INTERNATIONAL COUNCIL FOR
THE EXPLORATION OF THE SEA

C.M. 1987/M:22
Anadromous and Catadromous
Fish Committee

PRELIMINARY ASSESSMENT OF THE IJSSELMEER EEL FISHERY BASED ON LENGTH PREQUENCY SAMPLES

by

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ABSTRACT

The eel fishery on the IJsselmeer (185,000 ha) is rapidly declining from 15 kg/ha/yr in 1950 to less than 5 kg/ha/yr nowadays. Since no landing data are available, and ageing is practically infeasible, the fishery is assessed based on length compositions of survey catches. These catches are analysed by an ANOVA of length*gear*year*haul. It is shown that the qualitatively known increase in fishing effort in the 1970's is accompanied by a rapid decline of the stock around the minimum legal size. Thus, the stock seems heavily overexploited.

INTRODUCTION

During the last few years, immigration of glass eels (Anguilla anguilla) into the dutch fresh waters has been declining (Dekker,1985). This decline is the more serious, while the production during the glass eel rich years was falling anyhow. But, as Dekker,1986 pointed out, this declining production can not be explained solely by the failing glass eel immigration; a pure growth overfishing seems to be a more likely cause.

In order to investigate this assumed overfishing, an assessment of the eel stock and its fishery has to be made. However, up to now, almost all trials to assess the stock have been false starts. Therefore, Dekker, 1986, started a thorough discussion of the possibilities of an assessment, by examining one of the basic variables (age) of current assessment practices. Basically, it was argued, the (non-)availability of data should restrict the wide scala of assessment methods. Ageing, he concluded, might be possible, but lkength based methods should be prefered, as long as no routine ageing procedure is available. This paper ultimately serves the same goal (assessment), but attacks the problem from the other side: the available data are analyzed to detect any sign of overfishing.

Basically, a fishery assessment correlates the output (catch, quantity and quality) to the input (effort, quantity and quality) of the fishery. Unfortunately, neither the catch nor the effort of the IJsselmeer eel fishery has been recorded; only rumours on the rise of the fishing effort and the official catch figures are available. Thus, this paper analyses one of the intermediates between effort and catch, the standing stock, represented by the catch per unit effort only.

It is well known, that catches of eels are influenced by a wide scala of factors, including gear characteristics, water and bottom type, wheather conditions, etc. Catch volumes may vary by a factor of more than 100, only because of changing wheather. Quantifying all these factors for the historical data set used, turned out to be impossible. Thus, the analysis was restricted to the smallest data set of factors common to all samples: length group, gear type, time (interval=year) and an arbitrary haul number.

Material and method.

Since the goal of this paper is restricted to the preliminary exploration of an ANOVA of length frequencies, a rather rough data set is used: 25 years of data on the eel fishery of the IJsselmeer. The IJsselmeer bassin (185,000 ha) is described in more detail in Dekker, 1985

The data set used comprises market samples, samples taken on research trips, and catches of individual fishermen. The data were entered in the computer, but not yet double checked.

The data set spans 25 years of time. The following events during this interval should be known at forehand:

- 1968: Polder Zuidelijk Flevoland reclaims 50,000 ha (leaving 185,000 ha).
- 1970: exclusion of the eel trawl, guessed to comprise about half of the total fishery intensity.
- 1974: end of the official market enforcement. Fishermen were no longer forced to land their catch under governement inspection.
- ±1972 til ± 1976 increased fishing with eel boxes (a kind of wooden eel pot).
- 1975: IJsselmeer divided in two halves by the dyke from Enkhuizen to Lelystad. The northern part comprises 120,000 ha, the southern part 65,000 ha.
- ±1975: introduction of "schietfuiken", a type of fyke net that can be set anywhere in the water. Up till this year only

fyke nets fastened to vertical poles were in use near the shores. The number of "schietfuiken" has increased up to an estimated number of 30,000 in 1985.

1985: the known, but illegal trade in undersized eels is partly legalized for one experimental year. This legalization is repeated in 1986 and 1987.

Samplings of the following gear types were included:

1/ 3 m beam trawl with 300 V intermittent electric current between the shoes; mesh size of the cod end 1 mm (survey catches only),
2/ fyke nets, mesh size 18 mm (mostly market samples),
3/ idem, but catch sorted by the fisherman to be above the legal minimum size of 28 cm,
4/ long line fishery with hooks of 10 mm baited with smelt (market samples),
5/ 8 m beam trawl without shoes, cod end mesh size 18 mm (mostly market samples),
6/ idem, sorted to be above minimum legal size,
7/ 8 m beam trawl without shoes, cod end mesh size 1 mm (survey catches only).

