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Canadian Atlantic Fisheries Scientific Advisory Committee

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CAFSAC Research Document 83/11

CSCPCA Document de Recherche 83/11

Distribution, Abundance and Some Biological Characteristics of the Striped Pink Shrimp (*Pandalus montagui*) in the Eastern Hudson Strait and Ungava Bay

by

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Les Documents de Recherche sont publiés dans la langue officielle utilisée par les auteurs dans le manuscript envoyé au secrétariat.

Abstract

Results of a research survey in September, 1982 showed a relatively small area of high concentration of P. montagui in the area west of Resolution Island. A fishable biomass of roughly 3000 t was estimated by areal expansion over an area of 254 sq. n miles. No substantial concentrations of shrimp were found in Ungava Bay over an area of 1100 sq. n miles. Higher proportions of larger animals were found in shallow water in the former area. This pattern of distribution was not evident in Ungava Bay. Fecundity of females differed signifiantly between areas and the data showed that P. montagui in these areas is roughly twice as fecund as P. borealis off Labrador. Weight-length relationships were similar between areas and comparable at smaller sizes (<20 mm) to P. borealis. Bottom temperature where P. montagui were most abundant were around 0°C.

Sustainability of these resources is questionable, especially in light of extremely harsh environmental conditions (esp. strong currents). No advice was provided for potential yields in Ungava Bay because of the low concentrations of shrimp but in the area west of Resolution Island, removals in the order of 750 to 1000 t might be considered in the short term. In this area, catch rates are high, by-catches are low, and shrimp are of acceptable commercial size.

Résumé

Au cours d'un relevé par navire de recherche en septembre 1982, on a trouvé une aire relativement petite de fortes concentrations de P. montagui à l'ouest de l'île Résolution. Par expansion d'aire à une superficie de 254 milles marins carrés, on estime à environ 3 000 t la biomasse pêchable. On ne trouve aucune importante concentration de crevettes sur une superficie de plus de 1 100 milles marins carrés de la baie d'Ungava. Dans la première région, on observe de plus fortes concentrations de grosses crevettes en eau peu profonde. Ceci n'est pas évident dans la baie d'Ungava. Il y a, d'une région à l'autre, des différences significatives de fécondité des femelles et les données démontrent que P. montagui dans ces régions a une fécondité environ deux fois plus élevée que celle de P. borealis au large du Labrador. Les relations longueur-poids sont semblables dans les deux régions et, à de petites tailles (< 20 mm), se comparent à celles de P. borealis. La température du fond, là où P. montagui est les plus abondant, est aux alentours de 0°C.

On doute que ces ressources soient soutenues, surtout quand on songe aux conditions ambiantes extrêmement rudes (surtout forts courants). Nous n'émettons pas d'opinion sur les rendements potentiels dans la baie d'Ungava, à cause des faibles concentrations de crevettes. Par contre, dans la région de l'ouest de l'île Résolution, des récoltes de l'ordre de 750 à 1 000 t peuvent être envisagées à court terme. Dans cette région, les taux de capture sont élevés, les prises d'espèces secondaires faibles et les crevettes de taille commerciale acceptable.

Introduction

Concentrations of the striped pink shrimp (*Pandalus montagui* Leach) exhibiting commercial potential in areas of the eastern Hudson Strait and Ungava Bay were first reported in 1978 (Anonymous). In 1979, some research and experimental commercial fishing was conducted resulting in a total catch in excess of 90 t. Three management areas were established in 1980 with removals restricted to 100 t in each. These areas were: 1) west of Resolution Island (Hudson Strait), 2) off Port Burwell (Ungava Bay), and 3) grounds outside these defined areas of concentration. Approximately 240 t were taken in 1980, mostly from the Resolution Island grounds.

Data from the research and experimental fishing in 1979 were analyzed early in 1981 (Parsons *et al*. 1981). Estimates of biomass were provided and potential yields were estimated between, roughly, 300 and 400 t for the area off Port Burwell and between 550 and 650 t for the area west of Resolution Island. Because there was 'very little biological information available' and the 'degree of reliability in these estimates (was) low', the 100 t restrictions of 1980 were maintained for 1981. Except for 10 t taken in experimental work, no fishing was reported from these areas in 1981.

No new information was available to provide advice on catch levels for 1982 and the 'preemptive' TAC's of the previous two years were reiterated. Commercial fishing did not occur.

A research survey was conducted in and around the two areas previously identified from September 9-28, 1982, to provide up-to-date estimates of stock size and obtain more biological information on the species. Some of the results of that survey are presented below, along with comparative data from previous years, in an attempt to establish a basis for more meaningful resource management in these areas.

Materials and Methods

The 1982 survey was conducted onboard the 80.5 m research vessel, *Gadus Atlantica*. The fishing gear used was a Sputnik 1600 shrimp trawl with a headline of 43 m and a 51 m footrope. Mesh size ranged from around 80 mm (stretched) in the wings to 40 mm in the cod end. A 13 mm liner also was used in the last 6 m of the cod end. The estimated horizontal opening of the trawl between wingtips was 22 m and the vertical opening, approximately 7 m.

Randomly selected stations were fished in each area, according to a preliminary stratification scheme. Details of the stratification were subsequently refined (Fig. 1 and 2). Minimum trawlable biomass was estimated in both areas using areal expansion methods. The grounds west of Resolution Island were treated in two ways: 1) total area surveyed, and 2) area considered to be the commercially fishable zone. The latter was determined from records of commercial fishing in previous years and from the refinement of the stratification in the present study. Estimates for the area off Port Burwell were made for the complete survey area.

The standard fishing set was 30 minutes duration and vessel speed was 3.0 knots. The warp length to depth ratio was approximately 3 to 1. Bottom temperatures were obtained for each survey set using an expendable bathythermograph (XBT).

Fishing sets were made on one station west of Resolution Island to monitor patterns of diel variability in catch rates. A current meter was deployed providing records of temperature, salinity, current direction and current speed as a supplement to standard set and catch details.

Carapace lengths were measured to the nearest 0.1 mm for each fishing set which produced shrimp. These were grouped to 0.5 mm for length frequencies but the 0.1 precision was maintained for comparisons with weight and fecundity. In routine sampling, 200 animals or more were measured per set.

Additional samples from each area were preserved in 10% formalin for subsequent biological observations including fecundity of females and weight-length relationships. Least squares regression of log fecundity and log weight on log length provided estimates of the constants $\underline{a}$ and $\underline{b}$ under the assumed relationships:

$$\text{fecundity} = a\ \text{length}^{b} \quad \text{and} \quad \text{weight} = a\ \text{length}^{b}$$

Samples from each area were compared by analysis of covariance.

Results and Discussion

Distribution and abundance

An area of almost 900 square nautical miles was included in the survey west of Resolution Island. Highest catches occurred within 25 kilometers of the west coast of the Island in depths between 200 and 350 m (Fig. 3). Catches outside this area of high abundance were generally lower.

As indicated previously, the preliminary stratification guidelines were revised based on numerous soundings taken during the cruise. Areas were calculated for each stratum and catches obtained within were used to calculate estimates of biomass (Table 1). Some strata were combined to obtain a minimum of two sets per stratum, provided the catches did not differ greatly. The biomass estimate for the total area was 6617 t $\pm$ 4087. However, 62% of this estimate came from one stratum of approximately 130 square nautical miles between 250 and 300 m. Nine of ten sets made in this zone were in the northeastern portion (Stratum 114) where abundance was high. The other set was farther west (Stratum 104) and not as productive. In other areas, densities were substantially lower and much of the total estimate is a function of extrapolation of relatively small catches over large areas. Therefore, an area was designated as a commercial zone (Fig. 1, area inside broken line) based on catch records from commercial vessels which had fished the concentrations in previous years. New information obtained from results of the 1982 survey and the revised stratification also were considered in delineating this area.

Approximately 255 square nautical miles were included in the commercial zone (Table 2) of which around 190 can be considered productive.

The estimate obtained (3000 t + 2200) is more representative of a fishable biomass. Again, more than 60% of this estimate is generated from one stratum (53.8 sq. n mi.) indicating that density is high over a relatively small area.

Data from 1979 (Parsons et al. 1981) indicated a minimum trawlable biomass between 2000 and 3000 t for an area of roughly 190 square nautical miles. Considering the differences in the types of surveys and differences in times, the estimates and their components are in reasonable agreement. The confidence in the 1982 survey estimates is no better (or worse) than that obtained for other northern shrimp (Pandalus borealis) stocks in the Labrador Sea and Davis Strait.

Over 1100 square nautical miles were surveyed in the area off Port Burwell in Ungava Bay. No large concentrations of shrimp were located but best catches were obtained on the western slope of the depression in depths between 200 and 300 m (Fig. 4).

The preliminary stratification scheme in this area also was revised with new soundings obtained during the survey. Because of the extremely low abundance and absence of shrimp in most areas, many sets were deleted. Consequently, adjacent strata were combined in the final analysis to obtain a sufficient sample size. Differences in catches between these strata were not substantial.

Minimum trawlable biomass was estimated at 451 t ± 211 (Table 3). If strata 403 and 404 are calculated separately the estimate becomes 451 t ± 1241. This contrasts the estimates between 1166 and 1769 t obtained for an area 120-130 square nautical miles in 1979 (Parsons et al. 1981). Seasonal differences of this magnitude would not be anticipated (August-September 1979, September 1982). It also should be noted that poor catches were obtained with limited commercial effort in both 1980 and 1981.

Preliminary data on the diel variability in shrimp catches were presented at a November workshop of the Invertebrate & Marine Plant Subcommittee of CAFSAC. The current meter data have been processed but an in-depth statistical analysis of all data has not been completed.

Size Composition

Length frequencies from the 1982 survey in the area west of Resolution Island (Hudson Strait) are presented in Fig. 5 and 6. A range of size groups were represented in depths where shrimp were most abundant (250-300 m). Modes were evident around 16, 18-22, and 23-26 mm. The 18-22 and 23-26 mm modes often exhibited bimodality and are likely composed of two or more age groups. Around 25% of the animals were ovigerous in depths where most biomass was found.

The data suggest that higher proportions of larger animals (>22 mm) occurred in the shallower strata. This was especially evident in the commercial zone (Fig. 6). Highest proportions of ovigerous animals also were found in shallower water.

Limited sampling from September 1981 (Fig. 7) shows similar sizes at all depths with most animals between 18 and 22 mm. There was a smaller proportion of animals greater than 22 mm in all depths compared to the 1982 survey. In the 1979 survey, two modes were most prominent at 20 and 22 mm (Parsons et al. 1981). There was some indication of a slight increase in size with depth and the proportion of animals greater than 22 mm was higher than in 1982.

