# PRE-RECRUIT STUDIES OF THE NORTH-EAST ARCTIC GREENLAND HALIBUT STOCK

by

A. Hylen and K. H. Nedreaas

Institute of Marine Research
P.O.Box 1870, 5024 Bergen, Norway

## ABSTRACT

Abundance indices of 0-group Greenland halibut (*Reinhardtius hippoglossoides*) from the international 0-group surveys in the Barents Sea showed a sudden decrease from 1987 to 1988 to a low level which has remained for the last 5-6 years. The strength of these weak year-classes has been confirmed in later youngfish surveys, and this has caused strong regulations of the fishery at a time when the fishery itself was good. The drop in recruitment is discussed and related to a reduction of the spawning stock.

## INTRODUCTION

Already in 1989, ICES Advisory Committee on Fishery Management (ACFM) stated that the Greenland halibut stock in ICES Sub-areas I and II appeared to be small compared to historic levels, and that a strategy for rebuilding the stock should be adopted (ANON. 1990). This was mainly based on an observed increase in effort coupled with a decrease in catch-per-unit-effort (CPUE), indications of a shift in effort towards younger fish, and very low 0-group indices in 1988 and 1989 (ANON. 1989). In 1991 the Norwegian-Russian Fishery Commission decided to put strong regulations on the fishery in 1992, at a time when the landings were increasing, and the regulations therefore had a great sudden impact on the fishery. It thus became important to increase the research in order to confirm or invalidate the announced recruitment failure. This paper shows the results from the 0-group survey and youngfish surveys, how this early indication of recruitment failure in the 0-group survey has been confirmed in later surveys as 1-year olds and older. In order to enforce necessary regulations in time, this paper also stress the importance of different and independent pre-recruit studies in order to cross-check the results before advices are given.

## MATERIALS AND METHODS

The international 0-group survey has been conducted in the Barents Sea and Svalbard areas in August-September every year since 1965. The survey design has however improved since

Hylen, A. editor 1995. Proceedings of the sixth IMR-PINRO symposium, Bergen, 14-17 June 1994. Institute of Marine Research, Bergen, Norway. ISBN 82-7461-039-3.

then, but the same design has more or less been used since 1979 (e.g., ANON. 1994). Figure 1 shows, as an example, the pelagic trawl stations taken during the survey in 1987 and 1992.

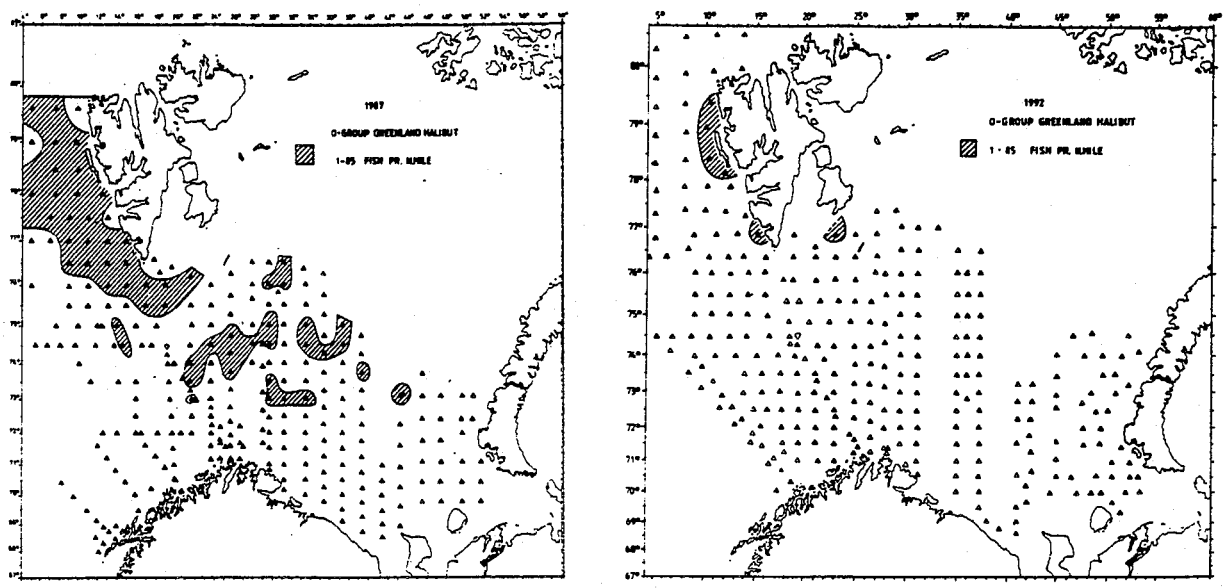


Figure 1. Distribution of 0-group Greenland halibut in August-September 1987 (left) and 1992 (right).

