International Council for
Exploration of the Sea

C.M. 1974/D : 8
Statistics Committee

Approach to the evaluation of the market sampling methods on the Belgian catches in 1973

by

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INTRODUCTION

According to resolution C. Res. 1973/4:8 a first statistical evaluation has been carried out on the Belgian market sampling for sole, plaice, cod, whiting and haddock. The main objective was to determine the accuracy with which the mean of the length measurements was estimated.

MATERIAL AND METHODS

The Belgian sampling in 1973 consisted of sole and plaice from the North Sea, Irish Sea, Bristol Channel and English Channel and of cod, whiting and haddock from the North Sea.

The following data per category and on a year basis were available :
- total catch in kg
- size of the samples : weight and numbers.

Each category was first considered on its own. For a given number of observations the error of the estimated population mean to the true mean was calculated. This error can be considered as an index of the sampling accuracy per category and was derived as follows :
Assuming normality, confidence limits can be put for the mean, according to the relation :

$$\bar{x} - t \cdot s_{\bar{x}} < \mu < \bar{x} + t \cdot s_{\bar{x}} \quad (1)$$

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From (1) it follows that :

$$d \leqslant t \cdot \frac{s}{\sqrt{n}} \quad (2)$$

or its equivalent :

$$\left(\frac{ts}{d} \right)^2 \geqslant n \quad (3)$$

In these formulae d is the difference between the true population mean and its estimate ; s is the standard deviation and n stands for the sample size. From (3) n can be determined for a given difference, whilst from (2) the difference can be determined for a given n. The latter is used as the sample size was already fixed. The aim was to check the value of d.

In the calculations the finite population correction was neglected as the sample fraction is small. Further on Student's t-value was substituted in most cases by the normal deviate, as n was quite large. The probability level for calculation d was set at 0.95.

Secondly, the different categories were considered as strata. The overall mean can be calculated with its variance, from which a new error can be determined as an index of accuracy of the sampling covering the whole population.

Considering the whole population the mean is given by :

$$\bar{x} = \sum_{i=1}^{k} w_i \bar{x}_i \qquad (k = strata)$$

where : $w_i = \frac{n_i}{N}$

with a variance : $V(\bar{x}) = \sum_{i=1}^{k} w_i^2 \, V(\bar{x}_i)$

Again the finite population correction was neglected.

RESULTS AND DISCUSSION

Table 1 shows the data of the catch and the sampling and the results of the calculations. Per category the mean ($\bar{x}$), the variance of the mean $V(\bar{x})$ and the error between the true population mean and its estimate (d) are given.

From this table the following conclusions can be drawn :

1. The sampling error per category.

As the measurements are carried out to the nearest cm-class a value of 0.5 cm of d is satisfactory.

- Sole:

The sampling size per category seems to be satisfactory in the North Sea, Irish Sea and Bristol Channel.

On the other hand the sample size of the English Channel stock appears in general too small.

- Plaice :

For the North Sea as well as for the Bristol Channel and the Irish Sea the sampling seems adequate. Exception must be made for category 4 in the Bristol Channel and the Irish Sea, due to the large variance.

As for sole the size of the plaice sampling in the English Channel is too small.

- Cod and haddock :

If a d-value of 0.5 is maintained the size sample of cod and haddock appears to be too small.

- Whiting :

The sampling is satisfactory.

2. The sampling error considering the whole population.

As the population consists of all categories it is rather obvious that the final conclusions considering the length measurement should be drawn from the stratified sampling. The sampling scheme (below 0.5 cm) is satisfactory for sole, plaice, cod, whiting and haddock in all areas, with the

exception of the English Channel plaice stock (0.8).

BIBLIOGRAPHY.

W.G. Cochran (1963) - Sampling Techniques (2nd ed.).

A. Hald (1952) - Statistical Theory with Engineering Applications.

Table 1 - Data of the Belgian sampling during 1973.

