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Interim Report of the Working Group on Cephalopod Fisheries and Life History (WGCEPH)

6-9 June 2017

Funchal, Madeira, Portugal

ICES
International Council for the Exploration of the Sea
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Executive summary

The ICES Working Group on Cephalopod Fisheries and Life History (WGCEPH) met in Funchal (Madeira, Portugal) on 6–9 June 2017 to work on five Terms of Reference. Information on the status of fished stocks and fisheries (ToR A) was updated based on previously compiled information updated with new information provided in response to a data call. Cephalopod landings from the Northeast Atlantic in 2016 were 30% higher than the 2000–2015 average, mainly due to high yields of octopuses and short-finned squid. New information on assessment and management was compiled and plans for a manuscript on stock trends were discussed (ToR B). A new empirical model to predict octopus abundance in the Gulf of Cadiz, using survey abundance and hydro-climatic variables, was presented. Limitations of available information were discussed and it is noted that lack of reliable species identification remains an issue both for almost all commercial data and data from many surveys.

A new review of life history information on fished cephalopods in the ICES area was assembled (ToR C). The group reviewed around 200 journal articles on life history, distribution, trophic relationships, taxonomy, fisheries and impact of climate change on cephalopods published during the last five years (2013–2017). Some new information on the economic and social importance of cephalopod fisheries was compiled and progress with a planned manuscript on socioeconomic aspects of cephalopod fisheries was discussed (ToR D).

Information on approximately 30 existing cephalopod identification guides was compiled and specifications were drawn up for a new ID sheets for use during research surveys and for sampling of commercial catches (ToR E).

The WGCEPH 2018 meeting will be hosted by AZTI (Spain), San Sebastian, Spain, June 2018.

1 Administrative details

Working Group name

Working Group on Cephalopod Fisheries and Life History (WGCEPH)

Year of Appointment within current cycle

2017

Reporting year within current cycle (1, 2 or 3)

1

Chair(s)

Graham J. Pierce, Spain

Jean-Paul Robin, France

Meeting dates

6–9 June 2017

Meeting venue

Funchal, Madeira, Portugal

2 Terms of Reference

a) Report on cephalopod stock status and trends: Update, quality check and analyse relevant data on European fishery statistics (landings, directed effort, discards and survey.

b) Conduct preliminary assessments of the main cephalopod species in the ICES area by means of trends and/or analytical methods. Assess the relevance of including environmental predictors.

c) Update information on life history parameters including variability in these parameters. Define cephalopod habitat requirements.

d) Evaluate the social and economic profile of the cephalopod fisheries, with emphasis on small-scale fisheries and mechanisms that add value to cephalopod products (e.g. certification).

e) Recommend tools for identification cephalopod species and update best practices for data collection.

3 Summary of Work plan

Year 1 (2017)	Report on updated trends in Cephalopod landings and abundance indices .(a)
	Report on updated cephalopod stock assessments (b)
	Report on scientific articles in relation to life-history and habitat requirements (c)
	Report on social and economic profile of cephalopod fisheries (d)

	Report on available information for species identification (e)
Year 2 (2018)	Report on status and trends in cephalopod stocks (a and b)) First draft of paper in relation to population modelling and assessment tools (b) Peer review paper on rearing conditions and/or habitat preferences (c) Report on mechanisms that add value to cephalopod products (e.g. certifications) (d) Draft of Manual for cephalopod field identification and data collection (e)
Year 3 (2019)	Report on updated trends in Cephalopod landings and abundance indices .(a) Peer-review paper on cephalopod population modelling and assessment tools (b) Report on socio-economic issues related to cephalopod management options Manual for cephalopod field identification and data collection guidelines (e)

4 List of Outcomes and Achievements of the WG in this delivery period

The main outcomes of the work of WGCEPH in 2017 were as follows:

1) Annual summary tables and accompanying text for cephalopod fishery production in the ICES area (ToR A);
2) A short review of assessment and management of cuttlefish fisheries (ToR B);
3) A review of relevant new research on cephalopods (ToR C);
4) A draft of a manuscript on socioeconomic aspects of cephalopod fisheries;
5) A bibliography of identification guides for cephalopods (ToR E).

Items 1, 3 and 5 are provided as appendices while item 2 is integrated into the main report.

5 Progress report on ToRs and workplan

5.1 Progress on ToRs a) and b)

a) Report on cephalopod stock status and trends: Update, quality check and analyse relevant data on European fishery statistics (landings, directed effort, discards and survey)

B) Conduct preliminary assessments of the main cephalopod species in the ICES area by means of trends and/or analytical methods. Assess the relevance of including environmental predictors

We report these two ToRs together as the latter depends on the former, first summarising general progress and then reviewing cuttlefish assessment and management in several countries both within and outside the ICES area.

Although WGCEPH has previously issued informal data calls, 2017 was the first year in which it adopted the InterCatch procedure for data submission and compilation. Four stock co-ordinators were identified (for the main species groups, i.e. cuttlefish, octopus, loliginid squid and ommastrephid squid). Some shortcomings were however identified in the specification of the data call and for ease of understanding by data providers the call text will be updated for 2018. Nevertheless, stock co-ordinators found InterCatch to be a useful tool for faster compilation of fishery statistics.

Updated tables of annual production by taxon and ICES division are appended to this report (Annex 3) along with detailed descriptions of trends in Annexes 4 (loliginids), 5 (ommastrephids) and 6 (octopuses). Cephalopod fisheries in Madeira are provided in Annex 7. Updates for cephalopod fisheries in Spain and Portugal are presented in Annexes 8 and 9, respectively.

It is worth noting that the 2016 cephalopod landings from the Northeast Atlantic were 30% higher than the 2000–2015 average. This was mainly due to high yields of octopuses and short-finned squid, while cuttlefish and long-finned squid productions were 4% below the average.

Annual loliginid (long-finned squid) landings have been relatively stable since 2000, although with important peaks in 2003 and 2010. In 2016, total loliginid landings showed a slight increase from the 2015 value but reflecting a more substantial increase in landings in the North Sea and English Channel northern areas coupled with a decrease in southern areas and in the Azores. Reported discards are generally very low. Catches of loliginids may include *L. vulgaris*, *L. forbesii*, *A. subulata* and *A. media*, although the proportions of each of these species are quite different between geographical areas. Despite improvements in the reporting of landings by species (since implementation of the DCF in 2008), in some areas lack of species identification is still an issue that will limit the use of fisheries data for stock status assessment.

The main new assessment prepared during 2017 concerns the *Octopus vulgaris* population in the Gulf of Cadiz. Sobrino el al. (Working Document, Annex 10) developed an empirical model to predict octopus abundance using survey abundance and hydro-climatic variables. They concluded: "the abundance of octopus in the Gulf of Cadiz is influenced mainly by rain in the previous year and secondarily by the surface sea temperature in April of the previous year. The recruitment index obtained in the autumn survey can be used to forecast the landings in the next year but this index is influenced by the number of survey stations falling within the main recruitment zone. For this reason, in the future, it is recommended that 3 or 4 hauls should be performed within the recruitment area during the autumn surveys."

In 2017, Pierce & Pita gave a presentation on management options for cephalopod fisheries in Europe at the Cephs In Action and CIAC conference in Heraklio, Greece. They pointed out the need for (a) solutions suitable for fisheries landing cephalopods as a by-catch (e.g. integrating cephalopods into multi-species management), (b) adequate data (e.g., landings identified to species, as noted above) and (c) co-management of small-scale cephalopod fisheries, with explicit recognition of socio-economic goals. The review gave examples of current approaches to cephalopod fisheries management around the world as well as, where possible, describing what data, if any, played a part in influencing management decisions. Additional information on this topic may be found in previous WGCEPH reports, two ICES Co-operative Research Reports on European cephalopod fisheries (Pierce *et al.*, 2010 and Jereb *et al.* 2015), Pita *et al.* (2015) for European octopus fisheries and review papers such as Arkhipkin *et al.* (2015) on world squid fisheries. There remains a need to a more comprehensive (ideally systematic) review of management and governance in these fisheries, in particular to highlight where EU fisheries could benefit from lessons learned elsewhere in the world.

A peer-reviewed manuscript on trends in cephalopod fisheries in the ICES area was planned for 2016 and the topic will be revisited at the 2018 meeting.

Review of assessment and management of fisheries for cuttlefish

United Kingdom

UK cuttlefish landings in 2015 (~ 6000 tonnes landed by U.K. vessels in England and Wales) were worth £10.6 million (MMO, 2016). There are no management strategies at EU or UK level, nor any formal stock assessments, in place to help conserve cuttlefish stocks and ascertain whether they are being fished to MSY. Within 12nm of the English coast, the Inshore Fisheries Conservation Authorities (IFCAs) have legal responsibility for fisheries management. Sussex IFCA requires anyone fishing for cuttlefish to have a shellfish permit, while Southern IFCA has a cuttlefish 'code of practice', which encourages pot fishers to take care to minimise damage caused to eggs when hauling and shooting gear, to avoid cleaning or washing traps with attached cuttlefish eggs, to keep pots in the sea (rather than remove them at the end of a season) until any remaining eggs have hatched. Finally, when traps are left in the sea, fishers are required to attend them regularly to remove captured animals and/or remove panels to avoid ghost fishing.

Seafish, a UK Non-Departmental Public Body, in its report on 'Risk Assessment for Sourcing Seafood' (RASS), categorises cuttlefish in ICES areas 7d and 7e as at 'medium risk' because of the uncertainty of the effectiveness of management measures (Seafish, 2017). As a non-quota species, there is no obligation under the E.U.'s Data Collection Framework (DCF) for the UK to collect data on cuttlefish, though some data are collected by scientific 'Observers' during sampling onboard commercial vessels associated with high amounts of discards, such as trawlers (both beam and otter), and netters. Furthermore, data are collected during fish surveys on various Research Vessels around the U.K. coast. It should be noted that, at least until recently, these data were not always attributed to individual species (although *Sepia officinalis* dominates commercial cuttlefish landings it is not the only sepiid landed.

Additionally, Marine Protected Areas (such as Lyme Bay, south England) help to protect grounds against towed-gear for spawning cuttlefish. Their effectiveness however, remains uncertain (see the review of cephalopod research in ToR 'C'). Whilst cuttlefish do not remain within the confines of any single protected area, given their highly-migratory behaviour, it is possible that the survival of (pre-migratory) juveniles is enhanced by MPAs.

No Minimum Conservation Reference Size (MCRS, historically referred to as Minimum Landing Size; MLS) exists for U.K. fishers.

France

In France, specific authorisation is needed to trawl for cuttlefish (under the framework of the "Direction Régionale des Affaires Maritimes") within 3nm of the coast, although an exemption allows fishers to target juveniles for two weeks in late summer. As in the U.K. (and the Falklands for *Illex argentinus*, California for *Doryteuthis opalescens*, Japan for *Todarodes pacificus*, and Taiwan Bank for *Loligo chinensis*, to name just a few examples), a restriction also exists on the numbers of pot and trap fishing licences available for fishing within 3nm of the coast. Only small vessels (<12m length) can obtain a licence and up to

500 traps can be used by each vessel. The spring trawling season is generally open from April to June each year. Fishing effort is not regulated and varies depending on migration of adult specimens (which can be documented with a one year delay by the national fishery statistics system "Système d'Information Halieutique" or via more local data bases of the "Comité Régional des Pêches"), as well as the predicted timing and arrival of cuttlefish at their spawning grounds (Wang *et al.*, 2003). Mesh size regulations for trawlers are issued for the management of fin fish stocks, with a minimum mesh size of 80 mm or 100 mm specified according to the metier. In French fish markets landings are sorted out per commercial categories and EU Council Regulation 2406/96 indicates that the smallest cuttlefish category is 0.1 to 0.3 kg. Thus 0.1 kg (or DML = 8–9 cm) is in theory a minimum landing size. For more detailed information, see Pierce *et al.* (2010), pp. 77–80.

Spain

In Spain, no formal management measures exist for cuttlefish fishing. Regionally, there are some Total Allowable Catch limits, such as in the Balearic Islands recreational fishery, where a fisher may catch up to 5 kg, or 10 individuals, of any cephalopod. Additionally, in the Marine Reserves of Fishing Interest, Ría de Cedeira, Galicia, a minimum mantle length (ML) is set at 80mm for cuttlefish (Tubío & Muiño, 2013).

A 2014 study by Keller *et al.* (2015), examined the E.U.'s Data Collection Framework's (DCF) minimum data requirements (MDR) which each member-country is obliged to obtain, using squid and cuttlefish fisheries of the western Mediterranean as a case study to determine whether data are adequate for assessing stocks, for example using depletion models. It was considered that currently DCF requirements for such cephalopods are insufficient for stock assessment, due to the plasticity of their life-history traits, and that shorter time-scales (weekly or fortnightly) should be monitored, rather than quarterly.

Iran

The coast of southern Iran borders two different marine ecosystems, in the Persian Gulf and Oman Sea. In both, there are fisheries for the pharaoh cuttlefish, *Sepia pharaonis*, the dominant species of cuttlefish In the Indian Ocean. Cuttlefish are managed differently in these two areas although closed seasons and closed areas apply in both. In the Persian Gulf, fishers can fish for 2 months of the year in shallow waters, the fishery being closed in the remaining 10 months. The timing of the opening of the fishery depends on the spawning period of the cuttlefish. In the Oman Sea, fishers can fish during the non-spawning season, in waters of >70m depth and during the SW-monsoon season. Only 18 commercial vessels are active in this period, which lasts for around 4 months.

Australia

In Australia, the giant cuttlefish (*Sepia apama*) is common along all but the northern coast. The South Australian Research and Development Institute (SARDI) undertakes annual population surveys, using divers to count cuttlefish and estimate specimen size at 10 sites around Point Lowly (South Australia) in May, June, and July, results of which are used to inform management. In June 2017, the population was estimated at 127 992, as compared to 2013's figure of 13 492. Current cuttlefish management in South Australia includes a permanent cephalopod fishing closure in False Bay and a closure for cuttlefish fishing in the northern Spencer Gulf until February 2018.

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5.2 Progress on ToR c)

ToR c) Update information on life history parameters including variability in these parameters. Define cephalopod habitat requirements

Summary of the review presented in Annex 11

Many scientific articles about commercially exploited cephalopod species in the ICES area were published over the last few years, although research effort has been unevenly distributed across different species and fields. Species which are important for both commercial fisheries and aquaculture have received most attention; those of importance only for fisheries were studied less, while species which are exploited mainly as by-catch were relatively poorly studied.

Published studies addressed biology, trophic relationships, spatial and temporal distribution, and the impact of environmental factors on stocks. Studies of particular societal relevance include those on the potential role of cephalopods as intermediate hosts of parasites dangerous for humans, and the accumulation of contaminants in the tissues of molluscs actively exploited by fisheries.

Several knowledge gaps were identified. For *O. vulgaris*, further studies are needed on environmental impacts on early life stages and the development of balanced diets for paralarvae. Additional studies on stock separation in *E. cirrhosa* and *E. moschata* are also required. Other important topics for future research on *E. cirrhosa* include spawning sites and early life stages, while further studies are needed on reproductive biology and stock status evaluation for *E. moschata.*

In *S. officinalis*, there remains a need for development of a simple and reliable tool for age estimation, and further studies are needed on contaminant accumulation and the impact of human-induced pollution on stocks. The systematic position of *S. elegans* remains unclear, and additional studies in this field are needed. Studies on cuttlefish stock status are essential in order to avoid potential overexploitation.

Important topics for future research in *L. vulgaris* and *L. forbesii* include development of identification keys and other methods allowing routine separation of these two species, investigations on trophic relationships and studies of environmental impact on both species. The problem of identification of *A. subulata* and *A. media* at species level is still extremely acute. This problem needs to be solved before any stock assessments can be carried out.

Further research on the systematic and ecological status of *I. coindetii* is needed, as well as trophic relationships and impacts of climate change. Data are lacking for *O. bartramii* although the species has been included in Russian studies on oceanic ommastrephids and there have been studies on the systematic status of North Atlantic and Pacific populations. Additional studies on *T. sagittatus* are needed in stock identification, reproductive biology and age estimation. Finally, for *T. eblanae*, important fields of future research include studies on stock separation, distribution and life history traits of populations.

5.3 Progress on ToR d)

ToR d) Evaluate the social and economic profile of the cephalopod fisheries, with emphasis on small scale fisheries and mechanisms that add value to cephalopod products (e.g. certification)

The European market is one of the most important markets in the world for cephalopods. European cephalopod landings were worth over 420 million euros at first sale in 2015 (Table 1). Cephalopods are especially important in southern Europe where more cephalopod species are consumed as part of the traditional diet and the small-scale fishing (SSF) industry targeting these species is of considerable social and economic importance.

The first economic assessment of European cephalopod fisheries (1994) focused on squid catching and highlighted its future potential. Most recently, Pita *et al.* (2015) reviewed governance and governability of octopus fishing in the EU. Several studies have examined specific fisheries, such as artisanal fishing for octopus in Northwest Spain (Rocha *et al.*, 2006) or the small directed squid fishery in the Moray Firth (Young *et al.*, 2006a, b; Hastie *et al.*, 2009; Smith, 2011).

The proposed new manuscript on socioeconomic aspects of European cephalopod fisheries exists in complete draft form and is expected to be submitted to a journal in 2018. This synthesis paper aims to summarise current knowledge about the human dimensions of cephalopods fisheries in Europe. At present, all cephalopod fisheries in Europe are excluded from quota regulations under the Common Fisheries Policy, and EU member states manage their cephalopods fisheries employing different input and output control measures. The level of participation of the fishing industry in the management of their activity varies and some management arrangements in place are tailored at the local level. The manuscript focuses on six European countries with important artisanal cephalopod fisheries. It describes and compares the status of these fisheries, their socioeconomic importance, the management arrangements in place, and the opportunities and challenges for the future of the cephalopods fisheries. Despite the increasing importance of cephalopods fisheries in Europe, few countries have collected detailed data on these artisanal fisheries.

A new INTERREG project, Cephs & Chefs (2017–2020), coordinated by the University of Galway in Ireland, will address the marketing of cephalopod products in Europe as well as looking at ways to ensure sustainability.

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Table 1. Fisheries in Greece, Italy, Portugal, Spain, France, UK and EU-28 (data for 2015).

	EU-28	France	Greece	Italy	Portugal	Spain	UK	% six countries in EU-28
Total landings of marine fish								
Quantity (thousand tonnes)	4,683.3	291.3	64.4	191.1	139.3	839.0	430.8	41.8%
Value (€ million)	6,943.7	841.3	225.2	895.3	237.1	1,953.9	848.0	72.0%
Average price (€/kg)	-	2,9	3,5	4,7	1,8	2,3	2,0	–
Total landings cephalopods (squids, cuttlefishes and octopuses)								
Quantity (tonnes)	100,109	18,525	5,047	17,070	7,434	39,117	8,296	95.5%
Value (€ million)	423.5	76.0	24.4	136.9	35.8	110.4	24.2	96.3%
Average price (€/kg)	-	4,1	4,8	8,0	4,8	2,8	2,9	–
% cephalopods / total landings (quantity)	2.1%	6.4%	7.8%	8.9%	5.3%	4.7%	1.9%	–
% cephalopods / total landings (value)	6.1%	9.0%	10.8%	15.3%	15.1%	5.7%	2.9%	–

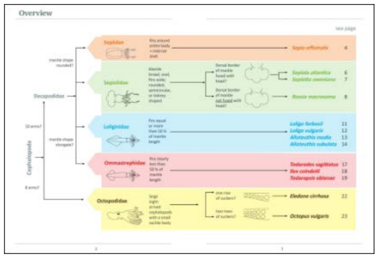
5.4 Progress on ToR e)

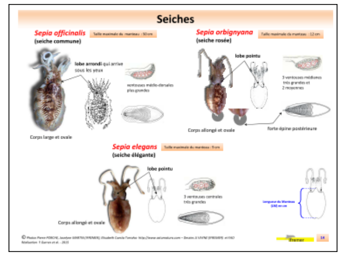
ToR e) Recommend tools for identification cephalopod species and update best practices for data collection

The background of this ToR is the need to identify cephalopods to species level in commercial catches and research surveys, so as to increase the quality of data available for assessing the status of cephalopod stocks. The main idea is to produce a cephalopod identification guide suitable or use on-board research and commercial vessels for different regions, to help with identification of the main commercial species in the survey or fishing area. The guide should be quick and easy to use without a large amount of text. The focus will be on easily used identification criteria, shown by pictures and drawings. We started this year to review and compile a table of existing cephalopod guides from the Atlantic region (see Annex 13), collecting information about what kind of guides the different countries use during the IBTS cruises. WGCEPH will stay in contact with the ICES IBTSWG, a potential user of the guides.

In addition, we discussed potential standards for the identification guides and the desired structure, which should include:

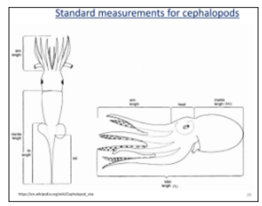
- A page to explain major identification criteria;
- A short overview (optimal length: one page) of the species which will be encountered within the region and their identification (at least to family level) (Figure 1a);
- A chapter for identification of the main species (optimally one family on each page); (Figure 1.b);
- A chapter of additional information (one page per species): detailed text for identification, distribution map, similar species, additional information about the species in the region: maximal length, weight, depth of occurrence (Figure 1c);
- Guidance on standard measurements (Figure 1d);
- Guidance on how to handle incomplete specimens and what to do if no time is available for identification (e.g. what should be photographed).





a. Overview page from Oesterwind *et al.* (In Prep)

b. Page for family identification (Garren *et al.*. 2015)



c. Additional information on species (Oesterwind *et al.* in prep)

d. guide to measurements from Laptikhovski & Ourens, 2016), based on FAO guide

Figure 1. Examples for different sections of the proposed guide(s).

There are still some open discussions:

1) The physical size of the identification guide: there is a trade-off between the number of species covered and convenient size. Guides are individually small, covering a few species, it is likely that several guides will be needed.

2) Copyright of photos and drawings: most of the available identification guides have compiled images from several sources, in some cases apparently using copyright-protected material.

3) Publishing format: e.g. book format (bound), compilation of individual ID sheets (laminated?), digital/online.

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6 Revisions to the work plan and justification

No specific revisions to the working plan are envisaged.

7 Next meetings

The WGCEPH 2018 meeting will be hosted by AZTI (Spain), San Sebastian, Spain, June 2018.

Annex 1: List of participants

Name	Type	Institution	Country	Email
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Annex 2: Recommendations

There were no recommendations from the 2017 WGCEPH meeting.

Annex 3: Annual landings of groups of cephalopod species (ToR A)

Table A.3.1.1. Landings (in tonnes) of Cuttlefish (Sepiidae) and Bobtail Squid (Sepiolidae).

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ICES Area 27.3.a	**2**	**6**	**18**	**21**	**29**	**58**	**50**	**37**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Denmark	2	6	18	21	29	58	50	37								
Germany																
Netherlands							0									
Sweden													0		0	0
ICES Area 27.4.a	**2**	**3**	**7**	**12**	**7**	**15**	**12**	**9**	**0**	**3**	**0**	**0**	**0**	**0**	**1**	**1**
Denmark	2	3	7	10	7	11	10	7								
England, Wales & N. Ireland													0		0	
France	0	0	0	1	0	4	2	2	0	3	0					
Germany																
Scotland				1			0	0							1	1
ICES Area 27.4.b	**13**	**31**	**43**	**43**	**16**	**22**	**26**	**16**	**2**	**4**	**1**	**2**	**0**	**1**	**2**	**3**
Belgium	12	12	4	4	1	1	2	4							1	1
Denmark	1	13	35	36	13	21	23	12								
England, Wales & N. Ireland	0	3	0	1	1		0	0				0	0	1	0	0
France	0	0	0						1	4	1	2	0	0	0	
Germany																
Netherlands	0	3	3	1	1	0	1	0	1						0	2
Scotland				1			0	0					0		0	0
ICES Area 27.4.c	273	728	415	557	305	424	282	286	132	234	34	48	117	38	224	284
Belgium		206	64	103	57	57	33	53							41	21
England, Wales & N. Ireland	5	4	2	2	3	3	3	2				7	3	5	11	10
France	173	184	135	120	103	77	84	108	77	89	34	41	114	33	82	61
Netherlands	95	333	214	330	141	287	161	123	55	145					90	192
Scotland				2	1		1	0								
ICES Area 27.5.b	0	0	0	5	2	0	0	0	0	0	0	0	0	0		
France				5	2									0		
ICES Areas 27.6.a,b	5	0	5	0	1	0	1	0	10	0	0	0	0	33	0	0
England, Wales & N. Ireland			0				0	0							0	0
France	0	0	4	0	1	0	1	0	10	0	0		0	33		0
Scotland	5						0	0					0			
Spain	0	0	0	0			0	0	0		0	0				
ICES Area 27.7.a	3	5	2	1	1	0	0	0	0	1	19	0	0	0	2	0
Belgium	2	5	1	1	1		0	0							0	0
England, Wales & N. Ireland	0	0	1				0	0	0	0	0		0		1	0
France	1	0	1	0	0	0	0	0	0	1	19	0	0	0		
Netherlands										0						

Table A.3.1.1. (Continued)

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ICES Areas 27.7.b,c	17	4	18	23	13	9	11	19	16	75	31	5	0	3	3	8
England, Wales & N. Ireland		0	0				0	0	4	1	0	1			0	1
France	0	1	14	13	1	0	2	0	1	2	2	3		3	3	7
Ireland									0	0	0					
Spain	17	3	5	10	12	9	9	19	11	73	29	1			0	0
ICES Areas 27.7.d,e	8515	14054	16046	18187	10938	12817	15295	9467	5117	9543	8266	12709	8507	6 086	11 939	10 257
Belgium	224	497	473	607	501	661	1331	801							642	824
Channel Islands	8	11	9	7	7	3										
England, Wales & N. Ireland	2608	3407	4581	4858	2821	3412	4279	3416	1525	2637	2037	5222	3 337	2 752	5 540	4 834
France	5672	10133	10970	12683	7582	8726	9663	5212	3555	6826	6229	7310	5 012	3 333	5 660	4 524
Ireland													4		7	36
Netherlands	3	6	13	32	28	15	12	31	37	81					90	38
Scotland							11	7				177	155			
ICES Area 27.7.f	44	35	87	116	47	30	59	43	8	13	17	46	22	13	52	22
Belgium	12	4	7	38	16	5	6	7							16	7
England, Wales & N. Ireland	7	19	39	28	11	8	12	6				9	8	3	15	8
France	25	12	41	50	20	17	41	30	8	13	17	37	13	10	21	7
Ireland													0			0
ICES Areas 27.7.g-k	93	113	350	211	197	189	143	170	974	1385	1920	530	22	866	1 312	664
Belgium	3	6	15	55	20	5	5	4							20	23
England, Wales & N. Ireland	80	102	325	135	153	166	129	143	238	386	746	105	1	286	478	198
France	3	5	7	19	20	18	9	22	736	999	1 173	402	13	576	799	433
Germany																
Ireland					3		0	1	0	0	1	22			5	2
Netherlands		0	1				0	0		1					0	
Scotland																
Spain	6	0	1	1	1		0		0	0	0	0	8	4	10	9
ICES Area 27.8	5328	3298	1495	6735	8214	4349	6189	2687	3914	3781	5585	6452	4594	3 958	4 975	4 899
Belgium	7	12	4	10	3		17	2							13	9
England, Wales & N. Ireland			29	18	19	1	0	0	0	0	0	0				0
France	4908	2978	1156	6173	7753	3954	5586	2227	3 666	3 508	5 158	5 693	4 147	3 690	4 667	4 512
Netherlands	38						0	0	0							
Portugal	10	6	18	40	32	37					24	23	24		8	6
Spain	365	302	288	494	407	357	586	458	248	273	403	735	423	268	288	373
ICES Area 27.9	2103	2182	2178	2403	2937	2912	2553	2388	2224	3173	2502	2143	2857	2 286	2 115	2 263
France															0	
Portugal	1338	1362	1186	1514	1825	1822	1517	1453	1259	2009	1511	1165	1 302	1 302	1 193	1 266
Spain	765	820	992	889	1112	1090	1036	935	965	1164	991	978	1 555	984	922	997
Total	**16397**	**20458**	**20666**	**28313**	**22706**	**20826**	**24621**	**15122**	**12397**	**18212**	**18376**	**21936**	**16119**	**13 284**	**20 625**	**18 400**

Table A.3.1.2. Landings (in tonnes) of Common Squid (includes *Loligo forbesii, L. Vulgaris* and *Alloteuthis subulata*).

Country	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
ICES Area 27.3.a	**7**	**0**	**0**	**1**	**5**	**3**	**10**	**0**	**0**	**3**	**1**	**2**	**4**	**4**	**1**	**8**	**3**
Denmark	7																
Sweden*	0			1	5	3	10						1	4		6	2
Germany*										3	0	0	1	0	1	2	0
Netherlands*				0	0	0	0				1	2	2	0			1
ICES Area 27.4.a	**553**	**351**	**690**	**1430**	**1444**	**346**	**677**	**878**	**677**	**1674**	**2109**	**0**	**685**	**541**	**1307**	**727**	**1459**
Denmark	3																
England, Wales & N. Ireland	3	2	1	1	1	1		13	0				12	5	17	1	5
France	0	0	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0
Germany*	0				1	0	1	1	2	0	1		1	1	1	3	2
Netherlands*			0											0		0	0
Scotland*	547	349	688	1428	1442	344	676	864	675	1674	2105		671	535	1289	723	1452
Sweden*														0		0	0
ICES Area 27.4.b	**156**	**155**	**343**	**596**	**593**	**435**	**293**	**381**	**115**	**19**	**63**	**37**	**90**	**145**	**138**	**285**	**186**
Belgium	24	3	14	22	16	8	17	20	4							35	20
Denmark	10																
England, Wales & N. Ireland	29	36	70	159	162	161	85	65	30				23	13	40	41	56
France			0	0	0	1	54	15	2	7	44	30	2	1	14	7	3
Germany*	3			58	33	23	13	21	8	7	8	7	5	1	10	14	16
Netherlands*	3	5	40	33	24	28	16	15	10	5	11			0			40
Scotland*	87	112	218	323	358	214	107	245	62				59	130	74	188	51
Sweden*														0		0	0
ICES Area 27.4.c	**897**	**401**	**910**	**555**	**328**	**200**	**160**	**186**	**329**	**499**	**179**	**96**	**57**	**50**	**662**	**156**	**591**
Belgium	121	20	40	17	12	10	9	7	10							15	11
England, Wales & N. Ireland	4	12	5	2	2	3	2	2	2					1	18	9	12
France	154	221	667	424	214	145	117	98	235	417	129	96	57	49	644	130	435
Germany*	2			4	4	1	1	0	0	0	0	0	0	0	0	2	1
Netherlands*	616	148	199	106	96	41	29	77	82	82	50			0			133
Scotland*				1		1	2	1	0					0	0	0	0
ICES Area 27.5.b	**2**	**0**	**0**	**5**	**2**	**0**	**0**	**2**	**10**	**8**	**27**	**0**	**0**	**0**	**26**	**20**	**0**
England, Wales & N. Ireland	0	0	0	0				0	0	5	15	0			0	0	0
Faroe Islands	0																
Scotland*	2			5	1			1	10	2	12				26	20	0
France	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0
ICES Area 27.6.a	**2304**	**2204**	**2232**	**2480**	**2356**	**2211**	**2143**	**2156**	**2165**	**2251**	**2434**	**2567**	**2119**	**2228**	**2161**	**157**	**124**
England, Wales & N. Ireland	2	3	3	14	4		1	2	1				3	4	2	0	1
France	51	9	28	24	25	85	28	38	29	60	55	44	19	40	23	18	10
Germany								0	4						0	10	0
Ireland*	38			63		49	20	29	15	34	41	57	26	19	13	10	8
Netherlands*	0								36		5	0		0		0	2
Scotland*	210	192	196	367	321	72	88	71	69	145	323	455	59	152	109	119	104
Spain	3	0	3	10	2			10	3	3	0	0		0	0	0	0

Table A.3.1.2. (Continued).

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ICES Area 27.6.b	**8**	**35**	**61**	**94**	**23**	**8**	**22**	**25**	**842**	**239**	**585**	**726**	**17**	**1**	**786**	**333**	**303**
England, Wales & N. Ireland	0	0	1	3				0	0					0	0	0	0
Ireland*	3			5		8	18	13	139			25	17	0	123	98	303
Scotland*	5	34	59	86	23		4	12	703	239	585	700			663	233	0
Spain	0		2									0	0	0	0	2	0
France	0	0	0	0	0	0	0	0	0	0		0		0	0	0	0
ICES Area 27.7.a	**52**	**130**	**170**	**127**	**62**	**37**	**15**	**16**	**18**	**25**	**19**	**54**	**32**	**47**	**14**	**2**	**4**
Belgium	3	2	9	2	1	3	1	1	1							0	0
England, Wales & N. Ireland	31	103	116	96	50	24	8	9	13	19	13	45	28	44	7	0	2
France	11	24	42	6	3	5	1	1	1	0	1	2	0	1	0	0	0
Ireland*	5		2	9		4	5	5	3	6	3	7	4	2	7	1	2
Isle of Man	0	1	0														
Netherlands*											1					0	0
Scotland*	2			13	8	1		0	0				0	0	0	0	0
ICES Area 27.7.b,c	**185**	**64**	**91**	**178**	**96**	**80**	**97**	**119**	**282**	**250**	**525**	**519**	**68**	**45**	**50**	**48**	**29**
England, Wales & N. Ireland	40	35	22	10	12	23	4	11	4	109	62	69	3	1	14	18	0
France	74	9	20	35	34	14	40	56	179	56	114	101	31	31	7	4	3
Ireland*	26	2	1	84		29	20	19	57	61	74	72	22	8	17	6	5
Netherlands*	0	0							13	0	0			1		0	0
Scotland*	27		19	14	19	2	14	7	1				3	0	8	14	13
Spain	17	18	29	35	31	12	19	26	28	23	276	277	9	4	4	6	8
ICES Area 27.7.d,e	**3585**	**2799**	**4205**	**5493**	**4720**	**3607**	**3665**	**3631**	**2772**	**3499**	**3311**	**2578**	**1818**	**2523**	**3108**	**3307**	**3492**
Belgium	254	22	59	72	54	36	46	106	76							213	185
Channel Islands	9	1	2	1			2										
England, Wales & N. Ireland*	449	439	553	435	481	321	273	369	313	295	253	371	353	431	863	773	564
France	2863	2318	3570	4926	4062	3139	3216	2960	2189	2 967	2 796	2 207	1 411	2037	2245	2321	2108
Netherlands*	10	20	20	59	123	111	128	196	195	237	262			1		0	635
Scotland*													54	54	0	0	0
ICES Area 27.7.f	**110**	**303**	**272**	**210**	**154**	**424**	**150**	**324**	**139**	**197**	**271**	**376**	**209**	**373**	**173**	**51**	**58**
Belgium	8	1	5	10	14	9	5	4	5		10					13	5
England, Wales & N. Ireland	16	55	114	56	17	172	29	141	17	94	75	158		143	87	5	8
France	86	248	153	145	123	243	116	179	117	103	187	218	209	201	86	33	45
Scotland														0	0	0	0
														29			
ICES Area 27.7.g-k	**481**	**256**	**235**	**308**	**232**	**323**	**164**	**154**	**198**	**297**	**242**	**419**	**486**	**511**	**565**	**451**	**138**
Belgium	5	3	8	7	6	6	3	6	4							1	3
England, Wales & N. Ireland	202	166	116	35	134	51	44	51	73				22	52	87	97	20
France	30	60	55	24	20	35	19	18	30	273	197	266	207	217	266	209	65
Germany*										1					0	10	0
Ireland*	67	12	37	164		172	52	75	84	20	21	152	181	102	128	15	9
Netherlands*	0	1	17				0	1	0	3	23	0		1		0	0
Scotland*	100			75	70	57	45	3	7				76	113	73	115	38
Spain	77	14	3	2	2	2		0	0	0	1	0		26	11	2	2
ICES Area 27.8	**1486**	**1480**	**1113**	**1183**	**1477**	**1287**	**1786**	**1812**	**312**	**1408**	**2657**	**2790**	**4971**	**1855**	**1865**	**2659**	**2157**
Belgium	48	0	2	1	1	1		2	1							1	0
England, Wales & N. Ireland	0			18	18	6		1	0	0	0	0	14	0	0	0	0
France	670	856	814	834	1076	913	1609	1362		1172	2103	2207	3666	1256	1618	2292	1980
Netherlands*		8	44							2	0		0	0		0	0
Portugal	1	1	1		9		1					4	18	29	0	0	0
Scotland*					1	61	12	0	0						0	0	0
Spain	767	614	253	330	372	306	164	447	311	234	554	579	1273	570	247	366	177
ICES Area 27.9	**1168**	**1741**	**1323**	**870**	**1710**	**1153**	**347**	**336**	**607**	**485**	**493**	**735**	**809**	**427**	**438**	**757**	**610**
France	42												0	0	0	0	0
Portugal	619	898	686	328	1129	601	92	128	360	199	207	395	408	226	203	414	301
Spain	507	843	637	542	581	552	255	209	247	286	286	340	401	201	235	343	309
ICES Area 27.10	**58**	**137**	**196**	**536**	**261**	**272**	**3**	**721**	**664**	**455**	**554**	**668**	**226**	**476**	**534**	**202**	**105**
Portugal	58	137	196	536	261	272	3	721	664	455	554	668	226	476	534	202	105
Total	**11054**	**10056**	**11842**	**14067**	**13462**	**10386**	**9531**	**10741**	**9132**	**11308**	**13469**	**11567**	**11591**	**9226**	**11827**	**9164**	**9261**

Table A.3.1.3. 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	2012	2013	2014	2015	2016
ICES Area 27.1+2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Norway								0	1								
France								0	0						0		
ICES Area 27.3.a	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Denmark					*												
Norway								0	1								
Sweden*																	0.5
ICES Area 27.4.a	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0	0
Germany*																	
Norway					4			0	1								
Scotland*								0	0								
ICES Area 27.4.b	0	0	0	0	0	0	0	0	0	0	2	11	0	0	7	0	0
Germany*																	
Netherlands*																	
France										0	2	11	0	0	7	0	
ICES Area 27.4.c	0	0	0	0	0	0	0	0	0	15	5	19	7	15	99	23	73
Germany*																	
Netherlands*																	
Scotland*								0	0								
France										15	5	19	7	15	99	23	73
ICES Area 27.5.a	1	0	0	0	1	0	0	0	7	0	0	0	0	0	0	0	0
Iceland	1	0	0		1			0	7								
ICES Area 27.5.b	0	0	0	16	0	1	0	0	41	0	0	0	0	0	0	0	0
Faroe Islands				16		1		0	41								
Scotland*								0	0	0	0	0					
ICES Area 27.6.a,b	0	1	12	45	1	3	15	1	264	2	10	1	1	9	0	2	8
England, Wales & N. 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	8	0	1	2	0	1	0
Ireland*				32		2	5	0	11	2	2	1	0	6	0		0
Scotland*								0	0								
Spain		0	11	0	0					0	0	0	0			0.6	8
ICES Area 27.7.a	0	0	0	6	0	7	0	0	1	0	0	0	0	5	0	0	0
England, Wales & N. Ireland				0				0	0	0	0	0					
France	0	0	0	0	0	0	0	0	0	0	0	0	0		0		
Ireland*	0			6		7		0	1	0	0	0		5			
Scotland*								0	0	0	0	0					

Table A.3.1.3. (Continued)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ICES Area 27.7.b,c	240	338	525	320	331	974	520	431	664	564	1478	1272	96	480	173	348	206
England, Wales & N. Ireland	35	19	25	16	26	1	1	1	0	0	0	0	0		4	19	18
France	28	11	27	61	20	14	46	9	34	9	16	9	10	107	64	104	45
Ireland*	29	75	63	27		8	15	1	2	14	49	6	6	18	2		0
Scotland*								0	0								
Spain	148	233	411	217	285	951	458	420	629	541	1413	1257	79	356	103	225	143
ICES Area 27.7.b,c	9	12	23	9	56	38	29	27	31	831	646	1152	344	1015	843	595	1280
England, Wales & N. Ireland*	0			1				0	0	0	0	0	0				0
France	3	4	8	2	19	13	10	9	10	277	215	384	114	338	281	198	426
Netherlands*																	
ICES Area 27.7.d,e	3	4	8	**3**	**19**	13	10	9	**10**	277	215	383.9	114.6	338.5	280.8	198.2	426.6
England, Wales & N. Ireland*	0			**1**				0	**0**	0	0	0	0.232				0.184
France	3	4	8	**2**	**19**	13	10	9	**10**	277	215	383.9	114.3	338.5	280.8	198.2	426.5
Netherlands*																	
ICES Area 27.7.d	0	0	0	0	0	0	0	0	0	0	0	0	0	249	249	198	404
Channel Islands																	
England, Wales & N. Ireland																	
France														249	249	198	404
ICES Area 27.7.e	0	0	0	0	0	0	0	0	0	0	0	0	0	89	32	0	23
Channel Islands																	
England, Wales & N. Ireland																0	0
France														89	32		23
ICES Area 27.7.g-k	946	573	323	171	103	94	83	72	32	106	97	71	73	354	802	1217	801
England, Wales & N. Ireland	151	173	144	85	66	18	9	17	7	0	0	0	21	7	43	46	40
France	2	1	1	2	2	5	0	0	4	100	75	53	40	260	162	316	166
Germany*											13						
Ireland*	83	60	91	49		19	4	12	16	1	1	13	12	87	10		0
Scotland*								0	0								
Spain	710	339	87	35	35	52	70	43	5	5	8	5			587	856	596
ICES Area 27.7.g-k	1556	957	844	611	629	910	441	350	537	722	1141	1656	4449	2015	2142	1048	2149
England, Wales & N. Ireland	0			0				0	0	0	0	0	0				
France	154	89	260	136	129	276	115	100	143	291	243	303	586	972	236	285	411
Portugal	2			1	5							1	79	252	10	0	0
Scotland*								0	0								
Spain	1400	868	584	474	495	634	326	251	395	430	898	1352	3784	791	1896	763	1738
ICES Area 27.8.a,b,d	172	101	351	98	136	315	127	141	196	190	124	289	133	984	282	323	531
England, Wales & N. Ireland															0		
France														963	234	282	404
Portugal														1	0		
Spain	172	101	351	98	136	315	127	141	196	190	124	289	133	20	48	42	127
ICES Area 27.8.c	530	462	373	377	359	319	199	180	219	240	756	1062	3651	1030	1860	724	1618
England, Wales & N. Ireland																	
France														9	2	3	8
Portugal														251	10		
Spain	530	462	373	377	359	319	199	180	219	240	756	1062	3651	771	1848	722	1611
ICES Area 27.9	2782	2365	797	556	952	573	206	108	509	347	740	805	876	721	1140	464	1047
Portugal	321	232	205	118	296	187	42	21	18	5	10	17	22	288	105	99	144
Spain	2461	2133	592	438	656	386	164	87	491	342	730	788	854	433	1035	365	903
Total	5535	4245	2524	1735	2077	2599	1294	989	2090	2588	4120	4988	5846	4614	5205	3696	5565

Table A.3.1.4. Landings (in tonnes) of Octopods (*Eledone* spp. and *Octopus vulgaris* mainly).

