THE INABILITY OF THE 0-GROUP SAITHE SURVEY TO FORECAST THE STRENGTH OF THE YEAR-CLASSES ENTERING THE FISHERY

by

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ABSTRACT

An 0-group saithe trawl survey was conducted annually in the Norwegian Sea and outside the Norwegian coast north of 62°N in April-May 1985-1992. The survey aimed at covering the distribution of 0-group saithe in the open sea before the fish entered inshore waters. The yearclass strength of the saithe measured at this stage did not correspond to the strength of the yearclasses measured later when entering the fishery.

INTRODUCTION

One of the biggest problems in assessing the saithe stocks in the North Atlantic is the lack of good recruitment estimates. The 0-group saithe are very early distributed in the inshore waters and it is almost impossible to measure the abundance when the fish are close to the shore. After the saithe postlarvae have reached the sheltered inshore areas, and until becomming 2-4 years old, oldest in the northern part of Norway, the saithe mostly stay inshore. Above a minimum size the saithe are during this period, however, exposed to a considerable purse seine fishery.

Very little had previously been done on this subject. Damas (1909) described the distribution of fry and alevins of saithe off Møre. Wiborg (e.g., 1960), Dragesund and Hognestad (1966), and Bjørke (1983 and internal survey reports) described the occurrence of fish eggs and larvae in Norwegian coastal and offshore waters, but not at the appropriate time to measure the abundance of 0-group saithe. In 1985 a cruise was undertaken with the aim of measuring the abundance of postlarvae/0-group of the Northeast Arctic saithe before the main concentrations reached the shore (Nedreaas 1986). In 1986 the investigation was expanded to also cover the North Sea south to 58°N (Nedreaas and Smedstad 1987). This paper summarize the experience from the investigations north of 62°N in the time period 1985-1992.

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MATERIALS AND METHODS

Table 1 gives an overview of survey time, research vessel and number of pelagic trawl stations each year. Figure 1 which shows all pelagic trawl stations taken in 1989-1992, illustrates also the regular survey design used every year. Knowledge about spawning grounds of saithe, and a calculated drift of the larvae up to the beginning of the survey were decisive for where and when to start the survey.

Table 1. 0-group saithe survey north of 62°. Time of the survey each year, research vessels and nos. trawl stations.

Year	Survey period	Vessel	Nos. pelagic trawl stations
1985	11.05 - 31.05	R/V "Eldjarn"	148
1986	07.05 - 29.05	R/V "Håkon Mosby"	155
1987	07.05 - 30.05	R/V "Eldjarn"	165
1988	30.04 - 24.05	R/V "Eldjarn"	184
1989	30.04 - 27.05	R/V "Eldjarn"	171
1990	30.04 - 22.05	R/V "Eldjarn"	169
1991	30.04 - 25.05	R/V "G. O. Sars"	171
1992	28.04 - 15.05	R/V "G. O. Sars"	114
		R/V "Michael Sars"	66

