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Temperature and Salinity Observations at Surface and near Bottom over the Eastern Bering Sea Shelf, averaged by 1° x ½° squares

October 1981

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TEMPERATURE AND SALINITY OBSERVATIONS AT SURFACE AND NEAR BOTTOM OVER THE EASTERN BERING SEA SHELF, AVERAGED BY $1^{\circ} \times 1/2^{\circ}$ SQUARES

By

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Ecosystem Model Task

RESOURCE ECOLOGY AND FISHERIES MANAGEMENT DIVISION

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INTRODUCTION

Water temperature affects growth, migrations, and survival of all biota in the sea. The seasonal and annual variations in water temperature are quite pronounced in high latitudes such as the Bering Sea where also pronounced anomalies can occur over the extensive, shallow eastern Bering Sea shelf. These anomalies must be taken into account in fisheries research, predictions, and in holistic ecosystem modeling.

To detect environmental anomalies, we must first know mean conditions. This report is an attempt to summarize the available observations of temperature and salinity from the eastern Bering Sea on a monthly time and $1^{o} \times 1/2^{o}$ space scale. The general ocean conditions and features which appear in these mean data charts presented here are discussed by Ingraham (1981). Earlier data summaries and atlases for the Bering Sea were presented by Laviolette and Seim (1969), Ingraham (1973), and Robinson and Bauer (1976).

DATA SUMMARY

The computer file for the eastern Bering Sea contains about 9,000 Bathythermograph (mechanical and expendable) and 10,000 Nansen cast salinity, temperature, and depth data stations from 1932 to June 1979. NODC (National Oceanographic Data Center) data files were the primary source of the salinity and temperature data before 1975. More recent data were obtained by NWAFC (Northwest and Alaska Fisheries Center), IPHC (International Pacific Halibut Commission), OCSEAP (Outer Continental Shelf Environmental Assessment Program) and PROBES (Processes and Resources of the Eastern Bering Sea) groups, and some data were obtained from Russian and Japanese publications. The total of 19,126 stations from the eastern Bering Sea averages only about 400 stations per year or 33 per month over a large eastern Bering Sea area of about 1.5×10^6 km^2. There were no data from 1942-46 or from 1950 or 1952. Also, no data were taken during any December, and November and January data totaled less than 50 stations each. The best data coverage was from 1975-78 with a maximum of about 2,000 stations in 1976.

The data were tested by various quality control criteria which reduced the number of acceptable data points. The rejection criteria for the various quality controls which were imposed while sorting the data, were:

1. Outside of latitude range, 54°-68°N;
2. Outside of longitude range, 175°E-157.2^{o}W;
3. Station depth greater than twice chart depth (position error implied on shelf);
4. Temperature values identically zero (missing data) or less than -2.0^{o}C;
5. Salinity values less than 10 ^{o}/oo; and
6. Bottom values more than 15 m or greater than 20% of water depth from the bottom.

Accepted values were sorted by location into $1/2^{o}$ (lat.) and 1° (long.) squares. Simple monthly arithmetic means were computed for each square and written by Calcomp Plotter in the center of each square on a Mercator map (Figures 1 to 43). The smaller number below each mean value is the number of observations used to compute each mean. The distribution of the number of final data values in time (by month and by year) for each parameter are shown in Tables 1-4, respectively. This report contains charts of long-term monthly mean sea surface temperature (Figures 1-11), near bottom temperature (Figures 12-22), surface salinity (Figures 23-33), and near bottom salinity (Figures 34-44). Because of the absence of data, no December monthly means are presented.

Caution is advised that there are several limitations to the presentations of mean conditions in this report. First, the amount of data are not sufficient for summaries by $1^{o} \times 1/2^{o}$ quadrangles (nor even 2×2°). Thus, there are numerous spatial data gaps in each month. Data from October to March were very limited. Secondly, the data from warm and cold years are not equally distributed; in some instances the values represent conditions in warm or cold years. The paucity of data can create isolated anomalous values and tongue-like protrusions that may merely reflect a preponderance of data from a single anomalous year rather than a significant mean environmental feature. Nevertheless, the data reflect a high degree of continuity of conditions throughout the area that cannot be obtained in any other manner.

LITERATURE CITED

Ingraham, W. J., Jr.

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Laviolette, P. E., and S. E. Seim.

1969. Monthly charts of mean, minimum, and maximum sea surface temperature of the North Pacific Ocean. U.S. Naval Oceanographic Office, special publication No. 123:1-58.

Robinson, M. K., and R. A. Bauer.

1976. Atlas of North Pacific Ocean monthly mean temperatures and mean salinities of the surface layer. U.S. Naval Oceanographic Office, Reference Publication No. 2:173 figures.

Table 1.--Number of accepted sea surface temperature values by year and month with totals.

MONTH=	1	2	3	4	5	6	7	8	9	10	11	12	
YEAR													TOTAL
1932	0	0	0	0	0	0	6	112	13	0	0	0	131
1933	0	0	0	0	0	0	17	78	0	0	0	0	95
1934	0	0	0	0	0	0	37	89	0	0	0	0	126
1935	0	0	0	0	0	0	9	23	0	0	0	0	32
1936	0	0	0	0	0	0	1	3	0	0	0	0	4
1937	0	0	0	0	0	60	79	19	36	0	0	0	214
1938	0	0	0	0	0	0	0	137	81	0	0	0	218
1939	0	0	0	0	14	91	139	112	6	0	0	0	362
1940	0	0	0	0	0	0	71	70	0	0	0	0	141
1941	0	0	0	0	27	11	39	0	0	0	0	0	77
1942	0	0	0	0	0	0	0	0	0	0	0	0	0
1943	0	0	0	0	0	0	0	0	0	0	0	0	0
1944	0	0	0	0	0	0	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0	0	0	0	0	0	0
1947	0	0	0	0	0	0	10	9	0	0	0	0	19
1948	0	0	0	0	0	0	11	15	0	0	0	0	26
1949	0	0	0	0	0	0	27	78	0	0	0	0	105
1950	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	4	22	0	0	0	0	0	0	0	0	0	0	26
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	1	0	15	125	38	0	0	0	179
1954	0	0	0	3	51	13	42	20	54	0	0	0	183
1955	0	0	24	40	20	43	11	8	7	0	0	0	153
1956	0	0	0	0	0	12	60	63	23	0	0	0	158
1957	0	0	0	0	0	43	70	96	0	0	0	0	209
1958	0	0	0	0	1	56	114	35	10	0	0	0	216
1959	0	0	1	0	0	116	113	55	35	2	0	0	322
1960	3	18	0	0	0	41	168	421	20	31	0	0	702
1961	0	0	43	68	23	114	115	98	171	9	0	0	641
1962	0	0	0	0	24	38	82	9	195	58	0	0	406
1963	0	0	2	0	12	64	66	43	14	0	4	0	225
1964	0	0	41	33	37	53	78	49	8	1	2	0	302
1965	0	0	5	12	1	98	106	41	1	0	0	0	264
1966	0	7	2	2	70	256	174	74	0	1	0	0	586
1967	0	0	0	0	8	200	250	110	8	0	0	0	576
1968	0	42	0	0	0	160	315	17	0	0	0	0	534
1969	0	15	5	111	69	225	206	86	1	0	0	0	718
1970	1	24	21	37	48	175	137	99	117	15	0	0	678
1971	0	3	9	27	43	392	49	68	58	0	0	0	649
1972	0	10	9	1	47	158	146	68	39	11	0	0	489
1973	0	2	4	44	55	153	206	34	7	8	3	0	516
1974	0	0	5	44	42	159	249	46	0	11	1	0	557
1975	11	9	17	6	91	271	175	344	357	129	33	0	1443
1976	5	2	62	160	341	469	209	253	377	133	0	0	2011
1977	0	26	16	53	217	134	234	241	181	12	0	0	1114
1978	0	25	20	179	215	400	174	70	0	0	0	0	1083
1979	0	0	0	115	144	122	0	0	0	0	0	0	381
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TOTAL	24	205	286	935	1601	4151	4030	3318	1857	421	43	0	16871

Table 2.--Number of accepted near bottom temperature values by year and month with totals.

MONTH=	1	2	3	4	5	6	7	8	9	10	11	12	
YEAR													TOTAL
1932	0	0	0	0	0	0	6	106	12	0	0	0	124
1933	0	0	0	0	0	0	16	78	0	0	0	0	94
1934	0	0	0	0	0	0	19	65	0	0	0	0	84
1935	0	0	0	0	0	0	0	20	0	0	0	0	20
1936	0	0	0	0	0	0	0	0	0	0	0	0	0
1937	0	0	0	0	0	74	52	12	27	0	0	0	165
1938	0	0	0	0	0	0	0	116	75	0	0	0	191
1939	0	0	0	0	14	91	134	93	6	0	0	0	338
1940	0	0	0	0	0	0	70	69	0	0	0	0	139
1941	0	0	0	0	22	11	23	0	0	0	0	0	56
1942	0	0	0	0	0	0	0	0	0	0	0	0	0
1943	0	0	0	0	0	0	0	0	0	0	0	0	0
1944	0	0	0	0	0	0	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0	0	0	0	0	0	0
1947	0	0	0	0	0	0	9	4	0	0	0	0	13
1948	0	0	0	0	0	0	11	6	0	0	0	0	17
1949	0	0	0	0	0	0	10	70	0	0	0	0	80
1950	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	4	22	0	0	0	0	0	0	0	0	0	0	26
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	14	40	9	0	0	0	63
1954	0	0	0	0	25	2	26	9	27	0	0	0	89
1955	0	0	24	27	15	40	8	2	2	0	0	0	118
1956	0	0	0	0	0	0	4	14	8	0	0	0	26
1957	0	0	0	0	0	9	15	29	0	0	0	0	53
1958	0	0	0	0	1	13	50	16	7	0	0	0	87
1959	0	0	0	0	0	33	55	33	29	1	0	0	151
1960	3	15	0	0	0	1	150	81	14	23	0	0	287
1961	0	0	5	47	1	33	80	41	122	3	0	0	332
1962	0	0	0	0	1	20	36	3	151	21	0	0	232
1963	0	0	0	0	0	15	44	11	2	0	1	0	73
1964	0	0	9	15	6	30	41	43	1	1	1	0	147
1965	0	0	3	2	1	28	58	1	0	0	0	0	93
1966	0	3	0	0	1	100	127	31	0	0	0	0	262
1967	0	0	0	0	3	74	93	93	0	0	0	0	263
1968	0	39	0	0	0	26	228	13	0	0	0	0	306
1969	0	15	4	111	67	152	112	60	1	0	0	0	522
1970	1	12	21	35	43	61	13	95	42	11	0	0	334
1971	0	0	8	7	0	85	16	46	52	0	0	0	214
1972	0	1	3	0	24	50	103	51	12	3	0	0	247
1973	0	0	0	25	3	31	80	22	1	0	0	0	162
1974	0	0	1	13	1	9	73	27	0	4	0	0	128
1975	2	1	5	1	29	75	62	141	190	78	22	0	606
1976	0	0	47	60	135	179	39	199	236	111	0	0	1006
1977	0	26	11	48	213	73	114	150	177	10	0	0	822
1978	0	6	0	145	165	170	9	1	0	0	0	0	496
1979	0	0	0	103	139	120	0	0	0	0	0	0	362
TOTAL	10	140	141	639	909	1605	2000	1891	1203	266	24	0	8828

Table 3.--Number of accepted sea surface salinity values by year and month with totals.

MONTH=	1	2	3	4	5	6	7	8	9	10	11	12	
YEAR													TOTAL
1932	0	0	0	0	0	0	6	110	14	0	0	0	130
1933	0	0	0	0	0	0	17	78	0	0	0	0	95
1934	0	0	0	0	0	0	37	89	0	0	0	0	126
1935	0	0	0	0	0	0	9	23	0	0	0	0	32
1936	0	0	0	0	0	0	1	3	0	0	0	0	4
1937	0	0	0	0	0	79	81	19	36	0	0	0	215
1938	0	0	0	0	0	0	0	138	82	0	0	0	220
1939	0	0	0	0	14	91	139	112	6	0	0	0	362
1940	0	0	0	0	0	0	71	70	0	0	0	0	141
1941	0	0	0	0	27	11	12	0	0	0	0	0	50
1942	0	0	0	0	0	0	0	0	0	0	0	0	0
1943	0	0	0	0	0	0	0	0	0	0	0	0	0
1944	0	0	0	0	0	0	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0	0	0	0	0	0	0
1947	0	0	0	0	0	0	10	9	0	0	0	0	19
1948	0	0	0	0	0	0	11	15	0	0	0	0	26
1949	0	0	0	0	0	0	27	78	0	0	0	0	105
1950	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	4	20	0	0	0	0	0	0	0	0	0	0	24
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	1	0	1	5	7	0	0	0	14
1954	0	0	0	0	17	10	0	0	3	0	0	0	30
1955	0	0	24	40	15	0	10	3	3	0	0	0	95
1956	0	0	0	0	0	12	36	47	13	0	0	0	108
1957	0	0	0	0	0	9	4	11	0	0	0	0	24
1958	0	0	0	0	0	20	76	8	6	0	0	0	110
1959	0	0	0	0	0	47	55	28	24	0	0	0	154
1960	3	14	0	0	0	23	49	26	14	17	0	0	146
1961	0	0	42	59	0	21	89	13	72	0	0	0	296
1962	0	0	0	0	0	15	15	0	89	18	0	0	137
1963	0	0	0	0	0	16	34	11	0	0	0	0	61
1964	0	0	0	0	0	23	37	37	0	0	0	0	97
1965	0	0	0	0	1	27	67	0	0	0	0	0	95
1966	0	0	0	0	0	32	44	2	0	0	0	0	78
1967	0	0	0	0	0	34	62	96	0	0	0	0	192
1968	0	41	0	0	0	41	139	15	0	0	0	0	236
1969	0	15	5	93	69	163	110	69	1	0	0	0	525
1970	1	24	21	37	41	76	12	91	77	0	0	0	380
1971	0	0	8	26	22	142	19	46	43	0	0	0	306
1972	0	8	7	0	19	47	106	55	21	0	0	0	263
1973	0	0	0	0	0	26	111	11	0	0	0	0	148
1974	0	0	0	0	0	10	95	15	0	0	0	0	120
1975	0	0	0	0	27	94	51	47	130	0	1	0	350
1976	0	0	53	22	91	206	63	203	204	80	0	0	922
1977	0	25	12	55	225	104	165	154	181	12	0	0	933
1978	0	6	0	179	173	213	9	0	0	0	0	0	580
1979	0	0	0	115	143	122	0	0	0	0	0	0	380
TOTAL	8	153	172	626	885	1714	1880	1737	1026	127	1	0	8329

Table 4.--Number of accepted near bottom salinity values by year and month with totals.

MONTH=	1	2	3	4	5	6	7	8	9	10	11	12	
YEAR													TOTAL
1932	0	0	0	0	0	0	6	105	11	0	0	0	122
1933	0	0	0	0	0	0	16	78	0	0	0	0	94
1934	0	0	0	0	0	0	19	65	0	0	0	0	84
1935	0	0	0	0	0	0	0	20	0	0	0	0	20
1936	0	0	0	0	0	0	0	0	0	0	0	0	0
1937	0	0	0	0	0	74	54	12	27	0	0	0	167
1938	0	0	0	0	0	0	0	120	78	0	0	0	198
1939	0	0	0	0	14	91	137	99	6	0	0	0	347
1940	0	0	0	0	0	0	70	68	0	0	0	0	138
1941	0	0	0	0	22	10	0	0	0	0	0	0	32
1942	0	0	0	0	0	0	0	0	0	0	0	0	0
1943	0	0	0	0	0	0	0	0	0	0	0	0	0
1944	0	0	0	0	0	0	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0	0	0	0	0	0	0
1947	0	0	0	0	0	0	9	4	0	0	0	0	13
1948	0	0	0	0	0	0	11	6	0	0	0	0	17
1949	0	0	0	0	0	0	11	68	0	0	0	0	79
1950	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	3	22	0	0	0	0	0	0	0	0	0	0	25
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	1	0	2	0	0	0	3
1954	0	0	0	0	7	1	0	0	3	0	0	0	11
1955	0	0	24	26	12	0	7	1	2	0	0	0	72
1956	0	0	0	0	0	0	0	13	2	0	0	0	15
1957	0	0	0	0	0	1	2	6	0	0	0	0	9
1958	0	0	0	0	0	4	47	5	6	0	0	0	62
1959	0	0	0	0	0	12	35	22	23	0	0	0	92
1960	3	13	0	0	0	0	46	26	12	17	0	0	117
1961	0	0	5	40	0	0	64	11	67	0	0	0	187
1962	0	0	0	0	0	1	11	0	85	18	0	0	115
1963	0	0	0	0	0	3	27	11	0	0	0	0	41
1964	0	0	0	0	0	11	29	28	0	0	0	0	68
1965	0	0	0	0	1	13	52	0	0	0	0	0	66
1966	0	0	0	0	0	13	39	0	0	0	0	0	52
1967	0	0	0	0	0	22	56	88	0	0	0	0	166
1968	0	36	0	0	0	25	132	12	0	0	0	0	205
1969	0	15	4	95	67	154	85	61	1	0	0	0	482
1970	1	12	21	35	42	61	11	88	42	0	0	0	313
1971	0	0	7	7	0	70	15	46	44	0	0	0	189
1972	0	2	3	0	19	40	106	51	12	0	0	0	233
1973	0	0	0	0	0	12	74	11	0	0	0	0	97
1974	0	0	0	0	0	3	53	15	0	0	0	0	71
1975	0	0	0	0	24	59	35	31	110	0	1	0	260
1976	0	0	46	16	77	160	31	199	197	80	0	0	806
1977	0	25	11	48	213	72	114	150	177	10	0	0	820
1978	0	6	0	145	160	160	7	0	0	0	0	0	478
1979	0	0	0	103	136	120	0	0	0	0	0	0	359
TOTAL	7	131	121	515	794	1192	1412	1520	907	125	1	0	6725

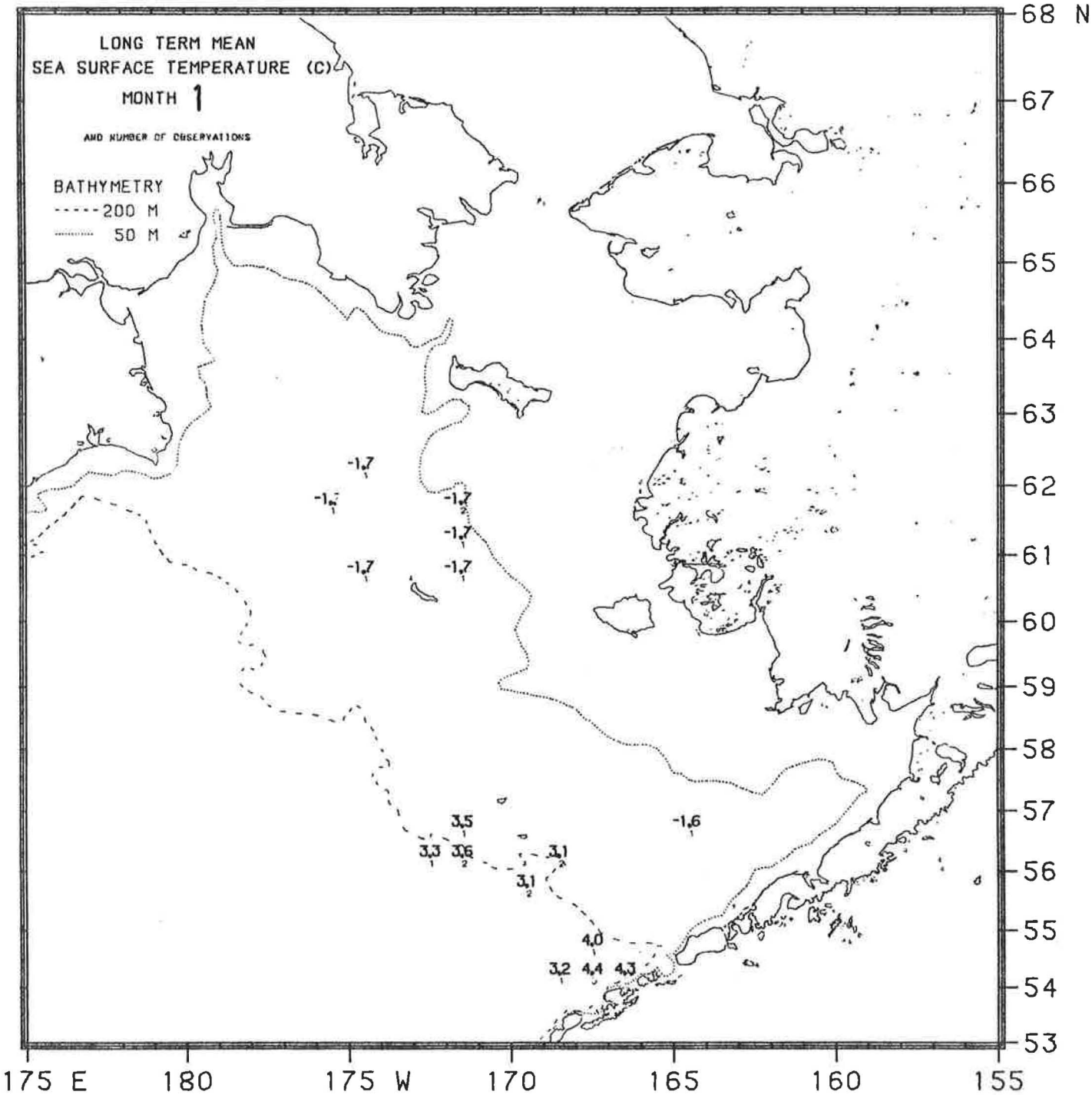

Figure 1.--Long term January mean sea surface temperature (^{o}C).

