Cod stocks investigations off West Greenland

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Introduction

In the last decade, the inshore cod fishery at West Greenland has contained cod from two different spawning areas: Icelandic cod spawned off South-western Iceland which in some years are carried by the Irminger current to settle off South Greenland, and local, possibly self-sustained, fjord populations. Spawning cod are found in several fjords of the West Greenland (Buch *et al.*, 1994) especially in NAFO Division 1B, 1C and 1D.

Trends in Catch and Effort

Historically, the inshore catches have been of limited importance as the inshore fisheries have accounted for only 5-10% of the total international catch. Annual catches of 15000-20000 t have been taken inshore during the period 1955-1973. Since then the catches have been varying consistent with the recruitment of strong year classes to the offshore fishery. High catches of about 50000 t in 1980 and 1989 have been followed by periods of very low catches.

In recent years the catches has decreased dramatically from about 2000 tons yearly in 1993-	
1995 to only 326 tons in 1998. In 1999 the catches has rose to 622 tons but decreased again	to
307 tons in 2000.	

Division	1993	1994	1995	1996	1997	1998	1999	2000*	2001*
Nafo 1A	333	209	53	41	18	9	360		
Nafo 1B	323	332	521	211	454	133	131		
Nafo 1C	173	589	710	471	198	79	44		
Nafo 1D	968	914	332	164	99	58	75		
Nafo 1E	18	11	4	11	4	9	8		
Nafo 1F	109	62	81	46	117	31	4		
Total	1926	2115	1710	948	904	319	622	307	

*no details on catch statistics were available

The inshore fishery takes place from small vessels (<40 GRT). Pound nets, gillnets and handlines are used to take about 95% of the inshore catch.

Juvenile cod survey.

A survey using gangs of gill-nets with different mesh-sizes (16.5, 18, 24, 28 and 33mm) has been developed and used since 1985. The objective of the programme is to assess the abundance and distribution of pre recruit cod in inshore areas of Greenland. The survey has usually been carry out in three inshore areas off West Greenland: Sisimiut (NAFO Div. 1B)

Nuuk (Div. 1D) and Qoqortoq (Div.1F) (Figure 2).



Figure 2. Survey areas

Analysis of the selectivity of the fleet of gill-nets have shown, that selection is best towards age 2 and age 3 cod (Hovgaard, 1992) whereas only the larger individuals of the age 1 cod are adequately selected. A total of 129 net settings were made. Nets were sat at bottom and it was attempted to set the fleets at constant depths and to divide the survey effort evenly on the depth zones of 0-5m, 5-10m, 10-15m and 15-20m. No information on the relative strata sizes was available, and the four depth strata were therefore assigned an equal weight in the computations. The stratified means and variances were calculated according to Cochran (1977). Survey results are given in Table 2-4. An abundance index (number of age 2 cod caught in 100 hours net setting) are shown in figure 3 and reveals a strong 1985 and 1987 year-class, a moderate 1990 - and 1993 year class and four successive weak year-classes in recent years. The survey results confirm the severely depleted status of the stock, although the very low 1997- and 1998- class year might not be representative due to insufficient survey coverage.

The survey results from year 2000 shows an increased index for Div. 1F, which contrast to a line of years with almost no cod abundance in this area. No juvenile cod survey was conducted in 2001 due to technical problems.



Figure 3. CPUE (numbers of age 2 cod caught per 100 hours net settings) in the Greenland young cod survey 1987-1997

Biomass and abundance of cod off West Greenland estimated from the Greenland shrimp survey 1988-2001.

Since 1988 has Greenland Institute of Natural Resources annually conducted a bottom trawl survey off West Greenland. The main purpose of the survey is to evaluate the biomass and abundance of Northern shrimp (*Pandalus borealis*), but data on most fish spices have been recorded.

Methods

The survey covers the offshore areas at West Greenland between 59°00'N and 72°30'N from the 3-mile limit to the 600 m depth contour line and the inshore area Disko Bay (Figure 4). The survey area is divided into NAFO Divisions, which were further subdivided into three depth strata (0-200, 201- 400 and 401- 600 m) on basis of depth contour lines. The area surveyed has, however, changed throughout the years. From 1988 to 1990 the survey area included Div. 1AN to 1D. In 1991 the Div. 1AN was not covered. In 1992 the survey area was extended to include Div. 1AN to 1F and Disko Bay (Div. 1AX), and this area is now surveyed annually. The survey was originally designed as a shrimp survey and sampling of fish data was not complete in the period 1988-1991. Since 1992 the sampling of fish has improved and the survey is now considered as a combined groundfish/shrimp survey. The survey period was July to September.

