International Commission for the Northwest Atlantic Fisheries

Serial No. 3360
(D.c.3)

ICNAF Res.Doc. 74/115

ANNUAL MEETING - JUNE 1974

A preliminary report on the joint FRG-US Juvenile Herring Survey by R/V Walther Herwig in ICNAF Division 4X and 5Z in March-April 1974 with a comparison with the 1973 FRG Juvenile Herring Survey

by

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INTRODUCTION

At the June 1973 Annual Meeting it was recommended by STACRES that spring surveys be continued in 1974 in Subareas 4 and 5 and Statistical Area 6 in order to provide, among other things, improved estimates of recruiting year-classes of both herring and mackerel. It was agreed that the Federal Republic of Germany would conduct such a survey in the Nantucket Shoals, Georges Bank, and Browns Bank area. Two U.S. scientists from the National Marine Fisheries Service, Woods Hole, Massachusetts, participated in the survey carried out by the R/V Walther Herwig during March 19-April 3.

Preliminary results of the 1974 survey are presented in this paper together with a comparison of the results of the 1973 FRG survey.

METHODS

The sampling pattern for the survey was based on the stratified random sampling design (Figure 1) used for the U.S. groundfish surveys (Grosslein, 1969). A total of 80 stations were selected in strata 9-24, 31-32. During the survey, 11 stations were omitted because of rough bottom and 8 additional stations were selected. Severe net damage resulted in lost catches at 3 stations. A total of 74 stations were successfully occupied (locations indicated Figures 6 and 7).

Normally, a 30-minute haul was made at each station employing a 180-foot herring bottom trawl rigged with rollers and a knotless codend liner (10 mm bar measure). Towing time less or greater than 30 minutes occurred at 12 stations because of actual or potential gear hang-ups or malfunctions. Catches at these stations were corrected to correspond to that from a 30-minute tow by adjustment on the basis of the time towed. Comprehensive echo-sounder traces were made during each trawl haul. Trawl hauls were made only during daylight hours.

Total weight and length measurements were recorded for all species caught. Large catches were subsampled for length measurements. Representative samples of herring and mackerel were collected for age analysis.

Ichthyoplankton sampling was conducted by scientists from the Institut für Meereskunde, Kiel University primarily during hours of darkness. Standard ICNAF oblique plankton tows using 61 cm Bongo samplers and neuston net tows were made to assess the abundance and distribution of larval herring.

Water temperature and salinity measurements were taken throughout the water column at 86 trawling and ichthyoplankton stations using Nansen bottles. Surface and bottom water temperature and salinity isograms are plotted in Figures 2-5.

Results from the 1973 FRG Juvenile Herring Survey (Dornheim, 1973) were re-analyzed for comparison with the 1974 results. The 1973 sampling design consisted of dividing the area between Cape Sable and Cape Hatteras into 30-minute squares and making a 30-minute trawl haul within each square with a 180-foot herring bottom trawl A tow was repeated if more than 1,000 herring were caught. The survey was conducted during February 26-March 15. Since the selection of the 1973 stations was not biased by hydroacoustic searching for herring concentrations, the stations were post-stratified according to the same sampling design employed in 1974. In other words, the stations were assigned to the appropriate groundfish survey sampling strata and the total weight and length measurement data from the trawl records were analyzed by the same procedures and strata sets as for 1974. A total of 71 stations (plus 8 replicate stations which were excluded from the analysis) were occupied during the 1973 survey (locations indicated in Figures 8-9). The post-stratification procedure assigned stations to the following strata: 1, 2, 5, 6, 9, 10, 13, 14, 16, 19-25, 27-29, 31-34, 36, 61, 62, 66, 69, 70, 73, and 74.

RESULTS

Herring - 1974

Herring were taken in hauls at 38 of the 74 stations during the 1974 survey varying in total weight from less than 1 pound to approximately 25,000 pounds. The largest concentrations were found in the southeast part of Georges Bank, between Georges Shoal and the Winter Fishing Ground near the Northern Edge of Georges Bank, directly south of Cape Cod, and east of Cape Cod along the west side of the Great South Channel (Figure 6). The largest herring catches (>1,000/tow) were obtained within a narrow range of bottom water temperature which varied from 4.9° to 5.6° C. The overall range in which herring were caught was 3.4° - 7.8° C.

Stratified mean catch [$\log_e (n+1)$] per tow values are given in Table 1. Number and weight indices in the strata sampled varied from 3.81 and 2.92, respectively, in Division 4X to 3.89 and 3.19, respectively, in Division 5Z. Mean weight was 0.26 pounds in 4X and 0.31 pounds in 5Z. Fish ranged in size from 19 to 35 cm with the modal length at 27 cm in both areas (Table 2).

Herring - 1973

Catches of herring were made at 41 of the 71 stations in 1973 with total weight varying from less than 1 pound to approximately 5,400 pounds. Large catches were obtained generally throughout Georges Bank, particularly on the slopes and especially on the west and southwest slopes (Figure 7). Moderate catches were taken south of Long Island.

Stratified catch per tow [$\log_e (n+1)$] of number and pounds] indices (including strata in which tows were made) were 3.21 and 1.54, respectively, in Division 4X, 4.11 and 2.98, respectively, in Division 5Z, and 1.69 and 1.21, respectively, in Statistical Area 6 (Table 1). Mean weight was 0.03 pounds in 4X, 0.19 pounds in 5Z, and 0.22 pounds in SA 6. Length varied from 10 to 35 cm with a modal size of 12 cm in 4X, 23 cm in 5Z, and 24 cm in SA 6 (Tables 6-8). Age/length keys from the three areas (Tables 3-5) were combined and applied to the length frequency of the stratified mean number per tow indicating that the 1971 year-class comprised 97 percent of the mean number per tow in 4X and the 1970 year-class comprised 98 and 93 percent of the mean number per tow in 5Z and SA 6, respectively (Tables 6-8).

Mackerel - 1974

Mackerel were caught at 24 of the 74 stations with total weight varying from less than 1 pound to approximately 32,000 pounds. Hauls containing mackerel in any significant quantity were limited to strata 10-15 and near the edge of the shelf in deep water (Figure 8). Bottom temperature at stations where most of the mackerel catches were made was within the range of 11.1° - 13.2° C.

The stratified catch per tow [$\log_e (n+1)$] of number and pounds] indices were 3.87 and 3.20, respectively, (Table 1). Mean weight was 0.68 pounds. Total length varied from 12 cm to 47 cm with the modal length at 38 cm (Table 10). An age/length key (Table 9) obtained from samples taken during the survey was applied to the length frequency of the stratified mean number per tow showing that the 1967 year-class comprised 26.1 percent, the 1971 year-class 24.3 percent, and the 1972 year-class 19.1 percent of the mean number per tow (Table 10).

Mackerel - 1973

Catches containing mackerel occurred at 17 of the 71 stations varying in total weight from less than 1 pound to 300 pounds. The largest hauls were taken in SA 6 (Figure 9). Stratified catch [$\log_e$ (n+1) of number and pounds] indices per tow were 1.21 and 0.74, respectively, in 5Z and 2.31 and 1.41, respectively, in SA 6 (Table 1). Mean weight was 0.25 pounds in 5Z and 0.44 pounds in SA 6. Length varied from 14 cm to 44 cm with the mode occurring at 22 cm in 5Z (Table 12) and at 28 cm in SA 6 (Table 13).

An age/length key (Table 11) prepared from samples taken during the 1973 spring surveys by Albatross IV, Delaware II, and Wieczno was applied to the length frequency of the stratified mean number per tow. In 5Z, the 1972 year-class comprised 83 percent of the mean number per tow with the 1967 and 1971 year-classes 4.0 and 3.4 percent respectively (Table 12). The 1971 and 1972 year-classes accounted for 37 and 36.4 percent of the mean number per tow, respectively, in SA 6 with the 1967 and 1969 year-classes comprising 7.8 and 6.3 percent, respectively (Table 13).