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ICES Area 27.3.a	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
Sweden*													1	1			2
ICES Area 27.4.a	15	6	1	11	5	2	1	3	3	0	0	0	1	2	0	4	9
Scotland	15	6	1	11	5	2	1	3	3				1	2		4	9
														0			
ICES Area 27.4.b	6	8	2	3	3	3	3	1	2	0	0	0	3	1	1	1	3
Belgium	5	6	2	2	2	2	2	1	2								0.62
England, Wales & N. Ireland	1	2	1	1	1	1	1	0	0				2	0	1	1	2
France												0				0	0
Netherlands		1	0	0		0	0	0									0.09
Scotland		0											1	0			0
														0			
ICES Area 27.4.c	1	1	3	1	0	0	0	1	0	0	0	0	0	0	0	2	0
Belgium	1	1	1	1				1	0								0.14
England, Wales & N. Ireland			0	0				0	0					0	0		
Netherlands		0	2	0	0	0	0	0	0	0	0						0.03
France																2	
ICES Area 27.6.a,b	1	0	0	2	2	0	0	0	2	0	0	0	5	2	0	5	12
Belgium								0	0								
England, Wales & N. Ireland				2	2			0	0	0	0	0					0
Ireland	1							0	2	0	0	0	4	0	0	4	0
Scotland	0												1	1			12
Spain				0	0			0	0	0		0	0	0		0	0
ICES Area 27.7.a	5	11	32	21	5	1	2	0	1	0	1	1	2	0	3	1	1
Belgium	5	11	31	20	5	1	2	0	1								0.05
England, Wales & N. Ireland		0	0	0				0	0	0	0	1	2	0	3	0	1
Ireland			1	1						0	1	0.1		0	0		0
France																0	0
ICES Area 27.7.b,c	60	304	745	443	357	424	409	407	384	499	647	993	18	642	38	19	60
England, Wales & N. Ireland	4	20	3	6	15	4	10	10	5	109	167	138	6	2	9		16
France	8	1	0	0		2	10					3	2	8	10	12	17
Ireland	4	5	1	6		1		0	0	1	17	21	0	1	2		1
Scotland		2		1				0	0				6			8	4
Spain	44	276	741	430	342	417	389	397	379	389	463	832	4	630	17		22
ICES Area 27.7.d,e	2035	2022	2031	2034	2020	2036	2036	2077	2102	2106	2134	2192	2262	2254	2122	2177	2213
Belgium		0	2	2	2	1	3	5	8								9
Channel Islands				3													
England, Wales & N. Ireland	22	15	20	21	14	21	21	65	86	97	108	174	248	235	101	153	182
France	13	5	7	5		9	6				14	7	0	1	7	9	7
Netherlands					0					0	2			0			0
Scotland													2	5			

Table A.3.1.4. (Continued)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ICES Area 27.7.d	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Belgium																	3
Channel Islands																	
England, Wales & N. Ireland																	0
France															0	0	1
Netherlands																	0
Scotland																	
ICES Area 27.7.e	0	0	0	0	0	0	0	0	0	0	0	0	2	241	108	162	193
Belgium																	6
Channel Islands																	
England, Wales & N. Ireland														235	101	153	181
France														1	7	9	6
Netherlands																	0
Scotland													2	5			
ICES Area 27.7.f	23	5	24	21	33	21	22	26	11	0	1	0	0	0	3	0	14
Belgium	13	1	9	13	24	10	16	20	9								11
England, Wales & N. Ireland	10	4	13	8	9	10	5	6	2						2		3
France						1	1			0	1	0	0	0	2	0	0
Spain			2														
ICES Area 27.7.g-k	656	305	294	174	154	221	169	195	148	33	71	79	152	238	266	149	215
Belgium	16	6	12	13	12	5	6	6	3								12
England, Wales & N. Ireland	78	105	141	99	113	131	103	137	104	30	58	52	68	13	94		66
France	32	19	18	11		17	13				11	4	9	181	31	37	47
Ireland	7	9	11	17		29	3	3	7	2	1	23	34	39	8		3
Scotland	5	10	1	6		7	8	12	31				40	5			6
Spain	518	156	111	28	29	32	36	37	3	1	1				133	112	81
ICES Area 27.8	1415	1407	1472	1289	2052	1788	1823	2366	1978	963	2366	2084	1718	1535	1471	1325	1405
Belgium	4	5	13	1	5	3	6	15	8								32
England, Wales & N. Ireland	0			1	29	8		0	0								
France	104	54	60	45	130	103	95	114	205		106	134	109	184	145	193	215
Netherlands		6															
Portugal	250	70	70	98	164	102	73					15	68	88	62	43	65
Spain	1057	1272	1329	1144	1724	1572	1649	2238	1765	963	2260	1935	1541	1263	1264	1090	1093
ICES Area 27.8.a,b,d	0	0	0	0	0	0	0	0	0	0	0	0	0	312	236	207	358
Belgium																	31.81
France														182	144	192	214
Portugal														0	0	0	0
Spain														130	92	15	113
ICES Area 27.8.c	0	0	0	0	0	0	0	0	0	0	0	0	0	1290	1235	1119	1047
England, Wales & N. Ireland																	
France														2	1	1	1
Portugal														155	62	43	65
Spain														1133	1172	1075	980
ICES Area 27.9	14224	9366	10224	12842	10571	15382	6532	10479	15994	10360	13527	9621	14501	18967	14004	8452	14961
Portugal	9019	7203	7288	10038	7784	11372	3368	8452	13258	7940	10471	7266	9654	13062	10728	5168	10503
Spain	5205	2163	2936	2804	2787	4010	3164	2027	2737	2421	3056	2355	4847	5905	3276	3283	4458
																1	
ICES Area 27.10	9	14	16	16	15	10	13	19	13	6	14	6	11	24	23	5	7
Portugal	9	14	16	16	15	10	13	19	13	6	14	6.2	11.3	24.2	23	5	7
Total	**18451**	**13448**	**14843**	**16857**	**15218**	**19888**	**11009**	**15574**	**20638**	**13968**	**18762**	**14976**	**18674**	**23665**	**17931**	**12139**	**18902**
* Data revised in WGCEPH 2014																	

Annex 4: ToR A) Working Document: Trends in long-finned squid (Loliginidae) resources

This WD presents the trends in unspecified loliginid landings between 2000 and 2016 by ICES Division/Sub-Area and country considerations concerning discards and fleets. Trends in landings, LPUE or CPUE and surveys by species/genus are analyzed in detail where available.

A.4.1 Fishery

Landings of unspecified loliginid landings between 2000 and 2016 by ICES Division/Sub-Area and country are presented in Annex 3, Table A.3.1.2. Catches of long-finned squid (Loliginidae) may be composed of *L. vulgaris*, *L. forbesii*, *A. subulata* and *A. media*. In the cases where no species identification of commercial catches was provided, catches are expected to be composed mostly of *Loligo* spp. Currently Loliginidae are not assessed at a regular basis and there is no TAC for the stocks.

Almost three quarters of north-eastern Atlantic loliginid landings come from three areas, the North Sea (Division 27.4, 10%), the English Channel (Division 27.7.d,e 37%) and Cantabria/Bay of Biscay (Sub-area 27.8, 20%) and in some years also from Galicia, Portuguese waters and the Gulf of Cadiz (Sub-area 27.9.a, 9%). There is a general stable trend since the year 2000, with two important peaks in 2003 and 2010 (Fig. A.4.1.1 and A4.1.2, see also Annex 3, Table A.3.1.2). In 2016, loliginid landings showed a slight increase, as a result of an increase in the northern areas combined with a decrease in the southern areas and in the Azores. Specifically, since the last peak (2010), landings in 2016 were above the mean in the North Sea and the English Channel, and below the mean elsewhere (Fig. A.4.1.2).

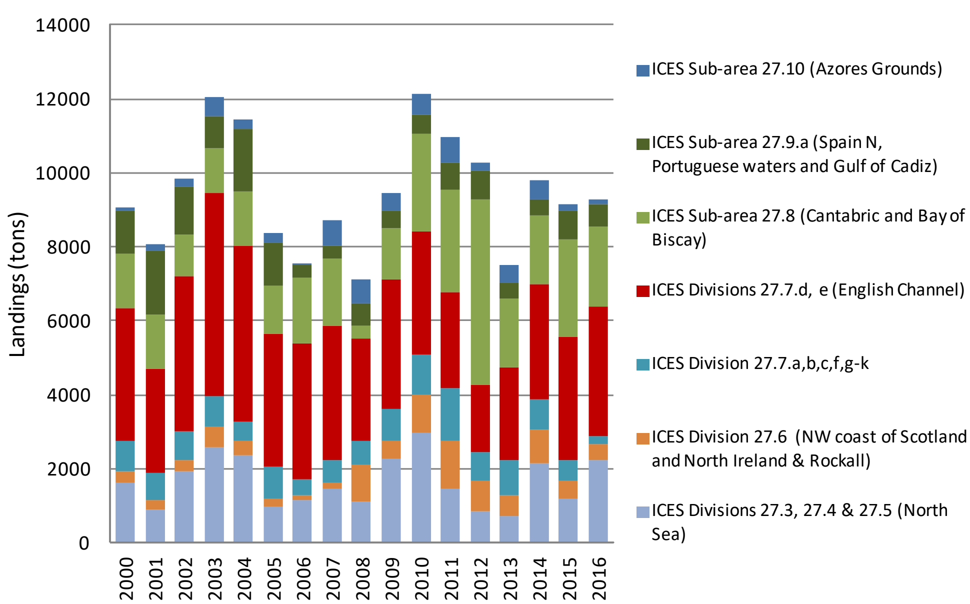


Figure A.4.1.1. Landings of loliginids by ICES areas and subareas between 2000 and 2016.

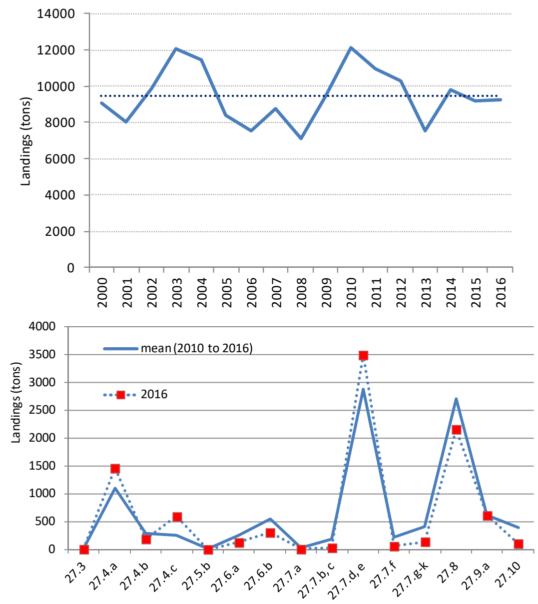


Figure A.4.1.2. Trends in total loliginid landings in the ICES area for the years 2000 to 2016 (left) and landings in 2016 by sub-area/Division compared with 2010–2016 mean (right).

A.4.1.1 Fishery in Division 27.4 (North Sea)

Provisional fisheries statistics indicate that catches in 2016 summed 2237 tons, which is a recovery to the 2014 landing level, after a drop in 2015. This increase was mainly observed in the northern (Division 27.4.a) and southern North Sea (Division 27.4.c). The fishing fleets exploiting this resource are unchanged, with Scottish vessels dominating in the north and central North Sea and French vessels in the south. However, in 2016 the Netherlands fleet reported a significant amount of landings of loliginids from the southern North Sea and some from the Central area (Fig. A.4.1.1.1). Discards are generally very low. In 2016, only 3.4 tons of loliginids were reported to have been discarded in the North Sea, and this was reported by England, France and Germany.

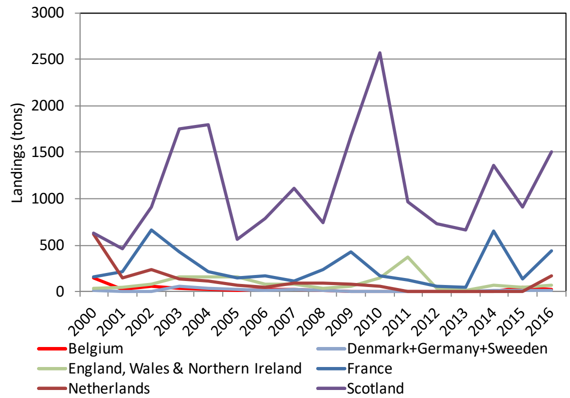


Figure A.4.1.1.1. Trends in loliginid landings in the North Sea (ICES Division 27.4a,b,c) area for the years 2000 to 2016 by national fleet.

A.4.1.2 Fishery in Subarea 27.7.d,e (English Channel)

English Channel squid production of 3492 tons in 2016 reflects a consistent increase, which has been observed since 2012. The fishing fleets exploiting this resource change in some years with significant contributions from the Netherlands equalling those of England, Wales & Northern Ireland in some years (e.g. 2010, 2016). Nevertheless, France dominates landings (Fig. 4.1.2.1). A total of 17.7 tons of loliginids were discarded in this area in 2016, as reported both by England and France.

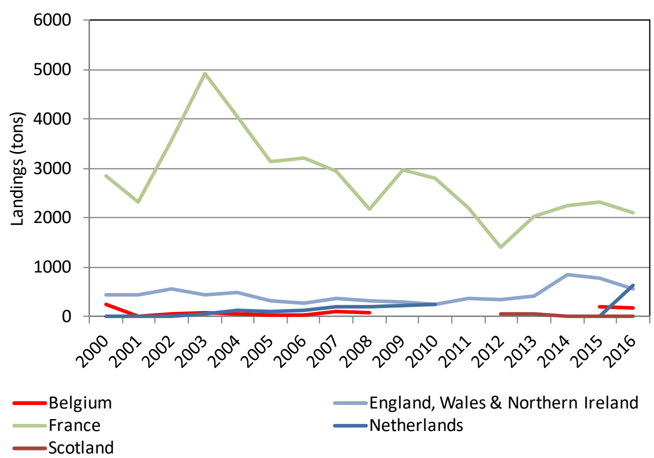


Figure A.4.1.2.1. Trends in loliginid landings in the English Channel (ICES Subarea 27.7.d,e) area for the years 2000 to 2016 by national fleet.

A.4.1.3 Fishery in Divisions 27.8.a,b,c,d (Cantabria/Bay of Biscay)

Catches in 2016 summed 2157 tons, which is a drop in relation to the 2015 landing level. This decrease was reported by both French and Spanish fleets. France dominates catches in divisions 27.8.a,b,d (ca. 95%) and Spain dominates catches in division 27.8.c (99%). Landings from other countries (Belgium, England, Wales & Northern Ireland, Netherlands, Portugal and Scotland) are generally residual (Fig. **A.4.1.3.1**). Loliginid discards from these divisions are important, with a total of 61 tons in 2016. Most discards in 2016 were reported by France in the divisions 27.8.a and 27.8.b.

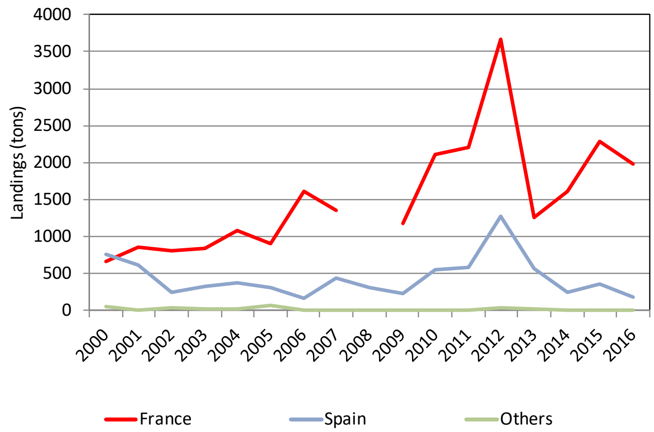


Figure A.4.1.3.1. Trends in loliginid landings in the Cantabria/Bay of Biscay (ICES Divisions 27.8.a,b,c,d) area for the years 2000 to 2016 by national fleet.

A.4.1.4 Fisheries in Subarea 27.9.a (Iberian waters)

Loliginid landings from Subarea 27.9.a decreased slightly in 2016 compared to 2015, to 610 tons. Landings have been at a low level since 2006, showing some oscillations and no significant trend. Catches in this area are taken mainly by Spain (ca. 60%) and Portugal (ca. 40%) and the landing pattern is similar. Because loliginids are captured mainly in the mixed trawl fisheries, these similar trends for the same area for two independent fleets/countries may be a good indication that the landings pattern reflects trends in abundance in area 27.9.a (Fig. **A.4.1.4.1.**).

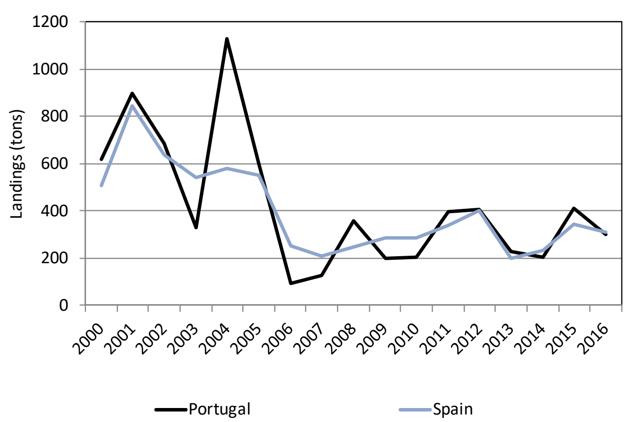


Figure A.4.1.4.1. Trends in loliginid landings in Iberian waters (ICES Subarea 27.9.a) for the years 2000 to 2016 by national fleet.

Loliginid landings include both *Loligo* sp. (ca. 80%) and *Alloteuthis* sp. (ca. 20%). *Loligo* spp. landings consist mainly of *L. vulgaris* (Annexes A.6 -Spain and A.7 -Portugal) as *L. forbesi* is currently very scarce in 27.9.a. *Loligo* spp and *Alloteuthis* spp landings appear separated in Spanish fishery statistics due to their high commercial importance. In Portuguese fishery statistics, *Alloteuthis* sp. and *A. subulata* landings started to be recorded separated from *Loligo* species only since 2008. It is worth mentioning that in the last few years *Alloteuthis africana* is also occasionally present in the Gulf of Cadiz (9a-South) landings, mixed with the other *Alloteuthis* species (Silva *et al.*, 2011).

There are important regional differences in the amount of *Loligo* and *Alloteuthis* landings within area 27.9.a. (Fig. A.4.1.4.2.). Both groups yield higher landings in the north of Portugal (9.a.c.n.) and in the Gulf of Cadiz (9.a.s.e). *Alloteuthis* landings are very low in Galiza (9.a.n) and absent in the Algarve (9.a.s.w). *Alloteuthis* landings from the region 9.a.c.s were important in some years, doubling those of *Loligo* in 2015.

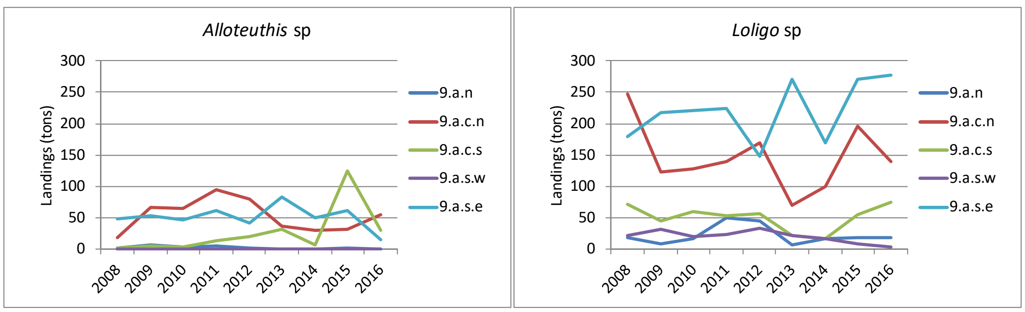


Figure A.4.1.4.2. *Loligo* and *Alloteuthis* landings in different regions of Subarea 27.9.a.

In 2016, Spain reported a total of 0.1 tons and 1.3 tons of *L. vulgaris* discarded in sub-areas 27.9.a.n and 27.9.a.s.e respectively. Portugal did not estimate discards of loliginids due to the low frequency of occurrence in sampling which hinders the estimations of total discards. Percentage of discards in Portuguese trawl fleets may vary from 2–25% in the OTB-CRU and 7–48% in the OTB-DEF. Percentage of discards in the Spanish OTB fleets may be quite high and variable (0–61%) in 27.9a.n. On the contrary % of discards of the Spanish OTB fleet in 27.9a.s.e are generally low (0–3%).

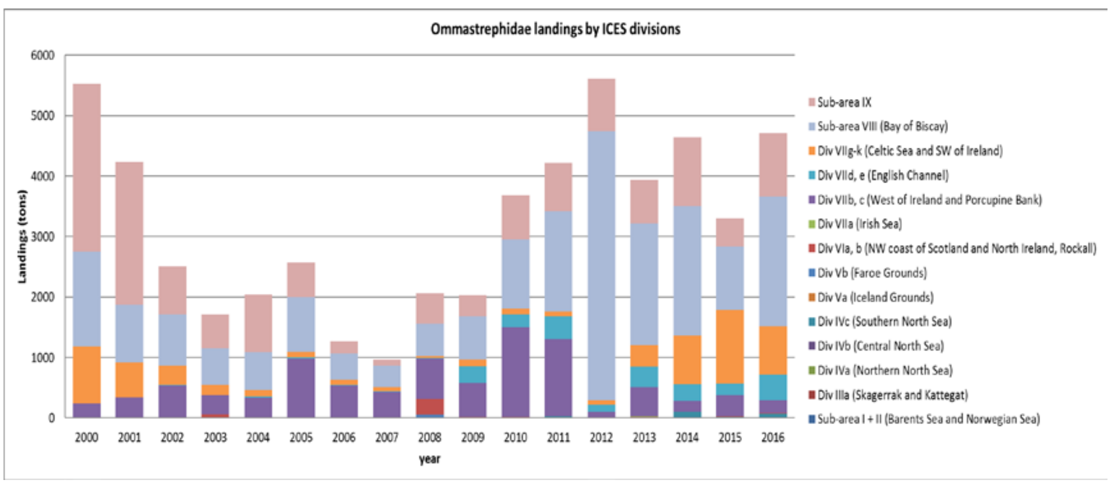
Annex 5: ToR A) Working Document: Trends in short-finned squid resources (Ommastrephidae)

Ommastrephidae in Subarea 2–7 and Divisions 8abd, 8c & 9a

A5.1. Fisheries

The short-finned squids of the family Ommastrephidae (broadtail shortfin squid *Illex coindetii*, lesser flying squid *Todaropsis eblanae*, European flying squid *Todarodes sagittatus* and neon flying squid *Ommastrephes bartramii*) and other less frequently captured families and species of decapod cephalopods are included in this document. All these species occur within the area that includes ICES Subarea 3 to Div. 9a, Mediterranean waters and the North African coast.

In FigureA5.1.1 landings of Ommastrephidae from all countries combined are presented by ICES divisions. Catches of this species group averaged around 3 200 t annually along the data series. There was a peak in 2012, mainly due to the high Spanish catches in Sub-area 8 and afterwards there are fluctuations in the time-series. In the last year, an increase of landings from Sub-area 8 was observed, mainly comprising Spanish catches.



FigureA5.1.1. Ommastrephidae landings from year 2000 to 2016 for all countries and ICES divisions.

For southern areas (Div. 8abd, 8c and 9a), the main countries exploiting these species are France, Spain and Portugal, with no catches recorded by England, Scotland or Ireland. In European waters, Ommastrephidae are usually exploited by trawlers in multispecies and mixed fisheries.

Catches of Ommastrephidae are thought to be composed mainly of *Illex coindetii, Todaropsis eblanae* and *Todarodes sagittatus*. However, no species identification has been provided for any country or area. WGCEPH reported on the species composition of ommastrephid squid in Galicia (NW Spain) in 2009 and 2010 (ICES 2009, 2010); No similar information for other areas or more up-to-date information for Galicia has been reported to WGCEPH.

A5.1.1. Fisheries in ICES Division 7abcdegk

Available commercial landings data indicate that between 300 and 1400 t are landed per year in area 7. Most of these landings were reported by Spain in 7b+c and 7g+k and by France in 7d+e and 7g+k. However, data from England, Scotland, Northern Ireland, Ireland, Wales, Netherland and Germany report undifferentiated landings of loliginids and ommastrephids. Therefore, it is questionable how useful these available landings data are.

A5.1.2. Fisheries in ICES Division 8abd

The countries contributing to ommastrephid catches in Division 8abd were France and Spain. In 2016, France landed 404 t of ommastrephids from Div. 8abd (76% of the catches of this group in this area), while Spanish landings amounted for 127 t (24%).

A5.1.3. Fisheries in ICES Division 8c & 9a

Overall, landings of ommastrephids amounted to 2 658 t caught by Spain and Portugal, 61% from ICES Div. 8c and around 39% from Div. 9a. Spain takes 99 % of the catches of these species in Div. 8c and 86% in Div. 9a.

A5.2. Survey

A5.2.1. ICES Division 4

CPUE per length class per area data from the IBTS quarter 1 were downloaded from ICES DATRAS (downloaded 8th of June 2017) and included data from DEN, FRA, GFR, NED, NOR, SCO, SWE and, for some years, ENG. Data were filtered for ommastrephids (incl. the following classifications: *Illex coindetii*, Ommastrephidae, *Todarodes*, *Todarodes sagittatus*, *Todadropsis eblanae*) and cpue per length class per area values were summed for each area. The quality of the data seems to be insufficient because in 2011 and 2012 some species were listed as 'teuthida' (and hence not included in the data preenting here), showing that problems with species identification occurred.

Based on the ICES DATRAS IBTS dataset, a trend analysis was performed on surveys carried out in the first quarter of the year. After a decrease in CPUE in 2011 the data show a strong increase in RFAs 1 and 2 and a smoother increase in RFA 3 and 7 within the last years. Stable but low CPUE values are observable in RFA 4 while in RFA 5 and 6 ommastrephid squid are very rare (Figure A5.2.1.1).

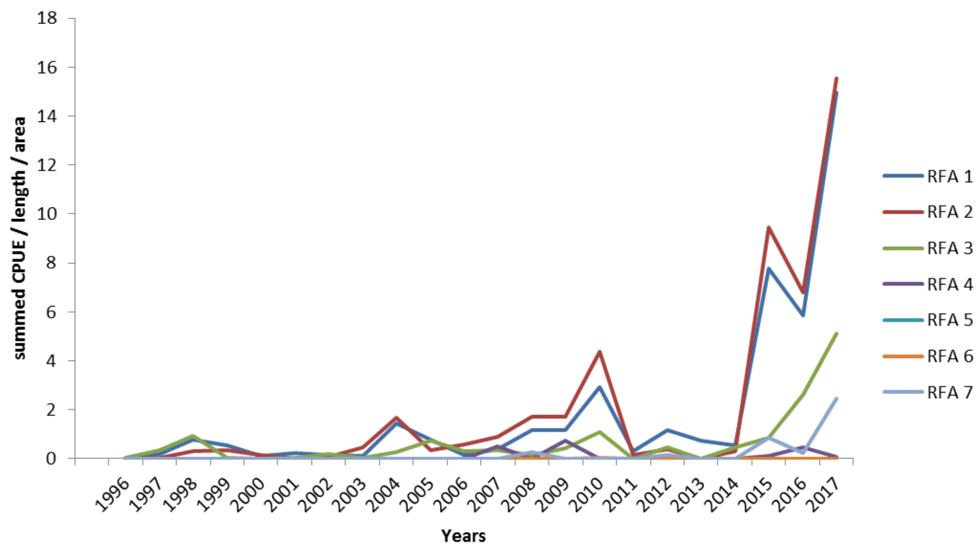


Figure A5.2.1.1.. Summed CPUE per length class per RFA (1–7) based on the ICES IBTS Q1 DATRAS database (download 8th of June 2017).

Based on the Cefas IBTS data (quarter 3 North Sea survey), average annual catch rates were extracted as well as standardized rates (based on a GAM that also accounted for spatial and day-of-year variation) (Figure A5.2.1.2).

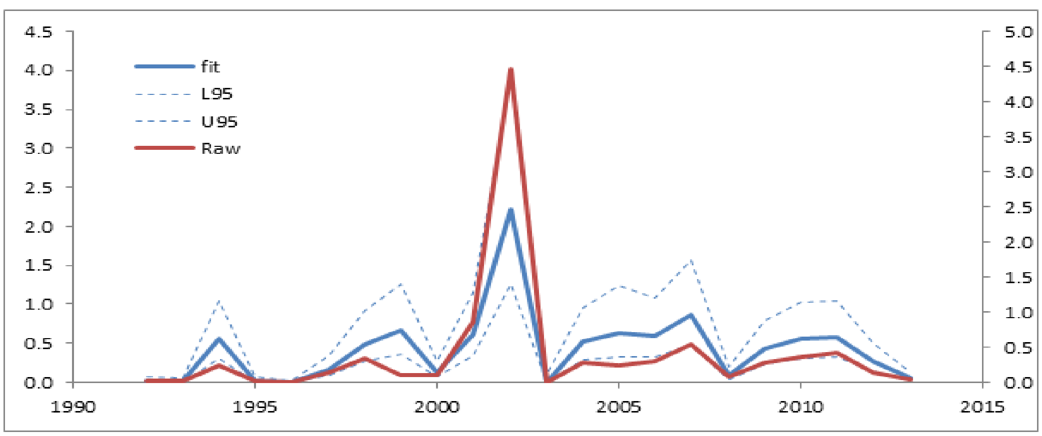


Figure A5.2.1.2. Ommastrephid squid caught per 30-minute haul in the Cefas IBTS3E survey): raw data (red, left axis) and standardized for effects of spatial and seasonal patterns (blue, right axis).

A5.2.2. ICES Division 7abcdegk

Cefas survey data permit some analysis of trends in area 7. The 7d beam trawl survey (BTS7D) and the northwest ground fish survey NWGFS caught too few ommastrephids to examine trends. Trends extracted from three other survey programmes look rather different but in all cases confidence limits are wide. Catch rates were low in Q1SWBEAM (quarter 1) but a general upward trend in ommastrephid catch rate was seen from 2006 to 2013. Catch rates in Q4IBTS (quarter 4) were also low, rising from 2003 to a peak in 2008 and then falling again to 2011. Catch rates in WCGFS were higher than in the other two survey series and suggested a general increase from 1982 to 1993 followed by a decline to 2004. These trends are illustrated below.

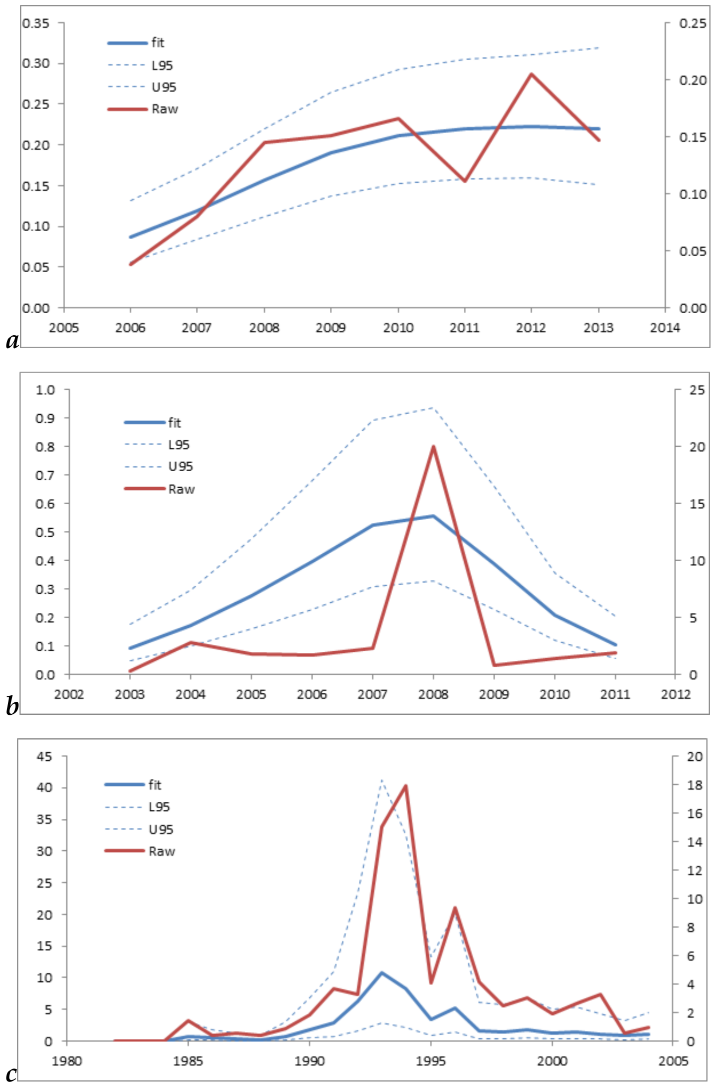


Figure A5.2.2.1. Trends in ommastrephid catch rates (numbers per 30-minute haul) in area 7 from Cefas surveys: (a) Q1SWBEAM, (b) Q4SWIBTS, (c) WCGFS. Each graph shows raw data (red, left axis) and standardized for effects of spatial and seasonal patterns (blue, right axis).

As for area 4, there are concerns about the lack of taxonomic resolution in the data. There are also concerns about the suitability of some of the trawl gears used and indeed doubts about the consistency of reporting.

A5.2.3. ICES Division 8ab

From the EVHOE survey, abundance indices for three species of Ommastrephids have been extracted: *Illex coindetii, Todaropsis eblanae* and *Todarodes sagittatus.* The time-series is from 1992 to 2016 and the area covered are Divisions 8ab. The abundance indices show fluctuating trends with a peak in year 2008 for both species *Illex coindetii* and *Todaropsis eblanae* (Figure A5.2.3.1)

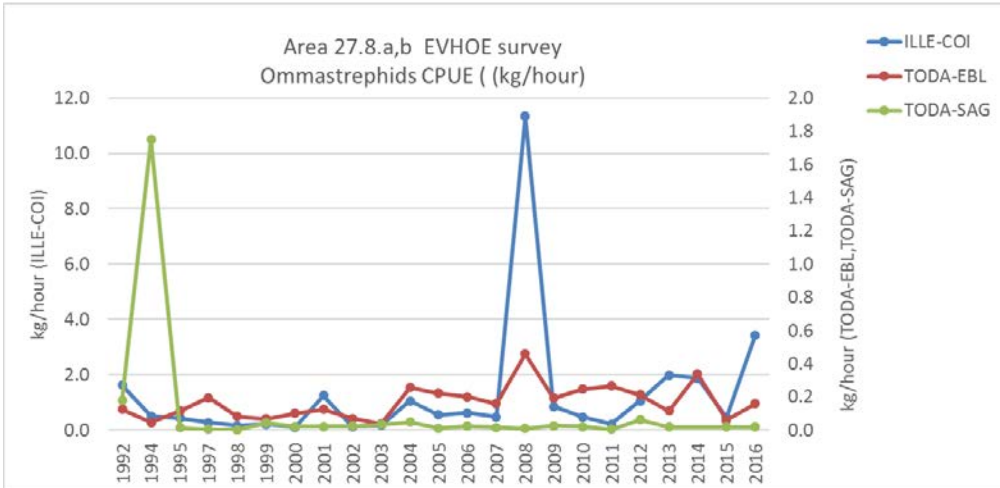


Figure 1.2.3.1 EVHOE survey CPUE for Ommastrephids selected species in Divisions 8ab. (Standardized values for a swept area per tow of 0.02 mi² (= 0.0686 km²)).

