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Greenland Halibut Deepwater Fishery in Divisions 3L and 3N: an Analysis of Catch Rate Trends from Portuguese Trawlers, 1988-1995

by

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Abstract

From the observed catch rates of monitored Portuguese trawlers two cpue series are derived for Greenland halibut deepwater fishery in the NAFO Regulatory Area. Both series start in 1988, prior to the large scale fishery beginning in 1990, one corresponding to the effective mesh size in use till April 1995, assumed to be smaller than 130 mm due to the overall cod oriented strategy of the trawl fleet, and the other corresponding to the catch rates expected with a 130 mm mesh size in the codend. Within each division either series presents the same pattern over time, with the exception for 1994 in Division 3N, due to the starting of the 1990 year class recruitment. In Division 3L observed and estimated cpue's were still declining in 1995 together with a steady decrease of the proportion in weight of fish larger than 40 cm in the catch. On the contrary in Division 3N both cpue series don't present a obvious trend and the sudden drop in 1994 of the proportion of larger fish reflects basically the abundance and availability of small Greenland halibut at the time. In 1992 in Division 3N and in 1993 in Division 3L isolated increases in cpue's are observed, probably related with a simultaneous shift in the distribution of the 1988 and 1989 cohorts towards depths greater than 700 m in the NAFO Regulatory Area.

Introduction

During the late eighties and early nineties the Portuguese trawlers operating in Northwest Atlantic prosecuted an opportunistic fishery directed to species and/or areas providing the highest catch rates in a given season. Cod and redfish were the major target species mainly fished on the nose of the Grand Bank and on Flemish Cap. However that didn't prevent that attractive concentrations of Greenland halibut were first detected in the NAFO Regulatory Area by a Portuguese trawler from June to August 1988. Those concentrations were located on the northwest slopes of the "Sackville Spur", a fishing ground on the extreme north of Flemish Pass, at depths between 700 m and 900 m . The fishery rapidly expanded in 1989 in Division 3L, representing 39% of the overall observed effort from the trawlers monitored by the Portuguese Sampling Programme (Ávila de Melo *et al.*, 1993). By 1990, just when the Greenland halibut fishery had its boom in the deep water in the Regulatory Area, carried out by Spanish "ex - Namibian" large freezers, Portuguese trawlers were stuck again to their traditional targets and this scenario didn't change in 1991. In 1992, with small quotas in the Grand Bank rapidly fished for cod and American plaice, directed effort to Greenland halibut raised again to the 1989 level but this time concentrated southwards in Division 3N. The fishery was kept mainly in the south for the next couple years but at lower level between 15% and 20% of the overall observed trawl effort. It was only in 1995, with the collapse of the 3M cod fishery and the maintenance of the closures on the Grand Bank cod and flatfish fisheries, that Greenland halibut was the most important fishery for Portuguese trawlers (56% of the observed effort) this time again concentrated in the Flemish Pass original grounds (Godinho *et al.*, 1996).

Despite its ups and downs the catch rates from the Portuguese trawlers are the longest series available for this deep water Greenland halibut fishery in the NAFO Regulatory Area, starting when the Canadian gillnet inshore and offshore fisheries in Divisions 3K and 3L were declining (Myers and Bowering, 1995) and before the beginning of the Spain fishery. Moreover it is obtained from depths not covered by the autumn groundfish surveys in Division 3L, the longest time series available for the division were most of this new deepwater fishery has been taken place (Bowering *et al.*, 1995). The purpose of the present work is to calculate a series of standardized cpue's from the observed monthly catch rates of Portuguese trawlers for each division 3L and 3N, and a combined one for the whole Grand Bank deep water grounds.

However Greenland halibut has been a second rank species for Portuguese trawlers and this should have implied that the same mesh size in the codend, smaller than 130 mm (see Ávila de Melo and Alpoim, 1996), would have also been in practice in this fishery till April 1995. In order to overcome the problem of changing the fishing pattern at the final year of the time interval a second cpue series has been derived from the observed one, corresponding to catches that one would expect to occurred if a 130 mm mesh size had been effective.

Material and methods

Observed catch and effort data from eleven Portuguese trawlers fishing in NAFO Regulatory Area during the 1988 - 1995 period were reviewed on a haul by haul basis. With the exception of one side trawler, all the other ten vessels were OTB2 stern trawlers from the early seventies with quite similar fishing efficiency The daily catch and effort data from each of these trawlers were used to estimate the direct effort to Greenland halibut by division and associated catch on a monthly basis. The catch rates available for each division/month/year were then averaged using the number of fishing days as a weighting factor. The observed monthly cpue's so obtained for the 1988/95 period were then standardized by an additive model already fully described in a previous paper (Ávila de Melo and Alpoim, 1995) in order to built annual series of observed 3L, 3N and 3LN Greenland halibut cpue's, corrected for the month of each observation for each division series and for the month and division of each observation for the two divisions lumped together.

Portuguese Greenland halibut trawl catches were sampled on board every year on the months corresponding to the peaks of the fishery in either divisions. The Greenland halibut length frequencies of the trawl catches from either divisions were presented annually in the Portuguese Research Reports covering the study period, and are representative of the total round weight catch taken, *i.e.* including any eventual discards. Mean weights at length were given by the length weight relationship from Bowering and Standsbury (1984).

As regards the real mesh size of the codend in use till April 1995 we decided to consider that the Greenland halibut 3LN trawl catches were taken with an effective mesh size of 65 mm, for the reasons explained in a similar work dealing with the 3M cod Portuguese trawl fishery (Ávila de Melo and Alpoim, 1996). These reasons were basically related with the fact that, regardless the division., cod was the main target of the Portuguese trawl fleet till 1995.

In order to derive an estimated cpue series for 130 mm covering the whole study interval (i.e. from January 1988 to December 1995) we calculate for each year and division an yield rate to apply to the observed monthly cpue's up to April 1995 (considered to correspond to a 65 mm mesh size). The observed monthly cpue's from May to December 1995 (corresponding finally to 130 mm mesh size) were then incorporated in to the previous estimated cpue matrix. This new cpue matrix for 130 mm mesh size has finally been standardized using the same model first applied to the observed values.