DISCUSSION

The composition of the herring catches differed markedly in the 1973 and 1974 surveys. Minimum size in 1973 was 10 cm with a modal length of 23-24 cm in 5Z-6 and 12 cm in 4X, whereas the minimum size in 1974 was 19 cm with a mode of 27 cm in both 5Z and 4X. Mean weight also showed a marked increase from 1973 to 1974. Stratified catch per tow indices for comparable strata were slightly greater in 1974 than in 1973 (Table 1).

The 1973 survey catch in 5Z and SA 6 was comprised of over 90 percent age 3 (1970 year-class) fish whereas the 1974 catch on the basis of length frequency data appears to include primarily age 4 (1970 year-class) herring. Lacking an age/length key for 1974, an estimate of the strength of the 1971 year-class compared to that of 1970 can be determined by comparing the mean number per tow of age 3 fish in 1973 and 1974 using the 1973 age/length key for 5Z (Table 7) which indicates an approximate size range for age 3 herring in March of 19-25 cm, total length. The ratio of the stratified catch per tow in this size interval in 1973 to that in 1974 was about 9:1, suggesting that the 1971 year-class is markedly smaller than the 1970 year-class. An estimate of the strength of the 1972 year-class relative to the 1971 year-class can be obtained by comparing the mean catch of age 2 fish (<19 cm) in 1973 and 1974. In 1973, 2 percent of the mean number per tow were less than 19 cm (1971 year-class) but in 1974 no herring of this size (1972 year-class) were caught, suggesting that the 1972 year-class may be of less magnitude than the 1971 year-class. However, since many untrawlable shoal areas were encountered on Georges Bank during the 1974 survey where age 2 and younger herring may have been located, an accurate evaluation concerning the strength of the 1972 year-class is not possible from the results of this survey.

The 1973 survey indicated 97 percent of age 2 (1971 year-class) herring on Browns Bank (4X). The length frequency data suggest that this year-class comprised a substantial part of the 1974 catches on Browns Bank. These results, however, were based on only 7 hauls in 1974 and 9 hauls in 1973, all in the western portion of 4X and do not allow full evaluation of the herring stock throughout 4X.

Stratified catch per tow indices for mackerel increased in 1974 over 1973 (Table 1). However, the sampling intensity was less in 1973 and no stations were occupied in the deep water along the edge of the continental shelf in 1973 (Figure 9) where the majority of large catches occurred in 1974 (Figure 8). Furthermore, in 1973 the survey was conducted one month earlier (February 26-March 15) than in 1974 (March 19-April 3) suggesting greater availability of mackerel to the survey the second year as the result of inshore migration being more advanced. Comparison of catches in SA 6 was not possible since the 1974 survey did not extend into that area.

Examination of the 1974 results suggests that the 1971 and 1972 year-classes may be of equivalent magnitude. The strong 1967 year-class, however, still constitutes a significant portion of the stock. Any meaningful comparison between the results of the 1973 and 1974 data is not possible because of the differences in the two surveys.

CONCLUSIONS

The 1974 Walther Herwig Juvenile Herring Survey was not successful in capturing age 1-2 herring. A longer time-series of similar surveys will be necessary to fully evaluate the usefulness of the results. Future surveys may have to employ sampling gear other than the conventional herring bottom trawl which is not capable of being used successfully in the shoal, rough portions of Georges Bank where young herring possibly congregate during the spring.

LITERATURE CITED

Dornheim, H. 1973. A preliminary report on the German Young-Herring-Survey carried out by R/V Walther Herwig in ICNAF Subarea 5 and Statistical Area 6 in February-March 1973. Int. Comm. Northw. Atlant. Fish., Res. Doc. 73/84, 4 pp.

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Table 1. Stratified catch per tow [$\log_e$ (n+1) of numbers and pounds] of herring and mackerel in selected strata sets during the 1973 and 1974 Walther Herwig Juvenile Herring Survey.

Area	Strata	1973 Mean no./tow	1973 Mean wt./tow	1973 Ave. wt.	1974 Mean no./tow	1974 Mean wt./tow	1974 Ave. wt.
				Herring			
4X	31-32	2.64	0.99	0.13	3.81	2.92	0.26
	31-34, 36	3.21	1.54	0.03	-	-	-
5Z	9-24	-	-	-	3.89	3.19	0.31
	9-10,13-14 16,19-25	4.11	2.98	0.19	4.20	3.45	0.30
6	1-2,61-62,66, 69-70,73-74	1.69	1.21	0.22	-	-	-
				Mackerel			
5Z	10-15	-	-	-	3.87	3.20	0.68
	10,13-14	1.21	0.74	0.25	3.52	2.78	0.40
6	1-2,61-62,66, 69-70,73-74	2.31	1.41	0.44	-	-	-

Table 2. Length frequency of the stratified no./tow of herring from the Walther Herwig Juvenile Herring Survey in Divisions 4X (strata 31-32) and 5Z (strata 9-24), March 19-April 3, 1974.

Total length (cm)	4X	5Z
19	2.04	0.02
20	8.98	7.18
21	28.99	12.81
22	21.76	17.66
23	33.34	34.20
24	18.97	38.22
25	32.84	138.60
26	37.93	696.74
27	41.57	1,791.26
28	39.66	1,646.10
29	18.70	544.92
30	5.35	35.71
31	0.09	3.44
32	0.09	1.52
33	0.56	0.02
34	----	<0.01
35	0.56	----
Total	291.43	4,968.40

Table 3. Herring age/length key from the Walther Herwig Juvenile Herring Survey in Division 4X, February 26-March 15, 1973.

Total Length (cm)	Year-class 1971	1970	1969	1968	1967	1966	1965	1964	Total
10	8	-	-	-	-	-	-	-	8
11	53	-	-	-	-	-	-	-	53
12	60	-	-	-	-	-	-	-	60
13	27	-	-	-	-	-	-	-	27
14	8	-	-	-	-	-	-	-	8
15	8	-	-	-	-	-	-	-	8
16	-	-	-	-	-	-	-	-	-
17	-	3	-	-	-	-	-	-	3
18	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-
Total	164	3	-	-	-	-	-	-	167

Table 4. Herring age/length key from the Walther Herwig Juvenile Herring Survey in Division 5Z, February 26-March 15, 1973.

Total length(cm)	Year-class 1971	1970	1969	1968	1967	1966	1965	1964	<1964	Total
10	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-
14	2	-	-	-	-	-	-	-	-	2
15	-	-	-	-	-	-	-	-		-
16	-	2	-	-	-	-	-	-	-	2
17	-	6	-	-	-	-	-	-	-	6
18	2	13	-	-	-	-	-	-	-	15
19	1	35	-	-	-	-	-	-	-	36
20	1	75	-	-	-	-	-	-	-	76
21	-	111	-	-	-	-	-	-	-	111
22	-	140	-	-	-	-	-	-	-	140
23	-	181	-	-	-	-	-	-	-	181
24	-	135	-	-	-	-	-	-	-	135
25	-	41	1	-	-	-	-	-	-	42
26	-	11	3	-	-	-	-	-	-	14
27	-	-	11	1	-	-	-	-	-	12
28	-	-	20	4	-	-	-	-	-	24
29	-	-	12	21	1	-	-	-	-	34
30	-	-	1	9	-	5	-	-	-	15
31	-	-	-	1	3	3	-	-	1	8
32	-	-	-	-	1	1	3	-	1	6
Total	6	750	48	36	5	9	3	-	2	859

Table 5. Herring age/length key from the Walther Herwig Juvenile Herring Survey in Statistical Area 6, February 26-March 15, 1973.

