ICES Living Resources Committee
ICES CM 2004/G:02, Ref. ACFM, ACE

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

By correspondence

https://doi.org/10.17895/ices.pub.9760

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46 · DK-1553 Copenhagen V · Denmark
Telephone + 45 33 38 67 00 · Telefax +45 33 93 42 15
www.ices.dk · info@ices.dk

Contents

1 Introduction

This report is based on work by correspondence. During 2004 the Working Group on Cephalopod Fisheries and Life History (WGCEPH) members have also been involved in two other different tasks at the European level: the preparation of a theme session on cephalopod stocks at the ICES Annual Science Conference 2004 in Vigo and the continuation of reviews prepared within CEPHSTOCK, an EEC concerted action. These two tasks have both been essential for the dissemination of knowledge and methodology of interest for northeast Atlantic cephalopod fisheries. In achieving this, the preparation of the current WGCEPH report was delayed.

The cephalopod theme session (CC) organised during the ICES 2004 ASC in Vigo will contribute to the dissemination of cephalopod studies with 29 oral presentations and 12 posters (the list of papers is annexed to this report).

CEPHSTOCK is not a research project that funds the acquisition of new data and new results but rather a Concerted Action, which provides the opportunity to review current knowledge. In comparison with previous years, European cephalopod scientists are facing a period of fewer EU projects, which does not seem to be sufficiently compensated by national budgets. WGCEPH considers that this situation is rather paradoxical in a period when the share of cephalopods in the fisheries is steadily increasing.

1.1 Terms of Reference

The **Working Group on Cephalopod Fisheries and Life History** [WGCEPH] (Chair: J.-P. Robin, France) will meet in Lesvos, Greece, from 9–10 October 2003 to organise work by correspondence with the following objectives:

a) update currently available landing statistics and information on fishing effort, discards, and gear selectivity, and explore the existing resource survey databases for information about sampled cephalopods in the ICES area;

b) compile results available for stock identification and estimation of population size of fished cephalopods;

c) identify possible precautionary approaches to the management of these cephalopod resources and evaluate management strategies;

d) compile available data and identify relationships between abundance and environmental conditions, factors affecting recruitment, migration and distribution patterns of juveniles and adults, trophic interactions and bio-accumulation of contaminants;

e) review cephalopod culture techniques and their interest in the understanding of biological phenomena;

f) update the bibliographic database of cephalopod literature relevant to fisheries, including grey literature.

2 Landings and effort statistics and survey data (TOR a)

The term of reference is as follows: Update currently available landing statistics and information on fishing effort, discards, and gear selectivity, and explore the existing resource survey databases for information about sampled cephalopods in the ICES area.

2.1 Compilation of Landing Statistics

The present report updates landing statistics from 1995 to 2002 and provides provisional catch data for 2003 for cephalopod groups caught in the ICES area (Tables 2.1 to 2.6). The data originate from the ICES STATLANT database and from additional national and more precise information supplied by Working Group members. In general, we feel that all 2003 data should be considered as preliminary, and they are marked as such in the tables (“P”).

The data compiled in this report represent the most precise information on cephalopod landings within the ICES area that can be obtained to date. For all major fishery nations (i.e., France, Portugal, Spain, UK) we relied on the statistical information provided by the Working Group members. This information is – as in previous years – not necessarily identical to the data officially reported to the ICES ATATLANT database and stresses the inaccuracy with which cephalopod statistics are still handled.

Tables 2.1 to 2.4 give information on annual catch statistics (1995–2001) per cephalopod group in each ICES division or subarea, separately for each nation. The cephalopod groups listed in the tables comprise the following species:

- Table 2.1. Cuttlefish (*Sepiidae*). The majority of landings summarised in this table are catches of *Sepia officinalis*, the common cuttlefish, plus small amounts of *S. elegans* and *S. orbignyana*. WGCEPH considers that no bobtail squids (*Sepiolidae*) occur in the reported catches.

- Table 2.2. Common squid (including the long-finned squids *Loligo forbesi*, *L. vulgaris, Alloteuthis subulata* and *A. media*). The majority of common squid landings are *L. forbesi* and *L.vulgaris*.

- Table 2.3. Short-finned squid (*Illex coindetii* and *Todaropsis eblanae*), European Flying squid (*Todarodes sagittatus*), and Neon Flying squid (*Ommastrephes bartrami*).

- Table 2.4. Octopods (including Eledone cirrhosa, E. moschata and Octopus vulgaris).

A compilation separated into single species is still not possible as all countries report landings for cephalopod groups, mostly in the format as given in the tables.

Table 2.5 summarises total annual cephalopod landings in the whole ICES area for major cephalopod groups. Table 2.6 provides information of total annual cephalopod landings in the whole ICES area for major cephalopod groups separated for each fishing nation.

In addition to the landings statistics compiled in the tables further information on general trends in the cephalopod fisheries is provided for the most important fishing nations (see below).

2.2 General Trends

For the period 1995–2002, total annual cephalopod landings within the ICES region show a peak in 2000 and a minimum in 2001. Year 2002 landings were higher than in 2001 but still below 50000 t. Year 2003 data are still provisional (with data for some fishing nations not available) but suggest that landings should at least reach the level of year 2001.

This general trend seems to be the result of contrasting situations according to the cephalopod group (table 2.5). Since 1997 cuttlefish have been the most important cephalopod group taken in the ICES area, and year 2002 landings (22600 t) followed the increasing trend for this group (i.e. higher than all values observed in 1995–1999). On the other hand, landings of octopods and short-finned squid are decreasing and, in both groups, landings in 2001 and 2002 were lower than in the period 1995–2000. Common squid landings appear more stable and thus show an intermediate situation.

In terms of total cephalopod landings, the most active nations are France (46% of total landings in 2002), followed by Portugal (20%) Spain (18%), and the UK (13%). The French fishery dominates cuttlefish and common squid landings, whereas Portugal and Spain fish are the major countries for short-finned squid and octopods.

It is worth noting that even in countries that show decreasing landings the importance of cephalopods resources in relation to other marine products is still increasing. In Portugal, socio-economic reviews carried out within the CEPHSTOCK programme indicate that this trend is even clearer when the value of the resource is considered instead of the weight (Figure 2.1.1). Differences between value and weight percentages are not so clear in French English Channel landings (Figure 2.2.2); nevertheless the increasing importance of cephalopods is also observed in this country.

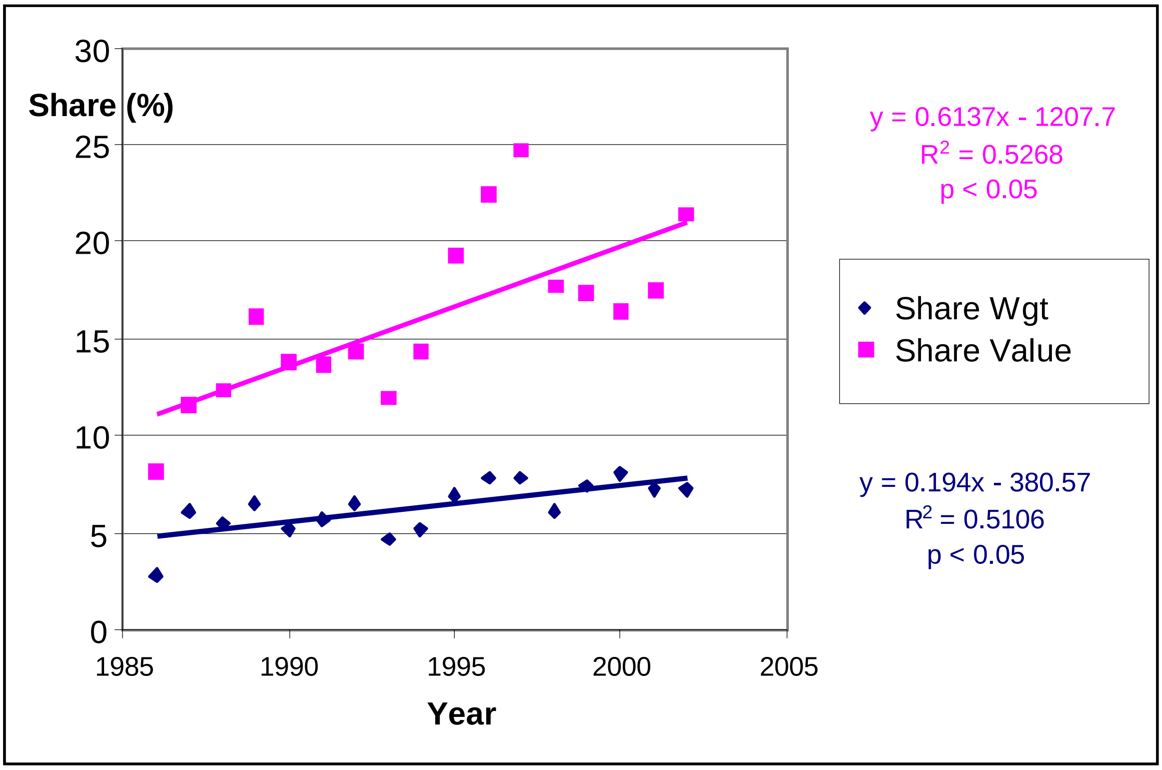

Figure 2.1.1. Evolution of the share of weight and first sale value of cephalopods in relation to all marine landings from the continental coast of Portugal.

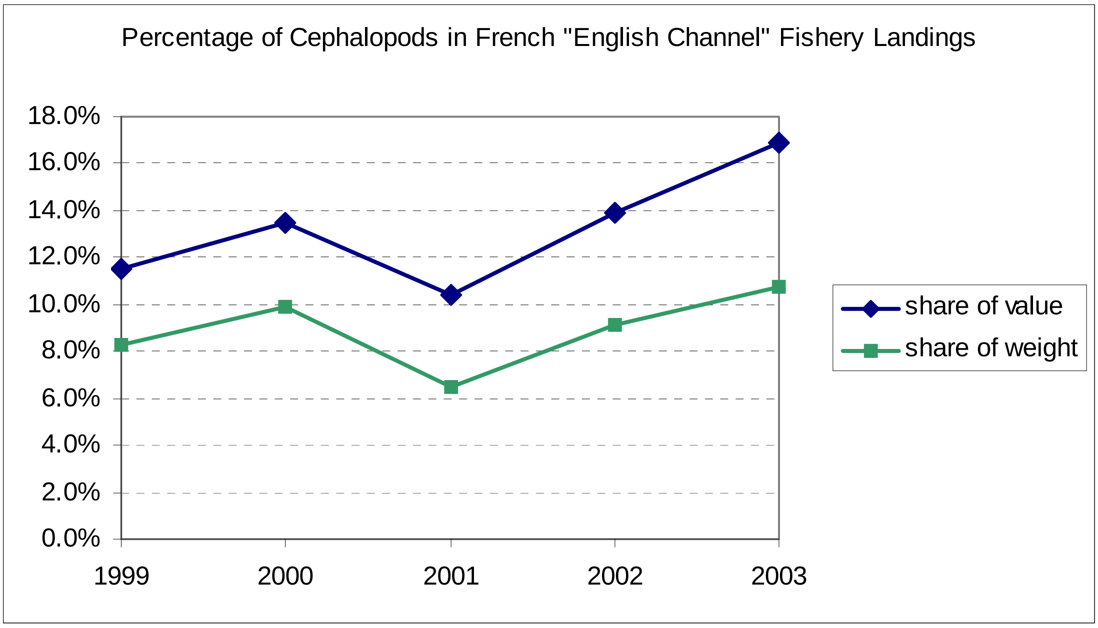

Figure 2.1.2. Evolution of the share of weight and first sale value of cephalopods in relation to all marine landings in the French English Channel fishery.

In the following paragraphs some information and trends for the major fishing nations are provided. The description of fishing techniques applied to cephalopods in European countries is also included in a review by the CEPHSTOCK project: "WP7: Fishing fleets and fishery metiers catching cephalopods".

2.3 National Trends

2.3.1 France

Details about cephalopod landings are available up to year 2003. Overall figures confirm that year 2002 yields were the highest ever observed (21834 t). In this year, French landings represented 46% of all northeast Atlantic cephalopod landings. Year 2003 landings are lower (~16900 t) but still higher than those observed in the period 1996–1997. Reduced landings in Year 2003 concern all cephalopod groups although a lesser reduction is observed in common squid.

The variability of cephalopod production by the French fishing fleet does not seem to be related to fluctuations in fishing activity. French trawlers are dominant whatever the cephalopod group. Overall fishing effort by trawlers in the main areas fished (Figure 2.3.2.1) suggests a rather constant pattern. The proportion of otter bottom trawl (versus all trawlers fishing effort) seems to have decreased in some areas. However, it is hard to tell if this is a result of more diverse types of gears used by trawlers or of poorer recording (with increasing "unspecified trawl").

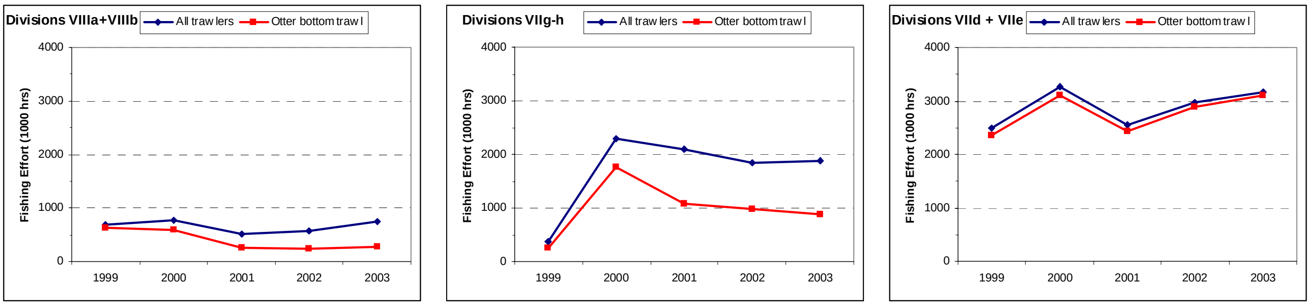

Figure 2.3.2.1. French trawlers fishing effort in 3 main areas (Bay of Biscay, Celtic Sea and English Channel) in the period 1999–2003.

Inshore fisheries, such as cuttlefish fishing with traps, do not show the same inter-annual variations in landings. Trap fishing along the coast of Normandy is better known than in other areas thanks to "unofficial records" collected by the "Comité Régional des Pêches Maritimes". This database suggests higher landings in 2001 than in 2002. Opposite trends between the dominant trawl fishery and the minor trap fishery are not surprising in the light of fleet interactions for the cuttlefish resource. Royer (2002) has shown that trawl and traps were successive fisheries and thus trap fishing appears sensitive to prior trawl catches.

2.3.2 Portugal

General trends:

During the period 1998–2002, there have been no notable changes in either the pattern or volume of the landings of any of the four groups of cephalopods displayed in official statistics. Cephalopods continue to yield landings of the same order of magnitude as they have done for the past 30 years. Presently, there is a tendency for a greater valuation of previously ignored fishery products, which will probably result in greater landings of shortfin squid and the *Eledone* octopus in the coming years.

