Northwest Atlantic Fisheries Organization

Serial No. N397

NAFO SCR Doc. 81/IX/99

THIRD ANNUAL MEETING - SEPTEMBER 1981

Indices of Abundance and Bottom Temperature Relationships for Squid in Div. 4VWX

by

R. K. Mohn

Marine Invertebrates and Plants Division
Department of Fisheries and Oceans
P. O. Box 550, Halifax, N. S., Canada

Introduction

Mohn (1981) observed a very low correlation between research survey catch rate and bottom temperature within a given year, but from year to year the mean catch rate and mean bottom temperature correlate well. From this, it was concluded that the bottom temperature was related to growth or survival but not choice of habitat. Dupouy (1981), in his Figure 4, shows that the catch rate forms a dome-shaped function of bottom temperature. Such a functional relationship would not have a high correlation with a linear regression model. In the present paper, the relationship between bottom temperature and catch rate is examined using groundfish survey data for the period 1970 to 1980. Another aspect of abundance is also investigated, the effects of diurnal correction on an index of abundance derived by areal expansion. It is shown that although the magnitude of the abundance estimate will vary with the corrections used, the pattern from year to year is virtually unaffected.

Methods

Data are from the stratified random sampled groundfish research surveys from 1970 to 1980 on the Scotian Shelf. The cruises were conducted mainly in July by R.V. "A.T. CAMERON" using a Yankee 36 survey trawl. The data were edited and estimates of abundance produced by areal expansion. Corrections are included for the distance covered by the trawl and the fluctuations in catch rate related to the time of day. The estimates from combinations of the corrections are compared to the raw catch rates, both in terms of numbers and weight per tow and the previously published results of Koeller (1980). The tow distance correction factor is determined by taking the product of the ship speed and the tow duration and comparing it to the standard of 1050 (30 minutes x 3.5 knots). The diurnal correction uses the values derived in Mohn (1981).

The catch rates were broken down by bottom temperature and depth of tow for each year in the data series. The data are discretized into 25 meter x 1°C blocks and the marginal distributions also computed.

Results

The first five columns of Table 1 are biomass estimates from areal expansion of the survey catch rates. The fifth column is from Koeller (1980). It and the second and fourth columns have been corrected for length of tow. The third and fourth columns have been corrected for diurnal effects. The tow length correction has a very small effect - less than a 5% reduction in most cases. The diurnal correction is approximately a 60% increase (based on the regression coefficient between Columns 1 and 3 of 1.6). The failure of the second and fifth columns to agree, although they both use the same corrections, is because of different assumptions used in preparing and compiling the data. The most important of these is that Koeller's (1980) estimates omit strata which have only one sample as a variance estimate cannot be obtained. Column 2 includes estimates from single sample strata. The last two columns in Table 1 are the catch per unit effort in units of kilograms per standard tow and number of animals per standard tow.

The first six columns are each regressed against the seventh. The correlation coefficient squared (coefficient of determination) given in the bottom row shows the high degree of linear dependence among the estimates. The lowest fit has a P in excess of 0.005. This high agreement is found even though the columns are in different units (thousand MT, kg/tow, no./tow).

Table 2 shows the catch rate as a function of depth and bottom temperature. Figure 1 shows the same data as a function of temperature which corresponds to the column averages of Table 2. An examination of these shows no consistent pattern.

In an attempt to find underlying relationships among these variables, the data in Table 2 are summarized in Table 3. The mean bottom temperature for each year, the temperature of highest catch rate, the mean depth, and the depth of highest catch rate are shown with a relative index of abundance. The two years of lowest abundance are denoted by minus signs, the three largest with a plus, and the remaining six by zeros. Neither Table 2 nor Table 3 showed any consistent pattern which would allow one to define a preferred habitat. The two years with the lowest catch rate have relatively low and high temperatures of maximum catch rate. The three years of high catch rate have maximum catch temperatures which range from the coldest to relatively high (3°-8°).

Discussion

The biomass estimates are about 60% higher when they are corrected for diurnal catch rate. The patterns from year to year are parallel, however, irrespective of the corrections applied or even when compared to the mean catch rates (either numbers or kg/tow).

The author could not discern any consistent pattern between depth, bottom temperature, and mean catch rate. These parameters do not seem to be useful in defining a preferred habitat of squid on the Scotian Shelf in July. Perhaps other oceanographic data (salinity, density, water mass identification, etc.) would make the definition of such a habitat possible. The regular dome-shaped results reported in Dupouy (1981) are not apparent in the data analyzed here. His results are from September, 1980, and may be either caused by a change in behaviour later in the season or simply an artifact of the data.

