ANGLERFISH (*LOPHIUS* SPP.) IN NORDIC AND EUROPEAN WATERS

Status of current knowledge and ongoing research

Trond Thangstad[1], Jan Erik Dyb[1], Einar Jónsson[2], Chevonne Laurenson[3],
Lise Helen Ofstad[4] & Stuart A. Reeves[5]

[1] Institute of Marine Research, Bergen, Norway
[2] Marine Research Institute, Reykjavík, Iceland
[3] North Atlantic Fisheries College, Scalloway, Shetland
[4] Faroese Fisheries Laboratory, Tórshavn, Faroe Islands
[5] Danish Institute for Fisheries Research, Charlottenlund, Denmark

INSTITUTE OF MARINE RESEARCH
Nordnesgaten 50 – P.O. Box 1870 Nordnes
N-5817 Bergen – Norway

Contents

Preface

This report was prepared as a pilot study for a proposed three-year research project called "Anglerfish (*Lophius* spp) in Nordic waters", aiming to coordinate a synoptic collection and analysis of anglerfish data in large parts of its Nordic area of distribution. The initial project phase was in 2002 financed through a grant from the Nordic Working Group on Fisheries Research (NAF).

Background for the project was the dramatic increase in directed fisheries aimed at anglerfish in Nordic and European waters during the last decade. At present, Nordic anglerfish stocks are managed mainly through gear regulations. The fishery thus needs to be limited, for instance through *total allowable catch* quotas (TACs), but necessary stock assessment is difficult to achieve because of the lack of fisheries and biological data on anglerfish in these waters.

The present report attempts to describe the status with regard to research and knowledge about anglerfish in the participating Nordic countries, as well as in other European regions. A meeting was held May 23-25 2002 in Tórshavn, Faroe Islands, with the participation from scientists from Norway, Iceland, the Faroes and Shetland, where project status and progress on the report were discussed. Proposed research topics and recommendations for a revised project application are given herein. Some results from initial analyses of recently collected gonad and genetic material are also presented.

The authors would like to thank NAF for providing financial support for the initial project. Many thanks go to Kjell H. Nedreaas for organisation and supervision of the project and for helpful suggestions and comments on the manuscript. We would also like to thank Merete Fonn and Olav Sigurd Kjesbu for preliminary analysis and presentation of gonad histology, Knut Jørstad for screening of DNA sequences from genetic samples, and finally Hjalti í Jakopstovu and colleagues at the Faroese Fisheries Laboratory in Tórshavn for their hospitality.

Summary

The demand for anglerfish (also monkfish, *Lophius* spp) for human consumption has increased in the last couple of decades because of the delicate consistency of its meat. In Nordic waters anglerfish are mainly caught by large-meshed gillnets. The fisheries are chiefly regulated through restrictions on gear use. So far relatively little is known about anglerfish biology and ecology. Two quite similar species (*Lophius piscatorius* and *L. budegassa*) are commonly distributed along the European continental shelf. *L. piscatorius* is a regular predator in near-coastal Nordic waters, where it preys upon a wide variety of prey types. It reaches maturity from an age of 4-6 years. At this time it weighs over 3 kg and is about half a metre long. Anglerfish can reach a length of up to 2 m when fully grown, but are usually much smaller. It is assumed that they spawn in deeper water, but this has never been directly observed. The spawning behaviour is special in that the eggs are released in long veils (up to 10 m) and hatch in open water. Eggs and larvae drift with ocean currents and the juveniles eventually settle on the seabed when they reach about 5 cm in length.

Answers to questions regarding the spawning behaviour, migratory behaviour and juvenile drift, as well as more knowledge about growth, sexual maturation, diet and natural mortality, will form crucial contributions to present and future management of Nordic anglerfish stocks. This report presents the status of knowledge and research on the biology, ecology, fisheries and stock management of anglerfish in the Nordic countries, as well as in other parts of Europe.

Sammendrag

Etterspørselen etter breiflabb (*Lophius* spp) for konsum har økt betraktelig de siste tiårene på grunn av kjøttets delikate konsistens. Fisket i nordiske farvann foregår hovedsakelig med stormaskede garn og er stort sett regulert gjennom restriksjoner i bruk av redskap. Foreløpig er relativt lite kjent omkring breiflabbens biologi og økologi. To arter som er ganske like i utseende (*Lophius piscatorius* og *L. budegassa*) er utbredt langs den europeiske kontinentalsokkelen. *L. piscatorius* er en vanlig predator i kystnære farvann hvor den beiter på et variert utvalg av byttedyr. Den blir kjønnsmoden ved en alder på ca 4-6 år. Da veier den over 3 kg og er bortimot en halv meter lang i nordiske farvann. Breiflabb kan bli over 2 m lang når den er fullt utvokst, men er vanligvis mye mindre. Den antas å gyte i dypere farvann, men dette er aldri blitt direkte observert. Gyteatferden er spesiell i og med at eggene gytes i lange rognband (opptil 10 m) og klekkes i det åpne hav. Egg og larver driver med havstrømmene og breiflabben bunnslår seg etter hvert ved en lengde på ca. 5 cm.

Besvarelse av spørsmål vedrørende gyteatferd, vandring og juvenil drift, samt mer viten omkring vekst, kjønnsmodning, diett og naturlig dødelighet, vil gi avgjørende bidrag til nåværende og fremtidig forvaltning av nordiske bestander av breiflabb. Denne rapporten inneholder status for viten og forskning omkring biologi, økologi, fiskerier og bestandsforvaltning av breiflabb i Norden og Europa for øvrig.

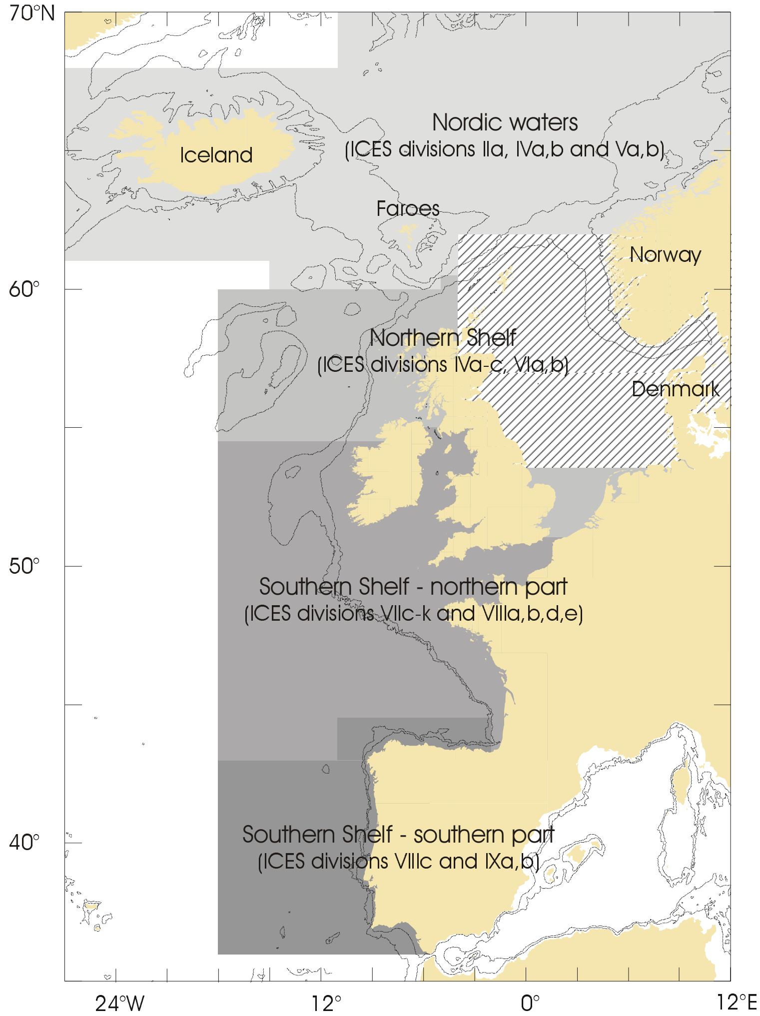

Figure 1.1 Overview of European commercial fishing areas for anglerfish. *Nordic waters* are defined for the purposes of this report. The *Northern* and *Southern Shelf* are areas for which the ICES carries out annual anglerfish stock assessments.

1 Introduction

1.1 Background and objective

During the last decade trawl and gillnet fisheries targeted on anglerfish (*Lophius* spp.) in Nordic waters (Figure 1.1) have increased considerably in catch and effort. Because of a general lack of fisheries and biological data concerning anglerfish in these waters, an appropriate stock assessment is as yet difficult to achieve. Only Iceland has so far set a precautionary TAC[1]. For the other countries in the region[2] the only regulations are gear specific, relating to e.g. minimum gillnet mesh size, number of nets allowed per boat/setting, and maximum soak time of the nets.

With these limitations in mind fisheries scientists at the Marine Research Institutes in Denmark, the Faroes, Iceland, Norway and Shetland have now undertaken efforts to co-ordinate a synoptic collection and analysis of anglerfish data in large parts of its Nordic area of distribution. Research areas of particular interest in the proposed project are:

- Mark and recapture of individuals to investigate distribution areas and possible migration patterns
- Collection of biological data in order to describe sexual maturation in anglerfish, localise spawning areas and determine the time of spawning
- Investigation of the age and length at first-time sexual maturation, in order to determine an optimal minimum fish size in commercial catches
- Genetic analysis of biological samples with the aim of describing stock and population structure of anglerfish
- Further research with regard to time of hatching, growth, and duration of the pelagic phase, as well as describing length and age structure of anglerfish in the distribution area, e.g. to define its nursery grounds

The objective of the present report is primarily to review and summarise existing data and knowledge concerning the biology and ecology of European anglerfish, especially with regard to future assessment of the size and distribution of the fishable stock(s) in Nordic waters. Emphasis is placed on more recent studies (from 1990 and onwards) relating to *Lophius piscatorius* and *L. budegassa*, which are the only occurring species in the Northeast Atlantic. Both are commercially exploited. The report is based on literature searches in the ASFA and ISI science citation databases, as well as on Internet searches and on information obtained from persons within the fisheries science community.

1.2 Recent research on anglerfish in Nordic waters

This section briefly outlines past and ongoing research efforts on anglerfish in the participating Nordic countries. Results pertinent to the biology, ecology and management

[1] Total Allowable Catch, 1 500 t based on previous years' catches, in effect from September 2001 until August 2002.
[2] Denmark, Faroe Islands, Norway, and the UK represented by Shetland

of anglerfish are discussed in later sections and compared with findings from other European countries.

Denmark

There has been little directed research on anglerfish in Danish waters. However, length compositions of landings and discards have been measured during observer trips since 1995, and market sampling of landed fish commenced in 2002.

Faroes

Research at the Faroese Fisheries Laboratory in Tórshavn has thus far focused on biological sampling of commercial trawl and gillnet landings. Data on length, weight (round, gutted, gonad, and liver), sex and maturation were collected, as well as otoliths and illicia (first dorsal fin ray) for ageing purposes. In addition a number of stomach samples were collected and analysed. Anglerfish samples were taken every fourth week from November 2001 to March 2002 from a trawler fishing on Skeivabanka southwest of the Faroe Islands (n = 312 samples) (Figure 1.2). 250 samples were taken in late August 2001 onboard a gillnetter, and 48 samples were collected from landings in the

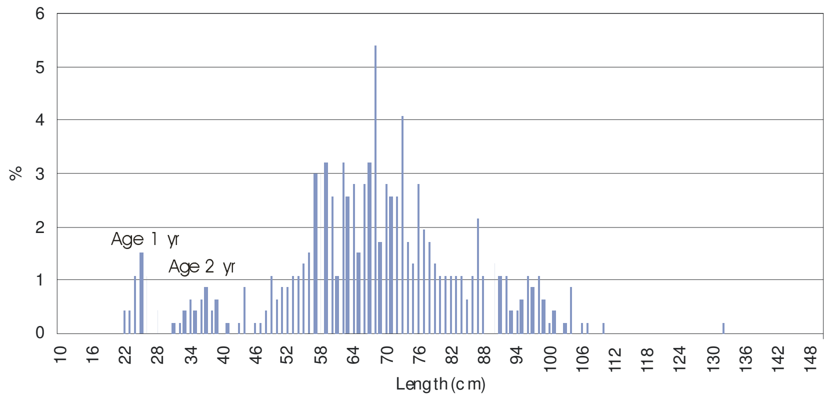

Figure 1.2 Length distribution of anglerfish (n = 470) from commercial trawl samples taken at 300-380 m depth on Skeivabanka off the Faroes, September 2001 – March 2002.

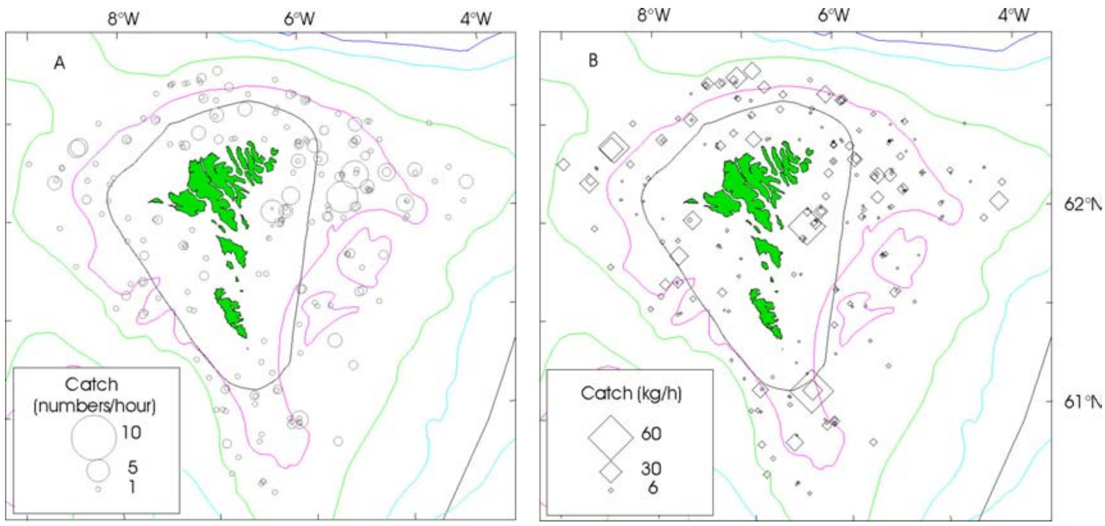

Figure 1.3 Distribution of anglerfish on the Faroe Plateau: (A) catch in numbers per hour and (B) catch in kg per hour during autumn bottom trawl surveys (1996-2001).

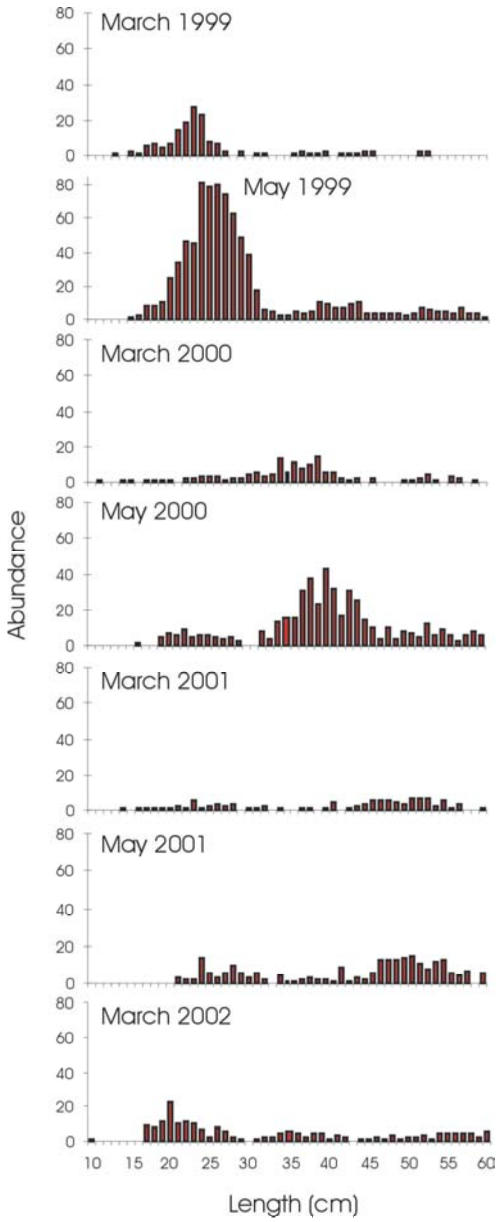

Figure 1.4 Length distribution of *L. piscatorius* in bottom trawl and *Nephrops* surveys in Icelandic waters March and May 1999-2002, respectively. A strong year class, probably hatched in 1997, can be followed during this period.

Faroes in June 2002. During a 10-day pilot anglerfish survey in February 2002 in near-Faroese waters 540 anglerfish were sampled. Some anglerfish have also been registered during regular bottom trawl surveys (Figure 1.3) (see section 3.4).