Total length(cm)	1971	1970	1969	1968	1967	1965	1964	Total
10	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-
20	-	1	-	-	-	-	-	1
21	-	5	-	-	-	-	-	5
22	-	15	-	-	-	-	-	15
23	-	28	-	-	-	-	-	28
24	-	38	-	-	-	-	-	38
25	-	12	-	-	-	-	-	12
26	-	1	-	-	-	-	-	1
27	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-
Total	-	100	-	-	-	-	-	100

Table 6. Age composition and length frequency of the stratified no./tow of herring from the Walther Herwig Juvenile Herring Survey in Division 4X (strata 31-34, 36), February 26-March 15, 1973.

Total length(cm)	Year-class 1971	1970	1969	1968	1967	1966	1965	1964	Stratified no./tow
10	19.14	-	-	-	-	-	-	-	19.14
11	162.39	-	-	-	-	-	-	-	162.39
12	206.71	-	-	-	-	-	-	-	206.71
13	90.69	-	-	-	-	-	-	-	90.69
14	17.44	-	-	-	-	-	-	-	17.44
15	17.20	-	-	-	-	-	-	-	17.20
16	-	4.11	-	-	-	-	-	-	4.11
17	-	0.42	-	-	-	-	-	-	0.42
18	0.83	5.43	-	-	-	-	-	-	6.26
19	0.04	1.49	-	-	-	-	-	-	1.53
20	0.01	1.07	-	-	-	-	-	-	1.08
21	-	0.34	-	-	-	-	-	-	0.34
22	-	0.74	-	-	-	-	-	-	0.74
23	-	0.58	-	-	-	-	-	-	0.58
24	-	0.58	-	-	-	-	-	-	0.58
25	-	0.35	0.01	-	-	-	-	-	0.36
26	-	0.16	0.04	-	-	-	-	-	0.20
27	-	-	0.24	0.02	-	-	-	-	0.26
28	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-
30	-	-	0.01	0.12	0.07	-	-	-	0.20
Total	514.45	15.27	0.29	0.14	0.07	-	-	-	530.22
Pct.	97.0	2.9	<0.1	<0.1	<0.1	-	-	-	100.0

Table 7. Age composition and length frequency of the stratified no./tow of herring from the Walther Herwig Juvenile Herring Survey in Division 5Z (strata 9-10,13-14,16,19-25), February 26-March 15, 1973.

Total length(cm)	Year-class 1971	1970	1969	1968	1967	1966	1965	1964	<1964	Stratified no./tow
12	0.06	-	-	-	-	-	-	-	-	0.06
13	0.04	-	-	-	-	-	-	-	-	0.04
14	0.28	-	-	-	-	-	-	-	-	0.28
15	0.43	-	-	-	-	-	-	-	-	0.43
16	-	0.11	-	-	-	-	-	-	-	0.11
17	-	1.10	-	-	-	-	-	-	-	1.10
18	0.37	2.38	-	-	-	-	-	-	-	2.75
19	0.87	30.13	-	-	-	-	-	-	-	31.00
20	1.18	89.48	-	-	-	-	-	-	-	90.66
21	-	271.36	-	-	-	-	-	-	-	271.36
22	-	483.25	-	-	-	-	-	-	-	483.25
23	-	560.27	-	-	-	-	-	-	-	560.27
24	-	464.93	-	-	-	-	-	-	-	464.93
25	-	254.49	4.93	-	-	-	-	-	-	259.42
26	-	54.44	13.61	-	-	-	-	-	-	68.05
27	-	-	12.61	1.14	-	-	-	-	-	13.75
28	-	-	2.76	0.55	-	-	-	-	-	3.31
29	-	-	1.24	2.17	0.10	-	-	-	-	3.51
30	-	-	0.11	0.95	0.53	-	-	-	-	1.59
31	-	-	-	0.11	0.33	0.32	-	-	0.11	0.87
32	-	-	-	-	0.07	0.07	0.21	-	0.07	0.42
33	-	-	-	-	-	0.12	-	-	-	0.12
34	-	-	-	-	-	0.02	-	-	-	0.02
Total	3.23	2211.94	35.26	4.92	1.03	0.53	0.21	-	0.18	2257.30
Pct.	0.1	98.0	1.6	0.2	<0.1	<0.1	<0.1	-	<0.1	100.0

Table 8. Age composition and length frequency of the stratified no./tow of herring from the Walther Herwig Juvenile Herring Survey in Statistical Area 6 (strata 1-2,61-62,66,69-70,73-74), February 26-March 15, 1973.

Total length(cm)	Year-class 1971	1970	1969	1968	1967	1966	1965	1964	<1964	Stratified no./tow
20	<0.01	0.06	-	-	-	-	-	-	-	0.06
21	-	0.86	-	-	-	-	-	-	-	0.86
22	-	4.24	-	-	-	-	-	-	-	4.24
23	-	16.77	-	-	-	-	-	-	-	16.77
24	-	42.72	-	-	-	-	-	-	-	42.72
25	-	30.90	0.60	-	-	-	-	-	-	31.50
26	-	8.00	2.00	-	-	-	-	-	-	10.00
27	-	-	0.82	0.07	-	-	-	-	-	0.89
28	-	-	0.21	0.04	-	-	-	-	-	0.25
29	-	-	0.06	0.09	0.01	-	-	-	-	0.16
30	-	-	0.08	0.67	0.38	-	-	-	-	1.13
31	-	-	-	0.14	0.42	0.43	-	-	0.14	1.13
32	-	-	-	-	0.19	0.19	0.57	-	0.19	1.14
33	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	0.25	-	-	-	0.25
35	-	-	-	-	-	0.16	-	-	-	0.16
Total	<0.01	103.55	3.77	1.01	1.00	1.03	0.57	-	0.33	111.26
Pct.	<0.1	93.1	3.4	0.9	0.9	0.9	0.5	-	0.3	100.0

Table 9. Mackerel age/length key from the Walther Herwig Juvenile Herring Survey in ICNAF Division 5Z, March 19-April 13, 1974.

Total length(cm)	Year-class 1973	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960	Total
18	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
19	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7
21	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
22	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
27	1	2	-	-	-	-	-	-	-	-	-	-	-	-	3
28	-	16	-	-	-	-	-	-	-	-	-	-	-	-	16
29	-	13	-	-	-	-	-	-	-	-	-	-	-	-	13
30	-	9	-	-	-	-	-	-	-	-	-	-	-	-	9
31	-	10	9	-	-	-	-	-	-	-	-	-	-	-	19
32	-	4	20	-	-	-	-	-	-	-	-	-	-	-	24
33	-	3	37	-	-	-	-	-	-	-	-	-	-	-	40
34	-	1	19	2	1	-	-	-	-	-	-	-	-	-	23
35	-	-	7	1	4	1	-	-	-	-	-	-	-	-	13
36	-	-	2	1	5	2	2	-	-	-	-	-	-	-	12
37	-	-	-	4	2	-	13	1	-	-	-	-	-	-	20
38	-	-	-	1	5	6	19	4	1	-	-	-	-	-	36
39	-	-	-	-	3	3	15	4	2	-	-	-	-	-	27
40	-	-	-	-	-	3	10	1	-	-	-	-	-	-	14
41	-	-	-	-	-	-	3	3	2	1	-	-	-	-	9
42	-	-	-	-	-	-	2	1	-	1	-	-	-	1	5
43	-	-	-	-	-	-	-	-	-	1	1	-	-	2	4
44	-	-	-	-	-	-	-	1	-	-	-	-	2	-	3
Total	18	59	94	9	20	15	64	15	5	3	1	-	2	3	308

Table 10. Age composition and length frequency of the stratified no./tow of mackerel from the Walther Herwig Juvenile Herring Survey in Division 5Z (strata 10-15), March 19-April 3, 1974.

