RESTRICTED

International Commission for the Northwest Atlantic Fisheries

Serial No. 3528

(D.c. 9)

ICNAF Res. Doc. 75/49
(Revised)

ANNUAL MEETING - JUNE 1975

Report of US fall 1974 larval herring cruises

by

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Introduction

Three cruises were conducted during fall 1974 as part of the ICNAF cooperative surveys to monitor the distribution, abundance, and dispersal of larval herring in the Georges Bank and Gulf of Maine area. *Duchess II*, 74-1 (7-14 September), in conjunction with the French vessel, *Cryos*, 74-1 (7-14 September), sampled 20 stations along the western coastal Gulf of Maine. *Delaware II*, 74-12 (8-16 October), sampled 56 stations along the coastal Gulf of Maine from Massachusetts Bay to Grand Manan Channel. *Albatross IV*, 74-13 (4-19 December), sampled 108 standard ICNAF stations covering Nantucket Shoals, Georges Bank, and the central, western part of the Gulf of Maine.

Gear and methods

A standard oblique plankton tow was made at each station covered on the cruise tracks using the 61 cm bongo sampler (.505 mm and .333 mm mesh nets) to a maximum depth of 100 m or to within 5 m of the bottom in shallower areas. Samplers were set to a maximum depth at 50 m/min. and retrieved at 10 m/min. Vessel speed was 3.5 knots. A V-fin depressor (122 cm) was attached to the towing wire and flowmeters were slung within the mouths of the bongo samplers. A time-depth recorder (TDR) was attached below the bongo sampler near the depressor.

Additional sampling was done on the December *Albatross IV* cruise 74-13. A 20 cm bongo sampler with fine mesh (.165 mm and .053 mm) was mounted above the standard sampler and towed simultaneously to sample the smaller size food organisms utilized by the larvae. Also, a 10 minute surface neuston haul was made at selected stations employing a 1x2 m aluminum frame fitted with a .505 mm mesh net. Vessel speed was 3.5 knots.

A BT cast, or XBT drop, surface salinity sample; wind-sea state, and cloud cover observations were taken routinely at each station during all cruises. An environmental profiling system (STD/DO) mated with a rosette sampler was used for hydrographic sampling on the *Albatross IV*, 74-13 cruise. STD casts within 10 m of the bottom to a maximum depth of 500 m were made on selected stations after the plankton work.

Ichthyoplankton have been identified, counted, and measured to the nearest mm (standard length) from the .505 mm mesh samples of the 61 cm bongo sampler for all three cruises and the neuston samples from the December *Albatross IV*, 74-13 cruise.

Results

I. *Duchess II* & *Cryos*, 74-1

The cruise track and densities of larvae are given in Figures 1-7. High densities (101-1000/10 m^2) of recently hatched (<10 mm) larvae occurred along the northeast Maine coast off Pleasant Bay and Machias Bay. Larger larvae (10-20 mm) appeared at lower densities and their range extended more southwesterly off Penobscot Bay. Larval lengths ranged from 6 to 25 mm with a dominant mode near 9 mm (Table 1, Figure 8).

II. *Delaware II*, 74-12

The cruise track is given in Figure 9. High densities of recently hatched larvae (<10 mm) appeared within the 100 m contour in three areas along the west coast of the Gulf of Maine off (1) Pleasant Bay and

Machias Bay, (2) Casco Bay near Cape Small and Cape Elizabeth, and (3) Cape Ann near the base of Jeffreys Ledge extending along Stellwagen Bank (Figures 10-15). Larvae ranged in length from 4 to 27 mm with a sharp mode of recently hatched larvae near 7 mm (Table 1, Figure 8). Two smaller length modes may be indicated at 13 and 19 mm. Few larvae greater than 20 mm were collected during the survey. Larvae of 10 to 20 mm appear to be dispersed southwest along the coast. The northern and middle sector larval populations overlap in their distribution as a result of the southwesterly transport reported in this area by Bumpus and Lauzier (1965). However, few larvae seem to be transported as far south as Cape Ann leaving the southern population relatively discrete. Most larvae seem to be retained in the nearshore area. Larvae transported beyond the 100 m contour appeared offshore near Boothbay Harbor.

Surface and 30 m depth temperatures and surface salinity are given in Figures 16-18. Coastal temperatures generally increased from east to west and from onshore to offshore. A complex system of eddies may occur off Cape Ann as suggested by the constricted temperature contours at 30 m.

III. *Albatross IV*, 74-13

In December, the highest densities of larvae (101-1001/10 m^2) occurred within the 100 m contour extending from Nantucket Shoals across Georges Bank (Figures 20-25). Small catches also occurred along the western Gulf of Maine off Cape Elizabeth, and a few larvae were observed in the central Gulf of Maine. The Nantucket Shoals-Georges Bank larval populations were contiguous in their distribution, whereas the western Gulf of Maine population remained isolated for the most part.

Most of the larvae collected by the bongo sampler ranged in size from 9 to 25 mm (Table 2, Figure 26). Two possible modal length groups, one near 13 mm and the other at 19 mm, appeared in the length frequency summaries for all areas. The Nantucket Shoals population was comprised of smaller larvae (<10 mm) than the others indicating more recently hatched larvae.

The relatively few neuston hauls indicate a similar distribution of larvae as observed in the bongo hauls (Figure 28), however, a greater frequency of large larvae was caught by neuston tows in all areas (Figure 29). Only larvae greater than 19 mm were collected in the central Gulf of Maine indicating offshore drift. A comparison of the abundance of herring larvae by day, night, and twilight hauls for both bongo and neuston samplers is given in Table 3.

1. Bongo hauls

Slightly more than half (56.5%) of the bongo hauls were made at night. Day hauls accounted for 29.6%, and twilight hauls, 13.9% of the total. Higher densities of larvae were collected by night than by day or twilight hauls. Day hauls had the highest percentage of zero catches of larvae.

Some interesting differences in length frequencies are observed by comparing bongo hauls by time periods (Table 4, Figure 27). Larger larvae, 16-21 mm in length for both areas combined, were collected more frequently by day, whereas smaller larvae, 10-15 mm were collected more frequently by night. The length frequency of larvae collected by twilight (13-21 mm) appears more similar to the day range. However, these diel differences in length frequency may not be significant when sampling variability is considered. Catches of larger larvae by day is contrary to most published work in the field. Most studies show larger larvae to be caught more frequently by night, indicating avoidance of the sampler by day (*e.g.* Graham *et al.*, 1972a. Another explanation for this discrepancy may be that the older larvae migrate near the surface by night where they are undersampled by the bongo sampler. By day, they disperse downward and are sampled throughout the water column. Further discussion of the diurnal migratory behavior of the larvae as an important factor in sampling variability is given by Lough (1975).

2. Neuston hauls.

A nearly equal percentage of hauls was made at night (51.6%) as by day and twilight. Higher densities of larvae were observed in night hauls than by day or twilight hauls, or a combination of the two. The percentage of zero hauls was small for all time periods (16.1%). Since most larvae were collected at night and few were collected by day or twilight hauls, a meaningful comparison of length frequencies by time periods could not be made from Table 4.

3. Bongo-Neuston inter-comparison.

Both samplers seem to show greater catches of larvae by night compared to day and twilight hauls (Table 3). Fewer zero catches of larvae were observed in neuston than bongo hauls, regardless of the time period. Higher densities of larvae were collected by the bongo than the neuston sampler. However, there was a significant difference in the length frequency distribution of the larvae caught by the two types of samplers. In all areas, larger larvae (>20 mm) were collected by the neuston sampler whereas smaller larvae (<20 mm) predominated in the bongo sampler. The bongo sampler may underestimate the true population of the largest larvae which are caught only by the neuston sampler.

Hydrography

Water of 9°-10° C predominated over most of Georges Bank in December (Figures 30-32). Somewhat cooler 8° C surface water was observed on the northeast part, whereas warmer 10°-11° C water was observed on the southwest part. Cool 7° - 8° C water occurred at 100 m-depth in the northern part of the Southwest Channel. Surface salinities on Georges Bank ranged from *ca.* 33.0-33.5 ppt (Figure 33). A gradient of rapidly increasing temperatures and salinities associated with the slope front occurred along the 100 m contour of the southern part of Georges Bank. High slope front temperatures and salinities were observed in the Nantucket Shoals area in shallow waters less than 100 m depth.

IV. Ichthyoplankton associated with herring larvae

The various ichthyoplankton groups collected and identified from *Duchess II* & *Cryos*, 74-1, *Delaware II*, 74-12, and *Albatross IV*, 74-13, are listed in Tables 5-8 by percentage frequency and relative abundance. Herring larvae occurred in greater frequency and abundance than any other species or group during the two inshore cruises (September and October) and the one offshore cruise (December).

Gadids were the second most abundant ichthyoplankton group collected. They were present in greater than half of the hauls, occurring most abundantly along the inshore area in October. *Merluccius*, *Enchelypus*, and *Urophycis* larvae were the principle representatives of the Gadidae in October along the inshore area, whereas *Pollachius*, *Gadus*, and *Merluccius* predominated in December offshore.

Flatfish larvae constituted the third most abundant group. Bothids were collected more frequently offshore in December, while pleuronectids (*Glyptocephalus*) were more represented inshore along the coastal western Gulf of Maine, particularly in October.

Deep-water larvae of the gonostomatids, myctophids, and paralepidids were collected more frequently during the offshore December cruise. These groups rarely occurred inshore as expected from the known distribution of the adults. Most of the other families of ichthyoplankton comprised a small percentage of the total catch. The diversity of ichthyoplankton was greater offshore in December than inshore during September and October.

A comparison of the December neuston and bongo catches of ichthyoplankton shows a greater diversity of fish larvae in the bongo catches. However, three times as many bongo tows were made as neuston hauls. Although both the neuston and bongo samplers strained approximately 1000 m^3 of water, the difference in diversity of species between the two samplers must be considered in relation to frequency of sampling as well as depth of tows. Considerably more *Urophycis* larvae were collected in neuston hauls than bongo tows. *Urophycis* comprised 45% of the total neuston catch compared to 53% for *Clupea*. The largest neuston catches of *Urophycis* larvae were observed during daylight hauls, whereas nearly every zero catch was observed at night. A more complete analysis of the September through February neuston catches of ichthyoplankton in the Gulf of Maine-Georges Bank area will be made in the future.

Discussion

The fall hatching of herring larvae within the Gulf of Maine and Georges Bank area usually coincides with the north to south progression of cooling surface temperatures. Recently hatched larvae are first caught along the Scotian Shelf and Bay of Fundy, then down along the western coast of the Gulf of Maine progressing southwest, the northeast part of Georges Bank and finally the Nantucket Shoals area. A similar pattern was observed this past fall except that the initial appearance of larvae was delayed by several weeks compared to the previous year, fall 1973 (*cf.* Balkovoy *et al.*, 1975; Schnack and Joakimsson, 1975; Paulmier and Briand, 1975, *Wieczno* ICNAF Basic Data Summary).

The abundance of larvae along the western coastal Gulf of Maine has been reported by Graham *et al.* (1972a) to be high in the eastern sector in early autumn, but larger in the western sector by mid-autumn. Larval abundance declines sharply in both sectors by late autumn to a low level. Larval herring cruises within the ICNAF Larval Herring Survey have been made along the western coastal Gulf of Maine only during fall 1971, 1972, and 1974. This past fall, 1974, three areas of recently hatched larvae (<10 mm) were observed in the eastern middle, and western sectors. During fall, 1971, three population sectors were identified, an eastern, middle, and western sector; however only two major spawning areas were delineated by recently hatched larvae and both of these were located in the western sector (Graham *et al.*, 1972b). In contrast to fall of 1971 and 1974, five major spawning areas were identified in 1972; 1) east of Penobscot Bay, 2) south of Boothbay Harbor, 3) south of Portland, 4) Jeffreys Ledge and 5) Stellwagen Bank (Graham *et al.*, 1973). The identification of these multiple spawning aggregations was made possibly, in part, by their extensive sampling coverage of four separate cruises from September through the first half of November. Sampling was more restricted this past fall. The initial catches of recently hatched larvae this past fall, 1974, appeared to be somewhat delayed compared to fall of 1971 and 1972. Hatching during fall 1972 appeared later than during 1971. The abundance of larvae along the coastal western Gulf of Maine seems to be higher this past fall than in previous years sampled. In all three years relatively few larvae occurred beyond the 100 m contour.

Herring larvae were collected during the December cruise, *Albatross IV*, 74-13, on most of the stations sampled and in areas previously reported by other ICNAF participants. Larvae in the central Gulf of Maine most likely originated from the shallow water populations and drift in the cyclonic circulation (Bumpus and Lauzier, 1965). Small catches of larvae appeared offshore along the coastal western Gulf of Maine near Cape Elizabeth. Larvae originating from Georges Bank-Nantucket Shoals are subject to a southerly flow in this area during the winter months, with a westerly component across the Great South Channel (Bumpus and Lauzier, 1965). The southwesterly dispersal of larvae during the fall in the Georges Bank-Nantucket Shoals areas follows the general drift pattern.

The distributional pattern and abundance of larvae appear similar this December compared to last year's survey, *Albatross IV*, 73-9 (4-20 December 1973) (Figures 53-55). However, higher densities of larvae were observed in the Nantucket Shoals-Georges Bank area this December than in the previous December. A comparison of length frequencies between the two Decembers (*cf.* Schnack, 1974) verifies the delayed hatching reported this year, particularly in the Nantucket Shoals area. Also, three length modes appear during December 1973 whereas only two modes appear this December--one large and the other small. The higher densities of larvae reported in the Nantucket Shoals area this December may be due to the delayed hatching and the shorter time for mortality processes to occur.

Temperatures in the study area were higher in the southern part of Georges Bank in December, 1973 than 1974 (Figures 35-38). Compared to Colton and Stoddard's (1972) 19-year temperature average (1940-1959), December temperatures in 1971-1974 were a couple of degrees warmer (9°-10° C) over the central and southern part of Georges Bank, particularly along the slope front. A qualitative comparison of December temperatures (surface, 30 m, and 100 m) were ranked from warmest (1) to coldest (4) and abundance of larvae in the Georges Bank area in the same manner according to Schnack and Joakimsson's (1975) abundance estimates.

Year (Dec.)	Temperature rank	Larval abundance rank
1974	2	2 ?
1973	1	1
1972	4	4
1971	3	3

Years of high larval abundance appear to be related to years of high temperatures in the Georges Bank area. This relationship needs to be investigated more thoroughly in the future, especially in regards to stock-recruitment relations of herring and the various plankton components.

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Table 1. Length frequency summary Western Gulf of Maine. *Duchess II* 74-1, 9-14 September 1974 and *Cryos* 74-1, 7-24 September 1974; *Delaware II* 74-12, 8-16 October 1974.

Standard Length (mm)	*Duchess II-Cryos*	*Delaware II*
4		7
5		86
6	14	581
7	121	2186
8	386	1738
9	571	490
10	280	464
11	159	412
12	184	346
13	190	425
14	134	446
15	109	238
16	63	105
17	69	121
18	39	174
19	14	169
20	10	154
21	1	49
22		43
23		29
24		20
25	7	10
26		7
27		1
Total	2,351	8,303

Table 2. Length frequency summary for herring larvae collected in 61 cm bongo hauls(.505 mm mesh) on *Albatross IV* Cruise 74-13, 4-19 December 1974.

Standard Length (mm)	Nantucket Shoals	Georges Bank	Western Gulf of Maine	Central Gulf of Maine	Total
4					
5					
6	6				6
7	6				6
8	7	2			9
9	21	40	2		63
10	123	76			199
11	212	195	2		409
12	193	386			579
13	235	429	6	1	671
14	231	488	8		727
15	147	490	21	2	662
16	118	378	18	1	515
17	104	365	6	2	477
18	59	448	7		514
19	74	429	10	1	514
20	72	303	8	4	387
21	55	229	2	2	288
22	17	177	5	1	200
23	7	100	1	1	109
24	6	75	5		86
25	1	40	1		42
26		17			17
27		23			23
28	1	3			4
29		8			8
30		5			5
Total	1695	4707	102	15	6520

Table 3. Diel variability of herring larvae collected on *Albatross IV*, 74-13, 4-19 December 1974. Day (0819-1529), Night (1729-0619), Twilight (0619-0819, 1529-1729).

BONGO HAULS

No. larvae per 1000m^3	Day	%	Night	%	Twilight	%	Total	%
0	19	59.9	10	16.4	3	20.0	32	29.6
1-10	8	25.0	15	24.6	6	40.0	29	26.9
11-100	4	12.5	15	24.6	1	6.7	20	18.5
101-1000	1	3.1	18	29.5	4	26.7	23	21.3
1001-10,000			3	4.9	1	6.7	4	3.7
Total	32		61		15		108	
%	29.6		56.5		13.9			

NEUSTON HAULS

No. larvae per 1000m^3	Day	%	Night	%	Twilight	%	Total	%
0	2	22.2	1	6.3	2	33.3	5	16.1
1-10	6	66.7	9	56.3	3	50.0	18	58.1
11-100	1	11.1	5	31.3	1	16.7	7	22.6
101-1000			1	6.3			1	3.2
Total	9		16		6		31	
%	29.0		51.6		19.4			

Table 4. Percentage length frequency (3mm intervals) of herring larvae by day, night, and twilight collected aboard *Albatross IV* 74-13, 4-19 December 1974.

