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Review of abundance indices and stock assessment for shrimp (*Pandalus borealis*) in the Labrador Channels

by

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ABSTRACT

Shrimp biomass, distribution and stock composition from research and commercial data for 1980 were compared to previous years to determine the status of the resources. Relative biomass and catch per unit effort appeared stable between 1979 and 1980 for the Hopedale and Cartwright Channels and catch rate indices indicated possible declines in abundance to approximately 50% of the original level. Hawke Channel remained unexploited. Recruitment patterns were not clear but it was indicated that in the Hopedale Channel the relative strength of the oldest male group was somewhat less than the cohort of the previous year. Major by-catches continued to be Greenland halibut and cod but catch rates of the former were much higher than in the previous year. Shrimp discards were reduced to roughly one-half of the 1979 levels. The relative stability of the shrimp stocks in these areas implied that TAC's for 1981 could remain near the 1980 level (vis. 4000, 800 and 850 MT for Hopedale, Cartwright and Hawke Channels, respectively).

RESUME

A partir de données expérimentales et commerciales recueillies en 1980, nous avons comparé la biomasse, la distribution et la composition des stocks de crevettes avec celles des années antérieures afin d'évaluer l'état de la ressource. La biomasse et les prises par unité d'effort relatives semblent être demeurées stables entre 1979 et 1980 dans les chenaux Hopedale et Cartwright. Les indices de taux de capture indiquent une diminution possible d'abondance à environ 50% du niveau original. Le chenal Hawke continue d'être inexploité. Les caractéristiques du recrutement n'apparaissent pas clairement, mais les données indiquent que dans le chenal Hopedale l'importance relative du groupe de mâles le plus âgé est quelque peu inférieure à celle de la cohorte de l'année précédente. Le flétan du Groenland et la morue constituent toujours les principales prises fortuites, mais les taux de capture de la première espèce sont beaucoup plus élevés au'en 1979. Les quantités de crevettes rejetées à la mer diminuent de moitié environ par rapport à 1979. La stabilité relative des stocks de crevettes dans ces régions donne à penser que les TPA de 1981 pourraient demeurer à peu près au niveaux de 1980 (viz 4 000; 800; et 850 tm pour les chenaux Hopedale, Cartwright et Hawke respectivement).

INTRODUCTION

The shrimp fishery off Labrador continued for the fourth consecutive year in 1980, again regulated by total allowable catch. During the year data from the fishery were collected through extensive surveillance of the fleet through the observer programme. A research survey was conducted during July-August and provided information on abundance, distribution and relevant biological characteristics of shrimp in each stock area (Fig. 1).

The following presents the new information for 1980, makes comparison with other years and interprets the data to provide advice on catch levels in 1981.

FISHING PATTERN

The 1980 fishery was slow-starting with some boats not participating till relatively late in the season. The overall pattern was similar to that observed for the pervious year with most fishing occurring in the Hopedale Channel because of higher catch rates (Fig. 2 and 3). In addition, initial effort in the Cartwright Channel produced large by-catches of cod and Greenland halibut which, at times, outweighed the shrimp catch. For these reasons fishing extended over the whole season and total allowable catches (TAC's) were not exceeded in either areas. Effort in the Cartwright Channel, however, was extremely low compared to other years while effort in the Hawke Channel remained virtually non-existant.

Effort in the whole Labrador area was also reduced briefly in September and October when some vessels diverted effort to a limited shrimp (P. montagui) fishery west of Resolution Island (Parsons, et al. 1981).

CATCH AND CATCH PER UNIT EFFORT

Preliminary catch figures for 1980 show that the TAC of 4000 metric tons for Hopedale Channel was essentially consumed by the end of the year (Table 1). Because of the conditions of fishing in 1980 (see section above) only 145 of the total 800 MT were taken in Cartwright Channel. Two metric tons were reported for Hawke Channel.

Patterns of daily catch per unit effort for the Hopedale Channel (Fig. 2) continue to support observations made in previous years (Parsons et al., 1979, 1980) that 1) catch rates are extremely variable on a day-to-day basis and 2) shrimp availability declines during the fishing season and increases later in the year. The 1980 catch rates show a decline from around 800 kg per hour in late June to less than 300 kg during September, then increasing in October and November to levels experienced earlier in the season. Catch rates by month for 1977 to 1980 are presented in Table 1. The months of August and September have been fished in all years and the catch rates for these months are used in the following table to reflect changes in stock abundance since 1977 (virgin level).

Catch per hour (kg.) Aug-September Hopedale Channel

	1977	1978	1979	1980
Unweighted	597	436	298	334
Weighted	591	423	320	324

Both weighted and unweighted averages for these months indicate an initial decline from the 1977 value and a levelling off in 1980. This pattern would be expected in a new fishery but it has been previously pointed out (Parsons,

et al. 1980) that such observations do not take into account the possibility of variations in patterns of abundance between years, i.e. seasons of high and low densities are not entirely coincidental.

The lack of effort in the Cartwright Channel during 1980 makes interpretation of the data difficult (Fig. 3, Table 1). No patterns can be interpreted from the daily catch rates and monthly summaries are based on very limited effort data. The latter do, however, show a trend for July to September since 1977 which is similar to that evident in the more northerly area.

Catch per hour (kg.) July-September Cartwright Channel

	1977	1978	1979	1980
Unweighted	571	505	380	336
Weighted	558	463	261	286

Declines observed between 1977 and 1979 appear to have slowed down in 1980 and weighted catch rates actually show some recovery from the 1979 level.

Observer coverage during 1980 was extensive and sufficient data have been collected to make comparisons between vessel logs and observer reports. The added information also permits some improvement to the data base for both channels. Table 2 compares monthly catch rates from observer data and vessel logs and shows that rates are generally higher from observer data. Although discarding of shrimp is discouraged in this fishery it is done quite often but seldom reported in vessel logs. Observer data, on the other hand, include discards which probably account for most of the discrepancy. Trends, however, are quite similar and either source can serve as a relative abundance index. In this respect it is interesting to note that the catch rate for December in the Hopedale Channel was the highest recorded for the whole season and that

catch rates from limited effort in the Cartwright Channel did not recover in late season as expected. The actual values of the October and November entries are questionable but their relatively low level is obvious. Obvious also is the fact that all vessel logs are not available by February.

BIOMASS

Methods of estimating biomass are the same as those described by Parsons, et al. (1980). Results for all three Channels show a remarkable similarity with those obtained in 1979 (Tables 3, 4 and 5). The 11,839 MT for 1980 in Hopedale Channel compares with 11,520 in 1979 for a similar survey area (Fig. 4). The survey area in Cartwright Channel (Fig. 5) was slightly larger than in 1979 but biomass is essentially the same. The density per square nautical mile in 1980 is a little less than the 1979 level and this can be compared to the slight decrease in CPUE between the two years observed from the unweighted rates from July to September.

Biomass also appears similar for the Hawke Channel between 1979 and 1980 but the latter estimate of 2519 MT has been calculated over an area (Fig. 6) 900 square natical miles larger then that in 1979. This implies 1) that the survey area in 1979 did not cover the entire distribution range and the result may be underestimated or 2) that biomass has not changed significantly but densities are lower. Priorities of the research cruises and relatively low sample size could be supportive of the first implication but, generally speaking, in similar areas in 1980 shrimp density was lower than experienced previously. The obvious conclusion now is that densities are not commercially viable for the existing fleet.

As in previous assessments diel variability has not been accounted for in these estimates. Catch rates in a limited area were again monitored for diel variability in the 1980 survey. These results are summarized by Parsons and Sandeman (1980). The peak catch period occurred around 1600 hours (NST) compared to 1200-1400 hours one year earlier. An interpretation of the 1980 data is being attempted through the application of a tidal model (Sandeman, pers. comm.) but results are not available at this time. Interpretation of other related cyclic data is also being considered (Misra, pers. comm.).

SIZE DISTRIBUTION

1. Research

Carapace length measurements (0.5 mm) of shrimp taken during the 1980 survey are presented in Fig. 7-9. A number of size groups was evident in Zone 1 of the Hopedale Channel (Fig. 7) with modes occurring at 8, 14-16, 18-20, 24 and 28 mm. The extremes of this range were represented by relatively few individuals. Depth distribution shows mostly small shrimp in shallower waters and the larger animals increasing in proportion with increasing depth. This zone accounts for the greatest proportion of total biomass in the channel. In Zone 2 the 18-20 mm mode was prominent in the shallower strata giving way to a strong 24-25 mm group at greater depths. The 16 mm group was not strongly represented at any depth. Zone 3 accounts for very little biomass and lacks detail in modal structure except for the 24 mm group. Clear modes at 15 and 20 mm are evident from two strata only. Deeper strata representing considerable biomass in 1979 (Parsons et al. 1980) showed a wide range of sizes representing a number of year-classes between 16 and 26 mm. In 1980 however only the female group (around 24 mm) is prominent in strata where biomass is high.

Thus, from the 1980 data, it appears that the relative strength of the year-class of males around 18-21 mm is somewhat less than the cohort of the previous year.

The Cartwright Channel shows modes similar to those in the more northerly area (Fig. 8) except that the smallest size group occurs at 11 mm. Numbers at this length are, however, extremely low. The 15-16 mm mode is prominent in shallower strata where biomass is relatively low while modes around 20 and 24 mm become more pronounced at intermediate depths where significant percentages of biomass occur. In the deepest zone the 24 mm mode is most outstanding. No trends in relative year-class strength are immediately obvious.

At least three size groups are evident from samples taken in the Hawke Channel (Fig. 9). These occur around 15-16, 18-21 and 23-25 mm and the modes compare with those observed in the other areas. The largest group is generally prominent where biomass is highest. As noted in previous years the survival of animals beyond the 23-25 mm mode appears to be very low. The distribution of size groups in 1980 appears 'normal' compared to 1979 when a size group present in the northern areas did not occur in the Hawke Channel.

Samples taken from the two commercially fished channels in 1980 were examined for sex and maturity. The data showed that the animals greater than 21.5 mm in carapace length fell into three categories: transitionals which would spawn in 1980, females which had not spawned previously and females which had spawned in the previous year. The latter two were separated on the basis of sternal spines (McCrary 1971) and the former two were considered a single year-class on the basis of similarity in length distribution and because of the relatively low numbers in the group of females with sternal spines. The older age group(s) without sternal spines comprised 54% of all transitionals

with head roe and females in the Hopedale Channel and 60% in the Cartwright. Although relatively few females were ovigerous it is possible that these proportions may be slightly overestimated if, for example, some females spawning for the first time were already in 'breeding dress'. Therefore the single mode at 24-25 mm can be broken down into two age groups if McCrary's theory is correct. Considering average length, annual growth increment between the two groups is about 1.14 mm for the Hopedale Channel and 1.66 mm for the Cartwright Channel.

