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Atlas of North Sea Fishes

Based on bottom-trawl survey data for the years 1985—1987

Ruud J. Knijn[1], Trevor W. Boon[2], Henk J. L. Heessen[1], and John R. G. Hislop[3]

[1]Netherlands Institute for Fisheries Research, Haringkade 1, PO Box 68, 1970 AB IJmuiden, The Netherlands
[2]MAFF, Fisheries Laboratory, Lowestoft, Suffolk NR33 0HT, England
[3]Marine Laboratory, PO Box 101, Victoria Road, Aberdeen AB9 8DB, Scotland

Fish illustrations by Peter Stebbing

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Within the text, numbers enclosed in square brackets refer to publications listed at the end of Chapter 5 (page 25) or at the end of the relevant species account.

1. Introduction

The information used by fishery biologists for the assessment of commercial fish stocks originates both from the fishing industry itself (catch and effort data) and from surveys carried out with research vessels. Over the last two decades these surveys have become an integral part of routine fish stock assessment, and the survey data, which are obtained independently of the commercial fisheries, have become increasingly important in recent years, owing to a general deterioration in the quality of catch statistics.

At present, a great many surveys are conducted in the North Sea, mostly under the supervision of the International Council for the Exploration of the Sea (ICES), the world's oldest intergovernmental organization concerned with marine and fishery science. Typically, survey data are routinely analysed to provide data on distribution, abundance, maturity, etc. for only a small group of commercially exploited fish species. The general procedure during a survey, however, is to sample at least the size distribution of all species in the catches. This has resulted in the accumulation of a large body of data which, for the most part, lie neglected in various databases. Few published data on the distribution of North Sea fishes are available; these are mainly on commercial species and, quite often, only refer to part of the North Sea [e.g. 1,2,3]. It is apparent, however, that the enormous amount of information collected during surveys is of value and may be of considerable interest not only to fisheries scientists, but also to a wider public.

The proposal to publish survey data in the form of an atlas was first discussed during the annual Statutory Meeting of ICES in 1988 [4]. In 1989 an ICES Study Group met for three days to investigate the feasibility of the project [5] and in the same year a Steering Group was formed to organize the necessary work. This Steering Group consisted of H.J.L. Heessen (IJmuiden, The Netherlands), J.R.G. Hislop (Aberdeen, United Kingdom), T.W. Boon (Lowestoft, United Kingdom), and W.L. Panhorst (ICES Secretariat). It was originally expected that most of the data would be extracted at the ICES Secretariat, but for logistic reasons the analyses were done at the fisheries research institutes in IJmuiden and Lowestoft. W.L. Panhorst, therefore, only participated in the 1989 meeting. In addition to the Steering Group, R.J. Knijn worked on the *Atlas* at the IJmuiden Institute during most of 1991 (funded by the Dutch Government) and 1992 (funded by the Commission of the European Communities, as part of the FAR programme). The Steering Group held two brief meetings (on 7 and 8 May 1991 in Lowestoft and from 29 April to 1 May 1992 in IJmuiden), but most of the work was done by correspondence.

The main objective of the *Atlas of North Sea Fishes* is to give an overview of the data available from surveys and at the same time to fill an important gap in our knowledge of the spatial distribution of North Sea fishes. In addition, it is hoped that the information presented here will provide a baseline which may in time serve to reveal secondary effects of fishing or changes in the fauna due to changes in the environment.

The *Atlas* is based on a series of bottom-trawl surveys carried out in the years 1985 – 1987. Following the introductory chapters, which describe the methods used to collect and process the data and provide relevant information on the biotic and abiotic environment, the distribution of 98 species or species groups is presented, together with a brief description of their biology. These 98 species (out of the 224 species known to occur in the North Sea) comprise all species caught during the surveys. Distribution maps are given for summer and winter and, for the more abundant species, for juvenile and adult fish separately.

It must be understood that the unit used to illustrate the distribution of the different species, i.e. the number caught per hour fishing, is a unit of relative abundance (see also Chapter 5). A bottom trawl will never catch all the fish in its path and the efficiency of the gear differs both between and within species. Within these confines, however, the authors hope that the data presented here will lead to a better understanding of the fishes of the North Sea.

Any atlas will undoubtedly have its limitations. The way in which the information is presented here was chosen by the Steering Group. Some users might prefer to have the data available at different levels of aggregation or might wish to add new data, and some people have already expressed their interest in obtaining the *Atlas* data in a digitized form. These possibilities, however, fell beyond the scope of the present project.

Since most of the surveys analysed here are annual events, more data on the distribution of fishes become available every year. In addition, in 1990 it was agreed within ICES that there should be more international coordination and standardization of national surveys, and it was decided that for a period of five years starting in 1991, the North Sea, Skagerrak, and Kattegat would be surveyed with bottom trawls on a quarterly basis [6]. This programme, the International Bottom Trawl Survey, should considerably increase our knowledge of fish distribution and migration, and should eventually form the basis of a revised and expanded *Atlas of North Sea Fishes*.

Acknowledgements

Many people have in one way or another contributed to the realization of this *Atlas*, and the authors wish to thank them for their cooperation. First of all the crews of the various research vessels should be mentioned as well as our colleagues who sorted and measured large amounts of fish and later worked up the data. Staff members of the ICES Secretariat put a lot of effort into setting up the International Young Fish Survey Database. Dr Niels Daan was one of the initiators of the Atlas Project, and

we also relied heavily on his computer programs for the analyses of the survey data done at the IJmuiden Institute. Several people gave their comments on (parts of) the text, provided references, or placed unpublished material at our disposal. We would also like to thank the librarians of the Netherlands Institute for Fisheries Research, Suze Koudenburg and Cecile Huber. French fish names were provided by Arnauld Souplet, German names by Dr Siegfried Ehrich, Danish names by Henrik Sparholt, Norwegian names by Odd Smedstad, and Swedish names by Olle Hagström. Finally, the authors wish to thank the Directorate-General for Fisheries of the Commission of the European Communities for financial support. Without that contribution the publication of this *Atlas* would certainly have been substantially delayed.

References: see page 25.

2. Recruit surveys

2.1 General purpose of the surveys

Several sources of information are used to assess commercial fish stocks [7]. The most important is the fishery itself. All countries surrounding the North Sea collect basic data on the weights of fish landed and the amount of fishing effort expended to harvest the fish. Market sampling programmes provide information on the numbers of fish landed and their age composition. By definition, however, the commercial fishery can only provide information on the current state of the exploitable component of the fish stocks. In order to be able to offer soundly based advice on the management of the fisheries, scientists must be able to forecast the state of the stocks in the near future, taking into account the numbers of fish that are still too young and too small to appear in the fishery. One of the routine methods used to collect information of this sort is the recruit survey.

Recruit surveys, which are usually undertaken by research vessels using small-meshed nets, provide annual indices of year-class strength, e.g. the mean number of one-year-old fish caught per hour fishing in a certain area. It is essential that the results of these surveys are comparable between years. This comparability can only be achieved if surveys are carried out at the same time of year, in the same area, and if the same methods are used from year to year. An example of an index is shown in Figure 1, which gives the annual catch rates of juvenile herring (*Clupea harengus*) in the North Sea from the International Young Fish Survey [8].

As mentioned above, the numbers and age compositions of the commercial landings are determined, on a routine basis, through a market sampling programme. Thus it is known, for example, how many one-year-old cod (*Gadus morhua*) were landed in 1981. These fish belong to year class 1980 (the year in which they were born). By determining how many two-year-old cod were landed in 1982, three-year-old cod in 1983, etc. a year class can be followed throughout its life in the fishery. By adding all the numbers of year class 1980 that were caught at each age, and assuming that a certain percentage died each year through 'natural' causes (such as disease or predation), one is in principle able to calculate the minimum estimate of the total number of cod of year class 1980 that were alive in the sea as one-year-olds. This procedure, in which a certain group, or cohort, is followed during its entire life span, is called cohort analysis or Virtual Population Analysis (VPA). After a number of years it is possible to calculate the relationship between the survey index (which is a measure of relative abundance) and the VPA figure (which is a measure of real abundance). This makes it possible to estimate the numerical strength of the youngest year classes, for which only survey indices are available. It is extremely important to be able to do this, because these young fish are likely to make up a large part of the landings in the coming year (Figure 2).

In addition to supplying information on the distribution and abundance of fish, recruit surveys provide material and information for a wide range of biological and environmental studies. They are used, for example, to collect fish stomachs for research into intra- and interspecific relations, to study the occurrence of fish diseases in relation to pollution, and to collect hydrographical data.

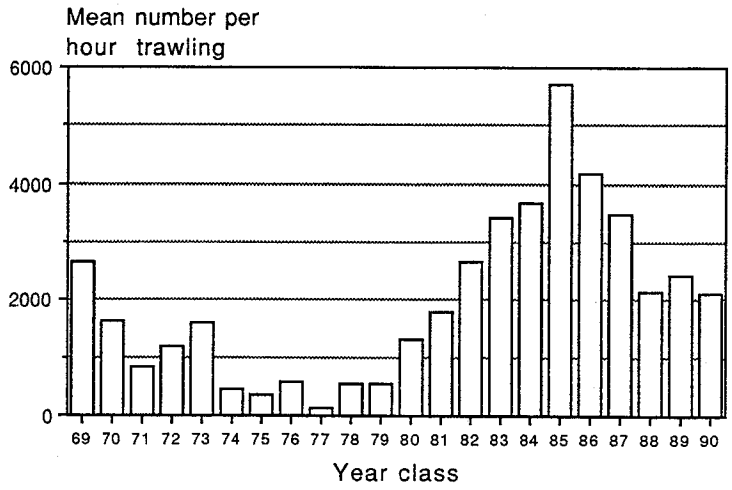

Figure 1. Index of year-class strength for North Sea herring caught as 1.5-year-old fish in the International Young Fish Survey in February.

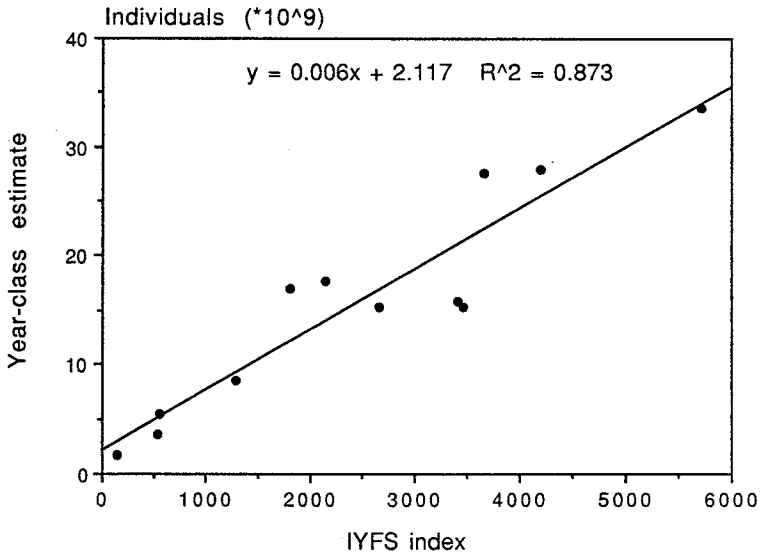

Figure 2. Relation between the herring index of the International Young Fish Survey (IYFS) and year-class size in number of individuals estimated from Virtual Population Analysis (VPA). The linear regression line calculated from this relation is indicated.

2.2 Surveys used for the *Atlas*

The data on winter distributions presented in this *Atlas* are based on information from the International Young Fish Survey (IYFS). The summer data originate from the English Groundfish Survey (EGFS), the Scottish Groundfish Survey (SGFS), and a number of additional Dutch multispecies surveys. A brief description of the history, aims, and methods of each survey is given below.

The International Young Fish Survey (IYFS)

This survey started in 1960/1961. In these years four large international trawling surveys were organized under the auspices of ICES to map the distribution of juvenile herring in the North Sea and to investigate the links between herring nursery grounds and the adult populations.

After an interval of three years, the Netherlands took the initiative in 1965 to resume the surveys, with the objective of obtaining annual recruitment indices for the combined North Sea herring stocks, and the survey was named the International Young Herring Survey (IYHS). Gradually, an increasing number of countries participated in this research. For the first few years, sampling was restricted to the southern and central North Sea and, beginning in 1969, the Skagerrak and Kattegat. When it was realized that the IYHS could provide recruitment indices not only for herring, but also for roundfish species such as cod, haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*), and Norway pout (*Trisopterus esmarki*), the survey area was extended northwards to cover the entire area of distribution of juvenile haddock and Norway pout. No longer exclusively aimed at herring, the survey was renamed the International Young Fish Survey (IYFS). The whole North Sea, the Skagerrak, and the Kattegat have been surveyed from 1974 onwards, with most hauls being made in the month of February.

The stratification of the survey is based on the grid of ICES statistical rectangles (one degree longitude × 0.5 degree latitude ≈ 30 × 30 nautical miles ≈ 56 × 56 km; see also Figure 13). Each rectangle is usually fished by the ships of two different countries so that at least two hauls are normally made per rectangle. The fishing positions within each rectangle should, in theory, be chosen at random. In practice, however, many vessels fish at more or less fixed positions in order to minimize damage to the trawl. Haul duration is standardized to 30 minutes, although the Scottish vessel makes one-hour hauls.

The English Groundfish Survey (EGFS)

In the summer of 1977 England began a series of trawl surveys of demersal fish. These surveys were planned to run for at least ten years to establish a time series of data which could be used to study the biology and ecology of demersal fish as well as some specific problems of fisheries management [9].

The EGFS attempts to cover the entire North Sea. To ensure comparability from year to year, the surveys were carried out in late summer (August – September) each year, by the same research vessel ('Cirolana'). The stations were chosen at random within five depth bands (0 – 30, 30 – 50, 50 – 100, 100 – 150, 150 – 200 m), but very rough grounds were avoided. During the first five-year period 46 stations were sampled and either two or three one-hour hauls were made at each station. From

1982 onwards another 35 stations were added to give better spatial coverage, but only a single one-hour haul was made at each station.

The Scottish Groundfish Survey (SGFS)

This survey, which takes place in August, began in 1982. Hauls lasting for one hour are made at fixed positions, one per statistical rectangle. The survey area includes the greater part of the central and northern North Sea. The SGFS is primarily intended to provide information on the strengths of the recruiting year classes of haddock, whiting, and cod, but all species in the catches are systematically sampled.

Dutch multispecies surveys

The Dutch surveys were carried out in summer (August – September) in 1985, 1986, and 1987. Their main objective was to collect stomachs of cod and whiting and the results of these investigations have been extensively used by the ICES Multispecies Assessment Working Group. The surveys were planned to complement the English and Scottish surveys, in order to ensure complete coverage of the North Sea.

2.3 Gear and fishing method

The basic fishing gear used during these surveys is the otter trawl. An otter trawl has three principal components: a funnel-shaped net, a pair of trawl doors (otter boards) and wires called sweeps, which connect the doors to the net (Figure 3). The doors are attached to the towing wires (warps) in such a way that they tend to move outwards, in opposite directions, thereby increasing the horizontal opening of the net. The height of the vertical opening of the net is determined by floats attached to the upper part of the mouth of the trawl. One or more 'kites' are sometimes used to increase the vertical opening.

The belief that it is only the net that 'fishes' is a common misunderstanding. However, the doors and sweeps also play a very important role in the operation, because when the gear is pulled along the bottom they raise clouds of sediment, which herd fish into the path of the net. This greatly increases the area swept by the gear.

The mesh size of the netting decreases from the front part of the net to the back, where the fish accumulate in the so-called codend. The mesh size of the codend has a significant influence on the size distribution of the fish which are retained by the trawl.

For a bottom trawl to fish properly, it is essential that the groundrope (the leading edge of the bottom of the trawl) makes good contact with the seabed. When fishing on smooth ground, the groundrope usually consists of a plain wire or, as in case of the GOV trawl (see below), small rubber discs. However, if it is necessary to work on rough or stony ground, large rollers or bobbins are often added to prevent the net from being damaged. A disadvantage of bobbins is that fish can escape beneath them.

Details of the gears used during the surveys

During the early years of the International Young Fish Survey a 78-foot Dutch herring trawl was recommended as the standard gear. However, this gear could not be operated from stern trawlers and in 1976 the GOV trawl was adopted as the new standard gear. This is a French-designed trawl, with a high vertical net opening (chalut à Grande Ouverture Verticale). The mesh sizes decrease from 100 mm at the mouth of the net to 10 mm (20 mm stretched mesh) in the codend. The horizontal opening of the trawl is approximately 20 m and the vertical opening 5 to 6 m. The standard sweeps used with this gear measure 50 m, but when the water is deeper than 70 m longer sweeps (100 m) are used. The distance between the trawl doors (which determines the area swept by the gear)

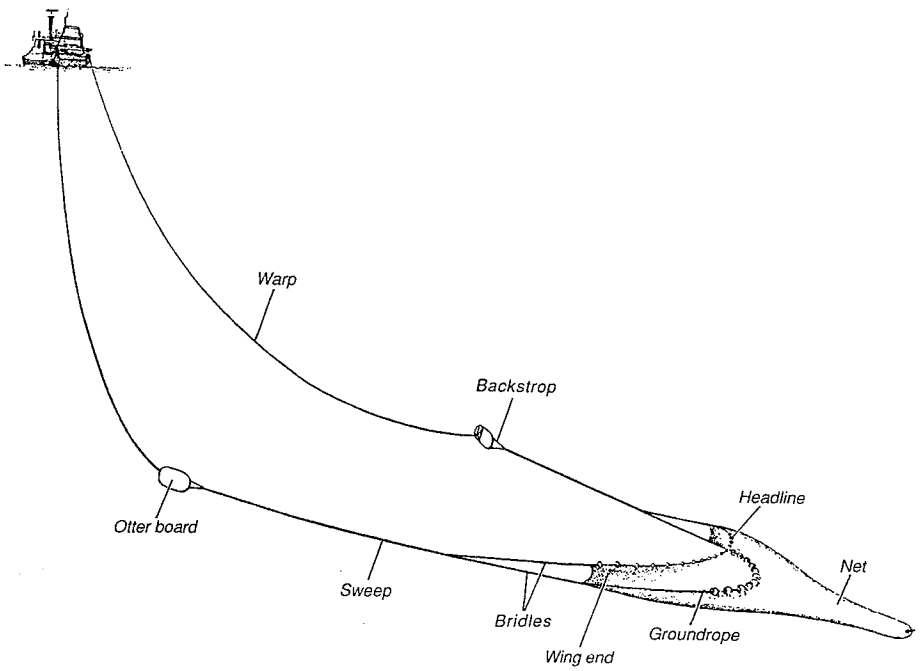

Figure 3. An otter trawl.

Table 1. Features of the trawls used during the *Atlas* surveys.

	GOV	Aberdeen 48 ft	Granton
Average distance between doors (m)	72	70	48
Average distance between wing ends (m)	21	22	18
Average headline height (m)	5	2	2
Length of backstrop (m)	10.0	8.5	11.5
Length of sweep (m)	50.0	55.0	18.3
Length of bridle + attachment (m)	40.0	6.4	5.2
Length of headline (m)	36.0	30.0	23.8
Number of floats (0.2 m Ø)	50	56	40
Area of kite (m^2)	0.7	none	0.5
Length of groundrope (m)	47.0	36.0	36.6

Structure of groundrope (rubber on a wire core), description of one half of the groundrope from wing end:

GOV:	16 m of 0.1 m Ø + 7.5 m of 0.2 m Ø (no bobbins)
Aberdeen 48 ft:	10 m of 0.15 m Ø + 2.5 m of 4 × 0.38 m Ø bobbins + 2.5 m of 4 × 0.46 m Ø bobbins + 3 m of 4 × 0.53 m Ø bobbins
Granton:	15.2 m of 0.1 m Ø + 3.1 m of 4 × 0.3 m Ø discs

Table 2. Participating research vessels and number of hauls in the different surveys.

WINTER SURVEYS

	1985		1986		1987	
Country	Vessel	Hauls	Vessel	Hauls	Vessel	Hauls
Denmark	Dana	39	Dana	39	Dana	40
England	Cirolana	56	Cirolana	61	Cirolana	64
France	Thalassa	78	Thalassa	73	Thalassa	85
Germany	Anton Dohrn	117	Anton Dohrn	114	Walther Herwig	99
Netherlands	Tridens	56	Tridens	59	Tridens	62
Netherlands	Isis	47	Isis	49	Isis	44
Norway	Eldjarn	46	Eldjarn	41	Eldjarn	41
Scotland	Scotia	58	Scotia	52	Scotia	58
Sweden	Argos	32	Argos	41	Argos	48
All		529		529		541

SUMMER SURVEYS

	1985		1986		1987	
Country	Vessel	Hauls	Vessel	Hauls	Vessel	Hauls
England	Cirolana	73	Cirolana	82	Cirolana	77
Netherlands	Tridens	35	Klaas sr (KW 34)	58	Tridens	51
Netherlands	-	-	Isis	18	Isis	35
Scotland	Scotia	83	Scotia	80	Scotia	73
All		191		238		236

depends on both the length of the sweeps and on the water depth, varying from 70 m in shallow water to about 120 m in the deeper parts of the North Sea.

Although the GOV trawl was adopted as the standard gear for the IYFS, and a detailed specification of the net is given in the IYFS *Manual* [10], in practice the nets used by individual vessels are all slightly different. This is mainly due to different interpretations of the net drawings and to differences in the way the nets are rigged. One factor which may have influenced the catches of the various vessels is the length of the small-mesh section of the net, which varies from country to country [11]. This has not been systematically investigated, and no correction has been applied to adjust for possible differences.

Another difference between the GOV trawls used by the vessels participating in the IYFS which may be important is the extent to which bobbins were used on rough grounds. Although the survey *Manual* strongly recommends that a standard groundrope, consisting of rubber discs, should be used throughout the survey area, bobbins are quite often used to reduce gear damage. Trawls fitted with bobbins are expected to catch fewer small fish than those with the standard groundrope [12,13] but no corrections have been applied to the data.

A Granton trawl is used for the EGFS. The main difference compared with the GOV trawl is the much smaller vertical opening (approximately 2 m). The mesh size of the codend is 10 mm (20 mm stretched mesh), i.e. the same as in the GOV. In order to increase the catch of flatfishes, a 'tickler' is used. This is a chain fixed in front of the groundrope for the purpose of disturbing fish on the seabed and coaxing them to swim over the groundrope into the net.

An Aberdeen 48-ft trawl is used for the SGFS. This net was chosen in order to maintain a degree of continuity with a long series of autumn/winter Scottish surveys that began in the 1920s [14]. The codend is enclosed within a cover with a stretched mesh size of 35 mm. Because of the bigger mesh size, as compared with the GOV and Granton trawls, this net catches fewer small fish than the other two gears.

The main differences between the three trawls are given in Table 1.

Because of the large differences between GOV, Granton, and Aberdeen trawls it was deemed necessary to correct the numbers of some species caught during the summer surveys for differences in gear efficiency (see also Chapter 4 and Appendix).

2.4 Sampling and measuring

Once the catch has been taken on board and sorted into species, the fish are measured. It is often possible to count and measure the entire catch, but in the case of a large catch only a representative subsample is worked up. All fish are measured from the tip of the snout to the end of the tail (total length). An exception to this rule is the practice on the Scottish research vessel of measuring the widths of skates and rays, rather than the lengths. These width measurements have been transformed to total length, using species-specific correction factors (A. Newton, Aberdeen, personal communication). Length is measured to the centimetre (or in some cases the half centimetre) below. This means that fish measuring from 24.0 up to and including 24.9 cm are recorded in the length class 24 cm.

In addition to length measurements, the otoliths (earstones) or scales of a number of commercial species are collected. When these structures are examined with a microscope, the age of the fish can be determined by counting annual growth zones.

Although haul duration varied from thirty to sixty minutes, all data were stored as numbers per hour fishing. In other words, when only one fish was caught during a thirty-minute tow, this was recorded as a catch rate of two per hour fishing.

All hauls in which there was significant damage to the net, or where it was suspected that the net had not been fishing properly, were excluded from the analyses.

2.5 Time period selected (1985 – 1987)

For this *Atlas*, the results of surveys made in 1985, 1986, and 1987 were averaged to describe the distributions of each species in winter (February) and in summer (August – September). The reasons for selecting this time period are as follows.

In the IYFS Database held at the ICES Secretariat in Copenhagen, complete computerized data are available from 1982 onwards and, for a limited number of participating countries, as far back as 1970. There are, therefore, plenty of winter survey data to choose from. However, the summer survey data are more limited. Computerized data from the English Groundfish Survey are available from 1977 onwards, and from the Scottish Groundfish Survey from 1982 onwards. However, it was only in the years 1985 – 1987, when an additional GOV survey was carried out by the Netherlands in the southern and central North Sea, that the whole North Sea was covered. These three surveys were thought to provide the best data available in a computerized format to describe the summer distributions of North Sea fishes and, for the sake of consistency, the same time period (1985 – 1987) was used for the winter surveys.

Table 2 gives a list of the participating vessels and the number of hauls made in each year.

References: see page 25.

3. Factors affecting the distribution of North Sea fishes

3.1 Physical environment

Although strictly speaking outside the scope of this *Atlas*, brief reference must be made to some basic physical features of the area covered, since these are likely to affect the spatial distribution of the fishes.

North Sea

The northwestern boundary of the North Sea lies along the edge of the continental shelf, west of the Orkneys and Shetlands, whilst the northeastern margin is formed by a trough, the Norwegian Deep, with a depth of up to 700 m. The North Sea is connected to the Baltic by the Skagerrak and Kattegat and has a southerly connection with the Atlantic by way of the English Channel. It is a relatively small basin, with a surface area of about 575,300 km^2, and a volume of 42,300 km^3 [15]. It is also rather shallow; the mean depth ranges from about 30 m in the southeast to 200 m in the northwest (Figure 4).

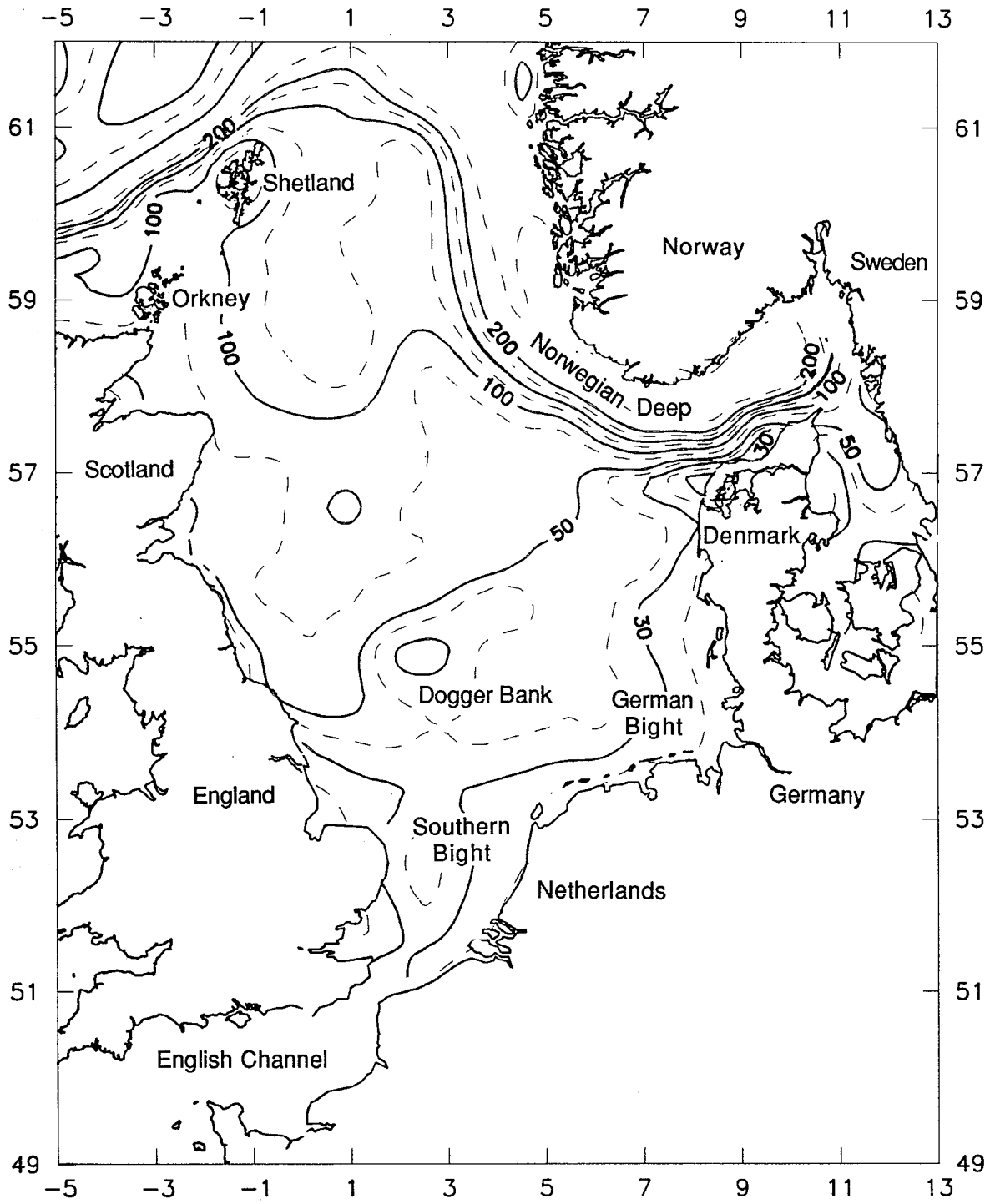

Figure 4. Depth contours (in metres) of the *Atlas* area. Data from the ICES Oceanographic Data Bank.

The North Sea is influenced by the Atlantic Ocean, mainly by input from the north but also, to a lesser extent, via the English Channel. To the northwest of the British Isles, a strong Atlantic current flows north along the edge of the continental shelf. Several currents bring Atlantic water into the northern North Sea, with one current entering the Norwegian Deep [16,17]. An extensive review of the physical oceanography of the North Sea is given in [18].

Although the North Sea occupies a rather small area, it is by no means homogeneous as regards, for example, depth, temperature, water type, and substratum. On the basis of hydrographic and biological conditions, the North Sea can be divided into seven geographical 'boxes' (Figure 5) [15]. There are marked seasonal and regional differences in the vertical structure of the water column. Throughout the winter, the water in most areas is vertically well mixed, or only slightly stratified. From spring to autumn, however, the water in some areas remains mixed, whereas in other areas it becomes stratified. In stratified areas, which include large parts of the northern and central North Sea, the water temperature near the surface increases much more rapidly than the temperature near the bottom and a strong seasonal thermocline develops during May and June. The thermocline becomes more pronounced during summer and autumn and is broken down by wind and wave action in late autumn. The boundaries

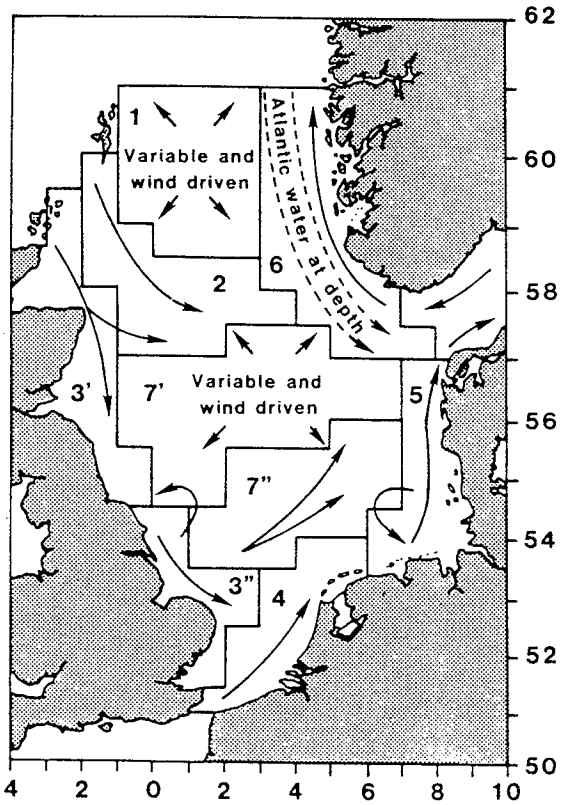

Figure 5. Hydrographical subdivisions of the North Sea [15] (after [19]). A schematic representation of the surface currents is superimposed. In [15] the following characteristics for these areas are given:

Area 1	:	Slow-moving water mass of recent oceanic origin, summer stratification.
Area 2	:	Fairly rapid water movement of mixed oceanic-coastal waters, in summer only partly stratified.
Area 3	:	Slow-moving southerly drift, transient stratification, fresh water content increasing southwards.
Area 3'	:	Relative deep water (> 50 m).
Area 3"	:	Relative shallow water (< 50 m).
Area 4	:	Inflow of Channel water, mixed with coastal water, strong horizontal gradients of salinity, vertical stratifications only close to the coast.
Area 5	:	Northward drift, coastal water mass with some stratification.
Area 6	:	Surface layers: northward movement of Norwegian coastal water and Baltic outflow. Deeper layers: laterally inhomogeneous, with southerly flow in the west (water of recent oceanic origin) and northerly flow in the east (mixed water masses).
Area 7	:	Water moving in variable directions, with slow net movements, strongly developed summer thermocline, central North Sea water mass. In summer two separate areas (7' and 7") underneath the thermocline, north and south of the Dogger Bank.

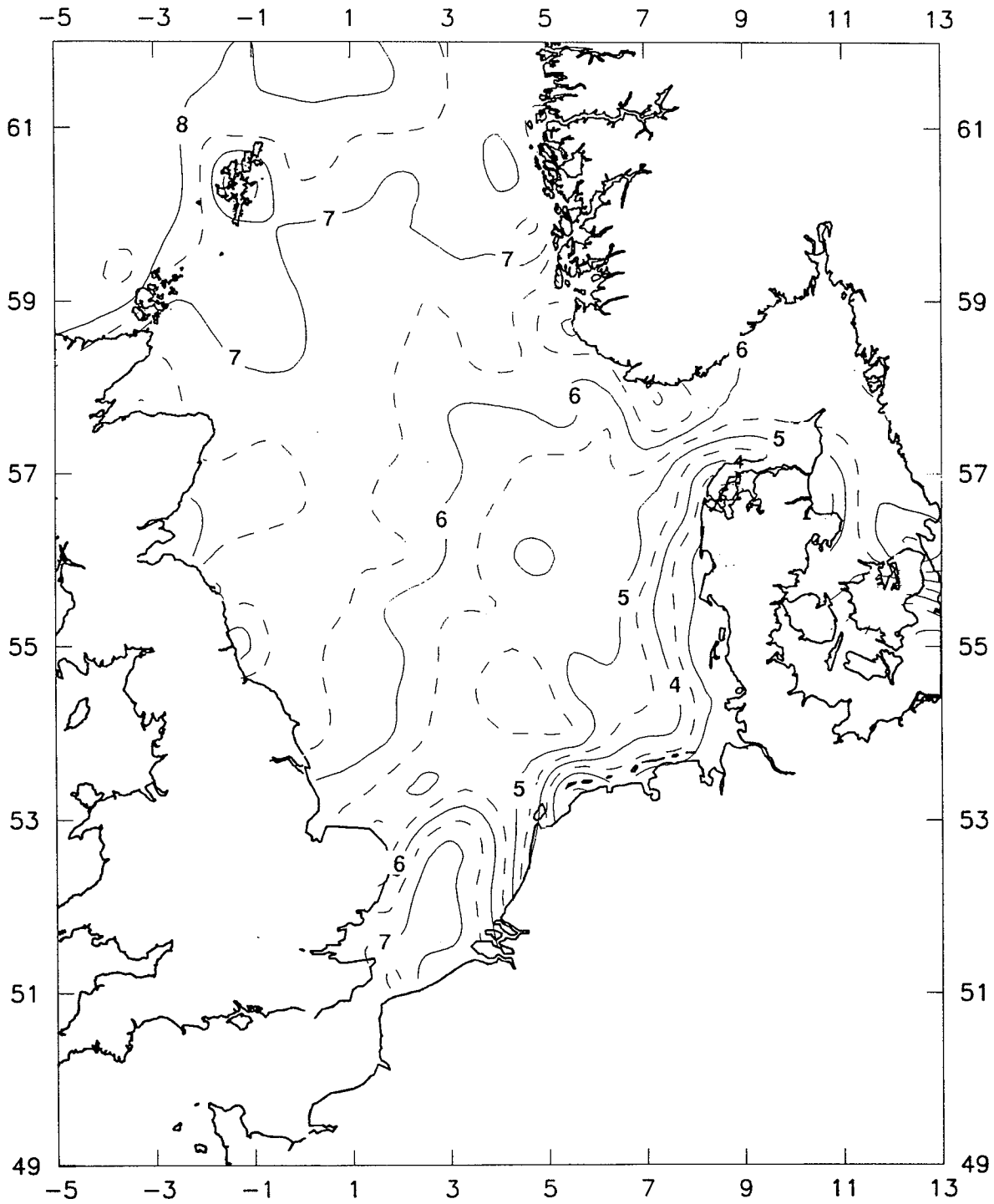

Figure 6. Average bottom temperature (in °C) in winter (January – March) during the period 1980 – 1989. Data from the ICES Oceanographic Data Bank.

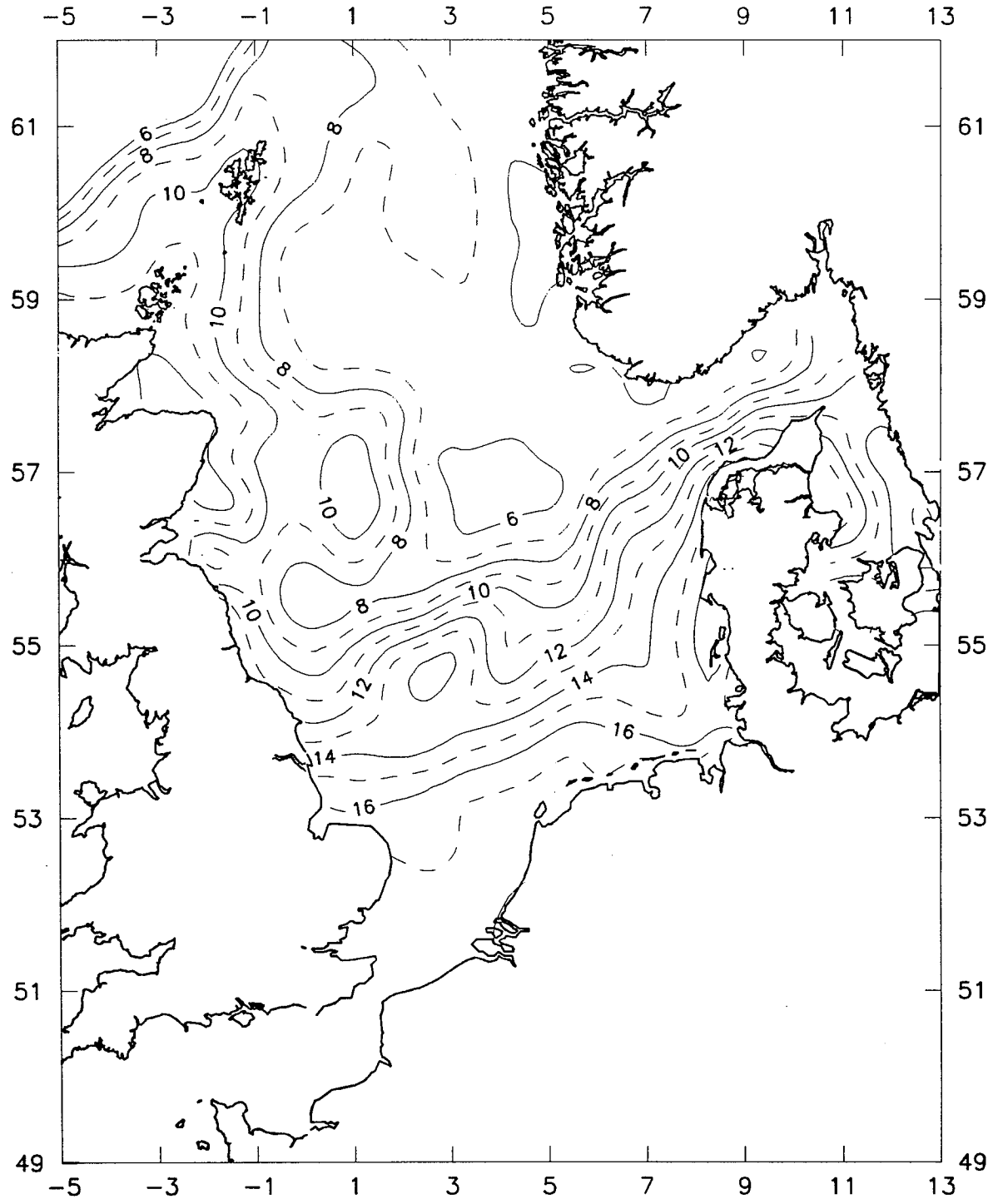

Figure 7. Average bottom temperature (in °C) in summer (July – September) during the period 1980 – 1989. Data from the ICES Oceanographic Data Bank.

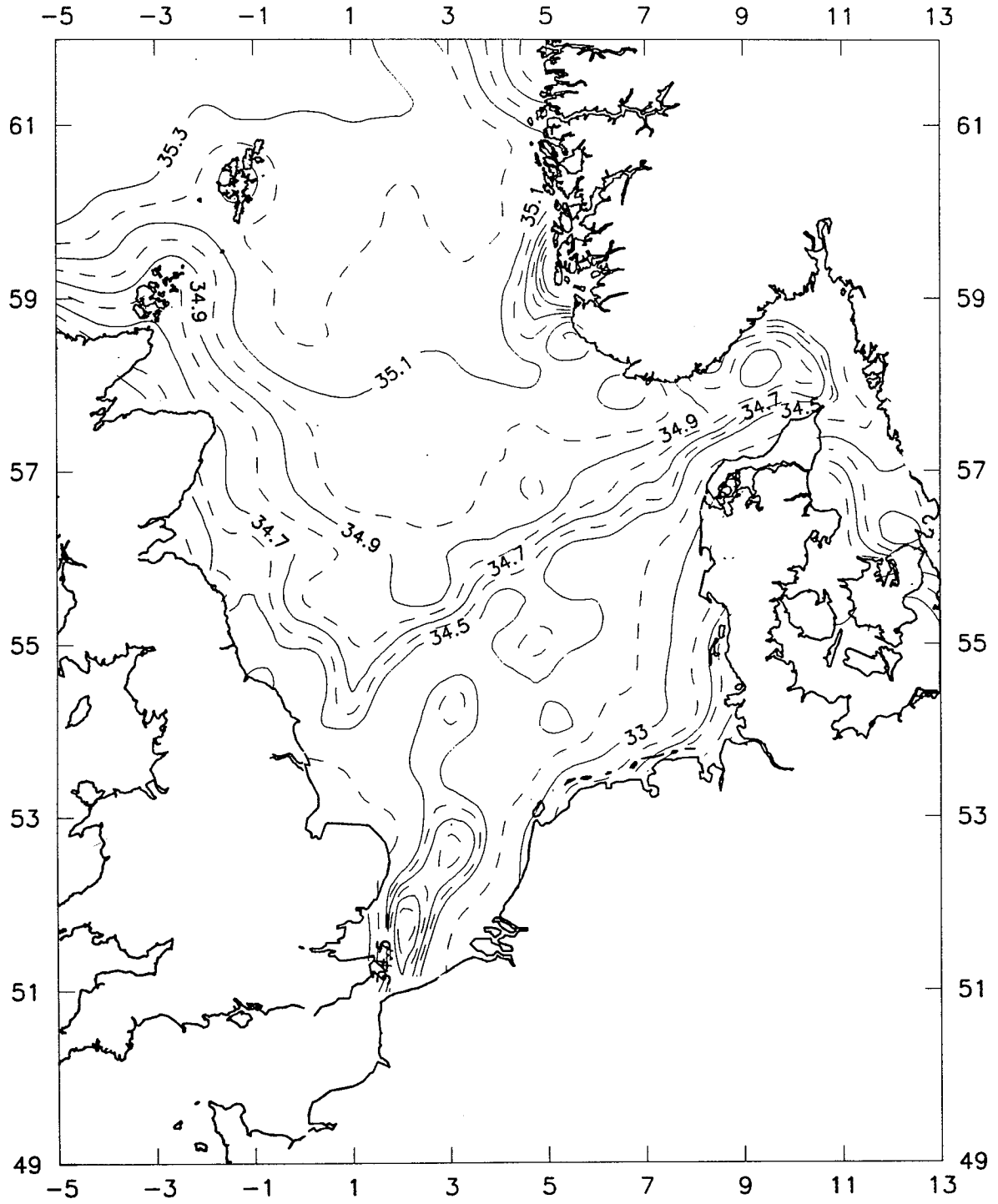

Figure 8. Average salinity in winter (January—March) during the period 1980—1989. Data from the ICES Oceanographic Data Bank.

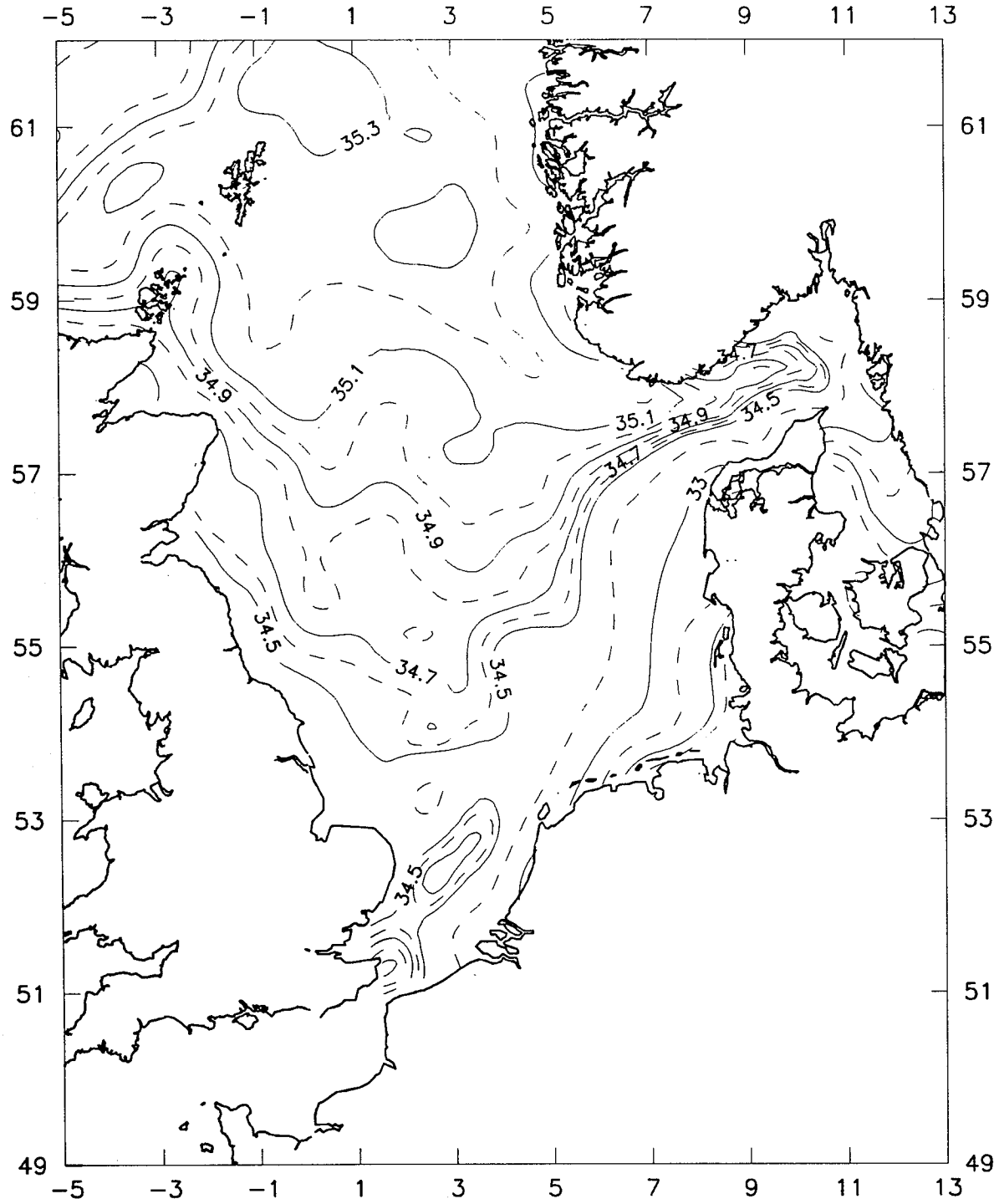

Figure 9. Average salinity in summer (July—September) during the period 1980—1989. Data from the ICES Oceanographic Data Bank.

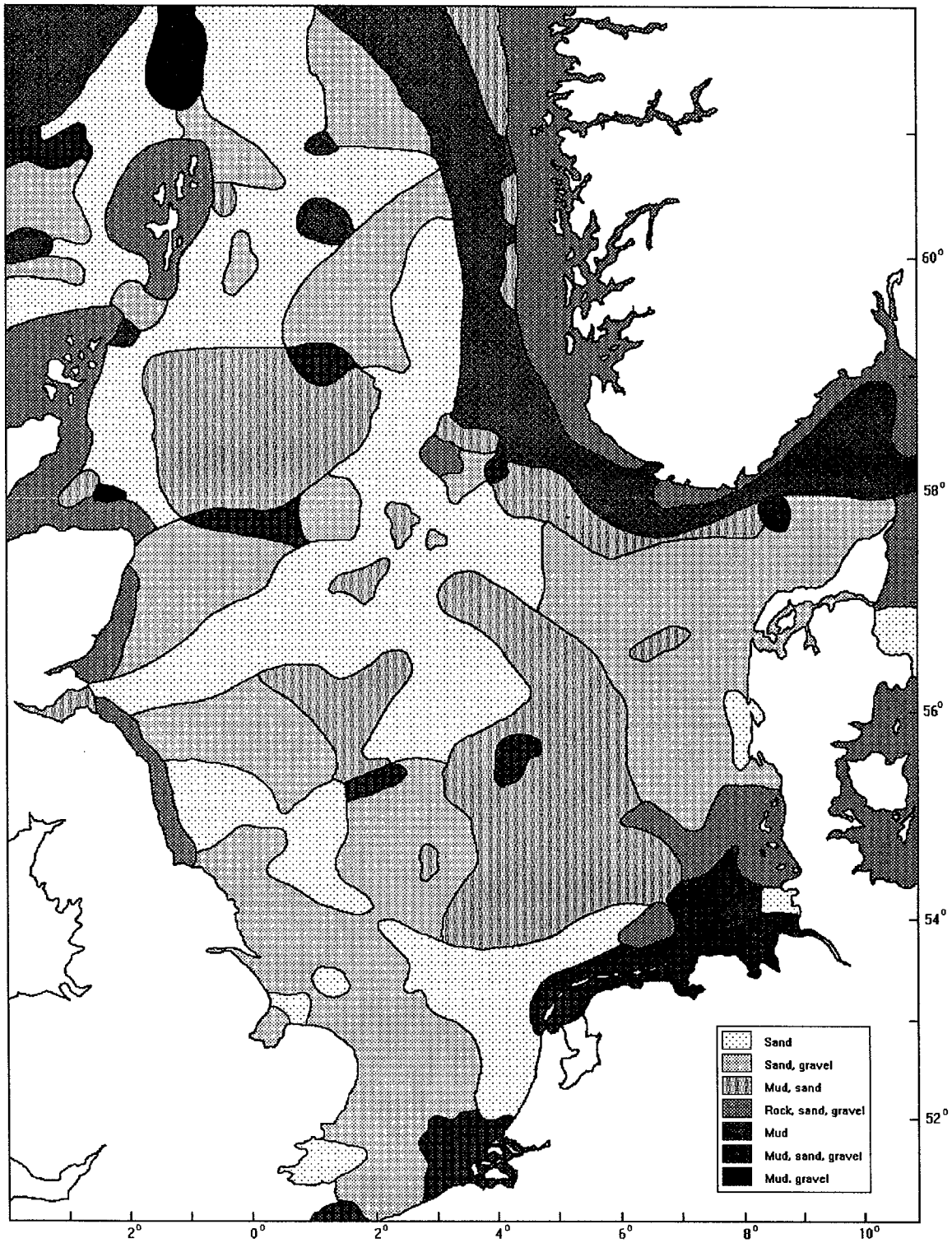

Figure 10. Substrata of the North Sea (after the Atlas of the Seas around the British Isles, MAFF).

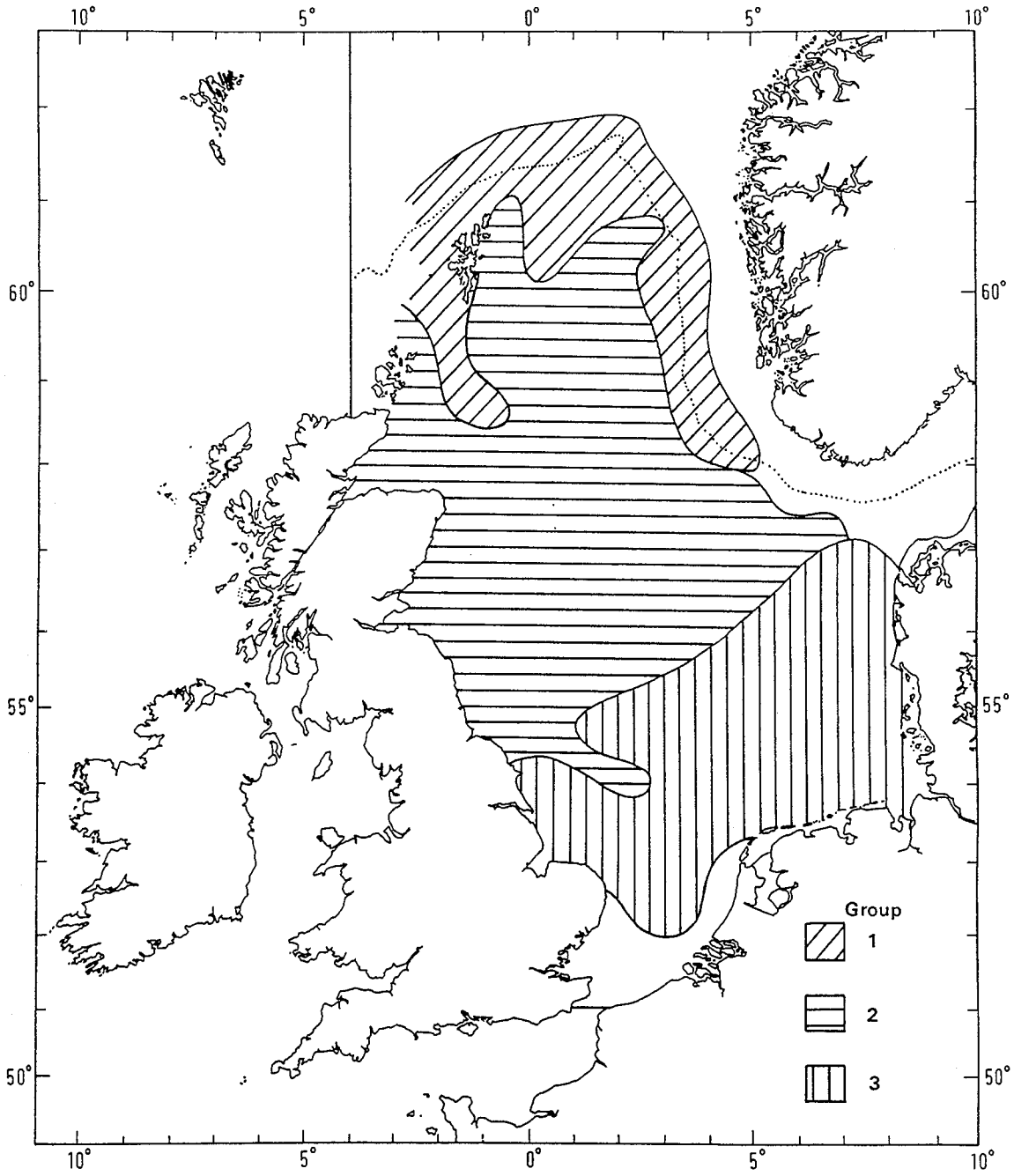

Figure 11. Distribution of three fish communities of the North Sea, based on average catches of the fifty most abundant species in the English Groundfish Survey in the years 1982 – 1986 [9]. 1) Shelf edge community, 2) North Central community, and 3) Southeastern community.

between mixed and stratified areas are usually characterized by steep horizontal gradients in temperatureand/or salinity [19]. Average bottom temperatures and salinities in winter and summer are shown in Figures 6 – 9. Temperatures in the deeper parts of the North Sea show rather little seasonal variation compared with the shallow waters of the German Bight, where drift ice may occur in cold winters. Salinity ranges from approximately 29 in the southeastern North Sea, where a large volume of fresh water runs off the continental land mass, to more than 35 in the northwest, where oceanic Atlantic water enters the North Sea.

The seabed is similarly very variable, consisting of mud, sand, gravel, or boulders (Figure 10).

Skagerrak and Kattegat

Detailed information on the Skagerrak and Kattegat can be found in [20] and [21]. The Skagerrak can be regarded as a transition area between the North Sea and the Baltic, whereas the Kattegat can be considered part of the Baltic. The surface area of the Skagerrak is 32,300 km^2, its volume 6,780 km^3 and its average depth is 210 m. The relatively great average depth of the Skagerrak is largely due to the fact that there is deep water (700 m) in the region where the Norwegian Deep and the Skagerrak meet. The Kattegat, in contrast, is a shallow area, with a mean depth of 23 m. Water from the Skagerrak enters the Kattegat via a deep current, while a surface current (the Baltic current) conducts brackish Baltic water to the Skagerrak. In the southern part of the Kattegat surface salinity may be as low as 15. In the Skagerrak salinity is lowest along the Norwegian and Swedish coasts (ca. 25) but increases from the border with the Kattegat to the border with the North Sea, where salinities of ca. 30 are reached. In February the mean surface temperature in the Kattegat is 2°C, and extensive areas of drift ice may occur in the Skagerrak and Kattegat in winter. In August, surface temperatures reach 16 – 17°C.

3.2 Biological environment

The variation in the physical environment is, of course, reflected in the flora and fauna. The different substrata support very diverse communities of bottom-living animals and, similarly, each water mass supports a different group of planktonic organisms. A description of this diversity would require several volumes, but general information can be found in a number of review papers [22, 23, 24, 25].

It must be realized that for the fish the North Sea is an open system which must not be considered in isolation from the west of Scotland shelf, the English Channel, and the Skagerrak [26]. A total of 224 fish species has been recorded from the North Sea. These species originate from three zoogeographical regions: 66 species are of Boreal (northern) origin, 110 species are Lusitanian (southern), and 48 species are Atlantic [27, 28].

The fish species can be grouped into communities that differ in species composition, abundance, and habitat. Rather surprisingly, very little work has been done on describing the communities. At least three groups have so far been identified [9]. The first one is associated with the shelf edge, the second group occurs in the central North Sea, and the third group is found in the southern and eastern North Sea (Table 3, Figure 11). A rather sharp boundary may be found near the 200 m isobath between species assemblages of the Norwegian Deep and those of the shallow plateaus of the North Sea and Skagerrak. The communities found in the Norwegian Deep resemble those found in the areas along the outer shelf of the Northeast Atlantic and the deep fjords of Norway [29].

3.3 Fisheries

The total amount of fish landed from the North Sea increased from one million tonnes at the beginning of this century to two million tonnes in 1956, with marked interruptions caused by the two World Wars (Figure 12). In the late 1950s landings declined slightly to 1.5 million tonnes, but there was a pronounced increase in the early 1960s. For a decade, landings fluctuated between 3 and 3.5 million tonnes but in recent years they have decreased to 2.5 million tonnes.

The landings of fish can be split into demersal and pelagic species landed for human consumption, and fish used for reduction to fish meal and fish oil (the industrial fishery). In terms of weight landed, the most important demersal species for human consumption are cod, haddock, whiting, and plaice (*Pleuronectes platessa*). The main pelagic species are herring and mackerel (*Scomber scombrus*). The landings from the industrial fishery mainly consist of sandeels (Ammodytidae), Norway pout, and sprat (*Sprattus sprattus*).

Until the late 1950s, the landings of demersal species remained remarkably stable (Figure 12), and the annual fluctuations in the total landings largely reflect the variations in the pelagic landings. The change in the total landings in the 1960s, however, coincided with a marked change in the contributions of the different components. Initially, the catch in all three categories increased, but the increase in the landings of pelagic species lasted for only two or three years, and a sharp decline followed. By 1980 the pelagic species were contributing only a small fraction of the long-term average. By 1990, however, owing to the recovery of the herring stock, the contribution of the pelagic species had increased again. In contrast, landings of the demersal species peaked in 1970, some years later than the pelagic species. Although there has been a subsequent decline, demersal landings in recent years are still slightly higher than ever recorded before the early 1960s. The industrial species have been the most important component of the fishery, in terms of weight, since the early 1970s. Landings reached a ceiling at the end of the 1970s and have remained at a high level.

It is by no means understood what factors affect the abundance and spatial distribution of fish. Despite all the gloomy discussions about overfishing, it is clear that fishermen have not yet succeeded in emptying the North Sea. However, fisheries undoubtedly have an enormous impact on the North Sea ecosystem, and on the abundance of fishes in particular [30]. It has been estimated that the total biomass of fish in the North Sea is about 10

million tonnes [31, 32]. Thus the fishery is currently removing about 25% of the total fish biomass each year. Taking the high levels of fishing mortality in the fisheries for roundfish and flatfish into account, it seems likely that fisheries may influence the distribution of the fish, as well as their abundance.

References: see page 25.

Table 3. Species composition of three North Sea fish communities as described in [9].

Shelf edge community	Percentage weight	North Central community	Percentage weight	Southeastern community	Percentage weight
Saithe	43.6	Haddock	42.4	Dab	21.8
Haddock	11.6	Whiting	13.9	Whiting	21.6
Norway pout	10.7	Cod	9.2	Grey gurnard	12.8
Whiting	9.1	Norway pout	4.7	Horse mackerel	10.1
Horse mackerel	7.6	Saithe	4.5	Plaice	6.3
Blue whiting	4.1	Dab	3.7	Cod	5.5
Remainder	13.3	Remainder	21.6	Remainder	21.9

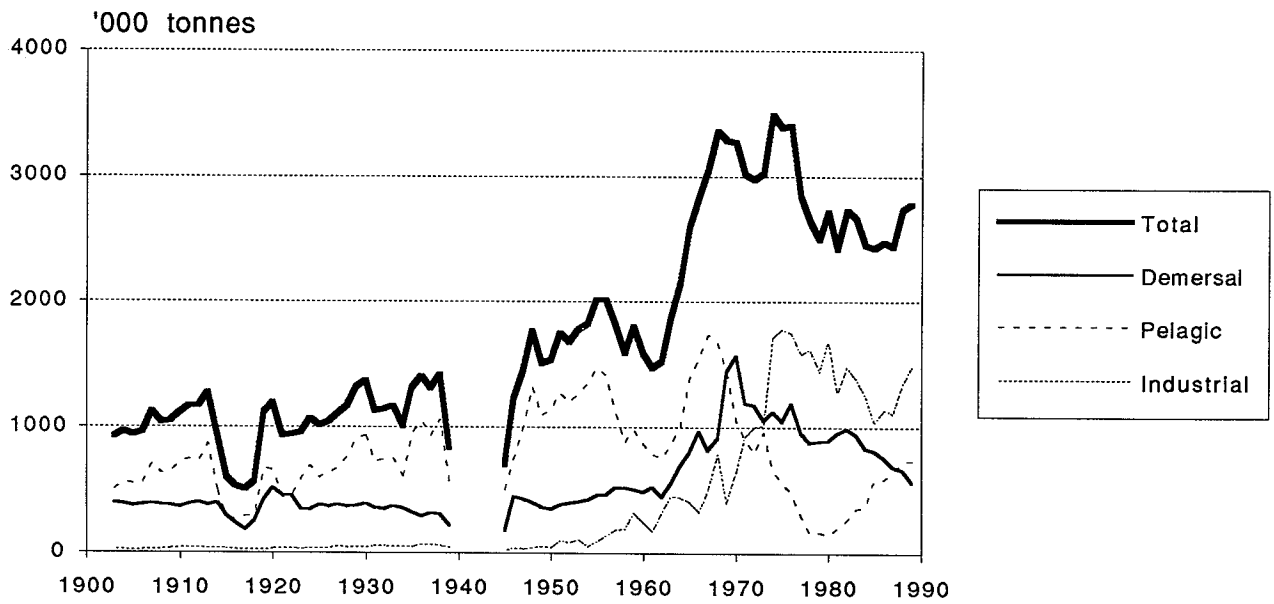

Figure 12. Total North Sea yield and yield split into three components: demersal, pelagic, and industrial fish.

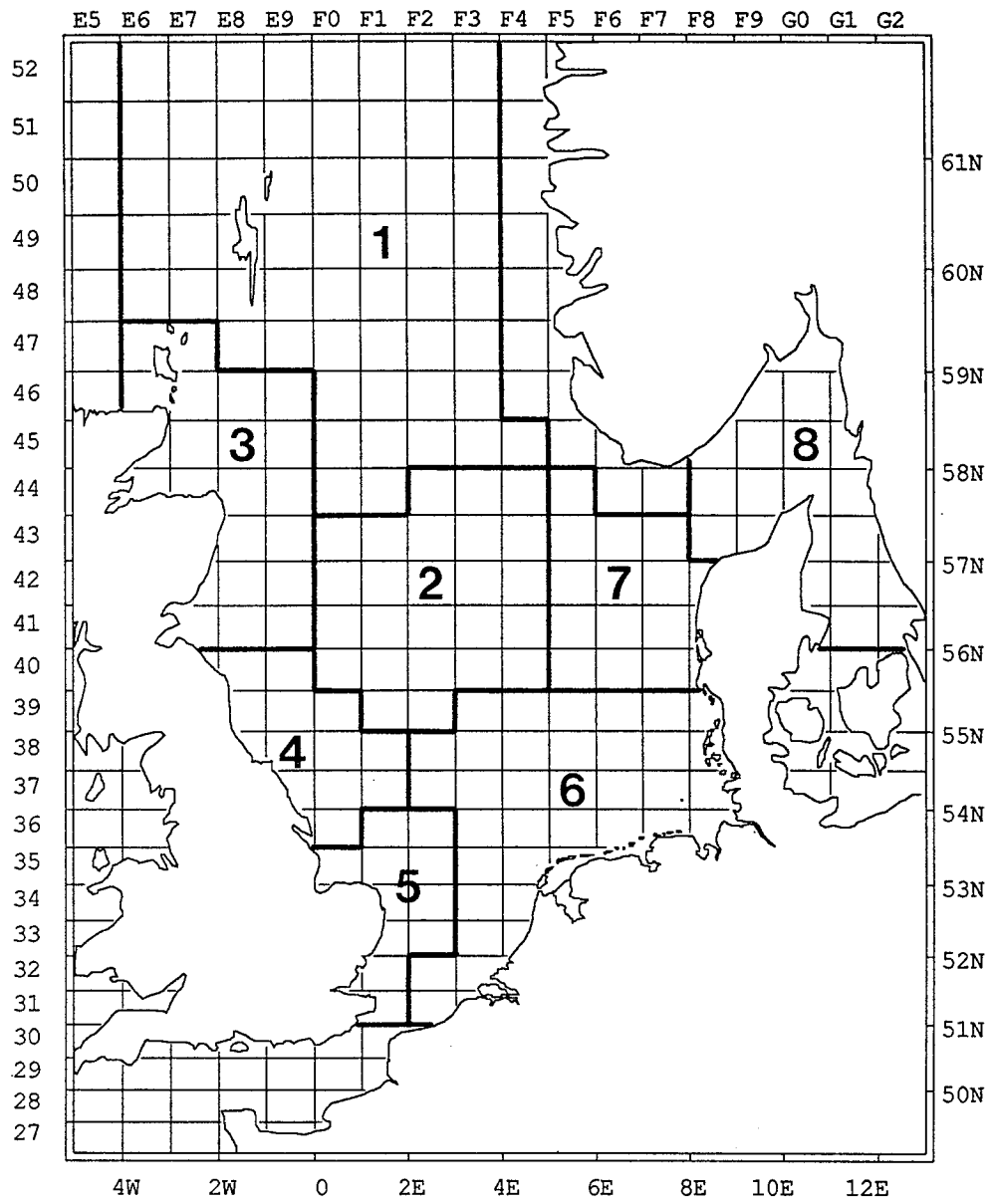

Figure 13. ICES roundfish sampling areas used in the *Atlas*.

4. Data presented in the *Atlas*

For all 98 species or species groups taken at any time during the surveys, Table 4 gives the number of hauls in which the species occurred and the total number of individuals caught, after converting the number in the catch to number per hour fishing. In the case of poorly represented species this may lead to minor discrepancies: in the text the actual number caught is given, whereas in Table 4 the number caught per hour, after conversion, is given.

The species have been split into three categories, 'A', 'B', and 'C' (see page 27). The 15 'A' species were regularly caught in winter and summer and most have at least some commercial importance. Information on total landings, the relationship between length and age, length at sexual maturity, etc. is available. The 46 'B' species make up the major part of the *Atlas*. In general, less is known about these species than the 'A' species. However, several are of commercial importance and data on their landings are available. The 37 'C' species were caught in very small numbers (fewer than approximately twenty individuals being taken in all). Very little information is available in the literature for many of the 'C' species, most of which are of negligible commercial importance.

It was mentioned earlier (2.3) that three different trawls were used for the summer surveys (the GOV trawl, the Granton trawl, and the Aberdeen 48-ft trawl). Since the GOV trawl was used during all the winter surveys, this was chosen as the standard summer trawl. Accordingly, the numbers of 'A' species caught in the English and Scottish summer surveys were recalculated to 'GOV-equivalent' catches (see Appendix). For all other species, it was assumed that the three trawls had equal efficiencies and the numbers in the catches were not standardized.

Winter and summer distribution charts are given for all species. Furthermore, the catches of each of the 'A' and 'B' species have been split into 'juveniles' and 'adults'. The criteria used to split the length compositions into immature and mature individuals differed between species. For all 'A' species information was available on the length (L) at which 50% of the fish are mature: L_{50}. Although the L_{50} is usually bigger for females than for males, the female L_{50} was accepted as the length at which the length composition was split; it was assumed that all fish larger than L_{50} were mature. Because there was little detailed information for most of the 'B' species, it was decided to use a length corresponding to 40% of the maximum reported length as a reasonable approximation of the L_{50} of these species. Within each species, the same length was used to split both winter and summer data.

The distributions of the 'A' and 'B' species are shown in maps in which dots are used to depict the catches per hour fishing per rectangle. The mean catch per rectangle was first calculated for each survey separately, and the numbers on which the dots are based are the average values for the three years. Six categories are used for the average number of fish caught per hour fishing:

-	0	●	100 – 999
·	> 0 – 9	●	1 000 – 9 999
•	10 – 99	●	≥ 10 000

The same scale was used for all species, allowing a direct comparison. We realize, however, that the spatial distributions of some of the less frequently caught species might have shown up more clearly, had individual scales been used. For the 'C' species the maps simply show how many individuals were caught in winter or summer, irrespective of size.

In addition to these charts, the relative length-frequency distributions of the catches are shown graphically for 'A' and 'B' species. The length axis is scaled from 0 to 25 cm for small species, from 0 to 75 cm for species of intermediate size, and from 0 to 125 cm for large species. Size class 125 cm contains all fish with a length of 125 cm and more. For most species, only lengths of the winter catches are given. Exceptions to this rule are migratory species such as mackerel and horse mackerel (*Trachurus trachurus*), which were almost exclusively caught in summer. Length-frequency distributions of 'A' species are displayed for eight sub-areas (the ICES roundfish sampling areas) (Figure 13) to illustrate regional differences. For the 'B' species, a single length-frequency distribution is given. If not otherwise indicated, this distribution is based on specimens caught in the North Sea *sensu stricto* (areas 1 – 7 in Figure 13). The length-frequency distributions were calculated for all hauls made within each roundfish area during each survey and the results from the three years were then averaged.

Historically, fish caught during the IYFS and exceeding 59 cm in length have been reported to ICES in 5-cm length groups, i.e. 60 – 64, 65 – 69, etc. This is reflected in the length distributions presented in this *Atlas*. Where this occurs, the percentage recorded on the graph is one fifth of the percentage for the whole 5-cm length group. This retains comparability within the graph.

For the 'A' species, available data on length-at-age, age-at-maturity, year-class strengths, spawning stock biomass, and total international landings from the North Sea are also given. These data have been obtained from a variety of sources, including the ICES *Bulletin Statistique des Pêches Maritimes* (now entitled *ICES Fisheries Statistics*) and the reports of the relevant ICES stock assessment Working Groups.

The order of the species and the scientific names of the fishes in this *Atlas* follow those used in the three volumes of *Fishes of the North-eastern Atlantic and the Mediterranean* [33]. The common names are given in seven languages and were provided by the colleagues listed in the Introduction. The abbreviations used to indicate the different languages in which the common names are given are: E.: English, F.: French, D.: German, DK.: Danish, N.: Norwegian, NL.: Dutch, and S.: Swedish.

References: see page 25.

Table 4. Species in systematic order, number of hauls in which each occurred, and total number of specimens caught (after converting the number in the catch to number per hour fishing) 1985 – 1987. The total number of hauls for the winter surveys was 529 in 1985, 529 in 1986, and 541 in 1987, and for the summer surveys, respectively 191, 238, and 236.

	WINTER					
	1985		1986		1987	
Species/ Family	Hauls	Catch	Hauls	Catch	Hauls	Catch
1 Petromyzontidae	2	5	3	6	1	2
2 *Myxine glutinosa*	4	5	4	11	11	39
3 *Galeus melastomus*	0	0	0	0	0	0
4 *Scyliorhinus canicula*	19	144	19	206	10	54
5 *Scyliorhinus stellaris*	0	0	0	0	0	0
6 *Galeorhinus galeus*	0	0	0	0	0	0
7 *Etmopterus spinax*	1	2	1	2	1	1
8 *Squalus acanthias*	59	490	77	264	57	199
9 *Raja radiata*	149	869	139	1 346	166	3 268
10 *Raja batis*	3	8	4	7	1	1
11 *Raja oxyrhinchus*	0	0	0	0	0	0
12 *Raja circularis*	1	2	0	0	0	0
13 *Raja fullonica*	2	3	0	0	0	0
14 *Raja naevus*	40	171	21	111	11	51
15 *Raja clavata*	18	94	10	180	26	612
16 *Raja montagui*	13	84	9	60	3	17
17 *Chimaera monstrosa*	0	0	2	3	4	46
18 *Alosa* spp.	2	3	0	0	3	8
19 *Clupea harengus*	453	1 722 911	465	2 526 563	488	3 108 881
20 *Sardina pilchardus*	0	0	0	0	0	0
21 *Sprattus sprattus*	277	579 557	258	282 100	267	999 969
22 *Engraulis encrasicolus*	0	0	0	0	0	0
23 *Maurolicus muelleri*	14	11 666	26	2 024	12	565
24 *Salmo trutta*	0	0	1	2	1	4
25 *Argentina* spp.	27	506	47	2 409	53	2 187
26 *Osmerus eperlanus*	11	366	11	254	10	774
27 *Anguilla anguilla*	1	2	3	6	1	4
28 *Conger conger*	1	2	0	0	0	0
29 *Belone belone*	0	0	0	0	0	0
30 *Scomberesox saurus*	1	2	0	0	0	0
31 Syngnathidae	2	6	2	6	10	22
32 *Gasterosteus aculeatus*	20	763	40	1 528	25	1 135
33 *Coryphaenoides rupestris*	0	0	0	0	1	1
34 *Merluccius merluccius*	47	265	60	711	62	1 090
35 *Gadiculus argenteus*	8	102	8	24	5	99
36 *Gadus morhua*	456	19 108	473	27 566	494	40 698
37 *Melanogrammus aeglefinus*	381	359 655	315	335 097	312	414 867
38 *Merlangius merlangus*	482	389 907	493	488 604	515	746 362
39 *Micromesistius poutassou*	8	16	3	8	4	6
40 *Pollachius pollachius*	13	854	21	124	20	82
41 *Pollachius virens*	82	18 004	91	40 111	77	2 594
42 *Trisopterus esmarki*	209	830 963	230	560 113	239	900 245
43 *Trisopterus luscus*	57	2 277	37	472	28	1 269
44 *Trisopterus minutus*	159	6 674	184	5 050	191	22 565
45 *Brosme brosme*	6	25	8	21	9	17
46 *Ciliata mustela*	5	13	5	10	4	10
47 *Ciliata septentrionalis*	2	3	1	2	0	0
48 *Gaidropsarus vulgaris*	4	5	5	14	1	1
49 *Molva dipterygia*	0	0	0	0	0	0
50 *Molva molva*	49	223	52	430	38	210

Table 4 continued.

Species	SUMMER 1985 Hauls	1985 Catch	1986 Hauls	1986 Catch	1987 Hauls	1987 Catch	Winter catch 85-87	Summer catch 85-87	Total catch 85-87
1	1	2	2	3	1	4	13	9	22
2	11	80	8	46	0	0	55	126	181
3	0	0	1	14	0	0	0	14	14
4	11	77	15	42	18	78	404	197	601
5	3	8	0	0	0	0	0	8	8
6	6	21	8	32	5	33	0	86	86
7	0	0	0	0	0	0	5	0	5
8	47	691	48	1 976	45	1 331	953	3 998	4 951
9	86	800	117	1 223	117	1 885	5 483	3 908	9 391
10	1	1	1	1	0	0	16	2	18
11	0	0	3	5	0	0	0	5	5
12	0	0	2	2	0	0	2	2	4
13	1	1	0	0	2	3	3	4	7
14	11	48	19	94	18	273	333	415	748
15	4	18	3	11	2	3	886	32	918
16	2	7	4	52	3	6	161	65	226
17	0	0	2	13	0	0	49	13	62
18	0	0	0	0	0	0	11	0	11
19	140	101 627	177	76 118	186	926 132	7 358 355	1 103 877	8 462 232
20	10	212	2	402	6	580	0	1 194	1 194
21	50	15 342	36	9 652	47	615 128	1 861 626	640 122	2 501 748
22	1	1	0	0	1	1	0	2	2
23	1	1	0	0	0	0	14 255	1	14 256
24	0	0	0	0	1	2	6	2	8
25	40	598	50	1 324	46	872	5 102	2 794	7 896
26	0	0	0	0	1	16	1 394	16	1 410
27	0	0	2	18	3	18	12	36	48
28	0	0	0	0	0	0	2	0	2
29	1	2	0	0	0	0	0	2	2
30	0	0	0	0	0	0	2	0	2
31	1	2	1	1	0	0	34	3	37
32	0	0	0	0	0	0	3 426	0	3 426
33	0	0	0	0	0	0	1	0	1
34	44	117	27	102	38	100	2 066	319	2385
35	11	60	14	577	9	90	225	727	952
36	161	4 338	224	12 190	213	10 349	87 372	26 877	114 249
37	162	89 070	195	108 435	191	100 594	1 109 619	298 099	1 407 718
38	191	180 202	231	176 427	233	332 016	1 624 873	688 645	2 313 518
39	7	173	7	371	7	299	30	843	873
40	5	35	3	4	3	7	1 060	46	1 106
41	79	9 837	73	5 980	58	1 860	60 709	17 677	78 386
42	101	93 399	132	129 989	104	48 858	2 291 321	272 246	2 563 567
43	2	3	8	158	4	53	4 018	214	4 232
44	42	1 742	48	2 298	44	3 468	34 289	7 508	41 797
45	7	8	5	5	7	7	63	20	83
46	1	5	0	0	0	0	33	5	38
47	0	0	0	0	0	0	5	0	5
48	0	0	0	0	0	0	20	0	20
49	0	0	1	2	0	0	0	2	2
50	30	101	33	86	29	54	863	241	1 104

Table 4 continued.

