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Size distribution and recruitment estimates for sea herring of the Georges Bank - Gulf of Maine region, based on trawl surveys by research vessels

Res. Doc. by

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Introduction

Uncertainty as to the size of future recruitment still represents a major problem in the management of sea herring stocks of the Georges Bank - Gulf of Maine region. Since 1973, special bottom trawl surveys have been conducted each spring in the area from Cape Hatteras to western Nova Scotia, in an attempt to develop reliable recruitment indices in terms of the abundance of two-year old herring (Dornheim, 1973; Anderson and Dornheim, 1974). A partial evaluation of the herring catches on these special surveys, as well as an analysis of the standard spring U.S. bottom trawl surveys, was conducted by the ICNAF Herring Working Group in April 1975. However, the Working Group considered that a more thorough analysis of the available data was desirable in order to obtain more accurate estimates of the relative strengths of incoming year classes. Specifically, it was noted that more accurate age-length keys could be constructed and that better statistical treatment of the data was possible.

In this paper we have used improved age-length keys in estimating relative abundance of age groups caught on the surveys and we have extended the recruitment analysis of U.S. surveys back to 1968 to include the entire time series of U.S. spring surveys. Also, we have included the final results of all the 1975 spring trawl surveys.

Although the new estimates of year class strength are considered more accurate than those presented at the April '75 meeting, there was insufficient time to apply the full range of available statistical methods for dealing with the highly skewed frequency distributions of catches. In particular, log transforms of individual catches at age were not possible with the time available. Further, there was insufficient time to investigate the very complex problem of sampling errors, and no measures of statistical precision have yet been developed. Thus the accuracy of available estimates of relative year class strengths must be judged largely on the basis of their consistency with other information and their own internal consistency. Sampling errors undoubtedly are substantial but probably not so large as to mask the factor differences which appear to exist among recent year classes.

In addition to the abundance at age data, we have summarized the geographic distribution of juvenile and adult herring caught on the U.S. spring trawl surveys and winter surveys for 1964-1966. This was done to provide a basis for stratifying the area for estimation of abundance, and also with a view toward improving sampling strategy on future surveys.

Survey Methods

A stratified random sampling design (illustrated in Figure 1 A) was used for the U.S. trawl surveys, employing the standard #36 trawl from 1964-72 and the #41 trawl thereafter for the spring surveys (Grosslein, 1974). With the exception of the Walther Herwig survey in 1973 (which was post-stratified before analysis), all the other special spring surveys by Walther Herwig (1974-75), Wieczno (1975), Khronometer (1974) and the Ernst Haeckel (1975) also used the same stratified sampling plan, but they were done with commercial herring (bottom) trawls. Wieczno also conducted a special survey in 1973 but station selection was not random and results are not comparable with the other surveys.

The U.S. vessel normally covered most of the entire area shown in Figure 1, except that no sampling was done south of strata 1-4 (Hudson Canyon area) prior to 1967; the location of stations for the area east of Long Island is illustrated in Figures 1-4, and the pattern was similar for the area south to Cape Hatteras. The cruise tracks for the surveys by other countries are shown in Figures 5-11.

Spring Distribution of Juvenile Herring

Catches of juvenile herring (age group 2) on eleven U.S. winter or spring trawl surveys were plotted to determine the distribution pattern of juveniles. For the purpose of plotting, numbers of two-year old herring in each catch were approximated by examination of length frequency distributions; the upper size limit chosen for age-group 2 was 15-16 cm (fork length) in all years except 1971 and 1972 when 17 cm and 18 cm respectively were used.

Plots for three winter cruises (Jan-Feb, 1964 to 1966) are presented in Figure 1 and eight spring cruises (March-April, 1968-1975) are shown in Figures 2-4. Virtually no juveniles were found south of Hudson Canyon in any of the surveys. The southernmost limit of their distribution seems to be in the vicinity of Long Island, and they are found east and north of this area on Georges Bank, off southern Nova Scotia and throughout the Gulf of Maine (see Figure 3 D for composite plot of all juvenile catches on the 1968-1974 series of spring surveys). In the southern New England area the juveniles are generally found inside the 60 m depth contour, and they are usually found inside 80 m on Georges Bank (Figure 3 D). However, they are found in much deeper water (100 to 200 m) in the Gulf of Maine and off southern Nova Scotia. It is quite likely they also occur inside 100 m north of Georges Bank, but the surveys there seldom sampled inside 100 m because of rough bottom.

Areas of concentration appear to fluctuate from year to year, e.g. they occur on Georges Bank but not in southern New England in some years and vice versa. The densest aggregations of juveniles have occurred in southern New England, but they are found most consistently off the mouth of the Bay of Fundy and off southern Nova Scotia (Figures 1-4). In the last three years (1973-1975) there has been a decline in the relative abundance of juveniles in all areas but the decline seems to be more severe in the southern New England - Georges Bank area than off western Nova Scotia. The possibility was considered that there may have been an eastward shift in distribution in response to some environmental change. Evidence has been accumulating to suggest a general warming in the region and we have observed some increases in temperature during these surveys.

Bottom temperatures shown in Figures 1-3 indicate there has been general warming in the deep waters of the Gulf of Maine since the mid-1960s. This is best illustrated by noting the amount of 8° C water in the Gulf. The bottom temperatures observed during the winter (Jan-Feb) cruises of 1964, 1965 and 1966 (see Figure 1) were for the most part $\leq$ 6° C which is slightly below the long term mean temperature of about 6° C for the period 1940-1966 (Colton and Stoddard, 1973). In April 1968 and 1969 small tongues of 8° water were observed in the Northeast Channel and by April 1970 and 1971, cells of 8° water had penetrated the deep basin of the Gulf (Figure 2). By 1972 a rather large volume of 8° water was found in the Gulf and it was also present in 1973 and 1974 (Figure 3). Since juvenile herring have been found in temperatures ranging from 2-10° C it is not at all clear how temperature alone could account for any shift in distribution. However, temperature might be related indirectly through other factors which may have altered the survival or movement of juveniles or of earlier life stages. Sigaev (1974) postulated that the numerous concentrations of young herring observed on the Nova Scotian Shelf and Georges Bank in the winter of 1972 may have been associated with an intensification of cold water advection from Cabot Strait during this period. Further study is needed to evaluate various hypotheses and the persistence of the apparent shift in distribution.

In general, the proportion of juveniles in survey catches increases from south to north, from catches of only age 3 and older south of Long Island, to a mixture of age groups in southern New England, and finally predominantly juvenile herring in the eastern Gulf of Maine where in many instances catches are made up entirely of juveniles. It seems likely that juvenile herring do not migrate as far south in the winter as do adults. In fact, the general similarity of the distribution pattern of juvenile herring (see Figure 3 D) to the larval distribution patterns suggests that migration in the first two years of life could be quite limited. Whatever the explanation, the preponderance of juveniles in the north suggested that more sampling in that area might improve precision of pre-recruit estimates.

In order to properly evaluate the possible benefits from a trawl survey in terms of predictive potentials for the sea herring population in general, a summary of geographic distribution by size was prepared for the spring trawl survey series, and is described below.

Geographic Distribution of Herring by Size

The survey region was subdivided into 5 blocks on the basis of the apparent discontinuities observed in the distribution pattern of juvenile catches (Figure 3 D). The 5 blocks are shown in Figure 12. Stratified mean length frequencies (on a per haul basis) were calculated for each block and each survey, with the U.S. series shown in Figures 12-19, and the special trawl surveys by other countries shown in Figures 20-25.

Starting with the southernmost block (#5, mid-Atlantic) it is obvious that juvenile herring (< 20 cm) are rare in all years sampled and that only age 3 and older fish are present. In block 4 (southern New England) juveniles and adults were both present in U.S. surveys from 1968-1972 but juveniles became scarce thereafter in all surveys. Similarly, in block 3 (Georges Bank) both juveniles and adults were usually caught in the 1968-1972 series but juveniles were very scarce thereafter; on the other hand in the U.S. trawl series on Georges Bank, herring catches were much smaller and

more widely scattered than in southern New England (as illustrated by the low numbers and irregularities in the length frequency plots for block 3). In the Gulf of Maine (block 2) both juveniles and adults were found in the 1968-1972 surveys but juveniles were much more abundant than adults; from 1973-1975 the reverse was true with adults (1970 year class) outnumbering juveniles. Block 1 (southern Nova Scotia) is generally similar to the Gulf of Maine in that juveniles tended to predominate in the earlier years. However, in the last three years (1973-75) the predominance of juveniles in U.S. survey catches in block 1 increased rather than decreased as for the Gulf of Maine. Size compositions of catches by other countries in 1974 and 1975 were consistent with the patterns noted for the Albatross series.

These patterns are consistent with the possibility that there may have been a shift of juvenile distribution to the east in recent years. Also, the distributional data are consistent with the evidence which indicates that abundance of the 1971 to 1973 year classes was poor.

Relative Abundance Estimates of Age Groups

One of the sources of error in the preliminary analysis of the spring surveys at the April 1975 meeting was the incompleteness of the age-length keys; for the most part only age samples from the surveys were used and they were usually quite incomplete. For this paper we have used both commercial and research age-length data, and have pooled samples between areas and countries where necessary, in order to reduce errors in estimates of abundance at age.

Herring age-length keys were compiled for 1968-1972 using ICNAF sampling yearbooks, and keys for 1973-1975 were compiled from samples collected on the research vessels Albatross IV, Wieczno, and Walther Herwig. The keys for 1968-1972 were constructed by combining 1st quarter samples where length frequency distributions and modes appeared similar, and the resulting pooled data are given in keys 1-7, each of which indicates the countries and divisions included in the pooled set (Table 1). The keys for 1973-1975 were constructed from survey samples only and are shown in keys 8-10 including the combinations of vessels and blocks which were pooled (Table 1). For the Albatross IV data of 1972, all herring caught in block 1 were assumed to be age 2, and key 8 was applied to the remaining 4 blocks.

The pooled age-length keys were then applied to the stratified mean length frequencies for each of the blocks on each survey (reference figures 12-19) as follows:

Key	Block	Year
1	1, 2	1968
2	1, 2	1969
3	1, 2	1970
4	1, 2	1971
5	4, 5	1968-71
6	3	1968, 1969
7	3	1970, 1971
8	1-5	1972, 1973
9	1-5	1974
10	1-5	1975

Prior to this operation the Albatross IV stratified length frequencies were converted to total length using the regression Y = .01 + 1.069X, where Y = total length and X = fork length. The resulting estimates of abundance at age are presented in Table 2 in terms of stratified numbers per tow at age for each of the 5 sampling blocks represented in each survey.

In order to facilitate the comparisons of the relative strengths of recent year classes, a portion of the data from Table 2 on numbers per haul for age groups 2-4, is re-formatted in Table 3. Certain vessel-block combinations were excluded because of small numbers of hauls, and blocks 1 and 2, and blocks 3 and 4, were combined where possible in an attempt to improve accuracy of the abundance estimates by building up the number of hauls. Combination of blocks was achieved by weighting catch per tow values in proportion to the number of hauls in each block.

The basic finding is the same as that reported in the April '75 meeting, that the 1971-1973 year classes appear very small in comparison with the 1970 year class (Table 4).

By extending the analysis of the Albatross IV series to the years prior to 1973 (when the standard #36 trawl was used) we had to adjust the catches from the earlier years to account for the greater fishing power of the #41 trawl used since 1973. Thus catch data for Albatross cruises 1964-1972 were multiplied by the factor 2.75, the estimated fishing power differential between the #41 and #36 trawls. While this adjustment adds another element of variability to the data, the variability is the same for all age groups.

Estimates of Recruitment

The survey abundance indices from the two major areas (Blocks 1 and 2 combined, and Blocks 3 and 4 combined) were compared with estimates of year-class abundance of herring based on commercial catch data for the Georges Bank stock (Division 5Z and Statistical Area 6). The comparisons between the survey and commercial data were restricted to ages 2 and 3 and the commercial indices were presented in the 1975 Herring Working Group Report (ICNAF Summ. Doc. 75/19, p. 50) for year-classes 1964 to 1970. These latter estimates were obtained from a cohort analysis and should be quite accurate for year-classes 1969 and earlier. The indices of abundance of the 1970, 1971, and 1972 year-classes at age 3 are those assumed in prior assessments (ICNAF Redbook 1974, p 44) which were assumed from general catch and catch per unit of effort information.

Blocks 1 and 2 - Division 4X and 5Y

Only Albatross IV survey data were used for analysis of Blocks 1 and 2 because the Walther Herwig made too few hauls in this area to provide reliable estimates (Table 2).

We assumed that the 1966 year-class was the best year-class to use as a standard for comparing survey indices with calculated year-class abundance from cohort analysis. Abundance estimates at age 2 and 3 are 5 and 6 years back in the cohort analysis which should provide accurate stock size estimates. The 1966 year-class was the most abundant year-class in the time series examined, other than the 1970 year-class, which should

have been well represented in the survey catches. The ratios of the survey indices relative to the 1970 year-class were equated to the calculated 1966 abundance at age 2 and 3 of 1863 and 1523 million herring, respectively. The estimates of recruitment for the other year-classes were then made on a proportional basis using the survey ratios. These are given in Table 5 for the Albatross catches for Blocks 1 and 2. Although the 1970, 1971, and 1972 year-classes are not calculated year-class sizes, these are included in the calculated abundance column in Table 5 and compared with abundance estimates made from the survey data because these year-class sizes have been used in setting TACs and are commonly referred to in the assessments. Survey estimates of year-class sizes which deviate more than 50% from the estimates based on cohort analysis for age 2 are the 1967 and 1971 year-classes, and for age 3 are the 1965, 1969, and 1970 year-classes. For year-classes 1965 to 1972, excluding the 1966 year-class, the average difference between the survey estimates and those calculated from the cohort analysis (ignoring direction of error) was 53%. The variation in year-class sizes for year classes 1965-1972 at both age 2 and age 3 is 5.8 to 1 so that any estimate of recruitment within 50% is useful for assessment purposes.

A second procedure of estimating prerecruitment abundance with the Albatross data was to average the relative ratios over ages 2 and 3 to obtain a smoothed set of ratios which were then applied to both ages 2 and 3 (Table 6). Again, the 1966 year-class was used as a standard for comparing survey indices with calculated stock size. The average percent difference between the cohort and survey estimates of abundance was 34% for each age. This is a significant improvement of the results in Table 5 and indicates that survey indices from Blocks 1 and 2 may be very useful in predicting recruitment to the Georges Bank stock.

Blocks 3 and 4 - Georges Bank and Southern New England

The same estimation procedures used in Blocks 1 and 2 were applied to the combined survey data from Blocks 3 and 4. Additional data were available from surveys conducted by the Walther Herwig for 1973-1975, the Khronometer for 1974, and the Wieczno and Ernst Haeckel for 1975. If we can assume that the 1972 year-class at age 3 was 550 million fish (Summ. Doc. 75/19), then using the survey ratios calculated from the stratified number per tow given in Table 3 for the Ernst Haeckel and Wieczno, the 1973 year-class at age 2 is only 27 million (Ernst Haeckel data) or 45 million (Wieczno data). If we assume that the 1971 year-class at age 4 was 414 million (cohort analysis - Summ. Doc. 75/19, p. 50), then estimates of age 3 herring can be made for the 1972 year-class as: 232 million (Ernst Haeckel data) or 64 million (Wieczno data). It was felt that the best estimation procedure was to use ratios from adjacent age groups to make these estimates rather than relating a year class size from the cohort analysis to an age 4 survey ratio and then applying both the ratio from age 3 and 2 to the year class abundance at age 4. Equating the year class size of 550 million fish of the 1971 year-class at age 3 to the survey ratio of age 2 and 3 of the Khronometer (Table 3) provides an estimate of the 1972 year-class at age 2 of 3 million herring. If the 1970 year class at age 4 is 1693 million (Summ. Doc. 75/19), then the estimate of abundance for the 1971 year-class at age 3 is 387 million (Table 9).

Averaging over the Ernst Haeckel and Wieczno suggests that the 1971 year-class at age 4 was 4.1 times larger than the 1972 year-class at age 3, and the 1972 year-class at age 3 was 16.2 times larger than the 1973 year-class at age 2. Both vessels were consistent in that the 1972 year-class was smaller than the 1971 year-class and that the 1973 year-class was even smaller. These differences in year-class strength (assuming constant

availability to the gear in Blocks 3 and 4 for ages 2, 3, and 4) imply that the differences would be even greater data for similar ages.

The estimates of abundance at ages 2 and 3 for the Georges Bank stock from the Albatross data are indicated in Table 7. The estimates of abundance show poor agreement. The average difference between the abundance as estimated from the survey data and that calculated from cohort analysis was 103% for age 2 and 97% for age 3. The estimates of recent year-classes (after the 1968 year-class) are substantially lower than the assumed values used in current assessments. The Albatross survey catch ratios were averaged over ages 2 and 3 and applied to both age 2 and age 3 data (Table 8). Averaging the ratios over ages only reduced the average difference between the estimates of abundance calculated by cohort analysis and those calculated from survey indices to 93%.

The Walther Herwig data cover only 3 years, from 1973 to 1975, but other than the Albatross survey data provide the longest time series of herring survey data. The fishing power of the Walther Herwig net is much greater than that used by the Albatross, resulting in larger herring catches and fewer zero catches. The survey ratios for the Walther Herwig are given in Table 9 over year-classes for each age and were also equated to estimates of stock size assumed by the Herring Working Group (Summ. Doc. 75/19). Assuming that the 1970 year-class is 3202 million fish at age 3, estimates of year-class abundance for the 1971 and 1972 year-classes at age 3 are 1121 and 32 million herring, respectively. Assuming that the 1971 year-class is 682 million at age 2 (from cohort analysis) provides estimates of abundance at age 2 for the 1972 and 1973 year-classes of 273 and 75 million herring, respectively (Table 9).

Conclusions

With one exception, estimates of abundance of the 1969-1972 year classes from the survey data from all vessels are substantially lower than the values used in current assessments (Summ. Doc. 75/19). One possibility is that the recent year-classes are less available in the Georges Bank and Southern New England areas and may have shifted their distribution to Blocks 1 and 2. On the other hand, the estimates of age 2 abundance in Blocks 1 and 2 for the same year-classes are also less than that calculated from the cohort analysis for the 1969 year-class and assumed for the 1970-1972 year-classes (Table 5). Such low estimates of abundance from survey data from all areas may, in fact, mean that the abundance calculated from cohort analysis for the 1969 year class and that assumed for year-classes 1970-1972 may be too high.

Survey indices of juvenile herring from Blocks 1 and 2 (Gulf of Maine and Division 4X) provide better estimates of year-class abundance at ages 2 and 3 than do survey indices from Blocks 3 and 4 (Georges Bank and Southern New England). For year-classes 1965-1972 the estimated abundance of ages 2 and 3 from the summary data varied from that calculated from the cohort analysis by an average of 34%.

Survey abundance estimates for ages 2 and 3 from Blocks 3 and 4, and age 2 from Blocks 1 and 2 for recent year-classes are consistently lower than those used for assessments by the Herring Working Group. The weight of the evidence suggests that the recruitment estimates of the 1971, 1972 and 1973 year classes used in assessment work were too large.

In recommending TACs for the Georges Bank stock for 1974 and 1975 it was assumed that the 1971 and 1972 year-classes at age 3 were very poor and they were assumed equal to the 1969 year-class at age 3, the poorest year-class observed in the fishery. All abundance estimates of these two year classes from survey indices (Table 10) are low

except for the Walther Herwig estimate of the 1971 year-class in 1974 in Blocks 3 and 4. Averaging all estimates, giving each equal weight, produced estimates of the 1971 and 1972 year-classes at age 3 of 331 and 199 million, respectively. This is considerably less than the 550 million assumed for each year class at age 3 in the TAC assessments.

The size of the 1973 year-class appears to be even smaller than either the 1971 or 1972 year-classes. An overall unweighted average (from values in Table 10) of abundance at age 2 is only 50 million herring.

While this paper presents estimates of year-class size with unknown confidence limits, it is obvious that year-classes 1969, 1971, and 1972 are very low in abundance (Table 10) and that the 1973 year-class is even less abundant than these three poor year-classes.

Although we still do not have statistical estimates of precision for survey abundance indices, the basic consistency observed in the survey data strongly suggests that the survey indices can be used to predict recruitment. The accuracy of the pre-recruit indices probably could be improved by increased sampling in Blocks 1 and 2.

Recommendations

1. Apply appropriate log transformation techniques to analysis of the spring trawl survey data base, and estimate statistical confidence limits for pre-recruit abundance indices.

2. Continue spring trawl surveys. The standard U.S. bottom trawl surveys provide the longest time series and therefore represent a valuable link with past stock changes. Also, it is considered especially important to continue the Walther Herwig coverage at least at the previous level of sampling since this is the only time series with a large commercial trawl Continued standard sampling by other vessels, particularly Wieczno and Ernst Haeckel, would be valuable for comparisons with results of the 1975 surveys by these vessels.