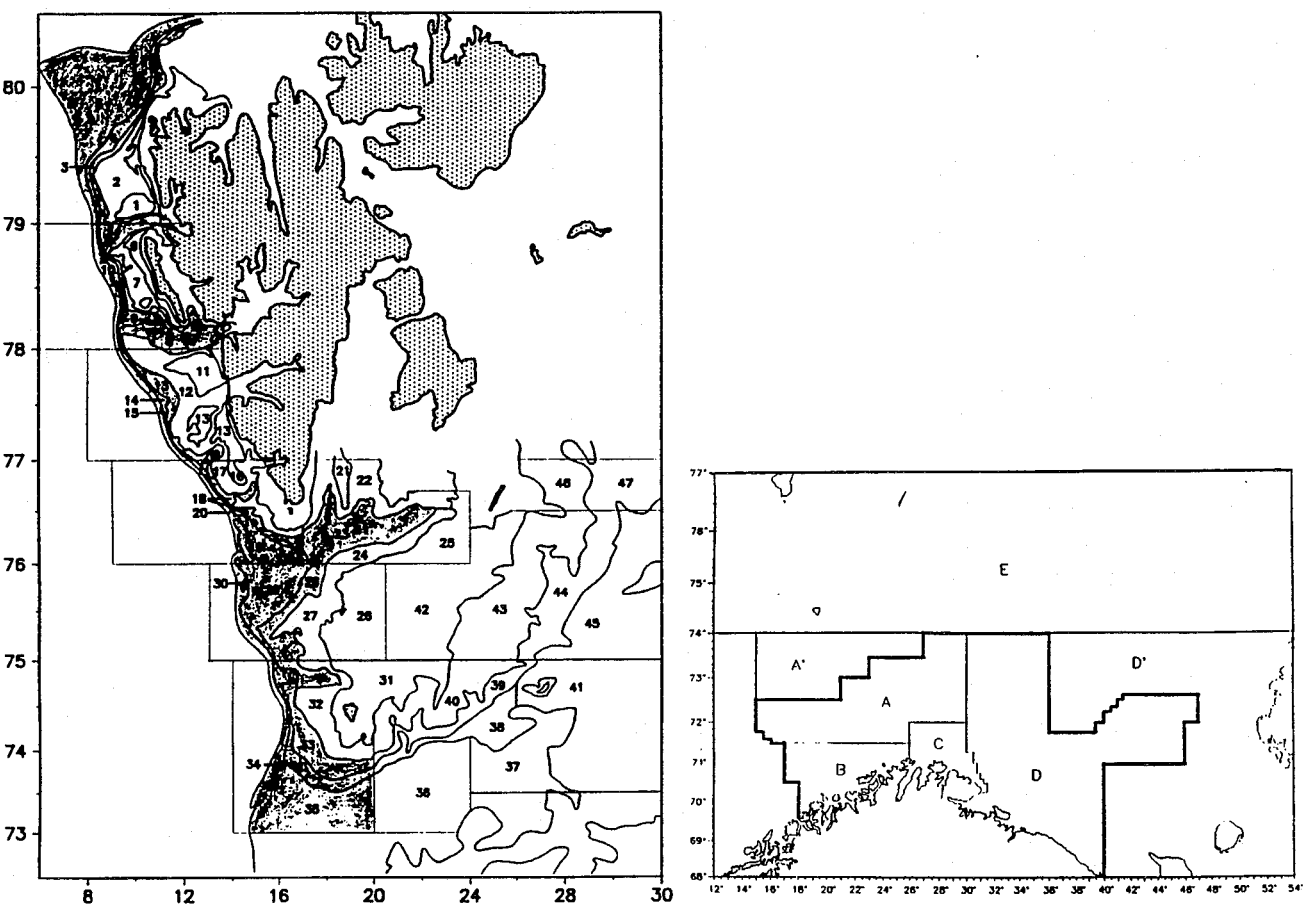


Figure 2. The areas surveyed during the Norwegian bottom trawl surveys at Svalbard (left) and in the Barents Sea (right). The area surveyed during the shrimp survey at Svalbard has been hatched (i.e. only strata deeper than 200 meters).

In the Svalbard area, a Norwegian stratified bottom trawl survey, mainly designed for cod, has been conducted in September every year since 1981. This survey covers depths from less than 100 meters to maximum 550 meters (Figure 2). Data on Greenland halibut are available on length for the time period 1984-1993, and on age for the years 1989-1993. In this study an attempt was made to use a procedure described by e.g., MACDONALD and PITCHER (1979), to split the 1988 length-distribution into age groups having information about mean length-at-age and corresponding standard deviation.

