Shellfish Committee

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# REPORT OF THE
# WORKING GROUP ON CEPHALOPOD FISHERIES AND LIFE HISTORY

Lisbon, Portugal

17–19 April 1996



International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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# 1 INTRODUCTION

## 1.1 Terms of Reference

ICES C.Res. 1995/2:44 stated that the Working Group on Cephalopod Fisheries and Life History (Chairman: Dr U. Piatkowski, Germany) would meet in Lisbon, Portugal, from 17–19 April 1996 to:

a) update currently available landing statistics;

b) collect and evaluate data on the life history and exploitation of relevant cephalopod stocks in the ICES Area;

c) describe trophic interactions between cephalopods and other marine resources.

## 1.2 Participants

The following twenty-three persons participated in the meeting. Seventeen participants are formal members of the Working Group. Their names are marked with an *.

| | |
|---|---|
| Pedro Andrade | Faro, Portugal |
| Herman Bjørke* | Bergen, Norway |
| Teresa Borges* | Faro, Portugal |
| Peter Boyle* | Aberdeen, UK |
| Manuela Morais da Cunha* | Lisbon, Portugal |
| Earl Dawe* | St. John's, Canada |
| Maria del Mar Fernandez* | Santa Cruz de Tenerife, Spain |
| Graham Gillespie | Nanaimo, Canada |
| Angel González* | Vigo, Spain |
| Vicente Hernández-García * | Las Palmas de Gran Canaria, Spain |
| Colm Lordan | Cork, Ireland |
| William Macy | Narragansett, USA |
| Helen Martins | Horta, Azores, Portugal |
| Ana Moreno* | Lisbon, Portugal |
| João Pereira * | Lisbon, Portugal |
| Uwe Piatkowski (Chairman)* | Kiel, Germany |
| Graham Pierce* | Aberdeen, UK |
| Julio Portela* | Vigo, Spain |
| João Quintela | Faro, Portugal |
| Jean-Paul Robin* | Caen, France |
| Francisco Rocha | Vigo, Spain |
| Paul Rodhouse* | Cambridge, UK |
| Carlos Sousa Reis* | Lisbon, Portugal |

A list of the participants' names and addresses is attached as Annex 1. A list of names and addresses of the Working Group members (as of April 1996) is given in Annex 2.

The following Working Group members excused their absence: Nick Bailey, UK; Angel Guerra, Spain; Lisa Hendrickson, USA; and Mike Vecchione, USA.

## 1.3 Opening of the Meeting

The meeting took place in the conference room of the Instituto Português de Investigação Marítima (IPIMAR) in Lisbon. The Chairman welcomed the participants, and Dr Carlos Sousa Reis, Director of IPIMAR and active member of the Working Group, gave some introductory remarks and wished the Working Group a stimulating and successful meeting. Local arrangements were extremely well-organized by the hosts, in particular by Manuela Morais da Cunha, Ana Moreno, and João Pereira, and the Working Group appreciated the superb atmosphere of the meeting. The Chairman further expressed his conviction that the meeting would not only contribute to the scientific work on cephalopods, but would also increase transnational contacts and exchanges of information between ICES cephalopod scientists and cephalopod scientists of adjacent areas.

## 1.4 General Considerations

During the 78th ICES Statutory Meeting in Copenhagen in 1990 the re-establishment of the former ICES Study Group on Squid Biology was decided. Since that time the Study Group had met four times and reports have been regularly presented at annual ICES Statutory Meetings (now the ICES Annual Science Conference). The Study Group developed into a Working Group on Cephalopod Fisheries and Life History mostly due to the growing economic importance of cephalopod fisheries in Europe. The Working Group collected available cephalopod catch statistics relevant to the ICES region and compiled comprehensive information on the life history and exploitation of cephalopod species which are of economic importance in the ICES area (ICES, 1993; 1994; 1995). Because cephalopod fisheries research is currently a very active science the permanent study of new publications is required and regular detailed updating of cephalopod life history data is necessary.

In the 1990s the Working Group largely benefited from two comprehensive projects of the European Community's Research Programmes in the Fisheries Sector (FAR: 1990–1992; AIR: 1993–1995) which concentrated on research on Northeast Atlantic cephalopods. On the other hand, ICES conferences have been the most important fora to introduce and discuss the results of these projects. In fact, nearly all European members of the present Working Group participated actively in the projects. They contributed substantially to the scientific sessions of the ICES Shellfish Committee.

This is documented in numerous ICES papers and posters on all subjects of cephalopod fisheries biology which dominated the ICES Shellfish Committee in recent years and which significantly improved our knowledge of the biology and fishery of Northeast Atlantic cephalopods. Most of the data compiled for the Working Group reports are also essential for the work undertaken within the projects.

The two projects of the European Community's Research Programmes in the Fisheries Sector related to cephalopod fisheries biology were *Fishery Potential of Northeast Atlantic Squid Stocks* (1990–1992) and *Stock Dynamics, Interactions and Recruitment in Northeast Atlantic Squid Fisheries* (1993–1995). They involved several ICES Member Countries such as the UK, France, Germany, Portugal, and Spain. The aims of the projects were to improve understanding of the basis life-cycle biology, stock structure, trophic interactions and fisheries exploitation of Northeast Atlantic squid, in particular the loliginids *Loligo forbesi* and *Loligo vulgaris*. Results of the first project have been published in a special issue of *Fisheries Research* (Boyle and Pierce, 1994a) comprising seventeen papers covering all aspects of the fishery biology of Northeast Atlantic squid; e.g., life history, population structure, fecundity, diet, stock assessment methods and economy of the squid catching industry. Detailed reports and publications on the work of the second project will appear in the near future.

At present no transnational European research projects on cephalopod fisheries biology exist. However, a third big European project on *Cephalopod Resources Dynamics: Patterns in Environmental and Genetic Variation* was proposed to the Third Call of the European Communitys Research Programmes in the Fisheries Sector. In addition, some smaller proposals related to cephalopod science have been or will be submitted to the European Community's Research Programmes. These proposed projects will form the basis of future transnational cephalopod fisheries research within the EEC and maintain active contributions to all cephalopod fisheries biology-related subjects relevant to ICES, such as advice on assessment and management of cephalopod fisheries.

## 2 CEPHALOPOD LANDING STATISTICS

### 2.1 Compilation of Landing Statistics

The present report updates the landing statistics available for cephalopod groups within the ICES area (see Tables 1 to 5). The data are largely based on last year's report (ICES, 1995). Tables 1 to 4 give information on annual catch statistics (1989–1995) per cephalopod group in each ICES division or sub-area separated for each nation. The cephalopod groups of the tables comprise the following species:

- Table 1. Cuttlefish (Sepiidae) and bobtail squid (Sepiolidae). The big majority of landings summarised in these tables are catches of *Sepia officinalis*, the common cuttlefish.
- Table 2. Common squid (includes the long-finned squids *Loligo forbesi*, *Loligo vulgaris* and *Alloteuthis subulata*).
- Table 3. Short-finned squid (*Illex coindetii* and *Todaropsis eblanae*) and European flying squid (*Todarodes sagittatus*).
- Table 4. Octopus (*Eledone cirrhosa* and *Octopus vulgaris*).

A compilation divided by species is not possible because fishing nations report landings for groups, mostly in the format presented in the tables. The data in the tables are based on official ICES statistics and information on national catch statistics supplied by Working Group members. When values differed between official ICES data and available national statistics, the higher value was included in the tables. Table 5 summarises cephalopod landings for the whole ICES area (FAO region 27). In contrast to last year's report, ICES data and national data available to the Working Group members have been used for this table instead of data published by the FAO. Data are compiled for each year (1989–1995), categorised according to cephalopod species groups and fishing nations. Table 6 comprises annual landings (1989–1995) for the entire ICES region separated into species groups. Information on the most important fishing techniques is given in various ICES papers prepared by Working Group members during recent years.

The quality of available landing statistics has been discussed in detail in earlier reports of the Working Group (ICES, 1993; 1994; 1995; see also "Recommendations for Improvement in Cephalopod Fishery Data" (ICES, 1994)). There have been some improvements since the last meeting of the Working Group. As already outlined in the 1995 report, difficulties remain in several aspects of data collection. Where cephalopod data are recorded there is frequently uncertainty on the species composition. The extent of this problem varies from country to country with some making no distinctions, some distiguishing between major groups (cuttlefish, squid, octopus), and some providing details on individual species.

Belgium reports data for cuttlefish, common squid (loliginid squid), and octopus. Cephalopods are only caught as bycatch and yields are relatively low. Major fishing areas are the southern North Sea and the English Channel. Loliginids are the most important cephalopods with a maximum annual catch of 546 tonnes in 1990.

Denmark reports landings of cuttlefish. However, these numbers most likely refer to common squid (*Loligo* spp.) as inspection of catches in Danish fishing ports (Hwide Sande, Hirtshals) demonstrate. Squid is caught as bycatch in the trawl fishery and numbers are low with a maximum of 54 tonnes in 1992.

England and Wales regularly provide data to ICES per species group. Landings increased significantly during the last years peaking in 1995 with more than 3,000 tonnes of cuttlefish and nearly 3,000 tonnes of common squid. Major fishing areas are the English Channel and the Celtic Sea.

France is the most important nation concerning landings of common cuttlefish (*Sepia officinalis*) and common squid (*Loligo* spp.) in the ICES region. Major fishing grounds are the English Channel and the Bay of Biscay. During recent years catches have been on a constant level with ca. 9,000 to 10,000 tonnes for common cuttlefish (peaks in 1990 with 17,776 tonnes and in 1995 with 14,741 tonnes) and 4,500 to 6,000 tonnes for common squid (peaks in 1989 with 6,404 tonnes and in 1995 with 6,011 tonnes). Landings for 1995 were only available as totals for each cephalopod group. Therefore, provisional data for ICES region/sub-areas were estimated according to the 1994 percent distribution of each species group in each area. Detailed information on French loliginid catches is provided by Robin and Boucaud-Camou (1995).

In Germany cephalopods are of no commercial importance and they are only landed occasionally as bycatch in the North Sea shrimp or flatfish fishery. A maximum bycatch of ca. 11 tonnes was yielded in 1995 in the North Sea and was composed of loliginid squid. As in Denmark the catches are erroneously reported as cuttlefish landings to ICES.

Surprisingly, Iceland again has reported catches of *Todarodes sagittatus*, the European flying squid. According to information provided by Einar Jonsson (Marine Research Institute in Reykjavik), the species appeared in the bycatch of redfish trawlers south of Iceland in autumn 1995. Although catch statistics of 11 tonnes for 1995 are low, this is the first record of *T. sagittatus* in Icelandic waters since 1985.

As in many other nations cephalopods are not "quota species" in Ireland. Therefore, available catch data have to be treated with caution. Common squid (mainly *Loligo forbesi*) contribute the major share of cephalopods landed in Ireland. They are caught in ICES divisions VI and VII. Yields ranged from ca. 150 to 450 tonnes during recent years. It should be mentioned, however, that a considerable amount of common squid caught in Irish waters is landed in Spanish ports. Detailed information on Irish cephalopod catches is provided by Collins *et al.* (1995a; 1995b) and Lordan *et al.* (1995).

In Norway the only important cephalopod fishery has been that of *Todarodes sagittatus* which was caught by a directed jigging fishery in the early 1980s. The fishery peaked in 1983 with ca. 18,000 tonnes. Since 1985 the fishery decreased dramatically due to the absence of the squid in coastal Norwegian waters, and since 1990 the squid was virtually absent according to available catch statistics. As in Iceland the squid appeared again in the fishery statistics in 1995 with ca. 352 tonnes which were caught in autumn. The possible "return" of *T. sagittatus* in North European waters should be observed with great interest as this species provided an important cephalopod fishery in the early 1980s. Recently Bjørke (1995) noted that the gonate squid *Gonatus fabricii* could become an economically interesting species in Norwegian waters as an estimated biomass of 1.5 million tonnes in July 1994 indicates.

Portugal regularly provides catch statistics for all major groups to ICES. Together with France and Spain it is the most important cephalopod fishery nation. During recent years Portugal yielded the highest octopus catches (*Octopus vulgaris* and *Eledone cirrhosa*) in the ICES region, particularly in ICES sub-area IX. The yields ranged from ca. 7,000 to 10,000 tonnes between 1989 and 1995. The other cephalopod groups are also exploited and show constant high catch rates with some slight declines in the loliginid fishery (see Tables 1 to 5). Detailed information on the fishery and population structure of cephalopods is given by Coelho *et al.* (1994), Cunha and Moreno (1994), Cunha *et al.* (1995), Moreno *et al.* (1994), and Porteiro and Martins (1994).

Scotland has also reported regular catch statistics during recent years. The most important catches are those of common squid (only *Loligo forbesi* in Scottish waters) with a peak of 1,937 tonnes in 1989. Since then, catches are somewhat lower varying between 300 and 1,500 tonnes per year. Catches of octopus (only *Eledone cirrhosa* in Scottish waters) were in the range of 5 to 122 tonnes between 1989 and 1995. For further information see Boyle and Pierce (1994a; 1994b; 1994c) and Pierce *et al.* (1994a; 1994b) among others.

For the first time, official catch statistics of Spain were made available to the Working Group. A document summarising available Spanish cephalopod landings for the period 1990–1995 separated by species and into ICES sub-areas VI, VII, VIII and IX is attached as Annex 3. Spain is the most important cephalopod fishery nation within the ICES region besides France and Portugal. Major fisheries exist on octopus and short-finned squid with annual landings of ca. 2,000 to 4,000 tonnes and 1,000 to 2,500 tonnes, respectively. Further information regarding the Galician coast was compiled by González *et al.* (1994a), Guerra and Rocha (1994), Guerra *et al.* (1994), and Simón *et al.* (1995).

USA. Landings statistics and stock assessments of the long-finned squid *Loligo pealei* and the short-finned squid *Illex illecebrosus* within the US EEZ (NAFO sub-areas 5 and 6) were submitted by Lisa Hendrickson. The draft documents were circulated among the participants. Data are not included in the present report. Data on recruitment of long-finned squid *L. pealei* in New England (USA) waters were published by Macy (1995).

Canada. Catch statistics of *Illex illecebrosus* in NAFO sub-areas 3 to 6 were discussed according to information published in the recent Scientific Council Report of the Northwest Atlantic Fisheries Organization (NAFO, 1996). After the decline of the *Illex* fishery in the early 1980s, recent catches began increasing in NAFO sub-areas 3 and 4 in 1989 and peaked at 11,000 tonnes in 1990. They declined again to ca. 2,000 tonnes in 1992. Since then, catches increased to ca. 6,000 tonnes in 1994 which were mostly taken as bycatch in the silver hake fishery.

Current fishery statistics of the opal squid *Loligo opalescens* (175 tonnes in 1994) and *Octopus* spp. (142 tonnes in 1993) off British Columbia were circulated by Graham Gillespie from Nanaimo, Canada.

During the meeting the Working Group also discussed the present cephalopod fisheries in seas adjacent to the ICES region such as the CECAF area (Hernández-García, 1995). Of particular interest is the Saharan Bank fishery where a directed trawl fishery yields nearly 110,000 tonnes of octopus per year. Vicente Hernández-Garcia reported on the squid fishery in the Canary Island region. An artisanal fishery on the short-finned squid *Sthenoteuthis pteropus* exists which yields ca. 800 to 1,000 kg per day during the summer season in very warm years. This fishery takes only immature females which attain 28 to 40 cm dorsal mantle length and which are sold for ca. 1,200 Ptas per kg.

In conclusion, it should be emphasized that with a total of at least 44,792 tonnes the cephalopod landings in the ICES region rose remarkably in 1995 (see Table 6). This was mostly due to the increase of landings of cuttlefish and common squid in the English Channel and adjacent waters. England and Wales, and France were the major fishery nations in these regions (Tables 1, 2, 5). Landings of short-finned squid and octopus remained comparatively constant during the past seven years. The major fishery of these groups took place in ICES sub-area IX (Portuguese waters) with Portugal and Spain being the dominating fishery nations (Tables 3, 4, 5).

### 2.2 Assessment of Squid

Cephalopods remain an extremely important component of marine ecosystems in many parts of the world and in some places offer a significant resource supporting large fisheries. In ICES waters, particularly the Northeast Atlantic, the position is presently less clear. However, fisheries for various species exist with increasing catch rates.

In the Northwest Atlantic the situation is different. There, two cephalopod species are exploited. Management advice is provided for their stocks and they have been of commercial importance for a long time: the long-finned squid *Loligo pealei* and the short-finned squid *Illex illecebrosus*. Total US landings of *L. pealei* averaged 17,500 tonnes during 1990–1992. Since then, they increased to an average of ca. 22,000 tonnes during 1993–1994. Almost all commercial landings were taken with otter trawl gear. Detailed landing statistics are available for recent decades as well as LPUE (tonnes/days fished) and standardized fishing efforts (days fished). *L. pealei* was last assessed by the 17th Stock Assessment Review Committee (SARC) during December 1993 (NEFSC, 1994) which found that the stock was probably fully-exploited and at a medium level of biomass.

A commercial fishery for *Illex illecebrosus* exists from Newfoundland to Cape Hatteras. The fishery is managed, in the US EEZ (NAFO sub-areas 5 and 6), by the Mid-Atlantic Fishery Management Council (MAFMC) and, in NAFO sub-areas 2, 3, and 4, by the NAFO. Since 1980, the NAFO total allowable catch (TAC), for sub-areas 2–4, has been 150,000 tonnes (NAFO, 1996). An assessment of the *I. illecebrosus* stock in the US EEZ was last conducted for review by the 17th Stock Assessment Review Committee in December 1993 (NEFSC, 1994). It was concluded that the stock was under-exploited and at a medium biomass level. An updated and revised analytical assessment of the US EEZ portion of the stock, for the period 1967–1993, based on analyses of statolith

ageing, commercial fishery data, and research survey data will be available soon (Hendrickson *et al.*, in prep.).

At present, assessments on cephalopod species exploited in the Northeast Atlantic are not available and TACs for the most important species cannot be recommended. This is mostly due to the inadequacy of basic fisheries data. In its 1995 report (ICES, 1995) the ICES Working Group on Cephalopod Fisheries and Life History pointed out that ICES should be more proactive in encouraging Member Countries to collect and collate basic fisheries data—disaggregated to the statistical square level. This will provide a better picture of the actual removals by fishing, a clearer picture of cephalopod distributions, and the basic data for use in fisheries or population models.

However, first attempts to assess the loliginid stock around the British Isles, including the English Channel and the Celtic Sea, are now underway and will become available as a result of the second European transnational cephalopod research project *Stock Dynamics, Interactions and Recruitment in North East Atlantic Squid Fisheries* (1993–1995). Overall loliginid squid catches per ICES division landed in France are available for 1989–1994 (Figure 1). In addition, as an example, monthly fishing effort data per ICES rectangle (CPUE in kg per fishing hour of a 100 kW fishing boat) are shown for 1994 (Figures 2–4). The data demonstrate the development of the fishery in the course of one year. Based on these statistics, DeLury methods were used to assess the stock and its level of exploitation (Pierce *et al.*, 1996).

Further, Scottish landings of *Loligo forbesi* have been correlated with sea surface temperature offering the potential for forecasting of the fishery (Pierce, 1995). Stock assessment methods used for cephalopod fisheries have recently been reviewed (see ICES, 1993, Table 1; Pierce and Guerra, 1994).

## 2.3 Management Advice

The Working Group cannot at present provide reliable assessments of cephalopod stocks under exploitation in ICES waters, and consequently advice on TACs for the major species is not possible.