Species/ Family	WINTER 1985 Hauls	1985 Catch	1986 Hauls	1986 Catch	1987 Hauls	1987 Catch
51 *Rhinonemus cimbrius*	37	452	43	649	72	1 593
52 *Zeus faber*	2	3	1	2	0	0
53 *Dicentrarchus labrax*	0	0	0	0	0	0
54 *Trachurus trachurus*	52	1 581	20	271	40	132
55 *Mullus surmuletus*	1	2	0	0	0	0
56 *Spondyliosoma cantharus*	0	0	0	0	0	0
57 Ammodytidae	29	1 072	57	8 872	42	20 617
58 *Echiichthys vipera*	6	46	8	98	15	336
59 *Trachinus draco*	5	30	3	76	7	4 834
60 *Scomber scombrus*	50	363	57	969	59	27 053
61 Gobiidae	11	1 130	22	553	27	1 032
62 *Callionymus* spp.	63	436	102	1 017	120	1 538
63 *Anarhichas lupus*	37	88	47	107	51	158
64 *Pholis gunnellus*	1	2	2	3	2	4
65 *Lumpenus lampretaeformis*	2	8	14	107	11	158
66 *Lycodes vahli*	7	58	13	435	14	245
67 *Zoarces viviparus*	1	4	14	461	19	814
68 *Echiodon drummondi*	0	0	2	6	1	1
69 Mugilidae	0	0	0	0	0	0
70 *Helicolenus dactylopterus*	0	0	0	0	0	0
71 *Sebastes viviparus*	16	87	17	497	14	81
72 *Aspitrigla cuculus*	2	2	8	257	4	56
73 *Eutrigla gurnardus*	221	11 498	160	25 213	168	16 664
74 *Trigla lucerna*	8	68	2	6	1	8
75 *Myoxocephalus scorpius*	48	584	79	1 418	87	1 936
76 *Taurulus bubalis*	5	90	4	32	3	22
77 *Triglops murrayi*	1	1	3	4	0	0
78 *Agonus cataphractus*	38	216	75	899	77	834
79 *Cyclopterus lumpus*	51	176	83	276	90	332
80 *Liparis liparis*	7	221	13	234	20	243
81 *Lepidorhombus whiffiagonis*	40	228	46	561	39	440
82 *Phrynorhombus norvegicus*	2	6	2	4	3	6
83 *Psetta maxima*	31	87	25	64	30	78
84 *Scophthalmus rhombus*	18	50	16	34	18	65
85 *Zeugopterus punctatus*	0	0	4	17	0	0
86 *Arnoglossus laterna*	9	50	6	26	15	140
87 *Glyptocephalus cynoglossus*	62	416	82	571	72	733
88 *Hippoglossoides platessoides*	293	20 370	323	27 037	354	55 936
89 *Hippoglossus hippoglossus*	6	14	2	4	4	7
90 *Limanda limanda*	428	163 539	449	268 523	484	410 017
91 *Microstomus kitt*	225	2 565	220	3 216	240	2 843
92 *Platichthys flesus*	113	1 985	149	3 717	172	7 018
93 *Pleuronectes platessa*	345	25 465	365	22 202	375	42 997
94 *Buglossidium luteum*	9	47	13	37	28	350
95 *Microchirus variegatus*	2	4	0	0	3	7
96 *Solea vulgaris*	36	182	42	288	49	304
97 *Diplecogaster bimaculata*	0	0	0	0	1	1
98 *Lophius piscatorius*	64	187	55	132	52	131

Table 4 continued.

Species	SUMMER 1985 Hauls	SUMMER 1985 Catch	SUMMER 1986 Hauls	SUMMER 1986 Catch	SUMMER 1987 Hauls	SUMMER 1987 Catch	Winter catch 85-87	Summer catch 85-87	Total catch 85-87
51	20	1 225	32	578	15	189	2 694	1 992	4 686
52	0	0	2	4	1	4	5	8	13
53	0	0	1	2	0	0	0	2	2
54	130	39 836	139	92 835	165	40 240	1 984	172 911	174 895
55	6	10	0	0	0	0	2	10	12
56	0	0	1	1	0	0	0	1	1
57	32	965	29	1 478	36	1 952	30 561	4 395	34 956
58	20	6 240	19	2 479	19	4 247	480	12 966	13 446
59	0	0	0	0	1	1	4 940	1	4 941
60	128	21 861	154	21 297	173	36 877	28 385	80 035	108 420
61	4	4	4	108	3	7	2 715	119	2 834
62	75	1 716	83	888	62	338	2 991	2 942	5 933
63	34	58	44	84	54	106	353	248	601
64	0	0	0	0	0	0	9	0	9
65	9	54	6	18	2	8	273	80	353
66	0	0	0	0	0	0	738	0	738
67	0	0	0	0	1	12	1 279	12	1 291
68	0	0	0	0	0	0	7	0	7
69	0	0	1	16	2	89	0	105	105
70	1	1	0	0	0	0	0	1	1
71	26	253	19	359	16	135	665	747	1 412
72	2	17	2	4	4	10	315	31	346
73	142	18 955	163	13 148	176	11 087	53 375	43 190	96 565
74	16	65	20	72	17	106	82	243	325
75	2	12	5	49	14	46	3 938	107	4 045
76	0	0	0	0	0	0	144	0	144
77	0	0	0	0	0	0	5	0	5
78	13	42	25	1 375	21	153	1 949	1 570	3 519
79	5	6	2	3	2	3	784	12	796
80	0	0	0	0	0	0	698	0	698
81	30	119	42	361	28	248	1 229	728	1 957
82	0	0	0	0	1	5	16	5	21
83	13	17	23	40	13	22	229	79	308
84	7	8	8	15	7	12	149	35	184
85	0	0	0	0	0	0	17	0	17
86	7	21	7	29	7	13	216	63	279
87	31	107	46	186	36	69	1 720	362	2 082
88	148	13 141	184	19 645	170	12 890	103 343	45 676	149 019
89	1	1	3	3	3	4	25	8	33
90	158	113 913	195	160 859	207	122 594	842 079	397 366	1 239 445
91	136	3 518	165	4 230	171	3 410	8 624	11 158	19 782
92	2	3	4	13	6	61	12 720	77	12 797
93	133	8 863	157	6 195	174	9 096	90 664	24 154	114 818
94	15	147	14	1035	13	200	434	1 382	1 816
95	0	0	1	3	0	0	11	3	14
96	7	11	11	29	5	13	774	53	827
97	0	0	0	0	0	0	1	0	1
98	26	35	46	81	47	68	450	184	634

5. Limitations of the data

As explained in the Introduction, the distribution maps in this *Atlas* are based on the mean numbers caught per hour fishing with the survey trawls and represent relative abundance, not absolute abundance. Furthermore, the efficiency of the trawl varies between species and even within species. Thus the small species and the juveniles of the larger species were sampled very inefficiently. For example, although sandeels (Ammodytidae) are known to be extremely abundant in the *Atlas* area and in recent years have been by far the largest single component of the commercial landings from the North Sea, they were poorly represented in the survey catches. This is because sandeels have very slender bodies and can easily pass through even a very small-meshed net. Another abundant species group which was almost absent from the catches comprises the gobies (Gobiidae). Not only are gobies very small fish, usually less than 10 cm, but they are also usually found in shallow inshore waters, beyond the reach of the survey trawls (see below).

Flatfishes are also rather poorly sampled by the trawls used during the surveys, particularly species like sole which usually lie buried in the substratum. Catches would undoubtedly have been higher had a specialized flatfish gear such as a beam trawl been used. The truly pelagic species, such as mackerel and garfish, will also have been inefficiently sampled, both because they usually occur too far from the seabed to be caught by a bottom trawl and because they swim so fast that they can usually avoid capture.

Reference should be made as well to the fishing positions. Although the title of this *Atlas* may imply that all parts of the North Sea were sampled, this was not the case. The survey design of the IYFS permits stations to be chosen at random within a rectangle. In practice, however, rough or muddy grounds are usually avoided in order to minimize damage to the fishing gear. When most of a rectangle consists of rough ground, a heavier gear, equipped with bobbins, may have been used (see also section 2.3). Avoiding particular substrata and/or modifying the groundrope undoubtedly influences the catches. It should also be borne in mind that, in addition to the general avoidance of 'difficult' fishing grounds, no hauls were made in the very shallow coastal areas. In consequence inshore species were sampled very incompletely, or not at all. Also, no hauls were made in the deeper parts of the Skagerrak and the Norwegian Deep. For information on the fish fauna of the Norwegian Deep, the reader is referred to [29].

Another factor that may have influenced the catches is the fact that the majority of the hauls were made during the hours of daylight. Although it is well known that the time of day may affect the catch rates of a number of species [34,35,36], no attempt was made to apply correction factors.

Certain fish are difficult to identify to the species level, and our original data will certainly include a number of incomplete or incorrect identifications. For example, on board many research vessels sandeels are merely recorded as Ammodytidae or *Ammodytes* spp. Dragonets (Callionymidae) and pipefishes (Syngnathidae) are sometimes also classified by family. In such cases we could only present data for a group of species.

In spite of these limitations, the authors believe that the data presented in this *Atlas* will lead to a better understanding of the fishes in the North Sea. In the case of the 'A' species, we think that our maps are a reasonably accurate representation of their distribution during the time period covered by the surveys. The information on the 'B' species is, by definition, less complete but it makes available data that are usually hidden in computer archives. The data on 'C' species, which by no means represent the real abundance and distribution of these fishes, may also be valuable one day, should significant changes occur in the future. Some species were not caught at all, even though they are known to be common in the North Sea.

This *Atlas* should be regarded as a snapshot, giving a broad picture of the distribution of a group of North Sea fishes as revealed by trawling surveys during a particular time period. The authors hope that it can be used as a reference point, for comparison with older data and the future situation, to investigate changes in the fish communities of the North Sea. We also hope that this first attempt will stimulate further research in this field.

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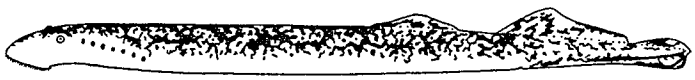
6. Accounts of the species caught in the years 1985–1987

The species are ordered taxonomically following *Fishes of the North-eastern Atlantic and the Mediterranean*, Volumes I, II, and III. Edited by P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris. 1984 – 1986. The species category, 'A', 'B', or 'C', is indicated (for explanation see Chapter 4).

			Page				Page
1.	Petromyzontidae	C	28	50.	*Molva molva*	B	140
2.	*Myxine glutinosa*	C	30	51.	*Rhinonemus cimbrius*	B	142
3.	*Galeus melastomus*	C	32	52.	*Zeus faber*	C	144
4.	*Scyliorhinus canicula*	B	34	53.	*Dicentrarchus labrax*	C	146
5.	*Scyliorhinus stellaris*	C	36	54.	*Trachurus trachurus*	A	148
6.	*Galeorhinus galeus*	B	38	55.	*Mullus surmuletus*	C	152
7.	*Etmopterus spinax*	C	40	56.	*Spondyliosoma cantharus*	C	154
8.	*Squalus acanthias*	B	42	57.	Ammodytidae	B	156
9.	*Raja radiata*	A	44	58.	*Echiichthys vipera*	B	158
10.	*Raja batis*	C	48	59.	*Trachinus draco*	B	160
11.	*Raja oxyrhinchus*	C	50	60.	*Scomber scombrus*	A	162
12.	*Raja circularis*	C	52	61.	Gobiidae	C	166
13.	*Raja fullonica*	C	54	62.	*Callionymus* spp.	B	168
14.	*Raja naevus*	B	56	63.	*Anarhichas lupus*	B	170
15.	*Raja clavata*	B	58	64.	*Pholis gunnellus*	C	172
16.	*Raja montagui*	B	60	65.	*Lumpenus lampretaeformis*	B	174
17.	*Chimaera monstrosa*	C	62	66.	*Lycodes vahli*	B	176
18.	*Alosa* spp.	C	64	67.	*Zoarces viviparus*	B	178
19.	*Clupea harengus*	A	66	68.	*Echiodon drummondi*	C	180
20.	*Sardina pilchardus*	B	70	69.	Mugilidae	C	182
21.	*Sprattus sprattus*	A	72	70.	*Helicolenus dactylopterus*	C	184
22.	*Engraulis encrasicolus*	C	76	71.	*Sebastes viviparus*	B	186
23.	*Maurolicus muelleri*	B	78	72.	*Aspitrigla cuculus*	B	188
24.	*Salmo trutta*	C	80	73.	*Eutrigla gurnardus*	A	190
25.	*Argentina* spp.	B	82	74.	*Trigla lucerna*	B	194
26.	*Osmerus eperlanus*	B	84	75.	*Myoxocephalus scorpius*	B	196
27.	*Anguilla anguilla*	C	86	76.	*Taurulus bubalis*	B	198
28.	*Conger conger*	C	88	77.	*Triglops murrayi*	C	200
29.	*Belone belone*	C	90	78.	*Agonus cataphractus*	B	202
30.	*Scomberesox saurus*	C	92	79.	*Cyclopterus lumpus*	B	204
31.	Syngnathidae	C	94	80.	*Liparis liparis*	B	206
32.	*Gasterosteus aculeatus*	B	96	81.	*Lepidorhombus whiffiagonis*	B	208
33.	*Coryphaenoides rupestris*	C	98	82.	*Phrynorhombus norvegicus*	C	210
34.	*Merluccius merluccius*	B	100	83.	*Psetta maxima*	B	212
35.	*Gadiculus argenteus*	B	102	84.	*Scophthalmus rhombus*	B	214
36.	*Gadus morhua*	A	104	85.	*Zeugopterus punctatus*	C	216
37.	*Melanogrammus aeglefinus*	A	108	86.	*Arnoglossus laterna*	B	218
38.	*Merlangius merlangus*	A	112	87.	*Glyptocephalus cynoglossus*	B	220
39.	*Micromesistius poutassou*	B	116	88.	*Hippoglossoides platessoides*	A	222
40.	*Pollachius pollachius*	B	118	89.	*Hippoglossus hippoglossus*	C	226
41.	*Pollachius virens*	B	120	90.	*Limanda limanda*	A	228
42.	*Trisopterus esmarki*	A	122	91.	*Microstomus kitt*	A	232
43.	*Trisopterus luscus*	B	126	92.	*Platichthys flesus*	B	236
44.	*Trisopterus minutus*	B	128	93.	*Pleuronectes platessa*	A	238
45.	*Brosme brosme*	B	130	94.	*Buglossidium luteum*	B	242
46.	*Ciliata mustela*	B	132	95.	*Microchirus variegatus*	C	244
47.	*Ciliata septentrionalis*	C	134	96.	*Solea vulgaris*	A	246
48.	*Gaidropsarus vulgaris*	C	136	97.	*Diplecogaster bimaculata*	C	250
49.	*Molva dipterygia*	C	138	98.	*Lophius piscatorius*	B	252

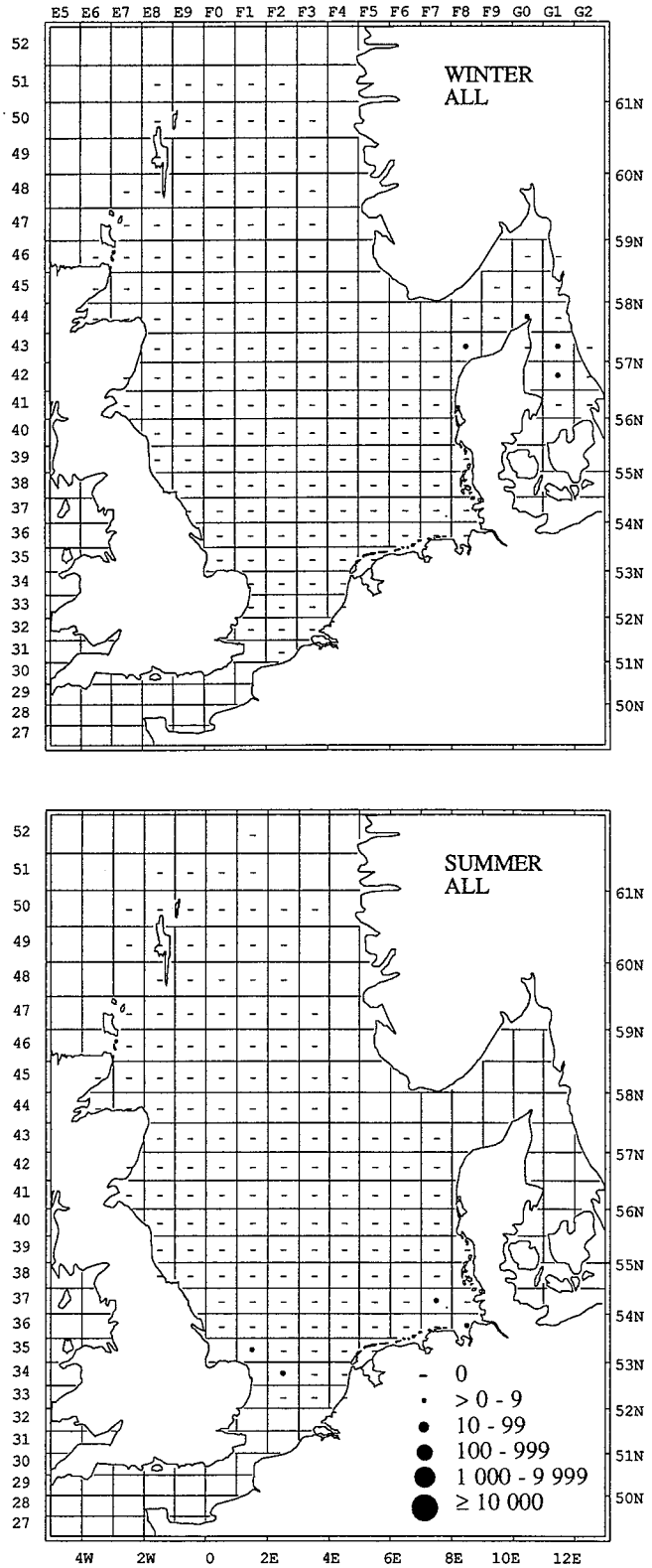
1. Petromyzontidae
Family Petromyzontidae



Petromyzon marinus

E. Lamprey, F. Lamproie marine, D. Meerneunauge, DK. Havlampret, N. Havniøye, NL. Zeeprik, S. Havsnejonöga

E. Lampern, F. Lamproie de rivière, D. Flußneunauge, DK. Flodlampret, N. Elveniøye, NL. Rivierprik, S. Flodnejonöga



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Two species of Petromyzontidae were reported in the *Atlas* surveys: the lamprey, *Petromyzon marinus*, and the lampern, *Lampetra fluviatilis*. Since proper identification is difficult they are treated together.

The catchability of lampreys in the survey gears is probably low owing to their body shape, and the survey data merely indicate that lampreys occurred in the Skagerrak and Kattegat, in the Southern Bight, and in the German Bight. Lamprey is believed to be more widely distributed in the open sea than lampern, which is more or less restricted to coastal or brackish areas [1].

Length composition

The lampreys recorded measured between 19 and 35 cm. The maximum length of adult lamprey is 120 cm, that of lampern, 40 cm [2].

Life history

Lampreys and lampern are primitive, jawless fishes with round, suctorial disc-like mouths and may be distinguished from each other by small differences in the size and number of their teeth, which are arranged in rows.

The life cycles of lamprey and lampern have much in common: the larvae live in fresh water, the adults grow and mature in the sea and return to fresh water to spawn.

After hatching the larvae drift downstream to suitable silt beds. They are blind and toothless and have such a remote resemblance to the adults that they were originally described as a separate species, *Ammocoetes* [1]. The larvae live buried in the mud and their food consists of microorganisms and detritus [2]. After at least three years they mature and migrate downstream to sea [2].

The adults spend one to two years in the sea, where they live a parasitic life on a wide range of fish species and, less frequently, cetaceans. They drain blood from the tissue of their host. Smaller victims die [1,2]. Lampern has been described more appropriately as a predatory carnivore, which bites out pieces of host tissue rather than feeding on blood [3].

They ascend freshwater streams to spawn in spring and early summer, depending on water temperature. The spawning sites of lampreys have a gravelly bottom and swift running water. The males excavate a nest, which may be 18 cm deep and 60 – 90 cm wide [1]. Fecundity varies between 230 and 400 eggs per gram body weight [3] and can reach 260,000 eggs in lamprey and 28,000 eggs in lampern. Lampreys die after reproduction [2].

Population and exploitation

Construction of dams and weirs in the lower reaches of major rivers and pollution are likely to have seriously affected the lampreys' distribution and abundance during the present century [2,3].

Extensive fisheries for lampern formerly existed, both for human consumption and for use as bait for more profitable fish [1,3].

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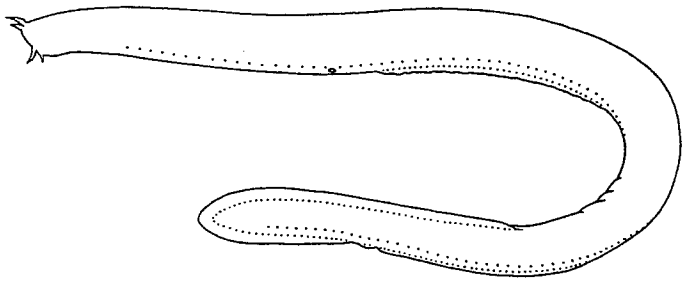
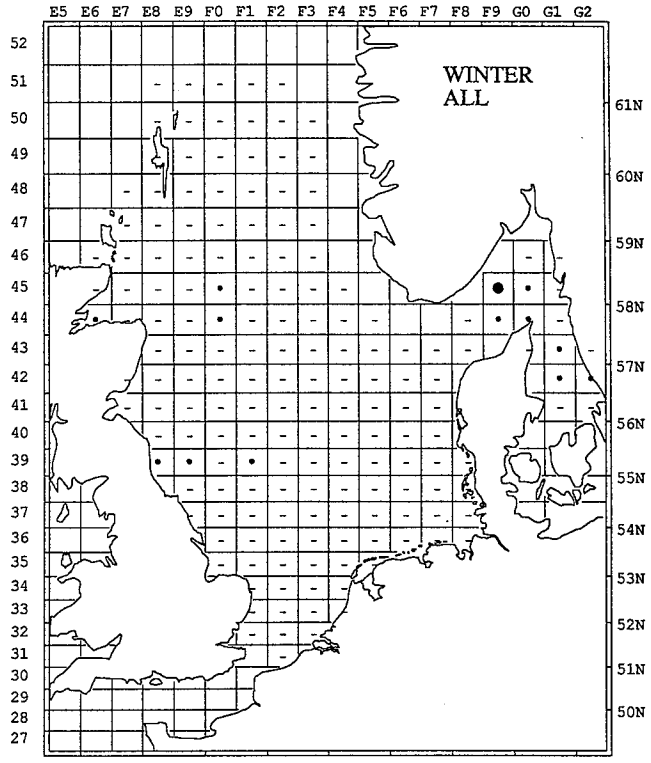
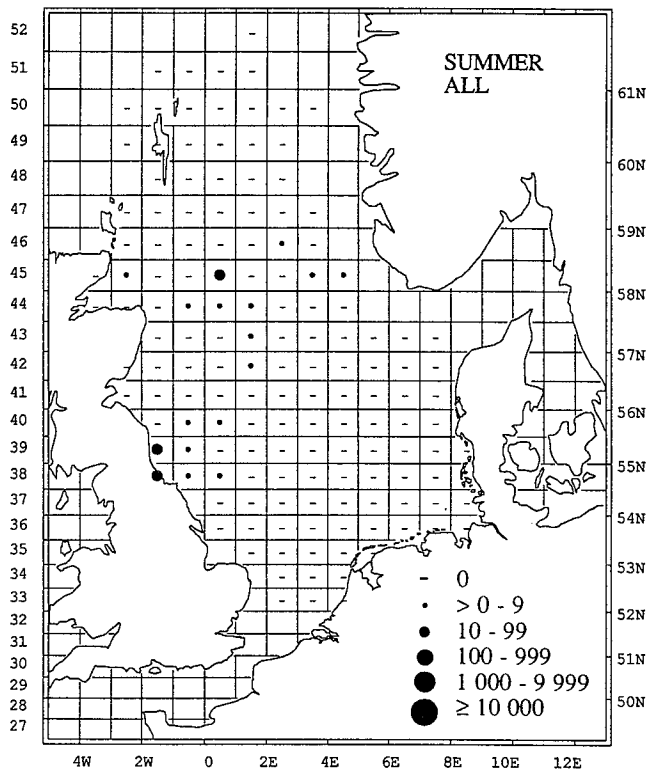
2. *Myxine glutinosa*
Family Myxinidae

E. Hagfish, F. Myxine, D. Inger, DK. Slimål,
N. Slimål, NL. Slijmprik, S. Pirål







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

The picture of hagfish distribution given here is undoubtedly incomplete. This is partly due to the fact that it was not certain whether this species should be reported at all during a number of the *Atlas* surveys, but to an even larger extent it is due to the very low catchability resulting from the hagfish's habit of lying buried in the mud and its elongate shape.

Hagfish were present in winter hauls made in the Kattegat and Skagerrak, and in summer hauls off the English coast and in the central North Sea. More hagfish were caught in summer than in winter. Whether this is caused by seasonal differences in behaviour is not known.

Length composition

The specimens caught measured 15 – 41 cm. The maximum length of hagfish reported in the literature is 60 cm [1].

Life history

The hagfish is a primitive, extremely slimy fish. It is associated with muddy bottoms where it excavates holes. The holes are covered by craterlike hillocks with an opening at the top [2,3]. The depths where hagfish occur range from 30 to 1100 m [4,5]. This species does not tolerate low salinities and usually occurs at temperatures lower than 10 – 13°C [4].

The eyes of the hagfish are degenerate. There are distinct sensory barbels round the jawless mouth and their olfactory orientation is presumably used in food-searching [3].

In the Farn Deeps and Fladen Ground hagfish were found to feed predominantly on the shrimp *Pandalus borealis*. Other food items were *Calocaris macandreae*, *Crangon crangon*, *Sepiola atlantica*, sprat, and the eggs of hagfish itself [7]. It is well known that this species attacks fishes caught in set nets and traps, or on long-lines. Having penetrated its prey via, for instance, the anus or gill covers, hagfish can eat into the soft tissue and hollow out its prey [4].

Hagfish seem to reproduce throughout the year [6]. The horny-shelled eggs have clusters of filaments at the ends and can reach 2.5 cm [4].

Population and exploitation

Because of their association with a very specific substratum hagfish are unlikely to show any migration and will form more or less discrete populations [4].

This species is of no economic importance.

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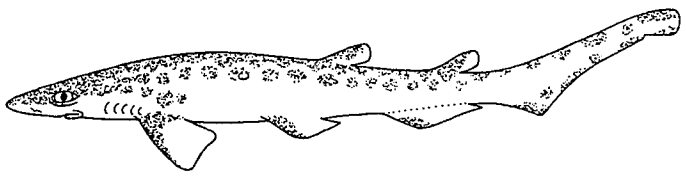
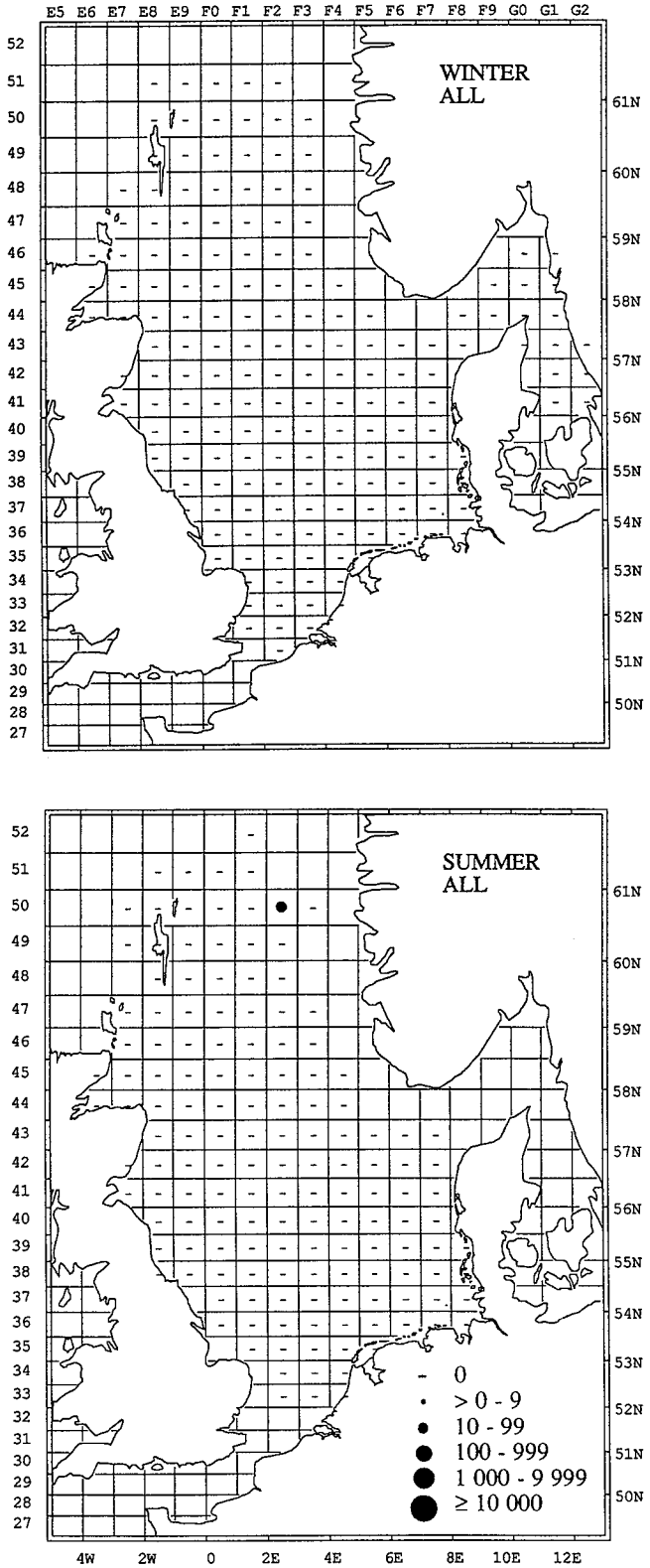
3. *Galeus melastomus*
Family Scyliorhinidae



E. Black-mouthed dogfish, F. Chien espagnol,
D. Fleckhai, DK. Ringhaj, N. Hågjel,
NL. Zwartbekhondshaai, S. Hågäl



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

This species was caught on only one occasion, with fourteen specimens taken in a summer haul on the edge of the Norwegian Deep. The black-mouthed dogfish is usually caught in depths of 200 – 500 m [1] and the trawl surveys probably provide a realistic picture of the distribution of this species in the *Atlas* area.

Length composition

Two size classes were caught. Specimens measuring 13 – 31 cm were immature fish, while the 60 – 75 cm size class were mature.

Life history

This is a rather small bottom-living shark. Females may grow to a length of 90 cm but the males are smaller. Sexual maturity is reached at a length of 34 – 42 cm (males) and 39 – 45 cm (females) [2]. Spawning takes place in summer or, in the Mediterranean, throughout the year [1,3]. The black-mouthed dogfish is oviparous, and females with up to thirteen eggs have been found [3].

Black-mouthed dogfish feeds mainly on benthic and midwater invertebrates (crustaceans, cephalopod molluscs) and fish, including lanternfishes (Myctophidae) and small elasmobranchs [1,2,3].

Population and exploitation

The distribution of the black-mouthed dogfish extends from Senegal to northern Norway, including the Mediterranean [1,3]. It is of negligible commercial importance in the *Atlas* area.

References

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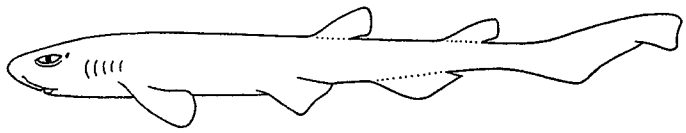
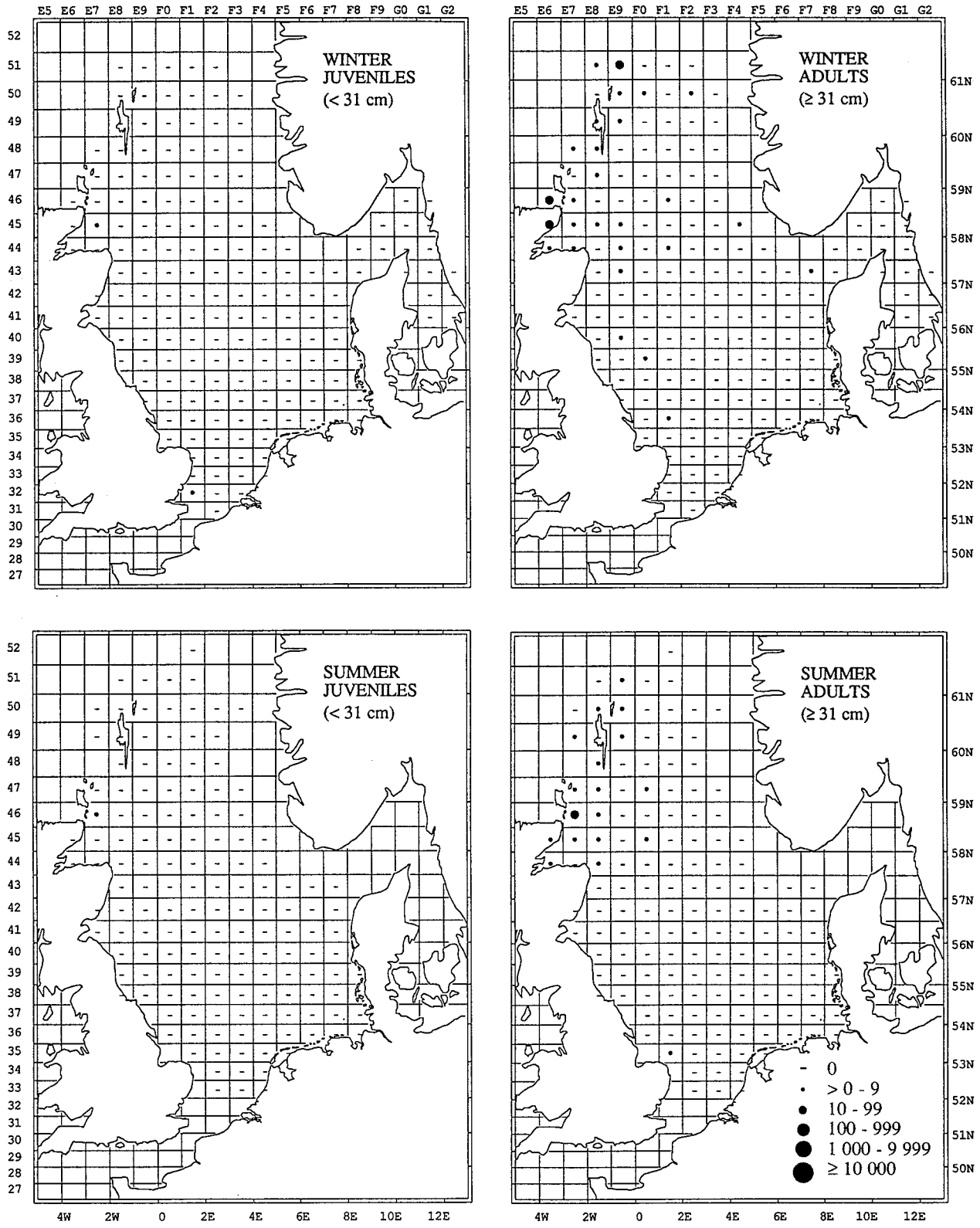
4. *Scyliorhinus canicula*
Family Scyliorhinidae



E. Lesser-spotted dogfish, F. Grande roussette,
D. Kleingefleckter Katzenhai, DK. Småplettet rødhaj,
N. Småflekket rødhai, NL. Hondshaai, S. Småfläckig rödhaj



Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

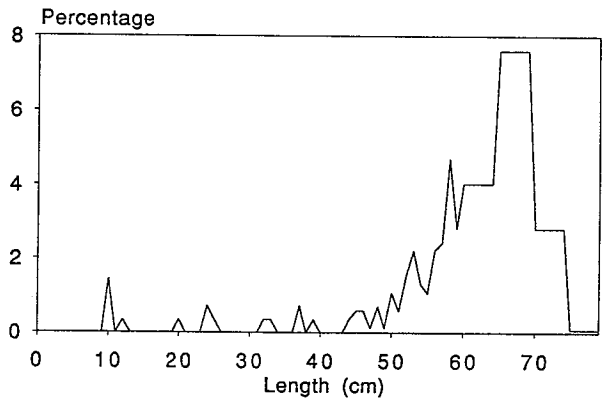
Spatial distribution

Although it was occasionally caught in the southern North Sea and near the entrance to the Skagerrak, lesser-spotted dogfish was mainly taken from the northwestern part of the *Atlas* area, during both winter and summer.

Several hauls contained more than the occasional single specimen. For instance, a winter haul in rectangle 45E6 (at a depth of 53 m) contained 33 lesser-spotted dogfish ranging from 56 to 74 cm in length.

Length composition

Fish of all sizes, including newly hatched young, were caught during the surveys but the majority were in the larger size classes (> 50 cm).



Length-frequency distribution of lesser-spotted dogfish during winter.

Life history

Important prey of this opportunistic, mostly benthic feeder are crustaceans (e.g. *Pagurus* spp., *Nephrops norvegicus*, *Crangon crangon*, *Pandalus* spp.), molluscs (cephalopods, bivalves), polychaete worms, and various fish species including sandeel, herring, haddock, and dab. Shelled molluscs are not usually swallowed whole; only the soft, protruding extremities are eaten [1,2].

This oviparous shark reaches sexual maturity at a length of approximately 57 – 60 cm in Plymouth waters [3]. The eggs, which are enclosed in horny capsules, may be found washed up on the beach. The young hatch at a length of about 10 cm [4].

No data on growth have been found.

Population and exploitation

An indication of the reproductive period of this species was obtained by examining females landed at Plymouth. Egg-carrying individuals occurred throughout the year, but more frequently during spring and summer [3].

Young and newly hatched dogfish live in shallower (i.e. less trawlable) waters than the larger ones [4], which explains why small (< 31 cm) lesser-spotted dogfish are almost absent from the *Atlas* catches.

The dogfish is of some economic importance, although it is not in as much demand as the spurdog (No. 8). It is mainly taken as by-catch by trawlers and longliners, and, as for all elasmobranchs, it is mainly used for human consumption [5].

References

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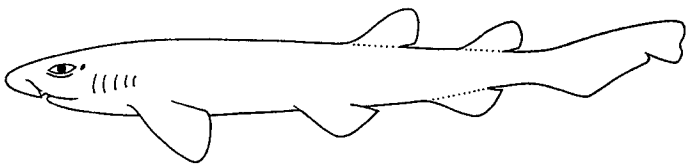
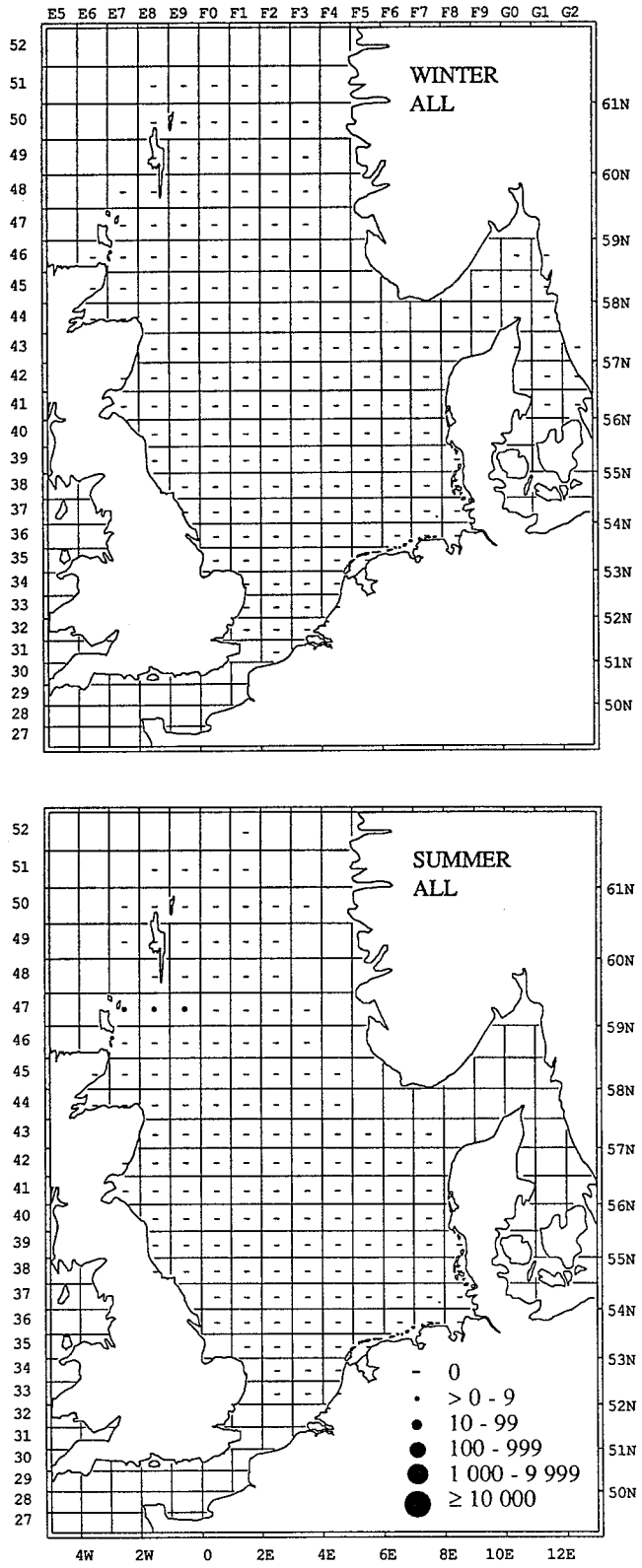
5. Anonymous. 1989. Report of the Study Group on Elasmobranch Fisheries. ICES CM 1989/G:54. 35 pp.

5. *Scyliorhinus stellaris*
Family Scyliorhinidae



E. Nursehound, F. Petite roussette,
D. Großgefleckter Katzenhai, DK. Storplettet rødhai,
N. Storflekket rødhai, NL. Kathaai, S. —



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Nursehound were only caught during summer *Atlas* surveys east of the Orkneys. This species prefers rough ground, which groundfish surveys usually avoid, so the *Atlas* survey data may give a distorted picture of its true North Sea distribution.

Length composition

The fish caught were all within the length range of 60 – 75 cm.

Life history

In spring and summer the nursehound lays individual eggs in dark brown horny cases. Long, much-twisted tendrils at each corner anchor the egg to algae or other projections. The empty egg cases are often found on the shoreline. The young fish hatches when it has reached a length of about 16 cm [1].

Nursehound feeds on hermit crab, edible crab, cephalopods (squid and octopus), and fish, including dogfish, dragonets, gurnards, flatfish, gadoids, and clupeoids. It is believed that this dogfish is a bottom-feeder [1]. It may grow to 152 cm [2].

Population and exploitation

The nursehound is not usually found at depths exceeding 63 m. It is relatively scarce in the North Sea, although it occurs more frequently to the west of the British Isles, southwards along the continental coast and into the Mediterranean Sea [3].

There is no recognized commercial fishery, the few small catches being combined with other dogfishes [1].

References

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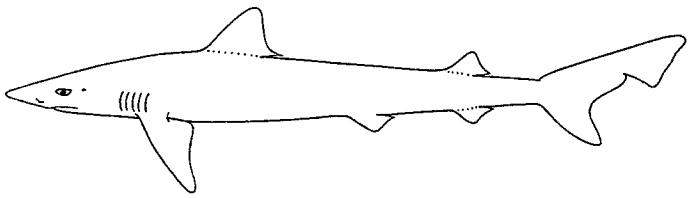
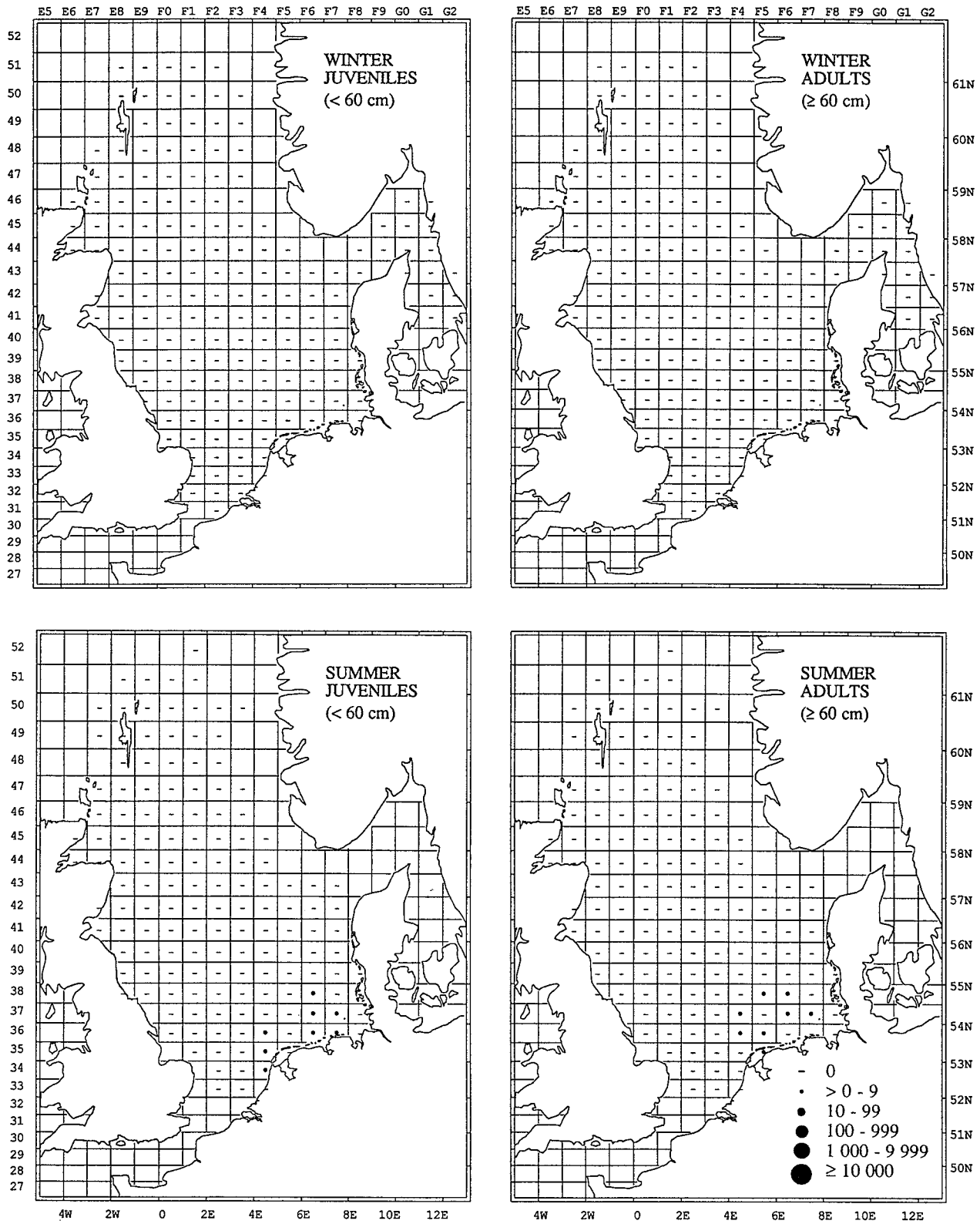
6. *Galeorhinus galeus*
Family Triakidae

E. Tope, F. Requin hâ, D. Hundshai, DK. Gråhaj,
N. Gråhai, NL. Ruwe haai, S. Gråhaj





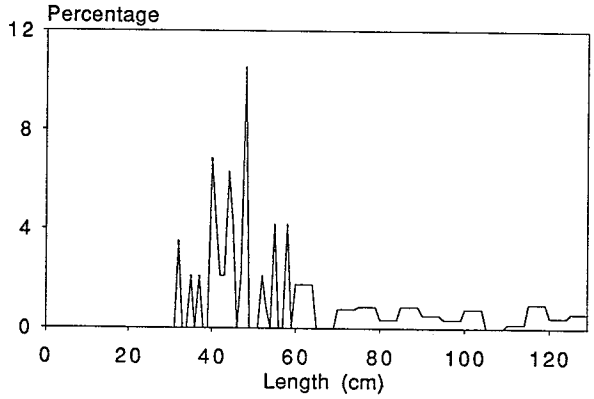
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Tope was caught in the German Bight during summer, but was absent from the survey area during winter.

Length composition

This shark is the largest species caught during the surveys. The largest one measured 152 cm.



Length-frequency distribution of tope during summer.

Life history

The *Atlas* catches suggest that tope lives a rather solitary life in the survey area. It is reported to be an active swimmer that feeds on both demersal and pelagic fish. Invertebrate prey is taken as well. Tope is ovoviviparous, usually producing litters of 25—35 young which are born at a length of about 35 cm [1,2].

Population and exploitation

This species probably migrates south during winter and makes a return migration to the North Sea during summer. A specimen tagged off the south coast of England was recaptured near the Canary Islands [3]. Small tope are said to live in shallow waters [1].

This shark is commercially exploited in the English Channel, where local landings showed a downward trend during the 1979 – 1989 decade [4]. Landings from the North Sea are minor.

References

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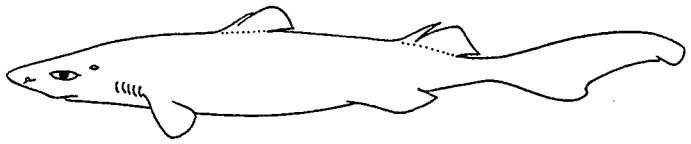
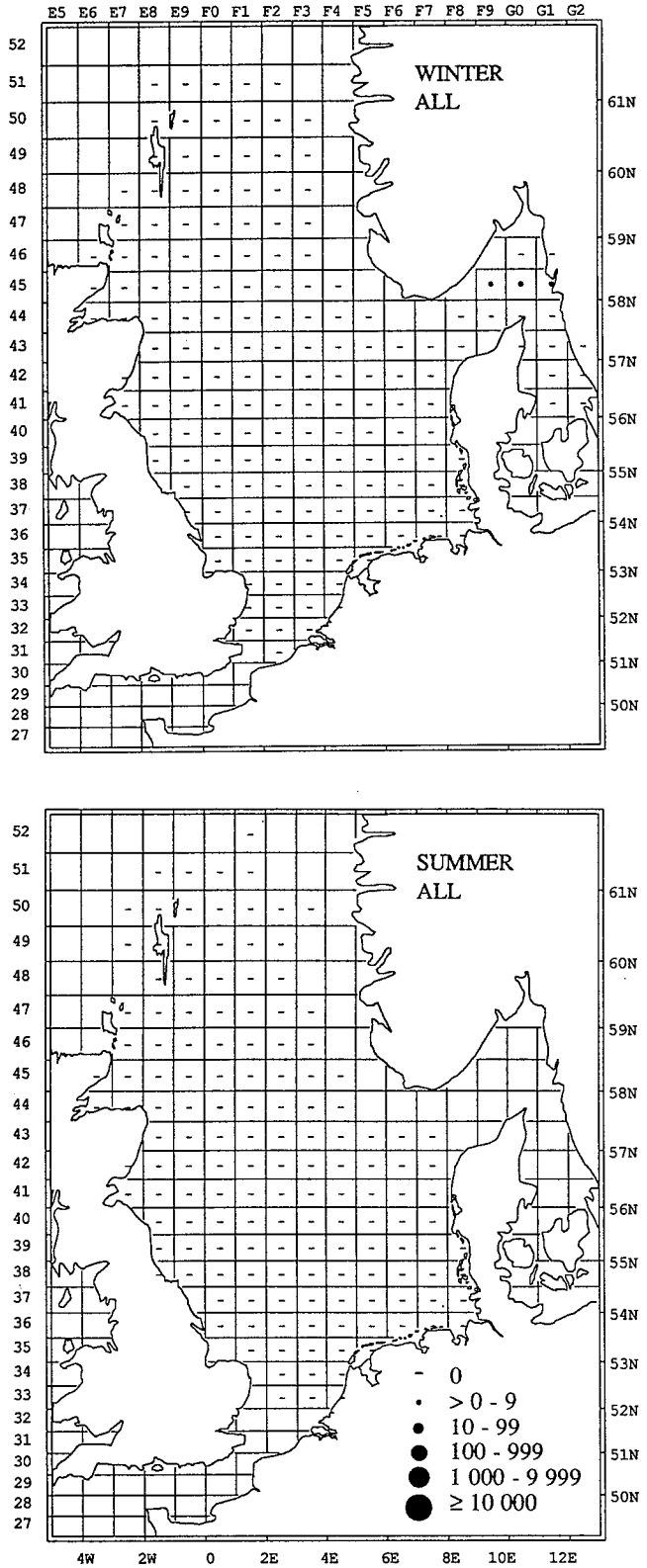
4. Anonymous. 1989. Report of the Study Group on Elasmobranch Fisheries. ICES CM 1989/G:54. 35 pp.

7. *Etmopterus spinax*
Family Squalidae



E. Velvet-belly, F. Sagre commun, D. Schwarzer Dornhai,
DK. Sorthaj, N. Svarthå, NL. Zwarte doornhaai, S. Blåkäxa



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

A total of three velvet-bellies were caught in three winter hauls in the Kattegat. The survey data are probably a fair representation of the distribution of this species within the *Atlas* area, because it is usually found on the edge of the continental shelf, at depths of 200 – 2000 m [1].

Length composition

The specimens caught measured 43 – 44 cm.

Life history

The velvet-belly occurs well above, as well as on, the seabed. When on the bottom, it is most often caught on soft or muddy ground. The food is known to include fish, squid, and crustaceans.

This is a small shark, with a maximum length of about 60 cm [2]. Males mature at approximately 33 cm and females at 36 cm [3]. The young are born live, at a length of 12 – 14 cm. Litter size varies from six to twenty, according to the size of the mother [2,3].

This is one of the lantern sharks, so named because they have light-producing organs [2].

Population and exploitation

The range of the velvet-belly extends from South Africa to Iceland [1]. It is of rather minor importance in the North Sea, although the livers, which are disproportionately large, are landed for their oil.

References

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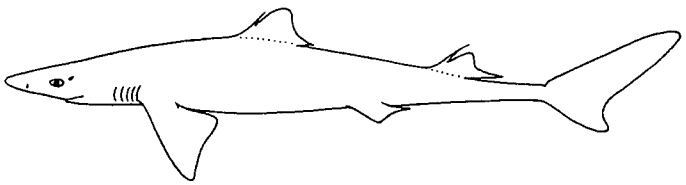
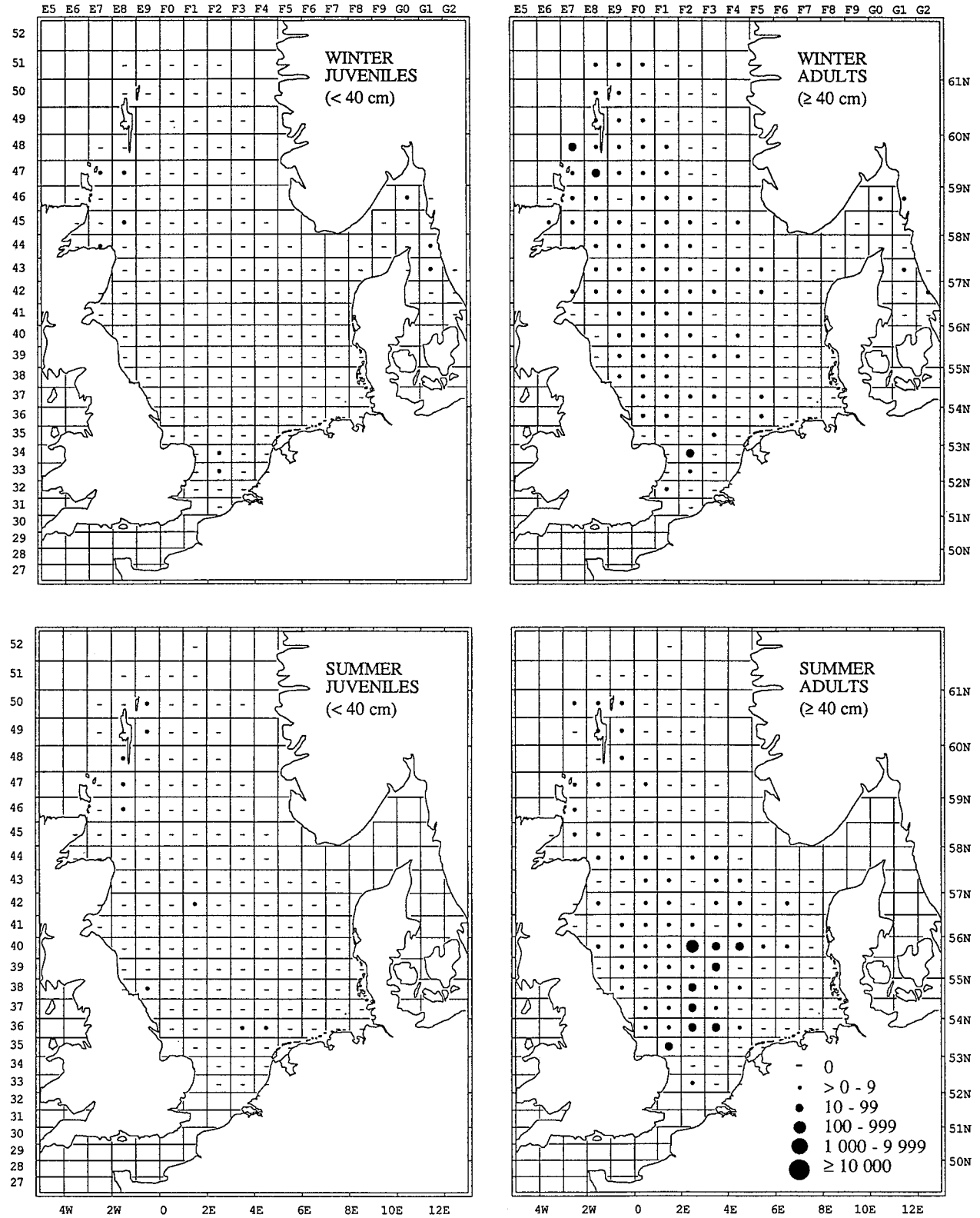
8. *Squalus acanthias*
Family Squalidae



E. Spurdog, F. Aiguillat commun, D. Dornhai,
DK. Pighaj, N. Pigghå, NL. Doornhaai, S. Pigghaj



Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

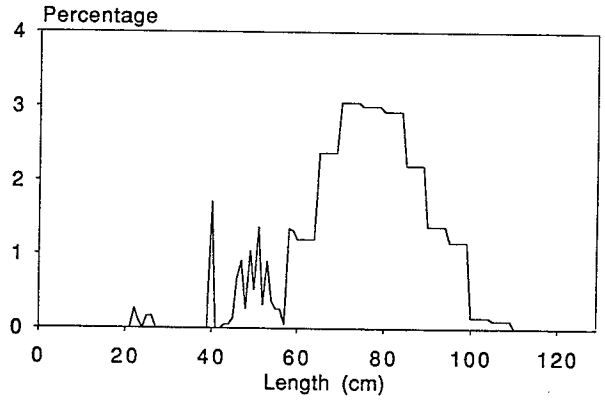
Spatial distribution

Spurdog, which is also called spiny dogfish because of the spines on its dorsal fins, was regularly caught throughout the western and central part of the North Sea during both winter and summer, but was scarce off the Norwegian, Danish, German, and Dutch coasts.

Seasonal differences within the main distribution area do occur. While the population appears to be evenly distributed during winter it seems to concentrate in southern parts during summer. It should be kept in mind, however, that disproportionately high densities in some rectangles during summer surveys are the result of a single haul catching many fish while no spurdog were caught in the other hauls made in that rectangle.

Length composition

Most specimens caught measured between 60 and 100 cm.



Length-frequency distribution of spurdog during winter.

Life history

It is generally assumed that females grow to a bigger size than males. They attain a maximum length of 110 cm, and mature at 70 – 80 cm; males grow to 85 cm and mature at about 60 cm [1]. Spurdog is ovoviviparous, which means that the young hatch from the eggs within the female. Litters of up to 21 young are produced at intervals of two years. The size of the young at birth is variable, ranging from less than 20 cm to more than 30 cm [2,3,4].

According to increments measured from tagged specimens, growth varies between 3.6 cm and 0.1 cm per year [5].

Spurdog is an opportunistic feeder that takes a wide range of predominantly pelagic prey. Important are fish (particularly herring, sandeel, mackerel), and, to a lesser extent, crustaceans (e.g. swimming crabs *Portunus* spp.), cephalopods (squids and octopods) and ctenophores (*Pleurobrachia* spp.) [6].

Population and exploitation

Off Plymouth the main pupping season, i.e. the period when the females give birth, is from August to December [1]. Only spurdogs of 40 cm and larger were caught in substantial numbers by the *Atlas* gears.

Although the majority of the catches consisted of single specimens, it is well known that this shark sometimes lives in shoals of uniform sex and size, and a summer haul in rectangle 40F2 caught more than a thousand spurdogs in the range 60 – 65 cm.

Tagging experiments have shown that spurdog is a highly migratory fish: individuals tagged off the Norwegian coast were recaptured in the Bay of Biscay. By tracking the spurdog fisheries it was concluded that they migrate clockwise in the North Sea, to the northern slopes of the Dogger Bank during summer, and to the north of Scotland during winter [7]. This migratory pattern is supported by the *Atlas* data, but spurdog leaving and entering the North Sea remains an alternative explanation [5].

Spurdog is commercially exploited, principally for human consumption. It is mainly caught as by-catch, but directed fisheries with gillnets and long-lines exist as well [8]. A low fecundity, coupled with an extremely low growth rate, makes spurdog vulnerable to commercial overexploitation [4]. North Sea shark landings have declined during the fifteen years between 1970 and 1985 and it is likely that this is chiefly due to a reduction in the landings of spurdog, the most abundant shark of the area.

References

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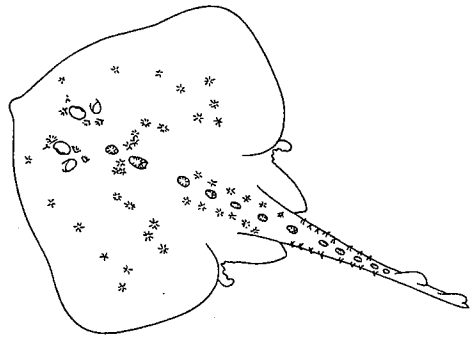
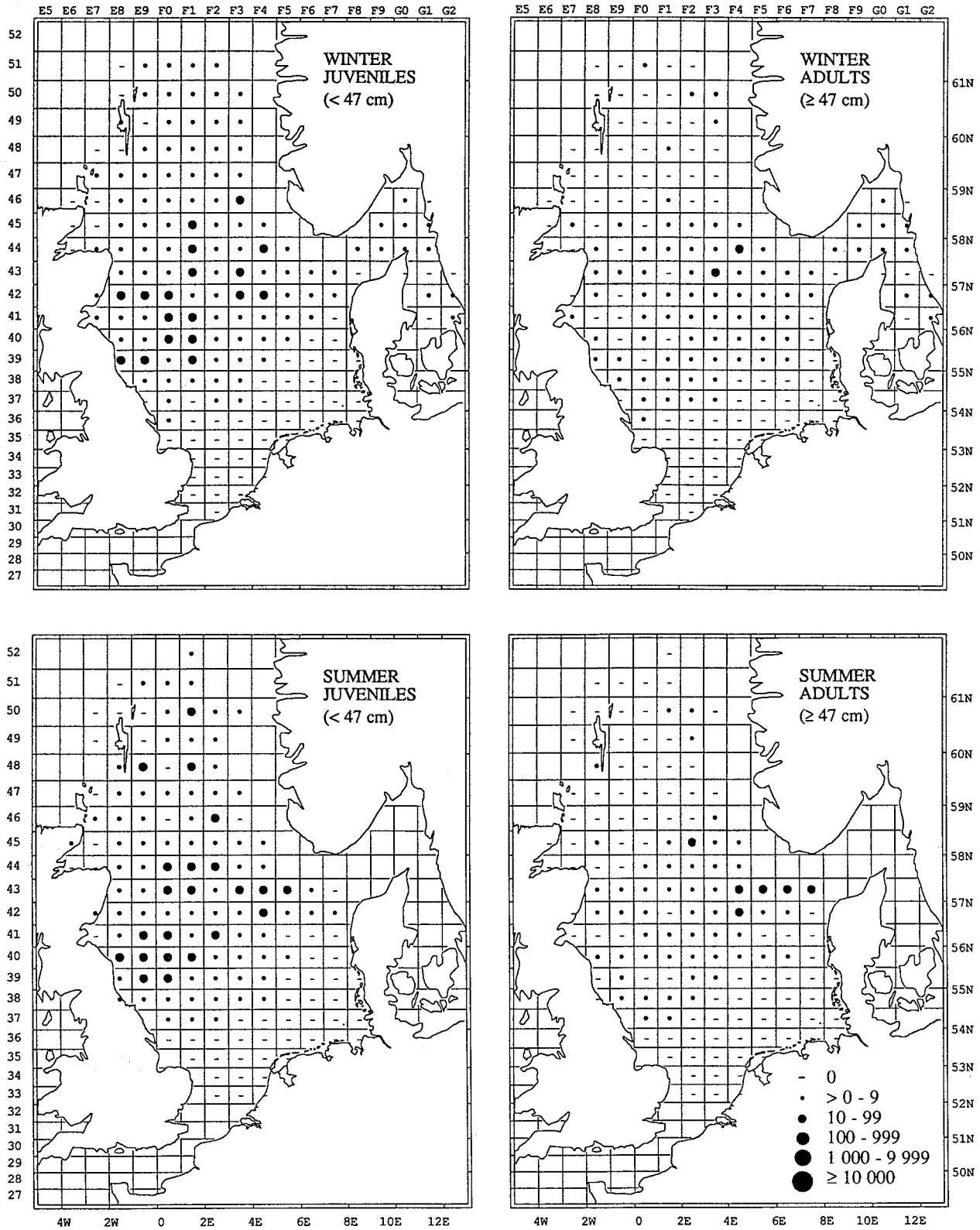
9. *Raja radiata*
Family Rajidae

E. Starry ray, F. Raie radiée, D. Sternroche, DK. Tærbe,
N. Kloskate, NL. Sterrog, S. Klorocka





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Modest numbers of starry ray were caught throughout the central and northern parts of the *Atlas* area. Starry ray was absent from the German and Southern Bights, and its centre of distribution was situated somewhere in the middle of the central North Sea.

No seasonal changes in the pattern of distribution were observed.

Length composition

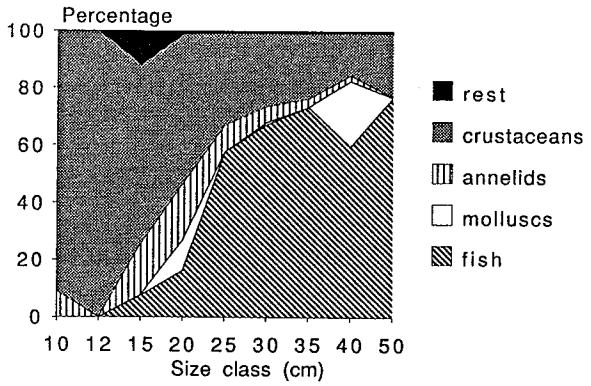
The *Atlas* winter catches were dominated by starry rays of 30 – 50 cm length, or approximately 20 – 33 cm 'wing-span'.

Life history

No information on the fecundity of this oviparous species is known for the North Sea, but relatives in Newfoundland waters produce between six and forty eggs during the breeding season [1]. Fertilization is internal and the eggs are deposited on the seabed.

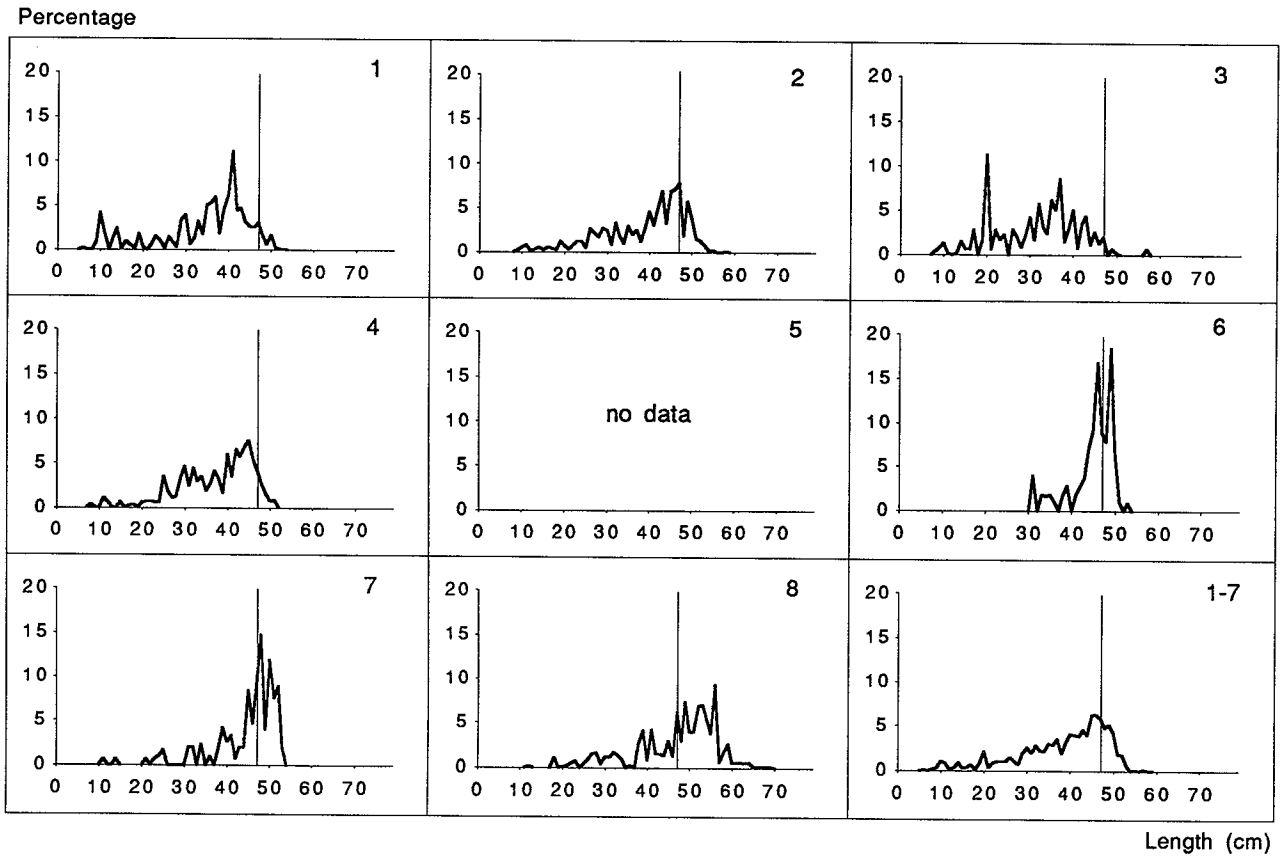
Length at first maturity for starry ray in the North Sea is about 40 cm [2], at an age of three to four years [3].

Starry ray in Scottish waters feeds on crustaceans (predominantly *Crangon crangon*, amphipods, *Pagurus* spp. and *Hyas* spp.), on fish (mostly sandeel), and on polychaete worms [4]. It is probably a noctural feeder [5], and its typical ray-like way of capturing prey is described as *'darting suddenly forward and settling down over it.'* [1]



Average stomach contents as percentage weight by size class in 1991 (data from [6]).

In the North Sea young starry rays feed predominantly on crustaceans. From a length of 15 cm onwards they start to prey on fish, and from 25 cm onwards more than 50% of the food consists of fish. Polychaete worms and some molluscs are also eaten. The average weight of the stomach contents was found to be rather low, e.g. for starry rays of the size class 40 – 50 cm it was only 3.1 g [6].

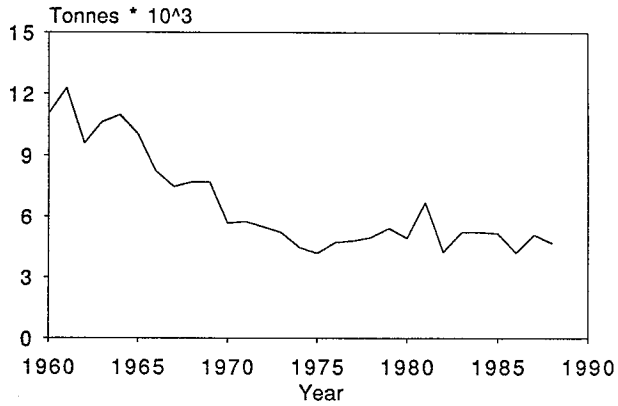


Length-frequency distribution of starry ray by roundfish area during winter (length split indicated).

Population and exploitation

The main spawning season in the North Sea is probably between February and June, but as in the Northwest Atlantic, mature females with well-developed eggs occur throughout the year [2,7].

Indications of a northward migration during summer [8] cannot be deduced from the *Atlas* data, nor is it possible to make firm statements on the existence and location of any spawning grounds.



Total North Sea landings of rays (all species combined) since 1960.

Starry ray is a by-catch species in the trawl, seine, and long-line fisheries. It is usually discarded because it is generally considered to be too small for human consumption. Fishery statistics on rays are not very well segregated, and generally only figures for the group as a whole are available [9]. Such figures indicate that the official yearly landings of rays from the North Sea decreased during 1945 – 1970 and remained at the same level during following years. It is estimated that the mean biomass of starry ray in the North Sea from 1977 to 1988 was 100,000 t [8].

References

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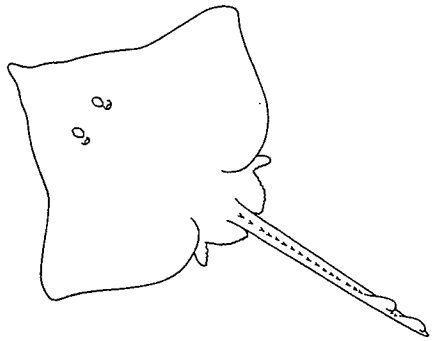
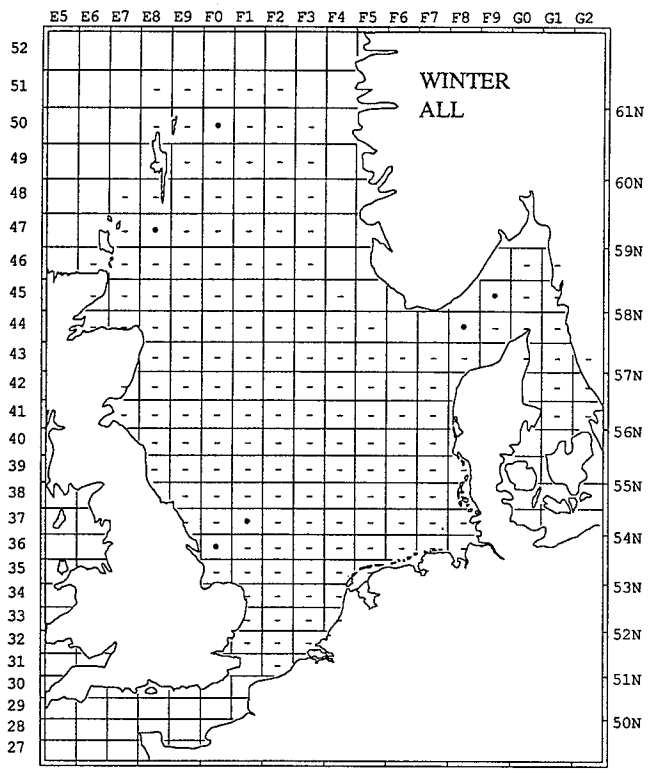
8. Sparholt, H., and Vinther, M. 1991. The biomass of starry ray (*Raja radiata*) in the North Sea. Journal du Conseil International pour l'Exploration de la Mer 47: 295-302.
9. Anonymous. 1989. Report of the Study Group on Elasmobranch Fisheries. ICES CM 1989/G:54. 35 pp.

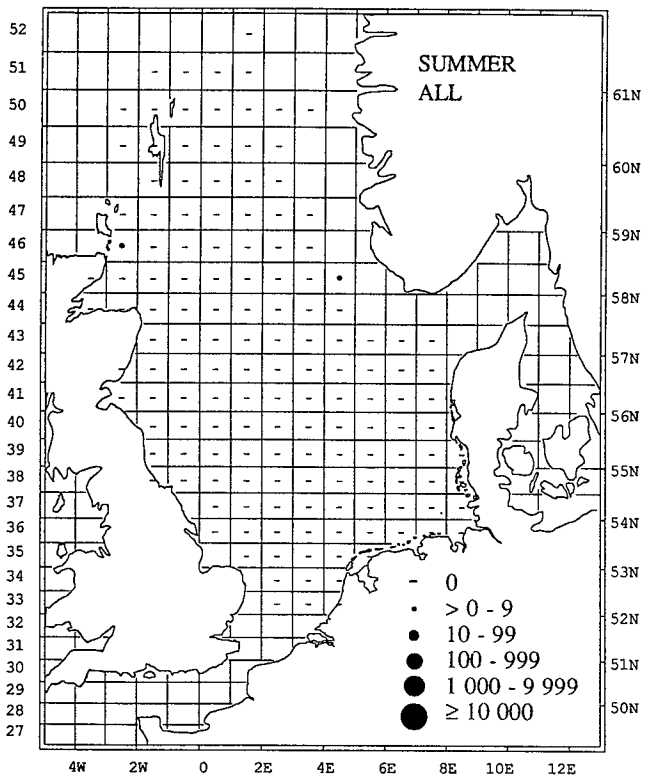
10. *Raja batis*: see page 48.

10. *Raja batis*
Family Rajidae

E. (Common) skate, F. Pocheteau gris, D. Glattroche,
DK. Skade, N. Storskate, NL. Vleet, S. Slätrocka







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Skate, the largest ray that occurs in the *Atlas* area, was caught in very low numbers. A total of ten specimens was present in hauls widely distributed over the deeper parts of the area.

Length composition

The length of individuals in the catches varied between 26 cm and 115 cm.

Life history

Skate deposit large egg capsules of 14 – 25 cm length and 8 – 14 cm width, mainly between February and August. The newly hatched young measure 21 cm [1]. Older skate from the Celtic Sea measure 80, 120, and 202 cm at five, ten, and twenty years of age respectively [3]. Males become sexually mature from a length of 150 cm; the females from a somewhat bigger size [1].

Stomachs of juvenile skate (≤ 50 cm) mainly contained crustaceans (*Crangon* spp. and *Pandalus* spp.) and some fish. Bigger specimens appeared to have fed principally on a wide variety of demersal fish, on several crustacean species, and on some cephalopod molluscs [2].

Population and exploitation

Skate occurs from Madeira to the northern coasts of Norway [4]. The adults live mainly at depths of 90 – 220 m, while the juveniles are found in shallower water [1].

Skate, a valuable commercial species, has become rare in the *Atlas* area. It was abundant in the Irish Sea at the turn of the century, but commercial fisheries brought the Irish population to the brink of extinction [5].