Total length(cm)	Year-class 1973	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960	Stratified no./tow
12	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05
13	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	1.51	-	-	-	-	-	-	-	-	-	-	-	-	-	1.51
17	10.14	-	-	-	-	-	-	-	-	-	-	-	-	-	10.14
18	28.18	-	-	-	-	-	-	-	-	-	-	-	-	-	28.18
19	18.80	-	-	-	-	-	-	-	-	-	-	-	-	-	18.80
20	9.40	-	-	-	-	-	-	-	-	-	-	-	-	-	9.40
21	7.52	-	-	-	-	-	-	-	-	-	-	-	-	-	7.52
22	3.93	-	-	-	-	-	-	-	-	-	-	-	-	-	3.93
23	2.25	-	-	-	-	-	-	-	-	-	-	-	-	-	2.25
24	2.42	-	-	-	-	-	-	-	-	-	-	-	-	-	2.42
25	3.59	3.59	-	-	-	-	-	-	-	-	-	-	-	-	7.18
26	-	15.48	-	-	-	-	-	-	-	-	-	-	-	-	15.48
27	32.31	64.73	-	-	-	-	-	-	-	-	-	-	-	-	97.04
28	-	157.35	-	-	-	-	-	-	-	-	-	-	-	-	157.35
29	-	103.16	-	-	-	-	-	-	-	-	-	-	-	-	103.16
30	-	126.56	-	-	-	-	-	-	-	-	-	-	-	-	126.56
31	-	84.02	75.71	-	-	-	-	-	-	-	-	-	-	-	159.73
32	-	50.92	253.97	-	-	-	-	-	-	-	-	-	-	-	304.89
33	-	20.80	256.60	-	-	-	-	-	-	-	-	-	-	-	277.40
34	-	4.61	88.73	9.33	4.61	-	-	-	-	-	-	-	-	-	107.28
35	-	-	87.86	12.58	50.30	12.58	-	-	-	-	-	-	-	-	163.32
36	-	-	43.03	21.38	107.17	43.03	43.03	-	-	-	-	-	-	-	257.64
37	-	-	-	69.50	34.75	-	225.88	17.38	-	-	-	-	-	-	347.51
38	-	-	-	12.76	63.33	76.08	240.08	50.57	12.76	-	-	-	-	-	455.58
39	-	-	-	-	25.34	25.34	126.95	33.79	16.89	-	-	-	-	-	228.31
40	-	-	-	-	-	59.45	198.64	19.73	-	-	-	-	-	-	277.82
41	-	-	-	-	-	-	17.75	17.75	11.88	5.92	-	-	-	-	53.30
42	-	-	-	-	-	-	11.84	5.92	-	5.92	-	-	-	5.92	29.60
43	-	-	-	-	-	-	-	-	-	11.64	11.64	-	-	23.30	46.58
44	-	-	-	-	-	-	-	0.07	-	-	-	-	0.15	-	0.22
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-	-	-	-	-	9.72	-	-	9.72
Total	120.15	631.22	805.90	125.55	285.50	216.48	864.17	145.21	41.53	23.48	11.64	9.72	0.15	29.22	3309.92
Pct.	3.6	19.1	24.3	3.8	8.6	6.5	26.1	4.4	1.3	0.7	0.4	0.3	<0.1	0.9	100.0

Table 11. Mackerel age/length key from Albatross IV, Delaware II, and Wieczno surveys in Division 5Z and Statistical Area 6, March 1-April 24, 1973.

Total length(cm)	Year-class 1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	Total
15	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
16	20	-	-	-	-	-	-	-	-	-	-	-	-	-	20
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	15	-	-	-	-	-	-	-	-	-	-	-	-	-	15
19	17	-	-	-	-	-	-	-	-	-	-	-	-	-	17
20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7
21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6
22	18	-	-	-	-	-	-	-	-	-	-	-	-	-	18
23	9	-	-	-	-	-	-	-	-	-	-	-	-	-	9
24	6	1	-	-	-	-	-	-	-	-	-	-	-	-	7
25	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2
26	1	9	-	-	-	-	-	-	-	-	-	-	-	-	10
27	1	4	-	-	-	-	-	-	-	-	-	-	-	-	5
28	-	31	-	-	-	-	-	-	-	-	-	-	-	-	31
29	-	28	1	-	-	-	-	-	-	-	-	-	-	-	29
30	-	11	-	-	-	-	-	-	-	-	-	-	-	-	11
31	-	5	-	-	-	-	-	-	-	-	-	-	-	-	5
32	-	5	2	-	-	-	-	-	-	-	-	-	-	-	7
33	-	4	7	5	-	-	-	-	-	-	-	-	-	-	16
34	-	-	16	19	3	4	-	-	-	-	-	-	-	-	42
35	-	-	7	21	3	8	1	-	-	-	-	-	-	-	40
36	-	-	1	11	2	29	6	1	-	-	-	-	-	-	50
37	-	-	1	1	4	19	6	4	-	-	-	-	-	-	35
38	-	-	-	2	4	19	13	7	1	-	-	-	-	-	46
39	-	-	-	-	-	3	3	5	-	-	-	-	-	-	11
40	-	-	-	-	-	4	9	9	3	-	-	-	-	-	25
41	-	-	-	-	-	-	3	5	1	-	-	-	-	-	9
42	-	-	-	-	-	1	-	3	-	1	-	4	2	1	12
43	-	-	-	-	-	-	-	-	1	1	1	1	1	1	6
44	-	-	-	-	-	-	-	-	-	-	-	2	1	1	4
45	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Total	103	99	35	59	16	87	41	34	6	4	1	7	4	3	499

Table 12. Age composition and length frequency of the stratified no./tow of mackerel from the Walther Herwig Juvenile Herring Survey in Division 5Z (strata 10,13-14), February 26-March 15, 1973.

Total length(cm)	Year-class 1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	Stratified no./tow
16	0.36	-	-	-	-	-	-	-	-	-	-	-	-	-	0.36
17	0.59	-	-	-	-	-	-	-	-	-	-	-	-	-	0.59
18	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-	1.54
19	1.89	-	-	-	-	-	-	-	-	-	-	-	-	-	1.89
20	1.06	-	-	-	-	-	-	-	-	-	-	-	-	-	1.06
21	0.95	-	-	-	-	-	-	-	-	-	-	-	-	-	0.95
22	2.37	-	-	-	-	-	-	-	-	-	-	-	-	-	2.37
23	2.25	-	-	-	-	-	-	-	-	-	-	-	-	-	2.25
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	0.01	0.11	-	-	-	-	-	-	-	-	-	-	-	-	0.12
27	0.02	0.10	-	-	-	-	-	-	-	-	-	-	-	-	0.12
28	-	0.12	-	-	-	-	-	-	-	-	-	-	-	-	0.12
29	-	0.12	<0.01	-	-	-	-	-	-	-	-	-	-	-	0.12
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	0.02	0.06	0.01	0.02	<0.01	-	-	-	-	-	-	-	0.11
36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	-	-	0.02	0.02	0.06	0.31	0.10	0.06	-	-	-	-	-	-	0.57
38	-	-	-	0.01	0.03	0.14	0.10	0.05	0.01	-	-	-	-	-	0.34
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	0.05	0.13	0.12	0.04	-	-	-	-	-	0.34
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	0.01	-	0.03	-	0.01	-	0.03	0.02	0.01	0.11
43	-	-	-	-	-	-	-	-	0.04	0.04	0.04	0.04	0.04	0.03	0.23
44	-	-	-	-	-	-	-	-	-	-	-	0.05	0.03	0.03	0.11
Total	11.04	0.45	0.04	0.09	0.10	0.53	0.33	0.26	0.09	0.05	0.04	0.12	0.09	0.07	13.30
Pct.	83.0	3.4	0.3	0.7	0.7	4.0	2.5	1.9	0.7	0.4	0.3	0.9	0.7	0.5	100.0

Table 13. Age composition and length frequency of the stratified no./tow of mackerel from the Walther Herwig Juvenile Herring Survey in Statistical Area 6 (strata 1-2,61-62,66,69-70,73-74), February 26-March 15, 1973.

