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SURFACE TEMPERATURES AND SALMON DISTRIBUTION RELATIVE TO
THE BOUNDARIES OF THE JAPANESE DRIFT GILLNET FISHERY
FOR FLYING SQUID (Ommastrephes bartrami)

by

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INTRODUCTION

Burgner, Mercer and Major (1982) presented information on surface temperatures and salmon distribution relative to the monthly northern boundaries of the Japanese drift gillnet fishery for flying squid. This information was presented in an attempt to evaluate the likelihood that Japanese vessels fishing legally for flying squid within the monthly fishing areas designated by Japan would intercept salmon of Asian or North American origin. Conclusions from that analysis were, briefly, that (1) squid vessels may at times be fishing legally in waters well below 15°C, (2) past research data do not adequately define the monthly southern boundary of salmon distribution, and (3) further analyses are needed to define better the expected frequency of high seas capture of salmon and steelhead trout at temperatures encountered in the vicinity of the squid fishery.

The purpose of this document is to follow up on recommendations (1) and (2) of the Burgner et al. (1982) report. These were: (1) That joint agency efforts be made to analyze and summarize available data on seasonal distribution of salmon and steelhead on the high seas with respect to statistical area and temperature, and (2) that further analyses of existing data on sea temperatures be made for the area of

the squid fishery. Data on steelhead distribution with respect to ocean temperature were not available for analysis.

METHODS AND DATA SOURCES

In order to provide more detail on salmon distribution by species with respect to sea surface temperature, data on salmon catches by Japanese research vessels 1972-81 and recorded sea surface temperatures for the years 1972-80 were analyzed further. The number of research vessel daily operations and catch per tan in the drift gillnets of commercial-size mesh were summarized by salmon species and month, stratified by 1°C intervals of recorded sea surface temperature. The data were obtained from the annual data records provided by the Japan Fisheries Agency.

To provide better analyses of monthly sea surface temperatures likely to be encountered in the northern area of the squid fishery, 1972-80 sea surface temperatures were analyzed to provide the monthly means and extremes of the position of the 12°C and 15°C isotherms for the Japanese squid fishery season, June-December. The means and extremes of latitude position of these temperatures were determined for the 9-year period for each 1 degree of longitude between 170°E and 145°W, the western and eastern boundaries of the squid fishery area. Sources of temperature data for this analysis were the monthly issues of FISHING INFORMATION, published by U.S. NOAA National Marine Fisheries Service, La Jolla, California.

RESULTS

Appendix Tables 1-7 present the monthly averages of Japanese research vessel gillnet catches per tan by species by 1°C temperature intervals for sampling conducted in the North Pacific, divided into two areas, 157°E to 170°E south of 54°N, and east of 170°E south of 52°N, for the months March through September. Since more sampling effort tended to be directed in the areas of higher salmon abundance, the combined multi-year data probably indicate quite accurately the temperatures at which highest concentrations of each species of salmon are found seasonally.

Sampling in March was less extensive and restricted to waters of temperatures ranging between 2 to 6°C so that the March sampling probably does not give a reliable indication of species distribution with respect to temperature. The number of operations in September was also limited. Data for these months are included because they are reasonably consistent with the seasonal trends of distribution reflected by the data for the other months, April-August. The patterns of salmon distribution with respect to temperature east of 170°E, the western boundary of the flying squid fishery, appear to be similar to those west of 170°E, so that the data could well have been combined.

The research vessel sampling effort was less extensive at ocean temperatures where salmon were less abundant. Consequently, the catch per tan data do not reflect as accurately the abundance of salmon species to be expected at the higher ranges of temperature. The consistent

pattern, however, is for very marked drops in CPUE as sampling deviates from the temperatures where highest CPUE's are obtained. Average catches per tan at the upper ranges of temperatures where a salmon species was encountered are quite consistently at least an order of magnitude lower than at the temperatures of highest abundance.

Temperatures at which highest catches per tan were made in each month west and east of 170°E and summarized in Table 1. Generally, for sockeye, chum, pink and chinook salmon the seasonal trend was for highest catches per tan to occur in warmer waters as the year progressed from March through September, and trends were similar west and east of 170°E . This seasonal trend was particularly evident for sockeye salmon. For coho salmon there was essentially no indication of a seasonal increase in water temperatures at which highest CPUE's were made. Highest coho catches were made in warmer waters than for the other four species through June. Highest CPUE's for sockeye, chum and pink salmon were made in waters less than 9°C through July, and more commonly, in waters less than 7°C . Highest CPUE's for coho and chinook salmon were encountered in waters below 10°C through July. In August and September, highest CPUE's of salmon were made in warmer water, ranging from $7-8^{\circ}$ to $12-13^{\circ}\text{C}$, with most values between $8-9^{\circ}$ and $11-12^{\circ}\text{C}$.

Maximum temperatures at which catches of salmon were made by Japanese research vessels are summarized by species in Table 2. Underlined values indicate that no sampling was conducted in waters warmer than where the species was encountered. Except for sockeye, seasonal trends

are little in evidence. Sockeye were not encountered in waters warmer than 10°C during the months March-June, but were encountered at temperatures warmer than 11°C in the months July-September. In September, sockeye were encountered to 14°C , the maximum temperatures fished. During the months June-September, when the squid fishery is open, chum salmon were encountered in waters above 11°C and ranging to $15\text{-}16^{\circ}\text{C}$. East of 170°E , the range was to $13\text{-}14^{\circ}\text{C}$, the maximum temperature fished in September. Pink salmon were found in waters ranging to $15\text{-}16^{\circ}\text{C}$ during June-September, coho were encountered in waters from 12°C to $15\text{-}16^{\circ}\text{C}$, and chinook, in waters to $12\text{-}13^{\circ}\text{C}$.

To examine the likelihood of salmon encounter in the northern part of the squid fishery zone, the 15°C and 12°C temperature mean and range positions were plotted. Figures 1 and 2 show these plots for June relative to the northern boundary of the squid fishery at 40°N . Figure 1 indicates that generally, the 15°C isotherm can be expected to fall within the squid fishery zone south of 40°N during the month of June. Figure 2 indicates that June monthly mean temperatures as low as 12°C would not occur within the squid fishery area. Table 2 suggests that under these conditions, sockeye and chinook salmon would not be encountered within the squid fishery in June, chum and pink salmon might be encountered, and coho salmon probably would be encountered in low numbers. Catches of coho would probably be less than 0.1 fish per tan along the northern border of the squid fishing zone. (A squid vessel normally fishes 600-700 tans per night (Japan Fisheries Agency 1982).) Because water temperatures are warmer at the same latitude east of about 160°W

longitude, there is less likelihood that coho would be encountered in this area.

Figures 3 and 4 present the expected location of the 15°C and 12°C isotherms with respect to the 42°N squid fishery boundary in July. Table 2 indicates that all five salmon species might be encountered, but that expected CPUE's would be low, on the order of 0.1 fish per tan or less, along the northern border of the July fishery.

Figure 5 indicates that for August, temperatures below 15°C would be encountered in about 50% of the years south of the August 44°N fishery boundary, particularly west of 170°W longitude. Table 2 and Figures 5-6 suggest that salmon are unlikely to be encountered in the August squid fishery zone east of 170°E.

The data on September salmon distribution with respect to temperature are more limited and do not define the upper extremes of temperature in which salmon may be found. Some fairly high CPUE's were encountered at the upper temperature samples (12-14°C). Figures 7 and 8 indicate that the 15°C temperature isotherm will fall consistently within the squid zone south of 46°N, and that the 12°C isotherm will often extend into the zone west of 160°W. Therefore the possibility of encountering all five species of salmon in numbers cannot be discounted in this analysis.

Figures 9-14 present the 15°C and 12°C temperature distributions for the months October-December, in which data on salmon distributions are lacking. The 15°C isotherm falls consistently within the squid fishery zone in all three months and the 12°C isotherm extends into the zone in all three months in cooler years. Lacking CPUE data, we can only speculate that it is quite possible that salmon may be encountered. Sometime during the winter, however, the salmon tend to shift to waters of cooler temperature, so that by early spring they are unlikely to be encountered in waters above 13°C. This is particularly true for sockeye, which were not caught in waters warmer than 10°C during spring months.

DISCUSSION

The analyses herein concerning salmon distribution with respect to ocean temperature provide detail on monthly distributions not included in Burgner et al. (1982) and more accurate information on monthly mean sea surface temperatures to be expected within the Japanese squid fishery zone. It is indicated that salmon may be encountered in low densities along the northern border of the squid fishery zone in June and July, that they are unlikely to be encountered in August, and that there is the potential for significant interceptions in September. October-December temperatures do not preclude the presence of salmon in the squid fishery area, but distribution of salmon with respect to temperatures is unknown for these months.

The only direct observer data available to the United States on the Japanese squid fishery was for a limited period in September-October 1982 (Cary and Burgner 1983). Fishing was conducted during 11 days in waters of 12.4-14.8°C. No salmon were observed in the catches of the commercial squid vessel. While these observations were informative, they were restricted in time and space.

LITERATURE CITED

- Burgner, R. L., R. W. Mercer, and R. L. Major. 1982. Surface temperatures and salmon distribution relative to the Japanese driftnet fishery for flying squid (Ommastrephes bartrami). (Document submitted to annual meeting of the INPFC, Tokyo, Japan, November 1982), 22 pp. Fisheries Research Institute, University of Washington, Seattle.
- Cary, Frank and Robert L. Burgner. 1983. Observations aboard a Japanese squid driftnet fishing vessel in September-October 1982. Final Rep. to Pac. Seafood Processors Assoc. 23 pp. Univ. Washington, Fish. Res. Inst., FRI-UW-8307. Seattle.
- Japan Fisheries Agency. 1982. Squid drift gillnet fishery. (Document submitted to INPFC, dated March 1982). 21 pp.

Table 1. Temperatures at which highest catches per tan were made by Japanese research vessels fishing west and east of 170°E longitude. (Lower temperature boundary inclusive).

