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Results for capelin from the surveys conducted by Spain in the NAFO Regulatory Area of Div. 3NO, 1995-2015

by

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Abstract

Since 1995, a stratified random spring bottom trawl survey in the NAFO Regulatory Area of Div. 3NO has been conducted by Spain every year. In 2001, the trawl vessel was replaced in the realization of the survey; a comparative survey between both vessels was made to transform the historical time-series into the new vessel index. The transformed entire series of mean catches and biomass distribution for capelin (*Mallotus villosus*) are presented for the period 1995-2000, and the no-transformed data for the years 2002-2015. In 2001, there are data from both vessels. The standard deviation is shown for biomass. Biomass fluctuated during all the period, and peaked in 2012.

Material and methods

Survey design and gear used

The survey on NAFO Regulatory Area of Divisions 3NO has been conducted yearly by Spain since 1995. From 1995 to 2001, the surveys were conducted on board the C/V *Playa de Menduiña* (338 GT and 800 HP) using bottom trawl net type *Pedreira.* In 2002, the R/V *Vizconde de Eza* replaced the former vessel using a *Campelen* type bottom trawl net. The main specifications and geometry of these gears, as the rigging profile and the net plan, and a sheet with the resume of the main technical data of the survey are described in previous works (Walsh *et. al.*, 2001). The number of valid tows, the depth strata covered and the dates of the survey series are presented in Table 1. The area is divided into 41 sampling strata up to 1460 m, but only from 1998 onwards the survey covered all the area. Hauls were made following the stratification charts described in Bishop (1994). Sets were allocated in accordance with the area of the strata, proportionally to their size, with a minimum of two planned hauls per stratum, and the trawl positions were chosen at random (Doubleday, 1981).

The catch from each haul was sorted by species and weighted. Biomass index was estimated by the swept-area method (Cochran, 1997), assuming a catchability factor of 1 for catches for each species.

In 2001, a comparative survey between both vessels was made to transform the historical time-series into the new vessel index, making 92 paired hauls, where 90 were valid. Mean catch and biomass and their respective standard deviations were transformed to create a combined 1995-2015 time-series for capelin.

Capelin stratified mean catches and SD

The mean catch ($\bar{y}_i$) and the variance (Var_i) are calculated by stratum by the following formulas:

$$\bar{y}_i = \sum_{j=1}^{T_i} \frac{y_j}{T_i}, \quad i = 1, \ldots, h$$

$$Var_i = \sum_{j=1}^{T_i} \frac{(y_j - \bar{y}_i)^2}{T_i - 1}, \quad i = 1, \ldots, h$$

where:

y_j is the catch in haul j

T_i is the number of hauls in the stratum i

h is the total number of strata

and the stratified mean catch ($\bar{y}_i^{str}$) and the stratified variance (Var_i^{str}) by stratum are obtained as follow:

$$\bar{y}_i^{str} = \bar{y}_i n_i, \quad i = 1, \ldots, h$$

$$Var_i^{str} = Var_i \frac{n_i^2}{T_i}, \quad i = 1, \ldots, h$$

where:

n_i is the area of the stratum i , $i = 1, \ldots, h$

Then the total stratified mean catch ($\bar{y}$) and the variance (Var) by year are calculated according to the formulas:

$$\bar{Y} = \sum_{i=1}^{h} \frac{\bar{y}_i^{str}}{N}$$

$$Var = \sum_{i=1}^{h} \frac{Var_i^{str}}{N^2}$$

where:

$N = \sum_{i=1}^{h} n_i$ is the total area by year

The stratified standard deviation (SD) by year is calculated as the square root of the stratified variance by year.

Conversion factors

To convert data series it was necessary to calculate the factor power correction (FPC), typically estimated by use of catch per unit of effort (CPUE) observations for the two vessels. In this case, we obtained an estimated FPC as the ratio of sum of CPUE, in this way:

$$FPC = \frac{\sum Campelen\ CPUE}{\sum Pedreira\ CPUE} \quad (1)$$

Robson (1966) proposed the following multiplicative model to establish the relationship between the CPUEs for the two ships:

$$CPUE_{ij} = e^{\mu + t_i + h_j + \varepsilon_{ij}}$$

where:

t_i is the effect of the ship i, $i = 1, 2$

h_j is the effect of the haul j, $j = 1, ..., 90$

μ is the model parameter

ε is the model error

A logarithmic transformation is performed in order to obtain a linear expression:

$$\ln(CPUE_{ij}) = \mu + t_i + h_j + \varepsilon_{ij}$$

This equation was adjusted by generalized linear regression assuming the following restriction necessary to estimate all parameters:

$$\sum_{i=1}^{2} t_i = 0 \Rightarrow t_1 = t = -t_2$$

giving the following estimation of the FPC (Sissenwine and Bowman, 1978):

$$FPC = \frac{CPUE_2}{CPUE_1} = e^{2t(1+0.5s^2)} \quad (1)$$

where s^2 is the variance obtained in the estimate of t.

This method has minor error than other methods used to convert CPUE data (González and Paz, 2003). Besides this, we had a large number of paired hauls without capelin catches, so in other models would appear problems in the fit (Wilderbuer *et al.*, 1998).

The Robson´s method was applied to convert mean catches and biomass. We use, in all cases, only the hauls in which both vessels had non-cero catch.

Data series

For 1995-2000, transformed C/V *Playa de Menduíña* data series are presented. For the period 2002-2015, original R/V *Vizconde de Eza* data series are presented. In 2001, not all strata were surveyed by the

comparative experience; however that were covered by the C/V *Playa de Menduiña*. In order to have data in all the strata surveyed and to obtain the more annual homogeneity possible in the series, data from 15 strata were transformed from the C/V *Playa de Menduiña* and there were included in the calculations. Catches from some hauls from C/V *Playa de Menduiña* were also included and transformed because R/V *Vizconde de Eza* only did 1 haul in 5 strata. This was made to calculate the mean catch and the biomass. In this way, in the strata surveyed by the new vessel, the original R/V *Vizconde de Eza* data are presented and in the strata not surveyed the transformed C/V *Playa de Menduíña* are offered.

Figure 1 presents the maps with the distribution of the catches for years 1995-2015 grouped by periods of five years.

