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Calculation of Catch-at-Age for Commercially Caught Greenland halibut in NAFO Subarea 2 and Divisions 3KLMNO during 1975-99 with Particular Emphasis on Construction of the Catch-at-Age Matrix since 1989

by

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Abstract

Catch-at-age data from the commercial Greenland halibut fishery in NAFO Subarea 2 and Divisions 3KLMNO have been calculated annually since 1975. However, the data have been incomplete since 1989 due to uncertainty in the yearly catches in the NAFO Regulatory Area (NRA) and lack of ageing data. Catch-at-age data from the Canadian portion of the fishery have been available annually from 1975-97 and are updated here for 1998 and 1999. This paper will describe how annual ageing data from the Canadian fishery were used in combination with annual length frequency data from other countries, primarily Spain and Portugal, fishing Greenland halibut in the NRA to compute catch-at-age from 1989-99. Where data were lacking from other countries their catches were generally adjusted by the combined catch-at-age of Spain and Portugal. Although total annual catches remain uncertain for many years, the computations were based on best estimates as agreed at the yearly June assessment meetings of the NAFO Scientific Council.

Introduction

At about 1988-89 a large unregulated fishery for Greenland halibut developed in the NAFO Regulatory Area (NRA) of Divisions 3L and 3M which later expanded to Division 3N and to a lesser degree Division 3O (Fig. 1). From 1990-94 the average annual catches were estimated to be about 50% higher than the maximum annual catch previously observed (39,000 tons in 1978) since the fishery began in earnest in the early 1960's (Table 1). Following an international disagreement between the coastal state and contracting parties participating in the unregulated fishery, in 1995 the Greenland halibut resource in Subarea 2 and Div. 3KL became the management responsibility of the NAFO Fisheries Commission with the inclusion of Div. 3MNO to the stock area. Annual total allowable catches (TAC's) for the entire stock area were introduced by the Fisheries Commission in consideration of scientific advice from the NAFO Scientific Council. For management purposes the annual TAC was then split between Subarea 2+Div. 3K controlled by the coastal state and Div. 3LMNO controlled by the Fisheries Commission. As a consequence, annual catches were greatly reduced compared to the early 1990's when the fishery was unregulated (Table 1).

Estimating catches from the NRA was exceedingly difficult during the 1990's due to non-reporting of Greenland halibut catches as well as misreporting Greenland halibut as other species. However, based upon various sources of information the Scientific Council usually agreed on annual "best estimates" or in some instances a range of estimates. These agreed catch estimates were not available by month or quarter. Although there were usually adequate length frequency data available from the main prosecutors of the fishery in the NRA no age data were available until recent years. These factors made it very difficult to conduct age-structured assessments required for

determining absolute stock size and impaired the scientific ability to advise on precise management options. It also severely restricted the Scientific Council's capability to develop biological reference points consistent with the precautionary approach to fisheries management.

Notwithstanding these difficulties, this paper will describe how various sources of age and length frequency data were used to determine annual catch-at-age of Greenland halibut from the "best estimates" of catch for potential used in an age-structured assessment.

Calculation of Catch-at-Age

All countries 1975-88

Catches-at-age from 1975-88 for all countries were calculated annually and at that time reflected the old stock area of Subarea 2 and Div. 3KL. The bulk of the non-Canadian catch during most of those years was by vessels licensed to fish inside the Canadian zone. The details on how the age compositions were constructed are available in the annual assessment documents and therefore won't be repeated here. Adjustments had to be made to account for catches in Div. 3MNO which has become part of a revised stock area of Subarea 2 and Div. 3KLMNO. This was accomplished by simply adjusting the numbers caught at age from the original stock area during 1975-88 proportionately upwards to account for the catch in Div. 3MNO. This resulted in a revised catch-at-age matrix, which is consistent with the new stock area.

Countries Fishing the NRA 1989-99

Work on developing a catch-at-age matrix for 1989-99 for other countries fishing in the NAFO Regulatory Area (NRA) began with the most recent year i.e. 1999 (where some non-Canadian age readings were available) and working backwards where available data became more problematic and a certain degree of inventiveness was required. The greatest uncertainty was with estimating the total annual catch particularly by countries fishing in the NRA. Ultimately, the total catches used were those agreed at the annual June meetings from a variety of official as well as non-official sources. For some years when the best that could be agreed was a range of catches, the catch-at-age was adjusted to the mean of the range.

For most years length frequency data were available in the national research reports from Spain and Portugal, which comprised the main components of the fishery in the NRA. In more recent years, ageing data were also available (1994-99). Initially, where ageing data were available from the NRA fisheries they were used to compute the removals at age for the respective fleets. However, an examination of the resultant mean weight at age (kg) arrays indicated substantial differences in age interpretations. In addition, these differences were not consistent over years or ages. The total calculated biomass at age produced very large discrepancies in the sum of product checks.

In order to maintain consistency in age interpretation throughout the entire time series from 1975-99, it was considered, therefore, more prudent to use Canadian age-length keys (alkeys) in most instances to adjust the catches for the entire fishery. Since most of the error in deriving catch-at-age was believed to be more likely associated with the total annual catch, it was decided to use one composite alkey for each year. Each annual alkey was comprised of commercial Greenland halibut ageing data collected by the Canadian Observer Program Sampling Section (OPSS) and the Canadian Port Sampling Section (PORT) at the Northwest Atlantic Fisheries Centre in St. John's, Newfoundland, Canada. For each year the alkey was comprised of all the data collected throughout the stock area from Div. 2G in the north to Div. 3O in the south. All months and gears were combined. The number of age readings in any one-year varied between 875 in 1995 to about 6300 in 1990. The annual A/L keys used are shown in Table 2a-2k for the years 1989-99, respectively. Where other countries fishing the NRA during this period provided sufficient size composition data they were used in a similar fashion to adjust the respective national catches. Where no data were available by other countries fishing the NRA their catches were adjusted to the combined Spanish and Portuguese catch-at-age data.

The mean weights (kg) at age were computed by applying a standard L/W regression to the mean lengths (cm) at age derived from the adjusted alkeys for each fleet (primarily Spain, Portugal, Canada and more recently Russia). The overall mean weights (kg) at age for each year was derived by averaging the fleet mean weights weighted by numbers caught at age by the respective fleets.

This process was followed for all years from 1989-99. The largest discrepancy in the annual sum of products check using this approach was 10% in only one year and exceeded 5% in only two years as shown in the catch biomass (tons) at age (Table 3). The resultant catch numbers at age is shown in Tables 4 and Fig. 3 and mean weights (kg) at age in Table 5 and Fig. 2.