Month	Sockeye	Chum	Pink	Coho	Chinook
<u>W of 170°E</u>					
Mar	2- 3*	5- 6**	5- 6**	-	3- 4
Apr	3- 4	5- 6	5- 6	7- 8	8- 9
May	3- 4	8- 9	5- 6	8- 9	7- 8
June	4- 5	5- 6	6- 7	9-10	6- 7
July	5- 6*	5- 6*	6- 7	5- 6*	5- 6*
Aug	11-12	9-10	9-10	9-10	10-11
Sept	12-13**	11-12	10-11	9-10	9-10
<u>E of 170°E</u>					
Mar	3- 4*	4- 5**	4- 5**	-	4- 5**
Apr	3- 4	7- 8	5- 6	9-10	8- 9
May	5- 6	6- 7	6- 7	8- 9	5- 6
June	5- 6	6- 7	5- 6	8- 9	7- 8
July	8- 9	5- 6*	6- 7	9-10	9-10
Aug	7- 8*	9-10	8- 9	9-10	9-10
Sept	11-12	8- 9*	8- 9*	8-10	-

*Coldest temperature interval sampled

**Warmest temperature interval sampled

Table 2. Maximum temperatures at which catches of salmon were made by Japanese research vessels fishing gillnets west and east of 170°E longitude. (Lower temperature boundary inclusive.)

Month	Sockeye	Chum	Pink	Coho	Chinook
<u>W of 170°E</u>					
Mar	<u>5- 6</u>	<u>5- 6</u>	<u>5- 6</u>	-	<u>5- 6</u>
Apr	<u>6- 7</u>	12-13	<u>9-10</u>	10-11	<u>12-13</u>
May	7- 8	12-13	11-12	11-12	11-12
June	9-10	<u>14-15</u>	12-13	13-14	11-12
July	11-12	<u>15-16</u>	14-15	15-16	11-12
Aug	12-13	14-15	13-14	14-15	12-13
Sept	<u>12-13</u>	<u>12-13</u>	11-12	<u>12-13</u>	<u>12-13</u>
<u>E of 170°E</u>					
Mar	<u>4- 5</u>	<u>4- 5</u>	<u>4- 5</u>	-	<u>4- 5</u>
Apr	<u>8- 9</u>	<u>12-13</u>	<u>12-13</u>	<u>12-13</u>	11-12
May	8- 9	10-11	10-11	10-11	10-11
June	9-10	11-12	11-12	14-15	9-10
July	13-14	13-14	15-16	13-14	12-13
Aug	12-13	13-14	11-12	13-14	12-13
Sept	<u>13-14</u>	<u>13-14</u>	9-10	12-13	-

Underlined values indicate salmon were encountered at the maximum temperature fished.

15 DEGREE ISOTHERM - JUNE

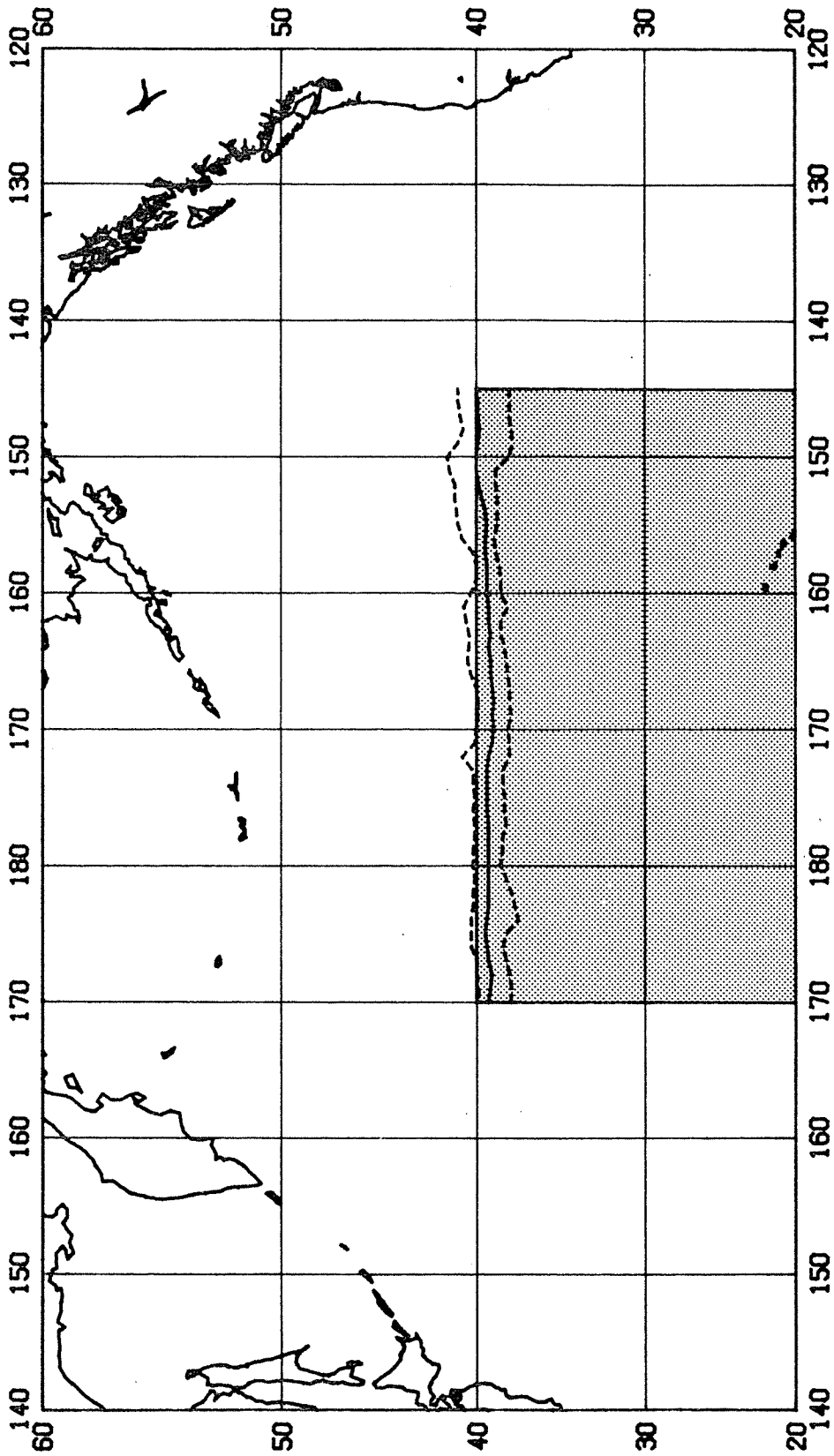


Figure 1. Multi-year means (solid line) and range (broken lines) of the 15°C sea surface isotherm position for the month of June, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

12 DEGREE ISOTHERM - JUNE

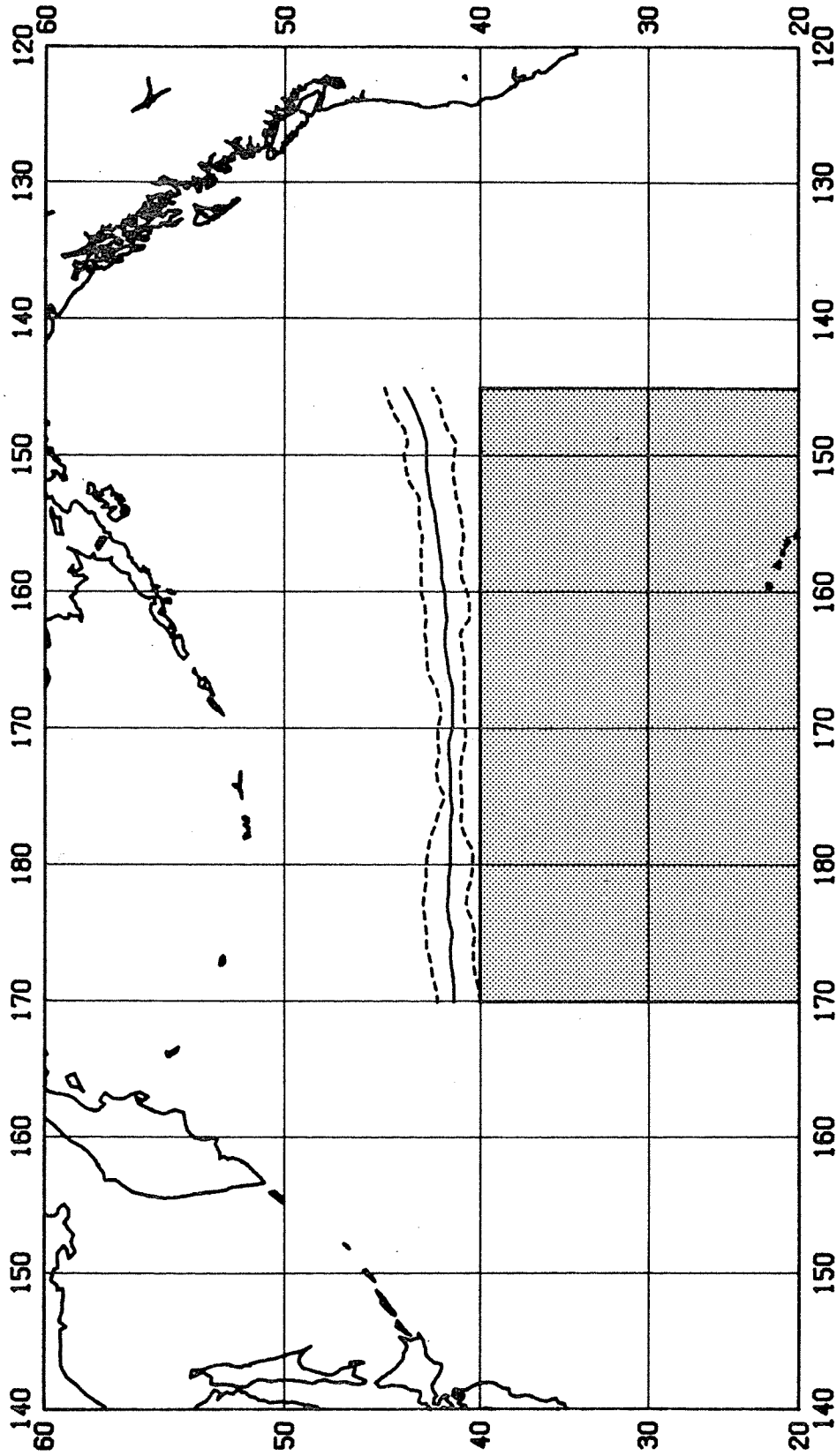


Figure 2. Multi-year means (solid line) and range (broken lines) of the 12°C sea surface isotherm position for the month of June, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

