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27–30 March 2012

Cadiz, Spain

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Executive summary

Cephalopod resources in the ICES area have apparently fluctuating with no trend in the last 4 years (2008–2011) in Europe. An important caveat however is that up-to-date landings data are not available for most ICES countries and few if any survey abundance indices are available. In 2011, a data call was launched through ICES to all European countries fishing in certain ICES areas (see Annex 2). Data was delivered for the most important countries deploying cephalopod fisheries. A detailed Table on data availability is summarised in Annex 2.

Landing and survey data were collected for 2009, 2010 and 2011. The 2011 Data has to be considered as preliminary and they will be revised in 2013 group. France (which takes around 65% of the European Atlantic cuttlefish catch) has no validated data for 2009 and delivered landings statistics for 2010 and 2011 to the group.

Due to the data call, data for the last years have been delivered however the catch matrix could show inconsistencies due to the lack of updated landings from all European countries for years previous to 2008. Despite this, cephalopod landings have steadily decreased in the last decade.

A wealth of recent research has focused on cephalopod on innovative research on age and growth and aquaculture and management measures have been developed. Valuable working documents in relation to fisheries and scientific research have been presented. It is of great interest the research for understanding the effect of the environment on cephalopod growth, in the context of the global interest in integrated research studies on the ecosystem. Linked to this, there is still a need of understand the variability of cephalopod recruitment (and so landings) which might greatly affect the ecosystem based fisheries assessment and management.

The current low level of fishery data collection on European cephalopods in relation to the high data demands imposed by their short life-cycles resulted in no analytical assessment of cephalopods in 2011. However, through the data call, the group was able to get cephalopod data previous to the meeting. A preliminary data analysis for trends in abundances, based on CPUEs and Abundance Indices from surveys, was deployed setting the basis for continuous work and future data calls. Also, a preliminary description of fleets, fisheries and metiers are presented for understanding the dynamics of the fishing activity exploiting these species. The aim of the ToR dedicated to metiers CPUEs and Surveys is to check whether catch trends of the commercial fishery are considered as good index of abundance of the stock. In case of some species and surveys (ARSA in Div. IXa) CPUEs appear to closely follow the abundances changes detected by the commercial fleet. Similar no-analytical approach for assessments would be tried in the future for other cephalopod species, under different segmentation (metiers) of the commercial fleets and restricted to the timing of the surveys. Ideally the group will look for the support of fisheries experts from each of the countries deploying cephalopod fisheries.

The group was able to partly evaluate the efficacy of the current DCF (Data Collection Framework) for cephalopods in France. Some positive facts are to be remarked as DCF_2011 programme provides data about areas and gear types which were not previously investigated. However, number of individuals sampled appears to be decreased for some important species (*Loligo forbesi*). Observations on the planned data collection, as for last year, can be made. Thus, given the short life cycles of most of these species (1 or 2 years), it is necessary to monitor biological variables regularly, ideally every week or month. Quarterly sampling is insufficient for cephalopod as-

sessment. Length composition sampling should be carried out on a more regular basis. Sampling effort should take into account the seasonality of cephalopod metiers, with a concentration of sampling during times when cephalopod catches are highest.

Ideas in relation to how the knowledge and experience of this expert group could be used in the context of the European Marine Strategy Framework Directive (EMSFD) and the new CFP are presented. The aim is to integrate the scientific and advisory work for implementing an ecosystem approach based on qualitative descriptors (including healthy stocks and sustainable exploitation). This expert group could assure the baseline knowledge of the species status to secure the ecological sustainability of cephalopod stocks on which these fishing communities ultimately depend.

WGCEPH has deployed a complete plan for the future ToRs and direction of the group.

1 Introduction

The working group met at IEO in Cadiz, Spain, 27–30 March 2012, in addition to working by correspondence. The meeting opened at 10.00 on the 27 March and the Agenda was adopted.

1.1 Terms of Reference 2010/2/SSGEF12

The Working Group on Cephalopod Fisheries and Life History (WGCEPH), chaired by Marina Santurtun, Spain, will meet at IEO, Cadiz, Spain, from 27 to 30 March 2012 to:

a) Report on status and trends of cephalopod stocks: relevant fishery statistics (landings, directed effort, discards, survey catches, etc.) across the ICES area;

b) Review and report on cephalopod research results in the ICES area, with particular emphasis on relevance to the management and assessment of cephalopod fisheries and populations focussing on innovative and progressive methodologies used in growth and age studies, upon which the foundation of management and assessment is based. Methods to accurately determine age and growth are of great importance in this context and the techniques and their reliability should be reviewed;

c) Produce CPUEs and survey data series of the main cephalopod metiers and species and assess to the possibility of their use as abundance indices;

d) Conduct preliminary assessments of the main cephalopod species in the ICES area through examination of the above trends in relative exploitation rates (i.e., catch/survey biomass);

e) Produce an overview of the fishery activities for fleets catching cephalopods and providing data to ToR c. This section should summarise for the species and "fisheries" where the item is relevant:

   i. Data available (including information from the fishing industry and NGOs that is pertinent to the knowledge status);

   ii. Historical performance of the metier (if trackable);

   iii. Mixed fisheries overview and considerations (if applicable);

f) List and summarise major national and European regulations and Directives and comment on the potential impacts on cephalopod stocks.

g) Provide an overview of the outcomes of the current fishery (and survey) data collection programmes for cephalopods, with particular attention to (i) utility of data currently collected for assessment purposes, and (ii) recommendations for improvements in the DCF and for any additional evaluation of the DCF that is thought to be needed; iii) suggestions for financial support for the required level of the DC.

1.2 Attendance

The WGCEPH meeting at IEO was attended by 8 of the currently appointed WGCEPH members. One more scientist was invited to the group as an expert. These participants represented four ICES member states (France, Spain, Portugal and UK). Four group members worked in the distance by correspondence giving their support to the group. Full details of the participants and contributors to the WGCEPH report can be found in Annex 1.

2 ToR a) Update relevant fishery statistics (landings, directed effort, discards, etc.) across the ICES area, and report on status and trends

2.1 Update of landing statistics

The present report provides new landing statistics for 2011 and updates numbers since 2000, for cephalopod groups caught in the ICES area (Tables 2.1.1 to 2.1.5). Data come from ICES STATLANT database, from additional national information supplied by Working Group members and from the data call on cephalopods launched by ICES in February 2012. The information supplied in this data call came from Spain, Portugal, Germany, The Netherland, Ireland and United Kingdom and Scotland. Data from France was not available for 2009/2010 due to changes in the national database program, although they could be recovered in short time, at least the data of the 2010. Data from French cephalopod landings was available for 2011. The experts rely on data compiled in this report as the most precise information on cephalopod landings within the ICES area that can be obtained to date.

It is still difficult to be certain of the degree of comparability of current vs. older data, because the identification of species is not very precise within national landing statistics. No assurance can be obtained that the classification used in one year is exactly the same as that used in another. Different squid species and families are frequently lumped with each other in landing statistics. Tables 2.1.1 to 2.1.4 give information on annual catch statistics (2000–2011) per cephalopod group in each ICES division or subarea, separately for each nation, being the 2011 date highly provisional.

Table 2.1.1. presents landings of the groups species of cuttlefish and bobtail squid (families *Sepiidae* and *Sepiolidae*). The main landings summarized in this table are catches of *Sepia officinalis*, the common cuttlefish, plus smaller amounts of *S. elegans* and *S. orbignyana* and various species of bobtail squid (*Sepiolidae*) in southernmost regions. *S. elegans* has a high commercial value in Sub-Division IXa south, and for this reason it appear separated in the landing date (WD a.1). The most significant landings of these two families are in the southern and central areas, sub-areas VII, VIII and IX.

In Table 2.1.2. landings of groups species of common squid (including the long-finned squids *Loligo forbesi, L. vulgaris, Alloteuthis subulata*, and *A. media*) are shown. The main common squid landings are L. forbesi, which is more important in the north, and *L. vulgaris*, more important in central and southern regions. Overall, long-finned squid landings concentrate in sub-area VII, and particularly divisions VIId,e. It is possible that some short-finned squid are currently grouped in this category. *Alloteuthis spp* is only separated in the landing of Sub-Division IXa south due to the high commercial value, as it occurs with *S. elegans* in the same area (WD a.1).

Table 2.1.3 contains landings of species group of short-finned squid (*Illex coindetii* and *Todaropsis eblanae*), European Flying squid (*Todarodes sagittatus*), Neon Flying squid (Ommastrephes bartrami) and occasionally a variety of species belonging to different decapod cephalopod families. This is commercially the least important group of the four defined, and its landings are more important in sub-areas VII and VIII, particularly as result of Spanish catches.

Finally, Table 2.1.4 compiles octopod species group (including *Eledone cirrhosa, E. moschata* only in Sub-Division IXa south and *Octopus vulgaris*, mostly, and some locally and temporally shallow-water species). The most significant proportion of landings in this group is the common octopus *Octopus vulgaris*, which is caught mainly in divisions VIII and IX, as a result of Portuguese and Spanish catches. The proportion of landings from trawl and artisanal fleets change considerably within the area along the Atlantic coast of the Iberian Peninsula (WD a.1).

Table 2.1.5 summarizes total annual cephalopod landings in the whole ICES area for main cephalopod groups. During the period of analysis (2000 to 2011), landings have been variable with a minimum of 21 400 t in 2009 and a maximum of 55 000 t in 2004. In 2010 landings increased to 31 000 t, with a trend to increase in 2011, despites being preliminary data. The peak of total cephalopod landings was in 2004 with 55 000 t. Cuttlefish, traditionally providing the most significant landings, returned to values in the order of 15 000–20 000 t, after an exceptional year 2004. The mean percentage of cuttlefish from total cephalopod landings was around 44% until 2008. In 2009 an important decrease in cuttlefish percentage was observed. This drop is caused mainly to the lack of French data which comprises 63% of total cuttlefish landed. In all the time series from 2000 to 2010, the landing proportions by species groups are: 43% cuttlefish, 32% octopods, 20% common squids and 6% short-finned squids.

Figure 2.1.1 provides information of total annual cephalopod landings in the whole ICES area for major cephalopod groups, per fishing nation. There are some annual fluctuations of landings per nation, but in general each nation maintains the similar proportional of the total share of annual landings. Data from 2011 have to be considered as preliminary causing changes in relative shares. It is expected that a increase in total landings will be registered when data will be updated next year.

If species landings are grouped into three groups, cuttlefish, squid (short-finned and long-finned) and octopus, each group can be seen to be exploited by a few nations, and this situation does not change significantly over the years. In the case of cuttlefish, France has always landed the largest proportion of the total in the ICES area but as in the last two years there is not available information neither from France nor UK (England, Wales & Northern Ireland) the landings have decreased sharply. From 2000 to 2008 France landed the 63% of cuttlefish and UK the 18%. They are followed by Spain and Portugal with the 9% of landings. The landings of these four nations have always accounted for over 95% of total cuttlefish landings in ICES area.

In the case of squid, landings have also been shared mostly among France, Scotland, Portugal and Spain, being France the one with highest share. In the years 2009 and 2010, due to the lack of data from France, Scottish landings became to be around 70% of total squid landings. However, France landings account for almost 12 000 t in 2011.

Short-finned Squid landings have suffered an important decrease with 5500 t in 2000 to 970 t in 2007. This is the lowest valuable for any cephalopods species group. Landings are mainly from Spain with the 80% of share, followed by France with about 8% of total landings.

In the group of octopus landings, more than 95% are shared by two nations, Portugal and Spain. In the last ten years from 2000 to 2010 Portuguese shares are increasing, being in year 2011 the 96% of landings, similar to the average of the time series.

It is important to note that despite of continuous fishing pressure, cephalopod resources in the ICES area remain stable in the trend in catches, with some fluctuations, throughout the 32 years of recorded data. (See ICES WGCEPH Report 2007; ICES WGCEPH Report 2009, ICES WGCEPH Report 2010). In addition, it is important to emphasize the amount of fishing gear used in the capture of cephalopods in the ICES area, highlighting the fishery of octopus in the Iberian waters (WD a.1).

In addition to the previous information, more disaggregated and detailed statistics of landings for different fisheries are presented as working documents. There are two working document attached in Annex 5:

- WD a.1: An update of cephalopod landing data of the Spanish fishing fleet operating in ICES area for 2000–2010 period.
- WD a.2: Update of the Basque cephalopod fishery in the North eastern Atlantic waters during the period 1994–2010.

Table 2.1.1. Landings (in tonnes) of Cuttlefish (*Sepiidae*) and Bobtail Squid (*Sepiolidae*).

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ICES Division IIIa (Skagerrak and Kattegat)												
Denmark		2	6	18	21	29	58	50	37			
Germany												
Netherlands								0				
ICES Division IVa (Northern North Sea)												
Denmark		2	3	7	10	7	11	10	7			
Scotland					1			0	0			
France	0	0	0	0	1	0	4	2	2			
Germany												
ICES Division IVb (Central North Sea)												
Belgium	7	12	12	4	4	1	1	2	4			
France	0	0	0	0								1
Denmark		1	13	35	36	13	21	23	12			
England, Wales & Northern Ireland		0	3	0	1	1		0	0			
Netherlands	0	0	3	3	1	1	0	1	0	1		
Scotland					1			0	0			
Germany												
ICES Division IVc (Southern North Sea)												
Belgium	12		206	64	103	57	57	33	53			
England, Wales & No	14	5	4	2	2	3	3	3	2			
France	381	173	184	135	120	103	77	84	108			34
Netherlands	83	95	333	214	330	141	287	161	123	55	145	
Scotland					2	1		1	0			
ICES Division Vb (Faroe Grounds)												
France					5	2						
ICES Division VIa,b (NW coast of Scotland and North Ireland, Rockall)												
England, Wales & No	0			0				0	0			
France	1	0	0	4	0	1	0	1	0			
Scotland		5						0	0			
Spain	1	0	0	0	0			0	0	0		0
ICES Division VIIa (Irish Sea)												
Belgium	1	2	5	1	1	1		0	0			
England, Wales & No	1	0	0	1				0	0	0	0	0
France	1	1	0	1	0	0	0	0	0			19
Netherlands											0	
ICES Divisions VIIb, c (West of Ireland and Porcupine Bank)												
England, Wales & No	0		0	0				0	0	4	1	0
France	0	0	1	14	13	1	0	2	0			2
Spain	3	17	3	5	10	12	9	9	19	11	73	0
Ireland										0	0	0
ICES Divisions VIId, e (English Channel)												
Belgium	35	224	497	473	607	501	661	1331	801			
Channel Islands	26	8	11	9	7	7	3					
England, Wales & No	2910	2608	3407	4581	4858	2821	3412	4279	3416	1525	2637	2037
France	8835	5672	10133	10970	12683	7582	8726	9663	5212			6258
Netherlands	4	3	6	13	32	28	15	12	31	37	81	
Scotland								11	7			
ICES Division VIIf (Bristol Channel)												
Belgium	1	12	4	7	38	16	5	6	7			
England, Wales & No	12	7	19	39	28	11	8	12	6			
France	17	25	12	41	50	20	17	41	30			17
ICES Divisions VIIg-k (Celtic Sea and SW of Ireland)												
Belgium	2	3	6	15	55	20	5	5	4			
England, Wales & No	139	80	102	325	135	153	166	129	143	238	386	746
France	7	3	5	7	19	20	18	9	22			1276
Ireland						3		0	1	0	0	0
Netherlands			0	1				0	0		1	
Spain	13	6	0	1	1	1		0		0	0	0
Germany												
ICES Subarea VIII (Bay of Biscay)												
Belgium	1	7	12	4	10	3		17	2			
England, Wales & No	0			29	18	19	1	0	0	0	0	0
France	5050	4908	2978	1156	6173	7753	3954	5586	2227			5190
Netherlands		38						0	0	0		
Portugal	8	10	6	18	40	32	37					
Spain	683	365	302	288	494	407	357	586	458	248	273	182
ICES Subarea IX												
Portugal	1357	1338	1362	1186	1514	1825	1822	1517	1453	1259	2009	
Spain	1454	765	820	992	889	1112	1090	1036	935	965	1164	954
Total	**21059**	**16397**	**20458**	**20666**	**28313**	**22706**	**20826**	**24621**	**15122**	**4344**	**6768**	**16716**

Table 2.1.2. Landings (in tonnes) of Common Squid (includes *Loligo forbesi, L. vulgaris* and *Alloteuthis subulata*).

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ICES Division IIIa (Skagerrak and Kattegat)												
Denmark	7											
Sweden*	0			1	5	3	10					
Germany*										3	0	0
Netherlands*				0	0	0	0				1	
ICES Division IVa (Northern North Sea)												
Denmark	3											
England, Wales &	3	2	1	1	1	1		13	0			
France	0	0	0	1	0	0	0	0	0			0
Germany*	0				1	0	1	1	2	0	1	
Netherlands*			0									
Scotland*	547	349	688	1428	1442	344	676	864	675	1674	2105	
ICES Division IVb (Central North Sea)												
Belgium	24	3	14	22	16	8	17	20	4			
Denmark	10											
England, Wales &	29	36	70	159	162	161	85	65	30			
France			0	0	0	1	54	15	2			30
Germany*	3			58	33	23	13	21	8	7	8	7
Netherlands*	3	5	40	33	24	28	16	15	10	5	11	
Scotland*	87	112	218	323	358	214	107	245	62			
ICES Division IVc (Southern North Sea)												
Belgium	121	20	40	17	12	10	9	7	10			
England, Wales &	4	12	5	2	2	3	2	2	2			
France	154	221	667	424	214	145	117	98	235			96
Germany*	2			4	4	1	1	0	0	0	0	0
Netherlands*	616	148	199	106	96	41	29	77	82	82	50	
Scotland*				1		1	2	1	0			
ICES Division Vb (Faroe Grounds)												
England, Wales &	0	0	0	0				0	0	5	15	0
Faroe Islands	0											
Scotland*	2			5	1			1	10	2	12	
France	0	0	0	0	1	0	0	1	0			
ICES Division VIa (NW coast of Scotland and North Ireland)												
England, Wales &	2	3	3	14	4		1	2	1			
France	51	9	28	24	25	85	28	38	29			44
Germany								0	4			
Ireland*	38			63		49	20	29	15	34	41	83
Netherlands*	0								36		5	0
Scotland*	210	192	196	367	321	72	88	71	69	145	323	455
Spain	3	0	3	10	2			10	3	3	0	0
ICES Division VIb (Rockall)												
England, Wales &	0	0	1	3				0	0			
Ireland*	3			5		8	18	13	139			
Scotland*	5	34	59	86	23		4	12	703	239	585	700
Spain	0		2									0
France	0	0	0	0	0	0	0	0	0			0
ICES Division VIIa (Irish Sea)												
Belgium	3	2	9	2	1	3	1	1	1			
England, Wales &	31	103	116	96	50	24	8	9	13	19	13	45
France	11	24	42	6	3	5	1	1	1			2
Ireland*	5		2	9		4	5	5	3	6	3	7
Isle of Man	0	1	0									
Netherlands*											1	
Scotland*	2			13	8	1		0	0			
ICES Divisions VIIb, c (West of Ireland and Porcupine Bank)												
England, Wales &	40	35	22	10	12	23	4	11	4	109	62	69
France	74	9	20	35	34	14	40	56	179			100
Ireland*	26	2	1	84		29	20	19	57	61	74	72
Netherlands*	0	0							13	0	0	
Scotland*	27		19	14	19	2	14	7	1			
Spain	17	18	29	35	31	12	19	26	28	23	276	
ICES Divisions VIId, e (English Channel)												
Belgium	254	22	59	72	54	36	46	106	76			
Channel Islands	9	1	2	1			2					
England, Wales &	449	439	553	435	481	321	273	369	313	295	253	371
France	2863	2318	3570	4926	4062	3139	3216	2960	2189			2210
Netherlands*	10	20	20	59	123	111	128	196	195	237	262	
ICES Division VIIf (Bristol Channel)												
Belgium	8	1	5	10	14	9	5	4	5		10	
England, Wales &	16	55	114	56	17	172	29	141	17	94	75	158
France	86	248	153	145	123	243	116	179	117			218
ICES Divisions VIIg-k (Celtic Sea and SW of Ireland)												
Belgium	5	3	8	7	6	6	3	6	4			
England, Wales &	202	166	116	35	134	51	44	51	73			
France	30	60	55	24	20	35	19	18	30			267
Germany*										1		
Ireland*	67	12	37	164		172	52	75	84	20	21	100
Netherlands*	0	1	17				0	1	0	3	23	0
Scotland*	100			75	70	57	45	3	7			
Spain	77	14	3	2	2	2		0	0	0	1	0
ICES Sub-area VIII (Bay of Biscay)												
Belgium	48	0	2	1	1	1		2	1			
England, Wales &	0			18	18	6		1	0	0	0	0
France	670	856	814	834	1076	913	1609	1362				2244
Netherlands*		8	44							2	0	
Portugal	1	1	1		9		1					
Scotland*					1	61	12	0	0			
Spain	767	614	253	330	372	306	164	447	311	234	554	281
ICES Sub-area IX												
France	42											
Portugal	619	898	686	328	1129	601	92	128	360	199	207	
Spain	507	843	637	542	581	552	255	209	247	286	286	299
ICES Sub-area X (Azores Grounds)												
Portugal	58	137	196	536	261	272	3	721	664			
Total	**9054**	**8055**	**9840**	**12464**	**11939**	**8381**	**7525**	**8734**	**7124**	**3788**	**5276**	**7859**

Country* - These countries report undifferentiated landings of Loliginids and Ommastrephids that were grouped here.

If 2 or more figures listed, the last one is the compound Loliginidae + Ommastrephidae.

Table 2.1.3. Landings (in tonnes) of Short-finned Squid (*Illex coindetii* and *Todaropsis eblanae*), European Flying Squid (*Todarodes sagittatus*), Neon Flying Squid (*Ommastrephes bartrami*) and other less frequent families and species of Decapod cephalopods.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ICES Sub-area I + II (Barents Sea and Norwegian Sea)												
Norway					*			0	1			
France								0	0			
ICES Division IIIa (Skagerrak and Kattegat)												
Denmark					*							
Norway								0	1			
Sweden*												
ICES Division IVa (Northern North Sea)												
Germany*												
Norway					4			0	1			
Scotland*								0	0			
ICES Division IVb (Central North Sea)												
Germany*												
Netherlands*												
France												11
ICES Division IVc (Southern North Sea)												
Germany*												
Netherlands*												
Scotland*								0	0			
France												18
ICES Division Va (Iceland Grounds)												
Iceland	1	0	0		1			0	7			
ICES Division Vb (Faroe Grounds)												
Faroe Islands				16		1		0	41			
Scotland*								0	0	0	0	0
ICES Division VIa, b (NW coast of Scotland and North Ireland, Rockall)												
England, Wales & Northern Ireland		1	1	13	1	1		0	0	0	0	0
Faroe Islands								0	250			
France	0	0	0	0	0	0	10	1	3			0
Ireland*				32		2	5	0	11	2	2	1
Scotland*								0	0			
Spain		0	11	0	0					0	0	0
ICES Division VIIa (Irish Sea)												
England, Wales & Northern Ireland				0				0	0	0	0	0
France	0	0	0	0	0	0	0	0	0			0
Ireland*	0			6		7		0	1	0	0	0
Scotland*								0	0	0	0	0
ICES Divisions VIIb, c (West of Ireland and Porcupine Bank)												
England, Wales & Northe	35	19	25	16	26	1	1	1	0	0	0	0
France	28	11	27	61	20	14	46	9	34			9
Ireland*	29	75	63	27		8	15	1	2	14	49	12
Scotland*								0	0			
Spain	148	233	411	217	285	951	458	420	629	541	1413	
ICES Divisions VIId, e (English Channel)												
England, Wales & Northe	0			1				0	0	0	0	0
France	3	4	8	2	19	13	10	9	10			374
Netherlands*												
ICES Divisions VIIg-k (Celtic Sea and SW of Ireland)												
England, Wales & Northe	151	173	144	85	66	18	9	17	7	0	0	0
France	2	1	1	2	2	5	0	0	4			53
Germany*											13	
Ireland*	83	60	91	49		19	4	12	16	1	1	3
Scotland*								0	0			
Spain	710	339	87	35	35	52	70	43	5	5	8	5
ICES Sub-area VIII (Bay of Biscay)												
England, Wales & Northe	0			0				0	0	0	0	0
France	154	89	260	136	129	276	115	100	143			295
Portugal	2			1	5							
Scotland*								0	0			
Spain	1400	868	584	474	495	634	326	251	395	430	898	127
ICES Sub-area IX												
Portugal	321	232	205	118	296	187	42	21	18	5	10	
Spain	2461	2133	592	438	656	386	164	87	491	342	730	700
Total	**5529**	**4238**	**2509**	**1729**	**2040**	**2574**	**1275**	**971**	**2069**	**1342**	**3124**	**1609**

Country* - These countries report undifferentiated landings of Loliginids and Ommastrephids that were grouped in Table 2.2. Here they are listed as “+”.

Table 2.1.4. Landings (in tonnes) of Octopods (*Eledone spp.* and *Octopus vulgaris* mainly).

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ICES Division IVa (Northern North Sea)												
Scotland	15	6	1	11	5	2	1	3	3			
ICES Division IVb (Central North Sea)												
Belgium	5	6	2	2	2	2	2	1	2			
England, Wale	1	2	1	1	1	1	1	0	0			
Netherlands		1	0	0		0	0	0				
Scotland		0										
ICES Division IVc (Southern North Sea)												
Belgium	1	1	1	1				1	0			
England, Wales & Northern Ireland			0	0				0	0			
Netherlands		0	2	0	0	0	0	0	0	0	0	
ICES Division VIa, b (NW coast of Scotland and North Ireland, Rockall)												
Belgium								0	0			
England, Wales & Northern Ireland				2	2			0	0	0	0	0
Ireland	1							0	2	0	0	0
Scotland	0											
Spain				0	0			0	0	0		
ICES Division VIIa (Irish Sea)												
Belgium	5	11	31	20	5	1	2	0	1			
England, Wales & Northerr		0	0	0				0	0	0	0	1
Ireland			1	1						0	1	0.1
ICES Divisions VIIb, c (West of Ireland and Porcupine Bank)												
England, Wale	4	20	3	6	15	4	10	10	5	109	167	138
France	8	1	0	0		2	10					3
Ireland	4	5	1	6		1		0	0	1	17	21
Scotland		2		1				0	0			
Spain	44	276	741	430	342	417	389	397	379	389	463	
ICES Divisions VIId, e (English Channel)												
Belgium		0	2	2	2	1	3	5	8			
Channel Islands				3								
England, Wale	22	15	20	21	14	21	21	65	86	97	108	174
France	13	5	7	5		9	6					7
Netherlands					0					0	2	
ICES Division VIIf (Bristol Channel)												
Belgium	13	1	9	13	24	10	16	20	9			
England, Wale	10	4	13	8	9	10	5	6	2			
France						1	1					0
Spain			2									
ICES Divisions VIIg-k (Celtic Sea and SW of Ireland)												
Belgium	16	6	12	13	12	5	6	6	3			
England, Wale	78	105	141	99	113	131	103	137	104	30	58	52
France	32	19	18	11		17	13					4
Ireland	7	9	11	17		29	3	3	7	2	1	2
Scotland	5	10	1	6		7	8	12	31			
Spain	518	156	111	28	29	32	36	37	3	1	1	
ICES Sub-area VIII (Bay of Biscay)												
Belgium	4	5	13	1	5	3	6	15	8			
England, Wale	0			1	29	8		0	0			
France	104	54	60	45	130	103	95	114	205			134
Netherlands		6										
Portugal	250	70	70	98	164	102	73					
Spain	1057	1272	1329	1144	1724	1572	1649	2238	1765	963	2260	211
ICES Sub-area IX												
Portugal	9019	7203	7288	10038	7784	11372	3368	8452	13258	7940	10471	
Spain	5205	2163	2936	2804	2787	4010	3164	2027	2737	2420.5	3056.2	1994.422
ICES Sub-area X (Azores Grounds)												
Portugal	9	14	16	16	15	10	13	19	13			
Total	**16451**	**11447**	**12841**	**14854**	**13214**	**17883**	**9003**	**13567**	**18630**	**11953**	**16605**	**2741**

Table 2.1.5. Total annual cephalopod landings (in tonnes) in the whole ICES area separated into major cephalopod species groups.

Cephalopod group	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Cuttlefish	21052	16394	20453	20658	28294	22686	20808	24612	15100	4344	6768	15440
Long-finned squid	9053	8055	9840	12064	11458	8381	7525	8733	7124	3788	5276	7859
Short-finned squid	5529	4238	2509	1729	2036	2574	1275	971	2069	1342	3124	1580
Octopods	16451	11447	12841	14854	13214	17883	9003	13567	18630	11953	16605	2741
Total	**52085**	**40132**	**45644**	**49305**	**55001**	**51523**	**38610**	**47884**	**42923**	**21426**	**31774**	**27620**

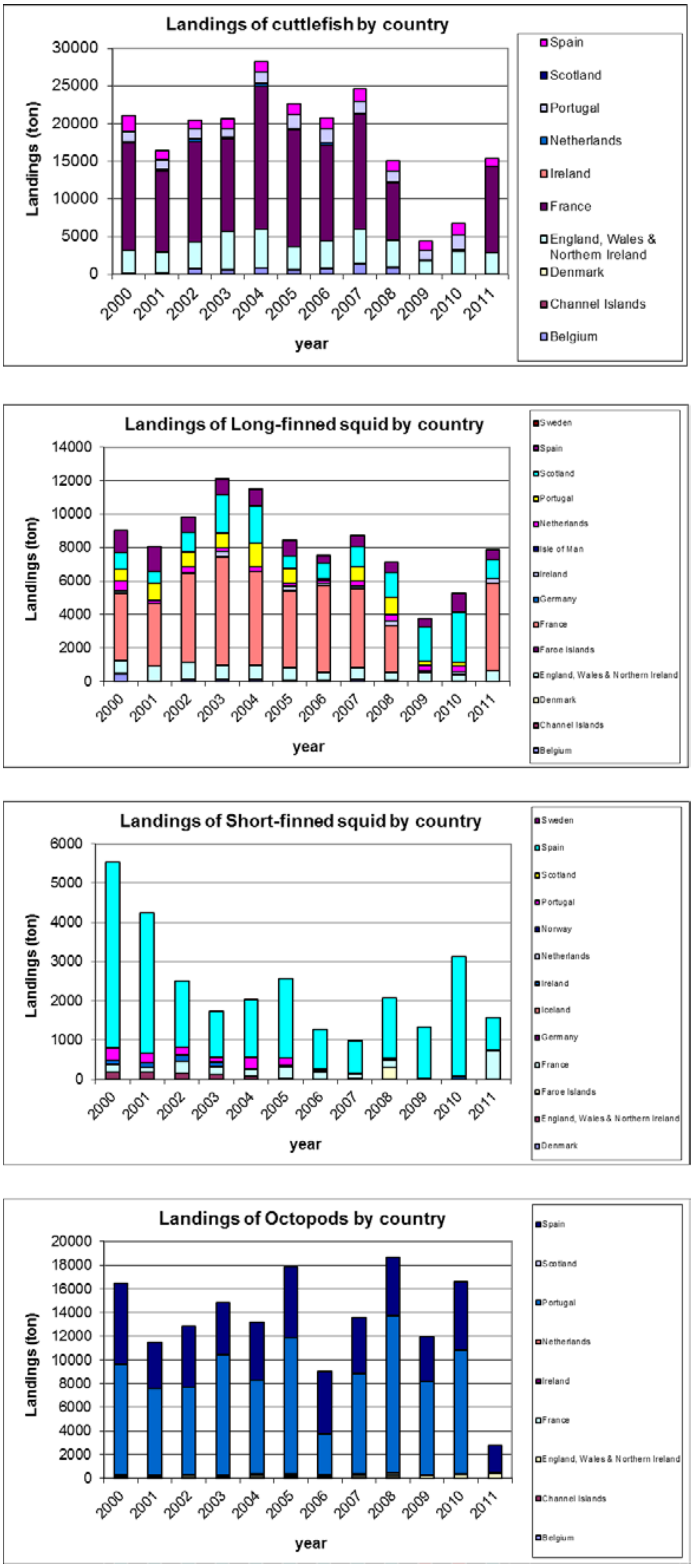

Figure 2.1.1. Total annual cephalopod landings (in tonnes) in whole ICES area by country and separated into major cephalopod.

2.2 Directed effort

Information regarding the effort directed at the cephalopod fisheries is still scarce, although is important to collect this information in order to conduct assessment exercises regarding the targeting cephalopods fisheries. In Portugal and Spain, some information already exists although is necessary standardize the data requirements between countries. See Section 4 (ToR c) for data effort requirements that need to be addressed.

2.3 Cephalopod Discards

Cephalopod fisheries discard data in the ICES area has been collected since 2004 in the UK, France, Spain and Portugal under the Data Collection Regulation and Framework (DCF). Sampling is performed in order to evaluate the quarterly volume of discards and data are collected by métier. The observers-on-board program is based on stratified random sampling, considering the métier as the stratum and the trip as the sampling unit. Sampling details may be found in:

Decision_2010_93_EU_DCFfinal

2.3.1 France

Considering, the reports of previous years (ICES 2009), the discard sampling programs in the English Channel, carried out both by CEFAS and IFREMER (since 2002 and 2003 respectively), suggest that the cuttlefish discarding rate can be significant (ranging from 6% to 23% of the catch of the UK fishing fleet and representing about 6% of French average catches). This is considerably higher than previous observations carried out on board of offshore trawlers (Denis *et al.* 2002).

IFREMER coordinates an observer program called OBSMER (coordinator: Christian Dintheer) collecting discards data in France. Observers are deployed along the entire French coast to go onboard French fishing vessels. Data are available between 2003 and 2009. Concerning cephalopods, during this period, observers sampled 1442 fishing trips, 6346 fishing operations, collected 10 445 samples about catch and measured 18 760 specimens. Under OBSMER, are sampled 22 ICES divisions and 31 métiers.

2.3.2 Spain

IEO (Spanish Oceanographic Institute) is responsible for monitoring discards, monthly by sea area and gear, of the entire Spanish fleet except for the Basque fleet which is covered by AZTI-Tecnalia.

Since 2002, under the National Sampling program of the Data Collection framework, the discard sampling programme has been conducted in different métiers for all species covered by the Regulation, including cephalopod species. At present the information has been compiled and processed. A complete information in relation to sampling, data collection and analysis can be found in WD a.3.

AZTI-Tecnalia is responsible for monitoring cephalopod discards, monthly by ICES area and gear, for the Basque Country. Since 2001, a discard sampling program has been carried out and has continued since 2003 under the National Sampling program. Only data for the trawl fleet is reported here, since the other segments of the Basque fleet in the North East Atlantic have negligible levels of discards. The discard sampling does not include information on length distributions. The sampling covers the four metiers of the trawl fleet: Basque “Baka” otter trawlers fishing in the ICES Subarea VI targeting hake, Basque “Baka” otter trawlers fishing in the ICES Sub-area VII targeting anglerfish and megrim, Basque “Baka” otter trawlers fishing in the ICES

Div. VIIIa,b,d targeting a great variety of species (mixed fisheries) (OTB) and Basque Pair trawls operating with VHVO nets in ICES Div. VIIIa,b,d targeting hake (PTB).

In Table 1.3.2.1. Yearly cephalopods discard estimations for Spanish trawl fleets operating in Northeast Atlantic area (ICES V I, V II, V IIIc and IXa) over the period 2003–2010 are presented. Estimations are aggregated from metier to fishing ground level. Only information for the most important species in terms of discarded biomass and those included in the Data Collection Framework directive are presented. Ommastrephidae is the most discarded cephalopods family in the Western Irish waters & Rockall bank fisheries exceeding 1400 tons in average for all sampled years. It must be noted a marked decrease in terms of biomass discarded during 2010 for this species. *Eledone cirrhosa* discards are estimated to be lesser than those obtained for Ommastrephidae, being the annual average estimated in 500 tons. Cephalopods species included in the DCF list represent minor amounts compared to the most discarded ones.

The discard rate was estimated based on landing estimation per species, or groups of species and the total fleet discard rate raised to total fleet effort. In species as *Eledone cirrhosa* and *Octopus vulgaris,* discard rate was estimated by adding the landings of those species to the percentage of landings of Octopidae family (especially in early years), per area, based in the retained profile of "Spanish Discard Sampling Programme" data. *Eledone cirrhosa* total discarded weight was calculated based on the sampled weight raised to the total effort by species. For *Octopus vulgaris*, total discarded weight was obtained by raising sampled weight to the total effort of the species plus the relative Octopus vulgaris weight observed in the Octopus spp. group registered in the "Spanish Discard Sampling Programme".

Estimations for the north Iberian waters (VIIIc) give lower values than those obtained for the Western Irish waters & Rockall bank. Interannual discard estimate for the most discarded species in the area, *Eledone cirrhosa*, represents 105 tons per years, while Ommastrephidae discard estimates is found to be 71 tons per year. Notable quantities of Sepiola spp. discards were found only for years 2004, 2005 and 2007 whereas peaks of *Rossia macrosoma* discards biomass were found in years 2003 and 2008. DCF species discards were also found to be low, except for *Sepia officinalis* in 2006 (35.6 tons).

Only four species discard estimations are presented for the Gulf of Cadiz. (IX) In terms of biomass, *Octopus vulgaris* was the most discarded species, ranging between 25.8 and 235.1 tons in 2006 and 2009, respectively. This species discards show very high inter-year variation, being 2005, 2007 and 2010 estimated to be 0. Discards of *Eledone moschata*, the second most discarded species in terms of biomass, are reported since 2007 with a maximum value of 44.2 t in 2009. *Alloteuthis spp and Sepia officinalis* showed very low discards, lower than 3.5 tonnes, with one peak of 27.5 tonnes in 2006, in both cases.

Table 1.3.2.1. Percentage of discards of cephalopod species, in the Spanish fleet in all ICES area between 2003 and 2011.

Gear	Area	Species	2003	2004	2005	2006	2007	2008	2009	2010
OTB	VI-VII	*Eledone cirrhosa*	59	34	51	46	67	60	72	39
		Loligo spp.	52	24	73	80	92	65	26	12
		Octopus vulgaris	0	100	100	91	0	0	0	37
		Ommastrephidae	90	79	69	71	79	74	77	29
		Sepia officinalis	77	9	6	77	5	22	2	0
	VIIIc + IXa north	*Eledone cirrhosa*	8	26	8	23	19	6	37	5
OTB_MIX		*Loligo spp.*	2	1	12	1	1	2	7	2
OTB_HOM		*Octopus vulgaris*	6	4	34	7	39	1	12	3
OTB_MAC		Ommastrephidae	11	27	19	11	21	19	14	7
		Sepia officinalis	61	1	13	60	1	1	18	6
PTB	VIIIc + IXa north	*Eledone cirrhosa*	0	0	64	63	94	32	90	96
		Loligo spp.	0	0	0	0	0	0	0	0
		Octopus vulgaris	0	0	0	0	0	0	0	0
		Ommastrephidae	2	2	10	4	3	3	9	0
		Sepia officinalis	0	0	0	0	0	0	100	0
OTB	IXa - south	*Alloteuthis spp*	-	-	0	0	0	0	3	4
		Eledone spp	-	-	0	0	1	5	17	19
		Loligo vulgaris	-	-	0	0	0	0	0	0
		Octopus vulgaris	-	-	0	3	0	19	35	0
		Ommastrephidae	-	-	0	0	0	0	2	6
		Sepia elegans	-	-	0	0	0	2	9	3
		Sepia officinalis	-	-	0	4	0	0	0	1

In Table 1.3.2.2 the percentage of cephalopods discarded deployed by Basque fleets, in relation to catches during 2003–2011 series, is presented by metier. As in previous years, the results on percentages of cephalopod species discarded show that short finned squids and curled octopus species are the most frequently discarded cephalopod species. For area VI, all short finned squids captured are discarded and no cephalopod discards are reported for area VII. In the last 2 years of the series, no effort has been deployed by Otter trawlers in Subarea VII, except for just one trip in 2011. Regarding the curled octopus (*Eledone cirrhosa*), a decreasing trend of this species occurred till 2010 but in 2011 a sharp increase occurred in division VIII abd in the two trawl metiers operating in that area. The "Baka" otter trawlers and pair trawlers operating in Divisions VIIIabd have a slightly lower discarding percentage compared to other ICES areas.

Table 1.3.2.2. Estimated cephalopod discards (% of total catches) during 2003–2011in the Basque Country.

Gear	Area	Species	2003	2004	2005	2006	2007	2008	2009	2010	2011
OTB	VI	Short finned squid	100%	-	-	-	-	100%	100%	100%	100%
		Curled octopus	-	-	-	-	-	-	-	-	-
		Cuttlefish	-	-	-	-	-	-	-	-	-
	VII	Short finned squid	61%	77%	19%	4%	52%	87%	-	-	-
		Curled octopus	33%	1%	38%	12%	56%	-	-	-	-
		Cuttlefish	12%	-	-	-	-	-	-	-	-
	VIIIabd	Short finned squid	59%	57%	17%	35%	38%	12%	15%	31%	87%
		Curled octopus	28%	5%	7%	0%	19%	2%	14%	5%	74%
		Cuttlefish	0%	1%	2%	-	1%	-	8%	-	3%
PTB	VIIIabd	Short finned squid	16%	41%	9%	4%	7%	-	39%	7%	9%
		Curled octopus	-	-	-	-	-	-	-	-	27%
		Cuttlefish	2%	-	-	-	-	-	-	-	-

2.3.3 Portugal

IPIMAR is responsible for discard sampling from ICES Division IXa under the DCF. The sampling covers the Otter Bottom Trawl for Crustaceans (OTB_CRU) and the Otter Bottom Trawl for demersal fish (OTB_DEF). The Otter Bottom trawl commercial fleet comprises two components: the Otter Bottom Trawl for Crustaceans (OTB_CRU) (>=55 mm mesh size for shrimps and above 70 mm for Norway lobster) and the Otter Bottom Trawl for demersal fish (OTB_DEF) (65-mm mesh size). The trawl fleet targeting crustaceans (Norway lobster and rose shrimp) operates mainly in the Southwest and South in deeper waters, from 100 to 750 m, while the trawl fleet targeting fish and cephalopods (hake, horse mackerel, auxiliary sea breams, pouting, octopus, squids, blue whiting) operates off the entire Portuguese coast mainly at depths between 100 and 250 m. Between 2004 and 2008, cephalopods represented a very small fraction of the total discards of the Otter Bottom Trawl fisheries in sub area IXa. The most important cephalopod discards are *Eledone* species, under-sized

Octopus vulgaris, and *Alloteuthis* sp. Cephalopod discards are generally higher in the OTB-CRU fleet than in the OTB-DEF fleet. In the OTB-CRU fleet, which operates in deeper waters, 90 to 100% of cephalopod catches are discarded. The only exception is for *Octopus vulgaris*, with only around 60% of catches discarded. The OTB-DEF shows a different discarding behaviour for cephalopods: species with some a market value show a much lower discard percentage, namely *Eledone cirrhosa*, *Sepia officinalis*, *Octopus vulgaris*, *Todaropsis eblanae* and *Loligo vulgaris* (ICES, 2010). Regarding 2009 and 2010, no noteworthy changes in cephalopod discards in the trawl fleet are expected, although the discard assessment methodology is presently under redefinition.

The complete information on Portuguese discards is presented in WD a.4. Information is available for the following species and sea areas: *Alloteuthis squids, Alloteuthis spp*.; common squids, *Loligo spp*.; Ommastrephid squids, family Ommastrephidae; cuttlefish, *Sepia spp*.; bobtail squids, family Sepiolidae; horned octopus, *Eledone cirrhosa*; musky octopus, *Eledone moschata*; common octopus, *Octopus vulgaris;* and lilliput longarm octopus, *Octopus delippi* produced by Portuguese vessels operating with bottom otter trawl (OTB) within the Portuguese reaches of ICES Division IXa. The data was collected by the Portuguese on-board sampling programme (EU DCR/NP) between 2004 and 2011. A description is presented of the on-board sampling programme, estimation algorithms and data quality assurance procedures and results provided for two fisheries: the crustacean fishery (OTB_CRU) and the demersal fish fishery (OTB_DEF). Cephalopods' annual frequency of occurrence in trawl discards is low for most species. However, in OTB_CRU horned octopus and bobtail squids were relatively frequent in some of the years and Alloteuthis squids and cuttlefishes were relatively frequent in discards from the OTB_DEF fishery in 2004 and 2005. Some estimates of annual discards for the latter species and time periods are presented.

The procedure generally used to raise discards from haul to fleet level in the Portuguese trawl fisheries is adapted from Fernandes *et al*. (2010) (Jardim and Fernandes, *in prep*.). This procedure is sensitive to the large number of zeros in the dataset (Jardim *et al*., 2011) and species with low frequency of occurrence or abundance in discards (i.e. a large number of zeros in the dataset) are not reliably estimated. The frequency of occurrence and abundance of Cephalopod species (and species groups) in the discards of the Portuguese bottom trawl fleet was below the 30%. Consequently, annual discard volumes at feet level were only estimated for some species and species groups.)

The annual frequency of occurrence of cephalopod discards in the sampled hauls was low to moderate ranging between 0% and 59% in OTB_CRU and between 0% and 46% in OTB_DEF. The most common cephalopod discards were *Eledone cirrhosa* and Sepiolidae in the OTB_CRU fishery and *Alloteuthis spp* and *Sepia spp*. In the OTB_DEF fishery. Complete data on the frequency of occurrence of cephalopods in discards are displayed in Table 1.3.3.1.

Table 1.3.3.1 Percentage of occurrence of discards of cephalopod species, data is presented at sampling level.

Gear	Area		Species	2009	2010	2011
			Sepiidae	13	15	12
			Sepia officinalis	1	3	2
			Sepia elegans	5	4	5
			Sepia orbignyana	7	5	4
			Loliginidae	10	6	14
			Loligo vulgaris	0	2	0
			Ommastrephidae	1	12	30
			Illex coindetii	1	10	14
			Todaropsis eblanae	0	2	14
OTB	IX	CRU	Octopodidae	15	20	36
			Eledone cirrhosa	8	10	14
			Eledone moschata	2	4	12
			Octopus vulgaris	4	2	4
			Sepia spp	0	3	2
			Sepiola rondeleti	4	0	0
			Octyopus defilippi	0	0	0
			Rossia macrosoma	31	13	7
			Loligo spp	0	1	2
			Family Sepiolidae	35	13	7
			Sepiidae	23	6	11
			Sepia officinalis	3	1	0
			Sepia elegans	11	3	7
			Sepia orbignyana	8	1	0
			Loliginidae	19	14	29
			Loligo vulgaris	0	0	1
			Ommastrephidae	0	0	2
			Illex coindetii	0	0	2
			Todaropsis eblanae	0	0	0
OTB	IX	DEF	Octopodidae	21	11	20
			Eledone cirrhosa	9	8	5
			Eledone moschata	1	2	2
			Octopus vulgaris	10	2	11
			Sepia spp	0	2	4
			Sepiola rondeleti	0	0	0
			Octyopus defilippi	0	0	1
			Rossia macrosoma	1	0	0
			Loligo spp	0	2	6
			Family Sepiolidae	1	0	0

2.3.4 Germany

There are no fisheries targeting cephalopod in German waters; the landings reported are by-catch landings mainly from bottom trawl fisheries in area IVb. German discard data are based on a small number of trips conducted with an observer on board, Data in table 1.3.4.1 represent single trips done on a yearly basis. This information reflects the sporadic nature of cephalopod catches by the trawl fleet in Germany and the limited opportunities to sample the trawl vessels. The amount of cephalopods discarded ranged between 0 and 100% of the catch. Nevertheless, long finned squids seem to be 100% discarded by the bottom trawl fleet, like other undetermined cephalopod species.

Table 1.3.4.1 Percentage of discards of cephalopod species, in the total hauls sampled in the trawl German fleet in areas between 2004 and 2011.

Gear	Area	Species	2004	2005	2006	2007	2008	2009	2010	2011
OTB	IV a	cephalopods	100%	-	-	-	-	-	-	100%
		long finned squids	-	100%	100%	-	90%	-	-	-
	IV b	cephalopods	-	-	-	-	-	-	-	-
		long finned squids	-	-	-	100%	-	-	-	100%
	XIV b	cephalopods	-	-	-	0%	-	-	-	-
		long finned squids	-	-	-	-	-	-	-	-
TBB	IV b	cephalopods	-	0%	-	-	-	100%	-	-
		long finned squids	-	29%	-	-	-	-	-	-
	IV c	cephalopods	-	-	-	-	-	-	100%	-
		long finned squids	-	-	-	-	-	-	-	-
PTB	IV b	Other cephalopods	-	-	-	-	0%	-	-	-
		long finned squids	-	-	-	-	0%	-	-	-
SSC	IV a	Other cephalopods	-	-	-	-	-	100%	-	-
		long finned squids	-	-	-	-	-	-	-	-
OTM	VII j	Other cephalopods	-	-	-	-	-	-	-	-
		long finned squids	-	-	-	-	-	-	100%	-

2.3.5 The Netherlands

In the Dutch discard program, only one cephalopod species (*Loligo spp*.) was reported by family name in the ICES areas VI and VII. In few cases full species name is listed. Thus, to avoid misidentification all discards as reported by family name.

Discards records only apply to the metier combinations which have been sampled. This means that a 0 in the table means that there was discard sampling but no catches were recorded.

Table 1.3.5.1. Percentage of discards of cephalopod species in The Netherlands.

Gear	Area	Species	2009	2010	2011
OTM	VI	Loliginidae	100%	12%	-
	VIIbjck	Loliginidae	0%	6%	100%
PTM	VIIe	Loliginidae	-	-	100%

2.3.6 United Kingdom (England and Wales)

Discard information from United Kingdom is only available by species since the beginning of 2011. Data here presented is thus grouped under species groups. In case of *Loginidae* and *Ommastrephidae* also identification problems are detected and thus both families are pooled together. Thus, grouping of species is as follows: *Loliginidae & Ommastrephidae ; Sepiidae; Octopodidae*.

Table 1.3.6.1. Percentage of discards of cephalopod species in The United Kingdom (England and Wales).

Gear	Area	Species	2009	2010	2011
HMD	VIIe	Sepiidae	0%	0%	98%
	VIIa	Sepiidae			100%
		Loliginidae & Ommastrephidae	2%	0%	0%
	VIIe	Loliginidae & Ommastrephidae	1%	3%	0%
		Sepiidae	7%	3%	5%
		Octopodidae	0%	1%	47%
OTB	VIIfgh	Loliginidae & Ommastrephidae	2%	0%	0%
		Sepiidae	3%	0%	0%
	VIIe	Loliginidae & Ommastrephidae	0%	0%	0%
		Sepiidae	0%	0%	0%
		Octopodidae	0%	0%	74%
	VIIfgh	Loliginidae & Ommastrephidae	0%	0%	0%
	VIIe	Loliginidae & Ommastrephidae	0%	0%	1%
		Sepiidae	2%	1%	3%
		Octopodidae	0%	1%	8%
OTT	VIIfgh	Loliginidae & Ommastrephidae	-	0%	1%
	VIIe	Loliginidae & Ommastrephidae	0%	0%	0%
		Sepiidae	0%	1%	0%
PTB	VIIe	Sepiidae	0%	1%	0%
		Octopodidae	0%	82%	0%
	VIIe	Loliginidae & Ommastrephidae	2%	4%	1%
		Sepiidae	3%	1%	2%
TBB		Octopodidae	0%	16%	8%
	VIIfgh	Loliginidae & Ommastrephidae	22%	7%	12%
		Sepiidae	9%	2%	2%
		Octopodidae	55%	36%	41%

2.3.7 Other countries (Ireland, Estonia, Lithuania, Latvia, Poland, Sweden & Denmark)

There is no requirement for Ireland under the Data Collection Framework to collect discard data on cephalopods other than cuttlefish in the areas fished by Irish vessels. All cuttlefish recorded on discard trips were landed as well as various Ommmastrephidae, mainly *Illex spp*.

Some other cephalopod species are occasionally sampled in routinely discard sampling on board but no raised data to fleet level has been deployed at this stage.

Discards of cephalopods by the Irish fleet is apparently quite low in relation to that of fin fish. The amount discarded could be around 10 t annually. The main species discarded are *Eledone cirrhosa*.

Estonia, Lithuania, Latvia and Poland reported to the group that as no cephalopod fisheries are deployed by the country no data on cephalopod discards are reported in ICES area.

Sweden has almost no effort data on cephalopods in the ICES areas included in the data call. In 2011, Sweden landed approximately 400 kg of cephalopods of not identified species from area IV.

Danish cephalopods landings and discards are mostly deployed in ICES areas III and IV, which were, at this stage, not included in the sea areas listed in the data call. Thus no data was provided to the group.

2.4 Survey information on cephalopods

The surveys carried out in the North eastern Atlantic IBTS area involved all countries of the European Atlantic coast. The IBTSWG has focused on improving the quality of the data collected during the surveys (including trawl, vessel, environmental, and catch parameters), as well as their availability by storing them in a common database at ICES headquarters, i.e. DATRAS (Database for TRAwl Surveys). The IBTSWG aims to make all data collected during IBT Surveys publicly available through this database.

Table 1.4.1 presents the different surveys conducted in the western and southern area as well as the country involved and the acronym used. The North Sea IBTS Q1 and Q3 surveys are carried out by several countries with their own research vessels, such as Sweden, Denmark, Norway, Scotland, England, France, Netherlands and Germany. In all surveys, abundance indices in weight or number are obtained for all cephalopod species during the time series. Besides, the survey manual requires recording of several cephalopod species during surveys, including three species of sepia (*S. officinalis*, *S. elegans* and *S. orbignyana*) teuthoidea (*Illex coindeti* and *Todaropsis eblanae*), *Eledone cirrhosa* and *Octopus vulgaris*. In the case of bobtail squid, they are analysed together.

Table 1.4.1. Summary of IBTS surveys in western and southern area (Northeastern Atlantic waters).

Survey	Division	Acronym
Scottish Surveys		
Scottish Western Coast VIa Groundfish Survey - Quarter 1	VIa	SWCGFS6a
Rockall Survey ICES VIb (every second year) - Quarter 3,	VIb	SWCGFS6b
Scottish Western Coast VIa Groundfish Survey - Quarter 4	VIa	SWCGFS6a
Northern Ireland surveys		
Northern Ireland Groundfish Survey in the Irish Sea - Quarter 1	VIIa	NIGFS
Northern Ireland Groundfish Survey in the Irish Sea - Quarter 4	VIIa	NIGFS
Irish survey		
Irish Groundfish Surveys - Quarter 4	VIa - VIIbcgj	IGFS
English Survey		
English Western IBTS survey – Quarter 4	VIIa,e-h	Q4SWIBTS
French surveys		
Groundfish Survey in the Eastern Channel - Quarter 4	VIId	FR-.CGFS
Groundfish Survey in the Celtic Sea and Bay of Biscay - Quarter 4	VIIfghj, VIIIab	FR-EVHOE
Spanish surveys		
Spanish Groundfish Survey in the Porcupine bank - Quarter 3	VIIbck	SP-PorcGFS
Spanish Groundfish Survey in Northern Spanish Shelf - Quarter 4	VIIIc, IXaN	SP-NGFS
Spanish survey in the Gulf of Cadiz - Quarters 1 & 4	IXaS	SP-GCGFS
Portuguese surveys		
Portuguese Groundfish Survey in Portuguese shelf - Quarter 4	IXaMS	PGFS

In the past five years, the information of cephalopod species has increased due to the requirements imposed by the DCF. In 2011, Spain presented biological information for *Loligo vulgaris*, *S. officinalis*, *Octopus vulgaris*, *Eledone cirrhosa* and *E. moschata* from SPNGFS and SPSGCGFS surveys. *E. moschata* is only caught in SPGCGFS survey carried out in IXa-south (Gulf of Cadiz).

At present, Spain, Portugal, Germany, Ireland and United Kingdom have contributed with survey data regarding yields and abundances, and additional information about length frequency, geographic distribution and bathymetric distribution in the case of Spanish survey. Main information of the surveys presented by country is described below. Denmark informed this expert group about the availability of Danish survey data at the DATRAS Data Base. No output of this Data Base was obtained during this meeting due to time limitation for extraction and analysis.

2.4.1 Spain

Spain carried out three survey in the fourth quarter: the Spanish Ground Fish Survey on the Porcupine bank (SPPGFS: "PORCUPINE"), the bottom trawl survey on the Northern Spanish Shelf (SPNGFS: "DEMERSALES") and the bottom trawl survey on the Gulf of Cádiz (SPGCGFS: "ARSA"). For each survey, a working document is presented, showing the mean results of the selected species (WD a.5, a.6, a.7). Information presented in each survey is compiled main commercial species. Abundances are presented as yield in biomass (kg/haul) and yield in number (indv./haul).). Additional information such as geographic distribution by species and by year, bathymetric distribution (average of the time series) and length frequency distribution by year are also summarised in the above WDs.

2.4.1.1 SPPGFS "PORCUPINE survey"

The Porcupine Bank bottom trawl survey has been carried out annually since 2001. The objective is to provide data and information for the assessment of the commercial fish species in the area (ICES divisions VIIc and VIIk) (ICES, 2010). During these 11 years of surveys, the cephalopods have occurred frequently but they have been little reported and assessed.

The aim of this working document (WD a.5) is to report the geographic and bathymetric distribution, relative abundance and biological parameters of the main cephalopods species in the Porcupine area from 2001 to 2011. The most common species in the survey time series are analysed in the present working document, namely *Eledone cirrhosa* and *Bathypolypus sponsalis* (fam. Octopodidae), *Haliphron atlanticus* (fam. Alloposidae), *Todarodes sagittatus, Todaropsis eblanae* and *Illex coindetii* (fam. Ommastrephidae), *Loligo forbesi* (fam. Loliginidae) and *Rossia macrosoma* (fam. Sepiolidae); (see more information in WD a.5).

Table 1.4.1.1. Biomass Indices (kg/30`) of the Spanish Porcupine Survey in VII from 2001 is presented. Species in table are commercial species also landed by the commercial fleets.

	Eledone cirrhosa		*Loligo forbesii*		*Todaropsis eblanae*		*Illex coindetii*	
Year	Yield (kg/30′)	S.E.	Yield (kg/30′)	S.E.	Yield (kg/30′)	S.E.	Yield (kg/30′)	S.E.
2001	1.57	0.16	0.00	0.00	0.13	0.03	0.01	0.01
2002	1.28	0.14	0.03	0.02	0.07	0.02	0.02	0.01
2003	0.80	0.09	0.00	0.00	0.07	0.01	0.01	0.00
2004	1.53	0.14	0.01	0.01	0.20	0.04	0.02	0.01
2005	1.47	0.11	0.02	0.01	0.22	0.04	0.00	0.00
2006	1.49	0.15	0.02	0.02	0.16	0.03	0.00	0.00
2007	1.20	0.10	0.03	0.01	0.01	0.00	0.14	0.02
2008	0.38	0.04	0.18	0.08	0.01	0.00	0.00	0.00
2009	0.81	0.08	0.60	0.23	0.06	0.02	0.50	0.34
2010	0.84	0.09	0.27	0.08	0.02	0.01	0.01	0.01
2011	0.42	0.05	0.22	0.12	0.00	0.00	0.01	0.01

2.4.1.2 SPNGFS: "DEMERSALES survey"

The bottom trawl survey on the Northern Spanish Shelf (SPNGFS: "DEMERSALES") aim to provide data and information for the assessment of the commercial species and the ecosystems on the Galician and Cantabrian Shelf (ICES Div. VIIIc and IXa North). The DEMERSALES Spanish survey has been carried out annually in autumn from 1983, although data on invertebrate species were collected mainly from 1990, and therefore results are presented from this year up to 2011.

Data collected on cephalopods for this survey is presented in detail in WD a.6. Thus, abundance indices, length frequency distributions and geographic and bathymetric distributions on the most common cephalopod species sampled in these surveys, namely curled octopus (*Eledone cirrhosa*), broadtail shortfin squid (*Illex coindetii*), lesser flying squid (*Todaropsis eblanae*), common octopus (*Octopus vulgaris*), long finned squid (*Loligo forbesi*), common squid (*Loligo vulgaris*), European flying squid (*Todarodes sagittatus*), pink cuttlefish (*Sepia orbignyana*), common cuttlefish (*Sepia officinalis*) and elegant cuttlefish (*Sepia elegans*) from the DEMERSALES bottom trawl survey's series are presented (see more information in WD a.6).

Table 1.4.1.2. Biomass Indices (kg/30´) of the Spanish Demersal Survey in VIIIc from 1990 is presented. Species in table are commercial species also landed by the commercial fleets.

	Octopus vulgaris		*Eledone cirrhosa*		*Loligo vulgaris*		*Loligo forbesii*		*Sepia officinalis*		*Todaropsis eblanae*		*Illex coindetii*	
Year	Yield (kg/30´)	S.E.	Yield (kg/30´)	S.E.	Yield (kg/30´)	S.E.	Yield (kg/30´)	S.E.	Yield (kg/30´)	S.E.	Yield (kg/30´)	S.E.	Yield (kg/30´)	S.E.
1990	1.12	0.39	0.82	0.12	0.02	0.01	0.07	0.03	0.07	0.05	0.84	0.15	1.47	0.17
1991	0.12	NA	0.68	NA	0.10	NA	0.11	NA	0.11	NA	0.33	NA	1.18	NA
1992	3.49	0.95	1.52	0.27	0.14	0.12	0.12	0.05	0.07	0.04	0.45	0.04	2.67	0.54
1993	0.21	0.05	1.59	0.13	0.08	0.07	0.18	0.09	0.04	0.03	0.86	0.10	0.24	0.08
1994	0.30	0.09	1.07	0.10	0.04	0.02	0.19	0.05	0.03	0.03	0.10	0.02	2.09	0.82
1995	0.49	NA	1.70	NA	0.20	NA	0.08	NA	0.07	NA	0.68	NA	0.30	NA
1996	0.14	NA	1.75	NA	0.36	NA	0.32	NA	0.20	NA	3.75	NA	0.75	NA
1997	0.80	0.29	2.46	0.19	0.30	0.21	0.17	0.04	0.01	0.01	3.10	0.49	1.45	0.15
1998	0.43	0.13	0.78	0.09	0.16	0.05	0.11	0.03	0.00	0.00	0.37	0.04	0.89	0.08
1999	0.48	0.12	1.12	0.11	0.11	0.04	0.31	0.13	0.04	0.02	1.90	0.36	1.63	0.24
2000	0.39	0.13	1.06	0.12	0.09	0.02	0.09	0.06	0.00	0.00	0.60	0.05	2.26	0.80
2001	0.73	0.21	1.57	0.16	0.13	0.04	0.08	0.02	0.00	0.00	0.48	0.10	0.30	0.04
2002	0.40	0.10	1.28	0.14	0.10	0.04	0.22	0.07	0.00	0.00	0.13	0.03	0.47	0.05
2003	0.19	0.07	0.80	0.09	0.09	0.04	0.39	0.12	0.02	0.02	0.34	0.09	0.95	0.45
2004	0.77	0.15	1.53	0.14	0.24	0.11	0.50	0.15	0.04	0.03	0.47	0.05	0.98	0.19
2005	0.12	0.04	1.47	0.11	0.05	0.02	0.40	0.11	0.00	0.00	1.30	0.12	0.61	0.12
2006	0.61	0.26	1.49	0.15	0.49	0.39	0.45	0.17	0.13	0.11	0.32	0.05	0.16	0.03
2007	0.84	0.23	1.20	0.10	0.32	0.08	0.04	0.03	0.01	0.01	0.43	0.04	0.20	0.03
2008	0.60	0.13	0.38	0.04	0.47	0.08	0.00	0.00	0.01	0.01	0.57	0.06	0.60	0.32
2009	0.16	0.06	0.81	0.08	0.28	0.12	0.19	0.06	0.02	0.02	0.62	0.06	0.46	0.10
2010	1.18	0.25	0.84	0.09	0.01	0.00	0.77	0.19	0.00	0.00	0.60	0.09	0.20	0.03
2011	0.36	0.10	0.42	0.05	0.09	0.02	0.76	0.22	0.01	0.01	1.35	0.44	1.32	0.39

2.4.1.3 SPGCGFS: "ARSA survey"

Since 1997 the Spanish bottom trawl survey ARSA has been carried out annually in autumn, during November, in the Gulf of Cádiz (ICES Sub-division IXa south) to study the distribution and relative abundance (in number and weight) of all demersal species in the area, as well to estimate biological parameters of main commercial species (ICES, 2010). Other similar survey is carried out in the same area since 1993 ("Spanish bottom trawl survey spring ARSA") in March. The yield of this survey are not included in the WD a.7, but this information has been used to obtain the average yield of both survey in order to compare it with the LPUE series of commercial trawl fleets presented in the next section.

The complete details of ARSA survey series including abundance indices, length frequency distributions and geographic and bathymetric distributions of the most commercial cephalopod species are presented in WD a.7. Most abundant species present in the survey are the cuttlefish *Sepia officinalis* and *Sepia elegans*, octopus: *Octopus vulgaris, Eledone moschata* and *Eledone cirrhosa*, the long-finned squids: *Loligo vulgaris, Loligo forbesii* and *Alloteuthis spp*., and the short-finned squids *Illex coindetii* and *Todaropsis eblanae* (see more information in WD a.7).

Table 1.4.1.3 Biomass Indices (kg/h) of the Spanish Demersal Survey in IXa-south (Gulf of Cádiz) from 1997 is presented. Species in table are commercial species also landed by the commercial fleets.

	Alloteuthis spp		*Loligo vulgaris*		*Loligo forbesii*		*Octopus vulgaris*		*Eledone cirrhosa*		*Eledone moschata*		*Sepia officinalis*		*Sepia elegans*		*Todaropsis eblanae*		*Illex coindetii*	
Year	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.
1997	0,84	30,88	0,00		0,32	18,67	0,76	78,06	0,47	28,44	2,69	146,81	0,24	12,35	4,75	223,70	0,47	35,26	9,93	1167,87
1998	1,17	41,67	0,00		0,11	4,91	0,45	22,66	0,03	2,39	1,22	37,47	0,06	2,10	0,85	43,42	0,08	5,63	43,72	5962,48
1999	0,62	24,10	0,40	63,18	0,92	37,06	2,59	107,42	0,18	7,53	1,84	29,98	0,08	2,58	1,25	45,28	0,12	6,48	0,79	26,14
2000	0,60	28,80	0,73	68,64	0,58	30,88	0,95	62,76	0,39	24,30	0,54	14,79	0,24	6,89	1,19	66,20	0,88	67,78	2,58	197,27
2001	1,35	53,74	0,19	13,48	1,72	50,94	1,10	63,94	0,42	15,43	0,69	16,07	0,03	1,28	1,43	67,67	1,00	34,91	6,03	528,32
2002	1,14	31,22	0,03	2,29	1,21	43,39	0,75	35,16	0,15	6,96	1,06	31,17	0,09	2,93	0,96	41,08	0,36	12,56	0,72	38,69
2003	1,20	36,83	0,15	22,89	0,78	34,70	0,91	62,79	1,20	47,26	1,24	25,18	0,04	2,08	2,60	96,32	0,19	7,65	0,10	6,73
2004	2,84	145,64	1,14	126,20	0,60	24,66	2,20	126,90	0,35	12,12	1,77	33,30	0,11	3,91	0,90	51,19	0,45	19,14	0,07	3,23
2005	0,66	23,68	0,66	68,25	1,77	86,93	7,56	231,09	0,81	22,52	1,02	20,28	0,32	8,80	2,46	88,43	0,67	25,44	0,25	5,86
2006	0,28	12,93	1,08	107,13	1,89	52,25	1,57	98,73	0,04	3,08	1,37	38,38	0,20	8,04	2,11	109,48	0,28	13,59	0,24	11,32
2007	1,51	50,02	0,12	17,89	1,30	49,84	4,03	286,91	0,14	8,87	1,00	30,09	0,15	7,13	1,03	54,95	0,07	4,00	0,64	56,86
2008	1,23	38,28	0,73	60,91	2,13	57,90	1,64	169,02	0,00	0,24	1,42	42,01	0,17	5,60	1,08	36,29	0,14	7,23	0,13	6,27
2009	1,74	74,96	1,40	101,28	0,87	36,77	3,82	272,65	0,04	2,67	1,97	43,42	0,21	5,98	0,76	35,19	0,06	3,61	0,08	3,71
2010	0,33	10,34	0,09	8,77	1,10	49,94	0,97	52,88	0,03	1,69	0,54	14,54	0,14	3,95	1,39	38,25	0,82	35,81	1,22	67,02
2011	0,54	23,74	0,04	3,42	0,50	28,45	1,39	80,34	0,44	20,36	1,13	34,88	0,09	4,08	1,61	54,81	0,24	10,48	2,18	77,17

2.4.2 Portugal

PGFS surveys were carried out on the Portuguese continental coast on board R/V Noruega and occasionally on R/V Capricórnio in autumn. The sampling area covers latitudes 36.7º to 41.8º N and longitudes 7.47º to 10.0º W in the NE Atlantic. The main objective of these research surveys is to estimate indices of abundance and biomass of the most commercially important fish and crustacean species. The autumn cruises done with R/V Noruega employ a Norwegian Campbell Trawl type with bobbins and the cruises done with R/V Capricórnio used an FGAV019 bottom trawling net, with a cod end of 20 mm mesh size, a mean vertical opening of 2.5 m and a mean horizontal opening between wings of 25 m. These cruises follow a depth stratified sampling design, with ca. 70–80 hauls distributed along the Portuguese continental shelf and slope. The tow duration vary between 20 and 60 min.

In Table 1.4.2.1 Abundance indices of the important commercial cephalopod species are presented.

By species groups, the trends in abundance observed in the data series are described below. The only real case of concern relates to *Loligo vulgari*s. The causes for the severe decreasing in abundance since 1993 remain unresolved.

Long-finned squid abundance time-series from research surveys

Loligo vulgaris

This is the most abundant long-finned squid in Portugal. The abundance shows a declining tendency since 1987 to the very end of the series, more rapidly up to 1995 and slower from there on. This is in accordance with similar length landings time-series and we believe it represents the true situation of the stock.

Loligo forbesi

Our research has shown that *Loligo forbesi* is a relatively uncommon presence in Portuguese waters, with occasional strong migrations at times of greater than average abundance northwards of Portuguese continental waters. The research survey series reflects this situation, showing only occasional appearances other than the large influx in the late eighties.

Octopus abundance time-series from research surveys

Octopus vulgaris

Our research time-series groups different types of gear, most of which are inadequate to sample this species. However the yields obtained appears to show the difference in abundance between the latest plateau and the lower abundance that preceded it.

Eledone cirrhosa

The time-series shows no abundance peak from the late nineties which appear to be real, but has decreased slightly in the latter decade.

Remaining species

For the most part, cephalopods collected in surveys in Portuguese waters appear to be in a relatively healthy status, without marked fluctuation in abundance, other than those resulting from migratory behaviours.

Table 1.4.2.1. Biomass Indices (Yield (kg/h)) of the Portuguese Ground Fish Survey (4thQ PGFS) since 1981 for the species more common in the landings.

	Sepia officinalis		*Sepia elegans*		*Sepia orbygniana*		*Alloteuthis spp.*		*Loligo vulgaris*		*Loligo forbesi*		*Illex coindetii*		*Todaropsis eblanae*		*Todarodes sagittatus*		*Octopus vulgaris*		*Eledone cirrhosa*		*Eledone moschata*	
Year	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.	Y (kg/h)	S.E.
1981	0.01	0.00	0.03	0.01	0.00	0.00	1.71	0.06	3.84	0.51	0.00	0.00	0.54	0.00	0.03	0.01	0.00	0.00	0.92	0.26	0.13	0.02	0.00	0.00
1982	0.04	0.02	0.01	0.00	0.00	0.00	1.20	0.13	1.60	0.26	0.26	0.06	0.63	0.12	0.03	0.00	0.01	0.00	0.09	0.02	0.02	0.00	0.00	0.00
1983	0.00	0.00	0.39	0.26	0.00	0.00	1.17	0.08	1.76	0.21	0.46	0.00	1.83	0.09	0.11	0.01	0.00	0.00	0.23	0.05	0.02	0.00	0.00	0.00
1985	0.20	0.06	0.01	0.00	0.00	0.00	0.94	0.24	0.43	0.06	0.17	0.07	0.07	0.01	0.02	0.01	0.00	0.00	0.17	0.04	0.08	0.03	0.00	0.00
1986	0.00	0.00	0.01	0.00	0.01	0.01	1.43	0.27	1.15	0.26	0.06	0.01	39.76	22.36	0.05	0.03	0.00	0.00	0.03	0.01	0.11	0.04	0.06	0.02
1987	0.01	0.01	0.00	0.00	0.00	0.00	0.09	0.03	6.28	1.94	4.84	3.68	2.99	0.42	0.02	0.01	0.03	0.01	0.42	0.11	0.17	0.07	0.00	0.00
1988	0.06	0.03	0.01	0.01	0.00	0.00	0.68	0.22	3.44	0.57	0.31	0.15	0.75	0.10	0.00	0.00	0.00	0.00	0.07	0.07	0.09	0.03	0.01	0.01
1989	0.12	0.08	0.00	0.00	0.00	0.00	0.84	0.07	4.00	0.97	0.29	0.11	0.48	0.08	0.01	0.00	0.00	0.00	0.17	0.04	0.01	0.00	0.12	0.03
1990	0.14	0.07	0.01	0.00	0.00	0.00	0.18	0.04	1.16	0.29	0.42	0.09	0.87	0.27	0.03	0.01	0.00	0.00	0.33	0.11	0.15	0.03	0.07	0.02
1991	0.02	0.02	0.01	0.00	0.02	0.01	0.10	0.03	2.64	0.53	0.26	0.05	1.62	0.95	0.01	0.00	0.00	0.00	0.04	0.02	0.03	0.03	0.00	0.00
1992	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.04	2.08	1.00	0.60	0.49	0.14	0.04	0.01	0.01	0.00	0.00	0.11	0.07	0.04	0.02	0.00	0.00
1993	0.03	0.02	0.01	0.00	0.00	0.00	0.10	0.03	0.81	0.37	0.07	0.06	0.01	0.01	0.00	0.00	0.00	0.00	0.17	0.05	0.12	0.05	0.01	0.00
1994	0.02	0.01	0.00	0.00	0.00	0.00	0.04	0.01	0.12	0.06	0.02	0.01	0.00	0.00	0.00	0.00	8.26	4.13	0.35	0.10	0.03	0.01	0.05	0.03
1995	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.04	0.28	0.07	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.11	0.04	0.00	0.00	0.00	0.00
1996	0.15	0.08	0.03	0.01	0.01	0.00	1.08	0.33	0.83	0.40	0.00	0.00	0.19	0.05	0.47	0.11	0.02	0.01	4.56	0.76	0.47	0.10	0.18	0.05
1997	0.09	0.04	0.01	0.01	0.00	0.00	0.02	0.00	0.66	0.21	0.05	0.04	0.81	0.23	0.02	0.01	0.00	0.00	0.22	0.09	0.00	0.00	0.13	0.02
1998	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.23	0.41	0.07	0.00	0.00	0.21	0.04	0.01	0.00	0.00	0.00	0.05	0.02	0.00	0.00	0.00	0.00
1999	0.07	0.05	0.01	0.00	0.01	0.00	0.22	0.04	0.76	0.22	0.00	0.00	0.15	0.03	0.18	0.03	0.00	0.00	1.39	0.29	0.20	0.08	0.13	0.05
2000	0.10	0.06	0.01	0.00	0.02	0.00	0.22	0.04	0.57	0.24	0.00	0.00	0.43	0.14	0.08	0.04	0.03	0.02	0.21	0.06	0.03	0.01	0.11	0.07
2001	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.18	0.57	0.21	0.00	0.00	0.41	0.20	0.03	0.01	0.00	0.00	0.25	0.13	0.02	0.01	0.05	0.03

2002	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.10	0.31	0.11	0.00	0.00	1.86	0.98	0.03	0.01	0.03	0.03	0.02	0.02	0.02	0.01	0.06	0.04
2003	0.07	0.04	0.21	0.08	0.09	0.02	1.21	0.38	0.46	0.08	0.01	0.00	0.54	0.08	0.37	0.04	0.00	0.00	1.99	0.35	2.28	0.23	0.17	0.06
2004	0.00	0.00	0.27	0.04	0.19	0.03	2.11	0.42	1.80	0.39	0.08	0.05	2.00	0.67	0.21	0.04	0.01	0.01	2.31	0.77	2.19	0.69	1.27	0.40
2005	0.02	0.02	0.00	0.00	0.00	0.00	0.77	0.27	0.35	0.07	0.00	0.00	0.09	0.02	0.03	0.01	0.02	0.00	0.27	0.09	0.09	0.04	0.10	0.03
2006	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.04	0.02	0.31	0.10	0.02	0.01	0.05	0.01
2007	0.00	0.00	0.00	0.00	0.00	0.00	3.50	0.68	0.06	0.03	0.00	0.00	0.01	0.01	0.01	0.00	0.03	0.01	0.04	0.02	0.07	0.04	0.05	0.03
2008	0.01	0.01	0.00	0.00	0.00	0.00	3.72	0.75	0.11	0.03	0.00	0.00	0.01	0.01	0.02	0.01	0.04	0.04	0.45	0.14	0.00	0.00	0.04	0.02
2009	0.06	0.05	0.00	0.00	0.00	0.00	3.45	0.60	0.23	0.04	0.01	0.00	0.03	0.01	0.04	0.02	0.04	0.03	0.13	0.06	0.01	0.00	0.07	0.03
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.53	0.22	0.07	0.03	0.08	0.02	0.01	0.00	0.03	0.02	0.20	0.10	0.01	0.01	0.12	0.05
2011	0	0	0.00	0.00	0.00	0.00	2.10	0.31	0.43	0.17	0.01	0.00	0.17	0.03	0.02	0.01	0.00	0.00	0.04	0.03	0.01	0.00	0.02	0.01

2.4.3 France

No Survey French data on cephalopods was made available by the time of the Working Group meeting.

2.4.4 Germany

In 2012, Germany has contributed with survey data regarding yields and abundance indices from 2009 to 2011. In Table 2.4.x yields of the Germany North Sea IBTS is presented. Just yields of *Loligo spp, Loligo forbesi, Loligo vulgaris* and Loliginidae are presented as *Loligo vulgaris* is the unique species in the landings for the same period of time. Moreover, German Survey delivered yields obtained in the same survey from 2009 to 2011 for the following cephalopod species: *Eledone cirrhosa; Sepiola atlantica; Sepietta oweniana; Eledone spp.*; Others; *Alloteuthis subulata; Rossia macrosoma; Loligo spp; Todarodes sagittatus; Loligo forbesi; Illex coindetii; L. vulgaris; Loliginidae; Todaropsis eblanae.*

Table 1.4.4.1 Biomass Indices (kr/h) of the Germany North Sea IBTS during 2009, 2010 and 2011. Species here presented are that most common in the landings and species belonging to the same Family group.

		Quarter 1		Quarter 3	
	Year	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.
Loligo spp	2011			0.04	0.03
Loligo forbesi	*2009*	*1.73*	*0.44*	*0.41*	*0.36*
	2010	3.68	0.83	0.13	0.07
	2011	5.67	2.68	0.29	0.13
Loligo vulgaris	2009	0.05	0.03		
	2010	0.05	0.02		
	2011			0.08	0.07
Loliginidae	2009	0.00	0.00		
	2010			0.00	0.00
	2011	0.00	0.00		

2.4.5 Ireland

Ireland provided yield and abundance Indices for the following species and/or species groups: *Sepia officinalis; S. elegans; Eledone cirrhosa; Octopus vulgaris; Alloteuthis subulata; Todarodes sagittatus; Loligo forbesi; Illex coindetii; L. vulgaris and Todaropsis eblanae.* A slope stratum was added to the Irish Ground Fish Survey (IGFS) in VIa, VIIb and VIIj from 2005 deployed in Quarter 4. From 2005, survey coverage was extended into deeper waters. Some concerns remain in the survey data. *Octopus vulgaris* records are, in the Irish platform, very unusual, so some individuals are identified as belonging to this species but this fact could be a misidentification of species. It appears that those individuals might be deep water species of Benthoctopus. Furthermore, *Eledone cirrhosa* records only begin in 2008 – that species is pretty much ubiquitous on Irish shelf- so catches before 2008 are also expected to have occurred. Identification problems could be caused by both wrong codification and/or some data extraction problem. Further revision of the data will be carry out in the next future.

Table 1.4.5.1. Biomass Indices (kg/h) of the Irish Ground Fish Survey (IGFS) from 2003 is presented. Species in table are the more common ones also in the landings.

	Eledone cirrhosa		*Alloteuthis subulata*		*Loligo forbesi*		*Illex coindetii*	
Year	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.	Yield (kg/h)	S.E.
2003	1.42	0.43	1.22	0.43	4.56	1.31	2.70	1.80
2004	7.60	6.03	7.38	3.12	5.48	1.95	0.91	0.71
2005	4.10	1.02	0.75	0.31	6.17	2.00	7.60	3.73
2006	1.30	0.41	0.69	0.42	7.74	2.47	1.25	0.40
2007	5.69	1.40	1.60	0.76	4.32	1.62	13.47	6.60
2008	4.27	0.91	0.87	0.48	6.48	2.40	9.38	3.62
2009	4.86	1.24	0.35	0.19	8.10	2.40	6.46	2.16
2010	9.88	2.01	0.94	0.53	8.03	2.42	4.10	2.95
2011	4.06	1.02	0.31	0.15	10.71	4.22	0.09	0.03

2.4.6 United Kingdom

United Kingdom provided data on abundance indices for the Scottish Western Coast VIa Groundfish Survey- Quarter 1 and Quarter 4 (SWCGF6a); for the Rockall Survey ICES deployed every second year during Quarter 3 (SWCGF6b); and for the English Western IBTS Survey (Q4SWIBTS) deployed during Quarter 4. For this last survey, also biomass indices (kg/h) were provided since 2005. In case of SWCGFS surveys, no CPUE (biomass indices) equivalent of the survey abundance index is available. United Kingdom also provided abundance and biomass indices for other species and/or species groups: *Sepia officinalis, S. elegans , Eledone cirrhosa, S. orbignyana, Alloteuthis subulata, Loligo forbesi, Illex coindetii, Loligo vulgaris, Todaropsis eblanae.* In the Table below just yields for the species and species groups more abundant in the landings are presented.

In 2010, no SWCGFS6a in Quarter 4 or SWCGF6b in Quarter 3 were deployed due to vessel breakdown. For the SWCGFS surveys, short-finned squid are recorded as Ommastrephidae, so although listed in the table as *Illex coindetii*, it may also include *Todaropsis eblanae* and other species. For English Q4WIBTS, any species not measured for length, the number of individuals caught is recorded. No data is provided from Northern Ireland Goundfish Survey in the Irish Sea in Quarter 1 & 4 (NIGFS Q1, Q4). Information required in DCF for species and countries has been updated and provided as much as possible.

Table 1.4.6.1. Biomass Indices (kg/h) of the English Western IBTS Survey Quarter 4 (Q4SWIBTS) from 2005 is presented. Species in table are the more common ones also in the landings.

	Year	Yield (kg/h)	S.E.
Sepia officinalis	2006	0.80	0.67
	2008	0.05	0.05
	2010	0.67	0.46
	2011	0.02	0.02
Sepia elegans	2005	0.01	0.01
	2007	0.05	0.02
	2008	0.01	0.01
	2009	0.02	0.01
	2010	0.01	0.01
	2011	0.01	0.00
Alloteuthis subulata	2005	1.76	0.63
	2006	2.47	0.94
	2007	5.61	2.27
	2008	2.06	0.76
	2009	2.96	1.85
	2010	1.05	0.64
	2011	2.78	1.32
Loligo forbesi	2005	10.95	3.86
	2006	37.86	14.04
	2007	16.12	5.58
	2008	9.48	4.28
	2009	13.38	5.41
	2010	15.01	5.80
	2011	29.91	11.24
Loligo vulgaris	2005	0.18	0.18

In Table 1.4.7. IBTS surveys are presented in which the involved countries and the acronym name of surveys, as well the species sampled and the obtained information are included.

