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An update of the assessment of shrimp (*Pandalus borealis*) stocks off Labrador

by

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Abstract

Catch per unit of effort (hours fished) for shrimp off Labrador from 1977-81 was standardized to represent the fishing power of tonnage class 5 vessels. Previous interpretations of nonstandardized data were not affected. The commercial catch rate data, biomass estimates from research surveys, distribution and stock composition were used to assess the status of shrimp resources in Hopedale, Cartwright and Hawke Channels. Shrimp in the former area were more widely distributed in 1981 than in other years resulting in reduced catchability for the commercial fleet and during the research survey. Although recruitment levels were uncertain, it was concluded that there was no real evidence of a reduction in abundance and that the TAC could be maintained at 4000 t. An increase in stock size due to reduced fishing pressure in the Cartwright Channel in 1980 and 1981 was not reflected in biomass estimates but have been limited by increased predation by Greenland halibut in 1980. The possibility of good recruitment and stability in research biomass estimates indicated that the TAC could be maintained at 800 t. Low catch rates and biomass estimates in the Hawke Channel suggested that the TAC of recent years (850 t) may be unnecessary.

Greenland halibut and cod were major by-catch species in the shrimp fishery but incidence of redfish was higher in 1981 than in other years. Some difficulties were noted in the collecting of reliable data on shrimp discards. Hydrographic observations showed that water temperatures in the channels were similar to those observed in previous surveys.

Résumé

Les prises par unité d'effort (heures de pêche) de crevettes du Labrador entre 1977 et 1981 ont été standardisées de façon à représenter la capacité de pêche des bateaux de classe de tonnage 5. Cette opération n'a pas influencé les interprétations antérieures des données non standardisées. Les taux de capture commerciaux, les estimations de biomasse à partir de relevés par navires de recherche, la distribution et la composition des stocks ont été utilisés pour évaluer l'état des ressources en crevettes des chenaux Hopedale, Cartwright et Hawke. Dans la première région, les crevettes étaient plus largement réparties en 1981 que dans les autres années avec, comme résultat, un potentiel de capture diminué, tant pour la flottille commerciale que dans les prises des relevés. Malgré des niveaux de recrutement incertains, nous avons conclu à l'absence de preuves réelles d'une diminution d'abondance et nous ne voyons pas de raisons de changer le TPA de 4000 t. Les estimations de biomasse ne reflètèrent pas une augmentation d'effectifs de stock à la suite d'une diminution de l'intensité de la pêche dans le chenal Cartwright en 1980 et 1981; une prédation accrue par le flétan du Groenland en 1981 peut avoir limité cette biomasse. La possibilité d'un bon recrutement et la stabilité des estimations de

biomasse par navires de recherche indiquent que le TPA pourrait être maintenu à 800 t. Les faibles taux de capture et estimations de biomasse dans le chanal Hawke donnent à penser que le TPA des récentes années (850 t) pourrait être inutile. Le flétan du Groenland et la morue sont les principales espèces capturées accessoirement dans la pêche des crevettes mais, en 1981, le sébaste y était plus abondant que les autres années. Nous notons certaines difficultés à recueillir des données fiables sur les quantités de crevettes rejetées à la mer. Des observations hydrographiques indiquent que les températures de l'eau dans les chenaux étaient semblables à celles observées lors de relevés antérieurs.

Introduction

The Labrador shrimp fishery in 1981 was concentrated in the Hopedale Channel. Very little effort was expended in the Cartwright Channel while in the Hawke Channel a catch of over 100 t was reported very early in the season when ice cover restricted effort in the more northern areas. Observer coverage of the fleet was again extensive and considerable data on details of the catch were collected. The 'annual' research survey was conducted in July providing information on distribution, abundance and biological detail of shrimp, Greenland halibut and cod.

This exercise was designed to incorporate the most recent data with those available for previous years, determine the status of the resource in relation to recent levels of fishing effort and project potential removals in the short term.

Catch and catch per unit effort

Preliminary landings for 1981 totalled 3592 t in the areas off the Labrador coast; 3382 t in Hopedale Channel, 135 t in Hawke Channel, 67 t in Cartwright and 8 t in Div. 2G. The pattern of fishing in 1981 was heavily influenced by a committment of the industry to catch as much shrimp as possible of 5000 t allocated by Canada in Subarea 0. Since there was no agreement with the EEC on reciprocal fishing in Subarea 0 and 1 in 1981, fishing during the early months of the year was not possible. This situation prompted nominal effort in the Hawke Channel in May which resulted in a catch which exceeded that of

previous years. Effort was not sufficient to catch the 4000 t TAC in the Hopedale Channel and Cartwright Channel was virtually unfished for the second consecutive year.

In past assessments no standardization of fishing effort had been attempted between gears and/or tonnage classes. The fishery is new and catch rate data are highly variable both within and between days. Vessels engaged in the fishery have changed each year and learning factors are difficult to demonstrate. In fact, since many of the vessels involved have had previous experience in other shrimp fisheries, and fishermen generally cooperate in locating concentrations of shrimp, learning may be a relatively minor problem. Primarily, vessels of tonnage classes 4 (151-500 t) and 5 (501-1000 t) exploit the shrimp resources off Labrador. A small proportion of the total catch has been taken by tonnage class (TC) 6 vessels since 1979, but differences in vessel performance between TC 5 and TC 6 are marginal. In 1977, the larger vessels reported approximately 72% of the total shrimp catch off Labrador. In subsequent years, proportions taken by TC 5 and 6 declined to 63% and 58% in 1978 and 1979 respectively but increased slightly from the 1979 level to 64% and 67% in 1980 and 1981.

Vessel log collections are incomplete in any year and it is possible that missing logs may be distributed disproportionately among tonnage classes. This appears to have occurred in 1980 and 1981 when there was a substantial shortage of TC 5 logs. Therefore, when using vessel log data to compute CPUE as an index of abundance, standardization becomes desirable.

Units of comparison between tonnage classes are difficult to define due to variability associated with time and location of fishing. Since catch

rates vary considerably on a diel basis it was necessary to select records for certain periods of a given day. Abundance of shrimp also varies with depth (as well as size distribution) making some depth stratification necessary. Only TC 4 and 5 were considered since coincidental fishing with TC 6 was lacking. An optimum comparison unit was eventually defined which minimized differences due to time and depth and produced a significant and meaningful correlation while maintaining a reasonable sample size. Data for both tonnage classes were selected from days when each fished between 1200 and 1800 hrs (NST) at 100 m depth intervals. These requirements produced 27 pairs of data collected by observers from vessels fishing in the Hopedale Channel in 1980 and 1981.

The data were best explained, statistically and practically, by linear regression through the origin (Fig. 1). Anomalous data points (circled) were not considered in the final estimation and were excluded on the basis of distribution of residuals observed from a preliminary fit of all data (i.e. points $> \pm 2s$ were deleted). This exercise resulted in a conversion factor (slope) of 1.26 ± 0.19 (95% C.I.). No learning factors were applied. Conversions of TC 4 data were made on a monthly basis for years prior to 1981 and on a daily basis for data obtained in 1981. A comparison of nonstandardized and standardized CPUE is presented in Table 1. The standardization procedure did not result in changes in interpretation of the data made in previous assessments (Parsons et al. 1981).

The daily trend in CPUE (standardized and nonstandardized) observed in the Hopedale Channel in 1981 (Fig. 2) differed from previous years in that catch rates at the beginning of the fishing season were lower. Data presented

in earlier reports (Parsons et al. 1979, 1980, 1981) showed high catch rates (although variable) at the beginning and end of the season (June-Nov.) with a period of relatively low abundance between. In 1981 catch rates were more uniform throughout the season and peak periods were lower than in other years. Catch rates in some months in 1979 and 1980 were less than the lowest monthly rate in 1981 (Table 1). August and September catch rates have been used to reflect changes in stock abundance since 1977. Unweighted averages are probably more representative because the catch from vessel logs is incomplete.

Catch (kg) per hour, Aug.-Sept. - Hopedale Channel

1977	1978	1979	1980	1981	
622	472	333	390	373	CPUE (Standardized)
1.00	0.76	0.54	0.63	0.60	Index
585	417	277	345	345	CPUE (not Standardized)
1.00	0.71	0.47	0.59	0.59	Index

These data might suggest reductions in CPUE of around 40% from virgin levels. However, since distribution and/or availability differs between years, comparison of catch rates for the same months in each year are likely misleading. Lacking data for all months of the year, it is difficult to select periods within individual years which might reflect the actual change in abundance.

Lack of fishing effort in the Cartwright Channel in 1981 does not permit comparisons with other years. Conversion of fishing effort in previous years to the standard described above have been made and results are presented in Table 1. Interpretation of the data presented previously (Parsons et al. 1981) are not affected.

Biomass estimates from research surveys

Stratification schemes for Hopedale and Hawke Channels were the same as used in previous assessments. New information on the bathymetry of the Cartwright Channel permitted a revision of the interpretations used previously. Strata were based on 50 meter intervals and data from earlier work were reanalysed accordingly (Fig. 3, Table 3).

In the Hopedale Channel shrimp were most abundant in the northern part of the area (Fig. 4, Table 2). However, concentrations were greatest in depths between 300 and 400 m in 1981 compared to depths greater than 400 m in 1979 and 1980. The mean estimate of biomass (4214 t) is considerably lower than the (approx.) 11,000-12,000 t calculated for the previous two years. The distribution pattern and low estimate of biomass are similar to those observed in September, 1978 which were considered unreliable vis-à -vis fishing success in other months of the year.

Biomass estimates for shrimp in the Cartwright Channel have been relatively consistent between 1979 and 1981 (Table 3). In 1981 shrimp density was highest in depths between 350 and 500 m (Fig. 5) whereas in the previous two years concentrations were found in depths greater than 400 m. It also appears that shrimp were more concentrated in a smaller area compared to earlier surveys.

No estimate of biomass was made for the Hawke Channel because of a general scarcity of shrimp throughout the area (Fig. 6). Although approximately 135 t were taken from this channel early in the season, catch rates during the research survey were the lowest ever obtained. This area may only support

concentrations attractive to industry early in the season when ice cover prevents fishing in the other channels.

