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## SAMPLING OF THE INDUSTRIAL FISHERIES IN NORWAY

by

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### INTRODUCTION

According to Council Resolution 1976/4:12 "member countries should be strongly urged to provide information to the 1977 Statutory Meeting on their methods for collecting statistics on by-catches on protected species in the mixed fisheries (NEAFC Recommendation 2)".

This paper deals with the sampling of the industrial fisheries in Norway with particular reference, however, to the present sampling of protected species from the North Sea.

The first regular small-scale sampling programme for industrial landings was established in 1961 in one of the main ports for the North Sea fleet (LAHN-JOHANNESSEN, OLSEN and STÅLESEN 1964), but for various reasons it came to an end in late 1965. Later on attempts were made to re-establish regular sampling in 1969 (LAHN-JOHANNESSEN and RADHAKRISHNAN 1970) and in 1970, but successfully only since 1971 when a new improved sampling scheme was introduced.

### GENERAL SAMPLING METHODS FOR INDUSTRIAL LANDINGS

From late 1971 onwards regular sampling has gradually been established in the most important ports along the southwest coast, where inspectors from the Directorate of Fisheries work according to standing instructions. The main objectives of sampling have been to estimate the amount of undersized protected species landed and the species composition in general. The basic sample size is 30 kg consisting of equal sub-samples extracted from the top, middle and bottom section of the landings respectively. All species are then sorted, counted and weighed. Protected

species are grouped in legal and undersized fish. Length measurements are usually taken of all species. The results are entered into forms which also contain information on date and place of unloading, vessel, trawl, fishing ground, fishing depth, number of days fished, quantities landed for human consumption and for reduction purposes and size of sample.

#### SPECIAL SAMPLING METHODS FOR BY-CATCH OF PROTECTED SPECIES

The quota regulations for some protected species in the North Sea since 1975 were supposed to call for require more adequate sampling of both legal and undersized fish than could be obtained through the general sampling of industrial landings. Therefore a special sampling programme for protected species was introduced in late 1975.

The sample size vary from 60 to 300 kg or more, on an average 100-150 kg, depending upon the magnitude of each landing and the relative amount of protected species as determined by preliminary visual inspection. Usually one sample is extracted by grab at random from the middle of the landing. Protected species and big unprotected fish are sorted out and number and weight of each species are entered into a special form which also contains similar information as mentioned in the previous chapter. Length measurements are usually taken of all fish sampled.

#### RESULTS

Landings of so-called Norway pout make up the major part of the annual industrial catch. They are rather heterogenous and usually contain some protected species and consequently the sampling effort has been directed mainly towards such landings.

Table 1 shows the average quarterly distribution in per cent of weight of protected species, industrial species and other species in general samples (30 kg) of Norway pout landings from the main statistical areas of the North Sea since 1972. The table indicates the successive increase in sampling effort and the general improved coverage of the areas during this period. Blue whiting form a considerable part of the samples from the Norwegian Deeps (area 28 and 08).

Table 2 compares samples with landings of Norway pout and shows the variation in fishing depth between and within the main statistical areas in the North Sea in 1976. The major sampling took place and the major quantities were landed from the southeastern part of the Norwegian Deeps (area 08). For all areas the amount of sampling has been to a great extent inversely related to the landings during the year because the sampling effort tends to be fairly stable whereas the quarterly landings vary. The average and range of fishing depth varied considerably between and within the areas, and the relative amount of both protected species and Norway pout increased with decreasing fishing depth (area 42).

Table 3 compares the by-catch of protected species from the special by-catch samples with the general industrial samples from the North Sea in 1976. Saithe occasionally contributed considerably more to the by-catch in the special samples than in the general ones from the Norwegian Deeps.

The species composition in general samples from the coastal Norway pout fishery off Møre (62° - 64° N) has been investigated regularly since 1972. The major components are blue whiting, greater silver smelt and silvery pout, whereas the contribution of Norway pout is rather small (average 9.7 per cent) and that of protected species poor (average 3.4 per cent in weight).