Total length(cm)	1972	1971	1970	1969	1968	1967	1966	1965	1964	Stratified no./tow
14	0.06	-	-	-	-	-	-	-	-	0.06
15	2.80	-	-	-	-	-	-	-	-	2.80
16	6.46	-	-	-	-	-	-	-	-	6.46
17	4.02	-	-	-	-	-	-	-	-	4.02
18	2.85	-	-	-	-	-	-	-	-	2.85
19	0.61	-	-	-	-	-	-	-	-	0.61
20	0.18	-	-	-	-	-	-	-	-	0.18
21	0.46	-	-	-	-	-	-	-	-	0.46
22	0.42	-	-	-	-	-	-	-	-	0.42
23	0.46	-	-	-	-	-	-	-	-	0.46
24	0.63	0.11	-	-	-	-	-	-	-	0.74
25	0.16	0.17	-	-	-	-	-	-	-	0.33
26	0.19	1.71	-	-	-	-	-	-	-	1.90
27	1.46	5.82	-	-	-	-	-	-	-	7.28
28	-	8.52	-	-	-	-	-	-	-	8.52
29	-	3.05	0.11	-	-	-	-	-	-	3.16
30	-	1.26	-	-	-	-	-	-	-	1.26
31	-	0.13	-	-	-	-	-	-	-	0.13
32	-	0.16	0.07	-	-	-	-	-	-	0.23
33	-	0.22	0.38	0.27	-	-	-	-	-	0.87
34	-	-	0.99	1.19	0.18	0.25	-	-	-	2.61
35	-	-	0.54	1.62	0.23	0.62	0.08	-	-	3.09
36	-	-	0.03	0.38	0.07	1.02	0.21	0.03	-	1.74
37	-	-	0.08	0.08	0.30	1.41	0.45	0.30	-	2.62
38	-	-	-	0.08	0.16	0.77	0.52	0.28	0.04	1.85
39	-	-	-	-	-	0.29	0.29	0.49	-	1.07
40	-	-	-	-	-	0.08	0.17	0.17	0.06	0.48
41	-	-	-	-	-	-	0.30	0.50	0.10	0.90
Total	20.76	21.15	2.20	3.62	0.94	4.44	2.02	1.77	0.20	57.10
Pct.	36.4	37.0	3.9	6.3	1.6	7.8	3.5	3.1	0.4	100.0

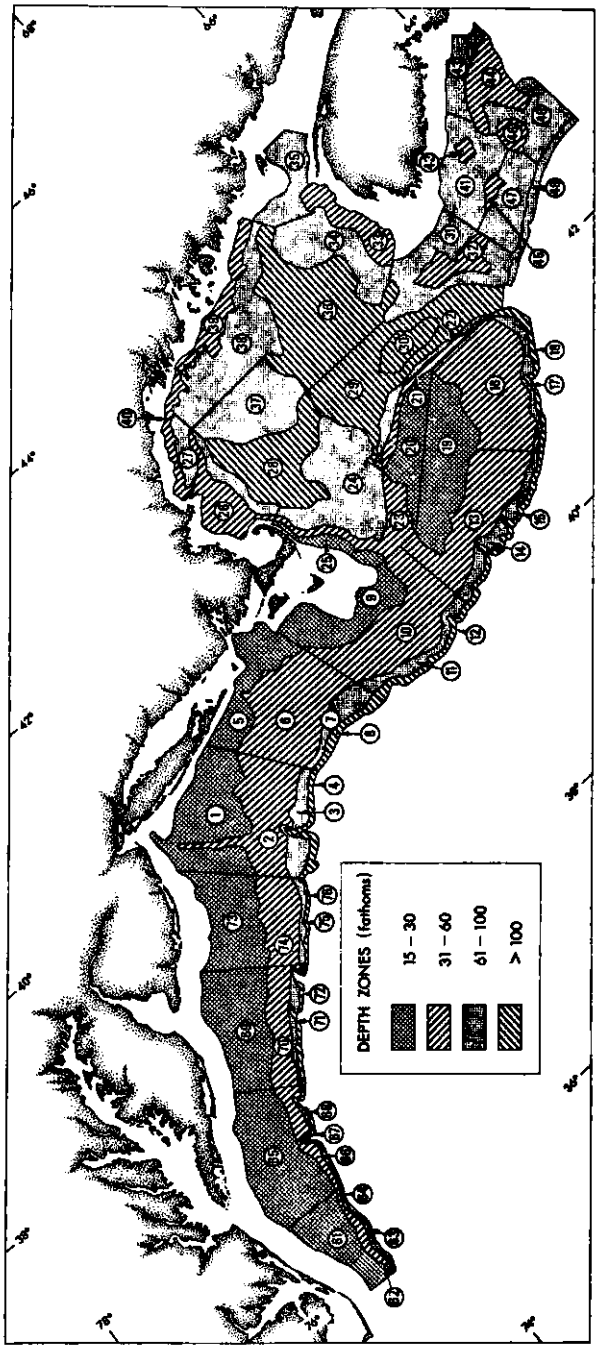

Fig. 1. U.S. groundfish survey sampling strata.