15 DEGREE ISOTHERM - JULY

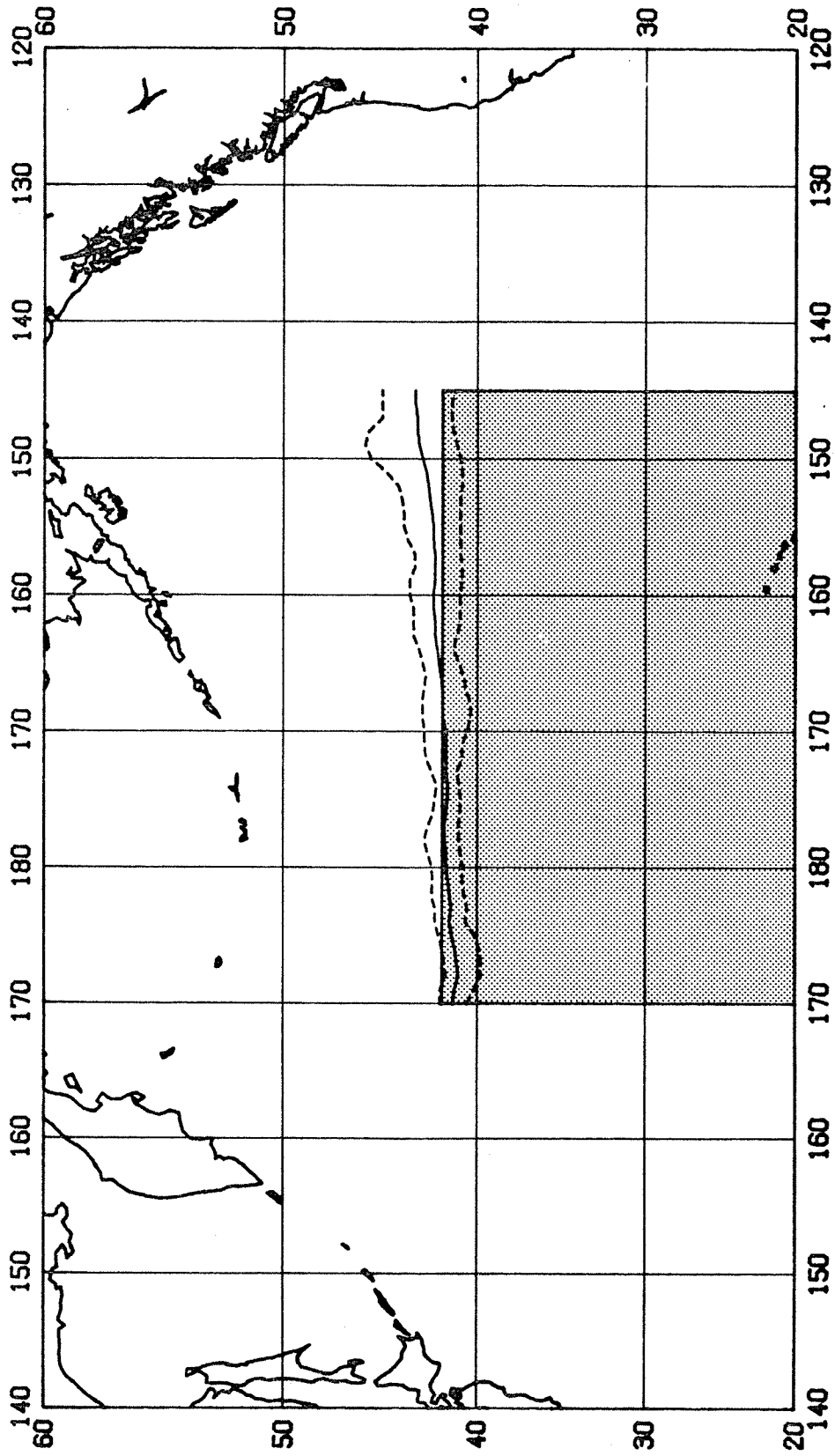


Figure 3. Multi-year means (solid line) and range (broken lines) of the 15°C sea surface isotherm position for the month of July, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

12 DEGREE ISOTHERM - JULY

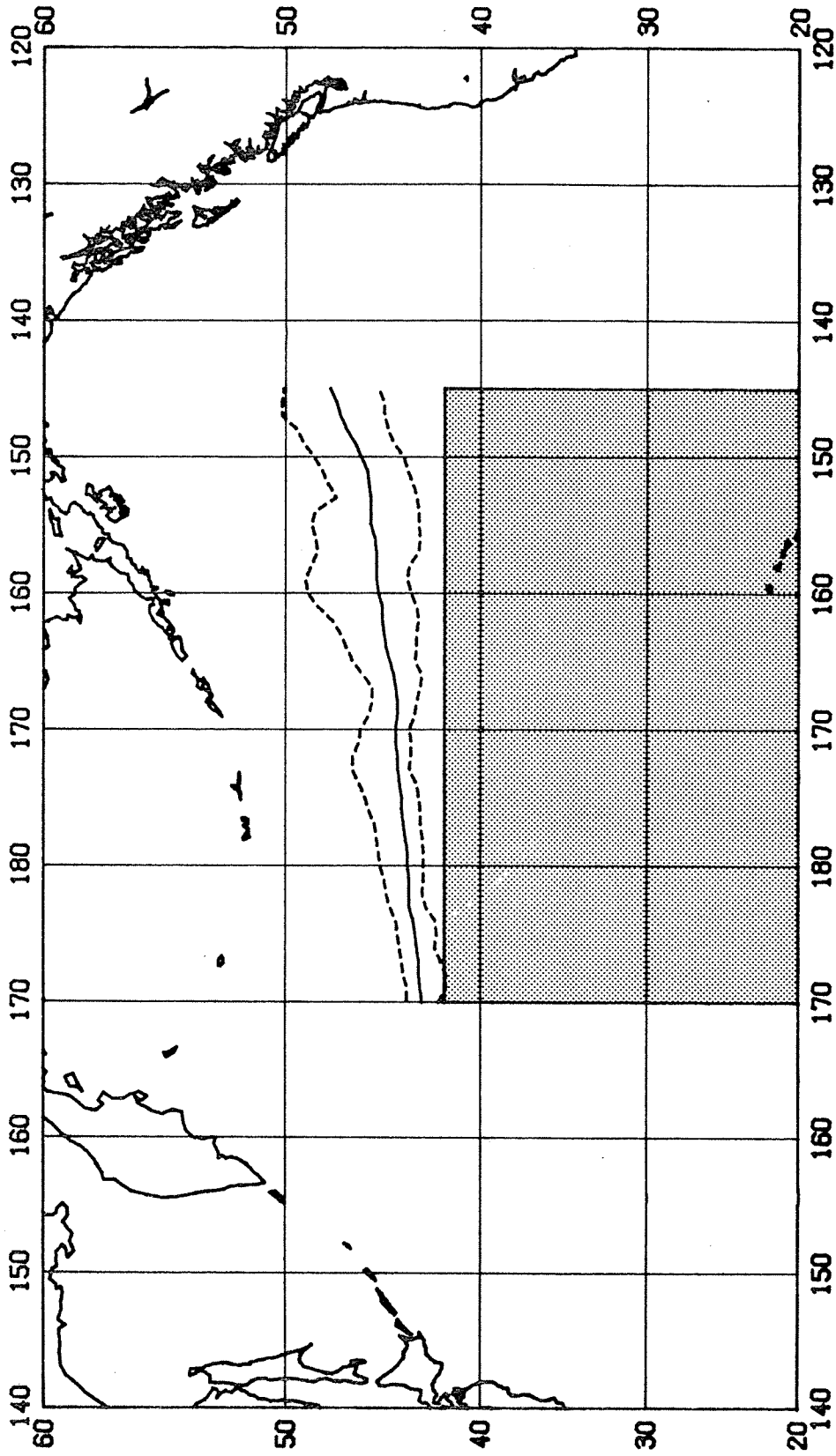


Figure 4. Multi-year means (solid line) and range (broken lines) of the 12°C sea surface isotherm position for the month of July, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