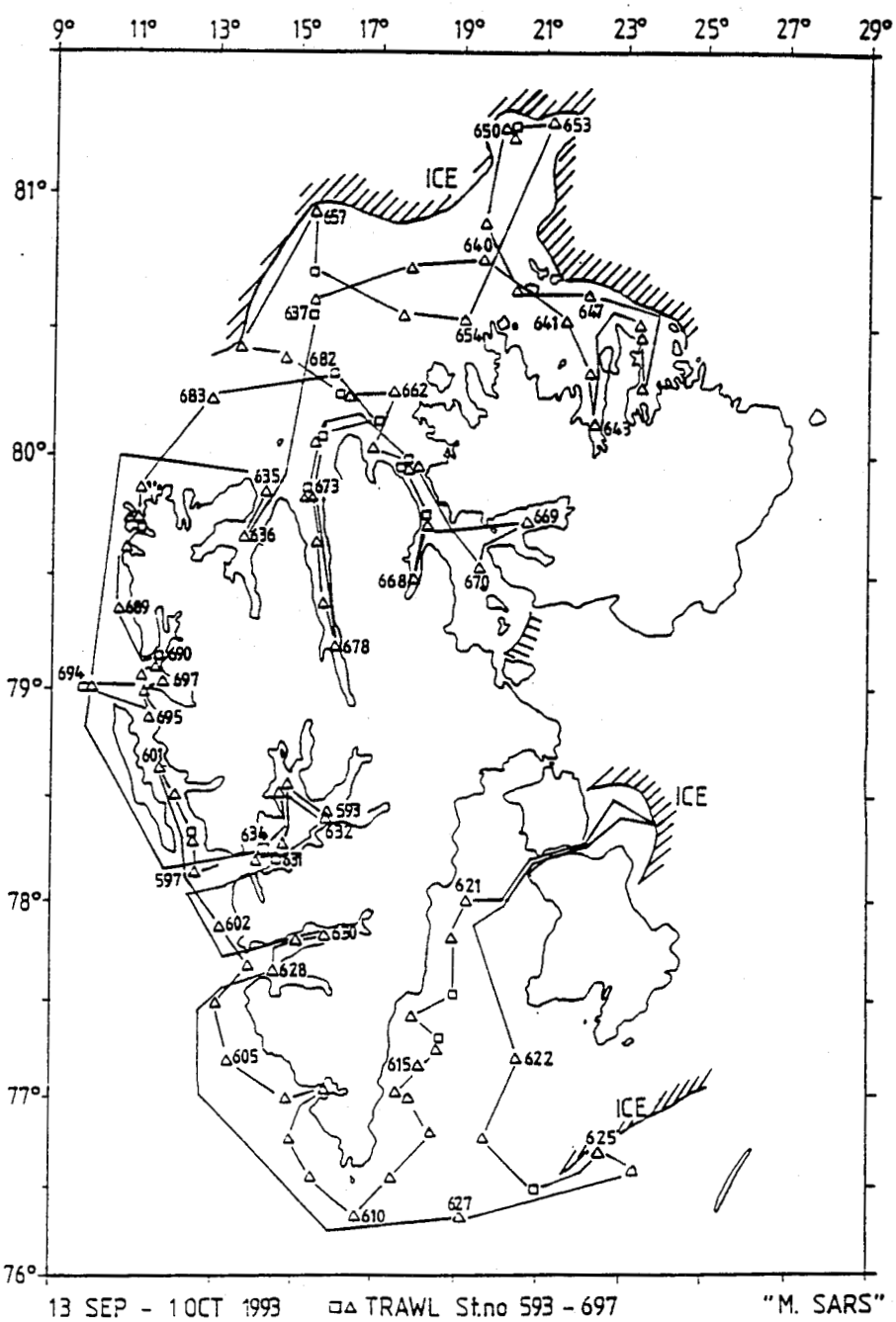


Figure 3. Area surveyed during the trawl survey around Spitsbergen 13 September - 1 October 1993. Squares = bottom trawl stations, triangels = pelagic trawl stations using the standard 0-group sampling trawl (capelin trawl with 8 mm stretced meshes in cod-end).

In the Svalbard area, a trawl survey for shrimp has been conducted in July-August up to 1992 and in June 1993. This survey uses the same stratification as the cod survey, but covers only the area deeper than 200 meters, but down to a maximum depth that usually exceeds that in the cod survey (Figure 2). Reliable age distribution of Greenland halibut in this survey exists for the years 1989-1993. In addition, the 1988 length-distribution was splitted into age groups according to the method described above.