Landings by fishing gear: (Table 2.3.2)

Cuttlefish

The dominant gear in the capture of cuttlefish in Portugal is always traps, of which there are several designs. These are included in the "artisanal" gear types, together with minor catches of other gear such as gillnets and trammel nets. Bottom otter trawling has always been the second most important source of catches, here represented in the trawling category. Year to year trends are not very marked, with a relatively stable pattern of distribution of catches between years and between gears.

Octopus

Very similarly to the situation in cuttlefish catches, the dominant gear in the capture of octopus in Portugal is always traps, but pots are also very important. Bottom otter trawling is also the second most important source of catches, again represented in the trawling category. Year to year trends in this period are also not very marked, with a relatively stable pattern of distribution of catches between years and between gears.

Long-finned Squid

Year to year trends in this period are also not very marked, with a relatively stable pattern of distribution of catches between years and between gears. The situation in long-finned squid catches is the opposite to that verified in cuttlefish and octopus, the dominant gear being bottom otter trawling. The second most important source of catches are jigs, which are categorised as artisanal gear.

Short-finned Squid

Landings of short-finned squid were always low, possibly as a consequence of the relatively low value they attain in the market. No significant change is apparent over the period concerned and catches are equally distributed between bottom trawling (trawling) and gill and trammel nets (artisanal).

Table 2.3.2. Portugal cephalopod landings (tonnes) by type of fishing gear in the period 1998–2002.

Cephalopod group of species	Capture technique	1998	1999	2000	2001	2002
Cuttlefish	Trawl	127	69	75	67	76
	Purse Seine	4	3	3	3	4
	Artisanal gears	1592	1084	1271	1269	1281
Octopods	Trawl	940	786	679	262	242
	Purse Seine	18	29	30	25	21
	Artisanal gears	5392	8210	8060	6890	6984
Longfin Squid	Trawl	876	223	385	618	482
	Purse Seine	5	4	22	17	7
	Artisanal gears	130	100	206	226	189
Shortfin Squid	Trawl	940	786	679	262	242
	Purse Seine	18	29	30	25	21
	Artisanal gears	5392	8210	8060	6890	6984

Development of new fishing techniques

No major alterations to the fishing techniques have taken place during the period under examination. An increase in the utilization of pots and traps is still expected.

2.3.3 Spain

Overall figures suggest that a decreasing trend is observed in cephalopod landings. Peak landings were observed in 1999 in cuttlefish, 1997 in common squid, 1999 in short-finned squid and 2000 in octopods and since then, decreasing landings have been recorded (Table 2.6).

In relation to the sea areas, the most important decrease (4,000 t), from the peak of the series to 2003, has been recorded in ICES Subarea IX and Subarea VIII (Bay of Biscay and Cantabrian Sea, considered together). In the other areas where the Spanish fleet operates, ICES Division VIIg-k (Celtic Sea and SW of Ireland) and Division VIIb, c (West of Ireland and Porcupine Bank), the decrease in the landings has been about 1, 600 t and 500 t respectively.

There does not appear to be any obvious reason for this decrease in the landings. Reviewing a small part of the discard data collected under the Minimum Sampling Programs and mainly related to Subarea VI, VII and Division VIIIa,b,d, cephalopod discards appear to be rather low in relation to those of fin fish species for the same sampled fleets (Santurtún pers. comm.) and, thus, the decrease in the landings does not appear to be due to a change in fishing tactics (change of target species, markets etc…). The possibility of a general decline in abundance must therefore be considered.

2.4 Cephalopod discards data

New information on cephalopod discards was provided by Spain (see Annex 3).

2.5 Opportunistic use of survey data

Portugal is the only European country with ongoing research cruises designed for the analysis of cephalopod stocks. In other areas it was suggested that WGCEPH should make use of existing survey programmes. An example of progress in this direction is given in one of the papers presented at the ASC in Vigo (CC:34 *C.-S. Chen, G.J. Pierce, J. Wang, P.R. Boyle, N. Bailey, J.-P. Robin and I. Sobrino:* The disappearance of *Loligo forbesi* from the south of its range in the 1990s). This paper used fishery and survey data from Scotland, France and Portugal to analyse common trends in abundance.

It is worth noting that within the CEPHSTOCK project, other survey data has been compiled (for instance German trawl surveys in the eastern North Sea), which were not used in the above study because *Loligo forbesi* is too scarce in this area.

Survey data is a useful source of information that provides species-specific indices based on standardized fishing techniques. Its compilation is an additional task that national fishery institutes can carry out more easily than university partners. It is worth noting that there are areas of known importance for cephalopod stocks (for instance the western English Channel -ICES Division VIIe) where no trawl survey data seem to be available (to our knowledge).

2.6 Conclusions

The compilation of annual cephalopod catches and landings within the ICES area is a time consuming exercise which provides an image of cephalopod production. In recent years, yields are still rather high although decreasing trends are observed in southern European countries like Spain.

The justification of this compilation is (i) to give an overview of recent fishery trends and (ii) to provide basic information needed for more detailed analyses (an example of this second step is given with the paper on *Loligo forbesi* spatial distribution described by survey data).

It is worth noting here that the classical use of fishery statistics (stock assessment and/or computation of abundance indices) in the case of cephalopods requires data on a **monthly** basis at least. Thus, if the compilation prepared for this TOR A was to become a first step in stock status studies (TOR B) then WGCEPH would have to change its way of working and concentrate on the collection of data per month (and possibly per ICES rectangle). It has already been pointed out that the major cephalopod fishing countries nowadays collect fishery statistics per month so this seems feasible. It has only been done so far in a limited number of separated areas (Scottish waters, English Channel, Portuguese coasts) most likely because of the large amount of data that must be handled.

2.7 TOR a Tables: Cephalopod Landings Statistics

Table 2.1. Landings (in tonnes) of Cuttlefish (*Sepiidae*).

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003P
ICES Division IIIa (Skagerrak and Kattegat)									
Denmark							2	6	
ICES Division IVa (Northern North Sea)									
Denmark							2	3	
ICES Division IVb (Central North Sea)									
Belgium	1	1	2	3	3	7	11.8	12	4.1
France					1.4	0.4	0.1	0.1	0.4
Denmark							1	13	
England, Wales & Northern Ireland							0.1	3.1	0.4
Netherlands	+	+	+	+	+	2		10.8	6
ICES Division IVc (Southern North Sea)									
Belgium	15	5	4	4	5	12		205.9	64.4
England, Wales & Northern Ireland	163	90	22	28	22	14	4.7	4.2	2.3
France	234	174	135	140	231.4	419.8	184.2	217.2	119.8
Netherlands	+	+	+	+	+	97	118	363.3	229
ICES Division VIa,b (NW coast of Scotland and North Ireland, Rockall)									
England, Wales & Northern Ireland	+	+	0	+	0	0			0.2
France	1	3	1	0	5.3	0.6	0.4	0.2	0
Scotland							4.8		
Spain	+	11	14	16	0	1	0	0	
ICES Division VIIa (Irish Sea)									
Belgium	2	1	1	1	1	1	2	4.7	
England, Wales & Northern Ireland	19	8	1	1	1	1	0.1	0	0.8
France	1	1	0	0	0.1	0.9	0.7	7.1	0.5
ICES Divisions VIIb, c (West of Ireland and Porcupine Bank)									
England, Wales & Northern Ireland	0	0	0	4	3	0		0	0.02
France					0.2	0	0.2	0.3	2.3
Spain	+	10	13	14	0	3	17	3	
ICES Divisions VIId, e (English Channel)									
Belgium	19	11	6	15	9	35	223.7	497.1	472.6
Channel Islands	1	11	8	20	22	26	8	11.3	9.4
England, Wales & Northern Ireland	3925	4038	1634	2449	2014	2910	2607.8	3406.7	4581.3
France	8869	8012	5742	7530	8342.9	11220.4	7242	11596.6	9124.6
Netherlands	+	+	+	+	+	2	2.6	6.4	14
ICES Division VIIf (Bristol Channel)									
Belgium	4	1	1	+	1	1	11.7	3.8	
England, Wales & Northern Ireland	42	64	44	39	9	12	6.9	18.8	39.2
France	14	33	29	36	23	22	27	62	
ICES Divisions VIIg-k (Celtic Sea and SW of Ireland)									
Belgium	5	2	3	3	4	2	3.1	5.6	
England, Wales & Northern Ireland	188	367	464	220	206	139	80.2	101.8	325.2

Table 2.1. Continued. Landings (in tonnes) of Cuttlefish (*Sepiidae*).

Country	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003P**
France	18	34	21	946	886.2	986	759.9	609.1	843.8
Netherlands								0.1	
Spain	+	46	57	181	122	13	6	0	1
ICES Subarea VIII (Bay of Biscay)									
Belgium	+	+	0	0	1	1	7.3	11.7	
England, Wales & Northern Ireland	2	40	37	19	4	0			28.9
France	3878	4058	5118	4363	4434.4	4322.8	4179.4	2939.1	1155.9
Netherlands							41		
Portugal	0	11	8	11	5	8	9.6	6.2	
Spain	194	260	368	593	829	683	365	302	287.5
ICES Subarea IX									
Portugal	981	1625	1415	1723	1156	1357	1338.3	1361.6	1186.1
Spain	1025	819	1504	1916	1868	1454	765	820	992.0
Grand Total	19601	19736	16652	20275	20210	23754	18034	22614	19492

Table 2.2. Landings (in tonnes) of Common Squid (i.e. *Loligo forbesi*, *L. vulgaris*, *Alloteuthis subulata* and *A. media*).

Country	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003P**
ICES Division IIIa (Skagerrak and Kattegat)									
Denmark	1	1	6	8	6	7			
Sweden	2	+	1	1	1	+			
ICES Division IVa (Northern North Sea)*									
Denmark	1	1	2	5	3	3			
England, Wales & Northern Ireland	+	0	0	3	2	3	2.1	1.3	1.2
France	0	0	1	0	0.2	0.1	0	0.3	0.7
Germany	+	+	+	+	+	+			
Scotland	268	279	453	844	712	547	348.9	687.9	
ICES Division IVb (Central North Sea)									
Belgium	14	9	7	11	16	24	3.2	14	22.1
Denmark	+	+	9	3	18	10			
England, Wales & Northern Ireland	22	21	39	144	65	29	35.5	70.4	159.3
Germany	3	1	3	5	5	3			58
Netherlands	+	+	+	+	+	4			
Scotland	25	14	66	214	144	87	112.1	218.3	
ICES Division IVc (Southern North Sea)									
Belgium	153	87	39	36	72	121	20.2	40	17.2
England, Wales & Northern Ireland	10	3	3	2	2	4	11.8	4.7	2.2
France	188	85	123	93	150.9	164.8	236.9	660.2	426.1
Germany	6	2	1	6	1	2			
Netherlands	+	+	+	+	+	758			
ICES Division Vb (Faroe Grounds) *									
England, Wales & Northern Ireland	+	0	0	+	+	+	0.2	0	0.1
Faroe Islands	+	+	5	32	23	+			
Scotland	+	1	1	1	2	2			
ICES Division VIa (NW coast of Scotland and North Ireland) *									
England, Wales & Northern Ireland	16	49	40	7	3	2	2.8	3.4	14
France	98	132	82	136	94.8	51	8.4	27.6	22.6
Ireland	85	114	140	99	106	38			
Scotland	267	287	301	285	334	210	191.6	196.2	
Spain	+	+	+	7	8	3	0	3	10
ICES Division VIb (Rockall) *									
England, Wales & Northern Ireland	2	8	5	14	1	+	0.3	0.6	2.6
Ireland	10	6	1	2	2	3			
Scotland	6	19	5	27	13	5	34.3	58.8	
Spain	2	61	76	49	2	+		2	0.55

Table 2.2. Continued. Landings (in tonnes) of Common Squid (i.e. *Loligo forbesi*, *L. vulgaris, Alloteuthis subulata* and *A. media*).

Country	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003P**
ICES Division VIIa (Irish Sea)									
Belgium	2	8	2	5	3	3	2.3	9.4	2.3
England, Wales & Northern Ireland	156	218	125	173	40	31	102.6	116.3	96.3
France	14	9	5	17	11.4	11.8	21.8	37.1	5.8
Ireland	7	9	6	22	13	5		2	
Isle of Man	7	3	2	2	2	+	0.8	0.4	
Scotland	2	2	3	2	2	2			
ICES Divisions VIIb, c (West of Ireland and Porcupine Bank)									
England, Wales & Northern Ireland	96	307	228	162	59	40	34.8	22	10.1
France	22	84	80	60	35.2	74.9	6.8	6.3	20.1
Ireland	50	48	42	34	40	26	2	1	
Scotland	1	76	45	71	34	27		19.2	
Spain	+	55	69	51	0	17	18	29	35
ICES Divisions VIId, e (English Channel)									
Belgium	220	163	77	133	113	254	22	59.3	72.4
Channel Islands	2	1	6	5	11	9	1	2.3	
England, Wales & Northern Ireland	672	392	496	419	641	449	438.5	553.1	434.6
France	2636	2033	2518	2689	3416.9	3217.8	2659.3	3980.1	4211.9
Netherlands	+	+	+	+	+	11			
ICES Division VIIf (Bristol Channel)									
Belgium	13	12	6	6	6	8	0.5	4.8	9.5
England, Wales & Northern Ireland	132	39	77	29	68	16	55	113.9	56.2
France	275	164	193	126	147	88			
ICES Divisions VIIg-k (Celtic Sea and SW of Ireland)									
Belgium	26	63	10	13	9	5	2.6	7.9	7.4
England, Wales & Northern Ireland	1002	1381	924	505	377	202	166.4	116.1	35.4
France	118	50	69	325	546.9	346.7	467.6	737.6	520.2
Ireland	80	143	168	158	123	67	12	37	
Scotland	1	121	127	128	109	100			
Spain	29	241	302	225	352	77	14	3	1
ICES Subarea VIII (Bay of Biscay)									
Belgium	40	46	14	49	3	48	0	1.8	0.9
England, Wales & Northern Ireland	55	46	68	8	3	+			18.2
France	1565	1419	1489	829	1351.8	1041.8	842.2	514.2	316
Portugal	0	2	2	2	1	1	1.1	0.6	
Spain	196	418	505	811	826	767	614	253	152
ICES Subarea IX									
France	+	+	+	+	4	42			

Table 2.2. Continued. Landings (in tonnes) of Common Squid (i.e. *Loligo forbesi*, *L. vulgaris, Alloteuthis subulata* and *A. media*).

Country	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003P**
Portugal	908	463	848	1011	329	619	897.6	686	236
Spain	245	236	1301	1043	540	507	843	637	549.3
ICES Subarea X (Azores Grounds)									
Portugal*	250	200	303	98	45	58			
Grand Total	10001	9632	11519	11245	11049	10253	8234	9939	7527

*Landings consist exclusively of *Loligo forbesi*.