3. Increased sampling in blocks 1 and 2 should be considered by vessels using high-opening bottom trawls.

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Key 1 - 1968
Canada, U.S.
Div. 4X & 5Y

Length class (cm)	Age 2	3	4
4.0-4.9			
5.0-5.9			
6.0-6.9			
7.0-7.9	1		
8.0-8.9	13		
9.0-9.9	49		
10.0-10.9	179		
11.0-11.9	304		
12.0-12.9	550		
13.0-13.9	727	1	
14.0-14.9	709	15	
15.0-15.9	16	31	
16.0-16.9		51	
17.0-17.9		20	
18.0-18.9		41	
19.0-19.9		23	
20.0-20.9		8	
21.0-21.9		1	
22.0-22.9		1	
23.0-23.9			1
24.0-24.9			
25.0-25.9			
26.0-26.9			
27.0-27.9			
28.0-28.9			
29.0-29.9			
30.0-30.9			
31.0-31.9			
32.0-32.9			
33.0-33.9			
34.0-34.9			
35.0-35.9			
36.0-36.9			

Key 2 - 1969
Canada, U.S.
Div. 5X & 5Y

Length class (cm)	Age 1	2	3	4	5
4.0-4.9					
5.0-5.9					
6.0-6.9					
7.0-7.9	1	10			
8.0-8.9		54			
9.0-9.9		188			
10.0-10.9		331			
11.0-11.9		460			
12.0-12.9		407			
13.0-13.9		281	54		
14.0-14.9		58	110		
15.0-15.9		9	112		
16.0-16.9			134		
17.0-17.9			141		
18.0-18.9			126		
19.0-19.9			102		
20.0-20.9			54	1	
21.0-21.9			19	3	
22.0-22.9			7	5	
23.0-23.9			2	3	
24.0-24.9				7	
25.0-25.9				3	
26.0-26.9				3	4
27.0-27.9					4
28.0-28.9					3
29.0-29.9					1
30.0-30.9					1
31.0-31.9					1
32.0-32.9					
33.0-33.9					
34.0-34.9					
35.0-35.9					
36.0-36.9					

Key 3 - 1970
Canada, U.S.
Div. 4X & 5Y

Length class (cm)	Age 2	3	4	5	6+
4.0-4.9					
5.0-5.9					
6.0-6.9					
7.0-7.9	4				
8.0-8.9	64				
9.0-9.9	320				
10.0-10.9	423				
11.0-11.9	334				
12.0-12.9	258				
13.0-13.9	181				
14.0-14.9	198	1			
15.0-15.9	38	8			
16.0-16.9	23	32			
17.0-17.9	13	77			
18.0-18.9	7	81	1		
19.0-19.9	2	62	4		
20.0-20.9		34	6		
21.0-21.9		6	5		
22.0-22.9		5	4		
23.0-23.9		2	5		
24.0-24.9		2	8		
25.0-25.9		1	8	2	
26.0-26.9			3	2	
27.0-27.9			1	6	
28.0-28.9				5	1
29.0-29.9				2	7
30.0-30.9				2	6
31.0-31.9					23
32.0-32.9					30
33.0-33.9					24
34.0-34.9					20
35.0-35.9					9
36.0-36.9					

Key 4 - 1971
Canada
Div. 4X

Length class (cm)	Age 1	2	3	4
4.0-4.9				
5.0-5.9				
6.0-6.9				
7.0-7.9				
8.0-8.9	3	1		
9.0-9.9	2	11		
10.0-10.9		19		
11.0-11.9		48		
12.0-12.9		62		
13.0-13.9		68		
14.0-14.9		36	2	
15.0-15.9		16	4	
16.0-16.9		3	3	
17.0-17.9		1	5	
18.0-18.9			2	
19.0-19.9			1	
20.0-20.9				1
21.0-21.9				
22.0-22.9				
23.0-23.9				
24.0-24.9				
25.0-25.9				
26.0-26.9				
27.0-27.9				
28.0-28.9				
29.0-29.9				
30.0-30.9				
31.0-31.9				
32.0-32.9				
33.0-33.9				
34.0-34.9				
35.0-35.9				
36.0-36.9				

Key 5 - 1969,1971,1972
U.S., U.S.S.R.
Div. 6

Length class (cm)	Age 2	3	4	5	6+
4.0-4.9					
5.0-5.9					
6.0-6.9					
7.0-7.9					
8.0-8.9					
9.0-9.9					
10.0-10.9	1				
11.0-11.9					
12.0-12.9					
13.0-13.9	2				
14.0-14.9	7				
15.0-15.9	10				
16.0-16.9	8				
17.0-17.9	3	1			
18.0-18.9	3				
19.0-19.9	2	3			
20.0-20.9		16			
21.0-21.9		26			
22.0-22.9		32			
23.0-23.9		21			
24.0-24.9		7	3		
25.0-25.9		1	11		
26.0-26.9			14	19	
27.0-27.9			24	53	
28.0-28.9			9	109	9
29.0-29.9				113	33
30.0-30.9				105	92
31.0-31.9				10	149
32.0-32.9					135
33.0-33.9					123
34.0-34.9					76
35.0-35.9					33
36.0-36.9					2

Key 6 - 1968, 1970
U.S., U.S.S.R.
Div. 5Z & 5Ze

Length class (cm)	Age 2	3	4	5	6+
4.0-4.9					
5.0-5.9					
6.0-6.9					
7.0-7.9					
8.0-8.9					
9.0-9.9					
10.0-10.9					
11.0-11.9					
12.0-12.9	2				
13.0-13.9	4				
14.0-14.9	15				
15.0-15.9	15				
16.0-16.9	9	1			
17.0-17.9	1	2			
18.0-18.9					
19.0-19.9		1			
20.0-20.9		6			
21.0-21.9					
22.0-22.9					
23.0-23.9					
24.0-24.9					
25.0-25.9					
26.0-26.9					
27.0-27.9			3	1	
28.0-28.9				1	1
29.0-29.9				7	5
30.0-30.9				14	25
31.0-31.9				11	42
32.0-32.9					36
33.0-33.9					17
34.0-34.9					16
35.0-35.9					5
36.0-36.9					

Key 7 - 1968, 1970, 1971
U.S., U.S.S.R.
Div. 5Z & 5Ze

Length class (cm)	Age 2	3	4	5	6+
4.0-4.9					
5.0-5.9					
6.0-6.9					
7.0-7.9					
8.0-8.9					
9.0-9.9					
10.0-10.9					
11.0-11.9					
12.0-12.9	2				
13.0-13.9	4				
14.0-14.9	16				
15.0-15.9	17				
16.0-16.9	10	1			
17.0-17.9	3	2			
18.0-18.9		1			
19.0-19.9		6			
20.0-20.9		22			
21.0-21.9		35			
22.0-22.9		29			
23.0-23.9		35	3		
24.0-24.9		24	32		
25.0-25.9			22		
26.0-26.9			17	10	
27.0-27.9			4	22	
28.0-28.9				16	2
29.0-29.9				14	13
30.0-30.9				11	33
31.0-31.9					45
32.0-32.9					36
33.0-33.9					17
34.0-34.9					16
35.0-35.9					5
36.0-36.9					

Key 8 - 1973
U.S. - ALB. IV
Germany, F.R.-W. Herwig
Blocks I-5

Length class (cm)	Age 2	3	4	5	6+
4.0-4.9					
5.0-5.9					
6.0-6.9					
7.0-7.9					
8.0-8.9					
9.0-9.9					
10.0-10.9					
11.0-11.9					
12.0-12.9					
13.0-13.9					
14.0-14.9	2				
15.0-15.9	1				
16.0-16.9	2	2			
17.0-17.9	2	6			
18.0-18.9	2	23			
19.0-19.9	1	53			
20.0-20.9		100			
21.0-21.9		136			
22.0-22.9		182			
23.0-23.9		227			
24.0-24.9		189			
25.0-25.9		66	3		
26.0-26.9		14	5		
27.0-27.9			11	5	
28.0-28.9			21	6	
29.0-29.9			12	22	3
30.0-30.9			1	10	8
31.0-31.9					18
32.0-32.9					7
33.0-33.9					
34.0-34.9					1
35.0-35.9					
36.0-36.9					

Key 9 - 1974
U.S. - ALB. IV
Germany, F.R. - W. Herwig
Blocks I-5

Length class (cm)	Age 2	3	4	5	6+
4.0-4.9					
5.0-5.9					
6.0-6.9					
7.0-7.9					
8.0-8.9					
9.0-9.9					
10.0-10.9	6				
11.0-11.9	8				
12.0-12.9	8				
13.0-13.9	9				
14.0-14.9	9				
15.0-15.9	2				
16.0-16.9	3				
17.0-17.9	1				
18.0-18.9	1	1			
19.0-19.9	2	5			
20.0-20.9	5				
21.0-21.9	3				
22.0-22.9	9				
23.0-23.9	10	3			
24.0-24.9	8	17			
25.0-25.9	5	64			
26.0-26.9		219			
27.0-27.9		231	3		
28.0-28.9		148	4		
29.0-29.9		43	7	3	
30.0-30.9		1	3	3	
31.0-31.9			2	10	
32.0-32.9				2	
33.0-33.9				3	
34.0-34.9				4	
35.0-35.9					
36.0-36.9				1	

Key 10 - 1975
U.S. - ALB. IV
Germany, F.R.. W. Herwig
Poland - Wieczno
Blocks I-5

Length class (cm)	Age 2	3	4	5	6+
4.0-4.9					
5.0-5.9					
6.0-6.9					
7.0-7.9					
8.0-8.9					
9.0-9.9					
10.0-10.9					
11.0-11.9	6				
12.0-12.9	7				
13.0-13.9	7				
14.0-14.9	1				
15.0-15.9	3				
16.0-16.9	1				
17.0-17.9					
18.0-18.9					
19.0-19.9					
20.0-20.9		1			
21.0-21.9		4			
22.0-22.9		10			
23.0-23.9		18			
24.0-24.9		11	2		
25.0-25.9		3	5		
26.0-26.9		1	14	1	
27.0-27.9			26	34	
28.0-28.9			6	39	
29.0-29.9				44	
30.0-30.9				15	1
31.0-31.9				2	
32.0-32.9					1
33.0-33.9					
34.0-34.9					
35.0-35.9					
36.0-36.9					

Table 1. Age length keys applied to length frequencies given in figures 12 - 21 (Keys 1-7 from ICNAF sampling yearbook -1st quarter, keys 8-10 from spring survey cruises)

Table 2. Stratified numbers per tow of herring at age, and % age composition for 1968-1975 spring research cruise.[1]

VESSEL	YEAR	2		3		4		5		6+		TOTAL		
		No/tow	%	No/tow	%	No/tow	%	No/tow	%	No/tow	%	No/tow	%	NO. TOWS
BLOCK 1														
Albatross III	1968	2.06	74.26	.72	25.74	0	0	0	0	0	0	2.78	100.00	21
"	1969	0	0	.61	81.48	.14	18.52	0	0	0	0	1.74	100.00	22
"	1970	3.71	88.82	.30	7.24	.06	1.32	.03	.66	.08	1.97	4.18	100.00	28
"	1971	1.21	12.87	.36	3.80	1.05	11.11	1.46	15.50	5.34	56.73	9.41	100.00	38
"	1972	8.11	100.00	0	0	0	0	0	0	0	0	8.11	100.00	35
"	1973	.52	5.80	6.19	69.01	.59	6.58	.35	3.90	1.32	14.72	8.97	100.00	33
Walther Herwig	1973	1.74	13.38	10.52	80.92	.74	5.69	0	0	0	0	13.00	100.00	2
Albatross III	1974	2.76	69.52	.23	5.79	.89	22.42	.01	.25	.08	2.02	3.97	100.00	29
Walther Herwig	1974	3.59	1.23	150.90	51.78	135.38	46.45	.48	.16	1.08	.37	291.43	100.00	7
Albatross III	1975	.53	53.00	.04	4.00	.03	3.00	.24	24.00	.16	16.00	1.00	100.00	12
Walther Herwig	1975	69.38	63.27	18.69	17.03	13.10	11.95	8.36	7.62	.14	.13	109.65	100.00	6
BLOCK 2														
Albatross III	1968	3.93	76.88	1.07	20.97	.06	1.08	0	0	.06	1.03	5.12	100.00	67
"	1969	.03	4.00	.58	84.00	.03	4.00	0	0	.06	8.00	.69	100.00	66
"	1970	1.29	64.38	.50	24.66	.06	2.74	.08	4.11	.08	4.11	2.00	100.00	73
"	1971	.91	82.50	.17	15.00	0	0	0	0	.03	2.50	1.10	100.00	77
"	1972	2.23	91.01	0	0	.06	2.25	.03	1.12	.14	5.62	2.45	100.00	76
"	1973	.17	2.83	.94	15.64	.78	12.98	.75	12.48	3.37	56.07	6.01	100.00	68
Walther Herwig	1973	263.31	94.90	14.05	5.06	.11	.04	0	0	0	0	277.47	100.00	14
Albatross III	1974	.28	32.94	0	0	.57	61.18	.03	5.88	0	0	.85	100.00	71
Albatross III	1975	.12	4.53	.45	16.98	.26	9.81	1.71	64.53	.11	4.15	2.63	100.00	65
Walther Herwig	1975	3.17	43.19	1.31	17.84	1.00	13.62	1.65	22.48	.21	2.86	7.34	100.00	6
BLOCK 3														
Albatross III	1968	.50	66.67	.08	11.11	0	0	.08	11.11	.08	11.11	.74	100.00	59
"	1969	0	0	0	0	0	0	0	0	.06	100.00	.06	100.00	64
"	1970	3.54	66.15	1.21	22.56	.06	1.03	.08	1.54	.47	8.72	5.36	100.00	59
"	1971	.11	9.52	.83	69.05	.19	16.67	.06	4.76	0	0	1.19	100.00	62
"	1972	11.41	91.01	.83	6.58	.22	1.75	.08	.66	0	0	12.54	100.00	65
"	1973	.02	.24	7.94	93.41	.40	4.71	.06	.71	.08	.94	8.50	100.00	61
Walther Herwig	1973	7.84	.24	3232.43	99.57	4.26	.13	1.66	.05	.27	.01	3246.46	100.00	25
Albatross III	1974	0	0	.02	.23	7.47	86.76	.46	5.34	.66	7.67	8.61	100.00	57
Walther Herwig	1974	.01	+	924.05	8.51	9716.07	91.29	20.61	.19	1.62	.01	10,562.36	100.00	39
Albatross III	1975	.13	4.26	.08	2.62	2.75	90.16	.09	2.95	0	0	3.05	100.00	53
Ernst Haeckel	1975	1.00	.16	15.11	2.46	26.90	4.38	553.71	90.09	17.88	2.91	614.60	100.00	10
Walther Herwig	1975	.91	.10	27.26	2.84	30.32	3.16	823.11	86.89	76.70	8.00	958.30	100.00	50

Table 2. continued

AGE

Vessel	YEAR	2 No/Tow	2 %	3 No/Tow	3 %	4 No/Tow	4 %	5 No/Tow	5 %	6+ No/Tow	6+ %	Total No/Tow	Total %	NO. TOWS
BLOCK 4														
Albatross IV	1968	36.85	15.16	77.55	31.90	27.69	11.39	43.09	17.73	57.89	23.81	243.07	100.00	57
"	1969	5.34	5.11	8.36	8.00	4.48	4.29	20.87	19.97	65.45	62.63	104.50	100.00	62
"	1970	43.34	54.67	12.43	15.68	10.09	12.73	8.36	10.54	5.06	6.38	79.28	100.00	74
"	1971	1.79	17.15	4.98	47.76	1.18	11.35	.72	6.86	1.76	16.89	10.43	100.00	68
"	1972	3.77	29.09	5.42	41.83	2.31	17.83	1.02	7.86	.44	3.40	12.96	100.00	70
"	1973	.18	1.09	14.54	87.80	.63	3.80	.24	1.45	.97	5.86	16.56	100.00	94
Walther Herwig	1973	1.64	.15	1,056.22	99.22	4.07	.38	1.91	.18	.72	.07	1,064.56	100.00	16
Albatross IV	1974	.02	.17	.13	1.10	11.46	97.04	.13	1.10	.07	.59	11.81	100.00	58
Walther Herwig	1974	8.21	.48	607.64	35.23	1,08.76	64.28	.25	.01	0	0	1,724.88	100.00	14
Kronameter	1974	1.71	.11	293.83	18.28	1,284.94	79.94	3.44	.21	23.56	1.47	1,607.48	100.00	38
Albatross IV	1975	.02	6.67	.02	6.67	.02	6.67	.18	60.00	.06	20.00	.30	100.00	63
E. Heckel	1975	.03	.08	2.78	7.25	5.04	13.15	29.95	78.14	.53	1.38	38.33	100.00	23
Wieczno	1975	.09	.11	1.09	1.35	7.01	8.69	71.75	88.94	.73	.90	80.67	100.00	59
Walther Herwig	1975	.03	T	2.32	1.55	5.70	3.80	133.50	89.02	8.44	5.63	149.96	100.00	25
Block 5														
Albatross IV	1968	.55	1.15	8.44	17.61	5.39	11.24	13.78	28.74	19.36	40.39	47.52	100.00	58
"	1969	.41	2.28	3.60	19.91	2.59	14.29	3.52	19.45	7.98	44.07	18.10	100.00	52
"	1970	.06	1.68	.19	5.88	.28	8.40	1.07	32.77	1.68	51.26	3.28	100.00	55
"	1971	.06	.54	2.75	27.03	1.54	15.14	1.90	18.65	3.93	38.65	10.18	100.00	53
"	1972	0	0	.50	7.29	3.14	46.15	1.65	24.29	1.51	22.27	6.80	100.00	54
"	1973	0	0	11.09	76.85	1.24	8.59	.38	2.63	1.72	11.92	14.43	100.00	55
Walther Herwig	1973	0	0	7.16	73.21	1.30	13.29	.90	9.20	.42	4.29	9.78	100.00	13
Albatross IV	1974	.07	3.06	.02	.87	1.99	86.90	.07	3.06	.14	6.11	2.29	100.00	38
Kronameter	1974	0	0	1.41	1.50	77.02	81.93	6.29	6.69	9.29	9.80	94.01	100.00	34
Albatross IV	1975	0	0	0	0	0	0	.06	100.00	0	0	.06	100.00	34

[1]The *Albatross IV* catch per haul indices for herring in 1968-1972 were increased by a factor of 2.75 to account for the estimated fishing power differential for this species between the #36 trawl (used in 1968-1972) and the #41 trawl (used in 1973 and subsequent spring surveys). This factor is based on unpublished US data on trawl comparison experiments.

Table 3. Stratified mean numbers/haul of 2-4-year-old herring in 1968-1975 spring surveys.

Year-class	Blocks 1 and 2 Albatross III Age-groups 2	3	4	Walther Herwig Age-groups 2	3	4	Blocks 3 and 4 Albatross III Age-groups 2	3	4	Ernst Haeckel Age-groups 2	3	4
1964			.06						27.69			
1965		.99	.06					38.14	4.48			
1966	3.48	.59	.06				18.36	8.36	5.61			
1967	.03	.44	1.05				5.34	7.45	.71			
1968	1.96	.23	.06				25.68	3.00	1.30			
1969	1.00	0	.72			4.19	.99	3.21	.54			
1970	4.08	2.65	.63		2383.18	7589.61	7.45	11.94	5.89			
1971	.28	.23	.22	5.42	840.48	21.11	.12	.08	.05			11.66
1972	1.00	.39		2.18	18.94		.02	.05			6.52	
1973	.18			0.62			.07			.32		

BLOCK 4

Year-class	Wieczno Age-groups 2	3	4	Khronometer Age-groups 2	3	4
1968						
1969						
1970						1284.94
1971			7.01		293.83	
1972		1.09		1.71		
1973	.09					

Table 4. Ratios of abundance indices of year-classes to the 1970 year-class, in terms of catch per haul at ages 2-4, for surveys by *W. Herwig* and *Albatross IV*.

Year-class	Blocks 1 and 2 Albatross IV Age-groups 2	3	4	Blocks 3 and 4 Walther Herwig Age-groups 2	3	4	Albatross IV Age-groups 2	3	4
1964			.096						4.701
1965		.374	.096					3.194	.761
1966	.853	.223	.095				2.464	.700	.953
1967	.007	.166	1.667				.717	.624	.121
1968	.480	.087	.095				3.447	.251	.221
1969	.245	0	1.143			.001	.133	.269	.092
1970	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
1971	.069	.087	.349	1.00	.353	.002	.016	.007	.009
1972	.245	.147		.402	.008		.003	.004	
1973	.044			.114			.009		

[1] Comparsion relative to 71 year-class, since there was no 1972 survey by W. Herwig.

B1

Table 5.
Estimates of recruitment from Blocks 1 and 2 combined using ALBATROSS IV survey catches.

Year class	AGE 2				AGE 3			
	Survey ratios from Table 4	Calculated abundance from cohort analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference	Survey ratios from Table 4	Calculated abundance from cohort analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference
1965					.37	1438	2561	+78
1966	.85	1863			.22	1523	1523[2]	
1967	.01	1172	22	-98	.17	959	1177	+23
1968	.48	835	1052	+26	.09	672	623	-7
1969	.25	771	548	-29	0	619	0	-100
1970	1.00	3942[1]	2192	-44	1.00	3202[1]	6923	+116
1971	.07	682[1]	153	-78	.09	550[1]	623	+13
1972	.25	682[1]	548	-20	.15		1038	
1973	.04		88					

1 Assumed year class sizes.

Table 6. Estimates of recruitment from Blocks 1 and 2 using Albatross IV survey catches. Survey ratios combined over ages 2 and 3.

	AGE 2				AGE 3		
Year Class	Average survey ratios over ages 2 and 3 from Table 4	Calculated abundance from cohort analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference	Calculated abundance from cohorts analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference
1965	.37[1]	1758	1277	-27	1438	1044	-27
1966	.54	1863	-	-	1523	-	-
1967	.09	1172	311	-73	959	254	-74
1968	.29	835	1000	+20	672	818	+22
1969	.13	771	449	-42	619	367	-41
1970	1.00	3942[2]	3450	-12	3202[2]	2820	-12
1971	.08	682[2]	276	-60	550[2]	226	-59
1972	.20	682[2]	690	+1	550[2]	564	+3
1973	.04[1]	-	138	-	-	113	-

[1] Only 1 value was available for the 1965 and 1973 year classes.

[2] Assumed year class sizes.

Table 7. Estimates of recruitment from Blocks 3 and 4 using *Albatross IV* survey catches.

Year-Class	Age 2				Age 3			
	Survey ratios from Table 4	Calculated abundance from cohort analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference	Survey ratios from Table 4	Calculated abundance from cohort analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference
1965					3.19	1438	6941	+383
1966	2.46	1863			.70	1523	1523	-
1967	.72	1172	515	-56	.62	959	1349	+41
1968	3.45	835	2466	+195	.25	672	544	-19
1969	.13	771	93	-88	.27	619	587	-5
1970	1.00	3942[1]	715	-82	1.00	3202[1]	2176	-32
1971	.02	682[1]	14	-98	.01	550[1]	22	-96
1972	0	682[1]	0	-100	0	550[1]	0	-100
1973	.01		7					

[1]Assumed year-class sizes.

Table 8. Estimates of recruitment from Blocks 3 and 4 using Albatross IV survey data. Survey ratios averaged over ages 2 and 3.

	AGE 2				AGE 3		
Year Class	Average survey ratios over ages 2 and 3 from Table 4	Calculated abundance from cohort analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference	Calculated abundance from cohort analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference
1965	3.19[1]	1758	3761	+114	1438	3075	+114
1966	1.58	1863	-	-	1523	-	-
1967	.67	1172	790	-33	959	646	-33
1968	1.85	835	2181	+161	672	1783	+165
1969	.20	771	236	-69	619	193	-69
1970	1.00	3942[1]	1179	-70	3202[1]	964	-70
1971	.015	682[1]	18	-97	550[1]	14	-97
1972	-	682[1]	-	-100	550[1]	-	-100
1973	.01[1]	-	12	-	-	10	-

[1] Assumed year class sizes.

Table 9. Estimates of recruitment from blocks 3 and 4 using Walther Herwig survey catches.

	AGE 2				AGE 3			
Year-Class	Survey ratios from Table 4	Calculated abundance from cohort analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference	Survey ratios from Table 4	Calculated abundance from cohort analysis (10^6)	Estimated abundance from surveys (10^6)	Percent difference
1970	-	-	-	-	1.0	3202[1]	-	-
1971	1.0	682[1]	-	-	.35	550[1]	1121	+104
1972	.40	682[1]	273	-60	.01	550[1]	32	-94
1973	.11	-	75	-	-	-	-	-

[1] Assumed year-class sizes.

Table 10. A summary of estimated year-class sizes at age 2 and 3 recruiting to the Georges Bank herring stock. Survey ratios were averaged over ages 2 and 3.