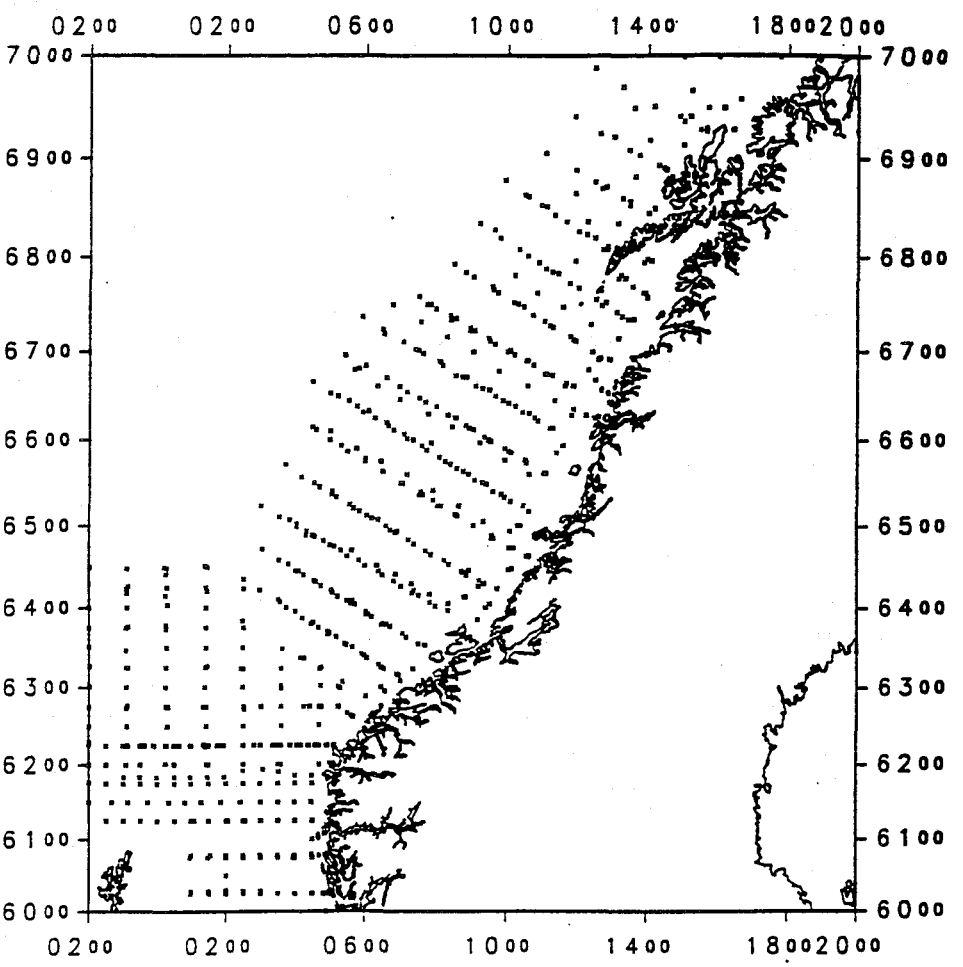

Figure 1. Pelagic trawl stations taken in 1989-1992 between 60°N and 70°N.

Some work was done to find the best sampling gear. The catch efficiency of Isaacs Kidd (9 m^2) and MOCNESS (1 m^2) midwater trawls were compared with the bigger midwater capelin trawl ("Harstad", 16x16 fathoms) possessing a 30 meter fine meshed (8 mm stretched mesh) cod-end.

The capelin trawl was towed with 3 knots for 0.5 n.m. with the headrope at the surface, then 0.5 n.m. at 20 meter, and 0.5 n.m. at 40 meters depth. Six 70" bladders were fastened to the headrope. The total towing distance became 1.5-1.8 n.m. Trawling was conducted both day and night.

The Isaacs Kidd trawl was lowered down to 60 meter, and the MOCNESS was hauled through 1000 m^3 seawater in each of the four depths 10, 20, 30, and 40 meters.

The capelin trawl turned out to be the most suitable gear for catching 2-3 mm saithe postlarvae of those three gears compared, and this trawl was therefore used as the standard gear in the subsequent years.

The catch was shaked or washed down in a tub with water and then filtered out. Afterwards the whole cod-end was thouroughly shaked and the remainder swept up from the deck. The entire catch was sorted, and the length of each fish species or category measured.

Vertical (height) and horizontal (distance between the trawl wings) distances of the trawl opening in front, as well as towing depth, were measured using SCANMAR sensors. Measurements of the trawl geometry were used to calculate the sea volume filtered by a standard trawl haul (V_1=area of the trawl opening times towed distance of 1.5 n.m.). An average trawl geometry for the whole survey was used in the index calculations.

The distance between survey tracks was usually 30 n.m., and between each trawl station it was usually 15 n.m. The trawl was assumed to fish down to approx. 55 meters depth (=0.0297 n.m.). The number of 0-group fish on each trawl station was therefore taken to be proportional to the actual number within a volume of 30x15x0.0297 $n.m.^3$ ($=V_2$). Outside the main regular survey area, especially close to shore, the catches from more than one trawl station were averaged for a given volume differing from place to place. The abundance index (I) was then calculated by the formula:

$$I = \sum V_2/V_1 \times X_i = V_2/V_1 \sum X_i \text{ , where } X_i \text{ is the number of 0-group saithe on station i.}$$

RESULTS

The average horizontal distribution of 0-group saithe in 1985-1988 is shown in Figure 2. The figure has been constructed by putting together the catches from all stations taken in these four years, and deviding by the number of survey years. Figure 3 shows a similar figure for the time period 1989-1992.

The distributions seem to coincide with the 7°C isotherm, at least to some extent (Figure 4). Although the saithe spawn in Atlantic waters in February-March, the larvae and 0-group are already in April-May found in the upper 50-60 meters in coastal waters with salinity less than 35% (Figure 5 and 6).

