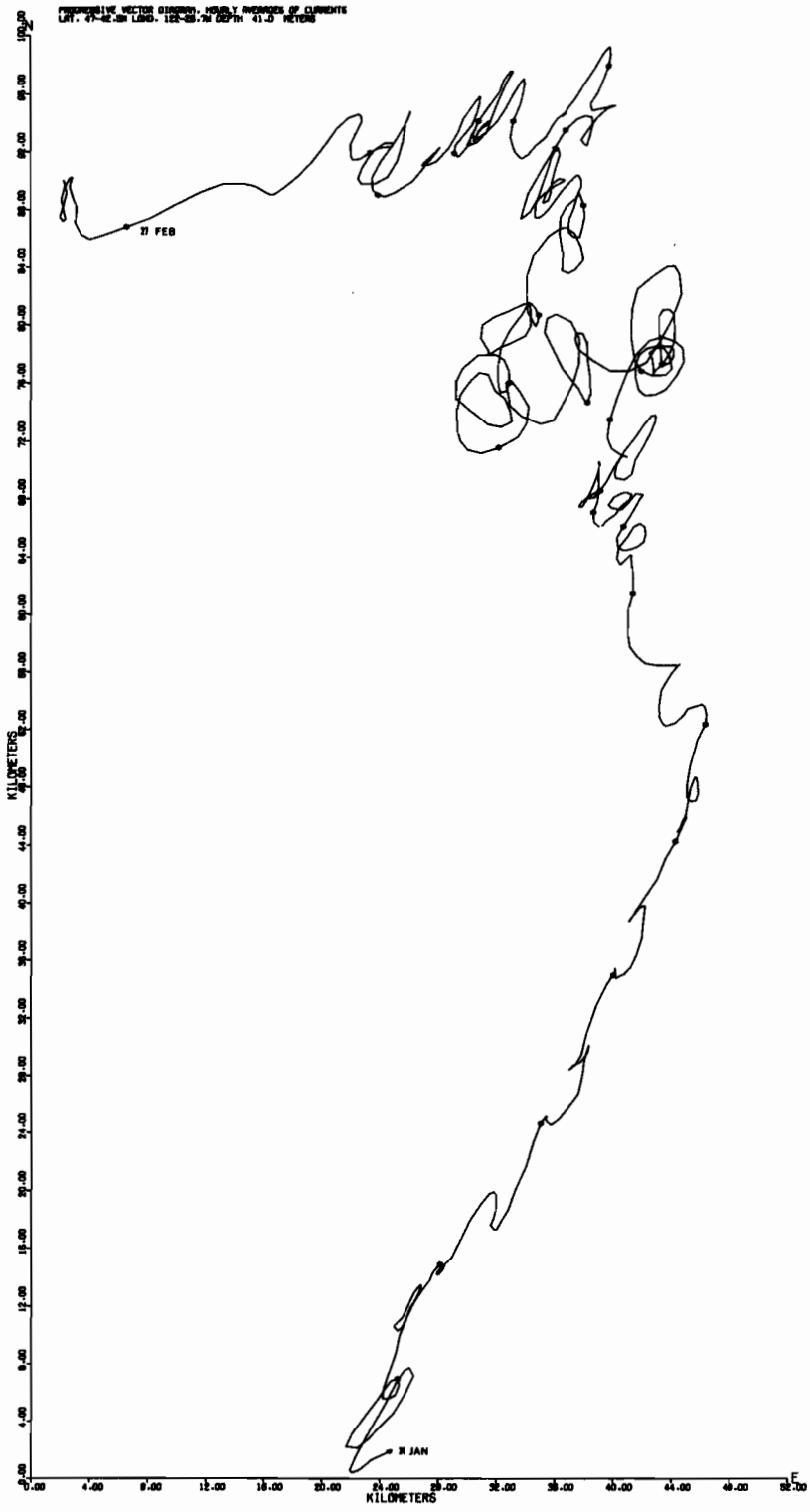


Figure 5. Progressive vector diagram from 41 m expanded.

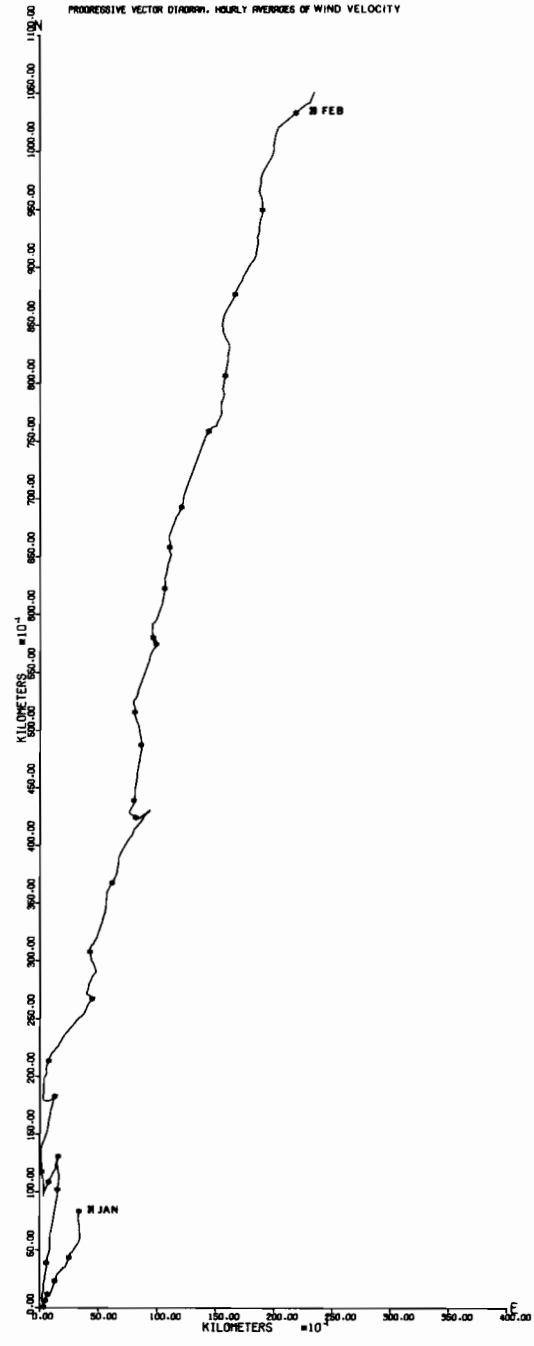


Figure 7. Progressive vector diagram of winds. Diagram indicates direction to which wind blows, and origin is 0000I31.

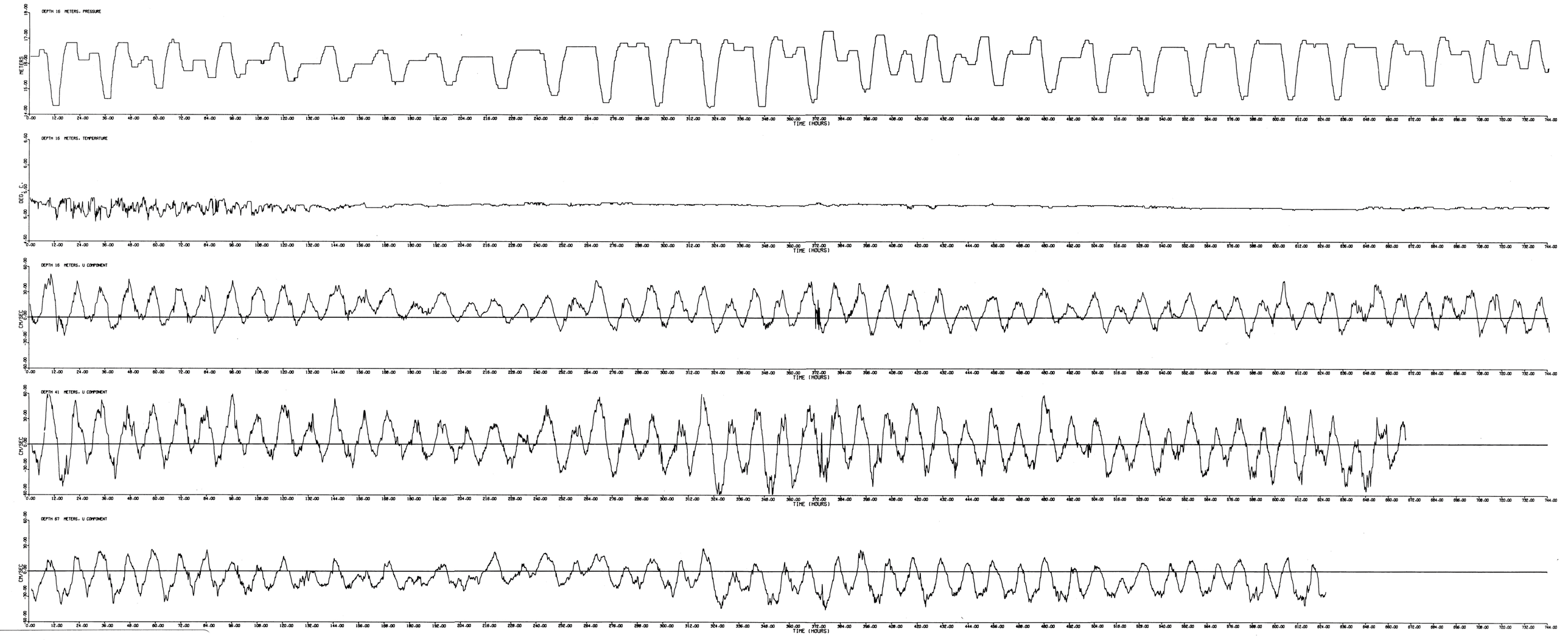


Figure 6. Time series of selected data. See text.

Time origin is 1200 I 31.