Iceland

Until 1999 anglerfish were only landed as bycatch in Iceland, and research at the Marine Research Institute (MRI) in Reykjavik was limited to length measurements from areas where anglerfish were found during annual bottom trawl surveys around Iceland and during *Nephrops* surveys off the south coast (Figure 1.4). However, since the same trawl gear has been used since 1985, these data provide valuable information on the dynamics of anglerfish stocks in Icelandic waters. After the initiation of a directed fishery

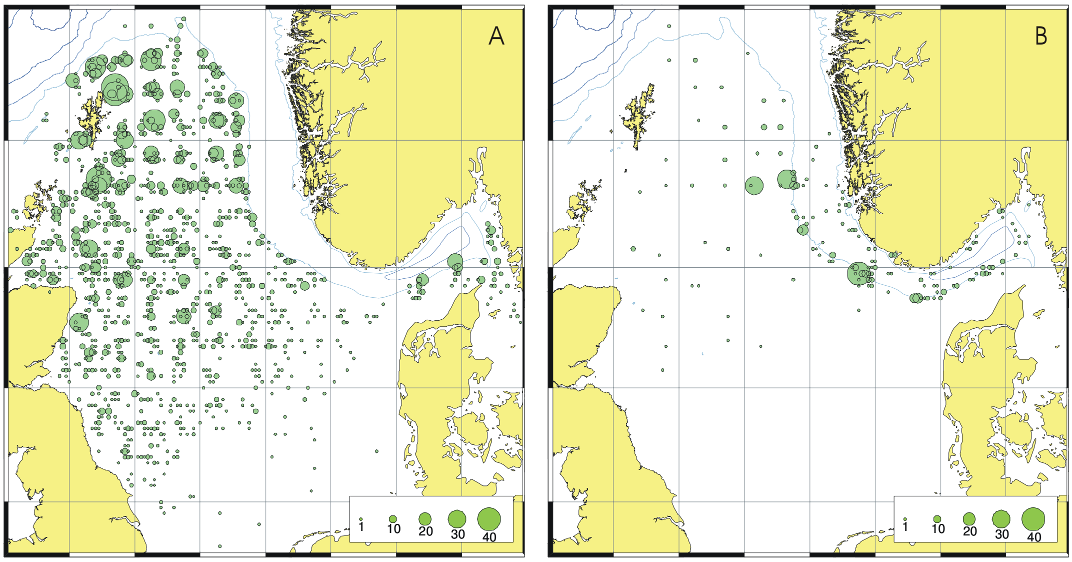

Figure 1.4 Distribution of anglerfish catches: (A) International Bottom Trawl Survey (IBTS) 1980-2000; (B) Norwegian Institute of Marine Research (IMR) 1989-2000. Circles represent total abundance within quadrants of 0.1*0.1°. (Adapted from Dyb 2002)

with gillnets and special *Nephrops* trawls in 1999, research efforts have intensified. Data on individual length and weight (round and gutted), sex, gonad weight, and maturation were collected with increased effort in 2000 (n = 1 624) and 2001 (n = 2 924). Liver samples are planned taken in the near future. Illicia have also been collected and efforts at age reading from these have been undertaken. This research is expected to be fruitful for future stock management.

Norway

As a result of increased fishing pressure on Norwegian anglerfish, cooperative investigations by the Institute of Marine Research in Bergen and the Møre Research Foundation in Ålesund (Woll *et al.* 1995b) were started in 1992 in order to aid in stock assessment and regulations. A survey of the biology of Norwegian anglerfish was presented in a *cand.scient*. thesis at the University of Bergen (Staalesen 1995), in which age determination and validation, length-weight relationship, growth, maturity stages and yield-per-recruit of anglerfish sampled monthly between November 1992 and October 1994 (n=1796) from commercial gillnet landings on the Norwegian west coast were considered. Another *cand.scient*. thesis is at present being concluded (Dyb 2002), dealing with the analysis of the size distribution of North Sea anglerfish, among others to investigate possible anglerfish migration. This thesis is based on data from the International Bottom Trawl Survey (IBTS) (Figure 1.4a, 1.5) and the Norwegian shrimp and *Nephrops* surveys (Figure 1.4b). Other information on Norwegian anglerfish includes catch data from commercial gillnetting and from demersal fish, shrimp and *Nephrops* surveys in the North Sea, as well as sporadic samples of bycatch from the trawl and Danish seine fisheries.

Shetland

At the North Atlantic Fisheries College (NAFC) in Shetland anglerfish data have been collected since late 1997. This started with market sampling of landed fish, however the main sources of data have been through observer trips onboard commercial vessels and through gear selectivity trials using chartered trawlers. Fish have been aged using otoliths, sex and maturation have been determined macroscopically, and a diet study has been completed. In addition a tagging programme was undertaken during 2001. A paper based on some of the data collected and describing aspects of the life history of the species (Laurenson *et al.* 2001) was presented at the ICES conference in 2001.

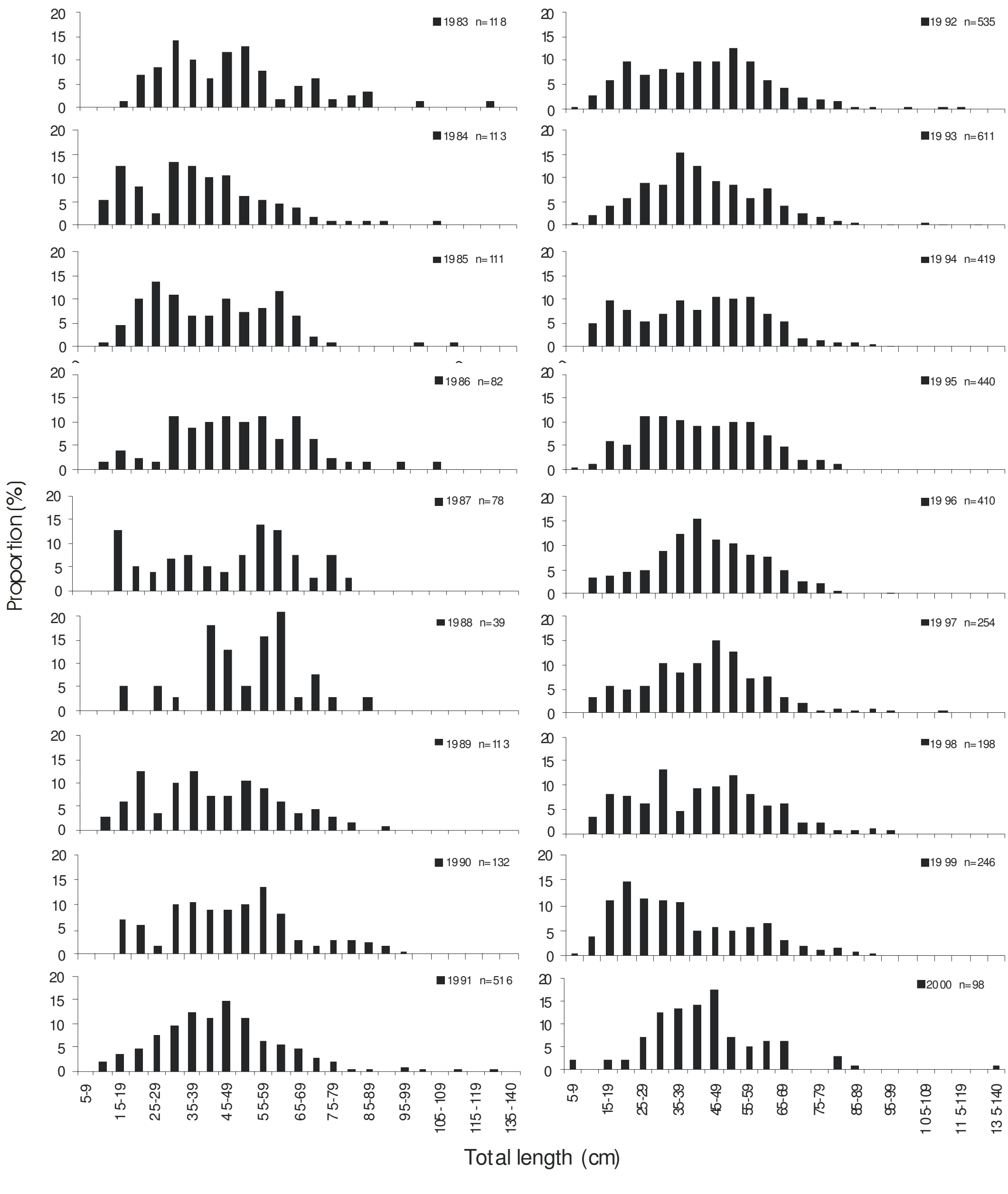

Figure 1.5 Length distribution (5 cm length intervals) of anglerfish in IBTS samples 1983-2000 (From Dyb 2002).

2 Biology and ecology of anglerfish

Anglerfish[3] (Teleostei: Lophiidae) belong to a family of bathydemersal, dorsoventrally depressed fishes (Caruso 1986). Two European anglerfish species of the genus *Lophius* are distributed in the Northeast Atlantic: white (or white-bellied) anglerfish (*L. piscatorius* L.) and black (or black-bellied) anglerfish (*L. budegassa* Spinola). The two species are very similar, the main distinguishing feature being the darker colouration of the mouth and peritoneum (body wall) of *L. budegassa* (Figure 2.1). The latter is also somewhat smaller than *L. piscatorius.*

Figure 2.1 The main difference between *Lophius piscatorius* (above) and *L. budegassa* (below) is easily seen, but only when the fish are gutted to reveal their white and black "bellies", respectively.

2.1 Occurrence and distribution

General distribution

Both anglerfish species occur on muddy to gravelly, occasionally rocky bottoms along the European continental shelf. *L. piscatorius* is distributed from Gibraltar to the south-eastern Barents Sea, and around the Faroes and at Iceland. *L. budegassa* appears to be more prevalent in warmer water, occurring mostly in the southernmost parts of this range, from the North Sea to south of Gibraltar, and including the Mediterranean Sea (Caruso 1983).

In Norwegian (Nedreaas, pers. comm.) and Faroese waters (Ofstad, pers. obs.) only 1 to 2 specimens out of about 1 000 landed anglerfish proved on closer inspection to be *L. budegassa*. Around Shetland and west of Scotland this species appears to be somewhat

[3]

English	*Danish*	*Faroese*	*Icelandic*	*Norwegian*	*French*
anglerfish	bredflab	havtaska	skötuselsur	breiflabb	baudroie
monkfish	havtaske			havtaske	lotte
goosefish				marulk	

more common, with a frequency of occurrence ranging from 1 to 3 out of about 100 landed anglerfish (Laurenson, pers. obs.)

Depth distribution

In the general literature (e.g. Caruso 1986) anglerfish are said to occur eurybathically to depths of about 1 000 m. In pelagic trawl surveys conducted in the North Sea north of 56°, the Atlantic coast of the British Isles, the Norwegian Sea and the south-western Barents Sea large *L. piscatorius* specimens >40 cm were found from 90 to 2 600 m, whereas smaller individuals were captured in shallower water (53-316 m) (Hislop *et al.* 2000). Most of the fish were caught in the northern North Sea. Around the Shetland Isles Laurenson *et al*. (2001) likewise found a trend of increasing *L. piscatorius* size with depth. On the banks west of Portugal *L. piscatorius* was found to be one of the most important deep water community species at 650-1 200 m depth (Piñeiro *et al.* 2001). However, depth appeared to have no statistically significant effect on the abundance of *L. piscatorius* and *L. budegassa* in trawl samples from the coastal regions north of Spain and Portugal (ICES Division VIIIc). Similar numbers of anglerfish were here observed from the continental shelf at 30 m depth to the shelf edge at 500 m depth (Azevedo & Pereda 1994). In Division IXa west of Portugal *L. budegassa* showed differential depth distribution patterns (Azevedo 1995), which are suggested to be related to differences in substratum, bathymetry and/or behaviour. During Icelandic trawl surveys very few anglerfish were recorded below 500 m, probably because of low temperature (Jónsson, unpubl. data).

Migratory behaviour

Horizontal displacement

Displacement over some distance horizontally is observed in anglerfish, and is suggested to be related to spawning. Spanish scientists have since 1995 tagged and released some 400 individuals of both *L. piscatorius* (Landa *et al.* 2001c) and *L. budegassa* (Landa *et al.* 2001b) in the Celtic Sea, Bay of Biscay and west of Portugal (ICES Divisions VIj,k, VIIIb and IXa). Conventional external spaghetti T-bar type tags were inserted in the dorsal area of the fish as shown in Figure 2.2. A dose of oxytetracyclin, which forms deposits visible under UV light in the hard parts of the fish, was also injected (50 mg/kg) anteriorly of the anal opening. The preliminary recovery index is considered good at an overall rate of 3.4-5 %. Highest displacement was observed after 15 months in the sea at about 300 km in a straight line from the release site (estimated overall mean *c.* 600 m day^{-1}). The migration routes taken by many adult fish, from deeper to shallower areas during the first quarters of the year, coincide with temporal variability in commercial catches in the same areas. It is suggested that they follow the same route back during the following months, a displacement pattern which would fit a general spawning migration.

Tag retention and mortality were investigated using the Marine Hatchery facilities at NAFC in Shetland during 2000 and following favourable results (60 % tank survival) a tag release programme was conducted on 22 inshore grounds around the Shetland Isles during the summer of 2001. Fish were trawl caught using short duration tows (<1hour) in shallow waters (<100m). 1650 fish were tagged and released with conventional dart tags (type small plastic tipped dart PDS/PDT, Hallprint[4] tags; see Figure 2.2), and to the

[4] 27 Jacobson Crescent, Holden Hill, Australia 5088

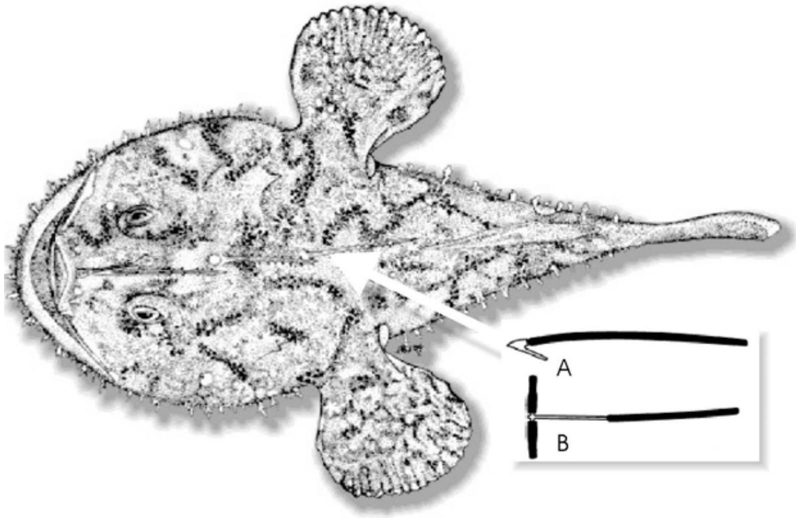

Figure 2.2 Tag placement on dorsal area of anglerfish, shown here with harpoon/dart-style tag (A) used in Laurenson *et al.* (2001) and T-type tag (B) used in Landa *et al.* (2001b, 2001c). (Anglerfish drawing taken from Bauchot (1987))

end May 2002 a total of 45 tags had been returned (2.5%). Recapture positions indicated a move offshore, mainly northwards and westwards, since the summer release (Laurenson, unpubl. data).

Experience at marine laboratories in Norway and Scotland from capture and handling of fish prior to tagging has shown anglerfish to be particularly vulnerable to skin abrasions (Holm *et al.* 1999). Danish seine captured fish survived longer than trawl-caught fish, while only diver-caught fish seemed to survive for any period of time. Landa *et al.* (2001b), however, concluded that manipulation during the catch did not have a drastic effect on survival. Anglerfish do not have a gas bladder and thus seem resilient to being brought to the surface from large depths. Use of specimens obtained by gillnetting and by commercial trawling of long duration is nevertheless not recommended due to the deteriorated condition of these individuals.

Holm *et al.* (1999) and Holst & McDonald (2000) present an alternative trawling method for capturing viable specimens of delicate species, using a towed metal cage connected to the trawl cod-end, into which the fish are lifted through a net funnel. In principle the fish then remain in low turbulence until removal after hauling, resulting in less skin damage and/or scale loss, and consequently a higher survival rate.

Vertical displacement

Although anglerfish are mainly bottom dwellers, Hislop *et al.* (2000) caught 34 well-grown individuals (length range 24-103 cm) close to the surface at widely scattered locations in the North-east Atlantic, some over considerable depths (to 2 600 m). The authors concluded that even though the body form of the anglerfish and its high percentage liver weight would give it enough hydrodynamic lift to make vertical migrations from the bottom possible, these individuals must have drifted or strayed from their normal habitat. Single *Lophius* specimens have also been caught on Japanese tuna longlines in the mid Atlantic, as well as in herring drift nets off Scotland and Shetland (Hjalti í Jakopstovu, pers. comm.).

