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Results of the Spanish Experimental Fishing in NAFO Subarea 1

by

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Abstract

An experimental fishing was carried out with a commercial Spanish vessel from October to December of the year 2003 in the Subarea 1. The main objective of the experimental fishing was to search for cephalopods species concentrations inside the territorial waters of Greenland. During the experimental fishing a scientific observer stayed on board to collect effort data, catches and yields by haul and Division, strata and gear. The observer carried out length distributions samplings of the following species: *Pandalus borealis*, *Sebastes spp.*, *Hippoglossoides platessoides*, *Gadus morhua* and *Macrourus berglax*. Biological samplings of *Reinhardtius hippoglossoides*, *Hippoglossoides platessoides*, *Gadus morhua* and *Gadus ogac* were also carried out. Greenland halibut was the main species caught and the cephalopods, target species, have not been found in the experimental fishing.

Introduction

Gonatus fabricii (Lichtenstein, 1818) is the most abundant squid of the arctic and subarctic waters of the North Atlantic and has been intensively studied by Nesis (1965) and Kristensen (1984). Piatkowski and Wieland (1993) based on the high occurrences of early life stages indicated that this species has a remarkable fishery potential in West Greenland waters.

A Spanish experimental fishing targeted to cephalopods concentrations inside the Economic Exclusive Zone of West Greenland waters has been conducted according to the Fourth Fisheries Protocol between the European Community and the Government of Denmark with the Local Government of Greenland (COM, 2002).

The aim of this exploratory fishing was the localization of concentrations in order to allow a potential cephalopods fishery in Greenland Western waters.

Material and Methods

The experimental fishing was carried out from Oct 16th to Dec 11th in 2003 (Del Río and Lorenzo, 2004; Del Río *et al.*, 2004). The area covered was NAFO Divisions 1ABCD between 6 nautical miles basin line and the 200 nautical miles line or the midline to Canada at depths between 26 and 1 456 m. According to indications of Greenland Authorities the fishing area was delimited from Nov 1st to Dec 9th between degrees 67° and 68°N (Div. 1B). The explored area is stratified in NAFO Divisions and subdivided in six depth strata: 0-200, 201-500, 501-700, 701-900, 901-1 100 and 1 101-1 500 m on basis of depth contour lines.

The fishing was conducted by the bottom trawler C/V *Iván Nores*. This vessel has 378 GRT and an Engine Power of 1500 HP. The gear used was a bottom trawl with a mesh size of 40 mm in the codend. Two types of bottom trawl

net were used, one type with a vertical opening of 3 m (BT) and the other one with a high-opening of 7 m (BT-GOV). Towing trawl was usually one hour and the towing average speed was 3.0 kn.

After each haul the catch was sorted by species and weighed. Due to difficulties in identification of species, redfishes were classified as *Sebastes spp.* Greenland halibut, redfish, American plaice and Atlantic cod were sexed and measured to the total length (TL) and to 1.0 cm below. Roughhead grenadier was measured to the pre anal fin length (AFL) and to 0.5 cm below. Northern shrimp was measured to the oblique carapace length (CL), the distance from the base of the eye to the posterior dorsal edge and to 0.5 mm below. Biological sampling on Greenland halibut, American plaice, Atlantic cod and Greenland cod was also carried out by the scientific observer.

Otoliths of Greenland halibut (232) and Atlantic cod (262) were collected for age determination.

Results

The number of valid hauls by Division, month and gear is given in Table 1. A total of 125 hauls were completed in NAFO Subarea 1. Only 9 hauls were performed with the high-opening net (BT-GOV). The highest number of hauls was realized on November in Div. 1B. The position of the hauls carried out with bottom trawl (BT) and with high-opening bottom trawl (BT-GOV) is shown in Fig. 1 and 2, respectively.

The distribution of the fishing effort (hours) by division, strata and gear is presented in Table 2. A total of 153 towing hours were made in the experimental fishing: 144 hours with bottom trawl of a vertical opening of 3 m (BT) and 9 hours with high-opening bottom trawl of 7 m (BT-GOV). Results show that more than 57% of fishing effort is performed in the strata 201-500 m and 1 101-1 500 m.

Table 3 shows total catches for the main species by Division and gear. Species with catches lower than 40 kg were grouped in others species. The number of species found and classified in the exploratory area was 79 (ANNEX 1) and the total catch in the experimental fishing was 85 714 kg. The catches of cephalopods, which were the target species, were very low with only 14 kg during the experimental fishing in Div. 1ABD. The main species caught was Greenland halibut (75 217 kg) mainly in Div. 1A (65 225 kg). Other less important species in the catches were northern shrimp, arctic skate, redfish and American plaice. The catch of each one of the remaining species during the experimental fishing was lower than 250 kg.