Estimate of age 2 abundance

Year Class	Calculated abundance from cohort analysis (10^6)	Blocks 1 & 2	Blocks 3 & 4			Block 4	
		Albatross	*Albatross*	*W. Herwig*	*E. Haeckel*	*Wieczno*	*Khronometer*
1965	1758	1277	3761				
1966	1863	-	-				
1967	1172	311	790				
1968	835	1000	2181				
1969	771	449	236				
1970	3942[1]	3450	1179				
1971	682[1]	276	18				
1972	682[1]	690	0	273			3
1973		138	12	75	27	45	

Estimate of age 3 abundance

Year-Class	Calculated abundance from cohort analysis (10^6)	Blocks 1 & 2	Blocks 3 & 4			Block 4	
		Albatross	*Albatross*	*W. Herwig*	*E. Haeckel*	*Wieczno*	*Khronometer*
1965	1438	1044	3075				
1966	1523	-	-				
1967	959	254	646				
1968	672	818	1783				
1969	619	367	193				
1970	3202[1]	2820	964				
1971	550[1]	226	14	1121	232	64	387
1972	550[1]	564	0	32			
1973		113	10				

[1]Assumed year-class sizes.

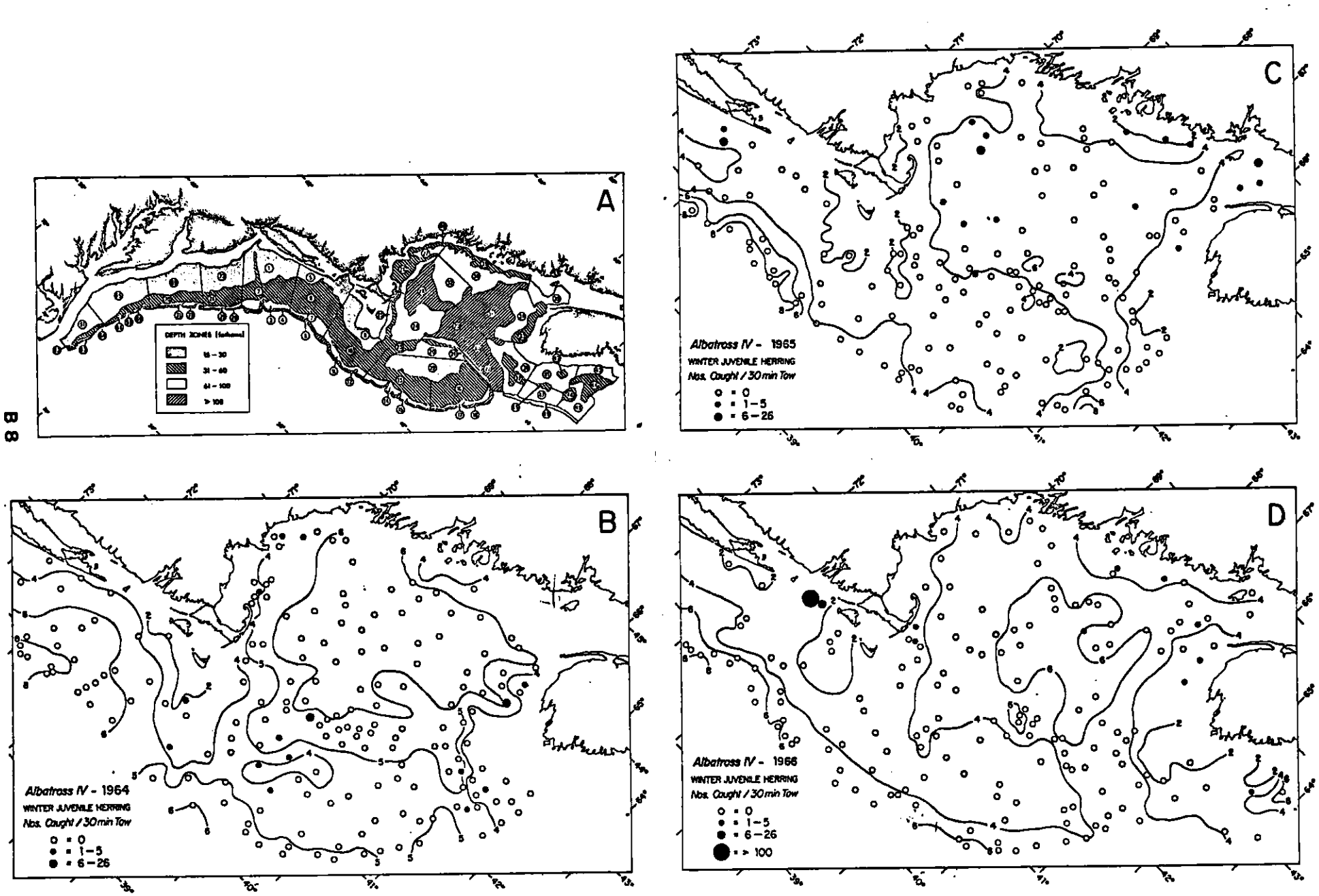


Figure 1. US groundfish survey sampling area and strata (A); catches of juvenile sea herring and bottom temperatures, winter 1964-1966 (B, C, and D). Prior to 1967 survey went only as far south as strata 1-4; beginning in autumn 1967, survey extended south to Hatteras but spring surveys did not begin until 1968.

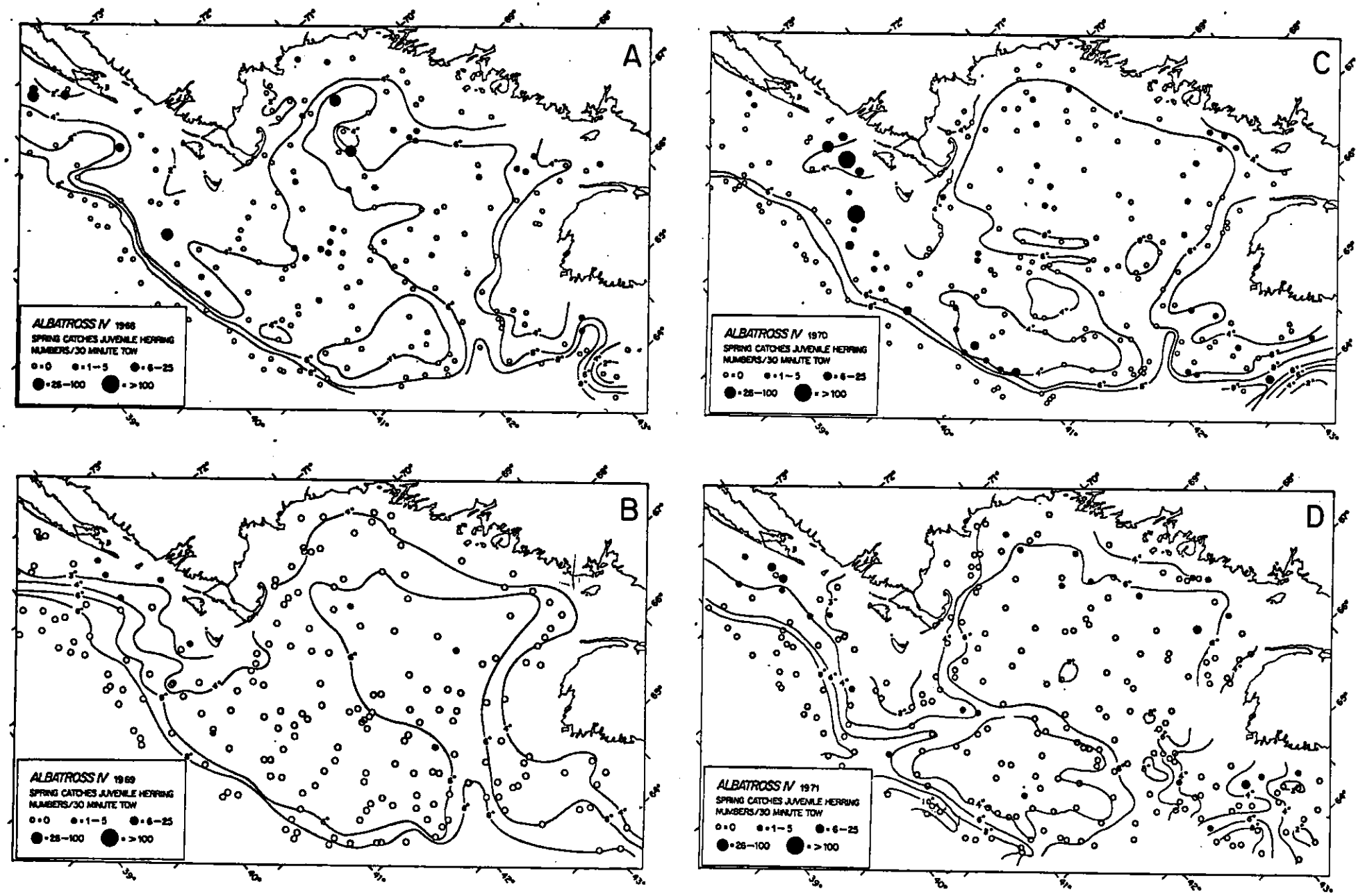


Figure 2. Catches of juvenile sea herring and bottom temperatures, US spring trawl surveys, 1968-1971.

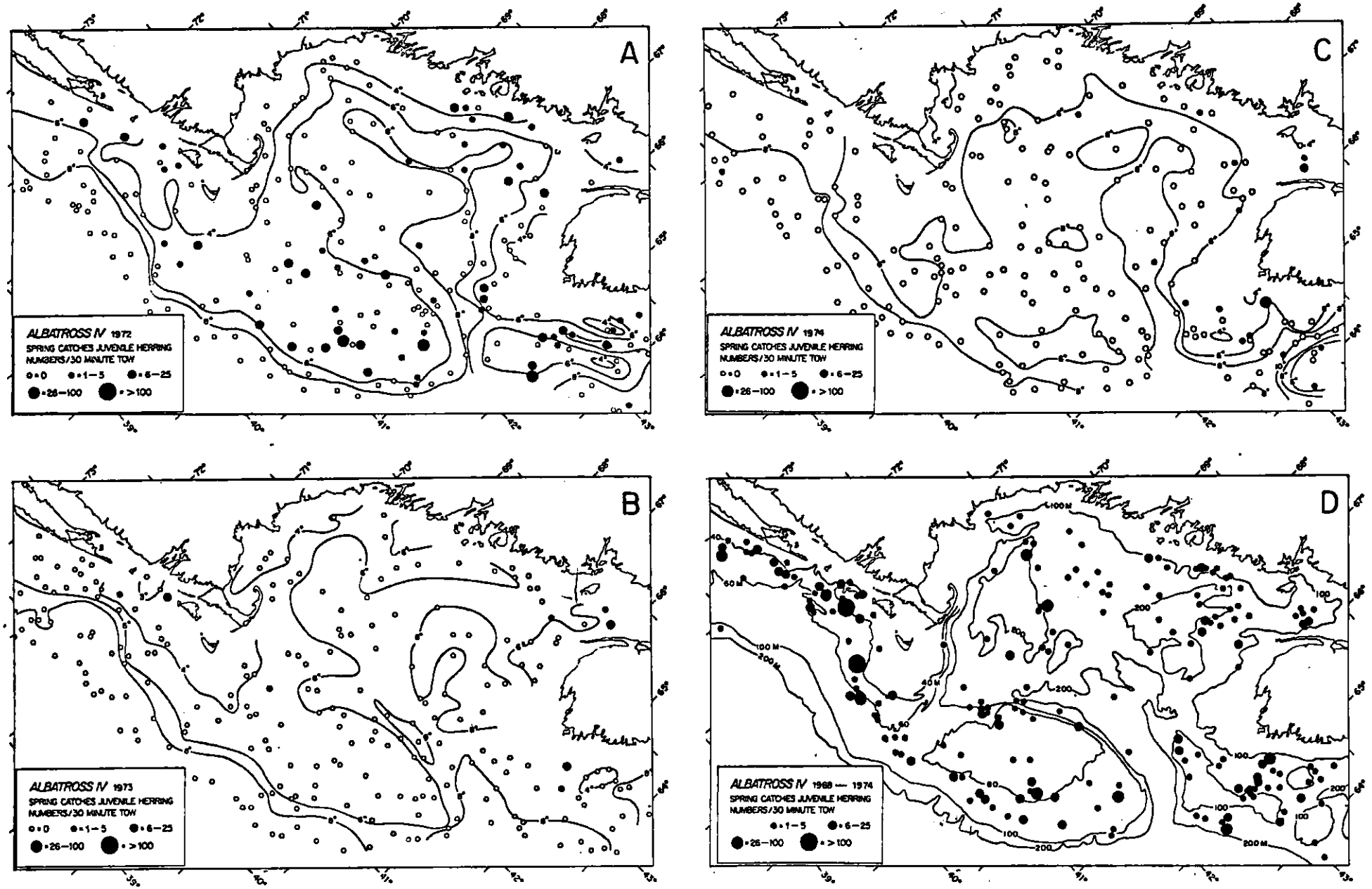


Figure 3. Catches of juvenile sea herring and bottom temperatures, spring 1972-1974 (A, B, and C) and composite of spring catches, 1968-1974 (D).

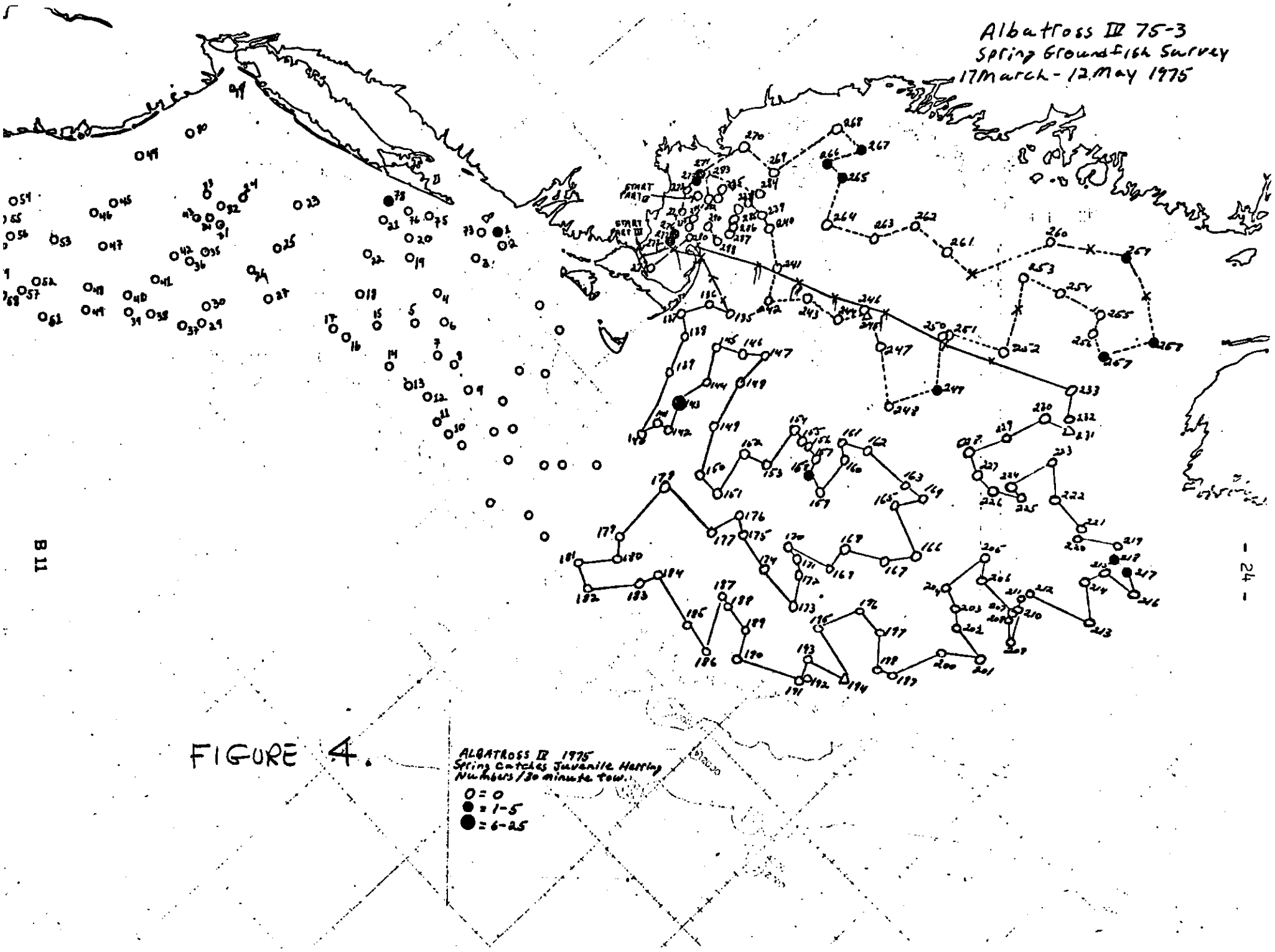

Albatross III 75-3
Spring Groundfish Survey
17 March - 12 May 1975
ALBATROSS III 1975
Spring Catches Juvenile Herring
Numbers / 30 minute tow.
0 = 0
● = 1-5
● = 6-25

FIGURE 4.

Figure 5.

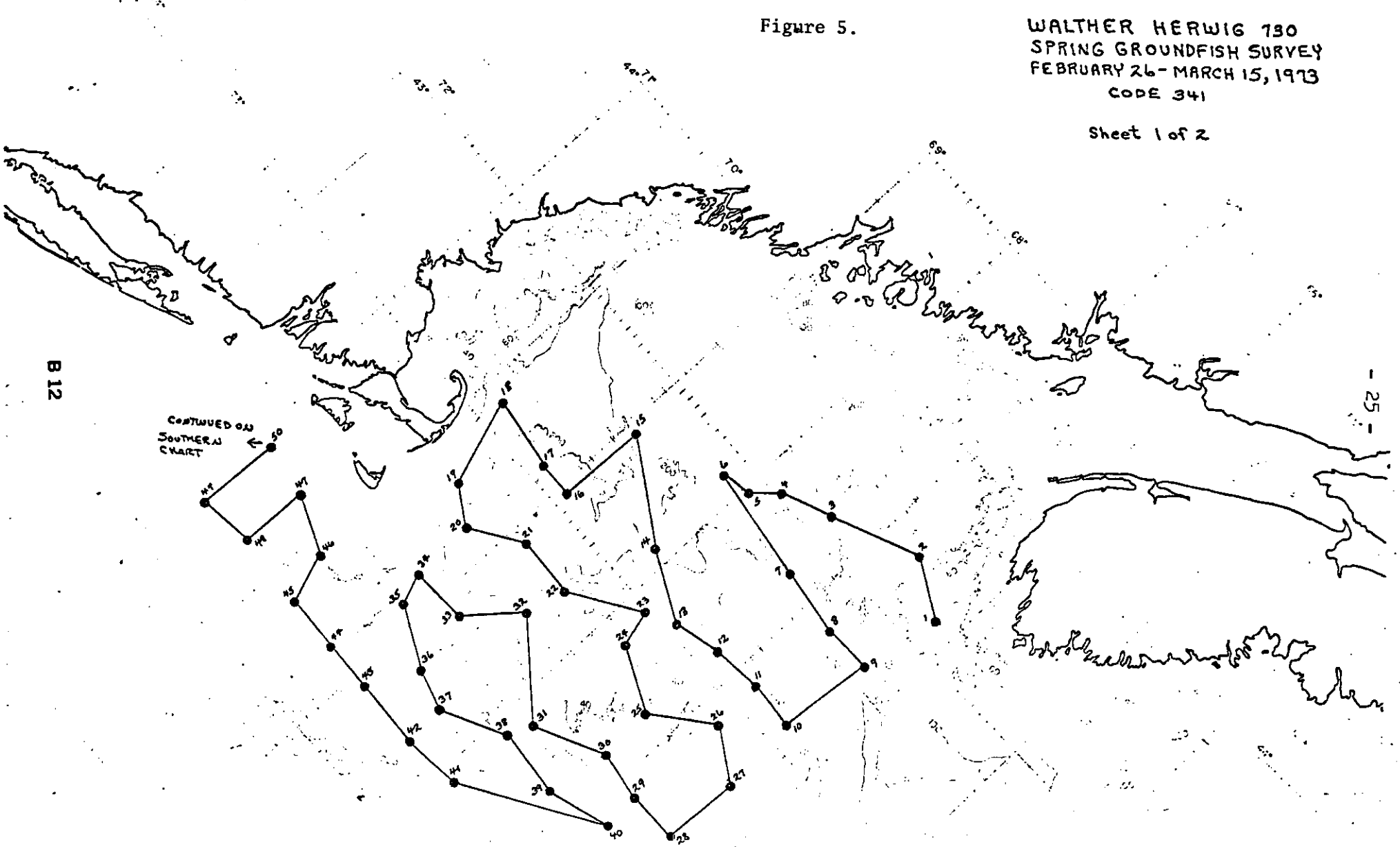
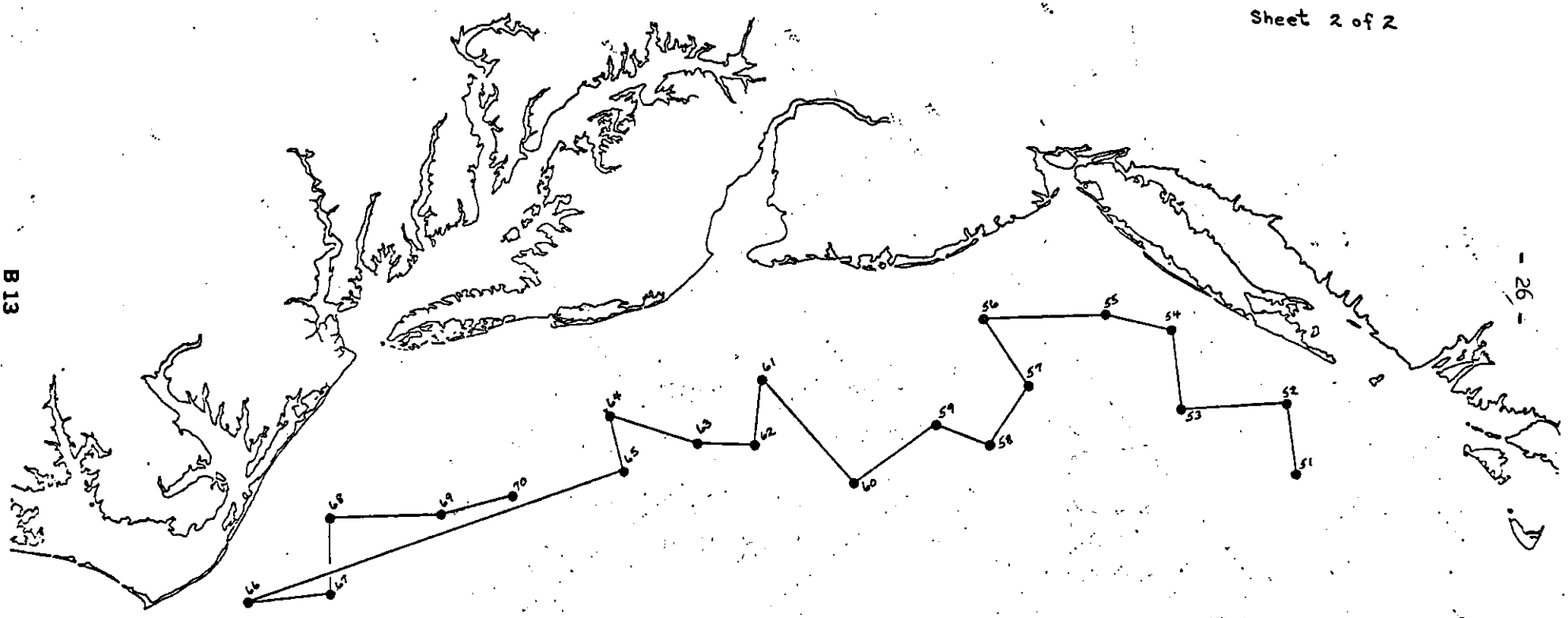

WALTHER HERWIG 730
SPRING GROUNDFISH SURVEY
FEBRUARY 26 - MARCH 15, 1973
CODE 341
Sheet 1 of 2
B12
CONTINUED ON SOUTHERN CHART
70°
69°
68°
67°
66°
65°
64°
63°
62°
61°
60°
59°
58°
57°
56°
55°
54°
53°
52°
51°
50°
49°
48°
47°
46°
45°
44°
43°
42°

Figure 6.