Morphological and genetic variation

The authors are not aware of any available studies on meristic, morphometric or genetic variation specifically with regard to geography in anglerfish populations in Europe. Generally, in most species of *Lophius* and *Lophiomus* meristic variation appears to reflect temperature variability rather than molecular phylogeny. Patterns of morphometric variability on the other hand seem to reflect convergence in body shape between distantly-related species (Leslie & Grant 1994). Morphometric and gene-diversity analysis has been used to study the geographic stock structure of the southern African anglerfish *Lophius vomerinus*, which is regarded as a geographic isolate of *L. piscatorius*. It was found that populations of *L. vomerinus* differed with regard to morphology, but that only a minor fraction of the total genetic variation could be attributed to geographic differences (Leslie & Grant 1990). With regard to allozyme phylogeny, cladistic analysis has shown *L. piscatorius* and *L. litulon* (Japan) to be sister taxa, whereas a link found between *L. budegassa* and *L. vomerinus* is not as clear (Grant & Leslie 1993).

As part of the pilot project described herein, preliminary analysis on allozyme variation in *L. piscatorius* muscle samples was performed at the Institute of Marine Research in Bergen in 2002. Tests conducted on 12 individuals collected in Icelandic and Faroese waters showed no apparent genetic variation that can be used to distinguish between populations in these areas (Knut E. Jørstad, pers. comm.). Analysis of larger samples is needed. Pending methodological optimisation, further analysis is planned in 2003. DNA was extracted from a small number of ethanol-preserved muscle samples taken from the same areas as above, for purposes of micro-satellite DNA analysis. The quality of the isolated DNA was tested by agarose electrophoresis, and was found to be adequate. Further study depends on the availability of DNA primer sequences and optimisation of PCR (polymerase chain reaction) conditions. Several research facilities in Europe and elsewhere are currently conducting this type of analysis, and it is hoped that additional work can be done in 2003 in cooperation with these milieus.

2.2 Growth

Ageing methods and validation

Three calcified bone structures that show annual growth increments have been used for ageing purposes in anglerfish: the sagittal otoliths (ear bones), illicium (first dorsal fin ray) and the first to third vertebrae. Microstructures in the lapilli otoliths of anglerfish have been used for daily growth estimation and for validation of age estimates obtained from macrostructures.

Compared to e.g. codfish (Gadidae), anglerfish otoliths are small and the growth zones are often indistinct and difficult to discern from the hyaline (winter) zones (Woll *et al.* 1995a). Transverse sections of the illicium show ring (annulus) patterns where the different growth bands are often more easily counted (Figure 2.3). Under microscopy with transmitted light and under scanning electron microscopy (SEM) the surfaces of the growth rings show up as alternating light and dark areas and as high and low areas, respectively (Quincoces *et al.* 1999a,b). Staalesen (1995) found the illicium to be the most suitable structure for age determination of anglerfish caught in Norwegian waters, because of the low variation and high reproducibility of the readings. Illicium readings were also found to have a low average percent error in ageing of *Lophius vomerinus* in Namibian waters (Maartens *et al.* 1999). Several European conferences (Peronnet *et al.*

Figure 2.3 Examples of light microscopic images of sectioned illicia used for ageing of anglerfish caught in Norwegian waters. (Images courtesy of J. E. Dyb)

1992) and workshops (Dupouy 1997, Anon. 2000) have been held during the last decade with the aim of achieving a consensus on anglerfish ageing criteria. Illicium ageing methods developed at these workshops have been adopted in most growth studies pertaining to southern European anglerfish stocks (Duarte *et al.* 1994, Landa & Pereda 1997, Duarte *et al.* 1997, Landa *et al.* 1998, Quincoces *et al.* 1998a,b, Anon. 2001a, Landa *et al.* 2001a). In recent years Icelandic researchers have also undertaken efforts at age reading from illicia.

Growth studies from northern British waters have more routinely used otoliths, because otolith removal does not cause external damage to the fish and thereby does not affect its market value (Laurenson 1999, Hislop *et al.* 2001, Laurenson *et al.* 2001). Daily otolith increment analysis was found particularly useful in determining the duration of the pelagic phase (Hislop *et al.* 2001). Faroese researchers have collected both illicia and otoliths, and have made preliminary attempts at otolith reading.

Vertebral annuli have been used for age determination in *Lophius americanus* (Armstrong *et al.* 1992), and in *Lophius litulon* (Yoneda *et al.* 1997, Cha *et al.* 1998) and *Lophiomus setigerus* from the East China Sea (Yoneda *et al.* 1998a).

A demonstration of ageing methods on sectioned illicia given at the project meeting in Tórshavn highlighted several problems encountered: determining the first annulus; large differences in the width of the first annulus between different fish were also reported, as were the presence of false rings in some samples. These problems are also encountered in the reading of otoliths (Laurenson, pers. obs.). Wright *et al.* (2002) present a method to distinguish between false rings and annuli: whereas false rings are characterised by an abrupt check in otolith formation followed by increments similar in width to adjacent opaque material, annuli appear as a sequence of gradually declining increment widths. Figure 2.4 shows the percentage throughout the year of otoliths sampled off Shetland showing opaque marginal growth.

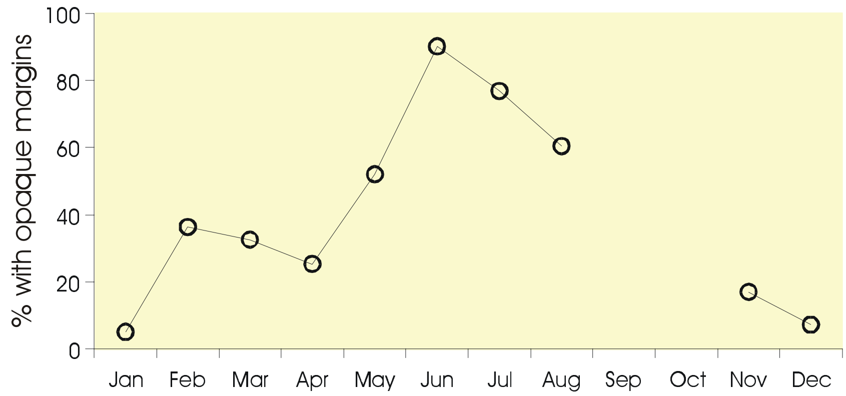

Figure 2.4 Percent of otoliths from anglerfish sampled in Shetland/Scotland showing opaque marginal growth. Data pooled across 1998-2000.

In mark-recapture studies Landa *et al*. (2001b,c) injected anglerfish with oxytetracyclin in an attempt to validate growth observed from illicium readings. Comparisons of growth rates do not yet appear to be conclusive, because of the small number of recaptured individuals that have been long enough in the sea to show significant growth. Oxytetracyclin was however observed deposited over half the width of a year zone in a *L. budegassa* specimen recovered after a little over half a year. Wright *et al*. (2002) used microincrements in the lapilli otoliths of *L. piscatorius* (Hislop *et al.* 2001) to verify age estimates of specimens <27 cm TL. These were found to be either 0- or 1-group, in contrast to estimates of small size at age by Dupouy *et al.* (1984) and Duarte *et al.* (1997).These differences may have been caused by earlier misinterpretation of the time of first formation of the translucent zone, which appears in autumn in the illicium of most 0-group individuals, but not in the sagittal otoliths. Validation of age estimates through length modes, as in the length distributions shown in Figures 1.3 and 1.6, is also often used.

Growth rates

Growth in anglerfish is described as fast, particularly during the first year (Hislop *et al.* 2001). Length-at-age analysis on *L. piscatorius* from Norwegian waters (Staalesen 1995) showed a growth rate until maturation of approximately 11.5 cm per year, and 8.4 cm per year afterwards. The relatively large variation in estimates of growth curve parameters (Table 2.1) may partly be ascribed to differences in growth rates between northern and southern areas, and partly to differences in sampling gear selectivity. Table 2.1 also shows the much smaller asymptotic maximum length for males compared to females of both species. Few males above 90 cm are found, the largest fish are therefore predominantly female.

Age and length at first maturity

L. piscatorius usually mature when they are 4-6 years old (Woll *et al.* 1995a). At this age they may be from about 40 cm up to 80 cm long in Norwegian waters, and weigh 3-6 kg. Males tend to mature at an earlier age and smaller size than females. Staalesen (1995) detected maturation as a distinct change in the appearance of the growth zones on all three growth structures between the third and the fifth year zone; this finding is to date however not validated.

Table 2.1 Some growth parameters of anglerfish. L_{inf}, k and t_0 are parameters of the von Bertalanffy growth curve equation.

Reference	No. of ind.	Age		Length (cm)		L_{inf}		k		t_0	
		Min	Max	Min	Max	Female	Male	Female	Male	Female	Male
<u>*L. piscatorius*</u>											
Staalesen (1995)		6	14			320	148	0.038	0.102	-0.342	-0.067
Landa & Pereda (1997)						132.05		0.1086		0.664	
Landa *et al.* (1998, 2001a)	844			14	140	140.5	110.5	0.08	0.11	0.09	0.23
Quincoces *et al.* (1998a)	1385	1	25			150	100	0.0882	0.1517	-0.2961	0.1051
Duarte *et al.* (2001a)	1297			11	129						
<u>*L. budegassa*</u>											
Landa *et al.* (1998, 2001a)	1049			5	93	110.1	72.9	0.08	0.13	0.39	0.36
Quincoces *et al.* (1998b)	2006	1	18	14.5	85.5	100	100	0.1113	0.1001	1.4772	1.1015
Duarte *et al.* (2001a)	1301			5	89						

For *L. piscatorius* around Shetland Laurenson *et al.* (2001) estimated the mean length at maturity ($L_{50\%}$) at 98 cm for females and 58 cm for males (Table 2.2, Figure 2.5a). Preliminary data indicate $L_{50\%}$ for anglerfish from the Norwegian west coast and the northern North Sea (Dyb, unpubl. data) (Figure 2.5b) and from Faroese waters (Ofstad, unpubl. data) (Figure 2.5c) to be 61 and 84 cm for females and 57 and 55 cm for males, respectively (Table 2.2). Similar, slightly lower estimates are given in Afonso-Dias & Hislop (1996), Duarte *et al.* (2001) and Quincoces *et al.* (1998a) (Table 2.2). The differences in $L_{50\%}$ estimates may be due to sample size or to variability resulting from the low proportion of mature fish in the samples. *L. budegassa* do not grow as large as *L. piscatorius*, and thus have a lower $L_{50\%}$ (Table 2.2). The maturity stages assigned macroscopically by Laurenson *et al.* (2001) were determined using the scale given by Afonso-Dias (1997) (Appendix 1). The scale used by Duarte *et al.* (2001) is essentially the same. The $L_{50\%}$ given by all three authors are determined on the basis that Stages I

Table 2.2 Some estimates of anglerfish length (l_{50}) and age (a_{50}) at first maturity.

Reference	Length (cm) at first maturity		Age (yr) at first maturity	
	Female	Male	Female	Male
<u>*L. piscatorius*</u>				
Afonso Dias & Hislop (1996)	73.5	48.9		
Duarte *et al.* (2001)	93.9	50.3	14	6
Dyb (Dyb 2002)	61	57		
Laurenson *et al.* (2001)	98	58		
Ofstad (unpubl.)	84	55		
Quincoces *et al.* (1998a)	73.2	52.7		
<u>*L. budegassa*</u>				
Azevedo (1996a)	56	37.6		
Duarte *et al.* (2001)	54.8	38.6	9	7
Quincoces *et al.* (1998a)	64.5	34.5	10.4	6

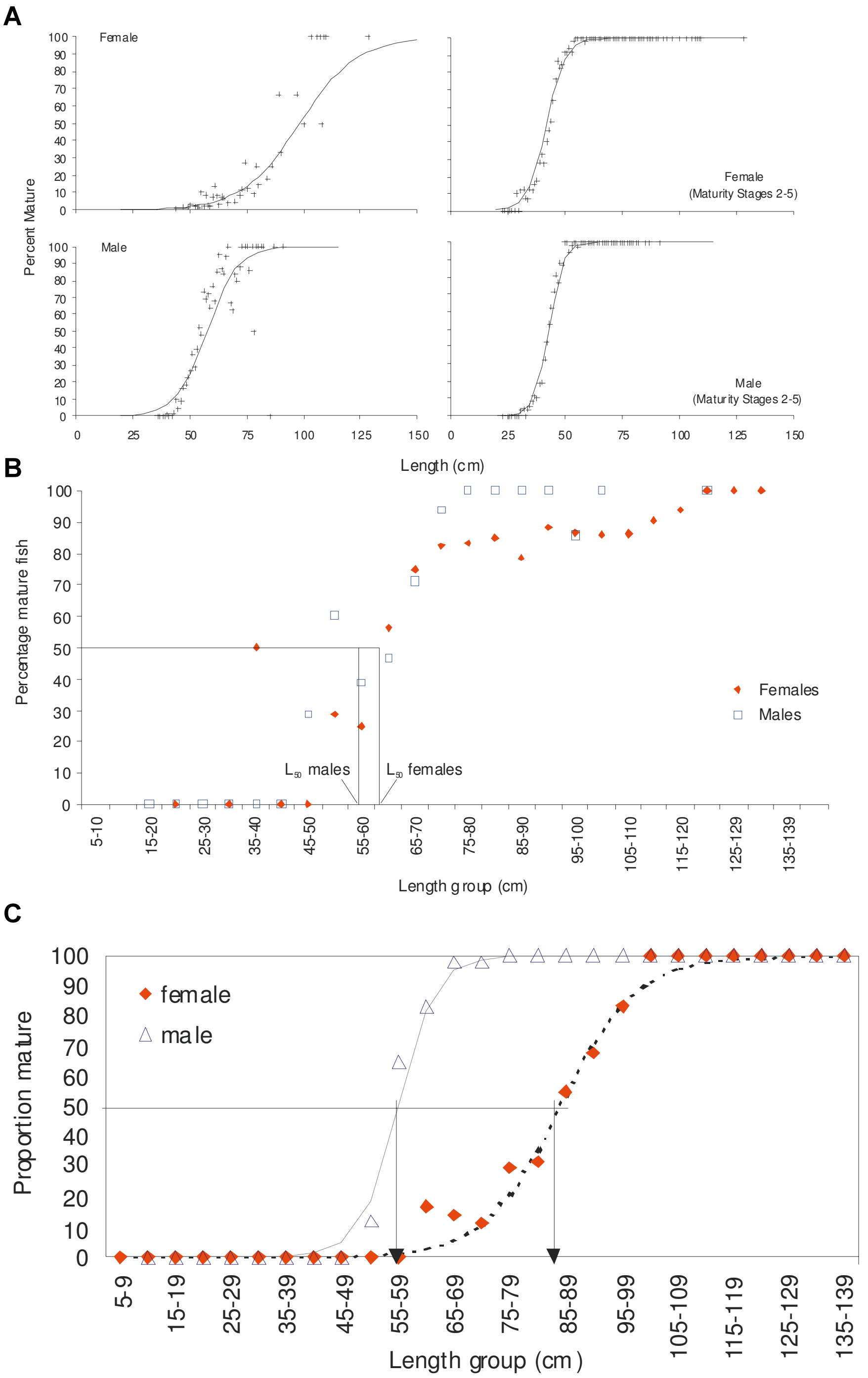

Figure 2.5 Maturity ogives for female and male *L. piscatorius*: (A) around Shetland. Plots on the left are based on maturity at stages 3-5, plots on the right at stages 2-5 (for maturity scale see Appendix 1); (B) North Sea (IBTS, 1983-2000) and off Møre (1992-1997); (C) Faroese waters (data from 2001-2002).

& II are immature and Stages III-V are mature. The calculation has been done in this manner, as it would appear that especially females are in stage II for an extended period of time (from about 40 cm in length) before moving into stage III (from about 60 cm in length) (Laurenson, pers. obs.). Similar five-stage maturation scales for anglerfish are used in Iceland (Appendix 2) and in the Faroes (Appendix 3). Maturity ogives for anglerfish obtained by the MRI in Iceland show lower $L_{50\%}$ compared to Laurenson *et al.* (2001), because Icelandic estimates are based on the assumption that also stage II fish are mature. The maturity scale used in the Faroes is for the most part based on Duarte *et al.* (2001), but with some additional gonad description from Staalesen (1995). The IMR in Norway uses the maturation scale described in the latter (Appendix 4), which is a four-stage key modified from Armstrong *et al.* (1992), with one stage describing both maturing and pre-spawning individuals. The participants at the project meeting in Tórshavn agreed on developing a common maturation key between the countries.