References

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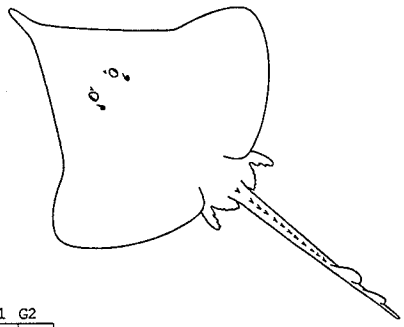
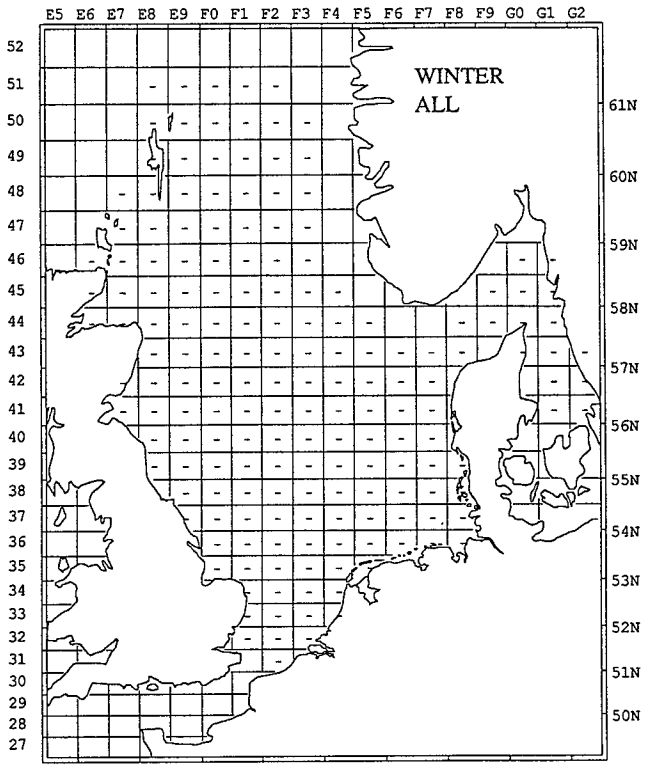
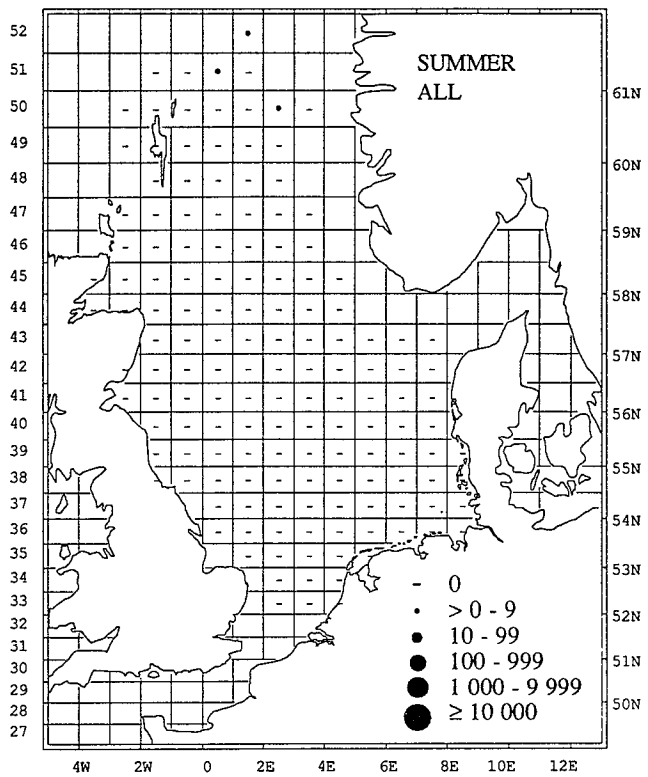
2. Rae, B.B., and Shelton, R.G.J. 1982. Notes on the food of nine species of elasmobranch (part I) and nine species of demersal teleost (part II) fishes from Scottish waters. ICES CM 1982/G:56. 5 pp.
3. Du Buit, M.H. 1977. Age et croissance de *Raja batis* et de *Raja naevus* en Mer Celtique. Journal du Conseil International pour l'Exploration de la Mer 37(3): 261-265.
4. Stehmann, M., and Bürkel, D.L. 1984. Rajidae. *In* Fishes of the North-eastern Atlantic and the Mediterranean, Volume I, pp. 163-196. Ed. by P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris. 510 pp.
5. Brander, K. 1981. Disappearance of common skate, *Raia batis* from the Irish Sea. Nature 290:48-49.

11. *Raja oxyrhinchus*
Family Rajidae



E. Long-nosed skate, F. Pocheteau noir,
D. Spitzschnauziger Roche, DK. Plovjerns rokke,
N. Spisskate, NL. Scherpsnuit, S. Plogjärnsrocka





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Five specimens of this rare skate were caught in deep waters in the northern North Sea during the summer of 1986.

Length composition

The length range of the specimens caught was 70 – 95 cm.

Life history

The egg cases are 13 cm long and 7 – 10 cm wide. The horns of the egg cases are short and the shell is closely coated with yellowish fibres. In the northern North Sea ripe females are found in September. Females grow to a size of 120 – 130 cm, males to 110 – 120 cm [1].

The food consists of crustaceans (*Pandalus* spp., *Corystes* spp., *Cancer* spp., *Munida* spp.) and a wide range of bottom-living fish, including redfish, gurnards, and dragonets [1].

Population and exploitation

Long-nosed skate are usually found on soft bottoms, the juveniles at depths of 50 – 100 m, the adults at depths of 150 – 300 m, but they may occur at depths as great as 900 m [1]. They are widely distributed from the Canaries to central Norway, the northern North Sea, and the Skagerrak [2].

Long-nosed skate are of minor commercial importance.

References

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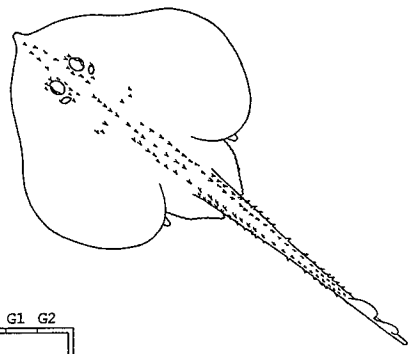
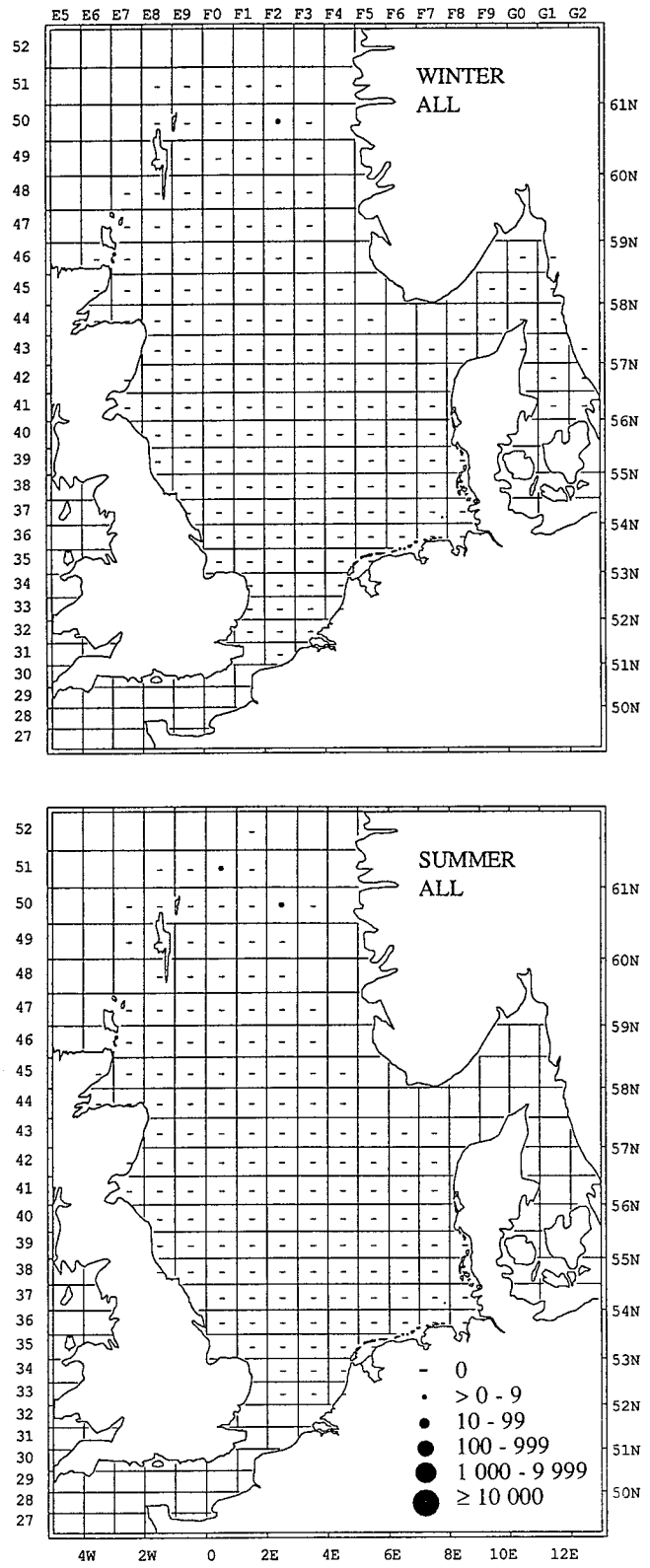
2. Stehmann, M., and Bürkel, D.L. 1984. Rajidae. *In* Fishes of the North-eastern Atlantic and the Mediterranean, Volume I, pp. 163-196. Ed. by P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris. 510 pp.

12. *Raja circularis*
Family Rajidae

E. Sandy ray, F. Raie circulaire, D. Sandroche, DK. Sandrokke, N. Sandskate, NL. Zandrog, S. —





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Three sandy rays were caught in northern rectangles 50F2 and 51F0: one in a winter haul and two in a summer haul.

Length composition

The sandy rays caught were 36, 60, and 70 cm in length.

Life history

This fish can attain a size of 120 cm [1].

Ripe females have been observed from November to August. The egg capsules are 8 – 9 cm long and 4 – 5 cm wide. Their side margins bear a film of fine threads [2].

Population and exploitation

As already expressed in its common name this species is usually found on sandy bottoms, at depths from 50 to 100 m [1]. It occurs from northern Morocco to southern Norway, in the northern North Sea and in the Skagerrak.

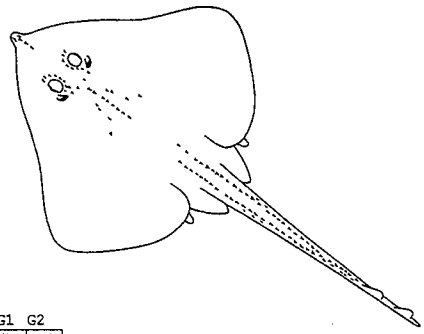
The fishery for sandy ray is of local importance in the southern part of its area of occurrence [3].

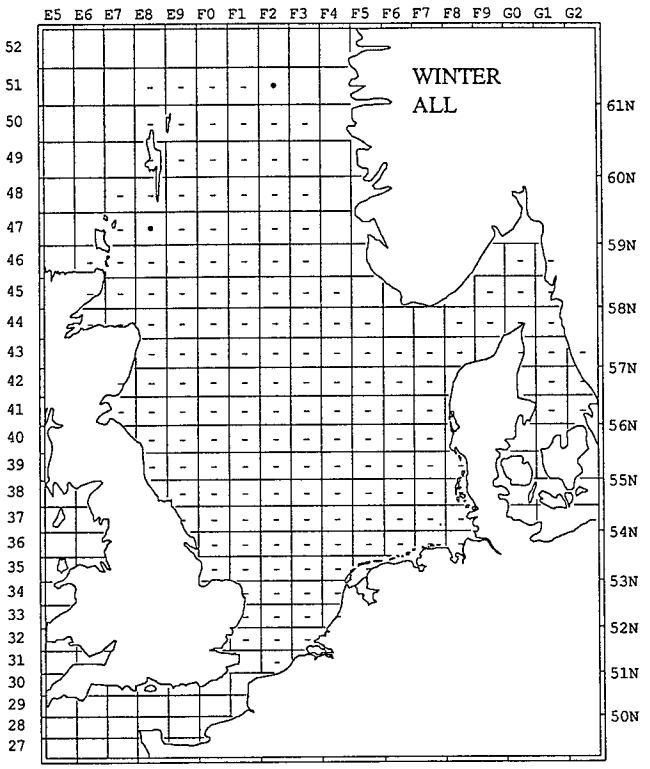
References

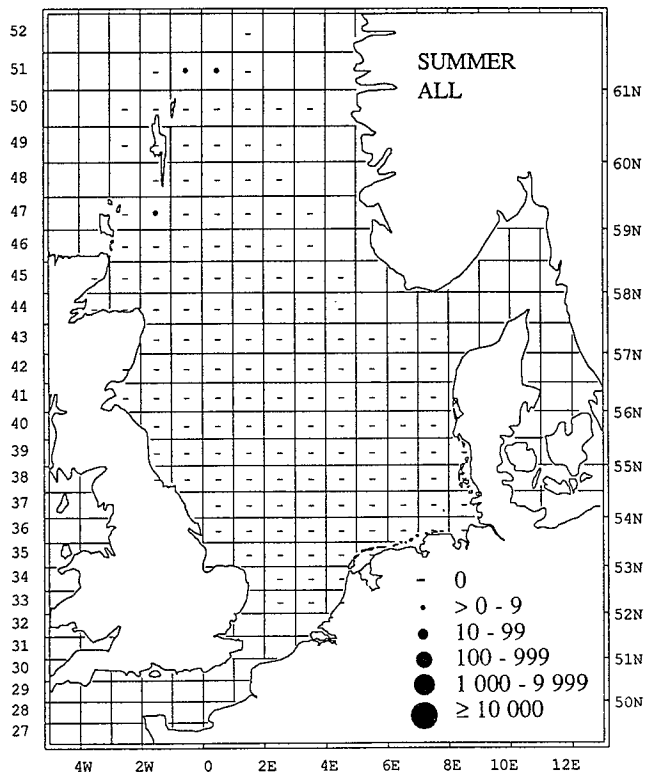
1. Wheeler, A. 1969. The fishes of the British Isles and north-west Europe. Macmillan, London. 613 pp.
2. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.
3. Stehmann, M., and Bürkel, D.L. 1984. Rajidae. *In* Fishes of the North-eastern Atlantic and the Mediterranean, Volume I, pp. 163-196. Ed. by P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris. 510 pp.

13. *Raja fullonica*
Family Rajidae

E. Shagreen ray, F. Raie chardon, D. Chagrin Roche,
DK. Gøgerokke, N. Nebbskate, NL. Kaardrog, S. Gökrocka







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Seven specimens of shagreen ray were caught. Catches were made in winter and in summer in the northern regions of the area.

This species prefers rough grounds [1] which may be why it is only poorly represented in the *Atlas* surveys. Shagreens are found on the upper parts of the continental slope at depths from 35 to 500 m [1].

Length composition

The shagreen ray caught measured between 41 and 95 cm.

Life history

Shagreen ray is oviparous. Egg capsules are probably laid in July in deep waters. The almost transparent egg capsules are 9 cm long and 5 cm wide and have very long horns [1].

Mean length at age in Irish waters was found to be 62 cm in two-year-old specimens, 83 cm at the age of four and 92 cm at the age of eight [4].

Small specimens (≤ 50 cm) of shagreen ray have been found to prey on crustaceans (*Pandalus* spp. and *Meganyctiphanes* spp.). Both small and large shagreens fed predominantly on fish such as sandeel, herring, dab, haddock, and Norway pout. Cephalopod molluscs were eaten as well [3].

Population and exploitation

In Icelandic waters a summertime inshore migration occurs, probably for feeding [1].

Shagreen rays, which are found from Madeira to the Murmansk coast, in the northern North Sea, and in the Skagerrak [2], are of minor economic importance.

References

1. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.
2. Stehmann, M., and Bürkel, D.L. 1984. Rajidae. *In* Fishes of the North-eastern Atlantic and the Mediterranean, Volume I, pp. 163-196. Ed. by P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris. 510 pp.
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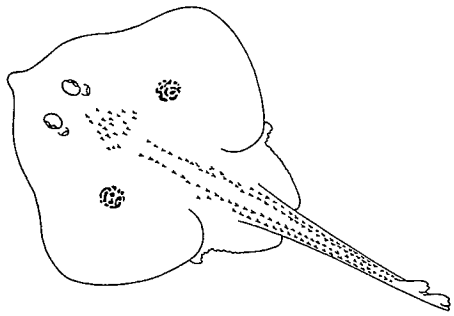
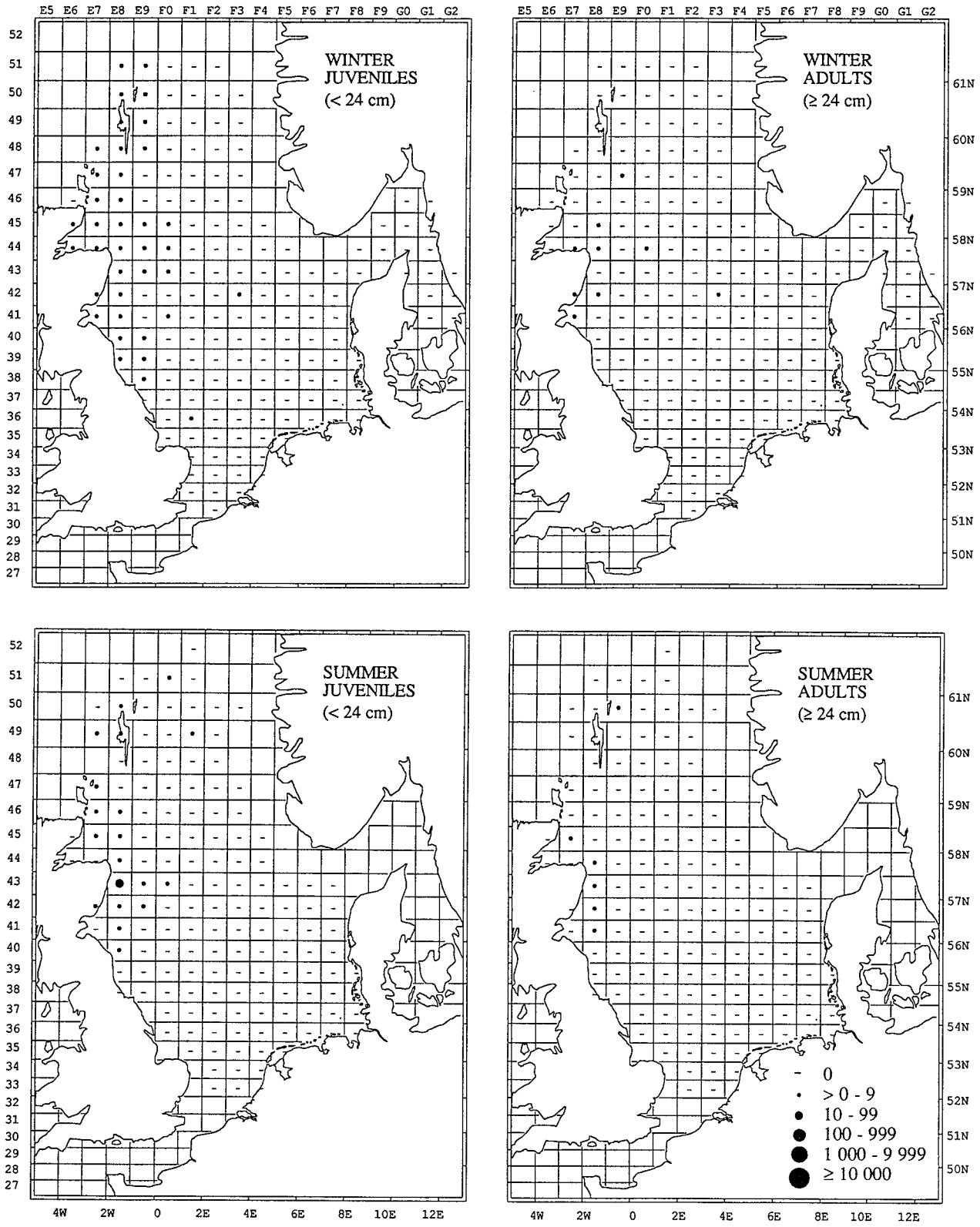
4. Fahy, E. 1989. Growth parameters of rays (Batoidei) in Irish waters, from material examined in commercial catches. ICES CM 1989/G:59. 7 pp.

14. *Raja naevus*
Family Rajidae

E. Cuckoo ray, F. Raie fleurie, D. Kuckucksroche,
DK. Pletrokke, N. —, NL. Grootoogrog, S. —





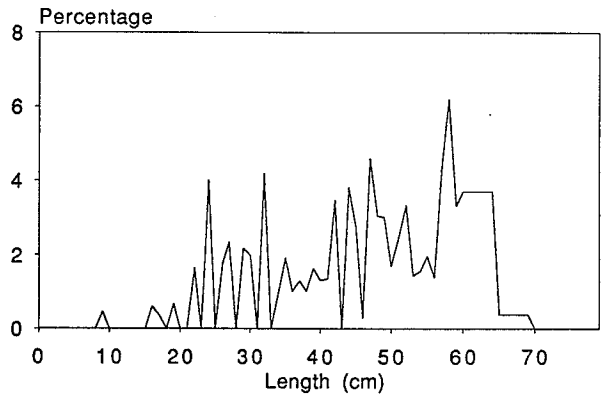
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Catches of 'cuckoos' were largely confined to the north-western part of the North Sea. No seasonal differences were detected, apart from the single exceptionally large haul made during summer in rectangle 43E8, which caught 168 rays at a depth of 88 m.

Length composition

The rays varied in length from 9 to 65 cm, with the majority being larger than 35 cm. The 168 specimens from rectangle 43E8 measured 55 – 65 cm in length.



Length-frequency distribution of cuckoo ray during winter.

Life history

The number of eggs produced by a Celtic Sea female is estimated at one hundred per year [1]. In this area, cuckoos are sexually mature from a length of 60 cm onward [1].

Cuckoo ray (30 – 70 cm length) from Scottish waters feed on crustaceans (e.g. *Crangon crangon*) and, particularly, on fish (sandeels). Polychaete worms and cephalopods are eaten as well [2].

Nothing is known about growth rates in the North Sea.

Population and exploitation

The presence of egg cases throughout the year in the Celtic Sea females suggests that spawning is a continuous process without a distinctive peak season [1].

The *Atlas* data indicate that some seasonal migration may take place although no information on this subject has been found in the literature.

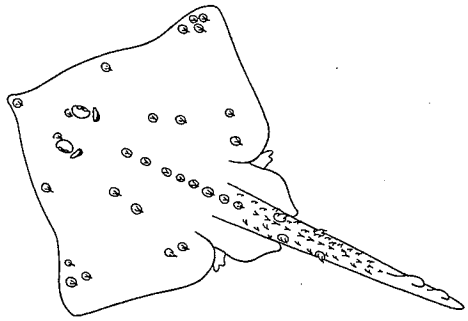
Cuckoo rays make up a significant part of the rays landed by the Scottish commercial fleet.

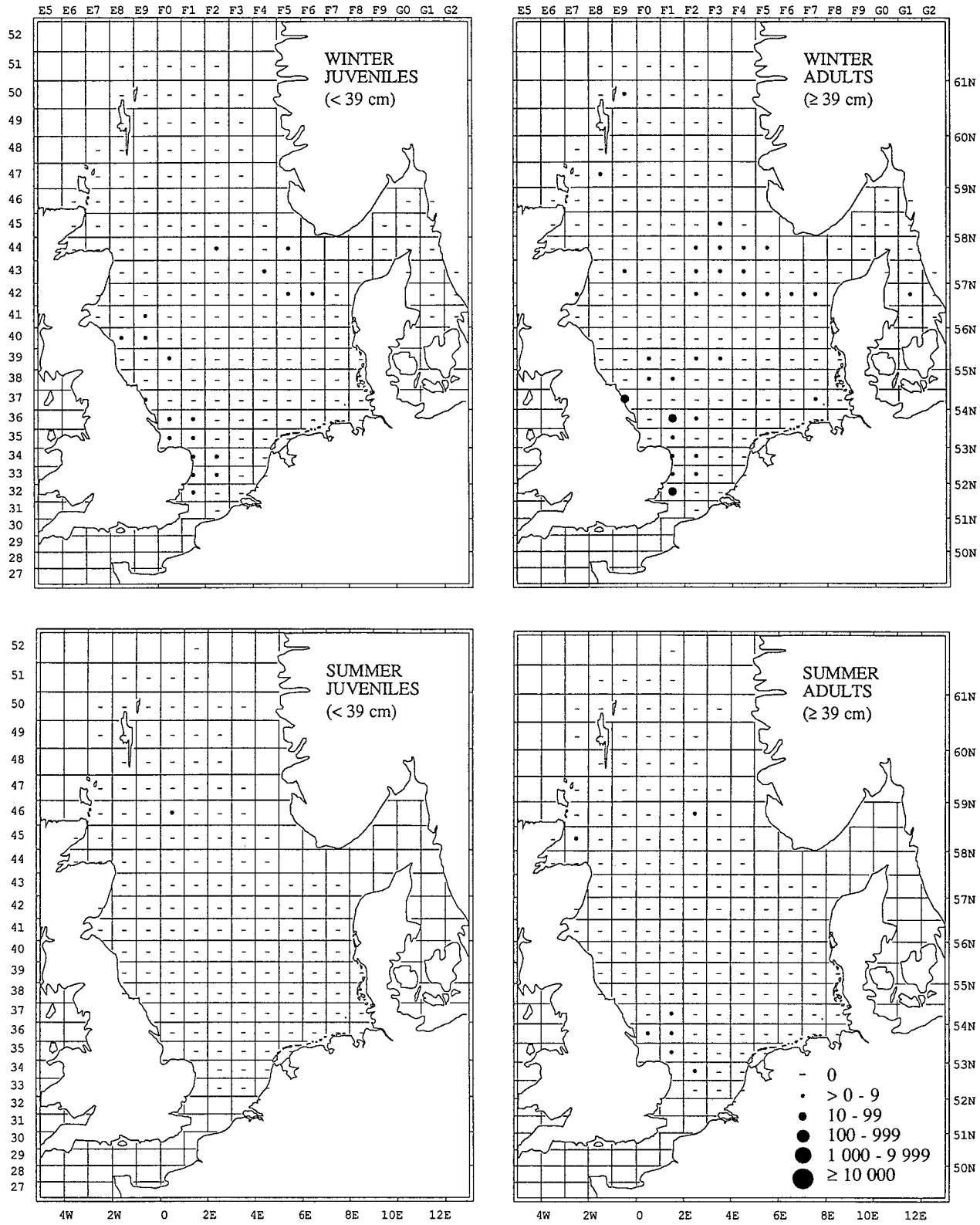
References

1. Du Buit, M.H. 1976. The ovarian cycle of the cuckoo ray, *Raja naevus* (Müller and Henle), in the Celtic Sea. Journal of Fish Biology 8: 199-207.
2. Rae, B.B., and Shelton, R.G.J. 1982. Notes on the food of nine species of elasmobranch (part I) and nine species of demersal teleost (Part II) fishes from Scottish waters. ICES CM 1982/G:56. 5 pp.

15. *Raja clavata*
Family Rajidae

E. Roker, F. Raie bouclée, D. Nagelroche, DK. Sømrokke,
N. Piggskate, NL. Stekelrog, S. Knaggrocka





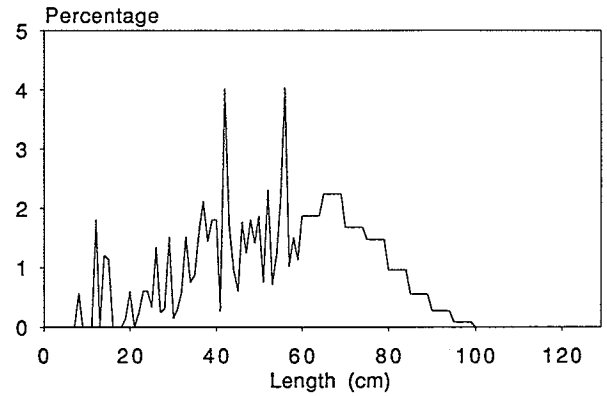
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

This prickly species, sometimes called the thornback ray as well as roker, was mainly caught during winter. The scattered catches, usually of single specimens, suggest that roker occurs from the far north to the far south, but in only two areas was the catch considerable: off the English coast and in the part of the central North Sea that borders the Norwegian Deep. Roker were very scarce in the southeastern part of the *Atlas* area. Two large catches (98 and 444 specimens) were made in rectangle 36F1.

Length composition

The distribution is distorted owing to the irregularity of the catches. Although most of the rays measured well over 35 cm, the whole size-range, from 10 to 95 cm, was caught in February.



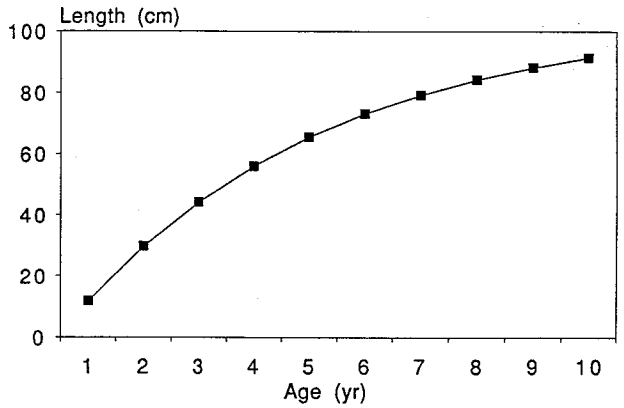
Length-frequency distribution of roker during winter (Scottish data excluded).

Life history

The young feed predominantly on brown shrimp (*Crangon crangon*) and amphipods. The diet of larger roker is more varied and includes polychaete worms, a wide range of crustaceans (such as pagurid and portunid crabs) and fish (e.g. sandeel and members of the gadoid, clupeid, and callionymid families) [1].

Roker may reach an age of twelve years, and grow to more than 100 cm in length. Females attain a larger size than the males. Sexual maturity is reached in the fifth year of life [2].

This ray is oviparous and the eggs are demersal. From 62 to 74 eggs have been counted in gravid females, but as rays are serial spawners, the total number of eggs shed per year could very well be higher [2]. In the laboratory the small rays (10 – 14 cm length) hatch from their egg cases after 4 – 5.5 months of incubation [3].



Mean length per age group in the northeast Irish Sea (parameters from [4]).

Population and exploitation

At the end of the winter, the Bay of Douarnenez (Brittany, 0 – 30 m deep) is invaded by both one-year-old roker and mature specimens. The bay serves as a nursery area for the one-year-olds which probably stay there for at least two years. The adults use the bay as a mating place and leave the area gradually after mating during spring. The eggs are laid elsewhere [5]. Spawning in general occurs in inshore areas, between March and September [3], and it is likely that similar movements occur in the *Atlas* area as well.

Roker is of moderate economic importance in the *Atlas* area. For North Sea landings of rays as a group, see *Raja radiata* (No. 9).

References

1. Holden, M.J., and Tucker, R.N. 1974. The food of *Raja clavata* Linnaeus 1758, *Raja montagui* Fowler 1910, *Raja naevus* Müller and Henle 1841 and *Raja brachyura* Lafont 1873 in British waters. Journal du Conseil International pour l'Exploration de la Mer 35(2): 189-193.

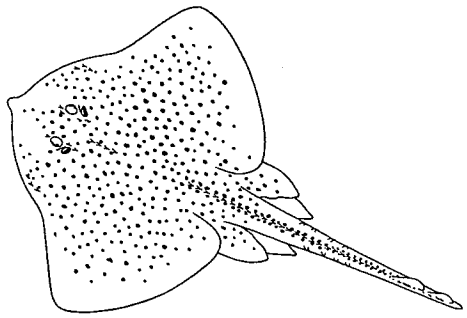
2. Ryland, J.S., and Ajayi, T.O. 1984. Growth and population dynamics of three *Raja* species (Batoidei) in Carmarthen Bay, British Isles. Journal du Conseil International pour l'Exploration de la Mer 41: 111-120.

3. Clark, R.S. 1922. Skates and rays (Raiae). No. 1. Egg-capsules and young. Journal of the Marine Biological Association of the United Kingdom 12: 577-643.

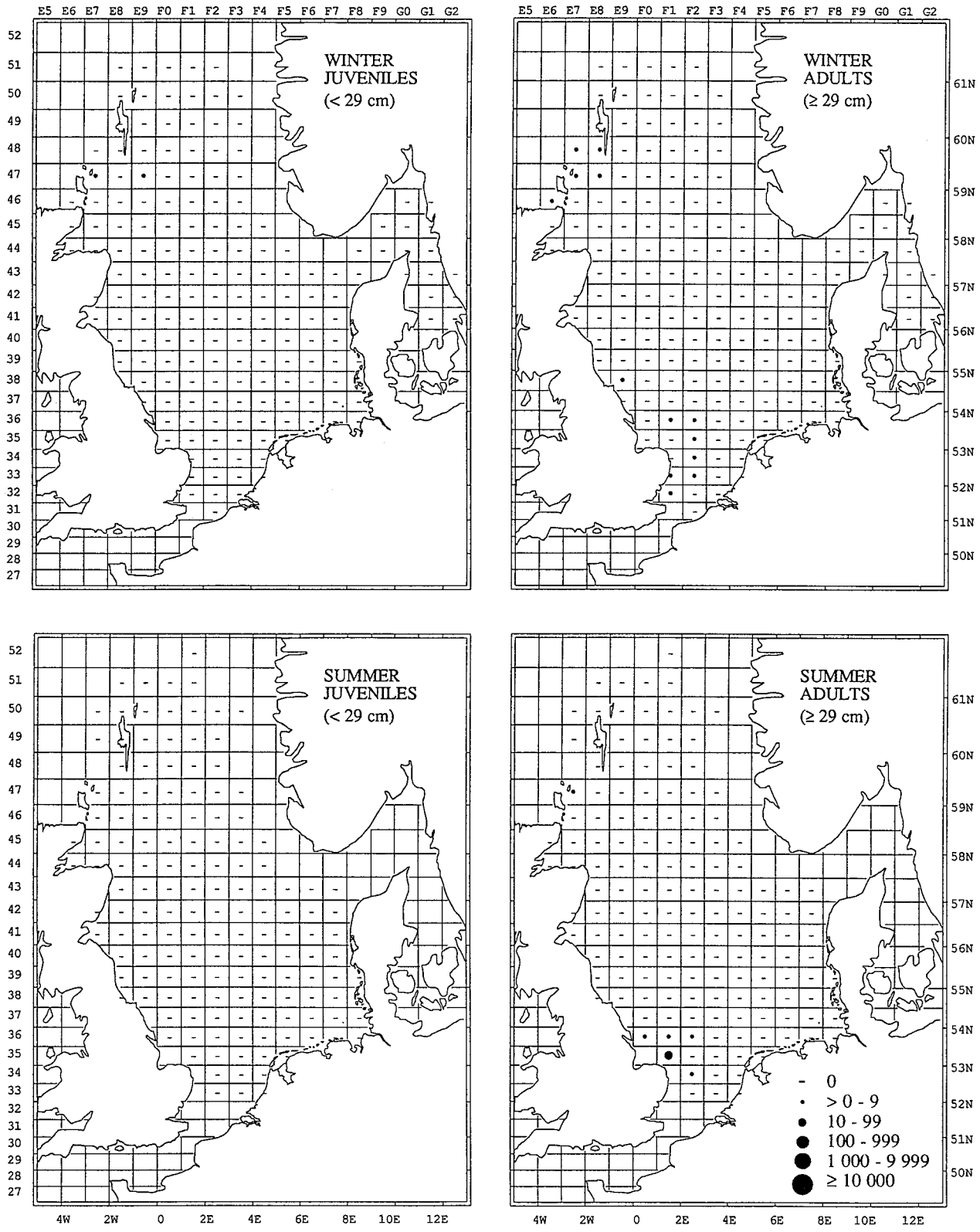
4. Brander, K., and Palmer, D. 1985. Growth rate of *Raia clavata* in the Northeast Irish Sea. Journal du Conseil International pour l'Exploration de la Mer 42: 125-128.

5. Rousset, J. 1990. Population structure of thornback rays *Raja clavata* and their movements in the bay of Douarnenez. Journal of the Marine Biological Association of the United Kingdom 70: 261-268.

16. *Raja montagui*
Family Rajidae



E. Spotted ray, F. Raie douce, D. Gefleckter Roche, DK. Storplettet rokke, N. Flekkskate, NL. Gevlekte rog, S. —



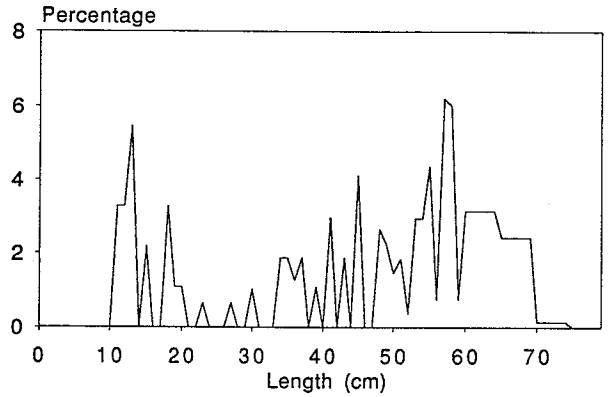
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

The spotted ray was caught in very small quantities. Its occurrence in the *Atlas* catches was limited to two well-separated areas, one south of Shetland, the other in the Southern Bight.

Length composition

The small numbers caught give only a general impression of the length range of this ray. One summer haul made in rectangle 35F1 contained 28, of which 15 had a length of 60 cm.

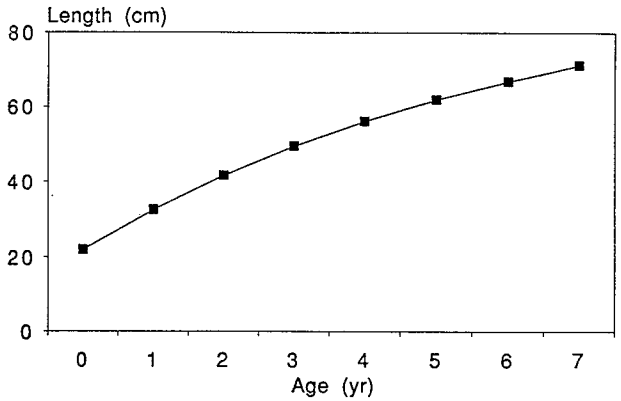


Length-frequency distribution of spotted ray during winter.

Life history

In common with its relatives roker (No. 15) and cuckoo ray (No. 14), the smaller length groups of spotted ray feed predominantly on amphipods and the shrimp *Crangon crangon*, while the diet of larger specimens is more diverse and contains a wide range of crustaceans, polychaete worms, and fish. However, fish seems to be less important for the spotted ray than for the other two species [1,2].

Spotted rays from the Bristol Channel have been shown to attain seven years of age. The maximum length observed was 75 cm, identical to the largest individual caught during the *Atlas* surveys. Bristol Channel specimens spawn for the first time in their fifth year of life at a size of 57 cm [3]. It takes five to six months for the eggs to hatch [4].



Mean length per age group (parameters from [3]).

Population and exploitation

Peak spawning in the Bristol Channel is from February to June [3].

This ray is landed in small quantities but is of minor economic importance. For North Sea landings of rays as a group, see *Raja radiata* (No. 9).

References

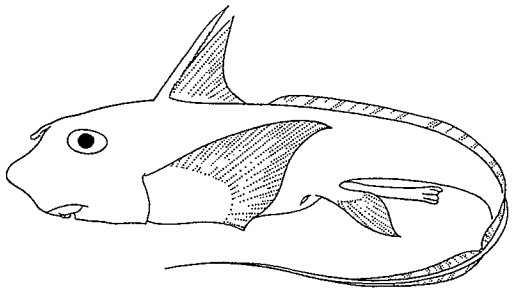
1. Holden, M.J., and Tucker, R.N. 1974. The food of *Raja clavata* Linnaeus 1758, *Raja montagui* Fowler 1910, *Raja naevus* Müller and Henle 1841 and *Raja brachyura* Lafont 1873 in British waters. Journal du Conseil International pour l'Exploration de la Mer 35(2): 189-193.

2. Ajayi, T.O 1982. Food and feeding habits of *Raja* species (Batoidei) in Carmarthen Bay, Bristol Channel. Journal of the Marine Biological Association of the United Kingdom 62: 215-223.

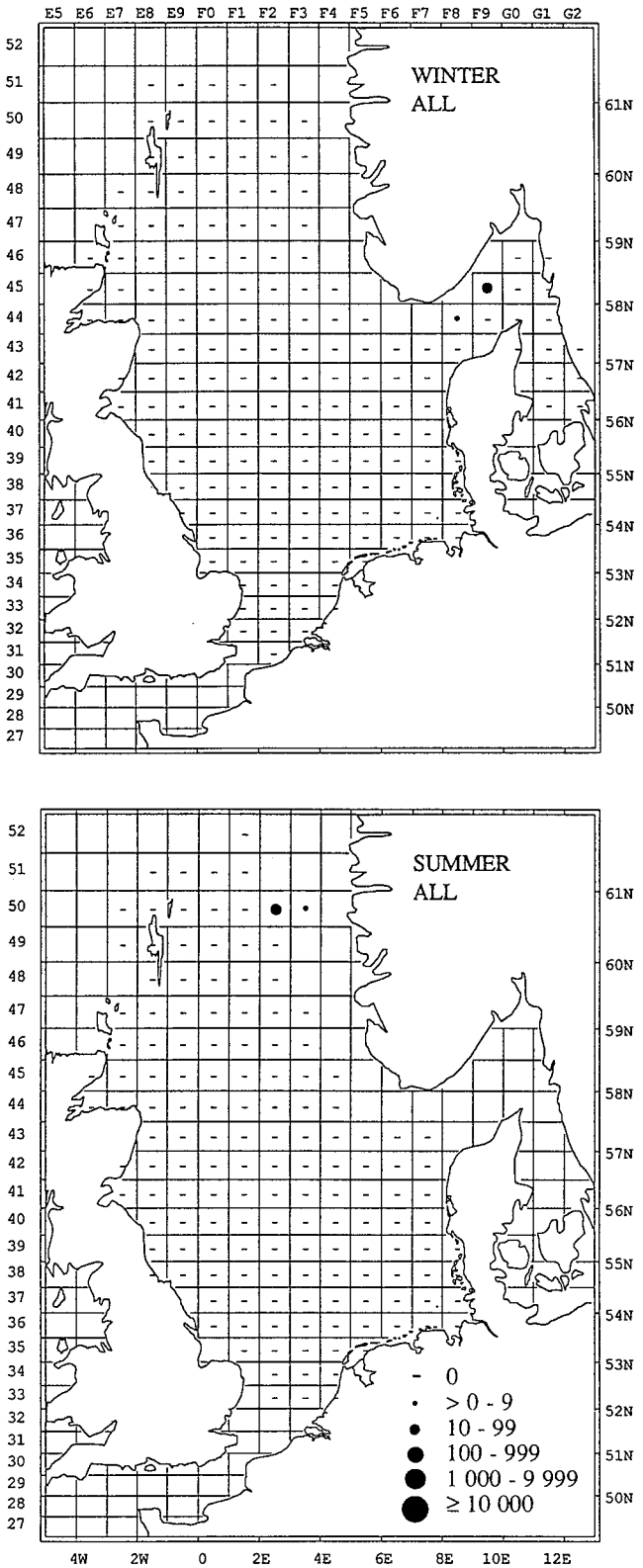
3. Ryland, J.S., and Ajayi, T.O. 1984. Growth and population dynamics of three *Raja* species (Batoidei) in Carmarthen Bay, British Isles. Journal du Conseil International pour l'Exploration de la Mer 41: 111-120.

5. Clark, R.S. 1922. Skates and rays (Raiae). No. 1. Egg-capsules and young. Journal of the Marine Biological Association of the United Kingdom 12: 577-643.

17. *Chimaera monstrosa*
Family Chimaeridae



E. Rabbit fish, F. Chimère commune, D. Seeratte, DK. Havmus, N. Havmus, NL. Draakvis, S. Havsmus



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Winter catches of rabbit fish were mostly made in the deep (> 200 m) waters of the Skagerrak. However, this area was not covered by the *Atlas* summer surveys, when only a few rabbit fish were caught, on the edge of the Norwegian Deep.

Length composition

The specimens caught measured 20 – 40 cm, which is rather small for a fish which is said to attain 150 cm [1].

Life history

Little is known about the biology of rabbit fish. The eggs are laid singly in long, tapering, chitinous capsules (17 by 2.5 cm) and have been found, newly laid, from April to August off the Norwegian coast [2]. Stomachs examined contained brittle star, crab, shrimps, molluscs, and unidentified fish remains [1].

Population and exploitation

This benthopelagic species is common over the entire European continental shelf between 300 – 500 m depth and occasionally down to 1000 m. There is a summer movement into shallower water (100 m) possibly connected with spawning [1].

Although large catches of rabbit fish have been made in the deeper areas, it is not exploited commercially because the flesh has a bitter taste [1].

References

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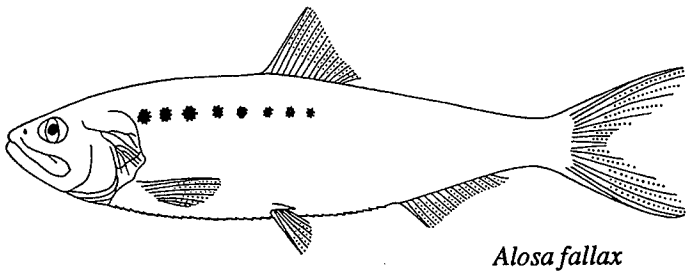
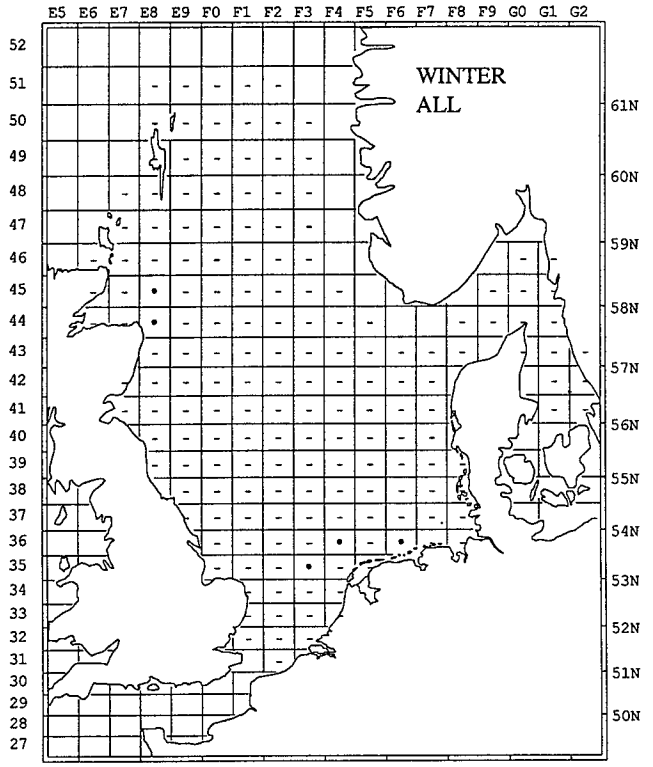
18. *Alosa* spp.
Family Clupeidae

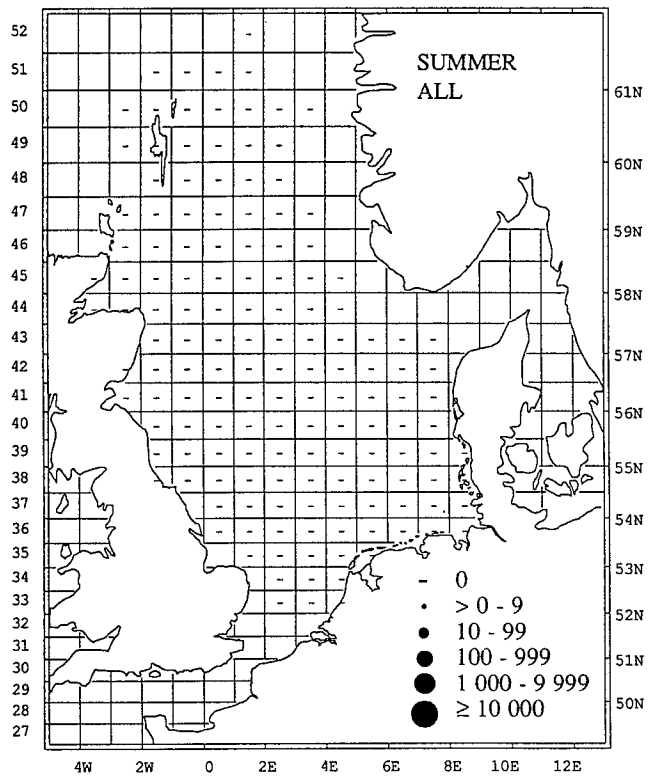
E. Allis shad, F. Alose vraie, D. Maifisch, DK. Majsild, N. Maisild, NL. Elft, S. Majfisk

E. Twaite shad, F. Alose fallax, D. Finte, DK. Stavsild, N. Stamsild, NL. Fint, S. Staksill



Alosa fallax





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Two species of anadromous clupeids occur in the *Atlas* area: allis shad, *Alosa alosa*, and twaite shad, *Alosa fallax*. Since correct identification is rather difficult, the catches of the two species were combined.

Six shad were caught, all during winter surveys, in the southeastern North Sea and off the Scottish east coast.

Length composition

The specimens caught measured between 9 and 36 cm.

Life history

The chief distinguishing feature between the two species is the number of gill rakers on the first gill arch: 80 – 130 in allis shad, and 40 – 60 in twaite shad. Adults enter rivers in May – June to spawn either far upstream (allis shad), or in or just above tidal reaches (twaite shad) [1,2,3]. Spawning is at night, and the mating fish swim in circles, violently beating the surface with their tailfins [2]. They return to sea after reproduction.

The eggs sink to the bottom and hatch in 4 – 8 days [1]. It takes the young fish six months to reach a length of 60 – 75 mm, and they measure 9 – 14 cm after one year. Juvenile allis shad stay one or two years in the river before moving to sea, while juvenile twaite shad emigrate already in their first year of life [1,4].

Allis shad can reach a length of 60 cm. The maximum length of twaite shad is 50 cm [1]. Males of twaite shad reach maturity in 2 – 3 years, females in 4 – 5 years [1]. Fecundity of 5 – 8 year-old twaite shad ranges from 155,000 to 266,000 eggs [3].

Allis shad is a plankton feeder. Juveniles in fresh water prey on copepods, insect (midge) larvae, cladocerans, and ostracods. Large fish feed on copepods (*Calanus* spp.), decapods (*Pandalus* spp.), euphausiids, and some young fish [1]. The juveniles of twaite shad feed on harpacticoid and calanoid copepods and mysids; large specimens prey on euphausiids and fish (sandeel, sprat, young herring) [4].

Population and exploitation

A fishery for both species existed in several rivers but has ceased because the stocks declined. This is due to overfishing, destruction of spawning areas, hindrance of migration through man-made obstacles, and pollution. In the Rhine the fishery for allis shad came to an end in 1910, and that for twaite shad ended in 1966 [5]. In Kurshkiy Bay (Baltic) the fishery for twaite shad ceased to exist in 1960 [3].

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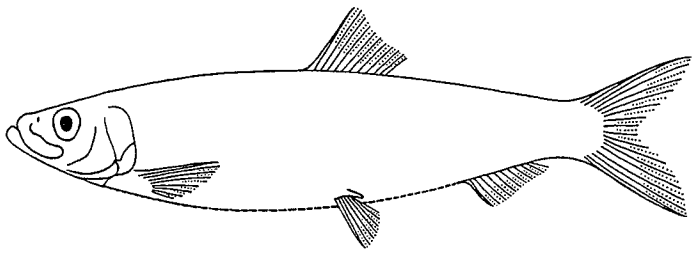
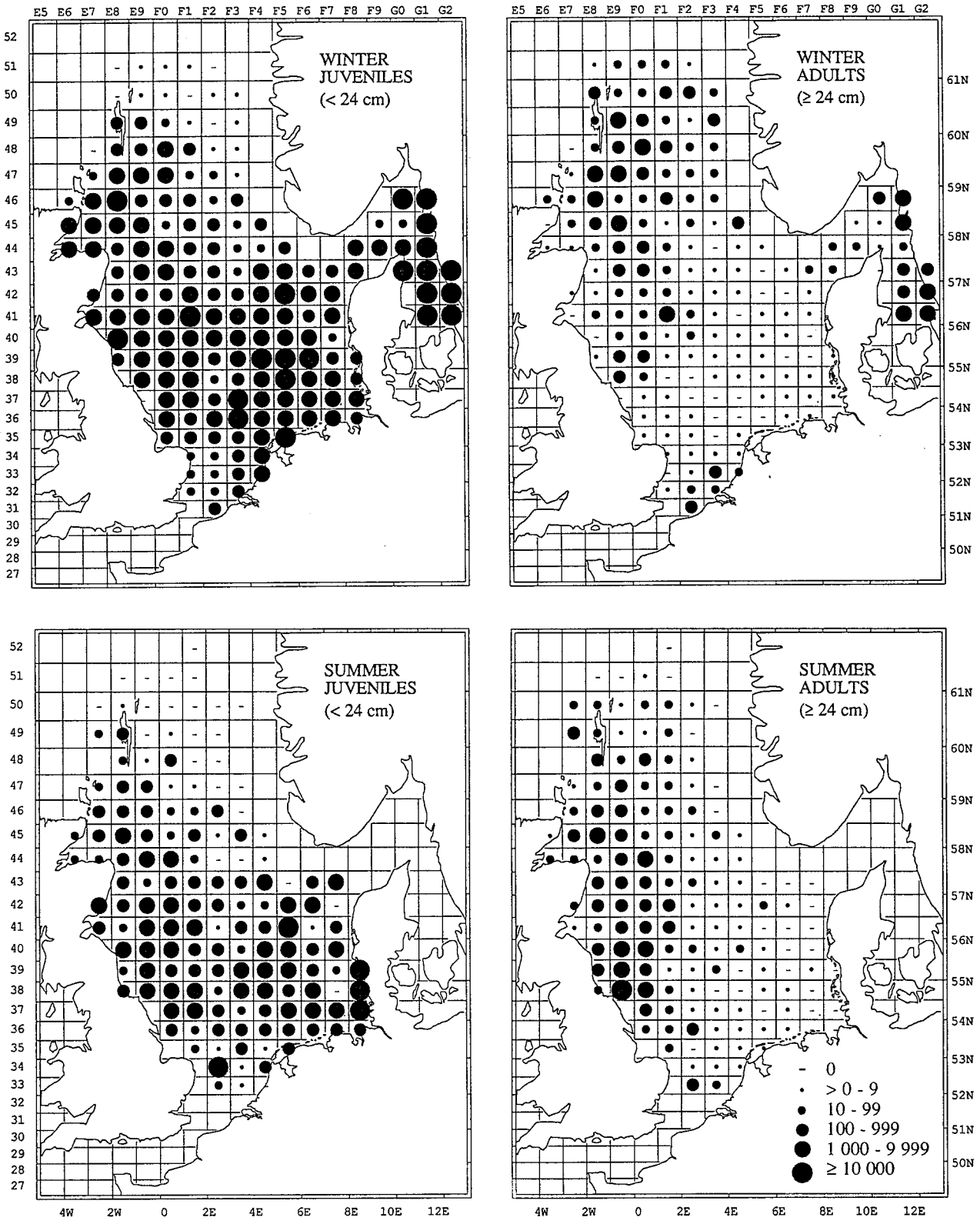
19. *Clupea harengus*
Family Clupeidae

E. Herring, F. Hareng, D. Hering, DK. Sild,
N. Sild, NL. Haring, S. Sill





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

'There is herring and there is fish' — an old saying that nicely illustrates the herring's significance as a food resource for the human populations around the North Sea.

Immature herring were caught throughout the *Atlas* area, apart from the northernmost, deeper part of the North Sea. Areas of high local abundance could be detected everywhere, but densities were highest in the Kattegat. A shoal of over 150,000 specimens was caught there in a single haul during the winter survey of 1986.

The mature specimens, in contrast, were mainly caught in the northern North Sea, in the western part of the central North Sea, in the Skagerrak and Kattegat, and in the Southern Bight. The pattern of distribution changed through the year. In winter mature herring were concentrated near Shetland, whereas in summer their distribution was more southerly.

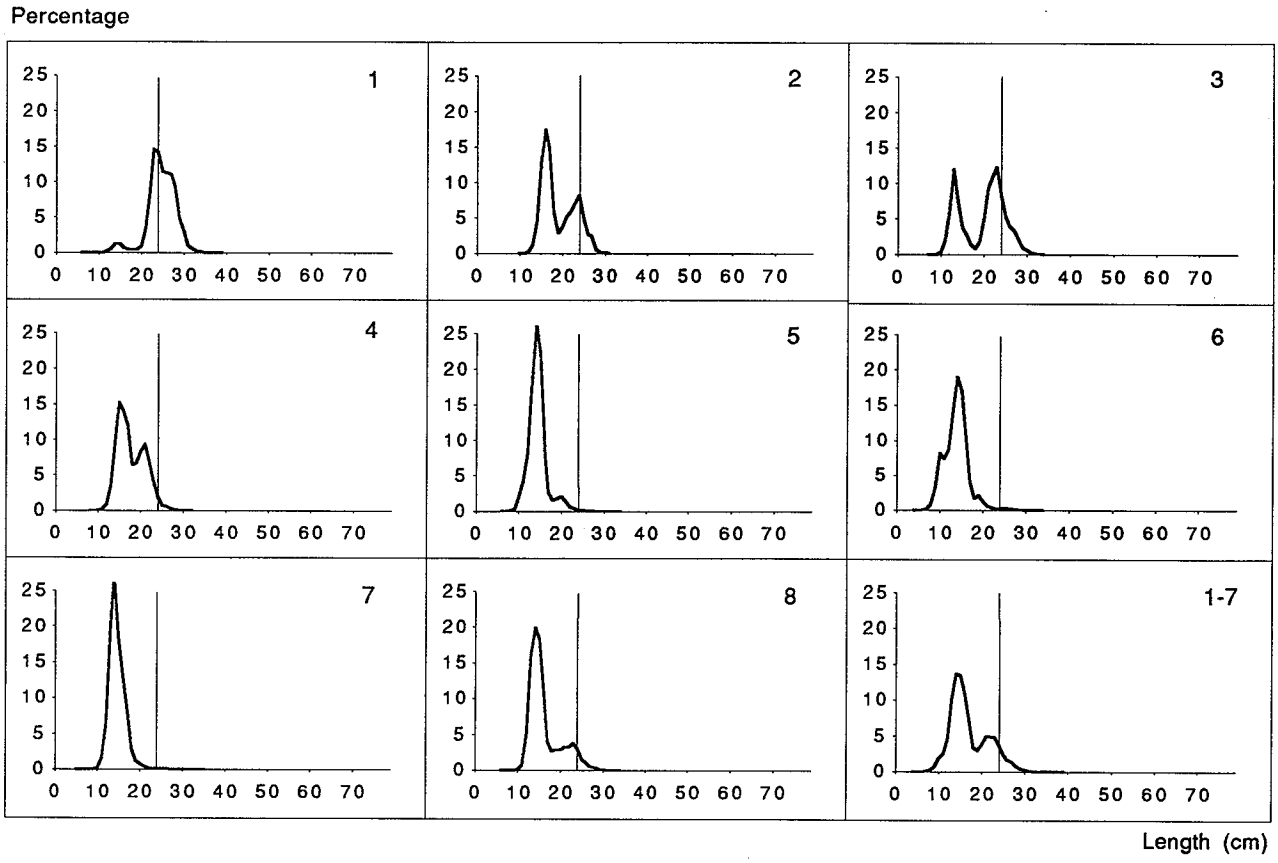
It should be stressed once again that *Atlas* bottom trawls are not very good sampling devices for pelagic, shoaling species such as herring, and that the *Atlas* data are probably a rather poor reflection of the real distribution in northern, deeper waters. Additionally, adult herring are constantly on the move during summer, making it difficult for both fishermen and scientists to keep track of the shoals.

Length composition

Winter catches were dominated by 1.5-year-old herring that measured 10 – 20 cm. Only in area 1 (the northern North Sea) were larger individuals more frequently caught than the smaller size groups. Hauls in area 3, the Scottish coast, contained equal numbers of small and large fish.

Life history

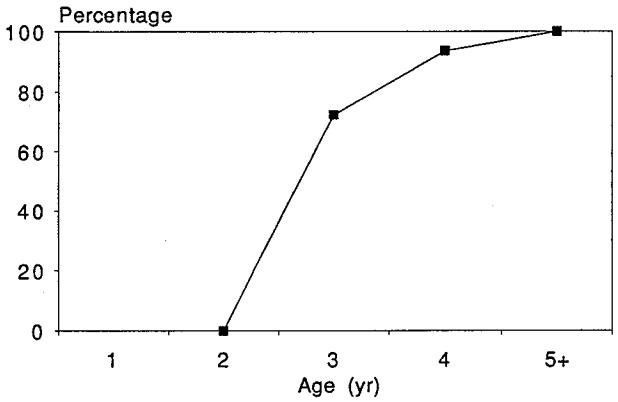
Herring are demersal spawners, who deposit sticky eggs on small stones and gravel. The shoals congregate on traditional spawning grounds, where all the members of a shoal spawn more or less simultaneously. The resulting egg carpets are 4 – 9 layers thick, and may cover an area of up to one hectare [1]. Herring show no courtship behaviour; the female releases a ribbon of eggs close to the bottom and the male sheds milt while swimming a few centimetres above the female [2]. Each female produces a single batch of eggs per year. There are pronounced differences between the fecundities of the various spawning 'races', and between the sizes and weights of their eggs. Thus an average-sized female (27.5 cm, 175 g) belonging to the Downs stock will produce 42,000 eggs per annum (240 eggs per gram body weight) whereas a similarly sized fish from the Buchan stock will produce 67,000 eggs (380 eggs per gram) [3].



Length-frequency distribution of herring by roundfish area during winter (length split indicated).

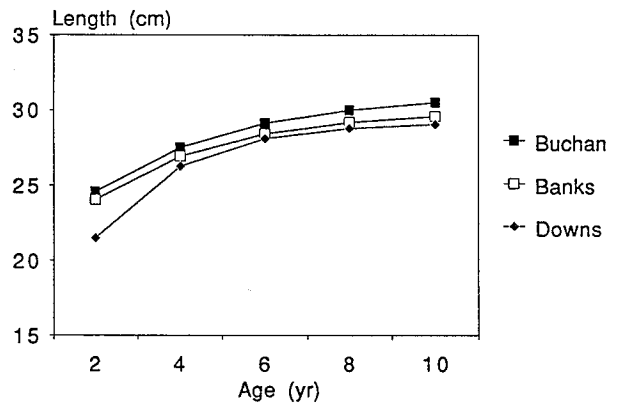
Incubation of the eggs takes one to three weeks depending on temperature [4]. The pelagic, anguilliform larvae, which measure between 8 and 10 mm at hatching, feed on naupliar and adult stages of copepods [1]. Calanoid copepods are the predominant prey items during the early juvenile (< 3 cm) stage of life, but euphausiids, hyperiids, juvenile sandeel, *Oikopleura* spp., and fish eggs are also eaten. The relative frequency of the prey groups varies during and between years, but there are no marked differences in the diets of smaller and larger herring [5].

The shoals of herring move towards the surface at dusk and disperse during the hours of darkness, while they stay near the bottom or in deep water during the day. The diurnal vertical movements may be related to availability of prey or to the stage in the gonad maturation cycle [6,1]. Of the three-year-old herring 75% is mature [8].



Average percentage mature individuals per age group for herring caught in the North Sea in 1988, 1989, and 1990 [8].

Different 'races' of herring are distinguished, not only by differences in spawning sites and spawning area, but also by meristic characters. For instance, herring that spawn in the central North Sea in autumn have on average 56.3 vertebrae, while this is 56.1 for Kattegat spring spawners [7]. There is intraspecific variation in growth and age parameters too, and it is assumed that this is mainly caused by environmental factors rather than by genetic processes [3].



Mean length (cm) per age group of three races of North Sea herring (parameters from [3]).

Population and exploitation

At present three major populations are distinguished in the North Sea. They mix during most of the year but split up during the reproductive season when each group migrates to its own spawning grounds. The populations are:

a. Buchan – Shetland herring, spawning off the Scottish and Shetland coasts during August – September;

b. Banks or Dogger herring, spawning in the central North Sea off the English coast during August – October;

c. Southern Bight or Downs herring, which spawn in the English Channel during November – January.

Observed shifts in the position of the spawning areas may be related to changes in plankton (i.e. food) abundance and distribution and, ultimately, to environmental changes [9]. The bulk of spawning in the North Sea is in autumn by the three populations mentioned above [10], but some spawning occurs in spring as well. Many more spawning populations can be described on a finer scale [11].

Most autumn-spawned larvae spend their first winter drifting in an easterly direction, from the western North Sea towards nursery areas where they metamorphose in spring. Important nurseries for one-year-old herring are the continental coastal waters and the Skagerrak and Kattegat. The larval drift, however, is very variable from one year to another, and it is possible that in some years most larvae do not reach the nursery areas in the east [12]. Herring in their second year of life move off shore into deeper waters [13], and with increasing age they join the adult population in feeding and spawning migrations in the western part of the survey area.

Migrations are sometimes beyond North Sea borders; older herring caught to the west of Scotland originate largely from nursery areas in the North Sea [13]. The Skagerrak – Kattegat area is temporarily visited by fish from the North Sea [7].

North Sea herring landings rose steadily after the Second World War and peaked in 1965. During the next fifteen years, catches dropped to the lowest level since 1903 (when recording of accurate statistics started). Reasons for this historic decline include overfishing, but a failure in recruitment due to natural causes seems to have been involved as well. In 1977 an estimated 200,000 t of two-group and older herring was left in the North Sea, whereas in 1965 there was still 2,000,000 t [14]. The herring fishery was closed in 1977 and eventually the stock recovered. In 1983 the fishery was reopened but in 1991 it was not yet clear whether the spawning stock size had reached a safe level [8].

Apart from the fishery for human consumption, a considerable fishery for immature herring for reduction purposes exists as well.

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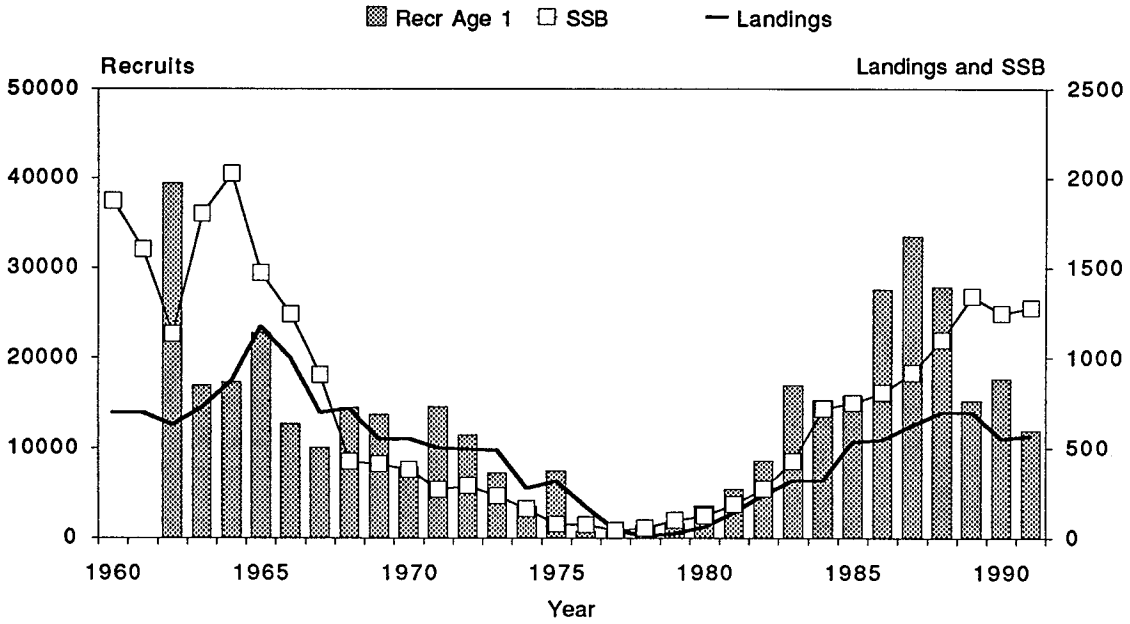
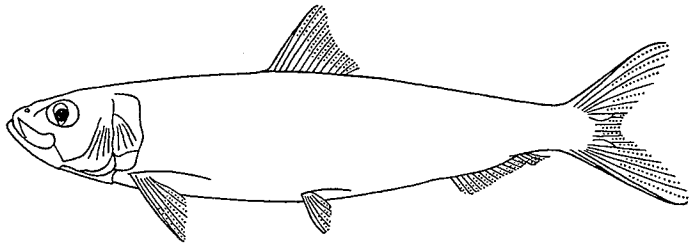
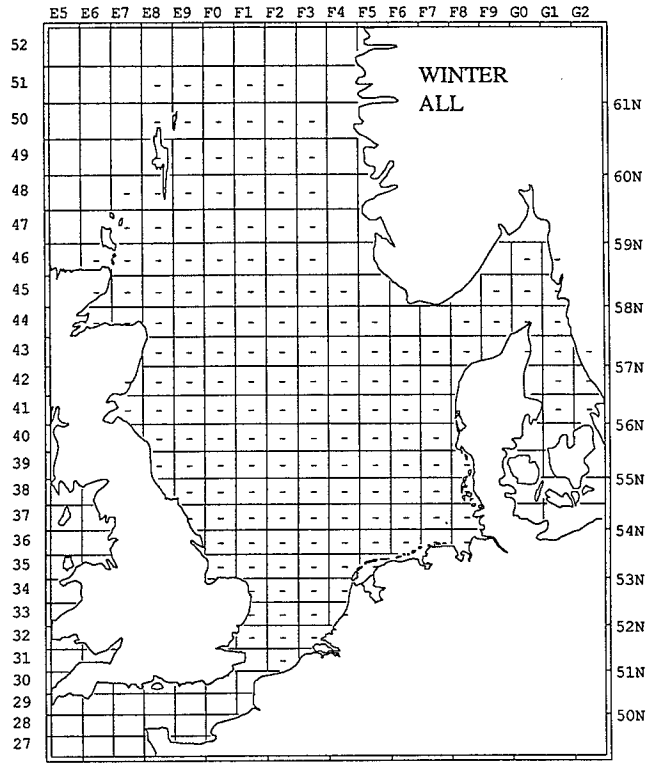


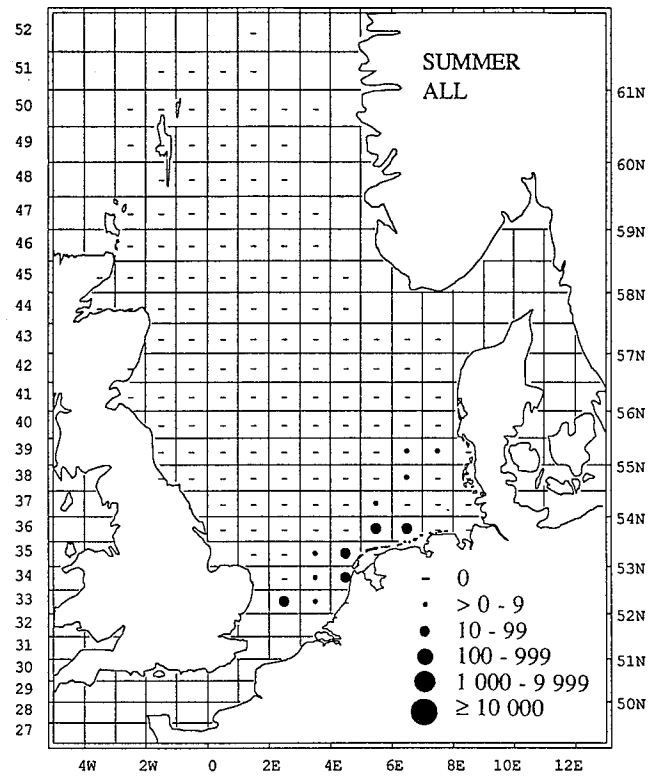
North Sea landings, spawning stock biomass (in 1000 t) for North Sea autumn spawners, and recruitment (in millions of one-ringers) according to the VPA since 1960.

20. *Sardina pilchardus*
Family Clupeidae

E. Pilchard, F. Sardine, D. Sardine, DK. Sardin,
N. Sardin, NL. Pelser/Sardien, S. Sardin







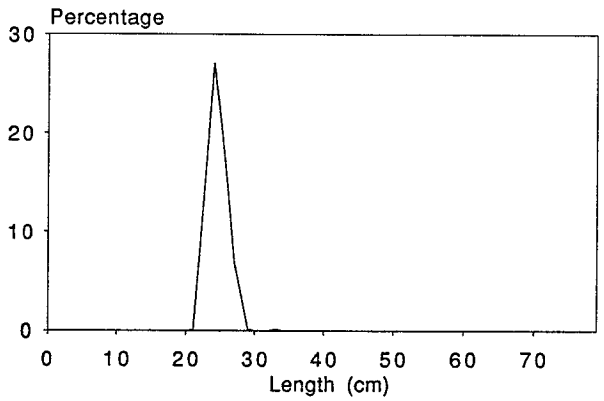
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Pilchard were caught only during summer in the south-eastern North Sea, particularly off the Dutch, German, and Danish coasts. This pelagic, schooling species is common in, and to the south of, the English Channel. The distribution of pilchard in the North Sea is known to be associated with an influx of relatively warm water from the English Channel [1].

Length composition

All the pilchard caught during the *Atlas* surveys were large specimens, with an average length of about 25 cm.



Length-frequency distribution of pilchard during summer.

Life history

Pilchard feed exclusively on zooplankton and phytoplankton. Important food items in Cornish waters are copepods, ostracods, euphausiids, the larval and juvenile stages of many other groups of crustaceans, and diatoms. Feeding intensity is highest during spawning and at a low level during winter [2].

Growth off Cornwall is fast during the first three years, when the fish attain a length of 19 cm. Specimens of 18 – 26 cm can be from two to more than eight years old. The onset of sexual maturity coincides with a reduction in growth rate at about three years of age [2]. It is estimated that a female produces 60,000 – 80,000 pelagic eggs [3].

Population and exploitation

As shown by the regular identification of pelagic eggs [4,5], spawning occurs far into the North Sea, but probably only by a small part of the main population in the south that has migrated to the north. Spawning in the English Channel takes place in the open sea in spring and summer. It appears that the maturing fish aggregate on zooplankton patches and spawn there [5].

Although pilchards and their young (sardines) are the object of an important fishery in more southern waters, they seldom appear in the North Sea in sufficient quantities to be of economic importance in this area. North Sea landings fluctuate between almost zero and 3000 t per year.

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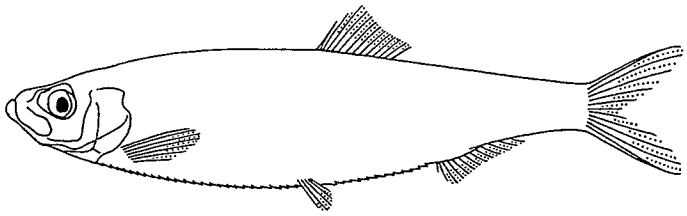
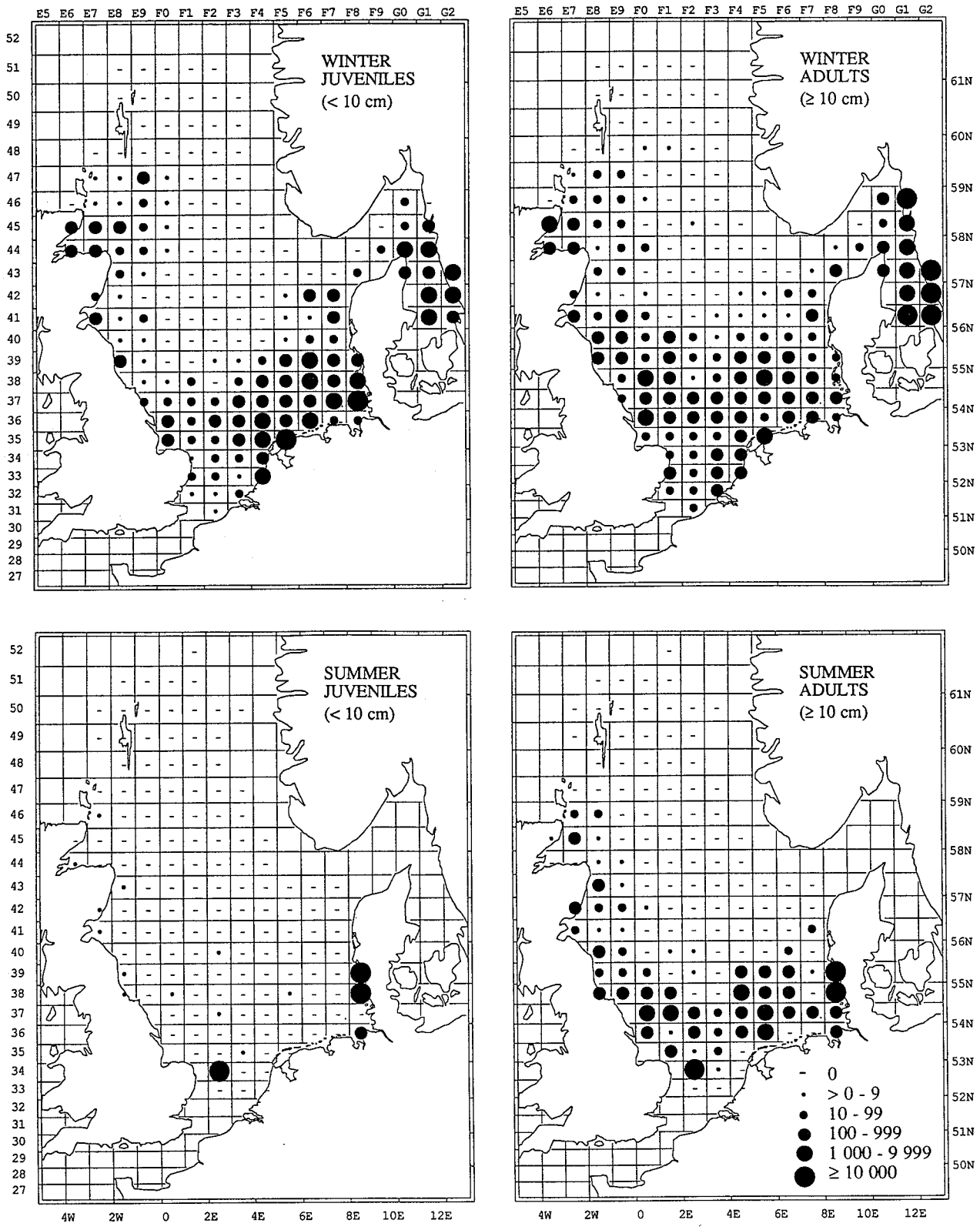
21. *Sprattus sprattus*
Family Clupeidae

E. Sprat, F. Sprat, D. Sprott, DK. Brisling,
N. Brisling, NL. Sprot, S. Skarpsill





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Sprat was caught throughout the *Atlas* area, except for the northern and central part of the North Sea. Densities in coastal parts were generally higher than in deeper, offshore regions. During the winter surveys both immature and mature fish were present in large amounts in the Skagerrak and Kattegat. Many immature sprat were caught in the German Bight.

During the summer surveys no immature sprat were caught, except for a few extremely rich hauls in the German and Southern Bights. At this time of year the juveniles caught during winter have reached adult size, and the young of the new year class are not yet big enough to be caught. The distribution of the mature specimens during summer is similar to the distribution during winter, but more confined to coastal areas.

Length composition

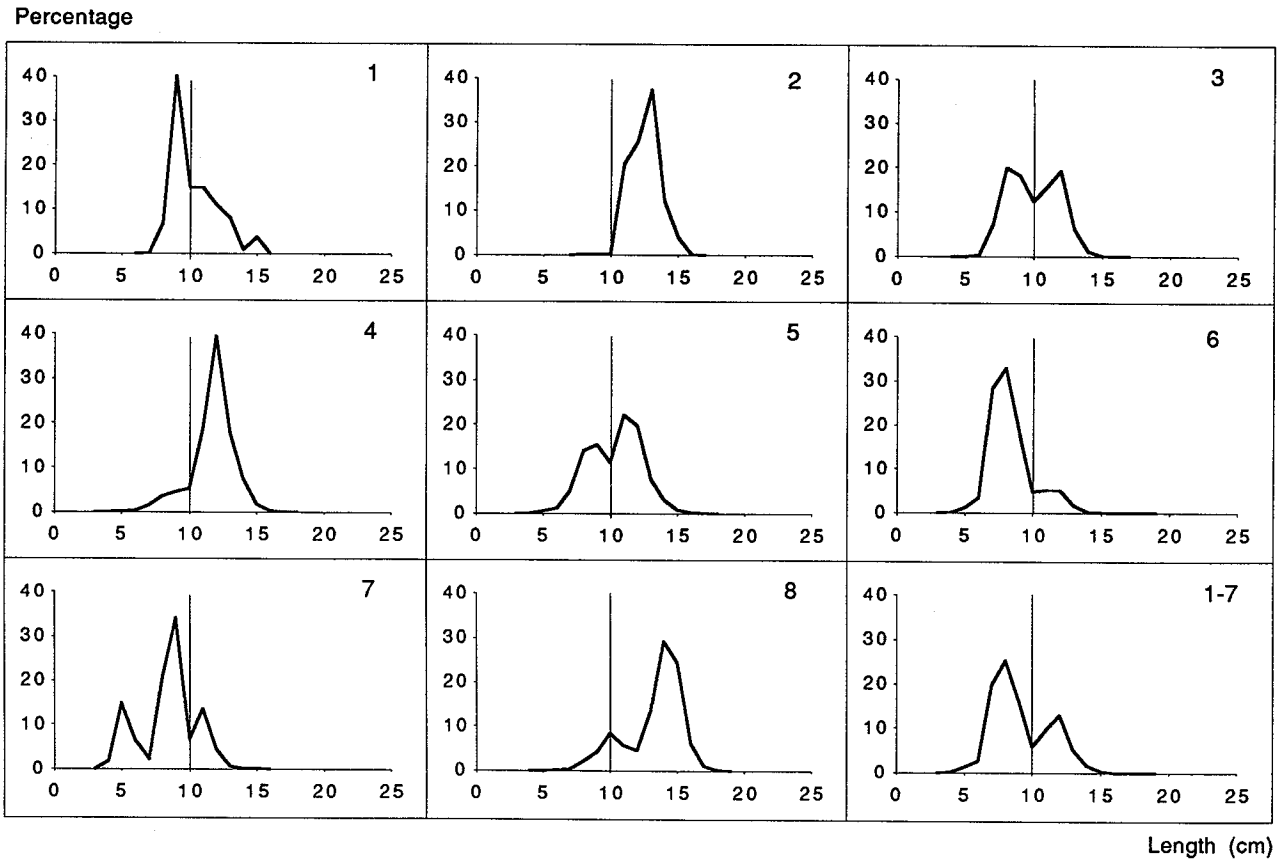
Length of sprat caught during the winter surveys ranged from < 5 to 17 cm, but comparison with other gear types showed that the *Atlas* gears do not catch small (< 5 cm) sprat very efficiently [1].