BONGO

	Nantucket Shoals			Georges Bank			Total		
Standard length (mm)	Day	Night	Twilight	Day	Night	Twilight	Day	Night	Twilight
4-6	0.7	0.3	1.3				0.7	0.3	1.3
7-9		2.6	1.5		0.7			2.1	
10-12	13.4	36.6	23.9	3.6	13.3	2.3	8.5	25.0	13.1
13-15	26.8	41.1	24.7	3.6	24.8	25.5	15.2	33.0	25.1
16-18	37.3	13.9	14.5	35.7	17.1	41.0	36.5	15.5	27.8
19-21	19.7	4.6	29.5	48.2	35.7	26.2	34.0	20.2	27.9
22-24	1.4	0.8	4.6	8.9	6.5	4.5	5.2	3.7	4.6
25-27		0.08			1.7	0.5		0.9	
28-30	0.7				0.3		0.7		
31-33									

NEUSTON

	Nantucket Shoals			Georges Bank			Total		
Standard length (mm)	Day	Night	Twilight	Day	Night	Twilight	Day	Night	Twilight
4-6									
7-9					0.4				0.4
10-12	25.0	10.3	11.1		6.5		15.8	10.3	11.1
13-15		6.9	55.6		6.5			6.7	55.6
16-18		13.8	33.3		7.6			10.7	33.3
19-21	50.0	27.6		100.0	26.3		75.0	27.0	
22-24	50.0	20.7			30.2		50.0	25.5	
25-27		17.2			13.7			15.5	
28-30		3.5			5.7			4.6	
31-33					3.1			3.1	

Table 5. Herring larvae and associated ichthyoplankton groups, 61 cm bongo sampler, .505 mm mesh, *Duchess II* & *Cryos*, 74-1, 7-14 September 1974.

FAMILY (Totals) *Genus*	Number Positive Hauls / Total Stations	%	Number/Positive Haul 1-10	11-100	101-1000
CLUPEIDAE	19/20	95%	5	7	7
Clupea	19/20	95	5	7	7
GADIDAE	11/20	55%	8	3	
Enchelyopus	6/20	30	3	3	
Merluccius	4/20	20	4		
Urophycis	1/20	5	1		
LABRIDAE	4/20	20%	4		
Tautogolabrus	4/20	20	4		
LUMPENIDAE	3/20	15%	3		
Lumpenus	3/20	15	3		
BOTHIDAE	2/20	10%	2		
Scopthalmus	2/20	10	2		
PLEURONECTIDAE	2/20	10%	2		
Glyptocephalus	2/20	10	2		
CYCLOPTERIDAE	1/20	5%	1		
Cylcopterus	1/20	5	1		
SCORPAENIDAE	1/20	5%	1		
Sebastes	1/20	5	1		
PARALEPIDIDAE	1/20	5%	1		

Table 6. Herring larvae and associated ichthyoplankton groups, 61 cm bongo sampler, .505 mm mesh, *Delaware II*, 74-12, 8-16 October 1974.

FAMILY (Totals) *Genus*	Number Positive Hauls / Total Stations	%	Number/Positive Haul 1-10	11-100	101-1000	1001+
CLUPEIDAE	52/56	93%	11	25	14	2
Clupea	47/56	84	9	23	13	2
GADIDAE	45/56	80%	28	14	3	
Merluccius	37/56	66	29	8		
Enchelyopus	28/56	50	18	10		
Urophycis	25/56	45	16	9		
Pollachius	1/56	2	1			
PLEURONECTIDAE	20/56	36%	20			
Glyptocephalus	19/56	34	19			
Limanda	1/56	2	1			
Paralichthys	1/56	2	1			
BOTHIDAE	3/56	5%	3			
Scopthalmus	2/56	4	2			
GONOSTOMATIDAE	1/56	2%	1			
Maurolicus	1/56	2	1			
LABRIDAE	1/56	2%	1			
Tautoga	1/56	2	1			
LIPARIDAE	1/56	2%	1			
Liparis	1/56	2	1			
PHOLIDAE	1/56	2%	1			
Pholis	1/56	2	1			

Table 7. Herring larvae and associated ichthyoplankton groups, 61 cm bongo sampler, .505 mm mesh, *Albatross IV*, 74-13, 4-19 December 1974.

FAMILY (Totals)	Number Positive Hauls / Total Staions	%	Number/Positive Haul 1-10	11-100	101-1000
CLUPEIDAE	76/108	70%	37	17	22
Clupea	76/108	70	37	17	22
GADIDAE	62/108	58%	36	24	2
Pollachius	34/108	31	25	7	2
Gadus	22/108	20	16	6	
Merluccius	22/108	20	17	5	
Urophycis	9/108	8	9		
Enchelyopus	5/108	5	5		
BOTHIDAE	26/108	24%	23	3	
Paralichthys	9/108	8	7	2	
Scopthalmus	8/108	7	8		
Bothus	3/108	3	3		
Citharichthys	2/108	2	2		
Hippoglossina	1/108	1	1		
Poecilopsetta	1/108	1	1		
PARALEPIDIDAE	22/108	20%	15	7	
Notolepis	7/108	7	3	4	
Paralepis	1/108	1	1		
GONOSTOMATIDAE	16/108	15%	14	2	
Cyclothone	6/108	5	6		
Maurolicus	4/108	4	4		
Gonostoma	2/108	2	2		
Vinciguerria	1/108	1	1		
MYCTOPHIDAE	15/108	14%	13	2	
Ceratoscopelus	3/108	3	3		
Myctophum	1/108	1	1		
GOBIIDAE	12/108	11%	12		
PLEURONECTIDAE	10/108	9%	8	2	
Paralichthys	9/108	8	7	2	
Limanda	1/108	1	1		
OPHICHTHYIDAE	10/108	9%	10		
LABRIDAE	4/108	4%	4		
SCARIDAE	4/108	4%	4		
CALLIONYMIDAE	3/108	3%	3		
Callionymus	1/108	1	1		
SYNODONTIDAE	3/108	3%	3		
ENGRAULIDAE	3/108	3%	3		
CONGRIDAE	3/108	3%	3		
BREGMACEROTIDAE	2/108	2%	2		
Bregmaceros	1/108	1	1		
OPHIDIIDAE	2/108	2%	2		
SCIAENIDAE	2/108	2%	2		
SERRANIDAE	2/108	2%	2		
CYNOGLOSSIDAE	1/108	1%	1		
Symphurus	1/108	1	1		
ELOPIDAE	1/108	1%	1		
Elops	1/108	1	1		
ANTENNARIIDAE	1/108	1%	1		
CARAPIDAE	1/108	1%	1		
CYCLOPTERIDAE	1/108	1%	1		
NOTACANTHIDAE	1/108	1%	1		
POMACENTRIDAE	1/108	1%	1		
SCOPELARCHIDAE	1/108	1%	1		
SCOPELOSAURIDAE	1/108	1%	1		

Table 8. Herring larvae and associated ichthyoplankton groups, 1 x 2 m neuston sampler, .505 mm mesh, *Albatross IV*, 74-13, 4-19 December 1974.

FAMILY (Totals) *Genus*	Number Positive Hauls / Total Stations	%	Number/Positive Haul 1-10	11-100	101-1000	1001+
CLUPEIDAE	26/31	84%	17	7	2	0
Clupea	26/31	84	17	7	2	0
GADIDAE	20/31	64%	8	11	1	
Urophycis	20/31	64	8	11	1	
Gadus	1/31	3	1			
Pollachius	1/31	3	1			
TETRADONTIDAE	2/31	6%	2			
Sphoeroides	2/31	6	2			
AMMODYTIDAE	1/31	3%	1			
Ammodytes	1/31	3	1			
BOTHIDAE	1/31	3%	1			
Scopthalmus	1/31	3	1			
CARANGIDAE	1/31	3%	1			
CERATIIDAE	1/31	3%	1			

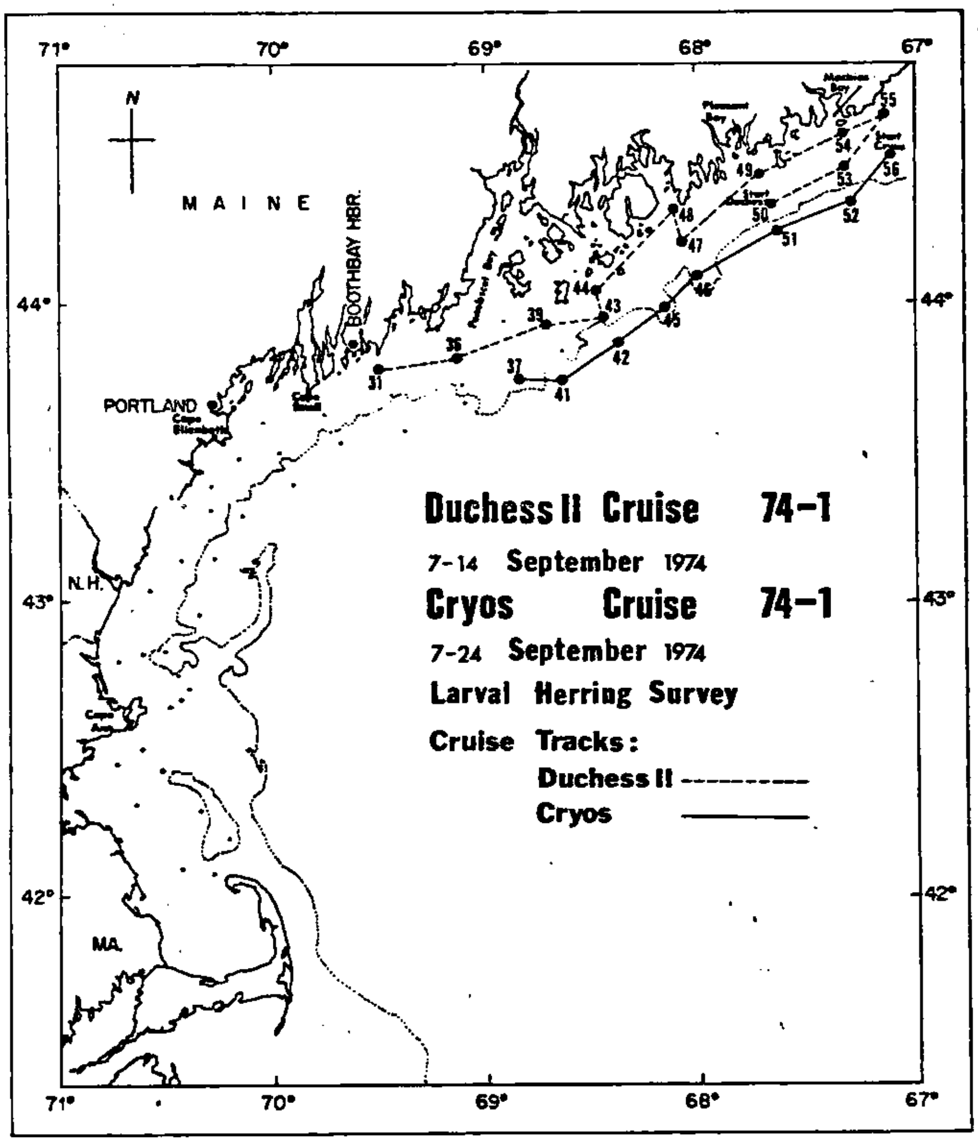
71°
70°
69°
68°
67°
44°
43°
42°
N
MAINE
BOOTHBAY HBR.
PORTLAND
N.H.
MA.
Duchess II Cruise 74-1
7-14 September 1974
Cryos Cruise 74-1
7-24 September 1974
Larval Herring Survey
Cruise Tracks:
Duchess II
Cryos

Fig. 1.

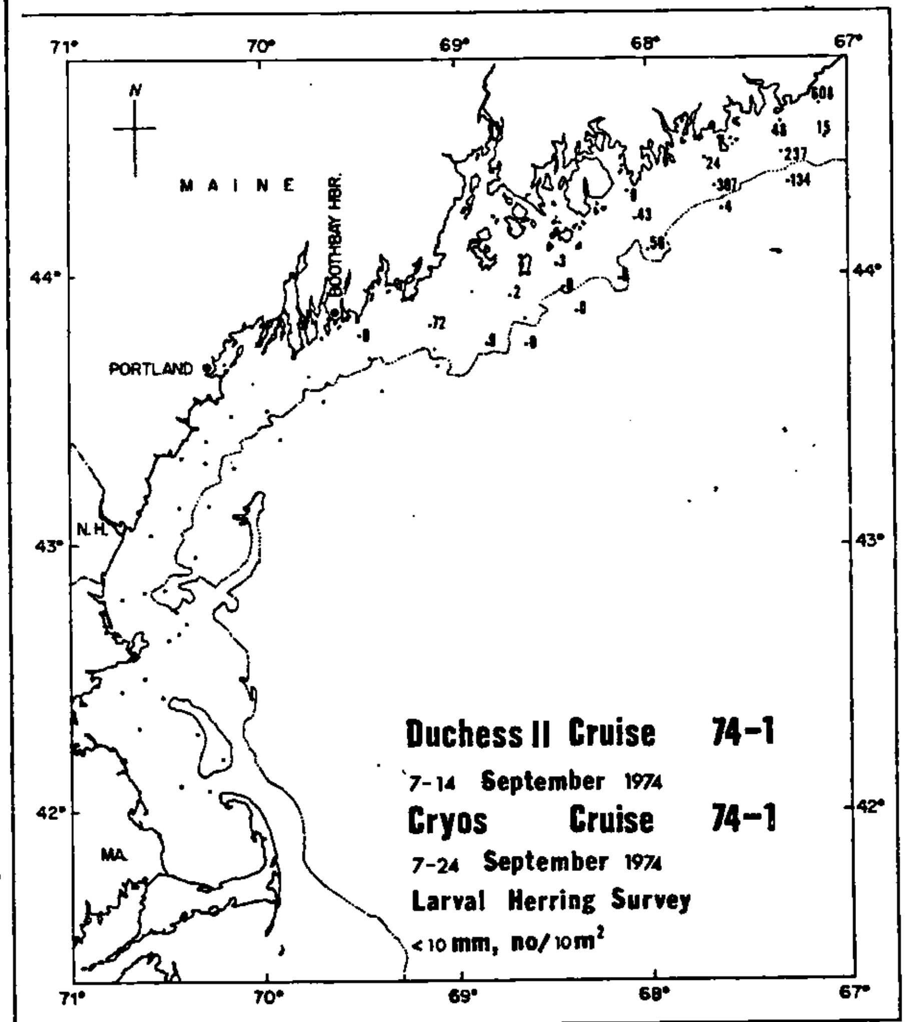
71°
70°
69°
68°
67°
44°
43°
42°
N
MAINE
BOOTHBAY HBR.
PORTLAND
N.H.
MA.
Duchess II Cruise 74-1
7-14 September 1974
Cryos Cruise 74-1
7-24 September 1974
Larval Herring Survey
<10 mm, no/10m²

Fig. 2.

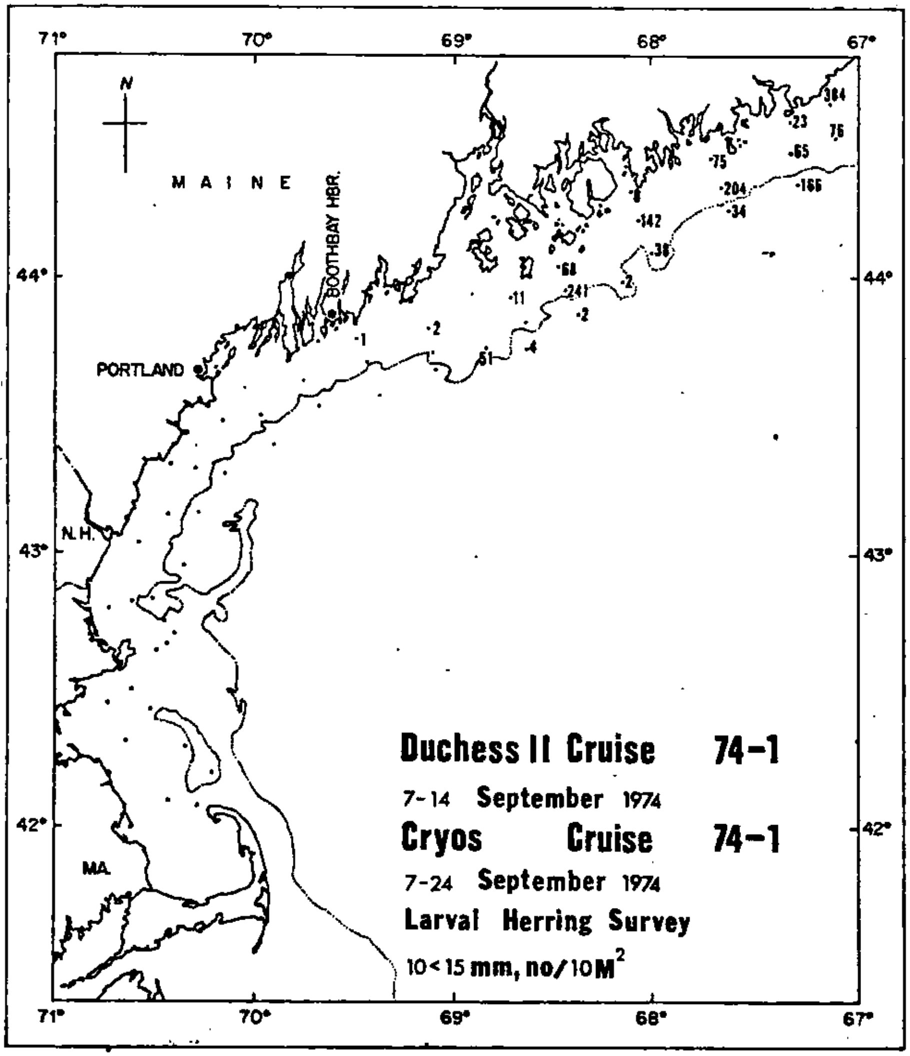
MAINE
BOOTHBAY HBR.
PORTLAND
N.H.
MA.
Duchess II Cruise 74-1
7-14 September 1974
Cryos Cruise 74-1
7-24 September 1974
Larval Herring Survey
10<15 mm, no/10M²

Fig. 3.