2. Commercial

Length distributions of shrimp taken in each month by the commercial fleet are given in Fig. 10 and 11. Mostly large shrimp, 24-26 mm, were taken in the Hopedale Channel in June, August and September (Fig. 10). Catches in July were dominated by a mode between 20 and 24 mm which does not correspond to size groups readily identifiable in other commercial and research data and probably represents either two overlapping groups or deep water samples of the 20-22 mm group evident in other months or both. Such lack of detail was also evident in the 1979 data. Two modal groups (20-22 mm and 24-25 mm) were more or less, equally represented in catches in October and November. The increase in catch rates in these months over the September low is apparently due to increase in abundance of the smaller group, possibly at shallower depths. The fishery in this area in 1980 for the first four months appears to have been more dependent on larger animals than for the same months in 1979. This observation is supported by the July survey, as well.

The fishery in the Cartwright Channel followed a similar pattern as described above (Fig. 11). Although the smaller size group gained relative

strength in the latter months, the overall abundance was extremely low. Data from both channels in previous years and from the Hopedale Channel in 1980 have shown increase in abundance and improvement of catch rates in the late season. Catch rates in October and November, 1980 in the Cartwright Channel are the lowest ever reported for that fishery.

BY-CATCH AND DISCARDS

The major by-catch species continue to be Greenland halibut and cod. The amounts of the former caught in the 1980 shrimp fishery, as reported by observers were high in the early months of the season when catch rates of shrimp were also high. In the Hopedale Channel an estimated 20% of the observed catch in August was Greenland halibut. In following months the percentage appears to have decreased.

Limited fishing in the Cartwright Channel in June produced very large catches of cod which amounted to almost 45% of the observed catch. In all other months except November, Greenland halibut was the major by-catch and was reported as high as 15% of the observed catch in August. Cod remained relatively high on the by-catch list comprising over 10% of the observed catch in November. Vessel logs show similar patterns of by-catch but the percentages are invariably lower.

The ability of observers to estimate by-catch varies with vessel and even under relatively ideal conditions only rough estimates can be obtained. Table 6 compares by-catch rates of Greenland halibut by month between 1979 and 1980 and demonstrates an increase in abundance between the two years. It is important to note that although catch rates of shrimp improved from October to December in the Hopedale Channel abundance of Greenland halibut appears to

have continued its decline indicating some seasonality in occurrence in these areas. Conversations with fishing captains also indicate recent increases in the abundance of Greenland halibut, especially the larger animals. These observations corroborate the results of the 1979 and 1980 research surveys which show a significant increase in Greenland halibut biomass between the two years (Bowering and Parsons 1981).

The fate of the by-catch is variable and depends on vessel, shrimp catches at the time and species of by-catch. As a general rule, most are discarded.

Discarding of shrimp continued in 1980 but reliable data from vessel logs are not available. Observer reports indicate that the pattern is variable over a wide range. Shrimp discards amounted to 7% of the total shrimp catch in some months in the Hopedale Channel and up to 12.5% in the Cartwright Channel (Table 7). Examination of the individual sets shows that discards can be extremely high. For example, an entry for July in Hopedale Channel shows that approximately 10,000 kg of shrimp were caught in a single set. Fifty per cent or 5000 kg was discarded! During 1980 in the same area observers reported 140 MT of discarded shrimp (valued in 1980 around $340,000). There was however, a general improvement over 1979 with total discard rates being reduced from 9% and 4% to 5% and 2% for Hopedale and Cartwright respectively.

Discarding is usually associated with small, broken and/or soft-shelled animals - conditions which are unavoidable in a commercial fishery. One observer in 1980 demonstrated that the animals being discarded (i.e. passed through the sorters) on his trip were approximately the same size as those being kept which eventually prompted adjustment of the tines. Another reported the discarding of all shrimp except the largest size category. Apparently catch

rates were good and the vessel could not process all the catch. Instead of cutting back on fishing effort, discarding was increased.

UNFISHABLE GROUNDS

Research surveys in the Labrador shrimp channels have been restricted to the seaward (eastern) sides of the depressions in the shelf, the western slopes being unfishable because of very rough bottom. Reports that commercial vessels had succeeded in making successful tows on the western side of the northern part (Zone 1) of Hopedale Channel in 1979 prompted consideration of this area for the 1980 survey. A two-day period was allotted to investigate shrimp distribution in this area. Fleets of four shrimp pots baited with herring were set at comparable depths on the east and west sides of the channel and left in position overnight. In the intervening time the vessel steamed over the western slope searching for suitable bottom to set the Sputnik 1600 trawl and taking comparative bottom samples with a Shipek sampler. Success with the shrimp pots was marginal since only 52 animals were taken in total. However, it should be noted that 45 of these were in the 'unfishable' zone. If this sampling technique is equally 'inefficient' in both areas then with considerable effort it could be used to estimate relative abundance and extrapolate survey data over a larger area.

The search for trawlable bottom was unsuccessful but a total of fourteen substrate samples was collected, seven from each side. Analyses of particle size and organic content have not yet been carried out but visual inspection indicates that mud is present over the whole area.

Limited effort and good catch rates by commercial vessels on the western slope of northern Hopedale Channel have again been reported in 1980 but apparently considerable risk is involved and not all vessels participate.

HYDROGRAPHY

Since it is generally accepted that shrimp are sensitive to changes in environmental parameters, water temperature has been closely monitored over the past four years. No obvious trends in temperatures have been detected to suggest either warming or cooling of bottom water within the channels. Bottom temperatures in areas of shrimp abundance during the 1980 cruise (Fig. 12-14) were comparable with those taken in 1979 (2-3.5°C) and compared with results from surveys in other areas do not fluctuate widely on a seasonal basis either.

DISCUSSION

Catch rate and biomass indices for 1979 and 1980 show some stability in relative abundance between the two years. Recruitment patterns remain unclear from length frequency data but there is indication that in the Hopedale Channel the male group between 18 and 21 mm is not as strong as the corresponding group in 1979. If catch rate data from 1977 to 1980 (see previous section) actually simulate trend in abundance and if the 1979 and 1980 research surveys are also good relative indices then some back-calculation can be made to revise estimates of virgin biomass. By indexing the catch rates from 1.00 in 1977 (virgin condition) and using the most recent biomass estimates, expected biomass can be calculated for other years.

	Hopedale Channel (August-September)			
	1977	1978	1979	1980
Unweighted CPUE index	1.00	0.73	0.50	0.56
Biomass (MT)	21,141	15,433	10,571	11,839
Weighted CPUE index	1.00	0.72	0.54	0.55
Biomass (MT)	21,525	15,498	11,624	11,839

	Cartwright Channel (July-September)			
	1977	1978	1979	1980
Unweighted CPUE index	1.00	0.88	0.67	0.59
Biomass (MT)	3947	3474	2644	2329
Weighted CPUE index	1.00	0.83	0.47	0.51
Biomass (MT)	4567	3790	2146	2329

Since research surveys are only comparable by season and gear for 1979 and 1980, comparison of the observed and expected biomass can only be made for the former year. In both cases the weighted CPUE index gives values very close to those obtained from the survey i.e. 11,624 compared to 11,520 and 2146 compared to 2106. Accepting these results as more than coincidental, virgin biomass (July 1977) is calculated at 21,525 MT for Hopedale and 4,567 for Cartwright. The latter is reasonably close to the 4,000 MT used in previous assessments (Parsons et al. 1979) but the former is much greater than any biomass figures used before, virgin or otherwise.

With these new calculations of virgin and exploited biomass we can return to the problem of estimating potential yield. The Gulland (1974) equation $Y = 0.5$ MBo requires an estimate of natural mortality which for fully recruited portions of shrimp stocks has been considered high. Fréchette (pers. comm.) provides a relationship of Y = 40% B (exploited) from a fishery off Sept-Iles which has exhibited sustainability. This 40% of an exploited biomass has been interpreted as 25% of a virgin biomass (Labonté, 1980). If the first relationship has truth in theory and the second truth in practice, then M is better approximated at 0.5 since 0.5 X 0.5 X Bo is effectively the same as 25% Bo. This value is lower than the 0.7 considered for the Labrador area in past assessments and much lower than that used for female age groups in the Davis Strait. The possibility of lower estimates of M has been considered previously by CAFSAC

especially for the Gulf of Maine and Iceland shrimp stocks. Some recent calculations for mortality of shrimp off Labrador (Parsons, unpubl.) and in the Anticosti Channel (Fréchette and Parsons, unpubl.) also point in this direction.

Assuming the Sept-Iles situation will also apply in Labrador, 40% of the exploited biomass in the Hopedale Channel at the beginning of the 1980 season implies a yield of 4736 MT or 22% of the virgin biomass. To obtain the same yield under the Gulland formula using the new estimate of virgin biomass, M would have to be interpreted as 0.44. The same rationale in Cartwright Channel produces an estimated yield of 932 MT, corresponding to 20% of the virgin biomass ($M \simeq 0.41$).

In 1980 the Scientific Council of NAFO examined indices of catch rate for the Davis Strait and interpreted these to represent patterns in spawning stock biomass (NAFO Scientific Council Report, 1979-80). It was estimated that a fishing mortality of 0.4 would reduce the virgin spawning stock biomass by 50% over several years provided the level of fishing remained stable (Ulltang 1978). The index in this case demonstrated the reduction predicted by the model assuming recruitment had remained relatively constant.

Although the Ulltang model has not been applied using input from the Labrador stocks, the catch rate indices can be interpreted in the same way. If we consider the weighted CPUE indices to be reasonably representative it appears that for both channels the reduction is sufficiently close to 50%. Catches in the Cartwright Channel in all years except 1980 have been over 1000 MT (despite TAC's of 800 MT since 1978) and it appears yields at 932 MT could be continued. In the Hopedale Channel, however, catches close to the TAC were only taken in 1979 and 1980. Less than 2000 MT were taken in 1977

and 1978, considerably less than the 4736 MT yield suggested above. Despite the seemingly low levels of fishing in the area, the reduction is still in the order of 55% for 1979 and 1980.

The following points are stressed in considering 1981 catch levels using 1980 biomass estimates.

1. It must first be assumed that the same level of biomass will be available in 1981. Biomass estimated at the beginning of the season should be used for catch levels during the same season. If the 1979-1980 trend continues this should not be a major problem.

2. The possibility of a significant underestimation of biomass cannot be ignored. Firstly, the research trawl is not totally efficient for catching shrimp (this may be a relatively minor problem). Secondly, diel variability in abundance has not been accounted for and thirdly, areas to the west of the traditionally fished grounds do harbour shrimp but their contribution has not been estimated.

3. The observed increase in Greenland halibut stocks between 1979 and 1980 must also be considered because of the predator-prey relationships.

CONCLUSIONS

The relative stability of shrimp stocks for all three channels as reflected by abundance indices would suggest a maintenance of TAC at the 1980 level. Since no fishing occurs in the Hawke Channel a revised TAC would appear unnecessary and the 1980 level could remain in 1981. Conclusions on the two other areas are not so easily reached. Yields around 932 MT for the Cartwright Channel appear reasonable considering relative stability in the last two years and the reduction (of spawning stock) to 50% of the virgin level under similar exploitation.

Yields around 4736 MT for Hopedale are questionable for two main reasons. Data from length frequencies indicate the possibility of a decrease in recruitment in 1981 and average catches of around 2600 MT per year from 1977 to 1980 may have already reduced the spawning stock to nearly 50% of the virgin level.