Size Distribution

1. Research

Length frequencies from the 1981 research survey in the Hopedale Channel must be interpreted with caution considering the distribution and apparent abundance at the time of the survey. Most obvious is the increase in the proportion of larger animals in the shallower strata, especially in Zone 1 (Fig. 7a, b, and c). This pattern of distribution confuses the recruitment picture compared to other years. Although the age groups present in the 23-25 mm mode far outnumber other modes (cohorts) in most depths, the relatively high proportion of smaller animals in depths where the percent of biomass is greatest indicates that these size groups are well represented.

Modal lengths correspond to those observed in 1980 except that in 1981 (as in 1979) a mode appeared around 21 mm. This mode was not prominent in 1980. There are also some indications of the possibility of a modal group around 12-13 mm but sample size at these lengths is relatively small and overlapping is severe.

The presence of large shrimp in shallower strata of the Cartwright Channel was not observed in the 1981 survey. There was, however, a prominent mode around 12 mm which could also be observed in some deeper strata (Fig. 8). The presence of a mode at 8 mm could not be detected with any certainty from length frequencies, but such a mode did appear in measurements of shrimp from cod stomachs taken in the area (Bowering et al. 1982). Other modes were present at 16-17, 19-20, and 24-25 mm, similar to those observed in 1980.

The relative strength of modes smaller than 24 mm in strata where considerable biomass was found indicates a potential for good recruitment in 1982.

2. Commercial

Representative commercial length frequencies were only available for the Hopedale Channel in 1981 (Fig. 9). In most months of the fishery, there appears to have been a greater dependency on shrimp around 18 mm than in previous years. Considering the pattern of distribution evident in the 1981 research survey, and depths fished by commercial vessels, effort occurred in shallower water where abundance was greatest, probably accounting for the higher proportion of smaller animals. In other years, fishing in the earlier months of the season centered on concentrations of larger animals in deeper water. Then, as concentrations declined, effort shifted to shallower strata where average size decreased but catch rates were optimal. This anomalous pattern of fishing in 1981, which depended on smaller animals to maintain good catch rates, may have affected recruitment for future years depending on the relative strength of the age groups involved. Since fishing was concentrated in shallower water, more fishing mortality might have been applied to size (age) groups which would not ordinarily be fished heavily until some later period. However, if these size (age) groups were particularly strong, they might have been more available to the commercial gear and may continue to contribute to the fishery in 1982. Past assessments have not been able to quantify recruitment and no predictions of abnormally strong year-classes have been made.

By-Catch and Discards

Observer data from the Hopedale Channel in 1981 show that Greenland halibut and cod continue to be major by-catch species in that area (Table 4). However, incidence of redfish in shrimp catches also appeared high compared to other years and was most prevalent in the latter part of the season. Redfish, although often found in areas of shrimp concentrations, are not considered an important predator of shrimp. Nevertheless, increases in abundance of any potential predator or competitor should be investigated.

Incidence of Greenland halibut was highest in July and August, as in previous year. Catch rates for this period were lower in 1981 and support the assumption that there has been a decrease in Greenland halibut abundance in this area between 1980 and 1981 (Bowering et al. 1982).

Discard rates for shrimp catches in the Hopedale Channel by month for 1981 are given in Table 5. These ranged from 3.6% to 17.0% of the total shrimp catch. Approximately 6.3% of the total observed catch was discarded. Estimates of discards are poor, mainly due to the less than ideal circumstances under which they are made. On some vessels the system of handling the discarded shrimp makes it virtually impossible to obtain reliable discard estimates. In other cases where the discards can be collected and quantified, reasonably representive estimates are possible. It also has been noted that the masters of some vessels have displayed animosity toward observers who try to keep good discard figures and actually take steps to obstruct them. It is not surprising, therefore, that at times the estimation of discards gets little attention. Available estimates must be considered as minimal and steps must be taken to

discourage discarding and/or improve reporting. Policy regarding discards should be elaborated in the licence or, as an alternative, TAC's could be reduced to account for the proportion consistently discarded.

Hydrography

Detailed observations on water temperatures in the Labrador shrimp channels are made on each research cruise. Figures 10, 11, and 12 show that temperatures in depths where shrimp were most abundant were similar to those observed in previous surveys (~2-3.5°C). In the Hopedale Channel shrimp were distributed in shallower depths in 1981 and a significant proportion of the biomass found in Zone 1 (Table 2) occurred at depths where the temperature was 1°C and less.

Discussion and Conclusions

The shrimp resource in the Hawke Channel has offered little to the industry considering the TAC's that have been in place since 1979. Recent research surveys have shown the area to be barren during the July-August period and the only commercial effort occurred in April and May, 1981 when vessels were prevented or restricted from fishing elsewhere. Catch rates during this period were generally less than 200 kg per hour. Therefore, a TAC for this area is meaningless, since it appears that it can never be attained within practical limits of the fleet. Vessels should be permitted access to the area at any time of year to take advantage of any seasonal concentrations of shrimp which might yield a viable catch rate in the short term. Research surveys to

the area in future will be sporadic, but we will continue to monitor commercial activity in the area in order to detect any significant changes in shrimp abundance.

Events in the Cartwright Channel in recent years (1979-1981) have changed radically but biomass indices have not fluctuated greatly during the same period. Fishing effort cannot be considered an important factor in 1980 or 1981 but significant changes in the abundance of a major predator, Greenland halibut, were observed during the period 1979-1981. Although such relationships are difficult to quantify (i.e. breaking down mortality components), an increase in natural mortality through predation in 1980 might have limited any expected increase in the stock resulting from a cessation of fishing effort. Assuming that stock size has not changed greatly during recent years and that the recruitment potential for 1982 is good, maintenance of the TAC near the present level (800 t) should be considered. If the stock has actually remained stable, catch rates of roughly 60% of those obtained in 1977 (virgin level) can be expected provided levels of effort are greater than those expended during 1980 and 1981.

Changes in catch rates of shrimp over the season in the Hopedale Channel were dissimilar to trends observed in previous years. Historic data show that abundance or, more likely availability is lowest around September-October. In 1981, lowest catch rates were obtained in July and August, a time which usually generates high catch rates. This would suggest that shrimp availability was reduced in these months affecting values of abundance indices from commercial catch rate data and research surveys (i.e. biomass). It seems reasonable to assume that if the survey were conducted either earlier or later in the year,

the biomass estimate would have been higher. The value obtained should be considered unreliable (for the same reasons the 1978 survey data were rejected) and cannot be used to interpret changes in abundance or influence advice on catch levels for 1982.

Despite a significant increase in abundance in Greenland halibut observed in July-August, 1980, good catch rates were maintained in 1981. Also the catch in 1980 was close to the TAC of 4000 t, the highest since the fishery began. In 1981 abundance of Greenland halibut was lower than the previous year but did not appear to fall to levels estimated prior to 1980 (Bowering et al. 1982). The catch in 1981 also exceeded 3000 t. Abundance of predators and the intensive fishery in 1980, did not reduce the abundance of shrimp to extremely low levels in 1981 but may have affected distribution. Time lags have not been considered but if they occur, are probably related to selective feeding by Greenland halibut. Such data have been collected but not processed or analyzed.

Commercial length frequency distributions for 1981 showed an increase in the proportion of small animals in the catch, especially animals around 18 mm carapace length. In earlier years there was a tendency for the fleet to move into shallower waters later in the season (Sept.-Dec.) resulting in an increase in the proportion of smaller animals in the catch. Numbers of individuals around 18 mm in these years were not so pronounced as in 1981. It should be noted also that the commercial gear (40 mm) is only around 50% efficient at this size (Parsons 1981). On the other hand, length frequencies from research surveys in 1979, 1980, and 1981 did not indicate the existence of a noticeably strong year-class despite the use of lined trawls in relatively shallow water.

Availability of this size (age) group might have been a factor, especially during the 1981 survey since these animals did not occur in great numbers in the commercial catch until August. Catch rates in months when animals of these sizes occurred most frequently in 1981 (Aug.-Oct.) were similar to those obtained in the previous year but in 1980, larger shrimp were taken in deeper water. The tendency in 1981 for fishing in relatively shallow water implies an increase in mortality on smaller, partially recruited animals. However, since the relative strength of the 18 mm group is uncertain, it is difficult to predict what effect this will have on catch rates in 1982 and beyond. It is encouraging to observe that catch rates at the end of 1981 remained good.

If the northern shrimp fishery in 1982 is similar to 1981 in the amount and distribution of fishing effort (i.e. priority in Subarea 0), effort available for the Hopedale Channel will not be sufficient to catch the 4000 t TAC at 1981 catch rates. If catch rates are actually lower, removals should be less again, especially if vessels seek more economically productive areas (e.g. return to Cartwright Channel). Although events in recent years, including increased predation and fishing, generate caution in providing advice, uncertainty as to what reductions to expect (if any) precludes recommendations for a reduction in TAC from the present (4000 t) level. Catch rates will ultimately dictate the amount of effort expended in the area and in this sense the fishery is self-regulating.

Effects of these pressures on the resource will become apparent as the fishery progresses in 1982. If a viable fishery is maintained, a valuable lesson will be learned concerning the resilience of these stocks and the advantage of a naturally closed season of six months during which females are ovigerous.

The standardization of fishing effort between tonnage classes produced no significant changes in the interpretation of the catch per unit effort indices reviewed in previous years. Variability within tonnage class is also high and standardization under such circumstances is, at best, general. More meaningful relationships might be obtained through analysis by the type of gear used, together with vessel size, time and depth. Vessel logs often omit gear type and to date observer reports require only one general gear category. In future efforts must be made to ensure vessel logs are completed in sufficient detail to separate catch and effort by gear type and that observers record in detail the type of trawl used for each fishing set.

Maintaining a monitor on by-catches in the shrimp fishery has provided valuable ancillary information on the biology of shrimp in these areas. Many finfish species undoubtedly feed on shrimp and the relative abundance of predators should be determined annually. In future research surveys, all major predators should be sampled routinely, with particular emphasis on food and feeding.

