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Fisheries oceanographic conditions in the Continental Shelf of Nova Scotia in the early summer of 1976

by

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ABSTRACT

The present paper shows the fisheries-oceanographic conditions observed in the Continental Shelf of Nova Scotia for July 1976, using the data provided by the research cruise of the R/V "Isla de la Juventud", as well as the Cuban Fishing Fleet. These data suggest that in early summer, there were atypical hydrologic conditions in the above mentioned area and that they had an effect on the species behaviour and distribution within the area.

INTRODUCTION

Despite the developments in oceanography and fisheries biology over the past ten years, there still exist a number of nonpredictable variables to establish the multiple correlations which in each zone determine the behaviour of the species and their commercial agregations. For that reason, every information and results obtained, both, from laboratory experiencies and from research vessels, constitute necessary elements to serve this purpose.

In the ICNAF area, different countries hold considerable fishing effort. Among the commercial species of major importance in the continental shelf of Nova Scotia are the following: silver hake (Merluccius bilinearies), cod (Gadus morhus), haddock (Melanogrammus aeglefinus), pollock (Pollachius virens), flounders (Hippoglossoides platessoides, Glyptocephalus cynoglossus, Limanda ferruginea) squid (Illex illecebrosus), and the argentine (Argentina silus). In the divisions 4VWX, of all the species taken, silver hake (M. bilinearis) is the one which shows the greatest catch. Thus, over the past two years, quotas for this species have been set up at 100×10^{-3} and 120×10^{-3} ton, while the nominal catches for all countries mounted to 96×10^{-3} and 112.1×10^{-3} tons. This suggests the importance of this fishery. In accordance with the Cuban research program for the Norwest Atlantic, the first cruise of the R/V "Isla de la Juventud" was performed in the Div 4VWX during the month of July 1976.

In this paper, we are describing the existing oceanographic conditions in thet area during that period, based on the information obtained from the cruise. We are also analysing the performances of the Cuban fishing fleet at that time, in connection with the hydrological picture observed. During the cruise, 31 oceanographic stations were carried out, twelve of which were done using Nansen bottles. Water samples were taken for oxygen and salinity determinations. In the remaining stations a bathythermograph was used, thus, the field most thoroughly observed was the thermal field.

In processing the data, the stations of effective fihsing were selected in order to analize the temperature-fish distribution relationship.

During the cruise, only a few hauls were carried out due to failures in the fishing gear and to the low densities of fish observed, along the selected track, so the hauls just had an identification nature. In bottom trawling, the 36m headline commercial trawl, described in the Fishing Gear review issued by the Fishing Cuban Fleet, was used.

A representative sample was taken in each succesful fishing operation, in which the species composition was determied as well as the length composition for the major species. The methodology utilized has been further described in the aboard Scientific Work Handbook. Proj. Cub/73, FAO/CIP, pub. 1975.

OCEANOGRAPHIC CONDITIONS IN THE AREA

From the thermal point of view, according to the characteristics observed at the begining of this summer -1976- it is possible to differentiate the situation and features of the waters in the shelf of Nova Scotia.

Shallow waters: It was found that these waters occupied a small volume, from the surface down to 20m depth as a maximun, and with temperatures ranging from $14^{o}C$ to $18^{o}C$. In these waters, there was an almost total isotherm with very little ranging in their values. They were limited by a heavy thermal gradient which, logically, prevented the distribution of the heat received by radiation to lower levels (See Figs. 2A-C).

Cold waters: They were just beloww the surface layer separated by a gradient averaging $-0.3^{o}C/m$. The minimum value of temperature was found 30-60m. depth. These waters reached the bottom, and in Fig. 3 -last level observed- it can be proved that their maximum rate in the shelf, near the bottom, was the northeast zone of Sable Island in the Bank of that same name.

In Fig. 4 -50m. level- it can be seen that these waters were present in practically the entire area of Nova Scotia.

Warm Waters: These waters, close to the bottom, as we may observe in Fig. 3, had higher values than $10^{o}C$, ascending up by the slope.

Depending on the intensity of their penetration, they were found at different depths, in the slope or over the shelf.

The zones with more noticeable water ascension were those south of Sable Island and Emerald Banks, and the slope of the Sambro and Browns Banks.

Mixed waters: These waters were found at the Gulf of Scotia and Sambro - Bank, being close to the bottom with temperatures over 9°C.

From the transversal sections IV and V (Figs. 5D and E) it is possible to infer that they are the result of the mixing of warm waters with those of the shelf zone.

The 50m. level chart shows that there are not mixed waters in it, thus, - suggesting that its thickness is restricted to the areas close to the bottom in the places above mentioned. However, the extension they occupy is - considerable. Also, there are mixed waters over the Roseway and La Have - Banks that seems to be the result of changes cause by drainage.

Deep waters: In the vertical temperature distributions, within the stations that reach, or are closed to, the 250m assigned limit, it is possible to - observe how, after the thermal inversion caused by warm waters just below - the cold ones, a new decline in temperature takes place produced by deeper - waters, probably referred to the types of waters of the North Atlantic.

See vertical dist., sta. No. 36, Fig. 28.

FISHING RESULTS

Information obtained from the hauls carried out during the cruise is the - following:

About 50% of the trawling were done between 80 - 100 m (Table No. 1). The main species caught, were: cod, silver hake, haddock, pollock and squid.

The best yields (3,91 and 6,43 tons/hr (Table 2) were obtained at stations 5 and 30, within th Banks of Sable Island and Sambro. In the first stations, the greatest percentage was of silver hake, while in the second was of squid. Both species were found in the two hauls, alternatively occupying the first and the second places in the catches. Largest silver hake specimens were - caught in Sta. 2, (28, 29 and 30 cm modal classes). They were found at - depths down to 95-207m (See Table 1).

The greatest percentage of cod was taken in Sta. 14 on the Middle Bank, - although a lower percentage of it was present in hauls St. 3 and 17 south - of Emerald Bank and north of Middle Bank - respectively. (See Fig. 1).
Cod was found in the hauls carried out from 80-140 m depth.

Haddock was taken from Emerald Bank and north of Middle Bank. It was found between 95-140 m. depth, having its greatest occurence in the lower limit of this range.

Most haddock specimens were caught in Sta. 25 (Emerald Bank).

The widest size distribution was observed at Sta. 17, showing a length range from 16 to 66 cm., although in every trawl, specimens smaller than 40 cm. - prevailed.
The biggest sizes of squid were those of Sta. 5, obtaining the widest size - distribution from Sta. 14, which was located over the Middle Bank.
Squid prevailing sizes ranged from 18-20 cm, in the two stations.

At the same time, the fishing fleet operations were concentrated over the Sambro, Emerald and Middle Banks, and the western slope of the Sable Island Bank (Fig. 6).
In commercial catches in this zone, cod appeared in a low percentage, southward of Emerald Bank, north and south of Sable Island, and Sambro Bank.

1. The sizes of this species were widely distributed, without prevalence of any modal class.

TEMPERATURE - FISHERIES RELATIONSHIP

From the temperature distribution data, it seems to be inferred that the behaviour of cold waters have not been normal this summer, no either possibly be, the behaviour of the warm waters ascensions to the Banks, because both phenomena should be interrelated.

Comparing the temperature valves at the transversal sections of our cruise in the area of Emerld Bank, Sable Island and Banquereau (Figs. 5A-c) with the ones presented by F.D. McCracken in 1964 (7) for the same zone and period it can be noticed that there are negative differences in regard to this year 1976.

Besides, the natural extension of cold waters observed in Fig. 4, in which they practically occupy the entire area at that depth, seems to mark out that hydrology is atypical this summer.