However, in the following table some regulations for exploited cephalopod species are compiled which are currently valid legislations in Spanish and Portuguese fisheries. They should be considered as regulation advice for developing fisheries in other ICES regions.

| **Portugal** | | **Spain** | |
|---|---|---|---|
| **Minimum sizes** | | **Minimum sizes** | |
| *Loligo vulgaris* | 10 cm DML* | *Loligo vulgaris* | 10 cm DML |
| *Sepia* spp. (for inland waters) | 10 cm DML | *Sepia officinalis* | 8 cm DML |
| *Sepia* spp. (in Sado river) | 15 cm DML | *Sepia elegans* | 4 cm DML |
| *Sepia* spp. (Ria Formosa) | 15 cm DML | *Octopus vulgaris* | 750 g |
| *Loligo vulgaris* (Ria Formosa) | 10 cm DML | | |
| *Octopus vulgaris* (Ria Formosa) | 500 g | | |
| | | **Maximum number of *Octopus* traps per boat (Galicia)** | |
| | | **Boat size** | **No. of traps** |
| | | < 2.50 TRB** | 90 |
| | | 2.50–5.00 TRB | 135 |
| | | 5.01–7.00 TRB | 180 |
| | | 7.01–10.00 TRB | 225 |
| | | > 10.00 TRB | 270 |

*DML = Dorsal mantle length.

**TRB = Registered brutto tonnes.

In Galician waters traps should be carried to port daily, and it is not allowed to fish with traps between 10.00 hrs on Saturday and 10.00 hrs on Monday. Traps for *Octopus*: there are limitations according to the type of trap and to fish in the Rias. Fishing is only allowed during the day. Portuguese traps (wire basket for *Octopus*) are not permitted in the Rias. Traps for *Sepia*: bait is not permitted.

The Working Group recommends that legislations on exploitation should be established. In addition, restrictions on the length and weight of exploited stocks should be introduced.

## 3 COLLECTION OF DATA ON CEPHALOPOD LIFE HISTORY

### 3.1 Compilation of Data

Cephalopod life history data are extensively compiled in Tables 7 to 11. All major species are covered. The data were first presented in the 1994 report of the Working Group (ICES, 1994). Since then, a large amount of new data was collected and the present report represents an updated and comprehensive data collection. For the first time, life history data on the European flying squid *Todarodes sagittatus* and the gonate squid *Gonatus fabricii* are also included in the tables (see Table 10).

The life history data will be reviewed on a regular basis with new interesting species added to existing data sets.

In the future, ICES should initiate links between activities on cephalopods and those in environmental disciplines such as hydrography in order to investigate more fully possible factors controlling recruitment in squid and distribution/migration patterns of juveniles and adults. Fisheries for these species are frequently characterised by their sporadic nature and environmental factors have been implicated—evidence has not, however, been fully considered and whether processes operate at the egg, paralarval, or later life stages is not known.

### 3.2 Reproductive Strategies in Cephalopods

Among cephalopod biologists there is a discussion about whether female cephalopods lay their eggs in one single spawning or in several consecutive spawnings. This is of great importance in estimating fecundity and recruitment. There are a number of definitions which explain the possible ways that cephalopods spawn. These definitions and possible examples within the animal group have been studied in detail by Rocha *et al.* (Working Group paper) who presented a review paper on this subject during the meeting which is attached as Annex 4.

The reproductive strategies of *Loligo forbesi* have recently been descibed in detail by Boyle *et al.* (1995a; 1995b)

## 4 TROPHIC INTERACTIONS INVOLVING CEPHALOPODS

### 4.1 Cephalopods as Predators

Cephalopods are entirely predatory. Early studies of diet composition suggest that approximately half of their food consists of crustaceans or fish, respectively. Among the fish prey identified many are of commercial importance. Neritic squid such as loliginids prey heavily on early life stages of gadoid fish and flatfish, thus potentially having a significant impact on the recruitment of economically important finfish. Recent studies show that *Loligo forbesi* feeds primarily on Gadidae, Ammodytidae, and Clupeidae. Fishes occurred in more than 80% of non-empty stomachs (Pierce *et al.*, 1994c). Importance of cephalopods increases in the diet of *L. forbesi* with growth showing considerable cannibalism in loliginid squid (Rocha *et al.*, 1994). The ommastrephid squid *Illex coindetii* also feeds primarily on fish such as Clupeidae and Sparidae (Castro and Hernández-García, 1995).

Detailed information on the role of cephalopods as predators will be soon available in a review paper compiled for the second EU project on cephalopod fisheries biology (see above; Pierce *et al.*, in prep) and in a review by Rodhouse and Nigmatullin (in press).

### 4.2 Cephalopods as Prey

The importance of cephalopods in the diet of marine mammals was reviewed by Pierce (1992) and González *et al.* (1994b). Furness (1994) has estimated the quantity of squid consumed by seabirds in the Northeast Atlantic. According to his assessment, annual squid consumption by seabirds reaches ca. 100,000 tonnes in the Northeast Atlantic. Further, it was recently shown that in the central eastern Atlantic, the swordfish *Xiphias gladius* is an important predator of oceanic squid such as ommastrephids (Clarke *et al.*, 1995; Hernández-García, 1995).

There is little evidence available as to what determines the proportion of cephalopods in the diet of different predators. Many predators are thought to be opportunistic. Also, the relative importance of trophic links involving cephalopods is largely unknown.

However, it is certain that some larger-toothed cetaceans, particularly sperm whales, are largely dependent on oceanic squids for their food. There are insufficient data on cephalopods as prey to make realistic estimates of natural mortality, although estimates of 50 million *Loligo* removed annually by porpoises, if reliable, may set a lower limit to the natural mortality parameter (Pierce and Santos, 1996).

Preliminary calculations have been done to estimate the numbers of cephalopods removed by seals in Scotland (Pierce and Santos, 1996). The calcutions are based on recent estimates of seal population sizes, literature values for daily energy requirements, and data on diet composition. Although cephalopods are generally a small proportion of the diet, amounts are large, exceeding significantly the amounts taken by commercial fisheries as demonstated in the table below.

ICES should encourage that the Working Group make use of existing ICES stomach sampling data to establish likely quantities of cephalopods removed by predators. At present, publications on investigations of fish stomach contents are of little use, because cephalopods are not identified at the species level. ICES should require that future stomach sampling programmes make greater attempts to identify cephalopod material in fish stomachs or to make such material available to cephalopod experts. This information would help to establish the relative importance of natural processes compared to fishery-induced mortality.

### 4.3 Review on Trophic Interactions of Squid in Scottish Waters

Trophic interactions of squid in Scottish waters was examined by Pierce and Santos (1996). This publication authored by two members of the Working Group is the first document that reviews the importance of the long-finned squid *Loligo forbesi* in the trophic food chain of the Northeast Atlantic. It provides a wealth of information on this subject and is attached as Annex 5 to the present report.

## 5 CEPHALOPOD SYMPOSIUM

During the 83rd ICES Statutory Meeting, the Shellfish Committee proposed a Mini-Symposium on "Cephalopods: Their role in the trophic chain". This could include particularly their abundance, the importance of fish predation by cephalopods, and their predation by marine mammals. The symposium should take place in 1997 or 1998. The Working Group discussed this suggestion in detail and concluded that a symposium on trophic interactions might be too late in 1997. There will appear a considerable amount of new publications on this subject during the next months (e.g.; "Role of cephalopods in the world's oceans"; theme issue of the *Phil Trans R Soc Lond B*). Therefore, the Working Group concluded that a symposium on this subject would not attract many participants.

Instead, the Working Group proposes a symposium on "Environmental changes and the reactions of cephalopod populations". This topic would cover all factors determining biomass and abundance of cephalopods. It would also address many subjects outlined in the GLOBEC programme. It should take place in Portugal in 1998 either just before or shortly after the ICES Annual Science Conference in Lisbon.

## 6 RECOMMENDATIONS/FUTURE WORK

Traditional finfish resources in the ICES convention area are heavily exploited and the importance of cephalopod resources may increase in the future. First indications are already apparent as the review on catch statistics over recent years indicates (see Section 2.1; Tables 1 to 6). Most cephalopod species are very short-lived and their biomass levels cannot currently be reliably assessed (see Section 2.2). Therefore, any increase in their exploitation should be approached with great caution and management advice (see Section 2.3) should be considered.

| Species | Area, year | cephalopod in diet % | *Loligo* in diet % | Annual population cephalopod consumption (tonnes) | Annual population *Loligo* consumption (tonnes) |
|---|---|---|---|---|---|
| Common seal | UK, 1991<br>Scotland, 1991 | 1.7% | 0.06% | 874<br>819 | 32<br>30 |
| Grey seal | UK, 1991<br>Scotland, 1991 | 9.4% | 0.25% | 21,211<br>19,373 | 552<br>504 |
| Harbour porpoise | North Sea, 1994 | 3.8% | 1.98% | 23,680 | 12,229 |

As previously outlined in the 1995 report of the Working Group it should, again, be stressed that recent projects funded by the EU (see above) have furnished considerable data on basic biology, reproduction, distribution, and genetic variability of a number of commercially important squid species. These projects have also begun to address quantitative aspects of cephalopod populations with the application of fishery models. It is still the case, however, that information on abundance and population dynamics are lacking for many Northeast Atlantic species. Amongst the various areas of work which could be addressed by ICES, those related to a better understanding of cephalopod populations, their role in North Atlantic ecosystems, and the likely effects of continued exploitation are probably the most pressing.

The Working Group recommends that it should continue work on its current terms of reference plus two additional ones:

a) update currently available landing statistics;

b) collect and evaluate data on the life history and exploitation of relevant cephalopod stocks in the ICES area;

c) describe trophic interactions between cephalopods and other marine resources;

d) review trade statistics of cephalopods relevant to the ICES area;

e) review current assessments of loliginid squid in France and UK.

The next meeting of the Working Group is proposed for 3–4 days in March 1997 at the Centro Oceanografico de Canarias (IEO) in Santa Cruz de Tenerife, Spain.

The Chairman closed the meeting at 17.00 hrs on 19 April 1996.

## 7 REFERENCES


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Table 1. Landings (in tonnes) of Cuttlefish (Sepiidae) and Bobtail Squid (Sepiolidae).

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994P | 1995P |
|---|---|---|---|---|---|---|---|
| ICES Division IVa (Northern North Sea) | | | | | | | |
| Scotland | + | + | + | + | + | + | + |
| Total | + | + | + | + | + | + | + |
| ICES Division IVb (Central North Sea) | | | | | | | |
| Belgium | 0 | 0 | 2 | 12 | 6 | + | 1 |
| England & Wales | 1 | 0 | + | + | 2 | + | 2 |
| France | + | 2 | + | + | + | + | + |
| Total | 1 | 2 | 2 | 12 | 8 | + | 3 |
| ICES Division IVc (Southern North Sea) | | | | | | | |
| Belgium | 0 | 0 | 9 | 13 | 25 | 13 | 8 |
| England & Wales | 10 | 2 | 15 | 26 | 22 | 47 | 163 |
| France | 82 | 117 | 42 | 109 | 172 | 182 | 348 |
| Total | 92 | 119 | 66 | 148 | 219 | 242 | 519 |
| ICES Division VIa (NW coast of Scotland and North Ireland) | | | | | | | |
| England & Wales | 1 | 0 | + | 1 | + | 1 | 3 |
| France | 1 | 2 | 4 | + | 1 | + | + |
| Total | 2 | 2 | 4 | 1 | 1 | 1 | 3 |
| ICES Division VIIa (Irish Sea) | | | | | | | |
| Belgium | 0 | 0 | 1 | 4 | 1 | 2 | 1 |
| England & Wales | 3 | 6 | 5 | 46 | 11 | 13 | 16 |
| France | 2 | 6 | 2 | + | 1 | + | + |
| Total | 5 | 12 | 8 | 50 | 13 | 15 | 17 |
| ICES Divisions VIIb,c (West of Ireland and Porcupine Bank) | | | | | | | |
| England & Wales | 0 | 0 | 0 | 0 | 0 | 5 | + |
| France | + | 1 | + | + | + | + | + |
| Total | + | 1 | + | + | + | 5 | + |
| ICES Divisions VIId,e (English Channel) | | | | | | | |
| Belgium | 0 | 0 | 15 | 20 | 24 | 19 | 17 |
| Channel Islands | 7 | 20 | 1 | 4 | 2 | 2 | ? |
| England & Wales | 1,292 | 3,000 | 642 | 898 | 1,882 | 1,797 | 3,113 |
| France | 5,517 | 9,144 | 2,820 | 3,281 | 6,561 | 4,151 | 7,966 |
| Scotland | 1 | 12 | 1 | 0 | 0 | 0 | 0 |
| Total | 6,817 | 12,176 | 3,479 | 4,203 | 8,469 | 5,969 | 11,096 |

Table 1. continued.

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| ICES Division VIIf (Bristol Channel) | | | | | | | |
| Belgium | 0 | 0 | 4 | 4 | 11 | 14 | 4 |
| England & Wales | 10 | 83 | 28 | 35 | 95 | 38 | 42 |
| France | 5 | 99 | 11 | 15 | 13 | 17 | 32 |
| Scotland | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| Total | 15 | 187 | 43 | 54 | 119 | 69 | 78 |
| ICES Divisions VIIg-k (Celtic Sea and SW of Ireland) | | | | | | | |
| Belgium | 0 | 0 | 3 | 9 | 12 | 4 | 5 |
| England & Wales | 68 | 443 | 39 | 101 | 114 | 134 | 197 |
| France | 386 | 2,295 | 1,215 | 347 | 373 | 295 | 566 |
| Spain | ? | 16 | 20 | 2 | 0 | 0 | 0 |
| Total | 454 | 2,754 | 1,277 | 459 | 499 | 433 | 768 |
| ICES Sub-area VIII (Bay of Biscay) | | | | | | | |
| Belgium | 0 | 0 | 0 | 3 | 5 | 4 | 0 |
| England & Wales | 9 | 7 | 42 | 58 | 41 | 56 | 39 |
| France | 3,068 | 6,110 | 4,411 | 5,463 | 3,707 | 3,043 | 5,829 |
| Portugal | 12 | 12 | 11 | 4 | 4 | 5 | 5 |
| Spain | ? | 445 | 581 | 542 | 0 | 1 | 0 |
| Total | 3,089 | 6,574 | 5,045 | 6,070 | 3,757 | 3,109 | 5,873 |
| ICES Sub-area IX (Portuguese Waters) | | | | | | | |
| Portugal | 1,562 | 1,608 | 1,197 | 1,230 | 1,205 | 1,120 | 1,000 |
| Spain | ? | 49 | 37 | 17 | 14 | 94 | 102 |
| Total | 1,562 | 1,657 | 1,234 | 1,247 | 1,219 | 1,214 | 1,102 |
| Grand Total | 12,037 | 23,484 | 11,158 | 12,244 | 14,304 | 11,057 | 19,459 |

Table 2. Landings (in tonnes) of Common Squid (includes *Loligo forbesi*, *Loligo vulgaris* and *Alloteuthis subulata*).

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| ICES Division IIIa (Skagerrak and Kattegat) | | | | | | | |
| Denmark | 14 | 19 | 13 | 37 | 2 | 0 | 1 |
| Sweden | 0 | 1 | 1 | 3 | 0 | + | 2 |
| Total | 14 | 20 | 14 | 40 | 2 | + | 3 |
| ICES Division IVa (Northern North Sea) | | | | | | | |
| Denmark | 1 | 5 | 7 | 7 | 1 | 1 | 1 |
| England & Wales | 1 | 4 | 1 | 9 | 1 | 1 | 276 |
| France | 19 | 27 | 11 | 7 | 2 | 0 | + |
| Germany | + | + | 1 | 3 | 1 | + | + |
| Scotland | 609 | 952 | 549 | 561 | 242 | 93 | 255 |
| Total | 630 | 988 | 569 | 587 | 247 | 95 | 532 |
| ICES Division IVb (Central North Sea) | | | | | | | |
| Belgium | 24 | 38 | 4 | 6 | 22 | 13 | 14 |
| Denmark | 3 | 9 | 2 | 10 | 2 | + | + |
| England & Wales | 87 | 83 | 22 | 50 | 22 | 4 | 47 |
| France | 1 | 4 | 2 | 1 | 1 | 1 | 1 |
| Germany | + | + | 1 | 2 | 1 | 1 | 3 |
| Scotland | 70 | 151 | 62 | 106 | 36 | 5 | 25 |
| Total | 185 | 287 | 93 | 175 | 84 | 24 | 90 |
| ICES Division IVc (Southern North Sea) | | | | | | | |
| Belgium | 68 | 142 | 19 | 35 | 84 | 113 | 153 |
| Denmark | 0 | 0 | 0 | 0 | 0 | + | + |
| England & Wales | 6 | 3 | 2 | 4 | 3 | 10 | 13 |
| France | 118 | 102 | 111 | 119 | 299 | 193 | 254 |
| Germany | + | + | 1 | 2 | 1 | 2 | 6 |
| Total | 192 | 247 | 133 | 160 | 387 | 318 | 426 |
| ICES Division Vb (Faroe Grounds) | | | | | | | |
| England & Wales | 0 | + | 0 | 0 | 0 | 1 | + |
| Faroe Islands | + | + | + | + | + | 1 | + |
| Scotland | + | 2 | + | 5 | + | + | + |
| Total | + | 2 | + | 5 | + | 2 | + |

Table 2. continued.

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| ICES Division VIa (NW coast of Scotland and North Ireland) | | | | | | | |
| England & Wales | 14 | 2 | 1 | 50 | 24 | 129 | 444 |
| France | 338 | 330 | 246 | 227 | 148 | 86 | 113 |
| Ireland | 206 | 30 | 15 | 30 | 78 | 36 | ? |
| Northern Ireland | + | 1 | 3 | 21 | 4 | 15 | ? |
| Scotland | 565 | 267 | 248 | 339 | 182 | 91 | 257 |
| Total | 1,123 | 630 | 513 | 667 | 436 | 357 | 810 |
| ICES Division VIb (Rockall) | | | | | | | |
| England & Wales | 21 | 6 | 1 | 8 | 1 | 6 | 11 |
| France | + | + | 1 | + | + | 0 | + |
| Ireland | 0 | 10 | 26 | 50 | 5 | 6 | ? |
| Northern Ireland | 4 | 0 | + | 0 | 0 | 0 | ? |
| Scotland | 681 | 70 | 21 | 65 | 9 | 28 | 4 |
| Total | 706 | 86 | 49 | 123 | 15 | 40 | 15 |
| ICES Division VIIa (Irish Sea) | | | | | | | |
| Belgium | 32 | 36 | 1 | 6 | 0 | 3 | 2 |
| England & Wales | 92 | 37 | 25 | 74 | 112 | 133 | 161 |
| France | 111 | 32 | 42 | 65 | 47 | 15 | 20 |
| Ireland | 175 | 5 | 4 | 5 | 112 | 66 | ? |
| Isle of Man | 21 | 12 | 7 | 15 | 15 | 6 | ? |
| Northern Ireland | 105 | 73 | 33 | 89 | 62 | 101 | ? |
| Scotland | 10 | 9 | 6 | 19 | 10 | 4 | 2 |
| Total | 546 | 204 | 118 | 273 | 358 | 328 | 185 |
| ICES Divisions VIIb,c (West of Ireland and Porcupine Bank) | | | | | | | |
| England & Wales | 0 | 0 | 1 | 13 | 47 | 79 | 107 |
| France | 120 | 62 | 60 | 21 | 56 | 11 | 14 |
| Ireland | 11 | 10 | 24 | 40 | 35 | 11 | ? |
| Northern Ireland | 0 | 0 | 0 | 0 | 1 | 0 | ? |
| Scotland | 2 | 2 | 2 | 5 | 1 | 18 | 1 |
| Total | 133 | 74 | 87 | 79 | 140 | 119 | 122 |
| ICES Divisions VIId,e (English Channel) | | | | | | | |
| Belgium | 142 | 213 | 45 | 86 | 70 | 132 | 220 |
| Channel Islands | 3 | 2 | 0 | 1 | 0 | 0 | 0 |
| England & Wales | 720 | 566 | 416 | 698 | 869 | 727 | 667 |
| France | 2,777 | 1,360 | 1,736 | 2,218 | 3,083 | 1,962 | 2,584 |
| Total | 3,642 | 2,141 | 2,197 | 3,003 | 4,022 | 2,821 | 3,469 |

Table 2. continued.