The winter length compositions in the sampling areas differ substantially. For example, large (10 – 15 cm) sprat were caught more frequently than smaller ones in the Kattegat and Skagerrak (area 8), while the opposite was true for the German Bight (area 6).

Life history

This clupeid is a multiple batch spawner, i.e. each female spawns repeatedly during the spawning season. Sprat from the Baltic spawns at least ten times a year [2]. For North Sea sprat, the number of eggs in a batch varies in the course of the spawning season, but is estimated to be between 100 and 400 eggs per gram body weight [3]. This equals 1500 – 6000 eggs per batch for a two-year-old female, weighing 15 g [4]. Spawning takes place at night [5] and the eggs are pelagic, in contrast to the demersal eggs of the closely related herring. Laboratory experiments showed that it takes about two days for 50% of the eggs to hatch at an ambient temperature of 18°C, and about eight days at 6°C [5].

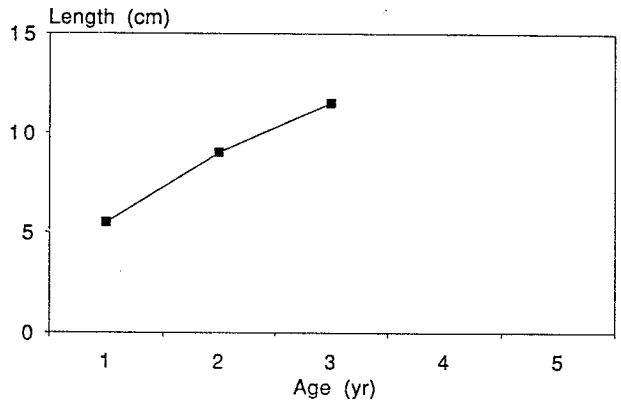
Larval sprat feed pelagically on all stages of copepods [6]. After metamorphosis, at 32 – 41 mm [7], sprat continues to feed pelagically on copepods, but cladocerans, *Oikopleura dioica*, bivalve larvae, mysids, and euphausiids are also eaten during this stage of life [8].



Length-frequency distribution of sprat by roundfish area during winter (length split indicated).

Growth in sprat is notoriously variable within and between age groups, areas, and years. One-group sprat in the North Sea, for instance, may have a modal length of 7 cm in the spring of one year, while 4 cm is the modal group length in the spring of another year [9]. This species is short-lived. It seldom attains an age of more than five years [4].

Most sprat spawn for the first time at an age of about two years, but a small proportion of the population spawns as one-year-olds [4].



Modal length (cm) per age group in the North Sea in winter, averaged for the years 1979 – 1981 (derived from Fig. 2.10 in [9]).

Population and exploitation

The distribution of sprat eggs largely matches that of the fish itself as shown by the *Atlas* surveys. Important spawning areas in the North Sea are the inner German Bight, the area off the northwestern coast of Jutland, an area off the English coast, and areas to the west and north of Scotland [1]. Spawning in the German Bight is from May to August and peaks in May – June, depending on water temperature [10]. Probably only a proportion of the sprat born in the German Bight during July – October metamorphose before their first winter. The remainder, hatched late in the season, spend their first winter as larvae [11].

Young sprat start immigrating into west Scottish sea lochs in July – August [12]. Migrations into, and over-wintering in, coastal parts of the *Atlas* area are evidenced by the existence of traditional winter fisheries close to the coast, but indications have been found that with increasing age, participation in these movements decreases [4].

While North Sea herring catches decreased, an industrial offshore fishery developed for sprat around 1972. North Sea sprat catches rose substantially and peaked at 700,000 t in the mid-1970s. Not only an increasing fishing effort but also some very successful recruiting year classes are likely to have contributed to the temporary boom in the North Sea sprat catches [9].

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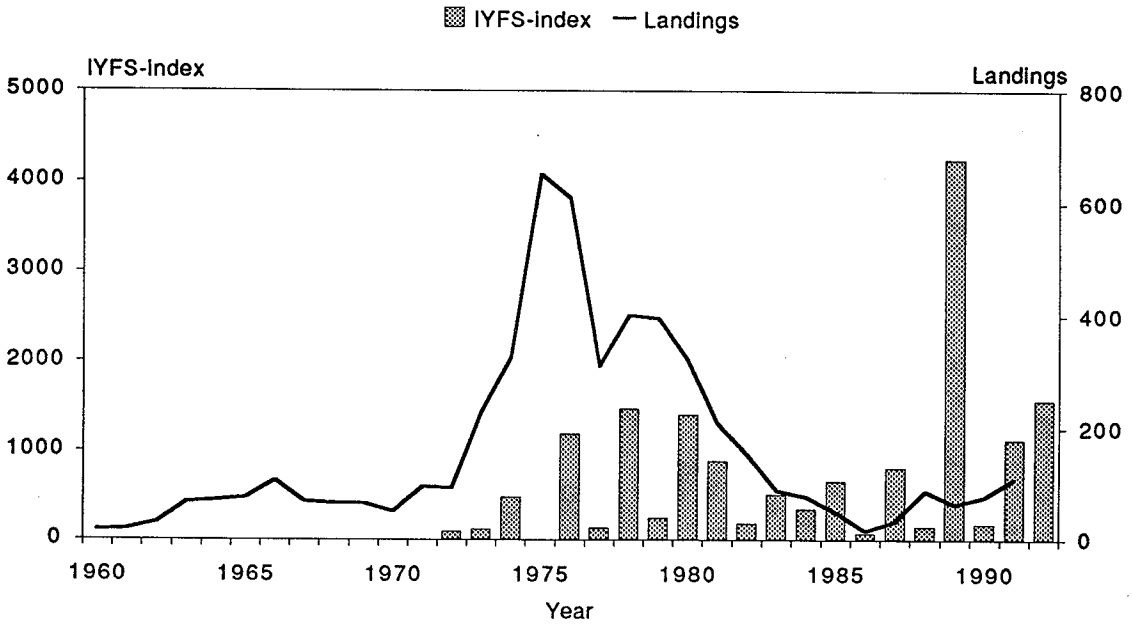

North Sea landings (1000 t) and IYFS-index for one-year-old sprat since 1960.

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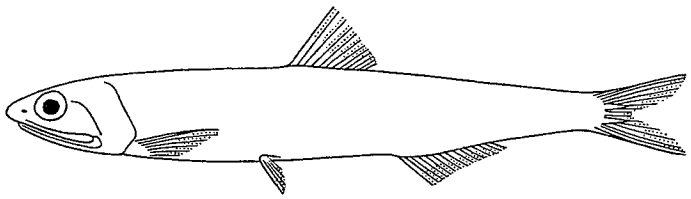
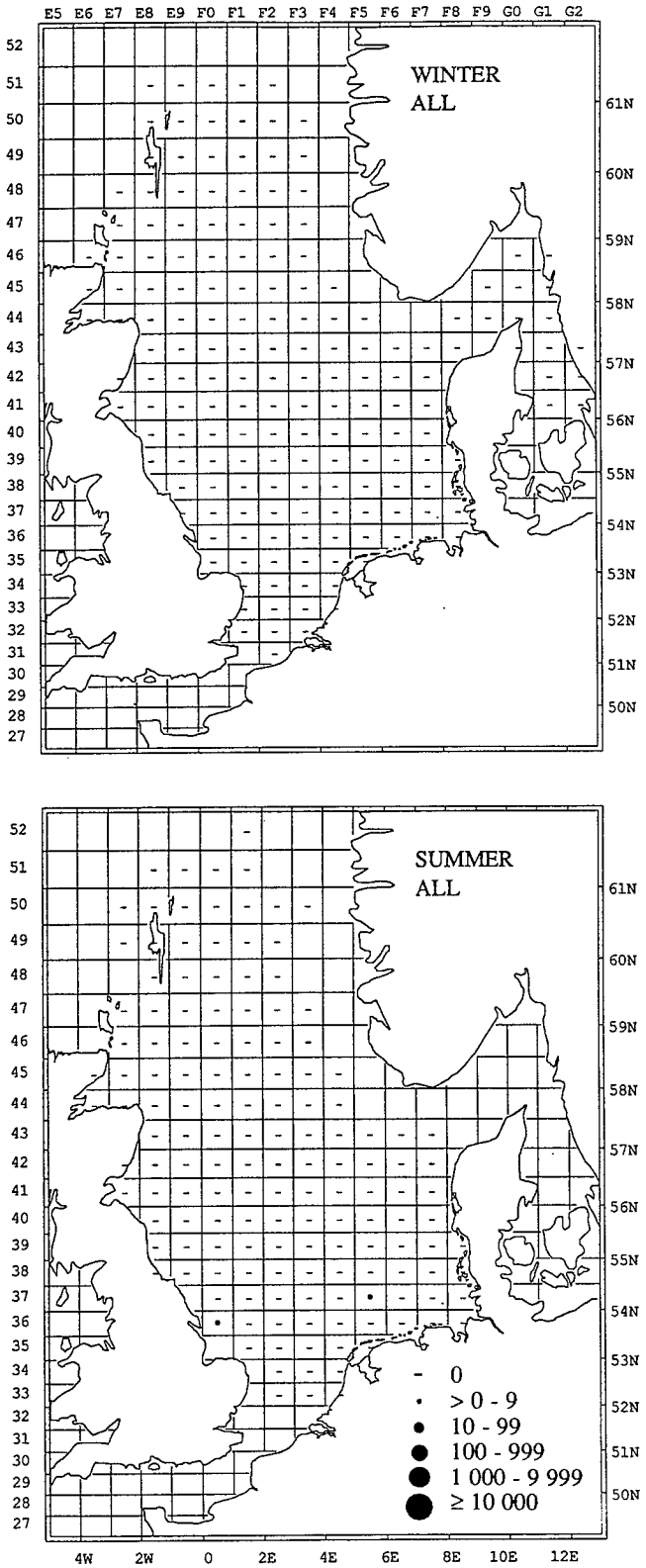
22. *Engraulis encrasicolus*
Family Engraulidae

E. Anchovy, F. Anchois, D. Sardelle, DK. Ansjos,
N. Ansjos, NL. Ansjovis, S. Ansjovis





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Anchovy is a southern, schooling species that does not occur in the *Atlas* area in winter. Summer catches in hauls made in southern rectangles 36F0 and 37F5 confirm that this species enters the North Sea in spring via the English Channel.

Length composition

Only two specimens were caught. They measured 14 and 20 cm, which is large considering that anchovy normally grows to a length of 9 – 12 cm [1].

Life history

Anchovy lives in surface waters and feeds on planktonic animals. Spawning takes place in summer and the eggs and larvae are pelagic [1]. By early October the juveniles have reached a size of 3 – 4 cm [2]. In the Bay of Biscay all one-year-old fish are mature [3].

Population and exploitation

In the late 1940s, three spawning areas were known: in the Scheldt estuary, in the former Zuiderzee, and in the German Bight. During the 1930s, this small fish penetrated as far north as the western Baltic [2].

Anchovy is an important commercial species off southern Europe, in the Mediterranean, and in the Black Sea. In the *Atlas* area this species has a negligible commercial importance, although there is a small fishery in the Easterscheldt with a catch of 21 tonnes in 1992.

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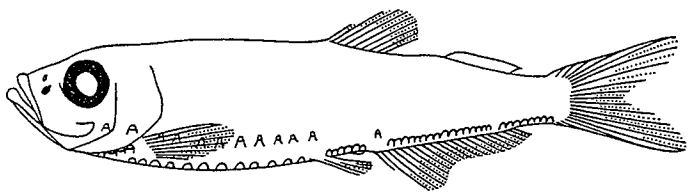
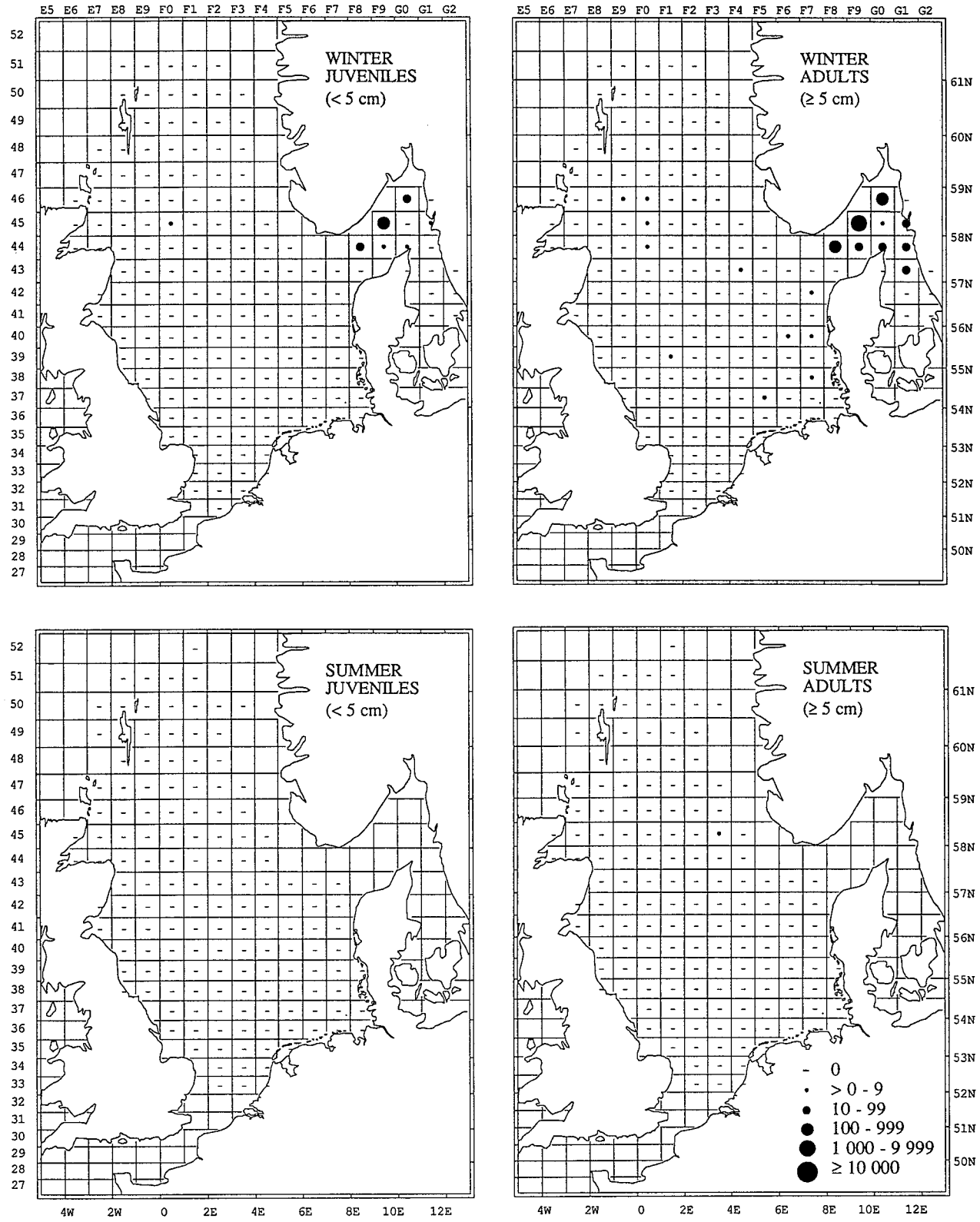
23. *Maurolicus muelleri*
Family Sternoptychidae

E. Pearlsides, F. —, D. Lachshering, DK. Laksesild,
N. Laksesild, NL. Lichtend sprotje, S. Laxsill





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

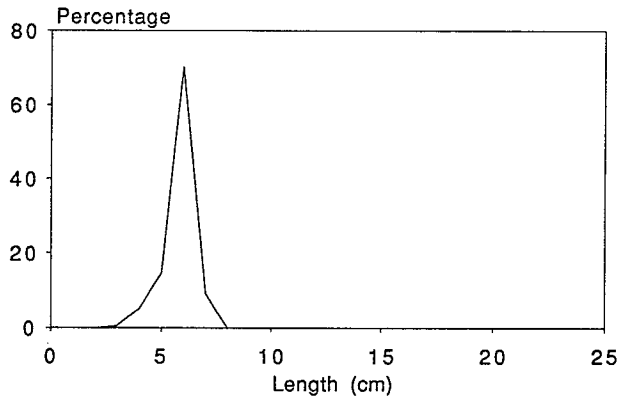
Spatial distribution

A species with prominent light organs on the sides and belly, pearlsides clearly conforms with the traditional view of a deep sea species. It was caught in the Skagerrak – Kattegat area, and, incidentally, in the North Sea. No *Atlas* data on the distribution in the Skagerrak – Kattegat area during summer are available. Pearlsides are known to be the most abundant mesopelagic fish in some of the fjords of western Norway and in the Norwegian Deep [1].

The *Atlas* data probably do not adequately describe the spatial distribution of this mesopelagic fish, as is shown by the relatively high frequency with which pearlsides were caught during small-mesh pelagic trawl surveys of the northern North Sea in summer [2].

Length composition

Pearlsides seldom grows bigger than 6.5 cm. All the fish caught during the *Atlas* surveys were, therefore, relatively large specimens. The smallest fish caught with krill trawls in Norwegian waters in February measured 2 cm, the largest over 6.5 cm [1].



Length-frequency distribution of pearlsides in area 8 during winter.

Life history

Pearlsides grow rapidly to 3 cm during their first year of life, and reach 5 cm in their fourth year. This fish matures when it is one year old.

The food of pearlsides mainly consists of copepods and krill [1]. Pearlsides rise to the surface at night [3]. Fish of the southern hemisphere follow the diurnal migration pattern of the zooplankton during the feeding season [4].

Pearlsides have a fecundity of 200 – 500 eggs. The eggs are pelagic and have a sculptured surface [5].

Population and exploitation

Spawning probably takes place from March to October. Since there are no indications of spawning migration, spawning is likely to take place wherever pearlsides occurs [1].

Pearlsides are occasionally caught in huge schools and are therefore of potential economic interest. For instance, 8000 were caught during a summer haul in rectangle 46F9.

References

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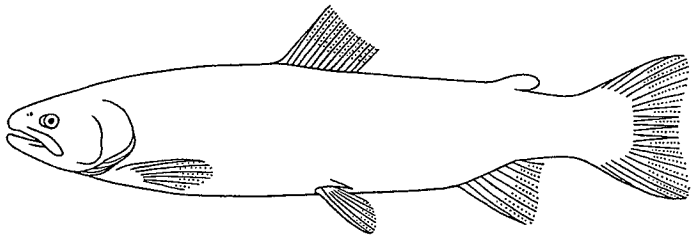
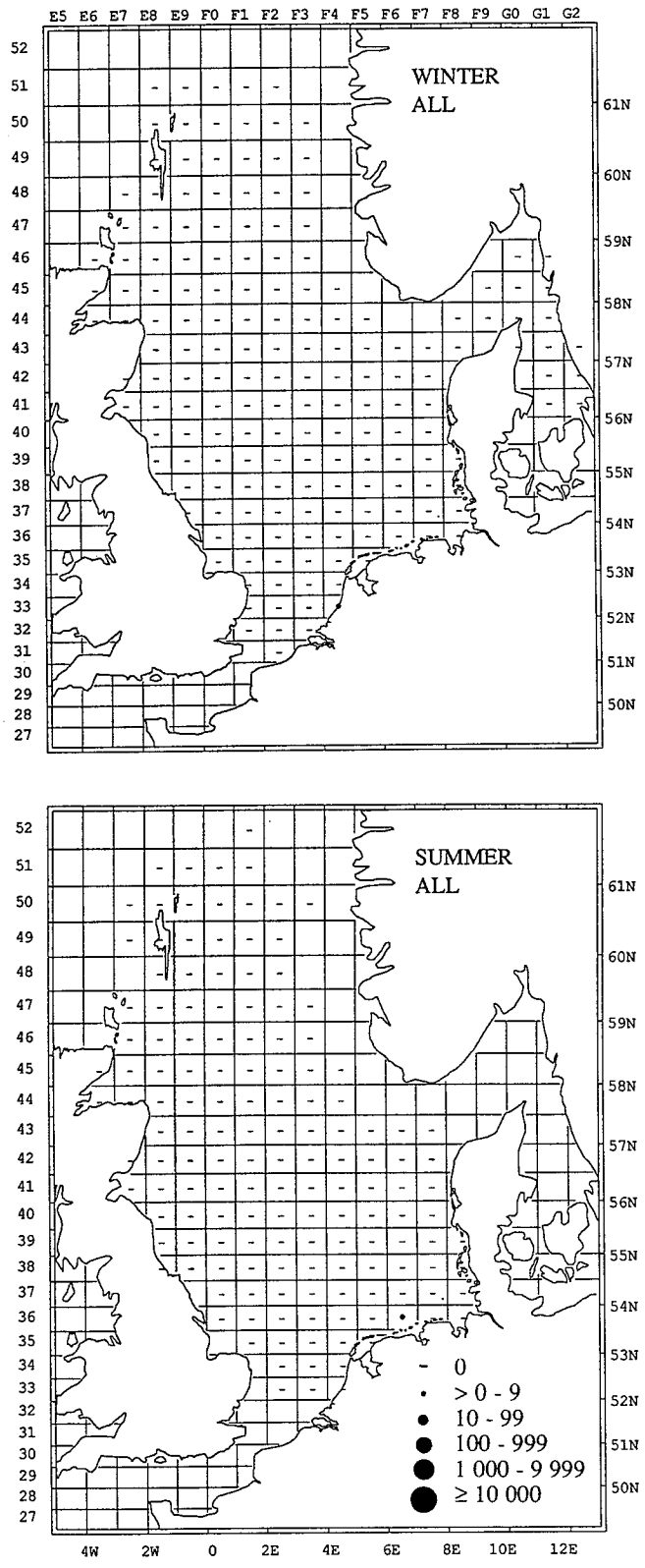
24. *Salmo trutta*
Family Salmonidae

E. Sea trout, F. Truite de mer, D. Meerforelle, DK. Ørred, N. Aure, NL. Zeeforel, S. Öring





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

A few sea trout were caught in both winter and summer surveys at inshore stations in the southeastern North Sea. Because the sea trout is probably largely pelagic, the trawl surveys are unlikely to provide a good picture of its abundance and distribution in the *Atlas* area.

Length composition

All specimens were rather large (50 – 80 cm) individuals.

Life history

The trout spawns in fresh water, most commonly during late autumn and early winter. The eggs are deposited in nests (redds) excavated by the female. After fertilization they are covered with a layer of gravel [1].

All trout spend their first few years, the fry and parr stages, in fresh water. Most of them remain in fresh water during the rest of their life and are known as brown trout. Some, however, after having spent up to seven years in the freshwater habitat, pass through a smolt phase with typically silver coloration and migrate to brackish or saline waters. These migratory trout are known as sea trout [1].

The sea trout is an active mid-water predator, feeding on fish, particularly clupeoids and sandeels, and on crustaceans [1]. The period at sea is a phase of rapid growth and sea trout may reach a large size (> 100 cm), depending on local conditions and the length of time spent in this habitat, which ranges from one to four years [2,3].

Population and exploitation

The trout is very widely distributed in European rivers and lakes and shows considerable local variation in form, colouration, and growth rate. Rather little is known about its marine distribution, but it is believed to remain nearer to the coast and travel shorter distances than the closely related salmon, *Salmo salar*.

Brown trout and sea trout are intensely exploited in fresh water by sport fishermen and there are coastal and estuarine commercial fisheries for sea trout.

References

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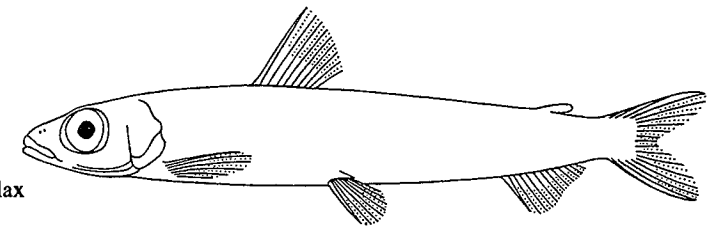
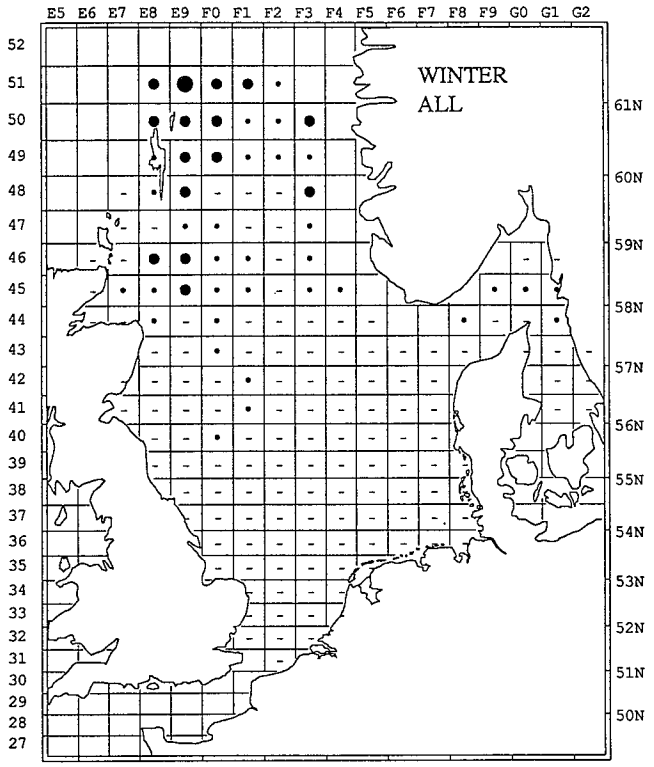
25. *Argentina* spp.
Family Argentinidae

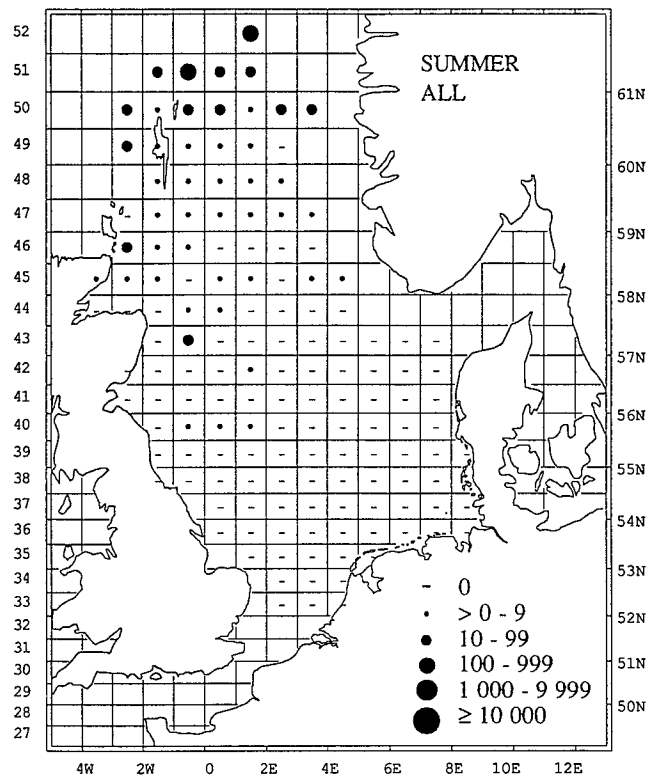


Argentina silus

E. Greater argentine, F. Grande argentine, D. Goldlachs, DK. Guldlaks, N. Vassild, NL. Grote zilversmelt, S. Guldlax

E. Lesser argentine, F. Petite argentine, D. Glasauge, DK. Strømsild, N. Strømsild, NL. Kleine zilversmelt, S. Silverfisk





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

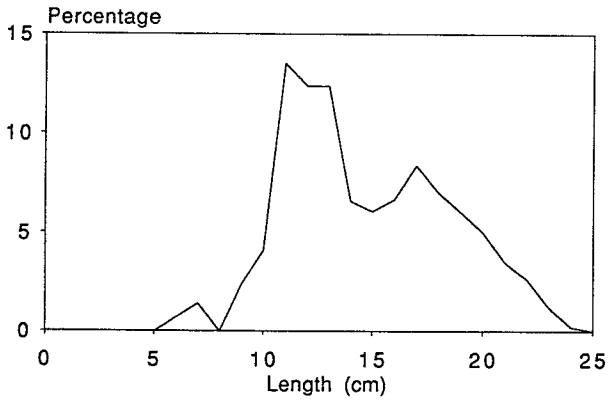
Spatial distribution

Two species of this genus occur in the survey area, namely the greater argentine, *Argentina silus*, and the lesser argentine, *Argentina sphyraena*. They differ in several respects, including the numbers of vertebrae, gill rakers, and scales, but inexperienced fishery biologists often find it difficult to distinguish between the two species so it is possible that some of the argentines caught during the surveys were incorrectly identified. Therefore, all catches of 'argentines' were combined to prepare the distribution charts. For the same reason they were not split into juvenile and adult fish.

Argentines usually inhabit waters deeper than 100 m. Highest densities of argentines were found on the edge of the continental shelf in the north. Their range extended southward into the North Sea through the Fladen Ground and eastward into the deeper parts of the Skagerrak and Kattegat through the Norwegian Deep.

Length composition

The greater argentine is reported to attain a maximum size of 56 cm, whereas the lesser argentine seldom exceeds 27 cm [1]. It is therefore remarkable that the peak in the length distribution at 11 – 13 cm is caused by specimens identified as greater argentine, whereas the peak at 17 cm is caused by lesser argentine.



Length-frequency distribution of *Argentina* spp. during winter.

Life history

Greater argentines from the shelf edge to the west and north of the British Isles are on average five years of age at a length of 30 cm, while 45 cm fish are 35 years old. They are sexually mature from 35 cm (seven years old) onwards [2]. The life span of lesser argentine from the Clyde area is significantly shorter: the oldest ones have an age of about ten years and measure at that age somewhat below 20 cm [6].

High numbers caught by a bottom trawl during cruises on the slopes of the Rockall Trough (west of Scotland) suggest a more or less semi-pelagic habit for the greater argentine [3]. However, stomachs of specimens from Shetland and Faroese waters contained bathypelagic fish species (*Cyclothone* spp., *Chauliodus* spp., *Xenodermichthys* spp.), mysids, and euphausiids, suggesting a mainly pelagic way of life [4]. This implies that bottom-trawl catches may considerably underestimate real abundance of greater argentine. The food of the lesser argentine, on the other hand, reportedly consists of benthic prey, indicating that it spends much of its time close to the bottom [5].

The eggs of argentines are pelagic.

Population and exploitation

The above-mentioned differences in diet and habit may be related to the different depth ranges over which these species can generally be found: 100 – 200 m for the lesser argentine and approximately 400 m for the greater argentine [4,5]. For both argentines an increase in mean fish length with depth of capture has been observed [2,5].

Greater argentine near Rockall Bank spawns all year long, with the maximum spawning period in the second half of the year [3]. During spawning, greater argentine is known to form dense concentrations on the shelf edge, and it has, consequently, potential commercial value [2]. The lesser argentine spawns in British waters from March to September [7].

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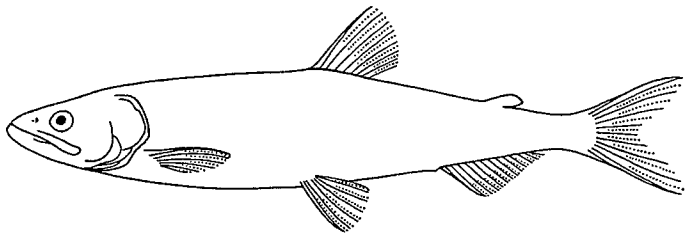
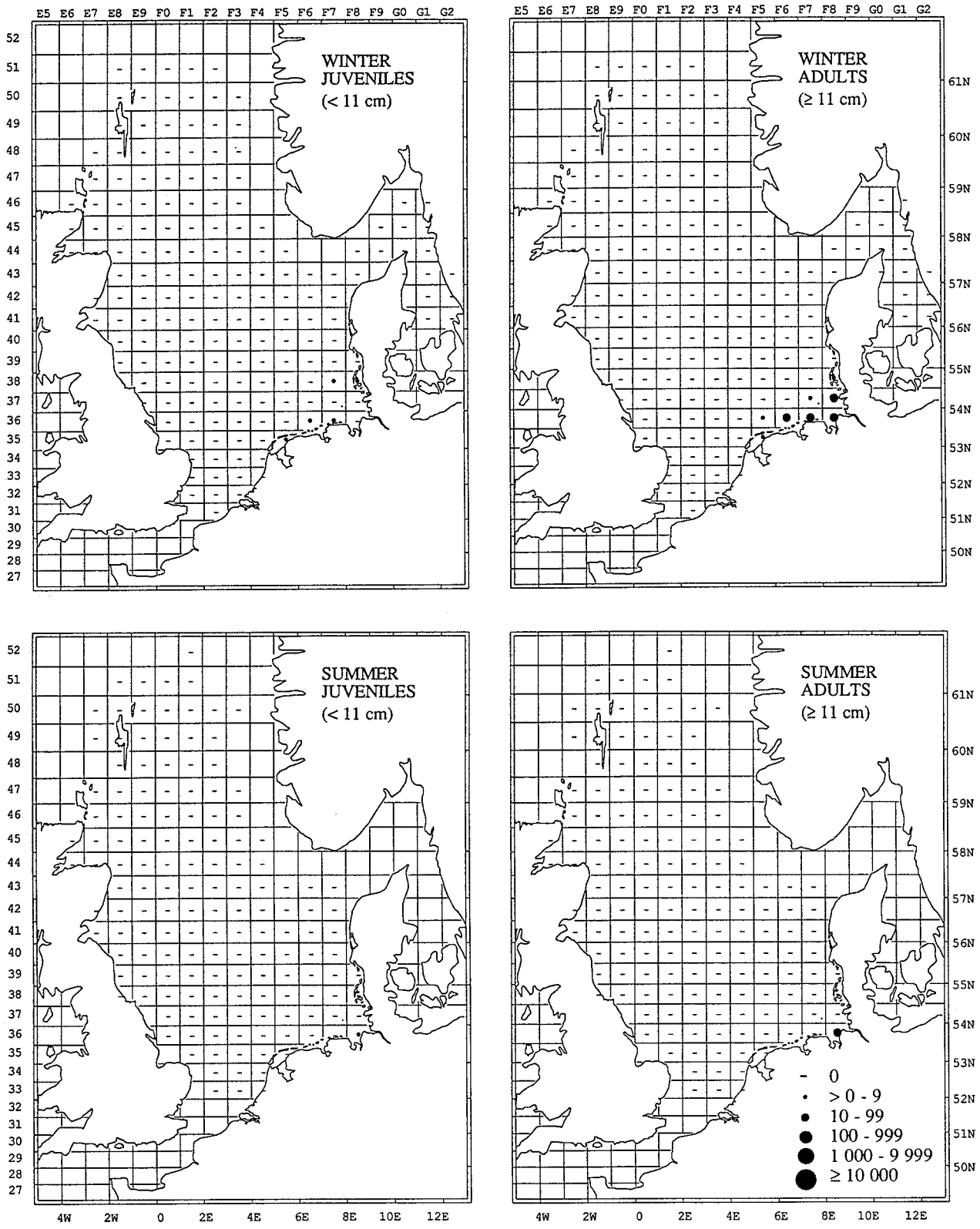
26. *Osmerus eperlanus*
Family Osmeridae

E. Smelt, F. Eperlan, D. Stint, DK. Smelt,
N. Krøkle, NL. Spiering, S. Nors





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

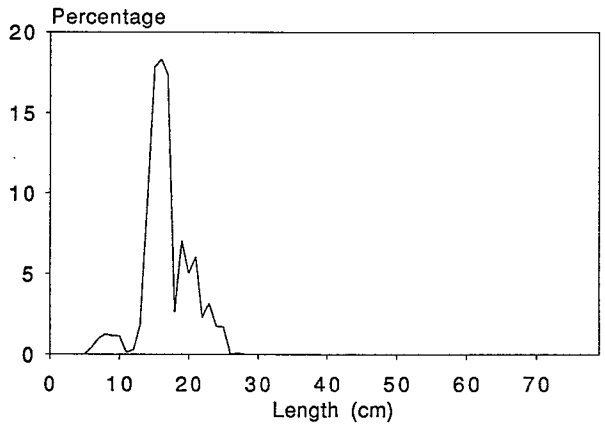
Spatial distribution

Migrating (anadromous) and non-migrating (landlocked) forms of smelt exist in the *Atlas* area [1]. This distant relative of the salmonids occurs even in the canals of the city of Amsterdam [2].

Smelt was only caught in the German Bight, and during winter surveys a clear preference for the coastal areas could be seen. Smelt were virtually absent from the area during summer.

Length composition

The smallest smelt in the winter hauls measured between 5 and 10 cm; the sixteen caught during summer were 10 to 23 cm long.



Length-frequency distribution of smelt during winter.

Life history

By the end of the year smelt of the Elbe estuary measure on average 7, 13, and 24 cm at 0, 1, and 4 years of age respectively. Most specimens mature at the end of their second year of life [3].

The diet of 0-group smelt in the Elbe estuary consists mainly of pelagic copepods, while the older specimens feed on amphipods, mysids, *Crangon crangon*, and juvenile smelt, herring, and gobiids [4].

Population and exploitation

The anadromous stocks caught during the *Atlas* surveys probably originate from Dutch, German, and Danish estuaries and rivermouths. It is surprising that no smelt were caught elsewhere as the anadromous form is known to live in river systems along the east coast of the United Kingdom [1].

Schools of mature smelt ascend the River Elbe in February and March to spawn in the river itself and in its tributaries, sometimes as far as 100 km upstream. The eggs are deposited on stones, pebbles, and waterplants. The young leave the river at the end of their first year of life [3].

Smelt, which smells of cucumber, is fished in both the marine and freshwater habitat. North Sea catches averaged 1500 t per year during 1900 – 1945, but have not exceeded 500 t since then. Smelt is now only of minor importance as a food-fish.

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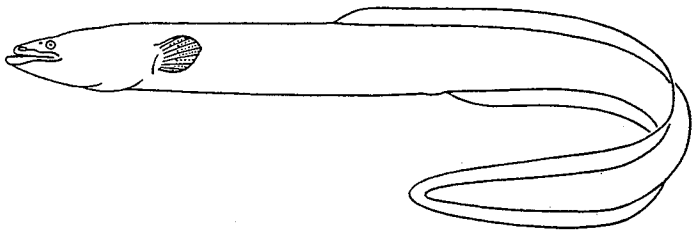
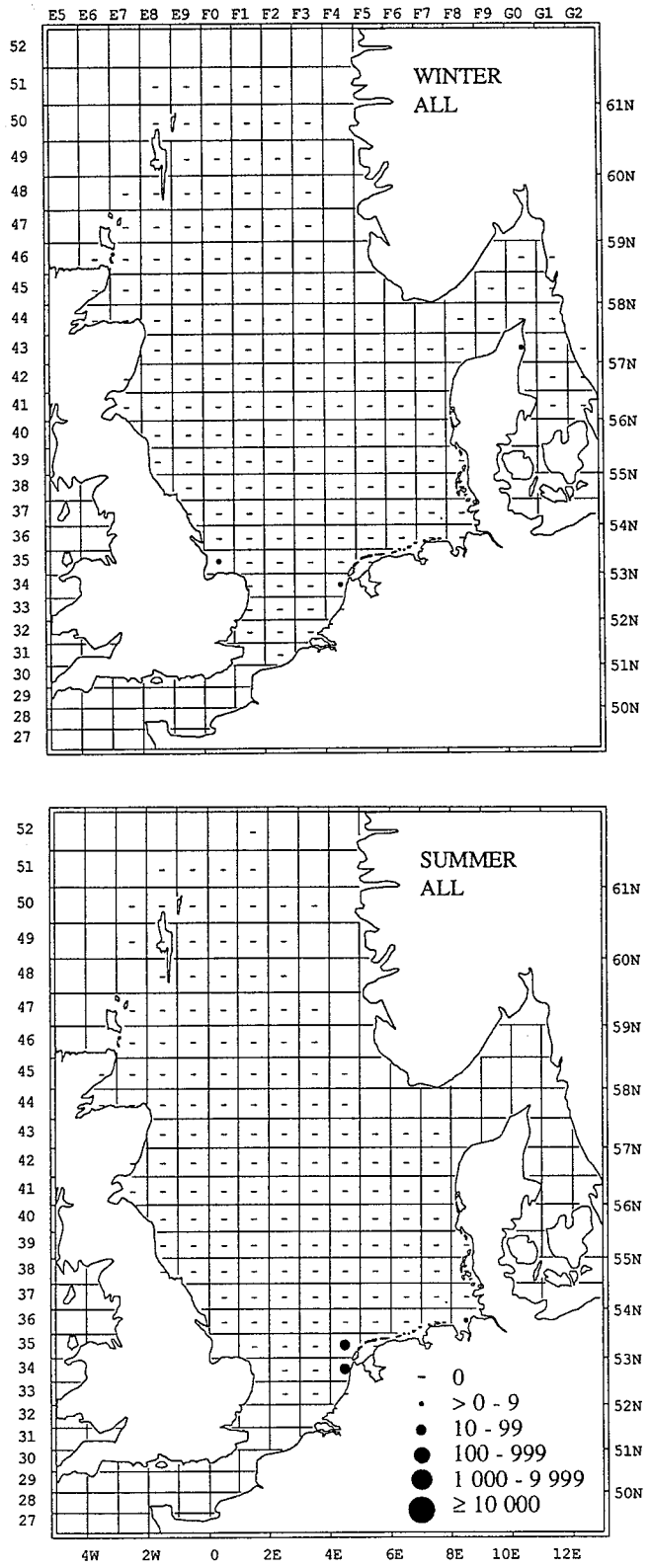
27. *Anguilla anguilla*
Family Anguillidae

E. Eel, F. Anguille, G. Flußaal, DK. Ål, N. Ål, NL. Paling/Aal, S. Ål





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

The few catches of eel were made in the southern North Sea and the Kattegat, in depths of 14 to 27 m. It is evident, given their snake-like body form, that eel may easily escape from bottom trawls. The survey data, therefore, are not likely to give a good impression of their abundance and distribution.

Length composition

The specimens caught measured between 35 and 60 cm.

Life history

The eel has a complex and not yet fully understood life history [1,2,3,4]. Although natural spawning has never been observed, it is assumed that eel from Europe breed somewhere in the mid-Atlantic and that the planktonic larvae, also known as leptocephali or 'tiny heads', are transported to European waters by the prevailing currents, taking one to three years to make the journey.

The larvae metamorphose first into transparent glass eels and, after they have arrived in European coastal waters by September – February, into pigmented miniature eel (elver). A large proportion of the elvers migrate into fresh water, where they spend up to twenty years feeding and growing prior to the onset of maturation. The immature freshwater fish are known as yellow eels. However, some elvers do not migrate into fresh water and the growth phase takes place in brackish or salt water. Presumably, some eel caught during the surveys were members of this group.

At the onset of sexual maturation the freshwater specimens return to sea. The downstream spawning migration is from late spring to winter, and the males are at this time 6 – 12 years old and measure 30 – 45 cm, and the females are 10 – 20 years of age and measure 45 – 65 cm. Their eyes enlarge and their colour changes and they become known as silver eels. Virtually nothing is known about the migration routes and behaviour of silver eels.

This fish is a noctural feeder, which during the day hides in crevices or burrows. The diet of this opportunistic predator includes amphipods, isopods, crabs, fish, snails, mussels, 'worms', and insect larvae [2].

Population and exploitation

The eel is a highly valued food fish and it is intensively exploited, particularly when the elvers enter fresh water and the silver eels are migrating to sea. Reported annual catches in the North Sea are modest and fluctuated between 1000 and 2000 t during the period 1945 – 1985, but unreported catches might be considerable.

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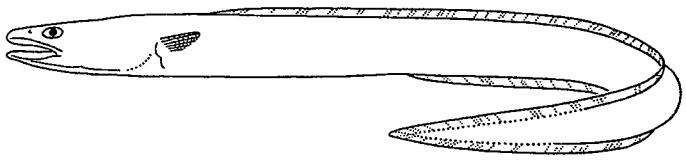
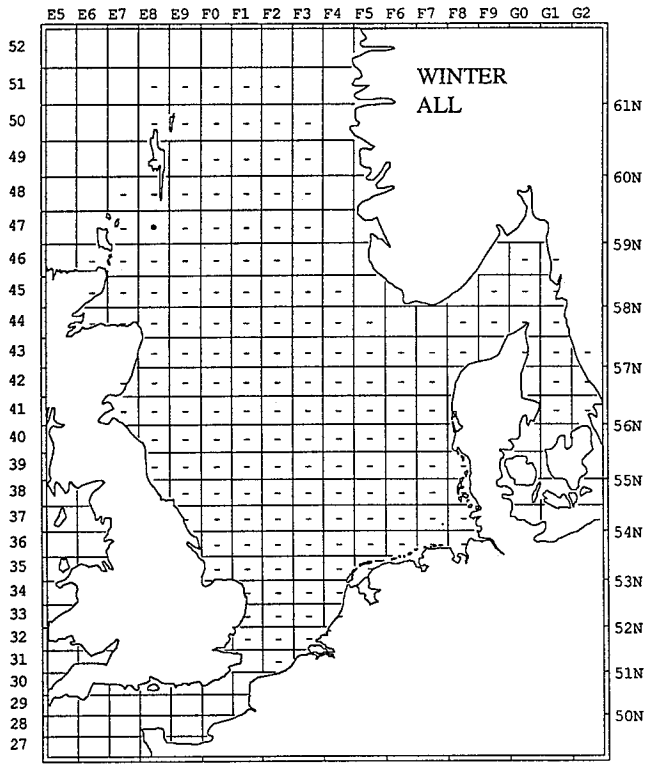
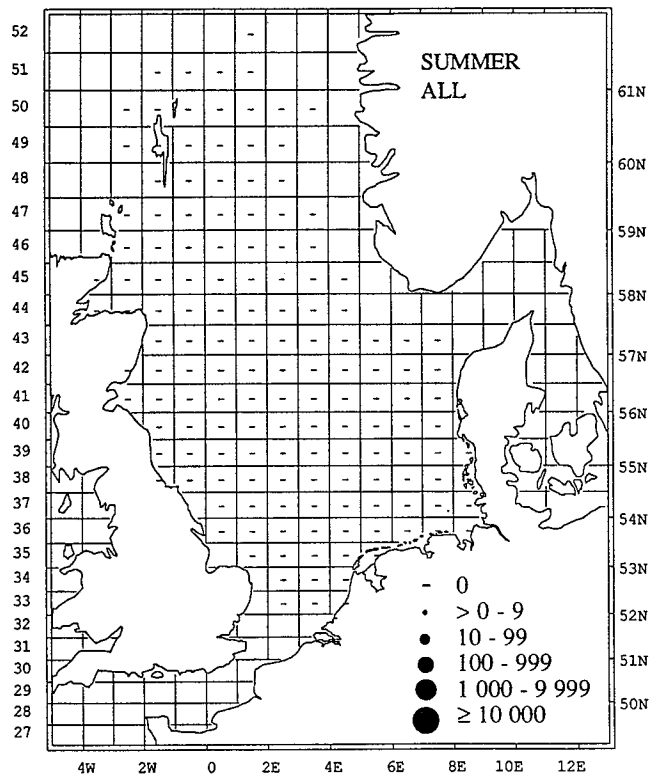
28. *Conger conger*
Family Congridae



E. Conger, F. Congre, D. Meeraal, DK. Havål, N. Havål, NL. Congeraal, S. Havsål





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

One conger was caught during a winter haul. This species is known to prefer grounds which are unsuitable for trawling, and the survey data by no means represent its real distribution and abundance.

Length composition

The specimen caught was large (110 cm) but not exceptionally so, since conger can reach a length of nearly 300 cm.

Life history

Conger is a bottom-living species, which is almost always found on hard ground, including rocky reefs and wrecks. Its distribution extends from the intertidal zone to moderately deep offshore waters. Conger feeds mainly on demersal fish, crustaceans (crabs), and cephalopod molluscs, including *Octopus* spp. and *Eledone* spp. [1].

Growth can be very rapid; a captive specimen grew to a weight of 40 kg in five years [1]. A female conger caught off the south Irish coast and probably twenty years old measured 200 cm and weighed 54.1 kg [2]. Conger reaches sexual maturity at an age of 5 – 15 years [3], and it is a very fecund species. The ovaries of the Irish specimen contained between 12 and 17 million eggs [2].

Conger, in common with all other eels, has a pelagic larva known as leptocephalus. Leptocephali have tiny heads and deep bodies. They are extremely thin and almost completely transparent. The leptocephalus phase may last for one or two years, during which the larvae may drift over long distances. Metamorphosis is at a length of 14 – 16 cm [3].

Population and exploitation

Spawning is believed to take place in summer, over depths of 3000 – 4000 m, in both the Atlantic and the Mediterranean [1].

Some conger are landed by commercial fisheries for human consumption. This species is popular with sport fishermen and underwater spearfishers, mainly because of its large size and its great strength.

References

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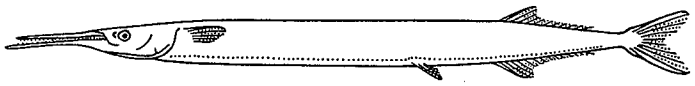
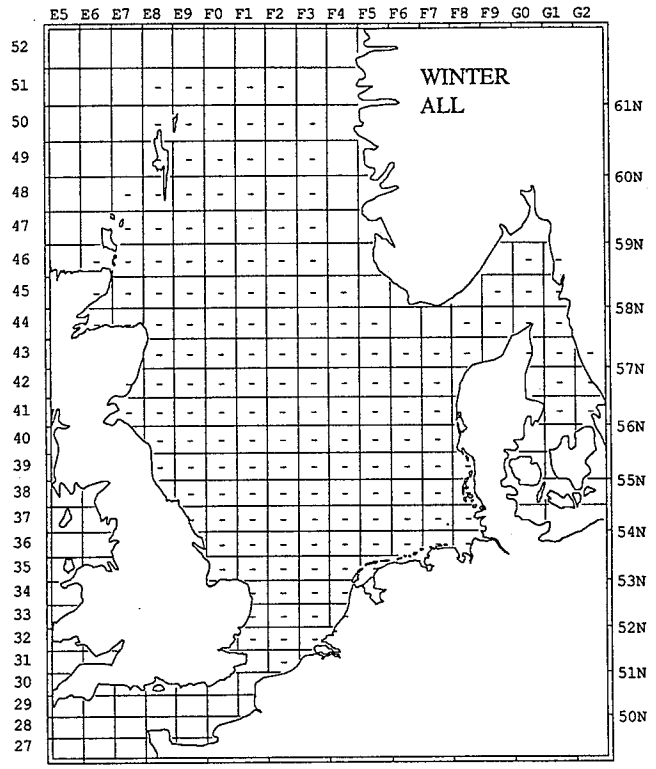
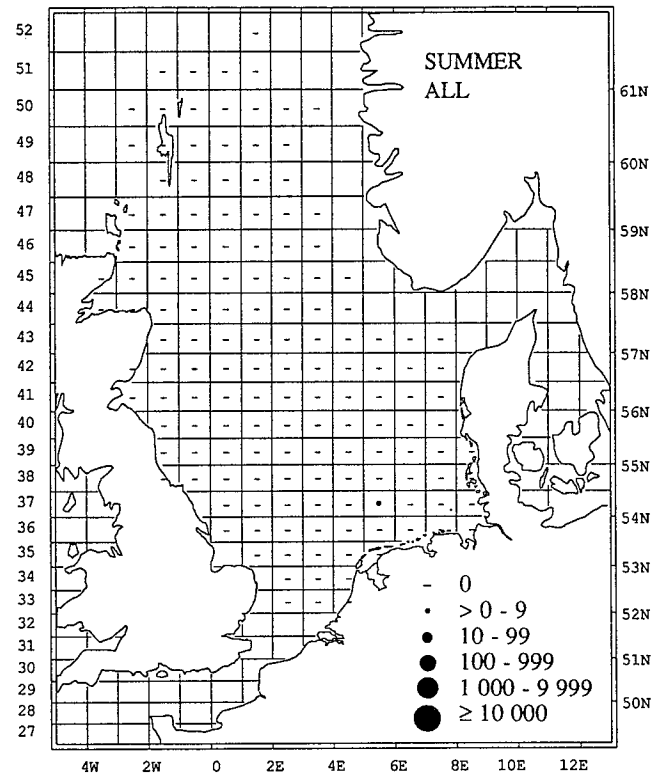
3. Bauchot, M.-L., and Saldanha, L. 1986. Congridae. *In* Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, pp. 567-574. Ed. by P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris. pp. 517-1007.

29. *Belone belone*
Family Belonidae



E. Garfish, F. Orphie, D. Hornhecht, DK. Hornfisk,
N. Horngjel, NL. Geep, S. Horngädda





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

The slender-bodied, surface-living garfish will undoubtedly be poorly sampled by the survey gears. It is known to occur in large parts of the North Sea, in the Skagerrak and Kattegat [1], but was caught only once, in the summer of 1985.

A close relative, *Belone svetovidovi*, has recently been described from the south coast of Ireland. Its beak is noticeably shorter relative to body length than in *Belone belone* [2].

Length composition

The specimen measured 60 cm. Garfish is reported to attain a maximum length of 94 cm [1].

Life history

A female garfish may produce up to 11,000 relatively large (3 mm) eggs that have numerous hair-like projections with which they are attached to the substratum [3]. The pelagic larvae hatch after 14 days at 16°C and 21 days at 20°C. Garfish grow very rapidly in their first two years. In the Dutch Wadden Sea, young fish attain a length of 12 – 15 cm in their first summer [4]; two-year-old individuals from Irish waters measure 62 cm by June – October, and seven-year-old garfish measure about 75 cm by that time of year [4,5]. The maximum age reported is eleven years [3].

Garfish caught to the south of Ireland fed predominantly on crustaceans such as euphausiids, isopods, amphipods, and decapod larvae, on fish, especially clupeids, and on insect flotsam (especially syrphids but also ants and staphylinid beetles). Garfish are regarded as opportunistic feeders whose food reflects what is available at the time [6].

Population and exploitation

In April adult garfish enter inshore, shallow areas for spawning, which in the Dutch part of the Wadden Sea and in Swedish waters is in May – June [3,4]. The adults and young leave these habitats in late autumn, apparently avoiding low water temperatures during winter [4].

Garfish is of minor commercial importance in the *Atlas* area. In the southern North Sea it is mainly caught by anglers.

References

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2. Dorman, J.A. 1987. *Belone svetovidovi* Colette and Parin: a species of garfish new to northern Europe. Journal of the Marine Biological Association of the United Kingdom 67: 679-685.
3. Dorman, J.A. 1991. Investigations into the biology of the garfish, *Belone belone* (L.), in Swedish waters. Journal of Fish Biology 39: 59-69.
4. Rosenthal, H., and Fonds, M. 1973. Biological observations during rearing experiments with the garfish *Belone belone*. Marine Biology 21: 203-218.
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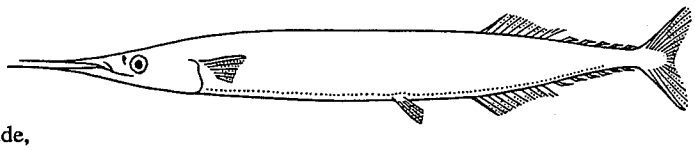
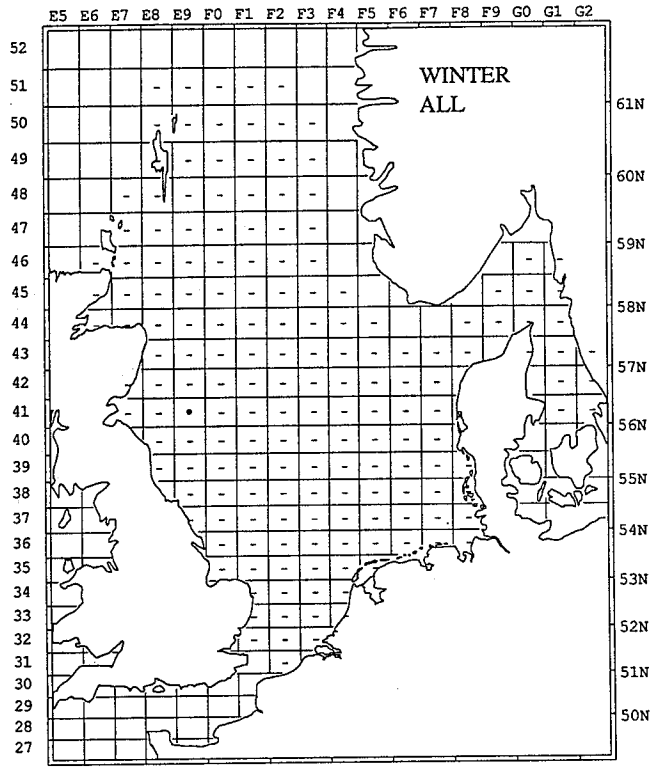
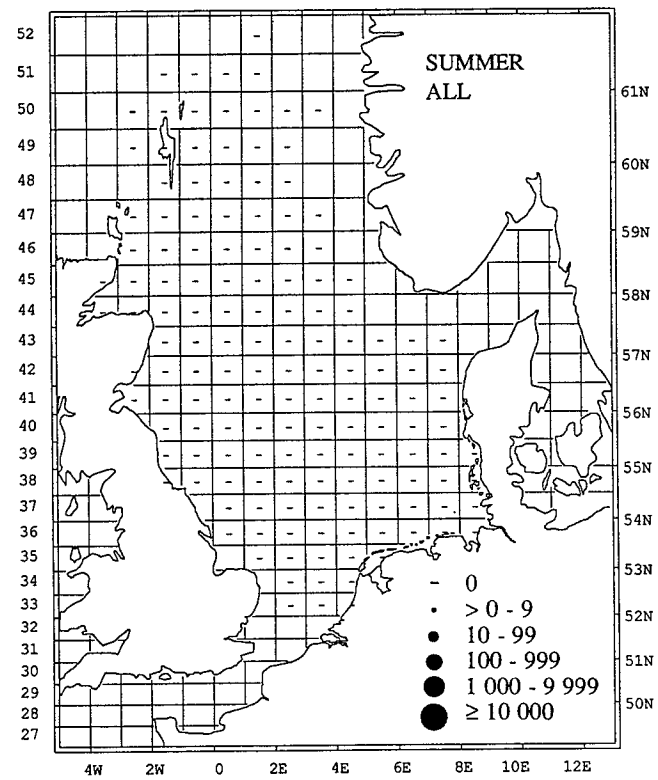
6. Dorman, J.A. 1988. Diet of the garfish, *Belone belone* (L.), from Courtmacsherry Bay, Ireland. Journal of Fish Biology 33: 339-346.

30. *Scomberesox saurus*
Family Scomberesocidae



E. Skipper, F. Balaou, D. Makrelenhecht, DK. Makrelgedde,
N. Makrellgjedde, NL. Makreelgeep, S. Makrillgädda





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Skipper, or saurey pike, was caught only once, during the winter survey of 1985. It is a widespread and common species in temperate and tropical seas [1]. Because of its preference for surface waters and its slender body shape skipper must have an extremely low catchability in bottom trawls.

Length composition

The single specimen caught had a length of 37 cm. The maximum length reported for skipper is 50 cm [1].

Life history

Skipper is an oceanic fish, usually found in shoals near the surface. It spawns in the open ocean, producing pelagic eggs covered with fine filaments. The food consists of small shrimp-like euphausiids and other crustaceans. Small fishes are eaten as well [1].

Population and exploitation

Skipper occasionally enters the North Sea and can strand in large numbers, typically in stormy weather. Noteworthy strandings of skipper on the Dutch coast occurred in 1909 and 1955 [2].

In the *Atlas* area the skipper has no commercial importance, but it is the object of limited fisheries in Spain [3].

References

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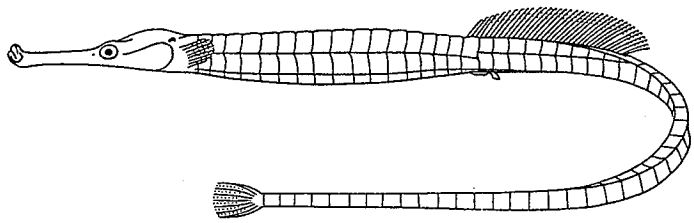
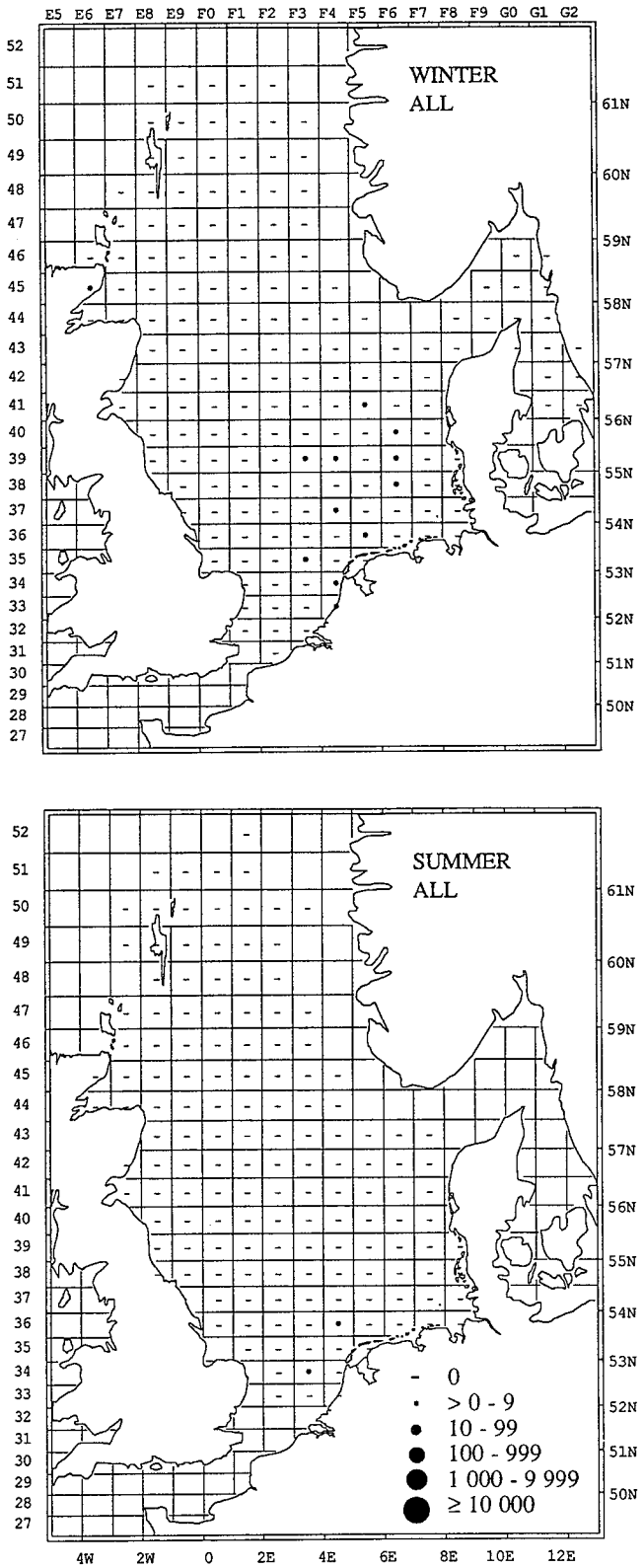
31. Syngnathidae
Family Syngnatidae

E. Pipefishes, F. Syngnathes, D. Seenadeln, DK. Tangål,
N. Nålefisker, NL. Zeenaalden, S. Kantnålar



Syngnathus acus



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Catches of pipefishes were widely distributed in the eastern part of the central and southern North Sea during winter but much reduced during summer.

Because of their very slender form, pipefish easily escape from trawls, even from those with very small mesh codends. As a consequence catches made during the *Atlas* surveys may not truly represent their abundance or distribution.

Length composition

The specimens caught measured between 10 and 47 cm.

Life history

Because of the possibilities of misidentification, pipefishes are here treated as a family. Six species may have been caught during the surveys: the great pipefish (*Syngnathus acus*, to 47 cm), the deep-snouted pipefish (*S. typhle*, to 30 cm), Nilsson's pipefish (*S. rostellatus*, to 17 cm), the worm pipefish (*Nerophis lumbriciformis*, to 15 cm), the straight-nosed pipefish (*N. ophidion*, to 30 cm), and the snake pipefish (*Entelurus aequoraeus*, to 61 cm). The short-snouted seahorse (*Hippocampus hippocampus*) is also incidentally caught during surveys.

The following is a summary [1,2,3] of the biology and ecology of the first five species, which are mostly inhabitants of shallow coastal waters (to 25 m) and even low salinity estuaries. Pipefishes can be found over a wide variety of substrata. They often occur amongst, or close to, marine plants (both floating and attached) and some members of the group are well camouflaged. They feed on planktonic organisms which are first stalked and then snapped up by a rapid expansion and extension of the tubular snout.

The eggs of pipefishes are incubated by the male, who holds them beneath his body, either in a groove on the underside of the abdomen or in a pouch formed by two flaps of skin. The eggs are large, 1.0 – 2.5 mm in diameter, and between 100 and 400 in number. They are carried between May and August, and the young are free swimming at 1 – 4 cm in length.

Population and exploitation

Pipefishes have little economic value but may be seen as curio bracelets, tail in mouth and heavily varnished, or in aquaria.

References

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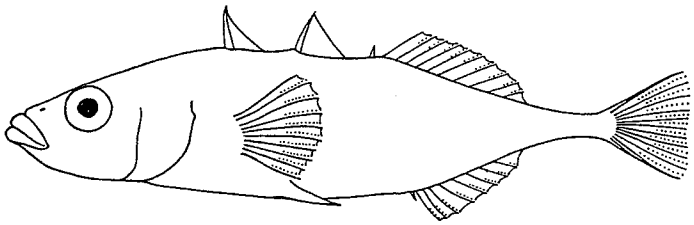
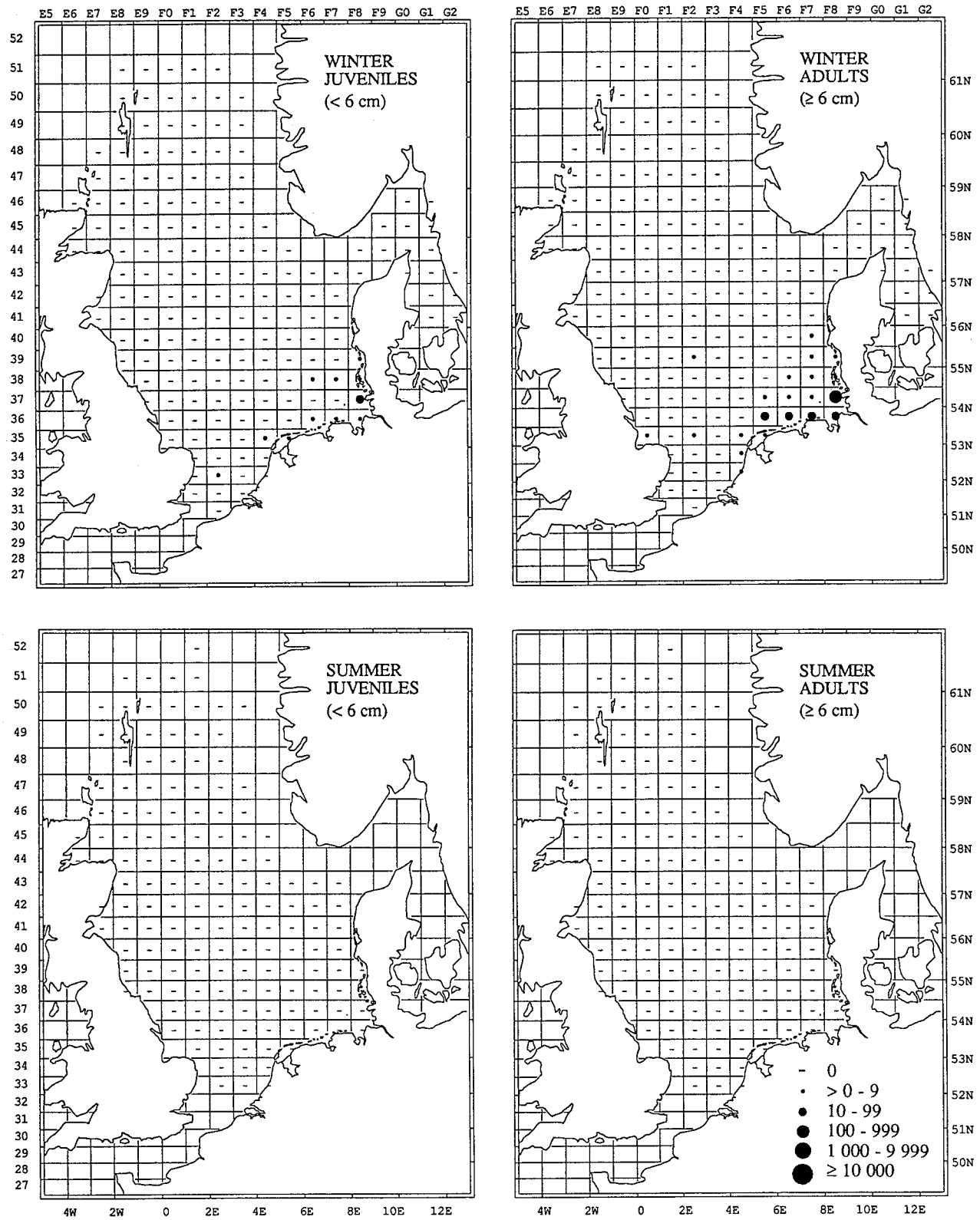
3. Russell, F.S. 1976. The eggs and planktonic stages of British marine fishes. Academic Press, London. 524 pp.

32. *Gasterosteus aculeatus*
Family Gasterosteidae



E. Three-spined stickleback, F. Epinoche,
D. Dreistacheliger Stichling, DK. Trepigget hundestejle,
N. Trepigget stingsild, NL. Driedoornige stekelbaars,
S. Storspigg



Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

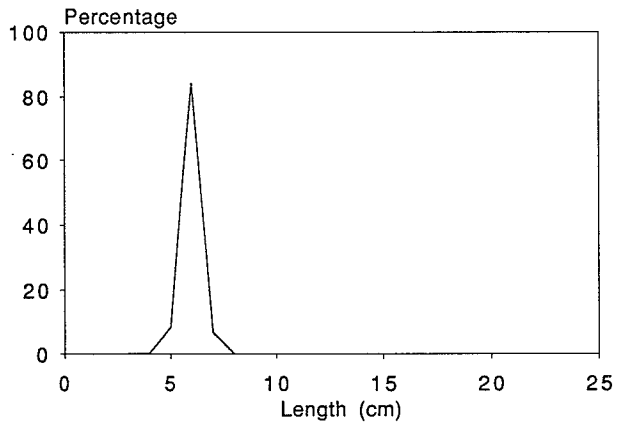
Spatial distribution

The three-spined stickleback was only caught during winter surveys, and was mainly confined to the German Bight. Densities were higher nearer to the coast.

Although many aspects of the biology of the three-spined stickleback have been intensively studied, the spatial distribution of this species still remains to be fully unravelled. Migratory and non-migratory populations exist [1], and the *Atlas* catches probably comprise an anadromous migratory population which winters in coastal marine areas to feed, and migrates into freshwater habitats to spawn during spring.

Length composition

Most sticklebacks caught during winter measured 6 cm. Pelagically caught, marine specimens from the northern North Sea measure up to 10.5 cm [2].



Length-frequency distribution of three-spined stickleback during winter.

Life history

The eggs of euryhaline *Gasterosteus aculeatus* are demersal and are deposited in a nest which is built and guarded by the male. When they are free-swimming, the young sticklebacks leave the nest and form schools of youngsters [1].

Some doubt remains as to the maximum age, but this small fish is not likely to exceed four years of age [1].

Stomach contents of the pelagic sticklebacks mentioned in the preceding section consisted of pelagic copepods and euphausiids [2]. Sticklebacks living in fresh water also prefer planktonic food, but the importance of benthos increases when plankton density decreases [3].

Population and exploitation

The regular occurrence of stickleback in pelagic trawl hauls in the northern North Sea suggests that they may form dense local aggregations well offshore [2]. These stickleback may belong to non-migratory populations, as do the sticklebacks from the Norwegian Oslofjord. The latter are known to live in the littoral zone during most of the year, while they remain deeper in the fjord during winter, thus not migrating into fresh water at all [4].

Sticklebacks are of no economic importance, although there are well-documented records of migrating schools which appeared in such great quantities that they could be used to fertilize the land (cited in [1]).

References

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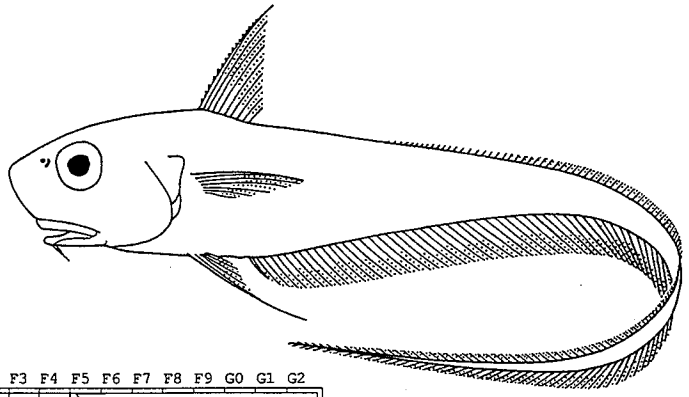
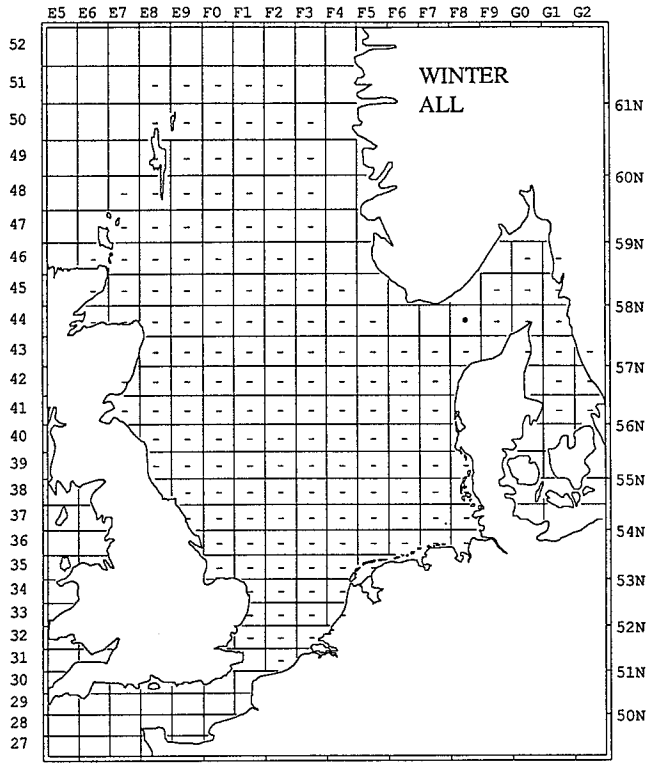
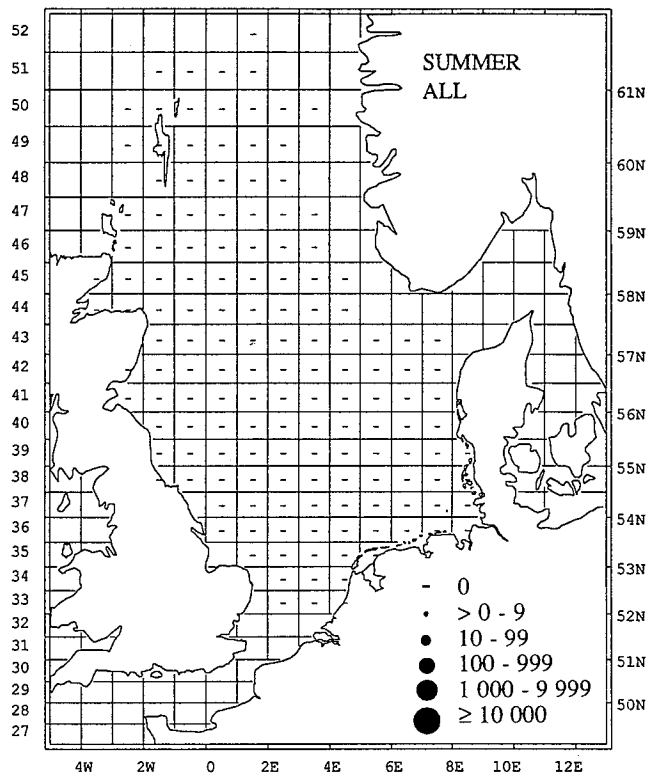
33. *Coryphaenoides rupestris*
Family Macrouridae



E. Roundnose grenadier, F. Grenadier à nez rond, D. Rundnasengrenadier, DK. Skolæst, N. Skolest, NL. Grenadiervis, S. Skoläst





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Roundnose grenadier is distributed throughout the North Atlantic in depths between 400 and 1200 m [1] and in the North Sea and Skagerrak it is found in high densities in the deepest parts of the Norwegian Deep [2]. A single specimen of roundnose grenadier was caught, during the *Atlas* winter surveys, in the Skagerrak. This area was not surveyed during summer.

Length composition

The single fish caught was 57 cm in length.

Life history

This is a benthopelagic species that usually lives near the seabed but sometimes in mid-water, up to 300 m off the bottom [2]. Its food consists mainly of deep water prawns, amphipods, and cumaceans, and, to a lesser extent, of cephalopods and lanternfishes (Myctophidae) [1,3].

Roundnose grenadier is a very long-lived species; otolith aging techniques indicate that fish may live as long as 72 years [2]. Fifty per cent of the males in the Skagerrak mature for the first time at eight years of age and females at the age of ten years. The corresponding lengths are 40 and 50 cm. Females grow to a larger size than males [2]. Specimens caught in waters to the west of Scotland may attain a length of 105 cm, but the largest fish caught in the Skagerrak measured only 70 cm [4,2].

Specimens from the west of Scotland that measure between 75 and 105 cm may lay an average of 32,000 eggs [4].

Population and exploitation

The main spawning season in the Skagerrak is probably in autumn and early winter [2]. It is not likely that roundnose grenadier from the Skagerrak make extensive migrations to other areas [2], notwithstanding the fact that they are said to undergo spawning migrations to shallower waters during winter [1].

There is a commercial fishery for this species to the west of Scotland [5].

