The Fishery for Shrimp (Pandalus borealis) and Status of the Stock in the Hopedale Channel (Div. 2H), 1983

by

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ABSTRACT

The fishery for shrimp in the Hopedale Channel in 1983 was sporadic and catch rates in months with significant effort were lower than for corresponding months in 1982. Particularly alarming were the low catch rates in November and December compared to previous years. Biomass estimates from July research surveys showed a decrease from the 1980 level and the stock appears to have become more dispersed. Despite a high proportion of small shrimp observed in the 1983 survey, catch rates in 1984 may be even lower due to the overall reduction in abundance and low densities.

Increased abundance of Greenland halibut implies higher mortality through predation and may result in a further dispersal of shrimp concentrations. Warmer temperatures observed in 1983 could provide more favourable conditions over a wider area, also encouraging dispersal.

This fishery has been self-regulating in recent years and the effort to be expended in 1984 will depend on suitable catch rates. Further effort restrictions would not likely improve stock status under present conditions. The TAC implemented in previous years, however, (4000 t) is no longer appropriate.

RESUME

La pêche des crevettes dans le chenal Hopedale en 1983 a été sporadique et, dans les mois où l'effort de pêche a été substantiel, les taux de capture ont été inférieurs à ceux des mois correspondants de 1982. Les faibles taux de capture de novembre et décembre, comparés à ceux des années antérieures, sont particulièrement alarmants. Les estimations de biomasse découlant des relevés de juillet par navire de recherche montrent une diminution par rapport au niveau de 1980 et le stock semble avoir été plus dispersé. En dépit d'une forte proportion de petites crevettes observée dans le relevé de 1983, les taux de capture de 1984 peuvent être encore plus faibles à cause d'une diminution générale d'abondance et de faibles densités.

La présence d'un plus grand nombre de flétans du Groenland laisse supposer des mortalités accrues par prédation avec, comme conséquence possible, une plus grande dispersion des concentrations de crevettes. Il se peut aussi que les températures de l'eau plus élevées observées en 1983 aient donné des conditions favorables sur une plus grande superficie, ce qui est de nature a encourager davantage la dispersion.

Récemment, cette pêche s'est contrôlée d'elle-même et l'effort qu'on y consacrera en 1984 dépendra de taux de capture convenables. Dans les conditions actuelles, il est peu probable que d'autres restrictions de l'effort améliorent l'état du stock. Le TPA passé (4 000 t), cependant, n'est plus approprié.

Introduction

The northern shrimp fishery in 1983 was concentrated in the Davis Strait where approximately 4000 tons (80%) of the 5000 ton TAC were taken. Nine vessels fished for shrimp in northern waters but only six fished off Labrador, mainly in the Hopedale Channel. Most fishing effort in this area was expended during the June-July and November-December periods.

Observer coverage for vessels fishing off Labrador in 1983 was minimal. The only sampling data from the commercial fishery were obtained from one vessel which fished in the Hopedale Channel during November and December. Therefore, comparisons with data from previous years were limited.

The 'annual' research cruise was conducted from July 6-25, 1983 and provided new information on shrimp abundance, distribution and biology. These data are compared to similar observations from previous years.

Catch and Catch Per Unit Effort

The total catch of shrimp in the Hopedale Channel in 1983 was 1014 tons (preliminary) compared to 1708 tons in 1982. The 1983 catch represented only 25% of the 4000 ton TAC. Ice in the Labrador Sea posed a problem to fishing well into July and, at times, vessels were unable to fish in the northernmost part of the Channel where shrimp concentrations generally have been high. As in 1982, all northern shrimp licences were not utilized. Only five vessels conducted significant operations in the Hopedale Channel in 1983.

Catch per unit effort, standardized to tonnage class 5 vessels, shows the sporadic fishing pattern over the season (Fig. 1). Daily catch rates in June varied from over 600 kg per hour to less than 200. Rates in July also varied but generally were less than in the previous month. Virtually no fishing occurred from August to October. Effort increased in November but the high rates observed around the same time in previous years did not occur. Fishing ended in the second week of December due to a combination of poor weather and low catch rates. The overall success of the fleet in the last two months of 1983 was extremely poor compared to other years.

Most monthly catch rates for 1983 were lower than for corresponding months in 1982 (Table 1). Values in August and September were based on only 6.75 and 17.33 hours, respectively, and cannot be considered representative. During the three months when effort was comparatively high (June, July and November), catch rates did not differ greatly, especially when compared to differences observed in previous years.

Unweighted catch rates for August and September have been used in past assessments to reflect changes in stock abundance in the Hopedale Channel since 1977. However, effort in these months in 1983 was so low that the average value cannot be used as an index of abundance. June, July and November catch rates were compared for most years from 1977 to 1983 (Fig. 2). The June rates show an overall decrease from 1979 to 1983. The 1981 to 1983 values were much lower than in the previous two years and showed a continuing decline. Catch

per hour in July showed a steady decline between 1978 and 1980, followed by a large drop in 1981. From 1981 to 1983, rates were relatively stable. November showed an initial decline between 1977 and 1978, followed by fluctuating catch rates from 1980 to 1983.

The difficulties in interpreting monthly catch rates have been discussed in previous reports but are reviewed briefly here. Prior to 1981, catch rates were high early in the season (June-August), declined substantially during September and October and increased again in November and December. In 1981, catch rates were more uniform throughout the season while in 1982, the high-low periods again were evident but not as pronounced as in earlier years. As stated previously, monthly catch rates in 1983 did not vary substantially. Variation in the timing of peak concentrations between years creates difficulties in interpreting monthly CPUE figures. The amount of fishing effort also affects catch rates. When only a few vessels are fishing, more time is spent searching for the best grounds while many vessels fishing in a small area (for shrimp or finfish) will disperse concentrations. Ice and poor weather also adversely affect performance and these factors vary between years.

The CPUE figures can be used to interpret changes in abundance in a general sense, despite the difficulties described above. Abundance apparently has declined from high levels encountered in the early years of the fishery. In more recent years, 1981 to 1983, there have been changes in fishing pattern and seasonal distribution of shrimp, which have resulted in lower catch rates. The low catch rates in 1983, however, are particularly alarming mainly because there was no evidence of improvement during November-December. In other years, some of the best catch rates were obtained during this period.

Biomass

Results of the July 1983 research survey show that shrimp were most abundant at depths greater than 400 m (Fig. 3, Table 2), similar to most other years. The mean estimate of biomass (6882 tons) was 72% of the revised estimate of 9498 tons from the 1982 survey (Bowering et al. 1983). It was noted for the first time in 1982 that over 50% of the estimated biomass occurred in the central part of the Channel whereas, in other years, the highest proportion of biomass always was found in the northern zone (Parsons et al. 1983). The distribution of biomass as observed from July surveys has changed during the period 1979 to 1983.

Percent of Biomass by Zone

	1979	1980	1981	1982	1983
Zone 1	70	62	68	41	50
Zone 2	27	30	25	57	40
Zone 3	3	8	7	2	10

Since 1979, there has been a decrease in the proportion of biomass in the northern part of the Hopedale Channel (Zone 1). In 1982, 57% was estimated to be in Zone 2 while in 1983, Zone 3 reached a high of 10%.

Biomass estimates and densities of shrimp from 1979 to 1983 are compared in Table 3 and Figure 4a. Assuming that the 1981 estimate is not representative, there appears to have been a decreasing trend in biomass from 1980 to 1983. Biomass of shrimp per square nautical mile declined from 6.18 tons in 1979 to 2.64 tons in 1983, a decrease of 57%. The area of distribution is represented to some extent by the area surveyed each year. In addition to declining abundance, shrimp seem to be distributed over a wider area.

Shrimp Size Composition

1. Research

Length frequencies from the Hopedale Channel in July 1983 (Fig. 5) showed increasing mean size with depth but the proportions of shrimp less than 23 mm carapace length were high in most areas and depths compared to previous years. In strata where most biomass was found, all sizes were well-represented. The size group between 24 and 27 mm, evident in deeper water, represented first year females and females which had spawned previously. Bimodality in this size range at times separated the two groups. Modal lengths of males were indistinct in many instances. A size group from around 14-16 mm was evident in the southern area (Zone 3) but was obscured by adjacent size groups in the other zones. Another mode around 18 mm especially was prominent in shallow strata in Zone 1 and could be seen in some other strata as well. A mode around 20 to 21 mm also was interpreted in some strata but often overlapped with the smaller males and/or larger females.

Although biomass was estimated to be lower than in 1982, abundance of shrimp that should recruit to the fishery in 1984 (and 1985) appears to be relatively good. However, the distribution of these shrimp, as well as abundance might significantly affect catch rates in the 1984 fishery.

Shrimp from stomachs of cod and Greenland halibut also were measured during the 1983 survey. A total of 678 shrimp were measured from 494 cod and the length frequency obtained (Fig. 6) showed a size range similar to that obtained from the trawl for the same sets. Unlike the 1982 survey (Parsons 1983), there was an absence of the size (age) group less than 10 mm. Measurements of 232 shrimp from 7112 Greenland halibut stomachs (Fig. 7) also were similar to those from the trawl and only a few shrimp less than 10 mm were found.

Standardization of the procedure for sampling predator stomachs must be attained before firm conclusions can be made concerning the relative strength of the 0 age group in 1983 compared to other years.

2. Commercial

Commercial length frequencies for the Hopedale Channel in 1983 only were available from one vessel for November and December (Fig. 8). The two are similar in size range and in the proportions of ovigerous and non-ovigerous shrimp. Because of the limited amount of sampling, comparison with other years is not possible.

Predator Abundance

Results of the 1983 research survey showed that biomass of Greenland halibut increased from 8550 t in 1981 to 11,118 t in 1982 and to 24,180 in 1983 (Table 4, Fig. 4b). The 1983 estimate was higher than the previously high level of approxiamtely 23,000 t in 1980 (Bowering et al. 1983). Confidence intervals for the latter (± 12%), however, were much more narrow than for the 1983 estimate (± 42%). Nevertheless, there has been an increasing trend from 1979 to 1983.