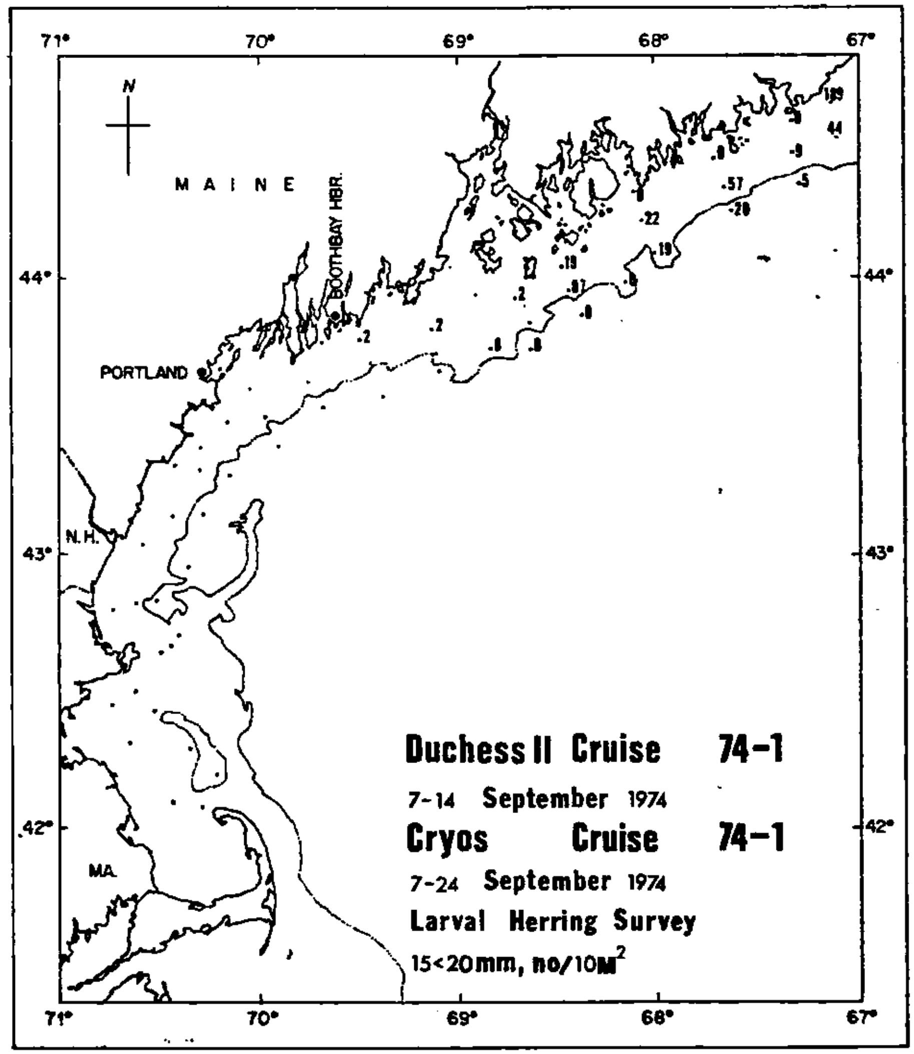
MAINE
BOOTHBAY HBR.
PORTLAND
N.H.
MA.
Duchess II Cruise 74-1
7-14 September 1974
Cryos Cruise 74-1
7-24 September 1974
Larval Herring Survey
15<20mm, no/10M²

Fig. 4.

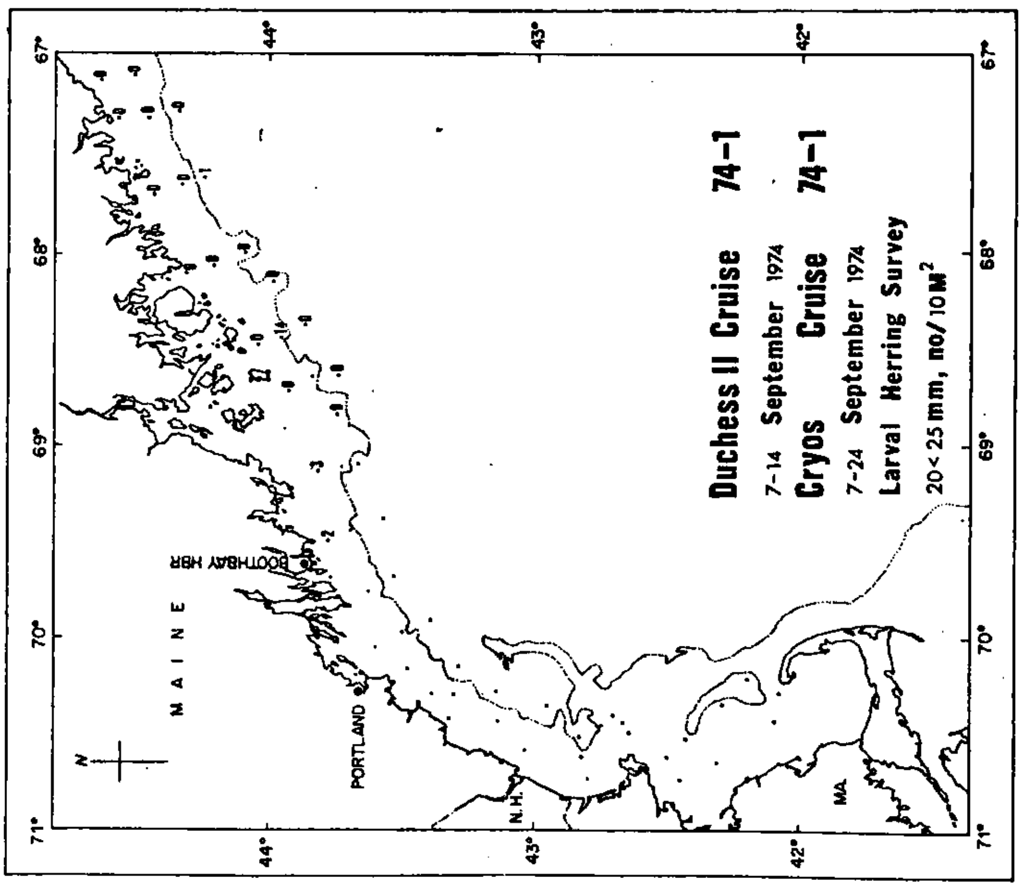
Duchess II Cruise 74-1
7-14 September 1974
Cryos Cruise 74-1
7-24 September 1974
Larval Herring Survey
20< 25 mm, no/10M²
MAINE
PORTLAND
BOOTHBAY HBR
N.H.
MA
N
71°
70°
69°
68°
67°
44°
43°
42°

Fig. 5.

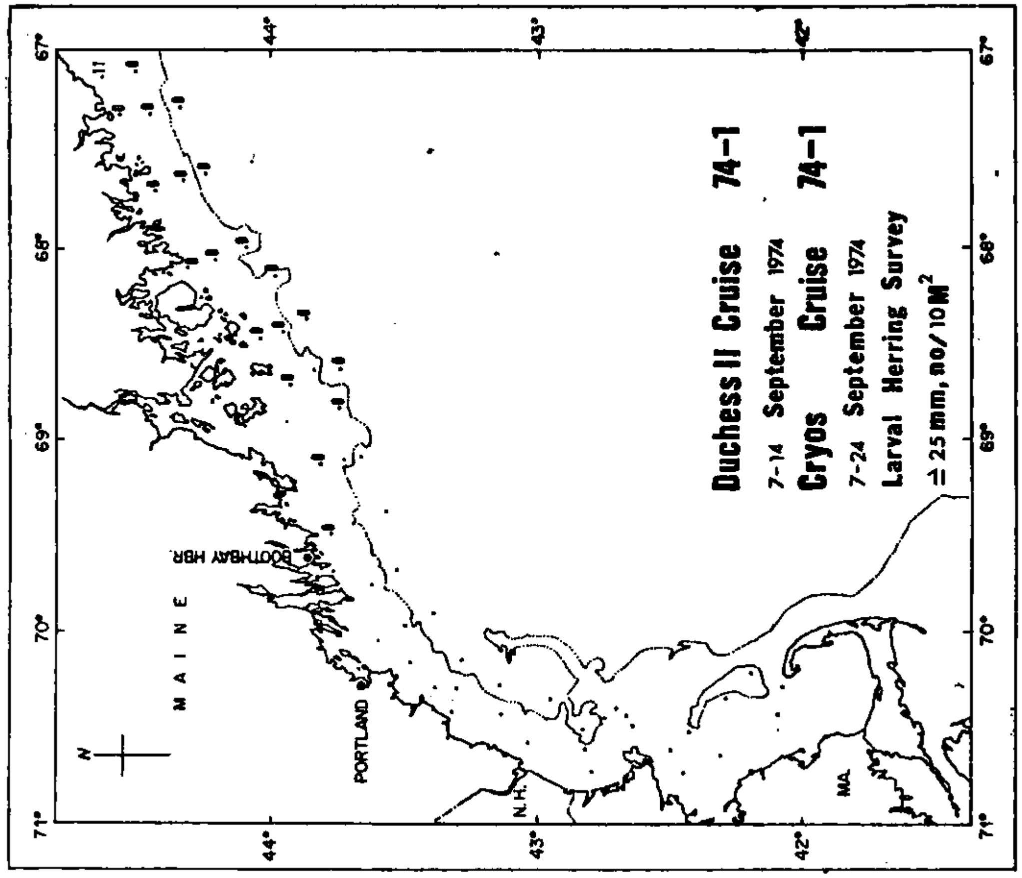
Duchess II Cruise 74-1
7-14 September 1974
Cryos Cruise 74-1
7-24 September 1974
Larval Herring Survey
≥ 25 mm, no/10M²
MAINE
PORTLAND
BOOTHBAY HBR
N.H.
MA
N
71°
70°
69°
68°
67°
44°
43°
42°

Fig. 6.

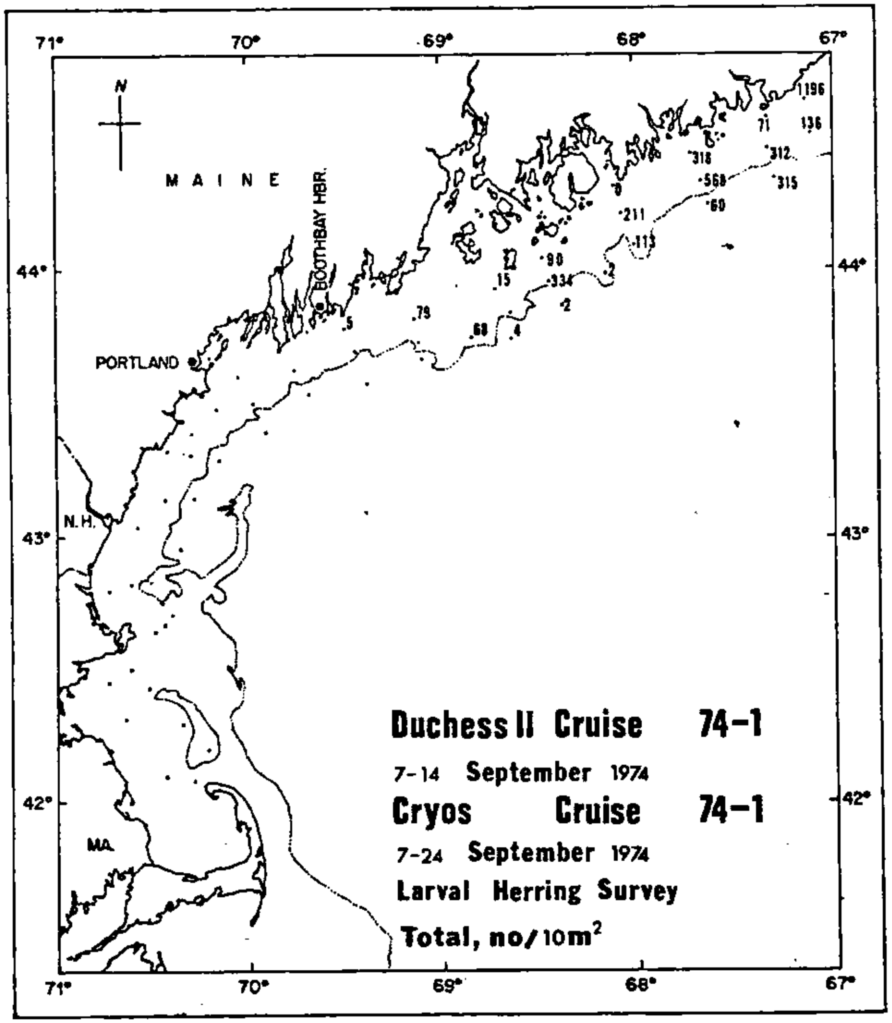
71°
70°
69°
68°
67°
44°
43°
42°
N
M A I N E
BOOTHBAY HBR.
PORTLAND
N.H.
MA.
Duchess II Cruise 74-1
7-14 September 1974
Cryos Cruise 74-1
7-24 September 1974
Larval Herring Survey
Total, no/10m²

Fig. 7.

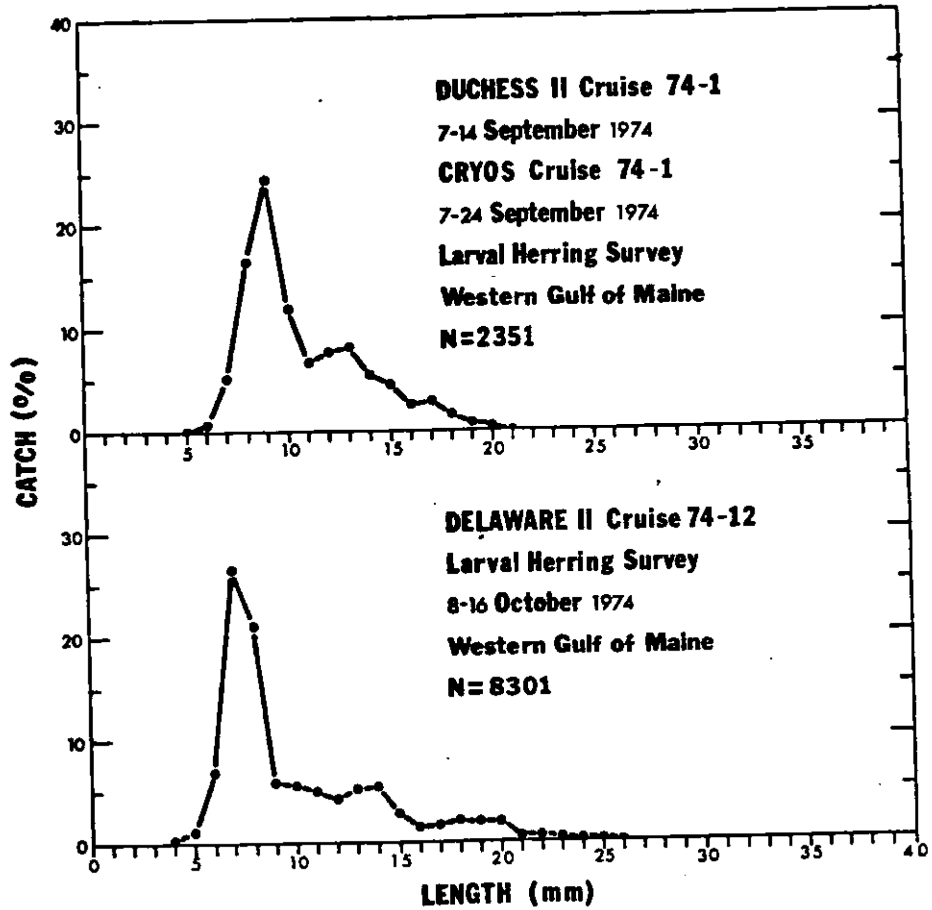
DUCHESS II Cruise 74-1
7-14 September 1974
CRYOS Cruise 74-1
7-24 September 1974
Larval Herring Survey
Western Gulf of Maine
N=2351
DELAWARE II Cruise 74-12
Larval Herring Survey
8-16 October 1974
Western Gulf of Maine
N=8301
CATCH (%)
LENGTH (mm)

Fig. 8.

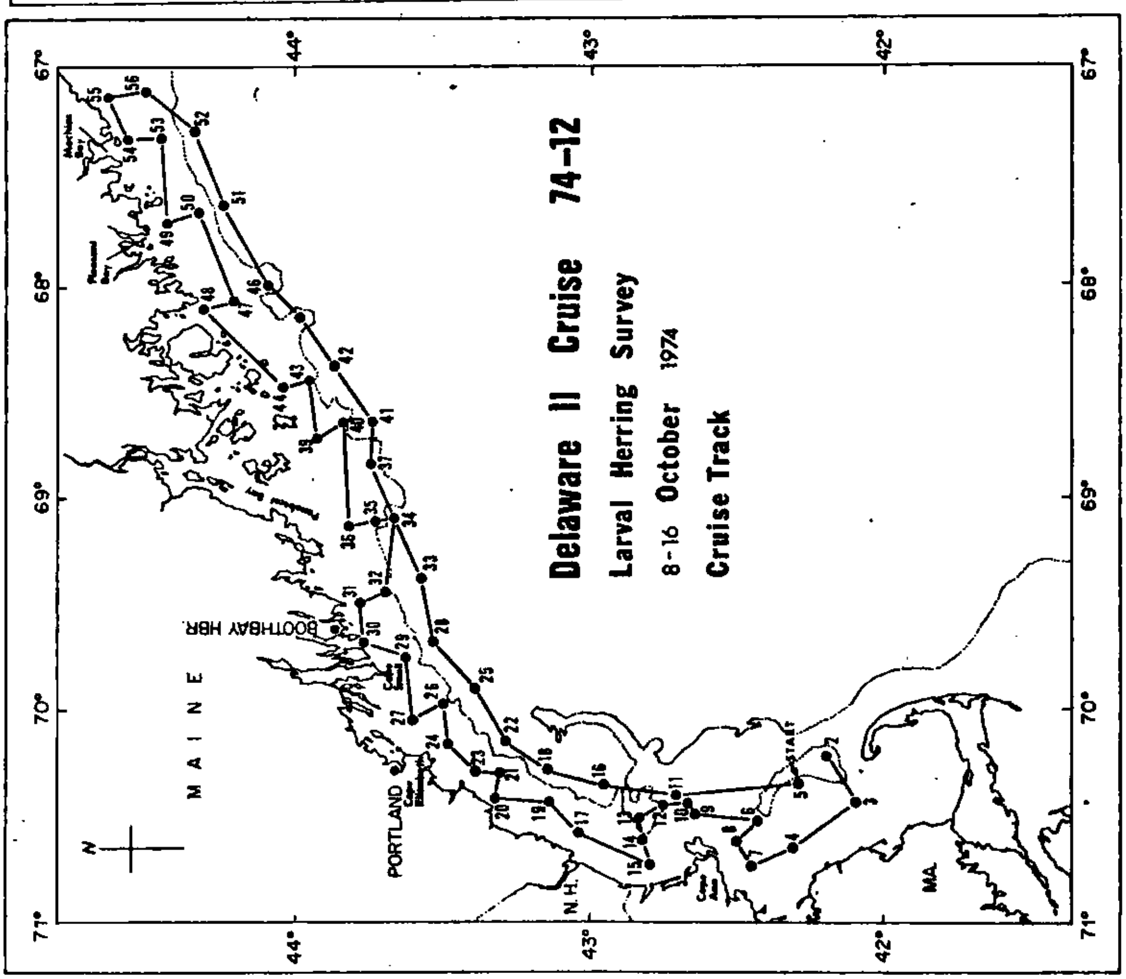
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
Cruise Track
MAINE
PORTLAND
BOOTHBAY HBR.
N.H.
MA.

