

## Freezer trawler survey report

Ref: "15.04.2016, 05.25.2016, 16/5271"

### Spanish bottom trawl autumn survey "*Fletán Ártico 2016*" in the Slope of Svalbard (ICES Division IIb2)

By

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#### Abstract

The "*Fletán Ártico 2016*" autumn survey is a continuation of the Spanish bottom trawl survey series started in 1997 on the slope of Svalbard (ICES IIb2) using freezer trawlers. The survey was carried out from the 05<sup>th</sup> to the 24<sup>th</sup> of September, 2016 on board the Spanish freezer trawler *C/V Eirado do Costal* using a bottom trawl gear. There were 68 valid hauls in which Greenland halibut was clearly the predominant species (Catch per unit effort [CPUE] = 5,176.9 kg/hr; abundance index = 214,778 ('000) individuals; and biomass index = 247,644 tons). The values estimated in the 2016 survey show a decrease in abundance and biomass indices when compared with the autumn survey carried out previously. The latitudinal and bathymetric distributions of the species were similar to those observed in previous years and the population structure was also quite similar to those described previously, with a predominance of males. Modal length was 48 cm for males and 43 and 51 cm for females. Greenland halibut shows a low level of feeding intensity in September in the study area. Mature individuals are dominant in the catches. Cod (20.4 kg/hr), Northern wolffish (16.4 kg/hr) and roughhead grenadier (13.3 kg/hr), were the three main accompanying species in terms of weight. When compared to the Greenland halibut, the accompanying species show very low CPUE values and very low abundance and biomass indices. By-catches of Vulnerable Marine Ecosystems (VMEs) indicator species were generally absent or low (particularly to the south of 76°00'N). Only in two hauls the by-catches of sponges or sea pens, respectively, exceeded the NAFO threshold for "*significant research vessel trawl catches of VME indicator species*".

**Key words:** Abundance, biomass, by-catch, deep-water bottom trawl, Greenland halibut, North-east Arctic, Svalbard, VME indicators.

Report date: 6 February 2017

## 1. Background and objectives of the Spanish bottom trawl surveys in the slope of Svalbard

The "Fletán Ártico 2016" survey is the continuation of the Spanish bottom trawl survey series (Table 1.1) started in 1997 (Paz & Durán Muñoz, 1997) by the *Instituto Español de Oceanografía (IEO)* on the slope of Svalbard (ICES IIb2), using freezer trawlers. Since the start of the series the main aim was to obtain abundance/biomass indices and data on the distribution and biology of the Greenland halibut (*Reinhardtius hippoglossoides*) on the slope of Svalbard (ICES IIb2).

Complementary data on accompanying species was also collected. Investigations on Greenland halibut in this area had already been done previously in 1995 during a pilot experimental fishing campaign (Durán Muñoz & Paz, 1996).

The results from these studies enable (i) the provision of updated information to the ICES Arctic Fisheries Working Group - AFWG (Hallfredsson *et al.*, 2013; Paz & Casas, 2014; Durán Muñoz *et al.*, 2015, 2016) which contributes to advice on sustainable management of deep-water fisheries resources and (ii) continuity of the Spanish fisheries studies in the Fisheries Protection Zone around Svalbard (Moleenar, 2012) within the framework of the Paris Treaty (1920).

**Table 1.1** Spanish investigations on Greenland halibut on the slope of Svalbard since 1995, using factory trawlers.

Nº	Survey series	Year	Vessel	No of Hauls	Quarter	Dates	Institution
1	Pilot experimental fishing	1995	*	657**	1	6 June - 8 July	IEO
1	Fletán Ártico	1997	EHKC	156	2	26 Sept -27 Oct	IEO
2	Fletán Ártico	1998	EFJS	148	2	1 - 24 Oct	IEO
3	Fletán Ártico	1999	EFJS	133	2	4 - 29 Oct	IEO
4	Fletán Ártico	2000	EHIM	147	2	2 - 31 Oct	IEO
5	Fletán Ártico	2001	EHIM	146	2	2 - 28 Oct	IEO
6	Fletán Ártico	2002	EHIM	155	2	4 - 30 Oct	IEO
7	Fletán Ártico	2003	EHIM	150	2	2 - 29 Oct	IEO
8	Fletán Ártico	2004	EHIM	149	2	2 - 28 Oct	IEO
9	Fletán Ártico	2005	EHIM	144	2	3 - 28 Oct	IEO
10	Fletán Ártico	2008	EDKX/ EBVD	84/74	1/2	2 - 15 May/1 -15 Oct	AZTI
11	Fletán Ártico	2009	EDKW	91	1	21 Apr - 8 May	AZTI
12	Fletán Ártico	2010	EBVD	73	2	5 - 20 Oct	AZTI
13	Fletán Ártico	2011	EDKX	114	1	1 - 19 Jun	AZTI
14	Fletán Ártico	2012	EBVD	49	2	15 Sep - 1 Oct	AZTI
15	Fletán Ártico	2013	EBVD	63	2	4 - 18 Sept	IEO
16	Fletán Ártico	2014	EBVD	57	2	2 - 19 Sept	IEO
17	Fletán Ártico	2015	EDKW	81	1	19 Jun - 10 Jul	IEO
18	Fletán Ártico	2016	EBVD	68	2	05 - 24 Sep	IEO

EBVD: Eirado do Costal; EDKX: Nuevo Virgen de la Barca; EDKW: Nuevo Virgen de Lodairo; EFJS: Puente Pereiras Cuatro; EHIM: Garoya Segundo; EHKC: Playa de Sartaxens; \* Six freezer trawlers; \*\* Barents Sea & Slope of Svalbard (Ia+IIb).

1: *Spring* survey; 2: *Autumn* survey.

## 2. Material and methods

### 2.1 Study area

As in previous surveys, the study area (Figure 2.1.1) is located on the Western slope of Svalbard, between 73°30'N and 80°00'N (North-East Arctic, ICES Division IIb2). The zone lies within the Fisheries Protection Zone around Svalbard, at depth strata between 500-1,500 m approx.

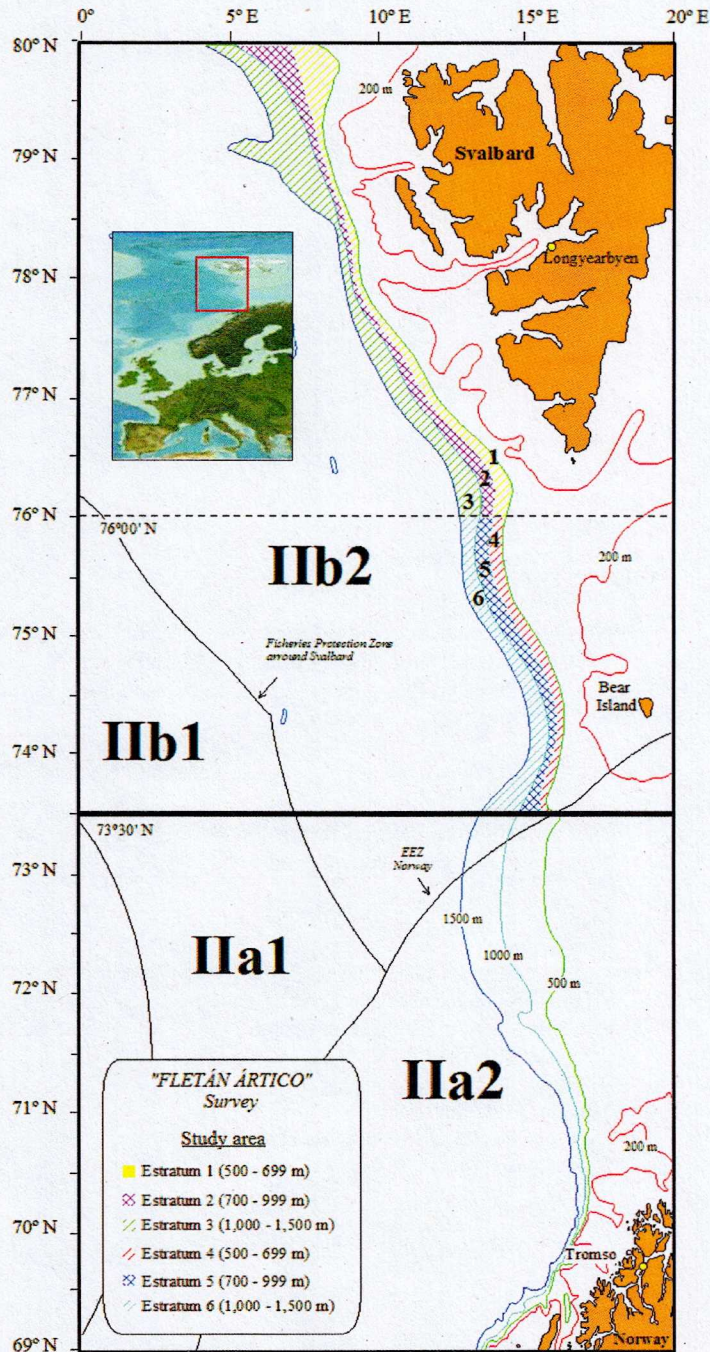


Figure 2.1.1 Study area of the *FLETÁN ÁRTICO* Spanish bottom trawl survey series.

## 2.2 Characteristics of the vessel

The 2016 survey was conducted using the freezer trawler *C/V Eirado do Costal* (Table 1.1). The technical characteristics of this trawler are presented in Table 2.2.1.

**Table 2.2.1** Characteristics of the vessel used. Spanish bottom trawl autumn survey “*FLETÁN ÁRTICO 2016*”. Source: ship-owner

Type:	Freezer trawler
Call sign:	EBVD
Crew:	25
Nationality:	Spanish
Owner of the ship	Moradiña S.L.
Registered port & No:	Vigo. VI-4-4-01 (3 <sup>th</sup> register )
Year of construction:	2004
Overall length:	56 m
Beam:	11 m
Maximum draught:	6.20 m
Net tonnage:	350 NT
Fridge capacity:	938031 m <sup>3</sup>
Freeze capacity	50 t/day
Propulsion:	Diesel oil engine. 1645.6 CV
Echo sounders:	Simrad ES60, Furuno FCU 1200L
Net/trawl sensors:	Scanmar
Weighing machine:	Scanvaegt - Scangrader 7100

## 2.3 Characteristics of the fishing gear

A bottom trawl gear type “*Pedreira*” was used during the survey. The technical characteristics of the gear used in 2016 are presented in Table 2.3.1. Net and rock hopper diagrams provided by the Captain are shown in Figure 2.3.1 and 2.3.2 respectively. This gear is similar to the one used during the 2014 autumn survey.

**Table 2.3.1** Characteristics of the fishing gear. Spanish bottom trawl autumn survey “*FLETÁN ÁRTICO 2016*”. Source: ship-owner/Captain.