Estimates for cod have been much more variable with no indication of trends. The 1983 estimate of 1548 t was less than the 1982 level (Table 4, Fig. 4C), but confidence limits for the former were too wide to relate the mean value to abundance.

Bowering et al. (1983) showed that Greenland halibut was a more important predator than cod in the Hopedale Channel in 1981. Predatory impact by both species was estimated at less than 10% of the trawlable shrimp biomass. Numbers of Greenland halibut from the 1983 survey were 2.65 times the 1981 level. Assuming that feeding patterns were similar to those observed in 1981, predation by Greenland halibut alone in 1983 might have exceeded 1500 t or approximately 23% of the estimated trawlable biomass.

Despite the assumptions necessary for such calculations, it can be stated with some certainty that predator abundance (and concomitant shrimp mortality) has been increasing, mainly due to increases in abundance of Greenland halibut.

Temperature

Bottom temperatures were taken at selected fishing stations in 1977 using a manual bathythermograph and from 1978 to 1983, at most fishing stations, using expendable bathythermographs (XBT). Mean temperatures and ranges per depth stratum per zone per year are given in Fig. 9.

In the northern part of the Channel (Zone 1), there appears to have been a decline in temperatures from the 1977-1978 level to a low in 1980 (Table 5). Some similarity in temperatures was observed from 1979 to 1981 at most depths but they were noticably colder than in the two previous years. An increasing trend is evident between 1981 and 1983. Temperatures at all depths > 312 m in 1983 (detailed profile in Fig. 10) were, on average, higher than in the previous year.

The decline in temperatures from 1977 to 1980 was evident in depths between 300 and 450 m in the central part of the Channel. In most deeper strata, temperatures increased slightly between 1979 and 1980. Only in depths greater than 530 m could increases be seen between 1981 and 1983. In all strata sampled, mean temperatures in 1983 were greater than those observed in 1982.

Data for Zone 3 are lacking for the early years. No trends can be seen in the data but there appears to have been an overall increase in temperature from 1982 to 1983. In most strata, the 1983 temperatures were warmer than in all previous years for which records were available.

By-catch and Discards

The observer records for November and December showed that Greenland halibut was the major by-catch species in both months, accounting for 11% of the observed catch in each. Catch rates were 57 and 37 kg per hour, respectively. Eelpouts, wolffish and cod represented 6, 4, and 4% of the observed catch in November and 9, 8, and 6% in December. Catch rates of redfish of 9 and 7 kg per hour respectively, were much lower than those observed in the same months in the previous two years (Parsons et al. 1982, 1983). However, all observations in 1983 are from only one vessel.

Estimates of shrimp discard rates from vessel logs are low in all months.

Month	June	July	Aug.	Sept.	Nov.	Dec.
% Discard	1.8	1.8	3.4	2.4	0.6	0.4

The observer data for November and December 1983 indicated that discarding might have been in the order of 7.4 and 5.0%, respectively. Therefore, estimates of discards from vessel logs are likely to be underestimates for all months.

Length frequencies of discarded shrimp (Fig. 11) showed a broad size range (predominantly males) between 16 and 22 mm in both November and December. Proportionately, there were more small shrimp in the sampled discards in November.

Discussion and Conclusions

Fishing effort in the Hopedale Channel in 1983 was sporadic over the season and, as in 1982, all licences were not utilized. Heavy ice in June and July restricted fishing somewhat in the northernmost areas where catch rates usually are high at that time of year. Catch rates later in the season, however, were much lower than in previous years but could not be associated with particularly poor weather. The absence of the characteristic increase in catch rates at the end of the year must be related to a similar observation for the Cartwright Channel in 1980 (Parsons et al. 1981). Stock size based on biomass estimates declined substantially in this area in subsequent years and the fishery has been virtually eliminated.

Abundance in the Hopedale Channel apparently declined in the first few years of the fishery but showed some stability between 1979 and 1982. This was concluded from catch rate indices and biomass estimates. In 1981, however, there were major changes in shrimp distribution which affected the interpretation of both the commercial and research data sources. These changes in distribution were possibly related to the high abundance of Greenland halibut and heavy fishing in 1980.

With the addition of the results from the 1983 survey, there appears to have been a decrease in biomass from the 1980 level. Declining densities (biomass per square nautical mile) also suggest that the stock has become less concentrated. Survey results showed that in 1982 and 1983 higher proportions of the stock were found in the southern zones compared to earlier years.

Although abundance appears reduced, the proportion of smaller shrimp in the stock was high in 1983. Catch rates in 1984 not only will depend on abundance but on distribution of the recruited biomass as well.

Predator abundance and temperatures observed in 1983 will likely have effects on both abundance and distribution in 1984. The mean estimate of Greenland halibut biomass in 1983 was higher than in 1980. This not only implies higher mortality through predation, but concentrations of shrimp are likely to become more dispersed as well. Also, temperatures in 1983 were the warmest observed for a number of years. If environmental conditions are more favourable over a wider area, then further dispersal is possible. This could account for the higher proportion of biomass in Zone 3 during the 1983 survey.

The increased potential for predation on shrimp by Greenland halibut may limit any recovery in the stock due to reduced fishing mortality in 1982 and, especially, 1983. Based on conditions described above, densities could be even lower in 1984 resulting in lower catch rates. Options for management advice must be considered accordingly.

The fleet, itself, has reduced fishing effort over the last two years in the Hopedale Channel through economic decisions (i.e. non-utilization, Davis Strait). Total mortality on the stock could be further reduced by additional effort restrictions, but, based on 1983 performance, this essentially would mean closure. Also, it is doubtful whether such measures would improve stock status under present environmental conditions. The main effect would be to prevent the fleet from optimizing the deployment of vessels to the various fishing grounds.

As concluded in past assessments, stock status will determine catch rates which, in turn, will determine how heavily the stock will be fished. Based on the conclusions of a recent economic assessment of the northern shrimp fishery (Voutier 1984), the fleet should not be able to absorb much more in terms of economic setbacks, including declining catch rates. Thus the fishery will remain self-regulating in 1984 and further limitations of fishing effort appear unwarranted. The TAC of 4000 t which has been effect since 1980 was approximately 35% of the available biomass estimated for 1979, 1980, and 1982.

Under present conditions of abundance and distribution, this TAC is no longer appropriate.

References

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Table 1. Catch per hour fished, 1977-83 (monthly values determined from vessel logs) adjusted to tonnage class five.

	1977		1978		1979		1980		1981		1982		1983	
	Catch (kg)	CPUE (kg)	Catch (kg)	CPUE (kg)	Catch (kg)	CPUE (kg)	Catch (kg)	CPUE (kg)	Catch (kg)	CPUE (kg)	Catch (kg)	CPUE (kg)	Catch (kg)	CPUE (kg)
Hopedale Channel														
May									5,455	253				
June					196,741	957	28,970	872	408,457	539	171,265	467	166,729	390
July			131,544	773	965,454	706	736,840	645	360,770	356	302,674	397	253,121	336
Aug.	93,695	611	85,570	560	812,378	368	589,206	475	474,218	344	219,227	376	6,625	981
Sept.	206,111	631	68,591	383	81,907	297	599,724	304	555,279	402	62,621	211	2,125	123
Oct.	330,574	361	584,589	580			390,295	423	406,217	404	246,110	389		
Nov.	641,516	780	470,170	555			163,316	598	469,023	418	471,095	569	370,427	353
Dec.			-[c]	-					168,375	607	113,325	366	71,302	239
Total[a]	1,271,896	573	1,340,464	569	2,056,480	507	2,508,351	449	2,847,794	409	1,586,317	420	870,329	341
Total[b]	1,203,000		2,109,000		2,693,000		3,938,000		3,382,266		1,707,900		1,014,000[d]	

[a]Based on catches from vessel logs

[b]Based on statistics from landings.

[c]Months with catches but no vessel logs.

[d]Preliminary.

Table 2. Minimum trawlable biomass - 1983 research, Hopedale Channel.

Stratum	Depth (m)	Area (sq. n mi.)	No. sets	Biomass (t)
101	166-201	61.3	2	7
102	202-238	48.7	3	72
103	239-274	44.4	3	142
104	275-311	38.8	3	172
105	312-348	38.8	3	239
106	349-384	40.7	4	199
107	385-421	37.9	4	469
108	422-457	39.3	3	668
109	458-494	41.6	6	665
110	495-530	109.9	4	590
111	531-567	51.5	2	210
204	275-311	290.1	3	158
205	312-348	174.0	2	553
206	349-384	134.7	2	234
207	385-421	95.0	3	253
208	422-457	147.8	3	546
209	458-494	161.9	4	529
210	495-530	168.0	3	286
211	531-567	168.4	4	128
212	568-604	163.3	3	98
213	605-641	63.6	4	10
304	275-311	47.3	2	2
305	312-348	30.4	2	17
306	349-384	23.4	2	40
307	385-421	18.7	2	82
308	422-457	18.3	3	43
309	458-494	18.7	2	61
310	495-530	24.3	2	162
311	531-567	30.9	2	113
312	568-604	37.9	2	73
313	605-641	236.3	2	61
TOTAL		2605.9	89	6882

Table 3. Biomass estimates, 95% confidence intervals and density (tons/sq. n mi.) for shrimp in the Hopedale Channel, 1979-83.

Year	Mean	Upper	Lower	Area (sq. n mi.)	No. sets	Biomass (t) per sq. n mi.
1979	11,608	19,730	3,487	1,878	54	6.18
1980	11,840	19,134	4,545	2,496	83	4.74
1981	4,213	5,974	2,452	2,434	56	1.73
1982	9,498	12,003	6,993	2,308	76	4.12
1983	6,882	8,330	5,434	2,606	89	2.64

Table 4. Biomass estimates (tons) and 95% confidence intervals for Greenland halibut and cod, 1979-83, Hopedale Channel.