General samples from sandeel landings have been comparatively few, but indicate a by-catch of other species being less than 5 - 10 per cent in weight.

For several years the sampling data collected have been used to estimate the species composition in industrial landings. The results have been reported regularly to ICES and NEAFC and basic data have been utilized in different Working groups and in ICES papers.

## DISCUSSION

Theoretically the estimates of the species composition in industrial fisheries should be based upon adequate random sampling being performed regularly and covering the whole fishing area. Table 1 indicates that these conditions only to some extent have been fulfilled, though the gradual

improvements give reason to suggest more reliable estimates for recent years.

Investigations show that the Norway pout fishery seems to follow certain regular patterns. In the Norwegian Deeps fishing is mainly carried out along the western and southern slopes by small to medium sized trawlers. Fishing takes place within rather restricted areas and the vessels unload in the nearest available port. They go fishing early in the week and land their catches at the end of the week. During peak seasons in summer two weekly trips may be made. A rather constant sampling from various ports is essential for this region.

In the northwestern North Sea fishing for Norway pout is mainly conducted by big trawlers over a rather large area. They may cover several fishing grounds during one trip and are often landing their catches at irregular intervals in different ports. Their maximum activity take place in the latter half of the year and part of this fleet also go for sandeel during summer. The problem of sampling is greater than in the Norwegian Deeps, but as the species composition tends to be more uniform (Table 1) the present level of sampling probably gives better estimates than would be expected from the number of samples alone.

Adequate sampling of individual landings presents the conflicting question of collecting a few, large samples or several smaller samples within a limited range of sampling effort. Practical experience from sampling landings from the Norwegian Deeps, however, indicate a greater variation between than within landings, thus pointing at smaller samples. General samples of 30 kg have been chosen because the sub-samples of 10 kg each can be collected easily by a bucket and working up the sample takes a reasonable time, allowing several landings to be sampled during the few days a week when the major quantities are landed.

Comparison between the large special by-catch samples and the general samples shows that the differences in by-catch of protected species probably is less than might be expected from the size of the samples types (Table 3). The one intriguing species seems to be saithe which usually is too big to be sampled adequately in general samples. This species moreover occurs in rather dense shoals at various depths along the Norwegian Deeps and may be difficult to sample adequately even in special samples.

Recent investigations on sampling fish of different sizes in special and general samples from individual landings show that fish of 0.5 kg or more tend to be underestimated in general samples. In such instances the relative proportion of legal protected species will be underestimated, undersized fish overestimated and the total fraction of protected species underestimated. Concerning special sampling the opposite conditions to some extent may be present because some undersized fish may be overlooked. The bias will be different for each species according to their legal size and the general size composition on the fishing grounds.

Random sampling of individual landings may be difficult to achieve during the hot season due to reduced quality of the fish. Sampling will then only be made from the part of the landing where fish can be identified. Such conditions, however, usually applies to small trawlers, as bigger ones are more likely to conserve their catches. The bias introduced may be either insignificant or rather small since smaller landings tend to be fairly homogeneous.

Using sample estimates for further calculations is (apart from the validity) basically a question of relevant grouping. Taking into account ecological conditions one may roughly divide the industrial fishing grounds for Norway pout in the North Sea into 3 major regions:

1. The deeper parts of the Northwestern North Sea stretching somewhat irregularly from Bressay Ground to Fladen Ground, where Norway pout is the predominant species and the element of protected species is comparatively high.
2. The narrow Norway pout zone along the Norwegian Deeps east of the comparatively shallow ridge stretching southwards from Viking Bank to the Coral Bank - Ling Bank area where the element of protected species is less.
3. The deeper zone in the Norwegian Deeps beneath that of Norway pout where blue whiting is predominant and the element of protected species is lowest. The two latter zones extend outside the Norwegian Deeps westwards along Tampen and north along the Norwegian coast.