Table 2.3. Landings (in tonnes) of Short-finned Squid (*Illex coindetii* and *Todaropsis eblanae*), European Flying Squid (*Todarodes sagittatus*), and Neon Flying Squid (*Ommastrephes bartrami*).

Country	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003P**
ICES Subarea I + II (Barents Sea and Norwegian Sea)									
Norway*	352	+	190	2	+	+			
ICES Division Va (Iceland Grounds)									
Iceland*	11	3	5	4	3	1	0	0.1	
ICES Division VIa, b (NW coast of Scotland and North Ireland, Rockall)									
England, Wales & Northern Ireland	+	+	+	3	5	+	0.6	1.1	0
France					2.7	0.4	0.1	0.2	0
Ireland	+	+	+	+	0	+			
Spain	0	43	112	177	3	+	0	11	
ICES Division VIIa (Irish Sea)									
England, Wales & Northern Ireland	0	0	0	0	0	+			0
France					0.2	0.2		0	
Ireland	17	23	+	+	0	0			
ICES Divisions VIIb, c (West of Ireland and Porcupine Bank)									
England, Wales & Northern Ireland	0	0	8	39	18	35	18.7	24.5	0
France	0	0	0	0	1.3	28	5.7	2.4	16.7
Ireland	21	36	+	52	+	29	75	63	
Spain	+	38	97	150	69	148	233	411	221
ICES Divisions VIId, e (English Channel)									
England, Wales & Northern Ireland	+	0	1	0	0	0			0.7
France	1	1	1	1	1.8	3.4	3.8	13	1.8
ICES Divisions VIIg-k (Celtic Sea and SW of Ireland)									
England, Wales & Northern Ireland	29	13	14	251	181	151	173.2	143.7	0
France	0	0	2	49	72.1	66	51.1	91.6	31.7
Ireland	167	312	+	295	9	83	60	91	
Spain	353	164	427	658	873	710	339	87	31
ICES Subarea VIII (Bay of Biscay)									
England, Wales & Northern Ireland	6	0	3	0	0	0			0
France	136	139	372	166	211.3	168.2	67.2	250.4	44
Portugal	0	1	11	5	1	2			
Spain	360	1830	2013	1806	1453	1400	868	584	471.8
ICES Subarea IX									
Portugal	101	121	353	383	313	321	232	205	
Spain	149	1495	2536	1800	4476	2461	2133	592	529.2
Grand Total	1703	4219	6145	5841	7693	5607	4260	2571	1348

*Landings consist exclusively of *Todarodes sagittatus*.

Table 2.4. Landings (in tonnes) of Octopods (*Eledone* spp. and *Octopus vulgaris*).

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003P
ICES Division IVa (Northern North Sea)									
Scotland	2	2	6	13	17	15	6	1.3	
ICES Division IVb (Central North Sea)									
Belgium	0	+	+	2	5	5	5.5	1.5	
England, Wales & Northern Ireland	0	0	0	1	1	1	1.7	0.6	0.52
Netherlands							0.5		
Scotland	0	0	0	1	1	+	0.1		
ICES Division IVc (Southern North Sea)									
Belgium	2	0	2	+	2	1	0.6	1.2	
England, Wales & Northern Ireland	8	4	1	+	+	+		0	0.03
Netherlands							0.1		
ICES Division VIa, b (NW coast of Scotland and North Ireland, Rockall)									
Belgium	0	0	1	1	+	+			
England, Wales & Northern Ireland	0	0	0	2	0	+			2.1
Ireland	1	1	+	0	1	1			
Scotland	4	1	1	0	+	0			
Spain	0	27	35	42	0	+			
ICES Division VIIa (Irish Sea)									
Belgium	14	3	18	26	4	5	10.9	31.1	
England, Wales & Northern Ireland	2	0	1	+	+	+	0.4	0.1	0.3
Ireland	1	+	0	1	0	+		1	
ICES Divisions VIIb, c (West of Ireland and Porcupine Bank)									
England, Wales & Northern Ireland	+	4	3	5	3	4	20.2	2.5	6
France	0	0	0	0	0	8.1	0.6	0.2	0
Ireland	2	2	4	0	2	4	5	1	
Scotland							1.7		
Spain	+	27	33	41	34	44	276	741	430.6
ICES Divisions VIId, e (English Channel)									
Belgium	6	1	1	+	+	+	0.3	2	
Channel Islands	0	0	0	0	+	+			
England, Wales & Northern Ireland	77	75	37	17	9	22	15.2	19.5	20.6
France	45	23	7	3	8.1	13.2	5.1	7.3	5.3
ICES Division VIIf (Bristol Channel)									
Belgium	9	6	6	3	3	13	0.5	8.6	
England, Wales & Northern Ireland	8	6	9	3	4	10	4.2	13	7.7
France	2	2	1	0	+	+			
Spain								2	
ICES Divisions VIIg-k (Celtic Sea and SW of Ireland)									
Belgium	27	17	13	11	10	16	6	12	

Table 2.4. Continued. Landings (in tonnes) of Octopods (*Eledone* spp. and *Octopus vulgaris*).

Country	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003P**
England, Wales & Northern Ireland	144	127	66	58	16	78	105.2	140.8	99.2
France	2	0	1	9	8	32.3	19.3	17.6	11.1
Ireland	4	25	3	2	7	7	9	11	
Scotland	0	5	1	9	1	5	9.5	1.3	
Spain	452	116	145	179	348	518	156	111	26
ICES Subarea VIII (Bay of Biscay)									
Belgium	3	1	4	4	17	4	4.9	13.4	
England, Wales & Northern Ireland	+	5	23	1	+	0			0.5
France	68	49	84	78	199.5	151.3	72.8	56.1	16.3
Netherlands							4.8		
Portugal	107	113	75	57	156	250	69.5	69.7	85.2
Spain	1779	2486	2448	2787	1261	1057	1272	1329	1117.8
ICES Subarea IX									
Portugal	9708	11523	9078	6350	9098	9019	7203.2	7287.9	7465
Spain	3741	2991	3630	3298	4490	5205	2163	2936	2896.4
ICES Subarea X (Azores Grounds)									
Portugal*	8	16	64	39	12	11	11	11	
Grand Total	16226	17658	15801	13043	15718	16500	11461	12831	12191

*Landings consist exclusively of *Octopus vulgaris*.

Table 2.5. Total annual cephalopod landings (in tonnes) in whole ICES area separated into major cephalopod species groups.

Cephalopod Group	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003P**
Cuttlefish	19601	19736	16652	20275	20210	23754	18034	22614	19492
Common Squid	10001	9632	11519	11245	11049	10253	8234	9939	7527
Short-finned Squid	1703	4219	6145	5841	7693	5607	4260	2571	1348
Octopods	16226	17658	15801	13043	15718	16500	11461	12831	12191
Total	47531	51245	50117	50404	54670	56114	41989	47955	40557

Table 2.6. Total annual cephalopod landings (in tonnes) in whole ICES area by country and separated into major cephalopod species groups.

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003P
(a) Cuttlefish (*Sepiidae*)									
Belgium	46	21	17	26	24	59	260	741	541
Channel Islands	1	11	8	20	22	26	8	11	9
Denmark	0	0	0	0	0	0	5	22	0
England, Wales & Northern Ireland	4339	4607	2202	2760	2259	3076	2700	3535	4978
France	13015	12315	11046	13015	13925	16973	12394	15432	11247
Netherlands	0	0	0	0	0	101	162	381	249
Portugal	981	1636	1423	1734	1161	1365	1348	1368	1186
Scotland	0	0	0	0	0	0	5	0	0
Spain	1219	1146	1956	2720	2819	2154	1153	1125	1281
Total	19601	19736	16652	20275	20210	23754	18034	22614	19492
(b) Common Squid (*Loliginidae*)									
Belgium	468	388	155	253	222	463	51	137	132
Channel Islands	2	1	6	5	11	9	1	2	
Denmark	2	2	17	16	27	20	0	0	0
England, Wales & Northern Ireland	2163	2464	2005	1466	1261	776	850	1002	830
Faroe Islands	+	+	5	32	23	+			
France	4916	3976	4560	4275	5759	5039	4243	5963	5523
Germany	9	3	4	11	6	5	0	0	58
Ireland	147	206	217	216	178	101	14	40	0
Isle of Man	7	3	2	2	2	+	1	0	
Netherlands	0	0	0	0	0	773	0	0	0
Portugal	1158	665	1153	1111	375	678	899	687	236
Scotland	570	799	1001	1572	1350	980	687	1180	0
Spain	472	1011	2253	2186	1728	1371	1489	927	748
Sweden	2	+	1	1	1	+			
Total	9916	9518	11379	11146	10943	10215	8234	9939	7527
(c) Short-finned Squid (*Ommatraephidae*)									
England, Wales & Northern Ireland	35	13	26	293	204	186	193	169	1
France	137	140	375	216	289	266	128	358	94
Iceland	11	3	5	4	3	1	0	0	
Ireland	205	371	0	347	9	112	135	154	0
Norway	352	+	190	2	+	+			
Portugal	101	122	364	388	314	323	232	205	0
Spain	862	3570	5185	4591	6874	4719	3573	1685	1253
Total	1703	4219	6145	5841	7693	5607	4260	2571	1348
(d) Octopods (*Octopodidae*)									
Belgium	61	28	45	47	41	44	29	70	0
Channel Islands	0	0	0	0	+	+			
England, Wales & Northern Ireland	239	221	140	87	33	115	147	177	137
France	117	74	93	90	216	205	98	81	33
Ireland	8	28	7	3	10	12	14	13	0
Netherlands	0	0	0	0	0	0	5	0	0
Portugal	9823	11652	9217	6446	9266	9280	7284	7369	7550
Scotland	6	8	8	23	19	20	17	3	0
Spain	5972	5647	6291	6347	6133	6824	3867	5119	4471
Total	16226	17658	15801	13043	15718	16500	11461	12831	12191

3 Stock identification and population size estimation (TOR b)

3.1 Stock identification

There is relatively little new work on stock identification. A review of genetics studies and population structuring in European Cephalopod is being prepared within the CEPHSTOCK project. The first stage was to identify existing molecular tools that reveal polymorphism and point out gaps in the knowledge or in sampling and the second step (review population studies) is still in progress.

The draft summary that is presented below has been prepared by Paul Shaw (Royal Holloway, University of London, UK). Concerning genetical information it seems that *Sepia officinalis* and *Octopus vulgaris* would be the only species showing heterogeneous populations in the northeast Atlantic, all other species seem to more homogenous within the ICES area.

Sepia officinalis: Both allozymes (Perez Losada *et al.* 1999) and microsatellites (Perez Losada *et al.* 2002) indicate stock structuring over relatively small geographical scales (down to ~300Km at least). This is for the populations around the Iberian Peninsula. Microsatellite data also indicated an association of a significant genetic break point with the position of the Almeria-Oran hydrographic feature. Genetic data indicates clinal changes in gene frequencies between the Mediterranean and Atlantic populations - this may indicate the presence of ancestral Mediterranean and Atlantic populations, that have recently come into contact and are introgressing. Unpublished microsatellite data from the FAIR CT1520 project indicate that stock structuring is present throughout the range investigated (English Channel to eastern Mediterranean). Allozyme data combined with morphological data, indicate that described subspecies of *Sepia officinalis* (*S. o. officinalis* .and *S. o. hierredda)* may in fact be distinct species (Guerra *et al.* 2001). This is supported by unpublished mtDNA sequence data (J. Murphy).

Loligo forbesi: Both allozymes (Brierley *et al.* 1995) and microsatellites (Shaw *et al.* 1999) indicate a single genetic population along the Atlantic coast of Europe (NW Scotland to southern Portugal), but a significantly differentiated population in the Azores. This is also supported by mitochondrial DNA data (Norman *et al.* 1995; Shaw *et al.* 1999). Possibly differentiated populations exist on off-shelf banks.

Loligo vulgaris: A study by Garoia *et al.* (2004) using microsatellites suggests a single population within Adriatic. Eastern and Western Mediterranean samples are consistently different from Atlantic samples, and from each other. The Western Sahara samples were the most different amongst the Atlantic samples.

Illexcoindetii: During the project FAIR CT1520, five microsatellites were analysed in a series of samples from West of Ireland to East Mediterranean. This showed no significant heterogeneity, but sample from Mauritania appeared differentiated.

Todaropsis eblanae: During the project FAIR CT1520, four microsatellites + one minisatellite were analysed showing no significant heterogeneity among NE Atlantic samples (West Ireland, English Channel, Vigo, Algarve) and a slight differentiation from Western Mediterranean samples, versus significant differentiation from Mauritania and South Africa.

Octopus vulgaris: Murphy *et al.* (2002) using three microsatellites showed significant differences between fishery samples from Western Sahara and Mauritania. FAIR CT1520 unpublished data showed significant differentiation between East Mediterranean, West Mediterranean, Vigo and Saharan Bank, but mostly non-significant differences among Saharan Bank samples. East Mediterranean was most divergent and West Mediterranean and Vigo least divergent (though still highly significantly different). West Mediterranean appeared equally placed between East Mediterranean and Vigo (so there seem to be homogeneity within localized areas but differentiation above several hundred kilometres. Maltgliati *et al.* (2002), in work based on allozymes (20 loci), showed significant differentiation between Western and Eastern Mediterranean basin samples, plus some evidence of differentiation at a local scale within these areas.

Genetic distances are clearly not the only tool that can be used to define stock boundaries and/or management units. Discussions are still needed about the way to take into account differences in biological parameters that can be related to environmental variables or show latitudinal gradients.

At the present time management units that have been used also took into account the availability of fishery statistics from all countries operating in the area and the presence of biological sampling programmes. For instance, in spite of the lack of genetic differentiation between English Channel and Bay of Biscay in *Loligo forbesi* the only management unit that was assessed is the English Channel and this is because common squid species proportion and length structure of Bay of Biscay landings are not available on a monthly basis.

3.2 Total stock size assessments

Previous WGCEPH reports have presented historical assessments carried out the following stocks:

- *Loligo forbesi* in Scottish waters (Young *et al.*, 2004) studied cohorts: 1989–1997
- *Loligo forbesi* and *L. vulgaris* in the English Channel (Royer *et al.*, 2002) studied cohorts: 1993–1996
- *Sepia officinalis* in the English Channel (Royer 2002) studied cohorts: 1996–1998

Assessments of the English Channel stocks have been updated. In *Loligo forbesi* this enables a preliminary analysis of trends in recruitment and spawning stock size, which is going to be presented at the cephalopod theme session (ICES 2004 CM/CC:22). In *Sepia officinalis* a manuscript is in preparation (Royer *et al.*, in prep.) and the main results are summarized below:

The study used fishery statistics collected from France and UK national databases and of biological data acquired during EU funded research projects (FAIR CT 96-1520 "Cephvar", CFP99-063 "Data collection for assessment of cephalopod stocks" and O5CA-2002-00962 "Cephstock").