From each sample, the length distribution was determined. The length interval taken was 1 cm. A rather large proportion of the samples using the electrified trawl and the 1 mm mesh beam trawl taken by the department of fisheries of the ministery of agriculture and fisheries was unfortunately rounded to the nearest centimeter instead of the centimeter below. Although this introduces a systematic error, I could find no way to correct for this, and therefore simply ignored this erroneous rounding.

Based on these data, an analysis of variance was performed, using a computer program in Pascal, written for this single application.

One final point should be said about the statistical distribution of the data. Because of the counting character of the data, an a priori choice was made for a log-transformation. As Pennington, 1983 has pointed out, many data points are so trivial, that their inclusion may corrupt the fitted model. For instance, a net with a mesh size of 20 mm will almost never catch eels under 10 cm, while a zero catch of eels over 40 cm in that net does provide sensible information. Where to put the transition from the non-informative to the informative length traject, is a rather subjective matter. Therefore, Pennington, 1983 proposed to leave out all zero observations. In doing so, one gets rid of all trivial zeroes, loosing some information about true zeroes. This restricted log-normal distribution is called the delta-distribution.

Moreover, skipping all zeroes, makes the addition of a non- zero quantity to all catch numbers redundant, i.e. log(C) is used instead of log(C+1), as has been used by e.g. Dekker, 1985.

Results

Tables 1 thru 3 and figures 2 and 3 present the results of the ANOVA of log catch numbers by length*gear*time*haul.

From the total of 16 possible terms in the ANOVA, only 7 were included; the remaining 9 terms do not have a sensible interpretation, and were thus thought to be components of the error term:
1) haul number is a trivial number starting from 1 for each combination of time*gear. Thus, any ANOVA-term having haul number without year or gear cannot have any interpretation.
2) a significant contribuition of gear*time would mean a change in overall gear efficiency, and would thus contradict the constant application of each gear type.
3) a likewise argument nulls any change in gear selectivity, and thus excludes the analysis of length*gear*time.
4) the four-way interaction length*gear*time*haul uniquely identifies each observation, and thus cannot be interpreted without repeating the data set in full.

3 of the remaining 7 terms were interpreted in the following way:
a) length*gear, interpreted as the size selectivity of the fishing gears
b) gear*time*haul uniquely indetifies each sample, without distinguishing anything within the sample, and is thus taken to represent the effort in taking the haul.
c) length*time is common to all gears and hauls, and is thus taken to represent changes in the length composition of the population.

The final 4 terms (gear, length, time and a constant) could be part of more than one interpretation, and thus were included in the ANOVA, but not interpreted.

Figure 3 presents the gear selectivities in a more comprehensive way: this figure gives the estimated log catch per gear per length class averaged over all years and hauls, and thus represents the typical catch per gear type.

Figure 2, on the opposite, presents the changes in length frequencies common to all gears, and thus is taken to represent relative changes in population abundance.

In figure 2, two trends can be observed in the most recent years:
- a hump around 10 cm length in 1979 grows slowly (3 cm/yr) towards around 25 cm in 1985.
- a hump just above 30 cm in 1971, moves very slowly upward until 1976, but from then onwards comes rapidly down to 25 cm in 1985.

Finally, table 1 explores two variants of the ANOVA model: including known sampling effort data, and halving the time interval (years to half years). It turns out that halving the time interval only marginally improves the fit of the model, while including effort data (and thus fixing the expected catch per unit effort) severely deteriorates the fit of the model (i.e. granting one extra degree of freedom to each haul (time*hear*haul), enhances the fity extraordinary).