Fig. 9.

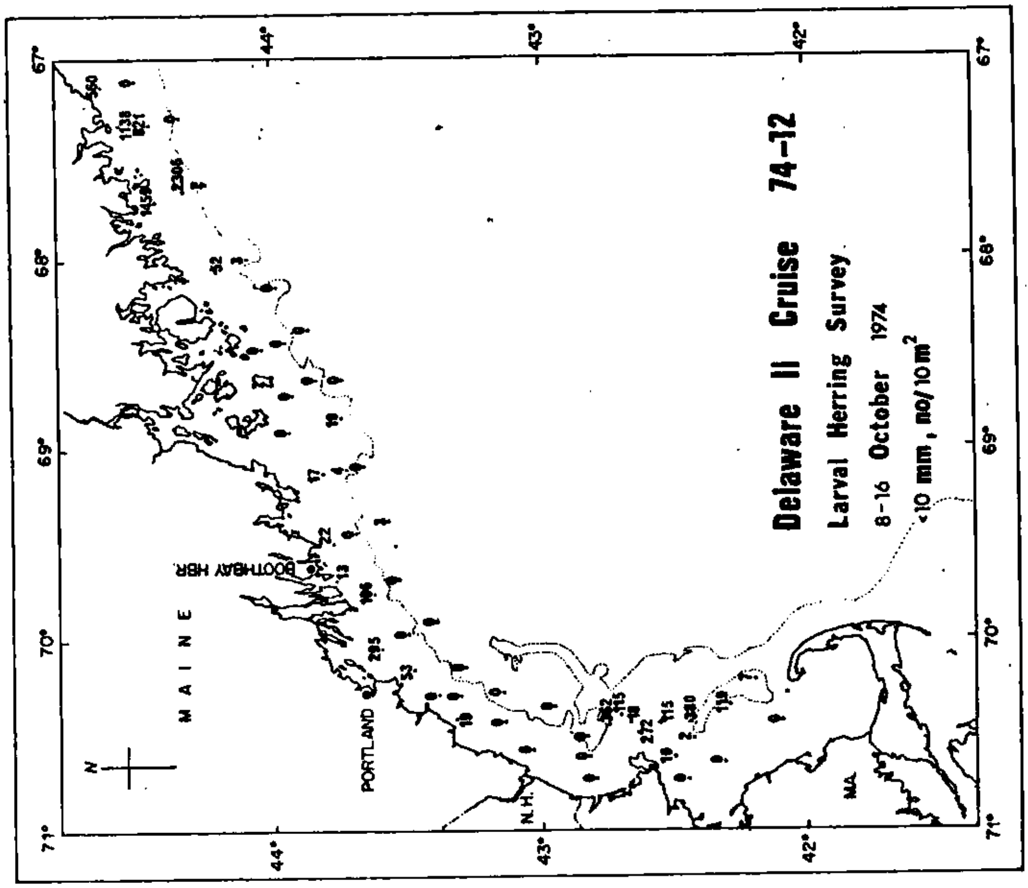
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
<10 mm, no/10 m²
MAINE
PORTLAND
BOOTHBAY HBR.
N.H.
MA.

Fig. 10.

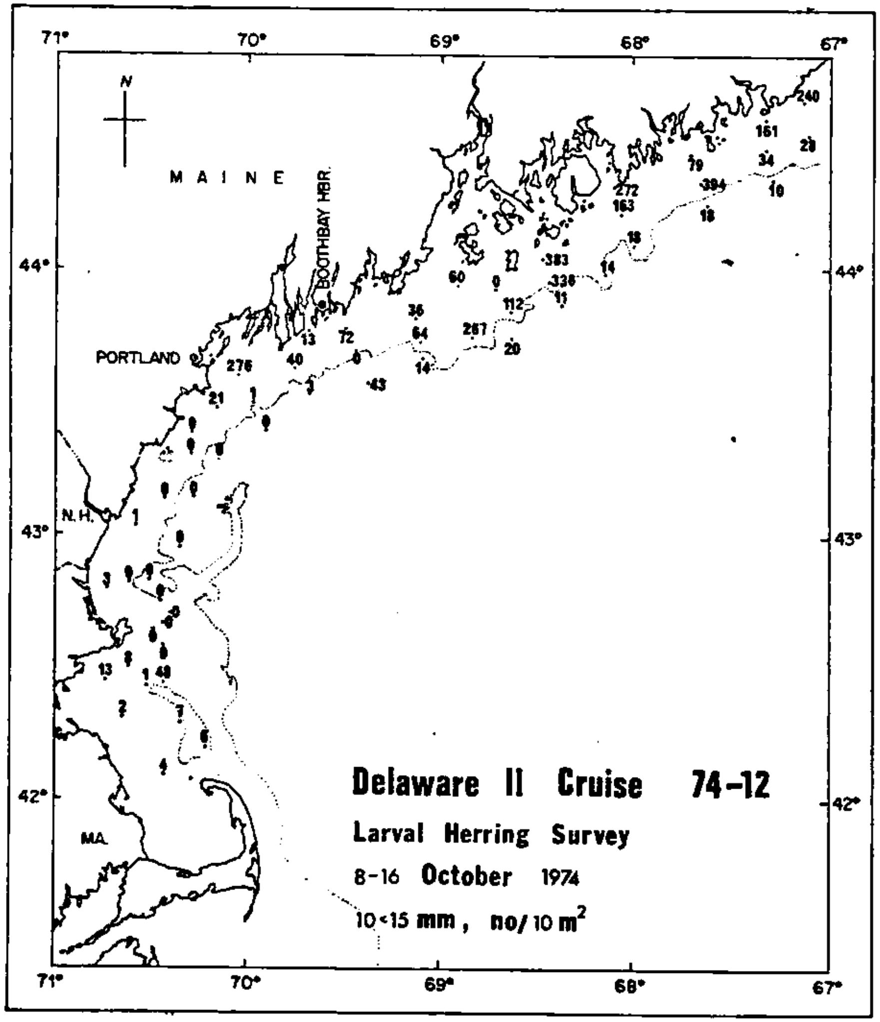
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
10<15 mm, no/10 m^2
MAINE
BOOTHBAY HBR.
PORTLAND
N.H.
MA.
N
71° 70° 69° 68° 67°
44° 43° 42°

Fig. 11.

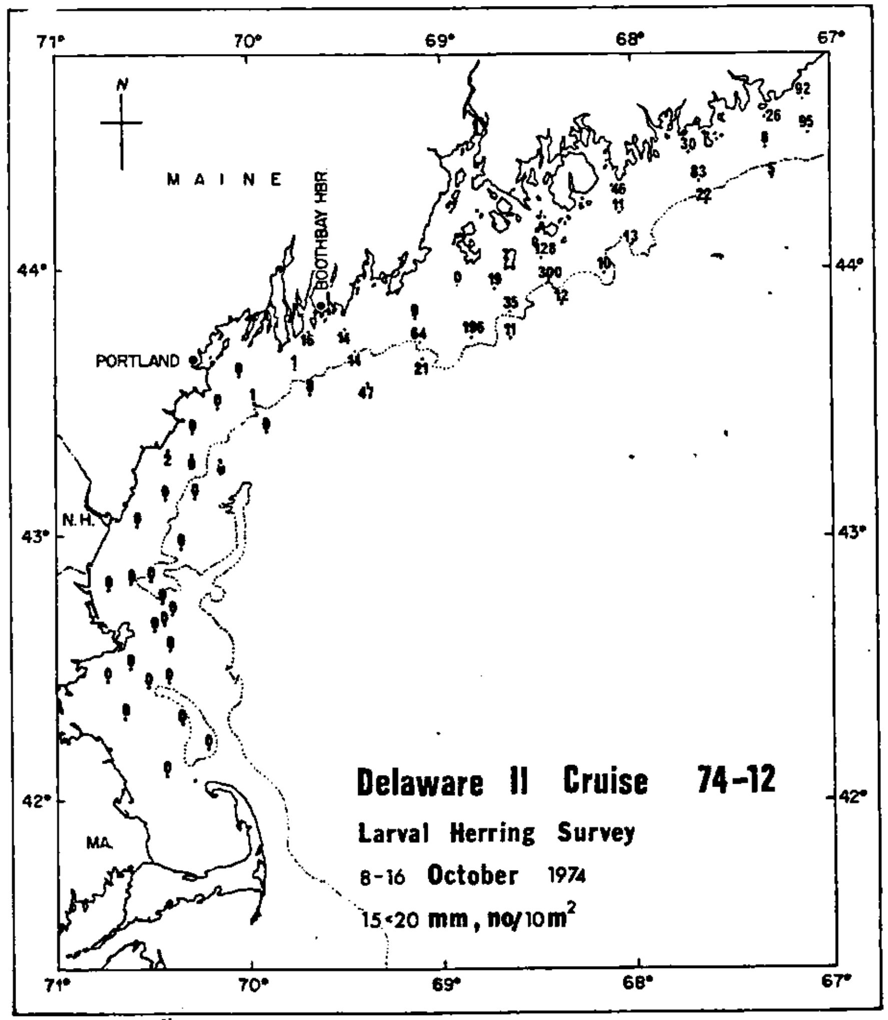
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
15<20 mm, no/10 m^2
MAINE
BOOTHBAY HBR.
PORTLAND
N.H.
MA.
N
71° 70° 69° 68° 67°
44° 43° 42°

Fig. 12.

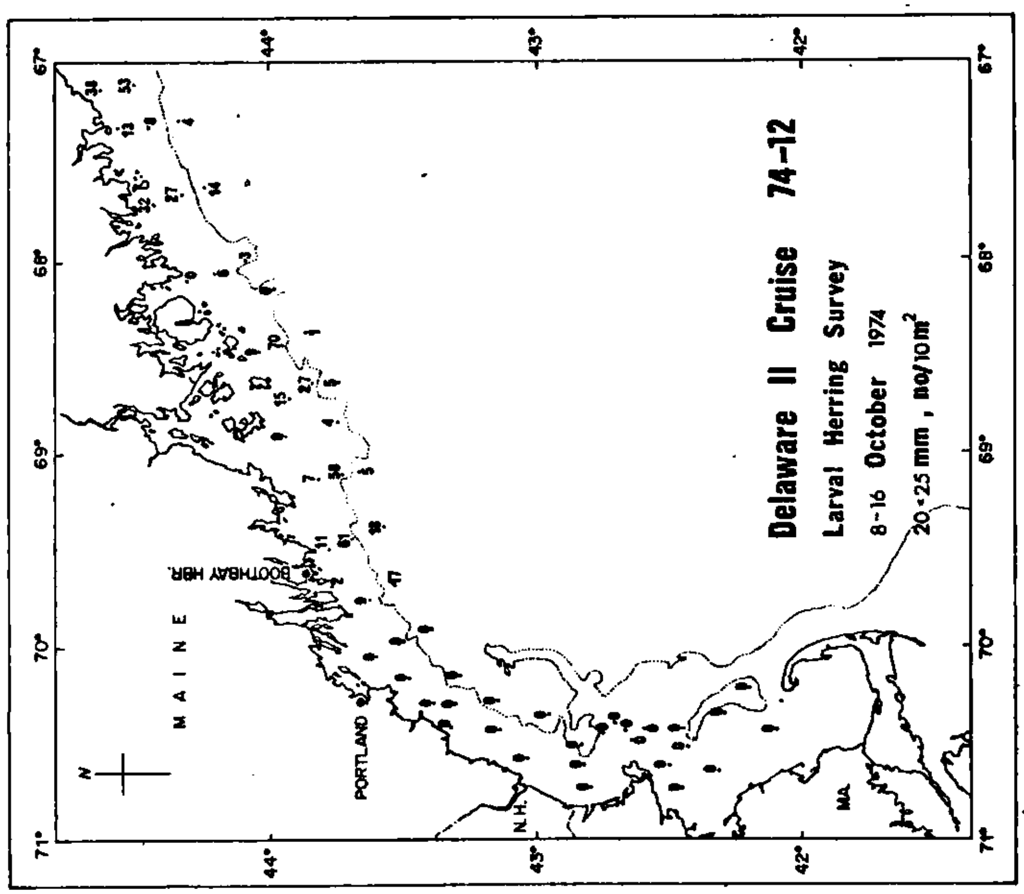
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
20-25 mm, no/10m²
MAINE
PORTLAND
BOOTHBAY HBR.
N.H.
MA
N
71°
70°
69°
68°
67°
44°
43°
42°

Fig. 13.

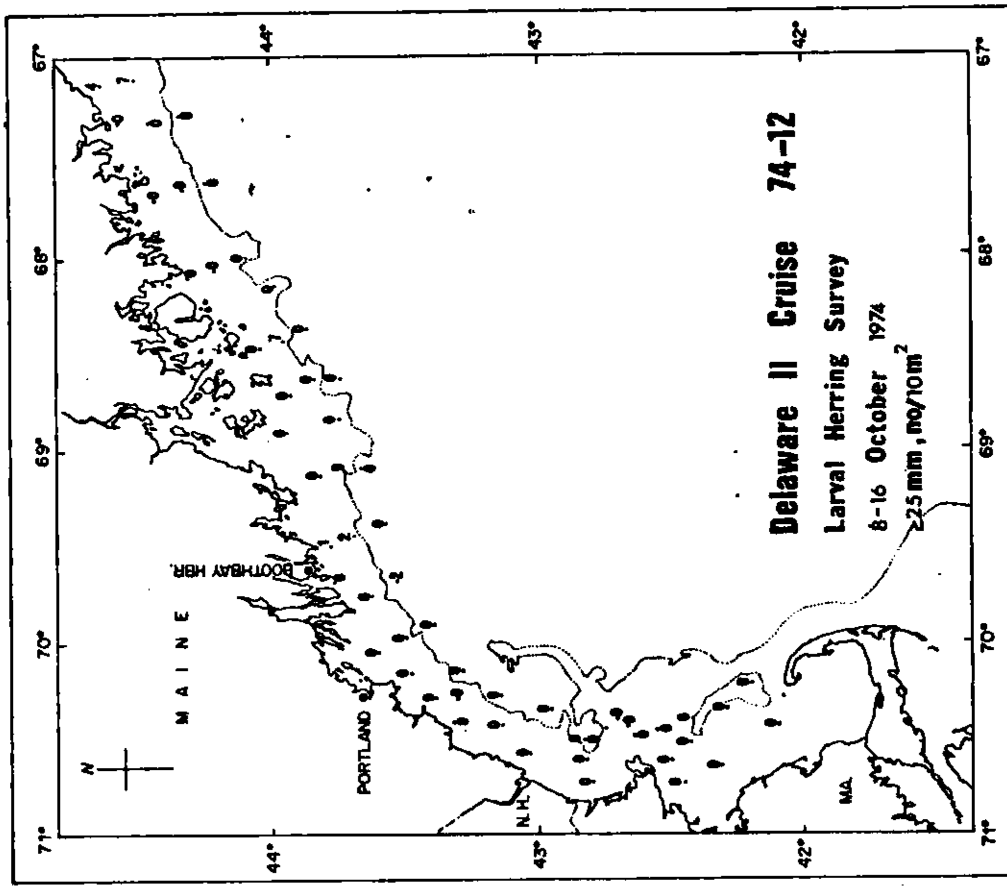
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
≥25 mm, no/10m²
MAINE
PORTLAND
BOOTHBAY HBR.
N.H.
MA
N
71°
70°
69°
68°
67°
44°
43°
42°

Fig. 14.

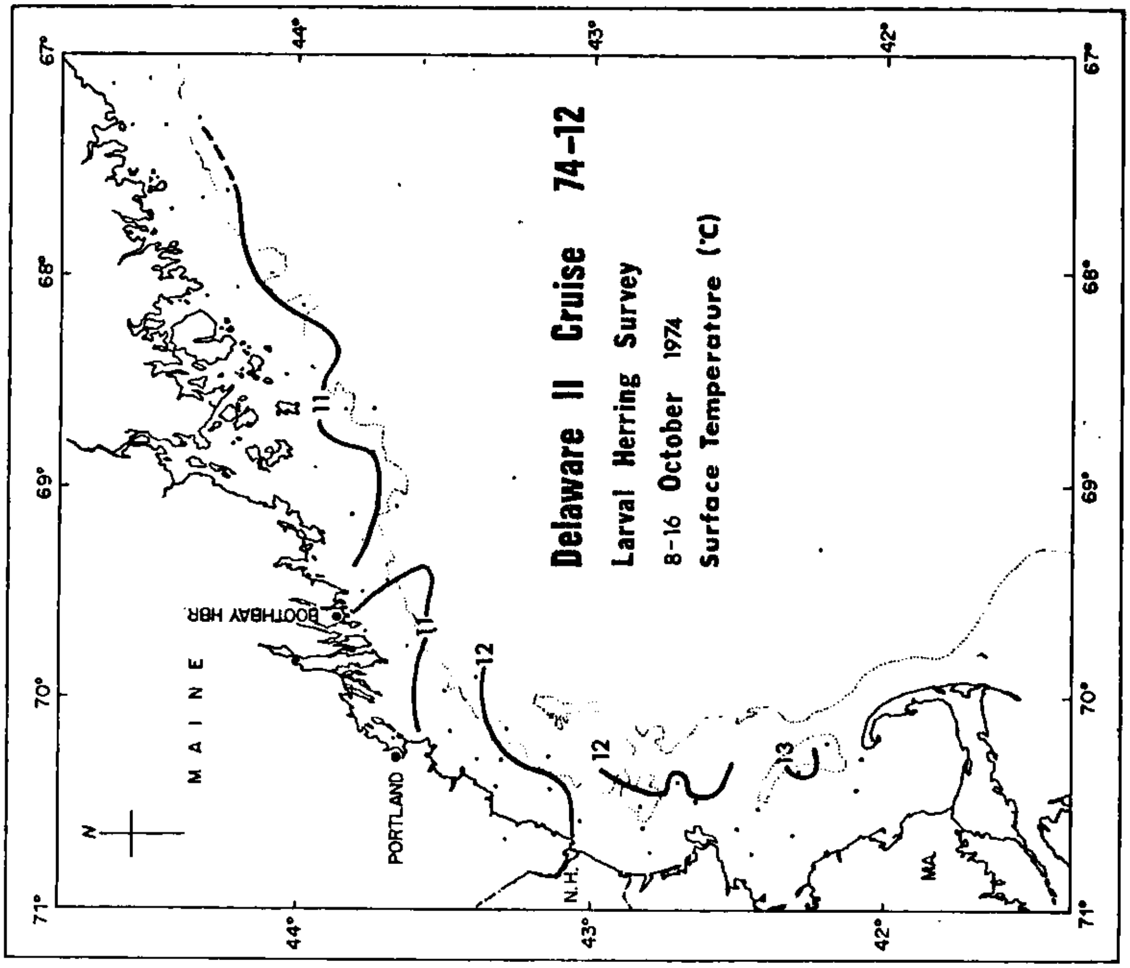
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
Surface Temperature (°C)
MAINE
PORTLAND
BOOTHBAY HBR
N.H.
MA.
N
11
12
13
71°
70°
69°
68°
67°
44°
43°
42°

Fig. 16.