The unstandardized catch rates (kg/hour) by Division, strata and gear are presented in Table 4. The highest yield was for Greenland halibut, with around 1450 kg/h in strata 901-1 100 m and Div. 1A. CPUE of northern shrimp and arctic skate were 97 kg/h (stratum 201-500 m in Div. 1B) and 70 kg/h (stratum 901- 1 100 m in Div. 1A), respectively. The yields for the others species were very low. Yields with the high-opening net (BT-GOV) were also quite poor, except for northern shrimp in Div. 1B, with a yield of 61 kg/h in stratum 201-500 m.

Length distributions of total catches for Greenland halibut in Div. 1ABD with the bottom trawl gear (BT) are presented in Table 5. In Div. 1A the length distribution ranged between 30 and 85 cm, with two modes around 44-45 cm and 48-49 cm. In Div. 1B, the length distribution ranged between 20 and 87 cm, with one mode around 40-41 cm. Finally, in Div. 1D, the length distribution ranged from 39 to 61 cm, with a mode in 44-45 cm. According to these results, size of individuals increased with depth strata. Jorgensen (2003) also reported the same increase in Div. 1CD. Greenland halibut percentages of total length frequency distribution by Division are illustrated in Fig. 3.

Length distributions for northern shrimp in Div. 1B by sex and gear are presented in Table 6. Males length distribution obtained with bottom trawl (BT) presented a CL between 11.5 and 24 mm, with one mode in 20 mm CL. Females presented a CL from 15 to 29.5 mm and one mode in 20 mm CL. The length distribution obtained with high-opening bottom trawl (BT-GOV) presented a CL between 14 and 24.5 mm for males, with one clear mode in 18 mm and for females the length range was between 16.5 and 26.5 mm CL, with one mode in 20.5 mm CL. Percentage length frequency distributions by sex and gear in Div. 1B are illustrated in Fig. 4.

The length frequency distributions of redfish by month and gear in Div. 1B are presented in Table 7. The length distribution ranged between 5 and 41 cm, with a clear mode in 11 cm in both gears.

Table 8 shows length distributions for American plaice in Div. 1B by month and gear. Length distributions of roughhead grenadiers in Div. 1D with the bottom trawl gear (BT) are presented in Table 9.

Length-weight relationship for Greenland halibut, Atlantic cod, Greenland cod and American plaice are presented in Fig. 5. Length-weight equations for this species in this experimental fishing were the following:

For Greenland halibut:	$W = 0,0023 * TL^{3,3436}$	(N= 1020, $r^2=0,97$)
For Atlantic cod:	$W = 0,0046 * TL^{3,1642}$	(N= 296, $r^2=0,98$)
For Greenland cod:	$W = 0,0052 * TL^{3,2383}$	(N= 68, $r^2=0,95$)
For American plaice:	$W = 0,0073 * TL^{3,0625}$	(N= 50, $r^2=0,91$)

where W is weight in g and TL is the total length in cm.

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Table 1. Fishing effort in number valid hauls by Division, month and gear in the experimental fishing in the SA 1.

Bottom trawl (BT)					
Month	Div. 1A	Div. 1B	Div. 1C	Div. 1D	Total
October	14	4	-	-	18
November	-	87	-	-	87
December	-	6	2	3	11
TOTAL	14	97	2	3	116

High-opening bottom trawl (BT-GOV)					
Month	Div. 1A	Div. 1B	Div. 1C	Div. 1D	Total
October	-	-	-	-	-
November	-	9	-	-	9
December	-	-	-	-	-
TOTAL	-	9	-	-	9

Table 2. Fishing effort in hours by strata, Division and gear in the experimental fishing in the SA 1.

Bottom trawl (BT)					
Stratum (m)	Div. 1A	Div. 1B	Div. 1C	Div. 1D	Total
0- 200	-	18	2	-	20
201- 500	-	42	-	-	42
501- 700	-	9	-	-	9
701- 900	-	19	-	-	19
901-1100	15	1	-	-	16
1101-1500	33	-	-	3	36
TOTAL	48	90	2	3	144

High-opening bottom trawl (BT-GOV)					
Stratum (m)	Div. 1A	Div. 1B	Div. 1C	Div. 1D	Total
0- 200	-	-	-	-	-
201- 500	-	8	-	-	8
501- 700	-	-	-	-	-
701- 900	-	-	-	-	-
901-1100	-	-	-	-	-
1101-1500	-	-	-	-	-
TOTAL	-	8	-	-	8

Table 3. Total catches (kg) by Division and gear in the experimental fishing in SA1.