With the possibility of being overly conservative some consideration should be given to the evidence which would suggest higher catch levels. Biomass is undoubtedly underestimated for reasons described previously. This may have been partially compensated in the past by overestimation of mortality. Finally, the potential effects of a dramatically increased Greenland halibut stock should not go unnoticed and may be implicated with the apparent failure in 1980 for catch rates in the Cartwright Channel to improve later in the season. The actual effects of this relationship will not be evident until the 1981 research survey.

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Table 1. Catch per hour fished 1977-1980.

Values for each month determined from vessel logs.

MONTH	1977 CATCH (kgs)	1977 CPUE (kgs)	1978 CATCH (kgs)	1978 CPUE (kgs)	1979 CATCH (kgs)	1979 CPUE (kgs)	1980 CATCH (kgs)	1980 CPUE (kgs)
				HOPEDALE CHANNEL				
JUNE	-	-	-	-	426,390	947	40,615	790
JULY	-	-	138,322	773	906,784	628	741,505	596
AUG.	109,502	611	92,097	547	836,384	329	593,369	396
SEPT.	254,408	582	69,605	325	111,813	266	565,048	272
OCT.	480,613	339	731,697	499	-	-	447,890	359
NOV.	657,580	707	853,954	520	-	-	149,113	474
DEC.	-	-	339,327	846	-	-	-	-
TOTAL[1]	1,502,102	507	2,225,002	546	2,281,371	470	2,537,540	397
TOTAL[2]	1,550,000	523	1,847,000	454	2,991,100	-	3,988,000[3]	-
				CARTWRIGHT CHANNEL				
JUNE	-	-	-	-	5,150	219	43,879	178
JULY	287,640	708	155,811	479	147,442	658	11,771	453
AUG.	536,346	572	401,228	636	153,104	274	22,465	292
SEPT.	257,302	434	714,616	400	374,846	207	55,919	264
OCT.	14,377	181	98,072	244	-	-	-	-
NOV.	73,946	700	-	-	-	-	-	-
DEC.	9,650	449	-	-	-	-	-	-
TOTAL[1]	1,179,261	550	1,369,727	435	680,542	260	134,034	239
TOTAL[2]	1,068,000	498	1,413,000	449	1,105,300	-	145,000[3]	-

[1]Based on catches from vessel logs.
[2]Based on statistics from landings.
[3]Based on quota reports.

Table 2. Comparison of catch (kg) per hour data from vessel logs and observer reports - 1980.

	Hopedale Channel		Cartwright Channel	
	Vessel logs	Observer data	Vessel logs	Observer data
JUNE	790	684	178	206
JULY	596	676	453	468
AUG.	396	451	292	231
SEPT.	272	328	264	388
OCT.	359	400		68
NOV.	474	512		53
DEC.		995		
AVERAGE	481	578	297	236
Average (June-Nov.)	481	508	297[1]	323

[1]June-September

Table 3. Minimum trawlable biomass - 1980 Research.

STRATUM	Depth (m)	HOPEDALE CHANNEL Area (sq. n. mi.)	No. Sets	Biomass (mt)
103	239-274	44.4	2	14
104	275-311	38.8	3	24
105	312-348	38.8	4	148
106	349-384	40.7	4	88
107	385-421	37.9	4	143
108	422-457	39.3	4	454
109	458-494	41.6	4	838
110	495-530	109.9	3	3798
111-113	>530	51.5	4	1848
204	275-311	290.1	3	150
205	312-348	174.0	2	142
206	349-384	134.7	3	230
207	385-421	95.0	4	269
208	422-457	147.8	3	2160
209	458-494	161.9	3	259
210	495-530	168.0	3	104
211	531-567	168.4	3	39
212	568-603	163.3	2	127
213+214	>603	63.6	3	39
304	275-311	47.3	2	18
305	312-348	30.4	2	48
306	349-384	23.4	2	97
307	385-421	18.7	2	128
308	422-457	18.3	2	130
309	458-494	18.7	2	82
310	495-530	24.3	2	71
311	531-567	30.9	2	120
312	568-603	37.9	2	67
313+314	>603	236.3	4	204
TOTAL		2495.9	83	11839

Table 4. Minimum trawlable biomass - 1980 Research.

STRATUM	Depth (m)	CARTWRIGHT CHANNEL Area (sq. n. mi.)	No. Sets	Biomass (mt)
4	275-311	54.1	2	1
5	312-348	83.7	4	82
6	349-384	31.0	5	57
7	385-421	34.2	4	184
8	422-457	36.5	4	391
9	458-494	59.7	5	435
10	495-530	88.8	6	788
11+12	>530	25.0	9	391
TOTAL		413.0	39	2329

Table 5. Minimum trawlable biomass - 1980 Research.

STRATUM	Depth (m)	HAWKE Channel Area (sq. n. mi.)	No. Sets	Biomass (mt)
203+204	261-340	94.3	3	63
105+205+305	341-380	292.5	3	377
505+506+605+606	341-420	302.0	2	95
106+206+306	381-420	307.6	4	476
207+307+507+607	421-460	507.6	5	760
208+308+508+608	461-500	375.5	5	508
209+509	501-540	354.7	5	195
10	>540	203.8	2	45
TOTAL		2438.0	29	2519

Table 6. Catch per hour (kgs), Greenland halibut.

	Observer's Reports			
	Hopedale		Cartwright	
	1979	1980	1979	1980
JUNE	18	7	4	24
JULY	26	97	-	49
AUG.	36	119	17	50
SEPT.	19	38	31	31
OCT.	-	15	-	4
NOV.	-	11	-	3
DEC.	-	5	-	-

Table 7. Shrimp Discards (kg) 1980 - Observer reports.

Month	HOPEDALE Observed catch	HOPEDALE Amt. Discarded	HOPEDALE % Discarded	CARTWRIGHT Observed catch	CARTWRIGHT Amt. discarded	CARTWRIGHT % discarded
JUNE	23410	0	0	28515	0	0
JULY	764007	52719	6.9	12950	0	0
AUG.	589843	28364	4.8	5011	626	12.5
SEPT.	446030	20860	4.7	1260	280	22.2[1]
OCT.	448122	14538	3.2	447	15	3.4
NOV.	603713	18435	3.1	2195	25	1.1
DEC.	62595	4360	7.0	-	-	-
TOTAL	2937720	139276	4.7	50378	946	1.9

[1]Based on 1 set only.

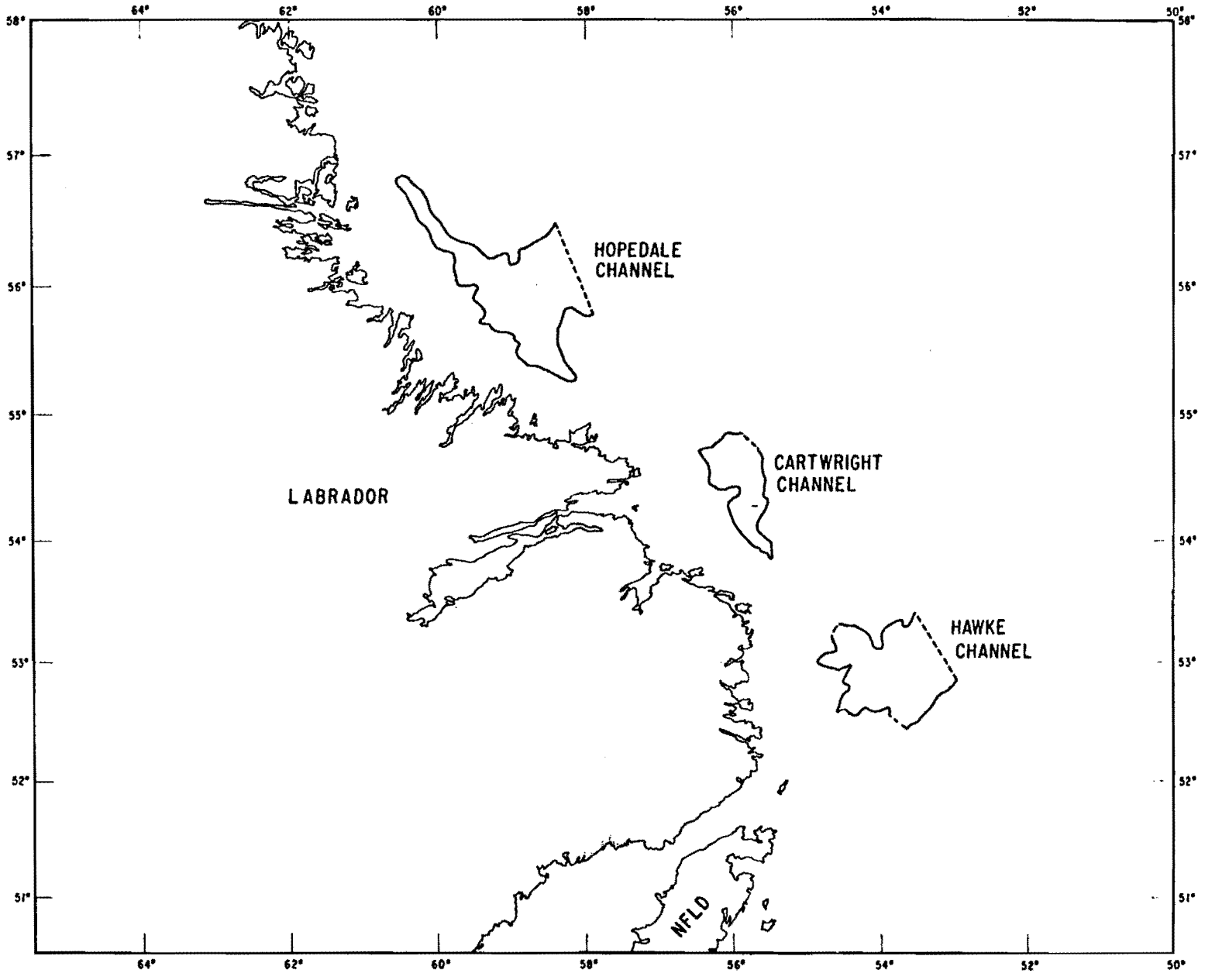


Fig. 1. Shrimp fishing areas in Div. 2H and 2J.