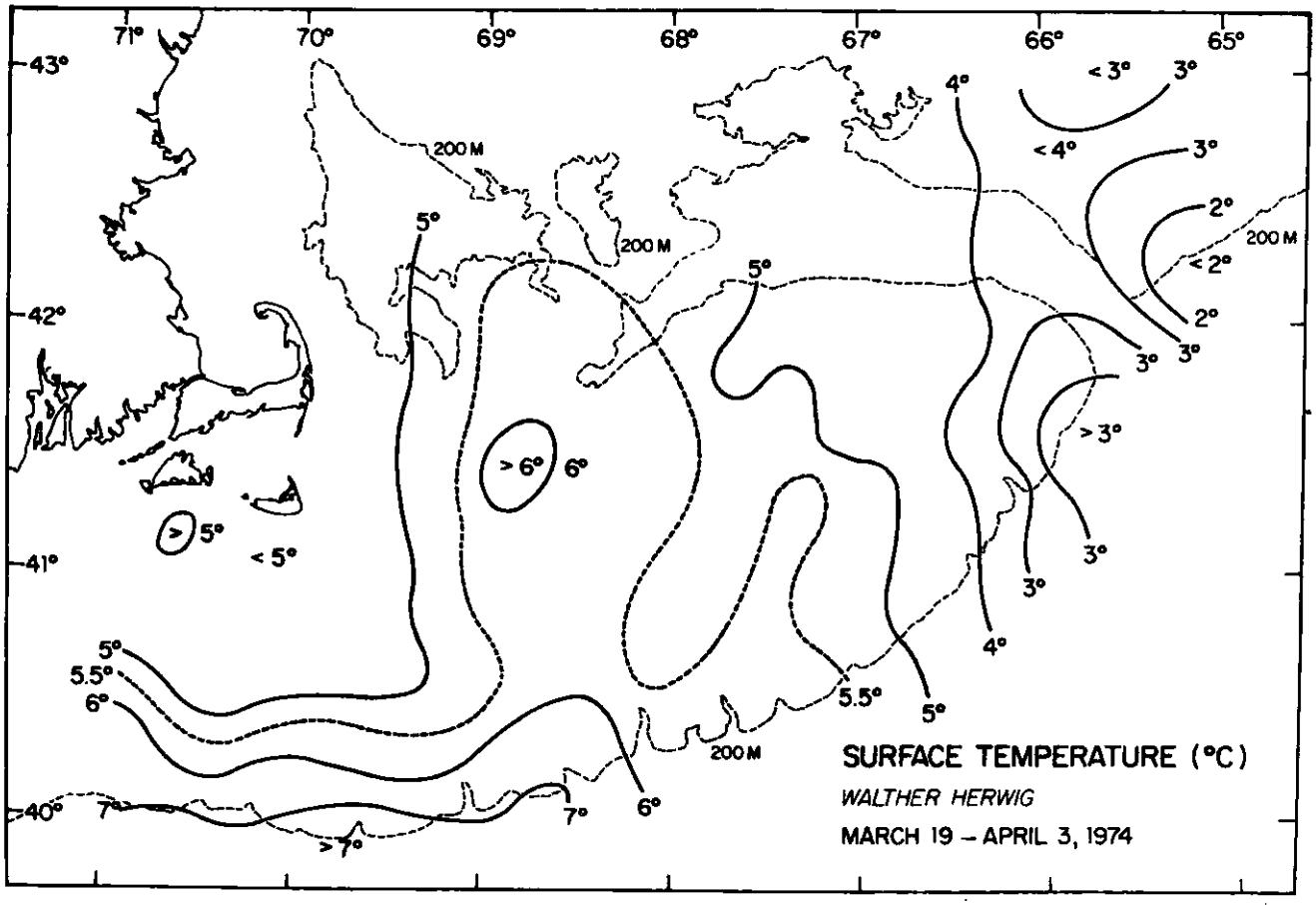

Fig. 2. Surface water temperature (°C) isogram from the 1974 Walther Herwig Juvenile Herring Survey.

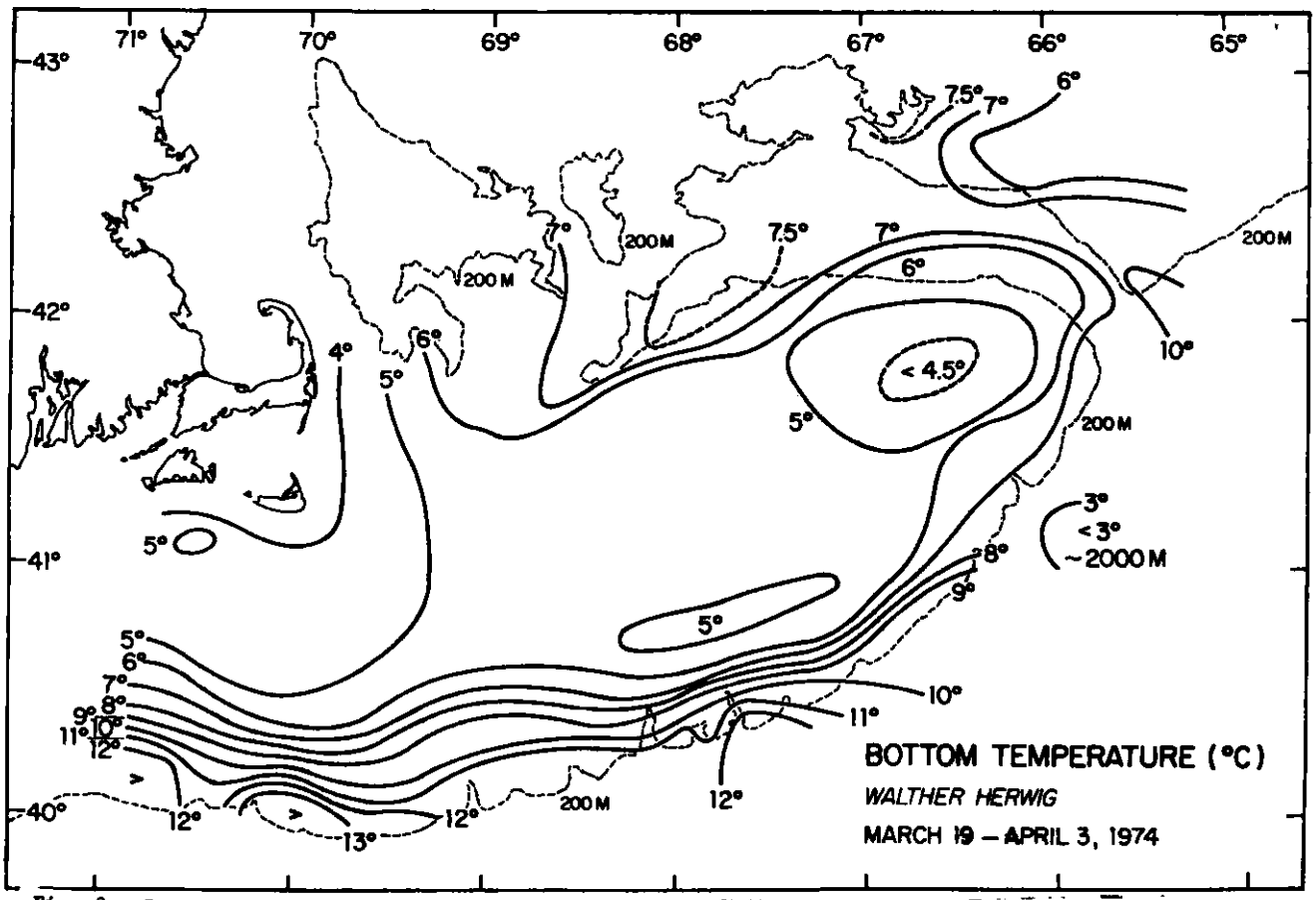

Fig. 3. Bottom water temperature (°C) isogram from the 1974 Walther Herwig Juvenile Herring Survey.

