SURVEYING THE YOUNGER AGE GROUPS OF SAITHE - EXPERIENCES FROM A SMALL SCALE ACOUSTIC SURVEY AT THE COAST OF WESTERN FINNMARK

by

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ABSTRACT

The small saithe (1- and 2- group) is mainly distributed in fairly shallow areas close to the Norwegian coast from Rogaland to eastern Finnmark. It is known to occur quite regularily at certain localities. It is usually schooling, at least in daylight. Thus, by using a small vessel equipped with an echo sounder it is usually easy to detect. This paper discuss the possibilities of acoustic surveying a fixed number of known "saithe localities" to obtain a yearclass index. Hypothesis regarding the distribution pattern and fish behaviour are presented, and the cosequences for the reliability of a survey index are discussed. Absolute estimates seem unrealistic, because a large proportion of the most important areas can not be surveyed even with a small vessel. Results from a survey in western Finnmark during early August 1993 are presented and discussed. The results indicate that in these areas the 1- group tended to stay rather close to the shore, while the 2- group showed a more favourable distribution. At the lower limit of its vertical distribution range it showed some overlap with the 3- group.

METHODS

A 49 feet research vessel ("Fjordfangst") equipped with a Simrad EY 200 (38 kHz) echo sounder was used for echo surveying in the period from 6 to 16 August 1993. The first 5 days were aimed at 0-group cod in the fjords on the north western part of Sørøya, while the rest of the survey were aimed at small saithe in the area around Rolvsøy and the areas west and south west of Havøysund. All observations were made during daytime.

A PC-based echo integrator (Floen *et al.* 1991) was connected to the echo sounder, and the system was calibrated by use of a standard copper sphere (TS= -33.6 dB), lowered to 9 meter range in Hammerfest harbour. Integrator outputs were given in absolute terms (S_A - values), and the distance interval (Elementary Sampling Distance Unit (ESDU)) was set to 0.3 nautical miles. Recordings were mainly identified by use of handline. To catch 0-group fish a small meshed Danish seine was used. After removing contributions from plankton and bottom, the

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s_A -values were allocated to the categories: small saithe (less than about 33 cm), larger saithe, 0-group cod, 0-group herring, larger herring and large demersal fish (cod and haddock).

Small saithe was the target for the last part of the survey. Narrow grounds where the bottom raised steeply from the surroundings to a minimum depth between 10 and 40 meters were considered as typical localities for small saithe and were selected for surveying. Figure 1 shows the survey tracks and the selected saithe localities. At most localities only one transect was worked "diametrically" across the ground. The vessel usually returned to the detected schools immidiately after finishing the transect to catch a few fish for identification. Mean S_A -value for saithe was calculated for each locality and converted to mean density by applying a target strength (TS) = 20 log L -68 (Foote 1987). An abundance estimate for the locality was obtained by assuming the area of the locality to be circular with diameter equal to the distance sailed across the locality (diameter = number of S_A -values times 0.3 nautical miles)