Table 1.4.7. IBTS surveys, indicating the involved countries and the acronym name, as well the species sampled and the obtained information.

	(North sea IBTS Q1 North sea IBTS Q3) **				Scottish survey (SWCGFS)				Northern Ireland survey (NIGFS)				Irish surveys (IGFS)				English surveys(Q4WIB TS)				France surveys (FR-CGFS FR-EVOE)				Spanish surveys (SPPorc.GFS SPNGFS SPGCGFS)				Portuguese Survey (PGFS)			
Octopus vulgaris	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Eledone moschata																									X		X	X				
Eledone cirrhosa																									X		X	X				
Sepia officinalis																									X		X	X				
Sepia elegans													X		X	X									X		X	X				
Sepia orbignyana																									X							
Loligo vulgaris																									X							
Loligo forbesii													X		X	X									X		X	X				
Alloteuthis sp																									X		X	X				
Illex coindetii																																
Todaropsis eblanae																									X							
Todarodes sagittatus																										X						

A= length; B= weight; C= sex; D= maturity

**** Sweden, Denmark, Norway, Scotland, England, France, Netherlands and Germany survey.**

3 ToR b) Review and report on innovative cephalopod research results in, with particular emphasis on relevance to the management and assessment of cephalopod fisheries and populations focussing on innovative and progressive methodologies used in growth and age studies, upon which the foundation of management and assessment is based

Contributions to this section were compiled by a sub-group comprising: Angel Gonzalez, Jean Paul Robin, Nousithé Kouta, Angel Guerra, Beatriz Morales-Nin and Sonia Seixas. The authors have focused in aging, new management, understanding ecology for a better management and other cephalopod studies of interest for the assessment and management of these species. The texts here collected are just a reflection of the knowledge made available at the meeting. Thus, this section does not intend to summarise all knowledge on the above topics related to cephalopods published in the last year 2011, but just an overview of what was discussed during the meeting.

3.1 Towards improving ageing studies in cephalopod for management support

Atlantic Area

Studies investigating age and growth in cephalopods are an important source of data providing the underlying basis for many assessment methods. Over the past few decades, the classic method used has been statolith analysis. However, this methodology has come into question in recent years and new alternative methodologies are currently under investigation. This has led to the introduction of other ageing methods similar to statolith increment reading: stylet analysis for *Octopus*, gladius analysis for squids and, most important and most generally applicable, the ageing of beaks.

In a recent study on ageing, a technique is described that produces a permanent and storable preparation of octopod stylets (Barratt and Allcock, 2010). The technique was developed using the stylets of *Octopus vulgaris* and *Eledone cirrhosa*. Stylets were dehydrated in ethanol and infiltrated with a low-viscosity resin, subsequent polymerization of the resin allowed the embedded stylet to be ground and polished to reveal the stylet microstructure. This comprised increments that are probably suitable for age estimation. Increments were composed of light and dark bands and were clearly defined at ×400 and at ×625 magnifications. The number of increments ranged from 189 to 399. The stylets of a deep-sea species (*Bathypolypus sponsalis*) and an Antarctic species (*Megaleledone setebos*) were also examined. Each appeared to have growth increments, despite the perception that the environments they inhabited may not provide daily cues. In another study using stylets, the daily periodicity of growth increments was validated in wild-caught caught *Octopus vulgaris* maintained under controlled conditions (Hermosilla *et al*., 2010). It was corroborated by staining the stylets either with oxytetracycline (OTC) or tetracycline (TC), and comparing the number of rings produced with the number of days elapsed. The animals were successfully maintained in captivity until sacrificed for up to 6 (one animal), 9 (one animal), 18 (the six animals from Naples), and 21 (17 animals) days. The number of increments counted in transverse stylet sections was 18.9 ± 1.4 and 20.5 ± 1.5 for octopuses maintained for 18 and 21 d, respectively. The mean rate of increment formation was 1.02 increments per day, suggesting a periodicity of 1 increment per day in the stylet. Consequently, the results successfully validate daily increment deposition in *O. vulgaris* stylets in the size range analysed.

A study in *Octopus vulgaris* demonstrate that growth increments in the upper beak of *O. vulgaris* provide a reliable method of aging (Canali *et al*., 2011). Also notice the relationship between body weight and number of rings was affected by sex and season, with the distance between rings clearly correlated to seasonal temperature oscillations. This study confirm that body size is a not a good index of age.

A study by Gonzalez *et al.* (2010) provides the first estimates of age, growth, and mortality in wild paralarvae of the common squid, *Loligo vulgaris*. Growth increments in a total of 273 statoliths of animals, collected of the Ria de Vigo (NW Spain), were examined. Hatching was found to occur all year round for the period 2003–2005, with a peak during late spring and a secondary peak during early autumn. Growth in dorsal mantle length (DML) during that period fitted an exponential equation, with the instantaneous relative growth rates recorded as 2.11, 2.15, and 1.82% DML d^{-1} for 2003, 2004, and 2005, respectively, with no significant differences in size-at-age between the 3 years. Taking into account the growth rates estimated for the whole cycle of *L. vulgaris*, the authors suggest that the lifespan may previously have been underestimated by 3 months, because the proximity of the rings deposited during paralarval and early juvenile stages would prevent accuracy in enumerating the number of growth increments in later stages. The authors also provided an estimate of the instantaneous rate of total mortality during the first 90 days of paralarval life as 9.6, 5.3, and 4.8% d^{-1} for 2003, 2004, and 2005, respectively. In addition, eye diameter was found to provide a reliable and rapid way of estimating DML and age.

In a study by Perales-Raya *et al*. (2010) the authors assess the two methods currently available for age estimation in octopus beaks. Both techniques were applied to 30 individuals of *Octopus vulgaris* caught in central-eastern Atlantic waters. These techniques aim at revealing growth increments in the rostrum sagittal sections (RSS) and lateral wall surfaces (LWS) of octopus upper and lower beaks. For each individual, two independent readings were done for upper and lower beak sections, as well as for the lateral wall surfaces. Vertical reflected light (epifluorescence) and image analysis system were shown to be useful in the observation and analysis of the sequence of increments. Precision of the ageing, increment counts obtained by both techniques, and increment widths were discussed. Using upper beak RSS led to more precise age estimates, whereas preparing LWS was quicker and simpler, and revealed a higher number of increments. Therefore, the authors of this study suggest that counting growth increments in LWS of beaks is the better of the two techniques currently used to age adult common octopus from beaks.

3.2 New approaches to Management: Marine Protected Areas (MPAs) initiatives and possibilities of incorporating cephalopods expertise

Except for *ommastrephid* squids, European cephalopod species of commercial importance have benthic laid egg-masses, and the success of reproduction, and consequently, stock renewal depends on the availability of a suitable habitat for egg-laying. These species have short life-spans and consequently fishery resources depend on annual recruitment. Therefore undesirable changes in environmental conditions in the spawning grounds may result quickly in reduced resource abundance.

In this sense, management measures that could help to protect habitats where recruitment is decided and biomass exportation is assured are of great interest for managing cephalopod species.

In general, the objective of MPAs is to conserve the natural environment, its surrounding waters and the occupant ecosystems, and any cultural or historical resources that may require preservation or management. Therefore, Marine Protected Areas are understood as regions in which human activity can take place under the restrictions aligned with the basic objective of the creation of this restricted area.

In relation to fisheries and the use of MPAs as management measures, the level of protection has to be considered because in most coastal grounds, traditional artisanal fisheries exist. The objective of "sustainable use of marine areas" and consequently, marine resources existing in those areas, requires, in any case, the incorporation of fishermen as part of the actual marine ecosystem.

MPAs proposals made by individual Member States result often from the implementation of the EU Marine Strategy Framework Directive (MSFD). This directive does not mention any list of species although the OSPAR list is sometimes used, which, however, it is just an example of not considering cephalopod species.

As mentioned above, the implementation of MSFD is done at Member State level. When a national initiative in MPA designation is presented, its governance and management should be taken into account. Among the countries with MPAs, regulation systems vary and sometimes depend on local authorities. In other cases regulations can be Regional, National and/or European. When governance and management reach the international scale, the need of expertise of cephalopod scientists, outside national study sites might be desirable for exchanging experiences, especially in those MPAs where artisanal fisheries, and so high socio-economic and cultural implications, are deployed. Thus, any pan-European initiatives related to Marine Protected areas are of interest to maintain a common knowledge framework, to organise consensual answers and to maintain a constant feedback between countries for exchanging experiences and "lessons learnt".

As an example of a pan-European network of MPAs, MAIA (Marine Protected Areas in the Atlantic Arc) is a cooperation project with the aim of creating a network of MPA managers and stakeholders. At this stage, it seems that the spatial coverage of the MAIA network is still quite preliminary. However it is a first step for a coordinated network in innovative management measures and it is expected to be strengthened in the near future.

The aim of a project undertaken in two Spanish National Parks (Atlantic and Mediterranean waters) is the characterization and identification of adequate habitats for spawning and early stages of development of commercially important cephalopod species, which lay their egg batches in benthic substrates within the Islas Atlánticas de Galicia (PNIA) and Archipiélago de Cabrera (PNAC) National Maritime-Terrestrial Parks. The visual census will be undertaken by diving in transects previously established and delimited according to the different substrates present in these areas, and considering the spawning season of the species studied during two years: quarterly in PNIA and every two weeks in winter, spring and summer in PNAC. Every egg mass will be photographed and situated in a map using a geographic positioning system. Temperature and water samples will be collected using Niskin bottles at the maximum and minimum depths to obtain the main hydrographic parameters (salinity, oxygen, pH, chlorophyll a y nutrients). We will count the number of eggs strings in each transect to test their presence in the following census. The location of spawning areas for the common octopus (*Octopus vulgaris*), cuttlefish (*Sepia officinalis*) and common squid (*Loligo vulgaris*), the identification of temporal variations within the spawning season for each species, as well as the definition of the suitability of the topographic, hydrographic and biological conditions for preferent spawning and settlement habitats (the former only for octopus and cuttlefish), will allow to elaborate a contingence plan to protect and preserve the spawning and early juvenile areas. This is the first time that a similar study is undertaken in European waters and affords the management of fisheries according to an ecosystem approach.

3.3 Ecology of cephalopods

Ecology of the common *octopus paralarvae*

One of the subjects ECOBIOMAR Research Group (IIM-CSIC) investigated was the possible underlying causes of the wide interannual fluctuations in catch of the common octopus *Octopus vulgaris* in one of the main small-scale fisheries off the coast of Galicia (northwest Spain). Galicia is at the northern boundary of the Iberian–Canary current upwelling system in the northeast Atlantic Ocean, where local winds induce seasonal upwelling, largely driving the annual cycles of primary and secondary production. It was hypothesized that such dynamics are also fundamental for the survival of the planktonic stages of octopus and set the year class strength. The authors address this hypothesis by investigating the influence of upwelling on time-series of octopus fishery data. Wind stress structure during the spring–summer (prior to the hatching peak) and autumn–winter (during the planktonic stage) was found to affect the early life phase of this species, and explains up to 85% of the total variance of the year-to-year variability of the adult catch. Despite this bottom-up modulation via environmental conditions, results also provide evidence for a between-cohort density-dependent interaction, probably caused by cannibalism and competition for habitat.

On the other hand, planktonic larval dispersal affects the structure, management, and conservation of many fish and coastal invertebrate populations. The dynamics in coastal upwelling areas favour transport of larvae to the open ocean during upwelling episodes, and concentration of larvae in coastal waters under upwelling relaxation or downwelling conditions. Recent work provides evidence those pelagic larval stages in upwelling areas are influenced by specific larval behaviour, biogeography, and life history parameters among others. Nevertheless, very few of these studies have addressed these findings quantitatively. We undertook a general approach for assessing the influence of high-frequency upwelling events on *Octopus vulgaris* planktonic larvae. Specifically, the rates of change were analysed in abundance and biomass of the *O. vulgaris* early larval phase in the NW Iberian coast, where upwelling events occur with a frequency of 10 to 20 d from April to September. The analysis indicates that the increase in larval abundance and biomass is significantly correlated with the simultaneous decrease of water column integrated nitrate, ammonium and chlorophyll levels. These conditions occur during the early stage of the relaxation phase of coastal upwelling events, when nutrient salts are consumed to produce biogenic matter, which is retained in the system and transferred through the food web.

Actually, that Research Group investigate the importance of biological parameters in the ecology of the paralarvae. Thus, the role of the accompanying zooplanktonic fauna for determining the distribution and abundance of the paralarvae in Galicia was elucidated

To advance in knowledge of the trophic position of the paralarvae of the planktonic paralarvae of *Octopus vulgaris*, a two-step study was undertaken. Thus, a molecular method to detect *Artemia franciscana* within *O. vulgaris* paralarvae was developed, as a first step towards understanding the diet of octopus during this life stage. Wild eggs were collected from a spawning female in the Ría de Vigo (NW Spain) in late summer, and brought to the laboratory. After hatching, paralarvae were reared in 30 l rectangular tanks with an open seawater filtered system. Paralarvae were fed with

Artemia, then immediately fixed in 80% ethanol and preserved at 2208C. Primers specific to *A. franciscana* were designed for the gene cytochrome c oxidase subunit I. A nested polymerase chain reaction was necessary to detect *A. franciscana* within octopus paralarvae. This molecular method provides a new framework for resolving the diet of cephalopod paralarvae in the wild, essential for ecological understanding and increasing survival rates in aquaculture. Secondly the identification of the prey ingested by these paralarvae in the wild had to be solved. Resolving diets of small animals immersed in complex food webs such as those in pelagic ecosystems is extremely impractical by simply using visual analysis. The only method to identify prey consumed by *Octopus vulgaris* paralarvae requires field collection of the animals and postmortem analysis of the digestive tract. However, morphological prey analysis is impossible to carry out in this species due to complete maceration of the prey during ingestion. Roura *et al*. (2012) developed a PCR-based method using group-specific primers to identify prey from paralarvae obtained from the wild. Group-specific PCR primers were designed to amplify the most common potential prey species from within Crustacea and also from Teleost fish. The 3′ end of the mitochondrial ribosomal 16S gene region was selected for designing these group-specific primers, because the universal primers 16Sar-16Sbr amplify a variable region widely used for both molecular identification and dietary analysis. These group-specific PCR primers are located within this region and effectively amplify prey DNA avoiding predator DNA by using a two-step semi-nested PCR-based approach. PCR products were subsequently cloned and sequenced to confirm the utility and specificity of the primers. This is the first time that prey items have been identified from *Octopus vulgaris* paralarvae collected from the wild. A range of ecological questions and aquaculture experiments can now be addressed concerning the trophic role of *O. vulgaris* and the potential for rearing of this species in order to increase the low survival of this early life stage, a goal which has been actively pursued since the 1960s.

Predation by a Tompot blenny on the common cuttlefish *Sepia officinalis* eggs

It was presented for the first time evidences of predation on black, ink-stained eggs of the cuttlefish *Sepia officinalis*. Observations were carried out in the Ría de Vigo (NW Spain) at a depth of 10 m, in late April 2010. The behaviour was photographed. The predator was a Tompot blenny *Parablennius gattorugine*. The fish attacked a cuttlefish egg mass laid on a Podweed (*Halydris siliquosa*). Cuttlefish embryos were in a late stage of development. It was suggested that cuttlefish embryos at late developmental stages are also able to recognize potential predators during the perinatal period and avoid them after hatchling.

Spatio-temporal movement patterns of the European squid *Loligo vulgaris* during the inshore spawning seasons

The European squid *Loligo vulgaris* in the Western Mediterranean is exploited by both commercial and recreational fleets when it reaches inshore waters to spawn. The inshore fishing in the southern waters Mallorca (Balearic Islands) concentrates within a narrow, well-delineated area and takes place during a very specific period of the day (sunset). Another closely related species, *Loligo reynaudii*, displays a daily activity cycle during the spawning season ("feeding-at-night and spawning-in-the-day"). Here, the hypothesis that *L. vulgaris* displays a similar daily activity pattern has been tested using acoustic tracking telemetry. Two tracking experiments during May–July 2010 and December 2010 – March 2011 were conducted, in which a total of 26 squid were tagged. The results obtained suggested that *L. vulgaris* movements differ between day and night. The squid seem to move within a small area during the daytime but cover a large area from sunset to sunrise. The probability of detecting squid was greatest between a depth of 25 and 30 m. The abundance of egg clutches at this depth range also seemed to be greater. The distribution of the recreational fishing effort using line jigging, both in time (at sunset) and in space (at the 20–35-m depth range), also supports the "feeding-at-night and spawning-in-the-day" hypothesis.

How environment affects catch rates in the recreational squid jigging fishery

How catch rates are influenced by the environment (e.g. moon phase) is a key topic when coping with ecological traits and fisheries management of exploited stocks by angling. However, these kinds of studies are still very scarce and limited to some freshwater and big game fish species. The objective of this study was to disentangle the effects of the environment factors on the angling of the most important species targeted by the anglers in the Mediterranean Sea, the European squid *Loligo vulgaris*. The results of two-year based study were presented, where a number of experimental angling sessions were carried out to estimate the independence of catch rates and different environmental explanatory variables in the recreational squid jigging fishery. Variables considered in the study were moon phase, water temperature, hour of catch (regarding sunset), angling pressure, as well as variables regarding weather (wave, speed wind intensity and direction, rain intensity or cloud cover). Variance partitioning showed how temporal variables explain large percentages of variability resulting in catch rates patterns at different time scales (i.e. within day (i.e. sunset), season and year). This study provides essential information to optimize the sampling efforts when attempting to asses squid stock. Moreover, this study reveals the keys for the anglers select the most productive periods, through the year and within day, to obtain the best efficient CPUE of this important cephalopod species.

Environmental effects on recreational squid jigging fishery catch rates

The plastic behaviour of the cephalopods allows them a rapid respond to the environmental changes, causing substantial implications on vulnerability to fishing. Several studies address the environmental effects on commercial squid catches without regard to the potential effects caused by recreational fishery. In this sense, experimental fishing sessions that emulated the techniques used by the recreational fishers were conducted. The specific objective was to describe the catch rate variability related to environmental variables and independent to fisher ability. Recreational jigging captures per unit of effort (cpue) were significantly related to environmental variation. The main environmental variable affecting catch rate was sea surface temperature (SST). This effect may be related to the period of optimum inshore temperatures for reproductive success, during which the squid is vulnerable to recreational fishing. The combination of environmental variables that maximized cpue was low SST, mild windspeed, low atmospheric pressure and days close to the new moon. Regarding the specific period of the day, we found the best catches narrowly clustered around sunset. This pattern may be dependent on the coupling between the daily pattern of squid activity and sunlight intensity, because the efficiency of recreational fishing lures depends on visual stimuli.

3.4 Other studies related to cephalopods: ecosystem indicators, sampling procedures for artisanal fisheries, Fisheries assessment and effects of fishing

Effects of chronic exposure to zinc on the immune and digestive systems of juveniles cuttlefish Sepia officinalis

The first month of juvenile cuttlefish *Sepia officinalis* development greatly influences recruitment and the adult size, and this period is spent in coastal waters where pollutants are very important. The digestive gland matures during this early life and is implicated in the detoxification, so the maturation and the digestive role of the digestive gland could be in competition with the detoxification activity when the field is polluted. Also the presence of contaminants can affect the immune system of juvenile cuttlefish during this coastal period. So the adverse effects of contaminants on digestive and immune systems strongly influence survival, digestion, growth, nervous system evolution and the behaviour of juveniles cuttlefish. Such effects can very quickly affect recruitment and stock abundance as this species has a short live cycle.

The objective of the study is to experimentally expose eggs and juvenile cuttlefish *Sepia officinalis* to contaminants such as heavy metals and medicines such as antibiotics or antidepressants used pharmaceutically by humans and which find their way into coastal water.

The effects of the pollutants on digestive gland physiology would be assessed by quantifying shifts between intracellular acidic digestive enzymes and extracellular alkaline digestive enzymes (with acidic and alkaline-phosphatase, acid and alkaline protease, cathepsin and trypsin. The effects of pollutants on immune physiology would be observed by measuring the some immunological enzymes as phenoloxydase and lysosyme-like.

For this first study, zinc was chosen because this heavy metal is widespread in the coastal environment but poorly studied and it is strongly accumulated in cuttlefish digestive gland. To contaminate the animals dissolved and trophic methods will be used. For the trophic method we would fed juveniles cuttlefish with contaminated mysids easily cultured in the laboratory, good food for juvenile growth performance, found in great amounts in estuarine areas.

The first experiment was carried out on juvenile cuttlefish exposed to dissolved zinc in a closed system design without biological filtration in order to prevent unwanted zinc. To maintain adequate water quality, 25% of the water was changed daily and the cuttlefish living area was 90 cm^2 (30–40 cm^2 per cuttlefish recommended by Forsythe *et al*. 1994). A 40 litre tank with 32 individual compartments was used and adequate water movement was ensured by two 550l/h immersed pumps and two airstones. Seawater used is natural and filtered on 3µm cartridge. Individual feeding was used to avoid competition and negative interactions and allowing individual follow-up, once a day with live adequately sized *Crangon crangon*. The juvenile cuttlefish were acclimated in contaminated water during 48 hours after hatching and they started feeding after this period.

The first results indicate high mortality (100%) only for very high concentration of zinc (500µg/l) after 12 rearing, 21% of mortality for 250µg/l after 14 days rearing and no mortality for a concentration of 100µg/l after 37 days rearing of juvenile cuttlefish. The concentration of 100µg/l had a negative effect on growth after 37 days rearing.

The first conclusions are that concentrations above 200µg/l are not suited for long-term exposure because they provoke the increase of mortality, dissolved zinc concentration of the control will be decreased and taken under 10µg/l ; significant differences in growth were recorded after 37days of rearing for a concentration of 100µg/l.

In future studies the concentrations used must be under 10µg/l and not more than100µg/l and the exposure carried up for 50 days, then enzymatic assays could begin. A similar study with trophic contamination will be carried out.

Relationship between first sale price, body size and total catch of trammelnet target species in Majorca (NW Mediterranean)

Most resources landed in the NW Mediterranean by small-scale fisheries are sold directly in local markets. Fish length and overall catch composition of trammel net target species were sampled at the Palma Fishing Wharf in Majorca. This showed that the two variables are essential for assigning a commercial category when selling the fish and have a major influence on the sale price obtained. There was a slight decrease in the sale price when catches were higher but the effect was masked due to the high variability around the average price found each month. This study highlights the importance of considering variables related to the first sale prices of the catch as market indicators in order to better understand small-scale fisheries.

Simulating the indirect handline jigging effects on the European squid *Loligo vulgaris* in captivity

The European squid *Loligo vulgaris* is an important target species of commercial and recreational fisheries in the NW Mediterranean. Handline jigging is one of the most common fishing gears used by both of these fisheries to catch squid, which are trapped when they try to seize the lure with their tentacles. An unknown but possibly significant number of squid is able to escape from this gear by losing one or both of their tentacles. In this study, two sets of experiments were carried out to test the indirect effects of tentacle loss on predation success and predation behaviour. The first set of experiments consisted in estimating the number of attacks and time spent until a squid with no, one or two tentacles successfully caught a prey item. Independent trials were carried out with two prey types with very different swimming capabilities (fish and shrimp). The second set of experiments consisted of prey-selectivity trials to determine whether squid prefer fish or shrimp when both are available. The results obtained clearly demonstrate not only that squid missing tentacles have a reduced predation performance but also that they can change predation preferences and predation behaviour. These changes might negatively affect the condition of injured squid. Therefore, the possibility of squid losing their tentacles deserves more attention in the management decisions of this fishery because it may imply unreported fishing mortality (ghost fishing) and/or reduced fitness.

Fishery assessment of the European squid *Loligo vulgaris* in NW Mediterranean

The research project CONFLICT focuses on disentangling the potential socio-economic, biological and ecological conflicts between professional and recreational fishing in the NW Mediterranean. In this sense, the marine coastal resources have been exploited by artisanal fleet for ages. However, during the last few decades, recreational fishing has become one of the main leisure activities and potential temporal and spatial conflicts between ones have appeared as consequence. Recent trends in fisheries assessment have demonstrated how these activities affected the population structures of targeted fish stocks, and indirect ecosystem effects have appeared at individual and populations levels. The project CONFLICT works simultaneously with scientists, managers and fishers with the final goal to establish the sustainable exploitation rates of the targeted species.

One of the most important conflict species is *Loligo vulgaris*. Therefore the population dynamics and exploitation of the species would be determined by: 1) The characterization of the spatial-temporal distribution of the professional and recreational fishing efforts; 2), the determination of the annual fishing mortality; and 3) the study of the biology and the population dynamics of this species. Methods include visual census to characterise the effort patterns, the evaluation of landing data recorded in Palma Wharf and experimental angling, as well as reproductive indices and age and growth using daily growth increments in the statoliths. Moreover, the movement and behavioural patterns will be investigated combining conventional and acoustic tagging. All of this information will be explicitly included in individual-based population models, which will allow understanding the population dynamics based in the individual life-history behaviour, providing a useful tool for assessment and management.

Other topics

Descriptions of some experiences on growing *Octopus vulgaris* in sea cages were published. In Mediterranean Sea, had good results and proved that octopus on-growing in sea cages is economically viable. Started in November or December and finishing in April or May (1 year cycle), starting with the same weight individuals (0.7 kg) and giving individuals with a final weight of 3.65 kg (Garcia and Garcia, 2011). Another publication of growing Octopus vulgaris in sea cages reveals the following equation to specific growth rate: SGR = (Ln Wf − Ln Wi) × 100/t (% day−1) (Estefanell *et al*., 2012).

The isotopic signature determine in gladii, of jumbo squid (*Dosidicus gigas*), proved to be a powerful tool to depict high resolution and ontogenic variations in individual foraging strategies of squids (Lorrain *et al*., 2011).

3.5 Commentary and recommendations

Further research is needed on:

1) Ecology of cephalopods, in particular to understand effects of environmental variables on cephalopod abundance. In the context of the sustainability of fisheries, especially the artisanal ones, this will help to explain and predict the wide fluctuations in cephalopod abundance, and hence in fishery catches, from year to year.

2) Methodologies for quantifying the role of cephalopods as predators and prey. Ecosystem models such as Ecopath have assumed increased importance in the context of the EAF and the MSFD. Cephalopods are potentially significant components, but their importance tends to be underestimated if emphasis is given to biomass rather than to energy flows (due to their high P/B ratio).

3) The use of some cephalopods as Indicators of Good Environmental Status (GES) under the MSFD. The high sensitivity of cephalopods to environmental change means they can be useful indicators.

4) To explore the use of MPAs as tools for management of some cephalopods species for assuring sustainability of ecosystem and the human activities deployed in them.

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4 ToR c) Produce CPUEs and survey data series of the main cephalopod metiers and species and assess to the possibility of their use as abundance indices. ToR d) Conduct preliminary assessments of the main cephalopod species in the ICES area through examination of the above trends in relative exploitation rates (i.e. catch/survey biomass)

4.1 General comparison of commercial species CPUEs and Indices of biomass from surveys

Data concerning to survey and commercial catches of groundfish resource assessment carried out in various area (ICES divisions IVa and IVb. Subarea VIIb, k; Divisions VII a,e-h. Divisions VIIIc; IXa North and IXa South) have been presented. No data on surveys was made available to the group in Div. VIIIabd (Bay of Biscay). Data available are the values of average yields (kg/hour or kg/0.5 hour) for main commercial species or species groups of cephalopods in surveys and kg of cephalopods by fishing day or hours for the commercial indices used.

No definition of each of the surveys are included in this section as the methodology and characteristics of each of the surveys analysed are completely covered in the reports and in the manual for the International Bottom Trawl Surveys in the western and southern areas (International Bottom Trawl Survey Working Group. IBTSWG.)

In order to test their quality as abundance index, these have been plot with the corresponding fishing yield. Thus, complete survey data series have been plotted jointly with annual data series coming from the commercial fleet. Information is presented by ICES sea areas and country as information was made available shortly before the group restricting the ability of this to carry out more detailed and complete analysis. Also lack of cephalopod or fisheries experts at the group limits the capacity of this to discern about species when these were included into Families in the data available.

The analysis of surveys and CPUEs of this section has to be considered as a first step in the analysis. Specifically, for some areas and metiers the use of survey and commercial catches offers as indices of abundances appears to be promising.

4.2 North Sea and Skagerrak (ICES Division IV and IIIa)

4.2.1 Germany

Commercial CPUEs for the main fleets exploiting cephalopod species were calculated for the last 3 years (2009, 2010 and 2011). Yields (kg/h) were plotted jointly with the Abundance indices of the German North Sea IBTS deployed during the 1st quarter of every year (Q4SWIBTS) and covering ICES Divisions IVa and IVb. Abundance Indices for this survey was calculated as kg per hour. Series of abundances were plotted by grouping Family Loliginidae and areas coincident between commercial CPUEs and Surveys. In this case just ICES IVb area was used for this preliminary analysis. For the commercial CPUEs, fleets with the highest abundance of loliginids were used. In case of Germany these were: Beam trawl (TBB) and Bottom otter trawl (OTB). (Figure 4.2.1.1)

Due to the shortness of the commercial CPUEs and survey abundance series, just three years of data, no analysis of trends could be deployed. However, it is worth to point out that if CPUEs data series could be recovered and if a more detailed work could be done in relation to the seasonality of some of the commercial fleets and restricting it to the metiers with larger percentages of cephalopods in the catches, it is expected that some signal of abundance could be extracted from commercial and survey data series.

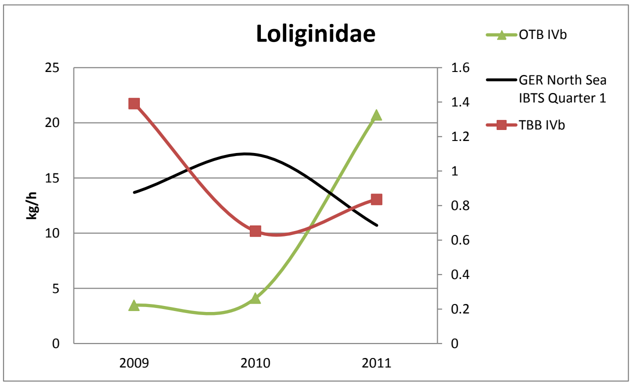


Figure 4.2.1.1. Abundance indices and commercial CPUEs indices for Germany in ICES Div. IVb during 2009, 2010 and 2011 for Loliginidae.

4.3 Porcupine Bank and Celtic Sea (ICES Divisions VIIb, e, f, j, k)

4.3.1 United Kingdom

Commercial CPUEs for the main fleets exploiting cephalopod species were calculated for the last 3 years (2009, 2010 and 2011). Yields (kg/h) were plotted jointly with the Abundance indices of the English Western IBTS Survey (Q4SWIBTS) deployed during the 4th quarter every year since 2005 and covering ICES Divisions VII a, e-h. Abundance Indices for all surveys were calculated as kg per hour. Series of abundances were plotted by grouping Families and areas coincident between commercial CPUEs and Surveys. For the commercial CPUEs, fleets with the highest abundance of cephalopods were used. In case of United Kingdom these were: OTB: Otter trawls, PTB: Bottom Pair trawl and SSC: Fly shooting (Scottish) seine.

Due to the shortness of the commercial CPUEs series, just three years of data, no analysis of trends could be deployed. However, it is worth to point out that if CPUEs data series could be recovered and a more detailed work could be done taking into account the seasonality of some of the commercial fleets. Then, it is expected that some signal of abundance could be extracted from both data series.

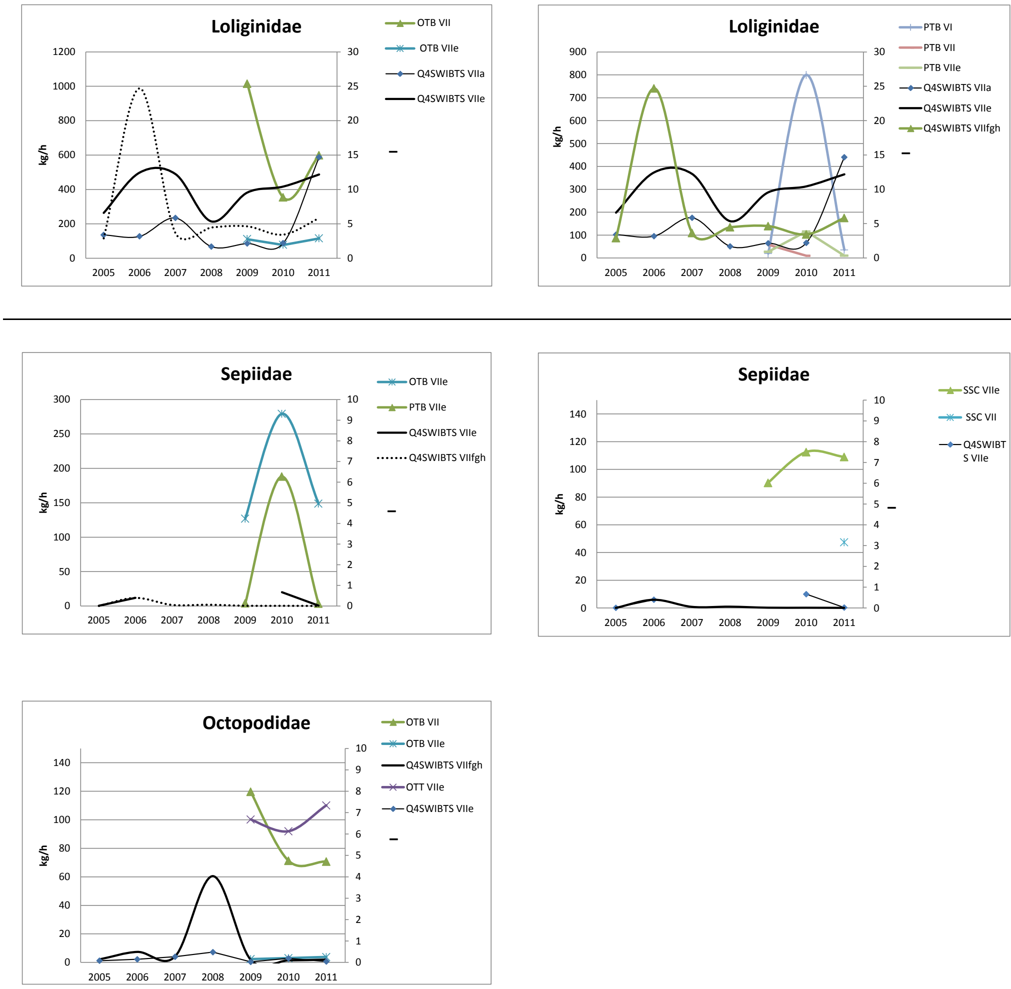


Figure 4.3.1.1. Abundance indices (2005 to 2011) and commercial CPUEs indices for United Kingdom from 2009 to 2011 for main cephalopod species groups.

4.3.2 Ireland

A series of commercial CPUEs for the main fleets exploiting cephalopod species were calculated for the last 3 years (2009, 2010 and 2011). Yields (kg/h) were plotted jointly with the Abundance indices of the Irish Ground Fish (IGFS) deployed during the 4th quarter every year since 2003 and covering ICES Divisions VII b, VIIg and VIIj. Abundance Indices for all surveys were calculated as kg per hour. Series of abundances were plotted by grouping Families (Loliginidae and Ommastrephiidae) and areas, coincident between commercial CPUEs and Surveys. For the commercial CPUEs, fleets with the highest abundance of cephalopods were used. In case of Ireland: OTB: Otter trawls, PTM: Midwater pair trawl and SSC: Fly shooting (Scottish) seine. Areas covered by the commercial fleet were VIIbcjk and VIIfgh (Figure 4.3.2.1).

Due to the shortness of the commercial CPUEs series, just three years of data, no analysis of trends could be deployed. However, it is worth to point out that if CPUEs data series could be recovered and a more detailed work could be carried out taking into account the seasonality of some of the commercial fleets. It is expected that some signal of abundance could be extracted when longer and more depurated data series would be available from commercial fleets and surveys, respectively.

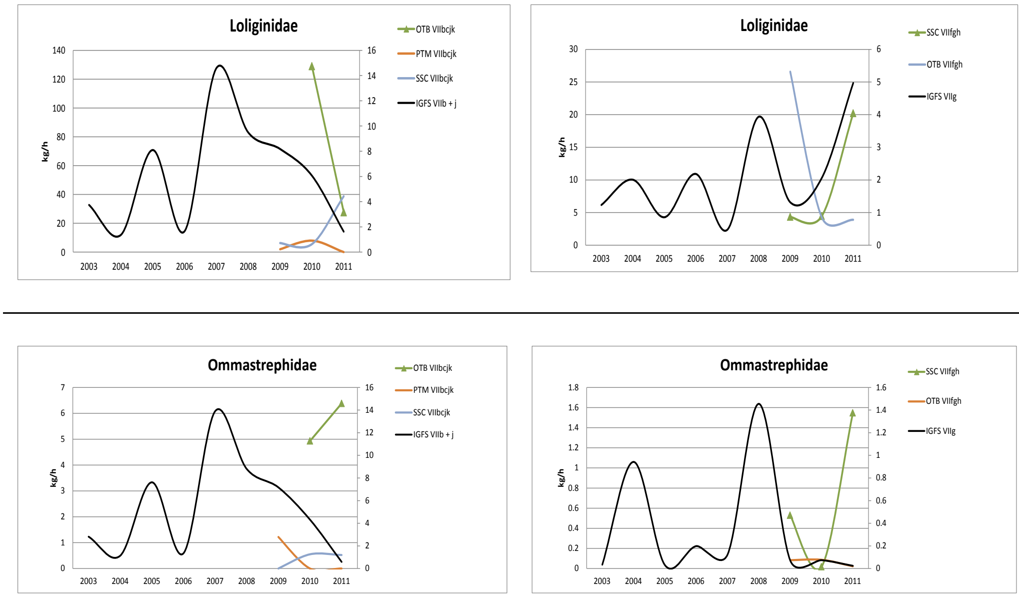


Figure 4.3.2.1. Abundance indices (2003 to 2011) and commercial CPUEs indices for Ireland from 2009 to 2011 for main cephalopod species groups.

4.3.3 Spain

Data concerning to all surveys on groundfish resources assessment carried out in different ICES areas (ICES VII; VIIIc; IXa North and IXa South) by Spain (WD 4.1; 4.2 and 4.3). When looking at the spatial coverage of the surveys, most of the fishing grounds where Spanish fleet operates is actually covered except for Div. VIIIabd which is covered by the French EVHOE Survey and Subarea VI covered by the Scottish Western Coast Surveys (Map 4.1). Abundance indices are calculated as the average yields (kg/hour or kg/30´) for main commercial species of cephalopods.

In order to test its quality, the series of abundance index by survey and species has been plotted with the corresponding fish yield of the main metiers deployed in the same ICES area. For the commercial CPUE indices just data from "Baca" Otter trawlers are used in the analysis as this fleet is the one with the highest catches of cephalopod species.

CPUEs of Otter Trawl in Subarea VII and Porcupine Survey in Subarea VII

The Spanish survey in the Porcupine bank covered ICES Division VIIb,k corresponding to the Porcupine Bank and adjacent area in western Irish waters from longitude 12° W to 15° W and from latitude 51° N to 54° N, covering depths between 180 and 800 m during the third quarter (August/September).

In Figure 4.3.3.1 Commercial catches of Bottom Otter trawlers and Porcupine Survey abundance series are plted together for Ommastrephidae; *Eledone spp*. and *Loligo spp.* based on the resulting figures show no apparent relation in trends between the values obtained during the survey and the CPUE series. Differences could be caused by the actual no overlap of the area covered in the survey (VIIb, k) and the areas related to fishing activity (VII).

From the preliminary analyses conducted during this working group seems to indicate that the abundance indices obtained in the groundfish survey could be indicative of the abundances of some species of cephalopods. Data should be worked out at metier level, also it would be interesting to compare those series with those surveys covering the actual sea area of fishing operation of the Spanish metiers and the Irish or UK surveys. Further work should be devoted to the identification of species and correct possible wrong assignations of some species to Families.

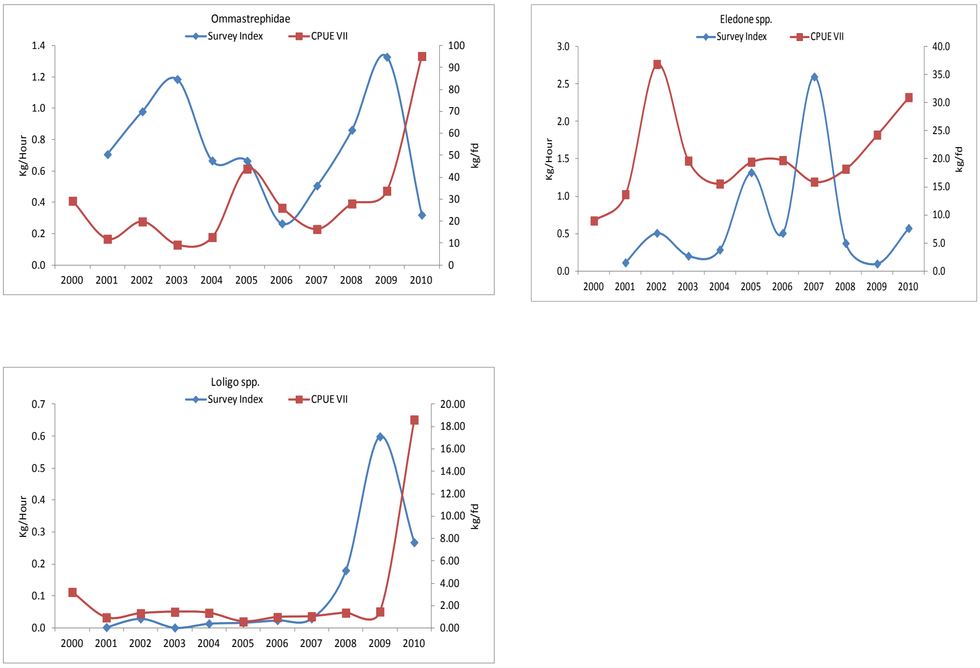


Figure 4.3.3.1. Evolution of abundance index for Spain obtained during the surveys and the CPUE series for main cephalopod species in Subarea VII since 2000.

Another set of data was provided for analysis. Basque fleets operating in Subarea VII and catching cephalopods were also plotted and analysed. Data provided was at Family level and gear level. Thus, Bottom Otter trawl and Pair trawl data are pooled together in one unique trawling gear.

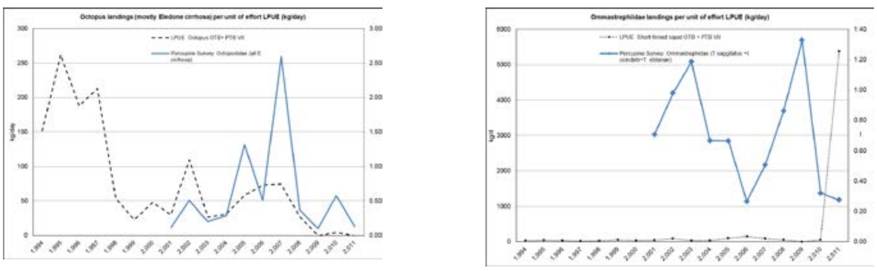


Figure 4.3.3.2. Evolution of abundance index for Basque Spain of trawling CPUE series for Octopus (mainly *Eledone cirrhosa*) and *Ommastrepids* in Subarea VII since 1994.

CPUEs of octopus markedly decreased along the data series. Yields appeared relatively high at the beginning of the series (250 kg/day) decreasing till 2000 and increasing again in 2004 reaching again a peak in 2007 (around 60 kg/day). Since then, a marked drop has been detected with almost nil Octopods caught at the end of the data series. Discards of *Eledone cirrhosa* appear to be higher during 2007, 2008 and 2009 (from 60 to 72%) than during the rest of the years coinciding with the peaks of higher abundance detected by the survey and commercial catch (Table 2.1.2.1). Porcupine Survey appear to follow main trends on CPUES from 2001 till the end of the series despite increases in abundances are identified more marked in this data series than in the commercial ones.

Ommatrephids CPUEs in Subarea VII are really low. The huge increase of last year in the data series, 2011, has to be considered carefully as this year is still under revision and data is considered still provisional. Porcupine Survey data series do not appear to reflect same trends as commercial fleets. One should bear in mind that this species groups are highly discarded in Subarea VII and for Bottom trawlers in a range of 29 to 90% (see Table 2.1.2.1).

From the preliminary analyses conducted during this working group seems to indicate that the abundance indices obtained in the groundfish survey appear to follow main increases and decreases in abundances of octopods. Further analysis are expected to give more information about possible used of CPUEs as abundances indices.

4.4 Bay of Biscay (ICES Divisions VIIIa, b, d)

4.4.1 Spain

No survey data is presented in this section. Data from survey taking place in Div. VIIIabd, FR-EVHOE, was not delivered to the group for discussion. Thus, in this section just, commercial CPUEs are presented.

Commercial fishery in Division VIIIabd (Bay of Biscay) is mostly composed by vessels with base port in the Basque country.

CPUEs were calculated for the different Cephalopod families, aggregated by gear. This is Bottom Otter trawl and Bottom pair trawl CPUEs were pooled together. CPUEs were available as kg/days of fishing. Abundance indices are presented at Family level for Div. VIIIabd.

It has to be pointed out that most of the trawling deployed in Subarea VII is carried out by Bottom Otter trawls. In Div. VIIIabd, the percentage of effort for each of the gears (Bottom Otter trawl and Bottom Pair trawl) changes along the data series (WD 4.4). In the next future would be possible to discern between CPUEs of both gears and also it is expected that a more detailed analysis based on metiers and species could be deployed.

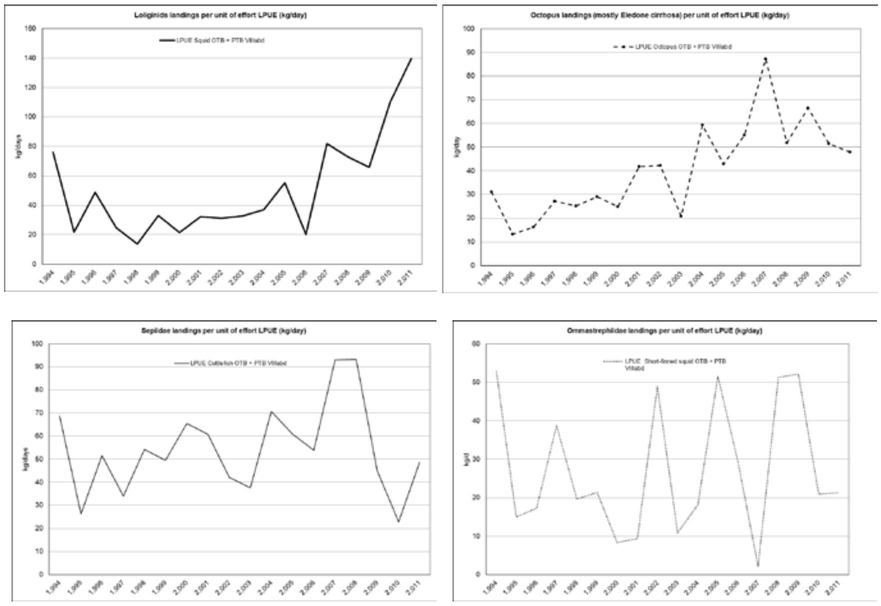


Figure 4.4.1.1. Evolution of abundance index for Basque Spain of trawling CPUE series for Octopus (mainly *Eledone cirrhosa*) and Ommastrepids in Subarea VIIIabd since 1994.

Loliginid CPUEs follow an increasing trend since 1998. Trawlers yield operating in Div. VIIIabd have double since 2006 those yields obtained from 1997 to 2005. For the last year of data series, 2011, yield reached an historical maximum of 140 kg/day of fishing. This value has to be taken with caution as it is still preliminary. However the positive trend of the last 3 years is assured.

Octopod CPUEs also follow an increasing trend since the lowest value in 1995. A maximum is reached in 2005, with around 90 kg octopus by fishing day. From 2005 till 2011 a decreasing trend is observed reaching a value of around 50 kg per day.

Increasing trends are also detectable for Sepiidae CPUEs from the beginning of the series till 2008 reaching an historical maximum of around 90 kg per day. After 2008, a sharp decreased was observed. Yield in 2010 reached the lowest value of the series (close to 24 kg(day)). In 2011, Sepiidae yield markedly increased till around 50kg/day, which is the mean value observed from 1998 to 2006.

Ommastrephids CPUEs are characterised by the low yield along data series when compared with the rest of the cephalopods groups. Also alternative sharp increases and decreases in consequent years are observed. No trends are evident from data.

4.5 Divisions VIIIc (Northern Spanish Ground Fish) and IXa North

4.5.1 Spain

The northern Spanish groundfish survey (SPGFN) covered ICES Division VIIIc and the northern part of IXa corresponding to the Cantabrian Sea and off Galicia waters. The surveys are conducted from 35 to 700 m. depths during the 3rd and the 4th quarter (September/October). The area has been stratified according to depth and geographical criteria and a stratified random sampling scheme has been adopted. In the northern survey (Cantabrian Sea and Galician waters) three depth strata have been used (80–120, 121–200, 201–500 m) and 5 geographic sectors. Supplementary hauls in deeper bottoms (500–700 m) and shallows waters (30–80 m) may be conducted depending of the ship time available at sea.

The number of hauls per strata is proportional to the trawlable surface adjusted with the ship time available at sea. A coverage of 5.4 hauls for every 1000 Km² (120 hauls per survey) is approximately conducted in the northern area. All the technical description of these surveys can be founded in Manual for the International Bottom Trawl surveys in the western and southern areas (International Bottom Trawl Survey Working Group. IBTSWG).

In figure 4.5.1.1 the evolution of abundance index of surveys and CPUE since 2000 for the main species of cephalopods: *Eledone spp.* (*E. moschata* and *E. cirrhosa*); *Loligo spp.* (*L. vulgaris* and *L. forbesi*); Ommastrephidae (*Illex coindetii* and *Todaropsis eblanae*) and *Octopus vulgaris* is presented.

For the group of Ommastrephidae we can observe a big correlation between both series. Probably the abundances index obtained during the survey are representative of real abundance of these species in the area. Similar results have been obtained in the Gulf of Cadiz.

In the case of squids and octopus also shows some similarities in the trends between the both series, although some years have incongruent values. It is interesting to highlight that catches of Octopus by the trawlers in this area do not exceed 10% of the total landing and the sea area covered during the survey is quite different to the range of this species. Therefore, these results should be taken with some caution.

Finally, for *Eledone spp*. there is no apparent relationship between CPUEs and abundance index from survey. Most probably discrepancies are due to unreported statistics rather than to a lack of these species in the catches.

Figure 4.5.1.1. Evolution of abundance index for Spain obtained during the surveys and the CPUE series for main cephalopod species in the region IXa North and VIIIc since 2000.

4.5.2 Portugal

PGFS surveys were carried out on the Portuguese continental coast on board R/V Noruega and occasionally on R/V Capricórnio in autumn. The sampling area covers latitudes 36.7º to 41.8º N and longitudes 7.47º to 10.0º W in the NE Atlantic. The main objective of these research surveys is to estimate indices of abundance and biomass of the most commercially important fish and crustacean species. The autumn cruises done with R/V Noruega employ a Norwegian Campbell Trawl type with bobbins and the cruises done with R/V Capricórnio used an FGAV019 bottom trawling net, with a cod end of 20 mm mesh size, a mean vertical opening of 2.5 m and a mean horizontal opening between wings of 25 m. These cruises follow a depth stratified sampling design, with ca. 70–80 hauls distributed along the Portuguese continental shelf and slope. The tow duration vary between 20 and 60 min.

The CPUEs data series used form analysis come from a variety of fleets including dreging, traps, gillnets, hooks and trawls. Data series were plotted together with the Portuguese Surveys mentioned above.

In figure 4.5.2.1 the evolution of abundance index of surveys and CPUE since 2009 by quarter for the main species of cephalopods: *Sepia officinalis, Loligo vulgaris* and *Octopus vulgaris* are presented.

In case of *Loligo vulgaris,* the survey appear to identify the three large peaks of abundance of the last 3 years of data for trawlers. No trends are obvious for *Octopus vuldaris* in any of the commercial fleets used in the analysis.

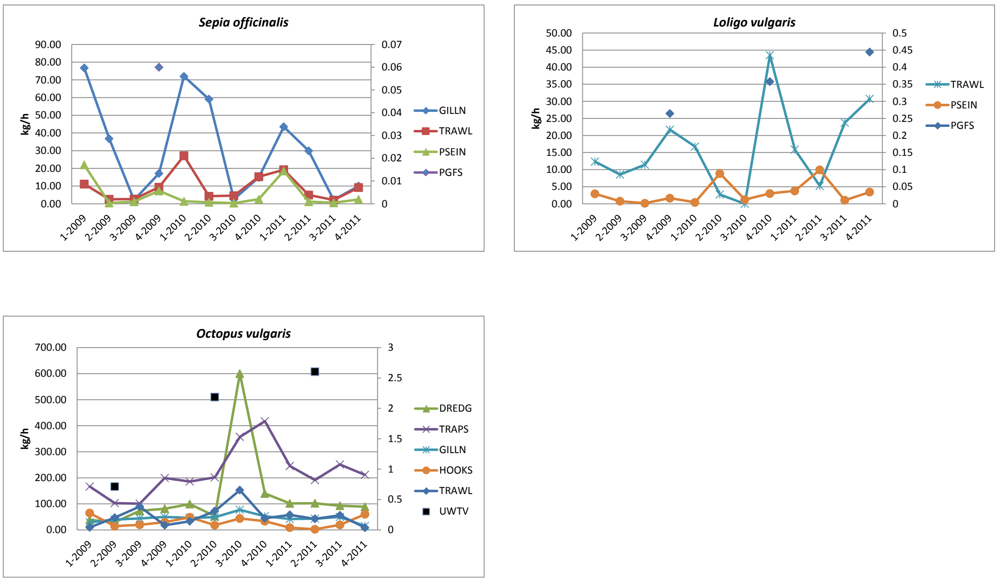


Figure 4.5.2.1. Evolution of abundance index for Portugal obtained during the surveys and the CPUE series for main cephalopod species in the region IXa north and south since 2009 by quarter.

It is expected that in the near future a more detailed analysis of these data could be carried out as group is aware about the availability of the data.

4.6 Divisions IXa South

4.6.1 Spain

The Spanish Ground Fish South (SPGFS) is conducted in the southern part of ICES Division IXa, the Gulf of Cadiz. The covered area extends from 15 m to 800 m depth, during spring (March) and autumn (November) every year. SPGFS aims to collect data on the distribution and relative abundance, and biological information of commercial fish in the Gulf of Cadiz area (ICES Division IXa). The primary species are hake, horse mackerel, wedge sole, sea breams, mackerel and Spanish mackerel. Data and abundance indices are also collected and estimated for other demersal fish species and invertebrates as rose & red shrimps, Nephrops, and cephalopod molluscs. All methodology is in the Manual for the International Bottom Trawl Surveys in the western and southern areas (International Bottom Trawl Survey Working Group. IBTSWG)

For SPGFS, two data series are available: i) First one started in 1993 (spring series of bottom trawl surveys) in the Gulf of Cadiz and ii) the second one (the autumn series), which started in 1997.

In figure 4.6.1.1 the evolution of abundance index of surveys and CPUE since 1993 for the main species of cephalopods: *Allotheutis spp.* (*A. media* and *A. subulata*); *Eledone spp.* (*E. moschata* and *E. cirrhosa*); *Loligo spp*. (*L. vulgaris* and *L. forbesi*); Ommastrephidae (*Illex coindetii* and *Todaropsis eblanae*); *Octopus vulgaris; Sepia officinalis* and *Sepia elegans)* is presented.

We can observe a group of figures where the trends of both sets of data show high similarities. They are the cases of *Allotheutis spp.; Eledone spp.; Loligo spp*.; Ommastrephidae and *Octopus vulgari*. While there is another group of species, where not detected the similarity between both sets of data such as the cases of *Sepia officinalis* and *Sepia elegans.*

When looking to the figures and in a no analytical approach, just based in the behaviour of both data series, the close similarities between trends and shapes would reflect that CPUEs commercial are able to catch up the changes in abundances detected by the surveys series. Thus, it could be concluded that changes in CPUEs appear to be real reflection of changes in the abundances. The idea would be to use these CPUEs as a proxy of abundances.

In the case of two species of cuttlefish, we observe that there are not similar trends between both data series. The 85% of *S. officinalis* commercial catches corresponds to the trawl fleet. However, for the overall trawl fleet, this species represents only 1% of total catch. Thus, the index obtained in the survey may not be representative of the abundances, either by not covering the area of distribution of the species (working from 6 miles of coastline) or because the dates of surveys are not the most appropriate for this species or because *S.officinalis* is a really very small part of the total trawl catches.

In the case of *S. elegans*, the area of the survey covers perfectly the area of distribution of the species. However, there are large discrepancies between both series. The series of CPUEs for this species may not be representative of the abundance due to low volume of capture (about 40 tons per year, around 1%).

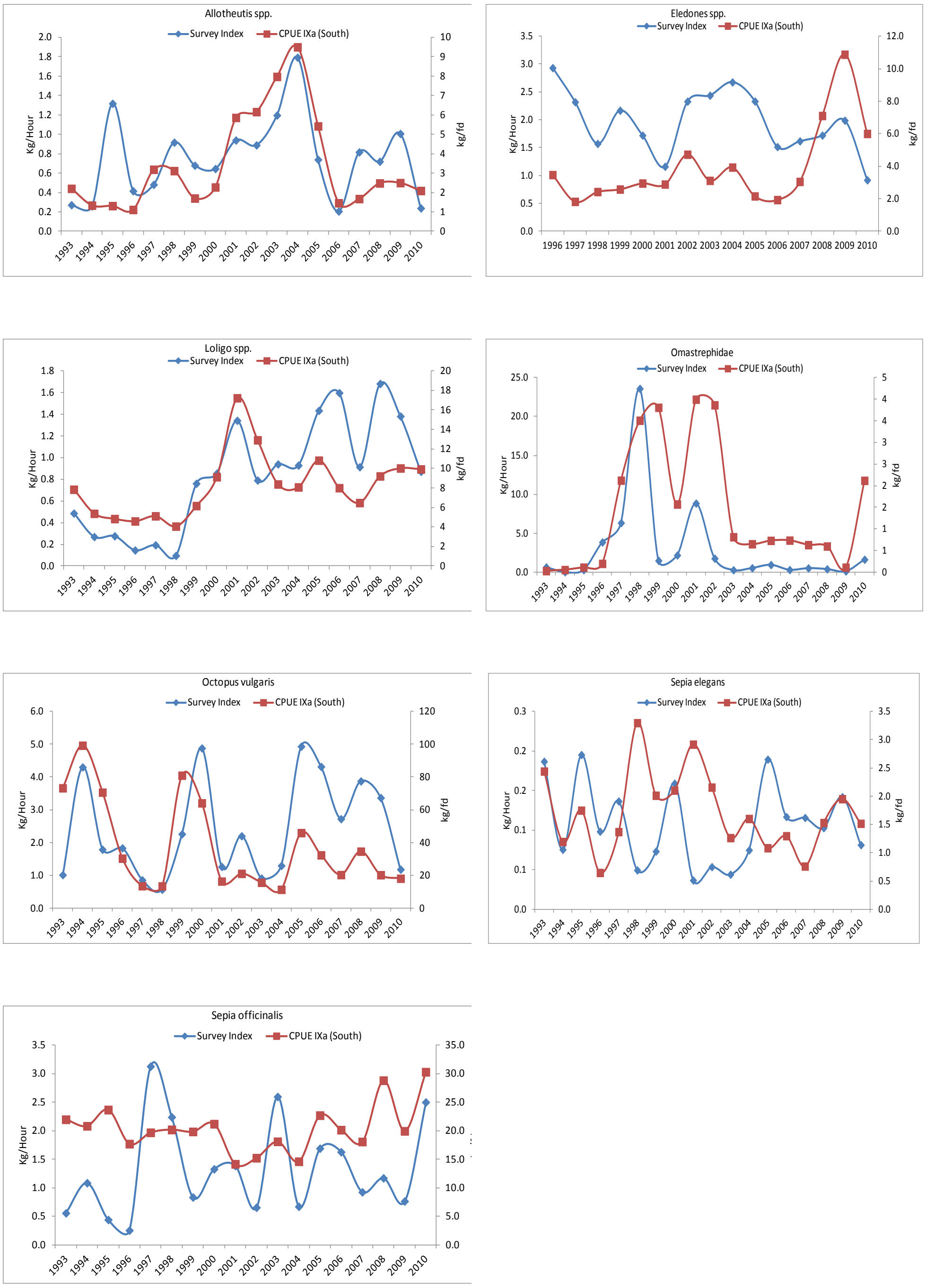


Figure 4.6.1.1. Evolution of abundance index for Spain obtained during the surveys and the CPUE series for main cephalopod species in the region IXa South since 1993.

4.7 Comments on the indices

In general, there are large fluctuations in stock abundance, regardless of existing fishing effort, for most of the species considered. In species with short life cycle, these situations are fairly common. Therefore, for these species, fluctuations of abundances of populations are closely related to the success of recruitment. At the same time, successes of recruitment are largely associated with the environmental oceanographic conditions existing.

The common signal detected for some metiers and surveys in relation to abundance (case of Spanish data) could be a promising indication of the real status of the species. It is expected that the analysis of the data available could be enlarged and so these indications could be actually confirmed.

4.8 Quality on the trends assessment

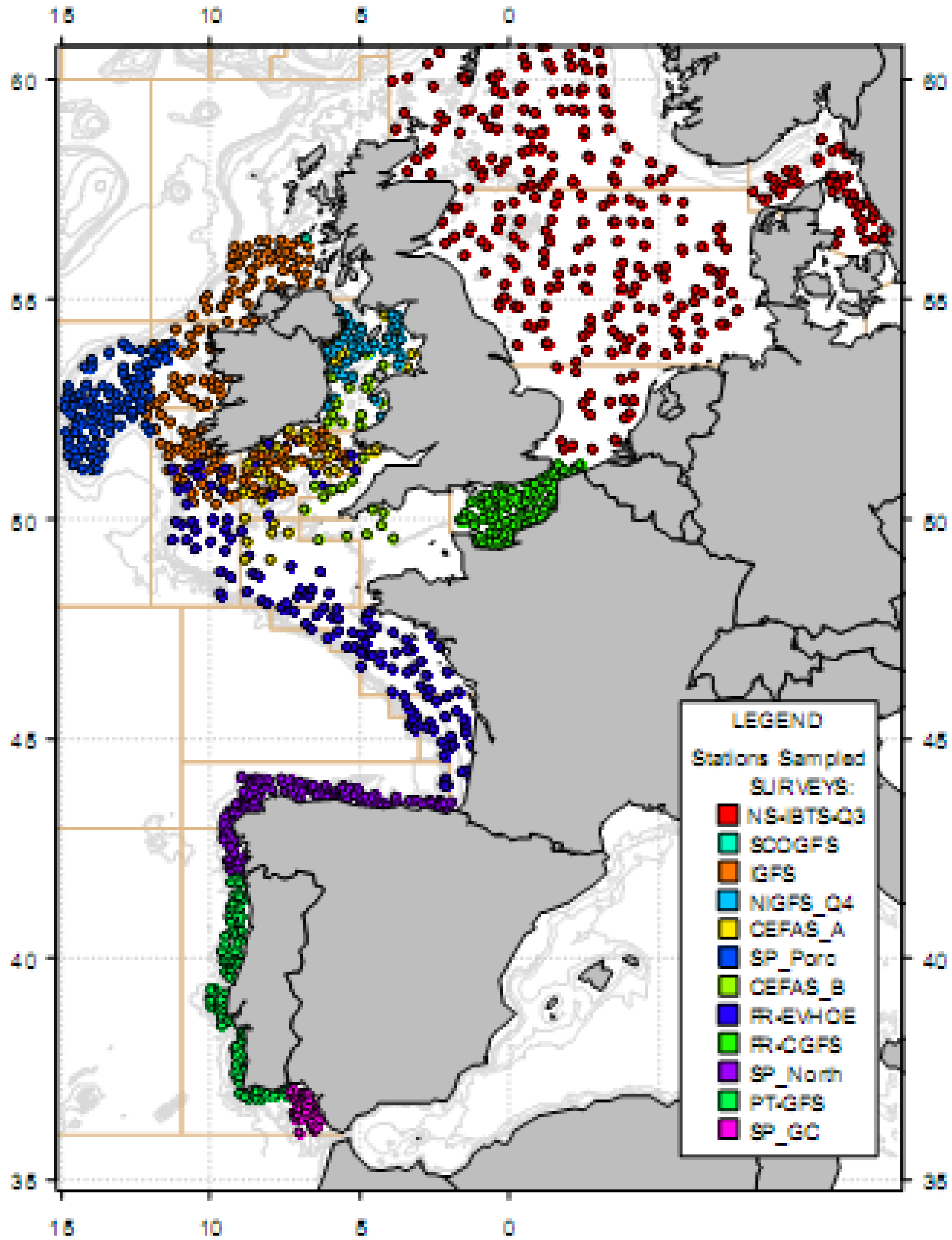
No analyses have been deployed in relation to the possible seasonality of the commercial catches to actually subtract the effect of no catches due to absence of the resource and other factor, such as, fleet behaviour influencing the catch. Moreover, what we present here as Catch per Unit effort should be actually named as Landings per Unit Effort. Thus, a better comparison of trends would be carried out when adding discard information to actual landings to have a more realistic picture of abundance.

Also it has to be taken into account that surveys covered a limited part of the area where commercial fisheries are deployed and also a limited time in the year is sampled.

Information is presented by country as information was made available shortly before the group restricting the ability of this to carry out more detailed and complete analysis (f.i. merging metiers between countries and ICES areas). Also lack of cephalopod or fisheries experts at the group limits the capacity of this to discern about species when these were included into Families in the data available.

Analysis could be improved taking all above concerns into consideration as well as having the input from experts for extracting the best period of time, metiers and species to be included in this analysis.

Thus, the analysis of surveys and CPUEs of this section has to be considered as incomplete and preliminary. Despites caveats, the group is satisfied with the large step taken in relation to the spatial coverage of the data obtained through the Data call launched in February 2012 and the great possibilities open for more detailed analysis of these indices (Map 4.1.). Specifically, for some areas and metiers the use of survey and commercial catches offers as indices of abundances appears to be promising.



Map 4.1. Station positions for the IBTS Surveys carried out in the Northeastern Atlantic and North Sea area in summer/autumn of 2010. Quarters 3 and 4 (Report of the International Bottom Trawl Survey Working Group (IBTSWG), 28 March – 1 April 2011 ICES Headquarters, Copenhagen. ICES CM 2011/SSGESST:06).

5 ToR e) Produce an overview of the fishery activities for fleets catching cephalopods and providing data to ToR c. This section should summarise for the species and "fisheries" where the item is relevant

i) Data available (including information from the fishing industry and NGOs that is pertinent to the knowledge status);

ii) Historical performance of the metier (if trackable) ;

iii) Mixed fisheries overview and considerations (if applicable);

5.1 General comments on the approach followed

In this section an overview of the fisheries activities for fleets catching cephalopods are included. Fleets, fisheries and metiers chosen has been those selected in ToR c & d for providing data on CPUEs to be used as abundance indices. Thus, the definition and historical performance of the metier, in the first instance if available, fishery and fleet, by sea area, and country, is presented for the most important metiers identified in the previous ToRs.

Data available for each of the fleet disaggregation was basically, kilos of cephalopod species or species groups by ICES sea area, caught by individual countries during, at least the last three years (2009, 2010 & 2011) by unit of effort. Most countries used days at sea as unit of effort while others used hours fishing.

In this review only metiers used to calculate CPUEs have been reviewed and do not represent the whole list of metier data submitted to the group. No data was available from the fishing industry and or NGOs. For the definition and historical performance of the metiers, the group has reviewed the last literature dedicated to the subject. In general this is mostly Study Group and Working Groups of ICES in relation to assessment and mix fisheries, as well as STECF Reports and the IBERMIX Report (IDENTIFICATION AND SEGMENTATION OF MIXED-SPECIES FISHERIES OPERATING IN THE ATLANTIC IBERIAN PENINSULA WATERS (IBERMIX project) FINAL REPORT to European Commission Directorate-General for Fisheries and maritime Affairs (Contract Ref.: FISH/2004/03-33)). Also revisions of Reports of WGHMM and WGCS were carried out.

First of all, the group would like to clarify some basic vocabulary, distinguishing between the following three concepts following definitions proposed by the "Study Group for the Development of Fishery-based Forecasts" (SGDFF) in 2003 and 2004. The STECF Subgroup SGRST Mixed fisheries (Ispra, October 2005) carried out an overview of some of the Western area fisheries, and that is reproduced below. This study group meant the base for the first guidelines of the operational definition of fisheries based on individual voyage data, together with the design of workable catch data structure and the selection of appropriate software for mixed-fisheries management. Thus, the expert group proposed the following definitions (ICES 2003):

- Fleet: A physical group of vessels sharing similar characteristics in terms of technical features and/or major activity (e.g. the Dutch beam trawler fleet < 300 hp, regardless of which species or species groups they are targeting).
- Fishery: Group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area (e.g. the Dutch flatfish-directed beam trawl fishery in the North Sea).

- Métier: Homogeneous Subdivision of a fishery by vessel type (e.g. the Dutch flatfish-directed beam trawl fishery by vessels < 300 hp in the North Sea).

A summary of the metiers/fisheries and fleets catching cephalopods operating in ICES areas from north to south is presented. In each of the ICES Regions also information about data on metiers made available to the group by country is available.

5.2 North Sea and Skagerrak (ICES Division IV and IIIa)

5.2.1 Germany

Germany presented a complete least of metiers in which cephalopod catches occurred. Just for the CPUEs analysis, *Loligo spp.*, were considered.

The list of metiers operating in ICES Divisions IIIaN, IVb, IVc are presented in the following Table 5.2.1.1.

Metier	Fleet	Target species	Mesh size	ICES area
GNS_DEF_0__	Set gillnets	Demersales	0_	IVc
GTR_DEF_100-119_0_0	Trammel net	Demersales	100-119	IVc
OTB_CRU_70-99_0_0	Bottom Otter trawl	Crustaceans	70-99	IIIaN IVb IVc
OTB_DEF_<16_0_0		Demersales	<16	IVb
OTB_DEF_>= 120_0_0			>= 120	IIIaN IVb IVc
OTB_DEF_100-119_0_0			100-119	IIIaN IVb
OTB_DEF_70-99_0_0			70-99	IVb
OTB_DEF_90-119_0_0			90-119	IIIaN IVb
OTB_SPF_>= 120_0_0		Small Pelagic Fish	>= 120	IVc
OTB_SPF_70-99_0_0			70-99	IVb
OTT_CRU_70-99_0_0	Multi-rig otter trawl	Crustaceans	70-99	IVb
PTB_DEF_>= 120_0_0	Bottom Pair trawl	Demersal fish	>= 120	IVb
TBB_CRU_16-31_0_0	Beam trawl	Crustaceans	16-31	IVb
TBB_CRU_70-99_0_0			70-99	IVb
TBB_DEF_16-31_0_0		Demersal fish	16-31	IVc
TBB_DEF_70-99_0_0			70-99	IVb IVc

For the CPUE calculations, those metiers with higher abundance of cephalopods were chosen. Thus, Bottom otter trawls (OTB) and Beam trawlers (TBB) targeting Crustaceans, Demersal fish and Small Pelagic fish in Div. IVb were considered. Those fisheries were pooled together regardless target species and mesh size under OTB and TBB.

A brief description of the most representative metiers of the German trawl fishery with is presented below. Description comes from a revision of the STECF Subgroup SGRST Mixed fisheries (Ispra, October 2005) carried out an overview of some of the North Sea that is reproduced below. Catch composition could have changed since then. No comments on cephalopod by-catch are noticeable. Thus, this is considered to be almost negligible.

Beam trawlers (TBB) ≥80 mm

Definition is mostly related to beam trawlers with mesh sizes greater than 80 mm. This fleet segment is mainly targeting flatfish with sole and plaice as the most important species, but is known to also catch also cod and whiting and dab. According to the sampling data (2004), the catch of this category is mainly composed of plaice, whiting, sole and cod. Discard rates in weight are highest for whiting (~90%).Catches of haddock, saithe and Nephrops appear low.

Bottom Otter trawl (≥100mm)

This gear segment covers a wide range of fisheries targeting roundfish and flatfish. The other demersal stocks exploited by this fleet segment are saithe and haddock. Tthe catch composition is found to be more diverse than in the beam (≥80 mm) and is mainly composed of round fish species haddock, saithe, cod and whiting. Plaice, whiting and Nephrops constitute minor components of the catch

Demersal trawl 16–31mm

Catch composition is dominated by Norway pout. The target species of the gear group demersal trawl 16–31mm are Norway pout, blue whiting and sprat, while sandeel fisheries often use mesh <16mm with catch retained on board consisting of no more than 10 % of other species. The information of the catch composition of this gear group is sparse.

Demersal trawl 70–99 mm

The main target species for this fleet segment is Nephrops. The " Nephrops " fishery can operate with only 30% Nephrops on board, up to 20% of cod, and the remaining catch made up of whiting, anglerfish, sole etc. As such it is effectively a mixed N Nephrops /fish fishery, though individual fishing operations can target particular species quite effectively. In addition to the Nephrops vessels the segment also includes vessels fishing with a mesh size of 80 mm or more for plaice and/or roundfish like cod, haddock, whiting and red mullet in the southern part of the North Sea, often using multi-net rigs or seines. Saithe is a minor by-catch. The target species (almost all species except cod, saithe and haddock) must account for at least 70% of the landings.

As described above, the sampling programmes of commercial catches reveal that these small meshed trawl fisheries have the most diverse catch composition with almost equal shares of Nephrops, haddock, whiting and plaice.

5.3 Porcupine Bank and Celtic Sea, Bay of Biscay (ICES Divisions VIIb, e, f, j, k)

5.3.1 United Kingdom

United Kingdom presented a complete least of metiers in which cephalopod catches occurred. Just for the CPUEs analysis, Family *Loliginidae*, *Octopodidae* and *Sepiidae* were considered.

The complete list of metiers operating in ICES Subarea VI, VIIa, VIIe and Divisions VIIbcjk & VIIfgh in which records of *loliginids*, *octopods* and *sepias* were found are presented in the following Table. For any of the metiers mesh size was available.

Table. 5.3.1.1. List of metiers for different sea areas where UK fleet operates in which *loliginid*, octopod and sepia catches have been registered.

Metier	Fleet	Target	Mesh	ICES area	Datos2
FPO_CRU_0_0_0	Traps and Pots	Crustaceans	no info	VI	Loliginidae
				VIIa	Loliginidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Octopodidae Sepiidae
FPO_FIF_0_0_0	Traps and Pots	Finfish	no info	VIIa	Loliginidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Octopodidae
FPO_MOL_0_0_0	Traps and Pots	Mollucs	no info	VI	Loliginidae
				VIIe	Loliginidae Sepiidae
				VIIfgh	Loliginidae Sepiidae
GND_DEF_0_0_0	Driftnet	Demersal fish	no info	VIIe	Loliginidae
GND_SPF_0_0_0	Driftnet	Small Pelagic Fish	no info	VIIe	Loliginidae Sepiidae
GNS_CRU_0_0_0	Set gillnet	Crustaceans	no info	VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae Octopodidae Sepiidae
GNS_DEF_0_0_0	Set gillnet	Demersal fish	no info	VIIbcjk	Loliginidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae Octopodidae Sepiidae
				VIII	Loliginidae
GNS_DWS_0_0_0	Set gillnet	Deep-Water Species	no info	VIIe	Loliginidae Octopodidae Sepiidae
GNS_SPF_0_0_0	Set gillnet	Small Pelagic Fish	no info	VIIe	Loliginidae Octopodidae

					Sepiidae
				VIIfgh	Loliginidae
GTR_DEF_0_0_0	Trammel net	Demersal fish	no info	VIIe	Sepiidae
				VIIfgh	Sepiidae
HMD_MOL_0_0_0	Mechanised/ Suction dredge	Mollucs	no info	VIIa	Loliginidae Octopodidae Sepiidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae Sepiidae
LHP_CEP_0_0_0	Pole lines	Cephalopods	no info	VIIe	Loliginidae Sepiidae
				VIIfgh	Loliginidae
LHP_FIF_0_0_0	Pole lines	Finfish	no info	VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae Sepiidae
LLS_DEF_0_0_0	Set longlines	Demersal fish	no info	VIIa	Loliginidae Octopodidae
				VIIe	Loliginidae Octopodidae Sepiidae
LLS_DWS_0_0_0	Set longlines	Deep-water fish	no info	VIIe	Loliginidae
OTB_CRU_0_0_0	Bottom Otter trawl	Crustaceans	no info	VI	Loliginidae Octopodidae
				VIIa	Loliginidae Octopodidae
				VIIbcjk	Loliginidae Octopodidae
				VIIe	Loliginidae Sepiidae
				VIIfgh	Loliginidae Sepiidae
OTB_DEF_0_0_0		Demersal fish	no info	Vb	Loliginidae
				VI	Loliginidae Octopodidae
				VIIa	Loliginidae Octopodidae Sepiidae
				VIIbcjk	Loliginidae Octopodidae

					Sepiidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae Octopodidae Sepiidae
				VIII	Loliginidae
OTB_DWS_0_0_0		Deep-water species	no info	Vb	Loliginidae
				VI	Loliginidae
				VIIe	Loliginidae Octopodidae Sepiidae
OTB_MOL_0_0_0		Mollucs	no info	VI	Loliginidae
				VIIa	Loliginidae Sepiidae
				VIIbcjk	Loliginidae Octopodidae Sepiidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae Octopodidae Sepiidae
OTB_SPF_0_0_0		Small Pelagic Fish	no info	VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae Sepiidae
OTH_MOL_0_0_0	Others	Mollucs	no info	VIIe	
OTM_DEF_0_0_0	Midwater otter trawl	Demersal fish	no info	VI	Loliginidae
				VIIa	Loliginidae
				VIIe	Loliginidae Sepiidae
OTM_SPF_0_0_0		Small Pelagic fish	no info	VIIe	Loliginidae Sepiidae
OTT_CRU_0_0_0	Multi-rig otter trawl	Crustaceans	no info	VI	Loliginidae Octopodidae
OTT_DEF_0_0_0		Demersal fish	no info	VI	Loliginidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae Octopodidae

					Sepiidae
OTT_MOL_0_0_0		Mollucs	no info	VI	Loliginidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae Sepiidae
PS_SPF_0_0_0	Pair seine	Small Pelegic fish	no info	VIIe	Loliginidae
				VIIfgh	Loliginidae
PTB_CRU_0_0_0	Bottom pair trawl	Crustaceans	no info	VI	Loliginidae
				VIIe	Loliginidae Sepiidae
PTB_DEF_0_0_0		Demersal fish	no info	VI	Loliginidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae
PTM_LPF_0_0_0	Midwater pair trawl	Large Pelagic fish	no info	VIIe	Loliginidae Octopodidae Sepiidae
PTM_SPF_0_0_0		Small Pelagic fish	no info	VIIbcjk	Loliginidae
				VIIe	Loliginidae Octopodidae Sepiidae
SPR_DEF_0_0_0	SPR	Demersal fish	no info	VIIa	Loliginidae
SSC_DEF_0_0_0	Fly shooting (Scottish) seine	Demersal fish	no info	VI	Loliginidae
				VIIa	Loliginidae
				VIIbcjk	Loliginidae Octopodidae Sepiidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae
TBB_CRU_0_0_0	Beam trawl	Crustaceans	no info	VIIa	Loliginidae
TBB_DEF_0_0_0		Demersal	no info	VIIa	Loliginidae Octopodidae Sepiidae
				VIIe	Loliginidae Octopodidae Sepiidae
				VIIfgh	Loliginidae

					Octopodidae Sepiidae

For the purpose of the CPUEs calculation just metiers with the highest abundances of cephalopod species were used. Again metiers were grouped into fleets regardless target species and mesh sizes. Calculation of CPUEs of *Loliginids* were carried out on Pair trawls in Subarea VI, Bottom Otter trawls and Bottom pair trawls operating in Subarea VII and separately Div. VIIe, as it was grouped by the data holders. For *Sepiidae*, fleets considered were Fly shooting (Scottish) seine in Subarea VII, and separately the analysis was also carried out for Division VIIe taking into account Fly shooting (Scottish) seine, Bottom Otter and Pair trawls. *Octopodidae* indices were calculated for Bottom Otter trawl in Sub area VII and Div. VII e and for Multi-rig otter trawl in Div. VIIe.

5.3.2 Ireland

Ireland presented a complete least of metiers in which cephalopod catches occurred. Just for the CPUEs analysis, Family *Loliginidae* and *Ommastrephidae* were considered

The complete list of metiers operating in ICES Subarea VI, VIIa and Divisions VIIbcjk & VIIfgh in which records of loliginids and omastrephids were found are presented in the following Table.

Table 5.3.2.1. List of metiers for different sea areas where Irish fleet operates in which loliginid and ommastrephid catches have been registered.