A5.2.4. Division 8c

The Northern Spanish Groundfish Survey (SPGFN) covered ICES Div. 8c and the Northern part of 9a corresponding to the Cantabrian Sea and off Galicia waters. Abundances of Ommastrephids in this survey are very low. They show fluctuations in the time-series and reach a maximum at around 5.6 kg per hour in 2015 (Figure A5.2.4.1).

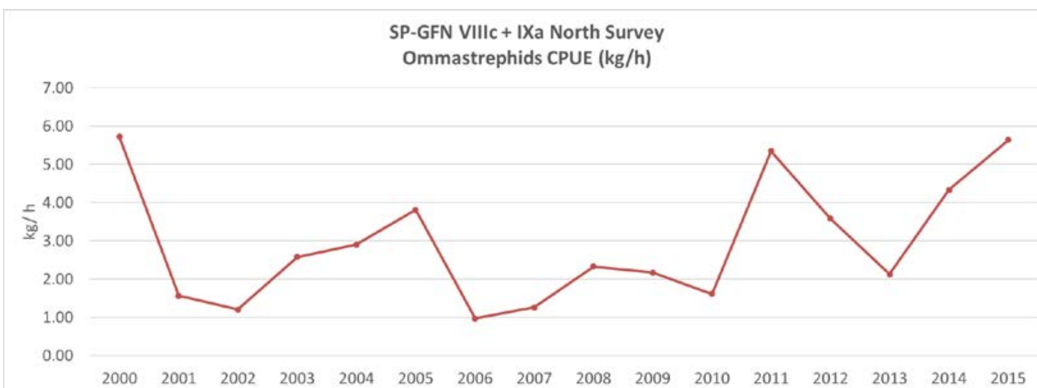


Figure 2. Abundance Indices (kg/h) of Ommastrephids of the Spanish Scientific Surveys in Division 8c & 9a North.

A5.2.5. ICES Division 9a

The South Spanish Groundfish Survey (ARSA/SPGFS) is conducted in the southern part of ICES Div. 9a, the Gulf of Cadiz. SPGFS aims to collect data on the distribution and relative abundance, and biological information of commercial fish and it is executed in November and March each year. Yields of some species of ommastrephids are compiled, for instance *Illex coindetii* and *Todaropsis eblanae*. For *Illex coindetii* there is a peak in 2001 reaching a maximum of 10 kg per hour in the March survey. A fluctuating trend in abundance is observed in the data series. For *Todaropsis eblanae*, the peak was observed in 2011 in the November survey and a fluctuating and decreasing trend has been observed in the most recent years (Figure A5.2.5.1).

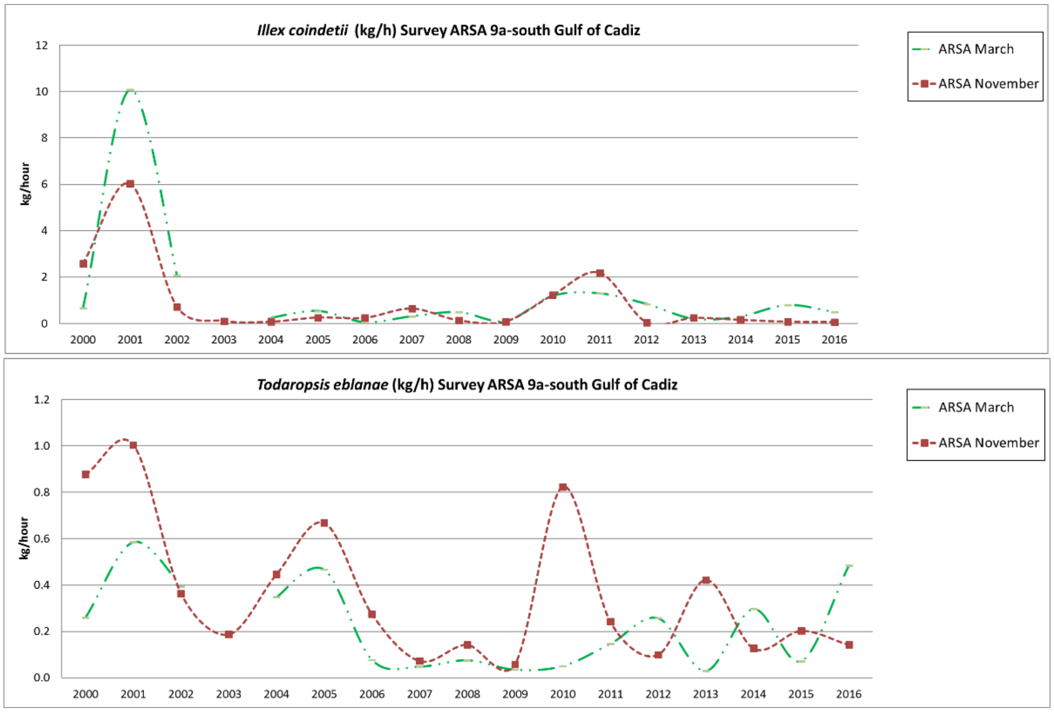


Figure A5.2.5.1. Abundance Indices for Ommastrephids, *Illex coindetii* (top) and *Todaropsis eblanae* (bottom) in (kg/h) in the Spanish Scientific Surveys in Divisions 9a South (Gulf of Cadiz).

Portugal provide data on Ommastrephids abundance by main species calculated in Portuguese Groundfish Survey for Div. 9a in Portuguese continental waters. *Illex coindetii, Todaropsis eblanae and Todarodes sagittatus* abundance indices are presented in Figure . *Illex coindetti* presents a peak in year 1986 but in the following years present a stable abundance index. *Todarodes sagittatus* and *Todaropsis eblanae* also show isolated peaks but they do not show any abundance trends.

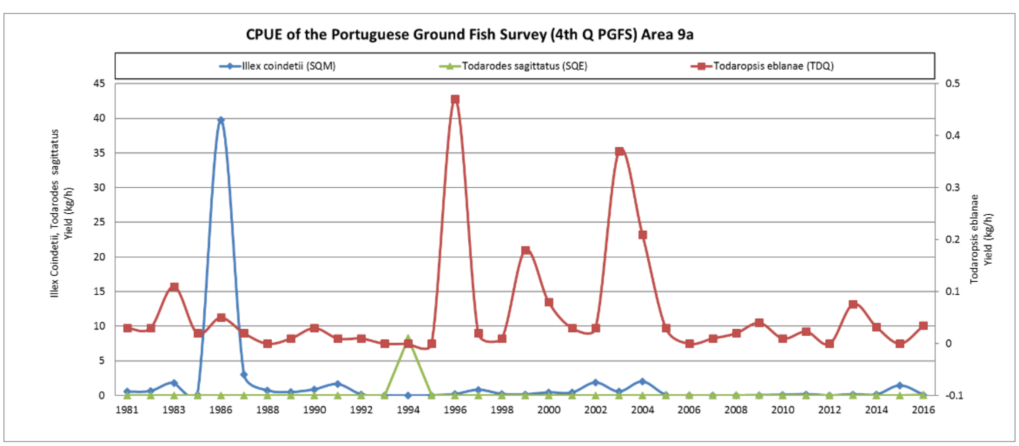


Figure A5.2.5.2. CPUE for the main species of Ommastrephidae in the Portuguese Ground Fish Survey from 1981 to 2016.

A5.3. Assessment/trends

A5.3.1. ICES Division 8abd

No assessment was attempted. Spanish Commercial LPUE and French EVHOE Survey abundance indices present conflicting trends. As Ommastrephidae are not among the target species for those fleets and, in particular, catches may not always be landed, the LPUE and CPUE values obtained could not be considered as abundance indices for this group of species.

A5.3.2. ICES Division 8c & 9a

Variation in abundance indices from Spanish commercial and survey series showed some correspondence. Thus, high abundances were seen at the beginning of the data series in 2000, low abundance for most intermediate years and increasing abundance from around 2011 although with high fluctuations (Figure A5.3.2.1).

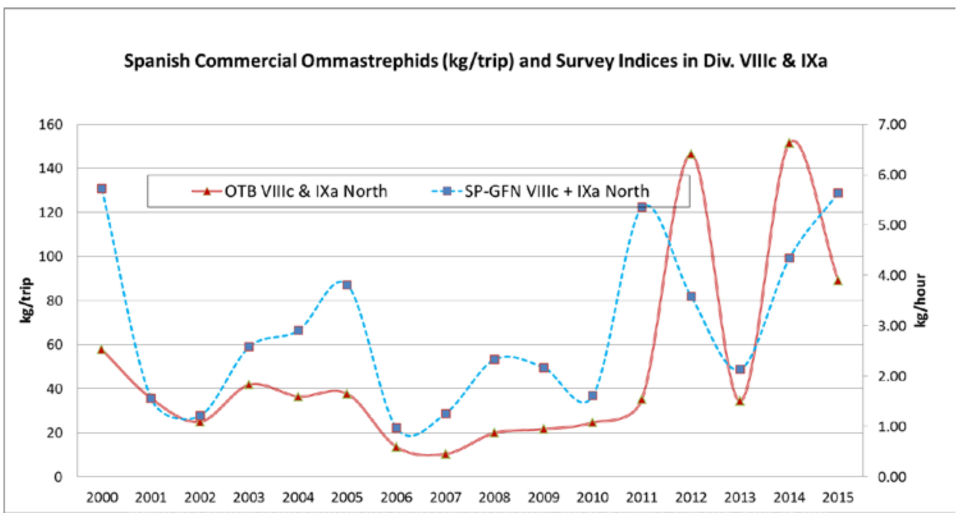


Figure A5.3.2.1. Comparison between commercial LPUE (kg/trip) and survey CPUE abundance Indices (kg/h), from the Spanish commercial fleet and scientific surveys in Divisions 8c & 9a North respectively.

The coincidence in trends of the indices obtained in the Spanish surveys has to be treated with some caution. A survey may generate a representative abundance index if it covers the whole area of distribution of the species and if the gear used and timing of survey were appropriate considering the characteristics and dynamics of the species. However, it has to be noted that at least 2 to 3 species are represented in these indices.

For Div. 9a south, commercial and survey data series provided by Spain again appear to coincide in trends and in peaks of abundance detected. However, the survey index did not show the marked high abundance seen in the commercial LPUE series in 2011. As commented above, for Div. 8c and 9a, high abundances were seen the first years (2000–2003) of the data series and in 2010–2012 (Figure A5.3.2.2). These promising results enhance the possibility of using these data series as abundance indices for ommastrephids.

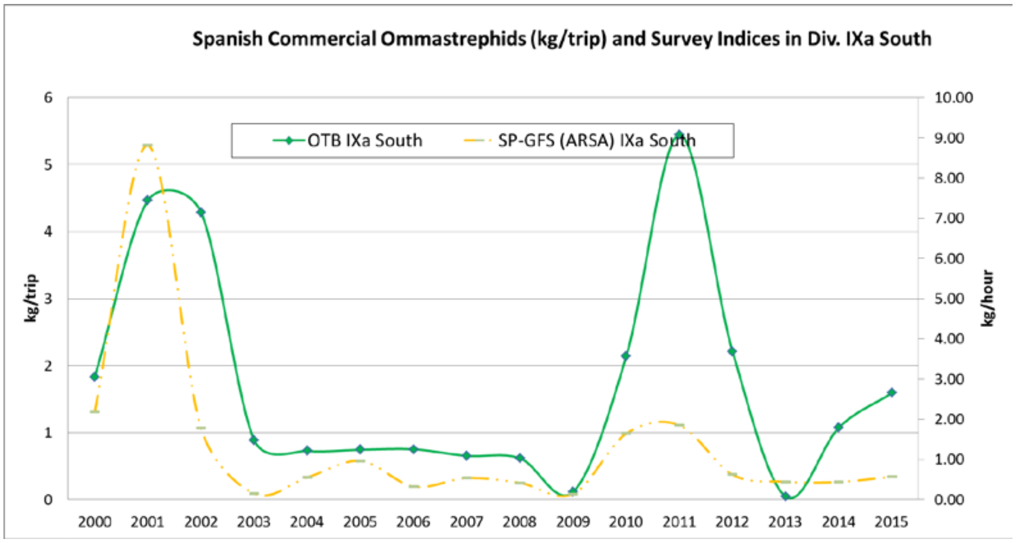


Figure 3. Comparison between LPUEs (kg/trip) and Abundance Indices (kg/h) trips of the Spanish commercial fleet and Scientific Surveys in Divisions 9a south.

A5.4 Conclusions

In some survey series (e.g. Cefas data), ommastrephids are occasionally identified to species and it is possible that ratios of the species could be estimated. More promisingly, landings of ommastrephids in Galicia (Spain) have been identified to species during market sampling.

However, despite there is an improvement, in general the lack of identification to species in both survey and commercial data is an ongoing problem.

Annex 6: ToR A) Working Document: Trends in Octopod resources (Octopodidae)

Octopodidae in Subarea 2, 4, 5, 6, 7, 8abd and Divisions 8c & 9a

A6.1 Fishery

Octopus (*Octopus vulgaris*), horned octopus (*Eledone cirrhosa*) and musky octopus (*Eledone moschata)* are included in this section. The first two species are distributed from ICES Subarea 3 to Div. 9a, Mediterranean waters and North African coast. *E. moschata* inhabits southern waters from Div. 9a towards the south.

Most of the catches recorded from Subareas 3 to 7 were taken by trawlers and are expected to comprise mainly of *E. cirrhosa* although catches are usually not identified to species. Only a small proportion of reported catches of Octopodidae derive from Subareas 3, 4, V and 6 (Figure 4.4.1.). Anecdotal evidence from Scotland indicates that *E. cirrhosa* is usually discarded; although its presence is confirmed by regular occurrence in small numbers in survey trawls (see MacLeod *et al.* 2014).

For more southern areas (Div. 8abd, 8c and 9a), the main countries exploiting these species are Spain, Portugal and France. These countries provide the greatest catches of octopods, with 61% reported by Portugal and 35% by Spain on average for the 2000–2016 period, mainly in Div. 8c and 9a. Species identification has been provided only for Spain and Portugal in Div. 8c and 9a. The annual average catches for the 2000–2016 period account for 14 898 t, with minimum in 2006 (9003 t) and maximum in 2008 (21 652 t); (Figure A6.1.1).

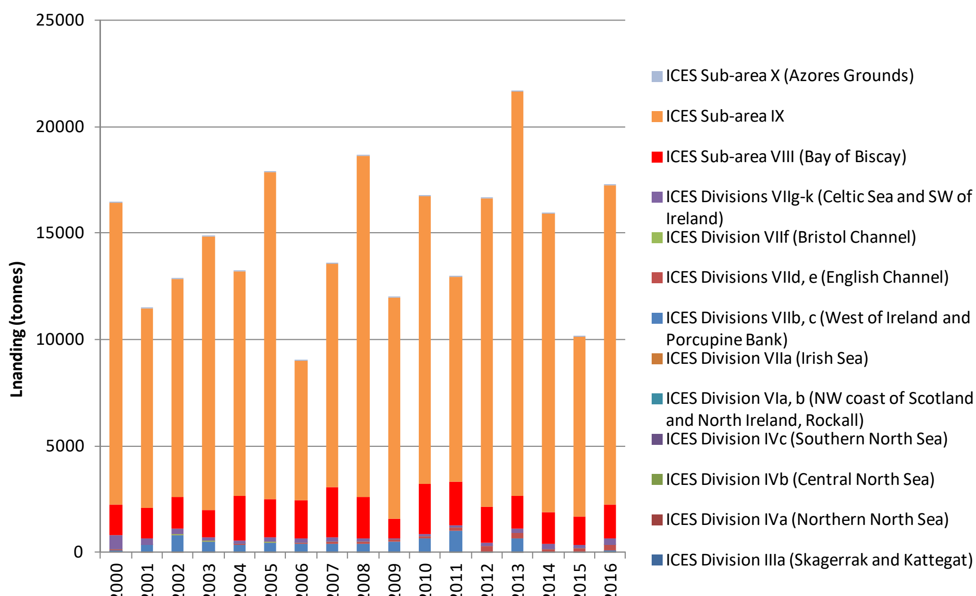


Figure A6.1.1. Octopodidae landings by ICES Division during 2000–2016.

A6.1.1. Fishery in Subarea 7

Catches in Div. 7d,e are almost all (99%) reported by England, Wales and Northern Ireland, with 93 t on average for the 2000–2016 period. French catches in these Divisions are minimal. Reported English catches of this group averaged around 19 t from 2000 to 2006 although they have subsequently increased, to a maximum of 248 t in 2012 with a similar amount in 2013. In the three last years, the catches were about 145 t.

Catches in ICES Divisions 7g-k (Celtic Sea and SW of Ireland) in 2013 were reported by England, Scotland, Ireland and France. Spain presented important catches of Octopodidae in the first years of the data series, but since 2008 catches decreased and no data were provided for 2011 and 2013. The annual average catches for the 2000–2016 period were 207 t. In 2015, only Spain and France reported catches, with 112 and 37 t, respectively. English catches (generally the largest amounts) averaged around 88 t annually, with a minimum of 13 t in 2013. In 2016, Spain reported the higher catch with 81 t, followed by England with 66 t and France with 47 t. The caught species was *Eledone cirrhosa* by trawlers.

Sweden, United Kingdom, The Netherlands, Germany and Ireland provided data in relation to discards, landings and effort in Subarea 3, 6 and 7 respectively for at least 2011 and 2013, and Belgium for 2016, only catches. Also for both areas survey data are provided. The Netherlands and Germany did not record any Octopodidae records in its waters.

A6.1.2. Fishery for Division 8a,b,d (Bay of Biscay)

In ICES Divisions 8a,b,d, catches of Octopodidae species are generally low. *E. cirrhosa* accounts for more than 95% of the total catches, although in the logbooks it appears as Octopodidae, which are not identified. These catches derive from otter trawlers, with 278 t on average in the last four years. The countries contributing to Octopodidae catches in Division 8abd were France and Spain, with 66% and 31%, respectively. The rest was accounted for by Belgium.

French landings of Octopodidae in Div. 8abd have followed a stable trend with an average of around 125 t in most years, although with peaks of 205 t in 2008 and 184 t in 2013. The Spanish commercial fleet operating in Division 8abd is mostly composed of vessels with base ports in the Basque country. For Spain, landings from Division 8abd varied from 2 t in 2009 to 300 t in 2007, reaching 130 t in 2013, and decreasing in the last two years.

No estimate of Octopodidae discards has been delivered to the group by France. AZTI-Tecnalia is responsible for monitoring cephalopod discards (monthly, by gear) in Div. 8abd for the Basque Country, thus covering around 95 % of the Spanish fleet operating in the Bay of Biscay. As was the case for landings by the Spanish fleet, Octopodidae discards appear to be highly variable, ranging from a minimum of 2% of catches in 2008, to a maximum of 74% in 2011.

LPUEs (kg per fishing trip) for the Basque country fleet were calculated for *O. vulgaris* and *E. cirrhosa* separately, pooling data for Bottom Otter trawl and Bottom Pair trawl. LPUE for *Octopus vulgaris* LPUEs were low during 2000–2012, never exceeding 2 k/trip (Figure A6.1.2.1.). In 2013 and 2014, LPUE increased to almost 30 kg/trip, returning to the low values in the two last years. Horned octopus LPUEs were generally higher than those for *O. vulgaris* (Figure A6.1.2.2.) and ranged from 0 kg per trip in 2008 to more than 230 kg per trip in 2013 (this peak corresponding to that seen in *O. vulgaris*), with a decreasing trend from 2014.

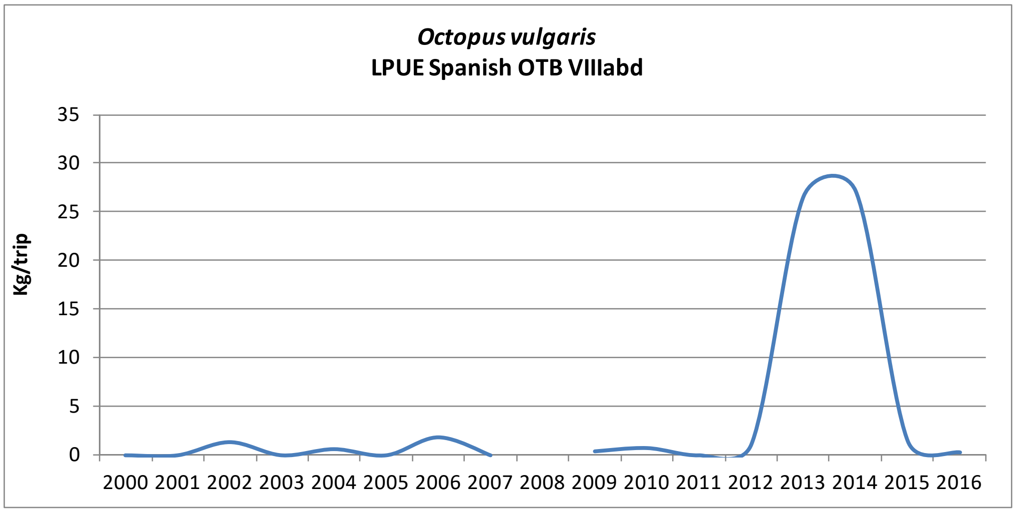


Figure A6.1.2.1. Commercial LPUE trends of the Spanish (kg/trip) OTB fleet in Div. 8abd for *O. vulgaris.*

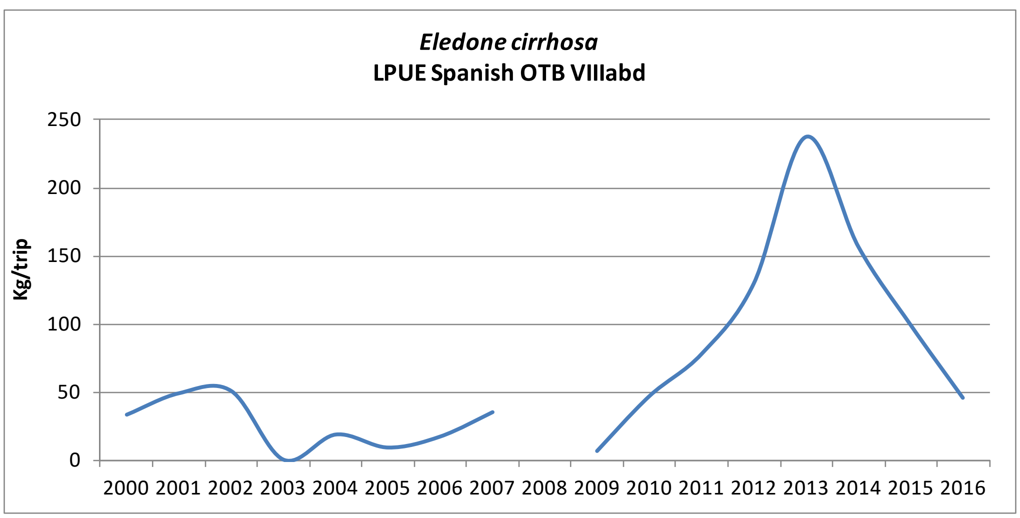


Figure A6.1.2.2. Commercial LPUE trends of the Spanish (kg/trip) OTB fleet in Div. 8abd for *Eledone cirrhosa.*

The recent high LPUE values for Octopodidae by Basque trawlers may reflect increased targeting of cephalopods. In 2009–2012, the metier targeting cephalopods (OTB_MCF) showed an increased number of trips and increased cephalopod catches. The increase in the OTB_MCF metier in 2103–2014 seems to be related to the decrease in the metier targeting demersal species like hake, megrim or anglerfish (OTB_DEF).

No data on Octopodidae from the survey taking place in Div. 8abd, FR-EVHOE were delivered to the group. No exploratory assessment was attempted due to the lack of French Survey data for Div. 8abd.

In Div. 8abd, the relative importance of the two main gears (Bottom Otter trawl and Bottom Pair trawl) changes along the data series (WD 2, in ICES WGCEPH Report 2016). It will be useful to analyse LPUE series from both gears separately and carry out a more detailed analysis based on metiers and species. It will also be useful to monitor the future importance of the cephalopod-targeting metier in the Basque trawl fleet, to see whether there has been a real shift in fishing strategies to increase targeting of species without TAC or Quota limits or if the situation during 2009–2013 simply represented a tactical response to high abundances of cephalopods.

A6.1.3. Fisheries in Division 8c & 9a

The catches in Division 9a account for 88% on average in the last four years of the time-series for all Subarea/Division, followed by Division 8c with 7%. The countries contributing to Octopodidae catches in Division 8c & 9a were Portugal and Spain, *Octopus vulgaris* being the main species caught.

In Spain, *O. vulgaris* is caught by artisanal and trawler fleets. In the Cantabrian Sea (Division 8c) and Galician waters (Subdivision 9a north), the artisanal fleet accounts for more than 98% of *O. vulgaris* landings, derived mostly from traps (see Annex 8). In Portuguese waters (Subdivision 9a-centre), a large percentage of *O. vulgaris* comes from the polyvalent (artisanal) fleet (91–97%), using a range of gears which includes gillnets, trammel nets, traps, pots and hooks lines (see Annex 9). In the Gulf of Cadiz (Sub-division 9a south), over most of the time-series the bottom-trawl fleet accounted for around 60% of the *O. vulgaris* catch on average and the remaining 40% is taken by the artisanal fleet using mainly clay pots and hand-jigs. In the last three years the proportion of catches attributed to the artisanal fleet increased to 77%, due possibly to tighter official control of landings (i.e. artisanal catches may not have changed but the proportion recorded in official statistics has increased).

Total landings of *O. vulgaris* in 2016 in Division 8c and 9a were 15 182 t (around 6000 t higher than in 2015), mainly by the artisanal fleet. Portugal contributed around 68 % of these landings (10400 t) from subdivision 9a-centre, and 98% corresponding to artisanal landings with zero discard (see Annex 9). Bottom trawling contributed significantly to landings only in Subdivision 9a-south, with 321 t and 1.6% of discard (5 t) (see Annex 8)

The available landings data for *O. vulgaris* in Spain covers sixteen years, from 2000 to 2015. In Portuguese waters (Subdivision 9a-center) the series starts in 2003. Total landings ranged from 6542 t in 2006 to 18967 t in 2013. The marked year to year changes in amounts landed (see Annex 8) may be related with environmental changes such as rainfall and discharges of rivers, as it was demonstrated in waters of the Gulf of Cádiz in subdivision 9a south (Sobrino *et al.*, 2002).

Data on commercial discards of *O. vulgaris* in Iberian waters are only available for bottom otter trawl metiers that operate in this area. The data were collected by the on-board sampling programme (EU-DCR) during last eight years. In 8c and 9a north the pair bottom trawler (PTB) metier is also sampled, although no *O. vulgaris* was discarded. In subdivision 9a south the estimated discards (5 t) were only 1.6% of the catch of the bottom trawl fleet in 2016. The sampling methods are described in WDa.3 (Spain) and WDa.4 (Portugal) of the WGCEPH 2012 report. Generally, amounts discarded were low or zero, possibly related with the high commercial value of this species (see also WD 2.4, WGCEPH 2014).

The two *Eledone* species are not separated in landings statistics but, except in the Gulf of Cadiz (Subdivision 9a south) where both *E. cirrhosa* with *E. moschata* are present, landings of *Eledone* will normally be *E. cirrhosa. E. cirrhosa* is caught by trawlers in both Divisions, mainly as a by-catch due its low commercial value. In Portuguese waters (Subdivision 9a centre), a small percentage (12%) is caught by artisanal vessels using a range of gears which includes gillnets, trammel nets, traps, pots and hooks (lines), classified under the polyvalent gear type group. Monthly landings of *E. cirrhosa* in 9a-centre show a marked seasonality, with much higher landings during spring months.

Total landings of *Eledone* spp in Div. 8c and 9a in 2016 were 703 tonnes, 103 in Portuguese waters (subdivision 9a centre) and 600 t in Spanish waters (8c and 9a north –south). The landings data for *Eledone* spp. in Spain cover 17 years, from 2000 to 2016. Annual landings ranged from 1333 t in 2000 to 460 t in 2008. Landings decreased from 2003 to 2008 in all areas, with a slight increase at the end of the time-series (mainly in 9a-south), with 1003 tonnes landed in 2015, but with a new decrease in 2016. Discards of horned octopus by Portuguese vessels seem to be low, although higher in OTB_DEF that in OTB_CRU, with about 30% (see Annex 9). In the case of Spanish vessels, discards from the OTB metier varied between areas and years but were always less than 20%, with lower values in subdivision 9a south than in 8c & 9a north. However, 100% of the PTB metier catch of *Eledone* was discarded (see Annex 8).

Fishing effort data are available for the Spanish OTB metier, in terms of numbers of fishing trips, in all areas of the Iberian waters. The LPUE series (*O. vulgaris* catches/fishing trip) for the OTB metier in the north (Division 8c and 9a north) and south (Div.9a-south) indicate a much higher LPUE in the south, and the trends are also different in the two areas (Figure A6.1.3.1.).

Portuguese LPUEs (catcher per day) are available for a shorter period but indices for trawl and polyvalent fleets show similarities, with peaks in 2010 and 2013 and the sharp decline from 2013 seen for Spanish trawlers in the south is also seen for Portuguese trawlers in 9a centre.

Figure A6.1.3.2 shows the trends in LPUE (*Eledone* spp./fishing trip) for the Spanish OTB metier in the north (8c, 9a-north) and south (9a-south). As was the case for *O. vulgaris*, both absolute values and trends differ between the two areas.

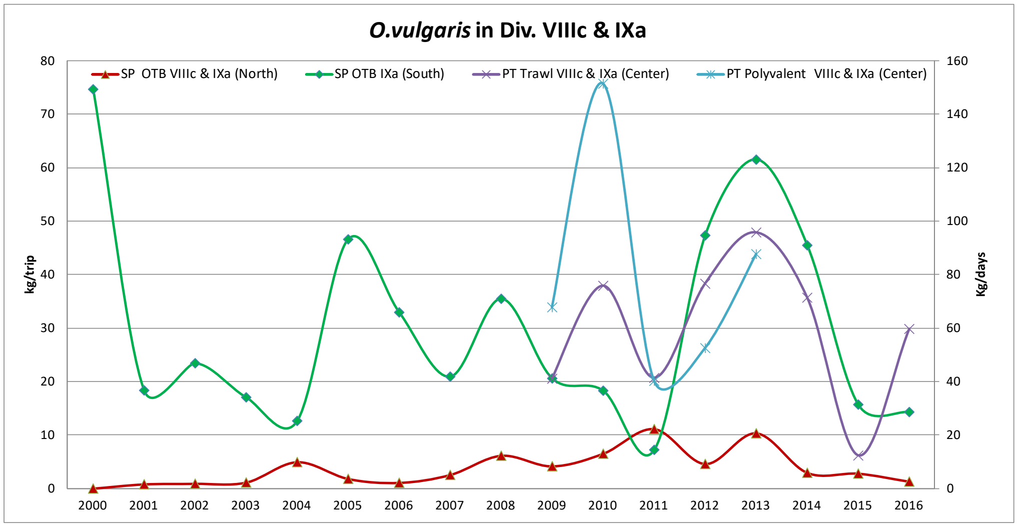


Figure A6.1.3.1. Commercial LPUE trends for *O. vulgaris*: Spanish trawlers (SP) bottom (kg/trip) in the north (8c, 9a north) and south (9a south), and Portuguese (PT) (kg/d) fleets in Div. 9a centre.

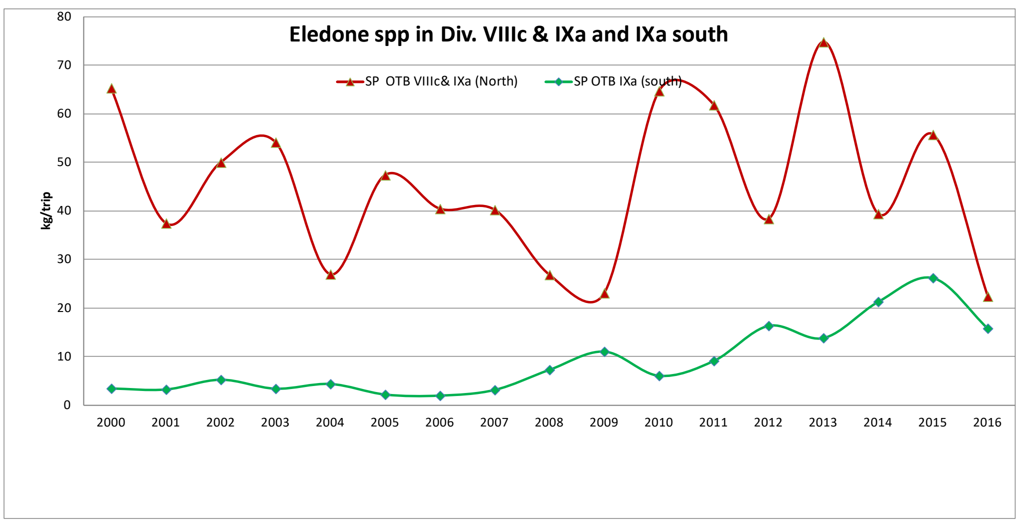


Figure A6.1.3.2. Commercial LPUE for *Eledone* spp.: trends for the Spanish (kg/trip) fleets in the north (8c, 9a north) and south (9a south).

A6.2. Surveys

Fishery-independent information was supplied for different surveys carried out annually in Iberian waters by Portugal and Spain: SP-NGPS "DEMERSALES" carried out in 8c and 9a north, PGFS in 9a-centre by Portugal and SP-GCGFS "ARSA" in 9a-south by Spain. The ARSA survey is carried out in spring and in autumn, and the mean values derived from both spring and autumn series are used in the Figures below.

The estimated yields (kg/hour) of *Octopus vulgaris* in Spanish DEMERSALES survey in the north during 2000–2106 (figure A6.2.1.) fluctuated widely, reaching a maximum values in 2012 (2.5 kg/h) but dropping to minimum (0.15 kg/h), in 2015. In the ARSA survey in the south, again strong fluctuations are evident, with a peak in 2013 (6.9 kg/h) in 2013 and a minimum of around 1 kg/h seen in six years in the series, most recently in 2014. In both series, an increase is detected in 2016. The information of the Portuguese survey is not relevant, with values lesser than 0.5 kg/hour. Only 203–2004 showed high values of around 2 kg/hour.

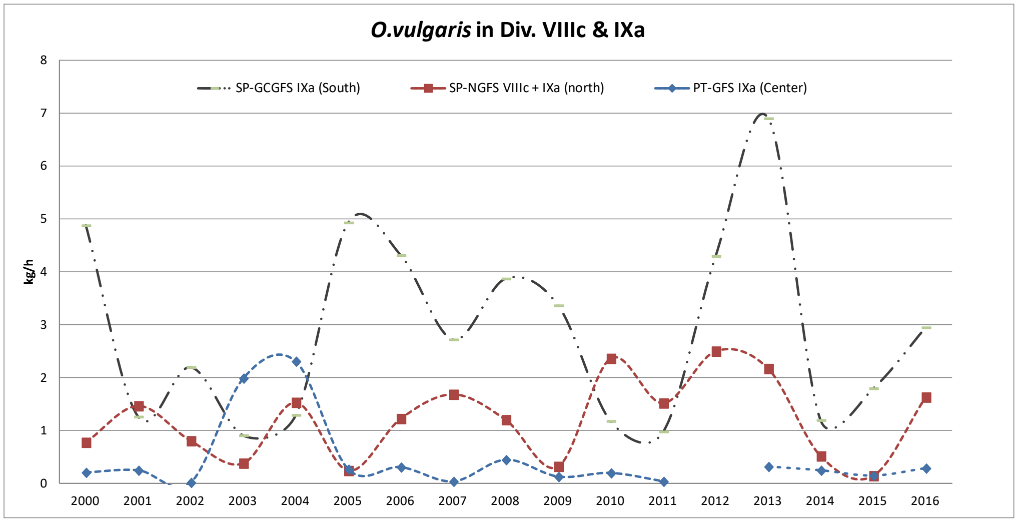


Figure A6.2.1. *Octopus vulgaris*. Abundance indices (Kg/h) of the Spanish (SP-GCGFS; SP-NGFS) scientific surveys in Div. 8c and 9a, and Portuguese survey (PT-GFS 9a center). 2000–2016 period.

The estimated yields (kg/hour) of *E. cirrhosa* in the DEMERSALES survey also fluctuated over the time-series with a sharp increase in 2013, tending to be slightly higher than values for *O. vulgaris* as shown in Figure A6.2.1 (above). In the ARSA survey, CPUE reached its highest value in 2015–2016 with around 4 kg/h (Figure A6.2.2), as compared to the peak of 8 kg/h seen in the DEMERSALES series in 2013. Generally, yields in both series (ARSA and DEMERSALES) ranged from 1–3 kg/h.

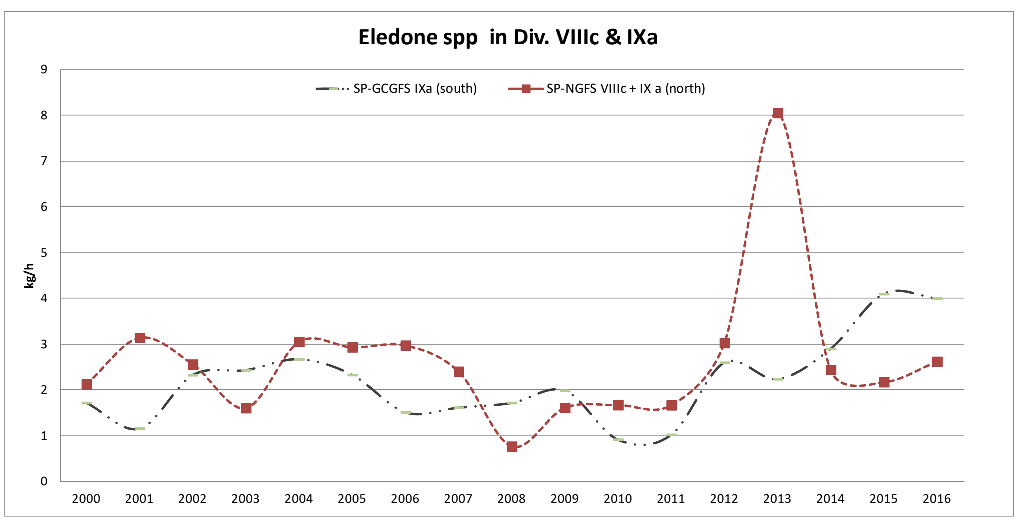


Figure A6.2.2. *Eledone* sp. Abundance indices (Kg/h) of the Spanish scientific survey in Div. 8c and 9a north and 9a south. 2000–2016 period.