RESULTS

Echo recordings

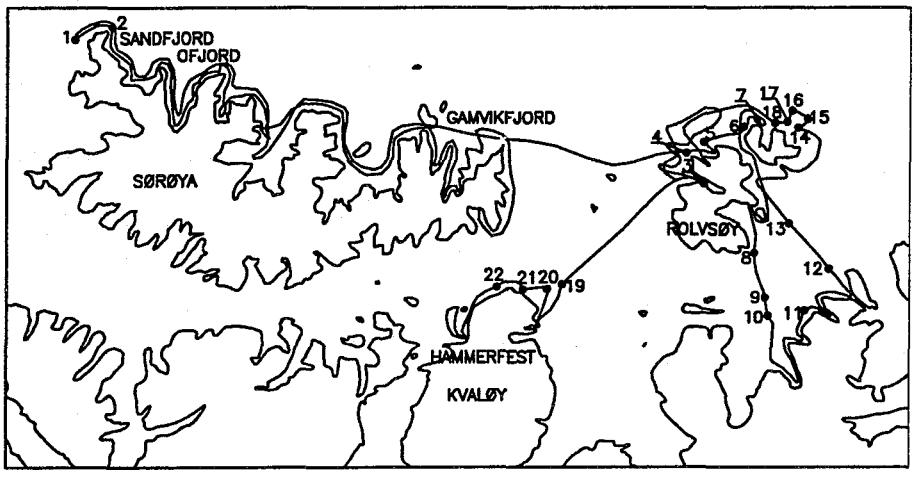

Figure 1. Survey tracks and saithe localities (filled circles 1-22). The localities 4-22 were preselected.

On the echogramme the small saithe formed rather dense schools, with irregularities along the edges indicating single fish traces. It was mainly restricted to the "typical" saithe localities described above. The larger saithe tended to occur deeper and the schools appeared looser; Single fish traces were evident throughout large parts of the school. Location 1 (Figure 1) showed an exception from this rule. Here, at 20 meter bottom depth, the schools appaered identical to schools of smaller saithe, but fishing showed fish in the size range 43-48 cm. Most schools of larger saithe were found along sloping bottom at bottom depths between 60 and 120 meters, while a few were recorded at rather flat bottom. The few traces identified as 0-group cod appeared as quite small schools of moderate acoustic density close to the bottom at bottom depths less than 25 meters. At common survey speed those traces were difficult to distinguish from traces of larger individual fish close to bottom. 0-group herring were recorded as fairly dense, irregular schools in the upper 20 meters, while the larger herring seemed to form more regular, nearly symmetrical, dense schools with rather wide vertical extension. Compared to the schools of small saithe they tended to have sharper edges and they did usually not occur at the typical saithe localities. Larger fish (cod and haddock) were

widespread, particulary at depths below 30 meters. They tended to be resolved as single fishes. One exception was close to Melkøy (outside Hammerfest) where dense schools seemed to be pure cod.

Saithe

Length distributions of all saithe and cod taken with handline are shown in Figure 2. Figure 3 indicates an increasing size of the saithe with increasing bottom depth. (Locality 1 and 2 are rather far from the other localities and are not included in Figures 2 and 3). Figure 4 shows the S_A -values allocated to small and larger saithe averaged within bottom depth intervals. Here also the observations outside saithe localities are included, except those around Sørøya. Table 2 shows within depth intervals the number of S_A -observations and the frequency of occurence of saithe for the same set of data. Both Figures 3 and 4 show that small saithe dominates where the bottom depth is 60 meters or less, while no small saithe were observed at larger bottom depths.