Discussion

In this paper, an analysis model for length frequencies is derived from a full ANOVA model, dropping any term without a reasonable interpretation. Assigning interpretations to the remaining terms seems to be rather subjective. However, Dekker, 1987a and b derived an analytical model for population abundances, gear selectivities and efforts per haul, which at the bottom line turned out to be identical to the final ANOVA model used here. In this paper, clipping the full model was prefered, since it assures no sensible term is accidentally missed. But, whether the model makes sense at all, still has to be checked. Thus one should contrast the results with known events occuring during the time span studied. Since the influence of the fishery is not known (overfishing or not, is the final question to the model), one can not check the model on changes in the exploitation pattern. However, it is known (Dekker, 1986) that the immigration of glasseels into the IJsselmeer dropped rather suddenly from 1980 onwards. Accordingly, the results show a hump of the youngest yearclass in 1979, which does not reappear in later years. Moreover, this last strong yearclass seems to grow from 10 to 25 cm in 1985, which reasonably coincides with growth estimates of eels in the Netherlands (Dekker, 1986). Thus, the model seems to make some sense. But, table 1 showed that the use of sampling effort data has a tremendous effect on the fit of the model; in fact, this lack of fit accounts for 50% of the total variance. Seperate factors, like wheather and catch conditions, seem to have a much bigger influence than the factors detected by the model. Therefore, the model appears to detect a relative weak signal amongst an enormous noise. Further analysis of this noise is clearly needed.

Finally, two end-of-the-day-questions will be taken up: was the sampling scheme appropriate, and is the IJsselmeer eel population overfished or not?

The last 6 years have shown an enormous upsurge in the number of samples taken by the department of fisheries of the MAF. Whether this was actually needed, may be derived from the current ANOVA. However, it is realized that the estimated parameters of the model are not interpreted one by one: the trend in the population abundance is detected from a group of lengthclasses. Thus, a more subjective judgment on the number of samples seems more appropriate.

In the sixties, the number of samples was restricted to 1 to 15 a year; in the seventies, this increased to 25 to 75. Accordingly, the estimates in figure 2 change from a blotchy landscape into a rather smooth surface. The eighties had more than 100 samples a year, but showed no further convergence of the estimates towards a continuous trend. Thus, this sampling appears to be superfluous for detecting trends in the population. About 25 samples per year would have been enough.

As stated in the introduction, in 1970, the eel trawl has been excluded from the IJsselmeer, in order to cut down the assumed overfishing. The current results enable an evaluation of this management action. Unfortunately, the years before have not been sampled adequately. Since the legal minimum length equals 28 cm, one would expect changes around this length becuase of the exclusion of the trawl. Indeed, starting in 1971, a hump appears in figure 2 just over 30 cm length, which very slowly moves upward. But, from 1976 onwards, this hump moved down again rather rapidly, which coincides with a well known upsurge in the number of fyke nets. However, before deciding that overfishing does occur, one should consider other explications. To my mind two features of figure 2 exclude other explications: firstly, the trend seems rather continuous, and thus not accidental. Secondly, it should be noted that the humps in figure 2 are constituted by new yearclasses year after year. The causing factor should have extended its impact downward each year, which seems very unlikely for any biological mechanism. Thus, one concludes that the increase in fishing effort starting in 1975 has depleted the stock over 25 cm completely.

Literature

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table 1

ANOVA-table of some of the terms in the model log catch by length*gear*time*haul

	SS	df	MS	F
length+year*length+gear*length	3162	1190	2.66	7.54
time*gear*haul	10391	881	11.80	33.46
halving time interval	1279	602	2.12	6.03
explained	14832	2673	5.55	15.74
unexplained	5907	16756	0.35	
total	20739	19429	1.07	