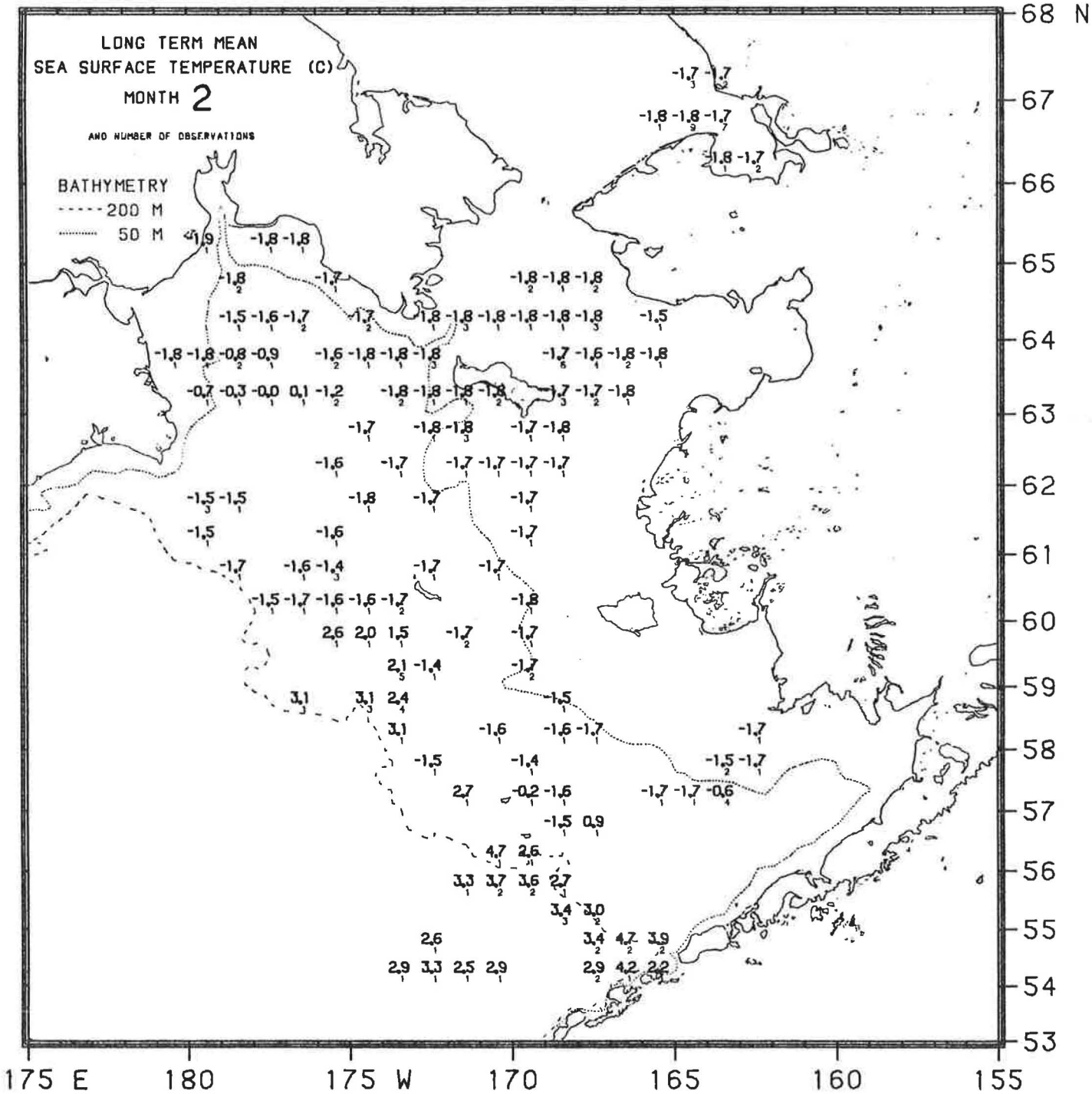

Figure 2.--Long term February mean sea surface temperature (^{o}C).

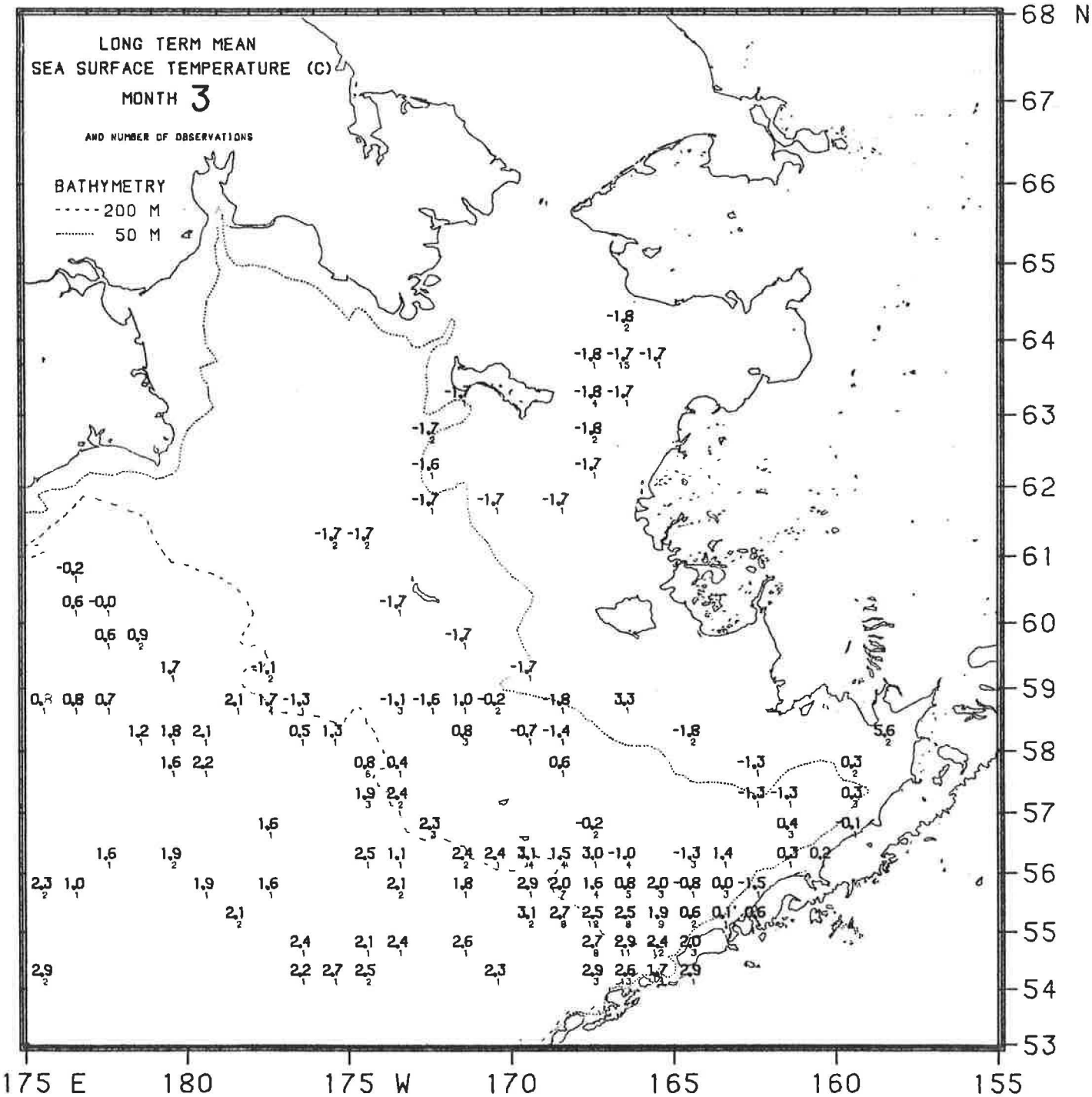

Figure 3.--Long term March mean sea surface temperature (^{o}C).

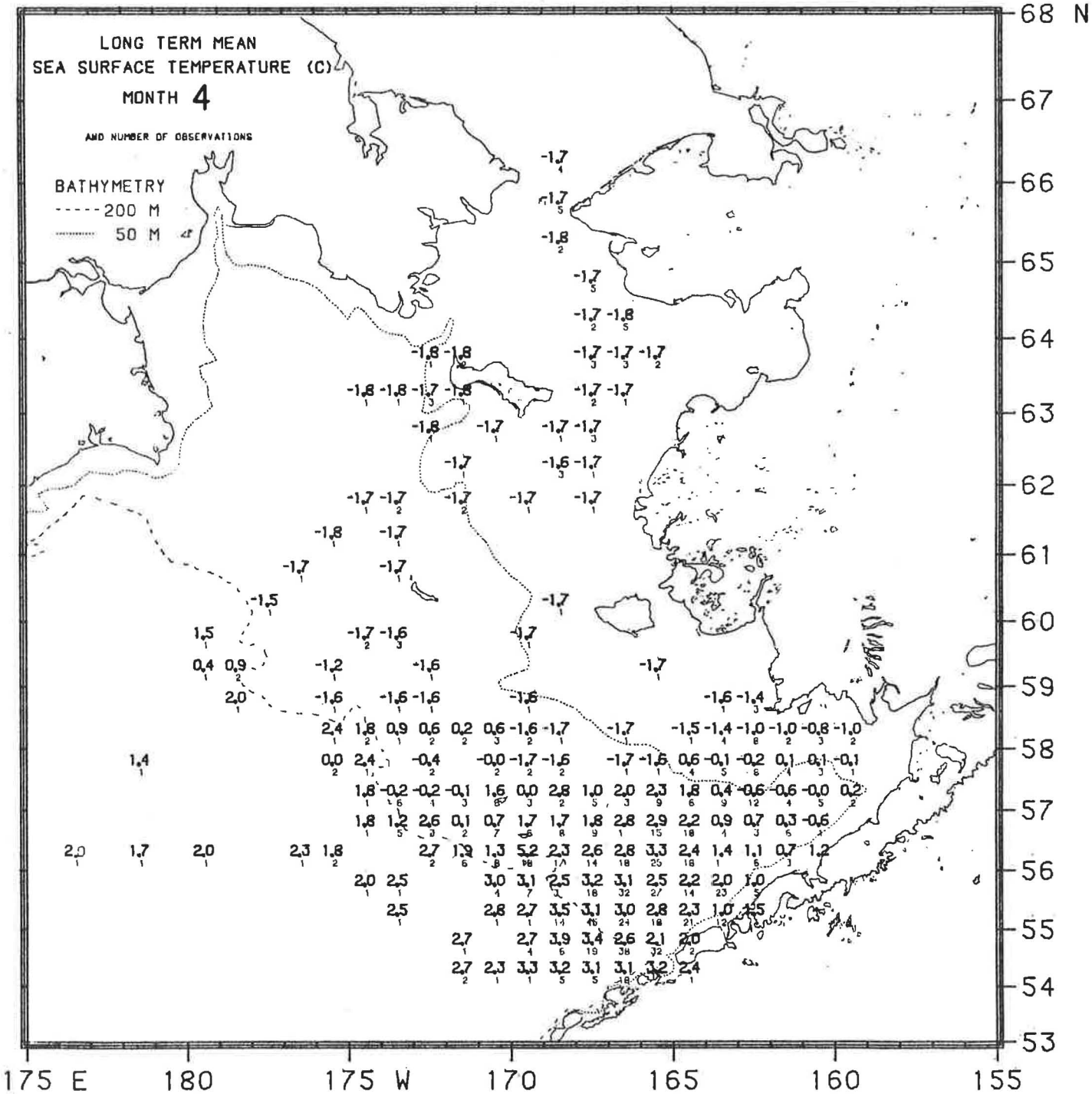

Figure 4.--Long term April mean sea surface temperature (^{o}C).

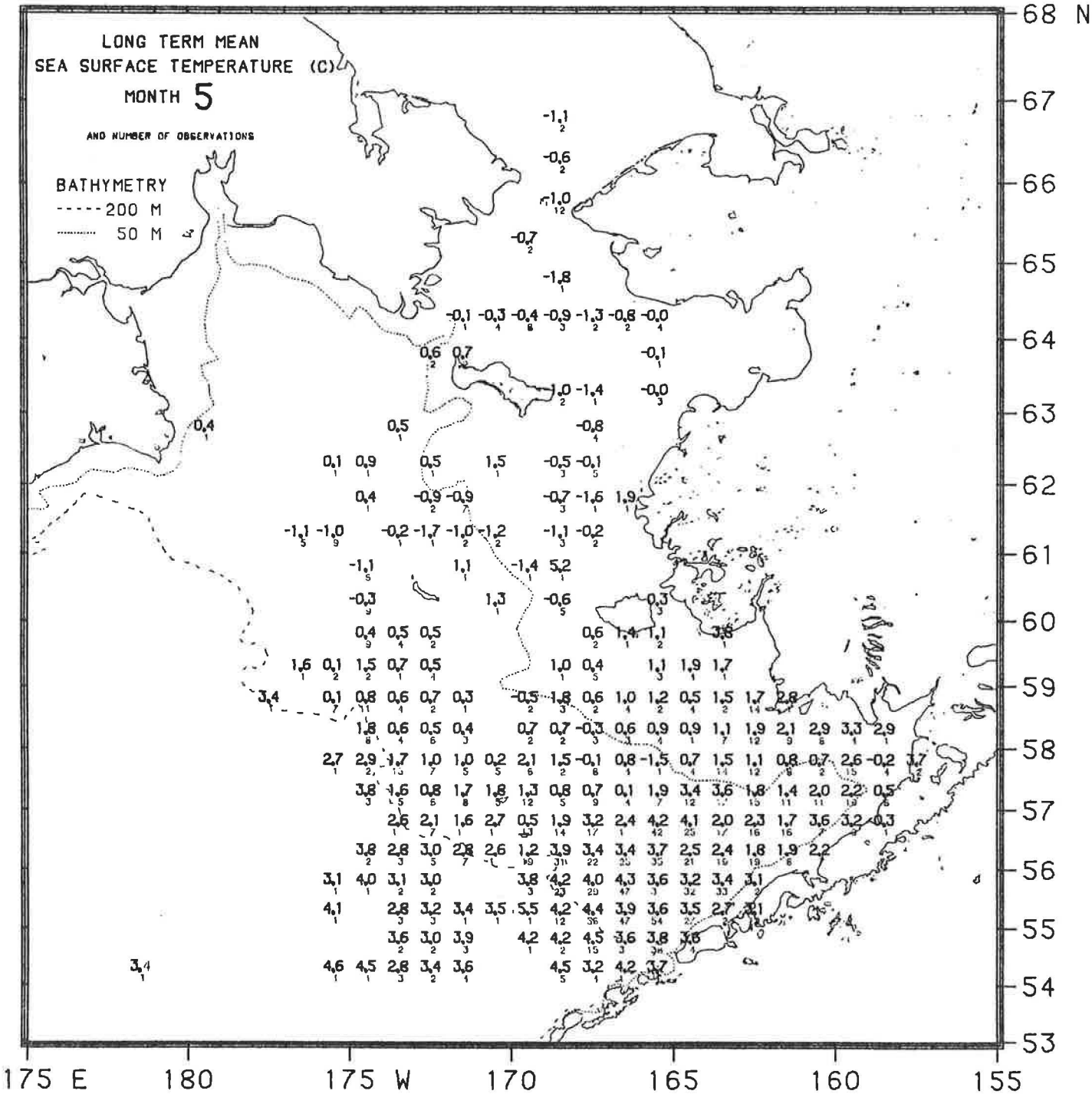

Figure 5.--Long term May mean sea surface temperature (^{o}C).

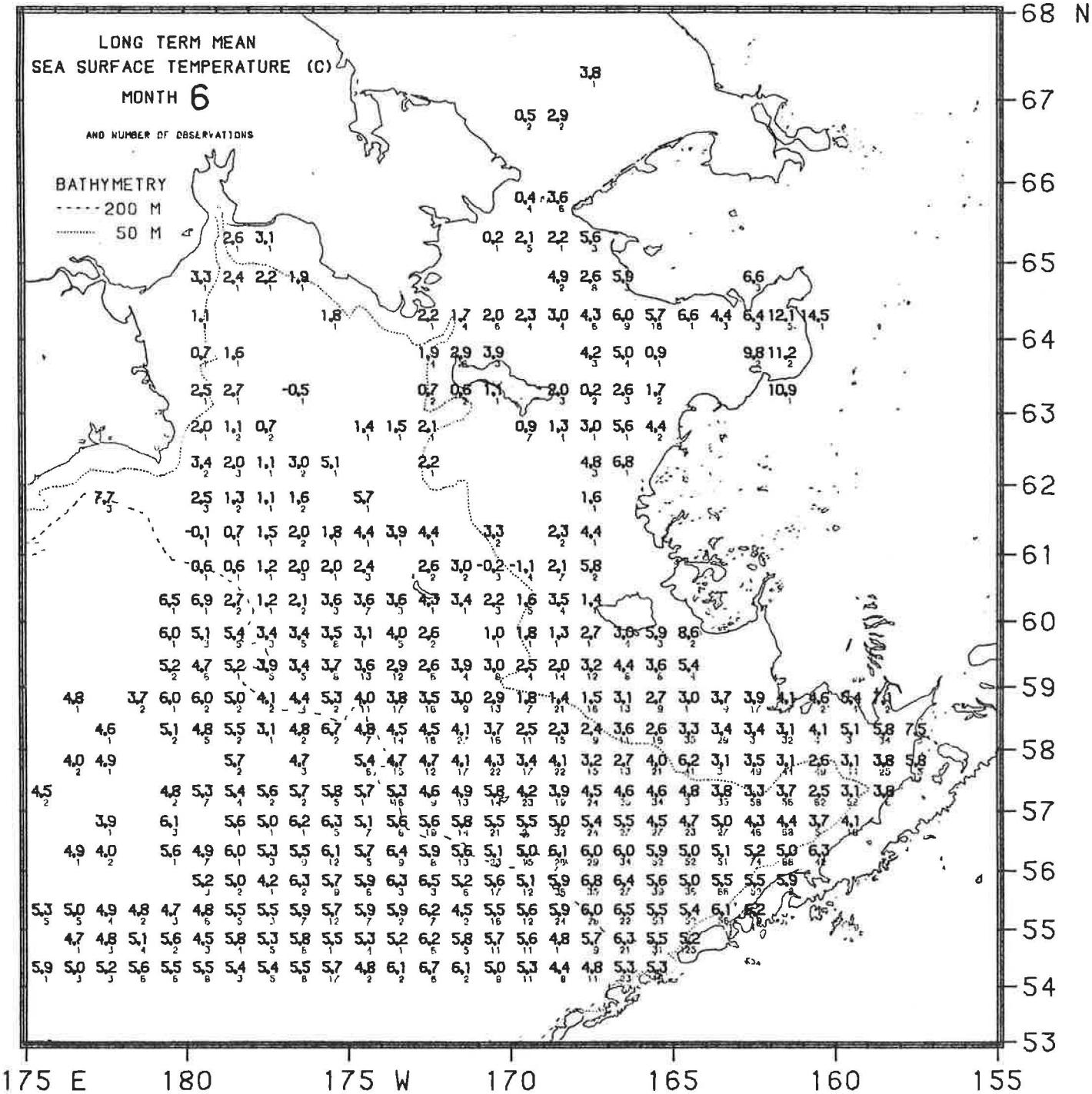

Figure 6.--Long term June mean sea surface temperature (^{o}C).

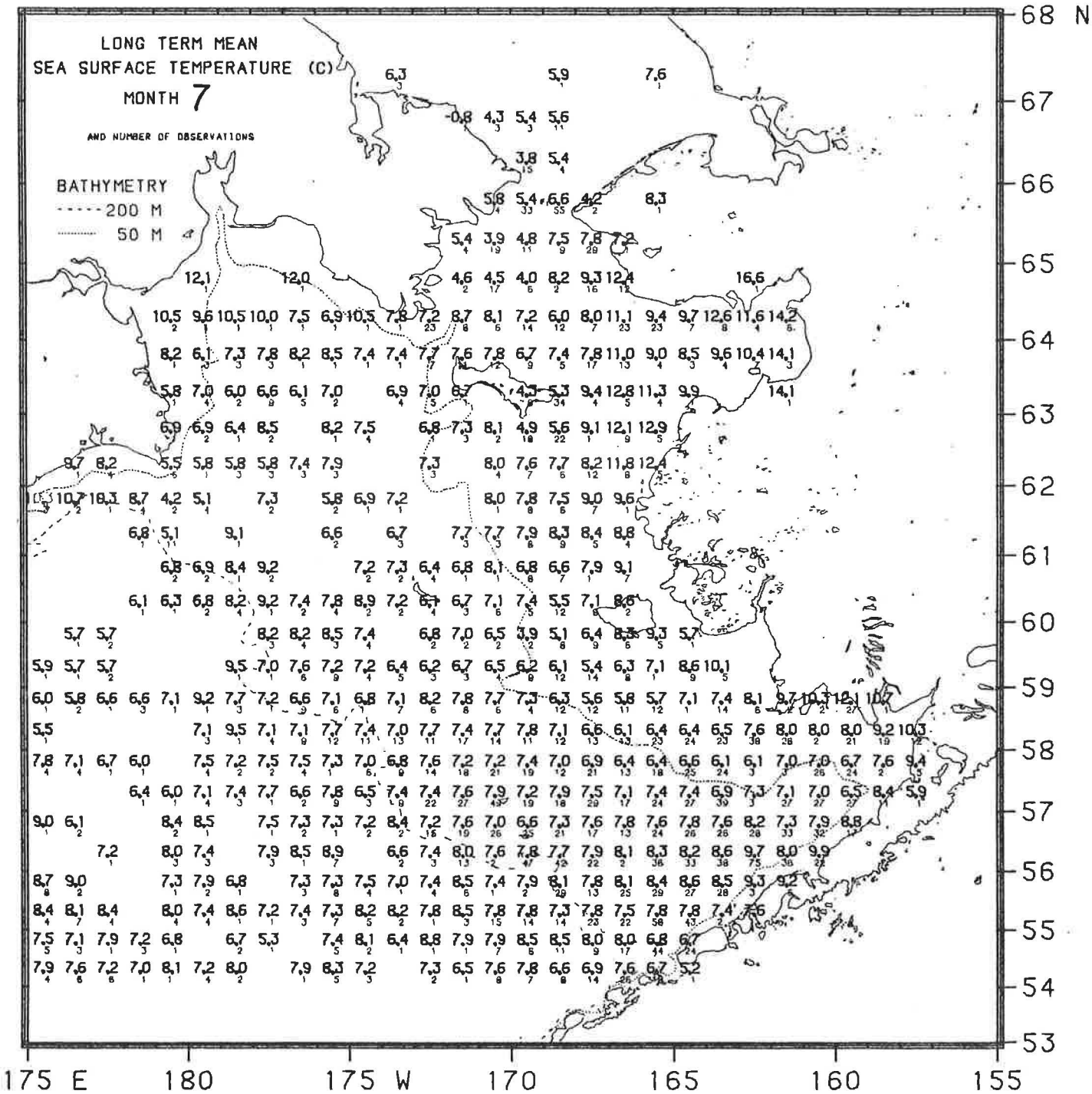

Figure 7.--Long term July mean sea surface temperature (^{o}C).

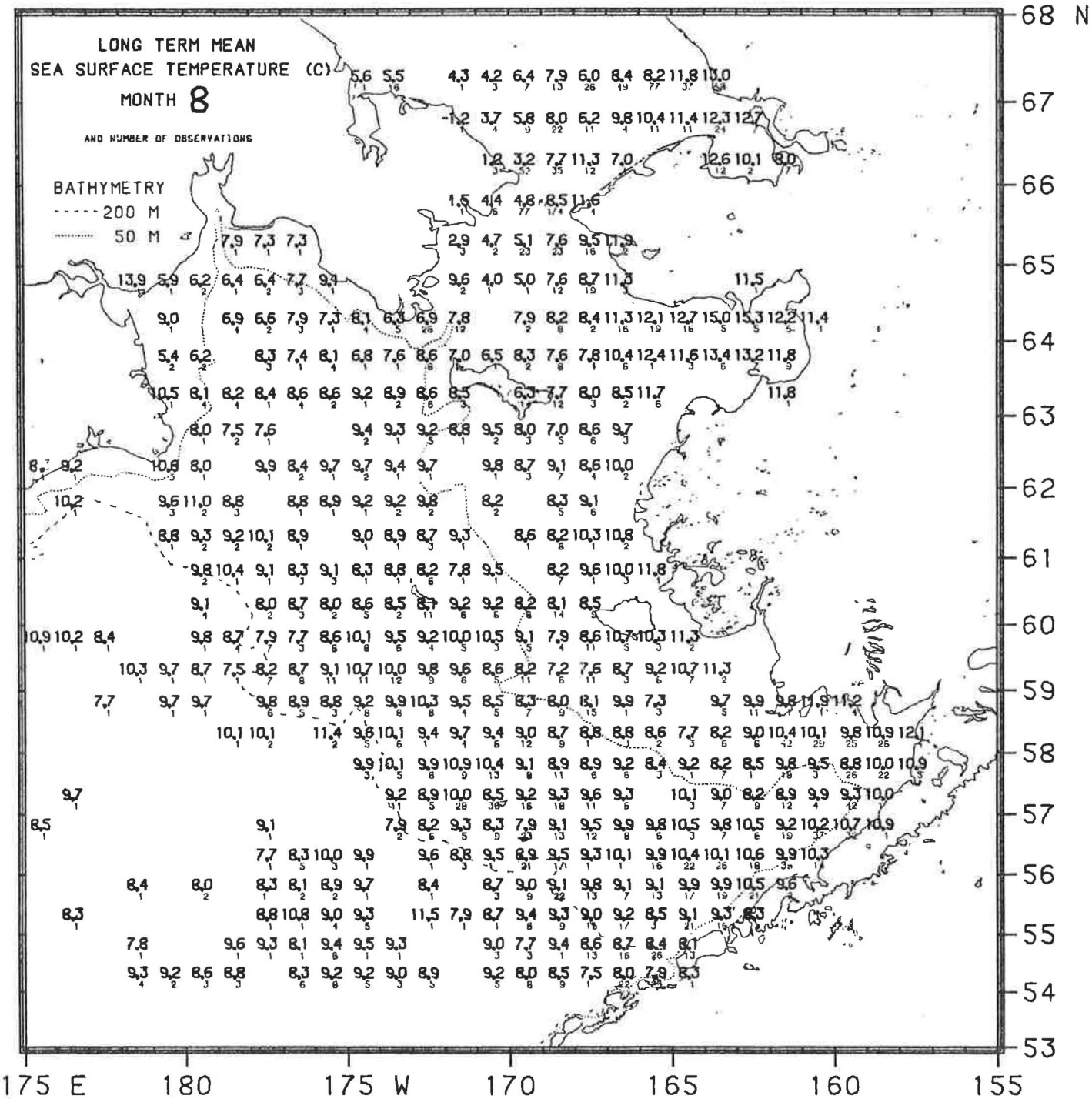

Figure 8.--Long term August mean sea surface temperature (^{o}C).