WALTHER HERWIG 730
SPRING GROUNDFISH SURVEY
FEBRUARY 26 - MARCH 15, 1973
CODE 341
Sheet 2 of 2
B13
- 26 -
51
52
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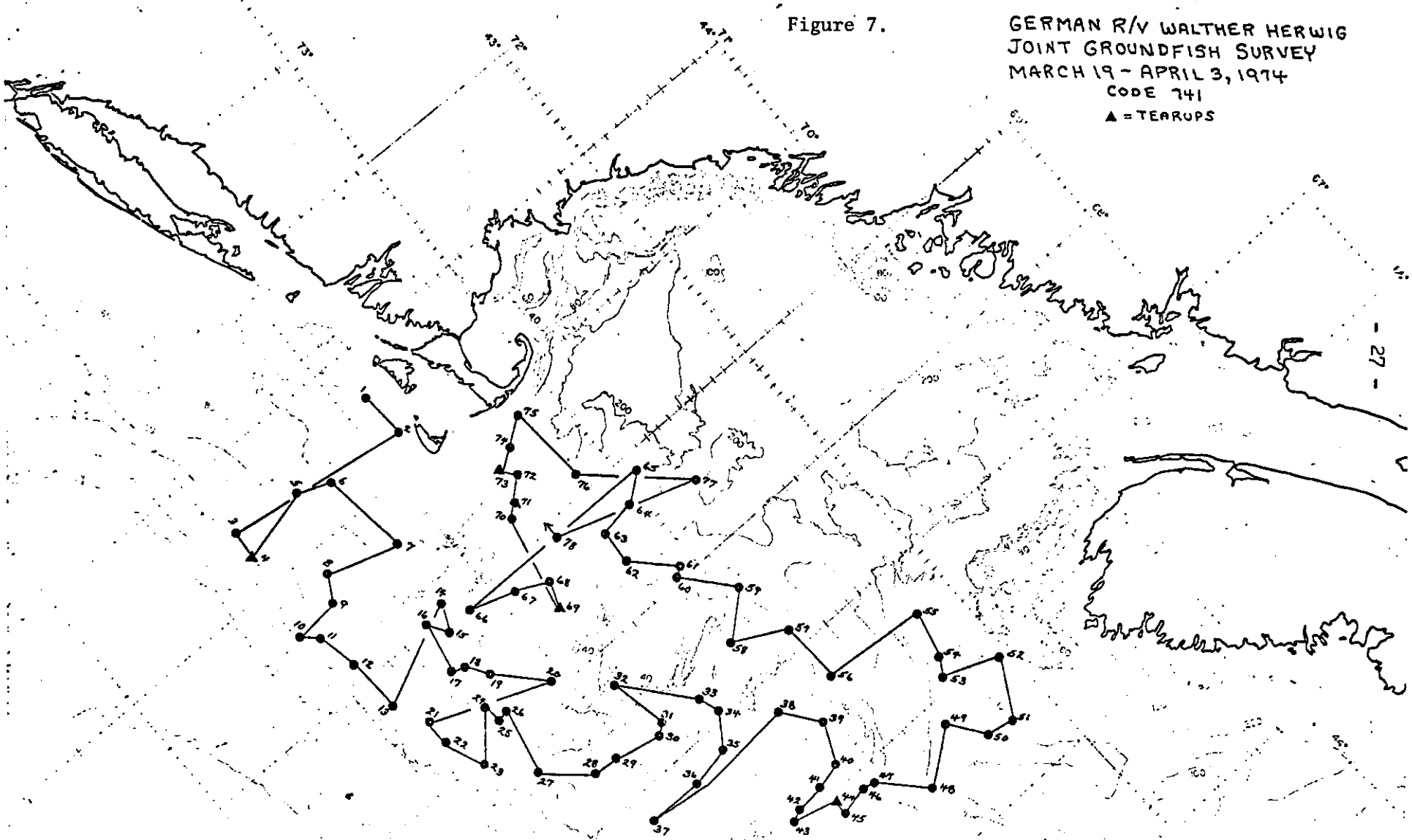

GERMAN R/V WALTHER HERWIG
JOINT GROUNDFISH SURVEY
MARCH 19 - APRIL 3, 1974
CODE 741
▲ = TEARUPS

Figure 7.

Figure 8. Walther Herwig 75

Juvenile Herring Survey

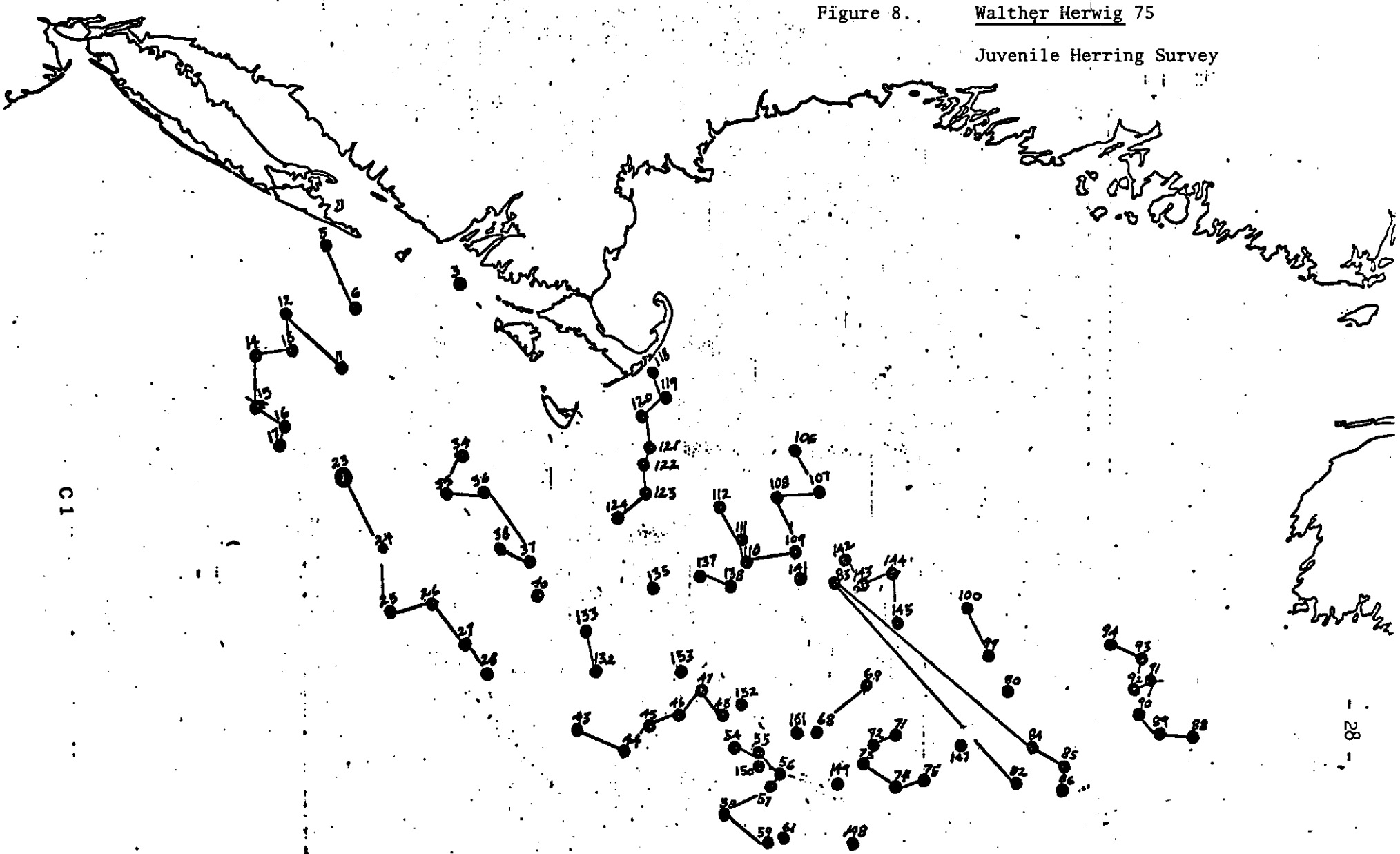
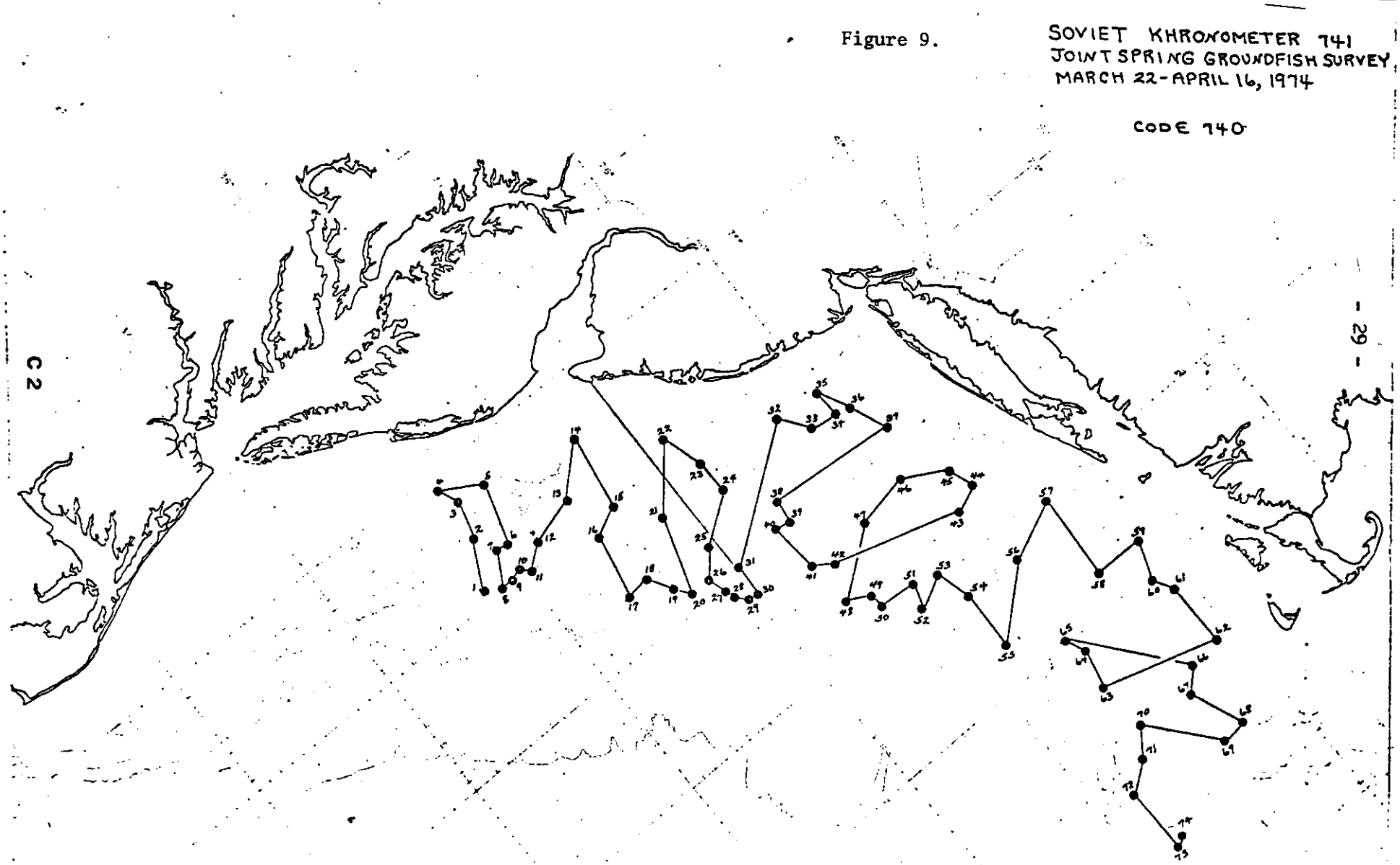


Figure 9.


SOVIET KHRONOMETER 741
JOINT SPRING GROUNDFISH SURVEY
MARCH 22-APRIL 16, 1974
CODE 740
C2

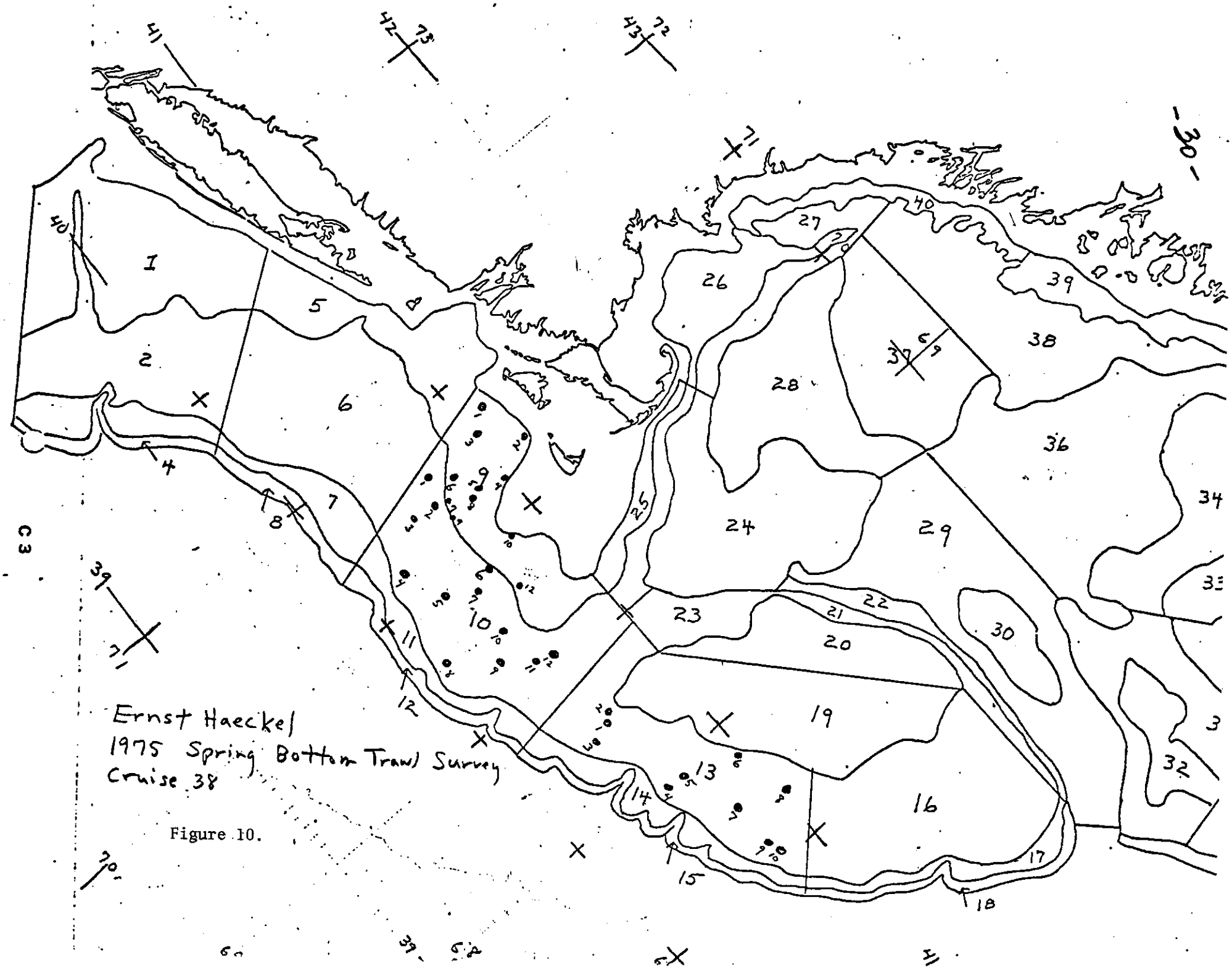
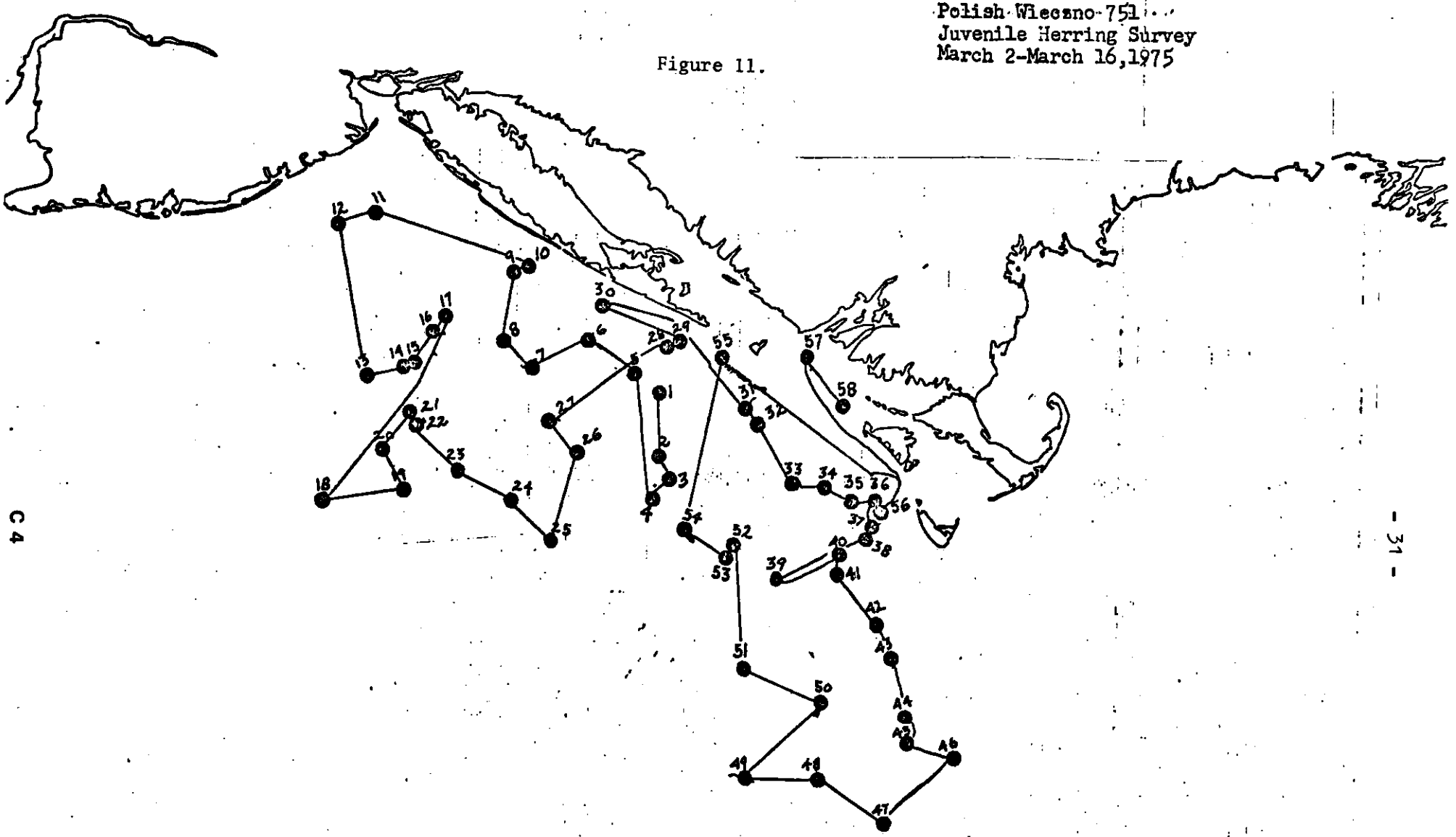
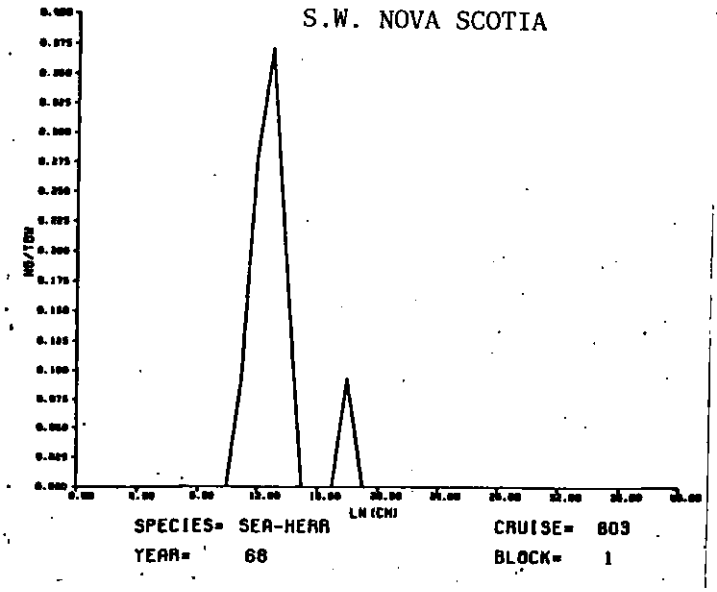


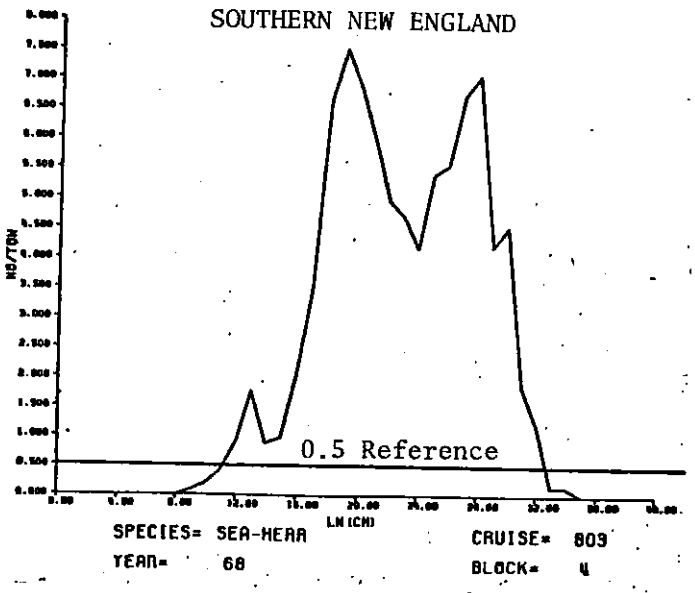
Figure 10.