table 2

estimated parameter values for interaction term length*time of the analysis of variance of catch number by length*gear*haul*time (vertical = length; horizontal = year)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
7	-1.8	-0.2	-0.1	miss	0.2	miss	miss	miss	miss	-0.2	0.0	miss	0.1
8	0.1	0.1	0.1	miss	0.1	miss	miss	miss	miss	0.0	-0.0	miss	-0.0
9	1.2	0.1	0.0	miss	-0.1	miss	miss	miss	-0.2	0.0	-0.1	miss	-0.2
10	1.5	0.0	0.3	miss	-0.0	miss	miss	miss	0.1	0.1	-0.2	miss	-0.2
11	0.6	0.1	0.4	miss	0.1	miss	miss	miss	0.1	0.0	-0.1	-0.2	-0.1
12	0.3	0.1	0.5	miss	0.1	miss	miss	miss	-0.0	0.0	-0.1	-0.1	-0.1
13	0.3	0.1	0.4	miss	-0.0	miss	miss	miss	0.2	0.1	-0.1	-0.1	-0.1
14	0.4	0.1	0.3	miss	0.1	miss	miss	-0.3	0.2	0.0	-0.0	-0.0	-0.0
15	0.3	0.0	0.3	miss	0.1	miss	miss	-0.2	0.2	0.1	0.0	0.0	-0.1
16	0.4	0.1	0.2	miss	0.1	miss	miss	miss	0.4	0.2	0.0	0.0	-0.0
17	0.6	0.1	0.2	miss	-0.0	miss	miss	-0.1	0.3	-0.1	0.1	0.1	0.0
18	0.4	0.2	0.2	miss	0.2	miss	miss	miss	0.2	0.1	0.1	0.1	0.0
19	-0.1	0.2	0.2	miss	0.1	miss	miss	0.0	0.2	-0.1	0.1	0.0	0.0
20	0.2	0.2	0.2	miss	0.2	miss	miss	-0.3	0.0	-0.3	0.3	-0.1	-0.1
21	0.0	0.2	0.0	miss	0.0	miss	miss	-0.2	0.3	0.0	0.0	-0.1	-0.3
22	0.1	0.1	0.1	miss	-0.1	miss	miss	0.0	-0.3	0.2	0.3	-0.4	-0.3
23	-0.3	-0.0	0.0	miss	-0.1	miss	miss	-0.2	-0.2	0.5	0.2	-0.3	-0.4
24	-0.3	-0.4	0.0	-0.2	-0.3	miss	miss	-0.2	-0.1	0.5	-0.0	-0.2	-0.1
25	-0.1	-0.4	-0.1	0.4	-0.4	miss	miss	-0.3	-0.1	0.6	-0.2	-0.2	-0.2
26	-0.0	0.1	0.1	1.1	0.0	-0.8	miss	-0.2	-0.2	0.4	-0.4	-0.2	0.0
27	-0.6	-0.8	0.1	0.9	0.2	-0.1	-0.2	0.2	0.1	0.3	-0.4	-0.1	-0.0
28	-1.3	-0.6	-0.1	0.2	-0.4	-0.2	0.2	0.4	0.0	0.4	0.0	-0.0	0.0
29	-0.5	-0.3	-0.8	-0.3	-0.6	-0.1	-0.0	0.7	0.2	0.4	0.2	0.3	0.2
30	-1.2	0.0	-0.4	-0.3	-0.3	0.3	0.0	0.6	0.2	0.4	0.1	0.4	0.3
31	miss	0.1	-0.3	-0.6	-0.1	0.1	0.2	0.3	-0.3	-0.0	0.1	0.2	0.3
32	miss	0.2	0.1	-0.4	-0.5	0.3	0.3	0.5	-0.3	-0.0	0.1	0.3	0.3
33	miss	0.3	0.1	-0.4	-0.2	0.4	0.8	0.2	0.2	-0.3	-0.2	-0.0	0.1
34	miss	0.3	0.1	-0.1	0.2	0.6	-0.3	-0.1	-0.4	0.1	0.1	-0.0	0.0
35	miss	-0.1	0.2	-0.1	0.1	0.5	0.4	-0.3	-0.1	-0.1	0.0	-0.1	-0.1
36	miss	0.0	0.2	-0.0	0.3	0.5	0.7	-0.5	0.3	-0.8	-0.1	-0.1	0.1
37	miss	0.0	-0.5	0.5	0.3	0.7	miss	-0.4	-0.1	0.3	-0.4	-0.0	-0.0
38	miss	0.1	-0.0	0.2	0.2	-0.1	miss	-0.0	-0.3	-0.3	-0.0	-0.0	0.1
39	miss	0.1	-0.4	-0.8	0.2	-0.7	miss	0.3	-0.1	0.2	0.1	0.1	0.1
40	miss	-0.0	-0.5	0.0	0.0	-0.2	miss	-0.1	0.4	-0.6	0.1	0.2	0.1
41	miss	0.1	-0.5	-0.0	0.2	-0.0	miss	-0.0	-0.5	-0.2	-0.1	0.0	0.2
42	miss	-0.2	-0.2	-0.1	-0.1	-0.5	miss	0.1	0.3	-0.7	-0.0	0.2	0.2
43	miss	-0.1	-0.3	miss	-0.0	-0.4	miss	0.1	-0.1	-0.7	0.3	0.1	0.2
44	miss	-0.0	miss	miss	miss	miss	miss	miss	-0.2	-0.7	0.2	0.1	miss
45	miss	0.1	miss	miss	miss	-0.4	miss	-0.0	-0.3	-0.0	-0.1	miss	0.1

