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Observations on the Abundance and Distribution of Predators of
Shrimp (Pandalus borealis) in the Cartwright and Hopedale Channels

by

D.G. Parsons
Fisheries Research Branch
Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland A1C 5X1

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Abstract

Shrimp and Greenland halibut occur in highest concentrations in the Cartwright (Div. 2J) and Hopedale (Div. 2H) Channels at depths greater than 400 m while cod are usually found in shallower water. There are indications that abundance of these predators may be increasing.

Cod in both areas were feeding frequently on shrimp whereas only around 20% of Greenland halibut had shrimp in their stomachs. Measurements of shrimp found in predator stomachs can be used to supplement data obtained from the research trawl.

Résumé

Les crevettes et le flétan du Groenland se trouvent en concentrations maximales dans les chenaux Cartwright (div. 2J) et Hopedale (div. 2H) à des profondeurs supérieures à 400 m, alors que la morue se rencontre généralement en eau moins profonde. Il se peut, d'après certains signes, que ces prédateurs soient en voie d'augmentation.

Dans les deux régions, la morue se nourrit souvent de crevettes, tandis que seulement 20 % environ des flétans du Groenland ont des crevettes dans leurs estomacs. Des mensurations sur les crevettes trouvées dans les estomacs des prédateurs peuvent être un complément aux données recueillies dans le chalut de recherche.

Introduction

Observations on the abundance and distribution of predators of Pandalus borealis used in past assessments have provided ancillary information on the shrimp resources and aided in the interpretation of available data (Bowering and Parsons 1981, Bowering et al. 1982). Initially, Greenland halibut were suspected as the major shrimp predators in the Labrador Channels because of their previously observed feeding habits and particularly high concentrations in these areas. However, Bowering et al. (1982) showed that although cod were less numerous than Greenland halibut, they appeared to feed more frequently and possibly consume more shrimp per unit biomass. Consequently, data were collected for both species during the 1982 research survey off the Labrador coast.

The 1982 data are presented below and are compared to those of previous years. Length measurements of shrimp taken from cod and Greenland halibut stomachs are discussed for each channel. General conclusions are given which should be considered in the overall assessment of shrimp resources in the Hopedale and Cartwright Channels.

Abundance Indices

Details of the estimates of biomass for shrimp, Greenland halibut and cod from 1979-82 are given in Table 1 (Hopedale Channel) and Table 2 (Cartwright Channel). These data show the relative distribution of each species in the two channels. Generally, shrimp and Greenland halibut are found in highest abundance in waters deeper than 400 m in both channels. The distribution of shrimp in the Hopedale Channel in July 1981 was an anomaly with most biomass occurring between 300 and 400 m (Zone 1). Cod, on the other hand, usually are more abundant in water less than 400 m. One notable exception is a high proportion of cod biomass from 400-450 m in the Cartwright Channel in 1981. It is evident in both channels that mean estimates of abundance of predators have fluctuated more than those of shrimp (the 1979 shrimp biomass in Cartwright Channel was from a smaller area and the 1981 estimate in Hopedale Channel was spurious).

Mean estimates and 95% confidence intervals for Greenland halibut and cod from both channels (1977-82) are given in Fig. 1 through 4. In the Hopedale Channel (Fig. 1), Greenland halibut appear to be increasing whereas in the Cartwright Channel (Fig. 2) only increased variation in abundance can be observed in later years (1979-82). Interpretation of changes in estimates of abundance of cod are greatly affected by the extremely wide confidence intervals associated with the mean estimates. The data for Hopedale Channel are inconclusive but mean values suggest some increase since 1978 (Fig. 3). The same can be said for the estimates of cod in the Cartwright Channel but to demonstrate the possibility of an increase, confidence limits have been omitted (Fig. 4).

Shrimp from Predator Stomachs

Shrimp from the stomachs of cod and Greenland halibut were measured during the 1982 research survey. Total shrimp length distributions from stomachs sampled in both channels are given in Fig. 5 through 7. A total of 1,694 shrimp were measurable from 596 cod in the Hopedale Channel. The resulting length frequency (Fig. 5) produced modes which correspond well with those obtained from research trawls (Parsons et al., 1983). Especially prominent in the stomach sample was a mode of very small animals (possibly age 0) between 7 and 8 mm carapace length. Approximately 1000 of 1200 cod examined (84%) contained shrimp in various stages of digestion.

Only 90 shrimp were measurable from 116 stomachs of Greenland halibut in the Hopedale Channel. Detail in the length frequency is lacking (Fig. 6) but some modes correspond to those found in the cod and trawl samples. Only 822 of 3795 fish examined (22%) had shrimp in their stomachs.

In the Cartwright Channel, 893 shrimp were measurable from 271 cod stomachs. The length frequency (Fig. 7) shows well-defined modes at 7, 11-12, 15-16, and 24 mm carapace length. The scarcity of animals between 17 and 21 mm is also reflected in some trawl data from the 1982 research survey (Parsons et al., 1983). In other trawl samples a separate mode can be interpreted in this size range. Around 70% (397/556) of cod examined were feeding on shrimp.

Only 39 Greenland halibut of 1229 sampled contained measurable shrimp. The resulting sample size (44) was not sufficient to construct a representative length frequency but it is worth noting that 12 of these occurred in the range between 17 and 21 mm. Around 18% of fish sampled contained shrimp.