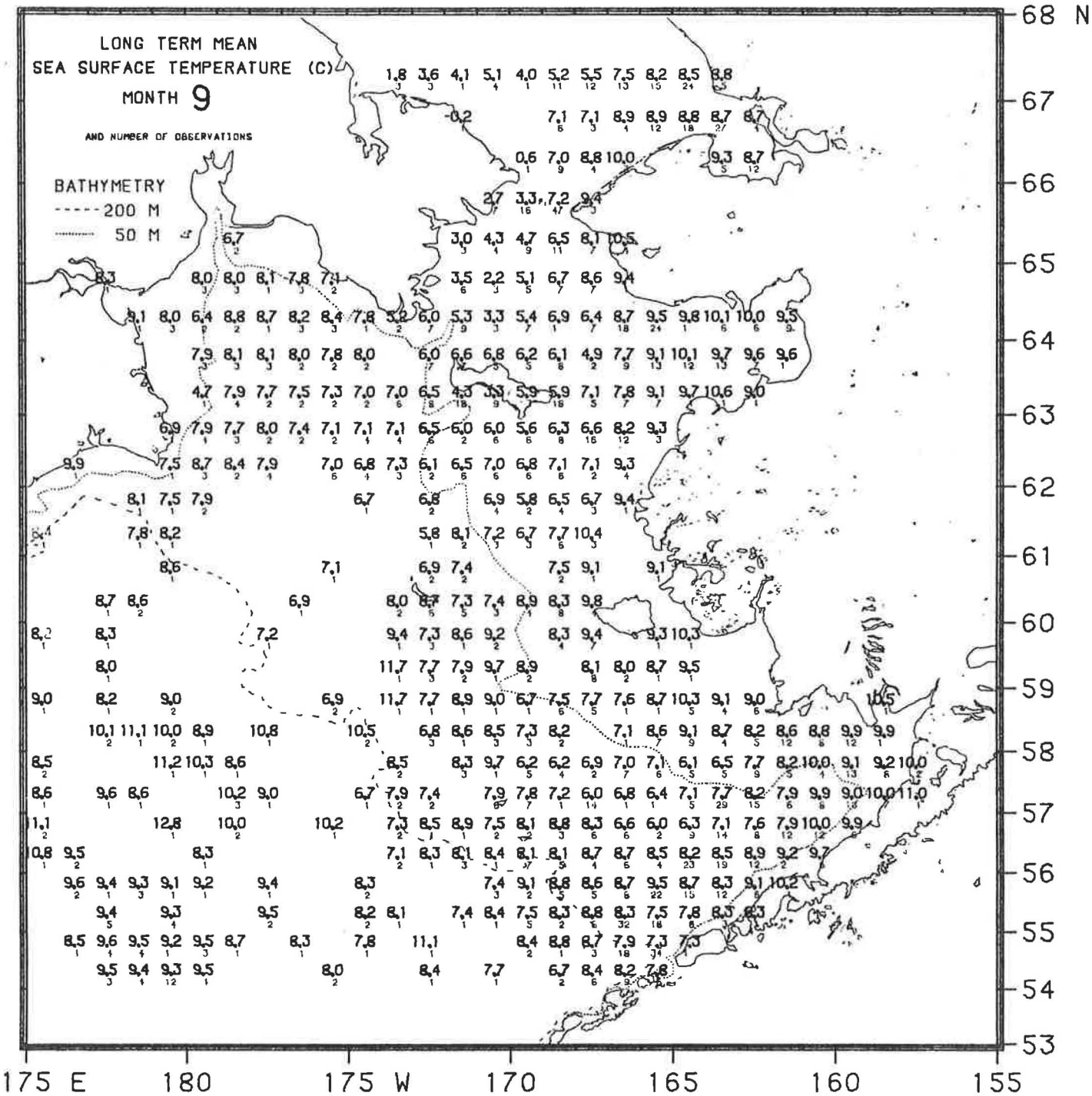

Figure 9.--Long term September mean sea surface temperature (^{o}C).

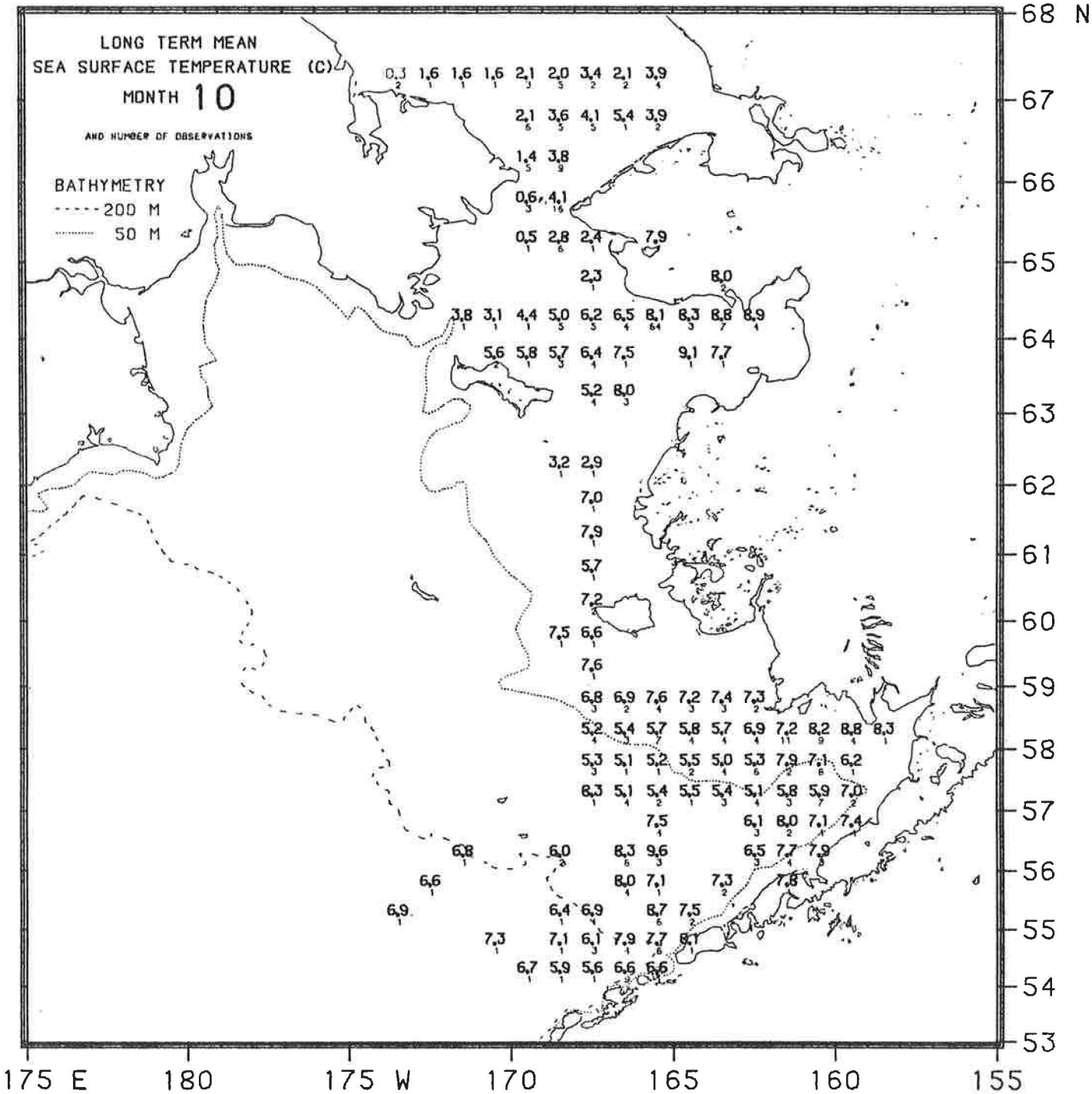

Figure 10.--Long term October mean sea surface temperature (^{o}C).

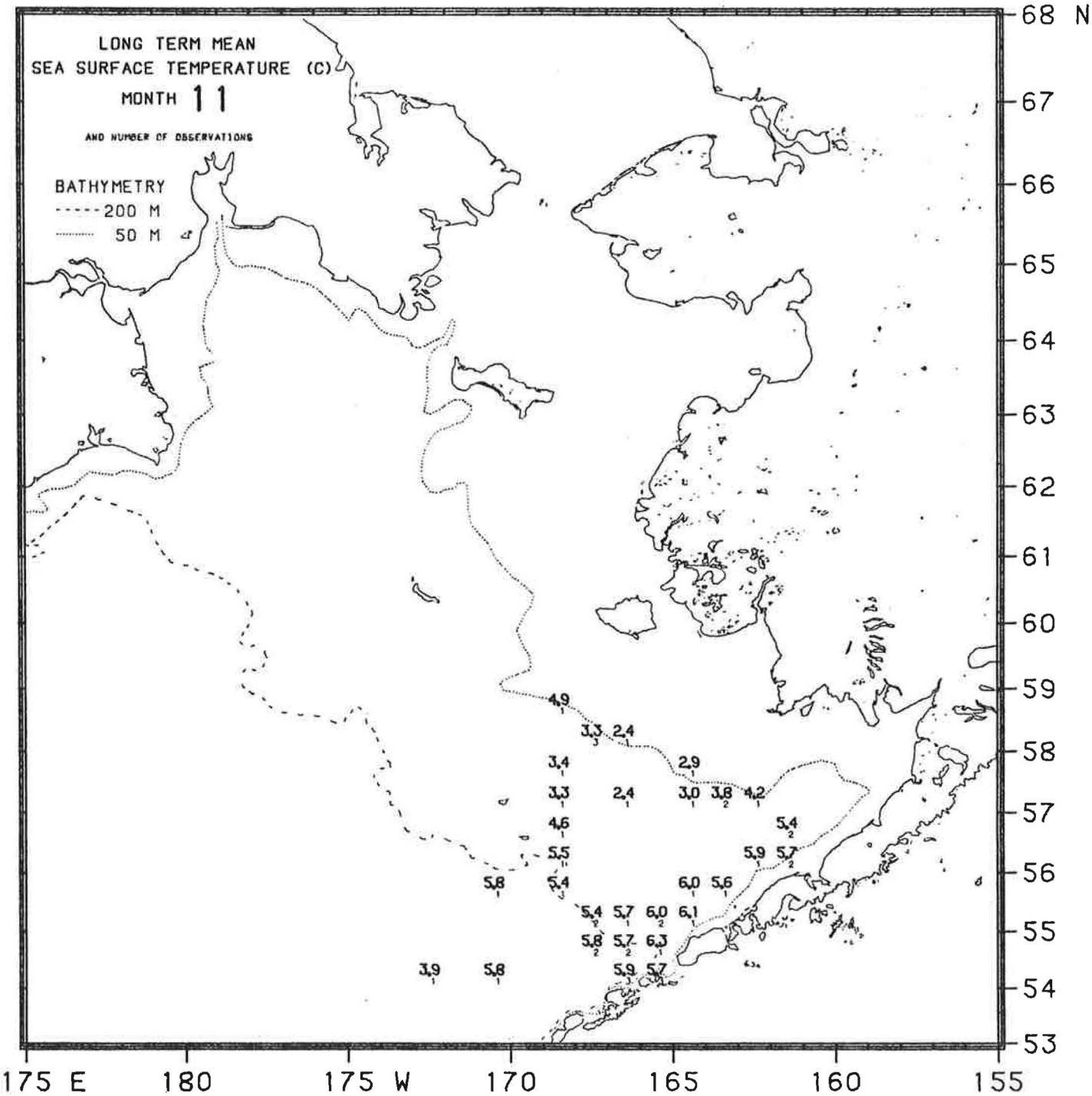

Figure 11.--Long term November mean sea surface temperature (^{o}C).

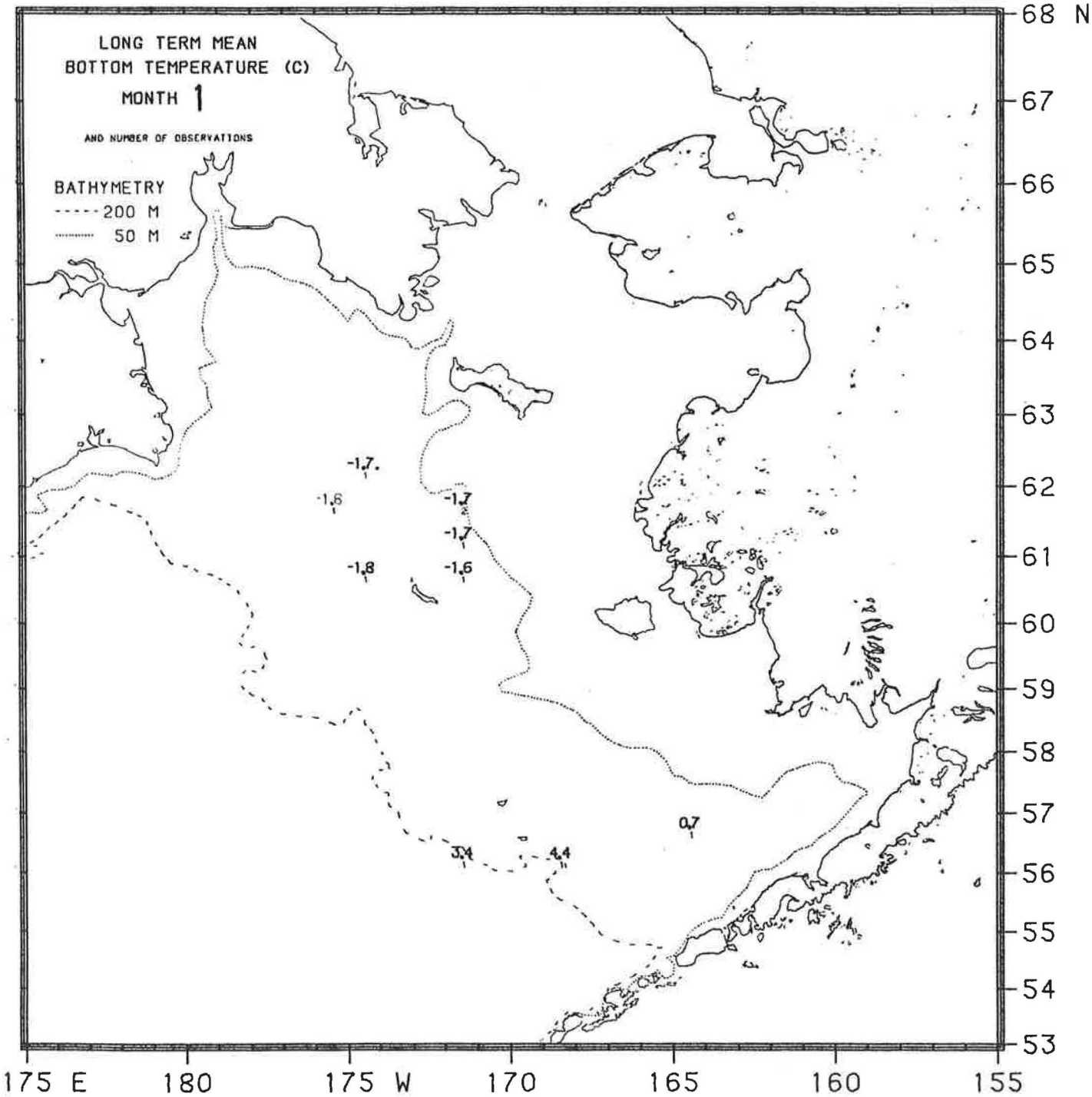

Figure 12.--Long term January near bottom temperature (°C).

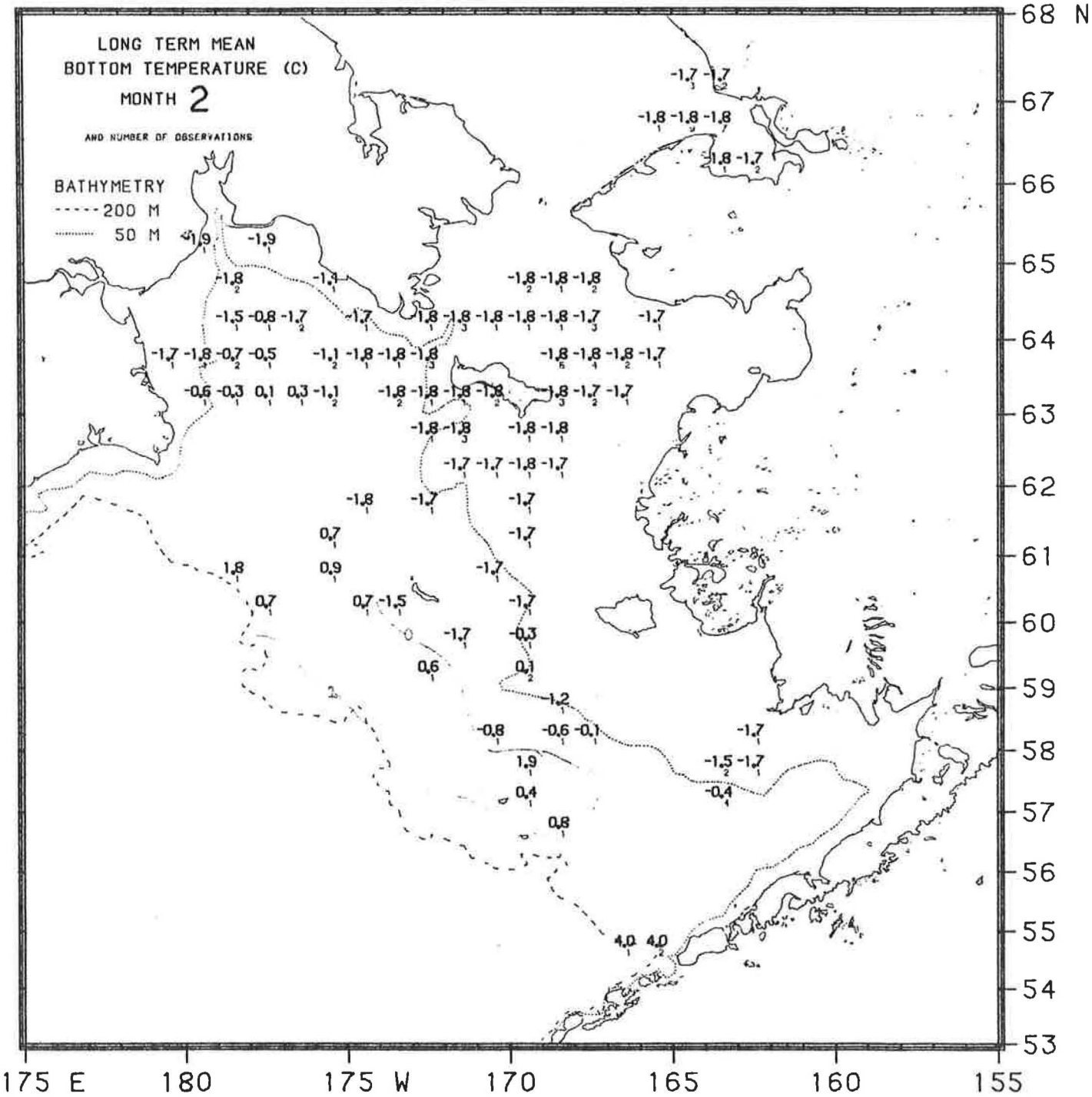

Figure 13.--Long term February near bottom temperature (^{o}C).

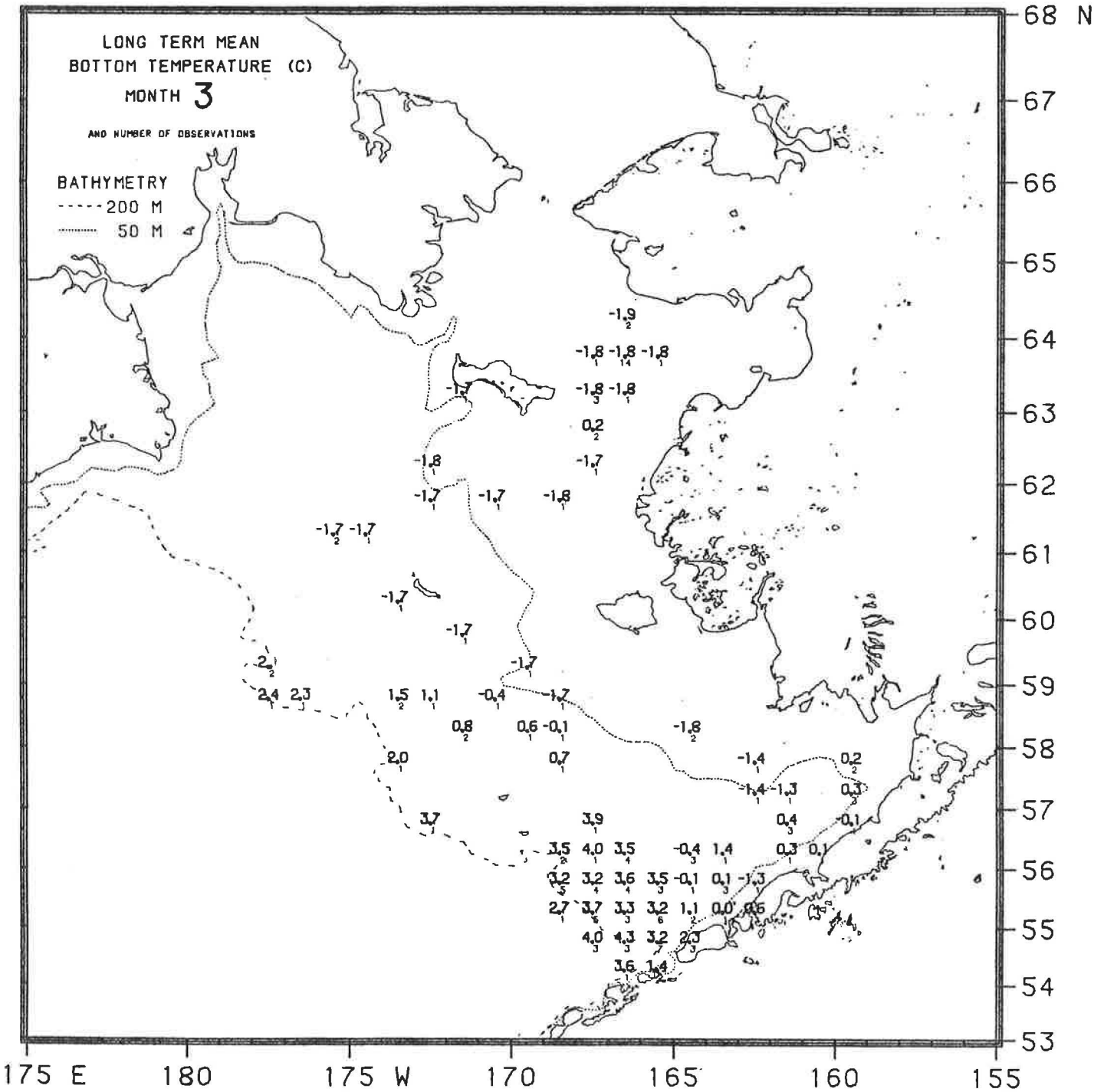

Figure 14.--Long term March near bottom temperature (^{o}C).