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| ICES Division VIIf (Bristol Channel) | | | | | | | |
| Belgium | 56 | 23 | 10 | 2 | + | 4 | 13 |
| England & Wales | 65 | 56 | 35 | 57 | 134 | 161 | 132 |
| France | 286 | 254 | 191 | 370 | 351 | 298 | 392 |
| Total | 407 | 333 | 236 | 429 | 485 | 463 | 537 |
| ICES Divisions VIIg-k (Celtic Sea and SW of Ireland) | | | | | | | |
| Belgium | 46 | 54 | 4 | 3 | 2 | 9 | 26 |
| England & Wales | 43 | 74 | 24 | 122 | 282 | 600 | 970 |
| France | 967 | 519 | 354 | 569 | 624 | 310 | 408 |
| Germany | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Ireland | 39 | 112 | 80 | 135 | 133 | 164 | ? |
| Scotland | 0 | 2 | 1 | 8 | 14 | 34 | 1 |
| Spain | ? | 28 | 31 | 62 | 85 | 34 | 27 |
| Total | 1,095 | 789 | 494 | 899 | 1,140 | 1,151 | 1,434 |
| ICES Sub-area VIII (Bay of Biscay) | | | | | | | |
| Belgium | 23 | 40 | 6 | 34 | 36 | 17 | 40 |
| England & Wales | 22 | 17 | 84 | 65 | 94 | 96 | 56 |
| France | 1,667 | 1,850 | 1,135 | 1,222 | 1,313 | 1,691 | 2,225 |
| Portugal | 2 | 7 | 1 | 1 | 0 | 1 | 1 |
| Spain | ? | 260 | 162 | 198 | 2 | 22 | 0 |
| Total | 1,714 | 2,174 | 1,388 | 1,520 | 1,445 | 1,827 | 2,321 |
| ICES Sub-area IX (Portuguese Waters) | | | | | | | |
| Portugal | 1,001 | 1,283 | 1,869 | 1,569 | 508 | 309 | 831 |
| Spain | ? | 124 | 200 | 246 | 137 | 153 | 167 |
| Total | 1,001 | 1,407 | 2,069 | 1,815 | 645 | 462 | 998 |
| ICES Sub-area X (Azores Grounds) | | | | | | | |
| Portugal[+] | 473 | 333 | 258 | 72 | 108 | 114 | 250 |
| Total | 473 | 333 | 258 | 72 | 108 | 114 | 250 |
| Grand Total | 11,861 | 9,715 | 8,218 | 9,847 | 9,514 | 8,121 | 11,199 |

[+]Landings consist exclusively of *Loligo forbesi*.

Table 3. Landings (in tonnes) of Short-finned Squid (*Illex coindetii* and *Todaropsis eblanae*) and European Flying Squid (*Todarodes sagittatus*).

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| ICES Sub-areas I + II (Barents Sea and Norwegian Sea) | | | | | | | |
| Norway | 5 | 0 | 0 | 0 | 0 | 0 | 352 |
| Total | 5 | 0 | 0 | 0 | 0 | 0 | 352 |
| ICES Division Va (Iceland Grounds) | | | | | | | |
| Iceland | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| ICES Division VIa, b (NW coast of Scotland and North Ireland, Rockall) | | | | | | | |
| France | 1 | 1 | 1 | 1 | + | + | + |
| Spain | ? | 0 | 68 | 2 | 0 | 0 | 0 |
| Total | 1 | 1 | 69 | 3 | + | + | + |
| ICES Divisions VIIb,c (West of Ireland and Porcupine Bank) | | | | | | | |
| France | 1 | + | 3 | 4 | + | + | + |
| Total | 1 | + | 3 | 4 | + | + | + |
| ICES Divisions VIId,e (English Channel) | | | | | | | |
| England & Wales | 1 | 7 | 0 | 0 | 0 | 0 | + |
| France | 2 | 1 | 2 | 2 | 1 | + | + |
| Total | 3 | 8 | 2 | 2 | 1 | + | + |
| ICES Division VIIf (Bristol Channel) | | | | | | | |
| France | + | + | + | 1 | + | + | + |
| Total | + | + | + | 1 | + | + | + |
| ICES Divisions VIIg-k (Celtic Sea and SW of Ireland) | | | | | | | |
| England & Wales | 0 | 0 | 0 | 0 | 0 | 0 | 29 |
| France | 38 | 37 | 63 | 70 | 44 | 28 | 66 |
| Spain | ? | 741 | 909 | 469 | 374 | 611 | 299 |
| Total | 38 | 778 | 972 | 539 | 418 | 639 | 394 |
| ICES Sub-area VIII (Bay of Biscay) | | | | | | | |
| England & Wales | 5 | 0 | 0 | 0 | 0 | 0 | 6 |
| France | 189 | 188 | 173 | 426 | 377 | 222 | 523 |
| Portugal | 2 | 3 | 3 | 11 | 1 | 4 | 3 |
| Spain | ? | 244 | 25 | 364 | 21 | 6 | 0 |
| Total | 196 | 435 | 201 | 801 | 399 | 232 | 532 |

**Landings consist exclusively of *Todarodes sagittatus*.

Table 3. continued.

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| ICES Sub-area IX (Portuguese Waters) | | | | | | | |
| Portugal | 267 | 310 | 509 | 766 | 259 | 190 | 96 |
| Spain | ? | 694 | 1,410 | 1,616 | 632 | 743 | 928 |
| Total | 267 | 1,004 | 1,919 | 2,382 | 891 | 933 | 1,024 |
| Grand Total | >511 | 2,226 | 3,166 | 3,732 | 1,709 | 1,804 | 2,313 |

Table 4. Landings (in tonnes) of Octopus (*Eledone cirrhosa* and *Octopus vulgaris*).

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| ICES Division IVa (Northern North Sea) | | | | | | | |
| England & Wales | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| Scotland | 59 | 110 | 86 | 31 | 10 | 2 | 12 |
| Total | 60 | 111 | 86 | 31 | 10 | 2 | 13 |
| ICES Division IVb (Central North Sea) | | | | | | | |
| Belgium | 0 | 0 | 43 | 24 | 10 | 3 | 0 |
| England & Wales | 1 | 7 | 2 | 8 | 1 | 4 | + |
| Scotland | 0 | 1 | 1 | 1 | 2 | 1 | 0 |
| Total | 1 | 8 | 46 | 33 | 13 | 8 | + |
| ICES Division IVc (Southern North Sea) | | | | | | | |
| Belgium | 0 | 0 | 1 | 0 | 1 | 1 | 2 |
| England & Wales | 0 | 0 | + | 1 | + | 4 | 8 |
| Total | 0 | 0 | 1 | 1 | 1 | 5 | 10 |
| ICES Division VIa, b (NW coast of Scotland and North Ireland, Rockall) | | | | | | | |
| England & Wales | 0 | 1 | 5 | 4 | + | 1 | 13 |
| Scotland | 8 | 11 | 1 | 3 | 1 | 2 | 39 |
| Spain | ? | 0 | 90 | 4 | 0 | 0 | 0 |
| Total | 8 | 12 | 96 | 11 | 1 | 3 | 52 |
| ICES Division VIIa (Irish Sea) | | | | | | | |
| Belgium | 0 | 0 | 1 | 14 | 8 | 14 | 14 |
| England & Wales | 3 | 2 | 1 | 2 | 4 | 24 | 1 |
| France | 0 | 0 | + | 0 | 0 | + | + |
| Ireland | 1 | 0 | 0 | 0 | 0 | + | 0 |
| Total | 4 | 2 | 2 | 16 | 12 | 38 | 15 |

Table 4. continued.

| Country | 1989 | 1990 | 1991 | 1992 | 1993P | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| ICES Divisions VIIb,c (West of Ireland and Porcupine Bank) | | | | | | | |
| England & Wales | 0 | 0 | 0 | 0 | + | + | 3 |
| Ireland | 0 | 0 | 0 | 0 | 3 | 2 | + |
| Total | 0 | 0 | 0 | 0 | 3 | 2 | 3 |
| ICES Divisions VIId,e (English Channel) | | | | | | | |
| Belgium | 0 | 0 | 0 | 1 | 2 | + | 6 |
| England & Wales | 47 | 9 | 9 | 20 | 21 | 60 | 77 |
| France | 0 | 638 | 38 | 1 | 2 | 32 | 97 |
| Total | 47 | 647 | 47 | 22 | 25 | 92 | 180 |
| ICES Division VIIf (Bristol Channel) | | | | | | | |
| Belgium | 0 | 0 | 1 | 2 | 4 | 6 | 9 |
| England & Wales | 4 | 1 | 1 | 8 | 13 | 26 | 7 |
| France | 0 | 5 | + | 1 | + | 3 | 9 |
| Total | 4 | 6 | 2 | 11 | 17 | 35 | 25 |
| ICES Divisions VIIg-k (Celtic Sea and SW of Ireland) | | | | | | | |
| Belgium | 0 | 0 | 1 | 2 | 6 | 10 | 27 |
| England & Wales | 14 | 3 | 3 | 22 | 57 | 77 | 215 |
| France | 0 | + | + | + | + | 6 | 18 |
| Ireland | 0 | 0 | 0 | 1 | 1 | 4 | ? |
| Spain | ? | 187 | 163 | 179 | 139 | 108 | 134 |
| Total | 14 | 190 | 167 | 204 | 203 | 205 | 394 |
| ICES Sub-area VIII (Bay of Biscay) | | | | | | | |
| Belgium | 0 | 0 | 0 | 0 | 7 | 6 | 3 |
| England & Wales | 18 | 0 | 22 | 0 | 0 | 0 | 8 |
| France | 12 | 3 | 4 | 3 | 2 | 56 | 170 |
| Portugal | 57 | 17 | 82 | 144 | 111 | 154 | 200 |
| Spain | ? | 240 | 90 | 214 | + | 1 | 0 |
| Total | 87 | 260 | 198 | 361 | 120 | 217 | 381 |
| ICES Sub-area IX (Portuguese Waters) | | | | | | | |
| Portugal | 9,831 | 6,913 | 7,440 | 9,476 | 7,099 | 7,319 | 8,842 |
| Spain | ? | 2,914 | 2,694 | 3,499 | 2,994 | 2,547 | 1,898 |
| Total | 9,831 | 9,827 | 10,134 | 12,975 | 10,093 | 9,866 | 10,740 |
| ICES Sub-area X (Azores Grounds) | | | | | | | |
| Portugal+ | 5 | 33 | 7 | 11 | 7 | 7 | 8 |
| Total | 5 | 33 | 7 | 11 | 7 | 7 | 8 |
| Grand Total | 10,061 | 11,096 | 10,786 | 13,676 | 10,505 | 10,480 | 11,821 |

Tab. 5. Total annual cephalopod landings (in tonnes) in ICES area by country and separated into major cephalopod species groups.

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| (a) Cuttlefish (Sepiidae) and Bobtail Squid (Sepiolidae). | | | | | | | |
| Belgium | 0 | 0 | 34 | 65 | 84 | 56 | 36 |
| Channel Islands | 7 | 20 | 1 | 4 | 2 | 2 | ? |
| England & Wales | 1,394 | 3,541 | 771 | 1,165 | 2,167 | 2,091 | 3,575 |
| France | 9,061 | 17,776 | 8,505 | 9,215 | 10,828 | 7,688 | 14,741 |
| Portugal | 1,574 | 1,620 | 1,208 | 1,234 | 1,209 | 1,125 | 1,005 |
| Scotland | 1 | 17 | 1 | 0 | 0 | 0 | 0 |
| Spain | ? | 510 | 638 | 561 | 14 | 95 | 102 |
| Total | 12,037 | 23,484 | 11,158 | 12,244 | 14,304 | 11,057 | 19,459 |
| (b) Common Squid: *Loligo forbesi, Loligo vulgaris, Alloteuthis subulata.* | | | | | | | |
| Belgium | 391 | 546 | 89 | 172 | 214 | 291 | 468 |
| Channel Islands | 3 | 2 | 0 | 1 | 0 | 0 | ? |
| Denmark | 18 | 33 | 22 | 54 | 5 | 1 | 2 |
| England & Wales | 1,071 | 848 | 612 | 1,150 | 1,589 | 1,947 | 2,884 |
| Faroe Islands | + | + | + | + | + | 1 | + |
| France | 6,404 | 4,540 | 3,889 | 4,819 | 5,924 | 4,567 | 6,011 |
| Germany | + | 2 | 3 | 7 | 3 | 3 | 11 |
| Ireland | 431 | 167 | 149 | 260 | 363 | 283 | ? |
| Isle of Man | 21 | 12 | 7 | 15 | 15 | 6 | ? |
| Northern Ireland | 109 | 74 | 36 | 110 | 67 | 116 | ? |
| Portugal | 1,476 | 1,623 | 2,128 | 1,642 | 616 | 424 | 1,082 |
| Scotland | 1,937 | 1,455 | 889 | 1,108 | 494 | 273 | 545 |
| Spain | ? | 412 | 393 | 506 | 224 | 209 | 194 |
| Sweden | 0 | 1 | 1 | 3 | 0 | + | 2 |
| Total | 11,861 | 9,715 | 8,218 | 9,847 | 9,514 | 8,121 | 11,199 |
| (c) Short-finned Squid: *Illex coindetii, Todaropsis eblanae, Todarodes sagittatus* | | | | | | | |
| England & Wales | 6 | 7 | 0 | 0 | 0 | 0 | 35 |
| France | 231 | 227 | 242 | 504 | 422 | 250 | 589 |
| Iceland* | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| Norway* | 5 | 0 | 0 | 0 | 0 | 0 | 352 |
| Portugal | 269 | 313 | 512 | 777 | 260 | 194 | 99 |
| Spain | ? | 1,679 | 2,412 | 2,451 | 1,027 | 1,360 | 1,227 |
| Total | >511 | 2,226 | 3,166 | 3,732 | 1,709 | 1,804 | 2,313 |

* Landings consist exclusively of *Todarodes sagittatus*.

Table 5. continued.

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| (d) Octopus: *Eledone cirrhosa, Octopus vulgaris.* | | | | | | | |
| Belgium | 0 | 0 | 47 | 43 | 38 | 40 | 61 |
| England & Wales | 88 | 24 | 43 | 64 | 96 | 196 | 333 |
| France | 12 | 646 | 42 | 5 | 4 | 97 | 294 |
| Ireland | 1 | 0 | 0 | 1 | 4 | 6 | ? |
| Portugal | 9,893 | 6,963 | 7,529 | 9,631 | 7,217 | 7,480 | 9,050 |
| Scotland | 67 | 122 | 88 | 35 | 13 | 5 | 51 |
| Spain | ? | 3,341 | 3,037 | 3,896 | 3,133 | 2,656 | 2,032 |
| Total | 10,061 | 11,096 | 10,786 | 13,676 | 10,505 | 10,480 | 11,821 |

Tab. 6. Total annual cephalopod landings (in tonnes) in ICES area separated into major cephalopod species groups.

| Cephalopod Group | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995P |
|---|---|---|---|---|---|---|---|
| Cuttlefish | 12,037 | 23,484 | 11,158 | 12,244 | 14,304 | 11,057 | 19,459 |
| Common squid | 11,861 | 9,715 | 8,218 | 9,847 | 9,514 | 8,121 | 11,199 |
| Short-finned squid | >511 | 2,226 | 3,166 | 3,732 | 1,709 | 1,804 | 2,313 |
| Octopus | 10,061 | 11,096 | 10,786 | 13,676 | 10,505 | 10,480 | 11,821 |
| Total | 34,470 | 46,521 | 33,328 | 39,499 | 36,032 | 31,462 | 44,792 |

Table 7. *Sepia officinalis* and *Alloteuthis subulata*. Data on life history, environmental factors and fisheries.

| | *Sepia officinalis* | *Alloteuthis subulata* |
|---|---|---|
| | | |
| **LIFE HISTORY** | | |
| Eggs: | | |
| Egg principal axis (mm) | 20 - 30 | 1.2 - 1.8 |
| Potential fecundity | 5,000 | unknown |
| No. of eggs spawned per female | 500 - 5,000 | 400 - 1,500 |
| No. of spawning episodes | several (1 - 5) | several |
| Benthic or pelagic | benthic | benthic, attached to substrate |
| Duration of embryological development | 80 - 90 days (15°C); 40 - 45 days (20°C) | not investigated |
| Paralarvae: | | |
| Size at hatching (mantle lenghth in mm) | 6 - 9 | 1.4 - 1.8 |
| Temperature dependence | weak - medium | medium |
| Location in water column | benthic | rarely found; pelagic? |
| Duration in plankton | no planktonic phase | 15 - 30 days |
| Reproductive cycle: | | |
| Spawning season | early spring to summer | all year; mainly spring to autumn |
| Spawning location | shallow waters | shallow waters |
| Spawning depth | 2 - 50 m | 8 - 200 m |
| Preferred substrate | sandy and muddy bottoms | sandy and hard bottoms |
| No. of cohorts per year | at least 2 | 2 (or 3) |
| Growth: | | |
| Mantle length at full maturity; male (mm) | 70 - 210 | 40 - 200 |
| Mantle length at full maturity; female (mm) | 42 - 250 | 50 - 120 |
| Weight range at full maturity; male (g) | 33 - 957 | 4 - 10 |
| Weight range at full maturity; female (g) | 72 - 1,560 | 5 - 16 |
| Lifespan | 16 - 24 months | 10 - 12 months |
| Minimum age at maturity | 16 months | variable; at ca. 10 months |
| Form of growth (mantle length) | sigmoid | exponential |
| Population recruitment: how variable | unknown | unknown |
| Natural mortality rates | unknown | high during early stages |
| Distibution: | | |
| Geographic | North East Atlantic (25-57°N) and Mediterranean shelf waters | North East Atlantic (20-60°N) and Mediterranean shelf waters |
| Bathymetric | surface - 300 m | surface - 200 m; max. 2,000 m |
| Migration pattern (e.g. inshore-offshore) | offshore - inshore | inshore - offshore |
| Migration scale (e.g. m; km; etc.) | 30 - 50 km | unknown |
| | | |

Table 7. Continued.

| | *Sepia officinalis* | *Alloteuthis subulata* |
|---|---|---|
| | | |
| **ENVIRONMENTAL FACTORS** | | |
| Habitat: | | |
| Depth range of paralarvae (m) | epibenthic in shallow waters | 45 - 100 |
| Depth range of juveniles/adults (m) | 10 - 300 | 15 - 300 |
| Temperature range of paralarvae (°C) | 10 - 30 | 2 - 25 |
| Temperature range of juveniles/adults (°C) | 10 - 30 | 2 - 25 |
| Salinity range of paralarvae (S ‰) | 18 - 36 | unknown |
| Salinity range of juveniles/adults (S ‰) | 18 - 36 | unknown |
| Effects on survival, development, growth | not as important as in squid | probably very strong |
| | | |
| **FISHERIES** | | |
| Directed or by-catch | both | by-catch |
| Seasonality of fishery | all year; mostly NOV - JUL | no season |
| Geographic location of fishery, main fishery nations | English Channel to Portugal; France, Portugal, Spain, UK | throughout range of distribution |
| Inshore or offshore | inshore | inshore |
| Fishing methods | traps and gillnets, artisanal fishery (91% in Portugal) | trawling |
| Estimated catch data: | | |
| Quality | poor | not available and mixed with other loliginid squids |
| Landings in ICES region (= FAO 27) | ca. 25,000 t (1995) | 353 t (Portugal, 1990) |
| Range of landings over past 10 years in ICES region | 5,000 - 27,000 t | unknown |
| Availability of CPUE data | not available | not available |
| Mantle length range of exploited population | 40 - 350 mm | 100 - 200 mm |
| Weight range of exploited population | 15 - 2,800 g | 5 - 35 g |
| Exploitation level | high | unknown |
| Stock recruitment relationship | unknown | unknown |
| Timing of recruitment to fishery | JAN - JUL | early summer |
| Variability of recruitment into fishery | unknown | unknown |
| Environmental influences on catch | new moon, storms | currents, hydrography |
| Assessment: | | |
| Stock biomass or abundance | unknown | Max.= 132 ind./h; 0.7 hg/h Min.= 14 ind./h; <0.1 kg/h (Portugal 1990; 1992) |
| No. of stocks identified | local stocks identified | unknown |
| Method applied | no assessment | swept area method; abundance indices from survey cruises (Portugal) |
| Research activities in ICES area: | | |
| Country | France, Portugal, Spain | Portugal |
| Region | ICES divisions VII - IX | ICES division IX |
| | | |