Bailey (1972) (2), in his work "1972: An unusual year" referring to observations done in 1972, declared: "The temperatures are now back at the level of the mean values for the years 1876-1915 and the climatic jump-back to cold conditions has been just as suden as the rise in temperatures in the twenties". Referring to sea surface temperature in 1972, during the spring, he writes: "On the ocean a two fold pattern appears to have taken place. The cold waters are colder and more widespread caused by abnormally low winter temperatures and an increased flow of the waters of Artic origin". He also stated that: "The impact of the flow of cold waters in the Grand Banks region appeared to be grater in the east in the spring and in the south in the summer". Some of the facts already pointed out seems to coincide with these opinions.

Most authors agree that water temperature is one of the principal factors for the distribution of commercial species and their catches.

These abnormalities in the hydrologic features in the area, must be reflected on the behaviour and thus in the relative abundance of the different species; which must causes increases or decreases in the catches and also, an abnormal occurence of non traditional species in the area concerned.

The distribution of silver hake had been related to the ascension and penetration of warm waters by the slopes and cannos to the Banks.

In the haul carried out at Sta. 5, silver hake had good yields, following warm waters penetration "tongue". Our opinion is that the density in which it was found was due to the characteristics of its distribution; that is, following the "tongue", because it has a reduced volume of warm water, and to remain in it silver hake must concentrate.

Works from Karasiev (1970) (6) about the southwest Atlantic silver hake point out that it has a similar behaviour -at least in form- because in this case it also penetrates the cold waters "tongue". Its density is bigger in the penetration to shallow waters and they scatter over the slopes in greater depths where there is no "tongue".

The fishing area of these species, therefore, should correspond to the location of the bigger ascensions, that took place in the area.

R.L. Edwards (1972) states, referring to silver hake, "Seasonal changes in relative abundance closely follow the seasonal temperature changes".
Then ifits usual presence is related to the warm waters ascensions and these ones are altered by hidrological atypical conditions, we assume that the later are also reflected on the species and should correspond with an alteration in the relative abundance.

If this summer was atypical, it must not be reflected over these species alone.

Edwards (1972) (4) writes about the influence that these abnormal hydrological conditions have over red hake: "The species was on the ground throughout the 1957, although generally less abundant than in 1956 or 1958. It did not return to the ground in numbers in the fall of 1957, probably because of the atypical hydrographic events of the year".

On the other hand, from our trip and the statistics of our fleet (Fig. 6 and Table 3), it can be inferred that squid has unusual presence in the zone in this period. The fact of having been found in trawlings carried out in regions with different thermal features, indicates that it is not affected by such conditions, but its abundance in the zone is due to other factors that are perhaps related to those variations.

Cod was occupying the zone where cold waters occur in the bottom. The fleet's catch data also suggest its presence; according to our data it inhabit the frontal zones between the cold and warm waters or the mixed ones.

Y. Jean (1964) pointed out that: "On the Nova Scotia Banks cod was less abundant than in the Gulf of St. Lawrence. They are found mainly around Banquereau, Middle Ground and the northern edges of Sable Island Bank", besides, he places it from 66 to 110m depth for summer and from 90 to 135m for winter. Our cruise reported its catch highest percentage at 140m, although other haulings showed its presence from 80m down. According to this, cod seemed to be found entirely in winter conditions, not in aestival ones. This was not the only variation. In the title, Fishing Results, it is stated that cod had been found not only in the areas pointed out by Jean, but also south of Emerald, south of Sable Island and Sambro Banks, regions

which are further south than the ones pointed out by him. Accordingly, cod seems to have behaved in an abnormal way.

Haddock was found more scaterred upon the banks in the mixed waters which reached temperatures of 9°C.

McCracken (1965)[2] writes about these species behaviour: "In summer, haddock return to shallower waters and are distributed more widely throughout the region. They merely move to shallows on top of the banks where small fish (40cm) are most numerous at depths of 35-70 m and at temperatures around 6-8°C". He continues: "On top of Sable Island Bank largest catches of haddock were taken at depths of 35-65m and temperatures of 6° to 10°C. Those summer catches were much larger than the winter, shallow-water catches, and small fish (40cm) predominated. In further contrast to winter conditions, there were few haddock on the slopes of the banks at depths greater than 65m". He points out: "Around Emerald Bank, which is further to the westward, the summer catches were slight compared to winter, and there were practically no haddock on the Scotian Gulf side of the bank at all depths exceeding 80m, even though temperatures there were from 4 to 6°C. Slight catches of both, small and large fish, were taken on the plain and slopes seaward of Emerald Bank from 100 to 185 m and temperatures from 7 to 10°C."

All catches of haddock in our trip occurred at 95-140m depths, and what is more, our best catches were taken out on Sta. 25 on the side of Emerald Bank which faces the Scotian Gulf at 96m depths. All this suggests that haddock did not follow the accostumed seasonal vertical migration pattern; that is, it does not move to shallows on top of the banks during summer.

From the data analyzed in the present paper two main conclusions can be reached at: a) 1976 summer, its early past, in the ICNAF area Divisions 4VWX, Nova Scotia shelf, was atypical, b) an entire number of important species in the area are affected - in different extents by these phenomena.

ACKNOWLEDGEMENTS: To the colleagues who offered us their cooperation making with us the trip to the zone aboard the R/V "Isla de la Juventud" and to the Fishing Cuban Fleet for the data supplied.

Table 1. Depth fishing distribution: B/I *Isla de la Juventud*.

	SPECIES (%)					
Depth	Cod	Haddock	Silverhake	Pollock	Illex	Others
80	2.9	-	-	-	4.8	92.3
95	11.4	29.7	32.6	-	1.0	25.3
96	-	93.0	-	5.5	-	1.5
100	12.6	50.6	-	6.7	3.6	26.7
140	57.4	1.2	0.3	1.5	33.6	6.0
188	-	-	8.4	2.8	30.2	58.6
200	-	-	72.0	-	27.0	1.0
207	-	-	9.0	-	86.0	5.0

Table 2. Fishing operations: B/I *Isla de la Juventud*.

No.	Stat	Catch	Depth	Bottom	Species (%)					Obs.
01	03	1.03	100	6.6	1(12.6)	2(50.6)	4(6.7)	5(3.6)	6(26.7)	1)
02	05	3.91	200	10.8	3(72.0)	5(27.0)	6(1.0)			
03	09	0.08	80	1.0	1(2.9)	5(4.8)	6(92.3)			
04	14	2.00	140	2.8	1(57.4)	2(1.2)	3(0.3)	4(1.5)	5(33.6)	
					6(6.0)					
05	17	1.50	95	7.3	1(11.4)	2(29.7)	3(32.6)	5(1.0)	6(25.3)	2)
06	22	0.93	188	9.5	3(8.4)	4(2.8)	5(30.2)	6(58.6)		
07	24	-	97	9.3						3)
08	25	1.20	96	8.5	2(93.0)	4(5.5)	6(1.5)			
09	29	-	224	-						4)
10	30	6.43	207	9.5	3(9.0)	5(86.0)	6(5.0)			

Species Key: 1) Cod 2) Haddock 3) Silver hake 4) Pollock 5) Illex 6) Others
Gear Except 09 (midwatter) all fishing operations carried out with bottom trawls
Observations: 1) Broken wings 2) Calibration 3) Broken cod end 4) net did not open

Table 3. Species composition (%) and catches per quadricle - Cuban fishing fleet.