References

1. Cohen, D.M., Inada, T., Iwamoto, T., and Scialabba, N. 1990. FAO species catalogue. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fisheries Synopsis 125(10). FAO, Rome. 442 pp.
2. Bergstad, O.A. 1990. Distribution, population structure, growth and reproduction of the roundnose grenadier *Coryphaenoides rupestris* (Pisces: Macrouridae) in the deep waters of the Skagerrak. Marine Biology 107: 25-39.
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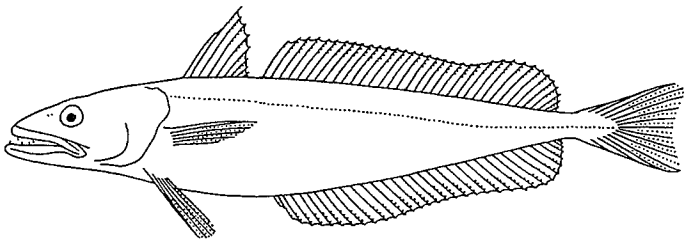
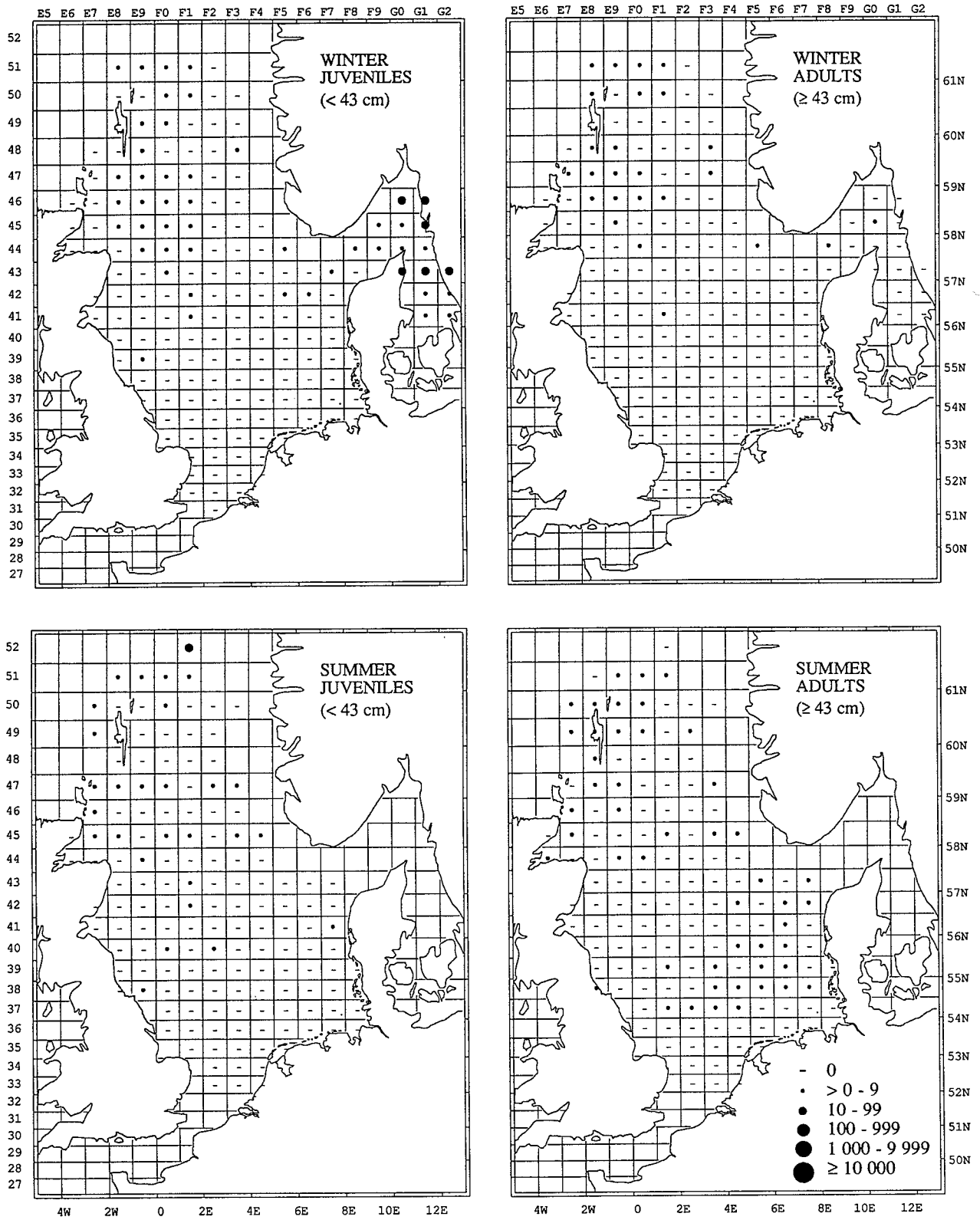
34. *Merluccius merluccius*
Family Merlucciidae

E. Hake, F. Merlu, D. Seehecht, DK. Kulmule,
N. Lysing, NL. Heek, S. Kummel





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

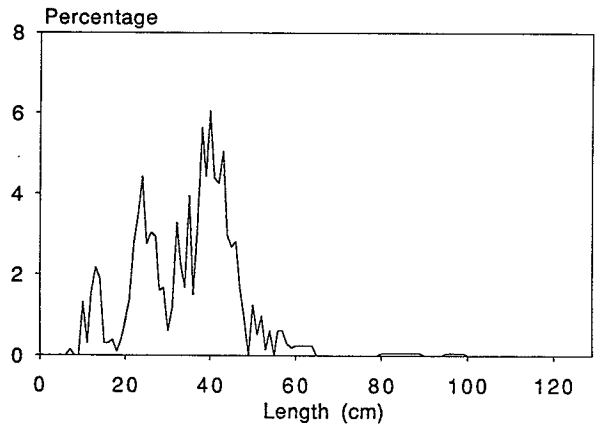
Spatial distribution

During winter, both large and small hake were caught in the northern part of the North Sea, whereas in the Skagerrak and Kattegat only the smaller size classes were caught (although in rather high numbers).

Hake were taken from more southerly positions during the summer months. The presence of large specimens in the southeastern part of the North Sea is obviously seasonally related.

Length composition

Winter catches contain mostly hake in the size range of 10 to 50 cm, larger individuals being rare. The largest hake was caught during summer and measured 105 cm.



Length-frequency distribution of hake during winter.

Life history

Adult hake are found near, or more likely on, the seabed during the day, and at night they swim up to feed in mid-water. Food of hake from the western shelf waters of Britain consists almost entirely of pelagic fish; blue whiting is by far the most important prey. Mackerel, silvery pout, hake itself, clupeoids, and squid are part of the menu, as are argentine, horse mackerel, and some demersal species (such as poor cod, megrim, and witch) [1].

There are no reliable age – length keys for North Sea hake, but the distinct 10 – 20, 20 – 30, and 30 – 50 cm classes in the *Atlas* length distribution probably represent age groups 1, 2, and 3 – 7 respectively. Fifty per cent of the three-year-old hake are sexually mature [2].

Population and exploitation

These near relatives of the cod-like fishes inhabit the middle and lower slope of the continental shelf in depths of over 180 m, but may move into shallower waters during summer to spawn [1]. Spawning to the west of Scotland occurs from May to August [3].

It is not known whether North Sea hake are stationary residents or seasonal visitors. No immigration through the English Channel into the North Sea has been described to date [2], and therefore hake found in the southeastern North Sea in summer may originate from northern or Kattegat – Skagerrak stocks.

Hake is a species of considerable economic importance, but catches in the North Sea are low compared with those taken in the Atlantic by Spanish, French, and Portuguese vessels. North Sea catches dropped steadily from 8000 t immediately after the Second World War to 2000 t in the 1980s.

References

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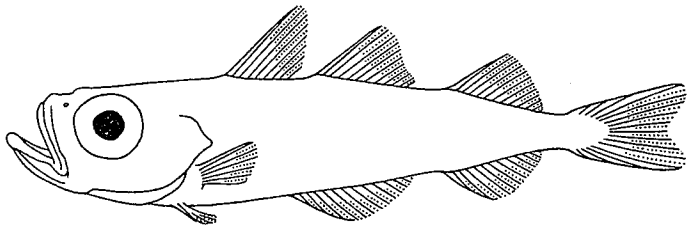
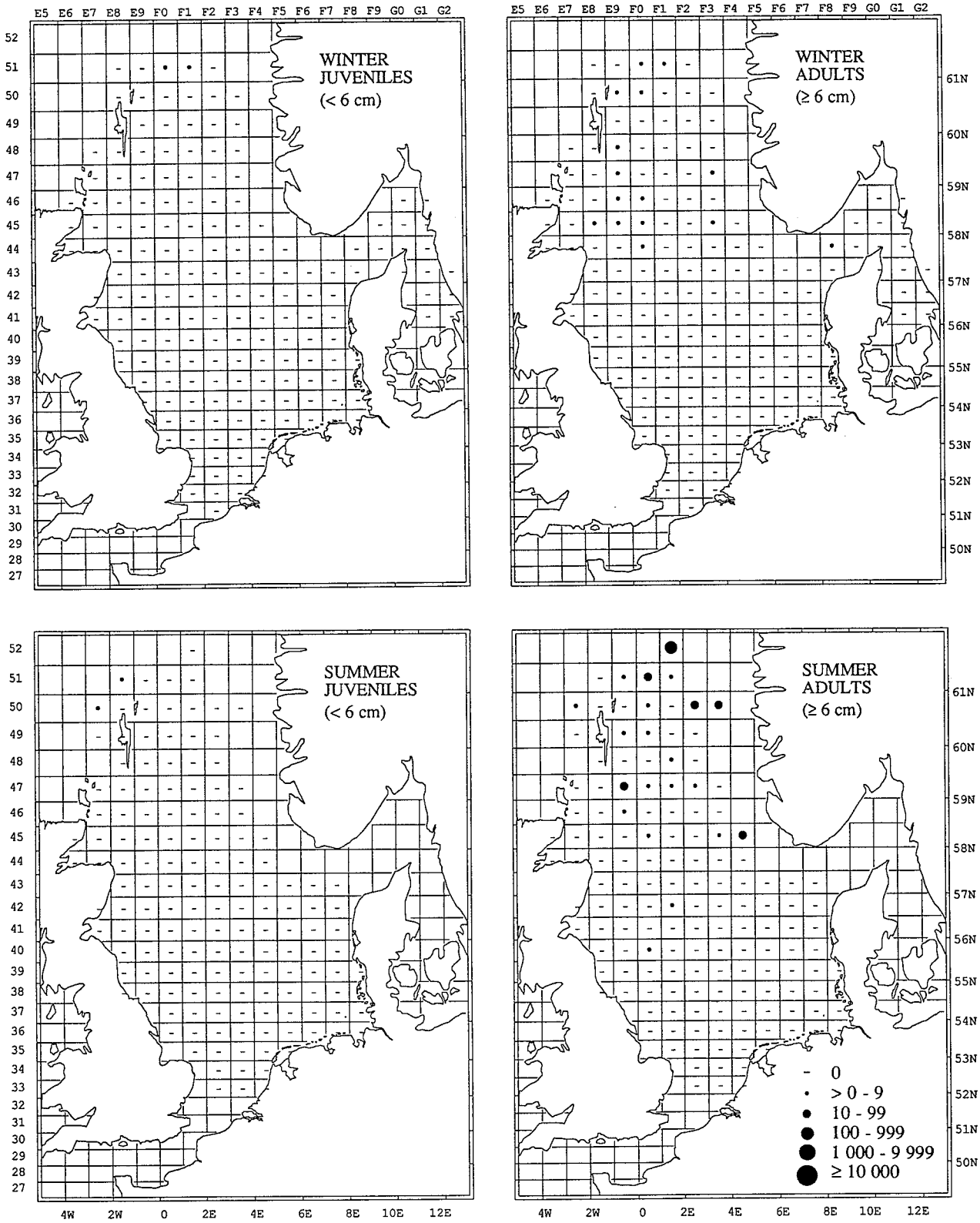
2. Anonymous. 1990. Report of the Working Group on the Assessment of the Stocks of Hake. ICES CM 1990/ Assess: 22. 171 pp.
3. Anonymous. 1977. Résumé des connaissances sur le merlu (*Merluccius merluccius* (L.)). ICES CM 1977/G:3-Appendix. 14 pp.

35. *Gadiculus argenteus*
Family Gadidae

E. Silvery pout, F. Gadicule, D. Silberdorsch, DK. Sølvtorsk, N. Sølvtorsk, NL. Zilverkabeljauw, S. Nordlig silvertorsk





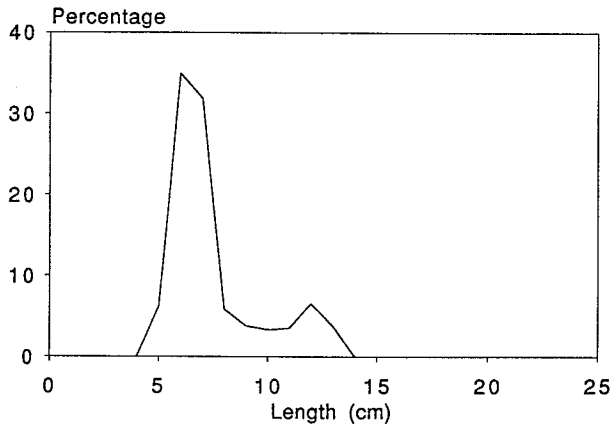
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Single specimens of silvery pout were caught sporadically all over the northern part of the survey area, but the only substantial catches were made on the edges of the northern shelf and the Norwegian Deep, in waters of 170 to 210 m depth.

Although the *Atlas* data demonstrate that silvery pout is typically an open-sea, deep-water fish common over the edge of the continental shelf, North Sea densities may be higher than shown, as this fish is known to occur pelagically in waters of 110 m and deeper [1].

Length composition



Length-frequency distribution of silvery pout during winter.

Silvery pout is a small species, with a maximum length of 15 cm [2]. Most of the individuals caught during the winter surveys measured less than 9 cm, but the average length in the large summer catch in rectangle 52F1 was 10 cm.

Life history

Euphausiids, copepods, and mysids are the most important prey groups in the Norwegian Raunefjord. These organisms are pelagic or semipelagic [3].

Population and exploitation

Spawning in northern Europe occurs from mid-winter to spring [1] and takes place in deeper (1000 m) waters outside the survey area [4].

Silvery pout has no particular economic importance [2].

References

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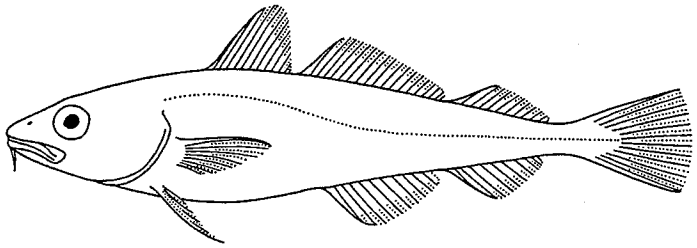
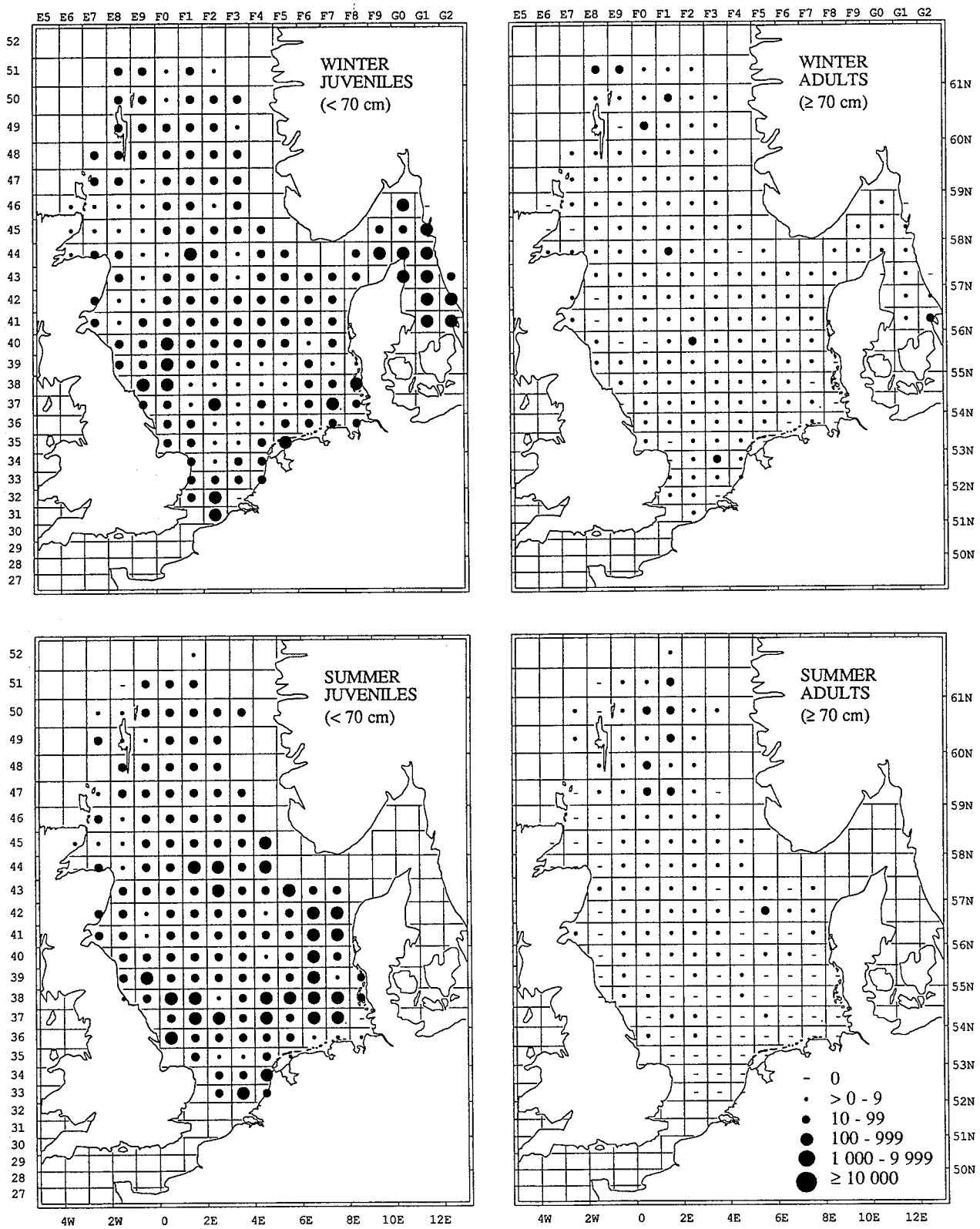
36. *Gadus morhua*
Family Gadidae

E. Cod, F. Morue, D. Kabeljau, DK. Torsk,
N. Torsk, NL. Kabeljauw, S. Torsk





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Juvenile cod occurred throughout the *Atlas* area. During winter, the most densely populated areas were in the Skagerrak and Kattegat, along the entire southeastern continental coast and off the English coast. Densities were low in the central part of the southern North Sea and off the east coast of Scotland. During the summer surveys, the juveniles were more evenly dispersed over the area.

Adult specimens were caught in minor quantities, but their main area of occurrence seemed to be situated in the north, between Shetland and Norway. The total absence of adult cod in the southern North Sea during summer was striking.

Length composition

Catches in the eight roundfish areas during winter consisted mainly of the two youngest age classes. The catches were dominated either by 10 – 25 cm cod, for instance in the southeastern North Sea (area 6) and off Jutland (area 7), or by those that measured 25 – 40 cm. Examples of areas that were dominated by catches of the 25 – 40 cm size classes are the English coast (area 4) and the Skagerrak and Kattegat (area 8). Only in the northernmost part of the North Sea (area 1) did cod larger than 40 cm equal the numbers of the smaller size classes.

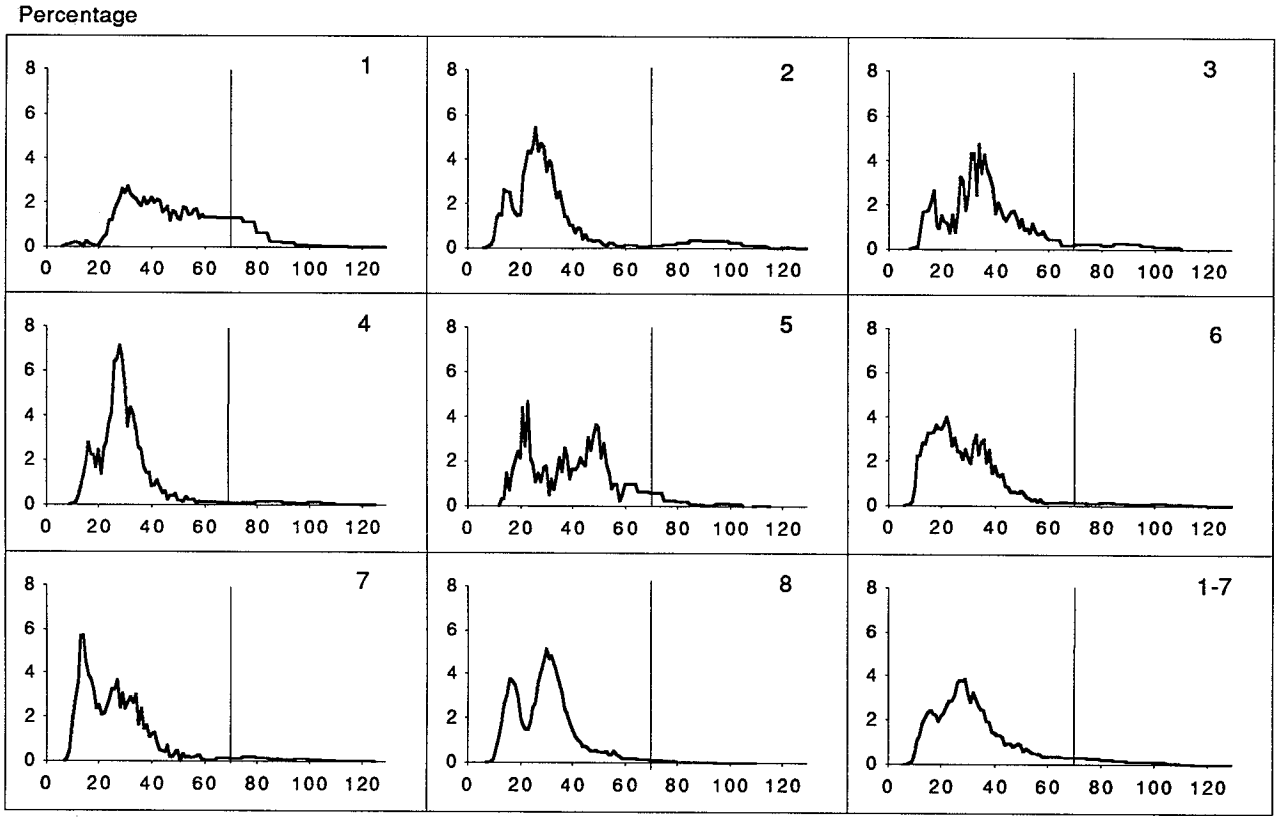
Life history

An average mature female carries around five hundred ripe eggs per gram body weight, which equals five million eggs for a 10 kg (100 cm) fish. Fecundity varies with time and place [1]. Spawning takes place in mid-water or near the bottom [2] and captive females shed the pelagic eggs in up to nineteen batches at intervals of about one to twelve days [3]. The eggs take ten to thirty days to hatch depending on temperature [4]. Larvae of 2 – 8 mm in length, caught pelagically during February and March, feed principally on the nauplii and copepodite stages of copepods [5].

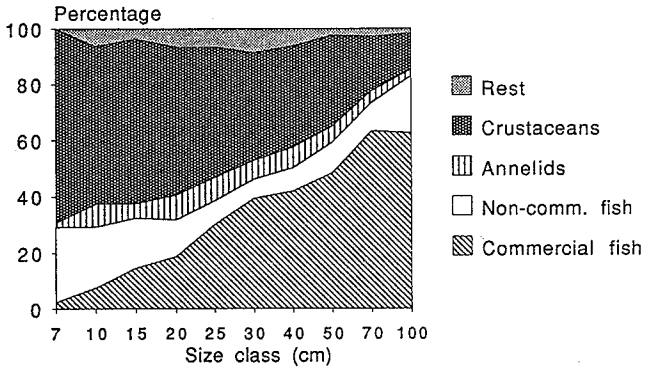
The 0-group cod continue to feed pelagically after metamorphosis but their diet changes as they grow larger. Five-centimetre specimens, collected in the northern North Sea during July, had already changed from a diet that consisted mainly of copepods and euphausiids to a diet that was dominated by fish [6].

From a length of 7 cm onwards, the juveniles are not to be found in pelagic catches any more. The demersal stage commences somewhere between midsummer and autumn [7]. The demersal nature of juvenile cod is mirrored in their diet, which is dominated by crustacean prey (e.g. *Crangon crangon*, crabs). Larger specimens feed predominantly on fish, most of which are of commercial importance and include gadoids, sandeel, flatfish, and clupeids [8].

Growth rate differs by area. For example, average length of two-year-old cod caught on International Young Fish Surveys in the years 1970 – 1980 varied between 32 cm and 44 cm [9]. Cod in the southern North Sea initially grow somewhat faster than those in the north but they reach a smaller maximum length [10].

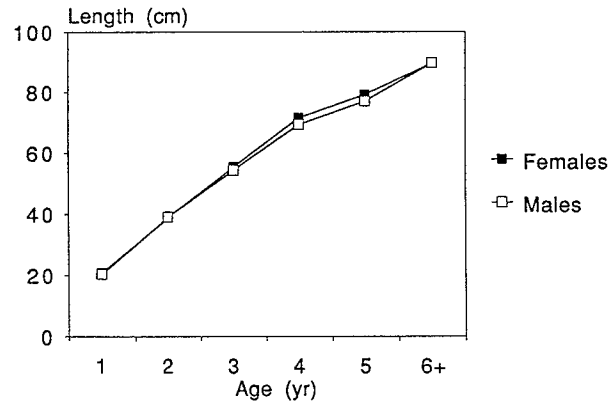


Length-frequency distribution of cod by roundfish area during winter (length split indicated).

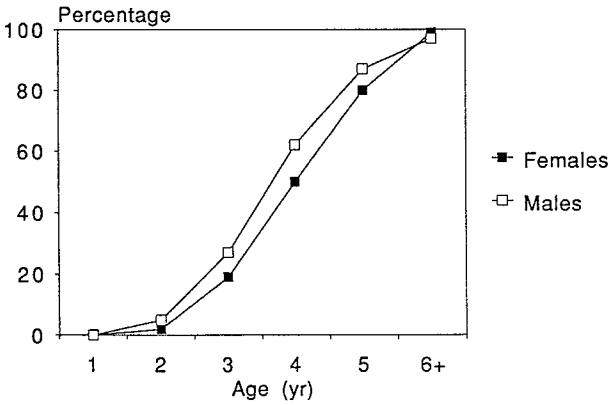


Average stomach contents as percentage weight by size class in 1981 (data from [8]).

Some cod mature in their second year of life, but it is not before they are six years old that they are all mature. Length at first maturity also shows some variation. Males mature slightly earlier than females, and there is a tendency for cod in the southern North Sea to mature at a younger age than in the northern North Sea [1,11].



Mean length (cm) per age group in February 1981 – 1983 (IYFS data).



Percentage of mature fish per age group in February 1981 – 1985 (IYFS data).

Population and exploitation

Spawning aggregations are found offshore all over the North Sea, but no detailed picture for the North Sea exists, owing to difficulties in distinguishing between eggs of cod and haddock. After spawning, which peaks in February – March, the pelagic 0-group cod are distributed over a large part of the central and northern North Sea [12]. High concentrations are found off the coast of Jutland and in the central part of the northern area during June – July [13]. Absence of pelagic 0-group cod in the German and Southern Bights, of which the coastal areas serve as major nurseries for demersal juvenile cod, suggests that the duration of the pelagic phase is extremely short in the shallow waters of the southern North Sea [7].

Older cod do not disperse at random throughout the North Sea, and their feeding and spawning movements are limited. The following regional groupings are distinguished [14]:

a. the Norwegian side of the Skagerrak;
b. the Danish side of the Skagerrak;
c. one or possibly several coastal regions, from Flamborough to the Scottish east and north coasts;
d. the central North Sea;
e. the Southern Bight, from the Straits of Dover to latitude 54°N;
f. the English Channel, south and west of the Straits of Dover.

A clear seasonal migration is found in 1- and 2-group cod of the southeastern North Sea. These age classes aggregate in shallow coastal areas during the winter period and disperse in a northwesterly direction over deeper parts of the central North Sea in summer, as is nicely illustrated by the *Atlas* data [15]. In the Norwegian Deep seasonal migrations (up and down the slope) are likely to occur as well [16]. The total absence of adult specimens from the southern part of the North Sea during the *Atlas* summer surveys may be related to a seasonal, temperature-induced migration or perhaps to a reduced catchability due to behavioural changes.

Yearly North Sea landings of cod, one of the most important commercial species in the area, fluctuated between 50,000 and 100,000 t during the first sixty years of this century. After this period, landings increased to a maximum of 345,000 t in 1972, and have steadily decreased since 1981. Landings in 1990 were the lowest since 1962 [17]. The spawning stock biomass shows a similar trend: a steady increase until 1970 followed by a decline down to around 60,000 t at the beginning of 1991, which is well below what is considered to be the safe biological limit (150,000 t) needed for the production of good recruitment.

The cause of the rapid increase in both biomass and landings in the 1960s is probably related to a sequence of strong year classes, whereas the decline of the spawning stock biomass since 1970 may be linked to the ever increasing fishing mortality during the last two decades.

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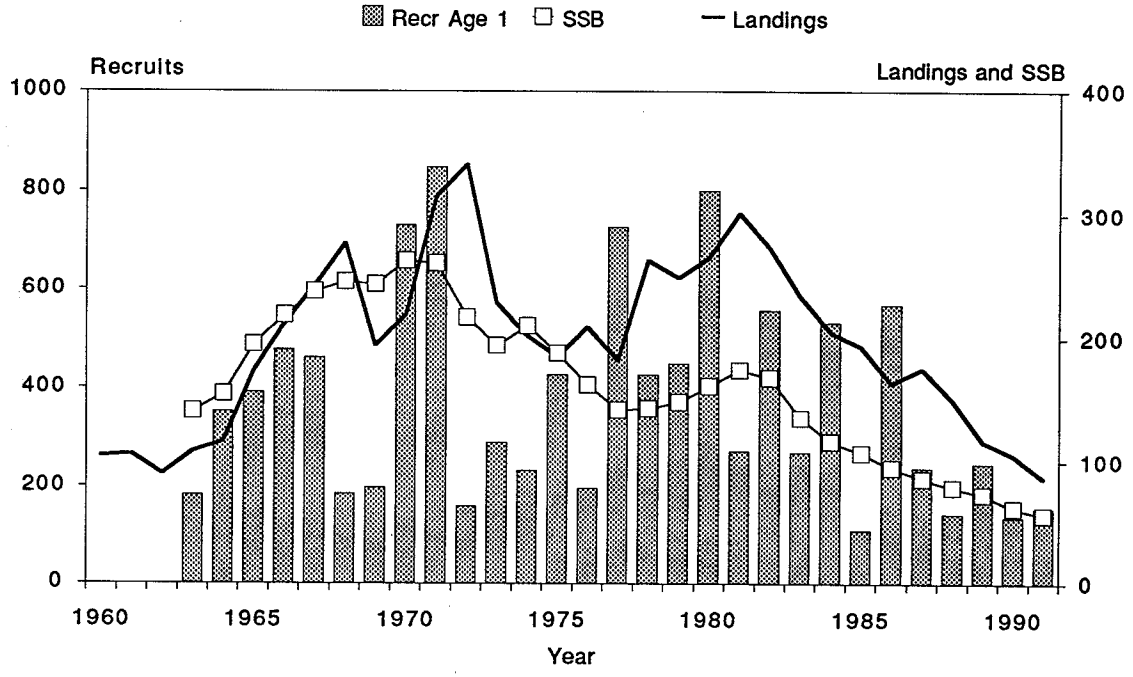
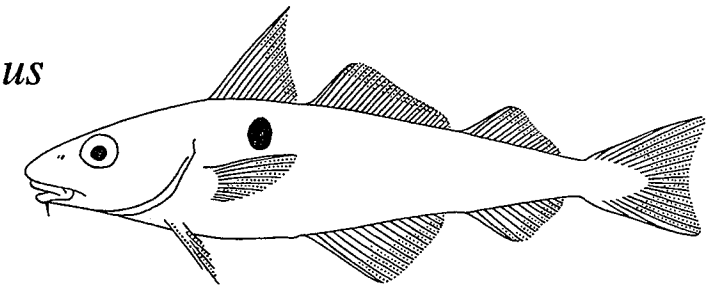
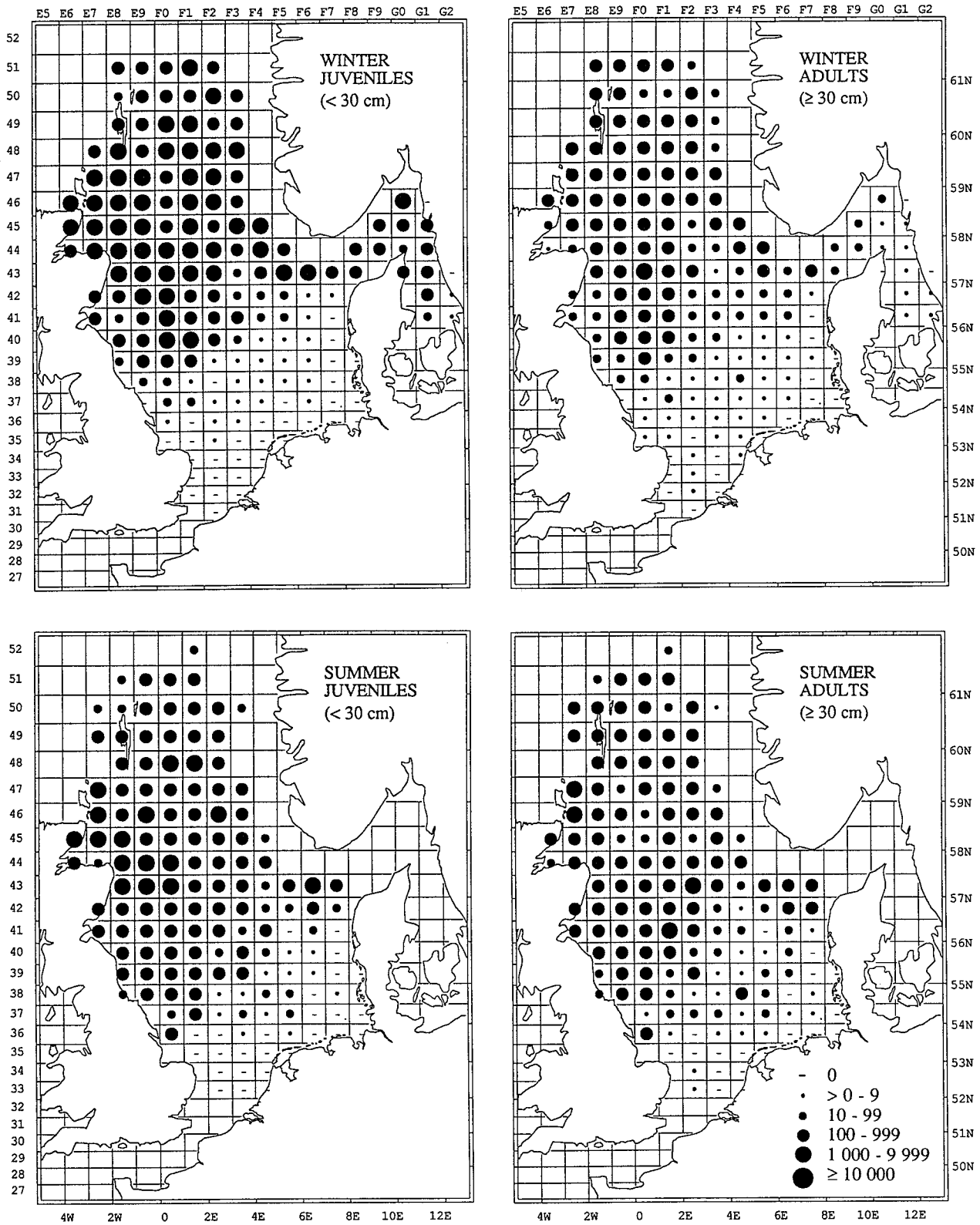


North Sea landings, spawning stock biomass (in 1000 t), and recruitment (in millions of one-year-old fish) to the stock [1,17] since 1960.

37. *Melanogrammus aeglefinus*
Family Gadidae

E. Haddock, F. Eglefin, D. Schellfisch, DK. Kuller,
N. Hyse, NL. Schelvis, S. Kolja





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

This species — of which it is said that the large dark blotch above the pectoral fin is a finger print of St Peter's, the biblical fisherman [1] — has a northerly distribution. Although substantial numbers of haddock were caught south of the Dogger Bank area during summer, densities were generally low in the southern and shallow parts of the area surveyed, while the deeper northern waters were more densely populated. In the Norwegian Deep, haddock is generally not found in waters of more than 300 m depth [2].

During winter, dense concentrations of juveniles occurred over most of the northern North Sea. In summer, the area of highest density was situated off the northeast coast of Scotland.

Length composition

The two youngest age classes made up the major part of the catches during winter. The one-year-olds (approximately 10 – 20 cm in length) were relatively abundant in northern area 1, in the northwestern North Sea (area 3), and in area 7, west of Denmark.

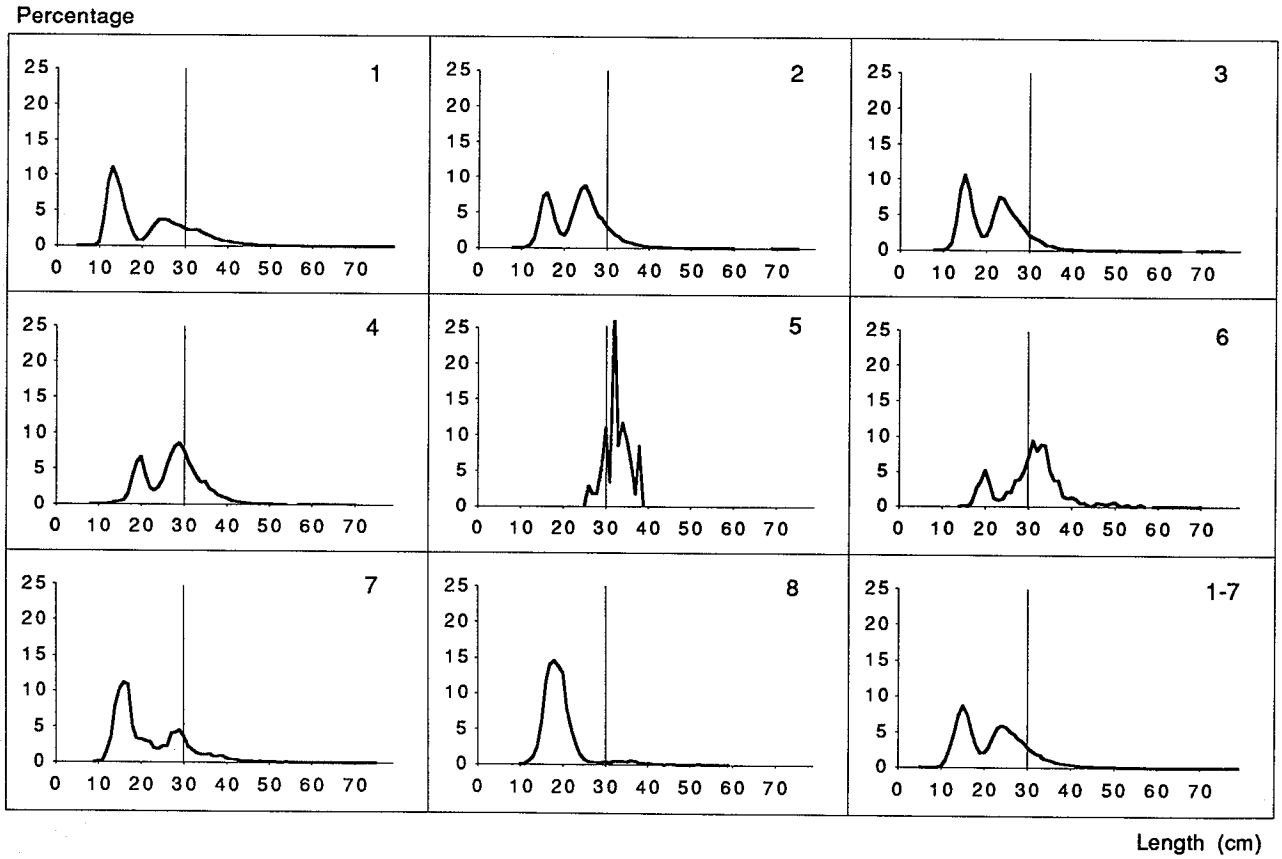
Mature haddock were virtually absent in the Skagerrak and Kattegat (area 8), but, in comparison with the younger age classes, were relatively abundant in the southern regions (areas 5 and 6, the Southern and German Bights).

Life history

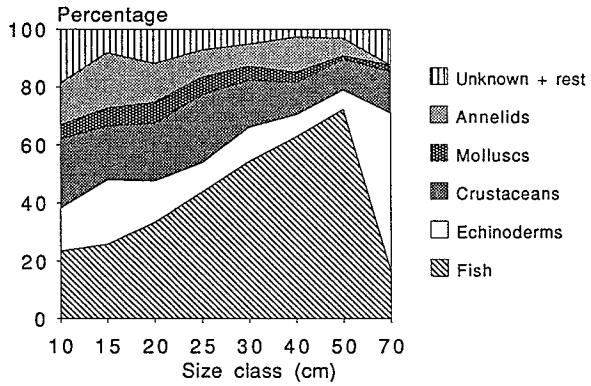
A four-year-old female carries on average 500 eggs per gram body weight, equalling 300,000 eggs for a 40 cm (630 g) female [3,4]. It takes from one to three weeks for the pelagic eggs to hatch [5].

The larval stages have been found to feed mainly on immature stages of copepods [5], while euphausiids, appendicularians, decapod larvae, fish, and copepods are important food items for pelagic 0-group haddock (3 – 14 cm) [6]. Once juvenile haddock have become demersal they still feed to some extent on pelagic organisms such as euphausiids and cephalopods, but from a length of 15 cm, benthic, slow-moving invertebrates become more important as prey.

Larger haddock also eat fish such as sandeel, Norway pout, long rough dab, gobies, sprat, and herring [7,8]. It is suggested that haddock feed in shoals, for the majority of the stomach contents at a given sampling station contained similar prey [8].

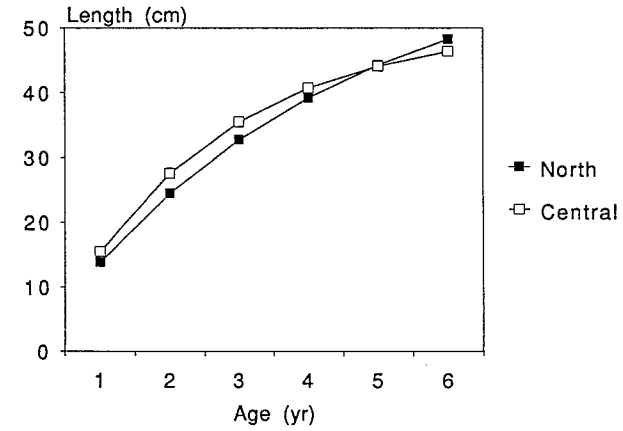


Length-frequency distribution of haddock by roundfish area during winter (length split indicated).

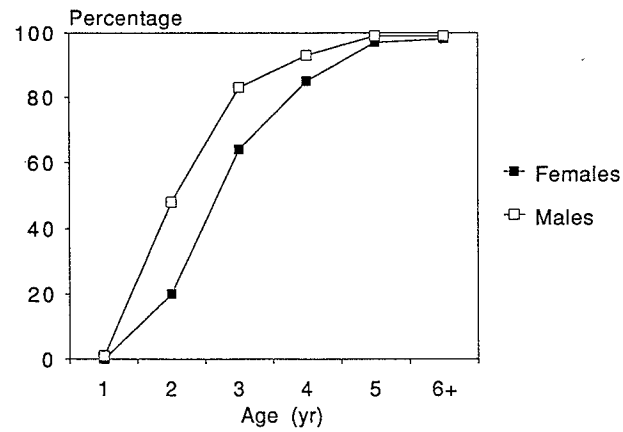


Average stomach contents as percentage weight by size class in 1981.

Growth rates of younger haddock may differ by area, as shown in the figure. Growth is also related to sex; female haddock grow faster than males [9]. Most of the fish have matured by the end of their third year of life. Both growth rate and age at first maturity have been observed to change over time [9].



Mean length (cm) per age group in 1982 – 1984 for the northern and central North Sea (parameters from [9]).



Percentage of mature fish per age group in 1981 – 1985 (IYFS data).

Population and exploitation

Spawning in the northern North Sea runs from March to May and occurs from the Scottish coast to the Norwegian Deep, the Moray Firth and an area around the Fladen Ground excepted. Transport of the larvae away from the spawning grounds is negligible. It is possible, however, that spawning products from the Scottish west and north coasts enter the North Sea through, for instance, the Fair Isle – Shetland passage [10]. Pelagic 0-group haddock have their main distribution to the north of latitude 57°30'N, but they have also been observed off the English and Danish coasts. 0-group individuals measure 2 – 12 cm during June and July [11].

After spawning, the shoals disperse. As the year proceeds some haddock gradually migrate westwards towards the Orkneys and Shetland to feed, while others move to the central part of the North Sea. Easterly and northerly return movements start in November and result in a reunion on the spawning grounds in December [12]. These movements are not obvious from the *Atlas* distribution charts.

Periodically, the haddock produces exceptionally successful year classes (for example those born in 1962, 1967, and 1974). During the existence of such strong year classes, when abundance is high, haddock is frequently caught in the southern part of the North Sea. Early this century there was a commercial fishery for haddock in the southeastern North Sea, but after the target species retreated into northern waters the local fishery ceased to exist. However, it was temporarily revived after the two World Wars, when stock size had increased and haddock occurred abundantly in southern waters, as described above [13].

Of the 87,000 t caught in 1990, 51,000 t were landed for human consumption, and 33,000 t were discarded, while 3000 t were landed as by-catch in the industrial fisheries. During the last two decades catches and biomass of this commercially important fish have decreased steadily and the 1990 stock biomass was the lowest in twenty years [3]. The decrease has been erratic owing to the periodic occurrence of exceptionally strong year classes, on which the stock and fisheries are heavily dependent.

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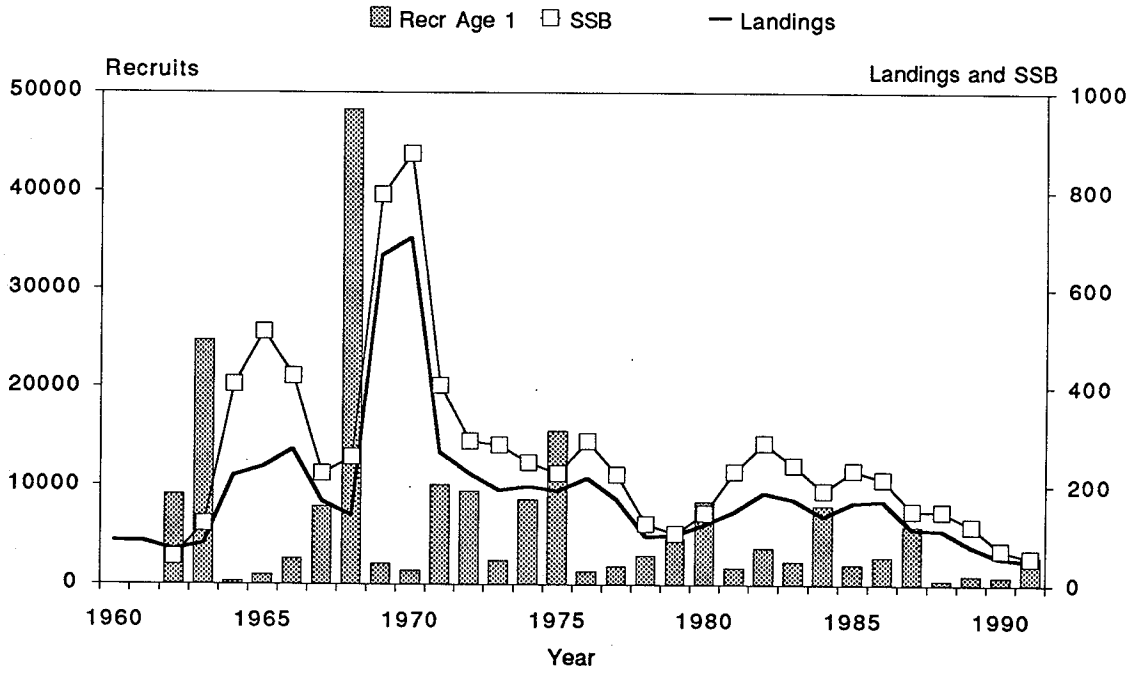
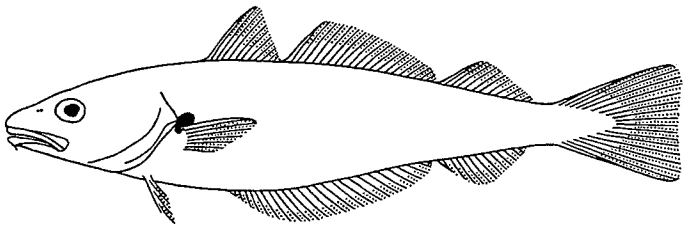
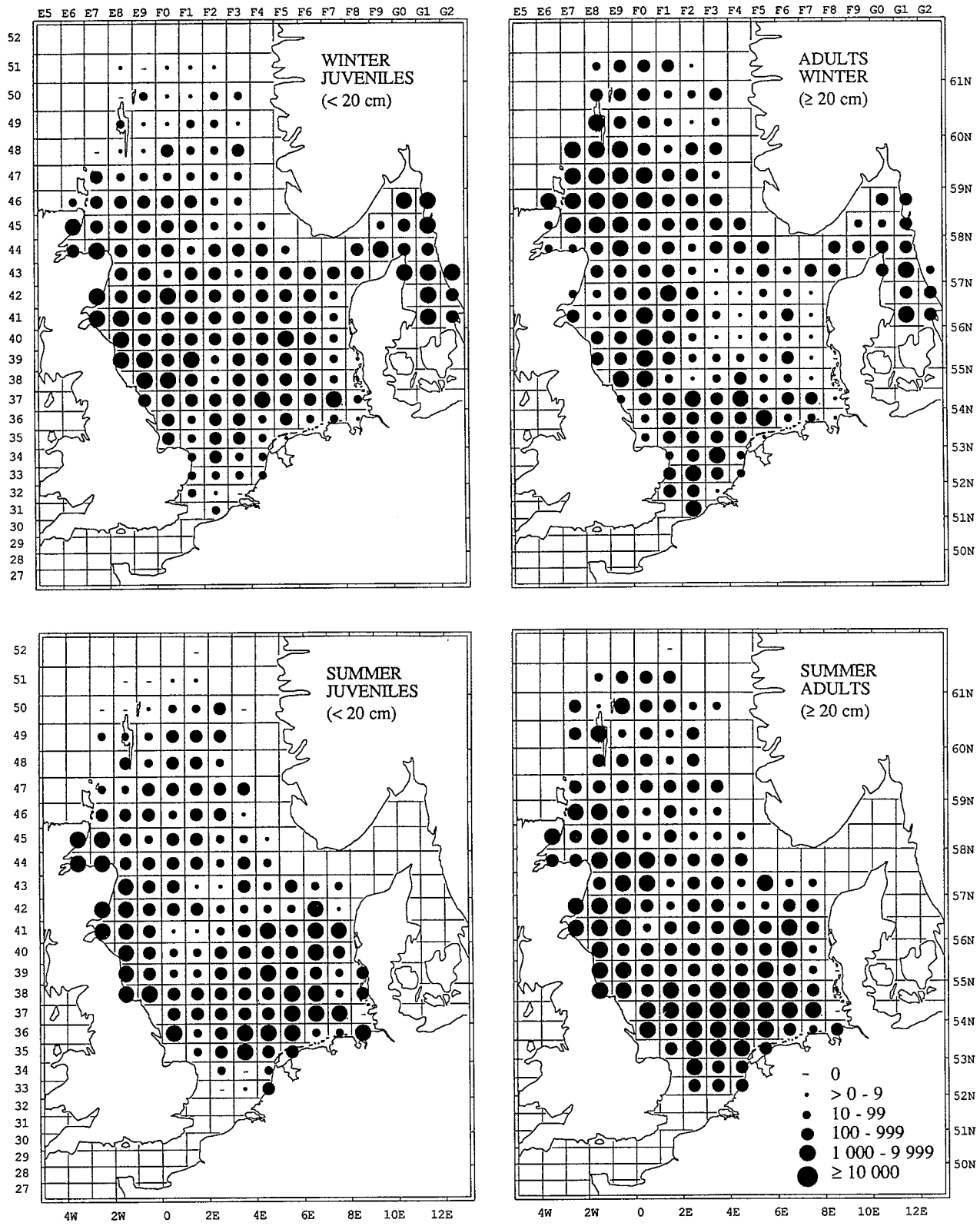


North Sea landings, spawning stock biomass (in 1000 t), and recruitment (in millions of one-year-old fish) to the stock [3] since 1960.

38. *Merlangius merlangus*
Family Gadidae

E. Whiting, F. Merlan, D. Wittling, DK. Hvilling,
N. Hvitting, NL. Wijting, S. Vitling





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

This is one of the most abundant and widely distributed North Sea gadoids. Whiting were caught in high numbers in all but the northernmost parts of the *Atlas* area, where densities of the immature fish, in particular, were relatively low.

High densities of immature fish were found off the Scottish coast, in the Skagerrak and Kattegat, and, notably during summer, in the German Bight and off the Dutch coast. Mature whiting occurred in high densities south of Shetland during winter, when densities were low in the central North Sea. The entire southern half of the area was densely populated by the larger size classes during summer, as was the area off the Scottish coast.

Length composition

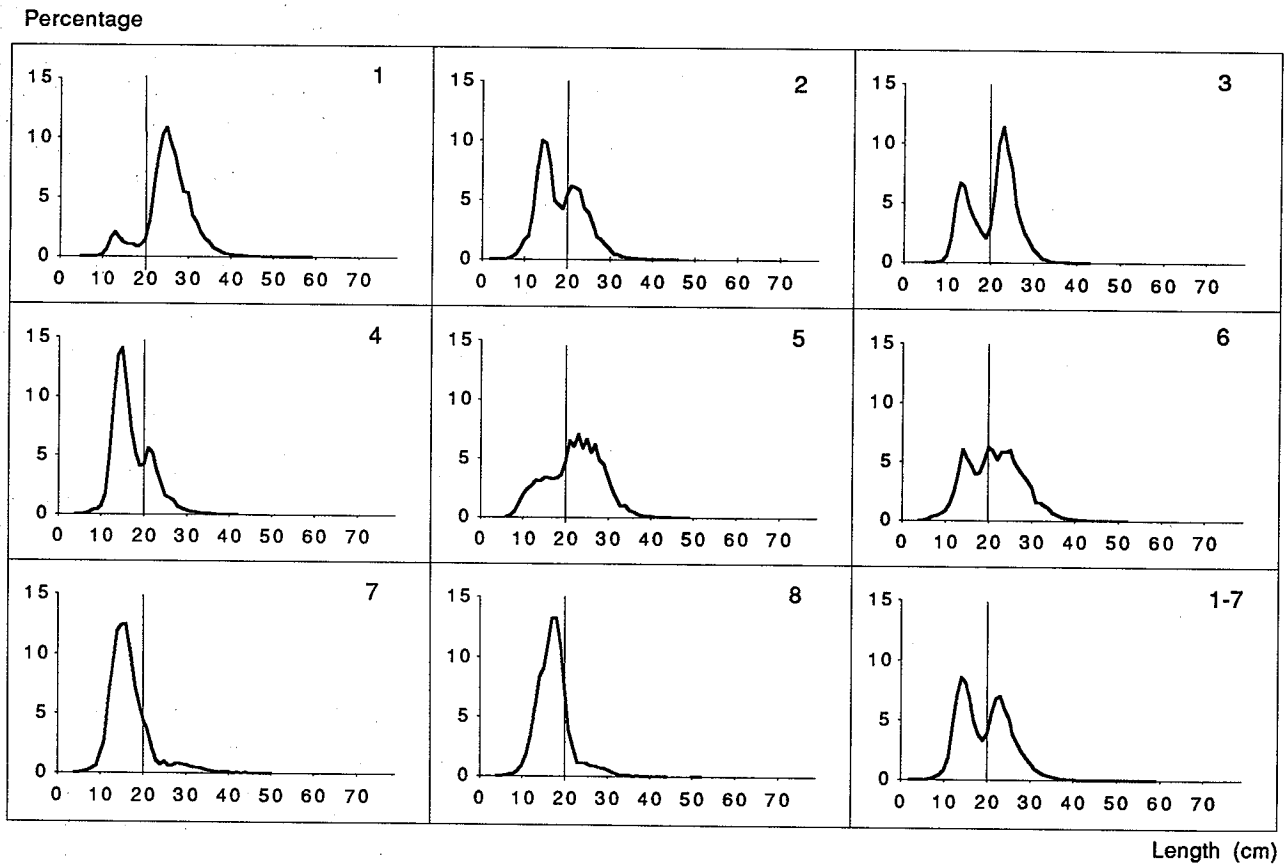
In all areas, the one-year-olds (< 20 cm) and older fish (> 20 cm) are readily distinguished in the length distributions of the winter catches. Areas in which the youngest age group dominated the catches are, for instance, the English coast (area 4) and the Skagerrak and Kattegat (area 8). The larger specimens outnumbered the smaller ones in the northern North Sea and off the Scottish coast (areas 1 and 3). Large and small whiting were equally abundant in area 6, the southeastern North Sea.

Life history

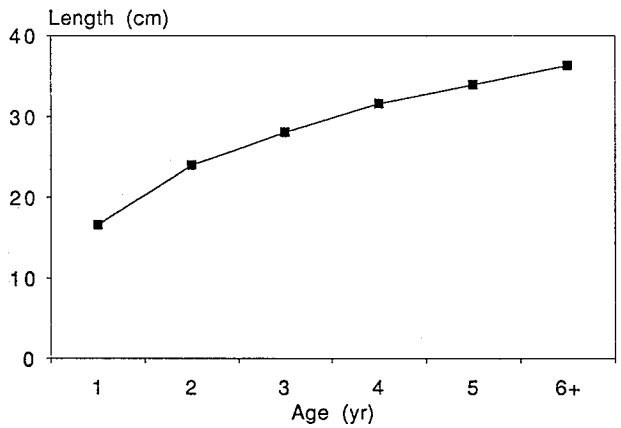
Whiting is a very fecund fish. A female of 30 cm length may produce 400,000 ripe eggs during the spawning season [1], which is 1700 eggs per gram body weight (data from [1] and [2] combined). The pelagic eggs, which take about ten days to hatch [3], are shed in numerous batches over a period that may last for up to fourteen weeks [1]. The pelagic larvae start feeding when they are 2.4 mm long, and their main prey are the nauplii and copepodite stages of copepods [4].

In West Scottish inshore waters 0-group whiting are first taken in bottom trawls during July and August. There exists evidence of a nocturnal migration into mid-water [5].

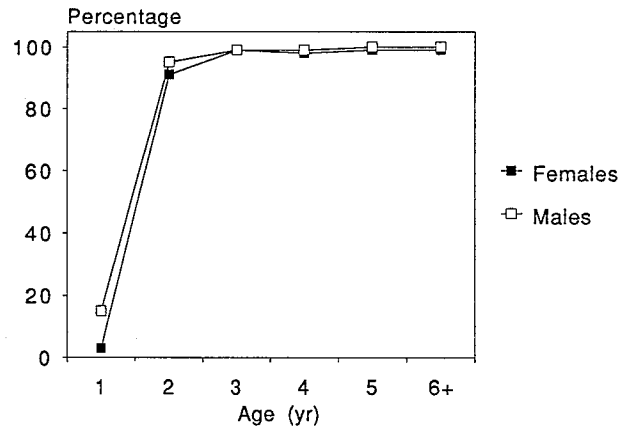
Whiting grow relatively slowly after their first year of life, and there is great individual variation in growth rate [2]. For example, a 30 cm fish in February may be from one to six years old. Most fish are sexually mature when they are two years old.



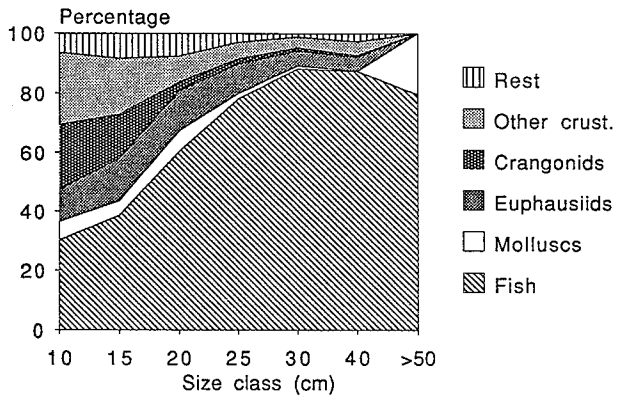
Length-frequency distribution of whiting by roundfish area during winter (length split indicated).



Mean length (cm) per age group during the first quarter of 1981 (data from [2]).



Percentage of mature fish per age group 1981 – 1985 (IYFS).



Average stomach contents as percentage weight by size class in 1981 (data from [2]).

Major food items of whiting less than about 20 cm in length are crustaceans such as euphausiids and crangonid shrimps. The diet varies according to the season. For instance, during part of the year annelids or cephalopod molluscs may form a significant part of the diet [2]. The importance of fishprey increases when the predator grows to a bigger size and whiting of >30 cm in length feed almost entirely on fish, including small species like Norway pout, sprat, and sandeel, and the younger age classes of larger species, such as herring, cod, and haddock. In fact, because of the composition of its diet and the size of the stock, whiting is considered to be one of the major predators of fish in the North Sea.

Population and exploitation

The spawning period of this species is prolonged. It may start in the southern North Sea as early as January and lasts until May – June [6]. Spawning is said to occur all over the North Sea, but the spatial distribution of pelagic 0-group whiting (3 – 5 cm) during summer shows considerable differences. The northern North Sea, the areas south of Shetland and west of Denmark, are densely populated by 0-group whiting during summer, whereas densities are lower in the central North Sea, the southern German Bight, and off the English east coast [7].

Several nursery areas are recognized outside the *Atlas* area. These inshore, shallow areas and sea lochs are colonized by 0-group whiting during summer and autumn. A gradual emigration into the open sea occurs in spring [5,8,9]. Whiting belonging to the 0-, 1-, and 2-groups are present throughout the year in offshore areas of the southeastern coasts of the *Atlas* area [10].

On the basis of tagging experiments and analyses of incidence of infection by parasites, it is suggested that whiting to the north and south of the Dogger Bank form two separate stocks that mix very little, and that movements in the northern North Sea are directed mainly along the Scottish coast, rather than inshore/offshore [11]. Part of the whiting stock in the Skagerrak probably migrates into the northeastern North Sea to spawn [12].

Yearly North Sea landings fluctuated below 100,000 t during the first forty years of this century. From 1945 to 1975 landings increased to over 200,000 t, followed by a decrease to 100,000 t in the 1980s. Of the North Sea catches made in 1990, about one third in weight was landed for human consumption, one third for industrial processing, and the remaining one third was discarded. The exploitation level of the North Sea stock is high and it is primarily because of relatively good recruitment that the spawning stock biomass has been sustained during the late 1980s [13].

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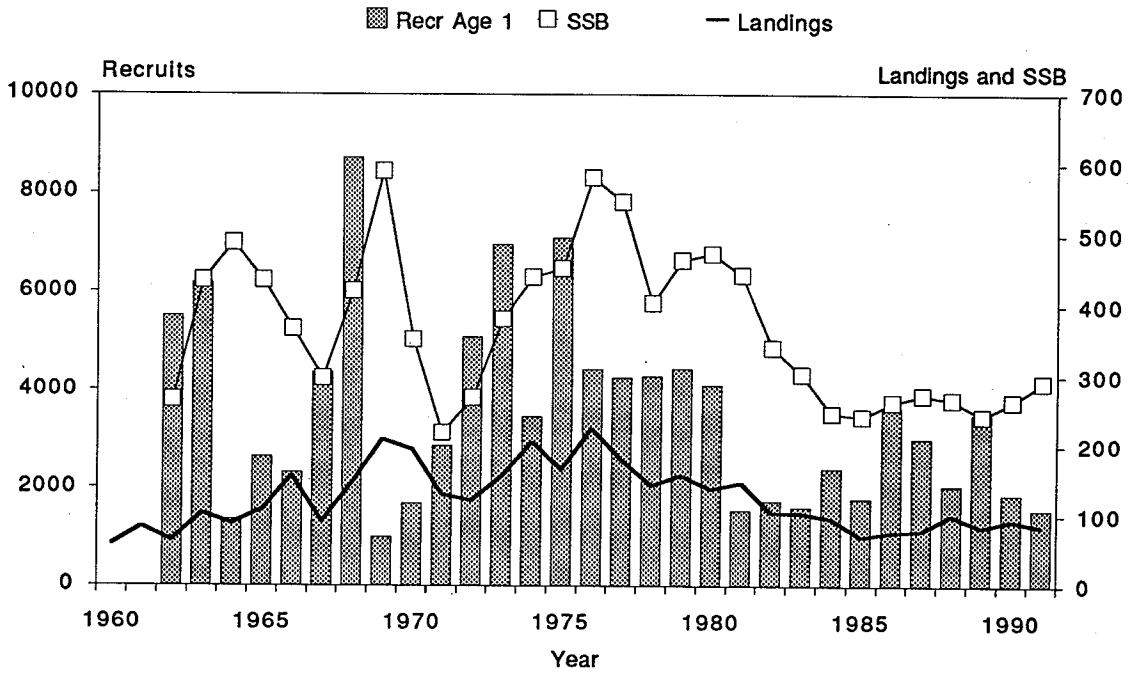
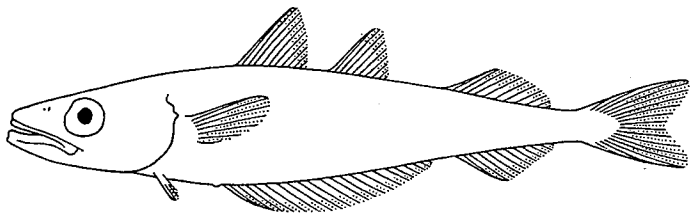
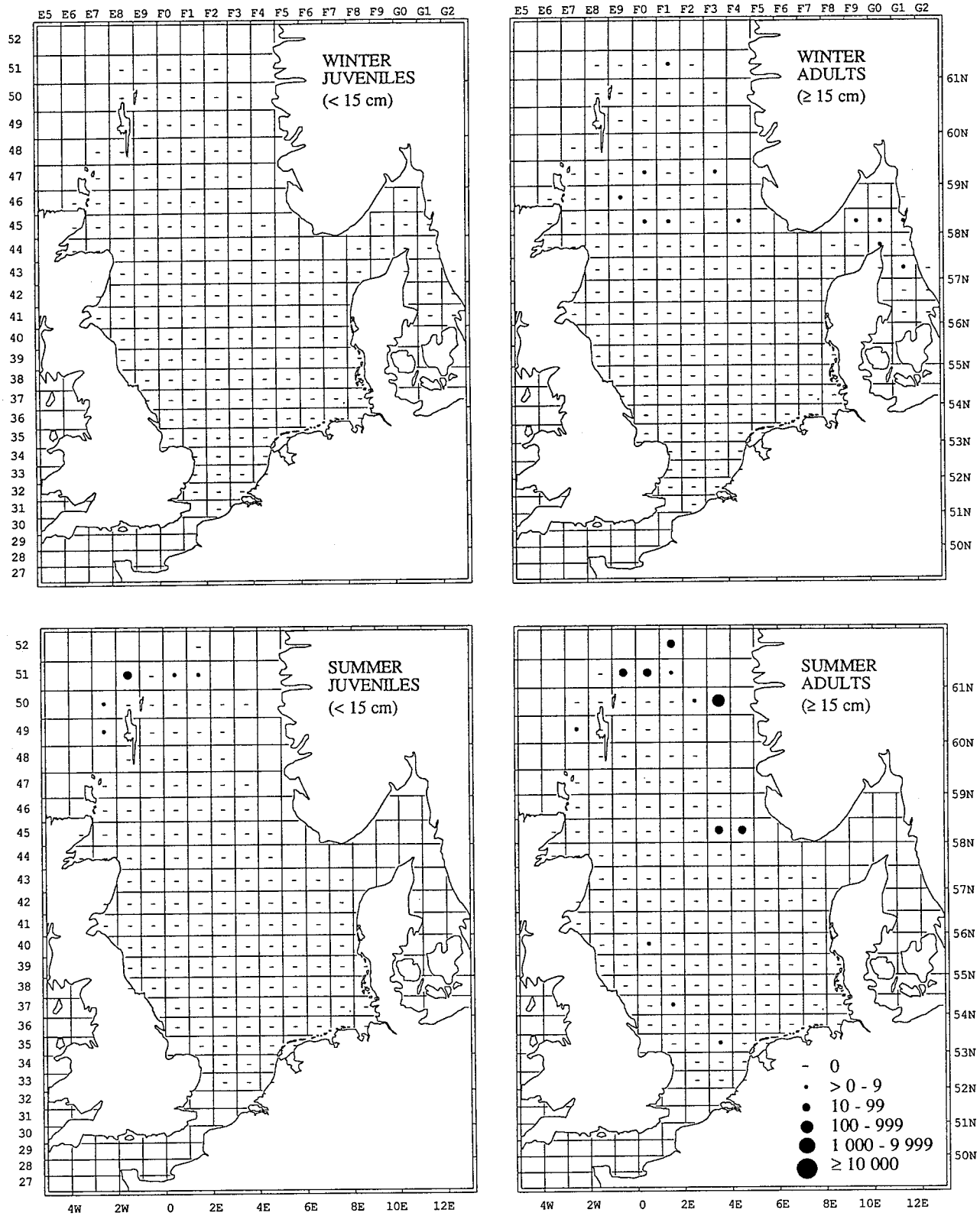


North Sea landings, spawning stock biomass (in 1000 t), and recruitment (in millions of one-year-old fish) to the stock [13] since 1960.

39. *Micromesistius poutassou*
Family Gadidae



E. Blue whiting, F. Merlan bleu, D. Blauer Wittling, DK. Blåhvilling, N. Kolmule, NL. Blauwe wijting, S. Blåvitling



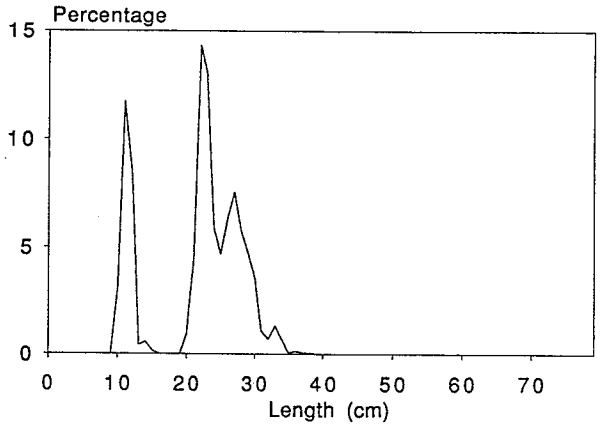
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Blue whiting was only caught in large numbers during summer, in the northernmost parts of the North Sea and along the Norwegian Deep. The near absence during the winter surveys is related to an annual migration between spring spawning areas to the west of the British Isles and summer feeding areas in the Norwegian Sea and northern North Sea [1]. This fish is the most abundant gadoid in the Norwegian Deep proper [2].

Length composition

The summer distribution clearly shows a split between 0-group and older individuals.



Length-frequency distribution of blue whiting during summer.

Life history

This is essentially a pelagic species with diurnal vertical migrations. It is found at greater depths during daylight [1].

Feeding activity is low in autumn and early spring when the blue whiting is in its spawning areas. When on the summer feeding grounds in the Norwegian Sea, blue whiting feeds intensively on pelagic prey (mainly euphausiids) [3].

There are some difficulties in estimating the growth rate (it is not completely clear how to interpret the different growth zones on the otoliths), but it appears to be highly variable. During June – October, the length of 0-group blue whiting from the northern North Sea ranged from 3 to 16 cm. Specimens from the spawning areas west of Scotland grow from 20 cm at one year of age to 30 cm at the ages of five (females) and seven (males). The females grow to a bigger size than the males. Maturity is attained at approximately 20 cm [1].

Population and exploitation

Spawning occurs during the spring months, when blue whiting congregate in waters west of the European continental shelf between the Bay of Biscay and the Faroes [1]. The largest quantities of newly spawned, pelagic eggs are to be found at depths of 250 – 450 m. The larvae, which hatch approximately eight days after spawning, ascend to the upper 40 m of the water column [4], and are carried north or northeastwards in the North Atlantic Drift Current. They appear as 0-group fish in the Norwegian Deep from September onwards [2].

After spawning the adults disperse into the eastern part of the Norwegian Sea and into the North Sea, where they are mainly found in the deep waters of the Norwegian Deep and the Skagerrak.

Blue whiting is taken in the North Sea as by-catch in the mixed industrial fisheries. Yearly catches rose from almost nil in 1975 to over 100,000 t in the early 1980s, and dropped to 50,000 t by the end of that decade. This sharp rise and fall is probably related to the recruitment of the abundant 1982 and 1983 year classes [5].

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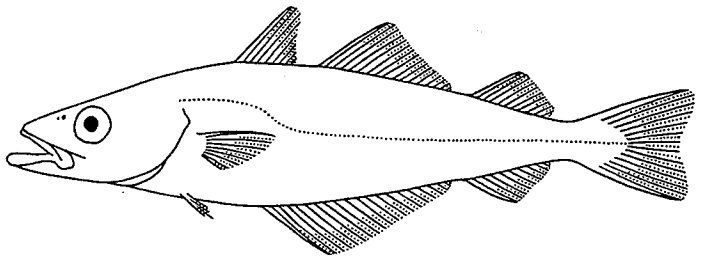
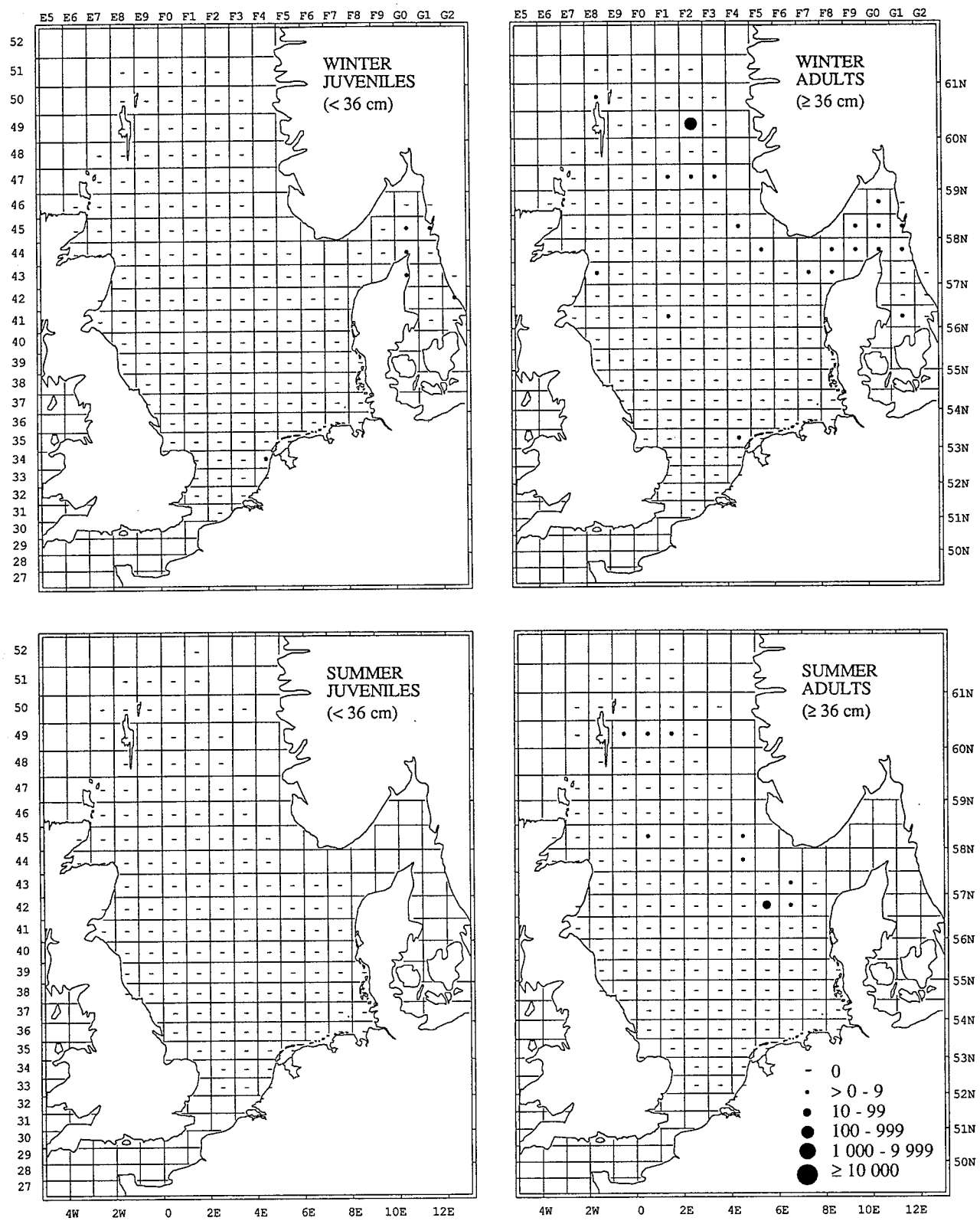
40. *Pollachius pollachius*
Family Gadidae

E. Pollack, F. Lieu jaune, D. Pollack, DK. Lubbe,
N. Lyr, NL. Pollak, S. Bleka





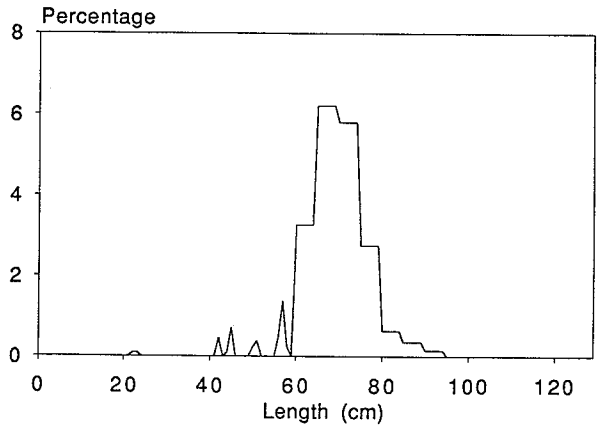
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Catches of this gadoid were scarce. Most of the pollack caught in winter came from the Kattegat and the Skagerrak, and from along the edge of the Norwegian Deep. The survey data may underestimate the pollack's distribution and abundance because this species appears to prefer rocky ground and may be semi-pelagic.

Length composition

Pollack between 60 and 80 cm in length dominated the winter catches.



Length-frequency distribution of pollack during winter.

Life history

A young pollack may attain a length of about 20 cm after its first winter [1]. Older (4 – 10 years), sexually mature pollack from the Norwegian Deep measure between 55 and 88 cm [2].

Stomach contents of pollack from the west of Scotland and from the Norwegian Deep indicate that the adult specimens predominantly feed on pelagic fish (e.g. herring, Norway pout, pearlsides) and on benthopelagic crustaceans, such as the shrimp *Pasiphaea multidentata* [2,3].

Population and exploitation

A near absence of juveniles from trawl catches has been reported before [2,4,5], and is partially related to the inshore habitat of the younger age groups. For instance, 0-group pollack are regularly caught in eel fykes in the harbour of IJmuiden. The young probably enter these areas as planktonic eggs or larvae and, once grown, migrate into deeper waters.

The exceptionally high density in rectangle 49F2 during winter has its origin in one single haul from 109 m depth that contained 800 pollack, ranging from 50 to 90 cm in size. This catch may be an example of pollack that have gathered into dense formations to spawn [2]. The spawning period lasts from January to April [4]. Catches of pollack not uncommonly coincide with catches of saithe (No. 41). The large haul in rectangle 49F2, for example, also contained 300 saithe.

North Sea catches gradually decreased from 3000 to 2000 t per year during the period 1945 – 1985. The minor economic importance of pollack is not very surprising in view of its preference for rocky or rough grounds; fifteen baskets of adult fish were caught in a haul near Shetland in February 1992 but the trawl was almost completely destroyed in the process.