Acknowledgements

The author acknowledges Lyle Fisher for his work in producing the computer outputs and graphics.

References

Dupouy, H. 1981. Biological characteristics and biomass estimate of the squid, Illex illecebrosus, on the Scotian Shelf (Divisions 4VWX) in late summer of 1980. NAFO SCR Doc. 81/VI/38, Ser. No. N320.

Koeller, P. 1980. Distribution, biomass, and length frequencies of squid (Illex illecebrosus) in Divisions 4VWX from Canadian research vessel surveys: an update for 1979. NAFO SCR Doc. 80/11/17, Ser. No. N049.

Mohn, R.K. 1981. Abiotic factors relating to squid abundance as determined from groundfish cruises, 1970-1980. NAFO SCR Doc. 81/VI/34, Ser. No. N316.

TABLE 1. INDICES OF ABUNDANCE.

	BIOMASS ESTIMATES THOUSAND MT					YPUE KG/TOW	CPUE #/TOW
TOW CORR.	NO	YES	NO	YES	YES*	NO	NO
DIURNAL CORR.	NO	NO	YES	YES	NO	NO	NO
1970	2.9	2.7	5.1	4.6	1.9	0.4	5.4
1971	17.7	16.9	28.0	26.7	14.7	2.4	23.6
1972	3.9	3.7	7.8	7.4	3.2	0.8	7.8
1973	14.8	15.0	23.6	23.8	8.9	1.2	8.4
1974	8.5	9.2	26.7	27.8	9.5	1.7	12.0
1975	29.4	30.3	44.0	45.8	24.8	4.1	35.7
1976	205.1	215.9	315.9	336.5	203.7	35.6	189.7
1977	83.9	80.2	115.3	110.2	46.6	9.7	51.0
1978	13.9	16.0	19.2	21.4	11.2	2.7	19.4
1979	80.8	74.6	179.8	117.6	70.3	10.8	72.5
1980	16.5	15.8	23.8	23.1		1.4	16.3
R SQUARE	0.97	0.98	0.95	0.99	0.99	0.99	

* FROM KOELLER(1980)

Table 2. Catch rate as a function of depth (m) and bottom temperature (°C).

1970

DEPTH	°C	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	
25.0											
50.0			0.9	0.2	0.3	2.5		2.0			0.6
75.0		2.0	3.8	6.0	3.3	14.4	29.0	4.5	11.5	13.0	11.3
100.0				0.5			51.5	2.2			16.2
125.0			1.0				2.8				1.5
150.0								2.0			0.4
175.0					0.5						0.3
200.0							1.5				0.4
225.0											
		1.0	1.5	0.9	1.0	6.7	18.8	2.1	2.1	4.3	

1971

DEPTH	°C	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	
25.0												
50.0		31.3	3.3	8.9	4.2	2.3	1.3					5.9
75.0			1.7	38.0	9.3	5.0	7.6	433.0	46.0	58.5	3.0	50.1
100.0			56.0	0.5	30.5	124.0	7.6	8.8	76.0	19.0	77.5	33.2
125.0							276.0	18.3	41.2	9.0		42.0
150.0												
175.0						4.3		50.0				11.2
200.0					1.0		14.0					4.0
225.0												
250.0												
275.0												
		18.8	8.9	14.9	8.0	20.1	19.7	56.4	29.8	24.2	39.5	

1972

DEPTH	°C	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	
25.0						17.5							8.8
50.0		0.1	0.1	6.1	1.0	0.5	2.6	0.9					1.8
75.0				0.3		5.4	12.4	5.4	37.0		1.0	88.5	11.9
100.0				0.3			12.0		14.2	7.0	9.0		7.1
125.0					3.0				51.7	56.7	14.0		21.4
150.0						3.0		5.2	20.6				9.4
175.0							2.5						1.2
200.0					1.0			3.0					2.3
225.0					1.0								1.0
250.0					1.0								1.0
275.0													
		0.1	0.1	3.1	0.8	4.5	8.7	2.5	20.8	30.7	6.6	88.5	

1973

DEPTH	°C	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	
25.0													
50.0	0.3	0.1	0.1	1.1	3.7	2.0	0.7		0.5	1.0			1.0
75.0	2.0	1.5		1.2	6.0		1.3	2.0	18.7	5.5		103.0	7.9
100.0		0.5		2.5		21.0		11.0	0.8	8.5		247.0	27.1
125.0							15.0			47.0			10.7
150.0								34.5	3.0	5.5	0.5		6.5
175.0				1.0					11.0				3.0
200.0					0.5	1.0	25.0						4.7
	0.6	0.6	0.1	1.3	2.9	2.6	5.1	6.9	6.7	10.6	0.3	149.3	

Table 2 Contd...