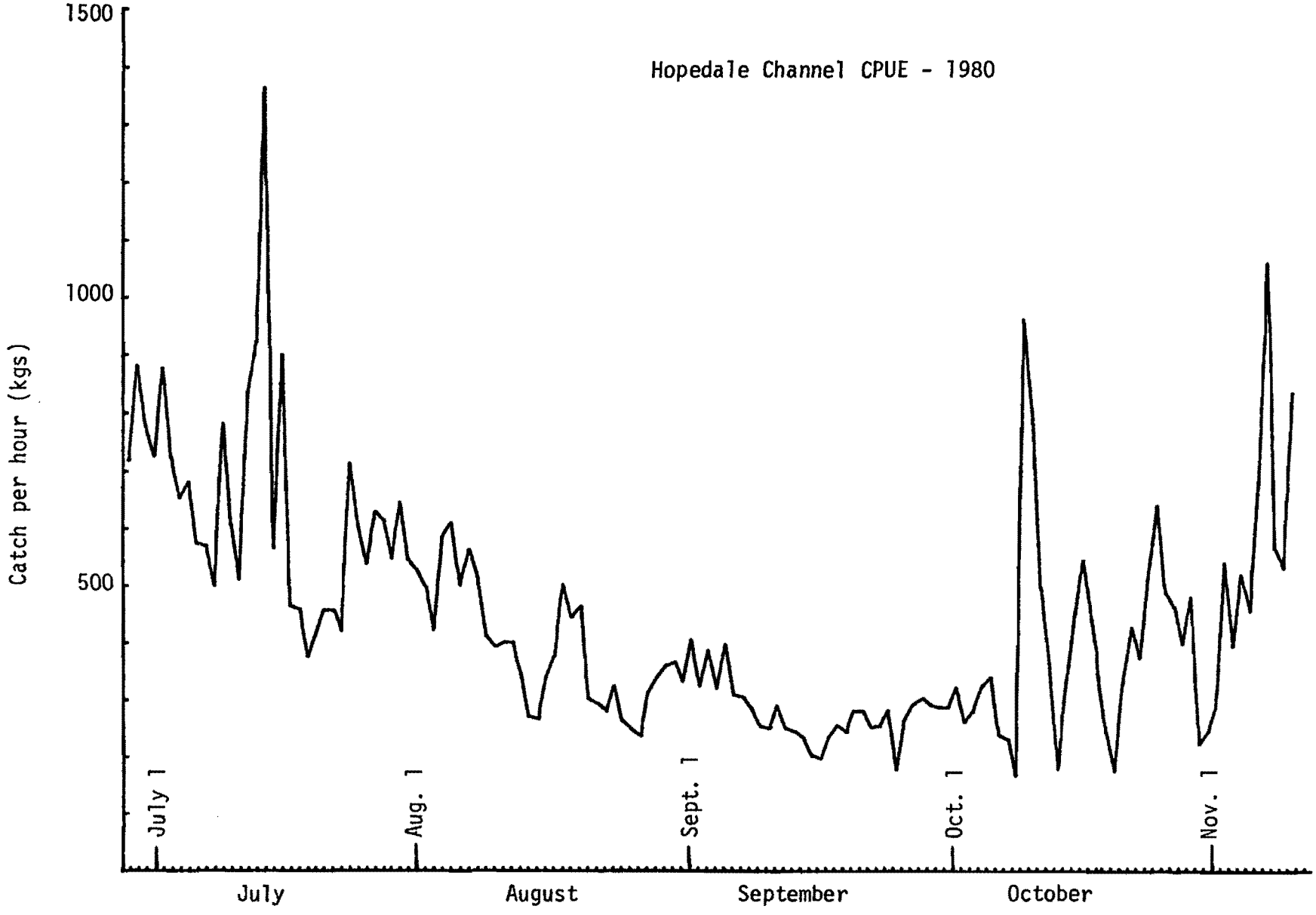


Fig. 2. Catch per unit effort, 1980.

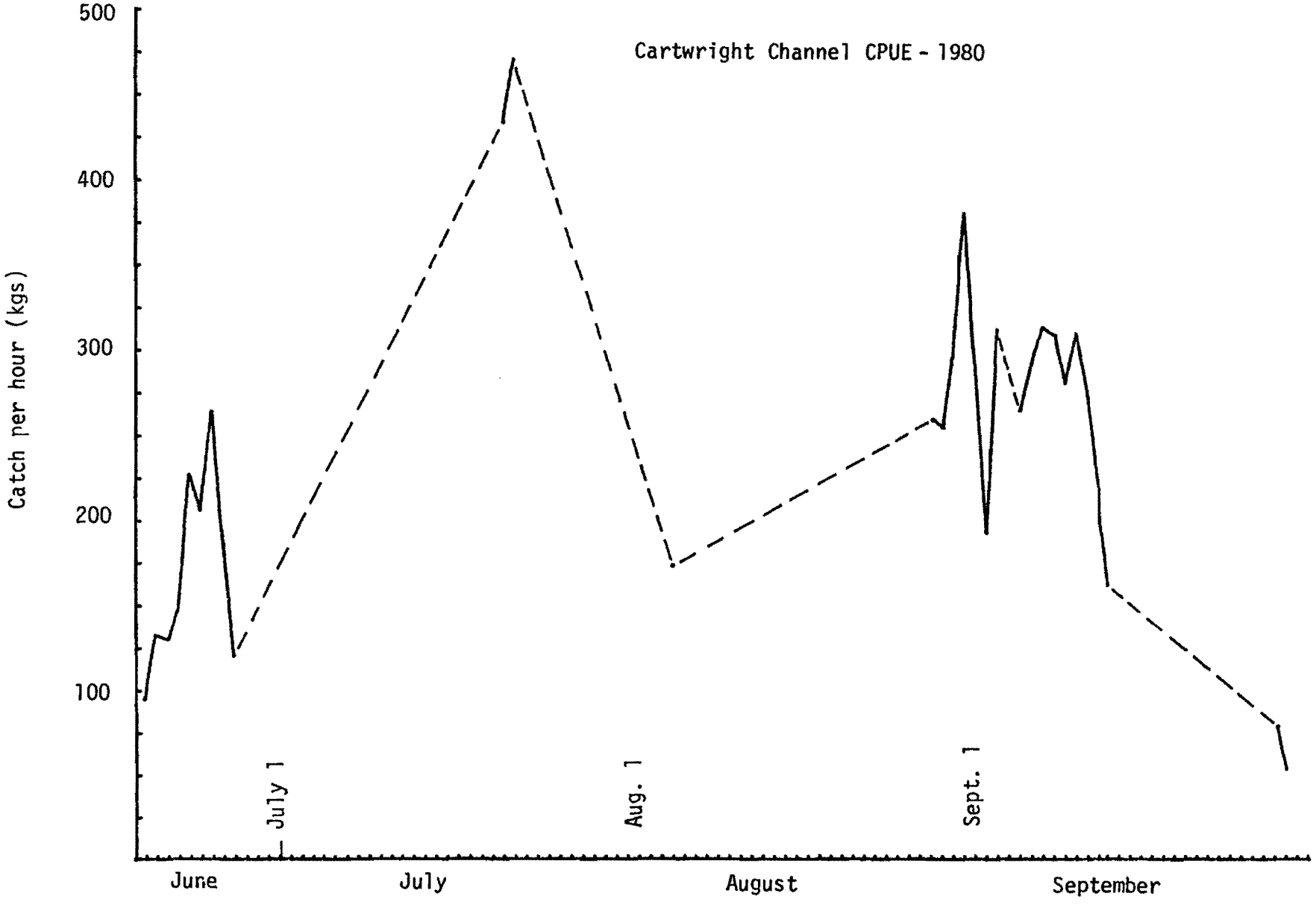


Fig. 3. Catch per unit effort, 1980.

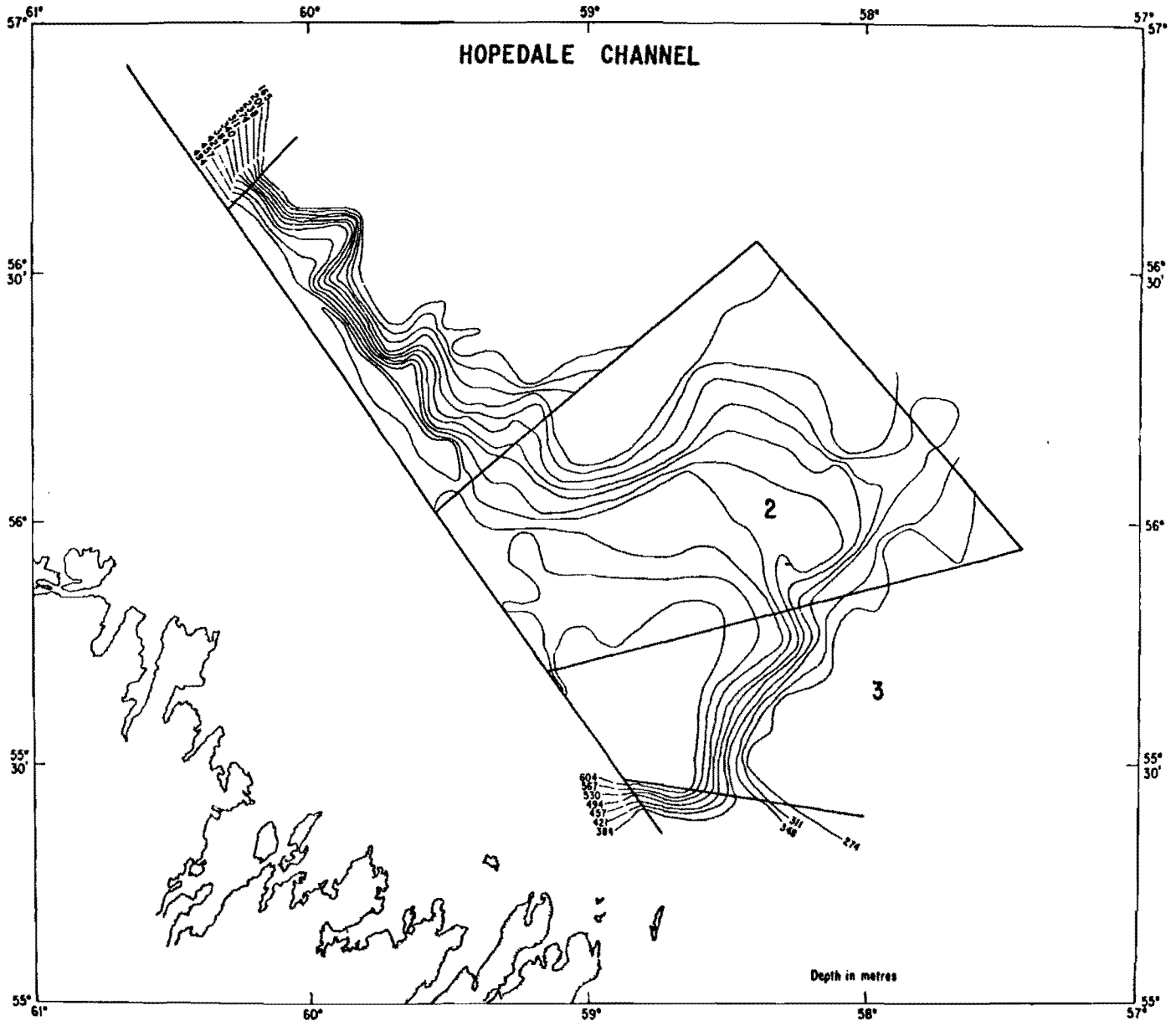


Fig. 4. Stratification of the Hopedale Channel.