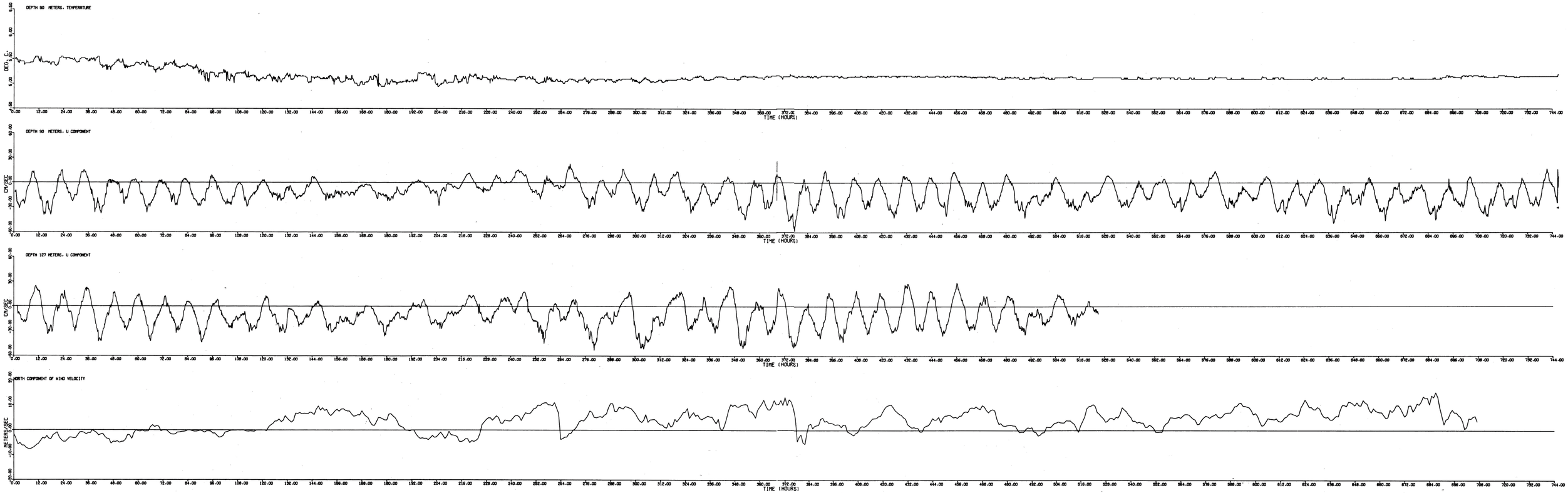


Figure 6. (continued)

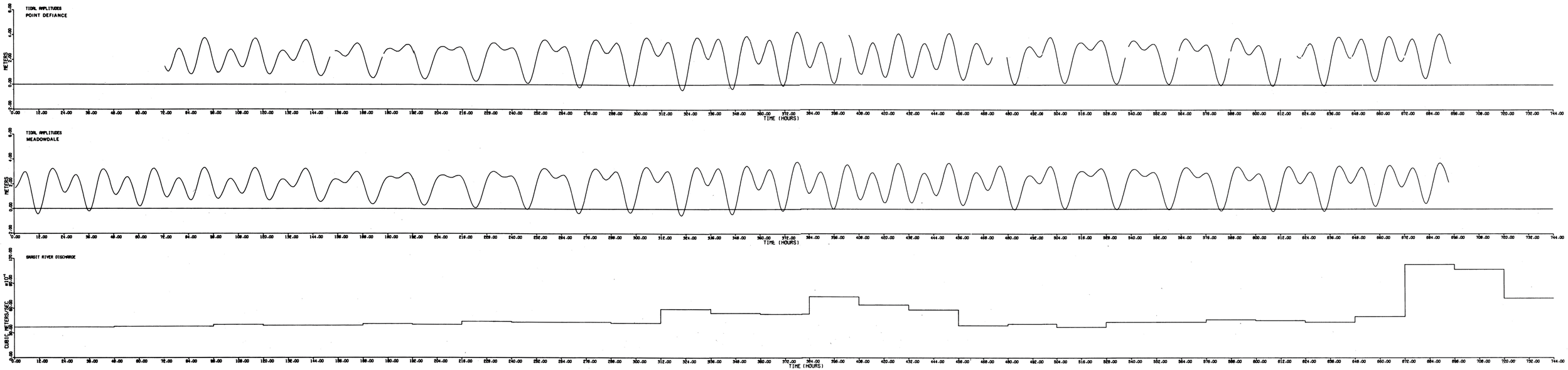


Figure 6. (continued)

3.4 Fourier Representations

A fast Fourier transform algorithm (FFT) was used to compute the Fourier coefficients of the time-series of u components of velocity (table 4) using programs outlined in Cannon (1969, 1971). Record lengths of 30 days (4320 points) were used for the longer series at 16 and 90 m and of 15 days (2160 points) for the shorter series at 41, 67, and 127 m (see table 1). The shorter series were about 3 weeks long, and the coefficients were computed both for the first and for the last 15 days; thus, the middle week was common to each of the computations. Only the first 90 of 2160 and first 50 of 1080 coefficients are given in the left- and right-hand sides, respectively, of table 4. Coefficients for periods less than 8.0 and 7.2 hrs, respectively were very small and have been omitted. If all of these amplitudes were squared and divided by two, the resulting series would be a representation called the periodogram. The sum of all of the values in the periodogram equals the u-component variance (table 3). Phases of the Fourier coefficients are not presented here because of the present uncertainty in the initial times of the Braincon-meter series.

3.5 Physical-Property Sections

Sections of temperature, salinity, and density as σ_t ($\sigma_t = 10^3 \times$ [density-1]) have been plotted (figs. 8 to 11). One section follows the main channel from Pt. Defiance to New Dungeness (fig. 8). The other follows the main side channel from the mooring to Camano Head (fig. 9). Cross sections are presented for the two channels at Possession

Table 4. Amplitudes of Fourier Coefficients of U-comonents of Current Velocity. Periods Are Given for the Usual Constant Frequency Interval. The Two Columns for Each Depth in the Right-Hand Columns are from the First and Last 15 Days of the Series, Respectively.

PERIOD (HRS)	AMPLITUDE (CM/S)	
	16 M	90 M
7.200000E+02	2.70	4.36
3.600000E+02	.87	2.97
2.400000E+02	1.04	2.49
1.800000E+02	.86	2.60
1.440000E+02	.37	.76
1.200000E+02	1.39	.24
1.028571E+02	1.36	1.63
9.000000E+01	.63	.70
8.000000E+01	.31	.11
7.200000E+01	.33	.51
6.545455E+01	.50	.30
6.000000E+01	.63	.20
5.538462E+01	.96	.44
5.142857E+01	1.07	.28
4.800000E+01	.68	.21
4.500000E+01	.85	.71
4.235294E+01	.82	.87
4.000000E+01	.54	.21
3.789474E+01	1.36	.51
3.600000E+01	1.01	.04
3.428571E+01	.29	.15
3.272727E+01	.69	.14
3.130435E+01	.69	.38
3.000000E+01	.83	.76
2.880000E+01	.67	.43
2.769231E+01	.47	1.05
2.666667E+01	.44	1.11
2.571429E+01	3.36	4.01
2.482759E+01	1.07	.71
2.400000E+01	4.88	7.05
2.322581E+01	1.03	.83
2.250000E+01	1.71	1.74
2.181818E+01	.03	.36
2.117647E+01	.58	.67
2.057143E+01	.14	.47
2.000000E+01	.99	.37
1.945946E+01	.43	.56
1.894737E+01	.57	.36
1.846154E+01	.22	.23
1.800000E+01	.72	.18
1.756098E+01	.19	.20
1.714286E+01	.73	.27
1.674419E+01	.48	.34
1.636364E+01	1.13	.30
1.600000E+01	.21	.32
1.565217E+01	.81	.18
1.531915E+01	.42	.86
1.500000E+01	.77	.36
1.469388E+01	.40	.14
1.440000E+01	1.37	.77
1.411765E+01	.54	.21
1.384615E+01	.67	.18
1.358491E+01	.79	1.05
1.333333E+01	.74	.72
1.309091E+01	.23	.56
1.285714E+01	.78	.93
1.263158E+01	1.88	2.48
1.241379E+01	16.22	11.96
1.220339E+01	1.74	.45
1.200000E+01	3.28	4.88
1.180328E+01	1.82	.29
1.161290E+01	1.46	1.04
1.142857E+01	.67	.37
1.125000E+01	.85	.36
1.107692E+01	.69	.47
1.090909E+01	.96	.81
1.074627E+01	.24	.47
1.058824E+01	.94	.70
1.043478E+01	.08	.55
1.028571E+01	.62	.20
1.014085E+01	.11	.75
1.000000E+01	.33	.48
9.863014E+00	.21	.06
9.729730E+00	.32	.08
9.600000E+00	.23	.28
9.473684E+00	.44	.22
9.350649E+00	.57	.43
9.230769E+00	.27	.20
9.113924E+00	.25	.13
9.000000E+00	.09	.47
8.888889E+00	.34	.50
8.780488E+00	.16	.28
8.674699E+00	.36	.40
8.571429E+00	.23	.76
8.470588E+00	.15	.48
8.372093E+00	.62	1.46
8.275862E+00	.64	.79
8.181818E+00	.42	.92
8.089888E+00	.38	.71
8.000000E+00	.24	.10

PERIOD (HRS)	AMPLITUDE (CM/S)					
	41 M		67 M		127 M	
3.600000E+02	5.92	5.16	2.67	1.99	1.39	2.99
1.800000E+02	4.55	2.03	5.35	1.45	4.15	1.20
1.200000E+02	2.87	.38	1.82	2.89	2.64	3.43
9.000000E+01	.93	3.52	1.17	2.28	1.99	3.84
7.200000E+01	1.32	2.63	.90	.62	.97	.55
6.000000E+01	.89	5.12	.82	.77	.84	1.34
5.142857E+01	1.43	1.39	.53	.32	1.06	.19
4.500000E+01	.58	2.41	1.06	1.24	1.81	1.96
4.000000E+01	1.37	2.93	1.01	.88	.77	1.43
3.600000E+01	1.48	2.61	.89	1.12	.64	1.42
3.272727E+01	1.05	.87	.67	.74	1.27	1.42
3.000000E+01	.29	1.08	.74	.94	1.50	1.09
2.769231E+01	1.73	1.49	.44	1.10	1.96	2.55
2.571429E+01	5.17	5.71	4.91	4.78	7.01	6.97
2.400000E+01	9.09	7.48	6.40	7.03	8.97	8.24
2.250000E+01	1.38	2.63	1.04	2.62	1.42	2.03
2.117647E+01	2.87	.79	.58	.78	.91	.77
2.000000E+01	1.60	1.50	1.54	.76	.88	.72
1.894737E+01	1.57	1.38	.77	.96	.98	.75
1.800000E+01	1.68	3.25	.32	.11	.63	1.24
1.714286E+01	1.91	1.22	.44	.63	.89	1.08
1.636364E+01	2.21	.90	.08	.85	1.77	.86
1.565217E+01	.60	1.51	.54	.82	1.24	1.49
1.500000E+01	.76	1.09	.51	.51	.71	.88
1.440000E+01	1.17	1.60	.46	.79	1.06	1.37
1.384615E+01	1.58	2.45	.42	1.26	1.41	2.38
1.333333E+01	2.25	2.58	.75	.72	1.94	.31
1.285714E+01	3.54	1.95	2.16	2.78	2.85	2.94
1.241379E+01	26.26	27.61	13.49	15.93	13.36	14.48
1.200000E+01	7.03	8.55	5.83	4.49	5.18	7.21
1.161290E+01	.96	.77	.95	1.24	.99	.99
1.125000E+01	.49	.78	.30	1.01	.66	.78
1.090909E+01	.49	.50	.97	.40	.52	.59
1.058824E+01	.67	.83	.86	1.76	.32	.32
1.028571E+01	1.99	.70	.17	1.28	.17	.58
1.000000E+01	.59	.40	1.07	.23	.36	.65
9.729730E+00	.41	.69	.42	.66	.40	.77
9.473684E+00	.38	1.21	.75	.98	.44	.21
9.230769E+00	1.08	2.28	.76	.33	.34	.95
9.000000E+00	.88	1.43	.38	.33	.26	.97
8.780488E+00	.56	1.37	.89	.27	.87	.22
8.571429E+00	.66	.96	1.40	1.60	.67	.41
8.372093E+00	.81	1.64	.90	1.99	.38	1.16
8.181818E+00	1.00	1.62	1.44	1.95	.39	.35
8.000000E+00	.64	.56	.32	1.40	1.28	1.11
7.826087E+00	1.86	.36	.71	1.07	1.66	1.90
7.659574E+00	.57	.63	.32	.54	.63	.94
7.500000E+00	.84	.47	.53	.98	.50	.67
7.346939E+00	.57	1.04	.05	.70	.85	.40
7.200000E+00	1.45	.47	.50	.70	.68	.67