Division	Quadricle	Silver hake	Cod	Illex	Others
4W	1232	90.2	1.4	8.4	-
"	1248	57.4	-	9.5	33.1
"	1249	55.3	7.6	3.7	33.4
"	1250	87.7	-	12.3	-
"	1268	25.8	0.6	59.2	14.4
"	1285	43.6	1.7	9.1	45.6
"	1300	27.5	0.10	36.2	36.3
"	1301	22.4	-	28.8	48.8
"	1302	45.7	0.1	23.0	31.2
"	1303	18.1	0.4	38.0	43.5
"	1304	3.8	-	84	12.2
"	1315	88.0	-	6	6
"	1316	35.5	0.4	14.5	49.6
"	1317	49.4	-	9.8	40.8
"	1319	32.1	0.2	30.2	37.5
"	1332	28.1	2.4	20.2	49.3
"	1335	11.1	8.2	68.0	12.7

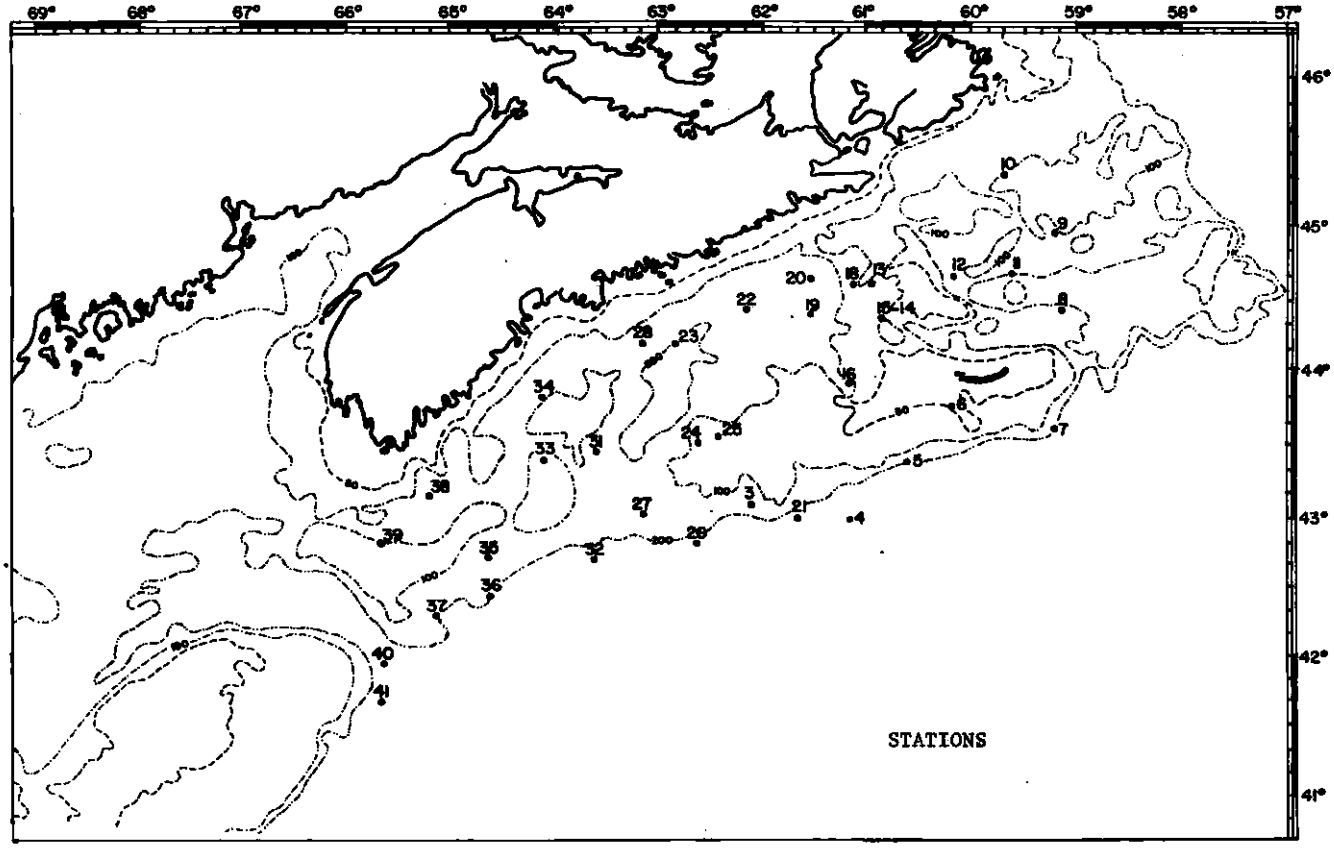


Fig. 1. Chart showing the hauls and thermal record stations in the zone.

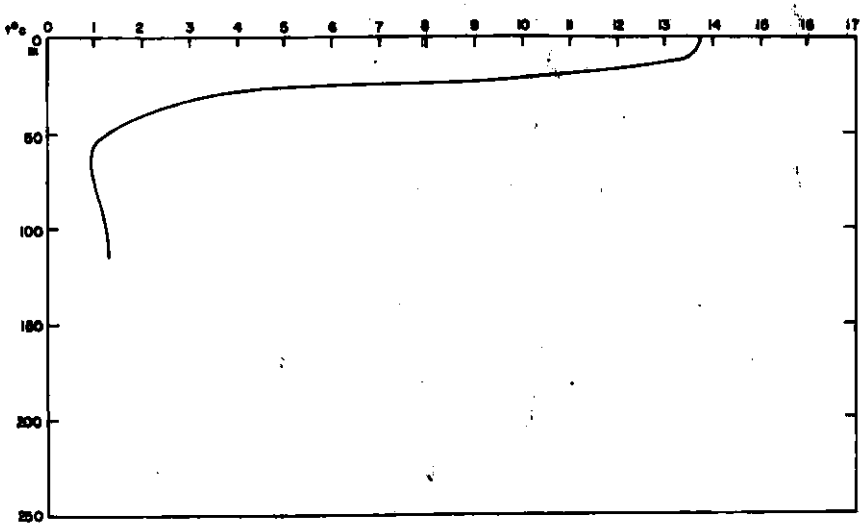


Fig. 2A. Vertical distribution of temperature, Station 9.

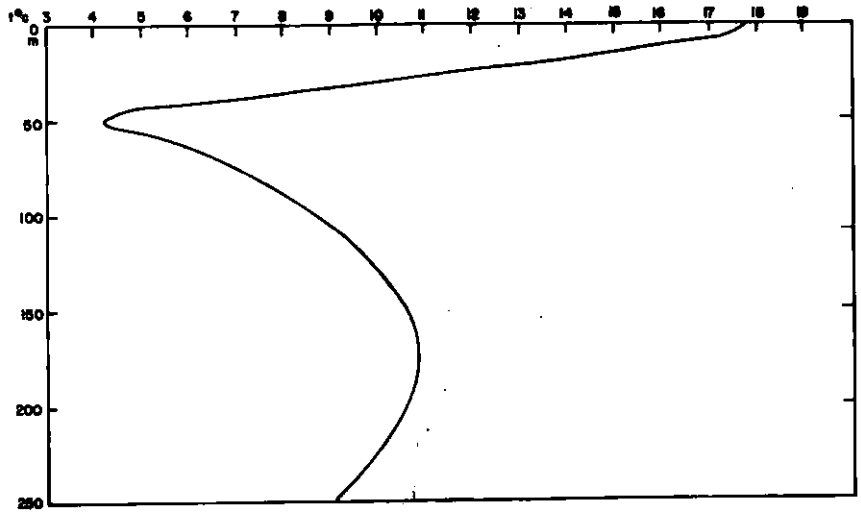


Fig. 2B. Vertical distribution of temperature, Station 36.