Table 8. *Loligo forbesi* and *Loligo vulgaris*. Data on life history, environmental factors and fisheries.

| | *Loligo forbesi* | *Loligo vulgaris* |
|---|---|---|
| | | |
| **LIFE HISTORY** | | |
| Eggs: | | |
| Egg principal axis (mm) | 3 - 5 | 2 - 4.1 |
| Potential fecundity | 5,000 - 32,000 | 3,000 - 25,000 (average 17,000) |
| No. of eggs spawned per female | ca. 2,000 | ca. 3,000 - 5,000 |
| No. of spawning episodes | several (2 - 3?) | several (1 - 2?) |
| Benthic or pelagic | benthic, attached to substrate | |
| Duration of embryological development | 1 - 3 months | 40 - 45 days (13°C); 26 days (22°C) |
| Paralarvae: | | |
| Size at hatching (mantle lenghth in mm) | 2.7 - 4.9 | 1.2 - 3 |
| Temperature dependence | strong | |
| Location in water column | planktonic; rarely found, low numbers close to bottom | |
| Duration in plankton | 1 - 3 months | ca. 2 months |
| Reproductive cycle: | | |
| Spawning season | OCT - MAY; extended; peak in DEC - JAN | all year, extended; peak mainly in winter |
| Spawning location | coastal shallow waters | |
| Spawning depth | 10 - 300 m | 5 - 195 m |
| Preferred substrate | hard substrate | hard substrate; coarse sand |
| No. of cohorts per year | multiple "microcohorts"; ≤ 2 | multiple cohorts |
| Growth: | | |
| Mantle length at full maturity; male (mm) | 100 - 650; (240 - 937)* | 75 - 500 |
| Mantle length at full maturity; female (mm) | 175 - 350; (200 - 462)* | 75 - 350 |
| Weight range at full maturity; male (g) | 155 - 3,700 (average 2,000) (370 - 8,300)* | 22 - 1,690 |
| Weight range at full maturity; female (g) | 200 - 1,150 (average 1,500) (260 - 2,200)* | 23 - 1,272 |
| Lifespan | 6 - 18 months (average 15 - 18) | 7 - 22 months (average 12 - 14) |
| Minimum age at maturity | 6 months; variable | 7 months; variable |
| Form of growth (mantle length) | exponential | initially exponential |
| Population recruitment: how variable | variable; higher during summer | variable; high in spring/summer |
| Natural mortality rates | high, if compared to fish | |
| Distibution: | | |
| Geographic | North East Atlantic (25-62°N) and Mediterranean shelf waters; Azores; central East Atlantic | North East Atlantic (15-60°N) and Mediterranean shelf waters; central East Atlantic |
| Bathymetric | shelf & shelf edge; 10 - 550 m; mainly in 50 - 250 m | shelf & shelf edge; 10 - 300; mainly in 10 - 100 m |
| Migration pattern (e.g. inshore-offshore) | inshore - offshore | |
| Migration scale (e.g. m; km; etc.) | <500 km | <200 km |
| | | |

* in Azores region

Table 8. Continued.

| | *Loligo forbesi* | *Loligo vulgaris* |
|---|---|---|
| | | |
| **ENVIRONMENTAL FACTORS** | | |
| Habitat: | | |
| Depth range of paralarvae (m) | 10 - 100 m | 10 - 120 m |
| Depth range of juveniles/adults (m) | 10 - 500 m; mainly 100-200m | 10 - 300 m; mainly 15-100m |
| Temperature range of paralarvae (°C) | 10 - 20 | 10 - 20 |
| Temperature range of juveniles/adults (°C) | 6 - 24 | 10 - 25 |
| Salinity range of paralarvae (S ‰) | 30 - 36 | 30 - 36 |
| Salinity range of juveniles/adults (S ‰) | 30 - 36 | 30 - 36 |
| Effects on survival, development, growth | high | |
| | | |
| **FISHERIES** | | |
| Directed or by-catch | both | both |
| Seasonality of fishery | all year; with variable peaks, mostly in early autumn | |
| Geographic location of fishery | throughout range of distribution | |
| Inshore or offshore | coastal continental shelf; mainly inshore | |
| Fishing methods | trawling; hand-jigging | mostly trawling, manual jigging |
| Estimated catch data: | | |
| Quality | poor; data not fully reported and not separated by species | |
| Landings in ICES region (= FAO 27) | 11,000 t (1995) | |
| Range of landings over past 10 years in ICES region | 8,000 - 12,000 t | |
| Availability of CPUE data | available only for some countries | |
| Mantle length range of exploited population | 70-640 mm (average 110 mm)<br><940 mm (Azores)<br>340-680 mm (Canaries) | 60-500 mm (average 110 mm) |
| Weight range of exploited population | 20 - 3,700 g (average 60 g)<br><8,300 g (Azores)<br>1,050 - 4,100 (Canaries) | 10 - 1,000 g (average 40 g) |
| Exploitation level | variable/unknown | |
| Stock recruitment relationship | weak | |
| Timing of recruitment to fishery | all year; seasonal peaks | |
| Variability of recruitment into fishery | high | |
| Environmental influences on catch | moon light; rough weather | |
| Assessment: | | |
| Stock biomass or abundance | preliminary estimates for northern range; abundance indices from research cruises (Portugal) | |
| No. of stocks identified | offshore and coastal European stock differences; separated stock around Azorers | 1 (European shelf) |
| Method applied | DeLury depletion methods | |
| Research activities in ICES area: | | |
| Country | France, Portugal, Spain, UK | France, Portugal, Spain, UK |
| Region | throughout ICES regions | throughout ICES regions |
| | | |

Table 9. *Illex coindetii* and *Todaropsis eblanae*. Data on life history, environmental factors and fisheries.

| | *Illex coindetii* | *Todaropsis eblanae* |
|---|---|---|
| | | |
| **LIFE HISTORY** | | |
| Eggs: | | |
| Egg principal axis (mm) | <1.0 | 1.4 - 1.7 |
| Potential fecundity | 6,500 - 285,000 (max.: 729,000) | 124,000 ± 18,000 |
| No. of eggs spawned per female | 4,000 - 120,000 | 122,000 ± 18,000 |
| No. of spawning episodes | several | several; probably 4 - 10 |
| Benthic or pelagic | pelagic | probably pelagic |
| Duration of embryological development | unknown | |
| Paralarvae: | | |
| Size at hatching (mantle lenghth in mm) | 0.8 - 1.0 | unknown |
| Temperature dependence | strong | probably strong |
| Location in water column | planktonic | |
| Duration in plankton | unknown | |
| Reproductive cycle: | | |
| Spawning season | all year, peaks in spring, autumn | all year, peaks in spring |
| Spawning location | probably slope water | probably shel edge |
| Spawning depth | unknown | probably above 150 m |
| Preferred substrate | unknown | associated with sandy or muddy bottom |
| No. of cohorts per year | unknown | |
| Growth: | | |
| Mantle length at full maturity; male (mm) | 95 - 360 | 98 - 168 |
| Mantle length at full maturity; female (mm) | 79 - 380 | 107 - 222 |
| Weight range at full maturity; male (g) | 30 - 1,549 (average 400) | 94 - 300 |
| Weight range at full maturity; female (g) | 32 - 1,180 (average 750) | 180 - 720 |
| Lifespan | 12 - 14 months | ca. 12 months |
| Minimum age at maturity | unknown | 220 - 280 days |
| Form of growth (mantle length) | linear? | linear |
| Population recruitment: how variable | linear in post-recruits | highly variable |
| Natural mortality rates | very high in early stages | |
| Distibution: | | |
| Geographic | Eastern Atlantic Ocean: 15°S to 60°N; Mediterranean and Black Seas; Caribbean Sea | Eastern Atlantic Ocean: 36°S to 60°N; Mediterranean Sea; Australia; Indian Ocean |
| Bathymetric | 30 - 1,000 m | 20 - 800 m |
| Migration pattern (e.g. inshore-offshore) | unknown | seasonal bathymetric migrations |
| Migration scale (e.g. m; km; etc.) | unknown | km |
| | | |

Table 9. Continued.

| | *Illex coindetii* | *Todaropsis eblanae* |
|---|---|---|
| | | |
| **ENVIRONMENTAL FACTORS** | | |
| Habitat: | | |
| Depth range of paralarvae (m) | 60 - 100 | 60 - 100 |
| Depth range of juveniles/adults (m) | 30 - 1,000 | 20 - 800 |
| Temperature range of paralarvae (°C) | 13 - 20 | 13 - 20 |
| Temperature range of juveniles/adults (°C) | 7.5 - 18 | 6 - 18 |
| Salinity range of paralarvae (S ‰) | unknown | |
| Salinity range of juveniles/adults (S ‰) | unknown | |
| Effects on survival, development, growth | very strong | |
| | | |
| **FISHERIES** | | |
| Directed or by-catch | by-catch | |
| Seasonality of fishery | all year; higher in spring and autumn | |
| Geographic location of fishery, main fishery nations | continental shelf and slope regions off Ireland, Portugal, Spain | |
| Inshore or offshore | offshore | |
| Fishing methods | trawling | |
| Estimated catch data: | | |
| Quality | poor; data not fully reported, species not separated and mixed with other short-fin squids | |
| Landings in ICES region (= FAO 27) | ca. 2,300 t (1995) | |
| Range of landings over past 10 years in ICES region | 1,500 - 6,000 t | |
| Availability of CPUE data | not available | |
| Mantle length range of exploited population | 55 - 380 | 42 - 220 |
| Weight range of exploited population | 4 - 1,500 | 6 - 720 |
| Exploitation level | low | probably low |
| Stock recruitment relationship | unknown | |
| Timing of recruitment to fishery | all year; peaks in autumn | |
| Variability of recruitment into fishery | high | moderate |
| Environmental influences on catch | hydrography; currents | |
| Assessment: | | |
| Stock biomass or abundance | unknown | |
| No. of stocks identified | 1 in Galician waters by morphometrics and enzymes | 1 in Galician waters by morphometrics and enzymes |
| Method applied | no assessment | no assessment |
| Research activities in ICES area: | | |
| Country | Ireland, Portugal, Russia (ageing studies), Spain | Ireland, Portugal, Spain |
| Region | ICES divisions VIII - IX | ICES divisions VIII - IX |
| | | |

Table 10. *Todarodes sagittatus* and *Gonatus fabricii*. Data on life history, environmental factors and fisheries.

| | *Todarodes sagittatus* | *Gonatus fabricii* |
|---|---|---|
| | | |
| **LIFE HISTORY** | | |
| Eggs: | | |
| Egg principal axis (mm) | unknown | 5 |
| Potential fecundity | unknown | unknown |
| No. of eggs spawned per female | 12,000 - 18,000 | ca. 10,000 |
| No. of spawning episodes | 1? | unknown |
| Benthic or pelagic | Benthic? | Benthic |
| Duration of embryological development | unknown | unknown |
| Paralarvae: | | |
| Size at hatching (mantle lenghth in mm) | unknown | 3 |
| Temperature dependence | unknown | 3.9 - 4.4 |
| Location in water column | unknown | 0 - 1,000 m |
| Duration in plankton | unknown | ca. 6 months |
| Reproductive cycle: | | |
| Spawning season | winter, early spring (northern range) | DEC - APR |
| Spawning location | slope waters; west off Ireland? | continental slope of North East Atlantic; grounds of bottlenose whales |
| Spawning depth | unknown | >400 m |
| Preferred substrate | unknown | unknown |
| No. of cohorts per year | unknown | unknown |
| Growth: | | |
| Mantle length at full maturity; male (mm) | >260 | 175 - 250 |
| Mantle length at full maturity; female (mm) | >370 | 250 - 340 |
| Weight range at full maturity; male (g) | unknown | 88 - 226 |
| Weight range at full maturity; female (g) | 493 - 1,156 (Canaries) | 400 - 615 |
| Lifespan | <24 months | >12 months |
| Minimum age at maturity | ca. 12 months | unknown |
| Form of growth (mantle length) | linear | linear |
| Population recruitment: how variable | probably highly variable | unknown |
| Natural mortality rates | very high in early stages | unknown |
| Distibution: | | |
| Geographic | whole North East Atlantic | Labrador Sea, Barents Sea and Norwegian Sea and adjacent waters |
| Bathymetric | 0 - 1,000 m | 0 - 2,700 m |
| Migration pattern (e.g. inshore-offshore) | pronounced feeding migrations | unknown |
| Migration scale (e.g. m; km; etc.) | unknown | unknown |
| | | |

Table 10. Continued.

| | *Todarodes sagittatus* | *Gonatus fabricii* |
|---|---|---|
| | | |
| **ENVIRONMENTAL FACTORS** | | |
| Habitat: | | |
| Depth range of paralarvae (m) | surface waters? | 0 - 2,000 |
| Depth range of juveniles/adults (m) | 0 - 1,000 | <2,700 |
| Temperature range of paralarvae (°C) | unknown | 0.5 - 14 |
| Temperature range of juveniles/adults (°C) | 5 - 7 (northern range)<br>16 - 24 (Canaries) | 0.5 - 14 |
| Salinity range of paralarvae (S ‰) | unknown | 31.2 - 35.3 |
| Salinity range of juveniles/adults (S ‰) | unknown | 31.2 - 35.3 |
| Effects on survival, development, growth | strong | unknown |
| | | |
| **FISHERIES** | | |
| Directed or by-catch | directed and by-catch | by-catch |
| Seasonality of fishery | AUG - DEC<br>(ICES sub-area IIa) | all year |
| Geographic location of fishery, main fishery nations | North East Atlantic slope regions; Norwegian fjords | North East Atlantic slope regions; Norwegian fjords |
| Inshore or offshore | mainly inshore | offshore |
| Fishing methods | jigging;<br>purse seines (Canaries) | trawling |
| Estimated catch data: | | |
| Quality | poor; data not fully reported, species not separated and mixed with other squids | |
| Landings in ICES region (= FAO 27) | ca. 400 t (1995) | unknown |
| Range of landings over past 10 years in ICES region | 0 - 15,000 t | unknown |
| Availability of CPUE data | not available | not available |
| Mantle length range of exploited population | ca. 200 - 400 mm (Norway)<br>147 - 340 mm (Canaries) | >200 mm in by-catch |
| Weight range of exploited population | 150 - 4,000 | unknown |
| Exploitation level | variable | no exploitation |
| Stock recruitment relationship | unknown | unknown |
| Timing of recruitment to fishery | 3 - 4 months | unknown |
| Variability of recruitment into fishery | high (one year class) | unknown |
| Environmental influences on catch | hydrography, currents | unknown |
| Assessment: | | |
| Stock biomass or abundance | unknown | unknown |
| No. of stocks identified | probably 2 (northern range, and southwestern range) | unknown |
| Method applied | no assessment | no assessment |
| Research activities in ICES area: | | |
| Country | Ireland, Norway; Spain | Germany, Iceland, Norway |
| Region | whole ICES region | ICES divisions I, II, Va; IX |
| | | |

Table 11. *Octopus vulgaris* and *Eledone cirrhosa*. Data on life history, environmental factors and fisheries.

| | *Octopus vulgaris* | *Eledone cirrhosa* |
|---|---|---|
| | | |
| **LIFE HISTORY** | | |
| Eggs: | | |
| Egg principal axis (mm) | 2.0 - 3.0 | 6.7 - 7.5 |
| Potential fecundity | 500,000 | 2,000 - 7,500 |
| No. of eggs spawned per female | 100,000 - 500,000 | unknown |
| No. of spawning episodes | 1 (within 1 - 2 months) | 1 (extended over 3 - 4 weeks) |
| Benthic or pelagic | Benthic, protected by female | |
| Duration of embryological development | 125 days (13°C); 30 - 60 days (15-20°C); 25 days (25°C) | 3 - 4 months |
| Paralarvae: | | |
| Size at hatching (mantle lenghth in mm) | 1.4 - 2.0; 1.4 mg | ca. 3 |
| Temperature dependence | strong | strong |
| Location in water column | planktonic | planktonic |
| Duration in plankton | 5 - 12 weeks | few days |
| Reproductive cycle: | | |
| Spawning season | FEB - OCT; peaks in June and September | all year; peaks between April to October |
| Spawning location | shallow waters, inshore | |
| Spawning depth | < 100 m | < 200 m |
| Preferred substrate | rocky and sandy bottom, caves | flat muddy and rocky bottom |
| No. of cohorts per year | 2 or more | probably 1 annual recruitment |
| Growth: | | |
| Mantle length at full maturity; male (mm) | 95 - 250 | 50 - 180 |
| Mantle length at full maturity; female (mm) | 185 - 260 | 120 - 400 |
| Weight range at full maturity; male (g) | 200 - 6,100 | 400 - 700 |
| Weight range at full maturity; female (g) | 390 - 4,300 | 1,200 - 2,000 |
| Lifespan | 12 - 24 months | 12 - 24 months |
| Minimum age at maturity | 10 - 18 months, variable | ca. 12 months, variable |
| Form of growth | exponential | exponential ? |
| Population recruitment: how variable | highly variable | highly variable (MAR-JUL) |
| Natural mortality rates | very high | |
| Distibution: | | |
| Geographic | cosmopolitan; in all North East Atlantic coastal waters, from southern North Sea to west of Africa | North East Atlantic coastal and shelf waters from Norway to Portugal, Iceland; eastern Mediterranean Sea |
| Bathymetric | benthic; 2-100 m; max. 400 m | benthic; 0-200 m (shore line); max. 770m |
| Migration pattern (e.g. inshore-offshore) | inshore for spawning | inshore for spawning |
| Migration scale (e.g. m; km; etc.) | < 50 km | unknown (few km?) |
| | | |

Table 11. Continued.

| | *Octopus vulgaris* | *Eledone cirrhosa* |
|---|---|---|
| | | |
| **ENVIRONMENTAL FACTORS** | | |
| Habitat: | | |
| Depth range of paralarvae (m) | surface - 500 | 0 - 500 |
| Depth range of juveniles/adults (m) | surface - 200 | 0 - 770 |
| Temperature range of paralarvae (°C) | 10 - 25 | unknown |
| Temperature range of juveniles/adults (°C) | 10 - 30 | unknown |
| Salinity range of paralarvae (S ‰) | not documented | unknown |
| Salinity range of juveniles/adults (S ‰) | 32 - 40‰ | unknown |
| Effects on survival, development, growth | strong | strong |
| | | |
| **FISHERIES** | | |
| Directed or by-catch | both | by-catch |
| Seasonality of fishery | all year | MAR - JUL |
| Geographic location of fishery, main fishery nations | whole range of distribution; Portugal, Spain | whole range of distribution in 10 - 12 m; Portugal, Spain |
| Inshore or offshore | inshore | mostly inshore |
| Fishing methods | traps and pots; trawling | bottom trawls; seines; pots |
| Estimated catch data: | | |
| Quality | poor; data not fully reported and not separated by species | |
| Landings in ICES region (= FAO 27) | ca. 12,000 t (1995) | |
| Range of landings over past 10 years in ICES region | 7,000 - 18,000 t | |
| Availability of CPUE data | not available | not available |
| Mantle length range of exploited population | 34 - 260 mm | unknown |
| Weight range of exploited population | 100 - 14,000 g (average 500 g) | <ca. 2,000 g |
| Exploitation level | high | variable/unknown |
| Stock recruitment relationship | unknown | unknown |
| Timing of recruitment to fishery | all year | unknown |
| Variability of recruitment into fishery | variable; mostly high | unknown |
| Environmental influences on catch | wind; hydrography | unknown |
| Assessment: | | |
| Stock biomass or abundance | unknown | unknown |
| No. of stocks identified | unknown | unknown |
| Method applied | no assessment | no assessment |
| Research activities in ICES area: | | |
| Country | Portugal, Spain | Scotland |
| Region | ICES divisions VIII - X | Scottish waters |
| | | |