Metier	Fleet	Target species	Mesh Size	Area	Species
FPO_CRU_0_0_0	Traps and Pots	Crustaceans	no info	VIIa	Loliginidae
				VIIbcjk	Ommastrephidae
FPO_DEF_0_0_0		Demersal Fish	no info	VIIbcjk	Loliginidae Ommamstrephidae
GNS_DEF_10-30	Set gillnets	Demersal Fish	10-30	VIIbcjk	Loliginidae
GNS_DEF_120-219			120-219	VIIbcjk	Loliginidae Ommamstrephidae
MIS__0_0_0	Miscellaneous		no info	VI	Loliginidae
OTB__>=120	Bottom Otter trawl		>=120	VIIbcjk	Ommamstrephidae
OTB__100-119			100-119	VI	Ommamstrephidae
				VIIbcjk	Ommamstrephidae
OTB__70-99			70-99	VIIbcjk	Ommamstrephidae
		No clear target		VIIfgh	Ommamstrephidae
OTB_CEP_100-119		Cephalopods	100-119	VIIfgh	Loliginidae
OTB_CEP_32-69			32-69	VIIbcjk	Loliginidae
OTB_CEP_70-99			70-99	VIIbcjk	Loliginidae
OTB_CRU_100-119		Crustaceans	100-119	VIIbcjk	Loliginidae Ommamstrephidae
				VIIfgh	Loliginidae Ommamstrephidae
OTB_CRU_70-99		Crustaceans	70-99	VIIa	Loliginidae Ommamstrephidae
				VIIbcjk	Loliginidae

					Ommamstrephidae
				VIIfgh	Loliginidae Ommamstrephidae
OTB_DEF_>=120		Demersal Fish	>=120	VI	Loliginidae Ommamstrephidae
				VIIbcjk	Loliginidae Ommamstrephidae
				VIIfgh	Loliginidae
OTB_DEF_100-119		Demersal Fish	100-119	VI	Loliginidae Ommamstrephidae
				VIIa	Loliginidae Ommamstrephidae
				VIIbcjk	Loliginidae Ommamstrephidae
				VIIfgh	Loliginidae Ommamstrephidae
OTB_DEF_16-31		Demersal Fish	16-31	VIIbcjk	Loliginidae
OTB_DEF_32-69			32-69	VIIa	Loliginidae
OTB_DEF_70-99		Demersal Fish	70-99	VI	Loliginidae Ommamstrephidae
				VIIa	Loliginidae Ommamstrephidae
				VIIbcjk	Loliginidae Ommamstrephidae
				VIIfgh	Loliginidae Ommamstrephidae
OTB_MOL_>=120		Mollucs	>=120	VI	Loliginidae
OTB_MOL_100-119			100-119	VI	Loliginidae
OTM_DEF_>=120	Mid water trawl	Demersal Fish	>=120	VIIbcjk	Loliginidae
OTM_DEF_70-99			70-99	VIIa	Ommamstrephidae
				VIIbcjk	Loliginidae
PTB__>=120	Bottom pair trawl		>=120	VI	Ommamstrephidae
PTB__100-119		No clear target	100-119	VIIbcjk	Ommamstrephidae
PTB_DEF_100-119		Demersal Fish	100-119	VIIbcjk	Loliginidae
PTB_DEF_70-99			70-99	VIIbcjk	Loliginidae
PTM_DEF_>=120	Midwater pair trawl	Demersal Fish	>=120	VIIbcjk	Loliginidae
PTM_DEF_16-31			16-31	VIIbcjk	Loliginidae
PTM_DEF_32-69			32-69	VI	Loliginidae
				VIIbcjk	Ommamstrephidae
PTM_DEF_70-99			70-99	VIIbcjk	Loliginidae
PTM_SPF_32-69		Small Pelagic Fish	32-69	VIIbcjk	Loliginidae
SPR			no info	VIIfgh	Loliginidae
SSC__100-119	Fly shooting (Scottish) seine	No clear target	100-119	VIIbcjk	Ommamstrephidae
				VIIfgh	Ommamstrephidae

SSC__70-99			70-99	VIIbcjk	Ommamstrephidae
SSC_DEF_100-119		Demersal Fish	100-119	VIIa	Loliginidae
				VIIbcjk	Loliginidae Ommamstrephidae
				VIIfgh	Loliginidae Ommamstrephidae
SSC_DEF_70-99			70-99	VIIbcjk	Loliginidae
				VIIfgh	Loliginidae
TBB__	Bean trawl	No clear target	no info	VIIfgh	Ommamstrephidae
TBB__70-99			70-99	VIIa	Ommamstrephidae
TBB_DEF_70-99		Demersal Fish	70-99	VIIa	Loliginidae
				VIIbcjk	Loliginidae
				VIIfgh	Loliginidae Ommamstrephidae

For the purpose of CPUE analysis, metiers with the highest abundance of these cephalopod families were chosen. Just, fleet level was taking into consideration and thus, Bottom Otter trawl, Fly Shooting (Scothish) seine, Midwater Otter trawl targeting Cephalopod, Crustacean, Demersal Species and Small Pelagic fish in Division VIIbcjk and VIIfgh were pooled together under OTB (CRU+DEF+SPF), SSC (DEF) and OTM (DEF). Then, CPUEs were plotted regardless assemblage of species target and mesh size used.

5.3.3 Spain

Spain presented CPUEs of Bottom Otter trawlers in which cephalopod catches occurred. Just for the CPUEs analysis, Family *Ommastrephidae* was considered as well as *Loligo spp.* and *Eledone spp*. Subarea VII was considered as a whole. Also, no presentation of possible different metiers operating in this area was presented but just trawling fleet regardless target species and mesh size.

Definition of general fleets and fisheries being deployed in Subarea VII by countries other than Spain, are presented below. Description comes from a revision of the STECF Subgroup SGRST Mixed fisheries (Ispra, October 2005) of some of the Western waters fleets and fisheries that is reproduced below. Also, information compiled in the AFRAME final report (2009) is included as it presented more updated information. For a detailed description of fleet, fisheries and metiers of Spain in Subarea VII and Division VIIIabd, the final report of the WGHMM2008 is presented.

The main demersal species exploited in the Southern Shelf area are hake, sole, cod, plaice, megrim, anglerfish, Nephrops, cod, whiting and haddock. The most important métiers for trawl fleet are multi-rig otter trawl targeting demersal fish, single otter trawl targeting demersal fish and multi-rig otter trawl targeting crustaceans and demersal fish. These are caught by a large variety of gears either as target species or as by-catch. Most of the demersal fisheries in this area have a mixed catch. However, it is currently possible to associate specific target species with particular fleets and sea areas. Thus, various quantities of hake, anglerfish, megrim and Nephrops are taken together, depending on gear type and area where these operate.

Bottom Otter trawl fishery directed at demersal fish (hake, monkfish and megrim) in the Celtic Sea.

Since the 1930s, hake has been the main demersal species supporting trawl fleets on the Atlantic coasts of France and Spain. A trawl fishery for anglerfish by Spanish and French vessels developed in the Celtic Sea. For this anglerfishery, by-catch species included hake, megrim and demersal elasmobranches (*Leucoraja fullonica, L. circularis,* and *Dipturus spp.).*

Bottom Otter trawl fishery directed at demersal fish (cod, whiting, haddock) in the Celtic Sea

Fisheries for demersal gadoids target mainly cod, whiting, haddock, and take by-catches of flatfish, rays and skates. These fisheries are mainly operated by French otter trawlers. The other countries contributing to that fishery are UK, Ireland, Spain, and Belgium. Cod is mainly landed by French gadoid trawlers. Landings are made throughout the year, but mainly in the winter months during November to April. French trawlers contribute to about 60% of the whiting landings. Ireland takes about a third of the landings and the UK and Belgium each take under 10% of the landings. French trawlers contribute to about 50–60% of the haddock landings. Ireland has usually taken about 25–40% of the landings. Fleets from Belgium, Norway, the Netherlands, Spain, and the UK take the remainder of the haddock landings.

Beam trawl fishery directed at demersal fish (flatfish)

The targeting of sole and plaice in the Celtic Sea using beam trawls became prevalent during the mid-1970s. More recently, cuttlefish have become an important component of beam trawl landings, particularly during the winter months. The gradual replacement of otter trawls by beam trawls has occurred in the Belgian and UK fleets.

In the Western Channel, UK vessels have in recent years accounted for around 70% of the total international landings, with France taking approximately a quarter and Belgian vessels the remainder. Sole is the target species of an offshore beam-trawl fleet, and also catches plaice and anglerfish. In recent years a winter beam trawl fishery targeting cuttlefish has developed in the Western Channel.

The beam-trawl fishery in VIIf,g involves vessels from Belgium, taking approx. 3/4, the UK taking approx. 1/4, and France and Ireland taking minimal amounts of the total landings.

In general, for fisheries described above no indication of the importance of cephalopods in the catches is included and thus, these percentage and importance in the fisheries are assumed to be relatively low. There is one exception, for trawl, specifically beam trawl fisheries deployed in the Channel and targeting *Sepia officinalis*.

Spain fleets fisheries and metiers deployed in Subarea VII

In 2008, WGHMM reviewed the list of fisheries proposed by Castro J. (2008) on the segmentation of the Spanish fleets. From this review, the following 2 fisheries were identified in Subarea VII:

5) Bottom Otter trawl targeting megrim deployed by vessels from South Galician ports (Marín and Vigo) specialising in flat fish such as megrim (*Lepidorhombus spp*.), rays (*Rajidae*) and witch flounder (*Glyptocephalus cynoglossus*), with 52% of the total effort.

6) Bottom Otter trawl targeting Hake deployed by vessels from Northern Galician ports (A Coruña and Celeiro) specialising in hake (*Merluccius merluccius*), anglerfish (*Lophius spp*.) and Norway lobster (*Nephrops novergicus*) with 25% of the total effort.

The geographical distribution shows that Bottom Otter trawl targeting megrim and Bottom Otter trawl targeting Hake occurred together in Divisions VIIj (Grande Sole Bank) and VIIc (Northern area of Porcupine Bank). Some indication of the importance of cephalopods in the catches is presented. In case of Bottom Otter trawl targeting megrim the most abundant species groups are ommastrephids with a percentage in the cathes ranging from 2 to 9% followed by squid with 1 to 9% of the catches and then Octopus with very low frequency in catches. In case of Bottom Otter trawl targeting Hake , octopodidae appear to be the most abundant species group followed by ommastrephidae and loliginidae, in any case percentages are almost negligible (1–9%).

5.4 Bay of Biscay (ICES Divisions VIIIa, b, d)

Most of the demersal trawl fisheries in this area have a mixed catch. However, it is currently possible to associate specific target species with particular fleets. Thus, various quantities of anglerfish, hake, sole, Nephrops and other target species are taken together, depending on gear type and area where these operate.

Other demersal and pelagic species are also caught by trawling gears in this area. Many of them are not under the TACs and Quotas system. However, some of these "other species" may represent for some fleets the bulk of their catches .Some fleets have also a large part of valuable non-TAC species in their catch (squids, cuttlefish, red mullet, etc.). This is particularly the case for purely mixed fisheries deployed in the Bay of Biscay.

Bottom Otter trawl targeting a mixed assemblage of species

Detailed analysis of the Basque trawling fleet resulted in seven Basque trawl métiers proposed (Iriondo *et al.* 2008). From which, one of them, Bottom Otter trawl in VIII targeting mixed cephalopods had a relatively high percentage of cephalopods (specially loliginids) in the catch (around 20%) and had a clear seasonal pattern (4th quarter of the year).

Bottom Otter trawl fishery directed at demersal fish (monkfish)

Hake has been the main demersal species supporting trawl fleets on the Atlantic coasts of France and Spain. However, in most recent years a trawl fishery by Spanish (mainly from Basque Country), and French vessels was developed in the Bay of Biscay with major landings of anglerfish and 23% of the total effort. This fishery used single and twin rig otter trawls in medium and deep water in Div. VIIIabd. It takes place all the year around and presented significant by-catches of cephalopods.

5.5 ICES Div. VIIIc and IXa north: Cantabrian Sea

5.5.1 Metiers of the Northern Spain coastal fleets (VIIIc)

5.5.1.1 Metiers of the Northern Spain coastal fleets using mobile gears (VIIIc)

Descriptions of metiers related to ICES Div. VIIIc and IXa foR Spain and Portugal are all reviewed and extracted from Final Report of the IBERMIX (2006).

The trip catch profiles of the Northern Spanish coastal bottom otter trawl (OTB) fleet obtained in the period 2003 to 2005 resulted in the definition of 3 different metiers. Otter trawl targeting horse mackerel (OTB-MAC); otter trawl targeting horse mackerel (OTB-HOM) and finally a group of trips were compiled under otter trawl purely mix targeting a mixed (OTB-mixed) of demersal species as hake (*Merluccius merluc-*

cius), megrim (*Lepidorhombus spp*.), monk (*Lophius spp*.), blue whiting (*Micromesistius poutassou*) and nephrops (*Nephrops novergicus*).

When checking the percentage of the cephalopod species in these metiers in relation to the total catch and for the years available, percentages are rather low for those metiers targeting mackerel and horse mackerel (Table 5.5.1.1.1.). The highest percentages correspond to the mix metier. *Eledone cirrhosa* contributes to around 4% to the catch and *Illex spp*. ranges from 3.6 to almost 5 % of the catch.

Table 5.5.1.1.1. Percentage of cephalopod species in the most representative Spanish mobile metiers in Div. VIIIc

	OTB-mixed			OTB-HOM			OTB-MAC		
	2003	2004	2005	2003	2004	2005	2003	2004	2005
Eledone cirrhosa	4.6	3.7	4.1	0.2	0.1	0.2	0.5	0.5	0.2
Illex spp.	3.6	4.8	2.9	0.2	0.2	0.2	0.2	0.3	0.1

5.5.1.2 Métiers of the Northern Spanish coastal fleets using fixed gears (VIIIc)

The Northern Spanish fleets using fixed gears are compounded by gillnet, trammel, long line, hand and pole line, and traps. The hand line fleet operating in the Northern Spanish coastal waters is a monospecific fishery targeting horse mackerel (Punzón *et al.*, 2004). The Northern Spanish coastal fleet using traps is mainly compounded by vessel smaller than 10m. The component of cephalopods in the set long line is really small and thus, taking into account the mixed nature of the fleets just a review of set gillnet (GNS) and trammel net (GTR) fleets are considered here.

Métiers of the Northern Spanish coastal set gillnet fleet

For the gillnet fleet, trips could be divided into trips targeting benthonic species (as crustaceans, cuttlefish, and benthonic sharks), and trips targeting a combination of demersal and pelagic species as mackerel and horse mackerel. However, only two of these grouping appeared with enough significance along the years to be considered as metiers Trips targeting monkfish (*Lophius spp*.). Trips targeting hake (*Merluccius merluccius*). A third grouping: gillnets targeting mixed assemblage of species which was not consistent along the years and it is the one that highest component of cephalopod presents.

Métiers of the Northern Spanish coastal trammel net fleet

For the trammel net, no consistent segmentation of metiers was defined. Provisional metiers could be trammel nets targeting crustaceans, trammel nets targeting monkfish (*Lophius spp*.) and a third metier defined as trammel net targeting a mix assemblage of species. The highest components of cephalopods are expected to be there.

5.5.2 Metiers of the Spain coastal fleets (IXa south: Gulf of Cadiz)

The Gulf of Cadiz waters are characterized by its high biological richness, which determines the marked multi-specific nature of its fisheries and the employment of diverse types of fishing gears. The most important oceanographic feature is characterized by the existence of a surface Atlantic current that flows towards the Mediterranean and a deep Mediterranean counter-current that outflows into the Atlantic (Folkard *et al.*, 1997).

Among species of commercial importance, 58% in weight correspond to fishes, 24% to molluscs and 18% to crustaceans. The most relevant fish species are hake (*Merluccius merluccius*), blue whiting (*M. poutassou*), anchovy (*Engraulis encrasicolus*), wedge sole (*Dicologoglosa cuneata*), blackspot seabream (*Pagellus bogaraveo*) and a number of other sparid species. Within molluscs, the most important species is undoubtedly octopus (*Octopus vulgaris*), together with the common cuttlefish (*Sepia officinalis*) and a bivalve which is very important from the socio-economic point of view, the striped venus clam (*Chamalea gallina*). Lastly, among the crustacean group of species, the most significant species is deepwater rose shrimp (*Parapenaeus longirostri*) and at a lesser level, Norway lobster (*Nephrops norvegicus*).

5.5.2.1 Metiers of the Spain coastal fleets using mobile gears (IXa south: Gulf of Cadiz)

The Gulf of Cádiz fleet using mobile gears is mainly composed of trawlers, purse seiners, drifting long liners and dredgers.

Trawlers are the fleet catching the highest amount of cephalopods. Thus, the trawl fishery observes a high degree of multi-specificity, among which most important are hake, octopus, shrimp, cuttlefish and blue whiting. In contrast, the purse seine fishery is mainly targeting anchovy, sardine and mackerel.

Gulf of Cádiz otter bottom trawl fleet (OTB)

The trawl fleet is mainly composed of around 200 vessels. Their average characteristics are about 17.9 m length, 31 HP and 212 GRT. The traditional trawl gear used is the "baca" gear with some modifications (Anom., 2001).

The south-Atlantic trawl fleet shows great spatial amplitude, from the geographic, as well as the bathymetric perspective (Sobrino, 1998). No clearly defined metiers are found in the trawling fleet for the Spanish fleet in the Gulf of Cadiz. It appears that one important part of the trip are dedicated to target rose shrimp, however, the mix component of this fleet is very high. Therefore, only highly multi-specific OTB metier was defined in the Gulf of Cádiz (IBERMIX Report) where the cephalopods species are caught with the rest of target species. The percentages of cephalopods contributing to the total bottom trawl catch in the last years are the following:

Table 5.5.2.1.1. Percentage of cephalopod catches in the mobile metiers defined in Div. IXa south : Gulf of Cadiz.

	OTB targeting mix species					
	2005	2006	2007	2008	2009	2010
Loligo spp.	4.8	3.8	2.3	3.0	3.0	2.8
Octopus vulgaris	20.3	15.1	7.3	11.0	5.9	5.0
Ommastrephiidae	0.3	0.3	0.2	0.2	0.0	0.6
Sepia officinalis	11.3	11.5	8.2	12.2	8.7	10.7

5.5.2.2 Métiers of the Spanish coastal fleets using fixed gears (IXa south: Gulf of Cadiz)

The Gulf of Cadiz fleet that operates with fixed fishing gears is categorized under the artisanal métiers. It includes trammel and gillnets, as well as hook and trap fishing.

The artisanal fleet comprises small fishing vessels. At present, around 600 vessels form part of the fleet census for this type of fishing activity operating with minor types of fishing gears. It approximately represents, in number, 72% of the total demersal fleet of the south-Atlantic region of the Gulf of Cadiz. However, these vessels represent a low contribution to the total GTR (36%) and HP (38%) of the demersal fleet.

From the landings viewpoint, longlines are most important with 400 t on average, although it is worth mentioning that a significant increase of traps since 2003, due to the great increase of octopus landings by the artisanal and trawl fleet. Concerning species composition, net gears show higher diversity than traps and set longlines.

Gulf of Cádiz set gillnet fleet (GNS)

In relation to gillnet fleet 6 different metiers were identified. The only metier with an important component in cephalopod was defined as GNS-SOL/CTC: in which all trips targeting soles (*Solea spp*.) and cuttlefish (*Sepia officinalis*) are pooled. This metier presents large landings of sole and cuttlefish mostly due to both species sharing habitats and reproductive seasonality (Arias and Drake, 1990; Andrade *et al.*, 2001; Ramos *et al.*, 2000). For the rest of the metiers, four more here not included, cephalopods consisted on a very small proportion in the catches.

Table 5.5.2.1.2. Percentage of *Octopus vulgaris* and *Sepia officinalis* catches in the fixed metiers defined in Div. IXa south : Gulf of Cadiz.

	2003						2004						2005					
	1	GNS-SOL/CTC	3	4	5	6	1	2	3	4	GNS-SOL/CTC	6	1	2	GNS-SOL/CTCS	4	5	6
Octpopus vulgaris		0.6	0.9			97.8	3.2	0.1			1.0	0.2	2.0	0.1	1.9	94.7	0.1	0.5
Sepia officinalis	0.5	32.9	2.4	0.2	3.8		1.8	0.4	0.3	3.1	50.1	2.7	3.4	0.3	41.9	0.8	3.4	0.4

Gulf of Cádiz trammels net fleet (GTR)

Cuttlefish are caught in the trammel nets. These, are categorised under two types: i) "claros" (clear) form part of those whose central part of the net has a greater mesh size targeting cuttlefish (*Sepia officinalis*) and sole (*Solea sp.*) and ii) "ciegos" (blind) that have a smaller mesh size and target caramote prawn (*Melicertus kerathurus*), wedge sole (*Dicologoglossa cuneata*) and red mullet (*Mullus surmuletus*). In the Fishing Reserve where the trammel net fishing is most important, the mesh size is set to 20–25 mm for caramote prawn and wedge sole and 45–50 m for cuttlefish (Sobrino *et al.*, 2005a). In all cases, the size of nets cannot exceed a length of 4500 m length and a height of 4 m.

Percentage of Sepia officinalis varied from 2003 to 2005 from 1% in metiers no targeting *Sepia spp*. to 32% for those in which *Sepia officinalis* was the target.

Gulf of Cádiz trap fleet (FPO)

Traps are widely used in the region, especially in the form of clay pots or in the form of creel traps. The clay pot fishery only catch octopus. Longlines are set with clay pots separated by 10 m. These may be set in two manners: either forming lines of 50–70 pots forming a labyrinth, or set in parallel lines parallel to the coast in which each line may contain from 100–250 pots. Each pot assemblage has two buoys marking the beginning and end of each line.

The fishery based on creel traps may be categorized in two types: those directed to fish species as well as molluscs (1 m in height and a diameter of 0,6 m) and those targeting exclusively on octopus, smaller in size. Both gears are set by way of longline in the region at depth not over 70–80 m, similarly to the clay pot fishery. The regulation of both types of trap fisheries is contemplated RD 1428/1997. The maximum number of clay pots per vessel is set to 1000, while for traps it is set to 250. Also clay post and creel traps cannot be set more than 6 miles of coast in order to avoid some conflict with the trawler fleet.

FPO-OCT trip type employs clay pots and traps works throughout the year, nevertheless its major activity occurs from spring to autumn, coincident with the reproductive peak of the target species (Silva *et al.*, 2002b). Catch composition is 99 % octopus. Increases and declines of octopus abundance may be of cyclic nature because such fluctuations were observed in the past during the nineties, possibly due to environmental factors that were beneficial to the life cycle of the species (Sobrino *et al.*, 2002).

5.5.3 Metiers of Portugal (IXa)

Portuguese continental coast is included in Atlantic Iberian Peninsula extending from latitude 41°20' N to 36°30' N, 07º 30′W. At north it makes boundary with Spanish Galician coast and at south with the Spanish coast of the Gulf of Cádiz. Portugal mainland coast has 942 km and it is included in ICES Division IXa.

Fishing in the Portuguese continental waters is carried out by three fleets: trawl, purse seine and polyvalent.

5.5.3.1 Metiers of Portugal using mobile gears (IXa)

The trawl fleet comprises two components, e.g., trawl fleet fishing for fish and trawl fleet fishing for crustaceans. The trawl fleet fishing for fish operates off the entire coast while the trawl fleet directed to crustaceans operates mainly in the Southwest and South, in deep waters, where crustaceans are more abundant. The fish trawlers are licensed to use a mesh size >= 65 mm and the crustacean trawlers are licensed for two different mesh sizes, 55 mm for catching shrimps and >= 70 mm for Norway lobster.

Three metiers can be identified:

Bottom Otter trawls directed to cephalopods (OTB-CEPH): trips targeting cephalopods (octopus and squids).

Bottom Otter trawls directed to Horse mackerel (OTB-HOM): trips targeting horse mackerel (*Trachurus trachurus*).

Bottom Otter trawls directed to mixed fishes (OTB-mixed): trips targeting a mixture of species as horse mackerel, hake (*Merluccius merluccius*), pouting (*Trisopterus luscus*) and axillary seabream (*Pagellus acarne*) among others.

The Bottom Otter trawls directed to mixed fishes is the most important group, constituting 44% to 51% of all fish trips. Horse mackerel is a constant presence in all groups.

The metier Bottom Otter trawl targeting Horse mackerel (OTB-HOM) shows a clear seasonal pattern with a higher number of trips in the first half of the year, whereas metier directed to cephalopods is more important in the second half. Octopus catches comprises from 15 to 50% and *Loligo spp*. from 10 to 50%, alternating large catches of octopus with reduced catches of squids and *viceversa*. Metier considered as mixed (OTB-MIX) is evenly distributed along the year

Crustacean trawl landings are mostly composed by blue whiting (*Micromesistius poutassou*) and Norway lobster (*Nephrops norvegicus*), while the landings from the fish trawl were dominated by horse mackerel (*Trachurus trachurus*) and blue whiting. Hake (*Merluccius merluccius*) was relatively more important in the crustacean trawl landings than in the fish trawl. In this fleet, no metiers are identified as having important catches of cephalopods.

5.5.3.2 Metiers of Portugal using fixed gears (IXa)

The Portuguese fleet using fixed gears is designated by polyvalent fleet. It operates along the total Portuguese coast (ICES Division IXa) and catches a great diversity of benthonic, demersal and pelagic species (fish, shellfish, cephalopods and crustacean). The polyvalent fleet includes two segments, both using fixed gears: (i) boats smaller than 12 m , also called small scale or artisanal, and (ii) boats larger or equal than 12 m designated as multi-gear. The landings in weight from the multi-gear represented around 40% of the total landings from both segments.

In general, vessels of the Portuguese multi-gear fleet operate with a range of different gears, including gill and trammel nets, hooks, longlines, traps and pots. Vessels may change fishing gears seasonally which may be related, in some areas, to seasonal changes in abundance of certain species or groups of species. Many vessels use simultaneously two or more gears in the same area or in different areas, making more complex the analysis of fishing trip types and the definition of fleet segments.

The multi-gear landings in 2005 were mostly composed by black scabardfish (*Aphanopus carbo*), common octopus (*Octopus vulgaris*), pouting (*Trisopterus luscus*) and hake (*Merluccius merluccius*). Cephalopods are caught mainly in traps and pots in around 75% while for nets catches summed up around 15%. The percentage of octopus catches in traps and pots is around 80% while *Sepia spp.* is caught in around 55% in this fleet. The rest of the catches of Octopus and Sepias are recorded in nets.

5.6 Comments on the revision of the actual metiers catching cephalopods

Revisions carried out related to metiers catching cephalopods from North Sea (ICES-Div. IV) to Gulf of Cadiz (ICES Div. IXa south) are of great use to:

- Chose the adequate metier for CPUEs in order to obtain data series as abundance indices;
- Understand possible features that could occur in the fleets and may affect to the catchability of cephalopod species;
- Check the evolution of the contributions of cephalopods to the catch of the metiers and assess importance in the economics of the fleets.

The metier review could be highly improved by the incorporation of experts in each of the countries or mixed fisheries in the ICES area of interest. The group feels that although an exhaustive revision of mixed fisheries documentation has been carried out, maybe the definitions of the metiers here presented are not the more actual ones or actually these definitions are used neither for sampling, assessing nor managing. Thus, it is necessary that the most recent metiers definition will be incorporated to this review. Also, the level of disaggregation for cephalopod species in relation to metier, fisheries and fleets and in relation to species and or species group should be revised and improved in the future.

5.7 References

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6 ToR f) List and summarise major national and European regulations and Directives and comment on the potential impacts on cephalopod stocks

Revision of this ToR has been focused on the European Marine Strategy Framework Directive (MSFD) and the new Common Fisheries Policy (CFP) as the major currently relevant European policies and Directives, and on how this expert group can contribute to their implementation.

The Marine Strategy Framework Directive (MSFD) (http://ec.europa.eu/environment/water/marine/ges.htm)

The Marine Strategy Framework Directive (MSFD), adopted in July 2008, aims at achieving or maintaining a good environmental status (GES) by 2020 at the latest. It is the first legislative instrument in relation to marine biodiversity policy in the European Union, as it contains the explicit regulatory objective that "biodiversity is maintained by 2020", as the cornerstone for achieving good environmental status. It preserves in a legislative framework the ecosystem approach to the management of human activities having an impact on the marine environment, integrating the concepts of environmental protection and sustainable use. In order to achieve the objective the Member States have to develop Marine Strategies which serve as Action Plans and which apply an ecosystem-based approach to the management of human activities. An important point is the regional cooperation required at each stage.

The Commission Decision on criteria and methodological standards on good environmental status (GES) of marine waters appear in the framework of Article 9 (3). To undertake the ecosystem-based approach and to determine the environmental status, the MSFD proposes the use of 11 qualitative descriptors (Cardoso *et al.*, 2010; European Commission, 2010). The criteria build on existing obligations and developments within EU legislation, also covering further relevant elements of the marine environment, not yet addressed in the acting policies. Once adopted, the Decision will be a major step to establish precise objectives for the achievement of GES within the implementation of the MSFD.

However, there are criteria that are fully developed and operational and others that require further refinement. Thus, the Decision will require a timely revision, in order to identify the need to develop additional scientific understanding for assessing good environmental status in a coherent and holistic manner. Also there will be a need to establish monitoring programmes.

The Qualitative descriptors for determining GES (Annex I) are presented below (available at http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF)

Descriptor 1: Biological diversity

Descriptor 2: Non-indigenous species

Descriptor 3: Population of commercial fish / shell fish

Descriptor 4: Elements of marine food webs

Descriptor 5: Eutrophication

Descriptor 6: Sea floor integrity

Descriptor 7: Alteration of hydrographical conditions

Descriptor 8: Contaminants

Descriptor 9: Contaminants in fish and seafood for human consumption

Descriptor 10: Marine litter

Descriptor 11: Introduction of energy, including underwater noise

Need for scientific support

A major challenge in the implementation of the MSFD is to gain the necessary scientific knowledge to define the state of the marine environment and also develop additional scientific understanding to underpin the Decision and to secure a successful revision. For a number of criteria and indicators the need for further development and additional scientific information has been already identified. Increasing scientific knowledge on the marine environment and its processes is required to adequately achieve the Directive's goal.

This knowledge needs to the developed, in particular, through the EU Strategy for Marine and Maritime Research (COM (2008) 534) in the framework of the Integrated Marine Policy (IMP). One of the major results of the EUROMARES Conference (Gijón, 18–19 May 2010) was the need for a long term structural partnership between marine research and marine environment policy. Science must provide the knowledge upon which integrated management can build the tools for assessing progress towards good environmental status.

Further challenges are identified and included as vital in the development and implementation of the Directive: i) The need to devise appropriate financing strategies, tapping into all relevant financial resources within the EU, in coherence with Article 22 of the MSFD; ii) The integration of sectorial policies, whether maritime sectors or activities on land affecting the marine environment; iii) Active dissemination and communication on the marine environment; iv) Enhanced participation of stakeholders at all levels: national, regional, European and international.

The Marine Strategy Framework Directive 2008/56/EC requires that, in developing their marine strategies, Member States use, where practical and appropriate, existing regional cooperation structures, including those under the regional sea conventions, to co-ordinate among themselves and to make every effort to coordinate their actions with those of third countries in the same region or subregion.

The Objective of the new Fisheries Common Policy (http://ec.europa.eu/fisheries/reform/index_en.htm)

By bringing fish stocks back to sustainable levels, the new common fisheries policy (CFP) aims to provide EU citizens with a stable, secure and healthy food supply for the long term. It seeks to bring new prosperity to the fishing sector, end dependence on subsidies and create new opportunities for jobs and growth in coastal areas. At the same time, it fosters the industry's accountability for good stewardship of the seas.

The most important areas of action of the common fisheries policy are:

i) laying down rules to ensure Europe's fisheries are sustainable and do not damage the marine environment (see fishing rules);

ii) providing national authorities with the tools to enforce these rules and punish offenders (see fisheries controls);

iii) monitoring the size of the European fishing fleet and preventing it from expanding further (see fishing fleet);

iv) providing funding and technical support for initiatives that can make the industry more sustainable (see European Fisheries Fund);

v) negotiating on behalf of EU countries in international fisheries organisations and with non-EU countries around the world (see international);

vi) helping producers, processors and distributors get a fair price for their produce and ensuring consumers can trust the seafood they eat (see market);

vii) supporting the development of a dynamic EU aquaculture sector (fish, seafood and algae farms) (see aquaculture);

viii) funding scientific research and data collection, to ensure a sound basis for policy and decision making (see research and data collection).

The Green Paper Reform of the Common Fisheries Policy. Commission of the European Communities (Brussels, 22.4.2009. COM(2009)163 final) states that:

"The fisheries sector can no longer be seen in isolation from its broader maritime environment and from other policies dealing with marine activities. Fisheries are heavily dependent on access to maritime space and to healthy marine ecosystems. Climate change is already having an impact on Europe's seas and is triggering changes to the abundance and distribution of fish stocks. Competition for maritime space is also on the rise as ever larger parts of our seas and coasts are dedicated to other uses. Fishing economies are heavily influenced by broader trends of employment and development in coastal communities, including the emergence of new sectors offering opportunities for reconversion or income diversification. Rethinking the CFP therefore requires us all to take a fresh look at the broader maritime picture as advocated by the Integrated Maritime Policy (IMP) and its environmental pillar, the Marine Strategy Framework Directive."

The possible role of this expert group supporting these Directives and Policy

Some ideas in relation to how the knowledge and experience of this expert group could be used in the context of the European Marine Strategy Framework Directive (EMSFD) and the new FCP are presented. The aim is to integrate the scientific and advisory work for implementing an ecosystem approach based on qualitative descriptors (including healthy stocks and sustainable exploitation), and give a coordinated and integrated assessment of marine environmental status.

In 2011, this ICES Working Group was invited, as were other expert Groups, to contribute with its knowledge to the recent European Marine Strategy. The MSFD is cross-cutting and will have implications for most of ICES' work and it is in the aim of ICES to better integrate its scientific and advisory work to meet the challenges of implementing an ecosystem approach. WGCEPH would like to be also an active contributor to this European Directive by means of offering its relevant knowledge and experience. Members of the WGCEPH want to provide, in this revision exercise related to the MSFD, an example for helping identifying and describing the work floods of our own working group with relevance to the GES Descriptors, with emphasis on linkages that could be made between cephalopods and ecosystem/environmental monitoring and future assessments. This revision is based on that already deployed by other Working Groups in support of the MSFD (Iriondo A. *et al.* 2011).

Thus, in the present review the expert group identifies elements of the group work that may help determine status for some of the 11 descriptors set out in the Commission Decision (available at:

http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF)

The work carried out during previous WGCEPH meetings and the incipient new work in this working group are one of the largest compilations deployed in relation to data and knowledge on cephalopod population dynamics and fishing activity. It is true that, for most of the cephalopods we still lack of population parameters to be able to define the current status of the most important cephalopod species commercially exploited in Europe to be used as a series of indicators (see recommendations section). However, its calculation could be a new challenge in the future of this WG. These indicators are traditionally used, as for fish stocks, to state population status in relation to some reference points (fishing mortality, recruitment and spawning stock biomass levels).

To undertake the ecosystem-based approach and to determine the environmental status, the MSFD proposes the use of 11 qualitative descriptors (Cardoso *et al.*, 2010; European Commission, 2010). A summary of those descriptors is found in Borja *et al.* (2011). These descriptors summarize the way in which the whole system functions. Some of the descriptors could be calculated based on the routine work carried out at fisheries Institutions. Thus, the following descriptors were chosen as those in which data and population dynamics could be applied:

3. Populations of exploited fish and shellfish (cephalopods should be here also included) are within safe biological limits, exhibiting a population age and size distribution indicative of a healthy stocks (Piet *et al.* 2010).

4. All elements of the marine food webs occur at normal abundance and diversity and levels capable of ensuring the long term abundances of the species (Rogers *et al.*, 2010).

6. Seafloor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems are not adversely affected (Rice *et al.* 2010).

Specifically, the following set of indicators (in bold) by descriptor was identified as feasible to be delivered through work of this experts group:

Descriptor	Aspect	Indicator
3. Exploited fish and shellfish	3.1. Level of pressure of the fishing activity	**3.1.1 Fishing mortality (F)**

		3.1.2 Catch/Biomass ratio
	3.2 Reproductive capacity of the stock	**3.2.1 Spawning stock Biomass (SSB)**
		3.2.2 Biomass indices
	3.3 Population age and size distribution	**3.3.1 Proportion of fish larger than the mean size of first Sexual maturation**
		3.3.2 Mean maximum length across all species found in research vessels surveys
		3.3.3 95% percentile of the fish length distribution observed in research vessels surveys
		3.3.4 Size at first sexual maturation
4. Food webs	4.1 Productivity of key species or trophic groups	**4.4.1 Performance of key predator species using their production per unit Biomass**
	4.2 Proportion of selected species at the top of food webs	**4.2.1 Large fish (by weight)**
	4.3 Abundance/distribution of key trophic groups/species	**4.3.1 Abundance trends of functionally important selected groups/species**
Seafloor integrity	6.1 Physical damage, having regard to substrate characteristics	**6.1.1 Type, abundance, biomass and areal extent of relevant biogenic Substrate**
		6.1.2 Extend of the seabed significantly affected by human activities for the different substrate types
	6.2 Condition of benthic community	**6.2.1 Presence of particularly sensitive and/or tolerant species**
		6.2.2 Multi-metric indices assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species.
		6.2.3 Proportion of biomass or number of individuals in the macrobenthos above specified length/size
		6.2.4 Parameters describing the characteristics of the size spectrum of the benthic community

Thus, population indicators of the main commercially-exploited cephalopods in the ICES area could be revised in relation to the level of pressure of the fishing activity. Fishing mortality (and also catch ratios) is one of the traditionally precautionary limits in commercial fish assessment. Spawning stock biomass and population age and size distribution are used also as indicators, to measure the health of the stock. These population variables could be calculated.

Also, data available from the International Council for the Exploration of the Sea (ICES), for bottom trawl surveys (http://datras.ices.dk/Data_products/EUIndicator.aspx), undertaken within the framework of the International Bottom Trawl Survey (IBTS), could be used to calculate the proportion of large cephalopods present.

In relation to descriptor 6, seafloor integrity, could be calculated at ICES area level or lower by means of synergies and feedback to from other experts groups. Thus, information from other WGs could be used to give values which, at area level, should be common.

In relation to the Common Fisheries Policy and orientated to the socio-economic part of the cephalopod fisheries.

This expert group acknowledges the fact that many European coastal communities are dependent on fisheries for their income, some of them limited to fisheries activities and with low possibilities of economic diversification. As the new PPC states, it is essential to secure a sustainable future for coastal small-scale fisheries. The social objective, in this case, is to try to protect the most fragile coastal communities.

The role of cephalopods in sustaining artisanal and, in some cases, large commercial fisheries in Europe has been poorly studied. Thus, the role of these species in relation to the sustainability of the ecosystem and the human activities (such as fishing) has been restricted to local studies, scarce and widely spaced in time and space. Although many small-scale cephalopod fisheries are managed, often locally, through various input and output controls, exploited cephalopod stocks are not routinely assessed at European scale, and there are no quota restrictions on landings.

This expert group could assure the baseline knowledge of the species status to secure the ecological sustainability of cephalopod stocks on which these fishing communities ultimately depend.

Conclusions

Cephalopods working group experts possess a significant body of knowledge on population dynamics and manage data on fisheries and stocks highly useful for purposes other than stock assessment. Determination of ecological status could be the next step to be undertaken under the ecosystem-based approach. It is worth to mention that in the MSFD and moving towards a Marine Spatial Planning, fishing activity is still one of the main activities affecting the status of the ecosystems. Thus, there is a need to take into account all knowledge held by experts groups and put effort in offering useful data to experts working on these issues. Also, the experience gained after years of work of scientists in relation to bridging management with advice should be considered.

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7 ToR g) Provide an overview of the outcomes of the current fishery (and survey) data collection programmes for cephalopods, with particular attention to (i) utility of data currently collected for assessment purposes, and (ii) recommendations for improvements in the DCF and for any additional evaluation of the DCF that is thought to be needed; iii) suggestions for financial support for the required level of the DC

In 2008, the European Council established the Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy (Council Regulation (EC) No 199/2008). This new framework aims to provide support for scientific advice taking into consideration the most recent developments in fisheries management, such as the fleet-based approach and the ecosystem approach.

Each species within a region is classified within a group according to the following rules:

- Group 1: species that drive the international management process including species under EU management plans or EU recovery plans or EU long term multiannual plans or EU action plans for conservation and management based on Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the common fisheries policy. No cephalopod species was classified presently into this group in any ICES region;
- Group 2: other internationally regulated species and major non-internationally regulated by-catch species. *Loligo vulgaris* (LV), *Loligo forbesi* (LF), *Octopus vulgaris* (OV) and/or *Sepia officinalis* (SO), are classified into this group in Spain (LV, OV and SO), Portugal (LV, OV and SO) and France (LV, LF, and SO);

- Group 3: all other by-catch (fish and shellfish) species. Most cephalopod species belong to Group 3 in every region.

In 2011, an assessment of the outcomes of the current fishery (and survey) data collection programmes for cephalopods for Portugal and Spain was carried out. At that time, it was apparent that with the implementation of the DCF (and therefore the métier-based approach), the number of specimens sampled had decreased markedly, while the number of species sampled has increased in both Portugal and Spain. This appears to be logical, since the sampling of the whole landing of selected vessels covers all species and not only those that are considered commercially important, which effectively increases the number of sampled species.

In 2012, a preliminary analysis of the application of the current DCF in France, based on 2011 data, was carried out.

Consequences of the application of the DCF sampling design adopted since 2009 can be analysed in the case of sampling for landings length frequencies because the previous sampling scheme was conducted by the University of Caen using other sources of funding.

The University of Caen sampling scheme is based on monthly samples but limited to one English Channel fish market (Port-en-Bessin) and concerns only the fishing fleet using otter bottom trawl. The DCF sampling design (carried out by IFREMER) concerns a larger number of ICES divisions and includes sampling of a wider range of gear types.

Sample sizes (number of specimens measured) by France are presented in Tables 1 and 2 (University of Caen and DCF_2011 respectively). These two set of tables indicate that the DCF_2011 programme provides data about areas and gear types not investigated by Caen. This is a very positive fact.

However, and also in relation to gear types, it is worth noting that the second most important gear type catching cuttlefish in the English Channel has not been sampled in the DCF: the 2011 trap fishery landings in this area were above 1,000 t (and such inshore métiers are likely underestimated in the national database).

The extended sampling of the DCF programme seems to be mainly useful in the Bay of Biscay where samples of significant size were analysed.

This improved situation can mainly benefit to a better knowledge of *Sepia officinalis* and *Loligo vulgaris* populations whereas the number of *Loligo forbesi* specimens measured is surprisingly low.

It is also surprising to see that a large number of *Loligo vulgaris* were sampled in the English Channel in the 3rd quarter (summer) when the recruitment in this specie occurs only in autumn. The analysis of length distributions could be useful to understand this point although temporal resolution (data by quarter) may not be sufficient.

Table 1. Sample sizes of fish-market sampling for landings length structure carried out by the University of Caen (number of specimens measured in the three Cephalopod species: *Sepia officinalis, Loligo vulgaris* and *Loligo forbesii*).

Fish market sampling by the University of Caen was funded within the DCF during the period 2002-2008 and after using other sources of funding

Fish market sampling of Landings by the University of Caen				*Sepia officinalis*		number of specimens sampled					
	Year										
Month	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
1	354	191	161	60	134	140	228	204	5	9	4
2	78	45	268	184	86	10	243	77	19	49	371
3	39	299	153	318	743	147	108	78		57	2
4	148	42	193	35	305	165	63	73	55	66	14
5	134	49	37	112	178	100	192	109	100	153	205
6	117	131	90	134	103	141	179	39		15	63
7	53	284	332	325	118	178	376		25	325	13
8	383	237	465	450	174	596	333	420	459	354	453
9	308	414	239	401	497	521	397	451	205		488
10	230	300	412	340	656	423	413	264	395	524	432
11	336	471	617	544	565	597	561	313	389	397	619
12	240	162	232	179	419	325	436	149	271	250	566
Total	**2420**	**2625**	**3199**	**3082**	**3978**	**3343**	**3529**	**2177**	**1923**	**2199**	**3230**

Fish market sampling of Landings by the University of Caen				*Loligo vulgaris*		number of specimens sampled					
	Year										
Month	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
1	735	826	960	1055	1001	895	1259	1045	610	864	1015
2	258	716	985	987	980	1354	724	916	739	977	955
3	442	645	268	946	810	912	595	922		840	445
4	436	239	133	858		256	335	761	171	477	310
5	89	14		616	254	421	226	123		630	613
6	0	10	1	0	0	13	11	4		0	3
7	0	0	0	0	0	2	1	3	0	0	0
8	1	1	0	0	2	0	2	22	1	0	0
9	52	5	4	3	48	19	51	6	192		2
10	74	103	413	399	576	377	494	368	465	298	77
11	1211	548	867	740	719	867	497	811	673	867	812
12	1048	95	591	264	854	846	997	917	815	535	766
Total	**4346**	**3201**	**4222**	**5867**	**5245**	**5962**	**5192**	**5898**	**3666**	**5488**	**4999**

Fish market sampling of Landings by the University of Caen				*Loligo forbesii*		number of specimens sampled					
	Year										
Month	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
1	218	81	55	6	23	125	37	20	0	0	0
2	70	59	28	13	14	33	79	70	13	0	36
3	16	428	223	32	88	18	52	29		105	12
4	273	39	11	4		58	16	69	26	19	17
5	6	22		30	5	9	6	80		46	21
6	1030	288	509	741	519	302	218	38		405	211
7	876	483	880	886	609	613	439	176	386	243	672
8	1083	416	1005	1137	941	1074	984	521	1017	920	846
9	870	755	928	848	571	710	701	703	603		593
10	773	843	600	475	315	549	403	468	511	575	510
11	104	640	95	308	259	147	540	166	380	157	242
12	23	121	123	444	127	19	72	73	136	44	251
Total	**5342**	**4176**	**4456**	**4925**	**3470**	**3657**	**3547**	**2413**	**3072**	**2514**	**3410**

Table 2. Sample sizes of sampling for length structure carried out within the DCF programme in 2011 (number of specimens measured in the three Cephalopod species: *Sepia officinalis*, *Loligo vulgaris* and *Loligo forbesii*).

Numer of specimens measured											***Sepia officinalis***															
Divisions	IV	Total IV	VIId				Total VIId	VIIe					Total VIIe	VIIfgh		Total VIIfgh	VIIIabde						Total VIIIabde	VIII	Total VIIIc, IXa	Total
Gear Type	OTB_DEF		GTR_DEF	MIS_MIS	OTB_DEF	OTB_MCD		GTR_DEF	MIS_MIS	OTB_DEF	OTB_MCD	SDN_DEF		MIS_MIS	OTB_DEF		GTR_CEP	GTR_DEF	MIS_MIS	OTB_DEF	OTB_MCD	SDN_DEF		MIS_MIS		
Quarter																										
2011 - 1					2		2		1	5			6		825	825	245	122	3	133	315		818			1651
2011 - 2			288	3	23	90	404		13	286	341		640					25	58	237	201		521			1565
2011 - 3				30	590	210	830	1	127	393	30		551					65	11	373	492		941	2	2	2324
2011 - 4	1	1	7		241		248	7	19	217		291	534	3	22	25		155	101	282	77	268	883			1691
Total général	1	1	295	33	856	300	1484	8	160	901	371	291	1731	3	847	850	245	367	173	1025	1085	268	3163	2	2	**7231**

Numer of specimens measured						***Loligo vulgaris***														
Divisions	VIIbc	Total V	VIId			Total VIId	VIIe				Total VIIe	VIIfgh		Total VIIfg	VIIIabde				Total VIIIabde	Total
Gear Type	OTB_DEF		MIS_MIS	OTB_DEF	OTB_MCD		MIS_MIS	OTB_DEF	OTB_MCD	SDN_DEF		MIS_MIS	OTB_DEF		MIS_MIS	OTB_DEF	OTB_MCD	SDN_DEF		
Quarter																				
2011 - 1			2	67	240	309		30			30		4	4	1	489	841		1331	1674
2011 - 2				153		153	2	68	165		235		54	54		131	5		136	578
2011 - 3	12	12		547	210	757	9	31	29		69		52	52	73	372	486		931	1821
2011 - 4	438	438	1	459		460		356		249	605	51	231	282	2	549	117	538	1206	2991
Total	450	450	3	1226	450	1679	11	485	194	249	939	51	341	392	76	1541	1449	538	3604	**7064**

Numer of specimens measured						***Loligo forbesii***				
Divisions	VIIbcjk		Total VIIbcj	VIIe	Total VIIe	VIIfgh	Total VIIfgh	VIIIa	Total VIIIabd	Total
Gear Type	MIS_MIS	OTB_DEF		OTB_DEF		OTB_DEF		MIS_MIS		
Quarter										
2011 - 1						3	3			3
2011 - 2	3		3	47	47					50
2011 - 3				29	29					29
2011 - 4		120	120	12	12			1	1	133
Total	3	120	123	88	88	3	3	1	1	**215**

7.1 Utility of data currently collected for assessment purposes

Last year 2011, it was detected that the number of specimens sampled by countries to obtain stock variables was not reached by any country. However, this is not as important as the fact that commitments to sample are still quarterly or yearly, in every country other than in Portugal.

Group has reiteratively expressed its concern related to the life history of cephalopod species. Given the short life cycles of most of these species (1 or 2 years), it is necessary to monitor biological variables regularly, ideally every week or month. Quarterly sampling is insufficient for cephalopod assessment and management. Even length composition sampling should be carried out on a finer time basis where cephalopods are considered as major non-international regulated by-catch species (G2). To achieve this, extra sampling should be done based on the seasonality of the landings and discards with higher sampling intensity during times when cephalopod catches are highest.

The identification of species group to species is also an important aspect of the DFC, which nonetheless is not yet fully achieved in any of the countries for which data were obtained. The assignment of some cephalopod species to the priority level G2 improved their identification among the previous group of species On the other hand; the assignment of all short-finned squid species to the sampling priority G3 resulted in a significant loss of effort in their identification to species level.

7.2 Recommendations for improvements in the DCF and for any additional evaluation of the DCF that is thought to be needed

- It is necessary to monitor length composition and biological variables on finer time basis (every week or month). Extra sampling should be done based on the seasonality of the landings and discards with a concentration during times when cephalopod catches are highest;

- Species identification training should be given to people involved in sampling to improve data collected from landings, discards and surveys.

7.3 Suggestions for financial support for the required level of DC

A cephalopod pilot study will be proposed to the Regional Coordination Meeting of the Atlantic waters. The Group understands that, first, a good understanding of the species catch composition is necessary. Then, biological parameters are required to be collected at the necessary level of sampling and at the right period of the year and frequency.

Other possibility is to propose a Call for Tender for improving the data collection, summarise already collected biological parameters of the most important commercial cephalopod species exploited by commercial and artisanal gears and set the basis for assessment, hopefully analytical to be carried out by this expert group, if it is the case, or by other assessment expert groups.

As the group understands, cephalopods are part of important artisanal and industrial fisheries as target and by-catch species. These natural resources are an alternative to the traditional TAC and Quotas species and consequently some fleets can derive their fishing effort, diversifying its activity, towards them. Cephalopods are known as top predator species, having an important role in the ecosystem. The group wants to point out that just under adequate sampling schemes and levels, the group would be able to deliver assessment and management. It appears clear that just under dedicated funding (e.g. CRESH) assessment exercises and first management advice could be carried out.

8 Other business

8.1 Presentations of recent and ongoing work

Several group members presented their work during the meeting, including:

- Angel Gonzalez: Preliminary approach to the daily increment counting in *Octopodidae* stylets for growth studies (WD 8).
- Luis Silva: presented the results on cephalopod landings and discards for 2011 (WD a.1 & WD a.3) and also presented the results of the three Spanish Surveys deployed in Porcupine Bank (Porcupine), Cantabrian Sea (DEMERSALES) and Gulf of Cadiz (ARSA) (WD a.5; WD a.6; WD a.7; respectively).
- Marina Santurtún presented the results of cephalopod landings and discards for 2011, and preliminary abundances indices (WD a.2).
- Jean Paul Robin: presented the recent results of the CRESH project in relation to biology, population dynamics and assessment of Cuttlefish in English Channel (WD 9).
- Nousithé Koueta: Presented the conclusion of pat of the CRESH project in relation to Sepia as indicators of heavy metals in the environment.

8.2 Information in relation to the future role of the WGCEPH in the context of ICES

Cephalopods are exploited resources. Directed cephalopod fisheries, especially small-scale fisheries, are increasingly important and it is necessary to have in place a functional system of data collection and stock evaluation that would be adequate to support management (and thus which takes into account unique features of cephalopod biology). The new CFP points out the importance of artisanal fisheries in relation to social, economic and environmental issues and the need for regional and dedicated (differentiated) management approaches. Thus, until WG CEPH moves further towards assessment (2010–2013) a dedicated group is needed to report on specific and focused cephalopod scientific work in disciplines such as: cephalopod biology, ecosystem, fisheries and assessment.

The working plan prepared by WGCEPH for a 3 year period is focused on:

Moving towards assessment through:

i) Data calls, if needed, in order to have access to up-to-date data on cephalopod landings, directed effort, discards, and survey catch data. This procedure follows the line of work of other ICES Working Groups.

ii) Monitoring of fishery trends remains basic to the work of the Group and to ensure that these fisheries remain sustainable. The group will focus more on the analysis than on the collection of the fisheries data (obtained by Data call).

iii) Updating and revising CPUE data series already produced as first step for a possible assessment also given the need to promote sustainable cephalopod fisheries.

iv) Synthesizing knowledge and understanding of fleet (metier) dynamics targeting cephalopods.

v) There is still a need to keep evaluating DCF effectiveness in cephalopod sampling. Thus, it is important to determine whether the new DCF will be delivering the information that is/would be needed to assess cephalopod stocks, and to identify any shortcomings.

Also, in the short and medium term a list of activities related to enhancing the knowledge base will be prioritised as follows:

- Contribute to increasing feedback between ICES groups related to environmental and ecosystem functions for understanding abundance fluctuations.
- Synthesize information on the importance of cephalopods as indicators of climate change, and importance as predator and prey species in marine ecosystems and incorporate this information into the knowledge base for the assessment.
- Compile knowledge to be directly applied to the assessment and management of these species.
- Start developing links with assessment and methodological ICES groups in which methods for assessing Data Poor Stocks are revised and used.

The need remains to progress on the biology basics, e.g., growth. While previous research on growth has been extensive, the highly flexible nature of growth patterns presents a challenge for fishery data collection. Implications on uncertainty in this variable are important in assessment.

The basic group work defined above has been identified and agreed by members. To accomplish with this, the group emphasises the commitment needed from all members to attend future meetings and contribute to ToRs defined by ICES. To assure this commitment can be realised, and taking into account the assessment focus that group is taking it will be desirable that the group is proposed for funding under new DCF.

8.3 Result of the Data Call launched in February 2012

The group is generally pleased with the answers obtained from most of the European countries in relation to the data call. In fact, the amount of information received previous to the group was so large and delivered on dates so close to the meeting that it was not possible analyse all the data. Despite this, the group was able to develop some preliminary analysis based on submitted data. Thus a basis for future work in relation to assessment was established.

Other caveat identified by the group was the early timing of the 2012 Working Group meeting, at the end of the first quarter of the year. This fact is always a drawback for the delivery of the data to the Group, even preliminary data. Also, data call was requested just one month before the group, as the minimum time required for the Commission to deliver Data Calls. However, the group understand that timing was very tight and data request, in some cases, may not have been sufficiently clear in relation to the kind of data, spatial and temporal resolution, species aggregation and time period of the data series.

To overcome all these problems and with the aim of continuous improvement, the group has identified two immediate actions: **i) to delay the 2013 WGCEPH meeting until 3rd or 4th week of June and ii) improve the common templates agreed by the group for requesting landings, discards, effort, surveys and biological data from National Correspondents**. Also, the possibility of using COST format for the next Data Call will be assessed by the group to facilitate this task.

8.4 New topics to be addressed in cephalopods and possibility of funding on cephalopod research

The group agreed on the need for vigilance and active searching in relation to the possibilities of obtaining funding to carry out new cephalopod research. Two possibilities were identified:. i) additional funding to improve the current sampling level included in DCF through Pilot Studies and ii) proposing topics to be covered by the traditional European Calls for Tender.

The other possibility for funding is to get support from multidisciplinary marine research teams in Europe. The group is aware of the lack of specific topic research on cephalopods but the group is also aware about the research potential of working together with food technologist and biotechnologist. Occasions to work within multidisciplinary teams of researches should not be wasted.

8.5 Future ICES ASC theme sessions

During the second semester of 2012, the next Cephalopod International Advisory Council (CIAC) conference will be held in Brazil, which thus becomes the first South American nation to host a CIAC symposium.

WGCEPH is proposing a Cephalopod Theme Session during the 2013 ICES ASC. The last cephalopod theme session took place in Vigo in 2004. Topics to be covered in this theme session will be based on: 3 main issues: i) cephalopods life history and population dynamics: Changes in distribution, spawning areas, essential habitats and modelling of recruitment, ii) linked to the necessity of managing human activities impacting on them (European Marine Strategy) and iii) the role of cephalopods in the ecosystem.

8.6 WGCEPH meeting in 2013

One venue was proposed for the next meeting, namely Caen, France. Given the importance of progressing in the data collection work previous to the group, thus optimising use of times during the meeting, WGCEPH meeting dates were proposed to be delayed to the 3rd or 4th week of June, meeting for 4 full days. However, dates remains to be confirmed.

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Annex 2: Data provided by countries in relation to Data Call 2012 previous to WGCEPH 2012

			GER	GBR	IRL	FRA	ESP	PRT	DNK	NLD	LTU	LVA	POL	EST	SWE
Landings	Year		X	X	X	X (just 2011)	X	X	NA	X	**				***
	ICES area		X	X	X	X	X	X		X					
	Quarter		X	X	X	X	X	X		X					
	Metier	Gear LVL4 (1)	X	X	X	X	X	X		X					
		Target assemblage LVL5 (2)	X	X	X	X	X	X		X					
		Mesh size authorised (3)	X	X	X	X	X	X		X					
	Effort		X	X	X		X	X		X					
	Effort unit		X	X	X		X	X		X					
	KG Landed by species		X	X	X	X	X	X							
	KG Landed by species group		X	X	X	X	X	X		X					
Discards	Year		X	X			X	X	NA		**				
	ICES area		X	X			X	X							
	Quarter		X	X			X	X							
	Metier	Gear LVL4 (1)	X	X			X	X							
		Target assemblage LVL5 (2)	X	X			X	X							
		Mesh size authorised (3)	X	X			X	X							
	Sampling level		X	X			X	X							
	Effort		X	X			X	X							
	Effort unit		X	X			X	X							
	KG Discarded by species		X				X	X							

	KG Discarded by species group	X	X			X	X							
Surveys	**Survey**	X	X	X		X	X	DATRAS	*	+	+	+	+	***
	Year	X	X	X		X	X							
	Quarter	X	X	X		X	X							
	ICES area	X	X	X		X	X							
	Species	X	X	X		X	X							
	Abundance index in number per hour	X	X	X		X	X							
	Units of effort	X	X	X		X	X							
	Survey	X	X	X		X	X	DATRAS	*	+	+	+	+	***
	Year	X	X	X		X	X							
	Quarter	X	X	X		X	X							
	ICES area	X	X	X		X	X							
	Species	X	X	X		X	X							
	CPUE (weight (kg) per hour)	X	X	X		X	X							
	Standard Error S.E.	X	X	X		X	X							
	Units of effort	X	X	X		X	X							

NA Danish data for Cephalopods, and there are only landings from the ICES areas III and IV, which were not included in the area list in the data call. The Danish IBTS data is uploaded to DATRAS, and can be retrieved from there.

Netherlands: some additional information.

As well in landing as discard records, only one cephalopod species (*Loligo spp.*) was reported by family name only in the areas requested. In a few cases a full species name is listed. However, it is doubtful whether the identification is correct. Therefore all catches are reported by family name.

The table with landings \ (from logbooks) contain records of landings and effort from all metiers and areas where fisheries have been identified.

For discards the records only apply to the metier combinations which have been sampled. This means that a 0 in this file means that there was sampling but no catches.

Effort in landing database sheet is total effort per quarter/metier/fishing ground whereas effort in discards database sheet is effort sampled per quarter/metier/fishing ground.

Netherlands participates in 2 scientific surveys in the area; a mackerel egg survey and an acoustic survey on blue whiting. Cephalopods are not sampled by these surveys

** **<u>Lithuania, Latvia, Poland and Estonia</u>**

> Lithuania is not able to submitte Cephalopods fisheries data, because that Cephalopods fishery was not deployed by Lithuania and such data were not collected
>
> Latvia has no cephalopod fishery and consequently has not any data to deliver.
>
> Poland for decades is not fishing for cephalopods and thus have no data to be provided.
>
> The concerned areas for "Data call - Cephalopods fisheries and biological DCF data" mentioned in Annex 1 are not included in the cephalopods fisheries deployed by Estonia. Estonia has cephalopod data for NAFO and South-West Atlantic (FAO 41.3.1) but these areas are not listed in Annex 1 (no ICES areas).

+ **<u>Lithuania, Latvia, Poland and Estonia</u>**: No comments are provided for Survey Data

*** **<u>Sweden</u>:** Sweden has almost no landing /effort data on cephalopods in the areas included in the data call. Sweden landed approximately 400 kg cephalopods (not species specific) in 2011 from area IV. Sweden is not undertaken any surveys in the areas included and therefore no data will be submitted.

Annex 3: WGCEPH 2013 terms of reference for the next meeting

The **Working Group on Cephalopod Fisheries and Life History** (WGCEPH), chaired by Marina Santurtún, Spain, will meet in Caen, France, DATE June 2013 to:

a) Report on status and trends of cephalopods. To update, quality check and report relevant data previous to the working group: relevant fishery statistics (landings, directed effort, discards, survey catches, etc) across the ICES area;

b) Review and report on cephalopod research results in the ICES area, with particular abundances related to environmental variables, role of cephalopods on ecosystem and assessment methods used in cephalopods commercial fisheries;

c) Review data availability of main commercial exploited cephalopod species in relation to main population parameters: length distribution, sex ratio, first maturity at age, first maturity at length, growth, spawning season;

d) Produce and update CPUEs and survey data series of the main cephalopod metiers and species and assess to the possibility of their use as abundance indices;

e) Conduct preliminary assessments of the main cephalopod species in the ICES area through examination of the above trends in relative exploitation rates (i.e., catch/survey biomass).

WGCEPH will report by 1 August 2013 (via SSGEF) for the attention of SCICOM.

Supporting Information

Priority	Cephalopods are important components of marine ecosystems. Under the European Marine Strategy Framework Directive, marine environment is defined as a precious heritage that must be protected, preserved and, where practicable, restored with the ultimate aim of maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive. Thus, for promoting the sustainable use of the seas and conserving marine ecosystems, cephalopod biology and life history has to be understood. As an example, directed cephalopod fisheries, especially small-scale fisheries, are increasingly important and it is necessary to have in place a useful system of data collection and stock evaluation that would be adequate to support management.
Scientific justification	Specific comments on the Terms of Reference are: ToR a) Monitoring of fishery trends remains basic to the work of the Group and to ensure that these fisheries remain sustainable. In next year 2013, the group has decided to focus more in the analysis than in the collection. The collection appears to be asured by the actual Data Call and a future provisional one for next year 2013 to be launched. Commercial and scientific data delivered to the group specifically appears in the report 2012 in Annex 2. ToR b) and c) The need to progress on the biology basics, as an example, growtyh and reproduction also cephalopods and relation to environmental variables. A revision of actual assessment methods used for cephalopods will be required for considering applicability on European cephalopods fisheries. ToR d) and e) the production of CPUEs data series is a first step for a possible assessment also given the need to promote sustainable cephalopod fisheries, the likely importance of cephalopods as indicators of climate change, and importance as predator and prey species in marine ecosystems. Thus, it is necessary to start conducting assessments of ICES cephalopod species. The working plan prepared by WGCEPH is focused on the evaluation and/or

	assessment (can be no-analytical). Effort will be put on these tasks avoinding previous effort dedications to data collection.
Resource requirements	As noted in the 2012 report and previously, participation in WGCEPH is limited by availability of funding, especially as many members and potential members are university staff with no access to “national funds” for attendance at ICES meetings. Effords to attend to the group are ackowledged. The future direction of the group focusing more into assessment would lead to group to be applicable for DCF funding. The group is willing that effort started in 2010 could be recognised in that way.
Participants	The Group was reduced in number of attendees form around 15 members and guests to 9 members. With a strong bias towards participants from the Iberian peninsula. It is desirable that more researcher working on National Fisheries Institution would have the chance to know the group work and participate in it
Secretariat facilities	None
Financial	
Linkages to advisory committees	PGCCDBS IBTSWG Provision of information to SciCom and its satellite committees as required to respond to requests for advice/information from NEAFC and EC DG Fish.
Linkages to other committees or groups	None
Linkages to other organizations	None

Annex 4: Recommendations

Recommendation	For follow up by:
1. WGCEPH would launch another Data Call reviewing templates and with enough time previous to the group meeting. The aim is to have access to up-to-date data on cephalopod landings, directed effort, discards, and survey catch data, in order to complete its ToRs. Thus, group will get in contact with National correspondants to inform about WGCEPH work procedure from 2013 in relation to data required to the. .	PGCCDBS Chair and National correspondants.
2. Routine collection of cephalopod length–frequency data, by species, during research bottom trawl surveys (e.g. IBTS) is suggested, in addition to provision of these data to the WGCEPH prior to the next meeting	ICES IBTS Chair, PGCCDBS Chair and National correspondant.
3. In relation to the DCF, WGCEPH recommends that for major cephalopod stocks in which assessment and management are likely to be necessary in the near future, data collection under the DCF should be modified to reflect the additional data requirements imposed by the short life cycles. We recommend: (a) Increases in the level of cephalopod sampling in metiers where these are highly valuable, based on the short life cycle of cephalopods. Thus, sampling of cephalopod species on a quarterly basis is not adequate. (b) Focus of the more intensive sampling (i.e. weekly or monthly) during periods of higher catches in order to ensure adequate characterizations of the length compositions of the multiple microcohorts that are often present, while avoiding unproductive sampling effort at times of low abundance. (c) Collection of maturity data for the most important cephalopod fisheries, to facilitate comparison of trends in maturity and length composition data by cohort, from research surveys versus the fishery, in order to assess trends in recruitment and length at 50% maturity (L50).	National Correspondents

Working Document presented to the ICES WGCEPH Working Group on Cephalopod Fisheries and Life History.
Cádiz, SPAIN, 27-30 March 2012

AN UPDATE OF CEPHALOPOD LANDINGS DATA OF THE SPANISH FISHING FLEET OPERATING IN ICES AREA FOR 2000-2012 PERIOD.

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Data of Spanish landings of cephalopods on an annual basis were collected both by the *Instituto Español de Oceanografía's* (IEO) Sampling and Information Network, for catches from the ICES sub-areas VII, VIIIabd, VIIIc and IXa, and by the *AZTI* Fundation, for catches from sub-areas VIab, VIIb-k and those ones from the VIIIc-East landed in the Euzkadi ports.

Table 1 shows the Spanish annual landings (in tons) by species group (Octopodidae, Loliginidae, Ommastrephidae and Sepiidae) and for the total annual for the 2000-2010 period. The 2010 landings have been updated in relation to the information reported last year. Landings data in 2011 should be considered as highly provisional because of gaps of information still present in some subdivisions. For this reason, the 2011 landings will not be considered in further analysis of trends henceforth presented.

Table 1. Spanish cephalopod annual landings (in tons) caught in the ICES Area by species group and total annual during the 2000-2011 period.

Year	Loliginidae	Octopodidae	Ommastrephidae	Sepioidea	Total
2000	675,6	7031,9	2017,1	1718,9	11443,5
2001	1052,2	3895,8	1305,2	1129,4	7382,6
2002	957,8	5150,0	1717,5	1133,3	8958,6
2003	917,4	4888,4	1164,5	1286,1	8256,4
2004	979,6	4881,9	1470,8	1394,0	8726,3
2005	880,3	6039,8	1949,9	1635,3	10505,3
2006	440,6	5237,5	1018,2	1456,0	8152,4
2007	691,5	4699,1	801,5	1631,0	7823,1
2008	765,4	4919,6	1636,2	1412,4	8733,6
2009	546,0	3935,3	1313,9	1223,9	7019,1
2010	1109,1	5776,2	3030,7	1508,3	11424,3
2011*	310,2	2025,0	719,8	966,6	4021,6

(*): highly provisional data

Figure 1 shows the trend of total annual landings through the analyzed time period (2000-2011). Average annual landings along the time series were around 8950 tons, with a minimum of 7019 t in 2009 and a maximum of 11400 tons in both 2000 and 2009 years. The highest landings correspond to the Octopodidae group which accounted for 57.3% of the averaged landings for the analyzed period, followed by Ommastrephidae (17.7%), Sepioidea (15.8%) and Loliginidae (9.2%). The trend present a drop of landings from 2000 to 2001, followed by a slight increase until to reach a peak in 2005 of 10500 t. Afterwards, a new decrease appear until 2009, with a great increase in 2010 of about 63% with regard to 2009.

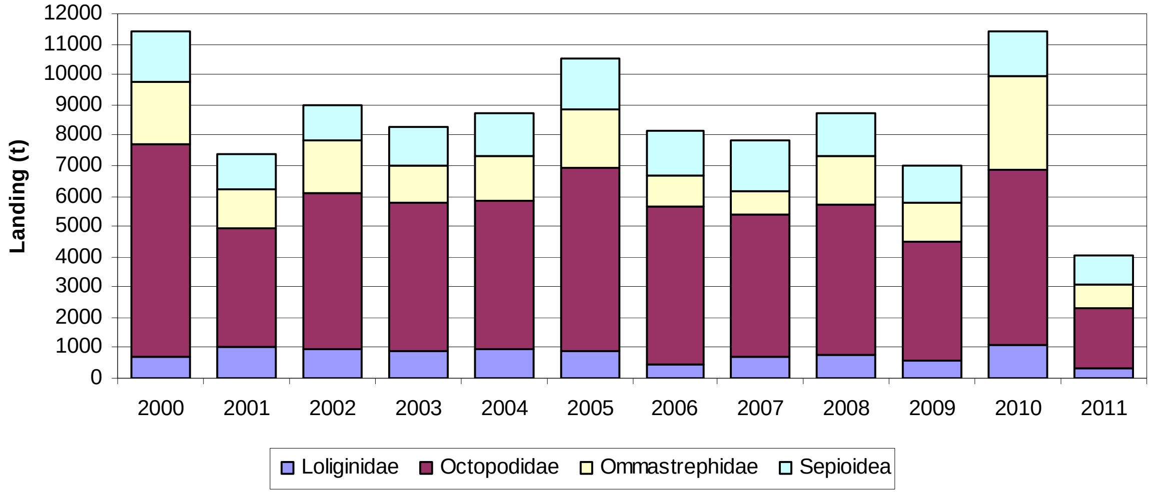


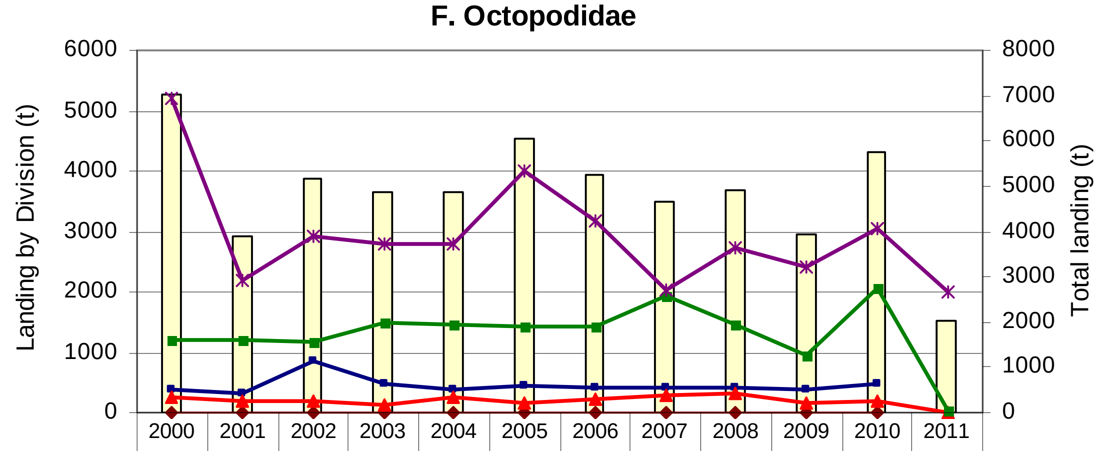
Figure 1. Spanish cephalopod annual landings (in tons) caught in the ICES area by species group during the 2000-2011 period. (2011: highly provisional data)

Octopodidae

Commercial landings of octopods (Fam. Octopodidae) comprise common octopus *Octopus vulgaris* and horned octopus *Eledone cirrhosa*, plus musky octopus *Eledone moschata* in Sub-Division IXa-South. Figure 2 shows the trend of total octopods landings and by Subarea/Division. Total annual catch ranged between 7031 t in 2000 and 3895 t in 2001, which represents the highest decrease along the time series. A slight increase until reaching a peak in 2005 of 6039 t can be observed. Afterwards, a new decreasing trend appear until 2009 with 3935 t, followed by a great increase in 2010 of about 46% with regard to 2009. More than 87% of octopodidae were caught along the Spanish coast (Divisions IXa and VIIIc), where common octopus *O. vulgaris* is the main species caught. In Division VIIIc and Subdivision IXa-north most of the *O. vulgaris* were caught by the artisanal fleet using traps, comprising more than 98% of octopus landings. The rest of landings is reported by the trawl fleet. However, this species is caught by the bottom-trawl fleet in the Subdivision IXa-South (Gulf of Cadiz), accounting for around 60% of total catch on average, and the remaining 40% by the artisanal fleet using mainly clay pots and hand-jigs (Figure 3). Subdivision IXa-South contributes to the total landings from the Division IXa with variable percentages that ranged between 29 % (454 t) in 2004 and 82% (3015 t) in 2005, with a 52% on average through the time series. Possibly, such oscillations may be related with environmental changes (Sobrino *et al*., 2002).

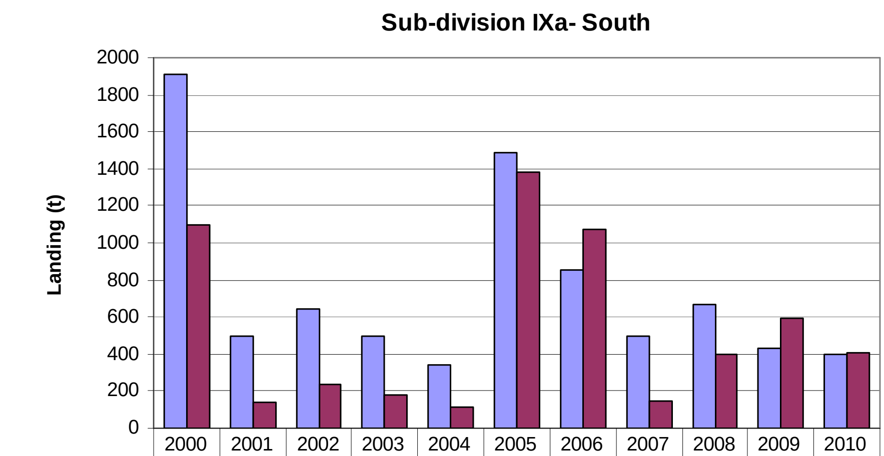
Most of the horned octopus *E. cirrhosa* is caught by the bottom-trawl fleet, with their landings accounting for the bulk of the octopod landings in Subarea VII (448 t of average) and Subdivisions VIIIabd (209 t) (Figure 2). Horned octopus landings in Division VIIIc account for 27%, on average, of total octopods landings. In Sub-division VIIIc-east the fishery statistics for the ‘octopodidae’ mixed species group correspond to *E. cirrhosa* landings in the case of the trawl fleet and to *O. vulgaris* for the artisanal fleet. The contribution of octopodidae species in the total cephalopod landings from Division IXa is higher in

Subdivision IXa north, with 23% of total landings, than in Subdivision IXa south, with only 11% (Figure 4). In this last Subdivision, the main landed species is the musky octopus *Eledone moschata* instead of *E. cirrhosa*, that is caught in the Gulf of Cadiz by the trawl fleet as a by-catch due its scarce commercial value (Silva *et al*., 2004).



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total	7031,8	3895,8	5150,0	4888,4	4881,9	6039,8	5237,5	4642,6	4919,6	3935,3	5776,2	2025,0
VI	0	0	0	0	0	0	0	0	0	0	0	
VII	387,0	326,1	851,4	474,5	371,1	448,8	424,9	400,3	398,9	389,05	464,0	
VIIIabd	246,7	181,9	196,9	111,5	257,0	160,5	216,0	282,3	308,4	164,49	180,8	11,0
VIIIc	1192,7	1209,2	1165,3	1498,0	1466,5	1420,6	1432,9	1932,7	1475,6	961,2	2075,2	19,7
IXa	5205,4	2178,6	2936,5	2804,4	2787,3	4009,9	3163,8	2027,3	2736,7	2420,6	3056,2	1994,4

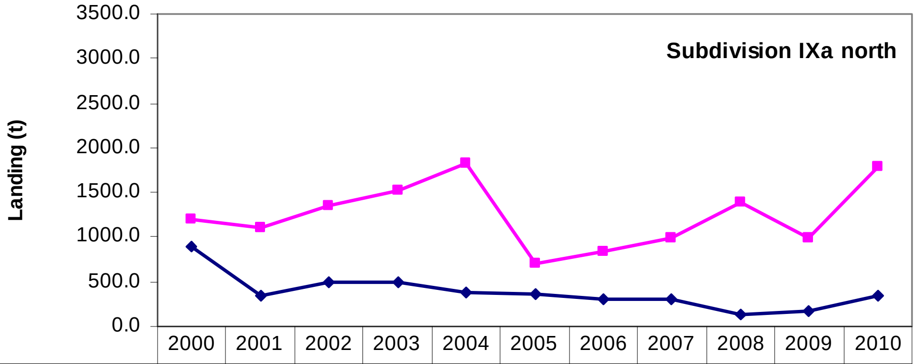
Figure 2. Spanish landings (in tons) of octopus species (Fam. Octopodidae) by ICES Subarea/Division during the 2000-2010 period.



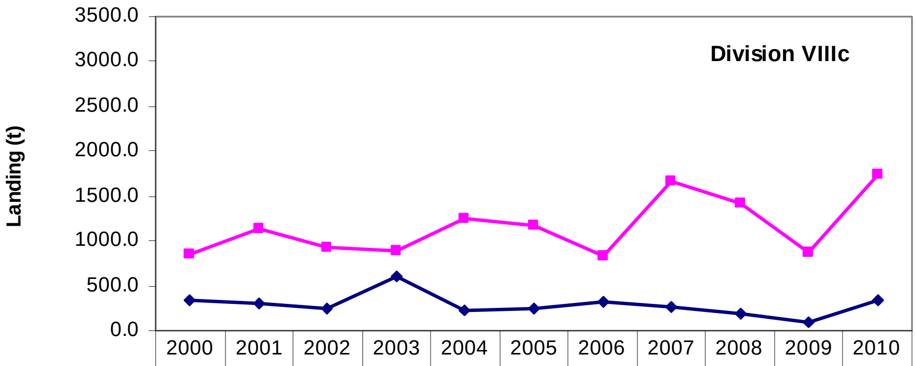
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Trawler fleet	1914.6	498.4	644.6	495.6	342.2	1489.9	855.0	497.0	662.8	433.9	395.8
Artisanal fleet	1101.2	139.2	234.3	181.5	112.3	1381.2	1077.0	149.0	401.9	595.0	402.7

Figure 3. *O. vulgaris* landings (in tons) by fleet in Sub-division IXa south during the 2000-2010 period.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Eledone spp	88.4	87.7	144.2	98.7	118.1	70.0	51.0	74.5	136.0	234.8	131.7
O. vulgaris	3015.7	637.6	878.9	677.1	454.5	2871.1	1932.0	646.0	1064.8	1028.9	798.5



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Eledone spp	900.6	349.6	486.1	500.5	379.6	363.8	300.9	311.3	140.6	170.3	335.1
O. vulgaris	1200.6	1103.8	1341.6	1528.2	1835.1	705.0	840.5	995.6	1395.4	986.6	1791.0

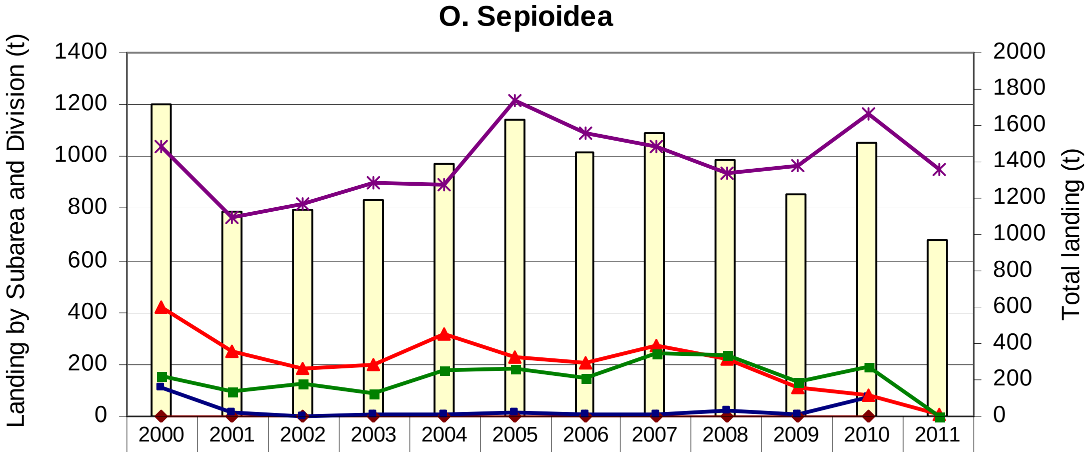


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Eledone spp	343.9	308.5	246.8	612.4	220.1	248.7	326.2	264.3	183.6	98.6	336.6
O. vulgaris	848.8	1132.9	918.3	886.3	1246.3	1172.3	825.1	1663.1	1428.0	862.5	1738.6

Figure 4. Octopodidae landings by species in Division VIIIc and IXa (north and south) during 2000-2010 period.

Sepiidae

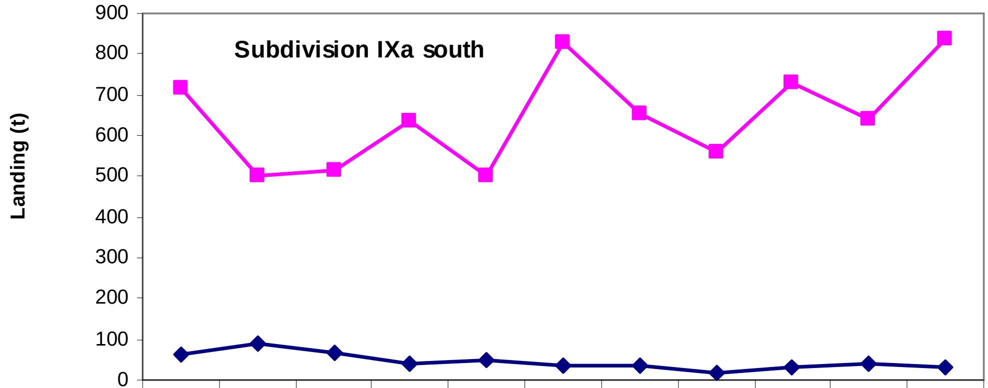
The trend of cuttlefish annual landings by Subarea/Division is shown in Figure 5. Total landings ranged between 1636 t in 2000 and 1129 t in 2001. Since 2001, landings increased to 2005 and 2007, when they reached two new maxima values similar to 2000. Afterwards, landings decreased slightly up to 1224 t in 2010. Division IXa contributed with 70% of total cuttlefish landed by Spanish fleet, with the 70% of landings in this Division corresponding to the Subdivision IXa-South (Gulf of Cadiz).. Landings in Division VIIIc increased at the end of the analysed period, reaching 245 t, whereas in Division VIIIabd they showed more or less constant, around 220 t in average, with a decrease in 2009 and 2010. Landings in Subarea VII were below 20 t, except in 2000 with 110 t, and they were almost absent in the Subarea VI.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total	1718,9	1129,4	1133,3	1192,7	1394,0	1635,3	1456,0	1563,1	1412,4	1223,9	1508,3	966,57
VI	0	0	0,5	0	0	0	0	0	0	0	0	
VII	110,3	17,5	3,0	6,1	10,9	12,4	9,1	9,1	19,4	10,6	73,2	
VIIIabd	417,7	247,5	187,0	200,5	317,6	225,9	207,7	272,2	220,6	113,95	82,9	10,734
VIIIc	153,6	99,0	122,6	87,6	176,0	181,9	149,2	245,9	237,1	134,2	188,6	1,983
IXa	1037,3	765,4	820,2	898,6	889,4	1215,2	1089,9	1035,9	935,3	965,1	1163,6	953,85

Figure 5. Spanish landings (in tons) of cuttlefish species (O. Sepioidea) by ICES Subarea/Division during the 2000-2010 period.

Cuttlefish (O. Sepioidea) landings from Subarea VII and Divisions VIIIabd mainly comprise common cuttlefish *Sepia officinalis* and, in a lesser amount, also elegant cuttlefish *Sepia elegans* and pink cuttlefish *Sepia orbignyana*. Bobtail squid *Sepiola* spp. is not identified in landings. Only *Sepia officinalis* and *Sepia elegans* are present in landings from Divisions IXa and VIIIc-West. Data on the proportion of each species are only available for Division IXa-South, where *Sepia officinalis* makes up about 93% of cuttlefish landed (Figure 5). In this Division *Sepia elegans* and *Sepia orbignyana* appear mixed in landings, although the last species is quite scarce.