To calculate the annual yield rates we considered that the selection curves from Greenland halibut in Divisions 3L and 3N could be derived from the logistic equation applied by Halliday and White (1989) to the major fish stocks exploited in the Scotia-Fundy region, including American plaice:

$$S(L) = 1 / (1+ \exp (\alpha \ (1 - L / L50)) \qquad (1)$$

Where $S(L)$ = selection of the Lth length group
$L50$ = Length at which 50% of fish is retained in the codend (= SF x mesh size)

A value for α , the parameter defining the shape of the ogive, of 7 was given by the equation:

$$\alpha = 2 \, Ln \, (3) \, L50 \, / \, r \qquad (2)$$

where the L50 and the selection range (r) were the selectivity parameters for Greenland halibut in the deep sea bottom trawl fishery in NAFO Regulatory Area, calculated for 130 mm mesh size and four hours trawling (Cardenas *et al.*, 1995). Assuming that the correspondent selection factor (SF) of 2.91 remains unchanged for the 65 mm/130 mm mesh size range, as well as the ratio

$$\beta = r \, / \, L50 \qquad (3)$$

both L50 and the selection range can also be derived for the selectivity of 65 mm mesh size codend. The selection at length for both 65 mm and 130 mm can then be calculated for length groups from 21 cm to 99 cm (minimum and maximum recorded in 1988-1995 3L and 3N Greenland halibut length sampling of trawl catches). For each length group within the length range of the catch, a retention rate is finally given by the ratio between the selections for 130 mm and 65 mm, representing at each length the proportion of Greenland halibuts retained in a 65 mm codend that will also be caught if the mesh size doubled. Selectivity parameters, selection at length for 65 mm and 130 mm and 130 mm/65 mm retention rate series are presented in Table 1.

In Tables 2 are calculated the yield rates to be applied to the catch rate observations of each year and division in order to built the estimated 130 mm catch rate matrices. From the observed per mille length frequencies of the annual catches for Divisions 3L and 3N and the 130 mm/65 mm retention rate series, is calculated the corresponding catches in numbers at length if a 130 mm mesh size had been used (the firsts series will totalize a thousand fish and the seconds a somewhat smaller number). Obviously for 1995 the length frequencies considered were representative of the 3L and 3N trawl catches only till April. With mean weights at length given by length weight relationship mentioned above, both those catches in numbers at length are converted in catches in weight at length and summed up. The annual yield rates for Divisions 3L and 3N were then given by the ratios between the respective total catches in weight for 130 mm and 65 mm mesh sizes.

Results and Discussion

From the ageing of the 1994 and 1995 Greenland halibut catches of Portuguese trawlers from Divisions 3L and 3N (Alpoim *et al.*,1994; Ávila de Melo *et al.*, 1995) a 21 cm length Greenland halibut (smallest length group recorded in the catch) is 2 years old, while 38 cm (L50 for 130 mm mesh size) is a length group falling basically in the age four size range. Yield rates for Divisions 3L and 3N would then reflect the importance (quantified in terms of proportion in weight) of larger fish of age four and older against fish from 2 years old onwards in the trawl catch (and, in a certain way, in the deep water concentrations of Greenland Halibut in those divisions).

The annual yield rates, presented for each year and division in each one of Tables 2, are as follows:

Yield rate	1988	1989	1990	1991	1992	1993	1994	1995
3L	0.976*	0.976	0.919	0.859	0.762	0.682	0.609*	0.552
3N			0.874	0.806	0.824	0.888	0.609	0.696

* there was no length sampling for Greenland halibut trawl catches in 1988. Taking into account that this was prior to the beginning of the deepwater fishery in the NAFO Regulatory Area in 1990 we considered that the 3L yield rate for this year was equal to the one calculated for 1989. The same happened in 3L in 1994. Considering that the value calculated for 3N catches was between the 1993 and 1995 3L yield rates we decided to consider it also valid to be applied to the 1994 3L catch rates.

Those values, regarded as conversion factors to estimate cpue's for 130 mm mesh size from the observed values, are put in graphic on Fig. 1. Although at lower levels at the final year than the ones observed at the beginning of each series, yield rates behave differently in each division indicating distinct impacts of this "new" deepwater fishery on the Greenland halibut stock components from the nose and the tail of the Grand Bank. In Division 3L yield rates begin at a level near 1 and so with fish larger than 40 cm representing almost 100% of the trawl catch. Since 1990, when the fishery started with an important concentration of a "newcomer" fleet on Flemish Pass, the yield rates started a steady decline at more or less the same rate from one year to the next, indicating that the proportion in weight of small fish didn't stop to increase till April 1995 . It is important to take notice however that the yield rates for 1995 were derived from length data corresponding only to 1% and 6% of the 3L and 3N Greenland halibut estimated catches for the Portuguese trawl fleet. Due to the effective use of 130 mm mesh size in the codend and to deeper grounds swept last year since May the bulk of those catches showed in fact a different structure towards larger lengths than the ones presented in Table 2 for 1995 (Godinho *et al.*, 1996). As for Division 3N the slightly lower values than the ones for 3L observed in 1990 and 1991 may be a consequence of higher concentration of "young" juveniles on the southern slopes. Yields rates remained stable from 1990 to 1993, however they drop in 1994. This minimum value of the 3N yield rate series, should not be justified by the sudden over exploitation of "older" juveniles but with the beginning of recruitment of the 1990 year class, by far the most abundant cohort at age 3 from the combined abundance indices of Canadian research surveys in Divisions 2J3KL, from 1978-94 (Bowering *et al.*, 1995). The 3N yield rate increase in 1995, following the growth of fish from this year class.