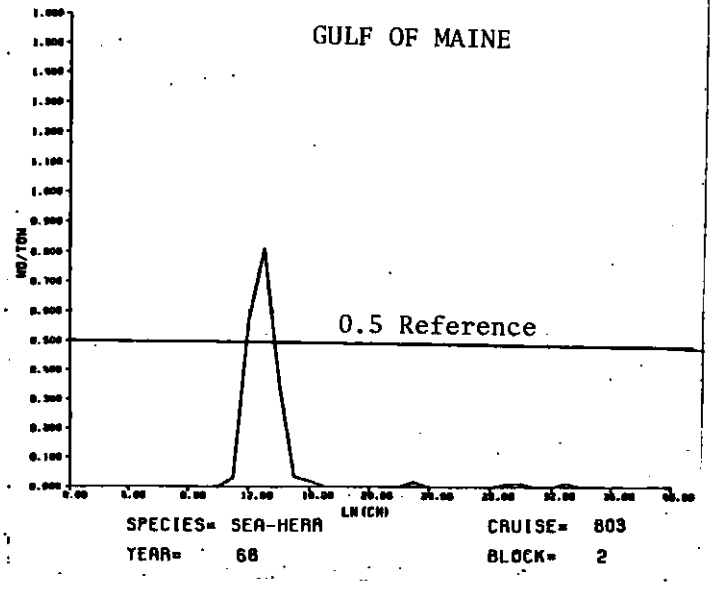
Figure 11.

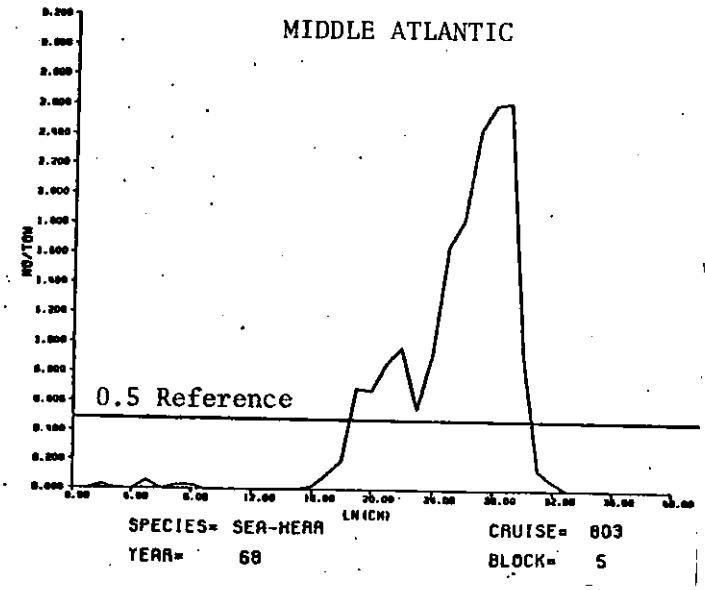
Polish Wieczno-751
Juvenile Herring Survey
March 2-March 16,1975

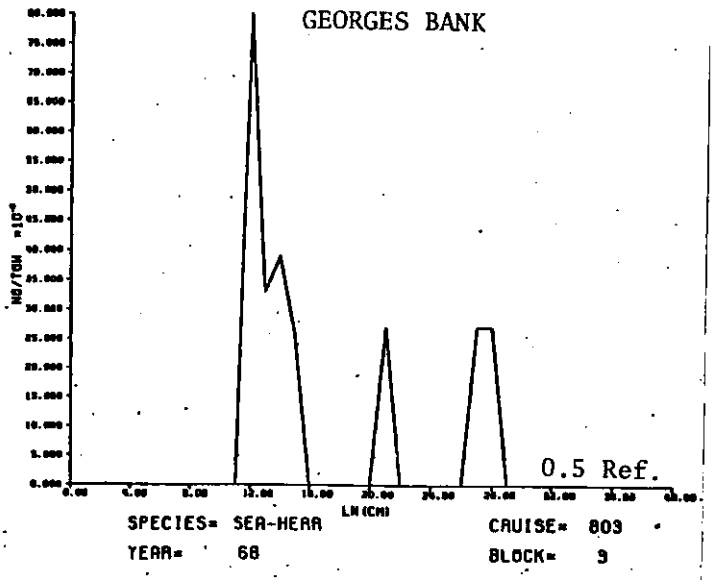












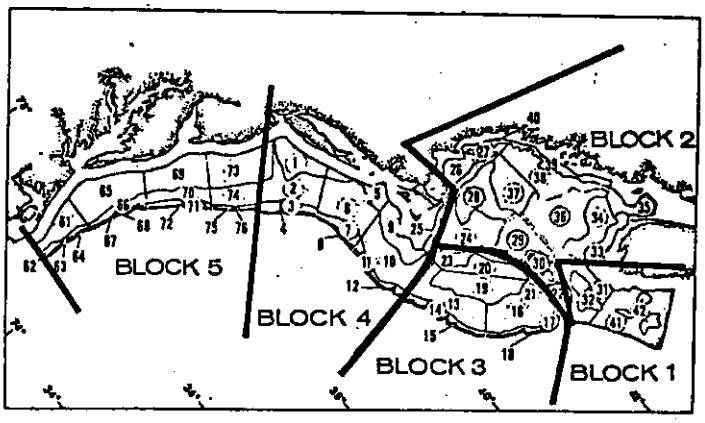
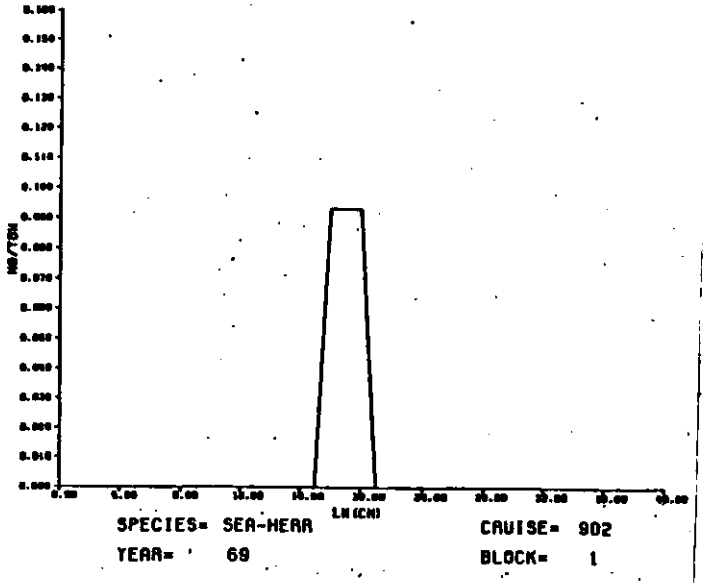
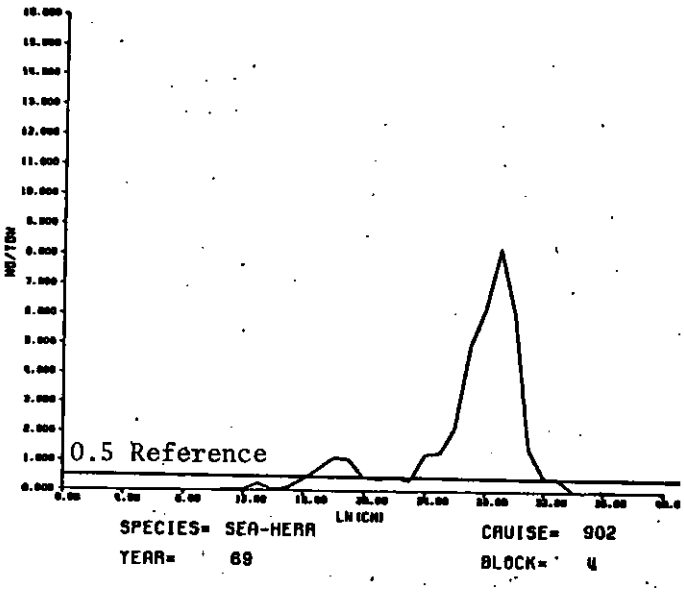
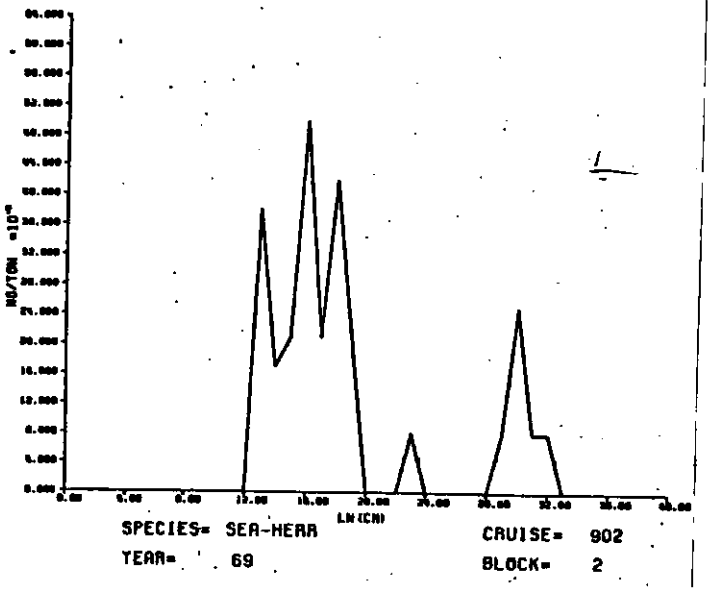
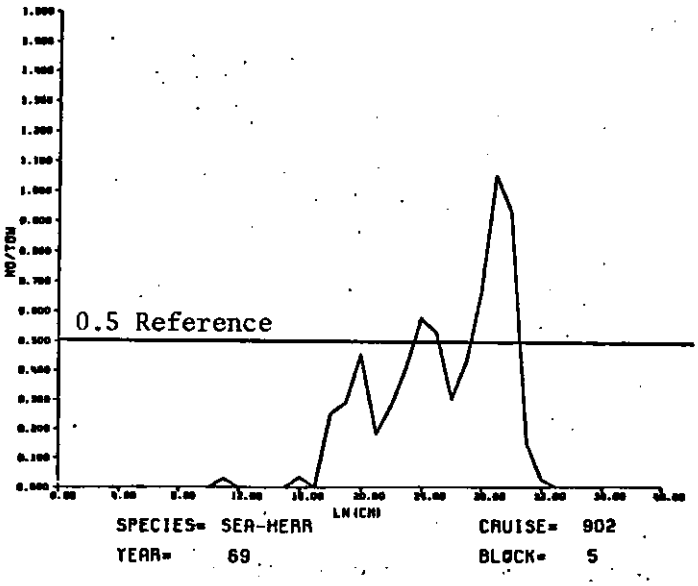


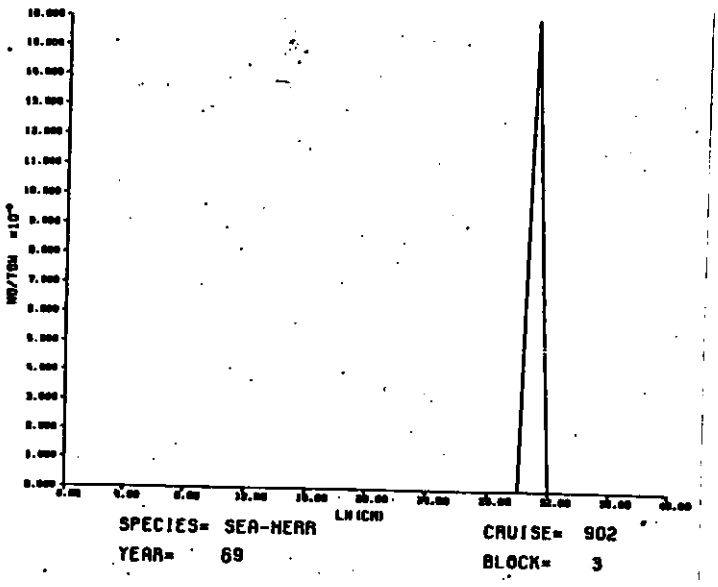
Figure 12. Stratified mean length frequencies (fork length) of sea herring caught on Albatross IV spring trawl survey in 1968. Data are subdivided into 5 blocks as shown above. Note that vertical scale varies from plot to plot - horizontal line at 0.5 fish/tow is shown for reference point.











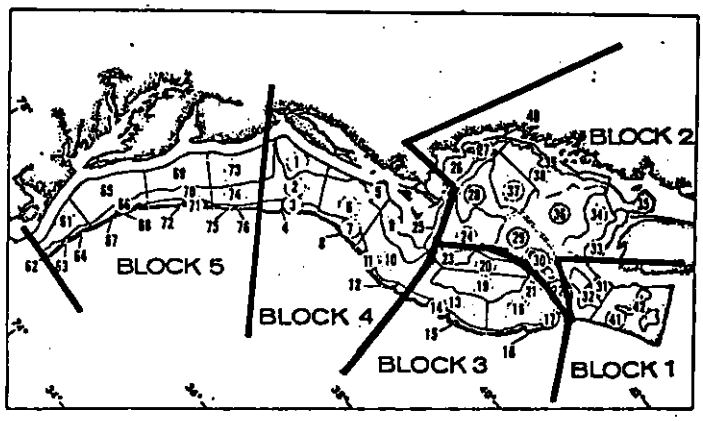
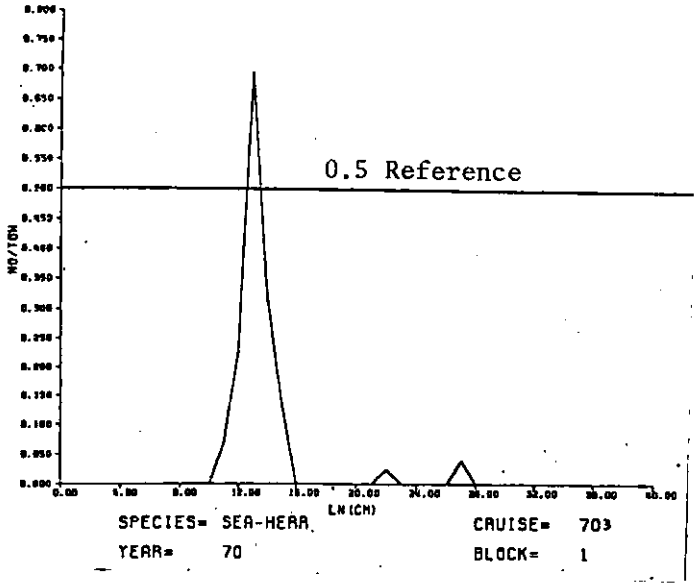
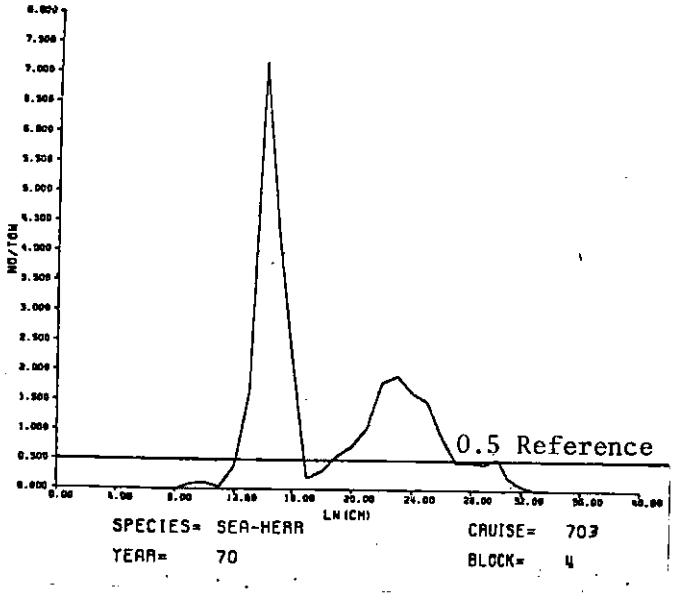
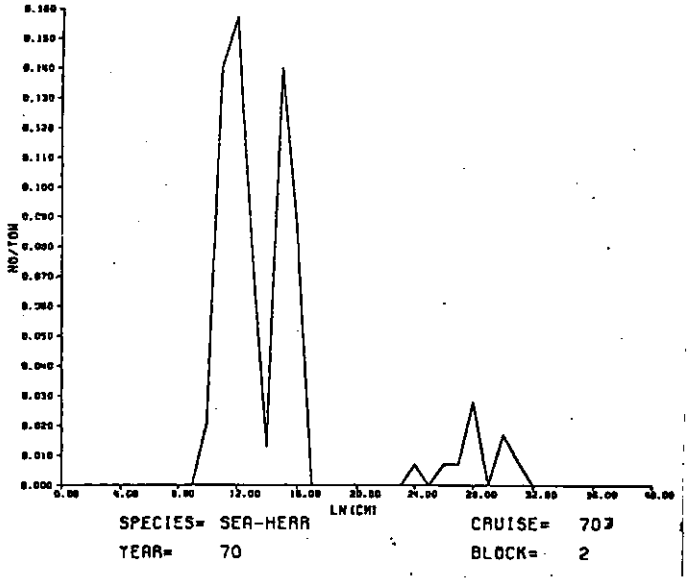
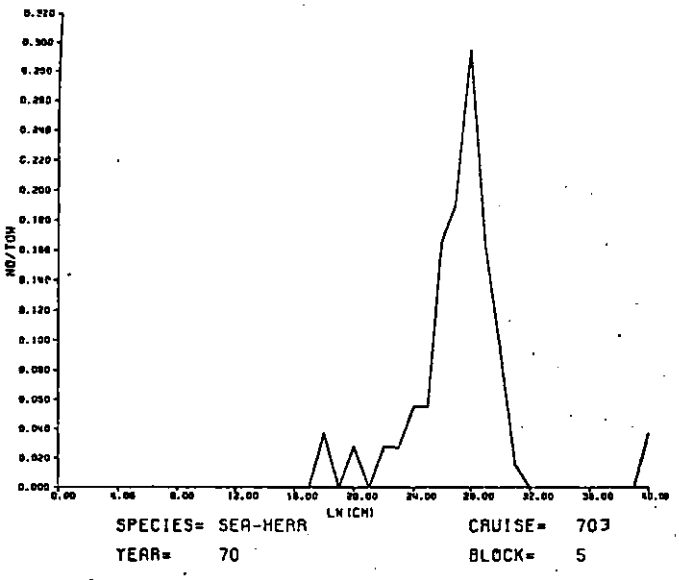


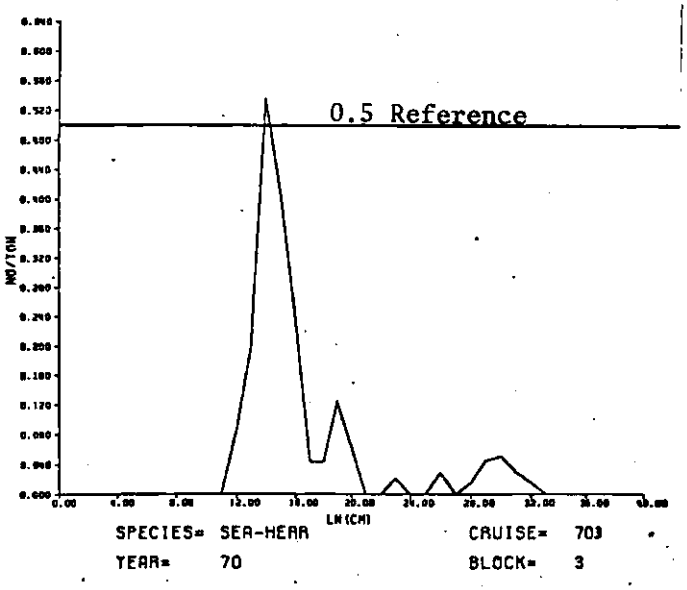
Figure 13. Stratified mean length frequencies (fork length) of sea herring caught on Albatross IV spring survey in 1969.