The survey is designed as a stratified-random trawl survey. A minimum of two hauls per stratum is always planned. Due to lack of information of the bottom tropografy Div. 1AN and Disko Bay are considered as two single strata. The number of valid hauls by year and stratum is listed in Table 2.

The trawl is a Skjervoy 3000/20 with bobbin gear and double bag. The mesh size in the codend is 20 mm.

The standard trawling time offshore is 15-60 minutes at a mean towing speed of 2.5 knots. Stratified abundance and biomass estimates were calculated from catch-per-tow data using the stratum areas as weighting factor (Cochran, 1953). The coefficient of catchability was set at 1.0, implying that estimates are merely indices of abundance and biomass. Confidence intervals (CI) were set at the 95% level of significance of the stratified mean.



Figure 4. Area of the Greenland shrimp survey

Results

Tables 2 and 3 list abundance and biomass indices of cod by stratum. The biomass-indices for cod were estimated to 4,000-7,000 tons in 1988-1990. In 1992 the biomass decreased with over 95% to only 250 tons and 528,000 individuals and remained at this low until recent years. There are indications of a slight improvement in the abundance of small cod. Abundance indices in 2001 were estimated to 1.6 million individuals, which is the highest estimate in the abundance time series. In 1999 to 2001 a significant amount of cod was captured in area 1AS and 1BN for the first time since 1990. A significant amount was also taken in the Disko Bay area (1AX)..

Stratificu		neompiei	e coverag		y area.						
Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr.	CI
1991	*	0	11	7	32	429	78	*	*	(528)	73
1992	0	0	4	16	33	242	242	0	9	547	45
1993	0	0	0	0	0	54	36	205	12	308	67
1994	9	0	0	0	54	98	0	7	0	167	43
1995	0	0	0	33	17	504	42	20	46	662	58
1996	0	0	0	0	0	47	78	66	108	298	40
1997	0	0	0	2	8	35	0	0	0	45	64
1998	0	0	0	5	0	0	25	28	4	62	44
1999	0	10	18	141	52	17	18	8	0	261	41
2000	0	188	273	311	201	86	47	9	205	1321	19
2001	0	0	15	239	86	140	498	210	373	1561	23

Table 2 Cod (*Gadus morhua*). Abundance indices (1000) for West Greenland with 95% confidence limits in per cent of the stratified mean. () incomplete coverage of survey area.

Table 3 Cod (*Gadus morhua*). Biomass indices (tons) for West Greenland with 95% confidence limits in per cent of the stratified mean. () incomplete coverage of survey area.

			0		<u></u>						
Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr.	CI
1988	0	0	*	35	0	1230	2613	*	*	(3879)	81
1989	44	0	*	73	0	41	1002	*	*	(1217)	51
1990	4	13	*	7	7	118	6825	*	*	(7004)	45
1991	*	0	7	1	2	188	53	*	*	(250)	58
1992	0	0	3	22	31	74	85	0	2	217	44
1993	0	0	0	0	0	24	8	87	4	122	69
1994	0	3	0	0	12	41	0	1	0	58	43
1995	0	0	0	3	2	158	22	2	5	190	67
1996	0	0	0	0	0	16	26	21	49	112	41
1997	0	0	0	2	2	60	0	0	0	64	65
1998	0	0	0	<1	0	0	55	57	4	117	43
1999	0	1	4	38	5	<1	13	1	0	64	31
2000	0	63	65	80	60	27	6	2	56	360	20
2001	0	0	9	126	38	72	186	67	110	609	26

$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Table 4	Cod (Gad	lus morhud	a). Abund	ance indic	es (1000) p	per age for	West Gree	enland		
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	1	0	0	0	19	0	0	0	7	90	97
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	2	221	39	10	345	14	0	17	144	711	540
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	3	126	170	126	101	203	10	25	66	363	546
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4	123	73	22	157	78	3	20	23	92	376
6 10 7 1 0 0 8 0 7 3 1 0 0 0 1 0	5	63	16	8	40	3	24	0	6	13	0
7 3 1 0 0 0 1 0	6	10	7	1	0	0	8	0	1	52	0
	7	3	1	0	0	0	1	0	1	0	0
8+ 1 2 0 0 0 0 0	8+	1	2	0	0	0	0	0	1	0	0

References

Cochran, W. G. 1977: Sampling techniques. John Wiley & Sons. New York 1977.