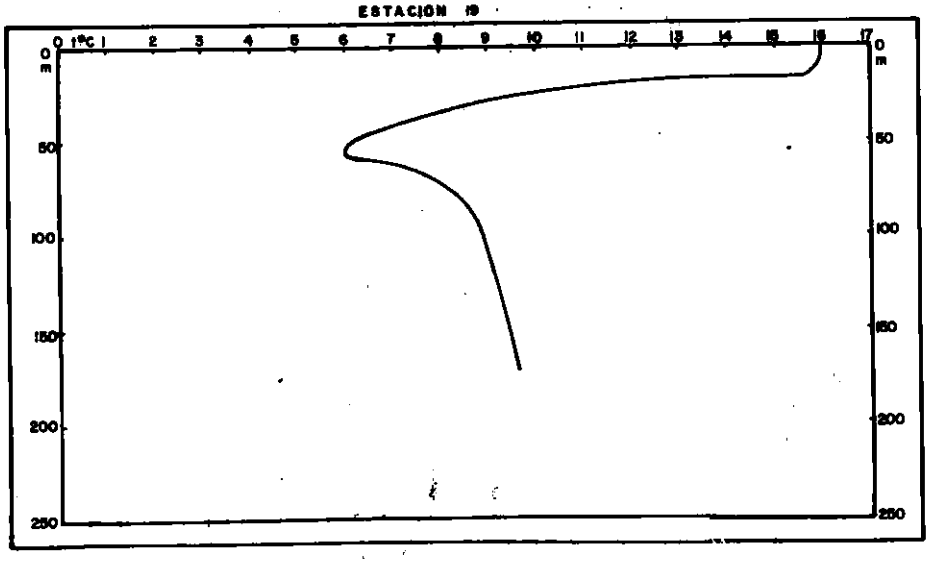


Fig. 2C. Vertical distribution of temperature.

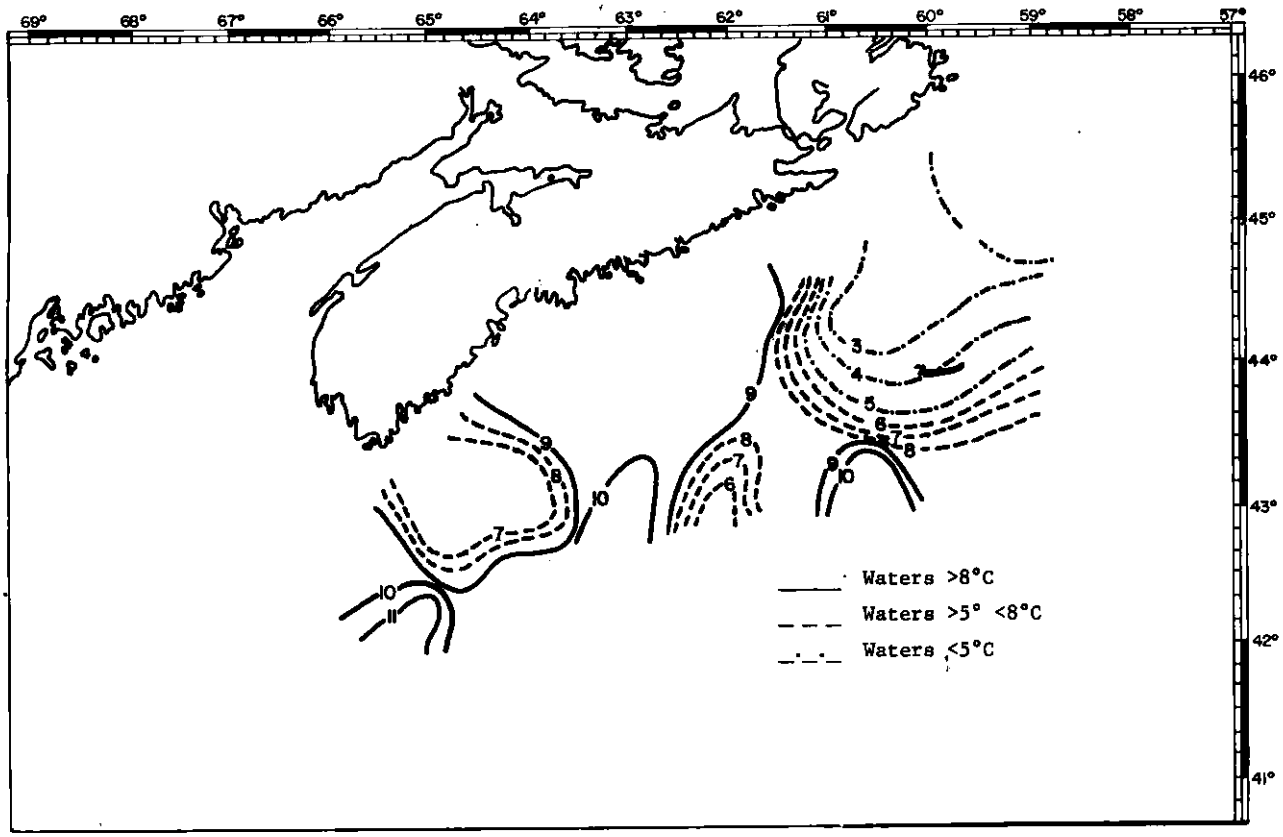


Fig. 3. Isotherms distribution in the last level observes (max. 250 m).