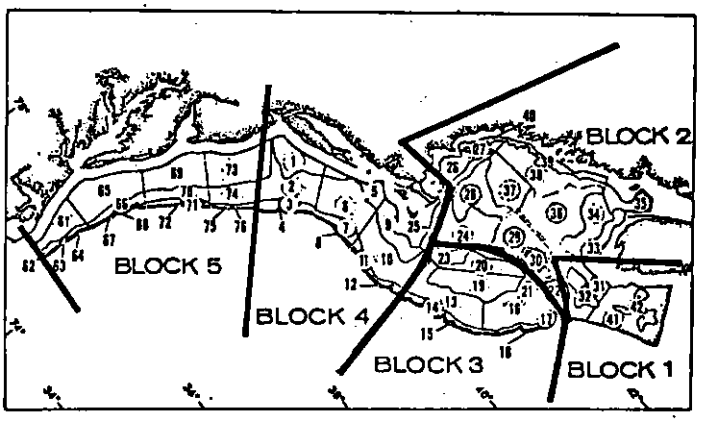
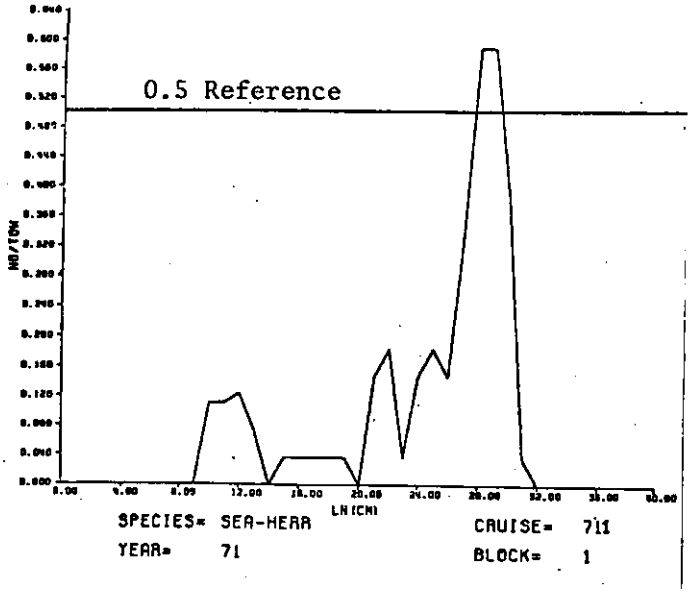
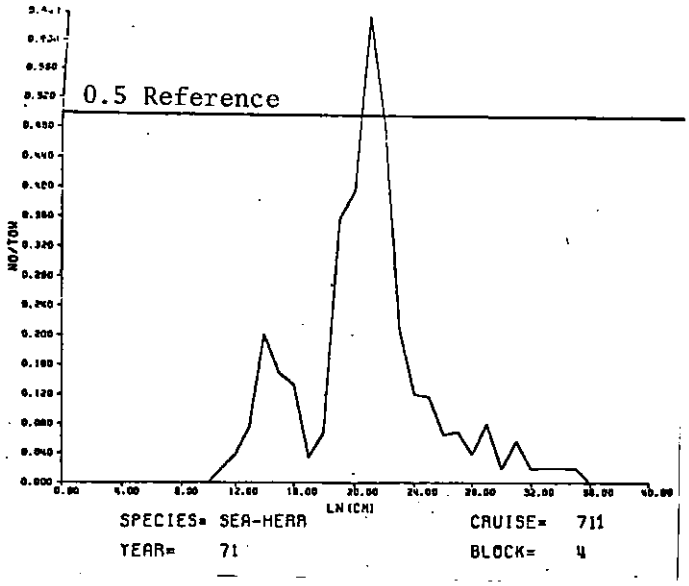
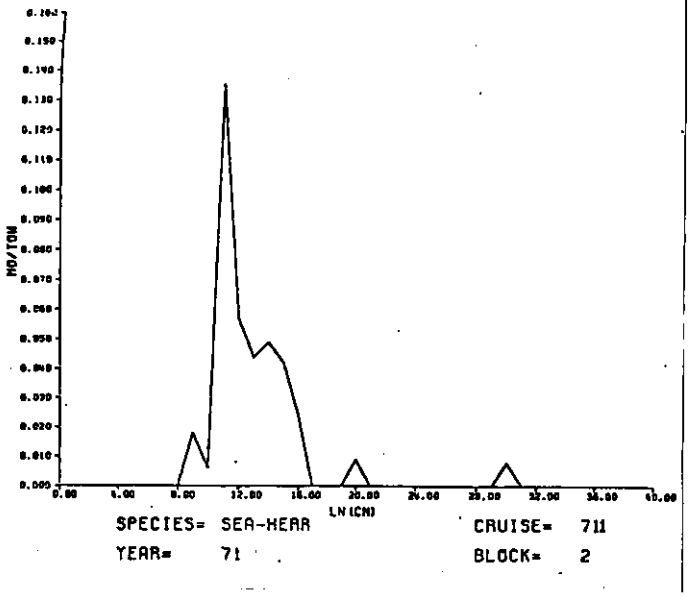
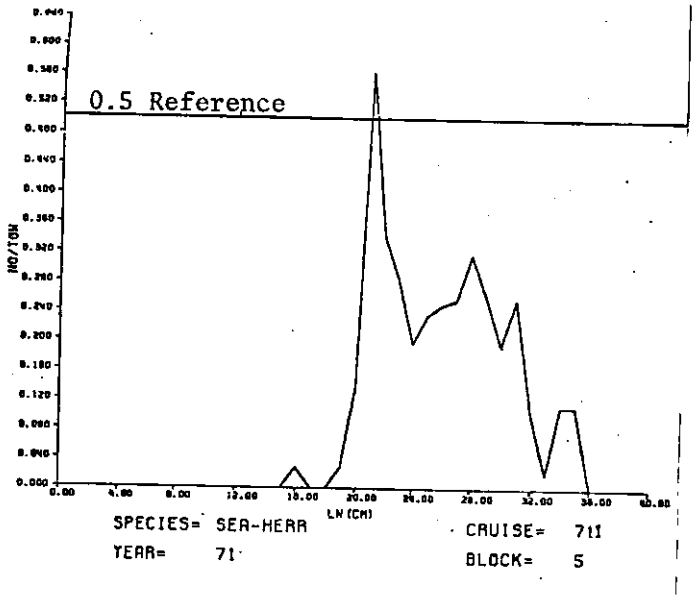


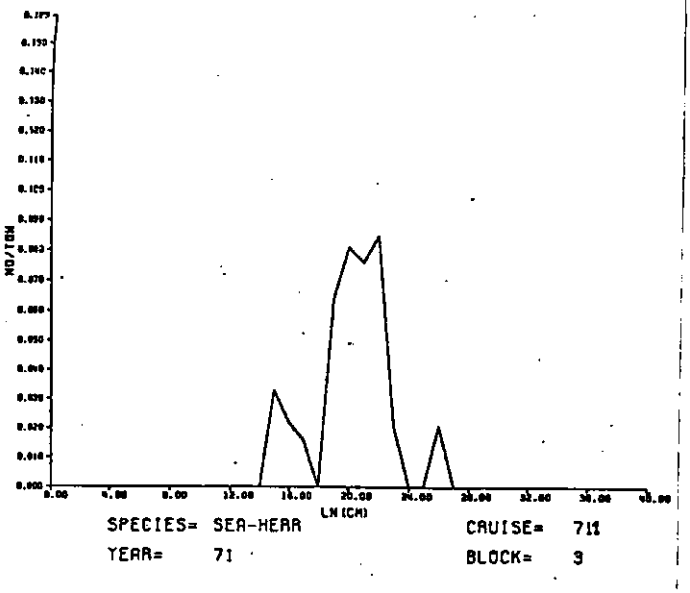
Figure 14. Stratified mean length frequencies (fork length) of herring on Albatross IV spring survey in 1970.











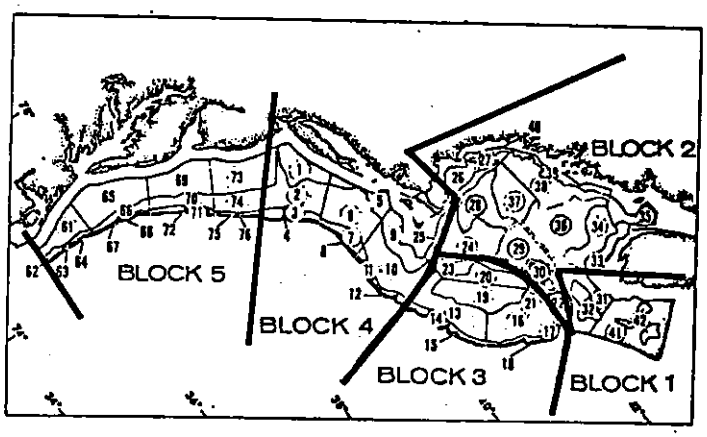
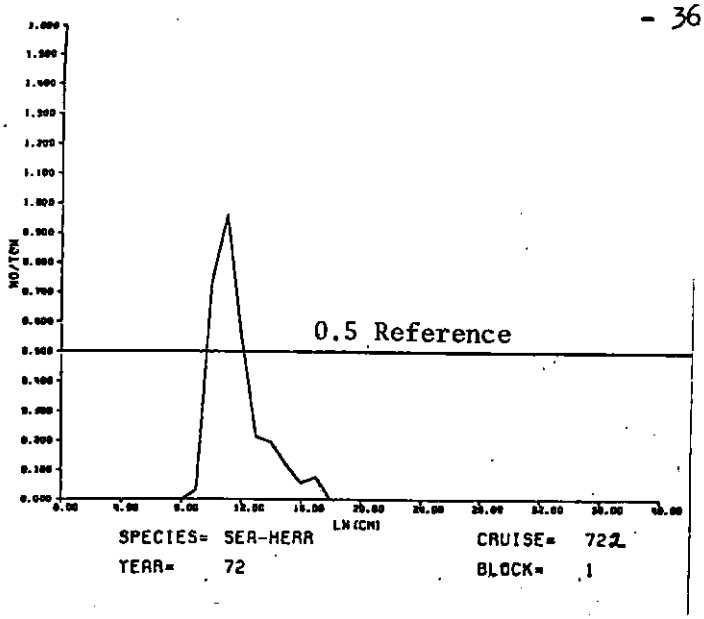
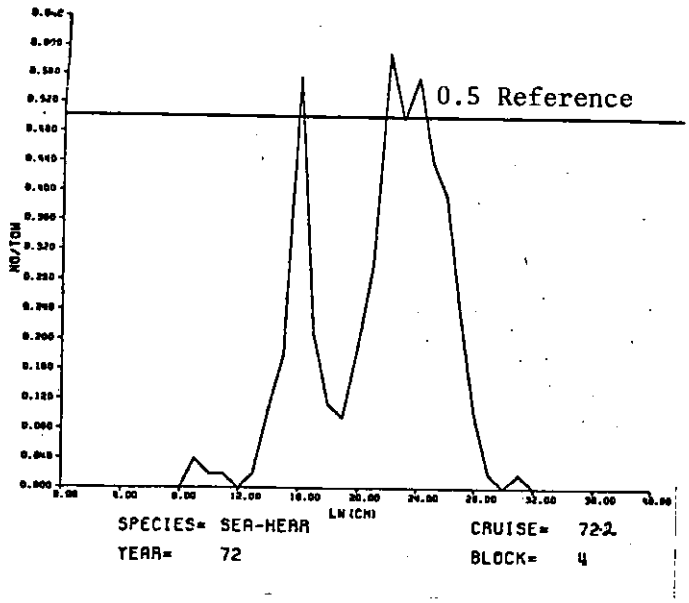
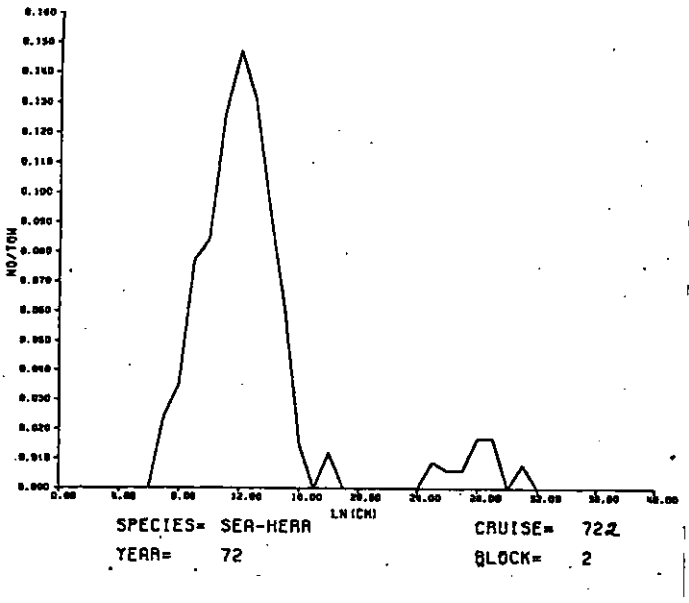
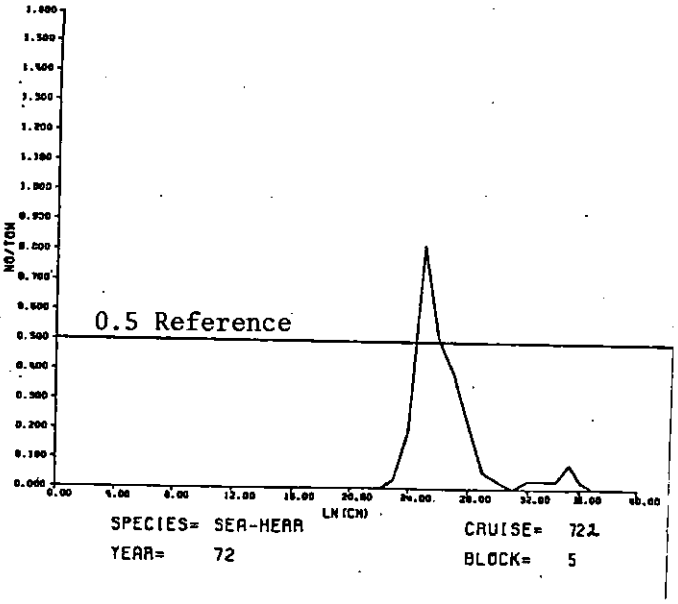


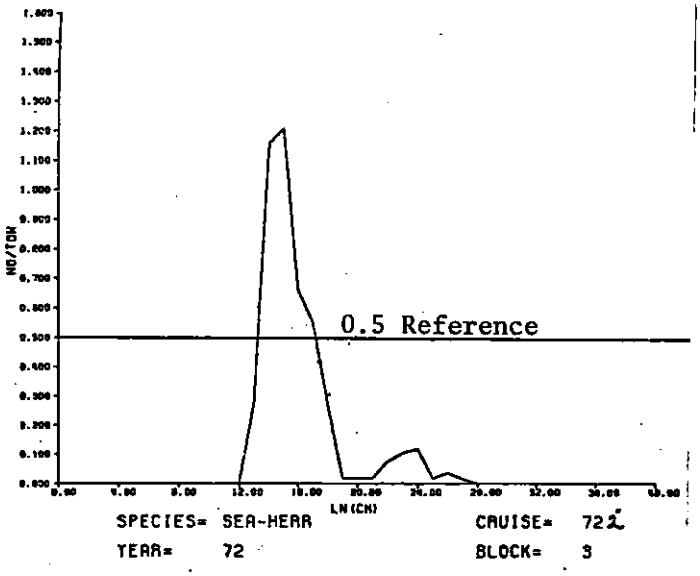
Figure 15. Stratified mean length frequencies (fork length) of sea herring on Albatross IV spring survey in 1971.











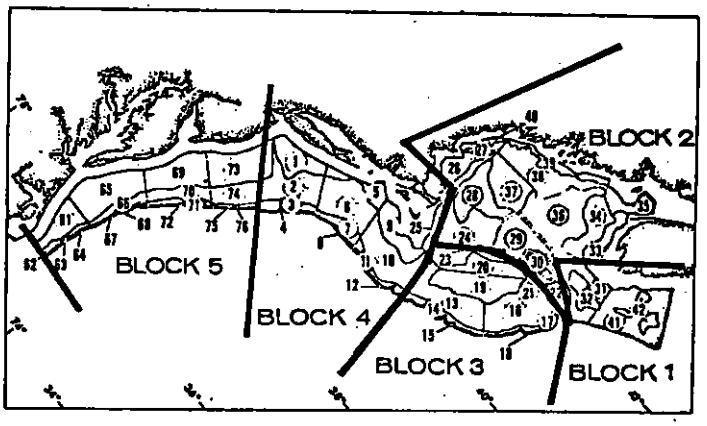
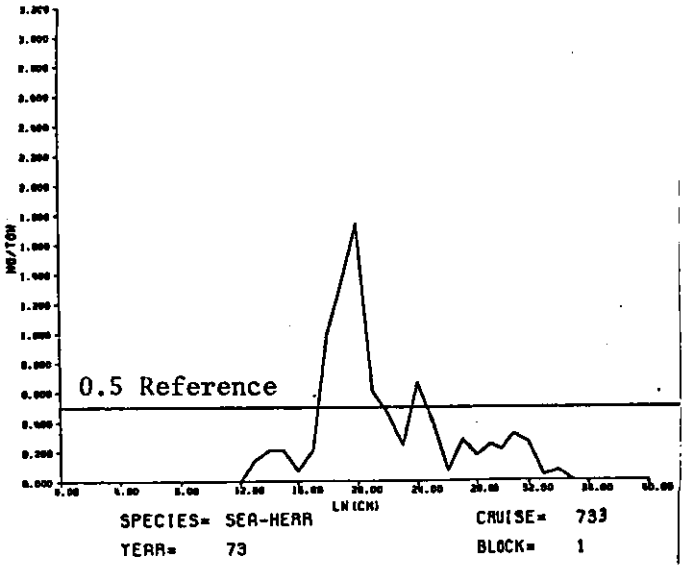
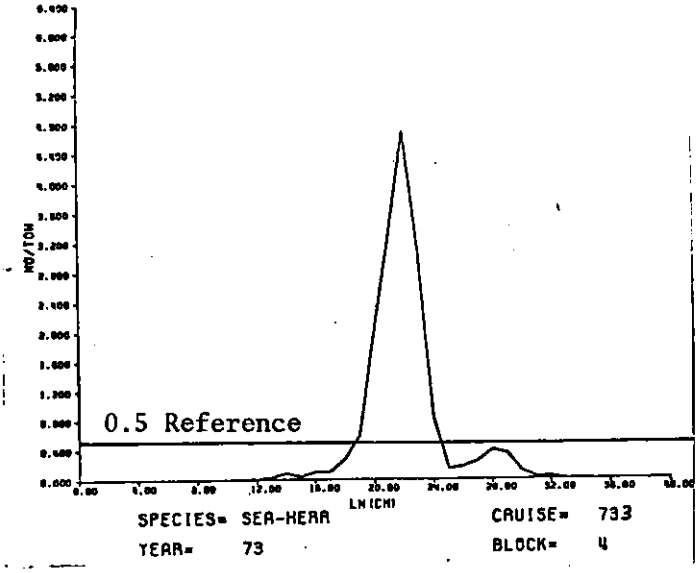
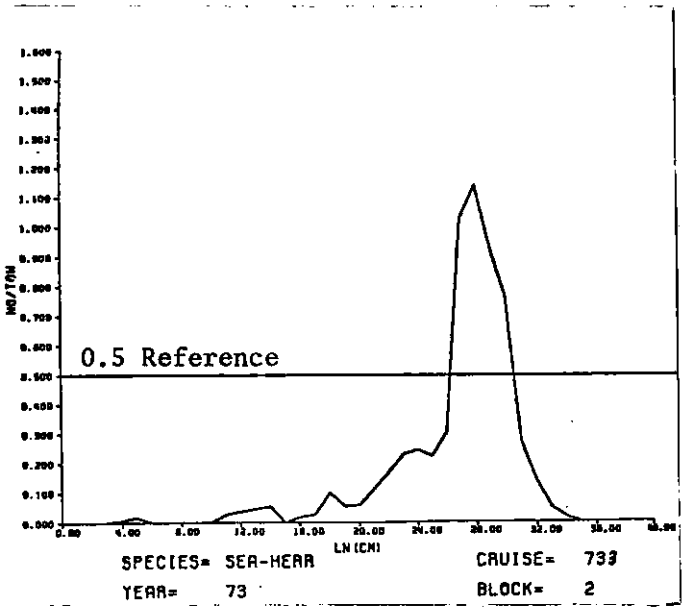
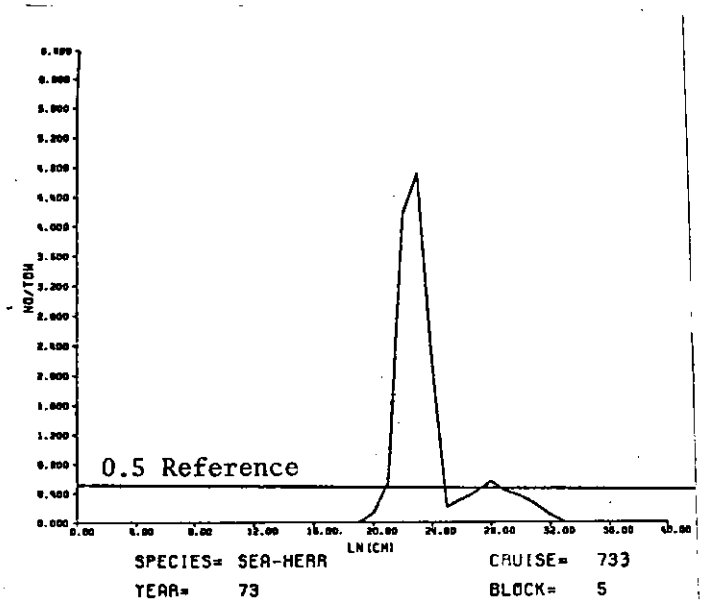


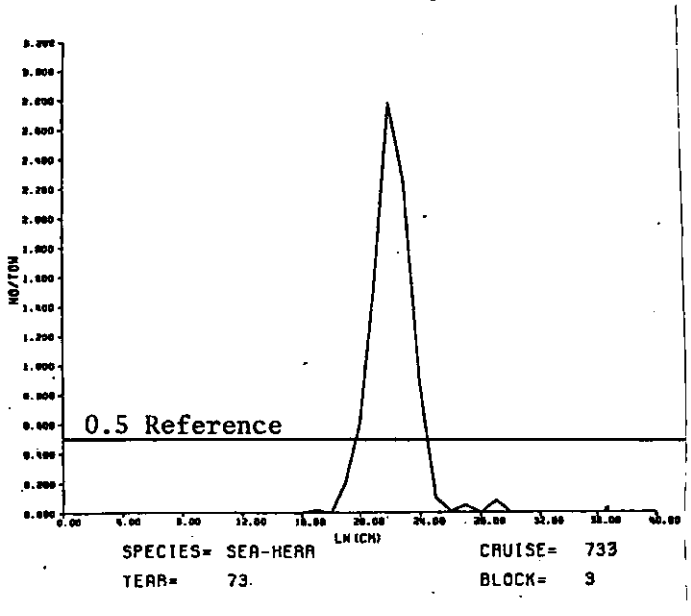
Figure 16. Stratified mean length frequencies (fork length) of herring on Albatross IV spring survey in 1972.