A6.3. Assessment/trends

In order to evaluate the quality of the LPUE series as abundance indices, these have been plotted alongside with corresponding commercial fishing LPUE series for "Baca" Otter trawlers are used in the analysis. In all series, it should be noted that the fishing effort was not effort directed at catching *O. vulgaris* (or *Eledone*). The LPUE series in the north of Spain refers to 8c and 9a north together, since the "DEMERSALES" survey covers these two areas. In division 9a south, Gulf of Cádiz, the survey index used is the average value of the two survey carried out during the year in this area (Spring-Autumn).

Figure A6.3.1 shows the Spanish DEMERSALES and Portuguese survey biomass index for *O. vulgaris* plotted jointly with annual data series coming from the Spanish commercial bottom trawl fleet "Baca" (OTB) in 8c and 9a north and LPUE indices for Portuguese trawl and polyvalent gears. In this species the main similarities in the trends are the peak in 2010 (not evident in the Spanish survey) and a clear decrease from 2013 to 2015 in all series. Portuguese LPUE data show a similar trend along the short period represented. The Portuguese survey biomass indices also show a similar trend with the LPUE series in spite of the low obtained values. The abundance index series for *O. vulgaris* taken by the commercial fleet (OTB) and ARSA survey biomass index in Subdivision 9a south are shown in Figure A6.3.2. In this case, the trend of both sets of data show high similarities along the time-series.

The DEMERSALES survey biomass index for *E. cirrhosa* in 8c and 9a north is plotted alongside the annual CPUE series from commercial bottom trawl fleet "Baca" (OTB) in Figure A6.3.3. In this species can be observer some similarities in the trend of the series in same periods, the trends were opposite during 2001 to 2004 and 2010 to 2012. Both series show a strong peak in 2013 with similar trend at the end of the time-series. The ARSA survey biomass for *Eledone* spp and LPUE series of the otter bottom trawl fleet "Baca" (OTB metier) in subdivision 9a south are plotted together in Figure A6.3.4. The trends in both series are quite similar, especially since 2009.

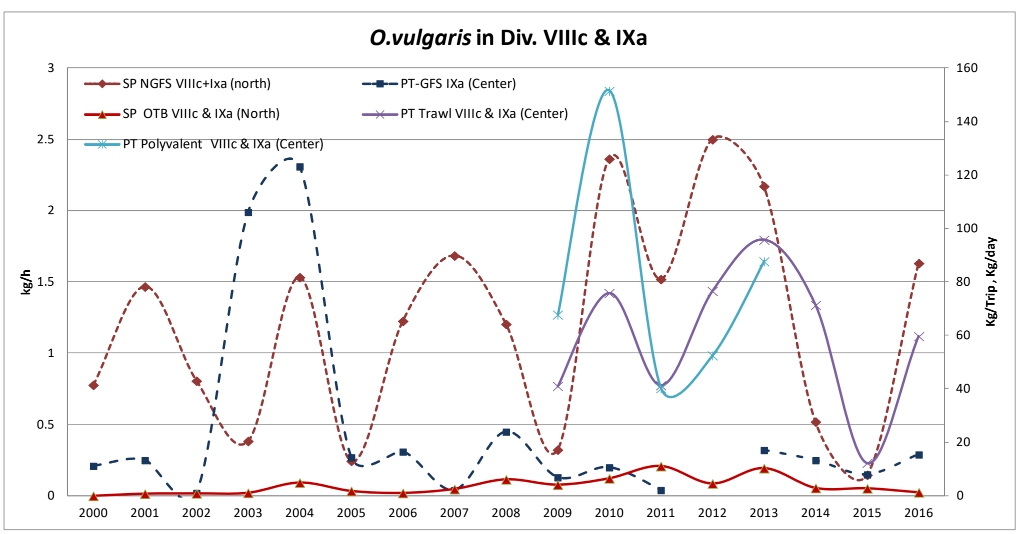


Figure A6.3.1. Comparison of commercial LPUE trends of the Spanish and Portuguese (kg/trip; kg/d) fleets and Spanish scientific survey (kg/h) in 8c, 9a north and 9a centre, for *Octopus vulgaris*.

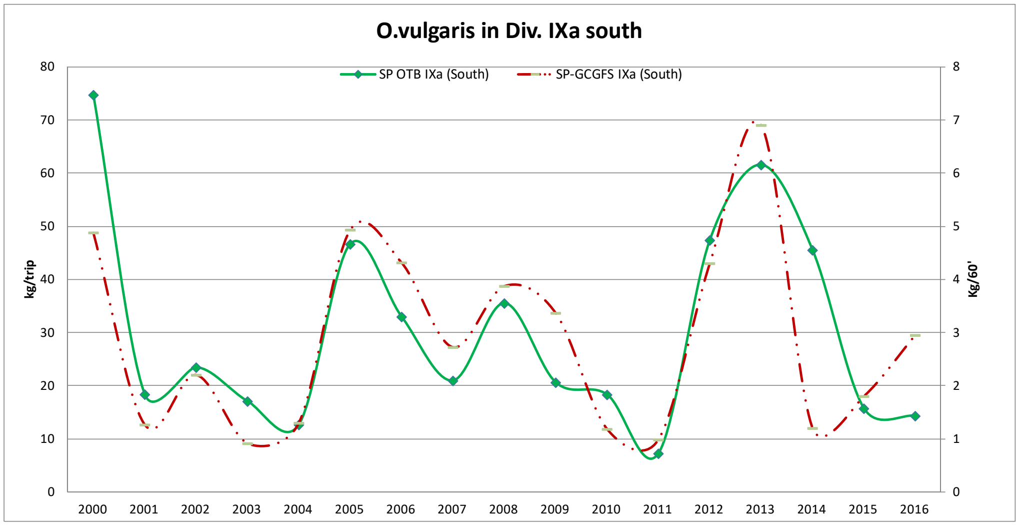


Figure A6.3.2. Comparison of commercial LPUE trends of the Spanish (kg/trip) fleets and Spanish scientific survey (kg/h) in Div. 9a south, for *Octopus vulgaris*, 2000–2016 period.

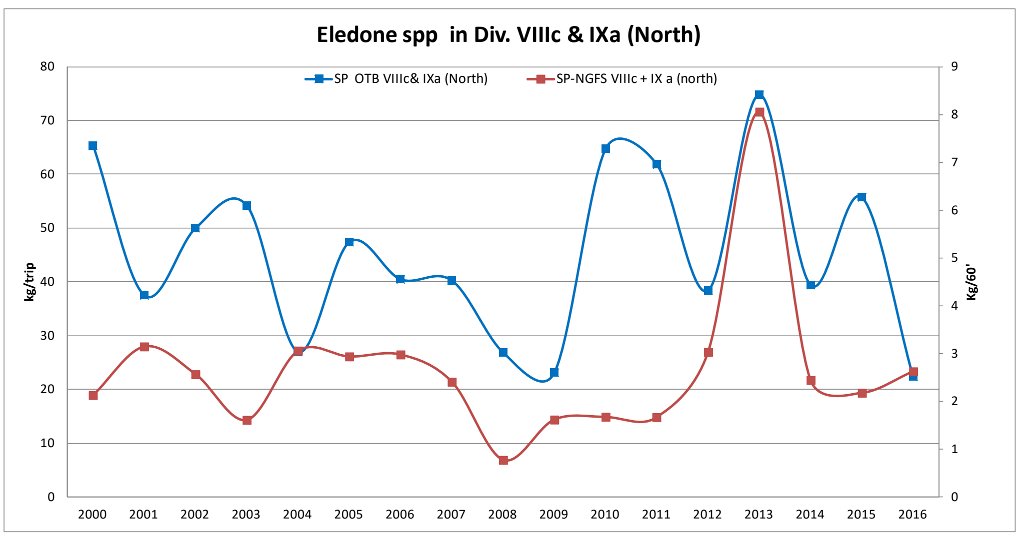


Figure A6.3.3. Comparison of commercial LPUE trends of the Spanish (kg/trip) fleets and Spanish scientific survey (kg/h) in 8c and 9a north for *Eledone* spp, 2000–2016 period.

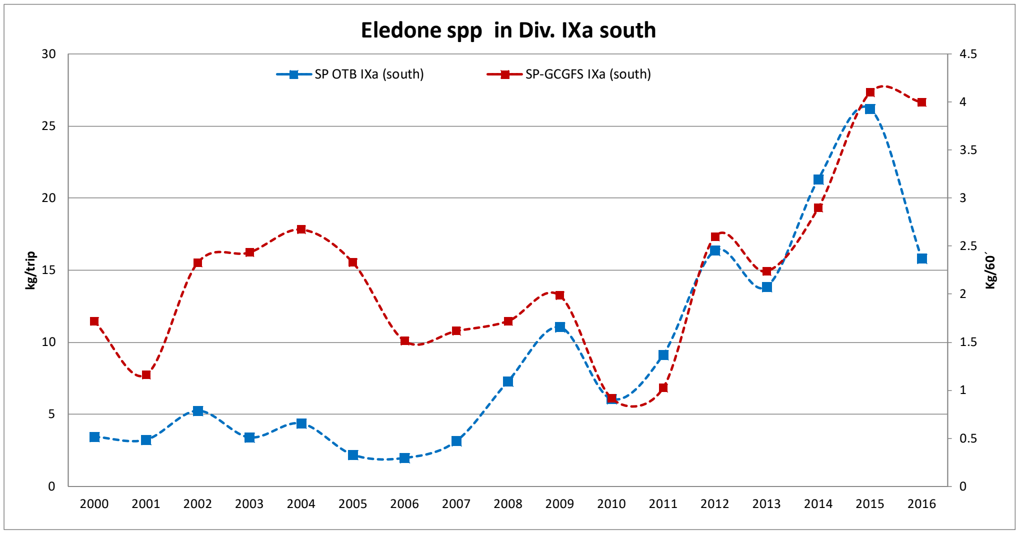


Figure A6.3.4. Comparison of commercial LPUE trends of the Spanish (kg/trip) fleets and Spanish scientific survey (kg/h) in Div. 9a-south for *Eledone* spp, 2000–2016 period.

Looking at the above figures, the correspondence of survey and commercial abundance series is much more apparent in 9a south than in the northern area, possibly because the northern area is much larger and encompasses a wider range of habitat conditions. Indices in the north may need to be refined, for example dividing the region into smaller areas. In any case, survey indices did capture peaks and troughs of octopod abundance at least in the most recent years of the years showed the marked high and low abundances shown by the commercial LPUEs series. Discards are negligible for *O. vulgaris* but more variable in *E. cirrhosa*, which needs to be considered when using commercial data. We can be cautiously optimistic that these data series can in future be used as abundance indices for octopods.

A6.3.1 Assessment of Octopus in the Gulf of Cadiz.

In relation with *Octopus vulgaris* in the Gulf of Cadiz, it has been analyzed the influence of environmental parameters on the abundance of this species (Annex 10). In the working document presented we have worked with different hydrography and oceanography parameters (Sea Surface Temperature; Sea Surface Salinity; Surface Chlorophyll; Surface turbidity; NAO Index; Rain; WeMoi Index; AMO index; River discharges and abundance index of octopus). We also used a recruitment index obtained during a demersal survey carry out in the zone to predict catches in the next year.

The main conclusions were that the abundance of octopus in the Gulf of Cadiz is influenced mainly by rain in the previous year and secondarily by the sea surface temperature in April of the previous year. The recruitment index obtained in autumn survey can be used to forecast the landing in the next year but this index is influenced by the number of stations fished within the recruitment zone.

The model to forecast the landings was

$$Landings_{i+1} = s(Recruit_i) + s(Rain_i) + as.factor(ZoneRecru_i)$$

When we applies the model with the data of 2016 (Recruitmnt Index in November and rain during October 2015 to July 2016), the model predicts 706 t for 2016–2017. In June of 2017 the total landing was about 750 t and the fisheries is close for spawning period until 15th June and will be close again in September and October for recruitment period. Probably the total landings for the period 2016–2017 will be about 800 t and the model had predicted 706 t.

Annex 7: ToR A) Working Document: Madeira Cephalopod fishery

Working Document for the ICES Working Group on Cephalopod Fisheries and Life History

Cephalopods Fisheries in Madeira Archipelago

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Summary

In the archipelago of Madeira, cephalopods are mainly captured by artisanal, subsistence and recreational fisheries, representing 2.4 % of the invertebrates' landings in the region. Cephalopods monthly landings show a strong seasonality being mostly landed during summer and earlier autumn months. The most landed species are the long-finned squids followed by flying squids and common octopus. Flying squids landing patterns coincide with skipjack which might indicate predation or simply a common environmental preference.

Introduction

Catches of Madeira Archipelago fisheries are mostly dominated by scabbardfish and tuna fisheries. Historically, cephalopods have been collected/fished for domestic consumption or as bait for the main fisheries. In fact, there is anecdotal information that the bigeye tuna (*Thunnus obesus*) follows schools of orangeback squid (*Sthenoteuthis pteropus*) in the region and fishermen take advantage of this migration event to capture bigeye.

In the period between 2006 and 2016, the fisheries for invertebrates represented approximately 1.8 % of total landings. Of the invertebrate landings, approximately 97 % are limpets and only 2.4 % are cephalopods, which are identified in the landing port as four species groups: common octopus (*Octopus vulgaris*), flying squids (*Ommastrephes bartramii*, *Sthenoteuthis pteropus* and *Todarodes sagittatus*), long-finned squids (*Loligo vulgaris* and *Loligo forbesii*) and cuttlefish (*Sepia officinalis*).

The aim of this report is to analyse the evolution of total landings and the landings proportion of the main species groups within the last 10 years, between 2006 and 2016.

Material & Methods

Cephalopod landings in weight (kg) recorded by the Fisheries Regional Directorate (DRP) landed between 2006 and 2016 in the Madeira Archipelago commercial ports were selected to determine mean monthly landings (kg) and landings proportion by month for common octopus, flying squids and long-finned squids.

Results and Conclusions

In the Madeira archipelago, cephalopods are mostly targeted by artisanal, subsistence and recreational fisheries, and also caught as by-catch of purse-seine fisheries targeting mackerel. Because cephalopods were traditionally used as bait, they are only occasionally landed at the first auction port, and landings data can only be indicative of the presence of the species in coastal waters of Madeira Island but not of its abundance.

Nevertheless, landings data collected between 2006 and 2016 show that long-finned squids are consistently the most landed cephalopods with landed weight ranging between 533.2 kg and 4488.3 kg, which corresponds to between 39 % and 88 % of total cephalopods landings per year (Figure A7.1). Flying squid landings were higher than long-finned squids only in 2009 and 2011, (Table A7.1).

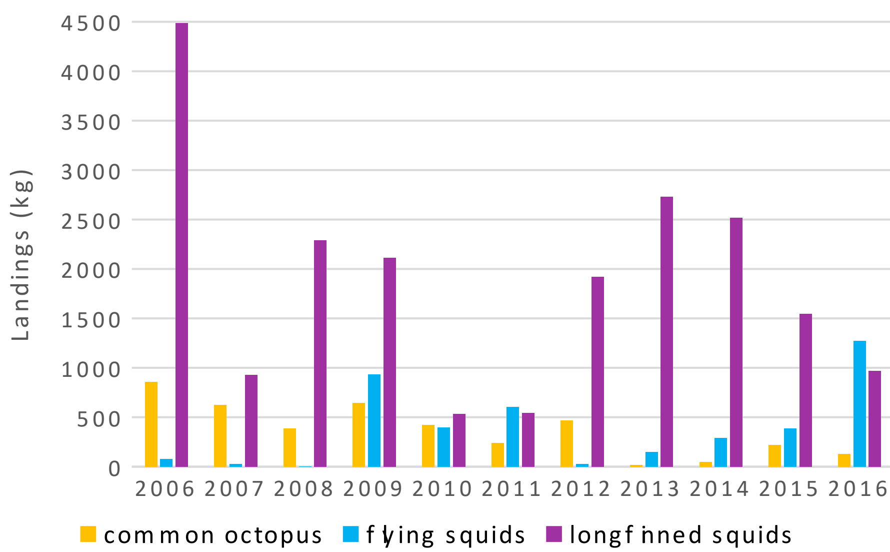

Figure A7.1 – Cephalopods annual landings in the Madeira Archipelago between 2006 and 2016.

Table A7.1 – Total landings (t) and cephalopods landings (kg and %) recorded in Madeira Archipelago between 2006 and 2016.

Year	Common octopus (kg and %)		Flying squids (kg and %)		long-finned squids (kg and %)		Cephalopods (kg)	Total landings (t)
2006	856.8	(15.80)	76	(1.40)	4488.3	(82.79)	5421.1	7748
2007	624.4	(39.55)	26	(1.65)	928.2	(58.80)	1578.6	7129
2008	388.6	(14.49)	3.7	(0.14)	2289.8	(85.37)	2682.1	6739
2009	647.4	(17.51)	935.6	(25.30)	2114.3	(57.18)	3697.3	6268
2010	423.8	(21.34)	395.4	(29.24)	533.2	(39.43)	1352.4	4683
2011	240.8	(17.31)	604.4	(43.44)	546.2	(39.26)	1391.4	4453
2012	468.8	(19.39)	29.4	(1.22)	1919.8	(79.40)	2418	5769
2013	16.5	(0.57)	149.5	(5.16)	2729.6	(94.27)	2895.6	4171
2014	47	(1.65)	290	(10.15)	2519.5	(88.20)	2856.5	7513
2015	221.8	(10.30)	384.7	(17.87)	1546.8	(71.83)	2153.3	5640
2016	127.4	(5.38)	1272.9	(53.78)	966.6	(40.84)	2366.9	5764

For the three species groups analysed, monthly landings show strong seasonality. In the case of common octopus, landings start to increase in April and have their peak in September and October (Figure A7.2a). However, the proportion of landings by month shows that the months with higher landings vary from year to year, occurring between March and October (Figure A7.3a).

Flying squids are almost exclusively captured between August and September (Figure A7.2b and A7.3b). The European flying squid *Todarodes sagittatus*, belonging to this group, is known to congregate and migrate to feed in the shelves around Madeira Islands which could explain the landings seasonality (Jereb and Roper, 2010). In fact, fisheries observers have reported the occurrence of *T. sagittatus* as by-catch of mackerel purse-seine fisheries in May of this year.

Long-finned squids are landed throughout the year with higher landings from June to October (Figure A7.2c and Figure A7.3c). These are target species in Madeira artisanal fisheries using hand-lines to capture this long-finned squid near shore, especially during summer months. Considering that at least one of the species, *Loligo forbesii,* shows migratory behaviour by gathering in shallow waters to breed (Jereb and Roper, 2010), we believe that an important proportion of the long-finned catches in the region belongs to this species.

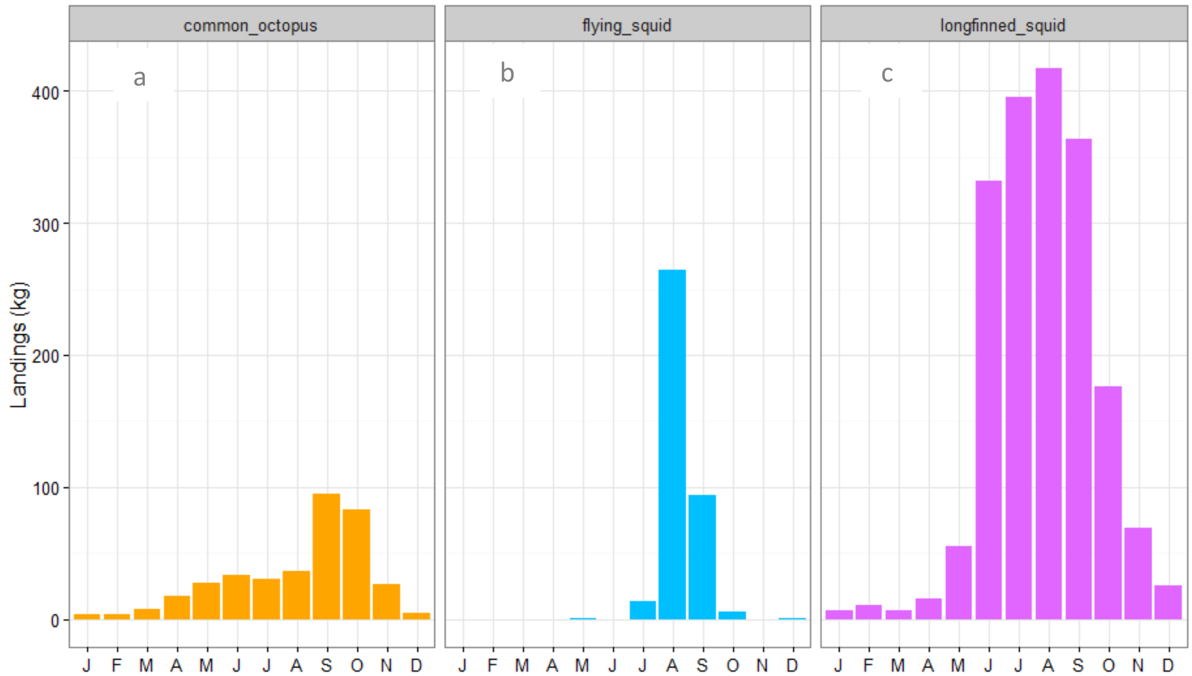

Figure A7.2 – Average monthly landings for common octopus, flying squid group and long-finned squid group between 2006 and 2016.

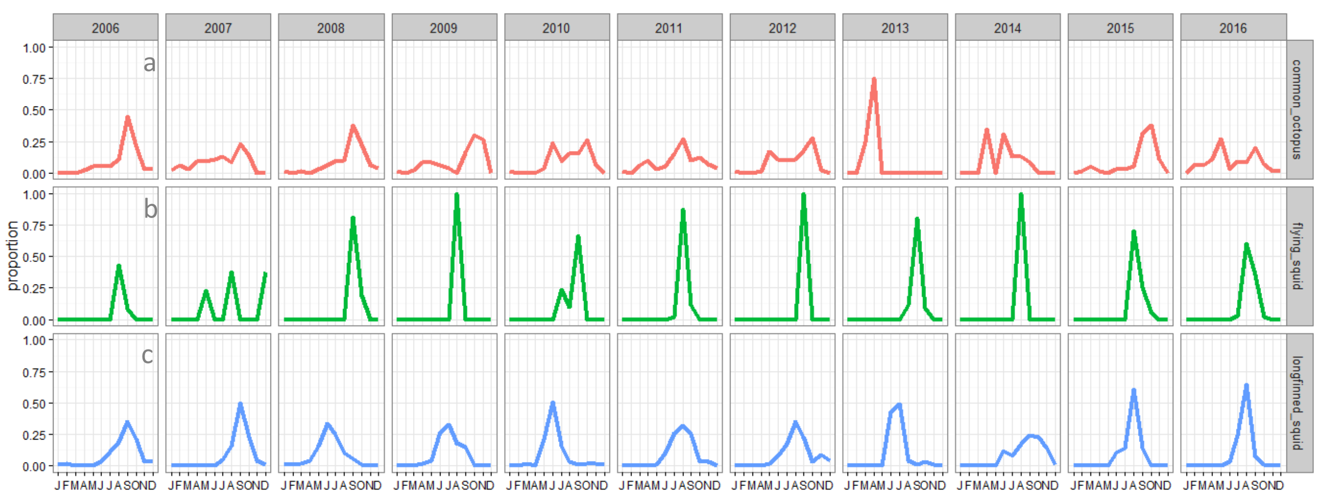

Figure A7.3 – Proportion of monthly landings in relation to total landings by year for the common octopus, flying squids and long-finned squids group of species.

By comparing the flying squids' landings with tuna landings, we observed an overlap between landing peaks of skipjack and flying squids (Figure A7.4). This could indicate predation or similar environmental preferences, e.g. for warmer waters. In fact, all the three flying squid species are referred as prey of several tuna species captured in the region (*Thunnus alalunga*, *T. obesus* and *T. albacares*) and at this stage the feeding habits of skipjack (*Katsuwonus pelamis*) are being studied.

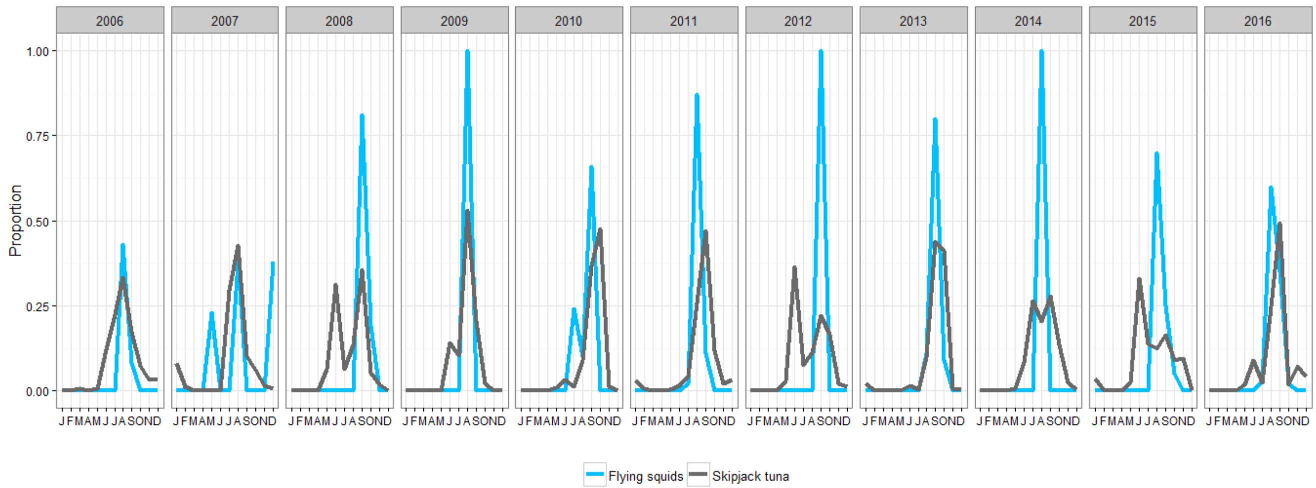

Figure A7.4 – Proportion of flying squid landings and skipjack tuna (*Katsuwonus pelamis*) between 2006 and 2016.

References

Jereb, P., Roper, C.F.E. (2010) Cephalopods of the world. An annotated and illustrated catalogue of cephalopod species known to date. Volume 2. Myopsid and Oegopsid Squids. FAO Species Catalogue for Fishery Purposes. No. 4, Vol. 2. Rome, FAO. 2010. 605p. 10 colour plates.

Annex 8: ToR A) Working Document: Spanish Cephalopod landings and discards

Working Document presented to the ICES WGCEPH Working Group on Cephalopod Fisheries and Life History

AN UPDATE OF CEPHALOPOD LANDINGS-DISCARD DATA OF THE SPANISH FISHING FLEET OPERATING IN ICES AREA FOR 2000–2016 PERIOD

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Data of Spanish landings of cephalopods on an annual basis were collected both by the *Instituto Español de Oceanografía* (IEO) Sampling and Information Network, for catches from the ICES sub-areas 7, 8abd, 8c and 9a. It has been used both the information from logbooks and sales sheets which have been provided by the Fishing General Secretary of the Spanish Government.

Table A8.1 shows the Spanish annual landings (in tons) by species group (Octopodidae, Loliginidae, Ommastrephidae and Sepiidae) and the total annual for the 2000–2016 period. Landings data of 2016 should be considered as provisional because of gaps of information still present in some subdivisions. However, the 2015 landings will be considered in further analysis of trends henceforth presented.

Figure A8.1 shows the trend of total annual landings through the analyzed time period (2000–2016). Mean annual landings along the time-series were around 9690 tons, with a minimum of 7019 t in 2009 and a maximum of 14504 tons in 2012. The highest landings belonged to the Octopodidae group which accounted for 55 % of the averaged landings for the analyzed period, followed by Ommastrephidae (22 %), Sepioidea (15 %) and Loliginidae (8 %). The trend presents a drop of landings from 2000 to 2001, followed by a slight increase until it reaches a peak in 2005 of 10 500 t. Subsequently, a new decrease appears until 2009, with a great increase in 2010 of about 63% in comparison to 2009. In 2011, the landings showed similar values to previous years, with a new increase in 2012 reaching the highest value of the time-series. In 2013, the landings decreased 16% with regard to the previous year due to the reduction of Ommastrephidae. This decrease continued in 2014, with an 18% reduction compared to 2013, which coincided with a decrease in abundance of Octopodidae. By 2015, there was a general reduction in catch which affected all taxonomic groups and was similar to that reported in 2014 (17.5%). However, an increase was detected in 2016 for all groups, mainly in Octopodidae.

Table A8.1. Spanish cephalopod annual landings (in tons) caught in the ICES Area by species group and total annual during the 2000–2016 period.

Year	Loliginidae	Octopodidae	Ommastrephidae	Sepioidea	Total
2000	676	7032	2017	1637	**11361**
2001	1052	3896	1305	1129	**7383**
2002	958	5150	1718	1133	**8959**
2003	917	4888	1164	1286	**8256**
2004	980	4882	1471	1394	**8726**
2005	880	6040	1950	1635	**10505**
2006	441	5238	1018	1456	**8152**
2007	598	4643	834	1563	**7637**
2008	765	4920	1636	1412	**8734**
2009	546	3935	1314	1224	**7019**
2010	1109	5776	3023	1535	**11444**
2011	1196	5122	3397	1423	**11138**
2012	1683	6391	4718	1714	**14505**
2013	814	7798	1580	1985	**12177**
2014	496	4689	3508	1257	**9950**
2015	453	4484	2209	1058	**8203**
2016	495	5654	3042	1382	**10573**

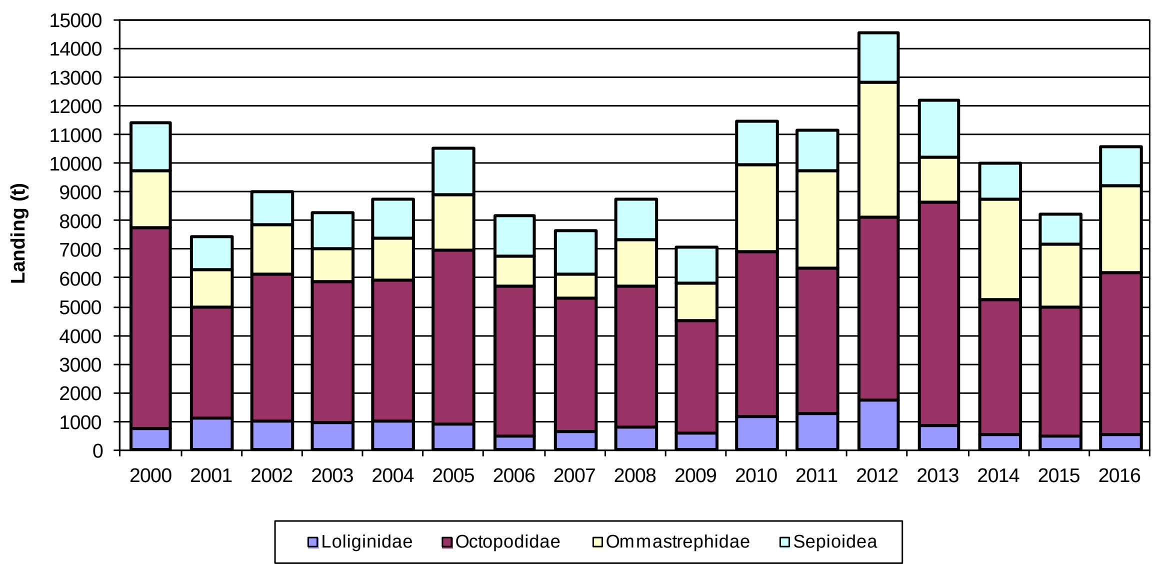
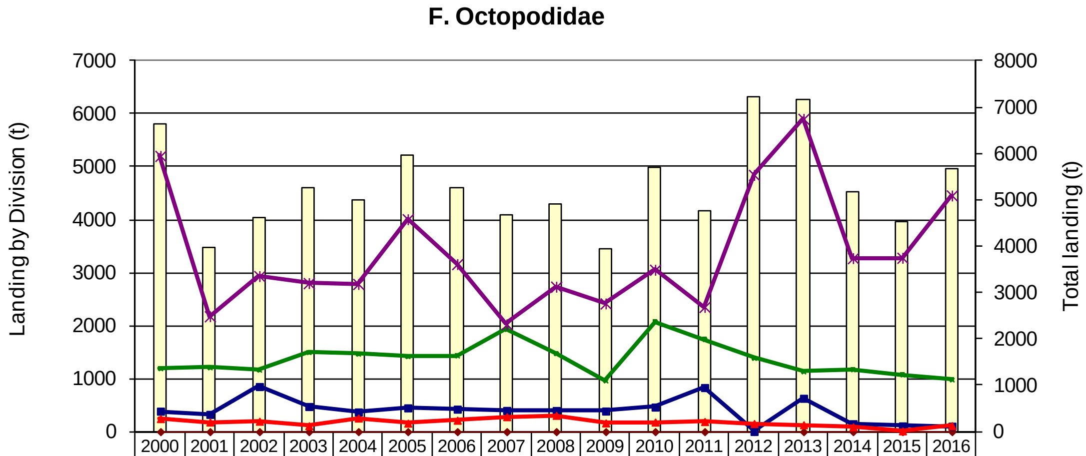


Figure A8.1. Spanish cephalopod annual landings (in tons) caught in the ICES area by species group for the 2000–2016 period. (2016: provisional data)

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 9a-South. Figure A8.2 shows the total octopods landings trend by Subarea/Division in the last fourteen years. Total annual catch ranged between 3895 t in 2001 and 7219 t in 2013, which represents a very important increase along the time-series. A slight increase until reaching a peak in 2005 of 6039 t can be observed. Afterwards, a new decreasing trend appears until 2009 with 3935 t, followed by a great increase in 2010 of about 46% with regard to 2009, maintaining a similar value in 2011. In 2012, a sharp increase can be observed until it reached the highest value of the time-series in 2013 with 7219 t. In 2016 was reported 5659 t, with previous decreasing in 2014–2015. More than 87% of Octopodidae were caught along the Spanish coast (Divisions 9a and 8c), where common octopus *O. vulgaris* is the main species caught. In Division 8c and Subdivision 9a-north most of the *O. vulgaris* were caught by the artisanal fleet using traps, comprising more than 98% of octopus landings (Figure 3). The remaining landings are reported by the trawl fleet. However, this species is caught by the bottom-trawl fleet in the Subdivision 9a-South (Gulf of Cadiz), accounting for around 51% of the total catch on average, and the remaining 49% by the artisanal fleet using mainly clay pots and hand-jigs (Figure A8.3), along the time-series. In the last five years, the artisanal landings have exceeded significantly the trawl landings, providing around 70%-80% of the total catch. This may be due to a progressive increase in the declaration of artisanal landings at the octopus market as a consequence of greater pressure by the fishing control. Subdivision 9a-South contributes to the total landings from the Division 9a with variable percentages that ranged between 16 % (285 t) in 2011 and 80% (2871 t) in 2005, with a 48% on average through the time-series. In figure 3, it can be observed these strong fluctuations in the octopus landing along the time-series in Subdivision 9a-South, with the minimum values in 2011 (285 t) and maximum values in 2013 (3785 t). However, these interannual fluctuations are less pronounced in Subdivision 9a-North. Possibly, such oscillations in Subdivision 9a-south may be related with environmental changes such as rainfall and discharges of rivers (Sobrino *et al.*, 2002).

Most of the horned octopus *Eledone cirrhosa* is caught by the bottom-trawl fleet, which landings account for the bulk of the octopod landings in Subarea 7 (398 t of average) and Subdivisions 8abd (176 t) (Figure A8.4). In the last two years, the trend tended to decrease. Horned octopus landings in Division 8c account for 23% (314 t), on average, of total octopods landings along the time-series. In Sub-division 8c-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 *Eledone* spp in the total cephalopod landings from Division 9a is higher in Subdivision 9a north, with 15.6 % (261 t) of total landings and tending to decrease in the last two years, than in Subdivision 9a south, which contributed with only 6.5 % (109 t) (Figure 4). In this last Subdivision, the main landed species is the musky octopus *Eledone moschata* instead of *E. cirrhosa*, which is caught in the Gulf of Cadiz by the trawl fleet as a by-catch due to its low commercial value (Silva *et al.*, 2004). This has been changing in the three last years, as it is possible to observe in the increase of landings during 2105, with almost 600 tonnes. In 2016, 356 tonnes were landed.

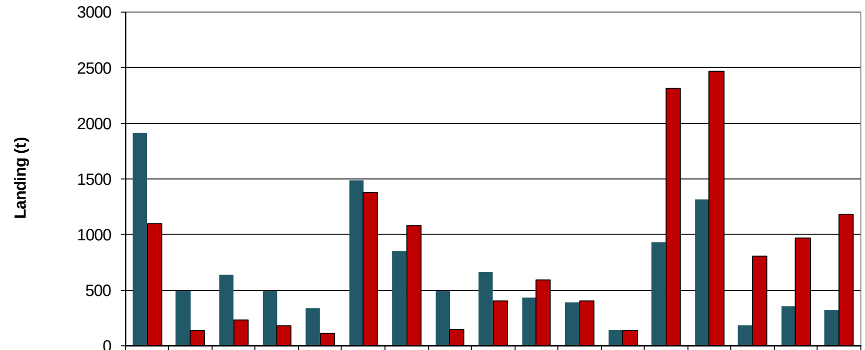


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total	6645	3957	4625	5265	4985	5962	5262	4667	4921	3945	5701	4754	7219	7172	5170	4521	5659
VI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VII	387	326	851	475	371	449	425	400	399	389	464	832	4	630	149	108	103
VIIIabd	247	182	197	112	257	161	216	282	308	164	181	191	153	130	92	15	113
VIIIc	1193	1209	1165	1498	1466	1421	1433	1933	1476	961	2075	1743	1387	1133	1172	1075	980
IXa	5205	2179	2936	2804	2787	4010	3164	2027	2737	2421	3056	2355	4847	5905	3276	3283	4458

Figure A8.2. Spanish landings (in tons) of octopus species (Fam. Octopodidae) by ICES Subarea/Division for the 2000–2015 period.