F 1

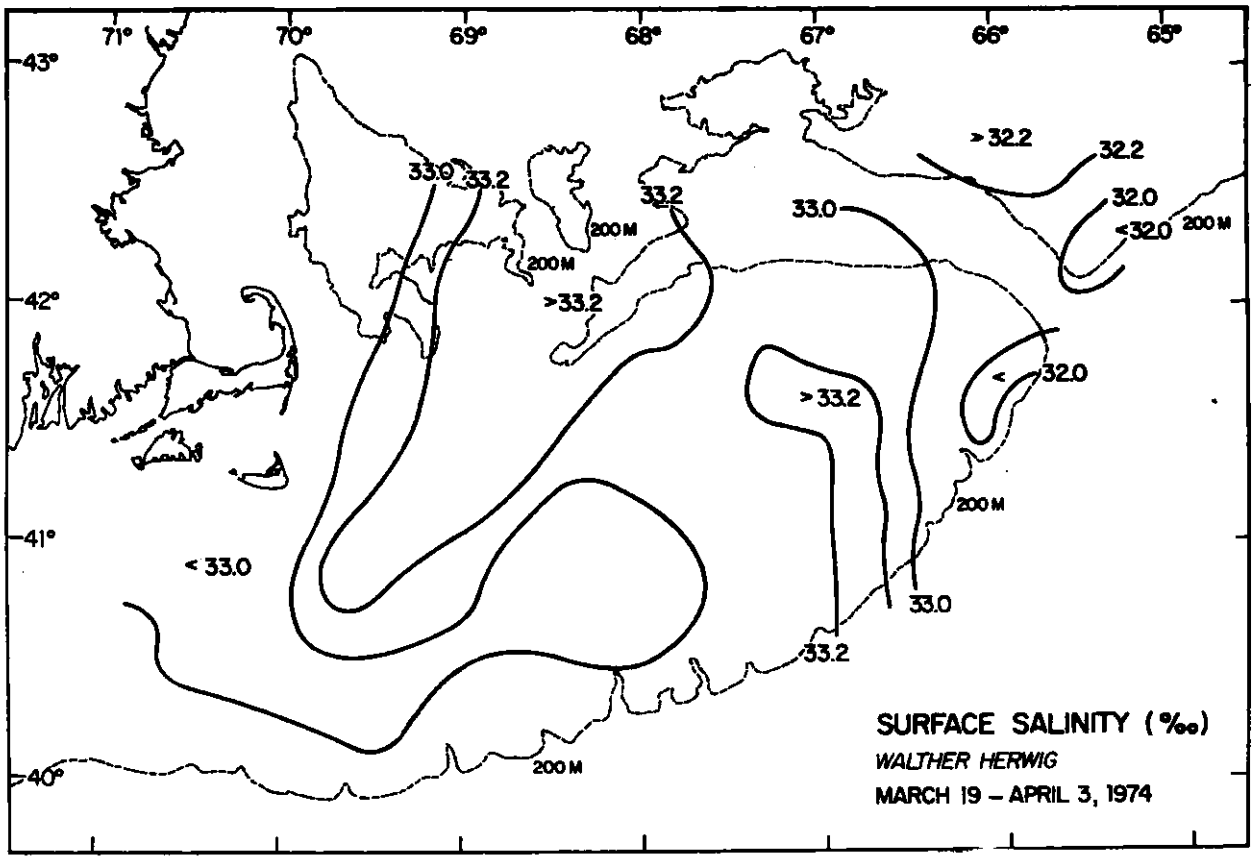

Fig. 4. Surface salinity (°/₀₀) isogram from the 1974 Walther Herwig Juvenile Herring Survey.

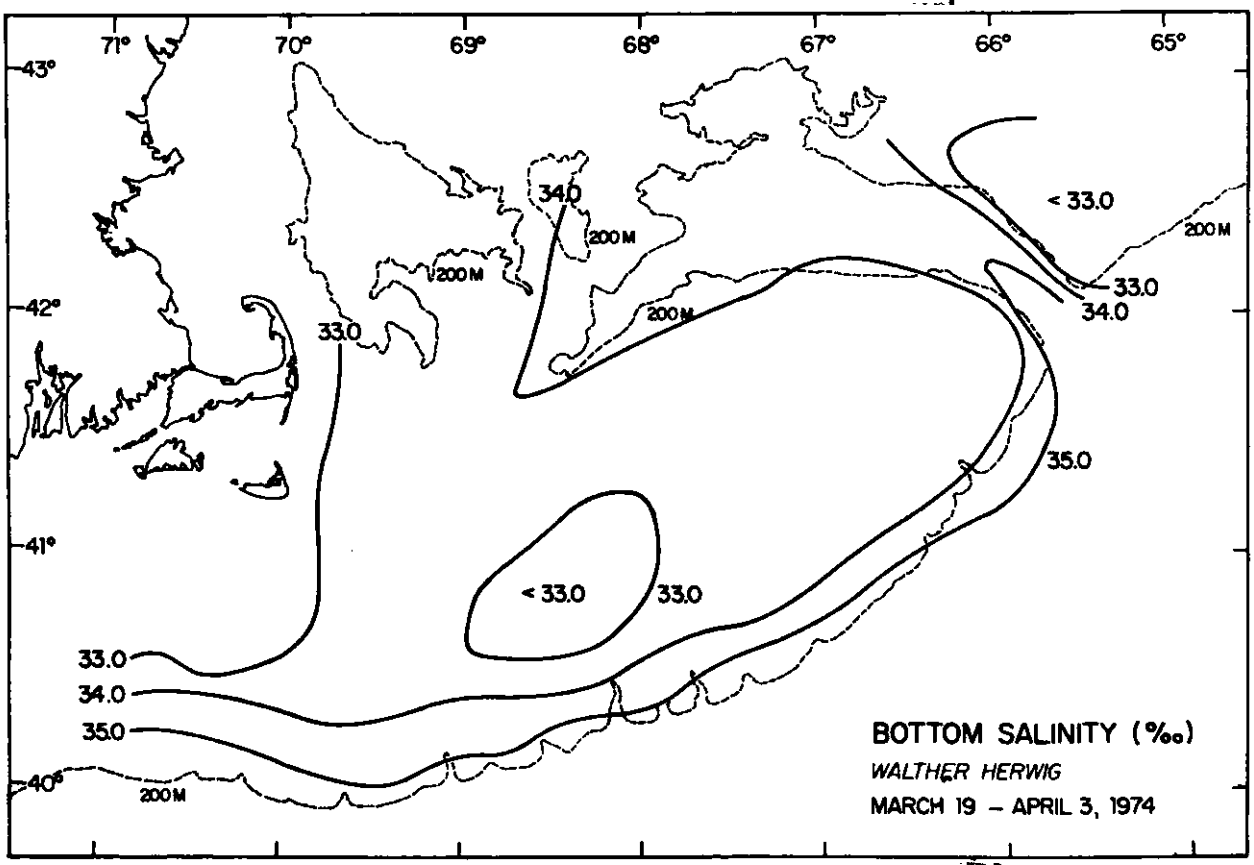

Fig. 5. Bottom salinity (°/₀₀) isogram from the 1974 Walther Herwig Juvenile Herring Survey.

F 2

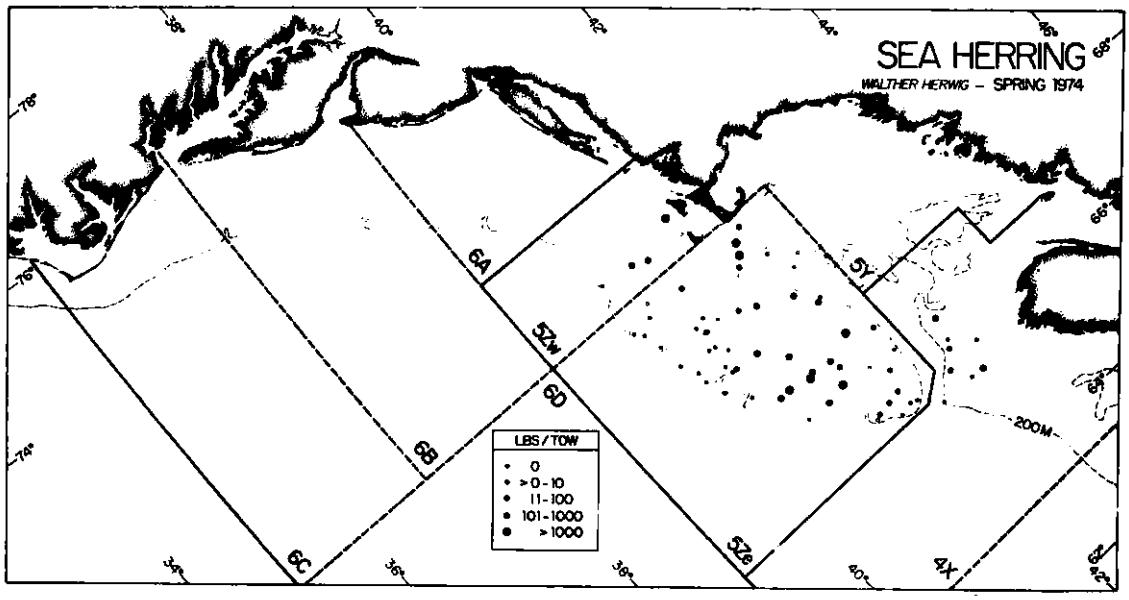

Fig. 6. Distribution of herring catches (lbs/tow) during the 1974 Walther Herwig Juvenile Herring Survey.