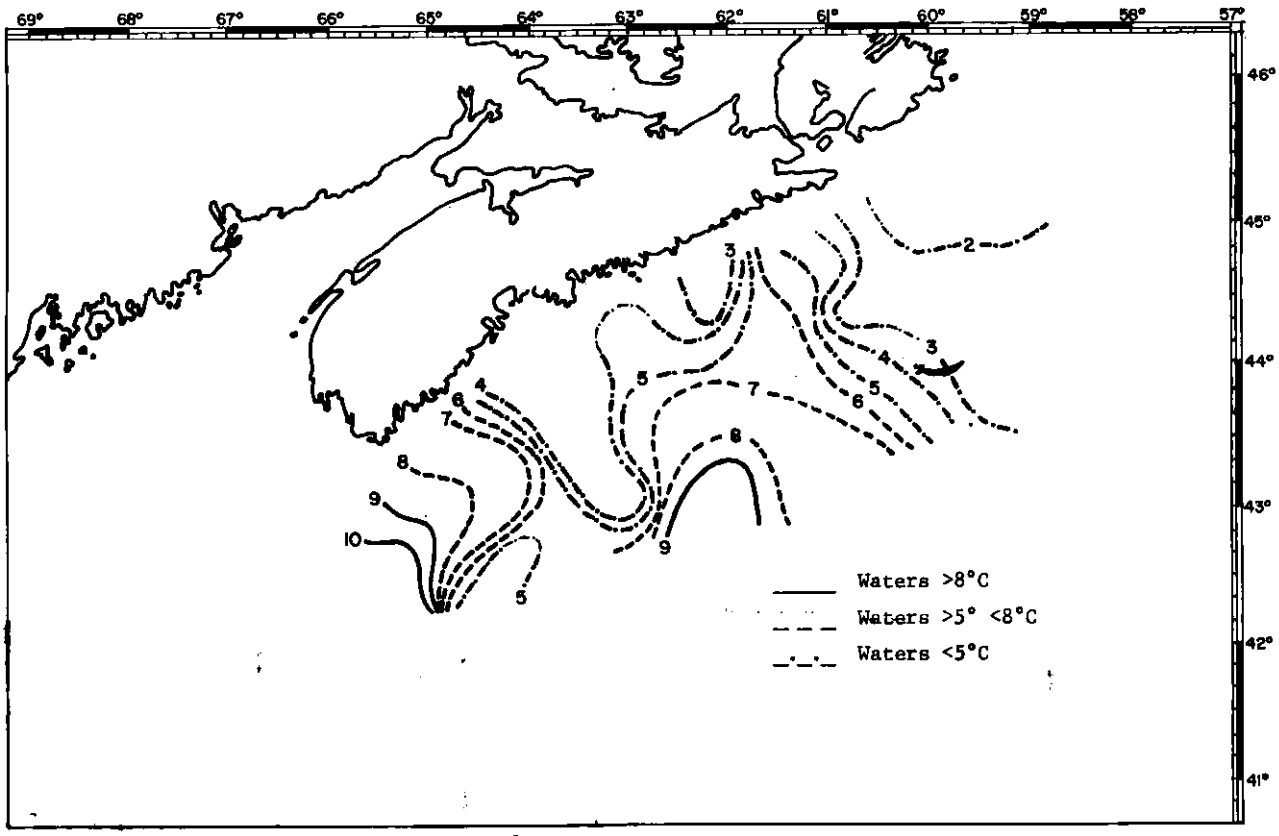


Fig. 4. Isotherms distribution at 50 m level.

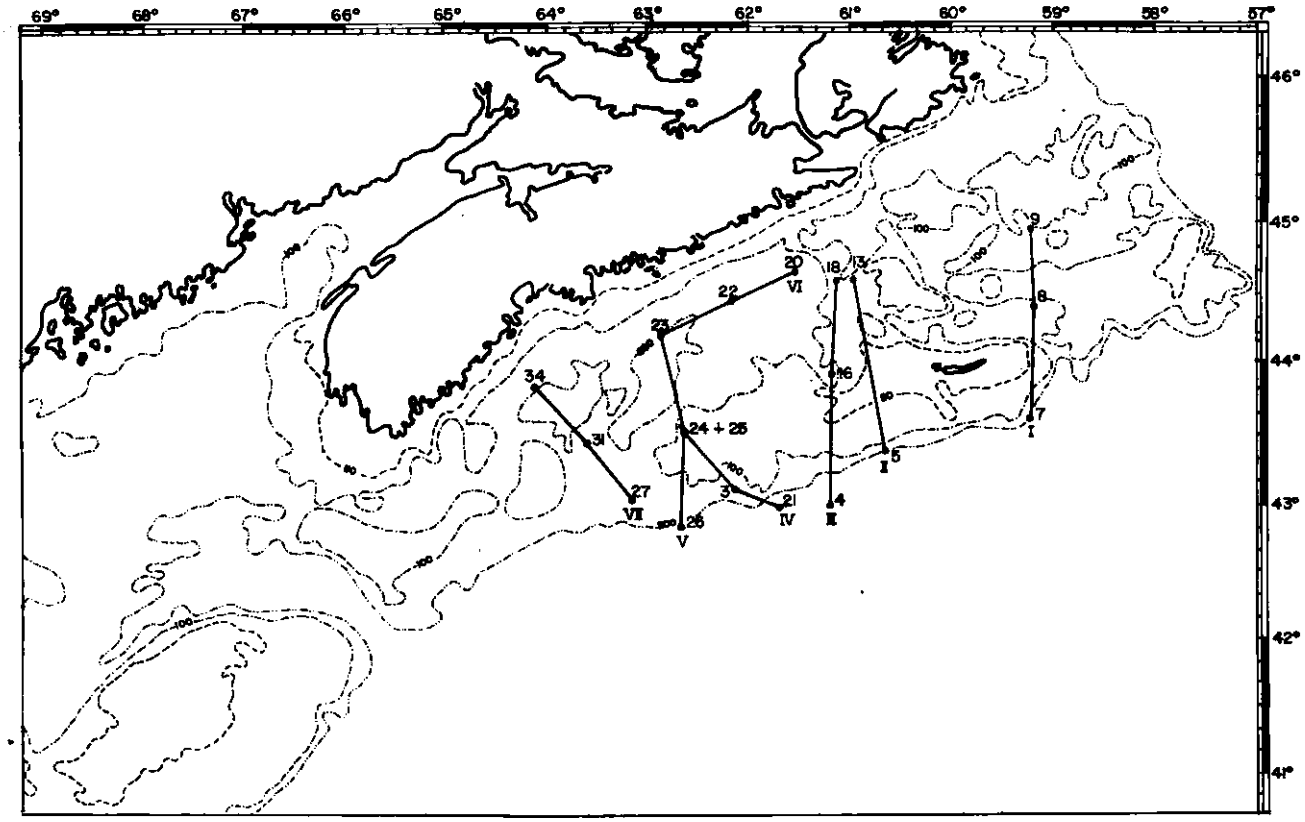


Fig. 5. Transversal section positions.

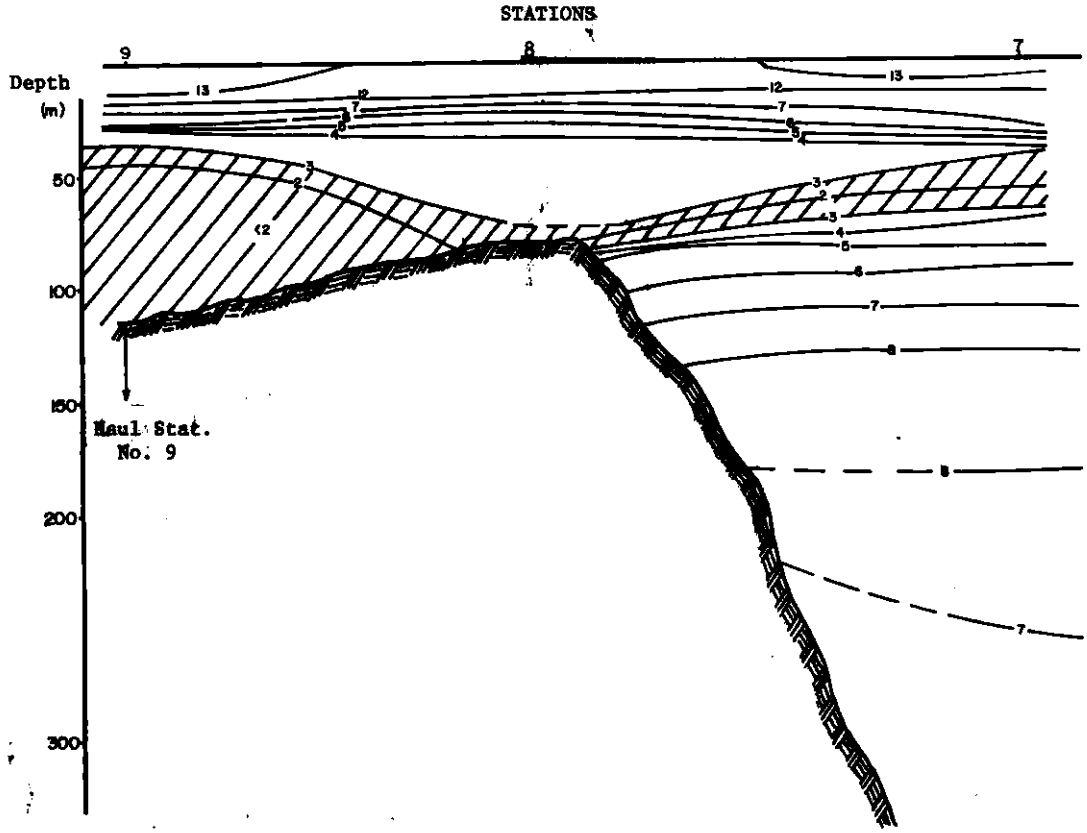


Fig. 5A. Transversal Section I.