Finally, discards of shrimp may be grossly underestimated due to conditions encountered aboard the vessels. There seems to be a need to underscore policy dealing with discards and to ensure that observers placed aboard fishing vessels will be unobstructed in obtaining these data.

References

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Table 1. Catch per hour fished, 1977-81 (monthly values determined from vessels logs) A = actual CPUE, B = CPUE adjusted to tonnage class five.

Month	1977 Catch (kg)	1977 CPUE (kg) A	1977 CPUE (kg) B	1978 Catch (kg)	1978 CPUE (kg) A	1978 CPUE (kg) B	1979 Catch (kg)	1979 CPUE (kg) A	1979 CPUE (kg) B	1980 Catch (kg)	1980 CPUE (kg) A	1980 CPUE (kg) B	1981 Catch (kg)	1981 CPUE (kg) A	1981 CPUE (kg) B
HOPEDALE CHANNEL															
May													5,455	201	253
June							196,741	902	957	28,970	812	872	408,457	454	539
July				131,544	735	773	965,454	594	706	736,840	596	645	360,770	300	356
August	93,695	532	611	85,570	506	560	812,378	309	368	589,206	397	475	474,218	329	344
Sept.	206,111	637	631	68,591	328	383	81,907	245	297	599,724	292	304	555,279	360	402
Oct.	330,574	316	361	584,589	477	580	-	-	-	390,295	334	423	406,217	380	404
Nov.	641,516	696	780	470,170	432	555	-	-	-	163,316	536	598	469,023	363	418
Dec.	-	-	-	-[3]	-	-	-	-	-	-	-	-	168,375	524	607
Total[1]	1,271,896	516	573	1,340,464	467	569	2,056,480	428	507	2,508,351	399	449	2,847,794	365	409
Total[2]	1,203,000			2,109,000			2,693,000			3,938,000			3,382,266		
CARTWRIGHT CHANNEL															
June							-[3]	-	-	23,134	187	212			
July	311,838	812	834	155,813	479	479	147,498	658	730	11,770	453	453	6,875	255	262
August	514,633	624	624	399,501	633	664	148,268	264	318	22,465	292	368	5,035	155	155
Sept.	234,037	454	465	638,159	395	463	353,821	216	235	55,919	264	326	907	202	202
Oct.	14,378	181	187	45,439	190	264	-	-	-	405	58	73			
Nov.	73,616	691	802	-	-	-	-	-	-	3,535	107	135			
Dec.	9,650	449	566	-	-	-	-	-	-	-	-	-			
Total[1]	1,158,152	600	614	1,238,912	441	500	649,587	268	299	117,228	245	294	12,817	200	203
Total[2]	1,414,000			1,521,000			1,034,300			170,000			67,149		

[1]Based on catches from vessel logs.
[2]Based on statistics from landings.
[3]Months with catches but no vessel logs.

Table 2. Minimum trawlable biomass - 1981 Research

Hopedale Channel

	Stratum	Depth (m)	Area (sq. n. mi.)	No. sets	Biomass (t)
Zone 1	102+103	202-274	93.1	3	302
	104	275-311	38.8	3	219
	105	312-348	38.8	4	635
	106	349-384	40.7	3	629
	107	385-421	37.9	3	203
	108	422-457	39.3	3	301
	109	458-494	41.6	3	184
	110	495-530	109.9	3	349
	111+112	531-604	51.5	2	50
Zone 2	204	275-311	290.1	2	367
	205+206	312-384	308.8	3	197
	207+208	385-457	242.8	3	296
	209-212	458-604	661.5	4	207
Zone 3	305	312-348	30.4	2	13
	306	349-384	23.4	2	21
	307+308	385-457	37.0	3	87
	309	458-494	18.7	2	33
	310	495-530	24.3	2	23
	311	531-567	30.9	2	9
	312	568-604	37.9	2	14
	313	605-641	236.3	2	75
	Total		2433.7	56	4214

Table 3. Minimum trawlable biomass 1979-81 Research, (revised stratification).

Cartwright Channel

Stratum	Depth (m)	Area (sq. n. mi)	1979 No. sets	1979 Biomass (t)	1980 No. sets	1980 Biomass (t)	1981 No. sets	1981 Biomass (t)
702	301-350	89.7			3	190	2	54
703	251-300	19.9						
704	<250	37.9					8	9
705	251-300	28.7						
706	301-350	45.7	3	7	2	3	3	25
707	351-400	36.0	4	17	6	99	9	240
708	401-450	45.0	6	116	6	405	10	887
709	451-500	53.9	3	529	4	513	9	612
710	501-550	89.7	6	1223	8	992	3	342
711	451-500	15.6			2	64	2	67
712	>551	41.3			6	523	3	131
Total		503.4	22	1892	37	2789	49	2367

Table 4. By-catches (kg per hr) in the Hopedale Channel, 1981 estimated by observers.

	Turbot	Cod	Redfish	Shark	Skate	Plaice	Wolffish
May	23	-	7	9	3	1	-
June	8	1	4	-	3	7	1
July	63	27	14	2	7	4	11
August	35	14	19	1	7	3	22
Sept.	12	3	39	-	2	1	6
Oct.	20	8	40	-	4	1	3
Nov.	26	69	23	1	4	1	4
Dec.	23	23	57	6	1	5	1

Table 5. Shrimp discards, Hopedale Channel, 1981.

Month	Observed catch (kg)	Amount discarded (kg)	% discarded
May	6,389	1,084	17.0
June	522,843	31,732	6.1
July	376,422	13,571	3.6
August	701,132	54,180	7.7
September	586,313	38,427	6.6
October	532,768	26,954	5.1
November	218,606	19,011	8.7
December	142,790	9,365	6.6
Total	3,087,263	194,324	6.3

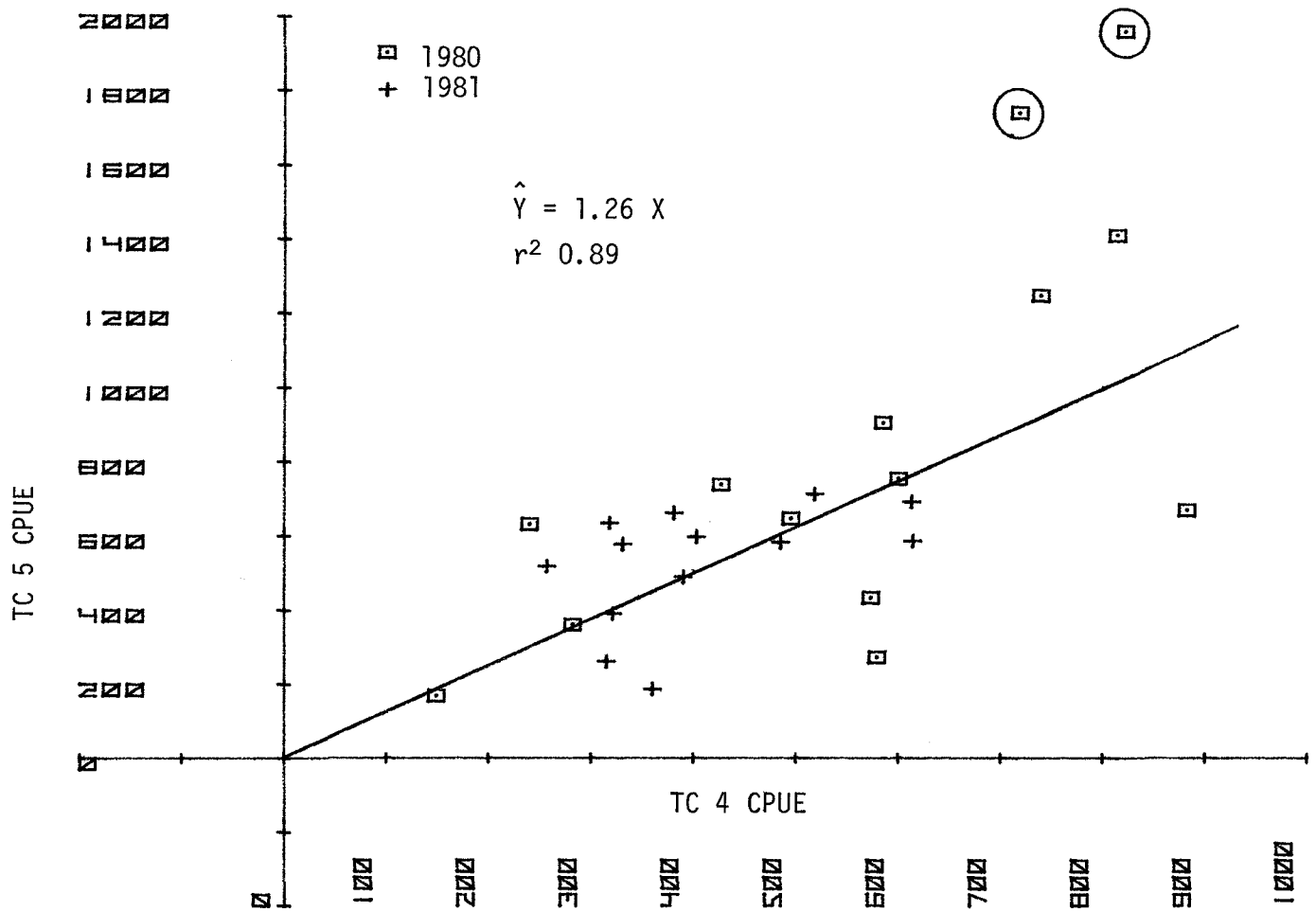

Fig. 1. Relationship between CPUE for tonnage class 5 and 4 vessels. Data selected from 100 m depth intervals between 1200 and 1800 hours NST (Hopedale Channel). Circled points not included.