Results

To convert the catch indices, we calculated the equation (1), giving the FPC_{bio} =13.8796. This FPC is quite high and indicates that the R/V *Vizconde de Eza* catches almost 14 times the capelin of the C/V *Playa de Menduíña*. This is probably due because the shape of the gear. The *Pedreira* is a specific gear to catch demersal species, while the *Campelen* has a major vertical opening. Moreover, we have to take into account that both gears are bottom gears and that the capelin is a pelagic forage species (Buren *et al.,* 2014). This could also explain fluctuation of catches, which in general are low.

Capelin Mean Catches:

Table 2 shows the swept area and number of hauls by stratum for the time-series 1995-2015. From 1995 to 2000, data are from the C/V *Playa de Menduiña*, in from 2002 to 2015, from R/V *Vizconde de Eza*.In 2001, there are data from both vessels in the way described above.

The capelin mean catches by stratum and total SD are presented in Table 3, as well as the total stratified mean catch and SD by year. The capelin stratified mean catches fluctuated until 2007 (12.11 kg in 1995 to 31.58 kg in 2007), then increased until 2010. It peaked in 2012 (151.43 kg), then decreased and fluctuated until the end of the studied period (Figure 2).

Capelin biomass:

The entire time series (1995-2015) of capelin biomass and their SD estimates per stratum and total are presented in Table 4. Biomass presented same trend than the total stratified mean catch. Biomass fluctuated until 2007 (6 776 t in 1995 to 24 851 t in 2007), then increased until 2010. It peaked in 2012 (134 193 t), then decreased and fluctuated until the end of the studied period (Figure 3).

Acknowledges

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Table 1. Spanish spring bottom trawl surveys on NAFO Div. 3NO: 1995-2015

Year	Vessel	Valid tows	Depth strata covered (m)	Dates
1995	C/V *Playa de Menduíña*	77	42-684	May 18-May 29
1996	C/V *Playa de Menduíña*	112	41-1135	May 07-May 24
1997	C/V *Playa de Menduíña*	128	42-1263	April 26-May 18
1998	C/V *Playa de Menduíña*	124	42-1390	May 06-May 26
1999	C/V *Playa de Menduíña*	114	41-1381	May 07-May 26
2000	C/V *Playa de Menduíña*	118	42-1401	May 07-May 28
2001(*)	R/V *Vizconde de Eza*	83	36-1156	May 03-May 24
	C/V *Playa de Menduíña*	121	40-1500	May 05-May 23
2002	R/V *Vizconde de Eza*	125	38-1540	April 29-May 19
2003	R/V *Vizconde de Eza*	118	38-1666	May 11-June 02
2004	R/V *Vizconde de Eza*	120	43-1539	June 06–June 24
2005	R/V *Vizconde de Eza*	119	47-1485	June 10–June 29
2005	R/V *Vizconde de Eza*	119	47-1485	June 10–June 29
2006	R/V *Vizconde de Eza*	120	45-1480	June 7–June 27
2007	R/V *Vizconde de Eza*	110	45-1374	May 29–June 19
2008	R/V *Vizconde de Eza*	122	45-1374	May 27–June 16
2009	R/V *Vizconde de Eza*	109	45-1374	May 31–June 18
2010	R/V *Vizconde de Eza*	95	45-1374	May 30–June 18
2011	R/V *Vizconde de Eza*	122	44-1450	June 5–June 24
2012	R/V *Vizconde de Eza*	122	44-1450	June 3–June 21
2013	R/V Vizconde de Eza	122	44-1450	June 1–June 21
2014	R/V Vizconde de Eza	122	44-1450	June 2–June 21
2015	R/V *Vizconde de Eza*	122	44-1450	May 31-June 19

(*)For the calculation of the series, 83 hauls were taken from the R/V *Vizconde de Eza* and 40 hauls from the C/V *Playa de Menduíña* (123 hauls in total)

Table 2. Swept area and number of hauls by stratum from the Spanish Spring bottom trawl survey in NAFO Divisions 3NO (1995-2015). Swept area in square miles. n.s. means stratum not surveyed. 1995-2000 data are from C/V *Playa de Menduiña*; 2001-2015 data are from R/V *Vizconde de Eza*. (*) indicates data from the two vessels and (**) indicates data from the C/V *Playa de Menduiña*.