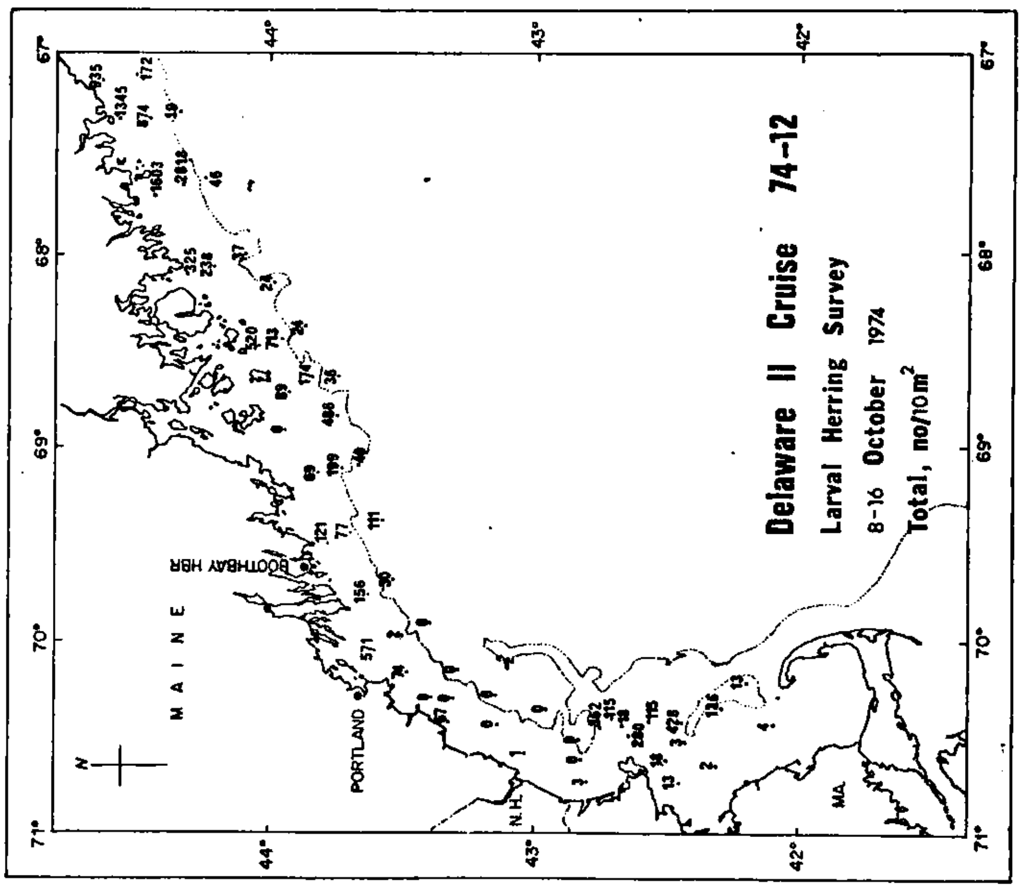
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
Total, no/10m²
MAINE
PORTLAND
BOOTHBAY HBR
N.H.
MA.
N
71°
70°
69°
68°
67°
44°
43°
42°

Fig. 15.

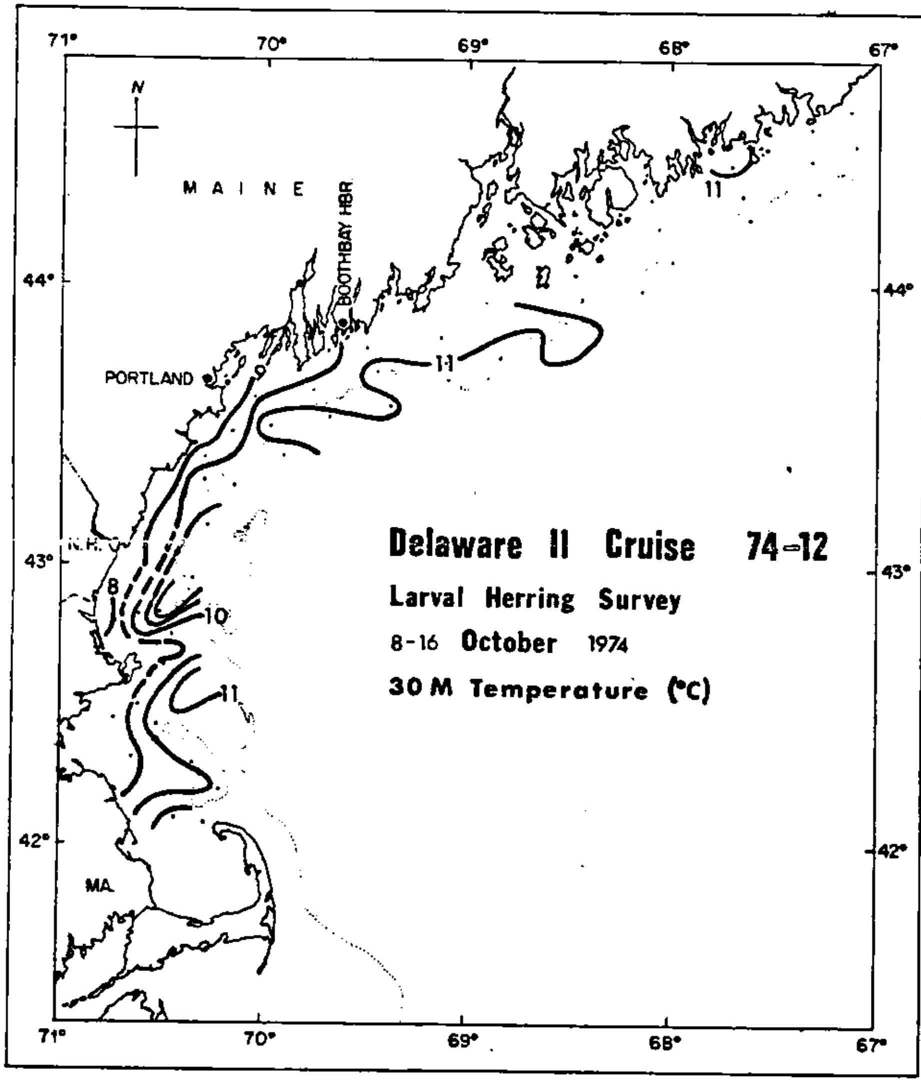
71°
70°
69°
68°
67°
44°
43°
42°
N
MAINE
BOOTHBAY HBR
PORTLAND
N.H.
MA
11
8
10
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
30 M Temperature (°C)

Fig. 17.

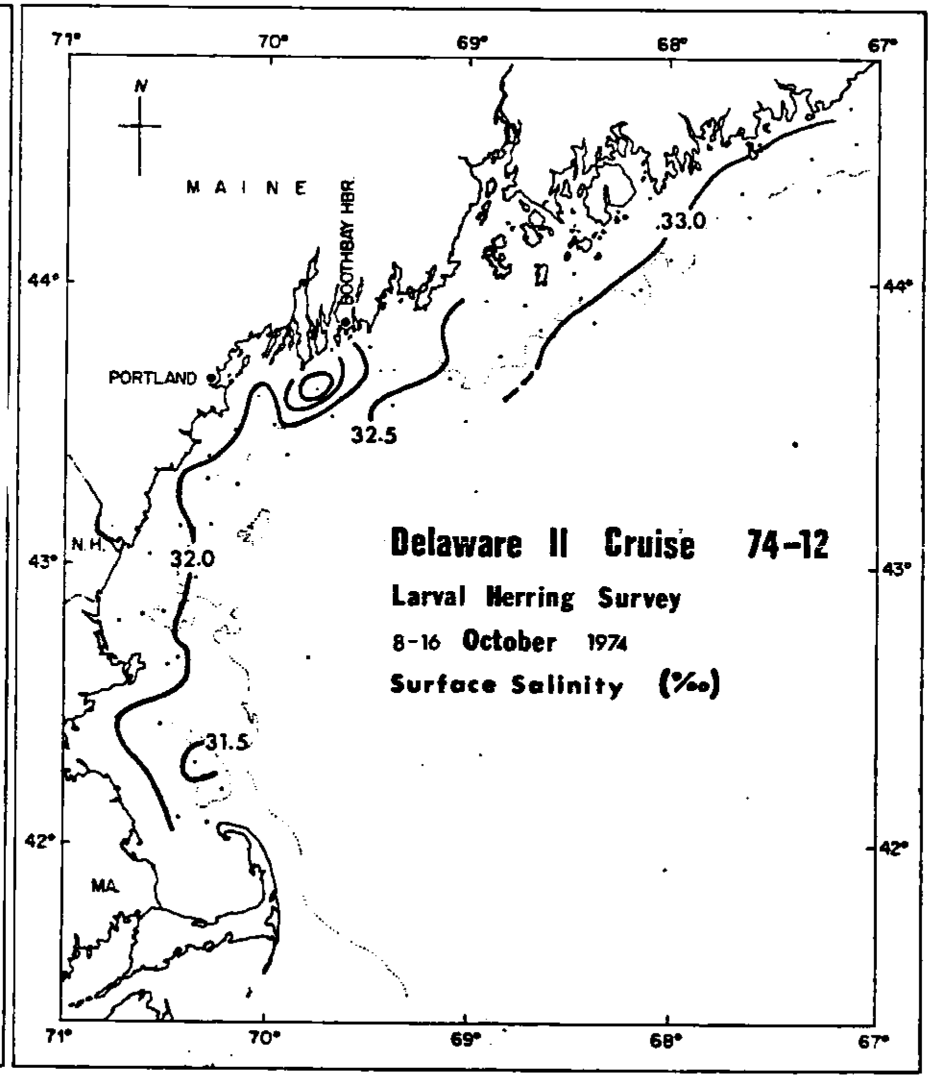
71°
70°
69°
68°
67°
44°
43°
42°
N
MAINE
BOOTHBAY HBR
PORTLAND
N.H.
MA
33.0
32.5
32.0
31.5
Delaware II Cruise 74-12
Larval Herring Survey
8-16 October 1974
Surface Salinity (‰)

Fig. 18.

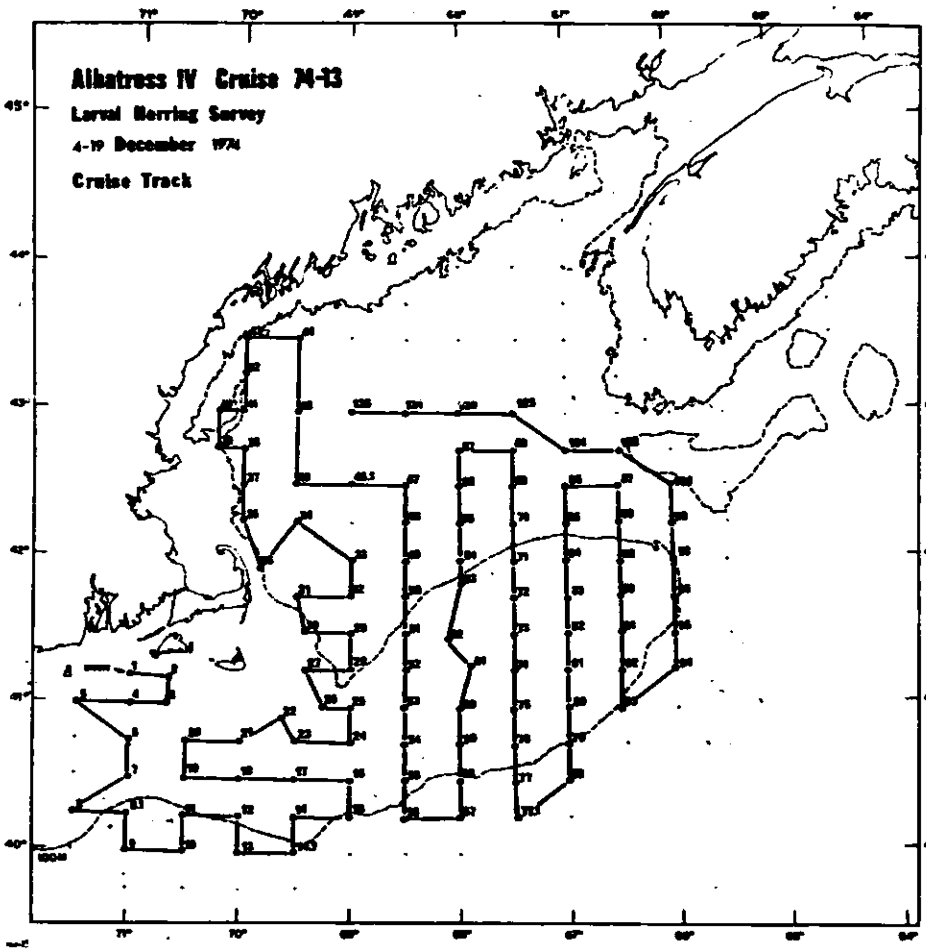
Albatross IV Cruise 74-13
Larval Herring Survey
4-19 December 1974
Cruise Track
100M

Fig. 19.

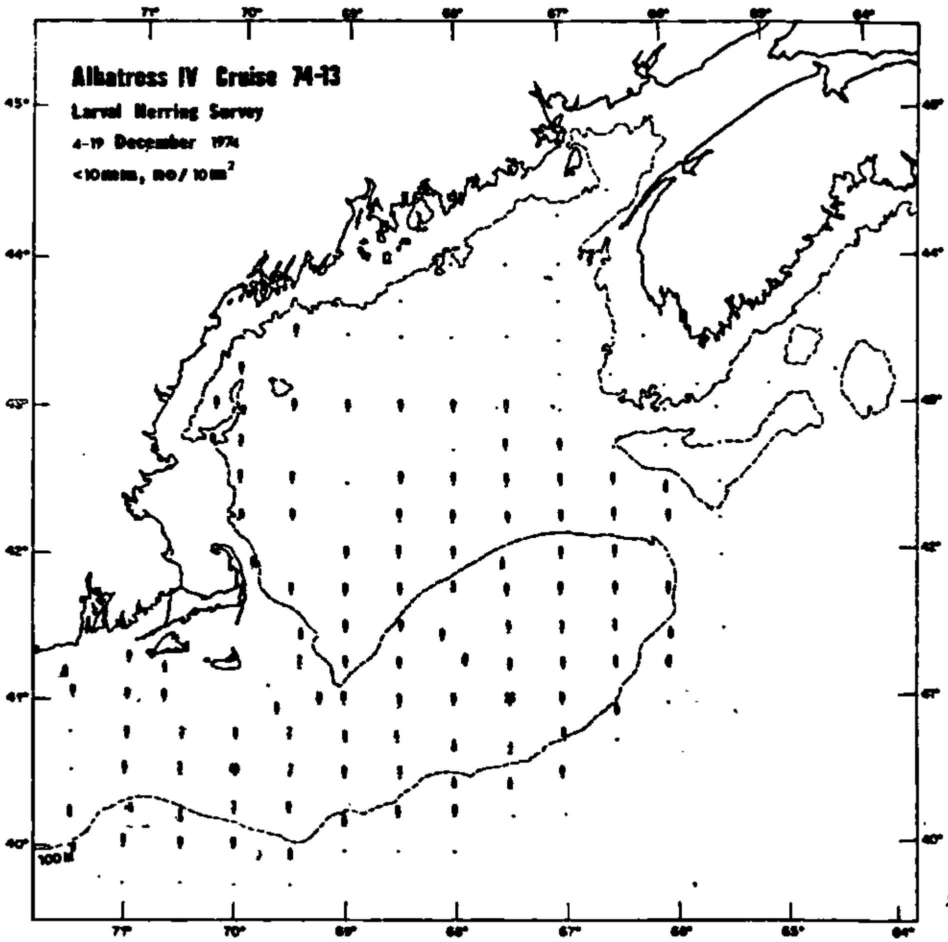
Albatross IV Cruise 74-13
Larval Herring Survey
4-19 December 1974
<10mm, no/10m²
100M

Fig. 20.