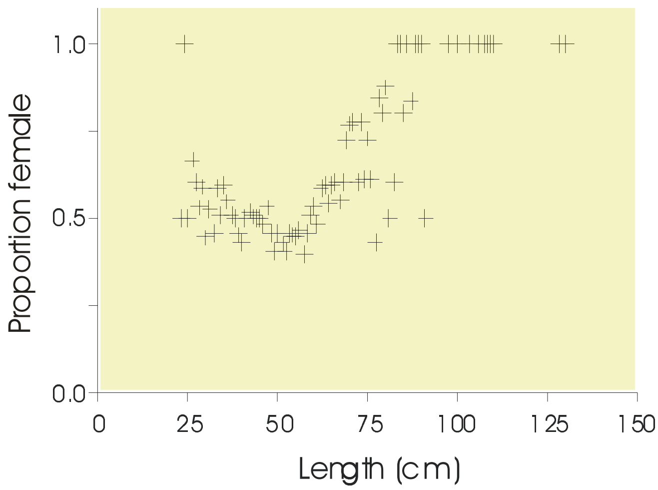

Figure 2.6 Sex ratio for *L. piscatorius* caught off Shetland

2.3 Sex composition

Because of the higher growth rate in females virtually all large anglerfish are female. Thus a comparison between samples obtained by 180 mm and 150 mm meshed gillnets in Norwegian waters showed that female *L. piscatorius* greatly outnumbered males (ratio 3:1) in the larger-meshed gillnets, while this difference was somewhat reduced at a 2:1 ratio in the 150 mm gillnet (Staalesen 1995). In trawl samples off the northwest coast of Scotland (Afonso Dias & Hislop 1996) and around Shetland (Laurenson *et al.* 2001) (Figure 2.6) both sexes occurred in roughly equal proportions up to lengths of 70 and 58 cm, respectively, after which females outnumbered males; above 90 cm all fish were female. In Portuguese and Spanish waters male *L. piscatorius* were slightly more numerous than females in the 60 to 75 cm length interval, after which the proportion of females increased until reaching 100 % above 100 cm (Duarte *et al.* 1998). For *L. budegassa* in the same area (Duarte *et al.* 1998, 2001) no sex was predominant for individuals less than 40 cm in length, between 40 and 52 cm males were over-represented, and above 52 cm females were predominant. Individuals over 70 cm were all female.

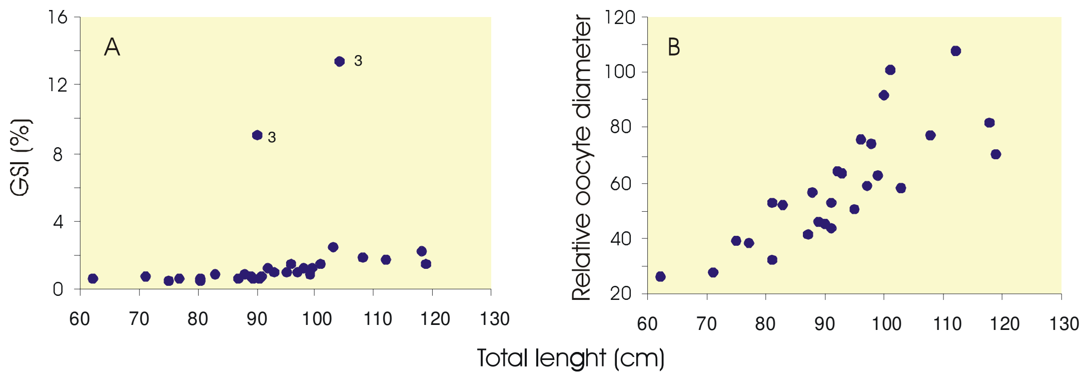

Figure 2.7 Gonadosomatic indices (GSI, %) (A) and relative oocyte diameter (B) of *L. piscatorius* caught in Faroese waters March – September 2002.

2.4 Reproduction

Sexual maturation and female fecundity

From samples taken on the Norwegian west coast Woll *et al*. (1995a) found that the gonadosomatic index (GSI) of anglerfish in this area gradually increases from January and peaks in June. In their study only females larger than 90 cm contained maturing eggs. Females as small as 60-70 cm had blood-rich ovaries, which is usually a sign that spawning has taken place. No females were found in which the eggs had started forming yolk substance as a preparation to spawning.

Detailed light and electronmicrographs have been presented for both male and female *Lophius* caught off northwest Scotland (Afonso Dias & Hislop 1996), as well as for a related species, *Lophiomus setigerus*, found in the East China Sea (Yoneda *et al.* 1998b,c). The latter study also reported fecundity data (number of eggs per specimen). To our knowledge, no such information, at least not accurate and comprehensive, has so far been presented for European *Lophius* species. Fecundity data are considered important in understanding the reproductive investment in species and their capacity to withstand fishing pressure.

A better understanding of the reproductive cycle of anglerfish in Nordic waters would require a dedicated sampling programme (e.g. at a monthly rate) combined with histological (microscopic) examinations. Preliminary analysis on gonads collected in Faroese waters on several occasions in 2002 has shown some discrepancies between macroscopic and microscopic gonad classification (Appendix 5), but a larger material is needed to clarify the level of precision in using the macroscopic scale. Interestingly, some of the ovaries containing only immature oocytes (perinucleolar) showed examples of mucus, indicating that there are spent specimens. There was also an example of a maturing specimen in late autumn (migratory). Generally, larger specimens showed larger oocytes (Figure 2.7b). Light microscopic images of oocyte development in anglerfish are shown in Figure 2.8. Our preliminary studies on oocyte development exemplify once more the unusual nature of anglerfish gonads (Afonso Dias & Hislop 1996).

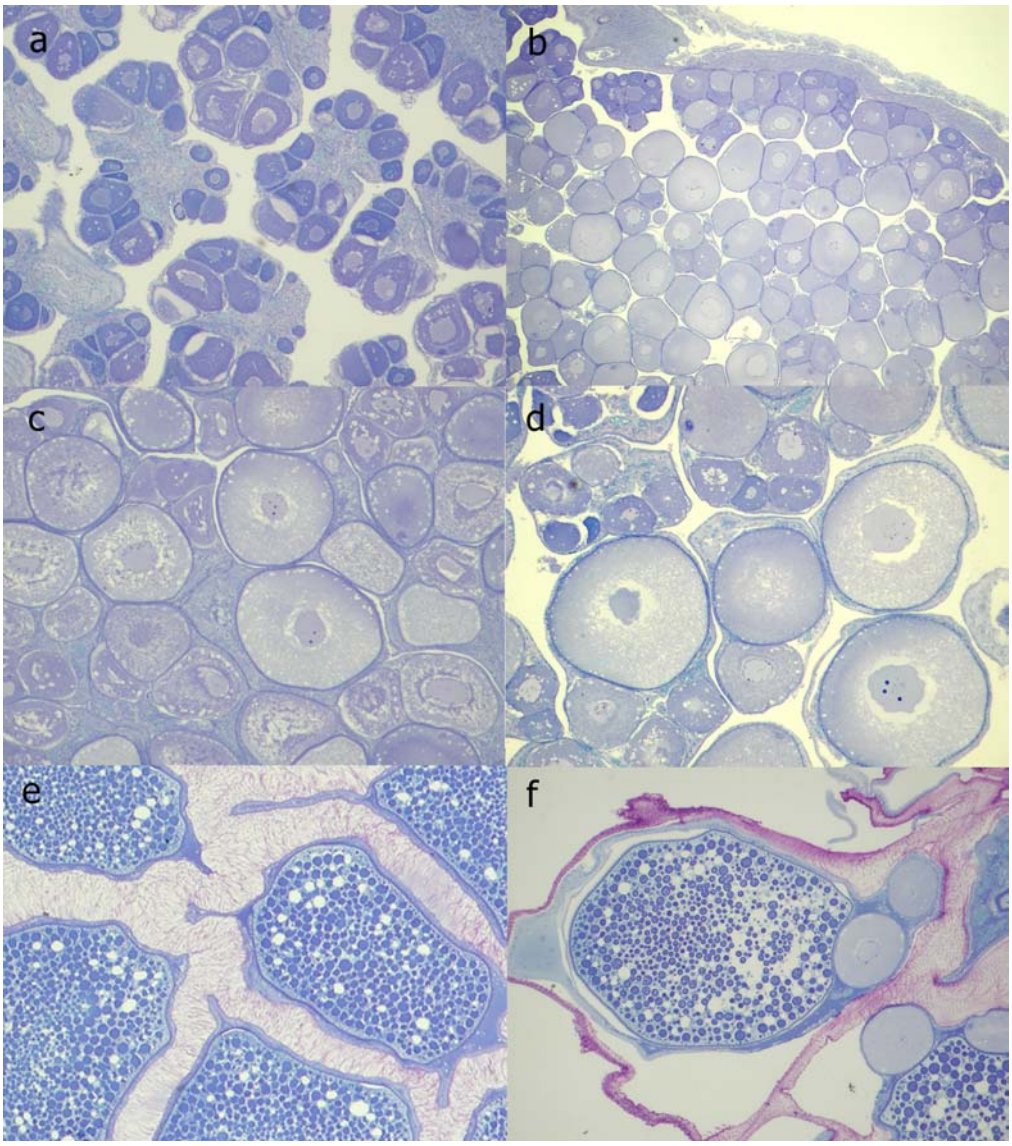

Figure 2.8 Light micrographs of oocyte development in *L. piscatorius*: from immature (a) to close to prior to spawning (f). Red: mucus. (Images courtesy of O. S. Kjesbu & M. Fonn)

Spawning

Little is known about when and where anglerfish spawn in northern European waters (Hislop *et al.* 2001). A reason for this lack of knowledge is undoubtedly the unusual way in which the spawning occurs. Whereas the eggs of most other marine fish are dispersed individually over a wide range, anglerfish eggs are produced in single gelatinous and buoyant, reddish to purple ribbons or tubes, which may be in excess of 10 m long and up to 1 m wide (Figure 2.9). In a mature female such a ribbon may amount to up to half of its total weight and contain more than 1 million eggs. The distribution of the eggs and newly emerged larvae is consequently highly aggregated, explaining why egg and larval surveys have provided little information about the time of spawning and the location of the spawning grounds (Hislop *et al.* 2001).

Figure 2.9 Examples of female egg veils and male testes from *L. piscatorius* caught at Iceland. Numbers refer to maturation stages. (Photo courtesy of E. Jónsson)

Spawning period

In samples from the Norwegian coast mature males were found from March until October (Staalesen 1995). Mature females were found between June and August, but numbers were low and the sampling irregular, so that the exact time of spawning in the area is difficult to determine. However, taken together the findings suggest that the spawning season in *L. piscatorius* extends from late winter to summer in northern areas. At Iceland spawning anglerfish were observed from end April - beginning of June, while spent anglerfish were found in July/August (Jónsson, unpubl. data). North-west of Scotland maturing females occurred most months, but mature females were only found between November and May (Afonso Dias & Hislop 1996). The largest number of spent females was found between April and July. Maturing and mature males were found in every month of the year; spent males were most frequent between April and August. In waters around Shetland seasonal occurrences of maturing and spent anglerfish are similar to those reported by Afonso Dias & Hislop (1996) (Laurenson, unpubl. data). In the Bay of Biscay the reproductive period for *L. piscatorius* was by macroscopic and histological studies observed to extend from May to August with a peak in May-June (Quincoces *et al.* 1998a). For *L. budegassa* the season appeared to last from April to July with a peak in May-July (Quincoces *et al.* 1998b).

In the Norwegian material the majority of females were in the spent/resting stage throughout the year, whereas most males were maturing (Staalesen 1995). These broad periods of gestation suggest either that gonadal development is long or that spawning is non-synchronous. The large number of spent/resting females in the catches may indicate that individuals do not spawn every season (Staalesen 1995, Laurenson, pers. obs.).

Spawning area

Spawning in anglerfish is believed to occur in deeper water. West of the British Isles spawning grounds have been reported at depths of 1 000-1 800 m. No observations exist to indicate whether Nordic stocks of anglerfish migrate to such depths to spawn. However, large mature females with a GSI of up to 32 % were reported at 350 m depth far off the coast of western Norway in June 1994 (Woll *et al.* 1995a). Egg ribbons have also been caught in cod gillnets off Norway in May-June, making it likely that spawning does occur in Norwegian waters during this period. From the absence of spawning females and the low number of mature females of both species in a Southern Shelf[5] study Duarte *et al*. (2001) suggested a reproductive migration to other areas or depths. From the distribution of demersal stages of British *L. piscatorius* and using a particle tracking model Hislop *et al*. (2001) suggested that this spawning occurs in deep water. This is also indicated by the increasing percentage of mature anglerfish which was found with increasing depth in the waters around Shetland (Laurenson *et al.* 2001) .

2.5 Life history

Laurenson *et al*. (2001) summarise the assumed life-history pattern of *Lophius* in a Harden-Jones type triangle as shown in Figure 2.10. Following migration of mature, adult anglerfish to deeper water, spawning occurs close to the seabed, whereupon the egg ribbons rise slowly towards the surface, the eggs hatching underway. Newly emerged anglerfish larvae are about 4 mm long, drift pelagically with surface currents for some time, then settle on the inshore seabed when they reach a length of 50-120 mm as post-larval stage juveniles (Hislop *et al.* 2000). The duration of the pelagic phase is not known with certainty, but may vary from weeks to several months. From otolith daily increment analysis Hislop *et al*. (2001) concluded that *L. piscatorius* larvae and

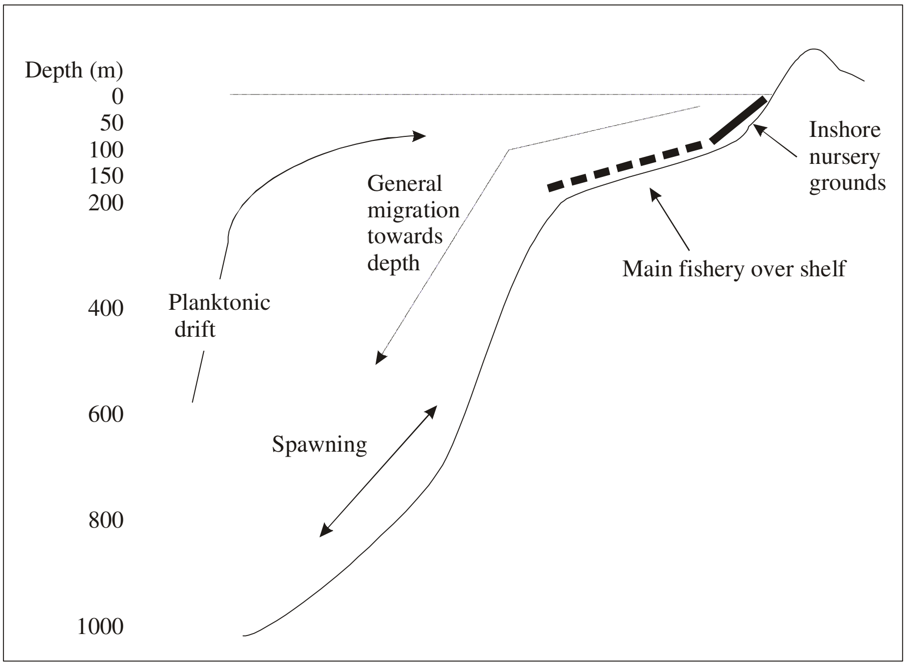

Figure 2.10 Harden-Jones triangle showing the general life-history pattern of *L. piscatorius* (fromLaurenson *et al.* 2001)

[5] See Figure 1.1

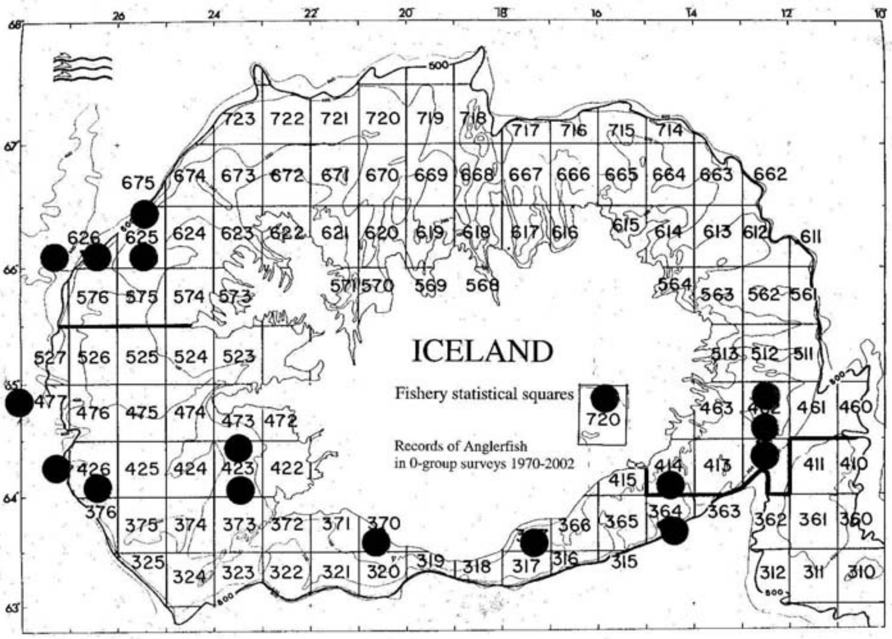

Figure 2.11 Occurrences of *L. piscatorius* in 0-group surveys at Iceland 1970-2002

juveniles from northern British waters drift for up to 120 days before settlement. Recruits may settle on the seabed hundreds of kilometres from the spawning grounds. For example, juveniles > *c*. 50 mm were caught by pelagic trawl in the upper 50 m on the northern Hatton Bank area during a survey for deep-sea fish in the mid-Atlantic in June 2001 (Nedreaas, pers. comm.). These could possibly have drifted north towards Iceland with the North Atlantic Current from spawning grounds west of the British Isles.