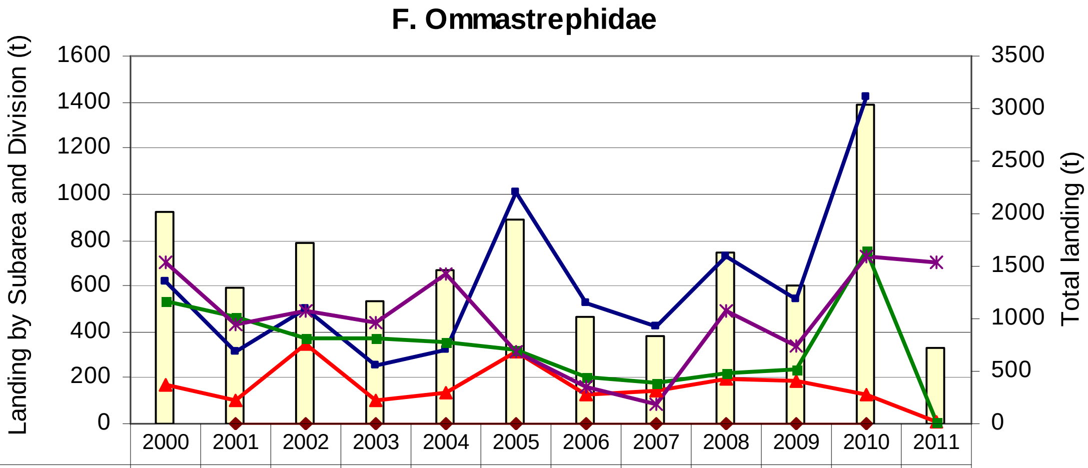
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
S.elegans	63.2	88.7	65.9	40.1	48.1	35.2	34.3	18.6	29.3	41.7	32.9
S.officinalis	718.3	500.3	514.0	637.0	500.7	830.2	652.1	560.9	731.1	642.3	839.3

Figure 6. Sepiidae landings by species in Sub-division IXa south during the 2000-2010 period.

Ommastrephidae

Short-finned squid landings (Fam. Ommastrephidae) comprise mainly broad-tail short-finned squid *Illex coindetii* and lesser flying squid *Todaropsis eblanae*. European flying squid *Todarodes sagitattus* also appears in catches, but it is very scarce. Figure 7 illustrates the trends of both total landings of short-finned squids and by Subarea/Division. Total landings presented two maxima values in 2000 and 2005 with 2000 t. Afterwards, landings quickly dropped reaching a minimum in 2007 with 834 t, In 2008, this value doubled in relation to the previous year, with a new decrease in 2009, but reaching then the maximum record of the time series in 2010 with 3030 tonnes.

The analysis by area shows scarce landings in Subarea VI throughout the time series. From 2000 to 2004, the Division IXa contributed with the highest landings, ranging between 700 and 430 t. Since 2004, landings from Subarea VII increased, reaching two maxima in 2005 and 2008 with 1000 and 730 tons, respectively. The rest of Divisions showed decreased landings, sharing similar levels below 200 t, with only the División IXa experiencing a significant recovery in 2008. In 2010, all the Subareas and Divisions reached the maxima values, except Division VIIIabd which presented a slightly decrease in relation to the previous years. Subdivision IXa–South account for the lower values of the time series with landings below of 1% of the total of short-finned squid species landings.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total	2017,1	1305,2	1717,5	1164,5	1470,8	1949,9	1018,2	833,91	1636,2	1314	3030,7	719,82
VI		0	0	0	0,285	0	0	0,0085	0	0	0	
VII	615,73	313,28	501,27	251,97	319,65	1003,3	528,32	425,7	730,7	541,2	1421,1	
VIIIabd	172,45	101,22	350,59	97,611	135,92	315,33	126,72	141,1	195,6	190,13	123,7	11,8
VIIIc	529,79	461,57	373,35	376,63	359,15	318,98	199,46	179,7	218,7	240,3	756,1	7,9
IXa	699,11	429,1	492,32	438,25	655,83	312,24	163,7	87,4	491,2	342,4	729,8	700,1

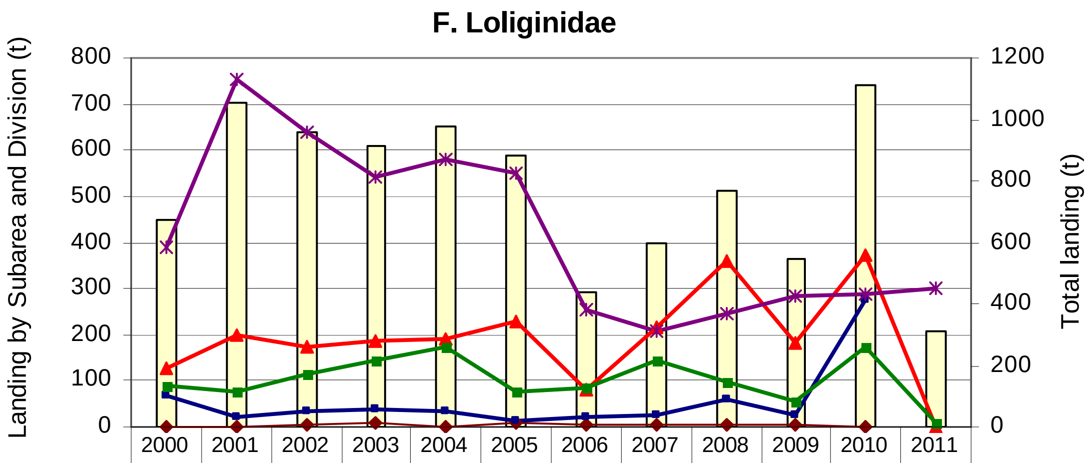
Figure 7. Spanish landings (in tons) of short-finned squid species (Fam. Ommastrephidae) by ICES Subarea/Division during the 2000-2010 period.

Loliginidae

Long-finned squid landings (F. Loliginidae) consist mainly of common European squid *Loligo vulgaris*. Three other species are present in unknown proportions. Of these, veined squid *Loligo forbesi* is currently thought to be very scarce, with variable presence in landings. Squids of the genus *Alloteuthis* (*Alloteuthis media* and *Alloteuthis subulata*) are mainly present in squid landings from Sub-Division IXa-South, showing low catch levels in Sub-Division IXa north during the same years.

Figure 8 shows the trend of total long-finned squid landings and by Subarea/Division. Total landings presented a maximum value in 2001 with 1052 t, and then they remain more o less stable at around 900 t until 2006, when they showed a drop, reaching the minimum value in the time series with 440 t. An increasing trend is observed from this year to 2010, reaching the maximum values in this year with 1109 tonnes, indicating a considerable recovery of landings.

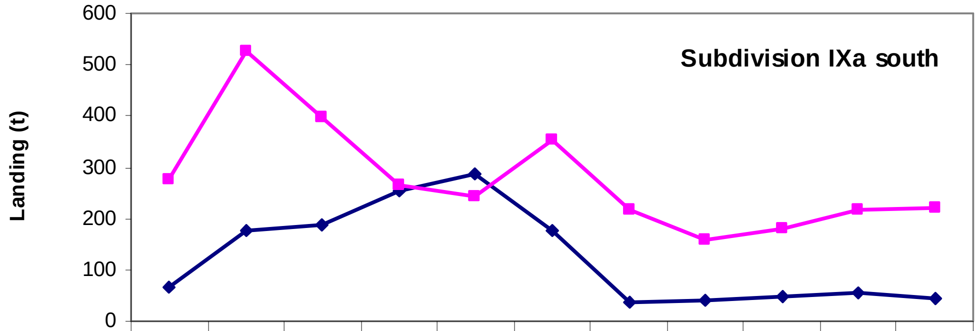
The analysis by Subarea/Division shows that the Division IXa recorded the highest landings from 2001 to 2005, with values ranging between 753 and 552 t, respectively. The 2007 landings fell to 200 t and remained stable at the end of the time series, at around 280 t. Landings in Division VIIIabd and VIIIc were lower than in IXa, oscillating between 128 t in 2000 and 360 t in 2006, and between 76 t in 2005 and 145 t in 2007, respectively. Landings in Subarea VII were also very low as compared with other areas, with average annual landings of only 30 t, but they showed a significant increase in 2010, as also happened in Division VIIIc and VIIIabd. The Subarea VI showed very scarce landings, below 10 t, as it was also abovementioned described for the other analysed groups of cephalopod species.



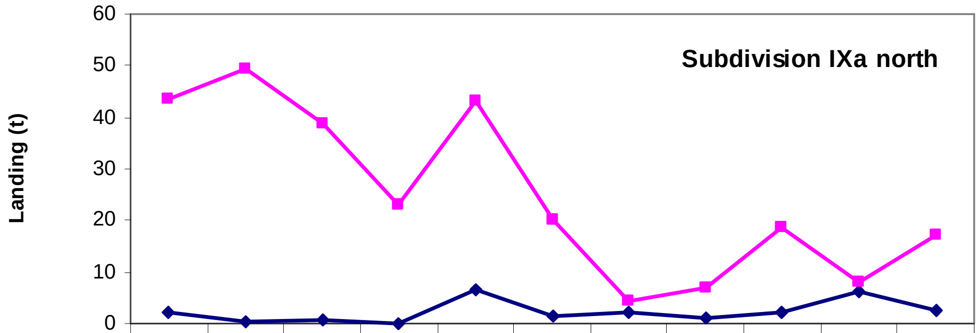
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total	675,6	1052,2	957,8	917,4	979,6	880,3	440,6	597,6	765,4	546,0	1109,1	310,2
VI	0,3	0,8	3,5	9,6	1,6	7,6	2,5	3,2	3,2	2,7	0,0	
VII	68,4	19,4	32,0	37,0	32,8	14,6	19,4	26,1	57,8	23,3	276,6	
VIIIabd	128,9	200,6	171,9	185,2	189,5	230,2	78,8	214,0	360,2	179,9	373,1	0,7
VIIIc	87,7	78,1	113,1	143,6	174,9	76,0	84,8	145,7	97,1	54,5	173,3	10,5
IXa	390,4	753,3	637,3	542,0	580,8	551,8	255,1	208,6	247,1	285,6	286,1	299,0

Figure 8. Spanish landings (in tons) of long-finned squid species (Fam. Loliginidae) by ICES Subarea/Division during the 2000-2010 period.

Both in Sub-divisions IXa south and north, *Loligo spp* and *Alloteuthis* spp landings appear separated due to their high commercial importance. Figure 9 shows the proportion of each species group by Sub-Division. Both groups yielded higher landings in IXa south than in IXa north. *Alloteuthis* spp landings in IXa south ranged between 286 t in 2004 (i.e. higher landings than *Loligo* spp ones in this year) and 40 t in 2007, whereas in IXa north the highest record was 6.5 t in 2004. In both Subdivisions, the first half of the time series in both Subdivisions recorded the highest landings. In the last years *Alloteuthis africana* is also occasionally present in the Gulf of Cadiz (IXa-South) landings, mixed with the other *Alloteuthis* species (Silva *et al.*, 2011).



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Alloteuthis spp	68.0	178.4	188.2	252.5	286.8	175.8	38.5	40.9	47.5	53.4	46.0
Loligo spp	276.8	524.8	395.8	266.3	244.4	354.4	215.6	159.9	178.7	218.0	220.2



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Alloteuthis spp	2.1	0.5	0.8	0.1	6.5	1.3	2.1	1.0	2.3	6.1	2.6
Loligo spp	43.4	49.5	38.8	23.2	43.1	20.3	4.5	6.8	18.6	8.1	17.3

Figure 9. Long finned squid landings by species in Sub-Division IXa south and north during 2000-2010 period.

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WORKING DOCUMENT
ICES Working Group on the Cephalopod
Fisheries and Life History
Cadiz, 26 March-30 March 2012

UPDATE OF THE BASQUE CEPHALOPOD FISHERY
IN THE NORTHEASTERN ATLANTIC WATERS
DURING THE PERIOD 1994-2011
by

Marina Santurtún[1], Ane Iriondo, Iñaki Artetxe, Estanis Mugerza, Jon Ruiz

INTRODUCTION

Up to 2011 AZTI-Tecnalia has continued monitoring cephalopod landings, as part of multispecific catch, and discards monthly and fishing effort by sea area and gear of the Basque Country. Compilation and updating of the cephalopods catches made by the Spanish and Basque fleets landed at the Basque Country ports is updated every year.

Cephalopod catches are considered as by-catches of other directed demersal fisheries operated by the Basque fleet, targeting hake, anglerfish and megrim and more than other 30 species. These demersal fisheries operate in different sea areas – ICES Sub-areas VI, VII and Divisions VIIIa,b,d (Bay of Biscay) and VIIIc (eastern Cantabrian Sea)- and different gears: bottom trawl, pair-trawlers, longliners, purse-seiners, nets, artisanal hook and lines and traps or pots. However, cephalopods obtained in mixed fisheries ("Baka" Otter trawls) are becoming more important in relation to the species composition of the catch.

In this document, data of the Basque Country cephalopod landings from 1994 to 2010 are presented. Catch data correspond to groups of similar species comprising more than two or three species, with similar appreciation in the markets. Data available were compiled in the following commercial species groups according to local names:

- Squid: mainly *Loligo vulgaris* and also*, L.forbesi, Alloteuthis media* and *A.subulata*
- Cuttlefish: mainly *Sepia officinalis* and also *S.elegans* and *S.orbignyana*
- Short-finned squid: mainly *Illex coindetii* and also *Todaropsis eblanae*, and European flying squid: *Todarodes sagitattus*,
-Octopus: mainly *Eledone cirrhosa* and also *Octopus vulgaris.*

Most of the large trawlers of the Basque Country catch cephalopods mainly in the Bay of Biscay (Div. VIIIa,b,d), but also in Sub-area VII (Celtic Sea and Porcupine Bank) and in Sub-area VI (both in the western part of Scotland and around Rockall Bank). Local trawls, artisanal gillneters and some pots or trap vessels working usually in the eastern Cantabrian Sea (Div. VIIIc) also catch some cephalopods.

The target species are usually mixed demersal fish, mainly hake, megrim or anglerfish, but together with those, variable quantities of cephalopods are caught. The proportion of these catches varies in relation to the sea area, the gear used and the distinct seasonality of these species.

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Landings of cephalopods in Sub-areas VI, VII and Divisions VIIIa,b,d and VIIIc.

During 2011 and in Div. VIIIa,b,d, the largest landings of squids were recorded during January and December and for cuttlefish mainly during October, November and December. Squid landings reached 98 t in December while cuttlefish landings reached a peak of around 45 t in November. Short-finned squid maximum landings occurred in March being around 39 t. Landings of octopus were higher in Div. VIIIa,b,d during March reaching around 52 t (Fig. 1).

In Figure 2 percentage of landings by species groups and sea area in 2011 are presented. Landings from Div. VIIIa,b,d for squids comprise 99.5% and for cuttlefish 97%. In the case of short-finned squid 63% and for octopus the 89% of landings came from Div. VIIIa,b,d.

For 2011, each of the cephalopod groups contributed evenly to the total cephalopod catches, 51% squids, 18% cuttlefish, 12% short-finned squid and 19% octopus. 92% of total cephalopod landings came from Div. VIIIa,b,d (Fig. 3).

Looking at the catch evolution of squid and cuttlefish during the period 1994-2011, the most remarkable feature is the continuous seasonality of the landings in all areas (Fig. 4). The largest landings occur from October to February for all cephalopod species, and also a marked alternation of years of rather high and low landings is observed mainly in squids. For all data series, no cuttlefish, short finned squid and octopus landings were registered in Sub-area VI. The great fishery *reservoir* for all species groups appears to be the sea area comprises within Div. VIIIa,b,d. Catches evolution of short-finned squid does not present the marked seasonality described for the other species groups, however maxima landings are registered from March and April almost till June. Octopus higher landings are registered during autumn and winter months (Fig. 4).

Cephalopod historical landings deployed by Basque vessels show an important decreasing trend from 1994 to 2001. From 2002 onwards, the total landings of cephalopods remain quite stable but with inter-annual fluctuations. From 2009 and increasing trend is observed (Figure 5). Focusing on fishing effort (Figure 6) it shows a decreasing trend from 1996 to 2009 which is caused by the disappearance of some Basque vessels in the last years due to regulation implementation and other different factors. In 2010 and 2011 an increasing trend in effort is observed, especially in relation to the increase in the number of days of the pair trawlers and some trips deployed in Subarea VII by the “Baka” otter trawler.

Nowadays, the most important Basque fleet targeting cephalopods are “Baka” bottom otter trawlers in the Division VIIIa,b,d. Within this fleet four different metiers have been defined and the landings of the species have been included in one or other metier following this segmentation: demersal fish, small pelagic, mixed cephalopods and demersal, and others. For the last five years, cephalopod percentages in catches for the different metiers are quite constant along the time series.

Landings per unit of effort of cephalopods in Sub-areas VI, VII and divisions VIIIa,b,d.

<u>Fleets selected</u>

A total of 6 fleets landing their catches in Ondarroa or Pasajes have been selected. Just the corresponding catches (landings) have been used for each fleet. Data on some other fleets have not been included because their significance in the cephalopod total catches is markedly small compared to those of the “Baka” Otter trawl and Pair Trawls with Very High Vertical Opening (VHVO) nets. The fleets considered are:

. BAKA-trawl-Ondarroa in Div. VIIIa,b,d

. BAKA-trawl-Ondarroa in Sub-area VII
. BAKA-trawl-Ondarroa in Sub-area VI
. VHVO P. Trawl-Ondarroa in Div. VIIIa,b,d
. VHVO P. Trawl-Pasajes in Div. VIIIa,b,d
. VHVO P. Trawl-Pasajes in Sub-area VII

All of them, together considered, represented close to 94% total cephalopod landings in the Basque Country ports in 2011.

It has to be mentioned that from 2005 onwards the VHVO P. Trawl-Pasajes in Sub-area VII fleet disappears and from 2008 onwards VHVO P. Trawl-Pasajes in Div. VIIIa,b,d fleet also disappears. In 2009 the BAKA-trawl-Ondarroa in Sub-area VII did no effort and change its fishing area to Division VIIIa,b,d. In spite of that, the 6 fleets selected above will be used to show time series trends in CPUE data but it must be considered that for the last years only 3 of them will be active and will provide effort information.

Effort for each fleet was obtained from the information provided yearly by the log books filled out by the skippers of most of vessels landing in Ondarroa and Pasajes, and processed by AZTI. The effort unit used has been the fishing days.

When summing up all cephalopod landings and they are divided by main fleets fishing efforts, the landing per unit of effort are obtained (LPUE) (Figure 8). This figure shows a stable situation in LPUE from 1995 till 2002. Some fluctuations with high and low abundances are observed in the data series. During the last period of the series, and in relation to Div. VIIIabd, LPUEs for squid has markedly increase whilst cuttlefish, octopus and short-finned squid have, in general, decreased. In Subarea VII, Octopus LPUEs have markedly decreased since 2007, mainly driven by the decrease in the effort deployed by the Basque fleet in that area. Octopus caught in this area is mainly *Eledone cirrhosa* catches of this species in the last year are nil. Short finned squids LPUEs are maintained at low levels along data series. In 2011 the sharp increase in due to a high catch in a unique trip deployed by “Baka” Otter trawlers in Subarea VII.

Discard estimation of cephalopods

Since 2001, a discard sampling program has been carried out by the AZTI- Tecnalia on the Basque fleet (North Spain). Sampling developed during 2001 and 2002 correspond to the Study Contract (98/039). 2003 onwards, AZTI has continued sampling discards onboard commercial fleet under the National Sampling program. Only the trawl fleet is considered in this study, since the rest of the segments of the Basque fleet in the North East Atlantic like purse seine, etc. (Ruiz, et al. 2009) have negligible levels of discard.

The sampling strategy and the estimation methodology used in the “Discard Sampling Programme” have been established following the “*Workshop on Discard Sampling Methodology and Raising Procedures*” guidelines (Anon., 2003). The observers-on-board programme is based on a stratified random sampling, considering the Fishery Unit as stratum and the trip as sampling unit.

The trawl fleet operating in the ICES Sub-area VII and Div. VIIIa,b,d was segmented in the following Fishery Units taken into account fishing area, gear and target species (described in the Report of the EC Study Contract 98/095; Santurtún *et al.*, 2003):

- Basque “Baka” bottom trawlers fishing in the ICES Sub-area VI targeting blue ling and witch.
- Basque “Baka” otter trawlers fishing in the ICES Sub-area VII targeting anglerfish and megrim.
- Basque “Baka” otter trawlers fishing in the ICES Div. VIIIa,b,d targeting a great variety of species (mixed fisheries).

- Basque Pair trawls operating with VHVO nets in ICES Div. VIIIa,b,d targeting hake.

Landings and effort are used in the raising procedure; nevertheless, only discard estimates using effort as raising procedure are presented in this document.

Although the sampling tried to cover all species retained and discarded in the different fleets, no length sampling was carried out for any of them. Thus, no length distribution and numbers of all discarded and retained cephalopod species were estimated whilst weights retained and discarded were obtained.

In Table 1 the amount of estimated cephalopods discarded (in percentage) during 2003-2011 series is presented.

In general terms, it can be said that:

- Short-finned squid mainly and curled octopus (*Eledone cirrhosa)* in a lesser extent are the most discarded species because of their low price in market. Short-finned squid are mainly discarded in Subarea VI. In Subarea VII, these species group are not discarded since 2009.

- The lower discarding percentage was deployed in “Baka” otter trawlers operating in Subarea VI and pair trawlers operating in Divisions VIIIabd, this may be because they catch less by catch species. Catch composition are less multispecific than in “Baka” Otter trawlers in the Bay of Biscay.

- Data presented in this document has to be considered as very preliminary. Thus, discard data here presented has to be taken just as reflect of the discard practices carried out by these fleets and never as absolute numbers.

Prices of cephalopods in Basque ports

Cephalopod prices in Basque ports from 2001 to 2009 are presented in figure 9. The price given is the mean value of both landing ports Ondarroa and Pasajes. It can be observed that the mean value has remained quite stable in the last nine years. Squids have the best price of landed cephalopod that goes from 6 euro in 2001 to 7.2 euro in 2010. Cuttlefish is the second better paid which goes from 2.50 euro in 2001 to 3.10 euro in 2009. Octopus had the peak in price in 2003 but after that it has decrease some years and in 2009 it was around 3.10 euro. Finally, the short-finned squid, which is the cephalopod with lower prices in the time series, shows a price of 1.23 euro in 2010.

In general terms, prices of cephalopods hardly have increased in the last nine years. Only in squids is observed a slight increase.

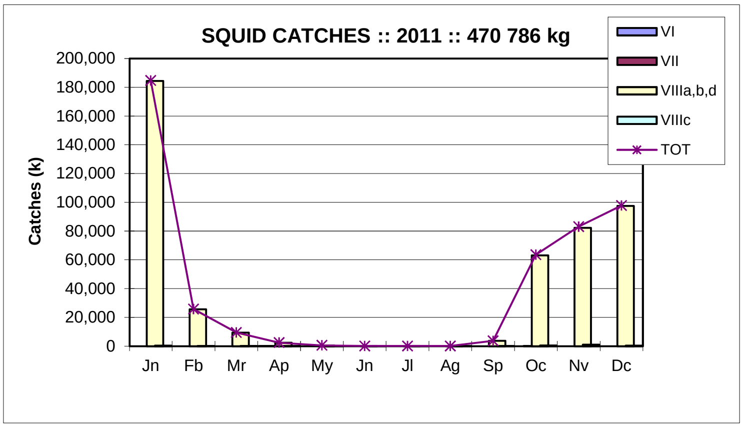
Conclusions and further work

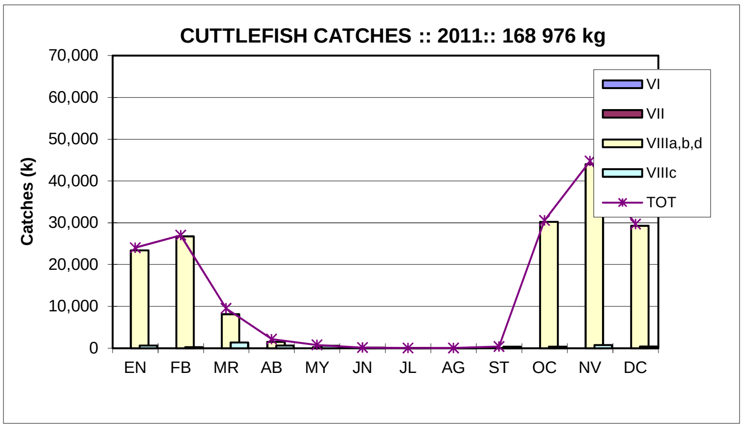
Cephalopod historical landings decreasing trend from 1994 to 2011 should be more in detail analyzed. A study should be desirable to actually define if changes in landings are due to changes in fisheries/metiers (fishing strategies due to market reasons), real decrease in fishing capacity or a real decrease in the abundance of these species. The comparison of the historical landings of cephalopods and LPUE data shows that LPUE data do not present the same decreasing trend as landing data. Therefore, one conclusion could be that despite the landings decrease, the abundance indices (LPUE data) of the fleets analyzed do not show this decreasing trend in the abundance of cephalopods.

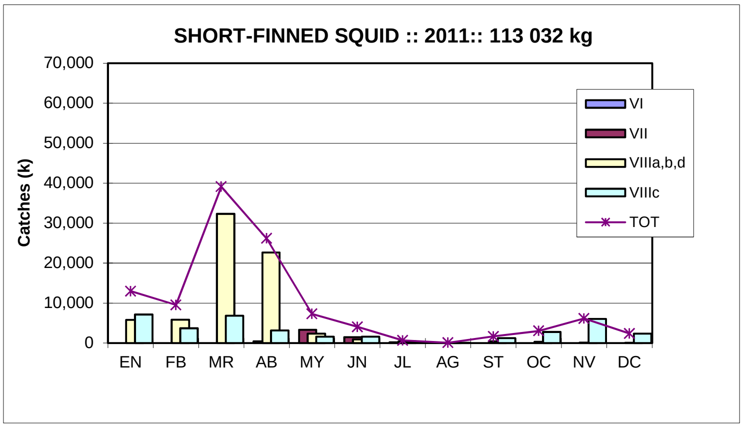
Studies on discards practices could support evidences to some of the possible scenarios described above. First discard studies deployed in AZTI started in 2000 under Study Contract (98/039) partly financed by the EU and the Basque Government. AZTI continues sampling discards on board commercial fleets under the National Sampling Programs since 2002. A more detail study on discard practices deployed by fisheries targeting cephalopod is still to be accomplished.

The contribution of the different cephalopods species groups to the total landing composition has been updated from 2005 to 2011. From previous studies, cephalopod proportion in the landings markedly increased from around 8 % in 1997 to almost twice in 2001 in "Baka" otter trawls operating in Div. VIIIa,b,d (Santurtun et al., 2005, WD), coinciding with the bad shape of the hake stock.. In the last studied five years, the cephalopod proportion in landings is around 15% with a peak of 28% in year 2007. Cephalopods appears to be an important accessory species for the baka trawlers in division VIIIa,b,d due to, specially, reduction of quotas of some traditional demersal species during the period 2002-2005, with apparent constant availability and relatively good market prices.

The analysis of prices shows that in the last nine years there has been hardly increase in prices of cephalopods, as it has also occurred for the rest of the main demersal commercial species. The squids remain being the cephalopod with highest price and the short-finned squid is the one with lowest price.







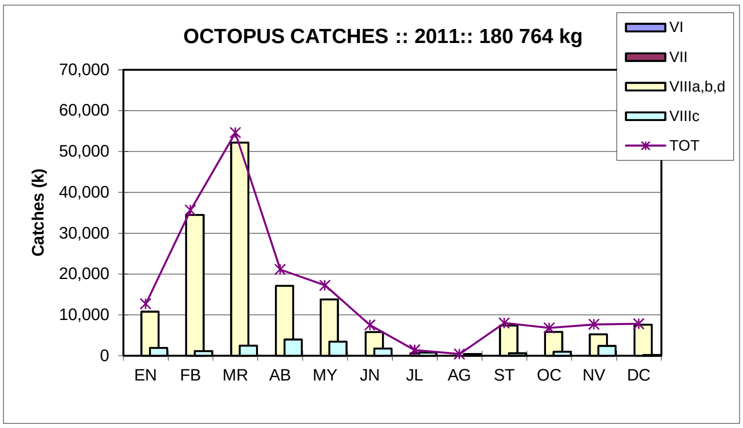
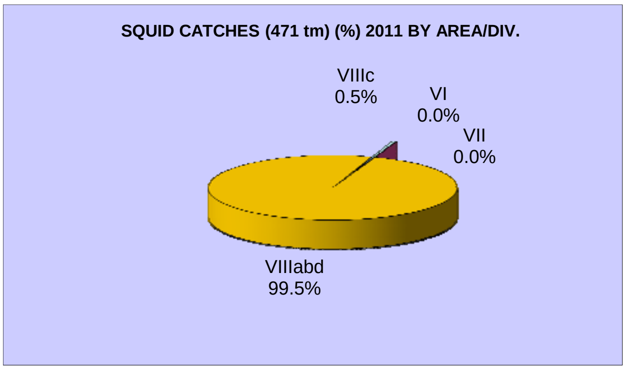
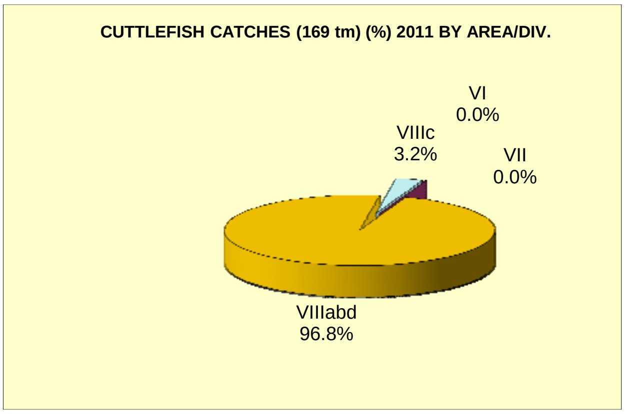
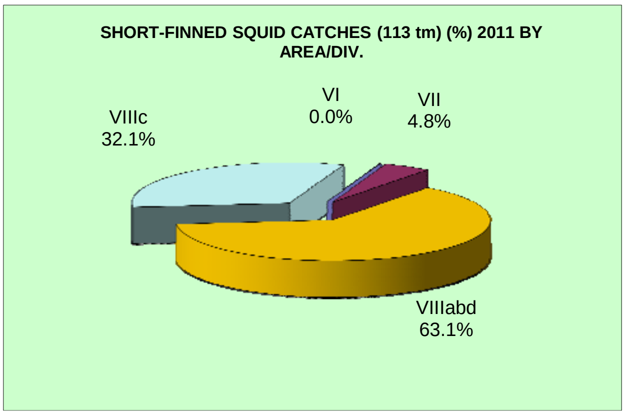


Figure 1. Monthly distribution of the Basque Country Catches (landings in kg) of Squid, Cuttlefish, Short-finned squid and Octopus by sea area, in 2011.







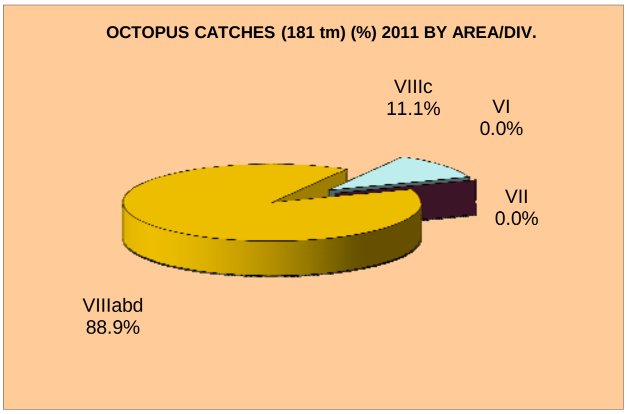
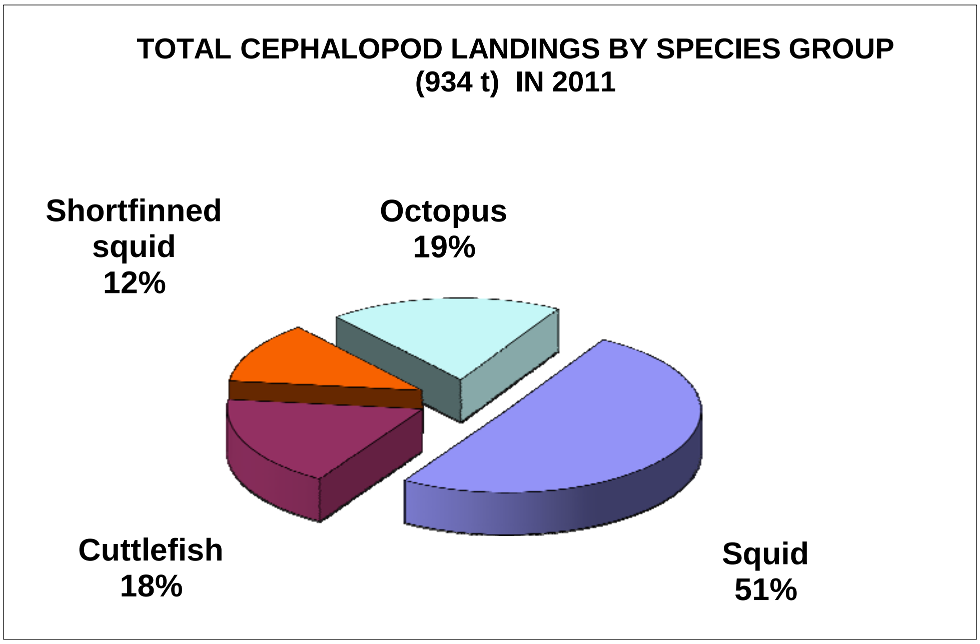


Figure 2. Percentage of the Basque Country landings of Squid, Cuttlefish, Short-finned squid and Octopus by sea area, in 2011.



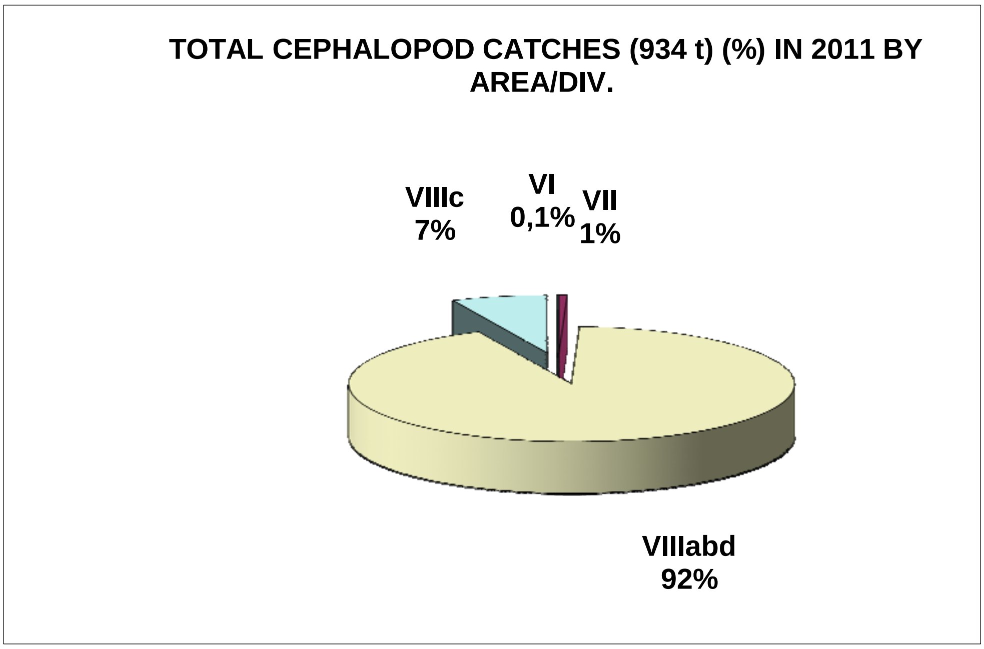


Figure 3. Total composition in percentage of the Basque Country landings. Above: By species group. Below: By sea area for 2011.

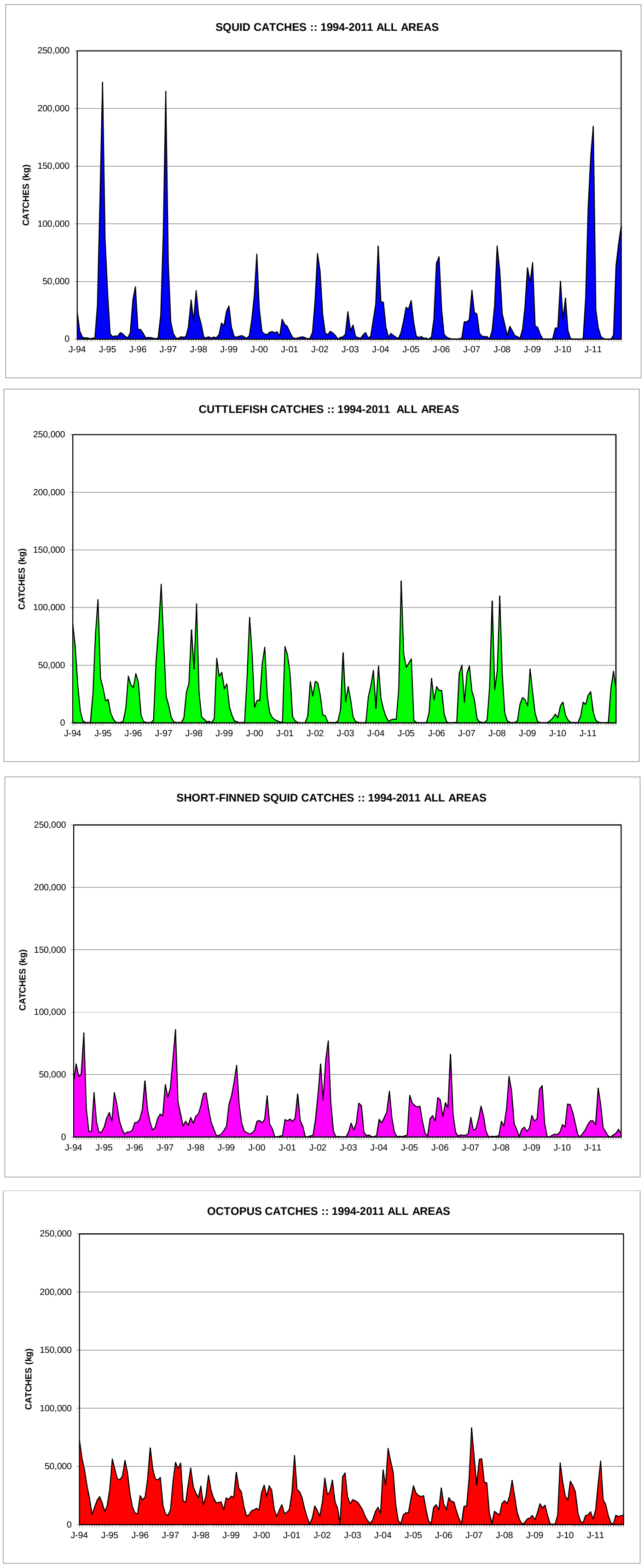


Figure 4. Cephalopods landing (in kg) evolution of the Basque Country by specie group considering all Areas and Divisions together (VI, VII, VIIIabd and VIIIc) for the total period 1994-2011.

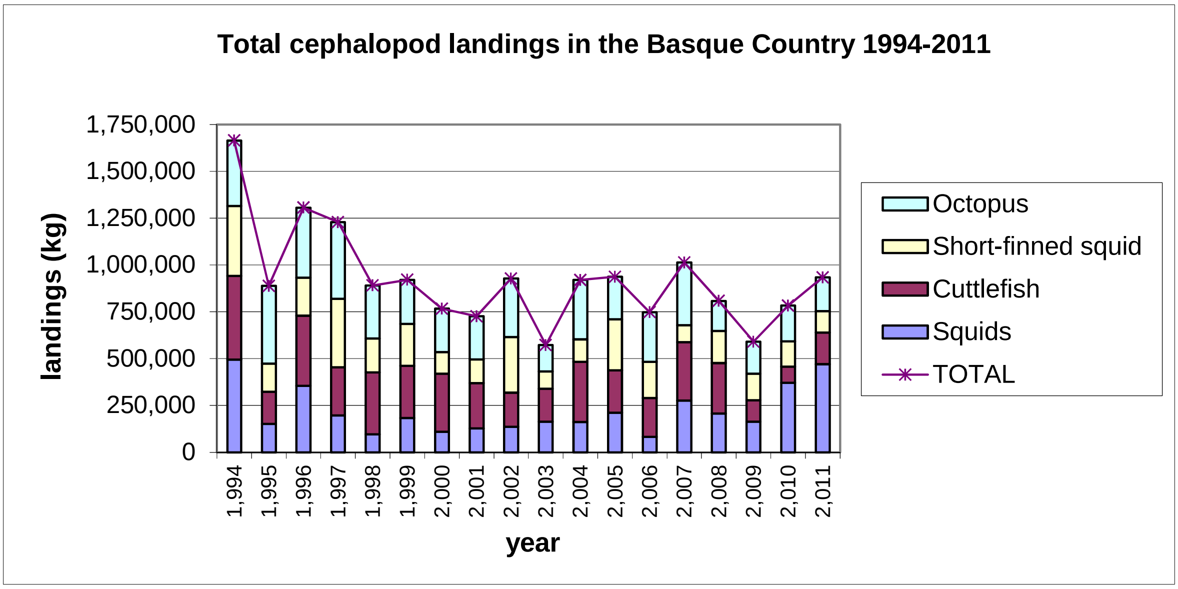


Figure 5. Cephalopods landing evolution of the Basque Country by species group for the total period 1994-2011.

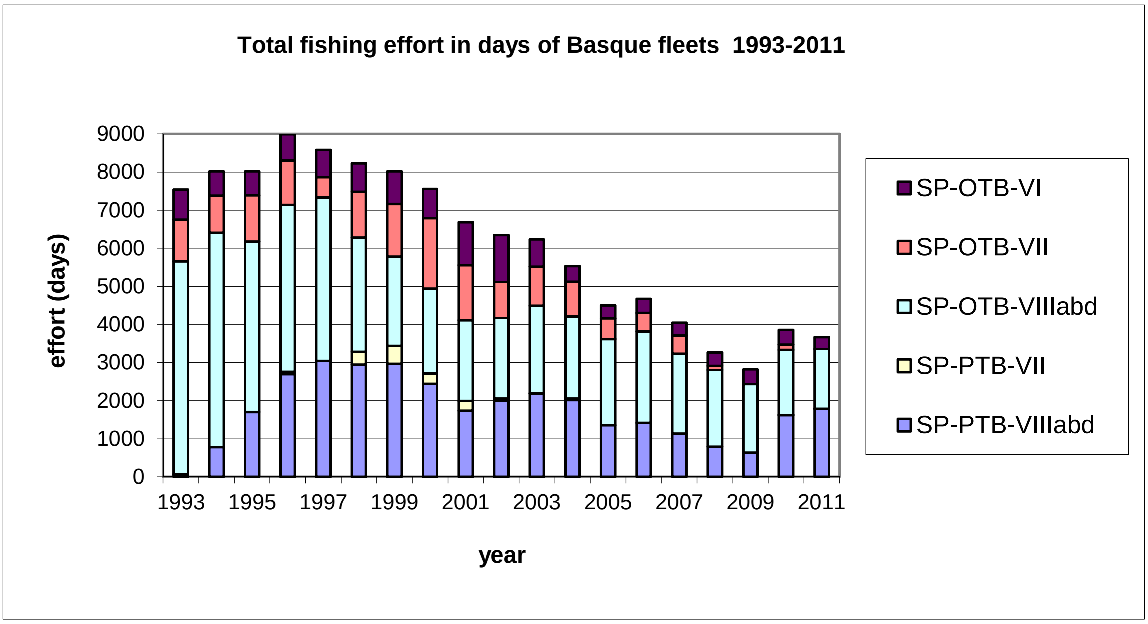


Figure 6. Total fishing effort of the Basque fleets from 1993 to 2011.

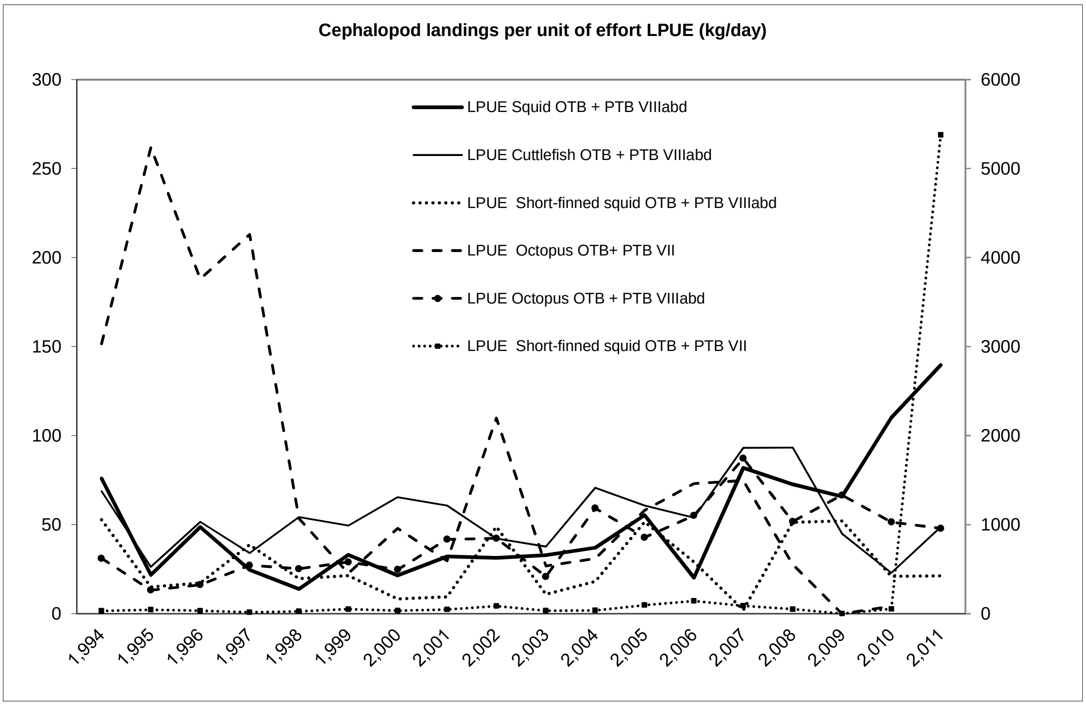


Figure 8. Cephalopod landings per unit of effort (kg/day) of the Basque fleet from 1994 to 2011.

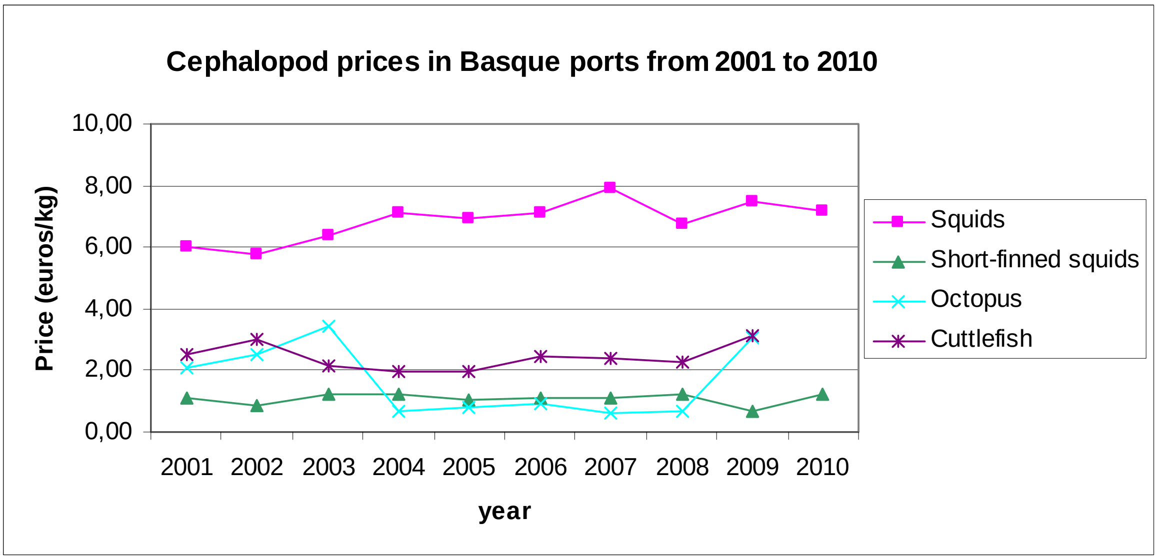


Figure 9. Cephalopod prices in Basque ports from 2001 to 2010.

Table 1. Estimated cephalopod discard (kg) during 2003-2011 series is presented.

			% discards from total cepphalopod catch								
Gear	Area	Species	2003	2004	2005	2006	2007	2008	2009	2010	2011
	VI	Short finned squid	100%	-	-	-	-	100%	100%	100%	100%
		Curled octopus	-	-	-	-	-	-	-	-	-
		Cuttlefish	-	-	-	-	-	-	-	-	-
	VII	Short finned squid	61%	77%	19%	4%	52%	87%	-	-	-
-OTB		Curled octopus	33%	1%	38%	12%	56%	-	-	-	-
		Cuttlefish	12%	-	-	-	-	-	-	-	-
	VIIIabd	Short finned squid	59%	57%	17%	35%	38%	12%	15%	31%	87%
		Curled octopus	28%	5%	7%	0%	19%	2%	14%	5%	74%
		Cuttlefish	0%	1%	2%	-	1%	-	8%	-	3%

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Estimates on Cephalopods Discards by Spanish NE Atlantic Trawl Fishing Fleets

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Abstract

Yearly cephalopods discard estimations for Spanish trawl fleets operating in Northeast Atlantic area (ICES VI, VII, $VIII_c$ and IX_a) over the period 2003-2010 are presented. Estimations are aggregated from métier to fishing ground level. Only information for the most important species in terms of discarded biomass and those included in the Data Collection Framework directive are presented. Squid species belonging to the family *Ommastrephidae* and the *Octopodidae Eledone cirrhosa* were the most discarded species in the northern fishing grounds, nevertheless volume discarded of those species are much higher in ICES Sub-area $VI - VII$ than in Divisions $VIII_c$ and IX_a north. Very low discard values were observed in ICES Division IX_a south (Gulf of Cádiz), being *Octopus vulgaris* and *Eledone moschata* the most discarded species.

Keywords: `Cephalops, Discards, Trawl, NE Atlantic.`

1 Introduction

Spanish data on cephalopods discards (from the Instituto Español de Oceanografía (IEO)) have never been provided to ICES `WGCEPH` in the past.

Information herein presented have been obtained by the 'Spanish Discards Sampling Programme' for Otter Botton Trawlers (OTB) and Pair Trawlers fleets (PTB), covering ICES Subareas VI-VII, and Divisions $VIII_c$ and IX_a. The programme started in 1988, with annual discontinuity until 2003, year of implementation of the Data Collection Framework (table 1).

Data series reveal cephalopods as common by-catches for the sampling fleets operating in the North East Atlantic Region. Once onboard, their sorting into marketable/discard fractions not always follows a clear pattern, and the skipper decisionmaking have described by the obsevers to be dependent on species, season, size, and many other factors acting alone or interacting each others.

The most common species found in discard fractions are squids species belonging to the family *Ommastrephidae*, such as *Illex coindetii* (Verany, 1839), or *Todaropsis eblanae* (Ball, 1841), and species representative to the family *Octopodidade* such as *Eledone cirrosha* (Lamarck, 1798) in the northern fisheries, and *Eledone moschata* (Lamarck, 1798) in the Gulf of Cádiz. Many other species, including deep species have been recorded during the onboard sampling, but their rare presence give low discard amounts once data is raised to fleet level.

The main objective of this working document is to provide information of mean kg/trip of all caught and discarded species of cephalopods and also a selection of the most discarded cephalopods species caught by Spanish fleets operating in ICES Subareas VI and VII and Divisions $VIII_c$ and IX_a. Data presented are only for the period with no discontinuity; 2003 to 2010. Total biomass discarded in 2011 are not presented due to no availability of total fleet effort information.

Year	Project
1988-1989	National Project
1994	EC Project: Pem/93/005
1997	EC Project: 95/ 094
1999-2000	EC Project: 98/095
2001	EC Project: 99/063
2003-2012	DCF

Table 1: Summary of funded projects which have supported the Spanish Discards Sampling Programme

2 Material and methods

2.1 Sampling strategy

The sampling strategy and the estimation methodology used in the 'Spanish Discards Sampling Programme' has been little modified since 1988, and since 2003 follows the guidelines established by ICES (ICES, 2003; ICES, 2007).

The observers-on-board programme is based on a hierarchial sampling design, applied to stratas defined by two dimensions. Year was considered the strata unit for the temporal dimension until 2009, when the DCF asked for quarterly estimates. Herein results are organised and presented at yearly basis. The second sampling dimension is technical, and the strata unit is the Métier. In regards to the sampling units, trips (the Primary Sampling Unit [PSU]) are randomly or quasi-randomly selected from the bidimensional strata. Once onboard, the observer sistematically select hauls for sampling, (the Secondary Sampling Unit [SSU]) when the total number of hauls is expected to be high during the sampled trip; otherwise, all hauls are sampled. The Ultimate Sampled Unit (USU) is the numbers of individuals by cephalopods species found in discard sample.

Only trawl fleet information is used in this document. Other fleets (i.e. long line fleet) were evaluated, showing low cephalopods discards along the areas under study (Pérez et al., 1996). Gillnet discard information is being obtained since 2008, but the time series available has been considered too short to be presented in the present document.

2.2 Fleets stratification

Fishing area, gear and target species are the auxiliary covariates used to stratify fleets into métiers. Two Spanish trawl métiers are defined in the ICES Subareas VI and VII:

- `OTB_DEF_70_99_0_0` trips targeting Megrim, Monk and Hake

- `OTB_DEF_100_119_0_0` trips targeting Hake and Monk

More complex structure is found for the Spanish trawl fleet operating in ICES Divisions $VIII_c$ and IX_a north :

- `OTB_DEF_>=55_0_0`: trips targeting a mixed of demersal species using conventional OTB gears
- `OTB_MPD_>=55_0_0`: trips targeting a mixed of pelagics and demersal species using high vertical opening OTB gears
- `PTB_DEF_>=55_0_0`: trips targeting demersal species using bottom pair trawls

Finally, only one métier is defined for the ICES Division IX_a south :

- `OTB_MCD_>=55_0_0`: trips targeting demersal species using conventional OTB gear

Discard estimates by métier have been aggregated into fishing ground level, in order to present total discards by the whole Spanish trawl fleets operating in 'Western Irish waters & Rockall bank' (Subareas VI and VII) , 'north Iberian waters' (Divisions $VIII_c$ and IX_a north) and Gulf of Cádiz (Division IX_a south) separately.

2.3 Sampling scheme & Raising procedures

Let h_{ij} be the j-th ($j = 1, \ldots, J$) sampled haul in sampled trip i ($i = 1, \ldots, t$) and d^s_{ij} be a randow sample drawn from the total discard volume (d_{ij}) in h_{ij}. Let

$$r_{ij} = \frac{d_{ij}}{d^s_{ij}} \tag{1}$$

be the ratio of the sample weigth to the total discard weight.

For a given species, let f_{ijk} be the k-th (k= 1,. . . , n) sampled individual in d^s_{ij}. Total individuals in d^s_{ij} is denoted as $F_{ij} = \sum_{k=1}^{n} f_{ijk}$. Once counted, F_{ij} is weigthed by using high precision dynamometers to obtain F^w_{ij}.

2.3.1 Trip level

To simplify the notation, further steps will be expressed in terms of numbers:

Let

$$y_{ij} = F_{ij} \times r_{ij} \tag{2}$$

be the estimated numbers of individuals discarded in haul j. The mean number of discarded in trip i is

$$\bar{y}_i = \frac{1}{J} \sum_{j=1}^{J} y_{ij} \tag{3}$$

with variance

$$Var(\bar{y}_i) = \frac{1}{J-1}\sum_{j=1}^{J}(y_{ij} - \bar{y}_i)^2 \quad (4)$$

if J is the total number of hauls carried out in trip i, then the estimated total discards (in numbers) is

$$Y_i = \sum_{j=1}^{J} y_{ij} \quad (5)$$

else,

$$Y_i = \bar{y}_i \times H_i \quad (6)$$

with H_i being the total number of hauls (sampled + unsampled). The variance associated to (6) is

$$Var(Y_i) = (1 - \frac{J}{H}) \times H^2 \times \frac{Var(\bar{y}_i)}{J} \quad (7)$$

2.3.2 Métier level

Estimates at trip level can be raised to métier level by using different auxiliary variables, such as fishing effort (used for the northern métiers), or total landings (used for the Gulf of Cádiz métier). As an exampled, steps for raising by effort is showed below:

Mean discarded by trip is estimated to be

$$\bar{Y} = \frac{1}{t}\sum_{i=1}^{t} \times Y_i \quad (8)$$

with associated variance

$$Var(\bar{Y}) = \frac{1}{t-1}\sum_{i=1}^{t}(Y_i - \bar{Y})^2 \quad (9)$$

(8) and (9) can be raised to the total fishing effort of the fleet (T), to obtain an estimation of total Discarded (D) of the fleet:

$$D = \bar{Y} \times T \quad (10)$$

with variance

$$Var(D) = (1 - \frac{t}{T}) \times T^2 \times \frac{Var(\bar{Y})}{t} \quad (11)$$

- Raising by landings (Method used for métiers operating in ICES IX_asouth)

2.4 Cephalopods species selection

A selection of species/groups of species were carried out using yearly mean species discards per trip information (eq.8). Only the selected species/groups estimations are raised to fleet (eq.10). The species selection criterion were;

- Species or groups of species representing $\sim 90\%$ of interannual cephalopods discards.

- Species not selected by the first criterion but included in the Data Cllection Framework (DCF) list of target species for sampling.

The criterion were applied separately for every fishing ground. Taxonomic difficulties to distinguish species onboard caused the aggregation of species into higher level taxon, such as family.

3 Results

3.1 Trip population and sampling coverage

Table 2 shows fishing effort of the fleets (T) sampled trips (t), sampling coverage (%, $(\frac{t}{T}) \times 100$) and total number of sampled hauls (h). In average, 1221 ± 7 trips were yearly performed by the fleet operating in the Western Irish waters & Rockall bank. The program covered around 1% of the total trips per year, increasing to 1.2 in the last two years. Concerning the north Iberian waters fishing activity, a yearly average of 16701.6 ± 379.3 trips were carried out by the fleet for the same period. It can be noted a steady increase in sampling coverage from 0.2% to $\sim 0.5\%$ in the last two years. Fleet effort for the Gulf of Cádiz yield high interannual 23834 ± 1910 value, being the sampling coverage ($\sim 0.1\%$) lower than the other fishing grounds (table 2) .

Fishing Ground	Year	T	t	%	h
Western Irish waters & Rockall bank (VI-VII)	2003	1275	9	0.70	369
	2004	1315	11	0.80	400
	2005	1297	10	0.80	337
	2006	1293	13	1.00	376
	2007	1322	12	0.90	368
	2008	1147	11	1.00	353
	2009	1206	15	1.20	428
	2010	1100	13	1.20	382
north Iberian waters ($VIII_c$,IXa north)	2003	18523	46	0.20	167
	2004	21257	43	0.10	177
	2005	12065	84	0.50	264
	2006	18749	68	0.30	211
	2007	18506	78	0.30	258
	2008	15328	82	0.40	256
	2009	15177	99	0.50	308
	2010	14008	94	0.50	295
Gulf of Cádiz (Division IXa south)	2005	31962	21	0.06	47
	2006	25924	29	0.11	72
	2007	23744	28	0.12	59
	2008	18675	18	0.09	58
	2009	21072	21	0.10	56
	2010	21631	23	0.10	57

Table 2: Trip population (T),sampled trips (t), sampling coverage (%) and number of sampled hauls (h) by fishing ground and year.

3.2 Species selection

Table 3 shows yearly kg/trip estimations of cephalopods discards ($\bar{Y}$) in Sub-areas VI-VII. The most discarded species over the sampling period 2003-2010 was found to be *Illex coindetii* $\bar{\bar{Y}} = 855.6 \pm 176.8$, followed by *Eledone cirrhosa* $\bar{\bar{Y}} = 650.1 \pm 142.8$ and *Todaropsis eblanae* $\bar{\bar{Y}} = 533.5 \pm 95.6$. Difficulties to distinguish *Illex coindetii* and *Todaropsis eblanae* during the onboard sampling explain the high values found for *Ommastrephidae* (the family containing both species), $\bar{\bar{Y}} = 353.5 \pm 154.7$. Hereafter, *Ommastrephidae* species will be integrated into this family record. Discards of *Eledone cirrhosa* and individuals belonging to the family *Ommastrephidae* represents $\sim$ 92% of total cephalopd discards in this area. Discards of species included in the DCF (*Anex III*) represents low percentage relative to the global cephalopods discards per trip; *Loligo vulgaris* represents 1.4% , whereas *Sepia officinalis* and *Octopus vulgaris* represents only 0.2% each.

Cumulative percentage of interannual cephalopods discards per trip shows more species diversity within 90% in the north Iberian waters (table 4), containing up to 8 species or groups. *Eledone cirrhosa* is the most discarded species in average, $\bar{\bar{Y}} = 35 \pm 6.60$. As in the northern ground, short finned squids belonging to the family *Ommastrephidae*, and the taxon *Ommastrephidae* itself, are represented within the quantile 90. *Rossia macrosoma* represents $\sim 7\%$ of the total average, being the 3^{er} species in importance $\bar{\bar{Y}} = 5.1 \pm 2.1$, whereas unidentified species belonging to the subfamily (*Sepiolinae*) represents $\sim 6\%$. Concerning species included in DCF, the *Octopus vulgaris* importance in discard profile is higher than in the northern fishery, representing 3.5%. Same pattern is found for *Sepia officinalis* (1.6%). Discard amounts for *Loligo vulgaris* are negligible.

Cephalopods discards estimations per sampled trip from the Gulf of Cádiz (IX_a South) fisheries are shown in table 5. Lower discards biomass are estimated in comparison to the northern fisheries. In general, species from the family *Octopodidae* represents $\sim 85\%$ of cephalopods discards. *Octopus vulgaris*, the unique species under legal regulation (Minimun Landing Weigth (MLW) = 1 Kilogram), is the most discarded species $\bar{\bar{Y}} = 1.27 \pm 1.09$ in the area. Personal observations indicates that MLW induces discard practices on the species. *Eledone moschata* present similar discard estimation with $\bar{\bar{Y}} = 1.13 \pm 0.89$; this species low commercial values contribute to discard it.

species	1994	1999	2000	2003	2004	2005	2006	2007	2008	2009	2010	$\bar{\bar{Y}}$	$Error_{\bar{\bar{Y}}}$	cum %
Illex coindetii	1072.60	171.80	524.30	814.60	497.20	364.70	447.00	1147.30	958.90	2439.50	973.20	855.60	176.80	32.80
Eledone cirrhosa	170.10	224.40	314.70	854.40	229.20	651.70	527.20	1031.50	850.10	1864.60	432.70	650.10	142.80	57.80
Todaropsis eblanae	417.00	385.60	593.40	1317.90	280.20	629.80	627.20	816.80	307.40	439.30	54.20	533.50	95.60	78.30
Ommastrephidae	0.00	0.00	27.30	0.00	519.30	1554.80	857.80	0.00	920.20	8.80	0.00	353.50	154.70	91.90
Todarodes sagittatus	76.20	0.00	5.10	38.00	57.50	160.40	37.90	18.30	475.60	130.00	0.00	90.80	39.70	95.40
Loligo vulgaris	56.90	0.00	0.00	26.30	5.50	18.00	15.30	195.70	31.10	2.70	44.50	36.00	16.10	96.80
Sepiola spp.	1.40	0.00	0.00	0.00	10.60	148.20	8.10	53.80	0.00	7.30	0.00	20.90	13.00	97.60
Sepia orbignyana	11.10	0.00	0.80	18.40	2.10	183.60	2.80	10.40	0.00	0.00	0.00	20.80	15.60	98.40
Rossia spp.	0.00	0.00	0.00	84.00	1.20	0.00	60.50	0.00	1.90	0.00	0.00	13.40	8.50	98.90
Loligo spp.	1.70	0.00	0.00	0.50	0.00	0.80	80.70	1.60	4.10	4.40	0.00	8.50	6.90	99.20
Sepia officinalis	0.00	0.00	2.50	16.50	1.10	0.90	39.30	0.50	4.00	0.30	0.00	5.90	3.50	99.40
Octopus vulgaris	16.90	0.00	0.00	0.00	0.00	44.10	0.00	0.00	0.00	0.00	3.80	5.90	3.90	99.60
Octopus spp.	2.70	0.00	0.00	0.00	8.00	14.90	17.00	0.00	0.00	0.00	0.00	3.90	1.90	99.70
Rossia macrosoma	7.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.50	0.00	0.00	3.50	2.70	99.80
Loligo forbesi	0.00	0.00	1.90	14.40	0.40	4.50	0.00	0.00	0.00	0.40	0.50	2.00	1.20	99.90
Sepia spp.	0.00	0.00	0.00	0.00	5.20	0.00	0.20	0.10	0.00	0.00	0.00	0.50	0.40	99.90
Alloteuthis spp.	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	1.60	0.00	0.20	0.10	99.90
Sepia elegans	0.10	0.00	0.00	0.10	0.00	0.40	0.00	0.40	0.00	0.00	0.00	0.10	0.00	99.90
Sepietta oweniana	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.10	0.10	99.90

Table 3: Mean kg/trip per year of cephalopoda discards in Spanish fleets operating in the Western Irish waters & Rockall bank.

3.3 Total fleet discard estimates

Yearly Estimations of the selected species discards for the northern fisheries are presented in terms of biomass for data series 2003-2010 (table 6), whereas discard estimations in terms of numbers are only available since 2007 (table 7).Estimations for the Gulf of Cádiz are presented for the period 2005-2010 in both cases (tables 8- 9). Biomass estimations present high CV values, ranging from 20.2% to 99.9%. *Ommastrephidae* is the most discarded cephapods family in the Western Irish waters & Rockall bank fisheries exceeding 1400 tons in average for all sampled

Species	1994	1997	1999	2000	2003	2004	2005	2006	2007	2008	2009	2010	$\bar{\bar{Y}}$	$Error_{\bar{\bar{Y}}}$	cum %
Eledone cirrhosa	71.40	28.00	19.30	13.10	47.80	63.40	13.90	36.80	50.70	8.40	63.10	3.70	35.00	6.60	46.40
Todaropsis eblanae	5.00	42.70	0.00	7.00	6.00	0.70	58.50	0.40	6.10	16.30	5.50	0.30	12.40	5.20	62.80
Rossia macrosoma	14.20	16.00	0.00	0.30	12.50	0.00	0.00	0.00	0.30	17.80	0.00	0.00	5.10	2.10	69.60
Sepiola spp.	0.30	0.00	0.00	0.30	0.00	4.00	17.80	0.80	24.40	0.10	0.00	0.00	4.00	2.30	74.90
Illex coindetii	0.80	6.00	4.30	10.00	6.10	2.90	0.50	1.40	4.00	0.00	2.00	0.00	3.20	0.80	79.10
Ommastrephidae	2.40	0.00	1.50	1.70	1.50	24.10	1.20	0.30	0.20	3.10	0.00	0.00	3.00	1.90	83.10
Octopus vulgaris	2.50	6.10	6.20	8.30	2.00	0.50	1.20	0.00	0.00	0.00	3.50	0.70	2.60	0.80	86.50
Todarodes sagittatus	0.20	15.60	0.00	0.00	1.30	6.90	0.00	0.00	0.00	0.00	0.30	0.00	2.00	1.30	89.10
Sepia spp.	0.20	15.60	0.00	0.00	1.30	6.90	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.30	91.70
Octopodidae	2.60	0.00	0.00	0.00	0.00	0.00	2.70	0.80	12.10	0.30	0.00	0.00	1.50	1.00	93.70
Sepia orbignyana	1.10	0.00	0.00	0.00	2.40	12.00	1.90	0.00	0.00	0.00	0.00	0.00	1.40	0.90	95.60
Sepia officinalis	0.20	0.00	0.00	0.00	2.90	0.00	3.10	7.30	0.00	0.20	1.00	0.20	1.20	0.60	97.20
Sepiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.40	0.00	0.00	0.00	0.50	0.50	97.90
Loligo vulgaris	0.00	0.40	0.00	0.00	0.10	0.10	4.60	0.20	0.00	0.40	0.20	0.20	0.50	0.40	98.60
Alloteuthis spp.	0.40	4.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.30	99.10
Sepiola atlantica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70	0.00	0.20	0.20	99.40
Alloteuthis media	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	99.50
Loligo forbesi	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	99.60
Rossia spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.60	0.10	0.00	99.70
Sepia elegans	0.60	0.10	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	99.80
Loligo spp.	0.30	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.10	0.00	99.90
Alloteuthis subulata	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.90

Table 4: Mean kg/trip per Year of Cephalopoda discards in Spanish fleets operating in the north Iberian waters.

years. It must be noted a marked decrease in terms of biomass discarded during 2010 for this species. *Eledone cirrosa* discards are estimated to be lesser than those obtained for *Ommastrephidae*, being the annual average estimated in $\sim$ 500 tons. Cephalops species included in the DCF list represent minor amounts compared to the most discarded ones.

Estimations for the north Iberian waters give lower values than those obtained for the western Irish waters & Rockall bank. Interannual discard estimate for the most discarded species in the area, *Eledone cirrosa*, represents 105 tons per years, while *Ommastrephidae* discard estimates is found to be $\sim$ 71 tons per year. Notable quantities of *Sepiola spp.* discards were found only for years 2004, 2005 and 2007 whereas peaks of *Rossia macrosoma* discards biomass were found in years 2003 and 2008. DCF species discards were also found to be low, except for *Sepia officinalis* in 2006 (35.6 tons).

Species	2005	2006	2007	2008	2009	2010	$\bar{\bar{Y}}$	$Error_{\bar{\bar{Y}}}$	cum %
Octopus vulgaris	0.00	0.23	0.00	0.69	6.68	0.00	1.27	1.09	40.84
Eledone moschata	0.00	0.00	0.03	0.00	5.44	1.29	1.13	0.89	77.17
Alloteuthis spp	0.05	1.41	0.08	0.00	0.00	0.00	0.26	0.23	85.53
Eledone spp	0.00	0.00	0.00	1.05	0.00	0.00	0.18	0.18	91.32
Eledone cirrhosa	0.00	0.00	0.00	0.00	0.00	0.47	0.08	0.08	93.89
Sepia elegans	0.00	0.00	0.00	0.04	0.23	0.05	0.05	0.04	95.50
Alloteuthis media	0.00	0.00	0.00	0.00	0.17	0.10	0.05	0.03	97.11
Sepia officinalis	0.02	0.12	0.00	0.00	0.00	0.06	0.03	0.02	98.07
Sepiola spp	0.11	0.00	0.00	0.00	0.00	0.00	0.02	0.02	98.71
Todaropsis eblanae	0.00	0.00	0.00	0.00	0.00	0.11	0.02	0.02	99.36
Illex coindetii	0.00	0.00	0.00	0.00	0.01	0.09	0.02	0.01	100.00
Sepia orbignyana	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	100.00
Loligo vulgaris	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Ommastrephidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Todarodes saggitatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

Table 5: Mean kg/trip per year of Cephalopoda discards in Spanish fleets operating in the Gulf of Cádiz fisheries

Only four species discard estimations are presented for the Gulf of Cádiz. In terms of biomass, *Octopus vulgaris* was the most discarded species, ranging between 25.8 and 235.1 tons in 2006 and 2009, respectively. This species discards show very high between-year variation, being 2005, 2007 and 2010 estimated to be 0. Discards of *Eledone mostacha*, the second most discarded species in terms of biomass, are reported since 2007 with a máximun values of 44. 2 tons in 2009. *Alloteuthis spp* and *Sepia officinalis* showed very low discards, lower than 3.5 tonnes, with one peak of 27.5 tonnes in 2006, in both cases.

Fishing Ground	Species	2003	2004	2005	2006	2007	2008	2009	2010
Western Irish waters & Rockall bank (VI-VII)	Ommastrephidae	1828(27.8)	1066(30.7)	2067(50.1)	1281(44.4)	1585(27.1)	1673(31.2)	1837(29.2)	586(27.4)
	Eledone cirrhosa	615.7(52.1)	177.8(24.8)	430.2(42.1)	364.8(33.8)	790(21)	561.9(30.9)	1011(36.6)	290.2(20.2)
	Loligo vulgaris	21.2(98.3)	4.5(59.6)	14.5(49.3)	11.2(58.7)	158.4(61.8)	24.3(73.8)	2.2(56.9)	17.8(87.8)
	Sepia officinalis	15.9(52.6)	0.9(99.5)	0.7(99.6)	29.5(76.7)	0.4(97.4)	3(65.9)	0.3(72.7)	0(-)
	Octopus vulgaris	0(-)	0(-)	21.6(60.4)	0(-)	0(-)	0(-)	0(-)	2.7(99.4)
north Iberian waters ($VIII_c$,IXa North)	Eledone cirrhosa	86.1(51.2)	155.4(53.4)	44.1(21.8)	189.9(52.9)	138.8(27.1)	20.6(31.5)	153.4(29.7)	54.8(27.9)
	Ommastrephidae	66(25)	214(56.6)	108(38.4)	29(39.9)	38(32.9)	57(46.2)	49(29.3)	21(26.4)
	Sepiola spp.	0(-)	33.6(61.9)	50.9(58.8)	4.5(64.4)	57.3(42.2)	0.1(99.6)	0(-)	0.7(99.7)
	Rossia macrosoma	32(52.5)	0(-)	0(-)	0(-)	1.8(72.7)	53.8(65.5)	0(-)	0(-)
	Sepia officinalis	9.2(62.1)	0.4(99.9)	5.3(60.3)	35.6(62.1)	0.1(99.8)	0.6(91.9)	1.9(41.6)	1(48.4)
	Octopus vulgaris	8.3(82.8)	4(70)	3.2(62.8)	0(-)	0(-)	0.5(84.9)	3.1(97.4)	4.1(44.2)
	Loligo vulgaris	0.1(99.9)	1(73.8)	4.8(66.4)	0.7(58.4)	0.3(53.3)	1.2(50.4)	3.8(40.2)	2.2(30.1)

Table 6: Biomass discarded (tons) of Cephalopoda species and CV of estimations (brackets) obtained in the northern fishing grounds

Fishing Ground	Species	2007	2008	2009	2010
Western Irish waters & Rockall bank (VI-VII)	Ommastrephidae	12257.1(35.9)	13921.2(26.7)	7302.8(23.9)	3038.4(29.7)
	Eledone cirrhosa	4654.5(17.2)	4138.9(37.8)	3218.4(28.5)	1751.3(19.1)
	Loligo vulgaris	2176.6(55.9)	879.4(75.5)	31.6(66)	245.7(91.5)
	Sepia officinalis	2.1(99.5)	72.7(70.9)	14(71.8)	0(NA)
	Octopus vulgaris	0(-)	0(-)	0(-)	11.5(99.4)
north Iberian waters ($VIII_c$,IXa north)	Ommastrephidae	584(42.5)	1331.8(61.4)	894.6(44.3)	369.5(31.4)
	Rossia macrosoma	136.2(73.2)	2697.7(57.1)	0(-)	0(-)
	Eledone cirrhosa	538.1(27.7)	217.7(39.2)	903.4(27.9)	507.9(38.3)
	Sepiola spp.	987.7(47.6)	1.4(99.7)	0(-)	7.3(99.7)
	Sepia spp.	487.6(98.7)	0(-)	0(-)	0(-)
	Sepia officinalis	9.7(99.8)	16.5(95)	59.9(35.5)	45.7(54.8)
	Loligo vulgaris	14.4(68.6)	17.6(65.9)	34.7(41)	39.7(30.7)
	Octopus vulgaris	0(-)	1.9(109.9)	2.2(91.1)	41.7(61.8)

Table 7: Numbers discarded (thousands) of Cephalopoda species and CV of estimations (brackets) obtained in the northern fishing grounds

Fishing Ground	Species	2005	2006	2007	2008	2009	2010
Gulf of Cádiz (Division IXa south)	Octopus vulgaris	0 (-)	25.8 (79.4)	0 (-)	153.9 (23.7)	235.1 (80.1)	0 (-)
	Eledone moschata	0 (-)	0 (-)	0.9 (99.3)	6.3 (83.0)	44.2 (17.1)	22.6 (67.6)
	Alloteuthis spp	3.5 (85.9)	27.6 (99.4)	3.2 (90.8)	0 (-)	1.8 (43.3)	2.1 (27.0)
	Sepia officinalis	1.18(66.1)	27.47 (93.4)	0(-)	0(-)	0(-)	3.50 (60.0)

Table 8: Biomass discarded (tons) of Cephalopoda species and CV of estimations (brackets) obtained in the Gulf of Cádiz fisheries

Fishing Ground	Species	2005	2006	2007	2008	2009	2010
Gulf of Cádiz (Division IXa south)	Octopus vulgaris	0 (-)	126.6 (13.6)	0 (-)	423.5 (33.2)	648.2 (68.3)	0 (-)
	Eledone moschata	0 (-)	0(-)	8.7 (-)	53.5 (71.9)	424.1 (78.8)	303.7 (114.0)
	Alloteuthis spp	692.6 (141.6)	5713.1 (146.9)	643 (128.8)	0 (-)	579.3 (94.8)	381.9 (77.4)
	Sepia officinalis	32.73(-)	938.99 (85.5)	0(-)	0(-)	0(-)	111.40 (56.9)

Table 9: Numbers discarded (thousands) of Cephalopoda species and CV of estimations (brackets) obtained in the Gulf of Cádiz fisheries

3.4 Exploratory Data analysis (EDA)

Maps presented in figures 1 to 7 show spatio-temporal discard patterns for the most discarded species. Color points indicates class intervals defined by discard amounts in terms of biomass (Kg/haul). Interval breaks have been generated by *Kmeans* technique. Black crosses represent sampled hauls with no catch for the plotted species. Maps presented in figures 1 and 2 indicates a wide distribution of *Ommastrephidae* and *Eledone cirrhosa* discards along the Celtic sea and Porcupine bank, and a negligible discard volume are found in the rockall bank. Same species are mapped in figures 3 and 4 for the north Iberian waters fishing ground, showing no clear pattern neither in spatial nor in temporal terms. The low cephalopods discard amounts estimated for the Gulf of Cádiz explain the prevalence of light colored points (figures 5 to 7).

Figures 8 to 10 show correlations between discard amounts at haul level (KD) and physical haul characteristics. They can be interpreted as it follows: shape visually indicates degree of correlation between pairs; The more narrower the ellipse, the more correlation between pairs. In the other hand, color and tilt orientation of the ellipse indicate the sign of the correlation. Pairs between KD with the rest of variables included in the analysis show low correlation for all species and fishing grounds.