	Greenland halibut			Cod		
Year	Mean	Upper	Lower	Mean	Upper	Lower
1979	4,140	5,422	2,857	435	899	-30
1980	23,045	25,894	20,197	1,763	2,284	1,242
1981	8,550	12,805	4,295	504	900	107
1982	11,118	15,218	7,018	2,204	3,247	1,162
1983	24,180	34,456	13,904	1,548	3,792	-695

Table 5. Mean bottom temperature (°C) by depth stratum, 1977-83, Hopedale Channel.

Stratum	1977	1978	1979	1980	1981	1982	1983
101		0.8	-1.2				-1.0
102		2.3	-0.2		0.5	-1.0	-0.8
103		2.3	2.5	1.7	1.7	1.1	0.9
104	3.2	3.0	2.2	2.2	2.0	2.3	2.4
105	3.4	3.2	2.9	2.7	2.7	2.9	3.0
106	3.4		2.9	2.9	3.3	3.3	3.7
107	3.6	3.8	3.2	3.0	3.1	3.1	3.8
108	3.6	3.8	3.5	3.2	3.1	3.4	3.8
109		3.8	3.3	3.0	3.2	3.4	3.7
110			3.2	3.3	3.2	3.4	3.8
111		3.7	3.1	3.2	3.2	3.4	4.0
112			3.3	3.2	3.2		
113			3.2	3.2			
204	3.5			2.6	2.1	2.3	3.1
205	3.7		3.5	3.0	3.7	1.6	2.1
206	3.6	3.6	3.3	3.1	3.4	3.5	3.5
207	3.6	3.6	3.4	3.2	3.7	3.3	3.6
208	3.9	3.6	3.3	3.2	3.7	3.6	3.8
209		3.5	3.3	3.4		3.3	3.9
210		3.5	3.4	3.5	3.8	3.8	3.9
211		3.6	3.2	3.4	3.3	3.5	3.8
212		3.5	3.2	3.5	3.3	3.4	3.7
213				3.5		3.7	3.9
214				3.4			
304				2.6	1.9	0.5	0.1
305	2.9		1.9	1.6	2.5	1.2	1.9
306	3.0		2.1	2.7	2.4	2.5	2.7
307	3.1		2.1	3.1	2.8	2.8	3.1
308	3.2		2.5	3.0	2.9	2.4	3.2
309			3.3	3.1	3.1	3.0	3.9
310			3.0	2.9	3.3	3.2	3.7
311				3.3	3.5	3.3	3.9
312			3.3	3.2	3.4	3.5	4.0
313				3.5	3.3		3.9
314			3.5	3.7			

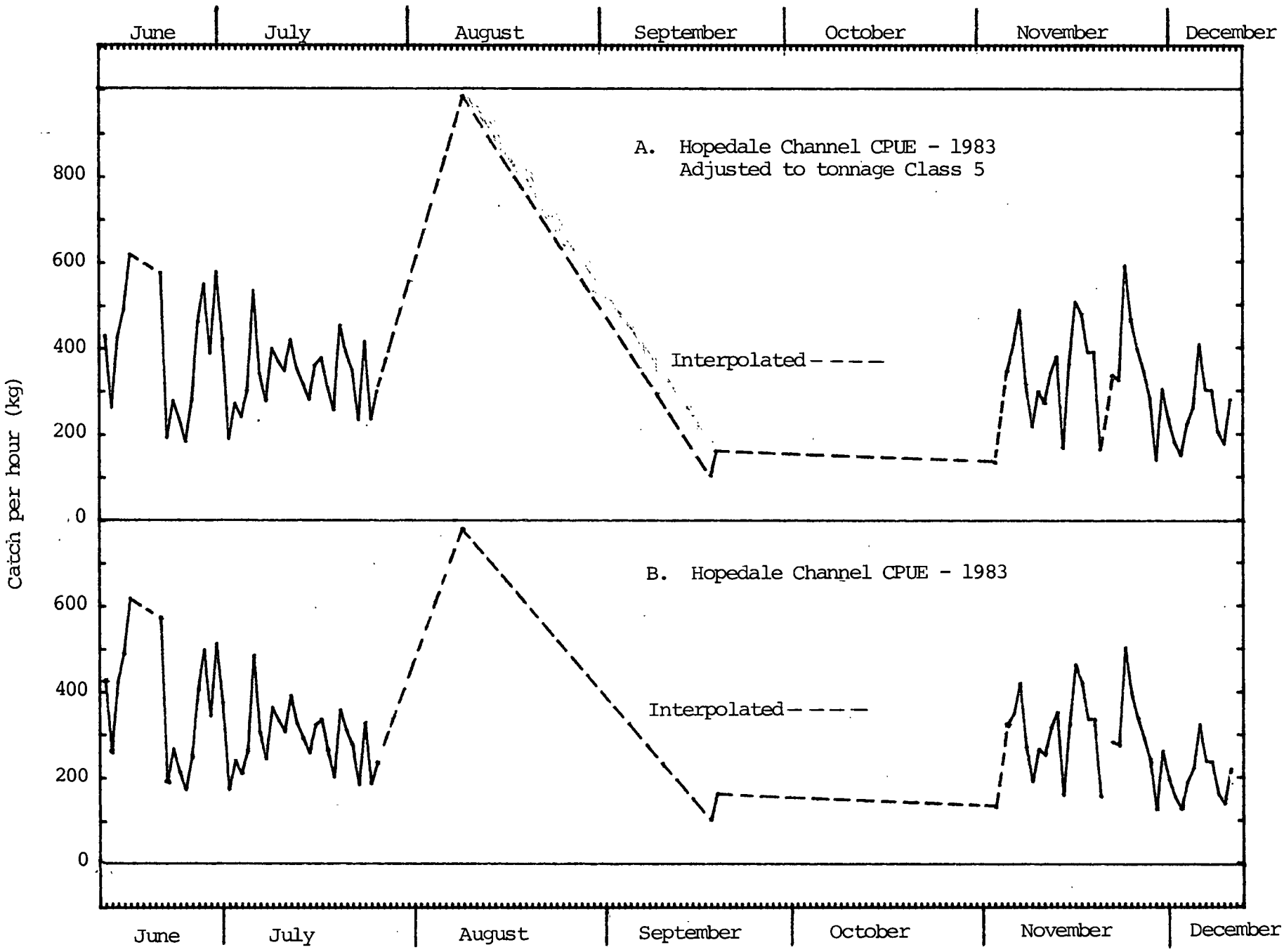

Fig. 1. Catch per unit effort - 1983, A = standardized; B = not standardized.

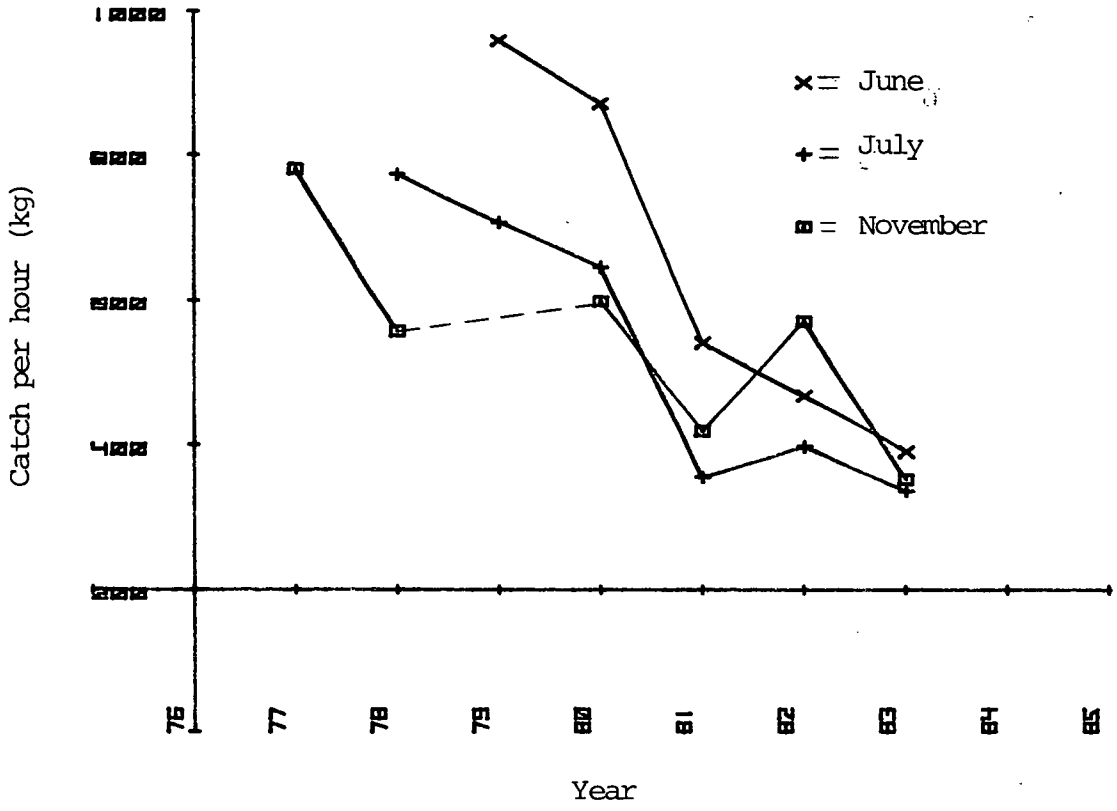

Fig. 2 Catch per hour fished, by month, 1977 - 83, Hopedale Channel.

