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INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

C.M. 1979/G : 35
Demersal Fish Committee

REPORT OF THE INTERNATIONAL GADOID SURVEY WORKING GROUP

Ymuiden, 13 - 17 August 1979.

This report has not yet been approved by the International Council for the Exploration of the Sea; it has therefore at present the status of an internal document and does not represent an advice given on behalf of the Council. The proviso that it shall not be cited without the consent of the Council should be strictly observed.

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I N D E X

I. TERMS OF REFERENCE

At the 1978 Statutory Meeting of ICES in Copenhagen it was resolved (C. Res. 1978/2 : 30) that the International Gadoid Survey Working Group should meet in Ymuiden for one week in order to:

(a) compare abundance indices from different sub-areas of the North Sea,

(b) compare abundance indices of I-group, II-group and older fish with independent stock size estimates from VPA,

(c) investigate aspects of density-dependent growth.

As indicated in the resolution, the Working Group has been renamed. This new name does not specifically refer to a particular survey or area, which apparently broadens the possible scope of the WG reponsibilities. Without any specific guidance from ICES in this respect, however, the Group continued to restrict its analysis to the roundfish data collected during those surveys, which have been commonly referred to as the "North Sea International Young Herring Surveys", carried out annually in February/March.

II. PARTICIPATION

The meeting was attended by:

Mr. T. Benjaminsen	- Norway
Dr. N. Daan	- The Netherlands
Mr. U. Damm	- Federal Republic of Germany
Dr. D. Gray	- Canada
Dr. J.R.G. Hislop	- U.K. (Scotland)
Mr. J. Lahn-Johannessen	- Norway
Mr. W.G. Parnell	- U.K. (England)
Dr. M. Pennington	- U.S.A.
Mr. P. Sparre	- Denmark

Mr. A. Corten (The Netherlands) and Mr. M.J. Holden (U.K., England), the coordinators of the International Young Herring Surveys and the Pelagic O-group Roundfish Surveys, respectively, participated in a general discussion about survey design.

III. INTRODUCTION

Since the meeting of the Gadoid I-Group Working Group in 1977 considerable progress has been made in automatic processing of the roundfish data collected during the North Sea International Young Herring Surveys. Not only have the 1978 and 1979 surveys been completely analysed by computer, but also earlier surveys have been reanalysed in view of the large number of mistakes, which have resulted from manual processing of the data. At present all surveys from 1972 up to and including 1979 have been processed and standard final reports, which replace the preliminary reports submitted annually to the ICES Statutory Meetings, are available upon request from the Ymuiden laboratory.

The computer files created contain, by individual hauls, information on date, square, depth, shooting time, position, bottom temperature and for each of the 4 roundfish species (cod, haddock, whiting and Norway pout) information on number, minimum length, maximum length and the common length statistics (sum x and sum x^2) of the I-group and II-group fish caught. For older fish only the total number is recorded.

Thus, 8 years of extensive survey data were directly accessible for the present evaluation.

In the former report of the Working Group (C.M. 1977/F : 19) attention has been drawn to the different sources of error and in particular to the lack of a sound statistical basis in the survey design as a result of the fact that the survey is run as a compromise between essentially conflicting requirements for estimating herring abundance on one hand and roundfish abundance on the other. In order to arrive at a final decision about the abundance indices to be derived from the surveys for use in predicting recruitment for stock assessment purposes, an analysis of the distribution properties of the trawl catches is required. The Working Group accepted that this aspect presented the primary objective in its present analysis.

IV. STATISTICAL CONSIDERATIONS

1. Theory')

A stratified random sample is taken during each survey. The strata consists of the statistical rectangles, within each a small number of tows are randomly made. If the estimator $\hat{\theta}_i$ is an estimator or an indicator of abundance for the i^{th} stratum, then since the area of each stratum is roughly the same, the unweighted average

$$\hat{\theta} = \frac{1}{N} \sum_{i}^{N} \theta_i \qquad (1)$$

is used as an estimator of abundance for N strata. The variance of θ is given by

$$\frac{1}{N^2} \sum_{i}^{N} \text{var}\ (\theta_i). \qquad (2)$$

A few of the more likely estimators of abundance within a stratum were examined but due to the shortness of time their usefulness could not be completely analysed.

The first and most intuitively appealing estimator is the arithmetic mean. That is, let

$$\theta_{1,i} = \frac{1}{n_i} \sum_{k=1}^{n_i} X_{i,k} \qquad (3)$$

where n_i is the number tows in the i^{th} stratum and $X_{i,k}$ is the number of fish caught (per/hr) during the k^{th} tow.

') For general reference to the subject:
W.G. Cochran, 1977 Sampling Techniques, 3rd edition, John Wiley and Sons, Inc.

Then

$$\mathrm{var}\,(\Theta_{1,i}) = \frac{1}{n_i}\ \frac{\Sigma\,(X_{i,k} - \Theta_{1,i})^2}{n_i}\ . \qquad (4)$$

Hence, the mean and variance of Θ_1 the estimator of abundance for N strata, is found by substituting the values calculated in equations (3) and (4) into equations (1) and (2) respectively.

The advantage of using Θ_1 is that it is easily understood and should be proportional to the actual abundance. It does have two drawbacks. One, a few relatively large catches weigh heavily in the index and two, stated confidence limits for Θ_1 may be inaccurate since Θ_1 may be far from normally distributed. Both problems reflect the fact that the distribution of catches from trawl surveys are usually highly skewed.

In an attempt to keep the desirable properties of the mean as an indicator of abundance while ameliorating some of its shortcomings, the estimator

$$\Theta_{2,i} = \exp\,(\overline{Y}_i + \frac{n-1}{n}\,S_i^2)$$

was examined where $\overline{Y}_i$ is average of $Y_{i,k} = \ln X_{i,k}$ and S_i^2 is its variance.

If the counts in each stratum are lognormally distributed, then $\Theta_{2,i}$ is an estimator of the arithmetic mean which is more efficient than $\Theta_{1,i}$, i.e, var $(\Theta_{2,i}) <$ var $(\Theta_{1,i})$.

We had some problems using $\Theta_{2,i}$. The factor $\exp \frac{n-1}{n} S_i^2$ is a poor approximation of the true adjustment factor for small n and/or large values of S_i^2. This can be easily rectified by using the correct value rather than the approximate value, but there was not enough time to make the exact calculations. Taking into account the upward bias in $\Theta_{2,i}$, it appears that $\Theta_{2,i}$ is estimating the arithmetic mean (i.e. Θ_1 and Θ_2 were nearly the same). A more serious problem was our inability to obtain an accurate estimate of var $(\Theta_{2,i})$; the available approximation seems to be grossly inadequate. No solution to this problem could be found during the short amount of time we had; further work needs to be done.

The last estimator tried is

$$\Theta_{3,i} = \frac{1}{n_i} \sum_{k=1}^{n_i} \ln X_{i,k}$$

with var $(\Theta_{3,i})$ estimated as in equation (4), $\ln X_{i,k}$ replacing $X_{1,k}$. The abundance indicator Θ_3 and its variance are calculated using equations (1) and (2).

The advantage of using $\Theta_{3,i}$ is that large catches are given less weight and, hence, Θ_3 should be more nearly normally distributed. A difficulty with Θ_3 is that it is harder to interpret intuitively. Loosely, it can be looked upon as the average magnitude of the catch per tow. Over the long term the usefulness of θ_3 as an indicator of abundance may be determined. Either θ_3 or

$$\exp\left(\theta_3 + \frac{\mathrm{var}\,(\theta_3)}{2}\right)$$

may prove to be useful, the latter estimates the mean of the random variable

$$e^{\theta_3}.$$

Confidence limits are calculated for an estimator by assuming it to be approximately normal with variance given by equation (2). That is, for θ approximately 95 % confidence limits are $\pm\, 2\sqrt{\mathrm{var}\,(\theta)}$. Again, confidence limits for θ_3 should be more accurate than those for θ_1.

2. Adjusting for missing data

Mean catch per hour

If fish catches were similar in all squares, a few missing values would not affect the estimated overall mean catch per hour. However, since this is not the case, the average over all sampled squares will depend on whether squares that usually yield large catches or squares that usually yield small catches are missing. Therefore we attempted to fill in for missing mean catch per hour with values that reflected both the average contribution of the square and the relative success of tows in sampled squares.

To control for the average contribution of a square we used long term average catches. The long term average will of course depend on sizes of the year classes sampled and missed so as long a series as possible is desirable. However, since the survey has expanded over the years, if we take a long time period, the sizes of year classes during the 1960's affect the average for only a few of the squares. Since there were some extreme values during the early years of the survey, these will distort the averages for squares in the survey at that time. As a compromise the time period 1974 to 1979 was selected. This includes all years in which most of the squares were sampled. For each square the average mean catch per tow for all years in this period for which samples were taken was calculated - let this value be A_i. For the area considered for a particular species, these were summed:

$$TA = \Sigma A_i$$

The per mille contribution of each square was then calculated from

$$P_i = (A_i \div TA) \, . \, 1000$$

The P_i are thus an index of importance of the squares.

To generate estimates of missing values using the P_i that also reflect the success of tows in sampled squares we proceed as follows:

if $\overline{X}_i$ is the mean catch per hour in square i, we calculate

$$TX = \Sigma\overline{X}_i$$ where the summation is taken over all sampled squares

and $$TP = \Sigma P_i$$ where the summation is also over all sampled squares

so $$FX = \frac{TX}{TP} . 1000$$ is the estimated total mean catch per tow in the area considered. The additional catch (FX - TX) is allocated to the missing squares according to

$$\overline{X}_i^{☆} = \frac{P_i}{1000} . FX$$ where $\overline{X}_i^{☆}$ is the estimated mean catch per tow in missed square i.

By adjusting total mean catch per tow by the importance of sampled vs unsampled squares we are taking account of both the relative importance of the individual squares and the size of catches in this year relative to others. The method was used in the calculations of all abundance figures. The weighting of the squares is an arithmetic weighting. For adjusting when calculating the average mean log catch the weightings should be geometric or constructed as above but using mean log catches instead of mean catches. Hence the weightings would be slightly different. Limited computing recources made it impossible to calculate a second set of weightings. This may affect the average mean log catch estimates and the size of this error should be investigated.

Missing variances.

When there is 0 or 1 haul we cannot estimate the variance of the mean catch per hour. To estimate the standard deviation of an abundance estimate we need estimates of the variances in each square. To develop an estimate for the missing data we assumed that the sample standard deviation was directly proportional to the mean in each block. For survey data it is common to find that the ratio of standard deviation to mean (the coefficient of variation) is relatively constant and this seemed to be true for these surveys also. We checked the data for cod and found that it varied very little even when the mean took on extreme values. We also did not have the resources to estimate the relationship in detail and it would be worthwhile giving this some consideration. Thus we assumed that

$$\sqrt{var(\overline{X}_i)} = C . \overline{X}_i$$

when C is a constant depending on species, age group and year.

To estimate C we cannot use squares in which $\overline{X}_i = 0$ because for such points C is not defined. If the number of hauls was at least 2 and $\overline{X}_i \neq 0$, we calculated

$$C_i = \sqrt{\text{var}(\overline{X}_i)} \; / \; \overline{X}_i$$

We then used $\overline{C}$ = average C_i as an estimator ☆) of C. For squares with one haul we then estimated the sample variance and the standard error of $\overline{X}_i$ to be:

$$\text{var}^{☆}(\overline{X}_i) = (\overline{C} \, . \, \overline{X}_i)^2$$

For squares with no hauls, we estimated the sample variance and the standard error of $\overline{X}_i^{☆}$ (the estimated mean catch per hour) to be:

$$\text{var}^{☆}(\overline{X}_i^{☆}) = (\overline{C} \, . \, \overline{X}_i^{☆})^2$$

(This gives the sample the same significance as a sample with one haul). For example, for II-group and older cod for 1979 calculations were carried out and the means of the C_i were 1.20 and 1.18 respectively. The sample variances were 0.22 and 0.19 respectively. Since these were based on about 100 points the standard errors of the $\overline{C}$ are small and the low variances show that these values do remain relatively constant from square to square.

When using log catch per tow as an abundance estimator the relationship between mean and standard deviation should break down since one of the aims of the log transform is to stabilize variance. However, we still had a reasonably good relationship between mean and standard deviation so we used the same technique as above with log X instead of X. The new estimates for the coefficient of variation were lower but the variation was a bit higher. For example for II-group and older cod for 1979 the means were 0.99 for both and the variances were 0.32 and 0.28. Hence, as expected, the log transformation did reduce the relationship between mean and standard deviation (but not as much as expected) and reduced the coefficient of variation.

All $\overline{C}$ estimates are given in tables IV - 1 and 2.

3. Future work

- A more thorough examination of the relationship between the variance and the mean should be made.
- Is the method of adjusting for missing mean catches adequate? To get some idea of the effect of the adjustments we could do the following. For the area considered, take all squares sampled every year for the last 5 years. Recalculate the average

☆) $\overline{C}$ would be better estimated by regressing the standard deviation in each rectangle on the mean in the rectangles.

abundance index and standard deviation. Repeat this for the last 10 years and the last 15 years. If these series and the original adjusted series are well correlated in the segments that overlap and if the standard deviation drops as we add more squares, than the adjustments are useful.

- It appears that the overall abundance measures and their standard deviations are heavily dependant on a few large tows every year. Also, since the standard deviation of mean catch per haul within a square is proportional to the mean, squares with large means are the least well known. Consideration should be given to designing a survey program that made the number of hauls in a square dependent on the mean catch per hour. For example, we might do two hauls in each square, add a third if the mean catch per tow of the two was over 100, add a fourth if the mean of the mean of the three was over 1000. Some work would then have to be done on the effects of such a survey design on the estimated statistics.
- Can we combine some blocks by stratifying with respect to depth or bottom type? This might help to reduce variance within a stratum and would give enough hauls in some of the strata to allow investigation of distributional properties.
- It would be useful to determine how much of the total variation is due to:

  a. differences between squares
  b. differences between vessels
  c. differences between gears
  d. different depths
  e. different times
  f. different bottom types
  g. different temperatures

  Once this was known it might be possible to control or adjust for the items having the biggest effect.

TABLE IV-1 - Average coefficients of variance for untransformed data by years and species. (Numbers in brackets are number of squares with more than one haul).

		72	73	74	75	76	77	78	79	Mean
COD	1	1.09 (36)	1.15 (53)	1.13 (53)	1.13 (60)	1.11 (67)	1.13 (90)	1.15 (87)	1.30 (78)	1.15
	2	1.08 (46)	1.22 (53)	1.01 (56)	1.19 (65)	.96 (99)	1.39 (68)	1.09 (114)	1.21 (96)	1.14
	> 2	1.08 (47)	.97 (64)	.91 (63)	1.00 (68)	.85 (86)	1.13 (103)	1.10 (107)	1.18 (118)	1.03
HADDOCK	1	1.00 (34)	1.04 (36)	.92 (49)	.69 (57)	.88 (67)	1.03 (89)	.92 (90)	1.06 (88)	.94
	2	.97 (36)	.90 (43)	.87 (45)	.85 (56)	.82 (74)	.96 (84)	.88 (87)	1.06 (86)	.91
	> 2	.98 (35)	.91 (47)	.72 (48)	.98 (52)	.78 (69)	.96 (83)	.87 (87)	1.12 (86)	.92
WHITING	1	.92 (45)	.98 (65)	.93 (66)	.92 (85)	.91 (99)	1.02 (116)	.94 (123)	1.00 (121)	.95
	2	1.03 (43)	1.01 (64)	.86 (66)	.95 (83)	.93 (99)	1.10 (106)	1.04 (119)	1.17 (114)	1.01
	> 2	1.23 (40)	1.04 (55)	1.01 (65)	1.01 (79)	.98 (90)	1.20 (102)	1.12 (105)	1.18 (102)	1.10
NORWAY POUT	1	1.05 (18)	1.11 (17)	1.00 (29)	1.07 (30)	.94 (43)	1.08 (65)	1.05 (57)	1.26 (63)	1.07
	2	1.00 (17)	.85 (32)	1.13 (25)	1.04 (31)	1.04 (34)	1.18 (48)	1.09 (52)	1.36 (47)	1.09
	> 2	1.57 (2)	1.07 (32)	1.02 (19)	1.41 (15)	1.13 (19)	1.43 (28)	1.42 (18)	1.55 (31)	1.33

TABLE IV-2 - Average coefficient of variance for log transformed data by year and species. (Numbers in brackets are number of squares with more than one haul).

		72	73	74	75	76	77	78	79	Mean
COD	1		.91 (53)	.94 (53)	.82 (60)	.92 (67)	.82 (90)	.92 (87)	1.06 (78)	.91
	2		1.02 (53)	.83 (56)	.97 (65)	.73 (99)	1.25 (68)	.87 (114)	1.01 (96)	.95
	> 2		.75 (64)	.74 (63)	.82 (68)	.65 (86)	.96 (103)	.96 (107)	1.00 (106)	.84
HADDOCK	1		.64 (36)	.49 (49)	.21 (57)	.50 (67)	.61 (89)	.48 (90)	.59 (88)	.50
	2		.32 (43)	.55 (45)	.41 (56)	.44 (74)	.63 (84)	.56 (87)	.67 (86)	.50
	> 2		.46 (47)	.32 (48)	.69 (52)	.44 (69)	.52 (83)	.54 (87)	.75 (86)	.53
WHITING	1		.43 (65)	.50 (66)	.36 (85)	.39 (99)	.49 (116)	.47 (123)	.43 (121)	.44
	2		.55 (64)	.48 (66)	.51 (83)	.47 (99)	.74 (106)	.65 (119)	.73 (114)	.59
	> 2		.72 (55)	.71 (65)	.64 (79)	.61 (90)	.89 (102)	.81 (105)	.79 (102)	.74
NORWAY POUT	1		.51 (17)	.68 (29)	.64 (30)	.60 (43)	.61 (65)	.71 (57)	.82 (63)	.65
	2		.40 (17)	.99 (25)	.78 (31)	.81 (34)	.88 (48)	.75 (52)	1.09 (47)	.81
	> 2		.57 (16)	.25 (19)	1.18 (15)	1.06 (19)	1.23 (28)	1.35 (18)	1.50 (31)	1.02

V. COD

Long-term abundance

Long-term mean numbers per hours fishing by rectangle based on data corrected during the 1972 - 1979 surveys are shown in Figures 5-1/3. A new "cod area" covering the rectangles in which cod of all ages are most likely to be caught was defined after examination of long-term means and delineated by the thick line on the figures.

Abundance by sub-areas

Year class abundance indices for I- and II-group cod taken on the IYHS survey are given together with estimates of VPA year class size in table V-4. The "missing data" adjustment was applied to all age groups. Abundance indices, both adjusted and unadjusted for 7 sub-areas which are based on demersal sampling areas as shown in Figure 10-1 are given in tables V-1 and V-2 and show that highest catches of I-group cod are taken in the eastern North Sea in sub-areas 6 and 7 while II-group cod are more widely distributed extending into the northern and central North Sea.

Comparison with other estimates

Regression analysis shows that there is a highly significant correlation between the geometric mean abundance of I-group and VPA estimates of year class size (table V-5). A similar correlation using the arithmetic mean is less strong. For the II-groups the converse is true, the arithmetic mean giving a stronger correlation than the geometric mean. There is a much poorer correlation between the I- and II-group fish. This could imply that one or other of the age groups is not being adequately sampled either because of emigration of the older fish or because the younger fish are close inshore where they cannot be fished. As all correlations have been carried out on unadjusted data they should be regarded with caution. There is no reason to suppose that any correlations may break down, but the value of slopes and intercepts could change when the adjusted data become available.

Length at age

There was no evidence of density dependant growth for either I- or II-group cod using data for the total North Sea. There are large differences in mean length between sub-areas (table V-6/7) but lack of time prevented the Group from examining the problem in greater detail.

TABLE V-1 - Abundance indices of I-group COD by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (144)	No of squares fished
1972	U	0.5	5.9	1.4	3.3	0.8	1.8	12.8	4.1	106
	A	0.5	5.4	1.2	3.1	0.5	9.9	12.8	5.3	
1973	U	0.5	15.0	1.7	60.6	0.2	66.4	96.2	37.7	110
	A	3.7	15.0	1.6	55.9	0.3	132.3	96.2	49.3	
1974	U	19.6	13.8	1.8	19.6	0.1	5.2	31.7	14.6	134
	A	11.7	13.8	1.7	16.6	0.2	29.8	31.7	19.6	
1975	U	0.3	8.1	5.8	40.5	6.0	344.8	92.8	95.7	132
	A	1.1	8.2	6.7	31.9	2.6	314.4	92.8	88.7	
1976	U	2.8	4.0	1.3	5.1	0.2	12.6	36.8	8.8	131
	A	1.9	4.0	1.0	4.3	0.1	11.5	37.6	8.4	
1977	U	0.4	29.2	2.3	13.8	50.3	85.8	156.3	40.3	141
	A	0.3	29.2	2.2	11.7	18.5	78.3	156.3	39.8	
1978	U	0.5	16.3	0.2	13.1	2.8	24.9	58.3	14.4	142
	A	0.3	16.3	0.2	11.1	1.3	23.1	58.3	14.5	
1979	U	0.3	6.3	0.6	1.5	2.2	30.6	17.7	9.8	140
	A	0.2	6.3	0.6	1.2	1.0	27.8	16.5	9.9	
Average 1972 - 1979	U	3.1	12.3	1.9	19.7	7.8	71.5	62.8	28.2	
	A	2.5	12.3	1.9	17.0	3.1	78.4	62.8	29.4	

TABLE V-2 - Abundance indices of II-group COD by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (144)	No of squares fished
1972	U	6.7	52.6	6.3	21.3	74.0	11.7	110.4	37.5	106
	A	11.5	49.2	6.1	19.7	40.4	30.6	110.4	37.6	
1973	U	15.8	14.5	4.1	27.8	0.0	2.7	12.2	10.5	110
	A	7.3	14.5	3.8	25.7	0.1	11.1	12.2	12.2	
1974	U	8.0	6.7	6.3	12.0	5.7	8.7	13.3	9.5	134
	A	5.0	6.7	5.7	10.1	2.7	7.6	13.3	9.0	
1975	U	12.6	2.2	3.7	7.7	1.8	1.9	3.8	6.1	132
	A	8.2	2.4	3.5	6.3	0.8	1.7	3.8	6.1	
1976	U	19.5	15.0	4.5	18.4	3.0	27.3	31.4	20.2	131
	A	13.9	15.8	4.0	15.5	1.3	24.9	30.5	19.1	
1977	U	3.3	4.4	1.3	1.7	0.0	1.3	7.6	3.2	141
	A	2.5	4.4	1.2	1.4	0.6	1.2	7.6	3.2	
1978	U	14.7	16.5	4.1	8.4	23.0	137.1	46.6	42.3	142
	A	10.6	16.5	3.9	7.1	10.7	121.0	46.6	41.8	
1979	U	7.7	5.2	3.4	12.0	5.9	20.0	6.0	9.2	140
	A	5.6	5.2	3.3	10.2	2.8	17.2	6.1	9.0	
Average 1972 - 1979	U	11.0	14.6	4.2	13.7	14.2	26.3	28.9	17.3	
	A	8.1	14.3	3.9	12.0	7.4	26.9	28.8	17.3	

TABLE V-3 - Abundance indices of older COD by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (144)	No of squares fished
1972	U	-	-	-	-	-	-	-	7.2	106
	A	4.3	7.6	1.6	11.1	5.6	5.0	9.6	6.7	
1973	U	-	-	-	-	-	-	-	37.3	110
	A	21.8	11.2	6.7	31.7	4.2	86.9	13.7	34.9	
1974	U	-	-	-	-	-	-	-	7.7	134
	A	9.6	6.8	3.9	4.9	5.1	3.6	2.9	7.3	
1975	U	-	-	-	-	-	-	-	3.7	132
	A	2.8	2.7	3.2	6.5	1.2	2.4	4.7	3.6	
1976	U	-	-	-	-	-	-	-	6.1	131
	A	7.4	2.0	4.2	3.8	2.1	5.5	5.2	5.8	
1977	U	-	-	-	-	-	-	-	6.5	141
	A	6.7	13.4	1.5	2.1	4.0	2.0	6.3	6.5	
1978	U	-	-	-	-	-	-	-	4.4	142
	A	4.9	4.8	2.2	3.7	1.7	2.6	2.4	4.3	
1979	U	-	-	-	-	-	-	-	6.2	140
	A	5.1	4.0	3.9	11.0	4.2	7.0	6.4	6.1	
Average 1972 - 1979	U	-	-	-	-	-	-	-	9.9	
	A	7.8	6.6	3.4	9.4	3.5	14.4	6.4	9.4	

TABLE V-4 - Year class abundance estimates Cod.

Year class	I-Group			II-group			VPA
	A.M. 1) (unadj)	A.M. 2) (adj)	G.M. 3) (unadj)	A.M. 1) (unadj)	A.M. 2) (adj)	G.M. 3) (unadj)	Nr of 1 year 4) old recruits (x 10^{-6})
1963				(1.9)		(1.0)	234
1964	16.0		7.2	18.6		1.0	222
1965	20.2		3.6	23.4		2.9	315
1966	28.5		7.4	17.0		5.0	283
1967	5.4		2.7	5.7		2.1	92
1968	6.5		2.8	5.7		2.2	87
1969	71.5		14.1	25.5		4.2	368
1970	85.0		14.7	37.5	37.6	6.2	451
1971	4.1	5.3	1.3	10.5	12.2	2.4	83
1972	37.7	49.3	4.7	9.5	9.0	3.4	160
1973	14.6	19.6	3.1	6.1	6.1	2.2	145
1974	95.7	88.7	5.4	20.2	19.1	5.7	245
1975	8.8	8.4	1.9	3.2	3.2	1.3	124
1976	40.3	39.8	6.5	42.3	41.8	6.6	(582)
1977	14.4	14.5	3.3	9.2	9.0	2.9	
1978	9.8	9.9	2.2				

1) Average mean nr/hr per square, not corrected for missing squares.

2) Average mean nr/hr per square, corrected for missing squares.

3) Antilog of the average elog mean nr/hr square + 1, not corrected for missing squares.
(No variance adjustment of the transformed mean has been applied).

4) from ICES C.M. 1979/G : 7.

TABLE V-5 - Correlations between abundance indices cod.

	VPA/I-Group			VPA/II-Group			II-Group/I-Group		
	A.M.[u]	A.M.[a]	G.M.[u]	A.M.[u]	A.M.[a]	G.M.[u]	A.M.[u]	A.M.[a]	G.M.[u]
Correlation: N	12	5	12	12	6	12	14	7	14
r	.74	.95	.88	.95	.93	.71	.65	.39	.59
Geometric mean									
regression: U_o	93.77	95.56	59.94	36.73	46.29	-14.78			
U_1	3.68	1.72	26.94	11.67	10.67	71.23			
Estimated nr of recruits									
year class 1976	242	164	235	530	492	455			
1977	146	121	149	144	142	192			
1978	130	113	119						

TABLE V-6

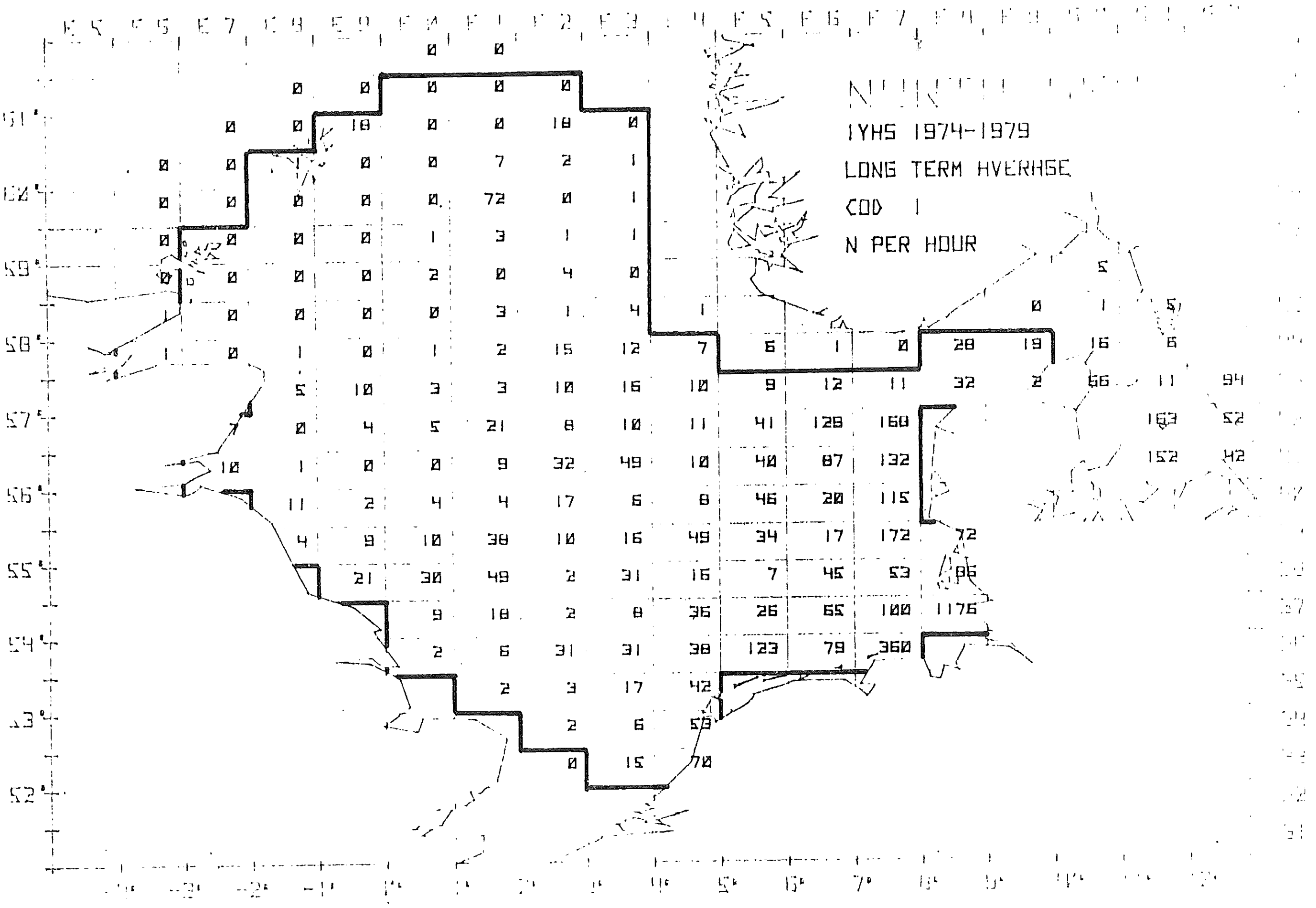
LENGTH STATISTICS BY AREAS IYHS 1972 - 1979

AREA:	RNDF-1	RNDF-2	RNDF-3	RNDF-4	RNDF-5	RNDF-6	RNDF-7	KATTEGAT	NORTH SEA
IYHS 1972 COD I									
NR OF SQUARES	12	21	18	12	6	26	12	12	106
MEAN N PER HOUR	0.5	5.9	1.4	3.3	0.8	1.8	12.8	6.5	4.1
MEAN LENGTH	18.41	16.67	21.43	21.83	24.10	18.20	15.59	18.17	17.23
STANDARD DEVIATION	2.70	4.13	5.19	5.07	3.36	4.98	3.53	3.95	4.69
MIN-L	12	10	13	11	20	10	9	9	9
MAX-L	23	29	31	30	28	30	30	26	31
IYHS 1973 COD I									
NR OF SQUARES	10	25	20	12	5	28	12	8	110
MEAN N PER HOUR	0.5	15.0	1.7	60.6	0.2	66.4	96.2	71.4	37.7
MEAN LENGTH	25.61	16.38	18.34	19.47	21.50	20.66	16.52	14.85	19.02
STANDARD DEVIATION	1.90	3.39	2.74	2.55	0.00	4.52	4.21	3.05	4.52
MIN-L	23	6	11	10	21	9	7	8	6
MAX-L	29	30	29	30	22	34	29	26	34
IYHS 1974 COD I									
NR OF SQUARES	34	25	20	11	5	29	12	12	134
MEAN N PER HOUR	19.6	13.8	1.8	19.6	0.1	5.2	31.7	47.5	14.6
MEAN LENGTH	16.77	17.90	18.51	16.89	20.50	19.13	17.58	20.72	17.50
STANDARD DEVIATION	5.46	4.39	2.90	2.67	1.41	3.44	4.23	5.02	4.43
MIN-L	11	9	13	11	19	11	8	8	8
MAX-L	27	32	27	28	22	30	30	31	32
IYHS 1975 COD I									
NR OF SQUARES	33	24	17	10	4	31	12	10	132
MEAN N PER HOUR	0.3	8.1	5.8	40.5	6.0	344.8	92.8	27.3	95.7
MEAN LENGTH	19.29	16.64	14.84	17.41	18.95	20.17	15.19	17.62	19.50
STANDARD DEVIATION	5.08	4.71	2.53	3.68	4.77	5.24	3.45	3.78	5.27
MIN-L	12	9	10	9	12	8	8	9	8
MAX-L	26	30	23	32	31	33	31	27	38
IYHS 1976 COD I									
NR OF SQUARES	39	24	15	11	4	31	11	14	131
MEAN N PER HOUR	2.8	4.0	1.3	5.1	0.2	12.6	36.8	15.3	8.8
MEAN LENGTH	22.23	16.54	19.30	17.28	17.00	19.97	16.90	21.99	18.77
STANDARD DEVIATION	3.76	3.70	3.69	3.22	0.71	3.93	3.50	5.08	4.10
MIN-L	16	6	13	12	16	6	9	11	6
MAX-L	33	28	26	28	18	31	30	31	33
IYHS 1977 COD I									
NR OF SQUARES	43	25	21	11	4	31	12	15	141
MEAN N PER HOUR	0.4	29.2	2.3	13.8	50.3	85.8	156.3	72.0	40.3
MEAN LENGTH	17.57	14.63	16.29	17.69	17.90	18.17	14.29	15.84	16.54
STANDARD DEVIATION	4.91	2.95	2.96	2.80	3.20	4.97	3.22	2.66	4.61
MIN-L	10	7	3	10	11	7	6	8	3
MAX-L	25	28	24	27	30	35	28	28	35
IYHS 1978 COD I									
NR OF SQUARES	41	25	21	11	5	30	12	14	142
MEAN N PER HOUR	0.5	16.3	0.2	13.1	2.8	24.9	58.3	45.4	14.4
MEAN LENGTH	17.78	14.87	21.50	18.70	19.93	21.09	18.96	17.51	19.70
STANDARD DEVIATION	3.98	2.65	4.04	3.54	3.17	3.80	3.27	3.68	4.09
MIN-L	12	8	14	10	14	9	8	10	8
MAX-L	26	25	28	28	26	31	27	26	31
IYHS 1979 COD I									
NR OF SQUARES	41	25	21	11	5	29	11	13	140
MEAN N PER HOUR	0.3	6.3	0.6	1.5	2.2	30.6	17.7	35.9	9.8
MEAN LENGTH	21.27	15.61	16.81	18.82	22.75	20.36	15.72	18.81	19.53
STANDARD DEVIATION	4.18	3.43	3.64	4.30	2.21	4.29	3.36	4.05	4.49
MIN-L	11	7	10	10	17	8	9	9	7
MAX-L	27	27	26	26	26	33	28	28	33
LONG TERM MEAN L	19.87	16.15	18.38	18.51	20.33	19.72	16.34	18.19	18.47