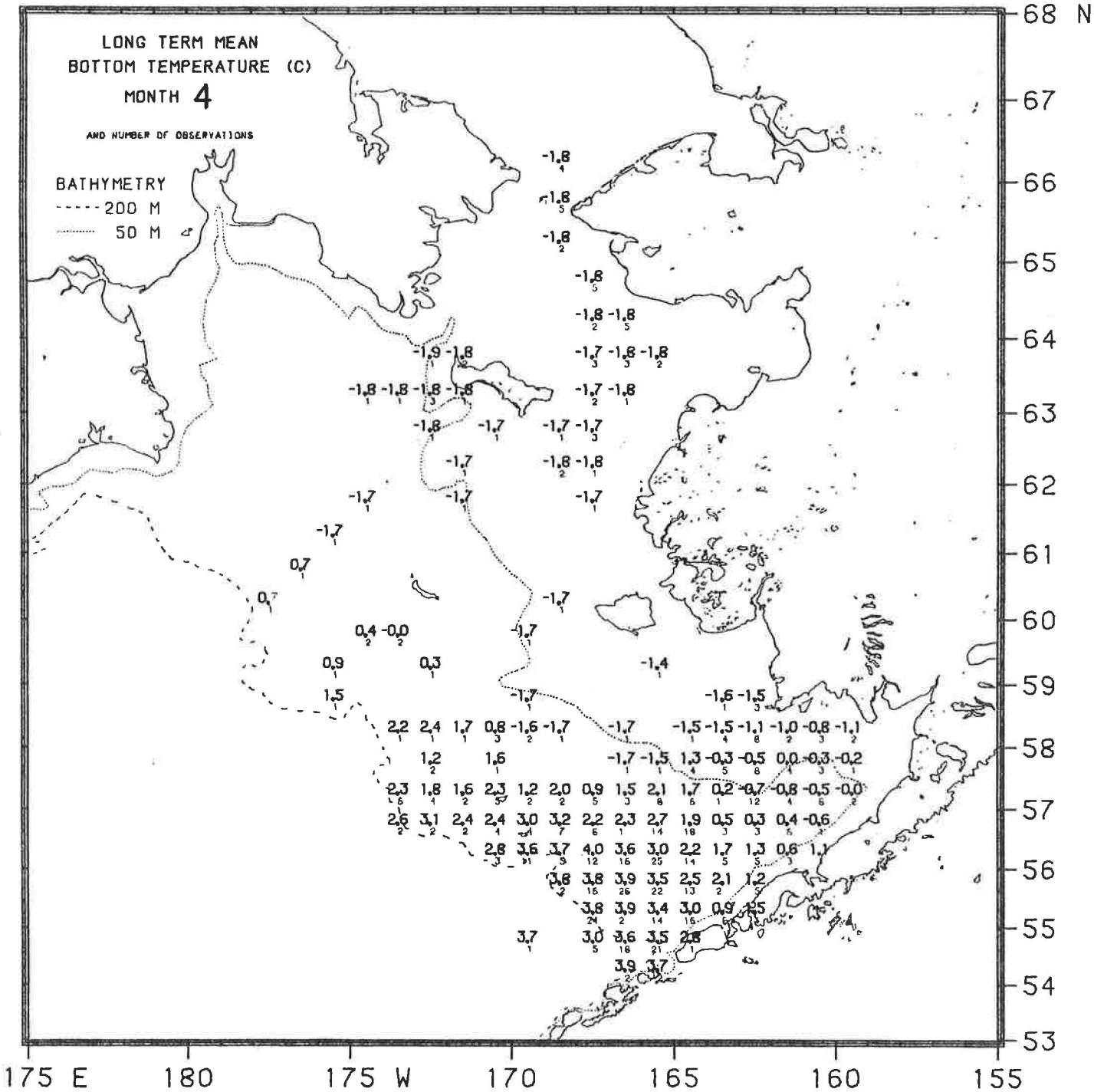

Figure 15.--Long term April near bottom temperature (^{o}C).

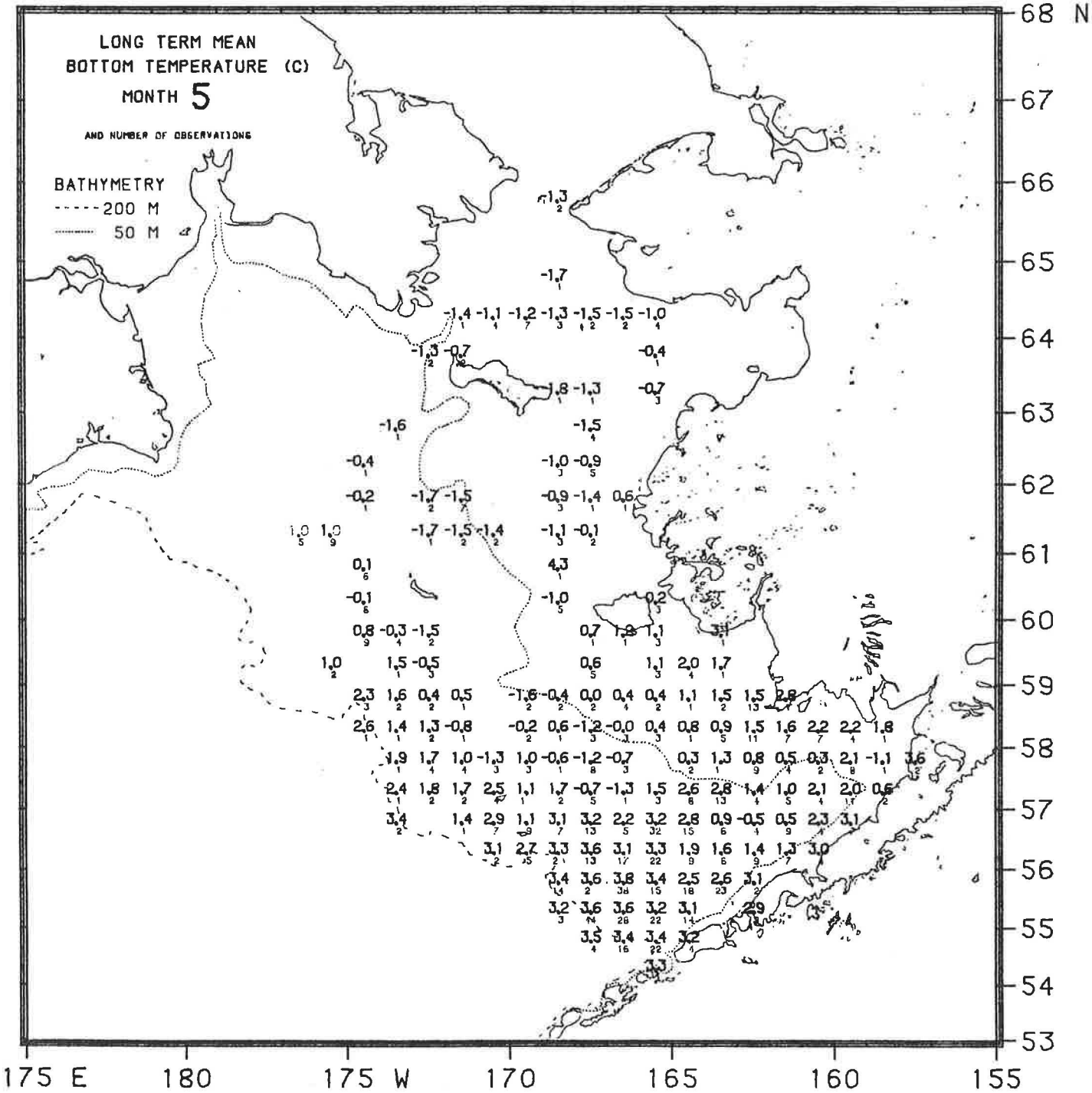

Figure 16.--Long term May near bottom temperature (^{o}C).

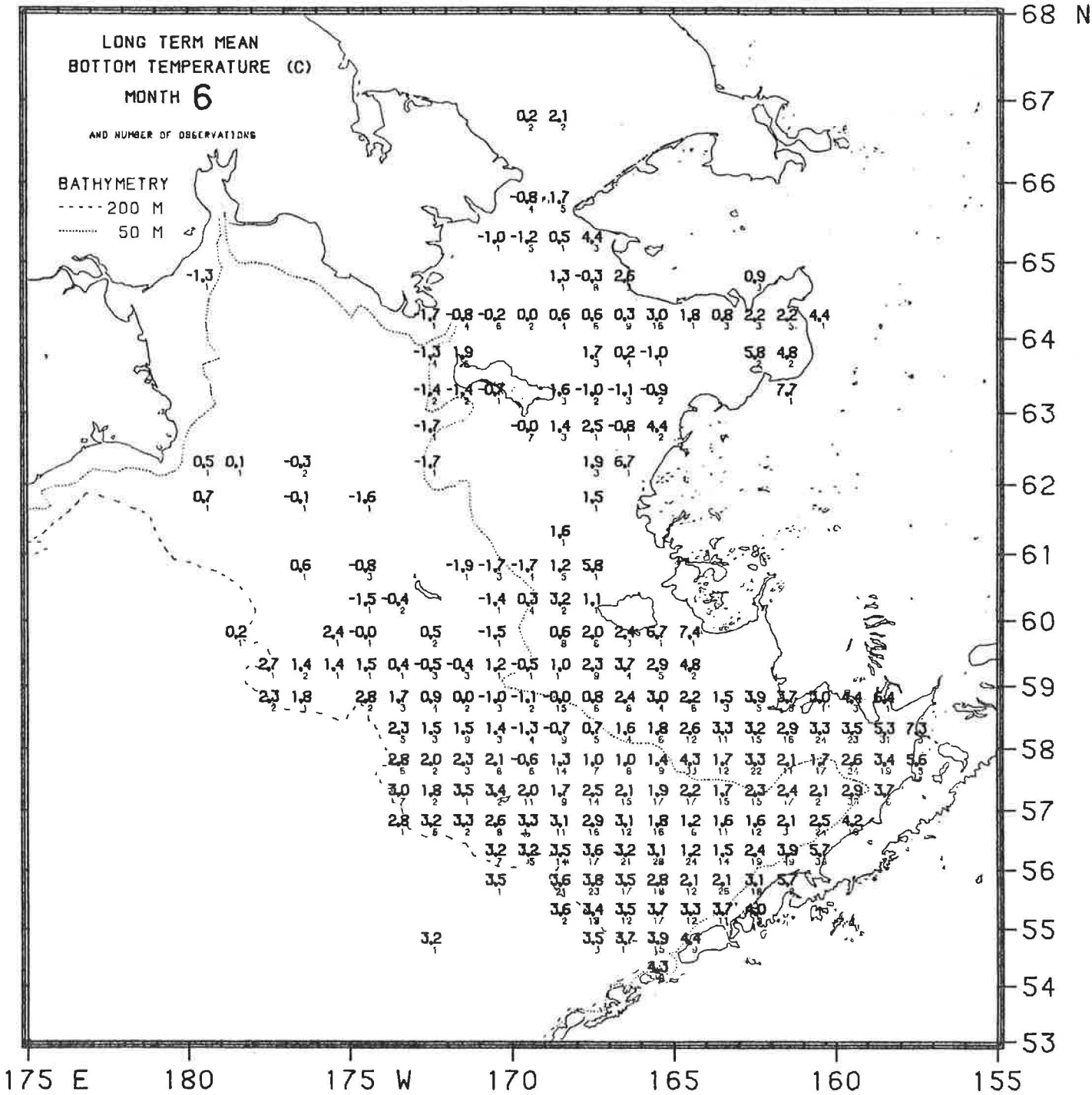

Figure 17.--Long term June near bottom temperature (^{o}C).

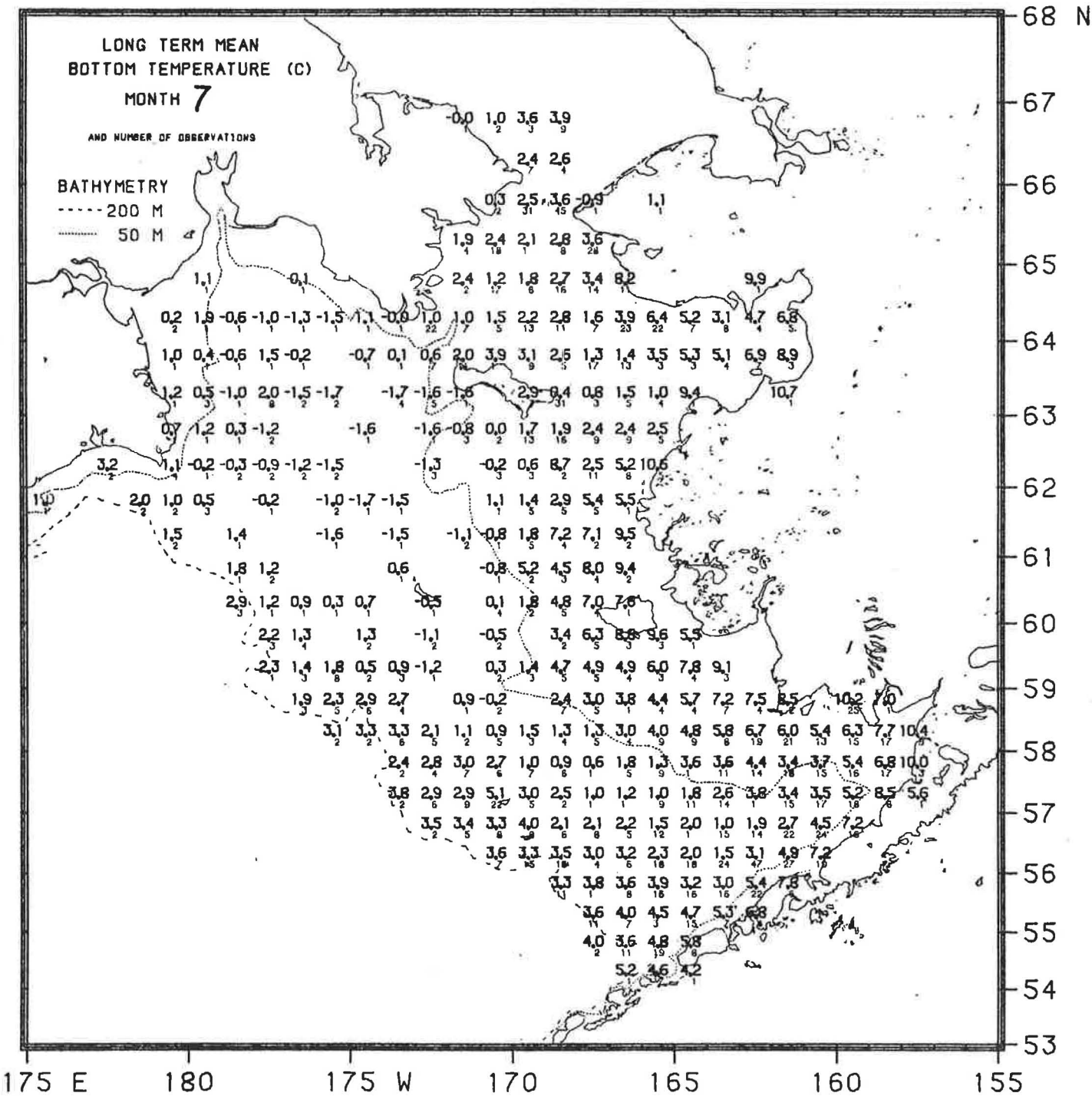

Figure 18.--Long term July near bottom temperature (^{o}C).

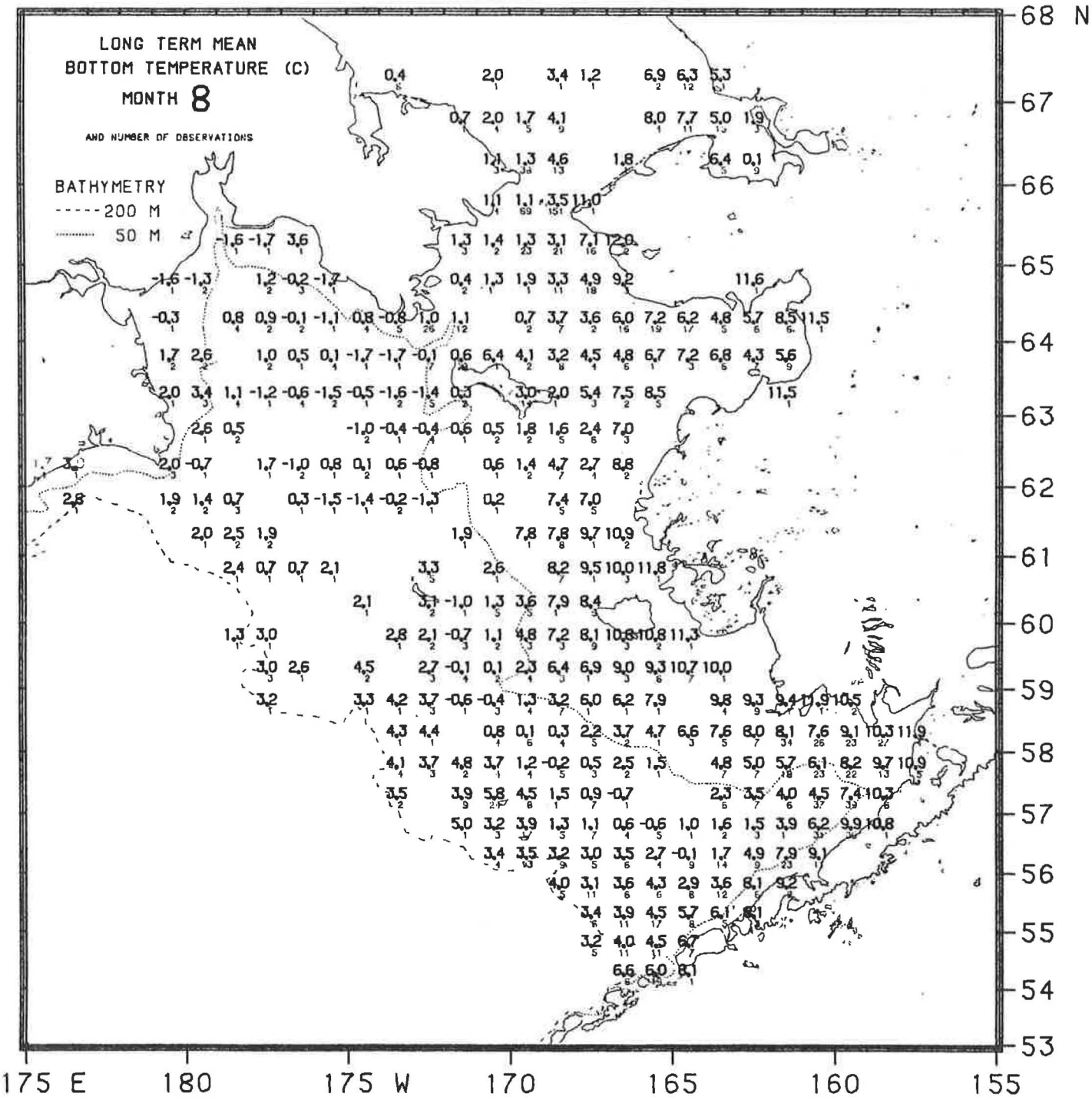

Figure 19.--Long term August near bottom temperature (^{o}C).

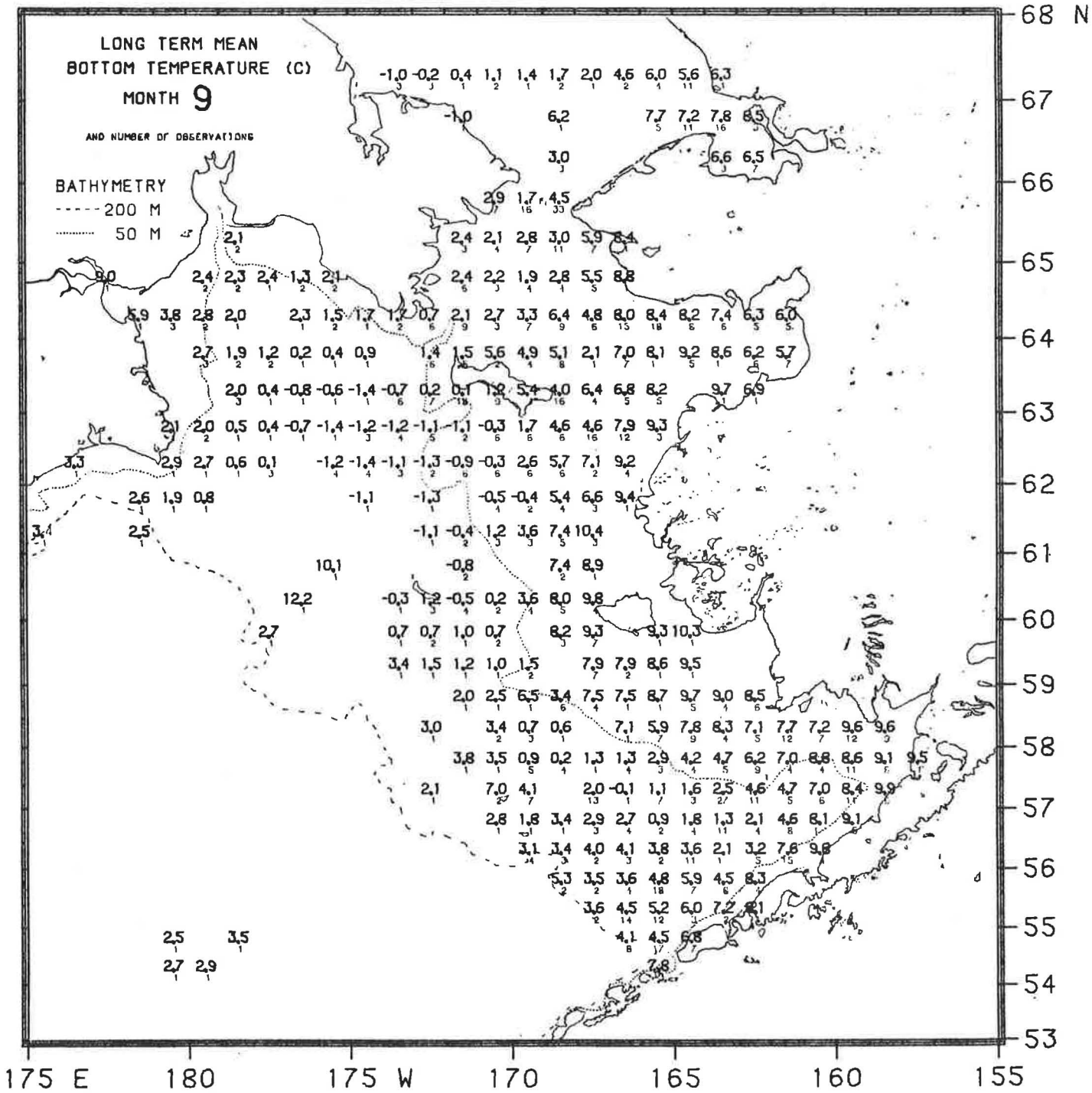

Figure 20.--Long term September near bottom temperature (^{o}C).