References

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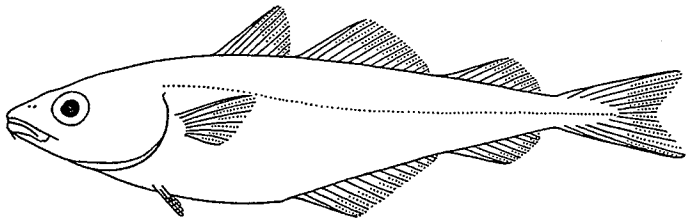
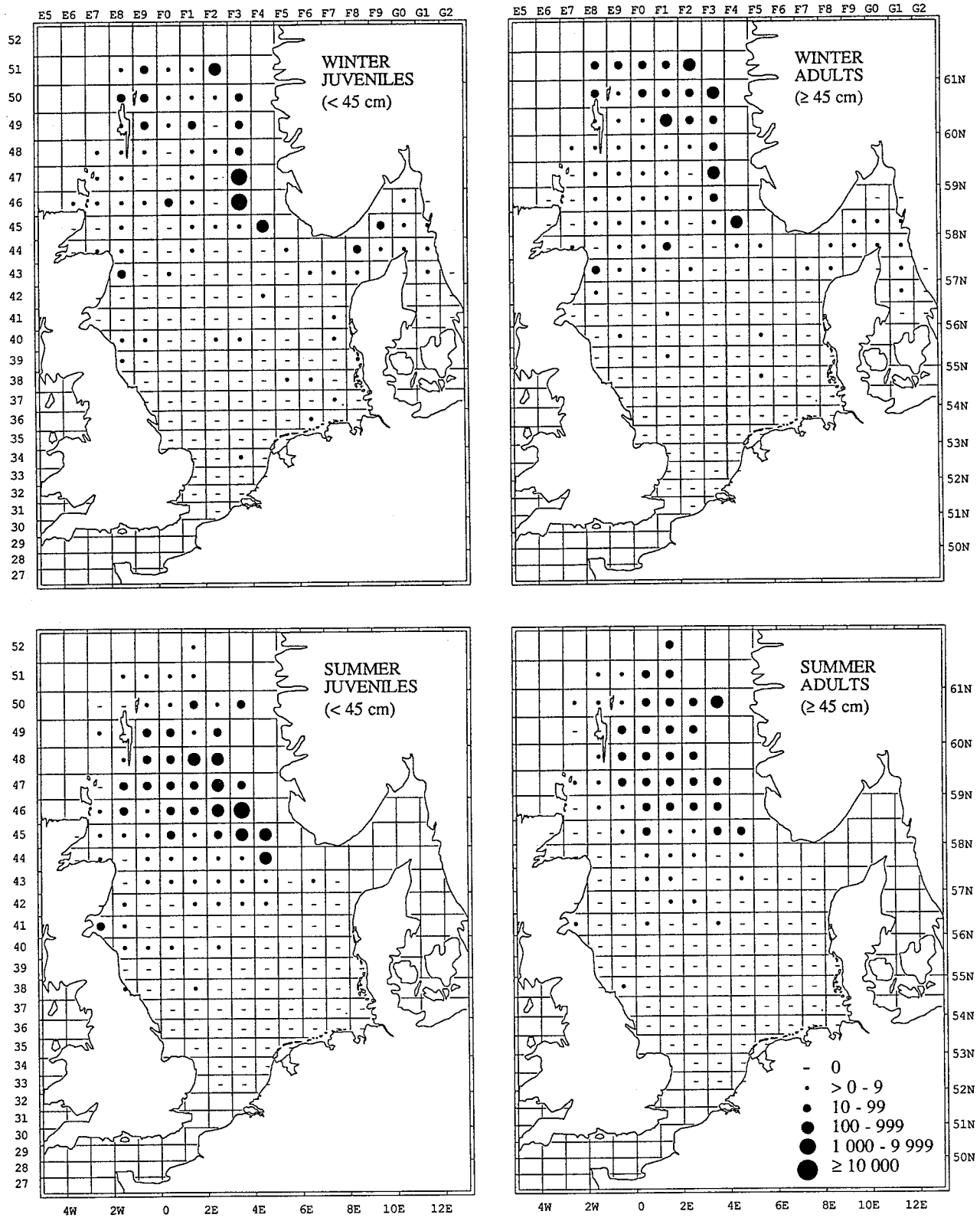
41. *Pollachius virens*
Family Gadidae

E. Saithe, F. Lieu noir, D. Seelachs, DK. Sej, N. Sei, NL. Koolvis, S. Gråsej





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

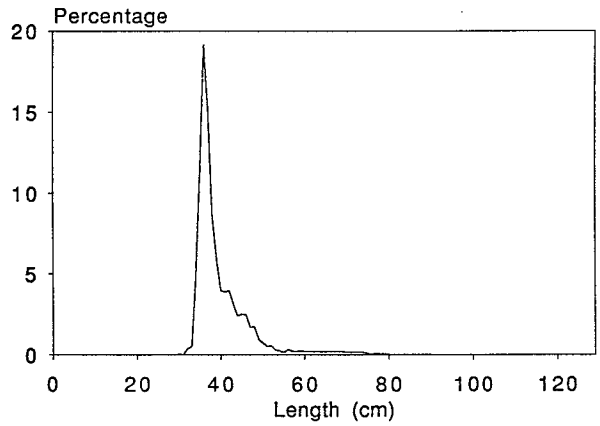
Spatial distribution

Both small and large saithe were caught in the northern North Sea, the Skagerrak, and the Kattegat. Density was markedly higher in the northeastern North Sea during summer.

Saithe sometimes form dense shoals; this is shown by a February haul in rectangle 46F3 in which 36,000 fish were caught, ranging from 32 to 42 cm.

Length composition

The youngest age groups are found in large numbers in British and Norwegian coastal waters, on grounds unsuitable for trawling, which explains why only saithe over 30 cm were caught during the surveys. Specimens larger than 50 cm were rare. The largest saithe caught measured 115 cm.



Length-frequency distribution of saithe during winter.

Life history

Young saithe from coastal Norwegian waters mostly prey on planktonic organisms like *Oikopleura dioica*, copepods and krill, but they are able to change to a benthic diet when suitable planktonic organisms are scarce. Larvae and young-of-the-year fish (e.g. herring, cod, and sandeel) are at times taken as well [1].

The adults are known to display daily vertical migrations and may occur pelagically, hundreds of metres above the bottom, as well as close to the bottom, down to depths of more than 300 m [2]. They are benthopelagic and epibenthic predators. Important prey are euphausiids, sandeel, Norway pout, and haddock [3].

Four-year-old saithe from Icelandic waters reach 55 cm in the first quarter of the year; they measure 100 cm when they are twelve years of age, and 110 cm at the age of nineteen. The majority of these Icelandic saithe become mature when they are six years old [4]. Spawning takes place in late winter and spring, near the edge of the continental shelf. A 75 cm female will on average produce 2.9 million eggs during a spawning season, equivalent to 750 eggs per gram body weight [5].

Population and exploitation

Tagging experiments have shown that the young saithe gradually leave their Scottish and Norwegian coastal nurseries during spring [1] and recruit to the stock in the northern North Sea [6].

Owing to the inshore habitat of the youngest age classes, fishery biologists have great difficulties in forecasting saithe catches because the standard gear used during recruitment surveys cannot be used in shallow rocky waters. Catches of saithe, a very important fish for the northern countries, rose from virtually nil at the turn of the century to over 300,000 t in the mid-1970s. After this peak, catches decreased to 100,000 t in 1990. The saithe spawning stock biomass in 1991 was at the lowest level recorded during the preceding twenty years [7].

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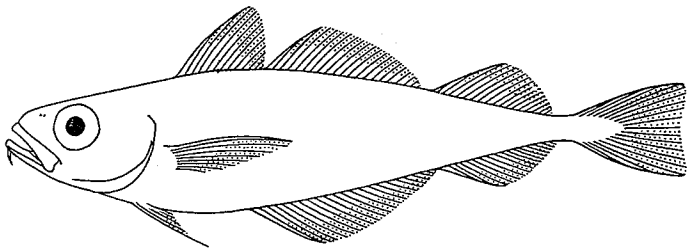
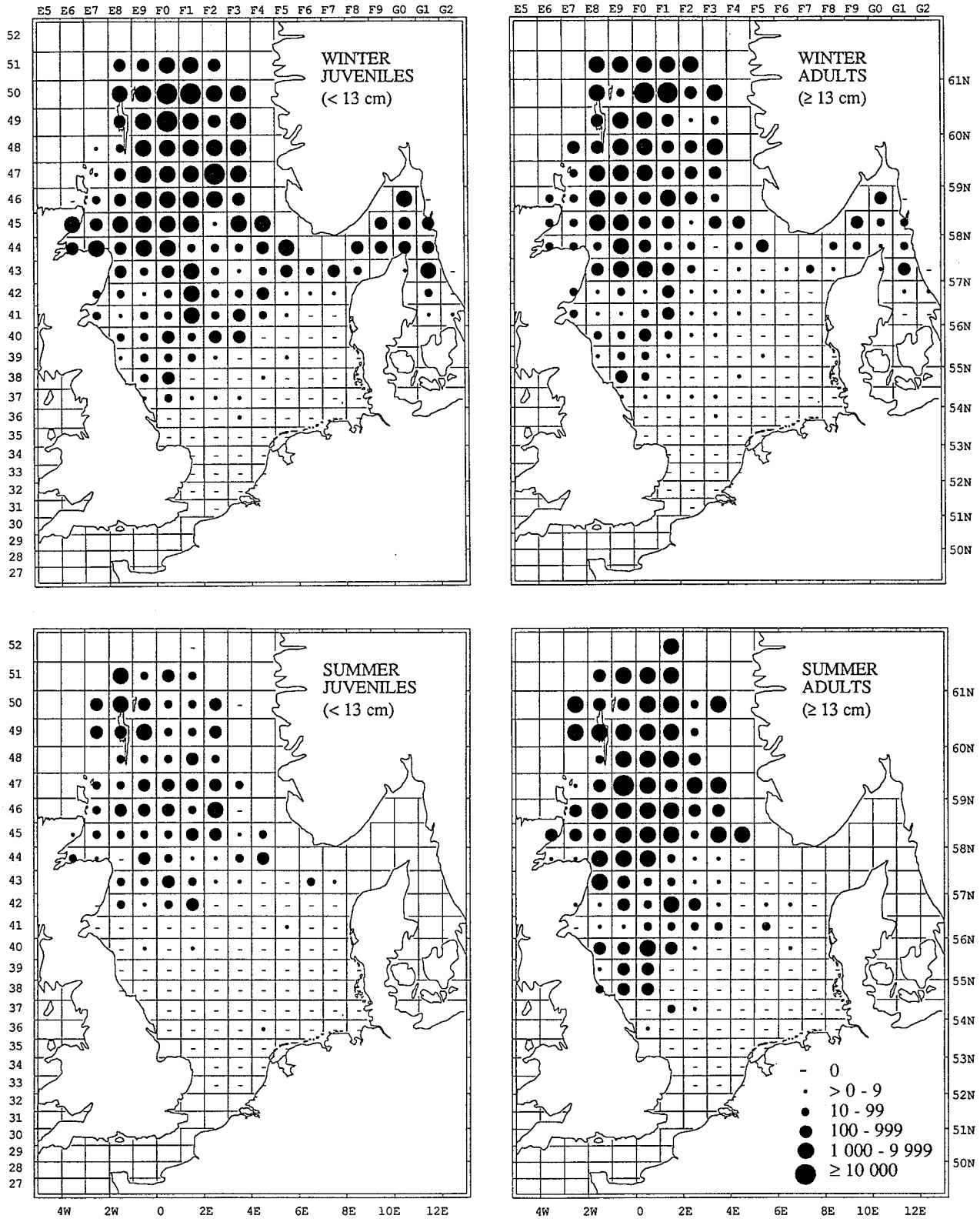
42. *Trisopterus esmarki*
Family Gadidae

E. Norway pout, F. Tacaud norvégien, D. Stintdorsch, DK. Spærling, N. Øyepål, NL. Kever, S, Vitlinglyra





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Norway pout was found in the northern and central part of the North Sea and in the Skagerrak and Kattegat. Its centre of distribution lay midway between Shetland and the Norwegian coast. Densities of immature Norway pout were generally lower during summer surveys and their area of occurrence did not extend as far south as during winter. In the period between the winter and summer surveys a significant part of the immature Norway pout population grows to a 'mature' size. Most of the 0-group fish are not big enough in summer to be caught by the survey gears.

In the North Sea, the Norway pout is usually found between 80 and 200 m, but it occurs frequently in depths of up to 450 m in the Norwegian Deep and in waters as shallow as 40 m in the Skagerrak [1,2].

Length composition

Norway pout is a small, short-lived species that seldom attains ages over three years old, and the winter *Atlas* catches mainly comprised one-year-old individuals which measured up to 13 cm. Relatively few older and larger specimens were caught; they were particularly scarce in the Skagerrak and Kattegat (area 8).

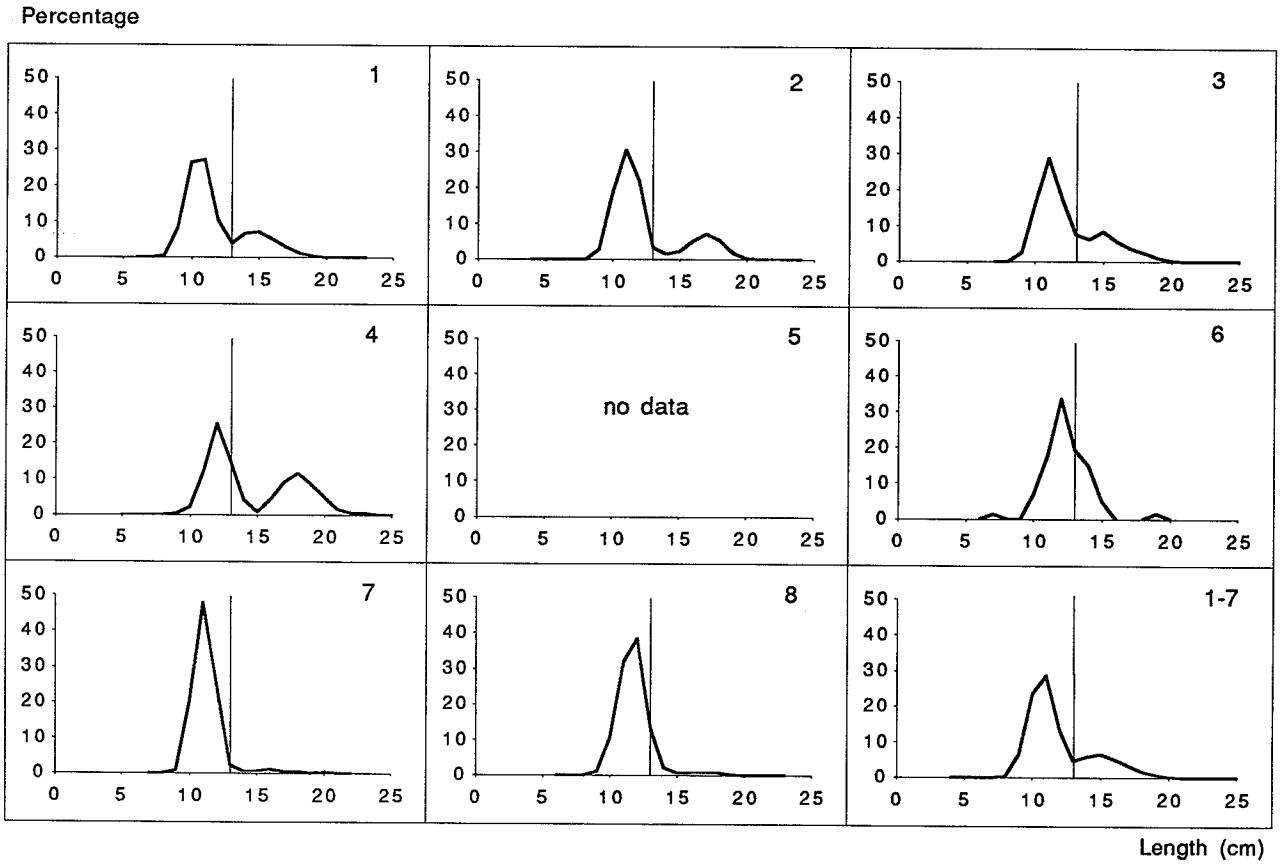
Life history

A female produces 420 – 980 eggs per gram body weight [3]. This is the equivalent of 21,000 eggs for a 30 g, two-year-old fish [4,5].

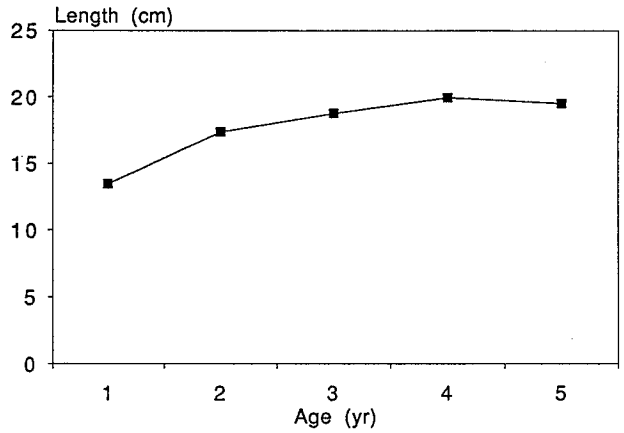
The pelagic 0-group measures 1.5 – 6.0 cm by June – July [6] and during this stage Norway pout may migrate vertically in the water column, being found close to the seabed during the daytime and spending the night in mid-water [7]. Principal food items during this stage of life are copepods and appendicularians [8].

The diet of 10 – 20 cm long specimens in a west Norwegian fjord consisted of crustaceans and small fish. The crustaceans were mysids, natantians, copepods, euphausiids, and amphipods; the fish were mainly gobiids [9]. Norway pout is classified as a hyperbenthic predator, usually found within a few metres of the seabed [10]. The industrial fishery for this fish is to a large extent carried out with bottom trawls [11].

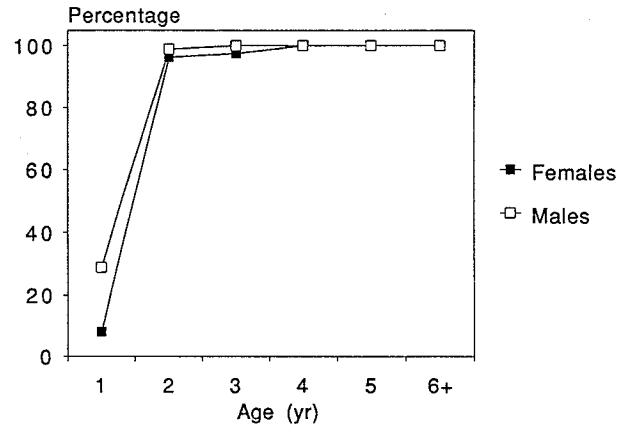
Female Norway pout grow faster and reach a larger size than males [5]. Mean length at age shows geographical and year-to-year variation [12]. The majority of the fish spawn for the first time when they are in their second year, but a variable proportion may do so when they are one year old [5].



Length-frequency distribution by roundfish area during winter (length split indicated).



Mean length (L) per age group in the northern North Sea in March – April [12].



Percentage maturity per age group in February 1983 – 1985 (IYFS data).

Population and exploitation

Norway pout is generally considered not to have specific nursery grounds [13]; pelagic 0-group fish occur mainly in the northern North Sea [6], similar to their larger conspecifics. Some migration is likely to occur, however. The existence is suggested of slight northerly spawning movements to an area between Shetland and Norway where large concentrations of Norway pout larvae are found in spring [14]. The eastern Skagerrak is colonized by larvae or 0-group fish that originate from spawning grounds in the North Sea. The colonists leave the area as maturing individuals [2]. Catches in the Skagerrak and Kattegat area (area 8) during winter surveys were dominated by the younger fish.

Norway pout is of no importance for human consumption because of its small size, but it is an important target species for the industrial fishery in northern European countries, in particular Denmark and Norway. Annual North Sea catches rose from almost nil in the 1960s to over 750,000 t in the mid-1970s, and decreased to little more than 100,000 t in the late 1980s. The average contribution by weight of the recruiting 1-group to the catches was 61% during 1980 – 1986 [4]. Such a high dependence of the catches on a single year class explains why Norway pout catches are very erratic over time.

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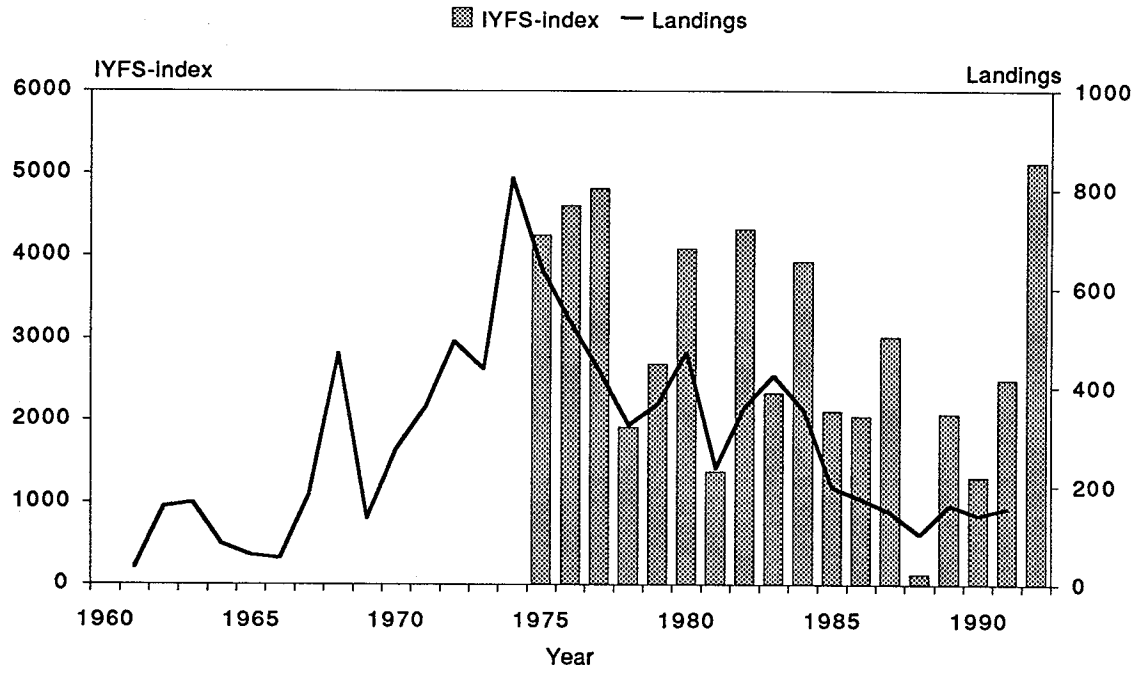
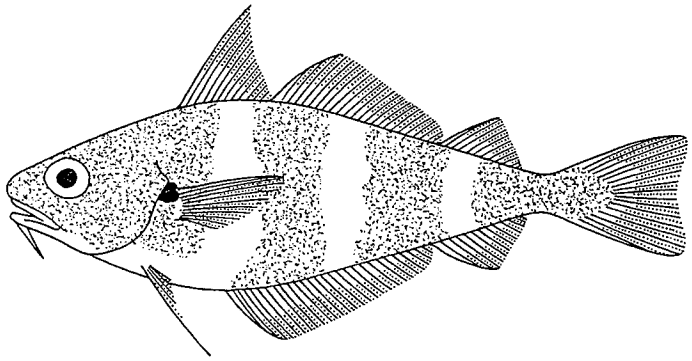
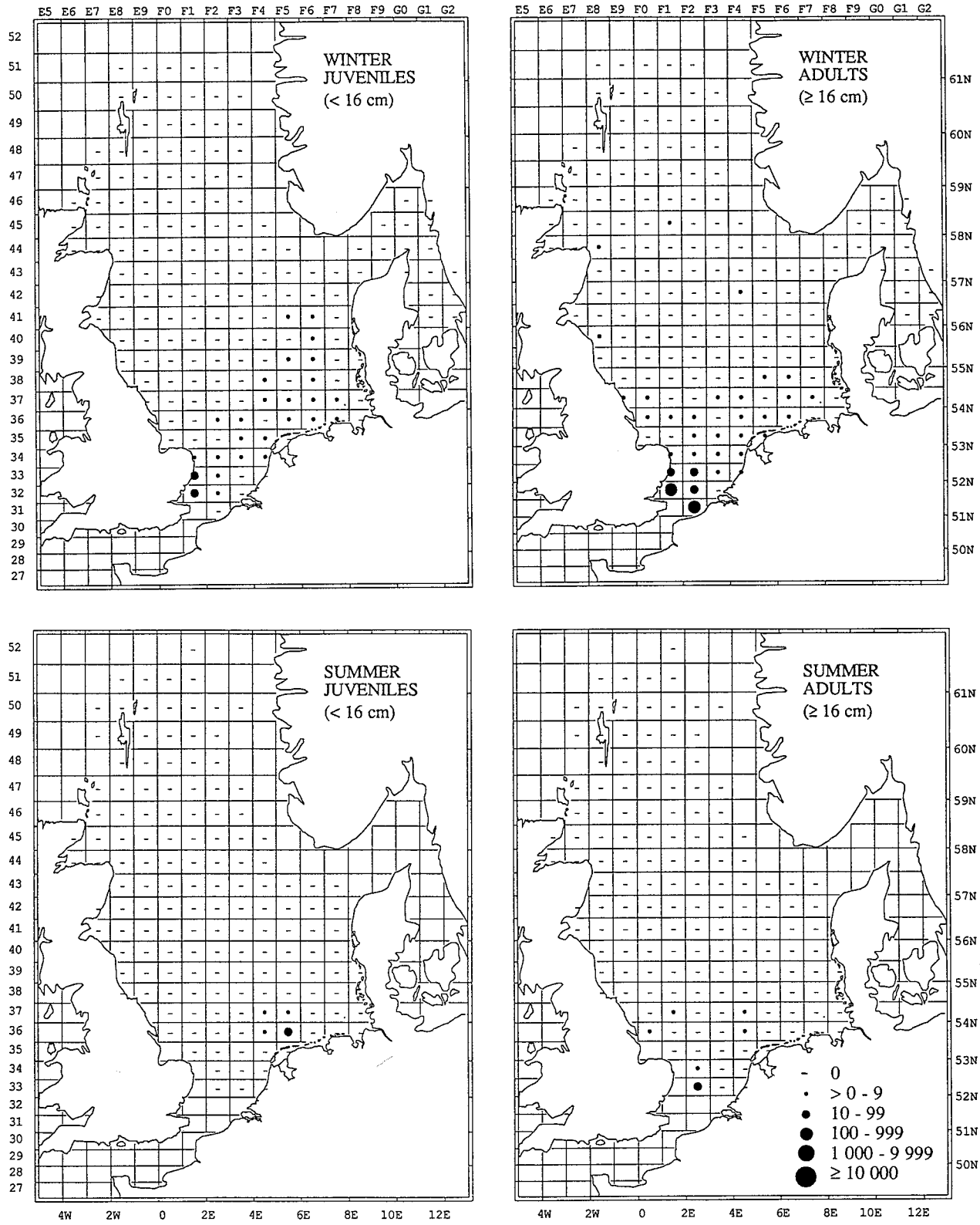


North Sea landings (in 1000 t), and IYFS-index for 1-group Norway pout since 1960.

43. *Trisopterus luscus*
Family Gadidae

E. Bib, F. Grand tacaud, D. Franzosendorsch,
DK. Skægtorsk, N. Skjeggtorsk, NL. Steenbolk,
S. Skäggtorsk





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

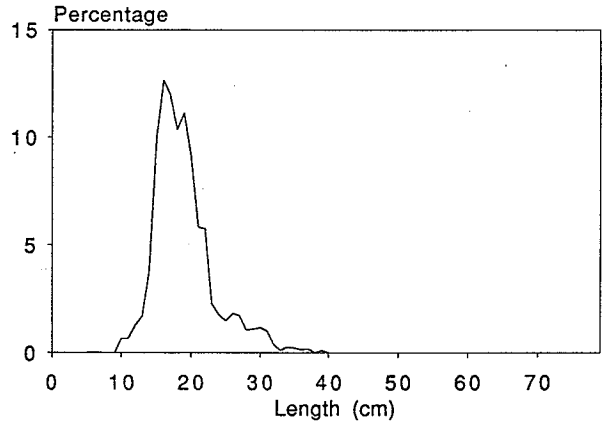
Spatial distribution

During winter, bib was caught in modest numbers in the southern part of the North Sea and in the German Bight, with higher densities in the southernmost part of the area. The summer hauls contained considerably less bib.

A local beam trawl survey off the Dutch coast showed that bib has a very patchy distribution, and that it is more frequently caught close inshore [1]. Divers regularly spot this gadoid near wrecks. In consequence, the *Atlas* surveys may not give a very reliable impression of its abundance and distribution.

Length composition

Large bib, up to 40 cm, were caught, but the majority measured 15 – 20 cm.



Length-frequency distribution of bib during winter.

Life history

Bib is a fast growing, relatively short-lived species that attains 18 cm during the first quarter of its second year of life, a length of 27 cm during its third year, and 32 cm during its fourth year. Females grow to a somewhat larger size than males. Both sexes mature at the age of two [1].

Small bib prey on shrimps (*Crangon crangon*), mysids (*Neomysis integer*), crabs (*Carcinus maenas*), and polychaete worms, while the larger individuals also prey on fish such as sprat and gobies [2].

Population and exploitation

Larvae of bib, hatched from pelagic eggs, occur in high densities close inshore in bays and estuaries. It is suggested that they are passively transported to these areas. As bib grows older, it moves into deeper waters. The spawning period in the southern North Sea is relatively long, from February to August [1].

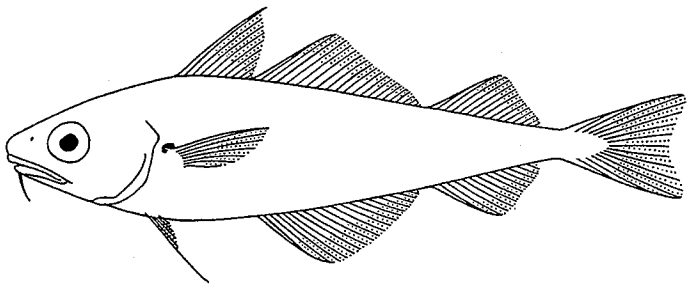
Bib is of marginal economic interest.

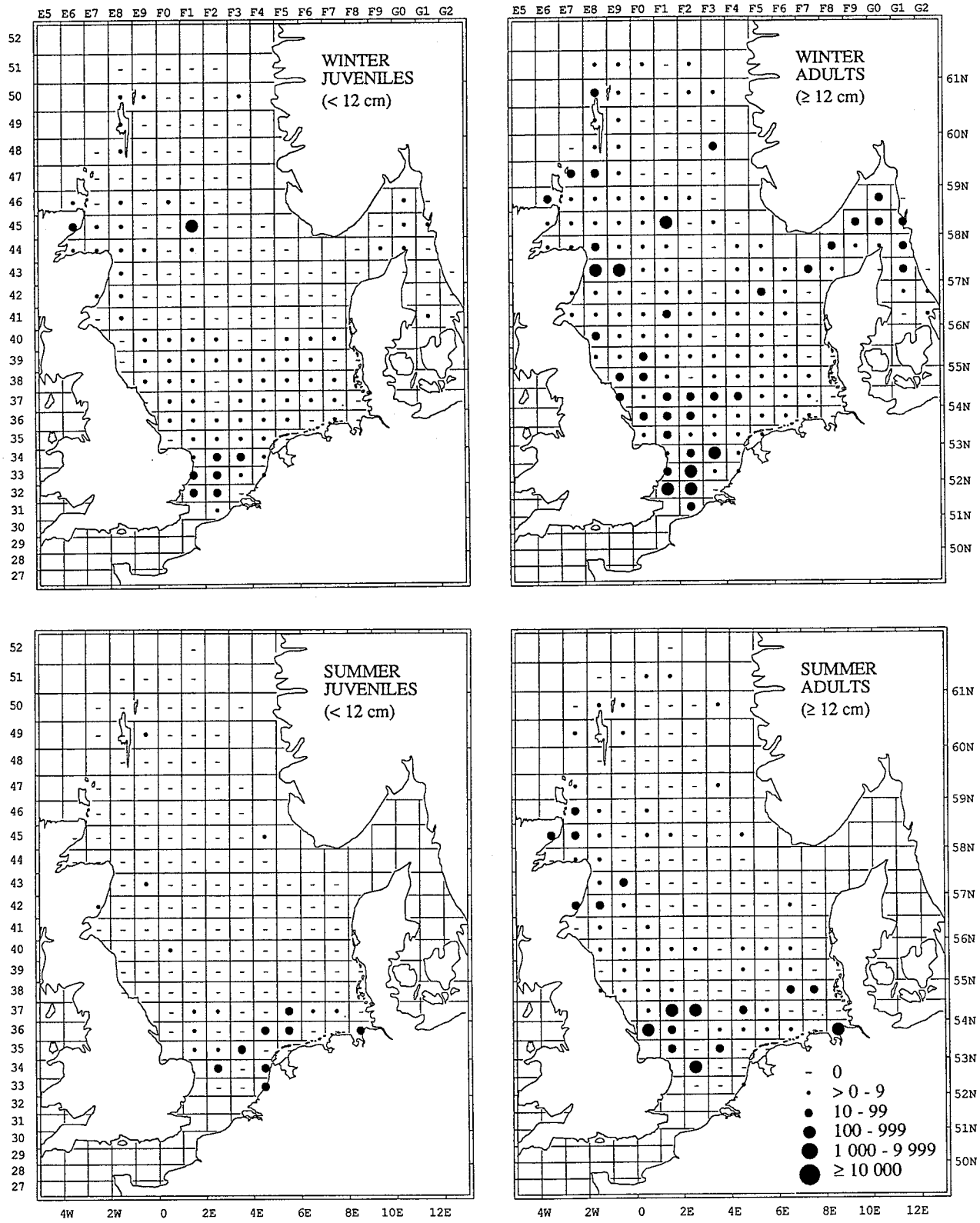
References

1. Korf, B. 1971. Steenbolk en dwergbolk, een oriënterend onderzoek naar twee mogelijke voedselconcurrenten van de kabeljauw. RIVO IJmuiden, internal report. 56 pp.
2. Van den Broek, W.L.F. 1978. Dietary habits of fish populations in the Lower Medway estuary. Journal of Fish Biology 13: 645-654.

44. *Trisopterus minutus*
Family Gadidae

E. Poor cod, F. Petit tacaud, D. Zwergdorsch, DK. Glyse, N. Sypike, NL. Dwergbolk, S. Glyskolja





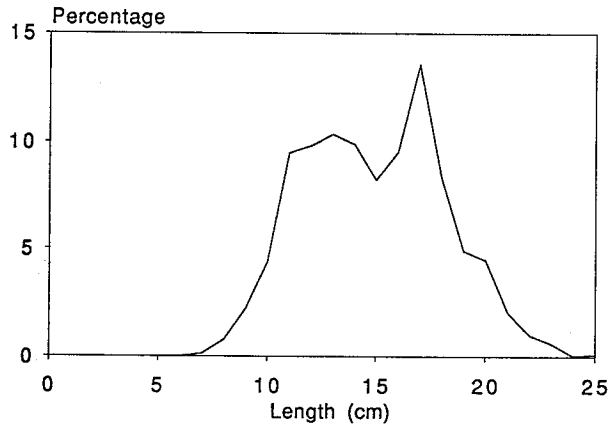
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Poor cod were widely distributed over almost the entire survey area. Densities were in general low in the deeper parts of the northern North Sea, juveniles being almost completely absent. The higher density areas were the Skagerrak and Kattegat (winter), the Scottish coastal belt, and the southern North Sea. Fewer individuals were caught during summer, particularly in the northern parts of the North Sea.

Length composition

The whole length range of this species was sampled, and is likely to contain several age groups.



Length-frequency distribution of poor cod during winter.

Life history

The irregularity of the catches may be partially related to the fact that poor cod can sometimes occur in huge schools (the high average winter density in rectangle 45F1 stems from one haul that contained 7088 individuals), and partially to the feeding ecology of this fish. Poor cod from Gullmarsfjord on the Swedish west coast is reported to feed on small, swift prey (e.g. mysids) that move above the bottom rather than on it [1], and living in mid-water makes a species less susceptible to trawling. In stomachs of southern North Sea specimens, however, benthic polychaete worms made up an important part of the diet, while poor cod (8 – 23 cm) from the Plymouth area mostly fed on benthic crustaceans (e.g. *Processa canaliculata*) and, less intensively, on small demersal fish species such as dragonets [2,3].

Aging is difficult, but poor cod of about 12 and 17 cm taken in the southern North Sea in the first quarter of the year were estimated to have an age of one and two years respectively [2,3]. Maturity is probably reached at the age of two years [2].

The eggs are pelagic.

Population and exploitation

Spawning off Plymouth occurs during February – March [3]. Underwater observations at Orkney made by one of the authors suggest that 0-group fish may be locally abundant in shallow water.

This species is of no economic importance.

References

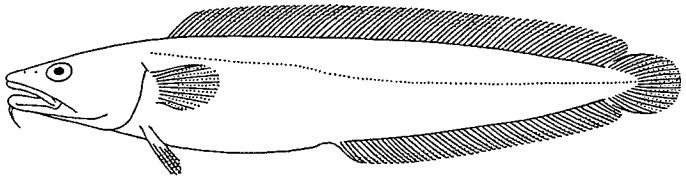
1. Mattson, S. 1990. Food and feeding habits of fish species over a soft sublittoral bottom in the Northeast Atlantic. 2. Poor-cod (*Trisopterus minutus* (L.)) (Gadidae). Sarsia 75: 261-267.

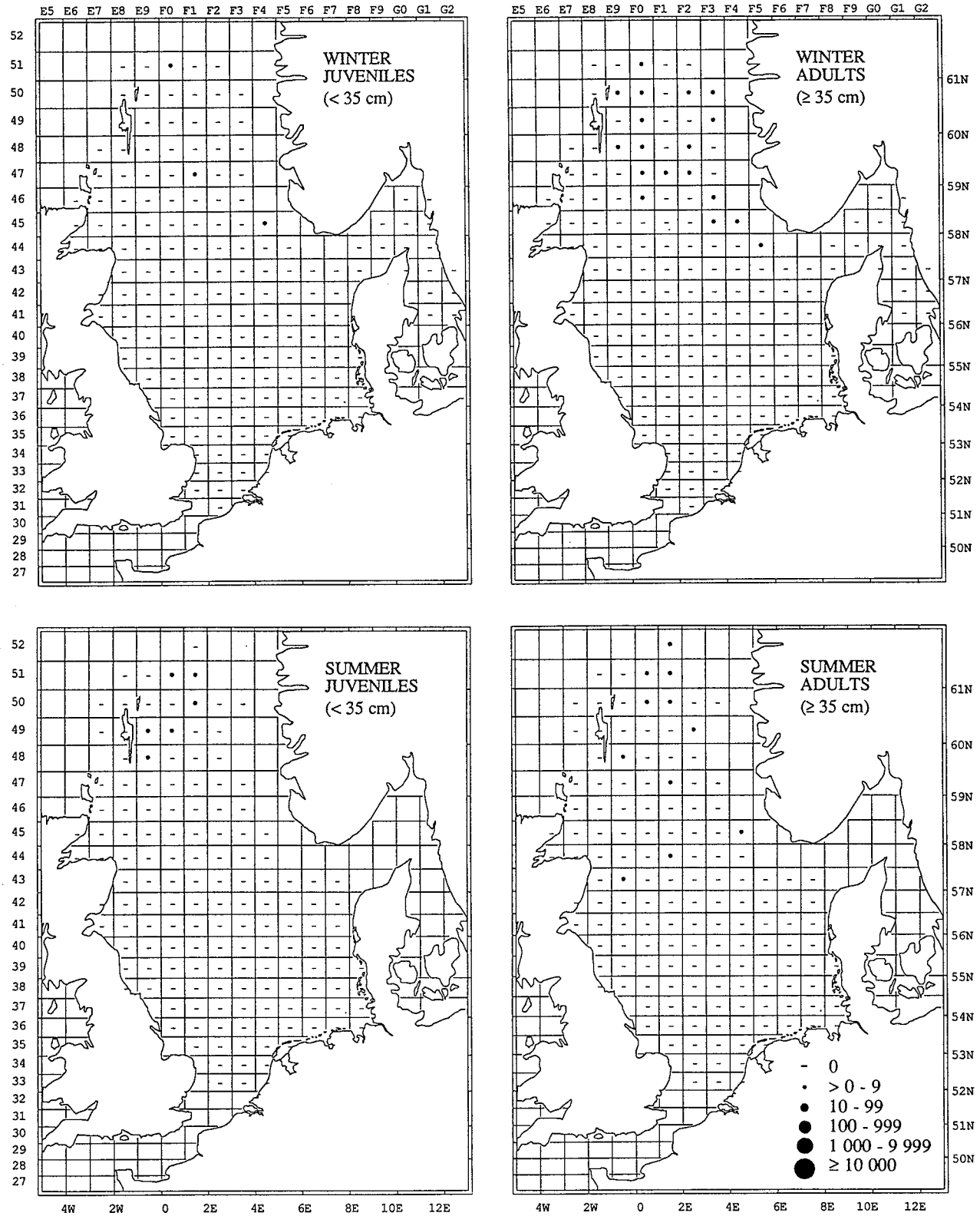
2. Korf, B. 1971. Steenbolk en dwergbolk, een oriënterend onderzoek naar twee mogelijke voedselconcurrenten van de kabeljauw. RIVO IJmuiden, internal report. 56 pp.

3. Devidas Menon, M. 1950. Bionomics of the poor-cod (*Gadus minutus* L.) in the Plymouth area. Journal of the Marine Biological Association of the United Kingdom 29(1): 185-239.

45. *Brosme brosme*
Family Gadidae

E. Tusk, F. Brosme, D. Lumb, DK. Brosme,
N. Brosme, NL. Lom, S. Lubb





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

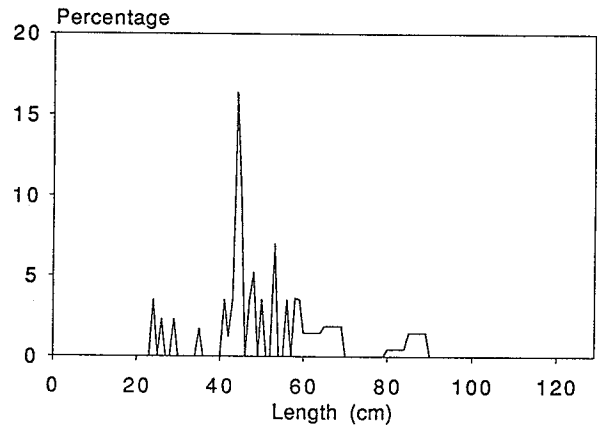
Spatial distribution

Tusk was caught only in the northern part of the North Sea. No clear differences between winter and summer distributions were observed. This is a deep-water species, which, in waters to the north of the *Atlas* area, is evenly distributed over the 150 – 450 m depth range [1].

It is likely that the *Atlas* catches do not reflect tusk abundance and distribution properly, because this fish prefers untrawlable, rocky areas. During Norwegian bottom trawl surveys, tusk was not reported along the Norwegian Skagerrak coast, an area well known for its traditional tusk line-fishery [2].

Length composition

Owing to the extremely small catches, the graph has a rather incomplete appearance. Tusk attains a maximum size of 110 cm [3].



Length-frequency distribution of tusk during winter.

Life history

Tusk of 40, 55, and 90 cm from the Norwegian Deep are respectively 5, 10, and 20 years of age [2]. In northern waters maturity is attained at a length of 50 cm [1].

The few stomach contents that have been analysed indicate that tusk feeds on Norway pout, herring, blue whiting, benthic crustaceans (*Munida* spp., crangonids), and also on hagfish (*Myxine glutinosa*, No. 2) [4,5]. The latter prey might indicate that at least some tusk live on or near mud bottoms.

Population and exploitation

In late June, pelagic eggs have been found in the Norwegian Fensfjord and Masfjord before apparently drifting into more shallow (100 m), inshore waters in which they supposedly hatch [6].

Tusk are not sufficiently abundant to be of major economic importance. They are fished with trawls and long-lines. The main tusk fishing areas are similar to those for ling (No. 50), i.e. along the continental shelf west of the British Isles, the Faroes, and along the Norwegian coast. From 1945 onwards, yearly North Sea catches rose to 5000 t in the mid-1980s.

References

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2. Bergstad, O.A. 1988. Ling (*Molva molva*), blue ling (*Molva dipterygia*) and tusk (*Brosme brosme*) of the Norwegian Deeps and adjacent slopes (Northeastern North Sea and Skagerrak). Working document. ICES Northwestern Working Group. Copenhagen, September 1988. 4 pp.
3. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.
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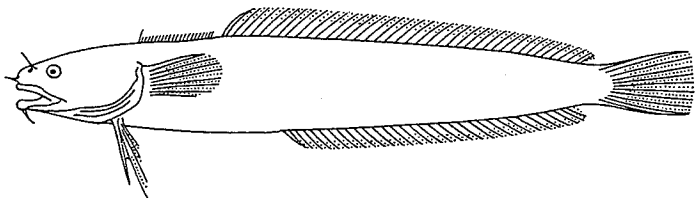
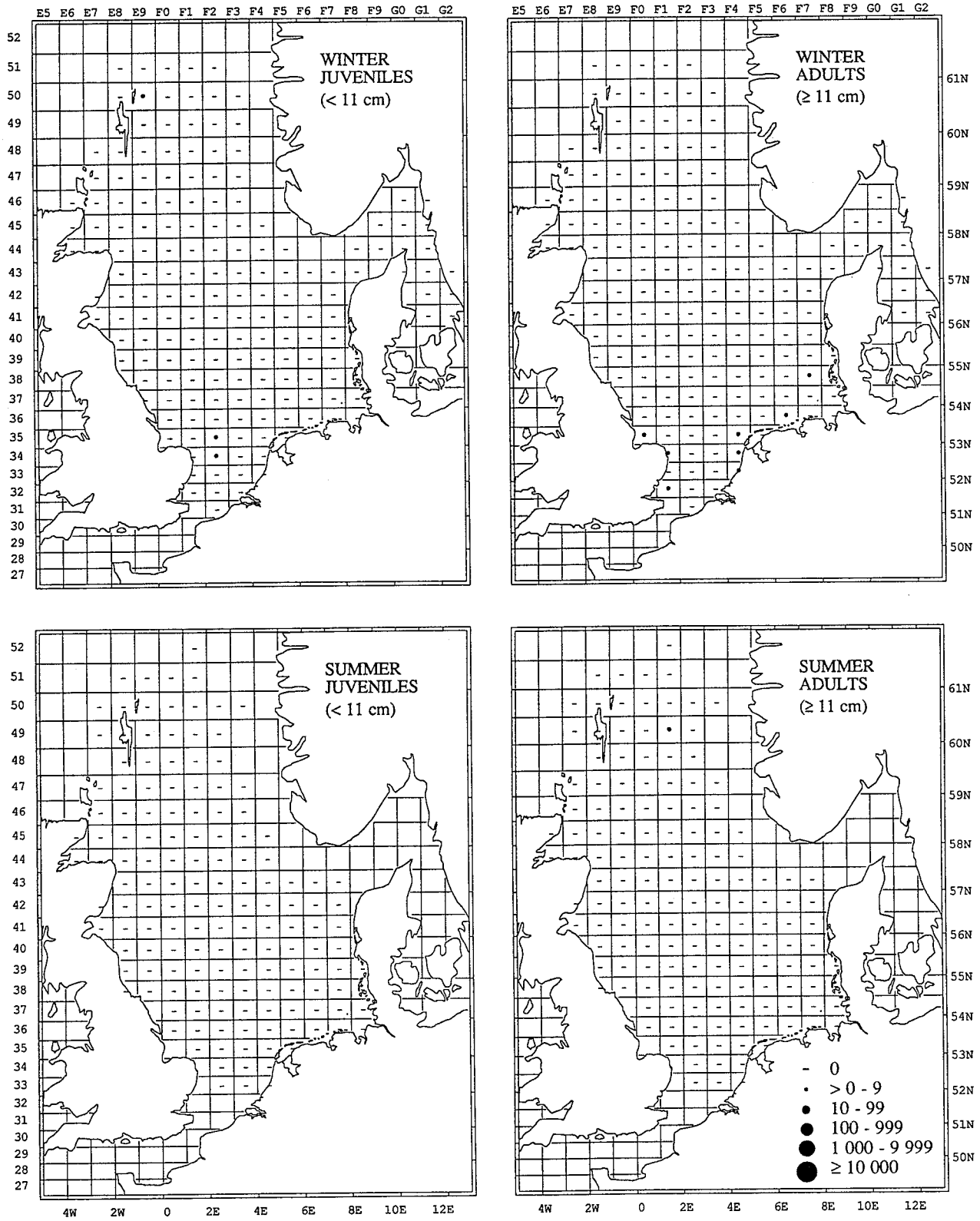
5. Rae, B.B., and Shelton, R.G.J. 1982. Notes on the food of nine species of elasmobranch (Part I) and nine species of demersal teleost (part II) fishes from Scottish waters. ICES CM 1982/G:56. 5 pp.
6. Carmo Lopes, P. do. 1979. Eggs and larvae of *Maurolicus muelleri* (Gonostomatidae) and other fish eggs and larvae from two fjords in western Norway. Sarsia 64(3): 199-210.

46. *Ciliata mustela*
Family Gadidae



E. Five-bearded rockling, F. Motelle à cinq barbillons, D. Fünfbärtelige Seequappe, DK. Femtrådet havkvabbe, N. Femtrådet tangbrosme, NL. Vijfdradige meun, S. Femtömmad skärlånga



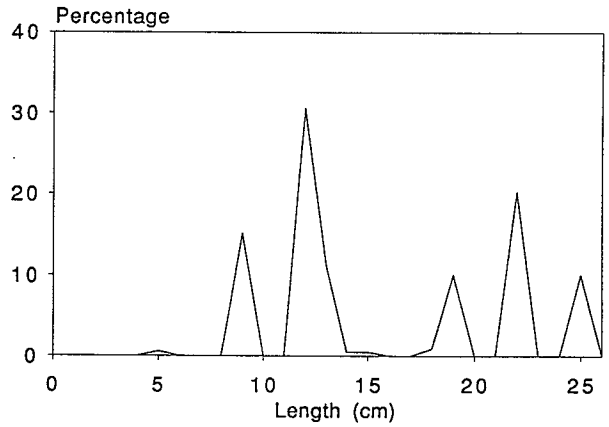
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

As this rockling is a littoral species, common in intertidal parts of rocky and sandy shores, the *Atlas* data do not adequately illustrate its spatial distribution. Small numbers were caught mainly in the southern, and some in the northern, North Sea.

Length composition

A very incomplete length distribution is attributable to the low numbers caught.



Length-frequency distribution of five-bearded rockling during winter.

Life history

Five-bearded rocklings from the west coast of England measure on average 13 cm in their first year of life; 18 cm in their second year, and 23 cm in their third year. Sexually mature females have been observed from a length of 14 cm onwards [1].

Severn estuary and Bristol Channel specimens prey on a wide range of organisms, but crustaceans (*Crangon crangon*, *Gammarus* spp., *Neomysis* spp.) and gobies (*Pomatoschistus minutus*) are generally of major importance [1].

As in all rocklings there is an early juvenile, pelagic 'mackerel-midge stage' (see No. 51).

Population and exploitation

Five-bearded rockling is a resident of the Dutch Wadden Sea. During winter it leaves this area to spawn [2] and large (> 10 cm) specimens caught sublittorally off the Dutch and German coast in February may be examples of five-beards making this spawning migration. Pelagic juveniles off Plymouth are found from early April until late September and are most abundant in June [3].

References

1. Badsha, K.S., and Sainsbury, M. 1978. Aspects of the biology and heavy metal accumulation of *Ciliata mustela*. Journal of Fish Biology 12: 213-220.

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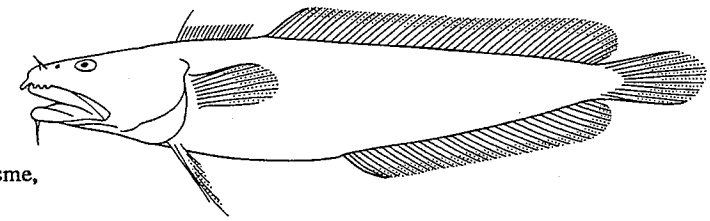
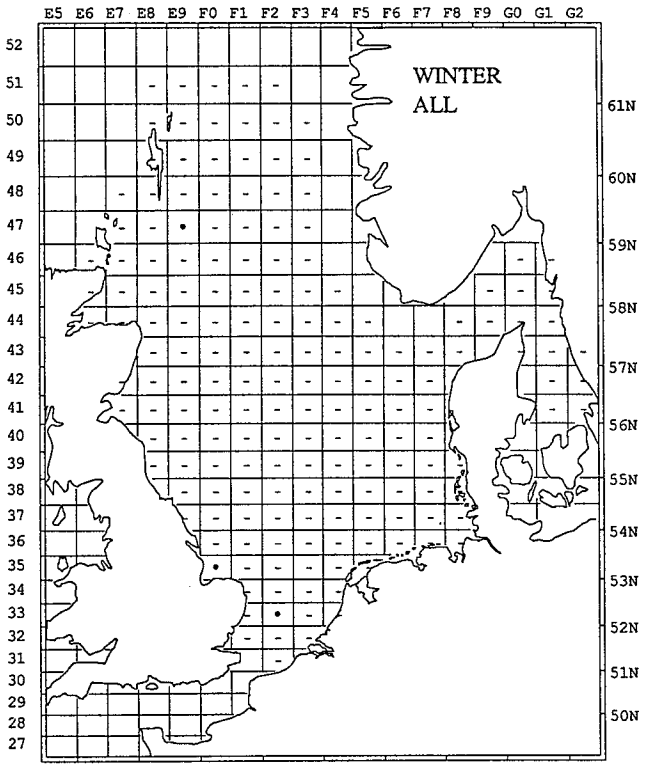
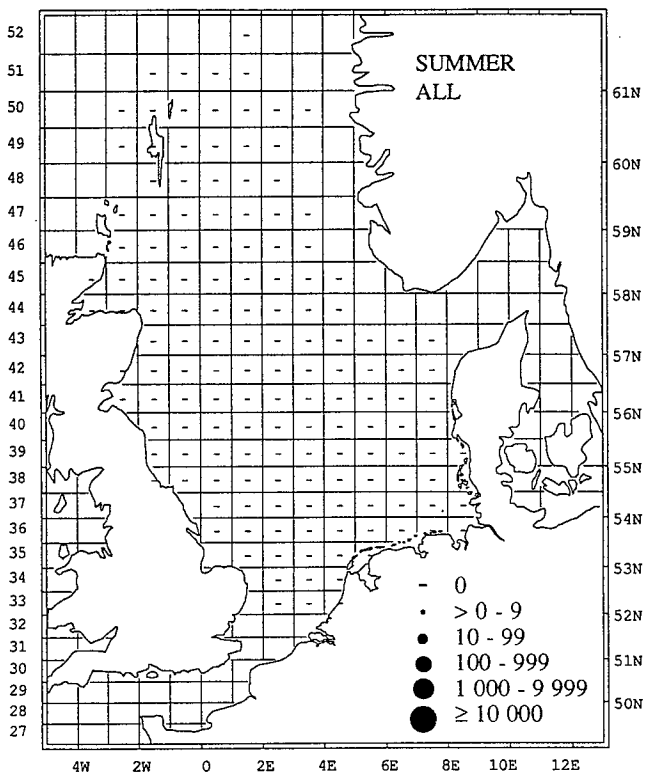
3. Demir, N., Southward, A.J., and Dando, P.R. 1985. Comparative notes on postlarvae and pelagic juveniles of the rocklings *Gaidropsaurus mediterraneus*, *Rhinonemus cimbrius*, *Ciliata mustela* and *C. septentrionalis*. Journal of the Marine Biological Association of the United Kingdom 65: 801-839.

47. *Ciliata septentrionalis*
Family Gadidae



E. Northern rockling, F. Motelle nordique,
D. Vielbärtelige Seequappe, DK. —, N. Nordlig tangbrosme,
NL. Noorse meun, S.—





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

This species is probably distributed throughout the coastal margins of the North Sea [1]. Occurrences during the *Atlas* surveys were few, and only during winter.

Northern rockling was not recorded in British waters until 1960. This apparent rarity may in part be due to its small size, making it generally unavailable to commercial fishing gear, and its similarity to the five-bearded rockling (*Ciliata mustela*, No. 46), leading to misidentification [1].

Length composition

The five specimens that were caught during the winter surveys ranged from 5 to 15 cm. Northern rockling may grow to 18 cm [1].

Life history

The males, which achieve a length of 12.5 cm in their second year of life, appear to grow faster than the females. Small crustaceans, especially amphipods, and polychaete worms are prey items in the Severn estuary and the Bristol Channel [2].

The irregularly shaped eggs, 0.7 – 0.9 mm in diameter, may be benthic according to laboratory observations [3] but the larvae and juveniles ('mackerel midges', No. 51) are pelagic [4].

Population and exploitation

Spawning off Plymouth probably takes place between March and May [2]; pelagic juvenile specimens occur in this area between March and September [4].

Northern rockling are of no commercial value.

References

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2. Claridge, P.N., and Gardner, D.C. 1977. The biology of the northern rockling, *Ciliata septentrionalis*, in the Severn Estuary and Bristol Channel. Journal of the Marine Biological Association of the United Kingdom 57: 839-848.
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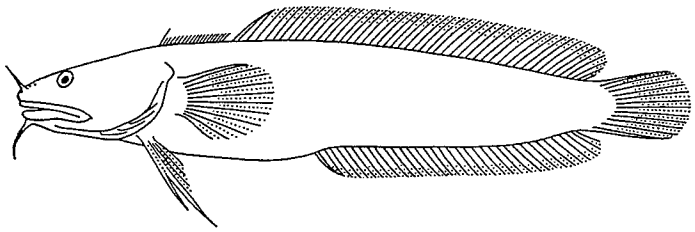
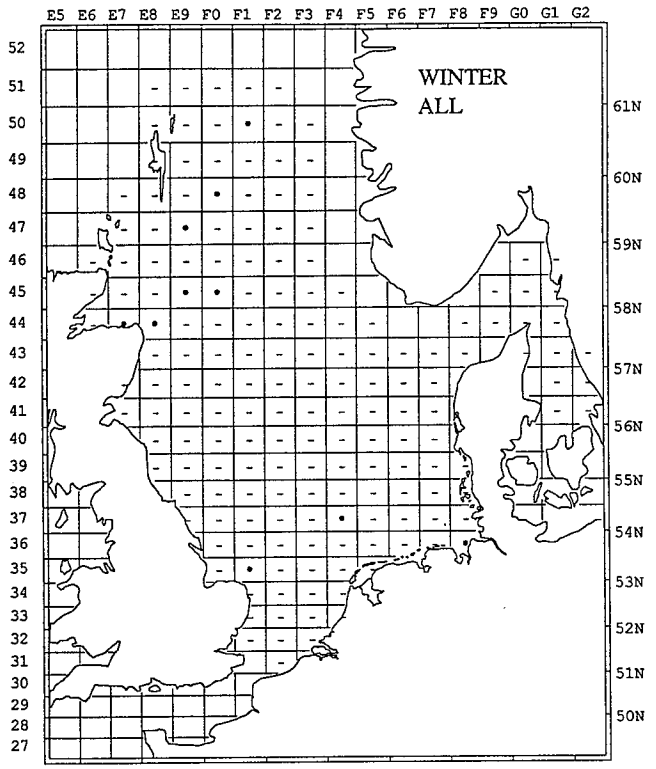
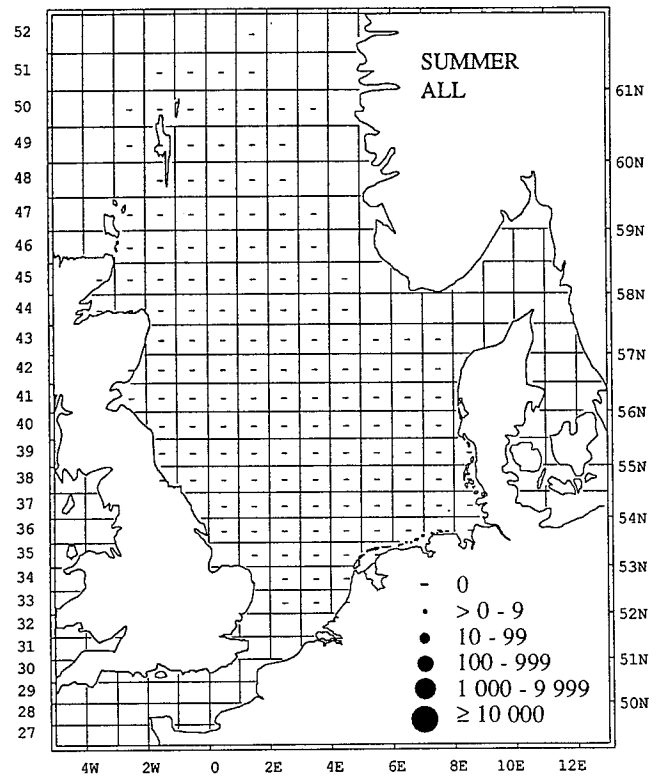
48. *Gaidropsarus vulgaris*
Family Gadidae



E. Three-bearded rockling, F. Motelle commune,
D. Dreibärtelige Seequappe, DK. Tretrådet havkvabbe,
N. Tretrådet tangbrosme, NL. Driedradige meun,
S. Tretömmad skärlånga





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Three-bearded rockling were caught only during the winter surveys, but although few in number they were widely spread over the *Atlas* area. The indicated distribution may be unreliable, because this species prefers rough ground, generally avoided during trawling surveys.

Length composition

The lengths of the individuals caught varied between 8 and 47 cm. Three-bearded rockling is the largest rockling species in the *Atlas* area. It may attain a length of 53 cm [1].

Life history

This species is usually found near rocks, but also on open ground over coarse gravel or sand. Its diet consists of crustaceans and small benthic fish. Spawning takes place in winter and the eggs and larvae are pelagic [1].

The pelagic, early juvenile 'mackerel-midge stage' (see No. 51) finishes when the fish become bottom-living, before a length of 6 cm is reached [1].

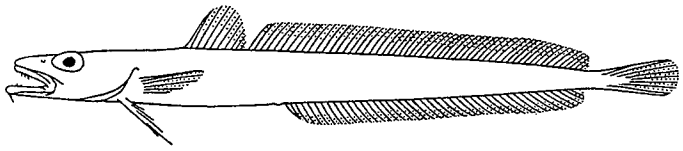
Population and exploitation

Although three-bearded rockling is widely distributed throughout the North Sea and it is frequently caught by trawlers and seiners, it has no commercial value.

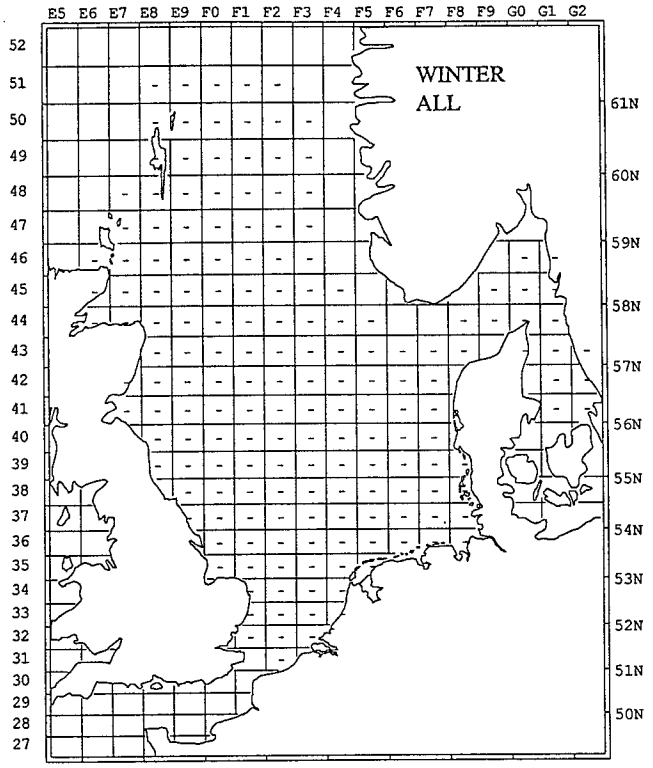
References

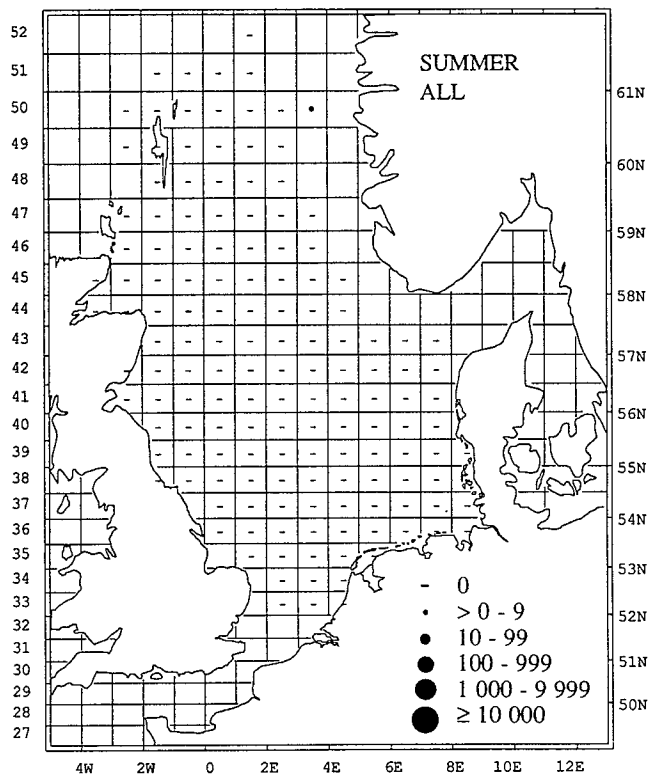
1. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.

49. *Molva dipterygia*
Family Gadidae



E. Blue ling, F. Lingue bleue, D. Blauleng, DK. Byrkelange, N. Blålange, NL. Blauwe leng, S. Birkelånga





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Two individuals were caught in a single haul on the edge of the Norwegian Deep during a summer survey. Infrequent catches were to be expected, because blue ling is known to be scarce in depths of less than 200 m [1,2].

Length composition

This fish can reach a size well in excess of 100 cm [1,2]. The two specimens caught during the surveys were relatively small (34 and 48 cm), probably immature individuals.

Life history

Blue ling grows relatively slowly, taking fourteen or fifteen years to reach a length of 100 cm [3]. It attains sexual maturity at an age of nine or ten years [4]. There appears to be no information on the fecundity of blue ling, but the closely related common ling (No. 50) is known to be extremely fecund. The eggs of blue ling are pelagic.

Stomach contents of blue ling from the Norwegian Deep indicate that the most important prey are fish (blue whiting, argentines, grenadiers), although crustaceans are also eaten [2].

Population and exploitation

Spawning takes place in spring and summer, in deep water [1,2]. Little is known about migrations. There is some evidence that blue ling may be less restricted to very deep water in summer and autumn than in winter [2]. Individuals smaller than 50 cm are relatively infrequent in both commercial [3] and research vessel catches [2].

Moderate quantities of blue ling are landed from trawl and line fisheries along the edge of the continental shelf and at Iceland.

References

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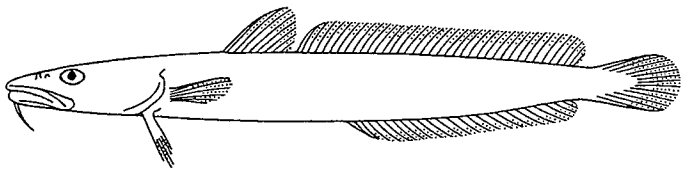
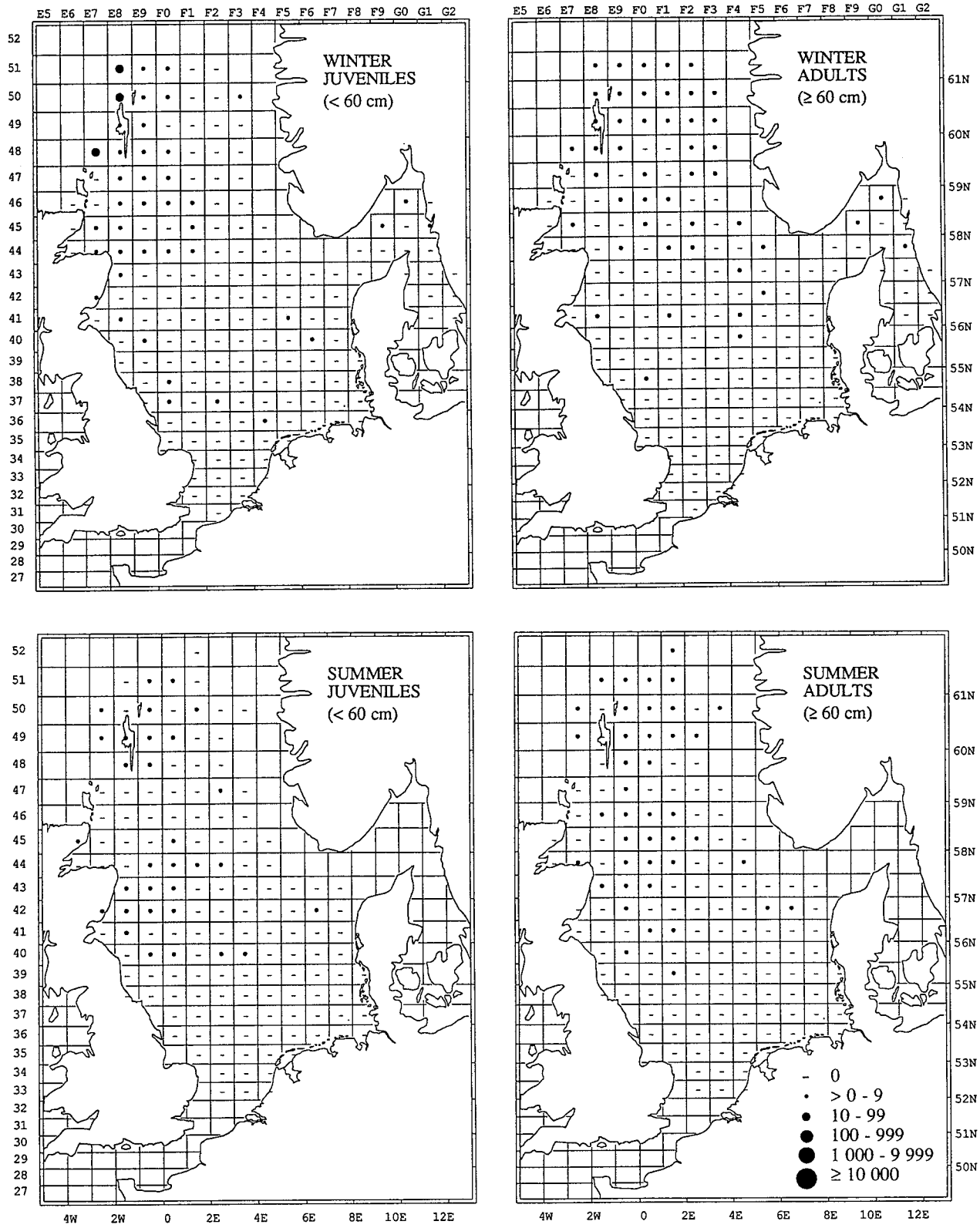
50. *Molva molva*
Family Gadidae



E. Ling, F. Lingue franche, D. Leng, DK. Lange, N. Lange, NL. Leng, S. Långa



Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

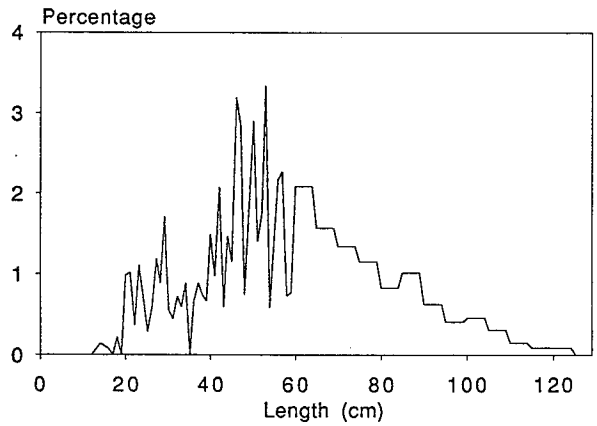
Spatial distribution

Ling, typical inhabitants of the continental deep sea banks [1], were mainly caught in the northern, deeper parts of the North Sea, although they occasionally turned up further south in shallower water. No clear seasonal or size-related differences in spatial distribution can be seen.

Ling are usually found on or near stony ground and wrecks and may be more abundant than indicated by trawl surveys.

Length composition

Ling of almost every length class were caught. This gadoid is reported to reach 200 cm in total length [2], but it is unlikely that many individuals of that length are part of the 'larger-than-125 cm' size class. Recently, a 155 cm ling was caught in the Norwegian Deep [3].



Length-frequency distribution of ling during winter.

Life history

Ling reach a length of approximately 30, 60, and 110 cm at the age of 2, 5, and 10 years. The females grow faster and to a larger size than the males. Mature specimens are found in both sexes from 70 cm length onwards [4]. The fecundity of ling is legendary, with large females producing tens of millions of pelagic eggs [1].

Knowledge on the feeding ecology of this species is limited because most individuals captured with trawls and lines have everted stomachs, but it is assumed that, apart from cephalopods, crustaceans, and echinoderms, fish account for an important part of the ling's diet; ling may be a heavy predator on both benthic and pelagic fish species [3,5].

Population and exploitation

This fish occupies a wide depth range during its life history. Young individuals are often seen in shallow waters by divers, and small specimens (20 cm) have been reported from shallow eastern Kattegat waters with a stony and hard bottom [1]. During spring and early summer, mature ling inhabiting the continental shelf south of the British Isles rise from deeper waters and aggregate to spawn near the 200 m isobath [6].

Ling are of considerable economic importance, being caught with trawls and, in particular, long-lines. Main fishing areas are along the continental shelf west of the British Isles, in Faroese waters, and along the Norwegian coast. Yearly North Sea ling catches during the early 1980s, 16,000 t, were a little higher than the 1900 – 1980 average of 7500 t. Analysis of the Faroese ling catches during 1971 – 1987 shows a continuously declining stock coinciding with an increasing fishing effort [5].

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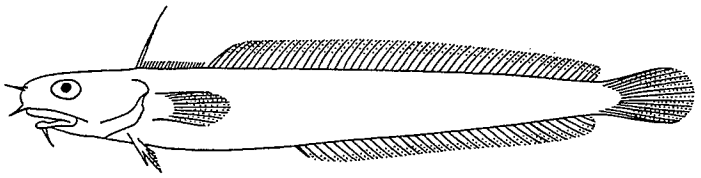
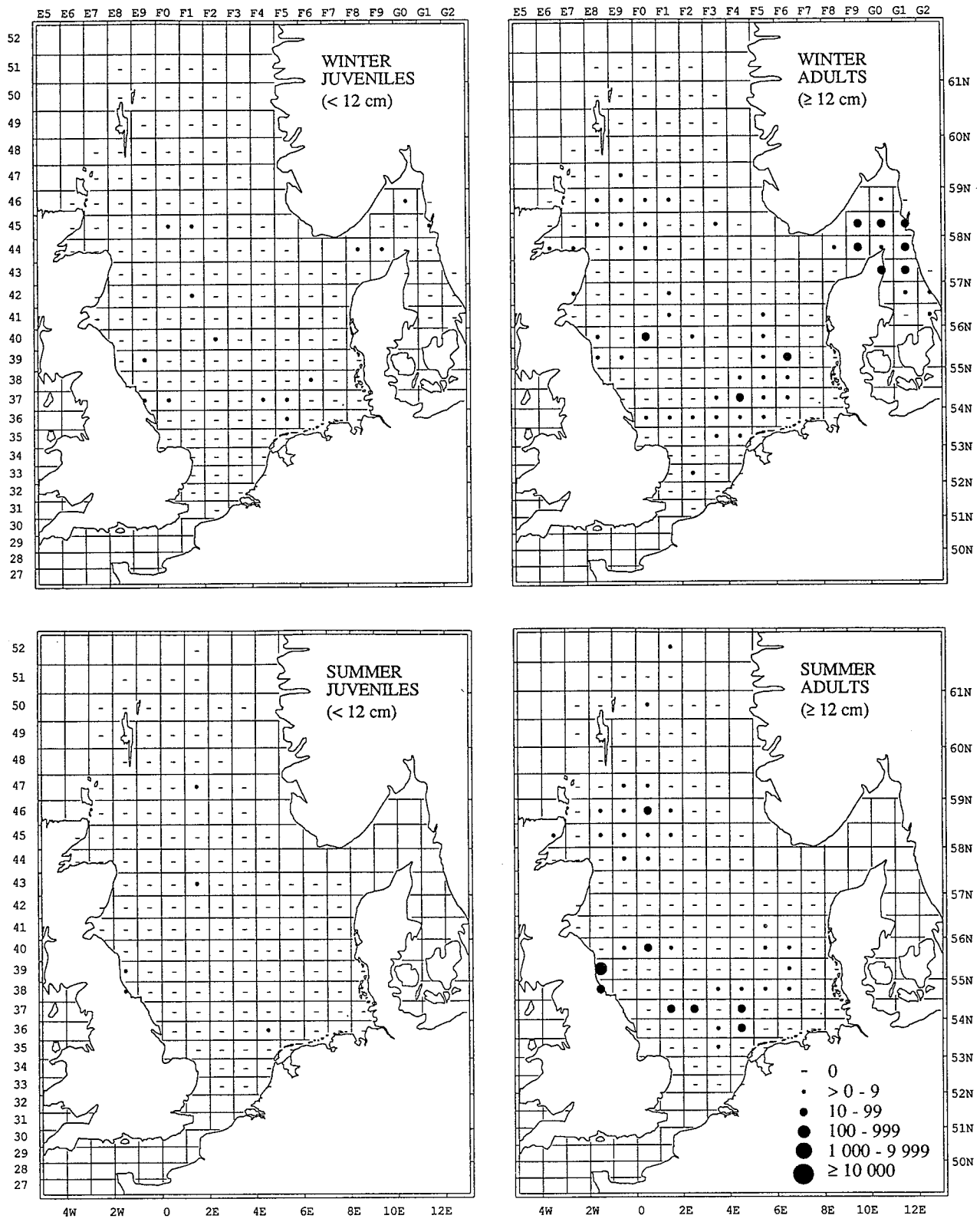
51. *Rhinonemus cimbrius*
Family Gadidae



E. Four-bearded rockling, F. Motelle à quatre barbillons,
D. Vierbärtelige Seequappe, DK. Firetrådet havkvabbe,
N. Firetrådet tangbrosme, NL. Vierdradige meun,
S. Fyrtömmad skärlånga



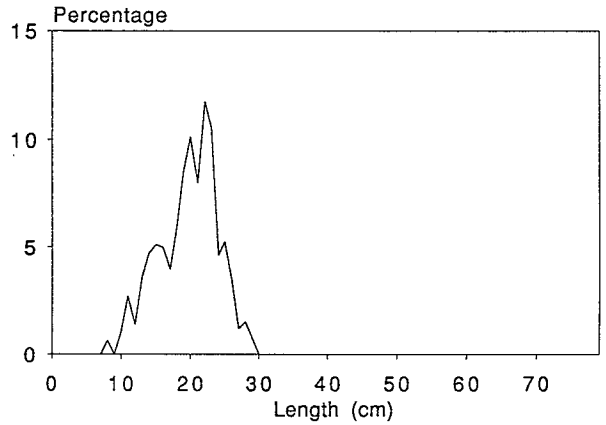
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

This was the most frequently caught rockling species in the *Atlas* surveys. This species is thought to prefer soft mud or sand [1], which probably accounts for its decidedly patchy distribution in the North Sea. Four-bearded rockling occurred in low densities all over the area, in both shallow and deep waters, and were very abundant locally. Relatively thinly populated areas were found in the central and northernmost parts of the North Sea, whereas the Skagerrak and Kattegat were comparatively densely populated.

Length composition

Almost the full length-range of four-bearded rockling was caught during the surveys.



Length-frequency distribution of four-bearded rockling during winter.

Life history

The diet of specimens from the Norwegian Deep is similar to that from other areas and consists mainly of crustaceans (such as decapods and mysids) and polychaetes, but gobiid fish and bivalves are also eaten. An important proportion of the prey species can be categorized as animals which live and swim just above the bottom, or live in the surface layer of the sediment [2].

Four-bearded rockling are reported to reach sexual maturity at the age of three years when they are approximately 15 cm long. A length of 20 cm is attained at the age of five. They seldom grow older than nine years [3].