Data from all years suggest that a significant part of the larger animals (females) may not spawn every year.

Sizes of shrimp observed in the area off Port Burwell are given in Fig. 8 (west) and Fig. 9 (east). Shrimp in the depths of highest abundance, 200-300 m on the western side covered a range of sizes but most were larger than 20 mm (Fig. 8). Changes in size with depth were not obvious except for a slightly higher proportion of smaller animals and a lower proportion of ovigerous females in depths less than 250 m. Over 30% of all animals were ovigerous at most depths.

On the east side where abundance was extremely low, larger animals occurred in deeper water (Fig. 9). The proportion of ovigerous animals (>50% in most strata) increased with depth and smaller sizes (12-17 mm) were found in depths less than 250 m.

Data from 1981 were similar to those from the western side except that a higher proportion of ovigerous shrimp were found in the shallower water (Fig. 10). In 1979 when abundance was much higher, most shrimp occurred in the 23-24 mm size group with a second size component around 16-18 mm (Parsons et al. 1981). Around 30% of the animals were ovigerous at this time as well.

As in the northern area of concentration, it appears that females may not spawn every year.

Fecundity

Eggs were removed from female shrimp from both areas and enumerated. The resulting relationships were

$$\text{No. of eggs} = 0.1773L^{3.0637} \quad (n = 47)$$

for the west Resolution concentration and

$$\text{No. of eggs} = 6.7370L^{1.9166} \quad (n = 45)$$

for the concentrations off Port Burwell (Fig. 11). Analysis of covariance indicated a significant difference between the slopes ($P < 0.01$). These data could just as well be explained by a straight line but were treated in the traditional manner for comparative purposes.

Relationships for female shrimp in these areas were plotted against a curve fitted to data for P. borealis in the Hopedale Channel (Fig. 12) (Parsons 1982). The comparison illustrates that P. montagui are roughly twice as fecund as the congeneric in the more southern area. Although egg diameters were not recorded, it was obvious that they are considerably smaller than those of P. borealis. However, it should be recalled that the evidence suggests intermittent spawning for P. montagui, making the 'effective' fecundity more comparable.

Weight-length

Preserved weights at length were obtained for samples from each area resulting in the relationships

$$\text{ovigerous } W = 0.001037L^{2.902046} \; (n = 96)$$

and

$$\text{non-ovigerous } W = 0.000992L^{2.859880} \; (n = 192)$$

for west Resolution and

$$\text{ovigerous } W = 0.004476L^{2.434924} \; (n = 101)$$

and

$$\text{non-ovigerous } W = 0.001208L^{2.793670} \; (n = 200)$$

for the shrimp off Port Burwell (Fig. 13). Analysis of covariance indicated a significant difference between slopes for ovigerous animals ($P < 0.01$) but no differences in slopes ($P = 0.15$) or intercept ($P = 0.70$) for non-ovigerous animals (Fig. 14). Differences in the former may simply be a reflection of differences in fecundity observed previously.

The non-ovigerous relationships were compared with a weight-length curve for P. borealis in the Hopedale Channel (Fig. 15) (Parsons 1982). The graphic comparison shows similar weights at smaller sizes but beyond 20 mm or so P. borealis appear heavier at comparable lengths.

Hydrography

Temperature profiles for both areas are presented in Fig. 16. In the Hudson Strait, water less than 0°C extended from the surface to the bottom in depths where shrimp were most plentiful (200-300 m). Temperature increased slightly in deeper water (to 400 m) but remained less than 1°C. Water in Ungava Bay off Port Burwell also was cold. Surface temperatures were above 1°C but cooled to 0°C around 100 m. Waters between 100 m and the bottom to depths of 400 m were below 0°C.

A deep water channel (to 900 m and more) runs between the two areas of shrimp concentration. Temperatures are not available from these depths but data recorded in 1978 (Anonymous) indicated warmer water (up to 2.3°C) in depths greater than 400 m.

Conclusions

The research survey in 1982 produced mean estimates of biomass that correspond reasonably well with those obtained in 1979 in the area west of Resolution Island. If, indeed, there is a fishable biomass in the order of 3000 t, then removals between 750 and 1000 t might seem appropriate (depending on whether an exploitation rate of 25% or 35% is applied). Abundance estimates are no more reliable than for other *Pandalus* 'stocks' in northern waters.

In 1981, the concept of sustainability for these concentrations was raised in light of the poor catch rates obtained off Port Burwell in 1979 compared with the previous year (Parsons *et al.* 1981). This question is even more relevant today since a limited amount of fishing effort in 1981 and an intensive research survey in 1982 failed to produce catch rates which would attract commercial vessels. The mean estimate of biomass in this area in 1982 was only 451 t, spread over an area of 1,100 square nautical miles. Advice on catch levels is not necessary under these conditions. The area may be identified simply as having shown some potential in the past and it may be in the best interest of industry to maintain a monitor on this potential and perhaps harvest on an opportunistic basis.

Using the Port Burwell situation as a model, some additional consideration might be given to the area west of Resolution Island. Although high catch rates have been obtained since 1978, the area has been virtually unfished and, thus, should possess many of its 'virgin' characteristics. Length distributions, however, have changed considerably over the years and the accumulation of old, large animals is not always apparent. Conditions may be very dynamic with respect to natural mortality, recruitment and/or environmental factors. Advice in terms of an annual 'sustainable' harvest may not be an appropriate management strategy.

The shrimp concentrations west of Resolution Island possess a number of characteristics which should be attractive to the industry. Catch rates are variable but daily production is high relative to that achieved off Labrador and in the Davis Strait. By-catches, mainly Greenland halibut, arctic cod and thorny skate (Parsons *et al.* 1981), are small resulting in better quality shrimp and more efficient processing. Sizes encountered in areas of highest abundance likely would fall into the medium and large processing categories but some reduction might be anticipated under sustained fishing pressure. Discard rates should be closely monitored. The similarity in weight-length relationships between *P. montagui* in this area and *P. borealis* in the Hopedale Channel indicate that yields should be very similar.

During September 1982, there was a high incidence of 'black head' which was most noticeable after cooking. The causes of this condition have not been identified but may be related to discoloration of the ovary after cooking and/or rupture of the stomach and spreading of its contents. Since it appears to be unavoidable, some alternative processing procedures may be desirable. Immediate cooking and peeling should minimize the problem.

From a biological point of view, it is not certain how or if concentrations in the two areas are related. Although weight-length relationships (for non-ovigerous animals) appear to be similar, fecundity levels show differences. The areas are separated by deep and relatively warm water and the surface currents are both strong and variable. Direct interaction between concentrations is not likely but recruitment mechanisms are not known.

This information is inadequate to conclude that the concentrations constitute separate stocks. However, since some differences were noted and the concentrations appear to be isolated from one another, they can be treated as such for preliminary assessment purposes.

References

Anonymous. 1978. Report on exploratory fishing assessments on pink shrimp fishery potential in northeastern Canadian waters. MacLaren Marex, Inc.

Parsons, D. G. 1982. Biological characteristics of Northern Shrimp (Pandalus borealis Krøyer) in areas off Labrador. M.Sc. Thesis. M.U.N. 123 p.

Parsons, D. G., G. E. Tucker, and P. J. Veitch. 1981. Estimates of potential yield for shrimp (Pandalus montagui) in the Eastern Hudson Strait and Ungava Bay. CAFSAC Res. Doc. 81/6, 22 p.

Table 1. Minimum trawlable biomass - 1982 research, Hudson Strait (total area).

Stratum	Depth (m)	Area (sq. n mi.)	No. sets	Biomass (t)	95% C.I.	
					Upper	Lower
104 + 114	251-300	128.9	10	4081.5		
105 + 126	>301	72.6	5	98.6		
206 + 207	351-450	28.7	3	92.4		
203 + 213	201-250	37.5	2	50.4		
204 + 214	251-300	46.5	3	117.0		
205 + 215	301-350	79.1	5	786.1		
202 + 212+ 302 + 312	151-200	41.9	2	181.2		
303 + 313	201-250	77.3	3	890.9		
314	251-300	26.3	2	17.2		
404	251-300	46.3	2	239.6		
106 + 107+ 405 + 406	>300	68.0	4	2.9		
403 + 413	<250	210.8	2	59.5		
TOTAL		863.9	43	6617.3	10704.2	2530.3

Table 2. Minimum trawlable biomass - 1982 research, Hudson Strait (commercial area).

Stratum	Depth (m)	Area (sq. n mi.)	No. sets	Biomass (t)	95% C.I.	
					Upper	Lower
114	251-300	53.8	9	1893.3		
214	251-300	9.5	3	75.5		
215	301-350	6.3	4	74.1		
212 + 312	151-200	31.8	2	181.2		
213 + 313	201-250	62.4	3	766.3		
314	251-300	26.3	2	17.2		
413[1]	<250	64.3	2	0.4		
TOTAL		254.4	25	3008.0	5206.0	809.9

[1] estimate obtained from two sets made in an adjacent stratum (403, Table 1).

Table 3. Minimum trawlable biomass - 1982 research, Ungava Bay.