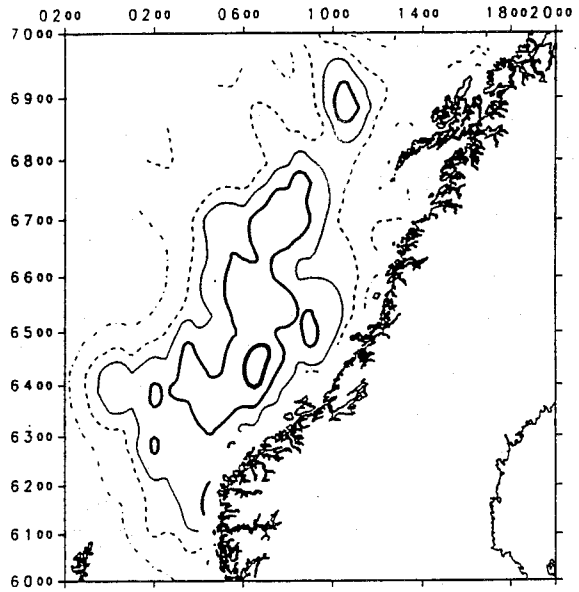

Figure 2. Distribution of 0-group saithe in 1985-1988. Isolines have been drawn for average number of saithe greater than 1 specimen/trawlhour (dotted/ stripled line), 10 specimens/trawlhour (stipled line), 30 specimens/trawlhour (single solid line), 100 specimens/ trawlhour (thick line), and more than 300 specimens/ trawlhour (extra thick line).

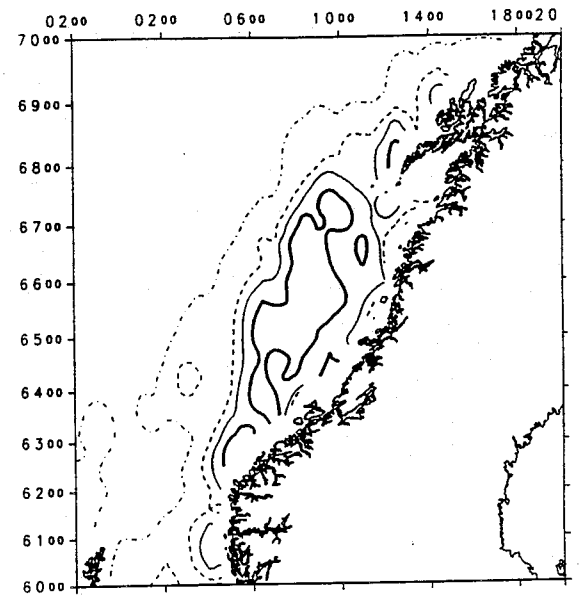

Figure 3. Distribution of 0-group saithe in 1989-1992. Isolines have been drawn for average number of saithe greater than 1 specimen/trawlhour (dotted/ stripled line), 10 specimens/trawlhour (stripled line), 30 specimens/trawlhour (single solid line), and greater than 100 specimens/ tawlhour (thick line). In this period the average number per trawlhour did not exceed 300 specimens on any station.

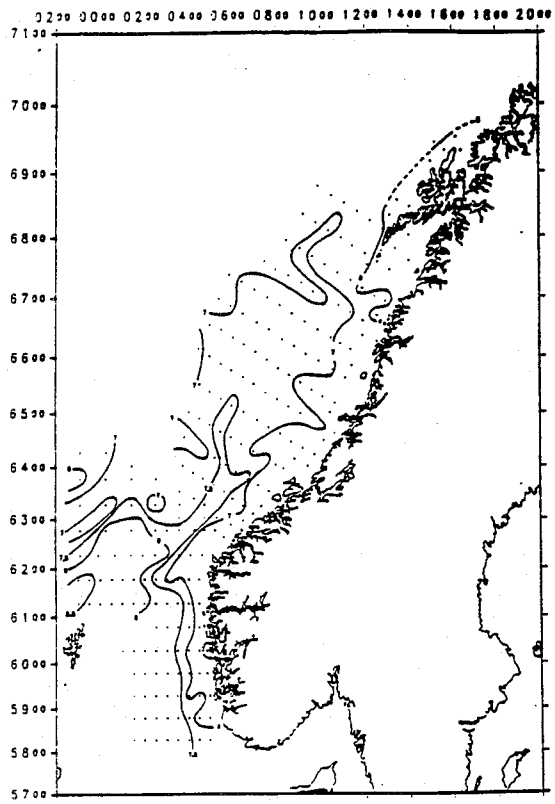

Figure 4. Temperature (C°) at the surface during the survey in May 1992.

The number of 0-group saithe caught each year is shown in the text table below together with the calculated indices.