TABLE V-7

LENGTH STATISTICS BY AREAS IYHS 1972 - 1979

AREA:	RNDF-1	RNDF-2	RNDF-3	RNDF-4	RNDF-5	RNDF-6	RNDF-7	KATTEGAT	NORTH SEA
IYHS 1972 COD II									
NR OF SQUARES	12	21	18	12	6	26	12	12	106
MEAN N PER HOUR	6.7	52.6	6.3	21.3	74.0	11.7	110.4	48.1	37.5
MEAN LENGTH	32.33	27.84	32.78	32.17	33.80	37.13	30.14	38.41	31.03
STANDARD DEVIATION	4.24	4.15	5.85	4.89	4.82	5.40	4.25	5.55	5.17
MIN-L	21	19	23	20	24	21	20	25	19
MAX-L	42	42	47	48	51	50	48	49	51
IYHS 1973 COD II									
NR OF SQUARES	10	25	20	12	5	28	12	8	110
MEAN N PER HOUR	15.8	14.5	4.1	27.8	0.0	2.7	12.2	71.8	10.5
MEAN LENGTH	30.80	31.95	38.60	27.89	0.00	44.73	33.30	27.87	32.63
STANDARD DEVIATION	3.42	3.84	6.63	3.62	0.00	9.05	4.65	5.26	6.61
MIN-L	21	24	24	20	0	24	24	20	20
MAX-L	43	42	56	47	0	54	43	49	56
IYHS 1974 COD II									
NR OF SQUARES	34	25	20	11	5	28	12	12	134
MEAN N PER HOUR	8.0	6.7	5.3	12.0	5.7	8.7	13.3	42.4	9.5
MEAN LENGTH	39.14	34.52	37.31	33.04	40.50	43.44	36.56	37.98	38.48
STANDARD DEVIATION	6.36	5.31	5.60	4.80	5.18	6.88	4.31	5.99	6.66
MIN-L	26	24	25	25	32	23	27	26	23
MAX-L	51	50	52	45	53	58	55	59	59
IYHS 1975 COD II									
NR OF SQUARES	33	24	17	10	4	31	12	10	132
MEAN N PER HOUR	12.6	2.2	3.7	7.7	1.8	1.9	3.8	57.0	6.1
MEAN LENGTH	35.62	37.55	34.84	34.28	44.58	43.91	35.85	38.23	37.86
STANDARD DEVIATION	5.77	6.20	6.16	5.18	3.25	5.33	5.88	5.89	6.63
MIN-L	22	25	23	23	41	25	25	24	22
MAX-L	57	59	61	52	50	59	55	53	61
IYHS 1976 COD II									
NR OF SQUARES	39	24	15	11	4	31	11	14	131
MEAN N PER HOUR	19.5	15.0	4.5	18.4	3.0	27.3	31.4	24.2	20.2
MEAN LENGTH	36.24	28.67	32.62	29.71	43.32	45.45	32.57	38.41	39.89
STANDARD DEVIATION	5.41	5.69	6.27	5.37	6.99	7.34	5.85	4.86	9.52
MIN-L	23	18	22	20	32	25	20	27	18
MAX-L	51	53	53	52	56	61	54	48	61
IYHS 1977 COD II									
NR OF SQUARES	43	25	21	11	4	31	12	15	141
MEAN N PER HOUR	3.3	4.4	1.3	1.7	0.0	1.3	7.6	14.0	3.2
MEAN LENGTH	32.53	31.78	35.10	33.47	0.00	37.27	34.18	33.50	34.07
STANDARD DEVIATION	3.77	3.80	3.65	3.24	0.00	8.42	3.75	6.68	5.23
MIN-L	23	24	23	24	0	22	24	23	22
MAX-L	44	44	45	42	0	60	46	49	60
IYHS 1978 COD II									
NR OF SQUARES	41	25	21	11	5	30	12	14	142
MEAN N PER HOUR	14.7	16.5	4.1	8.4	23.0	137.1	46.6	84.8	42.3
MEAN LENGTH	32.87	31.26	36.80	35.24	39.95	40.10	30.80	31.47	39.09
STANDARD DEVIATION	5.71	5.47	6.36	6.36	5.57	5.30	5.43	5.32	5.98
MIN-L	20	19	24	24	21	20	21	17	19
MAX-L	60	52	51	66	59	66	60	55	66
IYHS 1979 COD II									
NR OF SQUARES	41	25	21	11	5	29	11	13	140
MEAN N PER HOUR	7.7	5.2	3.4	12.0	5.9	20.0	6.0	106.6	9.2
MEAN LENGTH	33.46	33.45	35.50	37.51	42.08	40.11	36.10	36.92	38.16
STANDARD DEVIATION	5.45	5.56	6.83	6.32	5.63	6.92	4.80	5.34	7.02
MIN-L	22	21	20	24	28	21	23	26	20
MAX-L	55	49	54	58	54	58	45	49	58
LONG TERM MEAN L	34.12	32.13	35.44	32.91	40.70	41.52	33.69	35.35	36.40


IYHS 1974-1979
LONG TERM AVERAGE
COD 1
N PER HOUR

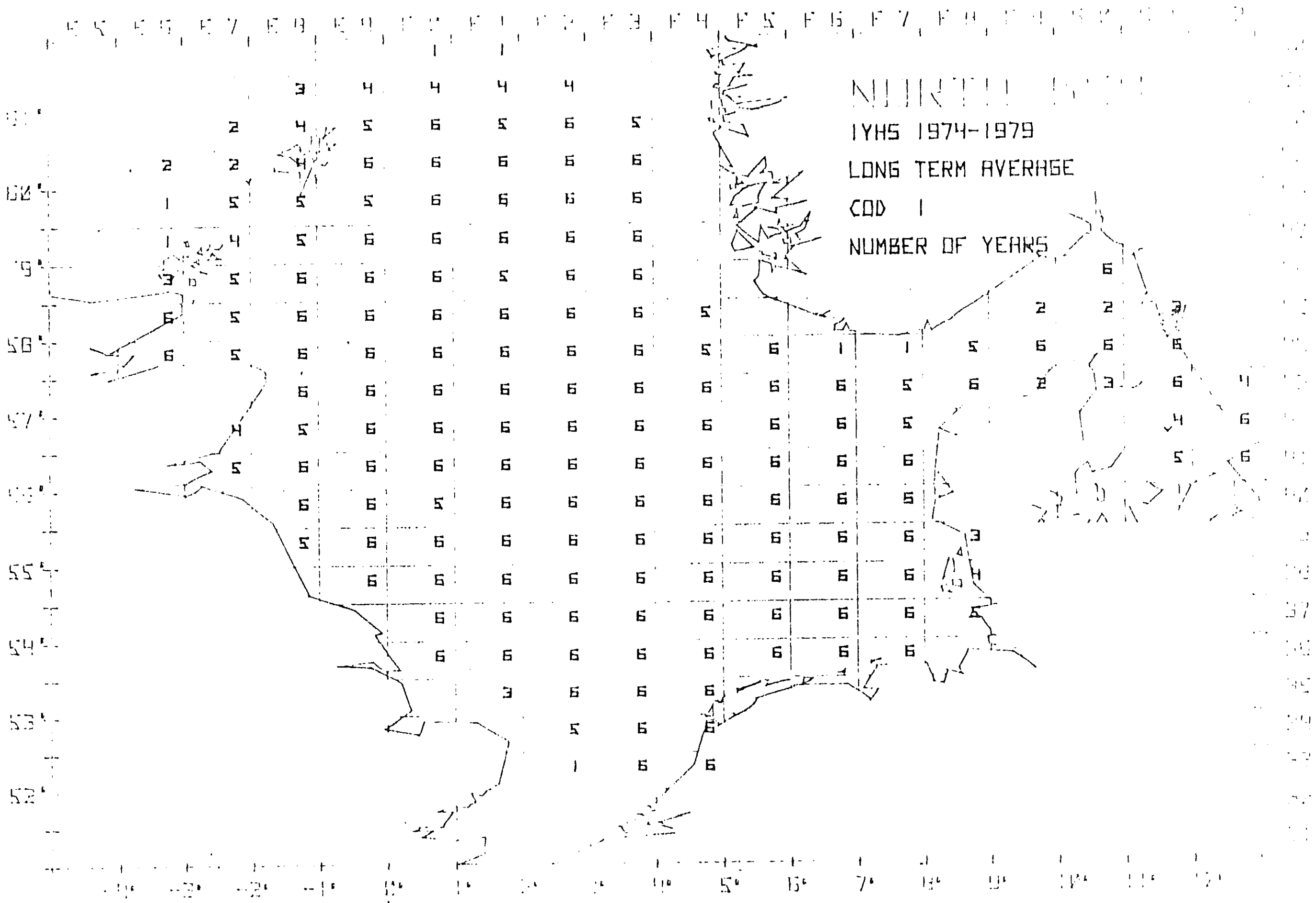
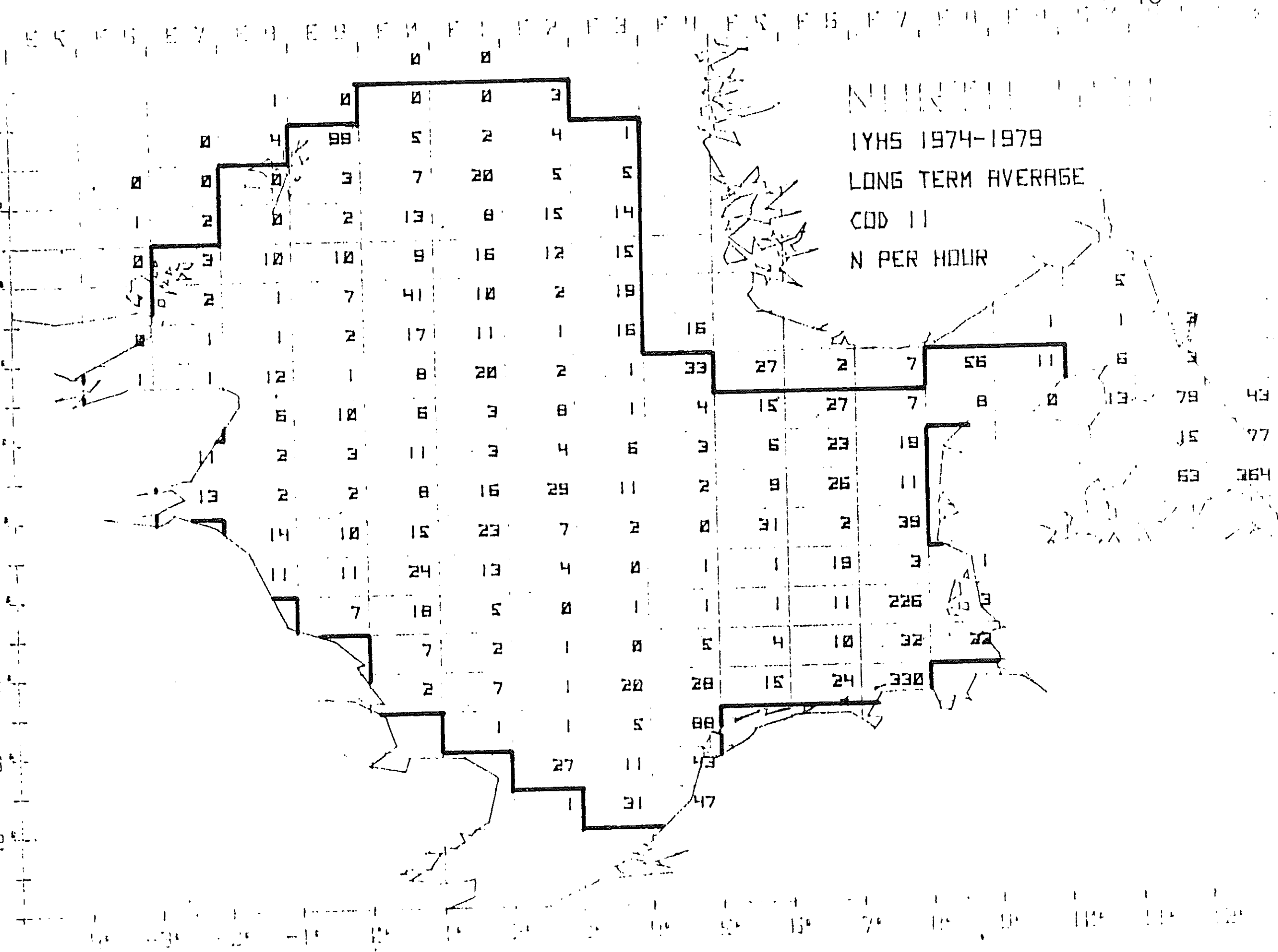

IYHS 1974-1979
LONG TERM AVERAGE
COD 1
NUMBER OF YEARS

Figure 5 - 1.


IYHS 1974-1979
LONG TERM AVERAGE
COD II
N PER HOUR

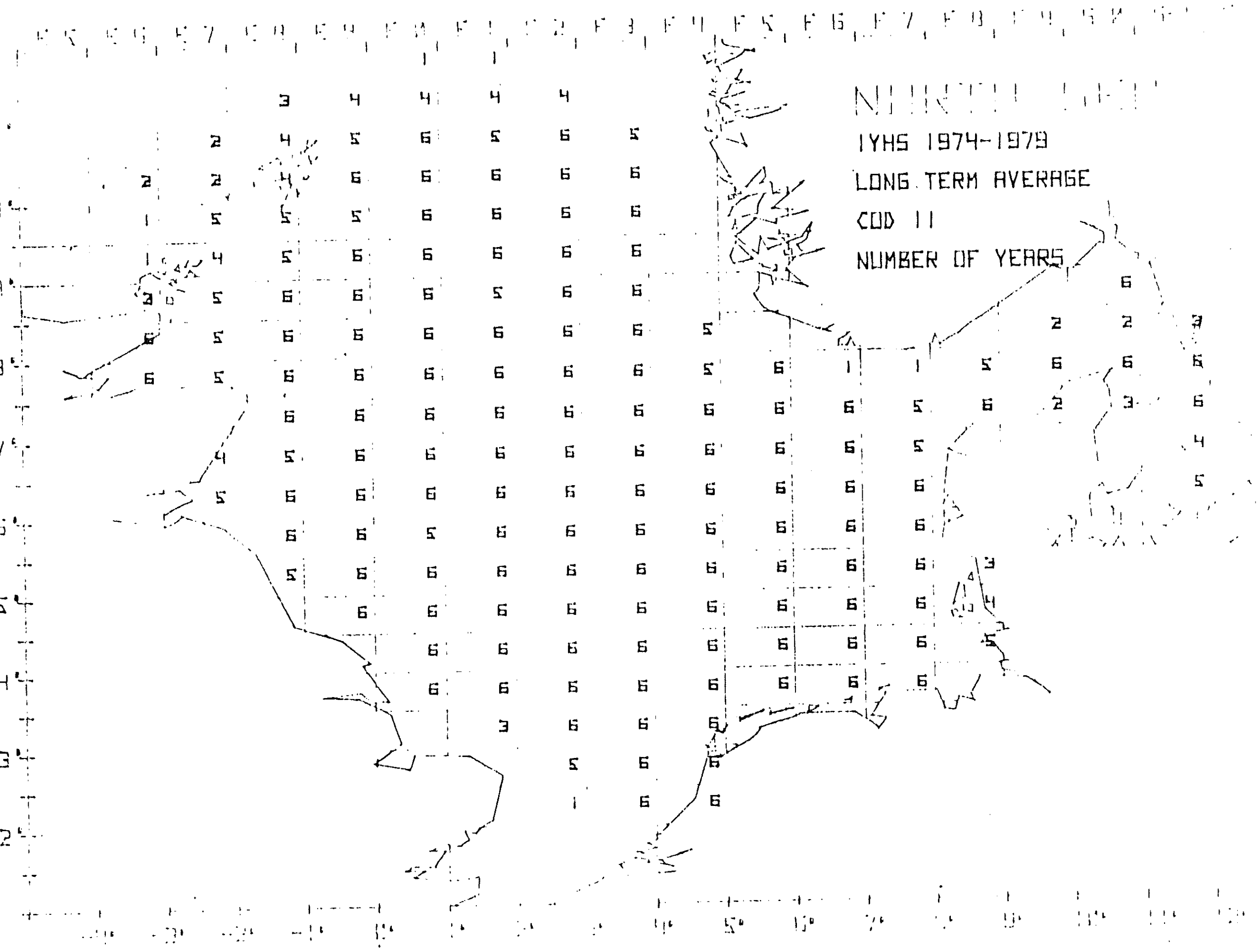
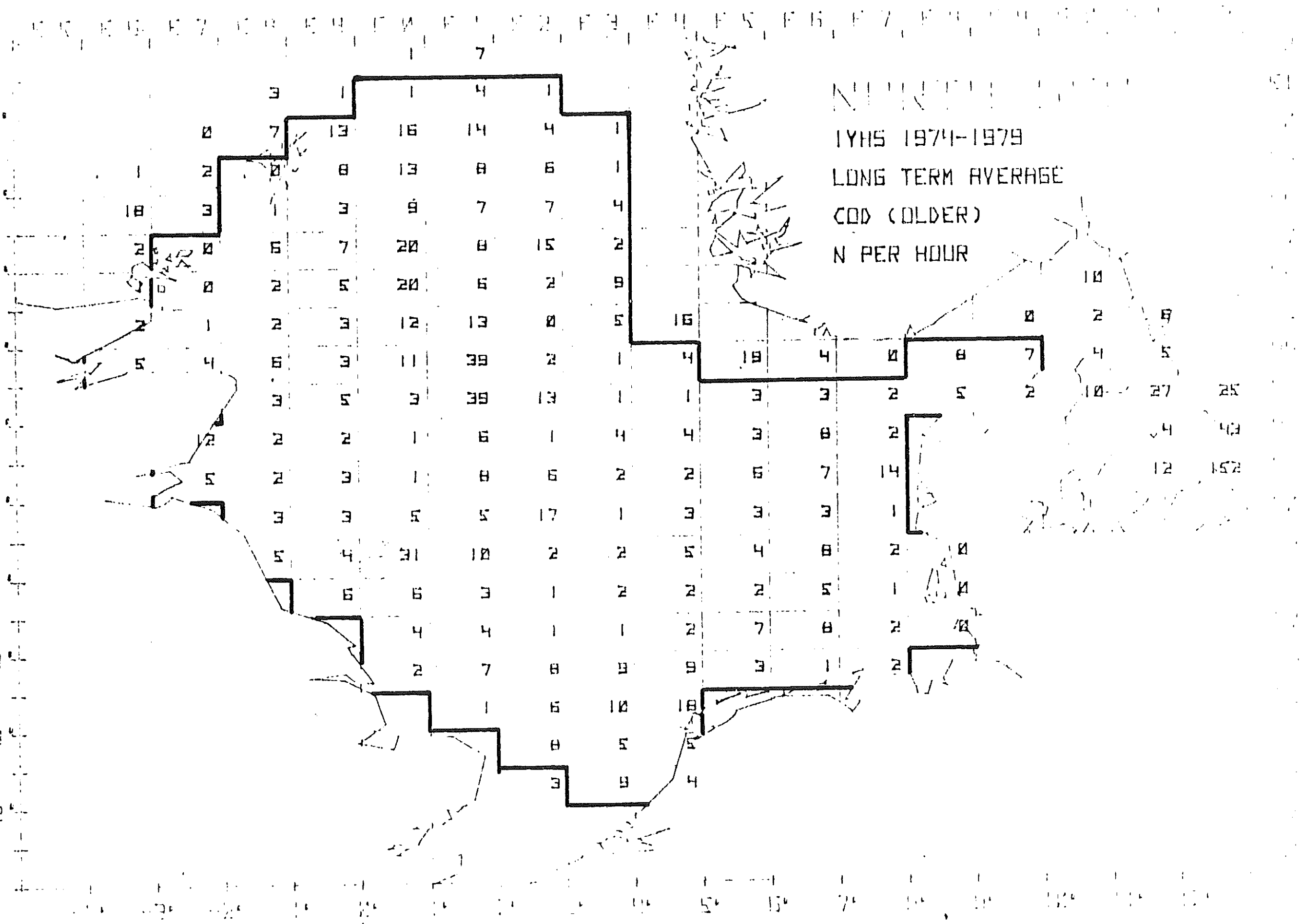

IYHS 1974-1979
LONG TERM AVERAGE
COD II
NUMBER OF YEARS

Figure 5 - 2.


IYHS 1974-1979
LONG TERM AVERAGE
COD (OLDER)
N PER HOUR

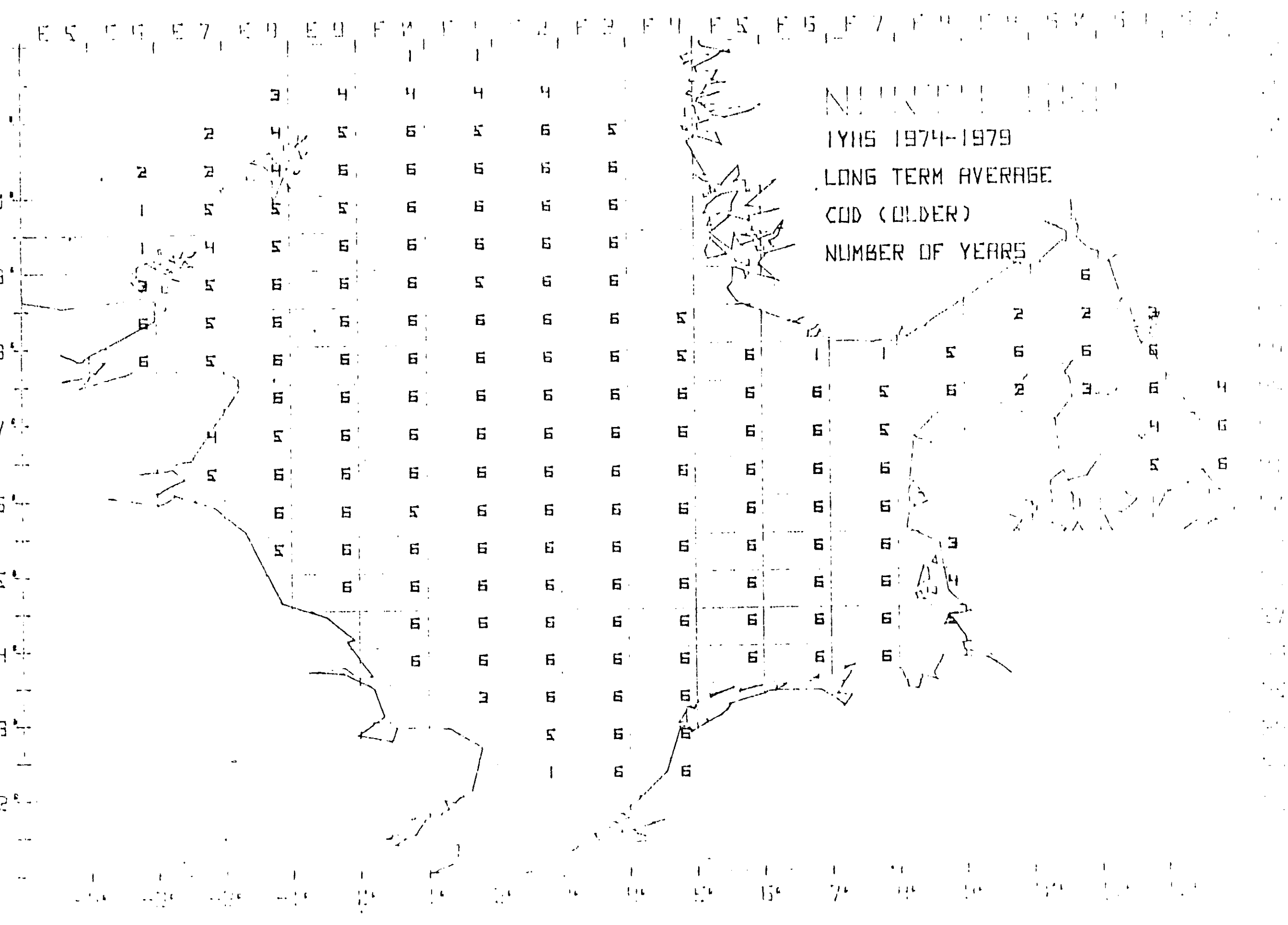

IYHS 1974-1979
LONG TERM AVERAGE
COD (OLDER)
NUMBER OF YEARS

Figure 5 - 3.

VI. HADDOCK

Long-term abundance

Haddock occur mainly in the northwestern parts of the North Sea, being only scarcely found south of 55°N. It seems that the concentration shifts slightly further northwards with increasing age, but no further evaluation was done on this topic (Fig. 6 -1/3).

Abundance by sub-areas

Tables VI-1 and -2 give the average catches both adjusted and unadjusted for I- and II-group split by sampling areas. The highest catches occurred in the northern sub-areas 1, 2 and 3 (Fig. X-1), whereas catches in sub-areas 5 and 6 were negligible. Adjusting the data has little affect on the overall North Sea means, but can have considerable influence on the average in sub-area 1.

The differences between arithmetic and geometric mean tend to be large, thus indicating a high degree of variability.

Comparison with other estimates

Correlations between average catches (both arithmetic and geometric) and VPA recruitment estimates were calculated (Table VI-4). Since coverage of the haddock area was poor before 1971, one set of calculations was done excluding these years of poor coverage. Nevertheless, all correlations between the two independant sources of year class strength estimates are highly significant. In order to eliminate the effects of outstanding year class sizes, a rank correlation coefficient was calculated, giving similar results.

In view of the fact that apparently reliable predictions of year class strength can be obtained using data from 1972 onwards and because coverage of the haddock area was poor in the earlier surveys, it seems appropriate that only these more recent data are used when making predictions of absolute numbers of recruits from IYHS. Another important argument why earlier data should be excluded for this particular purpose is that the regression parameters determined for the complete time series are to a large extent depending on the one data point, referring to the extremely abundant 1967 year class.

Length at age

The mean lengths of I- and II-group for the years 1972 to 1979 for separate areas are shown in table VI-6 and VI-7. At the bottom of the tables the long-term means are listed which show that the mean length for both I- and II-group increase from north to south. No significant correlation was found between mean length and year class abundance.

TABLE VI-1 - Abundance indices of I-group HADDOCK by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (115)	No of squares fished
1972	U	671	693	1767	201	0	0	5	740	76
	A	721	694	1607	136	0	0	5	821	
1973	U	708	60	301	11	0	0	8	187	78
	A	284	60	263	10	0	0	8	133	
1974	U	1784	634	1473	300	0	4	36	1072	102
	A	1125	634	1346	254	0	3	36	978	
1975	U	1572	913	1575	729	1	13	358	1168	97
	A	1014	886	1245	561	0	12	358	1042	
1976	U	284	77	114	14	0	3	168	177	96
	A	232	83	107	12	0	3	157	178	
1977	U	291	90	52	11	1	1	104	162	106
	A	225	90	50	9	0	1	104	153	
1978	U	513	571	261	57	0	1	35	385	107
	A	371	571	250	48	0	1	35	368	
1979	U	778	339	457	22	0	2	91	478	106
	A	562	339	437	18	0	1	87	443	
Average 1972 - 1979	U	825	422	750	168	0	3	101	546	
	A	567	420	663	131	0	3	99	515	

TABLE VI-2 - Abundance indices of II-group HADDOCK by sub-area (surveys 1972 - 1979).
(U : unadjested means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (115)	No of squares fished
1972	U	243	330	465	319	1	1	36	299	76
	A	318	323	443	295	1	1	36	344	
1973	U	2133	851	1263	692	0	0	73	971	78
	A	1167	851	1107	638	0	1	73	1042	
1974	U	124	47	285	8	0	0	1	110	102
	A	84	47	260	7	0	1	1	102	
1975	U	648	279	477	81	0	0	34	385	97
	A	440	283	389	66	0	0	34	361	
1976	U	847	733	1069	356	1	4	122	670	96
	A	682	442	854	301	0	1	112	642	
1977	U	107	119	33	30	0	1	28	84	106
	A	81	119	31	25	0	1	28	78	
1978	U	191	67	92	12	0	2	23	108	107
	A	199	67	88	11	0	1	32	107	
1979	U	499	93	114	21	0	1	12	239	106
	A	362	93	109	18	0	0	12	221	
Average 1972 - 1979	U	599	315	475	190	0	1	41	358	
	A	409	278	410	170	0	1	41	362	

TABLE VI-3 - Abundance indices of older HADDOCK by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (115)	No of squares fished
1972	U	-	-	-	-	-	-	-	37	76
	A	41	30	62	16	0	1	40	42	
1973	U	-	-	-	-	-	-	-	247	78
	A	240	200	373	504	0	21	30	279	
1974	U	-	-	-	-	-	-	-	268	102
	A	188	297	473	38	0	0	26	247	
1975	U	-	-	-	-	-	-	-	69	97
	A	101	22	43	26	0	0	16	65	
1976	U	-	-	-	-	-	-	-	130	96
	A	195	58	162	41	0	1	38	142	
1977	U	-	-	-	-	-	-	-	178	106
	A	202	128	188	45	0	1	22	166	
1978	U	-	-	-	-	-	-	-	104	107
	A	125	50	117	20	0	1	16	98	
1979	U	-	-	-	-	-	-	-	53	106
	A	76	23	48	4	0	0	12	50	
Average 1972 - 1979	U	-	-	-	-	-	-	-	136	
	A	146	101	183	87	0	3	25	136	

TABLE VI-4 - Year class abundance estimates Haddock.

Year class	I-Group			II-Group			VPA
	A.M. 1) (unadj)	A.M. 2) (adj)	C.M. 3) (unadj)	A.M. 1) (unadj)	A.M. 2) (adj)	G.M. 3) (unadj)	No of 2-year 4) old recruits (x 10^{-6})
1964				(1)		(1)	29
1965	12		3	13		4	109
1966	62		12	52		19	536
1967	5855		1302	4563		986	4816
1968	81		8	46		13	229
1969	27		6	32		8	85
1970	873		133	299	344	57	694
1971	740	821	61	971	1042	122	909
1972	187	133	12	110	102	24	190
1973	1072	978	206	385	361	89	830
1974	1168	1042	542	670	642	122	1396
1975	177	178	32	84	78	20	155
1976	162	153	38	108	107	25	(349)
1977	385	368	71	239	221	30	
1978	478	443	85				

1), 2), 3), 4) See foot notes on table V-4.

TABLE VI-5 - Correlations between abundance indices Haddock.