Headline:	60.8 m
Ground gear :	78 m
Type:	Rock hopper <ul style="list-style-type: none"> <li>• Central section: rubber disks (18’’) and rubber spacers (18 cm)</li> <li>• Lateral section: rubber disks (18’’) and rubber spacers (18 cm)</li> <li>• Lateral extensions: rubber half spheres (16’’), rubber spacers (18 cm) and iron spacers with chains.</li> </ul>
Floats:	240 mm / 300 mm
Codend:	Polyethylene 6 mm. 140 mm mesh size.
Liner:	40 mm mesh size.
Shorting grid:	NO
Bridles:	300 m.
Doors:	Injector - Cobra (7.5 m <sup>2</sup> . 2,500 kg)

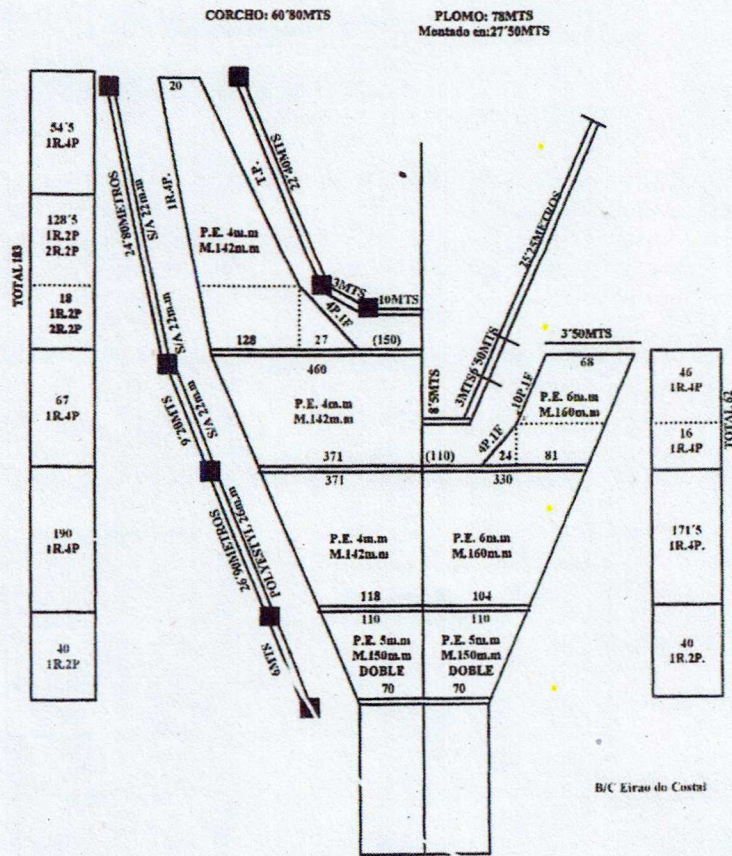
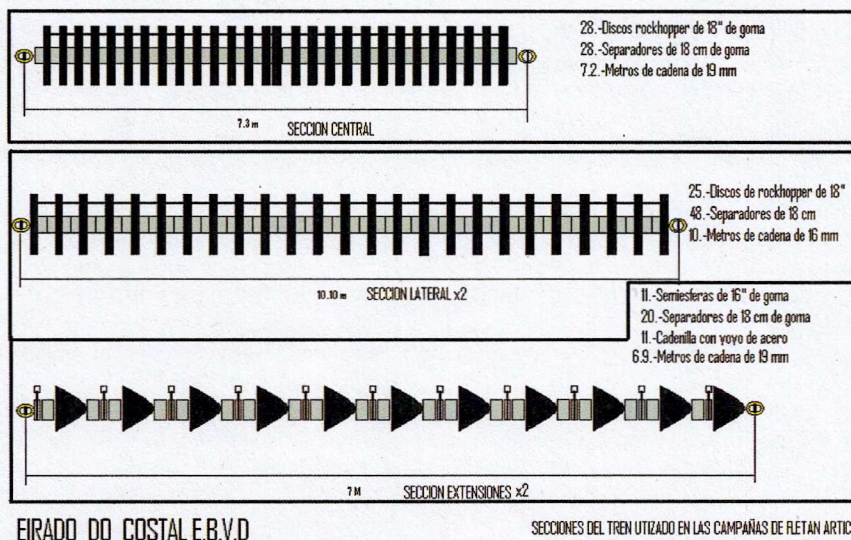


Figure 2.3.1 Net diagram. Spanish bottom trawl autumn survey “FLETÁN ÁRTICO 2016”. Source: Captain.



**Figure 2.3.2** Rock hopper diagram. Spanish bottom trawl autumn survey “*FLETÁN ÁRTICO 2016*”.

Source: Captain.

2.4 Survey dates, incidences, participants, methodology and data analysis

The 2016 survey was carried out from the 05<sup>th</sup> to the 24<sup>th</sup> of September, 2016 (port of call: Tromsø, Norway). Sampling took place between the 07<sup>th</sup> and the 22<sup>th</sup> of September, 2016.

A total of 68 valid bottom trawl hauls were carried out. The location of the trawls is presented in Figure 2.4.1 and the haul characteristics are shown in Annex I. Hauls were carried out on pre-selected locations based on the list of valid trawl sets from the “*Fletán Ártico*” IEO survey series (1997-2015). Survey plan was developed without incidences. The number of hauls was limited by the “*research quota of Greenland halibut*” (a total of 180 tons round weight in 2016).

The stratification designed by Norway in 1994 was used for the sampling scheme. Table 2.4.1 shows latitude and depth range limits for each stratum, as well as the surface area and the number of valid hauls conducted during the 2016 survey.

**Table 2.4.1** Survey stratification and number of valid hauls by stratum. Spanish bottom trawl autumn survey “*FLETÁN ÁRTICO 2016*”.

Strata	Latitude (N)	Depth (~m)	Area (~nautical miles <sup>2</sup> )	Number of valid hauls
1	76° 00' - 80° 00'	500- 699	702	15
2	76° 00' - 80° 00'	700- 999	1,263	15
3	76° 00' - 80° 00'	1,000-1,500	2,693	4
4	73° 30' - 76° 00'	500- 699	488	16
5	73° 30' - 76° 00'	700- 999	761	16
6	73° 30' - 76° 00'	1,000-1,500	1,672	2
Total				68

The list of scientific personnel on board during the survey is presented in Table 2.4.2.

**Table 2.4.2.** Scientific personnel on board during the survey “*FLETÁN ÁRTICO 2016*”.

Name	Role on board	
Dr. P. Durán Muñoz	Scientist in charge, chief of mission	A
BSc. A. Sánchez Bagués	Sampling team coordinator	B
BSc. N. Vilas Arrondo	Sampling	B
BSc. G. Martínez Iglesias	Sampling	B
BSc. F.J. Torres Rodríguez	Sampling	B

(A): IEO; (B): IPD

The effective duration of each haul was 30 minutes. *Scanmar* net/door sensors ensured that the fishing gear was properly configured at the bottom, besides providing information on the main geometry of the net, the distance between doors and the bottom temperature.

Catches were sorted and weighted by species. Fish and invertebrates were identified at the lowest possible taxonomical level using available literature. Length frequencies of Greenland halibut and the principal accompanying species were obtained by taking random samples (pre-anal length in the case of grenadiers; total length in the case of the remaining species). Other biological data of the main fish species were also obtained. Greenland halibut otoliths and gonads were collected and stomach contents were noted. A summary of biological sampling is presented in Table 2.4.3.

The standardised catch dataset (catch per 30 minute haul) was integrated within a GIS (QGIS 2.18). Regional bathymetric contours were obtained from the GEBCO database (General Bathymetric Chart of the Oceans). Abundance and biomass were estimated as in previous reports, using the swept area method.

To get the swept area, the distance travelled by the net was multiplied by the estimated horizontal opening (Basterrestxea *et al.*, 2013). To calculate the distance travelled by the net during the trawl, the initial and the final positions of the vessel were used. The horizontal opening of the net was measured in meters and converted to nautical miles by a factor of 1 km = 1852 nm. As in the last years (2008-2012) the conversion was made for miles, and not nautical miles, a conversion was made to the indices between 2008 and 2012.

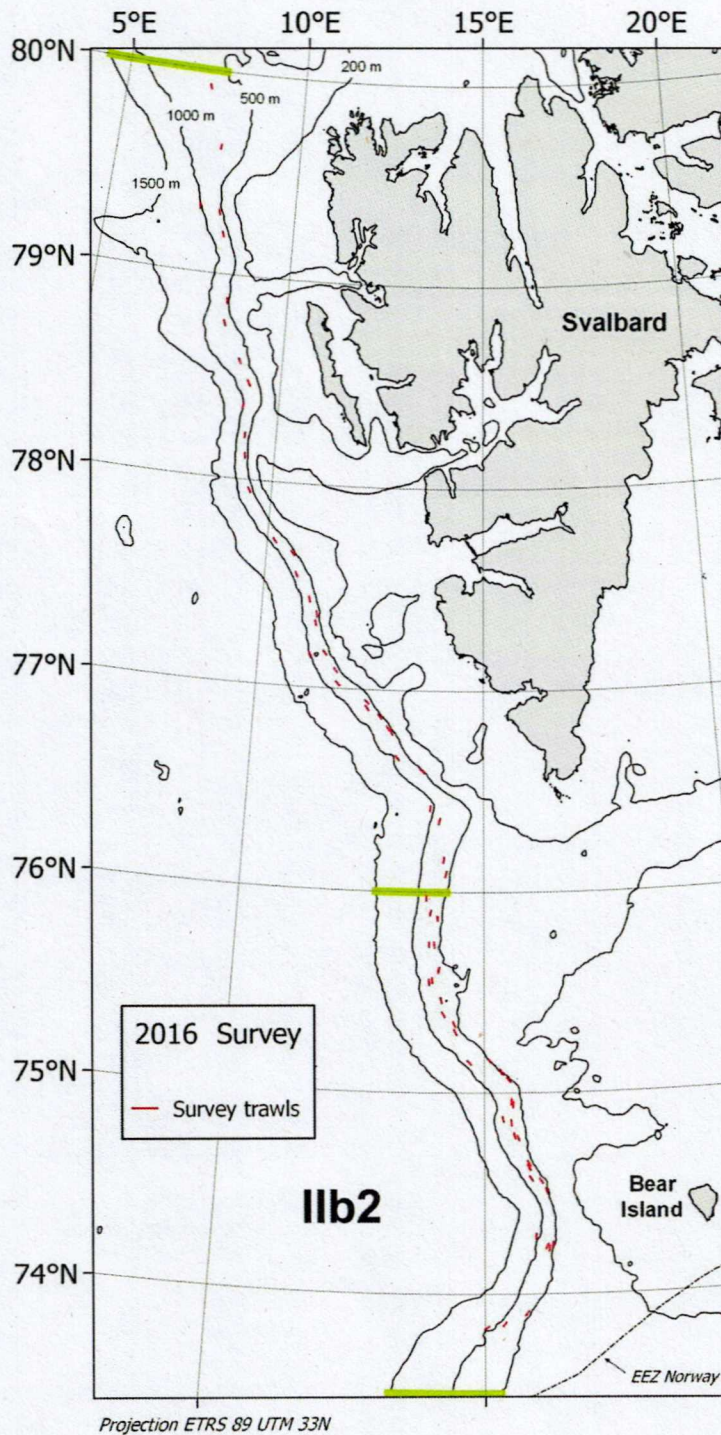


Figure 2.4.1 Location of the trawls performed during the Spanish bottom trawl autumn

survey "FLETÁN ÁRTICO 2016".

**Table 2.4. 3.** Summary of biological sampling.

Species	Length frequencies				Biological data					
	No of samples	No of indiv.	Type	Length range (cm)	No of samples	No of indiv.	Type	Otoliths	Gonads	Feeding activity
Greenland halibut	68	15,031	L <sub>S</sub>	30 - 105	66	1426	E <sub>S</sub>	503	305	x
Cod	25	127	L <sub>S</sub>	42 - 129	25	122	E <sub>S</sub>	122		
Long rough dab	10	11	L <sub>S</sub>	25 - 37	10	11	E <sub>S</sub>	11		
Roughhead grenadier	55	697	L <sub>S</sub>	3.5 - 37.5	38	249	E <sub>S</sub>			
Redfish	44	645	L <sub>S</sub>	17 - 47	31	160	E <sub>S</sub>			
Arctic skate	33	120	L <sub>S</sub>	16 - 82	31	112	R <sub>S</sub>			
Thorny skate	34	63	L <sub>S</sub>	10 - 57	32	60	E <sub>S</sub>			
Blue whiting	43	1,386	L <sub>C</sub>	19 - 41	23	148	R			
Northern wolffish	23	62	L <sub>C</sub>	48 - 127	22	61	R			
Spotted wolffish	1	1	L <sub>C</sub>	98	1	1	R			
Greater eelpout	55	531	L <sub>C</sub>	10 - 64	31	203	R			
<i>Lycodes</i> sp	13	39	L <sub>C</sub>	12 - 22	13	39	R			
Spinetail ray	7	9	L <sub>S</sub>	42 - 111	7	9	R <sub>S</sub>			
Round ray	3	3	L <sub>S</sub>	10 - 22	3	3	R <sub>S</sub>			
Arctic rockling	9	13	L <sub>C</sub>	16 - 39	9	13	R			
Greater argentina	21	52	L <sub>C</sub>	36 - 51	17	42	R			
Polar cod	2	5	L <sub>C</sub>	10 - 19	2	5	R			
Saithe	2	4	L <sub>C</sub>	44 - 78	2	4	R			
<i>C. monstrosa</i>	1	1	L <sub>S</sub>	47.5	1	1	R <sub>S</sub>			
Ling	1	1	L <sub>C</sub>	57	1	1	R			
<i>A. risso</i>	1	1	L <sub>C</sub>	26	1	1	R			
<i>Phycis</i> sp	1	1	L <sub>C</sub>	36	1	1	R			