table 2 continued

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
7	0.1	0.1	0.3	0.2	0.5	0.2	0.1	0.2	0.1	0.1	0.1	0.1	miss
8	-0.2	-0.1	-0.2	-0.2	0.4	0.0	-0.2	0.1	0.0	-0.1	-0.0	-0.1	0.1
9	-0.2	-0.2	-0.1	-0.4	0.2	-0.0	0.9	0.0	-0.1	-0.2	-0.2	-0.3	-0.2
10	-0.2	-0.3	-0.2	-0.2	0.0	-0.0	0.6	0.1	-0.1	-0.2	-0.3	-0.4	-0.4
11	-0.2	-0.2	-0.2	-0.2	0.1	0.0	0.5	0.2	0.0	-0.1	-0.3	-0.4	-0.3
12	-0.1	-0.2	-0.2	-0.1	0.1	0.1	0.7	0.1	0.1	-0.1	-0.2	-0.4	-0.4
13	-0.1	-0.0	-0.1	-0.3	0.0	0.1	0.5	0.1	0.1	-0.0	-0.2	-0.5	-0.3
14	-0.1	-0.1	0.0	-0.2	0.1	0.1	0.3	-0.1	0.1	0.1	-0.1	-0.4	-0.5
15	-0.0	0.0	-0.1	0.1	0.1	0.1	-0.1	-0.1	0.1	0.1	0.0	-0.4	-0.5
16	-0.0	0.1	-0.2	-0.1	0.1	0.1	-0.5	-0.3	-0.0	0.0	0.1	-0.2	-0.5
17	-0.1	0.1	-0.3	-0.0	0.2	0.2	-0.7	-0.4	0.0	0.1	0.2	-0.1	-0.3
18	-0.0	0.2	-0.3	0.1	0.2	0.0	-0.6	-0.5	-0.2	-0.1	0.1	0.1	-0.3
19	-0.1	0.2	-0.3	-0.2	0.1	0.2	-0.3	-0.5	-0.2	-0.0	0.2	0.2	-0.1
20	-0.1	0.2	-0.2	-0.0	0.1	0.1	-0.3	-0.5	-0.2	-0.1	0.3	0.3	0.2
21	-0.2	-0.2	-0.1	-0.0	0.0	-0.1	-0.2	-0.4	-0.2	0.0	0.4	0.4	0.5
22	-0.4	0.2	-0.1	0.0	-0.2	-0.3	-0.3	-0.2	0.0	0.1	0.4	0.4	0.6
23	-0.3	-0.0	-0.1	0.1	-0.3	-0.4	-0.1	0.0	0.1	0.1	0.4	0.6	0.7
24	-0.3	0.0	-0.1	0.1	-0.2	-0.3	0.2	0.1	0.2	0.1	0.4	0.4	0.8
25	-0.2	-0.2	0.1	0.0	-0.3	-0.1	0.3	0.3	0.0	0.0	0.2	0.2	0.6
26	-0.0	-0.1	0.2	0.0	-0.1	0.2	0.2	0.3	0.0	0.1	0.3	0.3	0.5
27	-0.0	-0.1	0.4	0.0	-0.2	0.1	0.0	0.3	-0.1	-0.1	-0.0	0.1	0.2
28	0.1	0.0	0.4	0.3	0.0	0.4	-0.1	0.4	0.0	-0.0	-0.3	-0.1	0.1
29	0.4	0.0	0.6	0.3	0.0	0.0	-0.3	0.2	-0.1	-0.0	-0.3	-0.1	-0.1
30	0.2	0.3	0.6	0.1	0.1	0.1	-0.3	0.0	-0.2	-0.1	-0.4	-0.2	-0.3
31	0.3	0.2	0.6	0.3	-0.2	-0.1	0.0	-0.1	-0.2	-0.1	-0.4	-0.3	-0.1
32	0.2	0.3	0.6	0.3	-0.1	-0.2	-0.4	-0.2	-0.3	-0.2	-0.4	-0.2	-0.2
33	0.2	0.1	0.6	0.4	-0.3	-0.5	0.0	-0.3	-0.2	-0.2	-0.4	-0.3	-0.2
34	0.1	-0.0	0.2	0.0	-0.2	-0.1	miss	-0.1	-0.1	-0.1	-0.2	-0.1	-0.0
35	0.1	0.1	0.1	0.1	-0.2	-0.2	0.1	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1
36	0.2	-0.2	-0.0	-0.3	-0.2	0.1	-0.1	-0.0	0.1	-0.1	-0.1	-0.1	-0.0
37	0.0	-0.1	-0.2	-0.4	-0.2	0.1	miss	0.1	0.2	0.1	0.1	0.1	0.1
38	0.1	0.1	-0.4	-0.3	-0.2	0.2	miss	0.1	0.1	0.1	0.0	0.1	0.1
39	0.2	-0.0	-0.4	-0.0	0.1	miss	miss	0.2	0.2	0.2	0.2	0.2	0.2
40	0.0	0.1	-0.4	-0.2	0.0	miss	miss	0.3	0.2	0.2	0.2	0.2	miss
41	0.1	0.0	-0.3	0.1	0.2	miss	miss	0.3	miss	0.2	0.2	0.2	miss
42	0.2	0.1	-0.2	0.2	miss	miss	miss	miss	0.2	0.2	0.2	0.2	miss
43	0.1	0.1	-0.0	-0.0	0.1	miss	miss	0.2	0.2	miss	miss	0.1	0.2
44	0.1	-0.2	-0.1	0.1	miss	miss	miss	0.2	0.1	0.1	miss	0.1	miss
45	0.1	-0.0	0.0	miss	miss	miss	0.1	0.1	miss	0.1	miss	0.1	miss