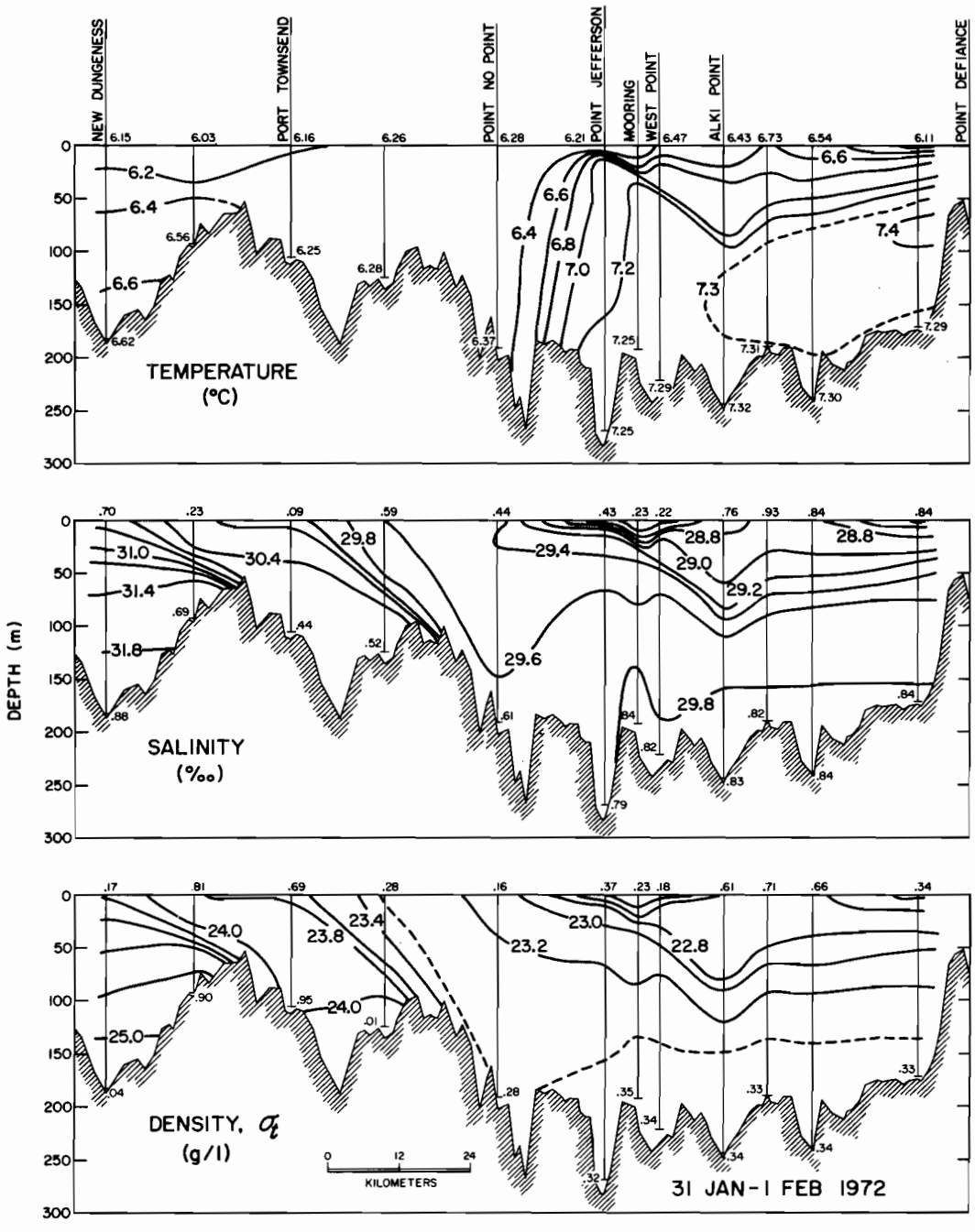


Figure 8. Physical properties: Point Defiance to New Dungeness,

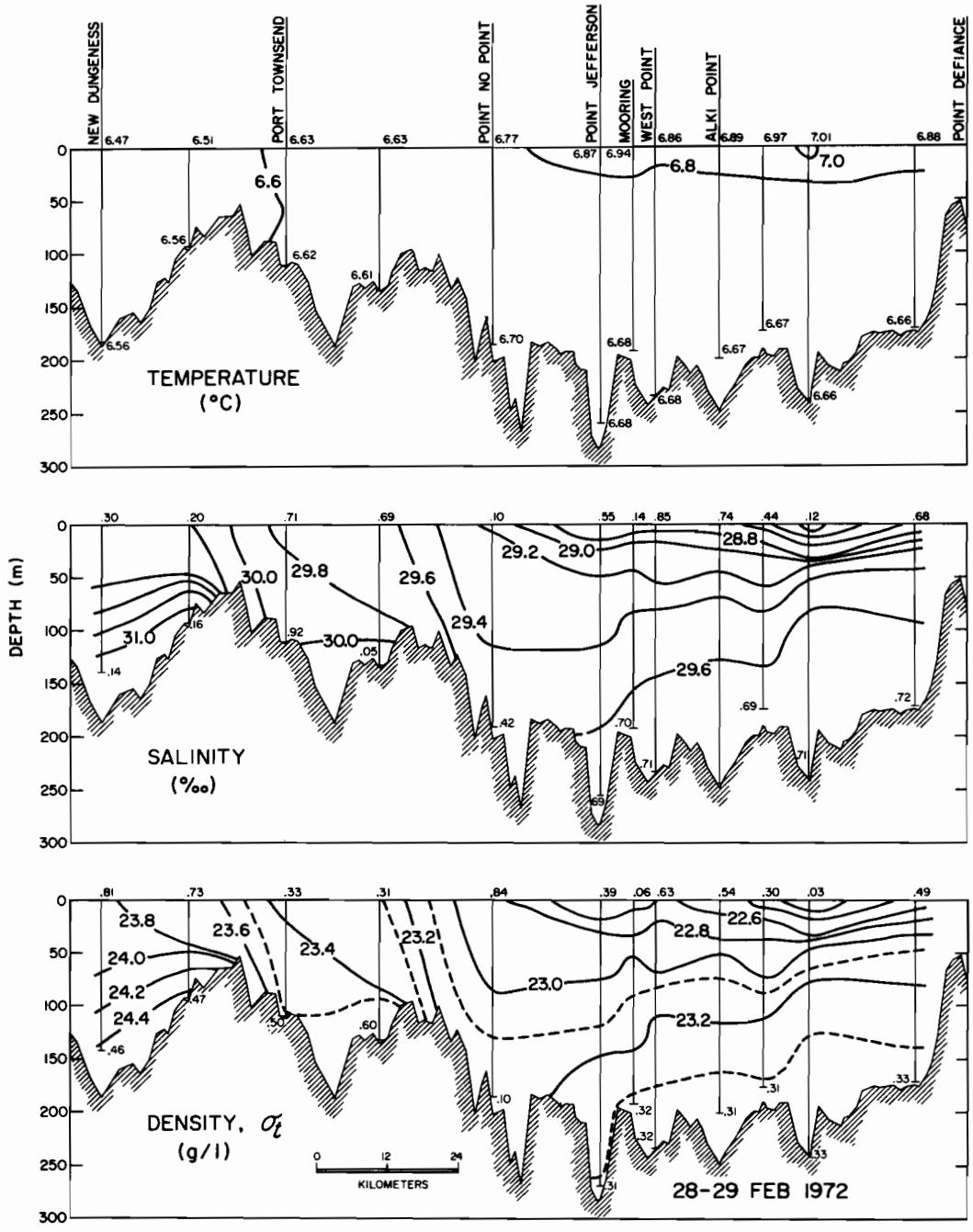


Figure 8. (continued)