15 DEGREE ISOTHERM - AUGUST

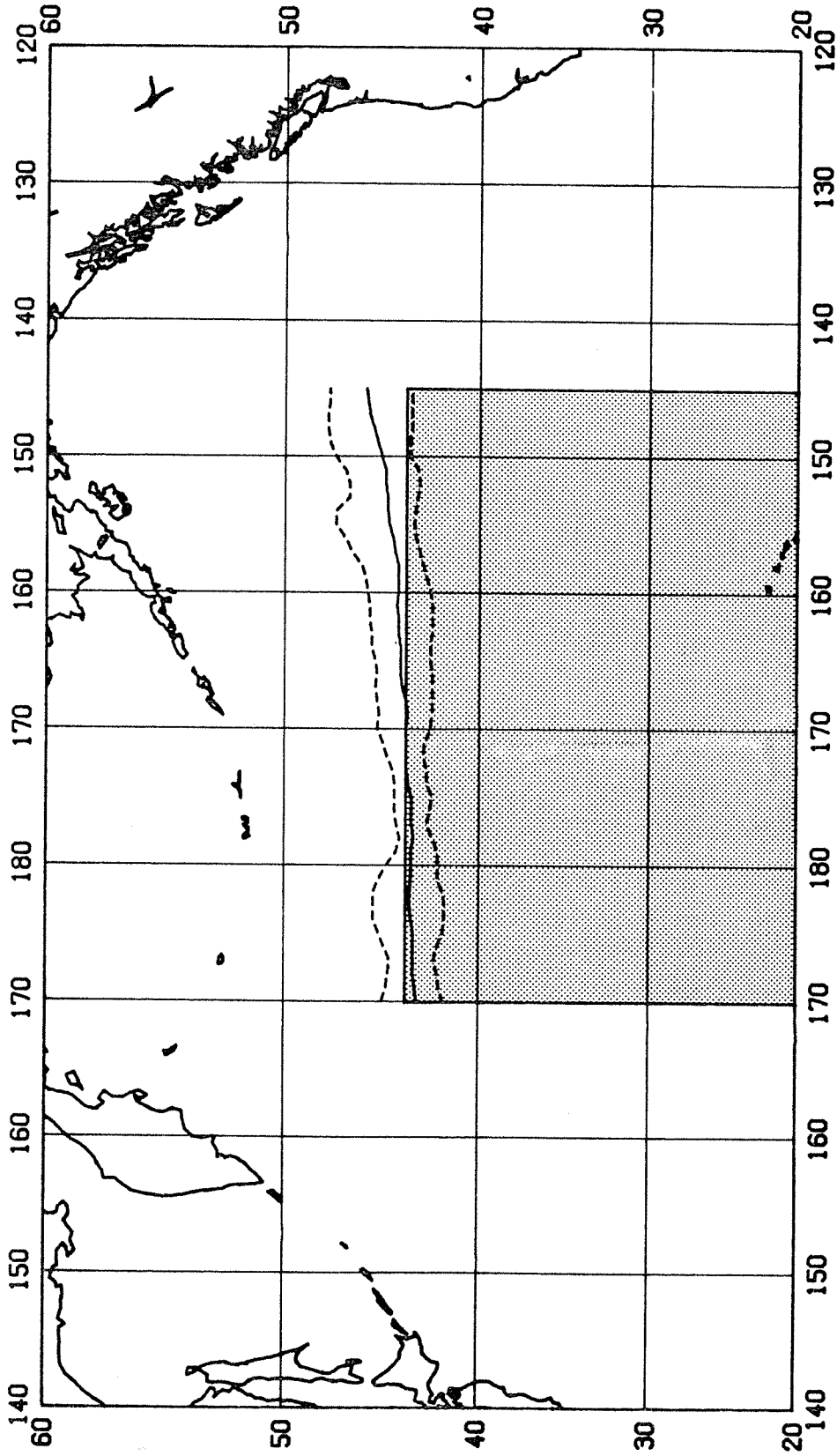


Figure 5. Multi-year means (solid line) and range (broken lines) of the 15°C sea surface isotherm position for the month of August, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

12 DEGREE ISOTHERM - AUGUST

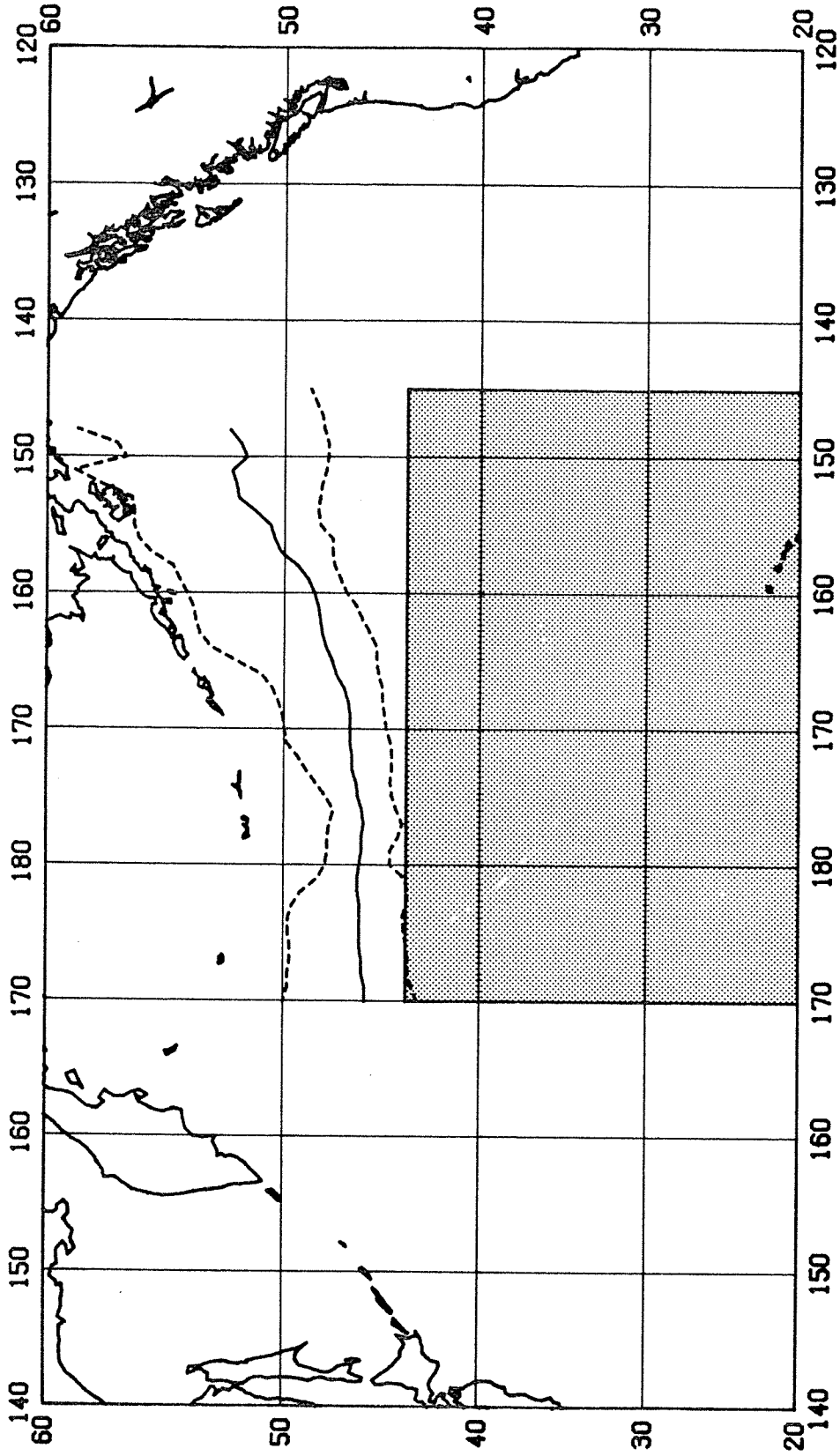


Figure 6. Multi-year means (solid line) and range (broken lines) of the 12°C sea surface isotherm position for the month of August, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

15 DEGREE ISOTHERM - SEPTEMBER

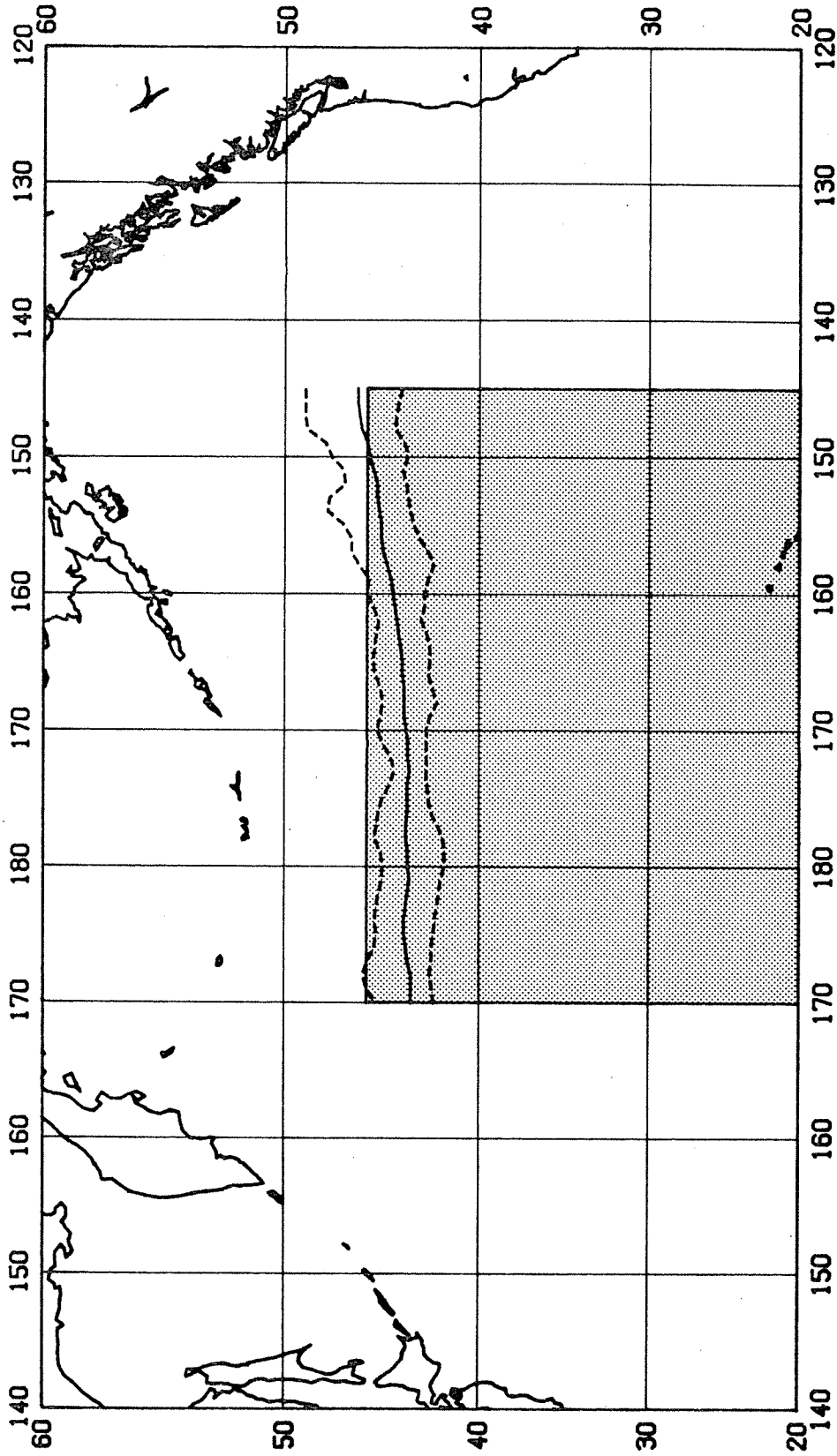


Figure 7. Multi-year means (solid line) and range (broken lines) of the 15°C sea surface isotherm position for the month of September, recorded by 10 longitude, 170°E - 145°W, 1972 - 1980.