Using a particle tracking model driven by hydrodynamic data Hislop *et al*. (2001) simulated the dispersal of *Lophius* eggs and larvae, using guesstimates of the spawning depth and egg ribbon ascent rate towards the surface. Based on temperature and depth the potential spawning range of anglerfish was defined as the continental slope west of Ireland north to 63°N, the northern perimeter of the North Sea and the Rockall Plateau. These regions were used as a start grid in the model. Model runs showed that 60-120 days old post-larvae caught north west of the Hebrides could originate from an extensive area of the continental slope (from the northern border of the North Sea at about 60°N to the shelf edge west of Ireland at about 50°N), as well as from the Rockall Plateau. In contrast, 80-120 days old post-larvae caught in the northern North Sea seemed to have originated far more locally, although some could have come from the continental slope west of Scotland.

Time series of 0-group survey data exist in all Nordic countries, which, when fully analysed, should provide valuable information on the distribution on the juvenile stages of anglerfish in these waters. Occurrences of larvae/juveniles in survey catches are, however, generally scarce. In Iceland, where 0-group surveys extend back to 1970, juvenile *Lophius* were recorded in only 8 out of 32 survey years, mostly one or two individuals (E. Jónsson, pers. obs.). Records of anglerfish were made partly outside the main fishing and spawning grounds on the south and southwest coast (Figure 2.11), where the predominating currents cause eggs and larvae to drift west- and northwards.

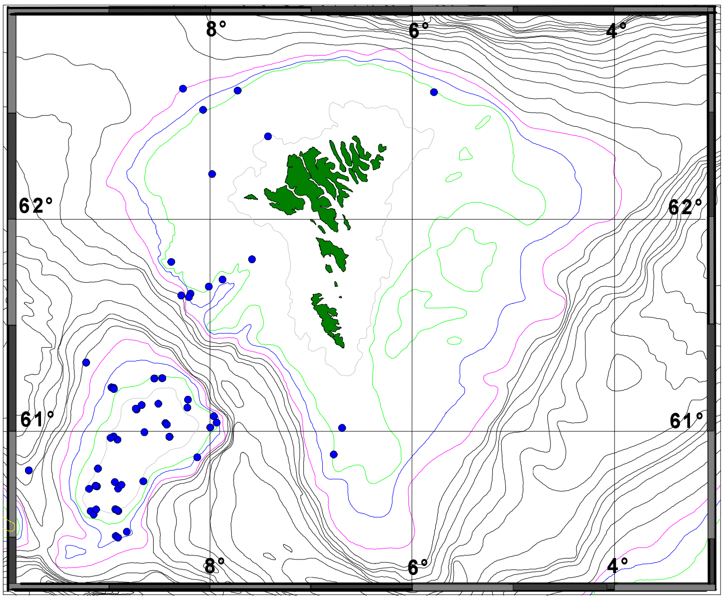

Figure 2.12 Observations of anglerfish larvae (n = 67) from the 0-group survey in Faroese waters in June/July 1984-2002. Depth contours per 100 m.

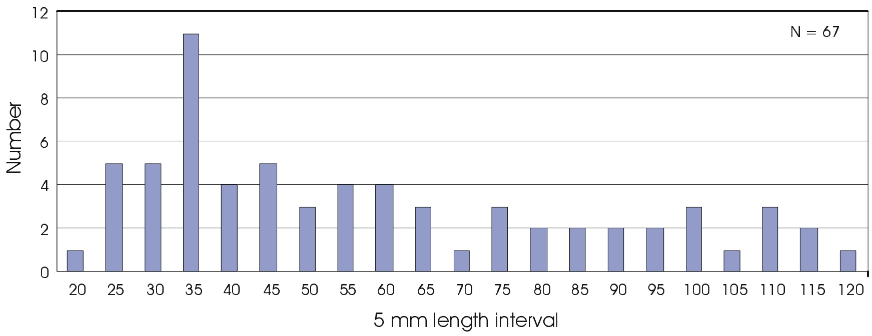

Figure 2.13 Length interval of anglerfish larvae from 0-group survey in Faroese waters in June/July 1984-2002.

During regular Faroese 0-group surveys[6] in the 100-200 m depth range June/July 1984-2002 a total of only 67 *Lophius* juveniles was recorded (Figure 2.12), in the length range 25-130 mm (Figure 2.13) (Ofstad, unpubl. data). Most were caught on the Faroe Bank, while the remainder were found on the shelf west of the Faroes. These areas are characterised by the mixing of the warm, northward bound North Atlantic Current and colder southward currents. This merging results in anticyclonic water flows around the shallow bank and shelf areas surrounding the Faroes, causing advection of plankton and nekton. Presumably most recruits that aggregate by advection in these areas originated from local spawning grounds, but a number of juveniles may also have drifted northward with the Atlantic current from southern spawning areas.

Depending on the recruitment variability level, variation in catch per unit effort due to strong and weak year classes would be expected. Some evidence of variation in year class abundance can be seen in data from Iceland (see Figure 1.3) and Shetland (Laurenson, pers. obs.). In 1998 5 specimens ranging in length from 6.4 to 12.8 cm, presumably originating from a strong 1997 year class, were recorded in the 0-group survey

[6] A good description of Faroese 0-group surveys is given in Gaard & Reinert (2002).

in Icelandic waters. An abundance of juveniles in the 18-28 cm length range in May/June 2002 seems to point to a new strong year class in 2001 (Jónsson, pers. obs.).

2.6 Mortality

Predation

Apart from a study concerning cormorant birds (*Phalacrocorax* sp.) preying on *L. piscatorius* (Choisy & Jones 1983), there are no reports of predators that specifically target anglerfish in European waters. Indirect predation through tail removal of netted fish by seals (Phocini) has, however, been described from the south coast of Ireland. According to Best (1999) male sperm whales (*Physeter macrocephalus*) may sometimes move into continental slope waters off Namibia to feed on benthic species including the anglerfish *Lophius upsicephalus*. It is likely that during the pelagic phase European anglerfish larvae and juveniles are heavily preyed upon by other species, but no studies are available to confirm this assumption.

Cannibalism

There is no clear evidence of conspecific predation (cannibalism) in European anglerfish (Crozier 1985), but some stomach samples from Faroese (Ofstad, pers. obs.) and Shetland waters (Laurenson, pers. obs.) did contain remains of conspecifics. A diet study in the Shetland area showed one incidence of cannibalism in 1 054 samples where a 74 cm monkfish had consumed a 42 cm individual (Laurenson, pers. obs.). Large individuals of *Lophius americanus* from the Northwest Atlantic are known to prey on smaller members of their own species (Armstrong *et al.* 1996). Being opportunistic feeders it seems likely that anglerfish do occasionally prey on members of their own species, as do the above observations confirm, but more research is needed to provide conclusive evidence as to the extent of cannibalism.

Natural mortality

No specific research on natural mortality in European anglerfish is at present known to the authors. For *L. americanus* Armstrong *et al*. (1992) found indications that males in the oldest age groups suffer a heavier mortality rate than females, possibly because of behavioural differences that cause higher predation or fishing mortality, or simply because of higher senescence in males. For stock assessment purposes the ICES uses a natural mortality rate of 0.15 yr^{-1} for all ages and lengths of *L. piscatorius*, adopted from earlier hake (*Merluccius merluccius*) assessments.

Mortality due to fishing is discussed in Section 3.5.

2.7 Diet composition

Anglerfish are lie-and-wait predators, usually lying half-buried on muddy to gravely bottoms, using their modified first dorsal fin ray as a “fishing rod” to lure prey (fish and sometimes seabirds) closer (Caruso 1986, Gordoa & Macpherson 1990). They further possess a wide, cavernous mouth with numerous sharp, backward pointing teeth to prevent the prey from escaping. Recent studies identify cephalopods (Velasco *et al.* 1998) and gadoids, particularly blue whiting (*Micromesistius potassou*) (Azevedo 1996b, Silva *et al.* 1997) as the most important forage for anglerfish on the Southern Shelf[7]. Gadoid fish were likewise the main food for *L. piscatorius* from the Irish Sea (Crozier 1985) and Norwegian waters (Woll *et al.* 1995a). Stomach samples from Faroese waters contained the remains of a variety of decapod and demersal fish species (Ofstad, unpubl. data). Laurenson (unpubl. data) found that stomachs contained a wide variety of prey including gadoids, sandeel species, flatfish species and cephalopods. Seasonally, herring were recorded, and samples collected on sandeel fishing grounds showed a diet predominantly of sandeels. Bony fishes and cephalopods were also the dominant prey groups in stomach samples of Lophids from other parts of the world (Macpherson 1985a,b, Gordoa & Macpherson 1990, Armstrong *et al.* 1996, Cha *et al.* 1997).

Anglerfish are essentially opportunistic feeders, displaying a low degree of prey selectivity. In tank experiments anglerfish nevertheless refused to take dead whitefish species (Laurenson, pers. obs.). Stomach contents reflect spatial and/or temporal prey availability or abundance (Crozier 1985). Thus, in addition to codfish, Woll *et al*. (1995a) found large amounts of migrating herring (*Clupea harengus*) in stomach samples from commercial anglerfish catches off the coast of Norway, February 1994. Bruno *et al*. (2001) suggest movement associated with feeding or reproduction as a likely cause of seasonality in Portuguese gillnet catches. Lordan (2000) describes a new project seeking among others to better describe the diet of both anglerfish species in the Irish Sea. No results appear as yet to have been published.

2.8 Parasite and disease studies

Only a limited number of studies is available that deals with parasitology and diseases of anglerfish in European waters. Most research involves *Lophius* as host species for a variety of nematode and trematode parasites. Køie (1993) investigated occurrences of nematodes in teleosts including *Lophius* to 1 540 m depth off the Faroese Islands. Other parasite studies from northern European waters include Crozier (1987) and Petter & Cabaret (Petter & Cabaret 1995).

[7] See Figure 1.1

3 Fisheries, assessment and management

3.1 Commercial fisheries in the North Atlantic

Nordic fisheries for anglerfish take place on the continental shelf areas around the Faroes and Iceland and west and south of Norway, specifically in ICES Divisions IIa, IIIa, IVa,b and Va,b (see Figure 1.1). For the purposes of the present report these areas are defined as *Nordic waters*. *Northern* and *Southern Shelf* refer to areas defined in reports prepared by the ICES Demersal Stocks Assessment Working Groups for these areas (Anon. 2001a) (see Figure 1.1), and may basically be characterised as the continental shelf north and south of the English Channel.

Anglerfish are usually not sorted by species in commercial landings in Northern Europe; consequently the TAC, where appropriate, is set for both species combined. The stock status of each species, however, is assessed separately on the basis of species composition in the various fisheries. Catch and survey data from the North Sea, west of Scotland and Norway indicate that the large majority of catches consist of *L. piscatorius* (Staalesen 1995, Woll *et al.* 1995b, Anon. 2001a). On the Southern Shelf the proportion of *L. piscatorius* in the catches has over the last ten years varied from 61 to 72 %. Total annual landings for each fishing area from 1990 to 2000 are shown in Figure 3.1.

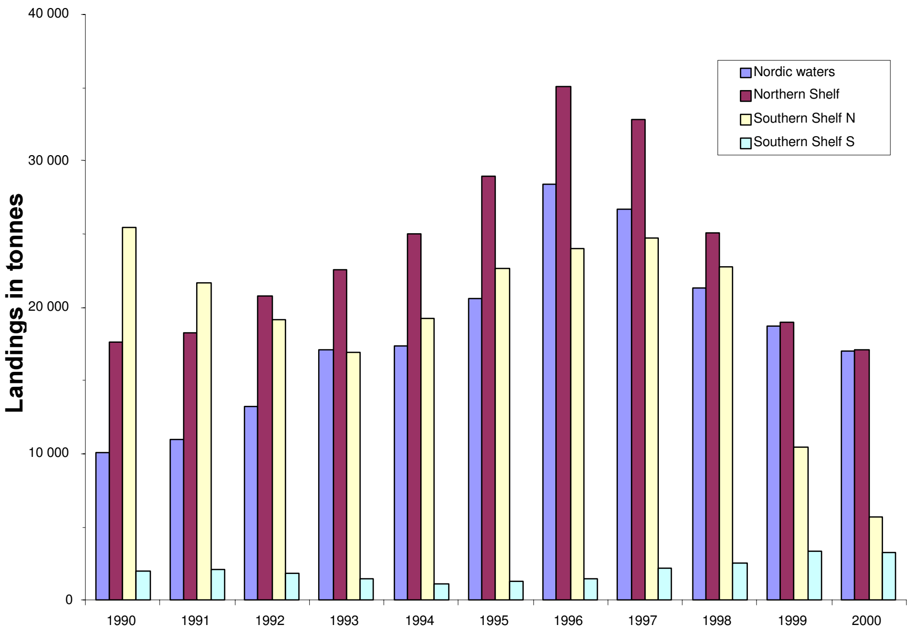

Figure 3.1 Annual anglerfish landings from different regions in the Northeast Atlantic 1990-2000 (in tonnes).

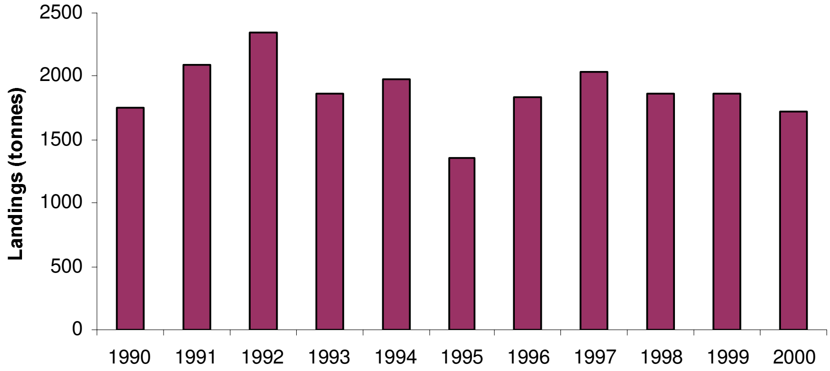

Figure 3.2 Annual landings (tonnes) of anglerfish in Denmark 1990-2000

Denmark

In Denmark anglerfish are largely taken as a bycatch in demersal fisheries in the North Sea and Skagerrak. However, these bycatches can form a relatively high proportion of the total value of the catch, so the species is important, particularly to the fishers of the ports in West Jutland. Reported Danish landings of anglerfish from the North Sea varied between 1 027 t and 1686 t over 1989 to 2000 (Figure 3.2), making Denmark the second most important exploiter of this stock after the UK. Denmark also takes the majority of catches of anglerfish reported from ICES Division IIIa (Skagerrak & Kattegat). Danish landings from this area have varied between 266 t and 658 t over 1989 to 2000.

Faroes

During the 1990's directed trawl and gillnet fishing efforts for anglerfish in Faroese waters intensified, resulting from 1997 onwards in a marked increase in landings (Figure 3.3). In 2001 some 2 200 t of anglerfish were landed, about half of which was caught by gillnets, mainly on the Faroe Plateau and the banks off the Faroes. The presently well-established Faroese deep-water tangle net fishery for anglerfish is described in Reinert (1995).

Since 1993 the gillnet fishery has been managed as a licensed fishery, without a TAC constraint. Eight vessels are currently licensed. The gillnet fishery is furthermore restricted by area, depth, mesh size and constraints on the number of nets. The fishery is allowed in a small area on the eastern side of the Faroes and in a larger area southwest of the islands. Fishery is only allowed at depths greater than 380 m, and the minimum mesh size allowed is 300 mm stretched.

Anglerfish are also caught as bycatch in other fisheries. In the pair-trawling fishery mainly for saithe, a decrease in total catch of anglerfish has been observed in later years. However, so far there is insufficient data to relate this decline to any changes in availability.

The directed fisheries for anglerfish with trawl are restricted by permanent and temporary area closures. The larger trawlers (>1 000 hp), which also take a significant amount of anglerfish are also restricted by permanent and temporal area closures for trawl, and are not allowed to fish within 12 nautical miles from the base line.

Iceland

In the relatively warm waters off the south coast of Iceland anglerfish were previously mainly taken as trawl bycatch. Total annual catch during the last 30 years was usually between 600 and 700 t, equally proportioned between *Nephrops* and conventional trawls (Figure 3.3). In 1999 a directed fishing effort on *Lophius* began, conducted by boats equipped with specially designed trawls, after which the annual catch increased to about 1 000 t. In 2000 a large-scale gillnet fishery with special wide-meshed nets was initiated, similar to the net fisheries in Norwegian and Faroese waters which were started some years earlier. During 2000 gillnet landings grew from about zero to 764 t, and the total *Lophius* catch in Icelandic waters rose to a record high of 1 503 t. During the same period the share of the catch in *Nephrops* and conventional trawls decreased 25 and 31 %, respectively, compared with the previous year. In 2001 gillnet landings were 150 t less than the previous year, while trawl landings remained stable, ending with a total catch of 1 350 t. This reduction in net landings seems not to be caused by a change in fishing effort (number of nets) - the total effort was even somewhat increased in 2001 compared to 2000 -, but rather by a drastic fall in CPUE (kg/net).

The gillnet fishery is partly conducted in much deeper water than on conventional trawling grounds, but anglerfish caught at these depths appear to migrate to shallower water during parts of the year. The net fishery therefore does not seem to be exploiting any new stock component. The main anglerfish grounds are concentrated off the south coast (Figure 3.4). The commercial fishery is limited to depths above 550 m, most likely because of water temperature. Temperature might also explain why *Lophius* rarely occur on the Iceland-Faroe and Reykjanes ridges. However, closer to the coast on the Reykjanes ridge, where water depth and low temperatures are certainly not limiting, experimental fishery with nets has had little success.