table 3

estimated parameter values for length term + interaction term length*gear of the analysis of variance of catch number by length*gear*haul*time
(vertical = length; horizontal = gear)

	1	2	3	4	5	6	7
7	-0.2968	missing	missing	missing	missing	missing	-0.3622
8	-0.2077	missing	missing	missing	missing	missing	-0.1510
9	-0.1042	missing	missing	missing	missing	missing	-0.1776
10	-0.0398	missing	missing	missing	missing	missing	-0.1433
11	-0.0782	missing	missing	missing	missing	missing	0.0119
12	-0.0154	missing	missing	missing	missing	missing	-0.0270
13	0.1081	missing	missing	missing	missing	missing	0.0460
14	0.2216	missing	missing	missing	-0.0598	missing	0.1292
15	0.3752	missing	missing	missing	-0.0786	missing	0.2502
16	0.5885	missing	missing	missing	-0.1136	missing	0.3102
17	0.6451	missing	missing	missing	-0.1667	missing	0.3877
18	0.7848	missing	missing	missing	-0.1769	missing	0.4059
19	0.7405	-0.2974	missing	missing	-0.2397	missing	0.5234
20	0.6106	-0.5091	missing	missing	-0.2083	missing	0.4282
21	0.5845	-0.7238	missing	missing	-0.0030	missing	0.7255
22	0.3873	-0.6524	missing	missing	0.2732	missing	0.7003
23	0.2644	-0.5807	-0.4578	missing	0.4064	missing	0.7767
24	0.1349	0.0885	-0.4122	-0.0671	0.6210	-0.1418	0.7942
25	0.0560	0.8943	-0.3475	-0.3598	0.7624	-0.7431	0.7700
26	-0.0874	1.3883	-0.7666	-0.4816	0.7698	0.2454	0.5592
27	-0.1078	1.7385	-0.0341	-0.3797	0.8640	1.7273	0.4242
28	-0.1143	1.6645	1.1509	0.4091	0.7796	2.3240	0.4473
29	-0.3511	1.4565	1.5747	0.6093	0.4675	2.0191	-0.0733
30	-0.3123	1.1862	1.6587	0.8663	0.1736	1.4426	-0.3732
31	-0.3812	1.0304	1.5392	0.7503	0.1426	0.9536	-0.4182
32	-0.2396	0.7155	1.2702	0.8738	0.0597	0.4509	-0.6109
33	-0.1711	0.4871	0.9764	0.7945	-0.0805	-0.2973	-0.8213
34	-0.2610	0.1575	0.4200	0.5648	-0.2013	-0.8228	-0.7581
35	-0.1725	-0.3428	-0.1282	0.4083	-0.2189	-0.8479	-0.9002
36	-0.1461	-0.5744	-0.5234	0.0302	-0.3780	-1.1613	-0.7769
37	-0.2603	-1.0829	-0.7545	-0.2790	-0.3922	-1.2248	-0.4498
38	-0.2379	-1.1337	-0.9997	-0.4581	-0.2963	-0.8962	-0.2240
39	-0.2894	-0.9951	-1.0124	-0.7183	-0.3383	-0.7161	-0.3407
40	-0.3144	-1.1070	-0.9689	-0.8274	-0.3251	-0.8130	-0.1119
41	-0.3245	-0.6830	-0.7884	-0.9699	-0.2823	-0.6652	-0.1291
42	-0.2779	-0.7924	-0.7323	-0.9805	-0.2933	-0.6950	-0.2503
43	-0.2557	-0.7058	-0.6196	-0.1585	-0.2436	-0.4974	-0.1493
44	-0.2272	-0.5815	-0.4751	-0.3179	-0.2393	missing	-0.2128
45	-0.2269	-0.4116	-0.5078	-0.3283	-0.2113	missing	-0.2288