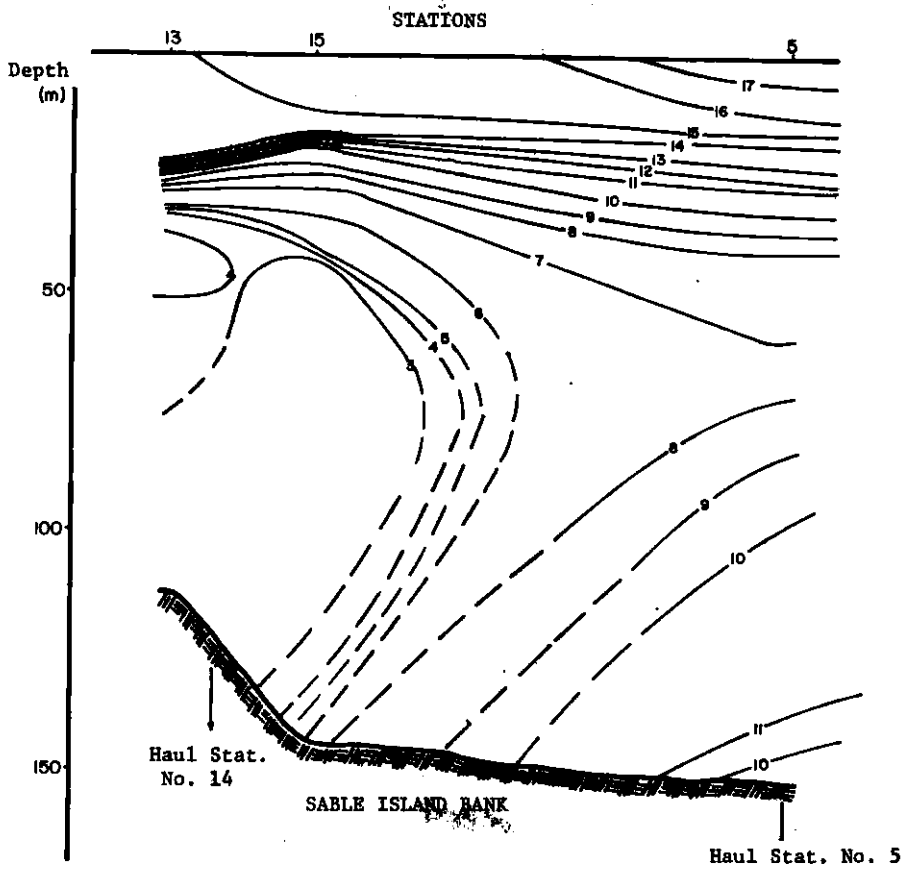


Fig. 5B. Transversal Section II.

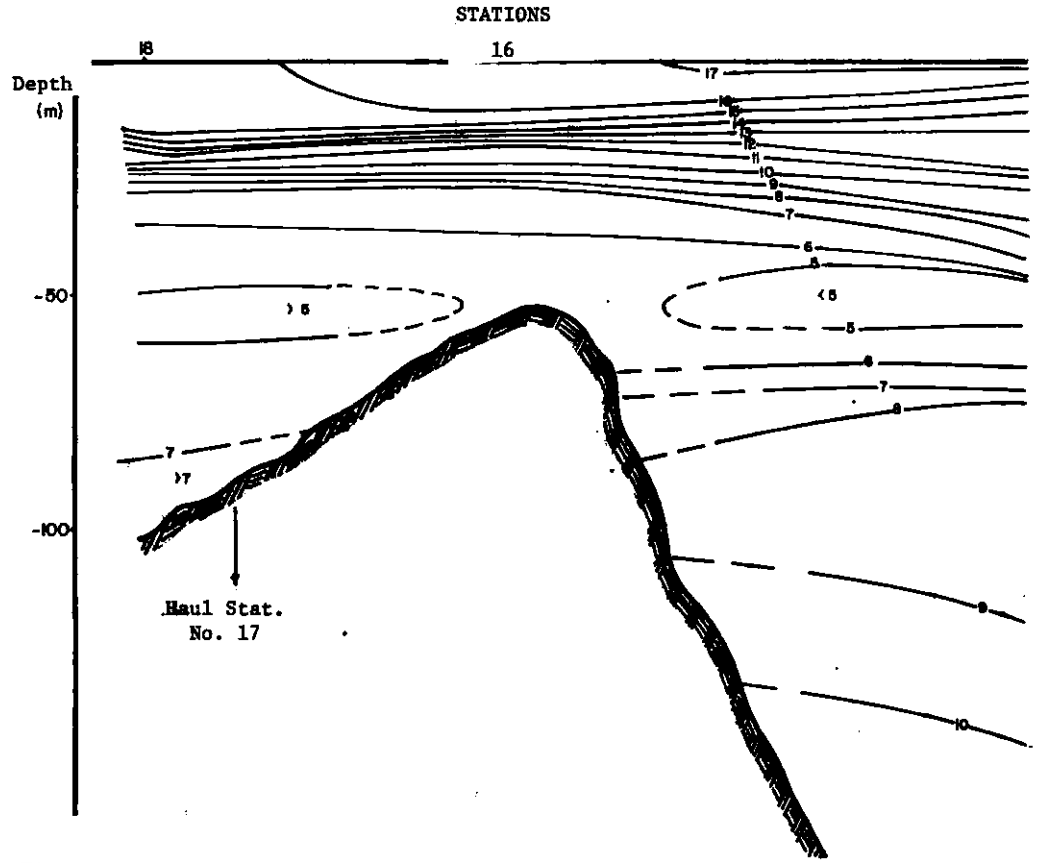


Fig. 5C. Transversal Section III.