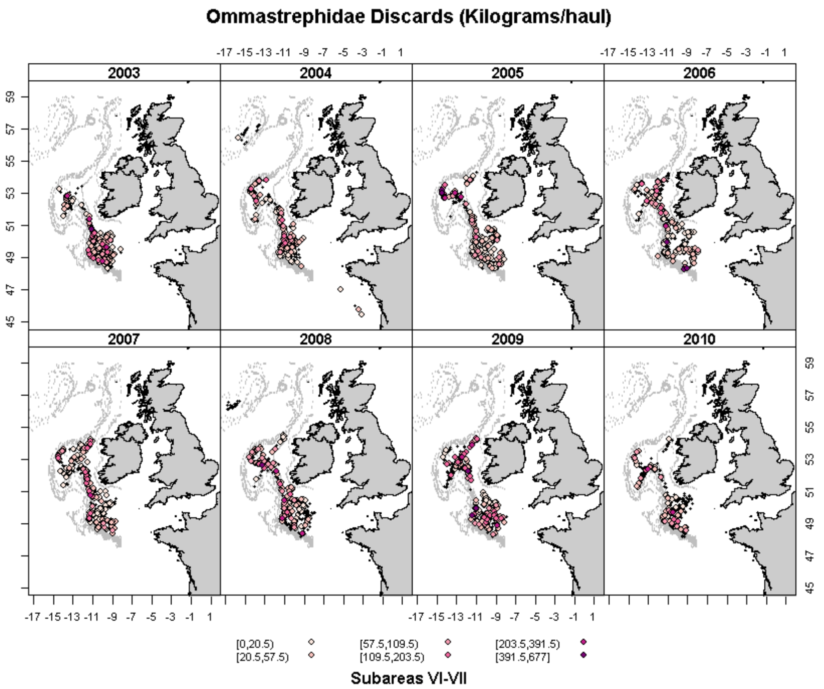

Figure 1: Estimated discards of species from family *Ommastrephidae* at haul level in the western Irish waters & Rockall bank fisheries

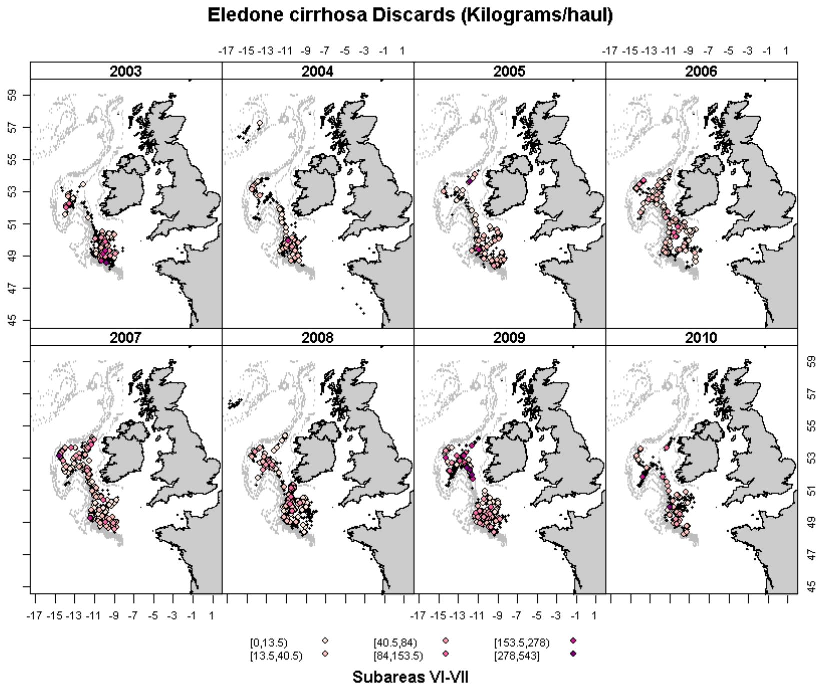

Figure 2: Estimated discards of *Eledone cirrosha* at haul level in the western Irish waters & Rockall bank fisheries

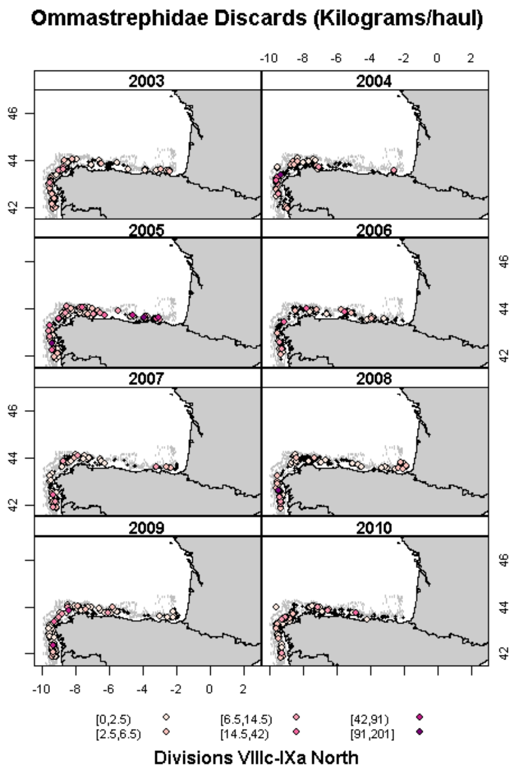

Figure 3: Estimated discards of species from family *Ommastrephidae* at haul level in the north Iberian waters fisheries

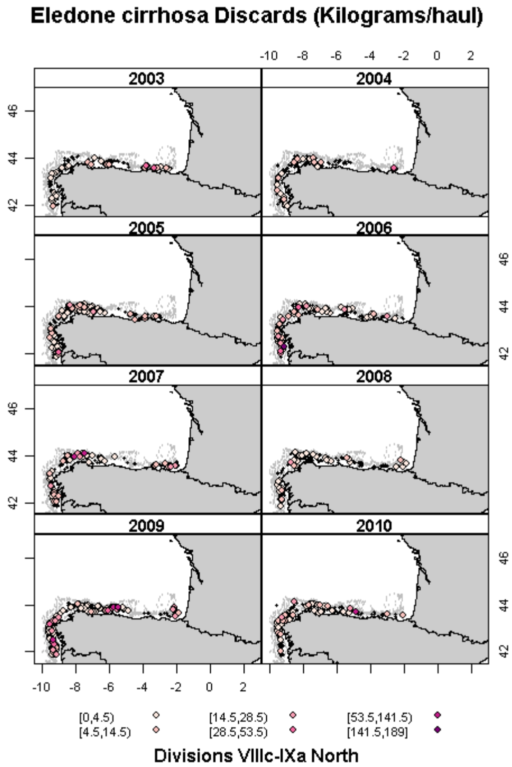

Figure 4: Estimated discards of *Eledone cirrosha* at haul level in the north Iberian waters fisheries

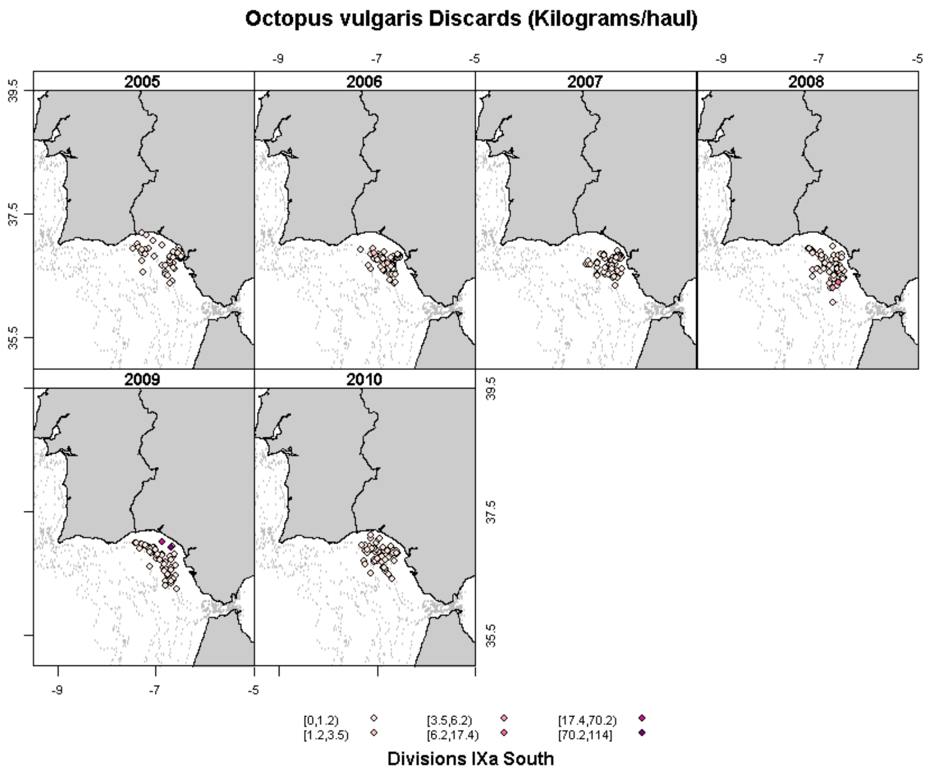

Figure 5: Estimated discards of *Octopus vulgaris* at haul level in the Gulf of Cádiz fisheries

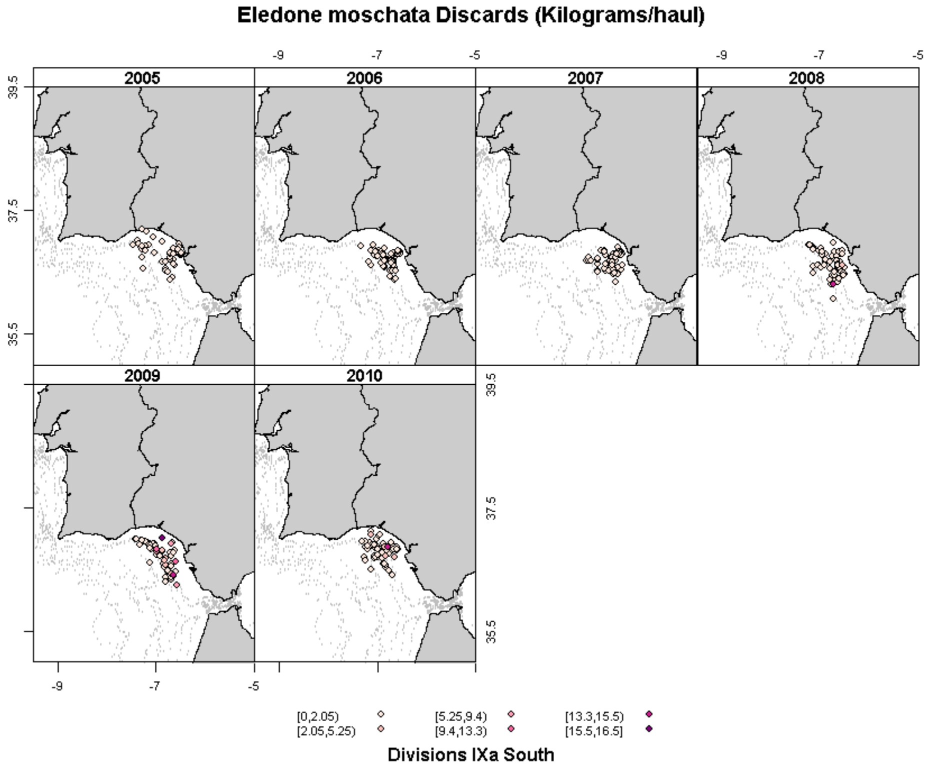

Figure 6: Estimated discards of *Eledone moschata* at haul level in the Gulf of Cádiz fisheries

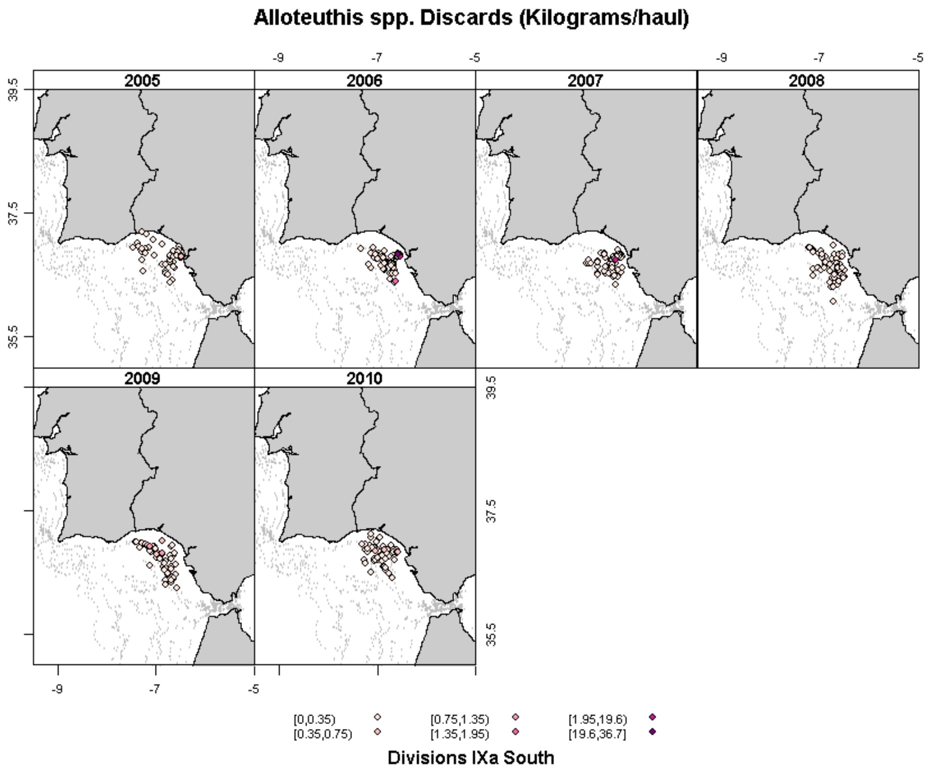

Figure 7: Estimated discards of *Alloteuthis spp.* at haul level in in the Gulf of Cádiz fisheries

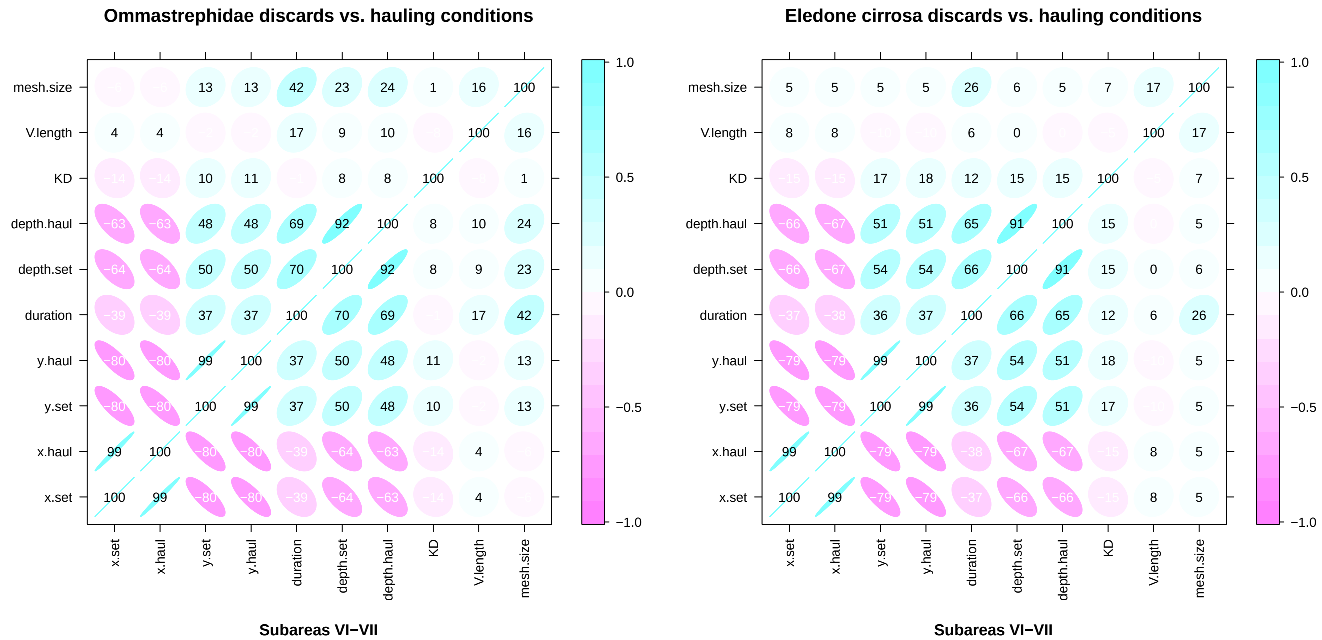

Figure 8: Correlogram representing correlations between *Ommastrephidae* (left) and *Eledone cirrosha* (right) and physical variables obtained at haul level in the western Irish waters & Rockall bank fisheries.

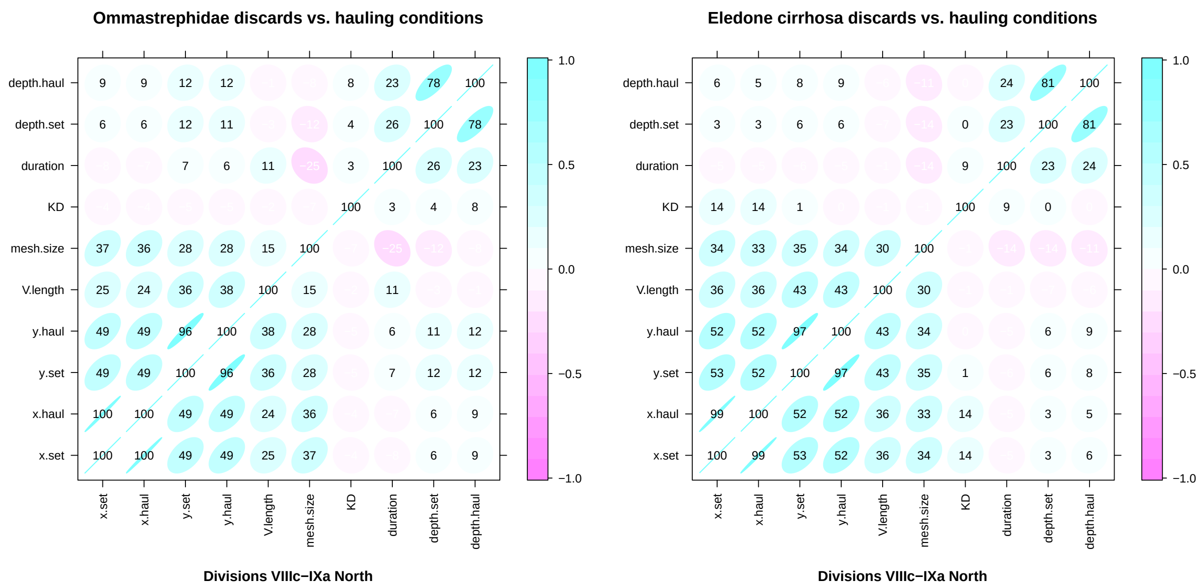

Figure 9: Correlogram representing correlations between *Ommastrephidae* (left) and *Eledone cirrosha* (right) and physical variables obtained at haul level in the north Iberian waters fisheries.

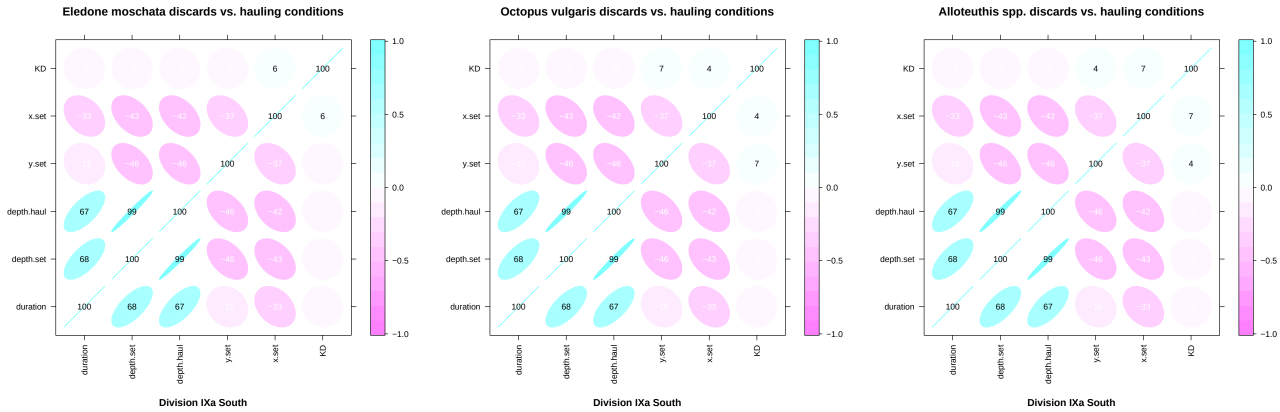

Figure 10: Correlogram representing correlations between *Eledone moschata* (left) , *Octopus vulgaris* (center) and *Alloteuthis spp.* and physical variables obtained at haul level in the Gulf of Cádiz fisheries.

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Cephalopods discarded by the Portuguese bottom otter trawl fleet

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Abstract

We compile the information available on the discards of cephalopod species (Alloteuthis squids, *Alloteuthis* spp.; common squids, *Loligo* spp.; Ommastrephid squids, family Ommastrephidae; cuttlefishes, *Sepia* spp.; bobtail squids, family Sepiolidae; horned octopus, *Eledone cirrosa*; musky octopus, *Eledone moschata*; common octopus, *Octopus vulgaris*; and lilliput longarm octopus*, Octopus defilippi*) produced by Portuguese vessels operating with bottom otter trawl (OTB) within the Portuguese reaches of ICES Division IXa. The data was collected by the Portuguese on-board sampling programme (EU DCR/NP) between 2004 and 2011. A description is presented of the on-board sampling programme, estimation algorithms and data quality assurance procedures and results provided for two fisheries: the crustacean fishery (OTB_CRU) and the demersal fish fishery (OTB_DEF). Because some cephalopod species presented low taxonomic resolution in our data we combined some species into supra-specific taxa before the analysis. We show that cephalopods' annual frequency of occurrence in trawl discards is low for most species. However, in OTB_CRU horned octopus and bobtail squids were relatively frequent in some of the years and Alloteuthis squids and cuttlefishes were relatively frequent in discards from the OTB_DEF fishery in 2004 and 2005. We provide estimates of annual discards for the latter species and time periods.

1 Introduction

This working document compiles the information available on the discards of Alloteuthis squids (*Alloteuthis* spp.), common squids (*Loligo* spp.), horned octopus (*Eledone cirrosa*), musky octopus (*Eledone moschata*), common octopus (*Octopus vulgaris*), Ommastrephidae squids (family Ommastrephidae), Cuttlefishes (*Sepia spp.*), and bobtail squids (family Sepiolidae) produced by the Portuguese bottom otter trawl fleet (OTB) operating in the Portuguese reaches of ICES Division IXa. The data was collected by the Portuguese on-board sampling programme (EU DCR/NP) between 2004 and 2011. The document starts with a description of the on-board sampling programme and details of the estimation algorithms and data quality assurance procedures (Section 2). Then, results on species' annual frequency of occurrence in discards, total discard estimates and length composition of discards are presented (Section 3). Finally, some additional information is provided on discards produced by other Portuguese fleets that operate in this geographical area (Section 4).

2 On-board sampling and data analysis

The Portuguese on-board sampling program, included in the EU DCR/NP, is based on a quasi-random sampling of cooperative commercial vessels between 12 and 40 meters long. The programme started in late 2003 and involves on-board sampling of several fishing métiers. These include, amongst other, bottom otter trawl, deep-water set longlines, gill and trammel nets (of various mesh sizes) and purse seines. From these, the bottom otter trawl fleet (OTB) constitutes the most comprehensively sampled fleet. For sampling purposes, the bottom otter trawl fleet is split into two different components: a crustacean fishery (OTB_CRU) that operates cod-end mesh sizes 55-59mm and >70mm and a demersal fish fishery (OTB_DEF) that operates cod-end mesh size 65-69mm. A detailed account of vessel characteristics in these components is found in Castro et al. (2007).

2.1 Trip selection

The EU DCR/NP (CR (EC) 199/2008; CD 2010/93/EU) establishes fishing trip as the sampling unit to be used by at-sea discard sampling programmes. The Portuguese on-board sampling programme targeting the bottom otter trawl fleet is based on a quasi-random sampling of trips from a set of cooperative vessels known to operate in each fishery. Annual sampling targets are fixed for each fishery, namely 12 trips in the OTB_CRU fishery and 27 trips in the OTB_DEF fishery. Sampling levels attained in the 2004-2011 period are presented in Table 1. In most years sampling attained or surpassed the annual sampling targets in both fisheries. The procedures used to collect data on board and raise discard data from samples to annual fleet discards produced by each fishery have been previously described in Fernandes et al. (2010) and Prista et al. (2011), amongst other. A brief account follows.

Table 1: Discard sampling levels of the Portuguese on-board sampling programme per fishery (2004-2011).

	Sampling levels					
	Trips		Hauls		Hours fished	
Year	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF
2004	17	24	111	125	479	315
2005	15	39	74	159	372	349
2006	7	42	30	194	133	376
2007	12	38	73	162	260	287
2008	12	34	66	128	267	250
2009	16	38	84	135	299	264
2010	16	31	103	116	372	192
2011	13	30	56	83	217	161

2.2 Catch sampling

The sampling protocols used in Portuguese on-board sampling of the OTB fisheries are detailed in Prista et al. (2011). Briefly, two observers are deployed in each trip and on each selected haul they take a sample from catch, sort the specimens into retained and discarded fraction and register the weight and length composition of each species fraction. Concurrently, observers also collect fishing effort information (hours fished) and register environmental information (GPS coordinates, depth, bottom type, etc.). The sampling protocol suffered only minor changes and adaptations between 2004 and 2010. In 2011 the size of samples was increased from 1 to 2 boxes (of catch) and the number of hauls sampled in each trip was standardized to "at least, every other haul".

2.3 Estimates of discards (haul level)

Total volume discarded (in kg) in each haul is estimated by multiplying the ratio of discard and retained sample weights (all species combined) by the total retained weight in the haul (all species combined). The volume of discards of individual species in each haul is calculated *a posteriori* by multiplying the proportion (in weight) of species discards in the catch sample by the total catch volume estimated for each haul (total volume discarded + total volume landed).

2.4 Estimates of discards (fleet level)

The procedure generally used to raise discards from haul to fleet level in the Portuguese trawl fisheries is adapted from Fernandes et al. (2010) (Jardim and Fernandes*, in prep.*). Using this procedure, species with low frequency of occurrence or abundance in discards (i.e., a large number of zeros in the dataset) cannot be reliably estimated at fleet level (Jardim et al., 2011). The frequency of occurrence and abundance of cephalopods in the discards of the Portuguese bottom trawl fleet was in some cases below 30% (see Section 3.1.). Consequently, annual discard volumes at fleet level were only estimated for some species and species groups.

2.5 Quality assurance procedures

The Portuguese on-board database is programmed in Oracle and contains internal routines for the detection of basic errors (e.g., errors in dates). The database contains general trip information (vessel information, date, location, haul number, retained weight by species), along with sample information by fraction (retained, discarded) and species, namely weight, number of specimens and length composition. Quality checks involving the manual checking of (at least) 10% of annual trawl records have been routinely carried out since the beginning of the on-board sampling programme. In 2010-2011 a semi-automated R quality assurance procedure was designed and the entire trawl database was checked for additional undetected errors. Minor updates and data reviews have been performed since then. The data used in the current estimates were extracted from the database in 01/03/2012.

2.6 Note on species aggregation

The Portuguese on-board observers are trained in using the FAO 3-alpha code list (ASFIS List of Species for Fishery Statistics Purposes: available at http://www.fao.org/fishery/collection/asfis/en, date: February 2011) to identify species and species groups during field observations. General training in species identification is provided to observers during demersal surveys and/or market sampling. When on board a commercial fishing trip observers are requested to record data at the most appropriate taxonomic level based on the specimen's conservation status, on field logistics, and their own identification expertise. Practice shows that Portuguese on-board observers are quite accurate in the identification of most commercial and non-commercial species but that substantial differences between observers and/or inaccuracies in species identification still exist during the identification of less common species and species that are very similar to others. To avoid the impact of these biases in the cephalopod analysis, some species records were aggregated into supra-specific taxa (Table 2).

Table 2: Supra-specific species aggregation. "nei" = not elsewhere included

ID ascribed in trips (3-alpha code)	Number specimens sampled		ID ascribed in analysis	Code in analysis
	OTB_CRU	OTB_DEF		
Alloteuthis subulata (OUL)	0	0	*Alloteuthis* spp.	OUW
Alloteuthis media (OUM)	0	0		
Genus *Alloteuthis* nei (OUW)	257	4673		
Loligo vulgaris (SQR)	6	22	*Loligo* spp.	SQC
Loligo forbesii (SQF)	0	0		
Genus *Loligo* nei (SQC)	2	40		
Ommastrephes bartrami (OFJ)	1	0	Family Ommastrephidae	OMZ
Todarodes sagittatus (SQE)	10	4		
Todaropsis eblanae (TDQ)	99	18		
Illex coindetii (AQM)	74	59		
Family Ommastrephidae nei (OMZ)	1	0		
Sepia (Sepia) elegans (EJE)	89	349	*Sepia* spp.	CTL
Sepia (Rhombosepion) officinalis (CTC)	20	36		
Sepia (Rhombosepion) orbignyana (IAR)	62	102		
Genus *Sepia* nei (CTL)	71	41		
Rossia macrosoma (ROA)	384	29	Family Sepiolidae	Sepiolidae
Sepiola rondeleti (CTR)	7	0		
Eledone cirrosa (EOI)	722	125	*Eledone cirrosa*	EOI
Eledone moschata (EDT)	78	31	*Eledone moschata*	EDT
Octopus defilippi (OQD)	1	1	*Octopus defilippi*	OQD
Octopus vulgaris (OCC)	21	127	*Octopus vulgaris*	OCC
Family Octopodidae nei (OCT)	4	2	Family Octopodidae	OCT

3 Species discards

3.1 Frequency of occurrence

The annual frequency of occurrence of cephalopod discards in the sampled hauls was low to moderate ranging between 0% and 59% in OTB_CRU and between 0% and 46% in OTB_DEF. The most common cephalopod discards were *Eledone cirrosa* and Sepiolidae in the OTB_CRU fishery and *Alloteuthis* spp and *Sepia* spp. in the OTB_DEF fishery. Complete data on the frequency of occurrence of cephalopods in discards are displayed in Table 3 and Table 4.

Table 3: Frequency of occurrence (%) of cephalopods in the discards of hauls sampled in the OTB_CRU fishery (2004-2011). See Table 2 for species codes. "—" = no occurrence

YEAR	OUW	SQC	OMZ	CTL	Sepiolidae	EOI	EDT	OQD	OCC	OCT
2004	16	—	38	33	26	59	4	1	2	—
2005	4	1	34	9	28	46	7	—	1	—
2006	—	—	3	13	37	40	13	—	—	—
2007	5	—	5	8	27	21	3	—	—	—
2008	11	2	5	12	20	12	2	—	9	—
2009	10	—	1	13	35	8	2	—	4	—
2010	3	3	12	15	13	10	9	—	2	—
2011	12	2	30	12	7	14	12	—	4	5

Table 4: Frequency of occurrence (%) of cephalopods in the discards of hauls sampled in the OTB_DEF fishery (2004-2011). See Table 2 for species codes. "—" = no occurrence

YEAR	OUW	SQC	OMZ	CTL	Sepiolidae	EOI	EDT	OQD	OCC	OCT
2004	46	4	19	38	1	17	1	—	1	—
2005	45	2	8	27	4	16	2	—	6	—
2006	18	—	—	10	1	8	1	—	4	—
2007	9	1	2	13	4	5	4	—	6	1
2008	24	—	1	19	2	4	2	—	20	—
2009	19	—	—	22	1	9	1	—	10	—
2010	12	2	—	6	—	8	2	—	2	—
2011	22	7	2	11	—	5	2	1	11	1

3.2 Total volume of discards

To accurately estimate the discard volume of rare species (i.e., species with low abundance and low frequency of occurrence in the sampled hauls) a large number of observations are generally required. Most cephalopod species and species aggregates were rare in the discard samples and/or when present were found in low number and weight. Because the current estimation algorithm is considered sensitive to large numbers of zeros in the dataset (Jardim et al., 2011), discard estimates were only obtained for species which frequency of occurrence was over 30% (Table and). For the sake of comparison, Portuguese official data on trawl landings (OTB_CRU and OTB_DEF combined) indicates that 673 tons and 285 tons of Loliginidae (OUW and SQC combined) and 120 tons and 95 tons of Ommastrephidae were landed in 2004 and 2005, respectively (DGPA, 2004-2006). The same data source indicates that 90 tons of *Sepia* spp. (CTL) were landed in 2004 and that the landings of Octopodidae family were 555, 460 and 318 tons in 2004, 2005, and 2006, respectively (DGPA, 2004-2006). Bobtail squids (Sepiolidae) are not landed in Portugal.

Table 5: Volume (in metric tons) and CVs (%, in brackets) of cephalopod discards in the Portuguese OTB_CRU fishery (2004-2011). See Table 2 for species codes. "—" = no occurrence, "(a)" = low frequency of occurrence, "(b)" = fishing effort data not available at the time of this report

YEAR	OUW	SQC	OMZ	CTL	Sepiolidae	EOI	EDT	OQD	OCC	OCT
2004	(a)	—	289 (30%)	7 (43%)	(a)	277 (32%)	(a)	(a)	(a)	—
2005	(a)	(a)	133 (37%)	(a)	(a)	99 (38%)	(a)	—	(a)	—
2006	—	—	(a)	(a)	22 (8%)	45 (10%)	(a)	—	—	—
2007	(a)	—	(a)	(a)	(a)	(a)	(a)	—	—	—
2008	(a)	(a)	(a)	(a)	(a)	(a)	(a)	—	(a)	—
2009	(a)	—	(a)	(a)	16 (55%)	(a)	(a)	—	(a)	—
2010	(a)	(a)	(a)	(a)	(a)	(a)	(a)	—	(a)	—
2011	(a)(b)	(a)(b)	(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)	— (b)	(a)(b)	(a)(b)

Table 6: Volume (in metric tons) and CVs (%, in brackets) of cephalopod discards in the Portuguese OTB_DEF fishery (2004-2011). See Table 2 for species codes. "—" = no occurrence, "(a)" = low frequency of occurrence, "(b)" = fishing effort data not available at the time of this report

YEAR	OUW	SQC	OMZ	CTL	Sepiolidae	EOI	EDT	OQD	OCC	OCT
2004	155 (28%)	(a)	(a)	19 (49%)	(a)	(a)	(a)	—	(a)	—
2005	61 (37%)	(a)	(a)	(a)	(a)	(a)	(a)	—	(a)	—
2006	(a)	—	—	(a)	(a)	(a)	(a)	—	(a)	—
2007	(a)	(a)	(a)	(a)	(a)	(a)	(a)	—	(a)	(a)
2008	(a)	—	(a)	(a)	(a)	(a)	(a)	—	(a)	—
2009	(a)	—	—	(a)	(a)	(a)	(a)	—	(a)	—
2010	(a)	(a)	—	(a)	—	(a)	(a)	—	(a)	—
2011	(a)(b)	(a)(b)	(a)(b)	(a)(b)	— (b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)	(a)(b)

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Results on main cephalopods species captured in the bottom trawl surveys in the Porcupine Bank (Division VIIc and VIIk)

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Abstract

This working document presents the results of the significant cephalopods in the Spanish Ground Fish Survey on the Porcupine bank (SPPGFS) from 2001 to 2011. The species more abundant in biomass terms in these surveys are curled octopus (Eledone cirrhosa), European flying squid (Todarodes sagittatus), seven-arm octopus (Haliphron atlanticus), Northern European squid (Loligo forbesi), globose octopus (Bathypolypus sponsalis), lesser flying squid (Todaropsis eblanae), broadtail shortfin squid (Illex coindetti) and stout bobtail squid (Rossia macrosoma). Biomass, distribution and length ranges were analysed. Most of the species occur in the shallower areas, except T. sagittatus, H. atlanticus and B. sponsalis that were mainly found in the deep strata.

Introduction

The Porcupine Bank bottom trawl survey has been carried out annually since 2001 to provide data and information for the assessment of the commercial fish species in the area (ICES divisions VIIc and VIIk) (ICES, 2010). During these 11 years of surveys, the cephalopods have occurred frequently but they have little reported and assessed.
The aim of this working document is to report the geographic and bathymetric distribution, relative abundance and biological parameters of the main cephalopods species in the area from 2001 to 2011. The most common species in the survey time series are analysed in the present working document, namely *Eledone cirrhosa and Bathypolypus sponsalis* (fam. Octopodidae), *Haliphron atlanticus (*fam. Alloposidae*)*, *Todarodes sagittatus*, *Todaropsis eblanae* and *Illex coindetii* (fam. Ommastrephidae), *Loligo forbesi* (fam. Loliginidae) and *Rossia macrosoma* (fam. Sepiolidae).

Material and methods

The Spanish Ground Fish Survey on the Porcupine bank (SPPGFS) has been carried out every autumn since 2001 on board the board the R/V "Vizconde de Eza", the stern trawler of 53 m and 1800 Kw.
The sampling design used was random stratified to the area, with two geographical sectors (North and South) and three depth strata (> 300 m, 300 – 450 m and 450 - 800 m) (**Figure 1**). This stratification was adopted in 2003, following the results of the two first surveys in the area. The results from the first two years were also reviewed according to the new stratification (Velasco and Serrano, 2003, ICES 2010). In each survey around 80 hauls are performed in the area. Hauls, performed with a Porcupine

Baca 40/52 otter trawl, last 30 minutes and are carried out during daylight, as described in the IBTS manual for the Western and Southern areas (ICES, 2010) where details on the sampling protocol are explained. Sampling was random stratified and allocated proportionally to strata area using a buffered random sampling procedure (as proposed by Kingsley *et al*., 2004) to avoid the selection of adjacent 5×5 nm rectangles. Cephalopods species are identified and sorted at the end of each haul, and since 2008, following IBTS protocols, length distributions are collected for the most common cephalopod species.

Two different methods were used to estimate abundance variability: (i) the parametric standard error derived from the random stratified sampling (Grosslein and Laurec, 1982), and (ii) a non parametric bootstrap procedure implemented in R (R Development Core Team, 2008) re-sampling randomly with replacement stations within each stratum and maintaining the sampling intensity, and using 80% bootstrap confidence intervals from the 0.1 and 0.9 quantiles of the resultant distribution of bootstrap replicates (Efron and Tibshirani, 1993). Geographical and bathymetric distributions of the most common species are analysed in biomass and number terms for the eleven years of the overall time series. Length distributions data just were collected from 2008 to 2011 and results are presented only for these years.

Results

Cephalopods represent a relatively small percentage of the invertebrates mean stratified biomass caught (4%) and of the mean stratified abundance (1%), but about 54% and 81% of the molluscs mean stratified biomass and abundance caught respectively.

The two species with larger stratified biomass were curled octopus *(Eledone cirrhosa)* and European flying squid *(Todarodes sagittatus),* then seven-arm octopus *(Haliphron atlanticus)* and long finned squid *(Loligo forbesi),* and lastly globose octopus *(Bathypolypus sponsalis),* lesser flying squid *(Todaropsis eblanae),* broadtail shortfin squid (*Illex coindetti*) and stout bobtail squid (*Rossia macrosoma).* However, there are differences in numeric abundance terms. *T. eblanae* and *I. coindetti* showed more abundance than *L. forbesi* while *H. atlanticus* showed marked lower abundances than *B. sponsalis* and *R. macrosoma*.

Some patterns of geographical distribution were observed in *E. cirrhosa* and *T. eblanae* which are mainly found in the North sector and close around the central mound of the Bank. Therefore, most of the species showed a higher percentage of occurrences in the shallower depth strata, below 300 m, although *T. sagittatus* also occurred frequently deeper than 450 m while the octopus *H. atlanticus* and *B. sponsalis* showed a narrower and deeper bathymetric range.

Although length size data have been collected for few years, some trends have been observed. *T. eblanae* showed lower sizes and *T. sagittatus* showed wider length size range than the other Ommastrephids. Finally, modes were observed in all species, although could not be followed during the four years.

Curled octopus *(Eledone cirrhosa)*

This species represented about 34% of the cephalopods mean stratified biomass caught and about 30% of the cephalopods mean stratified abundance. The stratified biomass and abundance trend were similar and showed two peaks in 2005 and 2007 (Figure 2).

E. cirrhosa was mainly found in the North sector, close around the Bank and in the east of the area close to the Irish shelf. It showed a depth range between 189 and 759 m, although in the overall time series it occurred in the 90% of the hauls shallower than 300 m (Figure 3).

The length size of the last four surveys ranged from 1 to 13 cm. In 2008 and 2010, larger sizes than 2009 and 2011 and a possible mode between 6 and 7 cm were found (Figure 4).

European flying squid *(Todarodes sagittatus)*

T. sagittatus represented about 30% of the cephalopods mean stratified biomass caught while it just showed about 10% of the stratified abundance caught. *T. sagittatus* stratified biomass trend was quite steady, although a higher capture was found in 2003 (Figure 5).

T. sagittatus extended throughout the Porcupine area from 190 to 763 m. Higher biomass were found in the deepest South and North sector in some years (2001, 2002, 2004, 2010, 2011) and in the deepest depth strata between 450 and 800 m. However, the species occurred between the 30 and 50% of the hauls in all depth strata, showing a wider bathymetric range than the other species (Figure 6).

The minimum length size of *T. sagittatus* in the last four years, were 10 cm in 2011 and the maximum 48 cm in 2008. A mode around 22 cm and 23 cm was evident in 2008, vaguely marked in 2009 and absent among the low values of 2010 and 2011(Figure 7).

Lesser flying squid *(Todaropsis eblanae)*

This species represented a small percentage of the cephalopods mean stratified abundance caught (7%) and of the stratified biomass caught (5%). The stratified biomass showed a smoother trend than stratified abundance trend. The abundance peaks in 2005 and 2009 represented little increases in biomass (Figure 8).

T. eblanae was mainly found in the North sector, close to the southern part of the central mound of the Bank and in the eastern area close to the Irish shelf. It extended from 189 to 719 m and occurred in about 61% of the hauls shallower than 300 m in the overall time series (Figure 9).

Most of the specimens of this species showed little sizes to 10 cm, even a marked mode in 6 cm were found in 2009, but some larger specimens about 20 cm was also observed in 2010 (Figure 10).

Broadtail shortfin squid *(Illex coindetii)*

This species also represented a small percentage of the cephalopods mean stratified abundance caught (7%) and biomass caught (4%). The stratified biomass and abundance were low in the overall time series, although two marked peaks were found in 2007 and 2009, of which the former year was quite lower in the stratified biomass trend (Figure 11).

No clear pattern was found in the geographical distribution of *I. coindetti*. The bathymetric distribution showed the majority of biomass in the shallowest depth strata, below 300 m, although this species was found from 200 to 724 m (Figure 12).

There were few size measurements to analyse the length size trend in that species, even so the specimens ranged from 6 to 21 in the last four years and 2009´ sizes showed a mode around 16 cm (Figure 13).

Long finned squid *(Loligo forbesi)*

L. forbesi represented about 7% of the cephalopods mean stratified biomass caught and 3% of the stratified abundance caught in the overall time series. The stratified biomass and abundance of *L. forbesi* increased from 2008, after seven years of very low values, showing a peak in 2009 (Figure 14).

This species was mainly found in the North sector, close around the Bank and in the shallower eastern area. It dwelled between 189 and 507 m, although higher biomass was found below 300 m (Figure 15).

L. forbesi showed a wide length size range, like that of *T. sagittatus*. It ranged from 9 to 47 cm in the last four surveys. A mode around 16 and 17 cm and a smaller one around 13 cm were found respectively in 2009 and 2011(Figure 16).
The two species of *Loligo* have been reported in the area (Lordan *et al*, 2011). *L. forbesi* is the most numerous species in catches of the cephalopods, while *L. vulgaris* have been occasionally caught, following these authors, who also recognize that the identification of the both *Loligo* species is especially difficult in smaller specimens, this fact that may have also affected our results. Even so, a special effort will be made to distinguish between both species in following years.

Other species

Although *Haliphron atlanticus*, *Bathypolypus sponsalis* and *Rossia macrosoma* also represented a small percentage of the cephalopods mean stratified biomass caught (13%, 5%, 1%, respectively) and abundance (1%, 4% and 6%, respectively), some trends have been observed. A slight decrease was found in the stratified biomass trend of *H. atlanticus* in the last four years, while a steady abundance was observed in *B. sponsalis* in the overall time series (Figure 17, Figure 19).
H. atlanticus and *B. sponsalis* were not found in depths shallower than 300 m in the overall time series. They dwelled respectively from 358 to 763 m and from 309 to 762 m. High biomass of *H. atlanticus* and *B. sponsalis* were found in the deepest South and North sector. Although the former species showed more biomass, it just occurred in about 18% of the hauls deeper than 450 m, while the latter, which was more abundant in number, occurred in about a half (49%) of that hauls (Figure 18, Figure 20).
R. macrosoma showed a steady stratified biomass trend, except the high amount of the first year of the series (Figure 21). In abundance terms, it mainly extended in the North sector from 192 to 760 m in the overall time series, although the higher abundances were found shallower than 450 m (Figure 22).

Acknowledgements

We would like to thank R/V *Vizconde de Eza* crews and the scientific teams from IEO, AZTI and Marine Institute that made possible SPPGFS Surveys.

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Figures

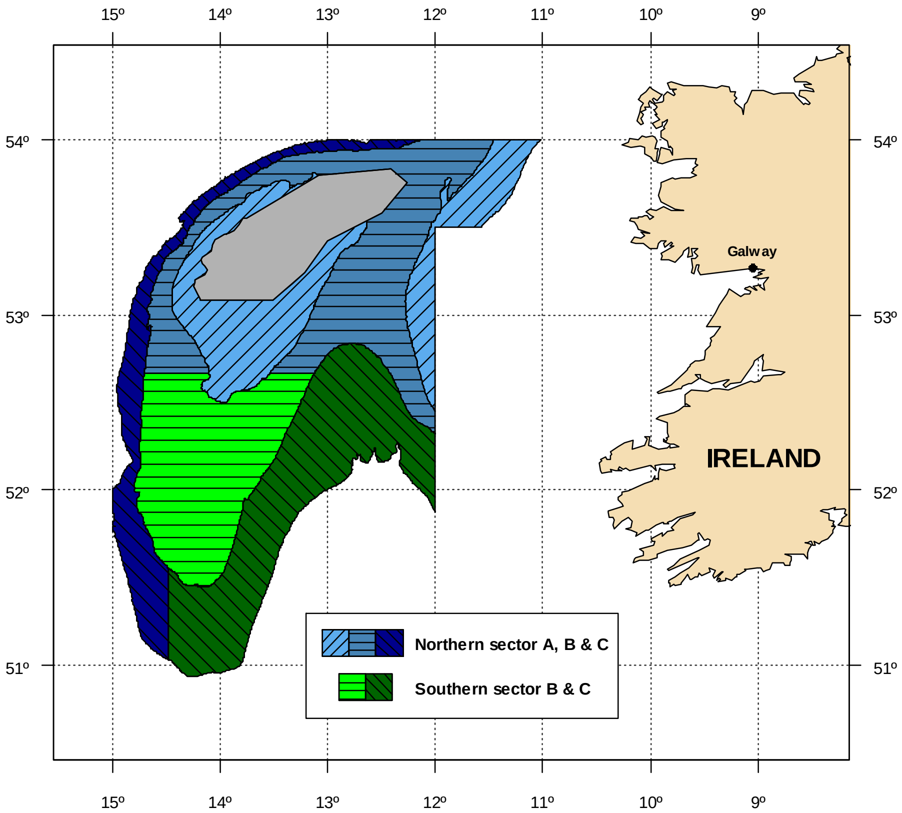


Figure 1 Stratification design of the Spanish Ground Fish Survey in the Porcupine Bank (IBTS: SPPGFS) with the depth strata > 300 m, 300 – 450 m and 450 - 800 m and the two geographic sectors, North (blue colours) and South (green colours).

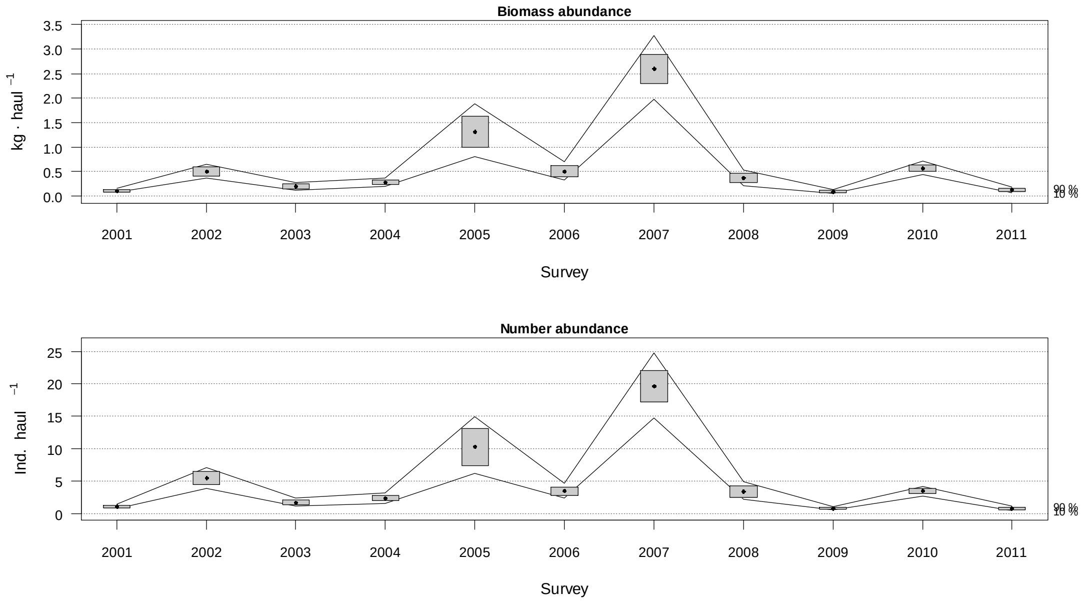
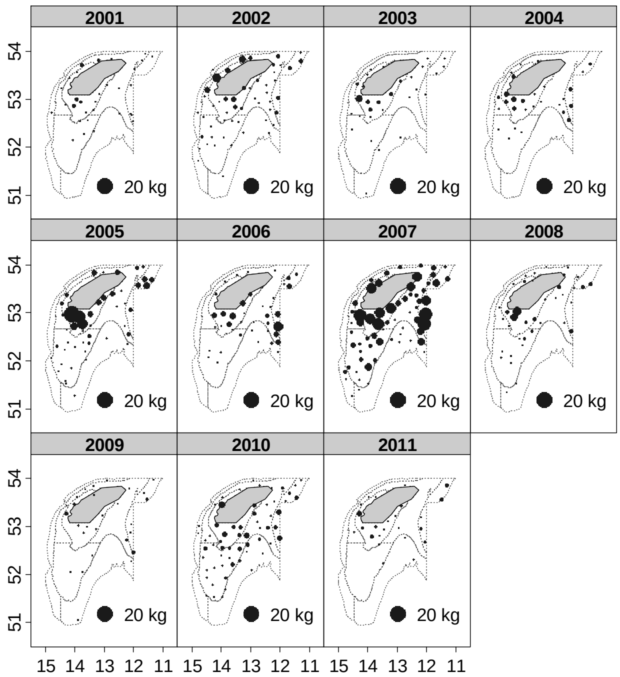


Figure 2 Evolution of *Eledone cirrhosa* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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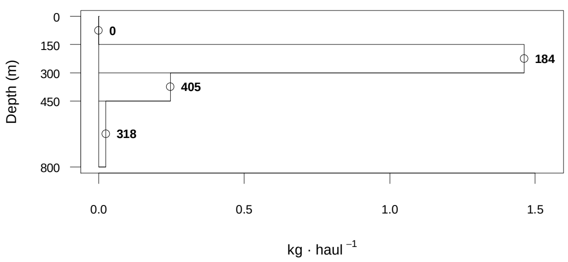


Figure 3 a) Geographic distribution of *Eledone cirrhosa* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *E. cirrhosa* in the Porcupine bank bottom trawl surveys (2001-2011)

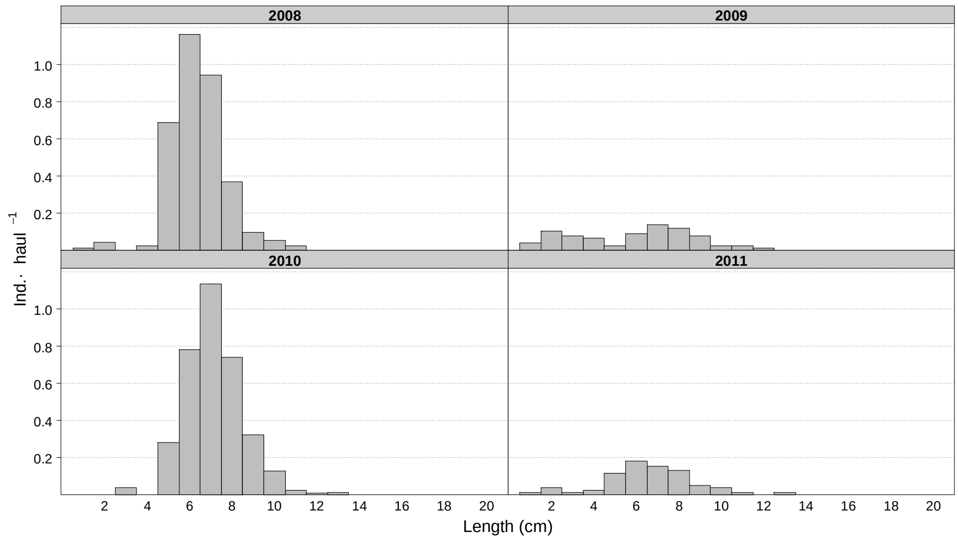


Figure 4 Mean stratified length distributions of *Eledone cirrhosa* in the Porcupine bank bottom trawl surveys (2008-2011)

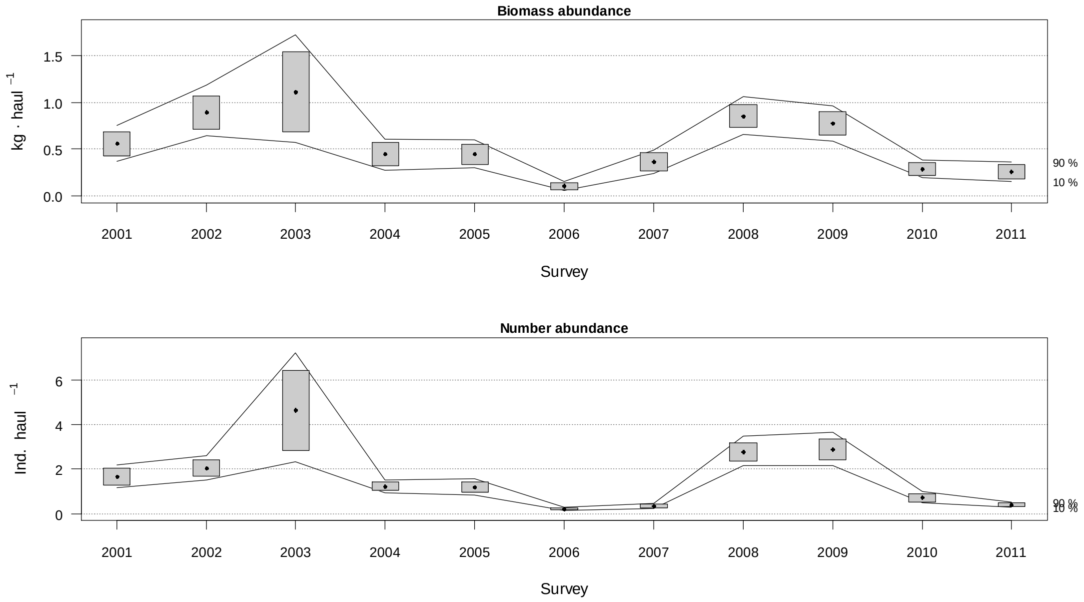
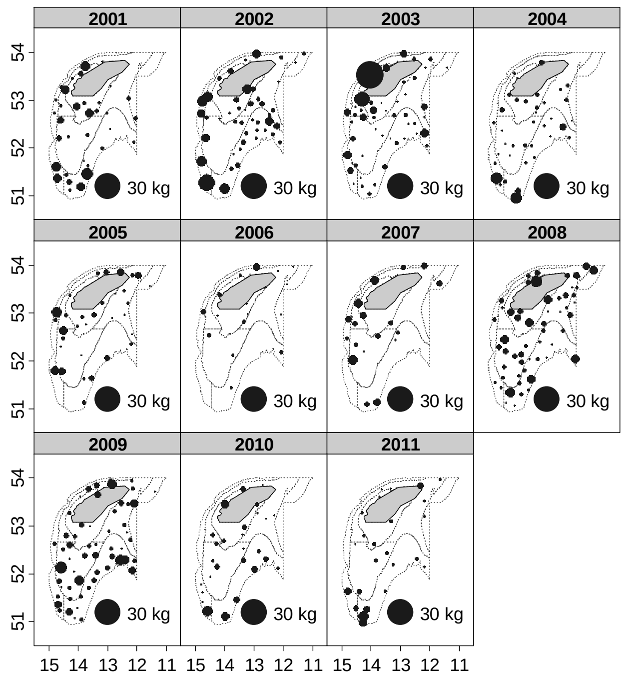


Figure 5 Evolution of *Todarodes sagitattus* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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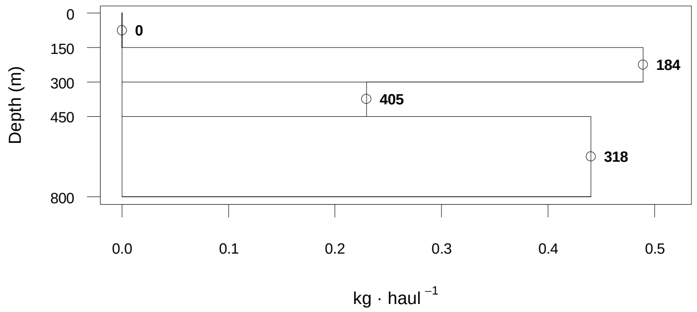


Figure 6 a) Geographic distribution of *Todarodes sagittatus* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *T. sagitattus* in the Porcupine bank bottom trawl surveys (2001-2011)

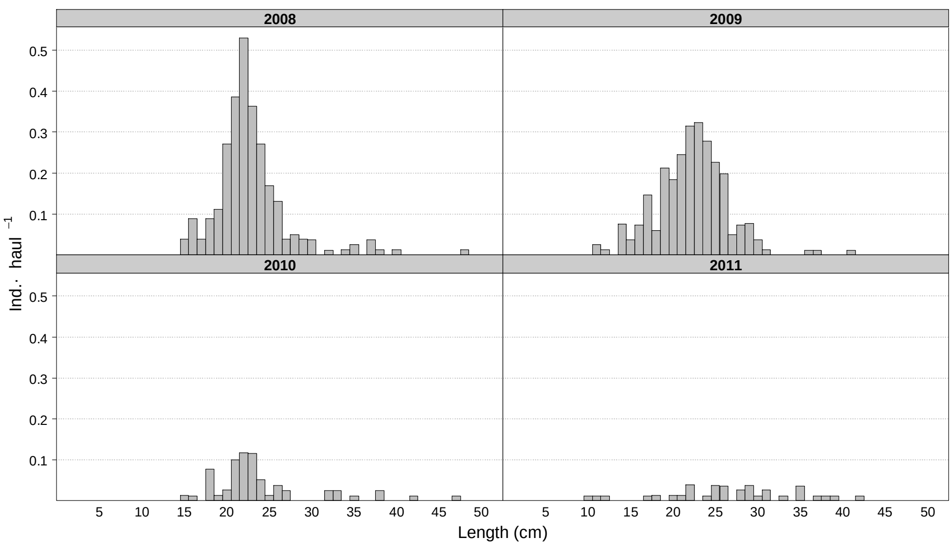


Figure 7 Mean stratified length distributions of *Todarodes sagitattus* in the Porcupine bank bottom trawl surveys (2008-2011)

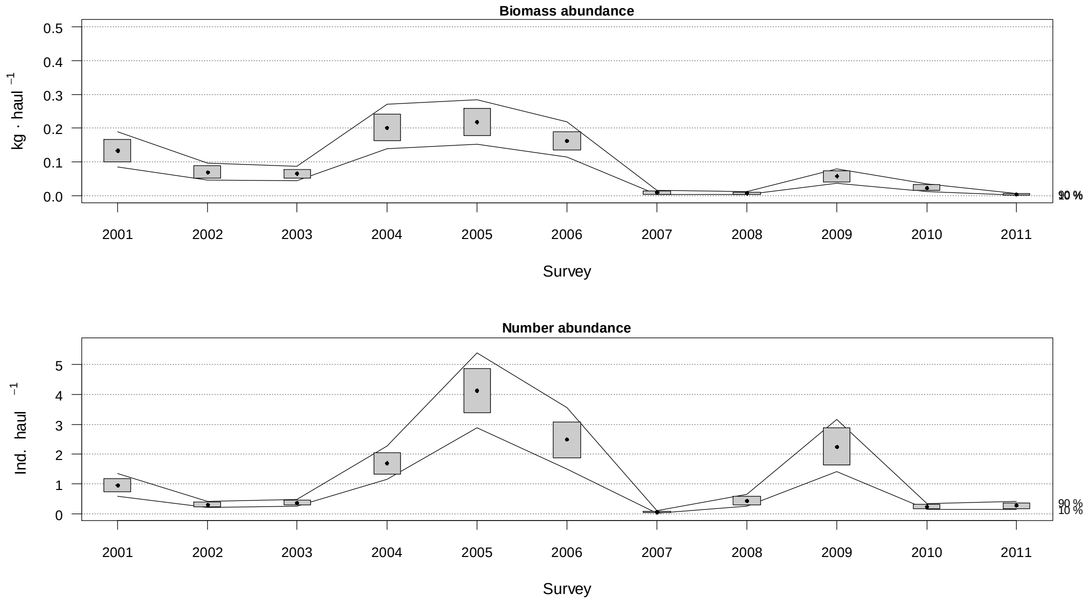
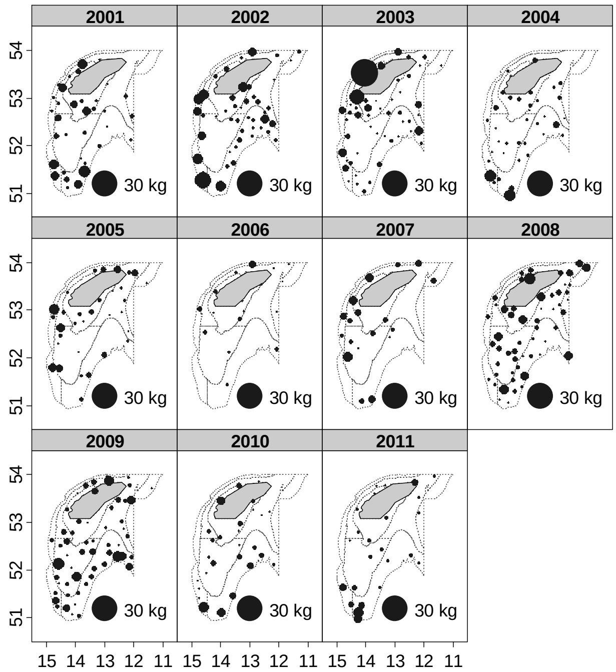


Figure 8 Evolution of *Todaropsis eblanae* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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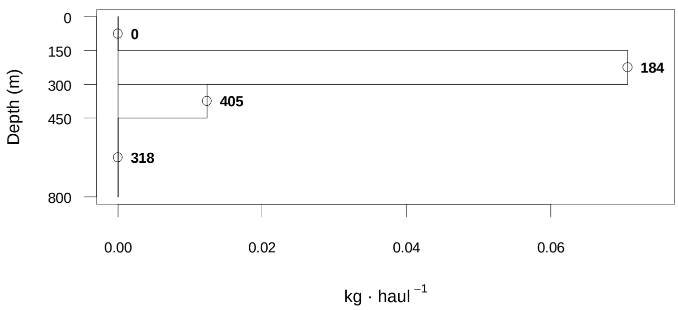


Figure 9 a) Geographic distribution of *Todaropsis eblanae* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *T. eblanae* in the Porcupine bank bottom trawl surveys (2001-2011)

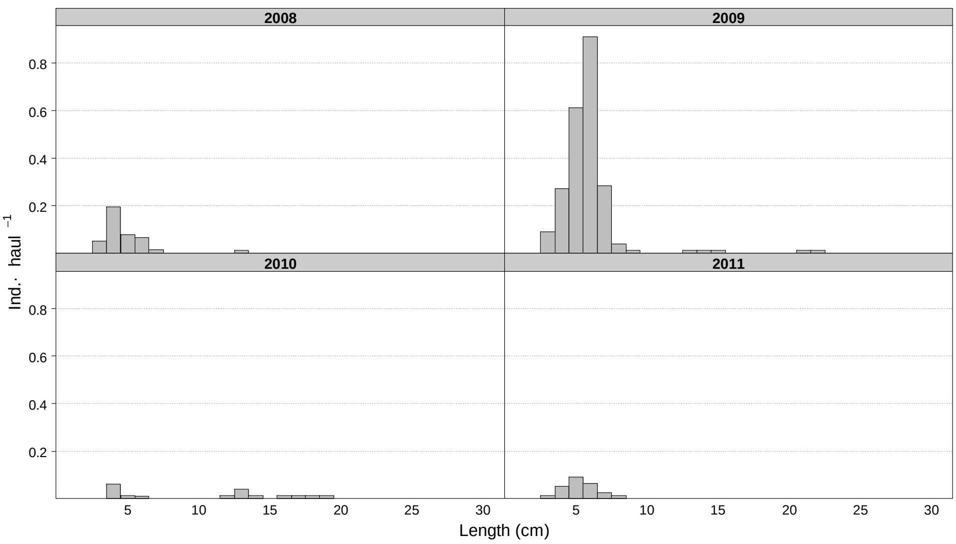


Figure 10 Mean stratified length distributions of *Todaropsis eblanae* in the Porcupine bank bottom trawl surveys (2008-2011)

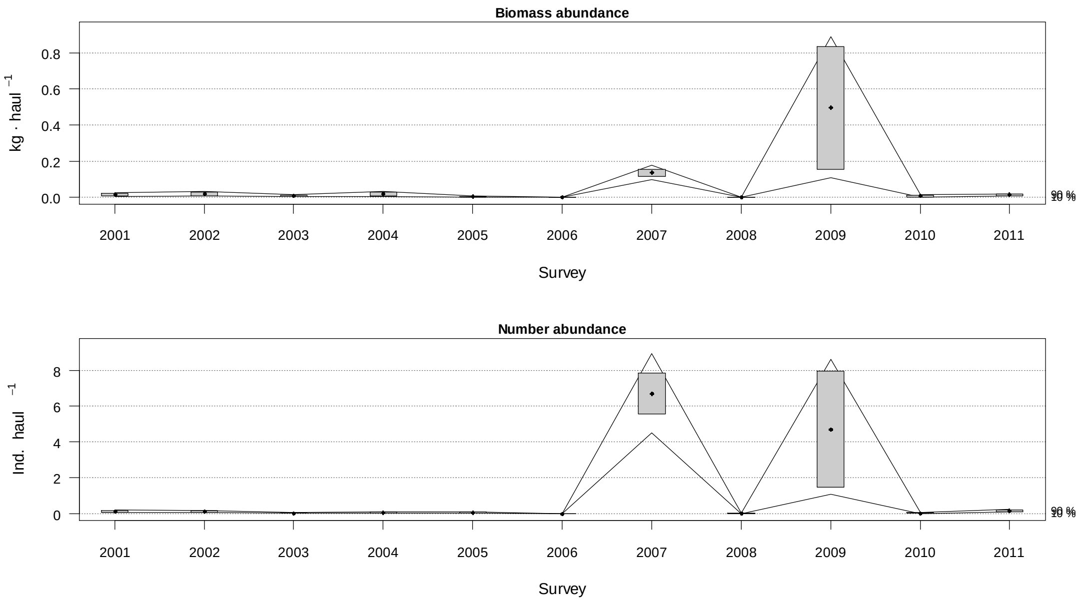
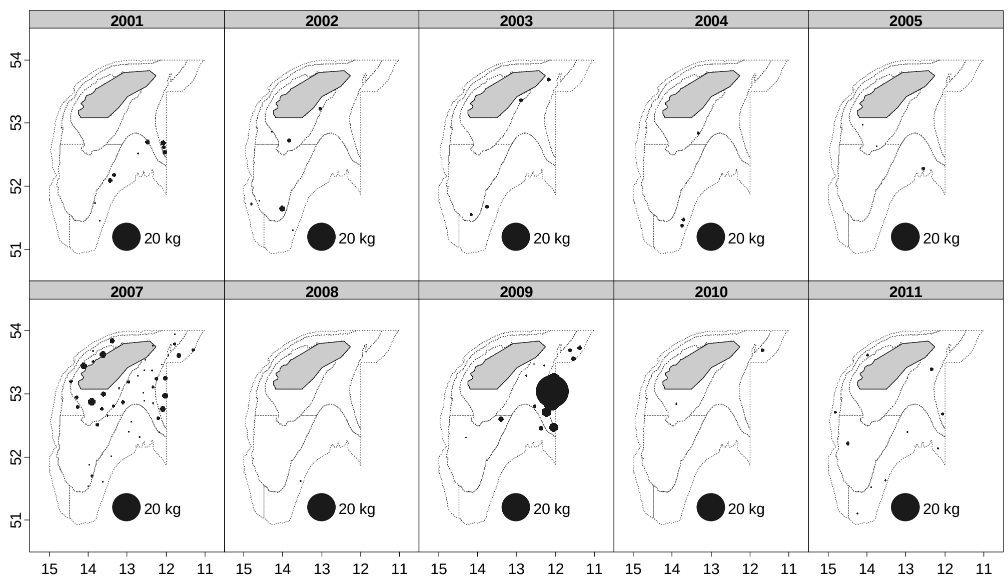


Figure 11 Evolution of *Illex coindetti* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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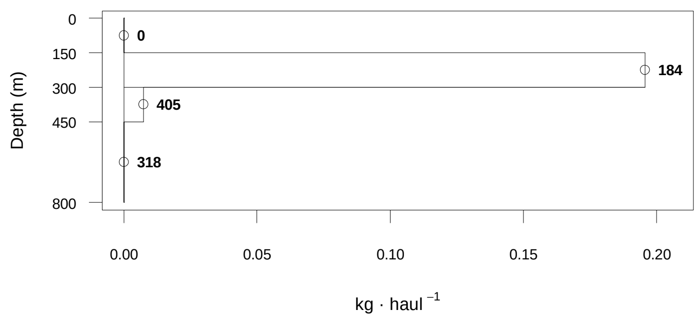


Figure 12 a) Geographic distribution of *Illex coindetti* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *I. coindetti* in the Porcupine bank bottom trawl surveys (2001-2011)

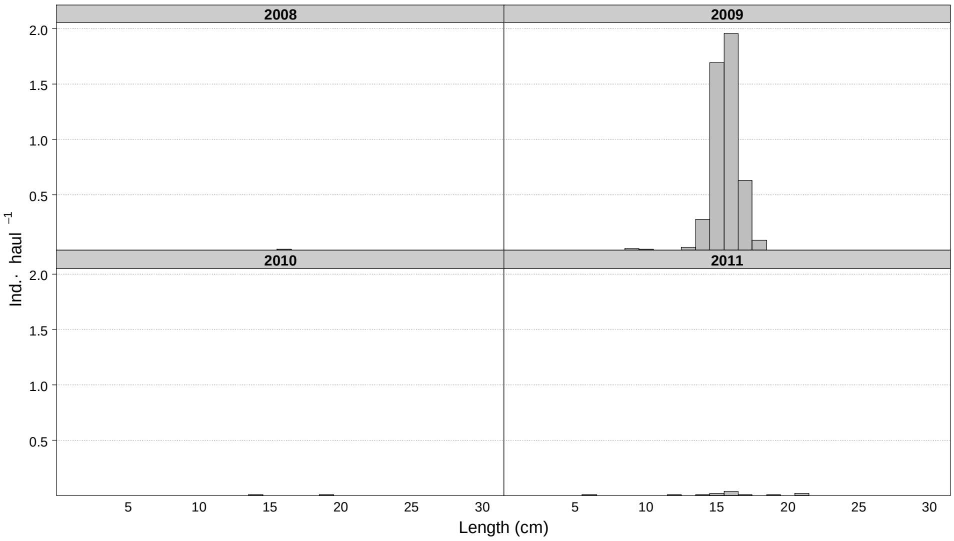


Figure 13 Mean stratified length distributions of *Illex coindetti* in the Porcupine bank bottom trawl surveys (2008-2011)

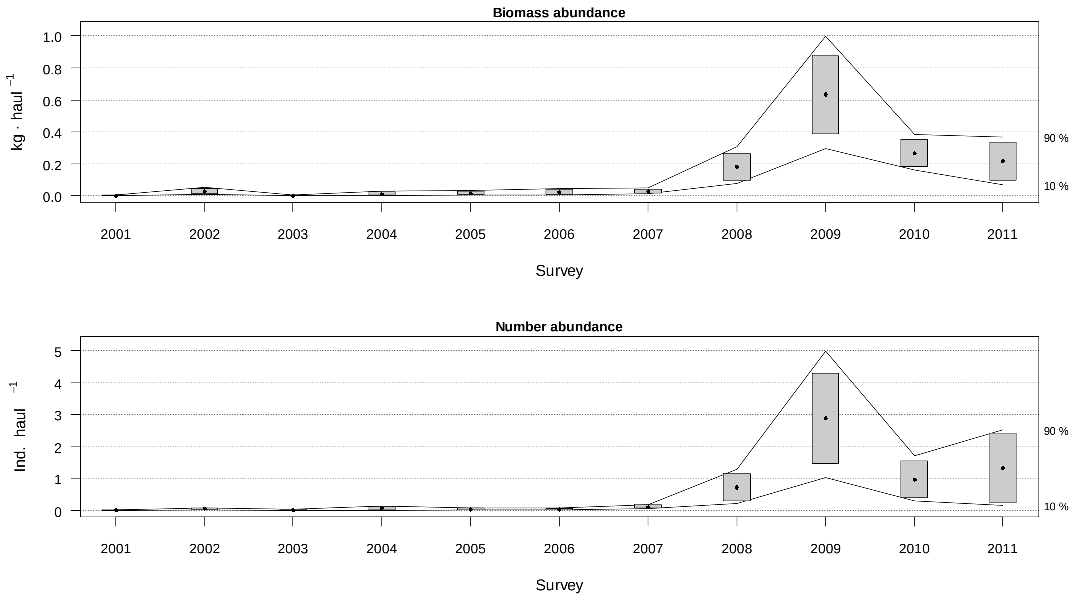
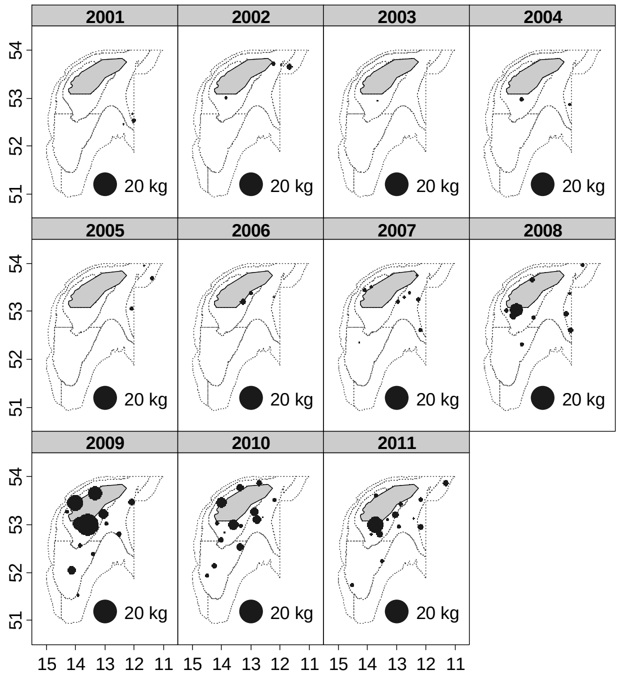


Figure 14 Evolution of *Loligo forbesi* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



b)

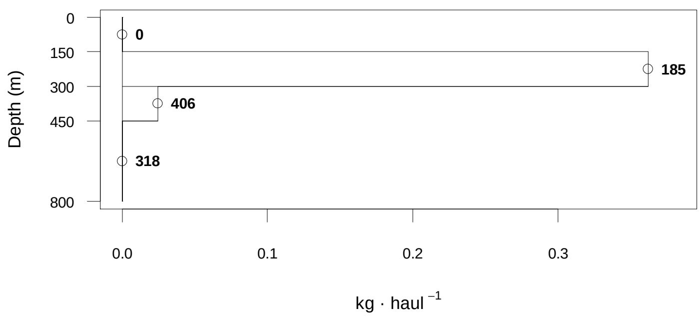


Figure 15 Geographic distribution of *Loligo forbesi* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011

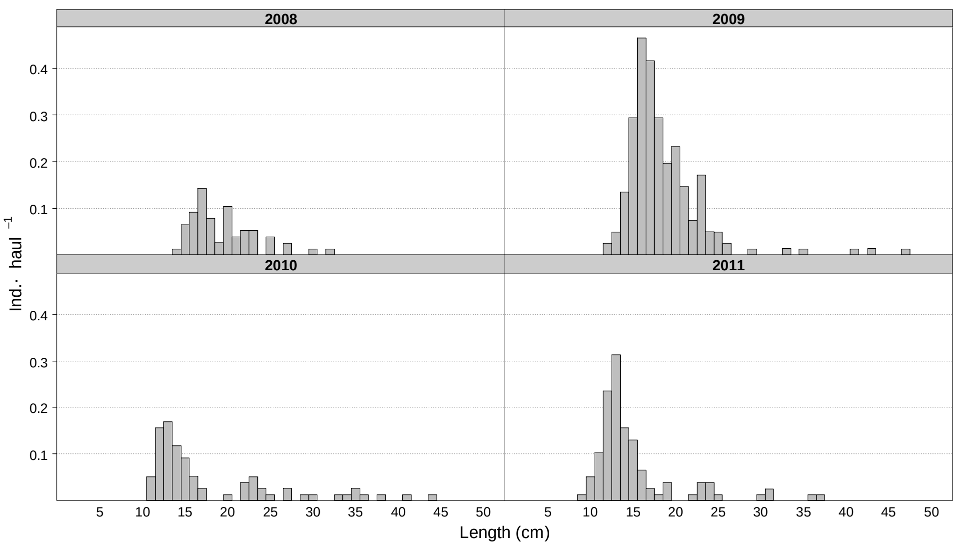


Figure 16 Mean stratified length distributions of *Loligo forbesi* in the Porcupine bank bottom trawl surveys (2008-2011)

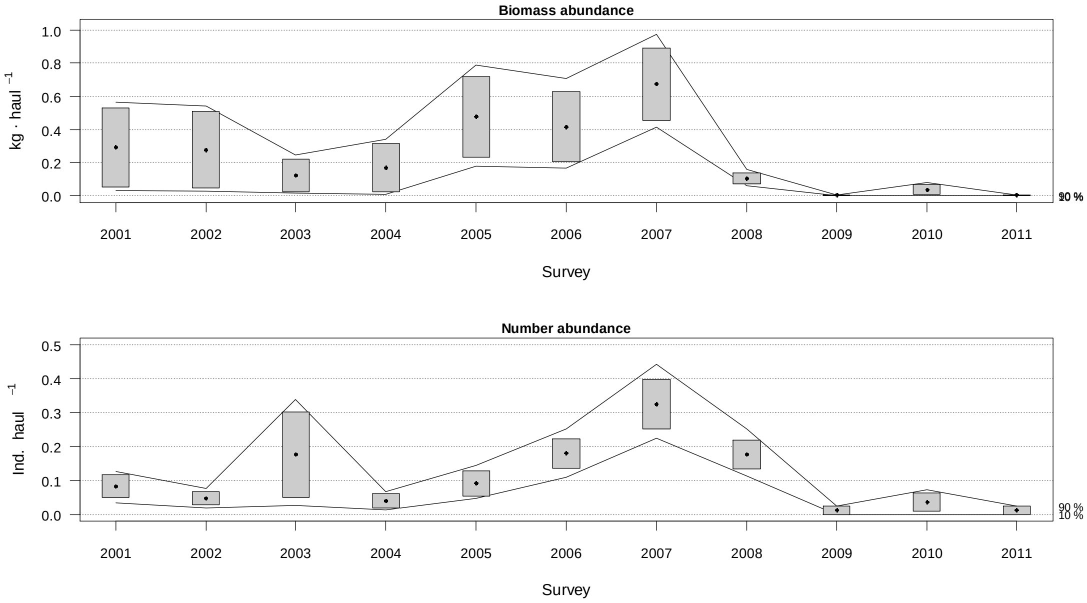
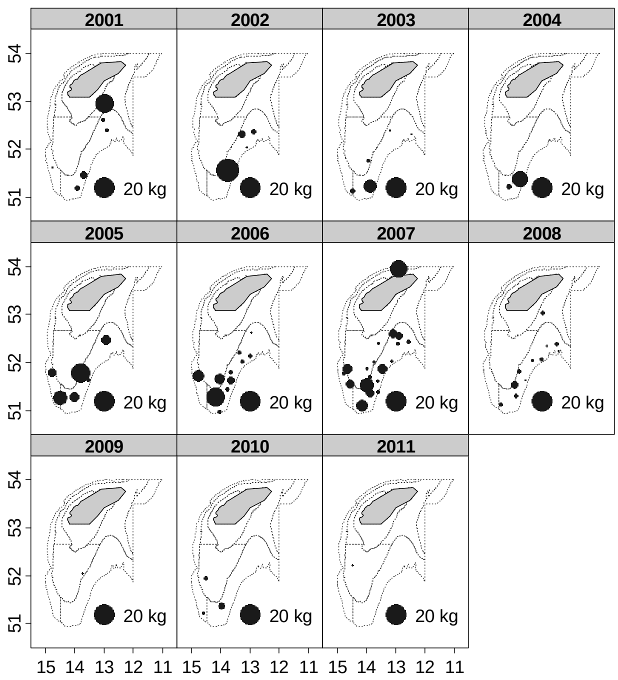


Figure 17 Evolution of *Haliprhon atlanticus* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



b)

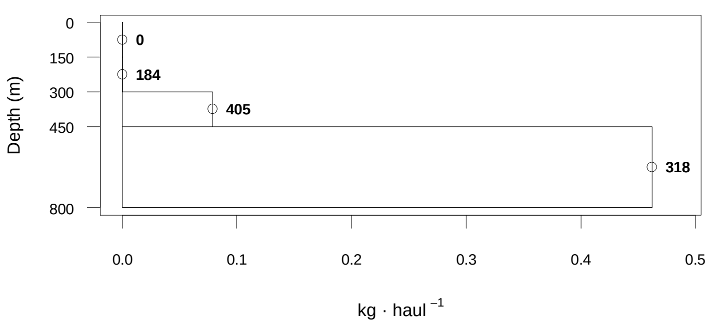


Figure 18 a) Geographic distribution of *Haliprhon atlanticus* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *H. atlanticus* in the Porcupine bank bottom trawl surveys (2001-2011)

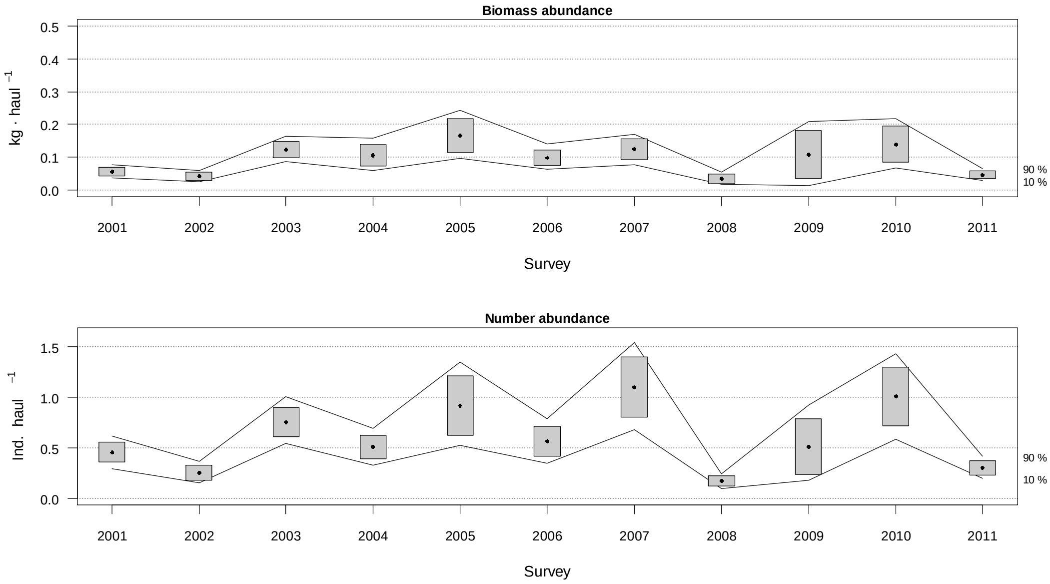
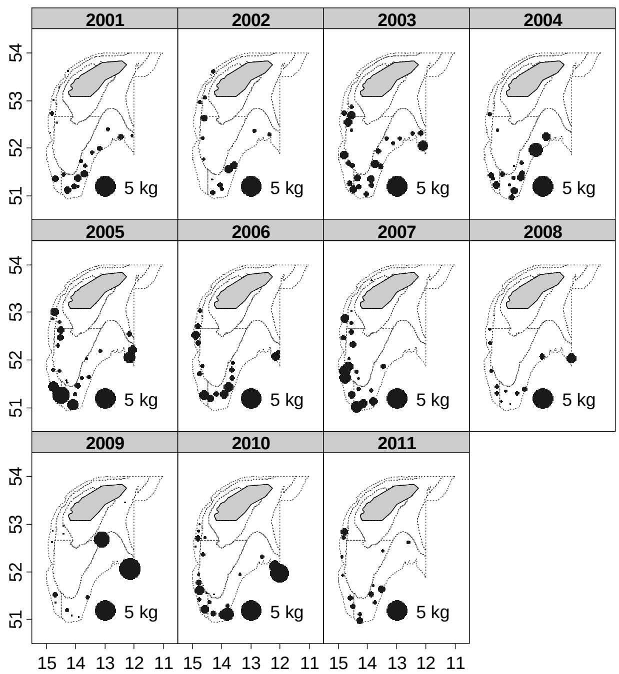


Figure 19 Evolution of *Bathypolypus sponsalis* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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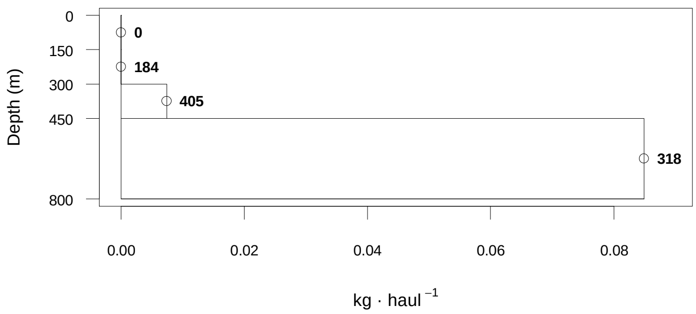


Figure 20 Geographic distribution of *Bathypolypus sponsalis* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *B. sponsalis* in the Porcupine bank bottom trawl surveys (2001-2011)

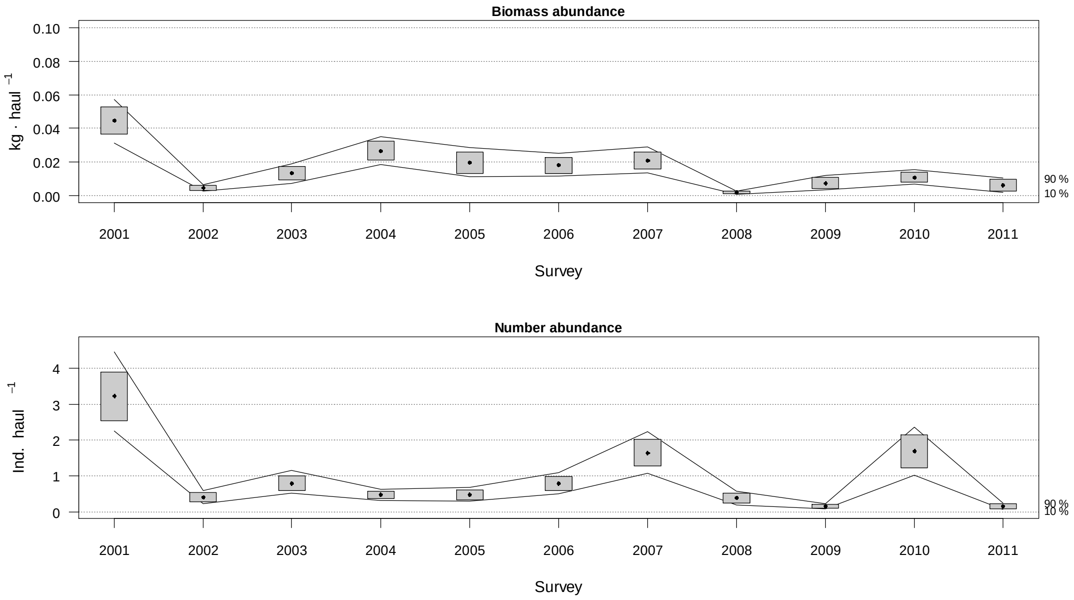
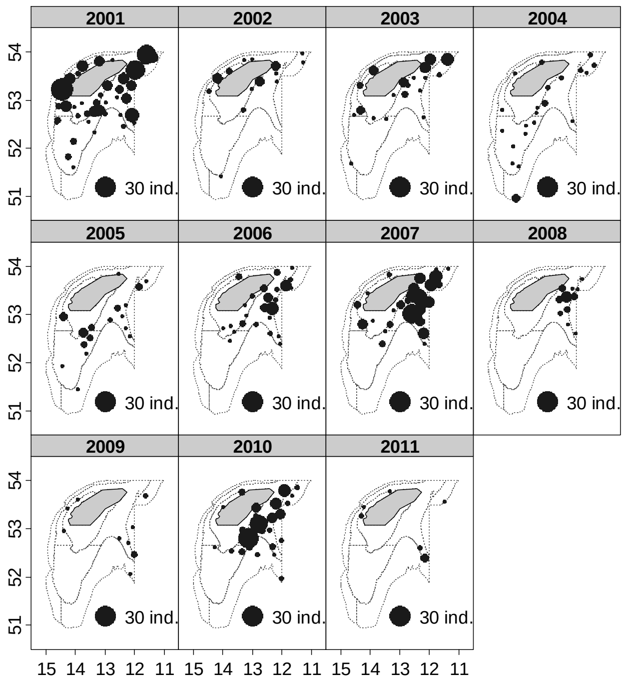


Figure 21 Evolution of *Rossia macrosoma* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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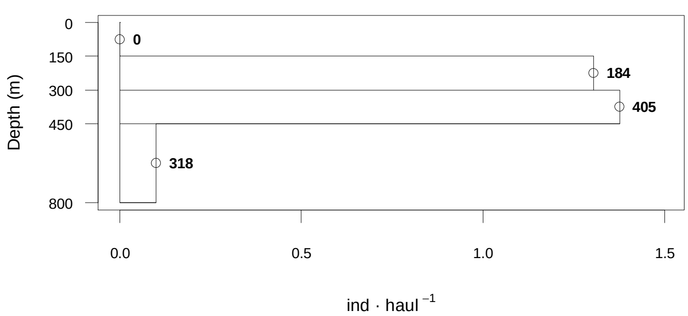

Figure 22 Geographic distribution of *Rossia macrosoma* catches (ind/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric abundance profile of *R. macrosoma* in the Porcupine bank bottom trawl surveys (2001-2011)

Working Document presented to the ICES Working Group on Cephalopod Fisheries and Life History
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Results on main cephalopods captured during the DEMERSALES bottom trawl surveys on the Northern Spanish Shelf

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Abstract

This paper presents the results on ten of the most important cephalopods species sampled during the DEMERSALES Spanish surveys form 1990 to 2011. The main species in biomass terms in this survey in decreasing abundance order were: curled octopus (*Eledone cirrhosa*), broadtail shortfin squid (*Illex coindetii*), lesser flying squid (*Todaropsis eblanae*), common octopus (*Octopus vulgaris*), long finned squid (*Loligo forbesi*), common squid (*Loligo vulgaris*), European flying squid (*Todarodes sagittatus*), pink cuttlefish (*Sepia orbignyana*), common cuttlefish (*Sepia officinalis*) and elegant cuttlefish (*Sepia elegans*). We present the geographic distribution and bathymetric abundance for these species. Length distributions of these species along the latest 5 years in the survey series are also presented and discussed.