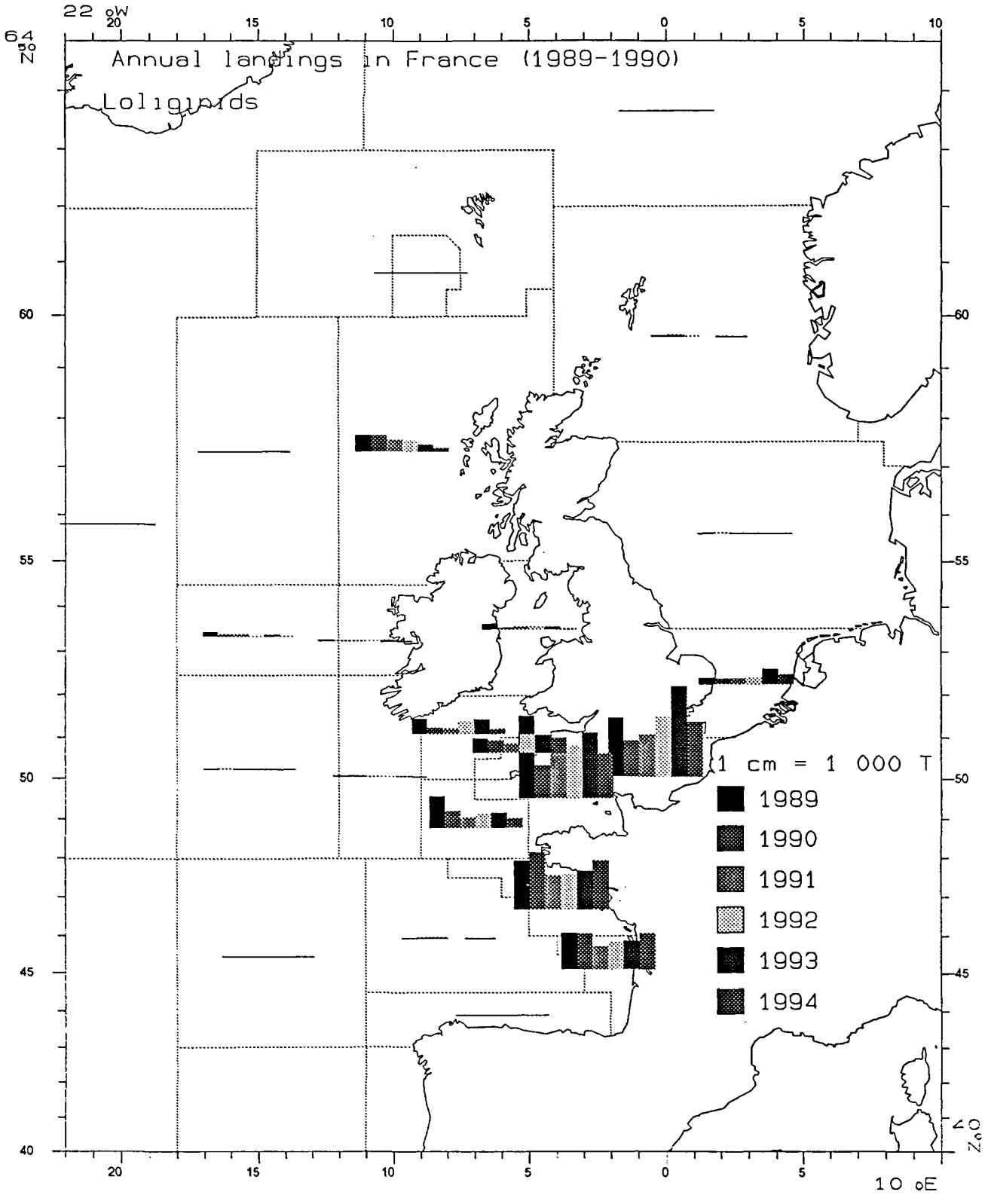
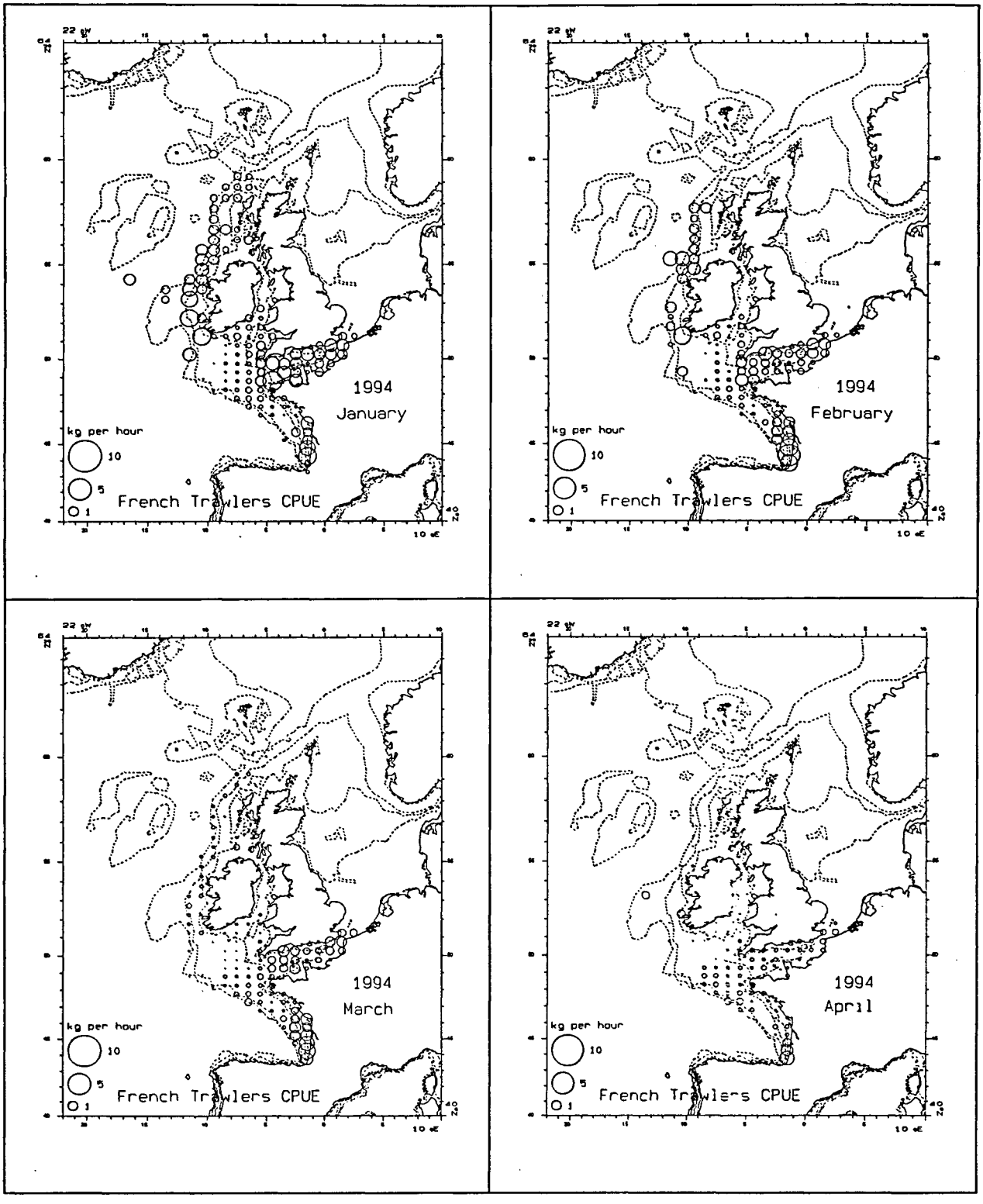


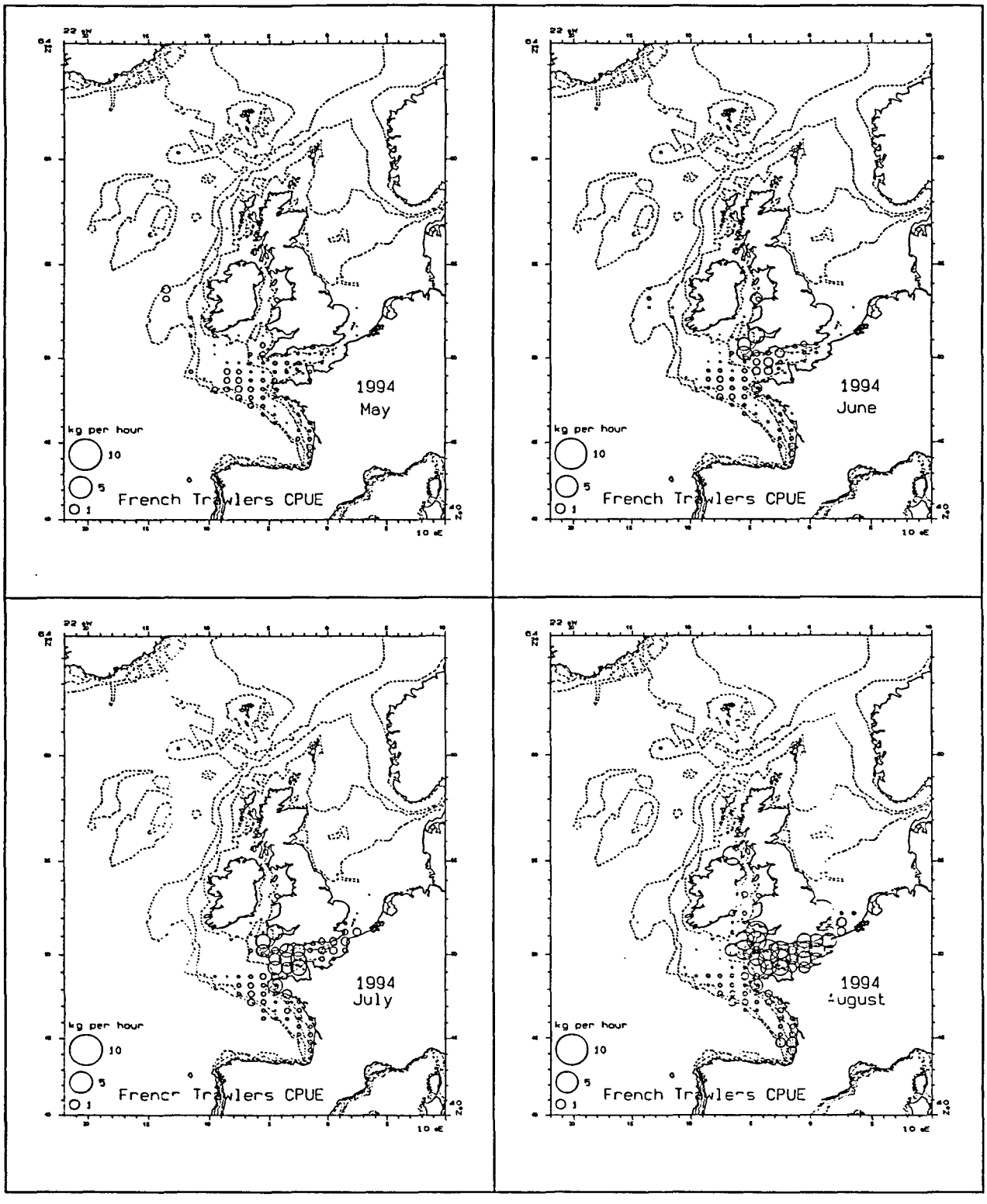

Fig. 1

Loliginid Annual Landings per ICES division in the French Fishery (1989 - 1994)



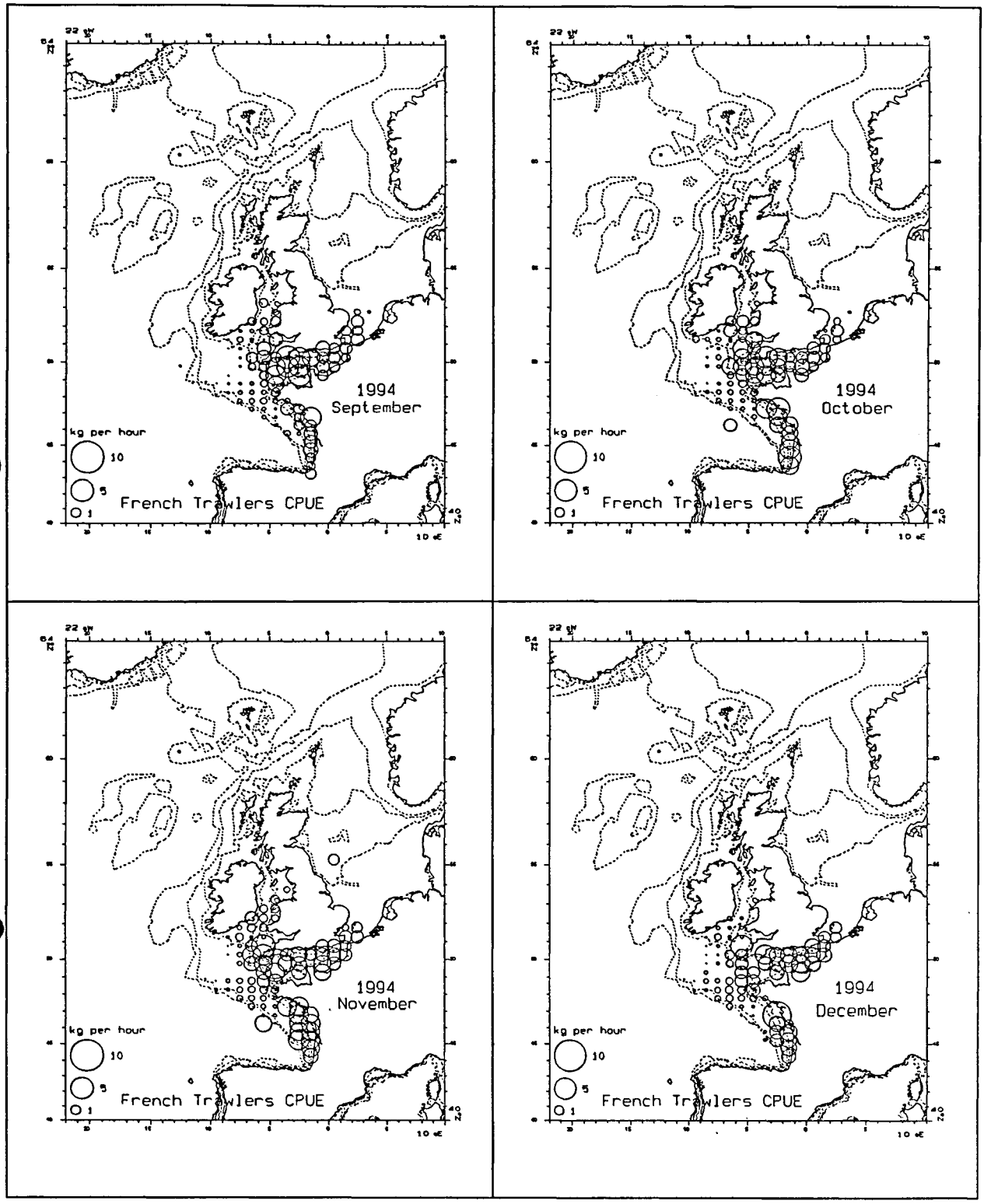

Loliginid CPUE in the French Trawlers Fishery: period 1994 January - April
(CPUE in kg per fishing hour of a 100kW fishing boat)

Fig. 2




Loliginid CPUE in the French Trawlers Fishery: period 1994 May - August
(CPUE in kg per fishing hour of a 100kW fishing boat)

Fig. 3




Loliginid CPUE in the French Trawlers Fishery: period 1994 September- December (CPUE in kg per fishing hour of a 100kW fishing boat)

Fig. 4

# ANNEX 1

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# ANNEX 3

Working document to the ICES Working Group on Cephalopods Fisheries
and Life History
Lisbon, 17-19 April 1996.

## SPANISH CEPHALOPOD LANDINGS IN ICES WATERS, 1990-1995 (Sub-areas VI, VII, VIII and IX)

by

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ABSTRACT

In this paper, available data on Spanish cephalopod landings for the period 1990-1995 in the ICES waters are presented. Catches were obtained in ICES Sub-areas VI, VII, VIII and IX by artisanal and industrial vessels.

The results indicate that Spanish cephalopod landings from ICES waters during the period ranged from 3600 to 7400 metric tonnes, with an average of 5400 tonnes/year. The main contribution to these landings was that of the octopods (*Octopus vulgaris* and *Eledone cirrosa*) accounting for 56 % of the total. Landings of ommastrephid squid (*Illex coindetii* and *Todaropsis eblanae*) and cuttlefish (particularly *Sepia officinalis*), show a marked seasonal distribution, with higher landings in autumn to spring, and lower in summer. Landings of *Alloteuthis* spp. occur only in the first half of the year, probably indicating the existence of an important spring recruitment. *Loligo* spp. is caught throughout the year, occurring higher landings in the second half, mainly in summer.

The total catch of *Octopus vulgaris* and *Alloteuthis* spp. was obtained in Divisions VIIIc and IXa, while most of the cuttlefish and a third of *Loligo* spp. were caught in Divisions VIIIa,b.

The seasonality observed in catches may be related to seasonality in fishing behaviour, abundance and/or in recruitments.

## MATERIAL AND METHODS

Data on landings of cephalopods was collected in the main fishing harbours of north and north-west Spain, using the statistical database compiled in the fish markets of those ports (Figure 1). Due to the difficulty for achieving an exhaustive monitoring of landings in the fish markets, occasionally, an unknown portion of landings is not registered in the statistics, mainly in some artisanal harbours (Table 1 shows data available by harbour and year). For this reason, the information presented in this document should be considered with caution.

Cephalopods are caught by artisanal vessels targeting *Loligo* spp., *Sepia* spp. and *Octopus vulgaris* in ICES divisions VIIIc and IXa, or as a by-catch by industrial vessels operating in ICES areas VI, VII, VIII and IX, being *Illex coindetii, Todaropsis eblanae* and *Eledone cirrhosa* the main species for this vessels.

Sometimes the statistics do not indicate the origin of landings, but we have estimated that in these cases, more than 80% of the catch originates in Divisions VIIIc and IXa, even though we cannot assess the proportion coming from each one of them.

Although statistics have some lacks and deficiencies, the figures can be taken as an approach to real landings, and as an index of the evolution of the fisheries.

Since most of the landings were not separated by species in the statistics, data is classified as follows:

"Loligo spp" includes *Loligo vulgaris* and *L.forbesi*.
"Cuttlefish" consists of *Sepia officinalis*, *S. elegans* and *S. orbignyana*, although most of the catch is made up of the first species.
"Ommastrephids" comprise *Illex coindetii* and *Todaropsis eblanae*, and some irrelevant quantities of *Todarodes sagitattus*.
"Unspecified octopods" includes *Eledone cirrhosa* and *Octopus vulgaris*, for those harbours in which landings of both species are not distinguished in the statistics.
"Alloteuthis spp." includes *Alloteuthis media* and *A. subulata*.

## RESULTS AND DISCUSSION

Table 2 shows total cephalopod landings in Spanish harbours (caught in ICES waters), by species or group of species for the study period. Landings are given by year, but also the period average for each species or group of species and the standard deviation (STD) is shown in the table.

The results indicate a general decrease in landings since 1993, particularly in *Loligo* spp. and *Sepia* spp. The explanation for this change is the absence of statistics for Pasajes and Ondarroa harbours (Basque Country) since 1993, when control of these ports was transferred to the Basque Government. Ondarroa and Pasajes have an important trawling fleet, and the lack of information since 1993 is well reflected in the data, particularly for Divisions VIIIab (see Table 5), where Basque trawlers have historically exerted an important activity. Data in Table 2 are represented in Figure 2 (except *Alloteuthis* spp., whose catches are irrelevant).

In Tables 3 and 4, landings of cephalopods coming from Sub-areas VI and VII are presented respectively, while these landings from Divisions VIIIab are shown in table 5.

Table 6 shows landings from divisions VIIIc and IXa. All landings of *Octopus vulgaris* and Alloteuthis spp. are caught in these divisions.

Figure 3 shows the relative importance (average percentage) of each cephalopod group in landings for the whole period. Octopods are by far the most important cephalopod resource to the Spanish fishing fleet in ICES waters, with 56 % of the total landings, while ommastrephids in second place represents 31.6 %. Results shown in Figure 3 are highly coincident with the results obtained in Galician waters (between Guarda and Ribadeo, Figure 1) by González et al. (in press) for the period 1980-1991. The similarity of the results suggests that no significant changes took place in the fishery pattern between both periods.