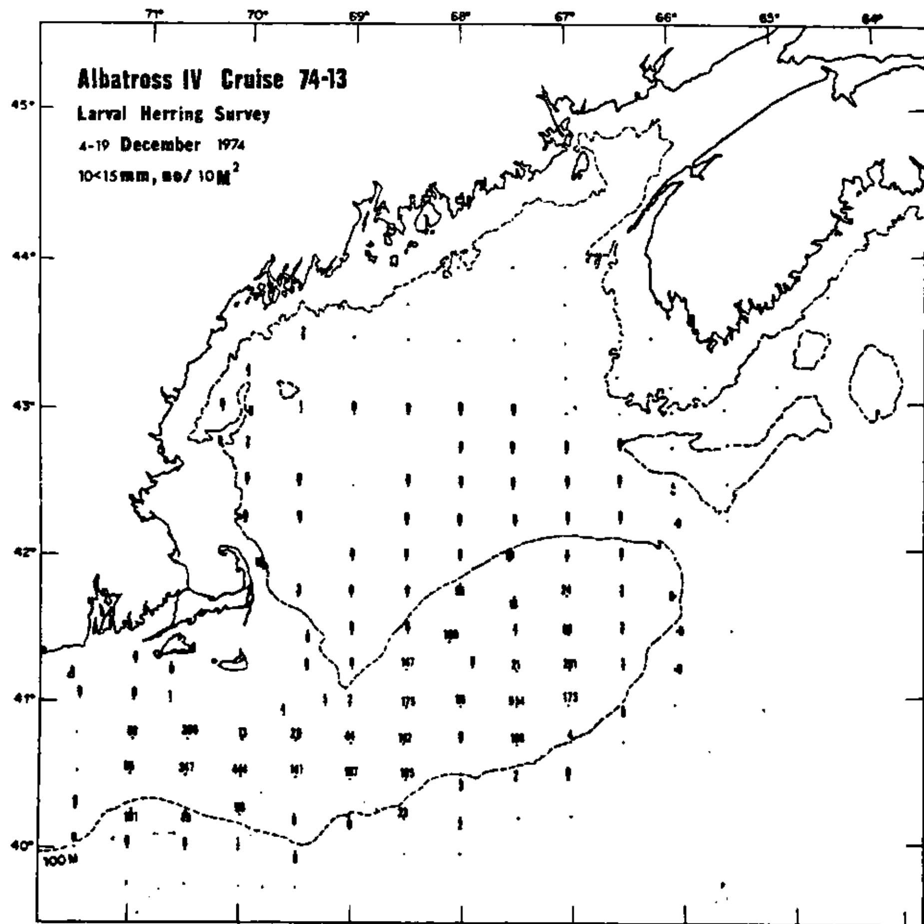

Fig. 21.

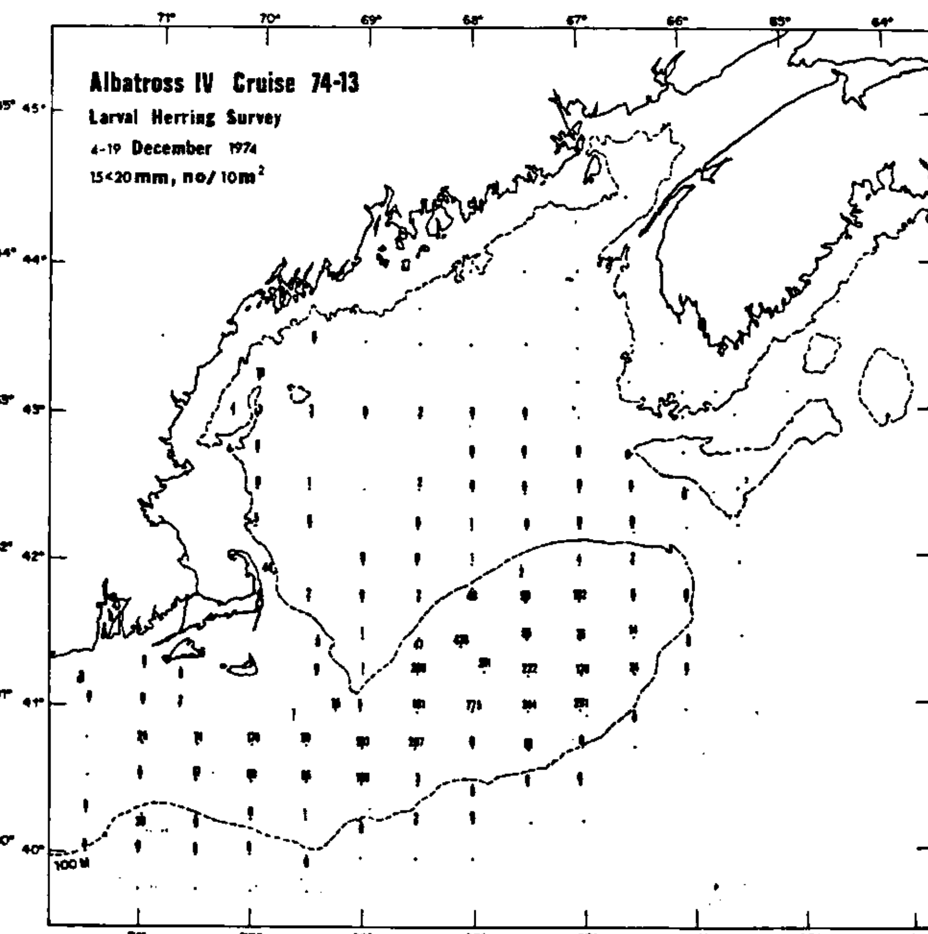

Fig. 22.

C 7

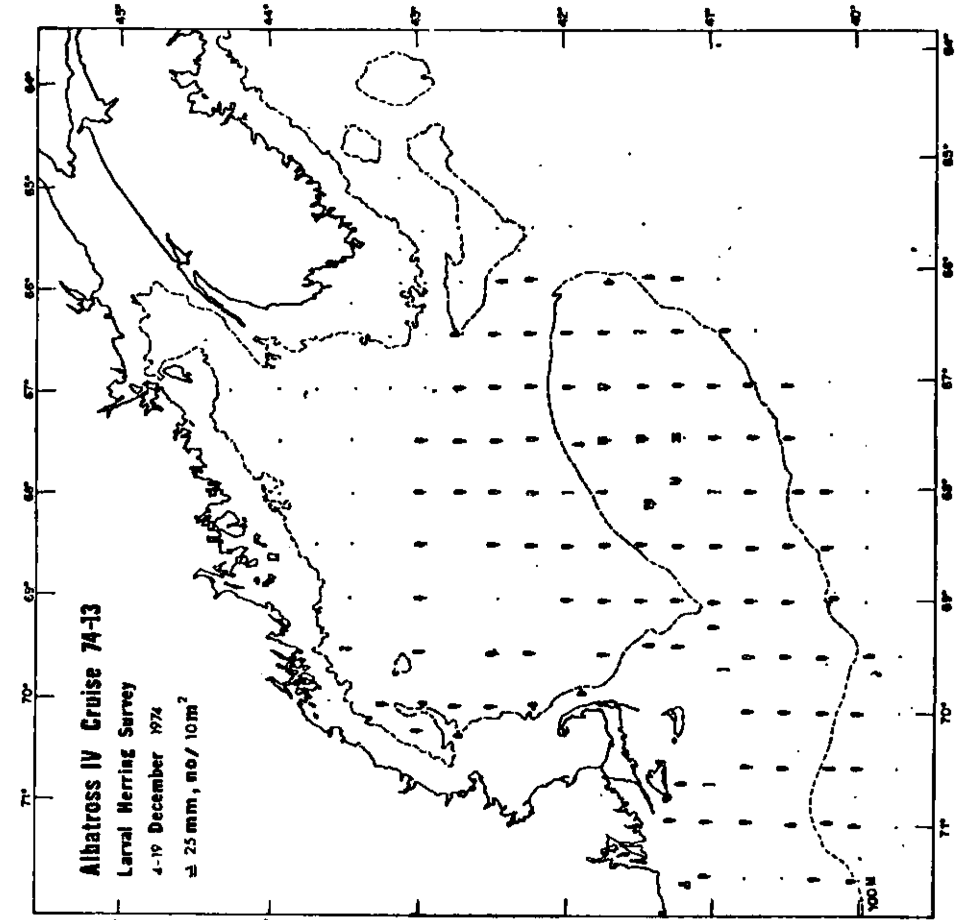

Fig. 24.

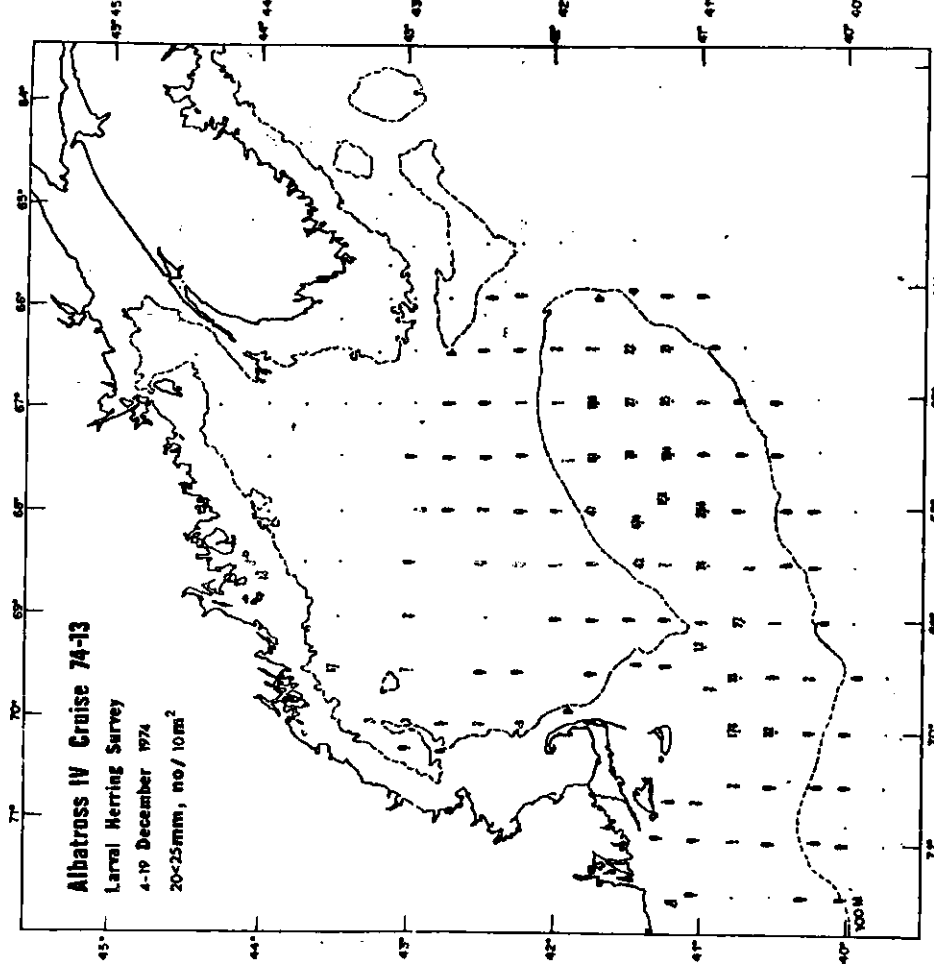

Fig. 23.

C 8

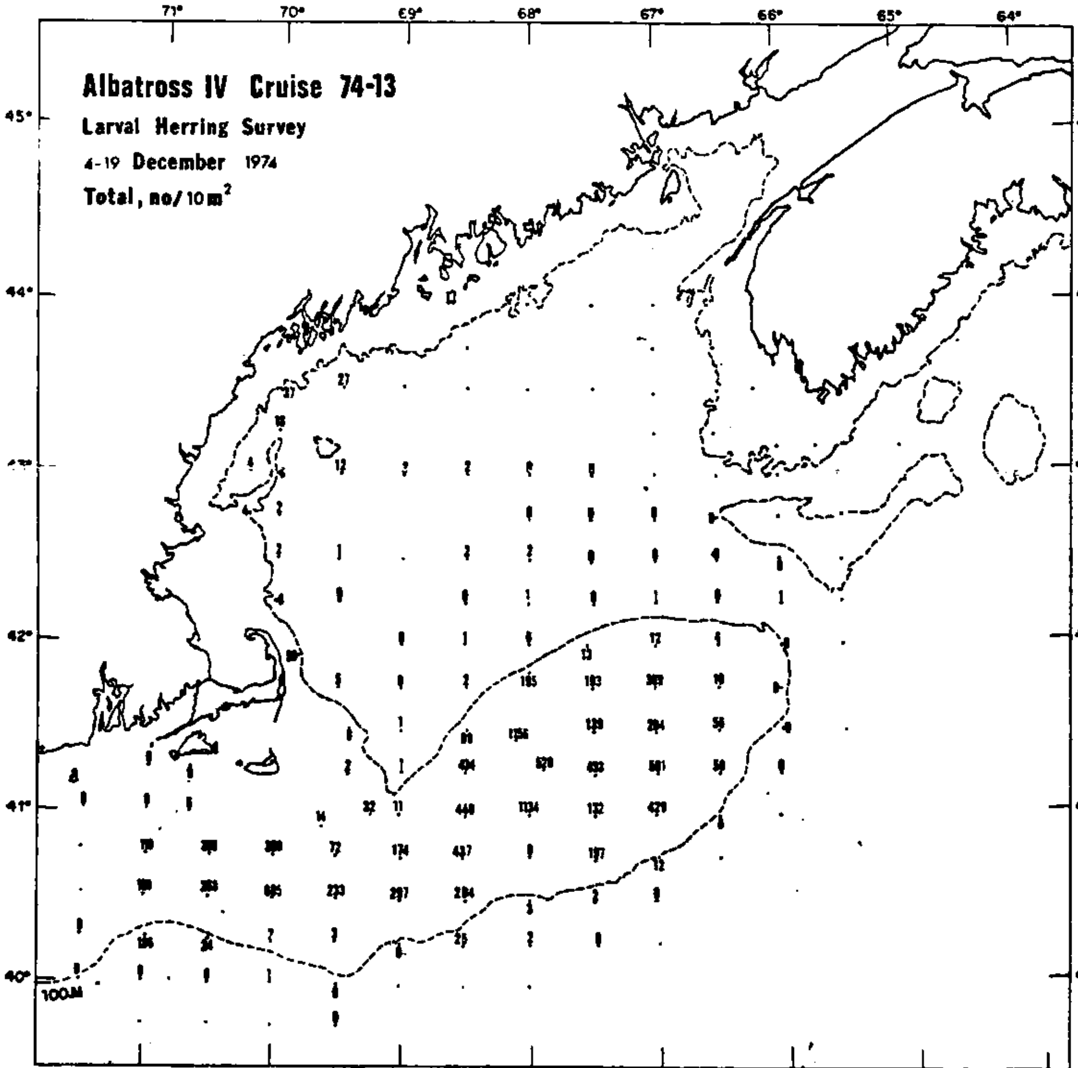

Fig. 25.

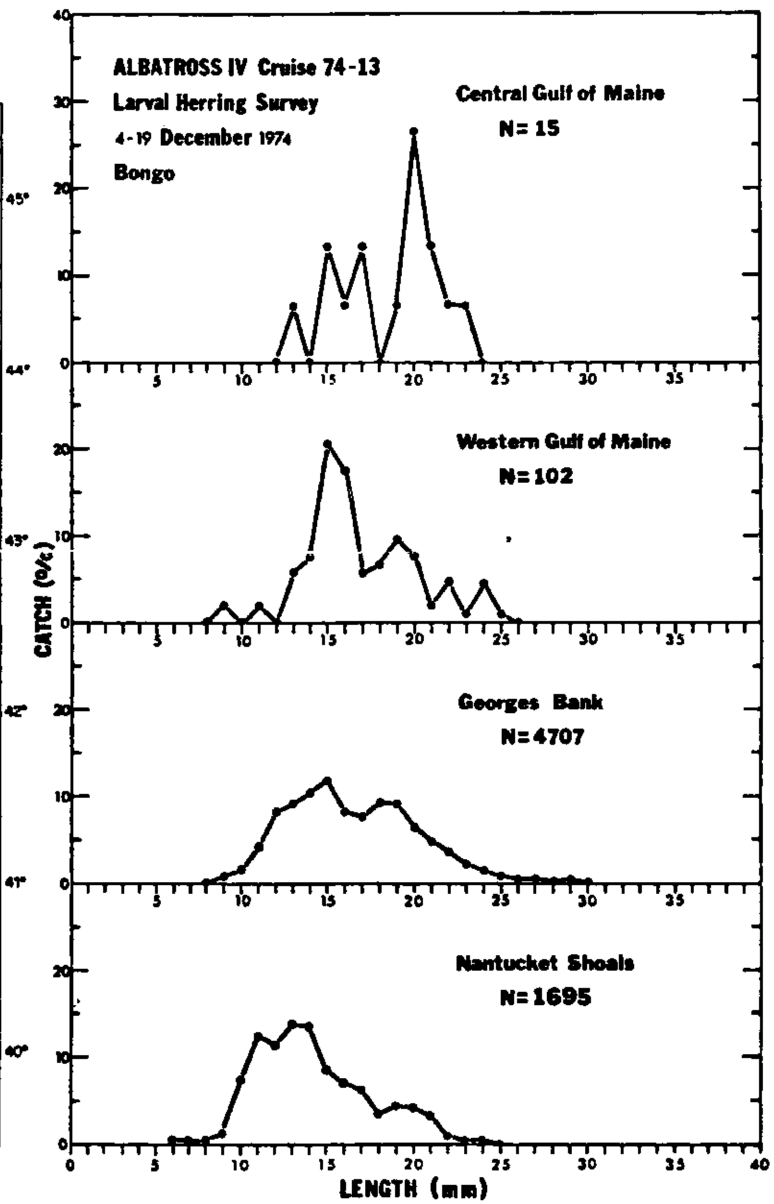

Fig. 26.