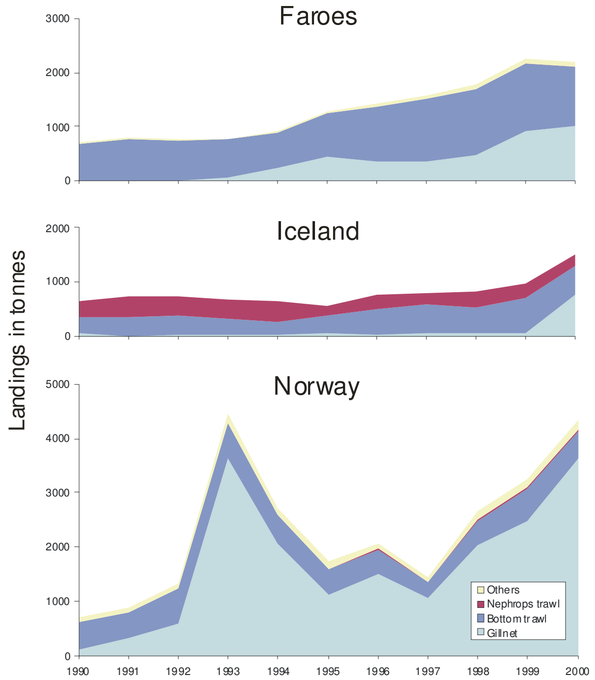

Figure 3.3 Annual anglerfish landings (tonnes) in the Faroes, Iceland and Norway, proportionally by gear type.

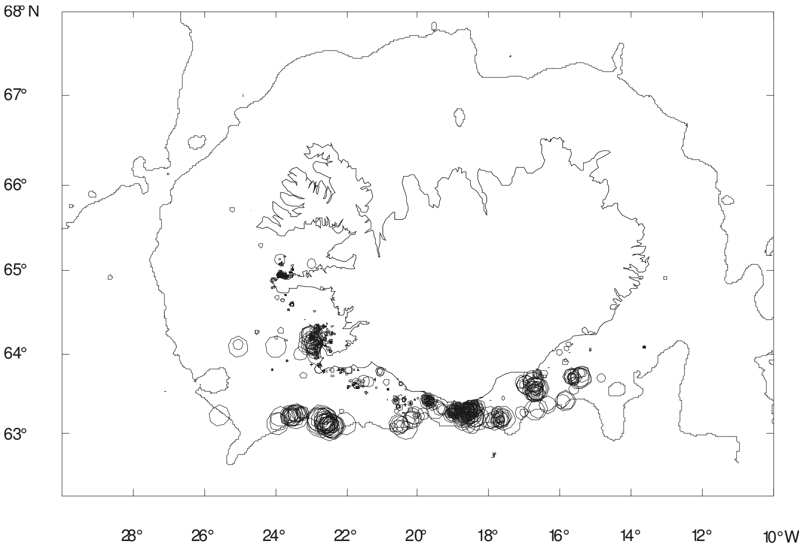

Figure 3.4 Anglerfish fishing grounds in Icelandic waters (gillnet fishery 2001). Catch size indicated by circle diameter.

Norway

In 1992 a new fishery with specially designed anglerfish gillnets started on the shelf off the northern part of the Norwegian west coast (Møre) (Woll *et al.* 1995a,b). Anglerfish were previously mainly taken as bycatch in gillnets and in shrimp and groundfish trawls. Total annual catch quickly reached a peak in 1993 with 4 452 t (Table 3.1). From a period of decline in reported landings since 1994, catches increased to a preliminary record high of 4 857 t in 2001 (Nedreaas 2002). Contributing factors for this increase may have been an illegal fishery using smaller gillnet mesh sizes (300 instead of 360 mm), an increase in the number of nets, increased soak times, as well as an extension of the fishing areas to the north. The majority of the landings (Table 3.1, Figure 3.3) presently come from small gillnetters less than 17 m in length and carrying from 100 to 500 nets per boat.

The fishery is mainly concentrated on the western coast off Møre inside 12 nautical miles. For most of the 1990's anglerfish landings from northern Norway were limited,

Table 3.1 Annual anglerfish landings (tonnes) in Norway for each fishing gear 1985-2000.

Gear type	Landings (tonnes)															
	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
Gillnet	204	160	215	177	104	98	304	577	3642	2056	1111	1504	1053	2049	2473	3644
Longline	65	64	68	53	84	75	70	71	118	80	122	73	39	80	58	125
Traps and pots	1	9	2	3	4	7	13	1	1	2	1	5	11	21	16	6
Bottom trawl	447	370	420	308	340	519	485	656	647	539	472	456	304	423	607	481
Nephrops trawl								0	4	13	4	6	10	24	29	41
Danish seine	12	11	8	8	7	5	11	21	40	32	19	26	29	47	56	61
Others	3	2	2	2	0	0			0	0		0	0			0
	732	616	715	551	539	704	883	1326	4452	2722	1729	2070	1446	2644	3239	4358

Source: Directorate of Fisheries, Norway

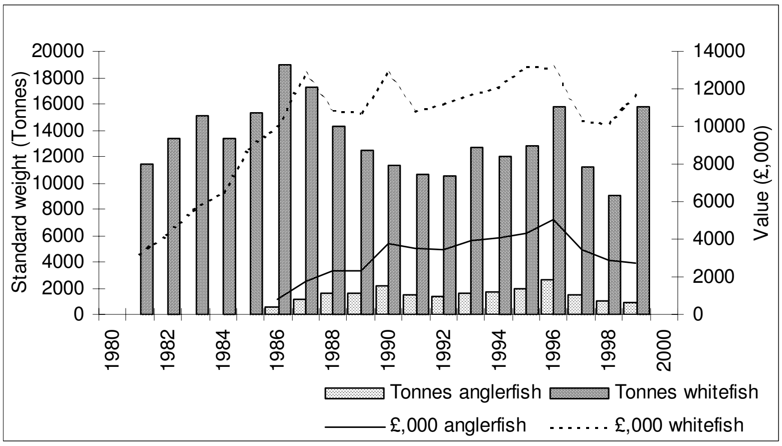

Figure 3.5 Annual landings (tonnes and value in GBP) of anglerfish and whitefish species in Shetland 1980-2000

varying between 2 and 5 % of the total anglerfish catch. In recent years catches originating from northern regions have increased dramatically, so that at present (2001) about 28 % of all Norwegian anglerfish are caught north of Halten.

The gillnet fishery is regulated through a smallest permitted mesh size (360 mm stretched mesh), a limit to the number of nets per boat, and a maximum soak time of two days to limit effort and to ensure good fish quality. No bycatch regulations exist for the trawl fishery. No annual quotas are presently set.

Shetland

The Shetland trawl fleet started to target anglerfish during the mid-eighties and the catch became important almost overnight. Compared to whitefish nets, the nets used to target anglerfish have got longer wings, a mouth in a tighter "V" rather than "U" shape, and hoppers that are smaller. The anglerfish net also does not stand as high in the water. Data on anglerfish landings at Shetland ports are available from 1986 and show an increase from 533 t to over 2 100 t in 1990 (Figure 3.5). During the peak landings in 1996 anglerfish accounted for 15 % weight and 40 % value of demersal landings (Figure 3.5). Following fleet redevelopment most of today's demersal fleet are designed to target anglerfish. The main fishing grounds being to the north of Shetland and along the shelf break to the west. During the 1990's, as the fleet from mainland Scotland underwent redevelopment, the number of twin-riggers which target anglerfish and are designed to fish deeper waters, increased. The increased fishing pressure to the west of Shetland and the subsequent decrease in catches has had the effect of squeezing single trawlers inshore which has in turn impacted on boats working those areas.

Northern and Southern Shelf

According to official landing statistics reported to the ICES in 2000 the total annual outtake of anglerfish on the Northern Shelf (ICES Divisions III, IV and VI) was about 22 000 t. About 18 000 t were taken in the northern North Sea (IVa), where a Scottish directed fishery is responsible for most of the catch (12 000 t). Landings from Northern Shelf areas increased sharply during the early nineties, peaking at about 34 000 t in 1996, but have since fallen back to approximately the same levels as before 1990. No reduction in fishing effort seems to be in evidence to explain this decrease. Following the drop in catch-per-unit-effort, the fishery has since the mid-nineties expanded into deeper water where large, mature anglerfish are believed to aggregate. For example, a fishery involving French and Scottish vessels has since the late 1980's developed in deeper water (1 000-1 500 m) west of the British Isles targeting a variety of species including *Lophius* (Blasdale & Newton 1998). Anglerfish are also an important target species in the bottom trawl fisheries on the upper ridge slopes to the west of the Hebrides and Shetland (Gordon 2001). Together with the high fishing mortality rates anglerfish prior to first maturity are subjected to, the new deepwater fisheries targeting adult fish have raised the level of concern about over-fishing in northern areas considerably.

Anglerfish are an important component of mixed species trawl fisheries taking gadoids, flatfish and *Nephrops* on the Southern Shelf from the west of the British Isles to the northern parts of the Bay of Biscay. These fisheries developed in the 1970's and annual landings increased steadily until 1986. Even though the fishing effort increased until 1990, anglerfish catches declined until 1993. Previous heights were reached again in 1996, but landings have since been falling again. Annual outtake in 2000 was about 12 000 t, compared to 20 000 t in 1990. French, Spanish and Irish trawlers take most of this catch, with UK trawlers and gillnetters taking the remainder. In Northern Spain specially designed anglerfish nets (280 mm mesh size) are used in a medium to deep-water (100-800 m) gillnet fishery (Pereda *et al.* 1998). Anglerfish make up 97 % of the total catch landed by this gear type.

On the shelf areas west of Portugal and north of Spain both species are caught in mixed fisheries by Spanish and Portuguese fleets. A directed small-scale artisanal fishery has also existed in the region since the 1970's. Annual outtake of both species combined has over the last 20 years fluctuated between some 2 000 and 6 000 t.

3.2 Fishing gear and methods

The most common fishing methods for anglerfish are trawling and gillnetting, but in certain areas Danish seines are also used. Sangster & Breen (1998) compared the fishing and engineering performance of single and twin rigged scraper trawls during trials aboard a commercial fishing boat. The twin trawl significantly out-fished the single trawl for *L. piscatorius*, even over the same swept area. Analysis of bridle herding efficiency demonstrated that anglerfish and flatfish may have been herded more effectively by the twin trawl bridles, which had the smaller angle of attack. Shetland trawlers now commonly use a twin rigger set-up. Madsen & Hansen (2001) describe a flexible grid system for reducing bycatch in the Danish trawl fishery targeting shrimps on the Fladen Ground in the North Sea, while still retaining marketable catches of roundfish like anglerfish. A similar grid system was previously tested in the groundfish trawl fishery in the Celtic Sea and the Bay of Biscay (Meillat *et al.* 1994). The authors have also been informed that commercial trawls have been equipped with so-called "tickler chains" to increase the catchability of anglerfish.

3.3 Fisheries statistics

Data on catches and landings of commercial fish species, as well as vessels and fishing gears are registered and published regularly by public offices in each country.

Denmark

Danish official statistics are administered by the Fiskeridirektorat of the Danish Ministry for food, land use and fisheries (Ministeriet for Fødevarer, Landbrug og Fiskeri). Their website is http://www.fd.dk/info/index.htm, and fisheries statistics can be found online at http://www.fd.dk/info/system/frm/7frm.htm.

Faroes

The Faroese statistical office (Hagstova Føroya) (http://www.hagstova.fo) publishes catch statistics twice a year in Faroese. Faroese catch statistics in English can be found under the website: http://www.hagstova.fo/Welcome_uk.html.

Iceland

Data on annual catches in Iceland are gathered and registered by the office of Fiskistofa. Information about landings on an annual and/or a daily basis is public and accessible by all under http://www.fiskistofa.is/dirfish/ (English version).

Norway

The Norwegian Directorate of Fisheries (Fiskeridirektoratet, http://www.fiskeridir.no) publishes weekly and monthly Norwegian catch statistics as tables in PDF and Excel format (Norwegian language only). English language tables of annual landings in previous years, as well as preliminary statistics for the current year, may be found at http://www.fiskeridir.no/english/pages/statistics/statistics.html#month.

Scotland/Shetland

The Scottish Executive publishes an annual report of fisheries statistics; the 2001 publication "Scottish Fisheries Statistics 2000" may be found at http://www.scotland.gov.uk/library3/fisheries/sfs2-00.asp. The Shetland Islands Council publishes an annual report "Shetland in Statistics" which contains information on the Shetland fleet and includes landings into Shetlands ports.

3.4 Biological sampling

Biological data on many fish species, including anglerfish, are collected on a regular basis in all countries, either from i) market sampling or ii) specific research surveys, where also pertinent non-biological data are gathered.

Denmark

There are no directed surveys for anglerfish in Danish waters. However, length data are available for anglerfish caught during the Danish surveys in the North Sea, Skagerrak and Kattegat. Length data are also available from commercial catches as noted in Section 1.2.

Faroes

There are no directed surveys for anglerfish in Faroese waters. However, in the annual bottom trawl surveys for cod, haddock and saithe around the Faroe Islands in February/March (spring survey since 1983) and August/September (autumn survey since 1996) some anglerfish are also caught (see Figure 1.3). From these, length and round weight data exist. There are also some length data from other surveys with the research vessel, and from commercial vessels hired for special investigations by the Fisheries Laboratory. From market sampling some data have also been collected from landings by gillnetters and trawlers.

In February 2002 a pilot trawl survey directed for anglerfish was conducted around the Faroes with the research vessel "Magnus Heinason". During this trip a commercial trawl was used, equipped with a so-called "tickler chain".

Iceland

The MRI (Marine Research Institute) in Reykjavik collects biological data on a regular basis from commercial landings. Further biological data are collected during an annual *Nephrops* survey that also covers the anglerfish fishing grounds. Length measurements of anglerfish have also been taken during Icelandic bottom trawl surveys in March and October for a number of years, as these surveys cover the anglerfish fishing grounds. Anglerfish surveys are also conducted twice yearly by MRI staff going out with commercial vessels for a week at a time sampling biological data.

Norway

Biological data from commercial anglerfish landings were collected from the northwest coast of Norway (Møre) during the period 1992-1997 (33 stations, n = 2 639 individuals). Most of the samples were taken from catches by gillnet vessels using nets with 300 and 360 mm mesh size; only one station was carried out on anglerfish landed by a Danish seine equipped vessel. Most of the sampling was performed on landed catch, therefore most of the sampled fish were gutted. In order to get complete biological data, some samples were also taken at sea from round anglerfish, and in some cases the fishermen agreed to deliver round fish onshore. In the beginning otoliths were collected for age determination, but later the illicium became the preferred ageing structure, so illicia were therefore collected instead of otoliths. The commercial catch sampling was restarted in the beginning of 2002.

The Institute of Marine Research in Bergen has since the early eighties sampled anglerfish during annual bottom trawl surveys, including the IBTS, and during shrimp and *Nephrops* surveys in the North Sea. Systematic sampling of anglerfish, which are regarded as bycatch in these surveys, was not performed before the late 1980's (O. Smedstad, pers. comm.), causing a lack of data in parts of the time series. From 1989 to 2000 Norwegian scientists sampled 1 834 anglerfish collected on 3 336 stations.

Scotland/Shetland

Since late 1997 data and biological samples have been collected at Shetland mainly from trips onboard commercial trawlers and during various gear selectivity trials. Some biological data have been collected from market sampling. Otoliths are collected from various ports throughout Scotland as part of a market-sampling programme run by the Marine Laboratory in Aberdeen.

An anglerfish tagging programme was conducted in Shetland during the summer of 2001, during which length frequencies and catch rates were recorded from each ground surveyed. During the last few years the Marine Laboratory in Aberdeen has conducted several anglerfish research surveys, mainly to the west of Scotland.

3.5 Stock assessment and management

With the exception of the Nordic stock component in the northern North Sea (ICES Division IVa), no assessments are carried out on anglerfish stocks in Nordic waters. Management of these stocks is achieved exclusively through regulations concerning minimum fish size, through restrictions on fishing gear (Norway), and by imposing precautionary TACs (Iceland).

The ICES Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS) carries out annual assessments of stocks in the North Sea (IVa-c), Skagerrak/Kattegat (IIIa), and north and west of Scotland (VIa,b). Similar assessments are performed by the Southern Shelf WGSSDS on anglerfish stocks in Divisions VIIb-k, VIIIa-c and IXa. TAC regulations are now set in all the above ICES areas. These TACs were formerly based on average landings in previous years, but have since 2000 been subjected to a precautionary approach in response to increased levels of fishing mortality as well as uncertainty about levels of recruitment and spawning stock biomass (SSB). Until recently, the lack of a TAC in Division IVa encouraged misreporting of landings from other areas on the Northern Shelf into that area, causing allocation uncertainty and undermining management efforts.