Scientific name	Div. 1A	Div. 1B		Div. 1C	Div. 1D	Total		TOTAL
	BT	BT	BT-GOV	BT	BT	BT	BT-GOV	
<i>Reinhardtius hippoglossoides</i>	65225	8079	17	5	1890	75200	17	75217
<i>Pandalus borealis</i>		4699	531	3		4702	531	5233
<i>Amblyraja hyperborea</i>	1425	2			3	1431		1431
<i>Sebastes spp.</i>		518	24	0	1	519	24	543
<i>Hippoglossoides platessoides</i>		479	42	8		487	42	529
<i>Gaidropsarus ensis</i>	204	23	0		16	244	0	244
<i>Gadus morhua</i>		172	31	19		190	31	221
<i>Amblyraja radiata</i>		155	12	3	1	160	12	172
<i>Macrourus berglax</i>	15	22	0		117	154		154
<i>Metacrangon jacqueti</i>		116				116		116
<i>Anarhichas lupus</i>		85	13	14	1	100	13	113
<i>Anarhichas minor</i>	35	58	1	1		94	1	95
<i>Liparididae</i>	1	79	11			80	11	91
<i>Bathyraja spinicauda</i>	80	5			1	86		86
<i>Chionocetes opilio</i>		71	0			71	0	71
<i>Lebbeus groenlandicus</i>		49				49		49
<i>Antimora rostrata</i>					47	47		47
<i>Lycodes reticulatus</i>	3	42	1			45	1	46
Others species	53	1081	37	38	48	1219	37	1256
TOTAL	67042	15734	722	90	2126	84992	722	85714

Table 4. Yields (kg/h) of the main species caught in the experimental fishing by Division, strata and gear.

Bottom trawl (BT)

Species	Stratum (m)	Div. 1A	Div. 1B	Div. 1C	Div. 1D	Total
<i>Reinhardtius hippoglossoides</i>	0- 200		0,1	2,5		0,4
	201- 500		6,5			6,5
	501- 700		143,6			143,6
	701- 900		309,8			309,8
	901-1100	1473,7	436,8			1396,7
	1101-1500	1267,8			630,0	1215,2
	<i>Total</i>		1333,4	81,7	2,5	630,0
<i>Pandalus borealis</i>	0- 200		4,8	1,3		4,5
	201- 500		97,7			97,7
	501- 700		11,5			11,5
	701- 900		0,1			0,1
	<i>Total</i>			52,8	1,3	
<i>Amblyraja hyperborea</i>	901-1100	70,6	1,8			65,5
	1101-1500	9,8			1,1	9,0
	<i>Total</i>	29,1	1,8		1,1	22,6
<i>Sebastes spp,</i>	0- 200		0,1	0,1		0,1
	201- 500		8,4			8,4
	501- 700		11,7			11,7
	701- 900		0,1			0,1
	901-1100		0,0			0,0
	1101-1500				0,4	0,4
	<i>Total</i>			5,5	0,1	0,4
<i>Hippoglossoides platessoides</i>	0- 200		2,2	4,2		2,4
	201- 500		6,9			6,9
	501- 700		10,5			10,5
	701- 900		1,6			1,6
	<i>Total</i>			5,3	4,2	
<i>Gaidropsarus ensis</i>	201- 500		0,0			0,0
	501- 700		0,1			0,1
	701- 900		1,1			1,1
	901-1100	2,5	1,1			2,4
	1101-1500	5,0			5,4	5,0
	<i>Total</i>	4,2	0,2		5,4	1,6
<i>Gadus morhua</i>	0- 200		0,8	9,2		1,7
	201- 500		3,6			3,6
	501- 700		0,1			0,1
	701- 900		0,2			0,2
	<i>Total</i>		2,1	9,2		1,5
<i>Amblyraja radiata</i>	0- 200		0,4	1,6		0,5
	201- 500		1,6			1,6
	501- 700		2,7			2,7
	701- 900		2,7			2,7
	1101-1500				0,5	0,5
	<i>Total</i>		1,7	1,6	0,5	1,1
<i>Macrourus berglax</i>	501- 700		1,1			1,1
	701- 900		0,6			0,6
	901-1100	0,2	0,2			0,2
	1101-1500	0,4			39,0	3,6
	<i>Total</i>	0,3	0,2		39,0	1,0

Table 4. (continuation).

High-opening bottom trawl (BT-GOV)

Species	Stratum (m)	Div. 1A	Div. 1B	Div. 1C	Div. 1D	Total
<i>Pandalus borealis</i>	201- 500		61,3			61,3
	<i>Total</i>		<i>61,3</i>			<i>61,3</i>
<i>Hippoglossoides platessoides</i>	201- 500		4,9			4,9
	<i>Total</i>		<i>4,9</i>			<i>4,9</i>
<i>Gadus morhua</i>	201- 500		3,6			3,6
	<i>Total</i>		<i>3,6</i>			<i>3,6</i>
<i>Sebastes spp,</i>	201- 500		2,8			2,8
	<i>Total</i>		<i>2,8</i>			<i>2,8</i>
<i>Reinhardtius hippoglossoides</i>	201- 500		1,9			1,9
	<i>Total</i>		<i>1,9</i>			<i>1,9</i>
<i>Amblyaja radiata</i>	201- 500		1,4			1,4
	<i>Total</i>		<i>1,4</i>			<i>1,4</i>
<i>Gaidropsarus ensis</i>	201- 500		0,1			0,1
	<i>Total</i>		<i>0,1</i>			<i>0,1</i>

Table 5. Greenland halibut length distributions samplings by Division in SA1 with bottom trawl (BT).