Canada 1989-99

Brodie et al. (1998) presented catch at age for Canadian catches only from 1989-97 and derivation of these data have been presented in annual documents and also won't be repeated here. Ages 6-8 dominated the catch in most years up to 1991. Mean weights at age in recent years were similar, and no trends are seen in the mean weights over the period 1989-99.

Canadian data for 1998 were not available at the June 1999 meeting, as the age readings had not been completed. In this analysis, catch-at-age data from both 1998 and 1999 were calculated for Canadian fisheries throughout NAFO Subarea 2 and Divisions 3KLMNO, and for the catches of France from Division 2J. These were the only fisheries operating in 1998 within the Canadian 200-mile fishery zone. Size and age composition data were collected by observers in both the Canadian and French fisheries, as well as by port samplers for some Canadian catches.

In 1998 (Table 6), both Canadian and French (Division 2J) otter trawl fisheries were comprised mainly of fish aged 6-8, which is typical of this gear in virtually all years. Length and age compositions of otter trawl catches in Div. 3LMN in the NRA in 1998 were similar. The fixed gear catch, which is mainly taken by gillnets, was a much larger component of the 1998 Canadian fishery, and was dominated by fish aged 7-11. Overall, the total catch in the Canadian zone in 1998 was comprised mainly of the 1990 and 1991 year classes, which were about equal in number in the catch. Mean weights at age were calculated using the same length weight relationship used in Brodie (1999) for Greenland halibut catches in Subarea 0 (from Gundersen and Brodie 1999).

In 1999, the Canadian fishery was very similar to that in 1998. Catches were around 4200 t in each year, and the fishery in both years was dominated by gillnet catches, mainly from Div. 2J and 3K. Also like 1998, data from the French fishery in Division 2J in 1999 were included in the analysis with the Canadian data to give catch at age from the Canadian zone. Data from the French fishery for Greenland halibut in Div. 3LM in 1998 was included with other non-Canadian catch at age data for the NRA.

As in 1998, the otter trawl fisheries by France and Canada in 1999 caught fish mainly in the age range 6-8 years (Table 7). Ages 7 and 8 were also predominant in the Canadian fixed gear catches in 1999, with higher numbers of age 9+ fish relative to the otter trawl catch. Overall, the 1992 year-class was most abundant in the fisheries in the Canadian zone in 1999, followed by the 1991 year-class. For mean weights at age, a slightly different length weight relationship was used in the 1999 calculations than for 1998, that for all Divisions combined, year 1997 (from Gundersen and Brodie 1999). Effect on mean weight calculation was minimal for most lengths, with larger fish having slightly lower weights with the new relationship. Mean weights at age were very similar in 1998 and 1999 up to age 11, after which the mean weights for 1998 were larger (Tables 6, 7). This is due in part to the change in the length weight relationship, and also to the higher mean length at age in 1998.

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Table 1. Catches and TAC's of Greenland halibut in
SA 2 + Div. 3KLMNO, 1960-2000.
Includes some estimated catches for years 1984 and later.
TAC's from 1995 onward set by NAFO Fisheries Commission.

Year	Catch (tons) SA2+Div. 3KL	Catch (tons) SA2+Div. 3KLMNO	TAC
1960	938	995	
1961	741	786	
1962	588	624	
1963	1602	1621	
1964	3928	4252	
1965	9501	10069	
1966	19244	19276	
1967	25644	26525	
1968	31986	32392	
1969	36520	37241	
1970	36402	36839	
1971	24654	24834	
1972	29822	30038	
1973	28944	29291	
1974	27123	27588	40000
1975	28681	28814	40000
1976	24599	24611	30000
1977	31941	32048	30000
1978	38532	39070	30000
1979	34069	34104	30000
1980	32642	32867	35000
1981	30682	30754	55000
1982	26214	26278	55000
1983	27839	27861	55000
1984	24809	26711	55000
1985	18610	20347	75000
1986	15878	17976	100000
1987	30938	32442	100000
1988	19086	19215	100000
1989	19496	20034	100000
1990	22237	47454	50000
1991	26868	65008	50000
1992	35160	63193	50000
1993	29070	62455	50000
1994		51029	25000
1995		15272	27000
1996		18840	27000
1997		19858	27000
1998		19946	27000
1999		24232	33000
2000			35000

Table 2a. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1989. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5		1																			1
14.5		5																			5
16.5		23	3																		26
18.5		11	32																		43
20.5			38	2																	40
22.5			20	11																	31
24.5			12	33																	45
26.5			2	38	4																44
28.5				35	13																48
30.5				18	47																65
32.5				14	70	4															88
34.5				1	78	14															93
36.5					76	58															134
38.5					52	171	4														227
40.5					12	287	28														327
42.5					1	202	176														379
44.5						38	337	3													378
46.5						4	331	43													378
48.5						1	177	191													369
50.5							11	337	1												349
52.5								284	22												306
54.5								111	163												274
56.5								8	218	3											229
58.5									154	38											192
60.5									74	75											149
62.5									16	115	2										133
64.5									1	100	18										119
66.5									1	25	61										87
68.5									1	5	77	5									88
70.5										1	48	19									68
72.5											10	33	1								44
74.5										1	2	33	6								42
76.5											1	27	13								41
78.5												11	30	1							42
80.5												3	30	10							43
82.5													23	10	2						35
84.5													10	19	5						34
86.5													4	13	7	1					25
88.5													1	10	14	2					27
90.5														7	4	2					13
92.5														4	17	2					23
94.5														2	9	1					12
96.5															10	9	4				23
98.5														1	1	12	5				19
100.5														1		8	4				13
102.5																8	5				13
104.5																	1				1
106.5																	1				1
108.5																					0
110.5																			1		1
Total	0	40	107	152	353	779	1064	977	651	363	219	131	118	78	69	45	20	0	1	0	5167

Table 2b. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1990. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5		1																			1
14.5		6																			6
16.5		11	2																		13
18.5		9	12																		21
20.5		2	23	1																	26
22.5			29	16																	45
24.5			12	33																	45
26.5			3	38	3																44
28.5				33	15																48
30.5				19	51																70
32.5				13	80	1															94
34.5				2	111	26															139
36.5					98	120															218
38.5					32	292	6														330
40.5					6	340	58														404
42.5					1	259	186														446
44.5						54	370	4													428
46.5						10	378	49													437
48.5							192	227													419
50.5							50	351	4												405
52.5								318	35												353
54.5								138	169												307
56.5								28	196	10											234
58.5								1	162	44											207
60.5									59	114											173
62.5									5	138	12										155
64.5										100	30										130
66.5										45	84	1									130
68.5										1	88	17	1								107
70.5											47	44									91
72.5											5	68	1								74
74.5												63	11								74
76.5												36	37								73
78.5												8	57	6							71
80.5													48	20							68
82.5													23	39							62
84.5													3	48	7						58
86.5														40	20						60
88.5													1	10	37						48
90.5														6	44	1					51
92.5															33	9					42
94.5															17	16	1				34
96.5															2	28	3				33
98.5															1	14	2				17
100.5																6	6				12
102.5																4	7				11
104.5																	3				3
106.5																					0
108.5																	1				1
110.5																			1		1
Total	0	29	81	155	397	1102	1240	1116	630	452	266	237	182	169	161	78	23	0	1	0	6319