	VPA/I-GROUP			VPA/II-GROUP			II-GROUP/I-GROUP		
	A.M.[u]	A.M.[a]	G.M.[u]	A.M.[u]	A.M.[a]	G.M.[u]	A.M.[u]	A.M.[a]	G.M.[u]
Correlation: N	11	5	11	11	6	11	13	7	13
r	.99	.94	.98	.99	.73	.99	.99	.76	.95
Geometric mean regression									
U_o	145.7	-54.18	196.0	234.5	143.3	270.9			
U_1	.814	1.19	3.44	1.02	1.29	4.76			
Estimated nr of recruits									
Year class 1976	278	128	327	345	281	390			
1977	459	384	440	478	428	414			
1978	535	582	488						
Spearman's Rank Correction Coefficient	.87	.79	.92	.94	.95	.95			

TABLE VI-6

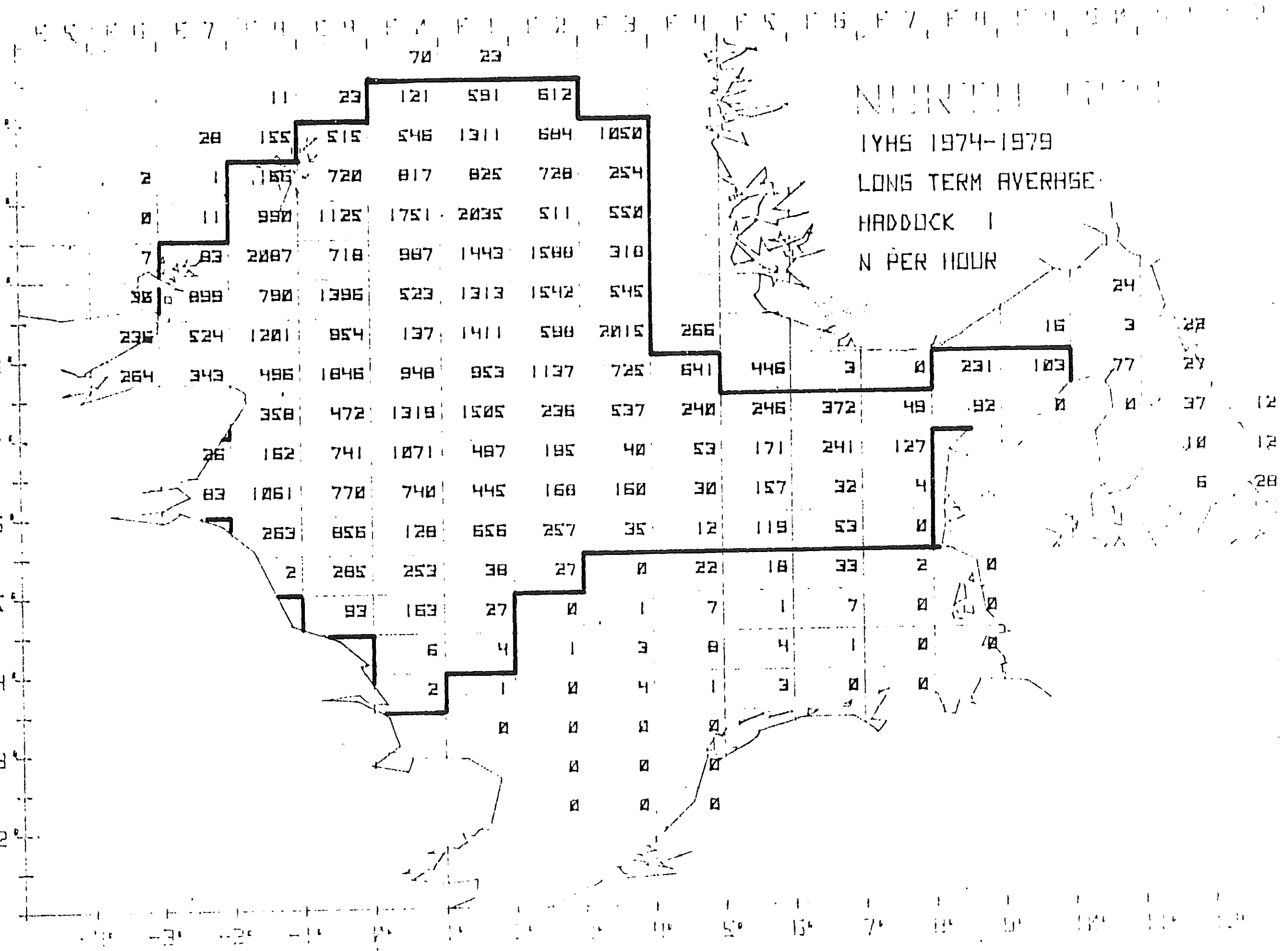
LENGTH STATISTICS BY AREAS IYHS 1972 - 1979

AREA:	RNDF-1	RNDF-2	RNDF-3	RNDF-4	RNDF-5	RNDF-6	RNDF-7	KATTEGAT	NORTH SEA
IYHS 1972 HADDOCK I									
NR OF SQUARES	12	22	18	12	6	27	12	12	76
MEAN N PER HOUR	670.5	693.4	1767.3	201.1	0.3	0.0	5.1	2.0	739.6
MEAN LENGTH	14.62	17.30	16.51	18.91	17.50	21.50	18.72	19.61	16.65
STANDARD DEVIATION	2.02	2.50	1.73	1.53	0.00	0.00	3.35	2.30	2.14
MIN-L	9	9	10	12	17	21	12	13	9
MAX-L	22	26	24	25	18	22	25	26	26
IYHS 1973 HADDOCK I									
NR OF SQUARES	10	25	19	12	5	28	12	8	78
MEAN N PER HOUR	708.3	59.9	301.3	11.1	0.0	0.0	8.3	4.7	186.5
MEAN LENGTH	15.33	16.81	16.95	18.29	0.00	0.00	19.73	19.83	16.47
STANDARD DEVIATION	1.42	1.37	1.81	1.01	0.00	0.00	2.01	2.61	1.93
MIN-L	11	13	11	16	0	0	15	14	11
MAX-L	20	24	22	21	0	0	23	26	26
IYHS 1974 HADDOCK I									
NR OF SQUARES	34	25	20	11	5	28	12	12	102
MEAN N PER HOUR	1783.5	633.5	1472.6	299.9	0.0	4.0	36.1	53.8	1072.2
MEAN LENGTH	15.54	17.84	16.46	19.09	0.00	23.20	17.92	19.99	16.19
STANDARD DEVIATION	1.92	2.34	1.89	1.73	0.00	1.52	3.58	2.48	2.17
MIN-L	10	11	12	13	0	18	10	12	10
MAX-L	28	26	27	25	0	29	27	26	28
IYHS 1975 HADDOCK I									
NR OF SQUARES	33	24	17	10	4	31	12	10	97
MEAN N PER HOUR	1571.8	912.8	1574.9	729.1	1.2	12.6	358.3	212.9	1167.6
MEAN LENGTH	15.44	17.51	16.31	18.37	22.19	21.35	19.21	19.84	16.56
STANDARD DEVIATION	1.84	2.07	1.44	1.85	0.75	1.72	2.54	2.29	2.26
MIN-L	9	11	11	11	20	16	11	12	9
MAX-L	22	28	24	28	23	33	28	28	28
IYHS 1976 HADDOCK I									
NR OF SQUARES	39	24	15	11	4	31	11	14	96
MEAN N PER HOUR	284.4	77.1	114.4	14.1	0.1	2.9	168.3	37.1	176.8
MEAN LENGTH	16.10	20.57	17.96	20.85	21.50	22.22	21.23	20.55	17.61
STANDARD DEVIATION	2.43	1.97	2.14	2.45	0.00	2.62	1.66	2.31	3.09
MIN-L	9	11	11	14	21	18	13	13	9
MAX-L	25	25	23	25	22	27	28	27	28
IYHS 1977 HADDOCK I									
NR OF SQUARES	43	25	21	11	4	31	12	15	106
MEAN N PER HOUR	291.2	89.5	51.9	10.6	0.5	0.9	104.4	10.7	161.8
MEAN LENGTH	15.10	17.40	16.25	20.35	21.90	21.52	20.02	18.49	16.22
STANDARD DEVIATION	2.12	2.12	2.13	1.90	0.89	1.98	2.11	2.66	2.75
MIN-L	9	11	11	12	20	16	6	12	6
MAX-L	24	27	27	26	23	28	28	26	28
IYHS 1978 HADDOCK I									
NR OF SQUARES	41	25	21	11	5	30	12	14	107
MEAN N PER HOUR	513.1	571.2	261.2	57.1	0.0	1.2	34.8	15.9	385.2
MEAN LENGTH	15.34	17.20	16.42	20.54	0.00	22.23	19.98	21.06	16.30
STANDARD DEVIATION	1.66	1.70	2.01	1.77	0.00	2.03	2.21	2.63	2.06
MIN-L	9	11	11	15	0	16	14	14	9
MAX-L	24	26	24	28	0	29	27	30	30
IYHS 1979 HADDOCK I									
NR OF SQUARES	41	25	21	11	5	29	11	13	106
MEAN N PER HOUR	778.3	338.7	457.0	21.6	0.0	1.5	91.0	7.1	478.4
MEAN LENGTH	15.39	17.38	16.84	19.78	0.00	22.47	19.89	21.97	16.31
STANDARD DEVIATION	2.01	1.70	1.76	1.75	0.00	1.65	2.14	1.92	2.15
MIN-L	10	11	10	15	0	18	12	13	10
MAX-L	24	27	34	26	0	27	26	27	34
LONG TERM MEAN L	15.36	17.75	16.71	19.52	20.77	22.07	19.59	20.17	16.54

TABLE VI-7

LENGTH STATISTICS BY AREAS IYHS 1972 - 1979

AREA:	RNDF-1	RNDF-2	RNDF-3	RNDF-4	RNDF-5	RNDF-6	RNDF-7	KATTEGAT	NORTH SEA
IYHS 1972 HADDOCK II									
NR OF SQUARES	12	22	18	12	6	27	12	12	76
MEAN N PER HOUR	242.6	330.1	465.1	319.3	0.5	1.2	35.5	0.4	298.5
MEAN LENGTH	27.24	28.17	26.61	28.92	35.17	35.34	33.05	35.05	27.57
STANDARD DEVIATION	2.82	2.52	2.84	2.43	0.58	2.66	2.73	2.38	2.96
MIN-L	20	22	18	22	34	30	23	32	18
MAX-L	35	43	37	45	36	43	42	40	45
IYHS 1973 HADDOCK II									
NR OF SQUARES	10	25	19	12	5	28	12	8	78
MEAN N PER HOUR	2132.5	850.9	1262.8	691.6	0.0	0.3	72.5	0.8	971.3
MEAN LENGTH	24.56	25.90	23.98	27.04	0.00	33.85	28.38	33.50	25.00
STANDARD DEVIATION	2.22	2.46	2.79	2.35	0.00	3.18	2.27	3.42	2.79
MIN-L	18	18	16	18	0	28	21	27	16
MAX-L	35	37	32	37	0	39	36	38	37
IYHS 1974 HADDOCK II									
NR OF SQUARES	34	25	20	11	5	28	12	12	102
MEAN N PER HOUR	124.3	46.8	284.6	8.0	0.0	0.1	1.3	3.5	109.9
MEAN LENGTH	25.11	25.11	23.80	25.28	0.00	26.00	30.15	32.67	24.40
STANDARD DEVIATION	2.46	2.45	2.81	2.38	0.00	3.70	5.36	5.96	2.80
MIN-L	19	21	16	19	0	23	22	21	16
MAX-L	32	36	45	33	0	32	42	41	45
IYHS 1975 HADDOCK II									
NR OF SQUARES	33	24	17	10	4	31	12	10	97
MEAN N PER HOUR	647.5	279.1	477.1	81.3	0.0	0.4	34.4	20.9	384.8
MEAN LENGTH	25.77	27.60	25.09	28.35	0.00	31.57	31.18	35.05	26.24
STANDARD DEVIATION	3.42	3.19	3.11	3.16	0.00	4.56	2.78	3.42	3.57
MIN-L	17	17	19	20	0	21	23	25	17
MAX-L	39	41	36	38	0	39	41	42	42
IYHS 1976 HADDOCK II									
NR OF SQUARES	39	24	15	11	4	31	11	14	96
MEAN N PER HOUR	846.7	432.9	1068.6	355.9	0.8	3.9	121.7	15.6	670.0
MEAN LENGTH	25.65	26.54	23.81	26.04	31.50	33.61	30.25	33.51	25.55
STANDARD DEVIATION	3.47	2.88	2.93	2.59	1.83	3.15	4.88	3.26	3.40
MIN-L	17	18	15	18	29	22	20	23	15
MAX-L	40	40	37	38	34	44	42	43	43
IYHS 1977 HADDOCK II									
NR OF SQUARES	43	25	21	11	4	31	12	15	105
MEAN N PER HOUR	106.7	119.2	32.7	29.6	0.4	0.6	27.8	4.2	83.9
MEAN LENGTH	25.64	27.54	24.74	28.85	36.10	33.85	32.77	32.69	26.87
STANDARD DEVIATION	3.09	2.94	2.21	2.63	1.34	3.18	2.65	3.47	3.37
MIN-L	17	20	17	20	35	20	23	23	17
MAX-L	35	39	31	36	39	39	40	39	40
IYHS 1978 HADDOCK II									
NR OF SQUARES	41	25	21	11	5	30	12	14	107
MEAN N PER HOUR	190.6	67.3	92.2	12.4	0.2	1.5	23.2	11.9	108.0
MEAN LENGTH	25.24	28.30	25.55	28.77	21.50	31.34	33.42	32.37	26.01
STANDARD DEVIATION	2.77	3.29	2.92	3.61	0.00	6.49	3.08	4.71	3.42
MIN-L	18	20	19	21	21	20	23	23	18
MAX-L	38	41	41	38	22	45	42	45	45
IYHS 1979 HADDOCK II									
NR OF SQUARES	41	25	21	11	5	29	11	13	106
MEAN N PER HOUR	499.0	93.2	114.1	21.4	0.3	0.6	12.0	1.3	239.4
MEAN LENGTH	26.73	29.96	27.11	28.71	34.50	35.72	29.30	32.36	27.13
STANDARD DEVIATION	3.04	2.85	3.07	2.74	10.39	3.95	3.85	3.60	3.18
MIN-L	18	21	17	21	25	24	21	23	17
MAX-L	38	40	37	39	44	44	39	37	40
LONG TERM MEAN L	25.74	27.39	25.09	27.75	31.75	32.66	31.06	33.40	26.10


IYHS 1974-1979
LONG TERM AVERAGE
HADDOCK I
N PER HOUR

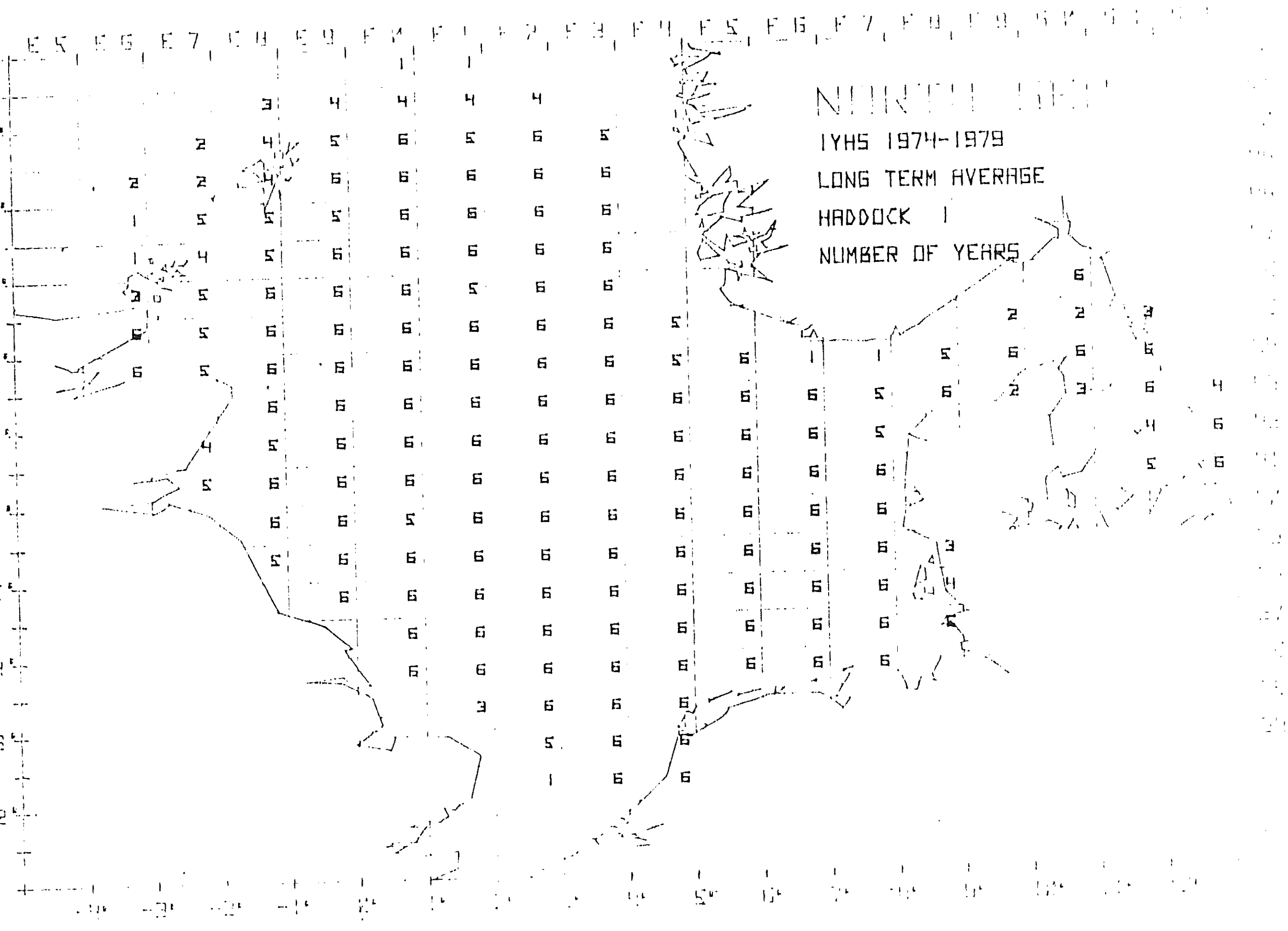
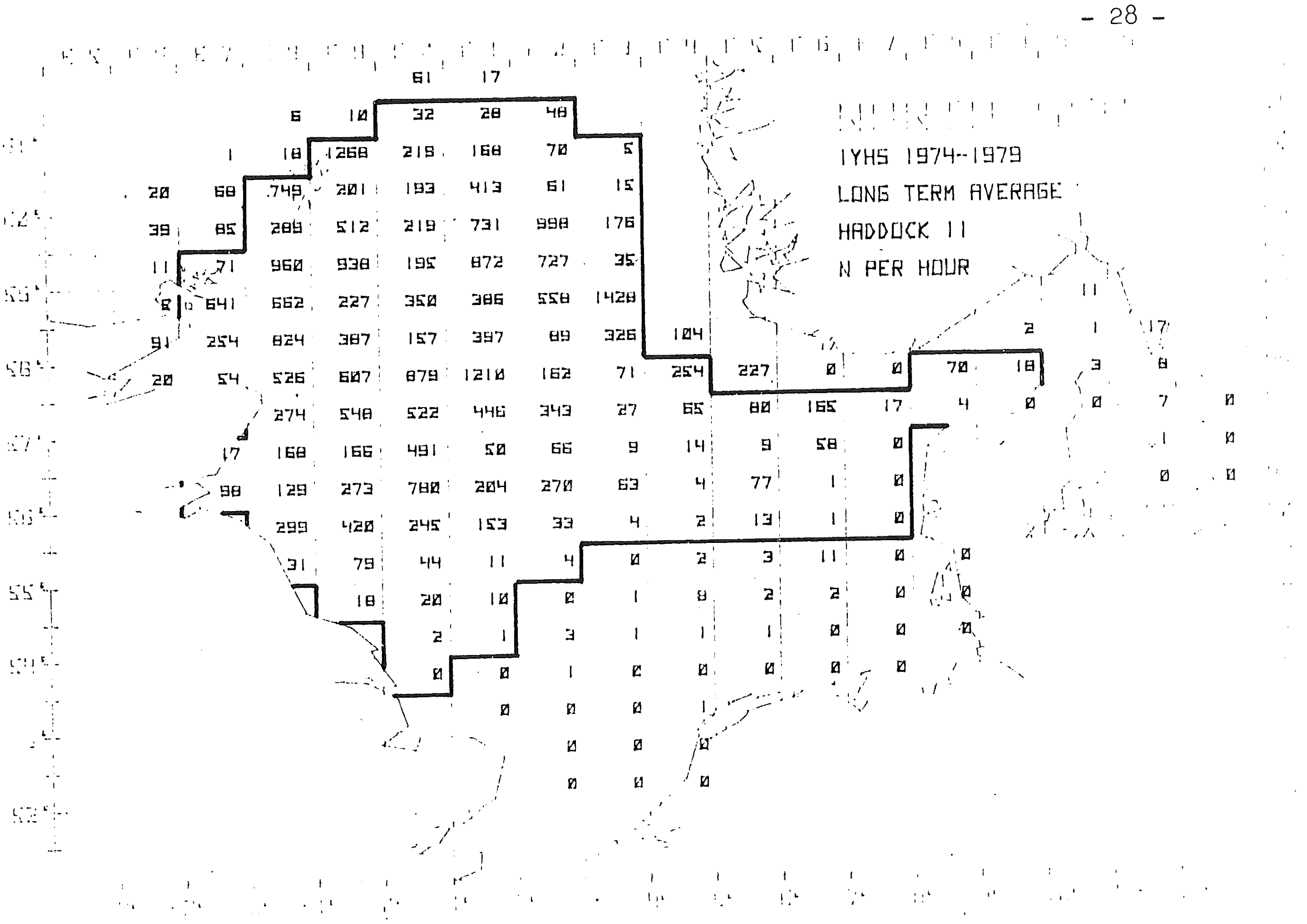

IYHS 1974-1979
LONG TERM AVERAGE
HADDOCK I
NUMBER OF YEARS

Figure 6 - 1.


IYHS 1974-1979
LONG TERM AVERAGE
HADDOCK II
N PER HOUR

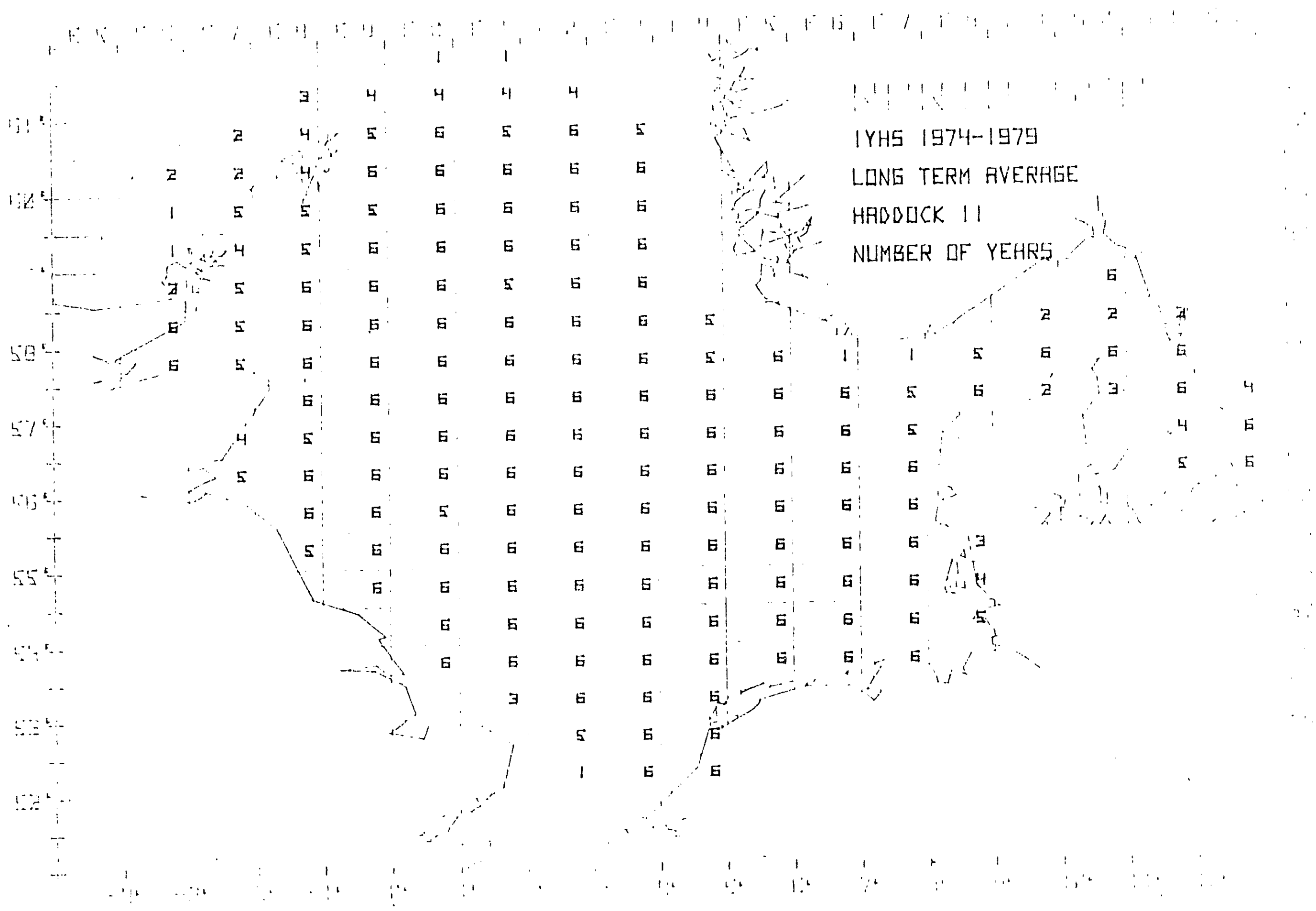
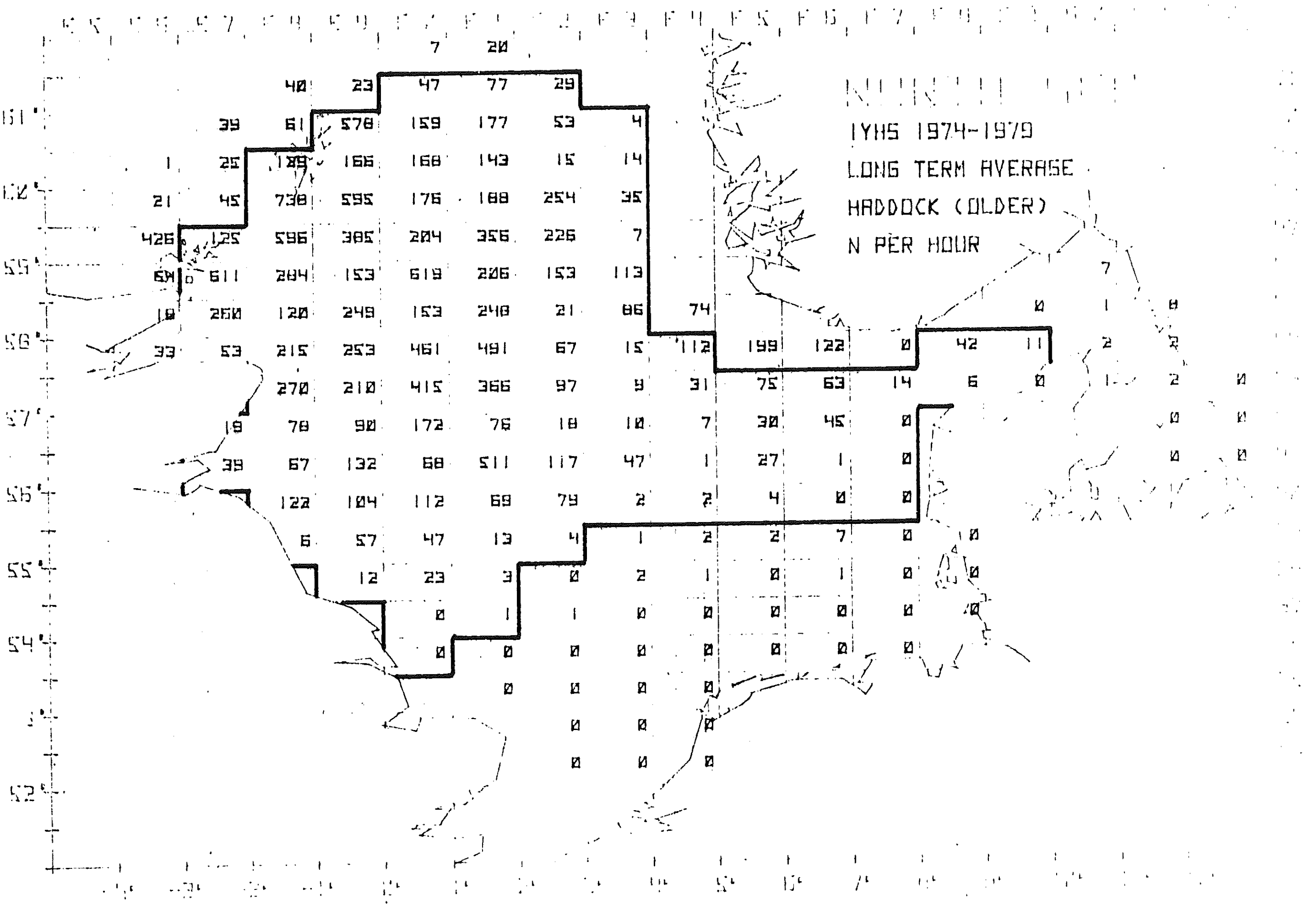

IYHS 1974-1979
LONG TERM AVERAGE
HADDOCK II
NUMBER OF YEARS

Figure 6 - 2.


IYHS 1974-1979
LONG TERM AVERAGE
HADDOCK (OLDER)
N PER HOUR

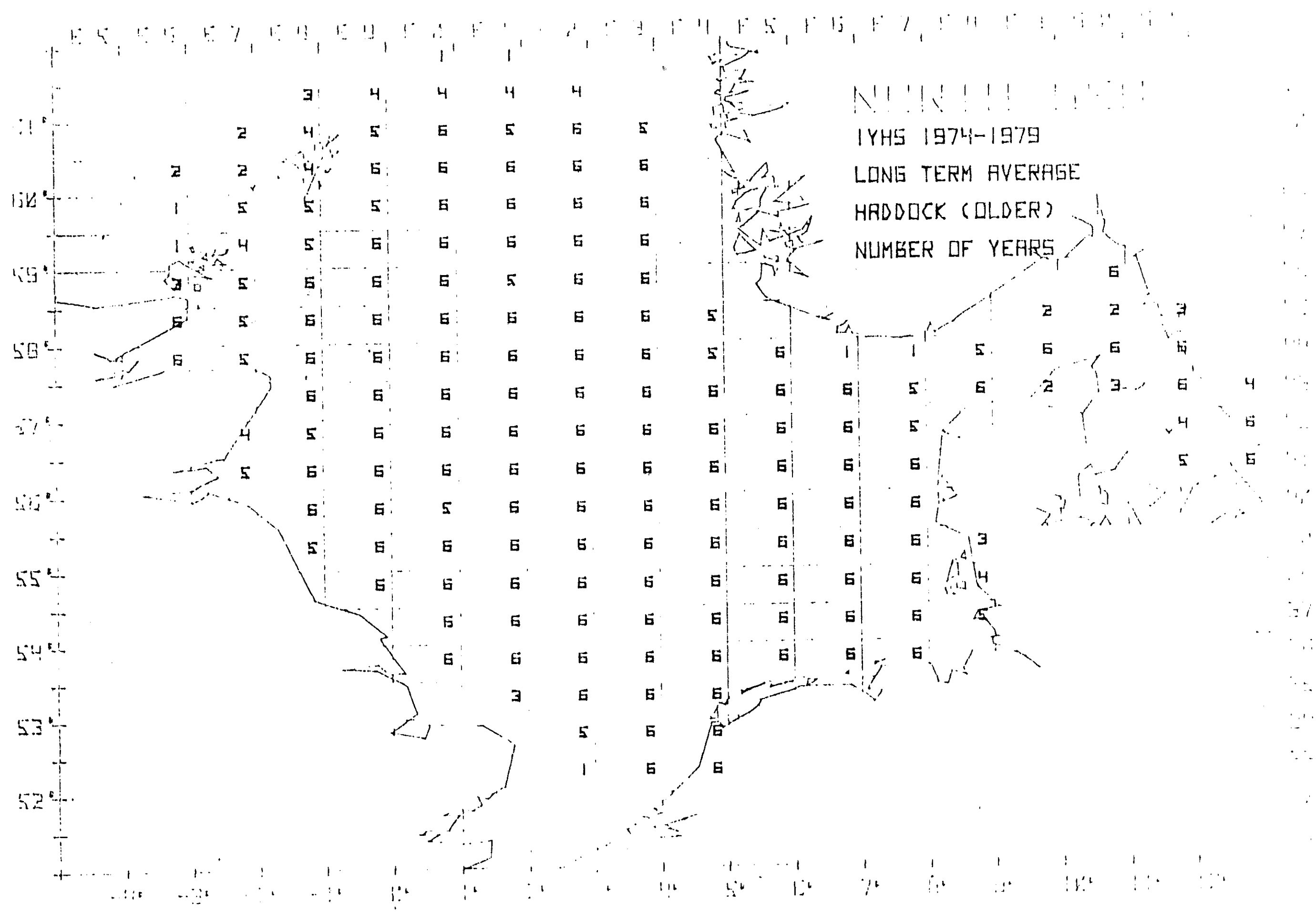

IYHS 1974-1979
LONG TERM AVERAGE
HADDOCK (OLDER)
NUMBER OF YEARS

Figure 6 - 3.

VII. WHITING

Long-term abundance

The long-term average abundance of whiting in each statistical rectangle, derived from the surveys of 1974 - 1979 is given in Figures 7-1/3, for age groups I, II and older respectively. I-group whiting are more evenly distributed throughout the North Sea than are the corresponding age groups of the other gadoid species. However, the abundance tends to be lower in sampling sub-areas 1 and 5 (Figure 10 - 1). The main centre of abundance of II-group whiting is in the western and northwestern parts of the North Sea, although a sizable proportion is still resident in sub-area 6. The distribution of the other age groups is broadly similar to that of the II-group fish although a greater proportion of the population is now found in the northwestern North Sea, particularly in sub-area 1.

Abundance indices

Tables VII - 1/3 give estimates of abundance within each North Sea sampling region for the years 1972 - 1979, for I-group, II-group and older whiting respectively. The data are in the form of arithmetic mean catches per statistical rectangle, both unadjusted and adjusted by means of the long-term average. In addition, arithmetic and geometric mean values are given for the total North Sea.

A long series of abundance indices, unadjusted by the long-term average technique, are given in table VII - 4. Both arithmetic and geometric means are given (it should be noted that the geometric means are presented in $\log_e$ form, thus differing from the values given in earlier reports). Estimates of abundance based on VPA are included for comparison.

Comparison with other estimates

The data given in table VII - 4 were used to calculate coefficients of correlation between survey abundance estimates, and estimates of population obtained by VPA. The regression parameters and the coefficients of correlation are shown in table VII - 5. For both age groups, the arithmetic mean IYHS index had a higher coefficient of correlation with the VPA estimates. I- and II-group yielded very similar correlations, which effect is reflected also in the high correlation coefficient between the two survey estimates as I- and II-group.

Length at age

Table VII - 6 and VII - 7 give mean lengths and catch rates of I-group and II-group whiting. The data are shown for the individual sampling regions within the North Sea, for the Kattegat and for the total North Sea, for the years 1972 - 1979. There was not sufficient time in which to properly analyze the data either to investigate possible regional growth rates or to look for evidence of density-dependant changes in growth. However, preliminary trials using a small number of data sets revealed no significant correlations between mean length and abundance, for either age group.

TABLE VII-1 - Abundance indices of I-group WHITING by sub-area (surveys 1972 - 1979). (U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (144)	No of squares fished
1972	U	11	137	756	266	113	276	528	339	85
	A	23	295	606	276	33	273	534	279	
1973	U	409	785	2945	1176	55	1081	295	1159	106
	A	113	791	2558	1085	29	1032	354	911	
1974	U	52	512	363	314	68	418	403	322	134
	A	32	512	331	265	32	393	403	299	
1975	U	201	1058	945	1934	102	1281	799	893	132
	A	120	1030	1091	1663	41	1168	799	856	
1976	U	34	278	591	1940	488	392	3244	679	130
	A	31	270	710	1641	180	357	2987	641	
1977	U	38	356	370	881	1142	581	796	427	141
	A	29	356	358	745	417	530	796	402	
1978	U	410	589	310	761	110	506	748	513	142
	A	295	589	296	644	50	452	748	487	
1979	U	180	622	1151	706	53	261	133	457	140
	A	130	622	1098	598	24	237	120	430	
Average 1972 - 1979	U	168	542	929	997	266	599	868	599	
	A	97	558	881	865	101	556	843	538	

TABLE VII-2 - Abundance indices of II-group WHITING by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (144)	No of squares fished
1972	U	73	15	29	441	124	467	43	192	85
	A	82	224	178	302	46	327	44	201	
1973	U	134	414	506	4681	23	145	49	763	106
	A	276	546	520	4321	55	129	50	682	
1974	U	182	1242	817	297	49	298	65	496	134
	A	119	1242	798	251	53	250	65	457	
1975	U	253	91	195	125	192	126	31	153	132
	A	153	122	174	121	80	115	31	149	
1976	U	388	499	1311	1640	33	160	91	535	130
	A	318	480	1006	1387	47	146	84	511	
1977	U	55	58	358	1535	26	50	69	218	141
	A	42	58	342	1298	16	46	69	205	
1978	U	174	165	334	1427	208	177	101	293	142
	A	126	165	319	1207	95	156	101	277	
1979	U	308	20	170	127	118	248	14	183	140
	A	222	20	163	108	54	211	14	171	
Average 1972 - 1979	U	196	313	465	1284	96	209	58	353	
	A	167	357	437	1124	56	172	57	332	

table VII-3 - Abundance indices of older WHITING by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SURVEY YEAR \ SUB-AREA (No of squares included:)		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (144)	No of squares fished
1972	U	-	-	-	-	-	-	-	36	85
	A	47	4	35	142	6	21	5	40	
1973	U	-	-	-	-	-	-	-	83	106
	A	196	63	63	333	9	52	19	134	
1974	U	-	-	-	-	-	-	-	59	134
	A	72	20	54	51	24	40	16	56	
1975	U	-	-	-	-	-	-	-	146	132
	A	293	19	87	71	21	47	10	143	
1976	U	-	-	-	-	-	-	-	179	130
	A	401	35	91	184	24	32	7	194	
1977	U	-	-	-	-	-	-	-	109	141
	A	157	15	79	164	12	25	126	103	
1978	U	-	-	-	-	-	-	-	133	142
	A	157	9	147	418	20	19	33	126	
1979	U	-	-	-	-	-	-	-	116	140
	A	203	6	72	52	31	74	11	108	
Average 1972 - 1979	U	-	-	-	-	-	-	-	108	
	A	191	21	78	177	18	39	28	113	

TABLE VII-4 - Year class abundance estimates Whiting.

YEAR CLASS	I-Group			II-Group			VPA
	A.M.^{u} [1]	A.M.^{a} [2]	G.M.^{u} [3]	A.M.^{u} [1]	A.M.^{a} [2]	G.M.^{u} [3]	No of 2-year old recruits ($x\ 10^{-6}$) [4]
1963				92			235
1964	418		151	300			485
1965	600		211	112		27	395
1966	501		59	190		42	630
1967	2019		556	1052		213	1753
1968	19		5	73		16	248
1969	70		19	30		7	204
1970	223		70	192	201	16	488
1971	339	279	59	763	682	65	886
1972	1159	911	191	496	457	55	1328
1973	322	299	58	153	149	38	537
1974	893	856	235	535	511	65	1294
1975	679	641	80	218	205	18	816
1976	427	402		293	277		
1977	513	487		183	171		
1978	457	430					

[1], [2], [3], [4] See foot note in table V-4.