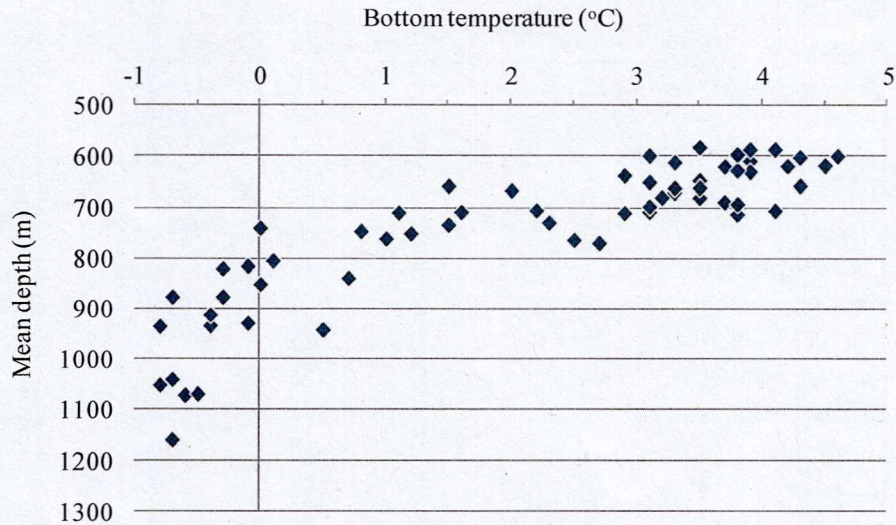
Type of sampling: (L<sub>S</sub>) length distributions by sex; (L<sub>C</sub>) length distributions, sex combined; (E<sub>S</sub>) biological data extended: sex, length, weight, maturity (macroscopic) and stomach content; (R<sub>S</sub>) biological data restricted: sex, length and weight; (R) biological data restricted: length and weight.



### 3. Results

#### 3.1 Observations on bottom temperature

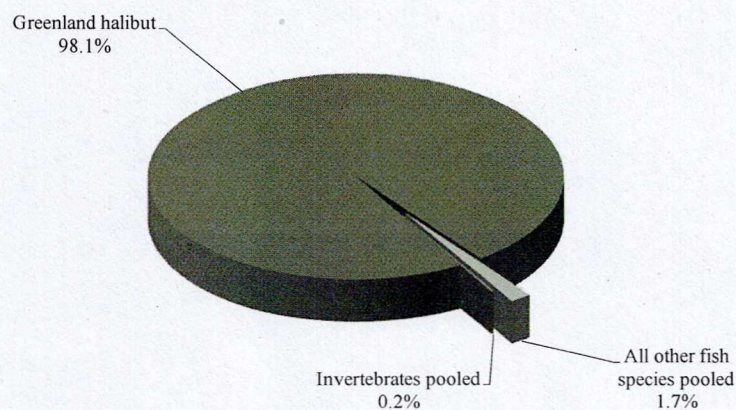
Figure 3.1.1 shows the information on bottom temperature ( $^{\circ}\text{C}$ ) in relation to depth, collected by the doors sensors in the hauls conducted during the 2016 survey. Deeper hauls ( $>800\text{m}$  depth) were characterized by water temperatures close or below Zero.



**Figure 3.1.1** Bottom temperature ( $^{\circ}\text{C}$ ) in relation to depth, haul by haul. Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”.

#### 3.2 Catch composition

The pie chart in Figure 3.2.1 shows the percentage composition of catches by weight. Greenland halibut was clearly predominant in the catches (98.1 % of live weight). All other fish species pooled accounted for 1.7 %, while the invertebrates pooled represented 0.2 %.



**Figure 3.2.1** Pie chart showing the percentage composition of catches by weight. Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”.

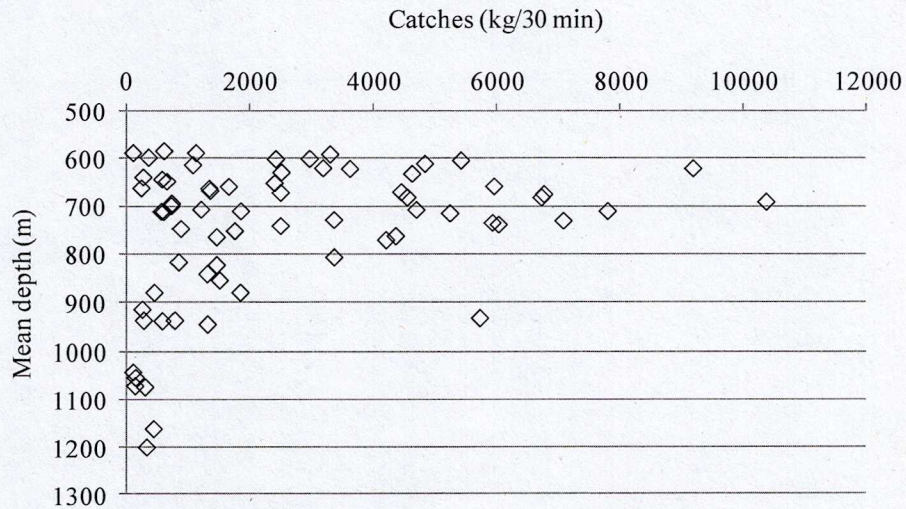
Greenland halibut was the principal species caught (176,015.1 kg), showing the highest CPUE. Cod (694.1 kg), Northern wolffish (556.0 kg) and roughhead grenadier (451.5 kg), were the three main accompanying species in terms of weight (Table 3.2.1). Annex II shows the catches (kg) of main fish species by haul (30 minute hauls).

**Table 3.2.1** Percentage of presence in the trawls [Presence (%)], estimated total catch in live weight [Catch (kg)] and catch per unit of effort [CPUE (kg/hr)] of main species/taxa. Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”.

Species/taxa	Presence (%)	Catch (kg)	CPUE (kg/hr)
Greenland halibut ( <i>R. hippoglossoides</i> )	100	176,015.1	5,176.9
Cod ( <i>G. morhua</i> )	38	694.1	20.4
Northern wolffish ( <i>A. denticulatus</i> )	38	556.0	16.4
Roughhead grenadier ( <i>M. berglax</i> )	85	451.5	13.3
Redfish ( <i>Sebastes</i> spp)	69	368.1	10.8
Blue whiting ( <i>M. poutassou</i> )	71	331.8	9.8
Arctic skate ( <i>A. hyperborea</i> )	51	260.0	7.6
Greater eelpout ( <i>L. esmarkii</i> )	93	139.5	4.1
Thorny skate ( <i>A. radiata</i> )	53	58.7	1.7
Other fish pooled (Other pisces)	88	119.5	3.5
Sponges (Porifera)	71	189.3	5.6
Echinoderms (Echinodermata)	84	150.5	4.4
Cnidarians (Cnidaria)	93	36.1	1.1
Moluscs (Mollusca)	66	12.7	0.4
Crustaceans (Crustacea)	78	9.9	0.3
Other invertebrates pooled (Other invertebrata)	74	1.0	<0.1
<b>TOTAL</b>		<b>179,393.9</b>	

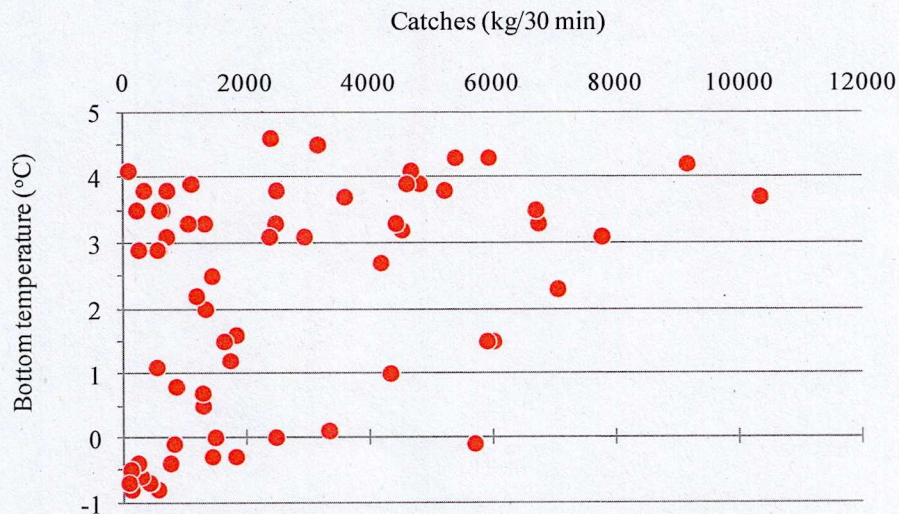
### 3.3 Greenland halibut distribution patterns

Figure 3.3.1 shows the standardised catches of Greenland halibut by depth, haul by haul (30 minute hauls). The most important catches were recorded at depths between 600 and 800 meters. Catches were generally low in the hauls conducted at depths greater than 900 m.



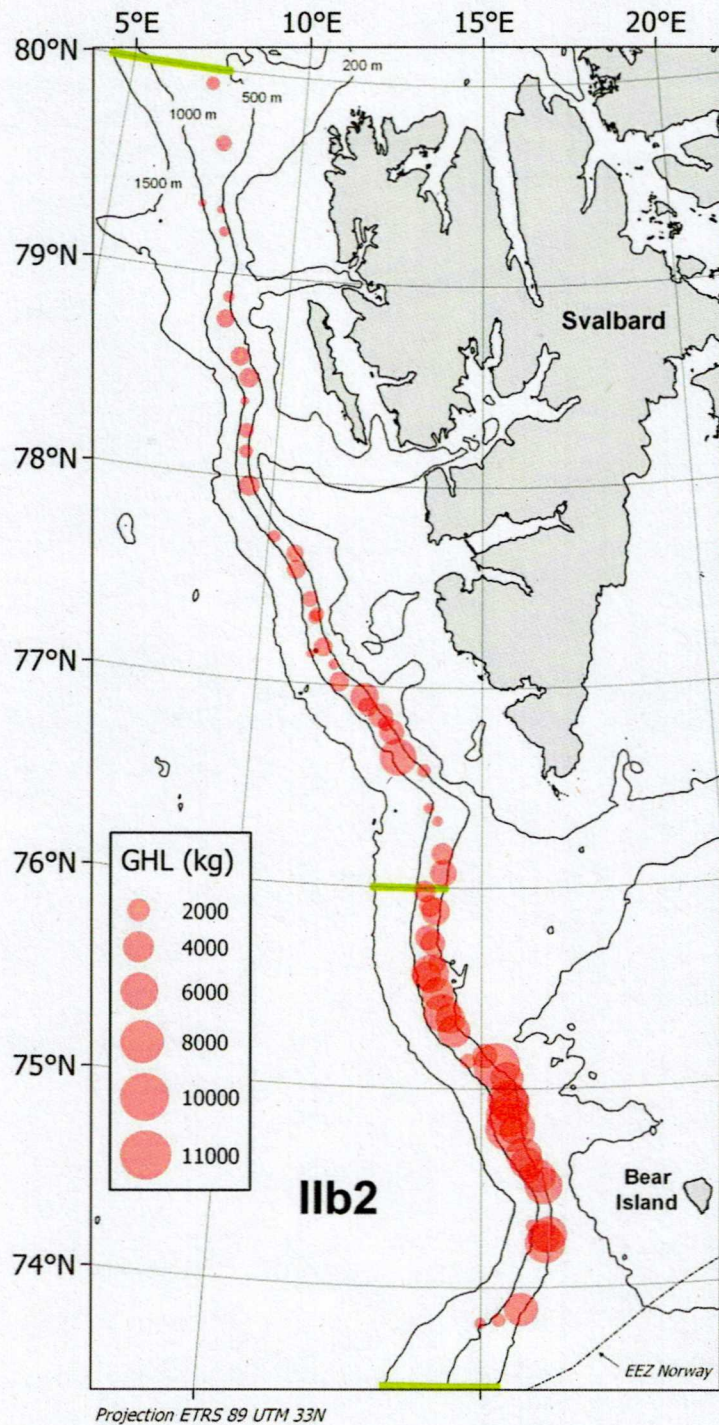
**Figure 3.3.1** Greenland halibut catches in relation to depth, haul by haul (30 min hauls). Spanish bottom trawl autumn survey "FLETAN ÁRTICO 2016".