The main statistical areas comply fairly well to the natural boundaries for Norway pout, but a few adjustments have been made. The Tampen area, both samples and landings, is transferred to the northeastern area (area 28) and some samples from the western Patch Bank are made valid for the northwestern area (area 42).

On the assumption that the distribution of samples reflects the prevailing fishery for Norway pout and blue whiting sample estimates may be used on a monthly basis, or if due to insufficient sampling in some months, rather on a quaterly basis as in this paper.

#### REFERENCES

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Table 1. Quarterly distribution in per cent of weight of protected, industrial and other species in general samples (30 kgs.) of Norway pout landings by area from the North Sea, 1972-1976.

Statistical area 28: ICES division IVa north of 60°N and east of 2°E.

Year	Quarter	No. of Samples	Protected species		Industrial species			Other species	Total landings tons
			Undersized	Legal	Norway pout	Blue whiting	Silver smelt		
1972	1	20	8.5	2.6	63.8	13.7	5.2	6.2	2 229
	2	60	3.6	3.0	35.1	35.2	6.9	16.2	4 703
	3	56	6.1	2.3	35.2	45.6	5.3	5.5	4 906
	4	13	8.2	1.4	21.7	57.6	5.8	5.3	820
1973	1	42	2.6	9.7	23.8	35.8	8.3	19.8	3 761
	2	23	1.4	8.8	9.3	56.2	8.7	15.6	11 836
	3	18	1.5	9.9	12.1	67.4	3.9	5.2	9 282
	4	10	2.5	6.6	8.3	72.0	6.0	4.6	3 495
1974	1	15	1.6	8.9	13.2	52.2	8.0	16.1	3 741
	2	48	0.8	6.6	19.8	51.7	7.6	13.5	12 834
	3	9	3.3	5.4	76.7	9.9	1.9	2.8	11 863
	4	22	8.2	5.7	51.4	22.8	6.7	5.2	4 090
1975	1	41	4.7	9.1	55.8	16.8	5.3	8.3	5 354
	2	22	2.2	10.5	61.2	14.5	6.0	5.6	22 906
	3	1	1.9	6.1	75.2	15.5	1.3	-	5 335
	4	17	3.4	3.8	38.3	48.1	3.1	3.3	9 307
76	1	30	3.1	11.1	54.9	19.7	4.9	6.3	2 664
	2	48	1.9	5.5	24.5	49.2	6.2	12.7	6 770
	3	31	1.9	3.9	37.5	29.7	-	10.9	8 680
	4	11	3.1	6.1	56.2	21.0	6.0	7.6	2 564

Statistical area 08: ICES division IVa south of 60°N and east of 2°E.

1972	1	3	4.9	11.1	80.8	-	1.2	2.0	10 772
	2	2	4.3	0.5	88.9	-	2.7	3.6	33 676
	3	-	-	-	-	-	-	-	28 711
	4	-	-	-	-	-	-	-	14 765
1973	1	2	3.4	10.0	74.1	-	-	12.5	15 920
	2	14	0.6	4.0	51.7	33.8	4.1	5.8	31 751
	3	2	0.3	1.6	5.1	78.8	6.9	7.3	23 734
	4	5	0.3	0.3	25.6	70.6	2.1	1.1	16 076
1974	1	8	0.6	5.7	76.3	11.0	1.5	4.9	18 181
	2	11	0.5	1.9	59.5	25.8	3.5	8.8	50 338
	3	-	-	-	-	-	-	-	43 960
	4	1	3.2	-	25.4	56.5	12.0	2.9	15 875
1975	1	12	7.9	13.7	72.6	1.6	1.4	2.8	21 464
	2	30	2.2	3.7	80.6	9.5	2.5	1.5	55 451
	3	18	0.7	3.4	65.8	27.9	1.8	0.4	30 549
	4	22	1.7	4.4	47.7	43.5	1.3	1.4	30 549
76	1	37	0.9	12.1	73.1	10.6	1.1	2.2	15 665
	2	50	0.9	4.4	61.6	27.2	3.0	2.9	35 149
	3	30	0.9	4.2	55.2	32.6	4.7	2.4	27 276
	4	27	3.2	8.3	68.3	16.0	1.2	3.0	8 978

Statistical area 42: ICES division IVa west of 2°E.