Total catches (in number), catch per "métier" and catch-at-length (total catch in number per size class of 1 cm) were computed by combining monthly fishery statistics (in kg) and monthly Port-en-Bessin fish market sampling. Catch-at-age for each fraction of cohort was estimated from catch-at-length by polymodal decomposition with the Normsep module implemented in FISAT package (Gayanilo *et al.*, 1995) using cuttlefish growth curves from Medhioub (1986) and Challier *et al.* (2002).

Cohort analysis: the hatching period being relatively short in the English Channel (June to September with a peak in July; Challier *et al*, 2002) the recruitment periods (autumnal or spring) are also short. This characteristic allowed an easier distinction of annual cohorts (cuttlefish from the same hatching season) from month to month. In reason of the presence of two recruitments for a same hatching season, each cohort was divided into two fractions (Figure 3.2.1). A monthly relative age was then attributed for each fraction considering that the first fraction, 4 months old, was recruited in October and the second fraction, 7 months old, was recruited in April. The first fraction is exploited from October (year N) to June (year N+2) and the second fraction from April (year N+1) to June (year N+2). Thus, cohort analysis can be carried out independently on both fractions of one cohort. It was conducted for 6 complete cohorts, 1995 to 2000 (each cohort is named according to the year of its first autumn recruitment). The outputs of cohort analysis for each fraction of cohort are estimates of the monthly population numbers at age (Ni) and monthly fishing mortality at age (Fi).

Simulations and exploitation diagnostics: Simulation of the whole stock, yield and average biomass, were predicted at various levels of fishing mortality for each cohort using the classical Thomson and Bell model (Sparre and Venema, 1998). A multiplier factor (mf) for fishing mortalities between 0 and 2.5 is integrated in the model to express the fishing intensity (mf=1 indicates the present fishing effort).

Simulations of "métiers" interactions: Typology of "métiers": Métiers are defined by fishing gear and fishing area from an allocation key proposed by Dintheer *et al.* (1995) and Tétard *et al.* (1995) for English Channel fleets. Each métier was considered as homogeneous with all boats having the same exploitation diagram.

Technical interactions were measured as described in Ulrich *et al.* (2001) with two coefficients that evaluate the variations of catch of métiers in relation to changes in effort of other métiers. Variations in effort were simulated using a multiplier of fishing mortality. The impact coefficient (r_m) corresponds to the decrease of production (in %) of all métiers when a métier m increases the fishing effort by 1% (mf_m=1.01 and mf_M=1). The sensitivity coefficient (sc_m) measures the decrease of production of the métier m when all other métiers (M-1) increase fishing effort of 1% (mf_m=1 and mf_M=1,01). The allocation of fishing mortality to each métier was computed from total fishing mortalities evaluated with cohort analysis in proportion to catch by metier.

Catch structure: Monthly catches of cuttlefish varied from 0.1 to 6 millions of individuals over the studied period (October 1995 – June 2002) with a peak in October 2000. (Figure 3.2.1)

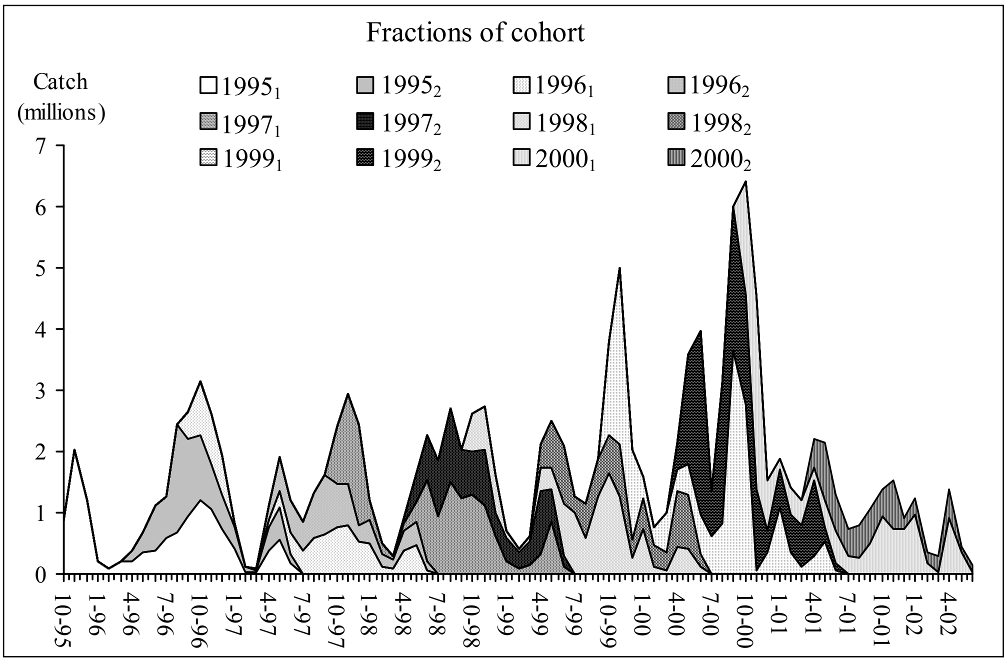

Figure 3.2.1. Monthly catch in millions for each fraction of cohort in the period October 1995 to June 2002.

Recruitment levels and interannual variability: At the cohort scale (Figure 2), recruitment levels largely fluctuated but no real trend in abundance was observed. It ranged between 44 millions of recruits (cohort 1996) and 79 millions (cohort 1999). Natural mortality influenced estimates of recruitment size but the inter-annual pattern remained similar.

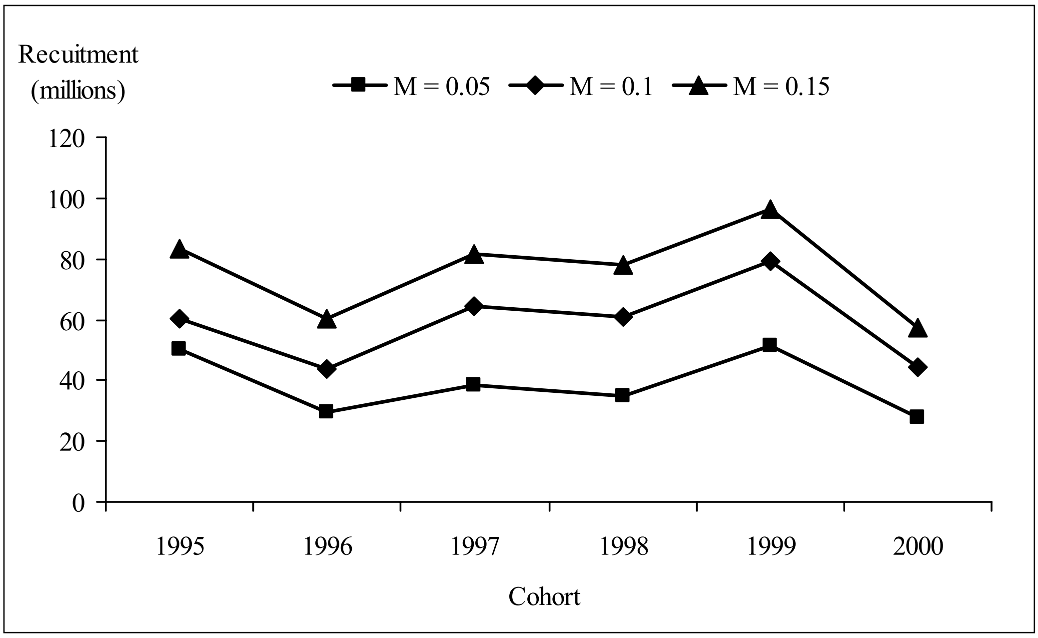

Figure 3.2.2. Cohort analysis estimates of recruitment (millions) of 6 cohorts 1995 to 2000 at three level of natural mortality (0.05, 0.1, 0.15).

Exploitation pattern and diagnostics: The cohort exploitation pattern (Figure 3.2.3a) shows that fishing mortalities were very low for recruits and during the first months after recruitment, they progressively increased during the second year of the cohorts and adult cuttlefish at the end of their life cycle in spring undergo the highest fishing pressure.

Simulations of production are illustrated in the case of a high recruitment cohort (1999) in Figure 3.2.3b. Observed fishing effort (mf = 1) were above the maximum yield effort in this 1999 cohort which suggests some growth overfishing. However, reduced fishing mortalities would not have given much higher yields

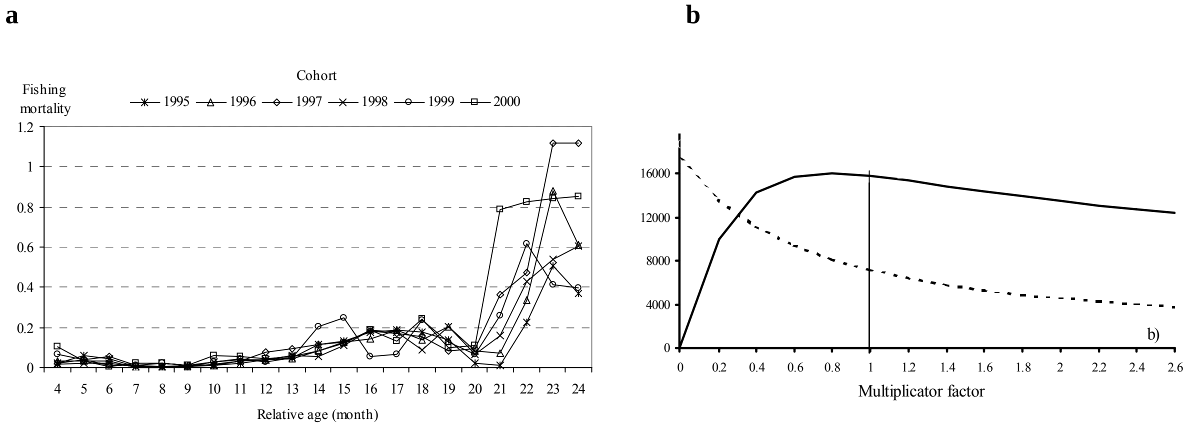

Figure 3.2.3. Fishing mortality estimates for the studied cohorts (a) and simulations of yields and biomass (in tonnes) for the 1999 cohort (b).

Interaction between fishing fleets: The analysis was carried out using cohort 1996, which showed recruitment close to the average level. Five groups of métiers were identified by plotting them according to sensitivity and impact coefficients (Figure 3.2.4). The first group includes five métiers that had a high impact and a low sensitivity: they include the four métiers of French otter trawling and the English western otter trawling. Opposed to this group is the group II of métiers that showed low impact but high sensitivity. This is for instance the case of French inshore trap fishing which appeared sensitive to preceding exploitation of the cohort by trawlers. Other groups comprise métiers which are less concerned by cuttlefish resource. This exercise performed on all other cohorts gave similar results to those of 1996 and led to the same conclusion about the composition of groups.

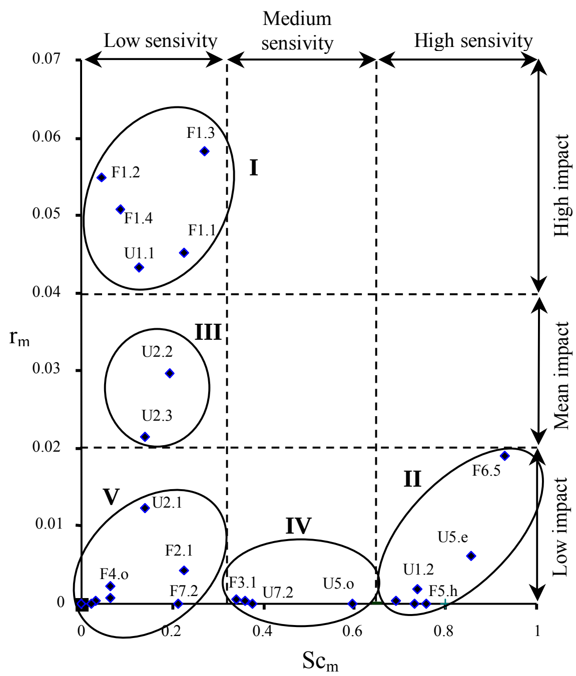

Figure 3.2.3. Sensitivity and Impact coefficients for 28 métiers catching cuttlefish in the English Channel.

3.3 Estimates of population trends based on indices.

Ongoing compilation of catch and effort data of selected fishing fleets and compilation of CPUE abundance indices has been presented during the first assessment work of the CEPHSTOCK project, hosted by Imperial College (London, 30–31 August 2004).

In the Gulf of Cadiz fishery for *Octopus vulgaris*, LPUE were correlated with survey abundance indices and were thus considered as describing abundance (presentation by Ignacio Sobrino, IEO, Cadiz, Spain).

In the Portuguese fishery, the utilisation of daily landings was tested (presentation by Joao Pereira, IPIMAR, Lisbon, Portugal). Although feasible, the computation of abundance indices at such a fine time scale did not show trends that could suggest straightforward application of depletion methods as shown in an example (Figure 3.3.1.).

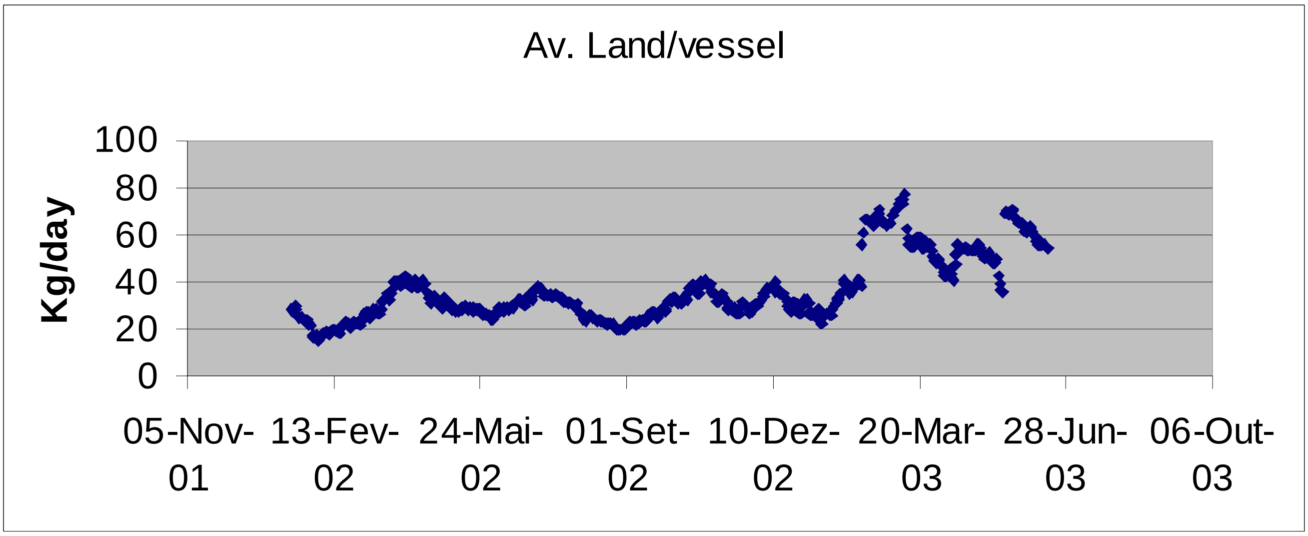

Figure 3.3.3. Example of *Octopus vulgaris* LPUE time series computed for the Portugal fishery with a daily time scale.