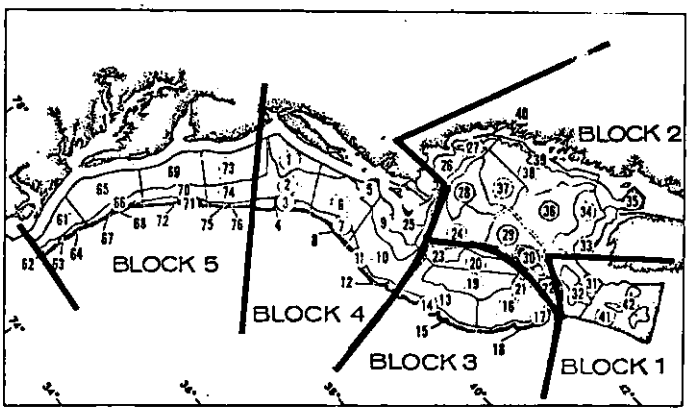
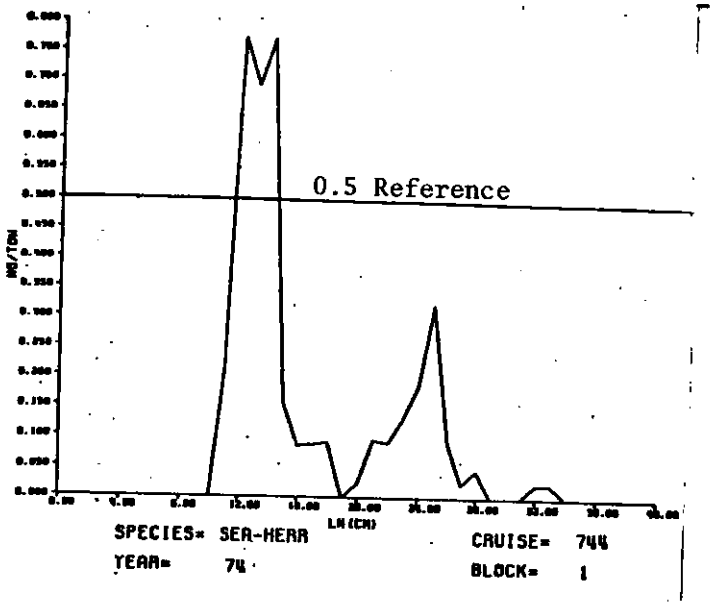
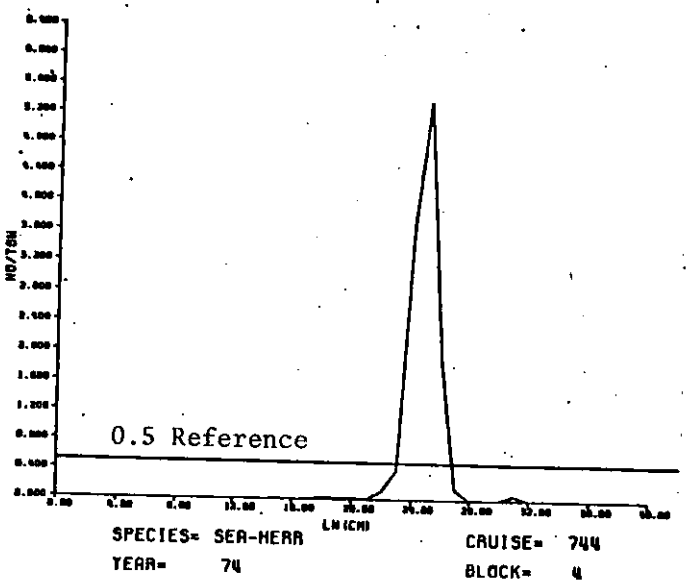
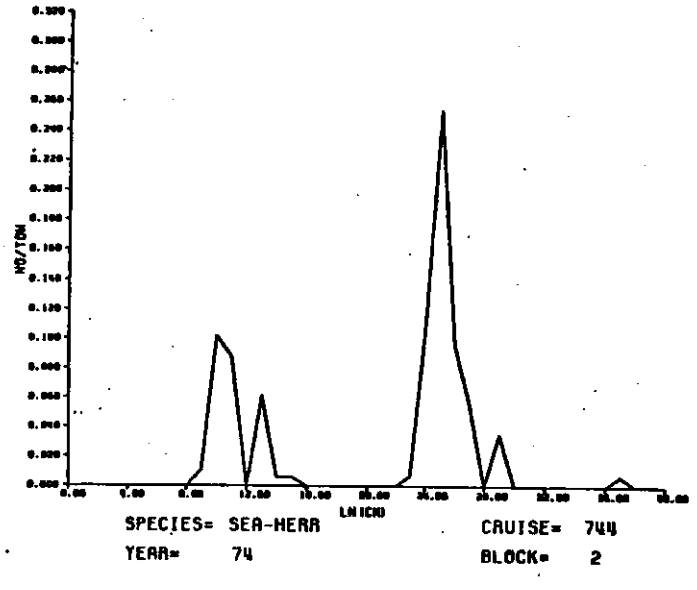
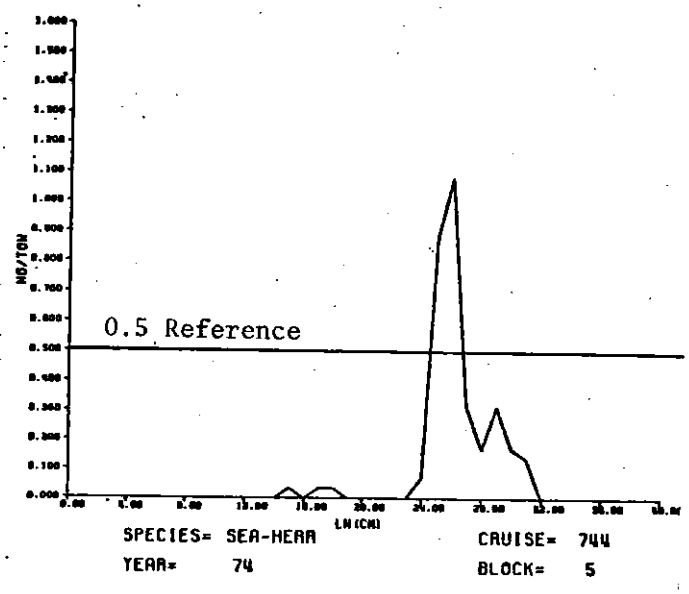


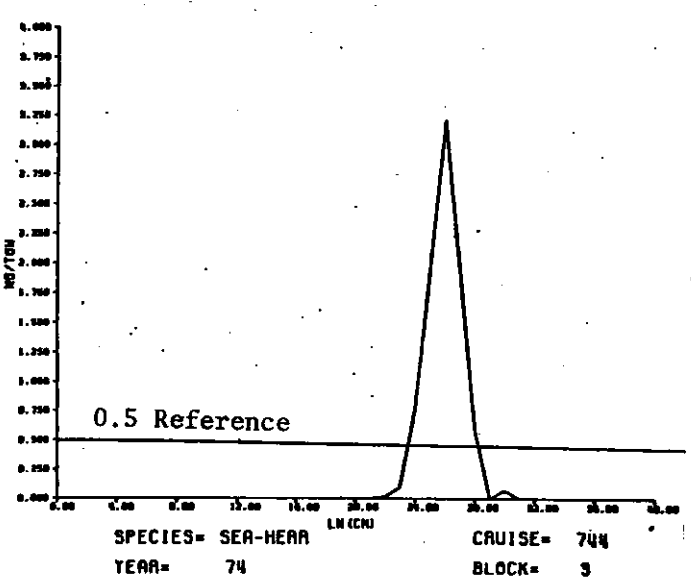
Figure 17. Stratified mean length frequencie (fork length) of sea herring on Albatross IV spring survey in 1973.











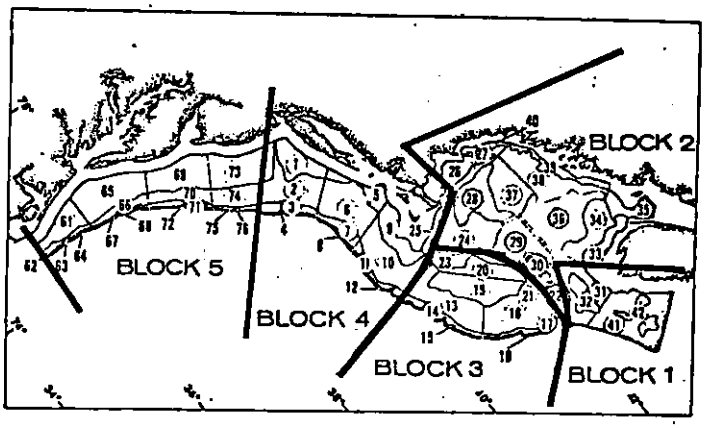
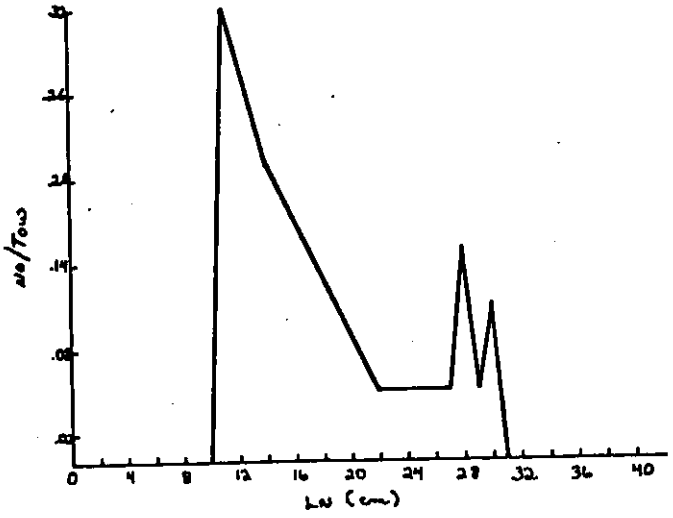
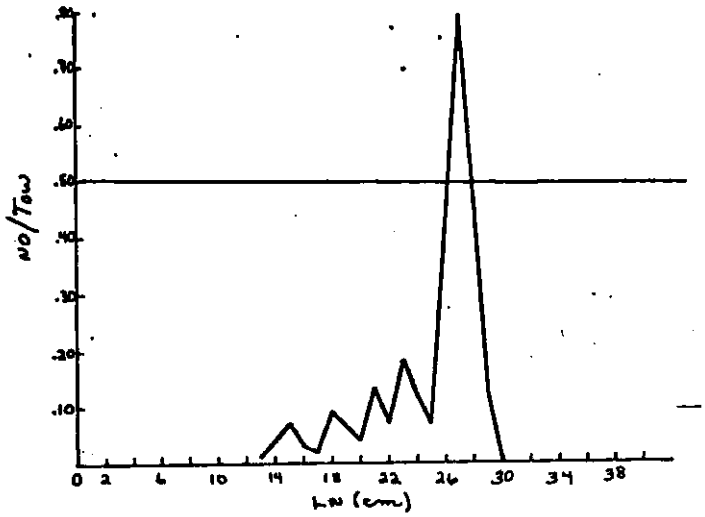


Figure 18. Stratified mean length frequencies (fork length) of sea herring caught on Albatross IV spring groundfish survey in 1974.



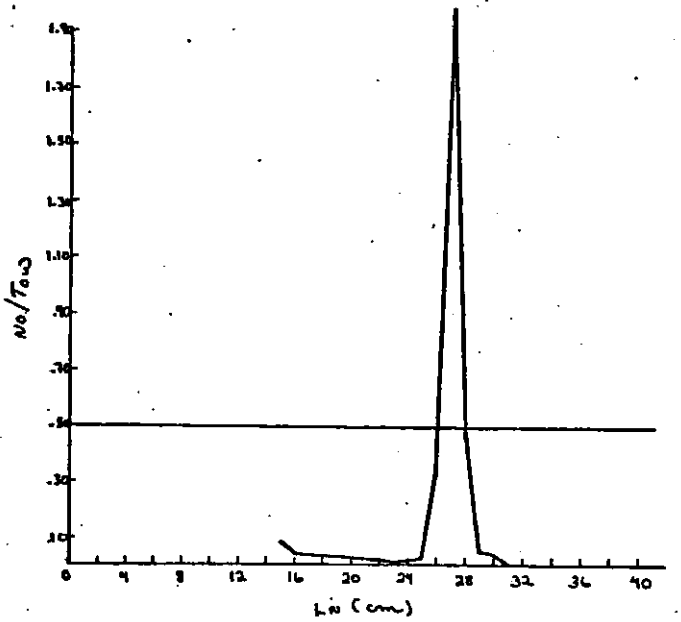
SPECIES= SEA-HERR CRUISE= 753

YEAR= 1975 BLOCK= 1



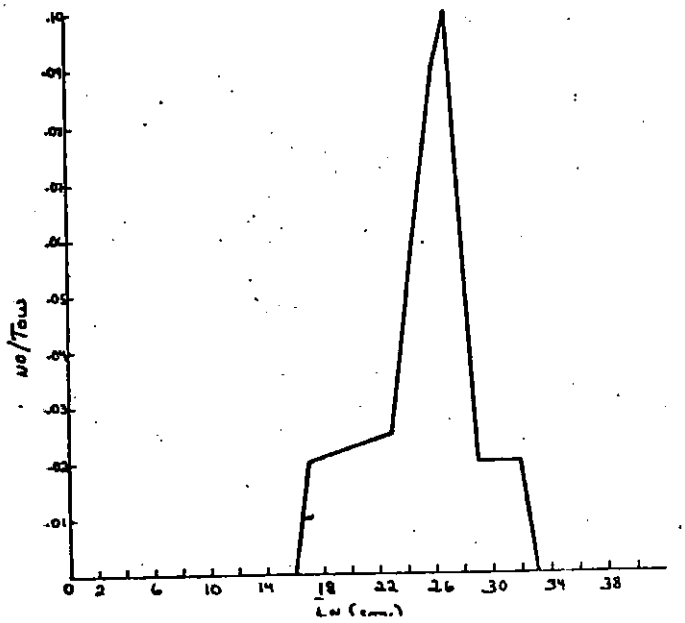
SPECIES= SEA-HERR CRUISE= 753

YEAR= 1975 BLOCK= 2



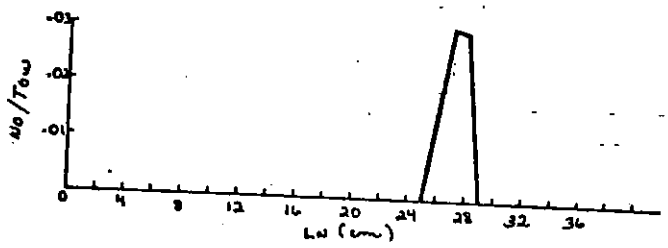
SPECIES= SEA-HERR CRUISE= 753

YEAR= 1975 BLOCK= 3



SPECIES= SEA-HERR CRUISE= 753

YEAR= 1975 BLOCK= 4



SPECIES= SEA-HERR CRUISE= 753

YEAR= 1975 BLOCK= 5

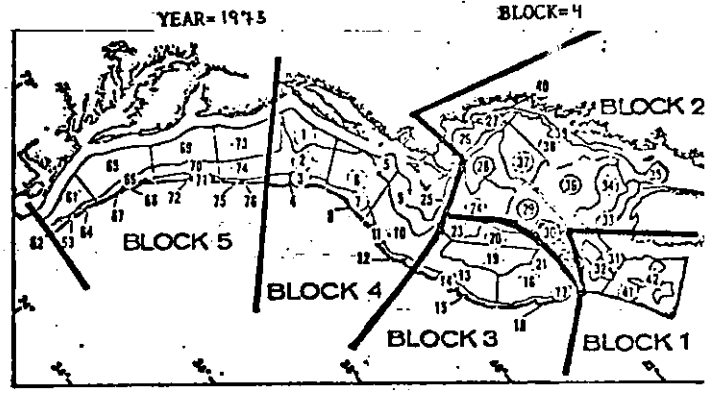
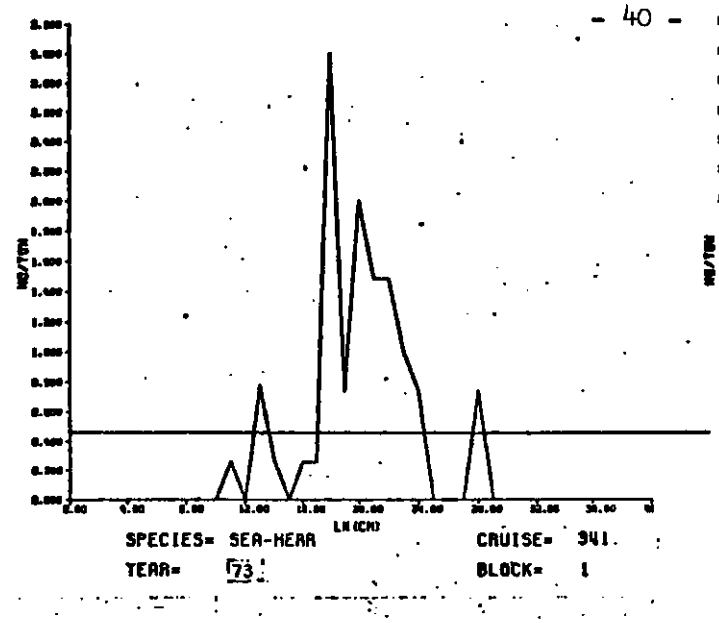
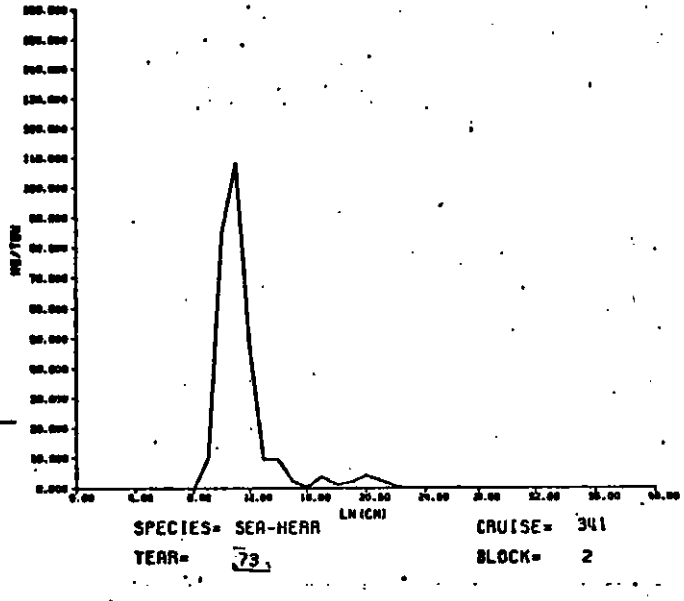
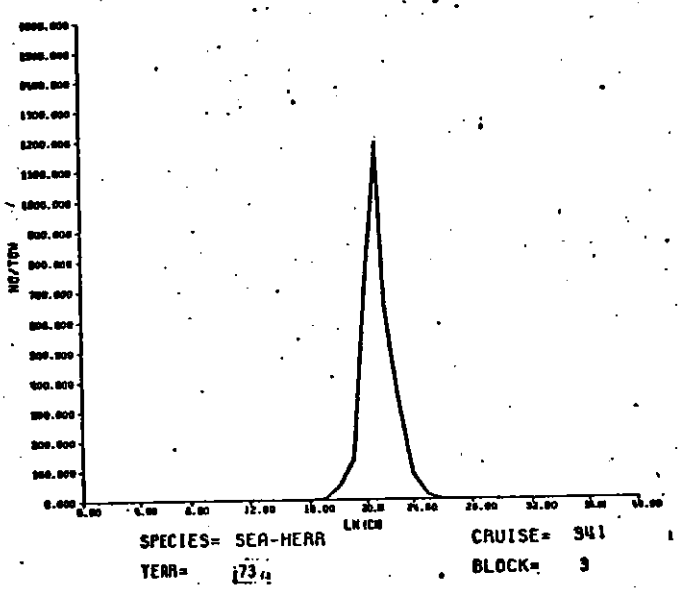
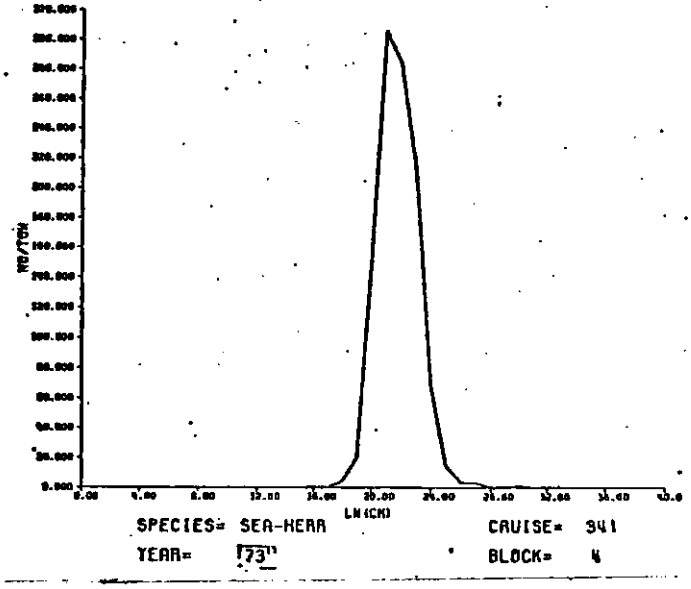


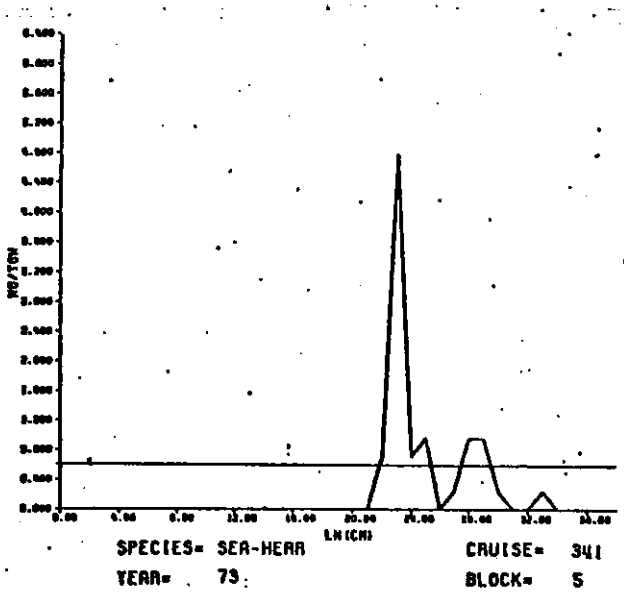
Figure 19. Stratified mean length frequencies (fork length) of sea herring on Albatross IV spring survey in 1975.