Table 2c. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1991. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5																					0
14.5																					0
16.5																					0
18.5																					0
20.5																					0
22.5																					0
24.5																					0
26.5																					0
28.5				1																	1
30.5				5																	5
32.5				1	6																7
34.5				2	17																19
36.5					45	9															54
38.5				1	57	52															110
40.5					18	129	3														150
42.5					5	122	41														168
44.5					1	52	110														163
46.5						26	141	6													173
48.5						4	116	54													174
50.5							48	119													167
52.5							9	156	1												166
54.5							3	122	25												150
56.5								50	90												140
58.5								7	118	1											126
60.5								1	93	20											114
62.5							1	3	44	58											106
64.5									10	83	2										95
66.5									1	65	20										86
68.5										25	47	1									73
70.5										5	49	6									60
72.5										1	30	22									53
74.5									2	1	17	32									52
76.5											1	43	4								48
78.5												24	14								38
80.5										2	4	5	30	5							46
82.5											2	3	27	6	1						39
84.5											3	1	23	10	3						40
86.5											1	1	3	25	3						33
88.5											1		1	18	7						27
90.5											1	1		14	8						24
92.5											1			6	11	1					19
94.5															5	1	1				7
96.5															7	1	1				9
98.5															4	2	2				8
100.5															2	2					4
102.5															1	1					2
104.5																2	1				3
106.5																					0
108.5																					0
110.5																					0
Total	0	0	0	10	149	394	472	518	384	261	179	139	102	84	52	10	5	0	0	0	2759

Table 2d. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1992. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5																					0
14.5																					0
16.5																					0
18.5	1																				1
20.5																					0
22.5		1	2																		3
24.5		1	3																		4
26.5			3	1																	4
28.5			3	1																	4
30.5			3	3																	6
32.5				8	2																10
34.5				6	16	2															24
36.5				5	24	5															34
38.5				1	25	49	5														80
40.5					10	76	15														101
42.5					9	70	43														122
44.5					3	15	102														120
46.5					3	11	101	6													121
48.5						9	94	20													123
50.5						5	21	105													131
52.5						1	12	128	1												142
54.5							5	111	13												129
56.5							2	67	60												129
58.5							1	25	118	3											147
60.5								6	113	17											136
62.5								1	75	53	1										130
64.5									19	99	2										120
66.5									4	60	29										93
68.5									2	22	68	1									93
70.5										10	54	16									80
72.5										2	23	38									63
74.5										1	8	55	2								66
76.5											5	47	17								69
78.5												12	43	4							59
80.5												8	44	11							63
82.5												3	31	16	3						53
84.5												3	21	24	9						57
86.5													6	40	8						54
88.5													2	25	18						45
90.5														12	7	12					31
92.5														5	15	8					28
94.5														1	7	8	2				18
96.5															4		3				7
98.5															2						2
100.5															2		1				3
102.5															1						1
104.5																					0
106.5																					0
108.5																					0
110.5																					0
Total	1	2	14	25	92	243	401	469	405	267	190	183	166	138	76	28	6	0	0	0	2706

Table 2e. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1993. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5																					0
14.5	1	1																			2
16.5	1																				1
18.5	1	3																			4
20.5		1	1																		2
22.5		1	4																		5
24.5			5																		5
26.5			2	1	1																4
28.5			1		1																2
30.5				2	1																3
32.5				2	3	1															6
34.5				1	14	2															17
36.5					45	6															51
38.5					39	45	3														87
40.5					11	120	5														136
42.5					5	104	39														148
44.5					3	32	117														152
46.5						16	148	9													173
48.5						8	131	57													196
50.5						1	57	149													207
52.5							18	168	4												190
54.5							2	161	39												202
56.5								74	119	1											194
58.5								16	182	11											209
60.5								3	137	65											205
62.5									55	123	10										188
64.5									20	125	23										168
66.5									3	70	69	6									148
68.5										14	82	12									108
70.5										5	72	32									109
72.5											23	74									97
74.5											5	74	12								91
76.5											1	48	36	1							86
78.5											1	42	37	6							86
80.5											1	12	62	15							90
82.5												1	48	31	1						81
84.5													28	40	8						76
86.5													11	32	21	2					66
88.5													4	29	32	3					68
90.5													1	7	21	14	1				44
92.5														2	16	19					37
94.5														3	8	9	6				26
96.5															6	9	3				18
98.5														1	1	9	0				11
100.5																2	6				8
102.5																1	2				3
104.5																	1				1
106.5																	1	1			2
108.5																		1			1
110.5																					0
Total	3	6	13	6	123	335	520	637	559	414	287	301	239	167	114	68	20	2	0	0	3814

Table 2f. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1994. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5																					0
14.5																					0
16.5		2																			2
18.5		3																			3
20.5			7																		7
22.5			7																		7
24.5			2	4																	6
26.5				3																	3
28.5				1																	1
30.5				3																	3
32.5				1	2																3
34.5					6																6
36.5					17	2															19
38.5					8	23															31
40.5						35	2														37
42.5						30	11														41
44.5						7	38	1													46
46.5						1	46	2													49
48.5							31	22													53
50.5							13	42													55
52.5							4	38	5												47
54.5								43	14												57
56.5								21	41												62
58.5								6	57	5											68
60.5								2	49	22											73
62.5									23	43	2	1									69
64.5									5	48	15										68
66.5									2	22	32	1									57
68.5										1	39	5									45
70.5											32	12	1								45
72.5											16	24	2								42
74.5											2	21	8	1							32
76.5												20	14	2							36
78.5												6	20	3							29
80.5												2	21	7							30
82.5												2	15	9	1						27
84.5													12	17	1						30
86.5													5	13	9	2					29
88.5													1	15	4	1					21
90.5													2	8	8	1					19
92.5														3	8	1					12
94.5														2	6						8
96.5														1	3	2					6
98.5															1						1
100.5																					0
102.5																1	1				2
104.5																	1				1
106.5																					0
108.5																					0
110.5																					0
Total	0	5	16	12	33	98	145	177	196	141	138	94	101	81	41	8	2	0	0	0	1288