Sporadic trawling in the fjords of Spitsbergen and northeast and east of the island have shown occurrence of juvenile Greenland halibut. In September 1993 a trawl survey, including both pelagic and bottom trawling, was conducted in these areas to improve the coverage of mainly 0-2-group Greenland halibut (Figure 3). Most of the pelagic trawling was conducted from the surface and down to approx. 50 meters, but some pelagic trawling were also carried out deeper than 50 meters.

In the Barents Sea, a Norwegian stratified bottom trawl survey, mainly designed for cod and haddock, has been conducted in February every year since 1981 (Figure 2). In 1992 and 1993 the survey was enlarged to cover a bigger area than before, but in order to analyse a time series, survey indices for the area ABCD are presented.

## RESULTS AND DISCUSSION

Figure 1 shows distributions of 0-group Greenland halibut representative for the years prior to the decrease in 1988, and for the years after. After the 0-group collapse, almost none 0-group have been found inside the Barents Sea, and only few individuals off Spitsbergen. 0-group indices are given in Table 1. Although the 0-group survey do not cover the entire area of the 0-group Greenland halibut distribution, no information exist though that can put doubt on the reliability of the low indices in 1988-1993 compared to the years before.

Table 1. Abundance indices of 0-group Greenland halibut in the Barents Sea and Svalbard areas in 1979-1993.

| Year | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|
| Index | 22 | 12 | 38 | 17 | 16 | 40 | 36 | 55 | 41 |

| Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|
| Index | 8 | 5 | 2 | 1 | 3 | 11 |

The survey in the fjords and northeast and east of Spitsbergen in 1993, which was conducted to enlarge the more or less standard areas of investigation, was to some extent hampered by ice between Edge Island and the Northeastland. However, only minor catches of 0-2 group were made, and then mainly north and northeast of Spitsbergen. Unfortunately, no time series exists for making comparisons. The survey showed that no 0-group Greenland halibut at that time, i.e., September, had settled on the bottom. But although some pelagic trawling which was conducted at greater depths during this survey did not catch any Greenland halibut, this can't exclude the possibility of 0-group Greenland halibut living in deeper pelagic layers outside the the reach of a standard 0-group haul down to 50-60 meters during the international 0-group survey.

Table 2. Greenland halibut. Abundance indices on age from the Norwegian bottom trawl survey at Svalbard for cod (ICES Division IIb), September 1988-1993.

| Year | Age | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| 1988[1)] | 1276 | 5283 | 1588 | 9888 | 18012 | 3775 (6+) | | | | 39822 |
| 1989 | 712 | 3232 | 8158 | 7493 | 7069 | 2374 | 1753 | 353 | 744 | 31888 |
| 1990 | 115 | 336 | 5050 | 7130 | 7730 | 4490 | 2330 | 918 | 544 | 28643 |
| 1991 | 71 | 877 | 3080 | 6720 | 9270 | 5450 | 2800 | 1660 | 524 | 30452 |
| 1992 | 33 | 30 | 338 | 1190 | 3520 | 4420 | 2280 | 1280 | 474 | 13565 |
| 1993 | 25 | 60 | 51 | 1049 | 2369 | 2056 | 2772 | 1114 | 665 | 10161 |

[1)] The length distribution splitted on age according to Macdonald and Pitcher (1979).

Tables 2 and 3 present the results from the cod survey at Svalbard, which show a decrease of Greenland halibut from the 1988-yearclass and onwards. The decrease is however most pronounced for the 1989- and later yearclasses. The results from the shrimp survey at Svalbard (Table 4) are very similar.

Table 3. Greenland halibut. Abundance indicies on length from the Norwegian bottom trawl surveys at Svalbard of cod (ICES Division IIb) 1984-1993 (number in thousands).