Year	1985	1986	1987	1988	1989	1990	1991	1992
Nos. 0-group	10424	6669	2569	1334	1459	578	6019	4344
Index x 10^6	828	545	280	165	242	58	637	443

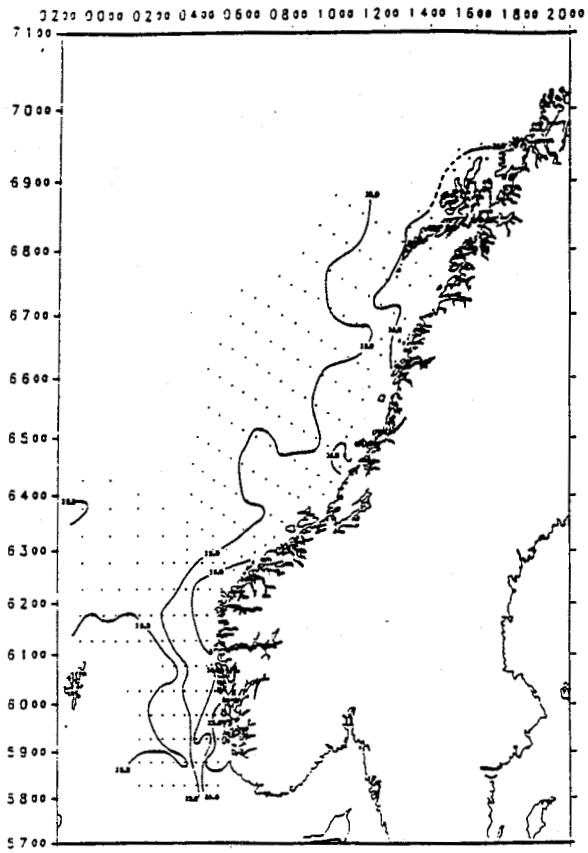

Figure 5. Salinity in 25 meters depth during the survey in May 1992.

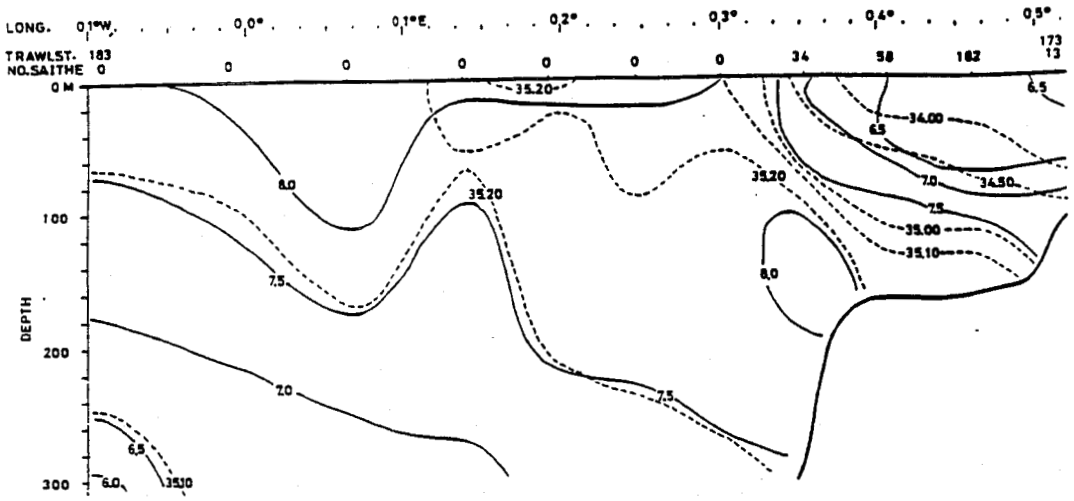

Figure 6. Vertical hydrographical section along 62°15'N during the survey in May 1992. The number of 0-group saithe caught at each trawl station along the section is given at the top of the figure.

In Table 2 and Figure 7 the 0-group indices are compared with the estimates of corresponding yearclasses from the trawl-acoustic survey and the VPA for age 3 (Anon. 1994). Since 1988 the trawl-acoustic survey for saithe has been conducted on the coastal banks from Finnmark to Møre in October each year. The trawl-acoustic survey data on ages 3-5 have been used for tuning the most recent assessments (Anon. 1994). Two year old saithe are in the transition of living inshore and offshore, and it is reasonable to believe that different feeding and hydrographical conditions from year to year will lead to variable recruitment to the offshore coastal banks and thus the acoustic survey results for this age class.