Conclusions

The two major predators of shrimp in the Hopedale and Cartwright Channels are usually found at different depths. Greenland halibut occur in abundance in the deeper strata where shrimp abound. Cod are usually more numerous in shallower water where fewer and smaller shrimp are found. This arrangement appears to be somewhat fortunate for the shrimp since cod seem to feed more frequently and consume more shrimp than the Greenland halibut (Bowering et al. 1982). However, anomalies in shrimp distribution by depth have been noted frequently in the literature both within and between years. Should cod abundance be relatively high at times when shrimp occur in shallower water, potential for mortality through predation increases.

Despite large fluctuations in mean estimates of predator abundance which themselves have wide confidence intervals (especially cod), there is evidence to suggest some increasing trends in recent years. Most obvious are increases in Greenland halibut in the Hopedale Channel which may be accompanied by marginal increases in cod biomass as well. Abundance estimates for Greenland halibut in the Cartwright Channel do not indicate any sustained increase in recent years and although mean estimates of cod biomass indicate large increases in abundance in 1981 and 1982, associated statistics tend to

invalidate such a conclusion. Independent observations from the cod fishery in and near the Cartwright Channel in recent years, however, do show increases in catch rates (winter-spring) especially in 1981 and 1982 which may reflect increased abundance (S. Gavaris, pers. comm.).

If predator abundance is increasing in these channels, there also should be a concomitant increase in shrimp mortality. Shrimp abundance in the Hopedale Channel has shown some stability in recent years while abundance in the Cartwright Channel may have declined since 1980 despite a virtual closure of the fishery. This decline may reflect increased predation by cod during this period. Relative stability in the Hopedale Channel, on the other hand, may indicate a relative insensitivity of the shrimp stock to increases in abundance of the infrequently feeding Greenland halibut. Under such conditions of uncertainty and evidence of increases in predator abundance, management by TAC in year i based on estimates of shrimp abundance in year $i-1$ may not be prudent.

Analysis of stomach contents in terms of sizes of shrimp consumed suggests that predators are relatively good samplers of shrimp at depths where the predators are caught. For example, cod in the Cartwright Channel consumed shrimp of sizes similar to those obtained in shallow strata in the research trawl. Those taken from Greenland halibut were larger and more representative of shrimp found in deeper water.

From a practical viewpoint, cod appear to be the best shrimp samplers. They eat more frequently and contain more measurable shrimp than Greenland halibut. Thus, less effort is expended in obtaining a representative shrimp sample. However, since the two predators 'sample' at different depths, shrimp data from both are desirable.

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Table 1. Estimates of mean biomass (t) for shrimp, Greenland halibut and cod in the Hopedale Channel, 1979-82.

Stratum	Depth Range (m)	1979			1980			1981			1982		
		Shrimp	Greenland halibut	Cod	Shrimp	Greenland halibut	Cod	Shrimp	Greenland halibut	Cod	Shrimp	Greenland halibut	Cod
102	202-238	67.6	30.0	3.8				301.6	23.4	18.2	86.1	15.4	22.5
103	239-274	337.9	17.8	162.9	14.0	41.9	21.4				145.3	59.0	105.7
104	275-311	53.4	20.2	12.9	24.1	50.8	39.3	219.4	54.9	4.3	189.0	101.1	152.6
105	312-348	119.1	62.9	43.2	147.7	136.0	72.5	634.5	156.4	22.4	391.3	374.4	409.9
106	349-384	343.3	81.7	55.5	88.0	289.5	132.6	628.7	286.6	55.6	585.7	335.2	176.7
107	385-421	728.2	137.8	72.8	143.3	452.6	139.4	203.2	207.0	26.2	983.4	664.1	61.0
108	422-457	582.6	132.5	41.8	454.2	725.4	151.9	301.4	412.3	11.6	726.8	482.3	40.0
109	458-494	1900.5	397.9	42.9	838.1	1334.1	24.1	184.5	618.9	53.6	204.3	637.4	4.3
110	495-530	2000.7	1021.1	0.0	3797.8	2562.8	110.5	348.6	1885.8	25.3	1201.7	1588.0	9.1
111	531-567	1972.6	370.5	1.4	1848.1	2160.4	16.6	49.8	484.7	0.0	181.4	1061.4	0.0
112	568-603												
113	604-639												
204	275-311				150.1	72.1	81.2	366.5	33.7	55.5	589.3	73.6	100.9
205	312-348	62.2	182.2	84.4	142.2	95.6	142.2	197.3	36.1	21.0	208.9	39.9	163.9
206	349-384	734.3	79.3	21.5	229.8	70.0	31.0				419.4	211.8	135.2
207	385-421	17.0	15.8	0.0	269.3	246.5	80.1	295.8	372.3	159.3	1250.1	350.9	272.2
208	422-457	2137.9	148.0	0.0	2159.8	720.4	110.8				2657.1	1106.3	275.2
209	458-494	45.5	153.4	8.3	259.3	1070.1	77.2	206.8	2621.7	0.0	297.0	780.7	209.2
210	495-530	23.2	107.3	0.0	103.9	1126.9	17.9				217.5	706.4	11.4
211	531-567	129.1	540.9	0.9	38.9	2923.0	11.4				25.5	761.5	0.0
212	568-603	15.6	395.5	0.0	127.4	2516.2	0.0		97.6	1113.3	0.0		
213	604-639				39.1	1472.0	0.0				17.2	212.7	0.0
214	640-675												

Table 1. (Cont'd.)