In conclusion, it should be noted that cephalopod stock assessment is useful to develop in order to understand the effect of fishing pressure on these stocks and provide a rational basis for management. However, population abundance indices are not only a fisheries assessment issue. The ecological study of environment related variations, of density-dependent phenomenon's, or of factors affecting survival also requires estimates of population size and/or population dynamics.

4 Possible precautionary approaches to management (TOR c)

There is no point in repeating the list of management measures that were discussed in year 2003 report. Increasing knowledge on cephalopod capture techniques in the ICES area suggests that management advice on cephalopod resources should take into account two different situations:

1) In southern countries cephalopod stocks tend to be fished at a national scale (overlap between Spain and Portugal fishing grounds seems to be low). Inshore fisheries are important and carried out by a number of artisanal metiers, which are interacting. In these areas, management is more a problem of fleet interactions.

2) In northern areas cephalopod fishing grounds are more international and dominated by multispecies trawlers. In this context the management of cephalopod resources should involve the analysis of species interactions. Multispecies or ecosystem approaches have been developed (for instance in the Celtic Sea). However the time scale relevant for fin-fish is generally not adapted to cephalopods.

5 Environmental factors affecting recruitment and distribution patterns (TOR d)

The term of reference is as follows: Compile available data and identify relationships between abundance and environmental conditions, factors affecting recruitment, migration and distribution patterns of juveniles and adults, and trophic interactions

The CEPHSTOCK project includes two work packages that concern this TOR:

"Review and new analysis of fisheries-environment interactions" and "Review of life-history, ecology and movements".

Work on these topics is still in progress and cannot provide relevant information for the actual WGCEPH report.

5.1 Environmental factors affecting cephalopod physiology

Two ecotoxicological studies in European cephalopods are summarized here to underline progress made in the quantification of heavy metals effect. A more comprehensive review of this theme is in preparation within CEPHSTOCK work package 6: Review of cephalopod immunology and physiology.

Le Bihan *et al.* (2004a) [Le Bihan E., Perrin A., and Koueta N., 2004. Development of a bioassay from isolated digestive gland cells of the cuttlefish *Sepia officinalis* L. (Mollusca Cephalopoda): effect of Cu, Zn and Ag on enzyme activities and cell viability. ICES ASC] established a bioassay from isolated digestive gland cells of the cuttlefish *Sepia officinalis* in order to observe the effect of heavy metals on digestive enzyme activities. Digestive cells were isolated using a pronase enzyme that was removed by several washings of the cell suspension. Cell viability was tested by the MTT assay (3-4,5-dimethylthiazol-2-yl-2,5-diphenyl tetrazolium) and microscopic analysis. The results showed that isolated digestive cells could be maintained 24 h with preservation of whole digestive functionality, measured in terms of MTT test. In fact, the viability was maintained at a high level during 24 h and the intra- and extracellular digestive enzyme activities became stabilised rapidly. Furthermore, suspension cells responded to calcium ionophore and 8-Bromo-cAMP by an unspecific secretion of extracellular digestive enzyme, trypsin, which demonstrated that isolated digestive cells were functional. Using the bioassay, ecotoxicological studies showed that heavy metals could have effects on digestive enzyme activities after 24 h of an incubation time of the metal with the cells. In fact, zinc and silver affected trypsin and/or cathepsins specific activity of the cells. On the contrary, copper had no effect on digestive enzyme activities. Zinc, which is a trace element in all living animals, generated two different responses of cathepsins and cell viability. At a low concentration (0.02 µM), it increased viability and cathepsins specific activity, whereas at a high concentration (0.02 mM), zinc inhibited the cathepsins specific activity with an inhibition of cathepsins. For silver, whatever the tested concentration (0.02 mM or 0.02 µM), it has no impact on digestive gland isolated cell viability. Nevertheless, heavy metal induced high disturbance of enzymatic systems.

Le Bihan *et al.* (2004b) [Le Bihan E., Pacary A., Perrin A., and Koueta N., 2004. Effects of water renewal plus Zn, Cu and Ag on growth of eggs and juvenile of cuttlefish *Sepia officinalis L.* (Mollusca: Cephalopoda). ICES ASC] determined the impact of heavy metals on survival and growth of eggs and juvenile cuttlefish by experimental rearing. Eggs were incubated from 20-days-old to hatching with 10 % of water renewed daily. A low concentration of zinc (7.5 µg/ L) or copper (10 µg/ L) permitted a better growth of cuttlefish eggs. In contrast, the eggs incubated from laying to hatching with 100 % of water renewed per day exhibited normal growth. Thus, the insufficient renewal of water in the first experiment induced an oligo-element deficiency. At high concentration, zinc (c= 23.2 mg/ L) or copper (c= 10 mg/ L) totally prohibited the eggs' growth. With 0.34 ng/ L of silver, weight increase of eggs stopped. Whatever the date or the temperature of egg incubation in polluted water, the effects of heavy metals on egg growth appeared 20 days after the eggs were placed in the polluted water. Therefore, the above results clearly demonstrated the toxicological effects of essential metals such as Cu and Zn at elevated levels of the metal exposures. However, the role played by the essential Cu and Zn at trace amounts is important to induce at relatively low levels of the two metal exposures. In the case of Ag, which is a non-essential metal, it totally inhibited the growth of the eggs since this phenomenon was well indicated by the drastic inhibition of eggs growth, regardless of whether low or high Ag exposures. Juvenile cuttlefish were reared in heavy metals polluted water. At high concentration, zinc (25 mg/ L), copper (500 mg/ L) and silver (6.8 to 0,34 µg/ L) induced quick death of juvenile cuttlefish.

6 Cephalopod culture techniques (TOR e)

The term of reference is as follows: Review cephalopod culture techniques and results and their interest in the understanding of biological phenomena.

This TOR was introduced in WGCEPH list of TORs in 2002 and it was noted in 2003 that work was too preliminary too be reported. So, the contribution below is the first review to be presented to ICES on this theme.

6.1 Introduction

Experimental culture of cephalopod started in the 1960s, by the Korean and Japanese, on some species of Sepiidae. These pioneer studies were then followed and complemented by European and North-American scientists in the following years. Richard (1971) and Pascual (1978) were some of the first researchers who succeeded in culturing the European cuttlefish *Sepia officinalis* in the laboratory. According to Lee (1994), growth rates for young cephalopods cultured at 23ºC can be as high as 13.5% $BW.d^{-1}$ (body weight per day). Hanlon *et al.* (1991) obtained daily growth rates of 3–4% $BW.d^{-1}$, with a weight increase from 500 to 1400 g, at temperatures which varied between 20–24ºC, over 10 months. Domingues *et al.* (2001b) cultured *S. officinalis* at 24–30ºC and obtained daily IGR's of 11.8% $BW.d^{-1}$ for hatchlings and mean IGR of 2.5–8.5% $BW.d^{-1}$, throughout the life cycle (Domingues *et al.*, 2001c). Since the problems with water quality have been minimized during the past few years, the main problem that kept this species out of the commercial aquaculture business is the adequate food supply and cost associated. A large amount of different diets have been tested but only live food has attained good results in growth, condition and survival (Toll and Strain, 1988; DeRusha *et al.*, 1989; Lee *et al.*, 1991; Castro *et al.*, 1993; Domingues, 1999; Koueta and Boucaud-Camou, 1999; Domingues *et al.*, 2001b).

The common octopus has been identified as an important potential candidate for mariculture (Iglesias *et al.,* 1996) because adults have suitable characteristics for rearing (Mangold and Boletzky, 1973; Boletzky and Hanlon, 1983; García and Aguado, 2002). However, the main problem with culture of common octopus is related to the impossibility of rearing the paralarvae of this species, which is still under development Availability of large specimens has declined during the past decade. In Galicia, the minimum legal weight of landed common octopus is 750 g. Therefore, the outgrowing of these small animals would increase their market value, and also would regulate the supply of large animals. Some limited outgrowing trials have been conducted in Galicia since 1995. Some trials were undertaken using tanks (Iglesias *et al.*, 1997; Sánchez *et al.*, 1998; Otero *et al.*, 2001), while others used various types of cages (Rama-Villar *et al.*, 1997; Luaces and Rey-Mendez, 1999).

6.2 Recent work

6.2.1 Cuttlefish

Koueta *et al*. (2002) found that the natural diet enriched on polyunsatured fatty acids (PUFA) induced fast growth in juvenile cuttlefish and the stimulating effect of PUFA on growth was essential during very early young stage and the benefit was conserved during further growth. In groups fed on enriched diet, the maximum ration was found lower, then the importance of PUFA n-3 series as docosahexaenoic acid (DHA), 22:6(n-3) and eicosapentaenoic acid (EPA), 20:5(n-3) in cephalopod larval culture .

Koueta and Boucaud-Camou (2003), by studying the combined effects of photoperiod and feeding frequency, demonstrated that an increase in feeding frequency can enhance survival and growth in the group receiving the shortest period of light per day. Temperature is an important factor in the regulation of the incubation period of eggs and of growth after hatching, but it also appears in this investigation that the combined effect of photoperiod and feeding frequency must be considered during growth of juvenile cuttlefish. enriched diet, when change to a diet of alternatively frozen prey and live prey, an adjustment period with lower growth was observed. when juvenile cuttlefish are fed on live prey enriched with PUFA, they accept frozen prey earlier in their life and the survival is enhanced.

Grass shrimp, *Palaemonetes varians*, could possibly be used as an alternative first diet and throughout the life cycle, since it has been used in post-hatchling culture of the cuttlefish with good results (Richard, 1971; DeRusha *et al.*, 1989; Domingues *et al.*, 2001b and 2001c). This species is much more abundant and can be obtained from the wild throughout the year in the Ria Formosa lagoon (South Portugal). Furthermore, lower growth was obtained when cuttlefish were fed fish compared to grass shrimp (Domingues *et al*., 2003 and 2004). Domingues *et al*. (2002) showed that frozen shrimp is as good as live shrimp to culture *S. officinalis*, even though total protein contents of the diet were probably affected (leaching) by the freezing procedure. The possibility of using frozen shrimp is a great advantage if large numbers of cuttlefish are to be produced, as large quantities of food can be stocked to be used when live food is not available. This allows the production of *S. officinalis* at inland sites, far away from the sea, and it also ends the dependence on live shrimp, their holding tanks and the feeds to maintain them. These factors can significantly reduce the production costs of the cuttlefish.

6.2.2 Octopus vulgaris

Two outgrowing experiments were conducted during summer and winter in the Ria of Vigo, Galicia, by Guerra *et al.* and show that culture of common octopus from mussel rafts may be commercially-viable, especially if problems with salinity, acquiring specimens from the wild, and losses due to spawning during culture can be reduced.

The fatty acids of the mature ovary, late eggs and wild juveniles of *Octopus vulgaris* were analysed by Navarro and Villanueva (2003) to establish, in accordance with the published data on the fatty acid composition of hatchlings, a theoretical framework of the ideal fatty acid profile, i.e. the "natural" fatty acid profile, during the early life of the species. The time course variation of the fatty acid composition of paralarvae reared in cultures fed enriched *Artemia* nauplii on their own, or supplemented with encapsulated microdiets, was also analysed and compared. The fatty acid composition of the cultured planktonic paralarvae was chemometrically related to that of the wild benthic juveniles by means of a multivariate discriminant analysis. Irrespective of the dietary treatment, the artificial feeding produced distinct lipid and fatty acid profiles as compared to the "natural" one. The influence of the fatty acid profile of *Artemia* seems clearly reflected in the cultured *O.vulgaris* paralarvae. The effect of the fatty acid composition of food was evident in the paralarvae after 10 days of feeding and remained essentially unchanged during the experimental period up to 30 days. The total lipid of the cultured animals increased notably, as did the levels of monounsaturated fatty acids, to the detriment of PUFA and, particularly, DHA. Poor growth and high mortality seemed to result from a nutritional imbalance in the fatty acid profile (i. e., DHA/EPA ratio) produced by the artificial feeding, suggesting also that the microdiet was inefficiently digested and/or assimilated. Wild juveniles tend to lose lipids as they increase in weight. Possible causes are discussed.

Lenzi *et al.* 2002; Mattei *et al.* 2002 fed actively paralarvae on Artemia naupli- metanaupli, while artificial feeds were not ingested at all. At best, the rearing conditions here adopted allowed an age of 28 days post hatch to be attained, while a total loss of specimens occurred earlier when rearing temperatures were kept above 24 °C. The results of the present study have shown a high reproductive potential of wild octopus kept under captive conditions.

Table 6.1. Aquaculture production (expressed in tonnes) of cephalopods (1992–2001).

		Year					
	Country	1996	1997	1998	1999	2000	2001
Sepia officinalis							
	Portugal	1	1	1	1	0	1
	Spain	-	-	-	-	-	-
Octopus vulgaris							
	Portugal	-	3	-	-	-	-
	Spain	-	-	32	32	28	15

FAO (2003). FAO Yearbook of Fishery Statistics: Aquaculture Production. Vol 92/2. 186 pp.

6.3 Discussion

It is now very important to document existing systems and methodologies, to improve production methods. The quantity and quality of the production for scientific investigations and for commercial aim must be indicated by year. Socioeconomic aspects of the aquaculture of cuttlefish is also carry up.

Within the CEPHSTOCK project a compilation of papers on cephalopods aquaculture has been prepared and a CD-ROM containing 401 research articles (as pdf files) on this theme is now available.

The second ecotoxicological paper presented above (in the TOR D section) is an example of how rearing facilities can contribute to understand ecological phenomenons that may affect cephalopods in the wild.

7 Cephalopod literature relevant to fisheries (TOR f)

Information on literature relevant to cephalopod fisheries published during the last calendar year (2003–2004) was downloaded from bibliographic databases and supplied by WGCEPH members. This information is presented in Annex 4 and divided in two sections (journal papers and grey literature).

8 Research priorities

WGCEPH considers that research priorities indicated last year remain entirely valid. The three main points that were underlined are listed again below:

- It is important to include cephalopods in national fisheries sampling programmes with samples schemes adapted to these species.

- It is necessary to update and develop stock assessments in the main stocks.

- Since most studies of environmental factors affecting cephalopod abundance have underlined that recruitment variations were the most important, ecological studies of early life stages should be encouraged.

Additional gaps in knowledge and possible research directions identified during discussions were:

- The role of cephalopods as ecosystem components, and their relationships with other fished resources;

- The use of trace elements to indicate migration patterns;

- The need to revisit and refine ageing techniques;

- The socio-economic value of small cephalopod fisheries;

- The role of cephalopods as indicators of marine pollution and as routes of transfer of toxic elements, hydrocarbons, and other contaminants to higher trophic levels.