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
Stratum	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number
353	0.0352	3	0.0371	3	0.048	4	0.0465	4	0.036	3	0.0356	3	0.0341	3	0.0476	4	0.0334	3	0.0338	3	0.0353	3
354	0.0353	3	0.0319	3	0.0232	2	0.0356	3	0.0217	2	0.0356	3	0.0338	3	0.0356	3	0.0338	3	0.0345	3	0.0353	3
355	n.s	n.s	0.0221	2	0.0232	2	0.0221	2	0.0229	2	0.0232	2	0.024	2	0.0236	2	0.0229	2	0.0229	2	0.0225	2
356	n.s	n.s	0.0202	2	0.0225	2	0.0221	2	0.0229	2	0.0225	2	0.024	2	0.0232	2	0.0225	2	0.0221	2	0.0232	2
357	0.0109	1	0.0217	2	0.0442	4	0.024	2	0.0236	2	0.0124	1	0.0244	2	0.024	2	0.0229	2	0.0229	2	0.0232	2
358	0.0319	3	0.0319	3	0.0562	5	0.0349	3	0.0349	3	0.0341	3	0.0345	3	0.0345	3	0.0338	3	0.033	3	0.0349	3
359	0.0345	3	0.0547	5	0.069	6	0.0698	6	0.0364	3	0.0469	4	0.0802	7	0.0686	6	0.0791	7	0.0791	7	0.0814	7
360	0.3562	31	0.3761	31	0.3754	32	0.2899	25	0.2325	19	0.2396	20	0.2422	20	0.2865	25	0.2254	20	0.231	20	0.2325	20
374	0.0225	2	0.0232	2	0.0353	3	0.0353	3	0.0244	2	0.024	2	0.024	2	0.0345	3	0.0225	2	0.0232	2	0.0229	2
375	0.0225	2	0.0229	2	0.0116	1	0.0345	3	0.0236	2	0.0244	2	0.0338	3	0.0353	3	0.033	3	0.0338	3	0.0349	3
376	0.1729	15	0.165	14	0.1582	14	0.1155	10	0.1219	10	0.12	10	0.1155	10	0.114	10	0.1125	10	0.1166	10	0.1174	10
377	0.0221	2	0.0229	2	0.0116	1	0.0229	2	0.024	2	0.0229	2	0.0229	2	0.0229	2	0.0225	2	0.0217	2	0.0232	2
378	0.0435	4	0.033	3	0.021	2	0.0232	2	0.0229	2	0.0232	2	0.0236	2	0.0232	2	0.0225	2	0.0225	2	0.0225	2
379	0.0221	2	0.0112	1	0.0206	2	0.0356	3	0.0236	2	0.0225	2	0.0229	2	0.0229	2	0.0229	2	0.0124	1	0.0236	2
380	n.s	n.s	0.0221	2	0.021	2	0.0225	2	0.0236	2	0.0236	2	(**)0.0206	(**)2	0.0225	2	0.0229	2	0.0221	2	0.0229	2
381	n.s	n.s	0.0229	2	0.0221	2	0.0229	2	0.0229	2	0.0236	2	(**)0.0236	(**)2	0.0229	2	0.0229	2	0.0225	2	0.0232	2
382	n.s	n.s	0.0338	3	0.0461	4	0.0341	3	0.0484	4	0.0499	4	(**)0.0469	(**)4	0.0341	3	0.0454	4	0.0461	4	0.0458	4
721	n.s	n.s	0.0214	2	0.0221	2	0.0202	2	0.0244	2	0.0236	2	0.0247	2	0.0232	2	0.0225	2	0.0221	2	0.0229	2
722	n.s	n.s	0.0206	2	0.0214	2	0.0214	2	0.0229	2	0.0217	2	0.0232	2	0.0236	2	0.0221	2	0.0217	2	0.0232	2
723	n.s	n.s	0.0109	1	0.021	2	0.0232	2	0.0229	2	0.0248	2	0.024	2	0.0232	2	0.0229	2	0.0229	2	0.0232	2
724	0.0105	1	0.0202	2	0.0225	2	0.0206	2	0.0225	2	0.0232	2	0.0353	3	0.0225	2	0.0225	2	0.0214	2	0.0225	2
725	0.0334	3	0.0225	2	0.0206	2	0.0086	1	0.0229	2	0.021	2	(*)0.0338	(*)3	0.0225	2	0.0229	2	0.0225	2	0.0236	2
726	0.0214	2	0.0217	2	n.s	n.s	0.0206	2	0.0225	2	0.0221	2	(*)0.0352	(*)3	0.0214	2	0.0225	2	0.0225	2	0.0112	1
727	n.s	n.s	0.021	2	0.0094	1	0.0232	2	0.0236	2	0.021	2	(**)0.0225	(**)2	0.0232	2	0.0217	2	0.0232	2	0.0229	2
728	n.s	n.s	0.0217	2	0.0214	2	0.0206	2	0.0232	2	0.021	2	(**)0.0229	(**)2	0.0229	2	0.0225	2	0.018	2	0.0109	1
752	n.s	n.s	0.0109	1	0.0217	2	0.0229	2	0.0232	2	0.0206	2	(**)0.021	(**)2	0.0229	2	0.0229	2	0.0214	2	0.0236	2
753	n.s	n.s	0.0199	2	0.0214	2	0.0217	2	0.0229	2	0.0217	2	(**)0.0214	(**)2	0.0229	2	0.0229	2	0.0217	2	0.0225	2
754	n.s	n.s	n.s	n.s	0.033	3	0.021	2	0.0206	2	0.0195	2	(**)0.0195	(**)2	0.0229	2	0.0217	2	0.0214	2	0.0225	2
755	n.s	n.s	n.s	n.s	n.s	n.s	0.0206	2	0.0311	3	0.0431	4	(**)0.0416	(**)4	0.0338	3	0.0221	2	0.0319	3	0.045	4
756	n.s	n.s	0.021	2	0.0109	1	0.0225	2	0.0225	2	0.0202	2	(*)0.0345	(*)3	0.0229	2	0.0221	2	0.0217	2	0.0232	2
757	n.s	n.s	0.0188	2	0.0304	3	0.0206	2	0.0232	2	0.0214	2	(**)0.0232	(**)2	0.0225	2	0.0221	2	0.0217	2	0.0225	2
758	n.s	n.s	n.s	n.s	0.0214	2	0.0217	2	0.0214	2	0.021	2	(**)0.0217	(**)2	0.0225	2	0.0221	2	0.0214	2	0.0225	2
759	n.s	n.s	n.s	n.s	n.s	n.s	0.0214	2	0.0217	2	0.021	2	(**)0.0221	(**)2	0.0225	2	0.0112	1	0.0214	2	0.0229	2
760	n.s	n.s	0.021	2	0.0105	1	0.0214	2	0.0225	2	0.021	2	0.0229	2	0.0229	2	0.0217	2	0.0221	2	0.0229	2
761	n.s	n.s	0.0199	2	0.0315	3	0.0206	2	0.021	2	0.0221	2	0.0225	2	0.0225	2	0.0225	2	0.0221	2	0.0221	2
762	n.s	n.s	n.s	n.s	0.0308	3	0.0206	2	0.021	2	0.0202	2	(*)0.0341	(*)3	0.0225	2	0.0225	2	0.0232	2	0.0225	2
763	n.s	n.s	n.s	n.s	n.s	n.s	0.0217	2	0.0311	3	0.0416	4	(**)0.033	(**)3	0.0225	2	0.0311	3	0.0326	3	0.0334	3
764	n.s	n.s	0.021	2	0.0206	2	0.0217	2	0.0225	2	0.0217	2	0.024	2	0.0236	2	0.0221	2	0.0229	2	0.0232	2
765	n.s	n.s	0.0199	2	0.0206	2	0.021	2	0.0221	2	0.0202	2	(*)0.033	(*)3	0.0236	2	0.0112	1	0.0225	2	0.0229	2
766	n.s	n.s	n.s	n.s	0.0308	3	0.0191	2	0.0217	2	0.0214	2	(**)0.0202	(**)2	0.0232	2	0.0225	2	0.0225	2	0.0229	2
767	n.s	n.s	n.s	n.s	n.s	n.s	0.0221	2	0.0214	2	0.021	2	(**)0.0217	(**)2	0.0225	2	0.0229	2	0.0217	2	0.0112	1

Table 2 (cont.). Swept area and number of hauls by stratum from the Spanish Spring bottom trawl survey in NAFO Divisions 3NO (1995-2015). Swept area in square miles. n.s. means stratum not surveyed. 1995-2000 data are from C/V *Playa de Menduiña*; 2001-2015 data are from R/V *Vizconde de Eza*. (*) indicates data from the two vessels and (**) indicates data from the C/V *Playa de Menduiña*.