Table 2g. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1995. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5																					0
14.5																					0
16.5																					0
18.5																					0
20.5																					0
22.5																					0
24.5																					0
26.5																					0
28.5																					0
30.5				3																	3
32.5				2	3																5
34.5				2	5																7
36.5					10																10
38.5					3	14															17
40.5				1	3	17															21
42.5						15	9														24
44.5						3	31	2													36
46.5							39	2													41
48.5						1	33	15													49
50.5							17	31													48
52.5							3	49	3												55
54.5								39	12												51
56.5								17	32	2											51
58.5								3	50												53
60.5									49	2											51
62.5									18	22											40
64.5									1	35	2										38
66.5										25	14										39
68.5										5	26	6									37
70.5										1	17	12	1								31
72.5											8	9	3								20
74.5											1	14	3								18
76.5												8	9	1							18
78.5												3	14	1							18
80.5													13	2							15
82.5												1	8	3		1					13
84.5													5	6	4						15
86.5													2	11	4						17
88.5															4	3					7
90.5															2	4					6
92.5															1	6	2				9
94.5															1	2	4				7
96.5																	1				1
98.5																	2				2
100.5																	2				2
102.5																					0
104.5																					0
106.5																					0
108.5																					0
110.5																					0
Total	0	0	0	8	24	50	132	158	165	92	68	53	58	24	16	16	11	0	0	0	875

Table 2h. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1996. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5																					0
14.5																					0
16.5																					0
18.5																					0
20.5	1																				1
22.5																					0
24.5																					0
26.5																					0
28.5		2																			2
30.5			5																		5
32.5				4	4																8
34.5				1	31																32
36.5				1	55	8															64
38.5					14	64															78
40.5					3	91	1														95
42.5					1	81	25														107
44.5						19	89														108
46.5						2	112														114
48.5							103	11													114
50.5							76	38													114
52.5							11	100	3												114
54.5							3	86	6												95
56.5								51	66	1											118
58.5								9	104	2											115
60.5								3	96	9											108
62.5									38	64	6										108
64.5									7	71	10	1									89
66.5										48	30	4									82
68.5										11	51	3									65
70.5										2	41	15	2								60
72.5											16	27	6								49
74.5											7	32	11								50
76.5												20	17	1							38
78.5												9	22	6							37
80.5												3	21	13							37
82.5													17	13	1						31
84.5												2	11	11	6						30
86.5													4	11	1	1					17
88.5													2	6	11						19
90.5													1	5	4	1					11
92.5														3	3	3	1				10
94.5														2	1	2					5
96.5																					0
98.5															2	1					3
100.5																					0
102.5																	1				1
104.5																					0
106.5																					0
108.5																					0
110.5																					0
Total	0	1	2	11	108	265	420	298	320	208	161	116	114	71	29	8	2	0	0	0	2134

Table 2i. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1997. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5																					0
14.5																					0
16.5																					0
18.5																					0
20.5																					0
22.5																					0
24.5			1																		1
26.5				5																	5
28.5			1	6	2																9
30.5				6	13																19
32.5				9	26	2															37
34.5				3	27	24															54
36.5				1	51	43															95
38.5					38	77	20														135
40.5					3	104	49														156
42.5						74	82														156
44.5						6	151	11													168
46.5						3	151	21													175
48.5						2	113	65													180
50.5							72	98	1												171
52.5							13	132	21												166
54.5							1	100	50	1											152
56.5								49	89	2											140
58.5								4	88	32											124
60.5									65	40	1										106
62.5									5	48	13										66
64.5									1	26	30										57
66.5										10	26	5									41
68.5										1	23	9									33
70.5											8	17									25
72.5											2	15	2								19
74.5												15	4	1							20
76.5												3	8	2							13
78.5												2	12	3							17
80.5													13	4	1						18
82.5													4	5	3						12
84.5													1	4	6						11
86.5														3	2	1					6
88.5														1	1	2					4
90.5															1	2					3
92.5																1					1
94.5																					0
96.5																					0
98.5																					0
100.5																					0
102.5																					0
104.5																					0
106.5																					0
108.5																					0
110.5																					0
Total	0	0	2	30	160	335	652	480	320	160	103	66	44	23	14	6	0	0	0	0	2395

Table 2j. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1998. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5	6																				6
14.5	8																				8
16.5		8																			8
18.5		8																			8
20.5		6	2																		8
22.5		2	6																		8
24.5			6	2																	8
26.5			4	4																	8
28.5			2	6																	8
30.5				8																	8
32.5				5	6																11
34.5				2	19	1															22
36.5					23	2															25
38.5					17	27															44
40.5					3	48	4														55
42.5					1	57	21														79
44.5						18	73	1													92
46.5						1	95	9													105
48.5						1	82	32													115
50.5							36	73													109
52.5							8	95	2												105
54.5								91	10												101
56.5								32	60	2											94
58.5								7	85	3											95
60.5								3	77	6											86
62.5									32	56											88
64.5									4	71	7										82
66.5										37	36										73
68.5										14	47										61
70.5											49	8									57
72.5											13	22									35
74.5											4	26	2								32
76.5											2	22	6								30
78.5												6	23	2							31
80.5												5	11	10							26
82.5												1	17	5	7						30
84.5												1	20	5	3	2					31
86.5													3	14	12						29
88.5														8	3						11
90.5													1	4	1	4					10
92.5															4	4	2				10
94.5															3						3
96.5																2					2
98.5																1					1
100.5																2					2
102.5																					
104.5																					
106.5																					
108.5																					
110.5																					
Total	14	24	20	27	69	155	319	343	270	189	158	91	83	48	33	15	2	0	0	0	1860

Table 2k. Age-Length key from Canadian Port Sampling (PORT) & Observer Program Sampling (OPSS) combined for 1999. The key is a composite of all samples collected throughout the entire year from Subarea 2 and Divisions 3KLMNO combined.