TABLE VII-5 - Correlations between year class abundance indices Whiting.

		VPA/I-Group			VPA/II-Group			II-Group/I-Group		
		A.M.[u]	A.M.[a]	G.M.[u]	A.M.[u]	A.M.[a]	G.M.[u]	A.M.[u]	A.M.[a]	G.M.[u]
Correlation:	N	12	5	12	13	6	11	14	7	11
	r	.92	.86	.80	.89	.65	.83	.78	.17	.91
Geometric mean regression										
	U_o	236.9	301.5	306.8	205.4	274.1	340.4			
	U_1	0.859	1.123	3.177	1.576	1.680	8.601			
Estimated recruitment										
Year class	1976	603	752		667	739				
	1977	678	848		494	561				
	1978	629	784							

TABLE VII-6

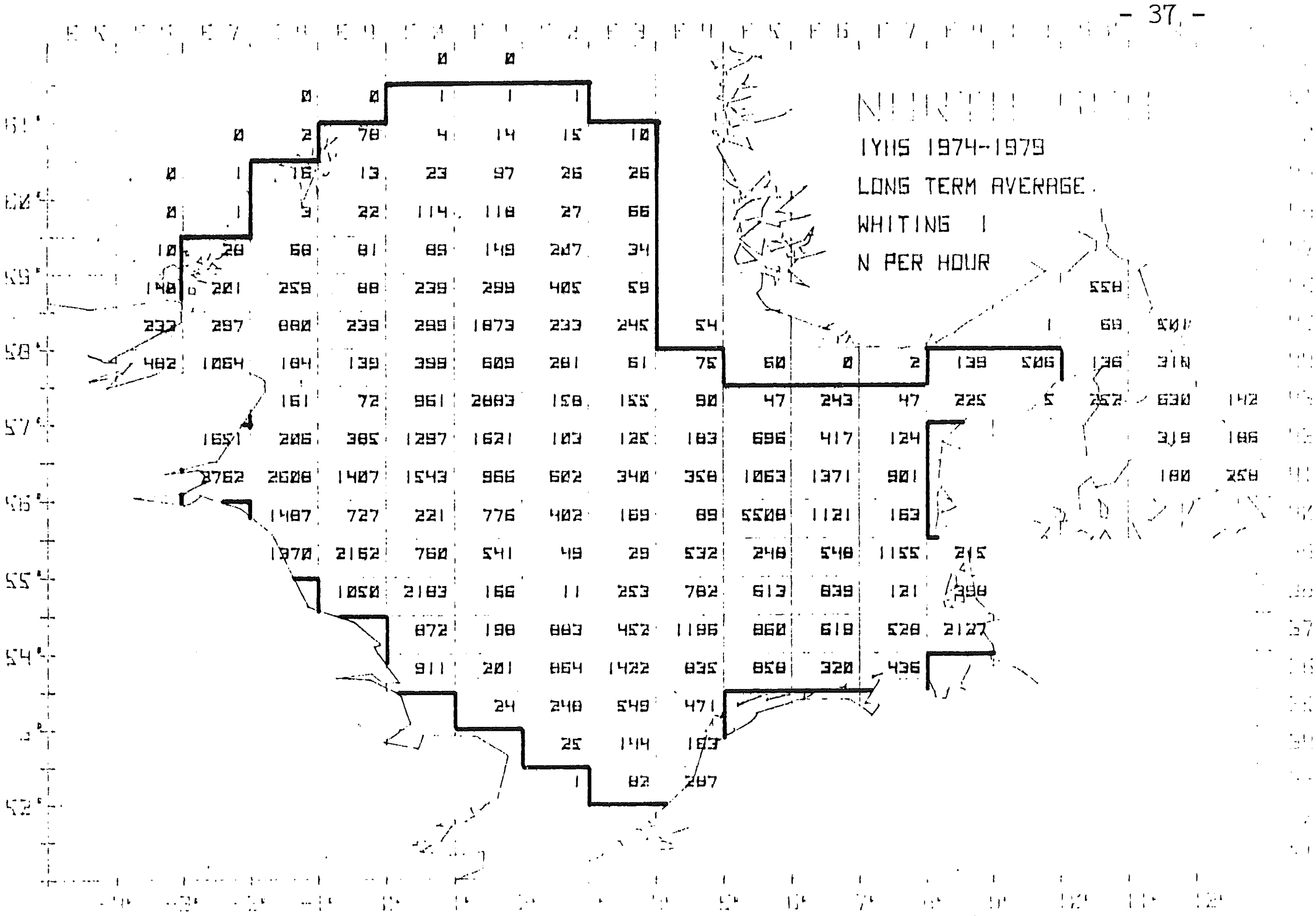
LENGTH STATISTICS BY AREAS IYHS 1972 - 1979

AREA:	RNDF-1	RNDF-2	RNDF-3	RNDF-4	RNDF-5	RNDF-6	RNDF-7	KATTEGAT	NORTH SEA
IYHS 1972 WHITING I									
NR OF SQUARES	9	14	16	8	2	23	11	12	85
MEAN N PER HOUR	10.6	137.3	756.3	266.3	113.0	275.6	528.1	102.8	339.1
MEAN LENGTH	20.22	15.17	15.94	17.53	15.10	16.87	17.88	16.99	16.51
STANDARD DEVIATION	2.66	2.81	2.81	3.07	3.28	3.22	2.18	2.42	2.98
MIN-L	15	6	6	8	7	7	6	9	6
MAX-L	25	24	25	24	23	32	24	24	32
IYHS 1973 WHITING I									
NR OF SQUARES	10	23	19	12	5	28	10	8	106
MEAN N PER HOUR	409.2	784.9	2945.2	1175.7	54.6	1081.3	295.4	138.8	1159.0
MEAN LENGTH	16.95	15.91	15.96	17.51	16.55	16.12	15.45	16.85	16.09
STANDARD DEVIATION	2.95	2.72	2.40	2.08	2.50	3.02	2.36	2.75	2.63
MIN-L	8	9	8	9	9	7	7	7	7
MAX-L	24	24	25	21	23	28	24	24	28
IYHS 1974 WHITING I									
NR OF SQUARES	34	25	20	11	5	28	12	12	134
MEAN N PER HOUR	51.8	511.7	363.4	313.5	67.6	417.6	403.0	381.5	321.8
MEAN LENGTH	19.28	16.84	16.91	15.50	15.18	16.54	16.35	16.35	16.62
STANDARD DEVIATION	2.75	2.41	2.21	2.44	2.14	2.73	2.15	2.36	2.53
MIN-L	11	8	10	8	11	6	7	10	6
MAX-L	26	26	26	22	24	29	26	24	29
IYHS 1975 WHITING I									
NR OF SQUARES	33	24	17	10	4	31	12	10	132
MEAN N PER HOUR	201.1	1057.7	945.3	1933.8	102.0	1281.4	799.0	398.4	893.1
MEAN LENGTH	19.71	16.08	17.29	17.73	18.06	17.62	15.62	17.31	17.30
STANDARD DEVIATION	3.31	2.07	2.28	1.70	2.87	3.17	2.00	2.35	2.83
MIN-L	10	8	9	8	7	6	8	9	6
MAX-L	28	25	25	26	25	34	27	25	34
IYHS 1976 WHITING I									
NR OF SQUARES	39	24	14	11	4	31	11	14	130
MEAN N PER HOUR	33.6	277.7	590.5	1939.6	488.4	391.8	3244.4	195.5	679.0
MEAN LENGTH	19.41	14.24	15.41	16.30	15.34	16.21	16.39	18.26	16.15
STANDARD DEVIATION	3.48	4.11	2.20	2.02	2.16	3.92	2.39	2.57	2.93
MIN-L	13	6	8	8	6	5	6	6	5
MAX-L	26	26	23	23	24	27	25	25	27
IYHS 1977 WHITING I									
NR OF SQUARES	43	25	21	11	4	31	12	15	141
MEAN N PER HOUR	37.9	355.8	369.9	880.8	1141.6	580.8	795.7	100.7	427.1
MEAN LENGTH	17.51	14.72	16.07	16.93	14.69	16.56	14.75	18.94	15.80
STANDARD DEVIATION	3.20	2.57	1.63	2.19	3.15	3.17	2.42	3.19	2.87
MIN-L	9	7	7	8	6	6	6	9	6
MAX-L	26	26	23	26	25	28	26	30	28
IYHS 1978 WHITING I									
NR OF SQUARES	41	25	21	11	5	30	12	14	142
MEAN N PER HOUR	409.5	589.4	309.8	760.8	109.8	505.7	748.2	536.1	513.0
MEAN LENGTH	18.01	16.19	16.41	16.72	14.66	17.12	16.88	17.97	17.01
STANDARD DEVIATION	1.95	2.52	2.71	2.54	3.47	2.97	2.16	3.38	2.65
MIN-L	9	7	6	6	7	6	8	7	6
MAX-L	31	24	26	23	26	27	25	27	31
IYHS 1979 WHITING I									
NR OF SQUARES	41	25	21	11	5	29	11	13	140
MEAN N PER HOUR	180.4	621.7	1150.8	706.3	52.5	260.5	127.3	187.0	456.8
MEAN LENGTH	17.58	14.84	15.07	15.32	16.48	16.79	14.22	16.49	15.45
STANDARD DEVIATION	3.11	3.03	2.32	3.30	3.66	2.35	2.24	2.89	2.82
MIN-L	7	6	6	6	7	5	5	5	5
MAX-L	27	24	26	25	23	24	25	23	27
LONG TERM MEAN L	18.58	15.50	16.13	16.69	15.76	16.73	15.94	17.40	16.37

TABLE VII-7

LENGTH STATISTICS BY AREAS IYHS 1972 - 1979

AREA:	RNDF-1	RNDF-2	RNDF-3	RNDF-4	RNDF-5	RNDF-6	RNDF-7	KATTEGAT	NORTH SEA
IYHS 1972 WHITING II									
NR OF SQUARES	9	14	16	8	2	23	11	12	85
MEAN N PER HOUR	72.0	14.8	29.4	441.0	124.0	467.1	43.1	9.0	192.0
MEAN LENGTH	26.71	23.87	26.47	25.36	26.03	25.80	24.24	24.43	25.71
STANDARD DEVIATION	3.20	2.10	3.17	2.56	2.56	2.32	2.17	2.14	2.47
MIN-L	20	20	20	20	21	20	19	20	19
MAX-L	36	33	35	34	31	33	33	30	36
IYHS 1973 WHITING II									
NR OF SQUARES	10	23	19	12	5	28	10	8	106
MEAN N PER HOUR	134.1	413.5	505.9	4680.5	22.6	144.5	49.2	21.0	763.0
MEAN LENGTH	25.15	24.81	23.68	23.51	24.82	25.20	26.01	25.69	23.85
STANDARD DEVIATION	2.78	1.89	2.72	2.18	2.38	3.00	2.39	2.74	2.40
MIN-L	19	19	18	19	21	19	19	21	18
MAX-L	33	32	35	32	30	35	33	34	35
IYHS 1974 WHITING II									
NR OF SQUARES	34	25	20	11	5	28	12	12	134
MEAN N PER HOUR	181.8	1242.1	816.9	296.7	49.1	298.3	65.2	69.5	496.2
MEAN LENGTH	25.60	25.28	22.96	23.69	23.68	25.04	23.77	26.73	24.39
STANDARD DEVIATION	2.55	1.61	2.49	1.69	2.24	2.95	2.50	3.13	2.56
MIN-L	18	18	16	19	18	16	18	19	16
MAX-L	34	33	33	30	35	36	34	35	36
IYHS 1975 WHITING II									
NR OF SQUARES	33	24	17	10	4	31	12	10	132
MEAN N PER HOUR	252.8	91.2	194.6	124.6	192.2	126.3	30.9	33.8	153.1
MEAN LENGTH	26.89	24.80	26.14	25.50	25.58	27.09	26.02	25.60	26.53
STANDARD DEVIATION	2.92	1.85	1.74	1.98	1.95	2.68	2.20	2.66	2.64
MIN-L	21	20	21	21	21	20	20	20	20
MAX-L	37	34	31	32	32	38	35	35	38
IYHS 1976 WHITING II									
NR OF SQUARES	39	24	14	11	4	31	11	14	130
MEAN N PER HOUR	388.3	499.2	1310.5	1639.7	32.8	160.1	90.7	14.9	535.0
MEAN LENGTH	26.62	25.20	24.22	24.74	25.57	27.08	26.84	27.25	25.22
STANDARD DEVIATION	2.39	2.28	2.08	2.23	2.96	3.34	3.22	2.02	2.57
MIN-L	17	12	18	17	14	14	15	22	12
MAX-L	35	34	34	34	32	38	37	32	38
IYHS 1977 WHITING II									
NR OF SQUARES	43	25	21	11	4	31	12	15	141
MEAN N PER HOUR	55.0	57.6	358.3	1534.5	25.5	50.0	69.3	5.9	217.6
MEAN LENGTH	25.93	24.22	23.50	23.15	24.20	24.19	25.81	28.05	23.45
STANDARD DEVIATION	3.37	1.84	1.84	1.79	2.47	3.01	4.14	3.45	2.14
MIN-L	20	18	19	19	20	19	17	19	17
MAX-L	36	31	33	31	32	35	32	39	36
IYHS 1978 WHITING II									
NR OF SQUARES	41	25	21	11	5	30	12	14	142
MEAN N PER HOUR	174.3	165.2	333.7	1426.6	207.6	176.8	101.3	43.4	292.9
MEAN LENGTH	26.21	23.84	24.62	24.93	26.78	26.22	24.92	26.91	25.41
STANDARD DEVIATION	1.96	3.17	1.90	2.50	2.78	2.27	3.18	3.33	2.55
MIN-L	20	16	20	16	18	18	16	19	16
MAX-L	33	32	33	35	36	37	39	37	39
IYHS 1979 WHITING II									
NR OF SQUARES	41	25	21	11	5	29	11	13	140
MEAN N PER HOUR	308.4	19.6	170.2	127.2	117.7	247.5	14.3	13.9	183.4
MEAN LENGTH	25.34	24.08	24.67	23.90	24.70	25.25	25.15	25.12	25.11
STANDARD DEVIATION	2.06	1.96	1.90	1.86	1.91	2.16	2.74	2.82	2.10
MIN-L	17	16	18	17	20	18	11	18	11
MAX-L	37	31	31	31	31	33	32	32	34
LONG TERM MEAN L	26.06	24.51	24.53	24.35	25.17	25.73	25.35	26.22	24.96


IYHS 1974-1979
LONG TERM AVERAGE
WHITING I
N PER HOUR

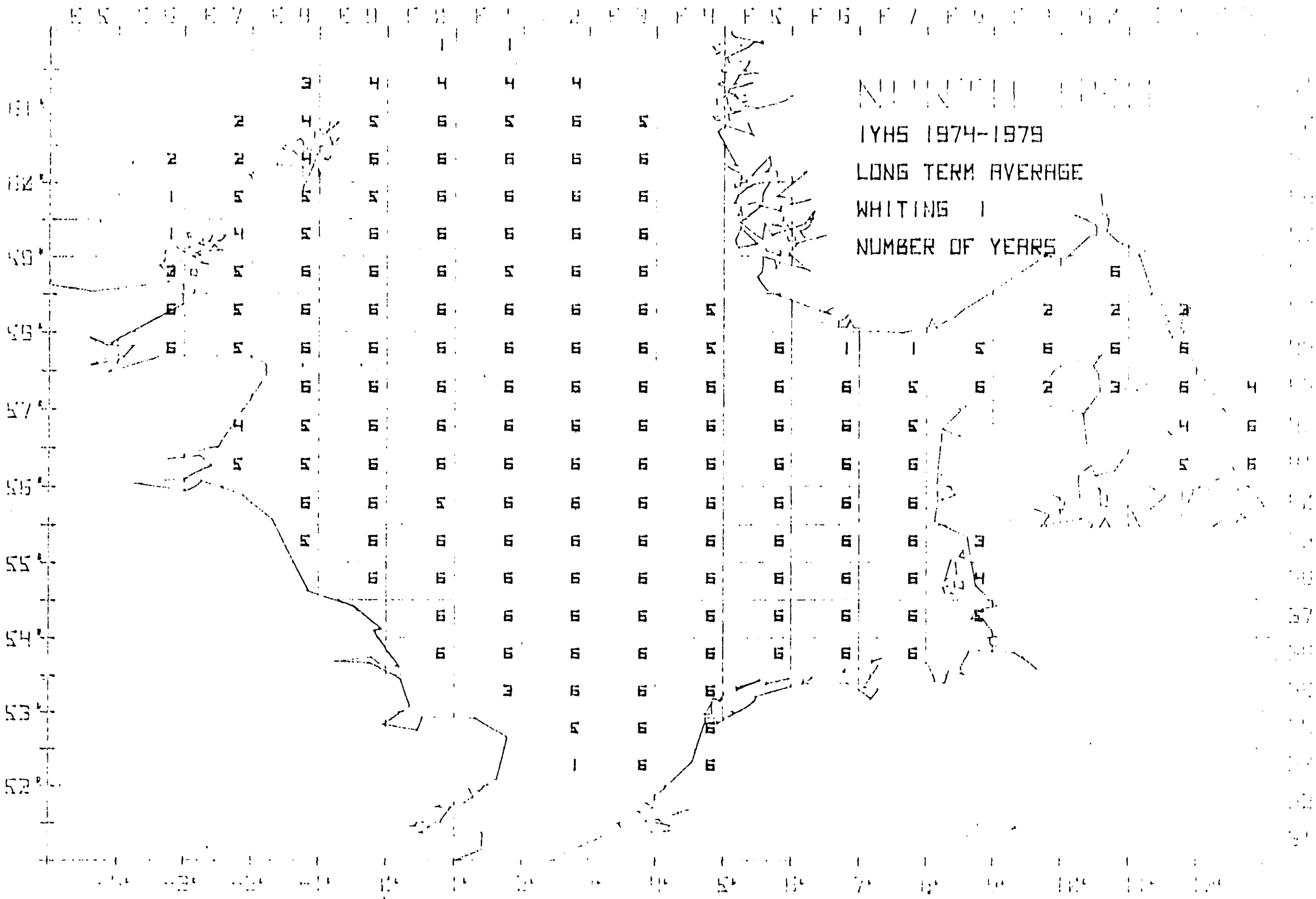
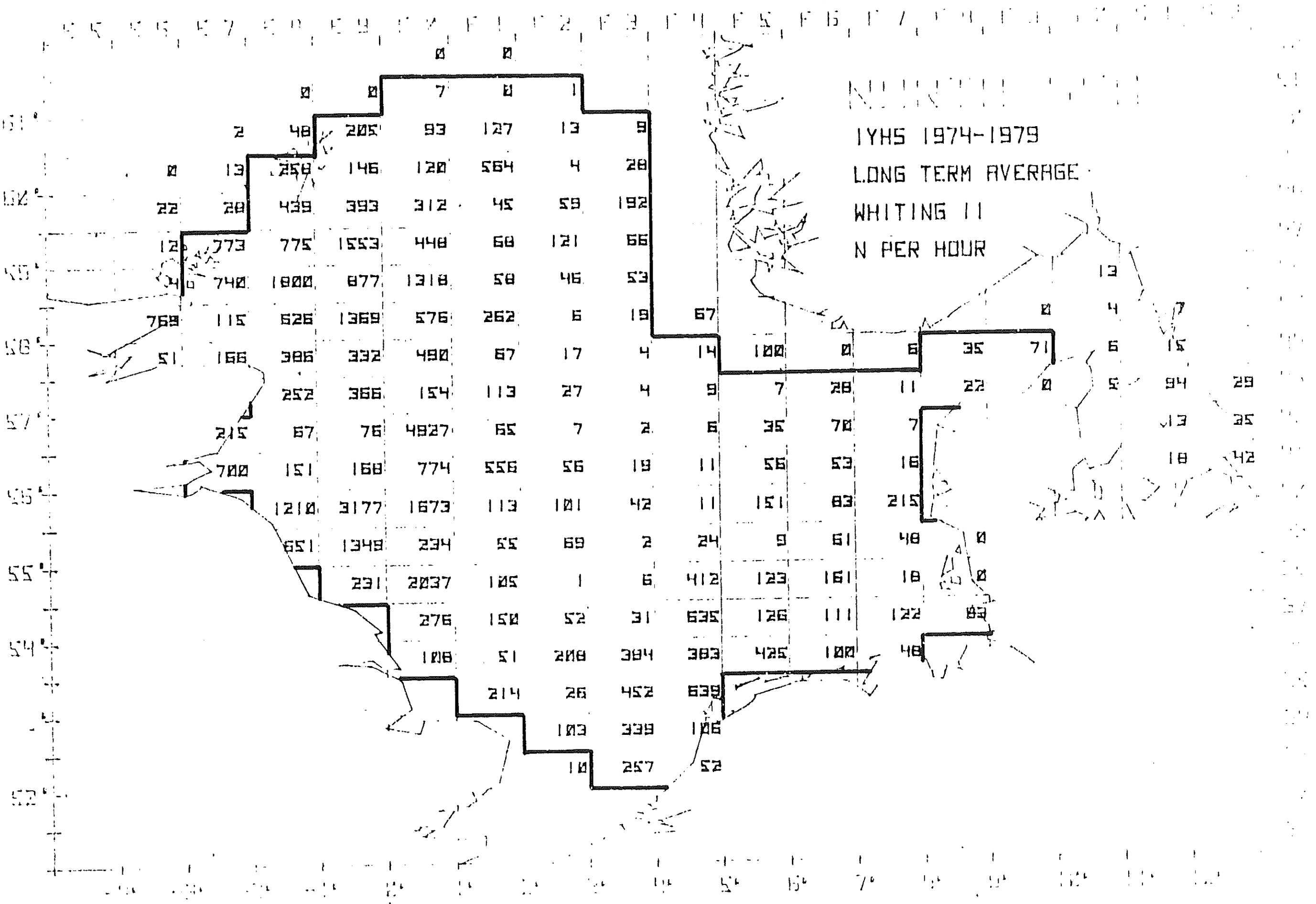

IYHS 1974-1979
LONG TERM AVERAGE
WHITING I
NUMBER OF YEARS

Figure 7 - 1


IYHS 1974-1979
LONG TERM AVERAGE
WHITING II
N PER HOUR

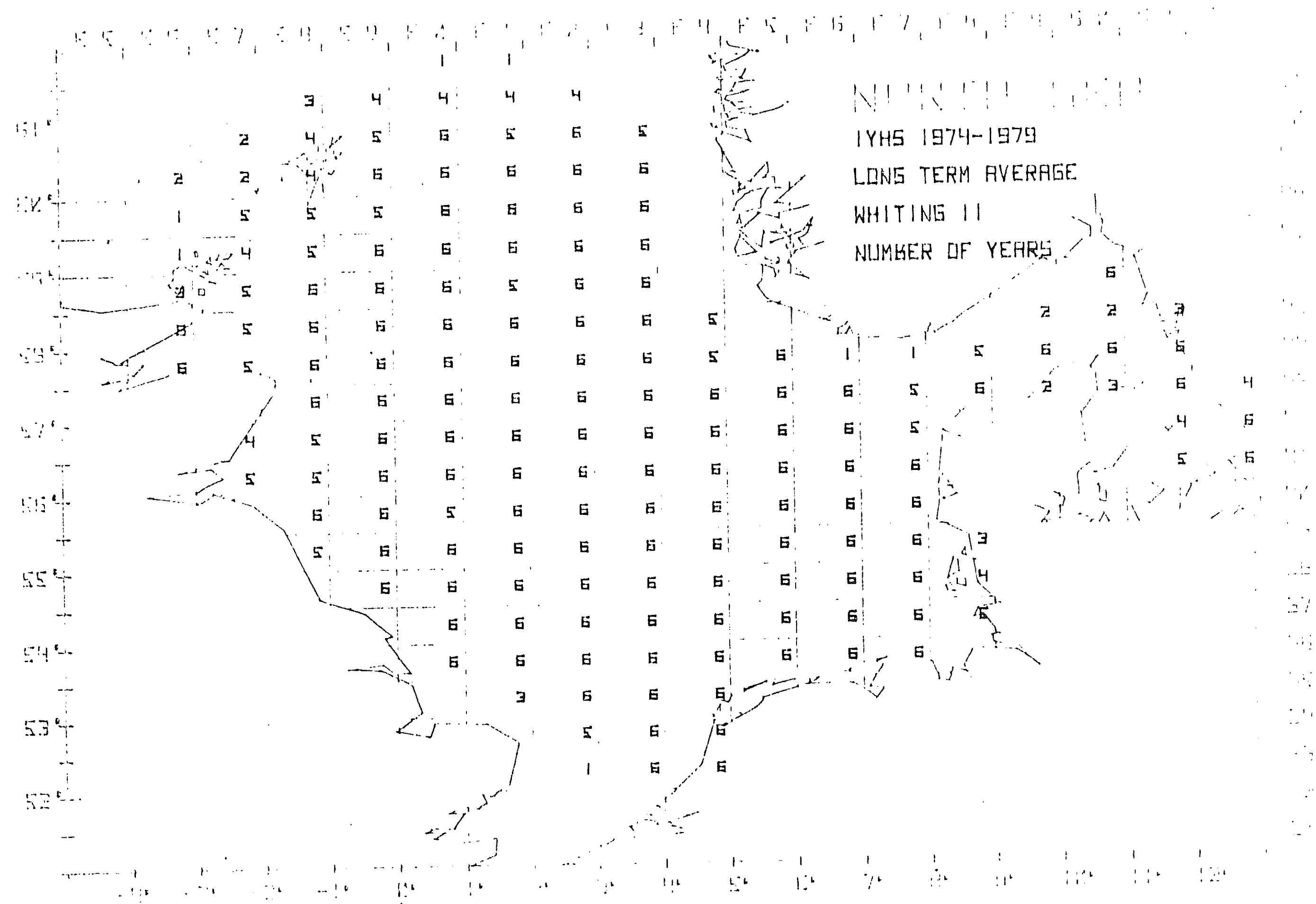
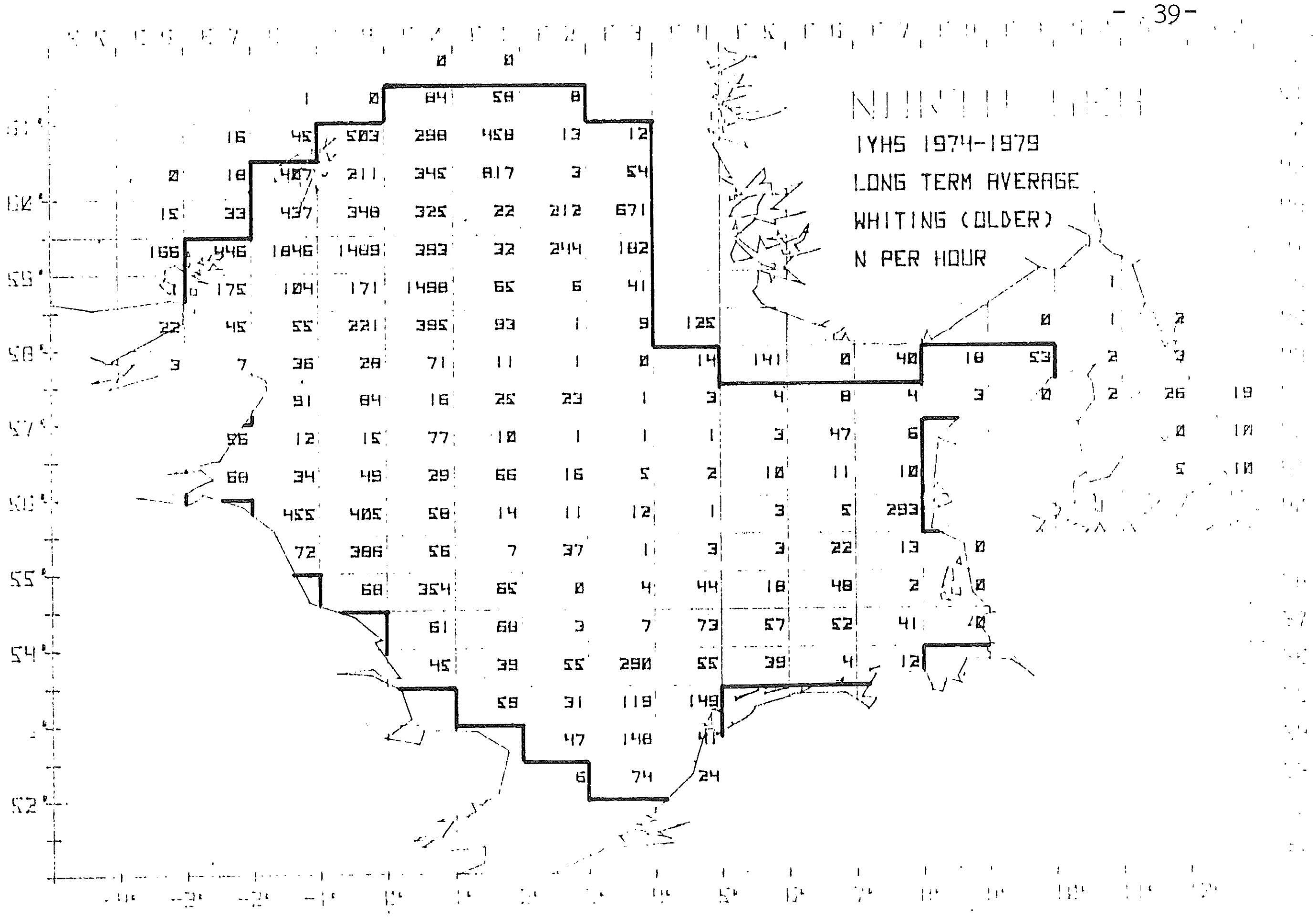

IYHS 1974-1979
LONG TERM AVERAGE
WHITING II
NUMBER OF YEARS

Figure 7 - 2


IYHS 1974-1979
LONG TERM AVERAGE
WHITING (OLDER)
N PER HOUR

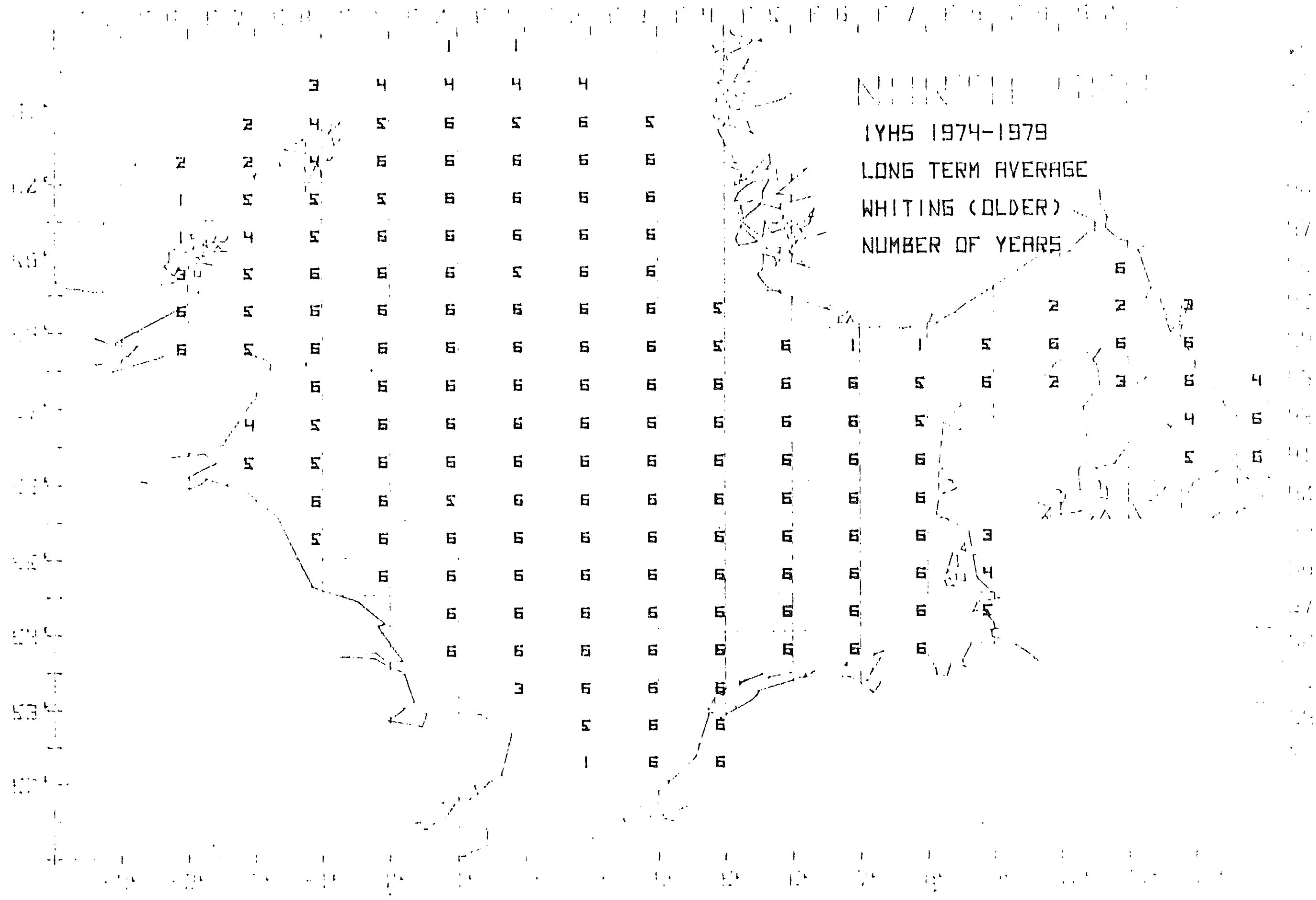

IYHS 1974-1979
LONG TERM AVERAGE
WHITING (OLDER)
NUMBER OF YEARS

Figure 7 - 3

VIII. NORWAY POUT

Long-term abundance

During the International Young Herring Surveys sampling of Norway Pout has only been carried out adequately since 1974. Older data are likely to be biased by inadequate sampling of the Norway Pout area. The area as defined by the Working Group includes almost the entire North Sea population (Figures 8 - 1/3). The long-term average abundance indices for the I-group, II-group and older age groups respectively are given in tables VIII - 1/3.

Abundance indices

Abundance indices for the I-group, II-group and older age groups were calculated for the years 1972 - 1979 for the different sub-areas proposed for grouping demersal fish data (Figure 10-1) for assessment purposes (Table VIII-1/3). It appears that the year classes of Norway Pout since 1974 have been mainly restricted to sub-area 1 while the very rich 1973 year class as I-group, however, were rather abundant in sub-area 2 as well.

The 1973 year class was outstanding. The year classes of 1974 - 1976 were considerably less abundant, but at a more constant level. The recent year classes have even been smaller. The estimates for the two year classes prior to 1973 indicate that these may have been of about average level, but the figures are less reliable due to inadequate sampling.