Stratum	Depth Range (m)	1979			1980			1981			1982		
		Shrimp	Greenland halibut	Cod	Shrimp	Greenland halibut	Cod	Shrimp	Greenland halibut	Cod	Shrimp	Greenland halibut	Cod
304	275-311				18.3	173.6	267.0						
305	312-348	11.7	105.1	43.7	47.8	276.6	62.1	13.4	33.3	16.5	11.5	68.3	45.5
306	349-384	78.1	61.7	19.4	96.5	333.5	80.8	21.2	43.8	286.0	16.7	8.2	4.1
307	385-421	144.1	51.2	4.0	127.8	199.2	18.4						
308	422-457	97.9	23.6	0.0	130.1	331.0	22.8	86.7	250.7	54.1	50.1	69.1	4.8
309	458-494				82.0	156.7	5.1	33.3	65.7	0.5	6.6	2.7	0.0
310	495-530	3.7	1.6	0.0	71.4	164.6	0.9	22.9	12.9	1.1	17.9	5.1	0.0
311	531-567				120.3	302.8	2.0	8.5	7.1	0.0	28.4	28.2	0.0
312	568-603	1.9	1.7	0.0	66.6	515.2	2.9	13.7	13.6	1.0	20.5	29.6	0.0
313	604-639							75.3	929.6	0.0	3.7	231.3	0.0
314	640-675				203.7	2765.8	0.0						
Total		11608.1	4139.7	619.4	11839.6	23285.3	1722.1	4213.1	8551.4	812.2	10633.0	11117.9	2204.2

Table 2. Estimates of mean biomass (t) for shrimp, Greenland halibut and cod in the Cartwright Channel, 1979-82.

Stratum	Depth Range (m)	1979			1980			1981			1982		
		Shrimp	Greenland halibut	Cod	Shrimp	Greenland halibut	Cod	Shrimp	Greenland halibut	Cod	Shrimp	Greenland halibut	Cod
702	301-350				189.9	381.4	201.1	54.4	44.3	47.1	103.0	167.8	999.9
703	251-300				-	-	-				22.7	11.6	7.3
704	< 250				-	-	-	9.0	17.8	81.0			
705	251-300				-	-	-				3.1	4.1	75.1
706	301-350	7.5	41.3	81.8	3.0	117.8	46.8	25.4	29.9	251.0	82.4	92.4	381.6
707	351-400	17.1	94.5	57.9	99.0	240.8	36.8	239.7	94.1	130.1	86.9	149.1	158.6
708	401-450	115.9	319.4	35.2	405.0	535.5	27.2	887.3	401.5	973.9	489.1	763.9	211.2
709	451-500	528.6	553.9	51.5	512.9	1018.2	60.2	612.0	316.0	60.2	345.4	488.7	94.2
710	501-550				992.0	1804.5	76.5	341.7	234.7	41.4	335.1	623.0	95.5
711	451-500	1222.6	730.0	17.1	63.8	304.3	20.5	66.9	92.6	2.9	58.9	159.0	20.9
712	> 551	-	-		523.5	929.9	42.6	131.1	146.6	7.2	396.6	615.5	72.0
TOTAL		1891.7	1739.1	243.5	2789.1	5332.4	511.7	2367.5	1377.5	1594.8	1923.2	3075.1	2116.3