Age/Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
12.5																					0
14.5																					0
16.5																					0
18.5																					0
20.5																					0
22.5																					0
24.5																					0
26.5																					0
28.5																					0
30.5				2																	2
32.5					8																8
34.5				3	28	4															35
36.5					33	11															44
38.5					4	50	2														56
40.5						58	5														63
42.5						47	37														84
44.5						3	107		1												111
46.5							112	4													116
48.5							97	34													131
50.5							86	54													140
52.5							24	119													143
54.5							1	122	16												139
56.5								64	58												122
58.5								5	116												121
60.5								1	109	12											122
62.5									31	80											111
64.5									1	106	6										113
66.5										45	45										90
68.5										4	87										91
70.5											38	31									69
72.5										1	15	55									71
74.5											1	63	4								68
76.5												38	26								64
78.5												8	46	8							62
80.5												1	31	32	1						65
82.5													27	20	6						53
84.5													9	14	17						40
86.5													2	14	17						33
88.5														10	12						22
90.5														3	8	7					18
92.5															2	4					6
94.5																3	4				7
96.5																1	1				2
98.5																2	1	1			4
100.5																1					1
102.5																					
104.5																					
106.5																					
108.5																					
110.5																					
Total	0	0	0	5	73	173	471	403	332	248	192	196	145	101	63	18	6	1	0	0	2427

Table 3. Catch biomass (tons) at age matrix for Greenland halibut catches by **all countries** for Subarea 2+ Div. 3KLMNO from **1975-99**.

Age (yrs)	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	54	307	234	1058	93	46	69	126	75
5	203	10	326	1816	1453	108	338	141	289	340	1127	98	50	107	72	373	1096	1797	3517	5438	491	597	639	1333	770
6	2142	464	3809	6396	6633	1375	2701	1572	2237	1355	3977	1308	1120	1813	1116	3693	4591	6299	8708	8132	1244	2812	2040	2936	3000
7	5491	3086	10312	8566	12247	7951	7737	5630	8438	4827	5564	5200	9199	6550	5735	9677	10932	16364	14337	8778	2587	5312	5816	4689	7108
8	5898	6441	8742	9015	7302	10163	11279	6512	8867	8450	4340	5600	10365	5094	4622	8454	13255	15056	14382	7946	2560	2433	3726	4394	4752
9	6258	5955	4634	4527	1847	6207	5341	4958	3787	5967	2331	2321	4508	2139	2457	6549	12937	7866	8021	5240	2081	1722	1966	2518	2779
10	3730	4874	2238	3177	1063	4823	1513	3015	1542	2443	1147	999	1817	1030	1716	5850	9159	4338	4240	2502	1320	1249	1427	1272	1425
11	1895	2237	594	1952	774	1591	629	1419	630	1070	468	704	1082	605	1313	3437	6171	3161	3165	2425	1076	1372	1283	1166	990
12	454	877	439	1236	501	348	497	889	301	499	367	543	1012	414	1031	3303	5037	2931	3821	1591	1042	900	971	645	1074
13	1082	394	451	863	556	167	204	734	537	477	423	345	1039	543	714	2037	2975	2016	1933	1561	1228	707	698	471	645
14	619	147	137	496	419	64	171	466	515	331	293	341	920	382	293	1229	1743	1319	648	960	504	352	334	197	459
15	387	112	123	340	492	47	172	471	495	526	154	280	706	403	143	644	982	650	325	333	380	147	150	91	270
16	303	6	181	381	437	14	121	286	79	245	128	224	445	111	8	130	163	201	168	64	346	46	68	23	100
17	352	7	64	304	380	10	51	183	145	181	28	12	179	25	10	26	100	58	39	0	134	20	0	2	45
Total	28814	24611	32048	39070	34104	32867	30754	26278	27861	26711	20347	17976	32442	19215	19230	45421	69194	62362	63540	46029	15085	17714	19186	19861	23492
Accepted catch (t)	28814	24611	32048	39070	34104	32867	30754	26278	27861	26711	20347	17976	32442	19215	20034	47454	65008	63193	62455	51029	15272	18840	19858	19946	24226
Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	0.96	1.06	0.99	1.02	0.90	0.99	0.94	0.97	1.00	0.97

Table 4. Catch numbers at age (000s) matrix for Greenland halibut catches by **all countries** for Subarea 2+ Div. 3KLMNO from **1975-99**.

Age (yrs)	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4															0	95	220	1064	1010	5395	323	190	335	552	297
5	334	17	534	2982	2386	209	863	269	701	902	1983	280	137	296	181	1102	2862	4180	9570	16500	1352	1659	1903	3575	2149
6	2819	610	5012	8415	8727	2086	4517	2299	3557	2324	5309	2240	1902	3186	1988	6758	7756	10922	15928	15815	2342	5197	4169	5407	5625
7	5750	3231	10798	8970	12824	9150	9806	6319	9800	5844	5913	6411	11004	8136	7480	12632	13152	20639	17716	11142	3201	6387	7544	5787	8611
8	4956	5413	7346	7576	6136	9679	11451	5763	7514	7682	3500	5091	8935	4380	4273	7557	10796	12205	11918	6739	2130	1914	3215	3653	3793
9	3961	3769	2933	2865	1169	5398	4307	3542	2295	4087	1380	1469	2835	1288	1482	4072	7145	4332	4642	3081	1183	956	1139	1435	1659
10	1688	2205	1013	1438	481	3828	890	1684	692	1259	512	471	853	465	767	2692	3721	1762	1836	1103	540	504	606	541	623
11	702	829	220	723	287	1013	256	596	209	407	159	244	384	201	438	1204	1865	1012	1055	811	345	436	420	377	343
12	135	260	130	367	149	128	142	256	76	143	99	140	281	105	267	885	1216	738	964	422	273	233	246	161	306
13	279	101	116	222	143	53	43	163	106	106	87	70	225	107	145	434	558	395	401	320	251	143	137	92	145
14	136	32	30	109	92	14	29	80	85	58	48	56	168	62	49	212	271	214	113	161	85	60	57	33	88
15	65	19	21	57	83	9	21	63	68	77	21	37	106	53	20	89	124	91	45	45	55	21	23	14	44
16	43	1	25	53	61	2	14	33	9	29	14	23	57	12	1	14	17	24	20	9	47	6	8	3	13
17	45	1	8	39	48	1	5	16	13	19	2	1	18	2	1	3	11	6	4	0	15	2	0	0	5
Total	20910	16489	28186	33817	32587	31572	32343	21082	25125	22937	19029	16533	26904	18292	17093	37751	49712	57585	65223	61542	12140	17707	19800	21629	23702

Table 5. Commercial Greenland halibut mean weights at age (kg) for Subarea 2 and Div. 3KL (1975-88) and SA2+Div. 3KLMNO (1989-99).