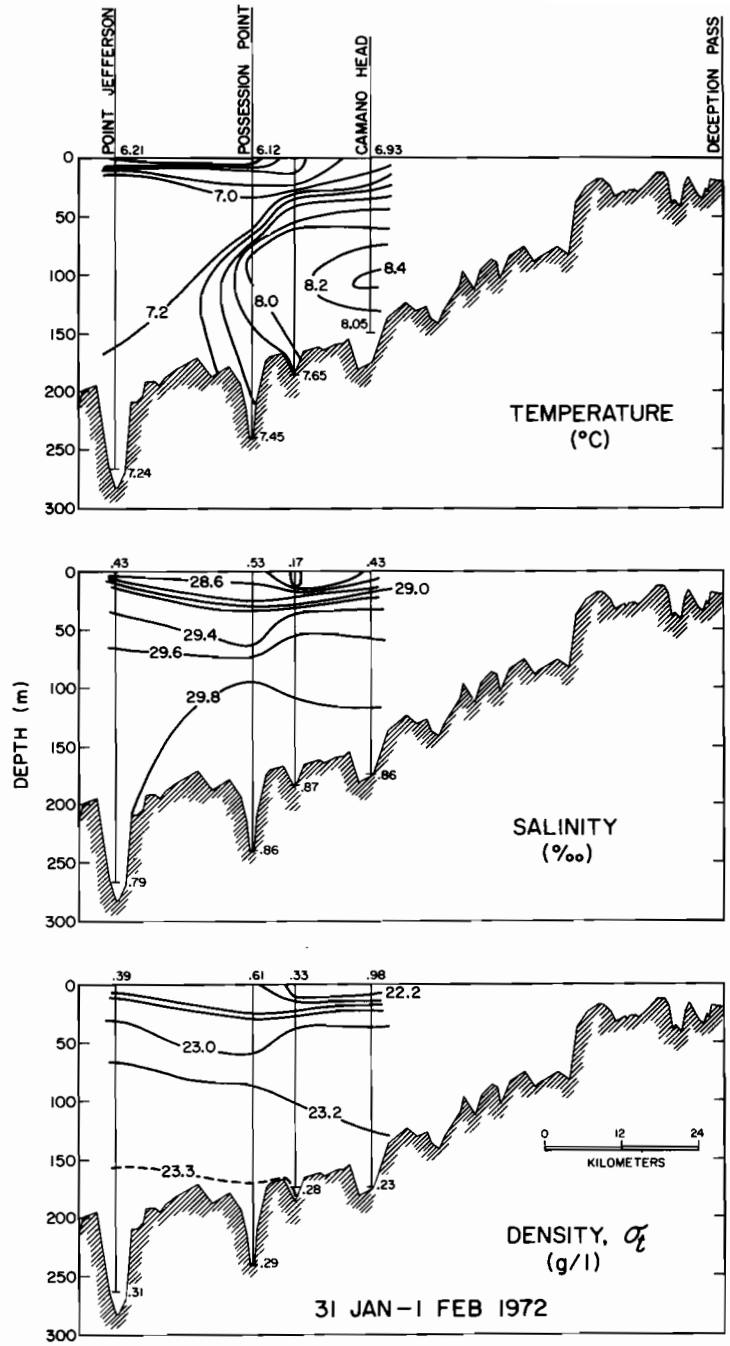


Figure 9. Physical properties: Mooring to Camano Head.

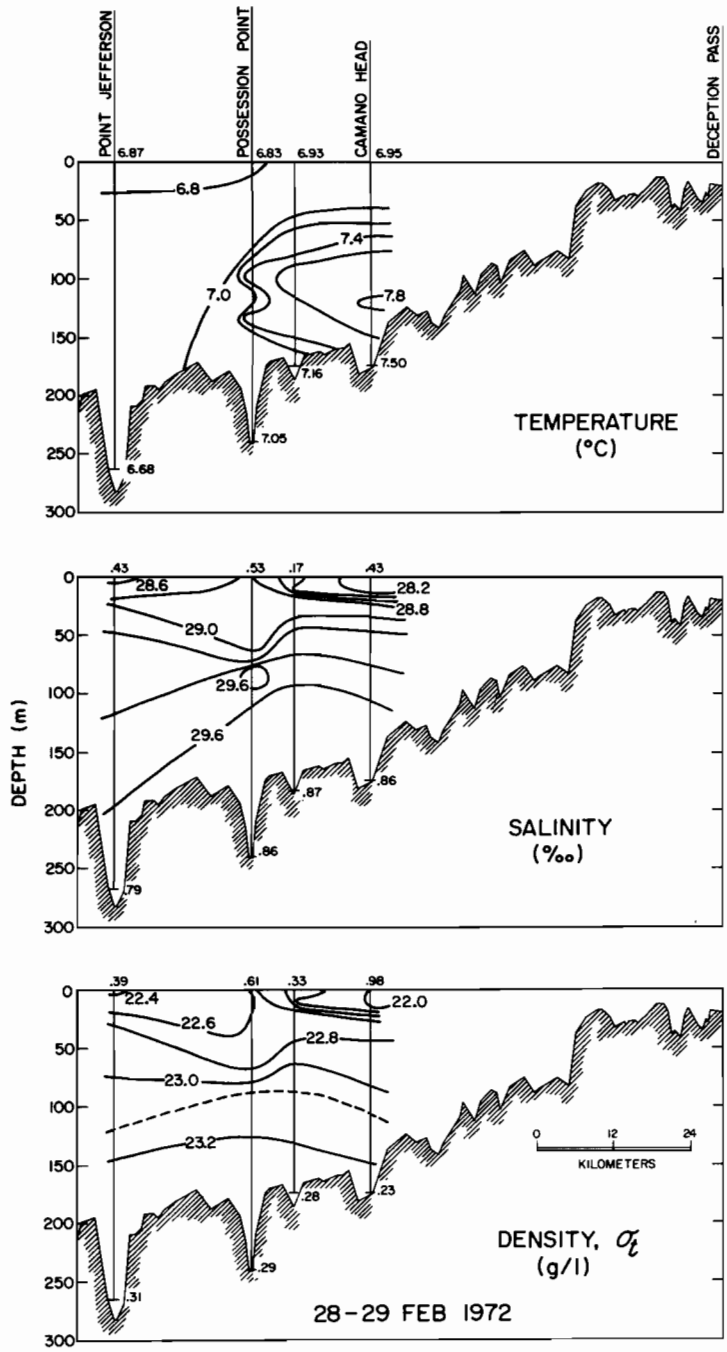


Figure 9. (continued)

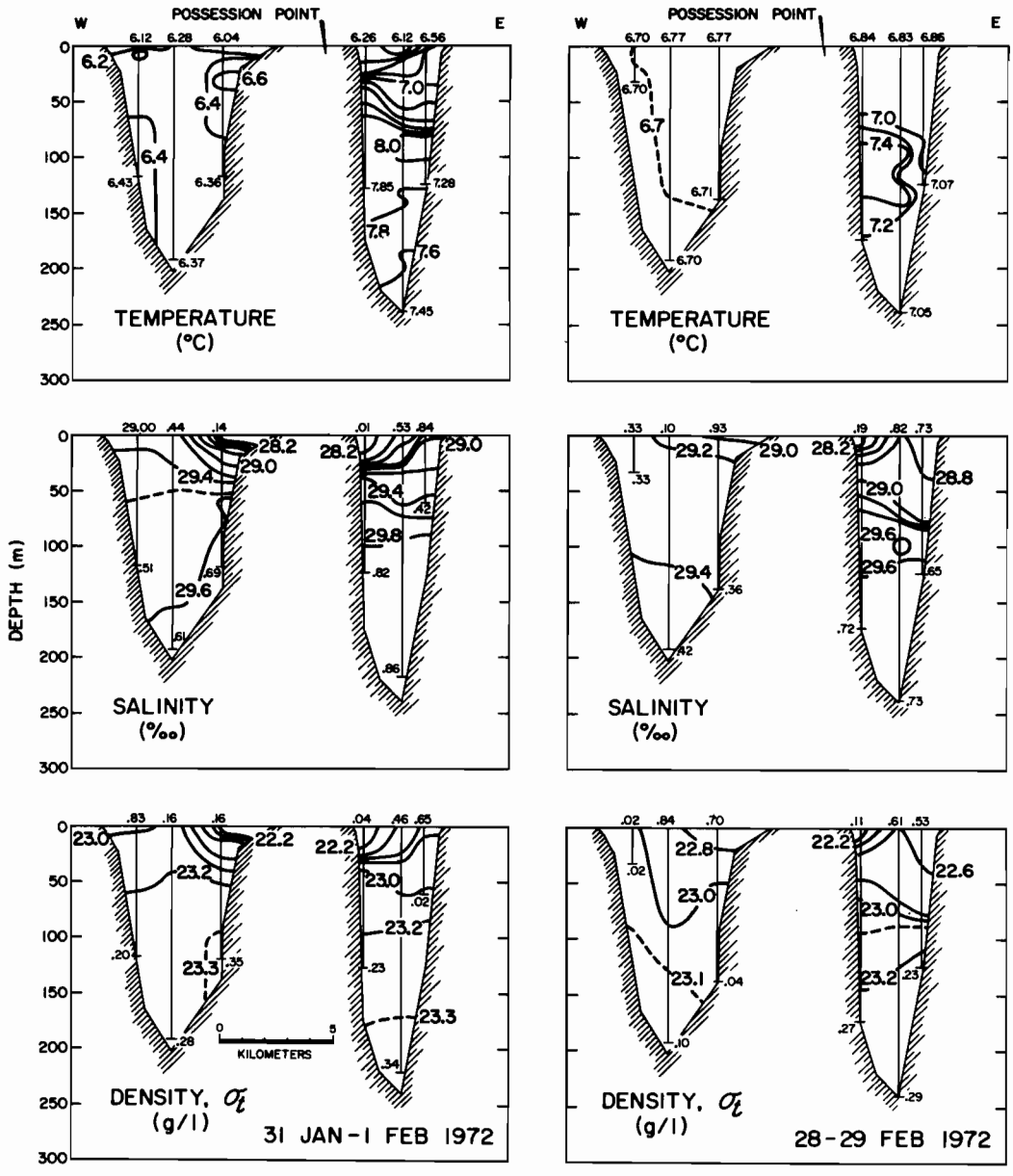


Figure 10. Physical properties: Sections at Possession Point.