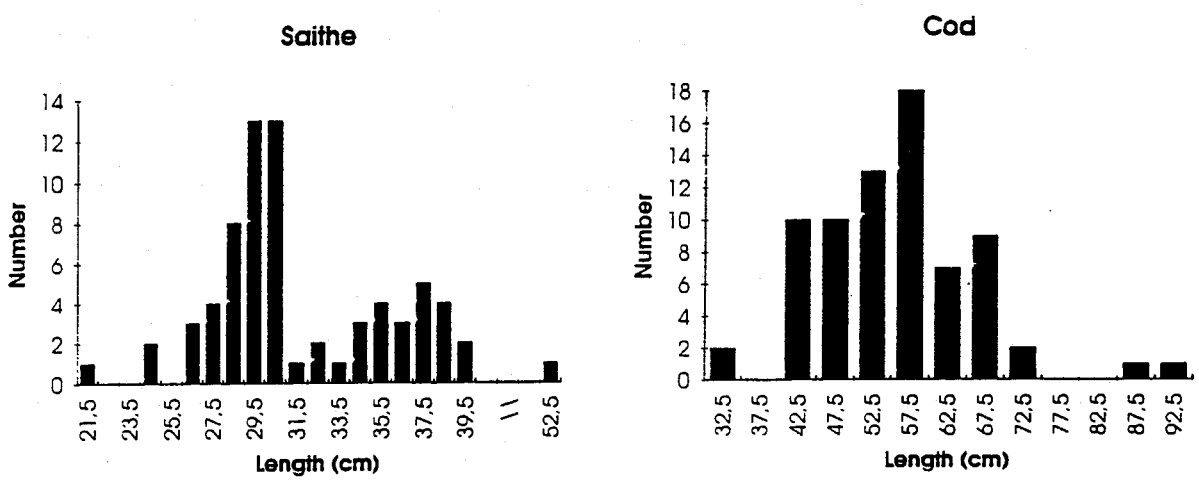

Figure 2. Length distribution of saithe and cod for all handline stations (except for locality 1 and 2) merged.

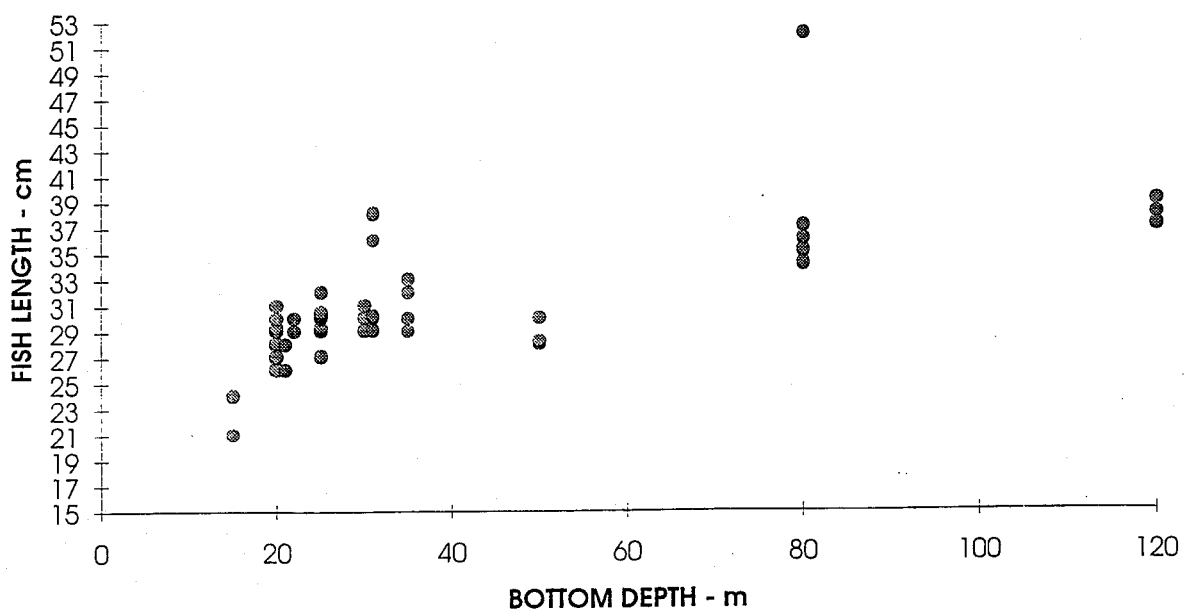

Figure 3. Length of saithe sampled at different bottom depths. Localities 1 and 2 are not included.