Table 2. Comparable results from the 0-group survey, the trawl-acoustic survey (two and three year olds) and the VPA (three year olds).

Year-class	1985	1986	1987	1988	1989	1990	1991	1992
0-group	828	545	280	165	242	58	637	443
Acoustic survey age 2		40	61	256	220	408		
Acoustic survey age 3	57	70	80	260	659			
VPA age 3	76	66	72	229	330	163		

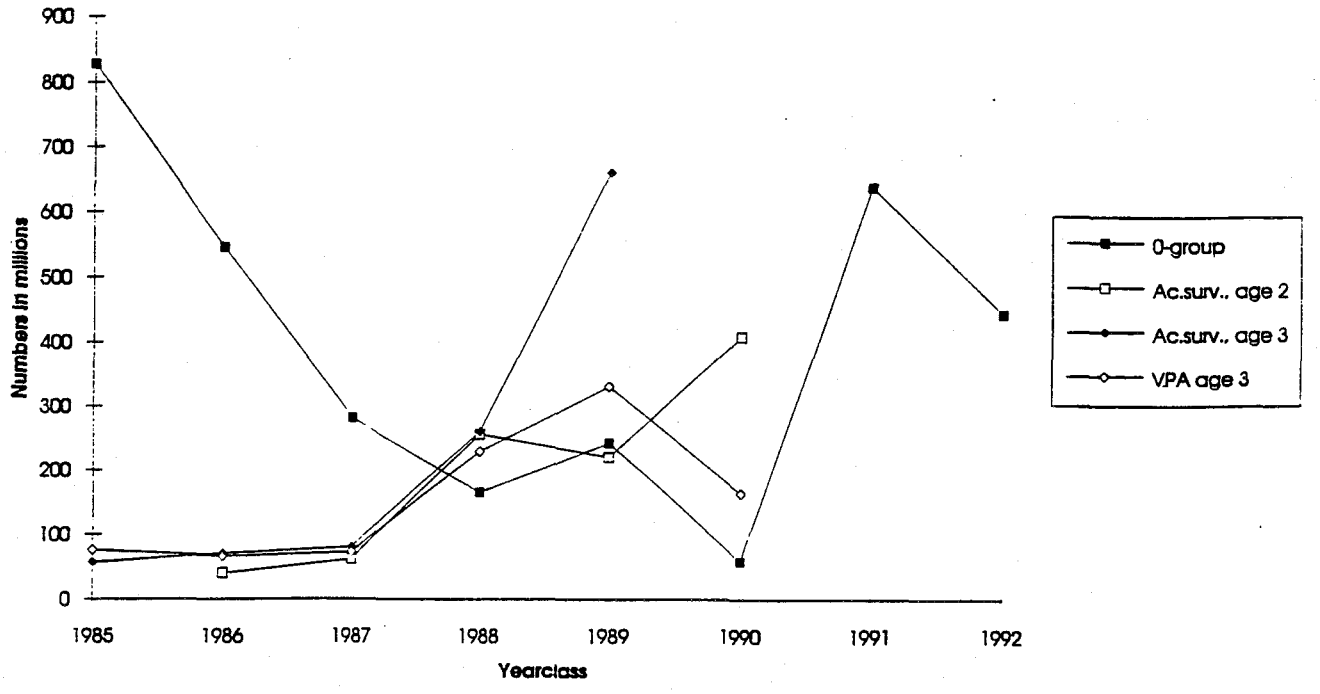

Figure 7. Year-class strength of the North-East Arctic saithe measured at the 0-group survey, the acoustic survey as 2 and 3 year olds, and as age 3 when backcalculated by the VPA.

Although a perfect fit between the 0-group indices and the survey and/or the VPA results was not expected unless suitable scaling, strong and weak yearclasses should have turned out the same way for the same year irrespective of survey or VPA. Figure 7 clearly shows that this is not the case, especially not for the years 1985-1987. For 1988-1990 there is a better fit between the 0-group index and the VPA. However, the 1991-yearclass is the last yearclass entering the VPA as 1-year-olds in 1992, and is therfore considered not reliably estimated by the VPA. The same can most probably also be said about the 1990- and 1989-yearclasses, thus explaining the deviation from the acoustic survey results regarding those yearclasses.

DISCUSSION

Since the time series from the trawl-acoustic survey and the VPA are still too short to compare with the entire 0-group series (1985-1992 yearclasses), the discussion of the results so far is mainly to put forward possible explanations for the big discrepancy between the postlarvae or 0-group index and the results from the acoustic surveys and the VPA regarding the 1985-1987 yearclasses.