Figure 4 shows the origin of the landings for each cephalopod group, and indicates that most of the landings originate in Spanish waters (divisions VIIIc and IXa). *Octopus vulgaris* and *Alloteuthis* spp. are not included in the figure because, as stated above, the total catch comes from the divisions mentioned. Most of the cuttlefish, and a little more than a third of *Loligo* spp., are caught off the French coast (Divisions VIII a,b). Landings from Sub-areas VI and VII are not significant, except for ommastrephids (one third of the short-finned squid landings have been caught in Sub-area VII).

Figure 5 shows average monthly landings for the period 1994-1995, using statistics from Riveira and Grove harbours exclusively. These statistics have an acceptable level of confidence, and, very probably, the temporary pattern of coastal catches in these ports represents the general pattern in Divisions VIIIc and IXa. A certain degree of seasonality in the landings of all the groups can be observed. Such seasonality is probably related to some biological features that will be briefly discussed in the following paragraphs.

Landings of ommastrephid squid have a marked seasonal distribution, with peak landings occurring from October-November to March-May, and lower landings in summer. This pattern has also been observed by González et al. (1994 and 'in press'). Besides a possible change in the fishing behaviour of the fleet during summer, the biological explanation could be the existence of an intense recruitment during autumn and winter, and a high post-spawning mortality at the end of spring, both causing the comparatively low catches of summer (González et al, 1994 and 'in press').

Landings of Cuttlefish (and less clearly, of *Octopus vulgaris*) have a temporal pattern similar to that of the ommastrephids, the causes of which may be similar to those discussed for short-finned squid. *Alloteuthis* spp. catches occur only in the first half of the year (especially in spring), probably indicating the existence of an important spring recruitment. *Loligo* spp. is caught throughout the year, the higher landings occurring in the second half, especially in summer. This is coincident with the observations by Guerra et al (1994) and Simon et al. (in press) in Galician waters, Pierce et al (1994) in Scotland, and Cunha and Moreno (1994) in Portugal. The seasonality observed in catches can be related to seasonality in fishing behaviour (especially in the hand-jig fishery; Simon et al, 1994), abundance and recruitment (Pierce et al., 1994; Guerra et al., 1994).

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**TABLE 1.** Fishing harbours in north and northwestern Spain where landing statistics were obtained. Columns indicate the years and species for which statistics were available.

| PORT | *Loligo* spp. | | | | | | Cuttlefish | | | | | | Ommastrephids | | | | | | *Octopus vulgaris* | | | | | | *Eledone cirrhosa* | | | | | | Unespecified Octopods | | | | | | *Alloteuthis* spp. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 90 | 91 | 92 | 93 | 94 | 95 | 90 | 91 | 92 | 93 | 94 | 95 | 90 | 91 | 92 | 93 | 94 | 95 | 90 | 91 | 92 | 93 | 94 | 95 | 90 | 91 | 92 | 93 | 94 | 95 | 90 | 91 | 92 | 93 | 94 | 95 | 90 | 91 | 92 | 93 | 94 | 95 |
| AVILES | X | X | X | X | X | | X | X | X | X | X | | X | X | X | X | X | | | | | | | | X | X | X | X | X | | | | | | | | | | | | | | |
| BAIONA | | | | | X | | | | | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | |
| BURELA | X | X | X | X | X | | | | | | | | X | X | X | X | X | | X | X | X | X | X | | X | X | X | X | X | | | | | | | | | | | | | | |
| CAMARIÑAS | X | X | X | X | | | | | | | | | | | | | | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| CAMELLE | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | |
| CARIÑO | X | X | X | X | X | | | | | | | | X | X | X | X | X | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| CAYON | | | | | | | | | | | | | | | | | | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| CEDEIRA | X | X | X | X | X | | | | | | | | | | | | | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| CILLERO | X | X | X | X | X | | X | X | X | X | X | | X | X | X | X | X | | | | | | | | | | | | | | X | X | X | X | X | | | | | | | |
| CORUÑA | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | |
| FERROL | X | X | X | X | | | | | | | | | | | | | | | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| FINISTERRE | X | X | X | | | | | | | | | | | X | X | X | X | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| FOZ | X | X | X | X | X | | | | | | | | | | | | | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| GROVE | | | | | X | X | | | | | X | X | | | | | X | | | | | | X | X | | | | | | | | | | | | | | | | | | | |
| GUARDA | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | |
| LAXE | X | X | X | X | X | | X | X | X | X | X | | X | X | X | X | X | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| MALPICA | X | X | X | X | X | | | | | | | | | | | | | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| MARIN | | X | X | X | X | X | | | | | | | | X | X | X | X | X | | | | | | | | | | | | | | X | X | X | X | X | | | | | | |
| MUXIA | X | X | X | X | X | | X | X | X | X | X | | | | | | | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| ONDARROA | X | X | X | | | | X | X | X | | | | X | X | X | | | | | | | | | | X | X | X | | | | | | | | | | | | | | | | |
| PASAJES | X | X | X | | | | X | X | X | | | | X | X | X | | | | | | | | | | X | X | X | | | | | | | | | | | | | | | | |
| PORTO DO SON | | | | | X | X | | | | | X | X | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | |
| RIBADEO | X | X | X | X | X | | X | X | | | | | X | X | X | X | X | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| RIVEIRA | | | | | X | X | | | | | X | X | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | X | X |
| SADA | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SANTANDER | X | X | X | X | X | | X | X | X | X | X | | X | X | X | X | X | | | | | | | | X | X | X | X | X | | | | | | | | | | | | | | |

TABLE 2. Total Spanish cephalopod landings (tonnes) in ICES waters for the period 1990-1995.

| YEAR | *Loligo* spp. | Cuttlefish | Ommastrephids | *Octopus vulgaris* | *Eledone cirrhosa* | Uns. Octopods | *Alloteuthis* spp. | YEARLY TOTAL |
|---|---|---|---|---|---|---|---|---|
| 1990 | 412 0 | 510 6 | 1680 0 | 1708 3 | 1105 6 | 527 3 | | 5943 8 |
| 1991 | 393 5 | 637 0 | 2412 0 | 1173 3 | 718 2 | 1145 3 | | 6479 4 |
| 1992 | 505 9 | 560 8 | 2450 9 | 1255 5 | 1341 4 | 1298 9 | | 7413 4 |
| 1993 | 223 8 | 13.7 | 1026 6 | 1170 2 | 1066 1 | 897 2 | | 4397 6 |
| 1994 | 197.1 | 93 9 | 1360.7 | 1110 8 | 471.5 | 1072.9 | 12 3 | 4319 3 |
| 1995 | 185 8 | 101.7 | 1261.3 | 230.4 | 588.1 | 1259.2 | 7 9 | 3634 5 |
| GROUP AVERAGE | 319 7 | 319 6 | 1698 6 | 1108.1 | 881.8 | 1033 5 | 10 1 | YEARLY AVERAGE |
| STD | 134.7 | 278 4 | 605 3 | 481.7 | 339 6 | 286.5 | 3 1 | 5364 7 ± 1469 5 |

TABLE 3. Spanish cephalopod landings (tonnes) in ICES Sub-area VI for the period 1990-1995.

| YEAR | *Loligo* spp. | Cuttlefish | Ommastrephids | *Octopus vulgaris* | *Eledone cirrhosa* | Uns. Octopods | *Alloteuthis* spp. |
|---|---|---|---|---|---|---|---|
| 1990 | | | | | | | |
| 1991 | | | 67.8 | | 89.7 | | |
| 1992 | | | 1.7 | | 3.5 | | |
| 1993 | | | | | | | |
| 1994 | | | | | | | |
| 1995 | | | | | | | |

TABLE 4. Spanish cephalopod landings (tonnes) in ICES Sub-area VII for the period 1990-1995.

| YEAR | *Loligo* spp. | Cuttlefish | Ommastrephids | *Octopus vulgaris* | *Eledone cirrhosa* | Uns. Octopods | *Alloteuthis* spp. |
|---|---|---|---|---|---|---|---|
| 1990 | 27.7 | 16.0 | 741.3 | | 186.7 | | |
| 1991 | 30.9 | 19.5 | 908.9 | | 162.8 | | |
| 1992 | 61.9 | 2.0 | 469.1 | | 178.6 | | |
| 1993 | 84.5 | | 374.3 | | 139.1 | | |
| 1994 | 34.3 | | 611.3 | | 107.7 | | |
| 1995 | 26.8 | | 298.7 | | 133.6 | | |

TABLE 5. Spanish cephalopod landings (tonnes) in ICES Divisions VIIIa,b for the period 1990-1995.

| YEAR | *Loligo* spp. | Cuttlefish | Ommastrephids | *Octopus vulgaris* | *Eledone cirrhosa* | Uns. Octopods | *Alloteuthis* spp. |
|---|---|---|---|---|---|---|---|
| 1990 | 260.4 | 445.4 | 244.4 | | 240.1 | | |
| 1991 | 162 4 | 581.0 | 25.1 | | 90.1 | | |
| 1992 | 198.2 | 541.6 | 364.4 | | 214.4 | | |
| 1993 | 2.1 | | 20.7 | | 0.1 | | |
| 1994 | 22.2 | 0 1 | 6.1 | | 0.8 | | |
| 1995 | | | | | | | |

TABLE 6. Spanish cephalopod landings (tonnes) in ICES Divisions VIIIc and IXa for the period 1990-1995.

| YEAR | *Loligo* spp. | Cuttlefish | Ommastrephids | *Octopus vulgaris* | *Eledone cirrhosa* | Uns. Octopods | *Alloteuthis* spp. |
|---|---|---|---|---|---|---|---|
| 1990 | 123.9 | 49.2 | 694.3 | 1708.3 | 678.8 | 527.3 | |
| 1991 | 200.1 | 36.5 | 1410.2 | 1173.3 | 375.7 | 1145.3 | |
| 1992 | 245.8 | 17.2 | 1615.6 | 1255.5 | 944.9 | 1298.9 | |
| 1993 | 137.2 | 13.7 | 631.5 | 1170.2 | 926.9 | 897.2 | |
| 1994 | 140.6 | 93.8 | 743.3 | 1110.8 | 363.1 | 1072.9 | 12.3 |
| 1995 | 159.0 | 101.7 | 927.9 | 230.4 | 407.9 | 1259.2 | 7.9 |

FIGURE 1. Chart showing the northern coast of Spain, and the ports where fishing statistics were obtained for the present study.

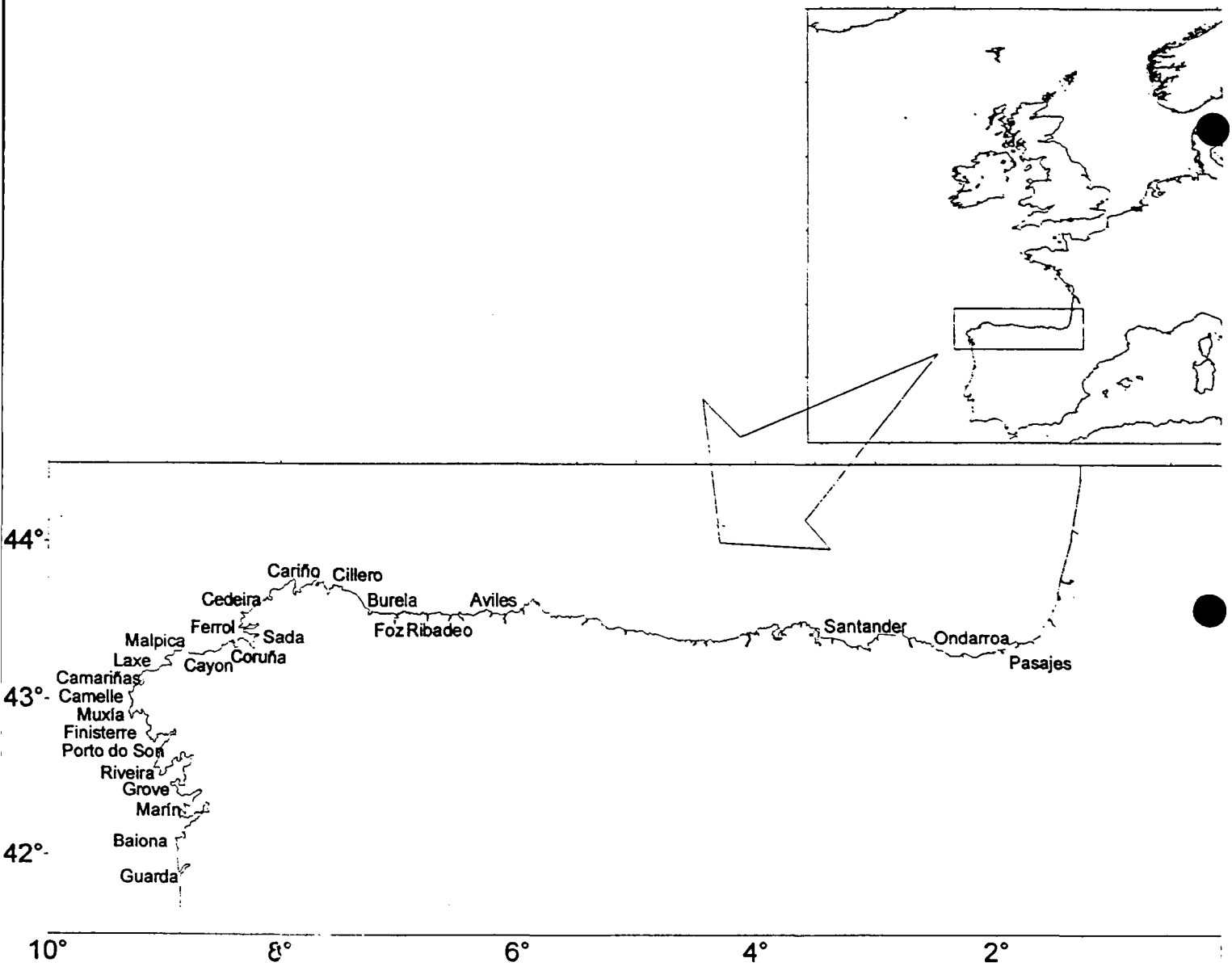
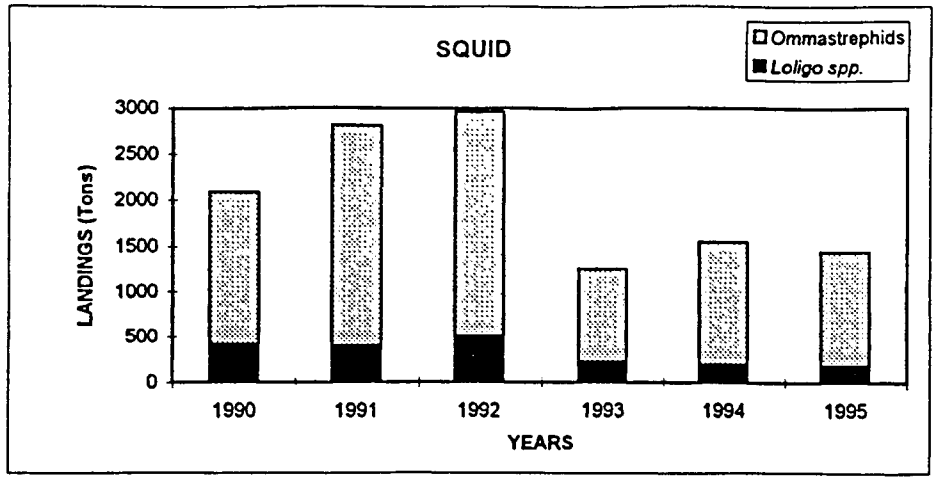
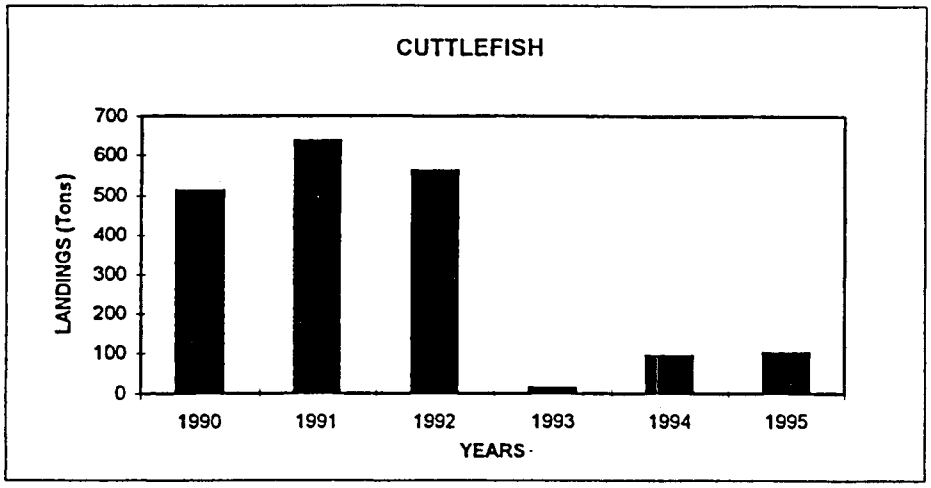


FIGURE 2.Total Spanish landings of squid, cuttlefish and octopus in ICES waters, for the period 1990-1995. *Alloteuthis* spp. is not included.



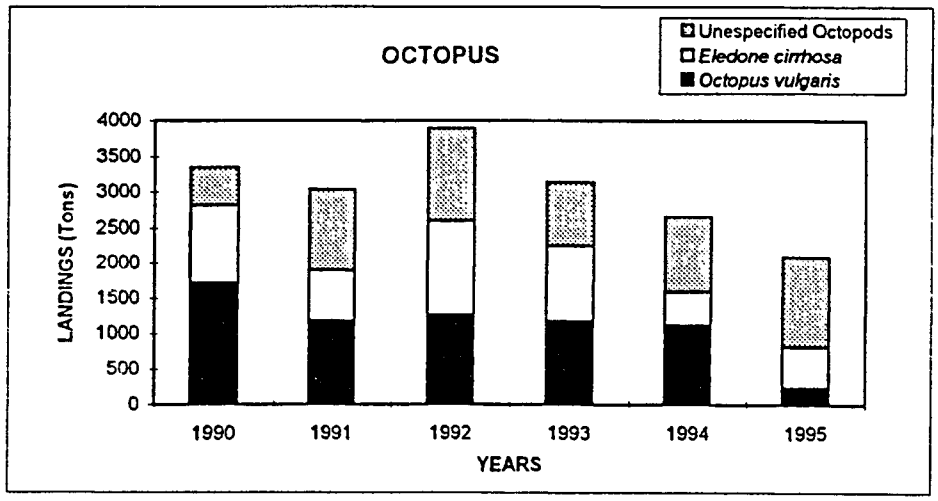



FIGURE 3. Average percentage for each cephalopod group, for the period 1990-1995.