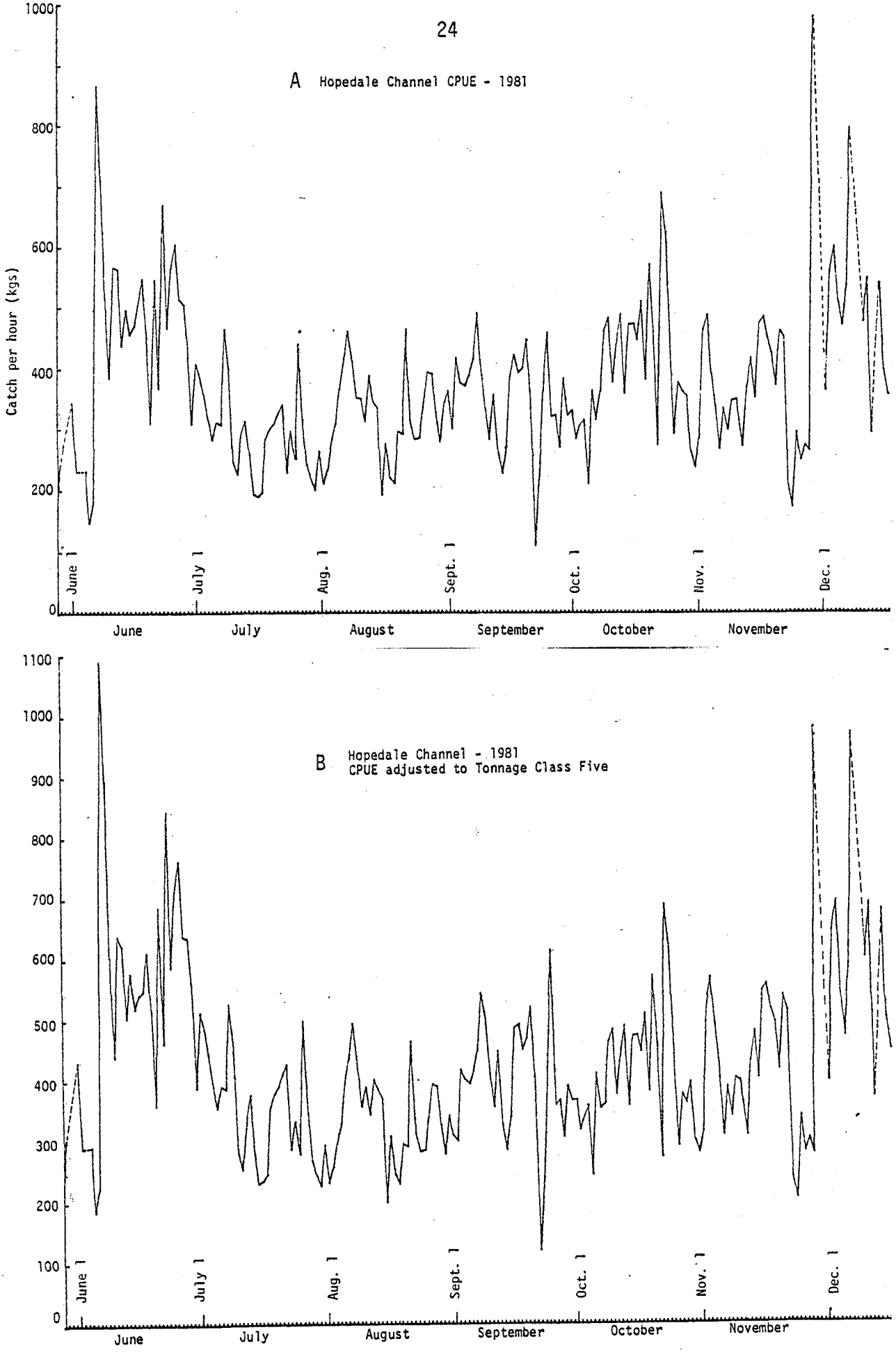

Fig. 2. Catch per unit effort - 1981, A = not standardized; B = standardized.

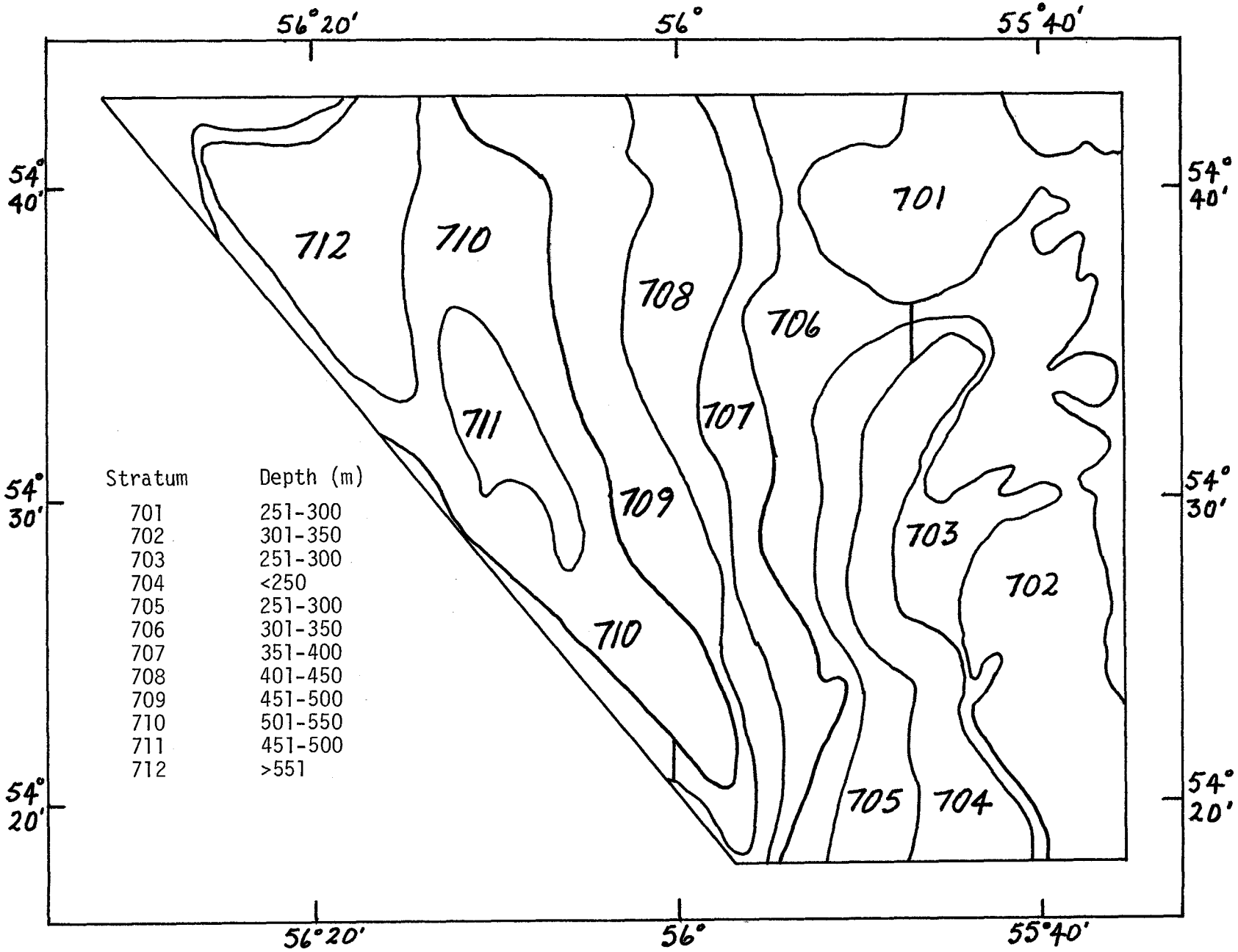

Fig. 3. Stratification of the Cartwright Channel.