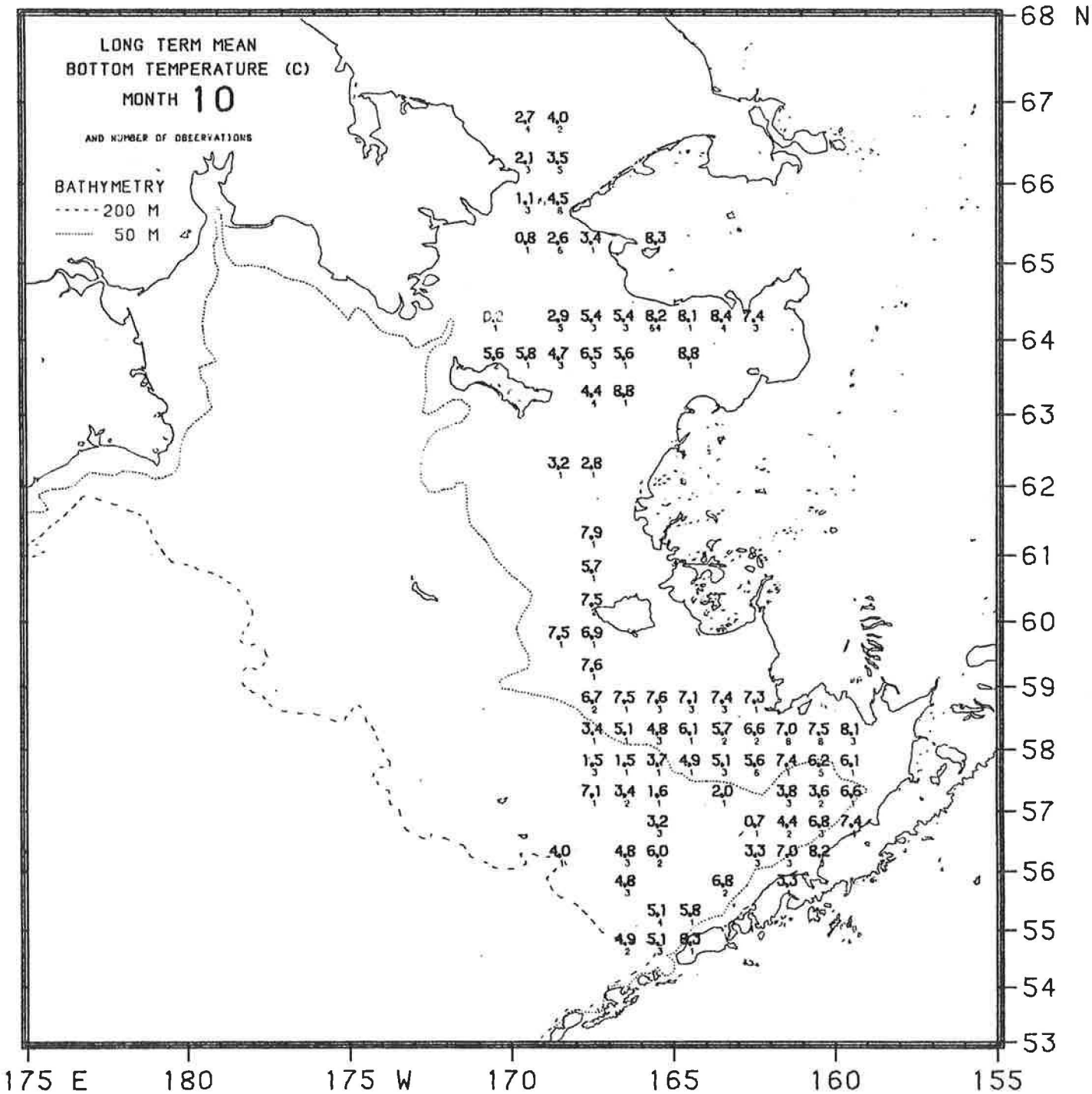

Figure 21.--Long term October near bottom temperature (^{o}C).

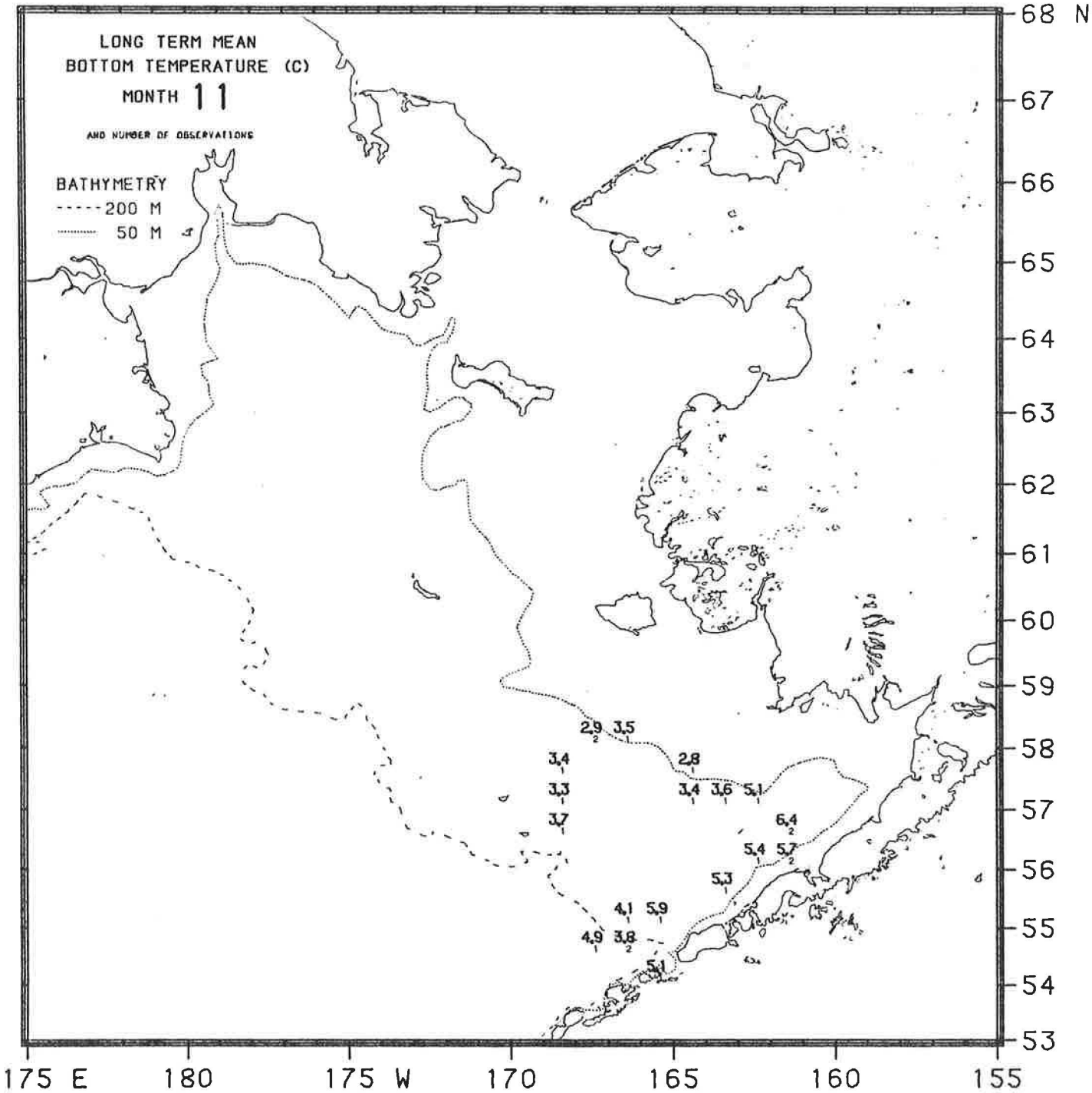

Figure 22.--Long term November near bottom temperature (^{o}C).

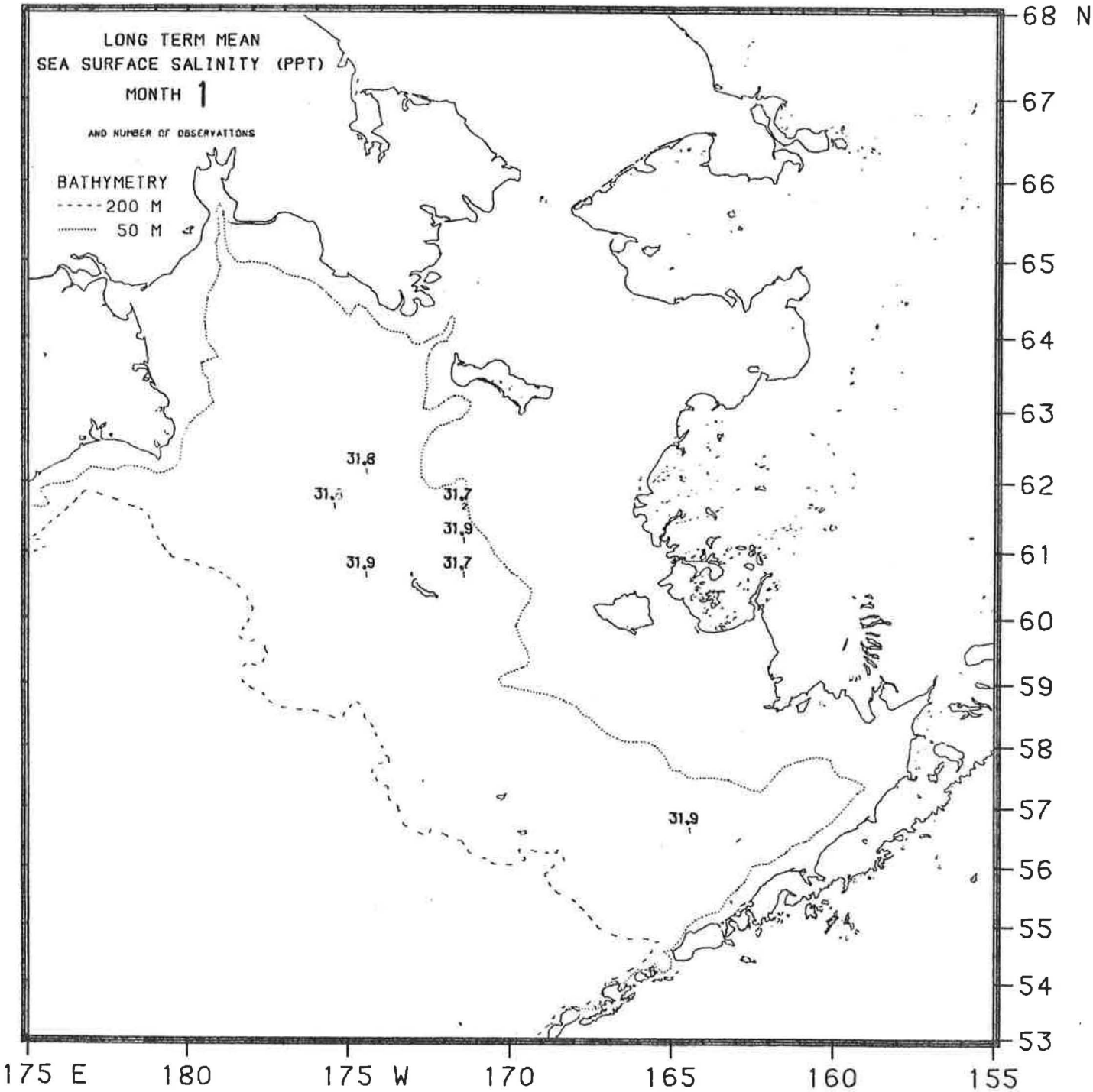

Figure 23.--Long term January mean sea surface salinity ($^{o}/oo$).

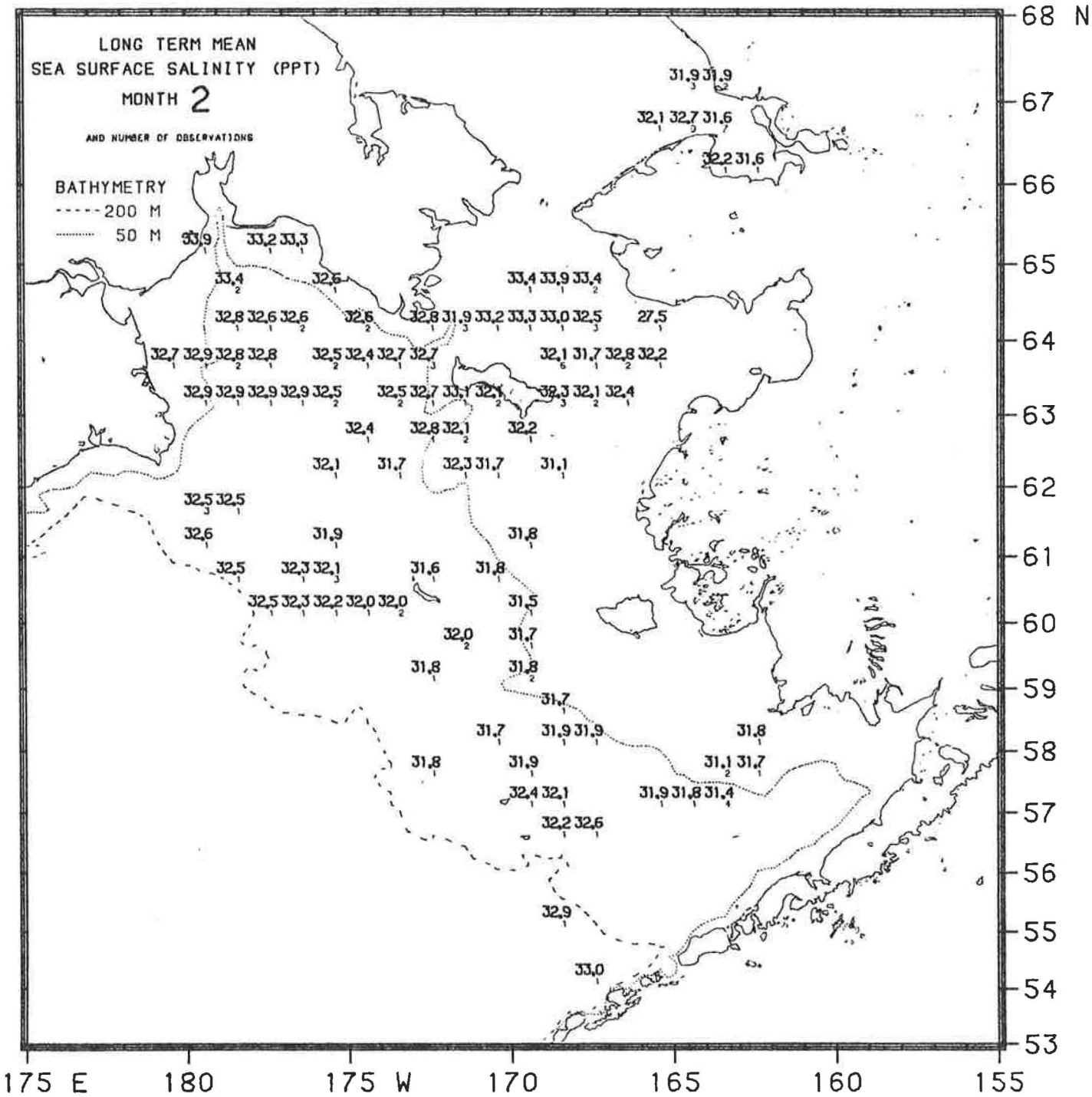

Figure 24.--Long term February mean sea surface salinity (^{o}/oo).

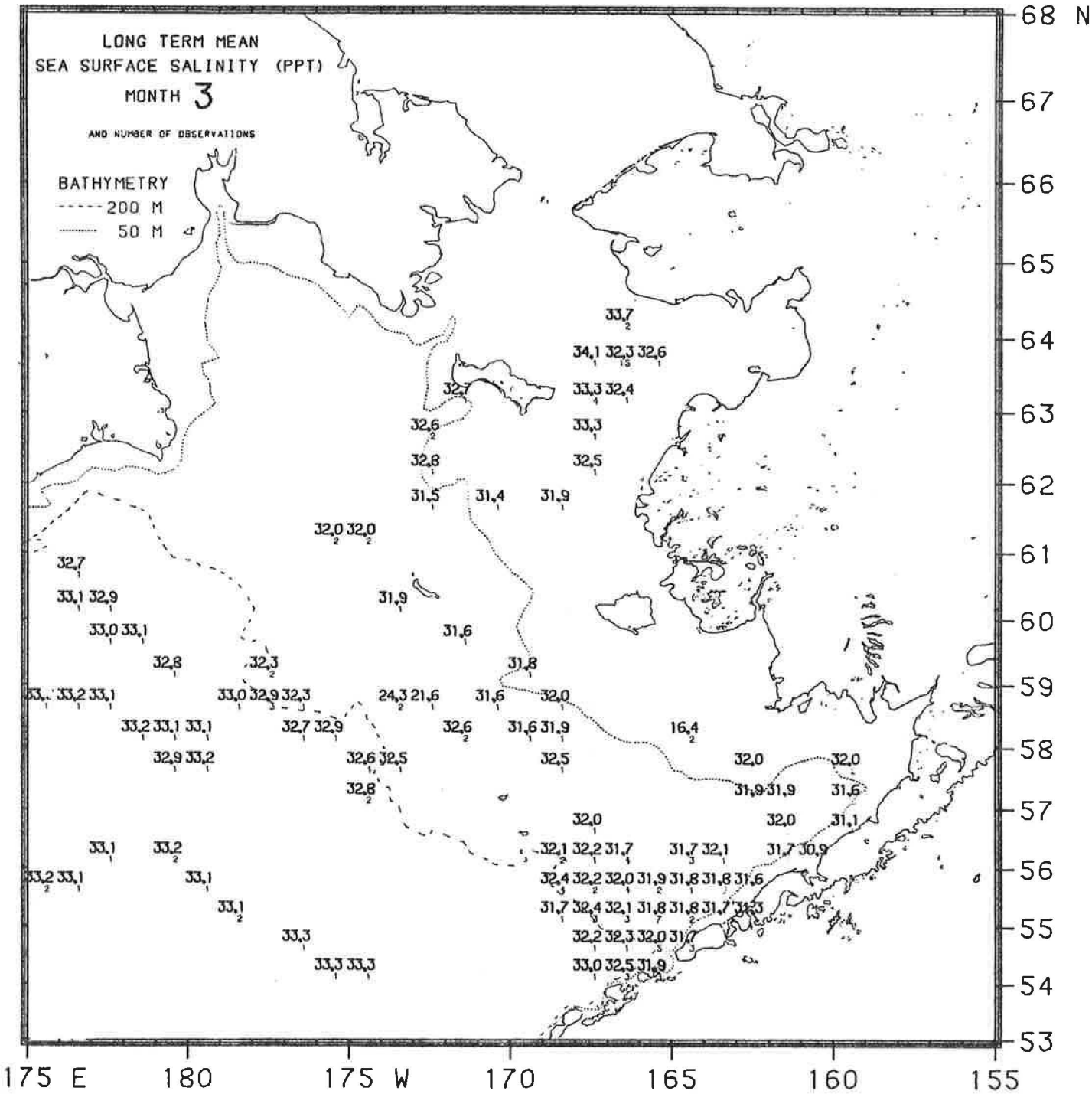

Figure 25.--Long term March mean sea surface salinity (^{o}/oo).