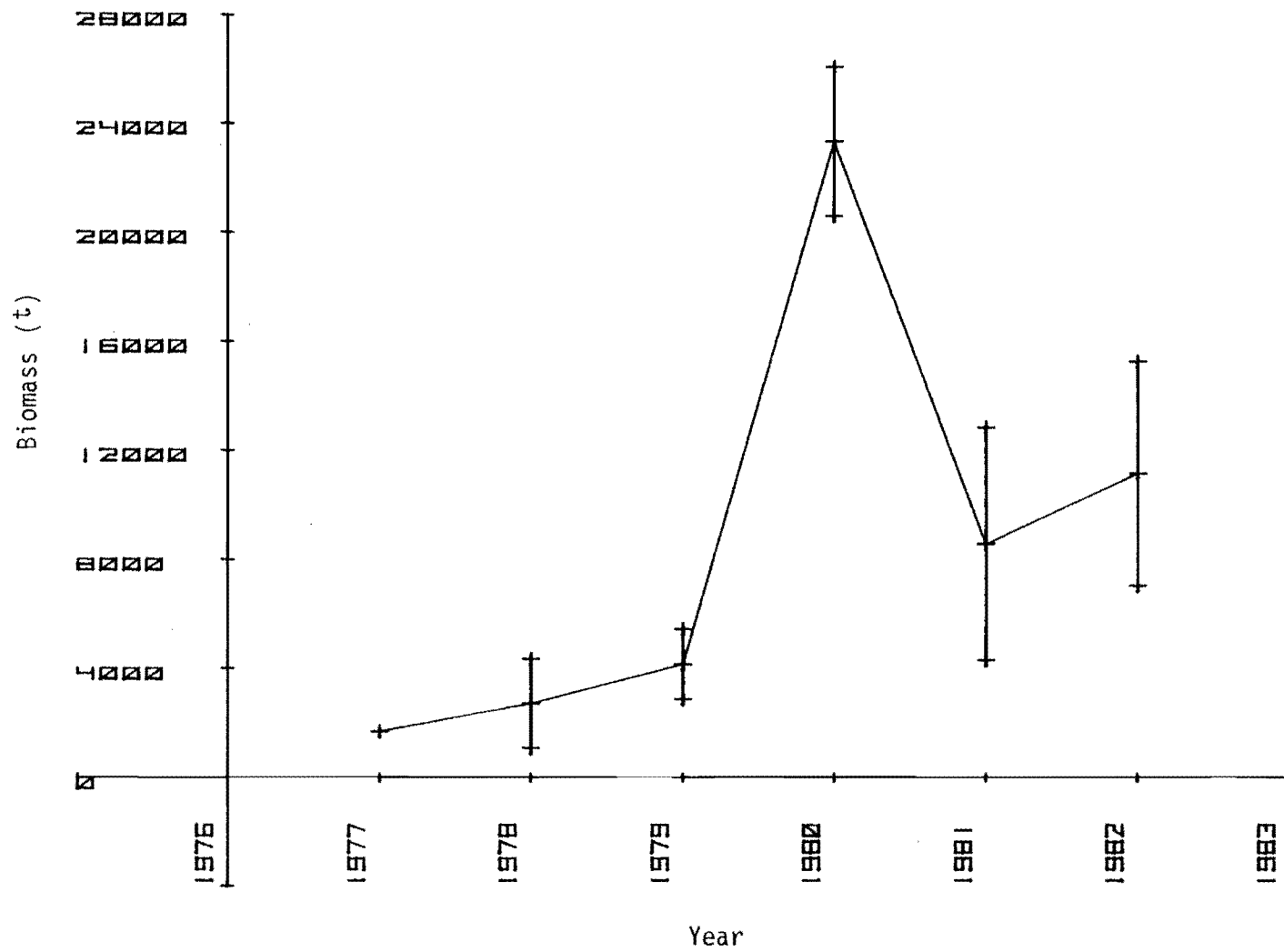


Fig. 1. Mean biomass estimates and 95% confidence intervals for Greenland halibut in the Hopedale Channel (1977-1982).