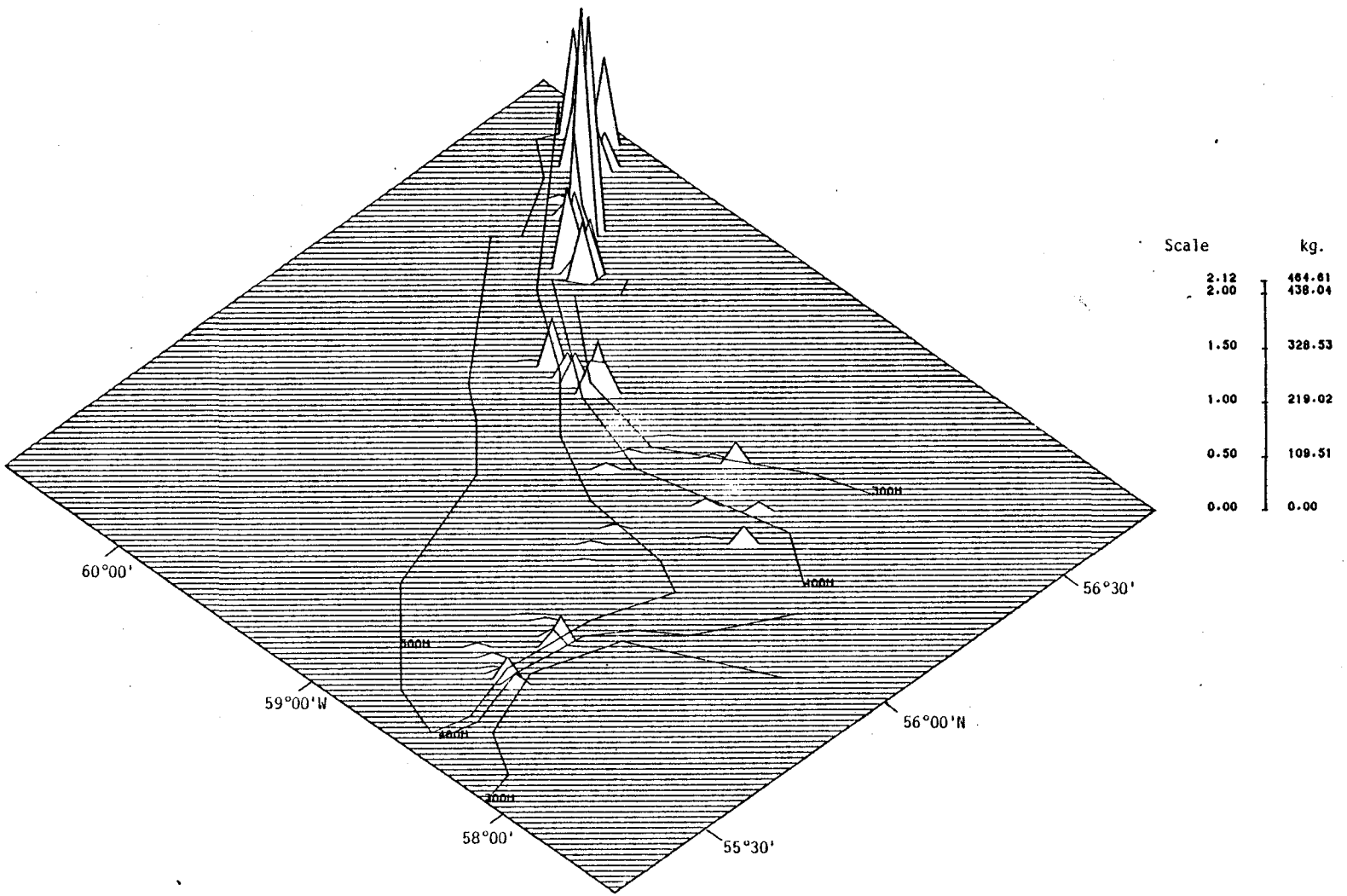

Fig. 4. Shrimp catches per 30 minute tow - Hopedale Channel, 1981

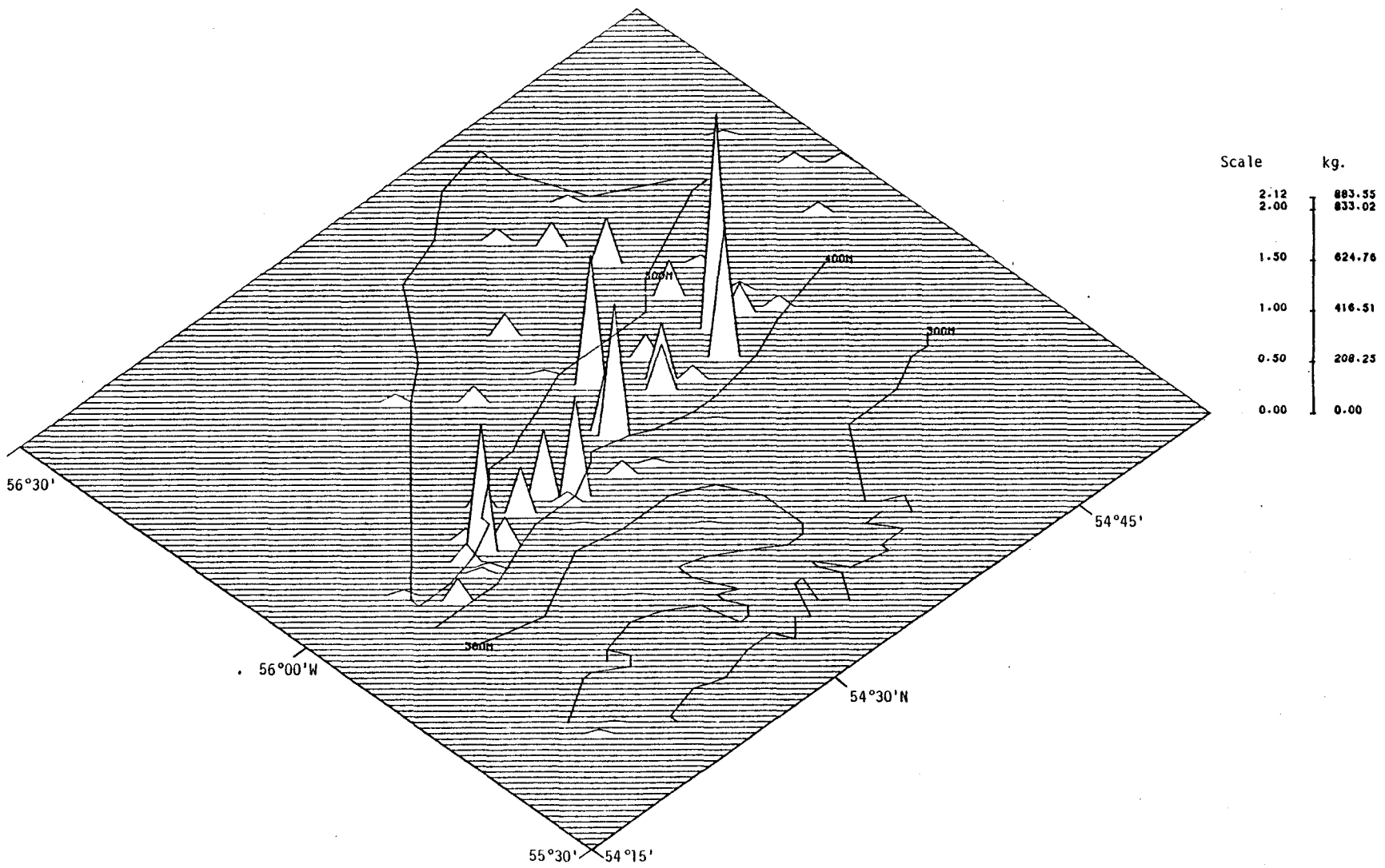

Fig. 5. Shrimp catches per 30 minute tow - Cartwright Channel, 1981

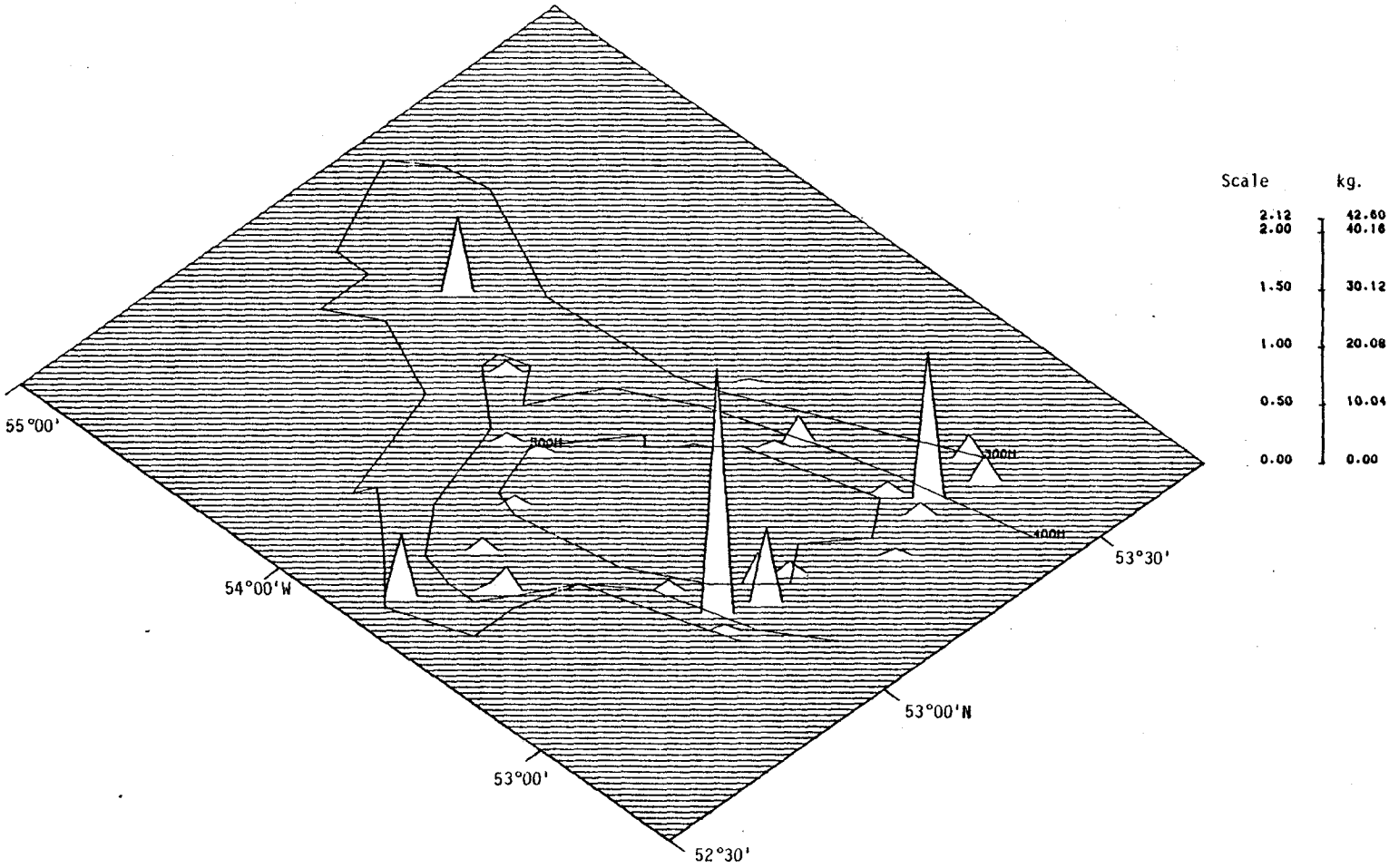

Fig. 6. Shrimp catches per 30 minute tow - Hawke Channel, 1981

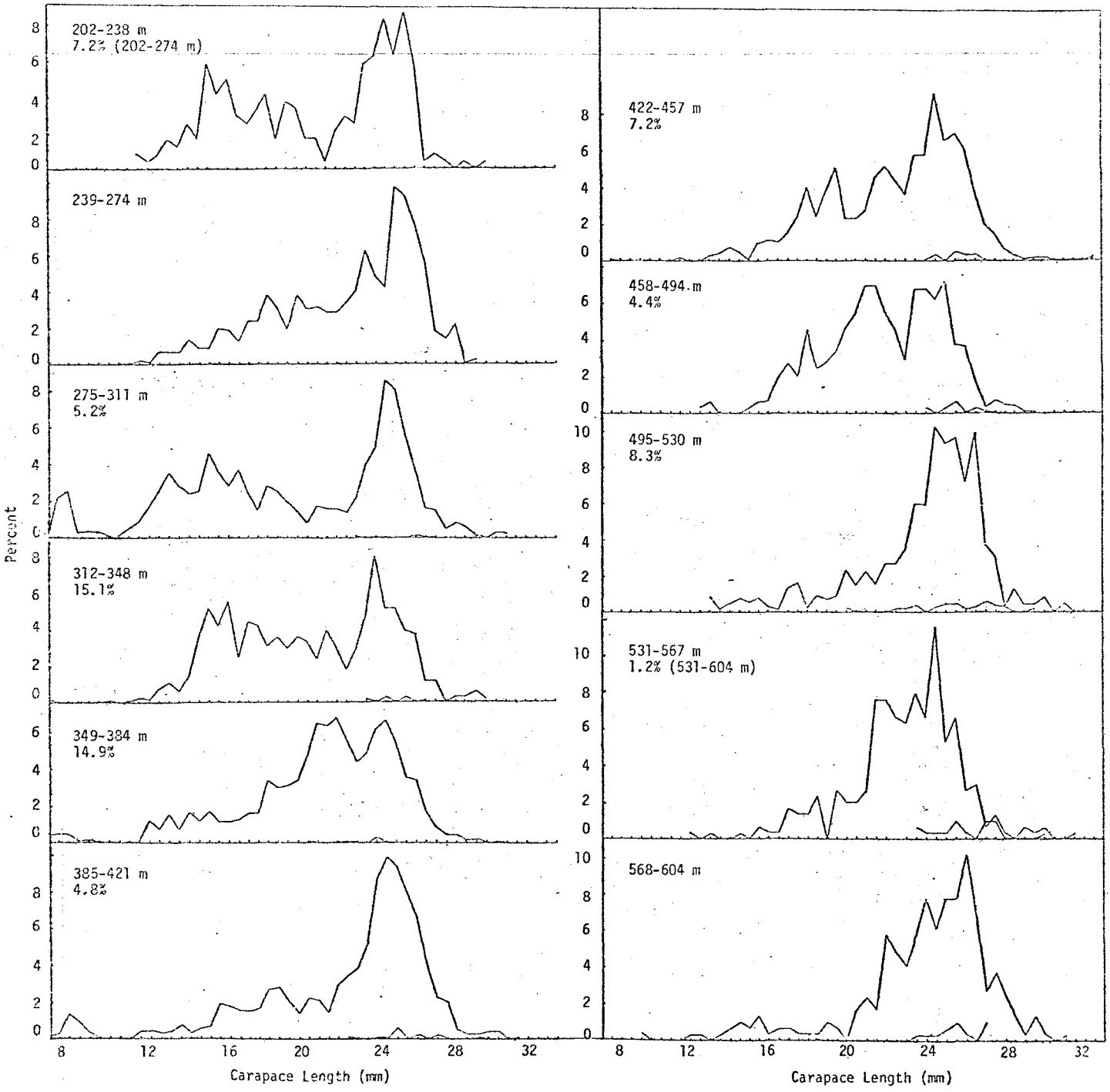