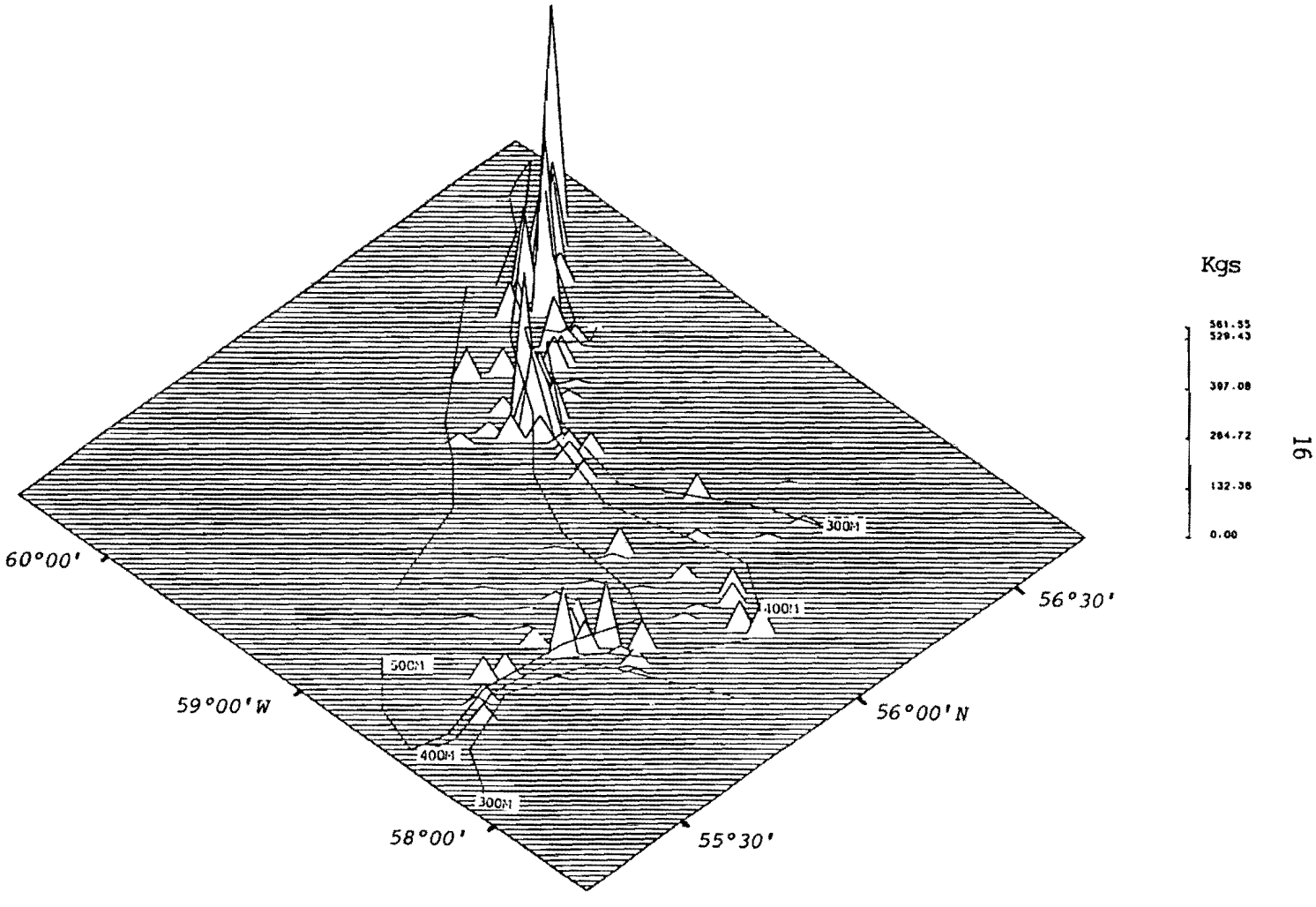

Fig. 3 SHRIMP CATCHES PER 30 MIN TOW HOPEDALE GADUS81 1983

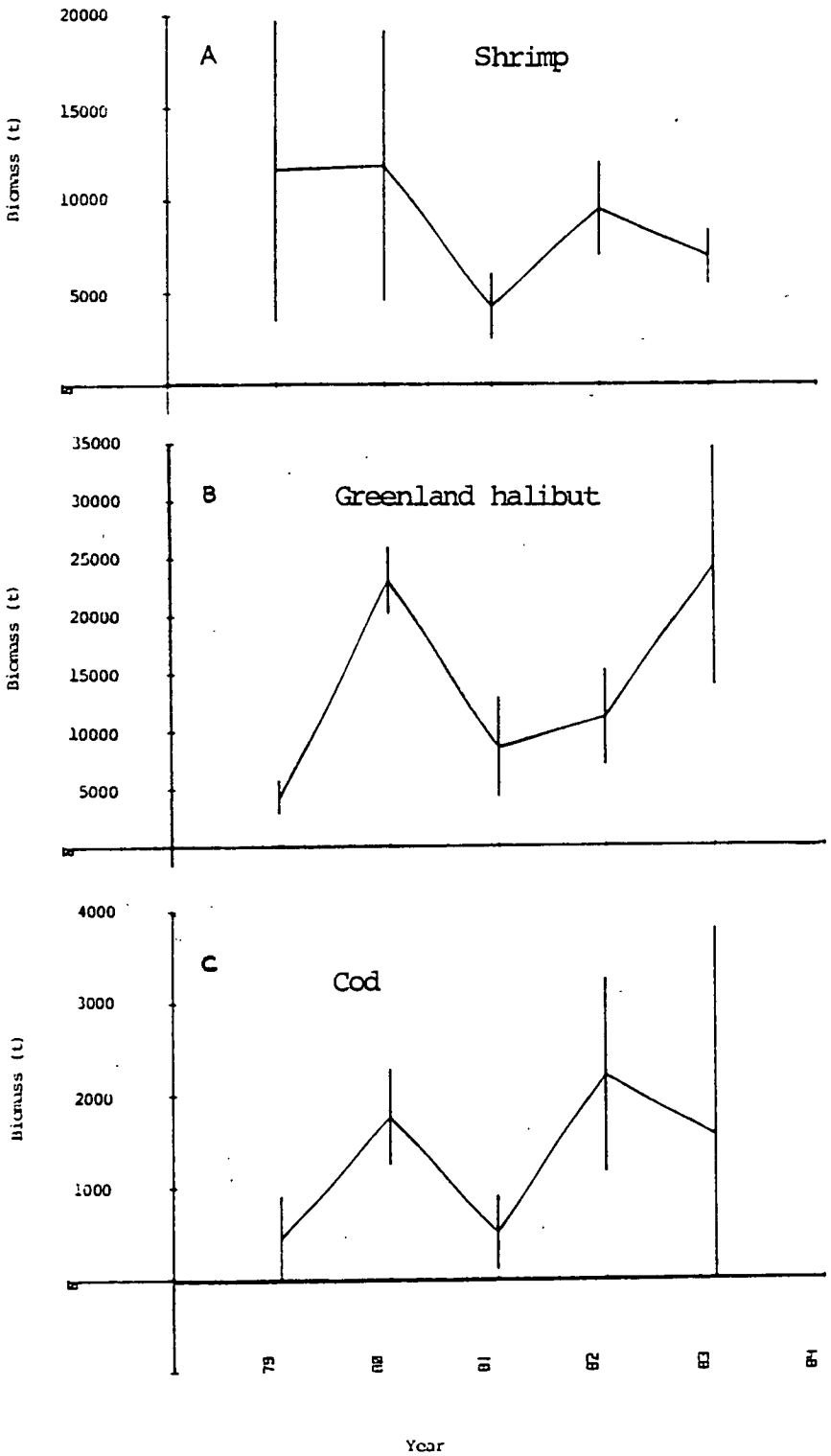

Fig. 4 Biomass of shrimp, Greenland halibut, and cod, 1979-1983, Hopedale Channel.