Figure 3.3.2 shows the standardised catches of Greenland halibut in relation to bottom temperature ( $^{\circ}\text{C}$ ), haul by haul. There is not a clear pattern, but higher catches were generally obtained in hauls with water temperatures  $>1^{\circ}\text{C}$ .



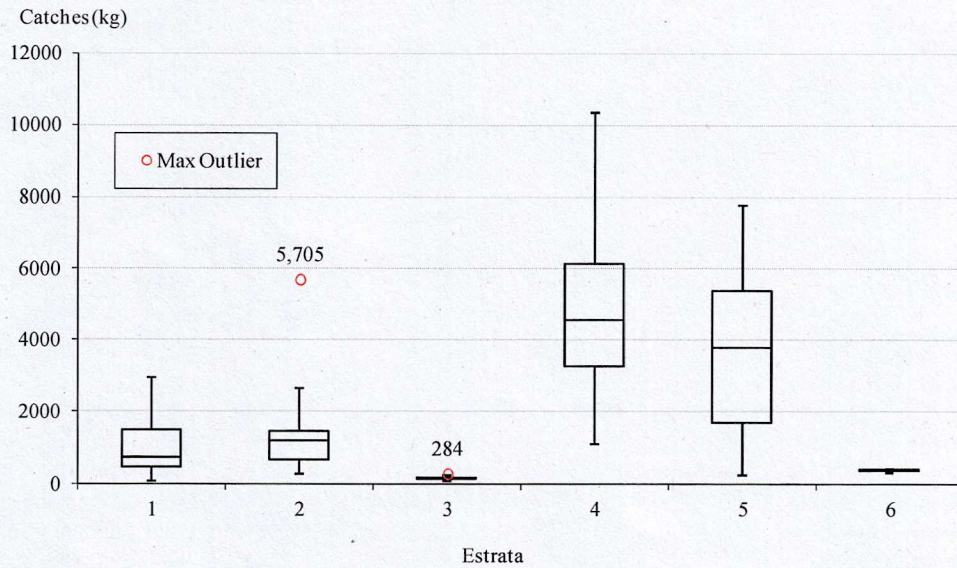
**Figure 3.3.2** Greenland halibut catches in relation to bottom temperature ( $^{\circ}\text{C}$ ), haul by haul (30 min hauls). Spanish bottom trawl autumn survey "FLETAN ÁRTICO 2016".

Greenland halibut was observed to be widely distributed in the study area and was present in 100% of the trawls (Table 3.2.1). Figure 3.3.2 provides a map of the study area and the distribution of standardised catches (kg) of Greenland Halibut by 30 minute hauls. Besides depth, latitude also seems to be another factor that influences the abundance of Greenland halibut on the Slope of Svalbard in September. As in previous surveys, the abundance of the species increased as latitude decreased: generally hauls carried out south of 75°30'N show higher values than the northern hauls.



**Figure 3.3.2** Map of the study area showing the distribution of the catches by haul (kg/30 min haul) of Greenland Halibut (GHL). Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”. Proportional symbols (area) using Flannery compensation method.

The *boxplot* in Figure 3.3.3 shows Greenland halibut catches by stratum. As in previous surveys, deeper strata (3 and 6) show lower concentrations of Greenland halibut while the shallower strata in the South (4 and 5) show the highest concentrations. Variability was observed to be higher in the strata with high concentrations.



**Figure 3.3.3** Greenland halibut catches by stratum. Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”.

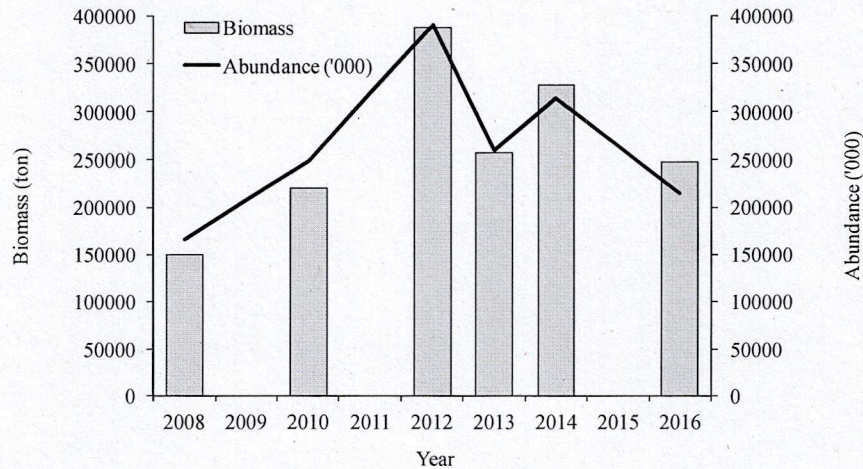
### 3.4 Greenland halibut relative abundance and biomass

The estimated Greenland halibut abundance recorded in the present survey was 214,778 ('000) individuals and the estimated biomass reached 247,644 tons (Table 3.4.1).

**Table 3.4.1** Abundance ('000) and biomass (ton) of Greenland halibut. Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”.

Estrata	Area (nm <sup>2</sup> )	No of hauls	Catch (number)	Catch (kg)	Swept area (nm <sup>2</sup> )	Abundance ('000)	Biomass (ton)
1	702	15	13,186	16,562.8	0.539	17,328	21,765
2	1,263	15	21,677	21,757.9	0.528	51,951	52,144
3	2,693	4	663	623.2	0.139	13,418	12,604
4	488	16	53,732	78,715.0	0.590	45,326	66,400
5	761	16	52,464	57,622.1	0.573	69,860	76,729
6	1,672	2	689	734.1	0.069	16,894	18,002
Total	7,579	68	142,413	176,015.1	2.438	214,778	247,644

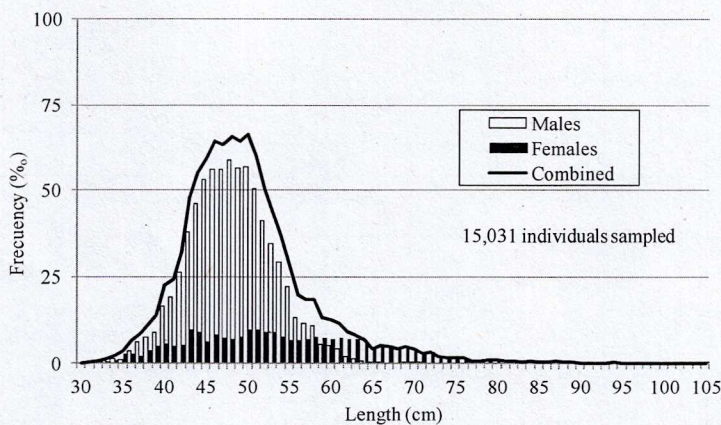
The values estimated in the 2016 survey show a decrease in both indices when compared with the autumn survey carried out in last years (Figure 3.4.1), but these values are higher than the ones obtained from the spring surveys.



**Figure 3.4.1** Greenland halibut biomass and abundance. Comparison between the recent Spanish autumn surveys “FLETAN ÁRTICO”. (No autumn surveys were conducted in 2009, 2011 and 2015).

### 3.5 Greenland halibut length distribution

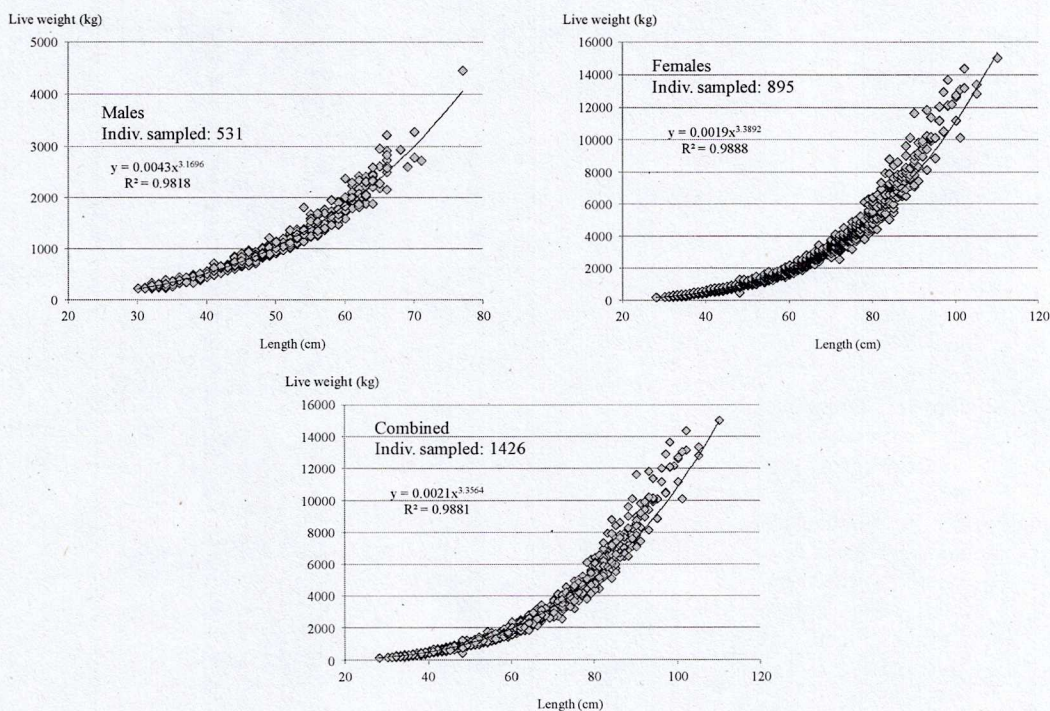
The length structure of the Greenland halibut population is presented in Figure 3.5.1. The length range for both sexes combined ranged from 30 cm to 105 cm. The proportion of males was higher just like in previous cruises (75% of males vs. 25% of females). Modal length was 48 cm for males and 43 and 51 cm for females. In the higher lengths (> 77 cm), all the individuals observed were female.



**Figure 3.5.1** Greenland halibut length distribution. Spanish bottom trawl autumn survey “*FLETAN ÁRTICO 2016*”.

### 3.6 Greenland halibut length-weight relationship

Figure 3.6.1 shows the Greenland halibut length – weight relationship: separated by sexes, and combined.



**Figure 3.6.1** Greenland halibut length – weight relationship. Spanish bottom trawl autumn survey “*FLETAN ÁRTICO 2016*”.

### 3.7 Preliminary observation on feeding activity of Greenland halibut.

Table 3.7.1 shows a summary of the trophic sampling (number of individuals sampled) and feeding intensity (FI) of Greenland halibut. The species shows a low level of feeding intensity in September in the study area (FI=15%).

**Table 3.7.1.** Trophic sampling and feeding intensity (FI) of Greenland halibut. Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”.

	Males	Females	Total
Number of individuals sampled	172	310	482
FI (%)	14	16	15

The diet composition of Greenland halibut in September is analyzed in terms of weight (%W) and using the Mean Weight Feeding Intensity Index (MWFI = prey's wet weight/predator's wet weight \* 100, giving the grams of prey ingested per each 100 grams of predator's body weight).

Fish are the main prey for both males (%W = 57.1%, MWFI = 3.5) and females (%W = 96%, MWFI = 3.2), followed by cephalopods and crustaceans (mainly decapod cephalopods and *Pasiphaea tarda*, respectively). Northern shrimp consumption is not remarkable. Blue whiting is a remarkable fish prey. For females, is noteworthy the predation on Greenland halibut (Table 3.7.2), observing cannibalism in 2.5% of the females sampled in this study (females from 66 to 102 cm).

**Table 3.7.2.** Diet composition (% in weight and MWFI index) of the Greenland halibut by sex. Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”.