1. Introduction

Cephalopod species are an important marine resource in the Northern Spain fisheries. Cephalopods are landed by both commercial and artisanal fleets, and landings from the latter have been relatively poorly documented in the past (Pierce *et al.*, 2010).

The bottom trawl survey on the Northern Spanish Shelf (SPNGFS: “DEMERSALES”) aim to provide data and information for the assessment of the commercial species and the ecosystems on the Galician and Cantabrian Shelf (ICES divisions VIIIc and IXa North). The DEMERSALES Spanish survey has been carried out annually in autumn from 1983, although data on invertebrate species were collected mainly from 1990, and therefore results are presented from this year up to 2011.

The aim of this working document is to present the results (abundance indices, length frequency distributions and geographic and bathymetric distributions) on the most common cephalopod species sampled in these surveys, namely curled octopus (*Eledone cirrhosa*), broadtail shortfin squid (*Illex coindetii*), lesser flying squid (*Todaropsis eblanae*), common octopus (*Octopus vulgaris*), long finned squid (*Loligo forbesi*), common squid (*Loligo vulgaris*), European flying squid (*Todarodes sagittatus*), pink cuttlefish (*Sepia orbignyana*), common cuttlefish (*Sepia officinalis*) and elegant cuttlefish (*Sepia elegans*) from the DEMERSALES bottom trawl survey's series.

2. Material and methods

The study area includes the Galician and Cantabrian Shelf from the River Miño mouth (10.0ºW) to the River Bidasoa mouth (2.2ºW) (Figure 1).

The data of species abundance (from 1990 to 2011) and length distribution (from 1997 to 2011) come from a series of bottom trawl surveys (DEMERSALES) carried out every autumn on board the R/V "Cornide de Saavedra" using standardized IBTS methodology from 1997 (ICES, 1997, 2010a, 2010b). The survey area was stratified according to depth (with three bathymetric strata: 70-120m, 121-200m, 201-500m) and geographical criteria (five predefined geographic sectors: Miño-Fisterra MF, Fisterra-Estaca de Bares FE, Estaca de Bares-Peñas EP, Peñas-Ajo PA and Ajo-Bidasoa AB) and a stratified random sampling scheme was adopted. Hauls shallower than 70 m and deeper than 500 m are considered additional hauls and performed every year if possible, thought they are not considered in the stratified abundance indices, nevertheless they are performed and plotted in the distribution maps. The information from these depths is considered relevant due to the changes in the depth of fishing activities in the area (Abad et al, 2010; Punzón et al, 2011a).

The fishing gear used in DEMERSALES Survey is an otter trawl sampler (BAKA 44/60) with a cod end mesh of 20 mm and a horizontal opening of 18.9 m, thus giving information on demersal and benthic megafauna (Olaso, 1990; Sánchez, 1993; Sánchez *et al.*, 1995; García-Castrillo and Olaso, 1995; Sánchez and Serrano, 2003). Standardized hauls are set during daylight, and towing time last 30 minutes between the end of wire shutting and starting to pull it back and towing speed was set to 3.0 Kn.

Evolution of abundance index is presented for each species along whole time series (1990-2011) in number and biomass by haul. To study geographic distribution trends we present species maps of plotted CPUE for fifteen years (1997-2011). To study bathymetric distribution of the species addressed, a histogram of depth of hauls performed along the time series was firstly performed obtaining the number of hauls per 50 m interval. Later the number of individuals in all the hauls performed in each depth interval was calculated and divided by the number of hauls.

Biological sampling of all catches of every cephalopod species was carried out from 2007. Individuals were weighted, measured (squids and cuttlefishes: total mantle length, octopuses: mantle length, measured from the posterior tip of the mantle to the midpoint between the eyes), sexed and maturity stage was examined following a standard protocol. The aim to obtain biological information about invertebrates is to improve the species knowledge and to be used in ecosystem modelling.

3. Results and discussion

3.1. Curled octopus (*Eledone cirrhosa*)

Curled octopus presents an irregular abundance in these surveys. It presented a slight decreasing trend in biomass during the latest years, with peaks in 1997 and 2001 and drops in 1998 and 2003; after a recovery during the period 2004-2007, biomass was low (0.4-0.8 Kg $haul^{-1}$) since 2008 (Figure 2). Curled octopus length sizes in this survey series (Figure 3) range from 1 to 25.4 cm. This species is distributed in all the survey area (Figure 4), especially in the westernmost area. Bathymetric distribution shows individuals in the whole range, with remarkable abundances between 100 - 300 m (Figure 5).

3.2. Broadtail shortfin squid (*Illex coindetii*)

The biomass abundance of shortfin squid is quite variable, with peaks every 2-3 years (Figure 6), which were mostly produced by hauls with high captures in the easternmost area (up to 2 Kg $haul^{-1}$). Nevertheless, the abundance of this species was also high in the Galician Shelf in 2000 (Figure 8). The variations in abundance are conditioned by the life cycle, spawning season and reproductive migrations, which determine geographic and seasonal variations (ICES, 2009). The *I. coindetii* sizes found in these surveys range between 3.1 and 25.8 cm, presenting a noteworthy mode in 14-16 cm (Figure 7). Bathymetrically, broadtail shortfin squid prefers the depths between 150 and 300 m, and almost no presence in grounds deeper than 400 m (Figure 9).

3.3. Lesser flying squid (*Todaropsis eblanae*)

Lesser flying squid also presented an irregular abundance in this surveys, with blooms in 1997 (up to 3 Kg $haul^{-1}$) and 1999 (~2 Kg $haul^{-1}$), and smaller new peaks in 2005 and 2011 (~1.5 Kg $haul^{-1}$) (Figure 10). Lesser flying squid individuals caught in the surveys vary from 1.1 and 28.0 cm, with a mode in 5-10 cm (Figure 11). This species is distributed in all the survey area (Figure 12). Bathymetric distribution of the species (Figure 13) reflects the preference of this species for depths between 150 and 350 m, though it appears in the whole water column to 600 m.

3.4. Common octopus (*Octopus vulgaris*)

Common octopus has similar biomass abundance values during the surveys series (lower than 1 kg $haul^{-1}$) (Figure 14), with a remarkable bloom in 1992 (~4 kg $haul^{-1}$). Common octopus length sizes in this surveys (Figure 15) range from 2.8 to 20.0 cm. This species is distributed in all the survey area (Figure 16). Bathymetric distribution (Figure 17) reflects the preference of this species for the shallowest grounds, with the highest abundances at depths lower than 100 m, and almost no presence in grounds deeper than 200 m.

3.5. Long finned squid (*Loligo forbesi*)

Long finned squid presents an irregular abundance in this surveys (Figure 18) that is relatively high between 2003 and 2006; it presents a drop in 2007-2008 (absence of capture) and a recovery in the latest years when the values were maximum (~0.8 kg $haul^{-1}$). The remaining years abundances were low (<0.2 kg $haul^{-1}$). The *L. forbesi* sizes found in these surveys range between 3.5 and 56.0 cm, presenting two noteworthy modes in 6-8 cm and another one in 23-27 cm (Figure

19). Regarding geographical distribution, long finned squid appears in the Cantabrian Shelf, especially at the easternmost areas (Figure 20), though the latest years the species is found at western positions (rarely at the west of Estaca). Bathymetrically, long finned squid also prefers shallowest areas (Figure 21), with the highest abundances lower than 50 m (special hauls), and almost no presence in grounds deeper than 350 m.

3.6. Common squid (*Loligo vulgaris*)

Common squid also presents an irregular abundance (Figure 22) with low values in general (lower than 0.2 kg $haul^{-1}$), except during the periods 1995-1997 (~0.3 kg $haul^{-1}$) and 2006-2009 (~0.3-0.5 kg $haul^{-1}$). The capture was scarce in 2010 and 2011. The *L. vulgaris* sizes found in these surveys range between 2.2 and 55.0 cm; the most frequent were the smallest specimens (Figure 23). The area occupied by common squid is very similar to the long finned squid (Figure 24), however this species can also be found in the Galician Shelf. Bathymetric distribution (Figure 25) reflects the preference of this species for the shallowest grounds, with the highest abundances at depths lower than 50 m (special hauls), and almost no presence in grounds deeper than 100 m.

3.7. European flying squid (*Todarodes sagittatus*)

European flying squid has similar biomass abundance values during the surveys series (lower than 0.2 kg $haul^{-1}$) (Figure 26), with a remarkable bloom in 1994 (~0.7 kg $haul^{-1}$) and smaller new peaks in 2006 and 2009 (~0.3 kg $haul^{-1}$). European flying squid length sizes in these surveys (Figure 27) range from 10.7 to 40.2 cm. This species is distributed in all the survey area (Figure 28), especially in the north of the Galician Shelf. Bathymetric distribution (Figure 29) reflects the preference of this species for deeper grounds, with the highest abundances at depths between 400 and 550 m.

3.8. Pink Cuttlefish (*Sepia orbignyana*)

The biomass abundance of pink cuttlefish is quite variable, with peaks every 4-5 years (Figure 30) (up to 0.15 Kg $haul^{-1}$). The *S. orbignyana* sizes found in these surveys range between 1.0 and 9.6 cm (Figure 31). This species is distributed in all the Cantabrian Shelf, with concentrations in the sectors EB (Estaca-Bares) and BP (Bares-Peñas) (Figure 32). Bathymetrically, pink cuttlefish prefers the shallowest grounds (between 50 and 150 m), and almost no presence in grounds deeper than 200 m (Figure 33).

3.9. Common cuttlefish (*Sepia officinalis*)

Presence of common cuttlefish is very scarce in the DEMERSALES surveys (Figure 34) due to its bathymetric preferences (shallower than those covered in this survey). The years with higher abundances were 1996 and 2006 (the biomass index was 0.15-0.2 kg $haul^{-1}$). The *S. officinalis* sizes found in these surveys range between 5.6 and 20.5 cm. The low number of common cuttlefish captured during the latest five years did not allow us to display any length distribution. Regarding geographical distribution, common cuttlefish appears at the easternmost areas of the Cantabrian Shelf (Figure 35). Bathymetric distribution shows the peak of abundance under 50 m and no presence of this species deeper than 100 m (Figure 36).

3.10. Elegant cuttlefish (*Sepia elegans*)

The biomass abundance of elegant cuttlefish is similar during the series, with a small peak in 1997 and a smaller one in 2009 (~0.1 kg haul^{-1}) (Figure 37). The *S. elegans* sizes found in these surveys range between 0.5 and 7.4 cm (Figure 38). The geographical preferences of elegant cuttlefish are Asturias and Galician Shelves (Figure 39). Bathymetric distribution of the species (Figure 40) reflects the shallow habits of this species that only occurs in grounds between 50 and 100 m.

Acknowledgements

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FIGURES

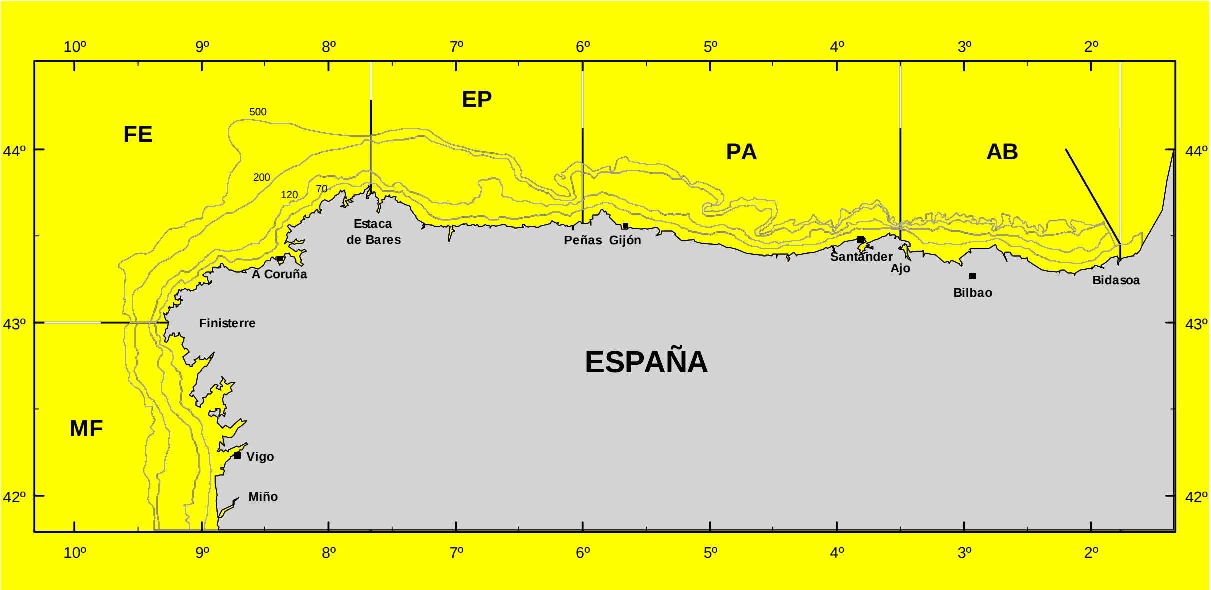

Figure 1. Stratification design on the Demersales surveys (ICES divisions VIIIc and IXa North). Depth strata are: A) 70-120 m, B) 121-200 m, and C) 201-500 m. Geographic transects are MF: Miño-Finisterre, FE: Finisterre-Estaca, EP: Estaca-Peñas, PA: Peñas-Ajo, and AB: Ajo-Bidasoa

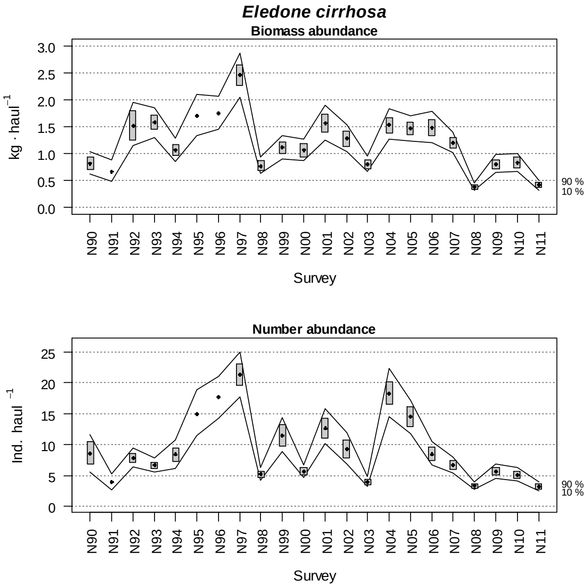

Figure 2. Evolution of biomass and abundance index in curled octopus (*Eledone cirrhosa*) during DEMERSALES Survey time series (1990-2011)

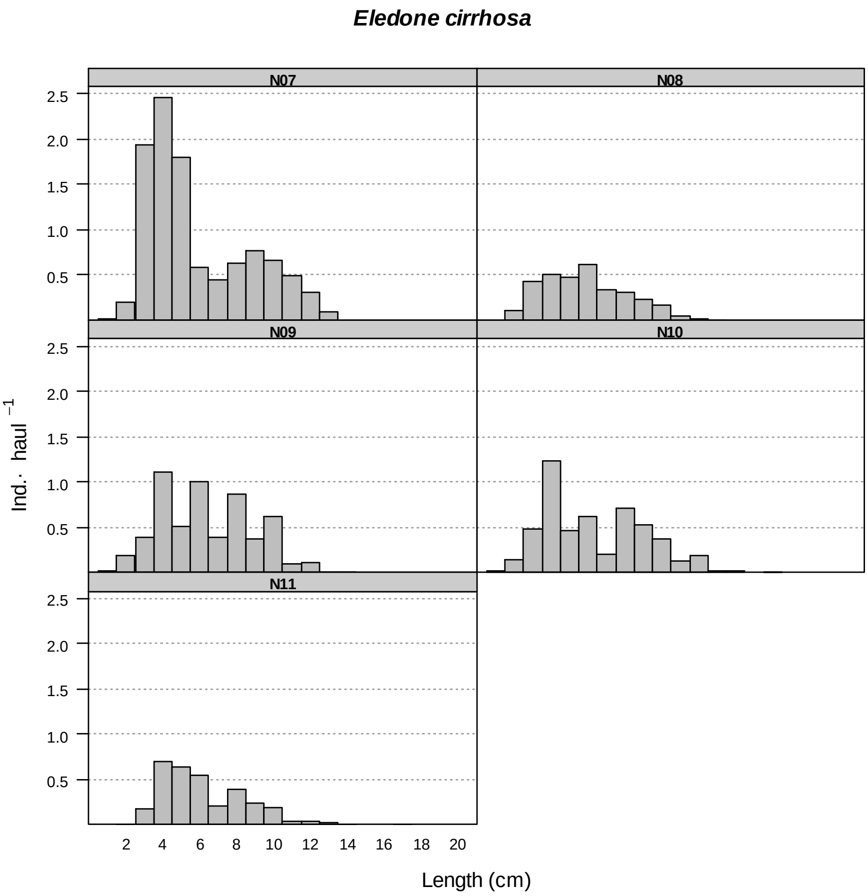

Figure 3. Length distributions of curled octopus (*Eledone cirrhosa*) during DEMERSALES Survey time series (2008-2011)

Eledone cirrhosa

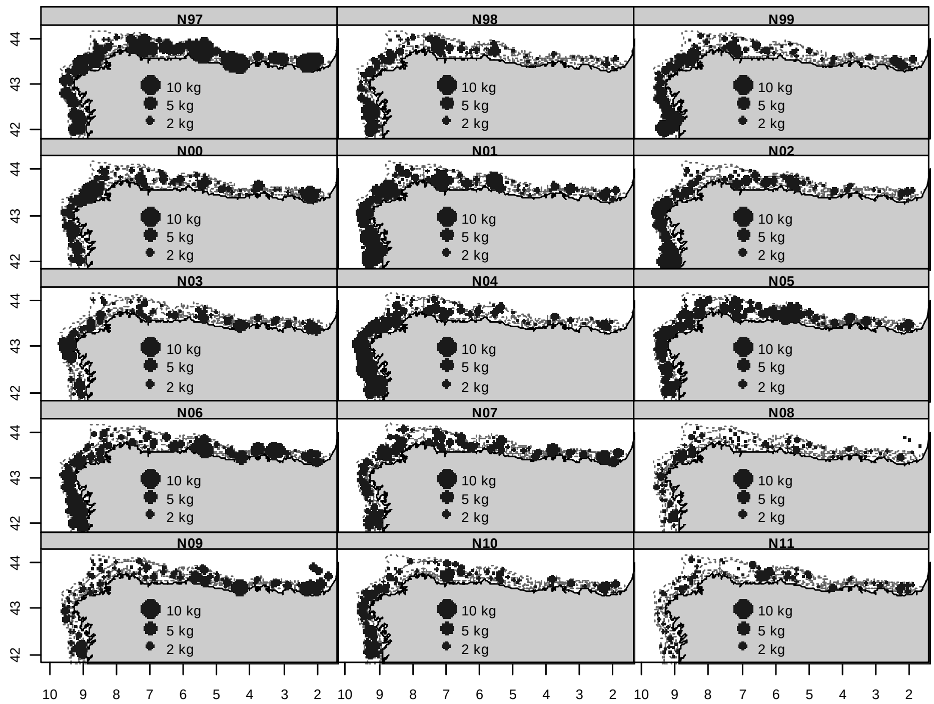

Figure 4. Geographic distribution of curled octopus (*Eledone cirrhosa*) during DEMERSALES Survey time series (1997-2011)

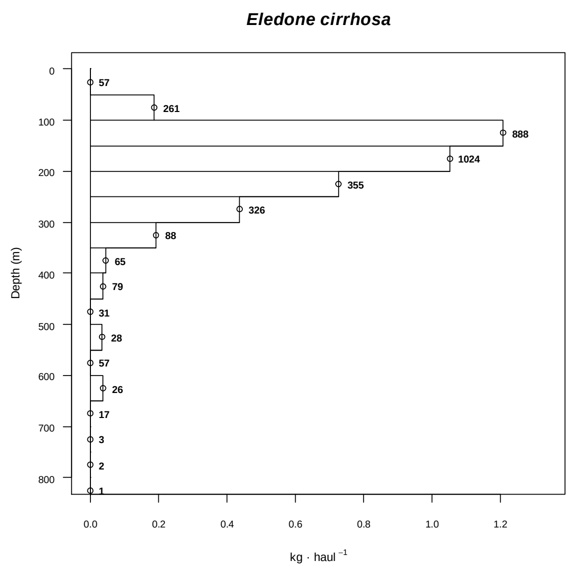

Figure 5. Bathymetric distribution of curled octopus (*Eledone cirrhosa*) catches (ind. haul^{-1}) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

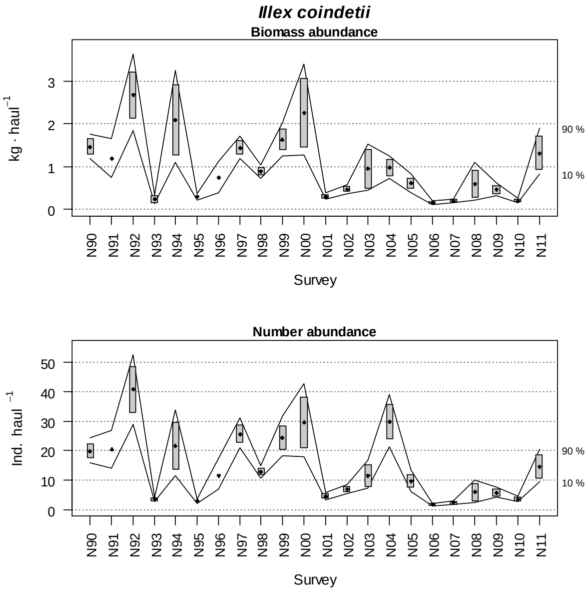

Figure 6. Evolution of biomass and abundance index in broadtail shortfin squid (*Illex coindetii*) during DEMERSALES Survey time series (1990-2011).

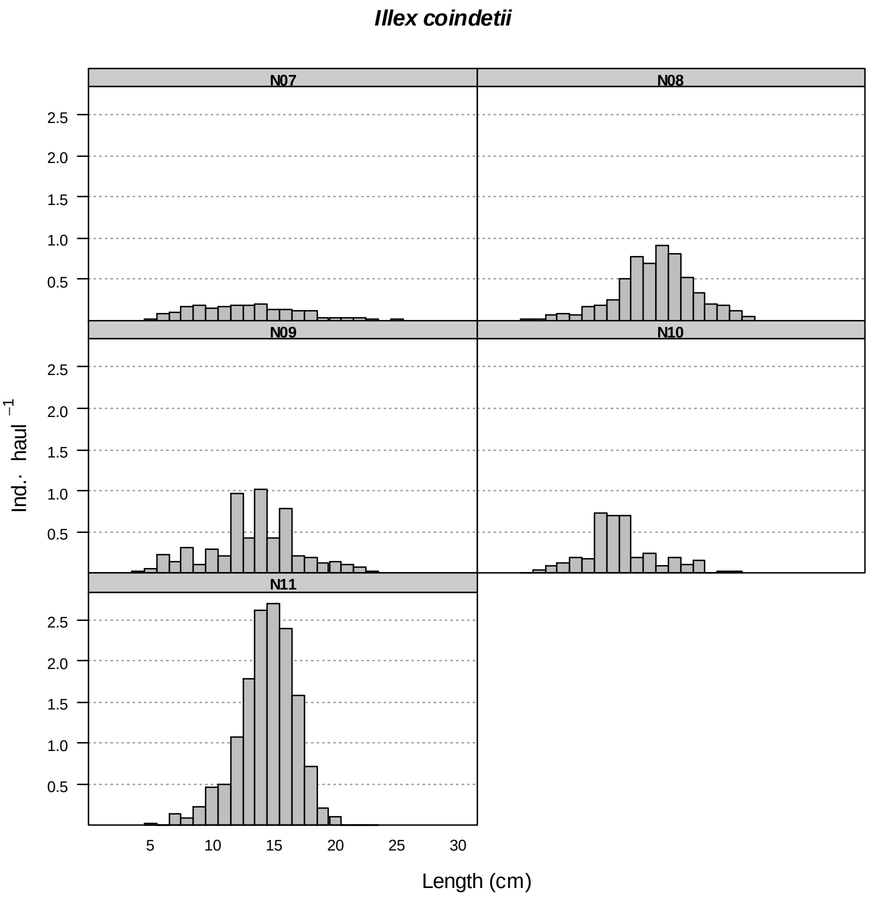

Figure 7. Length distributions of broadtail shortfin squid (*Illex coindetii*) during DEMERSALES Survey time series (2008-2011)

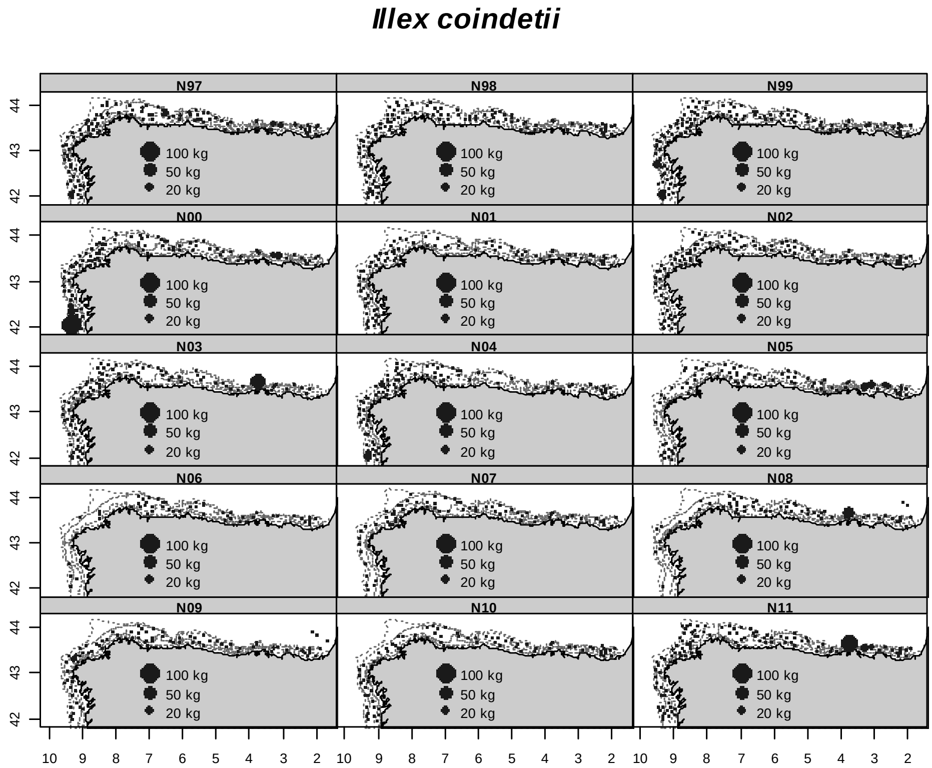

Figure 8. Geographic distribution of broadtail shortfin squid (*Illex coindetii*) during DEMERSALES Survey time series (1997-2011)

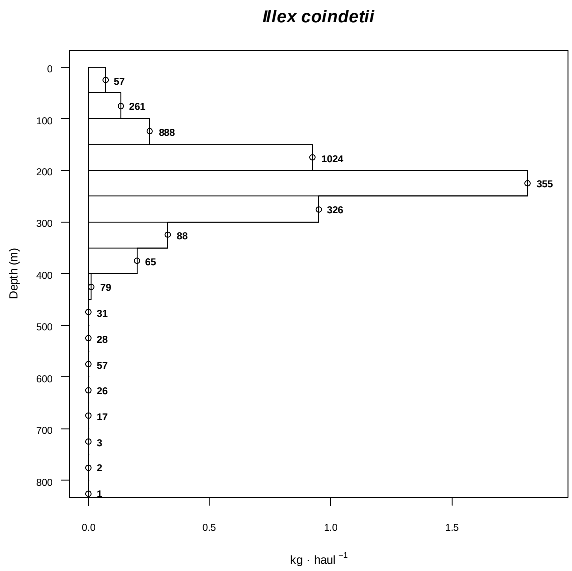

Figure 9. Bathymetric distribution of shortfin squid (*Illex coindetii*) catches (ind. haul^{-1}) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

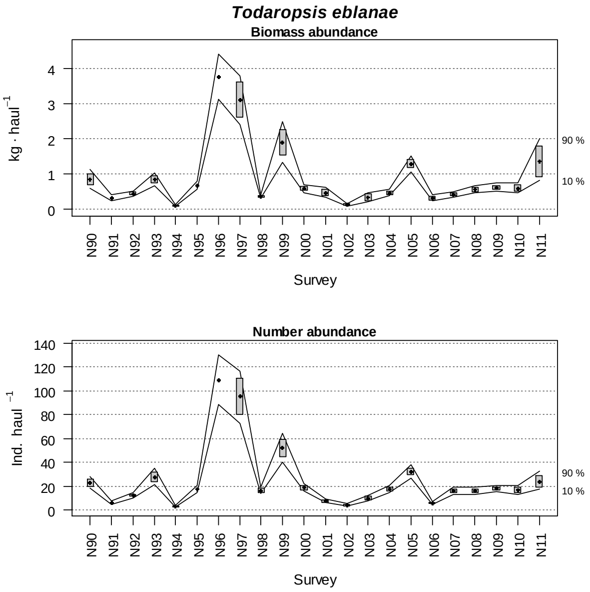

Figure 10. Evolution of biomass and abundance index in lesser flying squid (*Todaropsis eblanae*) during DEMERSALES Survey time series (1990-2011)

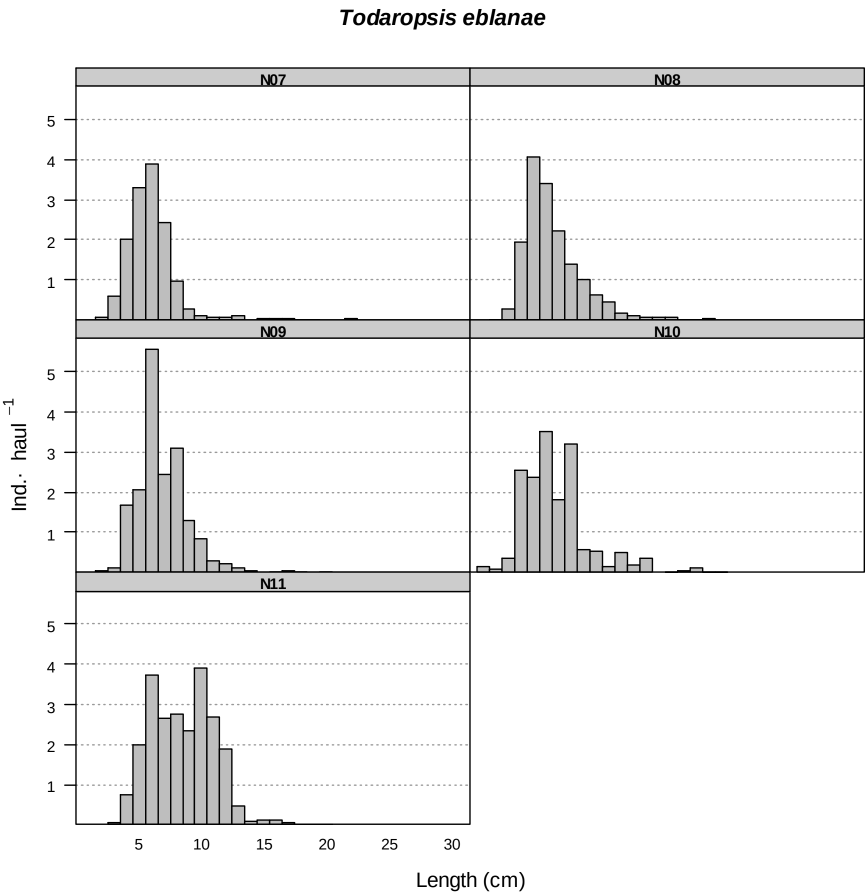

Figure 11. Length distributions of lesser flying squid (*Todaropsis eblanae*) during DEMERSALES Survey time series (2008-2011)

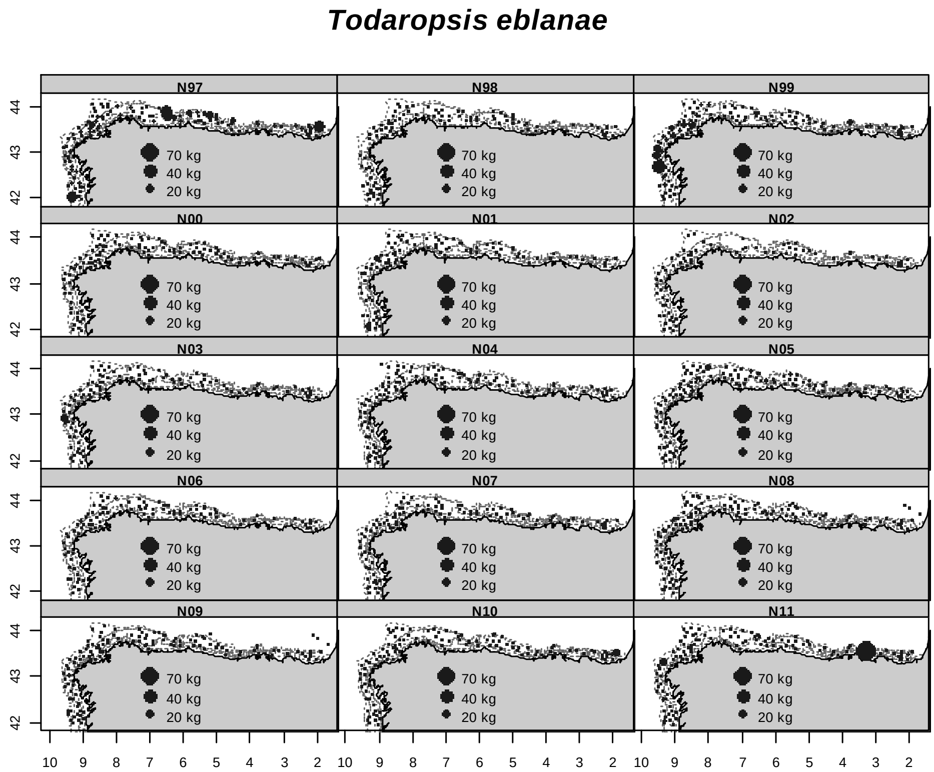

Figure 12. Geographic distribution of lesser flying squid (*Todaropsis eblanae*) during DEMERSALES Survey time series (1997-2011)

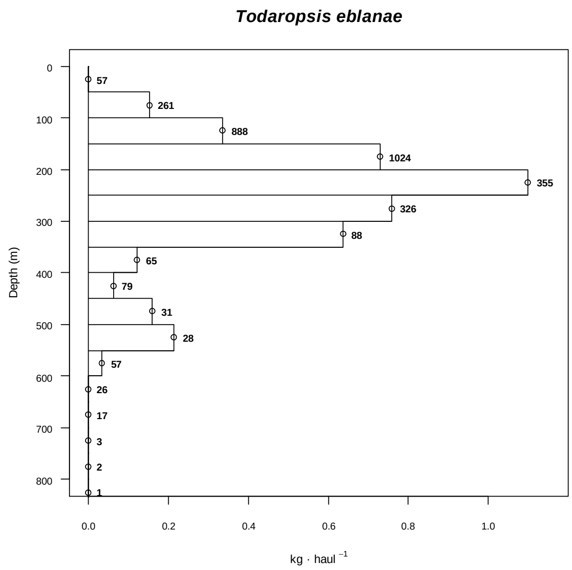

Figure 13. Bathymetric distribution of flying squid (*Todaropsis eblanae*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

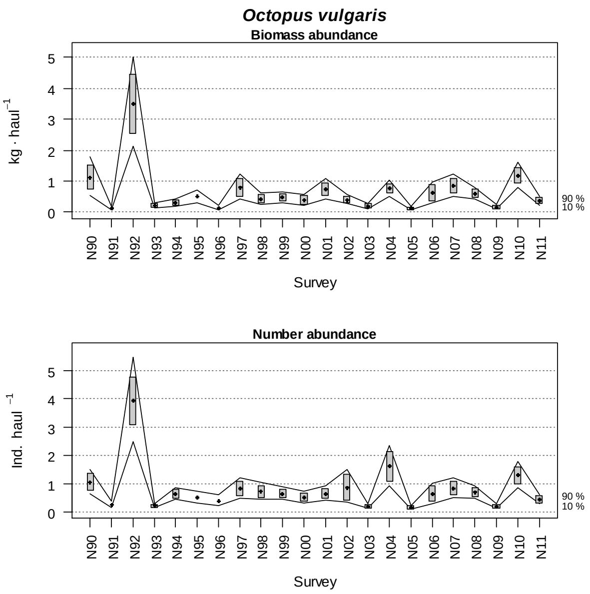

Figure 14. Evolution of biomass and abundance index in common octopus (*Octopus vulgaris*) during DEMERSALES Survey time series (1990-2011)

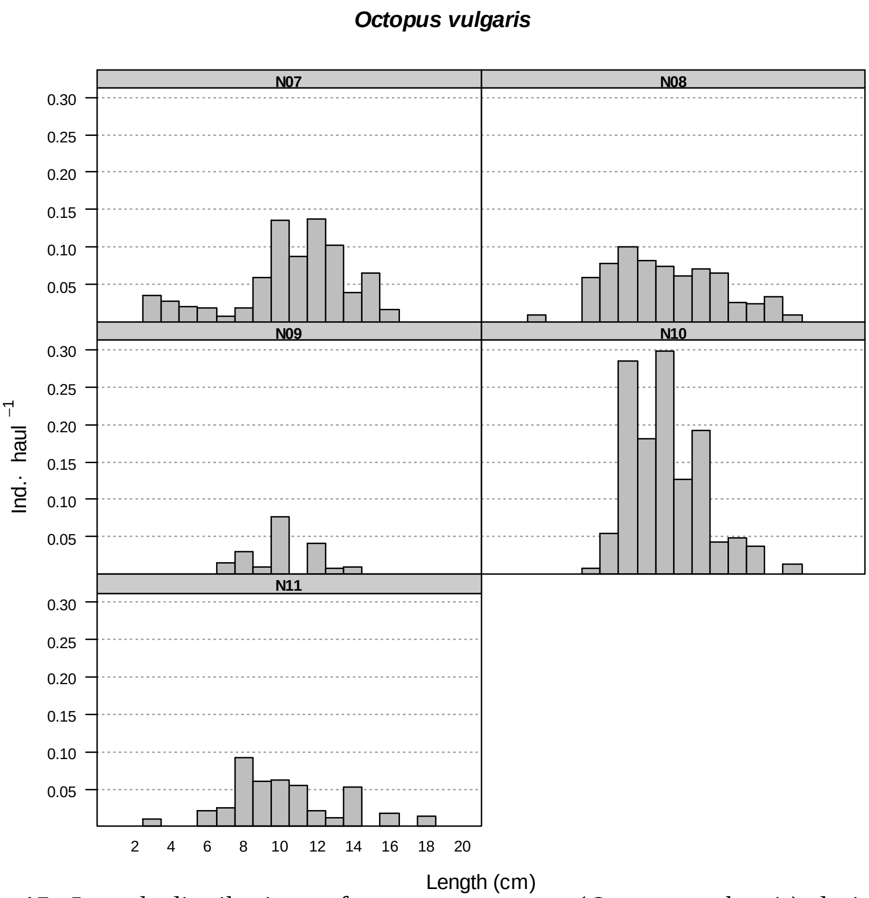

Figure 15. Length distributions of common octopus (*Octopus vulgaris*) during DEMERSALES Survey time series (2008-2011)

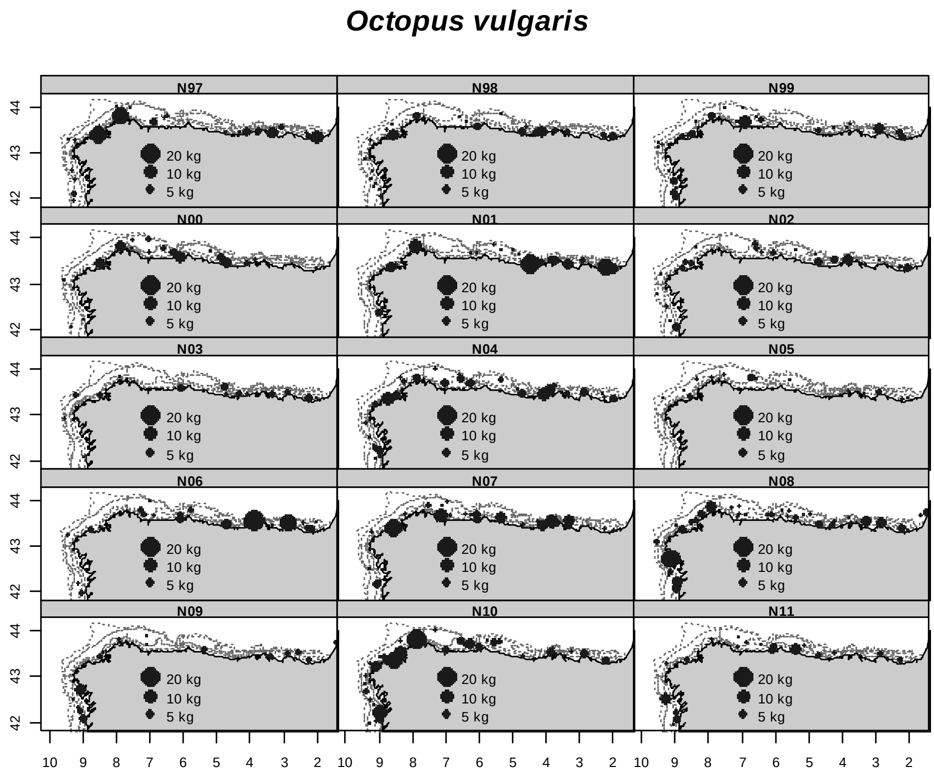

Figure 16. Geographic distribution of common octopus (*Octopus vulgaris*) during DEMERSALES Survey time series (1997-2011)

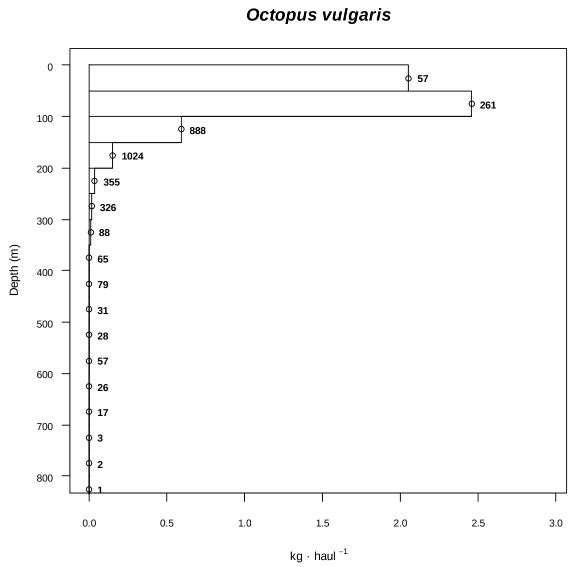

Figure 17. Bathymetric distribution of common octopus (*Octopus vulgaris*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

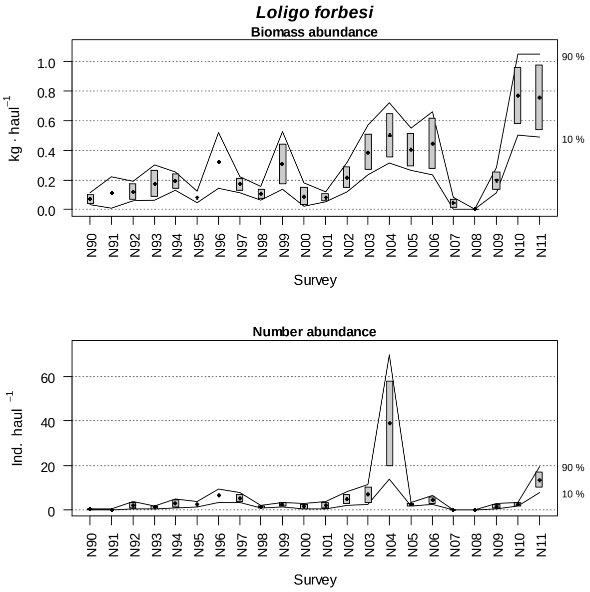

Figure 18. Evolution of biomass and abundance index in long finned squid (*Loligo forbesi*) during DEMERSALES Survey time series (1990-2011)

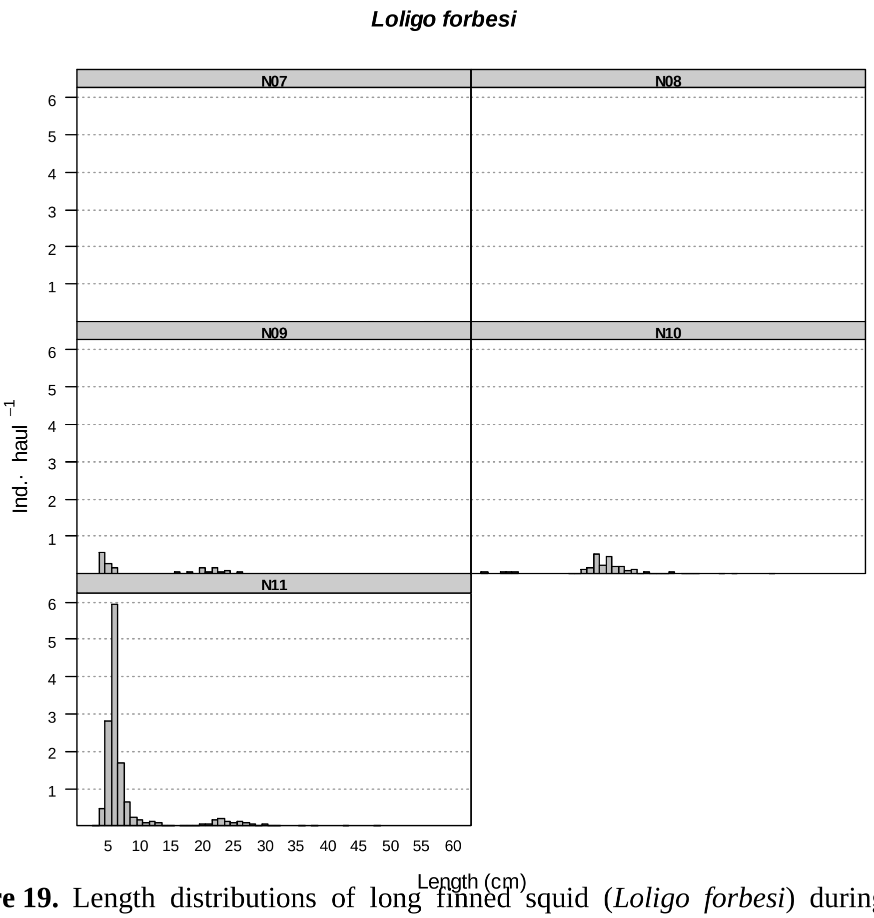

Figure 19. Length distributions of long finned squid (*Loligo forbesi*) during DEMERSALES Survey time series (2008-2011)

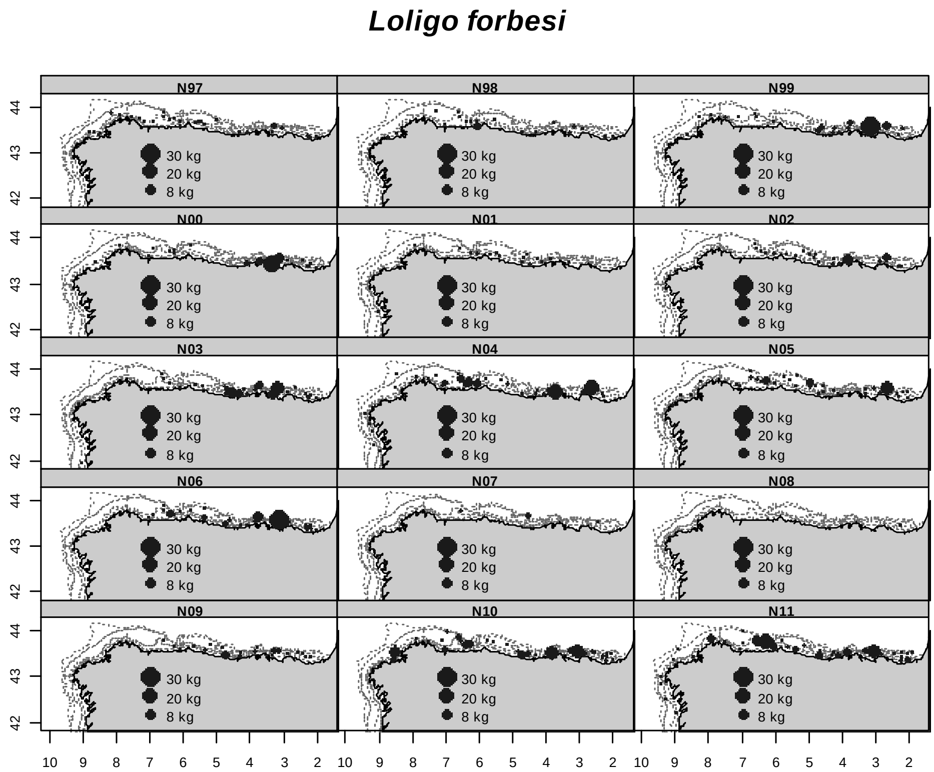

Figure 20. Geographic distribution of long finned squid (*Loligo forbesi*) during DEMERSALES Survey time series (1997-2011)

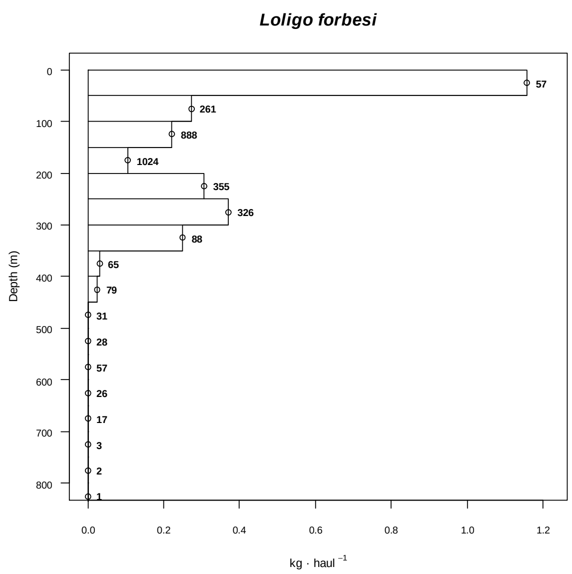

Figure 21. Bathymetric distribution of finned squid (*Loligo forbesi*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

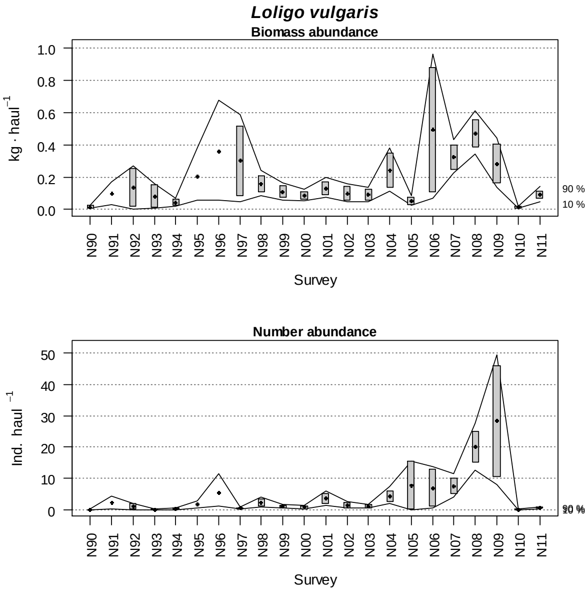

Figure 22. Evolution of biomass and abundance index in common squid (*Loligo vulgaris*) during DEMERSALES Survey time series (1990-2011)

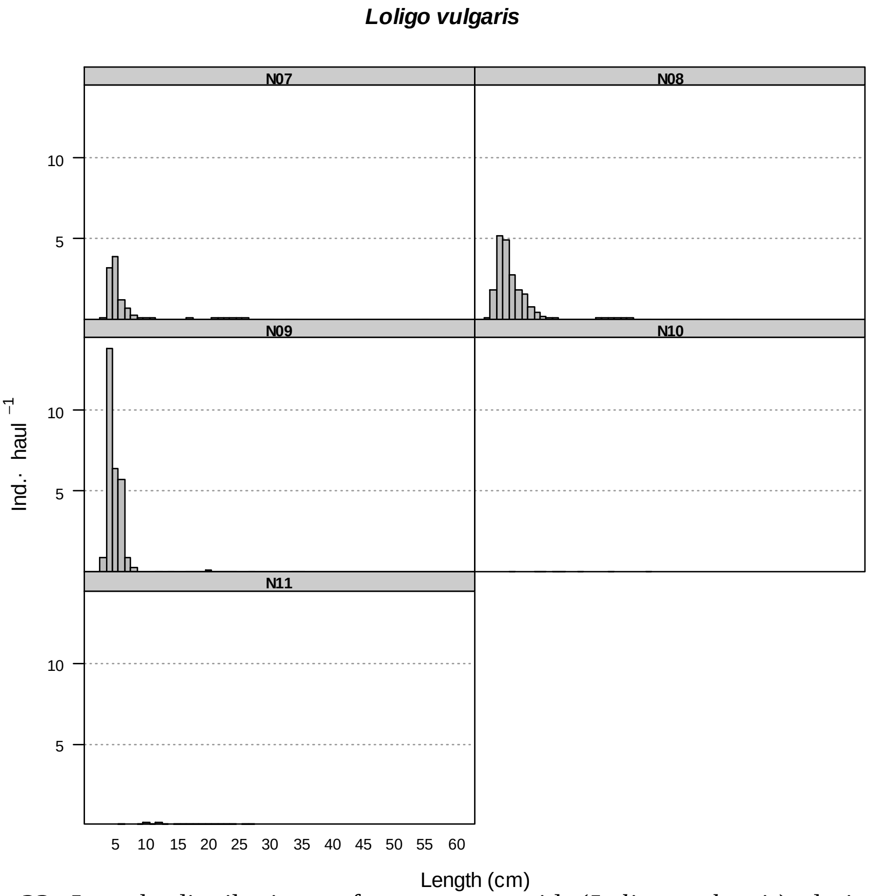

Figure 23. Length distributions of common squid (*Loligo vulgaris*) during DEMERSALES Survey time series (2008-2011)

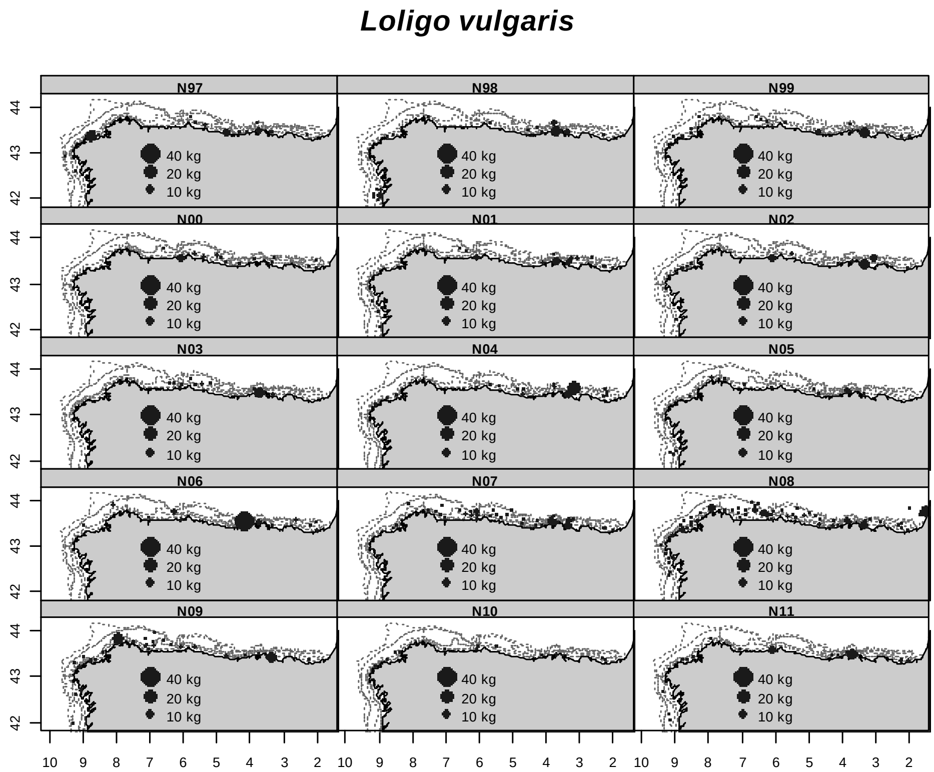

Figure 24. Geographic distribution of common squid (*Loligo vulgaris*) during DEMERSALES Survey time series (1997-2011)

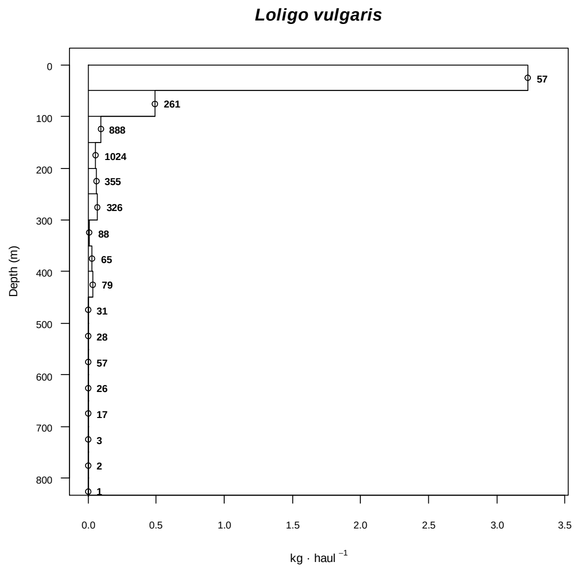

Figure 25. Bathymetric distribution of common squid (*Loligo vulgaris*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

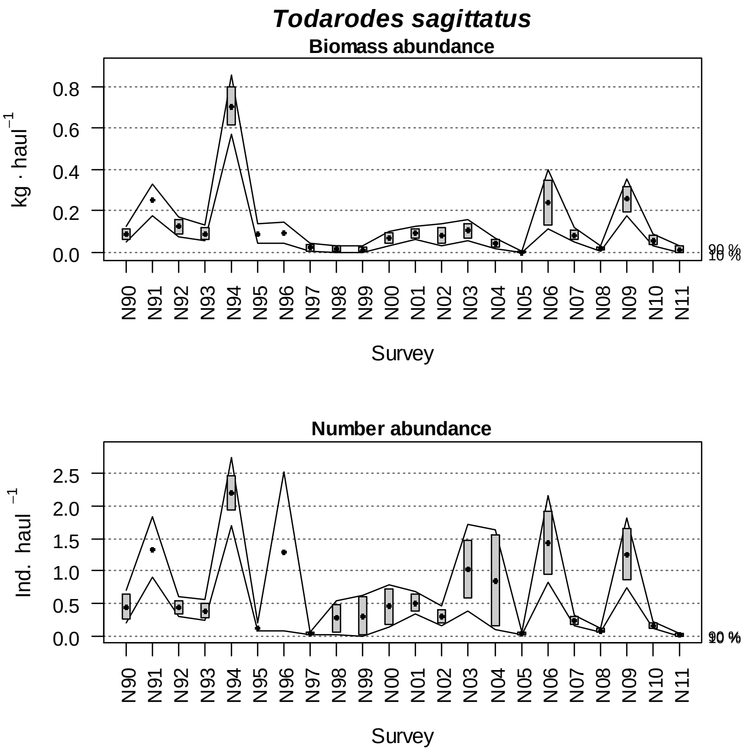

Figure 26. Evolution of biomass and abundance index in European flying squid (*Todarodes sagittatus*) during DEMERSALES Survey time series (1990-2011).

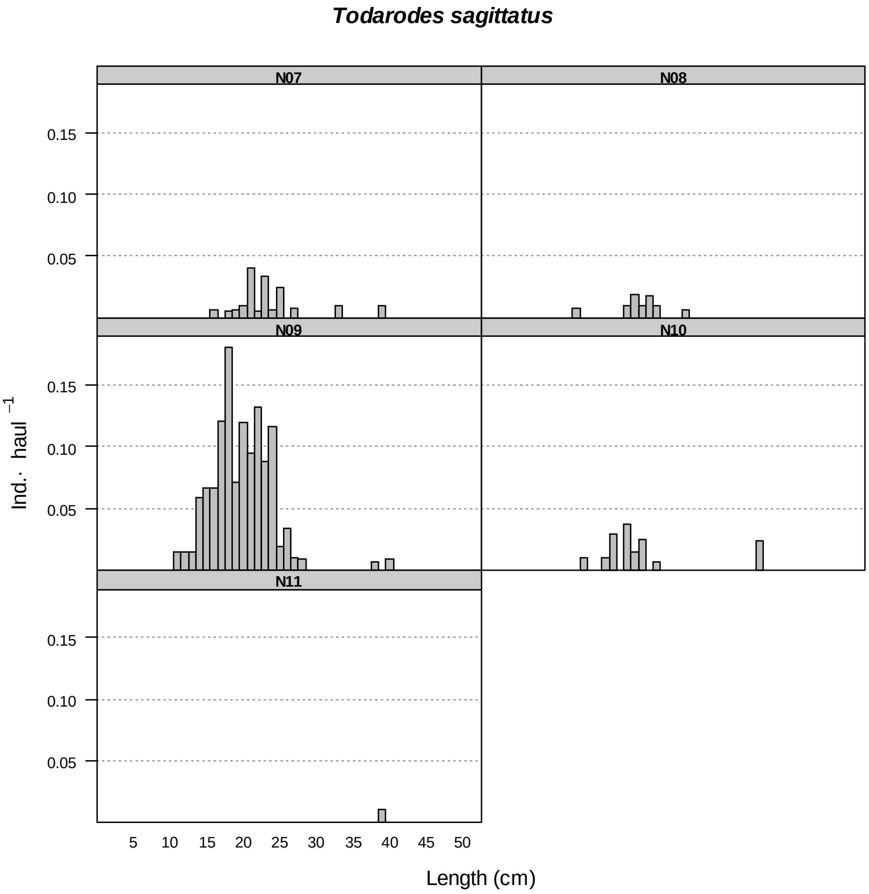

Figure 27. Length distributions of European flying squid (*Todarodes sagittatus*) during DEMERSALES Survey time series (2008-2011).

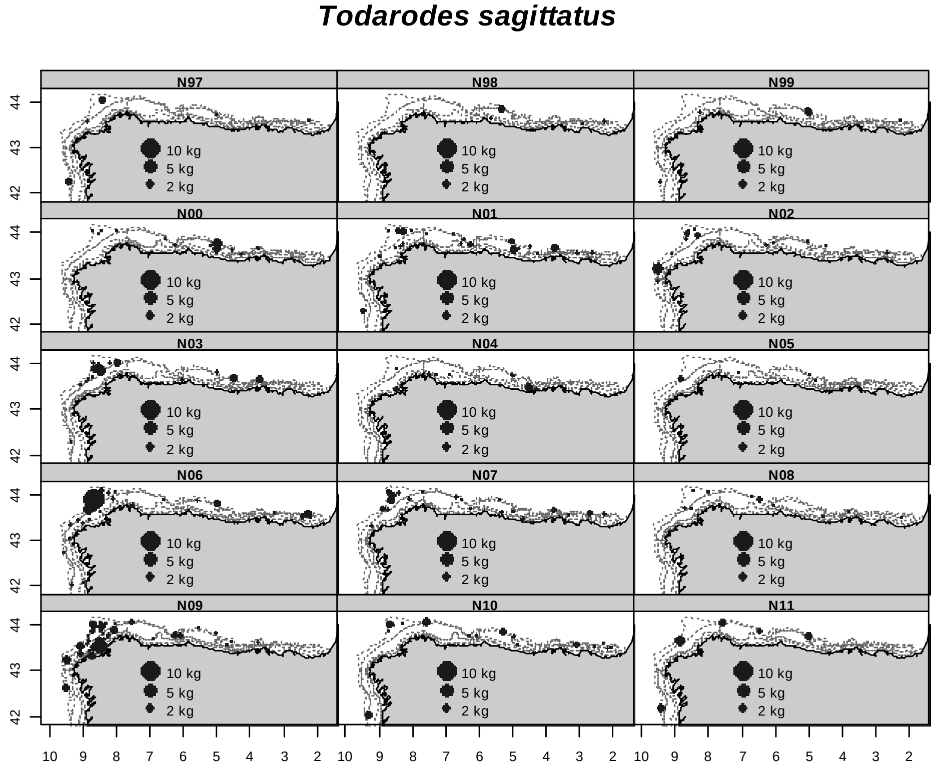

Figure 28. Geographic distribution of European flying squid (*Todarodes sagittatus*) during DEMERSALES Survey time series (1997-2011).

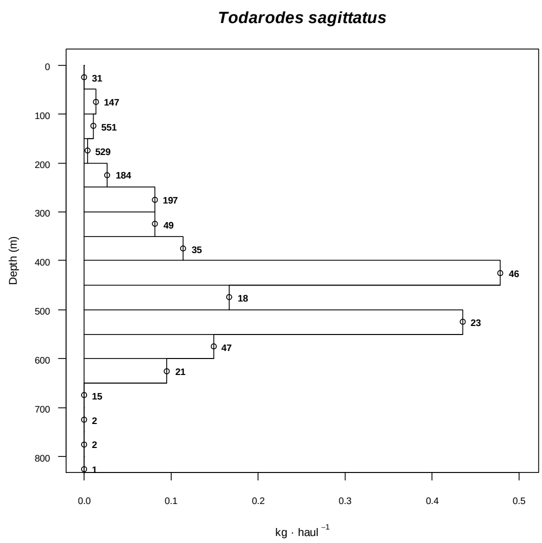

Figure 29. Bathymetric distribution of European flying squid (*Todarodes sagittatus*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure.

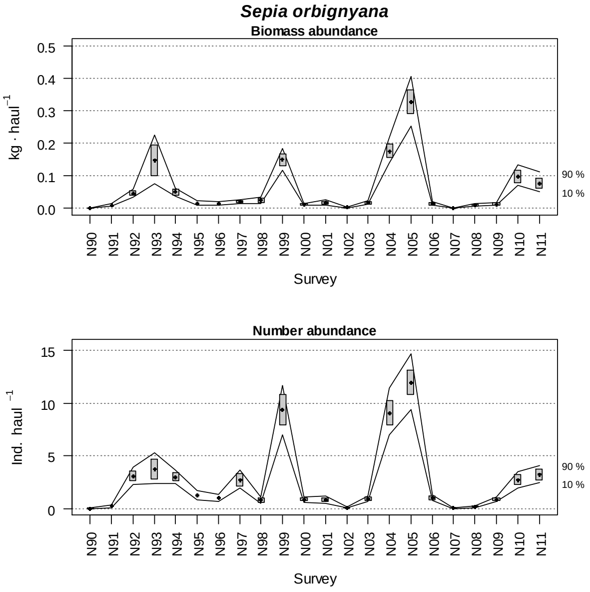

Figure 30. Evolution of biomass and abundance index in pink cuttlefish (*Sepia orbignyana*) during DEMERSALES Survey time series (1990-2011).

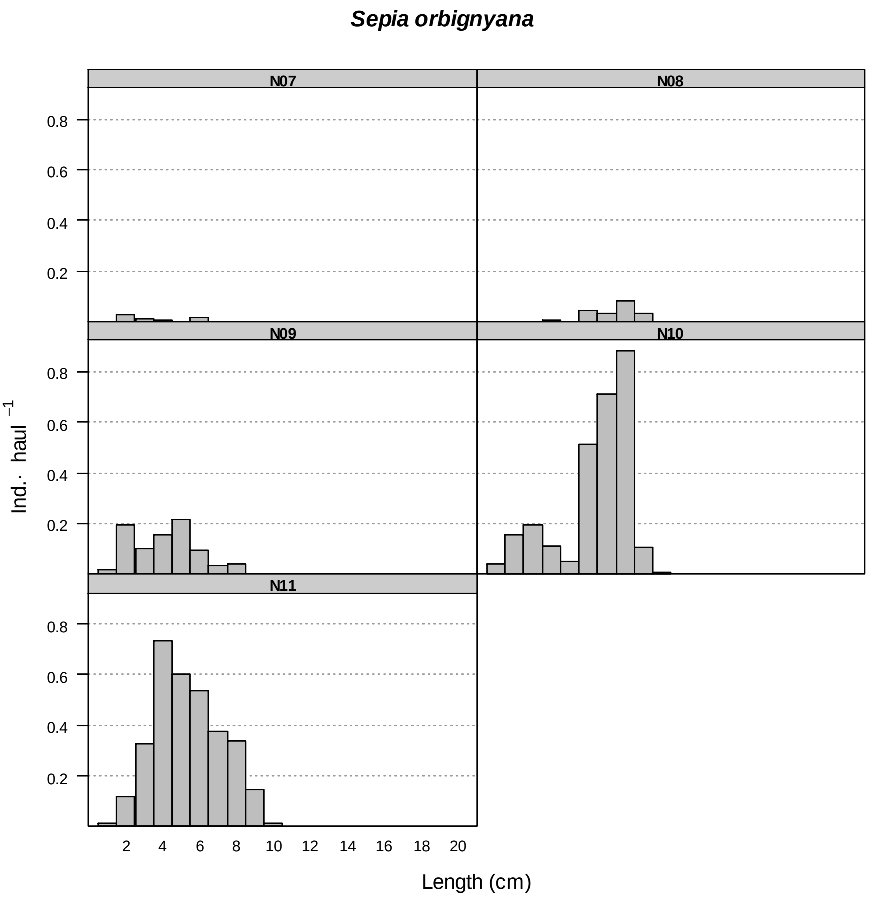

Figure 31. Length distributions of pink cuttlefish (*Sepia orbignyana*) during DEMERSALES Survey time series (2008-2011).

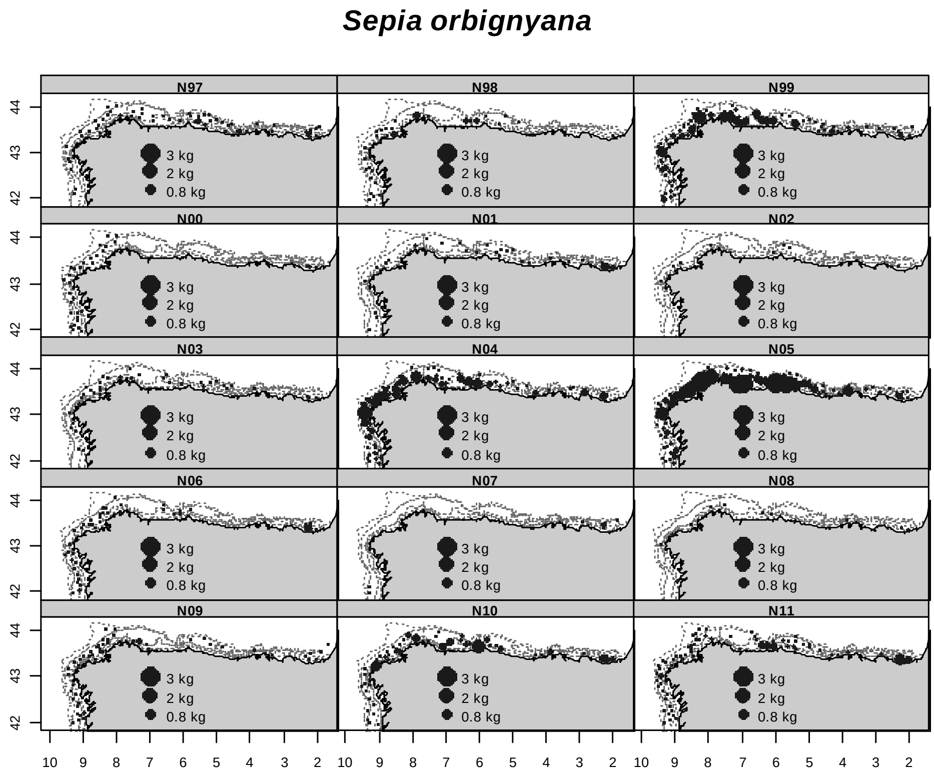

Figure 32. Geographic distribution of pink cuttlefish (*Sepia orbignyana*) during DEMERSALES Survey time series (1997-2011).

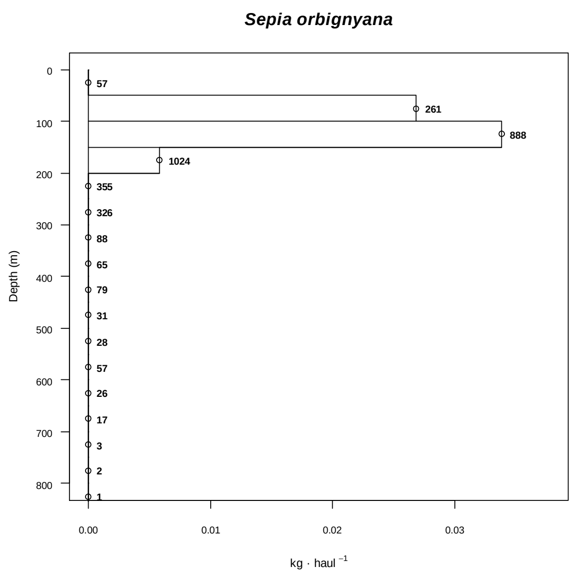

Figure 33. Bathymetric distribution of pink cuttlefish (*Sepia orbignyana*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure.

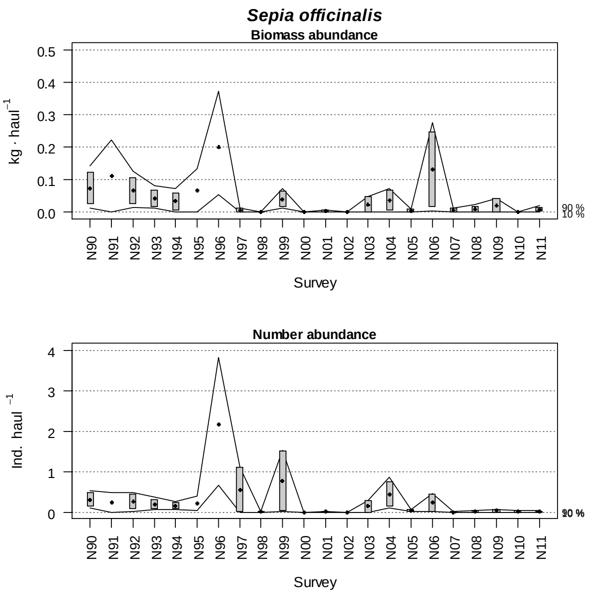

Figure 34. Evolution of biomass and abundance index in common cuttlefish (*Sepia officinalis*) during DEMERSALES Survey time series (1990-2011).

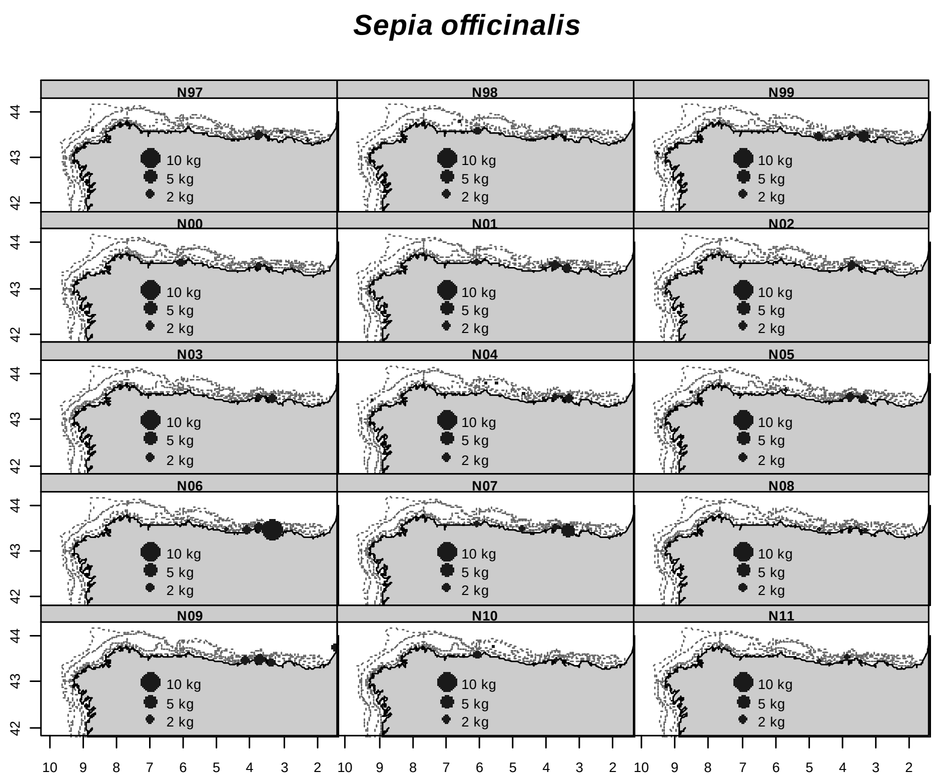

Figure 35. Geographic distribution of common cuttlefish (*Sepia officinalis*) during DEMERSALES Survey time series (1997-2011).

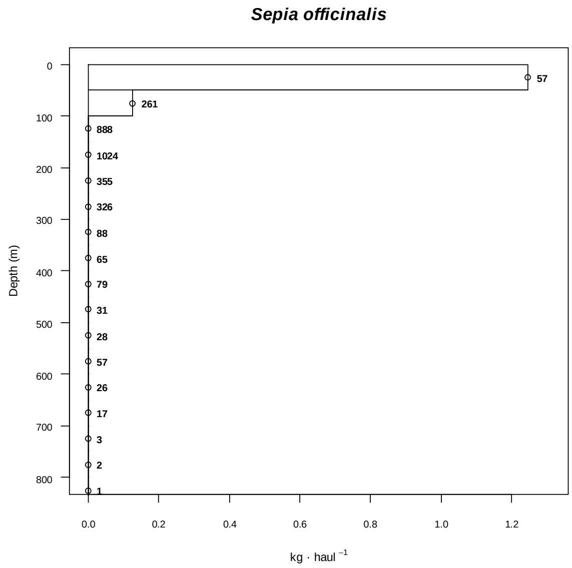

Figure 36. Bathymetric distribution of common cuttlefish (*Sepia officinalis*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure.