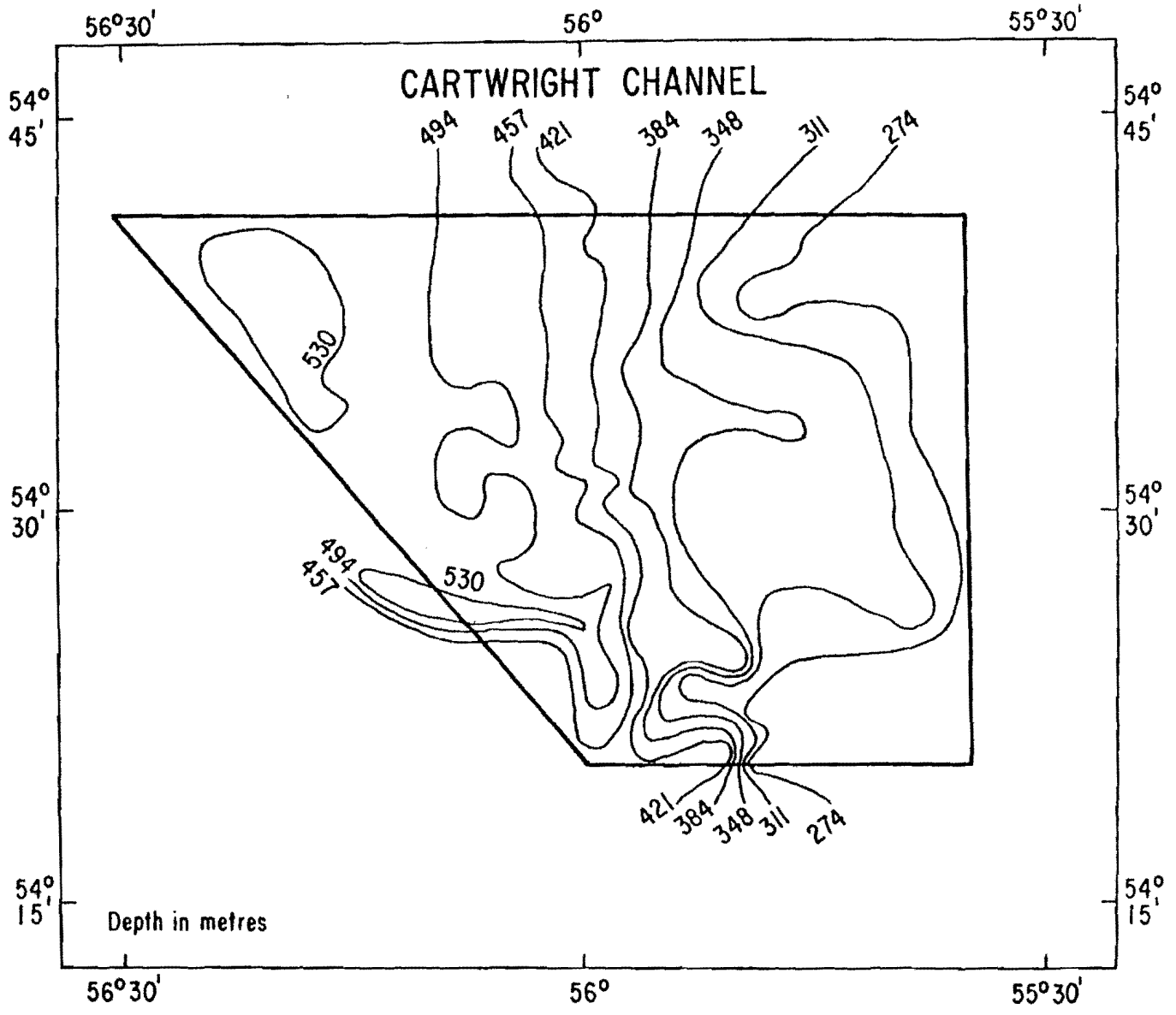


Fig. 5. Stratification of the Cartwright Channel.

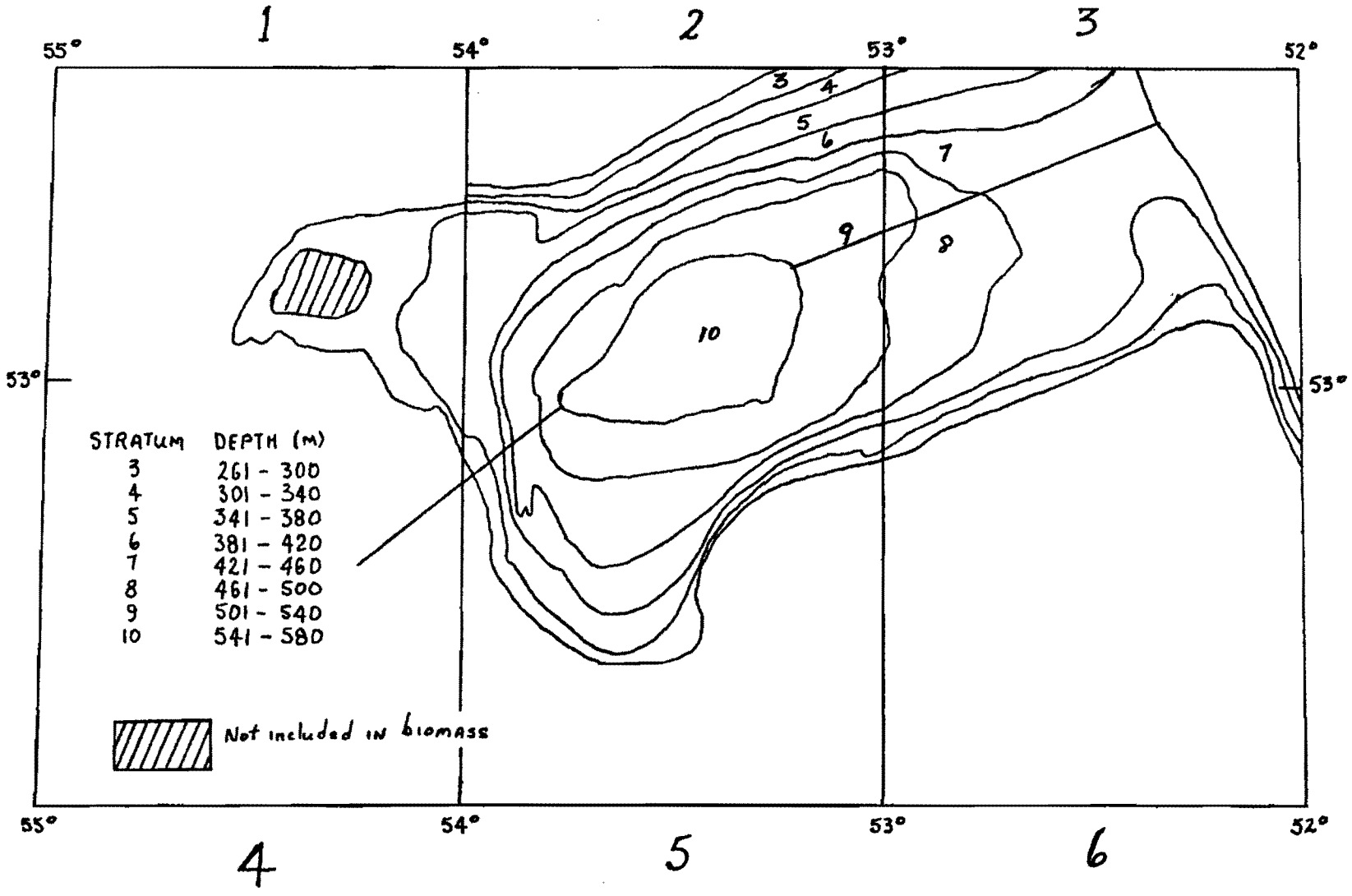


Fig. 6. Stratification of the Hawke Channel.

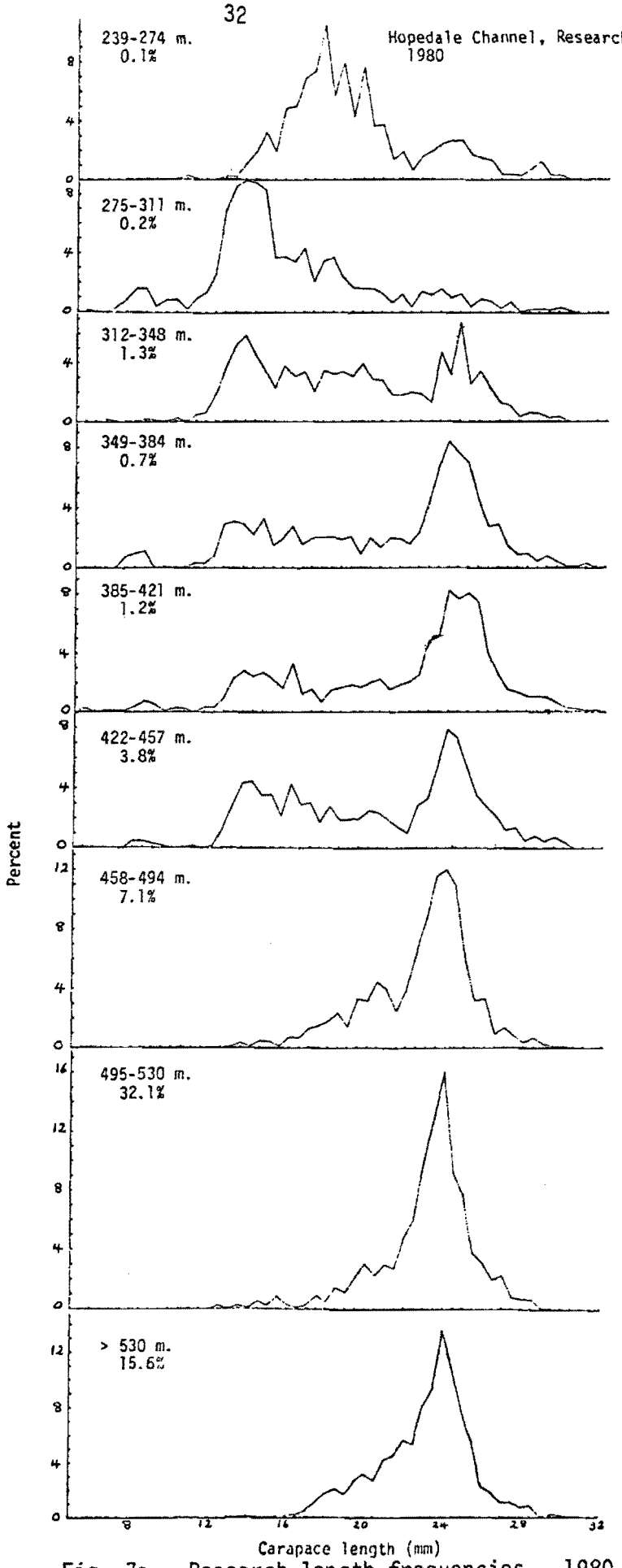


Fig. 7a. Research length frequencies - 1980. (% of biomass indicated)