Observed cpue's for Divisions 3L, 3N and combined are presented in Table 3 and the correspondent estimated cpue's for 130 mm mesh size in Table 4. Both series for each division and the combined series are presented in Figures 2 to 4 in ton/hour. All cpue series have also been transformed in relative values to the first year of the time interval and included in the tables, in order to make easy the comparison of the respective trends. The two cpue series within each division show very similar trends with the exception of the 1994 points in Division 3N, due to the above mentioned income in the fishery of the most abundant length groups from the 1990 year class. In Division 3L both series start declining prior to the beginning of the deep water fishery but it is from 1990 to 1991, *i.e* from its first to the second year, that cpue's fell by half. In 1993 a lower peak is observed but cpue's declined again and the observed and "130 mm" estimated value for 1995 are the lowest on record. In Division 3N no trend is apparent on either series, but a pronounced peak occurred in both cpue series for that division in 1992. Those peaks in the cpue's, first observed in Division 3N in 1992 and then in Division 3L in 1993, have one thing in common: they don't reflect a new entry of "small" fish in the catches since in either divisions the peaks have the same order of magnitude in the observed as well in the "130 mm" estimated cpue. Looking back at the length structure of the respective catches (Ávila de Melo *et. al.*, 1993; Alpoim *et.al.*, 1994) they were dominated by Greenland halibuts within 36 cm-56 cm corresponding basically to 5, 4 and 6 years old fish (with predominance of age 5). This occurrence can be related with the trends in the abundance at age given by the Canadian autumn groundfish surveys and the Canadian deepwater surveys during consecutive time periods and at different depths. From the first survey, covering depths till 720 m at the most on Divisions 2J3KL, ages 3 to 5 increased steadily their abundance from the early eighties till 1989 but declined sharply afterwards until 1992 (Anon., 1994). On the contrary the abundance of the same age groups at depths between 750 and 1500 on Divisions 3KLM recorded an important increase from 1991 to 1994 (Morgan *et.al.*, 1994). From the data now presented it can be inferred that this downward movement of Greenland halibut with ages 3 to 5 towards deeper bottoms and its availability to the trawl fishery in the NAFO Regulatory Area was first detected in 1992 on southern part of the distribution of the population and only in 1993 northwards, in Division 3L.

Conclusion

When all catch rate monthly observations are used to calculate the combined cpue series for Div. 3LN both observed and "130 mm" estimated series show the same picture for the 1988-1995 time interval (Tables 3 and 4; Fig. 4): a rapidly declining fishery at its beginning, from 1989 to 1991, has a consequence of a "sudden" concentration of high levels of fishing effort at the time and place where large deep water concentrations of Greenland halibut were found, and resulting on a sharp increase of fishing mortality on 9 years and older age groups (Bowering and Power, 1995) of those concentrations. The fishery recover to an intermediate level in 1992-1993, due to the entry in the deep grounds of the Regulatory Area of Greenland halibut at ages 3 to 5 years old, from the 1987-1989 year classes. However, the abundance indices at age 2 for those cohorts from Canadian research surveys in Divisions 2J and 3K combined were at the average (or bellow) of the survey time series (Bowering *et. al.*, 1995). Since then the overall fishing effort for the deepwater fishery has been kept at a high level till the end of 1994 with fish between ages 4 to 6 (most of them from the 1989 and 1988 cohorts) dominating the trawl catches (Ávila de Melo et. al., 1995). The decline of cpue's observed during the most recent years was the expected consequence of the coincidence of these factors, despite the recruiting to the fishery since 1994 of the abundant 1990 year class.

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Table 1: Greenland halibut, Divisions 3L and 3N. Selection parameters and retention proportions for 130mm against 65mm mesh size.

Mesh size (cm)	6.5	13	
SF ->	2.91	2.91	(Cardenas et al.,1995)
L75-L25 ->	5.923	11.800	(Cardenas et al.,1995)
L50	18.9	37.7	(Cardenas et al.,1995)
L75-L25/L50 ->	0.313	0.313	
ALFA ->	7.0	7.0	

Length group	Selection at length for 65mm	130mm	Retention rate 130mm/65mm
21	0.684	0.043	0.063
23	0.820	0.061	0.074
25	0.905	0.086	0.095
27	0.953	0.120	0.126
29	0.977	0.166	0.170
31	0.989	0.224	0.226
33	0.995	0.295	0.297
35	0.997	0.378	0.379
37	0.999	0.468	0.469
39	0.999	0.561	0.561
41	1.000	0.650	0.650
43	1.000	0.729	0.729
45	1.000	0.796	0.796
47	1.000	0.850	0.850
49	1.000	0.892	0.892
51	1.000	0.923	0.923
53	1.000	0.945	0.945
55	1.000	0.962	0.962
57	1.000	0.973	0.973
59	1.000	0.981	0.981
61	1.000	0.987	0.987
63	1.000	0.991	0.991
65	1.000	0.994	0.994
67	1.000	0.996	0.996
69	1.000	0.997	0.997
71	1.000	0.998	0.998
73	1.000	0.999	0.999
75	1.000	0.999	0.999
77	1.000	0.999	0.999
79	1.000	1.000	1.000
81	1.000	1.000	1.000
83	1.000	1.000	1.000
85	1.000	1.000	1.000
87	1.000	1.000	1.000
89	1.000	1.000	1.000
91	1.000	1.000	1.000
93	1.000	1.000	1.000
95	1.000	1.000	1.000
97	1.000	1.000	1.000
99	1.000	1.000	1.000

Table 2: Greenland halibut, Divisions 3L. Annual yeld rate between a catch weight estimated if 1,000 fish would pass through a 130mm mesh size and the weight of 1,000 fish caught with 65mm mesh size codend

(Length weight relationship from Bowering and Stansbury, 1984)

DIVISION 3L

Year 1989

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
31	0.2	213	0	0.226	0	0
33	0.4	263	0	0.297	0	0
35	0.9	320	0	0.379	0	0
37	2.4	385	1	0.469	1	0
39	4.1	459	2	0.561	2	1
41	10.5	543	6	0.650	7	4
43	22.7	637	14	0.729	17	11
45	36.1	741	27	0.796	29	21
47	45.5	857	39	0.850	39	33
49	49.6	985	49	0.892	44	44
51	63.9	1127	72	0.923	59	66
53	69.2	1281	89	0.945	65	84
55	77.5	1450	112	0.962	75	108
57	77.0	1634	126	0.973	75	122
59	82.9	1834	152	0.981	81	149
61	77.9	2051	160	0.987	77	158
63	70.4	2284	161	0.991	70	159
65	57.7	2536	146	0.994	57	146
67	48.3	2807	136	0.996	48	135
69	40.4	3097	125	0.997	40	125
71	36.5	3408	124	0.998	36	124
73	31.7	3739	118	0.999	32	118
75	24.1	4093	99	0.999	24	99
77	16.4	4470	73	0.999	16	73
79	17.1	4871	83	1.000	17	83
81	12.0	5295	64	1.000	12	64
83	9.9	5746	57	1.000	10	57
85	5.8	6222	36	1.000	6	36
87	3.5	6725	23	1.000	3	23
89	2.0	7257	14	1.000	2	14
91	1.6	7817	12	1.000	2	12
93	1.1	8407	9	1.000	1	9
95	0.5	9027	5	1.000	1	5
97	0.2	9678	2	1.000	0	2
99	0.2	10362	2	1.000	0	2
TOTAL	1000		2139		949	2088
				89	**3L Yield rate**	**0.976**