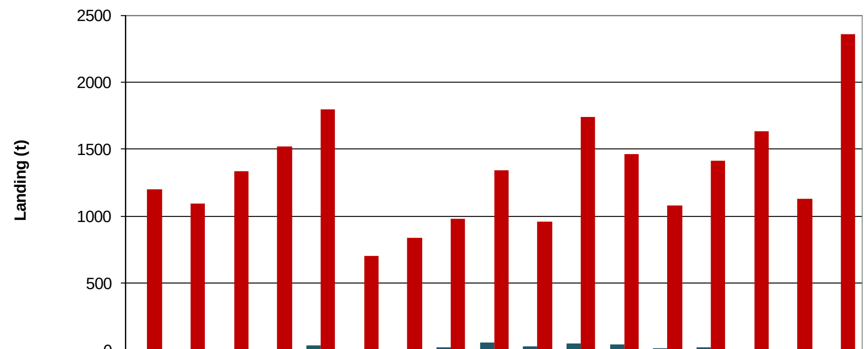
Octopus vulgaris

Subdivision IXa- South



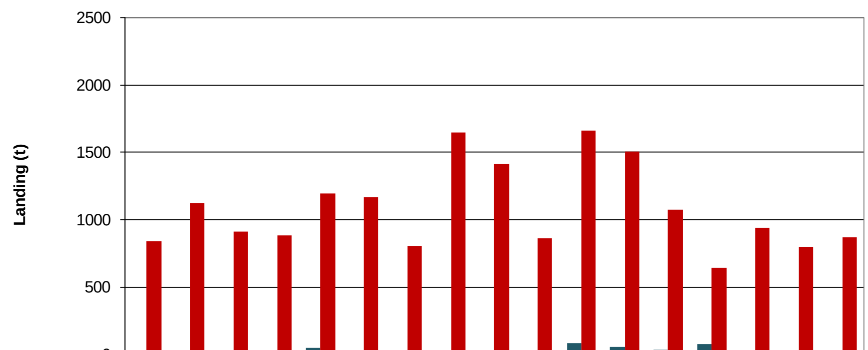
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Trawler fleet	1915	498	645	496	342	1490	855	497	663	434	396	146	927	1317	187	359	321
Artisanal fleet	1101	139	234	182	112	1381	1077	149	402	595	403	139	2315	2468	803	974	1181

Subdivision IXa- North



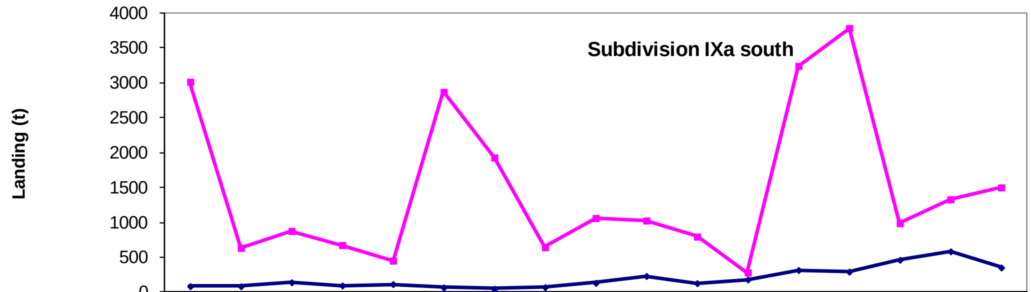
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Trawler fleet	0	7	5	10	37	4	4	18	54	29	50	42	12	18	9	3	1
Artisanal fleet	1201	1097	1337	1518	1798	701	837	977	1342	958	1741	1463	1078	1416	1633	1133	2360

Division VIIIc

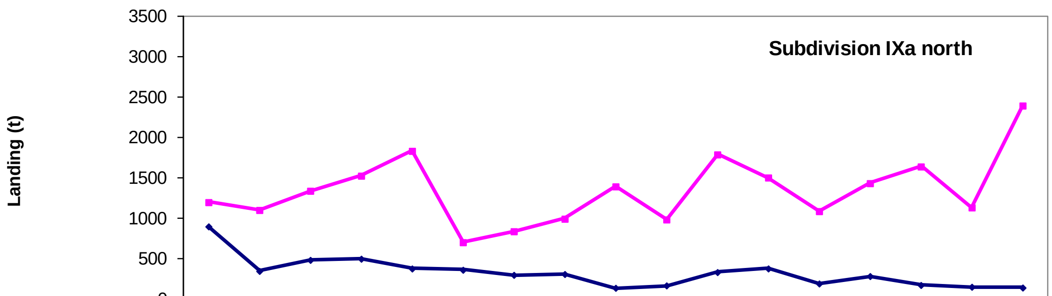


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Trawler fleet	6	7	4	5	51	4	23	15	16	3	80	55	37	76	20	17	7
Artisanal fleet	843	1126	914	881	1195	1168	802	1648	1412	860	1659	1502	1075	639	942	795	869

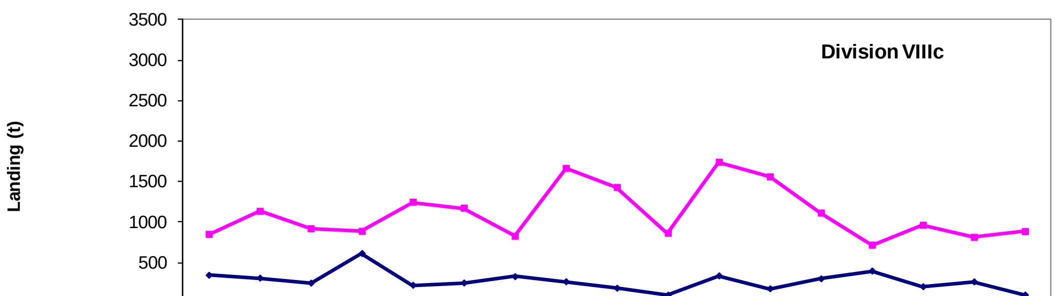
Figure A8.3. *O. vulgaris* landings (in tons) by fleet in Sub-division 9a-south, Sub-division 9a-north and Division 8c, for the 2000–2015 period.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Eledone spp	88	88	144	99	118	70	51	74	136	235	132	184	320	296	466	587	356
O. vulgaris	3016	638	879	677	454	2871	1932	646	1065	1029	799	285	3243	3785	990	1333	1503



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Eledone spp	901	350	486	501	380	364	301	311	141	170	335	380	194	286	175	154	144
O. vulgaris	1201	1104	1342	1528	1835	705	840	996	1395	987	1791	1505	1090	1435	1642	1136	2396

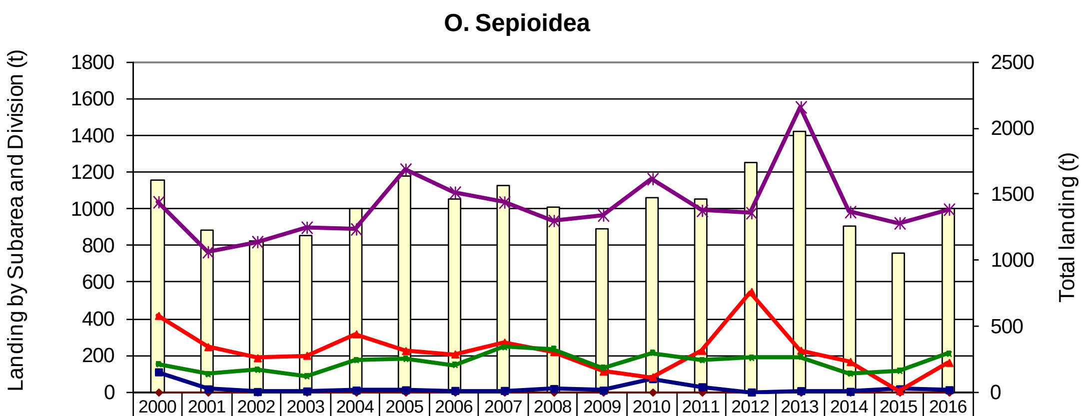


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Eledone spp	344	308	247	612	220	249	326	264	184	99	337	177	300	396	203	263	100
O. vulgaris	849	1133	918	886	1246	1172	825	1663	1428	863	1739	1559	1112	715	962	812	883

Figure A8.4. Octopodidae landings by species in Division 8c and 9a (north and south) for the 2000–2015 period.

Sepiidae

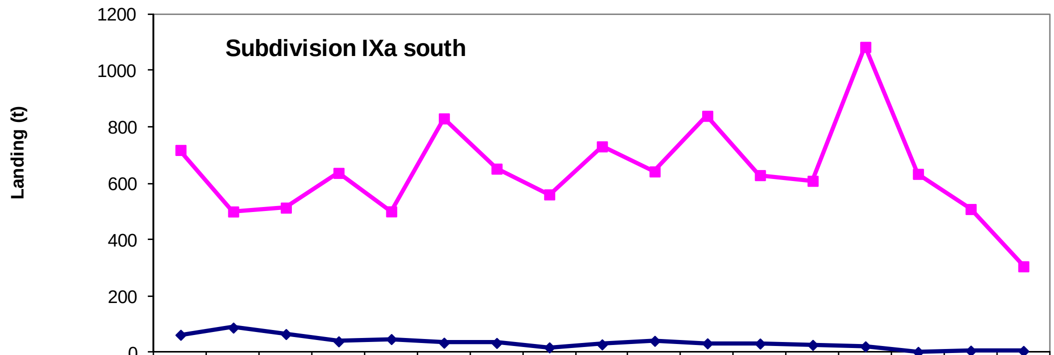
The cuttlefish annual landings trends by Subarea/Division are shown in Figure A8.5. Total landings ranged between 1978 t in 2013 and 1052 t in 2015. Since 2001, landings had been increasing until 2005 and 2007, when they reached the two new maximum values similar to those reached in 2000. Afterwards, landings decreased slightly up to 1224 t in 2010, reaching the highest values of the time-series in 2013, with an important decreasing trend in 2014 of 36% reduction in relation to the previous year, continuing the decline in 2015. In 2016, there was an increase in landings. Division 9a contributed with 75% of total cuttlefish landings by the Spanish fleet (1.014 t), with the 65% of landings (641 t), on average, in this Division corresponding to the Subdivision 9a-South (Gulf of Cadiz). Landings in Division 8c increased at the end of the analysed period, reaching 102 t in 2014, whereas in Division 8abd they showed a mean value of 170 t, with a marked drop in the last four years of the time-series, from 548 t in 2012 to 167 t in 2014, and only 8 t in 2015. Landings in Subarea 7 were below 20 t, and very scarce in the last three years, except in 2000 and 2010 with 110 t and 73 t, respectively, and they were almost absent in the Subarea 6. In 2016, the landings showed a slight increase to the previous year in all Division.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total	1609	1222	1147	1190	1389	1634	1459	1563	1402	1233	1473	1467	1742	1978	1261	1052	1387
VI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VII	110	18	3	6	11	12	9	9	19	11	73	29	1	8	4	18	13
VIIIabd	418	247	187	200	318	226	208	272	221	114	83	227	548	228	167	7.91	162
VIIIc	154	99	123	88	176	182	149	246	237	134	216	176	187	194	102	117	210
IXa	1037	765	820	899	889	1215	1090	1036	935	965	1164	991	978	1555	984	922	997

Figure A8.5. Spanish landings (in tons) of cuttlefish species (O. Sepioidea) by ICES Subarea/Division for the 2000–2016 period.

Cuttlefish (O. Sepioidea) landings from Subarea 7 and Divisions 8abd mainly comprise common cuttlefish *Sepia officinalis* and, in a smaller amount, also elegant cuttlefish *Sepia elegans* and pink cuttlefish *Sepia orbignyana*. Bobtail squid *Sepiola* spp. has not been identified in most of the landings. Only *Sepia officinalis* and *Sepia elegans* are present in landings from Divisions 9a and 8c. Data on the proportion of each species is only available for Subdivision 9a-south, where *Sepia officinalis* makes up to 98% of cuttlefish landed (Figure A8.6). In this area, *Sepia elegans* and *Sepia orbignyana* appeared mixed in the landings, although the last specie is quite scarce. The commercial value of *Sepia elegans* is high, and for this reason is separated in the catch. During the 2014–2016 periods, the landings of *Sepia elegans* in Subdivision 9a-South showed an important drop.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
S.elegans	63	89	66	40	48	35	34	19	29	42	33	32	28	22	3	7	6
S.officinalis	718	500	514	637	501	830	652	561	731	642	839	629	609	1084	634	509	306

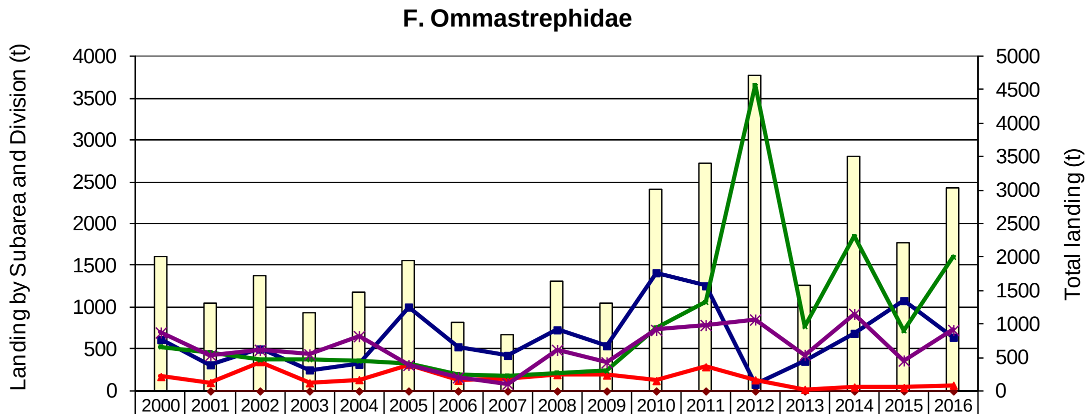
Figure A8.6. Sepiidae landings by species in Subdivision 9a-south for the 2000–2016 period.

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 sagittatus* also appears in catches, but it is very scarce. Figure A8.7 illustrates the trends of both total landings of short-finned squids and by Subarea/Division. Total landings presented a mean value of 2112 t, with low values in the first half of the time interval. Afterwards, landings quickly dropped reaching a minimum of 834 t in 2007. In 2008, this value doubled in relation to the previous year, with a new decrease in 2009. In the last three years of the time-series a strong increase occurs, reaching the maximum values of 4718 tonnes in 2012, as in the rest of cephalopod groups. However, a sharp decrease is observed in 2013, with a decline of 3000 t in comparison to the previous year. It is possible that this decrease in landings is due to a change in the fisheries information source and the correct name assignment to each species landed. In 2014, an increase of 2000 t is observed in Figure A8.7, reaching the second maximum value in the time-series, followed by a drop of 1400 t in 2015, and a new increase of about 900 t in 2016.

The analysis by area shows scarce landings in Subarea 6 throughout the time-series. From 2000 to 2004, the Division 9a contributed with the highest landings, ranging between 700 and 430 t. Since 2004, landings from Subarea 7 increased, reaching two maximums in 2005 and 2008 of 1000 and 730 tons, respectively. The rest of Divisions showed decreased landings, sharing similar levels below 200 t, with only the Division 9a experiencing a significant recovery in 2008. In 2010, all the Subareas and Divisions reached the maximum values, except Division 8abd which presented a slightly decrease in relation to the previous years. At the end of the time-series, both Divisions 9a and 8c showed considerable increases, mainly in Division 8c, a value 300% greater than in 2011 (3651 t) was reached in 2012. Subdivision 9a–South accounts for the lowest values of the time-series with landings below 1% of the total short-finned squid species landings. In 2013, the landings decreased in all Divisions, except in Division 7, which showed a significant recovery. The decrease was most important in Division 8c, with a reduction of 80% in 2013.

The reason has been described in the first paragraph. In 2014, all Divisions showed a significant increase of about 100% in relation to the previous year. However, only the Division 7 showed an increase in 2015, with the rest of them showing an overall drop as it has been mentioned before. This oscillating trend of the last five years continued in 2016 with increases in all Division.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total	2017	1305	1718	1164	1471	1950	1018	834	1636	1314	3023	3397	4718	1580	3508	2209	3042
VI		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3
VII	616	313	501	252	320	1003	528	426	731	541	1413	1257	79	356	689	1080	643
VIIIabd	172	101	351	98	136	315	127	141	196	190	124	289	133	20	48	42	69
VIIIc	530	462	373	377	359	319	199	180	219	240	756	1062	3651	771	1848	722	1601
IXa	699	429	492	438	656	312	164	87	491	342	730	788	854	433	923	365	729

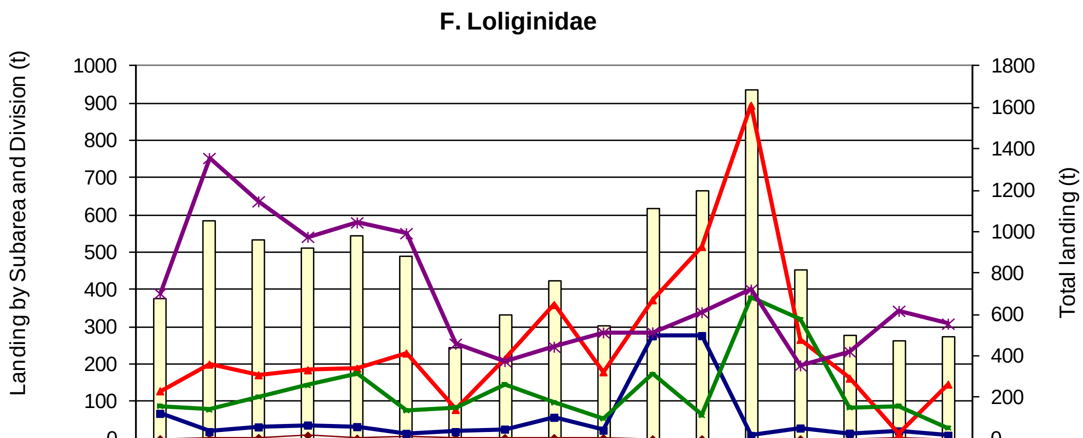
Figure A8.7. Spanish landings (in tons) of short-finned squid species (Fam. Ommastrephidae) by ICES Subarea/Division for the 2000–2016 period.

Loliginidae

Long-finned squid landings (Family Loliginidae) consist mainly of common European squid *Loligo vulgaris*. Three other species are present in unknown proportions. Of these, veined squid *Loligo forbesii* 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 9a-South, showing low catch levels in Sub-Division 9a north during the same years.

Figure A8.8 shows the trend of total long-finned squid landings and by Subarea/Division. Total landings presented a maximum value of 1052 t in 2001; afterwards they remain more or less stable at around 900 t until 2006, when they showed a drop, reaching the minimum value in the time-series of 441 t. An increasing trend is observed from this year up to 2012, reaching the maximum value in this year of 1683 t, indicating a considerable recovery of landings. However, the landings decreased in all Divisions in 2013, with only a slight recovery in Division 7. This trend to decrease kept going in 2014. The reason could be the same as in the case of Ommastrephidae. In 2015–216, global landings remained stable although there was a strong drop in the subarea 8abd and an appreciable increase in the 9a.

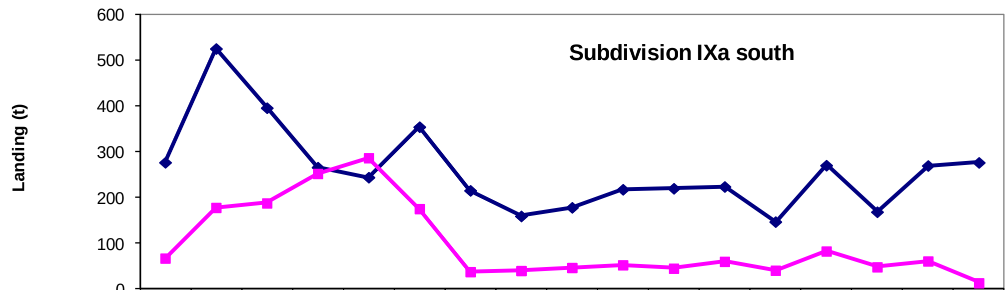
The analysis by Subarea/Division showed that the Division 9a recorded the highest landings from 2001 to 2005, with values ranging between 753 and 552 t, respectively. The 2007 landings fell to 200 t and remained stable during three years with an increasing trend up to 2012 when the maximum value is reached (401 t). In 2013, the landings decreased by 50% in relation to the previous year, with a slightly recover in 2014 that continued throughout the 2015–2016, when more than 310 t were reached. Landings in Division 8abd and 8c were lower than in 9a, except at the end of the time-series, oscillating between 128 t in 2000 and 895 t in 2012, and between 76 t in 2005 and 378 t in 2012, respectively. In 2015, the lowest value of the time-series, which was only 15 t, was registered in the Division 8abd, recovering 130 t in 2016. Landings in Subarea 7 were also very low as compared with other areas, with a mean value of the annual landings of only 30 t, but they showed a significant increase in 2010 and 2011, as also happened in Division 8c and 8abd. The Subarea 6 showed very scarce landings, below 10 t, as it was also mentioned above for the other analysed groups of cephalopod species, without landings in the last years. Only 2 t were registered in 2015 and almost zero in 2016.



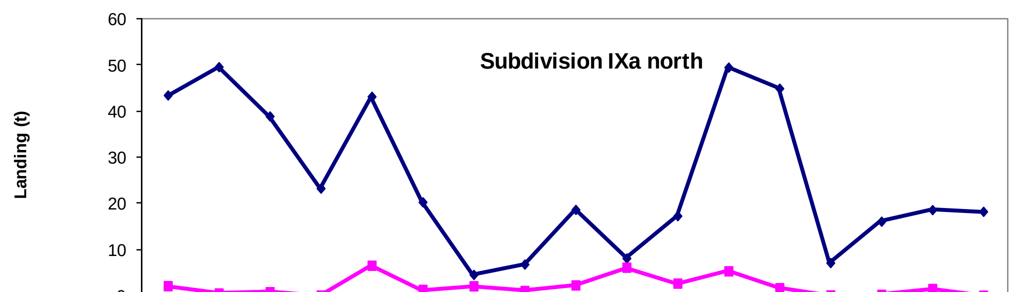
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total	676	1052	958	917	980	880	441	598	765	546	1109	1196	1683	814	496	470	495
VI	0	1	3	10	2	8	2	3	3	3	0	0	0	0	0	2	0
VII	68	19	32	37	33	15	19	26	58	23	277	277	9	29	15	21	10
VIIIabd	129	201	172	185	190	230	79	214	360	180	373	516	895	267	163	15	147
VIIIc	88	78	113	144	175	76	85	146	97	55	173	63	378	321	84	88	30
IXa	390	753	637	542	581	552	255	209	247	286	286	340	401	197	234	343	309

Figure A8.8. Spanish landings (in tons) of long-finned squid species (Fam. Loliginidae) by ICES Subarea/Division for the 2000–2016 period.

Both in Sub-divisions 9a south and north, *Loligo spp* and *Alloteuthis* spp landings appear separated due to their high commercial importance. Figure A8.9 shows the proportion of each species group by Sub-Division. Both groups yielded higher landings in 9a south than in 9a north. *Alloteuthis* spp landings in 9a south ranged between 286 t in 2004 (i.e. higher landings than *Loligo* spp ones in this year) and 38 t in 2006, whereas in 9a 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, although *Loligo* spp. showed an important increase in 2011–2012 in Subdivision 9a-north, with landings of around 45 t. In 2013, the landings of these species decreased significantly in subdivision 9a-north, while in 9a-south there was a 100% increase in relation to the previous year. Lower values were recorded in 2014, followed by a 22% increase in 2015. 2016 account for the lowest value of the times series for *Alloteuthis* in both subdivision, con 14 t in 9a-south and almost zero in 9a-north. However, *Loligo* sp showed a slight increase in 9a-south and remained stable in 9a-north. Finally, it is worth mentioning that in the last few years *Alloteuthis africana* is also occasionally present in the Gulf of Cadiz (9a-South) landings, mixed with the other *Alloteuthis* species (Silva *et al.*, 2011).



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Loligo spp	276.8	524.8	395.8	266.3	244.4	354.4	215.6	159.9	178.7	218.0	220.2	224.1	147.6	270.5	169.1	269.9	276.6
Alloteuthis spp	68.0	178.4	188.2	252.5	286.8	175.8	38.5	40.9	47.5	53.4	46.0	60.9	41.6	83.4	49.0	61.8	14.2



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Loligo spp	43.4	49.5	38.8	23.2	43.1	20.3	4.5	6.8	18.6	8.1	17.3	49.4	44.9	7.1	16.1	18.6	18.2
Alloteuthis spp	2.1	0.5	0.8	0.1	6.5	1.3	2.1	1.0	2.3	6.1	2.6	5.3	1.7	0.1	0.2	1.5	0.0

Figure A8.9. Long finned squid landings by species in Sub-Division 9a south and north for the 2000–2015 period.

Discard ratio

The discarded fraction has been estimated with the information got form the sampling programs carried out by the observers aboard the fishing vessels in the several bottom trawl fleets. Table A8.2 shows the discarded fraction in relation to the total amount of landings by species or group of species, for the different trawling métiers, by Sub-area/Division. The Sub-areas 6-7 exhibits the higher estimates of discards, while the smaller values were registered in the Sub-Division 9a south. The most discarded species for the time period 2003–2016 were *Eledone cirrhosa,* with mean values around 51% of the total catch along with the Ommastrephidae group, which accounted for 52% in the Sub-areas 6-7. In the Division 8c and Sub-Division 9a north, both species/group of species showed lower mean values, around 18%. It's likely that this low commercial value is related to the high discarding rate.

The lowest discard estimates arise from the bottom trawl metier of the Sub-Division 9a south (Table A8.2). The estimates mentioned before have mean values for the period 2005–2016 which oscillated between 5 % for *Eledone sp* and *Octopus vulgaris* and less than 1% registered for *Loligo* sp, Ommastrephids and *Sepia officinalis.* The highly multispecific nature of the OTB_MCD metier in the Sub-Division 9a, and that they take advantage of everything that is fished by the fleet makes the discards estimates to be low. The highest peaks observed for *O. vulgaris* between 2009 and 2011 occurred because of a high recruitment and also a tougher control by the fishing control. The last mentioned caused an increase in the discarding of octopus with less than 1 kg (Minimum capture weight: 1 kg; BOE nº 290, Orden de 22 de noviembre de 1996) (Santos *et al.*, 2012).

			% discard from total catches													
Gear	Area	Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
OTB	VI-VII	Eledone cirrhosa	59.0	34.2	50.8	46.0	66.5	59.9	72.3	38.7	71.2	96.6	12.7	52.8	23.8	27.8
		Loligo spp.	52.0	24.0	73.0	80.0	92.0	65.0	26.0	12.0	4.4	35.4	0.7	1.1	10.8	32.7
		Octopus vulgaris	0.0	100.0	100.0	91.0	0.0	0.0	0.0	37.0	0.0	0.0	10.3	0.0	0.0	0.0
		Ommastrephidae	90.1	79.2	68.7	71.4	79.5	74.3	77.3	29.4	10.7	74.4	32.7	18.0	12.4	8.1
		Sepia officinalis	77.4	8.7	5.9	76.6	4.6	21.7	2.4	0.0	0.5	94.6	21.8	0.7	0.0	0.0
OTB_MIX OTB_HOM OTB_MAC	VIIIc + IXa north	Eledone cirrhosa	8.0	26.0	8.2	23.0	18.6	5.9	36.7	5.2	24.2	14.0	35.7	22.4	11.7	12.2
		Loligo spp.	2.0	1.0	12.0	1.0	1.0	2.0	7.0	2.0	61.0	0.3	43.3	0.7	0.0	2.5
		Octopus vulgaris	6.0	4.4	34.0	7.0	39.0	0.8	12.0	3.1	25.3	1.3	0.0	0.0	0.9	24.8
		Ommastrephidae	10.8	26.7	18.7	11.4	20.6	19.4	13.9	6.5	27.0	6.1	73.0	3.8	6.5	0.9
		Sepia officinalis	60.8	0.9	13.1	60.5	1.2	1.2	17.7	5.9	33.6	11.4	0.0	3.3	0.0	7.1
PTB	VIIIc + IXa north	Eledone cirrhosa	0.0	0.0	64.0	63.0	94.0	31.6	90.3	95.5	36.8	0.6	0.0	94.6	100.0	98.3
		Loligo spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0
		Octopus vulgaris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Ommastrephidae	2.1	1.5	10.5	3.7	2.7	2.6	8.9	0.5	1.1	0.1	2.0	0.8	2.4	0.0
		Sepia officinalis	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
OTB	IXa - south	Alloteuthis spp	-	-	0.0	0.0	0.0	0.0	3.2	4.5	7.1	0.0	2.6	0.7	0.0	0.0
		Eledone spp	-	-	0.0	0.0	1.1	4.5	16.8	19.0	11.4	0.0	4.3	1.6	2.1	5.1
		Loligo vulgaris	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.1	0.5
		Octopus vulgaris	-	-	0.0	3.1	0.0	18.8	35.1	0.0	1.6	1.9	0.0	0.0	0.0	1.6
		Ommastrephidae	-	-	0.0	0.0	0.0	0.0	2.0	5.8	0.0	0.0	1.2	0.0	0.0	0.0
		Sepia elegans	-	-	0.0	0.0	0.0	2.1	9.0	2.7	1.2	0.0	21.1	5.1	0.0	9.9
		Sepia officinalis	-	-	0.2	4.0	0.0	0.0	0.0	0.5	0.0	3.2	0.7	0.0	0.0	1.0

Table A8.2. Estimated fraction of the total catch discarded for the main species/groups of species by Sub-area/Division, 2003–2016 period.

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Annex 9: ToR A) Working Document: Portugal Cephalopod landings and biological data

Portuguese cephalopod fishery statistics, distribution and population parameters – updating status and trends in ICES division 9.a

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Cephalopods are an important fishery resource in Portugal. The main commercial species are the common octopus *Octopus vulgaris*, the cuttlefish *Sepia officinalis* and the common squid *Loligo vulgaris*. Other species, such as *Eledone cirrhosa*, *Loligo forbesii*, *Illex coindetii*, *Todaropsis eblanae*, *Todarodes sagittatus* and more recently *Alloteuthis* sp. are also marketable species. On this document cephalopod fisheries data, distribution and abundance in surveys and length sampling for the Portuguese fleets operating in ICES division 9.a are analysed. Information on discards is obtained from the onboard sampling programme (PNAB/DCF) and refers mainly to bottom otter trawl fishery for crustaceans (OTB_CRU) and for demersal fish (OTB_DEF), but also a reference to polyvalent fleet (gill and trammel net) onboard sampling is made.

Cephalopod landings and discards from ICES division 9.a

The relative importance of cephalopod species in landings from Portuguese waters (ICES 9.a) is constant along the years with significantly higher landings of octopus, followed by cuttlefish, long-finned squid and short-finned squid (Table A9.1). Octopus landings represent ca. 85% of the total cephalopod Portuguese landings, with 9 389 tons landed in 2015 and 12 285 tons landed in 2016. Cuttlefish represent ca. 11%, long-finned squids 3.5% and short-finned squids only 1% of the total cephalopod landings. Cephalopod landings increased in general in 2016, except for long-finned squid.

The frequency of discarding of cephalopods taxa is low (<30%) or null in both OTB_CRU and OTB_DEF fisheries and when present cephalopods are generally discarded in low numbers (Prista *et al.*, 2014). However, when considering the overall cephalopods, frequencies of occurrence in discards are higher (more than 30%) in both fisheries (Table A9.2). Concerning supra-specific groupings, cuttlefish and sepiolids and octopuses are the most frequently discarded cephalopods in OTB_CRU and long-finned squids in OTB_DEF fisheries (Table A9.2). In these cases, total discards were estimated per year and fleet (Table A9.3). Trends are illustrated in Figure A9.1.

Table A9.1 – Landings in tons by Portuguese fleets from ICES sub area 9.a between 2000 and 2016.

Year	Cephalopods	Cuttlefish (Sepiidae)	Long-finned Squid (Lolig-inidae)	Octopus (Octopodidae)	Short-finned squid (Ommastrephidae)
2000	11346	1357.1	613.7	9052.0	323.2
2001	9744	1348.1	863.3	7300.5	232.5
2002	10410	1367.8	679.0	8158.3	204.9
2003	11434	1297.9	288.8	9700.2	146.7
2004	11126	1664.8	1009.0	8211.6	240.5
2005	13329	1805.4	447.4	10889.4	186.8
2006	8992	1787.3	89.1	7074.0	42.0
2007	10118	1517.5	127.6	8452.3	20.2
2008	15084	1453.0	360.1	13261.2	17.7
2009	9473	1258.8	269.2	7940.5	18.5
2010	12975	2009.4	273.5	10681.5	40.4
2011	9188	1522.4	323.8	7265.5	76.1
2012	11310	1165.0	267.0	9768.0	108.0
2013	14370	1295.0	179.0	12821.0	75.0
2014	12120	1234.0	171.0	10637.0	78.0
2015	9315	1193.0	413.8	7608.8	99.4
2016*	12214	1266.2	300.6	10503.1	143.9

*provisional data

Table A9.2 – Frequencies of discarding (%) of supra-specific cephalopod taxa in the hauls sampled for the OTB_CRU and OTB_DEF fisheries (2004–2016).

Year	Cephalopods		Sepiidae		Loliginidae		Octopodidae		Ommastrephidae	
	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF
2004	77	66	41	29	16	48	64	18	36	17
2005	74	59	38	26	5	47	50	21	31	8
2006	67	29	47	10	--	18	53	12	3	--
2007	52	31	33	15	5	10	23	15	5	2
2008	50	48	29	17	12	24	23	24	5	1
2009	54	38	42	18	10	19	14	20	1	--
2010	49	25	24	5	6	14	18	11	12	--
2011	48	53	16	11	14	29	32	19	25	2
2012	47	33	25	3	3	22	24	17	6	2
2013	57	40	36	4	25	28	25	18	4	2
2014	52	40	21	6	2	13	40	12	7	8
2015	75	33	18	4	2	15	63	12	--	--
2016*	64	34	26	5	--	7	45	15	24	11

*provisional data.

Table A9.3 – Volume (in metric tons) and CVs (%, in brackets) of supra-specific cephalopod taxa in the hauls sampled for the OTB_CRU and OTB_DEF fisheries (2004–2016); "—" indicates no occurrence, "(a)" = low frequency of occurrence.

Year	Cephalopods		Sepiidae		Loliginidae		Octopodidae		Ommastrephidae	
	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF	OTB_CRU	OTB_DEF
2004	392 (25%)	121 (16%)	16 (32%)	(a)	(a)	121 (31%)	341 (26%)	(a)	23 (32%)	(a)
2005	308 (39%)	57 (28%)	16 (58%)	(a)	(a)	39 (19%)	117 (26%)	(a)	59 (37%)	(a)
2006	94 (11%)	(a)	34 (23%)	(a)	0 (0%)	(a)	57 (15%)	(a)	(a)	0 (0%)
2007	35 (28%)	87 (35%)	3 (40%)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
2008	28 (50%)	140 (37%)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
2009	49 (18%)	57 (28%)	14 (20%)	(a)	(a)	(a)	(a)	(a)	(a)	0 (0%)
2010	34 (29%)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	0 (0%)
2011	44 (61%)	64 (25%)	(a)	(a)	(a)	(a)	24 (50%)	(a)	(a)	(a)
2012	34 (55%)	22 (26%)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
2013	19 (19%)	72 (25%)	2 (23%)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
2014	46 (29%)	41 (36%)	(a)	(a)	(a)	(a)	39 (33%)	(a)	(a)	(a)
2015	96 (21%)	12 (39%)	(a)	(a)	(a)	(a)	89 (24%)	(a)	0 (0%)	0 (0%)
2016*	244 (7%)*	83 (--%)*	(a)	(a)	0 (0%)	(a)	45 (32%)	(a)	(a)	(a)

*provisional data.

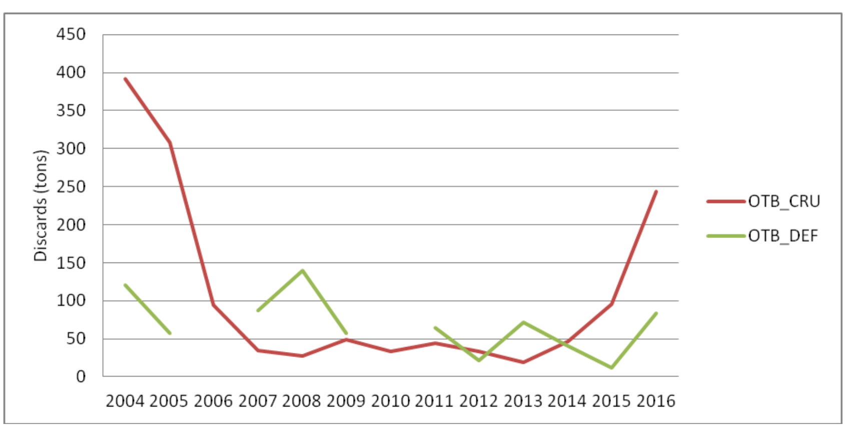

Figure A9.1 – Discards of cephalopods (all species combined) for the 2004–2016 periods.

Octopus vulgaris and *Eledone cirrhosa*

Landings and Discards

Presently, nearly all octopus landed in the Portuguese ports are reported to the species level. The annual landings from ICES sub area 9.a (only Portuguese waters) of *Octopus vulgaris* and *Eledone cirrhosa* (plus the fraction of octopus landings which is not split by species) are presented in Table A9.4 for the period 2003 to 2016. *O. vulgaris* account to ca. 98% all octopus landings. Discards of *O. vulgaris* are considered negligible given their low frequency of occurrence in sampled hauls (mean values for 2004–2016 periods are 3% in OTB_CRU and 8% in OTB_DEF). Due to this fact, no estimates of discards may be calculated with acceptable confidence. *E. cirrhosa* is one of the main discarded cephalopod species. OTB_CRU is the fleet that presents more discards from this species. However, frequencies of occurrence are quite variable between years (8% in 2009 to 59 in 2004) and discards estimates are only provided for years where it exceeded the 30% of occurrence in sampled hauls (Table A9.5). In OTB_DEF, frequencies of occurrence of E. cirrhosa for the 2004–2015 periods were very low (7% on average). In 2016 the frequency was of 8% and discards may be considered negligible like in previous period. Discards of this species is mainly related to market reasons (low or no commercial value). Trends over time are illustrated in Figure A9.2.

Table A9.4 – Landings (in tons) of *O. vulgaris* and *E. cirrhosa* from ICES sub area 9.a (only Portuguese waters) between 2003 and 2016.

Year	Octopus nei	*Octopus vulgaris*	*Eledone cirrhosa*	*Estimated O. vulgaris*
2003	8199	1182	220	*9382*
2004	7442	487	215	*7930*
2005	7388	3188	213	*10575*
2006	3172	3682	146	*6854*
2007	3573	4689	146	*8262*
2008	4334	8755	118	*13089*
2009	1107	6599	162	*7706*
2010	100	10309	211	*10409*
2011	49	7120	87	*7165*
2012	7	9675	93	*9682*
2013	2	12797	170	*12799*
2014	0	7906	64	*7906*
2015	0	7449	160	*7449*
2016*	0	10400	103	*10400*

*provisional data.

Table A9.5 – Frequency of occurrence and discards estimates *for Eledone cirrhosa* in OTB_CRU fishery with CV (in brackets); "…" – no results due to frequency of occurrence <30%.