Age (yrs)	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2																		0.090	0.062	0.038				0.058	0.145
3																0.090	0.126	0.175	0.134	0.080		0.161	0.120	0.119	0.176
4																0.181	0.244	0.289	0.232	0.196	0.288	0.242	0.206	0.228	0.253
5	0.609	0.609	0.609	0.609	0.609	0.514	0.392	0.525	0.412	0.377	0.568	0.350	0.364	0.363	0.400	0.338	0.383	0.430	0.368	0.330	0.363	0.360	0.336	0.373	0.358
6	0.760	0.760	0.760	0.760	0.760	0.659	0.598	0.684	0.629	0.583	0.749	0.584	0.589	0.569	0.561	0.546	0.592	0.577	0.547	0.514	0.531	0.541	0.489	0.543	0.533
7	0.955	0.955	0.955	0.955	0.955	0.869	0.789	0.891	0.861	0.826	0.941	0.811	0.836	0.805	0.767	0.766	0.831	0.793	0.809	0.788	0.808	0.832	0.771	0.810	0.825
8	1.190	1.190	1.190	1.190	1.190	1.050	0.985	1.130	1.180	1.100	1.240	1.100	1.160	1.163	1.082	1.119	1.228	1.234	1.207	1.179	1.202	1.272	1.159	1.203	1.253
9	1.580	1.580	1.580	1.580	1.580	1.150	1.240	1.400	1.650	1.460	1.690	1.580	1.590	1.661	1.657	1.608	1.811	1.816	1.728	1.701	1.759	1.801	1.727	1.754	1.675
10	2.210	2.210	2.210	2.210	2.210	1.260	1.700	1.790	2.230	1.940	2.240	2.120	2.130	2.216	2.237	2.173	2.461	2.462	2.309	2.268	2.446	2.478	2.355	2.351	2.287
11	2.700	2.700	2.700	2.700	2.700	1.570	2.460	2.380	3.010	2.630	2.950	2.890	2.820	3.007	2.997	2.854	3.309	3.122	2.999	2.990	3.122	3.148	3.053	3.095	2.888
12	3.370	3.370	3.370	3.370	3.370	2.710	3.510	3.470	3.960	3.490	3.710	3.890	3.600	3.925	3.862	3.731	4.142	3.972	3.965	3.766	3.813	3.856	3.953	4.010	3.509
13	3.880	3.880	3.880	3.880	3.880	3.120	4.790	4.510	5.060	4.490	4.850	4.950	4.630	5.091	4.919	4.691	5.333	5.099	4.816	4.882	4.893	4.953	5.108	5.132	4.456
14	4.560	4.560	4.560	4.560	4.560	4.420	5.940	5.850	6.060	5.730	6.130	6.090	5.480	6.203	6.000	5.805	6.437	6.173	5.742	5.963	5.952	5.881	5.893	5.884	5.195
15	5.920	5.920	5.920	5.920	5.920	5.040	8.060	7.530	7.310	6.850	7.160	7.640	6.670	7.644	7.041	7.257	7.928	7.145	7.176	7.430	6.902	6.857	6.608	6.445	6.131
16	7.140	7.140	7.140	7.140	7.140	7.020	8.710	8.680	8.600	8.330	8.920	9.810	7.850	9.187	7.547	9.006	9.724	8.243	8.511	7.545	7.451	7.918	8.183	7.269	7.481
17	7.890	7.890	7.890	7.890	7.890	10.100	9.580	11.500	11.300	9.570	11.800	10.100	9.840	11.444	9.659	10.050	9.433	9.490	9.823	**9.456**	9.089	8.361	**8.290**	8.218	8.623

Table 6. Catch at age, mean lengths and weights at age, and related statistics for Greenland halibut caught in the Canadian zone in 1998. Includes catches by France in Div. 2J.

Otter trawl

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
* 4	0.272	32.676	2	0.64	0.36
* 5	0.412	37.122	52	3.52	0.07
6	0.580	41.250	116	5.97	0.05
7	0.853	46.391	204	7.21	0.04
8	1.239	52.072	133	5.76	0.04
* 9	1.754	57.983	44	2.87	0.07
10	2.363	63.528	14	1.43	0.10
*11	3.002	68.420	8	0.90	0.11
*12	3.799	73.575	2	0.44	0.19
*13	4.795	79.020	1	0.30	0.28
*14	5.551	82.668	1	0.25	0.23
*15	7.977	92.500			0.01
*16	9.787	98.500			0.01

Fixed gear

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
5	0.494	39.209	8	2.49	0.30
6	0.650	42.741	101	10.12	0.10
* 7	0.906	47.284	590	23.79	0.04
8	1.253	52.202	664	25.05	0.04
9	1.832	58.740	399	16.67	0.04
10	2.435	64.144	246	14.86	0.06
*11	3.070	68.870	210	13.38	0.06
12	4.116	75.307	76	7.41	0.10
13	5.067	80.286	44	5.48	0.12
14	6.089	84.919	14	2.42	0.17
15	6.538	86.841	5	1.09	0.23
16	7.733	91.385	1	0.32	0.31
17	7.977	92.500		0.04	0.70

Total

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
* 4	0.272	32.676	2	0.64	0.36
* 5	0.424	37.406	60	4.31	0.07
6	0.613	41.947	217	11.75	0.05
* 7	0.892	47.054	794	24.86	0.03
8	1.250	52.181	798	25.70	0.03
* 9	1.824	58.665	444	16.92	0.04
10	2.432	64.111	260	14.93	0.06
*11	3.067	68.853	218	13.41	0.06
*12	4.107	75.257	79	7.42	0.09
*13	5.061	80.256	45	5.49	0.12
*14	6.051	84.763	15	2.43	0.16
*15	6.553	86.901	5	1.09	0.23
*16	7.820	91.687	1	0.32	0.30
17	7.977	92.500		0.04	0.70

Table 7. Catch at age, mean lengths and weights at age, and related statistics for Greenland halibut caught in the Canadian zone in 1999. Includes catches by France in Div. 2J.