1974

DEPTH	°C	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	
25.0						2.0							0.3
50.0	0.1	0.3	2.2	0.8	1.5	2.0	1.7	0.3	3.0				1.0
75.0		3.0		5.0	14.0	6.0	7.7		46.7	5.3			12.6
100.0						45.0	0.6		66.7	3.0		20.0	21.5
125.0				1.0		0.5	36.7	11.0	56.3		53.0		29.1
150.0								20.7	12.5				9.7
175.0					0.5	1.0	98.5						33.2
200.0					1.0	4.0							1.7
225.0						2.0							2.0
	0.1	~~1.0~~	0.9	1.4	5.8	9.3	13.2	8.5	46.0	3.2	53.0	20.0	

1975

DEPTH	°C	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	
25.0						313.0					4.0	79.3
50.0	1.6	1.7	6.6	5.0		45.0	1.4		0.2	15.0		6.6
75.0	0.5	5.5	172.4	5.0	14.5	1.0	0.8	23.5	47.0	6.0		43.9
100.0					58.0		85.0	66.7	464.0	180.5		124.2
125.0	122.0	6.5					7.0	1.0		3.8		15.7
150.0						1.0	2.0		4.3	17.0		6.3
175.0						4.0						2.7
200.0								2.5				1.2
	23.1	2.9	74.5	4.6	13.4	41.9	17.7	19.6	76.1	77.1	4.0	

1976

DEPTH	°C	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	
25.0						7.0	94.0		8.0				21.8
50.0		11.7	4.3	12.6	5.7	6.3	17.0	5.0		9.0	29.5	1.0	10.9
75.0		219.4	31.0		12.0	46.0	197.2	74.0	14.3	62.2	278.0		116.6
100.0			319.0	472.5		81.5	4.0		914.4	544.6	204.0	17.0	553.6
125.0						435.0			219.7	607.5			380.3
150.0						183.3		37.0	159.7	416.0			210.9
175.0						17.0		38.0	2.0				15.5
200.0				96.0		59.0							77.5
		91.6	56.3	138.0	5.8	74.9	104.7	38.5	382.0	304.1	144.5	9.0	

1977

DEPTH	°C	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	
25.0						6.3		8.0					3.9
50.0		5.0	2.0	6.8	1.0	30.2	1.2	5.0	0.5	19.8		4.0	10.1
75.0		35.0	1.5	629.0	4.3	48.8	15.9	36.2	307.0	31.0	5.0		86.4
100.0			180.0			154.0				53.7	243.8		77.4
125.0			5.0				1.0	172.0	45.5	327.0	128.6		104.3
150.0					2.0		7.0	5.0		10.0			4.7
175.0						2.0		6.0					3.0
200.0								5.0					3.3
		12.5	18.3	213.4	1.6	29.0	6.1	46.2	44.6	85.2	135.7	4.0	

Table 2 Contd...

1978

DEPTH	°C 1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	
25.0						1.0				0.3
50.0	2.0	5.5	3.0	5.8	9.8	0.8	0.5	3.2		4.1
75.0	7.0	60.8	95.0	3.5		7.1	39.6	21.3		25.3
100.0			9.5			3.7	1.5	7.0	10.0	5.4
125.0				2.0		33.3	19.6	10.5	230.8	66.1
150.0					43.0	39.0	1.7	2.0		17.3
175.0					3.5	6.0				3.2
200.0							3.5			2.3
(total)	3.0	22.1	13.6	4.1	11.7	10.1	16.8	9.3	146.8	

1979

DEPTH	°C 1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	
25.0			11.0		5.0	1.0			3.0	45.0				10.0
50.0	2.6	20.0	6.3	3.3	11.0	1.2	19.4	7.1	20.5	30.0			39.0	9.8
75.0	8.0	59.0		104.7	317.5	35.7	17.5	27.5	3.0	80.0				95.1
100.0		103.0	872.5	17.0	1500.0	1.0	1.5	123.5	9.0					288.2
125.0						62.0		28.4	204.0	2.0				68.2
150.0				6.0		18.7	309.0	7.0	14.5			3.0		37.9
175.0				6.0		3.7	130.5	5.0						40.4
200.0					7.3	1.0	1.0							4.8
225.0														
(total)	3.2	48.6	150.0	33.6	281.3	13.6	38.5	25.8	44.0	31.4		3.0	19.5	