Comparison with other indices

Catch in numbers at age by quarters for the total North Sea for the years 1974 to 1978 and estimates of the number of hours trawling in the Danish industrial fisheries from 1975 to 1978, taken from ICES C.M. 1979/G : 26, have been used for catch per unit of effort calculations. The CPUE values for the years 1974 - 1978 are listed in table VIII-4. The 1974 CPUE figure has been calculated under the assumption that effort increased rectilinearly from 1974 to 1977. In the table the abundance indices for I- and II-group, calculated as unadjusted arithmetic means an unadjusted geometric means, are also listed. Table VIII-5 gives correlations coefficients between the abundance of I- and II-group in the IYHS and the CPUE figures in table VIII-4. The IYHS indices have also been correlated with the abundance indices from the Scottish autumn surveys of the year class 1973-1975 and 1977-1978 as 0-group and the year classes 1973, 1974, 1976 and 1977 as I-group (C.M. 1979/G : 26). The table shows that there are highly significant correlations between CPUE and survey data for both I- and II-group and also between I- and II-group fish as estimated during consecutive years in the surveys.

Length at age

Table VIII-6/7 show the mean length of I- and II-group for the years 1972 to 1979 by areas. The means for the period for the different areas are listed at the bottom of the tables. These figures show that there is an increase in mean length for both I- and II-group from north to south.

Mean length as calculated for the total North Sea for the different year classes were correlated with their abundance indices as I- and II-group. No significant correlations were found.

TABLE VIII-1 - Abundance indices of I-group NORWAY POUT by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (95)	No of squares fished
1972	U	2464	4856	1369	3663	0	0	1	3425	38
	A	7282	6602	1272	2281	0	0	2	6787	
1973	U	15232	5723	520	639	0	0	0	4207	32
	A	8115	2758	772	288	0	0	19	5606	
1974	U	47851	26718	342	852	0	1	0	27534	60
	A	23678	23513	311	576	0	1	45	19832	
1975	U	8698	237	554	19	0	0	238	4293	80
	A	5743	230	438	15	0	0	200	3894	
1976	U	7943	56	463	11	0	0	24	4599	76
	A	5629	116	324	9	0	0	22	3977	
1977	U	8426	249	455	376	0	0	44	4814	90
	A	6645	249	435	318	0	0	44	4603	
1978	U	3792	185	643	35	0	0	10	1913	91
	A	2816	185	615	30	0	0	10	1832	
1979	U	5462	14	1291	8	0	0	5	2690	90
	A	4056	14	1235	7	0	0	5	2549	
Long-term average 1974 - 1979	U	13695	4577	625	217	0	0	54	7641	
	A	8095	4051	560	159	0	0	55	6114	

TABLE VIII-2 - Abundance indices of II-group NORWAY POUT by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SURVEY YEAR \ SUB-AREA (No of squares included:)		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (95)	No of squares fished
1972	U	717	0	1124	186	0	0	0	653	38
	A	5070	25	1090	116	0	0	0	3008	
1973	U	1278	329	148	620	0	0	0	438	32
	A	13615	207	959	268	0	0	15	7685	
1974	U	1092	27	35	1	0	0	0	420	60
	A	829	24	65	9	0	0	1	471	
1975	U	5687	9	406	8	0	0	19	2441	80
	A	5227	10	386	6	0	0	16	2929	
1976	U	929	8	16	22	0	0	6	385	76
	A	808	8	50	19	0	0	6	423	
1977	U	800	8	39	47	0	0	0	334	90
	A	632	8	37	39	0	0	0	323	
1978	U	2633	4	37	164	0	0	1	1215	91
	A	1977	4	63	139	0	0	1	1164	
1979	U	711	0	16	22	0	0	0	240	90
	A	533	0	22	18	0	0	0	228	
Long-term average 1974 - 1979	U	1975	9	91	44	0	0	4	839	
	A	1668	9	104	38	0	0	4	923	

TABLE VIII-3 - Abundance indices of older NORWAY POUT by sub-area (surveys 1972 - 1979).
(U : unadjusted means; A : adjusted for missing squares; both averages refer to untransformed mean catches per square).

SUB-AREA (No of squares included:) / SURVEY YEAR		1 (57)	2 (25)	3 (22)	4 (13)	5 (11)	6 (34)	7 (12)	North Sea (95)	No of squares fished
1972	U	-	-	-	-	-	-	-	5	38
	A	23	1	1	1	0	0	0	13	
1973	U	-	-	-	-	-	-	-	82	32
	A	534	38	63	81	0	0	0	316	
1974	U	-	-	-	-	-	-	-	9	60
	A	15	5	7	8	0	0	0	12	
1975	U	-	-	-	-	-	-	-	43	80
	A	93	3	4	1	0	0	0	51	
1976	U	-	-	-	-	-	-	-	33	76
	A	41	6	7	52	0	0	0	31	
1977	U	-	-	-	-	-	-	-	27	90
	A	45	1	4	24	0	0	0	26	
1978	U	-	-	-	-	-	-	-	21	91
	A	31	0	2	15	0	0	0	20	
1979	U	-	-	-	-	-	-	-	71	90
	A	120	0	5	3	0	0	0	67	
Long-term average 1974 - 1979	U	-	-	-	-	-	-	-	34	
	A	58	2	5	17	0	0	0	34	

TABLE VIII-4 - Year class abundance estimates Norway Pout.

YEAR CLASS	I-Group			II-Group		
	A.M.u 1)	G.M.u 2)	CPUE 3)	A.M.u	G.M.u	CPUE
1972				420	10.3	6.7
1973	27534	603	216	2441	45.3	22.7
1974	4293	91	47	385	10.2	6.7
1975	4599	106	57	334	13.7	9.3
1976	4814	186	89	1215	16.0	15.6
1977	1913	39	33	240	7.4	
1978	2690	65				

1) Average mean nr/hr per square, uncorrected for missing squares.

2) Antilog of the elog mean nr/hr per square + 1, uncorrected for missing squares.

3) Catch per unit of effort by age group during the first quarter in the North Sea. (Danish industrial fisheries).

TABLE VIII-5 - Correlation of year class abundance indices Norway Pout.

	CPUE 1)/IYHS		CPUE 1)/IYHS		IYHS		SAS 2)/IYHS		SAS 2)/IYHS	
	I-Group		II-Group		I-/II-Group		O/I	O/II	I/I	I/II
	A.M.u	G.M.u	A.M.u	G.M.u	A.M.u	G.M.u	G.M.u	G.M.u	G.M.u	G.M.u
N	5	5	5	5	5	5	5	5	4	5
r	0.98	1.00	0.98	0.92	0.93	1.00	0.83	0.93	0.52	0.56

1) CPUE in the Danish Industrial Fishery, cf Table VIII-4.

2) SAS : Scottish Autumn Surveys (data derived from ICES C.M. 1979/G : 26).

TABLE VIII-6

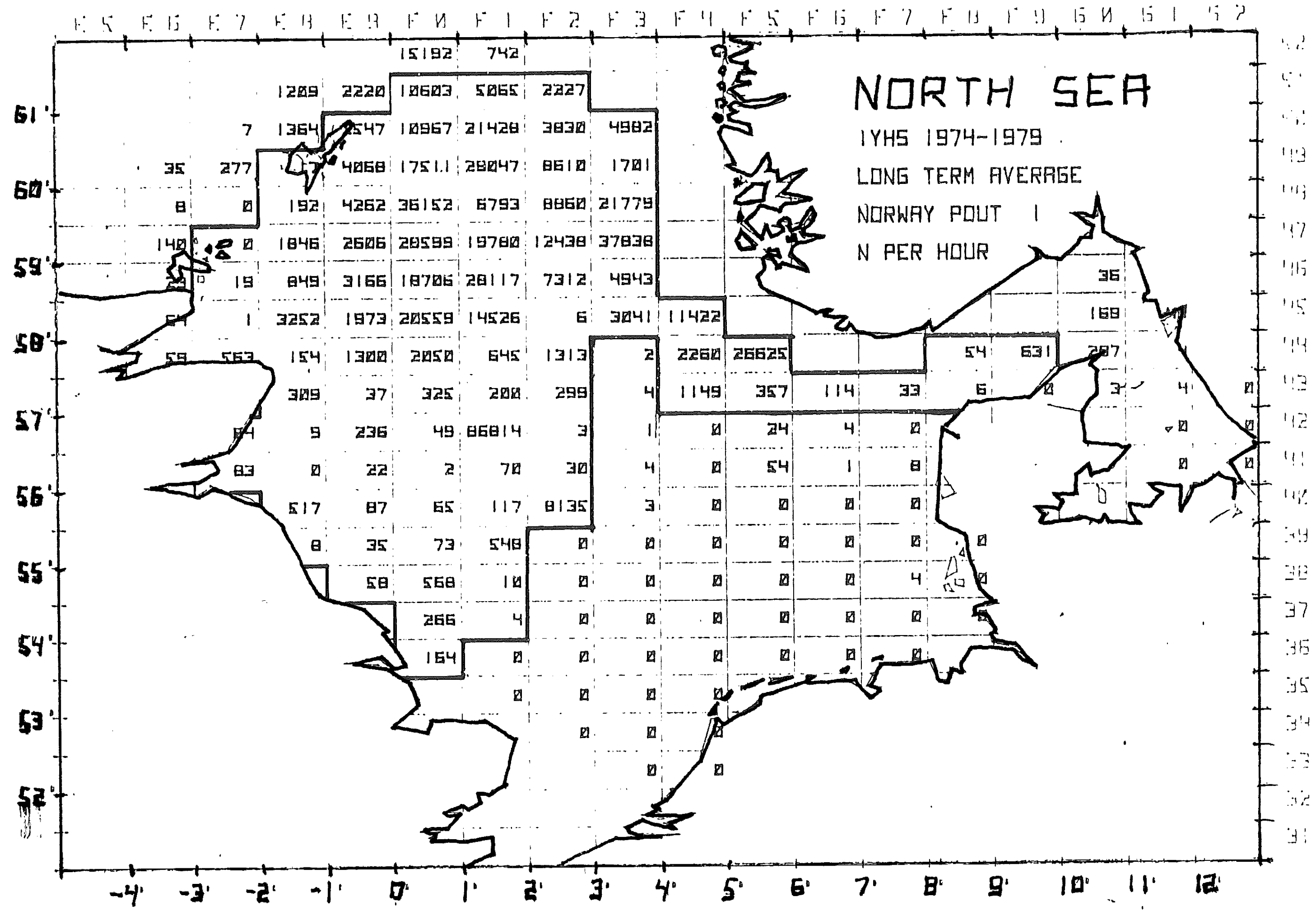
LENGTH STATISTICS BY AREAS IYHS 1972 - 1979

AREA:	RNDF-1	RNDF-2	RNDF-3	RNDF-4	RNDF-5	RNDF-6	RNDF-7	KATTEGAT	NORTH SEA
IYHS 1972 NORWAY POUT I									
NR OF SQUARES	9	12	15	8	0	24	10	0	38
MEAN N PER HOUR	2463.6	4855.8	1369.4	3663.4	0.0	0.0	1.0	0.0	3424.5
MEAN LENGTH	10.33	10.96	10.98	10.98	0.00	0.00	10.87	0.00	10.90
STANDARD DEVIATION	0.81	0.77	0.89	0.85	0.00	0.00	0.68	0.00	0.84
MIN-L	8	9	8	8	0	0	9	0	8
MAX-L	14	13	15	15	0	0	12	0	15
IYHS 1973 NORWAY POUT I									
NR OF SQUARES	4	11	15	5	0	19	1	0	32
MEAN N PER HOUR	15232.0	5722.7	520.1	639.2	0.0	0.1	0.0	0.0	4207.2
MEAN LENGTH	11.20	11.60	12.43	12.56	0.00	12.83	0.00	0.00	11.60
STANDARD DEVIATION	0.84	0.90	0.87	0.84	0.00	1.53	0.00	0.00	0.96
MIN-L	9	9	8	10	0	11	0	0	8
MAX-L	14	15	18	15	0	15	0	0	18
IYHS 1974 NORWAY POUT I									
NR OF SQUARES	22	22	16	6	1	19	5	0	60
MEAN N PER HOUR	47851.0	26718.3	341.9	851.6	0.0	1.4	0.0	0.0	27533.8
MEAN LENGTH	10.72	11.70	11.66	12.10	0.00	11.19	0.00	0.00	10.99
STANDARD DEVIATION	1.07	0.93	1.15	1.56	0.00	1.01	0.00	0.00	1.13
MIN-L	7	7	8	7	0	9	0	0	7
MAX-L	16	16	17	16	0	13	0	0	17
IYHS 1975 NORWAY POUT I									
NR OF SQUARES	33	24	17	10	4	31	10	3	80
MEAN N PER HOUR	8698.2	237.3	554.1	18.6	0.0	0.0	237.9	819.5	4292.5
MEAN LENGTH	11.54	10.52	13.15	10.14	0.00	14.00	10.92	11.29	11.53
STANDARD DEVIATION	1.35	1.05	0.95	1.69	0.00	0.71	1.02	1.01	1.30
MIN-L	7	8	10	8	0	13	8	7	7
MAX-L	16	15	16	16	0	15	15	15	16
IYHS 1976 NORWAY POUT I									
NR OF SQUARES	37	24	12	11	4	31	11	9	76
MEAN N PER HOUR	7943.1	55.8	462.8	11.0	0.0	0.0	24.3	218.7	4599.3
MEAN LENGTH	10.75	12.06	12.47	12.65	0.00	0.00	11.60	11.17	10.81
STANDARD DEVIATION	1.04	1.21	1.14	1.22	0.00	0.00	1.27	0.98	1.05
MIN-L	8	8	9	9	0	0	8	8	8
MAX-L	15	19	16	16	0	0	15	15	19
IYHS 1977 NORWAY POUT I									
NR OF SQUARES	43	25	21	11	4	31	12	8	90
MEAN N PER HOUR	8426.4	249.0	454.9	375.7	0.3	0.0	44.1	0.0	4814.4
MEAN LENGTH	10.97	11.40	12.20	13.65	11.50	12.50	12.17	0.00	11.04
STANDARD DEVIATION	0.97	0.99	1.11	1.05	1.00	0.00	0.99	0.00	1.16
MIN-L	7	8	8	7	10	12	8	0	7
MAX-L	15	15	17	17	13	13	15	0	17
IYHS 1978 NORWAY POUT I									
NR OF SQUARES	41	25	21	11	5	30	12	14	91
MEAN N PER HOUR	3791.7	184.9	642.5	35.4	0.0	0.0	10.3	33.3	1912.7
MEAN LENGTH	11.63	12.72	12.54	13.33	0.00	0.00	11.77	12.12	11.72
STANDARD DEVIATION	0.97	0.91	0.89	1.09	0.00	0.00	0.81	1.06	1.00
MIN-L	8	7	6	7	0	0	10	8	6
MAX-L	16	16	16	16	0	0	14	18	16
IYHS 1979 NORWAY POUT I									
NR OF SQUARES	41	25	21	11	5	29	11	13	90
MEAN N PER HOUR	5461.5	13.7	1291.2	8.0	0.3	0.0	4.6	14.4	2690.1
MEAN LENGTH	11.28	11.95	11.37	12.62	11.50	0.00	10.89	11.83	11.28
STANDARD DEVIATION	1.05	1.21	1.13	1.47	0.00	0.00	1.34	1.05	1.05
MIN-L	7	8	7	9	11	0	6	8	7
MAX-L	17	17	16	16	12	0	14	15	17
LONG TERM MEAN L	11.05	11.62	12.10	12.25	11.50	12.63	11.37	11.60	11.23

TABLE VIII-7

LENGTH STATISTICS BY AREAS IYHS 1972 - 1979

AREA:	RNDF-1	RNDF-2	RNDF-3	RNDF-4	RNDF-5	RNDF-6	RNDF-7	KATTEGAT	NORTH SEA
IYHS 1972 NORWAY POUT II									
NR OF SQUARES	9	12	15	8	0	24	10	0	38
MEAN N PER HOUR	717.3	0.0	1124.4	185.6	0.0	0.0	0.2	0.0	652.6
MEAN LENGTH	15.51	0.00	14.91	16.13	0.00	0.00	15.50	0.00	15.03
STANDARD DEVIATION	1.25	0.00	1.09	1.84	0.00	0.00	1.15	0.00	1.19
MIN-L	12	0	12	13	0	0	14	0	12
MAX-L	19	0	19	20	0	0	17	0	20
IYHS 1973 NORWAY POUT II									
NR OF SQUARES	4	11	15	5	0	19	1	0	32
MEAN N PER HOUR	1277.5	329.2	148.3	619.6	0.0	0.1	0.0	0.0	438.3
MEAN LENGTH	14.81	14.86	15.69	16.28	0.00	15.50	0.00	0.00	15.46
STANDARD DEVIATION	0.85	1.34	1.10	0.89	0.00	1.41	0.00	0.00	1.22
MIN-L	13	13	13	14	0	14	0	0	13
MAX-L	19	19	19	19	0	17	0	0	19
IYHS 1974 NORWAY POUT II									
NR OF SQUARES	22	22	16	6	1	19	5	0	60
MEAN N PER HOUR	1092.0	27.1	34.6	1.3	0.0	0.0	0.0	0.0	419.7
MEAN LENGTH	16.17	16.91	17.11	18.50	0.00	0.00	0.00	0.00	16.22
STANDARD DEVIATION	0.98	0.74	1.24	0.00	0.00	0.00	0.00	0.00	1.01
MIN-L	13	15	14	18	0	0	0	0	13
MAX-L	19	21	21	19	0	0	0	0	21
IYHS 1975 NORWAY POUT II									
NR OF SQUARES	33	24	17	10	4	31	10	3	80
MEAN N PER HOUR	5686.7	9.1	406.2	7.5	0.0	0.0	19.0	76.2	2441.0
MEAN LENGTH	15.86	16.97	16.10	17.04	0.00	0.00	16.96	16.50	15.87
STANDARD DEVIATION	1.12	1.65	1.24	4.08	0.00	0.00	1.35	1.15	1.14
MIN-L	12	14	12	14	0	0	14	13	12
MAX-L	20	21	20	21	0	0	20	20	21
IYHS 1976 NORWAY POUT II									
NR OF SQUARES	37	24	12	11	4	31	11	9	76
MEAN N PER HOUR	929.4	8.2	15.5	22.1	0.0	0.0	6.0	0.9	385.0
MEAN LENGTH	16.35	16.74	18.28	19.99	0.00	0.00	13.52	16.98	16.31
STANDARD DEVIATION	1.16	3.18	1.36	0.77	0.00	0.00	1.07	1.05	1.27
MIN-L	13	12	14	17	0	0	12	15	12
MAX-L	20	23	22	21	0	0	18	19	23
IYHS 1977 NORWAY POUT II									
NR OF SQUARES	43	25	21	11	4	31	12	8	90
MEAN N PER HOUR	799.8	7.6	38.7	46.5	0.0	0.0	0.3	0.0	333.8
MEAN LENGTH	15.34	17.36	16.89	18.80	0.00	0.00	17.27	0.00	15.49
STANDARD DEVIATION	1.60	1.03	1.35	1.70	0.00	0.00	1.54	0.00	1.89
MIN-L	8	14	14	13	0	0	13	0	8
MAX-L	21	20	22	23	0	0	19	0	23
IYHS 1978 NORWAY POUT II									
NR OF SQUARES	41	25	21	11	5	30	12	14	91
MEAN N PER HOUR	2632.5	4.0	37.2	164.4	0.0	0.0	1.2	10.4	1215.2
MEAN LENGTH	15.83	18.77	16.30	19.10	0.00	19.50	17.36	17.09	15.89
STANDARD DEVIATION	1.10	1.23	1.45	1.31	0.00	2.31	1.39	1.20	1.18
MIN-L	13	15	13	15	0	17	15	13	13
MAX-L	21	22	21	23	0	22	21	20	23
IYHS 1979 NORWAY POUT II									
NR OF SQUARES	41	25	21	11	5	29	11	13	90
MEAN N PER HOUR	710.5	0.1	15.8	21.6	0.0	0.0	0.0	0.8	240.3
MEAN LENGTH	16.33	20.17	13.89	19.74	0.00	0.00	11.50	13.34	16.35
STANDARD DEVIATION	1.21	1.53	2.60	1.27	0.00	0.00	0.00	1.41	1.37
MIN-L	13	18	9	14	0	0	11	11	9
MAX-L	23	22	22	22	0	0	12	17	23
LONG TERM MEAN L	15.78	17.40	16.15	18.20	0.00	17.50	15.35	15.98	15.83


NORTH SEA
IYHS 1974-1979
LONG TERM AVERAGE
NORWAY POUT I
N PER HOUR

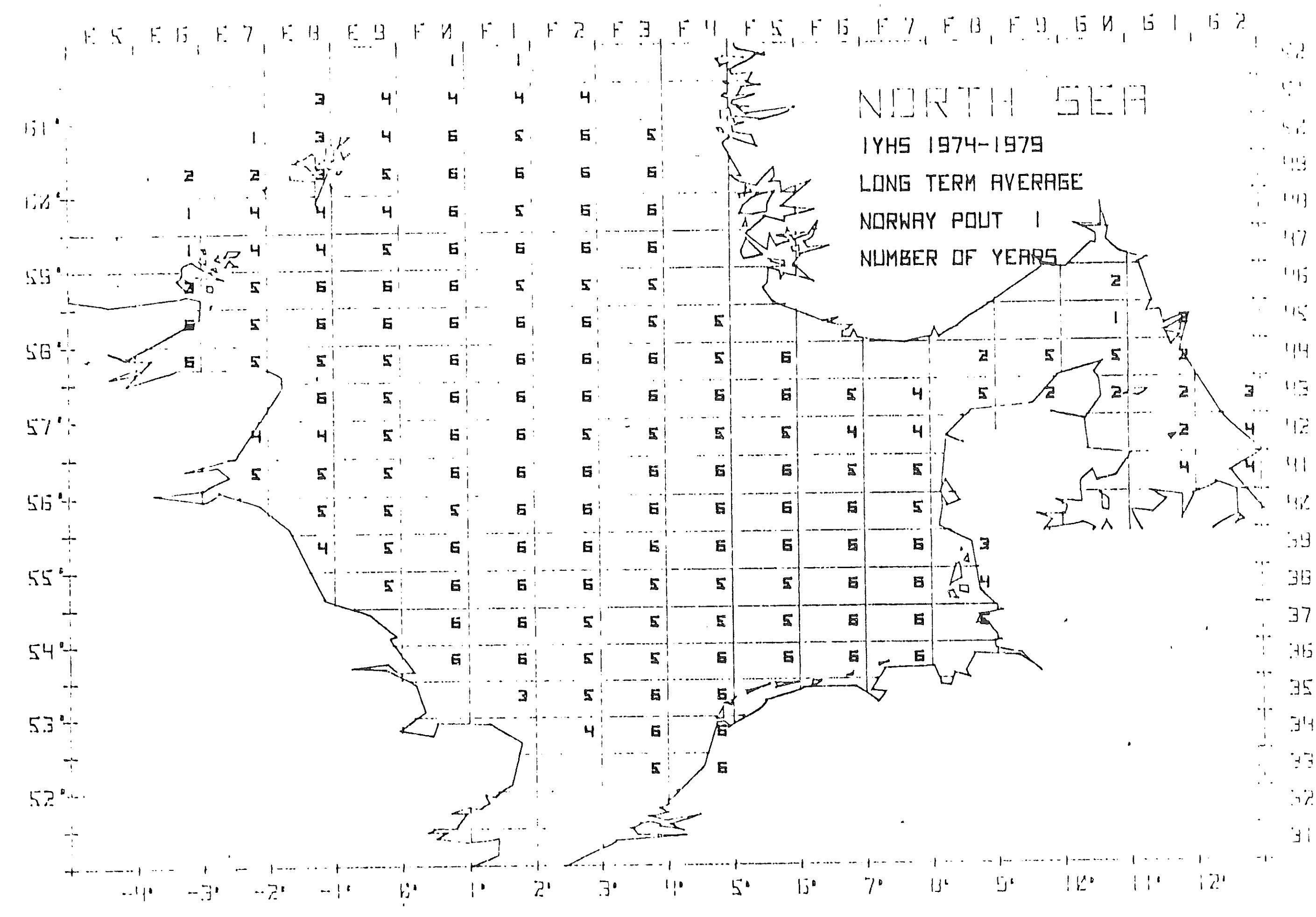
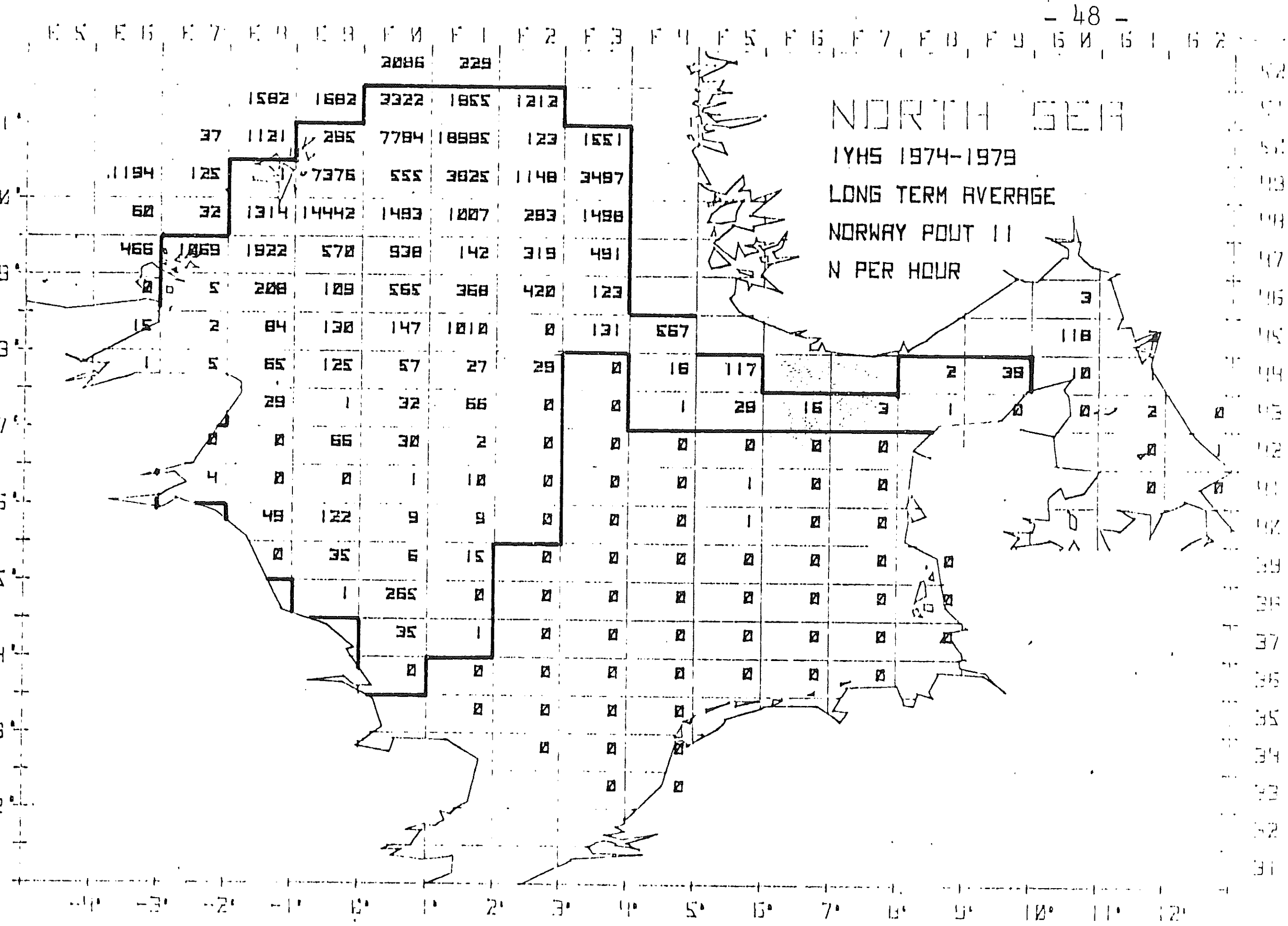

NORTH SEA
IYHS 1974-1979
LONG TERM AVERAGE
NORWAY POUT I
NUMBER OF YEARS

Figure 8 - 1.


NORTH SEA
IYHS 1974-1979
LONG TERM AVERAGE
NORWAY POUT II
N PER HOUR

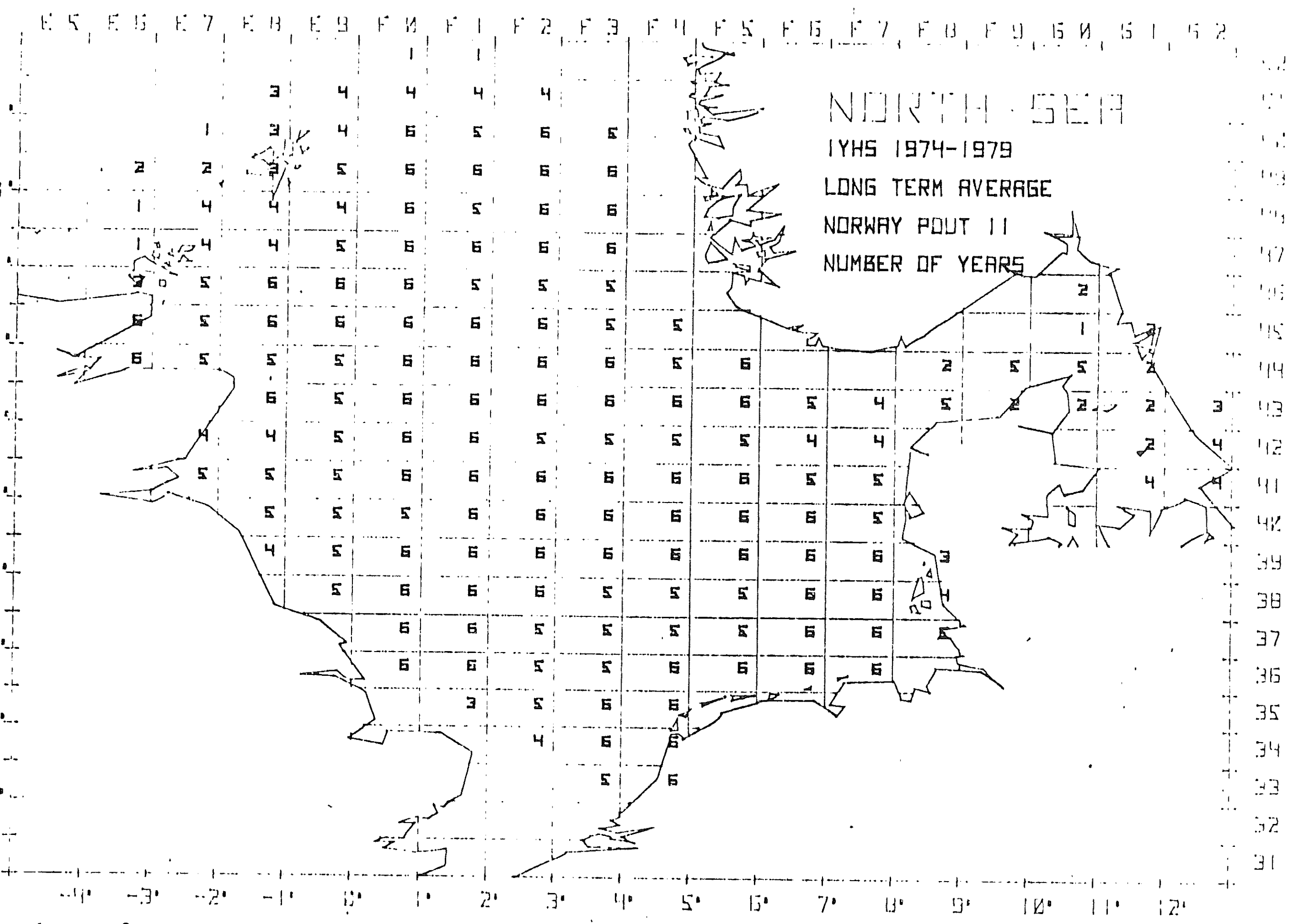
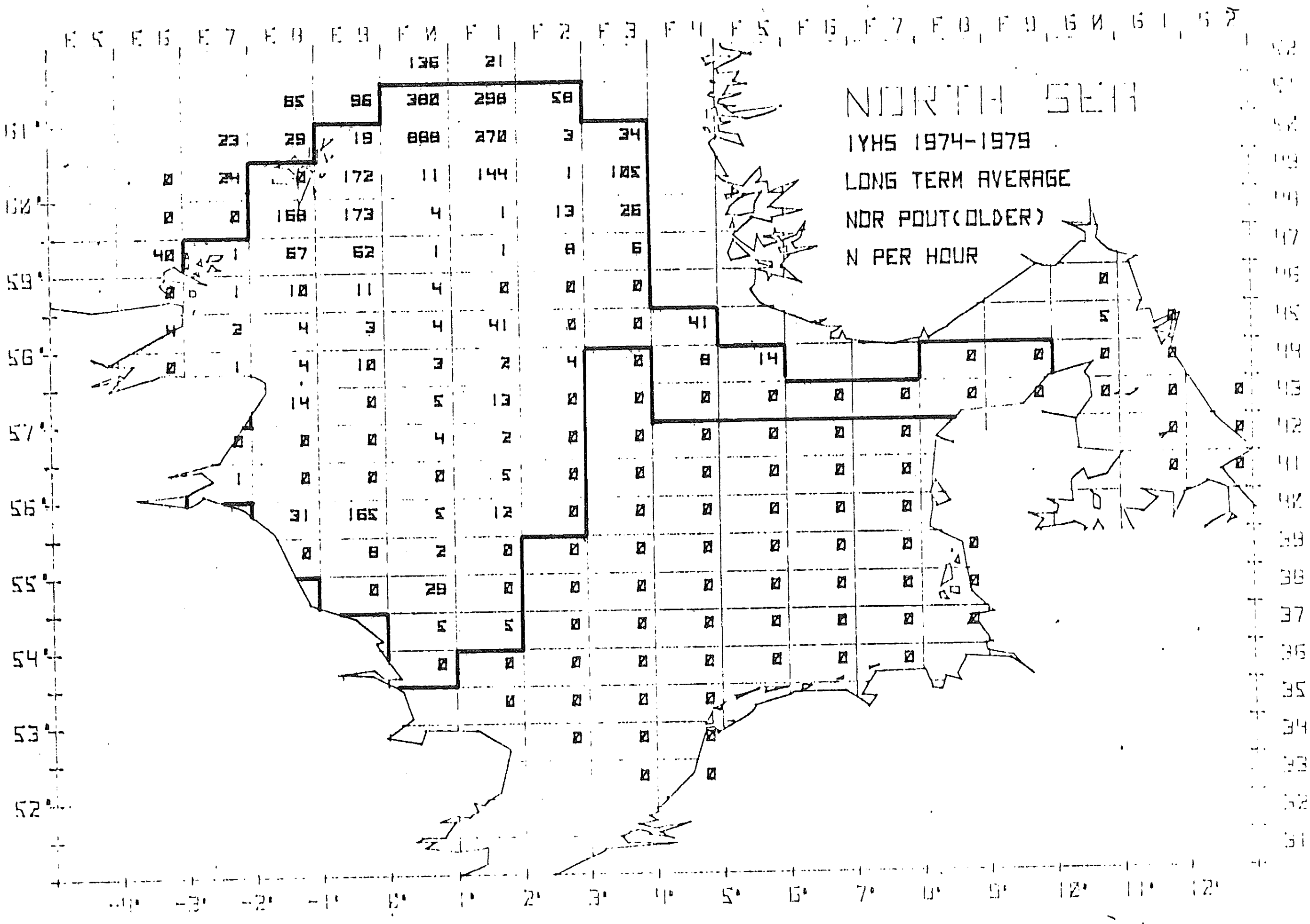

NORTH SEA
IYHS 1974-1979
LONG TERM AVERAGE
NORWAY POUT II
NUMBER OF YEARS

Figure 8 - 2.