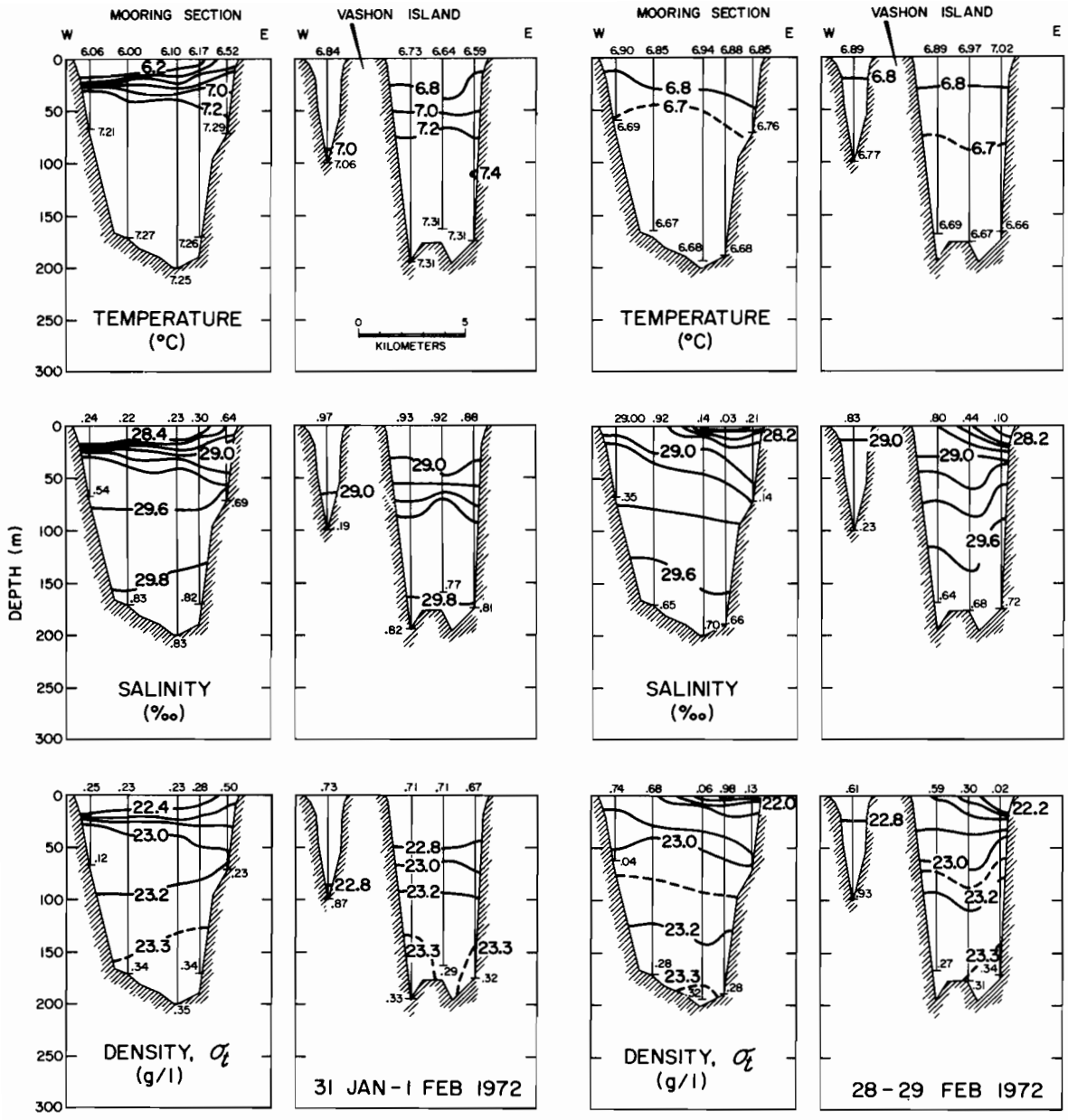


Figure 11. Physical properties: Sections at Mooring and at northern end Vashon Island.

Pt. (fig. 10) and for the main basin at the mooring and at the northern end of Vashon Island (fig. 11). The solid-line contour intervals are 0.2 °C, 0.2 °/oo, and 0.2 g/l, respectively, for the above three variables and are the same on all figures. The surface and deepest values also are given for temperature (entire value) and for salinity and σ_t (decimal part only). Vertical exaggeration is about 180 on the longitudinal sections (figs. 8 and 9) and about 50 on the cross sections (figs. 10 and 11).

3.6 Physical-Property Time Series

The time series of physical properties (table 2) have been tabulated in the Appendix as means and standard deviations at 5-m intervals. Under each variable heading, means are in the left column and standard deviations are in the right column. Values are included in the zero depth average if the shallowest observation is less than or equal to 3 m. The shallowest depth also is a mean value and its standard deviation is given. The far right column gives the number of observations used in the computations.

4. DISCUSSION

The following observations were noted:

(1) Puget Sound in 1972 was colder than most winters and got colder during the month interval. Bottom water became slightly fresher, hence slightly less dense (figs. 8-11). Significant northerly winds (flow to the south) occurred only during the first week, which also

was particulary cold and clear (figs. 6 and 7). Runoff generally was greater than the daily average of about 400 m^3/s for the same 6-week period during 1953-67 (fig. 6).

(2) Mean flow at the mooring was northerly at 16 and 41 m and southerly at 67, 90, and 127 m (figs. 2, 4 and 5; table 3). The depth of no mean flow occurred at approximately 50 m which is near the bottom of the pycnocline (figs. 8-11; Appendix, mooring stations 1 and 2).

(3) Kinetic energy in the motion as expressed by the variance at 41 m in the main pycnocline was more than double that at any other depth. Kinetic energy at 16 m and still somewhat in the pycnocline, was slightly higher than at depths below the pycnocline. The predominate concentration of this extra energy occurred in the lunar semidiurnal u-component of velocity (fig. 6; tables 3 and 4).

(4) The temperature time-series show relatively large fluctuations near the beginning of the record which decay and are not present at the end of the record (fig. 6). These characteristics also were observed during the following month by the UW-POL thermistor arrays mentioned in section 2.

(5) The STD time series showed relatively small variations (standard deviation) except at the Port Townsend station (see Appendix). There the salinity variations were much larger and exhibited semidiurnal fluctuations, but the temperature was uniform top-to-bottom.

Analysis and further discussion of this data will be presented in a later paper.

5. ACKNOWLEDGEMENTS

We thank the Department of Oceanography at UW for loan of the current meters. Considerable assistance by Mr. Jim Stephens at POL in preparation of equipment and in carrying out the field work at sea is gratefully acknowledged. We were very pleased with the support and cooperation provided by the Pacific Marine Center of NOS and the officers and crew of the NOS ship McARTHUR.

Jack Beck, Linda Olund, and Eugene Collias at UW did various aspects of data processing. Some of the formating ideas in the report originated from Dr. David Halpern at POL. Gary Fujita at POL did some of the plotting; Dick Cromoga at UW did the drafting; and Laurie Burgess at POL typed the manuscript.

One of us (GAC) is particularly grateful to Dr. Clifford Barnes at UW for many fruitful discussions concerning this experiment and Puget Sound in general.

6. REFERENCES

Barnes, Clifford A., 1953: Oceanographic survey on submarine portion of Snohamish-Kitsap 230 kv line. Final Report, Part I. Univ. Washington, Dept. Oceanogr., *Ref.* 53-2.

Cannon, Glenn A., 1969: Observations of motion at intermediate and large scales in a coastal plain estuary. Johns Hopkins Univ., Chesapeake Bay Inst., *Tech. Rep.* 52, 114 p.

Cannon, Glenn A., 1971: Statistical characteristics of velocity fluctuations at intermediate scales in a coastal plain estuary. *J. Geophys. Res.* 76, 5852-5858.

Collias, Eugene E., 1963: Current measurements off West Point, Washington. Univ. Washington, Dept. Oceanogr., *Spec. Rep.* 34, 35 p.

Hopkins, Thomas S., 1971: Velocity, temperature, and pressure observations from moored meters on the shelf near the Columbia River mouth, 1967-1969. Univ. Washington, Dept. Oceanogr. *Spec. Rep.* 45, 143 p.

Lincoln, John, and Eugene E. Collias, 1970: Skagit Bay study. Progress Report No. 3. Presentation and review of data obtained between 11 February and 8 October 1970. Univ. Washington, Dept. Oceanogr., *Ref.* M70-111, 88 p.

Roden, Gunnar I., 1967: On the river discharge into the north-eastern Pacific Ocean and the Bering Sea. *J. Geophys. Res.* 72, 5613-5629.

7. APPENDIX

Means and standard deviations of physical properties from time-series stations. See section 3.6 and table 2.

PORT TOWNSEND.1

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
.44	4.148	6.12	.049	29.854	.3043	23.50	.2410	23
5.00	0.000	6.13	.039	29.929	.3045	23.56	.2409	24
10.00	0.000	6.13	.033	29.990	.2879	23.61	.2275	24
15.00	0.000	6.14	.028	30.029	.2818	23.64	.2220	24
20.00	0.000	6.14	.028	30.067	.2898	23.67	.2281	24
25.00	0.000	6.14	.034	30.093	.2884	23.68	.2271	24
30.00	0.000	6.15	.037	30.115	.2990	23.71	.2349	24
35.00	0.000	6.15	.038	30.140	.3025	23.73	.2374	24
40.00	0.000	6.15	.031	30.174	.3138	23.75	.2461	24
45.00	0.000	6.15	.036	30.192	.3174	23.77	.2485	24
50.00	0.000	6.15	.052	30.234	.3162	23.80	.2478	25
55.00	0.000	6.15	.054	30.256	.2986	23.82	.2338	25
60.00	0.000	6.16	.053	30.280	.3054	23.84	.2385	25
65.00	0.000	6.16	.053	30.310	.3075	23.86	.2406	25
70.00	0.000	6.17	.049	30.331	.3061	23.87	.2394	25
75.00	0.000	6.17	.049	30.350	.3150	23.89	.2453	25
80.00	0.000	6.18	.049	30.367	.3262	23.90	.2532	25
85.00	0.000	6.18	.052	30.380	.3241	23.91	.2512	25
90.00	0.000	6.19	.052	30.394	.3377	23.92	.2611	25
95.00	0.000	6.18	.048	30.381	.3078	23.91	.2380	24
100.00	0.000	6.19	.053	30.417	.3278	23.94	.2530	22
105.00	0.000	6.20	.059	30.434	.3416	23.95	.2628	21
110.00	0.000	6.21	.069	30.568	.3273	24.06	.2498	12
115.00	0.000	6.22	.054	30.616	.2478	24.09	.1886	4

PORT TOWNSEND.2

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
.52	4.208	6.62	.036	29.707	.2344	23.33	.1869	25
5.00	0.000	6.62	.035	29.729	.2019	23.35	.1620	25
10.00	0.000	6.62	.036	29.746	.1873	23.36	.1507	25
15.00	0.000	6.62	.034	29.778	.1675	23.39	.1350	25
20.00	0.000	6.62	.035	29.796	.1537	23.40	.1244	25
25.00	0.000	6.62	.033	29.814	.1541	23.41	.1244	25
30.00	0.000	6.61	.035	29.833	.1606	23.43	.1297	25
35.00	0.000	6.61	.031	29.850	.1621	23.44	.1303	25
40.00	0.000	6.61	.030	29.865	.1618	23.45	.1302	25
45.00	0.000	6.61	.031	29.877	.1545	23.46	.1245	25
50.00	0.000	6.61	.031	29.877	.1619	23.46	.1303	25
55.00	0.000	6.61	.029	29.880	.1609	23.47	.1292	25
60.00	0.000	6.61	.028	29.886	.1690	23.47	.1357	24
65.00	0.000	6.61	.031	29.882	.1759	23.47	.1413	23
70.00	0.000	6.61	.031	29.900	.1815	23.48	.1459	23
75.00	0.000	6.61	.029	29.905	.1881	23.49	.1507	23
80.00	0.000	6.60	.032	29.934	.1922	23.51	.1545	23
85.00	0.000	6.60	.031	29.947	.1968	23.52	.1580	23
90.00	0.000	6.60	.031	29.949	.1987	23.52	.1595	23
95.00	0.000	6.60	.033	29.959	.2111	23.53	.1695	22
100.00	0.000	6.60	.032	29.970	.2146	23.54	.1721	21
105.00	0.000	6.59	.035	30.001	.2214	23.56	.1779	18
110.00	0.000	6.60	.037	29.979	.2217	23.55	.1781	14
115.00	0.000	6.59	.029	30.090	.1800	23.64	.1443	6