Year	Frequency of occurrence (%)	Discards (t)
2004	59	277 (32%)
2005	46	99 (38%)
2006	40	45 (10%)
…	…	…
2015	75	82 (29%)
2016	45	45 (32%)

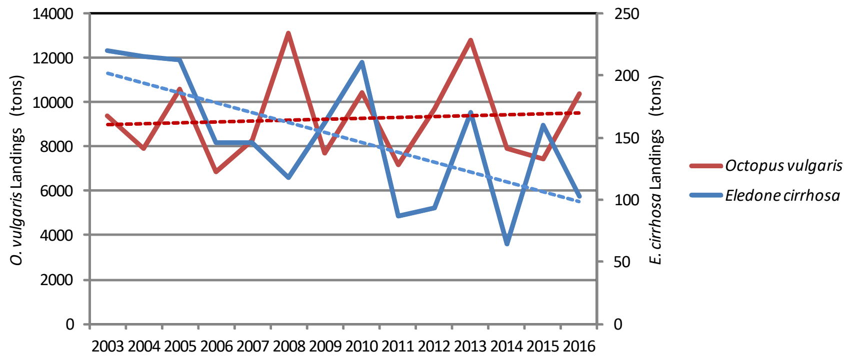

Figure A9.2 – Landing trends of *O. vulgaris* and *E. cirrhosa* in ICES sub area 9.a (only Portuguese waters).

Although *O. vulgaris* fishery used to be much more important in the Algarve than on the west coast of Portugal, in the last years, *O. vulgaris* fishery in the northwest increased significantly. This was particularly the case in 2016 (Table A9.6). The landings of *E. cirrhosa* are generally low and similar between regional sub-areas. *O. vulgaris* is mainly taken (ca. 98%) by the artisanal fishery with traps and pots. On the other hand *E. cirrhosa* is mainly taken (ca. 85%) by the trawl fishery (Table A9.7).

Table A9.6 – Landings in tons of *O. vulgaris* and *E. cirrhosa* from regional sub areas in 2015 and 2016 by the Portuguese fleets.

Year	Sub-Area	*Octopus vulgaris*	*Eledone cirrhosa*
2015	27.9a.c.n	2498.7	64.9
	27.9a.c.s	2351.1	75.9
	27.9a.s.w	2599.0	66.3
2016	27.9a.c.n	4731.7	41.1
	27.9a.c.s	3012.2	33.4
	27.9a.s.w	2655.8	28.9

Table A9.7 – Landings in tons of *O. vulgaris* and *E. cirrhosa* by fleet type in 2015 and 2016.

Year	Fleet	*Octopus vulgaris*	*Eledone cirrhosa*
2015	MIS	7288.0	27.5
	OTB	151.4	132.3
	PS	9.5	0.0
2016	MIS	10029.8	12.3
	OTB	358.3	91.2
	PS	11.6	0.0

LPUE trends

Four series of annual octopus LPUE were estimated, two using landings and effort for trawlers (1988–2016) on the west coast and Algarve; and the other two using landings and effort from the FPO metier (traps, 2001–2014) for the same areas. Only vessels with positive monthly octopus landings by ICES rectangle were considered for LPUE estimations. The analysis of these LPUE series as reliable abundance indices is not straightforward (Fig. A9.3). Considering the years when we have data for the 4 series (2003 to 2014) we may infer that the trawl fishery achieve a higher mean LPUE on the west coast (83 kg/d) than on the Algarve (39 kg/d), conversely the trap fishery yields a slightly higher mean LPUE on the Algarve (127 kg/d) than on the west coast (118 kg/d). Additionally, comparing trends, we may observe that both indices (based on the trawl or FPO fishery) show significant differences in annual trends between the west coast and the Algarve. On the other hand, trawl and FPO indices show rather different trends for the west coast and similar trends for the Algarve (though very different in yield). If we assume each index as an abundance index we may summarize that the octopus abundance increased on the Algarve since 2003, both in trawl (offshore) and FPO (inshore) fishing grounds. The abundance increased also on the FPO (inshore) fishing grounds of the west coast but decreased on the trawl fishing grounds in this area. A more in-depth analysis of the geographical distribution of fishing activity could help the achievement of more reliable fishery abundance indices for octopus.

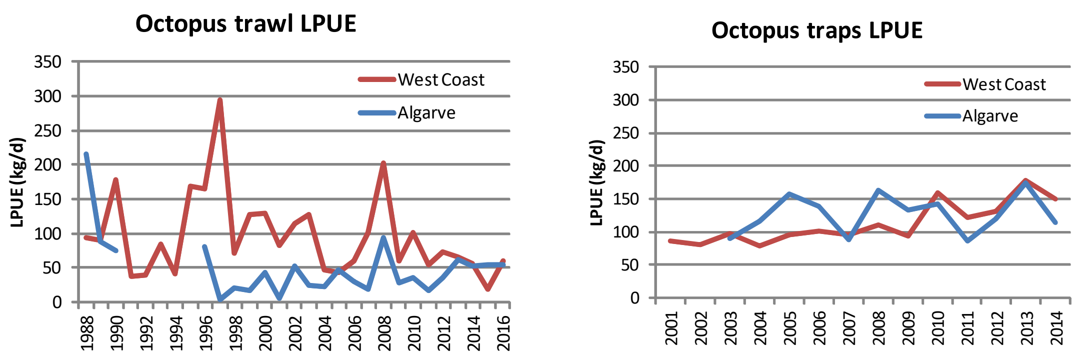

Figure A9.3 - Annual octopus LPUE for trawlers (1988–2016) the FPO métier (traps, 2001–2014) for the west Portuguese coast (27.9a.c.n and 27.9a.c.s) and Algarve (27.9a.s.w).

Population structure and recruitment trends

Length data on *O. vulgaris* landings were obtained by sampling in the fish auction markets as per the PNAB/DCF program. The resulting length distributions were then projected onto the total landings. As discussed, *O. vulgaris* catches were predominantly landed by the polyvalent fleet. Average lengths were consistent between fleets and across regions, with 13.97, 13.53 and 13.48 cm for the 27.9a.c.n (N), 27.9a.c.s (C) and 27.9a.s.w (S) regions respectively by the bottom trawl fleet and 14.05, 13.77 and 14.45 cm for the same regions by the polyvalent fleet (Fig. A9.4).

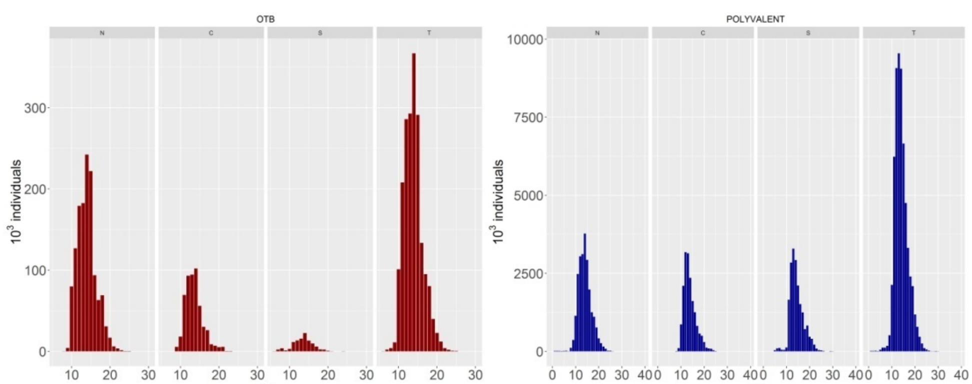

Figure A9.4 – Length distributions for *O. vulgaris* for the period between 2009 and 2016 for the bottom trawl and artisanal fleets and by region (N = 27.9a.c.n, C=27.9a.c.s, S=27.9a.s.w).

Figure A9.5 depicts monthly variations in mean length of landed *O. vulgaris*. There is evidence of two peaks of larger sized octopus, the first in winter months and the second in summer. The winter larger animals are caught in ca. 1 month earlier by the trawl fleet than by the polyvalent fleet. Trends between the polyvalent fleet and the trawlers seem to be consistently mismatched regarding the lowest mean length, with the notorious exception of 2016. Smaller mean length is usually landed in late summer/autumn by the polyvalent fleet. The mean length pattern in landings by the trawl fleet shows variable seasonality. Differences in fishing grounds (trawl catches more offshore than polyvalent fleet) and the behaviour of the two fisheries regarding octopus catches (by catch or target species) account for those differences.

Figure A9.5 – Seasonality in mean length of *O. vulgaris* in the Trawl and Polyvalent fleets between 2009 and 2016.

O. vulgaris recruits are estimated to account for 44.16% of the OTB fleet landings and 29.75% of the polyvalent fleet landings in the 2009–2016 period. *O. vulgaris* recruits were landed mainly in spring/summer by the OTB fishery between 2009 and 2011, and additionally in autumn since 2012. The highest landings of recruits from the polyvalent fishery occur in autumn/early winter (September through January) (Figure A9.6). Inter annual variation of the seasonal recruitment pattern is significant for the OTB. The seasonal pattern of recruit landings by the polyvalent fishery is consistent. The highest proportions of recruits in landings were verified in the years 2012, 2013 and 2016.

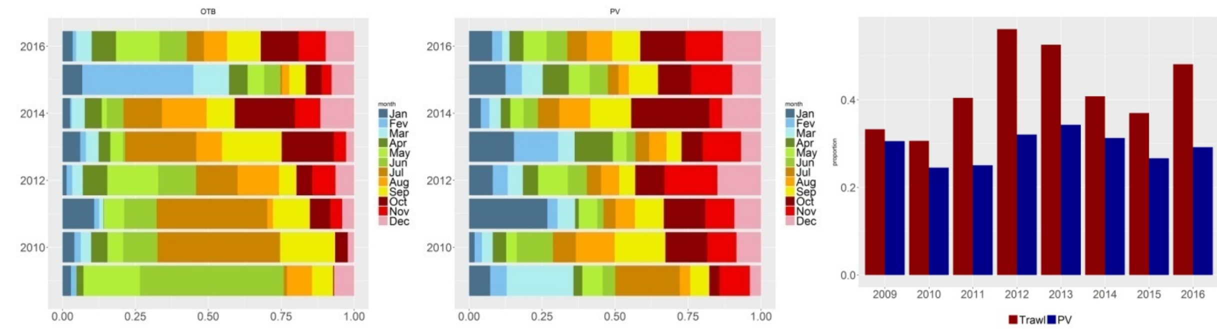

Figure A9.6 – Trends in seasonal and annual recruitment of *O. vulgaris* in the Trawl and Polyvalent fisheries.

Loligo spp. and *Alloteuthis* spp.

Landings and Discards

The effort to report long-finned squid landings by species is noticeable since 2005 (Table A9.8). However, due to the recent reappearance of *Loligo forbesii* in Portuguese waters, and the difficulty in the distinction between the two species, it is expected that the recent official landing statistics reported as *L. vulgaris* may contain some *L. forbesii*. *Alloteuthis* sp. and *A. subulata* landings started to be recorded since July 2008, separated from *Loligo* species. In spite of this, both *Alloteuthis* sp. and *A. subulata* landings should be joined and regarded as *Alloteuthis* sp., because of the co-occurring though less abundant *A. media*.

Table 9.8 – *Loligo* and *Alloteuthis* landings (in tons) from ICES sub area 9.a (only Portuguese waters) between 2003 and 2016.

Year	*Loligo* nei	*Loligo vulgaris*	*Alloteuthis* nei
2003	289	0	0
2004	1009	0	0
2005	242	205	0
2006	37	52	0
2007	18	110	0
2008	18	322	2
2009	4	195	34
2010	6	201	46
2011	4	214	107
2012	27	268	114
2013	7	118	78
2014	5	157	41
2015	0	282	132
2016*	0	269	31

*provisional data.

Loligo sp. landings remained in 2016 at a low level compared to the early 2000. Nevertheless, there is an increasing trend since the lowest landings recorded in 2006 (Figure A9.7), and 269 tons is above the last 10 years mean (222 tons).

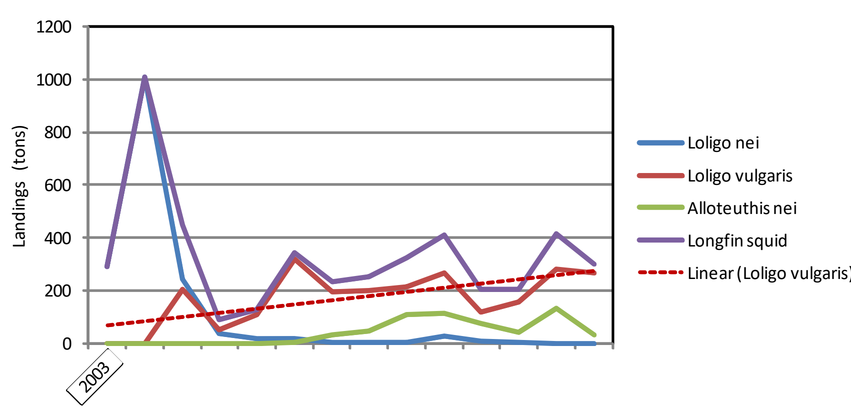

Figure A9.7 - *Loligo* and *Alloteuthis* landing trends in ICES sub area 9.a (only Portuguese waters).

In this group of species (Loliginidae), *Alloteuthis* sp. is the more frequently discarded taxon, especially in OTB_DEF (see loliginids discards in Table A9.2). However, percentages of occurrence are still low and discards are considered negligible or very low. No estimates of discards may be calculated with acceptable confidence, except for 2004 and 2005 (81t and 36t with coefficients of variation of 43% and 20%, respectively). Discards of *Alloteuthis* sp. are mainly related to market reasons (low or no commercial value) and the decreasing values in recent years may reflect some new market interest in these species (Moreno *et al.*, 2013).

Both *L. vulgaris* and *Alloteuthis* are mainly taken by the trawl fishery, ca. 65% and 85% respectively (Table A9.9). *L. vulgaris* landings from the purse seine fleet derive from beach seine vessels. The bulk of loliginids landings are taken on the sub area 27.9a.c.n. *L. vulgaris* landings in the Algarve (27.9a.c.s) are slightly higher than in 27.9a.c.s. (Table A9.10)

Table A9.9 – Landings in tons of *Loligo* and *Alloteuthis* by fleet type in 2015 and 2016.

Year	Fleet	*Alloteuthis*	*Loligo vulgaris*
2015	MIS	14.0	101.1
	OTB	117.9	178.8
	PS	0.0	1.9
2016	MIS	6.6	91.3
	OTB	24.8	174.0
	PS	0.0	3.8

Table A9.10 – Landings in tons of *Loligo* and *Alloteuthis* from regional sub-areas in 2015 and 2016 by the Portuguese fleets.

Year	Sub-Area	*Alloteuthis*	*Loligo vulgaris*
2015	27.9a.c.n	124.5	195.3
	27.9a.c.s	7.5	31.2
	27.9a.s.w	0.0	55.3
2016	27.9a.c.n	29.0	139.0
	27.9a.c.s	2.4	55.1
	27.9a.s.w	0.0	75.0

LPUE and Recruitment trends

A regional fishery abundance index for loliginids was estimated based on catch and effort data for OTB vessels with positive loliginid monthly landings in the Algarve and the west Portuguese coast. The index for Algarve is still incomplete, but these preliminary results seem to indicate rather similar trends between the two regions (Fig. A9.8). LPUE trend for Portuguese waters show peaks in loliginid abundance in 1994, 2005 and 2015.

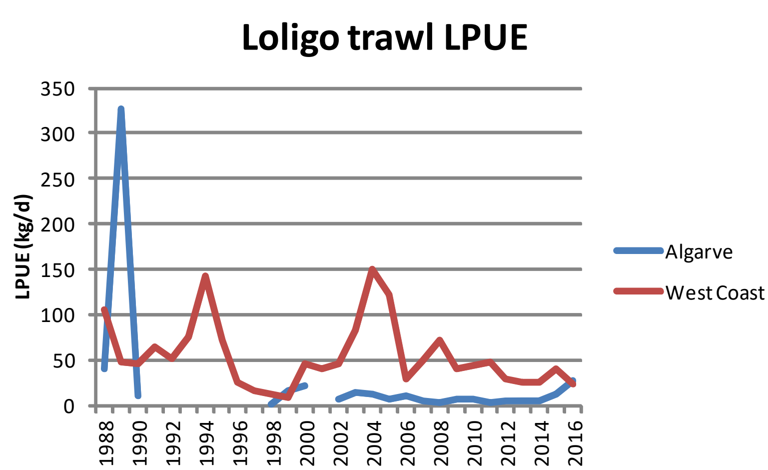

Figure A9.8 – Loliginid CPUE trends based on vessels with positive loliginid monthly landings in the Algarve (9a.s.w) and the west Portuguese coast (9a.c.n. and 9a.c.s).

Survey trends and distribution

Data collected from the Portuguese Groundfish Survey (PGFS) provides an abundance index, namely the mean number per hour tow, for loliginid species. Since 1990, the mean abundance of *L. vulgaris* was 6.4 ind/h, with a slight increase since 2007. Abundance is similar on the west coast and the Algarve (Figs. A9.9 and A9.12).

L. forbesii has become a rare species in Portuguese Surveys with an abundance index below 1 ind/h since 1992. *L. forbesii* is generally more abundant on the west coast (Figs. A9.10 and A9.12).

*Alloteuthi*s spp is very abundant in the Portuguese coastal waters (Figs. A9.11 and A9.12). The abundance of these species has been increasing since the earlier 2000's until 2009, where a maximum of 1600 ind/h was reached. From 2010 onwards, abundance started to decline to 135 ind/h in 2016, a value below the average of 445 ind/h for the 1990–2016 series. It is noteworthy the fact that *Alloteuthis* landings in the commercial fleet do not follow this increasing trend in the abundance levels. *Alloteuthis* distributes preferentially in the northwest sub-area.

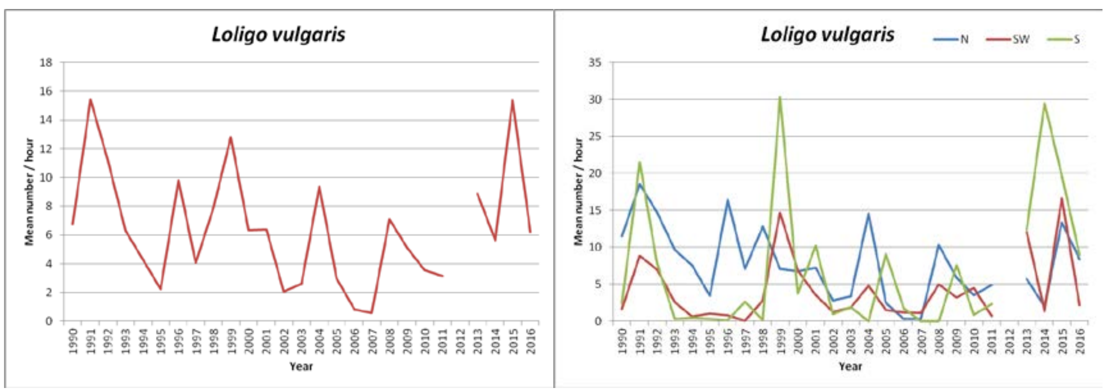

Figure A9.9 – Abundance index for *Loligo vulgaris* from PGFS from 1990 to 2016 (left – whole area, right (N=9a.c.n, SW=9a.c.s, S=9a.s.w).

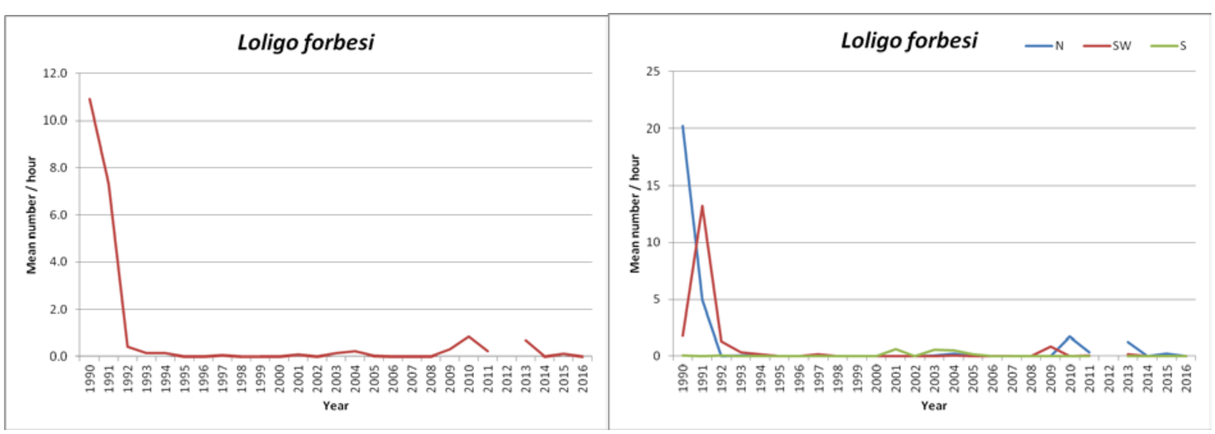

Figure A9.10 – Abundance index for *Loligo forbesii* from PGFS from 1990 to 2016 (left – whole area, right (N=9a.c.n, SW=9a.c.s, S=9a.s.w).

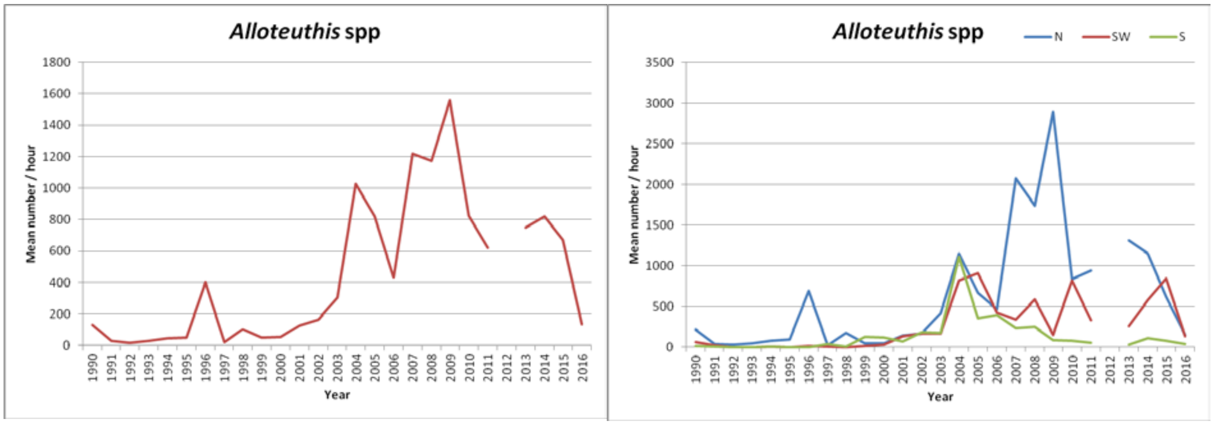

Figure A9.11 – Abundance index for *Alloteuthis* spp from PGFS from 1990 to 2016 (left – whole area, right (N=9a.c.n, SW=9a.c.s, S=9a.s.w).

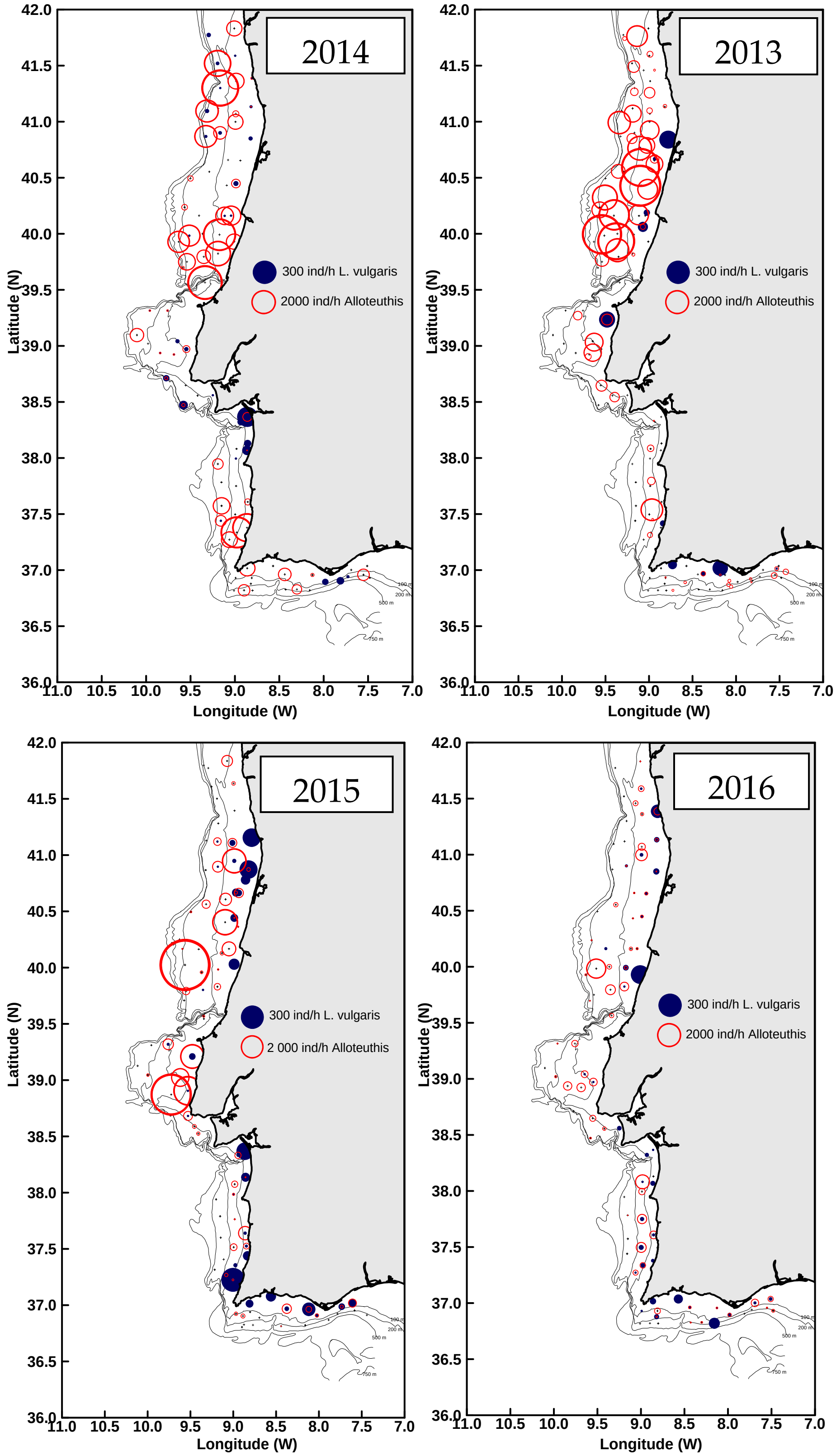

Figure A9.12 – Geographic distribution of *L. vulgaris* and *Alloteuthis* sp. given by the Portuguese Groundfish survey (PGFS) between 2013 and 2016.

Population structure and recruitment trends

The modal length of *L. vulgaris* catches is in the bottom trawl fishery was 14.5 cm. The length distribution of catches by the polyvalent vessels is bimodal (12.5 cm and 42 cm) (Fig. A9.13). The mean length of squid in the bottom trawl landings was quite constant throughout the period of 2009–2016 (Fig. A9.14).

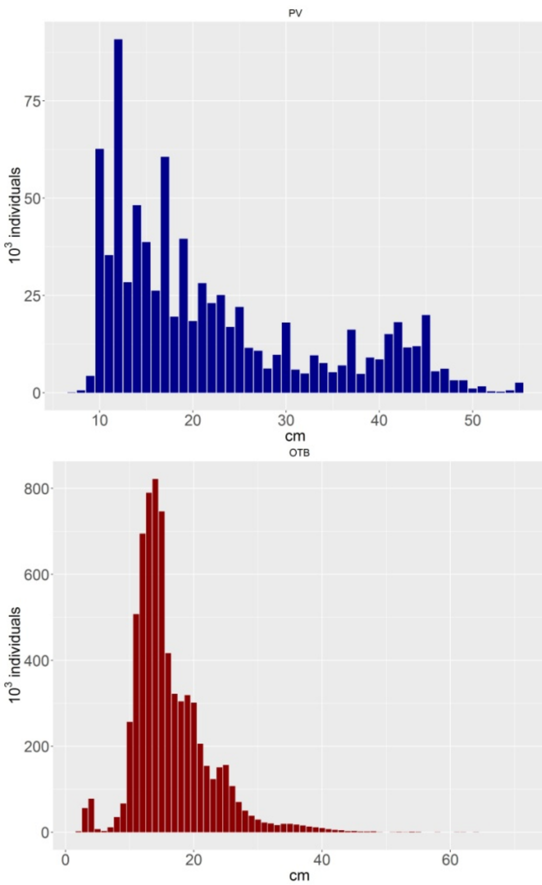

Figure A9.13 – *L. vulgaris* length classes for the bottom trawl and polyvalent fisheries between 2009 and 2016.

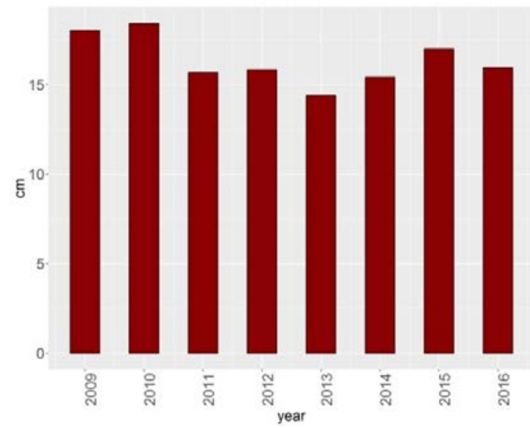

Figure A9.14 - Annual variation of mean length of *L. vulgaris* in the trawl fishery between 2009 and 2016.

Recruits (ML<14 cm) accounted for 34.79% of landings in the bottom trawl fishery. Recruitment of *L. vulgaris* usually peaks between September and January. 2011, 2012/13 and 2015/16 were particularly strong timings in this regard (Fig. A9.15 and A9.16).

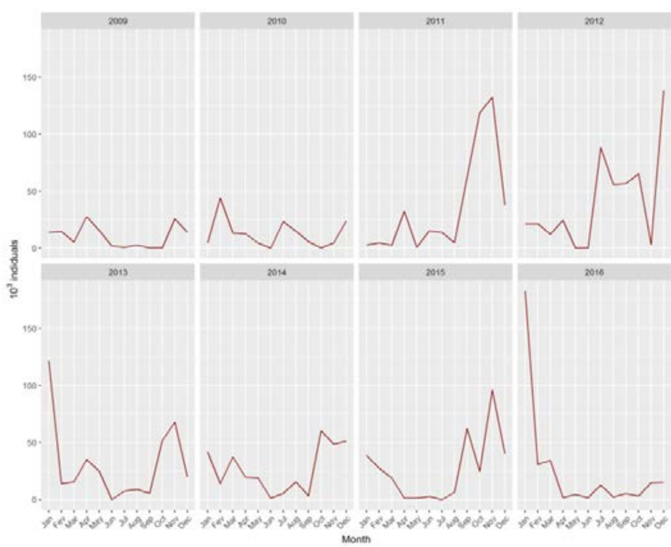

Figure A9.15 – Annual trends in recruitment of *L. vulgaris* to the trawl fisheries.

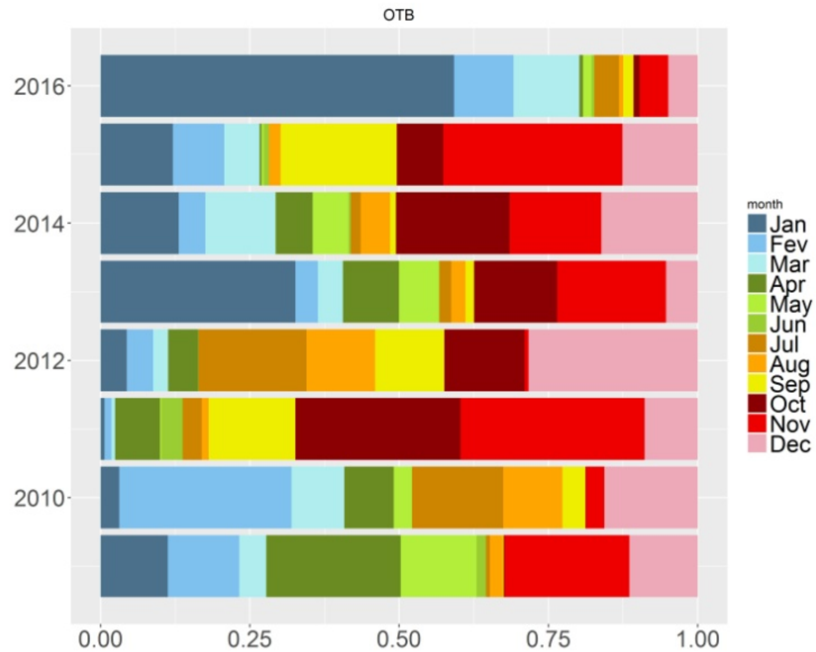

Figure A9.16 – Monthly proportion of *L. vulgaris* recruits in the trawl landings.

Cuttlefish

Landings and Discards

The annual landings of cuttlefish, *Sepia officinalis*, from the Portuguese waters of ICES sub-area 9.a, averaged 1444 tons between 2003 and 2016. There is a slight decreasing trend in this period and, in the last five years, landings averaged 1231 tons (Fig. A9.17). The cuttlefish fishery is mostly a small-scale fishery. Trammel nets and traps are the main fishing gears utilized to catch cuttlefish. However, most landings are reported in mix metiers of the polyvalent fleet (collection of fishing gears permissions), (Table A9.11). Cuttlefish is an important fishery resource in all Portuguese sub-areas (Table A9.12) and differences in regional landings reflect differences in year to year availability of local populations.

Discards of *S. officinalis* are considered negligible in bottom otter trawl fleets given its low frequency of occurrence in sampled hauls (mean values for 2004–2016 periods are less than 2% in both fleets). In what concerns to discards from polyvalent fleet (operating with gill and trammel nets), onboard sampling observations show no evidence of relevant discards from this species. This is a species with high commercial value and discards only occur when individuals are damaged. However, estimation of discards at fleet level is not being performed because information on adequate effort measures for polyvalent fleet (number of hauls, soaking time, length of the gear, etc.) is difficult to obtain due to the use of more than one type of fishing gear in the same trip.

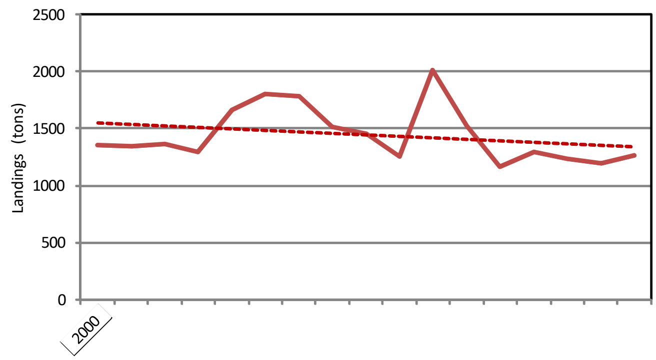

Figure A9.17 – *S. officinalis* landings from ICES sub area 9.a (Portuguese waters only).

Table A9.11 – Landings in tons of *S. officinalis* by fleet type in 2015 and 2016.

Year	Fleet	*S. officinalis*
2015	MIS	1161.2
	OTB	27.7
	PS	4.1
2016	MIS	1230.7
	OTB	33.7
	PS	1.8

Table A9.12 – Landings in tons of *S. officinalis* from regional sub areas in 2015 and 2016 by the Portuguese fleets.

Year	Sub-Area	*S. officinalis*
2015	29.9a.n	7.5
	27.9a.c.n	400.8
	27.9a.c.s	519.0
	27.9a.s.w	273.2
2016	29.9a.n	6.1
	27.9a.c.n	326.9
	27.9a.c.s	281.1
	27.9a.s.w	658.2

The cuttlefish landings are markedly seasonal, with most of the landings conducted in the first semester of the year. A peak in April is usual and this was also verified in 2015 and 2016 (Fig. A9.18). The seasonality of cuttlefish landings from the trawl (OTB) and polyvalent (MIS) fleets have some differences related to the availability in their respective fishing grounds. The trawl fishery lands cuttlefish mostly between November and March (peak Jan-Feb), earlier than the polyvalent fishery which lands cuttlefish mostly between January and June (peak April).

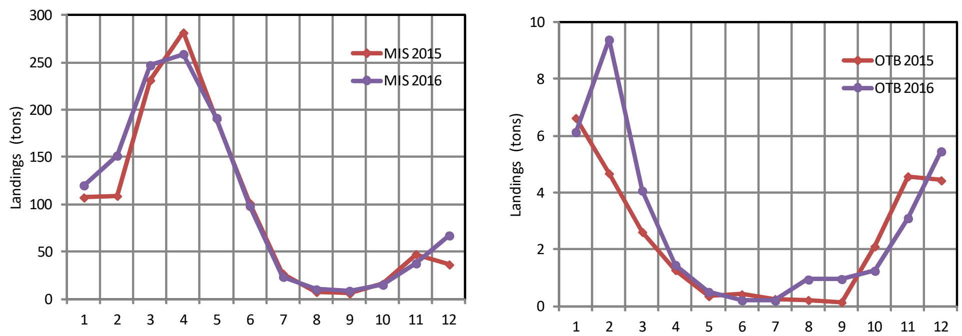

Figure A9.18 – *Sepia officinalis* monthly landings by the polyvalent (left) and the trawl fishery (right) from ICES sub area 9.a (Portuguese waters only).

LPUE

A regional fishery abundance index for *S. officinalis* was estimated based on catch and effort data for OTB vessels with positive cuttlefish monthly landings. LPUE trend for Portuguese waters show peaks in cuttlefish abundance in 2003 and in the period between 2005 and 2008 and a significant decrease since 2005. The abundance is generally lower in the 9a.c.s. and generally higher on the Algarve (9a.s.w) on the trawl fishing grounds. However, in some years (2002, 2006, 2008 and 2014) cuttlefish abundance in the 9a.c.n was higher than on the other sub-areas. Nevertheless, the decreasing trend in the last 10 years is similar in all sub-areas (Fig. A9.19).

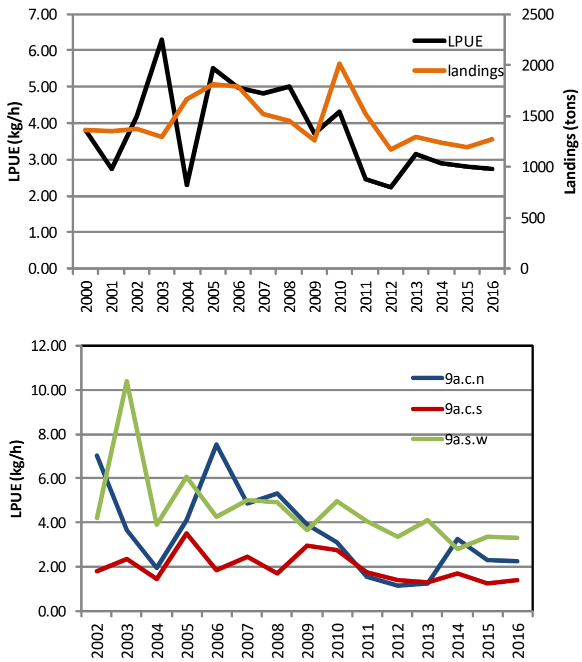

Figure A9.19 – Cuttlefish LPUE trends: total trawl LPUE and total landings (left) and trawl LPUE in the sub-areas 9a.c.n, 9a.c.s. and 9a.s.w (right) based on vessels with positive monthly landings.