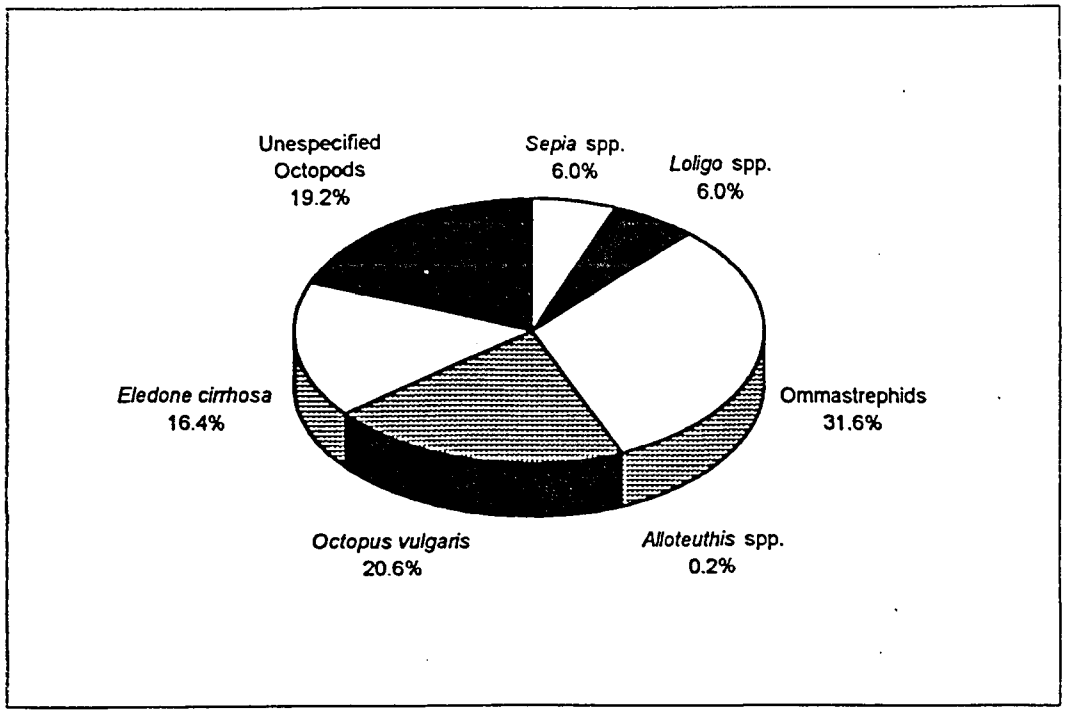



FIGURE 4. Area of origin of the landings for *Loligo* spp., Cuttlefish, Ommastrephids and *Eledone cirrhosa*. Average percentage for the period 1990-1995. Unespecified octopods are not shown. *Octopus vulgaris* and *Alloteuthis subulata* have been caught exclusively in Subarea VIIIc and IXa.

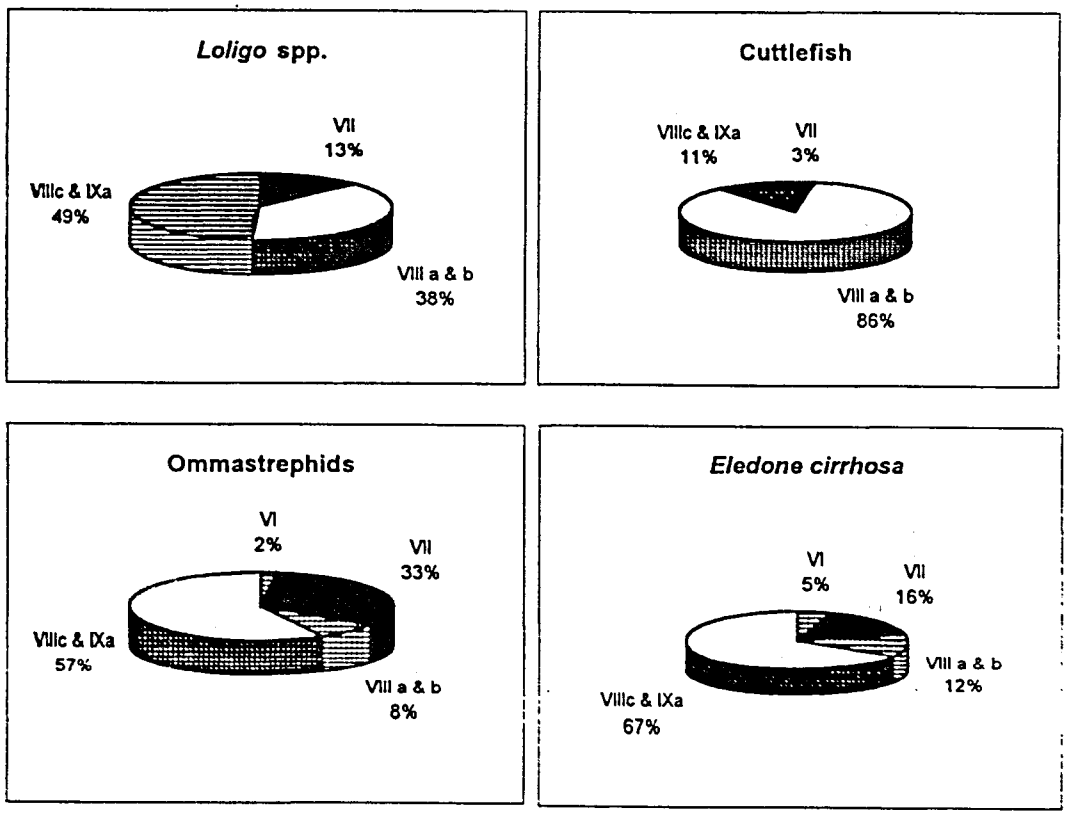
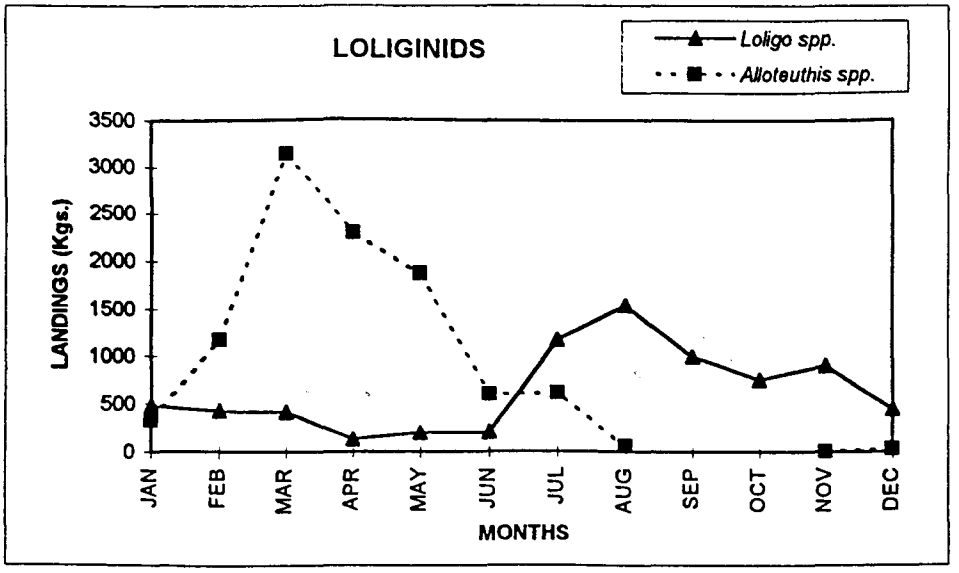
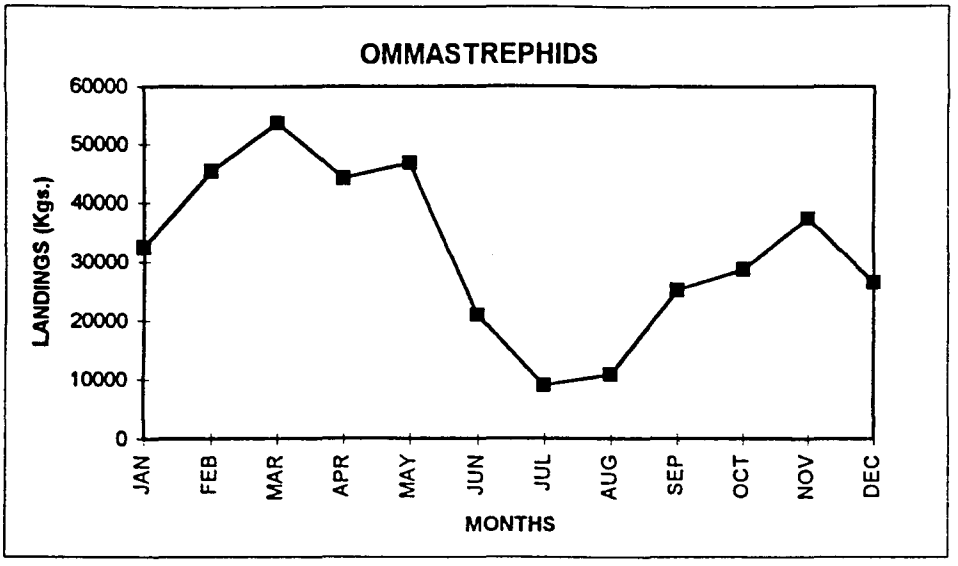
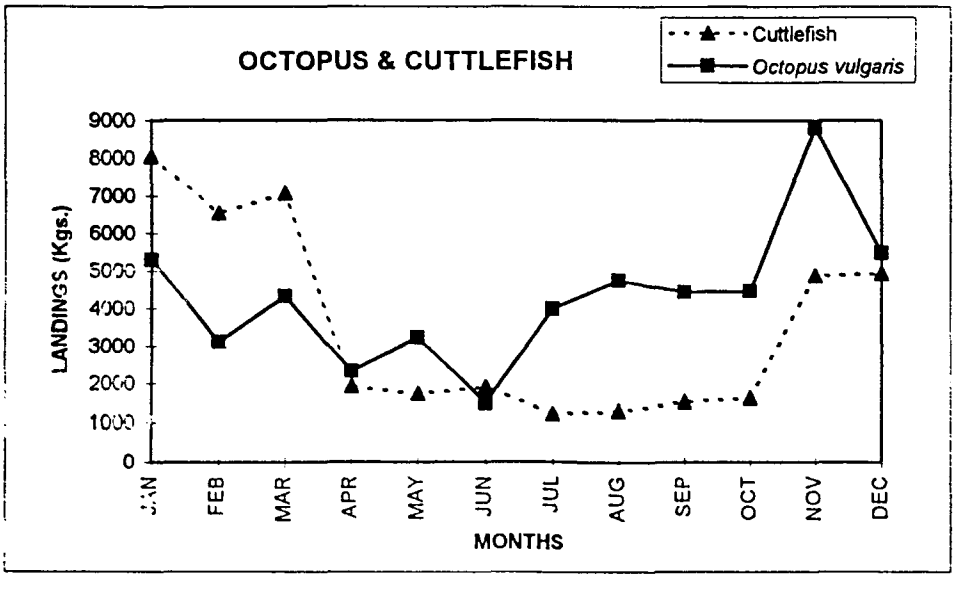


FIGURE 5. Evolution of the monthly catches of loliginids, ommastrephids, octopus and cuttlefish in the NW of Spain. Data from two Galician ports (Grove and Riveira) averaged for 1994-1995.



# ANNEX 4

*Rocha et al.*, 1996: *Reproductive strategies in cephalopods*

*ICES Working Group on Cephalopod Fisheries and Life History*
*17-19 April 1996, Lisbon, Portugal*

## An overview on the reproductive strategies in Cephalopoda

by

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### Introduction

Until recently, it was generally accepted that female cephalopods lay their eggs in one single spawning or in several consecutive ones, after which they would die of exhaustion (McGowan, 1954; Mangold, 1987; Harman *et al.*, 1989; Mangold *et al.*, 1993). The animals with this reproductive pattern where gonad regeneration is absent are known as semelparous. Conversely, iteroparous species are those in which gonadal regeneration following spawning occurs, making new reproductive cycles possible.

As knowledge has grown regarding the biology of this group, it has become increasingly difficult to support the notion of a single reproductive pattern (Boletzky, 1981, 1986; Rodaniche, 1984; Harman *et al.*, 1989; Mangold *et al.*, 1993). A case in point is *Nautilus* spp., with a life span of 20 years, which must be considered as an iteroparous species since the females spawn once a year, surviving, feeding, growing and regenerating their gonads for a further reproductive event the following year (Ward, 1987). With the exception of this particular case, the other cephalopods may be considered as semelparous, although there are significant differences between the maturation processes and spawning from one species to another (Boletzky, 1975; Mangold, 1987; Mangold *et al.*, 1993). Based on these differences, several reproductive strategies may be defined in cephalopods with regard to the oocyte maturation process and the type of spawning process in each species (Boletzky, 1981, 1986; Harman *et al.*, 1989; Villanueva, 1992; Mangold *et al.*, 1993; González, 1994; Rocha, 1994; Boyle *et al.*, 1995; Rasero, 1996; Rocha & Guerra, *in press*). In general, the current definitions for the different cephalopod reproductive strategies are confusing. For clarity and accuracy in this paper several reproductive strategies are defined, particularly regarding the duration of breeding period and types of ovulation and spawning.

## Definitions

The diferent reproductive strategies presented in this paper (Table 1) are:

### *Iteroparous Reproductive Pattern*

**"Iteroparous spawning"**. This is a type of spawning where the gonads regenerate after each breeding season, making new reproductive cycles possible. There appears to be a single breeding season each year, and with the animal surviving, feeding and growing between spawning events (Kirkendall & Stenseth, 1985). Egg-laying may occur in separate batches during each spawning period. The species of the genus *Nautilus* have been found which exhibit iteroparous spawning (Ward, 1983, 1987).

### *Semelparous Reproductive Pattern*

**"Simultaneous terminal spawning"**. This is a type of spawning where ovulation is synchroneous, egg-laying occurs in a very short period at the end of the animal's life before death, and there is not oocyte maturation during spawning period. Several species have been found which exhibit simultaneous terminal spawning, e.g. *Loligo opalescens*, *Illex illecebrosus* and *Todarodes pacificus* (Hixon, 1983; O'Dor, 1983; Ikeda *et al.*, 1993). This type of spawning is also called "terminal spawning" and "single spawning" (Hixon, 1983; Mangold *et al.*, 1993).

**"Intermittent terminal spawning"**. In this type of spawning "partial ovulation" occurs. Partial ovulation implies the presence of oocytes at various stages of development in the ovaries, thus enabling the continued production of ova once spawning has commenced. Partial ovulation has been described in several species: *Sthenoteuthis oualaniensis, Loligo bleekeri* and *Idiosepius pygmaeus* (Harman *et al.*, 1989; Hun Baeg *et al.*, 1993; Lewis & Choat, 1993). In intermittent terminal spawning egg-laying occurs in separate batches during the spawning period, which is usually relatively long, although in no case does it represent the greatest fraction of the animal's life. The species *Loligo vulgaris reynaudii, L. bleekeri, L. vulgaris vulgaris, L. forbesi, Illex coindetii* and *Todaropsis eblanae* (Sauer & Lipinski, 1990; Hung Baeg *et al.*, 1993; Rocha & Guerra, *in press*; Collins *et al.*, 1995; González & Guerra, *in press*; Rasero *et al.*, 1995) seem to be intermittent terminal spawners in which somatic growth does not take place between spawning events. This type of spawning corresponds to "intermittent spawning" defined by Boletzky (1975).

**"Multiple spawning"** (Harman *et al.*, 1989). This is a form of the intermittent terminal spawning. "Multiple spawning" is when somatic growth occurs between separate spawning events. Several species have been found which exhibit multiple spawning, e.g. *Octopus chierchiae, Sepia officinalis* and *Sthenoteuthis oualaniensis* (Rodaniche, 1984; Boletzky, 1975, 1987, 1988; Forsythe *et al.*, 1991; Harman *et al.*, 1989).

**"Continuous spawning"** (Villanueva, 1992). This is a type of reproductive strategy in which partial ovulation occurs with a continued production of ova once spawning has commenced and adults spawn many times during their extended life spans. Two species of cirrated octopods have been found which exhibit continuous spawning. e.g. *Opisthoteuthis agassizii* and *O. vossi* (Villanueva, 1992).

Table 1: Characteristics of the principal reproductive strategies in cephalopods and some examples.

| Reproductive pattern | Breeding season pattern | Ovulation pattern | Spawning pattern | Growth between egg batches or breeding seasons | Reproductive strategy name | Possible species example |
|---|---|---|---|---|---|---|
| Iteroparous | Single annual during several years | Partial ovulation | Egg-laying occurs in separate batches | Yes | Iteroparous spawning | *Nautilus* spp. |
| Semelparous | Single and short at the end at the animal's life | Simultaneous ovulation | Egg-laying occurs in a very short period | No | Simultaneous terminal spawning | *Loligo opalescens*<br>*Illex illecebrosus* |
| | | Partial ovulation | Egg-laying occurs in separate batches | Yes | Multiple spawning | *Sepia officinalis*<br>*Sthenoteuthis oualaniensis*<br>*Octopus chierchiae* |

**Table 1**: Characteristics of the principal reproductive strategies in cephalopods and some examples (Cont.)

| Reproductive pattern | Breeding season pattern | Ovulation pattern | Spawning pattern | Growth between egg batches or breeding seasons | Reproductive strategy name | Possible species example |
|---|---|---|---|---|---|---|
| Semelparous | Single and short at the end at the animal's life | Partial ovulation | Egg-laying occurs in separate batches | No | Intermittent terminal spawning | *Loligo vulgaris*<br>*Loligo forbesi*<br>*Todaropsis eblanae*<br>*Illex coindetii* |
| | Single and extended during the animal's life | Continuous ovulation | Egg-laying occurs in a extended and continuous period of spawning | Yes | Continuous spawning | *Opisthoteuthis agassizii*<br>*Opisthoteuthis vossi* |

## Discussion

The main problem in the use of these reproductive strategies is the knowledge of the main aspects involved in the definitions: ovulation pattern, spawning pattern and existence of growth between egg batches or breeding seasons. Data about these three caracteristics have been reported just in a few species. Information about some of these aspects have been reported for several species, but it is not enough to locate each one in the corresponding reproductive strategies. Therefore, it is necessary to improve the knowledge of these reproductive aspects for each species in order to classify them according to each reproductive strategies.

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# ANNEX 5

## CHAPTER 9

# Trophic interactions of squid *Loligo forbesi* in Scottish waters

*G.J. Pierce and M.B. Santos*


## SUMMARY

(1) Squid are an increasingly important fishery resource in the north-east Atlantic but their role as predators and prey of other marine organisms is poorly known. The main squid species of commercial importance in the northern north-east Atlantic is the veined squid *Loligo forbesi*. The present paper reviews trophic interactions involving this species in Scottish waters.

(2) Fishery and population data are used to develop a simple model of the squid population. Stock size estimates, combined with available data on diet and energetic requirements are used to estimate consumption of the main prey species for two annual cohorts (1990/91, 1991/92).

(3) *Loligo forbesi* is primarily piscivorous, although the diet also includes crustaceans and there is some cannibalism. In 1990/91, depending on assumptions about natural mortality, the Scottish population of *Loligo forbesi* may have eaten between 9000 and 16 000 tonnes of food, including 1700–3000 tonnes of sandeels (Ammodytidae), a similar amount of *Trisopterus* spp. and 1000–1700 tonnes of whiting *Merlangius merlangus*.

(4) *Loligo forbesi* is eaten by various predatory fish, seabirds and marine mammals in the north-east Atlantic. Harbour seals *Phoca vitulina* and grey seals *Halichoerus grypus* eat *Loligo forbesi* in small amounts. *Loligo forbesi* is more important in the diets of harbour porpoise *Phocoena phocoena* and these three mammal species alone may remove more squid from Scottish waters every year than the commercial fishery.

(5) The importance of *Loligo forbesi* in fish and seabird diets is not well documented, although many studies indicate that other squid species are eaten. Many toothed cetaceans are specialist feeders on cephalopods and good quantitative data on the diets of more of these potential predators is needed to obtain realistic estimates of natural mortality in *Loligo forbesi*.


*Key-words*: food consumption, *Loligo forbesi*, marine mammals, north-east Atlantic, population size

## INTRODUCTION

The veined squid *Loligo forbesi* is widely distributed in the north-east Atlantic, primarily in shelf and shelf edge waters and is the subject of increasingly important fisheries, both directed and by-catch. Recent studies in Scottish waters have examined distribution and abundance, population ecology, diet and the nature of the commercial fishery (Pierce *et al.* 1994a,b,c) but no previous attempts have been made to quantify the trophic interactions. The diet of *Loligo forbesi* has been documented in Scottish, Irish and Spanish waters (Ngoile 1987, Collins *et al.* 1993, Rocha *et al.* 1993, Pierce *et al.* 1994b) and the species is primarily piscivorous. However, there are no estimates of population size and the potential impact on fish stocks remains

unknown. Data on the importance of squid as prey are patchy. There are many relevant studies on diets of fish, seabirds and marine mammals in the north-east Atlantic, but few attempts to quantify the amounts of cephalopods eaten, although Furness (1994) estimates consumption of squids by seabird populations.