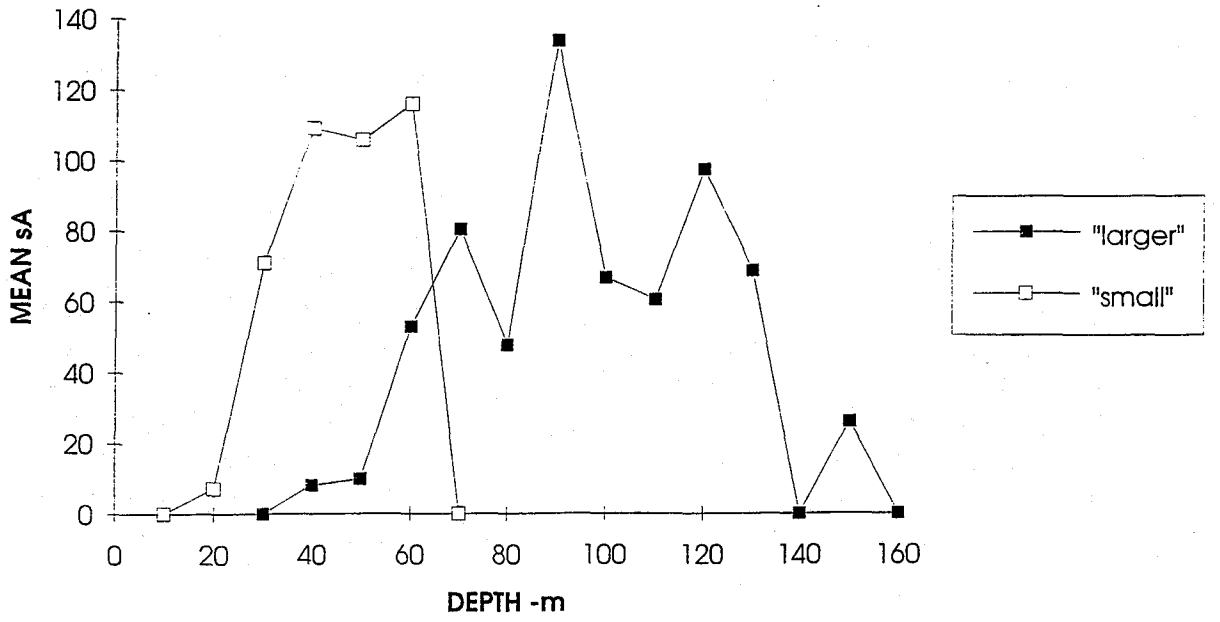

Figure 4. Mean S_A within intervals of bottom depth for "small" (<33 cm) and "larger" saithe. Observations along the transects between the selected localities are included. The observations along Sørøya are not included.

Table 1. Estimated mean density and abundance of saithe by locality. Localities marked with * were not pre-selected.

Locality	#samples á 0,3 nm	mean S_A	Area (sq. nm)	Density (#/sq.nm)	Abundance (#)	Age group
1* Darupskjær 1	2	237	0,28	58948	16659	3+
1* Darupskjær 2	2	123	0,28	30653	8663	3+
2* Skinnbrokskjær	2	151	0,28	56452	15953	3+
3* i Valfjord	3	135	0,64	85025	54063	2
4 Tunæringen	2	179	0,28	110556	31243	2
5 Kvalskjær 1	1	228	0,07	140853	9951	2
5 Kvalskjær 2	1	215	0,07	132880	9388	2
6 Vesterskjæra	1	129	0,07	73714	5208	2
7 Terningskallen	3	574	0,64	354086	225146	2
8 Gorgeboen	3	99	0,64	61049	38818	2
9 Lysgrunnen	1	258	0,07	159259	11252	2
10 Latøy	2	963	0,28	594568	168025	2
11 Rundgrunnen	3	527	0,64	304728	193762	2
12 Kjerkegrunnen	4	142	1,13	73600	83197	2
13 Saramannsgrunnen	5	65	1,77	42222	74575	2
14 Langeskjærgrunnen	2	73	0,28	46859	13242	2
15 Beskallen	3	748	0,64	479615	304963	2
16 Englan	5	1147	1,77	535593	945991	45% 2; 55% 3
17 Knausen	2	47	0,28	22082	6240	45% 2; 55% 3
18 Sandholmen	4	347	1,13	161802	182901	45% 2; 55% 3
19 Forsølgrunnen	1	155	0,07	54278	3835	3
20 Laibagrunnen	4	318	1,13	111571	126120	3
21 Mylingsbukta	2	194	0,28	67847	19174	3
22 Fluengrunnen	3	316	0,64	297194	188971	1
				TOTAL	0,19 mill. (21 t)	1-gr
					1,73 mill. (380 t)	2-gr
					0,81 mill. (370 t)	3+-gr