Different ways of calculating the 0-group index have been tried, but this had only impact on the scaling, and did not change the relative strength between years.

The big midwater capelin trawl may not be the optimal gear to use for quantitative sampling of these 16-40 mm 0-group saithe postlarvae. Godø and Valdemarsen (1993) used an experimental three level trawl (Hylen *et al.* 1995) and compared the catches with the standard capelin trawl. Although the comparisons were only conducted in two minor areas 180 naut. miles apart, the experimental trawl demonstrated an area difference in vertical distribution of the 0-group saithe. The differences in vertical distribution seemed to be geographic rather than diurnal, and since the efficiency of the capelin trawl is expected to be lower at the surface compared to deeper water (see also Godø, Valdemarsen and Engås 1993), this could affect the reliability of the catch data from the capelin trawl and hence the calculated indices. Godø and Valdemarsen (1993) not find any significant length differences of the 0-group saithe with depth, but differences in mean length between the two areas in the experiment may however explain the observed geographic different vertical distribution. Hence if the 0-group saithe has a different vertical distribution dependent on size, and the mean length of the 0-group differs from year to year as shown in Table 3 thus indicating different vertical distribution, and the trawl efficiency also differs with depth, then this might have had an impact on the index (see Figure 8). Bjørke and Bakkeplass (1991) did also observe similar vertical differences in saithe postlarvae distribution between years in June -August 1977-1981.

Table 3. Length-distribution (%) and mean length (mm) of 0-group saithe north of 62°N in 1985-1992.

Year	Length-group (mm)									Mean length
	<15	15-19	20-24	25-29	30-34	35-39	40-44	45-49	>50	
1985		1	13	37	31	13	3	1	1	29,84
1986	+	18	42	28	10	2	+	+	+	23,99
1987	1	13	43	34	8	2	+			23,98
1988	1	19	40	25	10	4	1			23,91
1989		7	42	33	7	10	1			24,59
1990	8	45	36	10						19,40
1991		1	13	47	32	8	+	+		28,62
1992	+	18	52	26	3	+				22,60

Although no size differences were observed when comparing the length of the postlarvae/0-group saithe caught by the capelin trawl and the Isaacs Kidd and MOCNESS trawls, one should not exclude the possibility that size selective properties of the capelin trawl may underestimate the index when the 0-group are small.

Godø and Valdemarsen (1993) found the catches to be generally lower at night irrespective of gear indicating possible behavioural differences of the postlarvae (more dispersed at night) or day-night differences in trawl efficiency.

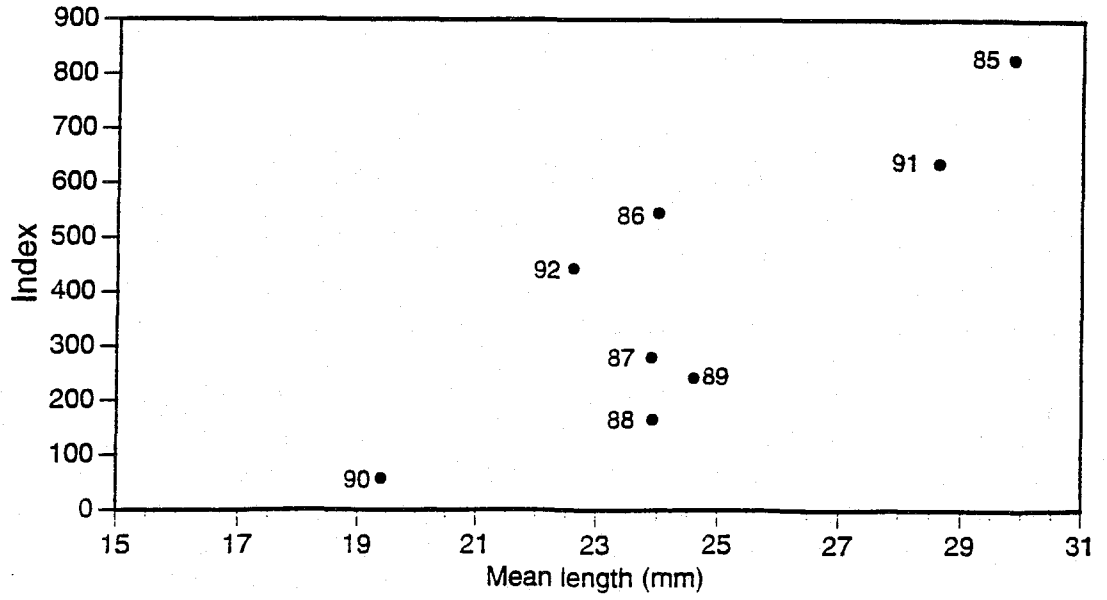

Figure 8. Relationship between calculated 0-group index and mean length of the 0-group saithe 1985-1992 (r^2=0,71).