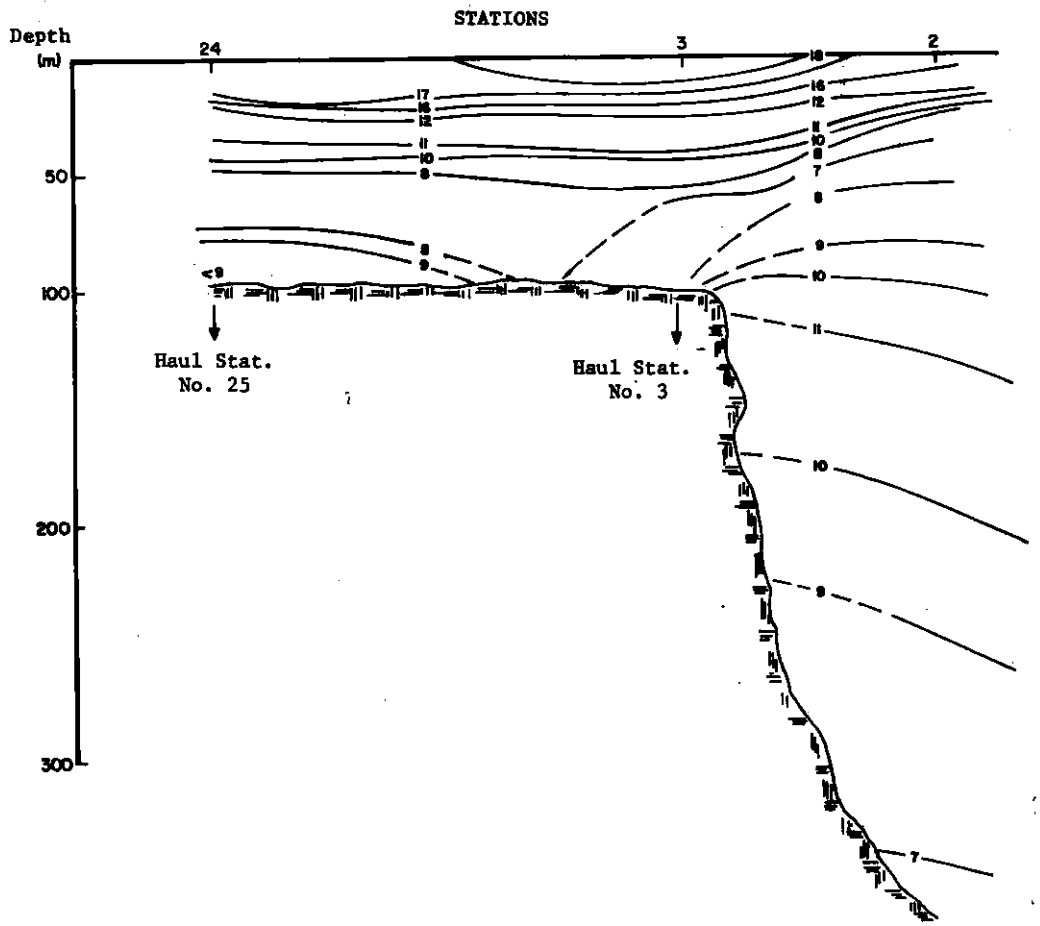
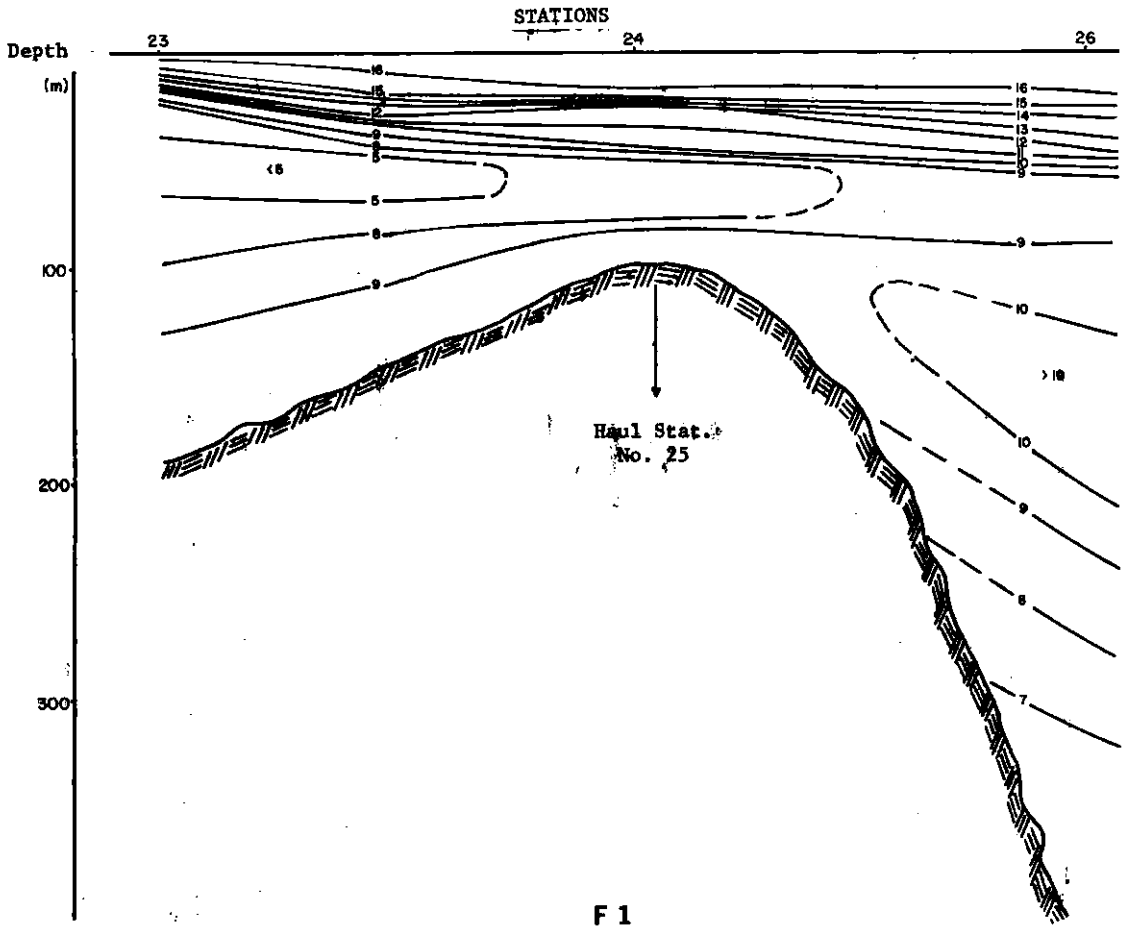


Fig. 5D. Transversal Section IV.