figure 1 - plot of number of samples per year

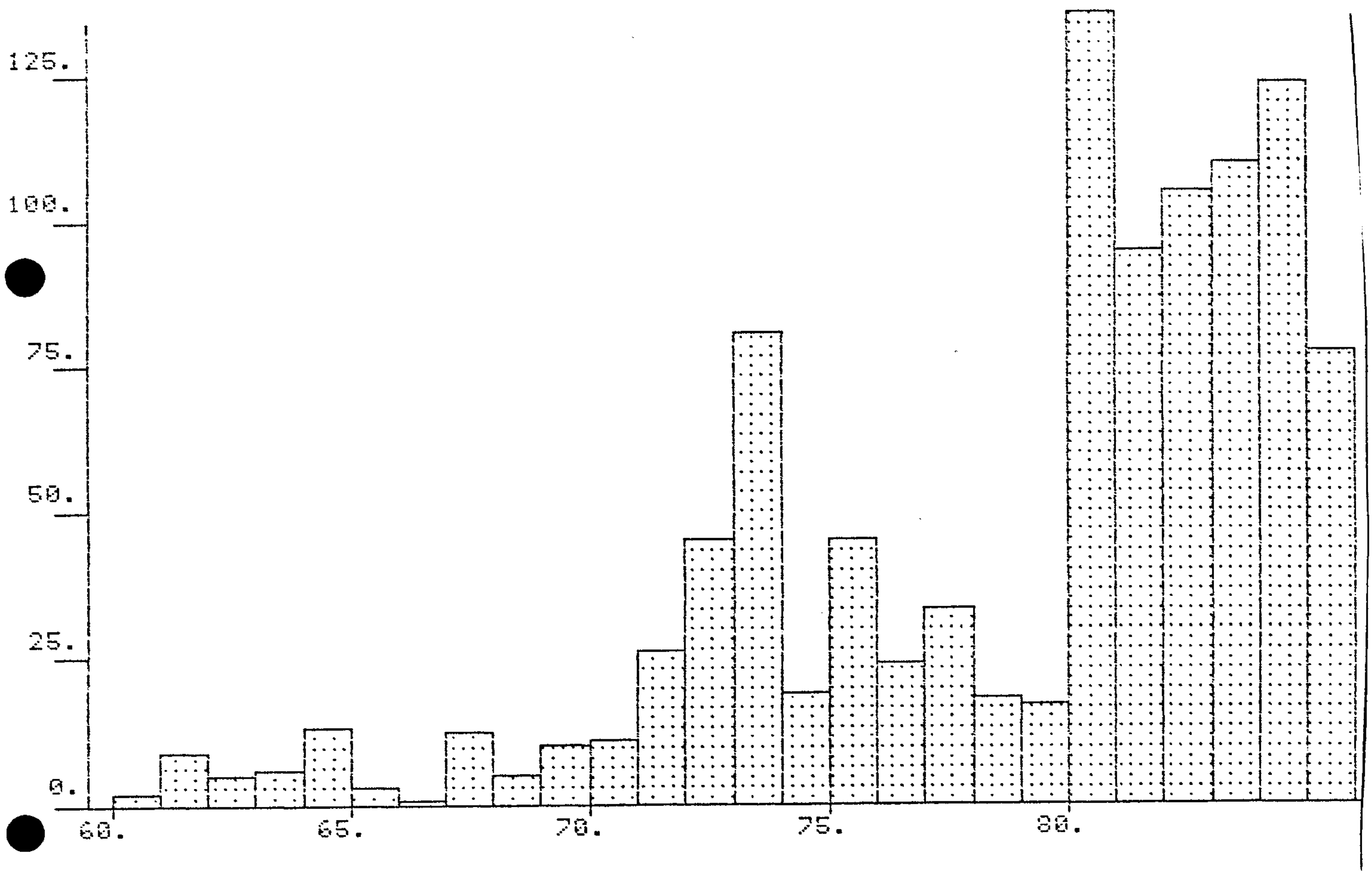

figure 2 - 3-dimensional plot of interaction term length*time of the analysis of variance of catch number by length*gear*time*haul
The third dimension of the plot is represented by varying gray tones,

having the minimum and maximum scaled to cover black to white completely.