Otter trawl

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
★ 4	0.265	32.160	1	0.22	0.31
★ 5	0.373	35.940	22	2.11	0.10
★ 6	0.533	40.205	101	4.96	0.05
7	0.816	45.949	143	5.35	0.04
8	1.221	52.277	52	2.98	0.06
9	1.721	58.301	17	1.24	0.07
10	2.275	63.776	4	0.60	0.14
★11	2.766	67.868	1	0.32	0.23
★12	3.302	71.781	1	0.11	0.16
13	4.834	80.924		0.03	0.55
14	5.256	83.172		0.01	0.96
15	5.439	84.100		0.03	1.14
16	7.858	94.500		0.03	1.65
17	7.858	94.500		0.03	1.65

Fixed gear

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
★ 5	0.363	35.678			0.01
★ 6	0.593	41.667	56	6.35	0.11
★ 7	0.938	48.038	625	26.14	0.04
★ 8	1.265	52.881	604	27.36	0.05
9	1.734	58.444	245	12.76	0.05
10	2.324	64.185	173	10.85	0.06
★11	2.883	68.733	150	13.29	0.09
★12	3.544	73.369	127	11.74	0.09
★13	4.534	79.322	64	5.69	0.09
★14	5.270	83.146	34	4.17	0.12
★15	5.918	86.292	17	2.57	0.15
★16	7.509	93.073	4	1.00	0.28
★17	8.008	95.049	2	0.81	0.49
★18	8.957	98.500			0.03

Total

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
★ 4	0.265	32.160	1	0.22	0.31
★ 5	0.373	35.938	22	2.11	0.09
★ 6	0.554	40.726	157	8.06	0.05
★ 7	0.915	47.650	767	26.68	0.03
★ 8	1.261	52.833	655	27.52	0.04
9	1.733	58.434	262	12.82	0.05
10	2.323	64.175	177	10.87	0.06
★11	2.882	68.725	151	13.29	0.09
★12	3.543	73.360	128	11.74	0.09
★13	4.534	79.323	64	5.69	0.09
★14	5.270	83.146	34	4.17	0.12
★15	5.917	86.289	17	2.57	0.15
★16	7.510	93.081	4	1.00	0.28
★17	8.006	95.043	2	0.81	0.49
★18	8.957	98.500			0.03

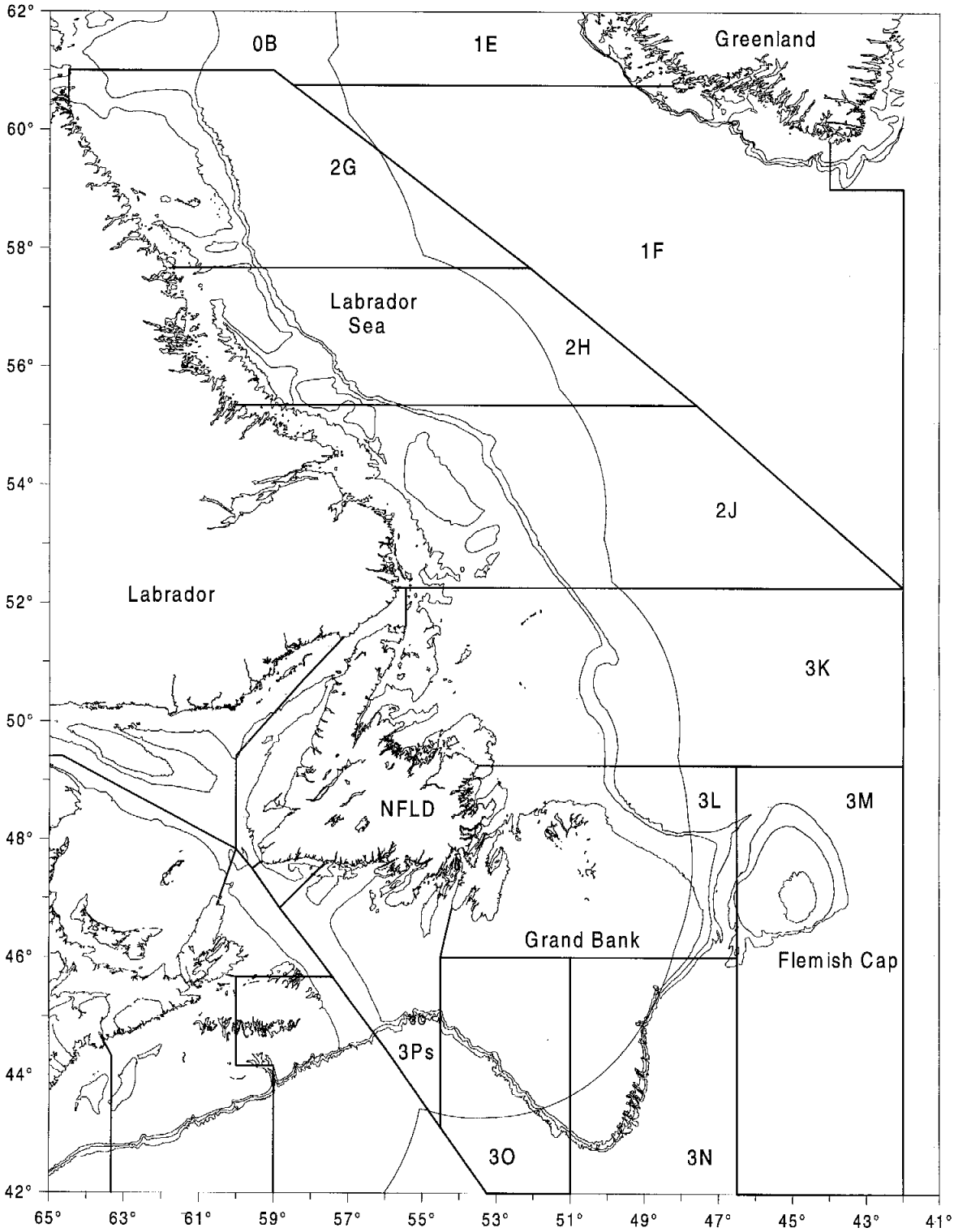

Fig. 1 Map of major place names and NAFO Divisions in the Newfoundland -Labrador area of the Northwest Atlantic.