Stratum	Depth (m)	Area (sq. n mi.)	No. sets	Biomass (t)	95% C.I.	
					Upper	Lower
104 + 105	251-350	225.6	6	23.8		
106	351-400	45.5	3	40.5		
204 + 205	251-350	156.3	2	95.8		
403 + 404	201-300	54.1	4	168.8		
405	301-350	32.0	2	14.3		
503	201-250	69.9	2	43.7		
504 + 505	251-350	36.7	2	6.8		
406 + 506	351-400	67.0	3	41.5		
103 + 203 + 603	201-250	206.2	3	8.3		
206 + 307 + 605 + 606	301-450	229.6	4	7.6		
TOTAL		1122.9	31	451.1	662.3	239.7

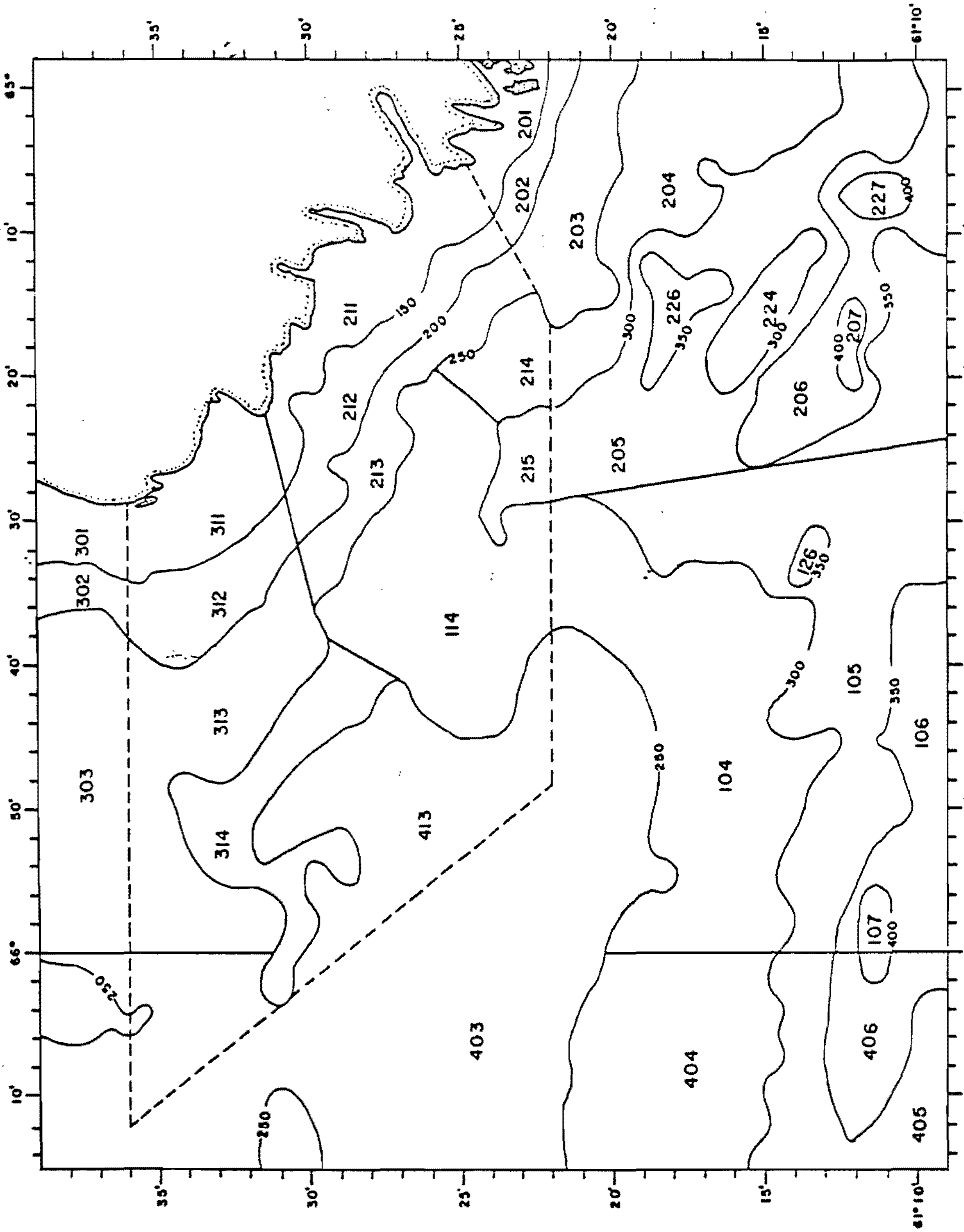


Fig. 1. Stratification of Hudson Strait (numbers indicate depth and stratum).

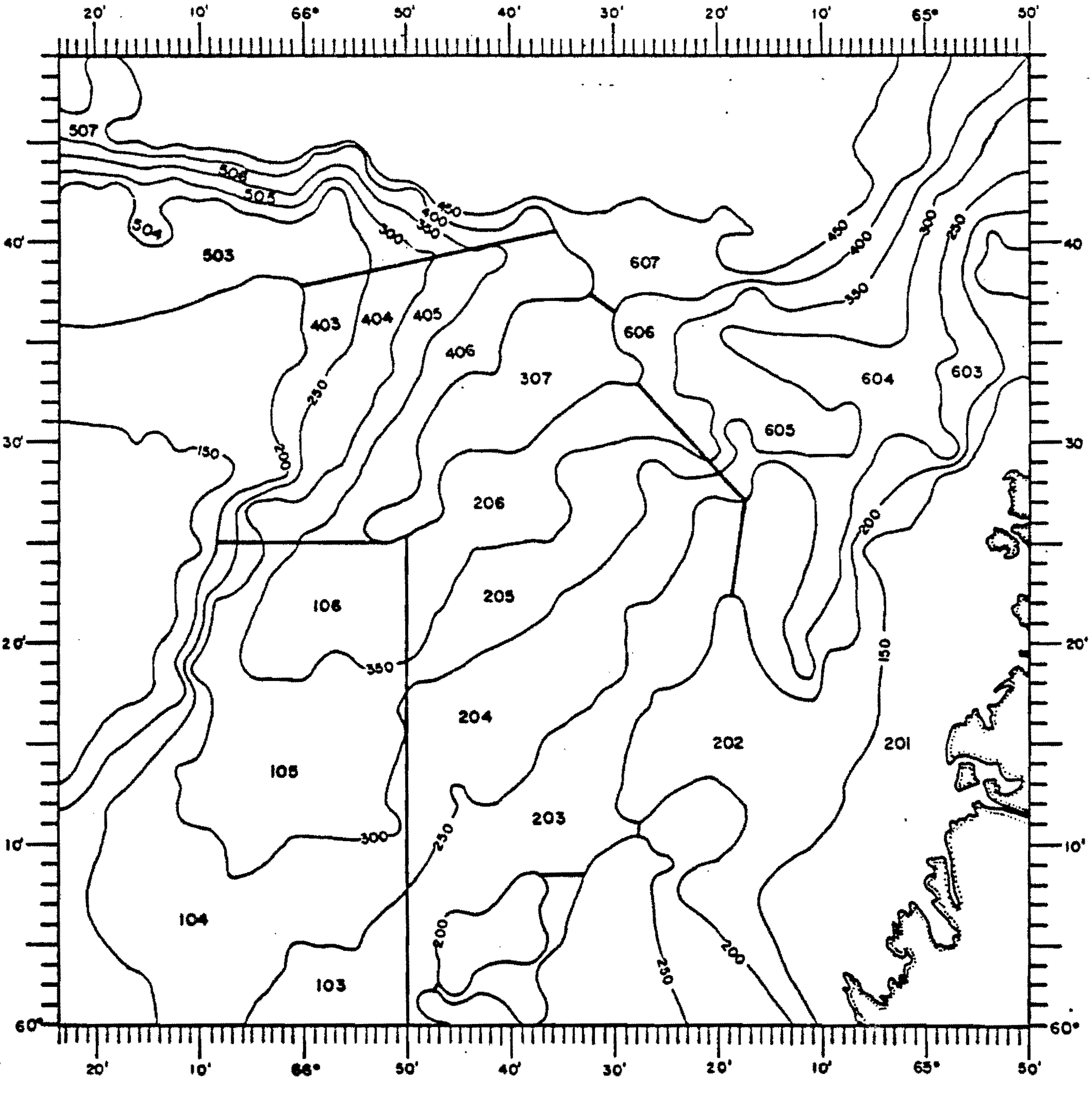


Fig. 2. Stratification of Ungava Bay.

(Numbers indicate depth and stratum.)