1980

DEPTH	°C 1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	
25.0											
50.0	1.0	18.0	5.0	2.6	1.3		16.3	0.2	2.7		4.2
75.0	15.3	17.7	18.5	36.0		68.2	77.7	3.1			38.3
100.0			1.0			5.0	11.0		55.8		22.7
125.0			6.0			0.7		11.0	11.8		6.7
150.0	5.0		1.0	1.0				3.2	3.0		2.0
175.0					1.5				3.0	1.0	1.2
200.0								1.0			0.5
(total)	10.5	17.9	8.9	5.4	1.0	31.5	38.8	3.2	18.7	0.3	

TABLE 3. RELATIVE ABUNDANCE COMPARED TO TEMPERATURE AND DEPTH.

YEAR	$\overline{\text{B.T.}}$	B.T.*	ABUND.	$\overline{\text{DEPTH}}$	DEPTH*
1970	5.3	6	-	76	100
1971	5.7	7	0	74	75
1972	5.8	9	-	79	125
1973	5.7	11	0	77	100
1974	5.8	9	0	73	175
1975	5.4	9	0	72	100
1976	6.8	8	+	72	100
1977	6.4	3	+	73	150
1978	5.8	9	0	73	125
1979	6.5	5	+	80	100
1980	6.2	7	0	71	75