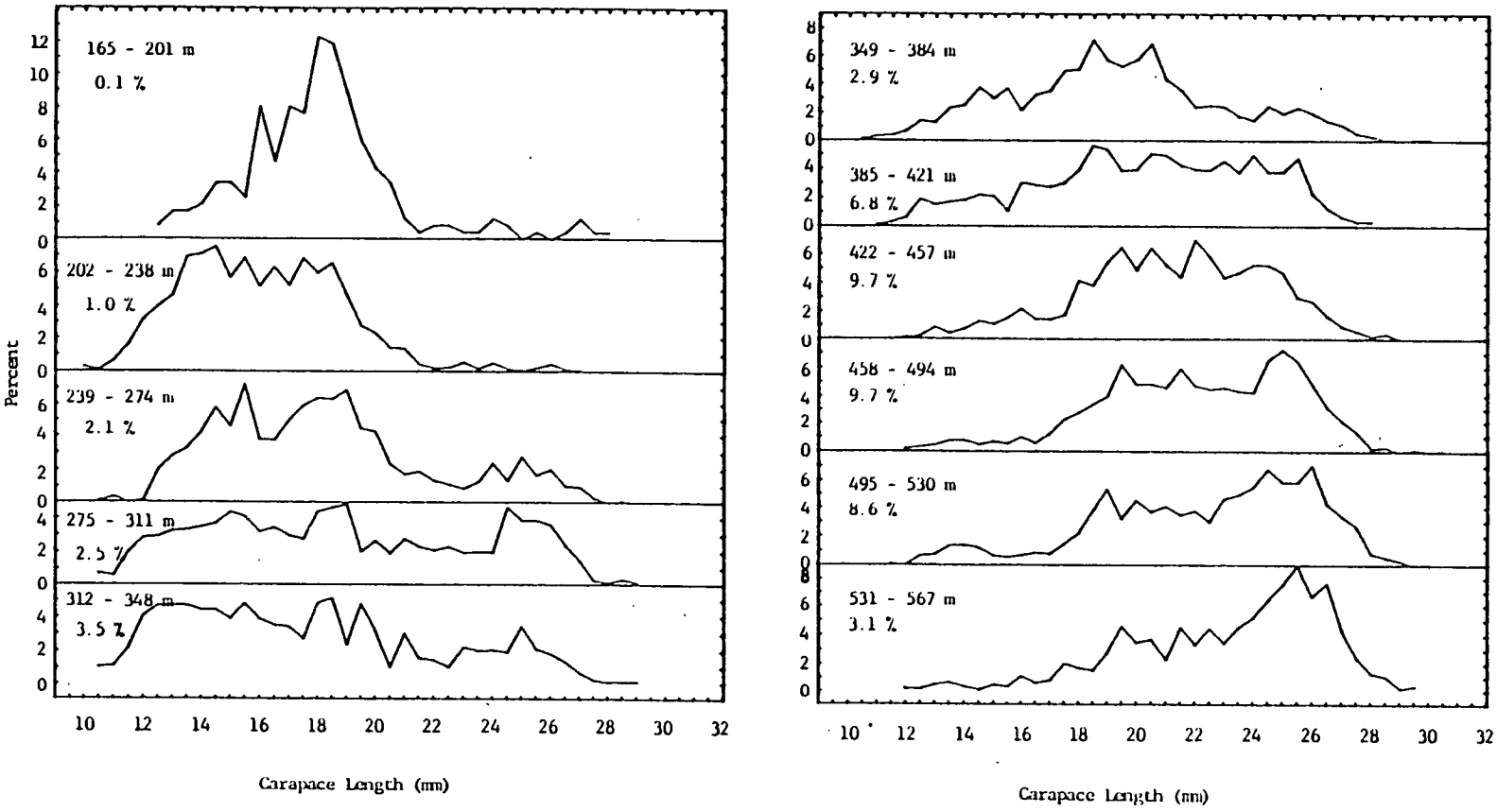

Fig. 5a. Research length frequencies, Hopedale Channel Zone 1 - 1983.

(% of biomass indicated).

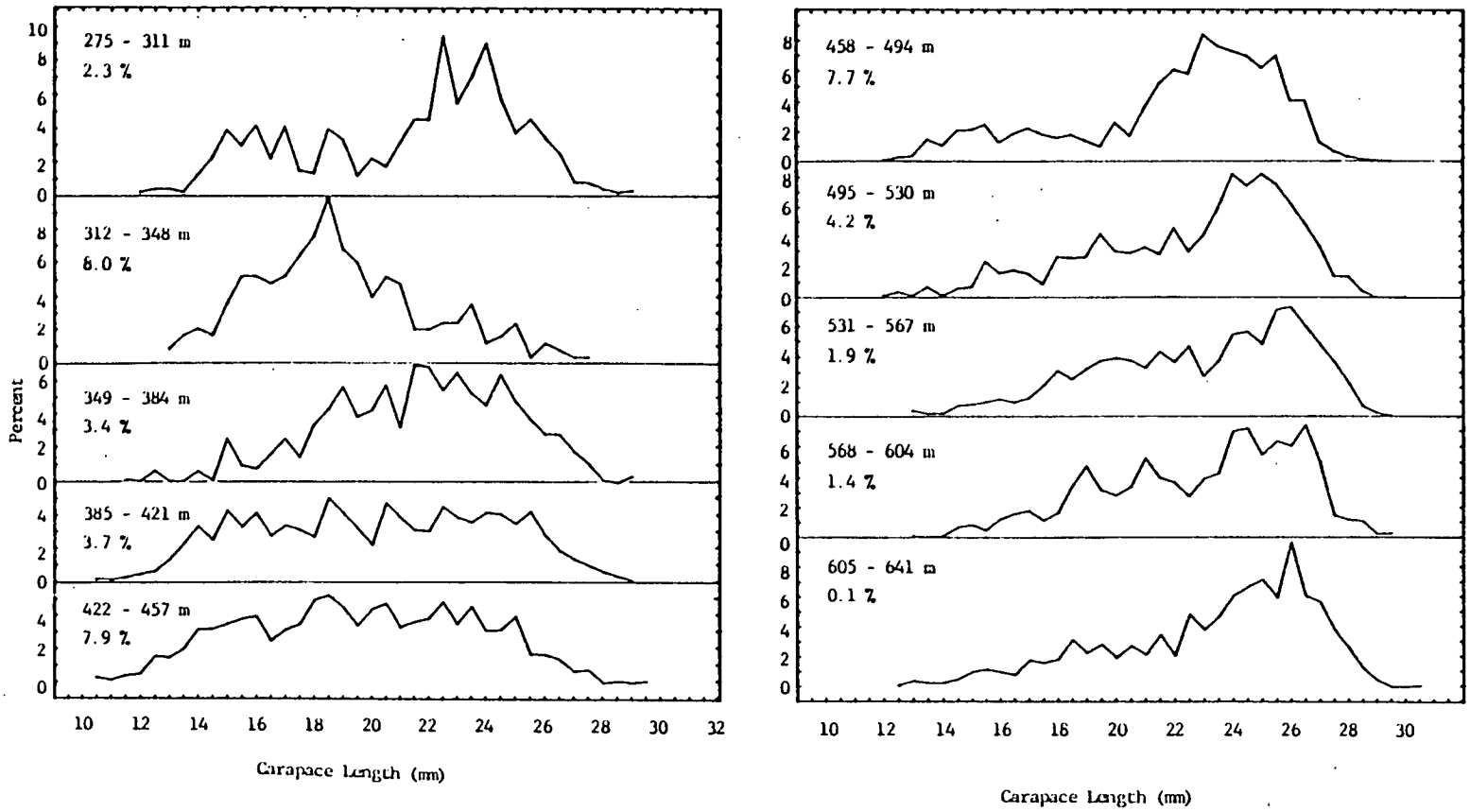

Fig. 5b. Research length frequencies, Hopedale Channel Zone 2 - 1983.
(% of biomass indicated).

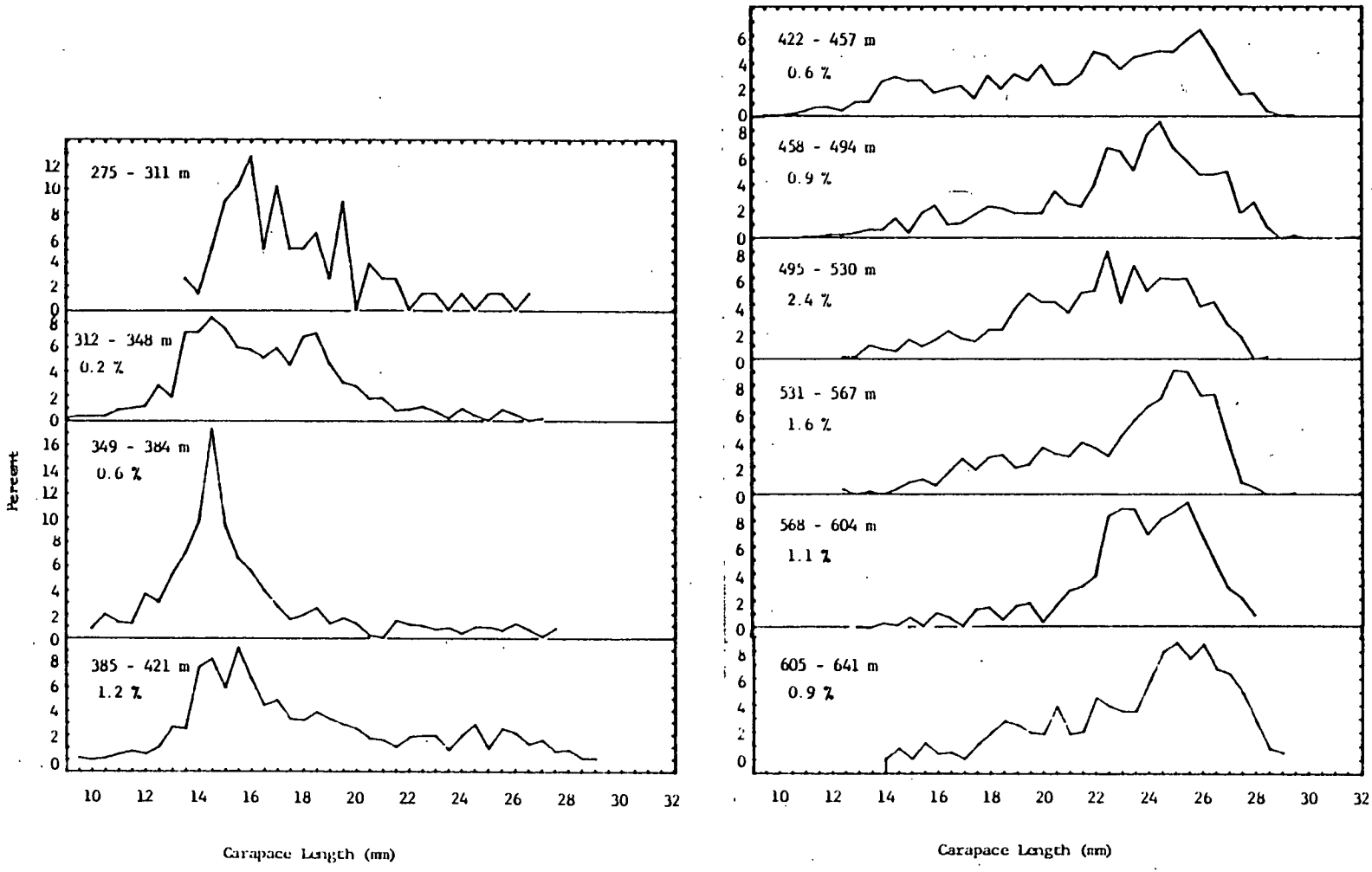

Fig. 5c. Research length frequencies, Hopedale Channel Zone 3 - 1983.
(% of biomass indicated).