C 9

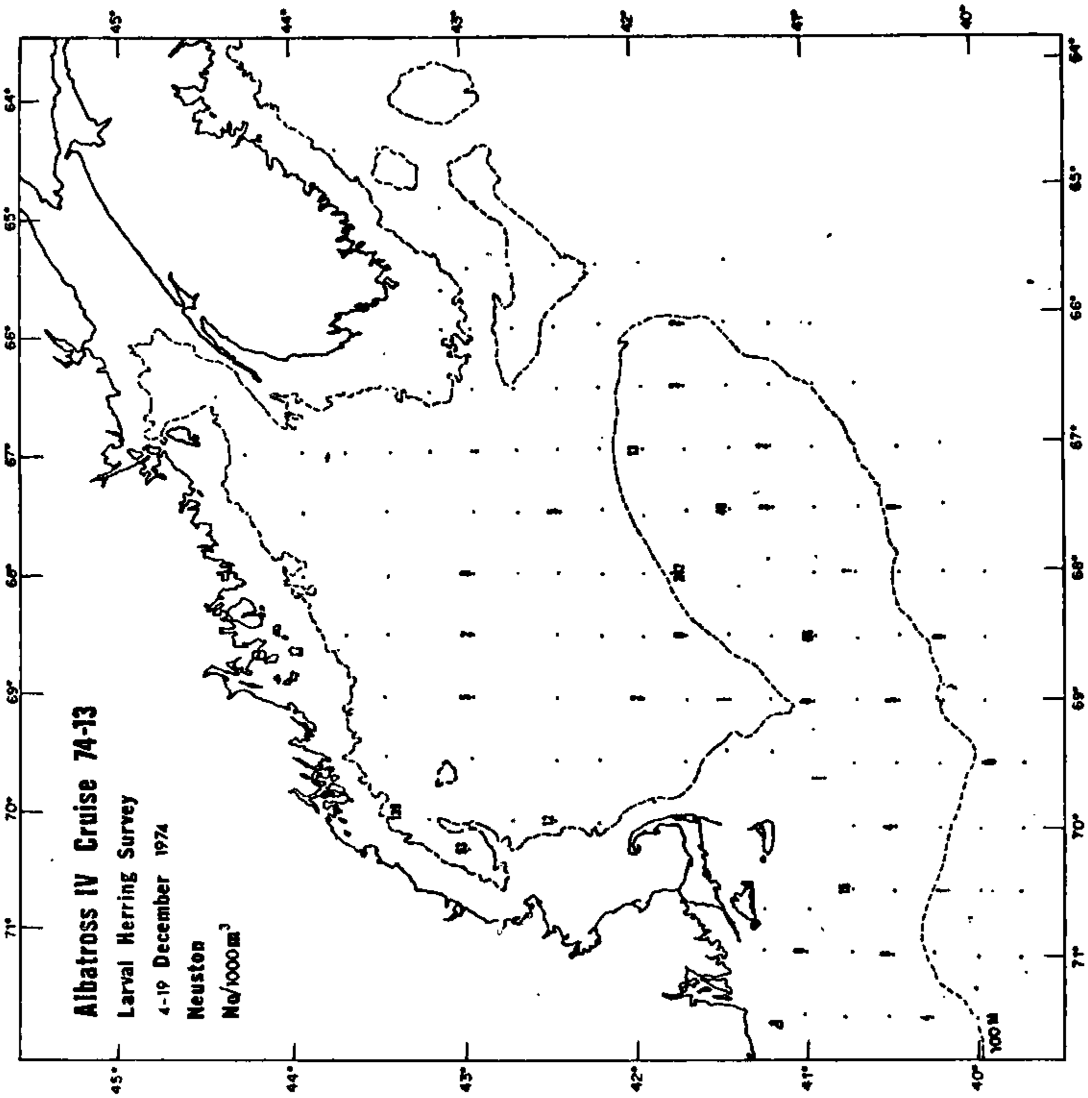
Albatross IV Cruise 74-13
Larval Herring Survey
4-19 December 1974
Neuston
No/1000m³
100M

Fig. 28.

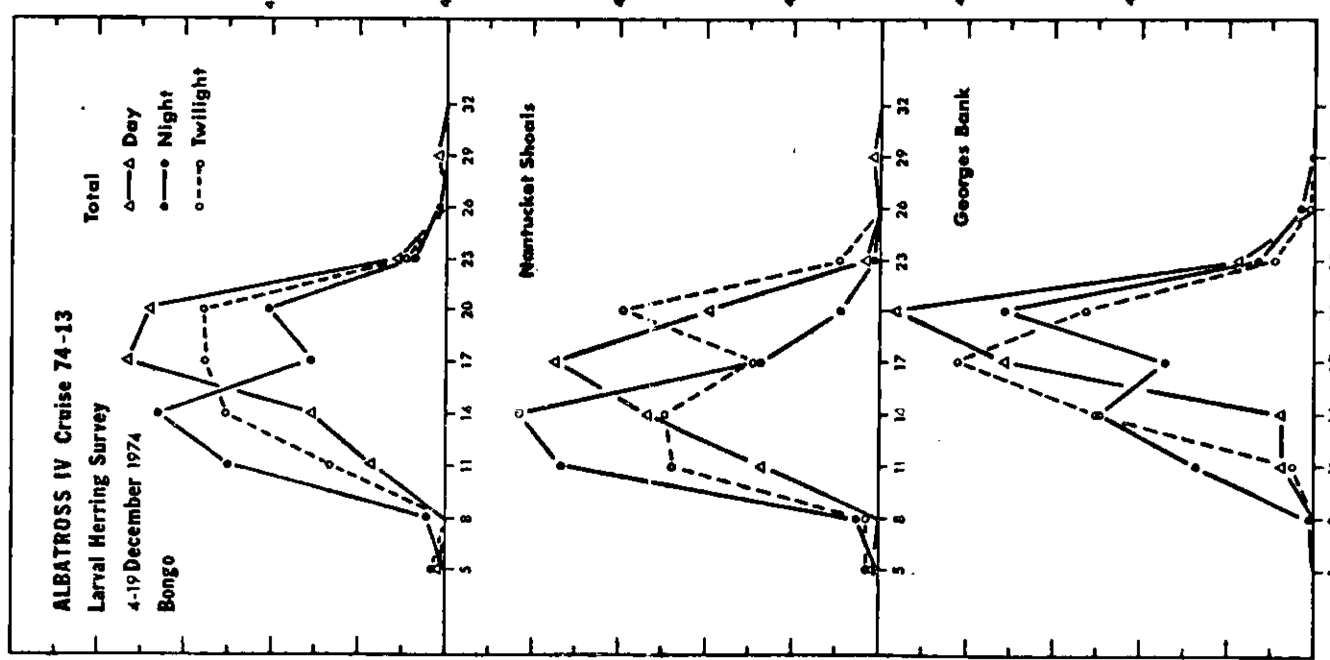
ALBATROSS IV Cruise 74-13
Larval Herring Survey
4-19 December 1974
Bongo
Total
Day
Night
Twilight
Nantucket Shoals
Georges Bank
CATCH (No/)
LENGTH (mm)

Fig. 27.

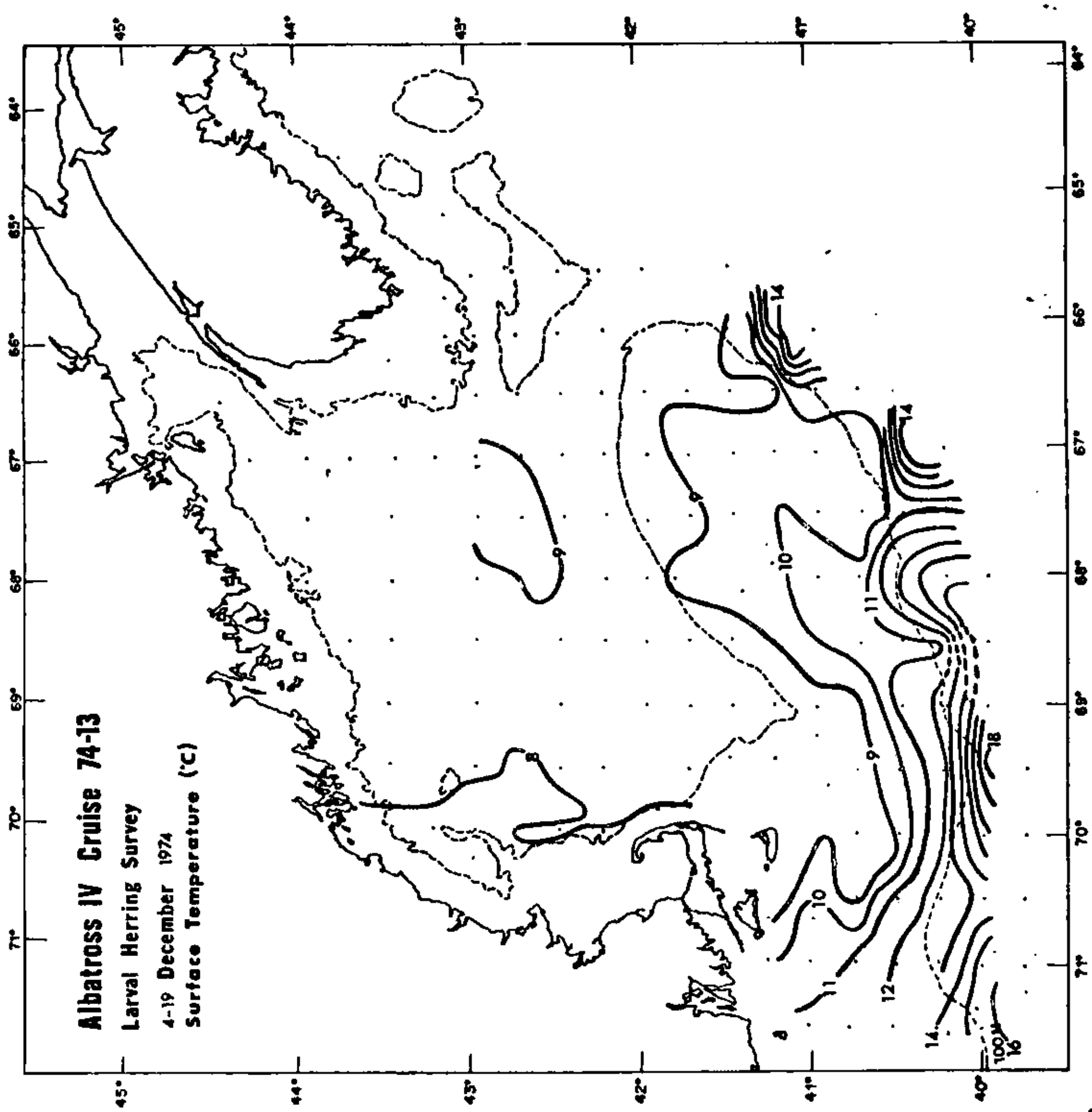
Albatross IV Cruise 74-13
Larval Herring Survey
4-19 December 1974
Surface Temperature (°C)

Fig. 30.

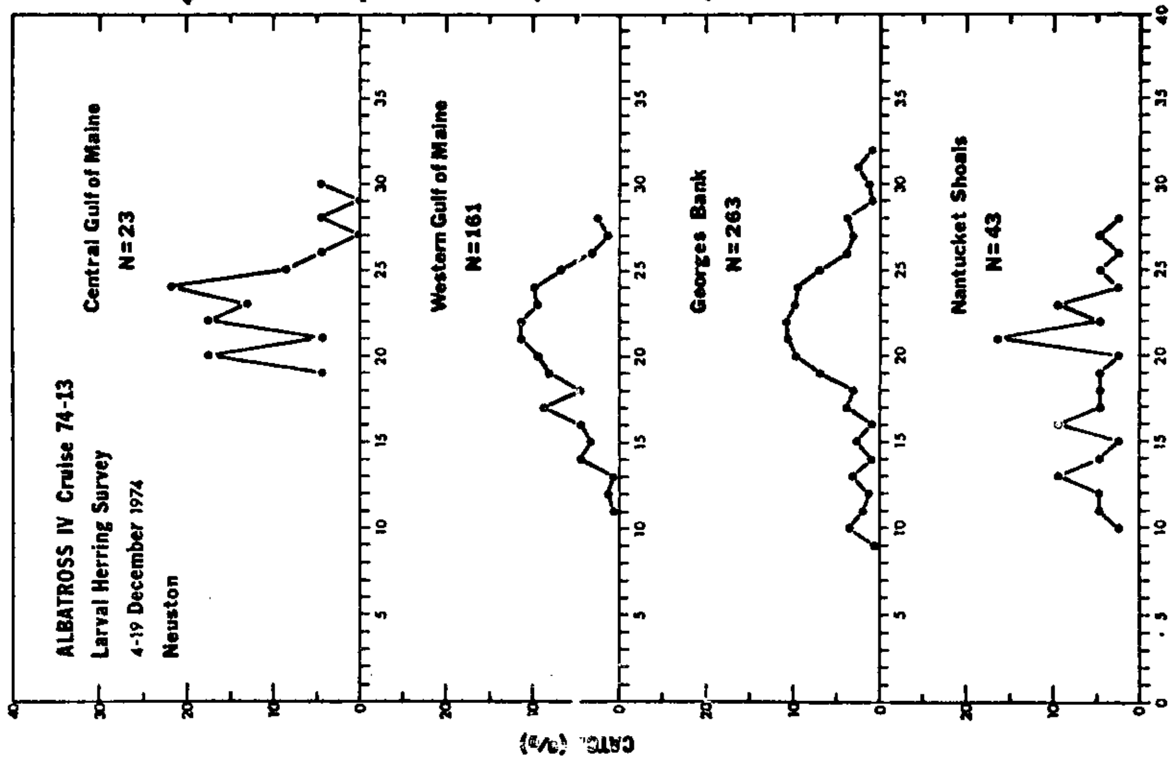
ALBATROSS IV Cruise 74-13
Larval Herring Survey
4-19 December 1974
Neuston
Central Gulf of Maine
N=23
Western Gulf of Maine
N=161
Georges Bank
N=263
Nantucket Shoals
N=43
LENGTH (mm)

Fig. 29.

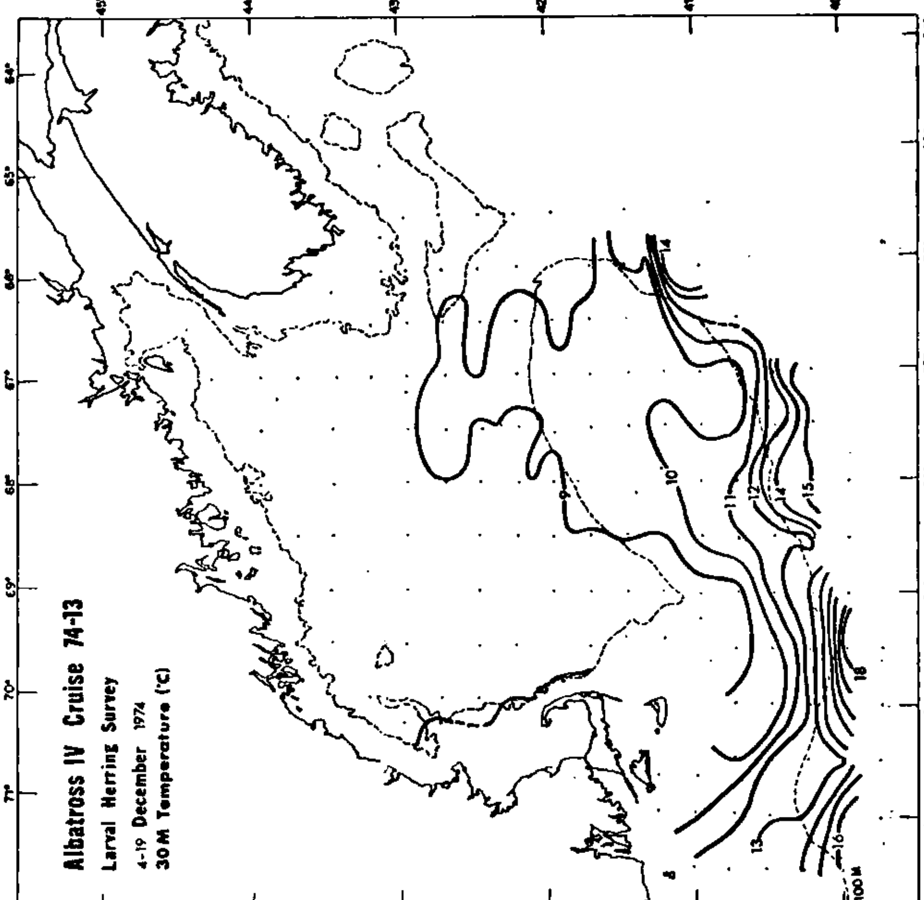
Albatross IV Cruise 74-13
Larval Herring Survey
4-19 December 1974
30 M Temperature (°C)

Fig. 31.

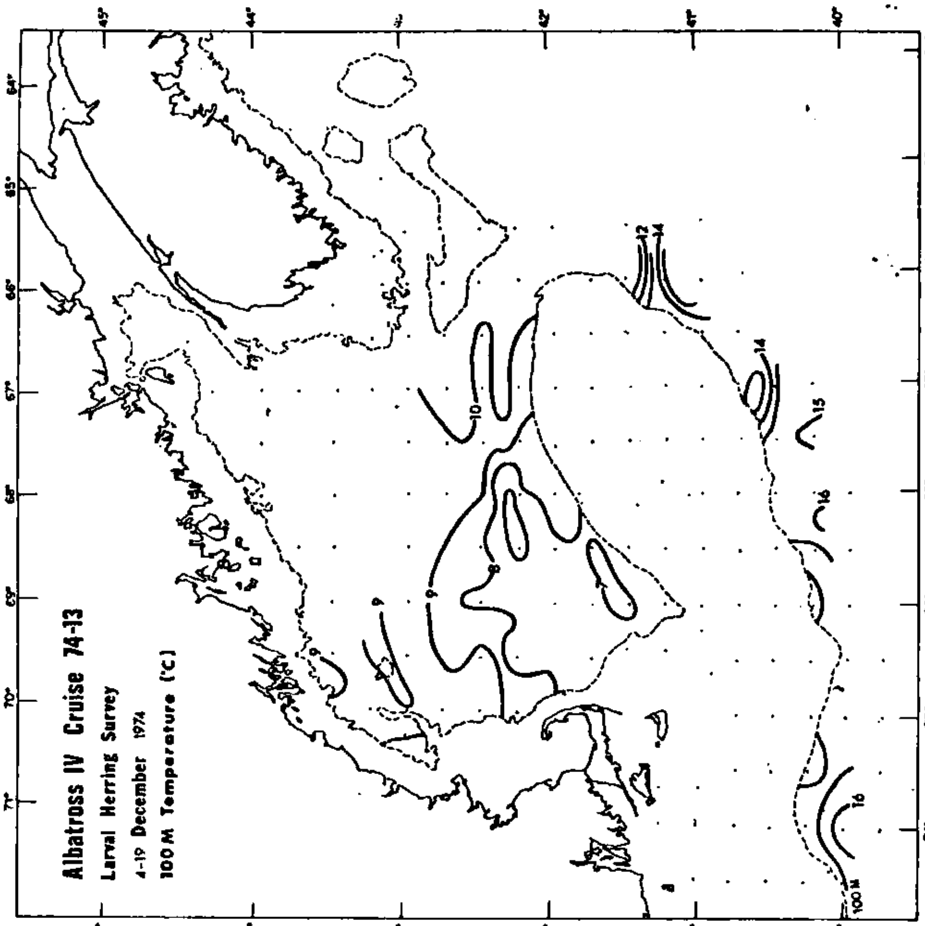
Albatross IV Cruise 74-13
Larval Herring Survey
4-19 December 1974
100 M Temperature (°C)

Fig. 32.