	2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
Stratum	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number	Swept area	Tow number
353	0.0371	3	0.0364	3	0.0341	3	0.0345	3	0.0225	2	0.0349	3	0.0338	3	0.0349	3	0.0379	3	0.0401	3
354	0.0364	3	0.0364	3	0.0345	3	0.0338	3	0.0225	2	0.0345	3	0.0338	3	0.0338	3	0.0394	3	0.039	3
355	0.0248	2	0.024	2	0.0221	2	0.0232	2	0.0229	2	0.0232	2	0.0229	2	0.0225	2	0.0262	2	0.0262	2
356	0.024	2	0.024	2	0.0236	2	0.0229	2	0.0225	2	0.0229	2	0.0225	2	0.0225	2	0.0266	2	0.0255	2
357	0.0244	2	0.036	3	0.0232	2	0.0229	2	0.0225	2	0.0225	2	0.0229	2	0.0236	2	0.0262	2	0.0232	2
358	0.0349	3	0.0368	3	0.0345	3	0.0341	3	0.0225	2	0.0345	3	0.033	3	0.0338	3	0.039	3	0.0349	3
359	0.0975	8	0.0855	7	0.0799	7	0.0795	7	0.0705	6	0.0806	7	0.0806	7	0.0829	7	0.0908	7	0.0855	7
360	0.234	19	0.2378	20	0.234	20	0.2272	20	0.1628	14	0.2374	20	0.2344	20	0.2231	19	0.2629	20	0.2362	20
374	0.0236	2	0.024	2	0.0232	2	0.0225	2	0.0225	2	0.0225	2	0.0229	2	0.0232	2	0.0259	2	0.0229	2
375	0.0364	3	0.0364	3	0.0334	3	0.0341	3	0.0364	3	0.036	3	0.0349	3	0.036	3	0.039	3	0.0341	3
376	0.1219	10	0.1185	10	0.1129	10	0.1132	10	0.0788	7	0.1178	10	0.1181	10	0.1305	11	0.1324	10	0.1159	10
377	0.0236	2	0.024	2	0.0232	2	0.0225	2	0.0232	2	0.0232	2	0.0229	2	0.0236	2	0.0259	2	0.0232	2
378	0.024	2	0.0232	2	0.024	2	0.0229	2	0.0225	2	0.024	2	0.0229	2	0.0225	2	0.0262	2	0.0225	2
379	0.0236	2	0.024	2	0.0229	2	0.0229	2	0.0229	2	0.0221	2	0.0225	2	0.024	2	0.0255	2	0.0225	2
380	0.0229	2	0.024	2	0.0225	2	0.0229	2	0.0236	2	0.0229	2	0.0229	2	0.0229	2	0.0262	2	0.0229	2
381	0.0229	2	0.024	2	0.0229	2	0.0229	2	0.0244	2	0.0232	2	0.0221	2	0.0244	2	0.0259	2	0.0236	2
382	0.0469	4	0.0484	4	0.0458	4	0.045	4	0.0232	2	0.045	4	0.0454	4	0.0484	4	0.0521	4	0.0458	4
721	0.0236	2	0.0116	1	0.0225	2	0.0229	2	0.0225	2	0.0229	2	0.0232	2	0.0225	2	0.0266	2	0.024	2
722	0.024	2	0.0225	2	0.0206	2	0.0225	2	0.0225	2	0.0225	2	0.0221	2	0.0221	2	0.0259	2	0.0259	2
723	0.0236	2	0.024	2	0.0225	2	0.0225	2	0.0225	2	0.0217	2	0.0225	2	0.0221	2	0.0259	2	0.0232	2
724	0.0232	2	0.0232	2	0.0221	2	0.0232	2	0.0229	2	0.0232	2	0.0225	2	0.0225	2	0.0255	2	0.0236	2
725	0.0232	2	0.0225	2	0.0229	2	0.0229	2	0.0232	2	0.024	2	0.0225	2	0.0229	2	0.0255	2	0.0229	2
726	0.0225	2	0.0229	2	0.0225	2	0.0229	2	0.0232	2	0.0225	2	0.0221	2	0.0221	2	0.0247	2	0.0229	2
727	0.0225	2	0.024	2	0.0221	2	0.0112	1	0.024	2	0.0225	2	0.0232	2	0.0229	2	0.0259	2	0.0225	2
728	0.0225	2	0.0225	2	0.0221	2	0.0229	2	0.024	2	0.0229	2	0.0229	2	0.0232	2	0.0248	2	0.0225	2
752	0.0225	2	0.0225	2	0.0217	2	0.0229	2	0.024	2	0.0236	2	0.0229	2	0.0232	2	0.024	2	0.0225	2
753	0.0225	2	0.0225	2	0.0221	2	0.0116	1	n.s	n.s	0.0225	2	0.0221	2	0.0236	2	0.024	2	0.0232	2
754	0.0225	2	0.0225	2	0.0217	2	0.0112	1	0.0225	2	0.0225	2	0.0221	2	0.024	2	0.0225	2	0.0225	2
755	0.0338	3	0.0338	3	0.0431	4	0.0116	1	0.012	1	0.0454	4	0.0446	4	0.0454	4	0.0454	4	0.045	4
756	0.0229	2	0.0225	2	0.0217	2	0.0225	2	0.0225	2	0.0206	2	0.0221	2	0.0229	2	0.0229	2	0.0229	2
757	0.0225	2	0.0229	2	0.0221	2	0.0229	2	0.0221	2	0.0236	2	0.0214	2	0.024	2	0.0244	2	0.0229	2
758	0.0225	2	0.0225	2	0.0217	2	0.0225	2	0.0225	2	0.0225	2	0.0221	2	0.0225	2	0.0221	2	0.0221	2
759	0.0225	2	n.s	n.s	0.0221	2	0.0112	1	0.0225	2	0.0217	2	0.0221	2	0.0225	2	0.0229	2	0.0229	2
760	0.0225	2	0.0232	2	0.0225	2	0.0229	2	0.0225	2	0.0214	2	0.0225	2	0.0229	2	0.0364	3	0.0225	2
761	0.0232	2	0.0225	2	0.0214	2	0.0225	2	0.0229	2	0.0236	2	0.0221	2	0.0225	2	0.024	2	0.024	2
762	0.0232	2	n.s	n.s	0.0214	2	0.0225	2	0.0229	2	0.0225	2	0.0225	2	0.0217	2	0.0229	2	0.0229	2
763	0.0225	2	n.s	n.s	0.0311	3	n.s	n.s	n.s	n.s	0.0349	3	0.033	3	0.0341	3	0.0232	2	0.0341	3
764	0.0232	2	0.0225	2	0.0221	2	0.0116	1	n.s	n.s	0.0225	2	0.0225	2	0.0214	2	0.0259	2	0.0251	2
765	0.0236	2	0.0225	2	0.0214	2	0.0225	2	0.0225	2	0.0225	2	0.0229	2	0.0221	2	0.024	2	0.0236	2
766	0.0229	2	n.s	n.s	0.0217	2	0.0225	2	0.0225	2	0.0225	2	0.0225	2	0.0221	2	0.0221	2	0.0236	2
767	0.0232	2	n.s	n.s	0.0214	2	n.s	n.s	n.s	n.s	0.0232	2	0.0202	2	0.0217	2	0.0221	2	0.0229	2