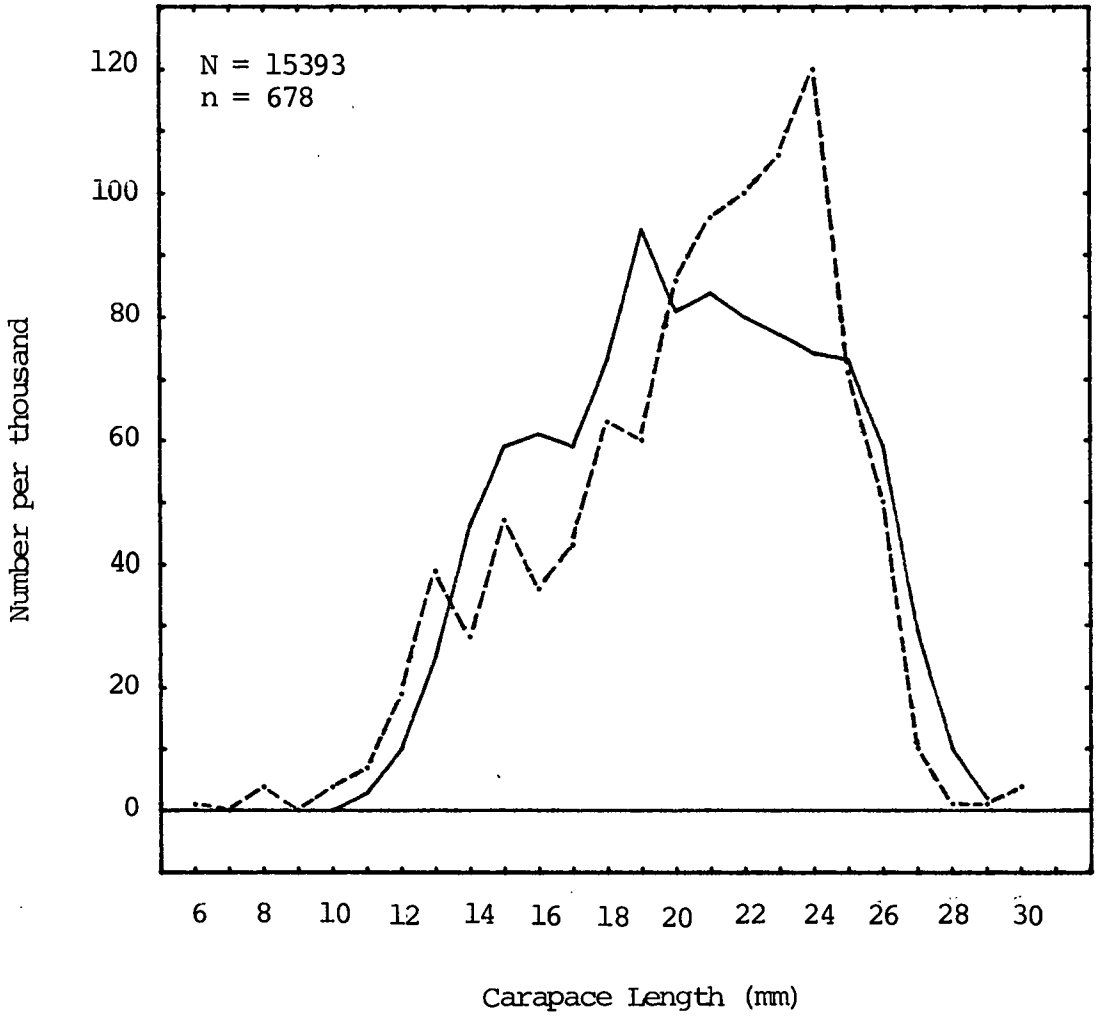

Fig. 6. Length distribution from Cod stomachs and trawl samples in the Hopedale Channel, 1983. N and n are the number of measured shrimp from the trawl and stomachs respectively, (broken line = cod stomach measurements).

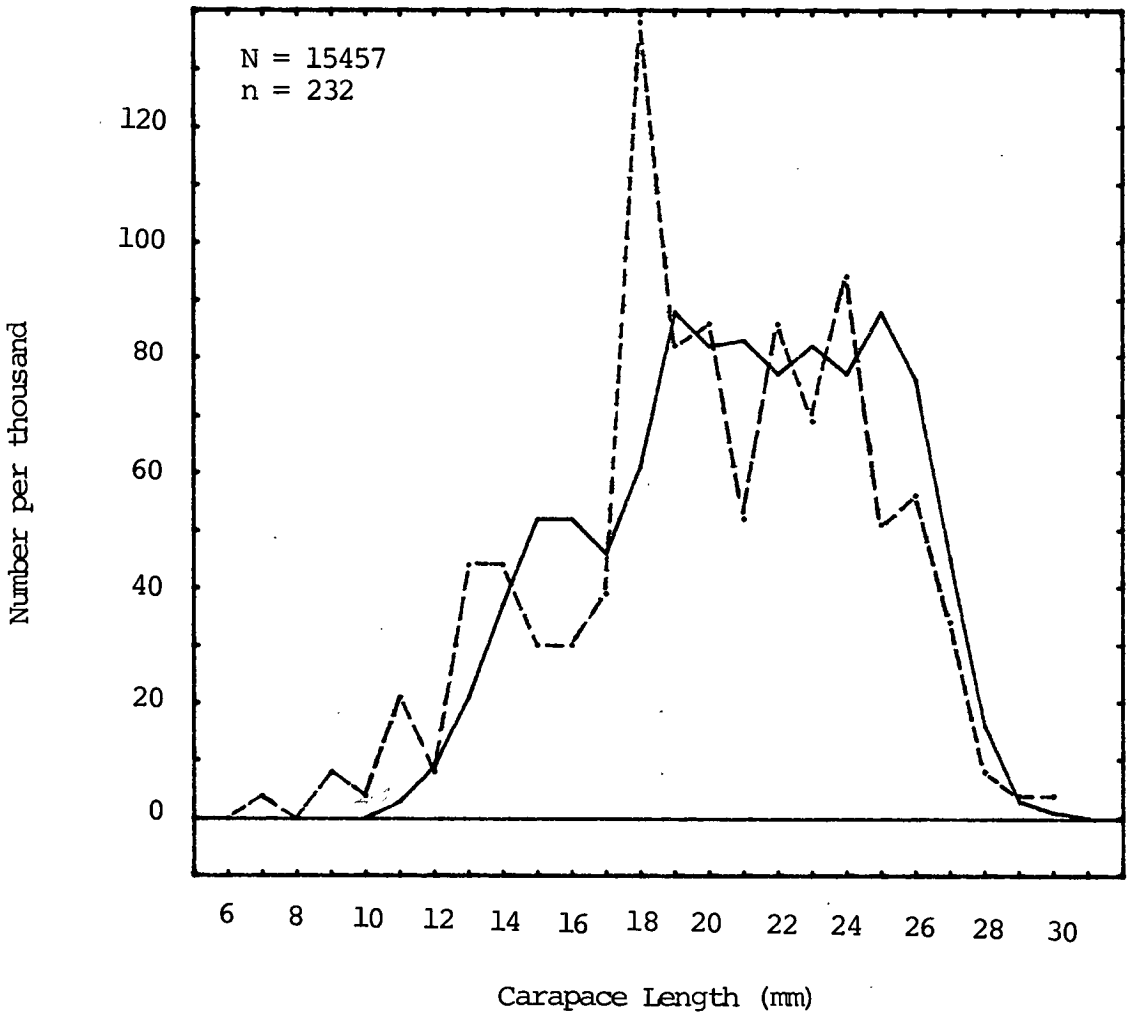

Fig. 7 Length distribution from Greenland halibut stomachs and trawl samples in the Hopedale Channel, 1983. N and n are the number of measured shrimp from the trawl and stomachs respectively, (broken line = Greenland halibut stomach measurement).

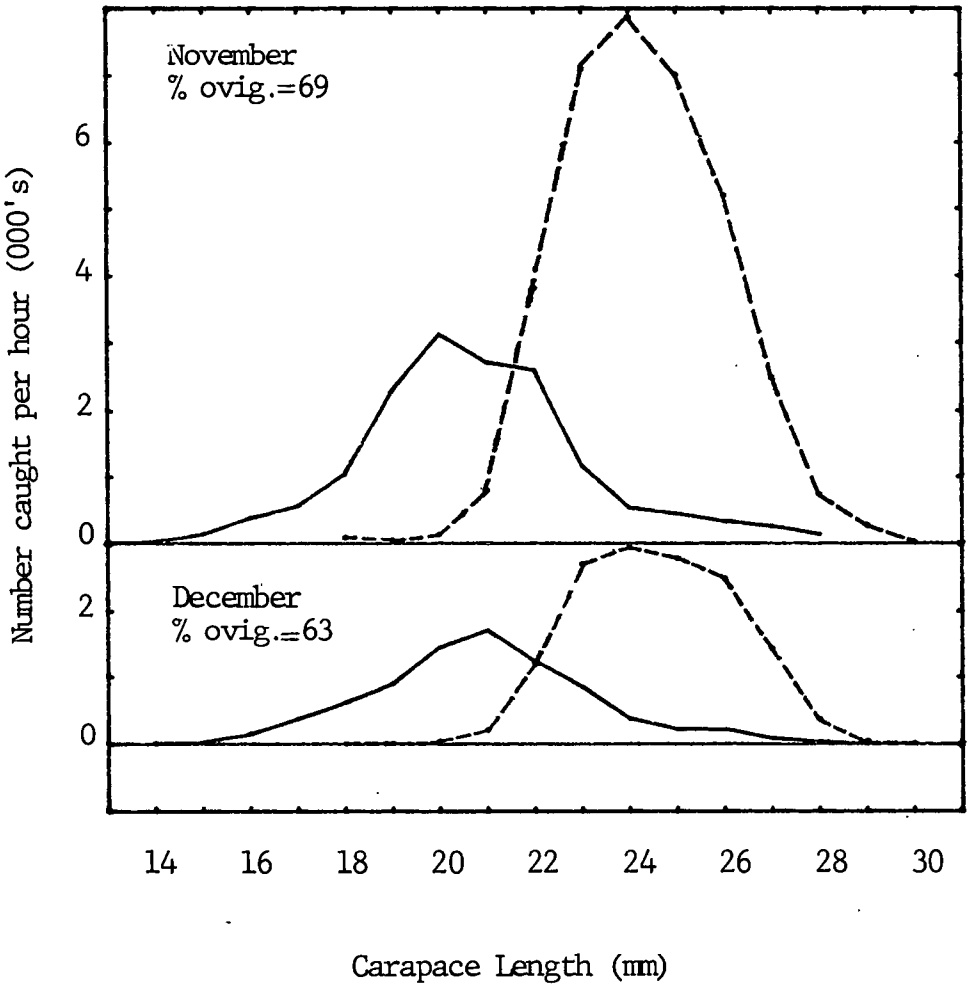

Fig. 8 Commercial length frequencies, Hopedale Channel, 1983.
(Broken line = ovigerous)