1972	1	1	4.7	23.7	56.0	-	-	6.6	2 376
	2	3	2.8	5.3	90.4	0.2	-	1.3	1 914
	3	3	2.2	11.4	60.8	11.8	4.0	9.8	11 269
	4	2	3.0	12.5	83.2	0.1	-	1.2	6 110
1973	1	2	2.3	13.7	75.3	3.4	0.2	5.1	1 462
	2	2	1.9	7.8	85.3	-	-	5.0	7 238
	3	2	3.6	11.2	62.6	15.6	0.4	6.6	33 770
	4	-	-	-	-	-	-	-	3 574
1974	1	1	0.7	5.0	80.0	-	-	14.3	5 336
	2	3	3.2	3.4	91.9	-	-	1.5	3 409
	3	8	2.5	4.0	87.0	3.9	0.9	1.7	42 849
	4	11	3.5	8.3	87.3	0.5	0.2	0.2	39 499
1975	1	18	6.5	15.3	72.7	0.7	0.9	3.9	7 586
	2	8	1.4	22.7	73.3	1.4	0.3	0.9	13 442
	3	2	1.0	2.9	95.0	-	0.2	0.9	61 623
	4	22	2.7	12.4	98.3	3.3	0.6	0.7	34 820
1976	1	2	2.0	16.7	75.2	2.7	1.3	2.1	697
	2	7	1.9	15.2	80.9	1.3	0.2	0.5	7 891
	3	27	5.1	12.7	77.2	1.2	1.4	2.4	21 747
	4	19	4.6	19.8	73.6	0.7	0.4	0.9	18 911

Table 2. Quarterly distribution of special samples (protected species), fishing depth and elements of protected, industrial and other species (in per cent of weight), in Norway pout landings from the North Sea in 1976, broken down

Statistical area 28: ICES division IVa north of 60°N and east of 2°E.

Quarter	Samples		Total landings		$\frac{100 \cdot n}{N}$	$\frac{100 \cdot w}{W}$	Fishing depth (m)		Protected species	Industrial species			Other species
	No. Landings n	w(tons)	No. Landings N	W(tons)			Mean <sup>1)</sup>	Range		Norway pout	Blue whiting	Silver smelts	
1	31	1032	88	2664	35.2	38.7	264	150-290	8.4	59.2	21.3	5.3	5.8
2	16	525	203	6770	7.9	7.8	245	165-330	5.6	25.4	51.0	6.4	11.6
3	21	1117	223	8680	9.4	12.9	223	125-245	14.1	36.6	29.0	15.8	4.5
4	20	469	102	2564	19.6	18.3	226	180-290	5.6	58.8	21.9	6.3	7.4
Mean <sup>1)</sup>	22	786	154	5170	14.3	15.2	240	125-330	8.4	45.0	30.8	8.5	7.3

Statistical area 08: ICES division IVa south of 60°N and east of 2°E.

1	63	2397	631	15665	10.0	15.3	204	145-280	30.2	58.5	8.5	0.9	1.9
2	67	1922	1174	35149	5.7	5.5	176	135-235	8.1	60.0	26.7	2.9	2.3
3	38	1282	845	27276	5.0	4.7	186	125-275	10.9	51.5	30.4	4.4	2.8
4	51	2178	327	8978	15.6	24.3	180	145-275	8.4	71.0	16.6	1.2	2.8
Mean <sup>1)</sup>	55	1945	744	21767	7.4	8.9	187	125-280	14.4	60.3	20.6	2.3	2.4

Statistical area 42: ICES division IVa west of 2°E.