Table 2 (cont): Greenland halibut, Divisions 3L and 3N. Annual yeld rate for 1990

(Length weight relationship from Bowering and Stansbury, 1984)

DIVISION 3L

Year 1990

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
25	1.1	104	0	0.095	0	0
27	1.1	134	0	0.126	0	0
29	3.4	170	1	0.170	1	0
31	1.7	213	0	0.226	0	0
33	4.5	263	1	0.297	1	0
35	13.1	320	4	0.379	5	2
37	21.6	385	8	0.469	10	4
39	40.9	459	19	0.561	23	11
41	54.5	543	30	0.650	35	19
43	76.1	637	48	0.729	56	35
45	101.7	741	75	0.796	81	60
47	109.1	857	94	0.850	93	79
49	92.0	985	91	0.892	82	81
51	96.0	1127	108	0.923	89	100
53	71.0	1281	91	0.945	67	86
55	73.9	1450	107	0.962	71	103
57	47.2	1634	77	0.973	46	75
59	47.2	1834	87	0.981	46	85
61	31.8	2051	65	0.987	31	64
63	30.7	2284	70	0.991	30	69
65	17.6	2536	45	0.994	18	44
67	13.1	2807	37	0.996	13	37
69	14.2	3097	44	0.997	14	44
71	5.7	3408	19	0.998	6	19
73	3.4	3739	13	0.999	3	13
75	8.5	4093	35	0.999	9	35
77	6.3	4470	28	0.999	6	28
79	4.0	4871	19	1.000	4	19
81	2.8	5295	15	1.000	3	15
83	0.6	5746	3	1.000	1	3
85	2.3	6222	14	1.000	2	14
87	1.1	6725	8	1.000	1	8
89	0.6	7257	4	1.000	1	4
91	0.6	7817	4	1.000	1	4
93	0.6	8407	5	1.000	1	5
TOTAL	1000		1270		849	1167
				90	3L Yield rate	0.919

DIVISION 3N

Year 1990

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
31	7.1	213	2	0.226	2	0
33	26.1	263	7	0.297	8	2
35	35.6	320	11	0.379	13	4
37	23.8	385	9	0.469	11	4
39	64.1	459	29	0.561	36	17
41	92.6	543	50	0.650	60	33
43	61.8	637	39	0.729	45	29
45	99.8	741	74	0.796	79	59
47	114.0	857	98	0.850	97	83
49	104.5	985	103	0.892	93	92
51	104.5	1127	118	0.923	96	109
53	104.5	1281	134	0.945	99	127
55	59.4	1450	86	0.962	57	83
57	28.5	1634	47	0.973	28	45
59	35.6	1834	65	0.981	35	64
61	21.4	2051	44	0.987	21	43
63	2.4	2284	5	0.991	2	5
65	4.8	2536	12	0.994	5	12
67	2.4	2807	7	0.996	2	7
69	0.0	3097	0	0.997	0	0
71	2.4	3408	8	0.998	2	8
73	2.4	3739	9	0.999	2	9
75						
77						
79						
81						
83						
85						
87						
89						
91	2.4	7817	19	1.000	2	19
TOTAL	1000		976		798	853
				90	3N Yield rate	0.874

Table 2 (cont): Greenland halibut, Divisions 3L and 3N. Annual yeld rate for 1991

(Length weight relationship from Bowering and Stansbury, 1984)

DIVISION 3L

Year 1991

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
31	0.9	213	0	0.226	0	0
33	3.8	263	1	0.297	1	0
35	43.0	320	14	0.379	16	5
37	50.0	385	19	0.469	23	9
39	62.1	459	29	0.561	35	16
41	99.5	543	54	0.650	65	35
43	90.1	637	57	0.729	66	42
45	139.0	741	103	0.796	111	82
47	127.1	857	109	0.850	108	93
49	118.1	985	116	0.892	105	104
51	67.7	1127	76	0.923	62	70
53	41.0	1281	53	0.945	39	50
55	53.5	1450	78	0.962	51	75
57	27.6	1634	45	0.973	27	44
59	18.8	1834	34	0.981	18	34
61	19.4	2051	40	0.987	19	39
63	19.1	2284	44	0.991	19	43
65	8.9	2536	23	0.994	9	23
67	3.1	2807	9	0.996	3	9
69	0.4	3097	1	0.997	0	1
71	3.6	3408	12	0.998	4	12
73	1.1	3739	4	0.999	1	4
75	1.1	4093	5	0.999	1	5
77						
79						
81						
83	1.1	5746	7	1.000	1	7
TOTAL	1000		932		786	801
				91	3L Yield rate	0.859

DIVISION 3N

Year 1991

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
21	0.3	58	0	0.063	0	0
23	0.3	78	0	0.074	0	0
25	0.3	104	0	0.095	0	0
27	1.5	134	0	0.126	0	0
29	3.4	170	1	0.170	1	0
31	10.9	213	2	0.226	2	1
33	23.0	263	6	0.297	7	2
35	44.8	320	14	0.379	17	5
37	76.3	385	29	0.469	36	14
39	80.1	459	37	0.561	45	21
41	144.5	543	78	0.650	94	51
43	150.9	637	96	0.729	110	70
45	131.8	741	98	0.796	105	78
47	92.5	857	79	0.850	79	67
49	57.5	985	57	0.892	51	51
51	63.3	1127	71	0.923	58	66
53	35.8	1281	46	0.945	34	43
55	28.8	1450	42	0.962	28	40
57	11.5	1634	19	0.973	11	18
59	8.2	1834	15	0.981	8	15
61	15.5	2051	32	0.987	15	31
63	2.2	2284	5	0.991	2	5
65	13.1	2536	33	0.994	13	33
67	3.6	2807	10	0.996	4	10
TOTAL	1000		771		720	621
				91	3N Yield rate	0.806

Table 2 (cont): Greenland halibut, Divisions 3L and 3N. Annual yeld rate for 1992

(Length weight relationship from Bowering and Stansbury, 1984)