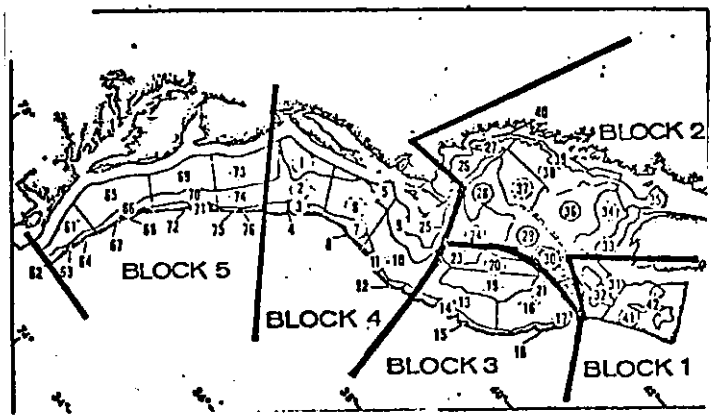
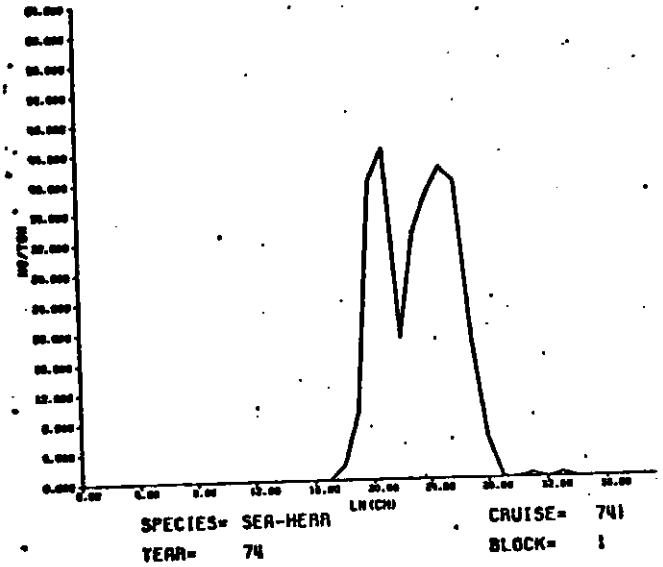
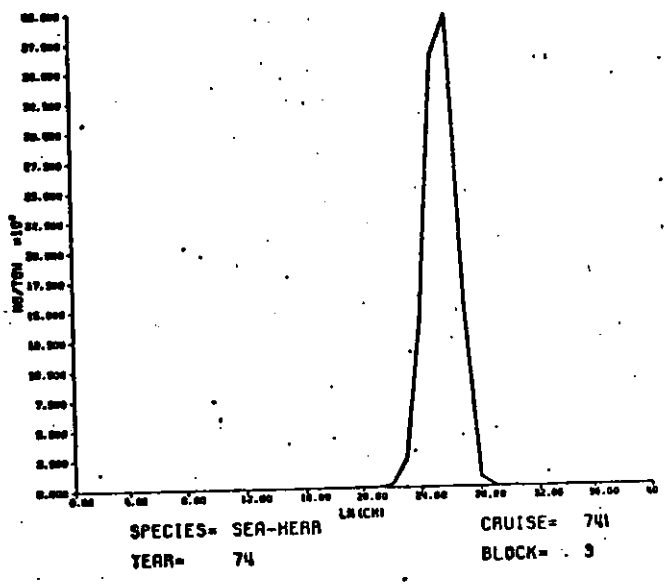
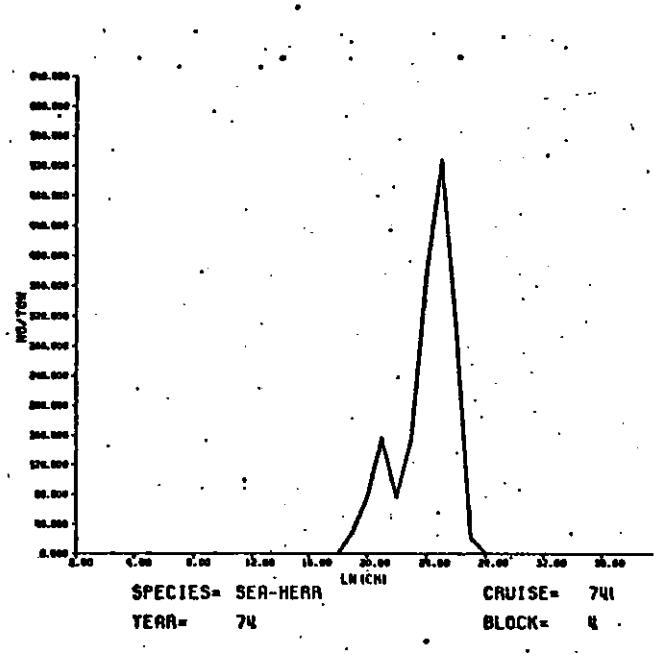


Figure 20. Stratified mean length frequencies (total length) of herring caught on 1973 spring survey by Walther Herwig.







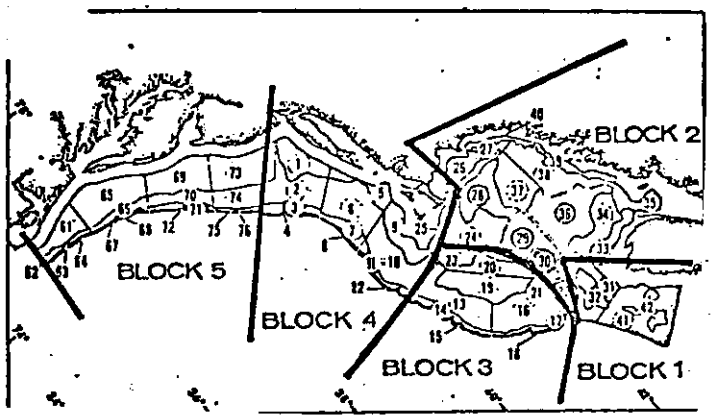
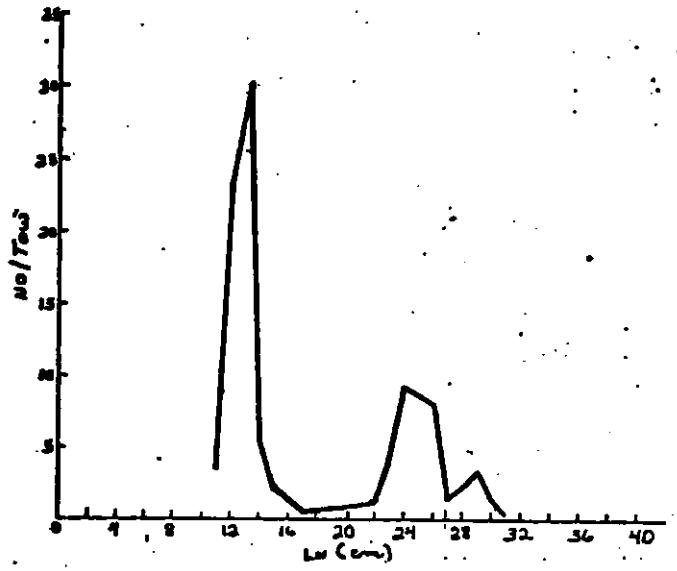
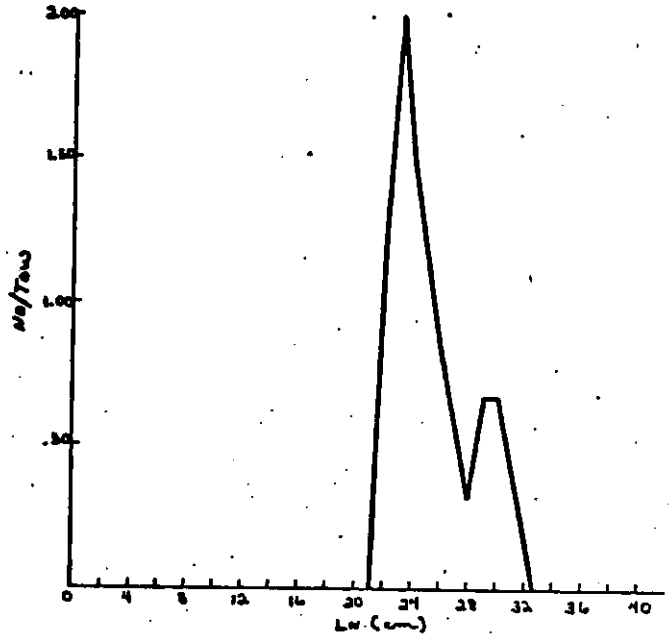


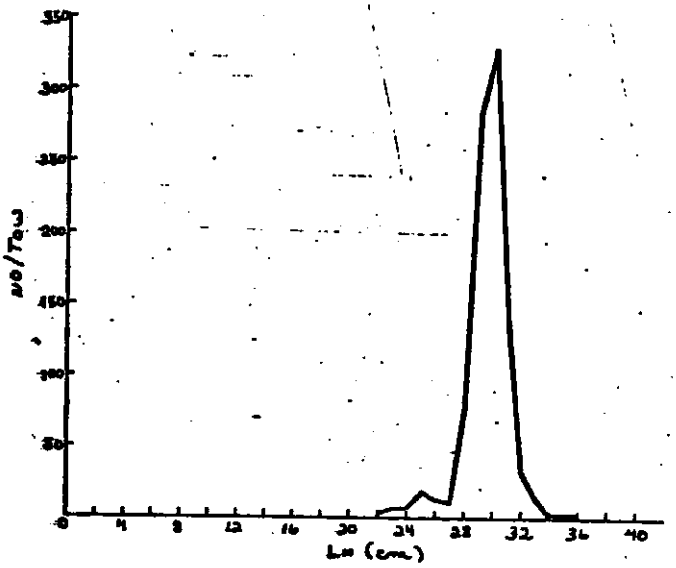
Figure 21. Stratified mean length frequencies (total length) of herring caught on 1974 spring survey by Walther Herwig.



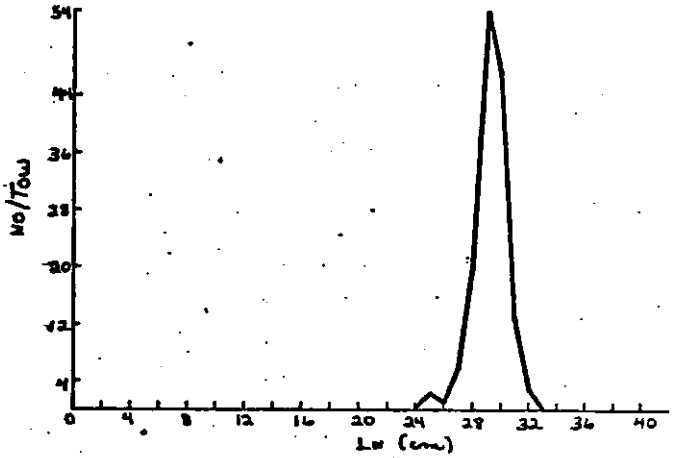
SPECIES= SEA-HERR CRUISE=754
YEAR=1975 BLOCK=1



SPECIES= SEA-HERR CRUISE=754
YEAR=1975 BLOCK=2



SPECIES= SEA-HERR CRUISE=754
YEAR= 1975 BLOCK= 3



SPECIES= SEA-HERR CRUISE=754
YEAR= 1975 BLOCK= 4

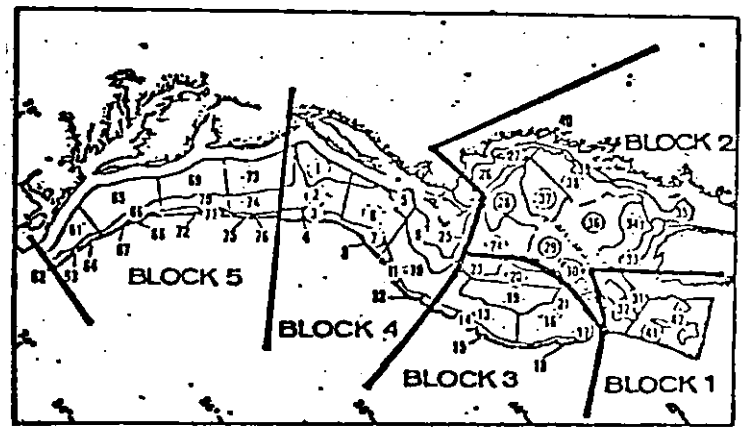
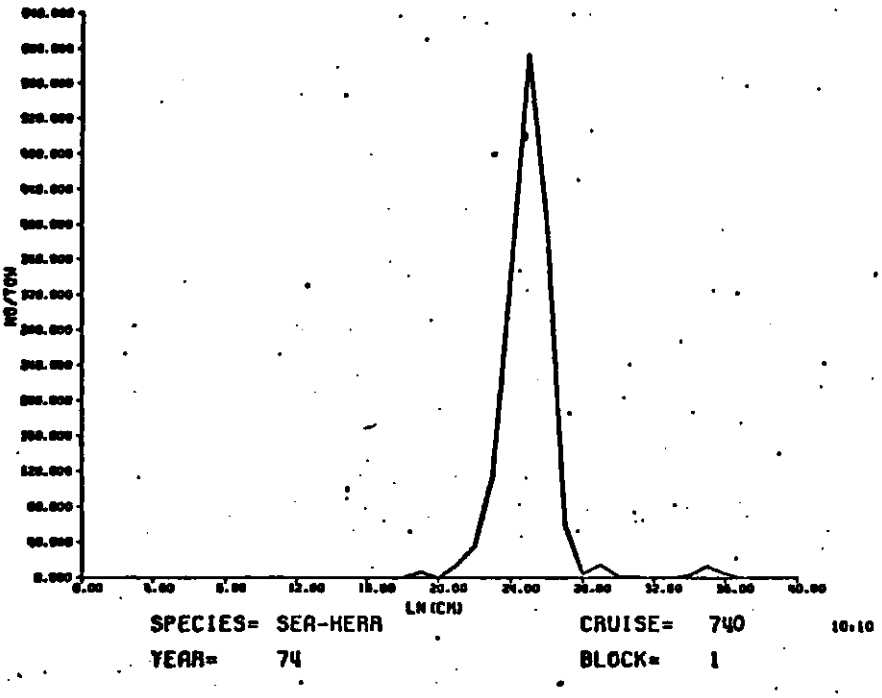
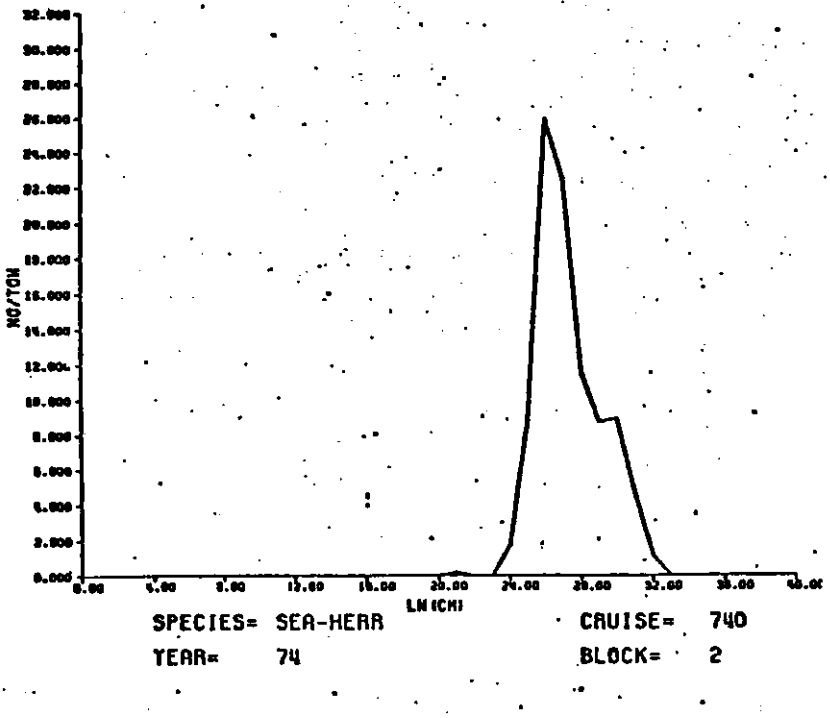


Figure 22. Stratified mean length frequencies (total length) of herring caught on 1975 spring survey by Walther Herwig.





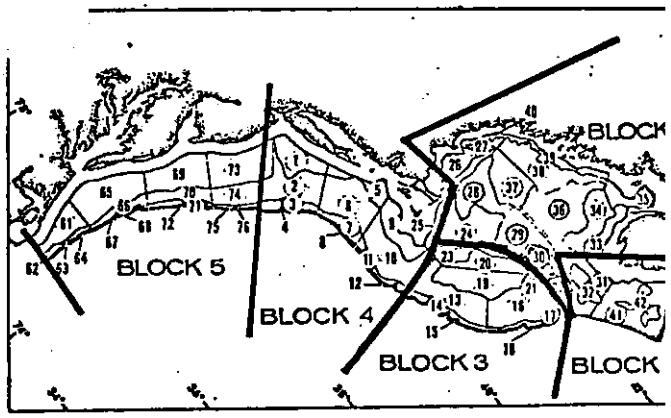
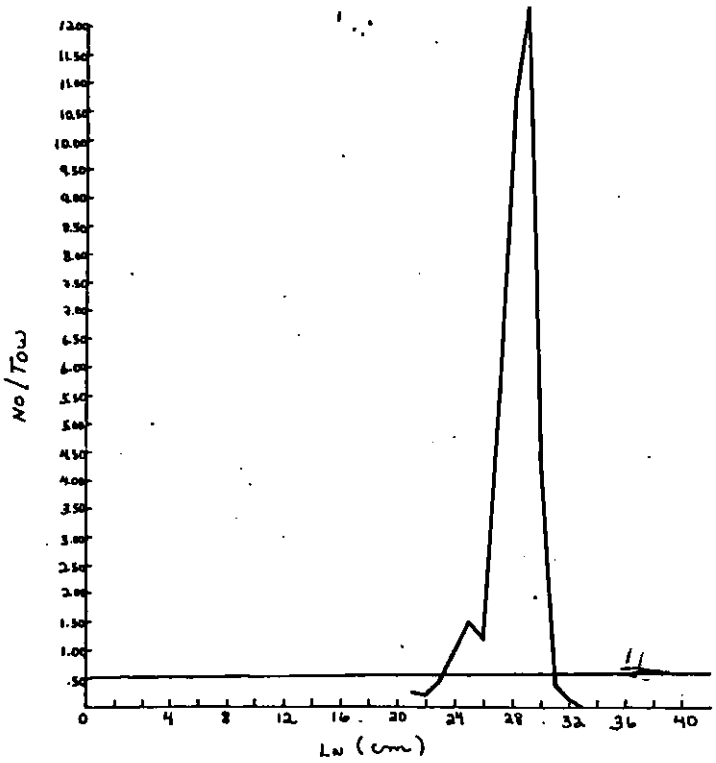
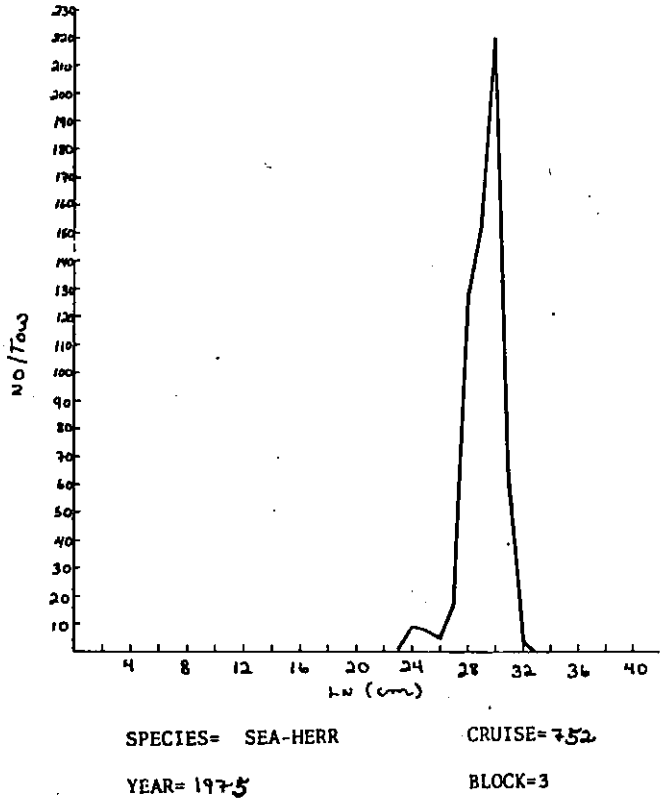


Figure 23. Stratified mean length frequencies (total length) of herring caught on 1974 spring survey by Khronometer.





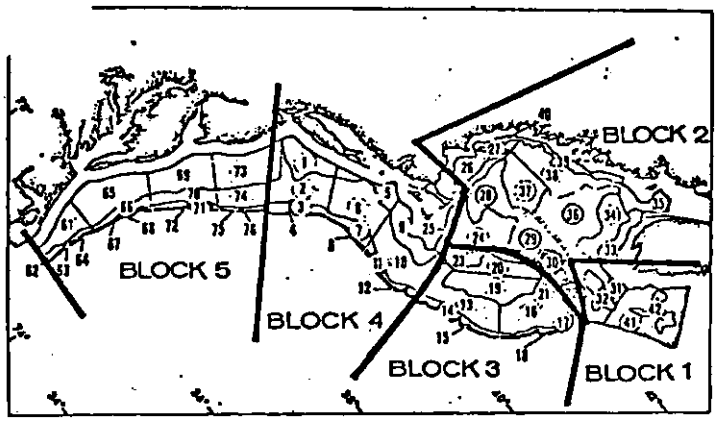
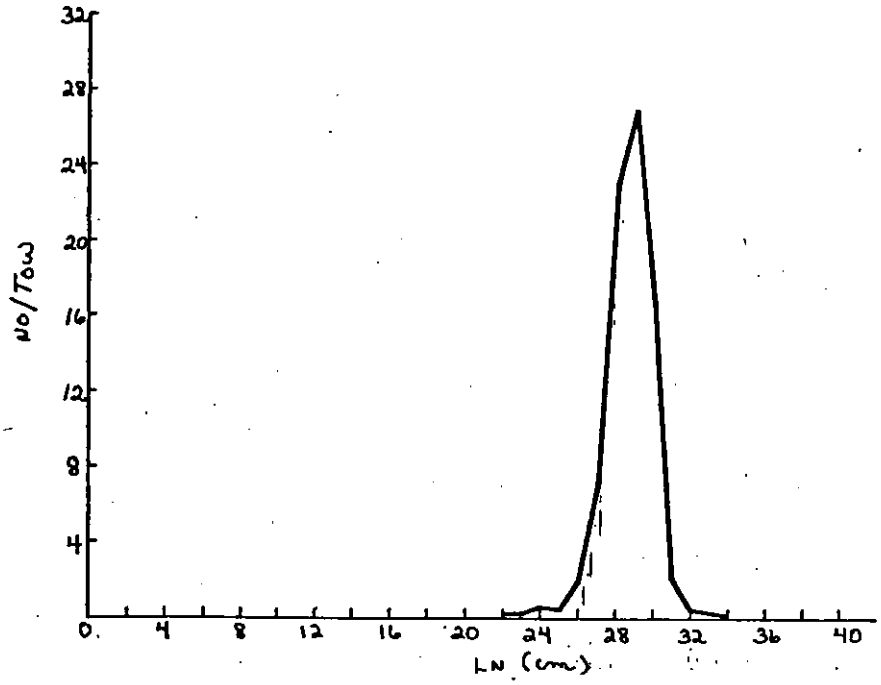


Figure 24. Stratified mean length frequencies (total length) of herring caught on the 1975 spring survey by Ernst Haeckel.



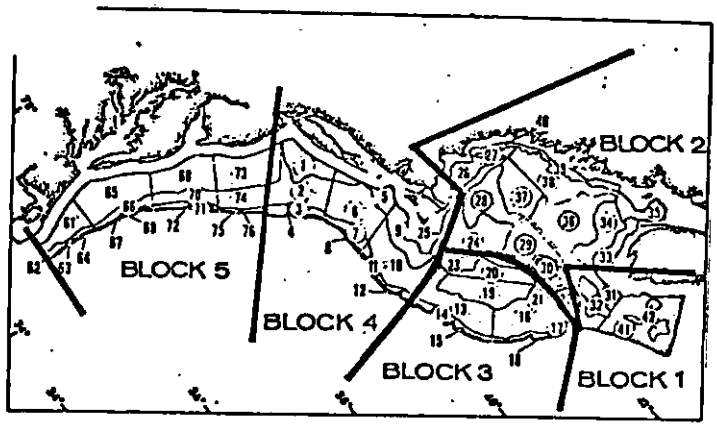


Figure 25. Stratified mean length frequencies (total length) of herring caught on 1975 spring survey by Wieczno.