9 The future programme of WGCEPH and recommendations

9.1 Terms of reference

WGCEPH considers that, broadly speaking, the present terms of reference continue to be relevant. The working group wishes to continue to gather expertise on European cephalopod fisheries and to make available to ICES Advisory Commission for Fisheries Management any progress in stock assessments. Also, the working group considers that progress in the understanding of cephalopod life history and of the role of cephalopod populations in changing ecosystems should be of interest to the Advisory Commission for Environmental Management.

The following update of terms of reference is proposed:

a) *Update and refine available landing statistics at relevant time-scales, compile available information on fishing effort of selected fleets, on discards and on selectivity and explore resource survey databases for information about sampled cephalopods in the ICES area.*

b) ***Compile methods and results available for stock identification and estimation of population size of fished cephalopods***. It should be noted that funding for formal analytical stock assessment has been project-based and some basic data (e.g. market sampling) will not be available. On the other hand, it will be possible to provide general "assessment" of stock trends (e.g. based on CPUE).

c) *Identify possible precautionary approaches to the management of these cephalopod resources; evaluate management options and consider socio-economic issues.* The changed wording reflects (a) the opinion that it is not yet possible to provide management options, in the absence of a specific remit to provide assessments, and (b) current interest in socio-economic issues. Any evaluation of management options requires an ability to take account of social and economic as well as biological objectives. It is useful to know what social and economic information would then be required.

d) *Compile available data and identify relationships between abundance and environmental conditions, factors affecting recruitment, migration and distribution patterns of juveniles and adults, trophic interactions and contaminants bio-accumulation.*

e) *Review cephalopod culture techniques and results and their interest in the understanding of biological phenomena*.

f) *Update the bibliographic database of cephalopod literature relevant to fisheries, including grey literature.*

9.2 WGCEPH working

It has already been underlined that WGCEPH, more than most ICES Working Groups, relies on participation from a wide range of scientists working often in universities where no funding is available for participation in ICES activities. The EU project CEPHSTOCK was an opportunity to combine meetings with WGCEPH. However, timing and location of CEPHSTOCK meetings is not always adapted to the ICES schedule.

During the next year (2004–2005) WGCEPH proposes to continue to work by correspondence.

The present Chair's 3-year term having come to an end. João Pereira (IPIMAR Portugal) received the support of WGCEPH and it is recommended that the group continue under his Chairmanship.

10 Annexes

Annex 1: Cephalopod Bibliography (2003–04)

New literature on cephalopods is listed under two headings: (a) the primary literature (mainly peer-reviewed journals) and (b) grey literature, including reports and PhD theses. Most subject areas are covered, although some palaeontological literature was excluded. This compilation concentrates on material published in 2002 but also includes material that is due for publication in early 2003 and older material that was missed in the previous compilation. Additionally we list data products (e.g. CD-ROMs) and relevant web sites.

Primary Literature

Agin, V; Chichery, R; Maubert, E; Chichery, M-P, 2003. Time-dependent effects of cycloheximide on long-term memory in the cuttlefish. Pharmacology Biochemistry and Behavior 75, 1, 141–146.

Allcock, A.L., Hochberg, F.G., Rodhouse, P.G.K., Thorpe, J.P., 2003. *Adelieledone*, a new genus of octopodid from the Southern Ocean. Antarctic Science, 15, 415–424.

Anderson, R.C., Mather, J.A., and Steele, C.W. 2004. Burying and associated behaviors of *Rossia pacifica* (Cephalopoda: Sepiolidae). Vie et Milieu-Life and Environment, 54, 13–19.

Anon., 2003. Kir Nazimovich Nesis: a life in science. Berliner Paläobiol. Abh., 3, 7–11.

Arkhipkin, A; Brickle, P; Laptikhovsky, V, 2003.Variation in the diet of the Patagonian toothfish with size, depth and season around the Falkland Islands. Journal of Fish Biology 63, 428–441.

Arkhipkin, AI; Grzebielec, R; Sirota, AM; Remeslo, AV; Polishchuk, IA; Middleton, DA, 2004. The influence of seasonal environmental changes on ontogenetic migrations of the squid *Loligo gahi* on the Falkland shelf. Fisheries Oceanography 13, 1–9.

Auclair, A.C., Lecuyer, C., Bucher, H., and Sheppard, S.M.F. 2004. Carbon and oxygen isotope composition of Nautilus macromphalus: a record of thermocline waters off New Caledonia. Chemical Geology, 207, 91–100.

Bairati, A; Comazzi, M; Gioria, M, 2003. An ultrastructural study of connective tissue in mollusc integument III Cephalopoda. Tissue & Cell 35, 155–168.

Bernay, B., Gagnon, J., and Henry, J. 2004. Egg capsule secretion in invertebrates: a new ovarian regulatory peptide identified by mass spectrometry comparative screening in *Sepia officinalis*. Biochemical and Biophysical Research Communications, 314, 215–222.

Bolstad, K.S. and O'Shea, S. 2004. Gut contents of a giant squid *Architeuthis dux* (Cephalopoda : Oegopsida) from New Zealand waters. New Zealand Journal of Zoology, 31, 15–21.

Bonnaud, L, Ozouf-Costaz, C,Boucher-Rodoni, R, 2004. A molecular and karyological approach to the taxonomy of *Nautilus*. Comptes Rendus Biologies, 327, 133–138.

Bower, JR,Takagi, S, 2004. Summer vertical distribution of paralarval gonatid squids in the northeast Pacific. Journal of Plankton Research, 26, 851–857.

Buresch, K.C., Boal, J.G., Nagle, G.T., Knowles, J., Nobuhara, R., Sweeney, K., and Hanlon, R.T. 2004. Experimental evidence that ovary and oviducal gland extracts influence male agonistic behavior in squids. Biological Bulletin, 206, 1–3.

Bustamante, P., Teyssie, J.L., Danis, B., Fowler, S.W., Miramand, P., Cotret, O., and Warnau, M. 2004. Uptake, transfer and distribution of silver and cobalt in tissues of the common cuttlefish *Sepia officinalis* at different stages of its life cycle. Marine Ecology-Progress Series, 269, 185–195.

Casaux, R, Bellizia, L,Baroni, A, 2004. The diet of the Antarctic fur seal *Arctocephalus gazella* at Harmony Point, South Shetland Islands: evidence of opportunistic foraging on penguins? Polar Biology, 27, 59–65.

Cherel, Y., Duhamel, G., and Gasco, N. 2004. Cephalopod fauna of subantarctic islands: new information from predators. Marine Ecology-Progress Series, 266, 143–156.

Collins, MA, 2003. The genus *Grimpoteuthis* (Octopoda : Grimpoteuthidae) in the north-east Atlantic, with descriptions of three new species. Zoological Journal of the Linnean Society, 139, 93–127.

Collins, MA, 2004. *Cryptoteuthis brevibracchiata*: A new species and genus of cirrate octopod (Octopoda : Cirrata). Journal of Molluscan Studies, 70, 263–267.

Collins, M.A., Allcock, A.L., and Belchier, M. 2004. Cephalopods of the South Georgia slope. Journal of the Marine Biological Association of the United Kingdom, 84, 415–419.

Costa, P.R., Rosa, R., and Sampayo, M.A.M. 2004. Tissue distribution of the amnesic shellfish toxin, domoic acid, in *Octopus vulgaris* from the Portuguese coast. Marine Biology, 144, 971–976.

Crookes, W.J., Ding, L.L., Huang, Q.L., Kimbell, J.R., Horwitz, J., and McFall-Ngai, M.J. 2004. Reflectins: The unusual proteins of squid reflective tissues. Science, 303, 235–238.

de Bruyn, PJN, Bester, MN, Mecenero, S, Kirkman, SP, Roux, JP, Klages, NTW, 2003. Temporal variation of cephalopods in the diet of Cape fur seals in Namibia. South African Journal of Wildlife Research, 33, 85–96.

Di Cosmo, A, Paolucci, M, Di Cristo, C, 2004. N-methyl-D-aspartate receptor-like immunoreactivity in the brain of *Sepia* and *Octopus*. Journal of Comparative Neurology, 477, 202–219.

Di Cristo, C, Delli Bovi, P, Di Cosmo, A, 2003. Role of FMRFamide in the reproduction of *Octopus vulgaris*: molecular analysis and effect on visual input. Peptides, 24, 1525–1532.

Domingues, P., Sykes, A., Sommerfield, A., Almansa, E., Lorenzo, A., and Andrade, J.P. 2004. Growth and survival of cuttlefish (*Sepia officinalis*) of different ages fed crustaceans and fish. Effects of frozen and live prey. Aquaculture, 229, 239–254.

Forsythe, J.W. 2004. Accounting for the effect of temperature on squid growth in nature: from hypothesis to practice. Marine and Freshwater Research, 55, 331–339.

Gao, Fengying; Liao, Yongyan; Ye, Fuliang, 2003. Feed study of the *Tachypleus tridentatus* juvenile. Marine science bulletin/Haiyang Tongbao 22, 92–96.

Garcia-Rodriguez, FJ, Aurioles-Gamboa, D, 2004. Spatial and temporal variation in the diet of the California sea lion (*Zalophus californianus*) in the Gulf of California, Mexico. Fishery Bulletin, 102, 47–62.

Garoia, F, Guarniero, I, Ramsak, A, Ungaro, N, Landi, M, Piccinetti, C, Mannini, P, Tinti, F, 2004. Microsatellite DNA variation reveals high gene flow and panmictic populations in the Adriatic shared stocks of the European squid and cuttlefish (Cephalopoda). Heredity, 93, 166–174.

Gielens, C., De Geest, N., Compernolle, F., and Preaux, G. 2004. Glycosylation sites of hemocyanins of *Helix pomatia* and *Sepia officinalis*. Micron, 35, 99–100.

Gimenez-Bonafe, P., Soler, F.M., Buesa, C., Sautiere, P.E., Ausio, J., Kouach, M., Kasinsky, H.E., and Chiva, M. 2004. Chromatin organization during spermiogenesis in *Octopus vulgaris*. II: DNA-interacting proteins. Molecular Reproduction and Development, 68, 232–239.

Gleadall, IG, 2003. A note on the Cephalopoda type specimens in the Zoology Department of Tokyo University Museum. Journal of Molluscan Studies, 69, 375–380.

Go, L; Mitchell, J, 2003. Palmitoylation is required for membrane association of activated but not inactive invertebrate visual Gq alpha. Comparative Biochemistry and Physiology, Part B: Biochemistry and Molecular Biology 135, 601–609.

Gomez-Guillen, MC; Martinez-Alvarez, O; Montero, P, 2003. Functional and Thermal Gelation Properties of Squid Mantle Proteins Affected by Chilled and Frozen Storage. Journal of Food Science 68, 1962–1967.

Gozansky, EK, Ezell, EL, Budelmann, BU, Quast, MJ, 2003. Magnetic resonance histology: in situ single cell imaging of receptor cells in an invertebrate (*Lolliguncula brevis*, Cephalopoda) sense organ. Magnetic Resonance Imaging, 21, 1019–1022.

Grist, E.P.M. and Jackson, G.D. 2004. Energy balance as a determinant of two-phase growth in cephalopods. Marine and Freshwater Research, 55, 395–401.

Guerra, A., Gonzalez, A.E., Dawe, E.G., and Rocha, E. 2004. Records of giant squid in the north-eastern Atlantic, and two records of male Architeuthis sp off the Iberian Peninsula. Journal of the Marine Biological Association of the United Kingdom, 84, 427–431.

Halm, MP; Chichery, MP; Chichery, R, 2003. Effect of nitric oxide synthase inhibition on the manipulative behaviour of *Sepia officinalis* Comparative Biochemistry and Physiology, C 134, 139–146.

He, Shen; Meng, Shengnan; Xie, Guanglin, 2003. Study on secretion of interleukin-1 induced by sepia in mice. Chinese journal of marine drugs/Zhongguo Haiyang Yaowu 22, 17–19.

Hendrickson, L.C. 2004. Population biology of northern shortfin squid (*Illex illecebrosus*) in the Northwest Atlantic Ocean and initial documentation of a spawning area. ICES Journal of Marine Science, 61, 252–266.

Ho, J.D., Moltschaniwskyj, N.A., and Carter, C.G. 2004. The effect of variability in growth on somatic condition and reproductive status in the southern calamary *Sepioteuthis australis*. Marine and Freshwater Research, 55, 423–428.

Hume, F, Hindell, MA, Pemberton, D, Gales, R, 2004. Spatial and temporal variation in the diet of a high trophic level predator, the Australian fur seal (*Arctocephalus pusillus doriferus*). Marine Biology, 144, 407–415.

Ikeda, Y., Ueta, Y., Sakurazawa, I., and Matsumoto, G. 2004. Transport of the oval squid *Sepioteuthis lessoniana* Ferussac, 1831 in Lesson 1830–1831 (Cephalopoda : Loliginidae) for up to 24 h and subsequent transfer to an aquarium. Fisheries Science, 70, 21–27.

Ingole, B, 2003. Benthic life on the tropical sandy shore: Miramar Beach--a case study. Recent advances in environmental science. 459–470.

Jackson, G.D. 2004. Advances in defining the life histories of myopsid squid. Marine and Freshwater Research, 55, 357–365.

Jackson, G.D. 2004. Cephalopod growth: historical context and future directions. Marine and Freshwater Research, 55, 327–329.

Jackson, GD, Pecl, G, 2003. The dynamics of the summer-spawning population of the loliginid squid (*Sepioteuthis australis*) in Tasmania, Australia - a conveyor belt of recruits. ICES Journal of Marine Science, 60, 290–296.

Jackson, GD, Steer, BM, Wotherspoon, S, Hobday, AJ, 2003. Variation in age, growth and maturity in the Australian arrow squid *Nototodarus gouldi* over time and space - what is the pattern? Marine Ecology-Progress Series, 264, 57–71.

Jones, B.W. and Nishiguchi, M.K. 2004. Counterillumination in the hawaiian bobtail squid, *Euprymna scolopes* Berry (Mollusca : Cephalopoda). Marine Biology, 144, 1151–1155.