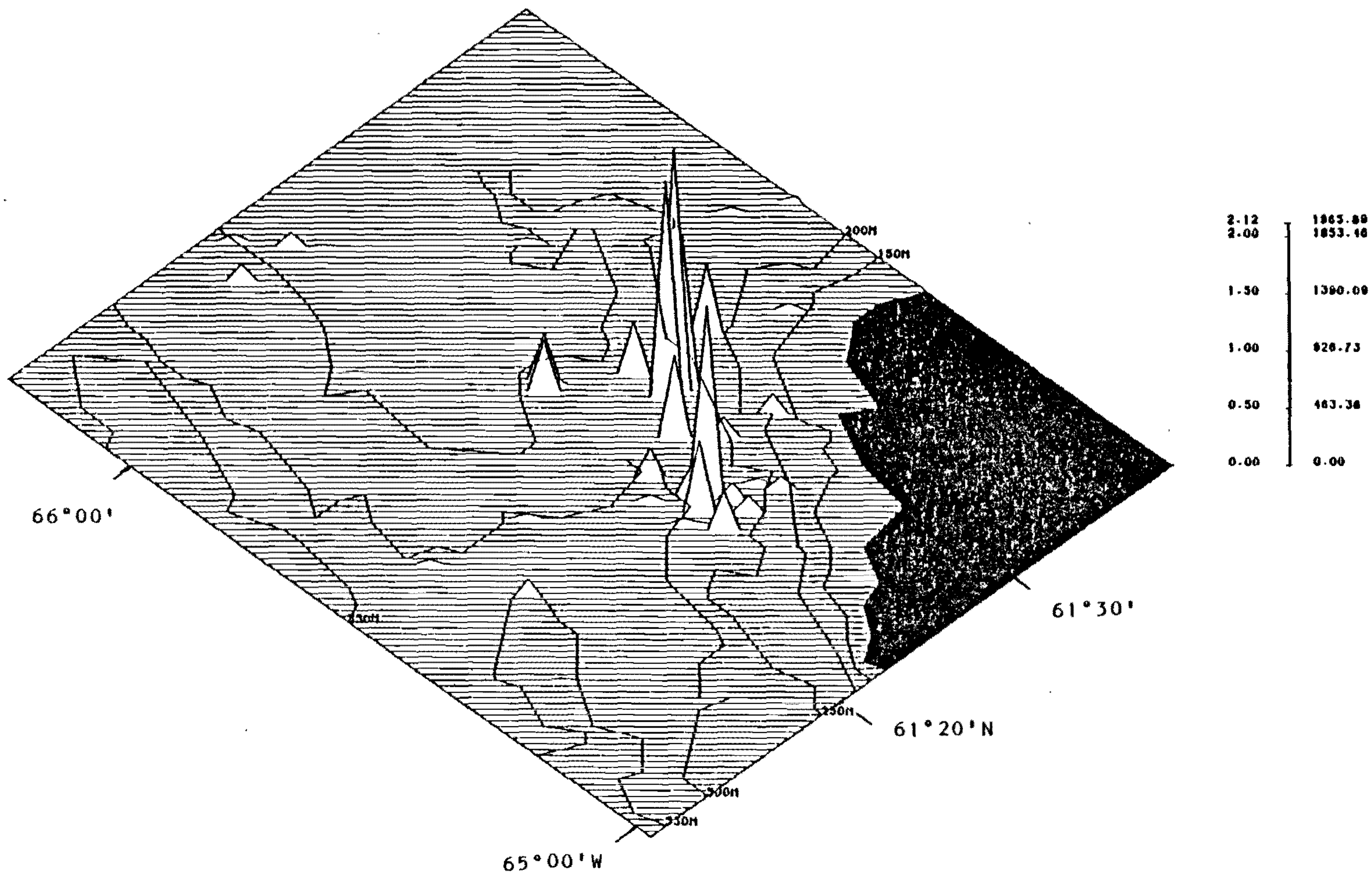


Fig. 3 SHRIMP CATCHES PER 30 MIN TOW - HUDSON STRAITS, 1982

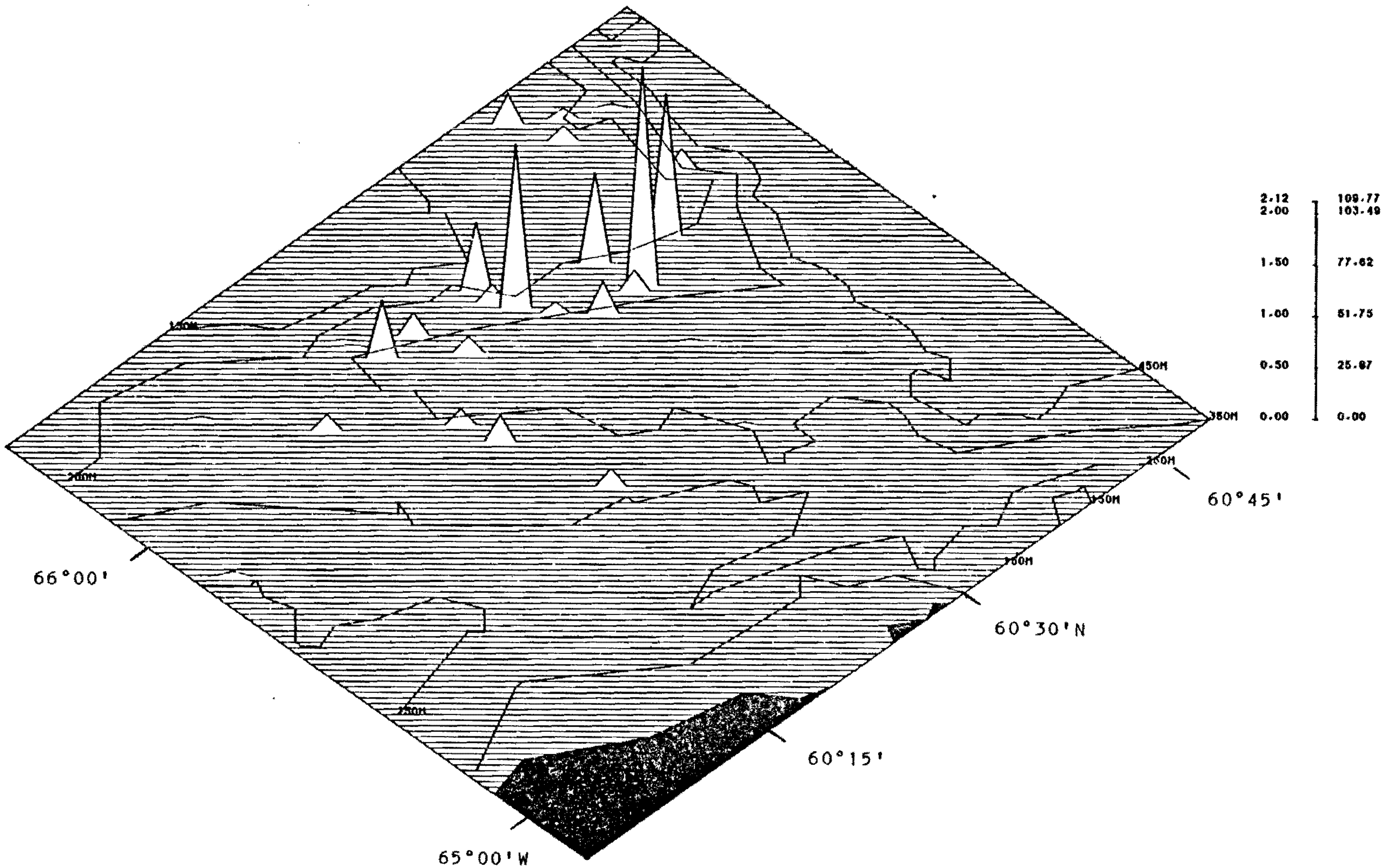


Fig. 4 SHRIMP CATCHES PER 30 MIN TOW - UNGAVA BAY, 1982

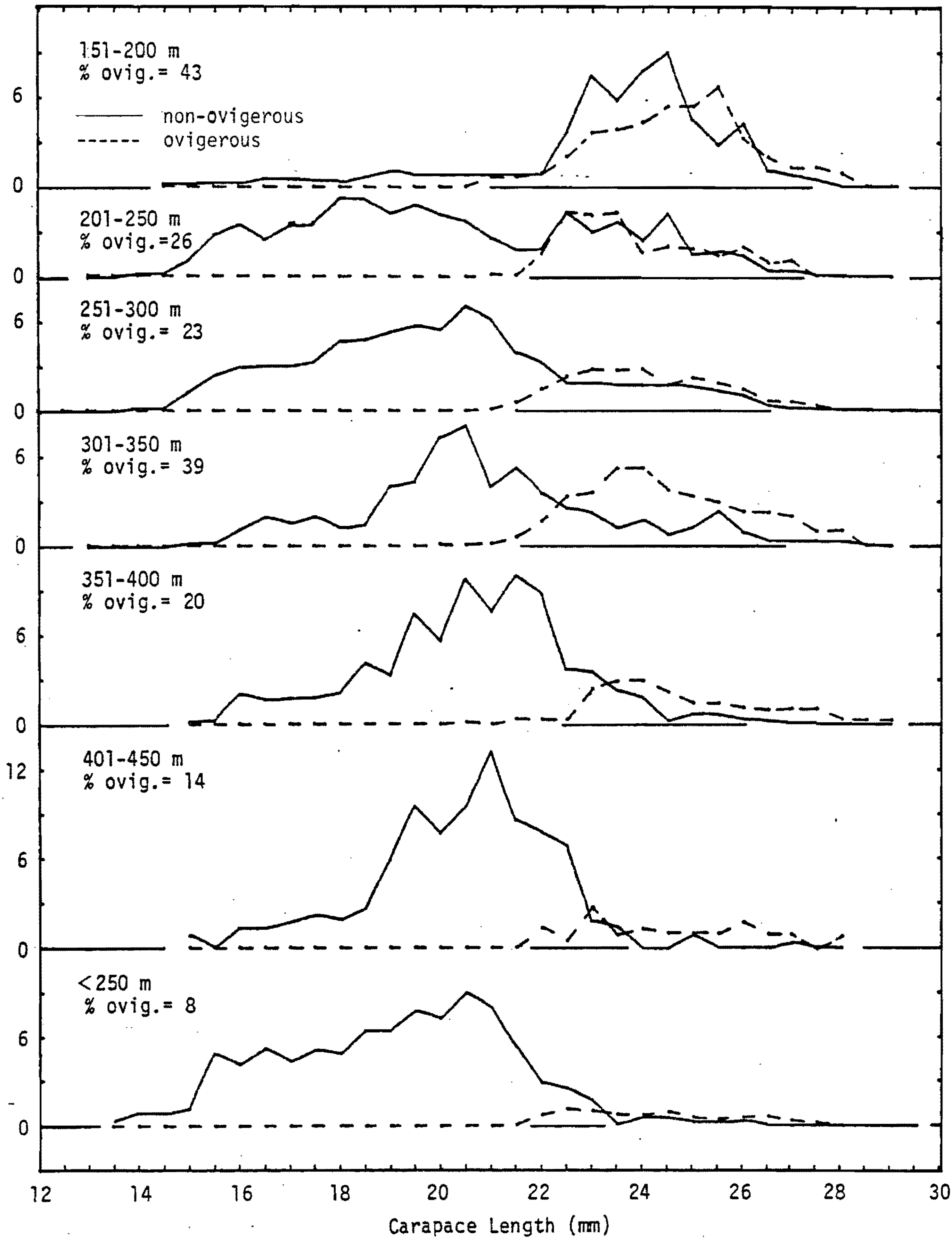


Fig. 5. Research length frequencies, Hudson Strait, Total Area - 1982.