12 DEGREE ISOTHERM - SEPTEMBER

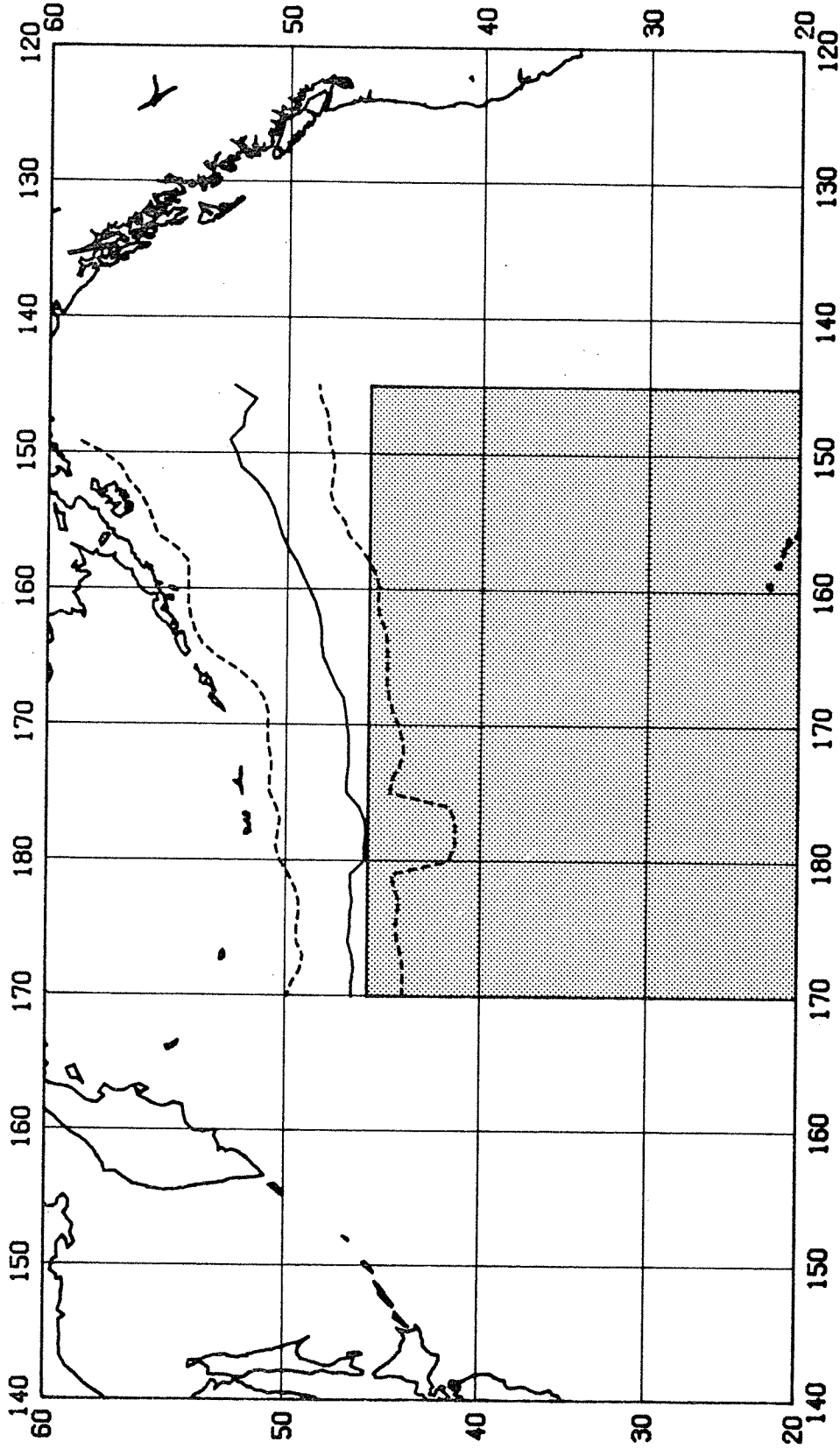


Figure 8. Multi-year means (solid line) and range (broken lines) of the 12°C sea surface isotherm position for the month of September, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

15 DEGREE ISOTHERM - OCTOBER

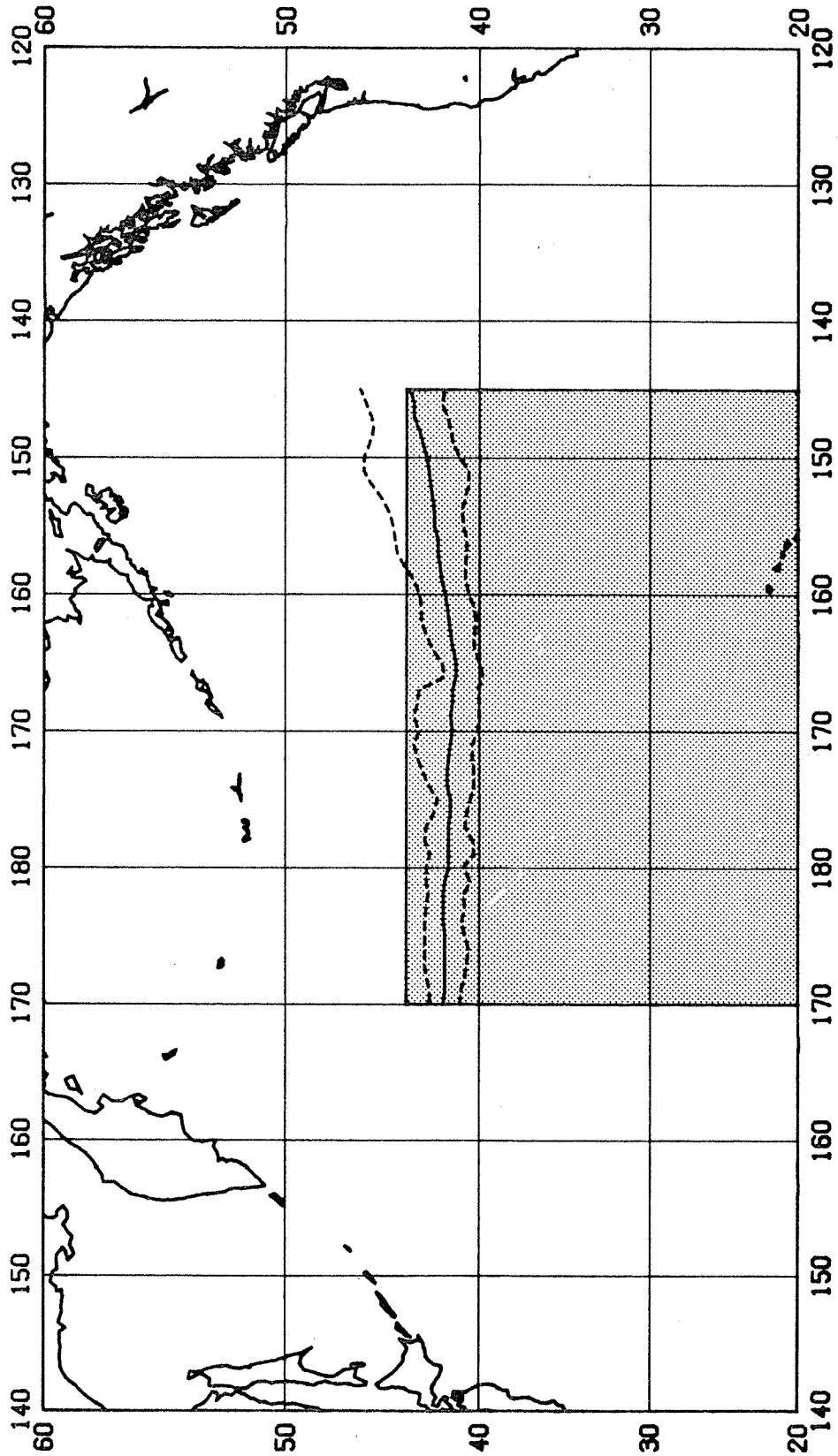


Figure 9. Multi-year means (solid line) and range (broken lines) of the 15°C sea surface isotherm position for the month of October, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