Discarding is known to occur in all areas, but data are not routinely collected. Recent Scottish survey data do however indicate that discard levels are probably low on the Northern Shelf. For Southern Shelf stocks, where no minimum mesh size restrictions are in effect, there is probably an even lower level of discards. For example, anglerfish caught by the multi-métier French trawler fleet operating in the Celtic sea were discarded in negligible numbers compared to numbers that were landed (Rochet *et al.* 2002). Anglerfish are almost always retained as a valuable commercial fish, like in the multi-species trawl fisheries. Nevertheless, the ICES Study Group on Unaccounted Mortalities in Fisheries does conclude that *L. piscatorius* is a species of concern in the Eastern North Atlantic fisheries, particularly with regard to unaccounted discard and escape mortality (Anon. 1995).

With the exception of southern *L. budegassa* the ICES Advisory Committee on Fisheries Management (ACFM) considers anglerfish stocks both in Northern and Southern Shelf waters to be outside safe biological limits, and therefore recommends the fishing mortality rate be reduced in accordance with a precautionary approach (F_{pa}=0.3), to allow for the rebuilding of the SSB. Because of the low precision of the assessments, exact guidance on fishing reduction is difficult to provide, but the ACFM stated in 2001 that catches in the North Sea and surrounding waters should probably not be higher than two thirds of the sustainable catches identified in the period 1973-1990. This corresponds to about 10 000 t. The TAC for 2002 was in December 2001 set to 15 270 t. In 2002 an assessment was for the first time accepted as giving sufficient information for an analytical forecast for these areas[8]. ICES proposes that landings not be higher than about 7 000 t for 2003.

Because of uncertainties in age reading, as well as the concern that the age-based separability assumption in catch-at-age analysis may be violated in the rapidly growing fisheries on the Northern Shelf, the WGNSDS has since 1999 instead explored a length-based approach to stock assessment (Anon. 2001b). Yield per recruit was estimated from a modified catch-at-size analysis (CASA), using the size transition matrix model

[8] http://www.ices.dk/committe/acfm/comwork/report/2002/oct/ang-ivvi.pdf

of Sullivan *et al*. (1990)[9]. Use of this method gave qualitatively similar results to catch-at-age analysis. For Southern Shelf anglerfish stocks the WGSSDS has used a separable age-based VPA with XSA tuning, although ageing problems have also here been suspected (Anon. 2002).

9 see also Appendix 1 of ICES-CM 2001/ACFM:01

4 Conclusions

Although an important part of the European fisheries for anglerfish takes place in Nordic and Northern Shelf waters this report indicates that the body of work done on anglerfish in these regions is somewhat lacking compared to research in more southern parts of Europe. More research on the biology, ecology and abundance of northern anglerfish is thus needed in order to properly manage the growing fisheries in the area.

4.1 Areas of research that need to be prioritised

- With the recent expansion of anglerfish fisheries into deeper water along the northern shelf-edges, an increasing fraction of both mature and immature anglerfish is being targeted. To properly address the impact of fisheries on northern anglerfish populations more basic data need to be gathered on their life-history and population dynamics. How many separate stocks do for example exist in northern waters? Mark-recapture experiments and population genetic research will to this end be useful tools.
- To achieve consistent data on length and age at first-time maturation among the participating countries it is important that a common maturation scale be constructed, and that consensus be reached over which stages represent mature fish.
- Furthermore, data on maturation processes, spawning time and spawning areas are relatively scarce.
- Ageing methodology has improved over the last decade, but a standardisation of techniques as well as structures used for ageing between the participating countries is in order to ensure accurate and consistent readings.
- If expensive data storage tags are decided upon in mark-recapture studies, preliminary trials using dummy or conventional tags would be recommendable considering the vulnerability of anglerfish to traumas due to handling. Methods of capture that ensure best survival rates need also be investigated.
- Tags placed on the dorsal area of the fish may be overlooked because commercial fishermen often immediately place caught fish on their backs for processing. Extra markings or dye applied to the ventral area may increase visibility in this respect.

4.2 Management lessons from other regions?

- Experience from the North Sea has shown that in order to discourage misreporting of landings, TAC restrictions, if implemented in management, need to be set in all fisheries statistic areas.
- To ensure adequate assessment it is important that data on catch composition be collected on a regular basis from commercial landings in all participating countries.

5 References

Anon. (1995) Report of the Study Group on Unaccounted Mortality in Fisheries, Aberdeen (Scotland), 17-18 April 1995. *ICES Council Meeting papers* CM-1995/B:1. 27 pp.

Anon. (2000) Third International Ageing Workshop on European Anglerfish, IPIMAR, Lisbon, 8-12 March 1999. European Fish Ageing Network, EFAN Report 2-2000 <http://www.efan.no/NewsAndReports/EFAN%20Report%202-2000.htm>. Accessed February 2002. 15 pp.

Anon. (2001a) Anglerfish in Divisions VIIb-k and VIIIa,b. p. 360-449 in: Report of the Working Group on the Assessment of Southern Shelf Demersal Stocks, Part 2, 13-16 June 2000. *ICES Council Meeting papers* CM-2001/ACFM:01. 449 pp.

Anon. (2001b) Anglerfish on the Northern Shelf. p. 171-202 in: Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks. *ICES Council Meeting papers* CM-2001/ACFM:01.

Anon. (2002) Report of the Working Group on the Assessment of Southern Shelf Demersal Stocks, 4-13 September 2001. *ICES Council Meeting papers* CM-2002/ACFM:05. 981 pp.

Afonso-Dias IP (1997) Aspects of the biology and ecology of anglerfish (*Lophius piscatorius* L.) off the west-coast of Scotland (ICES Sub-area VIa). Doctoral thesis, University of Aberdeen. 192 pp.

Afonso-Dias IP & Hislop JRG (1996) The reproduction of anglerfish *Lophius piscatorius* Linnaeus from the north-west coast of Scotland. *Journal of Fish Biology* 49(A): 18-39.

Armstrong MP, Musick JA & Colvocoresses JA (1992) Age, growth, and reproduction of the goosefish *Lophius americanus* (Pisces: Lophiiformes). *Fishery Bulletin* 90(2): 217-230.

Armstrong MP, Musick JA & Colvocoresses JA (1996) Food and ontogenetic shifts in feeding of the goosefish, *Lophius americanus*. *Journal of Northwest Atlantic Fishery Science* 18: 99-103.

Azevedo M & Pereda P (1994) Comparing monkfish (*Lophius piscatorius* and *L. budegassa*) abundance in ICES Division VIIIc by year and depth strata. *ICES Council Meeting papers* CM-1994/G:22. 7 pp.

Azevedo M (1995) A statistical analysis of black monkfish catch rates in ICES Division IXa. *Fisheries Research* 24(4):281-289.

Azevedo M (1996a) Contribution to the study of the biology of black monkfish, Lophius *budegassa* Spinola (ICES Division VIIIc and IXa). *Boletim do Instituto Portugues de Investigaçao Maritima* 2: 5-13.

Azevedo M (1996b) Studying the feeding habits of anglerfish (*Lophius* spp.) in Portuguese waters: A qualitative approach. *ICES Council Meeting papers* CM-1996/G:19. 9 pp.

Bauchot M-L (1987) Poissons osseux. p. 891-1421 in: Fischer W, Bauchot ML & Schneider M (eds) Fiches FAO d'identification pour les besoins de la pêche. Rev. 1. Méditerranée et mer Noire. Zone de pêche 37. Volume II. Rome: Commission des Communautés Européennes & FAO. (In French)

Best PB (1999) Food and feeding of sperm whales *Physeter macrocephalus* off the west coast of South Africa. *South African Journal of Marine Science* 21: 393-413.

Blasdale T & Newton AW (1998) Estimates of discards from two deepwater fleets in the Rockall Trough. *ICES Council Meeting papers* CM-1998/O:11. 18 pp.

Bruno I, Fariña AC, Landry J & Morlán R (2001) The gillnet fishery for anglerfish (*Lophius piscatorius*) in deep-water in the northwest of Iberian Peninsula. *NAFO Scientific Council Research Documents* 01/99. 5 pp.

Caruso JH (1983) The systematics and distribution of the lophiid anglerfishes: II. Revisions of the genera *Lophiomus* and *Lophius*. *Copeia* 1: 11-30.

Caruso JH (1986) Lophiidae. p. 1362-1363 in: Whitehead PJP, Bauchot M-L, Hureau J-C, Nielsen J & Tortonese E (eds) Fishes of the North-eastern Atlantic and the Mediterranean, volume 3. Paris: Unesco. 1473 pp.

Cha BY, Hong BQ, Jo HS, Sohn HS, Park YC, Yang WS & Choi OI (1997) Food habits of the yellow goosefish, *Lophius litulon*. *Journal of the Korean Fisheries Society* 30(1): 95-104. (In Korean, abstract in English)

Cha BY, Park YC & Huh SH (1998) Age and growth of the yellow goosefish, *Lophius litulon*. *Journal of the Korean Fisheries Society* 31(4): 529-534 . (In Korean, abstract in English)

Choisy JP & Jones R (1983) Predation of a cormorant *Phalacrocorax* sp. on an anglerfish *Lophius piscatorius*. *Oiseau et la Revue Française Ornithologie* 53(2): 181. (In French, summary in English)

Crozier WW (1985) Observations on the food and feeding of the angler-fish, *Lophius piscatorius* L., in the northern Irish Sea. *Journal of Fish Biology* 27(5): 655-665.

Crozier WW (1987) Occurrence of *Contracaecum clavatum* Rudolphi in angler-fish (*Lophius piscatorius* L.) from the north Irish Sea. *Fisheries Research* 5(1): 83-90.

Duarte R, Azevedo M & Pereda P (1994) Study on the growth of black monkfish (*Lophius budegassa* Spinola) and white anglerfish (*L. piscatorius*, L.) of ICES stock in Division VIIIc+IXa. *ICES Council Meeting papers* CM-1994/G:26. 16 pp.

Duarte R, Azevedo M & Pereda P (1997) Study of the growth of southern black and white monkfish stocks. *ICES Journal of Marine Science* 54(5): 866-874.

Duarte R, Azevedo M, Landa J & Pereda P (1998) Reproduction of black and white anglerfish (*Lophius budegassa* Spinola, 1807; *Lophius piscatorius* Linnaeus, 1758) in the southern stock (ICES Divisions VIIIc and IXa). *ICES Council Meeting papers* CM-1998/O:23. 21 pp.

Duarte R, Azevedo M, Landa J & Pereda P (2001) Reproduction of anglerfish (*Lophius budegassa* Spinola and *Lophius piscatorius* Linnaeus) from the Atlantic Iberian coast. *Fisheries Research* 51(2-3): 349-361.

Dupouy H, Pajot R & Kergoat B (1984) Etude de la croissance des baudroies, *Lophius piscatorius* et *L. budegassa*, de l'Atlantique Nord-Est, obtenue à partir de l'illicium. *Revue des Travaux de l'Institut des Pêches Maritimes, Nantes* 48(3-4): 107-131. (In French, summary in English)

Dupouy H (ed.) (1997) Report of the International ageing workshop on European monkfish, Lorient (France), 25-28 June 1991 and 9-11 July 1997. Lorient: IFREMER. 34 pp.

Dyb JE (2002) Bestandsstudier av breiflabb *L. piscatorius* langs kysten av Møre og i Nordsjøen. *Cand. scient*. thesis, University of Bergen. (In Norwegian)

Gordoa A & Macpherson E (1990) Food selection by a sit-and-wait predator, the monkfish, *Lophius* upsicephalus, off Namibia (South West Africa). *Environmental Biology of Fishes* 27(1): 71-76.

Gordon JDM (2001) Deep-water fisheries at the Atlantic Frontier. *Continental Shelf Research* 21(8-10): 987-1003.

Grant W & Leslie R (1993) Biochemical divergence and biogeography of anglerfish of the genus *Lophius* (Lophiiformes). *Journal of Zoology* 231: 465-485.

Gaard E & Reinert J (2002) Pelagic cod and haddock juveniles on the Faroe plateau: distribution, diets and feeding habitats, 1994-1996. *Sarsia* 87(3): 193-206.

Hislop JRG, Holst JC & Skagen D (2000) Near-surface captures of post-juvenile anglerfish in the North-east Atlantic - An unsolved mystery. *Journal of Fish Biology* 57(4): 1083-1087.

Hislop JRG, Gallego A, Heath MR, Kennedy FM, Reeves SA & Wright PJ (2001) A synthesis of the early life history of the anglerfish, *Lophius piscatorius* (Linnaeus, 1758) in northern British waters. *ICES Journal of Marine Science* 58(1): 70-86.

Holm M, Arnold GP, Holst JC & Midling KØ (1999) Capture and handling of fish for electronic tagging - a review and a new non-intrusive capture method. *ICES Council Meeting papers* CM-1999/AA:03. 24 pp.

Holst JC & McDonald A (2000) FISH-LIFT: a device for sampling live fish with trawls. Technical note. *Fisheries Research* 48: 87-91.

Køie M (1993) Nematode parasites in teleosts from 0 to 1540 m depth off the Faroe Islands (the North Atlantic). *Ophelia* 38(3): 217-243.

Landa J & Pereda P (1997) Growth of white monkfish (*Lophius piscatorius* L.) in the northern Spanish Continental Shelf (ICES Divisions VIIIc and IXa). *ICES Council Meeting papers* CM-1997/CC:07. 10 pp.

Landa J, Pereda P, Duarte R & Azevedo M (1998) Growth study of white and black anglerfish (*Lophius piscatorius* Linnaeus, 1758; *L. budegassa* Spinola 1807) based on annual sampling in the southern stock (ICES Divisions VIIIc and IXa). *ICES Council Meeting papers* CM-1998/O:21. 41 pp.

Landa J, Pereda P, Duarte R & Azevedo M (2001a) Growth of anglerfish (*Lophius piscatorius* and *L. budegassa*) in Atlantic Iberian waters. *Fisheries Research* 51(2-3): 363-376.

Landa J, Duarte R, Fariña AC, Bruno I & Castro J (2001b) Mark-recapture studies of black anglerfish (*Lophius budegassa*) in the Northeastern Atlantic: Preliminary results. *ICES Council Meeting papers* CM-2001/O:21 (Poster)

Landa J, Bruno I, Fariña AC & Autón U (2001c) Movement rates and validation trials of growth of white anglerfish (Lophius *piscatorius*) in the Northeastern Atlantic based on mark-recapture experiments. *ICES Council Meeting papers* CM-2001/O:22 (Poster)

Laurenson, C (1999) The monkfish *Lophius piscatorius* - its biology and fishery in Shetland waters. North Atlantic Fisheries College, Fisheries Development Note no. 9. <http://www.nafc.ac.uk/Research/fdn9monkfish.pdf>. Accessed February 2002. 4 pp.

Laurenson C, Priede IG, Bullough LW & Napier IR (2001) Where are the mature anglerfish? The population biology of *Lophius piscatorius* in northern European waters. *ICES Council Meeting papers* CM-2001/J:27 . 15 pp.

Leslie RW & Grant WS (1990) Lack of congruence between genetic and morphological stock structure of the southern African anglerfish *Lophius vomerinus*. *South African Journal of Marine Science* 9: 379-398.

Leslie RW & Grant WS (1994) Meristic and morphometric variation among anglerfish of the genus *Lophius* (Lophiiformes). *Journal of Zoology* 232(4): 565-584.

Lordan C (2000) The secret lives of monks and megrims! *Sherkin Comment* 25: 20.

Macpherson E (1985a) Daily ration and feeding periodicity of some fishes off the coast of Namibia. *Marine Ecology Progress Series* 26(3): 253-260.

Macpherson E (1985b) Effect of predation by *Lophius upsicephalus* on the *Merluccius capensis* population. *Collection of scientific papers. International Commission for the Southeast Atlantic Fisheries* 12(1): 155-162. (In Spanish, summary in English)

Madsen N & Hansen K (2001) Danish experiments with a grid system tested in the North Sea shrimp fishery. *Fisheries Research* 52(3): 203-216.

Meillat M, Dupouy H, Bavouzet G, Kergoat B, Morandeau F, Gaudou O & Vacherot JP (1994) Preliminary results of a trawl fitted with a selective grid for the fishery of benthic species from Celtic Sea and Bay of Biscay. *ICES Council Meeting papers* CM-1994/B:23. 15 pp.

Maartens L, Booth AJ & Hecht T (1999) The growth of monkfish *Lophius vomerinus* in Namibian waters, with a comparison of otolith and illicia methods of ageing. *Fisheries Research* 44(2): 139-148.

Nedreaas KH (2002) Breiflabb. p. 109-111 in: Iversen SA (ed.) Havets Ressurser 2002. Fisken og Havet, særnr. 1-2002. Bergen: Institute of Marine Research. 151 pp. (In Norwegian, summary in English)

Pereda P, Punzón A & Landa J (1998) The "rasco": A gillnet fishery for anglerfish (*Lophius piscatorius* L., 1758 and *L. budegassa* Spinola, 1807) in the Cantabrian Sea (ICES Division VIIIc). *ICES Council Meeting papers* CM-1998/O:46. 12 pp.