DIVISION 3L

Year 1992

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
33	44.8	263	12	0.297	13	3
35	49.0	320	16	0.379	19	6
37	154.1	385	59	0.469	72	28
39	107.0	459	49	0.561	60	28
41	137.6	543	75	0.650	89	49
43	128.0	637	81	0.729	93	59
45	106.7	741	79	0.796	85	63
47	70.4	857	60	0.850	60	51
49	86.5	985	85	0.892	77	76
51	48.2	1127	54	0.923	44	50
53	31.9	1281	41	0.945	30	39
55	8.8	1450	13	0.962	8	12
57	8.3	1634	14	0.973	8	13
59	12.6	1834	23	0.981	12	23
61						0
63	0.8	2284	2	0.991	1	2
65	2.3	2536	6	0.994	2	6
67	1.5	2807	4	0.996	1	4
69	0.8	3097	2	0.997	1	2
71						
73	0.8	3739	3	0.999	1	3
TOTAL	1000		679		679	517
				92 3L Yield rate		0.762

DIVISION 3N

Year 1992

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
25	0.3	104	0	0.095	0	0
27	0.8	134	0	0.126	0	0
29	15.3	170	3	0.170	3	0
31	9.9	213	2	0.226	2	0
33	36.8	263	10	0.297	11	3
35	35.6	320	11	0.379	13	4
37	51.6	385	20	0.469	24	9
39	73.1	459	34	0.561	41	19
41	128.2	543	70	0.650	83	45
43	132.4	637	84	0.729	97	61
45	127.7	741	95	0.796	102	75
47	106.7	857	91	0.850	91	78
49	73.7	985	73	0.892	66	65
51	66.3	1127	75	0.923	61	69
53	40.7	1281	52	0.945	39	49
55	32.2	1450	47	0.962	31	45
57	23.0	1634	38	0.973	22	37
59	16.6	1834	30	0.981	16	30
61	6.1	2051	12	0.987	6	12
63	5.9	2284	14	0.991	6	13
65	6.4	2536	16	0.994	6	16
67	2.5	2807	7	0.996	3	7
69	2.4	3097	7	0.997	2	7
71	1.7	3408	6	0.998	2	6
73	1.5	3739	6	0.999	2	6
75	0.7	4093	3	0.999	1	3
77	0.7	4470	3	0.999	1	3
79	0.4	4871	2	1.000	0	2
81	0.1	5295	0	1.000	0	0
83	0.3	5746	2	1.000	0	2
85	0.3	6222	2	1.000	0	2
87	0.2	6725	1	1.000	0	1
TOTAL	1000		815		731	671
				92 3N Yield rate		0.824

Table 2 (cont): Greenland halibut, Divisions 3L and 3N. Annual yeld rate for 1993

(Length weight relationship from Bowering and Stansbury, 1984)

DIVISION 3L

Year 1993

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
31	4.6	213	1	0.226	1	0
33	33.5	263	9	0.297	10	3
35	72.9	320	23	0.379	28	9
37	173.5	385	67	0.469	81	31
39	167.7	459	77	0.561	94	43
41	191.3	543	104	0.650	124	68
43	130.2	637	83	0.729	95	60
45	94.6	741	70	0.796	75	56
47	90.6	857	78	0.850	77	66
49	13.4	985	13	0.892	12	12
51	13.9	1127	16	0.923	13	14
53	4.8	1281	6	0.945	5	6
55	4.6	1450	7	0.962	4	6
57	2.4	1634	4	0.973	2	4
59						
61	2.1	2051	4	0.987	2	4
TOTAL	1000		561		624	383
				93	3L Yield rate	0.682

DIVISION 3N

Year 1993

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
25	0.1	104	0	0.095	0	0
27	0.6	134	0	0.126	0	0
29	0.2	170	0	0.170	0	0
31	1.6	213	0	0.226	0	0
33	4.8	263	1	0.297	1	0
35	12.7	320	4	0.379	5	2
37	27.7	385	11	0.469	13	5
39	46.7	459	21	0.561	26	12
41	91.2	543	49	0.650	59	32
43	135.0	637	86	0.729	98	63
45	118.7	741	88	0.796	95	70
47	101.6	857	87	0.850	86	74
49	84.4	985	83	0.892	75	74
51	89.4	1127	101	0.923	82	93
53	77.9	1281	100	0.945	74	94
55	53.0	1450	77	0.962	51	74
57	45.2	1634	74	0.973	44	72
59	26.4	1834	48	0.981	26	48
61	20.1	2051	41	0.987	20	41
63	14.8	2284	34	0.991	15	34
65	9.4	2536	24	0.994	9	24
67	8.6	2807	24	0.996	9	24
69	6.4	3097	20	0.997	6	20
71	6.4	3408	22	0.998	6	22
73	5.4	3739	20	0.999	5	20
75	3.9	4093	16	0.999	4	16
77	2.0	4470	9	0.999	2	9
79	2.4	4871	12	1.000	2	12
81	1.9	5295	10	1.000	2	10
83	1.0	5746	6	1.000	1	6
85	0.5	6222	3	1.000	0	3
87	0.1	6725	1	1.000	0	1
TOTAL	1000		1072		819	952
				93	3N Yield rate	0.888

Table 2 (cont): Greenland halibut, Division 3N. Annual yeld rate for 1994

(Length weight relationship from Bowering and Stansbury, 1984)

DIVISION 3N

Year 1994

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
27	0.5	134	0	0.126	0	0
29	35.5	170	6	0.170	6	1
31	106.9	213	23	0.226	24	5
33	129.6	263	34	0.297	38	10
35	151.1	320	48	0.379	57	18
37	142.1	385	55	0.469	67	26
39	123.3	459	57	0.561	69	32
41	95.7	543	52	0.650	62	34
43	69.5	637	44	0.729	51	32
45	52.8	741	39	0.796	42	31
47	39.5	857	34	0.850	34	29
49	20.8	985	20	0.892	19	18
51	11.7	1127	13	0.923	11	12
53	10.7	1281	14	0.945	10	13
55	6.1	1450	9	0.962	6	9
57	1.7	1634	3	0.973	2	3
59	1.8	1834	3	0.981	2	3
61	0.4	2051	1	0.987	0	1
63	0.1	2284	0	0.991	0	0
65	0.3	2536	1	0.994	0	1
TOTAL	1000		456		500	278
				94	**3N Yield rate**	**0.609**

Table 2 (cont): Greenland halibut, Divisions 3L and 3N. Annual yeld rate for 1995

(Length weight relationship from Bowering and Stansbury, 1984)