1	5	227	17	697	29.4	32.6	139	120-180	23.9	70.1	2.5	1.2	2.3
2	11	857	151	7891	7.3	10.9	158	135-200	10.7	87.4	1.4	0.2	0.3
3	11	638	374	21747	2.9	2.9	150	125-200	13.1	82.8	1.2	1.5	1.4
4	25	1185	273	18911	9.2	6.3	130	110-145	20.2	77.5	0.7	0.4	1.2
Mean <sup>1)</sup>	13	727	204	12312	6.4	5.9	144	110-200	17.0	79.5	1.4	0.8	1.3

1) Arithmetic mean.



Table 3. Quarterly distribution in per cent of weight of protected species from special by-catch samples (S) and from general industrial samples (G) by area from the North Sea in 1976.

Statistical area 28: ICES division IVa north of 60°N and east of 2°E.

Quarter	Samples		Cod		Haddock		Whiting		Saithe		Hake		Witch		Others <sup>1)</sup>		Sum	
	S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G	S	G
1	31	30	0.22	1.02	2.23	3.87	3.35	4.39	2.07	1.88	0.38	1.83	0.15	0.78	-	0.38	8.40	14.15
2	16	48	0.49	0.55	1.55	2.36	1.00	0.94	1.98	1.80	0.60	0.72	0.02	0.74	-	0.31	5.64	7.42
3	21	31	0.11	0.29	0.98	3.09	0.64	0.35	12.13	1.27	0.18	0.42	0.01	0.17	0.04	0.22	14.09	5.81
4	20	11	0.05	0.34	2.12	3.42	1.47	1.58	1.71	2.83	0.20	0.22	0.08	0.58	-	0.24	5.63	9.21
Mean	22	30	0.22	0.55	1.72	3.185	1.615	1.815	4.47	1.945	0.34	0.80	0.065	0.57	0.01	0.29	8.44	9.15

Statistical area 08: ICES division IVa south of 60°N and east of 2°E.

1	63	37	0.58	0.33	1.42	0.57	6.74	7.76	20.75	3.02	0.72	0.75	0.01	0.36	-	0.18	30.22	12.97
2	67	50	0.32	0.18	0.39	0.47	0.54	0.48	6.31	3.12	0.40	0.60	0.12	0.44	-	0.03	8.08	5.32
3	38	30	0.20	0.02	0.87	0.70	1.11	0.33	8.47	3.35	0.18	0.18	0.08	0.23	-	0.28	10.91	5.09
4	51	27	0.20	0.14	0.64	0.28	5.38	1.84	2.01	5.81	0.05	0.10	0.09	0.91	-	-	8.37	9.08
Mean	55	36	0.325	0.17	0.83	0.505	3.44	2.60	9.385	3.825	0.34	0.41	0.075	0.485	-	0.12	14.40	8.115

Statistical area 42: ICES division IVa west of 2°E.

1	5	2	0.31	-	10.46	3.33	8.62	9.67	4.27	5.67	0.24	-	-	-	-	-	23.90	18.67
2	11	7	0.08	0.33	1.47	2.95	8.15	11.98	0.79	0.43	0.13	0.79	0.12	0.55	-	0.05	10.74	17.08
3	11	27	1.69	0.83	3.97	7.80	4.45	8.51	2.83	0.38	0.24	-	0.02	0.16	-	0.09	13.12	17.77
4	25	19	0.55	0.64	4.09	6.62	14.98	14.95	0.12	1.63	0.01	0.07	0.40	0.33	-	0.12	20.15	24.36
Mean	13	14	0.66	0.45	5.00	5.18	9.05	11.28	2.00	2.03	0.155	0.215	0.135	0.26	-	0.065	16.98	19.47

1) Megrin, dab, lemon sole and sole.