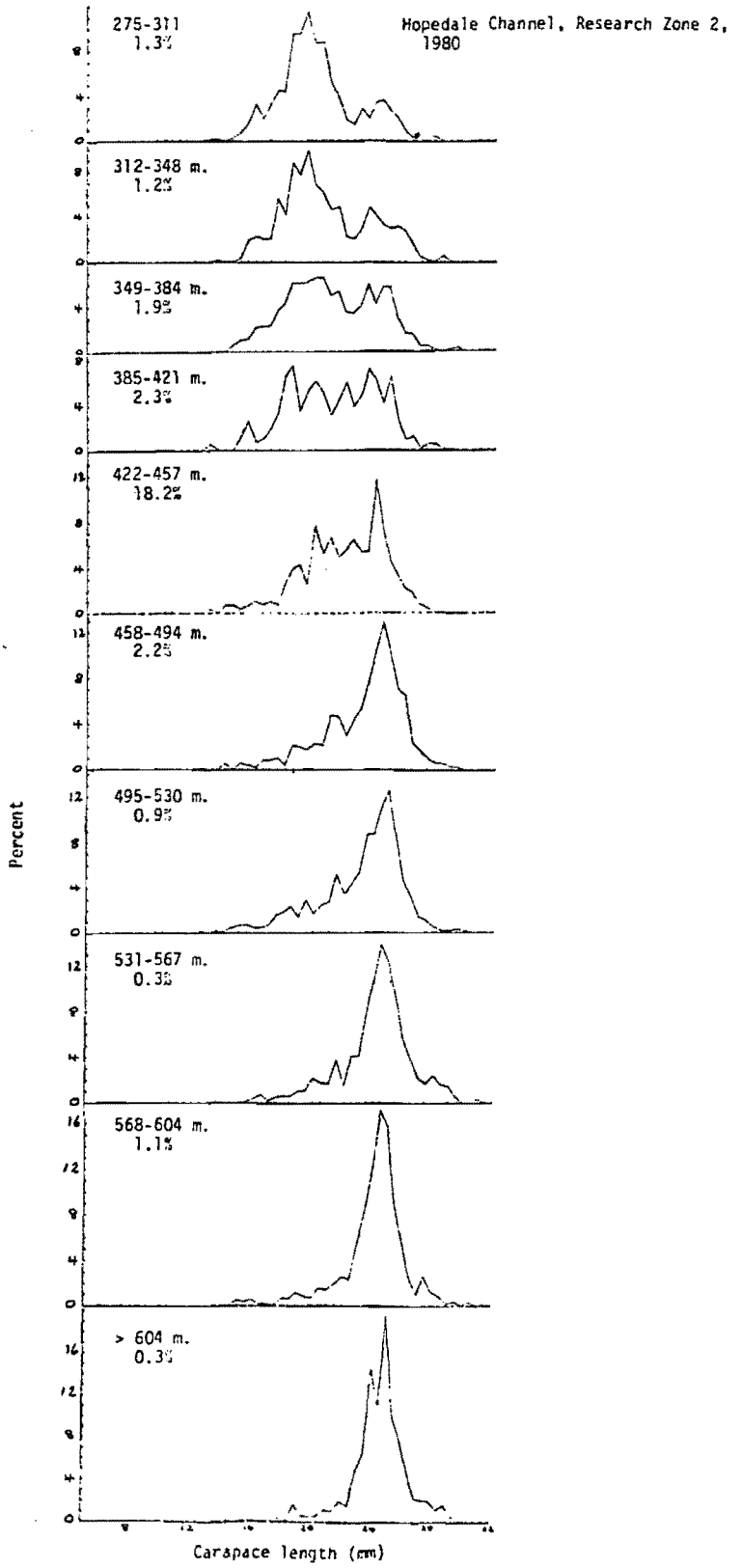


Fig. 7b. Research length frequencies - 1980. (% of biomass indicated)

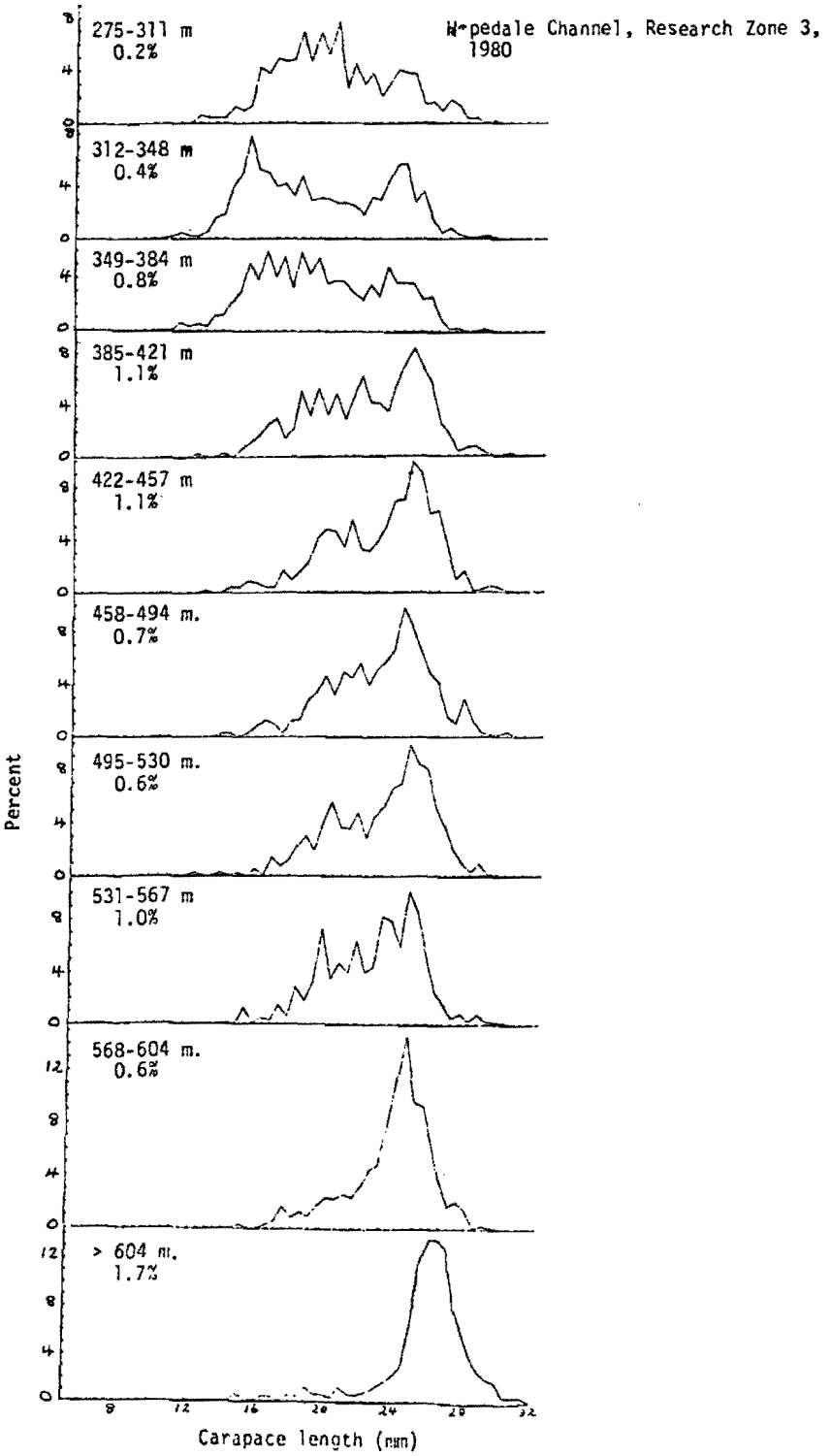


Fig. 7c. Research length frequencies - 1980. (% of biomass indicated)

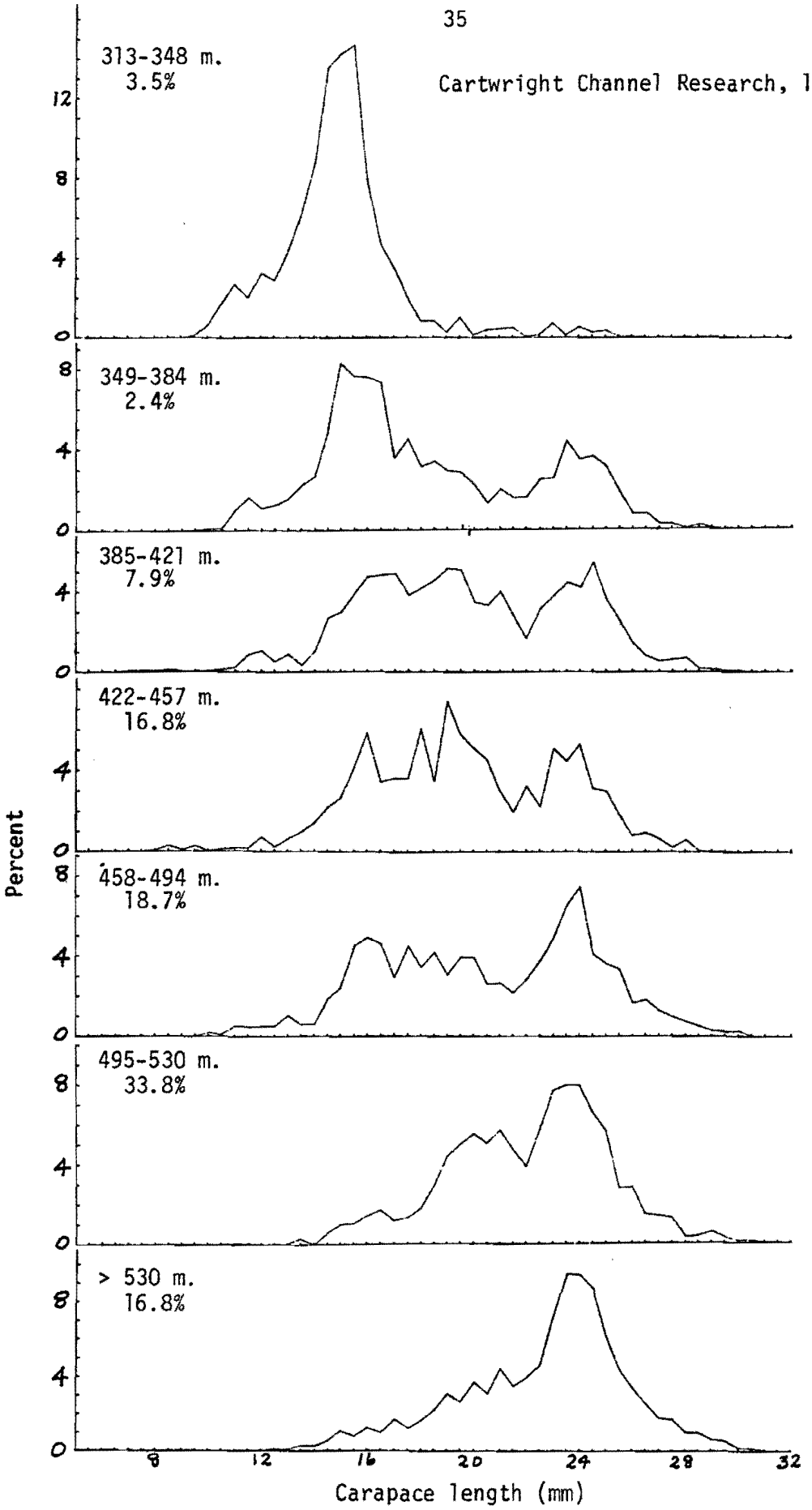


Fig. 8. Research length frequencies, 1980.
(% biomass indicated)