It is unlikely that very poor yearclasses of saithe would have been recorded in so high abundance as in the 1985-and 1986-surveys relative to the subsequent yearclasses, especially since the yearclasses 1988-1990 are abundant in both the acoustic survey and the fishery. Thus, there is some evidence that the yearclasses 1985 and 1986, possibly also 1987, were considerably reduced from the 0-group stage until they entered the fishery at 2-3 years of age.

In 1987 and 1988 a large number of harp seals (*Phoca groenlandica*) invaded the Norwegian coast, and approximately 80 000 animals were drowned in the gillnet fisheries. Ugland *et al.* (1993) studied the fish consumption by these invading harp seals, and estimated the consumption of saithe of the yearclasses 1985, 1986 and 1987 to be 129, 107, and 24 millions, respectively. Taken this into account, the 1985 and 1986 yearclasses would have been close to the long-term average recruitment of about 300 millions at age 1 (290 and 260 millions, respectively), while the 1987 yearclass would still be a poor one (Ugland *et al.* 1993). There are substantial uncertainties in the different estimates, but it would be a strange coincidence if the discrepancy between the 0-group indices and subsequent abundance on the fishing grounds, and the consumption of harp seals is not to some extent connected.

The 0-group saithe are exposed to predation also by other species. Nothing has been puplished about predation by adult fish on the saithe postlarvae at this time and in this area, but this probably also occurs. However, seabirds are preying on saithe postlarvae. Barrett (1991) showed that 0-group saithe was the most important prey for shags (*Phalacrocorax aristotelis* L.) in the Lofoten area in summer 1985 and 1986. The shags preyed upon both 0- and 1-

group saithe (Figure 9). No quantitative analysis was done, but contrary to the harp seal, the preying upon saithe by shags is likely to take place every year.

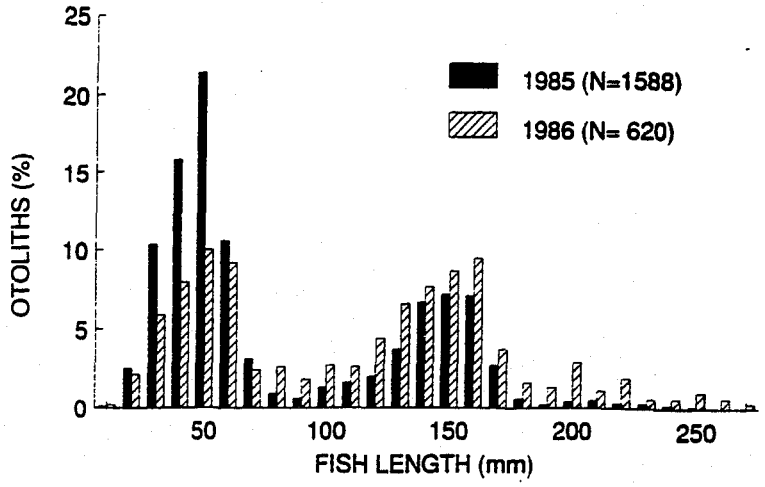

Figure 9. Length frequency distribution (calculated from otolith lengths) of saithe eaten by shags in July 1985 and 1986 (after Barrett 1991).

It has been difficult to find any connection between the different distributions of 0-group saithe in 1985-1987 (1988) and 1989-1992, and the relative high indices measured in the former period. Although we can not see that the 1985-1987 yearclasses later have shown up in the North Sea, one should keep in mind that there may be a different drift of eggs and larvae from the spawning sites (which also may contribute different to the yearclass strength from year to year) to either the stock north of 62°N or the North Sea stock. Jakobsen (1981) showed from tagging experiments that there is a substantial southward migration of 2-3 year old saithe to the North Sea from the nursery area between 62°N and 66°N, but we don't know whether or how this southward migration is linked to a northward drift of the same yearclass as larvae.

Some concluding remarks

It is likely that a trawl survey for 0-group saithe at this time of the year would give a reliable index of the yearclass at this stage, at least if a trawl that can better sample the near surface layer is used. This may be concluded since the survey up to 1992 managed to find the outer distribution limits of 0-group saithe towards west, north and south, and although some postlarvae had entered inshore areas in some years, the areas with highest 0-group concentrations were well defined.