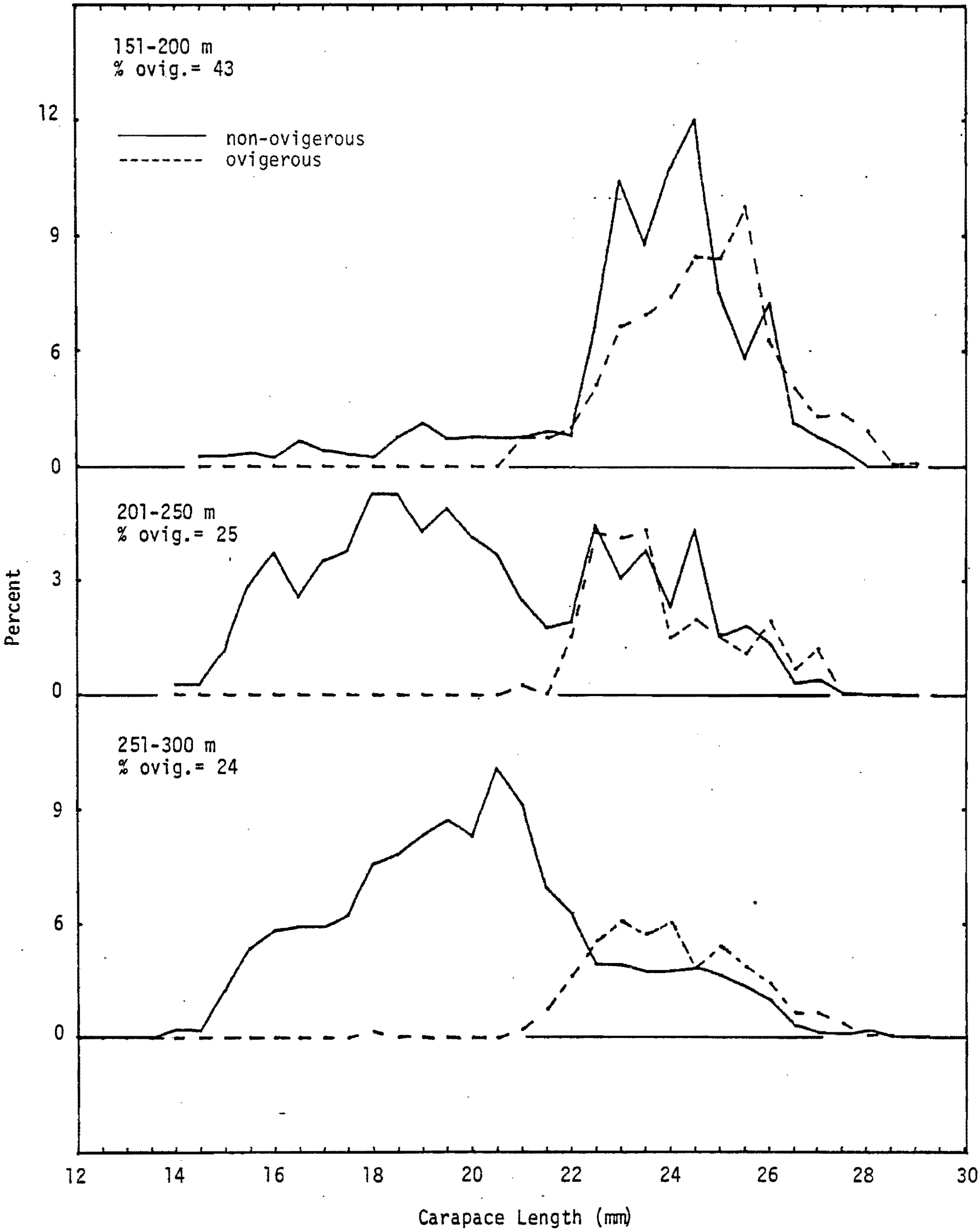


Fig. 6. Research length frequencies, Hudson Strait, Commercial Zone - 1982.

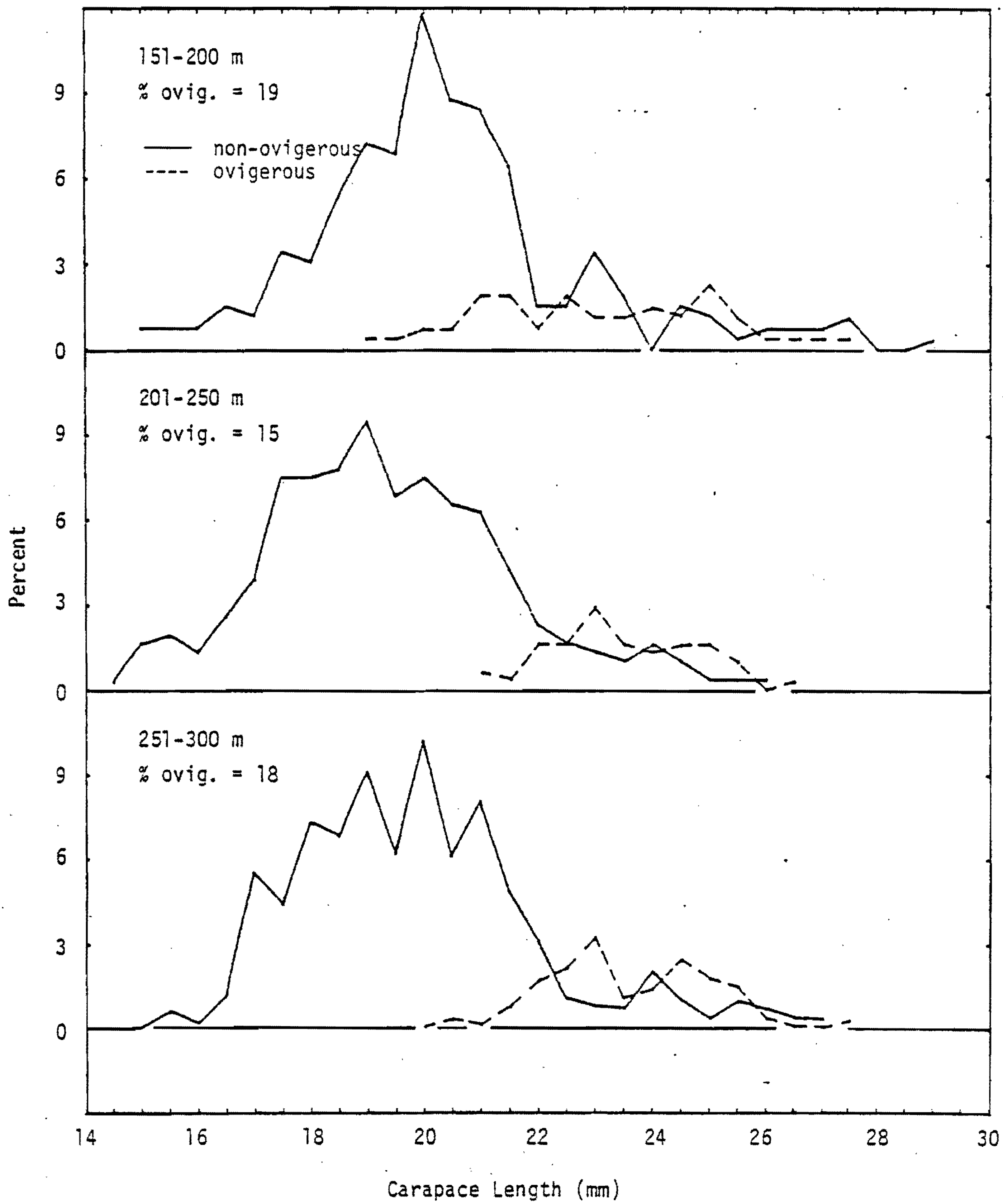


Fig. 7. Length frequencies, Hudson Strait - 1981.

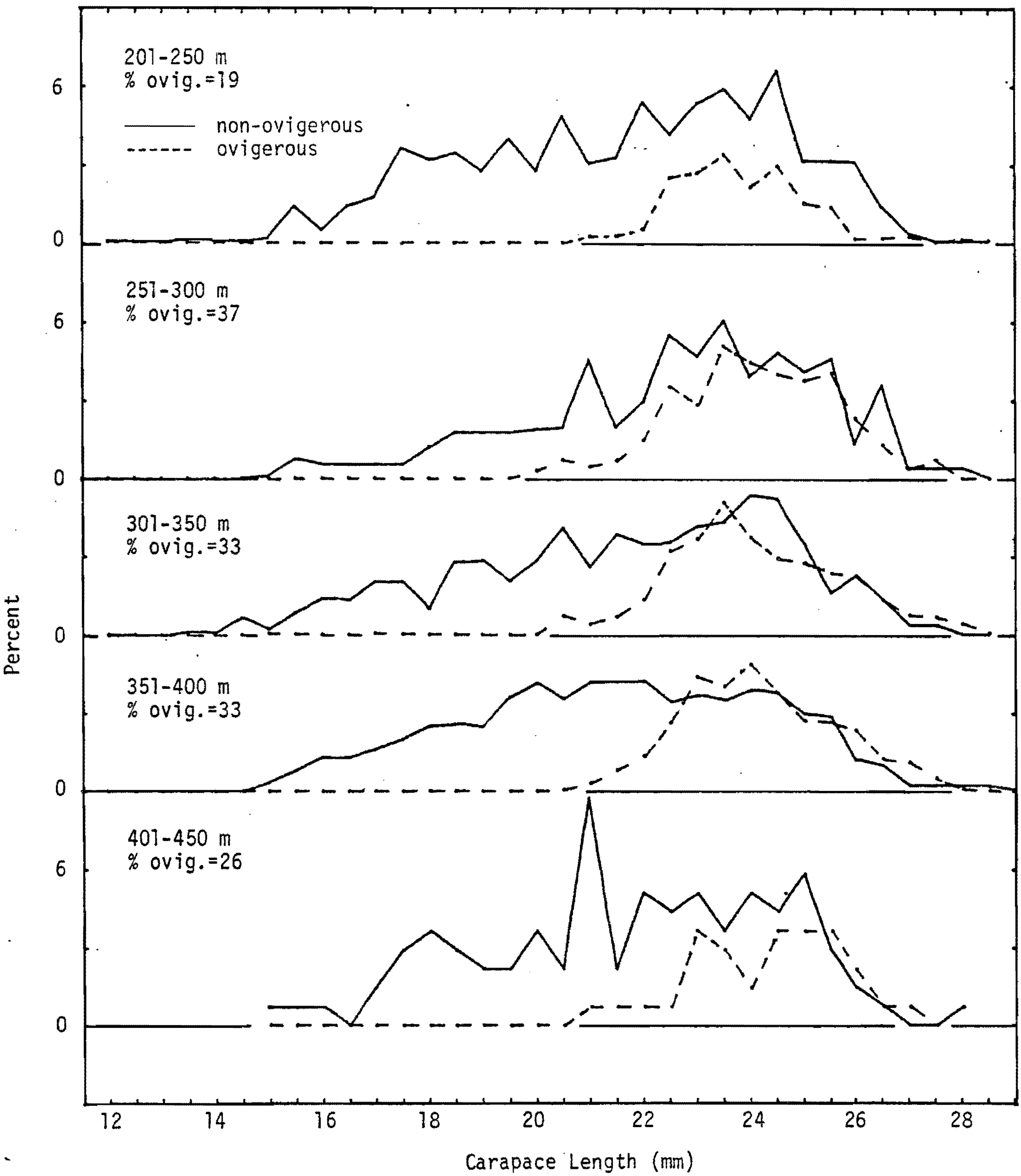


Fig. 8. Research length frequencies, Ungava Bay west - 1982.