Population structure and recruitment trends

The modal lengths of *S. officinalis* catches were 10.5 cm in the bottom trawl fishery and 17.5 cm in the polyvalent fishery (Fig. A9.20). Mean length in the polyvalent fisheries was consistently higher throughout the period of 2009–2016 (Fig. A921).

Recruits (% below modal length) accounted for 17.17% of landings in the bottom trawl fishery and 5.25% of landings in the polyvalent fishery. Recruit landings of *S. officinalis* peaks in the months of November and December on the bottom trawl fishery and March-May for the polyvalent fishery (Fig. A9.22).

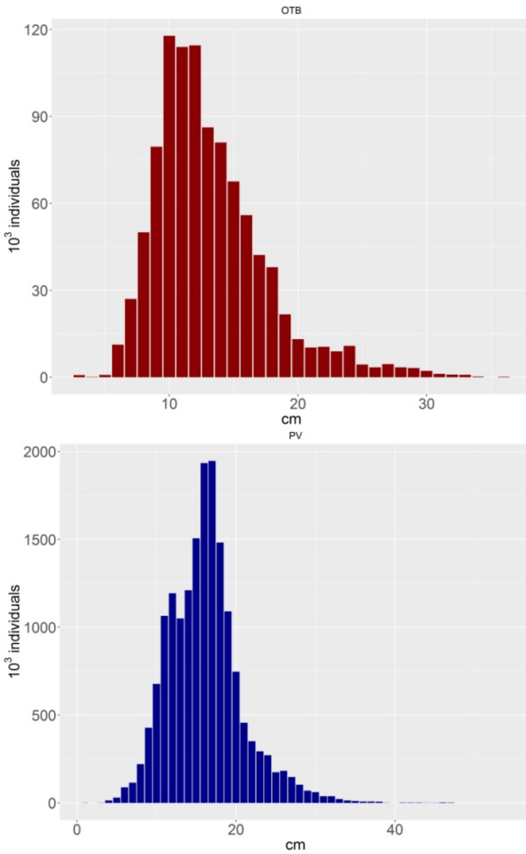

Figure A9.20 – Cuttlefish length classes for the bottom trawl and polyvalent fisheries between 2009 and 2016.

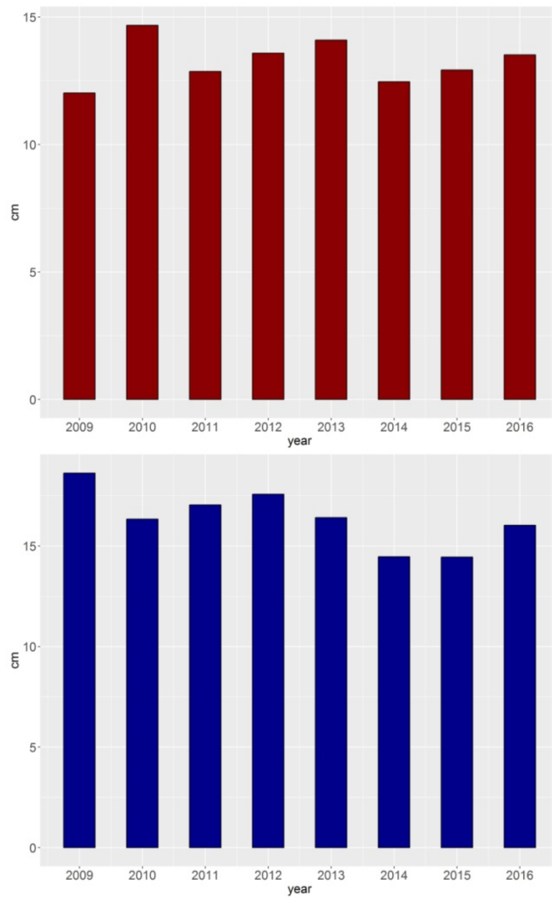

Fig. A9.21 – Length classes for the bottom trawl and polyvalent fisheries between 2009 and 2016.

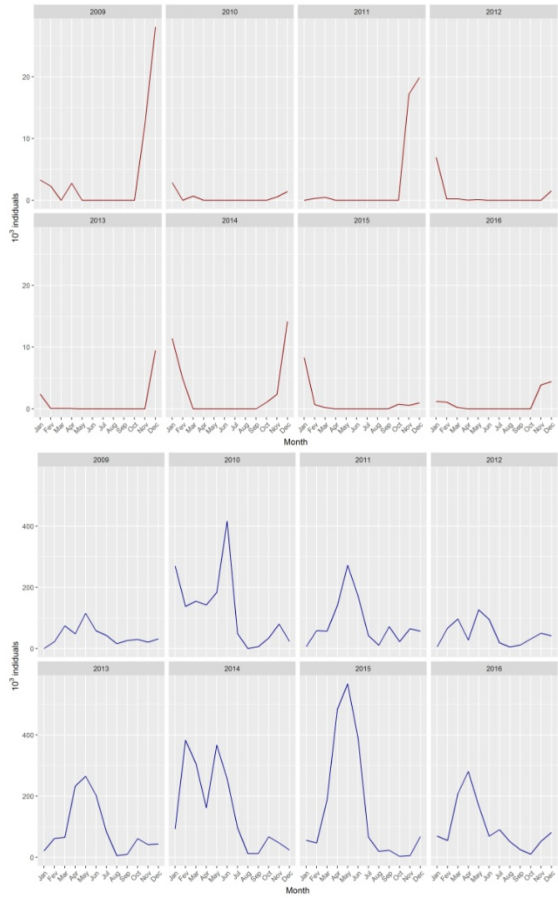

Figure A9.22 – Trends in recruitment of *S. officinalis* to the trawl and polyvalent fisheries.

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Annex 10: ToR B) Working Document: Octopus abundance and climate in the Gulf of Cadiz fishery

Influence of environmental parameter on the abundance of Octopus (*Octopus vulgaris*, Cuvier, 1797) in the Gulf of Cadiz

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INTRODUCTION

The Spanish South Atlantic Region (Gulf of Cádiz, ICES Division 9a south, SSAR) extends from Portugal to the Gibraltar strait. Demersal resources in the SSAR have long been characterized by the considerable diversity of exploited species (fish, crustaceans and molluscs) and of a wide variety of fishing gears. Multi-gear and multi-species fisheries compete for the same resource, exploited by very different fleets and gears. Nowadays, a trawl fleet of 130 vessels operates off the Gulf of Cadiz. The mean characteristics of this fleet are 37 GTR, 213 HP and 18 m. length. This fleet shows great heterogeneity in its exploitation pattern, fishing different species depending on the vessel's characteristics, the landing port, the season of the year and the personal criteria of the fishing skipper. The artisanal fishery in the Gulf of Cadiz is of a marked multi-gear and multi-species nature, where a fleet composed of around 540 vessels captures more than 50 commercial species (Sobrino *et al.*, 1994). The mean annual catch of this fleet is 12000 t, with the normal interannual variations. No particular species can be referred to as the principal one. Only the octopus (*Octopus vulgaris*) represents as much as 10% of the overall catch.

Octopus is a merobenthonic species with a short life cycle (about 12 to 15 month, Perales-Raya *et al.* 2010, Katsanevakis and Verriopoulos (2006), with a rapid non-asymptotic growth ((Alford and Jackson,1993) and high fecundity (from 70 000 to 634 445 oocytes; Mangold-Wirz, 1963a; Silva *et al.*, 2002; Otero *et al.*, 2007). This species is considered as displaying mainly r-strategist traits (Boyle, 1996).

Fluctuations in abundance of exploited stocks may be due to a great variety of factors. However, in short-lived animals such as cephalopods, where abundance depends on strength of the recruitment, it is well known that abundance is highly influenced by the environmental conditions, which affect recruitment (Caddy, 1983; Fogarty, 1989; Pierce *et al.*, 2010). Various studies relate distribution and abundance to environmental parameters in both demersal and pelagic cephalopods (Pierce, 1995; Mangold, 1997; Robin and Denis 1999; Pierce *et al.*, 1998; Waluda and Pierce, 1998, Bellido *et al.* 2001; Balguerias *et al.*, 2002; Sobrino *et al.*, 2002; Wang *et al.*, 2003).

In this study we investigated the relationship between octopus abundance and various hydrographic and oceanographic parameters that might plausibly influence abundance

(Sea Surface Temperature; Sea Surface Salinity; Surface Chlorophyll; Surface turbidity; NAO Index; Rain; WeMoi Index; AMO index; River discharges).

MATERIAL AND METHODS

Database of environmental parameters

In Table A10.1 we present all climatic and oceanographic covariables that have been used (monthly or yearly). We applied the protocol for data exploration described by Zuur *et al.* (2010), consisting of investigating the presence of outliers, homogeneity, normality, zero trouble, collinearity, relationships, interactions and independence.

Table A10.1. Initial climatic and oceanographic variables used (* Monthly data).

	name	unit	source
SST*	Sea Surface Temperature	ºC	Pathfinder AVHRR (1993–2002) and MODIS Aqua (2003–2015)
Chla*	Chlorophyll	mg m^{-3}	Seawifs (1997–2002) and MODIS Aqua (2003–2015)
SPM*	Suspended Particulate Matter.	m^{-1}	GlobColour (http://hermes.acri.fr/)
Rain*	Rainfall	l/m^2	Agencia Estatal de Meteorología
River*	River discharge.	m^3/s	http://www.chguadalquivir.es/saih/DatosHistoricos.asx
NAO	North Atlantic Oscillation	atm	https://crudata.uea.ac.uk/~timo/datapages/naoi.htm
AMO	Atlantic multidecadal oscillation.	ºC	http://www.esrl.noaa.gov/psd/data/timeseries/AMO/
WeMOi	Western Mediterranean Oscillation.	atm	http://www.ub.es

In the case of collinearity (r>0.5), we calculate the mean value of these covariates. Finally we select the covariate presented in Table A10.2.

Table A10.2 Covariates of environmental parameter used

Covariates Used	Description	Period
Rainperiod	Rain between September to August	1997–2015
Riverperiod	Guadalquivir discharge between September to August	1997–2015
Nao	NAO Index (mean December to March)	1997–2015
Amoperiod	Sum of Amo index between October to September	1997–2015
WeMOiperiod	WeMOi index (mean December to March)	1997–2014
sst11.3	Surface Temperature Mean between November to March	1997–2015

sst4	Surface Temperature in April	1997–2015
sst5.6	Surface Temperature Mean between May to June	1997–2015
sst7	Surface Temperature in July	1997–2015
sst8.10	Surface Temperature Mean between August to October	1997–2015
chla1.3	Chlorophyll mean January to March	1997–2015
chla4.6	Chlorophyll mean April to June	1997–2015
chla7.10	Chlorophyll mean July to October	1997–2015
chla11.12	Chlorophyll mean November to December	1997–2015
Tur-Extr1_4	Turbidity mean January to April	1997–2015
Tur-Extr5_11	Turbidity mean May to November	1997–2015
Tur-Extr12	Turbidity in December	1997–2015

Octopus abundance index

For indices of abundance, we used two different sources: data from fisheries statistical and data for demersal surveys.

We have monthly statistical data from 1993 to 2015 from trawl and artisanal fleet in the SSAR. Also we have monthly data of landing for unit effort (LPUE) for trawl fleet in the same period.

Since 1993 the Spanish Oceanographic Institute (IEO) has been carrying out two series of annual bottom trawl surveys (ARSA) in the Gulf of Cadiz (spring and autumn series), aimed at assessing the most important demersal resources in the surveyed area (Anon. 2015). The autumn surveys are during the recruitment season of octopus in November. We considered as recruit all specimens below of 9 cm ML (about 450gr) in the Gulf of Cadiz.

The recruit index was calculated in number of recruit/hour applied a sampling stratify methods. We also considered the number of hauls that were carried out in an important recruitment area because in each survey we applied a stratified random sampling.

Data analysis

We used Poisson, Gaussian and Negative Binomial Generalized Lineal Model (GLM) and Generalized Additive Models (GAM) to found the best model. To validate the fitted models, standardized or Pearson residuals were plotted against fitted values, against each covariate in the model and against each covariate not included in the final model. Also we explored the collinearity among the covariates and overdispersion, and carried out cross-validation. Akaike's information criterion (AIC) was used as a measure of goodness of fit to compare the models.

All statistical analyses were run in R (R Development Core Team, 2016)

RESULTS

The trend of landings in this period is presented in Figure A10.1. We can observe a strong fluctuation along the time-series.

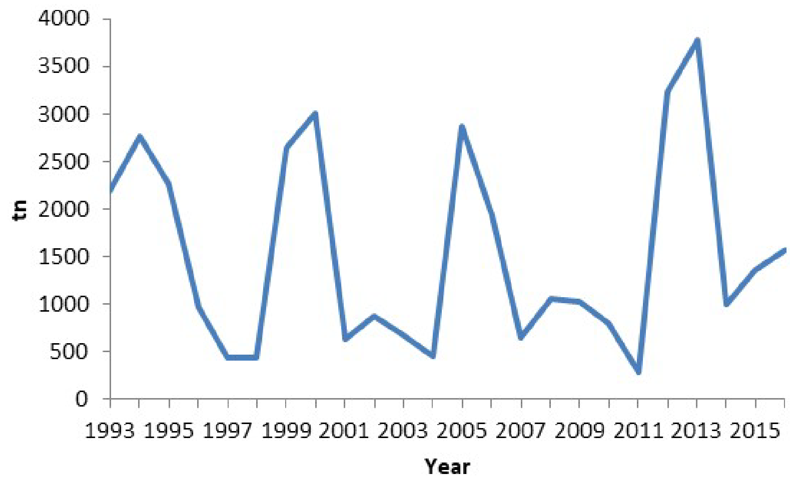

Fig A10.1. Trend of total annual landings (tons) of *Octopus vulgaris* in the Gulf of Cadiz.

In Figure A10.2 we present the mean value of landing by months. In the Gulf of Cádiz, the breeding season extends from February to October, with spawning peaks in April–May and August (Silva *et al.*, 2002) and the duration of the egg stage ranges from 20–120 days, depending inversely on temperature (Mangold, 1983a). The duration of the planktonic phase is from 1 month to nearly 2 months. We can consider October-November as a recruitment period.

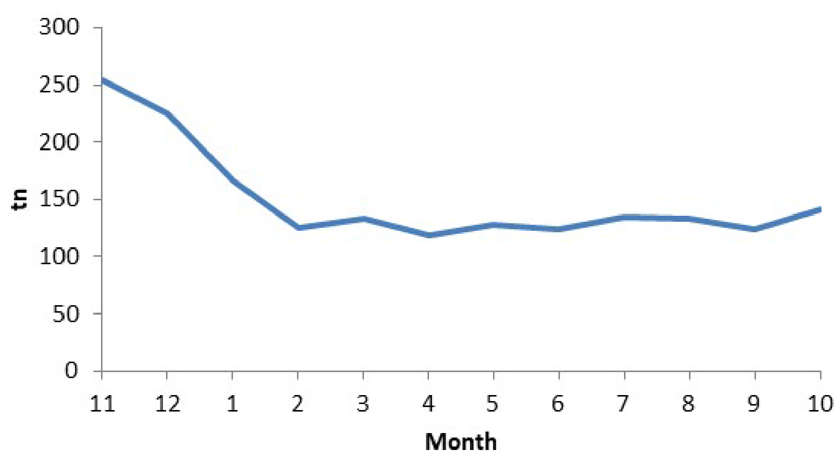

Figure A10.2. Seasonality of average landings of *Octopus vulgaris* in the Gulf of Cadiz.

Plotting the number of recruits caught by grid during the autumn survey series, we identified three main recruitment areas (Figure A10.3).

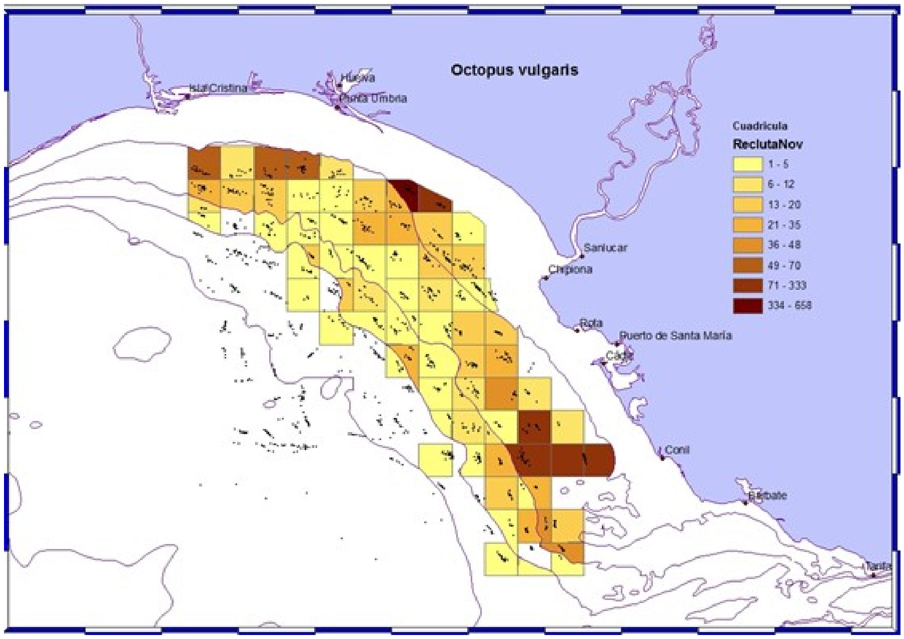

Figure A10.3. Recruit index in number/hour in autumn surveys by grid

Relationship between abundance index and environmental parameters

Only the Rain and temperature in April (SST4) in the previous year showed a correlation with our abundance index (Total catch). The best model found between theses covariates and the response variable (total catch in the period November-October) was a Generalized Additive Model (GAM) with a negative binomial function as a density function. In Table A10.3 is presented the result of the three models applied.

Table A10.3. Relationship between total catch (Abundance Index AI) and environmental variables

Relationship	Covariate	Model	Theta	p_value	Deviance	AIC	Overdispersion
AI vs Rain & SST	Rain and SST4	GAM	4.9	0.001	78.90%	299	0.9
AI vs Rain	Rain	GAM	3.3	0.001	60.5%	303	0.96
AI vs SST	SST4	GAM	1.82	0.01	29.2%	314	0.71

The best model related the abundance of octopus with the rain and SST in April of the previous year:

$$\mathbf{Catch_{i+1} = s(Rain_i) + s(SST4_i)}$$

where

$Catch_{i+1}$ is the total landing between November of year i to October year i+1.

$Rain_i$ is the rain between September of year i-1 to August of year i.

$SST4_i$ is the surface temperature in April of year i.

This model explains of 78.9% of variability in abundance. In Figure A10.4 we present the Pearson residual versus fitted values and versus predict values (Eta). Model validation indicated no problems.

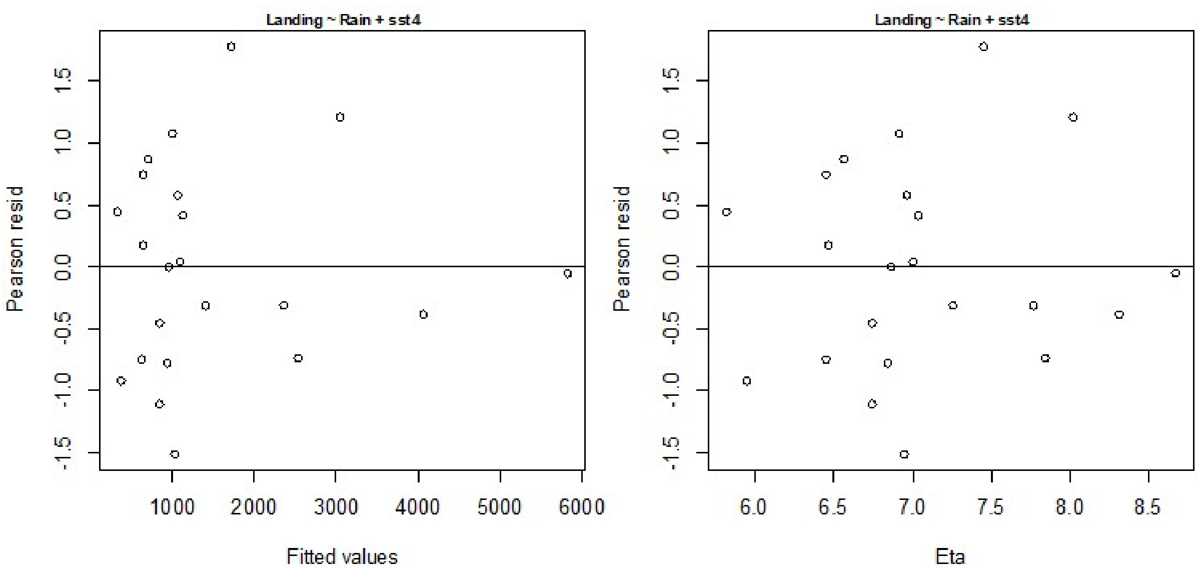

Figure A10.4. Pearson residual versus fitted values and versus predict values (Eta).

In Figure A10.5 we plotted catch versus rain and versus SST4 with the model selected. In the case of rain, the majority of the observations are between confidence intervals and it is a nonlinear regression. In the case of SST4 it is more similar to a linear regression but there are many observations outside of the confidence intervals.

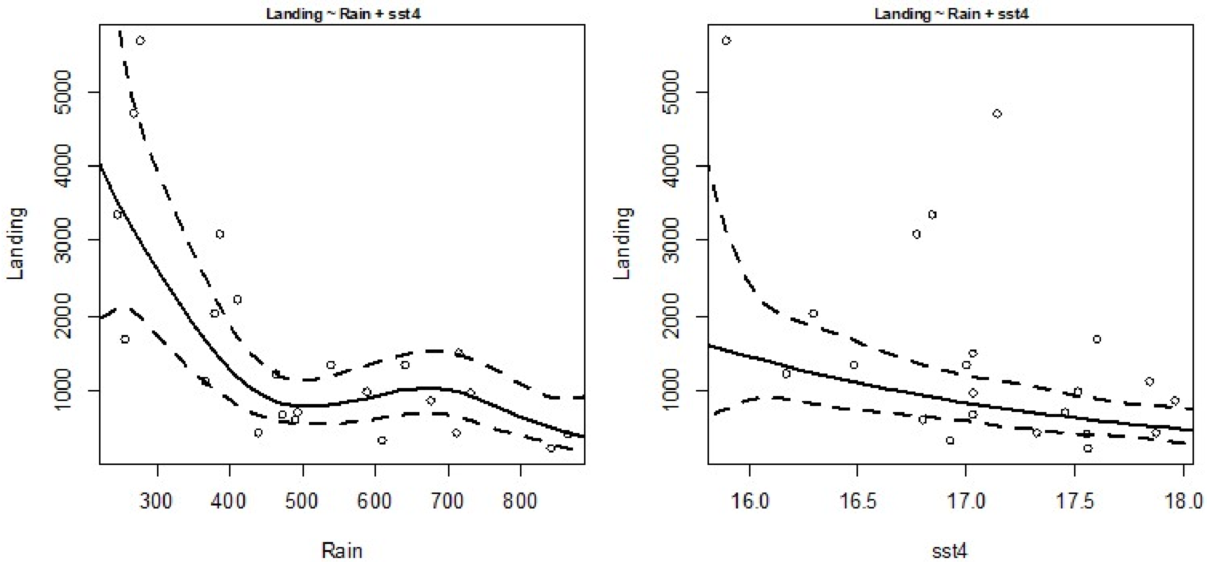

Figure A10.5. Model selected ($Catch_{i+1} = s(Rain_i) + s(SST4_i)$). Dotted lines show 95% confidence intervals and points the valour observed.

Forecasting landing of Octopus vulgaris

In the autumn survey we calculated a recruit index that has been defined before. This index has a strong correlation with the abundance of octopus and can be used to predict the landings for the next fishing period. During the survey we applied a stratified random sampling and the sampled grid is selected randomly. The recruit zone of octopus in the survey area is patchy and the recruit index calculated will be influenced by the grids selected in the survey.

The best model found to predict the landing using environmental parameters and recruit index was a Generalized Additive Models (GAM) with a negative binomial function as a density function:

$Landing_{i+1} = s(Recluit_i) + s(Rain_i) + as.factor(ZoneReclu_i)$

where

$Landing_{i+1}$ is the total landing between November of year i to October year i+1.

$Rain_i$ is the rain between September of year i-1 to August of year i.

$Recluit_i$ is the recruit index of autumn survey of year i.

$ZoneReclu_i$ is the number of stations performed within the recruitment zone.

This model explains 89.7% of variability in annual catch and could be used to predict the landings in the next period. Model validation indicated no problem. In Figure A10.6 we present the Pearson residual versus fitted values and versus predict values (Eta).

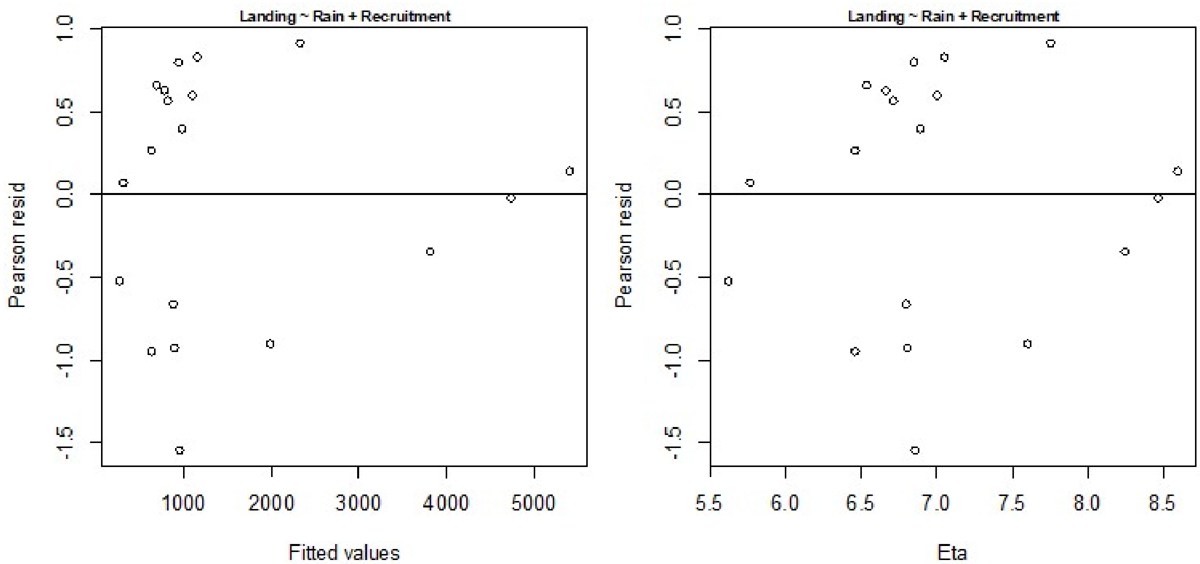

Figure A10.6. Pearson residual versus fitted values and versus predict values (Eta).

In Figure A10.7 we plotted landing versus Rain and versus Recruit index with the model selected with different values of ZoneRecruit (1, 2, 3, and 4). According to the sampling intensity within the recruitment zone, four types of surveys were identified with 1, 2, 3 or 4 hauls deployed in the recruitment area. The model shows lower variability and better adjustment when 3 or 4 stations fall within the recruitment area (ZoneReclu= 3 or 4) rather than when only 1 or 2 stations are performed in the recruitment zone (ZoneReclu= 1 or 2).

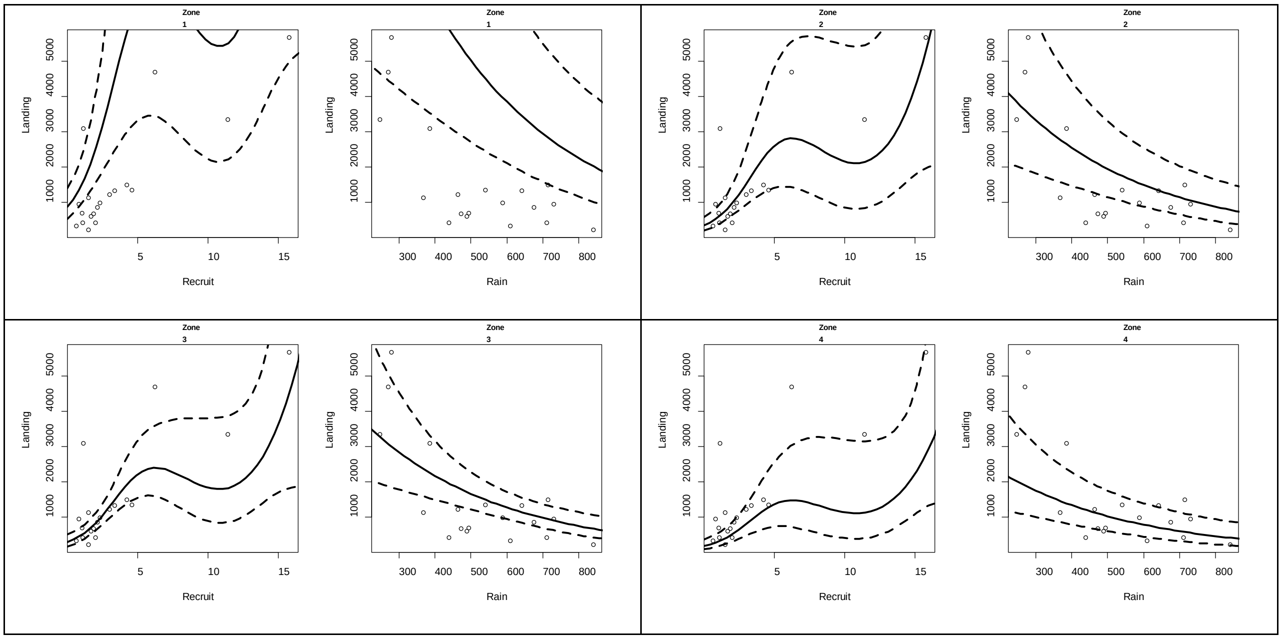

Figure A10.7. Model Landing$_{i+1}$ = s(Recruit$_i$)+(Rain$_i$)+ as.factor(ZonaReclu$_i$) to forecast the landing with different sampling intensity in recruit zone. Dashed lines are 95% confidence intervals.

CONCLUSION

The abundance of octopus in the Gulf of Cadiz is influenced mainly by rain in the previous year and secondary by the surface sea temperature in April of the previous year.

The recruit index obtained in autumn survey can be used to forecast the landing in the next year but this index it is influenced by the number of stations sampled within the recruitment zone. For this reason in the future, it is recommended that 3 or 4 hauls should be performed within the recruitment area during the autumn surveys.

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Annex 11: ToR C) Working document: Review of recent publications about life-history parameters in Cephalopods exploited in ICES waters

A11.1 Introduction

This section presents a brief review of the recent publications on the major cephalopod species commercially exploited in the ICES area and adjacent waters. The following cephalopod species were chosen for review based on the level of commercial exploitation and distribution: octopuses – *Octopus vulgaris*, *Eledone cirrhosa*, *Eledone moschata*; cuttlefishes – *Sepia officinalis* and *Sepia elegans*; squids – *Loligo vulgaris*, *Loligo forbesii*, *Alloteuthis subulata*, *Alloteuthis media*, *Illex coindetii*, *Todarodes sagittatus*, *Todaropsis eblanae* and *Ommastrephes bartramii*. Over 200 journal articles devoted to studies of life history, distribution, trophic relationships, taxonomy, fisheries and impact of climate change on these species were published during the last five years (2013–2017).

The majority of studies were devoted to 5 cephalopod species - *O. vulgaris* (85 articles), *S. officinalis* (42), *L. vulgaris* (13), *I. coindetii* (15) and *O. bartramii* (31). Such interest in *O. vulgaris* and *S. officinalis* reflects their exceptional importance for European fisheries and the interest in aquaculture. Thanks to well-developed methods of rearing in captivity, common octopus and common cuttlefish serve as models in a wide variety of studies. Both species are exploited across their range, providing the highest catches among cephalopods in the European waters. The next two species, *L. vulgaris* and *I. coindetii*, are the main commercially exploited squid species in Europe among the Myopsids and Oegopsids, respectively. Depending on region and season, *L. vulgaris* can contribute up to 90% of total loliginid catch while *I. coindetii* makes up to 80% of ommastrephid landings (Jereb *et al.*, 2015). In contrast to the aforementioned species, *O. bartramii* is mainly studied in the Pacific and more than 90% of articles reviewed were devoted to studies of Pacific populations of this squid. However, a number of these outputs are also relevant to Atlantic populations.

Other commercially exploited cephalopod species in the ICES area (*E. cirrhosa*, *E. moschata*, *S. elegans*, *L. forbesii*, *A. subulata*, *A. media*, *T. sagittatus*, *T. eblanae*) have been the subject of fewer studies in the last 5 years.

A11.2. Octopus vulgaris

A11.2.1. Introduction and overview

More than 90 journal articles connected with studies on this species were published during the period from 2013 to 2017. Recent studies on environmental effects allowed not only identification of factors affecting the distribution, migration and survival of adult octopuses, but also provided information on the impact of waters conditions on the paralarvae. This knowledge contributes to improvement of quality of life for reared larvae, which facilitates achievement of faster growth and better survival. Studies of various approaches to feeding octopus paralarvae, and an analysis of the effect of dietary nutritional composition on the composition and development of octopus tissues, contributed to better understanding of the nutritional requirements of hatchlings and juveniles. In addition, a considerable number of recent studies concerned age estimation, growth rates, parasite infections, morphology and reproductive biology of *O. vulgaris*.

Jereb *et al.* (2015) identified the following topics as important for future research: investigations on (1) early life stages, (2) the influence of environmental conditions on wild *Octopus vulgaris* populations and (3) development of inert diets or microencapsulated products to produce enriched *Artemia* for feeding paralarvae. Topics 1 and 3 continue to be areas in which further work is needed.

A11.2.2. Environmental effects

Previous studies on *Octopus vulgaris* have highlighted the need to develop topics such as early life stages and the influence of environmental conditions on the wild populations. Moreno *et al.* (2014a) showed that changes in bottom salinity and river runoff are major influences on *O. vulgaris* distribution and abundance. Salinity change affects the intensity of feeding and survival of octopuses (Amado *et al.*, 2015; Iglesias *et al.*, 2016). Low salinity leads to decreased food consumption and ultimately to the cessation of feeding. Decreased salinity during runoff events can be fatal to octopus, due to disruption of osmoregulation (Raimundo *et al.*, 2017). However, octopuses can survive reduced water salinity (not lower than 30 psu) at least for short periods.

Investigation of the spatio-temporal dynamics of the post-settlement population sex ratio of *O. vulgaris* off the NE Atlantic showed that sex ratio varied along a bathymetric gradient and between seasons (Alonso-Fernandez *et al.*, 2017). Male dominance was observed in summer, while autumn populations were female-biased. A larger proportion of females was observed in deeper waters during winter and spring. New information on environmental impacts on octopus abundance and the period of reproduction in the Northern Alboran Sea is described by Garcia-Martinez *et al.* (2017). A direct-observation study in the waters of the Atlantic Galician Islands (NW Spain) showed that the type of dens, substrate, abundance and availability of food are the main factors influencing octopus distribution. Juveniles of *O. vulgaris* generally occupied holes sunk perpendicular into the substrate. Some of the old and well-built dens occupied by older individuals may be used successively by several generations of octopus (Guerra *et al.*, 2014). The availability of shelters can be a limiting factor for octopus distribution, and several studies of different species have described home choice and suggested characteristics used in the selection of hiding places (Mather 1982, Altman 1967, Katsenevakis and Verriopoulos 2004b). A mark-recapture experiment in the Sardinian Sea revealed the significance of food and shelter availability (especially for females) for the migratory activity of *O. vulgaris* (Mereu *et al.*, 2015).

There is still relatively little information available on *O. vulgaris* early life stages. However, some recent studies have contributed to fill this gap. Observation of brooding, female octopus in their natural habitat showed that hatching took place when water temperature increased to ~20°C. During hatching, the females slightly opened and closed the den entrance to provide a way out for the small groups of hatchlings (Hernandez-Urcera *et al.*, 2014). Newly hatched paralarvae use external yolk to grow before they become able to catch prey. The intensity of yolk utilization is highly influenced by the ambient temperature. Lower temperatures reduce the energy requirements and increase the duration of yolk consumption, facilitating the survival of hatchlings (Nande *et al.*, 2017).

Paralarval abundance is influenced by the hydrography and circulation of inhabited waters. For instance, the North-West Iberian upwelling system provides the high water temperature and low water column stability preferred by octopus paralarvae (Otero *et al.*, 2016). Recent studies revealed that *O. vulgaris* paralarvae are not retained over the shelf, but have an oceanic strategy different from the other neritic species (loliginids and sepiolids) (Roura *et al.*, 2015, 2016).

Perales-Raya *et al.* (2017) estimated ages of wild and captive *Octopus vulgaris* paralarvae. Experiments in captivity showed that increment deposition in the beak was influenced by age (increment width increased with age) and temperature (daily increment deposition was confirmed at 21°C but <1 increment per day was recorded at 14°C) but was not affected by diet.

A11.2.3. Diet and nutrition

Recent studies on diets of octopus paralarvae included both experiments in captivity and investigation of the prey spectrum of wild individuals. Experiments revealed that enrichment of live prey by marine phospholipids has a beneficial effect on paralarval growth and improves animal survival rate (Garrido *et al.*, 2016a; Morales *et al.*, 2017; Roo *et al.*, 2017). However, analysis of diet nutritional composition showed that cultured paralarval rations differed significantly from those of wild ones (Garrido e. al., 2016b). *O. vulgaris* paralarvae are highly selective predators and changes in diet are driven by seasonal and spatial changes in availability of prey (Olmos-Pérez *et al.*, 2017; Roura *et al.*, 2017). Comparison of live prey and extruded diets, based on different fish, squid and crabs, revealed that the both types of food apparently promote growth and survival of octopus juveniles equally. Thus, dry, pelleted meals can be used in aquaculture, although optimization is needed as assimilation efficiency is still lower than for natural diets (Querol *et al.*, 2015, Rodríguez-González *et al.*, 2015).

A11.3. Eledone spp.