12 DEGREE ISOTHERM - OCTOBER

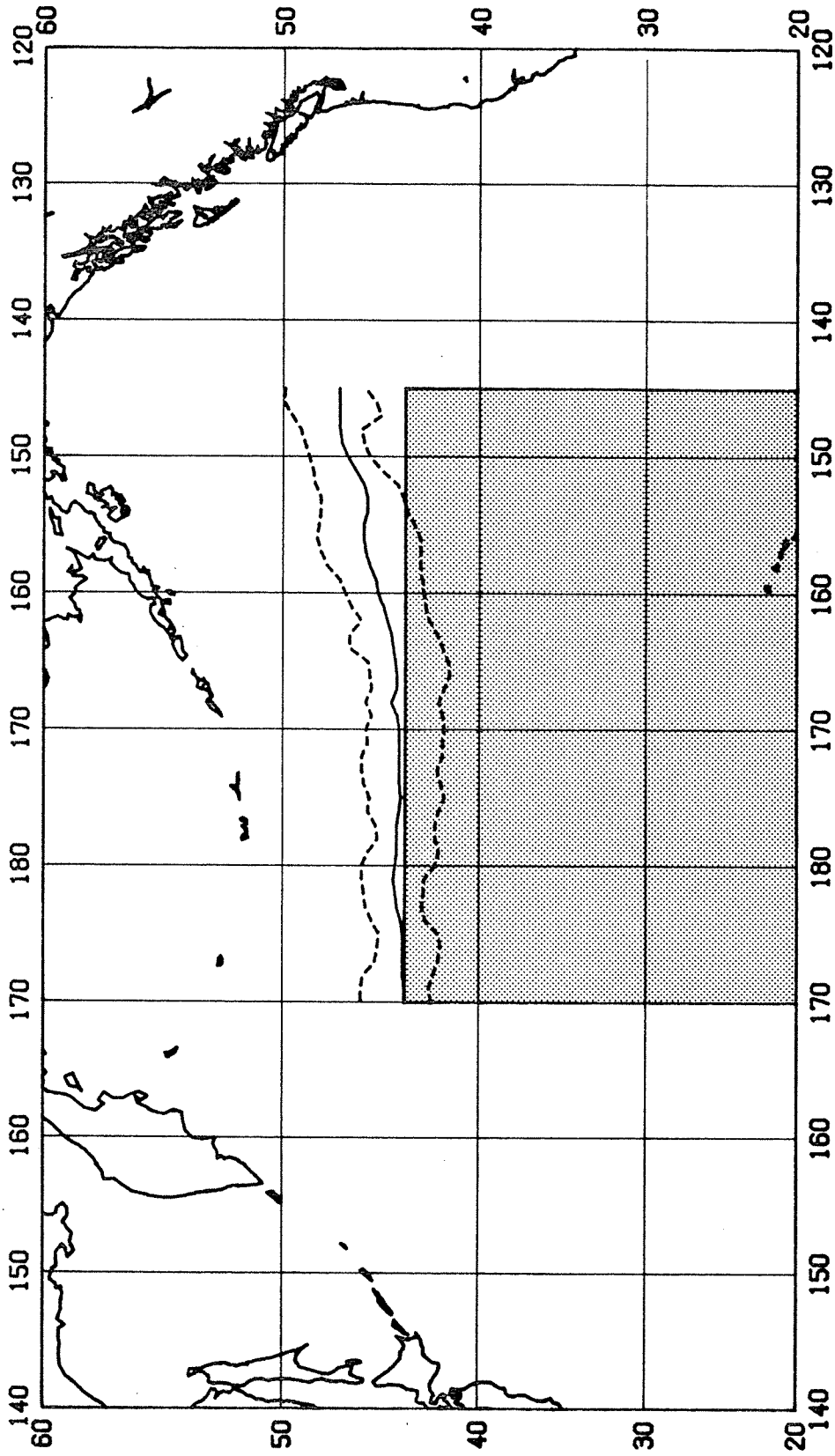


Figure 10. Multi-year means (solid line) and range (broken lines) of the 12°C sea surface isotherm position for the month of October, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

15 DEGREE ISOTHERM - NOVEMBER

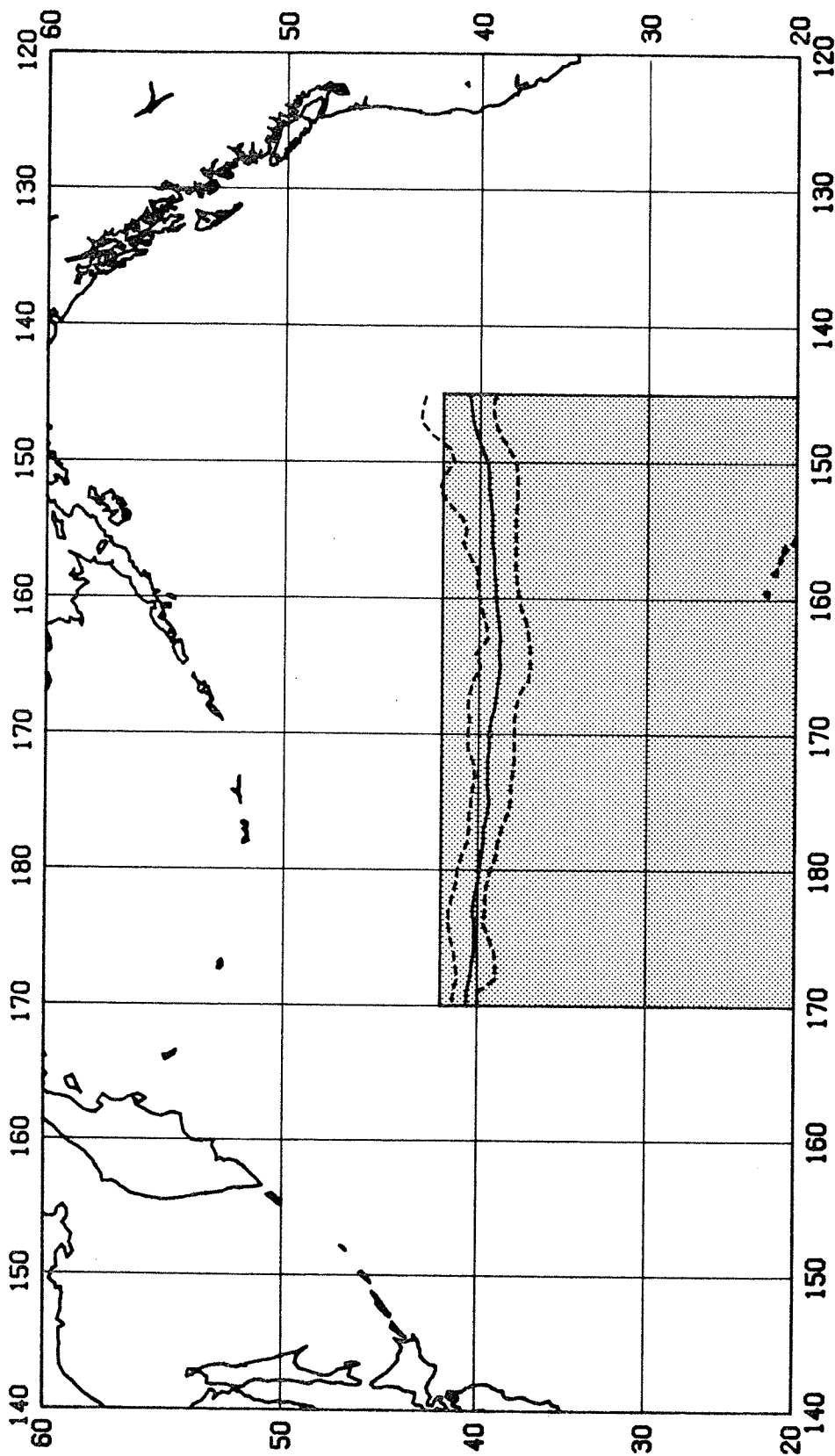


Figure 11. Multi-year means (solid line) and range (broken lines) of the 15°C sea surface isotherm position for the month of November, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

12 DEGREE ISOTHERM - NOVEMBER

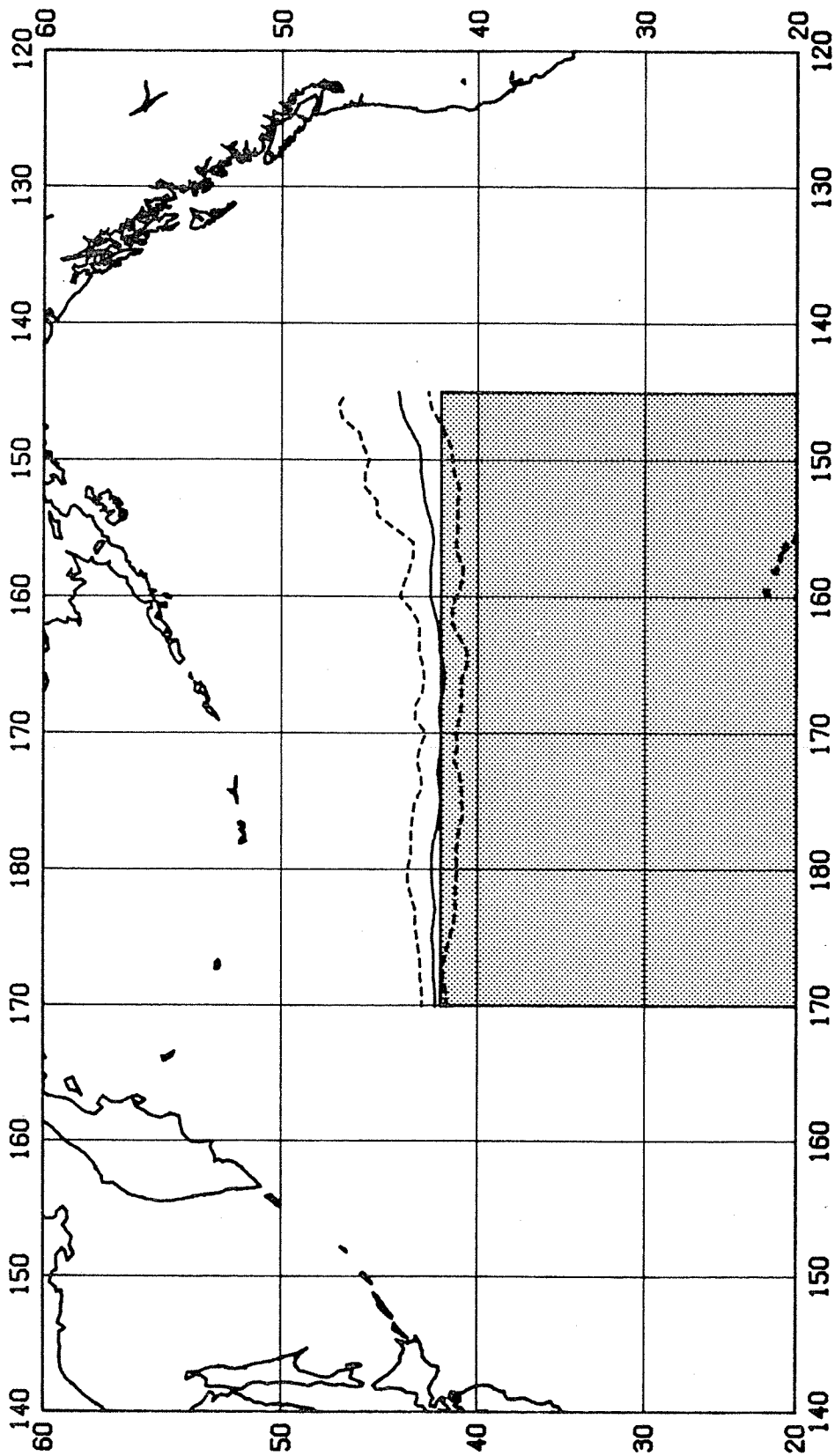


Figure 12. Multi-year means (solid line) and range (broken lines) of the 12°C sea surface isotherm position for the month of November, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