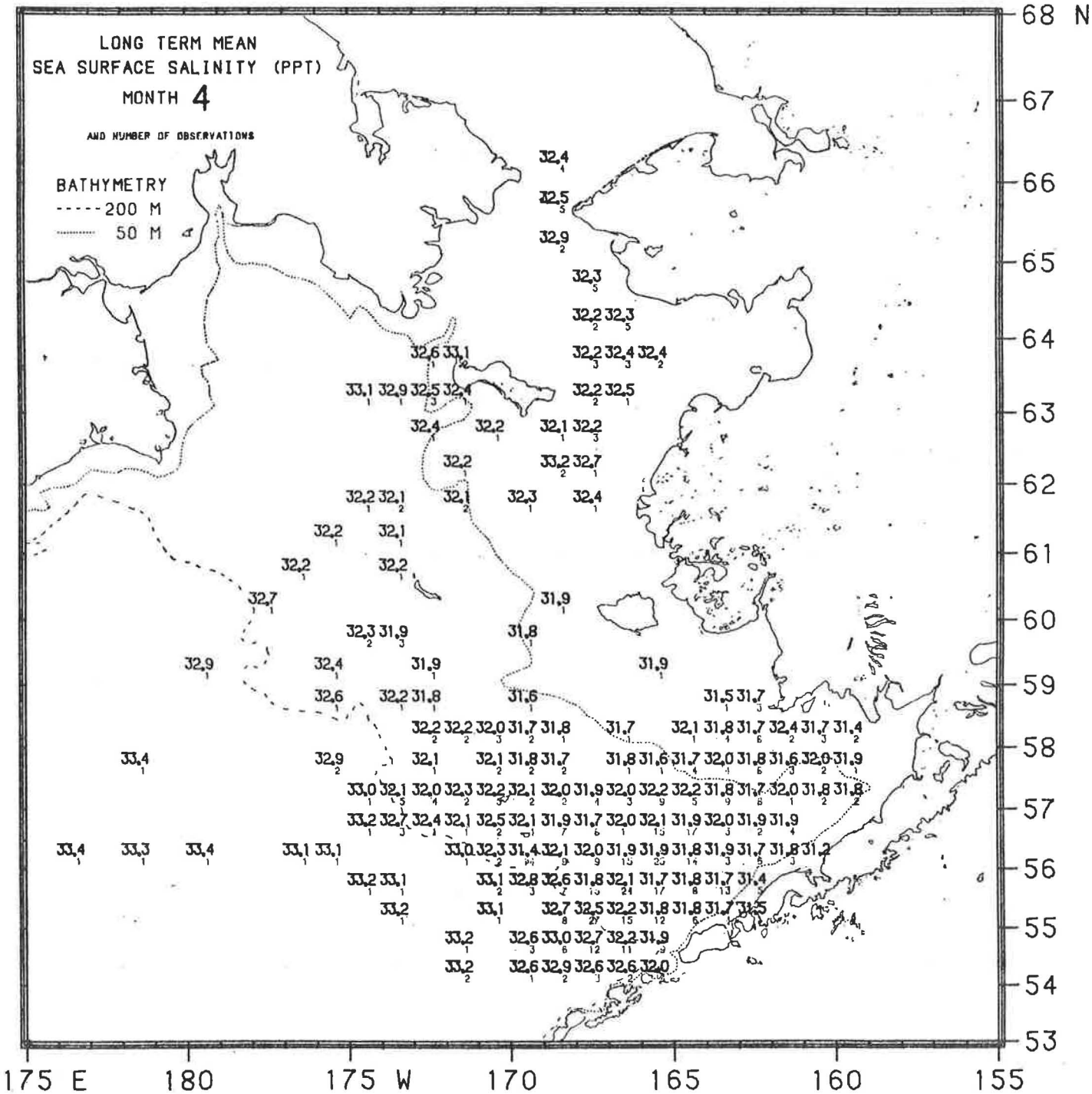

Figure 26.--Long term April mean sea surface salinity (^{o}/oo)

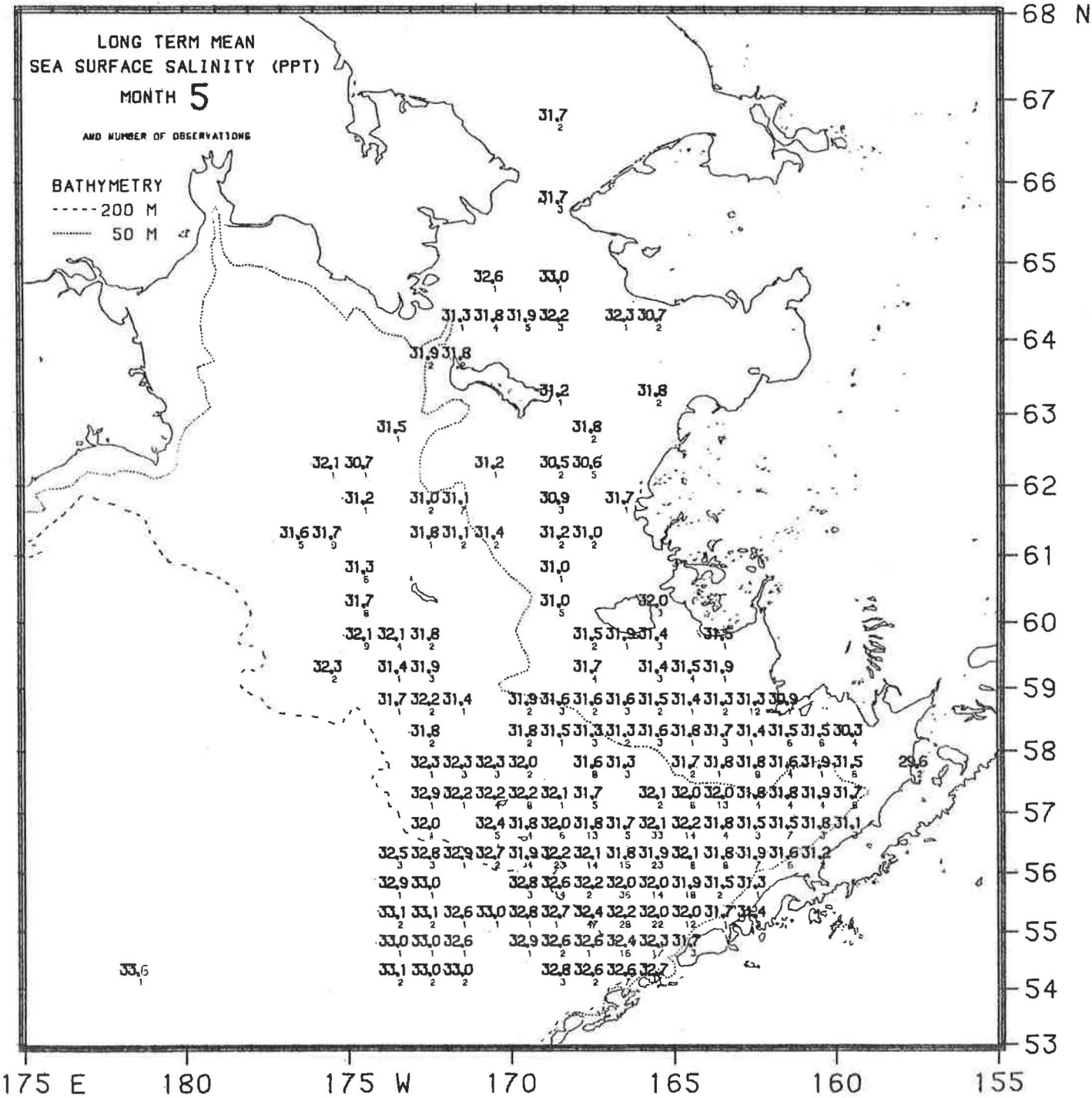

Figure 27.--Long term May mean sea surface salinity ($^{o}/oo$).

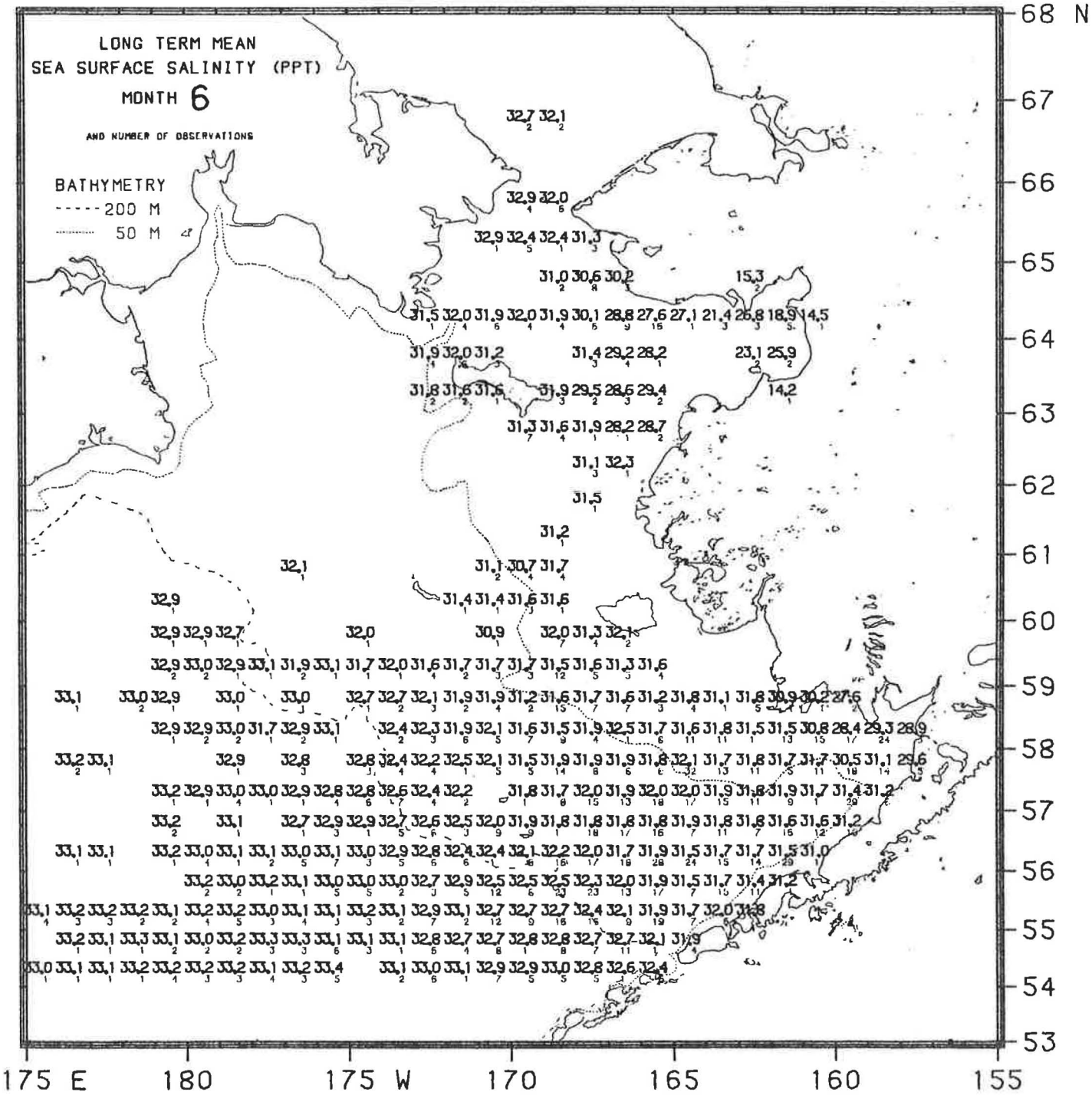

Figure 28.--Long term June mean sea surface salinity (^{o}/oo).

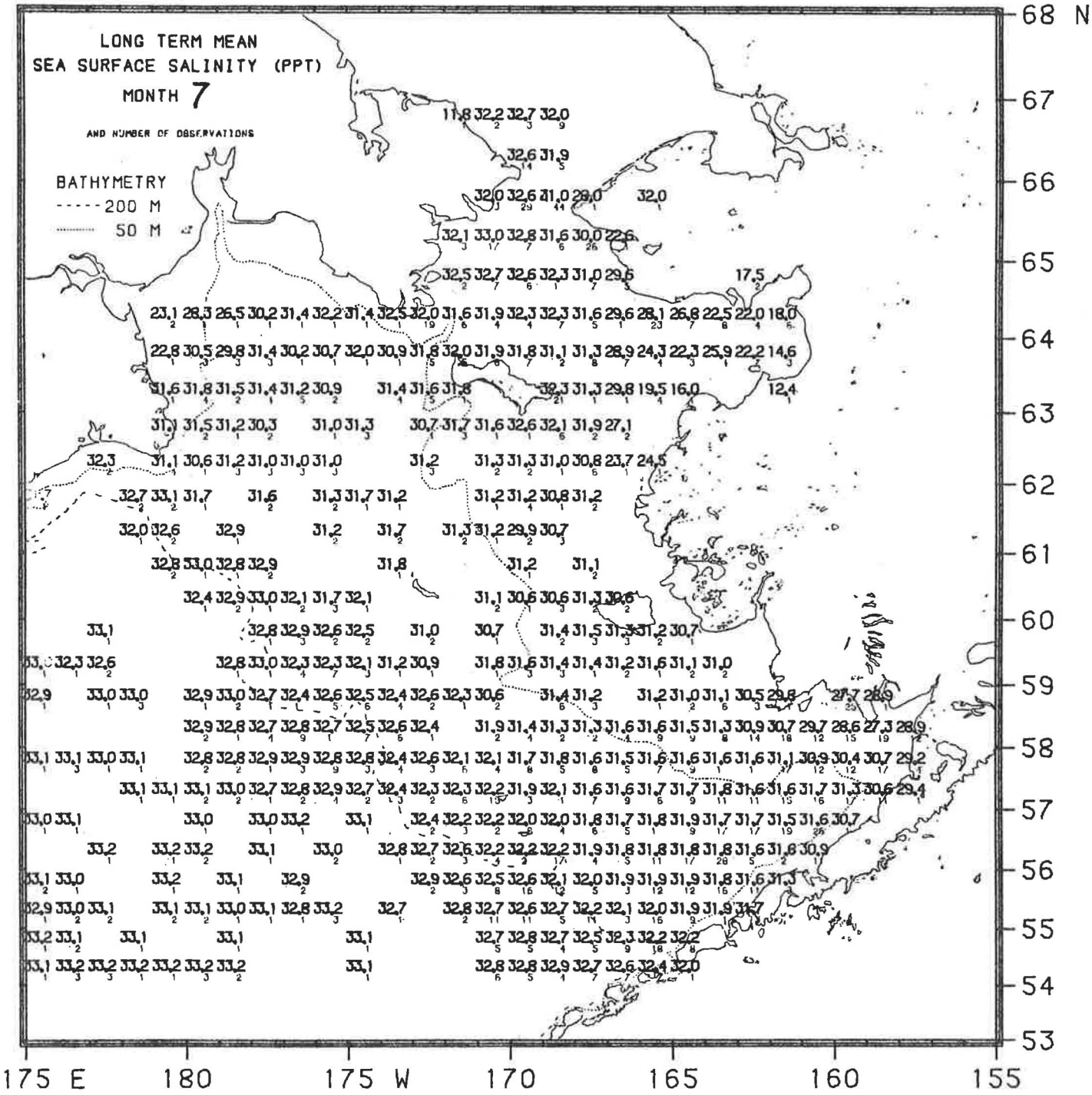

Figure 29.--Long term July mean sea surface salinity (^{o}/oo).

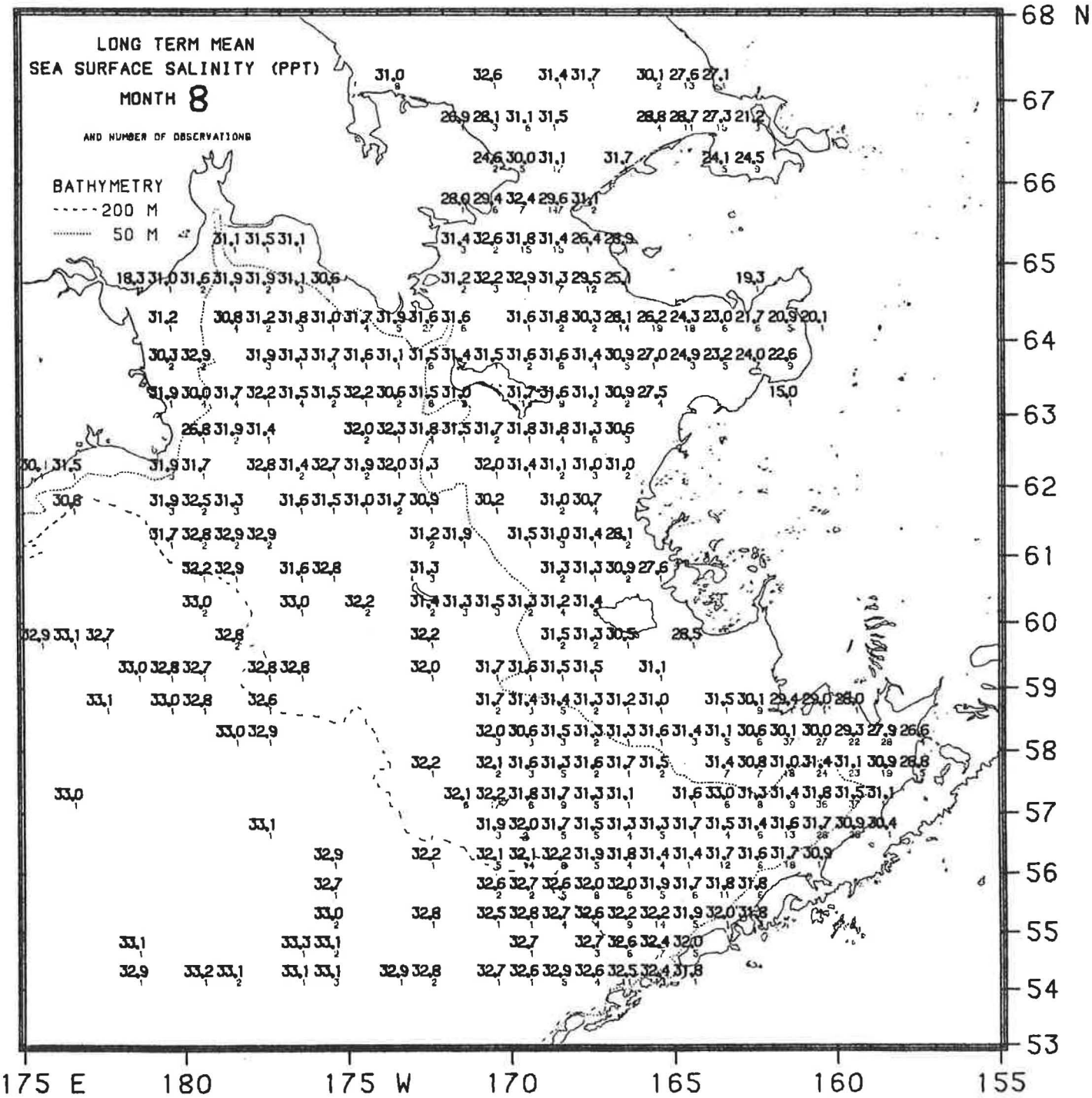

Figure 30.--Long term August mean sea surface salinity ($^{o}/oo$).

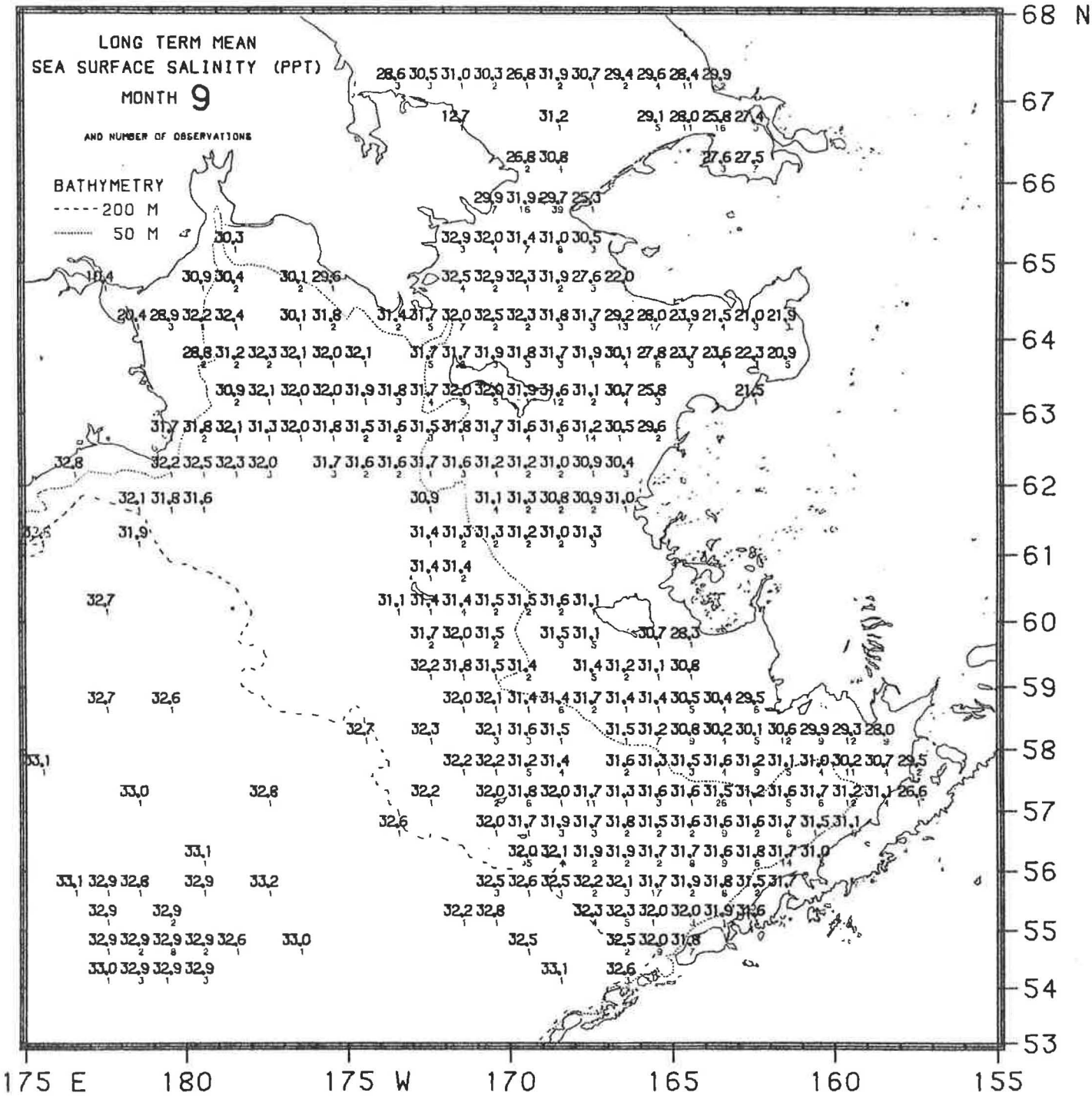

Figure 31.--Long term September mean sea surface salinity (^{o}/oo).

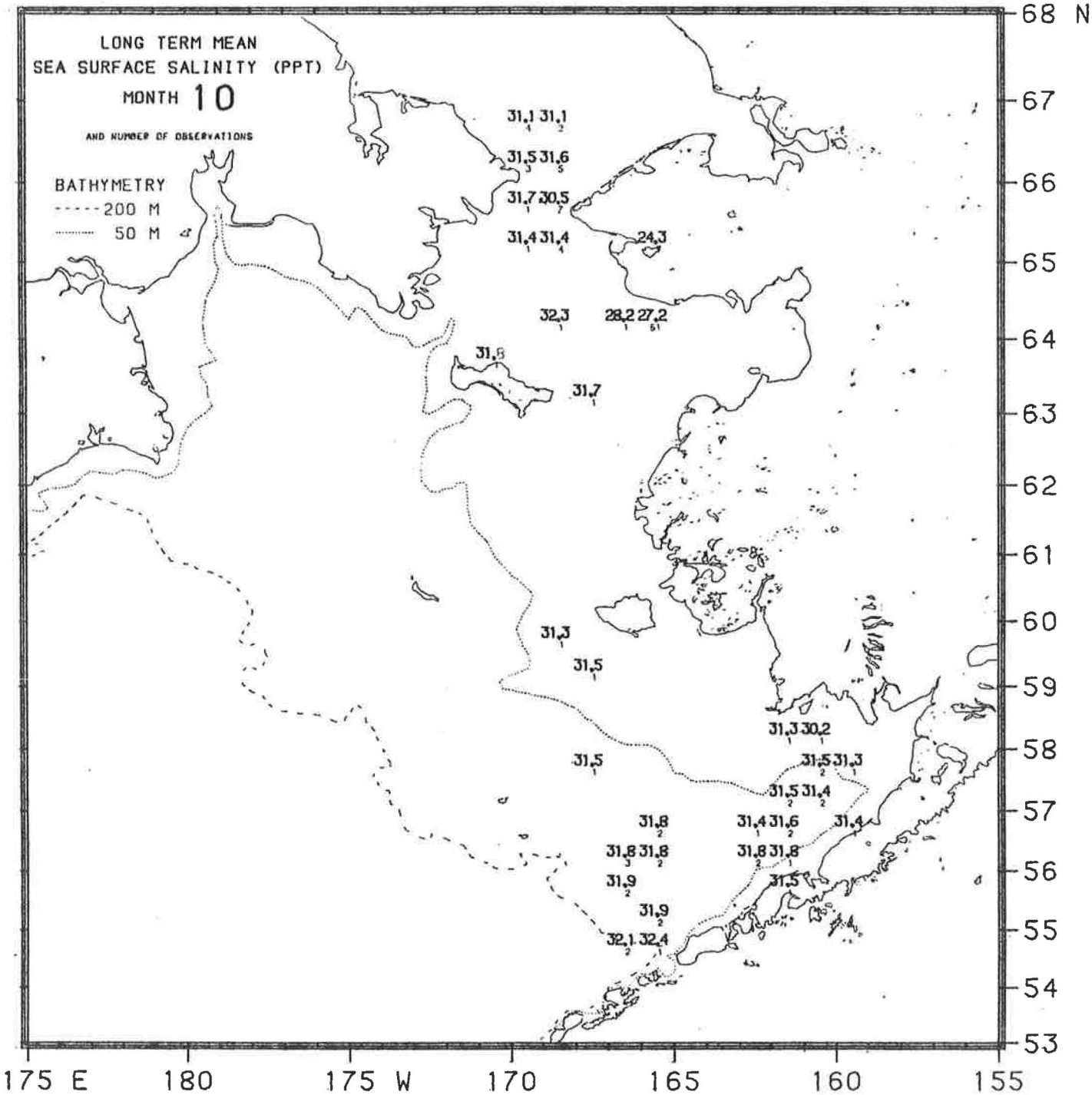

Figure 32.--Long term October mean sea surface salinity (^{o}/oo).