Hovgård, H., 1993: Young cod distribution and abundance in West Greenland inshore areas, 1992. Working Document to North-Western WG, 1993.

						Ye	ars						
Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	4,1	0,2	0,2	0,71	0	0,3	0	0	4,2	1,5	0	0	2,1
2	245,4	121,8	32,6	109,8	108,5	3,4	42,7	21,8	7,8	114,6	28,4	14,4	7,0
3	16,0	232,6	129,5	82,9	107,7	131,2	9,7	22,4	18,5	18,5	40,4	7,7	4,3
4	8,0	24,5	111,4	56,8	62,4	53,3	18,4	1,6	11,7	6,7	6,8	3,2	6,2
5	2,2	1,1	1,9	32,0	53,0	11,3	2,7	0,8	0,4	1,2	0,7	0,7	3,3
6	2,0	0,1	0,1	0,7	11,9	2,5	0,2	0,2	0,3	0,2	0,2	0	0,3
7	0,3	0,2	0	0	0	0,3	0,1	0,1>	0	0	0	0	0
8	0	0,1>	0	0	0	0	0	0	0	0	0	0	0

Table 2: Abundance indices (numbers of cod caught per 100 hours net settings) pr age as found in NAFO subarea 1B in the West Greenland inshore gill-net survey 1987 to 2000. The survey area is shown in fig. 1.

	Years	
Age	1999	2000
1	No	No
2	coverage	coverage
3		
4		
5		
6		
7		
8		

						Ye	ars						
Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0	0,6	0	0	0	123,9	0,2	0	0	0	0	2,5	0
2	95,5	15,7	19,6	78,3	14,4	2,7	60,6	3,9	0,4	2,6	1,1	3,3	10,3
3	14,8	67,6	48,0	47,2	34,5	17,3	22,0	57,0	6,0	1,8	1,2	1,2	17,0
4	0	5,3	30,1	12,8	4,0	6,4	9,5	19,7	4,5	4,2	0,1	0,1	0,5
5	0,4	0,1	0,9	13,2	3,7	2,3	7,0	1,8	0,5	3,6	1,7	0,2	0,1
6	0,5	0,1>	0,2	0,1>	2,8	0,8	0,6	0,3	0,1>	0,2	0,1>	0,5	0,1
7	2,3	0,1	0,1	0	0,1>	0,1>	0,3	0,1>	0	0	0	0	0
8	0	0,4	0,2	0	0	0	0,1>	0	0	0	0	0	0

Table 2 cont.: Abundance indices (numbers of cod caught per 100 hours net settings) pr age as found in NAFO subarea 1D in the West Greenland inshore gill-net survey 1987 to 2000. The survey area is shown in fig. 1.

	Years	
Age	1999	2000
1	0	0
2	0,4	3,0
3	1,2	1,1
4	2,7	0,4
5	0,4	1,1
6	0,1	0,2
7	0	0
8	0	0

						Ve	ars						
Aga	1086	1087	1088	1080	1000	1001	1007	1003	100/	1005	1006	1007	1008
Age	1980	1967	1900	1969	1990	1991	1992	1995	1994	1995	1990	1997	1990
1	16,5	0	0	0	0	2,0	0	0	0	0	No	No	0
2	111,7	142,8	0,9	5,4	0,35	1,5	2,6	4,6	0	0	coverage	coverage	4,0
3	5,3	146,9	82,8	1,8	2,56	0,1	1,4	2,4	1,4	0			12,3
4	0,1>	0,8	5,6	19,0	1,73	2,1	0,1	0,6	0,7	0			0,2
5	1,6	0,1	0,1>	2,3	12,5	0,2	0,9	0,1>	0,2	0			0
6	0,2	0	0	0	1,3	1,3	0,1	0,3	0,2	0,3			0
7	0,2	0	0	0	0	0,1>	1,0	0,1	0	0			0
8	0	0,1>	0	0	0	0	0	0	0	0			0

Table 2 cont.: Abundance indices (numbers of cod caught per 100 hours net settings) pr age as found in NAFO subarea 1F in the West Greenland inshore gill-net survey 1987 to 2000. The survey area is shown in fig. 1.

	Voora	
Δge	1000	2000
1	No	0.1>
2	INU	17.0
2	coverage	17,0
3		3,5
4		1,3
5		1,3
6		0
7		0
8		0