NORTH SEA
IYHS 1974-1979
LONG TERM AVERAGE
NOR POUT(OLDER)
N PER HOUR

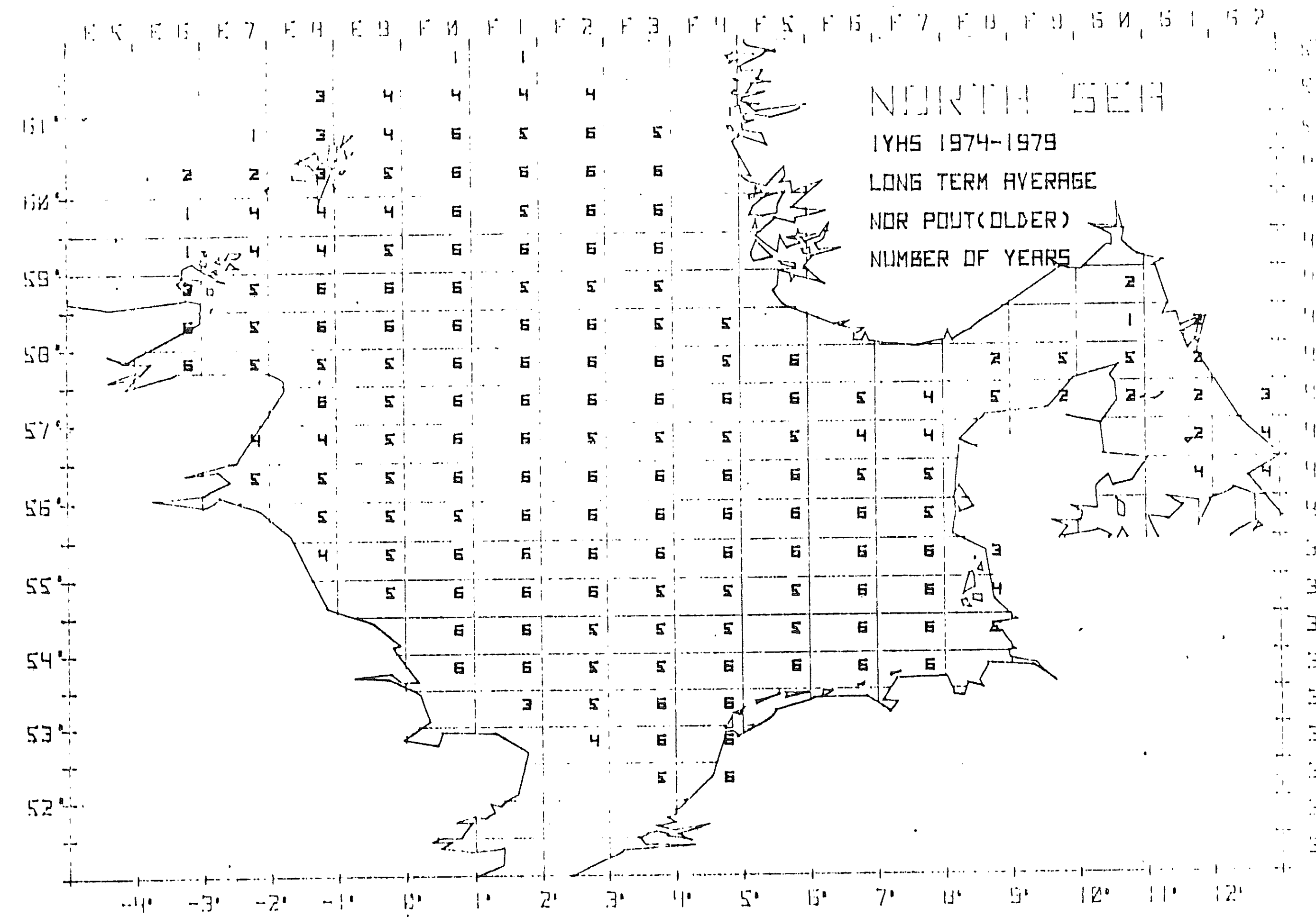

NORTH SEA
IYHS 1974-1979
LONG TERM AVERAGE
NOR POUT(OLDER)
NUMBER OF YEARS

Figure 8 - 3.

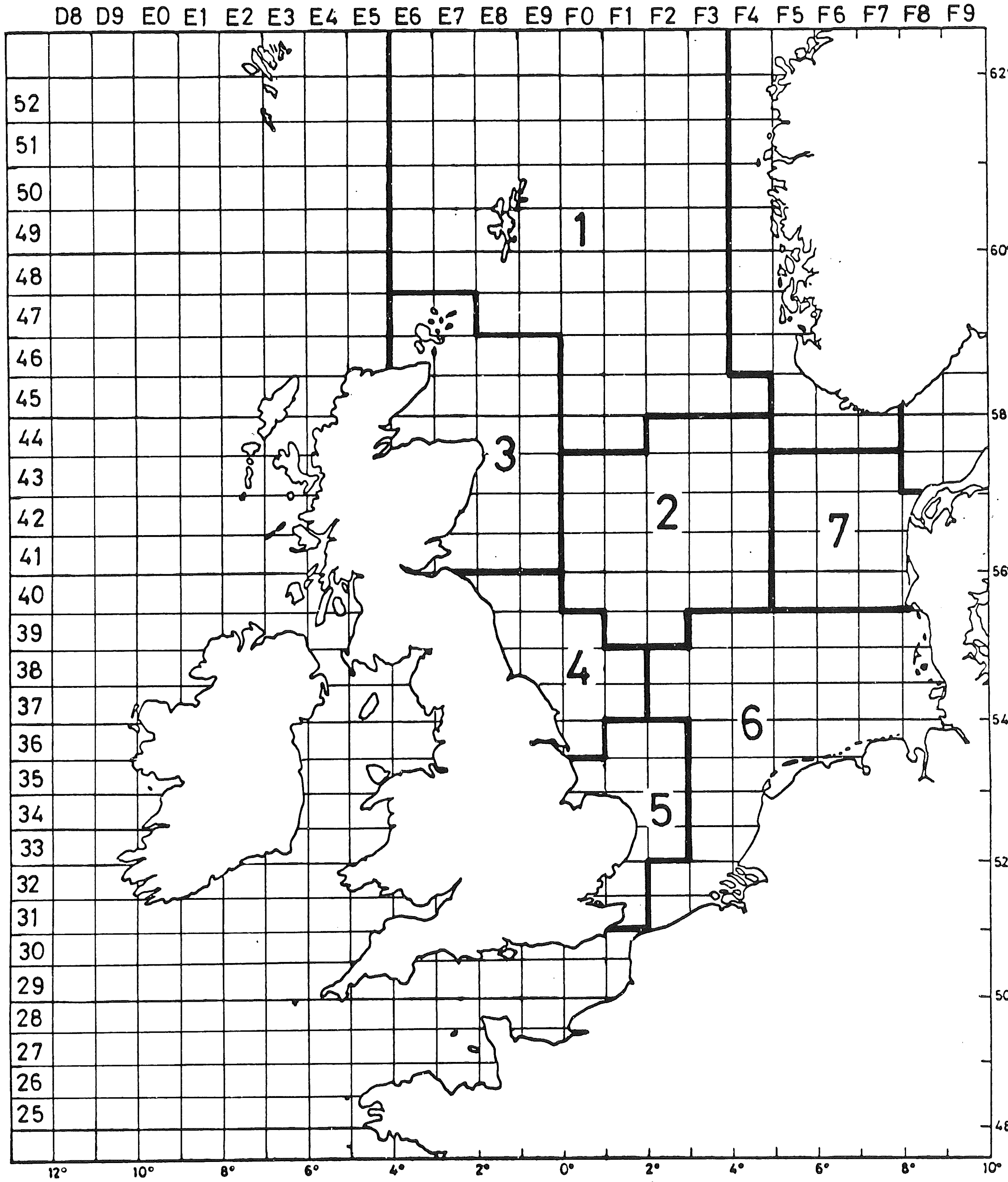


Figure 10 - 1.

Sub-areas of the North Sea as proposed for roundfish sampling in the North Sea and used in this analysis for investigating spatial differences in abundance during the International Young Herring Surveys.

IX. SURVEY DESIGN

The statistical basis of the surveys was discussed with particular reference to the procedures in distributing the participating vessels over the area. At present different squares are appointed to each vessel each year in order to reduce the chance of possible bias due to differences in gear efficiencies (since not all vessels are yet employing the standard GOV-trawl), when averaging mean catches per square to obtain an overall index of abundance. For similar reasons each square is assigned to at least two vessels, but this has the additional advantage that there is less chance that any square is completely missed during the survey.

Although in general this procedure, which is essentially random, is followed, in practice there are complications. Some vessels are not able to make valid hauls in particular squares (which are not necessarily the same squares from vessel to vessel) because the crew is less aquainted with the local circumstances. In such cases particular squares may be given to the same ship year after year. Also cruise logistics require that steaming time from the home country is taken into account, so that in general there is a tendency to concentrate the hauls to be made by any vessel in its home waters. However, these small deviations do not seem to largely violate the basic nature of the survey. The obvious disadvantage of this arrangement lies in the increase in within-square variance between hauls due to intership variation, but the corresponding loss in precision of the final estimate seems to be outweighed by the likely reduction in possible bias.
The concentration of research vessel effort in areas of higher abundance as a possible means of increasing the precision of the abundance estimate was rejected for two practical reasons.

1. The differences in distribution pattern of the different species and age groups effectively requires more or less "equal" distribution of the effort over most of the area, unless priorities are assigned to the different species.

2. The risk of missing out significant proportions of the population during any year becomes dangerously high, when the long-term average distribution pattern is based on a relatively small number of years only, due to possible deviations in the distribution pattern from "normal" years.

The standardization of the gear has always been a major goal of the Working Group and this still holds. Although progress has been made in this respect (in the 1979 survey three countries have actually used the GOV-trawl!) the situation is still far from satisfactory. It was further observed that the standard gear as it stands allows rigging with bobbin gear or without. Some concern was expressed about the effect of such differences in rigging on catch efficiency, and the future need for more data in this respect was stressed.

A major point raised related to the considerable differences in timing of the survey by individual vessels. The past survey results do indicate that both distribution patterns shifted and abundance varied over prolonged survey periods. In view of the extremely high running costs of these international surveys national laboratories are urgently requested to provide ship-time in the agreed survey period (February), because extending the survey period effectively devaluates the effort put in by other nations.

X. CONCLUSIONS

The statistical treatment of the data, as well as the revisions that were agreed by the Working Group with reference to standard areas and periods over which to calculate the long-term average, required both new programming and reruns of established programs. Since the computer system available at the Ymuiden laboratory is limited to the extent that it can only do one job at a time and also in terms of memory capacity, the Working Group could not make enough progress to cope with a complete analysis. Undoubtedly the report bears the signs of this incompleteness.

In analyzing 8 years of extensive survey data the severe limitations of the computer system became all too obvious and therefore the Working Group recommended to transfer the data base to a larger computer system. Laboratories with interest in this respect should contact the Ymuiden laboratory in order to establish a cooperative project on the analysis of Young Herring Survey data.

For the near future, however, the Working Group agreed that the Ymuiden laboratory should pursue some of the ideas brought up during the meeting and that after correspondence about the results a follow-up of the present Working Group report should be prepared as soon as possible.

One of the main conclusions of the statistical treatment of the data so far is that the within square coefficient of variance is remarkably constant from year to year for each species (Table IV - 1 and 2). Although this aspect could not be fully explored, essentially this should provide a means of estimating the overall variance of both the straight arithmetic abundance index and the one based on log transformation.

There is no 'a priori' statistical reasoning why one index should be better than another, although the inherent coefficient of variance may vary. The test, however, which one should serve the purposes of the use of these surveys best lies in the correlation of the index with independent estimates of year class strength. Again, this could not be fully explored in the available time, but the correlation between the two possible indices investigated (arithmetic means of the arithmetic mean catches per square and the antilog values of the mean log's of the arithmetic mean catches per square) and recruitment estimates (from VPA or CPUE data) both yielded significant coefficients for all species. In some cases the correlation coefficients between estimates of year class strength as I-group and II-group from the surveys were even higher. Since these two indices for one year class are obtained in consecutive years and therefore completely independent, this indicates that the level of precision obtained in the survey estimate is rather higher than in the VPA.

It should be observed that the survey data from the years before 1972 could not be incorporated adequately in the present analysis, because they have not yet been processed in the computer. Consequently, it remains difficult to evaluate the effect of the adjustment procedure followed, particularly since only in the earlier surveys, when coverage of the North Sea was less complete, the adjustment factor is likely to become significant. In view of the impact which the actual regression parameters have on the prediction of recruitment in future years when assessing roundfish TAC's and because the present correlations refer to a limited number of carefully checked data points, it was agreed that computer processing of the earlier survey data is an urgent matter.

With reference to the geometric means presented in this report, it should be observed that the retransformed values were not adjusted for the variance, because the latter could not be estimated adequately in the time available. As a consequence the straight antilog values of the logs of the mean catches per hour per square deviate greatly from the values presented in earlier reports. However, since the formerly used variance estimator was considered to represent a poor one, for the time being there was no other choice.

In its terms of reference the Group was asked to compare abundance indices from different aub-areas in the North Sea. The chart with the agreed roundfish sampling areas (Fig. 10 - 1) was used as a guideline in this respect and for each species adjusted and unadjusted straight arithmetic mean catches have been provided. Since there were no CPUE data from any particular sub-area available to the Group it has not been possible to evaluate the observed differences. However, the tables indicate that relative recruitment in the different areas is not constant from year to year.

The abundance indices of older fish in numbers have also been included in the tables, but no effort has been made to correlate these with data from other sources.

The length statistics by region for age groups I and II of each species show consistent geographical differences in mean size at age, the mean lengths presented in the tables are adjusted by 0.5 cm to account for the fact that fish lengths are reported to the cm below, but, although no conclusive analysis could be made of possible density-dependant growth, it appears from a superficial survey of the data that the annual differences in mean size at age do not line up very well with the annual differences in abundance.

XI RECOMMENDATIONS

1. The W.G. stresses the urgent need for standardization of the survey and in particular urges countries:

   a. to employ the agreed standard GOV-trawl;

   b. to make available their ship time during the month of February in order to have the survey as synoptic as possible.

2. The W.G. stresses the need for more extensive analysis of the survey data with particular emphasis on statistical evaluation. To facilitate this countries are invited to cooperate in transferring the data base to a large computer system.

   In addition the Group should continue the analysis started during the meeting by correspondence before a new meeting is arranged.

APPENDIX I - 1979 SURVEY RESULTS

Figure I - 1/6 : COD

Figure II - 1/6 : HADDOCK

Figure III - 1/6 : WHITING

Figure IV - 1/6 : NORWAY POUT

For each species the following charts are presented:

-1 Number of valid hauls per square,

-2 Average N/hr per square: I-Group,

-3 Average N/hr per square: II-group,

-4 Average N/hr per square: older fish,

-5 Length statistics by blocks of 4 statistical rectangles: I-Group,

-6 Length statistics by blocks of 4 statistical rectangles: II-Group.

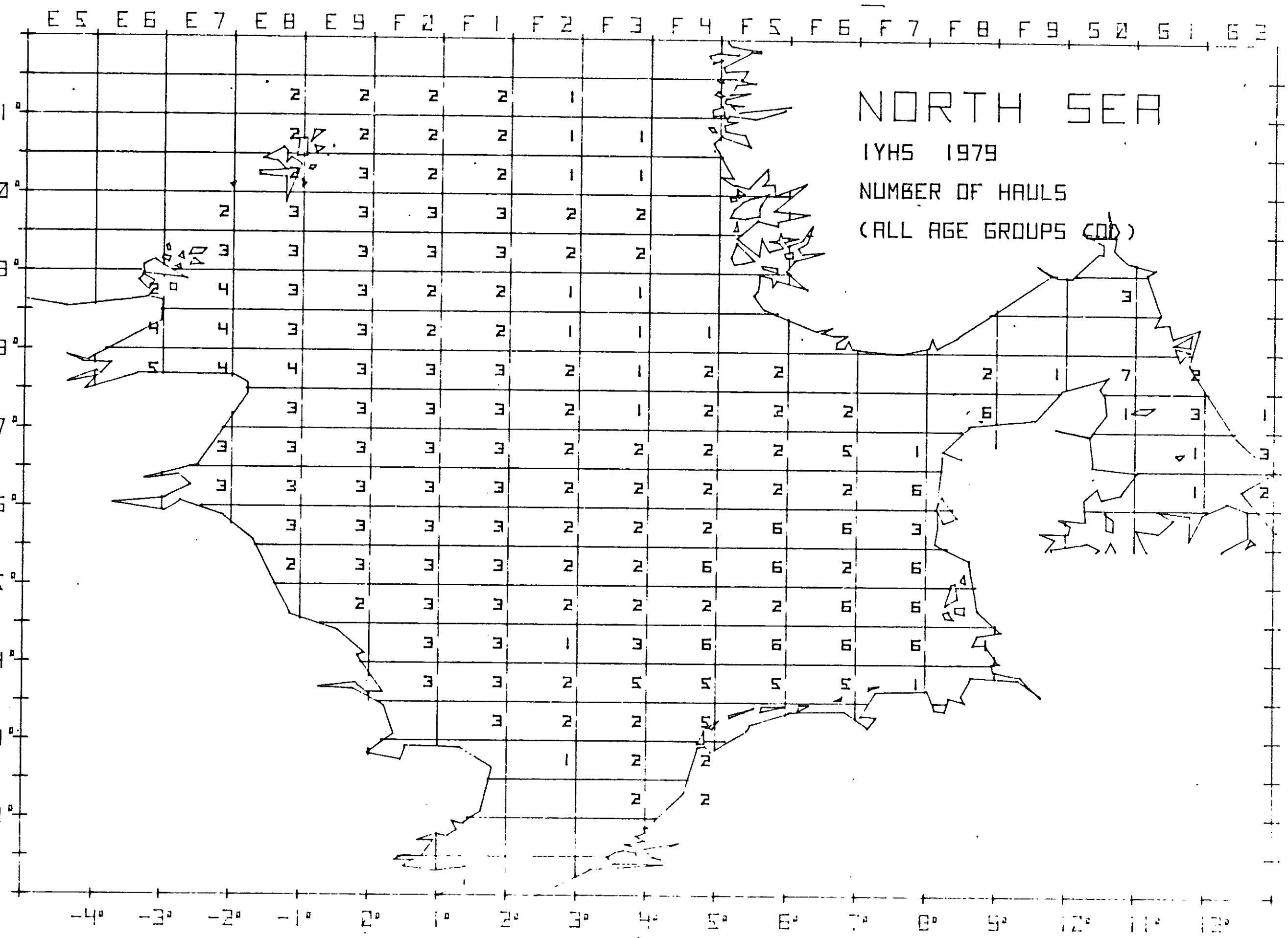


Figure I - 1.

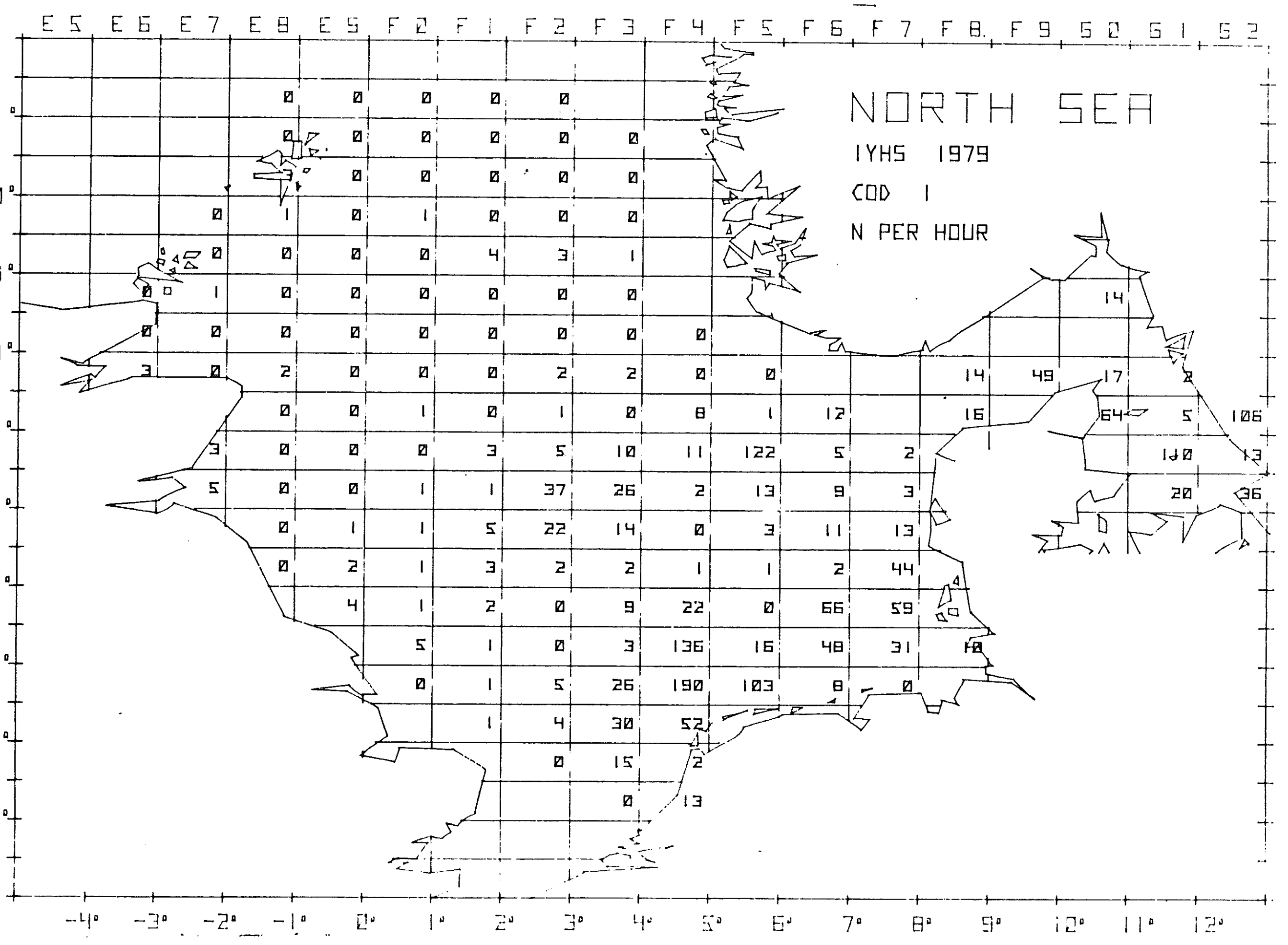


Figure I - 2.

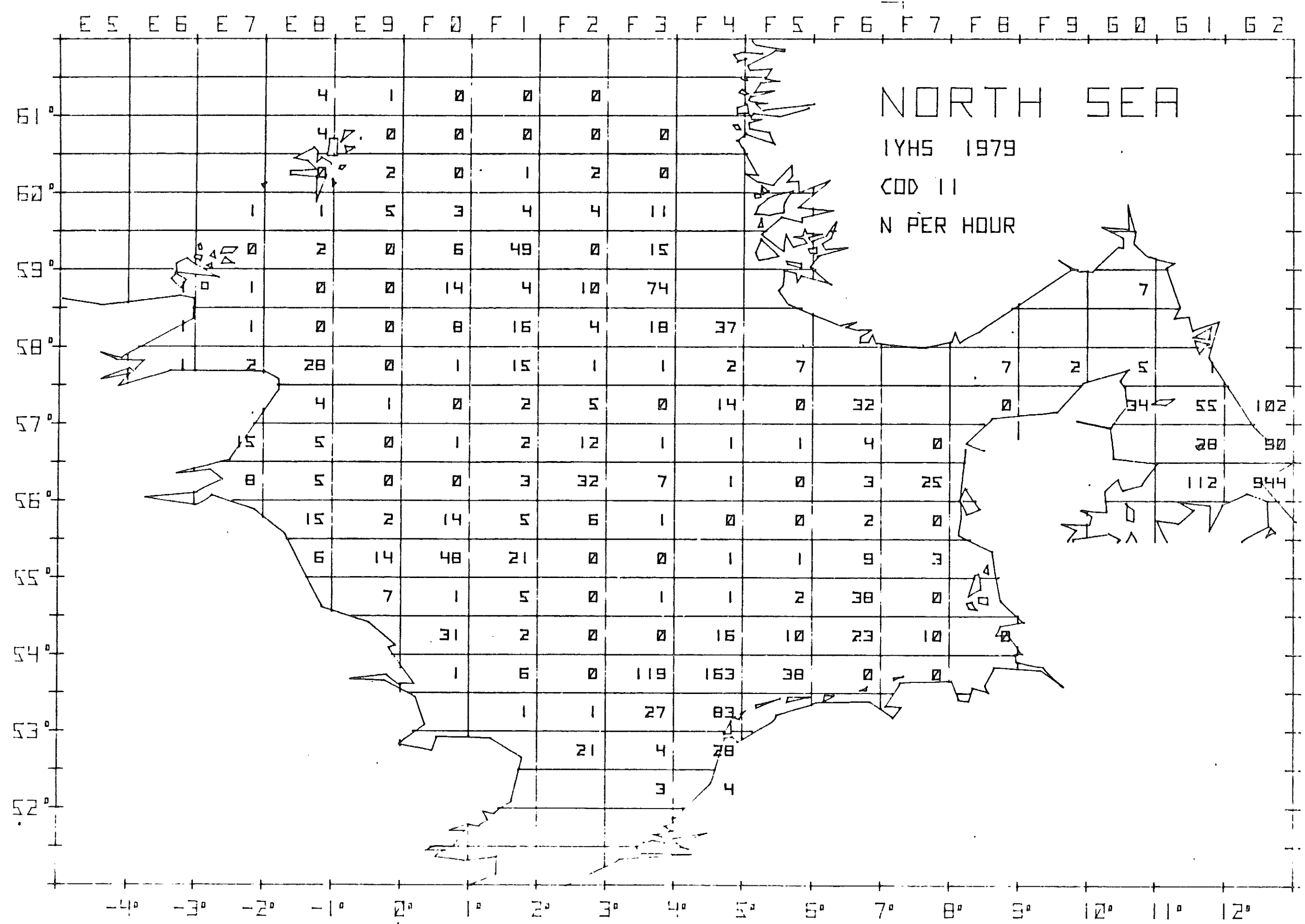


Figure I - 3.

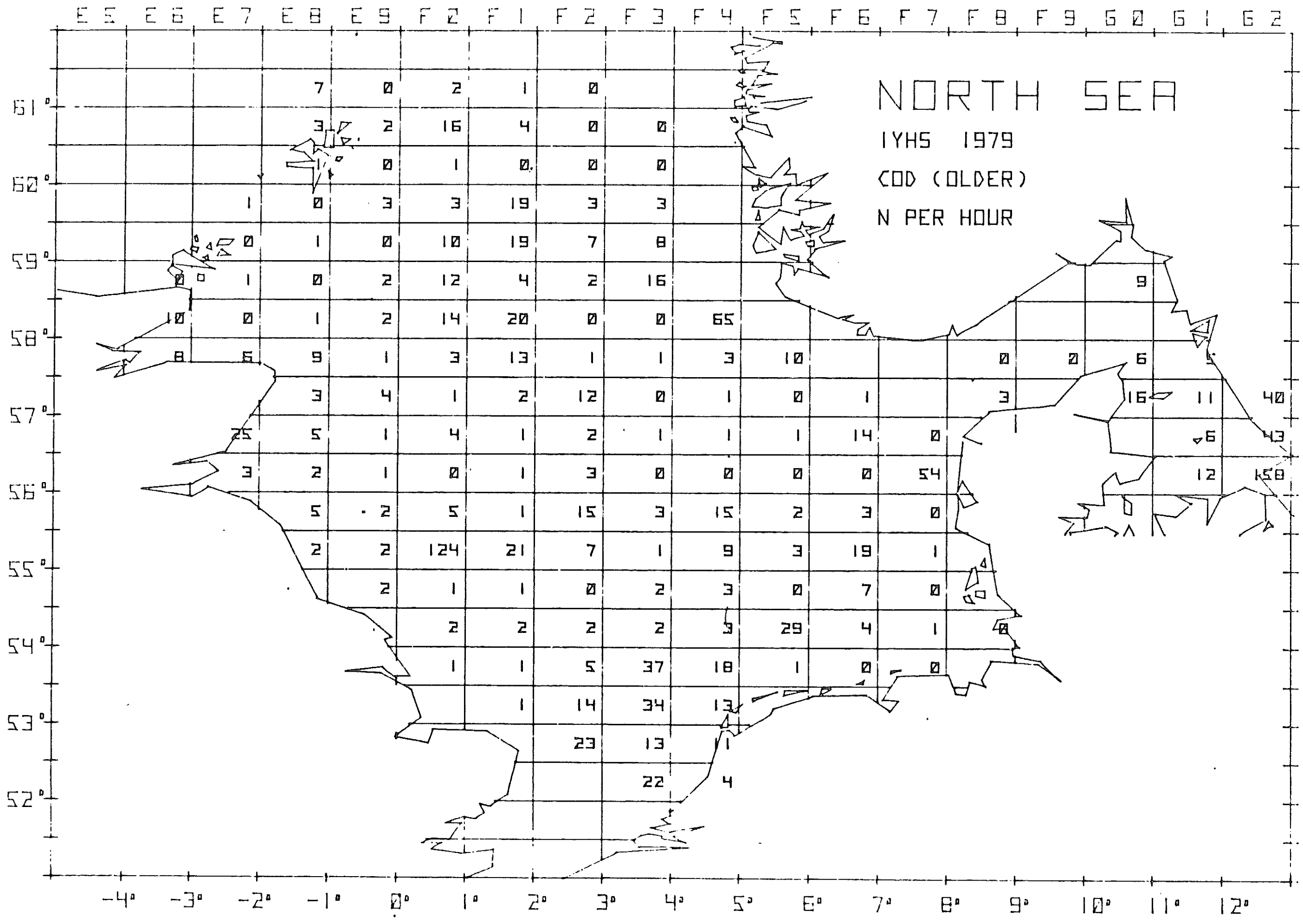


Figure I - 4.

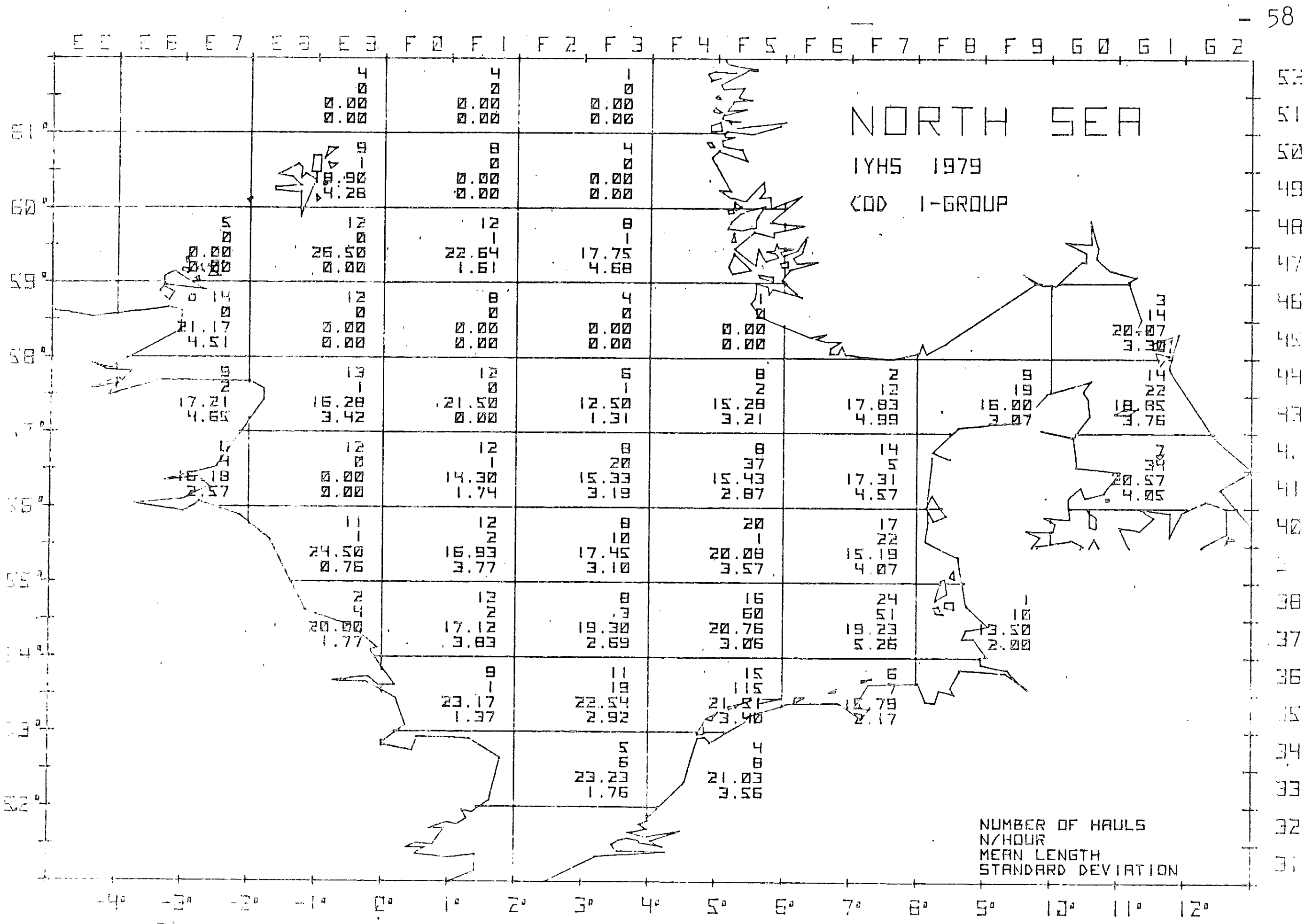


Figure I - 5.