The eggs of four-bearded rockling are pelagic.

Population and exploitation

The occurrence of pelagic juveniles off Plymouth indicates that spawning is very prolonged, between May and October [4]. Larval and early juvenile stages of rocklings in general can be found in large numbers near the surface [5,6], and 'are so sought after by predacious forms as mackerel and bass, that they have been termed "mackerel midges" ' [7]. The 'mackerel midge' has brilliant silver sides and belly and a clear green back.

Four-bearded rockling is of no economic importance.

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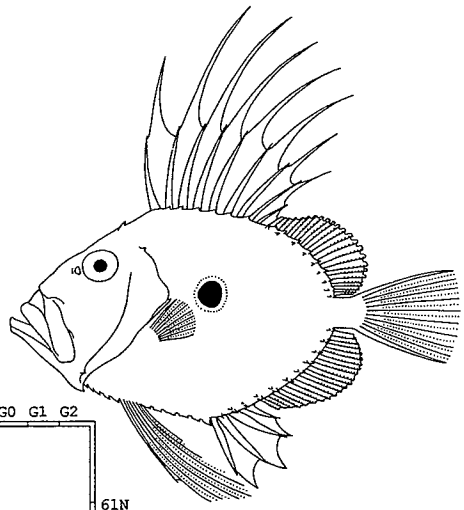
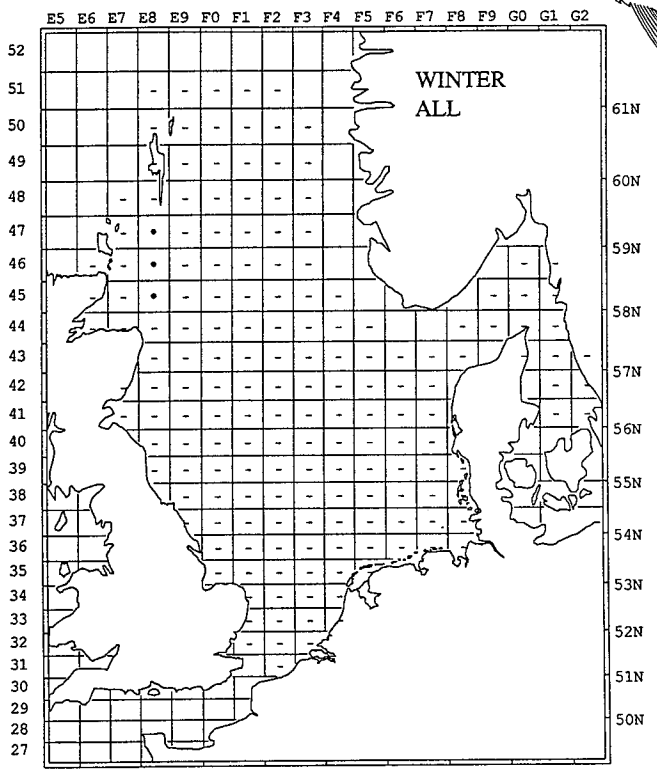
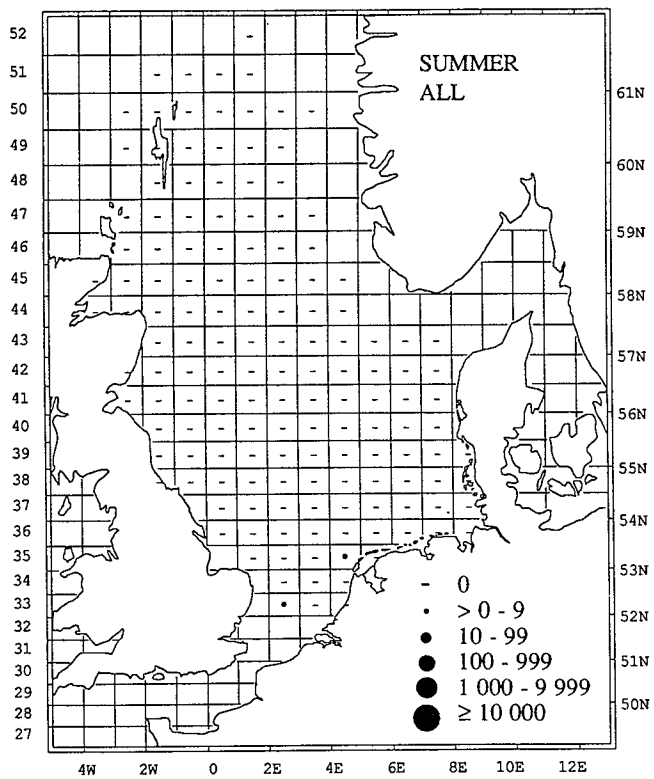
7. Day, F. 1880-1884. The fishes of Britain and Ireland, Vol. I. Williams and Norgate, London. 336 pp.

52. *Zeus faber*
Family Zeidae

E. John Dory, F. Saint Pierre, D. Heringskönig,
DK. Sankt Petersfisk, N. Sankt Petersfisk, NL. Zonnevis,
S. Sanktpersfisk







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

John Dory is a southern species that regularly enters the North Sea. In winter a few specimens were caught in the northwestern North Sea, in summer a few in the Southern Bight.

Length composition

The length of the seven specimens caught varied between 21 and 33 cm. Females are said to reach a length of 66 cm [1].

Life history

This fish measures 9 – 13 cm in its first winter [1]. Succeeding age classes caught in the coastal waters of the Netherlands during August measured 20, 30, and 40 cm respectively [2]. Sexual maturity is usually attained in the fourth year of life [1].

The food of John Dory consists mainly of fish, including gobies, herring, sandeel, horse mackerel, and pilchard [2]. The prey is suddenly engulfed by protruding the very mobile jaws [1]. Small (< 8 cm) specimens in the Mediterranean feed almost exclusively on zooplankton [3].

Population and exploitation

Spawning takes place during summer in the western part of the English Channel and in the Irish Sea, from June until August [1]. From these areas mainly juvenile fish (one, two, and three years old) wander into the North Sea. In the coastal waters of the Netherlands juvenile Dories are mostly caught from June through November [2].

This fish is not caught in sufficient quantities in the *Atlas* area to be of much economic importance. However, the small quantities that are landed fetch a high price.

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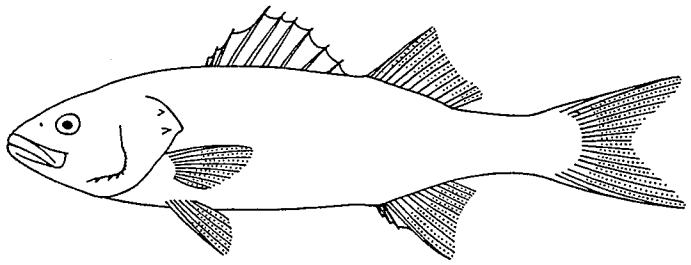
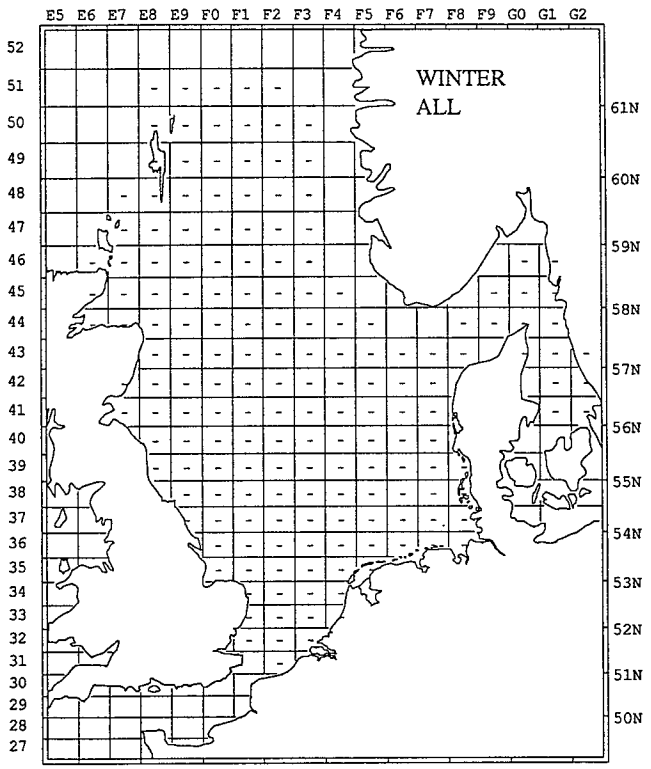
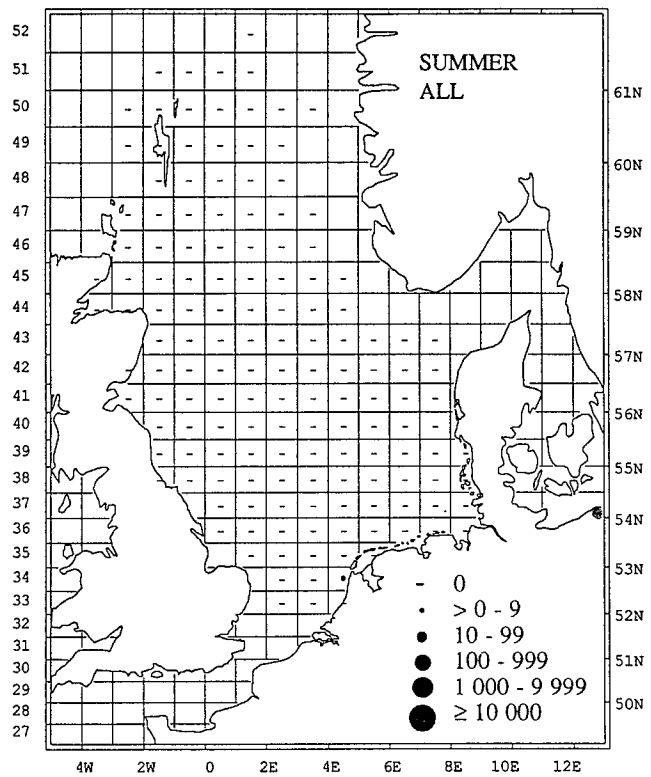
53. *Dicentrarchus labrax*
Family Moronidae

E. Bass, F. Bar, D. Wolfsbarsch, DK. Bars,
N. Havåbor, NL. Zeebaars, S. Havsabborre







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

There were no occurrences of bass during the winter surveys and only a single catch during the summer surveys. This is consistent with a species near the northern extreme of its range, but the fact that bass are fast swimming, semi-pelagic, and predominantly coastally distributed will undoubtedly have influenced the catches.

Length composition

The fish caught was 39 cm long.

Life history

Bass are mainly distributed from approximately 30°N to 55°N in the Northeast Atlantic and occur only rarely in the coastal areas of the central and northern North Sea [1]. At this cool extreme of their environmental range, males mature at 31 – 35 cm (4 – 7 years of age) and females at 35 – 45 cm (5 – 8 years). Bass may live longer than 24 years and reach a length of 100 cm and a weight of around 10 kg [2,3,4]. The adults are opportunistic feeders, consuming a variety of organisms including crabs, sandeels, and other small fish [5].

Population and exploitation

Egg surveys indicate that spawning occurs throughout the English Channel. Some eggs may be spawned in the southern North Sea [6]. In addition, the planktonic eggs and larvae may be transported from the eastern Channel into the southern North Sea by residual currents, but this has not been confirmed.

During development bass larvae move towards estuarine nursery areas [7,8,9]. The Thames estuary is probably the most important nursery in the *Atlas* area. The fish remain in the vicinity of the nursery until they reach maturity. After maturity winter migrations take place to the south, as far as the western English Channel [10], with spawning taking place on the return journey during February – June [6]. Adult fish then move to summer feeding areas in the southern North Sea.

The population is characterized by a predominance of juvenile fish (younger than six years old) found inshore, and an adult stock which contains a relatively high proportion of fish older than fifteen years.

Bass are commercially exploited in inshore and estuarine waters of the southern North Sea with gillnets, lines, and trawls. They are highly regarded by sport fishermen and the high prices paid for this species has encouraged some anglers to sell their catches.

References

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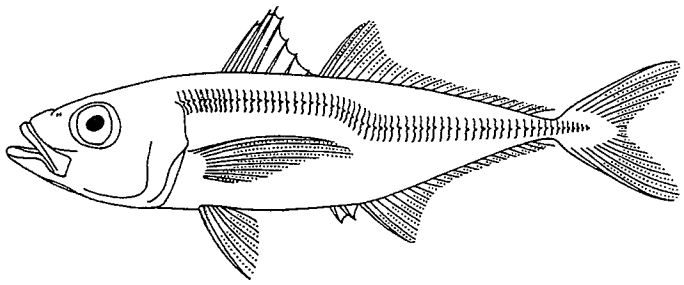
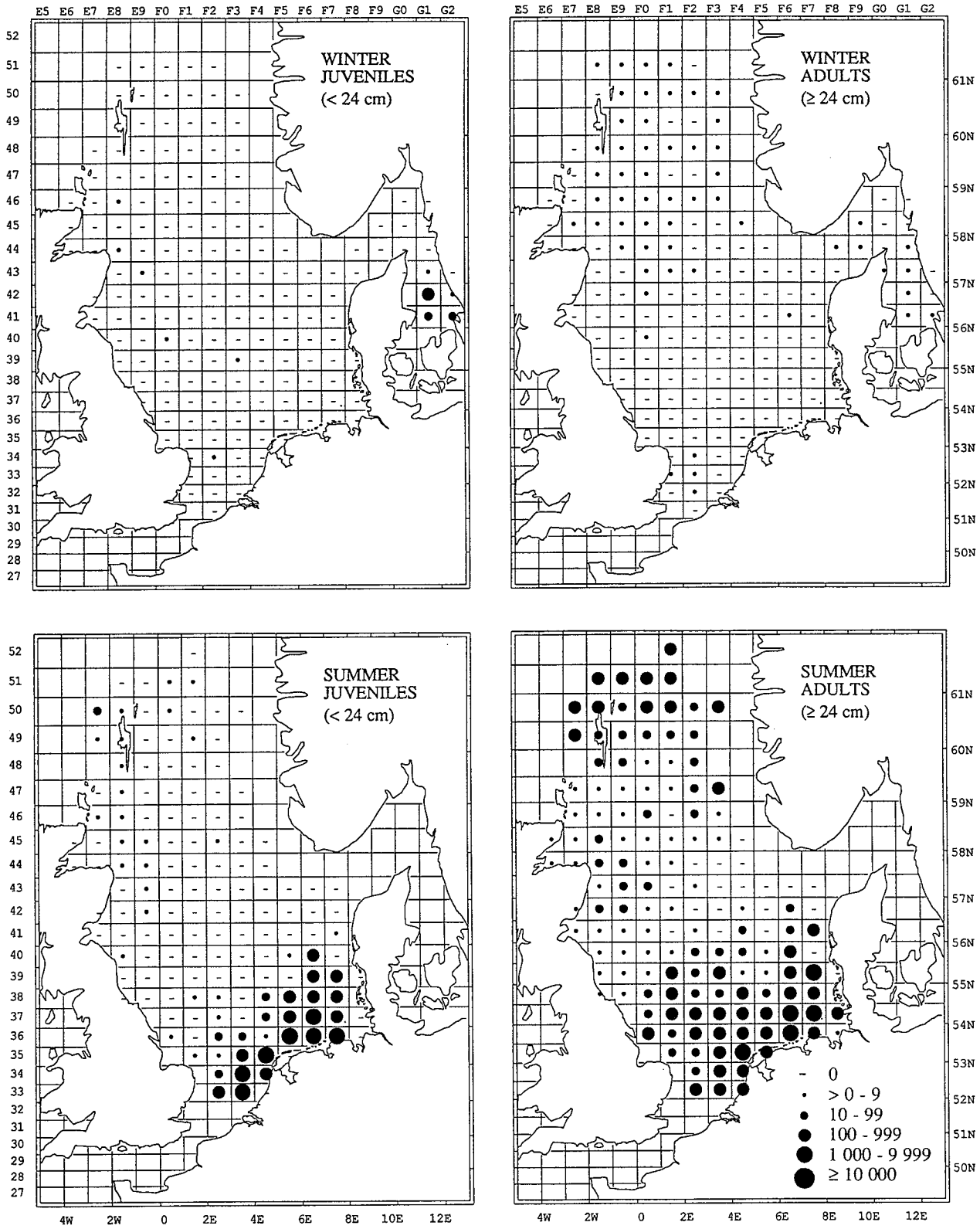
54. *Trachurus trachurus*
Family Carangidae

**E. Horse mackerel, F. Chinchard, D. Stöcker,
DK. Hestemakrel, N. Taggmakrell, NL. Horsmakreel,
S. Taggmakrill**





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Horse mackerel or scad, a southern species, was caught in negligible numbers during winter. Most of the winter catches were made in the northern part of the *Atlas* area and consisted mainly of larger specimens. Some hauls made in the Kattegat, however, contained considerable numbers of immature horse mackerel.

During summer, densities of both immature and mature horse mackerel had increased considerably. The mature fish, which were caught all over the area during this season, occurred in high densities in the southern North Sea, particularly in the German Bight and in the northernmost part of the North Sea. Immature horse mackerel were largely confined to the southern North Sea. Catch rates of immature specimens tended to increase toward the shore, but this pattern was less evident for the adults.

Length composition

Because horse mackerel were nearly absent from the survey area during winter, summer length distributions are given. These have not been corrected for differences in fishing gear efficiency.

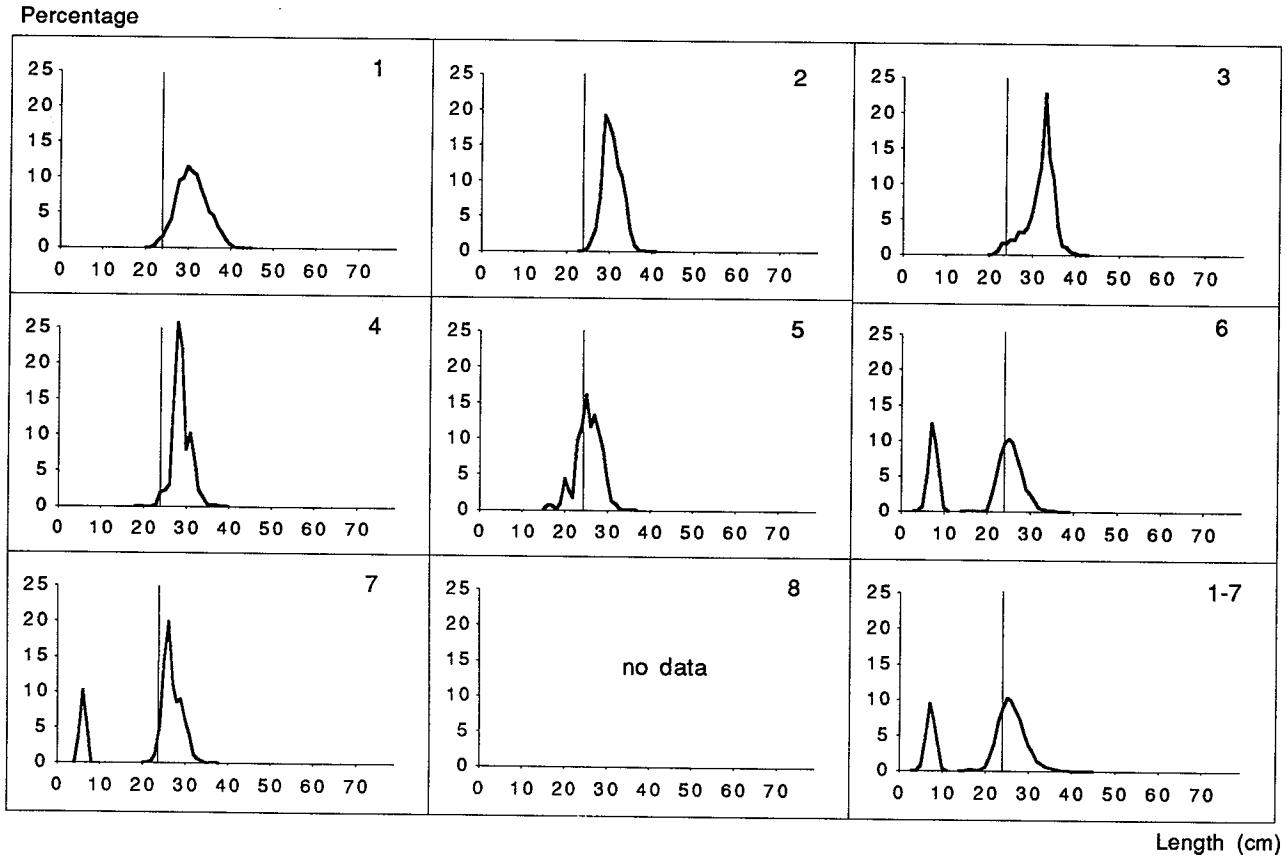
One single size class of mature horse mackerel dominated the catches in the northern North Sea (area 1), whereas catches in the south (area 6 and 7) were made up of two distinct size classes of immature (up to 10 cm) and mature (20 – 30 cm) specimens. Curiously, no fish of intermediate length (10 – 20 cm) were caught in these areas.

Life history

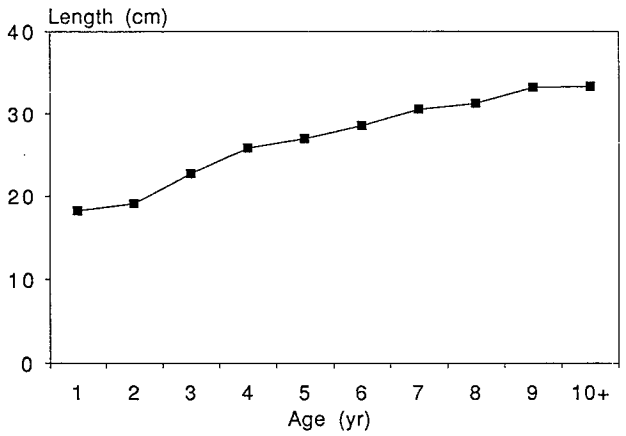
No recent data are available on the fecundity of North Sea horse mackerel. However, females from west of the British Isles produce up to 1655 eggs per gram body weight and an average-sized seven-year-old female (220 g, 30 cm) would produce 364,000 eggs during the spawning season [1,2].

It takes the eggs three to four days to hatch at temperatures recorded at the surface of North Sea spawning grounds [3]. The newly hatched larvae measure 2.5 mm [4], and the earliest occurrence of pelagic 0-group fish in the English Channel and the Southern Bight is in mid-August. By then they measure 4.4 cm and at the end of the year they have reached a length of 12 cm [5].

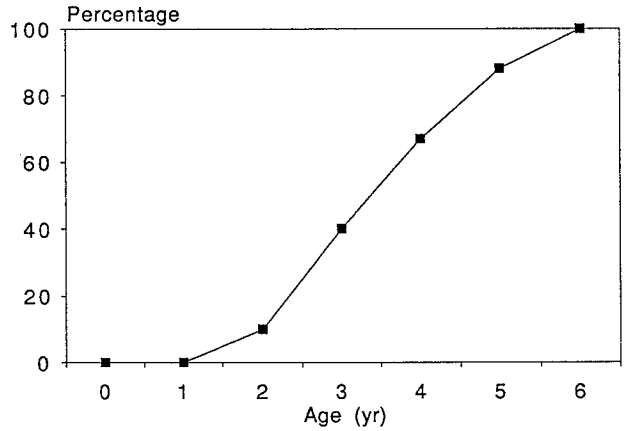
Horse mackerel is a slow-growing species and ages of thirty years and older have been reported. Growth, and the age at which fish become mature, show larger fluctuations than observed in other species. This is probably attributable to the extremely large fluctuations in year-class size [2].



Length-frequency distribution of horse mackerel by roundfish area during summer (length split indicated).



Mean length (cm) per age group of the western stock of horse mackerel in Dutch commercial catches during 1985 – 1987 [2].



Percentage of mature fish per age group for horse mackerel from European waters during 1985 – 1987 [2].

Horse mackerel from the English Channel has been classified as a pelagic feeder that preys on planktonic organisms such as euphausiids and copepods [5]. This is probably true for the smaller size classes, but larger horse mackerel become increasingly demersal, and small fish become more and more important in their diet [6]. For instance, 0-group herring, cod, and whiting (5 – 7 cm) were the major prey taken by 25 – 40 cm horse mackerel off the Danish coast [7].

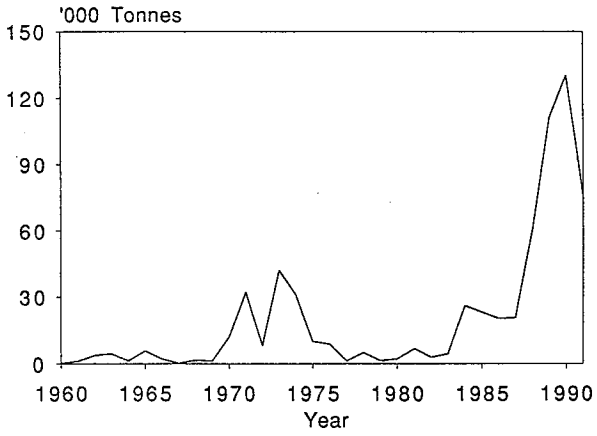
This fish may form compact shoals that reach from the bottom into mid-water during the day, whereas during the night they disperse and form a layer just off the bottom [5]. The range of the vertical migrations decreases during winter, when the level of activity is low [8].

Population and exploitation

North Sea horse mackerel spawn in May – July, close to the coasts of Belgium, the Netherlands, Germany, and Denmark. The stock disperses into the German Bight and adjacent areas after spawning, and, from October onwards, leaves the North Sea through the Dover Strait to spend the winter in the English Channel or the Celtic Sea [9]. It is during this period that the horse mackerel forms densely packed shoals near the bottom [6].

Apart from North Sea horse mackerel, a neighbouring western stock is recognized. The western stock spawns in the Celtic Sea in June, after which it makes a northerly feeding migration along the western edge of the British Isles. It eventually enters the North Sea from the north, and in October – November a return migration to the wintering areas to the southwest of Ireland commences [2,9]. The few northerly winter catches probably belong to this stock.

Immature horse mackerel do not join in the spawning migrations, as can be concluded from their absence in the summer length distributions in northern areas 1, 2, and 3 and in southern areas 5 and 6. The juveniles of up to 10 cm in length that were observed in the latter two areas hatched there and emigrated to the south later in the year.



North Sea landings since 1960

The economic importance of horse mackerel in northern Europe has increased greatly in recent years, but the fishery has mainly developed outside the *Atlas* area. Most of the fishery is directed to the western stock, which is very much bigger than the North Sea stock. In 1990 the spawning stock biomass of North Sea horse mackerel was estimated at 255,000 t, while the western stock was estimated to have a size of about 1,700,000 t. Catches of horse mackerel in the North Sea are a reflection of changes in fishing effort, of the changing numbers of western horse mackerel that enter the *Atlas* area, and of varying year-class strength of both North Sea and western stocks. Slightly higher catches of North Sea horse mackerel since 1984 are believed to be the result of the strong 1982 year class [6].

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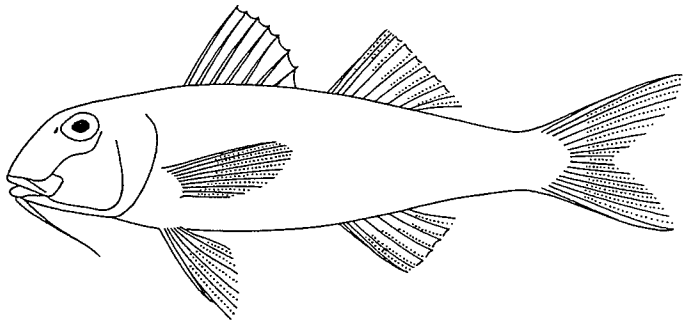
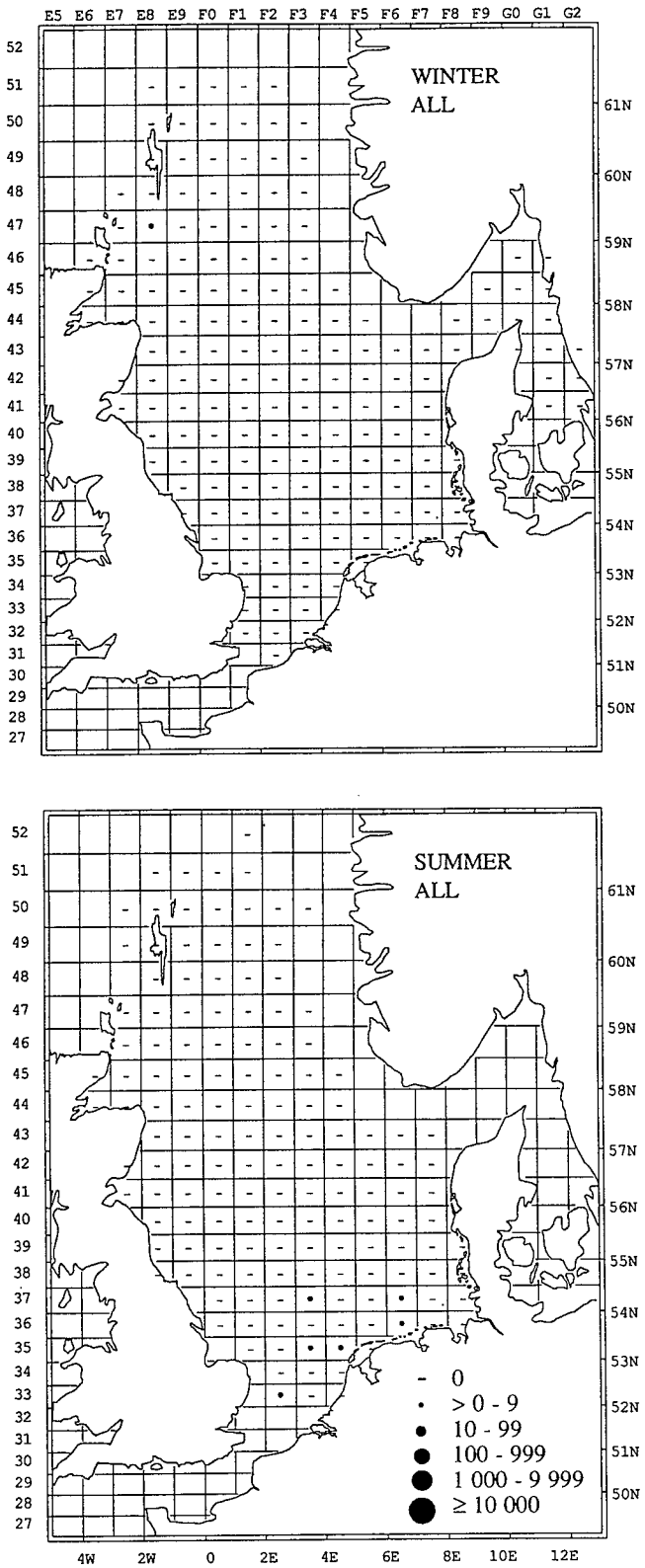
55. *Mullus surmuletus*
Family Mullidae

E. Red mullet, F. Rouget barbet, D. Meerbarbe, DK. Mulle, N. Mulle, NL. Mul, S. Mullus





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

There was only a single catch of red mullet in the northwestern North Sea during the *Atlas* winter surveys but a modest spread in the southeastern North Sea during summer. This is consistent with a warm-temperate species at its northern extreme.

Length composition

The few specimens caught measured 23 – 29 cm.

Life history

Both eggs and larvae of the red mullet are pelagic [1], as are the early young. These blue-backed and silvery-sided creatures live at the surface of the sea, feeding on larval crustaceans and copepods [2]. At about 5 cm they move towards the coast and take up adult coloration and a benthic existence. They are found in depths of 3 – 90 m on sandy or muddy bottoms but also at times on rocky ground [3].

This species uses its long barbels to probe the soft bottom in quest of food. It may vigorously excavate a pit to seize its prey, which consists entirely of benthic organisms such as shrimps, amphipods, polychaete worms, molluscs, and benthic fishes [2,3].

Red mullet may grow to 40 cm in length and weigh up to 1 kg, with females growing faster than males. They mature after one year and may live to ten years or older [2,3].

Population and exploitation

Red mullet is a warm-water species and occurrences in the North Sea are sporadic and usually during summer, indicating a northward migration at that time of year. There may also be an offshore migration during winter [2]. Off Plymouth, spawning takes place from May to July [1].

It is a much valued food fish, supporting fisheries in the southern Biscay area and the Mediterranean, but it is of minor importance in the North Sea.

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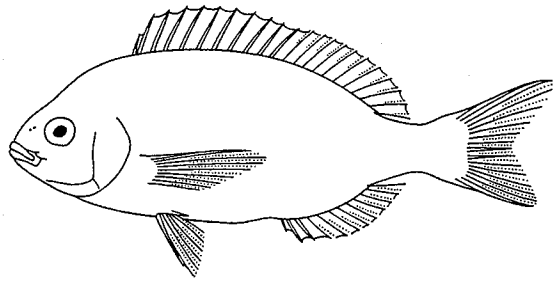
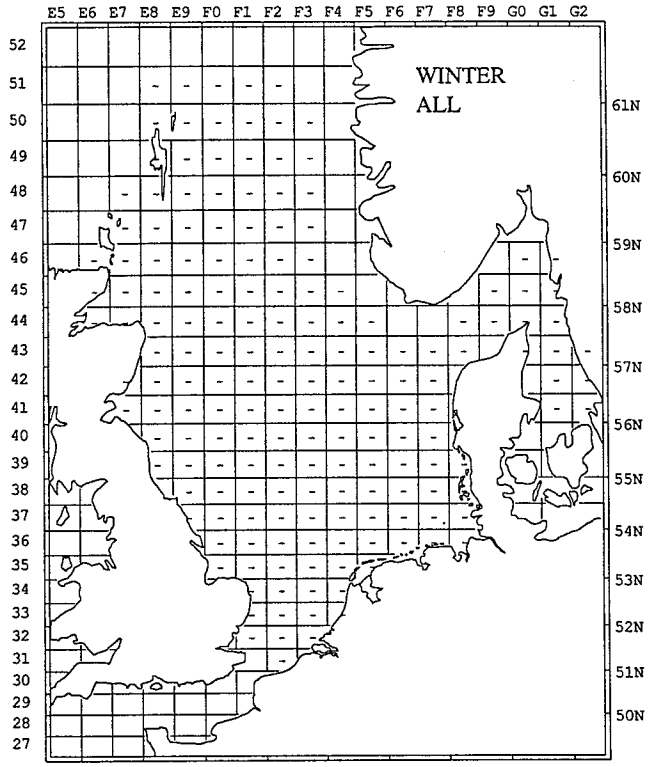
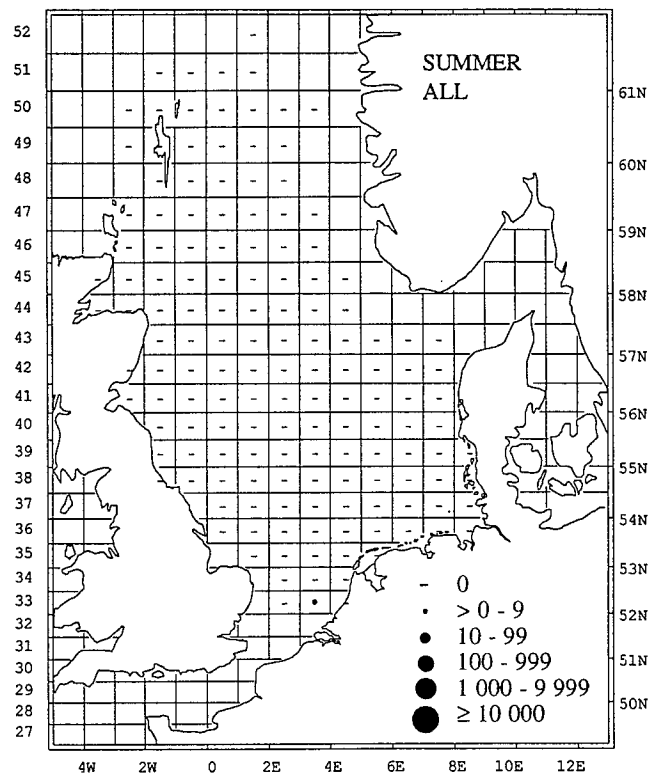
56. *Spondyliosoma cantharus*
Family Sparidae

E. Black sea-bream, F. Dorade grise, D. Streifenbrasse,
DK. Havrude, N. Havkaruss, NL. Zeekarper, S. Havsruda







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Only one specimen was caught, in rectangle 33F3 during the summer of 1986. Black sea-bream is most probably a summertime migrant, entering the survey area through the Dover Strait [1].

Length composition

The fish was 19 cm long.

Life history

Aquarium observations showed that the males make nests on the bottom in which the eggs are deposited. The eggs are kept clean and are guarded by the male, which, when excited, changes in an instant from the normal pale coloration to an intensely dark violet, and it is only then that it justifies the common name 'black' [2].

Individuals from the English Channel reach about 17 cm at the age of two, 25 cm at the age of four, 32 cm at the age of eight, and 40 cm at the age of sixteen years [3].

Population and exploitation

A school of 17-24 cm-sized black sea-bream, weighing 100 kg in total, was caught by a commercial vessel in the western part of the English Channel in early April 1992. The gonads of most of these fish were in an advanced stage of maturation, confirming that the local spawning period is in April and May [2]. Other species in this haul were mackerel, horse mackerel, and pilchard.

Black sea-bream is of no economic importance in the survey area. It is regularly caught by anglers in southern waters (for instance off the Canary Islands), where this species has its main distribution.

References

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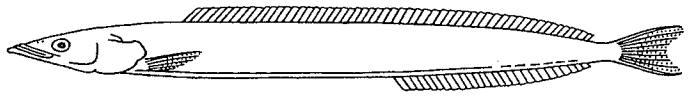
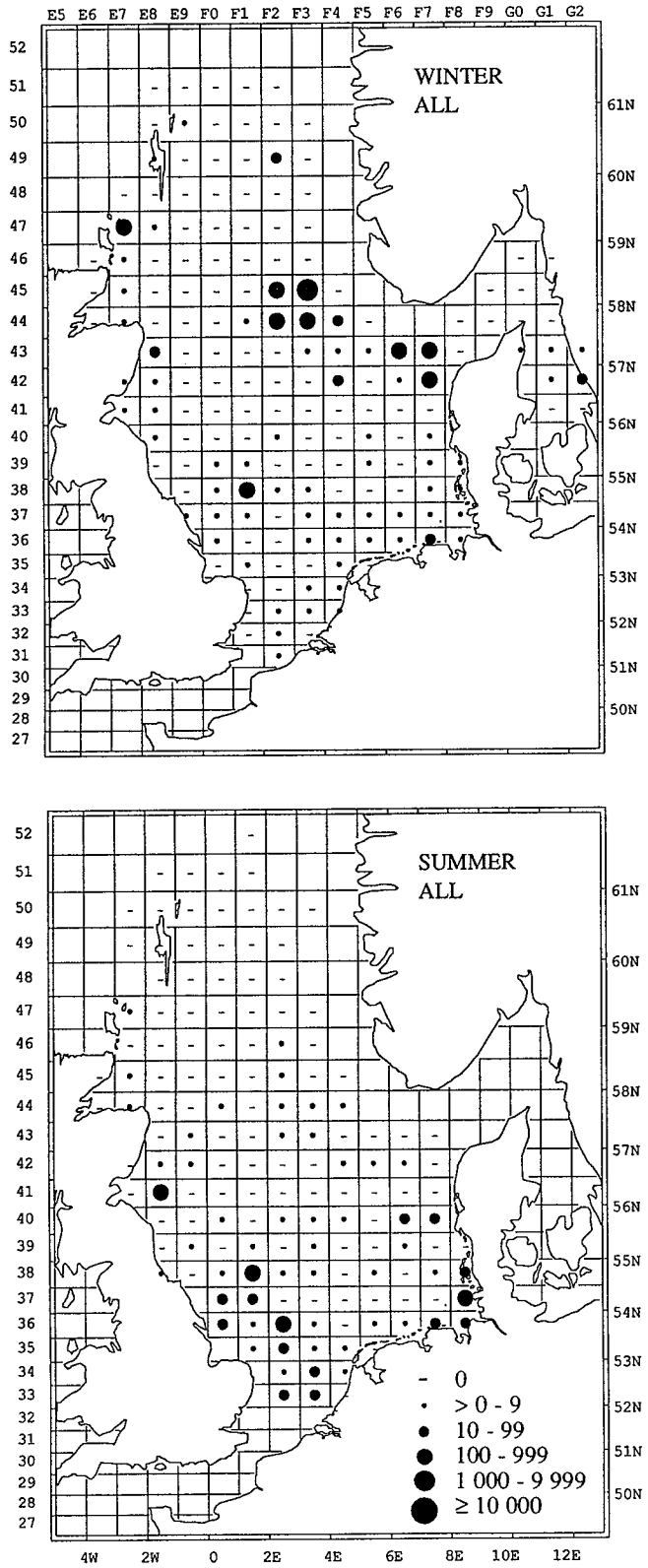
57. Ammodytidae
Family Ammodytidae

E. Sandeels, F. Lançons/Equilles, D. Sandaale, DK. Tobis,
N. Tobis, NL. Zandspieringen, S. Tobisar



Ammodytes tobianus



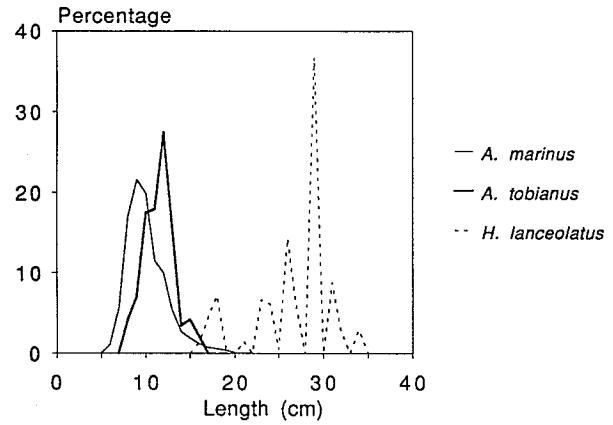
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

The catchability of sandeels is low owing to their needle-like shape and small size, and the maps shown here do not adequately reflect their abundance. Catches of all length classes have been combined, since they represent a mixture of species. Sandeels were caught in low numbers in the German and Southern Bights, off the English and Scottish coast, and near the edge of the Norwegian Deep. Catches per hour in the central parts of the North Sea, where there is a large fishery for sandeel, were in general very low.

Length composition

Although only a small number of the sandeel catches were identified to the species level, the figure clearly illustrates the difference in length range between lesser and greater sandeels.



Length-frequency distributions of lesser sandeels (*A. tobianus* and *A. marinus*) and the greater sandeel (*H. lanceolatus*) during winter.

Life history

Five species of sandeel occur in the North Sea. They are the common sandeel (*Ammodytes tobianus*), Raitt's sandeel (*A. marinus*), the smooth sandeel (*Gymnammodytes semisquamatus*), the greater sandeel (*Hyperoplus lanceolatus*) and Corbin's sandeel (*H. immaculatus*). Of these, three have been recognized during the 1985 – 1987 surveys (see: Length composition). The common and Raitt's sandeels are rather small fish (up to 25 cm) and are, together with the smooth sandeel, known collectively as the lesser sandeels; the greater sandeel grows to a considerably larger size (35 cm) and belongs, as is evident, with Corbin's sandeel, to the greater sandeels.

These pelagic, shoaling fish lie buried in the sand at night and emerge to hunt for prey during the day [1]. Specimens from the southwestern North Sea feed mainly on planktonic prey such as copepods and crustacean larvae. Polychaete worms, amphipods, and euphausiids are also eaten. The diet of the larger specimens of *Hyperoplus* includes fish, including other sandeels [2].

There are differences in the growth rates and longevity between individual species, although few sandeels reach an age of seven years. In addition, there can be great regional differences in growth within a species. For example, Raitt's sandeels at Shetland grow considerably more slowly than those in other parts of the North Sea.

Sandeels produce demersal eggs which adhere to the substratum.

Population and exploitation

The average sandeel biomass during 1983 – 1985 was estimated to be 1,750,000 t (cf. 1,300,000 t for herring) [3]. Apart from being a major prey for other fish species, sandeels are also of direct economic importance. Huge quantities are landed for reduction to meal and oil. Total North Sea catches have risen steeply from 100,000 t in 1960 to 1,000,000 t in 1989.

Although sandeels are believed to overwinter buried in the sand, they are found in fish stomachs and seal droppings during this season and alternative hypotheses are that the shoals are more compact during winter or that spawning behaviour (throughout the year, depending on species and latitude) negatively affects catchability of the mature specimens [2].

Being a major prey for other fish, seabirds, marine mammals, and man, this abundant group plays a very important role in the North Sea ecosystem.

Some concern has been expressed that the large-scale sandeel fishery is harming stocks of seabirds and predatory fish. In this respect much research has been done on the relation between the decline of breeding success of Shetland seabird populations and the abundance of sandeels [4].

References

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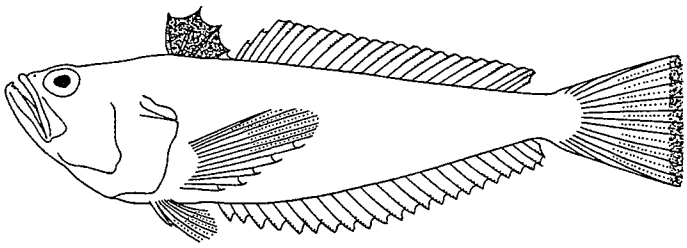
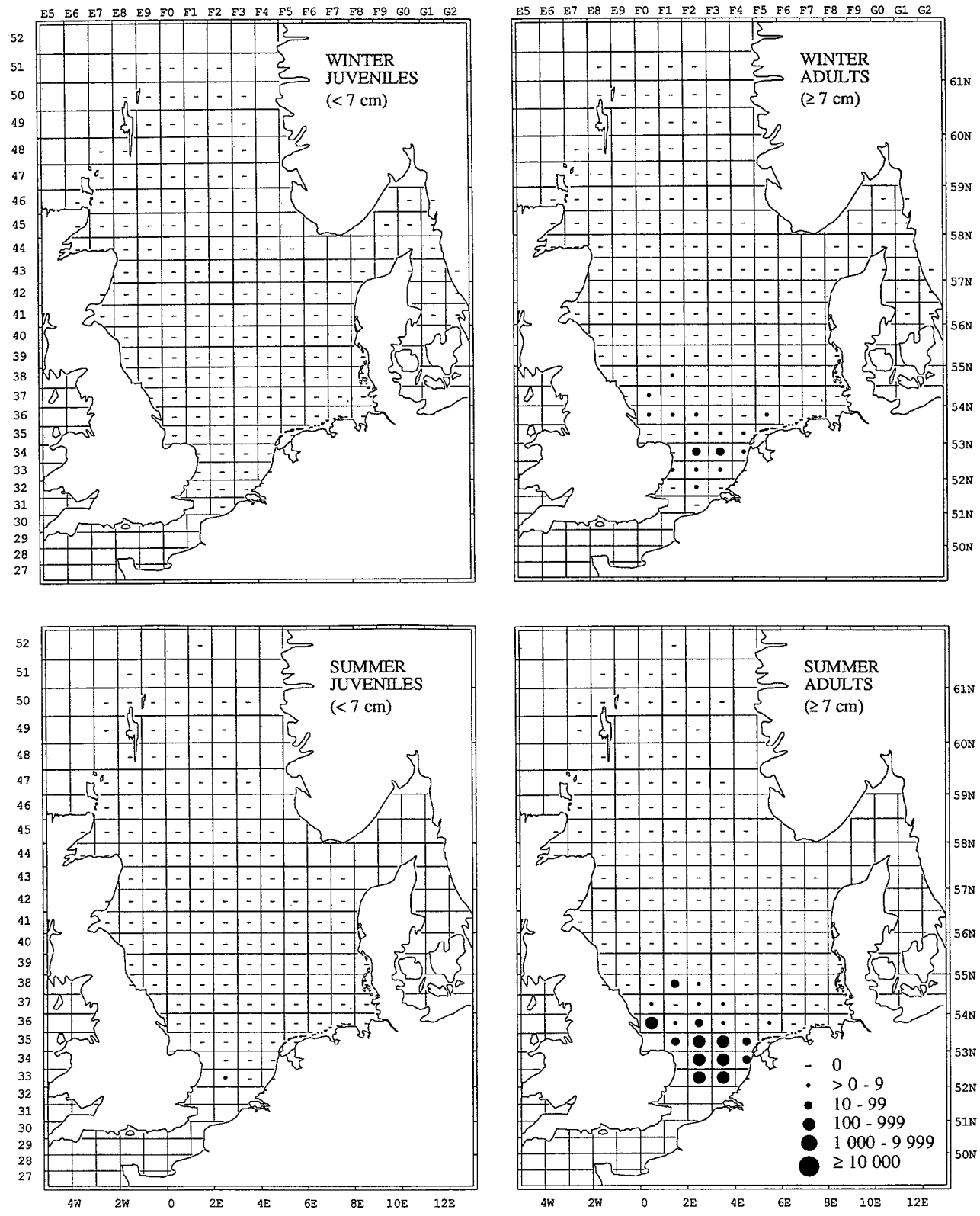
4. Bailey, R.S. 1991. The interaction between sandeels and seabirds – a case history at Shetland. ICES CM 1991/L:41. 12 pp.

58. *Echiichthys vipera*
Family Trachinidae



E. Lesser weever, F. Petite vive, D. Viperqueise, DK. Lille fjæsing, N. Dvergfjesing, NL. Kleine pieterman, S. Mindre fjärsing



Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

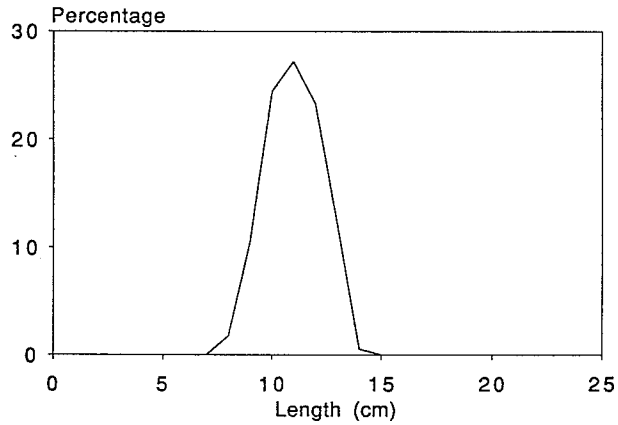
Spatial distribution

According to the survey data, the lesser weever only occurred in the southernmost part of the North Sea, but it certainly occurs in the Moray Firth and near Aberdeen and probably also along the Scottish north coast.

It is evident by reports of bathers being stung in the foot that this fish occurs in littoral zones of the area surveyed. Beach surveys with a small beam trawl confirm the presence of this fish along the Dutch coast during summer [1].

Length composition

Lesser weevers of 8 to 14 cm were caught during the winter surveys. The largest specimen, however, was caught during summer and measured 17 cm.



Length-frequency distribution of lesser weever during winter.

Life history

The lesser weever's main claim to fame is that it is, together with the greater weever (No. 59), one of the very few truly venomous fishes found in the *Atlas* area. This species has poison glands at the base of the first dorsal fin and on the gill covers, and it can inflict an extremely painful wound if it is trodden on or carelessly handled.

The lesser weever typically lies semi-buried in the sand. Lunging movements produced by the pectoral and caudal fins bring the fish up and underneath its prey, which is taken in the upwardly directed mouth and held by the numerous conical teeth [2]. Specimens from the southern North Sea feed almost exclusively on gobies (*Pomatoschistus* spp.), although crustaceans (such as mysids, *Crangon* spp., amphipods, and crabs), polychaete worms, and squid (*Sepiola* spp. and *Allotheutis* spp.) are eaten as well [3].

Growth is rather slow: lesser weevers in the southern North Sea take six years to reach a length of 13 cm [3].

Population and exploitation

Spawning occurs in summer, and densities of eggs off the Dutch, German, and Danish coasts are highest in June and July [4]. It is not clear whether the increased density of the larger individuals during summer is due to spawning migration, temperature-induced migration, or a higher catchability. It is suggested that the lesser weever 'migrates' into the sand, hibernating until the onset of warmer weather [5].

Lesser weever are of no economic importance.

References

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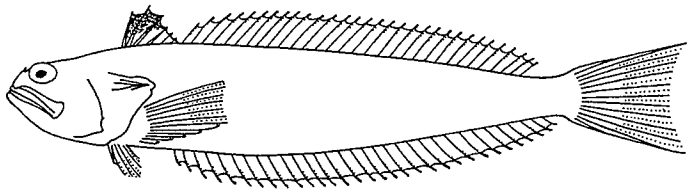
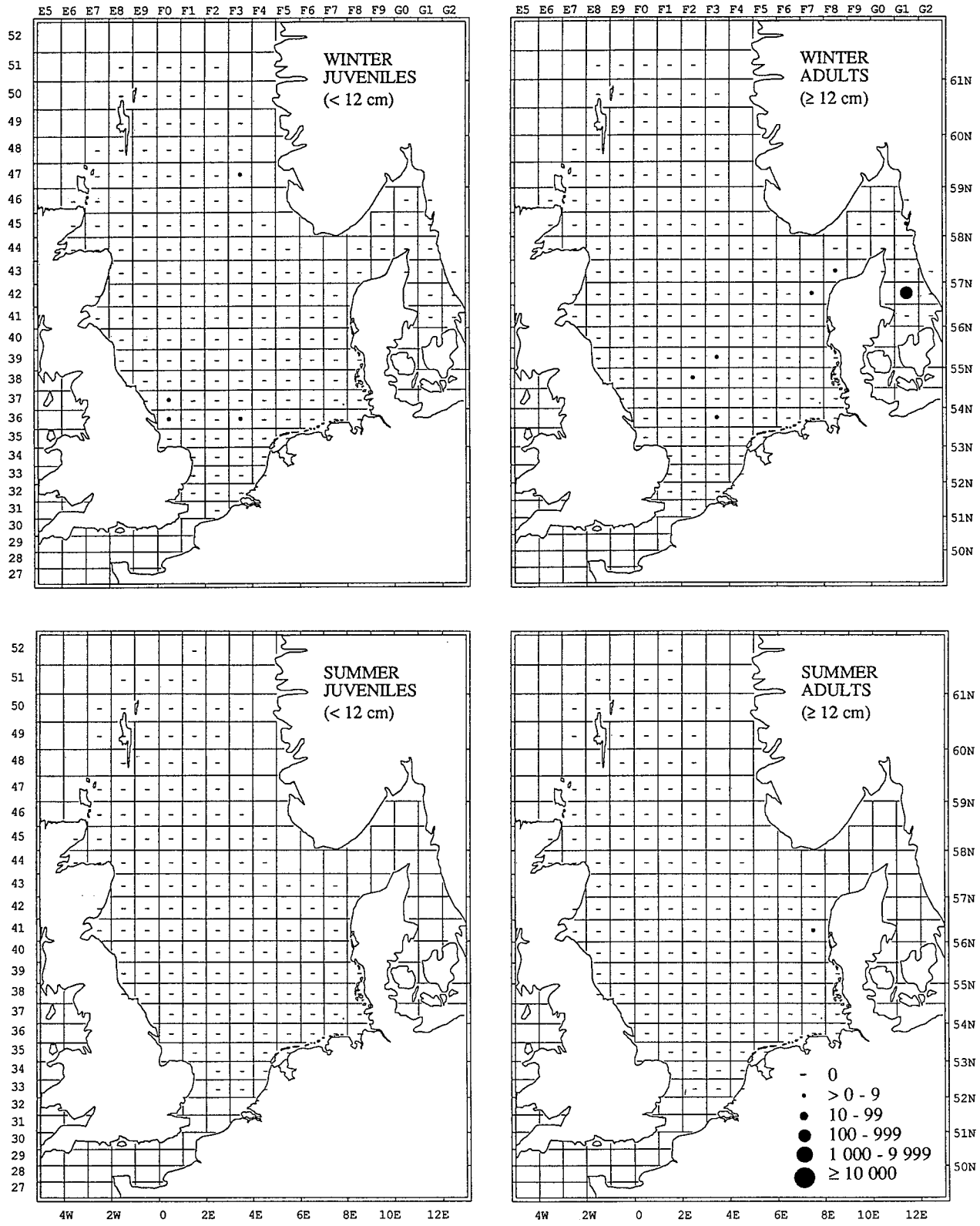
59. *Trachinus draco*
Family Trachinidae



E. Greater weever, F. Grande vive, D. Petermännchen, DK. Fjæsing, N. Fjesing, NL. Grote pieterman, S. Fjärsing



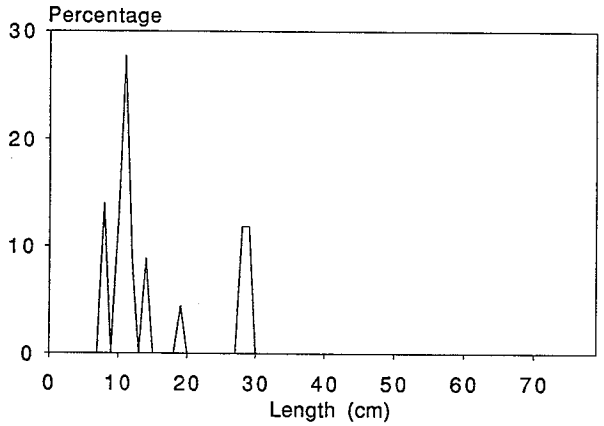
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

In the North Sea only a few, widely distributed, small catches of greater weever were made. An exceptional catch of almost 5000 was made in February 1987 in rectangle 42G1 (26 m depth) in the Kattegat. Similar high catches are unknown to the authors.

Length composition

The few greater weever that were caught in the North Sea measured between 10 and 15 cm in length. The fish caught in rectangle 42G1 (not shown) were in the range 16 – 30 cm.



Length-frequency distribution of greater weever during winter.

Life history

The greater weever and its close relative the lesser weever (No. 58) are both venomous fishes. The sting of the greater weever is more painful than that of the lesser weever and fishermen in particular may suffer severely after being stung while cleaning the nets [1]. Casualties on bathing beaches, however, are unlikely because of the greater weever's rarity in the survey area and its preference for relatively deep waters.

Biological data on this species are scarce, but the greater weever is likely to have many characteristics in common with the lesser weever.

Spawning is assumed to be in summer [2].

Population and exploitation

It has been suggested that this weever is under-represented in trawl data owing to its burrowing habits and occurrence in deeper waters [3]. However, this southern species disappeared from the Dutch commercial statistics after the severe winter of 1963 and has not returned since [2]. The weever is good to eat but is no longer caught in sufficient quantities to be of economic importance in the *Atlas* area.

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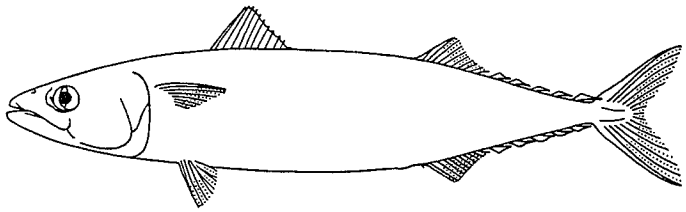
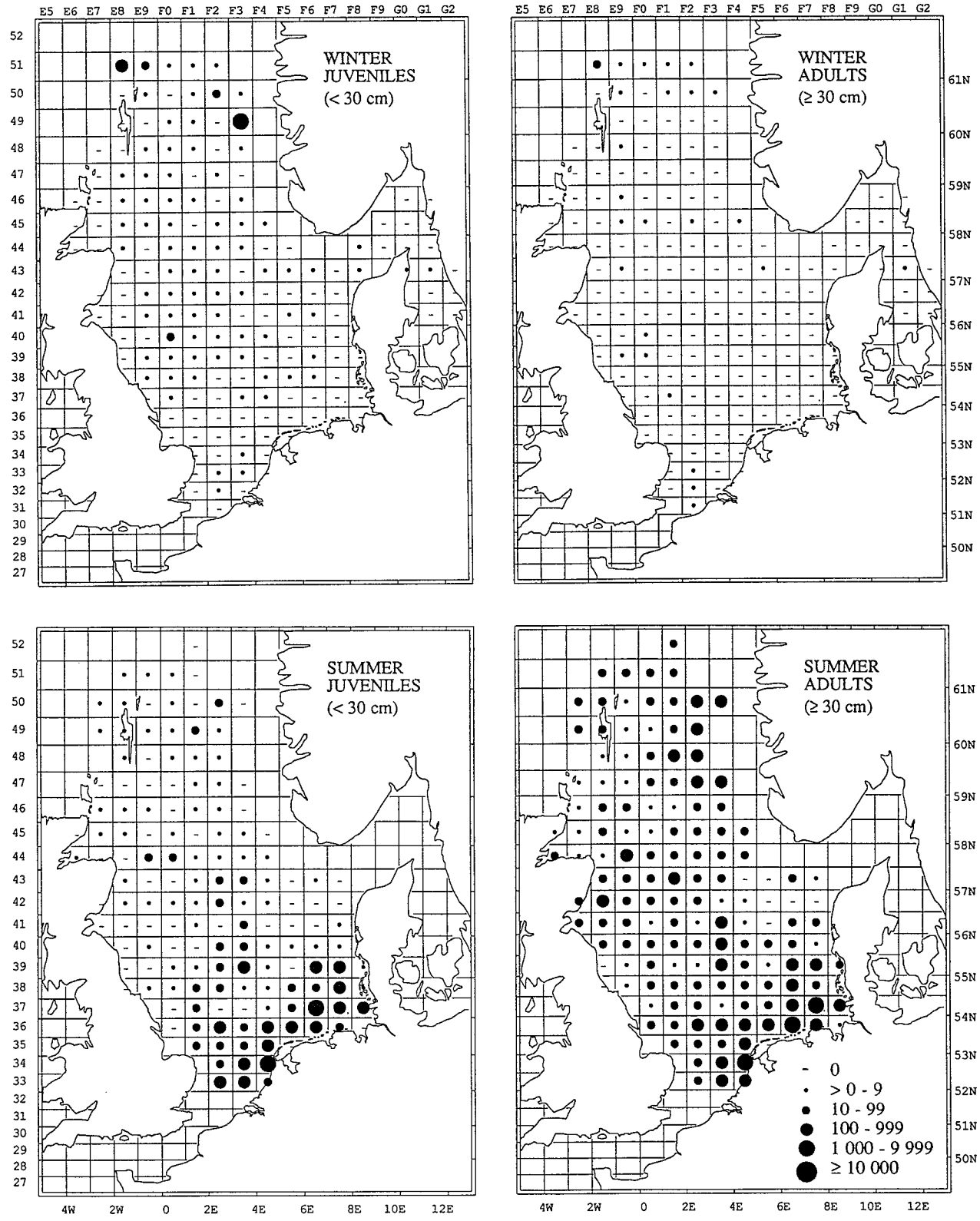
3. Wheeler, A. 1978. The fishes of northern Europe. Frederick Warne, London. 380 pp.

60. *Scomber scombrus*
Family Scombridae



E. Mackerel, F. Maquereau commun, D. Makrele, DK. Makrel, N. Makrell, NL. Makreel, S. Makrill



Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

During winter, densities of both mature and immature mackerel in the *Atlas* area were low. Most specimens caught were solitary, except those from rectangle 49F3, where 26,400 individuals were captured in one haul. These fish, which had a narrow size range of 20 to 23 cm, were about six months old. Mackerel is a classic example of a shoaling species; shoals of up to nine km long, four km wide, and 40 m deep, have been reported [1].

Numbers of immature and adult mackerel in the North Sea increase substantially during summer. The fish were caught throughout the area, and regions of relatively high abundance could be distinguished. Immatures occurred most frequently off the continental coast, whereas areas of high abundance for mature mackerel were found near the continental slope in the north, in the central part of the North Sea and, similar to the immatures, off the Danish, German, and Dutch coasts.

The maps probably do not give a realistic picture of the distribution because the survey gears may not be very efficient at catching this fast-swimming scombrid.

Length composition

Most mackerel have left the *Atlas* area by winter, and therefore length distributions by roundfish area are given for summer surveys. These have not been corrected for differences in fishing gear efficiency.

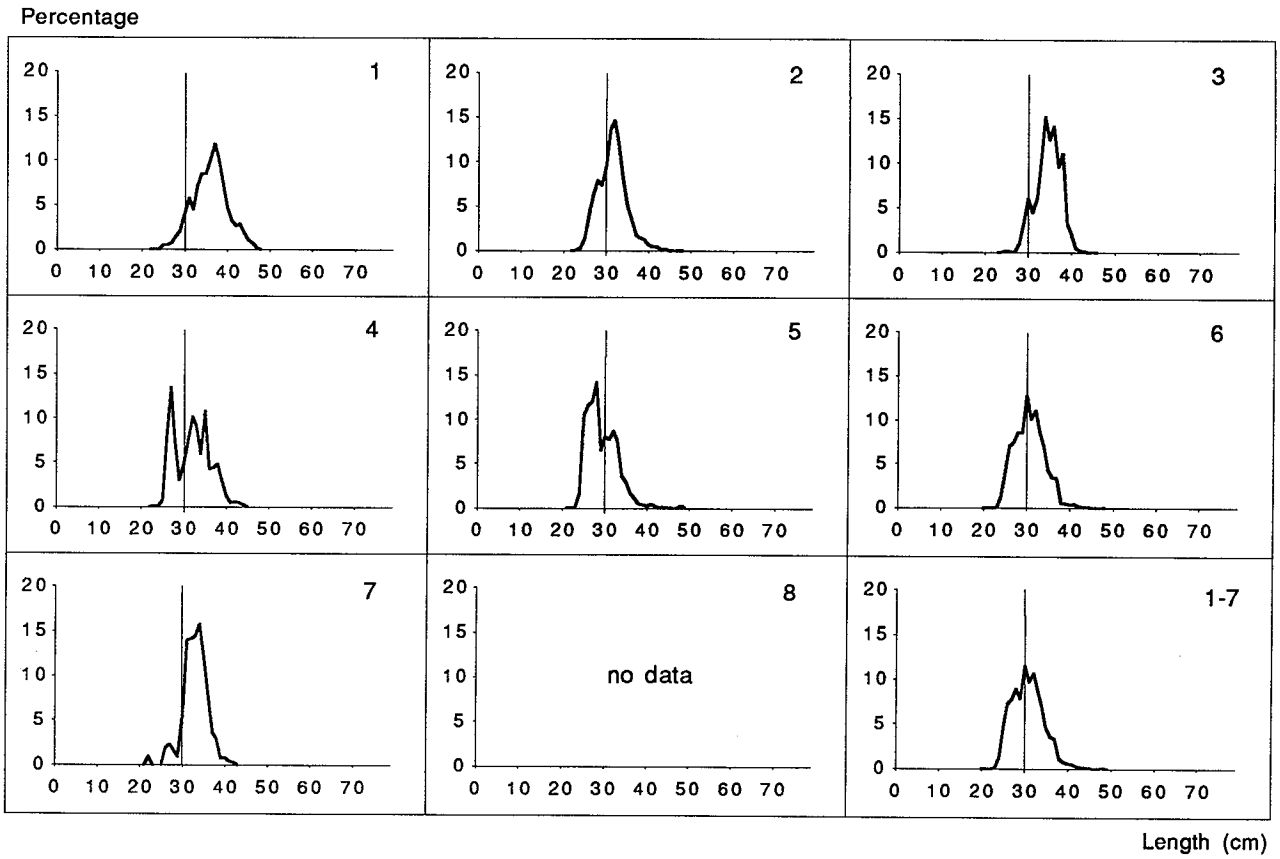
Catches in northern areas 1, 2, and 3 were characterized by a dominance of the larger (30 – 40 cm) size classes, while in southern areas (4, 5, and 6) the number of small mackerel (below 30 cm) was at least equal to the number of larger individuals. Area 7 was again dominated by the larger size classes.

Life history

Female mackerel shed their eggs in approximately twenty batches in the course of the spawning season [2]. The maximum number of ripe eggs for a 30 cm specimen is about 255,000 [2], or, assuming the weight for this female to be 200 g [1], 1275 eggs per gram body weight.

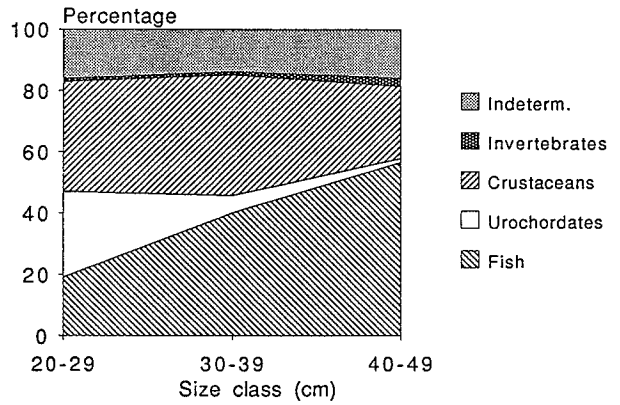
Pelagic eggs in the central North Sea were found up to 60 m below the surface, but the majority were taken in the upper mixed layer, above 26 m [4], and it is suggested that the adults concentrate in this warmer upper layer during spawning [1]. Larvae (< 5 mm) abound in the upper layers as well; during June and July highest numbers occurred at a depth of 6 – 8 m [4].

Mackerel of all sizes consume small planktonic prey such as copepods and euphausiids. However, fish, particularly herring, sprat, sandeel, and Norway pout, are eaten as well and constitute more than one third by weight of the diet of larger mackerel, on a yearly basis. The diet may vary by season and by area. Mackerel hardly feeds at all during the first quarter of the year, and while stomach

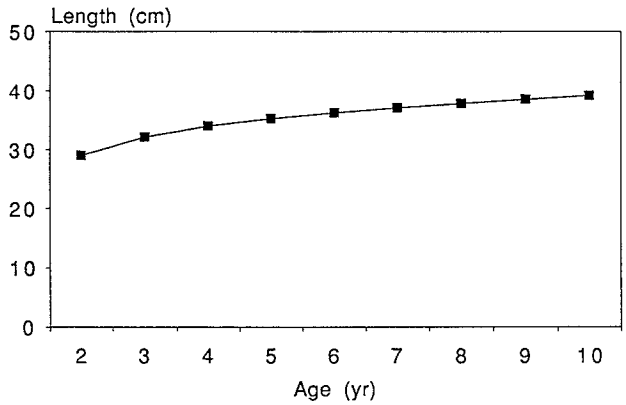


Length-frequency distribution of mackerel by roundfish area during summer (length split indicated).

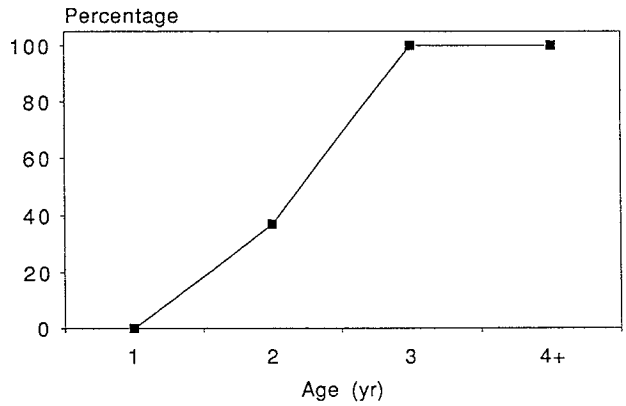
contents in the northwestern North Sea are generally dominated by euphausiids and copepods, fish are the most important prey in the southern North Sea [5].



Average stomach content as percentage weight by size group in the third quarters of 1981 and 1982 [5].



Mean length (cm) per age group of Norwegian catches of mackerel during 1960 – 1985 (parameters from [8]).



Percentage of mature fish per age group [9].

Growth is difficult to determine from catches because the mackerel is such a mobile, migratory species, that it is by no means certain that catches at a particular site, even when they are taken only a short time apart, are sampling the same component of the population. Apart from time of year and site of catch, length-at-age also depends on year-class strength [8]. Estimates of the percentage of mature two-year-old fish vary considerably from year to year [9,10].

This species is designed for very fast swimming. Mackerel in aquaria were found to have a maximum sustained swimming speed of up to 3.5 body lengths per second, which is almost 4 km/h for a 30 cm fish [6]. The 1200 km covered in thirteen days by a tagged specimen illustrates the capacity of this species to undertake long migrations [1].

Population and exploitation

It is generally assumed that mackerel caught in the North Sea belong to two different stocks. The Western stock inhabits a vast area to the south, west, and north of the British Isles, near the continental slope. After spawning in areas to the southwest of the British Isles, between March and July, most of the spent fish migrate to summer feeding grounds in the Norwegian Sea and the northern North Sea, where they mix with the North Sea stock. Western stock mackerel, predominantly smaller individuals, also enter the North Sea through the English Channel. North Sea mackerel spend the winter in deep waters close to the shelf edge to the west and north of Shetland and on the edge of the Norwegian Deep. They migrate south in spring to spawn in the central part of the North Sea from May to July [1,7]

Annual North Sea catches rose enormously after the introduction of the purse seine net in the northern North Sea in 1964, but since the 1967 climax of 900,000 t and a temporary revival in 1973 (a catch of 320,000 t due to the last successful year class of 1969) catches dropped to an extremely low level in the 1980s [10]. Currently, mackerel catches in the North Sea depend to a large extent on immigrating Western mackerel.

References

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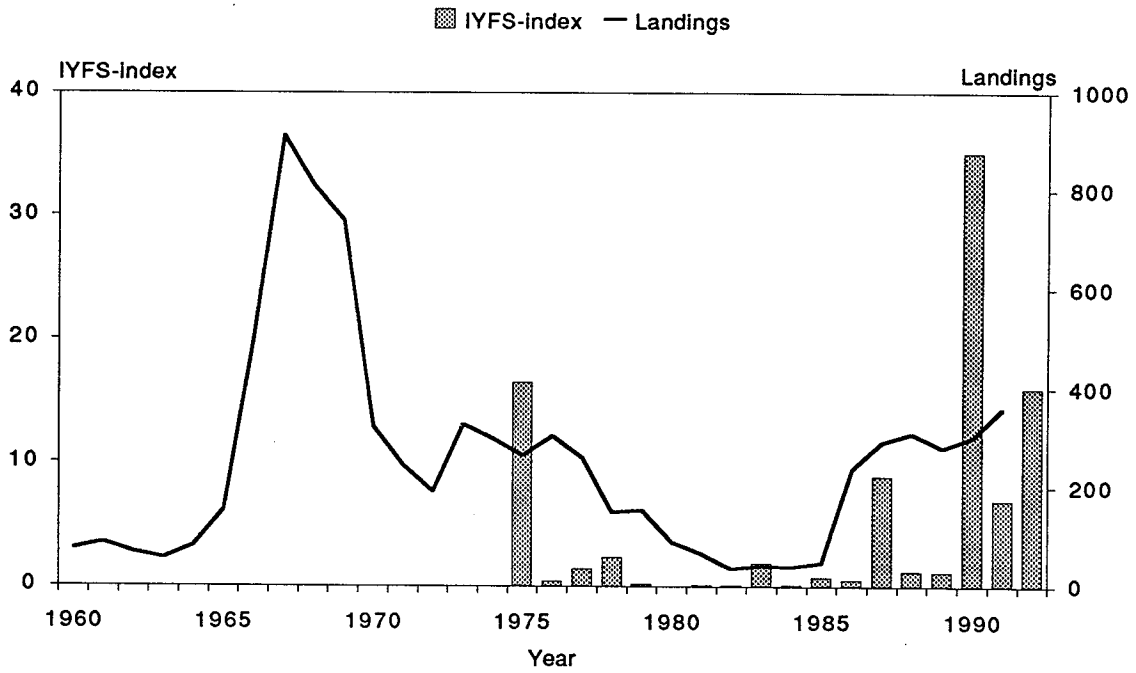
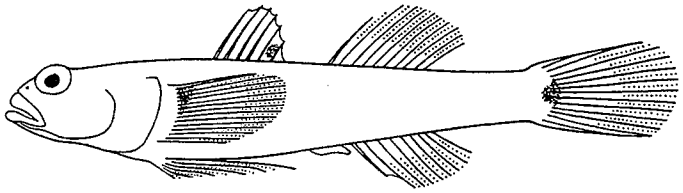


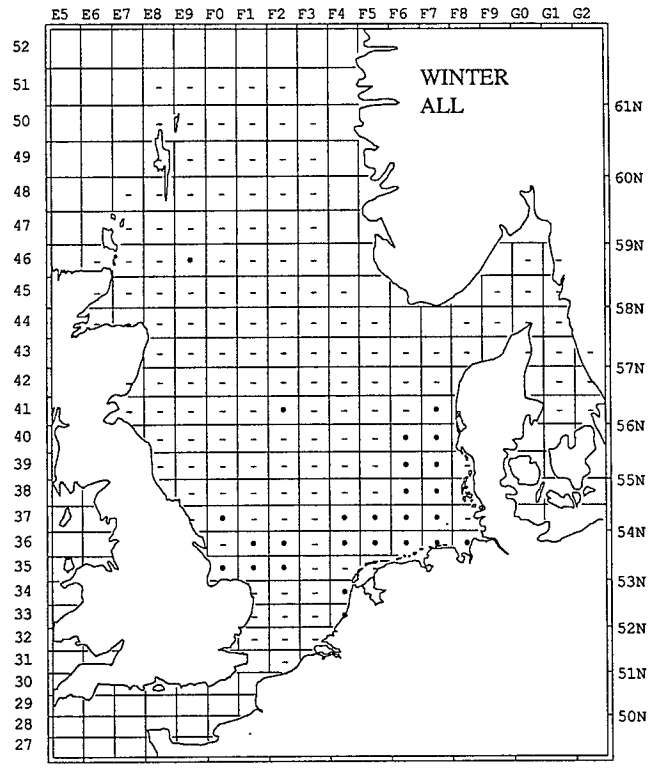
North Sea landings, IYFS-index of one-year-old fish, and pre-spawning stock biomass [9] of North Sea mackerel since 1960.

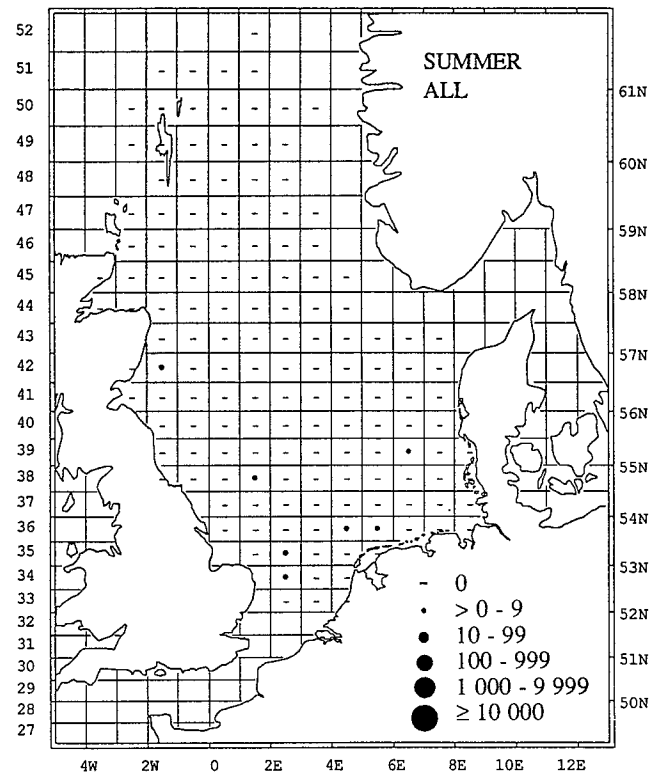
61. Gobiidae
Family Gobiidae

E. Gobies, F. Gobies, D. Grundel, DK. Kutling,
N. Kutlingfisker, NL. Grondels, S. —



Pomatoschistus microps





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

This large family is represented by eighteen species in the saline, brackish, and fresh waters of northern Europe [1]. The species are difficult to identify and therefore all specimens belonging to the genera of *Pomatoschistus* and *Gobius* have been combined and treated as 'gobies'.

The gobies that live in the survey area mostly occur in coastal waters and often live in untrawlable areas close to the coast [1]. Moreover, their extremely small size enables them to escape through the meshes, and it is clear that the *Atlas* data do not adequately represent the gobies' abundance and distribution; the charts merely give a crude indication of their presence or absence in the area.

Length composition

All specimens caught measured between 2 and 11 cm.