	%W			MWFI		
	Male	Female	Total	Male	Female	Total
<b>Fish</b>	<b>57.1</b>	<b>96.0</b>	<b>94.5</b>	<b>3.5</b>	<b>3.2</b>	<b>3.2</b>
Blue whiting ( <i>Micromesistius poutassou</i> )	14.7	3.7	4.1	2.8	3.5	3.2
Eelpout ( <i>Zoarcidae/Lycodes</i> )		0.02	0.02		0.1	0.1
Fish eggs		0.1	0.1		0.2	0.2
Fish indet.	42.5	31.7	32.1	3.9	1.9	2.1
Greenland halibut		60.1	57.8		7.0	7.0
Liparid ( <i>Liparidae</i> )		0.4	0.4		2.0	2.0
<b>Cephalopods</b>	<b>13.86</b>	<b>2.09</b>	<b>2.5</b>	<b>1.3</b>	<b>1.4</b>	<b>1.4</b>
Decapod cephalopod	5.4	0.03	0.2	2.5	0.2	1.3
Cephalopod indet.	7.7	1.5	1.7	1.3	2.1	1.6
Octopus ( <i>Octopodidae</i> )	0.8	0.6	0.6	0.1	1.3	0.7
<b>Crustaceans</b>	<b>17.8</b>	<b>1.9</b>	<b>2.5</b>	<b>0.4</b>	<b>0.4</b>	<b>0.4</b>
Amphipod ( <i>Amphipoda</i> )		0.1	0.09		0.1	0.1
Crustacean indet.	0.5	0.05	0.07	0.2	0.1	0.2
Decapod crustacean		0.1	0.1		0.4	0.4
Shrimp or prawns ( <i>Dendrobranchiata</i> )	4.5	0.1	0.3	0.1	0.2	0.2
Euphausiid ( <i>Euphausiacea</i> )	0.3		0.01	0.03		0.03
Gammarid ( <i>Gammaridae</i> )	0.3	0.01	0.03	0.2	0.1	0.1
Hyperiid ( <i>Hyperiidea</i> )		0.1	0.1		0.1	0.1
Northern shrimp ( <i>Pandalus borealis</i> )		0.1	0.1		0.1	0.1
Deep prawn ( <i>Pasiphaea tarda</i> )	12.2	1.4	1.8	0.9	0.5	0.6
<b>Other preys</b>	<b>11.2</b>	<b>0.01</b>	<b>0.4</b>	<b>2.7</b>	<b>0.01</b>	<b>1.4</b>

Younger individuals (males and females) eat mostly crustaceans. Male diet of intermediate sizes (40-49 cm) is based on cephalopods and crustaceans, while at larger sizes they feed only fish practically. Female diet is based on fish; crustaceans are also important prey at intermediate individuals (of 60-69 cm), while



cephalopods are eaten by intermediate sized individuals of 60-79 cm. Fish are eaten from the smallest sizes, turning to be the only prey at largest sizes. Females of Greenland halibut feed on different fish species according to predator size, observing the cannibalism described above.

There is a size range where the diet is more varied for both males (40-49 cm) and females (60-69 cm) reflecting the ontogenic changes in the feeding behavior of the Greenland halibut. These ranges represent the period of dietary transition (Figure 3.7.1).

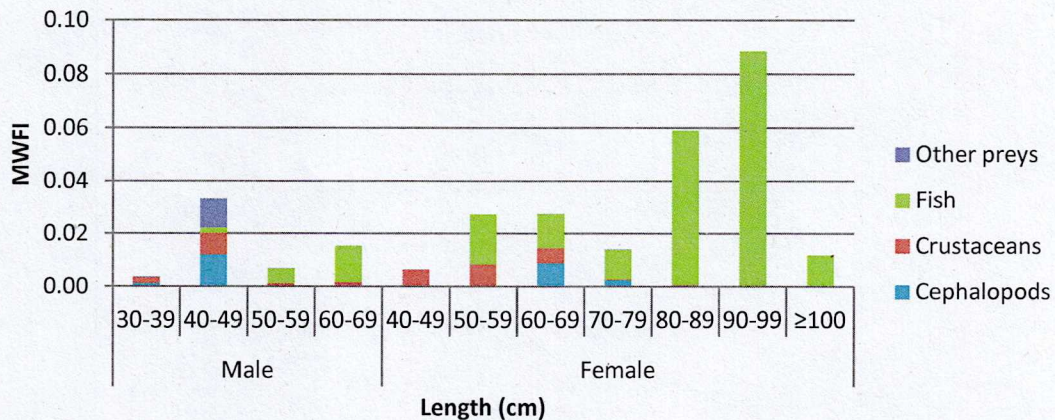


Figure 3.7.1. Ontogenic changes in the feeding behavior of the Greenland halibut by sex.

Despite the low level of FI, the three main prey groups of the Greenland halibut are energetically rich: crustaceans (wet weight 0.84-1.29 Kcal/g), cephalopods (wet weight 1.31 Kcal/g) and fish (wet weight 1.14-1.51 Kcal/g) (Steimle and Terranova, 1985). These are important prey for large sized individuals and for individuals in advanced stages of the reproductive cycle, being fish the most important one, for both males and females (Figures 3.7.1 and 3.7.2)

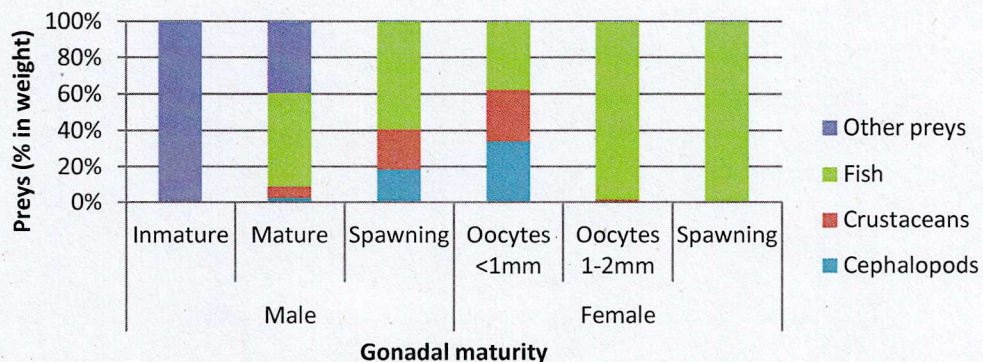


Figure 3.7.2. Diet composition by sex attending the stage of the reproductive cycle.

In general, the diet of Greenland halibut in this survey was similar to that observed in the study of the autumn survey of 2014, as well as in other studies (Vollen *et al.*, 2004). These studies agree aspects of diet such as: no notable differences between males and females, the main prey groups, the geographical variation of prey species, the pattern of dietary changes as they grow (crustaceans, cephalopods and finally fish), and the size predator-prey relationship.

### 3.8 Preliminary observations on maturity of Greenland halibut

The preliminary data on maturity of Greenland halibut were analysed based on visual observation of gonads (macroscopic).

The percentages of mature individuals by length and sex are presented in Figure 3.8.1. There is a predominance of mature fish, particularly in the case of the males. The estimated  $L_{50}$  value for females was 40.5 cm.

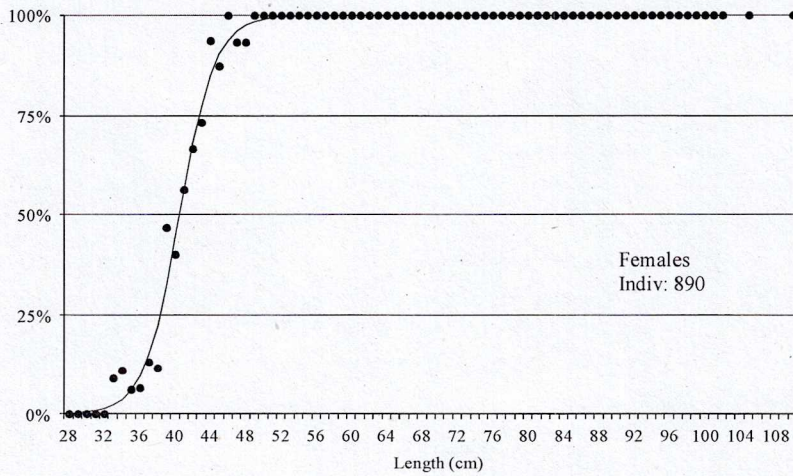
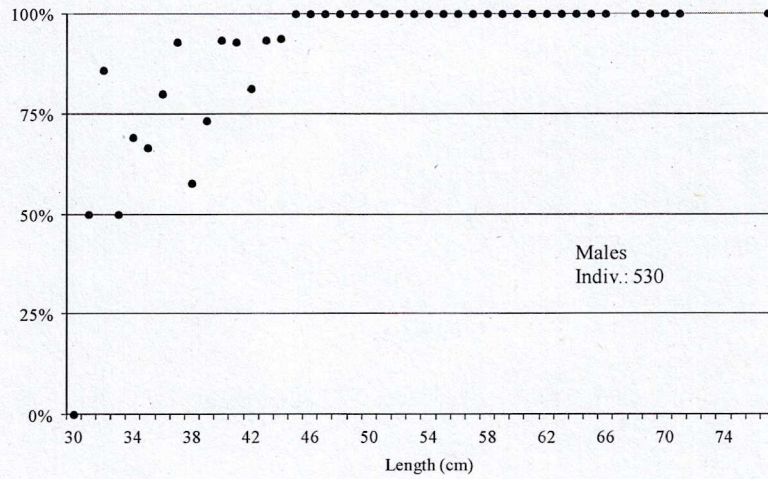
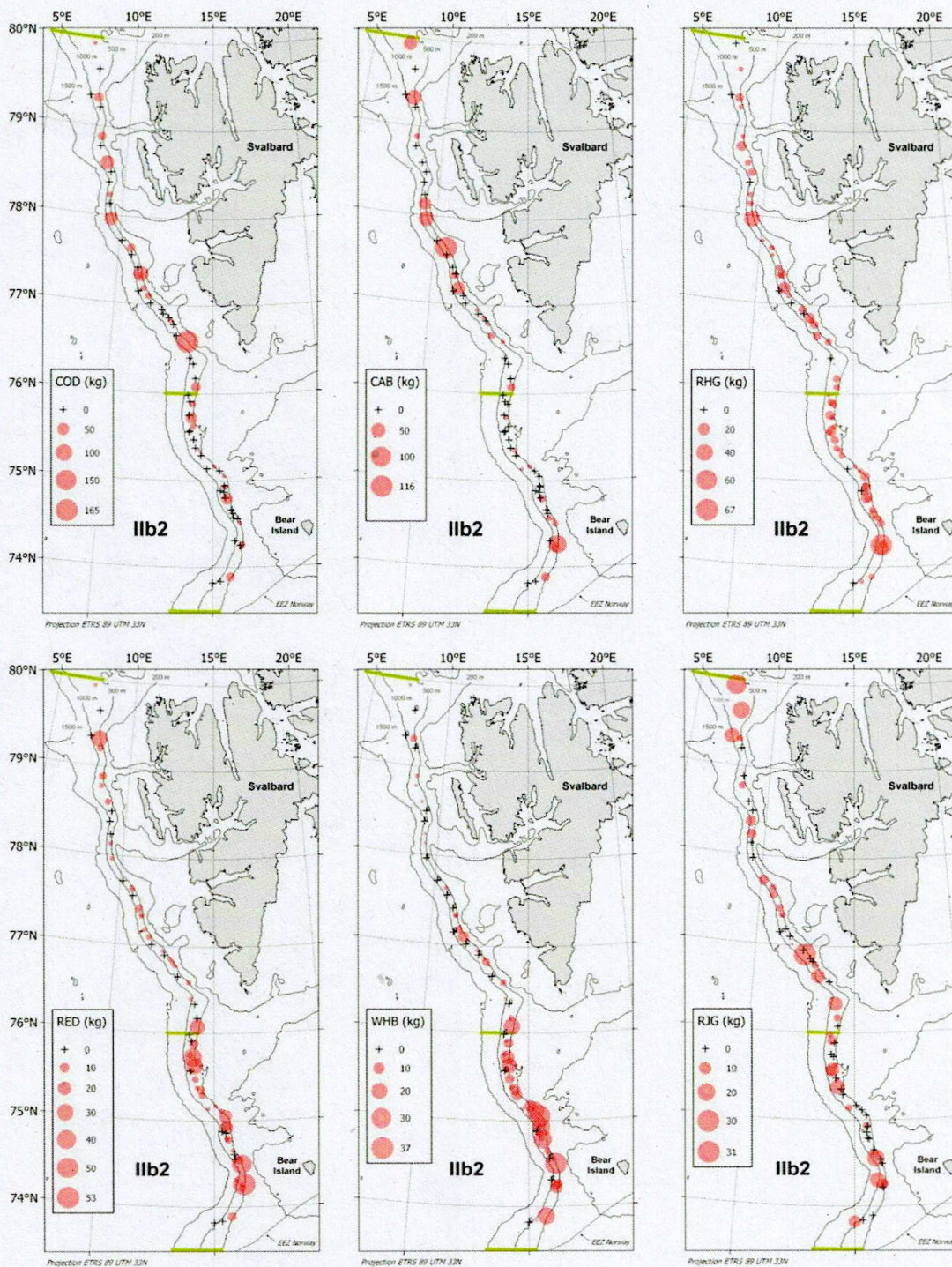


Figure 3.8.1 Percentages of mature Greenland halibut by length and sex. Spanish bottom trawl autumn survey "FLETAN ÁRTICO 2016".