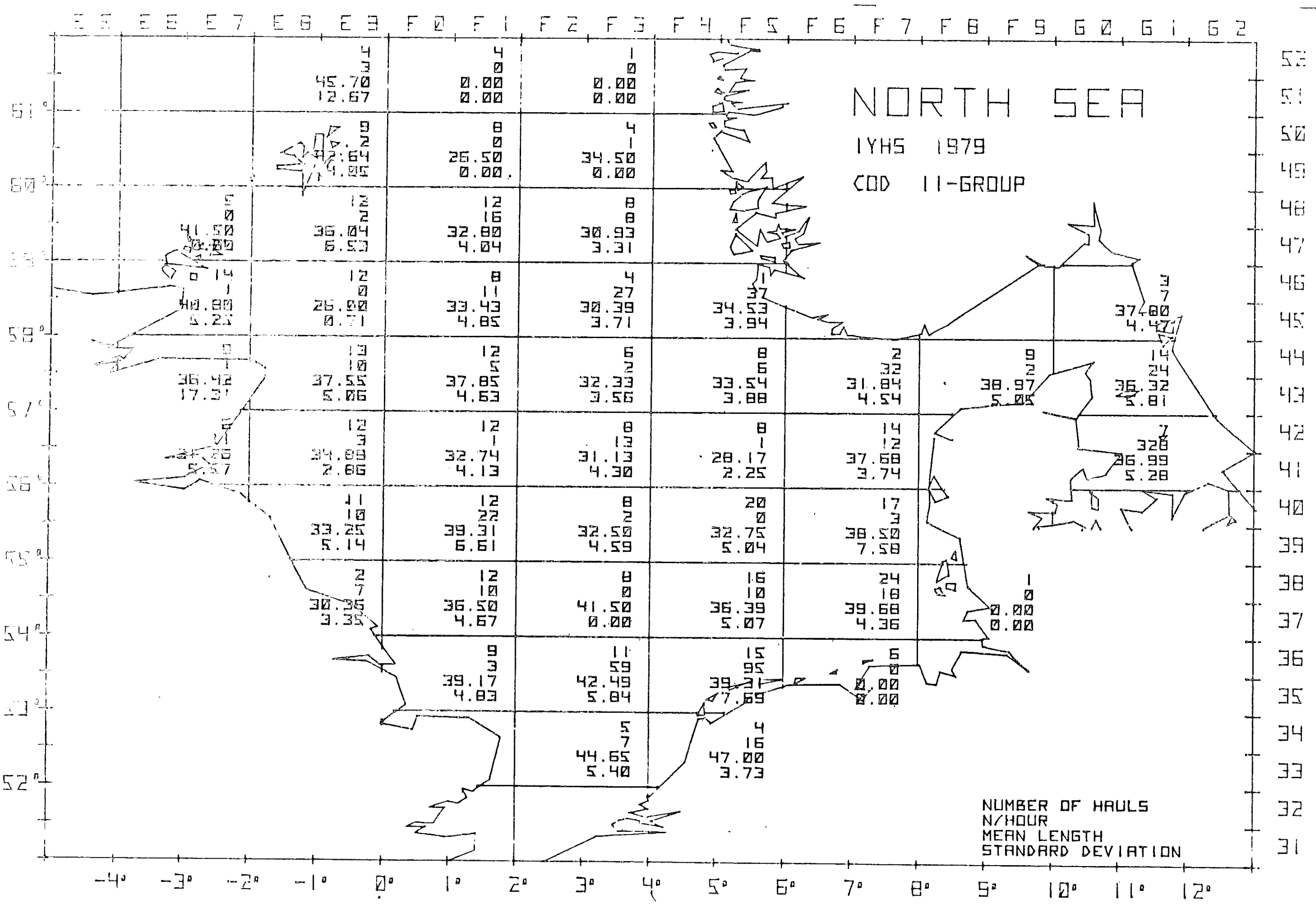
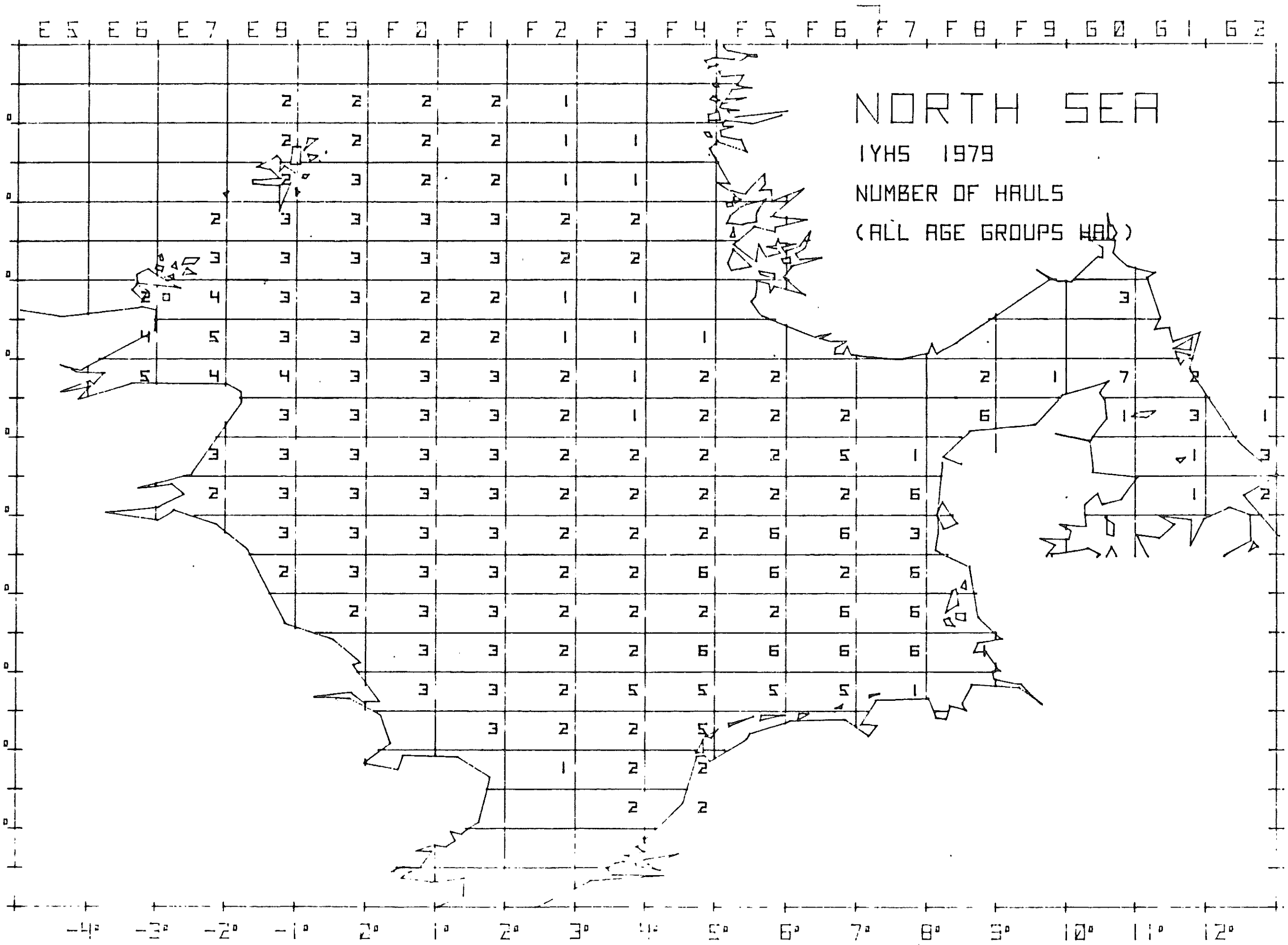


Figure I - 6.



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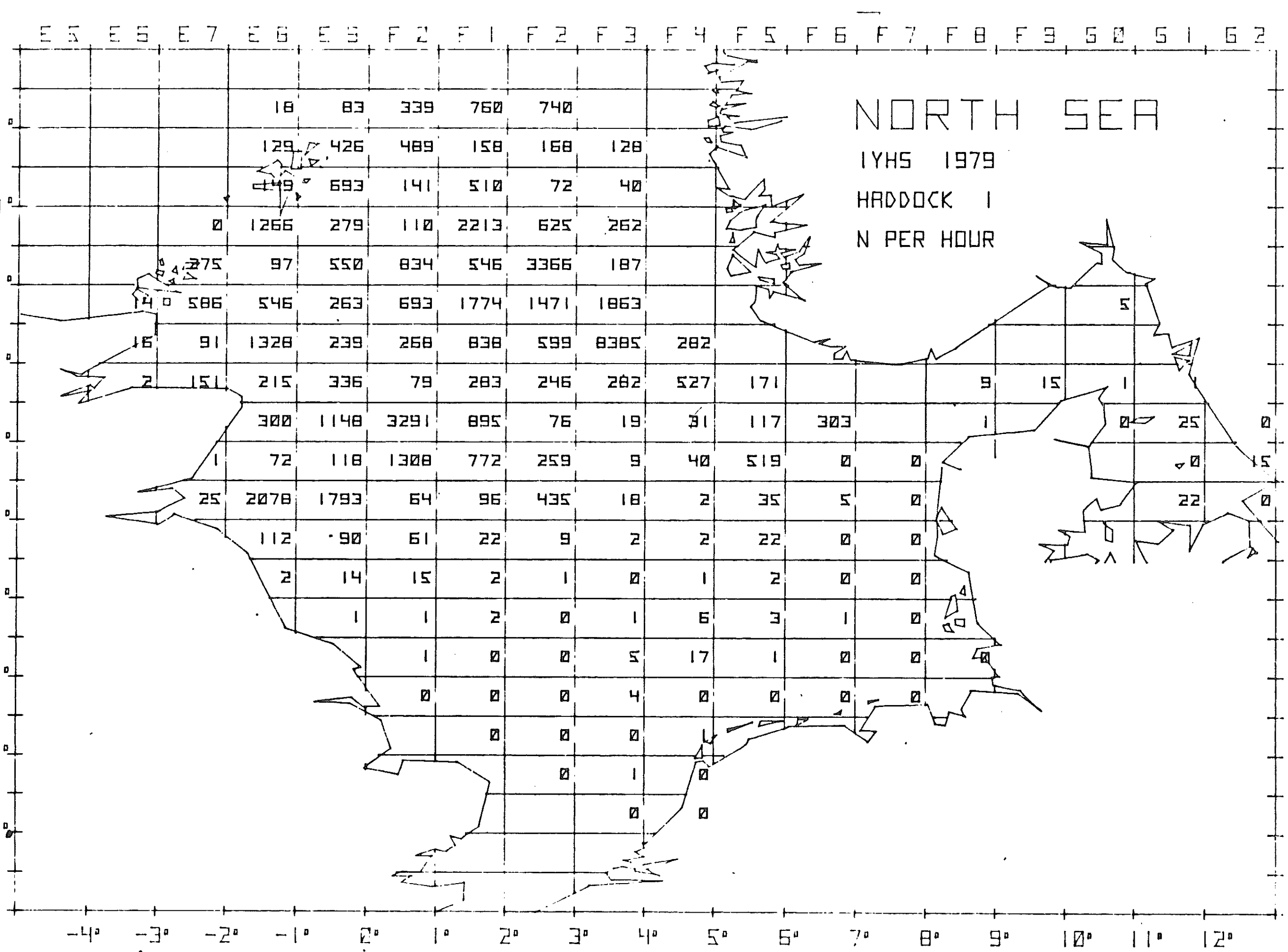

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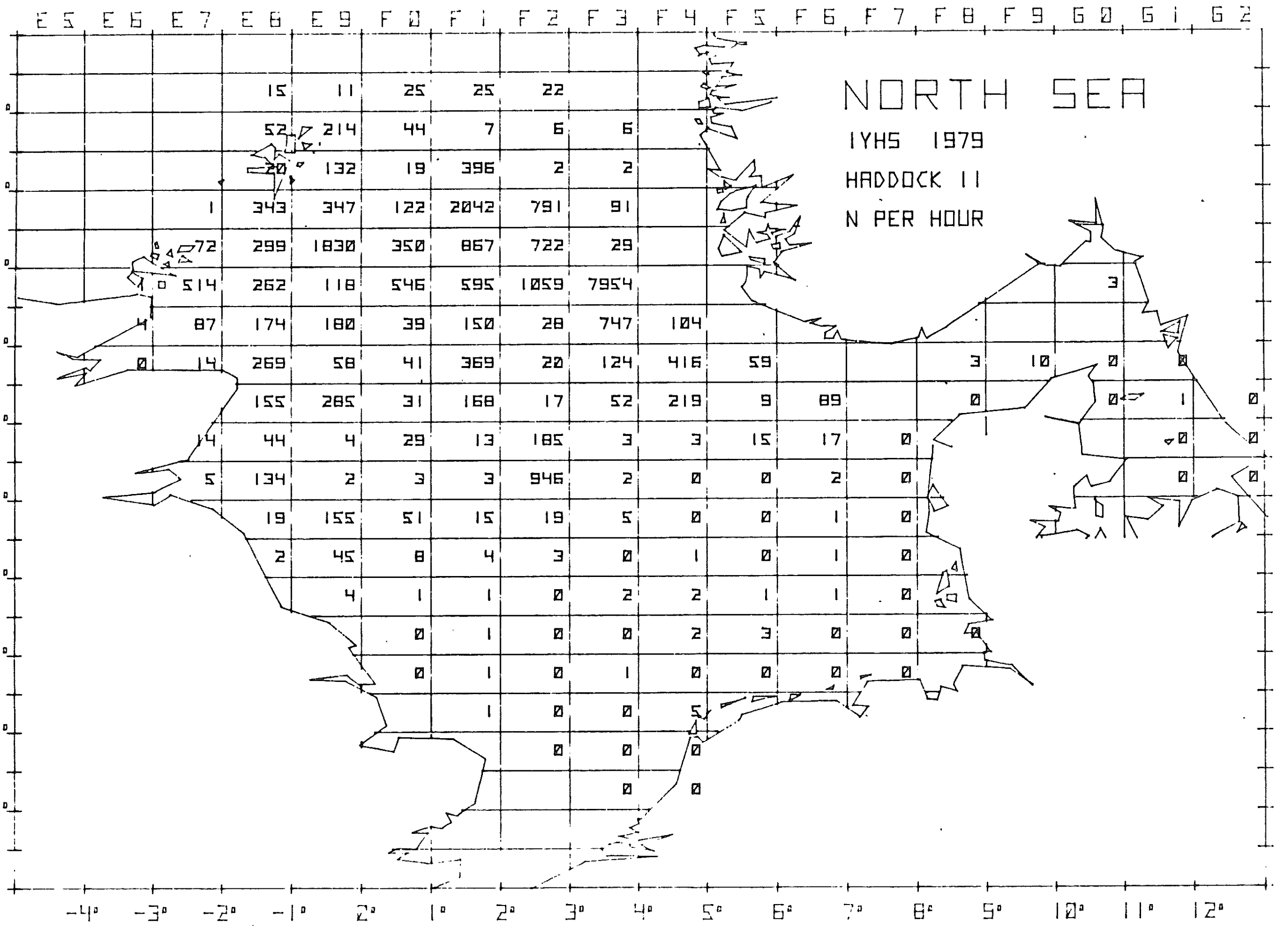

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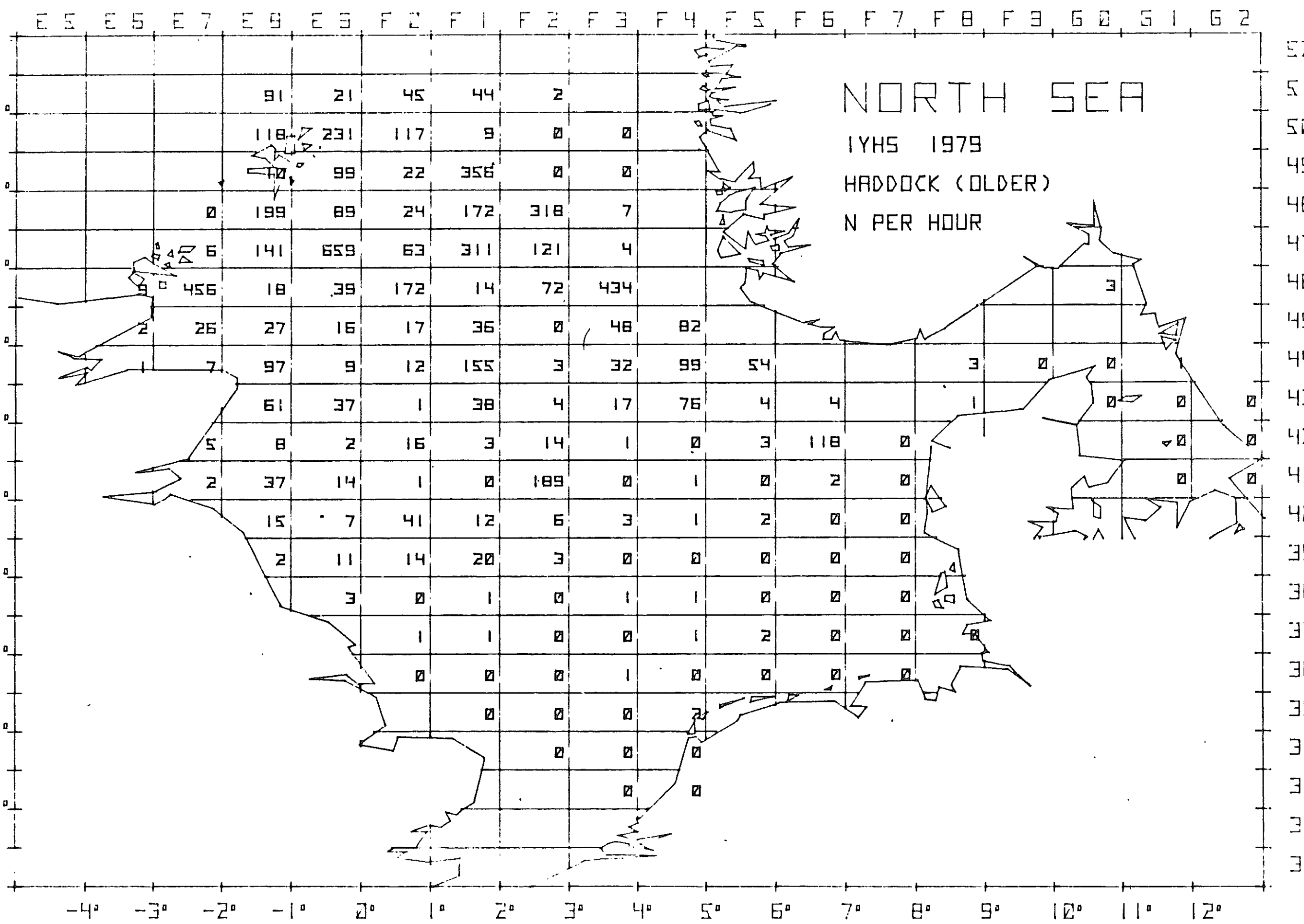
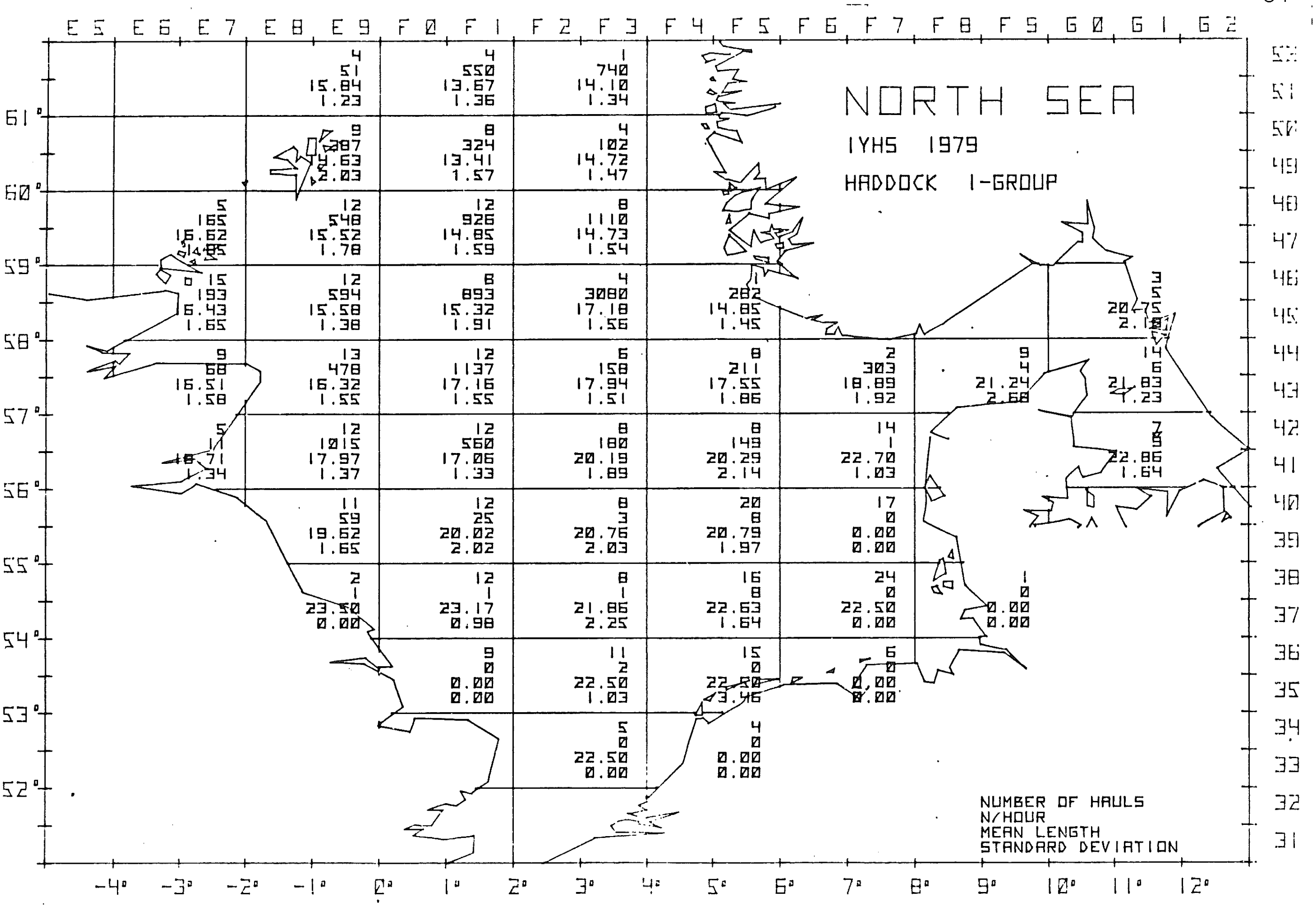


Figure II - 4.



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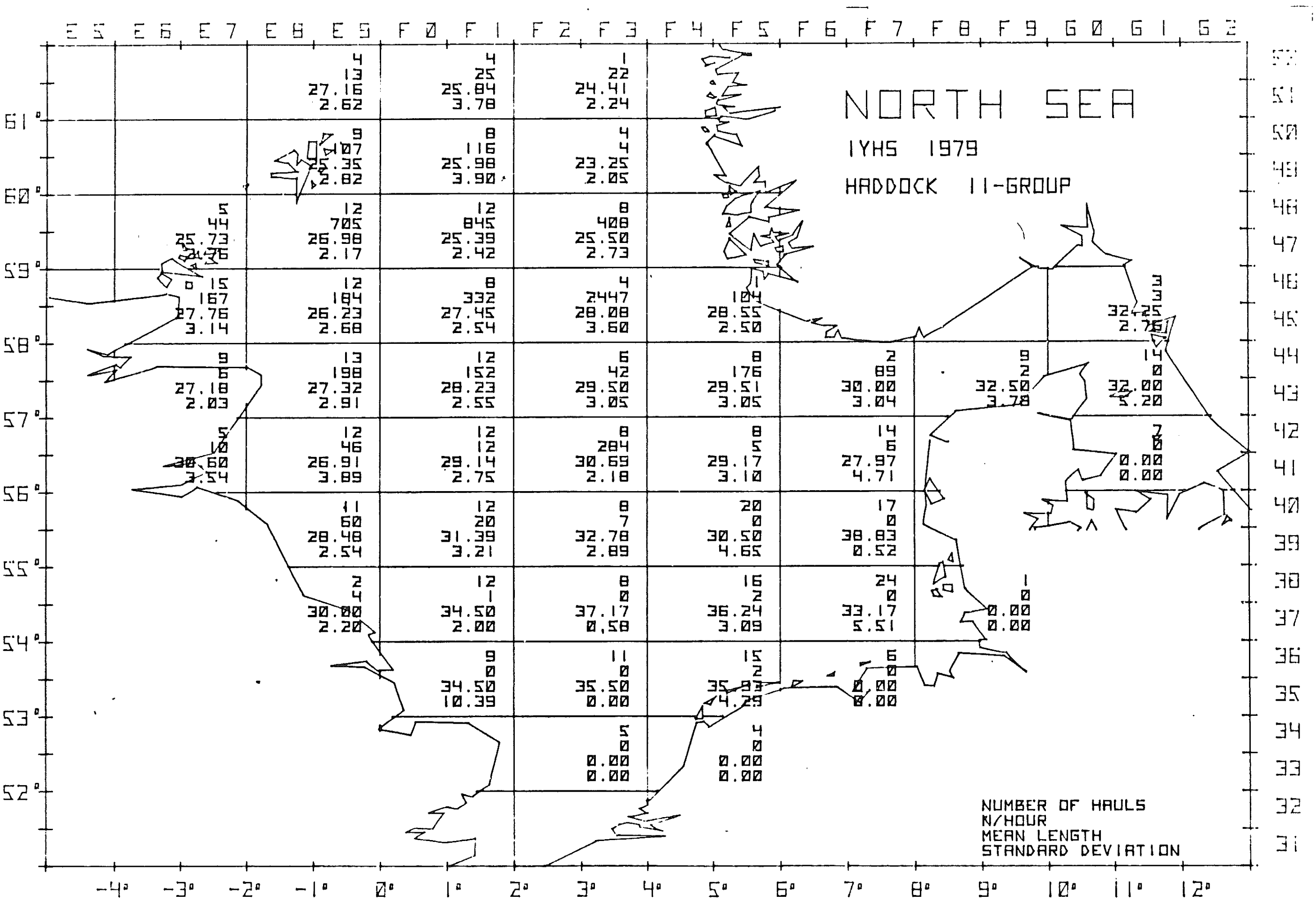


Figure II - 6.

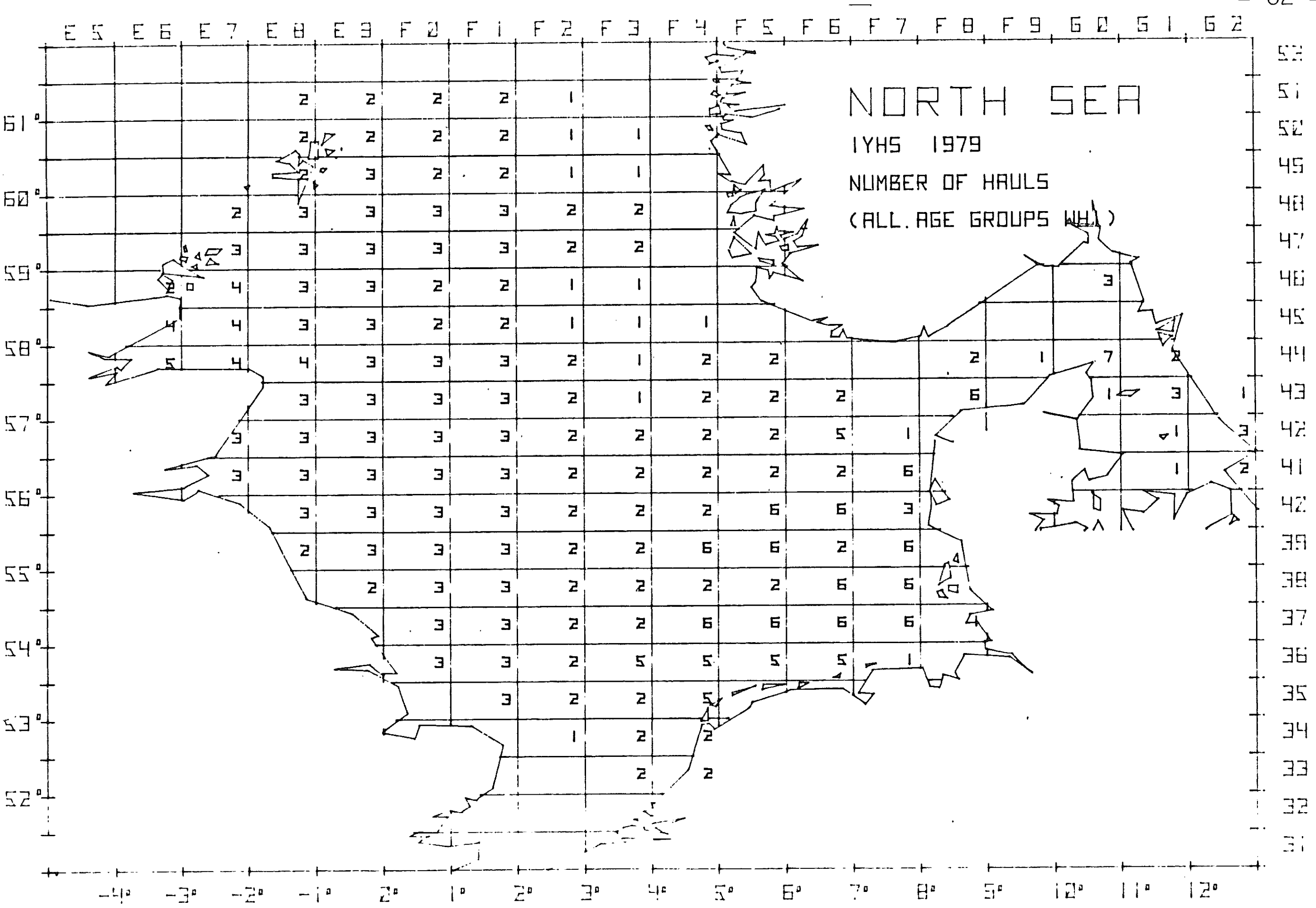


Figure III - 1.

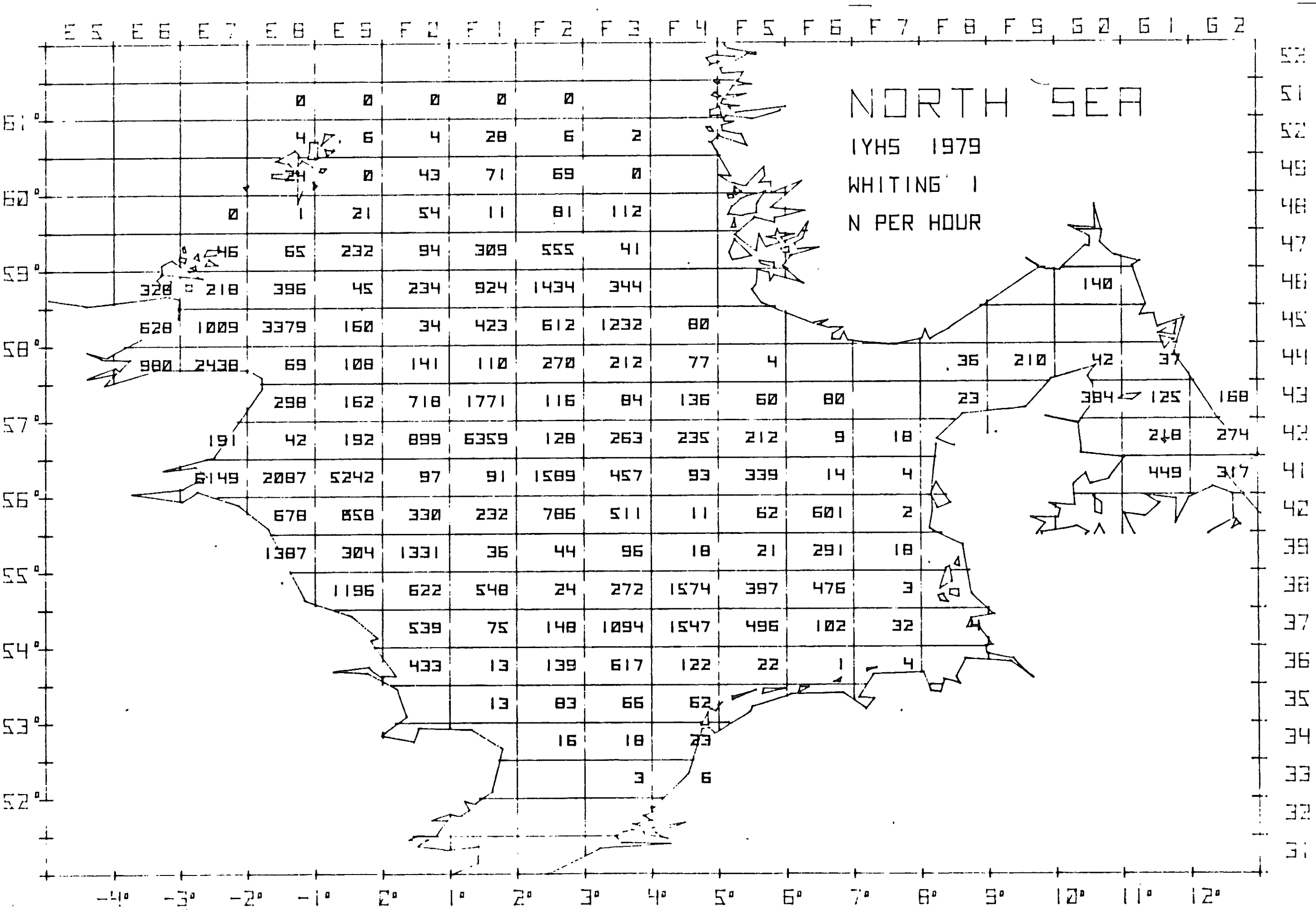
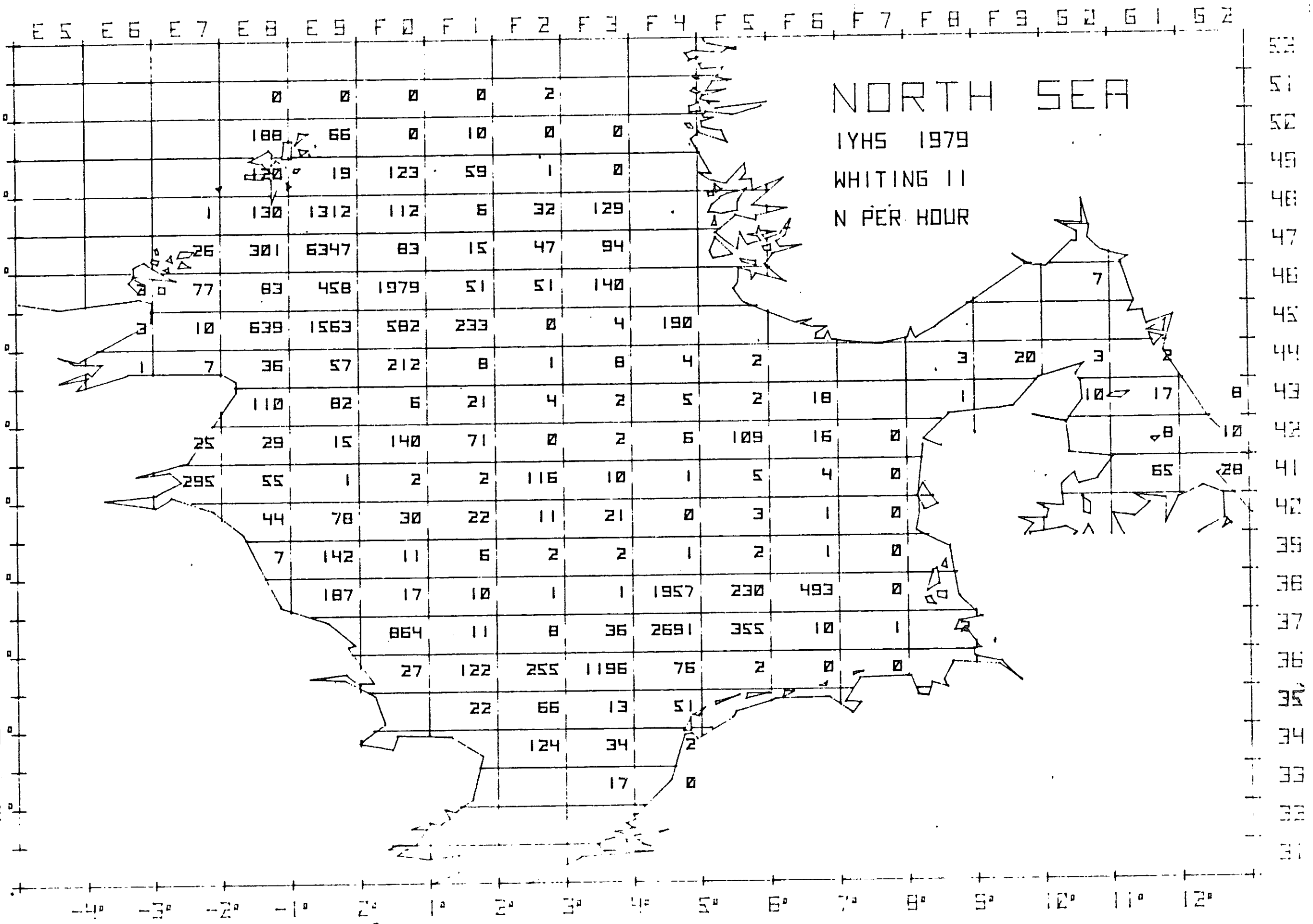


Figure III - 2.