NEW DUNGENESS

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
.46	3.235	6.18	.069	30.737	.2126	24.19	.1652	15
5.00	0.000	6.18	.089	30.758	.2308	24.21	.1764	17
10.00	0.000	6.18	.090	30.791	.2243	24.23	.1682	24
15.00	0.000	6.21	.086	30.857	.2113	24.28	.1575	25
20.00	0.000	6.24	.072	30.941	.1949	24.34	.1460	25
25.00	0.000	6.26	.072	30.993	.1899	24.38	.1413	25
30.00	0.000	6.29	.065	31.046	.1724	24.42	.1280	25
35.00	0.000	6.30	.075	31.093	.1769	24.46	.1304	25
40.00	0.000	6.31	.077	31.137	.1734	24.49	.1275	25
45.00	0.000	6.34	.071	31.192	.1653	24.53	.1217	25
50.00	0.000	6.36	.062	31.231	.1493	24.56	.1102	25
55.00	0.000	6.37	.050	31.273	.1341	24.59	.0997	25
60.00	0.000	6.39	.044	31.312	.1216	24.62	.0908	25
65.00	0.000	6.40	.032	31.349	.0953	24.65	.0717	25
70.00	0.000	6.41	.030	31.381	.0947	24.67	.0715	25
75.00	0.000	6.42	.031	31.413	.0940	24.70	.0712	25
80.00	0.000	6.43	.035	31.449	.1071	24.72	.0809	25
85.00	0.000	6.44	.037	31.476	.1108	24.74	.0833	25
90.00	0.000	6.44	.036	31.512	.1073	24.77	.0811	25
95.00	0.000	6.45	.039	31.546	.1118	24.80	.0842	25
100.00	0.000	6.47	.046	31.575	.1112	24.82	.0827	25
105.00	0.000	6.48	.056	31.601	.1167	24.83	.0857	25
110.00	0.000	6.49	.054	31.631	.1122	24.86	.0822	25
115.00	0.000	6.50	.056	31.651	.1141	24.87	.0834	25
120.00	0.000	6.51	.051	31.676	.1054	24.89	.0769	25
125.00	0.000	6.53	.052	31.710	.0937	24.91	.0676	25
130.00	0.000	6.55	.051	31.745	.0883	24.94	.0633	25
135.00	0.000	6.57	.045	31.775	.0875	24.96	.0632	25
140.00	0.000	6.58	.051	31.797	.0904	24.98	.0649	25
145.00	0.000	6.59	.043	31.823	.0786	25.00	.0565	25
150.00	0.000	6.61	.040	31.847	.0802	25.01	.0582	25
155.00	0.000	6.62	.032	31.865	.0696	25.03	.0500	24
160.00	0.000	6.62	.026	31.878	.0590	25.03	.0431	24
165.00	0.000	6.63	.024	31.887	.0577	25.04	.0424	9
170.00	0.000	6.64	.028	31.916	.0635	25.06	.0464	4
175.00	0.000	6.64	.006	31.889	.0100	25.04	.0071	2
180.00	0.000	6.62	0.000	31.880	0.0000	25.04	0.0000	1
185.00	0.000	6.62	0.000	31.882	0.0000	25.04	0.0000	1

MOORING•1

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
.89	6.286	6.80	.059	28.605	.2350	22.44	.1814	25
5.00	0.000	6.82	.033	28.847	.2117	22.63	.1631	25
10.00	0.000	6.83	.017	29.024	.0416	22.77	.0321	25
15.00	0.000	6.84	.017	29.058	.0214	22.79	.0154	25
20.00	0.000	6.85	.020	29.092	.0217	22.82	.0155	25
25.00	0.000	6.87	.023	29.122	.0263	22.84	.0193	25
30.00	0.000	6.88	.024	29.142	.0297	22.85	.0216	25
35.00	0.000	6.89	.024	29.177	.0508	22.88	.0373	25
40.00	0.000	6.91	.028	29.238	.0696	22.93	.0516	25
45.00	0.000	6.93	.037	29.315	.0608	22.98	.0485	25
50.00	0.000	6.92	.057	29.360	.0542	23.02	.0467	25
55.00	0.000	6.89	.081	29.411	.0615	23.06	.0543	25
60.00	0.000	6.86	.089	29.466	.0510	23.11	.0469	25
65.00	0.000	6.81	.079	29.516	.0380	23.16	.0368	25
70.00	0.000	6.80	.086	29.540	.0274	23.18	.0281	25
75.00	0.000	6.78	.076	29.558	.0166	23.19	.0172	25
80.00	0.000	6.76	.075	29.570	.0171	23.20	.0133	25
85.00	0.000	6.74	.101	29.574	.0162	23.21	.0117	25
90.00	0.000	6.70	.115	29.579	.0183	23.22	.0129	25
95.00	0.000	6.67	.116	29.584	.0185	23.23	.0105	25
100.00	0.000	6.65	.108	29.588	.0237	23.23	.0123	25
105.00	0.000	6.62	.113	29.591	.0233	23.24	.0107	25
110.00	0.000	6.60	.116	29.596	.0243	23.25	.0115	25
115.00	0.000	6.58	.110	29.601	.0224	23.25	.0118	25
120.00	0.000	6.56	.105	29.604	.0229	23.26	.0121	25
125.00	0.000	6.53	.094	29.606	.0224	23.26	.0123	25
130.00	0.000	6.51	.086	29.613	.0235	23.27	.0131	25
135.00	0.000	6.52	.100	29.622	.0242	23.28	.0120	25
140.00	0.000	6.51	.107	29.631	.0211	23.28	.0117	25
145.00	0.000	6.49	.092	29.640	.0220	23.29	.0138	25
150.00	0.000	6.49	.107	29.654	.0236	23.30	.0178	25
155.00	0.000	6.47	.102	29.665	.0244	23.31	.0220	25
160.00	0.000	6.44	.099	29.674	.0247	23.33	.0246	25
165.00	0.000	6.43	.102	29.688	.0240	23.34	.0246	25
170.00	0.000	6.40	.104	29.704	.0258	23.35	.0276	25
175.00	0.000	6.36	.063	29.717	.0396	23.37	.0363	25
180.00	0.000	6.33	.039	29.734	.0386	23.39	.0336	25
185.00	0.000	6.31	.033	29.758	.0430	23.41	.0362	25
190.00	0.000	6.29	.031	29.784	.0491	23.43	.0406	25
195.00	0.000	6.28	.030	29.814	.0484	23.45	.0398	21

MOORING•2

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
1.38	6.921	6.73	.067	28.968	1.2438	22.74	.9830	14
5.00	0.000	6.78	.033	28.469	.2064	22.34	.1616	19
10.00	0.000	6.80	.021	28.665	.1111	22.49	.0865	24
15.00	0.000	6.81	.014	28.777	.0774	22.58	.0608	24
20.00	0.000	6.81	.012	28.828	.0699	22.62	.0551	25
25.00	0.000	6.82	.010	28.869	.0584	22.65	.0465	25
30.00	0.000	6.81	.012	28.915	.0513	22.68	.0412	25
35.00	0.000	6.81	.013	28.963	.0589	22.74	.0475	25
40.00	0.000	6.80	.021	29.039	.0815	22.78	.0663	25
45.00	0.000	6.78	.022	29.098	.0888	22.83	.0720	25
50.00	0.000	6.77	.017	29.161	.0621	22.88	.0504	25
55.00	0.000	6.76	.017	29.217	.0483	22.93	.0393	25
60.00	0.000	6.75	.013	29.255	.0328	22.96	.0270	25
65.00	0.000	6.74	.012	29.283	.0273	22.98	.0225	25
70.00	0.000	6.74	.010	29.303	.0255	23.00	.0207	25
75.00	0.000	6.73	.012	29.321	.0314	23.01	.0251	25
80.00	0.000	6.73	.008	29.339	.0304	23.03	.0239	25
85.00	0.000	6.72	.012	29.357	.0338	23.04	.0268	25
90.00	0.000	6.72	.013	29.377	.0341	23.06	.0269	25
95.00	0.000	6.72	.013	29.393	.0345	23.07	.0269	25
100.00	0.000	6.72	.017	29.410	.0325	23.08	.0253	25
105.00	0.000	6.72	.014	29.422	.0328	23.09	.0251	25
110.00	0.000	6.72	.011	29.440	.0348	23.11	.0272	25
115.00	0.000	6.72	.013	29.455	.0337	23.12	.0264	25
120.00	0.000	6.72	.010	29.472	.0355	23.13	.0280	25
125.00	0.000	6.72	.011	29.493	.0396	23.15	.0319	25
130.00	0.000	6.71	.013	29.511	.0449	23.16	.0365	25
135.00	0.000	6.71	.019	29.528	.0474	23.18	.0391	25
140.00	0.000	6.70	.018	29.544	.0468	23.19	.0386	25
145.00	0.000	6.70	.024	29.558	.0470	23.20	.0395	25
150.00	0.000	6.70	.027	29.571	.0492	23.21	.0416	25
155.00	0.000	6.69	.022	29.592	.0480	23.23	.0399	25
160.00	0.000	6.68	.017	29.609	.0442	23.24	.0366	25
165.00	0.000	6.68	.012	29.620	.0429	23.25	.0351	25
170.00	0.000	6.68	.010	29.632	.0393	23.26	.0320	25
175.00	0.000	6.67	.008	29.644	.0339	23.27	.0275	25
180.00	0.000	6.67	.008	29.656	.0267	23.28	.0218	24
185.00	0.000	6.67	.005	29.664	.0231	23.29	.0188	24
190.00	0.000	6.67	.007	29.669	.0197	23.29	.0160	24
195.00	0.000	6.67	.006	29.670	.0190	23.29	.0152	18

MOORING (WEST)