Fig. 7a. Research length frequencies, Hopedale Channel Zone 1 - 1981. (% of biomass indicated)

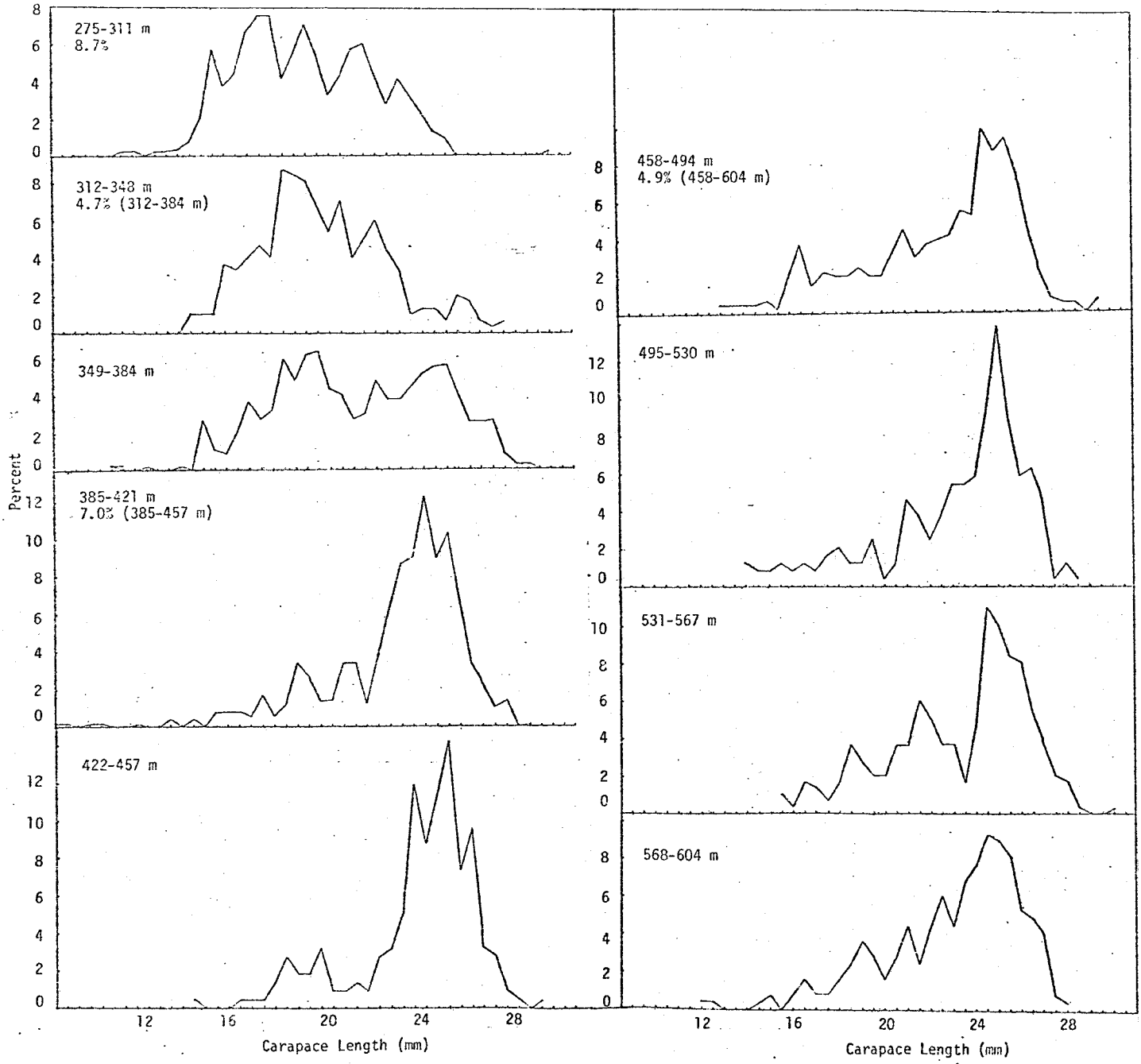

Fig. 7b. Research length frequencies, Hopedale Channel Zone 2 - 1981. (% of biomass indicated)

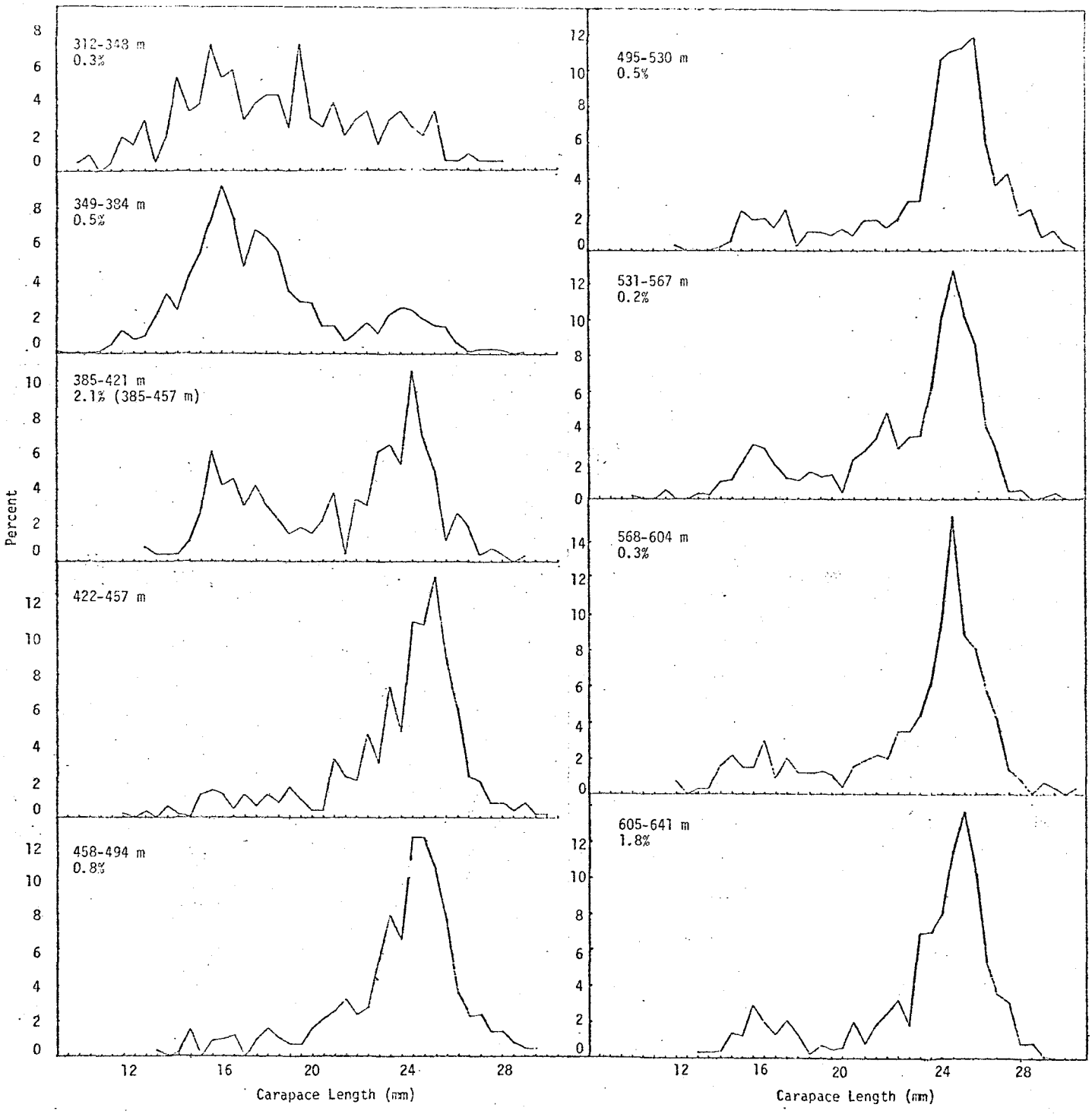

Fig. 7c. Research length frequencies, Hopedale Channel Zone 3 - 1981.
(% of biomass indicated)