15 DEGREE ISOTHERM - DECEMBER

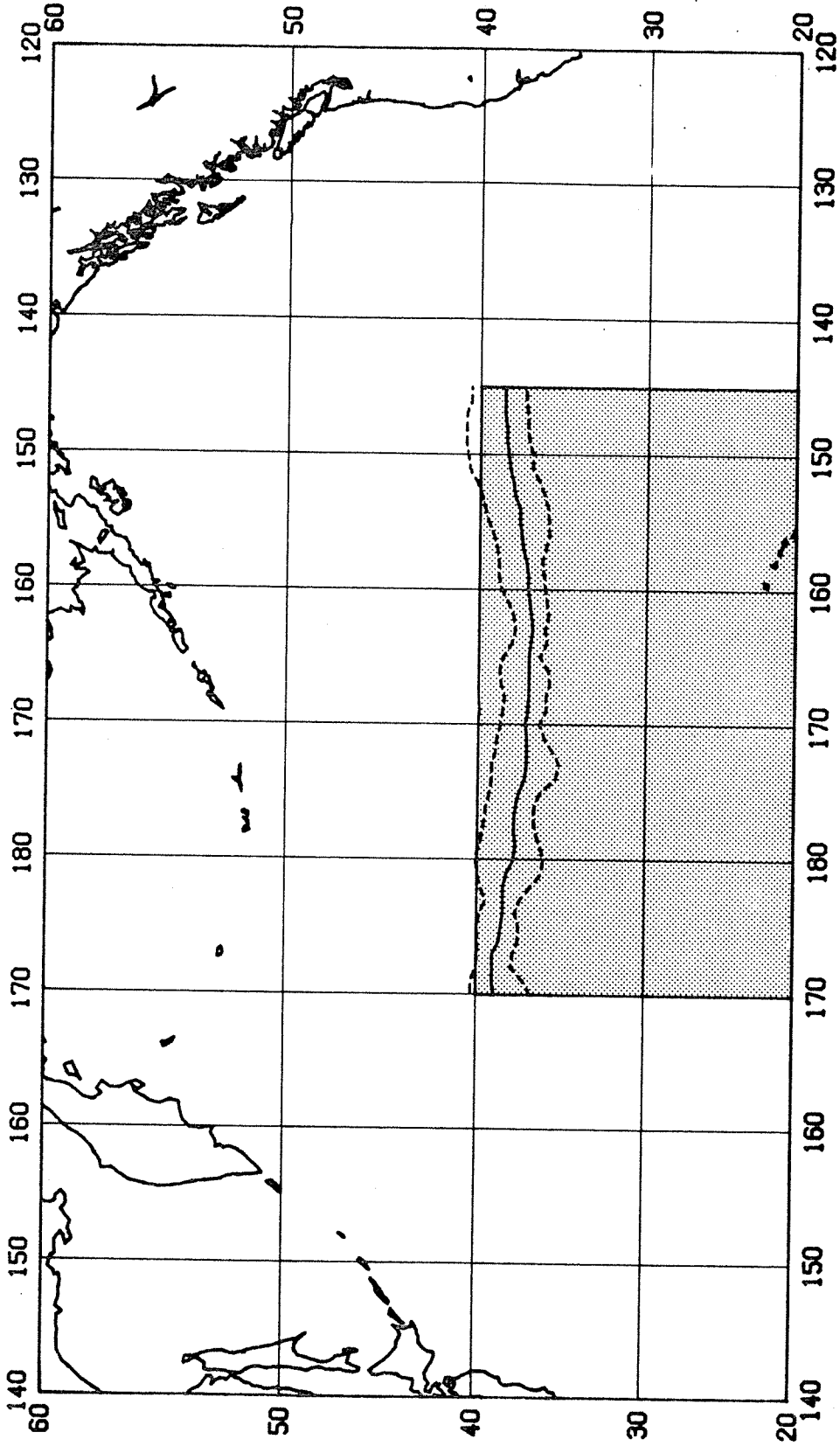


Figure 13. Multi-year means (solid line) and range (broken lines) of the 15°C sea surface isotherm position for the month of December, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

12 DEGREE ISOTHERM - DECEMBER

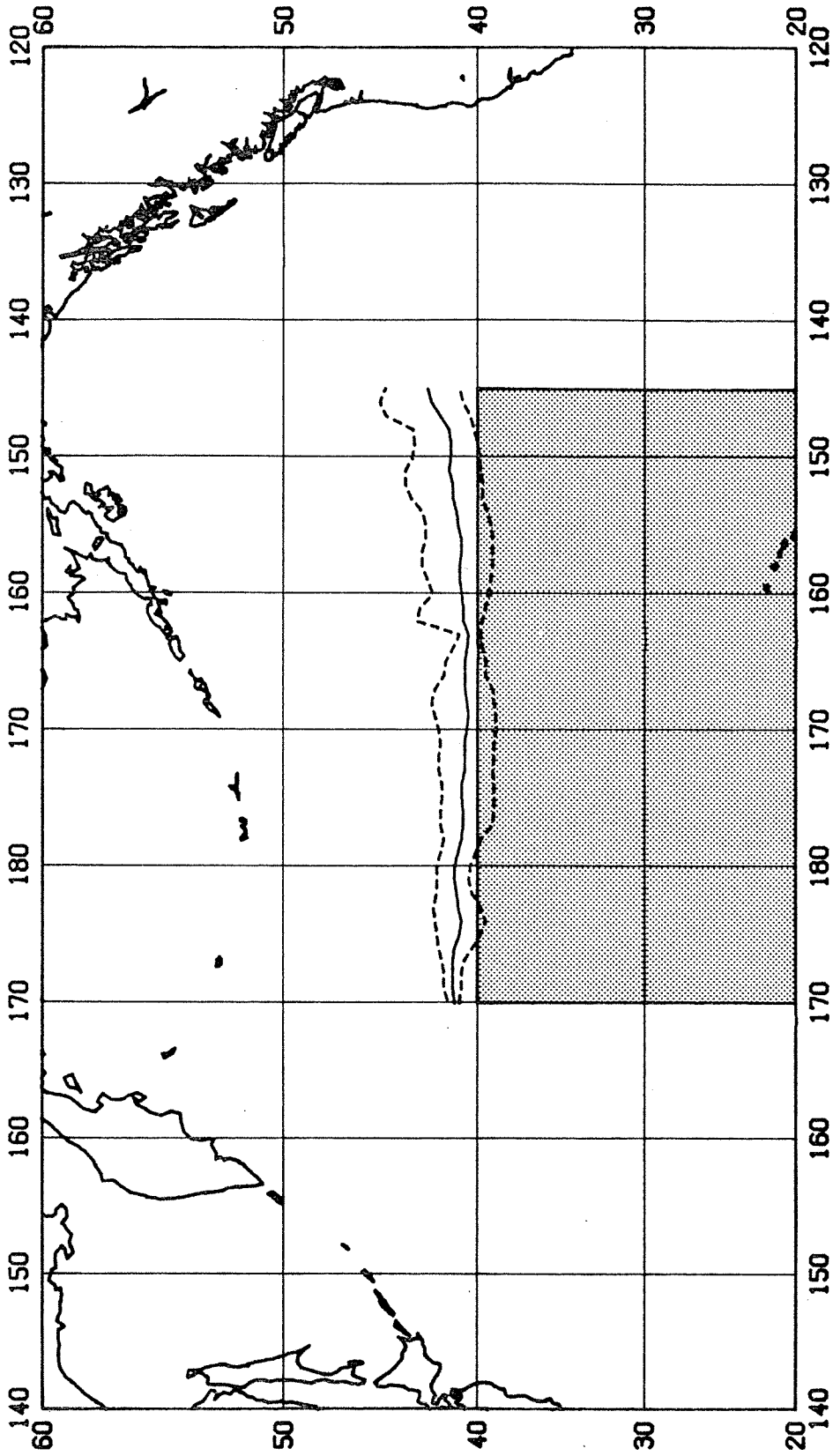


Figure 14. Multi-year means (solid line) and range (broken lines) of the 12°C sea surface isotherm position for the month of December, recorded by 1° longitude, 170°E - 145°W, 1972 - 1980.

APPENDIX

Appendix Table 3. Mean catches per tan in gillnets fished by Japanese research vessels for all operations in the month of May, 1972 - 1981, stratified by recorded sea surface temperature; catch data are for commercial-type gear (A).

MONTH = 5	157E TO 170E, SOUTH OF 54N					EAST OF 170E, SOUTH OF 52N							
	SURFACE TEMP.	NO. OPER.	SOCKEYE	CHUM	PINK	COHO	CHINOOK	NO. OPER.	SOCKEYE	CHUM	PINK	COHO	CHINOOK
0.0 - .9	1	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
1.0 - 1.9	20	.155	.255	0.000	0.000	.002	.002	0	0.000	0.000	0.000	0.000	0.000
2.0 - 2.9	76	.763	.620	.031	0.000	.002	.002	12	.407	.300	.003	0.000	.001
3.0 - 3.9	173	.834	1.072	.336	.000	.008	.008	100	.666	.458	.064	.000	.002
4.0 - 4.9	194	.721	1.070	1.534	.002	.013	.013	89	.615	.788	.224	.001	.006
5.0 - 5.9	99	.192	1.104	2.964	.004	.026	.026	56	.743	.883	.332	.020	.026
6.0 - 6.9	45	.089	.898	2.899	.030	.033	.033	37	.690	.945	.356	.163	.025
7.0 - 7.9	20	.250	.690	2.372	.021	.043	.043	27	.021	.468	.166	.314	.025
8.0 - 8.9	5	0.000	1.580	1.006	1.120	.006	.006	13	.014	.123	.115	.333	.003
9.0 - 9.9	0	0.000	0.000	0.000	0.000	0.000	0.000	12	0.000	.240	.072	.279	.001
10.0 - 10.9	0	0.000	0.000	0.000	0.000	0.000	0.000	15	0.000	.084	.027	.062	.001
11.0 - 11.9	7	0.000	.022	.048	.144	.002	.002	1	0.000	0.000	0.000	0.000	0.000
12.0 - 12.9	3	0.000	.014	0.000	0.000	0.000	0.000	2	0.000	0.000	0.000	0.000	0.000
13.0 - 13.9	1	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
14.0 - 14.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
15.0 - 15.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
16.0 - 16.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
17.0 - 17.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
18.0 - 18.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
19.0 - 19.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
20.0 -	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000

Appendix Table 4. Mean catches per tan in gillnets fished by Japanese research vessels for all operations in the month of June, 1972 - 1981, stratified by recorded sea surface temperature; catch data are for commercial-type gear (A).