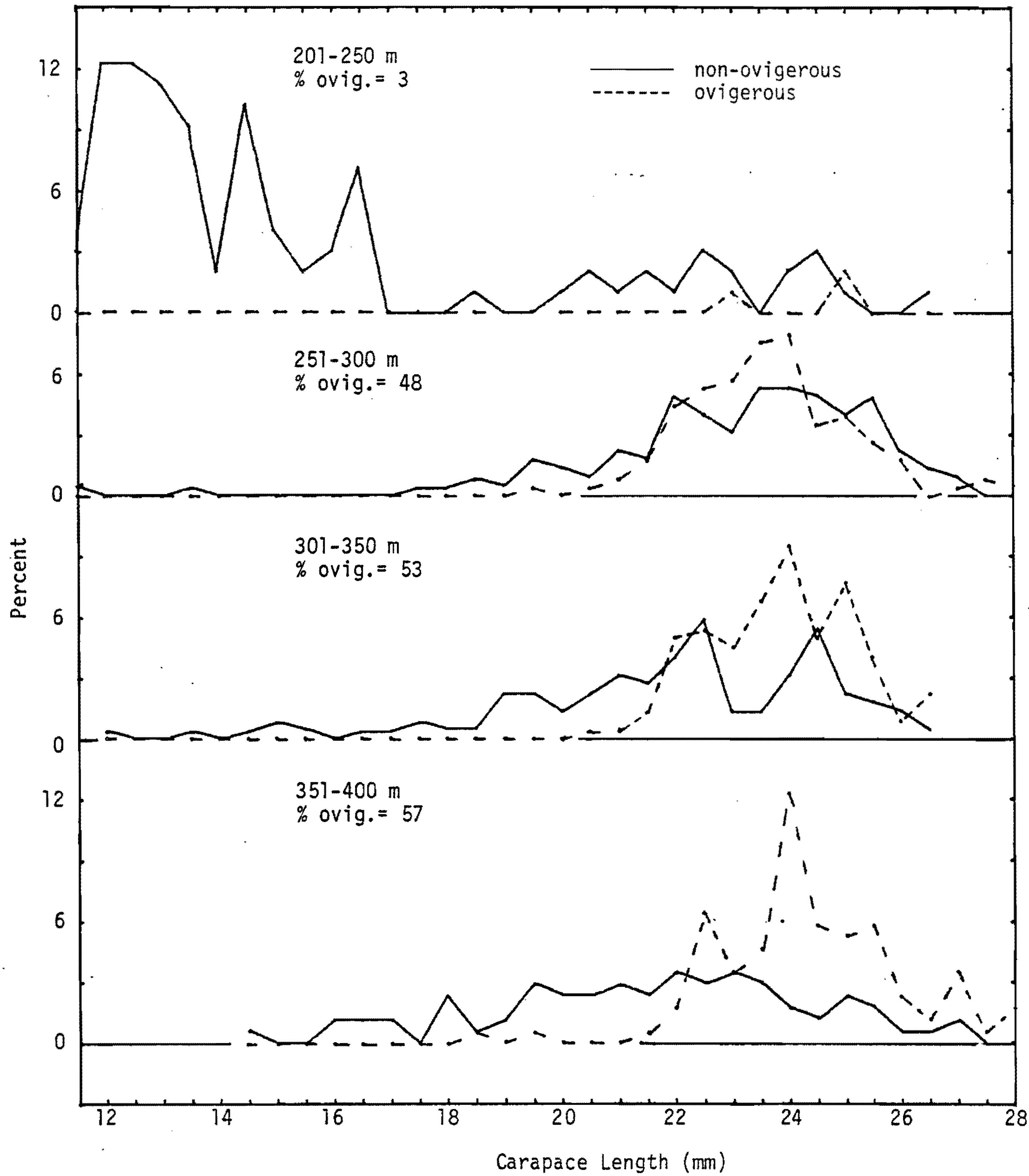


Fig. 9. Research length frequencies, Ungava Bay east - 1982.

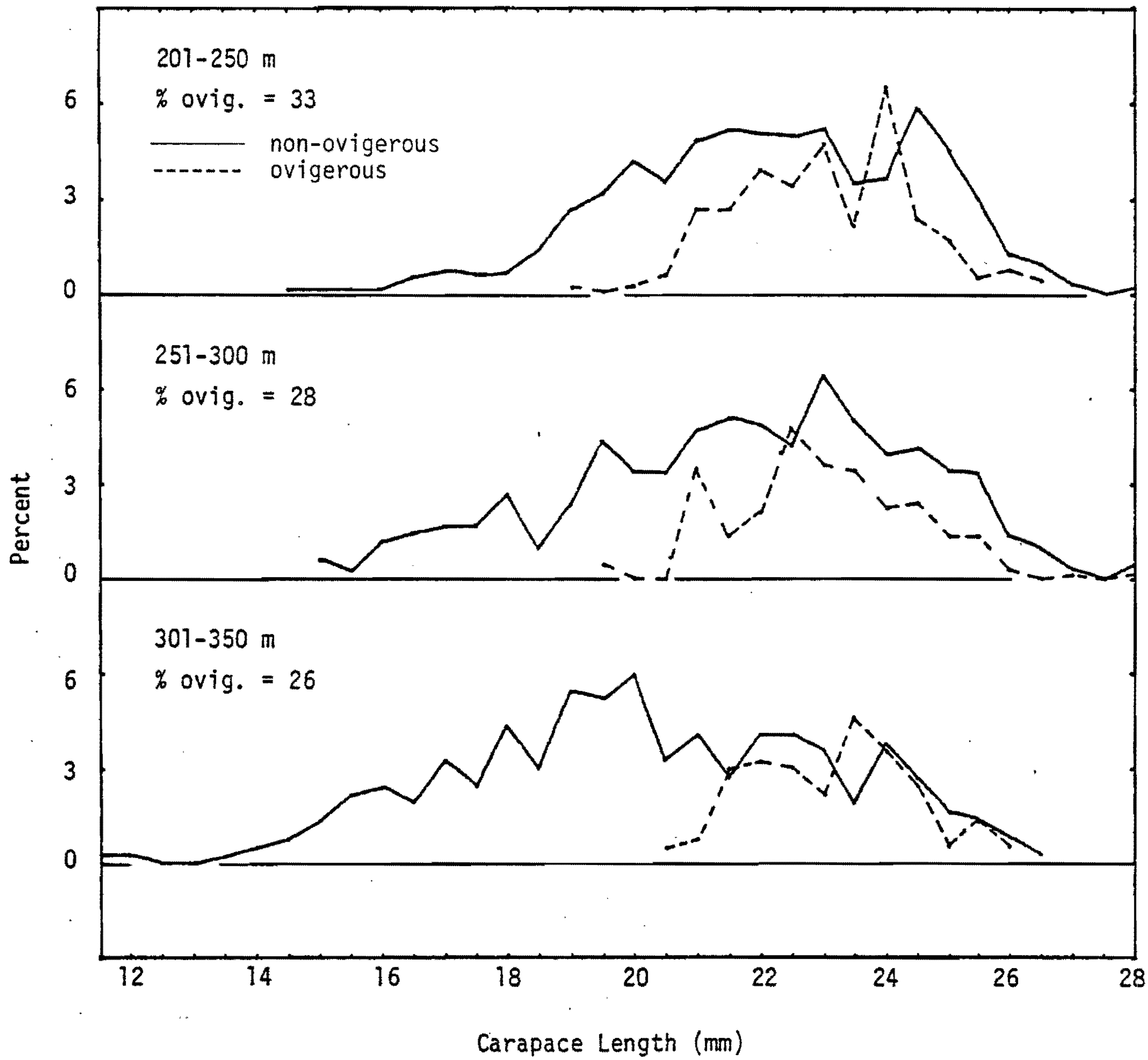


Fig. 10. Length frequencies, Ungava Bay, 1981.

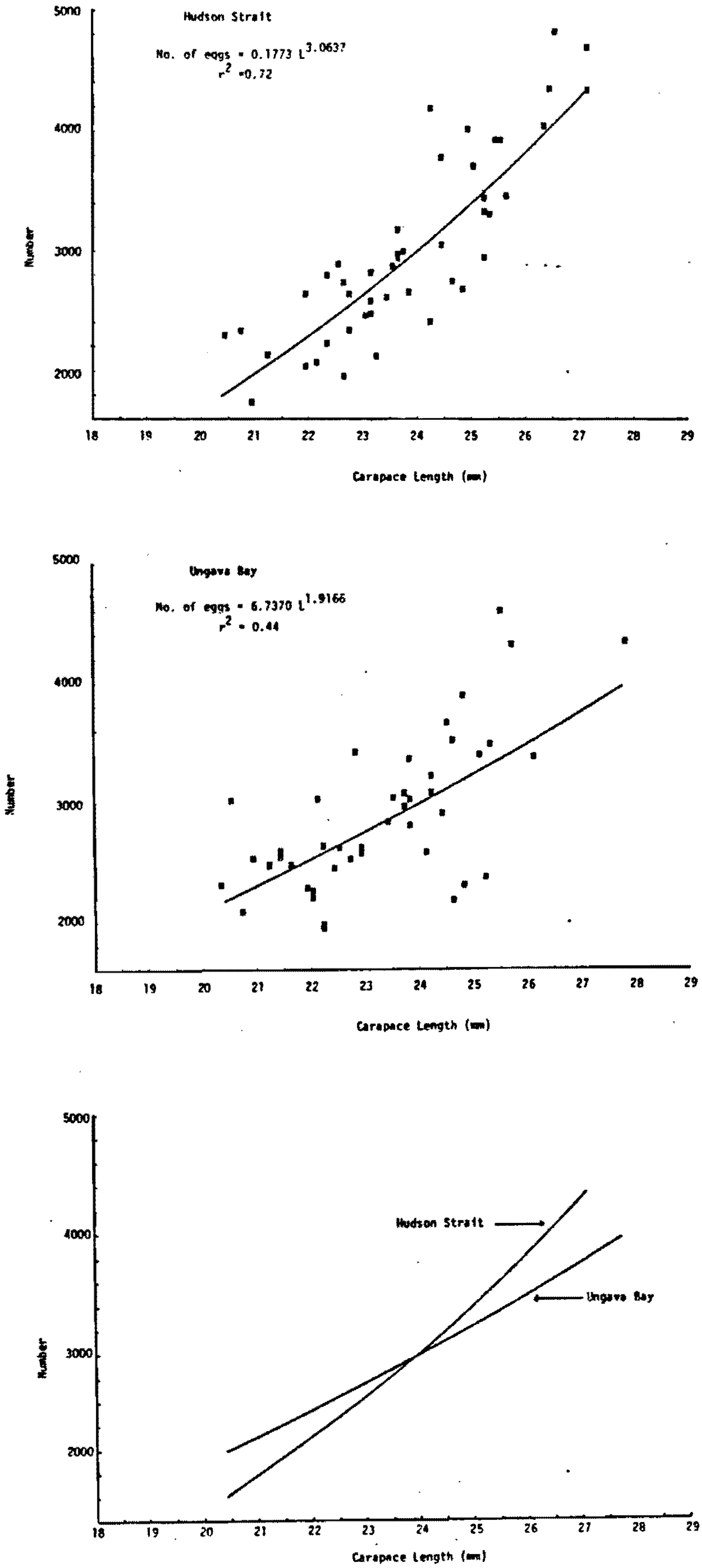


Fig. 11. Regression of egg counts against carapace length, Hudson Strait and Ungava Bay, 1982.