Peronnet I, Dupouy H, Rivoalen JJ & Kergoat B (1992) Methods of ageing based on caudal fin-rays for megrim (*Lepidorhombus wiffiagonis*) and on sections of illicium for anglerfishes (*Lophius piscatorius* and *L. budegassa*). p. 307-324 in: Bagliniere J-L, Castanet J, Conand F & Meunier FJ (eds) Hard tissues and individual age of vertebrates. Colloque et Séminaires. Institut Français de Recherche Scientifique pour le Développement en Coopération. (In French, summary in

English)

Petter AJ & Cabaret J (1995) Ascaridoid nematodes of teleostean fishes from the eastern North Atlantic and seas of the north of Europe. *Parasite* 2(2): 217-230.

Piñeiro CG, Casas M & Araujo H (2001) Results of exploratory deep-sea fishing survey in the Galician Bank: Biological aspects on some of seamount-associated fish (ICES Division 9b). *NAFO Scientific Council Research Documents* 01/146. 7 pp.

Quincoces I, Santurtún M & Lucio P (1998a) Biological aspects of white anglerfish (*Lophius piscatorius*) in the Bay of Biscay (ICES Divison VIIIa, b, d) in 1996-1997. *ICES Council Meeting papers* CM-1998/O:48. 29 pp.

Quincoces I, Lucio P & Santurtún M (1998b) Biology of black anglerfish (Lophius *budegassa*) in the Bay of Biscay waters, during 1996-1997. *ICES Council Meeting papers* CM-1998/O:47. 28 pp.

Quincoces I, Lucio P & Santurtún M (1999a) The growth structures in black anglerfish, *Lophius budegassa* (Spinola 1807) illicia: A photographic approximation. *ICES Council Meeting papers* CM-1999/Post:08 (Poster).

Quincoces I, Santurtún M & Lucio P (1999b) Photographical study using scanning electron microscopy techniques of illicia of white anglerfish, *Lophius piscatorius* (L. 1758). *ICES Council Meeting papers* CM-1999/Post:07 (Poster).

Reinert J (1995) Deep water resources in Faroese waters to the South, Southwest and West of the Faroes: A preliminary account. p. 201-225 in: Hopper AG (ed.) Proceedings of the NATO Advanced Research Workshop on Deep-Water Fisheries of the North Atlantic Oceanic Slope, Hull (UK), 1-4 March 1994. *NATO Advanced Science Institutes Series E: Applied Sciences* no. 296. Dordrecht: Kluwer Academic Publishers. 420 pp.

Rochet M-J, Péronnet I & Trenkel VM (2002) An analysis of discards from the French trawler fleet in the Celtic Sea. *ICES Journal of Marine Science* 59: 538-552.

Sangster G & Breen M (1998) Gear performance and catch comparison trials between a single trawl and a twin rigged gear. *Fisheries Research* 36(1): 15-26.

Silva A, Azevedo M, Cabral H, Machado P, Murta A & Silva MA (1997) Blue whiting (*Micromesistius poutassou*) as a forage fish in Portuguese waters. p. 127-146 in: Forage Fishes in Marine Ecosystems: Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems, Anchorage (USA), 13-16 November 1996. *Lowell Wakefield Fisheries Symposium Series* no. 14. Fairbanks: University of Alaska. 816 pp.

Staalesen BI (1995) Breiflabb (*Lophius piscatorius* L.) langs norskekysten. *Cand. scient*. thesis, University of Bergen. 88 pp. (In Norwegian, summary in English)

Sullivan PJ, Lai HL & Gallucci VF (1990) A catch-at-length analysis that incorporates a stochastic model of growth. *Canadian Journal of Fisheries and Aquatic Sciences* 47: 184-198.

Velasco F, Olaso I & Sánchez F (1998) The role of cephalopods as forage for the demersal fish community in the Southern Bay of Biscay. *ICES Council Meeting papers* CM-1998/M:26. 15 pp.

Woll A, Nedreaas KH & Staalesen BI (1995a) Breiflabb langs norskekysten: Fiske, biologi og bestandsgrunnlag. *Fiskets Gang* 2: 19-26. (In Norwegian)

Woll A, Staalesen BI & Nedreaas K (1995b) The development of a new gillnet fishery for anglerfish (*Lophius piscatorius*) in Norwegian waters: Biological parameters, selectivity in size and sex ratios for gillnets with 300 and 360 mm mesh sizes. *ICES Council Meeting papers* CM-1995/G:12. 11 pp.

Wright PM, Woodroffe DA, Gibb FM & Gordon JDM (2002) Verification of first annulus formation in the illicia and otoliths of white anglerfish, *Lophius piscatorius* using otolith microstructure. *ICES Journal of Marine Science* 59: 587-593.

Yoneda M, Tokimura M, Fujita H, Takeshita N, Takeshita K, Matsuyama M & Matsuura S (1998a) Age and growth of the anglerfish *Lophiomus setigerus* in the East China Sea. *Fisheries science* 64(3): 379-384.

Yoneda M, Tokimura M, Fujita H, Takeshita N, Takeshita K, Matsuyama M & Matsuura S (1998b) Ovarian structure and batch fecundity in *Lophiomus setigerus*. *Journal of Fish Biology* 52(1): 94-106.

Yoneda M, Tokimura M, Fujita H, Takeshita N, Takeshita K, Matsuyama M & Matsuura S (1998c) Reproductive cycle and sexual maturity of the anglerfish *Lophiomus setigerus* in the east China Sea with a note on specialized spermatogenesis. *Journal of Fish Biology* 53(1): 164-178.

Yoneda M, Tokimura M, Fujita H, Takeshita N, Takeshita K, Matsuyama M & Matsuura S (1997) Age and growth of anglerfish *Lophius litulon* in the East China Sea and the Yellow Sea. *Fisheries Science* 63(6): 887-892.

6 Appendices

Appendix 1 Macroscopic maturity scale for *L. piscatorius* (Afonso-Dias 1997), as used by the NAFC, Shetland.

Maturity stage		**Female**	**Male**
I	Virgin	The ovaries are very narrow (~<2cm broad), thin and ribbon-like. They are translucent and no individual oocyte-clusters or vascularization can be seen. Their volume is negligible compared with that of the other internal organs.	The testes are long, narrow (~< 1 cm broad) and have a tubular-like structure. The medial seminiferous duct is distinct, being very pale with no visible vascularization. Their volume is negligible compared with that of the other internal organs.
II	Developing or recovering/resting	The ovaries increase in length and, particularly, in width (~2 to 4cm broad). They become less translucent and there is visible vascularization. There are still no visible individual oocyte clusters. The volume occupied by the ovaries is roughly the same as the one occupied by the intestine.	The flattened tubular shaped testes increase in length and, especially, in width. Blood vessels become visible around the medial seminiferous duct. The volume occupied is roughly half that occupied by the intestine.
III	Maturing	The ovaries increase considerably in width (>4cm) and, particularly, in length. They are highly vascularized. Individual opaque oocyte clusters are visible, embedded in a gelatinous matrix. At this stage the ovaries occupy most of the abdominal cavity.	The testes have a very firm texture and moderate to large amounts of milt are produced when they are dissected. The seminiferous duct is now highly vascularized. Stage III testis still occupy less volume than the intestine.
IV	Ripe	The ovaries are extremely long (>6m) and wide (30cm) and occupy most of the body cavity. The bright orange oocyte clusters (1 to 2 mm) are embedded in a transparent gelatinous matrix. The ovaries are highly vascularized.	Milt runs from the genital pore on slight pressure. The testes are extremely turgid in texture and large amounts of milt are produced when dissected. Even at this stage the testis still occupy less volume than the intestine (except in very large fishes, where the volume are similar).
V	Spent	The ovaries are opaque and flaccid, with longitudinal striations. They are still very wide (10-15 cm) and highly vascularized.	The testes are very flaccid. Frequently, there are roseate/salmon areas in the beige surface of the testis. Milt is often present in the seminiferous duct and also when dissected. The posterior edge is sometimes narrower than the anterior part of the gonad. At this stage the testis still are highly vascularized in the vicinity of the seminiferous duct.

Appendix 2 Macroscopic maturity scale for *L. piscatorius*, as used by the MRI, Iceland (source: Mike Pawson, Lowestoft, UK).

Maturity stage	**Female**	**Male**
I	Ovaries flat and transparent, wider than the testes in male fish of similar length. The membrane connecting the ovary extends further out than that in the testes, so that gonad stretches further away from the vertebrae than in the males. In larger fish the ovary looks frilly. No eggs.	Testes pink, taking up an insignificant part of the body cavity. Slightly more rounded than the female, running almost parallel to the vertebral column. 1-2 mm in width.
II	Taking up a larger proportion of the body cavity. The ovary is broader, flat, ribbon like and longer. Egg follicles are visible as white specks and are densely packed giving the ovary a creamy appearance.	Taking up a larger proportion of the body cavity. Not transparent, firm, yellow creamy pink. No ripe milt visible in sperm ducts.
III	Thickening, becoming more orange but still flat and ribbon like. Eggs much larger and densely packed edges of the ovary beginning to curl and veins on membrane running to the ovary are more prominent. The ovary may be up to 9 m in length.	Testes larger in diameter and comprise a significant proportion of the body cavity. Creamy and firm. Sperm ducts are more pronounced but no milt extrudes when pressure applied.
IV	Eggs round and gelatinous with yellow brown centres and look similar to frog spawn. Eggs not in obvious ribbons as with the earlier stages, but appear free flowing within the ovary membrane and occupy most of the body cavity.	Milt is present in the sperm ducts of the testes or the testes contain running milt. The testes feel quite spongy and are a greeny cream colour when very ripe.
V	The ovaries have shrunk back to the size they were when maturing and the membrane appears loose and flabby. The remaining oocytes are yellow red in colour, of different sizes and breaking down as they are reabsorbed.	The testes look bruised, red and blotchy. They are not as firm as they were when maturing and there is no milt present in the sperm ducts.

Appendix 3 Macroscopic maturity scale for *L. piscatorius*, as used by the Faroese Fisheries Laboratory. Modified from Duarte *et al*. (2001) and Staalesen (1995).

Maturity stage	**Female**	**Male**
I Immature	Band-shaped ovaries Very transparent No visible oocytes	Very small tube-shaped testicles Transparent/pink/brown colour No sperm visible
II Maturing	Ovaries take up a little part of the visceral cavity Brown/orange colour Small oocytes visible Not gelatinous	Testicles take up a greater proportion of the visceral cavity White/creamy coloured Sperm not visible by cutting the gonad
III Mature	Ovaries taking up a part of the vis-ceral cavity Ovaries orange coloured Visible oocytes Gelatinous	White/creamy colour with some red areas Sperm visible by cutting the gonad Strong blood vessel in mesentery Testes have a very firm texture
IV Spawning	Orange/yellow coloured ovaries Enormous gelatinous mass wraps the hyaline oocytes	White/creamy colour with some red areas Sperm is easily freed by applying pressure to the abdomen, A lot of sperm visible by cutting the gonad Strong blood vessels in mesentery Testes have a very firm texture
V Spent/resting	Soft or retracted ovaries Grey/orange colour No visible oocytes	Grey/red stained testicles Little sperm visible by cutting the gonad Edge area sometimes transparent Testes very flaccid

Appendix 4 Macroscopic maturity scale for *L. piscatorius*, as used by the IMR, Norway. From Staalesen (1995), modified from Armstrong *et al*. (1992).

a) Female (ovaries)

<table>
<tr><th>Maturity stage</th><th></th><th>Colour</th><th>Size/form</th><th>Eggs (ova)</th><th>Vascularisation</th><th>Period</th></tr>
<tr><td>I</td><td>Immature</td><td>Greyish-pink</td><td>Small, ribbon-like ovaries, appearing almost empty</td><td>No visible eggs</td><td>No</td><td>All year</td></tr>
<tr><td>II</td><td>Developing</td><td>Pink</td><td>Ovaries increased in size, abdominal cavity slightly bulging</td><td>Ova discernible by eye</td><td rowspan="2">High</td><td>January-October</td></tr>
<tr><td>III</td><td>Ripe</td><td>Straw-coloured to almost clear</td><td>Abdominal cavity greatly bulging</td><td>Distinct ova present</td><td>March-August</td></tr>
<tr><td>IV</td><td>Spent/resting</td><td>Grayish or orange</td><td>Ovaries extremely flaccid. Appear almost empty. Larger than in Stage I</td><td>No visible eggs/atretic ova appear as black or white dots</td><td>Moderate/little</td><td>All year (spent from March-August)</td></tr>
<tr><td>V</td><td>Immature/spent (uncertain)</td><td colspan="5"></td></tr>
</table>

b) Male (testes)

<table>
<tr><th>Maturity stage</th><th></th><th>Colour</th><th>Size/form</th><th>Milt</th><th>Texture</th><th>Period</th></tr>
<tr><td>I</td><td>Immature</td><td>White to tan</td><td>Medial groove less distinct. Similar in shape to mature testes, but very small</td><td>No</td><td></td><td>All year</td></tr>
<tr><td>II</td><td>Developing</td><td>Blotchy cream to tan</td><td rowspan="2">Ring of creamy testes. Enlarged blood vessels in mesentery.</td><td>Moderate to large amount of milt produced when dissected</td><td>Very firm</td><td>January-June</td></tr>
<tr><td>III</td><td>Ripe</td><td>Blotchy cream to tan with areas of pink</td><td>Milt produced from genital pore when pressure is applied to abdomen, copious amounts present when dissected</td><td>Extremely firm</td><td>March-August (until October)</td></tr>
<tr><td>IV</td><td>Spent/resting</td><td>Grayish-tan with pink areas. Edges appear translucent.</td><td>Extremely flaccid. Larger than Stage I. Medial groove distinct.</td><td>Small amount of milt present when dissected</td><td>Flaccid</td><td>July-October (spent from October-January-)</td></tr>
<tr><td>V</td><td>Immature/spent (uncertain)</td><td colspan="5"></td></tr>
</table>

Appendix 5 Data from preliminary analyses of the maturation cycle in anglerfish, from gonad samples collected in Faroese waters in 2002. GSI = gonadosomatic index (gonad weight/whole body weight); chorion = egg shell, yolk granules = yolk-containing structures found in cytoplasm; atretic = resorbing oocytes.

Date	Fish no.	Total length (cm)	GSI (%)	Maturity scale		Rel. oocyte diam.	Oocyte stage	Chorion	Yolk granules	Mucus	Cytoplasmic activity	Cell packing	Atretic
				Macroscopic	Microscopic								
8.3.02	52	62	0.56	1	1	26.0	Perinucleolar	no	no	no	low	high	-
8.3.02	24	77	0.66	Uncert.	1	38.0	Perinucleolar	no	no	no	med	high	-
8.3.02	61	75	0.52	1	1	39.0	Perinucleolar	no	no	no	low	high	-
2.9.02	16	91	0.76	2	1	53.0	Perinucleolar	no	no	no	low	high	-
8.3.02	36	88	0.82	5	1	56.5	Perinucleolar	no	no	no	low	high	-
2.9.02	5	71	0.70	1	1	27.5	Perinucleolar	no	no	no	low	high	-
2.9.02	10	81	0.48	5	1	32.0	Perinucleolar	no	no	no	high	high	-
5.6.02	29	87	0.64	1	1	41.0	Perinucleolar	no	no	no	low	high	-
2.9.02	11	91	0.61	5	1	43.5	Perinucleolar	no	no	no	low	med	-
2.9.02	7	90	0.65	1	1	45.0	Perinucleolar	no	no	no	low	high	yes
5.6.02	44	89	0.80	1	1	46.0	Perinucleolar	no	no	no	med	med	-
8.3.02	23	95	0.99	5	1/2	50.5	Perinucleolar	no	no	no	med	high	-
2.9.02	18	83	0.86	2	1/2	52.0	Perinucleolar	no	no	some	med	high	-
2.9.02	8	81	0.58	1	1/2	52.5	Perinucleolar	no	no	no	med	med	-
5.6.02	43	97	1.00	1	1/2	59.0	Perinucleolar	no	no	little	high	high	-
5.6.02	15	103	2.50	2	2	58.5	Perinucleolar	no	no	no	high	med	-
2.9.02	23	99	0.86	2	2	63.0	Perinucleolar	no	no	no	med	med	-
5.6.02	16	93	0.95	2	2	63.5	Perinucleolar	no	no	no	med	med	yes
5.6.02	40	92	1.28	2	2	64.0	Perinucleolar	no	no	little	high	high	-
5.6.02	1	119	1.54	2	2	70.5	Perinucleolar	no	no	yes	low	high	yes
2.9.02	12	118	2.24	2	2	82.0	Perinucleolar	no	no	some	high	high	-
5.6.02	37	98	1.24	2	2/3	74.0	Perinucleolar	no	no	some	high	med	-
2.9.02	14	96	1.47	2	2/3	76.0	Migratory	yes	beg.	some	high		yes
2.9.02	17	108	1.90	2	2/3	77.5	Perinucleolar	no	no	some	high	med	-
2.9.02	13	100	1.28	2	2/3	91.5	Perinucleolar	yes	no	little	high	low	-
5.6.02	36	101	1.51	2	2/3	101.0	Perinucleolar	beg.	no	no	high	low	-
5.6.02	48	112	1.72	2	2/3	108.0	Perinucleolar	yes	no	some	med	high	-
8.3.02	30	90	9.00	3	3		Migratory	yes	yes	yes	high	low	-
8.3.02	45	104	13.44	3	3		Migratory	yes	yes	yes	high	low	yes