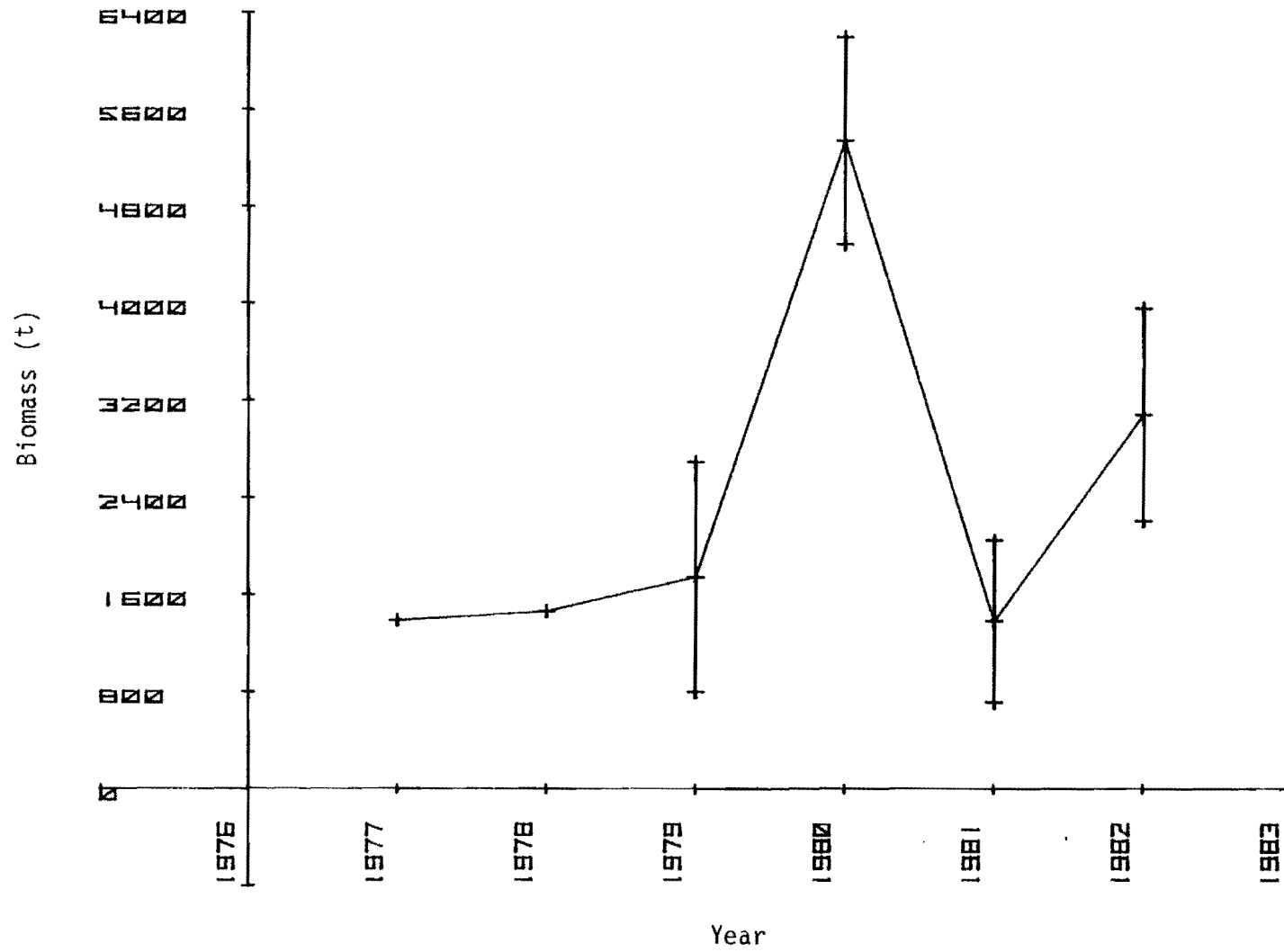


Fig. 2. Mean biomass estimates and 95% confidence intervals for Greenland halibut in the Cartwright Channel (1977-1982).

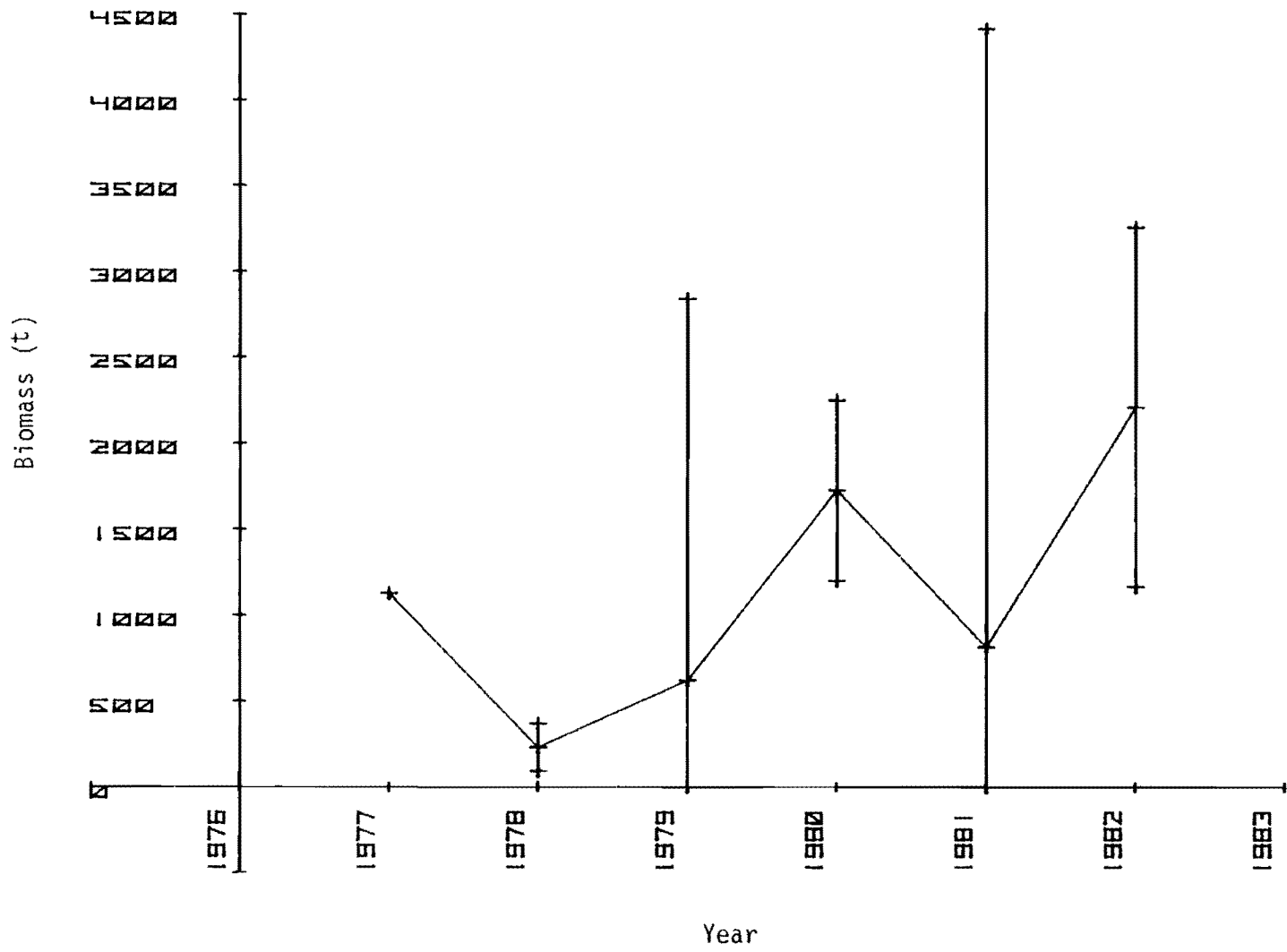


Fig. 3. Mean biomass estimates and 95% confidence intervals for Cod in the Hopedale Channel (1977-1982).