Table 1 shows estimated density and abundance of saithe for each locality. A tentative split on age

groups was based on the observed fish lengths by applying age/ length keys from samples taken in neighbouring areas during october. Locality 19, 20 and 21 were the deepest ones with minimum bottom depths of 60-90 meters, while locality 22 was the most shallow (11 meters). All the remaining localities have minimum bottom depth in the range 15-45 meters, and except for the localities 16, 17 and 18 (and 1 and 2, beeing considerably further to the west) they seemed dominated by the 2-group.

Table 2. Total number of S_A observation and number where S_A for saithe is >0, within bottom dept intervals. Observations outside the saithe localities are included.

Mean bottom depth (m)	Total obs.	Obs. >0	Frequency of obs. >0
10	30	0	0,00
20	48	3	0,06
30	80	30	0,38
40	81	33	0,41
50	58	18	0,31
60	35	12	0,34
70	26	5	0,19
80	13	6	0,46
90	19	8	0,42
100	13	7	0,54
110	21	6	0,29
120	12	5	0,42
130	8	2	0,25
140	13	0	0,00
150	5	2	0,40
>150	45	0	0,00

Other species

When planning the survey one of the purposes was to make acoustic measurements of 0-group cod in the the north western fjords on Sørøya, to compare with those reported by Olsen and Soldal (1989). During this survey in 1993 recordings of 0-group cod were quite scarce in these areas. Five fishing stations were made with a small meshed Danish seine. Only one of the stations (in Sandfjord) gave a reasonable catch of 0-group cod. The length distribution is shown in Figure 5. This distribution, with modal length slightly below 5 cm , is similar to those observed in these areas in August 1987. Echo recordings resembling those giving this catch occured at a few locations in Sandfjord, Ofjord and Gamvikfjord. The total abundance of 0-group cod along Sørøya seemed to be considerably lower than reported by Olsen and Soldal (1989) for the years 1987 and 1988.

By using buoys on the headline the Danish seine was also used to identify recordings of 0-group herring close to surface. Besides herring around 5 cm (Figure 5) the catch showed a small admixture of sandeel (size range 5.5-7.5 cm). Such recordings were widespread both along Sørøya, outside Hammerfest and around Rolvsøy. The highest densities were observed in the inner parts of the fjords at Sørøya. 0-group herring were frequently observed in the stomack of saithe and cod. Schools classified as larger herring were observed along the eastern side of Sørøya, outside Forsøl, and a number of schools were recorded in Bakfjord. The cod caught in Bakfjord had herring (15-20 cm) in their stomacks.

DISCUSSION

Survey design

The survey reported here did not follow the usual design of an acoustic survey. The topography and the typical distribution of saithe would mean that a systematic survey grid

with equally spaced transects over the entire large-scale distribution area would be a waste of effort. Instead the survey was aimed at the type of localities which the saithe seem to prefer.

The observed distribution of saithe confirms that the smaller saithe are assossiated with certain localities; Only at 4 or 5 occasions schools of small saithe were observed outside such localities. The results also indicate that, at least in this area during the present survey, the possibility of findig saithe at a typical locality is quite high; Saithe recordings were absent only at one of the 20 preselected localities. Bearing in mind that only one transect were worked through each locality, this is a rather high rate of "success". The repeatability of such one-transect coverages was not systematically investigated. Locality 1 was covered during the afternoon one day and covered again the next morning, while at locality 5 the same transect was repeated within half an hour. The results (Table 1) indicate large variation at locality 1 and small variation at locality 5. Due to variations in currents, weather, light conditions and diurnal rythms in the activity of the fish, it is quite likely to have temporal variations of the distribution within a locality. On schooling fish the likely sampling variation (at a fixed fish distribution) also tends to be large, and the result from locality 5 should not be taken as typical.