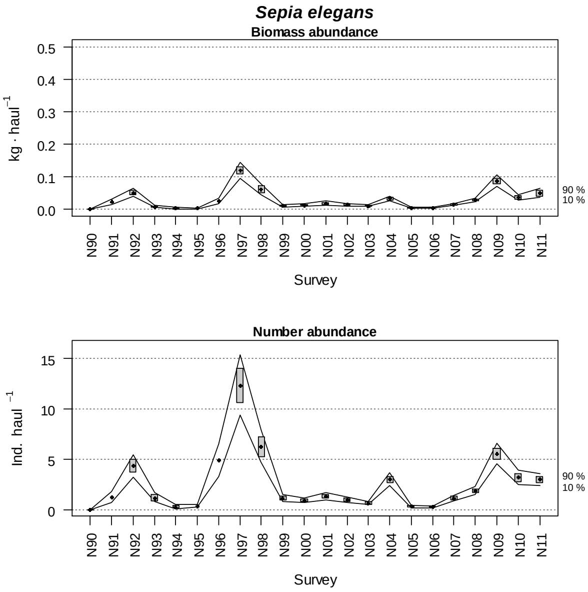

Figure 37. Evolution of biomass and abundance index in elegant cuttlefish (*Sepia elegans*) during DEMERSALES Survey time series (1990-2011).

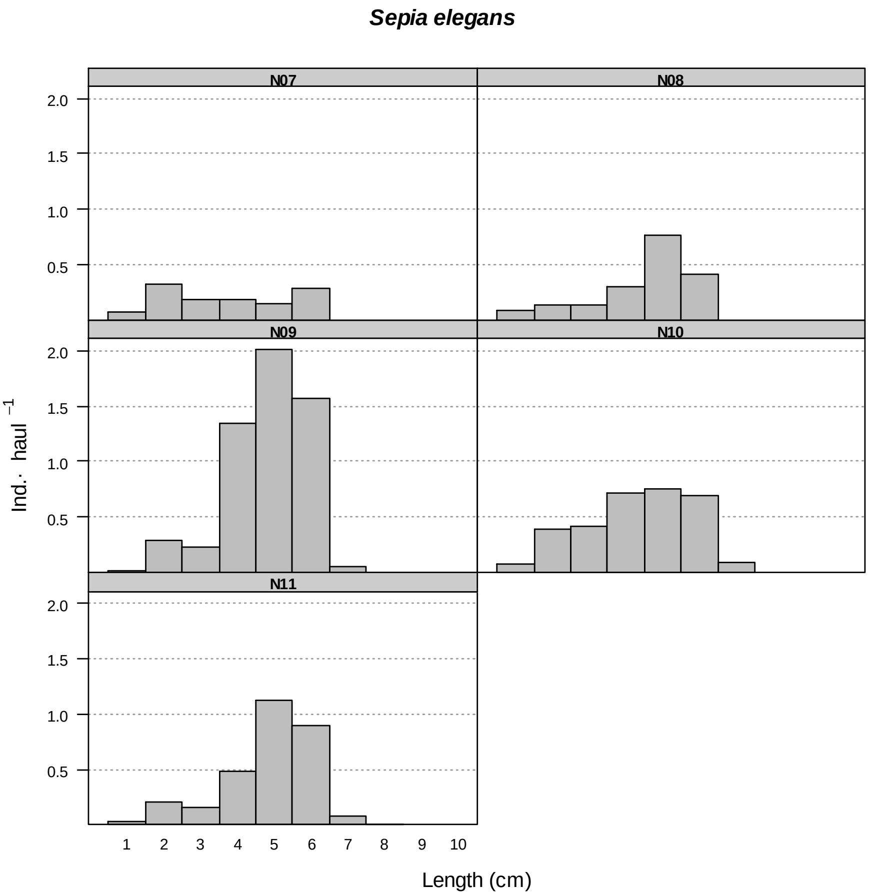

Figure 38. Length distributions of elegant cuttlefish (*Sepia elegans*) during DEMERSALES Survey time series (2008-2011).

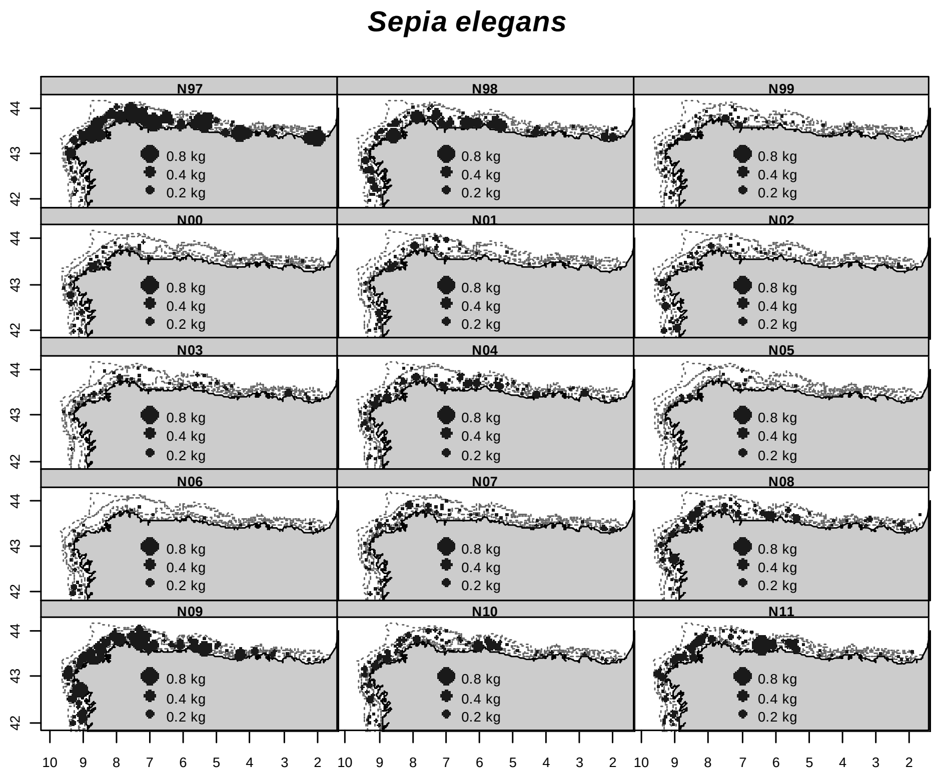

Figure 39. Geographic distribution of elegant cuttlefish (*Sepia elegans*) during DEMERSALES Survey time series (1997-2011).

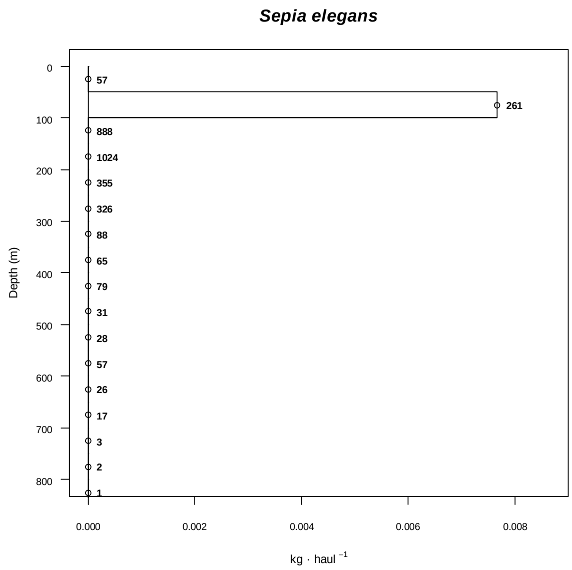

Figure 40. Bathymetric distribution of elegant cuttlefish (*Sepia elegans*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure.

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Results on main commercial cephalopod species captured during the ARSA bottom trawl surveys in the Gulf of Cádiz (NE Atlantic, SW Spain): 1997-2011 autumn series.

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Abstract

This working document presents the results on ten of the main commercial cephalopod species of the fifteen years (1997-2011) of the autumn series of the ARSA bottom trawl survey (Q4 SP-GCGFS) carried out in the Gulf of Cádiz (NE Atlantic, SW Spain).The main species in biomass terms in this survey time series in decreasing abundance order were: Illex coindetii, Octopus vulgaris, Sepia officinalis, Eledone moschata, Loligo vulgaris, Alloteuthis spp., Loligo forbesii, Todaropsis eblanae, Eledone cirrhosa and Sepia elegans. I. coindetii is located in first place due to the exceptional biomass caught in 1998. Many of these species occupy mainly the continental shelf area, especially O.vulgaris, S. officinalis and L. vulgaris, located in shallow waters of this area. Others, like Alloteuthis spp., S. elegans and E. moschata extend their distribution areas until the deep shelf. The rest of analysed species are more abundant in the upper and middle slope. Length distributions of these species along the survey series are also presented and discussed.

1. Introduction

Since 1997 the Spanish bottom trawl survey ARSA has been carried out annually in autumn, during November, in the Gulf of Cádiz (ICES Sub-division IXa south) to study the distribution and relative abundance (in number and weight) of all demersal species in the area, as well to estimate biological parameters of main commercial species (ICES, 2010).

The aim of this working document is to present the results (abundance indices, length frequency distributions and geographic and bathymetric distributions) of the most commercial cephalopod species in these surveys series. These species are the cuttlefish *Sepia officinalis* and *Sepia elegans*, the octopus *Octopus vulgaris*, *Eledone moschata* and *Eledone cirrhosa*, the long-finned squids *Loligo vulgaris*, *Loligo forbesii* and *Alloteuthis* spp., and the short-finned squids *Illex coindetii* and *Todaropsis eblanae*. Recently, it has been published an article with survey data of this species (Silva *et al*., 2011), whose information can be complementary to the one provided in this WD.

2. Material and methods

The autumn ARSA survey (Q4 Spanish Ground Fish Survey on the Gulf of Cádiz) was conducted every November in the southern part of ICES Division IXa, Gulf of Cádiz, extending from longitude 6° 10` W to 7° 20` W and from latitude 36° N to 37° N and covering between 15 m and 800 m depth. The whole area (7224 km^2) has been broken up in five depth strata (15–30, 31–100, 101–200, 201–500 and 501–800 m; Figure 1). The surveyed area was divided in 5x5 nm squares. The sampling design is random stratified with proportional allocation to the strata, by setting a total of 42 fishing stations (Figure 1).

This survey was always carried out with RV "Cornide de Saavedra". The fishing gear used is a Baka trawl 44/60 with a 43.6 m footrope and a 60.1 m headline. Thyboron trawl doors weighting 330 kg and 1.8 m² of surface were used. Mean vertical opening of the eye trawl during the surveys was 2 m, doors opening 107 m and horizontal opening 20 m, varying with depth. Net mesh size is 40 mm all along the gear, with a 10 mm liner covering the cod-end inner part to retain small. Towing time was set to 60 minutes between the end of wire shutting and starting to pull it back and towing speed was set to 3 kn. In each haul, catches of all species were weighed and representative samples of the catch of these species were counted. Biological sampling was carried out (length, weigth, sex and maturity) since 1997 of the main commercial species. Length distributions were obtained to the lowest cm, measuring the dorsal mantle length (DML), in all cephalopod species, except in *Alloteuthis* spp. and species belonging to sepiolid group.

Evolution of abundance index in number and biomass by haul are presented for each species along the time series (1997-2011). In order to compare abundances between years, the abundance variability has been studied with two different methods: the parametric standard error derived random stratified sampling (Grosslein and Laurec, 1982), and a non parametric bootstrap procedure. The bootstrap method was implemented in R (R Development Core Team, 2004) resampling randomly with replacement stations within each stratum, to obtain the same number of stations per strata as in the original sample. Sampling intensity in each stratum, which was proportional to the stratum area, was thus conserved. A total of 1000 resamples were performed for each survey and 80% bootstrap confidence intervals were estimated using the 0.1 and 0.9 quantiles of the resultant distribution of bootstrap replicates (Efron and Tibshirani, 1993).

To study bathymetric distribution of the species addressed, firstly a histogram of depth of hauls carried out along the time series was performed obtaining the number of hauls per 50 m interval. Later the number of individuals in all the hauls performed in each depth interval was calculated and divided by the number of hauls.

3. Results and discussion

Alloteuthis spp.

Alloteuthis media and *Alloteuthis subulata* have been both analyzed like *Alloteuthis* spp. due to taxonomic identification problem. It showed a range of abundance in biomass and number from 0.4 to 1.4 kg/haul and 90 and 600 ind/haul,, respectively (Figure 2). The maximum and minimum values were detected in 2004 and 2006 in both cases. This group of species is distributed along the whole continental shelf in the study area, with the highest number of specimens and biomass below 100 m of depth (Figures 3 and 4). Distribution sizes were not carried out in these surveys.

Sepia officinalis

The common cuttlefish presented an abundance series in biomass and number quite stable along the time series, with a mean value of 0.7 kg/haul and 3 ind/haul, respectively (Figure 5). A remarkable peak was detected in the first year (1997), corresponding with the highest values of the time series (2.8 kg/haul and 8 ind/haul). Length frequency distributions (Figure 6) showed a wide range size (4-35 cm) with a clear mode in 10-12 cm in most of the years, corresponding with the spring-autumn recruitment in the study area (Ramos *et al.*; 2002). Geographical distribution showed a presence throughout the shallower waters of the continental shelf (Figure 7) with a bathymetric distribution below 150 m depth (Figure 8).

Sepia elegans

The elegans cuttlefish presented an irregular abundance in this ARSA survey series (Figure 9), with maxima peaks in 1997, 2000 and 2005. In 2005, it was obtained the highest values in biomass and number, respectively. Since 2005, the trend was slightly decreasing up to 2011. Length distribution ranged between 2 and 6 cm, with a mode in 4 cm in all year (Figure 10). The geographic distribution showed a wide occupied area in the deep shelf and upper slope strata (Figure 11). However, it has been caught in shallow waters too (Figure 12).

Octopus vulgaris

The common octopus presented oscillations in the abundance indices, with the highest values in the second half of the time series (Figure 13). The maximum values were obtained in 2005 with 3.8 kg/haul and 9 ind/haul, followed by other lesser peaks in 2007, 2009 and 1999. The lowest values were obtained in 2003 with 0.3 kg/haul and 0.3 ind/haul. According to the studies carried out in the Gulf of Cádiz, it appears to exist an inverse relationship between environmental factors and the abundance of this species (Sobrino *et al.*, 2002). Length frequency distributions showed a great presence of small individuals, with a mode around 7-9 cm (Figure 14), from the spring-summer spawning season (Silva *et al.*, 2002). Few octopus with size higher than 15-18 cm were caught because in this period of the year the spawning season in the Gulf of Cadiz finishes, and the spawners die. Most individuals were caught in shallow waters, below 50 m of depth (Figure 15), although same octopuses were caught at the end of the deep shelf, around 200 m of depth (Figure 16).

Eledone moschata

Musky octopus showed the maximum biomass and abundance indices at the beginning of the time series, in 1997, with 1.5 kg/haul and 11 ind/haul (Figure 17). A decrease occurred from 1997 to 2000, reaching the minimum value with 0.3 kg/haul, followed by a slight increase up to 2009 (1 kg/haul). In 2010, a new decrease is observed, reaching again the minimum value of the time series. Length frequency distributions showed a sizes range between 2-14 cm, with only one clear mode in all year about 6-7 cm (Figure

18). This mode come from the annual recruitment (Silva *et al.*, 2004) This species was only present in the continental shelf, with higher yields in the central-west zone of the study area (Figure19). Musky octopus has been caught up to 250 m, with maximum number in depth lower than 100 m (Figure 20).

Eledone cirrhosa

Horned octopus presented an increase trend in the abundance indices from 1998 to 2005, reaching in this year the maximum values with 0.4 kg/haul and 6 ind/haul (Figure 21). An important drop occurred in 2004, remaining the indices in low values close to zero until 2010, In 2011 showed a significant recovery. Length distribution ranged between 2-11 cm, with a mode in 5-6 cm (Figure 22). Geographic distribution was overlapped to the *E. moschata*, although the occupied area was wider in *E. cirrhosa*, reaching the middle slope in all the study area (Figure 23). Bathymetric distribution showed the higher number of individuals in depth around 150-200 m. The maximum and minimum depth reached were 620 m and 44 m, respectively (Figure 24).

Loligo vulgaris

Biomass and abundance trends of the common European squid showed significant oscillations along the time series (Figure 25). The biomass and abundance in number recorded the minimum values in 1998, with 0.1 kg/haul and 1 ind/haul, respectively. The biomass reached the maximum values in 2008 with 1.1 kg/haul, while in number was in 1999, with 8.2 ind/haul. From 2008 to 2011, the trend was decreasing in both indices (Figure 25), being the species abundance closely related with the reproductive cycle in the study area (Vila *et al*., 2011). Length frequency distribution showed a wide size range with minimum and maximum size of 4 cm and 45 cm, respectively, in the time series (Figure 26). A strong mode of 8-10 cm appeared in 1999 and 2001, corresponding with an important recruitment in the area. In the rest of the years the mode changes, with an increasing trend. Geographical and bathymetric distribution (Figure 27 and 28) pointed out the preference of this species for the shallow waters of the continental shelf, with important concentrations in coastal waters nearby to the main mouth river (Guadalquivir river), below 50 m of depth.

Loligo forbesii

Veined squid was sampled since 2000. Biomass and abundance indices have fluctuated without any marked trend. Biomass index ranged from 0.7 kg/haul in 2009 to almost zero in 2011, with other three maximum peaks in 2004, 2003 and 2000. Abundance index showed a similar trend, ranging from 9 ind/haul in 2009 to almost zero in 2011. Length distribution ranged between 2 and 33 cm. A clear and small mode of about 6-7 cm was detected in 2000, 2008 and 2009, while in 2004 and 2005 was higher (12-13 cm). In the rest of the years were caught few individuals. Geographical and bathymetric distribution (Figure 31 and 32) showed a concentration of these veined squid in the south of study area, close to the Strait of Gibraltar, from the end of the deep shelf to upper-middle slope (200-500 m of depth). In this area, the tidal currents, the exchanges of waters masses and a submarine ridge that breaks the continental shelf of Cape Trafalgar causes upwelling of could waters rich in nutrients that increase productivity (Vargas *et al.*, 2009; Silva *et al.*, 2011). This fact could be related with the presence of this species in this area.

Todaropsis eblanae

Like in others cephalopod species, the abundance indices of lesser flying squid presented oscillations without any clear trend. Three peaks in both indices were obtained, showing the highest values in 2001 with 0.5 kg/haul and 11 ind/haul, and other peak with high values in 2010 and 2005 (Figure 33). The period 2007-2009, besides the years 2003 and 1999, showed the lowest values of abundance indices with less than 0.1 kg/haul and between 1-2 ind/haul. Length frequency distributions were obtained from 2004 and the mode ranged from 6 cm in 2011 to 11 cm in 2010, with a range size of 2-31 cm (Figure 34). Regarding geographic distribution, this species appeared in the central and south zones of the surveyed area (Figure 35). The higher caught were obtained in the deep shelf-upper slope strata, according to the bathymetric distribution, where it is shown how the highest abundances were found between 250-350 m (Figure 36), being present in a wide range of depth (50-700 m).

Illex coindetii

Broadtail shortfin squid presented in 1998 avery high peak of biomass and abundance, with respect to the rest of years, with values of 19 kg/haul and 217 ind/haul, respectively (Figure 37). Values below 3 kg/haul and 10 ind/haul were obtained the rest o the year, except a small peak in 2001 and in the two last year of the time series, where is observed a slight increase. Length distributions were available since 2001 and ranged between 4-33 cm (Figure 38). Regarding geographic distribution, the higher caught were obtained in the south of surveyed area, near to the Strait of Gibraltar, like *L.forbesii* and *T. eblanae* (Figure 39). A pattern of bathymetric distribution, similar to that shown for *T. eblanae*, has been obtained for this species, although the number of individuals between 400 and 700 m was quite more reduced (Figure 40).

4. Acknowledgements

We would like to thank R/V Cornide de Saavedra crews and the scientific teams from IEO that made possible ARSA Surveys.

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6. Figures

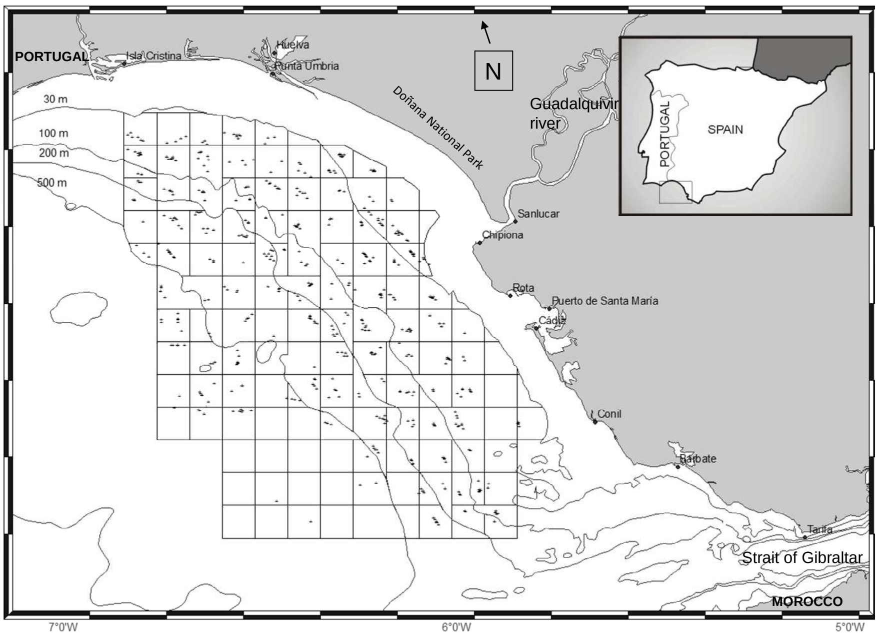

Figure 1. Study area showing the surveyed area and haul positions

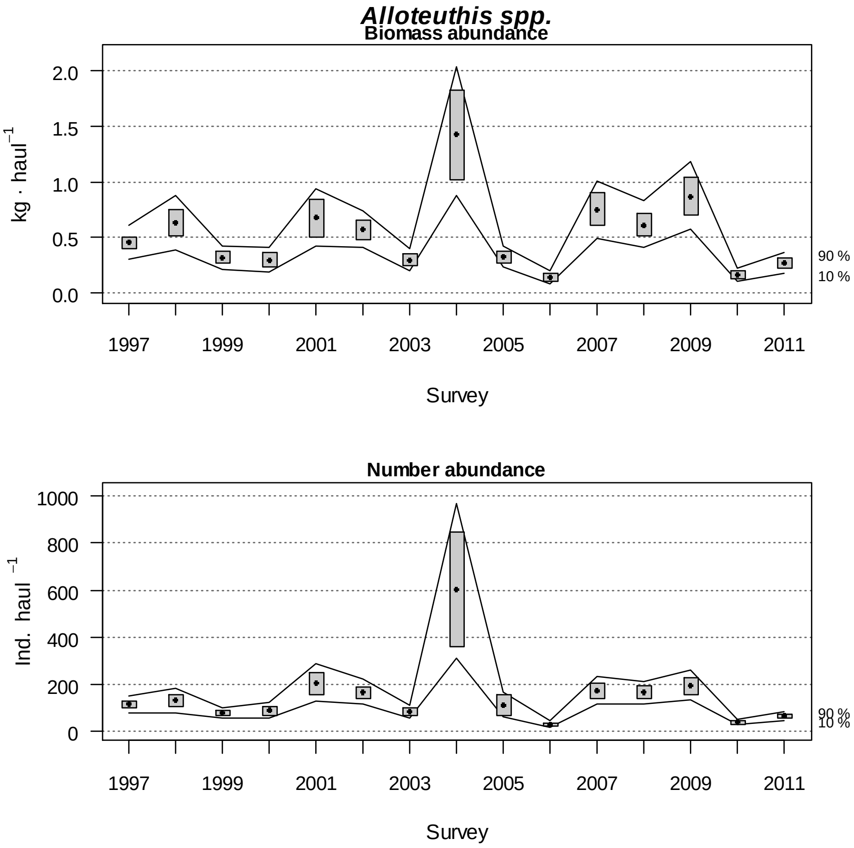

Figure 2. Evolution of *Alloteuthis* spp. biomass and abundance indices during Autumn ARSA bottom trawl surveys (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000)

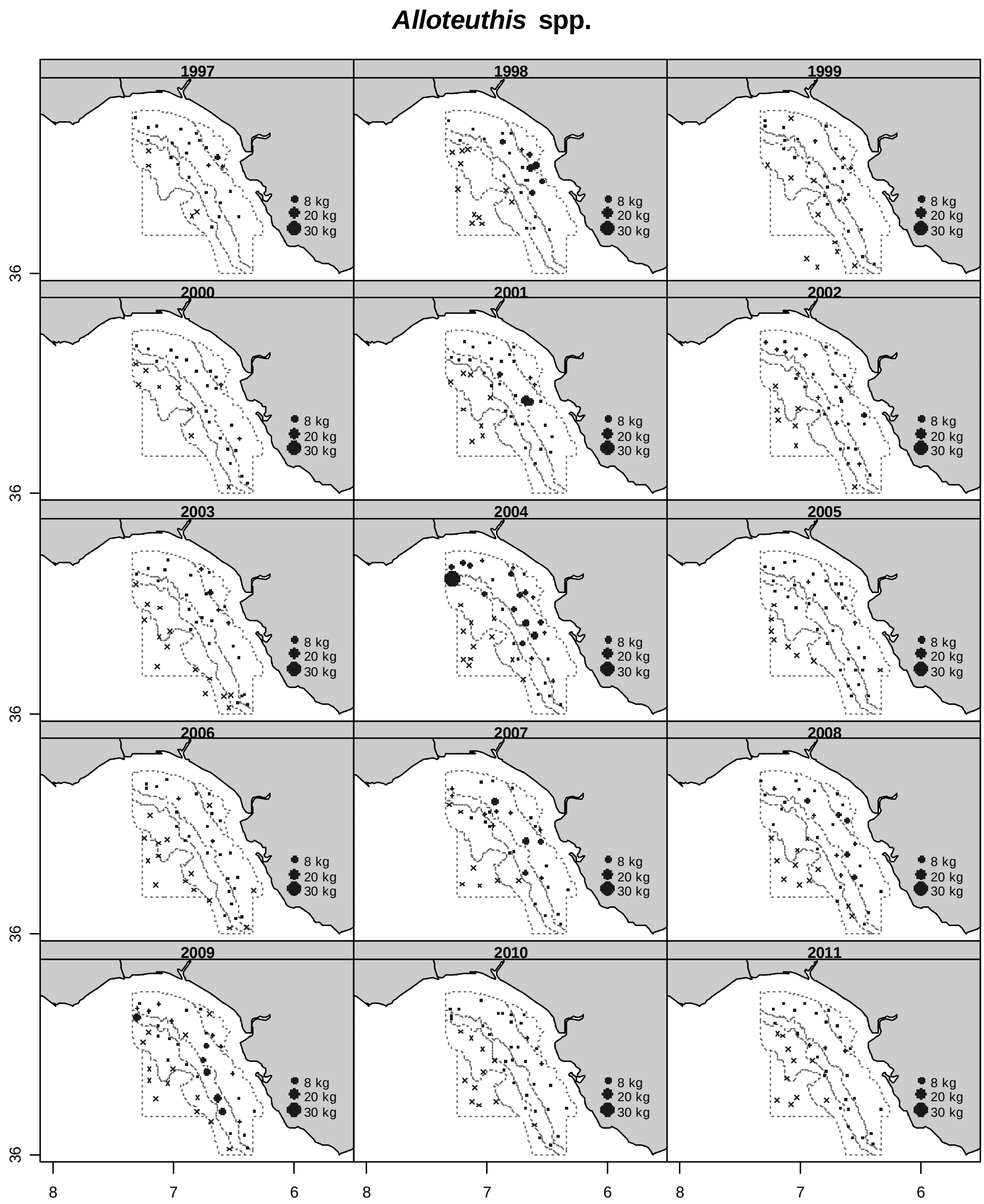

Figure 3. Geographic distribution of *Alloteuthis* spp. catches (kg/60 min haul) during Autumn ARSA bottom trawl surveys (1997-2011).

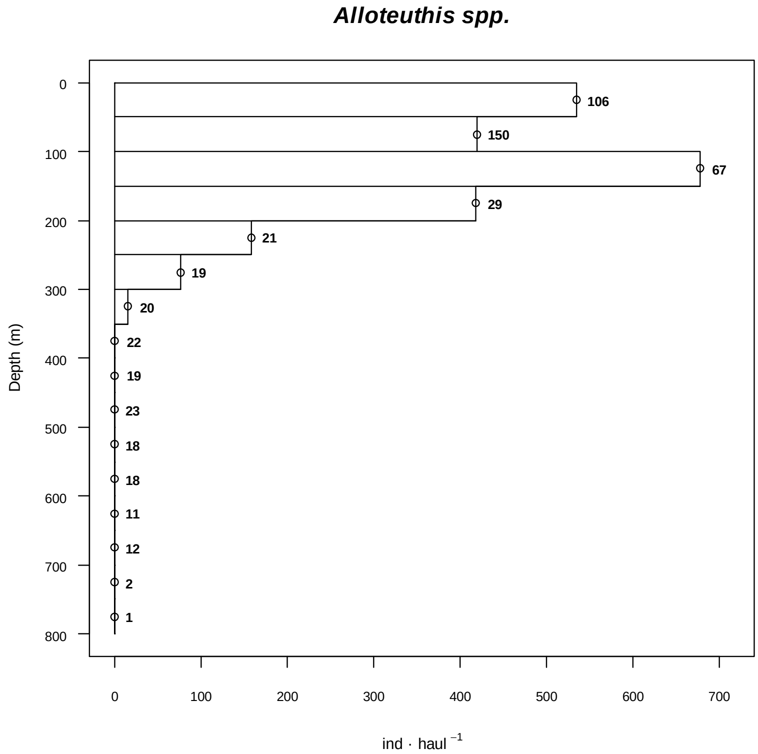

Figure 4. Bathymetric distribution (ind./60 min haul) of *Alloteuthis* spp. in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

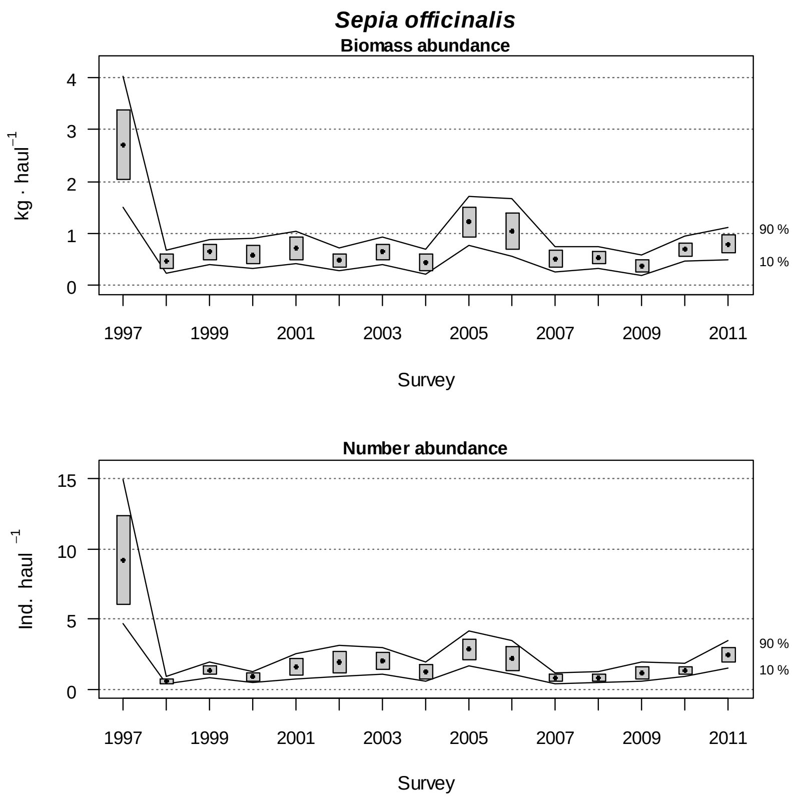

Figure 5. Evolution of S*epia officinalis* biomass and abundance indices during Autumn ARSA bottom trawl survey (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000)

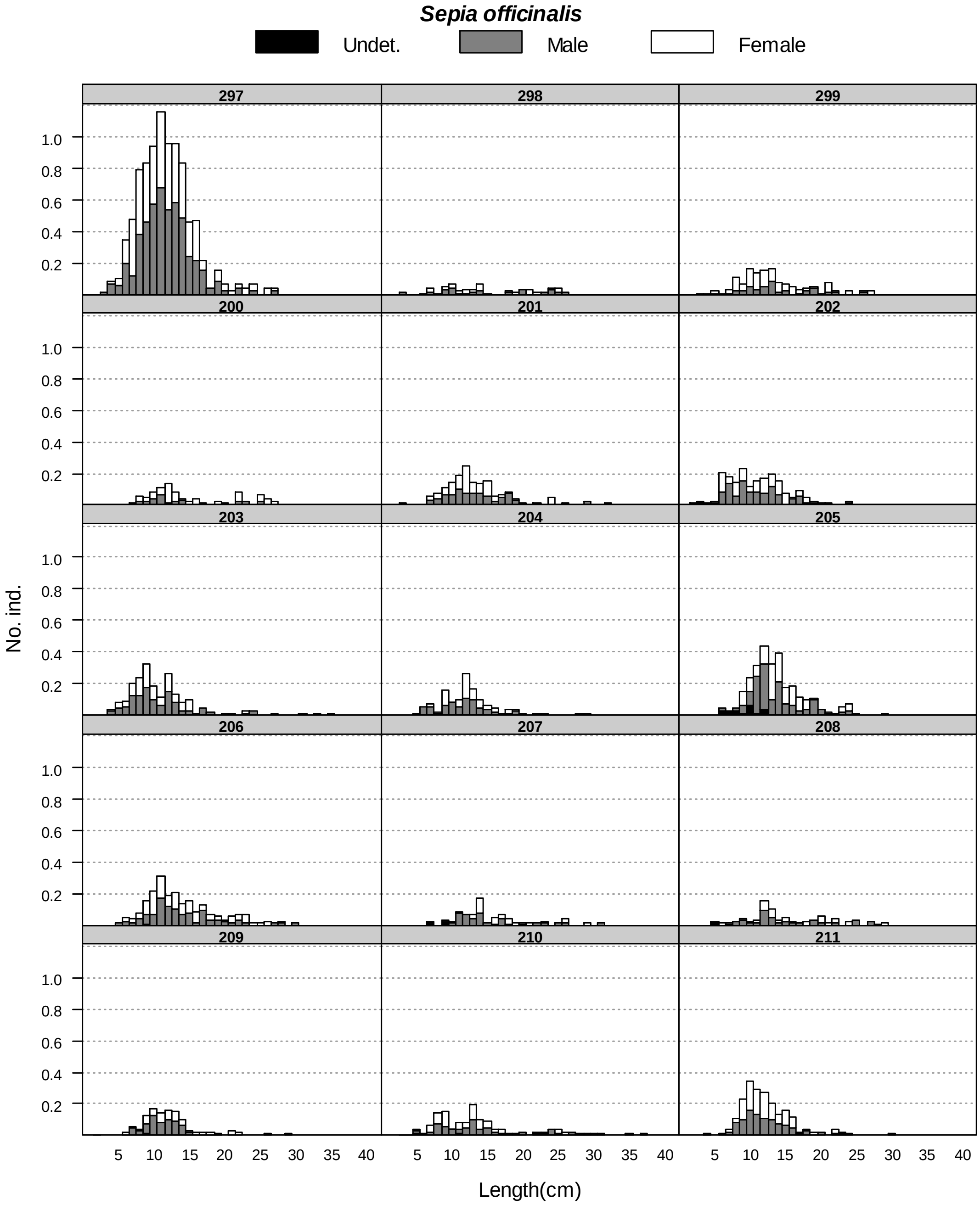

Figure 6. Mean stratified length distributions of S*epia officinalis* in Autumn ARSA bottom trawl surveys (1997-2011).

Sepia officinalis

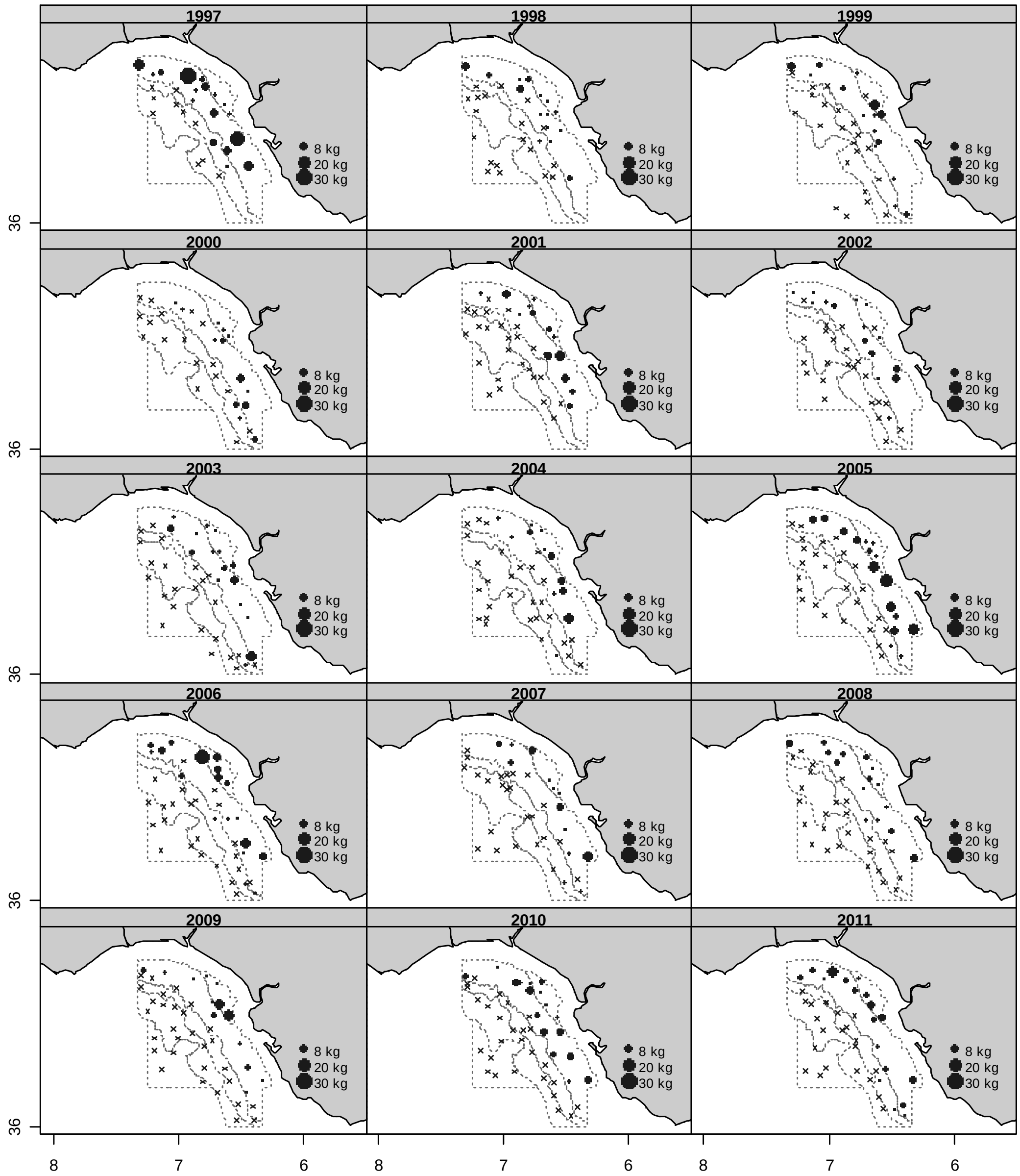

Figure 7. Geographic distribution of S*epia officinalis* catches (kg/60 min haul) during Autumn ARSA bottom trawl surveys (1997-2011).

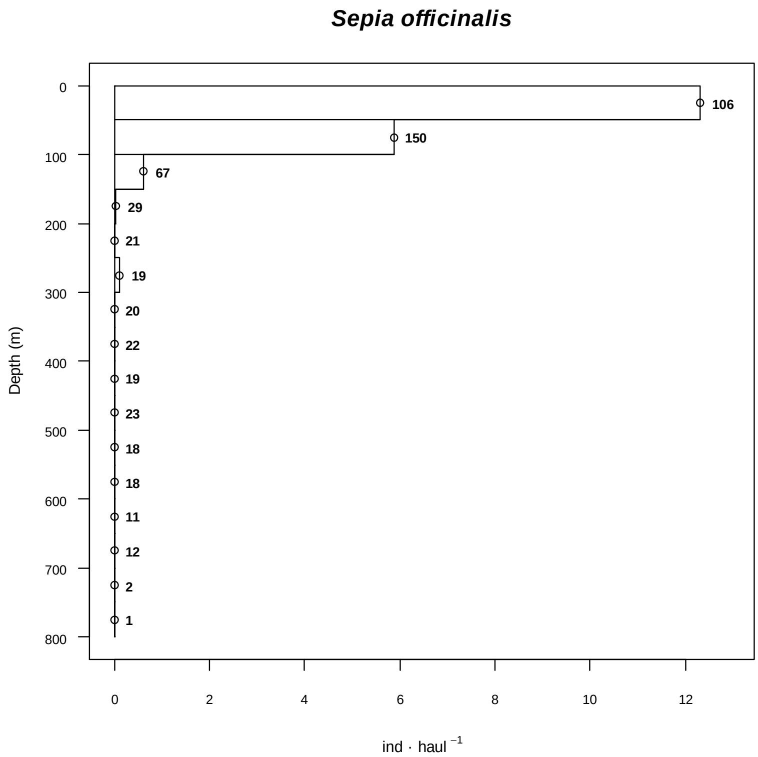

Figure 8. Bathymetric distribution (ind./60 min haul) of S*epia officinalis* in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

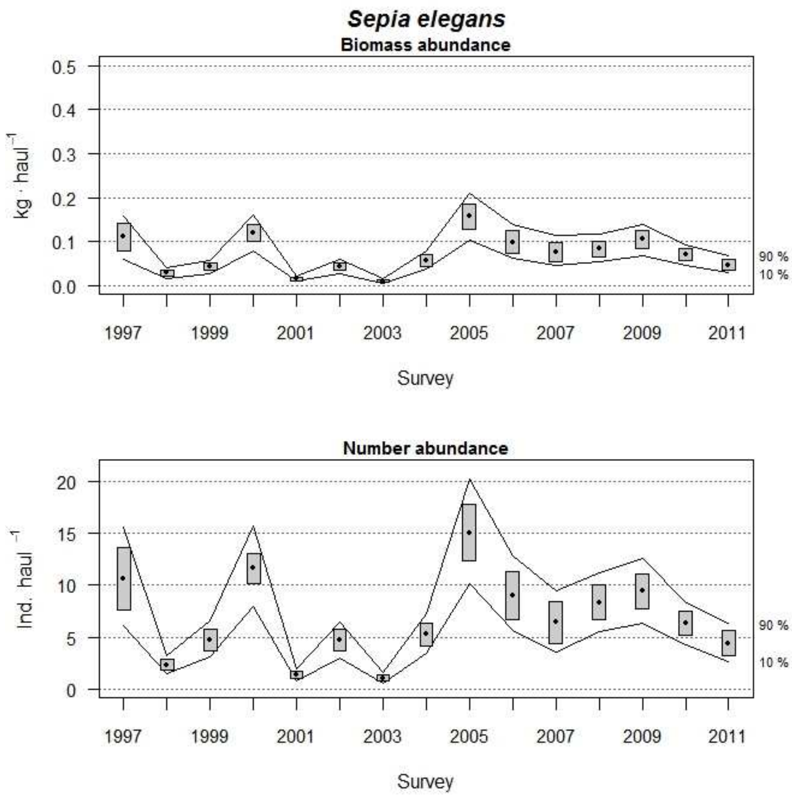

Figure 9. Evolution of the S*epia elegans*. biomass and abundance indices during Autumn ARSA bottom trawl surveys (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000)

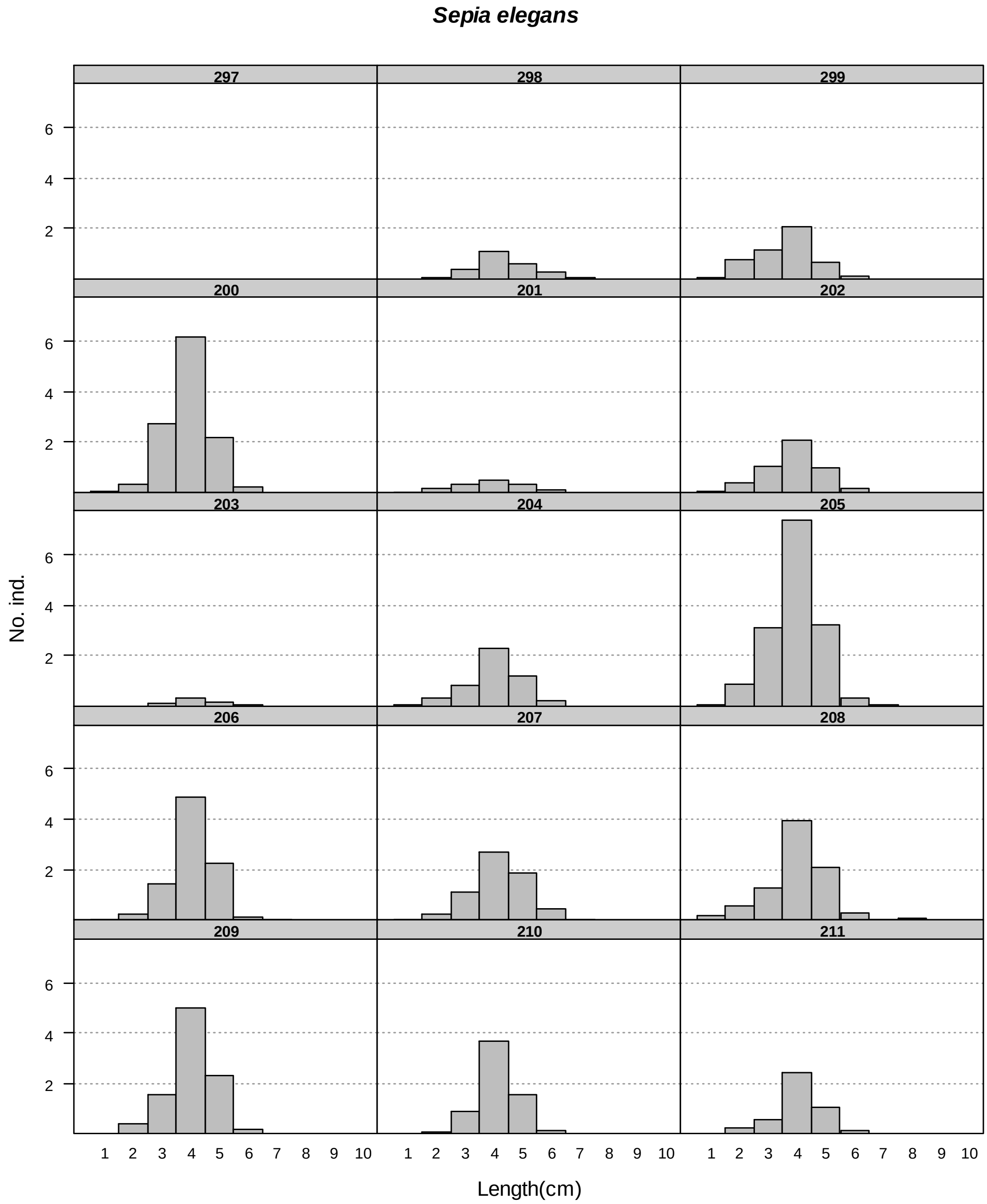

Figure 10. Mean stratified length distributions of S*epia elegans* in Autumn ARSA bottom trawl surveys (1998-2011).

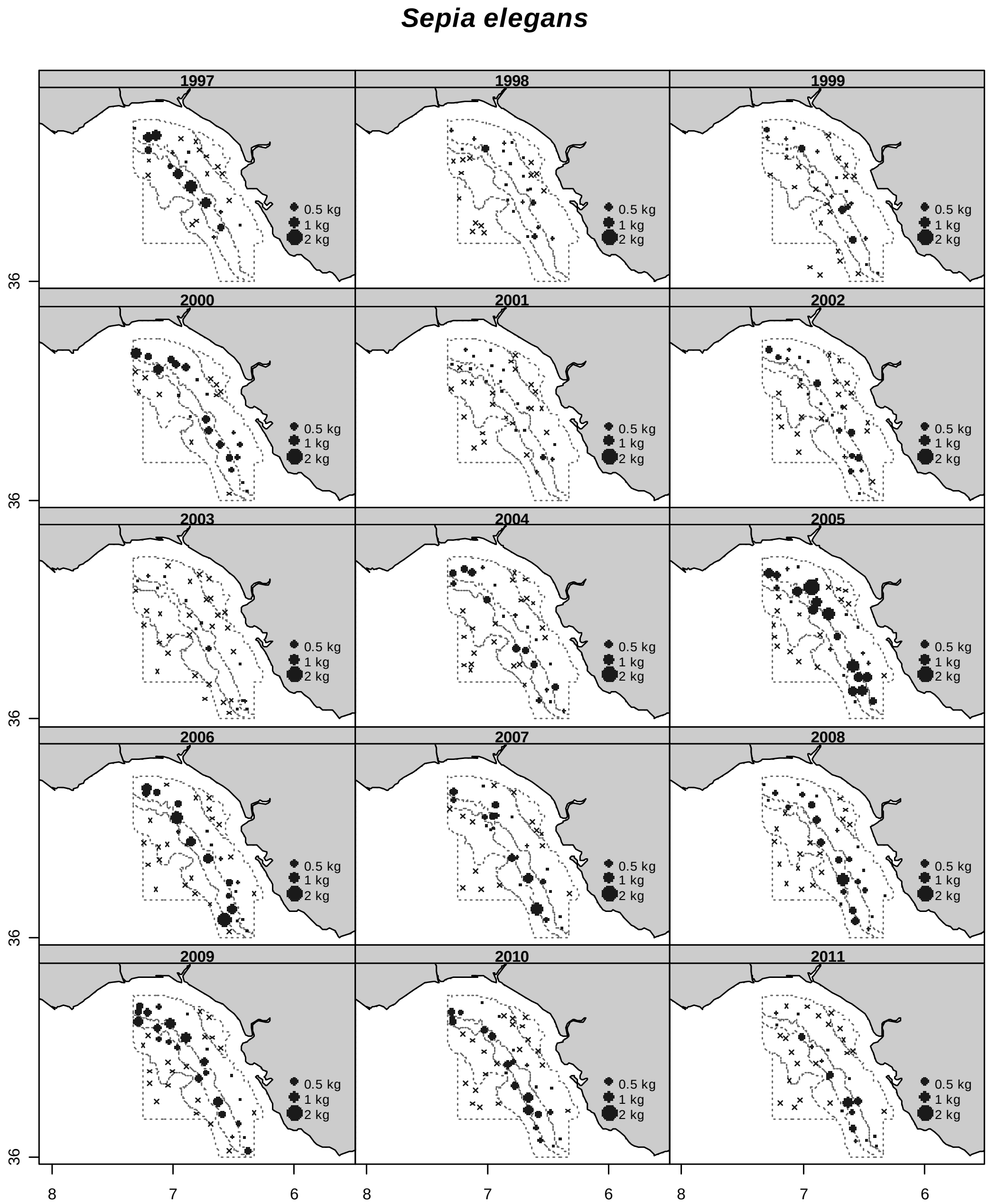

Figure 11. Geographic distribution of S*epia elegans* catches (kg/60 min haul) during Autumn ARSA bottom trawl surveys (1997-2011).

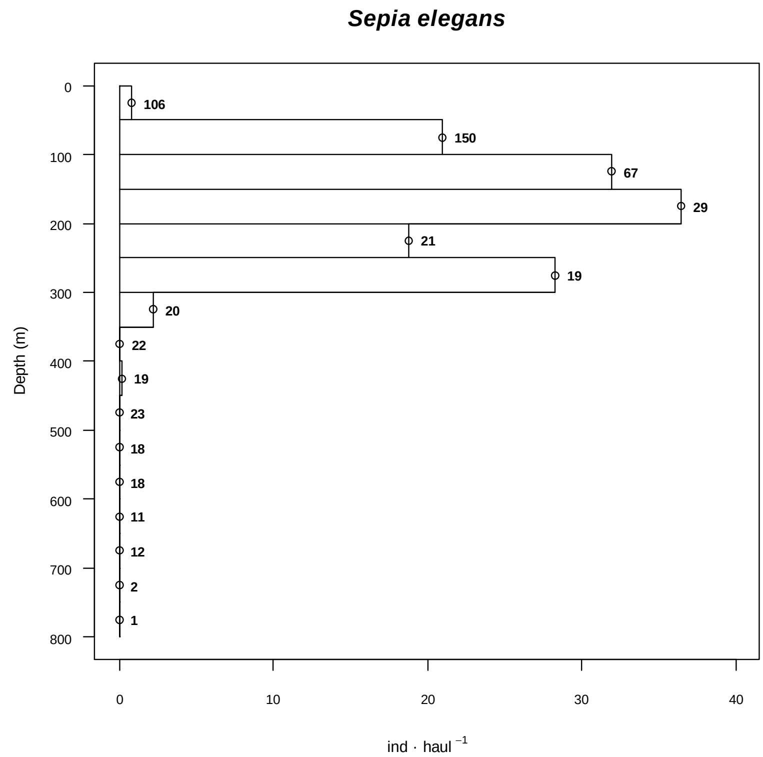

Figure 12. Bathymetric distribution (ind./60 min haul) of S*epia elegans* in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

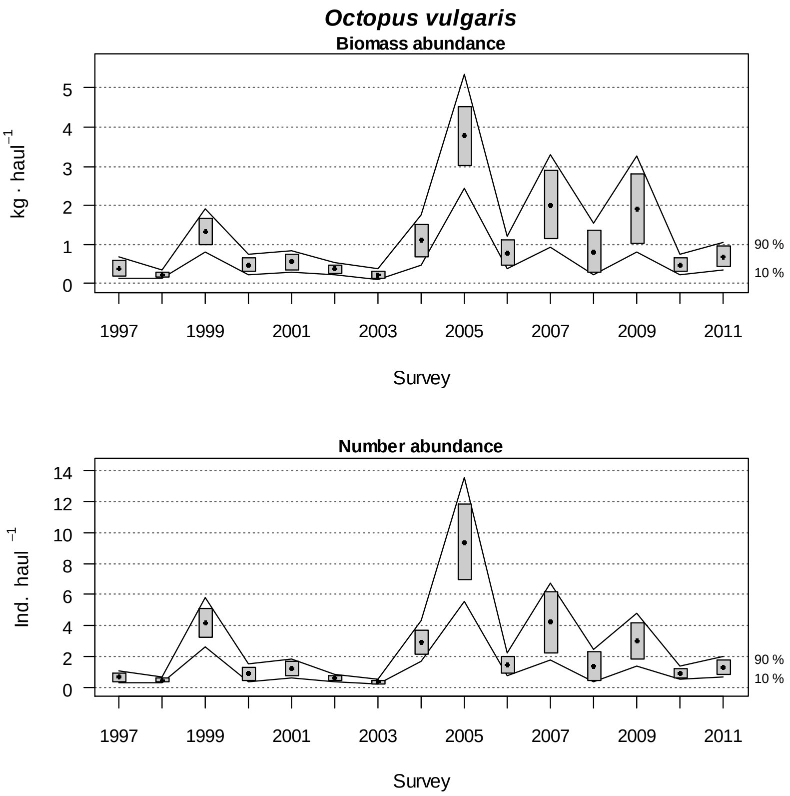

Figure 13. Evolution of the *Octupus vulgaris* biomass and abundance indices during Autumn ARSA bottom trawl surveys (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000)

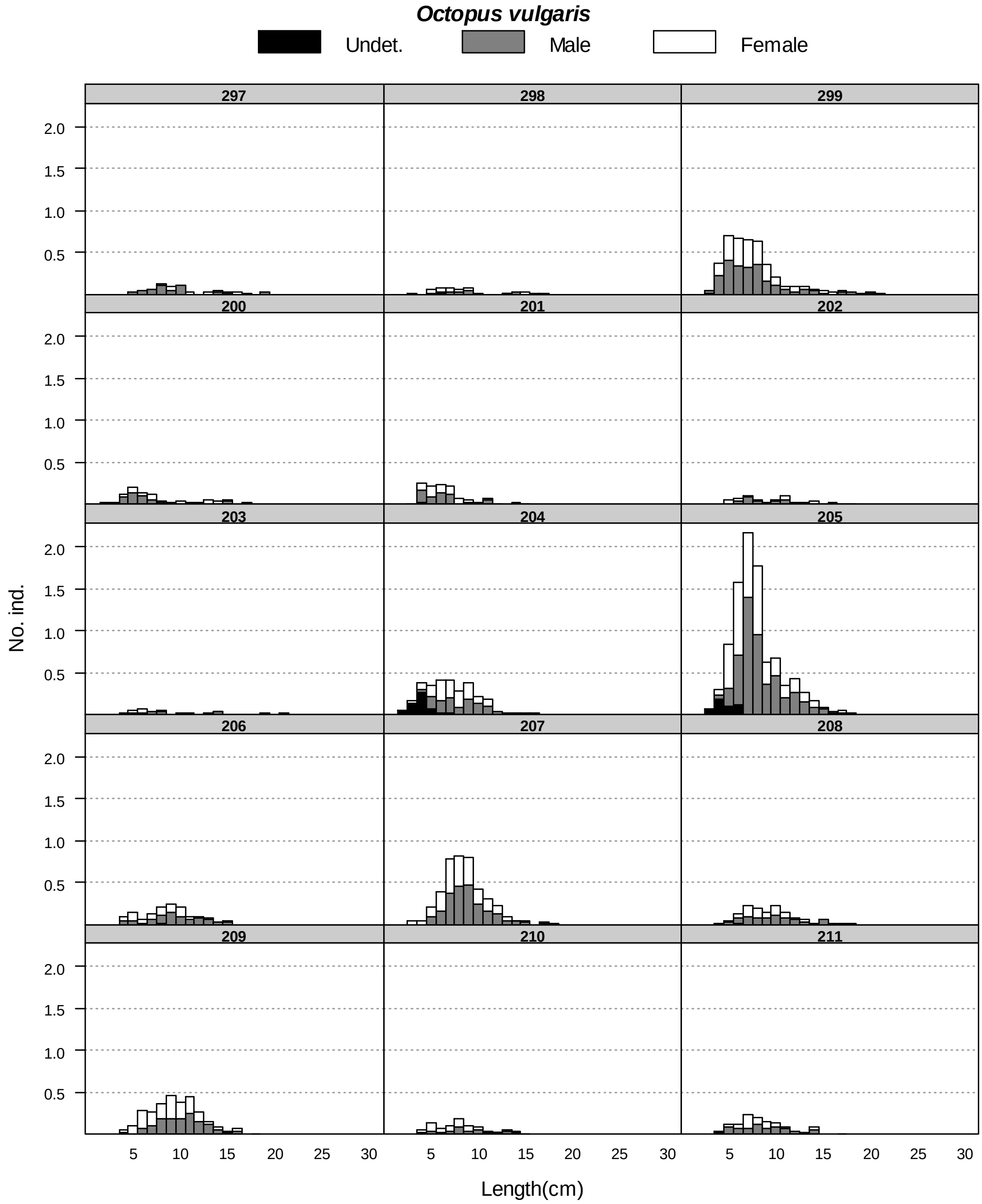

Figure 14. Mean stratified length distribution of *Octupus vulgaris* in Autumn ARSA bottom trawl surveys (1997-2011).

Octopus vulgaris

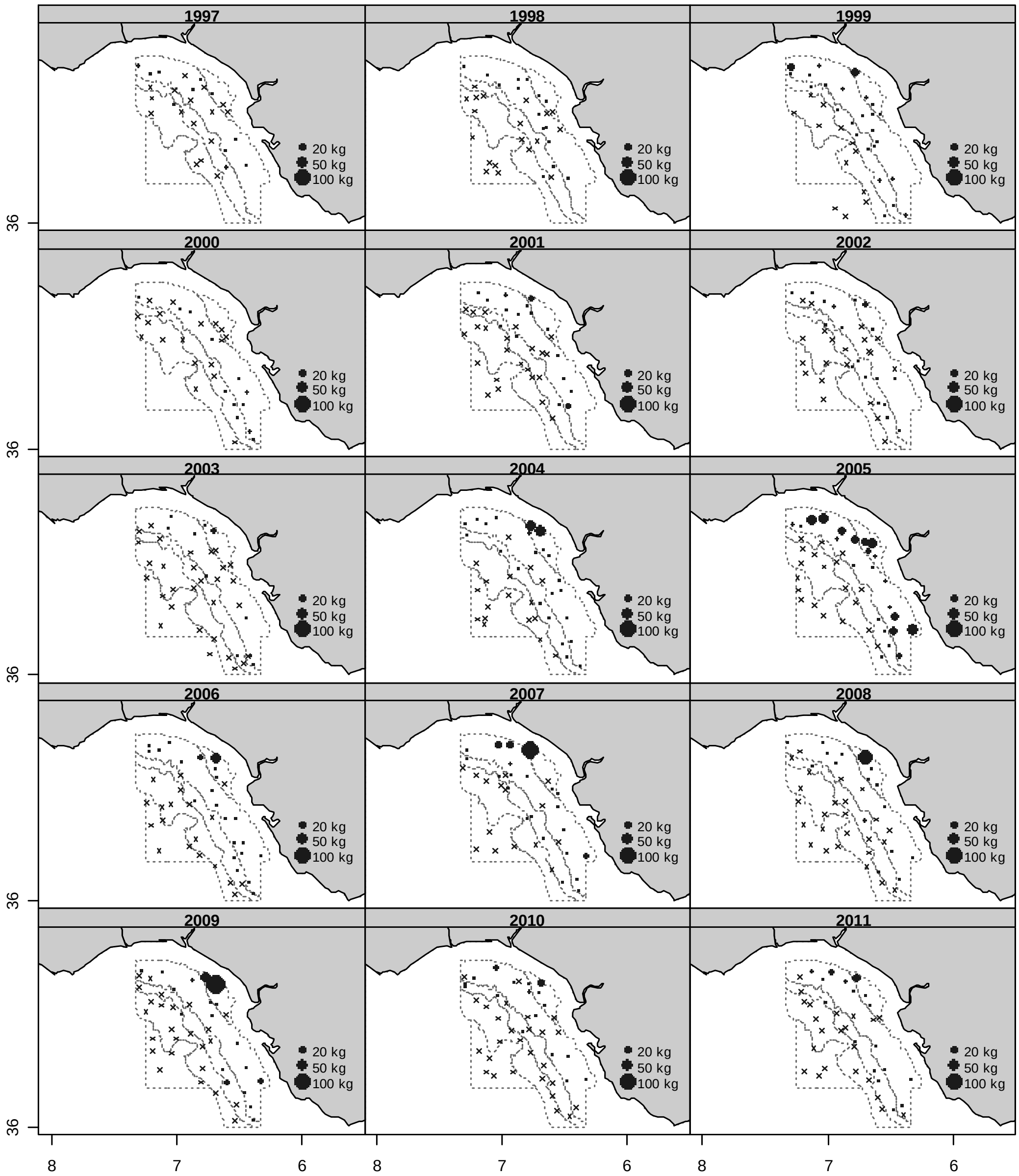

Figure 15. Geographic distribution of *Octupus vulgaris* catches (kg/60 min haul) during Autumn ARSA bottom trawl surveys (1997-2011).

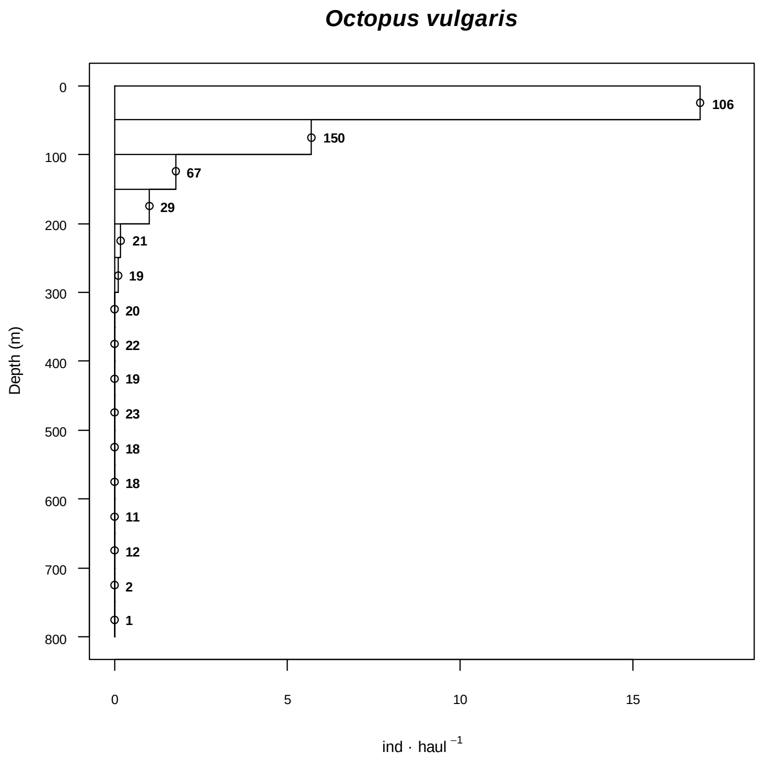

Figure 16. Bathymetric distribution (ind./60 min haul) of *Octupus vulgaris* in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

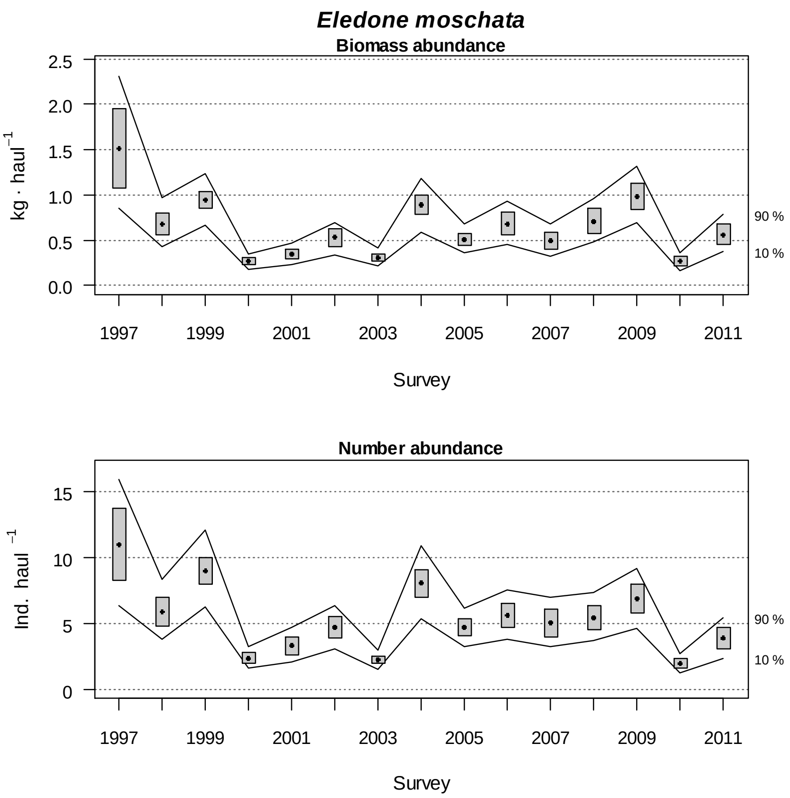

Figure 17. Evolution of the *Eledone moschata* biomass and abundance indices during Autumn ARSA bottom trawl survey (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000)

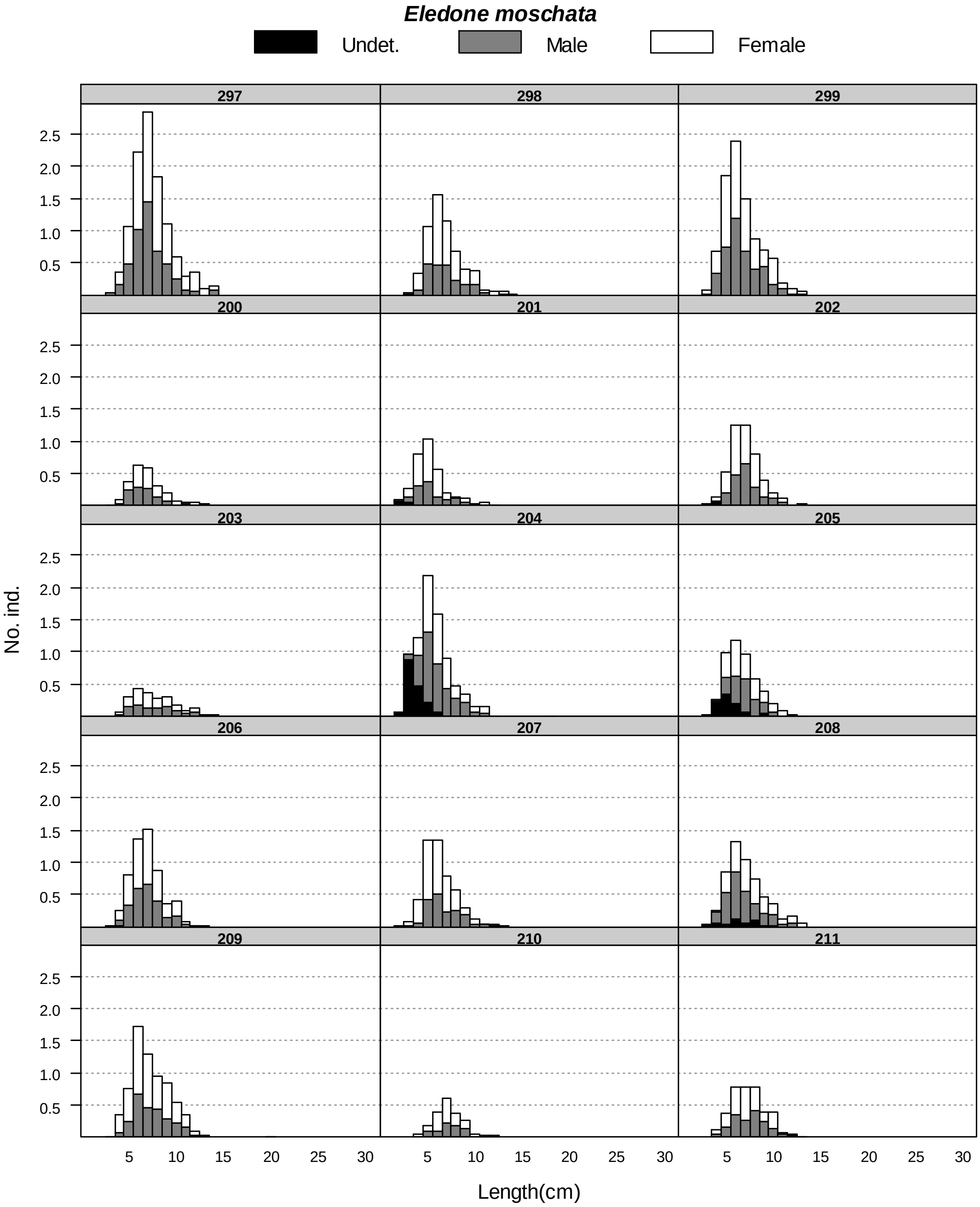

Figure 18. Mean stratified length distribution of *Eledone moschata* in Autumn ARSA bottom trawl surveys (1997-2011).

Eledone cirrhosa

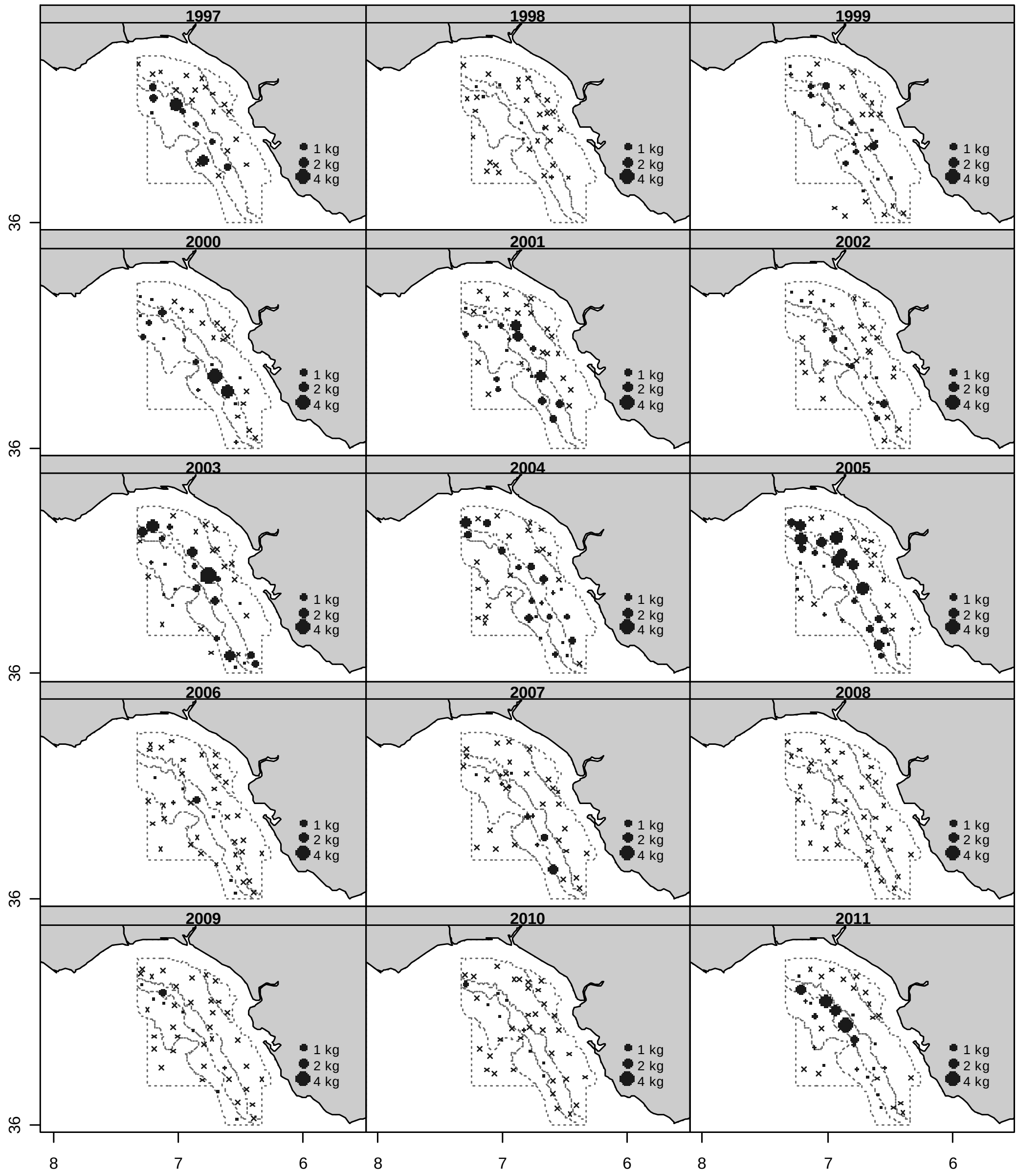

Figure 19. Geographic distribution of *Eledone moschata* catches (kg/60 min haul) during Autumn ARSA bottom trawl surveys (1997-2011).

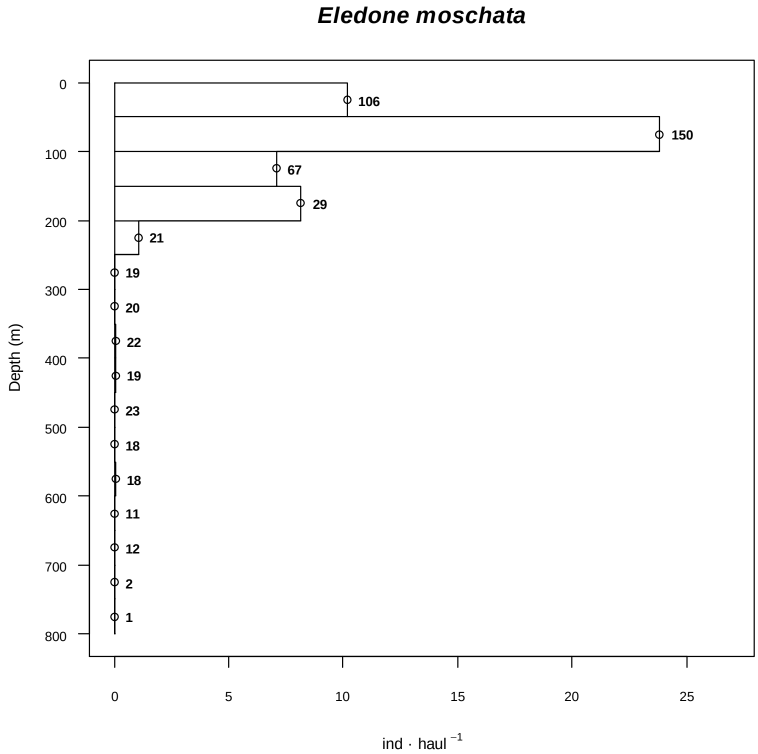

Figure 20. Bathymetric distribution (ind./60 min haul) of *Eledone moschata* in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

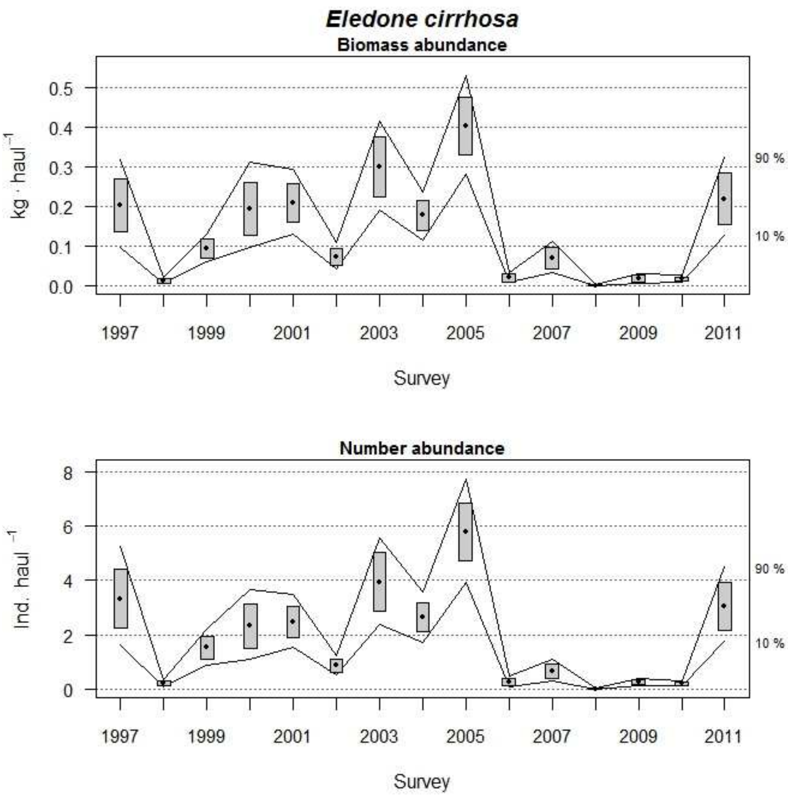

Figure 21. Evolution of the *Eledone cirrhosa* biomass and abundance indices during Autumn ARSA bottom trawl survey (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000)

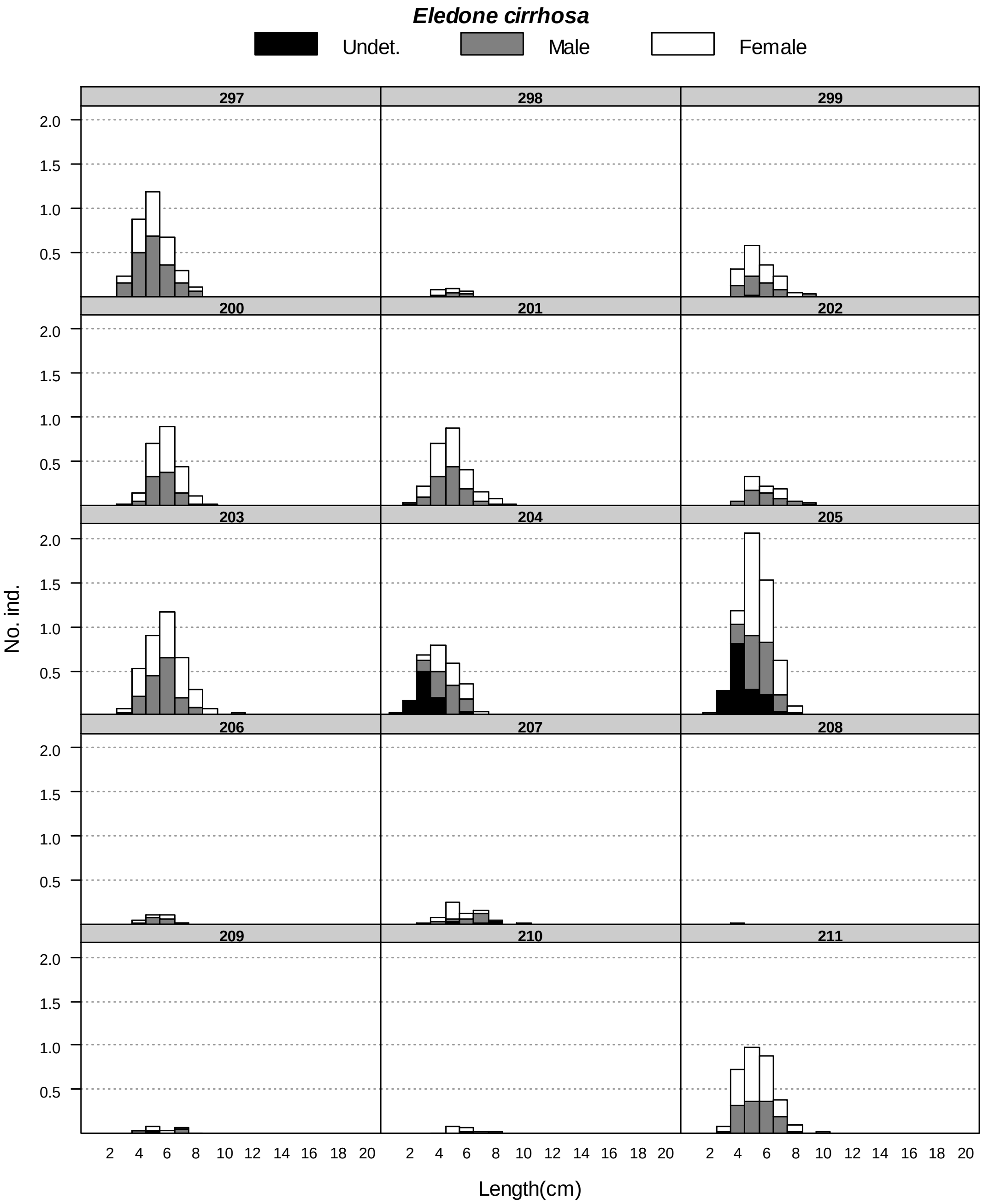

Figure 22. Mean stratified length distributions of *Eledone cirrhosa* in Autumn ARSA bottom trawl surveys (1997-2011).