Table 3. Capelin mean catch (kg) and SD by stratum, as well as total stratified mean catch and SD by year. Spanish Spring Surveys on NAFO Div. 3NO: 1995-2015. n.s. means stratum not surveyed. 1997-2000 data are transformed from C/V *Playa de Menduíña* data, and 2002-2015 data are original from R/V *Vizconde de Eza*. In 2001, (*) indicates transformed data from C/V *Playa de Menduiña*; (**) indicates data from R/*V Vizconde de Eza* and data transformed from C/V *Playa de Menduiña*.

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
Stratum	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD
353	0	0	0	0	0	0	0	0	2.5	1.47	140.55	45.1	79.41	125.08	24.63	40.44	290.12	232.31	270.17	174.05	1.41	1.1
354	323.63	560.55	0	0	1.38	0.98	0	0	0.21	0.3	165.98	269.61	1.25	1.11	28.03	36.69	236.5	277.04	0	0	0.32	0.53
355	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.14	0.13	1.25	1.77	0	0	0	0
356	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.42	1.52	2.16	0	0	0	0
357	0	-	0	0	0	0	0	0	0	0	0	-	0.06	0.08	0.34	0.45	0.28	0.39	0	0	0.04	0.06
358	0	0	0	0	0	0	0	0	0	0	0	0	12.99	17.72	36.53	45.85	109.03	188.68	0	0	0	0
359	0	0	0	0	0.69	1.7	0	0	0.18	0.32	134.54	155.5	57.74	124.66	101.08	158.77	35.61	44.78	3.15	7.7	0.03	0.09
360	0	0	0	0	65.02	253.4	0	0	15.85	60.31	5.35	13.26	18.5	39.72	45.03	108.9	82	141.23	72.88	98.01	8.33	18.9
374	0	0	0	0	0	0	0	0	0.55	0	0	0	1.26	1.46	0.09	0.1	12.92	18.21	0.02	0.02	0.7	0.57
375	0	0	0	0	0	-	0	0	0.34	0.49	0	0	0.07	0.06	0.12	0.08	14.4	20.7	0.29	0.49	0.02	0.03
376	0	0	0	0	0	0	0	0	0.03	0.09	0	0	0.93	1.28	2.07	3.35	6.01	12.77	1.04	1.8	0.1	0.16
377	0	0	69.35	98.08	0	-	0	0	64.08	90.03	1400.87	1981.13	190.35	76.3	51.95	73.19	18.1	19.94	0.15	0.21	0.12	0.15
378	0	0	0	0	0	0	738.58	1044.5	0	0	90.16	68.65	58.37	72.45	3.3	4.38	324	323.29	0	0	0	0
379	0	0	0	-	0	0	0	0	0	0	0	0	3.23	2.14	0.42	0.38	0.55	0.78	0	-	0.04	0.06
380	n.s	n.s	0	0	0	0	0.28	0.39	0	0	0.34	0.49	0	0	0.4	0.57	12.15	7.14	0	0	0.09	0.13
381	n.s	n.s	0	0	231.63	1.97	0	0	0	0	0.28	0.39	(*)1026.17	(*)1449.85	18.25	11.24	19.55	9.97	0	0.01	0.1	0.14
382	n.s	n.s	8.09	14.01	5.27	6.29	0.23	0.4	4.96	8.09	1.04	2.08	0	0	0.2	0.27	0.99	1.27	0.17	0.2	20.41	29.28
721	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0.15	0.21	0	0	0	0	0	0
722	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0	0	0
723	n.s	n.s	0	-	0	0	0	0	0	0	0	0	0.8	1.13	3.45	3.32	0	0	0	0	0	0
724	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.01	0.42	0.6	0	0	0	0
725	0	0	0	0	0	0	0	-	0	0	0	0	2.6	4.5	0.12	0.12	0.4	0.56	0.02	0.03	0	0
726	0	0	0	0	n.s	n.s	0	0	0	0	0	0	0.44	0.76	0.02	0.04	0.02	0.03	0	0	0	-
727	n.s	n.s	0	0	0	-	0	0	0	0	0	0	0	0	16.9	14.14	0.05	0.07	0	0	0	0
728	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	1.15	1.63	0	0	0	0	0	-
752	n.s	n.s	0	-	0	0	0	0	0	0	0	0	0	0	0.07	0.1	0	0	0	0	0	0
753	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.16	0.23
754	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
755	n.s	n.s	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
756	n.s	n.s	0	0	0	-	0	0	0	0	0	0	(**)0.41	(**)0.72	0	0	0	0	0.01	0.01	0	0
757	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	4.14	5.74	0	0	0	0	0	0
758	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0.01	0.07	0.1	0	0.01	0	0
759	n.s	n.s	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0
760	n.s	n.s	0	0	-	-	0	0	0	0	0	0	0.48	0.59	0	0	0	0	0	0	0	0
761	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0.02	0.04	0.02	0.03	0	0	0	0	0	0
762	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	(**)0.03	(**)0.06	0.05	0.07	0	0	0	0	0	0
763	n.s	n.s	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
764	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.14	0	0	0	0	0	0
765	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	-	0	0	0	0
766	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
767	n.s	n.s	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total stratified	12.11	12.11	1.11	0.85	23.21	13.35	9.94	9.93	5.15	3.78	29.32	14.45	26.86	14.75	19.69	6.52	45.46	10.72	26.92	6.45	3.00	1.24