| Year | Length group (cm) | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60+ | |
| 1984 | 1179 | 1834 | 1175 | 1925 | 3654 | 5912 | 6733 | 5309 | 3952 | 2140 | 2630 | 36443 |
| 1985 | 867 | 708 | 1679 | 1787 | 3598 | 6114 | 9234 | 7201 | 4431 | 1880 | 1934 | 39433 |
| 1986 | 59 | 59 | 506 | 1071 | 2453 | 2940 | 4790 | 3524 | 1830 | 915 | 1304 | 19451 |
| 1987 | 463 | 333 | 370 | 1110 | 2904 | 4311 | 4162 | 2738 | 1184 | 499 | 259 | 18333 |
| 1988 | 797 | 1642 | 3424 | 2435 | 4922 | 8202 | 7910 | 5846 | 2792 | 1203 | 648 | 39821 |
| 1989 | 357 | 1014 | 3090 | 3702 | 5808 | 5799 | 5649 | 3567 | 1986 | 489 | 427 | 31888 |
| 1990 | 115 | 267 | 428 | 1806 | 4359 | 5218 | 6516 | 4637 | 3078 | 1291 | 917 | 28643 |
| 1991 | 71 | 45 | 711 | 1447 | 2901 | 5957 | 8006 | 5260 | 3440 | 1823 | 791 | 30452 |
| 1992 | 29 | 10 | 11 | 60 | 342 | 863 | 3209 | 4400 | 3063 | 855 | 723 | 13565 |
| 1993 | 8 | 68 | 23 | 38 | 25 | 833 | 2106 | 2732 | 2549 | 1114 | 665 | 10161 |

Table 4. Greenland halibut. Abundance indices on age from the Norwegian trawl survey for shrimp at Svalbard. July-August 1988-1992 (number in thousands).

| Year | Age | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ | |
| 1988[1)] | 4163 | 14278 | 8259 | 8354 | 2594 | 6+144 | | | | 37792 |
| 1989[2)] | 4653 | 9777 | 9943 | 4855 | 4057 | 1054 | 542 | 83 | 372 | 35336 |
| 1990 | 247 | 1569 | 8324 | 9800 | 6910 | 2148 | 295 | 245 | 175 | 29713 |
| 1991 | 25 | 577 | 2465 | 4969 | 5362 | 2541 | 1380 | 158 | 278 | 17755 |
| 1992 | 95 | 57 | 505 | 1780 | 2914 | 1129 | 713 | 333 | 200 | 7726 |
| 1993[3)] | 39 | 54 | 50 | 814 | 1572 | 433 | 589 | 395 | 512 | 4458 |

[1)] The length distribution was splitted on age according to Macdonald and Picher (1979).

[2)] An age-length key from the bottom trawl survey for cod at Svalbard in September 1989 was used to convert the indices from length to age.

[3)] An age-length key from the bottom trawl survey for cod at Svalbard in September 1993 was used to convert the indices from length to age.

The results from the Barents Sea winter survey also show a clear decrease in the abundance of small Greenland halibut (Table 5). Also from this survey some uncertainty can be put on the strength of the 1988-yearclass, which do not seem to be as weak as the more recent ones. By including the enlarged area in winter 1994, no Greenland halibut less than 30 cm were, however, added to the index.

Table 5. Greenland halibut. Abundance indicies on length from the Norwegian bottom trawl surveys in the Barents Sea area ABCD) winter 1988-1994 (number in thousands).

| Year | Length group (cm) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80+ | Total |
| 1988 | 141 | 426 | 226 | 258 | 810 | 1858 | 2997 | 1800 | 869 | 402 | 203 | 166 | 201 | 58 | 104 | 10518 |
| 1989 | 457 | 508 | 647 | 478 | 786 | 1680 | 3890 | 2856 | 1287 | 610 | 149 | 19 | 75 | 0 | 55 | 13493 |
| 1990 | 21 | 199 | 777 | 785 | 1205 | 1657 | 1829 | 2043 | 1349 | 479 | 159 | 160 | 40 | 82 | 0 | 10800 |
| 1991 | 0 | 42 | 262 | 618 | 655 | 868 | 954 | 1320 | 1875 | 1577 | 847 | 165 | 34 | 51 | 0 | 9270 |
| 1992 | 14 | 35 | 64 | 149 | 509 | 843 | 1096 | 1072 | 1029 | 827 | 633 | 108 | 31 | 27 | 26 | 6500 |
| 1993 | 0 | 0 | 17 | 67 | 117 | 484 | 1415 | 1255 | 1418 | 846 | 589 | 358 | 89 | 31 | 34 | 6720 |
| 1994 | 0 | 0 | 16 | 99 | 118 | 957 | 1631 | 2379 | 1473 | 800 | 307 | 264 | 25 | 0 | 0 | 8069 |

Figure 4 shows the geographical distribution of Greenland halibut during the Svalbard cod survey in 1992 and the Barents Sea winter survey in 1994.