<u>Greenland halibut</u>	DIVISION				
	Length (TL) cm	1A	1B	1C	1D
20-21	0	70	0	0	70
22-23	0	105	0	0	105
24-25	0	283	0	0	283
26-27	0	782	0	0	782
28-29	0	1058	0	0	1058
30-31	76	996	0	0	1072
32-33	295	1388	0	0	1683
34-35	44	1404	0	0	1448
36-37	1038	1564	0	0	2602
38-39	2645	1439	0	38	4122
40-41	4656	1766	0	57	6479
42-43	8085	1509	0	133	9727
44-45	10604	1246	0	343	12193
46-47	8411	899	0	323	9633
48-49	10660	555	0	324	11539
50-51	7293	347	0	114	7754
52-53	5522	299	0	190	6011
54-55	3675	139	0	228	4042
56-57	1136	132	0	57	1325
58-59	559	48	0	38	645
60-61	336	34	0	57	427
62-63	336	31	0	0	367
64-65	277	10	0	0	287
66-67	0	10	0	0	10
68-69	108	0	0	0	108
70-71	0	10	0	0	10
72-73	251	0	0	0	251
74-75	0	20	0	0	20
76-77	0	0	0	0	0
78-79	0	0	0	0	0
80-81	0	0	0	0	0
82-83	0	0	0	0	0
84-85	22	0	0	0	22
86-87	0	10	0	0	10
TOTAL	66030	16150	0	1908	84088
Samples	5	15		1	21
Fish Measured	505	1511		100	2116
Total Catches (Kg)	65225	8079	5	1890	75199

Table 6.- Northern shrimp length distributions samplings by sex and gear in Div. 1B.

<u>Northern shrimp</u>	<u>Bottom trawl (BT)</u>			<u>High-opening bottom trawl (BT-GOV)</u>		
	<u>Length (CL) mm</u>	<u>Males</u>	<u>Females</u>	<u>Total</u>	<u>Males</u>	<u>Females</u>
11,5	167	0	167	0	0	0
12	317	0	317	0	0	0
12,5	167	0	167	0	0	0
13	167	0	167	0	0	0
13,5	999	0	999	0	0	0
14	2300	0	2300	466	0	466
14,5	2267	0	2267	0	0	0
15	3654	334	3988	466	0	466
15,5	3081	334	3415	1864	0	1864
16	4078	249	4327	1864	0	1864
16,5	5927	794	6721	5125	466	5591
17	9655	1868	11523	5591	0	5591
17,5	9659	11625	21284	3728	1864	5592
18	9551	13095	22646	7455	932	8387
18,5	9616	20380	29996	4194	1398	5592
19	10935	29378	40313	2796	1864	4660
19,5	9288	43149	52437	3728	4194	7922
20	11326	44535	55861	3728	3728	7456
20,5	8978	42965	51943	3728	6989	10717
21	8182	41705	49887	2796	5591	8387
21,5	4796	40238	45034	932	2330	3262
22	2425	38611	41036	466	3728	4194
22,5	1742	34487	36229	0	2330	2330
23	571	46272	46843	466	3262	3728
23,5	392	34846	35238	0	2330	2330
24	111	41720	41831	0	2796	2796
24,5	0	29411	29411	466	1398	1864
25	0	33944	33944	0	2330	2330
25,5	0	24468	24468	0	1864	1864
26	0	12298	12298	0	2330	2330
26,5	0	6134	6134	0	932	932
27	0	2084	2084	0	0	0
27,5	0	1933	1933	0	0	0
28	0	798	798	0	0	0
28,5	0	0	0	0	0	0
29	0	0	0	0	0	0
29,5	0	72	72	0	0	0
TOTAL	120351	597727	718078	49856	52652	102508
<hr/>				<hr/>		
Samples			13			1
Fish Measured	686	1688	2374	107	113	220
Total Catches (Kg)			4699			531

Table 7. Redfish length distributions samplings by month and gear in Div. 1B.

Redfish Length (TL) cm	Bottom trawl (BT)			High-opening bottom trawl (BT-GOV)	
	Nov	Dec	Total	Nov	Total
5	0	0	0	3	3
6	20	66	88	13	13
7	27	44	72	5	5
8	0	0	0	5	5
9	433	22	462	114	114
10	4346	862	5285	288	288
11	5887	2145	8150	291	291
12	1635	708	2378	67	67
13	390	22	418	0	0
14	997	22	1034	3	3
15	533	0	540	8	8
16	624	0	634	4	4
17	176	0	178	9	9
18	112	0	114	0	0
19	105	0	108	4	4
20	81	0	83	0	0
21	61	0	62	0	0
22	55	0	56	4	4
23	20	0	20	4	4
24	20	0	20	0	0
25	10	0	10	0	0
26	45	0	46	0	0
27	30	0	30	4	4
28	51	0	52	0	0
29	0	0	0	0	0
30	20	0	20	0	0
31	0	0	0	0	0
32	30	0	30	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	4	4
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	20	0	20	0	0
41	0	0	0	4	4
TOTAL	15728	3891	19909	834	838
Samples	6	1	7	2	2
Fish Measured	798	176	974	244	244
Total Catches (Kg)	446	64	518	24	24

Table 8. American plaice length distributions samplings by month and gear in Div. 1B.