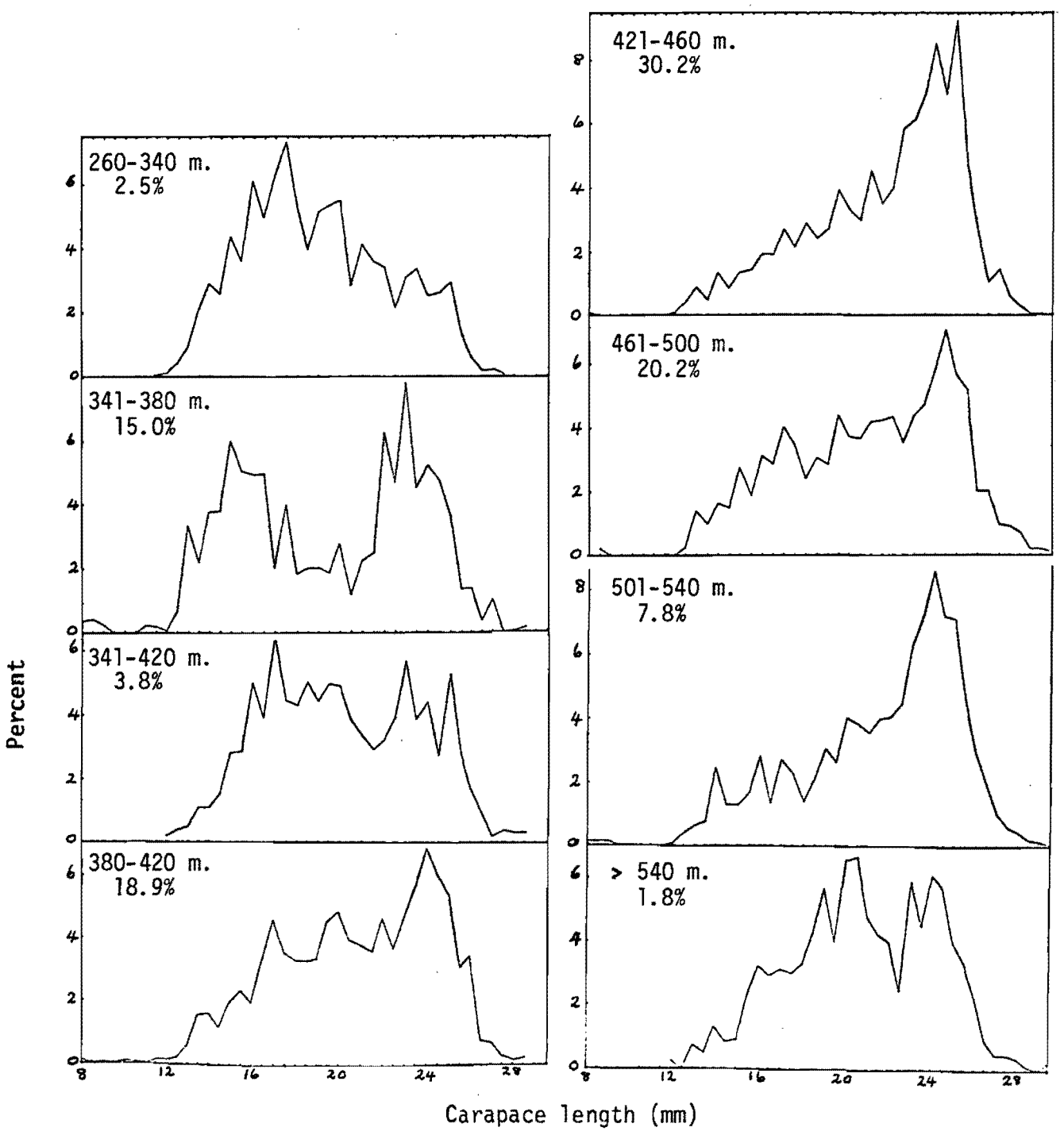


Fig. 9. Research length frequencies - 1980. (% of biomass indicated)

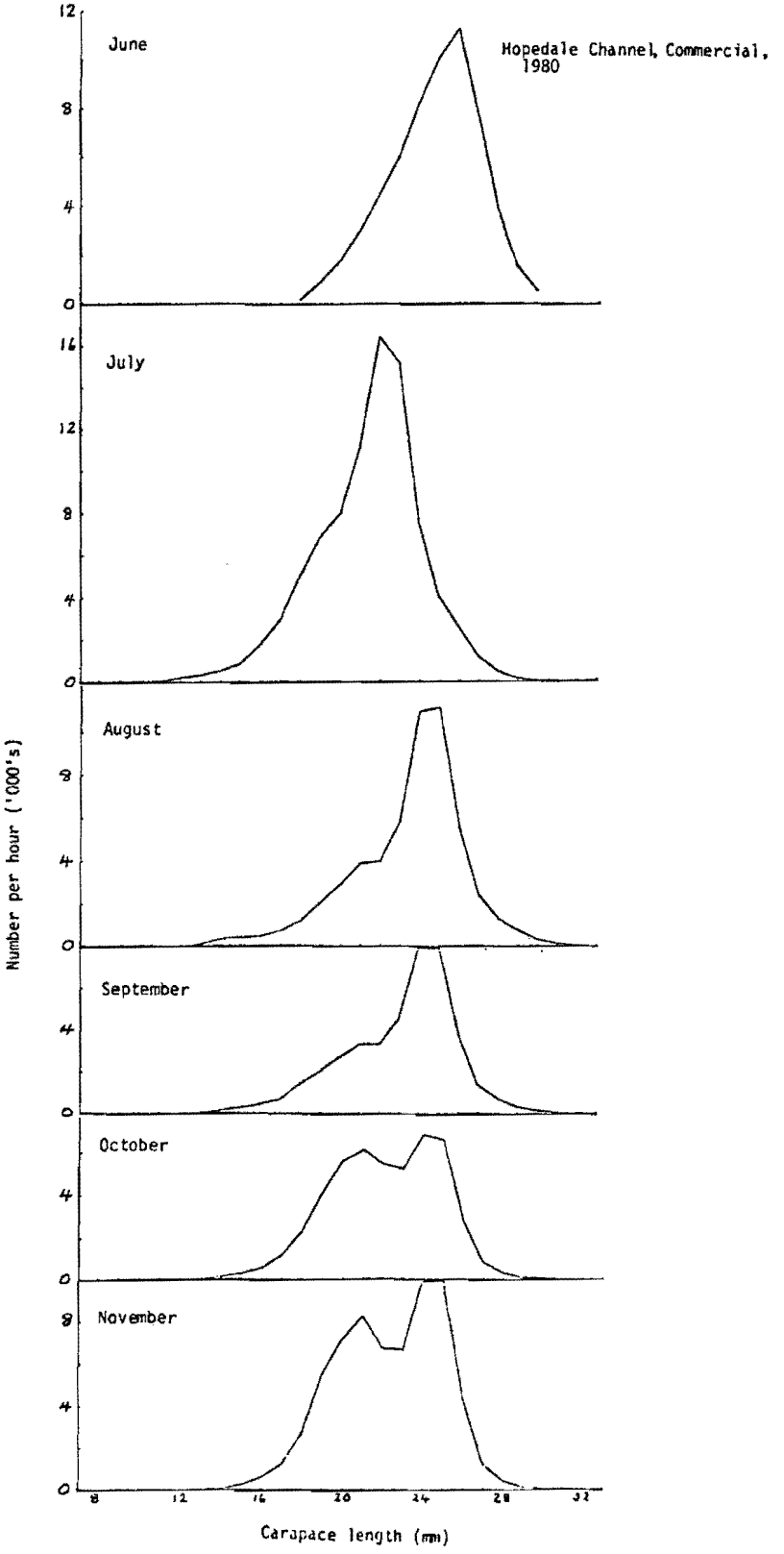


Fig. 10. Commercial length frequencies - 1980.

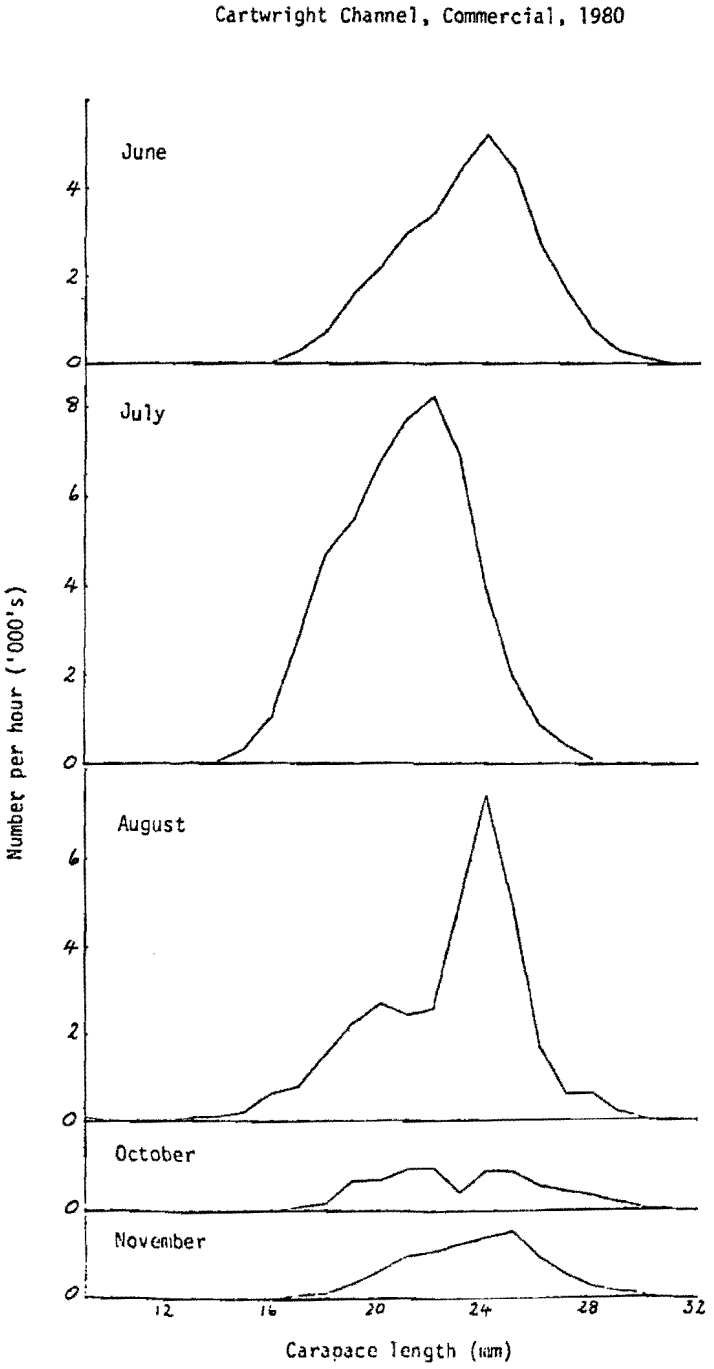
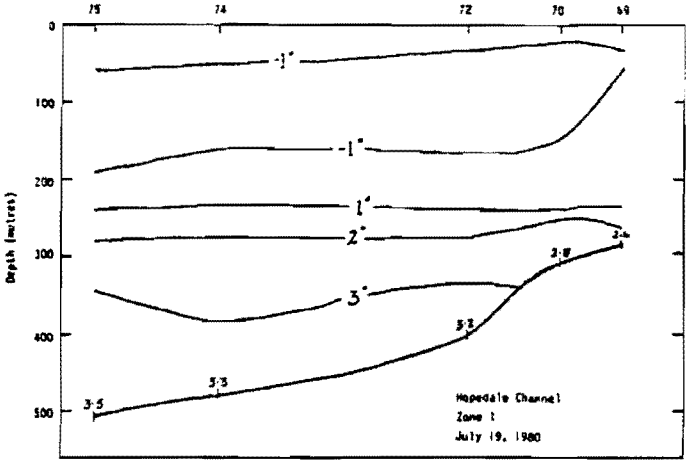
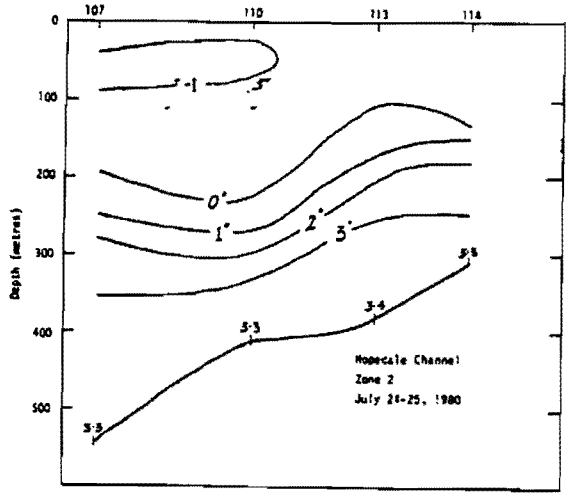