DIVISION 3L

Year 1995

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
29	19.3	170	3	0.170	3	1
31	139.5	213	30	0.226	32	7
33	109.2	263	29	0.297	32	9
35	136.9	320	44	0.379	52	17
37	167.8	385	65	0.469	79	30
39	182.0	459	84	0.561	102	47
41	118.6	543	64	0.650	77	42
43	52.5	637	33	0.729	38	24
45	34.3	741	25	0.796	27	20
47	26.0	857	22	0.850	22	19
49	11.5	985	11	0.892	10	10
51						
53						
55	2.4	1450	3	0.962	2	3
TOTAL	1000		414		477	228
				96	3L Yield rate	0.552

DIVISION 3N

Year 1995

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
25	11.0	104	1	0.095	1	0
27	68.6	134	9	0.126	9	1
29	80.3	170	14	0.170	14	2
31	108.8	213	23	0.226	25	5
33	138.8	263	36	0.297	41	11
35	117.5	320	38	0.379	44	14
37	93.1	385	36	0.469	44	17
39	63.4	459	29	0.561	36	16
41	58.2	543	32	0.650	38	21
43	51.3	637	33	0.729	37	24
45	44.3	741	33	0.796	35	26
47	38.6	857	33	0.850	33	28
49	23.0	985	23	0.892	20	20
51	22.1	1127	25	0.923	20	23
53	14.9	1281	19	0.945	14	18
55	15.0	1450	22	0.962	14	21
57	12.4	1634	20	0.973	12	20
59	7.7	1834	14	0.981	8	14
61	6.8	2051	14	0.987	7	14
63	8.7	2284	20	0.991	9	20
65	7.3	2536	18	0.994	7	18
67	3.5	2807	10	0.996	3	10
69	1.8	3097	6	0.997	2	6
71	1.2	3408	4	0.998	1	4
73	0.6	3739	2	0.999	1	2
75	0.5	4093	2	0.999	1	2
77	0.5	4470	2	0.999	1	2
79						0
81						0
83						0
85						0
87						0
89						0
91	0.2	7817	2	1.000	0	2
TOTAL	1000		520		476	362
				96	3N Yield rate	0.696

TABLE 3 : GREENLAND HALIBUT TRAWL CATCH RATES, 1988-95 : mean annual observed cpue's corrected for the month and division of each observation. Relative values (CPUEr) to 1988.

Division	3L				3N				3LN			
Year	CPUE	ST.ERROR	C.V.	CPUEr	CPUE	ST.ERROR	C.V.	CPUEr	CPUE	ST.ERROR	C.V.	CPUEr
1988	0.449	0.074	28.4	1.0					0.431	0.094	37.8	1.0
1989	0.457	0.068	39.7	1.0					0.419	0.070	44.0	1.0
1990	0.409	0.032	22.3	0.9	0.233			1.0	0.360	0.031	26.1	0.8
1991	0.225	0.038	29.1	0.5	0.164	0.046	48.2	0.7	0.185	0.021	28.3	0.4
1992	0.253	0.031	27.6	0.6	0.336	0.029	22.8	1.4	0.313	0.035	38.4	0.7
1993	0.319	0.022	9.9	0.7	0.205	0.017	21.8	0.9	0.257	0.016	18.8	0.6
1994	0.186			0.4	0.207	0.005	3.8	0.9	0.249	0.045	35.8	0.6
1995	0.134	0.056	94.1	0.3	0.185	0.028	33.5	0.8	0.166	0.038	72.8	0.4

TABLE 4 : GREENLAND HALIBUT TRAWL CATCH RATES, 1988-95 : mean annual estimated cpue's for 130mm mesh size, corrected for the month and division of each observation. Relative values (CPUEr) to 1988.

Division	3L				3N				3LN			
Year	CPUE	ST.ERROR	C.V.	CPUEr	CPUE	ST.ERROR	C.V.	CPUEr	CPUE	ST.ERROR	C.V.	CPUEr
1988	0.430	0.069	27.9	1.0					0.409	0.089	37.6	1.0
1989	0.448	0.064	37.7	1.0					0.405	0.066	43.1	1.0
1990	0.377	0.031	23.5	0.9	0.194			1.0	0.322	0.030	27.7	0.8
1991	0.195	0.039	34.6	0.5	0.135	0.036	45.7	0.7	0.158	0.023	35.3	0.4
1992	0.193	0.027	30.8	0.4	0.276	0.025	24.3	1.4	0.255	0.035	47.6	0.6
1993	0.262	0.018	9.7	0.6	0.182	0.015	21.3	0.9	0.230	0.018	23.8	0.6
1994	0.136			0.3	0.133	0.009	11.9	0.7	0.185	0.043	46.1	0.5
1995	0.123	0.054	99.1	0.3	0.170	0.019	25.4	0.9	0.153	0.037	76.1	0.4