American plaice	Bottom trawl (BT)			High-opening bottom trawl (BT-GOV)	
	Length (TL) cm	Oct	Nov	Total	Nov
8	0	20	20	0	0
9	0	277	280	13	13
10	0	751	759	127	127
11	4	698	709	89	89
12	4	1036	1050	203	203
13	0	834	842	101	101
14	19	699	724	115	115
15	45	576	627	127	127
16	15	571	592	77	77
17	22	402	429	127	127
18	19	497	521	38	38
19	22	354	381	64	64
20	41	356	401	25	25
21	37	477	520	26	26
22	30	422	457	51	51
23	52	231	286	25	25
24	19	301	323	25	25
25	19	300	323	25	25
26	11	188	201	0	0
27	4	110	114	13	13
28	0	72	73	0	0
29	0	62	64	0	0
30	11	13	24	0	0
31	0	14	15	0	0
32	0	38	39	0	0
33	0	0	0	0	0
34	0	14	15	0	0
TOTAL	374	9313	9788	1271	1272
Samples	1	6	7	1	1
Fish Measured	100	675	775	100	100
Total Catches (Kg)	27	452	479	42	42

Table 9. Roughhead grenadier length distributions samplings by month in Div. 1D with bottom trawl (BT).

<u>Roughhead grenadier</u> <u>Length (AFL) cm</u>	Div. 1D	
	Dec	Total
7	2	2
8	0	0
9	0	0
10	4	4
11	6	6
12	6	6
13	16	16
14	14	14
15	12	12
16	20	20
17	32	32
18	14	14
19	16	16
20	6	6
21	8	8
22	2	2
23	0	0
24	2	2
25	6	6
26	2	2
27	4	4
28	2	2
29	0	0
30	2	2
31	0	0
32	2	2
33	0	0
34	2	2
35	0	0
36	2	2
37	0	0
38	2	2
TOTAL	184	187
<hr/>		
Samples	1	1
Fish Measured	92	92
Total Catches (Kg)	117	117