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
.81	3.854	6.63	.119	28.386	.2296	22.29	.1746	12
5.00	0.900	6.71	.056	28.652	.1540	22.49	.1170	12
10.00	0.000	6.85	.039	29.028	.0761	22.77	.0554	12
15.00	0.000	6.89	.022	29.117	.0278	22.83	.0217	12
20.00	0.000	6.91	.023	29.152	.0322	22.86	.0238	12
25.00	0.000	6.92	.021	29.205	.0416	22.90	.0310	12
30.00	0.000	6.93	.016	29.277	.0533	22.95	.0407	12
35.00	0.000	6.94	.009	29.340	.0541	23.00	.0428	12
40.00	0.000	6.93	.019	29.408	.0403	23.06	.0325	12
45.00	0.000	6.91	.041	29.442	.0248	23.09	.0223	12
50.00	0.000	6.86	.065	29.466	.0135	23.11	.0163	12
55.00	0.000	6.82	.057	29.487	.0211	23.13	.0214	12
60.00	0.000	6.79	.052	29.512	.0243	23.15	.0224	12
65.00	0.000	6.77	.077	29.523	.0253	23.17	.0265	12
70.00	0.000	6.73	.087	29.543	.0207	23.19	.0237	12
75.00	0.000	6.72	.096	29.556	.0175	23.20	.0199	12
80.00	0.000	6.70	.089	29.573	.0103	23.21	.0100	12
85.00	0.000	6.67	.077	29.576	.0115	23.22	.0094	12
90.00	0.000	6.63	.064	29.577	.0071	23.23	.0099	12
95.00	0.000	6.59	.053	29.584	.0092	23.24	.0101	12
100.00	0.000	6.55	.068	29.596	.0169	23.25	.0169	12
105.00	0.000	6.53	.072	29.600	.0204	23.26	.0193	12
110.00	0.000	6.51	.074	29.612	.0267	23.27	.0248	12
115.00	0.000	6.48	.069	29.622	.0352	23.28	.0305	12
120.00	0.000	6.46	.062	29.631	.0366	23.29	.0310	12
125.00	0.000	6.46	.062	29.639	.0327	23.30	.0286	12
130.00	0.000	6.44	.052	29.644	.0298	23.30	.0267	12
135.00	0.000	6.42	.049	29.652	.0274	23.31	.0240	12
140.00	0.000	6.40	.033	29.667	.0364	23.32	.0311	12
145.00	0.000	6.39	.035	29.688	.0571	23.34	.0477	12
150.00	0.000	6.38	.035	29.702	.0618	23.36	.0509	12
155.00	0.000	6.37	.034	29.715	.0615	23.37	.0504	12
160.00	0.000	6.35	.016	29.741	.0514	23.39	.0408	12
165.00	0.000	6.34	.023	29.772	.0510	23.41	.0407	12
170.00	0.000	6.33	.020	29.807	.0673	23.44	.0528	9

MOORING (EAST)

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
.73	3.727	6.66	.136	28.535	.3095	22.40	.2328	12
5.00	0.000	6.73	.128	28.782	.1861	22.59	.1335	12
10.00	0.000	6.81	.040	29.007	.0633	22.76	.0467	12
15.00	0.000	6.84	.022	29.050	.0387	22.79	.0283	12
20.00	0.000	6.85	.007	29.074	.0377	22.80	.0290	12
25.00	0.000	6.85	.007	29.103	.0286	22.83	.0224	12
30.00	0.000	6.86	.015	29.156	.0456	22.87	.0343	12
35.00	0.000	6.88	.025	29.216	.0565	22.91	.0424	12
40.00	0.000	6.90	.029	29.287	.0753	22.97	.0575	12
45.00	0.000	6.90	.037	29.336	.0682	23.00	.0521	12
50.00	0.000	6.89	.042	29.402	.0644	23.06	.0526	12
55.00	0.000	6.87	.048	29.470	.0447	23.11	.0382	12
60.00	0.000	6.84	.046	29.520	.0380	23.16	.0333	12
65.00	0.000	6.80	.051	29.554	.0297	23.19	.0279	12
70.00	0.000	6.79	.051	29.573	.0144	23.20	.0158	12
75.00	0.000	6.75	.042	29.586	.0096	23.22	.0112	12
80.00	0.000	6.72	.054	29.585	.0101	23.22	.0095	12
85.00	0.000	6.69	.050	29.594	.0120	23.23	.0139	12
90.00	0.000	6.66	.045	29.599	.0138	23.24	.0143	12
95.00	0.000	6.66	.038	29.609	.0203	23.25	.0182	12
100.00	0.000	6.65	.031	29.613	.0196	23.25	.0174	12
105.00	0.000	6.63	.032	29.617	.0177	23.26	.0128	12
110.00	0.000	6.62	.043	29.623	.0138	23.26	.0102	12
115.00	0.000	6.61	.054	29.626	.0147	23.27	.0126	12
120.00	0.000	6.61	.047	29.633	.0168	23.27	.0143	12
125.00	0.000	6.59	.058	29.640	.0195	23.28	.0179	12
130.00	0.000	6.59	.078	29.648	.0263	23.29	.0273	12
135.00	0.000	6.57	.082	29.656	.0285	23.29	.0309	12
140.00	0.000	6.56	.091	29.662	.0309	23.30	.0340	12
145.00	0.000	6.55	.096	29.675	.0307	23.31	.0353	12
150.00	0.000	6.51	.096	29.683	.0339	23.32	.0379	12
155.00	0.000	6.47	.093	29.696	.0358	23.34	.0387	12
160.00	0.000	6.44	.097	29.712	.0418	23.35	.0440	12
165.00	0.000	6.41	.082	29.734	.0473	23.38	.0463	11
170.00	0.000	6.39	.065	29.755	.0543	23.40	.0499	10
175.00	0.000	6.34	.049	29.780	.0652	23.42	.0568	7
180.00	0.000	6.34	.024	29.866	.0632	23.49	.0508	5
185.00	0.000	6.33	.015	29.902	.0204	23.52	.0142	2
190.00	0.000	6.32	0.000	29.886	0.0000	23.51	0.0000	1

POINT JEFFERSON

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
.99	2.321	6.76	.045	28.657	.2818	22.49	.2165	11
5.00	0.000	6.75	.050	28.723	.2478	22.54	.1894	12
10.00	0.000	6.80	.042	28.944	.1290	22.71	.0984	12
15.00	0.000	6.83	.028	29.051	.0456	22.79	.0343	12
20.00	0.000	6.86	.027	29.110	.0331	22.83	.0239	12
25.00	0.000	6.87	.033	29.170	.0537	22.88	.0412	12
30.00	0.000	6.87	.043	29.222	.0734	22.92	.0582	12
35.00	0.000	6.86	.051	29.261	.0959	22.95	.0759	12
40.00	0.000	6.85	.053	29.315	.1004	22.99	.0864	12
45.00	0.000	6.82	.050	29.372	.1119	23.04	.0909	12
50.00	0.000	6.80	.070	29.422	.1110	23.08	.0924	12
55.00	0.000	6.76	.073	29.467	.1018	23.12	.0864	12
60.00	0.000	6.71	.061	29.527	.0442	23.18	.0407	12
65.00	0.000	6.68	.029	29.545	.0291	23.20	.0244	12
70.00	0.000	6.66	.030	29.550	.0220	23.21	.0187	12
75.00	0.000	6.64	.028	29.568	.0227	23.22	.0200	12
80.00	0.000	6.62	.037	29.583	.0233	23.23	.0211	12
85.00	0.000	6.59	.043	29.600	.0225	23.25	.0206	12
90.00	0.000	6.57	.043	29.614	.0247	23.26	.0228	12
95.00	0.000	6.56	.046	29.623	.0278	23.27	.0259	12
100.00	0.000	6.55	.042	29.628	.0288	23.28	.0259	12
105.00	0.000	6.51	.053	29.643	.0286	23.29	.0257	12
110.00	0.000	6.48	.051	29.654	.0262	23.30	.0229	12
115.00	0.000	6.47	.052	29.669	.0299	23.32	.0257	12
120.00	0.000	6.47	.052	29.683	.0326	23.33	.0258	12
125.00	0.000	6.47	.067	29.699	.0476	23.34	.0370	12
130.00	0.000	6.47	.059	29.714	.0476	23.35	.0348	12
135.00	0.000	6.47	.058	29.735	.0515	23.37	.0377	12
140.00	0.000	6.48	.060	29.750	.0488	23.38	.0346	12
145.00	0.000	6.49	.058	29.776	.0541	23.40	.0381	12
150.00	0.000	6.49	.055	29.793	.0567	23.41	.0407	12
155.00	0.000	6.48	.056	29.816	.0630	23.43	.0460	12
160.00	0.000	6.48	.057	29.852	.0636	23.46	.0490	12
165.00	0.000	6.48	.051	29.874	.0600	23.48	.0468	12
170.00	0.000	6.48	.052	29.897	.0507	23.50	.0399	12
175.00	0.000	6.48	.045	29.915	.0408	23.51	.0334	12
180.00	0.000	6.48	.043	29.932	.0381	23.52	.0319	12
185.00	0.000	6.47	.044	29.945	.0395	23.53	.0331	12
190.00	0.000	6.48	.048	29.958	.0376	23.54	.0321	12
195.00	0.000	6.48	.044	29.970	.0308	23.55	.0266	12
200.00	0.000	6.48	.039	29.983	.0422	23.56	.0352	12
205.00	0.000	6.47	.030	30.000	.0426	23.58	.0342	12
210.00	0.000	6.48	.028	30.013	.0440	23.59	.0349	12
215.00	0.000	6.47	.031	30.030	.0473	23.60	.0377	12
220.00	0.000	6.47	.033	30.041	.0428	23.61	.0342	12
225.00	0.000	6.47	.030	30.062	.0436	23.63	.0339	12
230.00	0.000	6.47	.034	30.069	.0419	23.63	.0322	11
235.00	0.000	6.47	.029	30.091	.0409	23.65	.0313	11
240.00	0.000	6.47	.031	30.109	.0449	23.66	.0337	10
245.00	0.000	6.47	.034	30.120	.0465	23.67	.0344	10
250.00	0.000	6.47	.031	30.123	.0457	23.68	.0335	9
255.00	0.000	6.46	.032	30.134	.0462	23.68	.0337	9
260.00	0.000	6.48	.013	30.157	.0287	23.70	.0233	8
265.00	0.000	6.47	.010	30.156	.0236	23.70	.0185	8
270.00	0.000	6.48	.014	30.155	.0200	23.70	.0161	5
275.00	0.000	6.47	.007	30.160	.0257	23.70	.0208	3
280.00	0.000	6.48	0.000	30.127	0.0000	23.68	0.0000	1
285.00	0.000	6.49	0.000	30.139	0.0000	23.69	0.0000	1