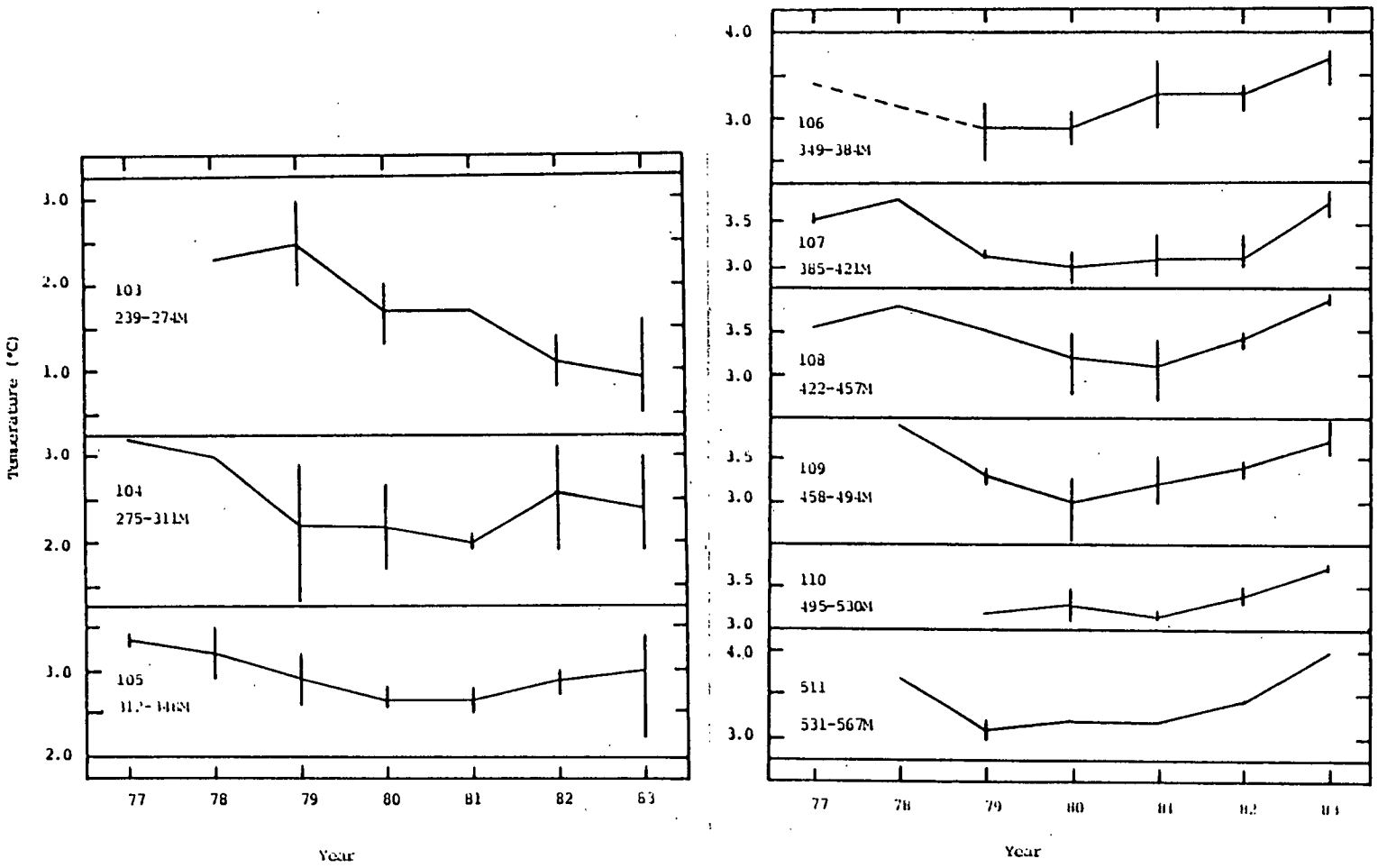

Fig. 9a. Temperature by depth stratum, 1977 - 1983, Hopedale Channel (Zone 1).

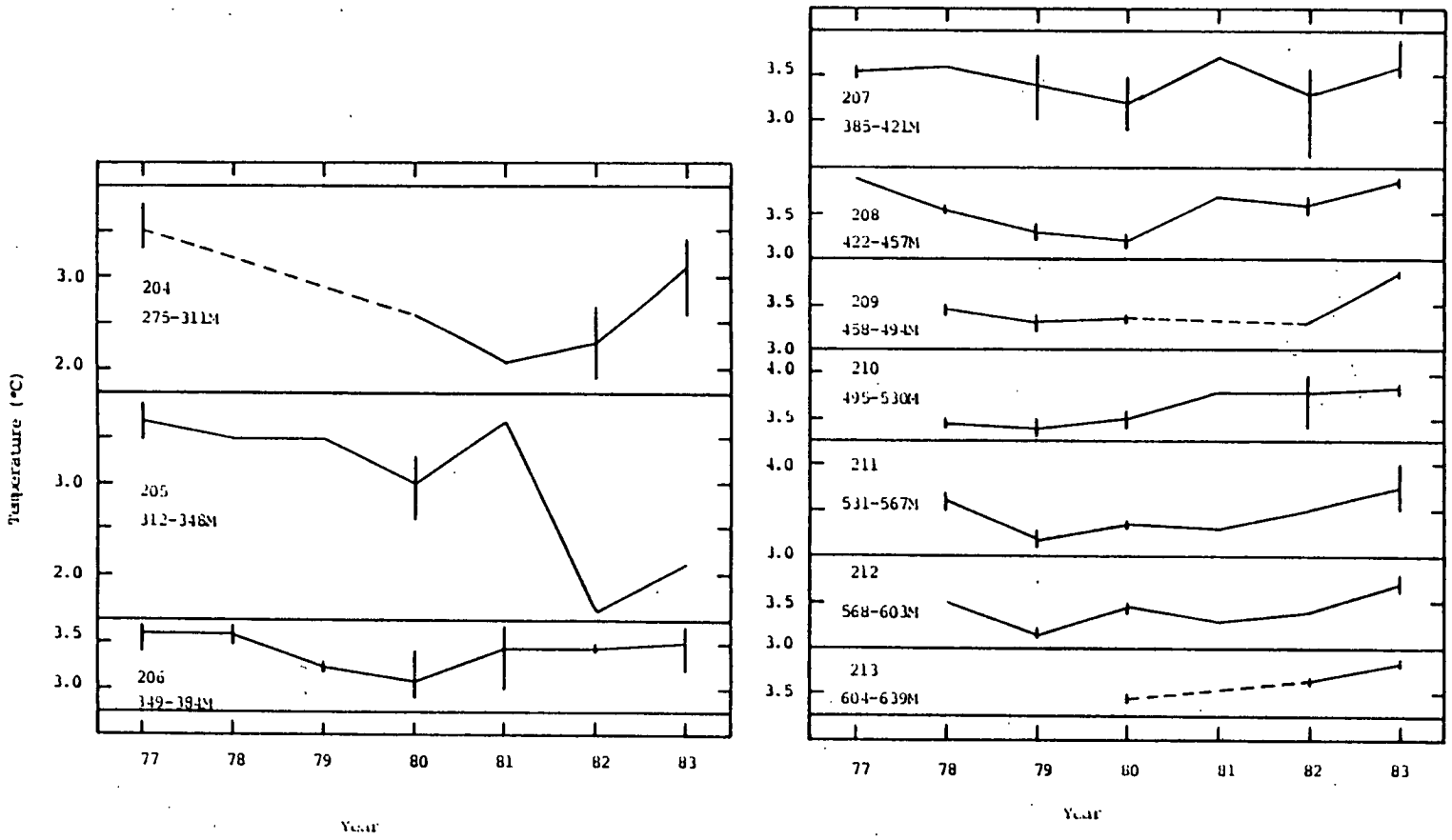

Fig. 9b. Temperature by depth stratum, 1977 - 1983, Hopedale Channel (Zone 2).