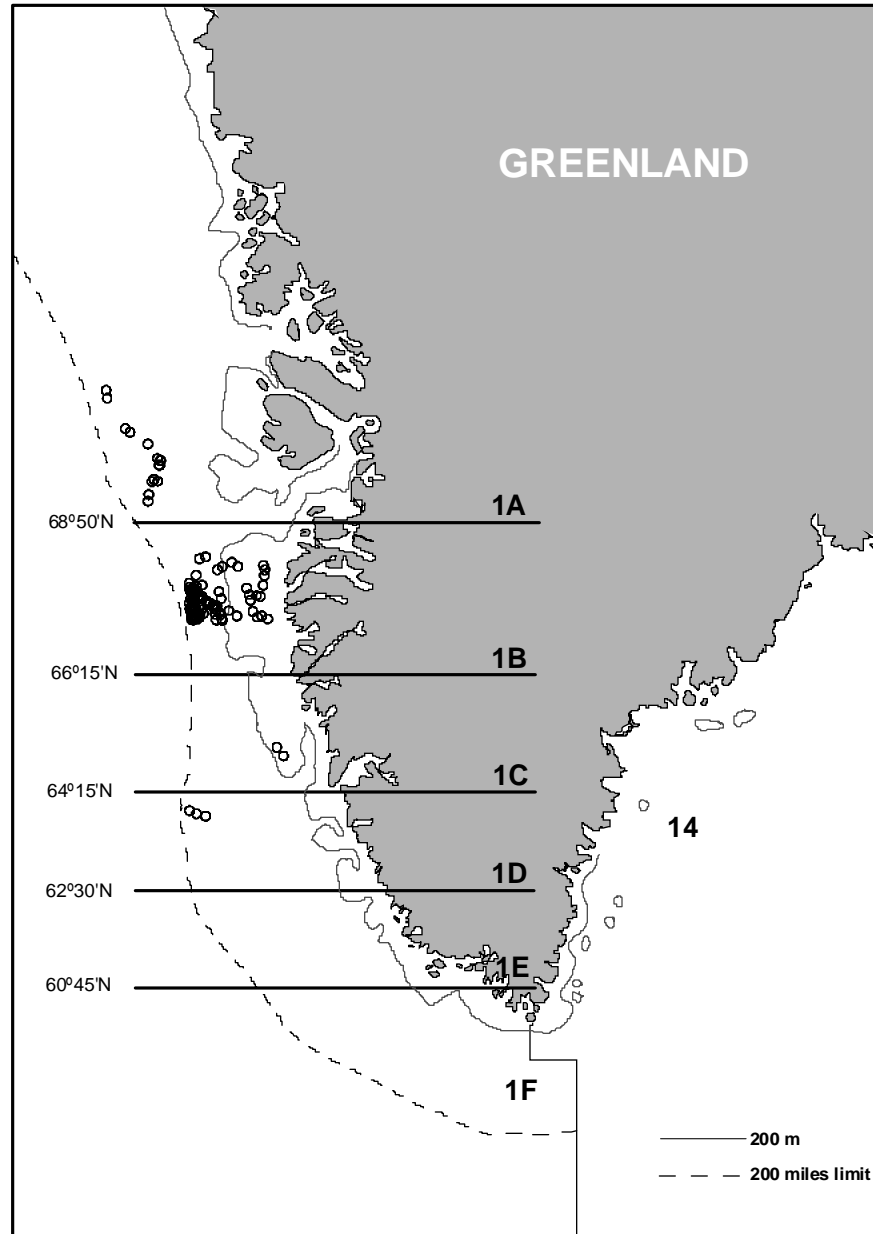


Fig. 1. Position of hauls in the experimental fishing in NAFO Div. 1ABCD made with bottom trawl (BT).

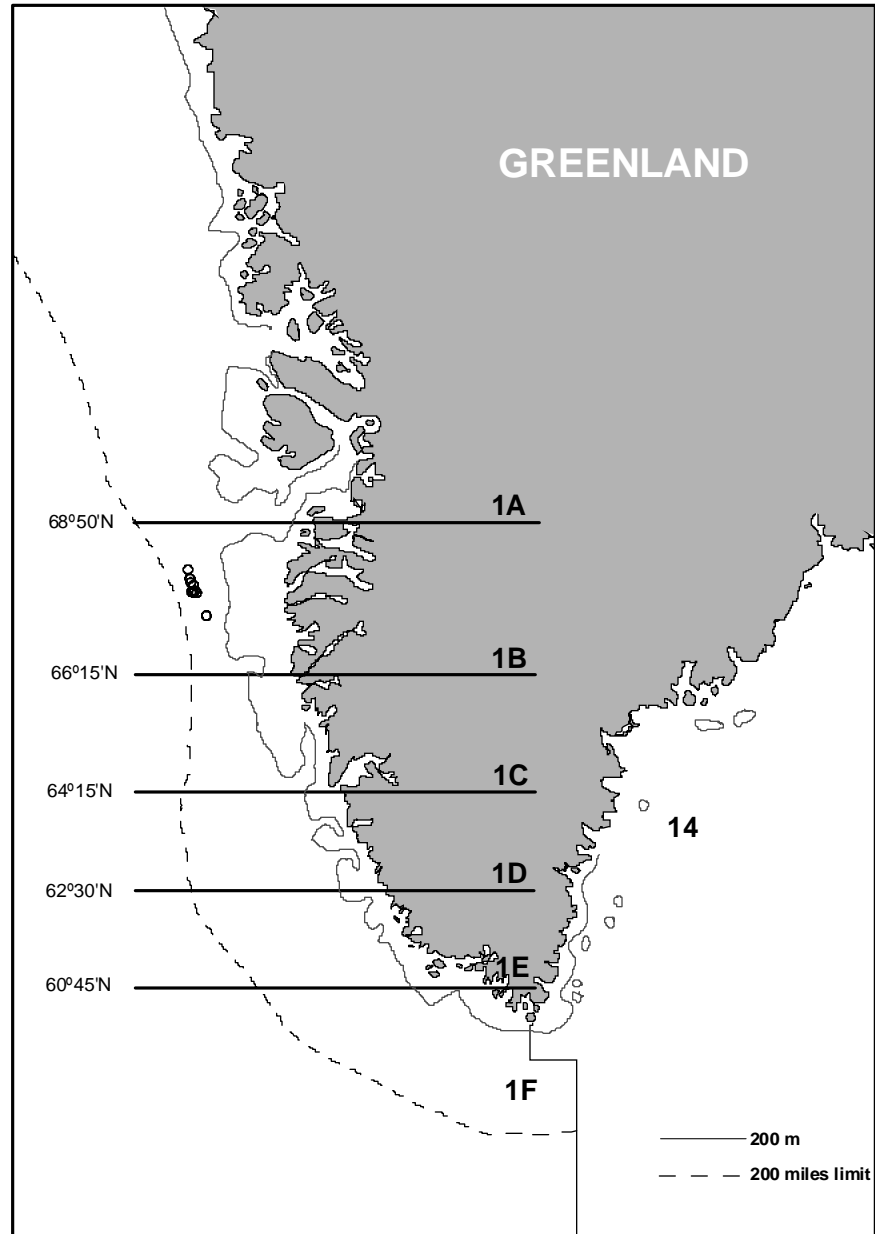


Fig. 2. Position of hauls in the experimental fishing in NAFO Div. 1 ABCD made with high bottom trawl (BT-GOV).