Species	Area	Category	Catch (in kg)	Weight of samples (in kg)	Number of samples (ni)	$\bar{x}$ (cm)	$V(\bar{x})$	d p = 95%
Sole	North Sea	1	30 134	109	793	24.9	0.0026	0.10
		2	95 549	160	922	27.0	0.0020	0.09
		3	147 804	188	881	28.8	0.0020	0.09
		4	170 946	222	829	31.0	0.0022	0.09
		5	192 365	259	755	33.4	0.0053	0.14
		6	217 440	294	685	35.7	0.0032	0.11
		7	369.098	369	607	39.7	0.0104	0.20
		1 - 7	1 223 336	1 601	5 472	31.0	0.0005	0.04
	Englishᵒ Chanᵒ	1	2 322	4	30	25.1	0.0569	0.49
		2	9 687	5	30	27.6	0.0799	0.58
		3	16 079	7	30	29.3	0.0482	0.45
		4	15 804	8	30	31.9	0.0366	0.39
		5	18 001	10	30	33.8	0.0416	0.42
		6	19 470	13	30	36.1	0.0675	0.53
		7	37 157	18	30	40.2	0.1412	0.77
		1 - 7	118.520	65	210	32.0	0.0096	0.19
	Bristol Chanᵒ	1	70 224	96	701	25.2	0.0024	0.10
		2	95 976	114	666	26.9	0.0033	0.11
		3	101 829	147	675	28.9	0.0022	0.10
		4	92 108	173	635	31.1	0.0027	0.10
		5	86 465	206	600	33.2	0.0029	0.11
		6	113 259	233	534	36.2	0.3220	1.11
		7	197 279	300	471	39.8	0.0211	0.29
		1 - 7	757 140	1 269	4 282	31.0	0.0056	0.15

Plaice

Area	Age						
Irish Sea	1	153 619	67	500	24.6	0.0020	0.09
	2	159 986	80	481	26.4	0.0043	0.13
	3	86 733	98	446	28.5	0.0031	0.11
	4	68 371	120	438	30.4	0.0042	0.13
	5	67 038	138	404	32.5	0.0044	0.13
	6	88 018	166	390	34.7	0.0060	0.15
	7	101 083	223	358	38.9	0.0202	0.28
	1 - 7	724 848	892	3 017	30.4	0.0008	0.06
North Sea	1	913 381	190	787	29.3	0.0032	0.11
	2	1 183 659	239	680	33.1	0.0038	0.12
	3	767 323	288	585	37.1	0.0052	0.14
	4	1 220 521	835	1 009	44.0	0.0217	0.29
	1 - 4	4 084 884	1 552	3 061	36.5	0.0029	0.11
English Chan.	1	31 194	3	10	30.2	0.1067	0.73
	2	40 862	4	10	33.7	0.2455	1.11
	3	24 690	5	10	36.1	0.1656	0.91
	4	31 178	49	20	42.2	0.8661	1.95
	1 - 4	127 924	61	50	36.9	0.1593	0.78
Bristol Chan.	1	73 971	38	147	30.3	0.0159	0.25
	2	78 600	50	133	33.7	0.0181	0.26
	3	62 015	89	151	38.0	0.0377	0.38
	4	71 026	166	161	45.3	0.2248	0.93
	1 - 4	285 612	343	592	37.1	0.0210	0.28
Irish Sea	1	106 213	20	80	29.9	0.0265	0.32
	2	39 737	26	76	33.5	0.0521	0.45
	3	26 030	86	112	37.8	0.0584	0.47
	4	29 994	73	80	45.7	0.3507	1.16
	1 - 4	201 974	205	348	36.9	0.0285	0.33

Cod	North Sea	1	2 013 692	199	268	42.9	0.1714	0.81
		2	1 837 953	270	167	57.2	0.0871	0.58
		3	3 505 509	468	177	67.0	0.1370	0.73
		4	1 158 813	644	143	79.8	0.6073	1.53
		5	99 138	782	109	93.2	0.9437	1.90
		1 - 5	8 615 105	2 363	864	63.1	0.0572	0.47
Whiting	North Sea	1	2 252 753	80	301	31.7	0.0570	0.47
		2	572 280	142	294	39.4	0.0550	0.46
		1 - 2	2 825 033	222	595	35.5	0.0280	0.33
Haddock	North Sea	1	1 101 526	29	87	35.0	0.2246	0.93
		2	285 934	28	59	39.8	0.2081	0.90
		3	382 128	85	112	44.8	0.1236	0.69
		4	62 206	170	117	56.4	0.2811	1.04
		1 - 4	1 831 794	312	375	45.4	0.0556	0.46