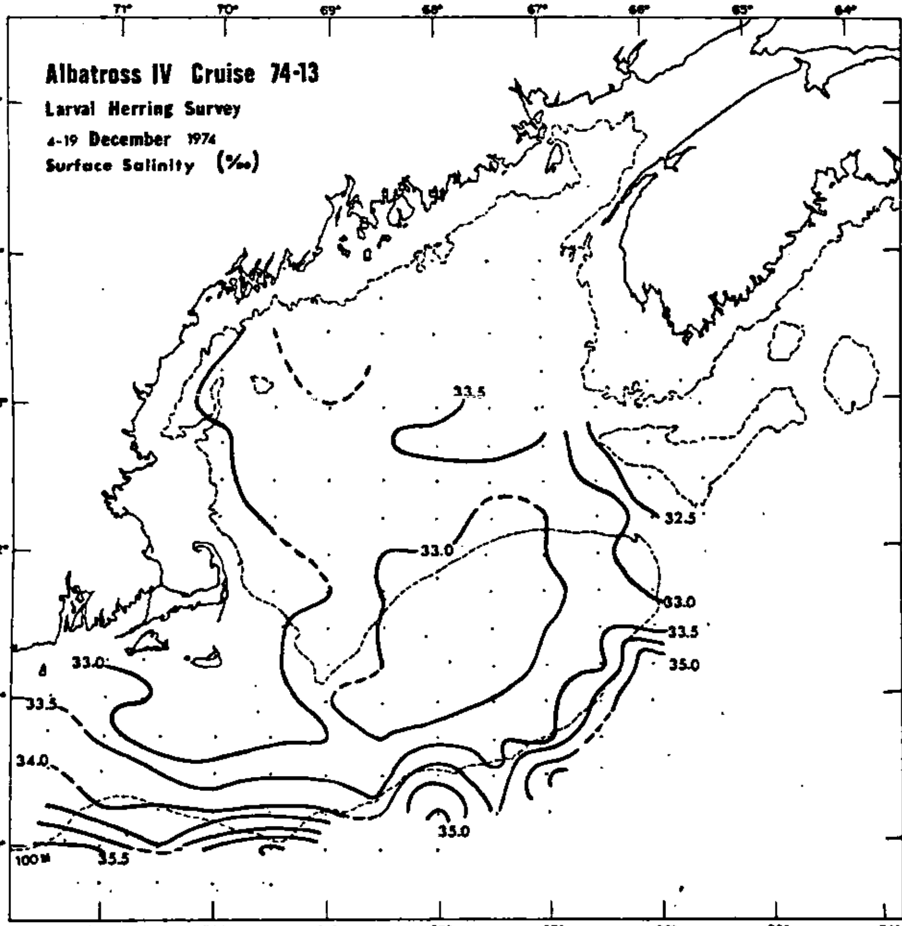

Fig. 33.

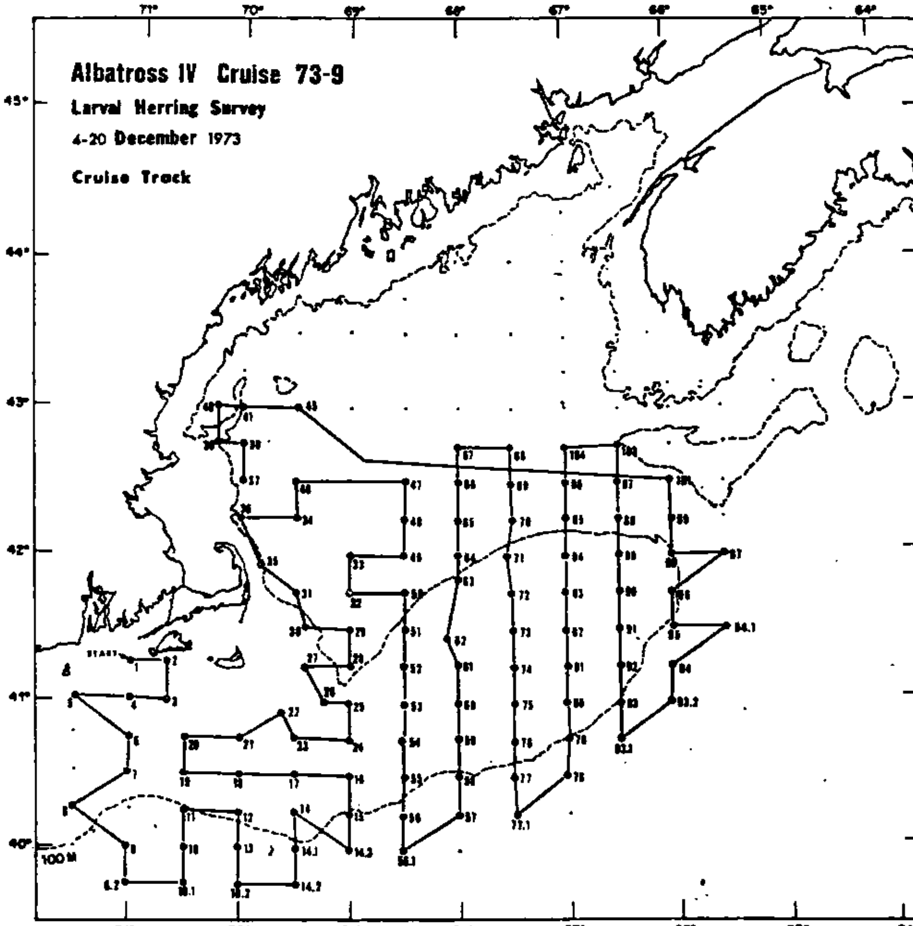

Fig. 34.

C 13

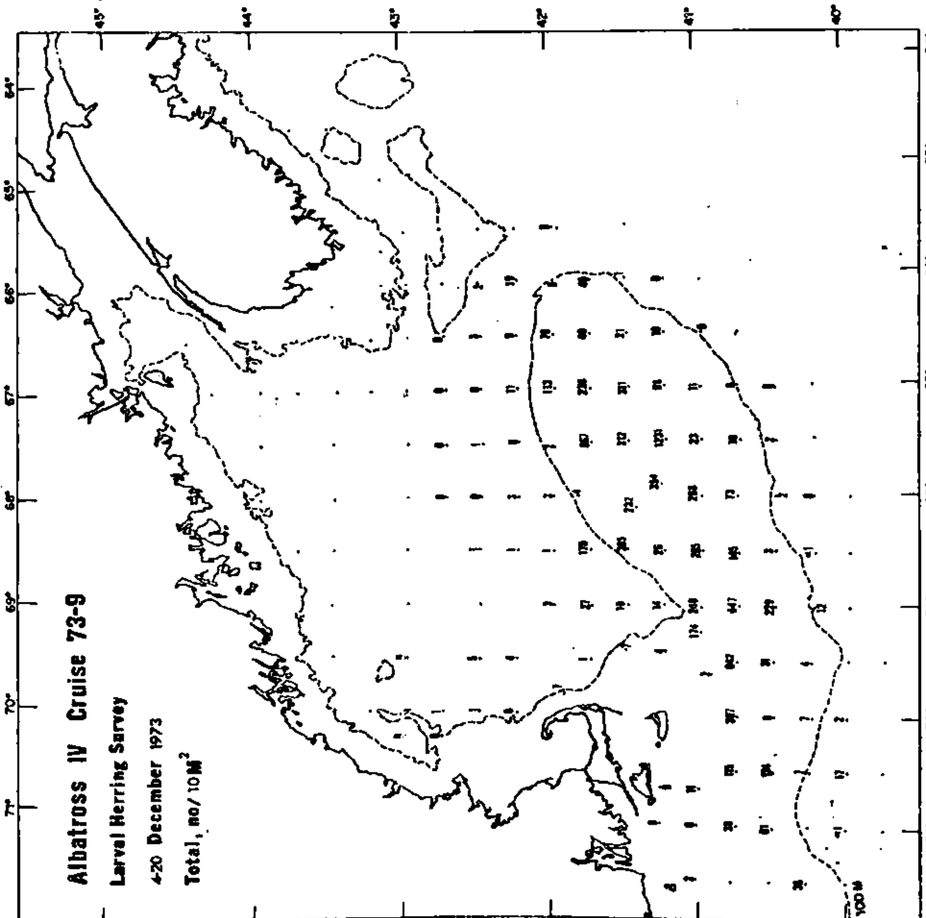
Albatross IV Cruise 73-9
Larval Herring Survey
4-20 December 1973
Total, no/10M²

Fig. 35.

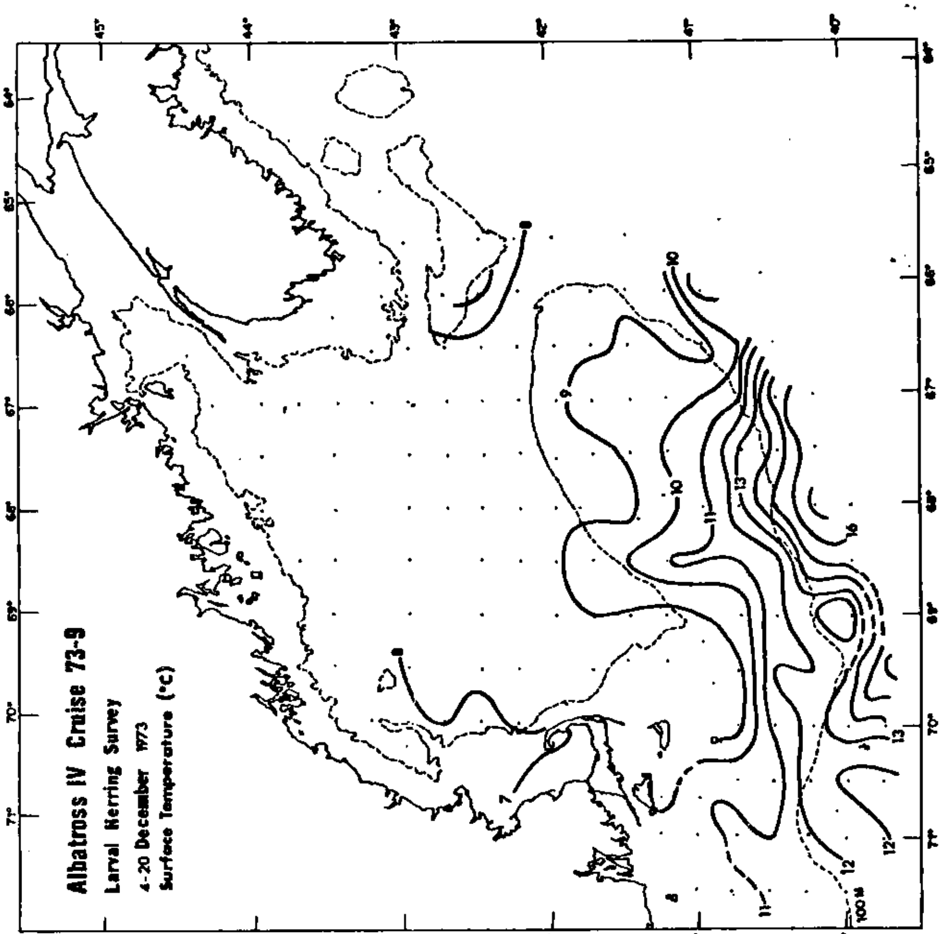
Albatross IV Cruise 73-9
Larval Herring Survey
4-20 December 1973
Surface Temperature (°C)

Fig. 36.

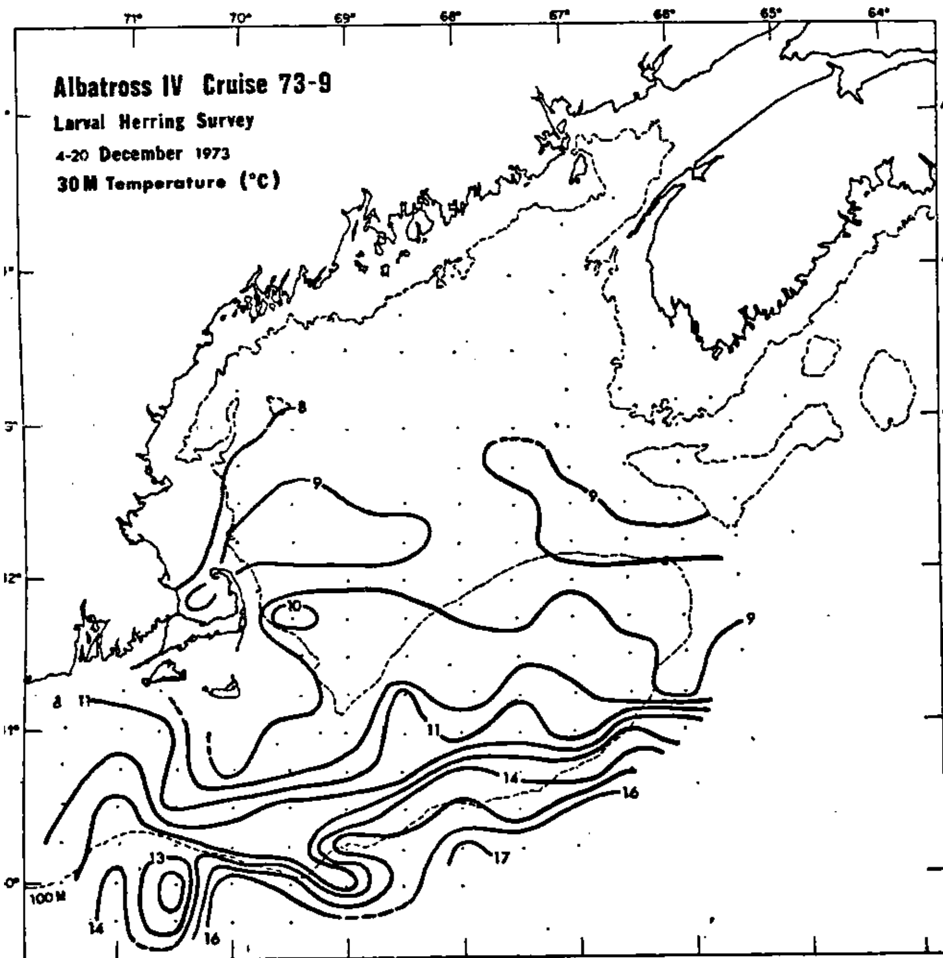

Fig. 37.

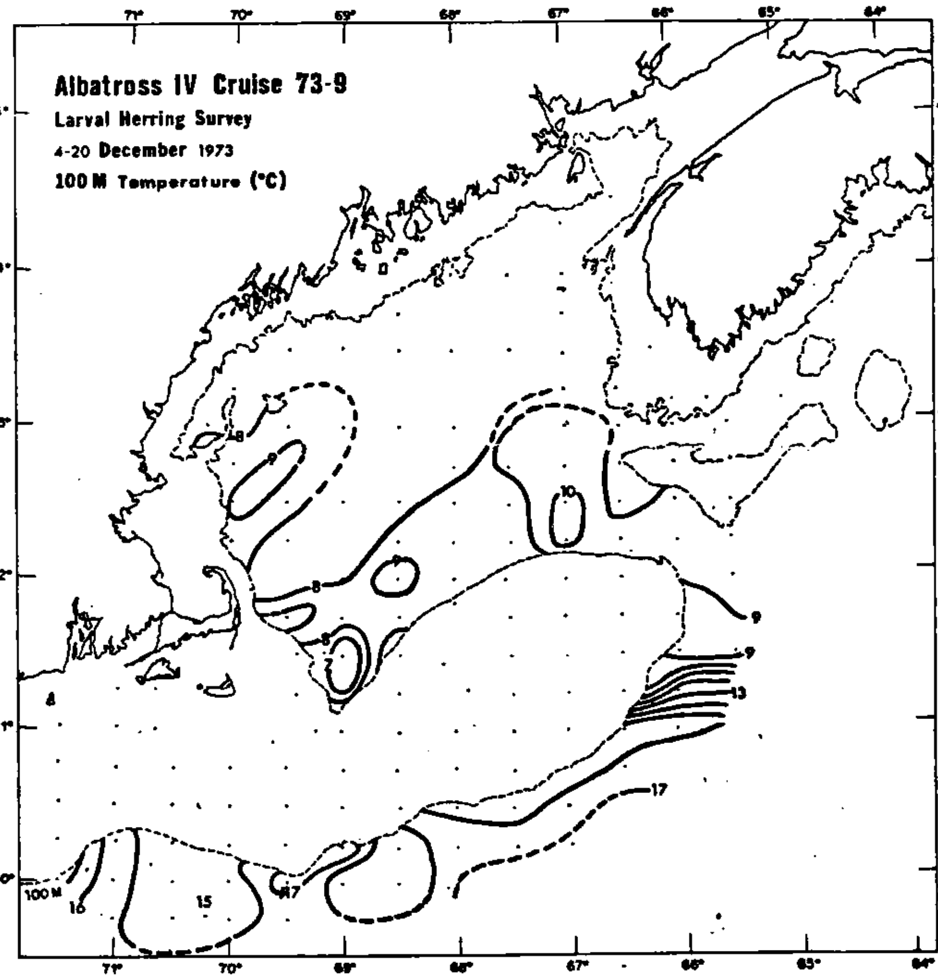

Fig. 38.

D 1