opening

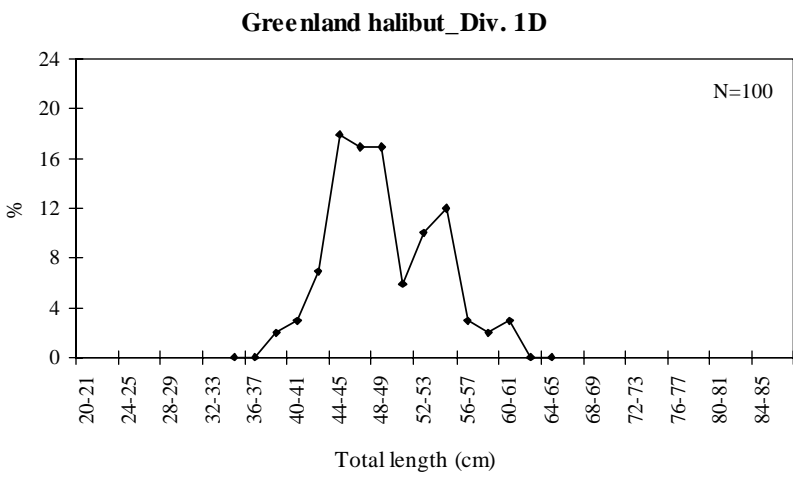
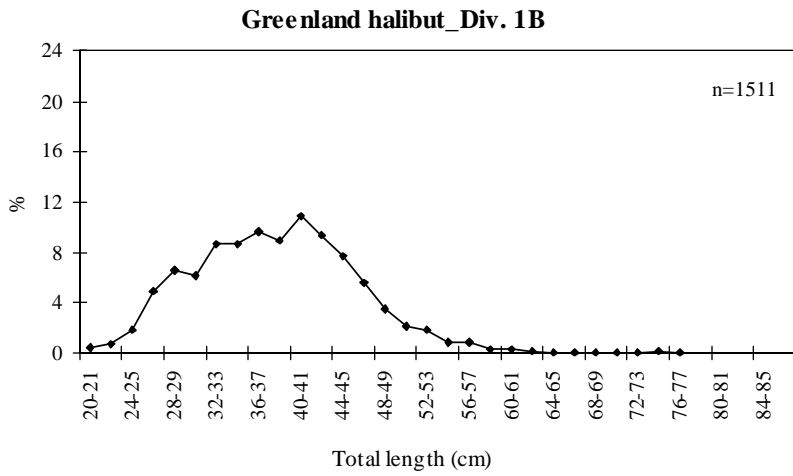
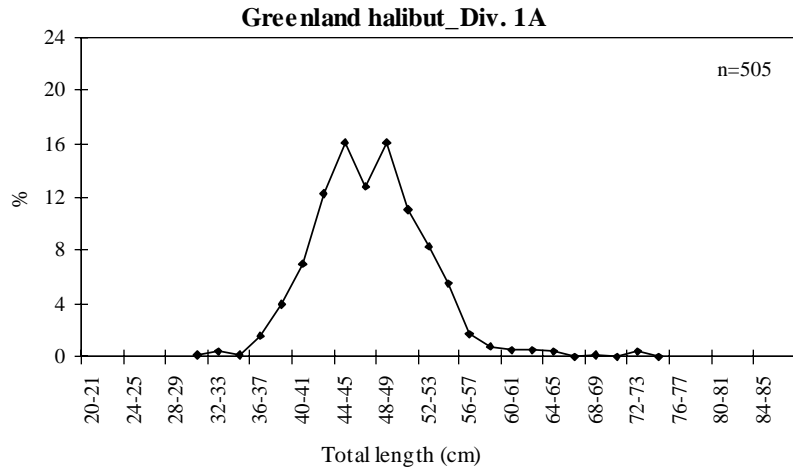
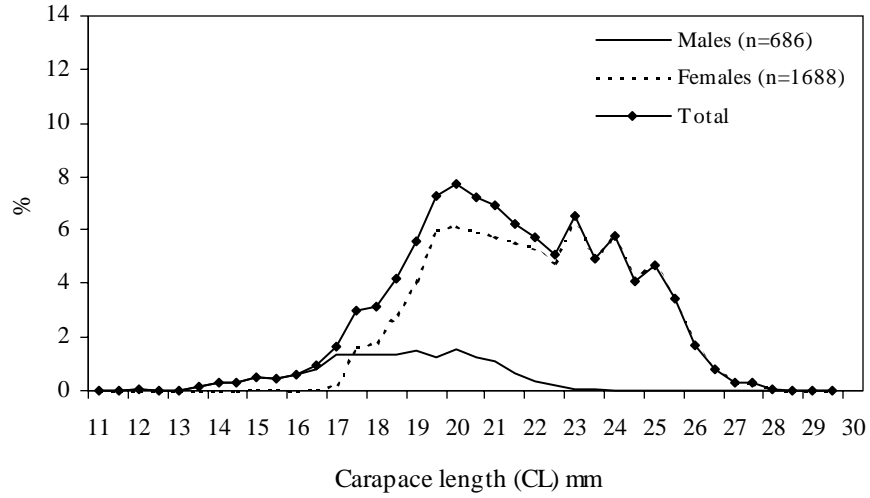


Fig. 3. Length frequency distributions (%) of Greenland halibut by Division from bottom trawl (BT).