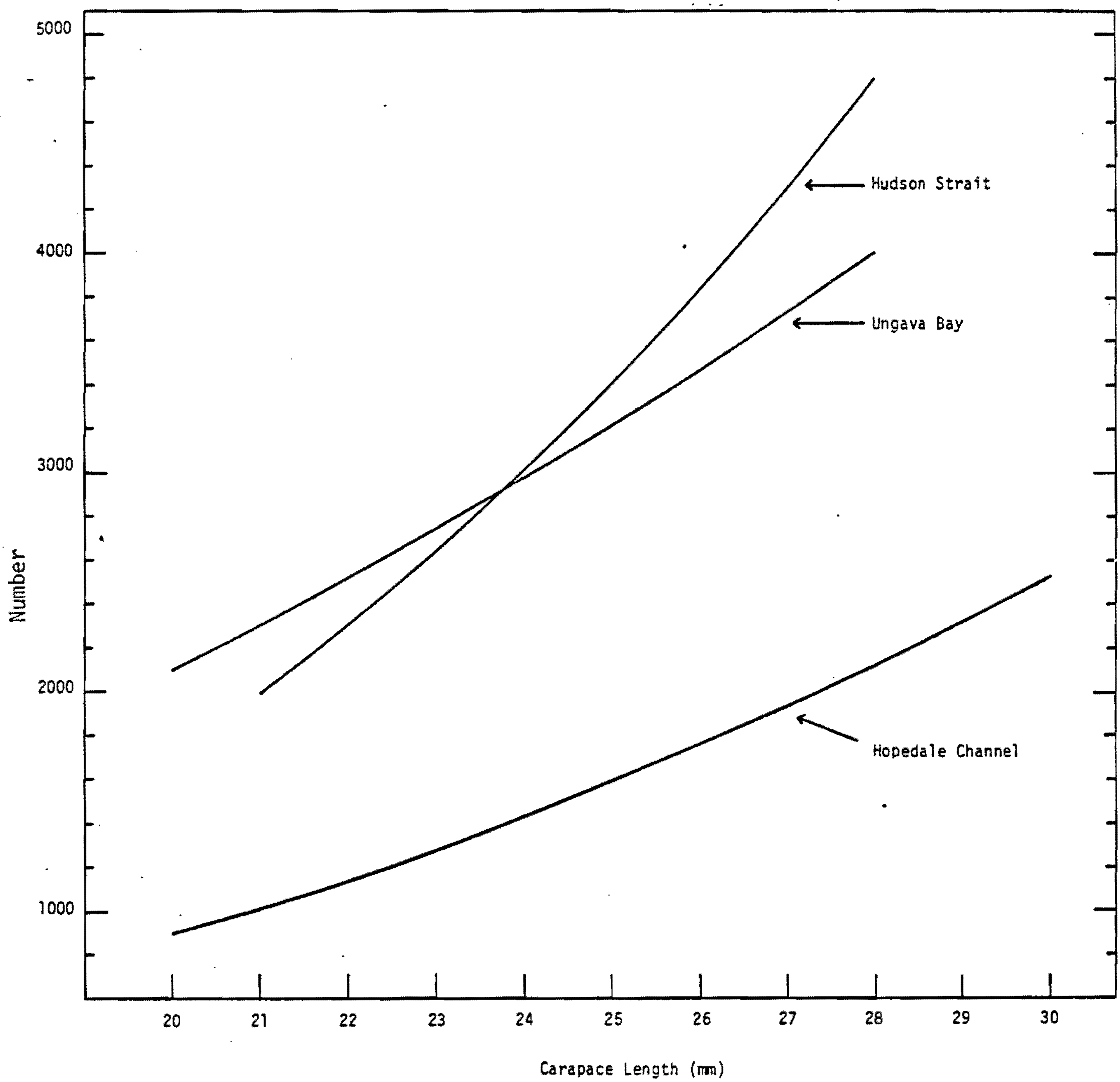


Fig. 12. Regression of egg counts against carapace length for Hudson Strait, Ungava Bay and Hopedale Channel.

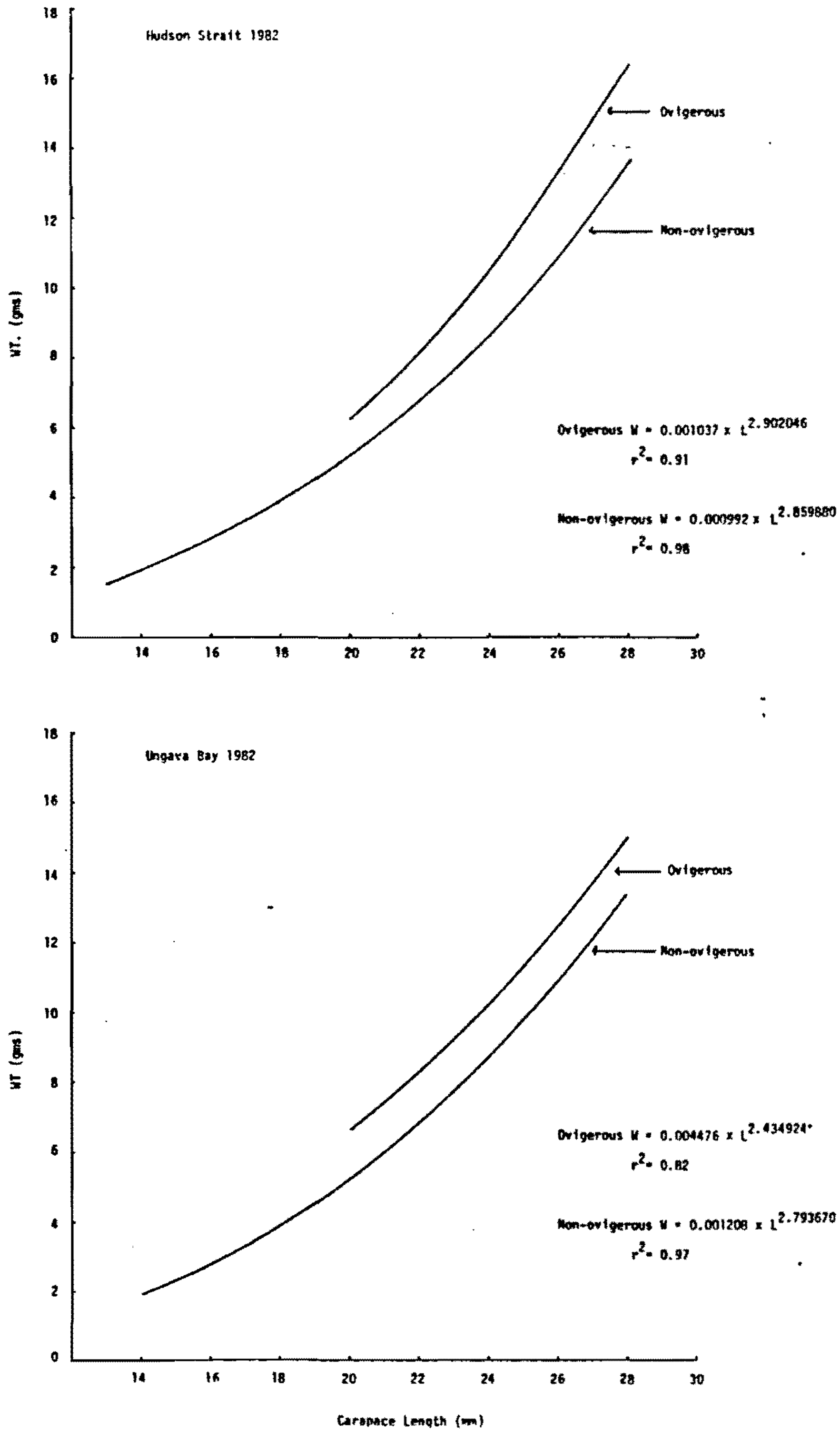


Fig. 13. Regression of weight against carapace length for Hudson Strait and Ungava Bay, 1982.

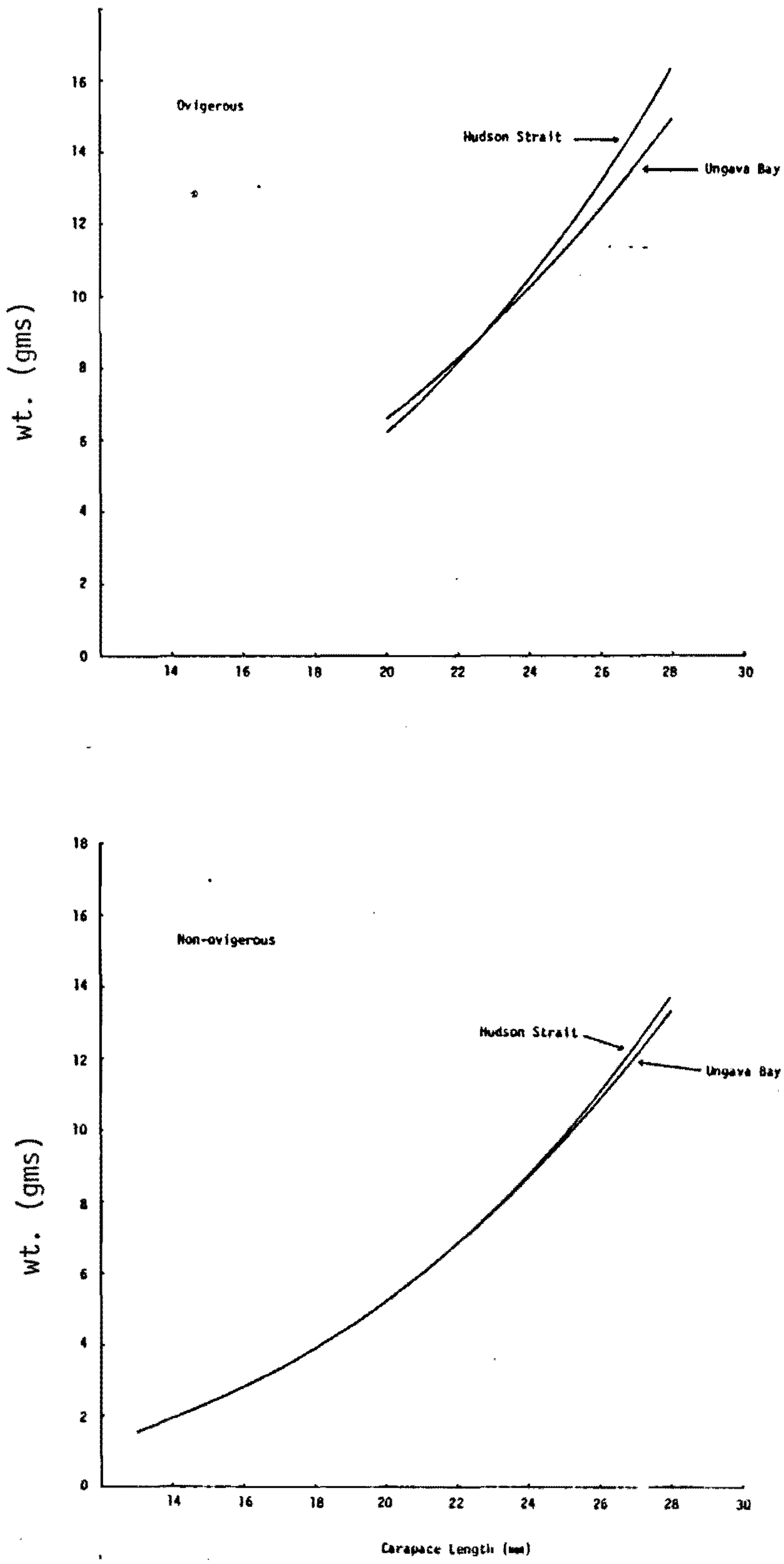


Fig. 14. Comparison of weight against carapace length for ovigerous and non-ovigerous, Hudson Strait and Ungava Bay - 1982.