MONTH = 6	157E TO 170E, SOUTH OF 54N					EAST OF 170E, SOUTH OF 52N							
	SURFACE TEMP.	NO. OPER.	SOCKEYE	CHUM	PINK	COHO	CHINOOK	NO. OPER.	SOCKEYE	CHUM	PINK	COHO	CHINOOK
0.0 - .9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
1.0 - 1.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
2.0 - 2.9	7	.268	.594	3.094	0.000	.007	.007	0	0.000	0.000	0.000	0.000	0.000
3.0 - 3.9	74	.317	.913	3.987	.001	.007	.007	8	.670	.922	.673	0.000	.006
4.0 - 4.9	160	.378	.779	4.991	.007	.014	.014	66	.675	.812	1.142	.001	.007
5.0 - 5.9	141	.374	1.030	4.552	.061	.024	.024	123	1.011	1.132	2.630	.020	.012
6.0 - 6.9	117	.153	.947	6.627	.160	.028	.028	88	.670	1.287	1.212	.153	.044
7.0 - 7.9	79	.050	.922	6.156	.274	.028	.028	60	.247	.630	.906	.752	.050
8.0 - 8.9	59	.001	.760	4.218	.299	.012	.012	68	.074	.392	.643	2.229	.021
9.0 - 9.9	38	.009	1.000	2.723	.437	.014	.014	42	.000	.368	.230	1.514	.002
10.0 - 10.9	11	0.000	.798	1.262	.245	.012	.012	11	0.000	.199	.089	.316	0.000
11.0 - 11.9	9	0.000	.134	.411	.100	.003	.003	6	0.000	.525	.078	.829	0.000
12.0 - 12.9	3	0.000	.086	.329	.329	0.000	0.000	2	0.000	0.000	0.000	.013	0.000
13.0 - 13.9	1	0.000	0.000	0.000	.039	0.000	0.000	5	0.000	0.000	0.000	.086	0.000
14.0 - 14.9	1	0.000	.015	0.000	0.000	0.000	0.000	3	0.000	0.000	0.000	.006	0.000
15.0 - 15.9	0	0.000	0.000	0.000	0.000	0.000	0.000	1	0.000	0.000	0.000	0.000	0.000
16.0 - 16.9	0	0.000	0.000	0.000	0.000	0.000	0.000	2	0.000	0.000	0.000	0.000	0.000
17.0 - 17.9	0	0.000	0.000	0.000	0.000	0.000	0.000	1	0.000	0.000	0.000	0.000	0.000
18.0 - 18.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
19.0 - 19.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
20.0 -	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000

Appendix Table 5. Mean catches per tan in gillnets fished by Japanese research vessels for all operations in the month of July, 1972 - 1981, stratified by recorded sea surface temperature; catch data are for commercial-type gear (A).

MONTH = 7

SURFACE TEMP.	NO. OPER.	157E TO 170E, SOUTH OF 54N				NO. OPER.	EAST OF 170E, SOUTH OF 52N						
		SOCKEYE	CHUM	PINK	COHO		CHINOOK	SOCKEYE	CHUM	PINK	COHO	CHINOOK	
0.0 - .9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.0 - 1.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.0 - 2.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.0 - 3.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0 - 4.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0 - 5.9	6	1.044	1.179	8.051	.923	4	.803	2.513	2.178	.013	.013	0.000	0.000
6.0 - 6.9	56	.410	.990	9.037	.766	20	1.354	1.471	2.530	.423	.423	.021	.021
7.0 - 7.9	142	.296	.992	7.696	.597	113	1.633	1.065	.441	1.027	.050	.050	.050
8.0 - 8.9	182	.292	.805	5.574	.539	150	3.389	.939	.749	.960	.059	.059	.059
9.0 - 9.9	122	.168	.860	7.427	.505	103	.913	.997	.635	1.139	.090	.090	.090
10.0 - 10.9	62	.028	.511	2.270	.389	50	.102	.909	.284	.758	.032	.032	.032
11.0 - 11.9	17	.001	.437	2.291	.396	29	.015	.413	.003	.230	.001	.001	.001
12.0 - 12.9	9	0.000	.051	.108	.138	15	.144	.214	.033	.296	.002	.002	.002
13.0 - 13.9	7	0.000	.294	.017	.083	6	.013	.003	.016	.013	0.000	0.000	0.000
14.0 - 14.9	6	0.000	.005	.002	.009	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.0 - 15.9	7	0.000	.030	0.000	.005	6	0.000	0.000	.002	0.000	0.000	0.000	0.000
16.0 - 16.9	1	0.000	0.000	0.000	0.000	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.0 - 17.9	1	0.000	0.000	0.000	0.000	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18.0 - 18.9	1	0.000	0.000	0.000	0.000	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19.0 - 19.9	0	0.000	0.000	0.000	0.000	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.0 -	0	0.000	0.000	0.000	0.000	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix Table 6. Mean catches per tan in gillnets fished by Japanese research vessels for all operations in the month of August, 1972 - 1981, stratified by recorded sea surface temperature; catch data are for commercial-type gear (A).

MONTH	SURFACE TEMP.	157E TO 170E, SOUTH OF 54N					EAST OF 170E, SOUTH OF 52N						
		NO. OPER.	SOCKEYE	CHUM	PINK	COHD	CHINDOK	NO. OPER.	SOCKEYE	CHUM	PINK	COHD	CHINDOK
0.0 - .9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
1.0 - 1.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
2.0 - 2.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
3.0 - 3.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
4.0 - 4.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
5.0 - 5.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
6.0 - 6.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
7.0 - 7.9	1	.168	.911	.248	.341	.033	.375	2	2.784	.375	0.000	.324	.045
8.0 - 8.9	7	.528	.707	.278	.811	.012	1.329	1	.207	1.329	.171	.720	.110
9.0 - 9.9	18	1.094	1.485	1.034	.923	.020	1.560	7	1.515	1.560	.117	1.739	.196
10.0 - 10.9	31	1.116	1.053	.102	.497	.045	1.322	17	.810	1.322	.048	1.270	.044
11.0 - 11.9	20	1.349	.745	.085	.807	.038	.985	20	.998	.985	.009	.255	.016
12.0 - 12.9	12	.182	.661	.060	.451	.014	.572	8	.217	.572	0.000	.164	.006
13.0 - 13.9	4	0.000	.133	.033	.540	0.000	.500	2	0.000	.500	0.000	.025	0.000
14.0 - 14.9	5	0.000	.022	0.000	.007	0.000	0.000	1	0.000	0.000	0.000	0.000	0.000
15.0 - 15.9	1	0.000	0.000	0.000	0.000	0.000	0.000	2	0.000	0.000	0.000	0.000	0.000
16.0 - 16.9	2	0.000	0.000	0.000	0.000	0.000	0.000	2	0.000	0.000	0.000	0.000	0.000
17.0 - 17.9	0	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
18.0 - 18.9	0	0.000	0.000	0.000	0.000	0.000	0.000	1	0.000	0.000	0.000	0.000	0.000
19.0 - 19.9	0	0.000	0.000	0.000	0.000	0.000	0.000	2	0.000	0.000	0.000	0.000	0.000
20.0 -	0	0.000	0.000	0.000	0.000	0.000	0.000	2	0.000	0.000	0.000	0.000	0.000

Appendix Table 7. Mean catches per tan in gillnets fished by Japanese research vessels for all operations in the month of September, 1972 - 1981, stratified by recorded sea surface temperature; catch data are for commercial-type gear (A).

MONTH = 9

SURFACE TEMP.	ND. OPER.	157E TO 170E, SOUTH OF 54N				ND. OPER.	EAST OF 170E, SOUTH OF 52N						
		SOCKEYE	CHUM	PINK	COHO		CHINOOK	COHO	PINK	CHUM	CHINOOK		
0.0 - .9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.0 - 1.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.0 - 2.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.0 - 3.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0 - 4.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.0 - 5.9	1	1.314	.092	.039	.098	0	0.000	.046	0.000	0.000	0.000	0.000	0.000
6.0 - 6.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0 - 7.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.0 - 8.9	0	0.000	0.000	0.000	0.000	1	1.150	3.113	.213	.063	0.000	0.000	0.000
9.0 - 9.9	1	.319	.522	0.000	.254	1	1.000	.413	.050	.063	0.000	0.000	0.000
10.0 - 10.9	4	.938	.322	.045	.080	1	.050	.775	0.000	.013	0.000	0.000	0.000
11.0 - 11.9	5	1.694	.758	.014	.066	1	1.600	.475	0.000	0.000	0.000	0.000	0.000
12.0 - 12.9	1	1.741	.249	0.000	.081	4	.394	1.138	0.000	.019	0.000	0.000	0.000
13.0 - 13.9	0	0.000	0.000	0.000	0.000	1	.050	1.950	0.000	0.000	0.000	0.000	0.000
14.0 - 14.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.0 - 15.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.0 - 16.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.0 - 17.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18.0 - 18.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19.0 - 19.9	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.0 -	0	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000