Kasugai, T, Shigeno, S, Ikeda, Y, 2004. Feeding and external digestion in the Japanese pygmy squid *Idiosepius paradoxus* (Cephalopoda : Idiosepiidae). Journal of Molluscan Studies, 70, 231–236.
Katsanevakis, S. and Verriopoulos, G. 2004. Den ecology of *Octopus vulgaris* Cuvier, 1797, on soft sediment: availability and types of shelter. Scientia Marina, 68, 147–157.
King, AJ; Adamo, SA; Hanlon, RT, 2003. Squid egg mops provide sensory cues for increased agonistic behaviour between male squid. Animal Behaviour 66, 49–58.
Koueta, N. and Boucaud-Camou, E. 2003. Combined effects of photoperiod and feeding frequency on survival and growth of juvenile cuttlefish *Sepia officinalis* L. in experimental rearing. Journal of Experimental Marine Biology and Ecology. 296: 215–226.
Kroger, RHH, Gislen, A, 2004. Compensation for longitudinal chromatic aberration in the eye of the firefly squid, *Watasenia scintillans*. Vision Research, 44, 2129–2134.
Laptikhovsky, V, Arkhipkin, A, 2003. The reproductive features of a mature female of the deep sea planktonic squid *Galiteuthis glacialis* (Cephalopoda : Cranchiidae) from the Southern Ocean. Polar Research, 22, 395–397.
Laptikhovsky, V; Salman, A; Oensoy, B; Katagan, T, 2003. Fecundity of the common cuttlefish, *Sepia officinalis* L. (Cephalopoda, Sepiidae): A new look at an old problem. Scientia Marina 67, 279–284.
Le Bihan, E., Perrin, A., Koueta, N. 2004. Development of bioassay from isolated digestive gland cells of the cuttlefish *Sepia officinalis* L. (Mollusca Cephalopoda): effect of Cu, Zn and Ag on enzyme activities and cell viability. Journal of Experimental Marine Biology and Ecology. 309: 47–66.
Lehr, T. and Schipp, R. 2004. Serotonergic regulation of the central heart auricles of *Sepia officinalis* L. (Mollusca, Cephalopoda). Comparative Biochemistry and Physiology a-Molecular & Integrative Physiology, 138, 69–77.
Lindgren, A.R. and Nishiguchi, M.K. 2004. A new phylogeny of the Cephalopoda using total evidence. Cladistics-the International Journal of the Willi Hennig Society, 20, 87–87.
Leone, F, Bairati, A, Vitellaro-Zuccarello, L, 2004. The cytoskeleton of chondrocytes of *Sepia officinalis* (Mollusca, Cephalopoda): an immunocytochemical study. European Journal of Histochemistry, 48, 159–165.
Longinelli, A; Wierzbowski, H; Matteo, AD, 2003. delta super(18)O(PO sub(4) super(3-)) and delta super(18)O(CO sub(3) super(2-)) from belemnite guards from Eastern Europe: implications for palaeoceanographic reconstructions and for the preservation of pristine isotopic values. Earth and Planetary Science Letters, 209, 337–350.
Macewicz, BJ, Hunter, JR, Lo, NCH, LaCasella, EL, 2004. Fecundity, egg deposition, and mortality of market squid (*Loligo opalescens*). Fishery Bulletin, 102, 306–327.
Macia, S, Robinson, MP, Craze, P, Dalton, R, Thomas, JD, 2004. New observations on airborne jet propulsion (flight) in squid, with a review of previous reports. Journal of Molluscan Studies, 70, 297–299.
Markaida, U., Quinonez-Velazquez, C., and Sosa-Nishizaki, O. 2004. Age, growth and maturation of jumbo squid *Dosidicus gigas* (Cephalopoda : Ommastrephidae) from the Gulf of California, Mexico. Fisheries Research, 66, 31–47.
Mather, J.A. and Mather, D.L. 2004. Apparent movement in a visual display: the ‘passing cloud’ of *Octopus cyanea* (Mollusca : Cephalopoda). Journal of Zoology, 263, 89–94.
Minton, J.W. 2004. The pattern of growth in the early life cycle of individual *Sepia pharaonis*. Marine and Freshwater Research, 55, 415–422.
Moltschaniwskyj, N.A. 2004. Understanding the process of growth in cephalopods. Marine and Freshwater Research, 55, 379–386.
Nasopoulou, C., Nomikos, T., Rementzis, J., Demopoulos, C.A., and Zabetakis, I. 2004. Biologically active lipid fractions in fish and cephalopods of the Mediterranean diet. Chemistry and Physics of Lipids, 130, 63–63.
Naud, MJ, Hanlon, RT, Hall, KC, Shaw, PW, Havenhand, JN, 2004. Behavioural and genetic assessment of reproductive success in a spawning aggregation of the Australian giant cuttlefish, *Sepia apama*. Animal Behaviour, 67, 1043–1050.
Nesis, K., 2003. Distribution of recent cephalopoda and implications for Plio-Pleistocene events. Berliner Paläobiol. Abh., 3, 199–204.
Nigmatullin, ChM, Sabirov, RM, Zalygalin, VP, 2003. Ontogenetic aspects of morphology, size, structure and production of spermatophors in ommastrephid squids: an overview. Berliner Paläobiol. Abh., 3, 225–240.
Nishiguchi, MK, Lopez, JE, von Boletzky, S, 2004. Enlightenment of old ideas from new investigations: more questions regarding the evolution of bacteriogenic light organs in squids. Evolution & Development, 6, 41–49.
Norman, MD, Boucher, R, Hochberg, FG, 2004. The sharkclub octopus, *Galeoctopus lateralis*, a new genus and species of deep-water octopus from the western Pacific Ocean (Cephalopoda : Octopodidae). Journal of Molluscan Studies, 70, 247–256.
O’Shea, S. 2004. The giant octopus *Haliphron atlanticus* (Mollusca : Octopoda) in New Zealand waters. New Zealand Journal of Zoology, 31, 7–13.
O’Shea, S, Bolstad, KS, 2004. First records of egg masses of *Nototodarus gouldi* McCoy, 1888 (Mollusca : Cephalopoda : Ommastrephidae), with comments on egg-mass susceptibility to damage by fisheries trawl. New Zealand Journal of Zoology, 31, 161–166.
Pecl, G.T., Steer, M.A., and Hodgson, K.E. 2004. The role of hatchling size in generating the intrinsic size-at- age variability of cephalopods: extending the Forsythe Hypothesis. Marine and Freshwater Research, 55, 387–394.

Perrin, A., Le Bihan, E., Koueta, N. 2004. Experimental study of frozen diet on digestive enzymes and growth of juvenile cuttlefish *Sepia officinalis* L. (Mollusca Cephalopoda) in press. Journal of Experimental Marine Biology and Ecology.

Quetglas, A. and Morales-Nin, B. 2004. Age and growth of the ommastrephid squid *Todarodes sagittatus* from the western Mediterranean Sea. Journal of the Marine Biological Association of the United Kingdom, 84, 421–426.

Raimundo, J., Caetano, M., and Vale, C. 2004. Geographical variation and partition of metals in tissues of *Octopus vulgaris* along the Portuguese coast. Science of the Total Environment, 325, 71–81.

Ribes, E., Gimenez-Bonafe, P., Martinez-Soler, F., Gonzalez, A., Saperas, N., Kasinsky, H.E., and Chiva, M. 2004. Chromatin organization during spermiogenesis in *Octopus vulgaris*. I: Morphological structures. Molecular Reproduction and Development, 68, 223–231.

Rosa, R, Marques, AM, Nunes, ML, Bandarra, N, Reis, CS, 2004. Spatial-temporal changes in dimethyl acetal (octadecanal) levels of *Octopus vulgaris* (Mollusca, Cephalopoda): relation to feeding ecology. Scientia Marina, 68, 227–236.

Ruiz-Capillas, C; Moral, A; Morales, J; Montero, P, 2003. Characterization and Functionality of Frozen Muscle Protein in Volador (*Illex coindetii*), Pota (*Todaropsis eblanae*), and Octopus (*Eledone cirrhosa*). Journal of Food Science 68, 2164–2168.

Russo, GL; De Nisco, E; Fiore, G; Di Donato, P; d'Ischia, M, Palumbo, A, 2003. Toxicity of melanin-free ink of *Sepia officinalis* to transformed cell lines: Identification of the active factor as tyrosinase. Biochemical and Biophysical Research Communications, 308, 293–299.

Salman, A. 2004. The role of cephalopods in the diet of swordfish (Xiphias gladius Linnaeus, 1758) in the Aegean Sea (eastern Mediteranean). Bulletin of Marine Science, 74, 21–29.

Sanchez, P; Maynou, F; Demestre, M, 2004. Modelling catch, effort and price in a juvenile *Eledone cirrhosa* fishery over a 10-year period. Fisheries Research 68, 319–327.

Sanchez, F. and Olaso, I. 2004. Effects of fisheries on the Cantabrian Sea shelf ecosystem. Ecological Modelling, 172, 151–174.

Santos, M.B., Pierce, G.J., Learmonth, J.A., Reid, R.J., Ross, H.M., Patterson, I.A.P., Reid D.G. and Beare, D., 2004. Variability in the diet of harbor porpoises (*Phocoena phocoena*) in Scottish waters 1992–2003. Marine Mammal Science 20, 1–27.

Semmens, J.M., Pecl, G.T., Villanueva, R., Jouffre, D., Sobrino, I., Wood, J.B., and Rigby, P.R. 2004. Understanding octopus growth: patterns, variability and physiology. Marine and Freshwater Research, 55, 367–377.

Schiavini, A, Rey, AR, 2004. Long days, long trips: foraging ecology of female rockhopper penguins *Eudyptes chrysocome chrysocome* at Tierra del Fuego. Marine Ecology-Progress Series, 275, 251–262.

Shaw, PW, Arkhipkin, AI, Adcock, GJ, Burnett, WJ, Carvalho, GR, Scherbich, JN, Villegas, PA, 2004. DNA markers indicate that distinct spawning cohorts and aggregations of Patagonian squid, *Loligo gahi*, do not represent genetically discrete subpopulations. Marine Biology, 144, 961–970.

Shaw, P.W. and Sauer, W.H.H. 2004. Multiple paternity and complex fertilisation dynamics in the squid *Loligo vulgaris* reynaudii. Marine Ecology-Progress Series, 270, 173–179.

Sivakumar, P; Suguna, L; Chandrakasan, G, 2003. Similarity between the major collagens of cuttlefish cranial cartilage and cornea. Comparative Biochemistry and Physiology, Part B: Biochemistry and Molecular Biology 134, 171–180.

Steer, B.L.M. and Jackson, G.D. 2004. Temporal shifts in the allocation of energy in the arrow squid, *Nototodarus gouldi*: sex-specific responses. Marine Biology, 144, 1141–1149.

Stowasser, G., Pierce, G.J., Wang, J. and Santos, M.B., 2004. An Overview of Cephalopods Relevant to the SEA 5 Area. A review on behalf of the Department of Trade and Industry, University of Aberdeen.

Sykes, AV, Domingues, PM, Loyd, M, Sommerfield, A, Andrade, JP, 2003. The influence of culture density and enriched environments on the first stage culture of young cuttlefish, *Sepia officinalis* (Linnaeus, 1758). Aquaculture International, 11, 531–544.

Tracey, SR, Steer, MA, Pecl, GT, 2003. Life history traits of the temperate mini-maximalist *Idiosepius notoides*, (Cephalopoda: Sepioidea). Journal of the Marine Biological Association of the United Kingdom, 83, 1297–1300.

Triantafillos, L. 2004. Effects of genetic and environmental factors on growth of southern calamary, *Sepioteuthis australis*, from southern Australia and northern New Zealand. Marine and Freshwater Research, 55, 439–446.

Triantafillos, L, Jackson, GD, Adams, M, Steer, BLM, 2004. An allozyme investigation of the stock structure of arrow squid *Nototodarus gouldi* (Cephalopoda : Ommastrephidae) from Australia. ICES Journal of Marine Science, 61, 829–835.

Valavanis, VD, Georgakarakos, S, Kapantagakis, A, Palialexis, A, Katara, I, 2004. A GIS environmental modelling approach to essential fish habitat designation. Ecological Modelling, 178, 417–427.

Valavanis, V.D., Kapantagakis, A., Katara, I., and Palialexis, A. 2004. Critical regions: A GIS-based model of marine productivity hotspots. Aquatic Sciences, 66, 139–148.

Valverde, J.C. and Garcia, B.G. 2004. Influence of body weight and temperature on post-prandial oxygen consumption of common octopus (*Octopus vulgaris*). Aquaculture, 233, 599–613.

Van Camp, LM, Saint, KM, Donnellan, S, Havenhand, JN, Fairweather, PG, 2003. Polymorphic microsatellite markers for paternity assessment in southern calamari *Sepioteuthis australis* (Cephalopoda : Loliginidae). Molecular Ecology Notes, 3, 654–655.

Vaz-Pires, P. and Barbosa, A. 2004. Sensory, microbiological, physical and nutritional properties of iced whole common octopus (*Octopus vulgaris*). Lebensmittel-Wissenschaft Und-Technologie-Food Science and Technology, 37, 105–114.

von Boletzky, S. 2004. “Nude ammonoids”: a challenge to cephalopod phylogeny? Geobios, 37, 117–118.

Waluda, C.M., Trathan, P.N., and Rodhouse, P.G. 2004. Synchronicity in southern hemisphere squid stocks and the influence of the Southern Oscillation and Trans Polar Index. Fisheries Oceanography, 13, 255–266.

Wang, J. and Pierce G.J., 2004. Integration of GIS, remote sensing and statistical technologies for analysing and modelling cephalopod resources dynamics in the Northeast Atlantic waters. Poster. Littoral 2004. Seventh International Conference Delivering Sustainable Coasts: Connecting Science and Policy. Aberdeen, UK, September 2004.

Wang, J; Pierce, GJ; Boyle, PR; Denis, V; Robin, J; Bellido, JM, 2003. Spatial and temporal patterns of cuttlefish (*Sepia officinalis*) abundance and environmental influences - a case study using trawl fishery data in French Atlantic coastal, English Channel, and adjacent waters. ICES Journal of Marine Science, 60, 1149–1158.

Wexler, JB; Scholey, VP; Olson, RJ; Margulies, D; Nakazawa, A, Suter, JM, 2003. Tank culture of yellowfin tuna, *Thunnus albacares*: developing a spawning population for research purposes. Aquaculture 220, 327–353.

Williamson, R, Chrachri, A, 2004. Cephalopod neural networks. Neurosignals, 13, 87–98.

Young, I.A.G., Pierce, G.J., Daly, H.I., Santos, M.B., Key, L.N., Bailey, N., Robin, J.-P., Bishop, A.J., Stowasser, G., Nyegaard, M., Cho, S.K., Rasero, M. and Pereira, J.M.F., 2004. Application of depletion methods to estimate stock size in the squid *Loligo forbesi* in Scottish waters (UK). Fisheries Research, 69, 211–227.

Zeidberg, L.D., Hamner, W., Moorehead, K., and Kristof, E. 2004. Egg masses of Loligo opalescens (Cephalopoda : Myopsida) in Monterey Bay, California following the El Nino event of 1997–1998. Bulletin of Marine Science, 74, 129–141.

Zuur, A.F. and Pierce, G.J. 2004. Common trends in northeast Atlantic squid time series. Journal of Sea Research, 52, 57–72.

Grey Literature

Le Bihan, E. 2003. Mise au point de techniques de dissociation des cellules de la glande digestive de la seiche *Sepia officinalis* L. (Mollusque Céphalopode) : Application à l’étude de l’effet de polluants sur les activités des enzymes digestives. Memoire de DEA de Biologie et de Production Animales.