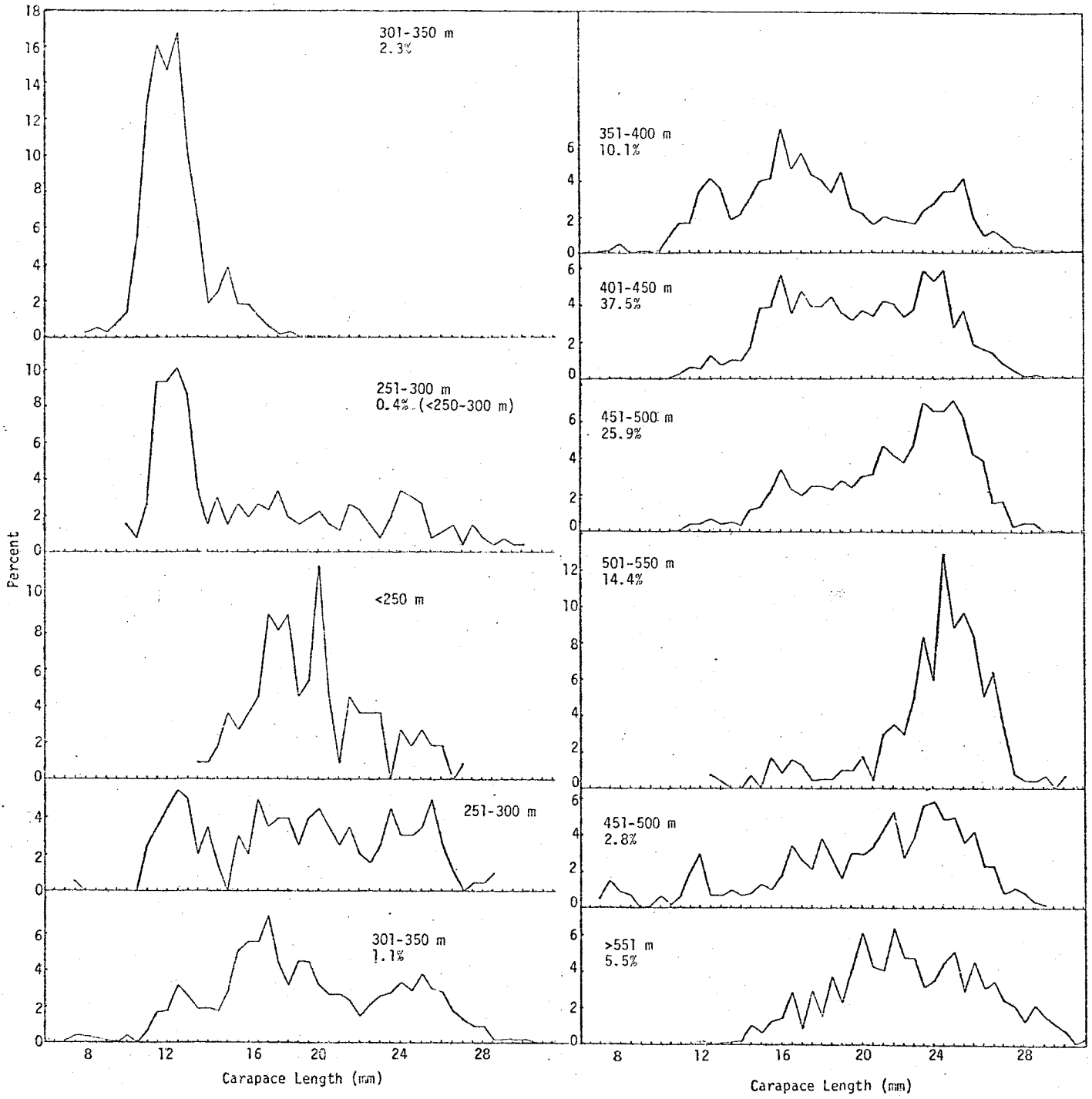

Fig. 8. Research length frequencies, Cartwright Channel - 1981.
(% of biomass indicated)

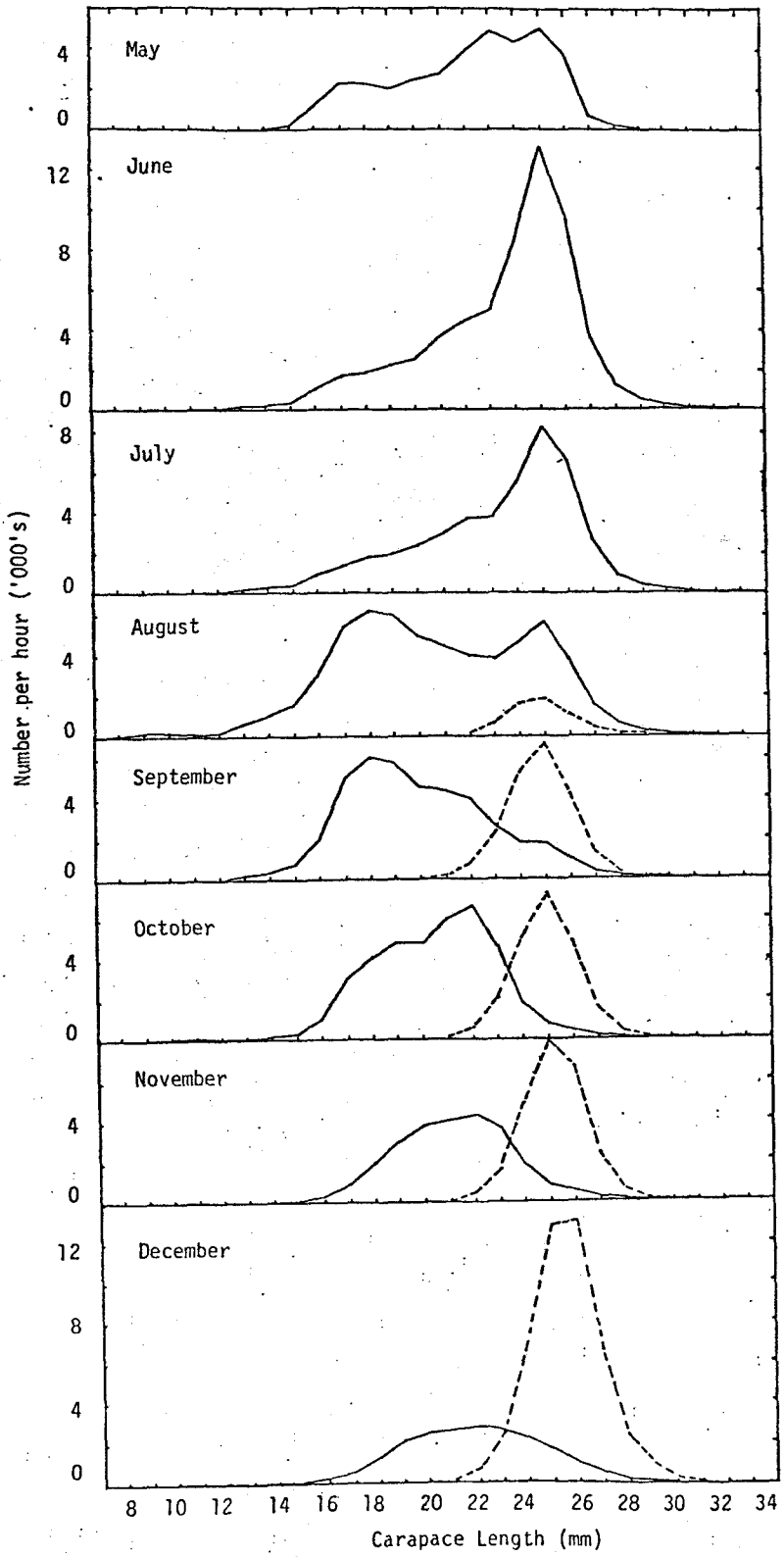

Fig. 9. Commercial length frequencies, Hopedale Channel - 1981. (broken line - ovigerous)