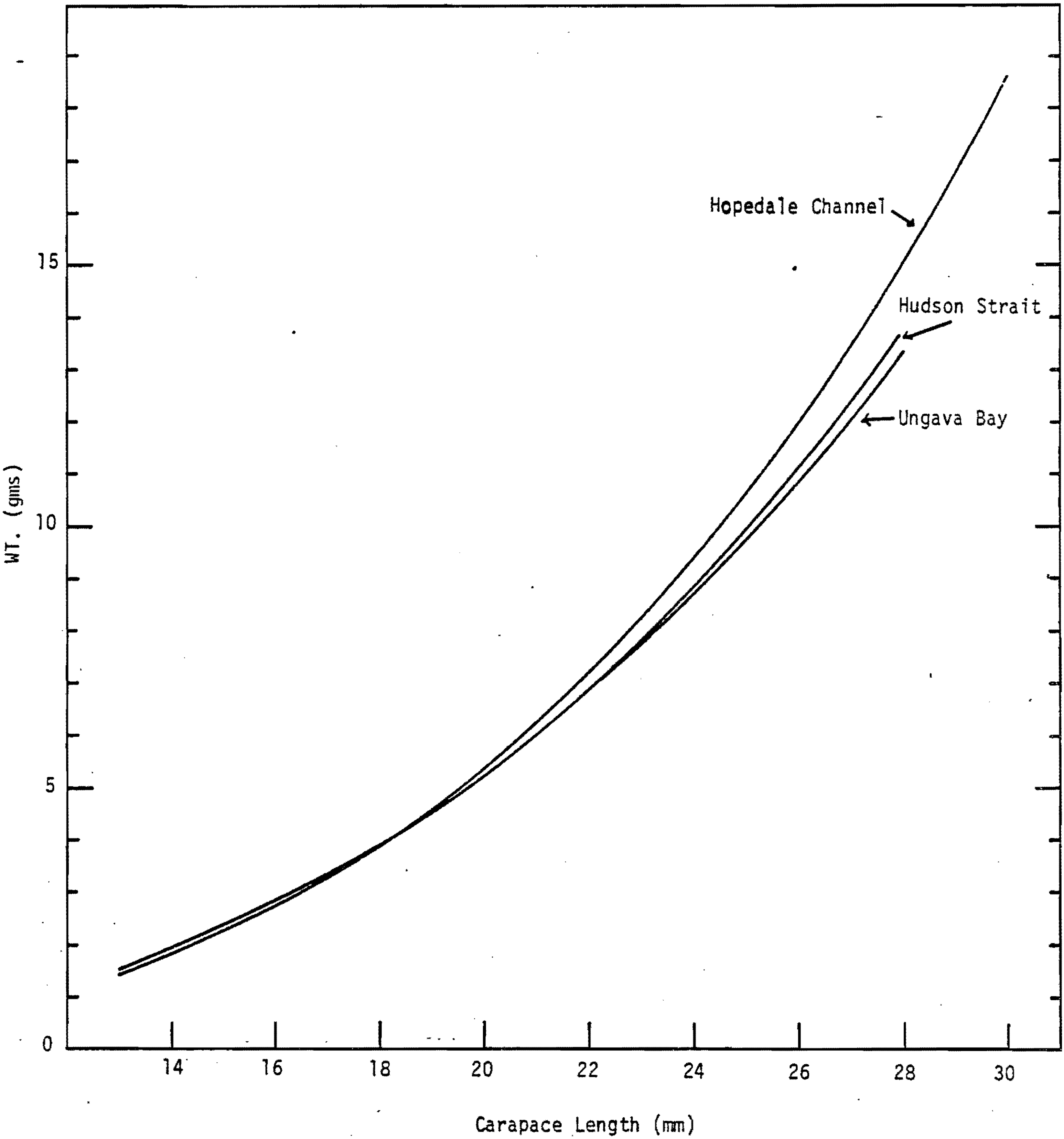
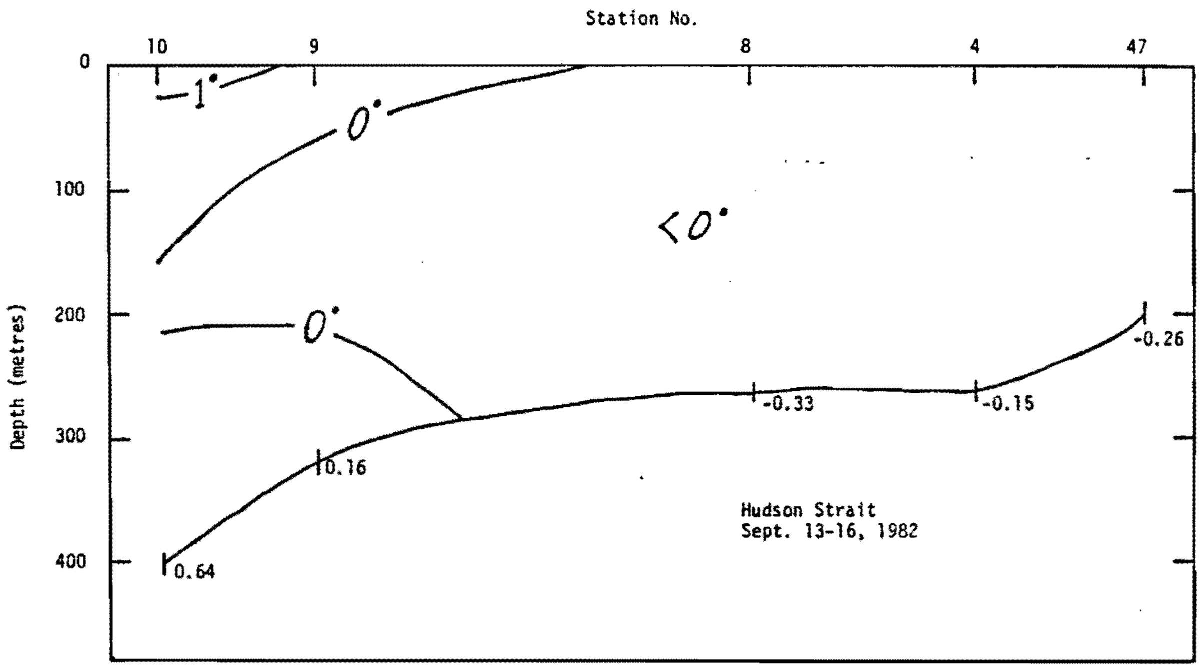
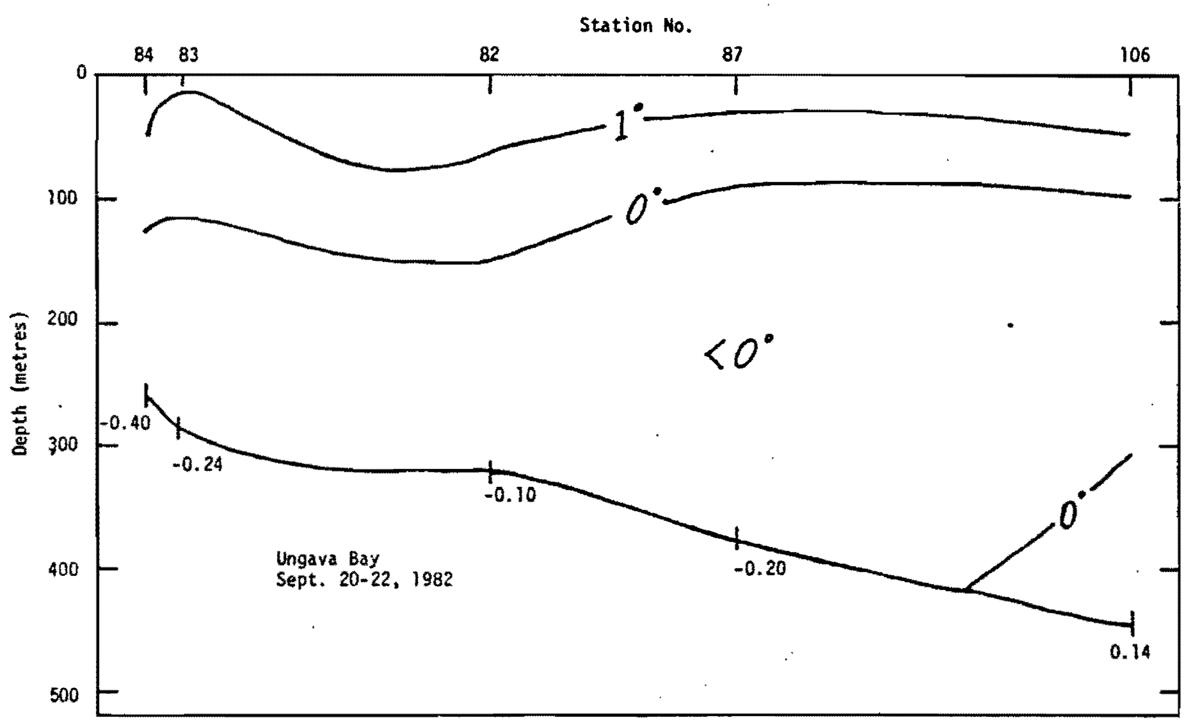


Fig. 15. Regression of weight against carapace length for Hudson Strait, Ungava Bay and Hopedale Channel.



Hydrographic section, Hudson Strait, 1982.



Hydrographic section, Ungava Bay, 1982.

Fig. 16. Hydrographic sections, Hudson Strait and Ungava Bay - 1982.