* VALUE AT MAXIMUM CATCH RATE

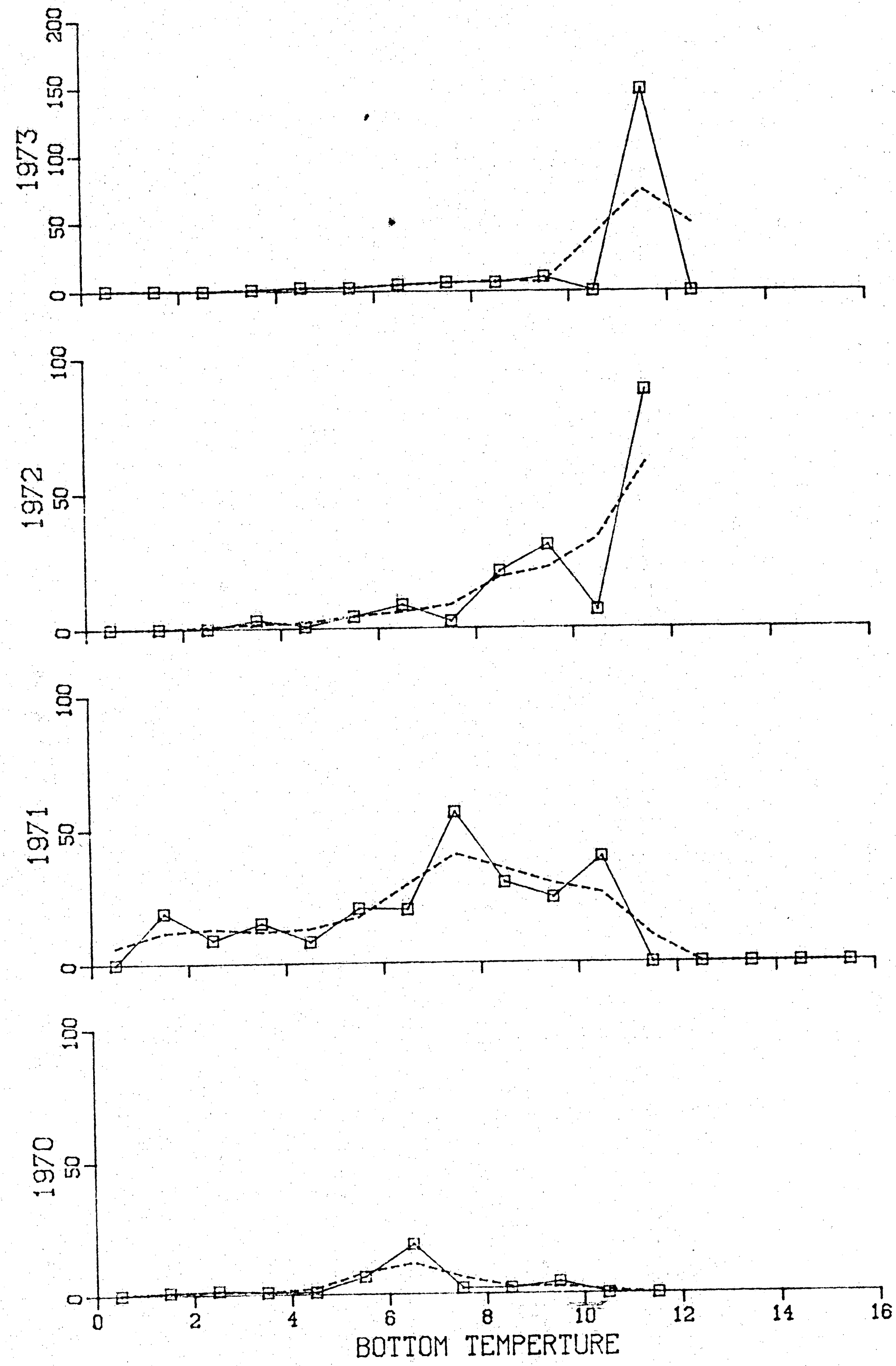

FIGURE 1. Catch rate as a function of temperature.

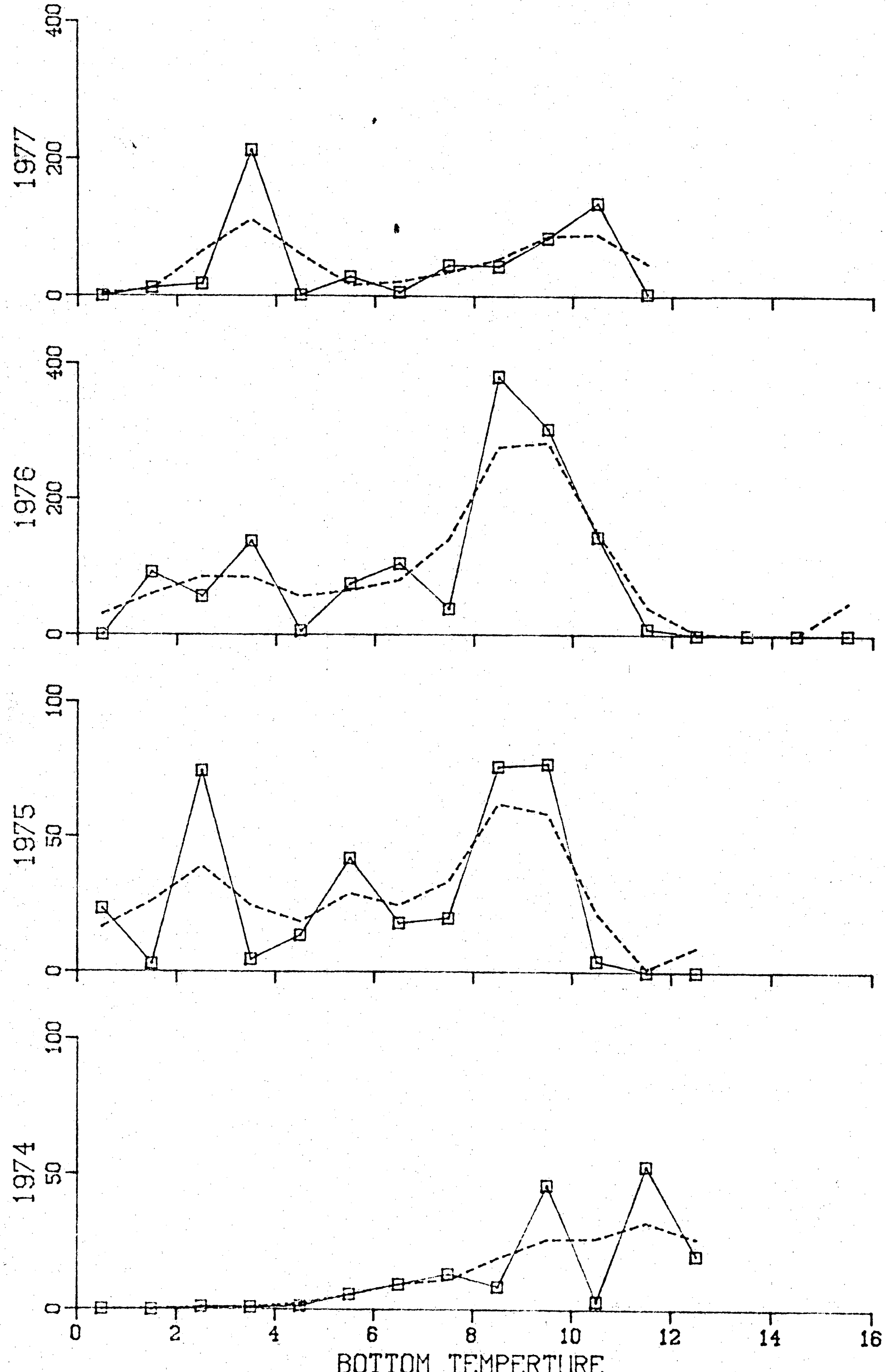

FIGURE 1. Continued.