Table 3 (cont.). Capelin mean catch (kg) and SD by stratum, as well as total stratified mean catch and SD by year. Spanish Spring Surveys on NAFO Div. 3NO: 1995-2015. n.s. means stratum not surveyed. 1997-2000 data are transformed from C/V *Playa de Menduíña* data, and 2002-2015 data are original from R/V *Vizconde de Eza*. In 2001, (*) indicates transformed data from C/V *Playa de Menduiña*; (**) indicates data from R/*V Vizconde de Eza* and data transformed from C/V *Playa de Menduiña*.

	2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
Stratum	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD	CAP Mean Catch	CAP SD
353	14.6	24.51	287.7	136.99	70.83	31.65	964.7	303.81	87.59	17.1	248.71	206.53	342.17	21.36	49.19	42.02	1012.56	941.3	286.68	306.34
354	0	0	6.83	8.05	560.87	757.95	792.58	1367.3	671.53	816.18	0.01	0.02	414.92	440.24	0.42	0.43	857	960.58	58.25	100.38
355	0	0	0.04	0.05	0.21	0.3	0	0	0	0	0	0	0.03	0.04	0	0	0	0	0	0
356	0	0	0	0	1.26	1.76	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0
357	0	0	0.18	0.28	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0.12	0	0
358	0	0	0	0.01	0.02	0.04	0.03	0.05	0	0	0	0	0	0	0	0	0.03	0.05	0	0
359	0	0	72.58	95.37	49.25	130.28	212.05	560.45	18.68	29.91	3.83	10.13	346.67	550	0.46	1.19	11.5	24.77	59.32	71.62
360	7.03	14.85	57.37	207.04	28.47	44.77	99.3	179.48	139.4	277.44	10	24.23	225.67	268.13	144.41	251.71	110.19	195.61	79.61	158.36
374	0.15	0.21	0.55	0.21	0.16	0.2	0.67	0.95	6.46	7.41	0	0	0.15	0.21	0.6	0.85	0.43	0.6	1.08	0.98
375	1.51	0.79	6.73	5.11	0.18	0.25	1.12	1.75	0.03	0.06	0.03	0.05	129.19	221.97	4.21	5.5	0.44	0.49	2.2	3.17
376	6.1	9.54	0.2	0.48	0.11	0.24	2.61	2.68	45.39	66.58	2.66	4.5	422.02	695.99	45.15	45.52	3.96	7.4	17.96	36.98
377	0.04	0.05	0.34	0.44	0.01	0.01	8.82	12.47	102.45	127.92	0.63	0.89	0	0	0.01	0.02	0	0	0.02	0
378	0	0	0.08	0.05	0.04	0.02	0.13	0.16	2.68	3.79	0	0	0	0	0	0	0	0	0	0
379	0	0	0	0	0.03	0.04	0.01	0.02	0	0	0	0	0	0	0.48	0.69	0	0	0	0
380	0	0	4.48	6.25	0.87	1.1	0.96	1.36	0	0	0	0	0	0	0	0	0	0	0	0
381	0	0	171.82	185.51	125.45	177.12	3.1	3.46	323.98	440.5	0	0	0	0	0.01	0.02	241.32	340.9	58.77	82.15
382	0.14	0.15	3.83	3.1	855.23	1081.04	0.08	0.09	106.36	148.69	0.35	0.37	0.01	0.03	0	0	142.79	149.81	31.54	25.06
721	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
722	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
723	0	0	0	0	0	0	0	0	0.17	0.18	0	0	0	0	0	0	0	0	0	0
724	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
725	0	0	0	0	0	0	0.02	0.02	0.14	0.04	0	0	0	0	0	0	0	0	0	0
726	0	0	0	0	0	0	0.01	0.02	0	0	0	0	0	0	0	0	0	0	0	0
727	0.01	0.01	0.2	0.28	0.01	0.01	0	-	0	0	0	0	0.01	0.01	0	0	0	0	0	0
728	0	0	0	0	0	0	0.04	0.05	0	0	0	0	0	0	0	0	0	0	0	0
752	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
753	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0
754	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0
755	0	0	0	0	0	0	0	-	0	-	0	0	0	0	0	0	0	0	0	0
756	0	0	0	0	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
757	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
758	0.01	0.02	0	0	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
759	0	0	n.s	n.s	0	0	0	-	0	0	0	0	0	0	0	0	0	0	10.55	14.92
760	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
761	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
762	0	0	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
763	0	0	n.s	n.s	0	0	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0
764	0	0	0	0	0	0	0	-	n.s	n.s	0	0	0	0	0	0	0	0	0	0
765	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766	0	0	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
767	0	0	n.s	n.s	0	0	n.s	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0
Total stratified	3.11	1.06	31.58	14.07	55.00	21.08	83.19	24.76	76.44	26.79	9.68	3.44	151.43	34.44	46.12	15.65	85.47	23.02	37.07	10.87

Table 4. Capelin survey biomass (t) by stratum and SD in NAFO Divisions 3NO: 1995-2015. n.s. means stratum not surveyed. 1995-2000 data are transformed from C/V *Playa de Menduíña* data, and 2002-2015 data are original from R/V *Vizconde de Eza*. In 2001, (*) indicates transformed data from C/V *Playa de Menduiña*.; (**) indicates data from R/V *Vizconde de Eza* and data transformed from C/V *Playa de Menduiña*.