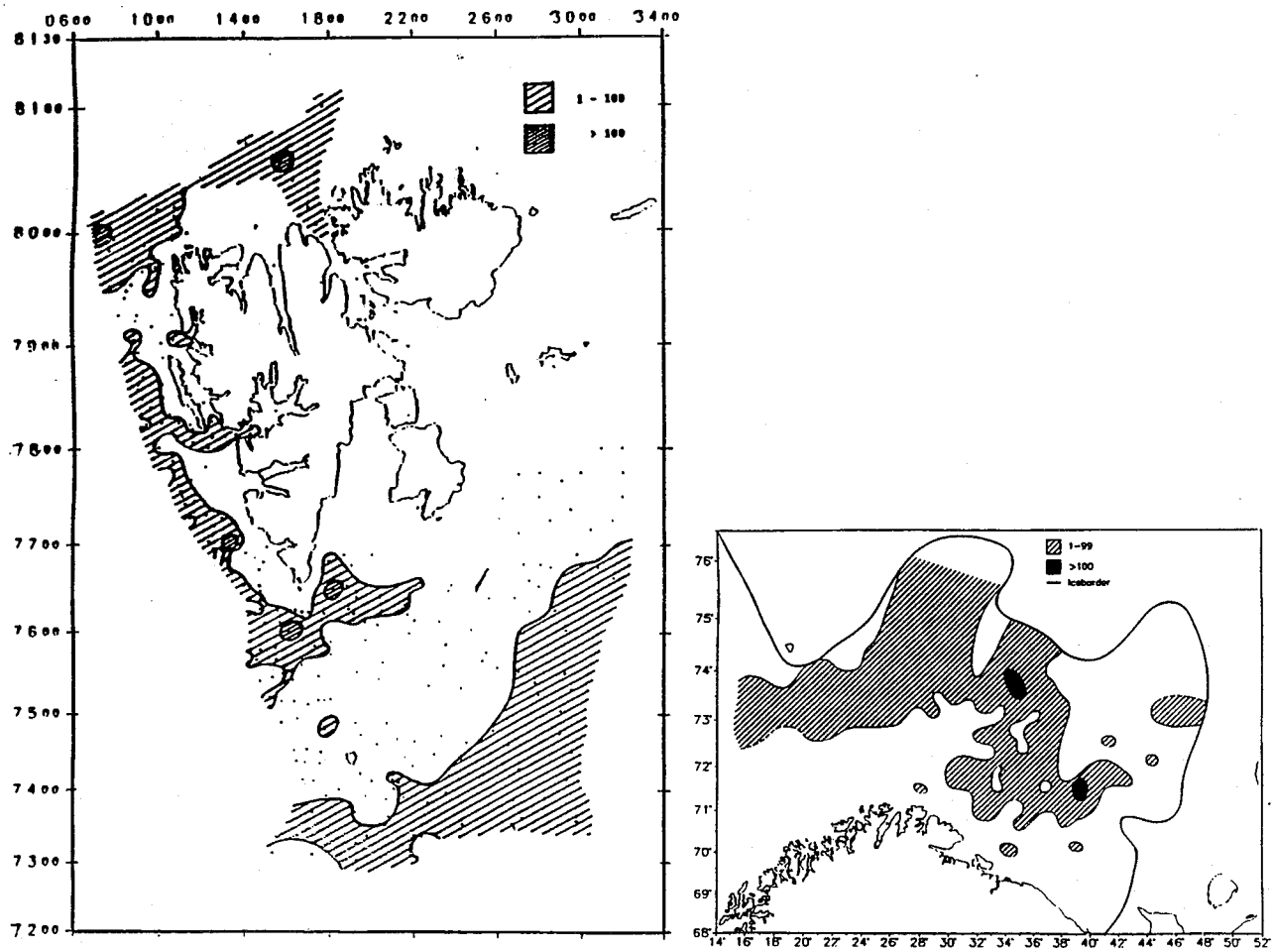


Figure 4. Distribution of Greenland halibut (all sizes) during the bottom trawl survey for cod at Svalbard in September 1992 (left), and in the Barents Sea in February 1994 (right).

Regression analyses of different survey indices (e.g., for different age groups) versus indices for other age groups from the same survey, or versus the same age group in other surveys, or versus VPA, showed that the 2-group survey indices produced the best linear fit. This probably has to do with the migration of Greenland halibut from shallow to deeper waters as it grows combined with the different area coverage of the surveys. In Figure 5 some of these analyses are shown.