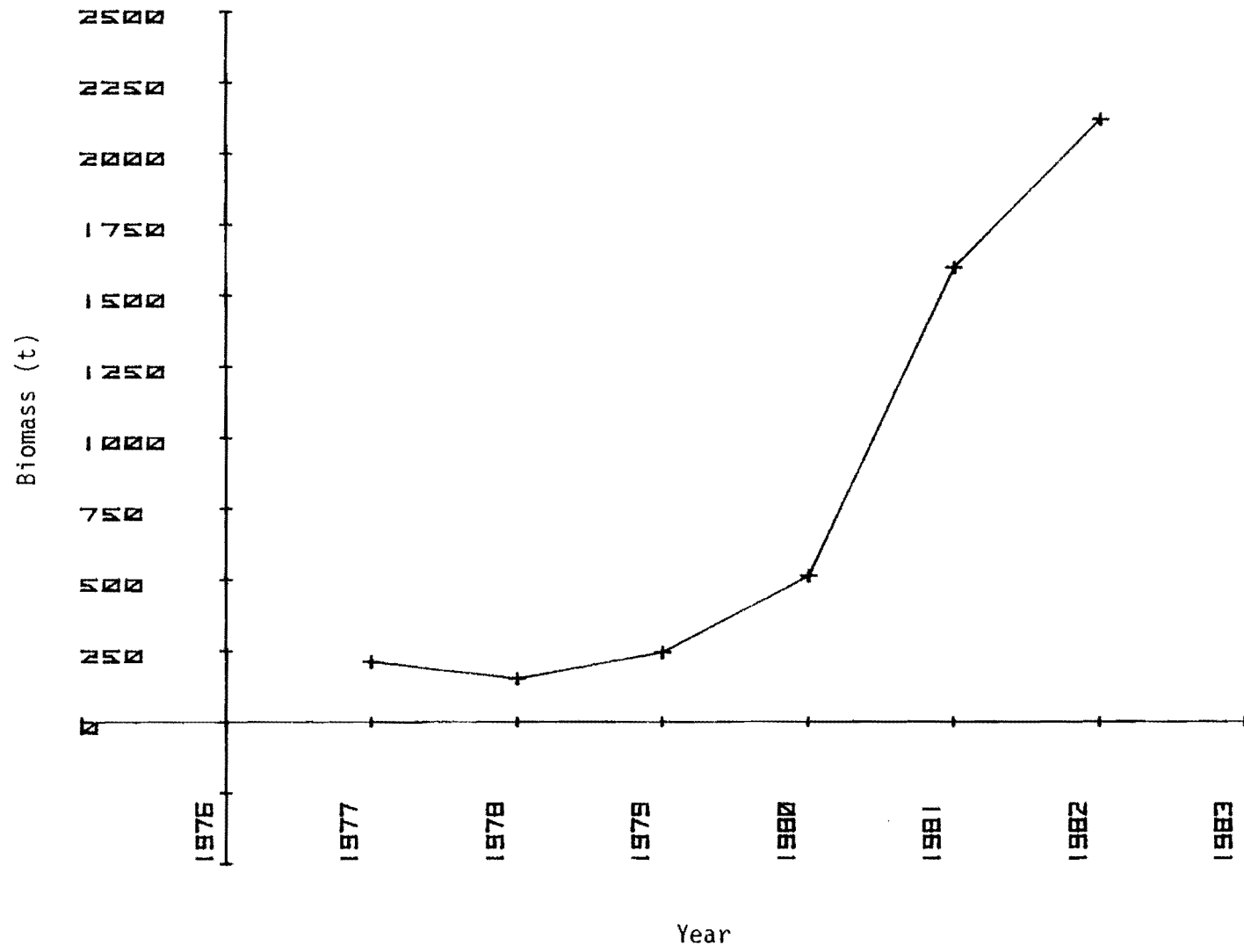


Fig. 4. Mean biomass estimates for Cod in the Cartwright Channel (1977-1982).