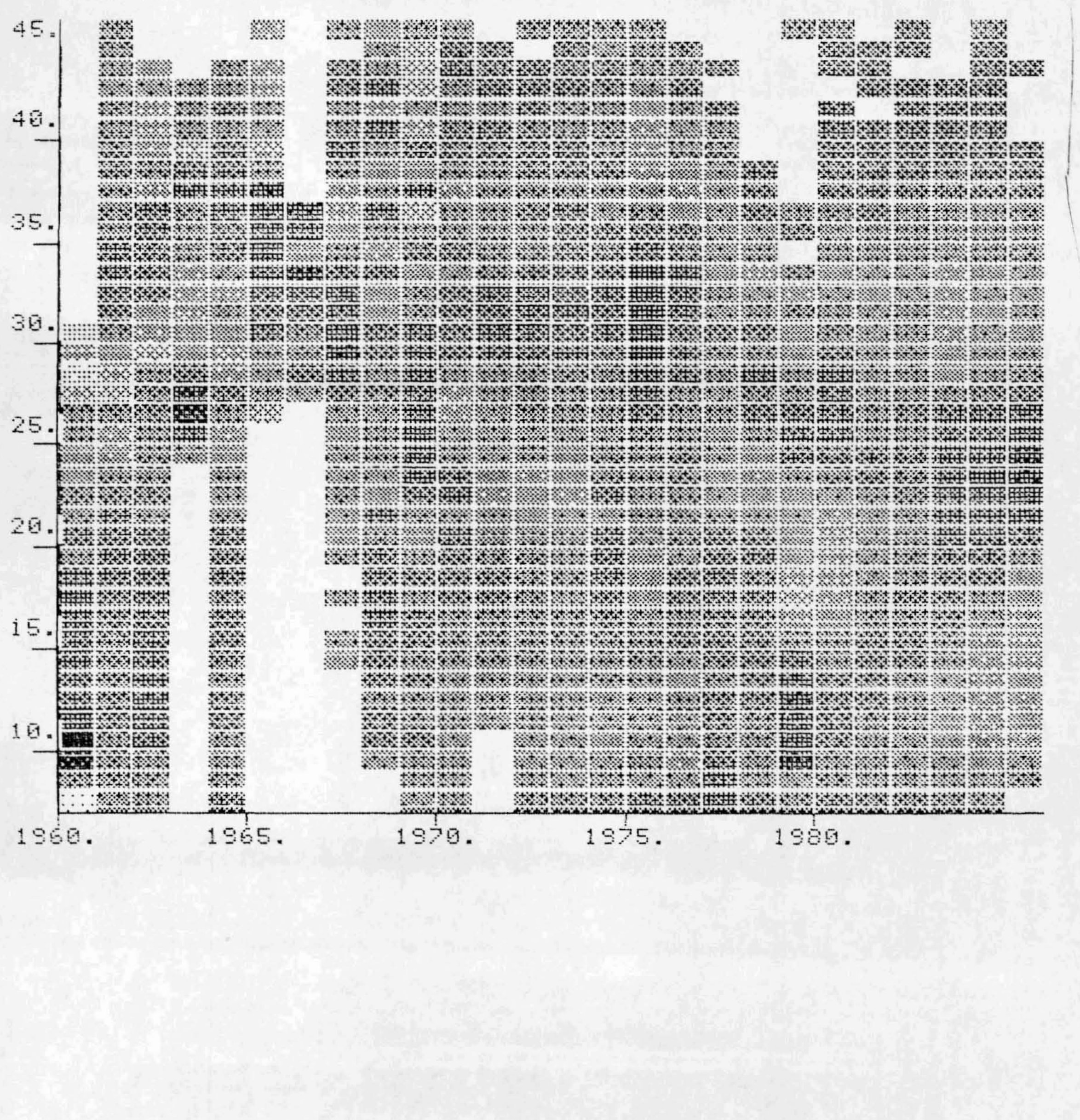

figure 3 - 3-dimensional plot of length term + interaction term of length*gear of the analysis of variance of catch number by length*gear*time*haul.
The third dimension of the plot is represented by varying gray tones,

having the minimum and maximum scaled to cover black to white completely.