### 3.9 Distribution patterns of the principal by-catch species

Figure 3.9.1 shows maps of the catches by haul (kg/30 minute hauls) for the main by-catch species. None of them presents a clear latitudinal distribution pattern, but the abundance of redfish and blue whiting apparently increased with a decrease of latitude: hauls carried out south of 76°00'N show higher values than the northern hauls.



**Figure 3.9.1** Maps of the study area showing the distribution of the catches by haul (kg/30 min haul) of main by-catch species. COD: Cod; CAB: Northern wolffish; RHG: Roughhead grenadier; RED: Redfish; WHB: Blue whiting; RJG: Arctic skate. Spanish bottom trawl autumn survey “FLETAN ARTICO 2016”. Proportional symbols (area) using Flannery compensation method.

### 3.10 Abundance and biomass of the principal by-catch species

The estimated abundance and biomass indices for the principal by-catch species (Annex III) were very low when compared with the Greenland halibut indices, indicating that the Greenland halibut is clearly the dominant fish species on the slope of Svalbard in September.

### 3.11 Vulnerable Marine Ecosystems indicator species

As in previous surveys, in general by-catch of Vulnerable Marine Ecosystems (VME) indicator species (FAO, 2009) was either absent or low. Stony corals, cup corals, black corals and sea fans were not present in the by-catch. The presence of cauliflower corals (Nephtheidae) and other potentially vulnerable invertebrate species or groups (e.g. Bryozoans) cited in the FAO Guidelines (2009) was also negligible. This seems that sponges (Porifera indet) and sea pens (Umbellulidae) were the two main VME indicator species in the area. The distribution maps of both indicators are presented in Figure 3.11.1. Worth noting is the low by-catches of VME indicator species, particularly sponges, in most of the hauls carried out to the south of 76°00'N.

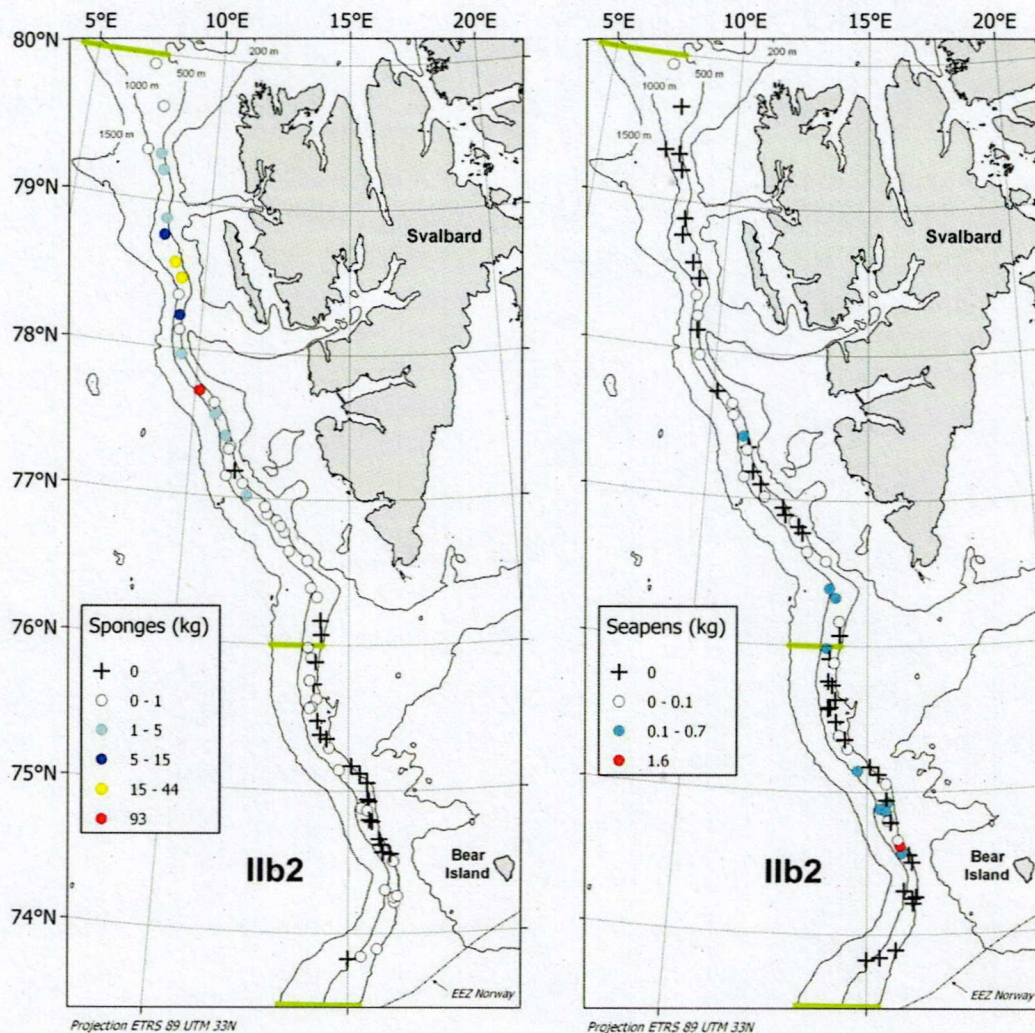
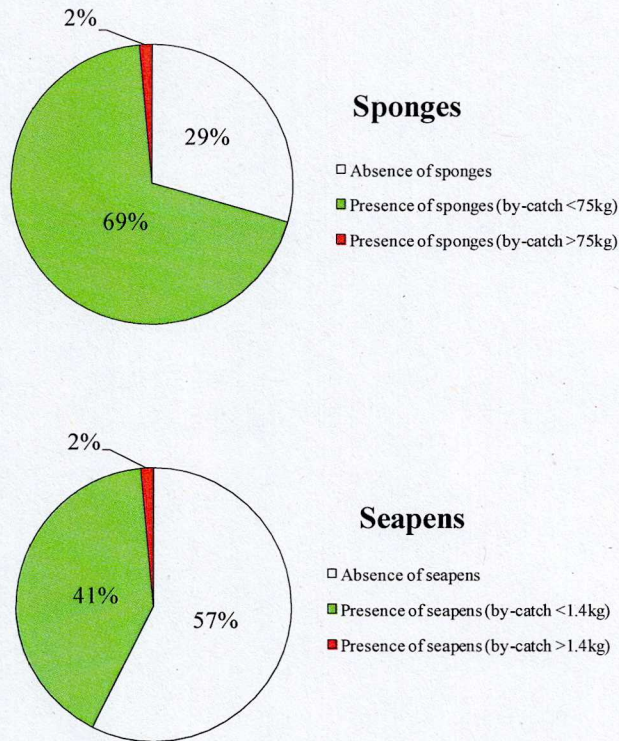


Figure 3.11.1 Distribution of the two main VME indicator species (sponges and sea pens) by haul (kg/30 minutes) in the study area. Black crosses represent absence of such indicators (by-catch = 0 kg). Spanish bottom trawl autumn survey "FLETAN ÁRTICO 2016".

The amounts of by-catch of sponges and cold-water corals in the survey hauls were lower than the thresholds recommended by NEAFC/NAFO to define “encounters” with VMEs in commercial trawls. Moreover, in most of the hauls, by-catch of such organisms was lower than the NAFO threshold<sup>1</sup> for “significant research vessel trawl catches of VME indicator species” (Figure 3.11.2). Only in two hauls the by-catches of sponges (haul No 43 = 92.7 kg) or sea pens (haul No 9 = 1.6 kg) respectively, exceeded the NAFO threshold for “significant research vessel trawl catches of VME indicator species”.

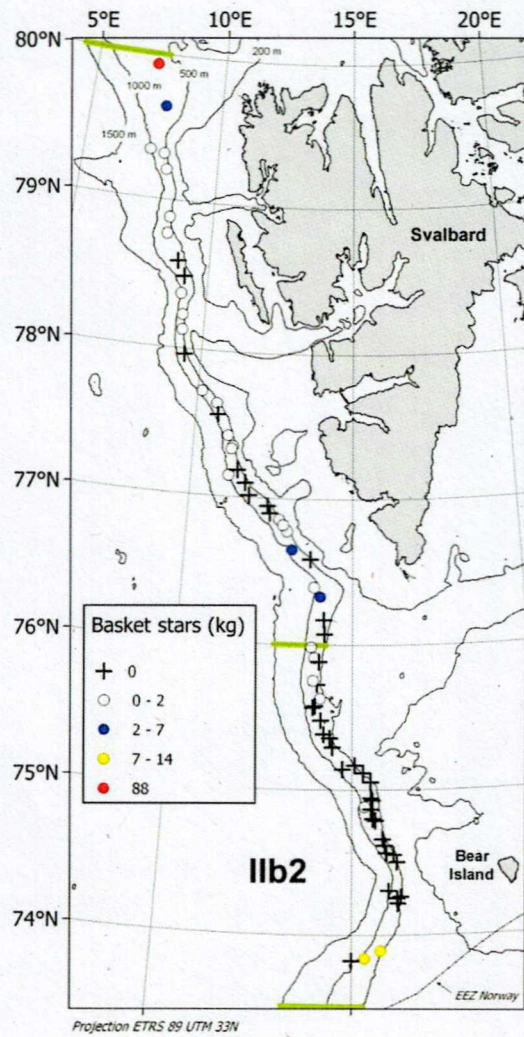


**Figure 3.11.2** Pie chart showing the percentage of hauls (in terms of number) with presence/absence of the main VME indicator species. Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”.

<sup>1</sup> NAFO threshold for “significant research vessel trawl catches of VME indicator species”: Sponges = 75 kg; Sea-pens = 1.4 kg; Large gorgonians = 0.6 kg; Small gorgonians = 0.15 kg; Bryozoans = 0.2 kg; Ascidiars = 0.3 kg.

### 3.12 Other invertebrates

Echinoderms represented the second group of invertebrates in the by-catch in terms of weight (Table 3.2.1). Basket stars (*Gorgonocephalus* indet) are Echinoderms easily caught by bottom trawl because of their large body size and height over the seabed (Jørgensen *et al.*, 2015a). They are likely vulnerable because the arms are easily fragmented during the trawl (Jørgensen *et al.*, 2015b). Figure 3.12.1 shows the map of the distribution of basket stars in the study area. Worth noting is the low by-catches of basket stars in most of the hauls carried out to between 74°00'N - 76°00'N.



**Figure 3.12.1** Distribution of basket stars by haul (kg/30 minutes) in the study area. Black crosses represent absence of such species (by-catch = 0 kg). Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”.

#### 4. Conclusions

The following main conclusions are derived from the results of the Spanish bottom trawl autumn survey “FLETAN ÁRTICO 2016”:

1. Greenland halibut is clearly the predominant species on the slope of Svalbard (ICES Division IIb2) in September.
2. The values estimated in the 2016 survey show a decrease in biomass and abundance indices when compared with the autumn survey carried out in the last years.
3. Latitudinal and bathymetric distributions of Greenland halibut are similar to those observed in previous surveys: the main catches were recorded at depths between 600-800 m and the shallower strata of the South (4 and 5) show greatest concentrations of the species.
4. The length range (both sexes combined) of the Greenland halibut population ranged from 30 cm to 105 cm. The proportion of males was higher just like in previous cruises. Modal length was 48 cm for males and 43 and 51 cm for females.
5. Greenland halibut shows a low level of feeding intensity in September in the study area (FI=15%). Mature individuals are dominant in the catches.
6. When compared with the Greenland halibut, the accompanying species show very low CPUE values and very low abundance and biomass indices.
7. By-catches of Vulnerable Marine Ecosystems (VMEs) indicator species were generally absent or low. Worth noting is the low by-catches of VME indicator species, particularly sponges, in most of the hauls carried out to the south of 76°00'N. Only in two hauls the by-catches of sponges or sea pens, respectively, exceeded the NAFO threshold for “*significant research vessel trawl catches of VME indicator species*”.