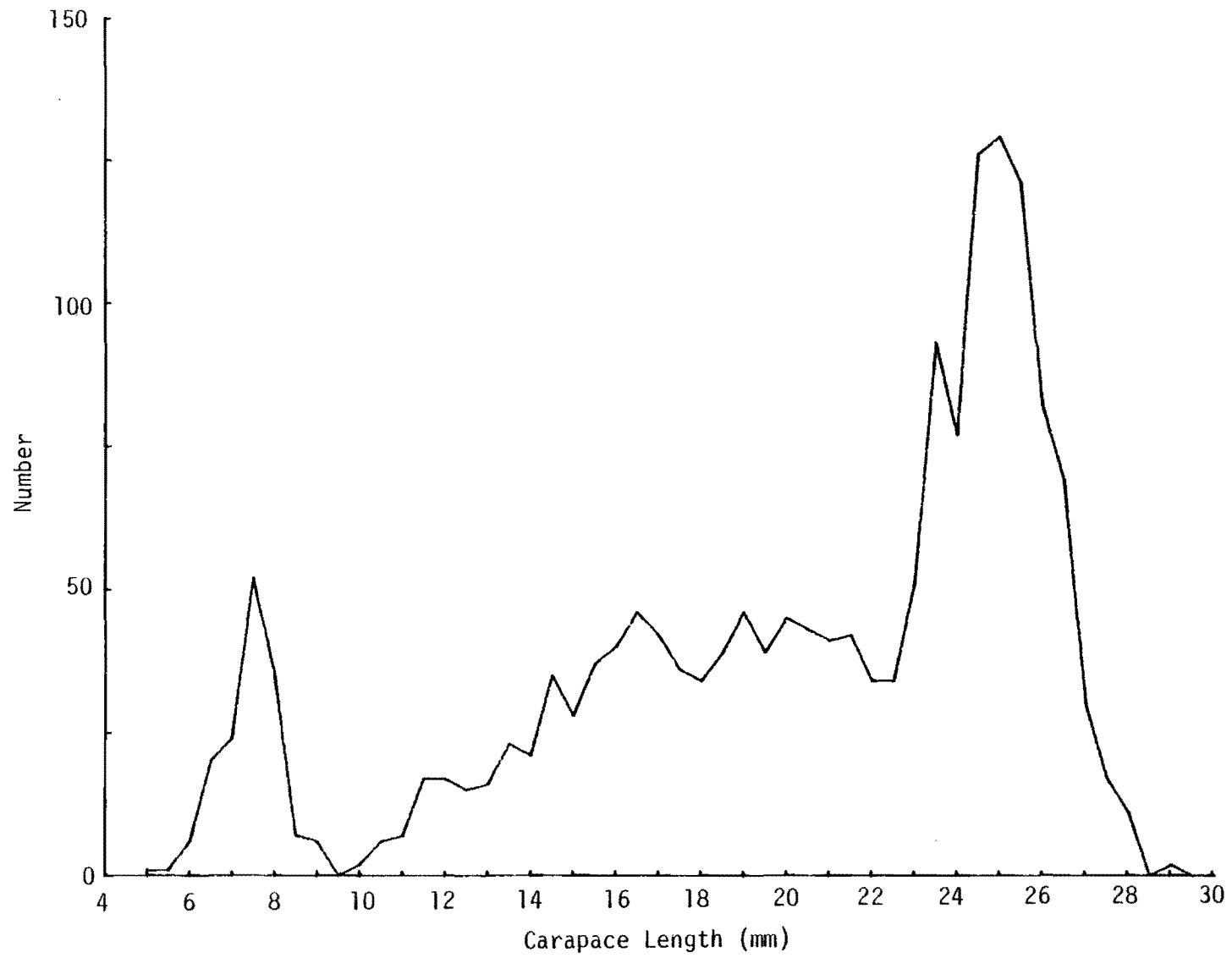


Fig. 5. Length distribution from Cod stomachs in the Hopedale Channel, 1982.