Eledone cirrhosa

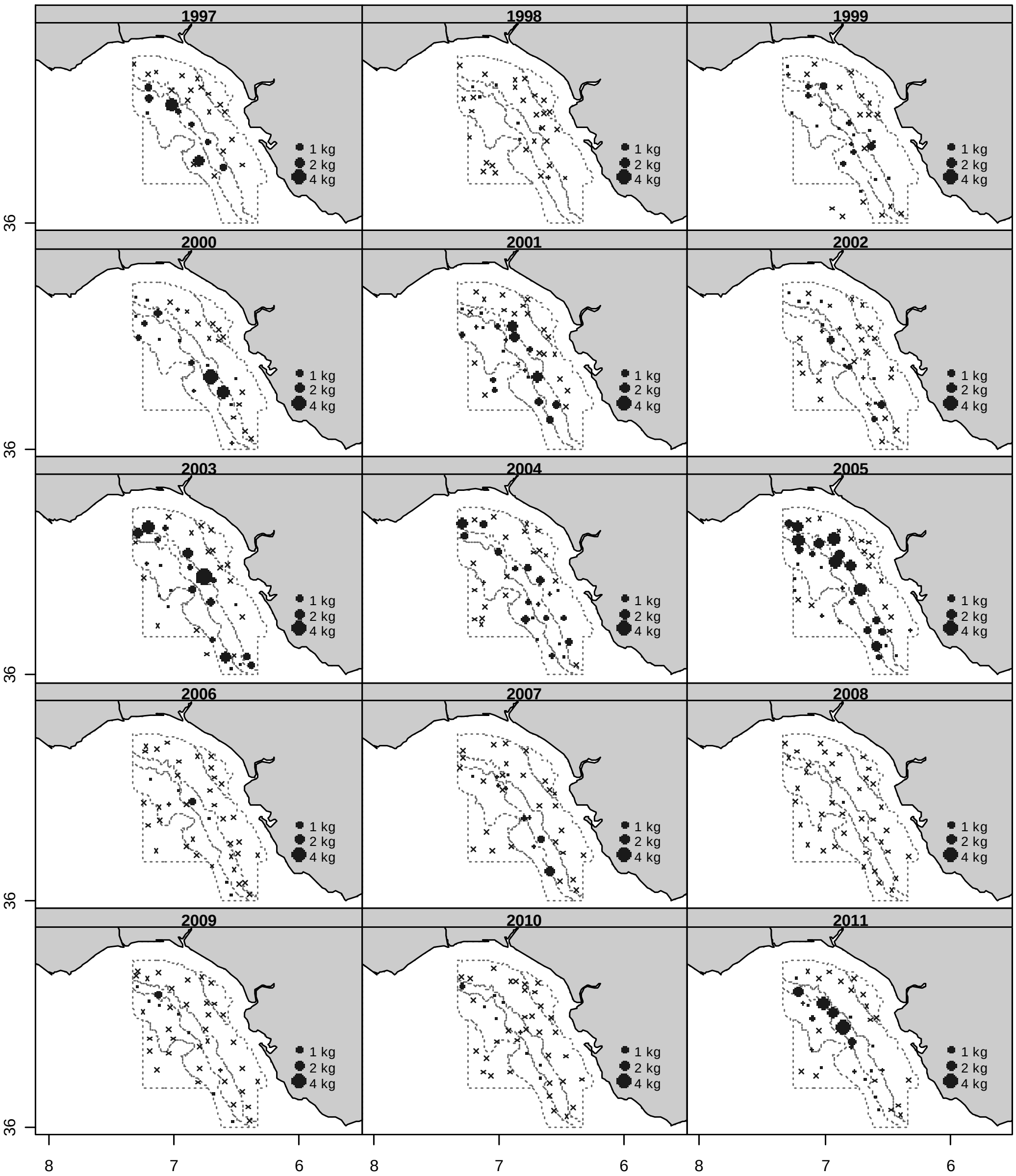

Figure 23. Geographic distribution of *Eledone cirrhosa* catches (kg/60 min haul) during Autumn ARSA bottom trawl surveys (1997-2011).

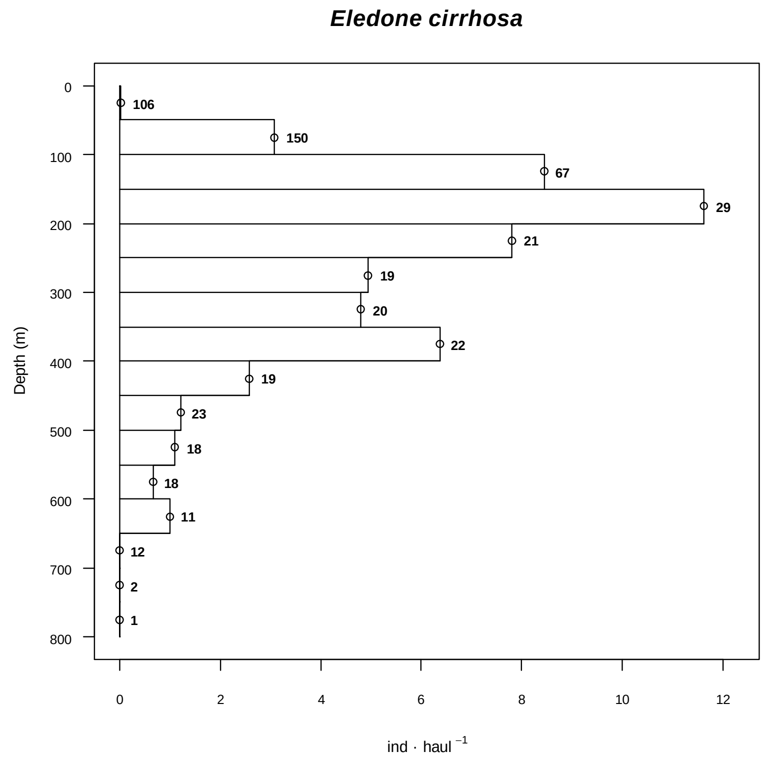

Figure 24. Bathymetric distribution (ind./60 min haul) of *Eledone cirrhosa* in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

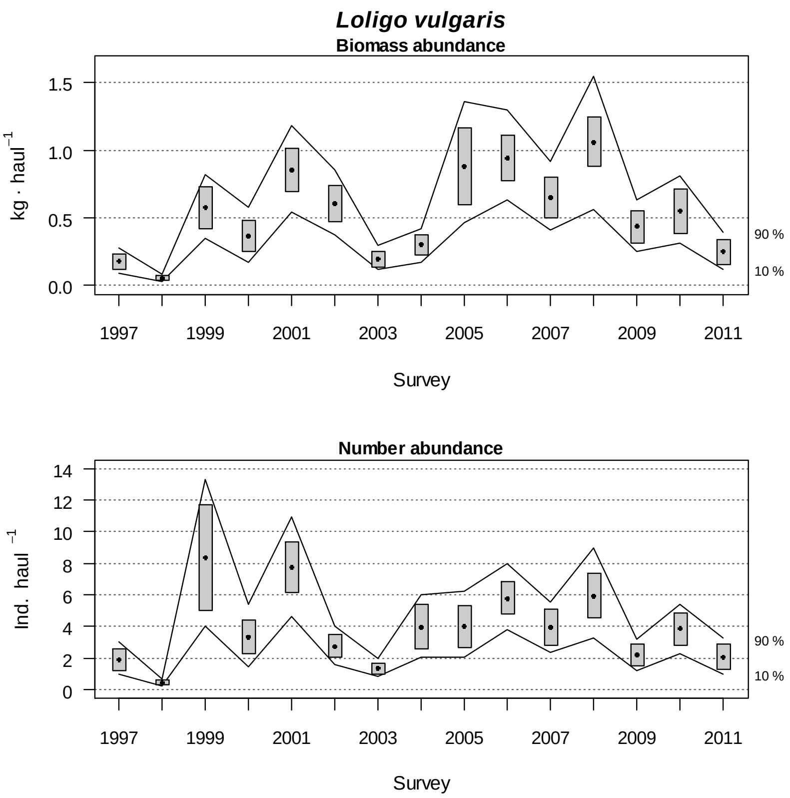

Figure 25. Evolution of the *Loligo vulgaris* biomass and abundance indices during Autumn ARSA bottom trawl surveys (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000)

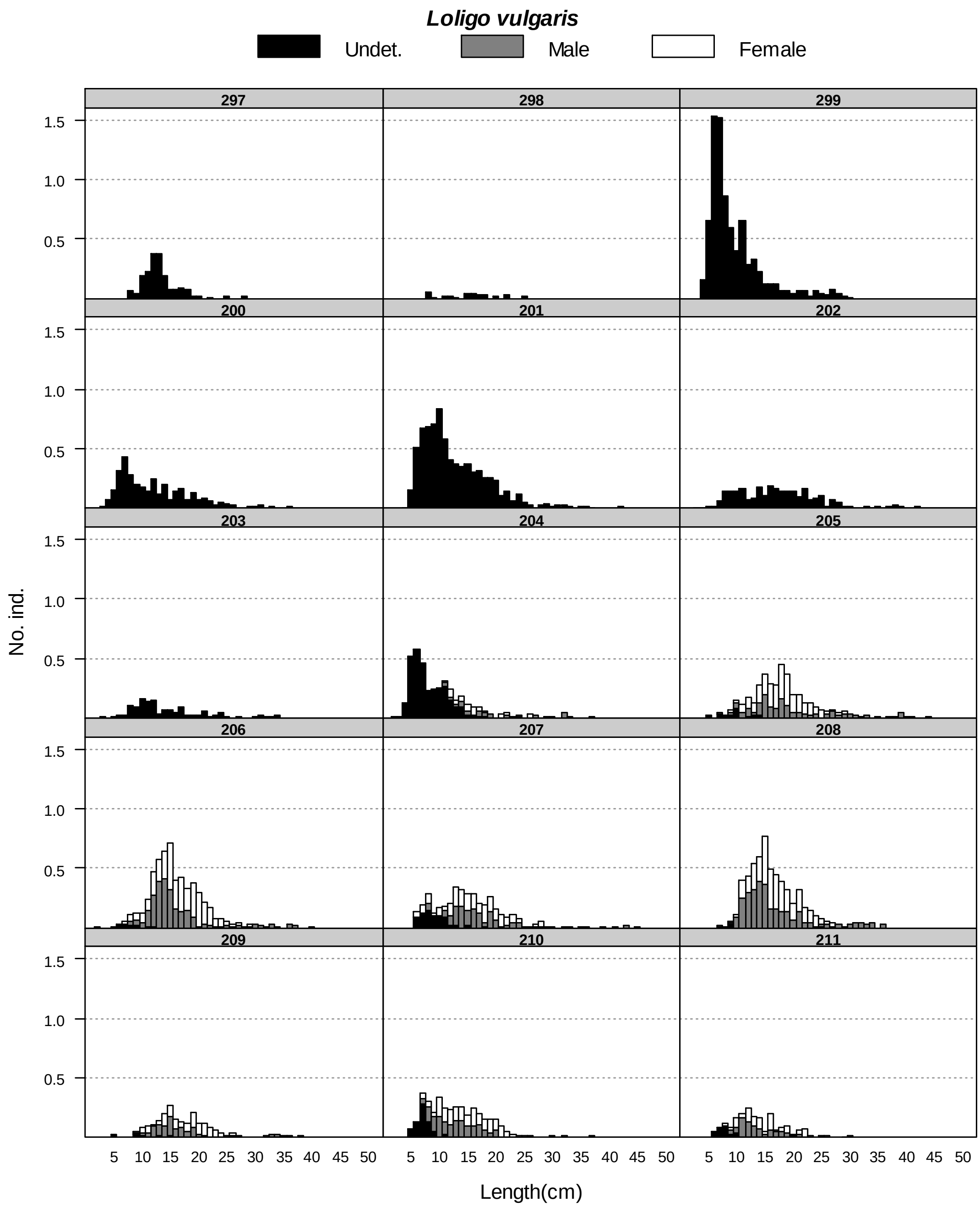

Figure 26. Mean stratified length distributions of *Loligo vulgaris* in Autumn ARSA bottom trawl surveys (1997-2011).

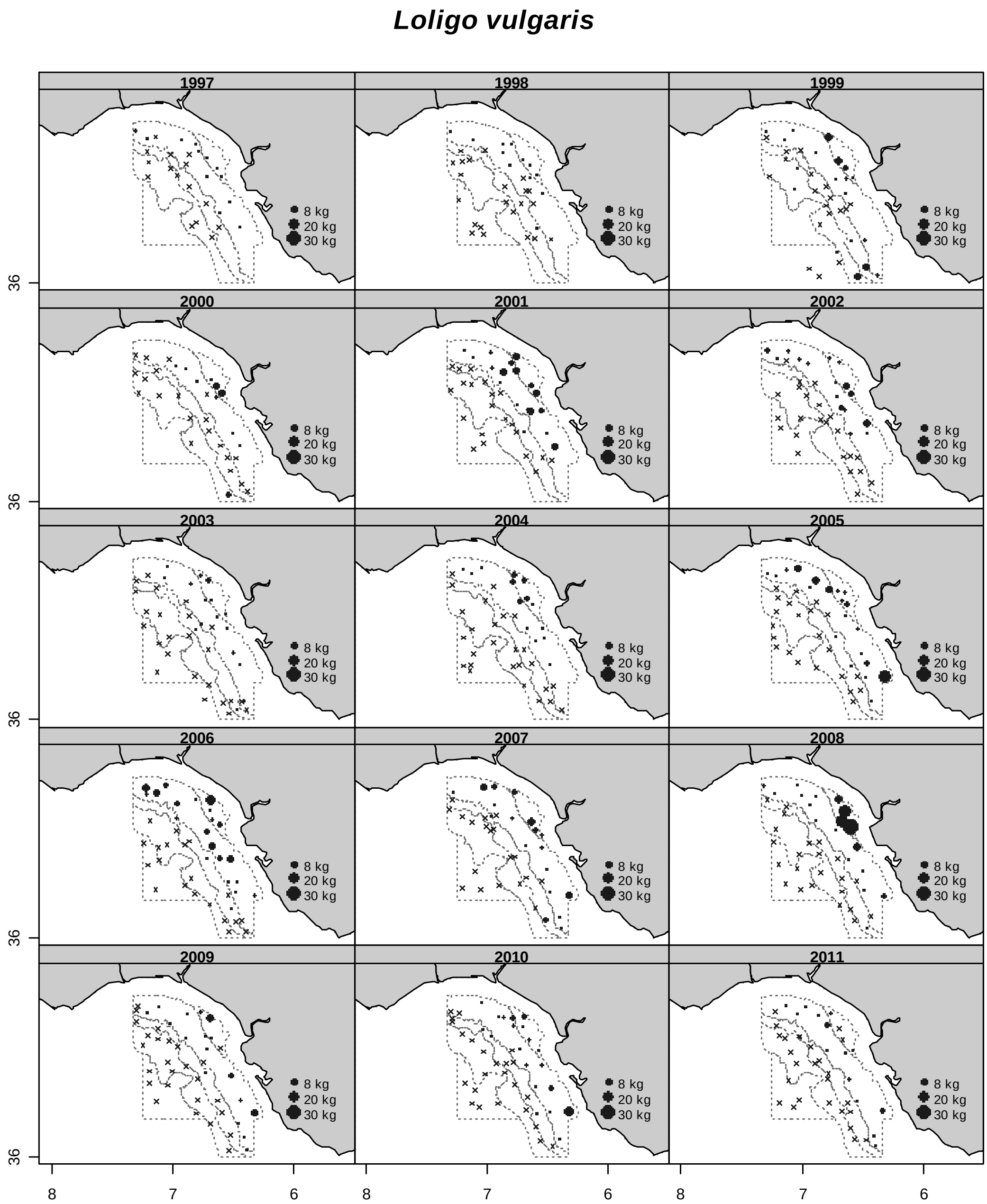

Figure 27. Geographic distribution of *Loligo vulgaris* catches (kg/60 min haul) during Autumn ARSA bottom trawl surveys (1997-2011).

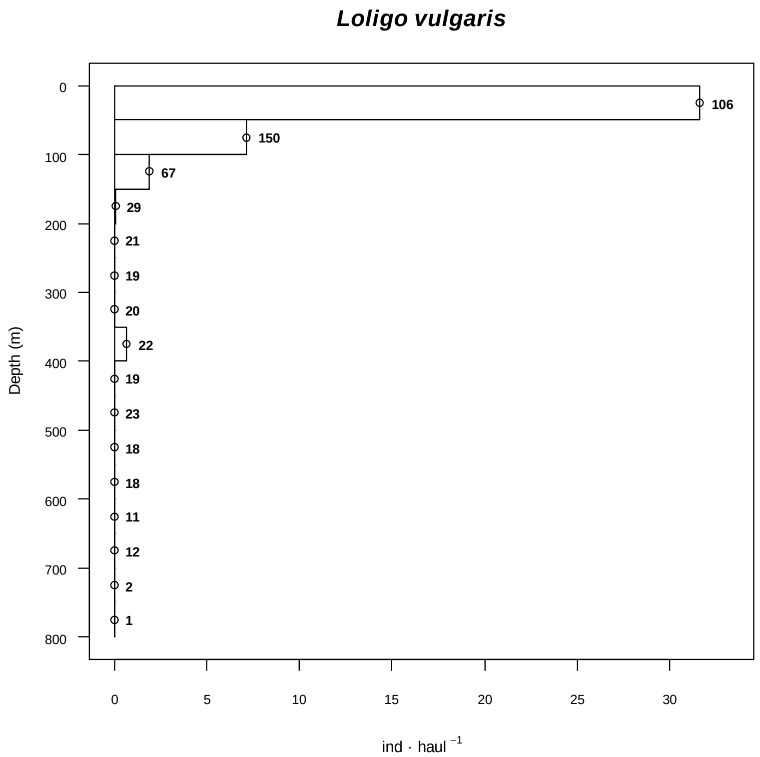

Figure 28. Bathymetric distribution (ind./60 min haul) of *Loligo vulgaris* in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

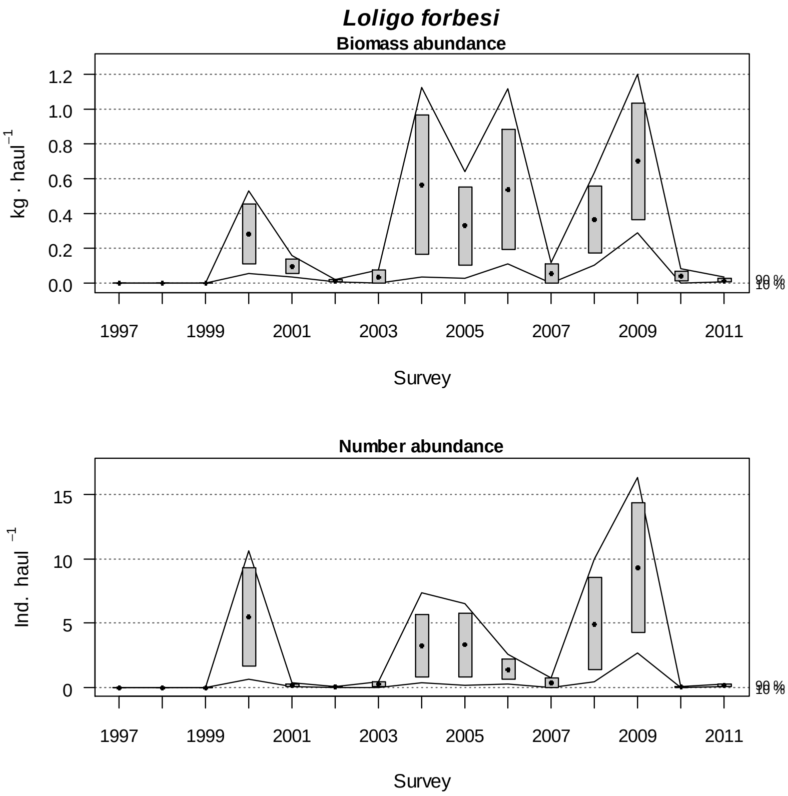

Figure 29. Evolution of the *Loligo forbesi* biomass and abundance indices during Autumn ARSA bottom trawl survey (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000

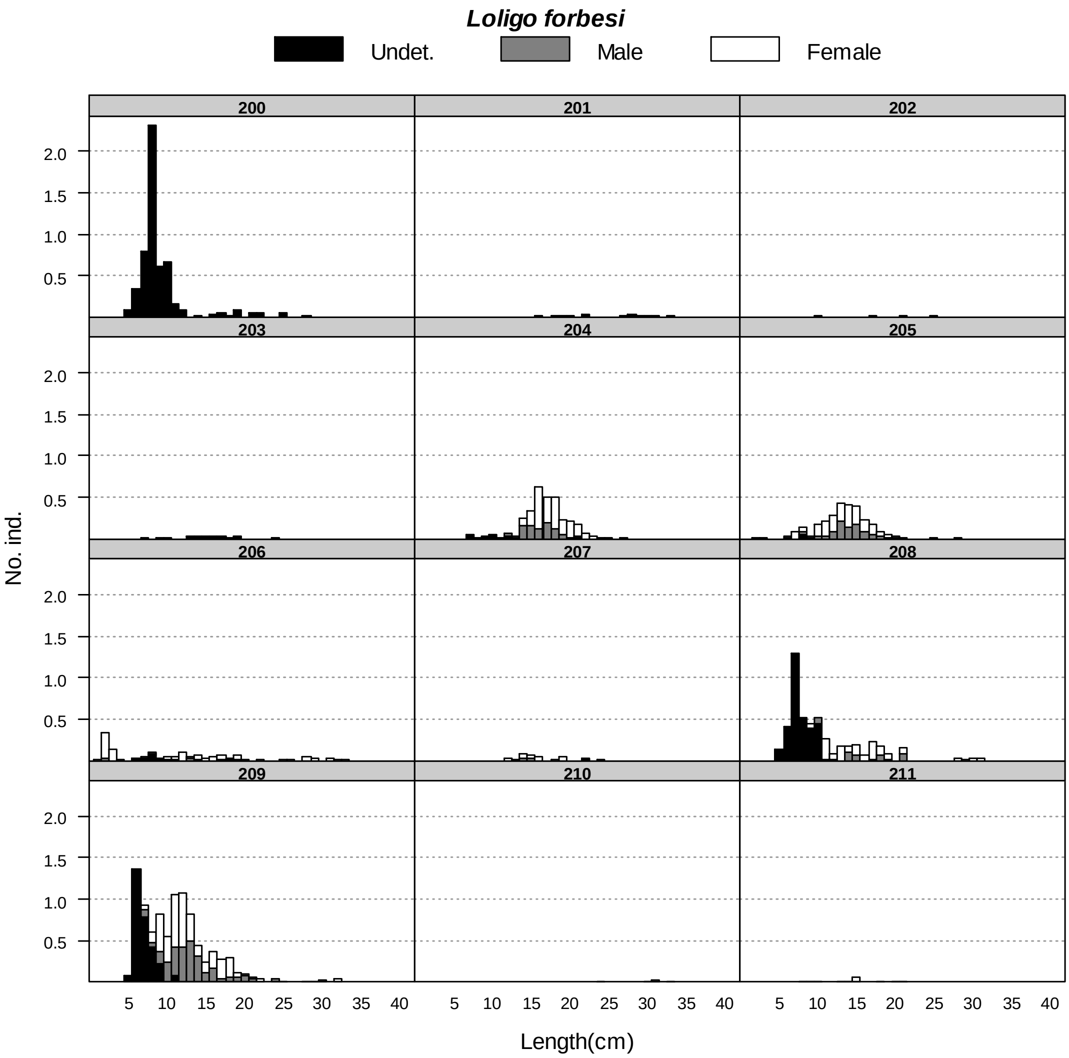

Figure 30. Mean stratified length distributions of *Loligo forbesi* in Autumn ARSA bottom trawl surveys (2000-2011).

Loligo forbesi

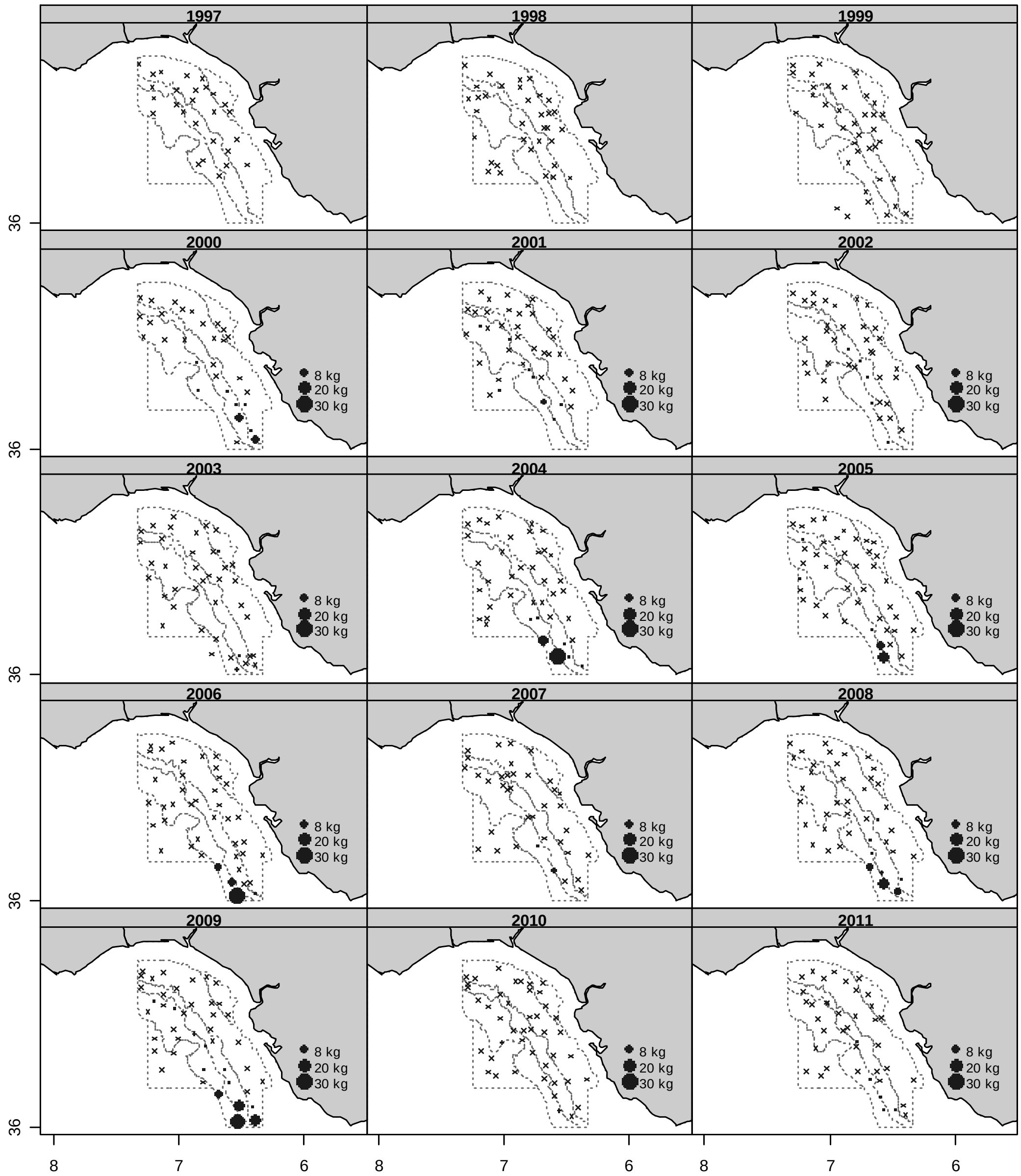

Figure 31. Geographic distribution of *Loligo forbesi* catches (kg/60 min haul) during Autumn ARSA bottom trawl survey (1997-2011).

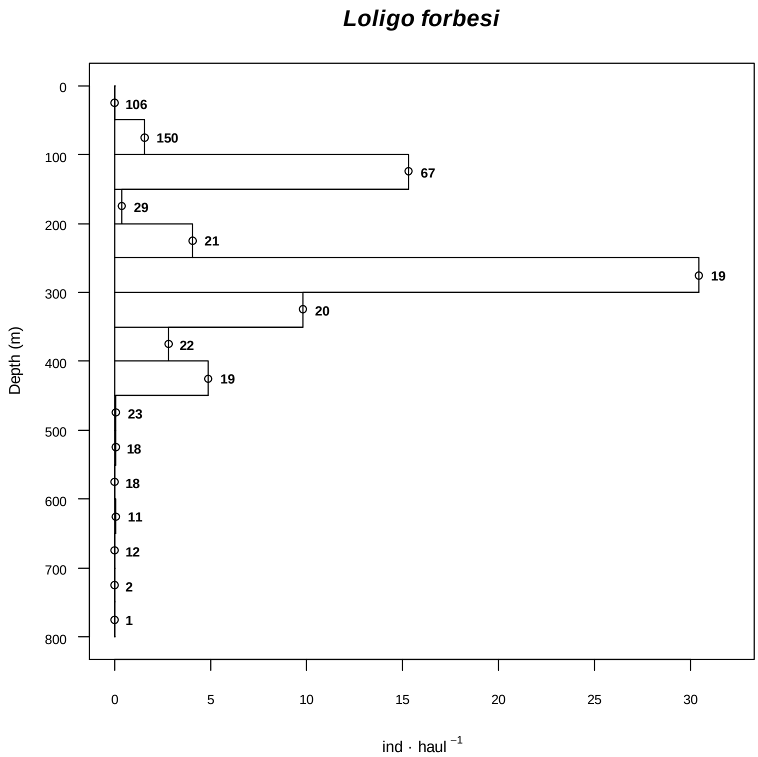

Figure 32. Bathymetric distribution (ind./60 min haul) of *Loligo forbesi* in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

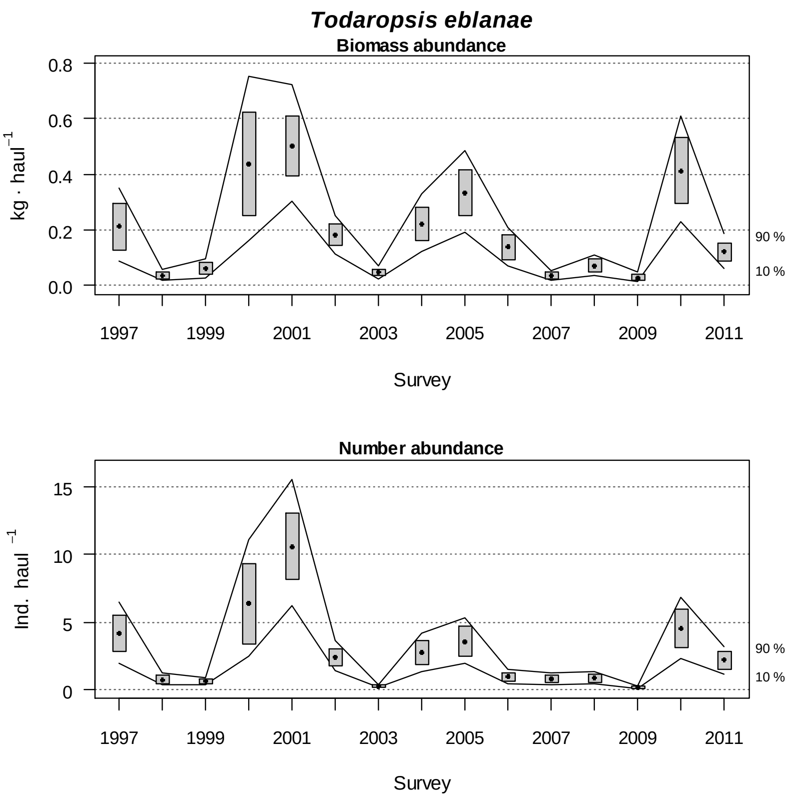

Figure 33. Evolution of the *Todaropsis eblanae* biomass and abundance indices during Autumn ARSA bottom trawl surveys (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000)

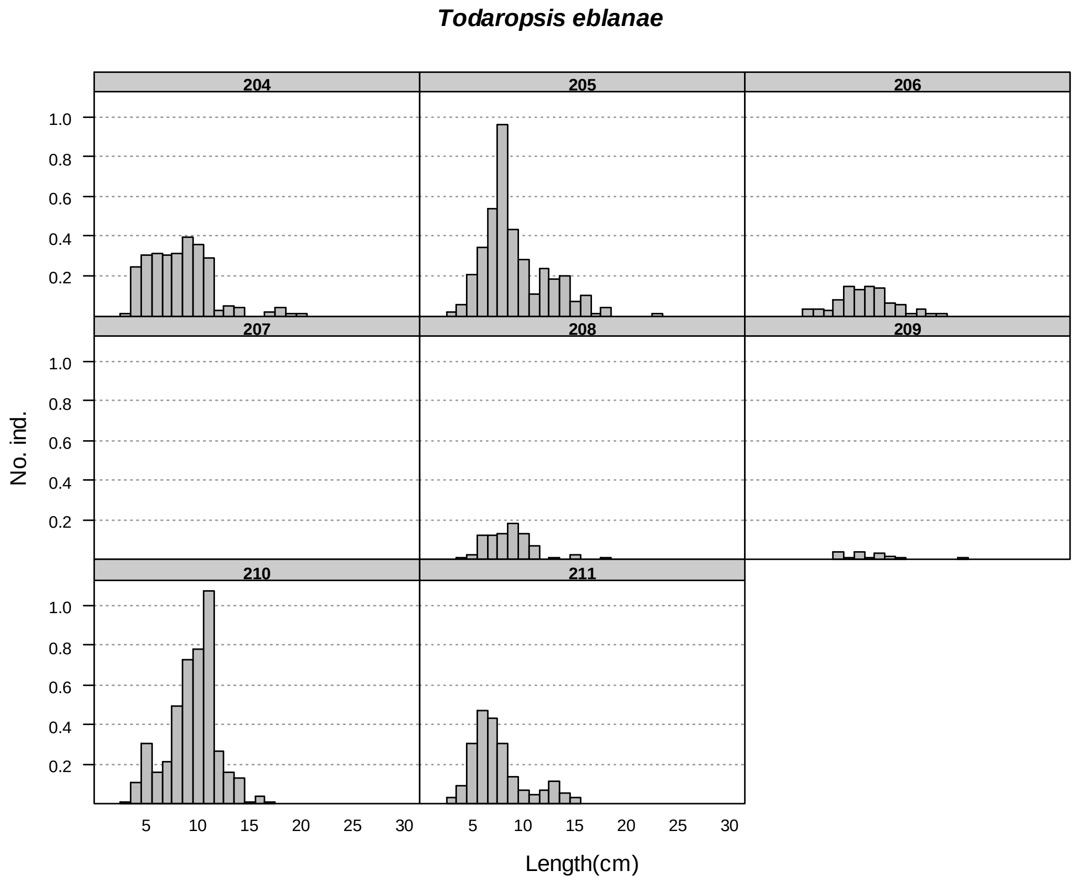

Figure 34. Mean stratified length distributions of *Todaropsis eblanae* in Autumn ARSA bottom trawl surveys (2004-2011).

Todaropsis eblanae

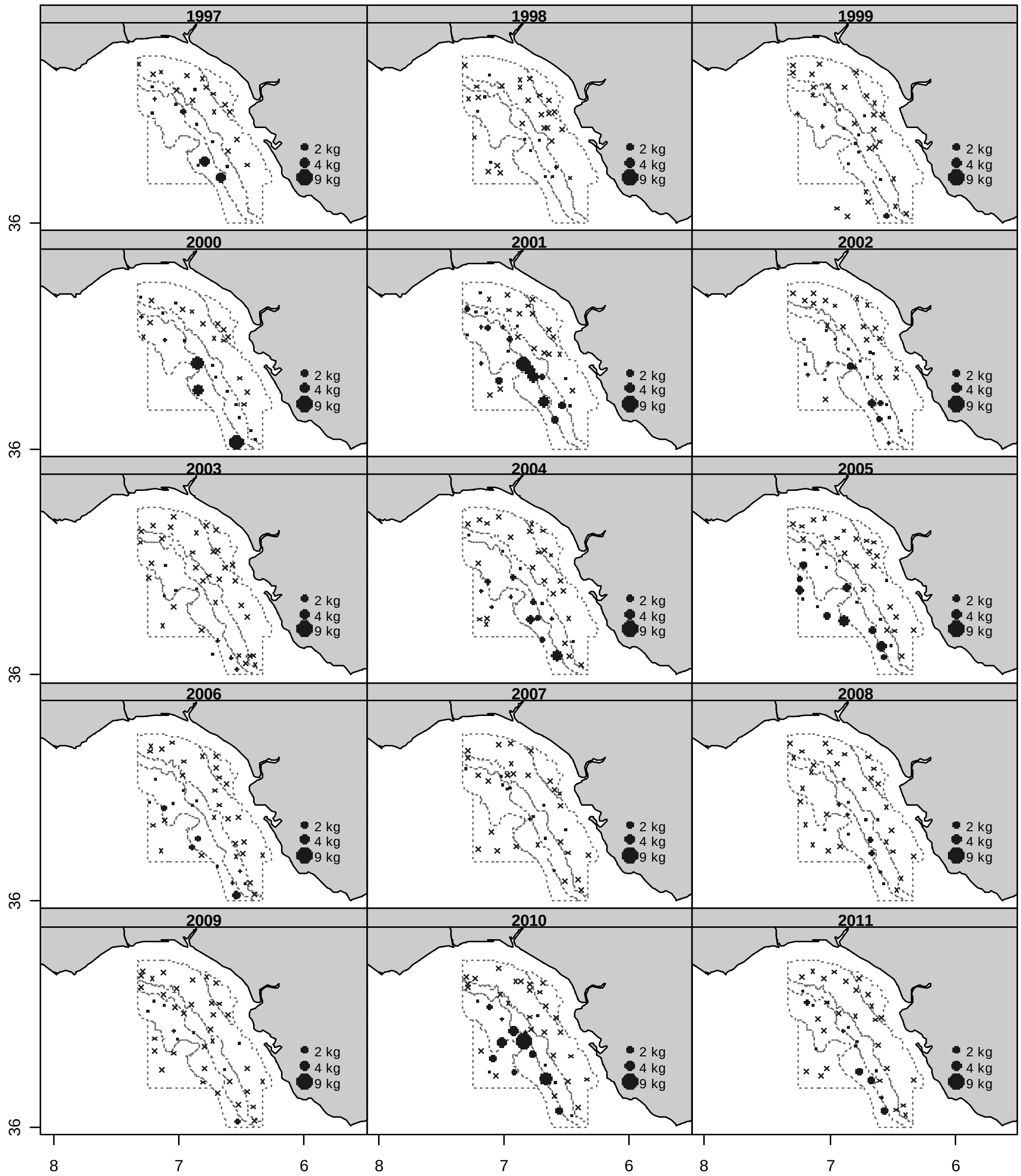

Figure 35. Geographic distribution of *Todaropsis eblanae* catches (kg/60 min haul) during Autumn ARSA bottom trawl surveys (1997-2011).

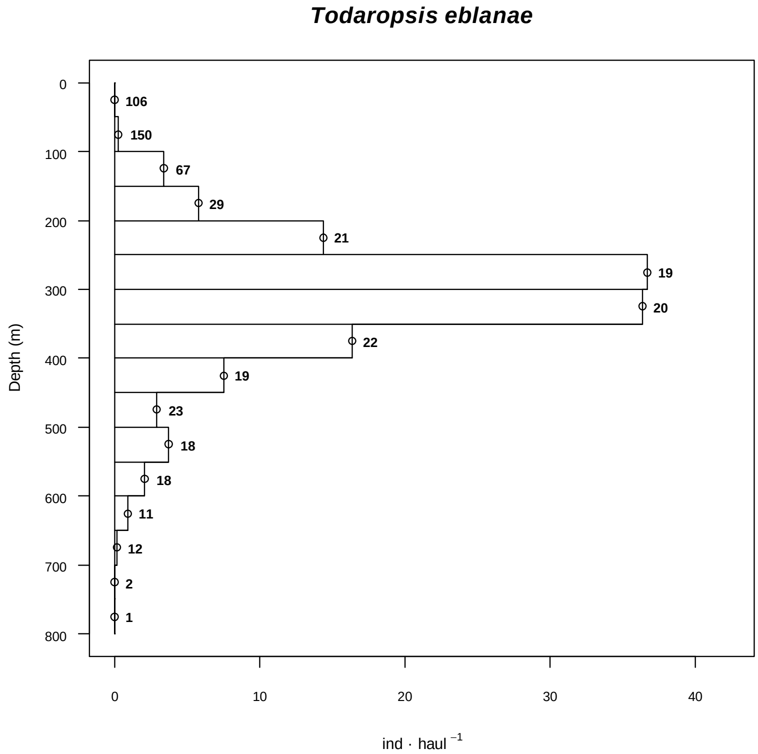

Figure 36. Bathymetric distribution (ind./60 min haul) of *Todaropsis eblanae* in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

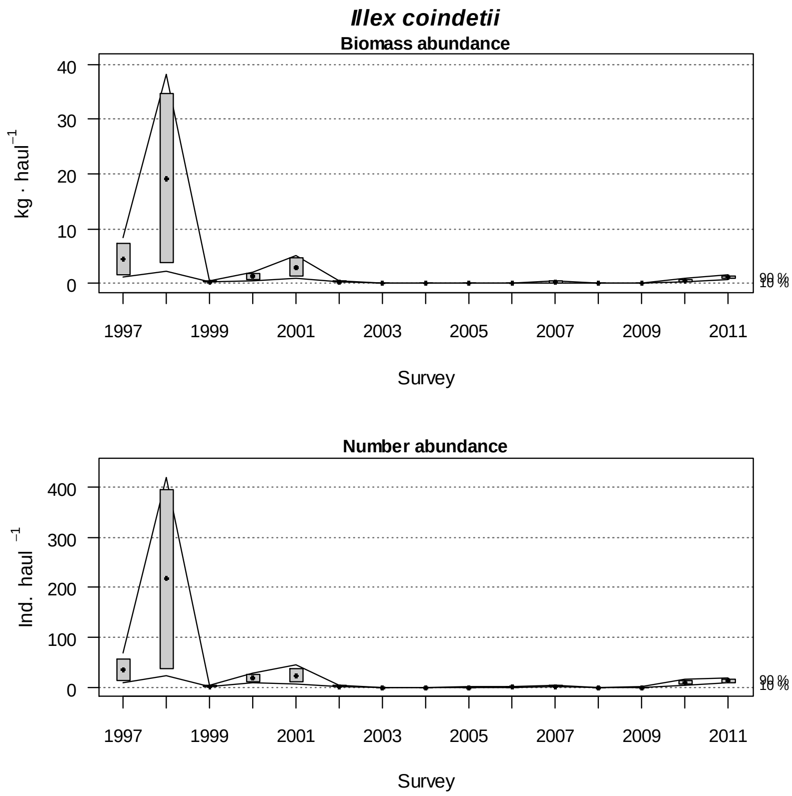

Figure 37. Evolution of the *Illex coindetii* biomass and abundance indices during Autumn ARSA bottom trawl surveys (1997-2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α =0.80, bootstrap iterations = 1000)

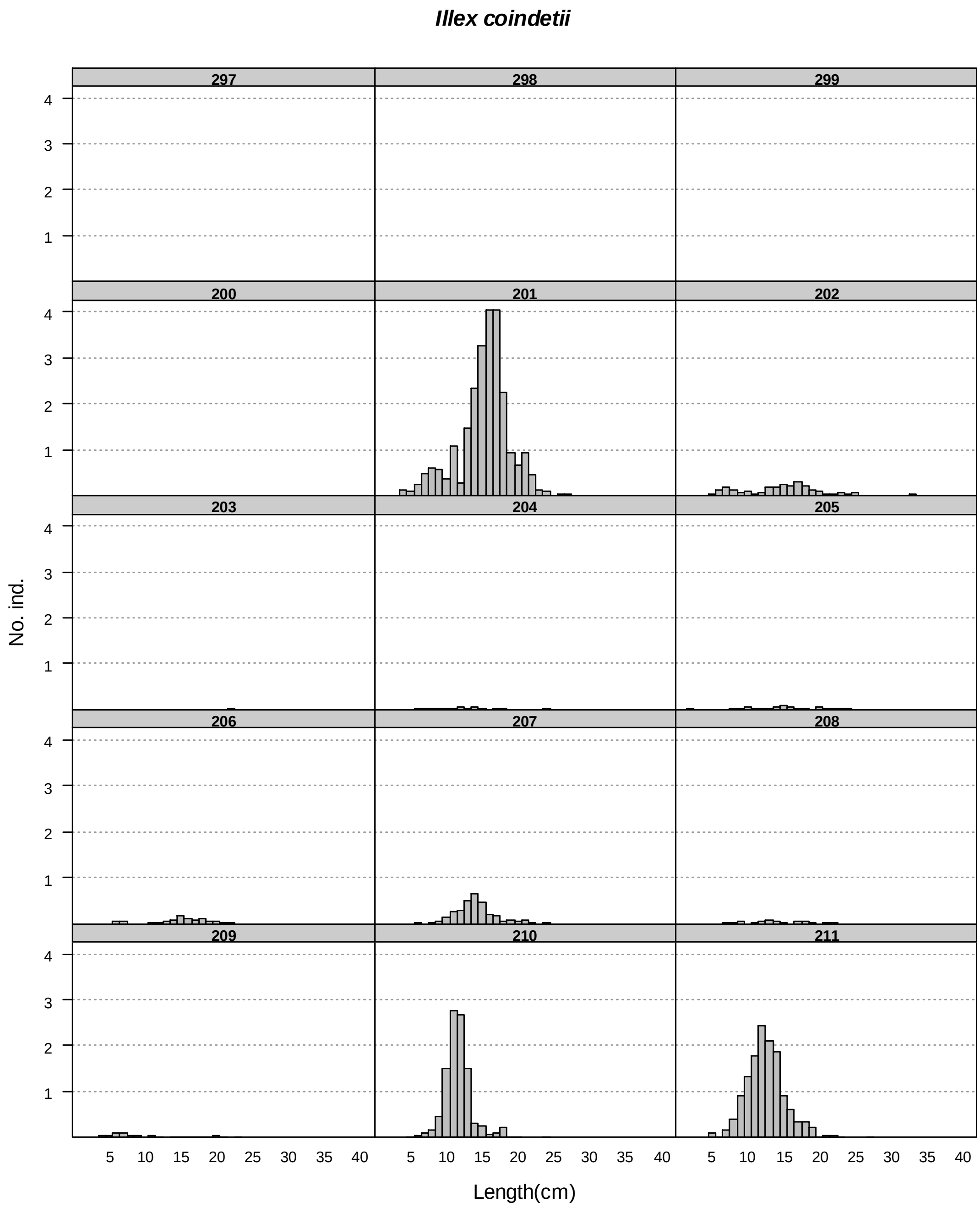

Figure 38. Mean stratified length distributions of *Illex coindetii* in Autumn ARSA bottom trawl surveys (1997-2011).

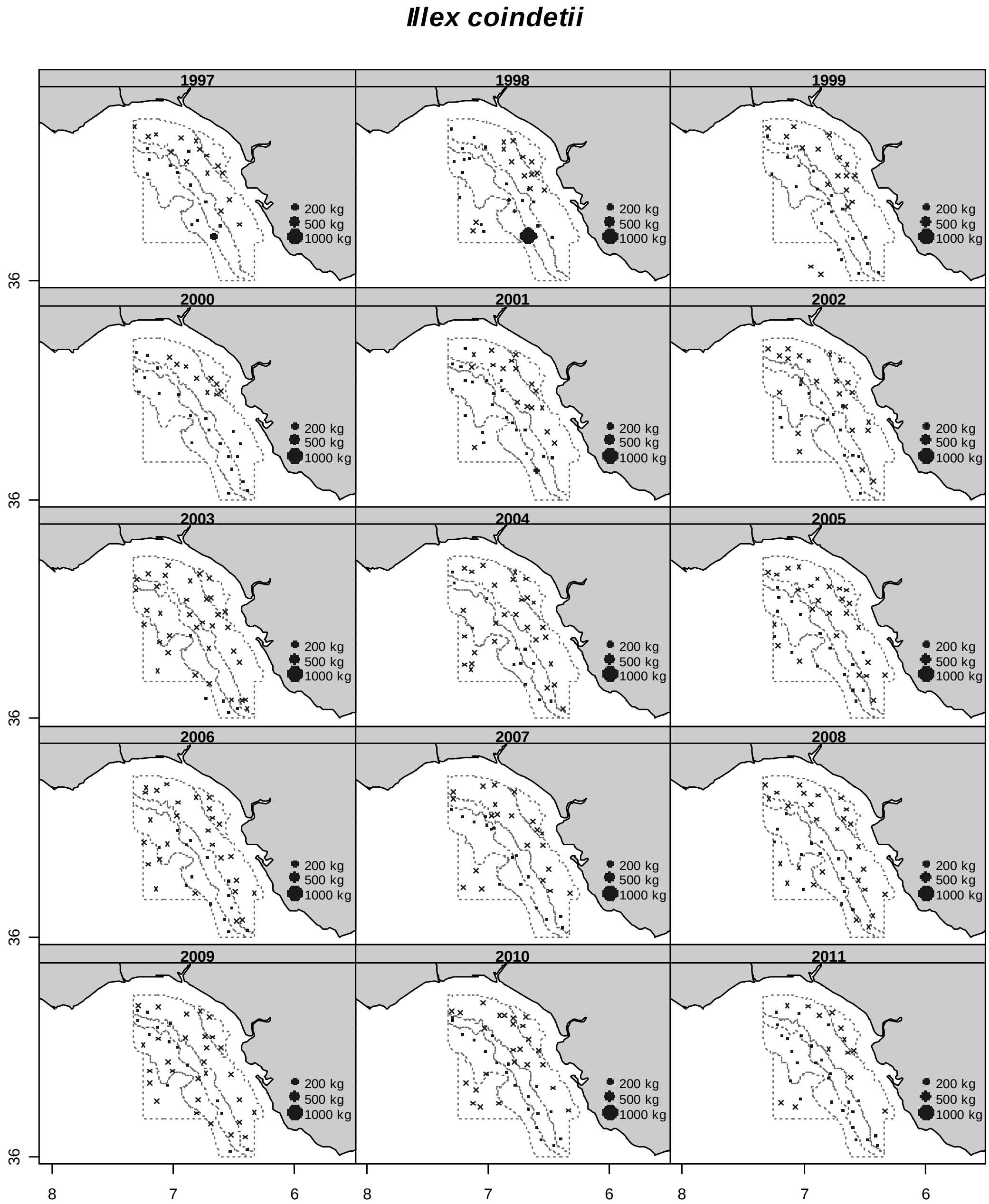

Figure 39. Geographic distribution of *Illex coindetii* catches (kg/60 min haul) during Autumn ARSA bottom trawl surveys (1997-2011).

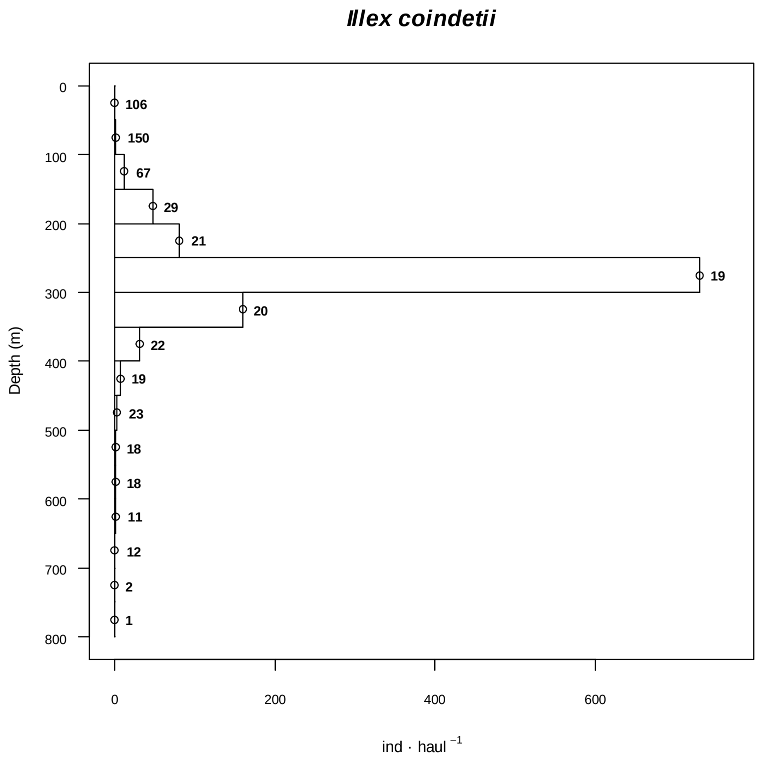

Figure 40. Bathymetric distribution (ind./60 min haul) of *Illex coindetii* in Autumn ARSA bottom trawl surveys. Numbers to the right of each bar correspond with the number of hauls per depth stratum.

Working Document for the ICES WGCEPH Working Group on Cephalopod Fisheries and Life History. Cadiz, Spain, 27 to 30 March 2012

Preliminar approach to the daily increment counting in Octopodidae stylets for growth studies

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1. INTRODUCTION

The assessment of growth and age of species stocks are very important for the sustainable management of the fisheries. Several studies have been conducted regarding the age and growth assessment of several cephalopod species (Moreno et al, 2012; Keyl et al., 2011). Despite that, specifically for *Octopus vulgaris* the direct age methods using statolits proved to be not useful, and *Eledone cirrhosa* no studies are known using these structure for ageing purposes, and recent approaches using the *Octopus vulgaris* beaks still needs proper validation (Raya and Hernández-González, 1998; Perales-Raya et al., 2010; Canali et al., 2011).

In the family Octopodidae, the stylets belong to the same structure, a chitin reduced cephalopod shell, which in this family separates in two pieces during embryonic development. It is located in the base of the funnel retractor muscle, with a structural function. Unlike other species of cephalopods, it doesn't suffer the mineralization process, maintaining its flexible structure during all life cycle (Budelmann et al., 1997; Dauphin, 1996).

The use of the stylets to assess age have been tried times to times (e.g. Reis and Fernandes, 2002) and improvements have been achieved in the techniques to preserve and to observe the growth structure in transversal sections of these structures. In their work, Doubleday et al. (2006) used successfully stylets transversal sections of the *Octopus pallidus* to assess the age of the species, although the fast degradation of the structure with contact with air and with the abrasive techniques to expose the growth structure, didn't allow using this technique in a regular basis. More recently, Barrat and Allcock (2010) had developed a technique to produce permanent preparations of different octopus stylets sections based in the embedding of the stylet section in acrylic resin. Other sections embedding methods have been tried to achieve definitive stylet sections with apparent success, as the use of a gelatine-glicerol gel medium (Mélzer, *unpublished data*). Those techniques allow preparing an ageing protocol based on the sequential increments counts aiming to assess individual age. In the same year, Hermosilla et al. (2010) successfully validate the daily deposition of growth increments in the stylets of adult *Octopus vulgaris*, by staining the stylets with oxytetracycline and tetracycline, and comparing the number of rings produced after staining with the number of days elapsed.

Based on the methodologies defined in the studies of Doubleday et al. (2006), Barrat and Allcock (2010) and Hermosilla et al. (2010), the present report aims to describe the recent achievements and challenges in appling the permanent preparation technique developed by Barrat and Allcock (2010) and the polish technique developed by Doubleday et al (2006), to *Octopus vulgaris* stylets from specimens captured along the Portuguese coast to investigate the possibility of determine the age structure and growth rates to the both populations. *Octopus vulgaris* paralarvae were used to determine the deposition of the hatch ring in the stylet transversal section, by using histological methodologies to cut and stain sagittal sections of the paralarvae were used.

2. MATERIAL AND METHODS

2.1. ADULT SAMPLING

Stylets collected from individuals captured in the small-scale fisheries samples were stored in a 4% formalin solution. For each pair of stylets collected, the individual dorsal mantle length (DML in mm), individual weight (W in g) were measured to the nearest 5 mm and 0.1 g, sexed and maturity stage determined following the a four stages maturity scale for males (I: immature; II: maturing; III: mature; IV: post-spawning) and five stages for females (I: immature; II: maturing; III: pre-spawning; IV: mature; V: post-spawning) (adapted from Guerra, 1975).

2.2. Identifying hatch mark

Common Octopus larvae newly hatched in the wild (n=10) around Cies Islands, Vigo, and captivity hatched paralarvae (n=10) at 13ºC with 3 days old were transversely sectioned in 10 µm slices and histological coloured using two different techniques: the Hematoxylin & Eosin technique (H&E) and the Masson Trichrome technique. The 10 µm sections were observed with immersion oil under x1000 magnification binocular transmitted-light microscope. Digital images of the paralarvae stylets were captured and increments counts and stylet diameter and hatch mark radius measurements were conducted using the images analysis software.

2.3. Stylets sectioning and mounting

Based on the methodology described by Barrat and Allcock (2010), the stylets were dehydrated in sequential ethanol baths: overnight in ethanol 70%, two hours in ethanol 90% and two hours in absolute ethanol. After dehydration, approximately 1 mm slices were cut in the post-rostral side near the stylet bend accordingly with Doubleday et al (2006), and then embed in low-viscosity LR white acrylic resin overnight. Then the slices were, again, embed in the polymerized resin (with LR white UV accelerator solution) in eppendorfs lids over a cooler table to avoid overheating. Once the resin was hardened, the block containing the embedded portion of the stylet was removed from the lid and affixed to a glass slide with cyanoacrylate-based adhesive. This block was then ground down using a Jean Wirtz grinder-polisher. Once the stylet surface emerged, the slices were polished in a decrease grain sequence of sandpapers (30 µm, 9 µm and 1 µm). When the stylet section was transparent enough and the growth increments were visible, the growth structure was observed under a 100x and 400x magnification under the microscope (Figure 1).

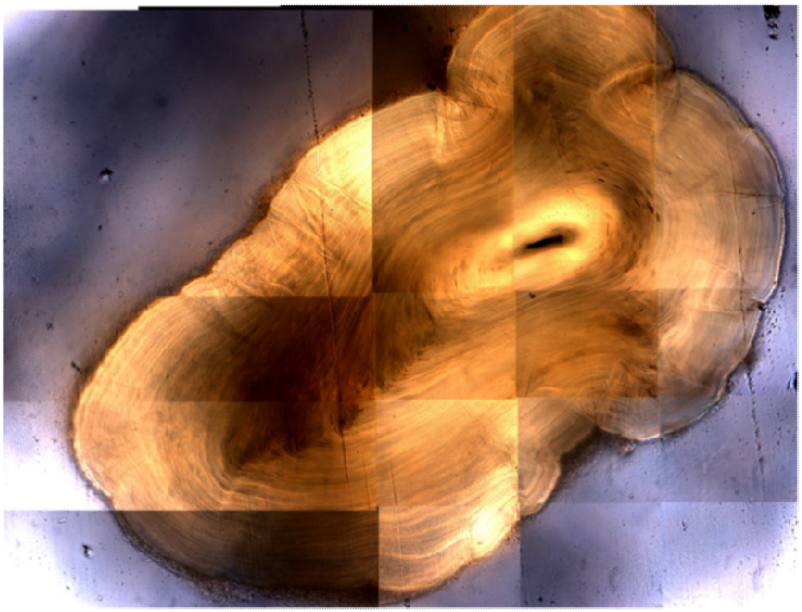

Figure 1 - Transversal section of a *Eledone cirrhosa* stylet. Montage of sequential photos taken at 400x magnification.

2.4. Visualization and counting of growth increments

To identify and count growth increments in the stylet surface, the stylet microstructure is observed under x400 and x600 magnification using an Olympus Bx51 binocular transmitted-light microscope. Growth increments were observed under full light power, with the condenser adjusted to optimize brightness and contrast. For each preparation, a series of digital images were captured from the centre to the shed of the stylet with a Sony DFW-SX910 digital camera. The images were processed using the Image J and the mosaics were created using the software tool MosaiJ. The growth increments were count along a line segment of known length using the multipoint tool of Image J. To identify and measure growth areas, a series of digital images under x100 magnification photographs were captured to posterior analysis and areas measurements using the software Image J.

3. Preliminary Results

3.1. Hatch Mark

Both histological staining techniques, the H&E and the Masson Trichrome, allow identifying the stylet in the insertion between the mantle muscle and the funnel retractors muscles in the posterior end of the larvae (Figure 2).

The stylet diameter is variable and seems to be dependent of the environmental conditions with the larvae hatched at 13ºC, with a stylet diameter of 0.81 (±0.08 SE) µm, and the wild paralarvae present an stylet diameter of 2.20 (±0.10 SE) µm, although the shrinking effect of the dehydration process cannot be neglected and further studies need to be conducted to understand how environmental conditions influences the stylet development and increments deposition in the larval stage. Nevertheless, this is the first attempt to identify and measure the hatch mark on the stylet surface. The identification of this mark, allows understanding were the deposition of daily growth increments begins. As the larvae stylet diameter, the hatch mark radius is also variable between larvae, the 3 day larvae maintained at 13ºC present a mean hatch mark radius of 0.211 (±0.02 SE) and the wild larvae presented a nucleus radius of 0.477 (±0.04 SE). This gives the indication that the hatch nucleus is very small regarding the dimension of the adults stylets and almost the entire surface of the stylet develops after hatch and should be considered in terms of age assessment, including the area previous indicated as nucleus by Doubleday et al. (2006).

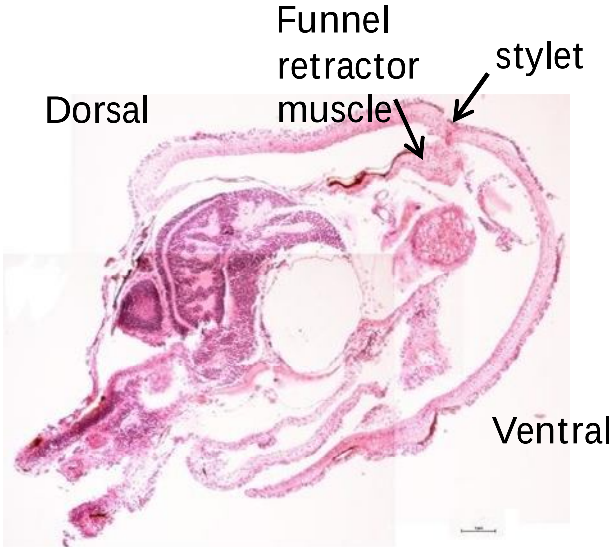

Figure 2 – Sagital section of an *Octopus vulgaris* paralarva with the indication of the relative position of the stylets in the insertion of the mantle muscle with the funnel retractor muscle.

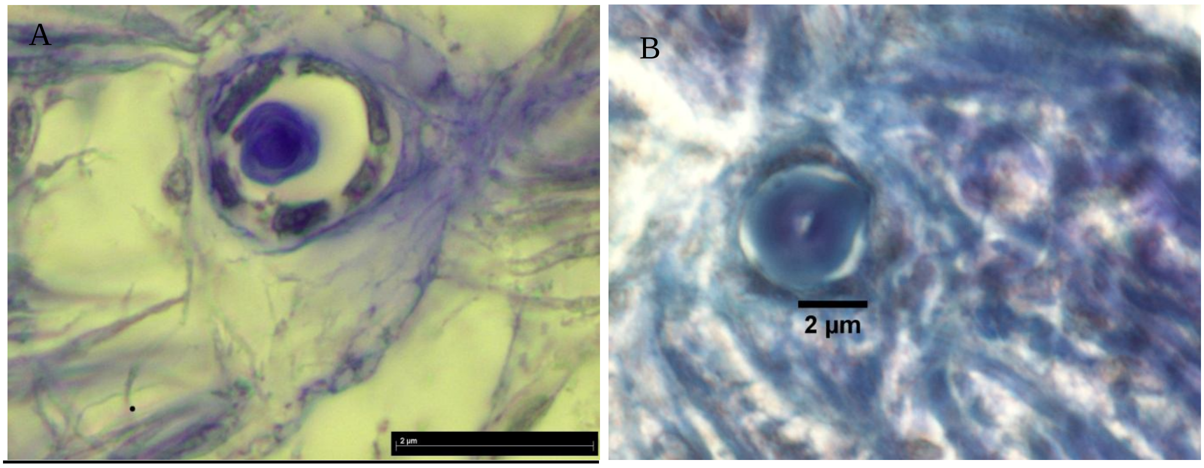

Figure 3 – Masson Trichrome stained 10 µm sections of the stylets of *Octopus vulgaris* larvae: A: 3 days old captivity larvae under 13ºC; B: wild larvae captured in Ria de Vigo, Galicia.

3.2. GROWTH AREAS

In their work Doubleday et al. (2006) identified four different deposition regions, nucleus, inner region, mid region and sheath for *Octopus pallidus* stylets. In our preliminary analysis is possible to identify, in most cases, three to four different regions distinguish between them by the distinctness of the growth increments or by the regular presence of distinct growth marks as it happens between the inner region and the mid region in the stylet image in Figure 4. Regarding the nuclear region, it is characterized by the clear surface or by the presence of a few thin marks almost invisible (Figure 5 A). The inner and mid regions present well defined and regularly deposit growth marks similar to the ones identify as daily by Hermosilla et al. (2010) (Figure 5 B) .

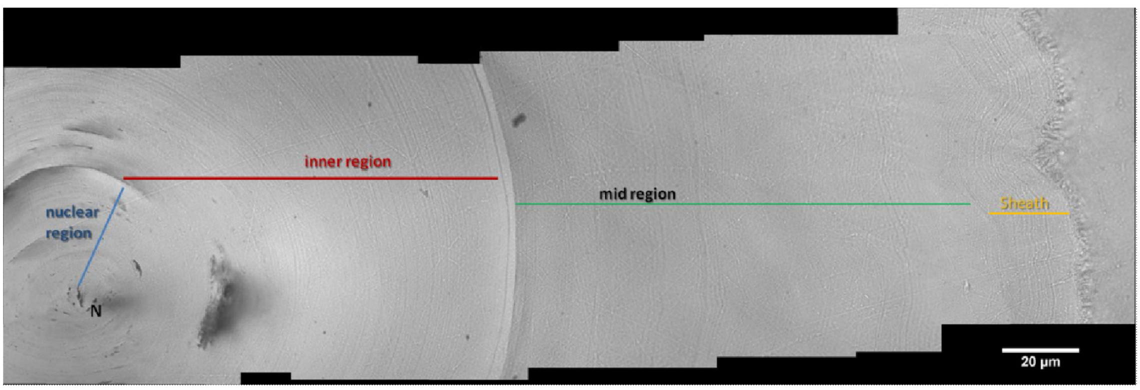

Figure 4 – Growth regions identifiable in the stylet surface of the *Octopus vulgaris*. Magnification x200.

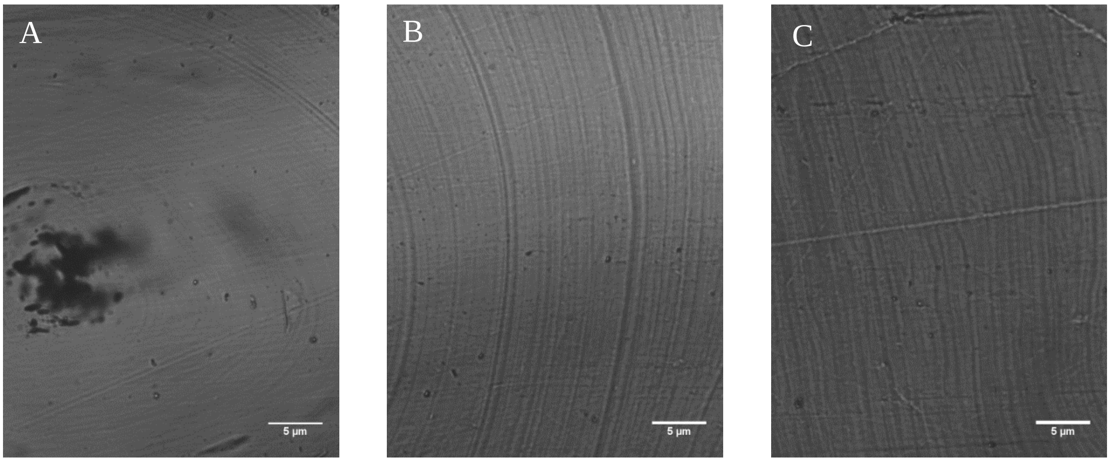

Figure 5 – Growth increments in different regions of the stylet surface: A-nuclear region; B – inner region; C – sheath.

3.3. GROWTH INCREMENTS

The growth increments observed in the stylet section surface were recently validated as daily (Hermosilla et al., 2010). Image magnification of x400 and x600, depending of the stylet size, allows to count and measure distances between daily increments (Figure 6). The preliminary approach to the count of daily increments allowed counting between 136 and 344 increments (Table 1) in maturing and fully mature individuals. Nevertheless is possible to observe the existence of first order and second order increments which should be considered as being of different nature (Figure 5 B and C), probably the existence of a sub daily deposition as considered by Doubleday et al. (2006). The deposition of the increments is regular with a mean distance between rings of 0.25 (± 0.01 SE) µm, although differences in deposition rate between stylet regions and between different size individual should to be expected in future analysis.

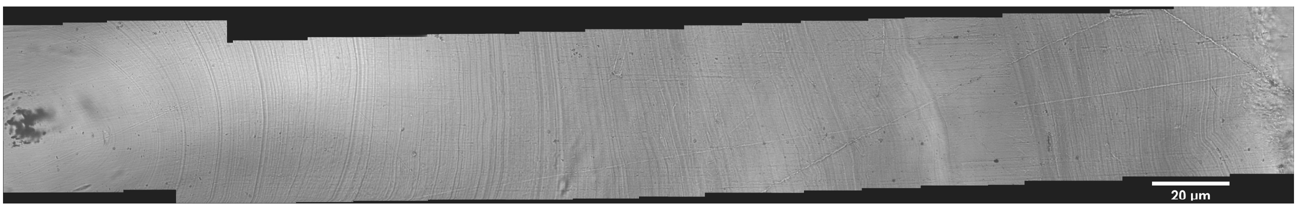

Figure 6 – *Octopus vulgaris* growth increments in the stylet section surface. . Magnification x400.

Table 1 – Preliminary results of the increments counts in the stylet surface under x600 magnification.

Sample	Mantle length (mm)	W class (200 g)	Sex	Mat	Increments	Distance within increments (µm)	% Readible area
1	204	2500	f	2	224	0.28	78.37
2	192	2300	f	2	344	0.15	86.24
3	204	3300	f	2	241	0.31	91.75
4	227	4100	m	3	216	0.31	92.66
5	165	1100	f	2	173	0.25	67.32
6	175	1700	f	2	136	0.25	79.15
7	160	2100	m	3	161	0.23	78.95
8	230	4100	f	4	284	0.28	88.80
9	175	2700	m	2	278	0.30	95.49
10	180	2300	m	3	314	0.26	92.08
11	190	3100	m	3	218	0.22	81.98

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A two stage biomass model to assess the English Channel cuttlefish (*Sepia officinalis* L.) stock

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Introduction

The English Channel cuttlefish stock is one of the most important cephalopod resources exploited in the Northern-Eastern Atlantic. Annual landings (11000 tons on average between 2000 and 2008) are caught mostly by French and UK fishermen (6500 t. and 3500 t. respectively) from ICES divisions VIId and VIIe.

English Channel cuttlefish (*Sepia officinalis*) is semelparous, hatches inshore in summer and perform offshore/inshore migrations to wintering grounds in the centre of the Channel and to coastal feeding and spawning grounds (spring and summer). The lifespan in this population is approximately 2 years, spawners dying at the end of the reproduction period. Recruitment into the fishery begins in October of the first year of life and the annual cohort is fully recruited at the end of the second summer (at the age 1 year and a few months).

In spite of local management measures, the English Channel cuttlefish stock is not routinely assessed and management is restricted to French regions by delivering fishing licences to trap fishermen. Stock assessment exercises have already been carried out using surplus production models (Dunn, 1999) and mainly VPA adapted with a monthly time scale (Royer *et al*. 2006). Difficulties encountered to determine the age structure of the catch lead to consider the application of a two stage biomass model (Roel *et al*. 2000 and 2009).

Biomass estimated with the two stage biomass model (between 1993 and 2008) are presented here together with the input time series. Data on recruitment strength are provided by survey indices whereas abundance of the exploited stage is obtained by modelling Landings Per Unit Effort (LPUE) with the Delta-Generalised Linear Model (Delta-GLM) method.

Input data for the cuttlefish stock assessment

Fisheries data

Commercial and survey data were extracted from CEFAS and Ifremer databases from 1992 to 2008.

In the eastern English Channel (ICES division VIId), CEFAS carries out the Bottom Trawl Survey (BTS) in July each year with R/V Endeavour equipped with a 4 meter wide beam trawl. Data collected during this survey can be considered as a representation of one year old cuttlefish population at the beginning of the modelled period.

Ifremer also carries out a survey in the eastern English Channel, the Channel Ground Fishery Survey (CGFS) in October each year with R/V Gwen Drez equipped with a GOV trawl. Data collected during this survey can be used to model the one year old cuttlefish population at the end of the first quarter after the recruitment.

Both research institutes also collect landings (by all gears) and trawler landings associated with effort data which are used to model LPUE variations and its spatial/temporal components. These data are used to model the cuttlefish population on the whole studied period.

Abundance indices:

Scientific and commercial data were computed to obtain abundance indices in Kg of cuttlefish per hour of trawling as:

$$S = \frac{C_n}{E_n} \text{ or } U = \frac{C_n}{E_n}$$

Where S and U are respectively the survey abundance indices and commercial LPUE, C_n and E_n are respectively the catch in Kg of cuttlefish and the effort in hour of trawling for the fishing trip n. Abundance indices derived from survey data can be considered as standardised abundance indices while abundance indices derived from commercial data must be standardised.

Generalised Linear Models

As Hilborn and Walters (1992) suggest, fitting a GLM is the most powerful way to derive abundance indices from commercial LPUE. In addition, we have taken into account the numerous null values using the Delta-GLM method (Le Pape *et al.*, 2003) which consists in combining a binomial error GLM and a Gaussian error GLM to explain firstly the presence-absence and secondly the resource abundance. As a consequence, LPUE variability is explained by 4 variables (the year Y, the month M, the ICES rectangle R and the Engine Power of the vessel P) which are introduced in both models:

$$\log it(U_{Y,M,R,P})_{0/1} \approx \alpha_Y + \beta_M + \gamma_R + \delta_P + \varepsilon_{Y,M,R,P}$$

and

$$Ln(U_{Y,M,R,P})_{>0} \approx Ln(\alpha_Y) + Ln(\beta_M) + Ln(\gamma_R) + Ln(\delta_P) + \varepsilon_{Y,M,R,P}$$

Corrected LPUE noted Û are then estimated using the formula:

$$\hat{U}_{Y,M,R,P} = \frac{e^{\log it(U_{Y,M,R,P})_{0/1}}}{1 + e^{\log it(U_{Y,M,R,P})_{0/1}}} \times e^{ln(U_{Y,M,R,P})_{>0}} \times e^{\sigma^2(ln(U_{Y,M,R,P})_{>0})/2}$$

This method was discussed during the last CRESH meeting in Lowestoft with CEFAS and Ifremer partners and it still has to be analysed or compared with other time series to be validated.

Two Stage Biomass Model and model fitting

In a simplified version of cuttlefish life cycle, fishing seasons start in July of year "y" and end in June of year "y+1" (when spawners die). In the cohort of year "y" the model describes population dynamic between 1 year-old specimens in July y+1 and 2 year old specimens at the end of June y+2. During the second year of life, initial biomass is influenced by catch and by a "growth and natural mortality" parameter g. The exploitable biomass at the beginning of every July of year y+1

($B_{T,y+1}$) consists of 1 and 2 year-old individuals and is modelled by

$$B_{T,y+1} = B_{1,y+1} + \left[\left(B_{1,y}\right).e^{-g/2} - C_{1+,y}\right].e^{-g/2}$$

Just like Pope's simplified procedure in Cohort Analysis, the catch $C_{1+,y}$ is assumed to happen as a pulse in the middle of the fishing season (i.e. in January).
Considering that the recruitment is assumed to take place in July of every year the biomass can be modelled using the July BTS index as:

$$S_y^1 = k_1.B_{1,y}.e^{\xi_y}$$

Where S^1_y is the BTS survey index for the year y, k_1 is the catchability of the BTS survey and $B_{1,y}$ is the biomass at the beginning of the year y in July.

Ifremer survey index can also be used to derive initial biomass as:

$$S_y^2 = k_2.B_{1,y}.e^{-g/4}.e^{\xi_y}$$

Where S^2_y is CGFS survey index for the year y, k_2 is the catchability of the CGFS survey.

Finally, biomass of the second year of life is related to modelled LPUE ($\hat{U}^{fr}$ and $\hat{U}^{uk}$ for the French and UK trawlers fishing fleets respectively) using the formula:

$$\hat{U}_y^{fr} = \frac{1}{2} q_{fr}.\left[B_1 + (B_1.e^{-g/2} - C_{1+,y})e^{-g/2}\right]$$

and

$$\hat{U}_y^{uk} = \frac{1}{2} q_{uk}.\left[B_1.e^{-g/4} + (B_1.e^{-g/2} - C'_{1+,y})e^{-g/4}\right]$$

Where q_{fr} and q_{uk} are respectively the French and UK catchability coefficients. The model is finally fitted by minimizing the sum of squares residuals (SSR).

Results

Total observed landings increase during the studied period from around 3000 t and 1500 t respectively for French and UK fisheries to reach on average 8000 and 3500 t. in 2008 (figure 1). It should be noted that despite the general trend, French landings seem to decrease after 2004 while the UK landings seem to increase slightly.
The model seems to follow both the trends and the inter-annual fluctuations of the data which suggests that it fits well the data (figure 2 and 3). The main common feature of the 4 indices is the random inter-annual fluctuations of the variables around the trend. Concerning both the survey and the commercial indices, it seems that there is no trend before the years 2002-2003. From these years, abundance indices start to decrease more or less slightly with the same random variations around the trend.
Time series of the biomass computed with the two stage biomass model shows that B_1 (biomass of one year old cuttlefish in July, the beginning of the assessment year) presents no trend on the whole studied period and fluctuate around 20000 tons. The total biomass (cumulated biomass B_1 of one year old specimens and B_2 of two year old specimens) also seems to fluctuate around a mean before 2003. After 2003, the total biomass appears to decrease from 93000 tons to 64000 while B_1 stays constant.

Conclusion

Large inter-annual fluctuations observed are typical of short lifespan species such as cephalopods (Royer *et al.*, 2006; Young *et al.*, 2002). This variations are quite well described by the model. Both catch and average exploitable biomass seem to depend mainly on recruitment strength. Rather weak recruitment in the last studied years still has to be analysed but do not seem to correspond to increasing fishing pressure. This exercise is consistent with previous stock assessments (Royer *et al.*, 2006) who considered that cohorts were fully exploited but that the resource did not show dramatic over-exploitation.

Although the model seems to fit well and the results are informative to assess the stock status, spatialisation of the model should be an interesting improvement to take into account cuttlefish migrations. Another desirable development would be to take into account partial recruitment since the first autumn. The two stage biomass model which was firstly developed with an Excel spreadsheet has been developed in R, the open-source statistical software. R will be useful to fit the model using non linear minimization and maximum likelihood fitting method. In addition, it will let us obtain confidence intervals of the abundance estimation modelled.

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Figures

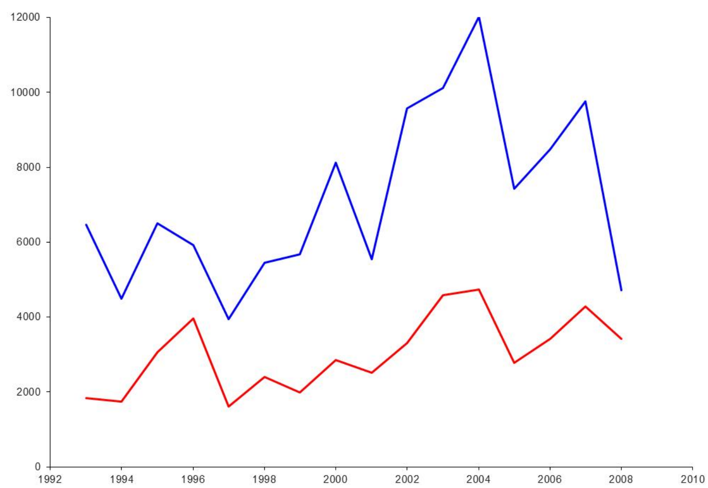

Figure 1: Time series of French (blue) and UK (red) total landings between 1993 and 2008.

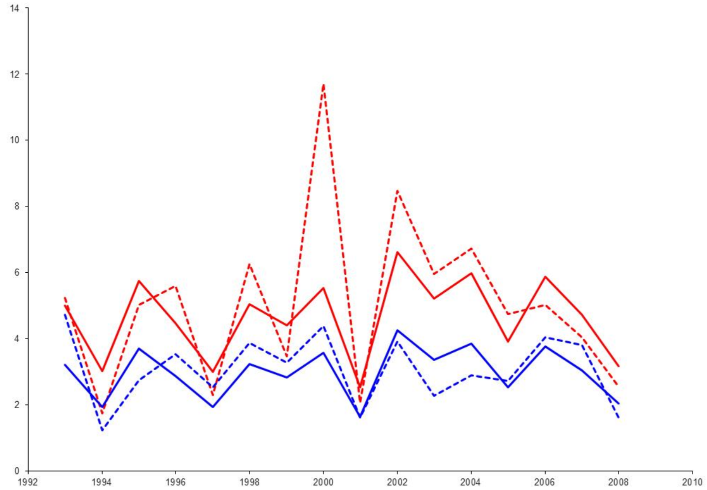

Figure 2 : Observed (dashed lines) and predicted (continuous lines) of French (blue) and English (red) survey indices computed with the BTS and CGFS data collected in 1993-2008

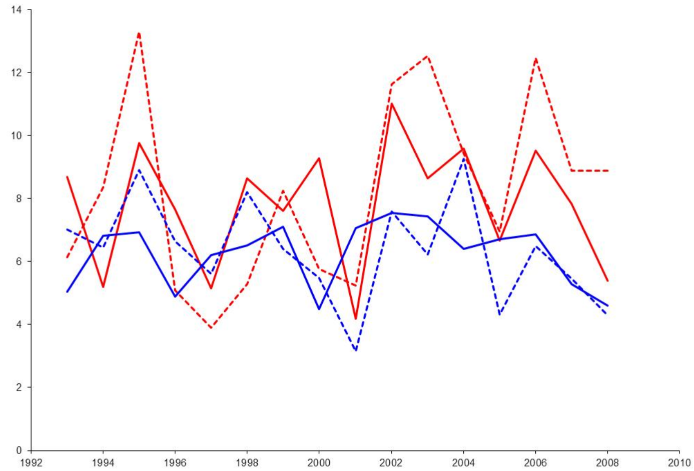

Figure 3 : Observed (dashed lines) and predicted (continuous lines) of French (blue) and English (red) commercial indices computed with the landings data collected by the Ifremer and the CEFAS in 1993-2008.

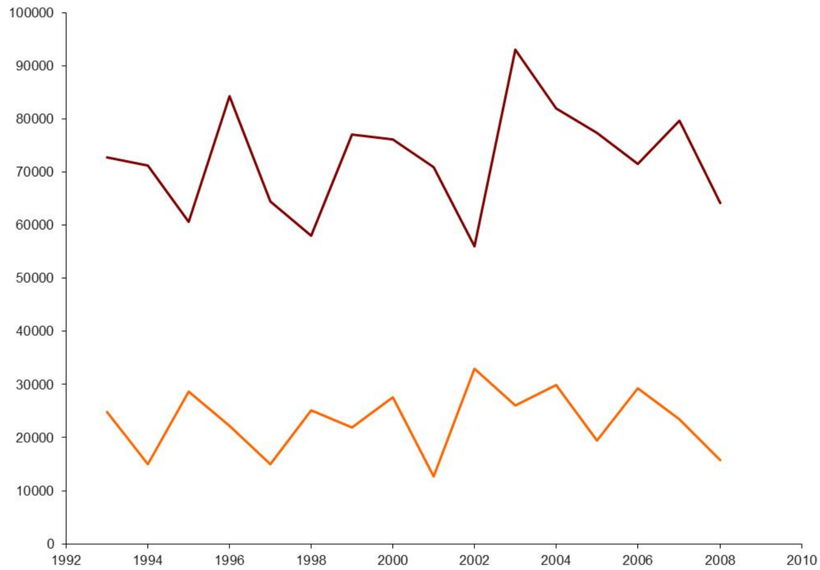

Figure 4: Time series of estimated B1 (orange) and total biomass (brown) during the exploitation period of cuttlefish in the period 1993-2008.