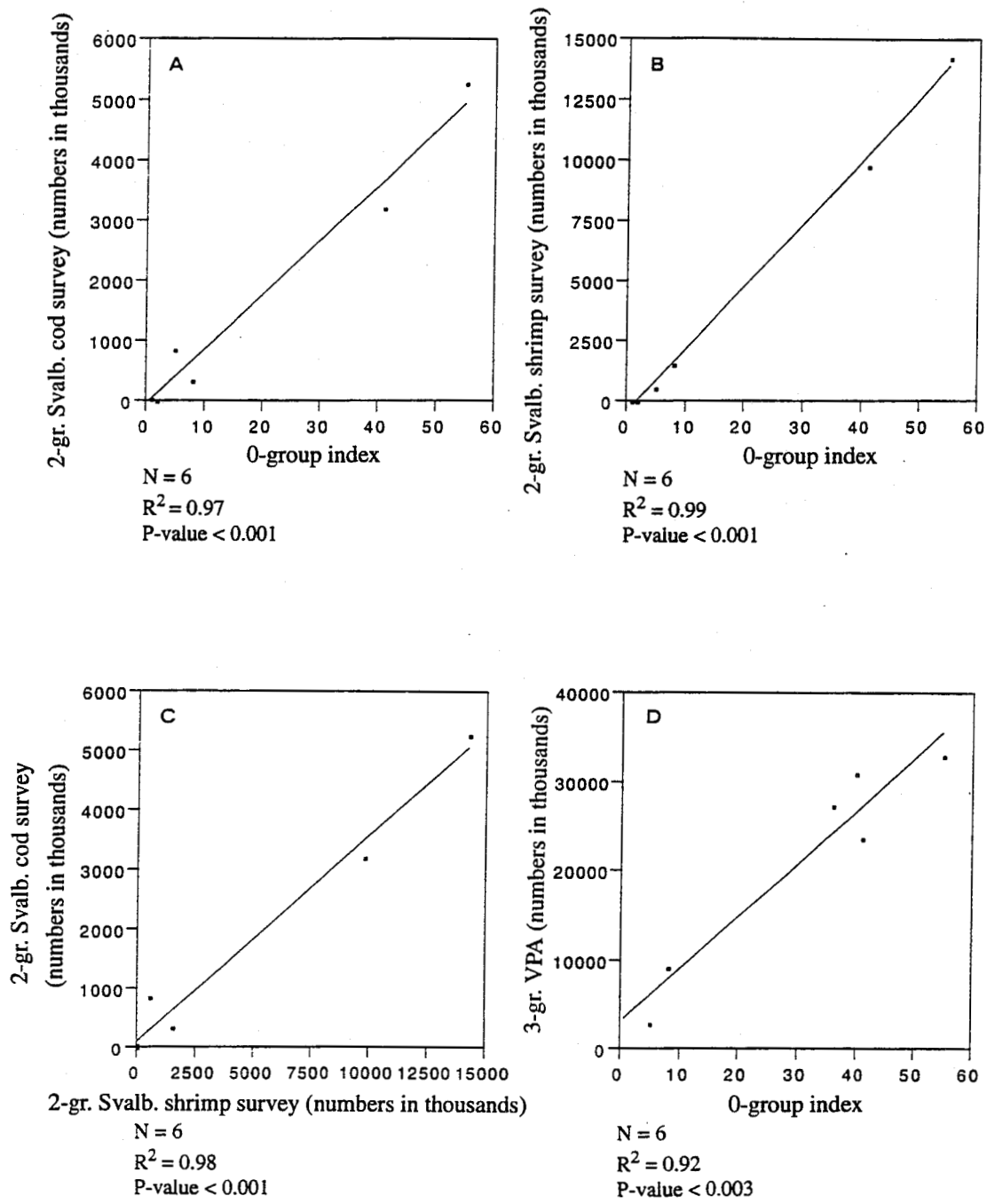


Figure 5. Results from the regression analyses of the Greenland halibut year-class indices at the 0-group stage versus the same year-classes measured at the 2-group stage during the trawl surveys for cod and shrimp at Svalbard (A,B), and versus the number of the year-class at age 3 as measured by the VPA (D). The 2-group indices from the cod and shrimp surveys are also compared versus each other (C). A short regression summary is shown in each case.

Russia has since 1990 conducted a stratified trawl survey to assess the Greenland halibut stock (SMIRNOV *et al.* 1993). In 1992 this survey showed a decrease of Greenland halibut smaller than 36 cm, which is in agreement with the results from the Norwegian research surveys. This is further discussed in a paper by SMIRNOV (1995).

The assessments of the Greenland halibut stock did for many years show a stable recruitment of 3-year-olds despite an estimated decrease of the spawning stock (Figure 6). Although the assessments may not have succeeded in estimating the spawning stock accurately, this will only move the curve in Figure 6 left-right. We don't have any answer to the recruitment's independance of spawning stock size above a certain level of the spawning stock, but a lower critical level of the spawning stock size seems to have been passed. We also notice an increase in both recruitment and spawning stock just before the collapse, this probably accounting for satisfactory recruitment to the fishery at the same time when strong regulations were enforced.