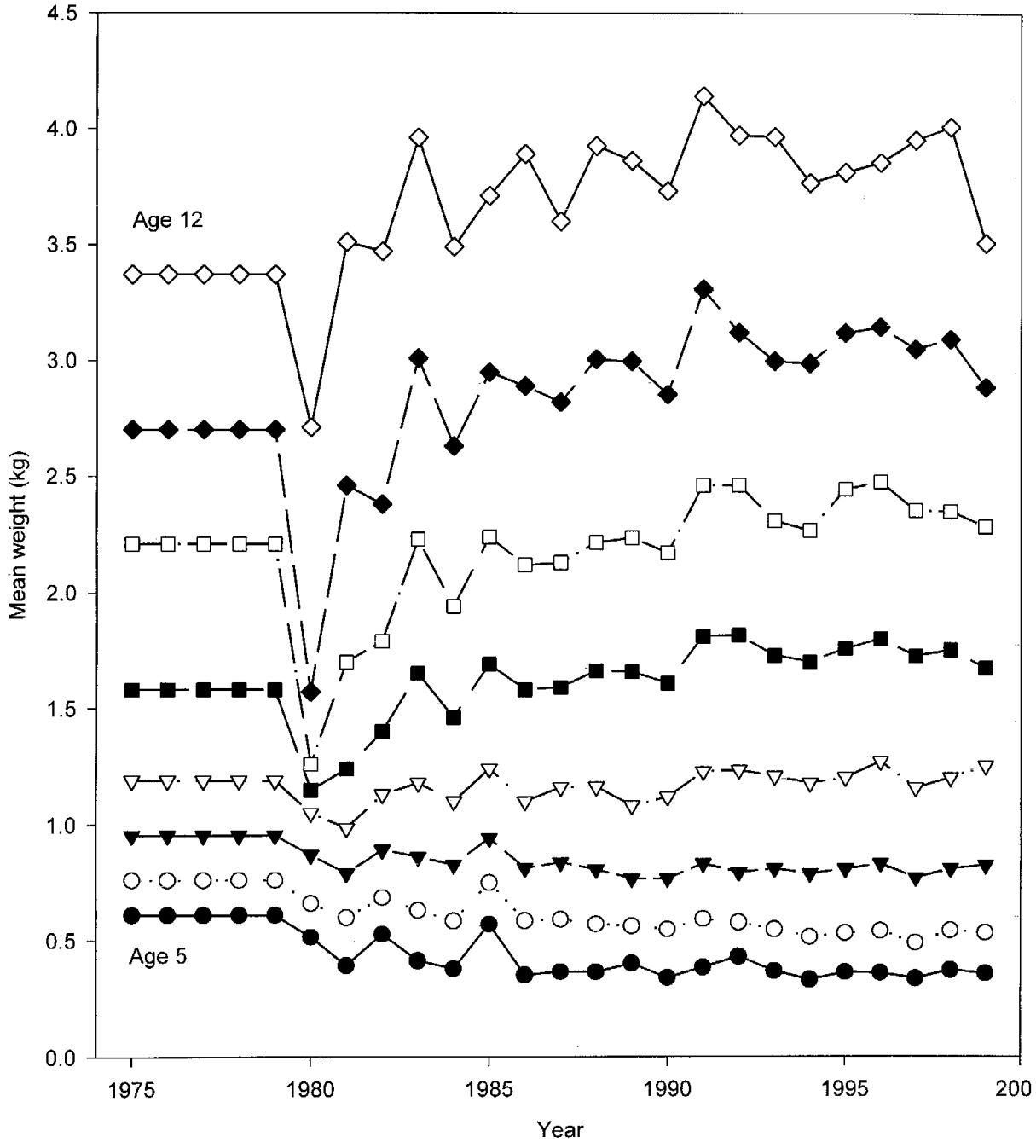

Fig. 2 Mean weights (kg) at age of commercial Greenland halibut in NAFO Subarea 2 and Divisions 3KLMNO from 1975-99. Only ages 5-12 are shown.

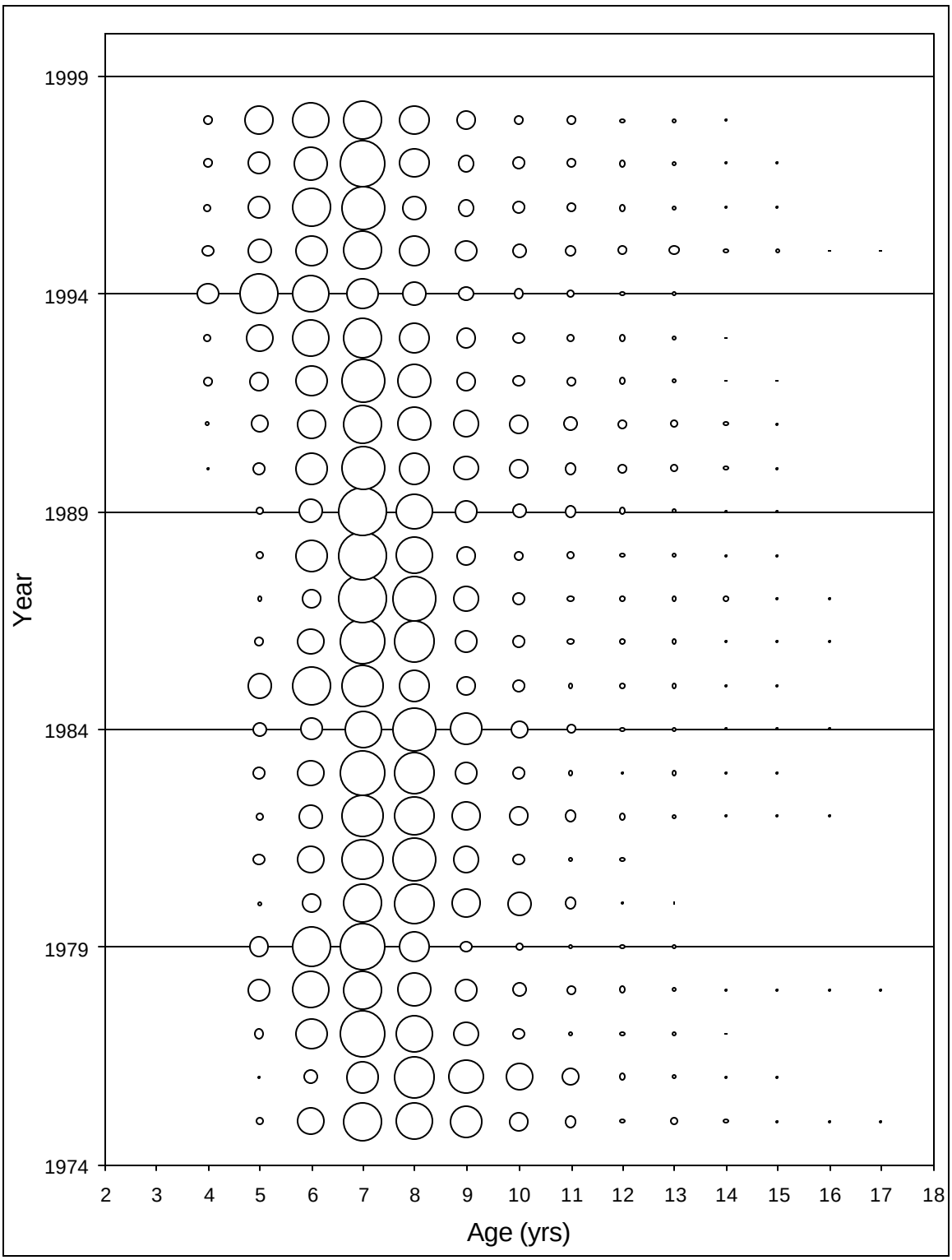

Figure 3. Proportions caught at age (yrs) of Greenland halibut in the commercial fishery in NAFO Subarea 2 and Divisions 3KLMNO during 1975-98.