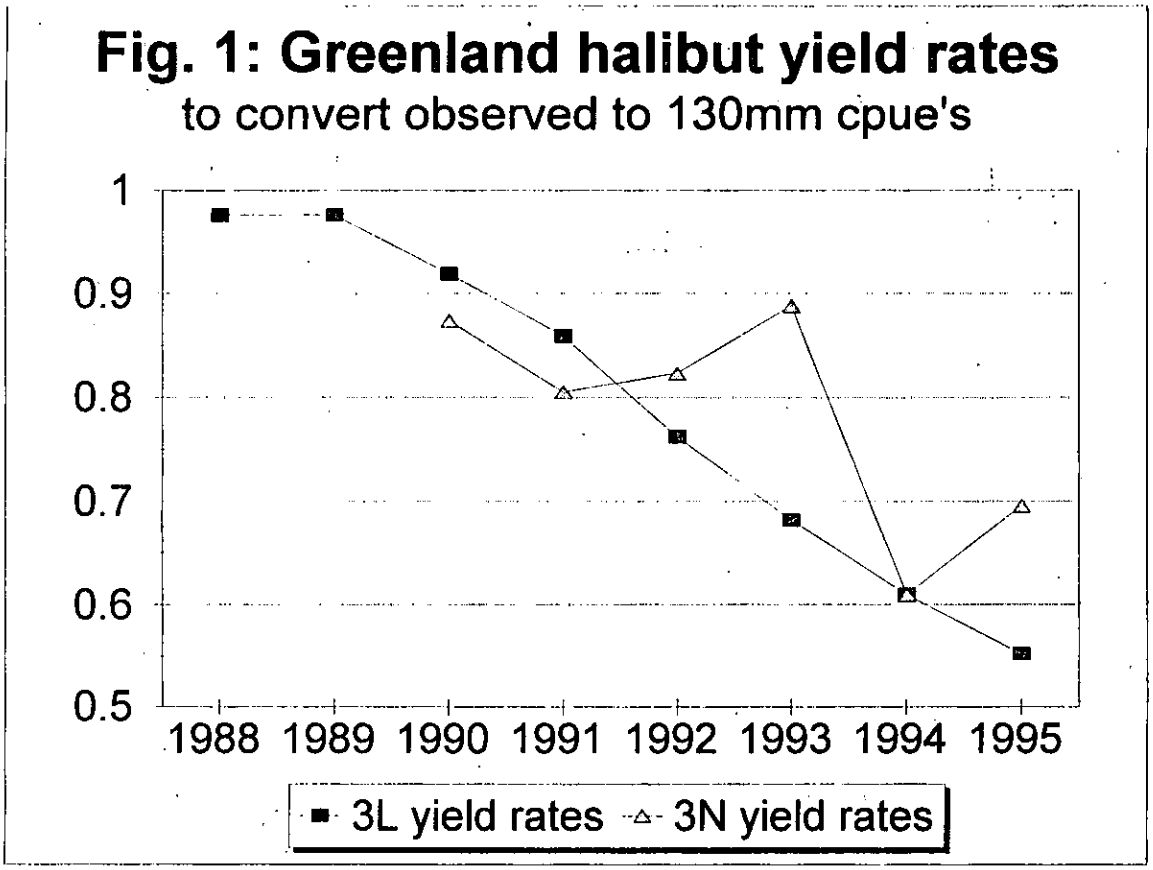
Fig. 1: Greenland halibut yield rates
to convert observed to 130mm cpue's
1
0.9
0.8
0.7
0.6
0.5
1988 1989 1990 1991 1992 1993 1994 1995
3L yield rates
3N yield rates

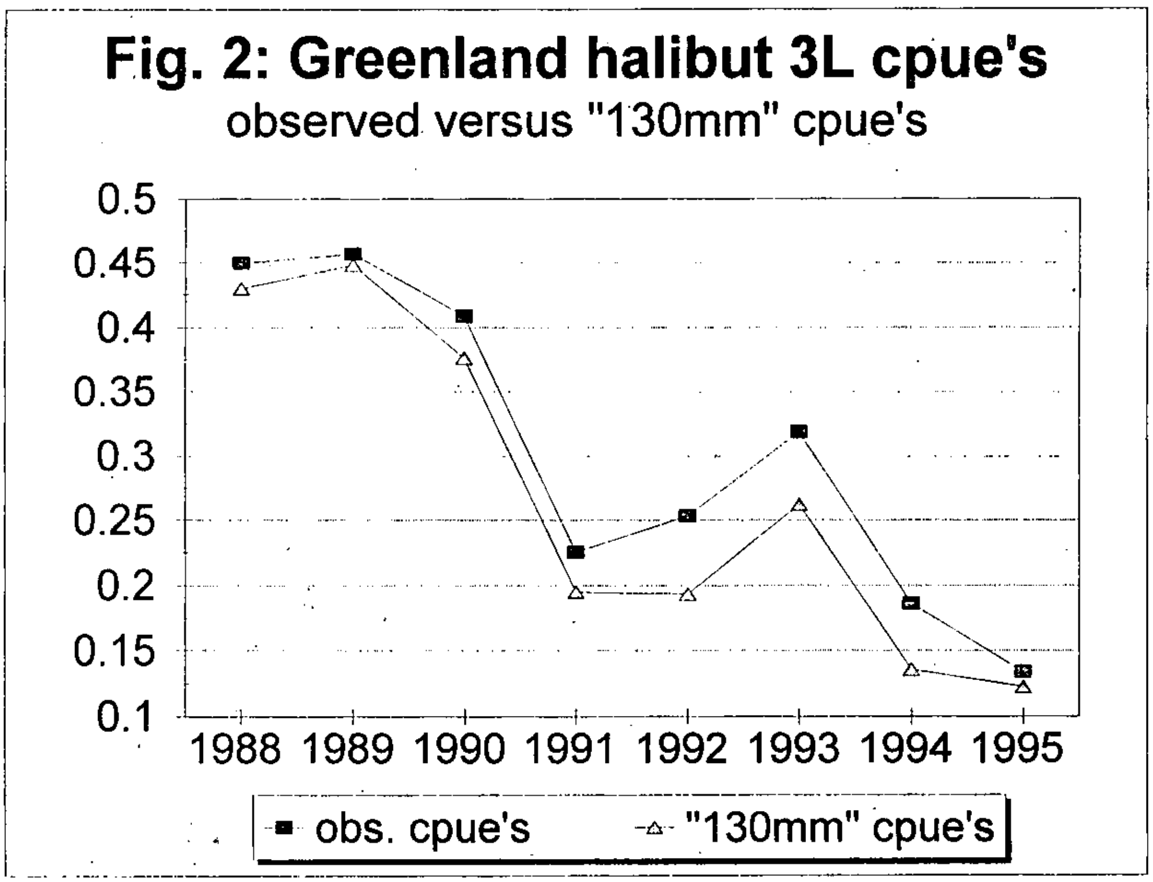
Fig. 2: Greenland halibut 3L cpue's
observed versus "130mm" cpue's
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
1988 1989 1990 1991 1992 1993 1994 1995
obs. cpue's
"130mm" cpue's