The present paper uses existing data to quantify some of the trophic interactions involving *Loligo forbesi* in the north-east Atlantic, focusing on the fished population in Scottish waters.

## SOURCES OF DATA

### Consumption by squid

#### *Squid energy requirements*

Based on data for *Illex illecebrosus* and *Loligo* spp. compiled by O'Dor & Wells (1987), daily food intake (I, $g \cdot day^{-1}$) may be expressed in relation to body weight (W, g) as:

$$I = 0.0683 + 0.0474 \times W \qquad (1)$$

Using this regression, daily food intake was estimated for all individuals in monthly population samples (July 1990–July 1992) (Pierce *et al.* 1994a), and the mean daily food requirement per individual calculated for each month.

#### *Squid population size*

A simple difference equation model is used here, including terms for recruitment, fishing mortality and natural mortality. Immigration and emigration are assumed to be negligible. Data on the monthly landings in Scotland (SOAFD, unpublished data) and monthly size composition (Pierce *et al.* 1994a) were used to estimate the number of *Loligo* landed monthly between July 1990 and July 1992. This assumes that all squid caught in Scottish waters are *Loligo forbesi* and are landed in Scotland, and the size composition in monthly samples was representative of the population. Recruitment in *Loligo forbesi* occurs during much of the year, although with varying seasonal peaks (Lum-Kong *et al.* 1992, Boyle & Ngoile 1993; Pierce *et al.* 1994a). The proportion of recruits (animals of <150 mm mantle length) in monthly samples is assumed to be representative of the rate of recruitment to the population:

$$N_t = (N_{t+1} + C_t)/(1 + r_t - m) \qquad (2)$$

where $N_t$ is the population size at the start of month t, $r_t$ is the recruitment in month t expressed as a proportion of $N_t$, $C_t$ is the commercial catch in month t and m is the monthly natural mortality, expressed as a (fixed) proportion of $N_t$.

Pauly (1985) gives values in the range 0.53–2.13 for instantaneous (annual) natural mortality (M) in squids. This corresponds to values for m as defined above between 0.043 and 0.163. Most adults disappear from the fished population in July, while in 1991 recruitment reached a peak in August (Pierce *et al.* 1994a). Setting the population level at the end of July in each year to zero, population sizes for the preceding months were estimated using Equation (2) for different levels of monthly natural mortality (m = 0, 0.04, 0.16). Input catch parameters and population results for m = 0.16 are illustrated in Figure 9.1.

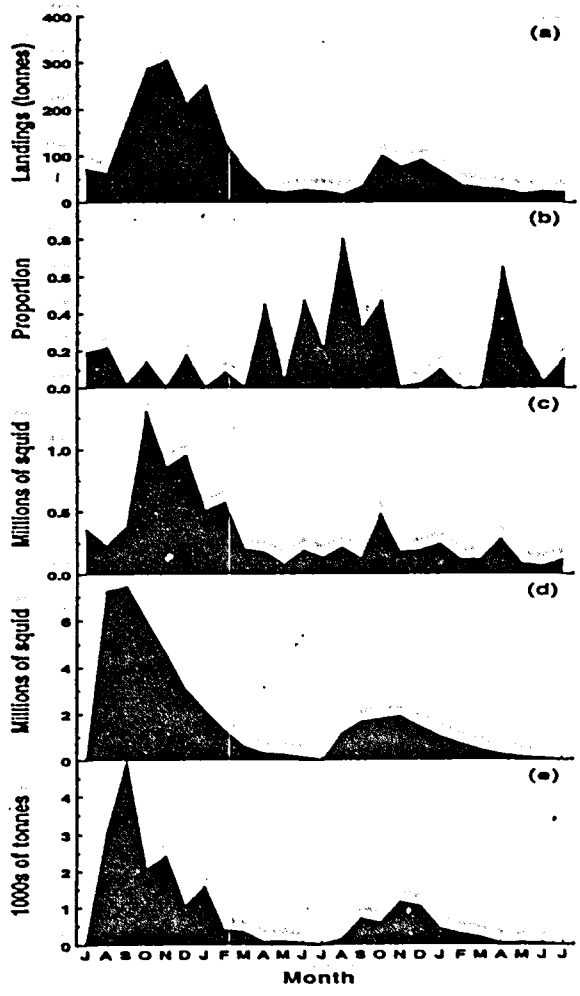


Fig. 9.1. Population model for *Loligo forbesi* in Scottish waters July 1990–July 1992 using m = 0.16 for illustration purposes: (a) monthly landings (tonnes) by the commercial fishery in Scotland; (b) monthly recruitment to the fished population based on the proportion of squid with mantle length <150 mm in monthly samples; (c) estimated numbers (millions) of squid landed monthly; (d) estimated monthly population size (millions of squid); (e) estimated monthly population food consumption (thousands of tonnes).

### *Squid diet*

Data on the diet of *Loligo forbesi* in Scottish waters were taken from Pierce *et al.* (1994b). Variation in diet with body size and season is ignored. Assuming that meals of different prey taxa are normally of equivalent weight, the proportion by weight in the diet is equivalent to the modified frequency of occurrence: fish (75.7%), crustacean (17.4%), cephalopod (6.9%). Within taxa, relative weights eaten are assumed to be proportional to the number of individuals identified from bones, otoliths (fish) and beaks (cephalopods). Fish identified only as *Gadidae* were assigned *pro rata* to those gadid species which were identified, while beaks of decapod cephalopods were similarly assigned.

### *Population food intake*

Monthly food intake by the squid population (I, tonnes) for prey type i is given by:

$$I = N_t \times P_i \times F_t \times T_t \qquad (3)$$

where $N_t$ is the squid population size at the start of month t, $T_t$ is the number of days in month t, $P_i$ is the proportion by weight of prey-type i in the diet, $F_t$ is the average weight of food eaten daily per individual. Monthly food intake was summed to give annual food consumption (Table 9.1).

## Consumption of squid by marine mammals and other predators

Population consumption is calculated for marine mammals on which we have some dietary data: harbour seals *Phoca vitulina*, grey seals *Halichoerus grypus* and harbour porpoise *Phocoena phocoena* (Table 9.2). For other potential predators on squid, data in the literature are summarized (Table 9.3). Ignoring within-year variation and effects of population structure, annual consumption of squid by a population of marine mammals (I, tonnes ) is given by:

$$I = \frac{365 \times N \times E}{10^6 \times D_s} \times \frac{P_s \times D_s}{P_o \times D_o} \qquad (4)$$

where N is the estimated population size, E is the average individual daily energy intake (kcal), $D_s$ is the calorific density of squid ($kcal \cdot g^{-1}$), $D_o$ is the average calorific density of other prey in the diet ($kcal \cdot g^{-1}$), $P_s$ is the proportion (by weight) of squid in the diet and $P_o$ is the proportion (by weight) of other prey.

Not all data are precisely known. Estimated energetic intake for the harbour porpoise (Table 9.2) assumes a normal daily energy expenditure of approximately three times the basal metabolic rate predicted, using the Kleiber relationship, from body weight (after Worthy *et al.* 1987, Murie 1987). Taking average body weight to be 45 kg (at the lower end of the range for mean adult body size) (Leatherwood *et al.* 1983), this is equivalent to approximately $3600\,kcal \cdot day^{-1}$. At 90% assimilation efficiency (a realistic figure for seals) (Prime & Hammond 1987) this would require a daily intake of $4000\,kcal \cdot day^{-1}$.

Croxall & Prince (1982) give a figure of $3.5\,kJ \cdot g^{-1}$ for average calorific density of cephalopods, i.e. $836\,kcal \cdot kg^{-1}$, noting that values for fish are usually higher. However, although calorific densities often quoted for fish such as sandeels (1367), sprat (≤1587) and *Tri-*

Table 9.1. Amounts of food eaten by *Loligo forbesi* 1990/91 and 1991/92, based on estimated importance of main prey species in the diet and estimates of squid population size using various values for natural mortality (m).

| Prey species | Proportion of diet | Weights (tonnes) eaten 1990/91 for m = | | | Weights (tonnes) eaten 1991/92 for m = | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 0.04 | 0.16 | 0 | 0.04 | 0.16 |
| *Trisopterus* | 0.166 | 1559 | 1754 | 2678 | 467 | 524 | 800 |
| Haddock | 0.060 | 563 | 634 | 968 | 169 | 190 | 289 |
| Whiting | 0.104 | 976 | 1099 | 1678 | 292 | 329 | 501 |
| Cod | 0.009 | 85 | 95 | 145 | 25 | 28 | 43 |
| Sandeel | 0.183 | 1718 | 1933 | 2952 | 515 | 579 | 881 |
| Clupeidae | 0.088 | 826 | 930 | 1419 | 247 | 278 | 423 |
| Mackerel/scad | 0.022 | 207 | 232 | 355 | 62 | 70 | 106 |
| Other fish | 0.126 | 1183 | 1331 | 2032 | 354 | 398 | 606 |
| Crustacea | 0.174 | 1634 | 1838 | 2806 | 489 | 550 | 838 |
| *Loligo forbesi* | 0.049 | 460 | 518 | 790 | 138 | 155 | 236 |
| Other ceph. | 0.020 | 188 | 211 | 323 | 56 | 63 | 96 |
| Total | 1.000 | 9389 | 10563 | 16130 | 2812 | 3161 | 4817 |

Table 9.2. Estimated annual cephalopod consumption for seals and porpoises.

| | Harbour seal | | Grey seal | | Harbour porpoise |
|---|---|---|---|---|---|
| | UK 1991 | Scotland 1991 | UK 1991 | Scotland 1991 | North Sea 1994 |
| Population size | 24 640 (1) | 23 089 (1) | 93 500 (1) | 85 400 (1) | 352 500 (5) |
| Daily energy intake (kcal) | 4 680 (2) | | 5 530 (4) | | 4 000 (6), (7) |
| Daily food intake (kg) | 5.6 (2) | | 6.6 (4) | | 4.8 (6), (7) |
| %Diet = Cephalopod | 1.7 (3) | | 9.4 (3) | | 3.8 (3), (8) |
| %Diet = *Loligo* | 0.06 (3) | | 0.25 (3) | | 1.98 (3), (8) |
| Annual population Cephalopod consumption (tonnes) | 874 | 819 | 21 211 | 19 373 | 23 680 |
| Annual population *Loligo* consumption (tonnes) | 32 | 30 | 552 | 504 | 12 229 |

Sources: (1) Hiby *et al.* (1993); (2) Härkönen & Heide-Jørgensen (1991); (3) G.J. Pierce *et al.* unpublished data; (4) Fedak & Hiby (1985); (5) Hammond *et al.* (1995); (6) Worthy *et al.* (1987); (7) Leatherwood *et al.* (1983); (8) Santos *et al.* (1994).

*sopterus* spp. (1058–1146) are higher than values for most Gadidae and flatfish (700–800) (Murray & Burt 1969, Prime & Hammond 1987). Hislop *et al.* (1991a) show that there are very large seasonal and size-related changes in calorific density. Thus small sprat may on average be no more energy rich than cod or whiting. We make the simplifying assumption that fish and cephalopods are on average of equal calorific value.

Diet was quantified by analysis of harbour seal faeces (N = 658), grey seal faeces (N = 495) and porpoise stomachs (N = 108). Weights of fish and cephalopods eaten were calculated from measurements on otoliths and beaks (Pierce *et al.* 1991a,b, unpublished data, Santos *et al.* 1994).

## RESULTS AND DISCUSSION

### Predation by *Loligo forbesi*

Maximum population size for *Loligo forbesi* in Scottish waters during the study period is estimated to have ranged between 4 million (for m = 0) and 7.5 million (for m = 0.16). Depending on m, the population would have eaten between 9000 and 16 000 tonnes of food in 1990/91 and 3000 to 5000 tonnes in 1991/92 (Table 9.1). In 1990/91, the food eaten included 1700–3000 tonnes of sandeels (Ammodytidae), 1600–2700 tonnes of *Trisopterus* spp. and 1000–1700 tonnes of whiting *Merlangius merlangus*. This excludes any estimate of consumption by pre-recruit and paralarval squid. Empirical estimates of natural mortality, on a seasonal or monthly basis, are needed to provide meaningful confidence limits for the size of the squid population. Scottish squid landings vary widely from year to year, possibly reflecting cyclic variations in population size (Pierce *et al.* 1994c). From a low of 88 tonnes in 1979, annual landings rose to approximately 1900 tonnes in 1989. Landings in 1990, 1991 and 1992 were relatively large (approximately 1400, 900 and 1100 tonnes, respectively) and estimated consumption by squid in these years would therefore be towards the upper end of the natural range of values. To put the amount of food eaten by squid in Scottish waters in perspective, predators in the North Sea are estimated to have eaten approximately 2.2 million tonnes of fish and 6.1 million tonnes of other food during 1991 (Anon. 1994), and these figures may even be underestimates (Greenstreet, in press).

### Predation by seals and propoises on *Loligo forbesi*

Seals ate very little *Loligo forbesi* (Table 9.2); in fact only single specimens were found in faeces of both species. Most of the cephalopods eaten by grey seals were octopus *Eledone cirrhosa*. Porpoises probably have a more significant impact on *Loligo forbesi*, although population estimates are for the North Sea rather than for Scotland (Table 9.2). Mortality of *Loligo forbesi* due to marine mammals appears to be of at least a similar order of magnitude to fishing mortality (see Pierce *et al.* 1994c) and probably rather higher, implying that the higher values for natural mortality in the preceding squid model are more realistic.

### Predation by other predators on cephalopods

As the selective list of predators in Table 9.3 makes clear, there is a long way to go before natural mortality of *Loligo forbesi* can be fully quantified. Large-scale

Table 9.3. Marine predators of cephalopods in the north-east Atlantic.

| Area | Predator | % of diet = cephalopods[a] | Species eaten[b]; other comments | Sources |
|---|---|---|---|---|
| North Sea | Cod *Gadus morhua* | 0–11 | Not stated but includes A | Daan (1981), Anon. (1994), J.R.G. Hislop, personal communication |
| | Haddock *Melanogrammus aeglefinus* | 0–11 | | |
| | Whiting *Merlangius merlangus* | 0–14 | Cephalopods mainly eaten in 1st quarter of year | |
| | Saithe *Pollachius virens* | 0–30 | | |
| | Mackerel *Scomber scombrus* | 0–80 | | |
| | Grey gurnard *Eutrigla gurnardus* | 0–11 | | |
| | Ray *Raja radiata* | 0–1 | | |
| NE Atlantic | Swordfish *Xiphias gladius* | (4) | H, T, ocs | Guerra *et al.* (1993) |
| Scotland | Puffin *Fratercula artica* | (1) | A | Harris & Hislop (1978) |
| Skomer (Wales) | Guillemot *Uria aalge* | (1) | Squid | Hatchwell (1990) |
| Rum | Manx shearwater *Puffinus puffinus* | 40 | Omm, ocs | Furness (1994) |
| Foula, St Kilda | Northern fulmar *Fulmarus galcialis* | 1 | Omm | Furness (1994) |
| | Leach's stormpetrel *Oceanodroma leucorhoa* | (1) | Omm | |
| | British stormpetrel *Hydrobates pelagicus* | (1) | Omm | |
| Foula | Great skua *Catharcta skua* | 0.1 | L | Furness (1994) |
| | Various other seabirds | Absent | | |
| UK waters | Harbour seal *Phoca vitulina* | (1)–(2) | E, L, S | Steven (1934), Sergeant (1951), Rae (1968), Pierce *et al.* (1991b), Thompson *et al.* (1993) |
| | Grey seal *Halichoerus grypus* | (1) | E, L, R, T | Rae (1968), SMRU (1984), Pierce *et al.* (1991a) |
| UK and other NE Atlantic waters, Mediterranean | Fin whale *Balaenoptera physalus* | (1) | | Rae (1965), Rae (1973), Clarke & MacLeod (1974), Clarke & Kristensen (1980), Leatherwood *et al.* (1983), Clarke & Pascoe (1985), Clarke (1986), Martin & Clarke (1986), Corbet & Harris (1991), Bello (1992), Würtz *et al.* (1992), Clarke *et al.* (1993), Haug *et al.* (1993), González *et al.* (1994a); Santos *et al.* (1994) |
| | Sei whale *Balaenoptera borealis* | (2) | | |
| | Minke whale *Balaenoptera acutorostrata* | (1)–(2) | | |
| | Sperm whale *Physeter macrocephalus* | (4) | B, G, H, T, ocs | |
| | Pygmy sperm whale *Kogia breviceps* | (4) | E, H, L, Sl, ocs | |
| | White whale *Delpinapterus leucas* | (4) | | |
| | Narwhal *Monodon monocerus* | (2) | | |
| | Northern bottlenose whale *Hyperoodon ampullatus* | (4) | G, H, L, S, T, ocs | |
| | Cuvier's beaked whale *Ziphius cavirostris* | (3) | B, H, ocs | |
| | Sowerby's beaked whale *Mesoplodon bidens* | (3) | Omm? | |
| | True's beaked whale *Mesoplodon mirus* | (4) | | |
| | Harbour porpoise *Phocoena phocoena* | (1) | L | |
| | Common dolphin *Delphinus delphis* | (2) | A, L, Sa | |
| | Striped dolphin *Stenella coeruleoalba* | (2) | A, G, H, I, L, Sl, T | |
| | Bottle-nosed dolphin *Tursiops truncatus* | (1) | L, S | |
| | Atlantic white-sided dolphin *Lagenorhynchus acutus* | (2) | L | |
| | White-beaked dolphin *Lagenorhynchus albirostris* | (2) | L | |
| | Melon-headed whale *Peponocephala electra* | (2)–(3) | | |
| | False killer whale *Pseudorca crassidens* | (1) | | |
| | Killer whale *Orcinus orca* | (1) | I, L, S, T | |
| | Long-finned pilot whale *Globicephala melaena* | (3) | B, E, G, H, L, O, Sl, S, T | |
| | Risso's dolphin *Grampus griseus* | (4) | E, G, H, L, R, S, St, T, Te | |

[a] Where no data on %weight were available, importance of cephalopods in the diet is expressed as: (1) some, (2) considerable, (3) large proportion, (4) main food (after Clarke, 1986).

[b] Key to cephalopods: A, *Alloteuthis*; B, *Brachioteuthis*; E, *Eledone*; G, *Gonatus*; H, *Histioteuthis*; L, *Loligo* (*L. forbesi* + *L. vulgaris*); I, *Illex*; O, *Ommastrephes*; Omm, Ommastrephidae; ocs, oceanic squids; R, *Rossia*; S, *Sepia*; Sl, *Sepiola*; St, *Sepietta*; T, *Todarodes*; Te, *Todaropsis*.

studies on fish diets in the North Sea (Daan 1981, Anon. 1994) showed that cephalopods are seasonally important prey of some commercial fish. The squid *Alloteuthis subulata* was the principal cephalopod prey at least in the case of whiting (Hislop *et al.* 1991b). For younger fish, any *Loligo forbesi* eaten would probably be pre-recruits. Although squid are among the main prey of the swordfish *Xiphias gladius*, it takes oceanic species rather than the (neritic) loliginids (Guerra *et al.* 1993). Furness (1994) estimated that seabirds may remove 100 000 tonnes of squid annually from the north-east Atlantic, but most squid eaten are probably ommastrephids rather than *Loligo*. Also, the smaller loliginid *Alloteuthis subulata* is a more likely prey for most seabirds than adult *Loligo forbesi*, which may reach weights of more than 1 kg (Pierce *et al.* 1994a).

Many cetaceans of north-east Atlantic waters eat *Loligo* spp. (Clarke, 1986, Corbet & Harris 1991) and some, e.g. Risso's dolphin and sperm whales, are specialist feeders on cephalopods. Some of the other cephalopods eaten are also fished commercially in Europe, e.g. the cuttlefish *Sepia officinalis* and the ommastrephid squids *Todaropsis eblanae* and *Illex coindetii* (Pierce *et al.* 1994c, González *et al.* 1994a,b).

Quantitative information on consumption by a wider array of predators is needed to provide realistic estimates of natural mortality in *Loligo forbesi*.

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