#### 5. Acknowledgements

We are grateful to the skipper and crew of the trawler for their cooperation during the survey and to the scientific staff onboard the vessel for the sampling work done during the cruise. Thanks are also due to the Secretaría General de Pesca (SGP) for facilitating the necessary administrative support, as well as to the staff of the IEO, the ship-owner and the association ARVI for assistance with the logistics of the survey. The survey was funded by the ship-owner under the IEO ECOPESE-2 project.

#### 6. References

- Basterretxea, M., Ruiz, J., Iriondo, A. & Mugerza, E. (2013) Spanish bottom trawl autumn survey Fletán Ártico 2012 in the slope of Svalbard Area, ICES Division IIb. Working document presented to the 2013 ICES Arctic Fisheries Working Group (AFWG). International Council for the Exploration of the Sea.
- Durán Muñoz, P., Martínez-Escauriaza, R., González, C. and Ramilo, L. (2016) Spanish bottom trawl spring survey “Fletán Ártico 2015” in the slope of Svalbard (ICES Division IIb2). Working document presented to the 2016 ICES Arctic Fisheries Working Group (AFWG). International Council for the Exploration of the Sea.
- Durán Muñoz, P., Sánchez Bagués, A., González, C. and Ramilo, L. (2015) Spanish bottom trawl autumn survey “Fletán Ártico 2014” in the slope of Svalbard (ICES Division IIb2). Working document presented to the 2015 ICES Arctic Fisheries Working Group (AFWG). International Council for the Exploration of the Sea.
- Durán Muñoz, P. & Paz, X. (1996) Pilot Experimental Fishing in the Barents Sea (6<sup>th</sup> June to 08<sup>th</sup> July, 1995) targeting long rough dab. Working document presented to the 1996 ICES Arctic Fisheries Working Group (AFWG). International Council for the Exploration of the Sea.
- FAO (2009) International guidelines for the management of deep-sea fisheries in the high seas. Rome: Food and Agriculture Organization of the United Nations, 73 pp.
- Hallfredsson, E.H., Smirnov, O. & Harbitz, A. (2013) Comparison of NEA Greenland halibut survey trends in the Barents Sea. Working document presented to the 2013 ICES Arctic Fisheries Working Group (AFWG). International Council for the Exploration of the Sea.

- Jørgensen, L.L., Planque, B., Thangstad, T.H., and Certain, G. (2015a) Vulnerability of megabenthic species to trawling in the Barents Sea. *ICES Journal of Marine Science*, 73: i84–i97.
- Jørgensen, L.L., Ljubin, P., Skjoldal, H.R., Ingvaldsen, R.B., Anisimova, N., and Manushin, I. (2015b) Distribution of benthic megafauna in the Barents Sea: baseline for an ecosystem approach to management. *ICES Journal of Marine Science*, 72:595 – 613.
- Molenaar, E.J. (2012) Fisheries Regulation in the Maritime Zones of Svalbard. *International Journal of Marine and Coastal Law* 27, 4-58.
- Paz, X. & Casas, J.M. (2014) Spanish bottom trawl survey “Fletán Ártico 2013” in the slope of Svalbard Area. ICES Division IIb. Working document presented to the 2014 ICES Arctic Fisheries Working Group (AFWG). International Council for the Exploration of the Sea.
- Paz, X. & Durán Muñoz, P. (1997) Informe de la Campaña “Fletán Ártico 97” en la Zona de Protección de Svalbard, División IIc del CIEM. Instituto Español de Oceanografía. 45 pp.
- Steimle, F.W., and Terranova, R.J. (1985) Energy Equivalents of Marine Organisms from the Continental Shelf of the Temperate Northwest Atlantic. *Journal of Northwest Atlantic Fishery Science*, 6: 118-124.
- Vollen, T., Thomas Albert, O. and Nilssen, E.M. (2004) Diet composition and feeding behavior of juvenile Greenland halibut (*Reinhardtius hippoglossoides*) in the Svalbard area. *Journal of Sea Research*, 51: 251-259.



## **ANNEXES**

**ANNEX I.** Haul characteristics.

**ANNEX II.** Catches (kg in live weight) by haul of main fish species.

**ANNEX III.** Abundance ('000) and biomass (ton) by stratum for the main by-catch species.

ANNEX I. Haul characteristics. Spanish bottom trawl autumn survey "FLETAN ÁRTICO 2016".

Haul	Estrata	Valid	Date	Speed (kn)	Wire (m)	Bottom Temp. (°C)	Hour start (UTC)	Hour end (UTC)	Lat start	Lat end	Long start	Long end	Depth start (m)	Depth end (m)	Doors opening (m)	Vertical opening (m)
1	6	Yes	07/09/2016	3.0	2575	-	05:24	05:54	734933	735017	145944	150391	1206	1190	-	3.0
2	5	Yes	07/09/2016	3.2	2050	-0.8	07:47	08:17	735034	735148	151912	152238	948	923	333	2.7
3	4	Yes	07/09/2016	3.0	1400	3.9	10:13	10:43	735352	735471	154323	154680	631	585	302	2.4
4	4	Yes	07/09/2016	3.3	1575	3.5	15:16	15:46	741318	741481	161018	161097	684	675	306	2.9
5	5	Yes	07/09/2016	3.0	1600	2.7	16:33	17:03	741527	741397	160924	160688	723	815	304	2.7
6	4	Yes	08/09/2016	3.2	1500	4.3	04:31	05:01	743043	743202	160951	160791	631	681	314	2.8
7	5	Yes	08/09/2016	3.2	1455	4.1	08:29	08:59	743345	743474	160472	160114	708	702	289	2.9
8	5	Yes	08/09/2016	3.3	1825	0.0	12:12	12:42	743414	743548	155356	155003	854	849	333	2.6
9	5	Yes	08/09/2016	3.2	1750	1.0	15:12	15:42	743727	743883	155112	154800	769	752	340	2.6
10	4	Yes	09/09/2016	3.5	1520	3.3	05:00	05:30	745580	745746	153252	153305	658	687	307	2.8
11	5	Yes	09/09/2016	3.5	1465	2.3	9:54	10:24	745665	745838	153032	153085	717	740	292	2.7
12	4	Yes	09/09/2016	3.6	1400	3.9	13:59	14:29	750331	750463	152977	152568	631	627	307	2.7
13	5	Yes	10/09/2016	3.2	2075	-0.4	05:09	05:39	750855	750972	144441	143996	940	929	350	2.4
14	4	Yes	10/09/2016	3.5	1401	3.2	07:16	07:46	751755	751903	142777	142435	675	683	295	3.0
15	5	Yes	10/09/2016	3.3	1640	1.5	10:35	11:05	752290	752437	141339	141014	731	735	324	2.5
16	4	Yes	10/09/2016	3.5	1450	3.8	14:35	15:05	754362	754524	140094	140003	617	635	316	2.8
17	1	Yes	11/09/2016	3.5	1450	3.1	05:00	05:30	760453	760619	141225	141420	605	590	321	2.8
18	2	Yes	11/09/2016	3.5	2000	-0.4	08:19	08:49	762019	762179	140375	140511	929	940	335	2.8
19	3	Yes	11/09/2016	3.2	2350	-0.6	11:18	11:48	762405	762558	135276	135353	1069	1075	358	2.8
20	1	Yes	11/09/2016	3.5	1400	3.5	13:39	14:09	763537	763671	134518	133938	588	575	315	3.0
21	2	Yes	11/09/2016	3.3	2050	-0.1	15:30	16:00	763918	764044	131160	130715	921	938	336	2.5
22	1	Yes	12/09/2016	3.2	1550	3.3	04:58	05:28	764671	764812	130225	125923	681	658	331	2.9
23	1	Yes	12/09/2016	3.3	1400	3.1	07:55	08:25	765139	765272	124726	124314	665	633	308	3.0
24	2	Yes	12/09/2016	3.1	1900	0.7	10:44	11:14	765384	765512	122994	122576	850	827	343	2.7
25	2	Yes	12/09/2016	3.3	1850	-0.3	13:28	13:58	770093	770208	115031	114513	826	814	342	2.6
26	3	Yes	13/09/2016	3.0	2250	-0.8	05:11	05:41	770869	771001	111026	110746	1050	1054	345	2.7
27	1	Yes	13/09/2016	3.3	1405	3.5	07:27	07:57	772072	772234	111524	111399	642	649	315	2.9
28	2	Yes	13/09/2016	3.2	1755	-0.1	09:49	10:19	772508	772662	110438	110253	819	810	343	2.6
29	1	Yes	13/09/2016	3.2	1455	3.3	13:11	13:41	773842	773970	103874	103439	621	600	313	3.1
30	2	Yes	14/09/2016	2.9	1625	1.1	05:01	05:31	795572	795443	71904	72171	708	710	303	3.1

ANNEX I (Cont). Haul characteristics. Spanish bottom trawl autumn survey "FLETAN ÁRTICO 2016".

Haul	Estrata	Valid	Date	Speed (kn)	Wire (m)	Bottom Temp. (°C)	Hour start (UTC)	Hour end (UTC)	Lat start	Lat end	Long start	Long end	Depth start (m)	Depth end (m)	Doors opening (m)	Vertical opening (m)
31	2	Yes	14/09/2016	2.9	1575	0.8	9:22	9:52	793849	793710	74976	74893	737	754	297	3.1
32	3	Yes	14/09/2016	3.2	2175	-0.7	12:43	13:13	792016	791871	72724	72822	1021	1060	335	3.0
33	1	Yes	14/09/2016	3.1	1375	4.1	14:48	15:18	791889	791742	75841	80078	583	588	294	3.1
34	1	Yes	15/09/2016	3.0	1475	3.5	16:32	17:02	791239	791103	80792	81090	660	660	313	2.9
35	1	Yes	15/09/2016	3.2	1350	3.8	05:07	05:37	785300	785148	82680	82799	594	596	309	3.3
36	2	Yes	15/09/2016	3.2	1550	2.2	06:52	07:22	784636	784496	82582	82855	706	703	306	3.0
37	1	Yes	15/09/2016	3.0	1500	2.0	09:15	09:45	783560	783431	85437	85759	658	673	311	3.1
38	2	Yes	15/09/2016	3.1	1675	2.5	11:49	12:19	782951	782790	91090	91504	751	775	319	2.9
39	3	Yes	15/09/2016	2.9	2250	-0.5	14:08	14:38	782245	782105	90800	90718	1062	1077	342	2.7
40	2	Yes	16/09/2016	3.0	1600	3.1	05:06	05:36	781394	781247	91472	91457	709	685	321	2.9
41	1	Yes	16/09/2016	3.2	1450	2.9	06:47	07:17	780786	780634	91717	91807	638	644	286	3.1
42	1	Yes	16/09/2016	3.1	1550	1.5	08:54	09:24	775763	775628	92648	93012	669	644	328	3.0
43	2	Yes	16/09/2016	3.1	2000	-0.7	11:47	12:17	774305	774180	100804	101257	871	883	310	2.8
44	2	Yes	16/09/2016	2.8	2000	0.5	14:21	14:51	773361	773222	104233	104542	933	952	324	3.2
45	2	Yes	17/09/2016	2.9	1600	2.9	05:10	05:40	771967	771824	111280	111454	721	698	337	3.5
46	1	Yes	17/09/2016	3.1	1600	3.3	07:26	07:56	771092	770975	112643	113063	677	644	333	2.9
47	1	Yes	17/09/2016	2.9	1500	2.9	09:50	10:20	770590	770481	114200	114617	632	641	335	3.7
48	2	Yes	17/09/2016	3.2	1600	-	12:47	13:17	765681	765575	122515	122959	743	710	-	-
49	1	Yes	17/09/2016	2.9	1600	3.8	15:39	16:09	764917	764790	125460	125826	692	692	336	3.0
50	2	Yes	18/09/2016	3.1	1600	1.6	05:00	05:30	761040	760886	141070	140983	710	706	330	2.8
51	5	Yes	18/09/2016	3.1	2050	-0.3	07:28	07:58	755905	755753	134986	135004	881	873	352	2.7
52	5	Yes	18/09/2016	3.0	1600	1.2	09:28	09:58	755463	755325	135594	135449	744	756	326	3.1
53	4	Yes	18/09/2016	2.7	1400	-	11:50	12:20	755297	755168	140353	140394	598	579	324	-
54	5	Yes	18/09/2016	2.8	1600	0.0	14:18	14:48	754525	754394	135417	135415	738	741	330	2.9
55	4	Yes	19/09/2016	3.2	1350	3.9	05:01	05:31	753769	753617	140650	140567	569	602	332	2.8
56	5	Yes	19/09/2016	3.1	1710	1.5	06:52	07:22	753452	753298	135827	135881	731	742	328	2.7
57	5	Yes	19/09/2016	3.0	1810	0.1	10:36	11:06	753395	753242	135460	135509	796	812	324	2.7
58	4	Yes	19/09/2016	3.1	1610	3.3	12:57	13:27	752862	752708	140819	140991	665	671	323	2.5
59	4	Yes	19/09/2016	3.1	1610	3.7	15:39	16:09	752132	751990	142342	142611	618	619	334	2.6
60	4	Yes	20/09/2016	3.1	1405	4.6	05:07	05:37	751017	750905	150413	150859	592	605	332	2.7

ANNEX I (Cont). Haul characteristics. Spanish bottom trawl autumn survey "FLETAN ÁRTICO 2016".