From Table 1 it is seen that the range between the lowest and highest estimate of the area of the localities is 1 to 25, which is approximately the same as the ratio between the lowest and the highest density estimate. It is also seen that the decision whether the locality extends over 1 or 2 ESDUs changes the area by a factor of 4. It is evident that for this purpose an ESDU of 0.3 nautical miles is too large, and the abundance estimates are strongly influenced by area estimation errors. This could have been improved by adjusting the S_A -value and area estimate according to the proportion of each ESDU falling within the locality. This would require some criteria based on the topography (like bottom depth and bottom slope) to determine the extent of the location. Preferably the area should be worked out from a map with detailed depth contours.

One could argue that mean S_A -values could be used as an abundance index without taking the area of the localities into account. If mean values are wanted by locality, the problem of deciding the averaging distance still remains. A better alternative is to use the sum of S_A -values for each locality as a basis for an index. An underlaying assumption would then be that all localities have the same extension across the transect. The basis for estimating total S_A, mean S_A and area would be considerably improved by working an additional transect perpendicular to the first one at ech locality.

The survey reported here is a pilot study on the possibility of designing a survey for estimating the year class strength of the younger age groups of saithe. The results indicate that it is easy to design an "aimed" survey that covers a large number of saithe schools. Therefore, one possibility could be to select a number of typical localities in all regions along the coast where young saithe tend to be distributed, to get a direct index for the covered localities. A refined index could be obtained by taking account of the number of uncovered saithe localities within each region. The reliability of such an index will both depend on sampling errors at the covered localities and on the between year variability in the proportion of a year class inhabiting the selected localities. The sampling errors could be studied by repeated coverages of a number of localities.

Regarding the between year variability one could speculate that in the case of large year classes the "best" localities become saturated and a large proportion of the fish is forced to

stay at less typical areas. It is also conceivable that different age groups might compete for the same localities, thereby influencing the between year variability of the distribution of a given age group.

By including some less typical locations in the coverage, the index would become more robust against such effects. This could be done by stratifying the whole survey area according to how suitable the environment is for saithe. (Bottom depth, bottom slope and exposure to waves and currents would be important parameters for stratification). Then the effort could be allocated to strata according to the expected distribution of saithe. Precise maps are required for defining and calculating the area of such strata. One remaining problem is that along the Norwegian coast there are large areas containing typical saithe localities which, for safety reasons, are not surveyable even for a small vessel.

Which age groups?

0-group saithe is known to have a predominantly littoral distribution during most of the year and is thus not available for acoustic surveying. At the present survey 0-group were only observed in the harbour areas visited. The information obtained on 1-group was also quite scarce. It was recorded acoustically only at one of the selected localities. In addition some amounts of 1-group were observed visiually in harbours. It seems to be a tendency for the 1-group to stay in more shallow waters and closer to the shore than the 2-group, thus making it less surveyable. The lack of 1-group at most selected localities might as well be caused by a low abundance of that year class in this region. In other regions of the coast 1-group is commonly occuring at the type of localities investigated here.

Anyhow, judging from this small survey, the 2-group seem to show the most favourable distribution for such an aimed acoustic survey.

Fish sampling

Sampling with handline (jigging and trolling) might be regarded as both ineffective and biased. At the present survey conditions it showed to be a surprisingly effective way of identifying echo records. With such a small, easily manoeuvrable vessel it was possible to fish on any fish recordings of interest. We could take a look at the echo sunder at the particular moment when the fish was biting and get an "answer" when the fish were taken onboard. Both saithe, cod and haddock seemed to be in the right mood for biting all day, and some catch was obtained at every trial when large fish were seen on the echogramme. Herring and other small fish did of course not take the hooks, but they could usually be distinguished from larger fish on the echogramme. Their presence were often verified by inspecting the stomack contents of larger fish caught. The conclusion is that for this kind of studies jigging is a quick way of identifying records, while when aiming for large samples it tends to be time consuming.