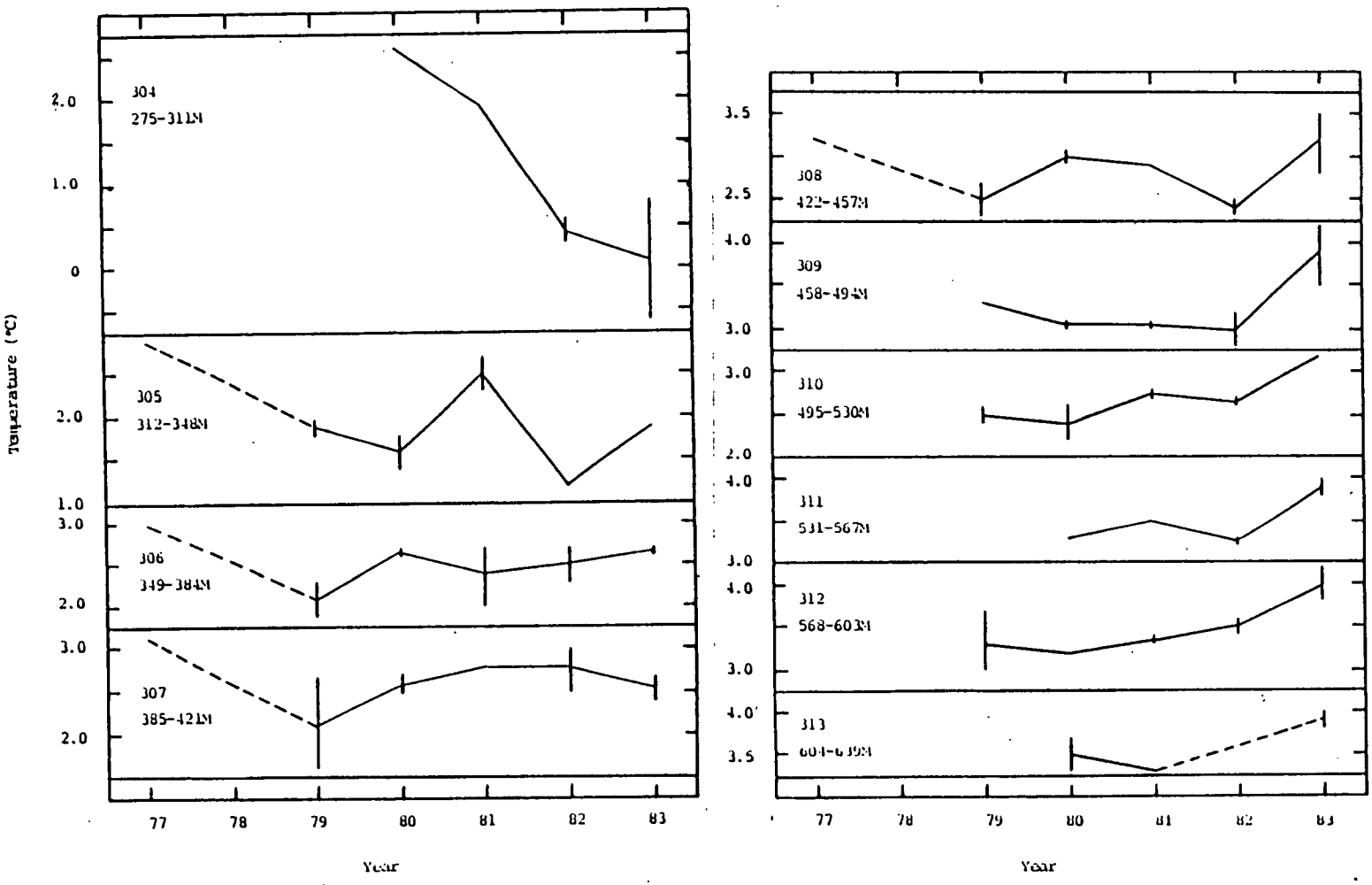

Fig. 9c. Temperature by depth stratum, 1977 - 1983, Hopedale Channel (Zone 3).

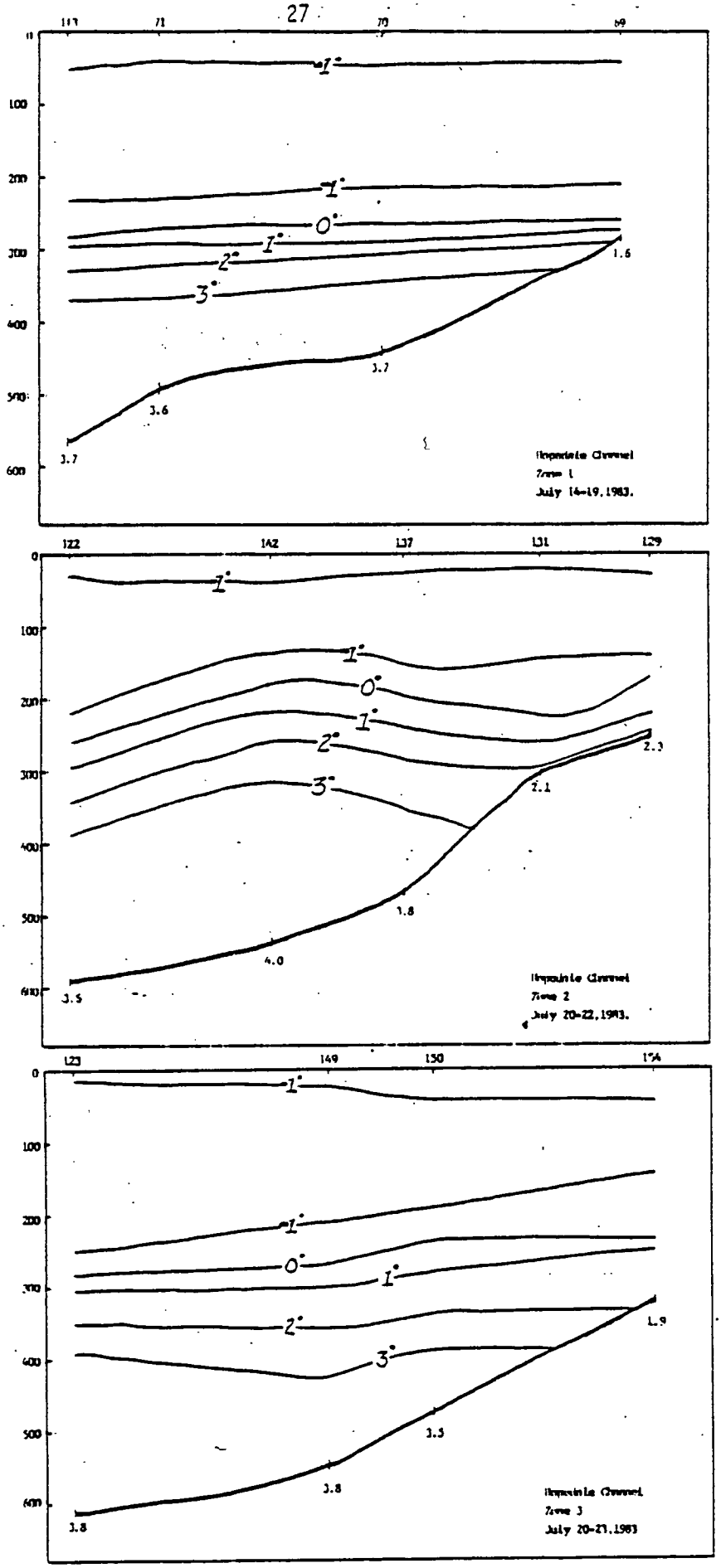

Fig. 10 Hydrographic sections, Hopedale Channel - 1983.

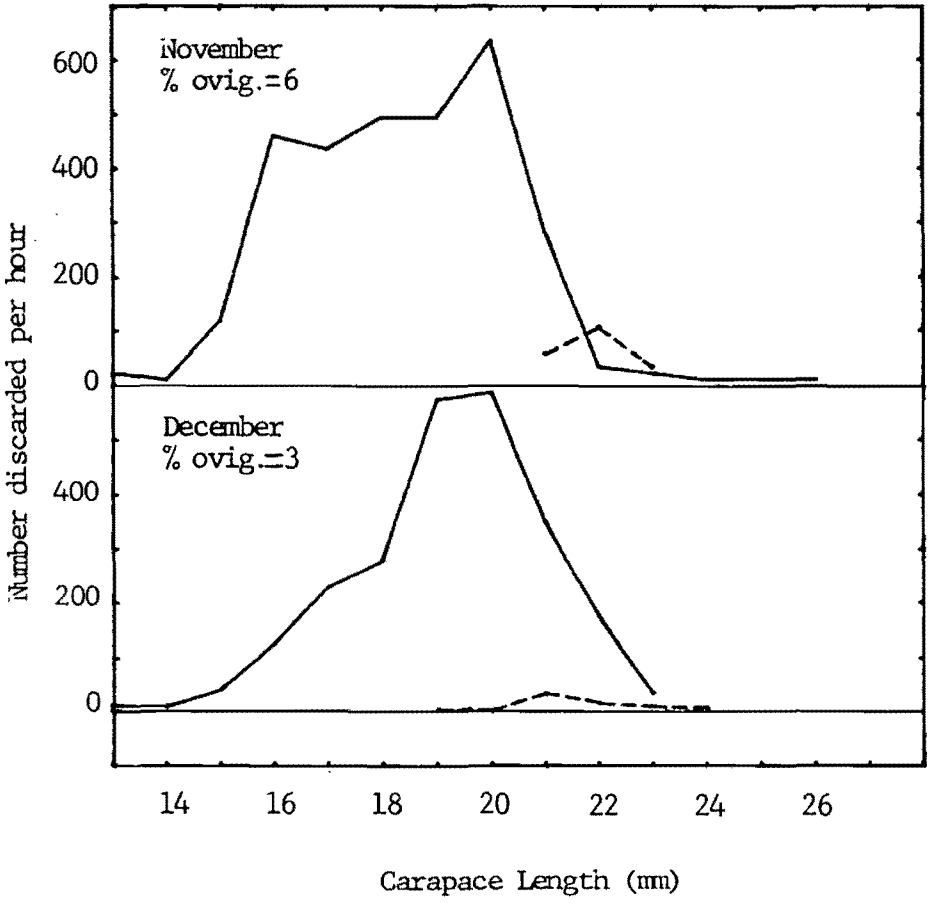

Fig.11 Discard length frequencies, Hopedale Channel. 1983.
(Broken line=ovigerous.)