Stratum	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
353	0	0	0	0	56	3184	1878	557	7015	6460	32	317	6383	1675	22566	2094	5755	8182	1138	21575	5766
354	6776	0	29	0	5	3438	27	581	5171	0	7	0	139	11998	17331	14684	0	9073	9	16063	1102
355	n.s	0	0	0	0	0	0	1	8	0	0	0	0	1	0	0	0	0	0	0	0
356	n.s	0	0	0	0	0	0	1	6	0	0	0	0	5	0	0	0	0	0	0	0
357	0	0	0	0	0	0	1	5	4	0	1	0	2	0	0	0	0	0	0	1	0
358	0	0	0	0	0	0	254	715	2181	0	0	0	0	0	1	0	0	0	0	0	0
359	0	0	25	0	6	4833	2120	3721	1326	117	1	0	2502	1817	7860	669	140	12671	16	373	2045
360	0	0	15425	0	3604	1242	4250	10934	20252	17562	1995	1588	13432	6771	24323	33371	2345	53594	34222	23330	18756
374	0	0	0	0	10	0	23	2	246	0	13	3	10	3	13	123	0	3	11	7	20
375	0	0	0	0	8	0	2	3	355	7	0	34	150	4	27	1	1	3012	95	9	52
376	0	0	0	0	3	0	107	242	713	119	12	667	22	13	308	5382	302	47659	5077	399	2067
377	0	606	0	0	534	12248	1664	454	161	1	1	0	3	0	78	881	5	0	0	0	0
378	0	0	0	8831	0	1078	687	39	4003	0	0	0	1	0	2	33	0	0	0	0	0
379	0	0	0	0	0	0	30	4	5	0	0	0	0	0	0	0	0	0	4	0	0
380	n.s	0	0	2	0	3	0	3	102	0	1	0	36	7	8	0	0	0	0	0	0
381	n.s	0	3015	0	0	3	(*)12509	230	246	0	1	0	2062	1579	39	3828	0	0	0	2686	716
382	n.s	247	157	7	141	29	0	6	30	5	612	4	109	25647	2	3138	11	0	0	3759	946
721	n.s	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
722	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
723	n.s	0	0	0	0	0	10	46	0	0	0	0	0	0	0	2	0	0	0	0	0
724	0	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0
725	0	0	0	0	0	0	(**)24	1	4	0	0	0	0	0	0	1	0	0	0	0	0
726	0	0	n.s	0	0	0	(**)2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
727	n.s	0	0	0	0	0	0	140	0	0	0	0	2	0	0	0	0	0	0	0	0
728	n.s	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
752	n.s	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
753	n.s	0	0	0	0	0	0	0	0	0	2	0	0	0	0	n.s	0	0	0	0	0
754	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
755	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
756	n.s	0	0	0	0	0	(**)4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
757	n.s	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	0	0	0	0
758	n.s	n.s	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
759	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	n.s	0	0	0	0	0	0	0	117
760	n.s	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
761	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
762	n.s	n.s	0	0	0	0	(**)1	1	0	0	0	0	n.s	0	0	0	0	0	0	0	0
763	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	n.s	0	n.s	n.s	0	0	0	0	0
764	n.s	0	0	0	0	0	0	1	0	0	0	0	0	0	0	n.s	0	0	0	0	0
765	n.s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766	n.s	n.s	0	0	0	0	0	0	0	0	0	0	n.s	0	0	0	0	0	0	0	0
767	n.s	n.s	n.s	0	0	0	0	0	0	0	0	0	n.s	0	n.s	n.s	0	0	0	0	0
BIOMASS	6776	853	18651	8840	4367	26059	23601	17734	41835	24272	2678	2613	24851	49523	72557	64209	8559	134193	40573	68202	31588
SD	6634	646	10416	9126	3159	13594	12741	5842	9877	5996	1098	872	11067	18706	21867	23007	3057	30327	14083	18289	8752