Haul	Estrata	Valid	Date	Speed (kn)	Wire (m)	Bottom Temp. (°C)	Hour start (UTC)	Hour end (UTC)	Lat start	Lat end	Long start	Long end	Depth start (m)	Depth end (m)	Doors opening (m)	Vertical opening (m)
61	4	Yes	20/09/2016	3.4	1500	4.2	07:52	08:22	750706	750581	151786	152202	615	621	327	2.8
62	5	Yes	20/09/2016	3.1	2100	-0.4	13:30	14:00	745305	745148	152030	152161	923	901	347	2.8
63	5	Yes	20/09/2016	3.2	1700	3.1	15:28	15:58	745204	745044	153001	153076	710	706	318	2.8
64	4	Yes	21/09/2016	3.3	1625	3.7	05:00	05:30	744817	744664	153292	153461	682	695	314	2.9
65	4	Yes	21/09/2016	3.2	1550	4.5	11:44	12:14	744748	744600	153701	153900	621	613	323	2.7
66	5	Yes	21/09/2016	3.3	1675	3.8	14:34	15:04	743992	743853	154793	155151	715	710	314	2.8
67	6	Yes	22/09/2016	3.1	2450	-0.7	05:22	05:52	741847	741697	155641	155597	1248	1071	356	-
68	4	Yes	22/09/2016	3.3	1510	4.3	07:34	08:04	741593	741439	161476	161393	629	573	320	3.5

ANNEX II. Catches (kg in live weight) by haul of main fish species. Spanish bottom trawl autumn survey  
 "FLETAN ÁRTICO 2016".

Haul No	Greenland halibut	Cod	Northern wolffish	Roughhead grenadier	Redfish	Blue whiting	Arctic skate	Grater eelpout	Thorny skate
1	311.4	-	-	-	-	-	9.56	1.69	-
2	564.2	-	-	2.03	-	0.05	-	1.74	-
3	4,816.0	26.18	17.56	3.95	7.95	22.30	-	2.92	0.01
4	6,706.0	2.81	10.80	22.87	4.17	10.71	-	2.00	1.22
5	4,186.0	-	9.56	66.20	1.76	6.74	7.10	2.70	-
6	5,936.0	3.73	8.14	8.57	42.43	37.20	-	1.92	0.53
7	4,676.0	-	1.00	3.00	6.00	1.00	-	7.00	-
8	1,491.0	-	6.72	2.76	-	-	19.43	1.72	0.62
9	4,340.0	-	-	9.69	-	0.84	3.73	3.53	2.76
10	6,748.0	9.05	-	11.00	17.70	25.35	-	2.71	0.51
11	7,063.0	-	-	5.79	8.30	2.62	2.71	7.33	-
12	4,606.0	2.08	-	11.30	17.55	33.25	-	2.08	-
13	763.0	-	1.42	-	0.74	0.31	2.58	0.13	-
14	4,529.0	-	-	4.44	4.27	9.00	-	1.59	3.63
15	5,908.0	-	-	5.19	1.55	1.51	14.03	3.31	-
16	2,492.0	41.76	1.96	1.80	36.00	14.76	-	3.32	4.34
17	2,947.0	31.55	15.30	4.94	25.70	21.15	-	6.14	1.92
18	260.9	-	-	-	-	-	13.36	0.27	1.24
19	283.9	-	-	-	1.48	0.09	0.04	0.96	-
20	590.6	164.85	2.45	6.40	1.90	2.45	-	4.35	3.30
21	5,705.0	-	9.32	9.50	-	-	12.38	1.54	0.94
22	2,478.0	-	1.85	8.95	1.12	0.14	2.76	4.70	1.10
23	2,380.0	-	3.70	14.55	1.34	0.64	-	4.15	1.12
24	1,288.0	-	-	-	-	-	30.60	1.04	0.60
25	1,442.0	-	-	-	-	-	0.05	-	-
26	129.6	-	-	-	0.53	-	-	0.49	-
27	637.0	80.38	-	12.70	1.94	1.75	2.26	0.92	2.04
28	826.0	-	-	3.58	6.34	-	3.06	0.64	1.54
29	1,057.0	21.35	115.17	3.50	3.30	0.80	2.76	0.95	3.76
30	546.0	2.82	44.80	-	0.64	0.25	24.93	0.63	1.33
31	861.0	-	-	2.27	-	-	19.84	1.49	1.62
32	89.9	-	-	-	-	-	14.68	0.69	-
33	88.1	30.25	54.85	9.55	29.75	3.50	1.97	0.98	1.99
34	221.0	-	-	2.32	4.78	-	-	0.31	2.42
35	339.3	23.86	6.48	2.02	5.85	0.79	-	0.58	2.94
36	1,190.0	-	-	12.75	2.15	0.18	2.76	0.36	-
37	1,337.0	64.25	-	4.50	3.55	0.20	-	0.70	2.05
38	1,442.0	-	-	8.12	-	-	-	-	-
39	119.9	-	-	-	-	-	6.71	0.46	-
40	707.0	8.05	-	2.82	-	0.13	5.87	0.84	0.87
41	560.0	-	36.89	3.71	1.13	0.12	-	1.92	-
42	1,638.0	63.75	54.65	35.90	1.15	-	-	4.62	3.76
43	434.0	-	-	1.14	-	-	5.99	0.48	0.75
44	1,295.0	-	-	0.91	-	-	3.29	0.09	1.08
45	588.0	8.48	14.75	2.35	0.51	0.21	0.04	1.79	1.42
46	1,323.0	9.80	39.00	20.55	1.76	4.10	-	4.21	-

ANNEX II. Catches (kg in live weight) by haul of main fish species. Spanish bottom trawl autumn survey  
 "FLETAN ÁRTICO 2016".

Haul No	Greenland halibut	Cod	Northern wolffish	Roughhead grenadier	Redfish	Blue whiting	Arctic skate	Grater eelpout	Thorny skate
47	252.9	13.65	-	2.08	3.13	9.75	-	1.25	1.30
48	3,339.0	-	1.29	7.95	0.68	0.42	-	3.18	-
49	714.0	5.09	-	2.64	1.47	4.15	-	4.75	-
50	1,834.0	-	-	6.21	-	2.12	3.02	4.45	-
51	1,827.0	-	-	0.69	-	-	1.84	0.02	1.03
52	1,736.0	-	-	6.36	-	0.48	5.42	0.79	-
53	3,276.0	11.95	-	7.05	9.20	5.90	-	2.81	-
54	2,478.0	-	-	10.70	3.25	0.60	-	0.25	0.01
55	1,106.0	8.95	-	2.96	29.82	18.27	0.79	6.30	-
56	6,010.0	-	-	14.15	2.60	1.70	12.60	1.75	-
57	3,342.0	-	-	2.65	-	-	5.42	-	-
58	4,431.0	-	-	8.45	4.00	6.45	-	1.00	-
59	3,598.0	1.66	3.20	2.65	6.00	8.70	-	1.45	-
60	2,401.0	3.00	3.20	2.10	0.88	10.10	-	0.49	-
61	9,163.0	-	-	3.33	1.86	24.15	-	1.04	-
62	239.0	-	-	-	-	-	0.12	0.08	-
63	7,777.0	-	-	6.30	-	1.95	-	0.72	1.07
64	10,346.0	-	-	17.81	2.05	1.81	-	4.25	0.90
65	3,164.0	42.95	10.97	3.53	5.76	25.65	-	11.85	1.43
66	5,222.0	-	-	5.25	1.42	2.65	-	-	-
67	422.8	-	-	0.32	0.35	-	15.66	1.04	-
68	5,397.0	11.88	80.95	6.71	52.30	4.80	2.63	-	1.57

ANNEX III. Abundance ('000) and biomass (ton) by stratum for the main by-catch species. Spanish bottom trawl autumn survey "FLETAN ÁRTICO 2016".

Table A. Cod.

Strata	Area (nm <sup>2</sup> )	No of hauls	Catch (number)	Catch (kg)	Swept area (nm <sup>2</sup> )	Abundance ('000)	Biomass (ton)
1	702	15	99	509	0.539	130	669
2	1,263	15	6	19	0.528	14	46
3	2,693	4	-	-	0.139	-	-
4	488	16	28	166	0.590	25	140
5	761	16	-	-	0.573	-	-
6	1,672	2	-	-	0.069	-	-
Total	7,579	68	133	694	2.438	169	855

Table B. Northern wolffish (*A. denticulatus*).

Strata	Area (nm <sup>2</sup> )	No of hauls	Catch (number)	Catch (kg)	Swept area (nm <sup>2</sup> )	Abundance ('000)	Biomass (ton)
1	702	15	28	330	0.539	37	434
2	1,263	15	6	70	0.528	14	168
3	2,693	4	-	-	0.139	-	-
4	488	16	25	137	0.590	21	115
5	761	16	3	19	0.573	9	25
6	1,672	2	-	-	0.069	-	-
Total	7,579	68	62	556	2.438	82	743

Table C. Roughhead grenadier

Strata	Area (nm <sup>2</sup> )	No of hauls	Catch (number)	Catch (kg)	Swept area (nm <sup>2</sup> )	Abundance ('000)	Biomass (ton)
1	702	15	291	134	0.539	402	177
2	1,263	15	105	58	0.528	252	138
3	2,693	4	-	-	0.139	-	-
4	488	16	228	119	0.590	193	100
5	761	16	77	141	0.573	202	187
6	1,672	2	1	0.3	0.069	25	8
Total	7,579	68	702	452	2.438	1,072	610

ANNEX III. (Cont.). Abundance ('000) and biomass (ton) by stratum for the main by-catch species. Spanish bottom trawl autumn survey "FLETAN ÁRTICO 2016".

**Table D.** Redfish (*Sebastes* spp)

Strata	Area (nm <sup>2</sup> )	No of hauls	Catch (number)	Catch (kg)	Swept area (nm <sup>2</sup> )	Abundance ('000)	Biomass (ton)
1	702	15	175	88	0.539	235	115
2	1,263	15	20	10	0.528	48	25
3	2,693	4	4	2	0.139	81	41
4	488	16	426	242	0.590	359	204
5	761	16	24	26	0.573	46	34
6	1,672	2	1	0.3	0.069	25	8
Total	7,579	68	650	368	2.438	793	428

**Table E.** Blue whiting (*M. poutassou*)

Strata	Area (nm <sup>2</sup> )	No of hauls	Catch (number)	Catch (kg)	Swept area (nm <sup>2</sup> )	Abundance ('000)	Biomass (ton)
1	702	15	294	50	0.539	406	65
2	1,263	15	22	3	0.528	53	8
3	2,693	4	0	0.1	0.139	0	2
4	488	16	1,647	258	0.590	1389	218
5	761	16	78	20	0.573	193	27
6	1,672	2	-	-	0.069	-	-
Total	7,579	68	2,041	332	2.438	2,041	320

**Table F.** Arctic skate (*A. hyperborea*)

Strata	Area (nm <sup>2</sup> )	No of hauls	Catch (number)	Catch (kg)	Swept area (nm <sup>2</sup> )	Abundance ('000)	Biomass (ton)
1	702	15	4	10	0.539	5	13
2	1,263	15	54	125	0.528	129	300
3	2,693	4	21	21	0.139	425	434
4	488	16	3	3	0.590	3	3
5	761	16	28	75	0.573	45	100
6	1,672	2	10	25	0.069	245	618
Total	7,579	68	120	260	2.438	852	1,468