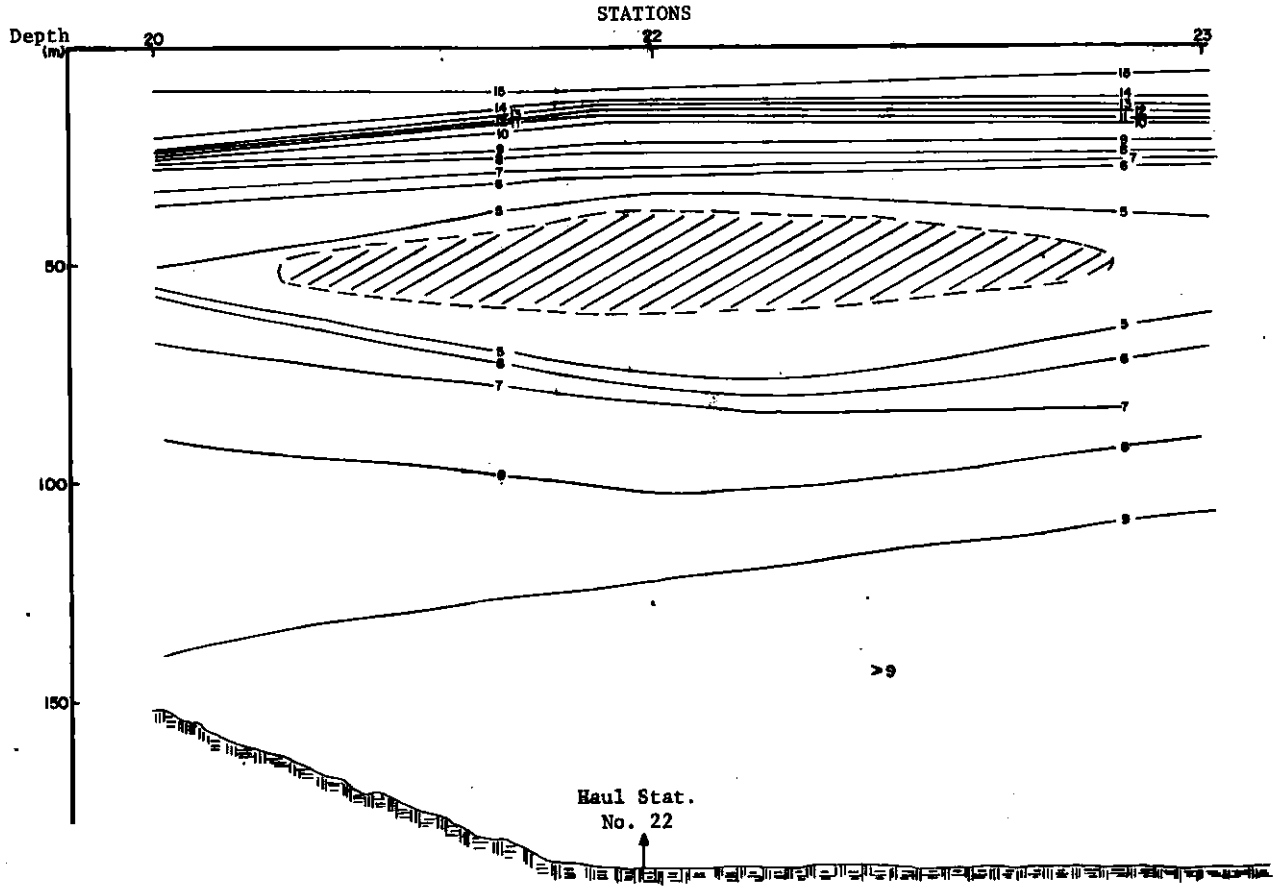


Fig. 5F. Transversal Section VI.

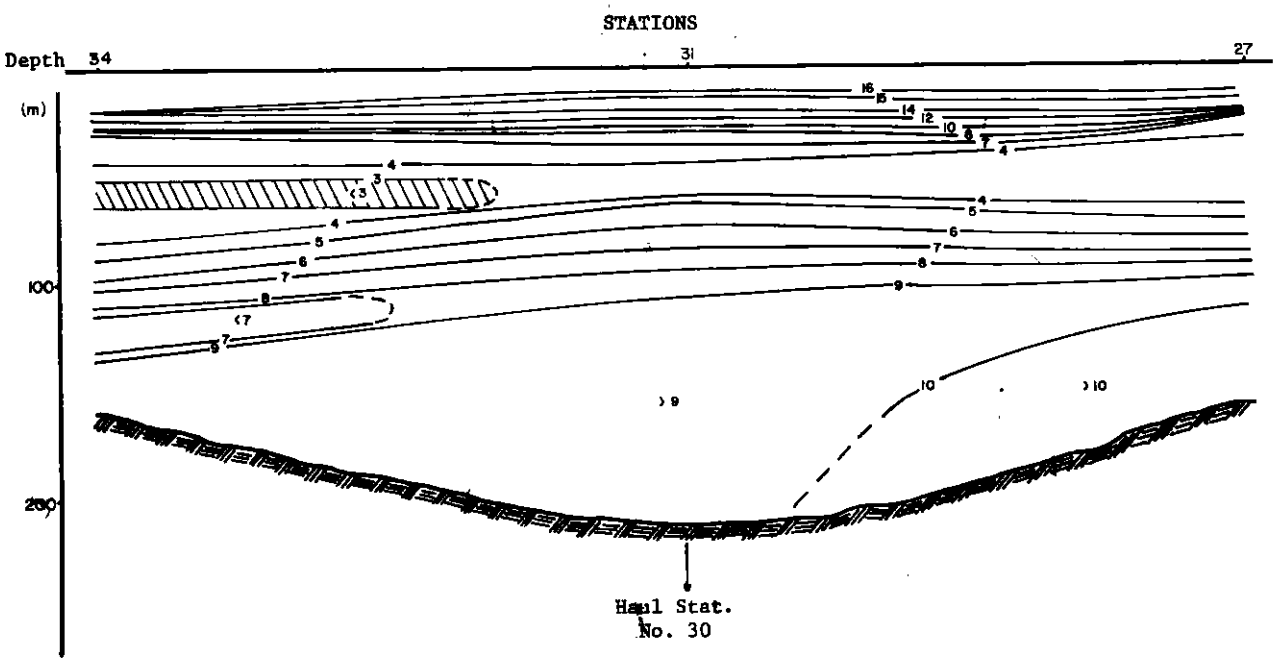


Fig. 5G. Transversal Section VII.

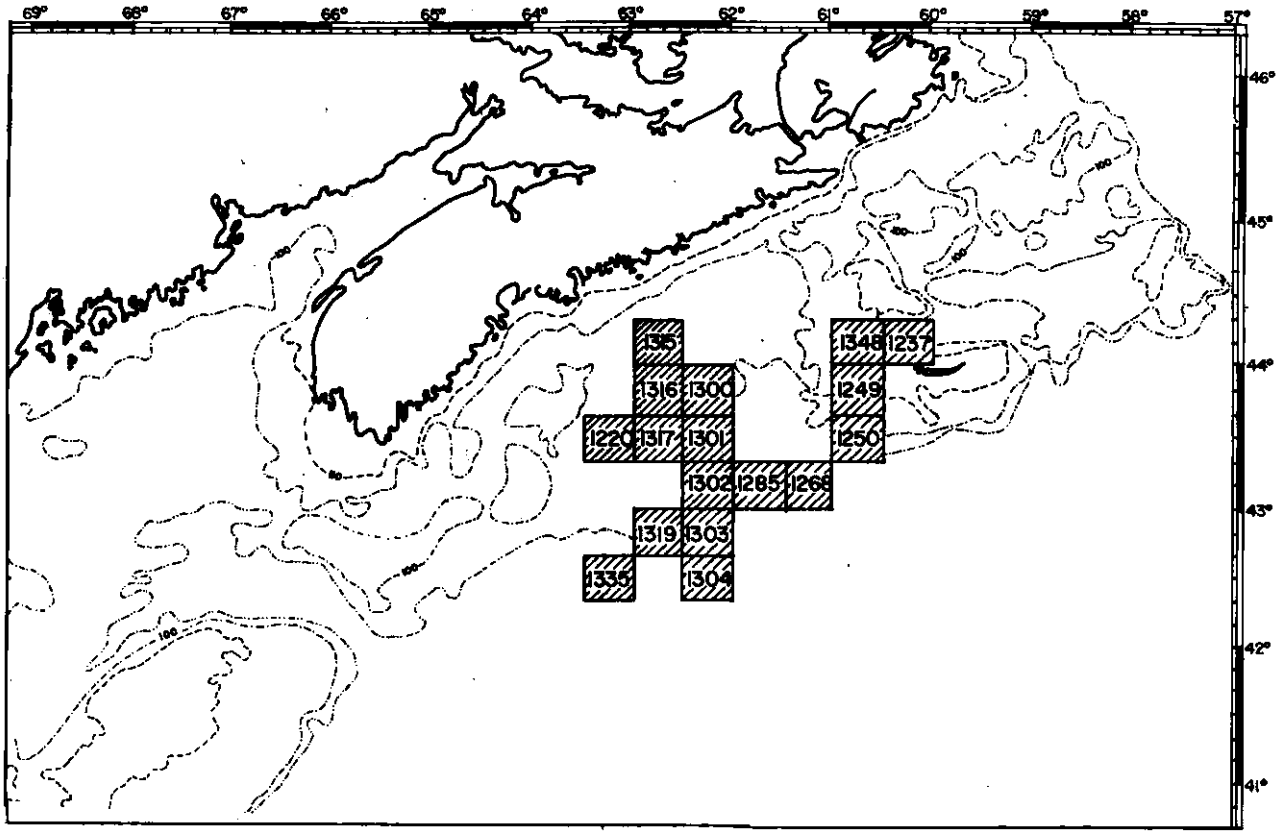


Fig. 6. Deep fishing distribution, according to *Isla de la Juventud*.