Bottom trawl (BT)

Northern shrimp_Div. 1B



High-opening bottom trawl (BT-GOV)

Northern shrimp_Div. 1B

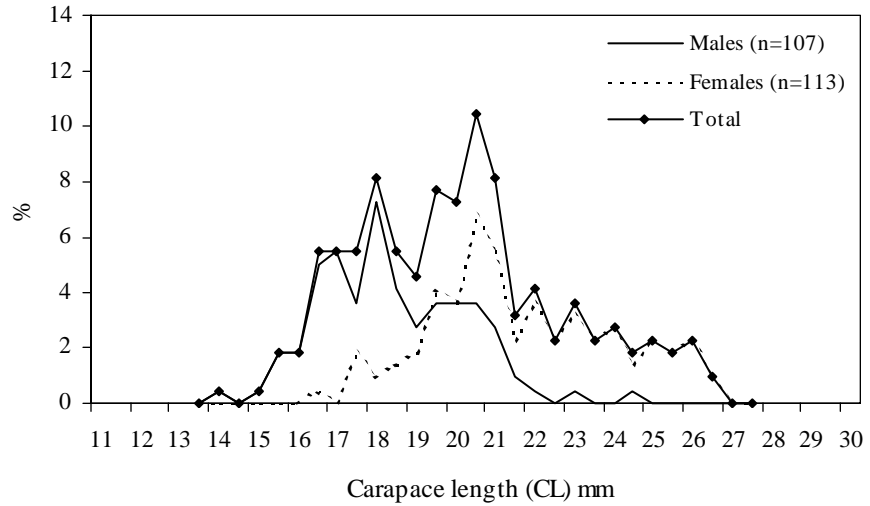


Fig. 4. Length frequency distributions (%) of northern shrimp in Div. 1B by sex and gear.

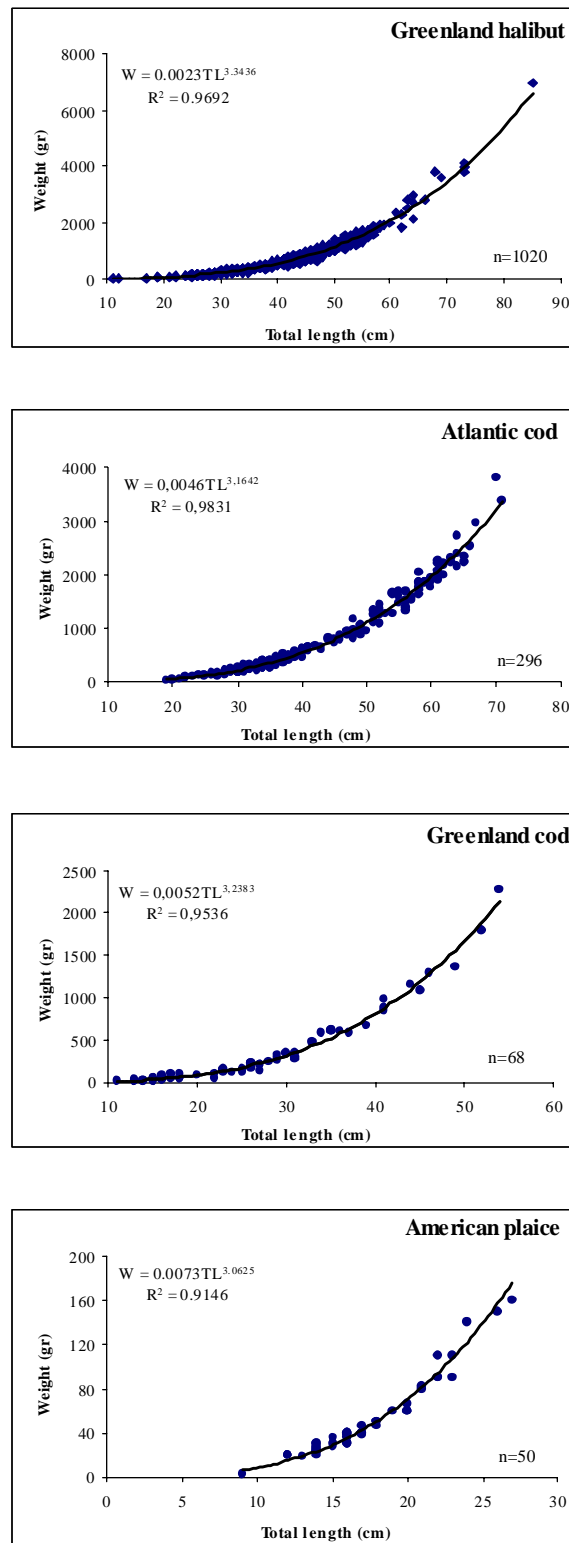


Fig. 5. Length-weight relationships for Greenland halibut, Atlantic cod, Greenland cod and American plaice during the experimental fishing in West Greenland waters.