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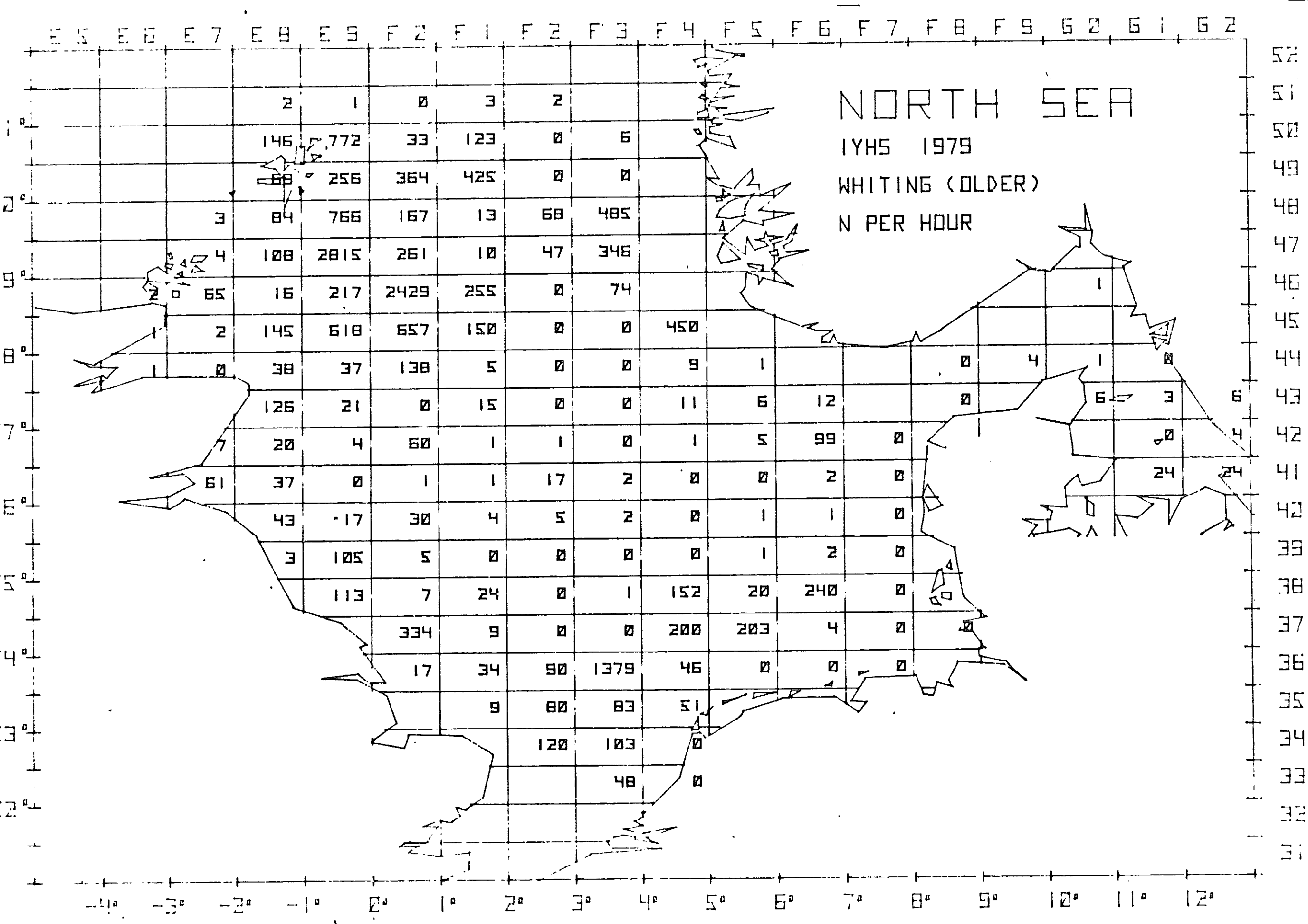

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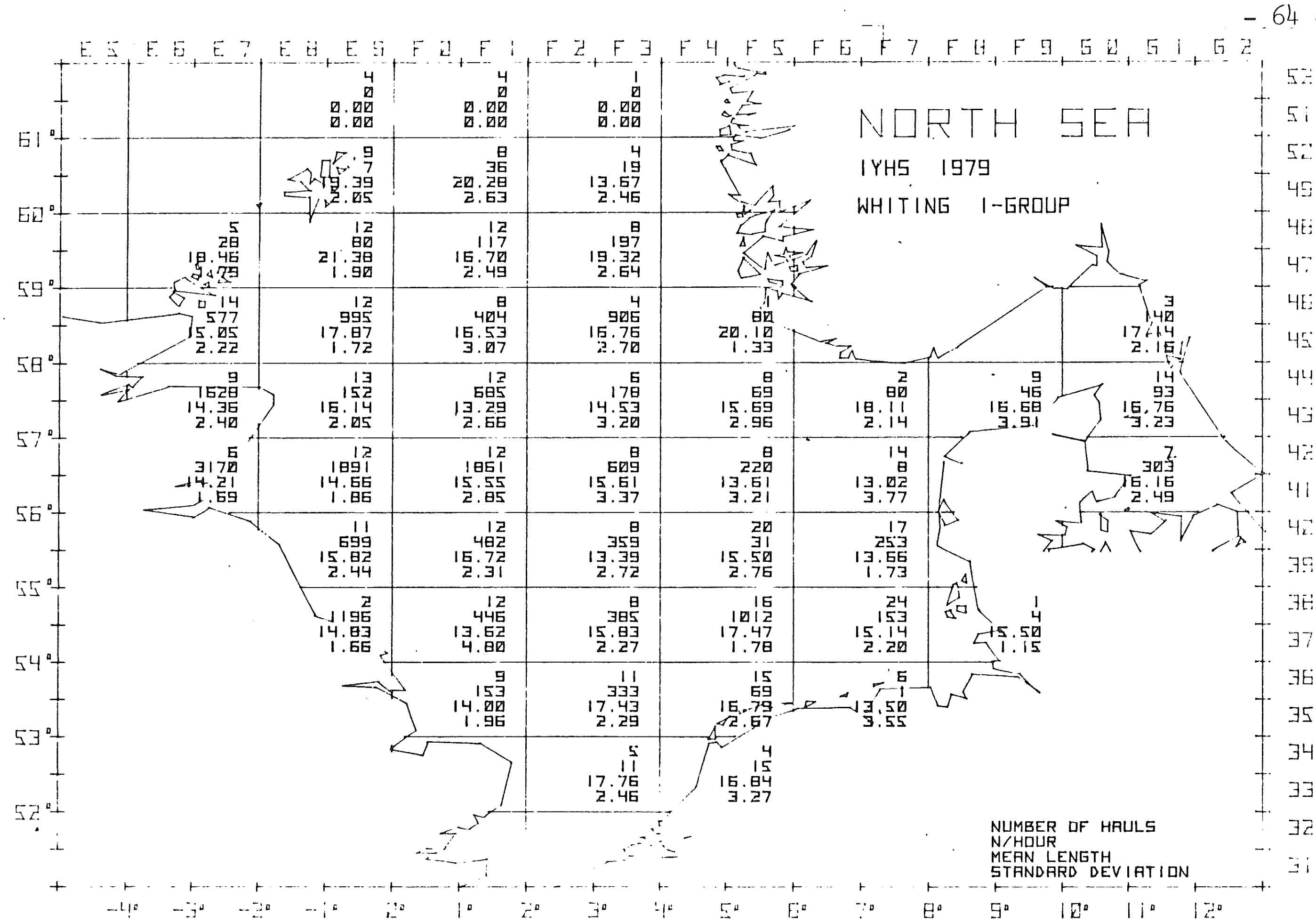

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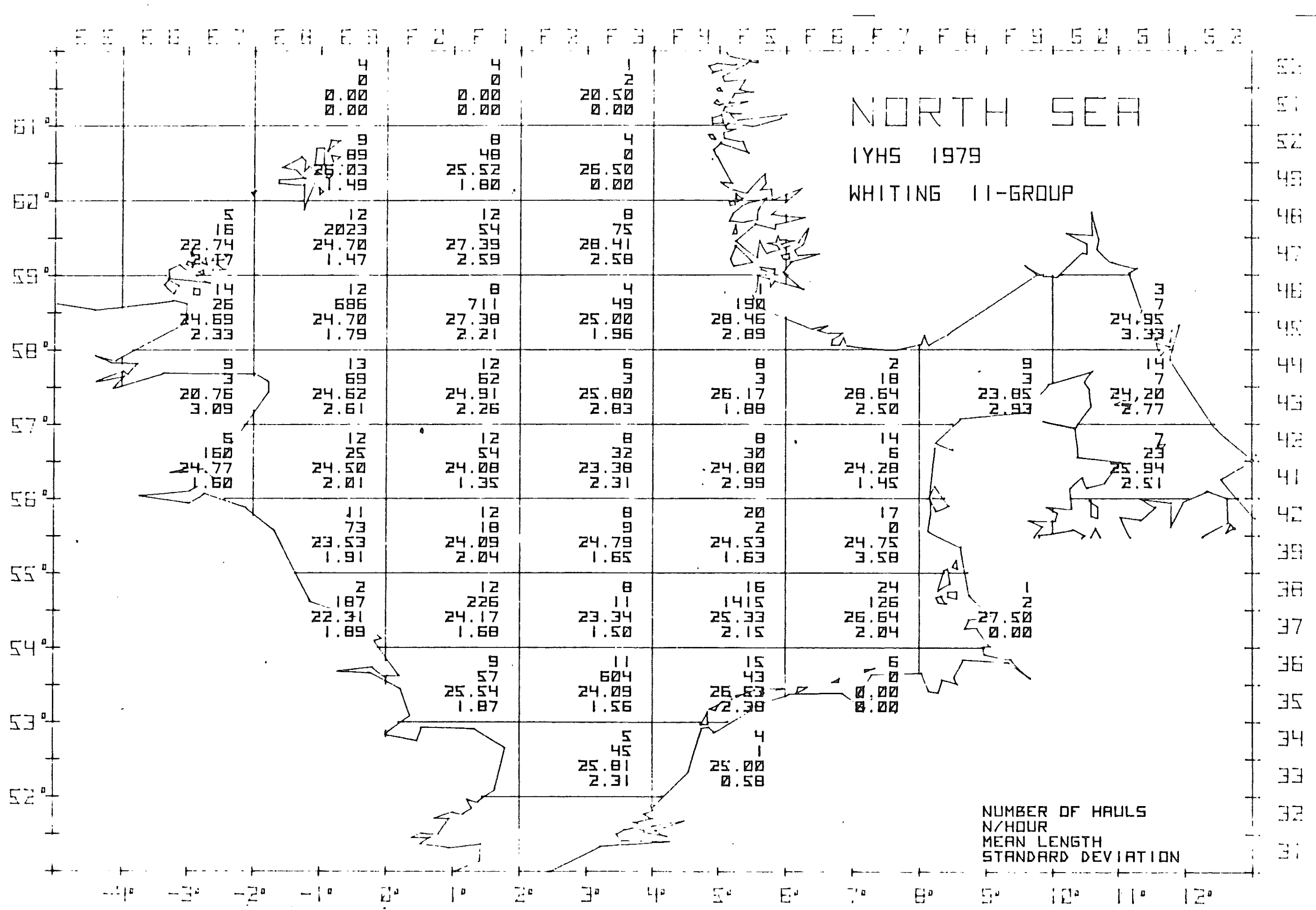

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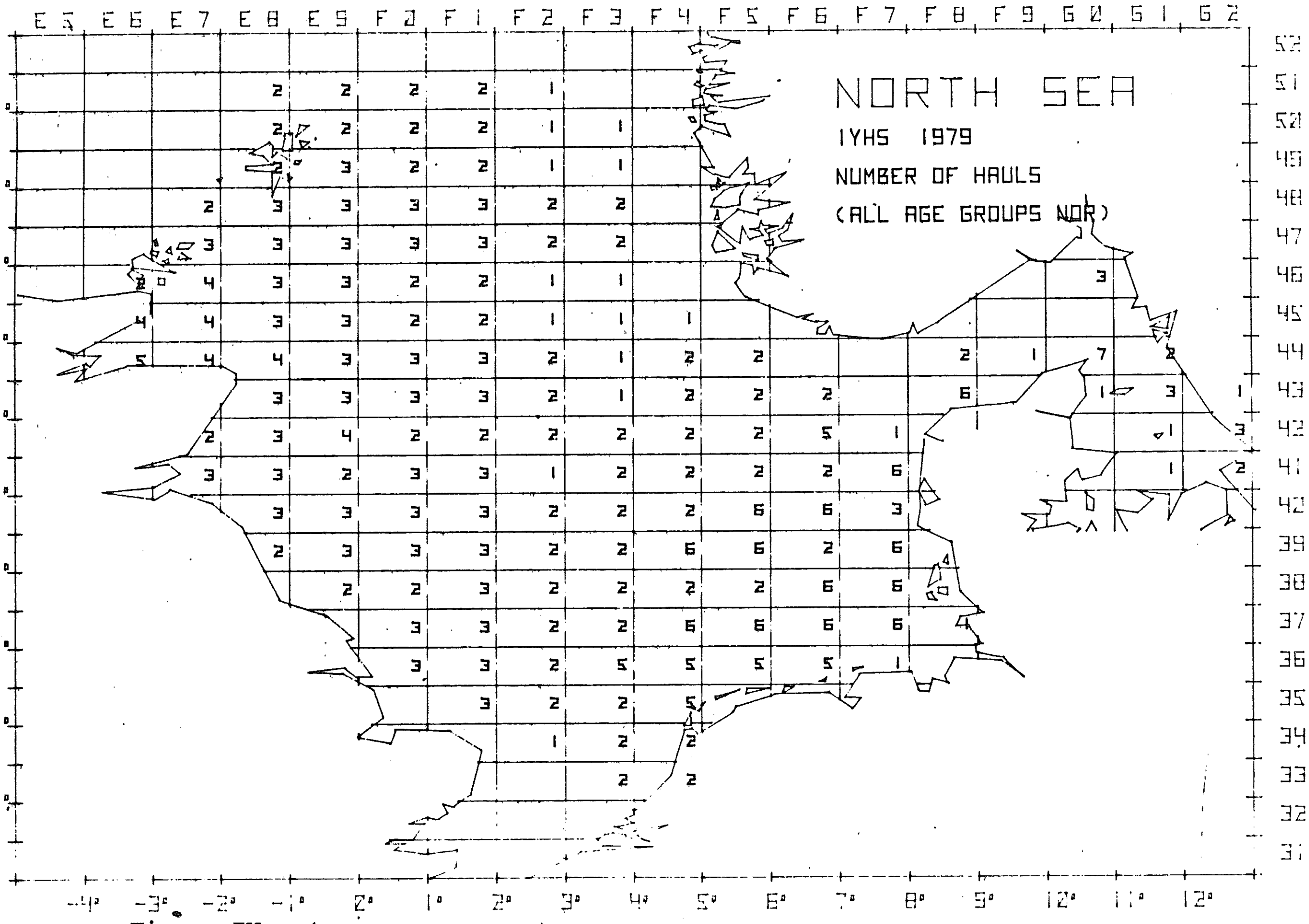
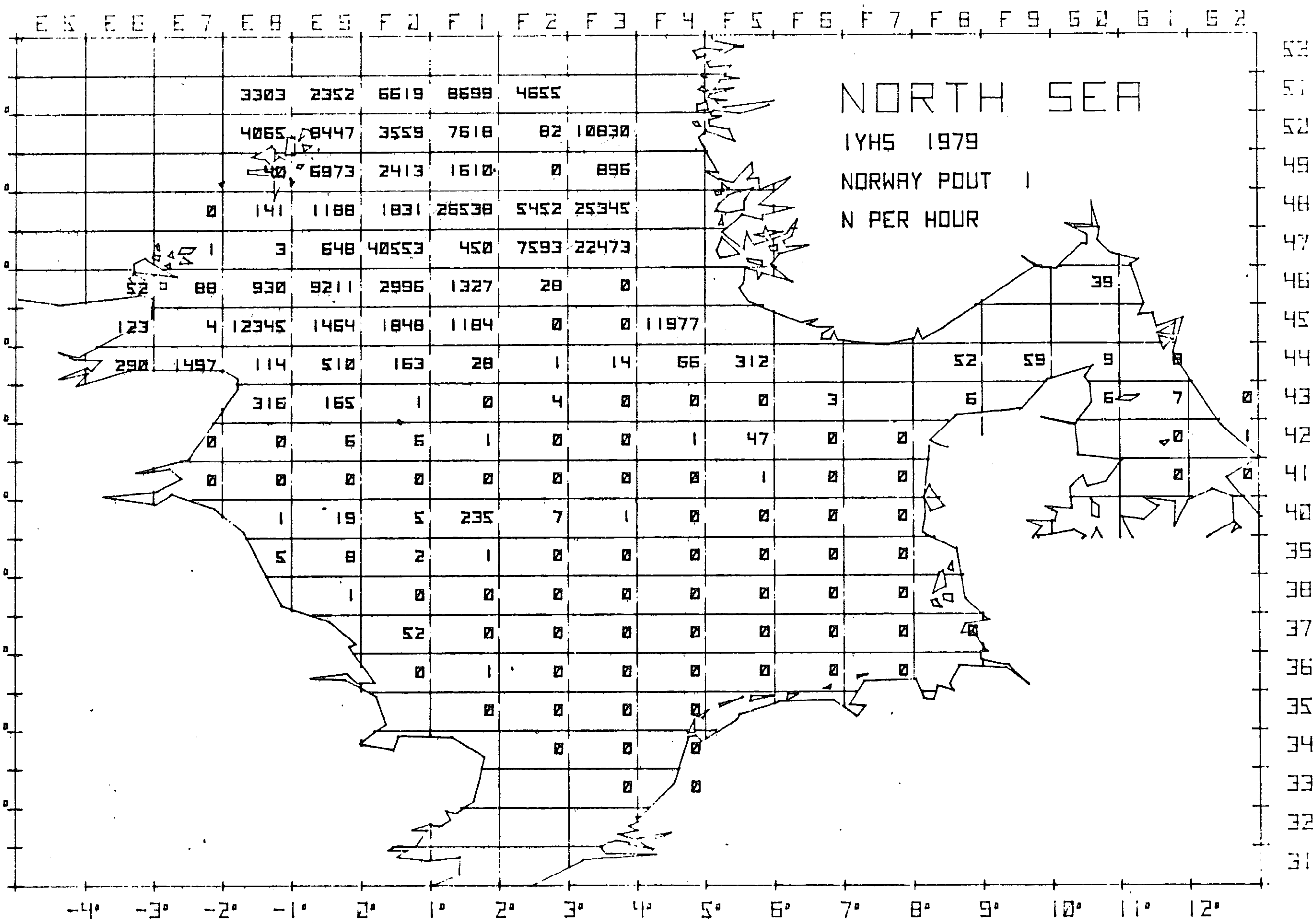


Figure IV - 1.



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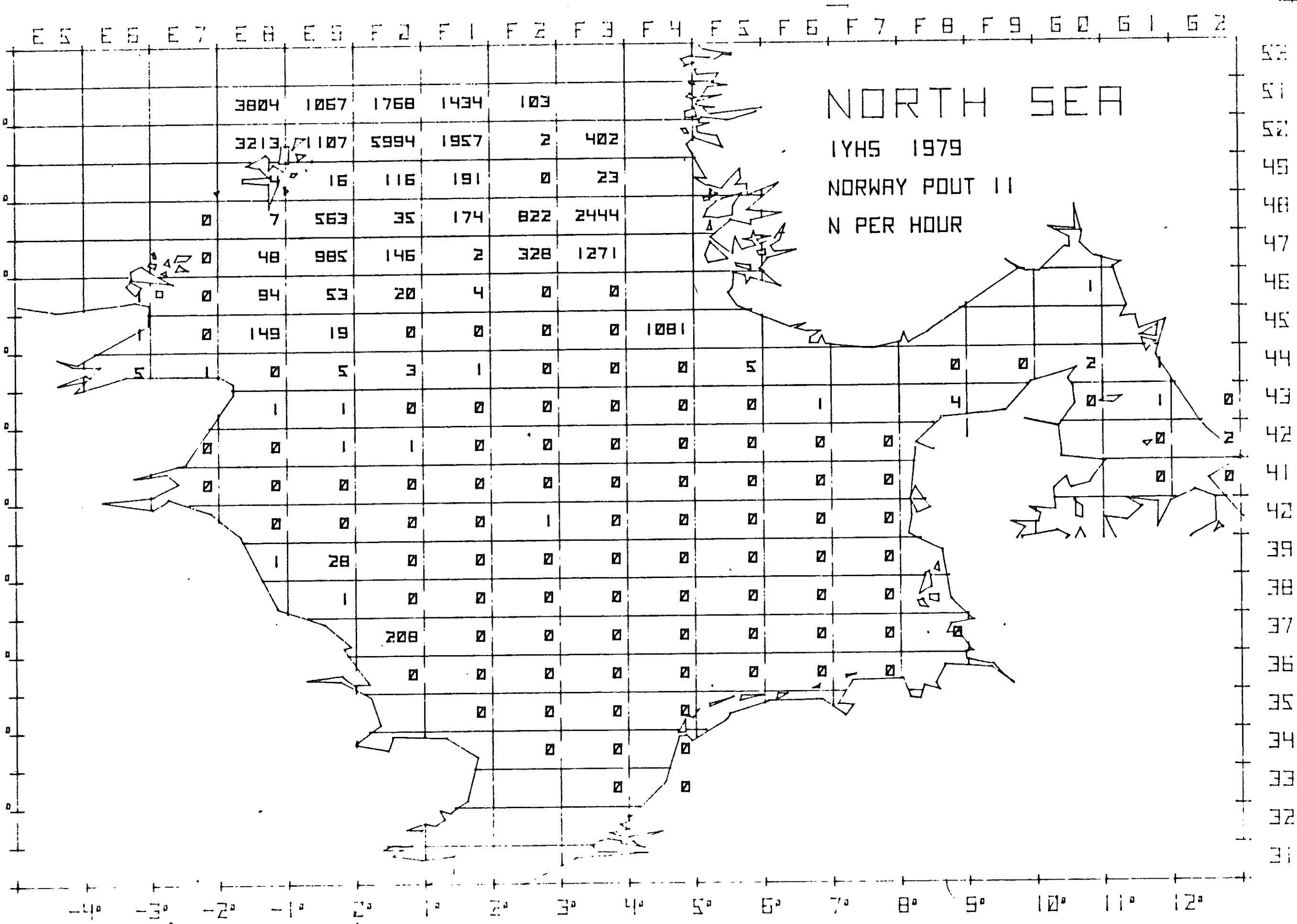

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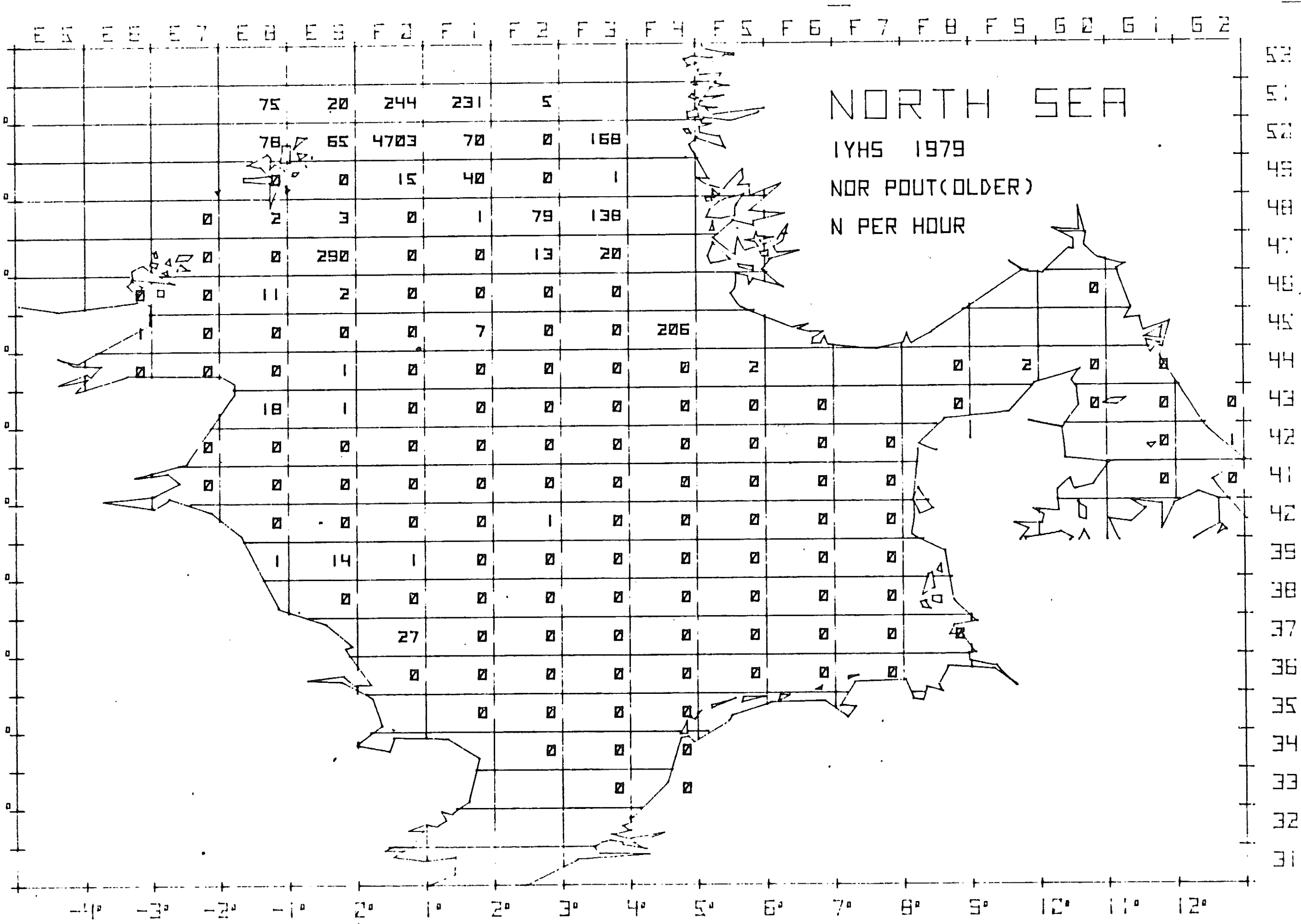

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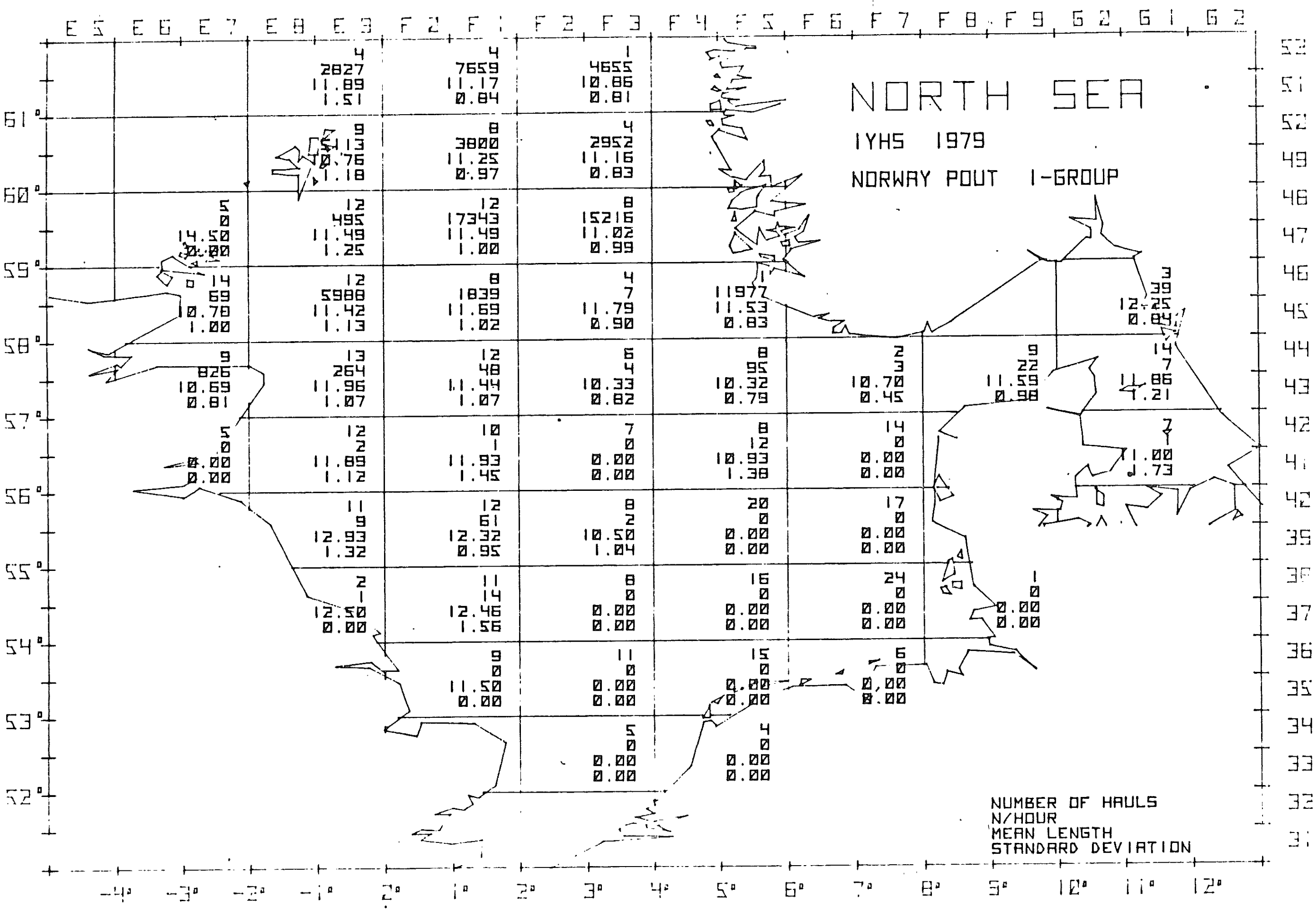

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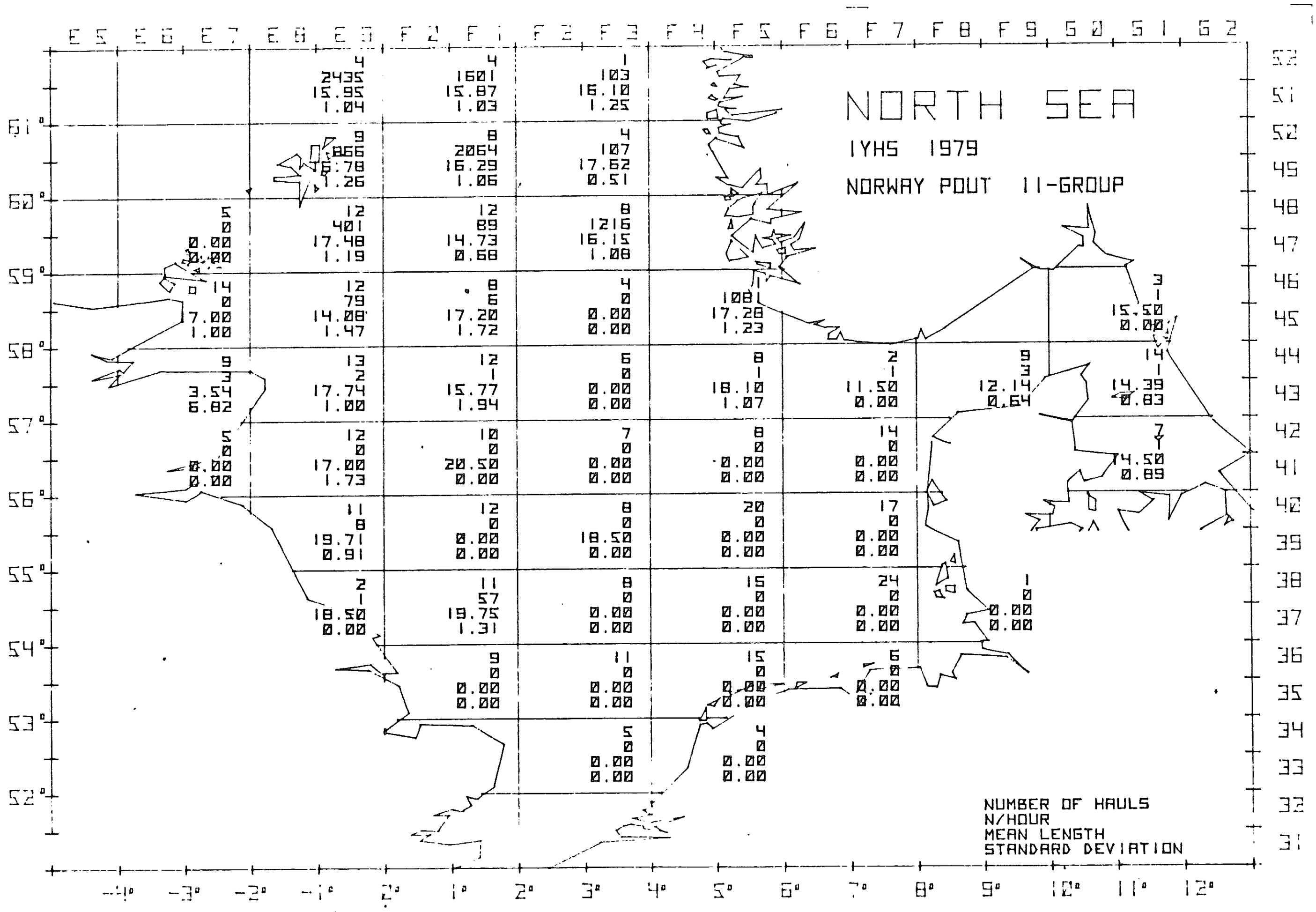

Figure IV - 6.