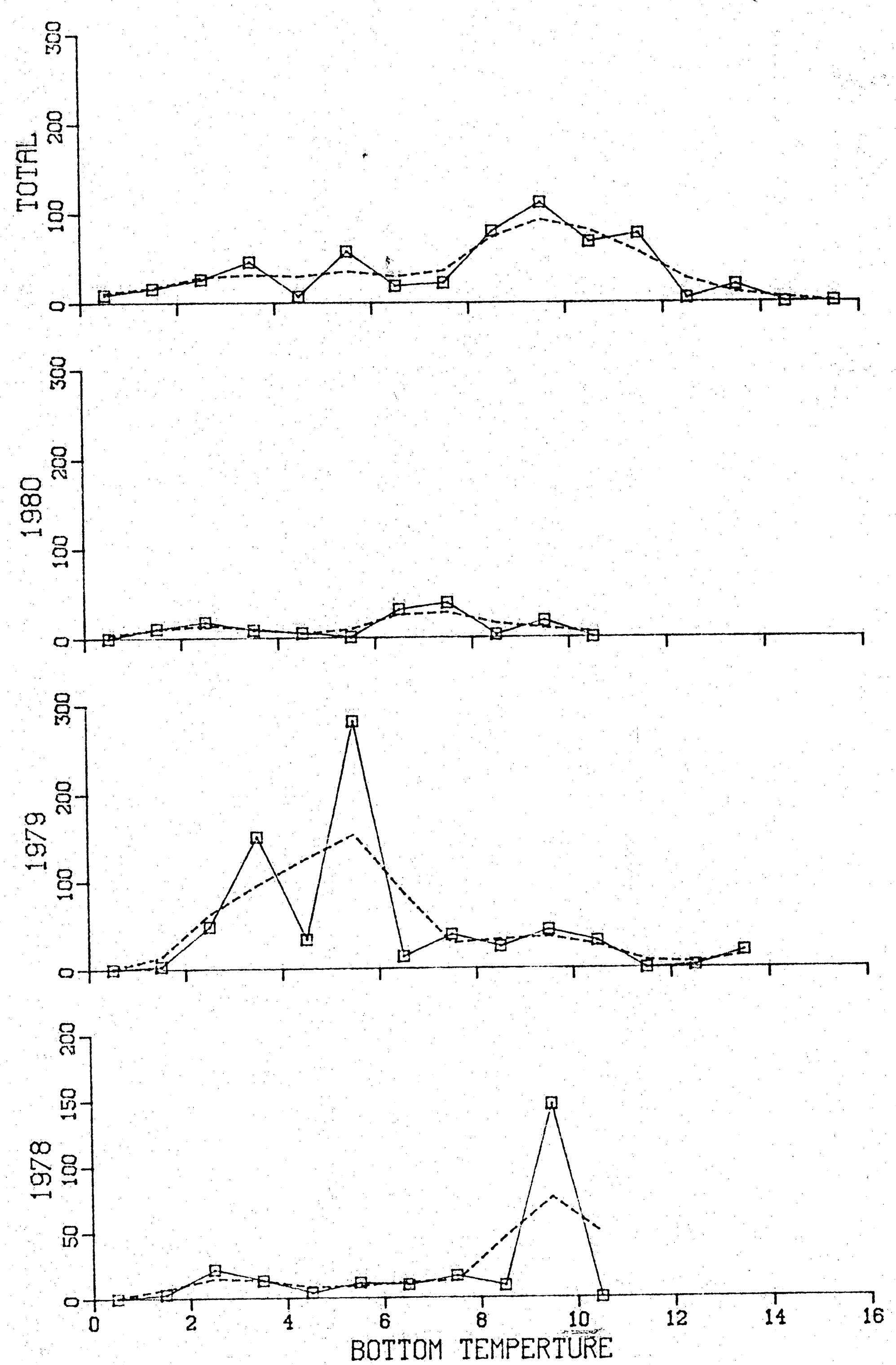

Figure 1. Continued.