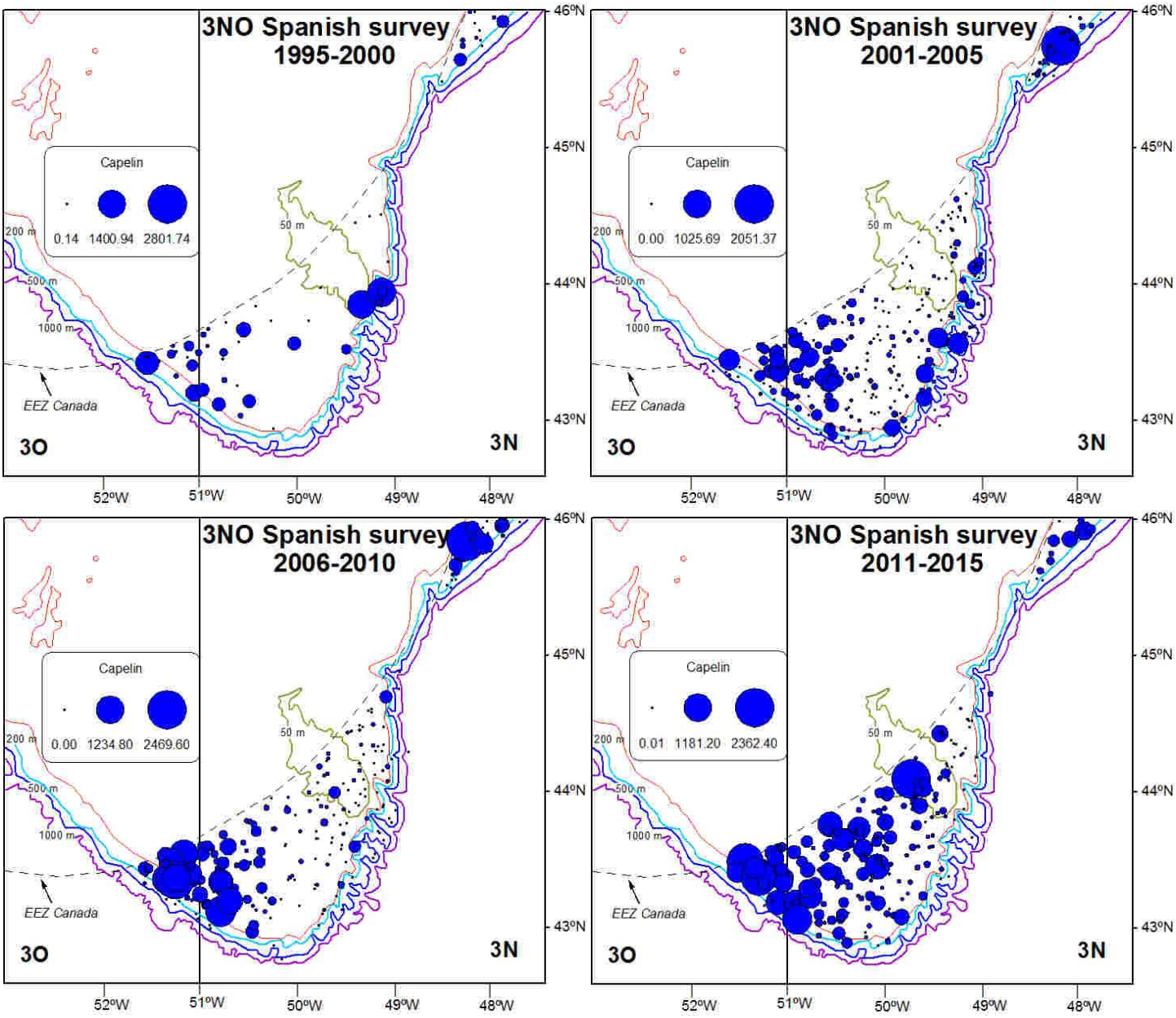

Fig. 1. Position of the hauls and the catch of capelin during the 1995-2015 Spanish 3NO survey grouped by 5 years. Note that the scale is different in the three graphs.

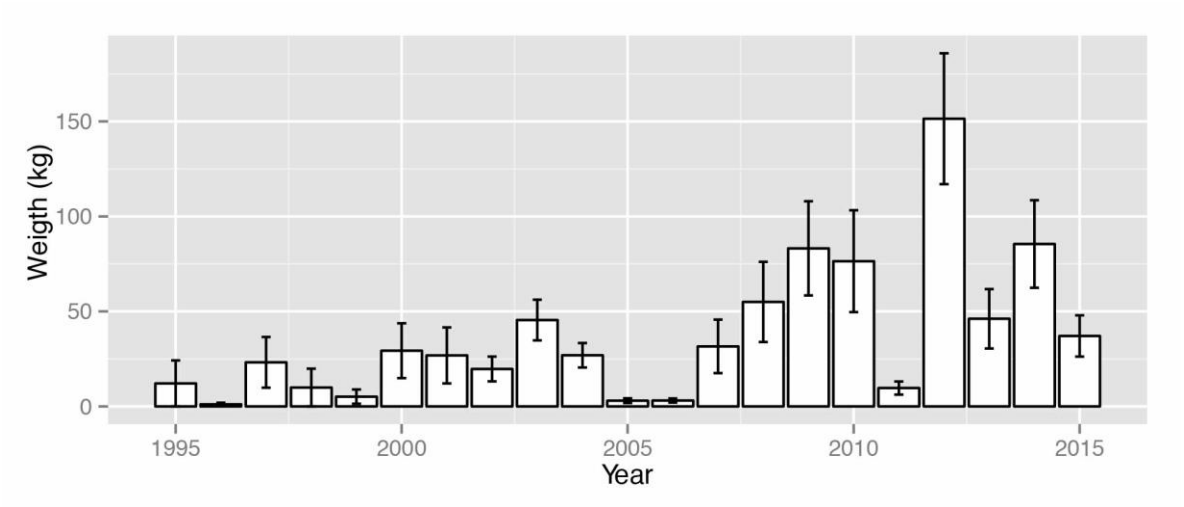

Fig. 2. Capelin stratified mean catch by year. Spanish Spring surveys on NAFO Div. 3NO: 1995-2015 (1995-2000 transformed data from C/V *Playa de Menduíña*; 2002-2015 original data from R/V *Vizconde de Eza*; in 2001, there are data from both vessels).

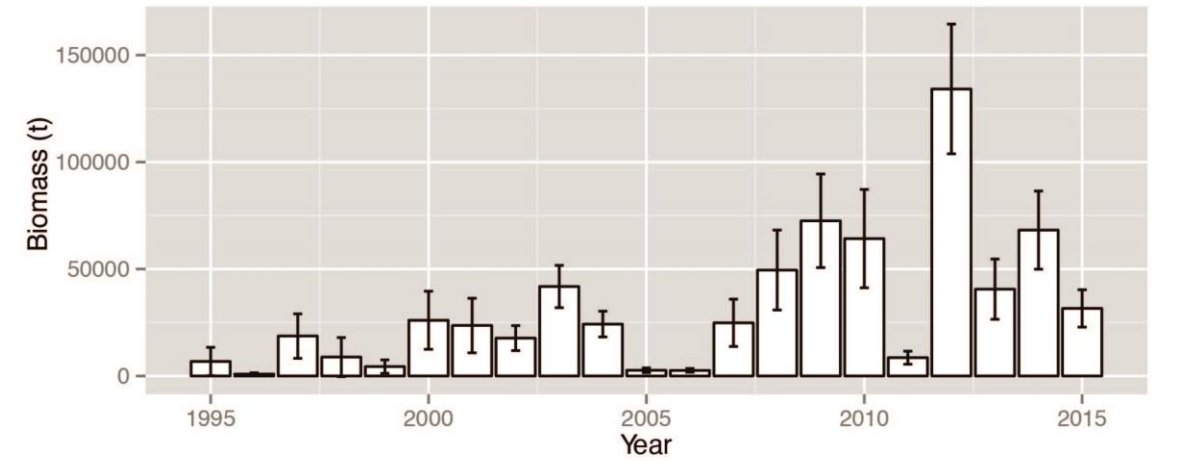

Fig. 3. Capelin biomass in tons and ±SD by strata and year. Spanish Spring surveys on NAFO Div. 3NO: 1995-2015 (1995-2000 transformed data from C/V *Playa de Menduíña*; 2002-2015 original data from R/V *Vizconde de Eza*; in 2001, there are data from both vessels).