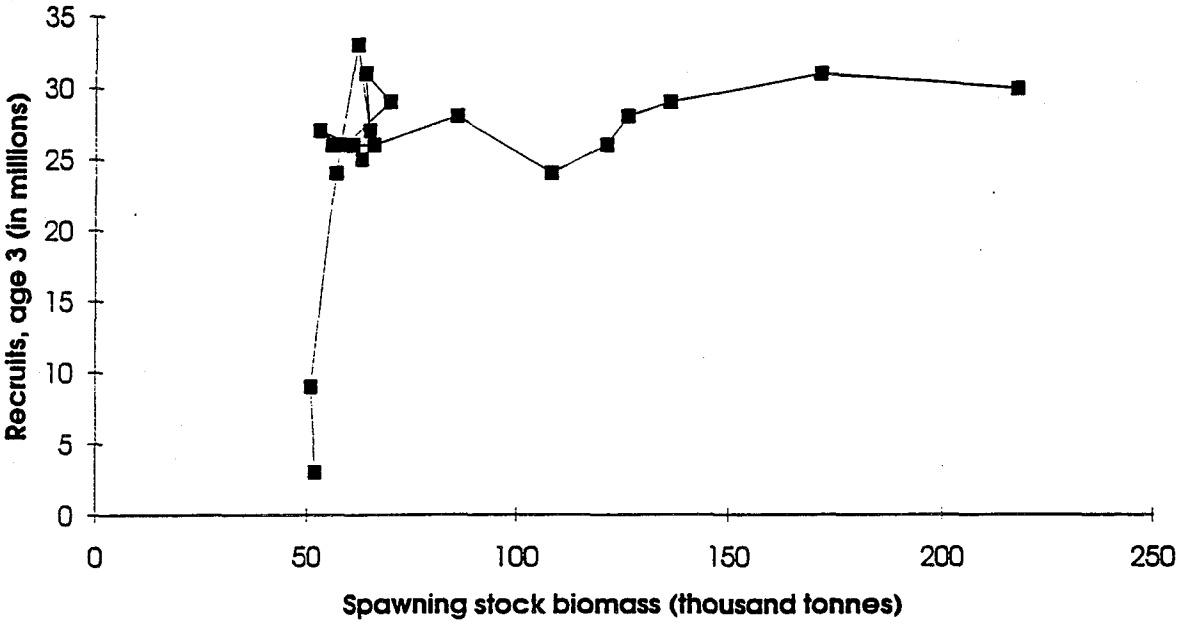


Figure 6. Greenland halibut. Spawning stock biomass vs. recruitment at age 3 as estimated by VPA during the Arctic Fisheries Working Group in Copenhagen in August-September 1994 (Anon. 1995).

## ACKNOWLEDGEMENT

The authors thank the Norwegian Institute of Fisheries and Aquaculture, Tromsø, for making available the results on Greenland halibut from the Norwegian shrimp surveys at Svalbard in 1992 and 1993.

# REFERENCES

**ANON.** 1989. Preliminary report of the international 0-group survey in the Barents Sea and adjacent waters in August-September 1989. *ICES CM 1989*/G:40, 40 pp.

**ANON.** 1990. Reports of the ICES Advisory Committee on Fishery Management, 1989. *ICES Co-op.Res.Rep. 168* (part I): 361 pp.

**ANON.** 1994. Preliminary report of the international 0-group fish survey in the Barents Sea and adjacent waters in August-September 1993. *ICES CM 1994*/G:3. 38 pp.

**ANON.** 1995. Report of the Arctic Fisheries Working Group. Copenhagen, 23 August- 1 September 1994. *ICES CM 1995*/Assess: 3, 252 pp.

**MACDONALD, P.D.M.** and **PITCHER, T.J.** 1979. Age-groups from size-frequency data: a versatile and efficient method of analyzing distribution mixtures. *J.Fish.Res.BoardCan. 36*: 987-1001.

**SMIRNOV, O.V.** 1995. Dynamics of Greenland halibut recruitment to the Norwegian-Barents Sea stock from the 1984-1993 trawl survey data. Pp. xx-xx in Hylen, A. (ed.): *Precision and relevance of pre-recruit studies for fishery management related to fish stocks in the Baretns Sea and adjacent waters. Proceedings of the Russian-Norwegian symposium. Bergen, 14-17 June 1994.* Institute of Marine Research, Bergen, Norway.

**SMIRNOV, O.V., LEPESEVICH, YU.M.** and **SHEVELEV, M.S.** 1994. Results of Russian investigations for Greenland halibut from the Norwegian/Barents Sea stock in 1993. *ICES CM 1994*/G: 31, 12 pp.