WEST POINT

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
1.09	3.446	6.78	.073	28.865	.2126	22.65	.1587	12
5.00	0.000	6.78	.072	28.895	.1875	22.67	.1395	12
10.00	0.000	6.81	.049	28.998	.1027	22.75	.0752	12
15.00	0.000	6.86	.039	29.088	.0692	22.81	.0498	12
20.00	0.000	6.88	.036	29.127	.0607	22.84	.0437	12
25.00	0.000	6.91	.026	29.166	.0819	22.87	.0621	12
30.00	0.000	6.93	.024	29.258	.0598	22.94	.0451	12
35.00	0.000	6.94	.017	29.314	.0674	22.98	.0522	12
40.00	0.000	6.94	.015	29.393	.0494	23.04	.0379	12
45.00	0.000	6.92	.032	29.444	.0527	23.09	.0438	12
50.00	0.000	6.91	.051	29.472	.0496	23.11	.0439	12
55.00	0.000	6.86	.055	29.518	.0274	23.15	.0276	12
60.00	0.000	6.82	.050	29.543	.0267	23.18	.0265	12
65.00	0.000	6.79	.042	29.563	.0206	23.20	.0185	12
70.00	0.000	6.75	.055	29.577	.0268	23.21	.0206	12
75.00	0.000	6.75	.060	29.593	.0289	23.22	.0198	12
80.00	0.000	6.75	.113	29.604	.0307	23.23	.0161	12
85.00	0.000	6.73	.118	29.612	.0249	23.24	.0101	12
90.00	0.000	6.71	.135	29.617	.0212	23.25	.0087	12
95.00	0.000	6.70	.162	29.622	.0309	23.25	.0118	12
100.00	0.000	6.68	.192	29.626	.0278	23.26	.0085	12
105.00	0.000	6.67	.210	29.631	.0349	23.26	.0078	12
110.00	0.000	6.66	.229	29.637	.0338	23.27	.0101	12
115.00	0.000	6.65	.218	29.641	.0324	23.27	.0097	12
120.00	0.000	6.67	.235	29.651	.0334	23.28	.0157	12
125.00	0.000	6.61	.203	29.648	.0325	23.28	.0195	12
130.00	0.000	6.52	.058	29.636	.0321	23.29	.0306	12
135.00	0.000	6.49	.025	29.652	.0229	23.30	.0195	12
140.00	0.000	6.47	.040	29.662	.0260	23.31	.0223	12
145.00	0.000	6.45	.037	29.679	.0350	23.33	.0296	12
150.00	0.000	6.43	.040	29.698	.0415	23.34	.0333	12
155.00	0.000	6.42	.041	29.705	.0391	23.35	.0321	12
160.00	0.000	6.42	.039	29.712	.0387	23.36	.0315	12
165.00	0.000	6.41	.035	29.721	.0403	23.37	.0316	12
170.00	0.000	6.41	.036	29.732	.0407	23.37	.0314	12
175.00	0.000	6.41	.039	29.746	.0385	23.38	.0297	12
180.00	0.000	6.41	.041	29.755	.0436	23.39	.0336	12
185.00	0.000	6.41	.039	29.766	.0556	23.40	.0423	12
190.00	0.000	6.41	.033	29.791	.0614	23.42	.0465	12
195.00	0.000	6.41	.036	29.818	.0733	23.44	.0550	12
200.00	0.000	6.41	.036	29.840	.0819	23.46	.0617	12
205.00	0.000	6.41	.036	29.864	.0844	23.48	.0632	12
210.00	0.000	6.40	.041	29.893	.0812	23.50	.0606	12
215.00	0.000	6.41	.044	29.917	.0752	23.52	.0551	12
220.00	0.000	6.41	.042	29.946	.0629	23.54	.0446	12
225.00	0.000	6.43	.037	29.992	.0538	23.58	.0383	9

VASHON ISLAND

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
.81	7.065	6.61	.083	28.581	.2843	22.45	.2146	23
5.00	0.000	6.60	.112	28.726	.2088	22.56	.1525	24
10.00	0.000	6.66	.105	28.907	.1229	22.70	.0861	24
15.00	0.000	6.73	.073	28.992	.0537	22.75	.0368	25
20.00	0.000	6.77	.056	29.029	.0392	22.78	.0282	25
25.00	0.000	6.81	.071	29.068	.0506	22.80	.0336	25
30.00	0.000	6.84	.066	29.100	.0394	22.83	.0238	25
35.00	0.000	6.87	.061	29.142	.0634	22.86	.0431	25
40.00	0.000	6.91	.066	29.222	.0946	22.91	.0666	25
45.00	0.000	6.94	.062	29.288	.0991	22.96	.0703	25
50.00	0.000	6.98	.062	29.370	.1286	23.02	.0939	25
55.00	0.000	6.99	.057	29.425	.1320	23.06	.0981	25
60.00	0.000	7.01	.053	29.493	.1199	23.11	.0898	25
65.00	0.000	7.03	.051	29.552	.0754	23.16	.0587	25
70.00	0.000	7.02	.082	29.591	.0371	23.19	.0344	25
75.00	0.000	6.99	.096	29.605	.0313	23.20	.0290	25
80.00	0.000	6.96	.076	29.613	.0284	23.21	.0244	25
85.00	0.000	6.94	.067	29.626	.0295	23.23	.0223	25
90.00	0.000	6.96	.073	29.643	.0278	23.24	.0152	25
95.00	0.000	6.97	.078	29.655	.0229	23.25	.0107	25
100.00	0.000	6.98	.087	29.663	.0221	23.25	.0090	25
105.00	0.000	7.00	.074	29.672	.0181	23.25	.0068	25
110.00	0.000	7.02	.056	29.680	.0127	23.26	.0057	25
115.00	0.000	7.04	.064	29.686	.0141	23.26	.0062	25
120.00	0.000	7.04	.069	29.688	.0160	23.26	.0070	25
125.00	0.000	7.06	.065	29.696	.0151	23.27	.0063	25
130.00	0.000	7.08	.073	29.703	.0172	23.27	.0062	25
135.00	0.000	7.11	.070	29.710	.0137	23.27	.0038	25
140.00	0.000	7.13	.064	29.715	.0147	23.27	.0057	25
145.00	0.000	7.15	.067	29.720	.0147	23.27	.0046	25
150.00	0.000	7.15	.069	29.723	.0132	23.28	.0045	25
155.00	0.000	7.16	.065	29.727	.0113	23.28	.0053	25
160.00	0.000	7.18	.064	29.732	.0107	23.28	.0042	25
165.00	0.000	7.18	.079	29.734	.0165	23.28	.0064	25
170.00	0.000	7.18	.097	29.739	.0160	23.28	.0051	25
175.00	0.000	7.17	.140	29.739	.0267	23.29	.0053	25
180.00	0.000	7.16	.186	29.742	.0294	23.29	.0054	25
185.00	0.000	7.12	.218	29.737	.0390	23.29	.0126	19
190.00	0.000	7.02	.276	29.731	.0480	23.30	.0026	4

POINT NO POINT

DEPTH (M)		TEMPERATURE (C)		SALINTY (PER MIL)		SIGMA-T (G/L)		
.70	.813	6.20	.058	28.431	.1666	22.38	.1264	5
5.00	0.000	6.28	.141	28.631	.2617	22.52	.1918	7
10.00	0.000	6.31	.148	28.708	.2605	22.58	.1898	19
15.00	0.000	6.43	.156	28.920	.2601	22.73	.1886	20
20.00	0.000	6.53	.100	29.102	.1762	22.87	.1295	20
25.00	0.000	6.57	.087	29.197	.1130	22.94	.0834	20
30.00	0.000	6.53	.127	29.211	.1487	22.95	.1071	21
35.00	0.000	6.54	.118	29.261	.1062	22.99	.0778	21
40.00	0.000	6.54	.139	29.303	.0831	23.02	.0583	21
45.00	0.000	6.53	.139	29.331	.0745	23.04	.0520	21
50.00	0.000	6.50	.144	29.354	.0680	23.07	.0480	21
55.00	0.000	6.49	.152	29.384	.0695	23.09	.0518	21
60.00	0.000	6.49	.157	29.409	.0643	23.11	.0441	21
65.00	0.000	6.48	.158	29.426	.0569	23.13	.0381	21
70.00	0.000	6.45	.151	29.446	.0501	23.14	.0314	21
75.00	0.000	6.43	.142	29.459	.0421	23.16	.0264	21
80.00	0.000	6.41	.132	29.466	.0401	23.17	.0303	21
85.00	0.000	6.39	.121	29.473	.0386	23.17	.0291	21
90.00	0.000	6.38	.108	29.481	.0366	23.18	.0295	21
95.00	0.000	6.37	.107	29.489	.0352	23.19	.0307	21
100.00	0.000	6.35	.091	29.494	.0435	23.19	.0383	21
105.00	0.000	6.34	.082	29.508	.0460	23.21	.0407	21
110.00	0.000	6.33	.078	29.522	.0532	23.22	.0475	21
115.00	0.000	6.33	.080	29.528	.0555	23.22	.0503	21
120.00	0.000	6.32	.072	29.544	.0602	23.24	.0538	21
125.00	0.000	6.30	.065	29.552	.0605	23.25	.0532	21
130.00	0.000	6.30	.061	29.559	.0632	23.25	.0553	21
135.00	0.000	6.29	.054	29.567	.0539	23.26	.0468	21
140.00	0.000	6.29	.057	29.576	.0531	23.27	.0465	21
145.00	0.000	6.28	.057	29.582	.0518	23.27	.0457	21
150.00	0.000	6.28	.056	29.586	.0505	23.28	.0446	21
155.00	0.000	6.27	.051	29.593	.0534	23.28	.0467	21
160.00	0.000	6.26	.043	29.603	.0580	23.29	.0497	21
165.00	0.000	6.26	.044	29.607	.0616	23.29	.0526	21
170.00	0.000	6.26	.041	29.612	.0581	23.30	.0497	21
175.00	0.000	6.25	.046	29.626	.0763	23.31	.0645	21
180.00	0.000	6.25	.045	29.634	.0841	23.32	.0707	21
185.00	0.000	6.24	.052	29.654	.1088	23.33	.0909	21
190.00	0.000	6.24	.052	29.673	.1192	23.35	.0989	21
195.00	0.000	6.23	.044	29.697	.1301	23.37	.1069	20
200.00	0.000	6.22	.054	29.739	.1429	23.40	.1180	10

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