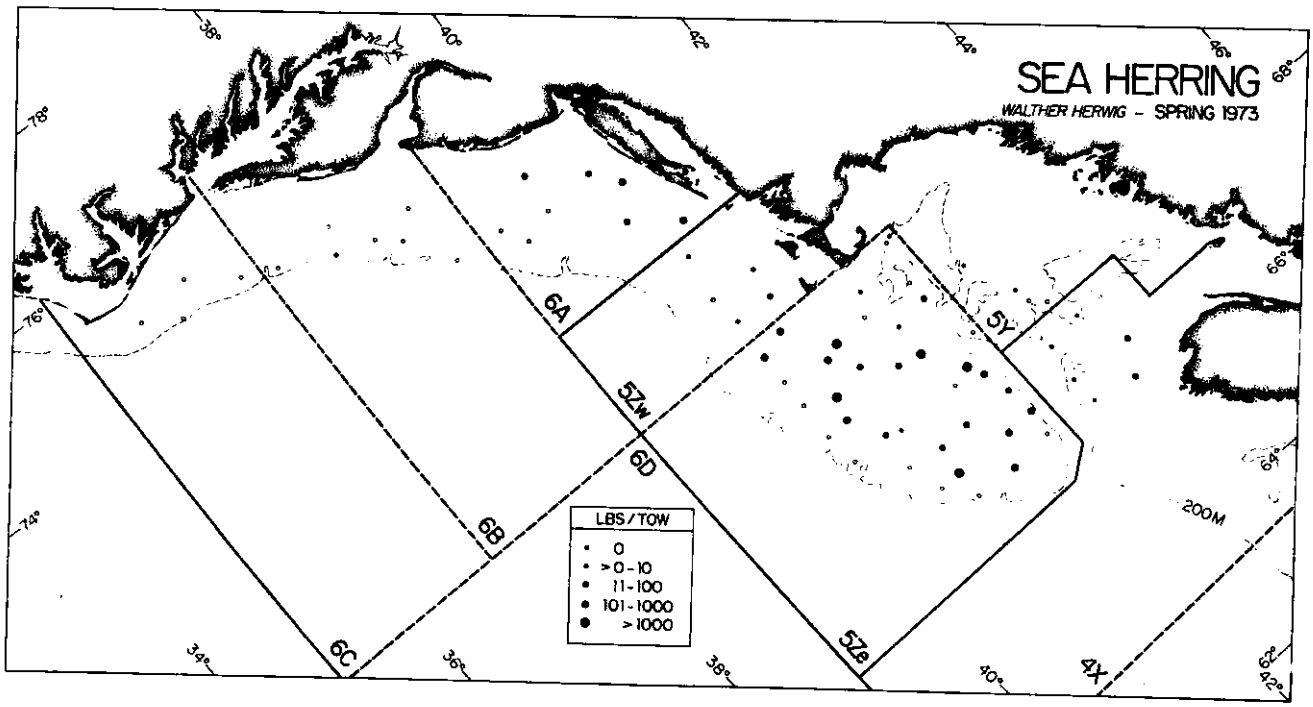

Fig. 7. Distribution of herring catches (lbs/tow) during the 1973 Walther Herwig Juvenile Herring Survey.

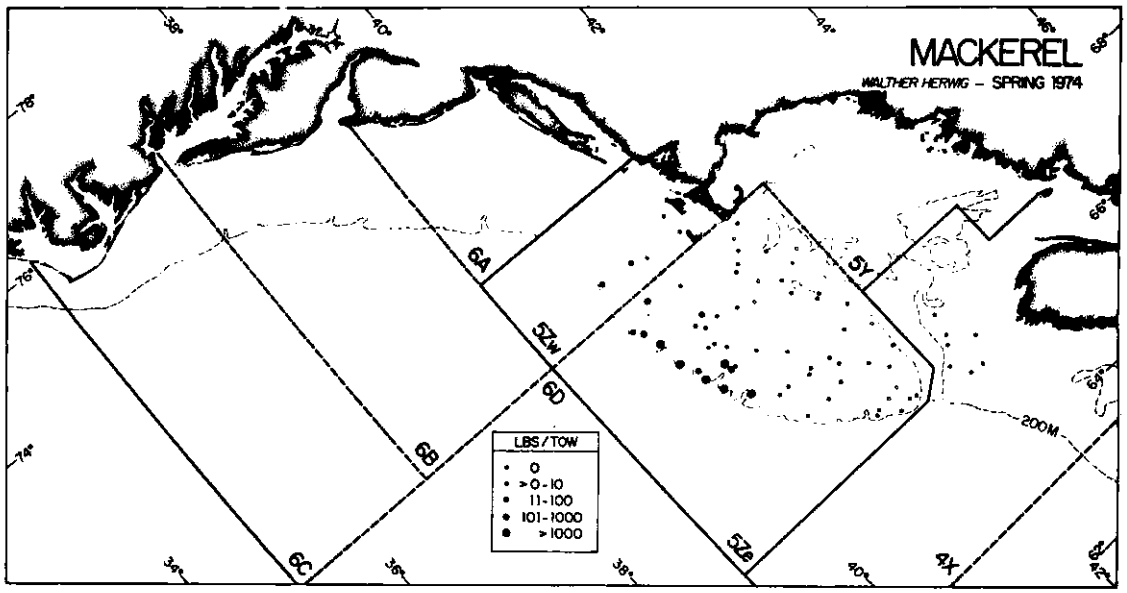

Fig. 8. Distribution of mackerel catches (lbs/tow) during the 1974 Walther Herwig Juvenile Herring Survey.

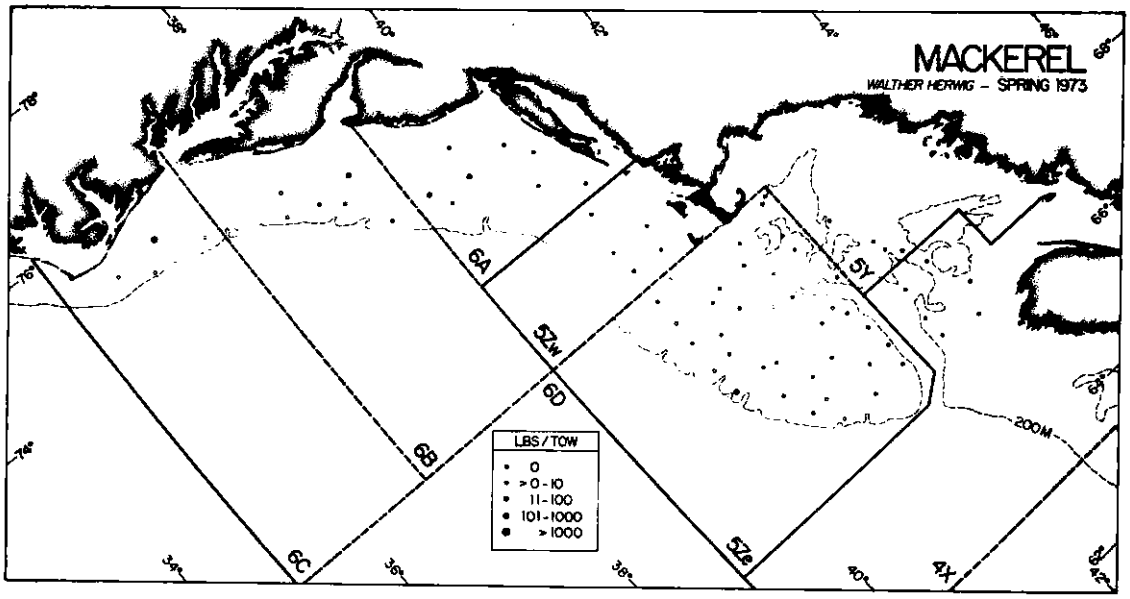

Fig. 9. Distribution of mackerel catches (lbs/tow) during the 1973 Walther Herwig Juvenile Herring Survey.