Fig. 11. Commercial length frequencies - 1980.





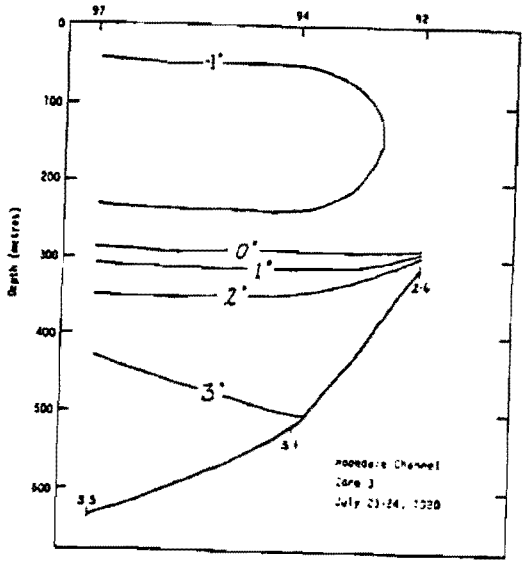


Fig. 12. Hydrographic sections, Hopedale Channel, 1980.

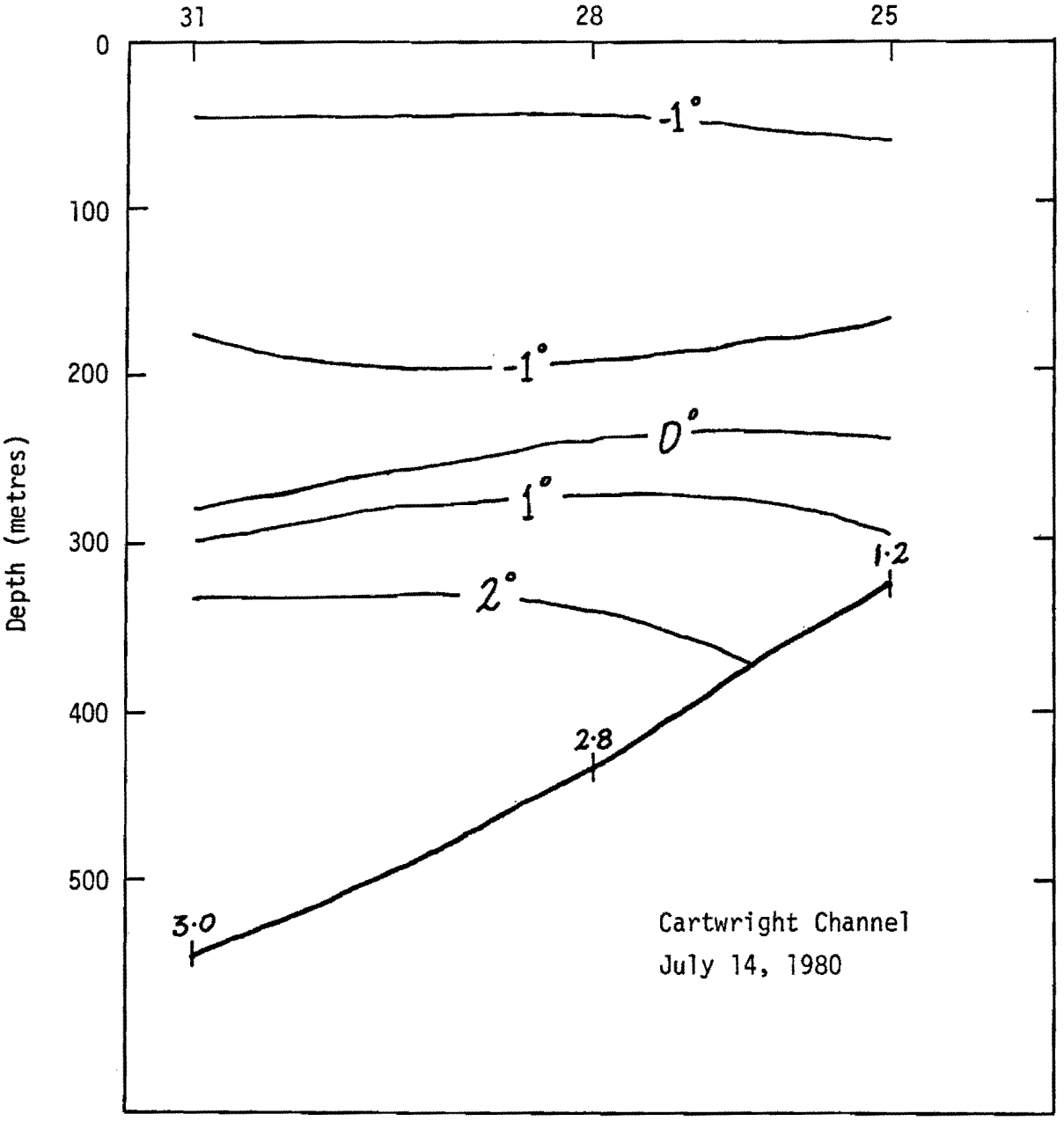


Fig. 13. Hydrographic section , Cartwright Channel, 1980.

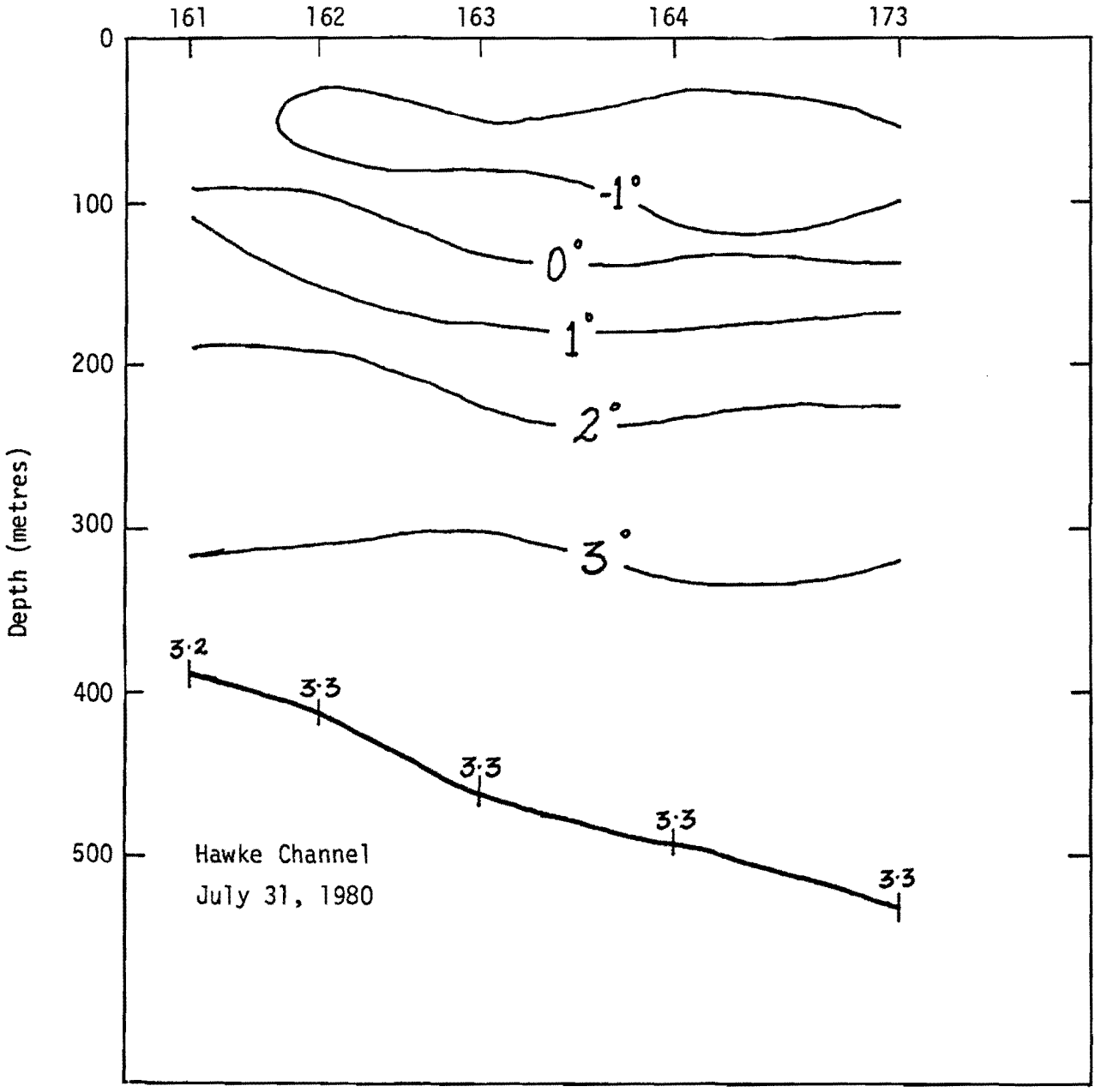


Fig. 14. Hydrographic section, Hawke Channel, 1980.