This paper has shown, however, that the estimated yearclass strength of the saithe at this early stage is unreliable to use as an index or prediction of the strength of the same yearclass two or three years later when entering the fishery. It is believed that this is due to variable, and so far unpredictive mortality during the first year(s).

Trough this 0-group saithe survey we have got more knowledge, not only about the saithe at this postlarval stage, but also about other fish species that were caught (e.g., herring, catfish, haddock etc.). However, since the survey failed to fill the main purpose, i.e., to forecast the strength of the saithe yearclass when entering the fishery, these investigations were stopped

in 1992. They will probably not be continued until a final evaluation after the latest yearclass, i.e. the 1992 yearclass, has fully recruited to the fishery so that the whole time series of the 0-group survey could be compared with the acoustic survey and the back-calculations by VPA. In meantime the efficiency of the samling gear will be tried improved, and the methodology further developed to take into account differences in the vertical distribution of the saithe postlarvae.

REFERENCES

ANON. 1994. Report of Arctic Fisheries Working Group. Copenhagen, 24 August - 2 September 1993. *ICES CM 1994/*Assess:2, 253 pp.

BARRETT, R.T. 1991. Shags (Phalocrocorax aristotelis L.) as potential samplers of juvenile saithe (Pollachius virens (L.)) stocks in northern Norway. *Sarsia 76*: 153-156.

BJØRKE, H. 1984. Distribution of eggs and larvae of gadoid fishes from Stad to Lofoten during April 1976-1983. Pp. 365-394 in Dahl, E. Danielsen, D.S. Moksness, E. and Solemdal, P. (eds.): *The Propagation of Cod, Gadus morhua L., Fløddevigen rapportser., Part 1.* Institute of Marine Research, Biological station Fløddevigen, Arendal, Norway.

BJØRKE, H. and **BAKKEPLASS, K.** 1991. Vertikalfordeling av fiskeyngel utenfor Nord-Norge i juni-august. *Havforskningsinstituttet Egg- og Larveprogram (HELP),* No. 40, 24 pp. (In Norwegian)

DAMAS 1909. Contribution a la biologie des gadides. *Rapp. P.-v. Reun. Cons. perm. int. Explor. Mer, 10* (3), 277 pp.

DRAGESUND, O. and **HOGNESTAD, P.T.** 1966. Forekomst av egg og yngel av fisk i vest- og nordnorske kyst- og bankfarvann våren 1965. *Fiskets Gang, 52*: 467-472. (In Norwegian)

GODØ, O.R. and **VALDEMARSEN, J.W.** 1993. A three level pelagic trawl for near surface sampling of juvenile fish. *ICES CM 1993/*B:19, 10 pp.

GODØ, O.R., VALDEMARSEN, J.W. and **ENGÅS, A.** 1993. Coparison of efficiency of standard and experimental juvenile gadoid sampling trawls. *ICES mar.Sci. symp., 196*, 196-201.

HYLEN, A., KORSBREKKE, K., NAKKEN, O. and **ONA, E.** 1995. Comparison of the capture efficiency of 0-group fish in pelagic trawls. Pp. 145-156 in Hylen, A. (ed): *Precision and relevance of pre-recruit studies for fishery management related to fish stocks in the Barents Sea. Proceedings of the sixth IMR-PINRO symposium. Bergen, 14-17 June 1994.* Institute of Marine Research, Bergen, Norway.

JAKOBSEN, T. 1981. Preliminary results of saithe tagging experiments on the Norwegian coast 1975-1977. *ICES CM 1981/*G:35, 25 pp.

NEDREAAS, K. 1986. Abundance and distributon of postlarvae in the 0-group saithe survey in the north-east Arctic in 1985. *NAFO SCR Doc. 86/117*, Ser.no. N1244, 24 pp.

NEDREAAS, K. and **SMEDSTAD, O.M.** 1987. 0-group saithe and herring of Norwegian coast in 1986 and 1987. *Havforskningsinstituttets Egg- og Larveprogram (HELP),*(9): 27 pp.

UGLAND, K.I., JØDESTØL, K.A., ASPHOLM, P.E., KRØYER, A.B. and **JAKOBSEN, T.** 1993. Fish consumption by invading harp seals off Norwegian coast in 1987 and 1988. *ICES J. mar.Sci., 50*: 27-38.

WIBORG, K.F. 1960. Investigations on eggs and larvae of commercial fishes in Norwegian coastal and offshore waters in 1957-58. *FiskDir. Skr. Ser. Havunders., 12*(7): 1-27.