The selectivity of a handline is difficult to evaluate. We got the impression that when jigging in saithe schools occuring inbetween recordings of cod, the cod tended to be overrepresented in the catch. It might be that cod is more effective in competing for the hooks. In a few cases trolling was applied. Then the tendency appeared opposite.

One could expect that the saithe, at least to some extent, is schooling by size, thereby reducing the bias caused by size selectivity of the gear. This could be studied by sampling on the same schools both with handline and purse seine.

CONCLUSIONS

In spite of the variable topography and the patchy distribution of young saithe along the Norwegian coast, one should not rule out the possibility of obtaining a useful acoustic index of year class strength. One should not expect a high precision, but it might be worth the relatively small effort required for running a small vessel fishing with handline. Such a survey will also provide valuable additional information, for instance regarding predation on 0-group herring in coastal areas.

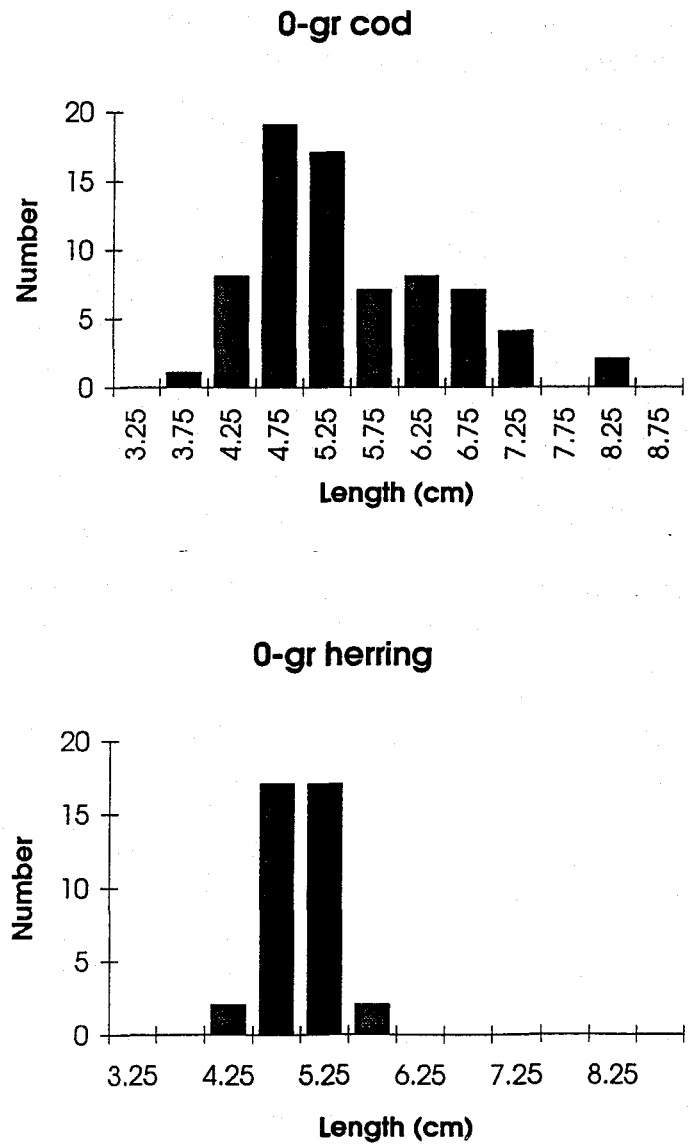

Figure 5. Length distribution of 0-group cod at Sandfjord, Sørøya, and of 0-group herring at Ofjord, Sørøya.

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