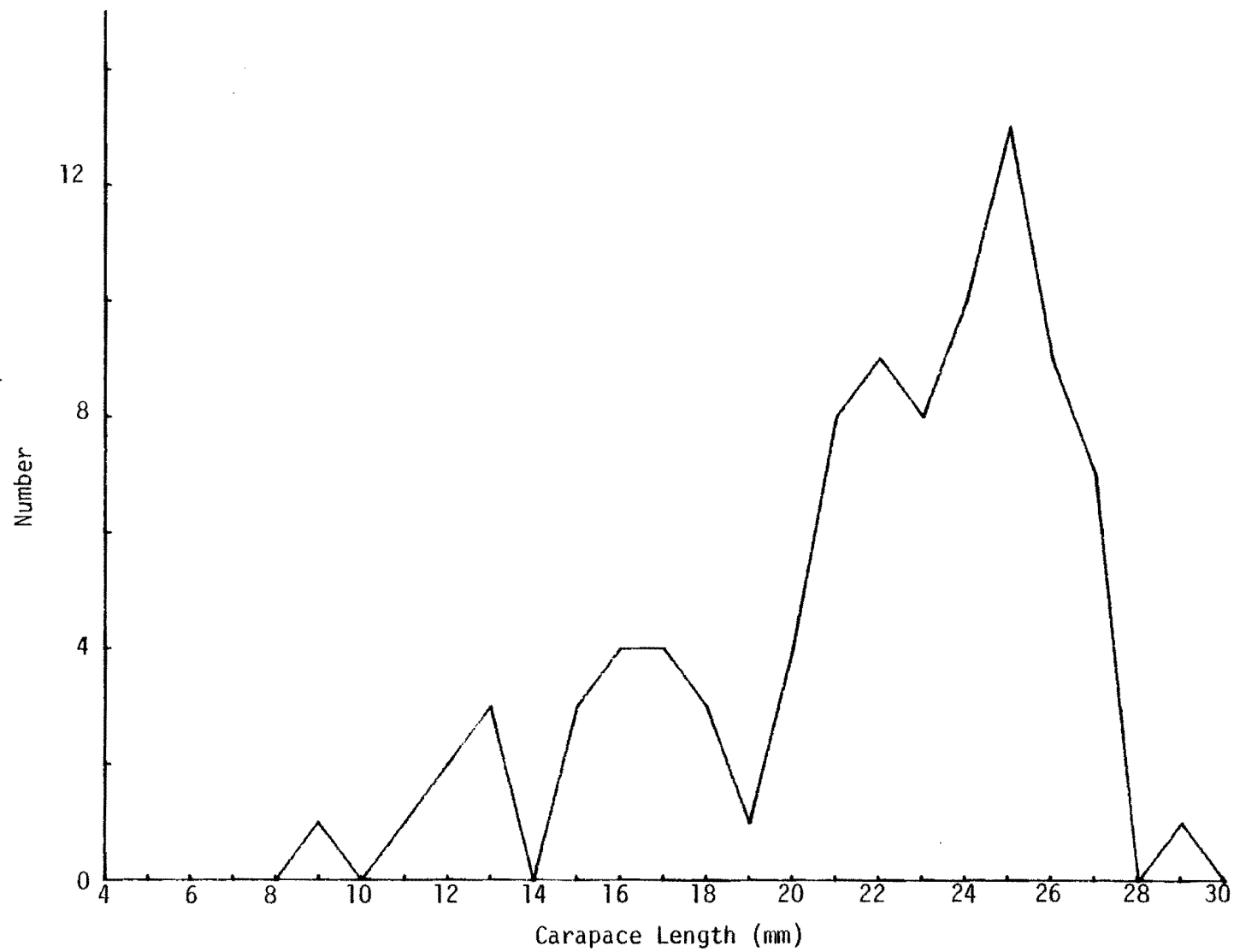


Fig. 6. Length distribution from Greenland halibut stomachs in the Hopedale Channel, 1982.

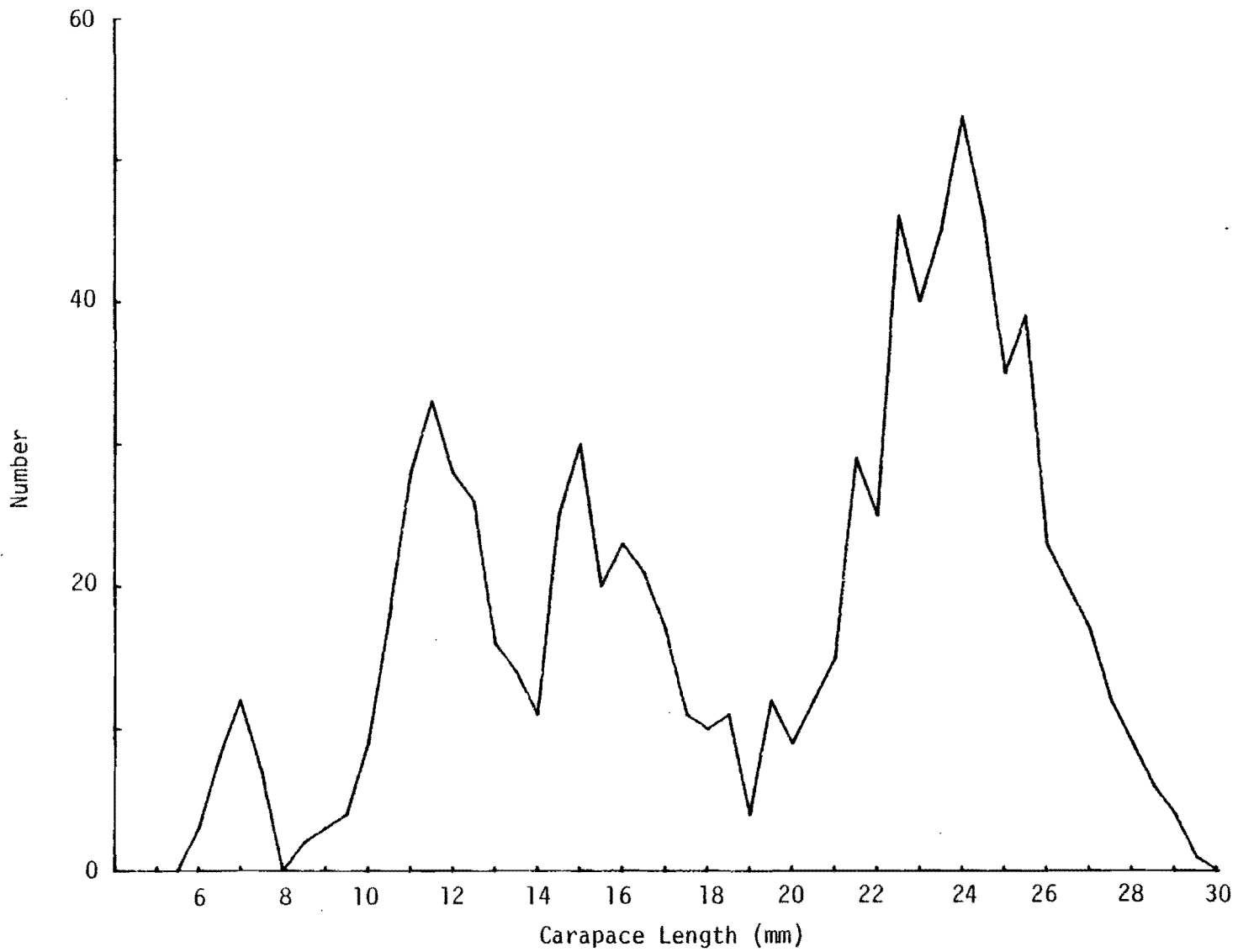


Fig. 7. Length distribution from Cod stomachs in the Cartwright Channel, 1982