Jereb *et al.* (2015) highlighted five priority fields for future research on *E. cirrhosa* and *E. moschata*, namely (1) spawning sites, (2) fecundity, (3) studies on early life stages, (4) age increment reading of beaks and stylets, and (5) genetic studies for stock identification of these species. Of these, only three have received substantial attention. Additional research is still needed on stock separation in both *E. cirrhosa* and *E. moschata*¸ spawning sites and early life stages in *E. cirrhosa* and reproductive biology and stock status evaluation in *E. moschata*.

The age of *E. cirrhosa* was estimated using stylets (Regueira *et al.*, 2015) and it was found that lifespan could reach 17 months, with instantaneous growth rates ranging from 0.03% to 2.17% of body weight per day. Reproductive biology of this species in Tunisian waters was described by Rjeibi *et al.* (2014). Parasites of *E. cirrhosa* in the Bay of Biskay and Gulf of Tunis were investigated by Souidenne *et al.* (2016), who examined an 18S rDNA sequence for *D. eledones* which showed genetic differences from other dicyemids. Other studies of *E. cirrhosa* concern distribution, impact of environmental variation and trophic relationships (Lauria *et al.*, 2016, Regueira *et al.*, 2014, Puerta *et al.*, 2014).

Recent studies on *E. moschata* concerned distribution (Gajic *et al.*, 2014, Ikica *et al.*, 2015) and environmental effects on abundance and distribution (Lauria *et al.*, 2016, Torres *et al.*, 2017).

A11.4. Sepia officinalis

A11.4.1. Introduction and overview

In the most recent review of studies on cephalopod life cycle biology (Jereb *et al.*, 2015), the following fields of study were highlighted as important future research directions of common cuttlefish (*Sepia officinalis*): (1) separation of stocks and populations, (2) studies on trace element and isotope composition of hard structures, (3) development of age estimation methods, and (4) investigation of climate change impact on cuttlefish populations.

In past five years, only two of the four topics indicated as priority fields of research by Jereb *et al.* (2015) (the second and fourth listed above) have been covered adequately. Significant advances in stock assessment were also reported. Nevertheless, further studies on climate change impact and the effects of pollution on cuttlefish are still needed, despite the relatively high level of knowledge in this field. Studies on the effect of coastal waste (including plastics, heavy metals, oil industry waste) and sound/light pollution on cuttlefish are of a great interest. Monitoring the exploited stocks' status is essential due to the considerable commercial value of cuttlefish. Protected areas are of great importance, which could benefit the widely-migrating species of cephalopods, and the development of fishery management options for cases of stock depletions. Research is still needed to develop a simple and reliable tool for age estimation.

Methods for cuttlefish age determination are still not very effective (Raya *et al.*, 1994; Le Goff *et al.*, 1998, Bettencourt & Guerra, 2001, Challier *et al.*, 2002, Domingues *et al.*, 2006). Beaks could possibly be used as a practical and reliable tool for age determination but additional studies (validation of increments formation periodicity, investigation of erosion of the tip, etc.) are needed. Studies on the spatial structure of cuttlefish populations remain relevant; the great potential of electronic tags in this field should be noted (Wearmouth *et al.*, 2013). In addition, important results on population structure can be achieved using morphometric analysis of hard structure shape, trace-element composition analysis and molecular methods (Fang *et al.*, 2014 b, Fang *et al.*, 2016 a, Fang *et al.*, 2016 b, Green *et al.*, 2015, Lishchenko *et al.*, 2017; McKeown *et al.*, 2015).

Some studies on cuttlefish published over the last 5 years were not so closely related to these major goals. However, they significantly broaden our knowledge in respect of species biology, its behaviour, study methodologies and fishery management.

A11.4.2. Insights from studies on stable isotopes and trace elements

In a study on the variation of $\delta^{13}C$ and $\delta^{18}O$ in the cuttlebones of three cuttlefish species, Dance *et al.* (2014) showed that the values of $\delta^{13}C$ and $\delta^{18}O$ increased from cuttlebone core to its edge, which may be a consequence of ontogenetic migration nearshore nurseries (lower seawater $\delta^{13}C$ and $\delta^{18}O$ values) to offshore overwintering habitats (higher seawater $\delta^{13}C$ and $\delta^{18}O$ values). Additionally, this study showed lower values of $\delta^{13}C$ and $\delta^{18}O$ in *S. officinalis* in comparison with *S. elegans* and *S. orbigniana,* reflecting different spawning behaviours of these species.

Variability in trace element concentration variability and its effects on juvenile cuttlefish have been investigated in several recent studies (Raimundo *et al.*, 2014, Le Pabic *et al.*, 2014, Rjeibi *et al.*, 2014, Le Pabic *et al.*, 2015, Lacoue-Labarthe *et al.*, 2016). Trace elements are consistently accumulated in the tissues of cuttlefish, with the highest levels in the digestive gland tissue and the lowest in muscles (Rjeibi *et al.*, 2014). Several studies concern the effects on cuttlefish of high concentrations of dissolved Zn in seawater (Le Pabic *et al.*, 2014, 2015, Lacoue-Labarthe *et al.*, 2016). The studies highlighted Zn-induced growth reduction (at a concentration of 108 $\mu g \cdot l^{-1}$) and mortality (at 185–230 $\mu g \cdot l^{-1}$) as well as effects on digestion, behaviour and immunity (Le Pabic *et al.*, 2015). Pharmaceuticals released in the environment are also a cause for concern. Antidepressants released into the environment can affect the camouflage patterns and hunting behaviour of cuttlefish, leading to lower rates of survival (Di Poi *et al.*, 2013, 2014, Lacoue-Labarthe *et al.*, 2016). It has been shown that released. These studies, and studies on the effect of sediment contamination (Rodrigo *et al.*, 2013), have suggested the use of common cuttlefish as a widely distributed and highly sensitive bioindicator of pollution.

A11.4.3. Climate change impacts

The impacts of climate change on distributions and abundances of cuttlefish was the second most popular field of study (see Dorey *et al.*, 2013, Giansante *et al.*, 2014, Keller *et al.*, 2014, Xavier *et al.*, 2016). Dorey *et al.* (2013) showed how increasing ocean acidification would affect the development of cuttlefish. Although growth rate was apparently not affected by lower pH, incorporation of ^{45}Ca (i.e. a radiotracer) into cuttlebones significantly decreased with increased acidification. The authors state that "a decrease in seawater pH by 0.25–0.50 units, as expected in average for the end of the century in global oceans, would increase the accumulation of calcium in the internal calcareous structure by 17–80 % in embryonic and juvenile cuttlefish, respectively."

Migration in Mediterranean populations of cuttlefish is affected by increasing annual SST but, with the exception of a shift in the cuttlefish population dynamics in the early 1980s, no lasting effect of climate change on cuttlefish populations has been found to date (Giansante *et al.*, 2014, Keller *et al.*, 2014). Xavier *et al.* (2016) discussed possible long-term effects of climate change on *S. officinalis*, noting temperature rises to 9.5º C in the north Atlantic could lead to an expansion of the range of *S. officinalis* to reach the eastern American coast, with potentially high impacts on coastal marine ecosystems.

A11.4.4. Stock assessment

Probably the most significant progress was made in the field of stock assessment, where a two-stage biomass model was developed (Gras *et al.*, 2014) and improved (Alemany *et al.*, 2015, 2017) for assessment of English Channel cuttlefish stocks. The model developed allows for estimating biomass, not only of the exploited part of stock, but also an unexploited winter biomass, and provides a potentially useful tool to allow detection of excessive stock depletion.

The protective potential of marine protective areas (MPA) for cuttlefish was assessed by Abecasis *et al.* (2013), who concluded that MPAs are not effective in long-term protection of highly migratory cephalopods such as cuttlefish and thus do not benefit the stocks. Note however, that the most likely value of MPAs would be to protect spawning habitat.

Two more studies should be noted in relation to fishery management and regulation. A study on the Adriatic Sea stock of cuttlefish (Mion *et al.*, 2014) revealed that extension of a summer ban for a trawling fishery could allow a higher portion of stock to reach a commercial size. From our point of view, the results of this research closely relate to the study on cuttlefish survival rate in the English Channel (Revill *et al.*, 2015). According to that study, only 31% of captured non-commercial size cuttlefish remain alive by the time they reach the sorting table. This reveals the necessity of developing methods to reduce the capture of small cuttlefish. It is possible that the solution recommended for the Adriatic Sea stock could benefit English Channel fisheries as well.

A11.4.5. Other studies

There are a number of studies on general cuttlefish biology which should be highlighted in this review. The experimental study on cuttlefish reactions to different levels and frequencies of sound (Samson *et al.*, 2014) showed that cuttlefish demonstrate escape responses to frequencies from 80 to 300 Hz at sound levels above 140 dB. These findings could be used for estimation of the sound pollution impact on cuttlefish stocks. The study on effects on artificial incubation on cuttlefish (O'Brien *et al.*, 2017) showed that this type of incubation is no different from natural incubation in relation to hatchling size, defense and predation behaviour. These results show that eggs which would otherwise be lost as bycatch could be reared artificially. Finally, the study on common reproductive biology in the Aegean Sea (Lampri *et al.*, 2016) showed that spawning and recruitment occurs throughout the whole year, with the peak in the spring-summer period.

The increasing need for methods of tracking cuttlefish migratory activities were met by the development of long-term electronic tagging methods (Wearmouth *et al.*, 2013). Tests showed that the electronic tags don't significantly affect cuttlefish natural behavior and can be used to monitor their migrations. Methods of cuttlefish biology research in the laboratory studies changed significantly after adopting the Directive 2010/63/EU. Methods of sex and maturity determination, tagging and DNA sample collecting were tested, regarding pain, suffering, distress and lasting, harmful effects (Sykes *et al.*, 2017). Tests revealed that the use of an endoscope, visual implant elastomer and swabbing could provide all necessary information without causing said effects.

A11.5. Sepia elegans

Sepia elegans has been much less studied than *S. officinalis*. Of three studies on *S. elegans* published during 2013 to 2017, a large-scale study of its reproductive biology in the eastern Mediterranean revealed a number of differences from the western Mediterranean and Atlantic Ocean (Salman, 2015). Dance *et al.* (2014) confirmed differences in the spawning and nursery ground locations of the three Mediterranean cuttlefish species (*S. officinalis*, *S. elegans* and *S. orbignyana*) based on stable isotope analysis of cuttlebone. A study on the composition of trawling fleet catches in the south-eastern Mediterranean in 2014–2015 (Rizkalla *et al.*, 2016), showed that *S. elegans* is the sole representative of the family occurring in the catches.

The systematic position of *S. elegans* remains unclear and studies on stocks status are needed in order to avoid potential overexploitation.

A11.6. Loligo vulgaris

A11.6.1. Introduction and overview

The list of research fields on *Loligo vulgaris*, marked in the previous report as having a significant importance includes three major topics: (1) impacts of climate change, (2) trophic relationships and (3) the development of simple and reliable tools for identification of caught individuals. At present, *L. vulgaris* remains the most studied of European squids. Two of three topics of significant importance were covered by recent studies, although more work is still needed on trophic relationships and environmental relationships. The development of identification methods for Loliginid species remains a priority, to ensure that data are made available at species level. Combining morphological and molecular methods may help deliver a rapid, cost-effective and reliable tool for identification at species level.

The further development of fishery management methods incorporating data on spatial and temporal structure of squid populations is needed due to the risk of overexploitation. Finally, further development of methods for rearing in captivity appears to be highly desirable.

A11.6.2. Climate change effects

A study on impact of ocean warming and acidification (Rosa *et al.*, 2014) revealed that ocean warming led to a significant decrease of embryo survival rate. According to the study, 2˚C warming and 0.5 decrease of pH caused a decrease of survival rate in summer hatching embryos from approximately 94% to 47%. Additionally, higher ambient temperature and hypercapnia cause shortening of the embryonic development period, a higher percentage of abnormalities and a decrease in growth rate. Moreno *et al.* (2014b) suggested that temperature effects may be responsible for high inter-annual variation in juvenile abundance on the southern shelf of Portugal.

A11.6.3. Trophic relationships

A stable isotope study on trophic relationships of pelagic fish and squid in the Mediterranean (Albo-Puigserver *et al.*, 2016) suggested that *L. vulgaris* predated primarily on sardine and anchovy. Furthermore, the study showed significantly less overlap in the diet of two squids (*L. vulgaris* and *I. coindetii*) than there was between *L. vulgaris* and both Atlantic bonito *Sarda sarda* and horse mackerel *Trachurus mediterraneus*. *Loligo vulgaris* did not show clear seasonal differences in $\delta^{15}N$ and $\delta^{13}C$ values, implying that feeding habits are not changing significantly during the year.

A11.6.4. Fishery and other studies

Three recent studies are of significant interest for fishery management. A study on the recreational cephalopod fishery in Galicia (Palas & Pita, 2015) revealed that *Loligo vulgaris* is one of the two most exploited cephalopod species (along with *S. officinalis*). Recreational fishery catches account for approximately 30% of total squid catch in the Ría de Vigo and these data should be included in reported catches so as to be available for future stock assessment and management.

According to Malhomme *et al.* (2015), squid mortality due to recreational fishing in the English Channel could be sufficient to result in overexploitation the stocks. However, the authors also note that the current status of the *L. vulgaris* stock is close to the long-term optimum. Pilar-Fonseca *et al.* (2014) showed how integration of geo-referenced fisheries data and data on population structure for *L. vulgaris* in Portuguese waters can allow detailed description of exploited squid stocks distribution. It was found that the main fishing season coincides with the period when squid migration into inshore waters to breed. Thus, higher direct fishing effort on squid at this time could lead to depletion of the stock due to reduction of population reproduction potential.

Finally, Vidal & Boletzky (2014) reviewed the culture potential of the species and Feyjoo *et al.* (2016) presented a new scale for description of embryonic development stages.

A11.7. Loligo forbesii

Despite its significant commercial value, *Loligo forbesii* was studied much less than the European squid over the last few years. However, fields of research which were marked as 'of importance' in the previous report of the Working Group were well covered by these studies. Life history, distribution, trophic relationships and stock assessment were all described in Pierce *et al.* (2013). A study on post-recruit life stages (Smith *et al.*, 2013) revealed habitat preferences of squids at different maturity stages. It was shown that in winter, squid prefer lower salinity, while in spring and summer, higher salinity. Also, summer and autumn are characterized by higher abundance of squid at shallower depths. As for substrate preferences, it was found that squid aggregations are associated more with gravel substrate, than with mud.

The status of the English Channel stock was assessed by Malhomme *et al.* (2015). In case of *L. vulgaris*, it was shown that the squid stock is overexploited but nevertheless currently close to long-term optimum. The potentially important role of squid in the ecosystem of the Channel was highlighted, and recommendations provided on methods to evaluate.

There is still a need for tools to permit rapid routine separation of *L. forbesii* and *L. vulgaris* in commercial and survey catches, to permit separate assessment of stocks of these species. Additional studies on the trophic role and the impact of environmental factors would also be useful.

A11.8. Alloteuthis spp.

Two species of *Alloteuthis* (*A. subulate*, *A. media*) have the widest distribution among European Myopsid squids. However, perhaps due to a lack of direct commercial interest, they are much less studied than *Loligo vulgaris*. Although at least two different morphotypes can be identified and are often assumed to characterise the two species, in practice identification of *Alloteuthis* by traditional morphological methods is nearly impossible (Jereb *et al.*, 2015). It seems that different morphotypes may occur in both species; one possibility is that a consistent relationship between species and morphotype is only found in areas where both species coexist. The issue of lack of consistent correspondence between genotype and morphotype in *Alloteuthis* still needs to be resolved and reliable identification methods developed, not least to ensure that stocks can be assessed and sustainable exploitation assured.

A study on *Alloteuthis* in the English Channel indicated the possibility of separating the two species using PCR-RFLP (McKeown *et al.*, 2015). Gebhartd *et al.* (2015) found three morphotypes of *Alloteuthis* in the North and Baltic seas, but the analysis of COI and rDNA did not confirm any differences between them. Identification methods based on analysis of shape and colour also appear to be quite promising for squids (Fang *et al.*, 2016 a, Green *et al.*, 2015, Lishchenko *et al.*,, 2017, Jin *et al.*, 2017).

Analysis of a 35-year series of data on squid catches during trawling surveys in the North Sea showed that *Alloteuthis* dominated in catches from shallow areas (depths <50 m) of the southern North Sea during August and September, and that *Alloteuthis* had expanded its range northwards and increased in abundance over the study period. Barrett & Laptikhovsky (2017) also found that *Alloteuthis* were the most common Myopsid squids in this area. Quetglas *et al.* (2014) reported that *A. media* as among the three most numerous cephalopods in the Western Mediterranean, observed only in the bottom layer and showing high seasonal variability in occurrence.

Studies on trophic relations of *A. media* have shown that the paralarvae consume prey from 10 orders, the most frequently detected families being Campanulariidae (order Leptothecata), Paracalanidae and Clausocalanidae (order Calanoida) (Olmos-Perez *et al.*, 2017). In the adults, teleost fishes make up 84% of the diet, followed by crustaceans (8%), and molluscs (3%) (Rosas-Luis and Sanchez, 2015).

A11.9. Illex coindetii

A11.9.1. Introduction and overview

Illex coindetii is a widespread Ommastrephid squid, of increasing commercial value, the distribution of which covers both sides of the Atlantic and the Mediterranean Sea from surface waters to approximately 1000 m depth. Previous studies did not reveal significant genetic differences among populations. Further research is needed on the systematic and ecological status of *I. coindetii* morphotypes, as well as studies on stock structure (both spatial and temporal), climate change effects and trophic role are required to ensure sustainable exploitation (Jereb *et al.*, 2015). Information on squid populations dynamics in relation to environmental and community variability can be used in fishery management within the ecosystem approach.

A11.9.2. Distribution, abundance and stock structure

Studies on distribution of squids in the North Sea showed that Ommastrephidae are distributed throughout most parts of the northern and central North Sea, but aggregations of *I. coindetii* were observed only in the central part of the sea in winter (Oesterwind *et al.*, 2015). Despite the relatively low abundance and apparently limited distribution in the North Sea, *I. coindetii* could be an important species for the ecosystem of this region (Oesterwind *et al.*, 2015).

Studies on the eastern Iberian coast population revealed a negative correlation of local abundance with depth, probably because of recruitment at shallow depths (Puerta *et al.*, 2014). These authors note that squid responses to environmental drivers are difficult to recognize due to the high mobility of individuals and the constant mixing of subpopulations in neighbouring areas.

Recent studies suggest the existence of 4–8 separate stock units are recognised in the Mediterranean Sea (Fiorentino *et al.*, 2014; see also Keller *et al.*, 2017). In this area, *I. coindetii* is distributed across a wide range of depths. The greatest abundance is reached at depths less than 200 m and more than 600 m, with the minimum at approximately 400 m. The densest concentrations of squid are observed in the most highly productive zones, related to the Atlantic Ionian Stream (Lauria *et al.*, 2016).

A11.9.3. Life history and trophic ecology

Observations on squid from the Adriatic and Aegean Seas provided evidence that *I. coindetii* has a multiple-spawning reproductive strategy (Ceriola *et al.*, 2017, Salman *et al.*, 2017). The smallest mature individuals in Greek seas were recorded in this area (Pattoura, *et al.*, 2016). This is likely a result of the gradual rise in temperature both in the surface and the deepest layers of the sea which leads to the faster maturation rates of individuals.

A recent study of trophic ecology of the squid in the north-western part of the Mediterranean Sea showed the presence of 35 species in the squid's diet, mainly crustaceans, squid and mesopelagic fish. Food preferences depend on ontogenetic stages. The juveniles' diet mainly consisted of crustaceans, especially in winter, while adults preyed mainly on fish and crustaceans, with no apparent seasonal differences. It was hypothesized that diet composition is dependent on the development of the beak as well as availability of prey (Martinez-Baena *et al.*, 2016).

A11.10. Ommastrephes bartramii

Ommastrephes bartramii is a widely distributed species, with high commercial importance outside the ICES area. In North Atlantic waters the species is less common and its commercial value markedly lower. Consequently, the species is much less studied in the North Atlantic than in the Pacific counterpart. This problem was noted in the previous report of the Working Group; it was stated that additional studies are needed in all fields of research, with emphasis on the basic biology of species, and this continues to be the case. As with several of the other species mentioned, further studies are needed on stock identity and trophic relationships of this species in the North Atlantic. While lessons can be learned from studies in the Pacific, especially in relation to methodological developments, such tools for age determination, in general caution is necessary in applying results to the species in the North Atlantic since we may be dealing with different subspecies (Jereb *et al.*, 2015). There is a need to review on Russian studies on this species and other oceanic ommastrephids, and for studies on the systematic status of North Atlantic and Pacific populations.

Only two articles were published on this species in the North Atlantic and adjacent waters during the reviewed period. Both studies concerned distribution across the Mediterranean Sea (Lefkaditou *et al.*, 2013; Franjevic *et al.*, 2015). According to the second study, frequency of observations of young specimens increased significantly from the beginning of 1990's (Lefkaditou *et al.*, 2013), which probably reflects spawning in this, or adjacent, area(s). Recent records of large females in this area support this hypothesis. The second study represents a modern report on capture of the mature female in the Adriatic Sea (Franjevic *et al.*, 2015). Outputs of both studies reflect the possible connection of the climate change and *O. bartramii* range expansion.

Among studies on *O. bartramii* in other regions, some are potentially relevant to the North Atlantic population. Several studies on hard structures of the squid provide reliable tools for age determination (Fang *et al.*, 2016 (a), Liu *et al.*, 2015), while others concern tools for stock identification (Fang *et al.*, 2014 a, Fang *et al.*, 2014 b, Fang *et al.*, 2017) or for monitoring of migrations (Fang *et al.*, 2016 (c), Kato *et al.*, 2016). In general, it could be concluded that hard structures of squids (not only of *O. bartramii*) could be used in a wide variety of studies.

Another relevant topic is the assessment of the impact of abiotic factors on distribution and abundance (Alabia *et al.*, 2015, Feng *et al.*, 2016, Xu *et al.*, 2016, Wang *et al.*, 2017, Yu *et al.*, 2015, Yu *et al.*, 2016, Feng *et al.*, 2016). It has been shown that warming has a positive effect on abundance and allows it to expand its range into high-latitude waters. These results are consistent with studies in Mediterranean (Lefkaditou *et al.*, 2013).

A11.11 Todaropsis eblanae and Todarodes sagittatus

A study on the squid distribution and abundance in the North Sea (Oesterwind *et al.*, 2015) showed that *Todaropsis eblanae* is the most widespread ommastrephid species in this area while *Todarodes sagittatus* was found to be the least common squid in the area, possibly because it passes through the area only when migrating between feeding areas and the spawning areas on the mid-Atlantic ridge and western continental slope of Europe. More recent surveys performed by Cefas (C. Barrett, pers. comm.) found that *T. eblanae* was abundant only in the western part of the sea. Previous studies suggest that high abundance of both species in the northeast Atlantic may be sporadic and that large shifts in distribution can be seen.

Lauria *et al.* (2016) showed that spatial distribution of *T. eblanae* in the Mediterranean was related to the temperature regime, salinity and chlorophyll-a concentration. It was concluded that squid prefers highly productive areas associated with the Adventure Bank Vortex.

Fernandez-Alvarez *et al.* (2017) developed an identification key for paralarvae of ommastrephids (*I. coindetti*, *T. eblanae*, *T. sagittatus*) based on morphological differences. Among the most useful characters were the relative size and the arrangement of pegs on the lateral and medial proboscis suckers and the presence of photophores. This key provides a cost-effective and reliable tool for studies on the life-cycles and population dynamics of ommastrephid squids in the North Atlantic.

A study on feeding habits of *Todarodes sagittatus* in the NW Mediterranean (Rosas-Luis *et al.*, 2014) showed that the species has a wide prey spectrum: 49 types of prey were identified, most being mesopelagic fish, decapod crustaceans and amphipods. It was concluded that *T. sagittatus* feeds opportunistically on the most accessible prey, adjusting its vertical distribution in the water column according to the availability of prey resources. Choice of prey also depends on the size of squid: small squid primarily consume small crustaceans, squids of medium size include medium-sized fish in the diet, and large individuals feed on larger fish, crustaceans and molluscs.

Additional studies on *T. sagittatus* are needed in the fields of reproductive biology, age estimation and stock identification. For *T. eblanae*, important fields of future research include studies on stock separation, distribution and life history traits of populations.

A11.12. References

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Anne 12: ToR D) Complementary contribution – The UK Squid Fishery

The long-finned squid *Loligo forbesii* occurs in the northeast Atlantic from the southern Iberian Peninsula and up through UK and Irish waters, including as far north as the Faroe Islands (Roper *et al.*, 1984). Distribution of *L. forbesii* in UK waters is primarily over the continental shelf and shelf edge in water depths of 50–250 m (Pierce *et al.*, 1994a). It is a semelparous organism and appears to have a nearly annual life cycle (Ngoile, 1987; Lum-Kong *et al.*, 1992; Boyle and Pierce, 1994; Pierce *et al.*, 1994b; Collins *et al.*, 1997, 1999). It is generally targeted by small-scale artisanal fisheries, often using handmade or bespoke fishing gear, but also taken as by-catch of trawling. In UK waters, *L. forbesii* was previously the most important cephalopod resource in terms of quantity of landings and value (Boyle and Pierce, 1994) and, although it has been surpassed in some years by the *Sepia officinalis* fishery in the English Channel, *L. forbesii* remains the most productive cephalopod species targeted in Scottish waters.

In the northern UK range of *L. forbesii*, its abundance appears to be highly variable in both space and time (Boyle and Pierce, 1994). Previous visual examination of historical Scottish landings (1904–1990) suggested approximately 15-year abundance cycles (Pierce *et al.*, 1994a). Stock size for *L. forbesii* in Scottish waters (ICES areas 4a and 6a) has been estimated using depletion methods to be in the order of some millions of animals (Young *et al.* 2004). Between-year variation in fishery abundance in coastal waters appears to be correlated with several annual environmental indices, including winter NAO and the average sea surface temperature (SST) and sea surface salinity (SSS) (Pierce and Boyle, 2003; Zuur and Pierce, 2004), while an earlier study also showed distribution of this species in the North Sea to be related to bottom temperatures (squid avoided temperatures of <7°C) and, to a lesser extent, salinity (Pierce *et al.*, 1998).

Lower abundance in summer months may indicate that the animals move outside the range of the fishery and into deeper waters or simply that winter breeders die before summer (Collins *et al.*, 1999). There are inshore-offshore movements during the life cycle of the autumn recruiting cohort, with animals appearing to spawn in inshore waters (Stowasser *et al.*, 2005; Viana *et al.*, 2009) as well as apparent west-east migrations in some years (Waluda *et al.*, 1998). Although doubts remain about how the existence of at least two peaks in recruitment and the existence of multiple microcohorts mesh with an apparently annual life-cycle (Boyle *et al.* 1995, Collins *et al.*, 1999), it has been hypothesized that the summer breeding population (identified by Holme (1974) in the English Channel and presumed to exist elsewhere) has declined and the winter population now dominates and breeds later (Pierce *et al.*, 2005).

In England, targeting of squid with jigs has been described, while some directed trawling of *L. forbesii* took place around Rockall in the 1980s and there were several experimental trials of jigging machines, which were apparently unsuccessful (Pierce *et al.* 1994a).

The small, directed commercial squid fishery in the Moray Firth, Scotland operates primarily in coastal waters (Pierce *et al.*, 1994b, Hastie *et al.* 2009a, Young *et al.* 2006a,b; Smith 2011) and landings are comprised almost entirely of *L. forbesii*, although sporadic landings of *Loligo vulgaris*, *Alloteuthis subulata*, *Todaropsis eblanae* and *Todarodes sagittatus* have been known to occur (Boyle & Pierce, 1994; Hastie *et al.*, 1994, 2009b) - in contrast with landings in England and Wales, which may often contain a significant proportion of *L. vulgaris* (Pierce *et al.*, 1994b). The fishery typically shows a seasonal peak during the months of August through November, with directed catch continuing as late as December and January. Squid are targeted when they are ascending the water column in the evening to feed in surface waters and when descending to the seabed in the early morning hours. At start of the season, fishing takes place in shallow, near-shore waters and progressively shifts to deeper waters later in the season (Smith *et al.*, in prep).

Historically, the directed fishery had been small-scale, with 2–3 vessels off each fishing area participating each year. However, starting in 2003, a larger directed fishery with over 65 boats (Young *et al.*, 2006a) was established approximately 50 m offshore from Buckie (north Scotland), with increased landings also seen in other ports in the area. Peaks in both landings and CPUE in the directed fishery were experienced through 2005, with a marked decline in 2006 (Smith *et al.*, in prep.)

Fishers attributed between-year variability in catch to a range of factors including early entry of large vessels into the fishery, damage to spawning grounds, changes in weather patterns and variation in abundance of food sources. Fishers' preferred options for any future regulatory measures included limits on catches of new recruits, restricted entry to the fishery, and protected areas for spawning grounds (Smith *et al.*, in prep).

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Annex 13: ToR E) Guides to cephalopod identification

Year	Country / Institution	Contact	Language	Title	Author(s)	Geographical focus	Photos / drawings / both	Comments	Source of text / photos (if known)	Physical format	Available on IBTS SharePoint
	-	R.E. Young, M. Vecchione	English	http://tolweb.org/Cephalopoda/19386	Different authors, depend on group/species	World Ocean (including ICES area)	Drawings/photos partly own, partly from other sources	Open source, guide is incomplete/in development, only digital version	Partly own, partly taken from other sources	Digital	
???	??	ICES WGCEPH	English	Identification of squid in Irish waters	??	Irish Sea	Photos and drawings				
2017	England / CEFAS	Chris Lynam and Vlad Laptikhovsky	English	Identification guide for shelf cephalopods in the UK waters (North Sea, the English Channel, Celtic and Irish Seas)	Vladimir Laptikhovsky & Rosana Ourens	North Sea, English Channel, Celtic and Irish Seas, Scotland	Photos and drawings	Guide for the shelf and upper slope cephalopods of the area, depth < 400 m	Photos/drawings from ICES, FAO and individual authors. Copyright agreed.		
2005	FAO		English	Cephalopods Of The World An Annotated And Illustrated Catalogue Of Species Known To Date (Sepiids)	Eds. P. Jereb & C.F.E. Roper	World Ocean (including ICES area)	Drawings	Very imprecise information on distribution, some data on systematics is out of date, only sepiids and nautiluses	Drawings and text from different resources	hard/digital	

Year	Country / Institution	Contact	Language	Title	Author(s)	Geographical focus	Photos / drawings / both	Comments	Source of text / photos (if known)	Physical format	Available on IBTS SharePoint
2005	FAO		English	Cephalopods Of The World An Annotated And Illustrated Catalogue Of Species Known To Date (Chambered Nautiluses and Sepioids	Eds. P. Jereb & C.F.E. Roper	World Ocean (including ICES area)	Drawings	Very imprecise information on distribution, some data on systematics are out of date, only squids	Drawings and text from different resources	hard/digital	
2016	FAO		English	Cephalopods Of The World An Annotated And Illustrated Catalogue Of Species Known To Date (Octopods and Vampire squids))	Eds. P. Jereb, C.F.E. Roper, M. Norman, J.K. Finn	World Ocean (including ICES area)	drawings	Very imprecise information on distribution, some data on systematics are out of date, only octopuses	drawings and text from different resources	hard/digital	
2008	Germany / GEOMAR	Uwe Piatkowski, , Daniel Oesterwind	German	Cephalopods in the North Sea - A field guide (draft)	Karsten Zumholz, Uwe Piatkowski	North Sea	Photos and drawings	Draft, some photos still without copyright clearance. Lead author not available => plan to produce new guide, see below.	not published yet		
In prep	Germany / Thuenen, GEOMAR	Daniel Oesterwind, Uwe Piaatkowski, Anne Sell	German	Cephalopod-Guide for the North Sea (DRAFT)	Daniel Oesterwind, Uwe Piatkowski, Anne Sell	North Sea	Photos and drawings	in preparation, some high quality images are missing, final draft expected in summer 2017	own photos and drawings		

Year	Country / Institution	Contact	Language	Title	Author(s)	Geographical focus	Photos / drawings / both	Comments	Source of text / photos (if known)	Physical format	Available on IBTS SharePoint
	Iceland	Alexey Golikov	Icelandic/English	http://www.ni.is/biota/animalia/mollusca/cephalopoda	Icelandian waters	drawings	Only digital version (website)	Jereb & Roper, 2010, mainly	Iceland	Digital	
1995	Instituto Arion	G. Bello	English	A Key for the identification of Mediterranean sepiolids (Mollusca:Cephalopoda)	G. Bello	Mediterranean sea	drawings	Only family Sepiolidae	Own drawings	hard/digital	
	Norway	Rupert Wieneroither	Norwegian	Nøkkel til BLEKKSPRUTER i norske og tilstøtende farvann	Rupert Wienerroither	??	??				Yes
	Russia	K. Nesis	russian	Short identification guide for cephalopods of World Ocean	K. Nesis	World Ocean (including ICES area)	Drawings	only hard version is available, identification guide is partially out of date	Own drawings	hard	
1969	Smithsonian Institution		english	An Illustrated Key to the Families of the Order Teuthoidea (Cephalopoda)	C.F.E. Roper, R.E. Young, G.L. Voss	World Ocean (including ICES area)	drawings	Identification only to Family level	drawings and text from different resources	hard/digital	

Year	Country /	Contact	Language	Title	Author(s)	Geograph-	Photos /	Comments	Source of text /	Physical	Available on

Year	Country / Institution	Contact	Language	Title	Author(s)	Geographical focus	Photos / drawings / both	Comments	Source of text / photos (if known)	Physical format	Available on IBTS SharePoint
1992	Smithsonian Institution	M.J. Sweeney, C.F.E. Roper, M.R. Clarke, S. v. Boletzky	English	„Larval" and Juvenile Cephalopods: A Manual for Their Identification	M.J. Sweeney, C.F.E. Roper, K.M. Mangold, M.R. Clarke, S. v. Boletzky	World Ocean (including ICES area)	drawings	Identification guide for cephalopod juveniles	Roper *et al.*, 1984	hard/digital	
1997	VNIRO	Ju.A.Filippova, D.O.Alekseev, V.A.Bizikov, D.N.Khromov	russian	Commercial and mass cephalopods of the world ocean. A manual for identification	D.O.Alekseev, V.A.Bizikov	World Ocean (including ICES area)	Drawings of low quality	Only commercially exploited species, digital version hardly available	Own drawings	hard/digital	
	VNIRO	V. Bizikov	Russian/English	Evolution oft he shell in Cephalopoda	V.Bizikov	World Ocean (including ICES area)	Drawings and photos	Description of vestigial shells of cephalopods, possible to use for identification	Own drawings/photos	hard	
1959	Sweden	Barbara Bland	Danish	Danmarks fauna 65: skallus, sötänder bläcksprutter	Bent J Muus	Danish waters	Drawings	Origional drawings by Poul H. Winther and the author. Published 1959.	Published by Dansk Naturhistorisk Forening		Yes
1963	ICES	ICES WGCEPH	English	ICES Identification sheet; Cephalopoda: Decapoda: Sepioidea	B. J. Muus	North Atlantic	Drawings		Drawings from different resources	digital	

	Institu-tion					ical focus	drawings / both		photos (if known)	format	IBTS Share-Point
1963	ICES	ICES WGCEPH	English	ICES Identification sheet; Cephalopoda: Decapoda: Teuthoidea: Loliginidae	B. J. Muus	North Atlantic	Drawings		Drawings from different resources		
1963	ICES	ICES WGCEPH	English	ICES Identification sheet; Cephalopoda: Decapoda: Teuthoidea: Ommastrephidae, Chiroteuthidae, Cranchidae	B. J. Muus	North Atlantic	Drawings		Drawings from different resources		
1963	ICES	ICES WGCEPH	English	ICES Identification sheet; Cephalopoda: Decapoda: Teuthoidea: Octopoteithidae, Gonatidae, Onychoteuthidae, Histioteuthidae, Branchioteuthidae	B. J. Muus	North Atlantic	Drawings		Drawings from different resources		
1963	ICES	ICES WGCEPH	English	Cephalopoda: Octopoda1963	B. J. Muus	North Atlantic	Drawings		Drawings from different resources		
1990	Eurosquid project	A. Guerra, R. Ledo	English, Spanish	Fishery potential of North Eastern Atlantic squid stocks	A. Guerra & R. Ledo	North East Atlantic	Drawings		Drawings and maps from Roper *et al.*	Hard	

Year	Country / Institution	Contact	Language	Title	Author(s)	Geographical focus	Photos / drawings / both	Comments	Source of text / photos (if known)	Physical format	Available on IBTS SharePoint
2004	Greenland / Greenland Institute of Natural Resources	Uwe Piatkowski (?)	English	Cephalopods in Greenland Waters –a field guide	Rikke Petri Frandsen, Karsten Zumholz	Greenland	Photos and drawings	Technical report no. 58,Pinngortitaleriffik, Greenland Institute of Natural Resources http://www.natur.gl/publikationer/tekniske rapporter	Various, some from acknowledged published sources		
2012	Lebanon, / Department of Biology, American University of Beirut	Michel Bariche	English, Arabic	Field Identification Guide to the Living Marine Resources of the Eastern and Southern Mediterranean	M. Bariche	Eastern and Southern Mediterranean Sea	Drawings	The first FAO field guide to be translated into Arabic language for the benefit of Arabic-speaking countries of the Southern and Eastern Mediterranean Sea.	Basic information was compiled from various national facilitators from Eastern and Southern Mediterranean countries and supplemented by major publications of FAO and CIESM.		
2015	France / IFREMER	Pascal Laffargue	French	Fiches d'aide à l'identification Poissons, céphalopodes et décapodes mer du Nord, Manche, Golfe de Gascogne et mer Celtique (Version 2015)	F.Garren, S.P. Iglesias, J.C. Quéro, P. Porche, J.-J. Vayne, J. Martin, Y. Verin, J.-L. Dufour, L. Metral, D. Le Roy, E. Rostiaux, S. Martin, K. Mahe	Bay of Biscay, Celtic Sea, Channel, North Sea	Photos and drawings	Guide for cephalopods and fish species. A complementary guide has been specifically developed for Sepiolidae and is not included in that one.	Illustrations of cephalopods and other invertebrates included were mostly taken from Martin J (2011) Les invertébrés du golfe de Gascogne à la Manche orientale. Editions QUAE.		Excerpt on *Loligo*.

Year	Country / Institution	Contact	Language	Title	Author(s)	Geographical focus	Photos / drawings / both	Comments	Source of text / photos (if known)	Physical format	Available on IBTS SharePoint
2015	ICES	Patrizia Jereb, Louise Allcock, Graham Pierce	English	Cephalopod biology and fisheries in Europe: II. Species Accounts	Jereb et al	European waters	Drawings and photos	Species accounts including identification	Mainly the authors; outside sources all acknowledged	Digital	
2015	ICES	Núria Zaragoza, Antoni Quetglas, and Ana Moreno		Identification guide for cephalopod paralarvae from the Mediterranean Sea	Núria Zaragoza, Antoni Quetglas, and Ana Moreno	Mediterranean	Drawings and photos	Identification guide for paralarvae	All sources acknowledged	Digital	