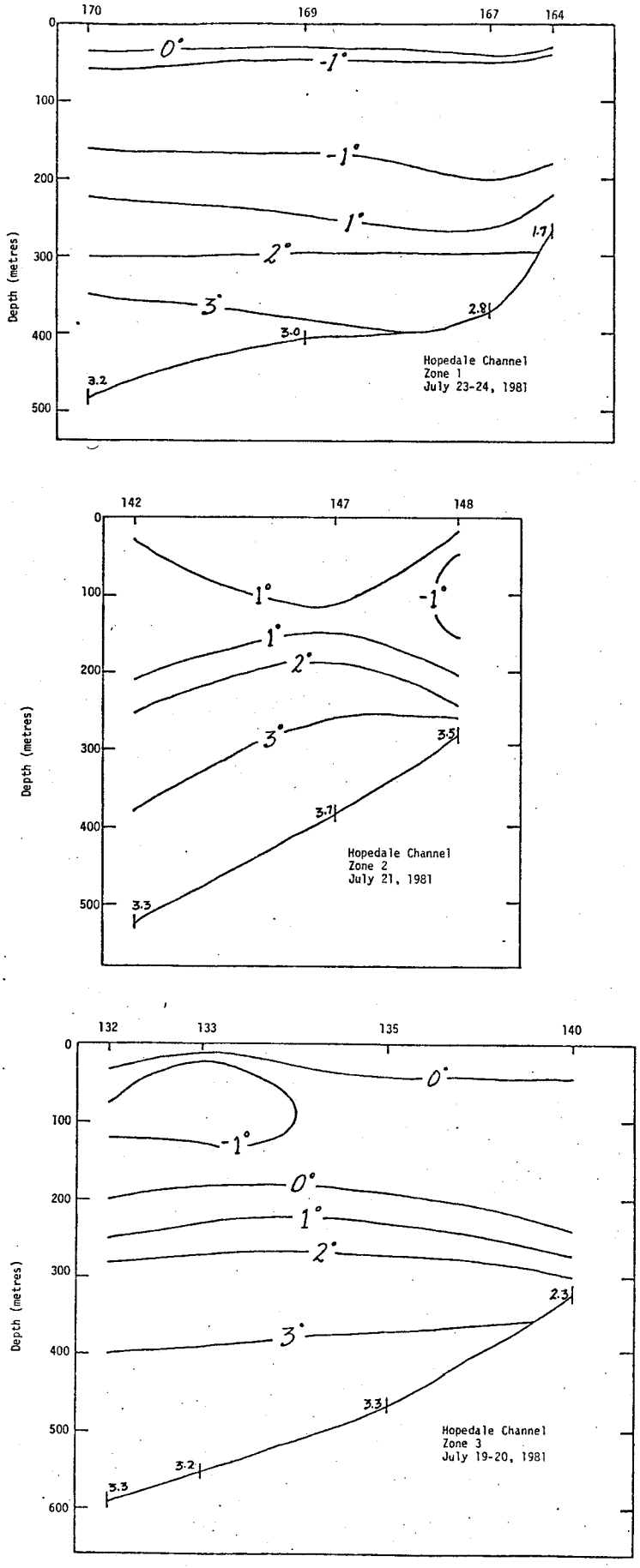

Fig. 10. Hydrographic sections, Hopedale Channel - 1981.

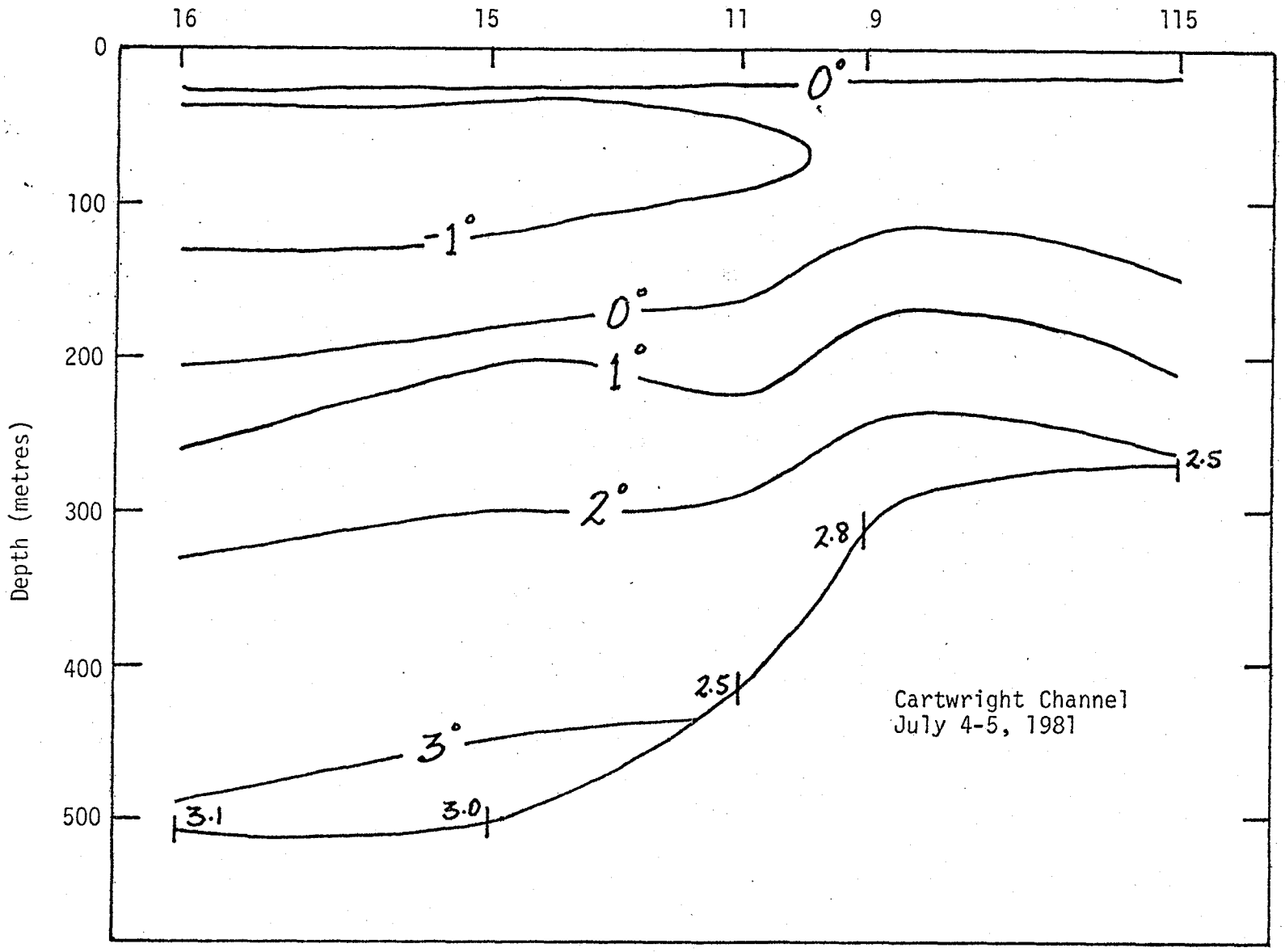

Fig. 11. Hydrographic section, Cartwright Channel, 1981.

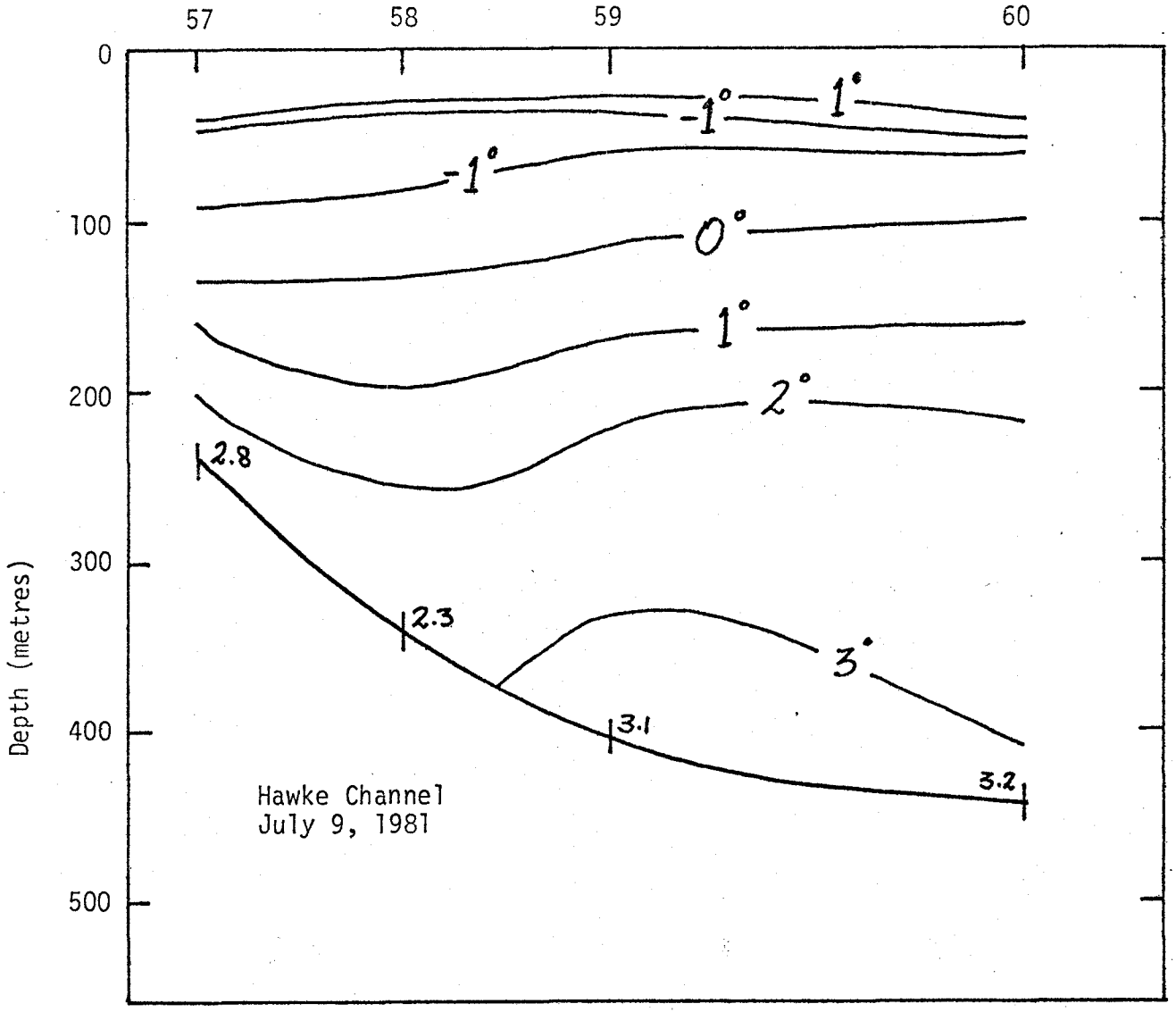

Fig. 12. Hydrographic section, Hawke Channel, 1981.