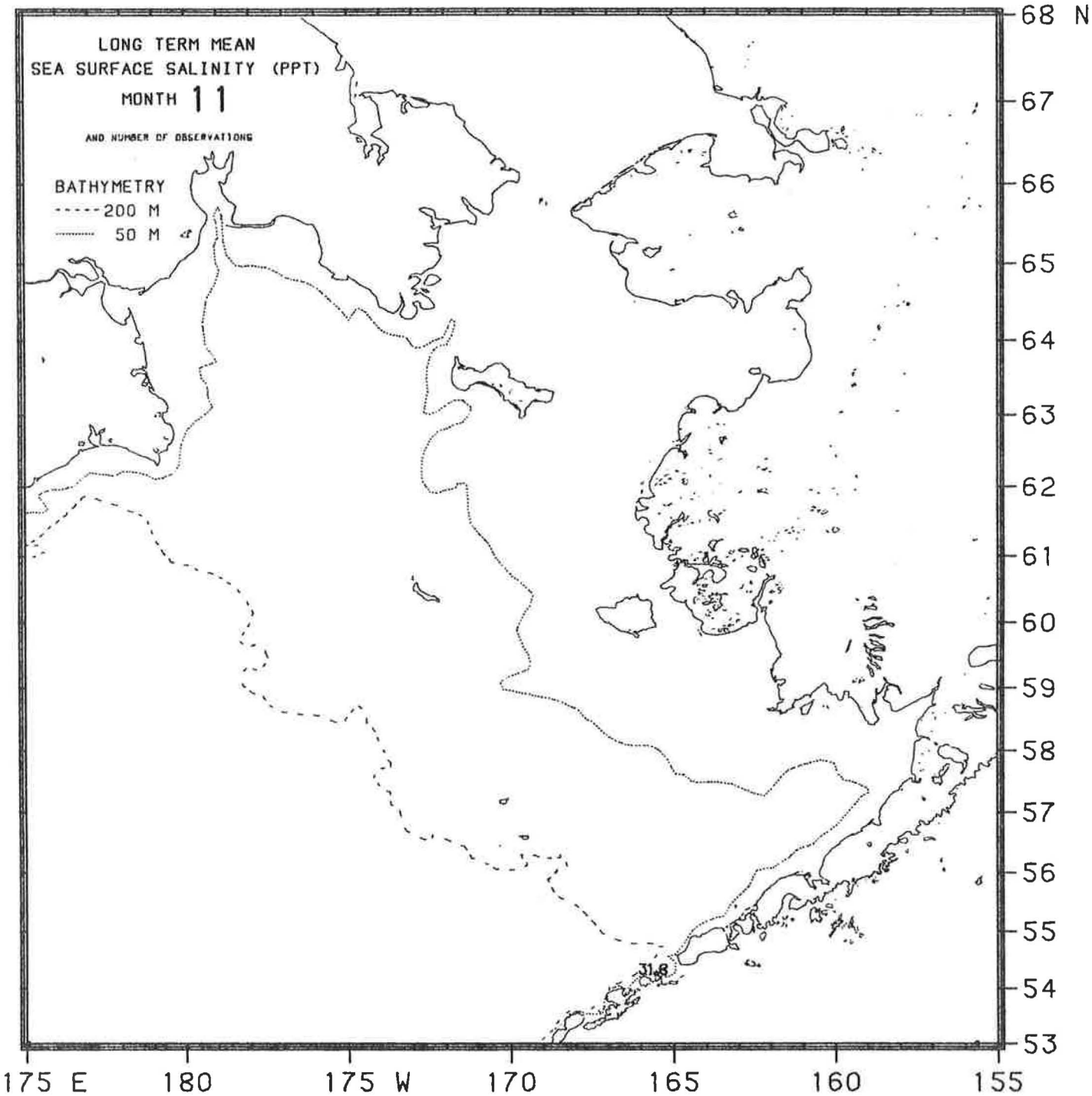

Figure 33.--Long term November mean sea surface salinity (^{o}/oo).

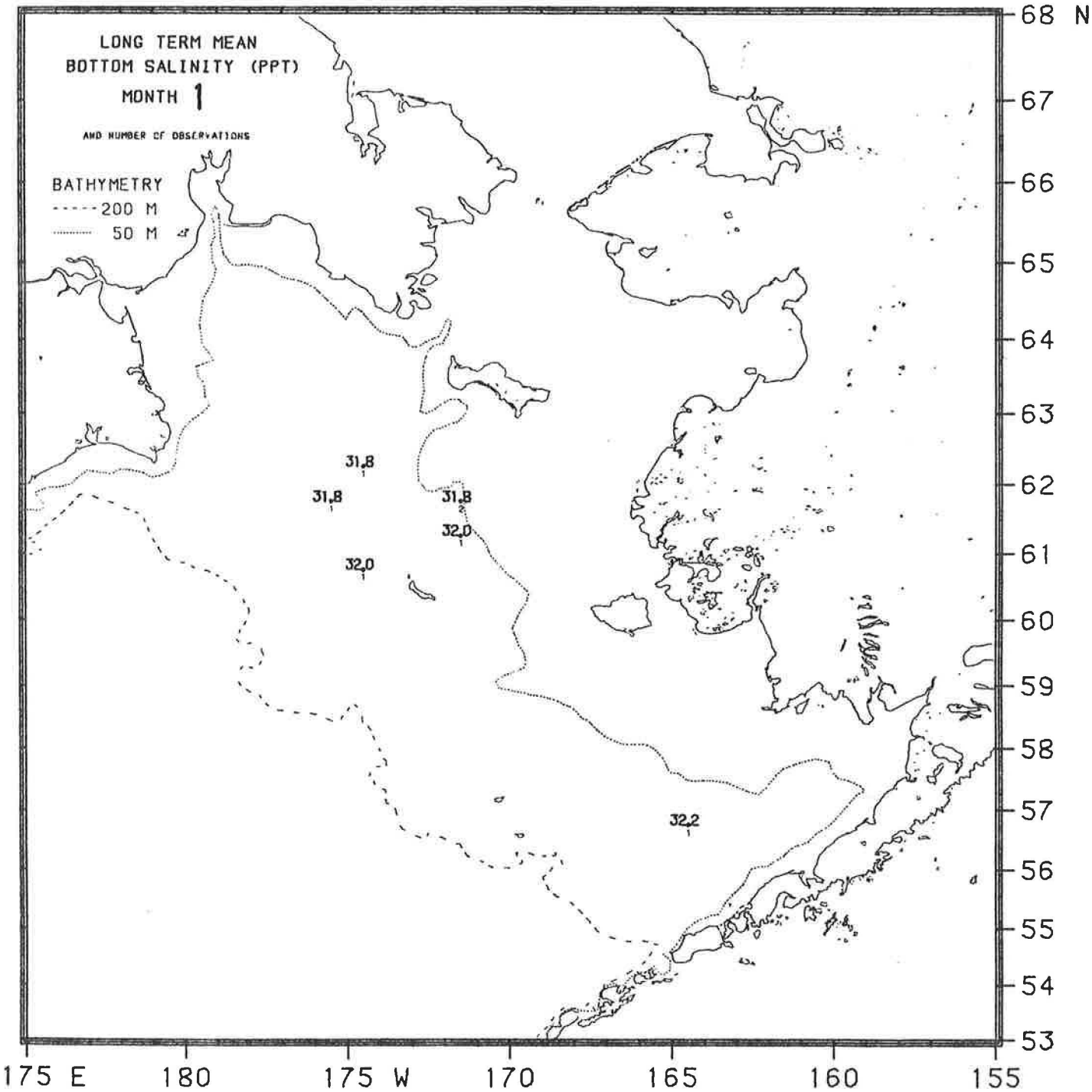

Figure 34.--Long term January mean near bottom salinity (^{o}/oo).

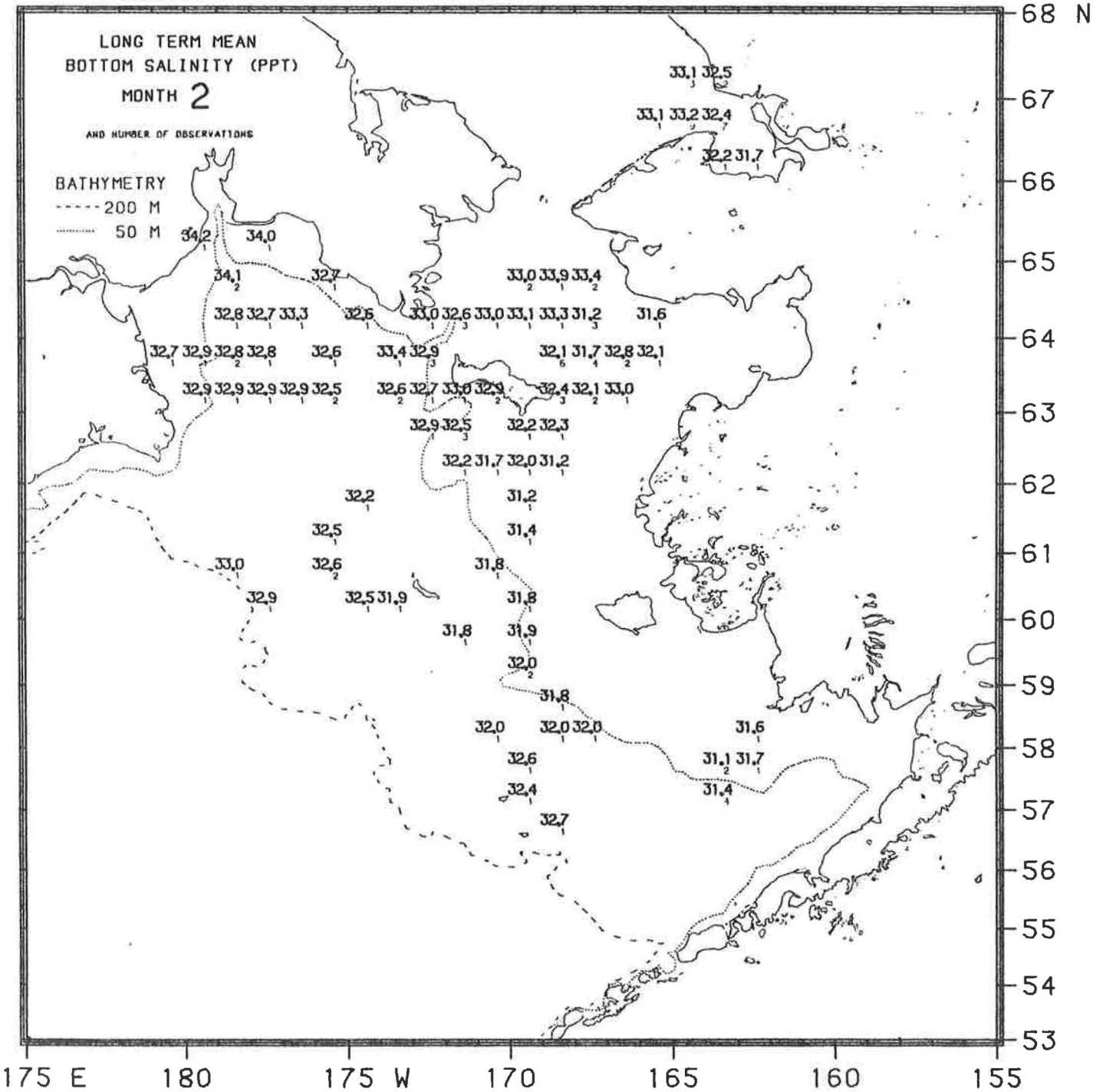

Figure 35.--Long term February mean near bottom salinity (^{o}/oo).

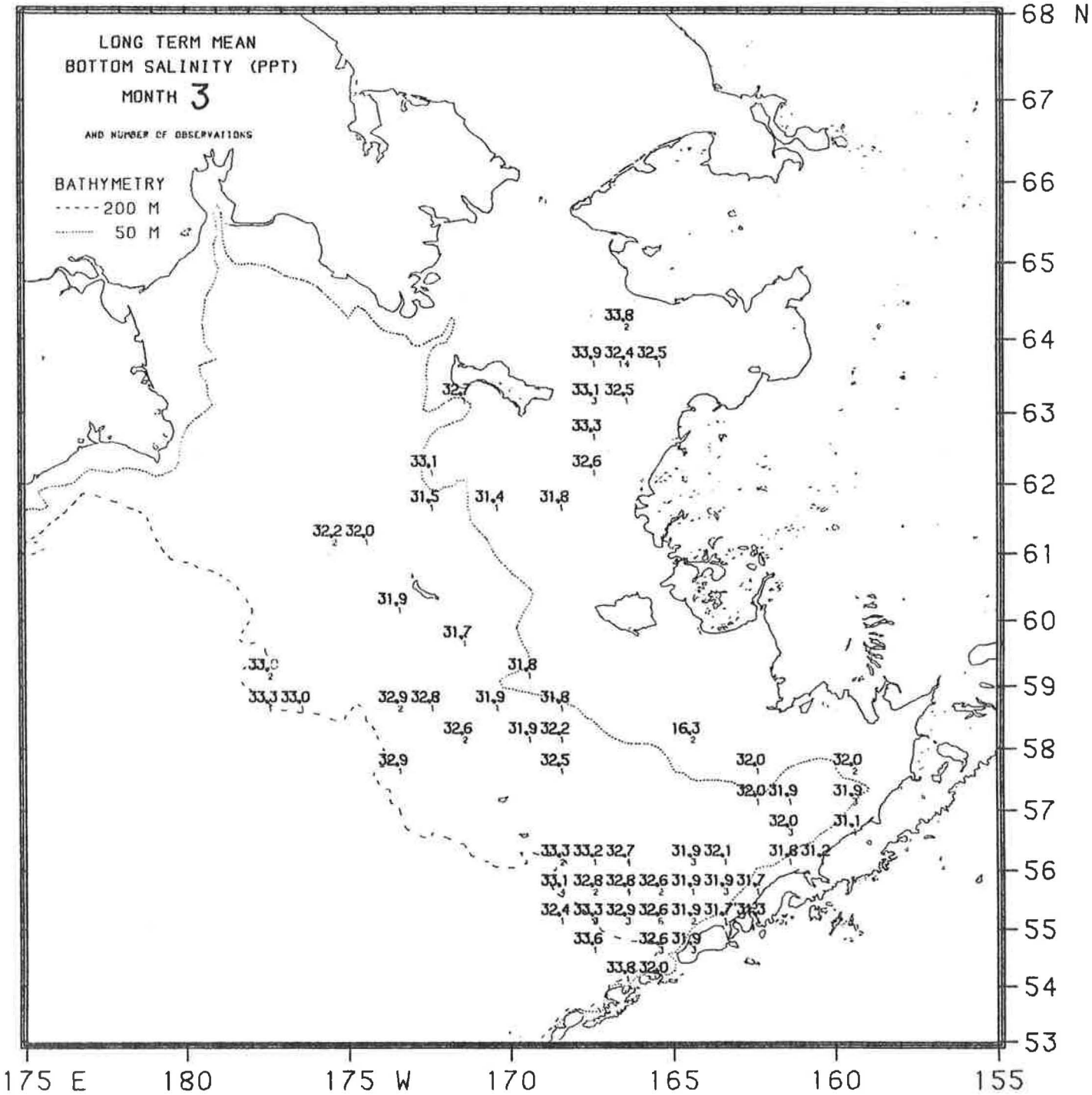

Figure 36.--Long term March mean near bottom salinity ($^{o}/oo$).

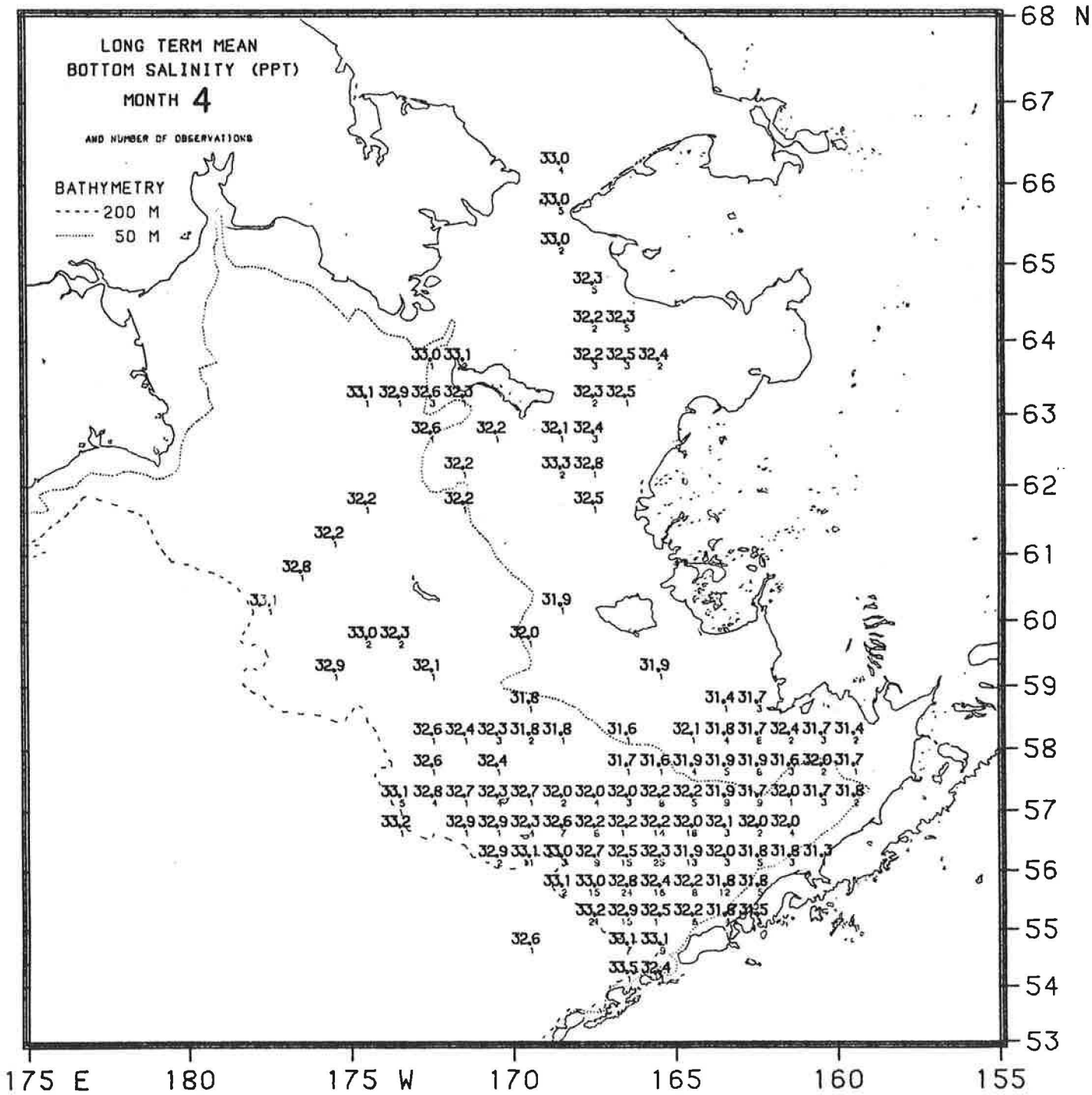

Figure 37.--Long term April mean near bottom salinity (^{o}/oo).

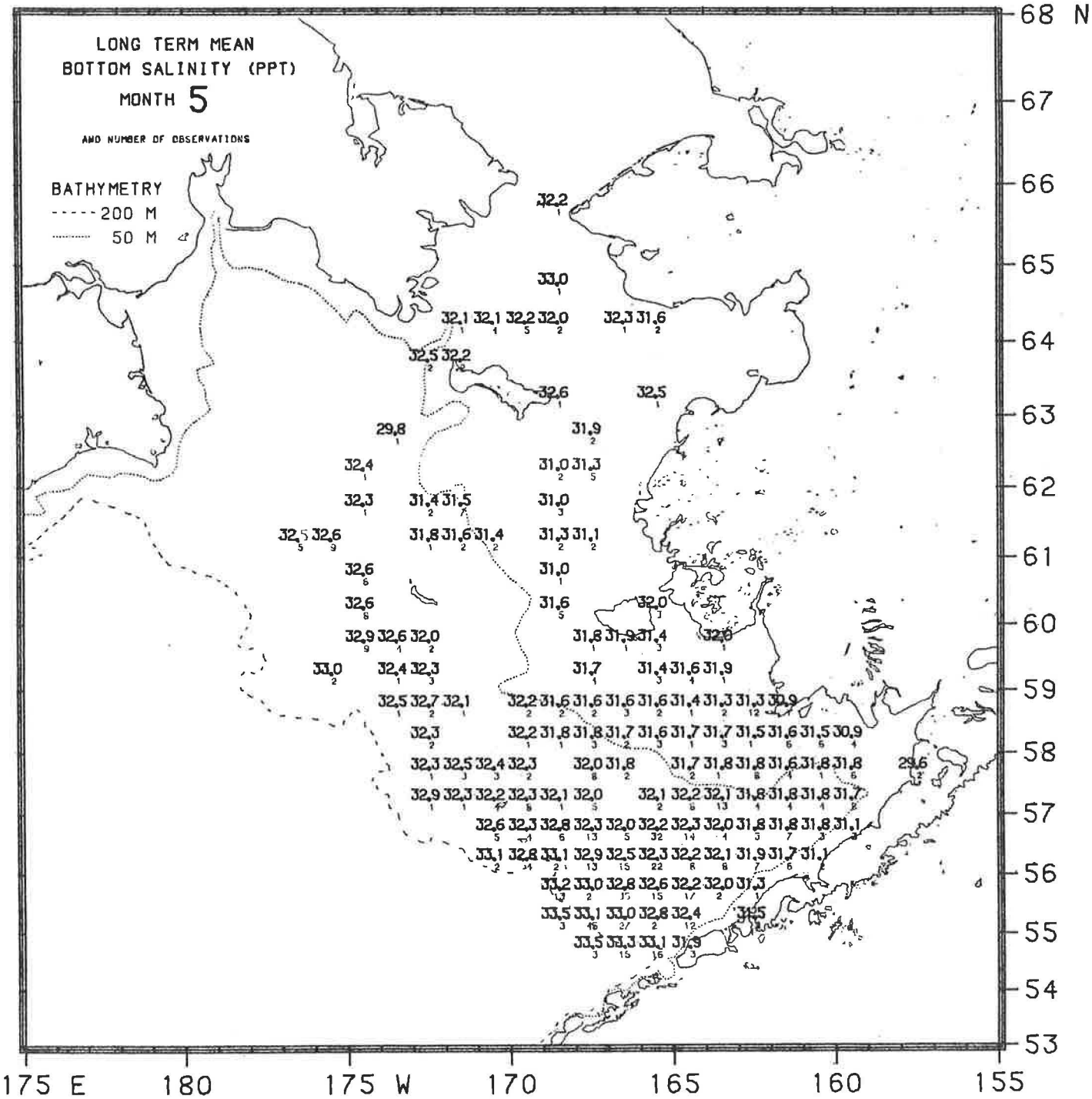

Figure 38.--Long term May mean near bottom salinity (^{o}/oo).