Kallianiotis, A; Argyri, A; Vidoris, P, 2003. Catch and effort of some target species of the artisanal fishery in the Thracian Sea - Greece. Hellenic Symposium on Oceanography and Fisheries. Abstracts p. 195.

Lefkaditou, E; Bekas, P, Analysis of beak morphometry for the horned octopus Eledone cirrhosa (Cephalopoda: Octapoda) from the Tracian Sea (NE Mediterranean). Hellenic Symposium on Oceanography and Fisheries. Abstracts. p. 179.

Pacary, A. 2003. Impacts de polluants sur la maturation des œufs et la survie des juvéniles, chez la seiche *Sepia officinalis*. Rapport de stage TER(maîtrise de Biologie), Université de Caen.

Annex 2: List of contributions to the Theme Session on Cephalopod Stocks: Review, Analyses, Assessment, and Sustainable Management (CC)

Oral presentations:

CC:01 J. Otero, A.F. González, A. Guerra, M. Regueira and M.E. Garci: Reproductive biology of Octopus vulgaris in an upwelling area (NE Atlantic)

CC:02 *S. Hideaki Kidokoro and Ken Mori*: Stock assessment methods and management procedure of *Todarodes pacificus* in Japan

CC:03 *Anna Di Cosmo, Marina Paolucci, Carlo Di Cristo*: Progesterone and 17ß-estradiol involvement in the yolk protein synthesis in the ovary of *Octopus vulgaris*

CC:04 *A.M. Costa and J. Pereira*: Long-time conservation of biological structures as a possible solution for time-series preservation

CC:05 *S. Lourenço and J. Pereira*: Abundance of the common octopus (*Octopus vulgaris*) and sea surface temperature off the Portuguese coast

CC:06 *Ch.M. Nigmatullin*: Estimation of biomass, production and fishery potential of ommastrephid squids in the World Ocean and problems of their fishery forecasting

CC:09 *Rui Rosa, João Pereira, Maria L. Nunes*: Biogeography, biology and biochemistry of the deep-sea cirrate octopus *Opisthoteuthis* from the Portuguese continental slope

CC:10 *Ch.M.Nigmatullin, A.V. Zimin, A.Z. Sundakov*: The stock and fishery variability of the Argentine squid (*Illex argentinus*) in 1982–2004 related to environmental conditions

CC:11 *N. Koueta, E. Le Bihan, and A. Perrin*: Effect of amino acid on isolated cells of digestive gland of cuttlefish *Sepia officinalis*-

CC:13 *M. Sacau, J. Wang, A. I. Arkhipkin, J. Portela, G. J. Pierce, Paul Brickle and X. Cardoso*: The spatio-temporal pattern of Argentine shortfin squid (*Illex argentinus*) abundance in the Spanish bottom-trawl fishery in the southwest Atlantic

CC:14 *Frank Melzner, C. Bock, H.-O. Pörtner*: Coordination of ventilation and circulation in the cuttlefish *Sepia officinalis* (L.) in the light of an oxygen limitation of thermal tolerance

CC:15 *Abdelmalek Faraj and Nicolas Bez*: Advantages and limits of the direct approach for the octopus stock assessment, geostatistical approach

CC:16 *Pedro R. Costa, Rui Rosa, João Pereira and Maria A.M. Sampayo*: Detection of domoic acid, the amnesic shellfish toxin, in the digestive gland of *Eledone cirrhosa* and *E. moschata* (Cephalopoda, Octopoda) from the Portuguese coast

CC:17 *Abdelmalek Faraj and Nicolas Bez*: Spatial pattern of the octopus life cycle in the South Atlantic of Morocco -

CC:19 *E. Lefkaditou, J. Haralabous, D. Sarikas, S. Karamelidou, and S. Kavadas*: The cephalopods in the small-scale fishery in the eastern Thracian Sea (NE Mediterranean)

CC:20 *Ana Moreno, João Pereira, and Manuela Morais da Cunha*: The effect of time of hatching in age and size at maturity of *Loligo vulgaris* -

CC:21 *Rui Rosa, João Pereira, Pedro R. Costa, and Maria L. Nunes*: Distribution, abundance, biology and biochemical profile associated to sexual maturation of the Stout bobtail squid (*Rossia macrosoma*) from the Portuguese coast

CC:22 *L. Challier., J. Royer, G. J. Pierce, N. Bailey, B. A. Roel, and J. P. Robin*: Preliminary analysis of stock-recruitment relationships in the English Channel squid (*Loligo forbesi*)

CC:24 *L. Challier, M. R. Dunn, and J. P. Robin*: Trends in age-at-recruitment and juvenile growth in the English Channel cuttlefish *Sepia officinalis*

CC:25 *Erica A. G. Vidal, Dominique P. Ibbotson and Edward J. Buskey*: Factors affecting the encounter and feeding rates in squid paralarvae

CC:28 *G. Stowasser, G. J. Pierce, C. Moffat , and M.A. Collins:* Ontogenetic changes in the diet of *L. forbesi*: Insights from fatty acid and stable isotope analysis

CC:29 *A. Guerra, A. F. González. and F. Rocha*: **Opening talk**: A review of records of giant squid in the north-eastern Atlantic and severe injuries in *Architeuthis dux* stranded after acoustic exploration

CC:30 *J.M. Smith, G.J. Pierce, A.F. Zuur and P.R. Boyle*: Patterns of investment in reproductive and somatic growth in *Loligo forbesi*

CC:31 *G. J. Pierce, P. R. Boyle, A. Zuur, and J. M. Smith*: Interannual variation in life-cycle characteristics of *Loligo forbesi*

CC:34 C.-S. Chen, G.J. Pierce, J. Wang, P.R. Boyle, N. Bailey, J.-P. Robin and I. Sobrino: The disappearance of Loligo forbesi from the south of its range in the 1990s

CC:35 *S. Seixas, P. Bustamante, and G. J. Pierce*: Interannual patterns of variation in concentrations of trace elements in arms of *Octopus vulgaris* in two localities on the Portuguese coast

CC:36 *Rubén Roa and Alexander Arkhipkin*: Approaches to short-term and long-term stock assessment of *Loligo gahi* around the Falkland Islands

CC: *Marek Lipinski:* Stock assessment of squid

CC: *Patrizia Jereb, Maria Cozzolino and Carla Iandoli*: The social and economic importance of cephalopod fishery in Italy: A preliminary description

Posters

CC:07 *E. Le Bihan, C. Zatylny, A. Perrin, and N. Koueta*: Studies of post-mortem evolution of cuttlefish viscera during their storage at two different temperatures

CC:08 J. Sendão, P. Calixto, T.C. and Borges: Behaviour of the common octopus (Octopus vulgaris) towards entrapment fishing gears: clay and plastic pots ("alcatruzes") and iron traps ("covos")

CC:12 *X. Mas, O. Reñones and R. Goñi*: Cuttlefish trammel net artisanal fishery in the Balearic Islands (Western Mediterranean)

CC:18 *Marina Santurtún, Yolanda Sagarminaga, Paulino Lucio, Ibon Galparsoro, Iñaki Quincocesm and Ane Iriondo*: Intrannual trends in catches of squid (*Loligo spp.)* in the Bay of Biscay (ICES Division VIIIa, b, d) during 2000 in relation to oceanographic features

CC:23 Thomas M., L. Challier, M. B. Santos, G. J. Pierce., A. Moreno, J. Pereira, M. M. Cunha, F. Porteiro, J. Gonçalvesm and J. P. Robin: Spatial differences in biological characteristics of Loligo forbesi (Cephalopoda Loliginidae) in the Northeast Atlantic

CC:26 *A. R. G. Tomás, M. A. Gasalla,B. G. Loyo, and C. A. Marques*: Cephalopods in the trawl fisheries in the southeastern Brazil (1979–2000)

CC:27 *Tomás, Acácio R.G.; Ávila-da-Silva, Antônio O.; Bastos, Gastão C.C.*: Pot fishery for octopus, an alternative for trawling in São Paulo State coast, southeastern Brazil

CC:32 P.R. Boyle, G.J. Pierce, L. C. Hastie, J. Wang, M.B. Santos, J.P. Robin, P. Jereb: Review of variation in the life-cycle of Loligo forbesi across its range

CC:33 I. A. G. Young, G. J. Pierce, J. Wang, P. R. Boyle, J. M. Smith, and N. Bailey: The Moray Firth directed squid fishery

CC:37 *Karsten Zumholz and Uwe Piatkowski*: New data on the biology of the Lesser Flying Squid, (*Todaropsis eblanae*) (Cephalopoda, Ommastrephidae) in the North Sea

CC:38 *Karsten Zumholz, Uwe Piatkowski, and Thor H. Hansteen*: Statolith trace element distributions in response to a manipulated environment in cuttlefish (*Sepia officinalis*)

CC:39 Erica A. G. Vidal, Vivian Hackbart, and Mike J. Roberts: Rearing, yolk absorption and growth in *Loligo vulgaris reynaudii* paralarvae

Annex 3: Cephalopod discards at the Spain national sampling programme

Brief note on cephalopod discards at the Spain national sampling programme (ICES Subarea VI, VII and Division VIIIa,b,d, and c), by Marina Santurtun; Paulino Lucio; Iñaki Quincoces; Guzman Díez and Ane Iriondo, AZTI Foundation Technological Institute for Fisheries and Food, Marine Research Division, Txatxarramendi Ugartea z/g. 48395 Sukarrieta (Bizkaia, SPAIN). http://www.azti.es:

The European Commission has adopted the minimum and extended programmes for the collection of the fisheries data needed to conduct the Common Fisheries Policy (Council Regulation 1639/2001). At the minimum programme level discards must be one of the subjects of estimation.

The AZTI pilot survey was carried out from May to the end of November 2002, covering a total of five months sampling as no sampling was deployed during August and September. For 2003, sampling started in March. Data on the first semester of the year are presented here. Results should be considered as very preliminary. General information on the sampling programme is summarised in Table 2.4.1 and sampling effort is summarised in Table 2.4.2.

Table 2.4.1. General information on the AZTI discard sampling program.

Geographic coverage	VII, VIIIa,b, VIIIc
Participating countries/institutes	AZTI
Fleets and fisheries covered	Trawls: Baka, and VHVO Pair Trawl
Objectives	Pilot Survey
Funding	Data Collection Regulation, Community funding and Basque Autonomic Government for AZTI funding
Coordinator(s)	Marina Santurtún (AZTI)
Year	2002 and 2003
Method of selecting vessels	Random, quasi random and cooperative vessels
Types of data collected	Discard and Retained weight,
Documentation of data	ICES WG Reports. Anon., 2002. Monitoring of discarding and retention by trawl fisheries in Western Waters and the Irish Sea in relation to stock assessment and technical measures. Study Project 98/095. Workshop on Discard Sampling Methodology and Raising Procedures. Danish Institute for Fisheries Research, Charlottenlund, Denmark. 2– 4 September, 2003.
Products/dissemination	Data provision to ICES WGHMM
Lowest (effective) stratum level	2002 (AZTI): Gear (2), area (2), quarter* (4) (*However, data is presented annually). Total strata sampled: 2 2003 (AZTI): Gear (2), area (3), quarter* (4) (*However, data is presented annually). Total strata sampled: 4
Potential auxiliary raising variables	AZTI: Effort (number of trips, trip duration) landings by species, total landings

Table 2.4.2. Sampling effort in the AZTI discard sampling programme. The primary sampling unit is the trip.

AZTI Stratum (By Fishery Unit)	Number of Trips sampled (AZTI: five months)	Total number of Trips (yearly) 2002 and 1st semester 2003.	Number of failures to get onboard for sampling 1)
AZTI (2002)-"Baka" Otter trawl in Division VIIIa,b,d-Mixed fishery	2	595	Not Available (NA)
AZTI (2002)- Pair trawl with VHVO nets in Division VIIIa,b,d- targeting Hake	5	422	NA
AZTI (2003) -"Baka" Otter trawl in Subarea VI-targeting Hake, Monk and Megrim	2	76	NA
AZTI (2003)- "Baka" Otter trawl in Division VIIIa,b,d- Mixed fishery	5	361	NA
AZTI (2003)- Pair trawl with VHVO nets in Division VIIIa,b,d-targeting Hake	3	156	NA
AZTI (2003)- Pair trawls with VHVO nets in Division VIIIc-Targeting Blue-whiting	2	153	NA

AZTI observers work in Great Sole, Rockall and Porcupine Banks i.e. ICES Subareas VI and VII, the Bay of Biscay (Division VIIIa,b,d) and the most eastern part of the Cantabrian Sea (Division VIIIc). Sampled vessels are always based in Basque ports. Data collection is based on voluntary cooperation of vessels, assuming that discarding behaviour does not change when an observer is on board.

The discard sampling programme is carried out based on stratified random sampling per Fishery Unit or fishery (as defined in the AZTI report annexed), i.e. units characterised by area, gear and target species. The fisheries chosen for discard samplings were those of different activity in relation to target species, although these fisheries showed very similar pattern of discards in relation to species composition between the two years sampled.

Table 2.4.3 shows result for the fisheries sampled by AZTI. Results are presented as total weight of individuals discarded, percentage discarded, mean biomass and variance discarded, by cephalopod species groups for each fishery (stratum).

"Baka" Otter trawl in Division VIIIa,b,d extracts a very large range of species groups including: pout, red mullet, rays, wedge sole, lesser spotted dogfish, horse mackerel, hake, black anglerfish, argentine, gurnards, octopus, Mediterranean horse mackerel, white anglerfish, megrim and squid. These 15 groups comprise around 90% in weight of total landings. Species such as crabs and short-finned squid are completely discarded, but in small amounts, probably due to catches during in each of the trips being too limited to justify keeping for the market.

No cephalopod discards were detected in the sampling carried out on board VHVO Pair trawl in Divisions VIIIa,b,d and VIIIc during 2002 and 1st semester of 2003. Also no discards were detected in the sampled "Baka" trips deployed in Sub area VI during 2003.

Table 2.4.3a. Cephalopod discard of "Baka" Otter trawl in Divisions VIIIa, b,d. AZTI information 2002.

Species		Total discards in stratum d (kg.)	Estimated % discards in relation to total catch	Mean discards in stratum $\bar{d}$ (kg.)	Variance of the sample in stratum σ^2
Fin fish		47546,6	5–100*		
Common octopus	*Octopodidae*	197.1	11.7	197.1	

*Range, depending on species.

Table 2.4.3b. Discard of "Baka" Otter trawl in Divisions VIIIa,b,d. AZTI information 2003.

Species		Total discards in stratum d (kg.)	Estimated % discards in relation to total catch	Mean discards in stratum $\bar{d}$ (kg.)	Variance of the sample in stratum σ2
Fin fish		39840,4	5–100		
Octopus	*Octopodidae*	1.5	0.1	1.5	
Short finned squid	*Ommastrephidae*	34.8	100	17.4	87.7
Cuttlefish	*Sepia officinalis*	0.5	0.1	0.5	

*Range, depending on species.