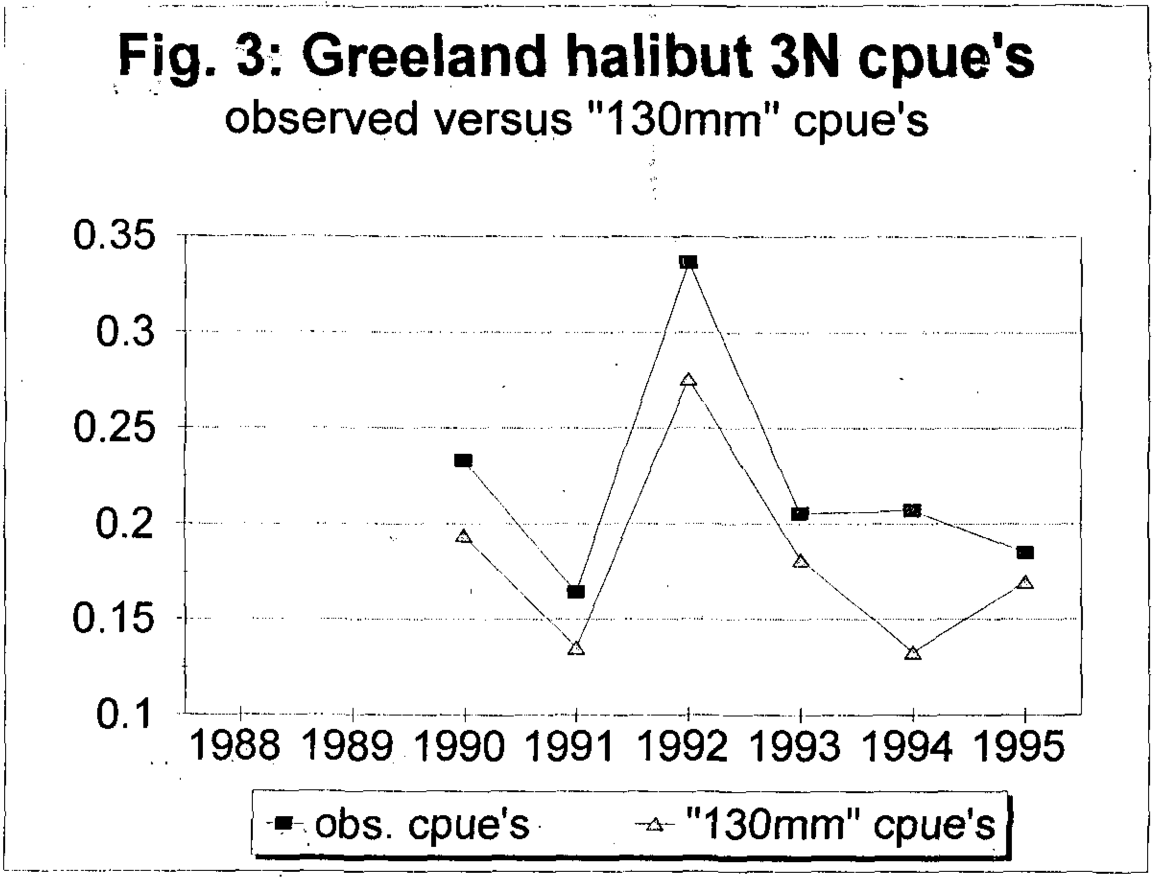
Fig. 3: Greeland halibut 3N cpue's
observed versus "130mm" cpue's
0.35
0.3
0.25
0.2
0.15
0.1
1988 1989 1990 1991 1992 1993 1994 1995
obs. cpue's
"130mm" cpue's

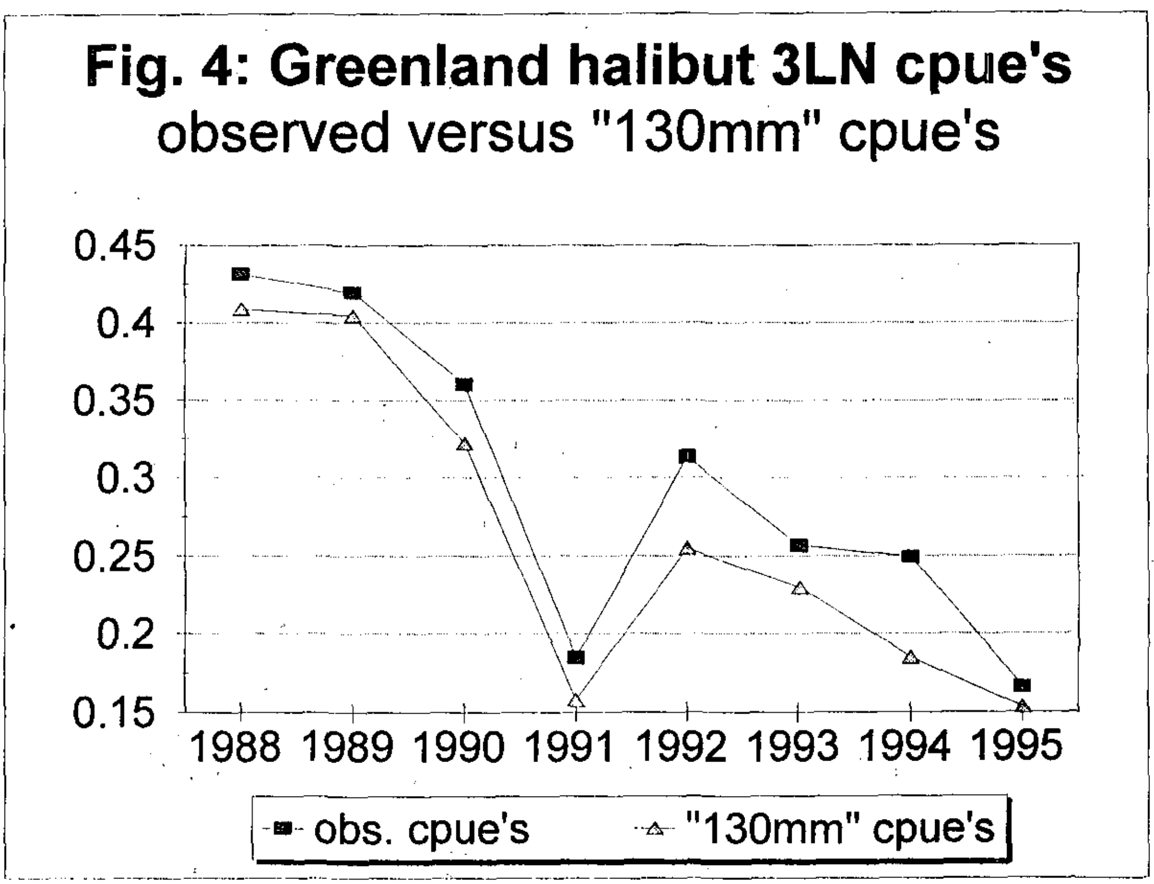
Fig. 4: Greenland halibut 3LN cpue's
observed versus "130mm" cpue's
0.45
0.4
0.35
0.3
0.25
0.2
0.15
1988 1989 1990 1991 1992 1993 1994 1995
obs. cpue's
"130mm" cpue's