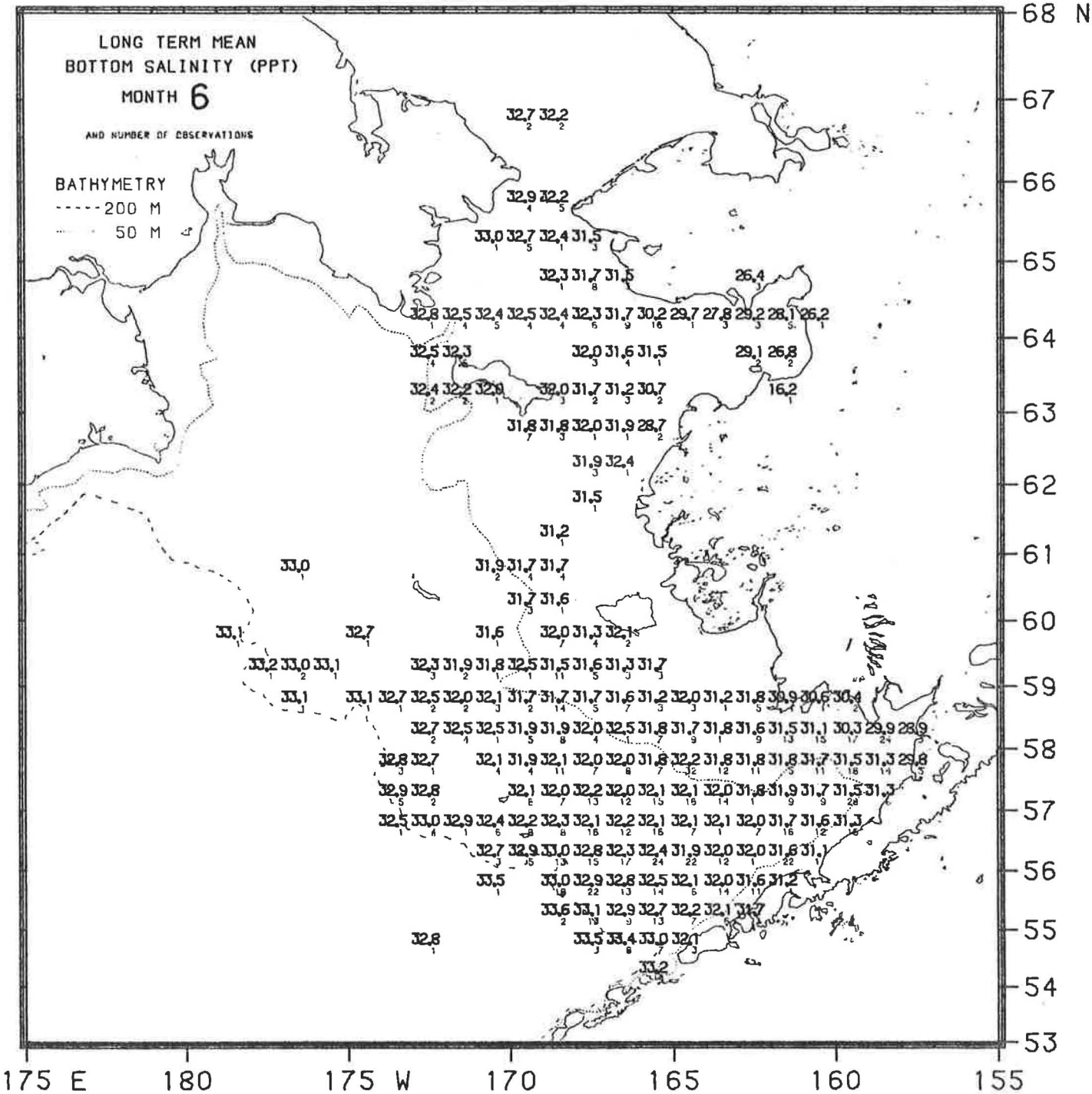

Figure 39.--Long term June mean near bottom salinity (^{o}/oo).

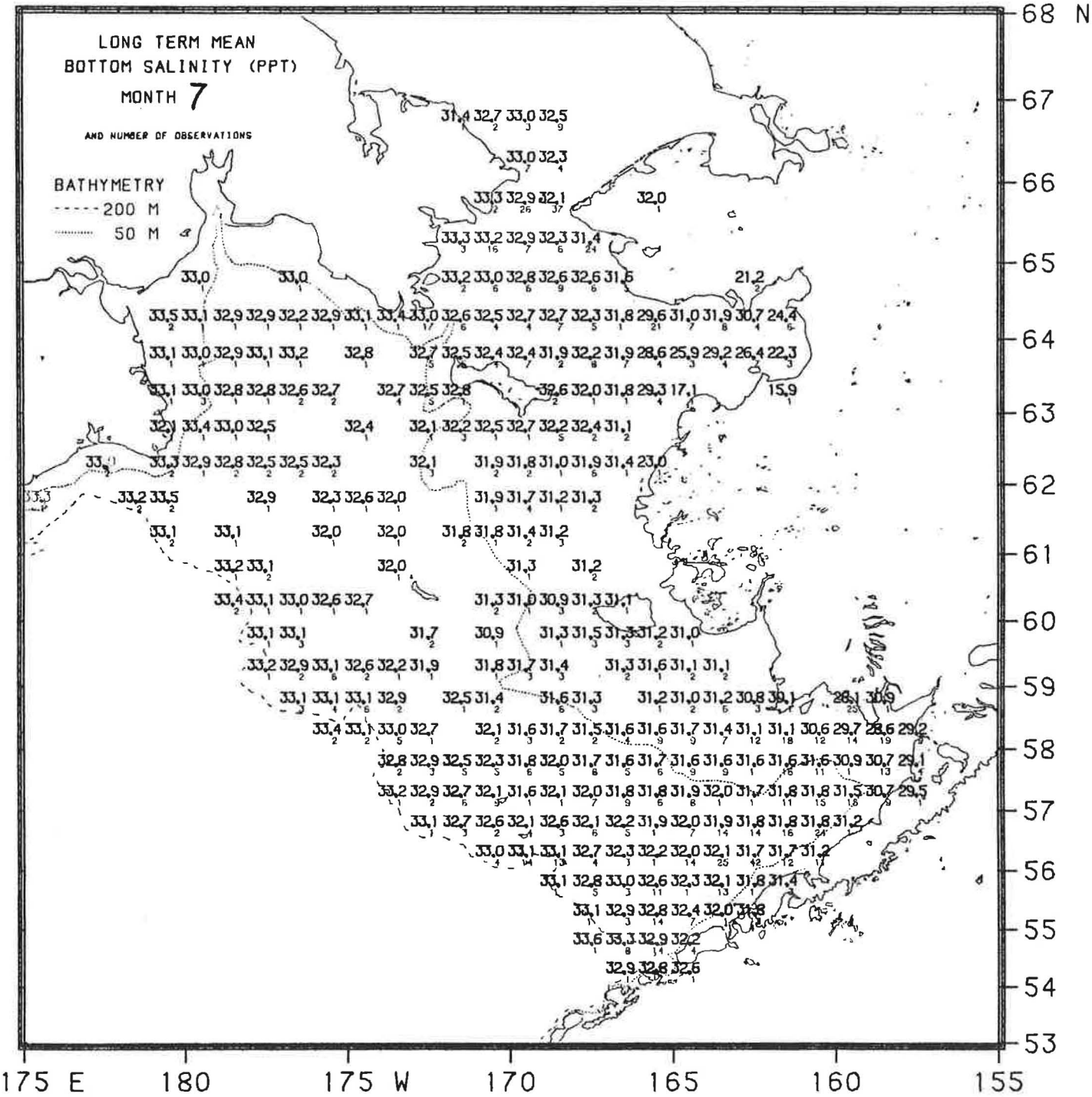

Figure 40.--Long term July mean near bottom salinity ($^{o}/oo$).

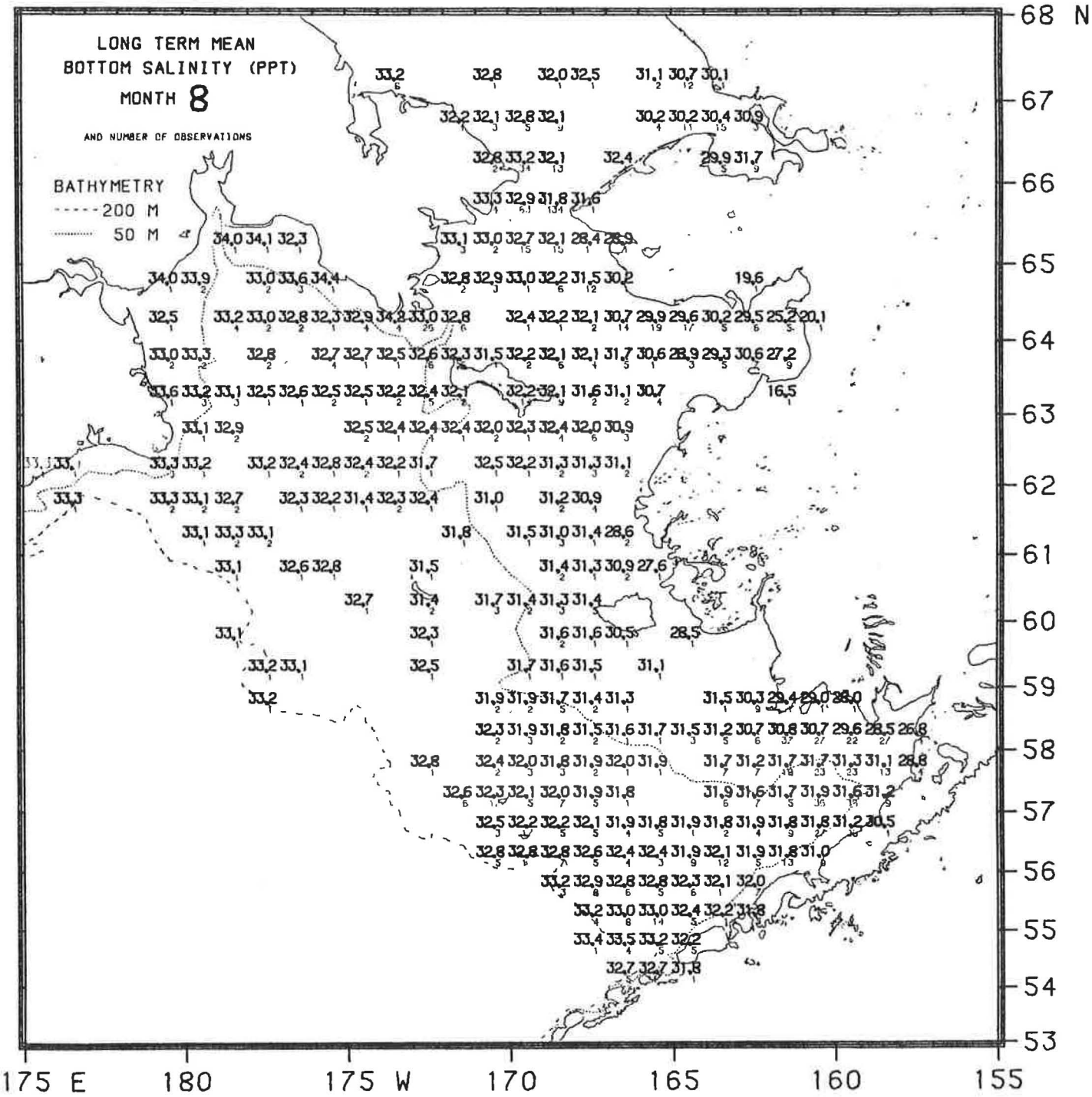

Figure 41.--Long term August mean near bottom salinity (^{o}/oo).

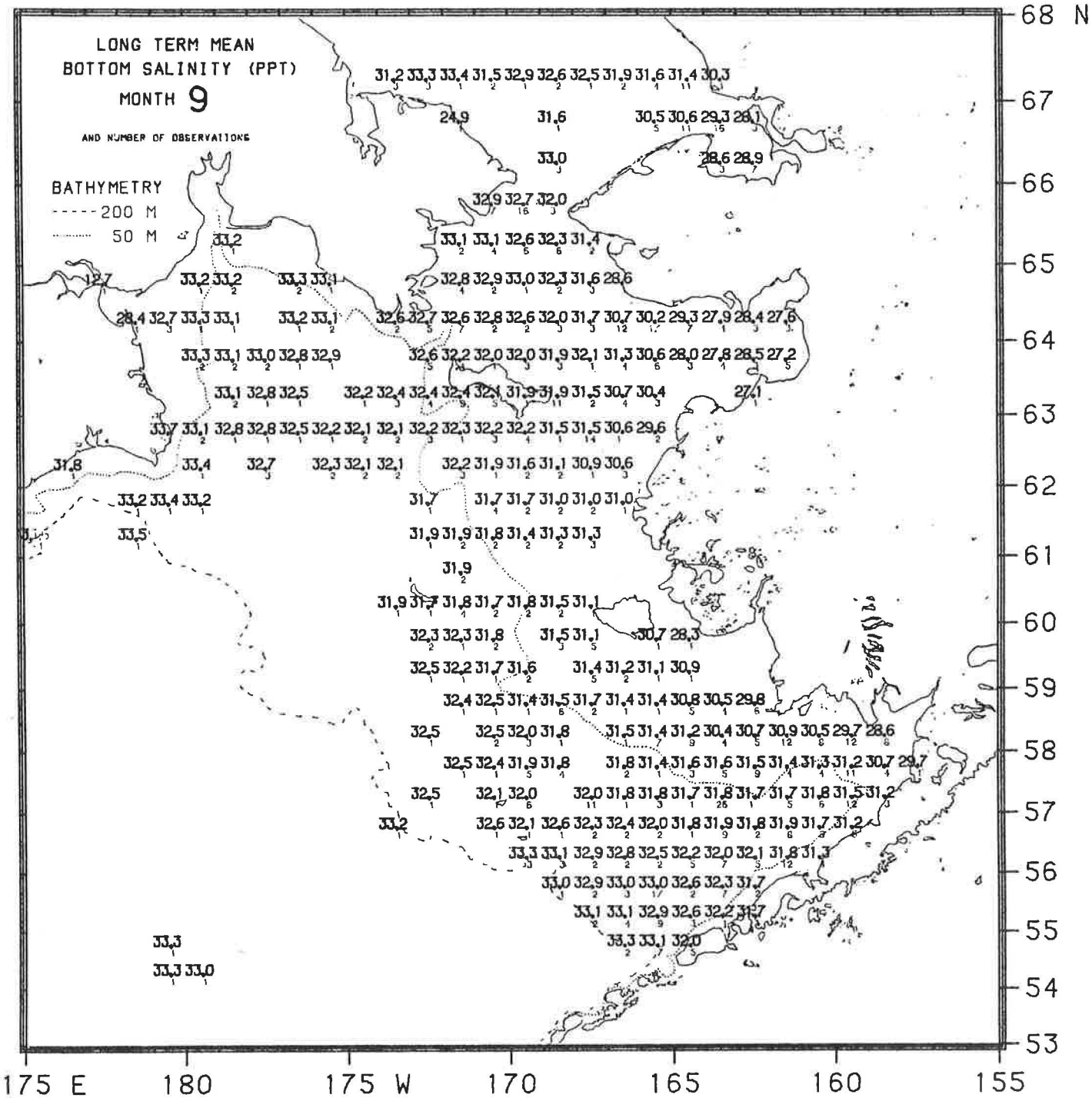

Figure 42.--Long term September mean near bottom salinity (^{o}/oo).

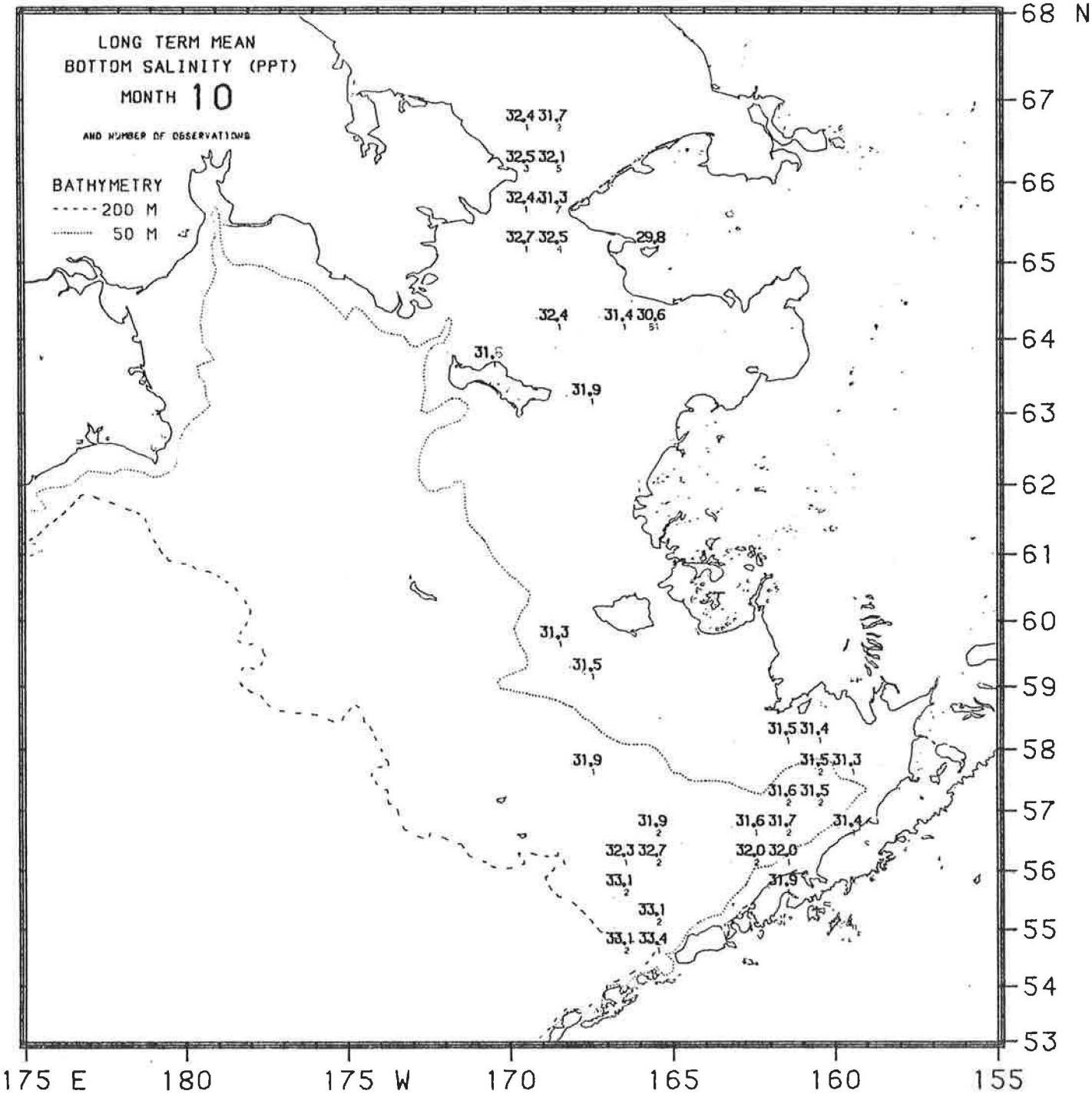

Figure 43.--Long term October mean near bottom salinity (^{o}/oo).

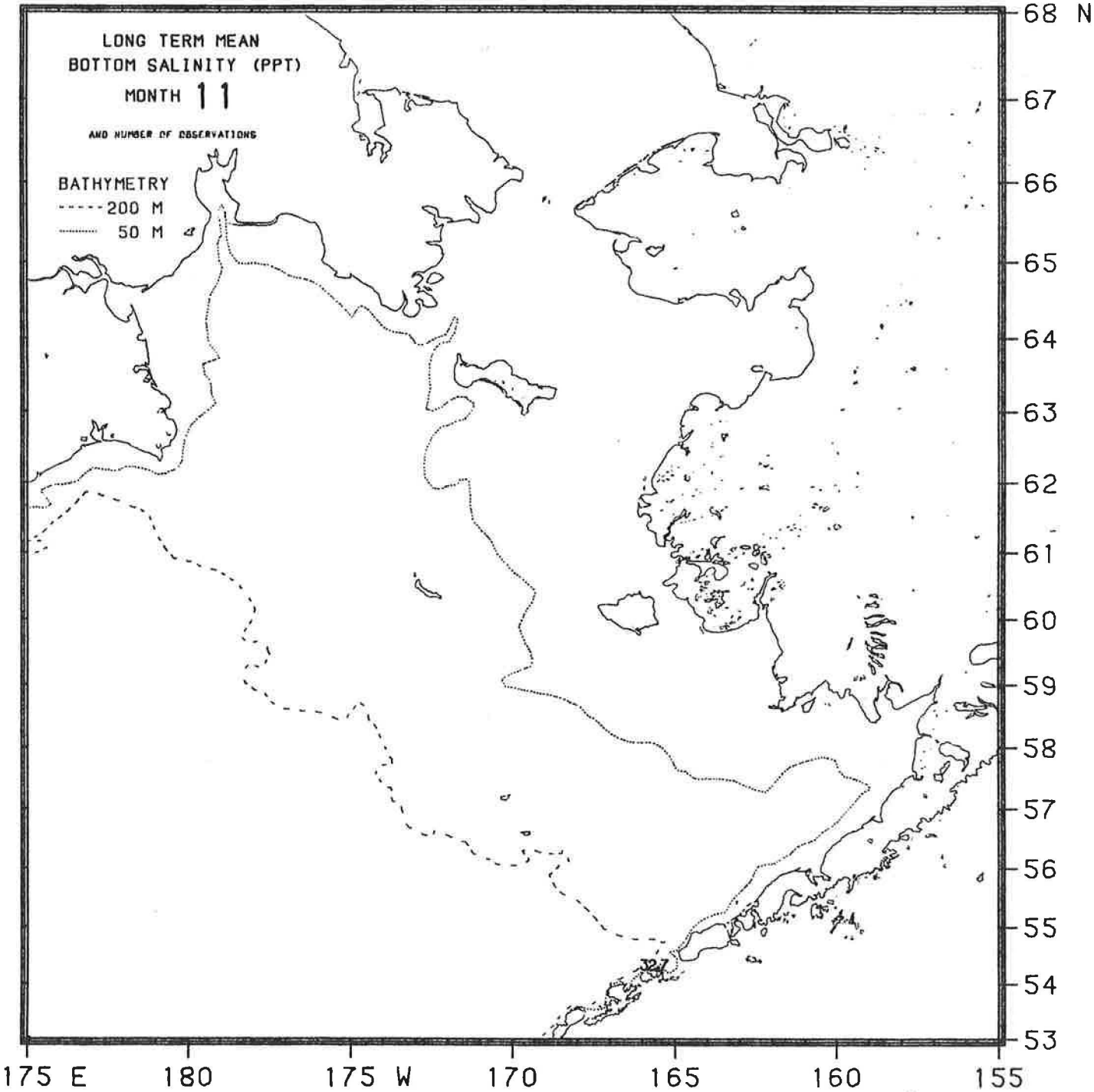

Figure 44.--Long term November mean near bottom salinity (^{o}/oo).