Life history

A Dutch beam-trawl survey showed that two species of gobies occur in the territorial waters of the Netherlands in densities that exceed one thousand specimens per hectare [2]. They are the sand goby (*Pomatoschistus minutus*) and Lozano's goby (*P. lozanoi*). These two species live a benthic life, and in common with other gobiids they have fused pelvic fins which they use to attach themselves to the substratum [1]. They typically swim in an intermittent way, with short darting movements when disturbed [3]. Gobiids may be territorial [3]. These fish usually do not survive their second year of life, during which they are apt to reach 7 to 9 cm. The males are often larger than the females [4].

The sand goby and Lozano's goby feed mainly on small crustaceans such as copepods, amphipods, and mysids, but polychaete worms and fish larvae are also eaten [4].

The eggs are deposited on empty bivalve shells or on stones. They are guarded by the male.

Population and exploitation

In the Dutch Wadden Sea gobies are most abundant during autumn. They disappear to deeper, offshore areas during winter. The adults spawn mainly in offshore areas of 10 – 25 m depth during spring and early summer [4].

Gobies are of no economic importance.

References

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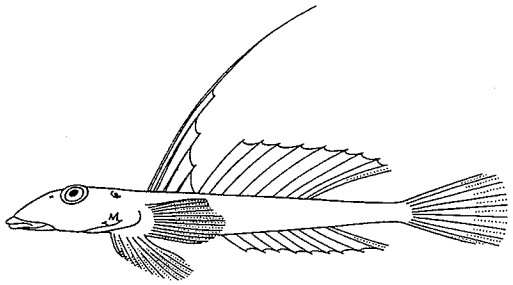
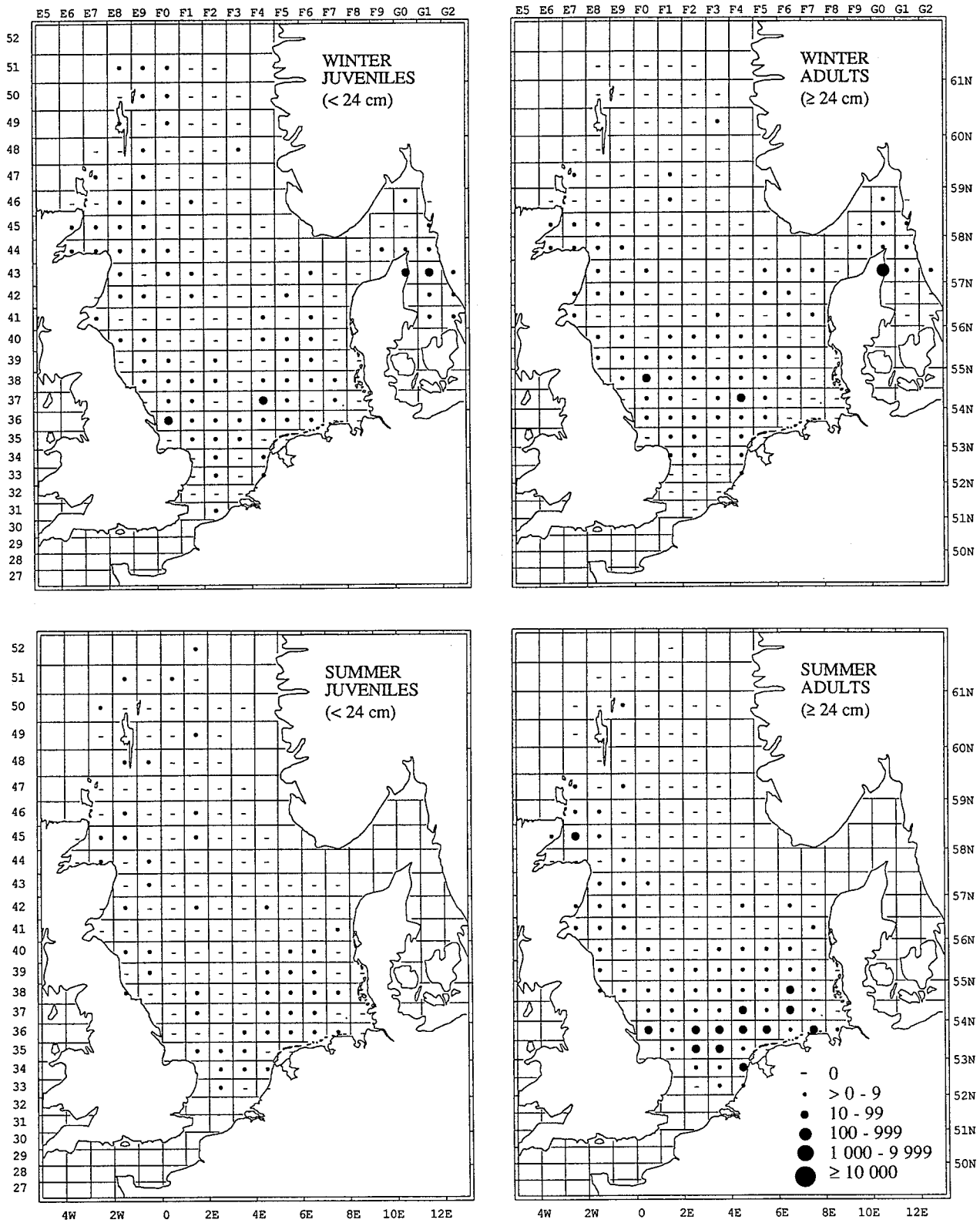
2. Witte, H., Dapper, R., Noort, G.J. van, and Veer, H.W. van der. 1991. De verspreiding van vissen op het Nederlands continentaal plat van de Noordzee. Netherlands Institute for Sea Research, NIOZ-Rapport 1991-7. 110 pp.
3. Miller, P.J. 1986. Gobiidae. *In* Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III. pp. 1019-1086. Ed. by P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris. pp. 1015-1473.
4. Fonds, M. 1973. Sand gobies in the Dutch Wadden Sea (*Pomatoschistus*, Gobiidae, Pisces). Netherlands Journal of Sea Research 6(4): 417-478.

62. *Callionymus* spp.
Family Callionymidae

E. Dragonet, F. Callionyme, D. Leierfisch, DK. Fløjfisk,
N. Fløyfisk, NL. Pitvis, S. Sjökock



Callionymus lyra



Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

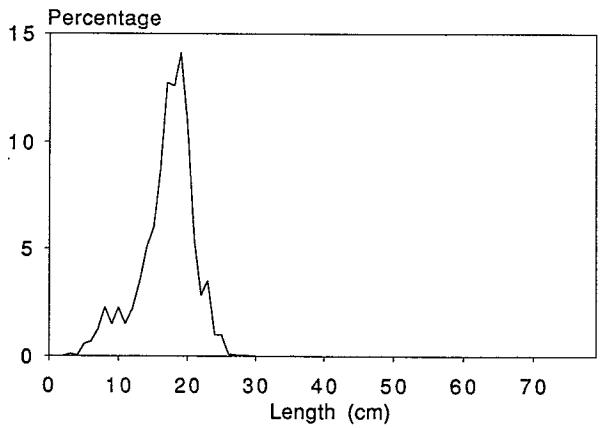
Three species of dragonet occur in the North Sea: common dragonet (*Callionymus lyra*), spotted dragonet (*C. maculatus*), and reticulated dragonet (*C. reticulatus*). Although it is reasonably easy to distinguish between the adult males, which have prominent markings on their flanks and second dorsal fins, it is sometimes very difficult to assign females and juveniles to species level, and for this reason all catches of 'dragonet' have been combined. However, it is likely that a large proportion of the catches are common dragonet. Not only is it the largest of the three (up to 38 cm), but it seems to be the most widely distributed species as well. The smaller (up to 17 cm) spotted dragonet has been recognized only in restricted areas off the Scottish coast and in the Kattegat. Despite its regular occurrence off the Dutch coast [1] only one reticulated dragonet (7 cm) was identified during the surveys.

Dragonets were caught in modest numbers all over the survey area, except for the northeastern parts of the North Sea, where they were almost absent. The contrast between the relatively thinly populated northern area and the higher densities in the south is less evident for the smaller specimens than for the larger ones. The latter size group was much more abundant in the shallow German and Southern Bights during summer than during winter.

Local Dutch beam-trawl surveys have shown that the highest numbers of common dragonet occur in the coastal zone, and that the numbers decrease offshore.

Length composition

The length composition of the common dragonet peaked at about 8 and 18 cm, while that of the spotted dragonet (not shown) peaked at about 12 cm.



Length-frequency distribution of common dragonet during winter.

Life history

Dragonets are demersal fish. The gill openings are situated on the upper part of the head to facilitate exhalation when the animal lies buried in the sand. Echinoderms, and, to a lesser extent 'worms', are important prey of common dragonet in the southern North Sea during May – September [1]. Spotted dragonet from a Scottish sea loch were found to feed mainly on polychaete worms and amphipods [3].

By the end of the year, 0-, 1-, and 2-year-old common dragonet from the southern North Sea have reached lengths of 8, 15, and 19 cm, respectively [2]. Males of the common dragonet become sexually mature from 13 cm onwards [4]. They are territorial during spawning [5] and perform an elaborate courtship display, making use of their large and prominently marked dorsal fins.

Population and exploitation

Spawning is thought to occur in spring and summer. Densities of the pelagic eggs of common and reticulated dragonet in the southern North Sea were highest during May [6].

Dragonets are of no economic value.

References

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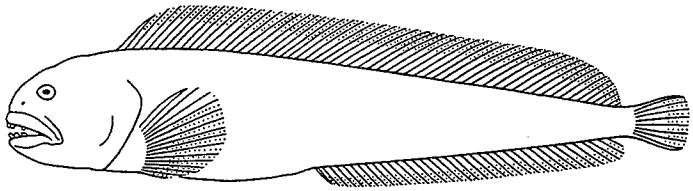
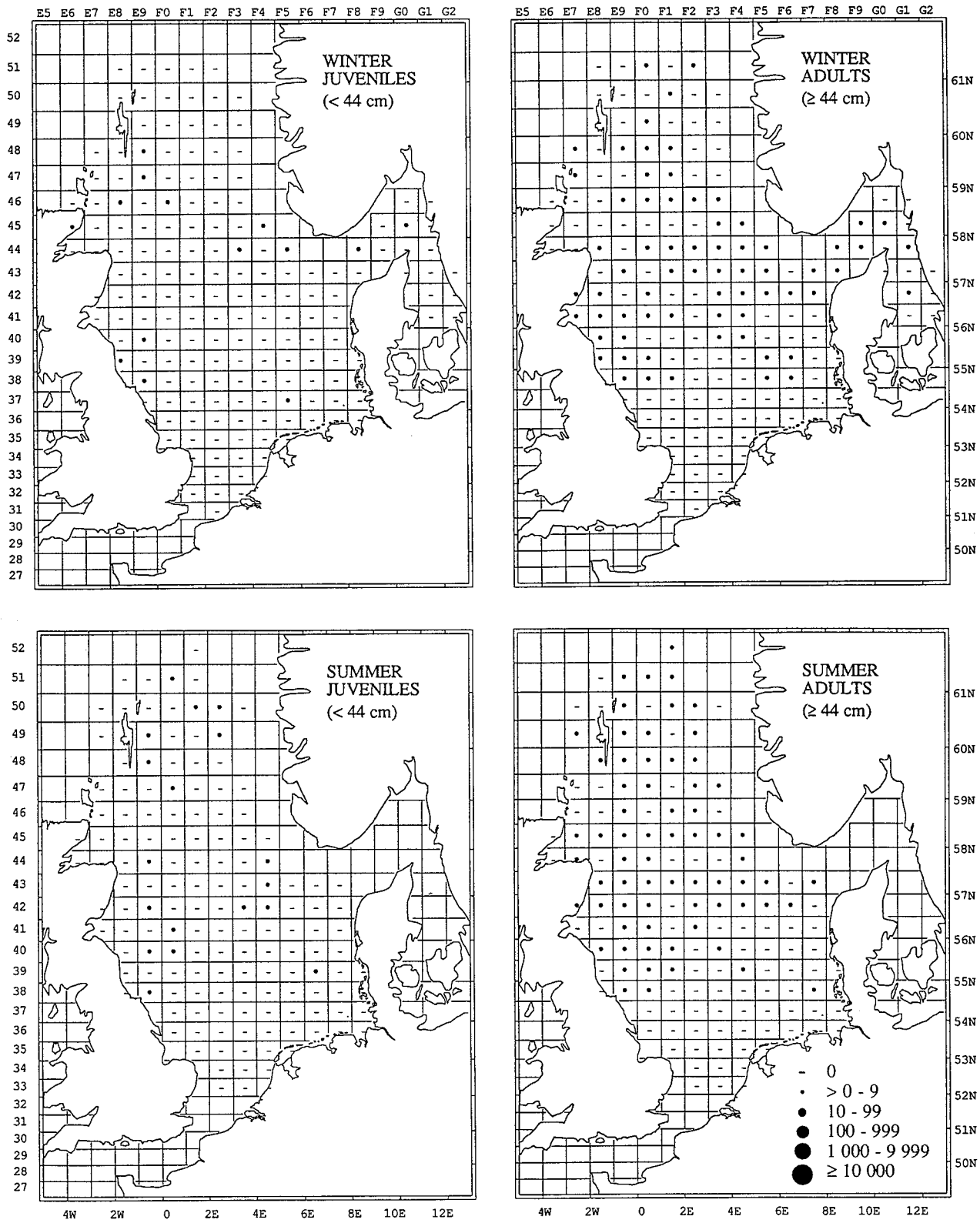
2. Veer, H.W. van der, Creutzberg, F., Dapper, R., Duineveld, G.C.A., Fonds, M., Kuipers, B.R., Noort, G.J. van, and Witte, J.IJ. 1990. On the ecology of the dragonet *Callionymus lyra* L. in the southern North Sea. Netherlands Journal of Sea Research 26(1): 139-150.
3. Gibson, R.N., and Ezzi, I.A. 1979. Aspects of the biology of the spotted dragonet *Callionymus maculatus* Rafinesque-Schmaltz from the west coast of Scotland. Journal of Fish Biology 15: 555-569.
4. Chang, H.W. 1951. Age and growth of *Callionymus lyra* L. Journal of the Marine Biological Association of the United Kingdom 30: 281-296.
5. Wilson, D.P. 1978. Territorial behaviour of male dragonets (*Callionymus lyra*). Journal of the Marine Biological Association of the United Kingdom 58: 731-734.
6. Land, M.A. van der. 1991. Distribution of flatfish eggs in the 1989 egg surveys in the southeastern North Sea, and mortality of plaice and sole eggs. Netherlands Journal of Sea Research 27(3/4): 277-286.

63. *Anarhichas lupus*
Family Anarhichadidae



E. Catfish/Wolffish, F. Loup, D. Gestreifter Katfisch,
DK. Havkat, N. Gråsteinbit, NL. Zeewolf, S. Havskatt



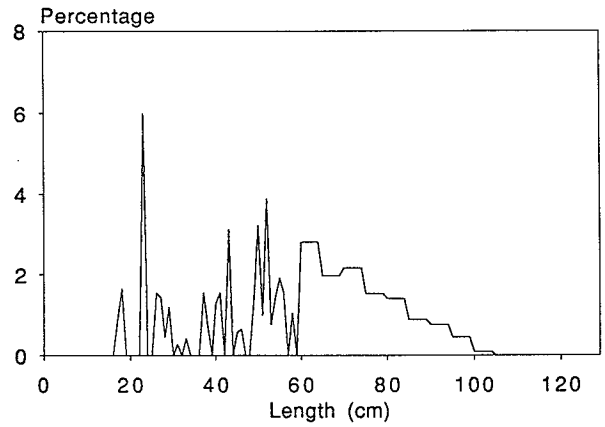
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Catfish occurred in minor quantities in the northern part of the area and was absent from the south. The winter and summer distributions of the larger specimens did not differ much.

Length composition

Most of the fish caught were larger than 60 cm. The smaller specimens were less numerous, resulting in an irregular pattern for these size classes. Lack of smaller specimens in catches has been reported before [1,2].



Length-frequency distribution of catfish during winter.

Life history

This species is a large, blenny-like fish, benthic and solitary. Its main diet consists of hard-shelled animals such as echinoderms, bivalve and gastropod molluscs, and crustaceans, which are pierced and pulverized by the massive teeth [1]. Unlike other fish, which renew their teeth gradually as they are worn down by use, catfish have been shown to change their teeth regularly each year and to be toothless during a certain period, which greatly impedes their feeding ability [1].

Individuals of 26 to 112 cm length caught off the northern Norwegian coast were 5 to 23 years old [3]. Specimens of 40 cm (six years of age) were sexually mature. The demersal eggs, which are deposited as a ball-like clump, are guarded by the male [1,4]. The incubation takes several months [4]. Larvae and juveniles, up to 7 cm, have been caught in pelagic trawl hauls [3,5,6].

Population and exploitation

The almost identical spatial distribution during winter and summer does not, of course, preclude the possibility of restricted seasonal migrations which are related to feeding and spawning: a catfish tagged off the Icelandic coast was recaptured some 300 nautical miles from the tagging position seven months later. During this period it travelled at an average speed of 2.5 km a day [1].

Spawning in the North Sea takes place in autumn.

In the survey area, catfish is not caught in sufficient quantities to be of more than moderate economic importance. Total North Sea catches fluctuated around 15,000 t during the first eighty years of this century, but have been showing a rising trend since 1981. The meat is of excellent quality and this species has considerable potential for aquaculture [4].

References

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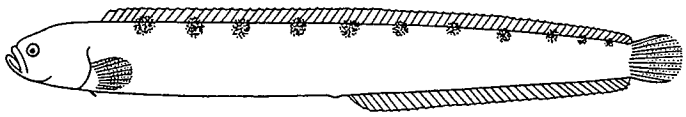
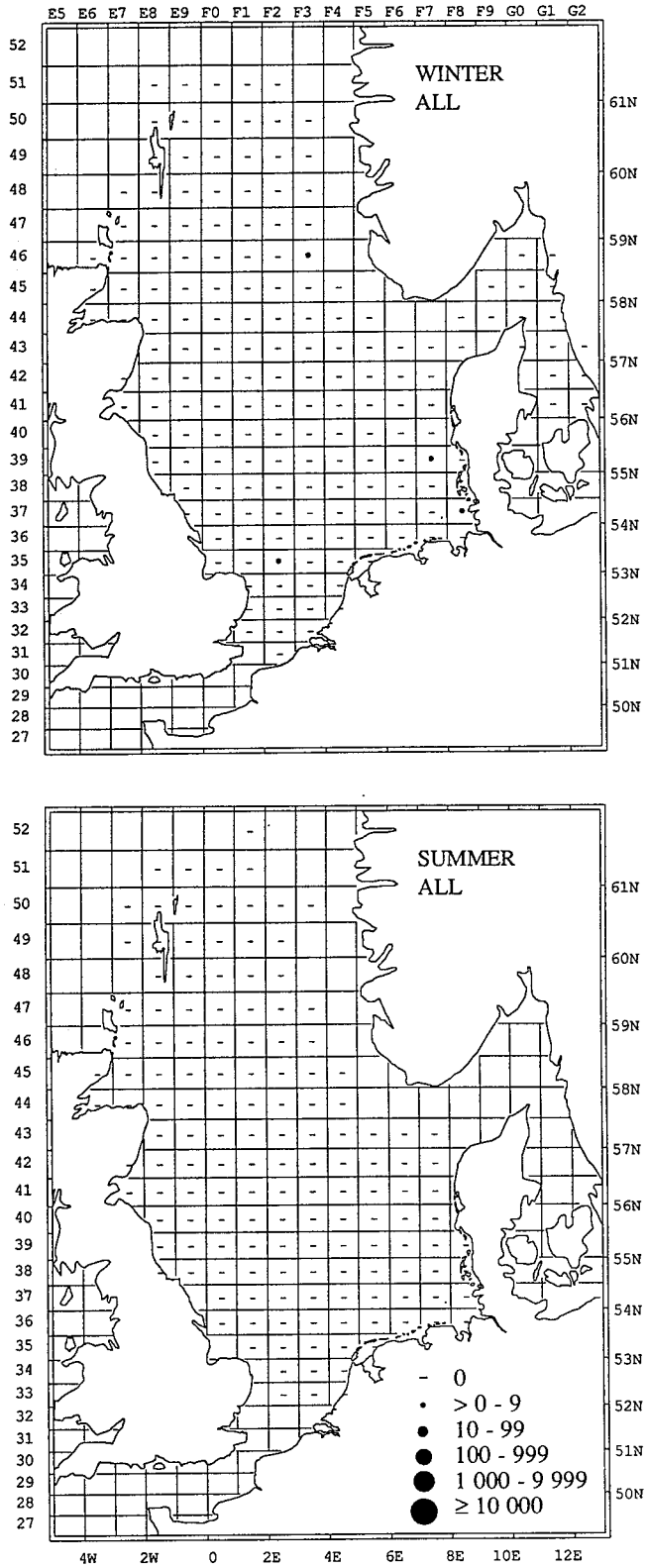
3. Falk-Petersen, I.B., and Hansen, T.K. 1991. Reproductive biology of wolffish *Anarhichas lupus* from north-Norwegian waters. ICES CM 1991/G:14. 9 pp.
4. Ringø, E., and Lorentsen, H. 1987. Brood protection of wolf fish (*Anarhichas lupus* L.) eggs. Aquaculture 65: 239-241.
5. Hislop, J.R.G., Heessen, H.J.L., and Parnell, W.G. 1986. Report on the International 0-Group Gadoid Survey in the North Sea in June/July 1983. ICES Annales Biologiques 40: 190-199.
6. Falk-Petersen, I.B., Haug, T., and Moksness, E. 1990. Observations on the occurrence, size and feeding of pelagic larvae of the common wolffish (*Anarhichas lupus*) in western Finnmark, northern Norway. Journal du Conseil International pour l'Exploration de la Mer 46: 148-154.

64. *Pholis gunnellus*
Family Pholididae



E. Gunnel, F. Gonelle, D. Butterfisch, DK. Tangspræl,
N. Tangsprell, NL. Botervis, S. Tejstefisk



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Five gunnel were caught in five hauls during the winter surveys. The catches were distributed over a large part of the *Atlas* area. Because these fish prefer stony ground and have slim, flexible bodies, trawl surveys may provide a misleading impression of their offshore abundance and distribution.

Length composition

The fish caught were in the length range 6 – 17 cm.

Life history

The gunnel is extremely common inshore, where it can be found hiding under stones and algae in the intertidal zone, but it is occasionally caught in deeper waters, down to 100 m or more [1].

Gunnel grows to a maximum length of about 25 cm [2] and can live for at least five years [3]. It matures at a length of 9 – 10 cm, at two years of age [3].

Spawning takes place in winter (southwest Britain) or early spring [3]. Clumps of eggs are laid in crevices or in empty mollusc shells and guarded by one or both parents [2]. The larvae are pelagic, moving to the bottom at a length of 33 – 35 mm [2].

Gunnel feed on small prey, including polychaetes, molluscs, and crustaceans, particularly amphipods and isopods. The parents feed very little when tending their eggs [3].

Population and exploitation

Little is known about the movements of this species, but in southwest Britain it may leave the littoral zone in December [3].

Gunnel is of no economic importance.

References

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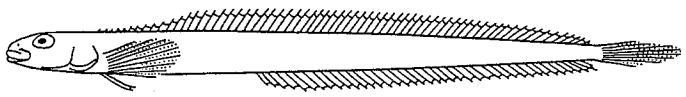
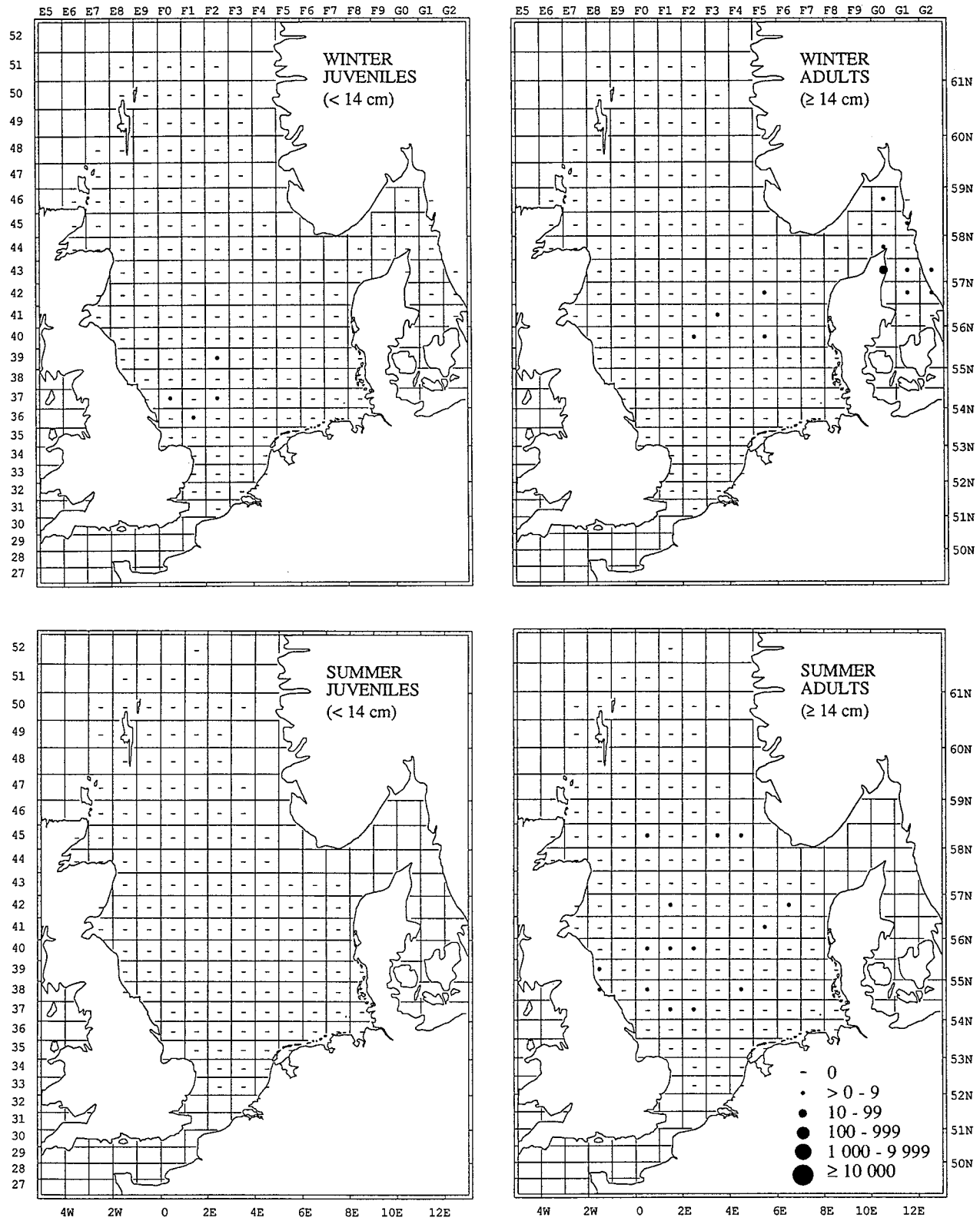
2. Makushok, V.M. 1986. Pholididae. *In* Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III. pp. 1124-1025. Ed. by P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris. pp. 1015-1473.
3. Quasim, S.J. 1957. The biology of *Centronotus gunnellus*. Journal of Animal Ecology 26: 389-401.

65. *Lumpenus lampretaeformis*
Family Lumpenidae



E. Snake blenny, F. —, D. Bandfisch,
DK. Spidshalet langebarn, N. Langhalet langebarn,
NL. IJslandse bandvis, S. Spetsstjärtat långebarn



Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

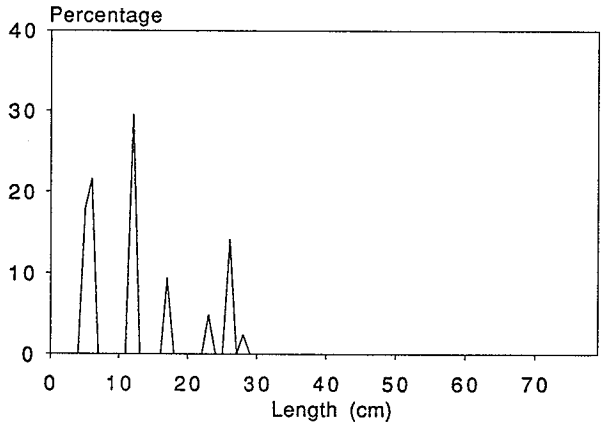
Spatial distribution

The highest catches of snake blennies were made in the Skagerrak and Kattegat during winter. In both seasons they occurred in very low numbers throughout the central part of the North Sea.

The only haul containing a respectable number of snake blennies was made in rectangle 43G0 during winter, and came from a depth of 40 m.

Length composition

The largest specimen caught during winter measured 28 cm. Individuals of up to 35 cm have been caught during the summer surveys.



Length-frequency distribution of snake blenny during winter.

Life history

It is assumed that the younger stages of *Lumpenus lampretaeformis* are pelagic and that a change to a benthic way of life occurs at lengths between 3 and 4 cm [1]. Snake blennies from Scottish lochs may reach a length of 20 cm at nine years of age [2].

The benthic nature of the larger specimens is illustrated by stomach contents of specimens (> 8 cm) from west Scottish waters, which frequently consist of benthic and meiobenthic organisms such as polychaete worms, harpacticoid copepods, nematodes and ostracods [2].

Laboratory experiments showed that the snake blenny is capable of building complicated burrows in soft sediments. The burrows may be used for shelter or perhaps for egg-laying [3]. The burying behaviour is likely to affect catchability.

Population and exploitation

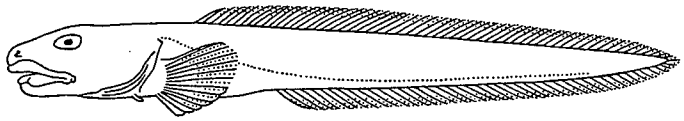
Early juveniles have been described in the North Sea only once, in mid-March [1]. However, they have on occasion been caught in west Scottish waters, always in the month of April [2], and therefore spawning is likely to occur in winter or early spring.

The species is of no commercial interest.

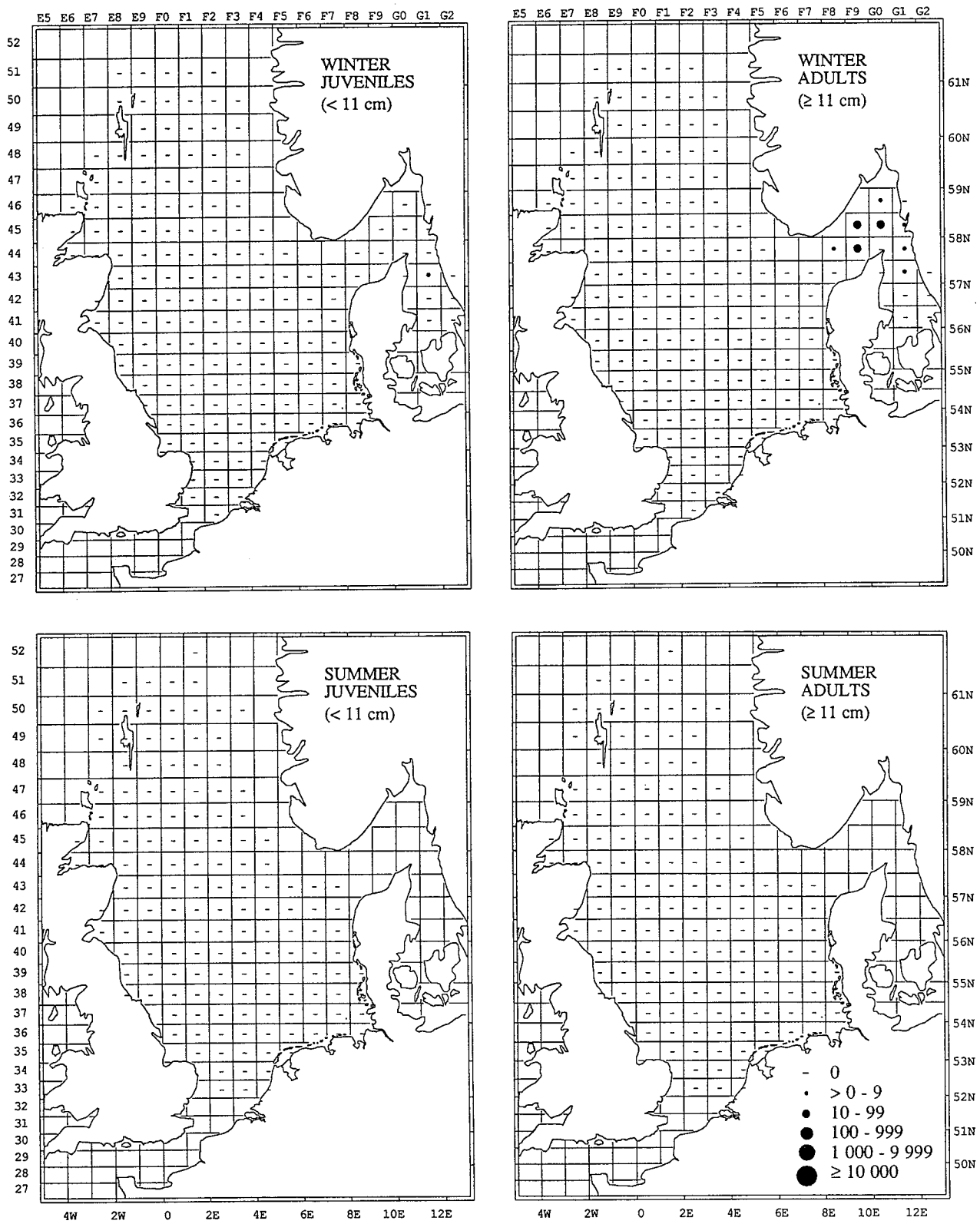
References

1. Russell, F.S. 1976. The eggs and planktonic stages of British marine fishes. Academic Press, London. 524 pp.
2. Gordon, J.D.M., and Duncan, J.A.R. 1979. Some notes on the biology of the snake blenny, *Lumpenus lampretaeformis* on the west coast of Scotland. Journal of the Marine Biological Association of the United Kingdom 59: 413-419.
3. Nash, R.D.M. 1980. Laboratory observations on the burrowing of the snake blenny, *Lumpenus lampretaeformis* (Walbaum), in soft sediment. Journal of Fish Biology 16: 639-648.

66. *Lycodes vahli*
Family Zoarcidae



E. Vahl's eelpout, F. —, D. Vahl's Wolfsfisch,
DK. Vahl's ålebrosme, N. (Vanlig) ålebrosme, NL. Wolfsvis,
S. Vahls ålbrosme



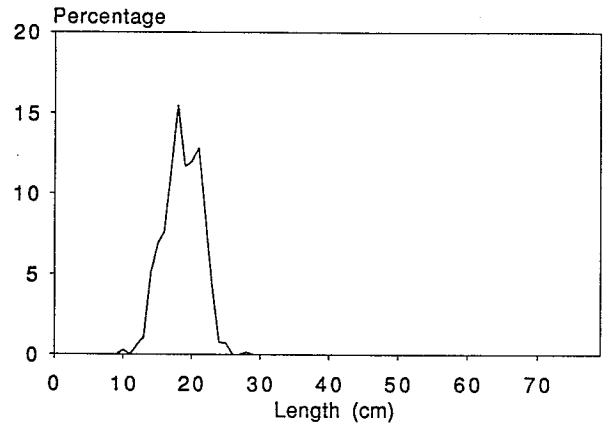
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

This inhabitant of moderately deep (100 m and deeper) waters was caught exclusively in the Skagerrak and Kattegat. Although the maps suggest that Vahl's eelpout was caught in small numbers, two of the *Atlas* hauls contained more than a hundred specimens. Catches containing a single specimen were rare.

Length composition

The mean length of the fish caught was just under 20 cm.

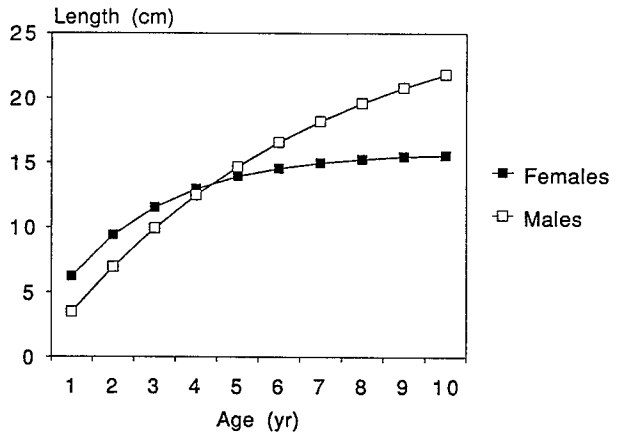


Length-frequency distribution of Vahl's eelpout in area 8 during winter.

Life history

The length-at-age figure clearly illustrates sexual dimorphism in growth of eelpout from the Oslofjord. The largest female measured 16.7 cm, while the largest male measured 23.0 cm.

The very modest number (18 – 40) of large (2.4 – 6.6 mm in diameter) eggs found in the body of the females suggests that the eggs are demersal and that some kind of parental care occurs. It has also been suggested that Vahl's eelpout has a number of behavioural responses that account for the highly variable catches made during the *Atlas* and other surveys. Unfortunately, nothing is known about possible cryptobenthic habits, seasonal movements, or parental care [1].



Mean length-at-age of Vahl's eelpout captured in the Oslofjord [1].

Population and exploitation

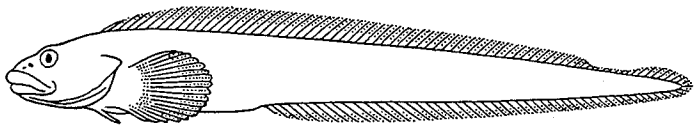
Spawning in the Oslofjord probably takes place in autumn from August onwards [1].

Vahl's eelpout is of no commercial interest.

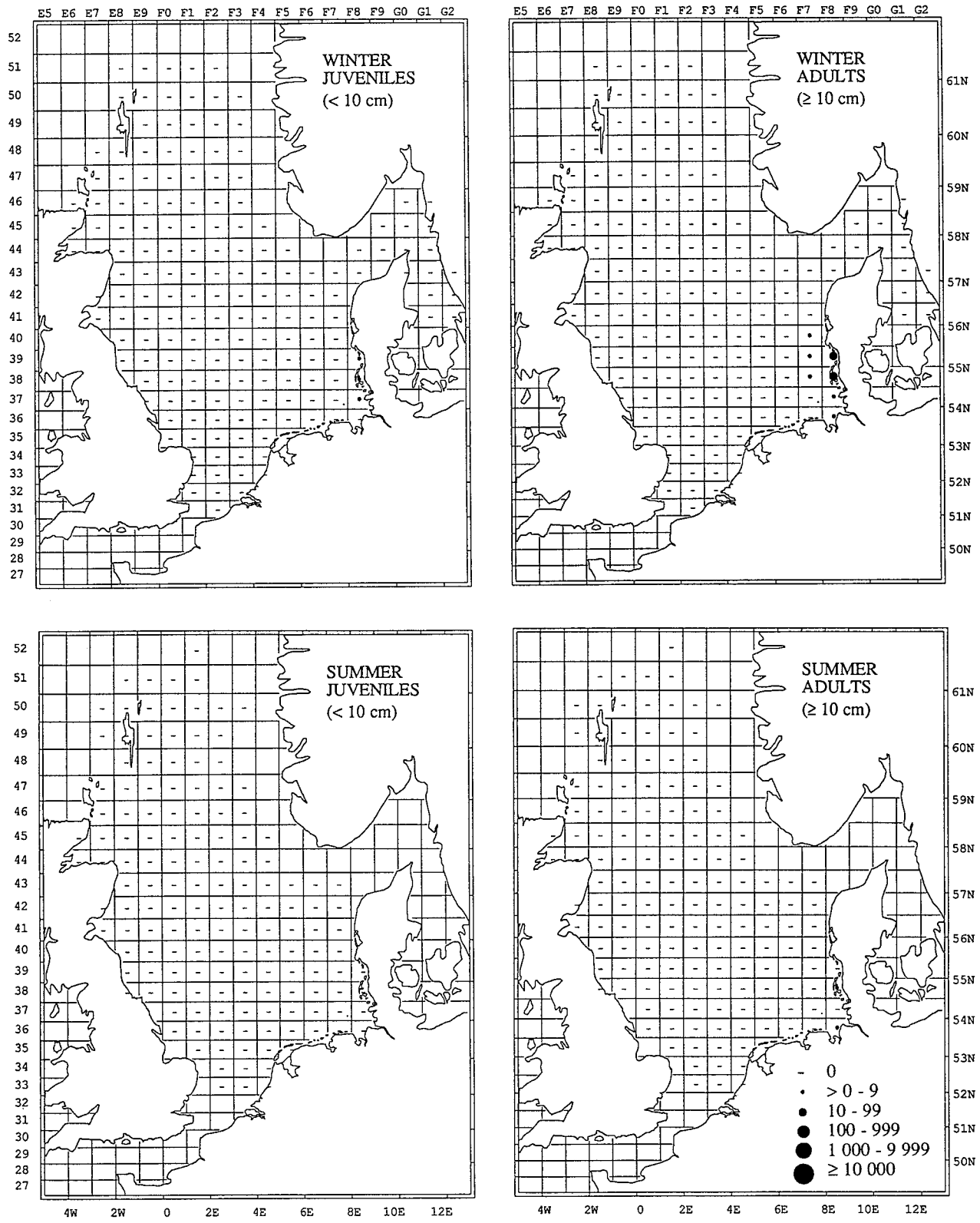
References

1. Nash, R.D.M. 1986. Aspects of the general biology of Vahl's eelpout, *Lycodes vahlii gracilis* M. Sars, 1867 (Pisces, Zoarcidae), in Oslofjorden, Norway. Sarsia 71: 289-296.

67. *Zoarces viviparus*
Family Zoarcidae



E. Eelpout, F. Loquette, D. Aalmutter, DK. Ålekvabbe, N. Ålekvabbe, NL. Puitaal, S. Ålkusa



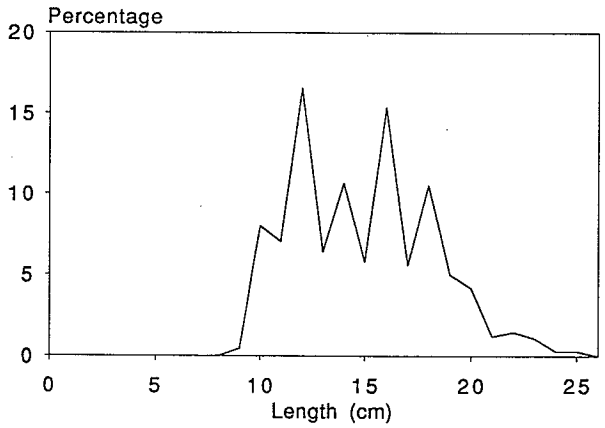
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Eelpout is a coastal species, common in the intertidal zones of the *Atlas* area, as shown by the ample catches taken from the shallow (15 m), coastal waters of the German Bight. Catches of up to 224 individuals per haul were made here during winter. The eelpout's preference for shallow waters and rough substratum leads to an underestimation of its distribution in the *Atlas* area.

Length composition

Most specimens caught measured between 10 and 20 cm; a few were as large as 25 cm. Eelpout grows to a maximum size of about 30 cm [1].



Length-frequency distribution of eelpout during winter.

Life history

Eelpout is a characteristic inhabitant of the Dutch Wadden Sea, found particularly in the tidal channels on mussel beds [2]. In West Scottish sea lochs, this species is placed in a community of benthic fishes which occur in areas with boulders and algal cover [3].

Eelpout feeds mostly on small crustaceans such as amphipods, copepods, young *Carcinus maenas*, and young shrimps. It also feeds on mysids and small molluscs [4].

Despite its scientific name, eelpout is ovoviviparous. Mating with internal fertilization takes place in autumn, probably in August, and the young are born as fully developed, 5 cm long eelpout in February and March [5].

In autumn, 0-group eelpout from the Dutch Wadden Sea measure 10 – 12 cm, one-year-olds measure 15 – 17 cm, and two-year-olds, 18 – 21 cm. The females, which grow to a larger size than males, may become 7 – 8 years old. Eelpout mature at the end of their second summer [1].

Population and exploitation

No clear indications of any sort of migration have been reported. The lower numbers caught during the summer surveys as compared with the winter catches are probably the result of less frequent sampling.

Eelpout is of no economic importance.

References

1. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.
2. Fonds, M., Jaworski, A., Iedema, A., and Puyl, P. v.d. 1989. Metabolism, food consumption, growth and food conversion of shorthorn sculpin (*Myoxocephalus scorpius*) and eelpout (*Zoarces viviparus*). ICES CM 1989/G:31. 10 pp.
3. Kislalioglu, M., and Gibson, R.N. 1977. The feeding relationship of shallow water fishes in a Scottish sea loch. Journal of Fish Biology 11: 257-266.
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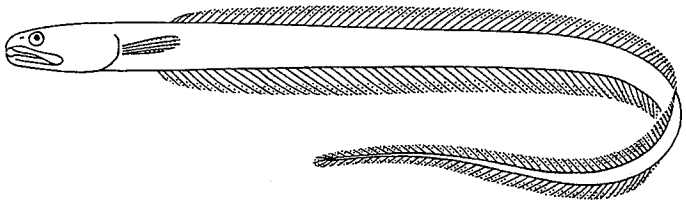
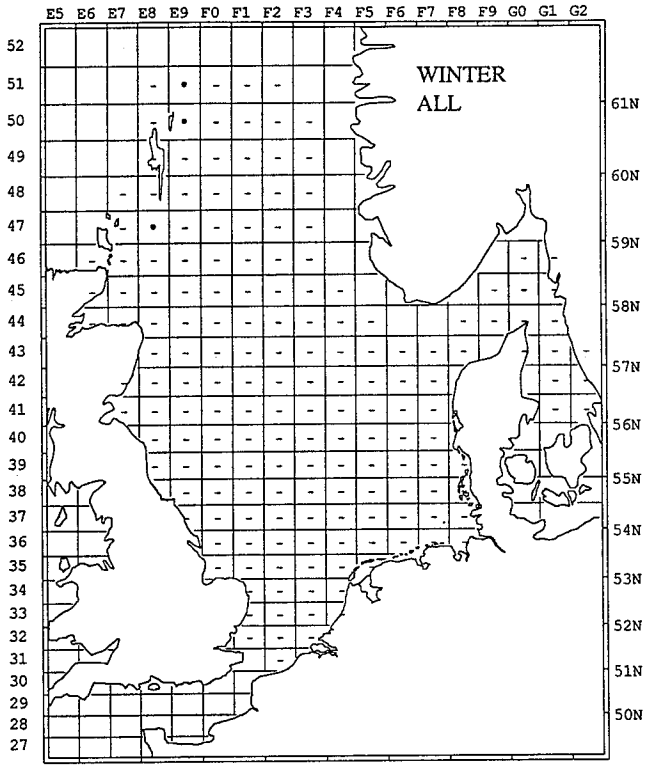
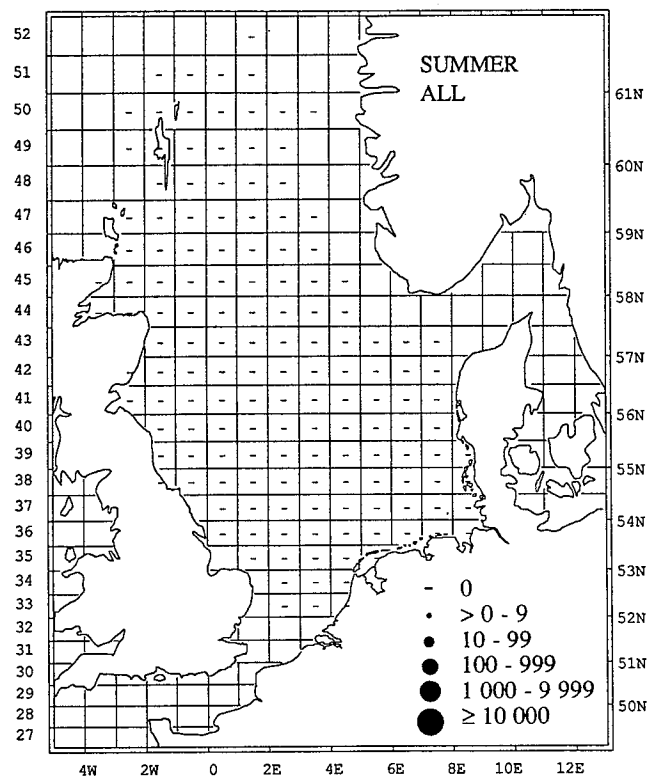
68. *Echiodon drummondi*
Family Carapidae

E. Pearlfish, F. Aurin, D. Perlfisch, DK. —,
N. Snyltefisk, NL. Parelvis, S. —







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

A total of seven pearlfish were caught on three occasions in winter hauls in the northwestern part of the survey area. Pearlfish has a very slender body, which may partly account for its scarcity in the catches.

Length composition

The fish caught were in the length range 23 – 27 cm. Since the maximum length of this species is about 30 cm, it can be assumed that they were adults.

Life history

Little is known about the biology of pearlfish in the North Sea. Although several closely related genera are known to live in commensal or semi-parasitic relationships with invertebrates, particularly echinoderms, it is thought that *Echiodon* spp. are free-swimming [1]. The diet is known to include small crustaceans [2].

Population and exploitation

The larvae of the Carapidae, including *Echiodon*, are of interest in that they carry an elongate filament (the vexillum) on their dorsal surface [1]. These vexillifer larvae are not uncommon in plankton samples [2], nevertheless the early life history of the pearlfish is little understood.

Pearlfish is of no economic importance.

References

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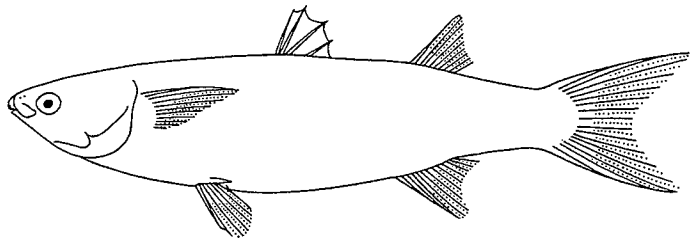
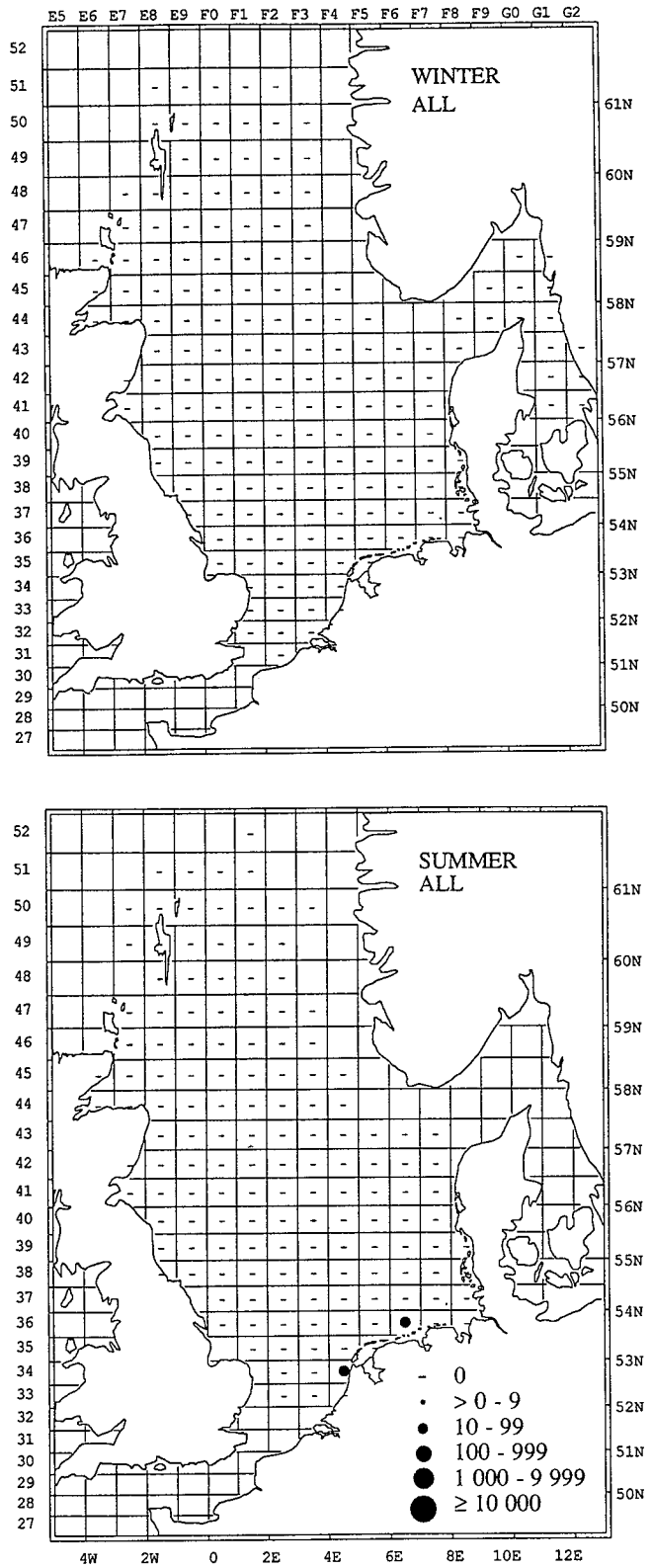
2. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.

69. Mugilidae
Family Mugilidae

E. Grey mullets, F. Mulets, D. Meeräschen, DK. Multe, N. Multefisker, NL. Harders, S. Multar



Chelon labrosus



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Shoals of grey mullet were caught in two coastal locations in the southeastern North Sea during summer. As a species from the warm temperate regions Mugilidae are close to their northern limit in the *Atlas* area. They prefer shallow coastal waters and may even be found in fresh water [1,2].

Length composition

The fish caught measured between 34 and 70 cm. The youngest two or three year classes were missing from the *Atlas* catches.

Life history

There are three members of the grey mullet family (Mugilidae) that may have been caught during the *Atlas* surveys: thick-lipped mullet (*Chelon labrosus*, to 75 cm), thin-lipped mullet (*Liza ramada*, to 60 cm), and golden mullet (*L. aurata*, to 45 cm) [1,2]. Because of difficulties with identification, spatial and length distributions are given for total catches of 'grey mullet'. As the thick-lipped grey mullet is the most ubiquitous and most studied, the following information refers to this species only.

The thick-lipped mullet feeds by filtering mud or scraping surfaces covered with algae, such as pier pilings. [1]. The material is worked for a while between the pharyngeal bones after which the roughest and most indigestible portion is ejected. Grey mullet have very long guts, up to five times their total body length, which may help them get the most from their low nutrition diet. Their gastric system allows them to meet their energy needs from material mostly containing less than 15% of organic matter [3].

At their northern extreme grey mullets are slow growing and late maturing; fifty percent of the males are mature at 40 cm (nine years old) and females at 47 cm (eleven years old) [3].

The females produce eggs in batches. Annual fecundity is between 275 and 465 eggs per gram body weight, or 564,000 eggs for a 50 cm individual [3].

The eggs and larval stages are planktonic [4].

Population and exploitation

There is no recorded spawning of grey mullet in the North Sea, but offshore spawning probably occurs in the vicinity of the Isles of Scilly from January to April. The young appear in coastal waters at about 1 cm length in May and reach 2.5 cm in August [3].

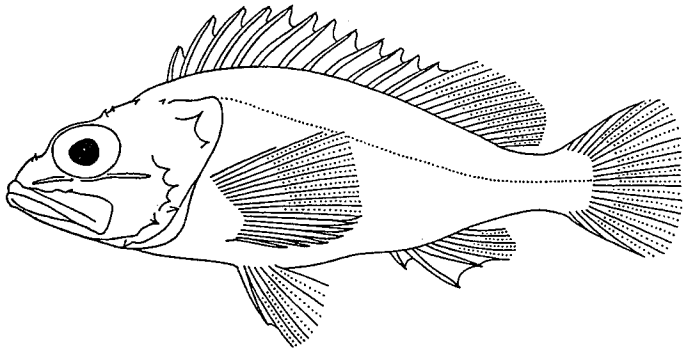
There are commercial landings of grey mullet in the North Sea, usually only amounting to a few tonnes annually, taken in seines, trammel nets, or gill nets set for more valuable species. They are pursued by anglers, who are challenged by the grey mullet's reluctance to take a baited hook.

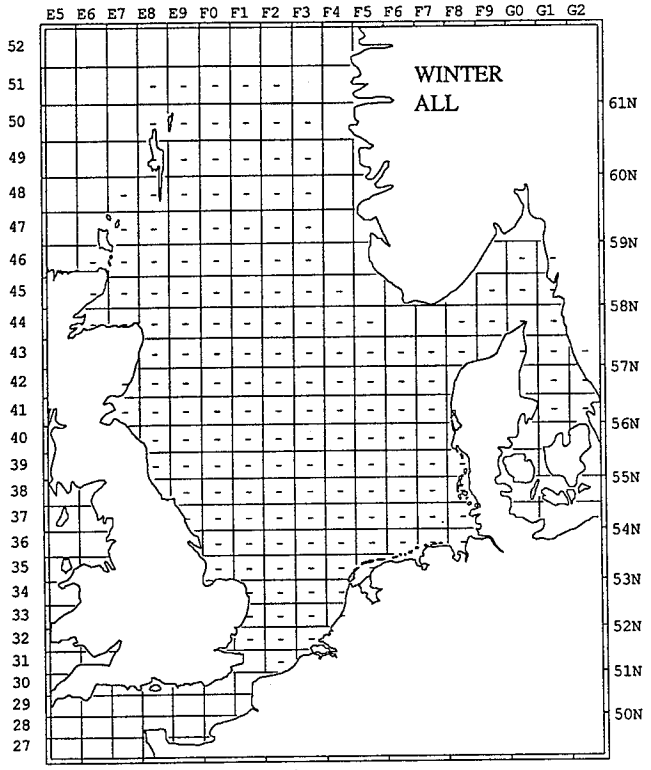
References

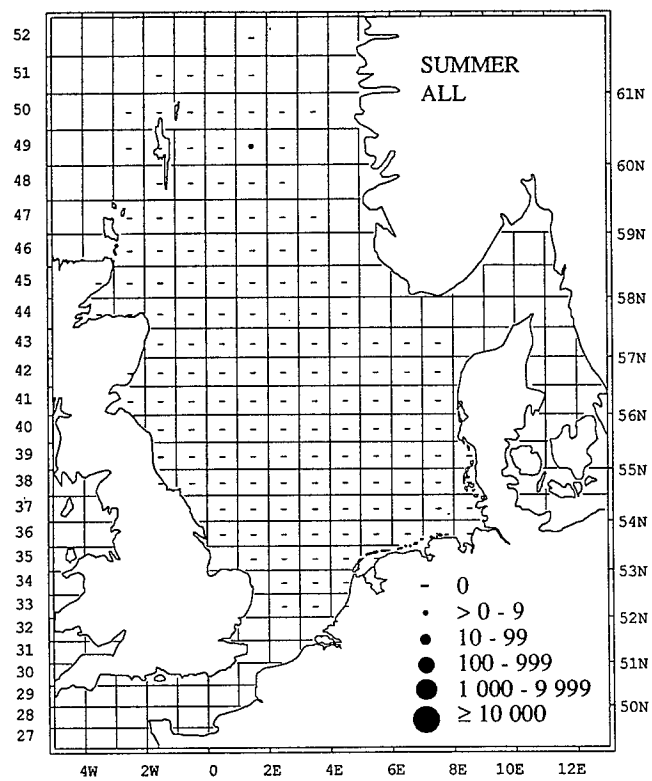
1. Wheeler, A. 1969. The fishes of the British Isles and north-west Europe. Macmillan, London. 613 pp.
2. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.
3. Hickling, C.F. 1970. A contribution to the natural history of the English grey mullets (Pisces: Mugilidae). Journal of the Marine Biological Association of the United Kingdom 50: 609-633.
4. Russell, F.S. 1976. The eggs and planktonic stages of British marine fishes. Academic Press, London. 524 pp.

70. *Helicolenus dactylopterus*
Family Scorpaenidae

E. Bluemouth, F. Sébaste chèvre, D. Blaumäulchen,
DK. Blåkæften, N. Blåkjeft, NL. Blauwkeeltje, S. Blåkäft







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

One specimen of bluemouth was captured, midway between Shetland and Norway during a summer survey. Bluemouth is normally encountered along the edge of the continental shelf, which explains its scarcity in the survey area [1].

Length composition

The fish measured 11 cm and may have been immature, since this species can reach a length of more than 40 cm [1].

Life history

Bluemouth is usually found on sandy or muddy ground. It feeds on or close to the bottom and the diet includes both benthic and pelagic prey (echinoderms, crustaceans, squid, and fish) [1].

The eggs and larvae are pelagic [1].

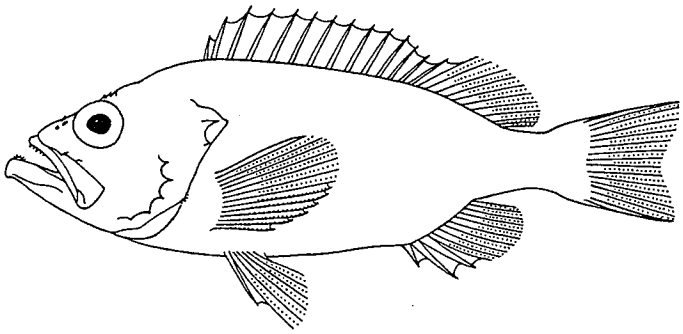
Population and exploitation

The bluemouth spawns in winter and spring, and is of minor economic importance.

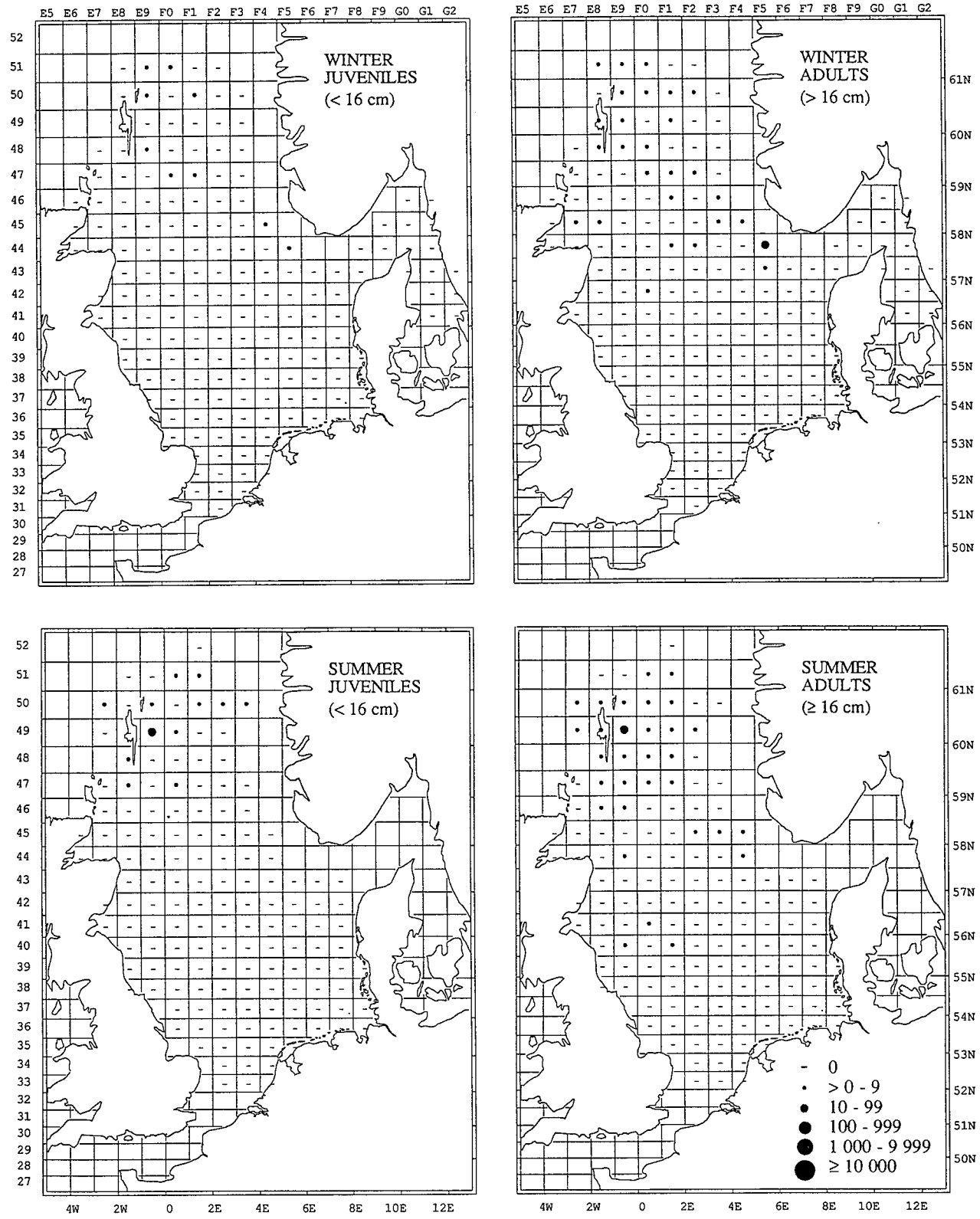
References

1. Hureau, J.-C., and Litvinenko, N.I. 1986. Scorpaenidae. *In* Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III, pp. 1211-1229. Ed. by P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese. UNESCO, Paris. pp. 1015-1473.

71. *Sebastes viviparus*
Family Scorpaenidae



E. Norway haddock, F. Petit sébaste, D. Küstenrotbarsch,
DK. Lille rødfisk, N. Lusuer, NL. Kleine roodbaars,
S. Mindre kungsfisk



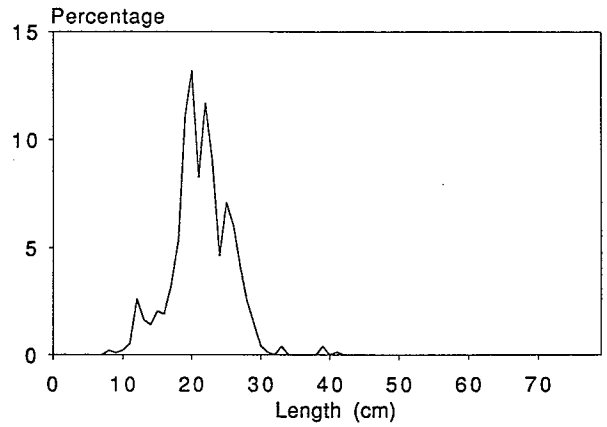
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Norway haddock was caught throughout the northern, deeper parts of the area. Although in general densities were low, catches in rectangle 49E9 east of Shetland were quite high during all summer surveys.

Length composition

This species reportedly attains a maximum size of 35 cm [1]. Single larger specimens caught during the *Atlas* surveys are probably misidentified *Sebastes marinus* (redfish), which is common in deeper waters.



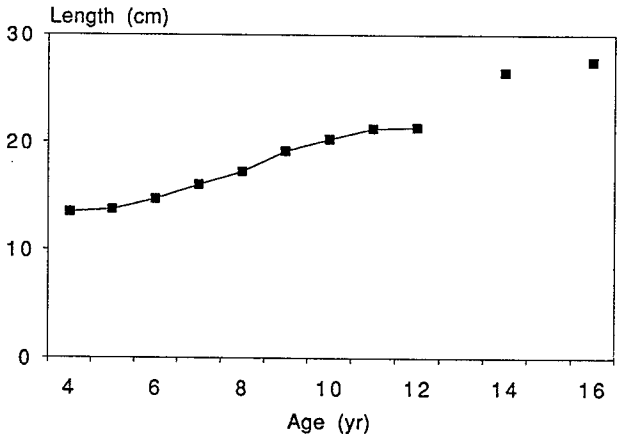
Length-frequency distribution of Norway haddock during winter.

Life history

Norway haddock is usually found in fairly shallow water (40 – 100 m), over rocky bottoms. It is believed to feed mainly on crustaceans and fish [2].

Growth is relatively slow, with males growing more slowly than females [3].

Not much is known about the breeding biology of this scorpaenid other than that it is ovoviviparous, despite its scientific name. Larval stages of scorpaenids, or redfish, are difficult to distinguish,but planktonic larvae found in the Norwegian Sea in July and August were probably Norway haddock [4]. Norway haddock from the North Sea are generally believed to release the larvae in spring and summer but it is not known when the females are inseminated.



Length-at-age of Norway haddock [3].

Population and exploitation

High catches of Norway haddock are generally related to rough grounds (and damaged trawls!).

Because of its small size, Norway haddock is of little or no economic importance. In the North Sea a small fishery exists for the closely related *Sebastes marinus*.

References

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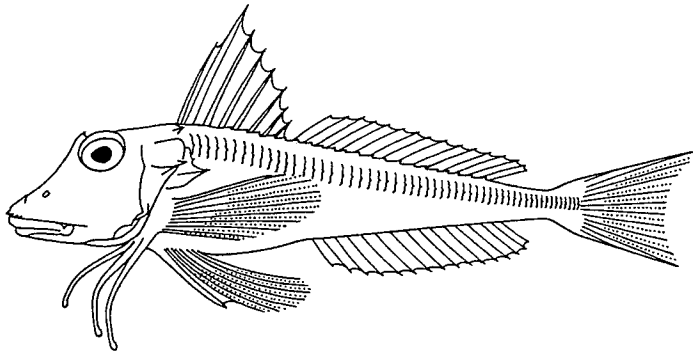
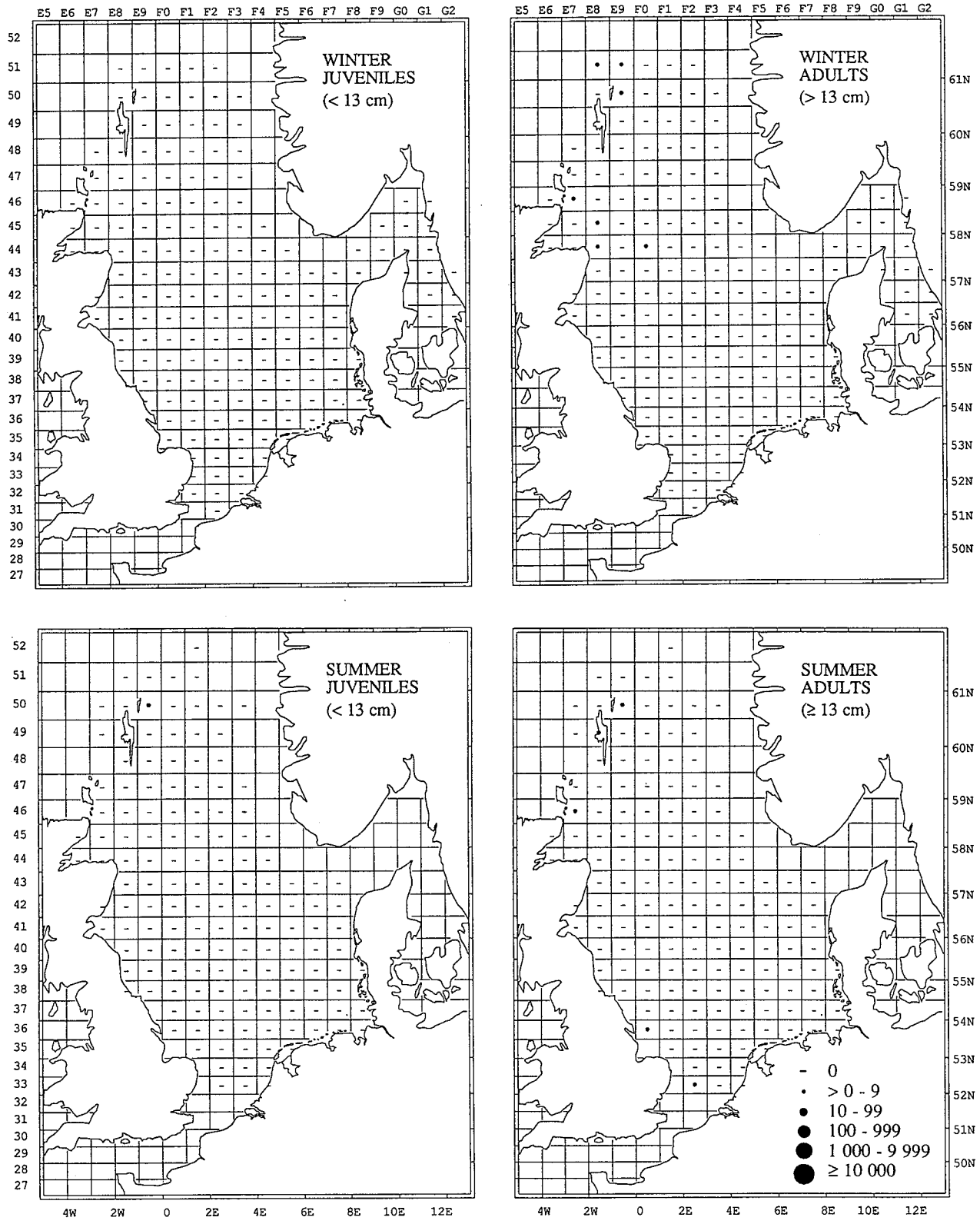
72. *Aspitrigla cuculus*
Family Triglidae

E. Red gurnard, F. Grondin pin, D. Roter Knurrhahn, DK. Knurhane, N. Tverrstripet knurr, NL. Engelse poon, S. Rödknot





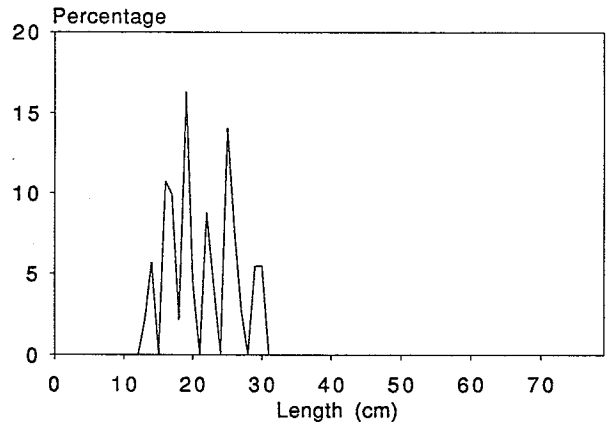
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Catches of red gurnard to the east of Scotland and near Shetland are noteworthy as it is usually regarded as a southern species, reported to be uncommon in the northern North Sea and not abundant in the southern part. Red gurnard was entirely absent from the central North Sea.

Length composition

The red gurnard caught during the surveys measured 12 – 30 cm.



Length-frequency distribution of red gurnard during winter.

Life history

No up-to-date information on the biology of this species in the North Sea was found. It is said to occur on all kinds of substratum (rocks included), and to feed mainly on crustaceans such as shrimps and swimming crabs [1]. Shrimps, for instance *Crangon crangon* and *Processa mediterranea*, and crabs, such as *Carcinus maenas* and *Goneplax rhomboides*, are important food for red gurnard off the Galician coast [2].

Population and exploitation

Spawning takes place in summer [1].

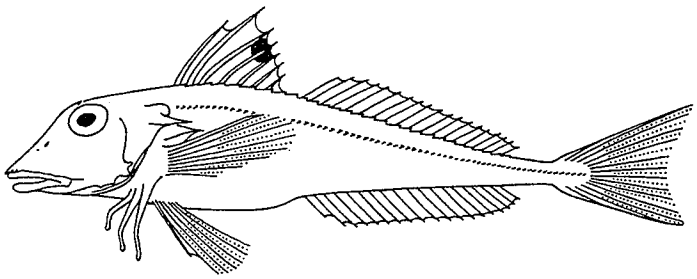
Red gurnard is of very little economic importance in the North Sea.

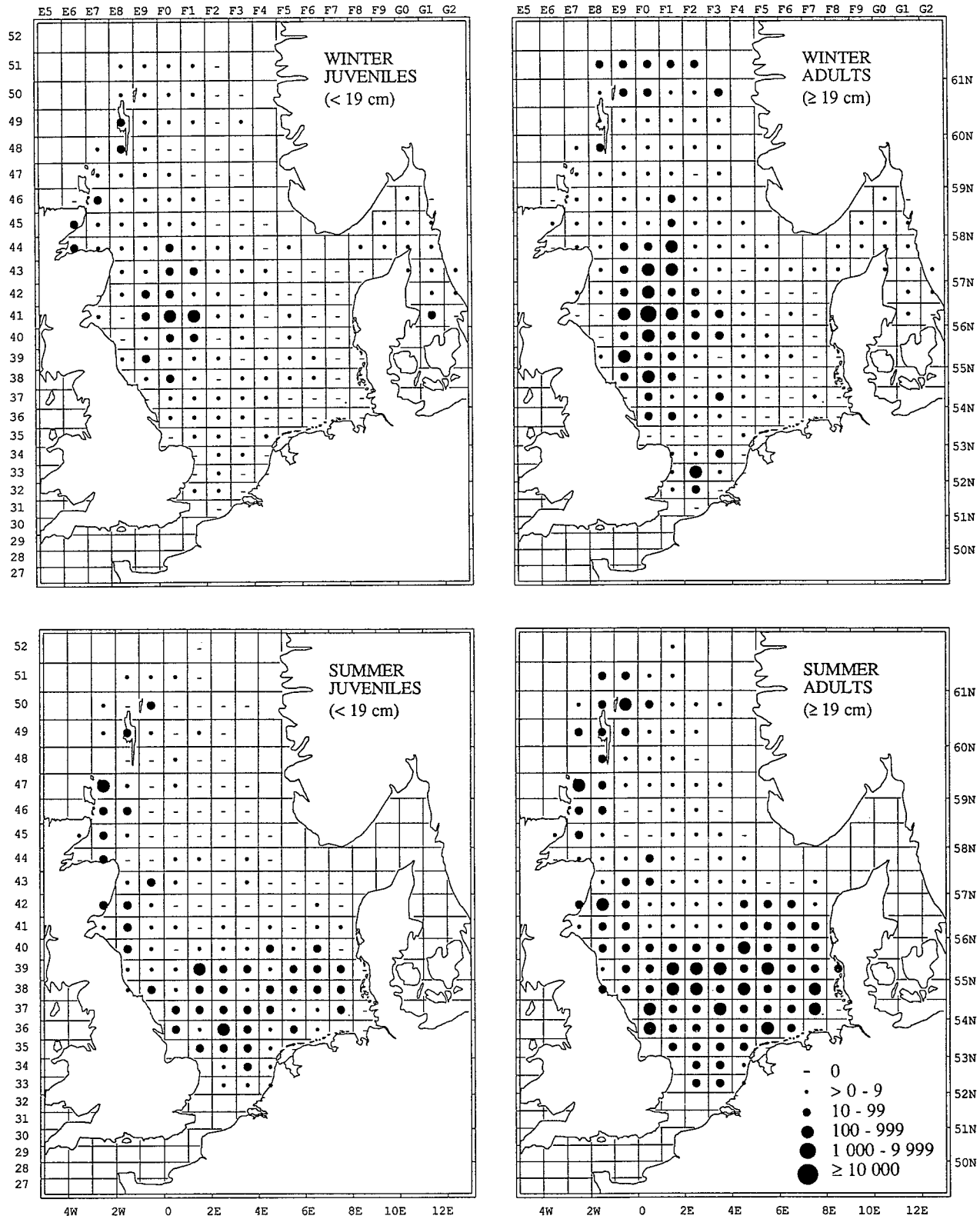
References

1. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.
2. Labarta, E. 1976. Aportación al estudio del régimen alimentario y competencia interespecífica de *Aspitrigla cuculus*, *Trisopterus luscus* y *Trisopterus minutus*, de las costas Galicia. Investigación Pesquera 40(2): 341-354.

73. *Eutrigla gurnardus*
Family Triglidae

E. Grey gurnard, F. Grondin gris, D. Grauer Knurrhahn,
DK. Grå knurhane, N. Knurr, NL. Grauwe poon, S. Knot





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

The grey gurnard, which is ranked among the dominant species in the North Sea, occurred throughout the *Atlas* area. Evident high-density areas could be distinguished. Patterns in distribution of the small and large fish were similar in space and time.

During winter, grey gurnards were concentrated in the western part of the central North Sea, while densities were low in areas off the Danish coast, in the German Bight, and in the eastern part of the Southern Bight. Five winter hauls in rectangle 41F0 contained more than a thousand grey gurnards; one haul during the winter survey of 1986 contained over eight thousand fish.

The pattern of distribution changed substantially during summer. The whole area south of 56°N was densely populated but high concentrations in the central North Sea had disappeared. Many gurnards were caught in the northernmost part of the area in both seasons.

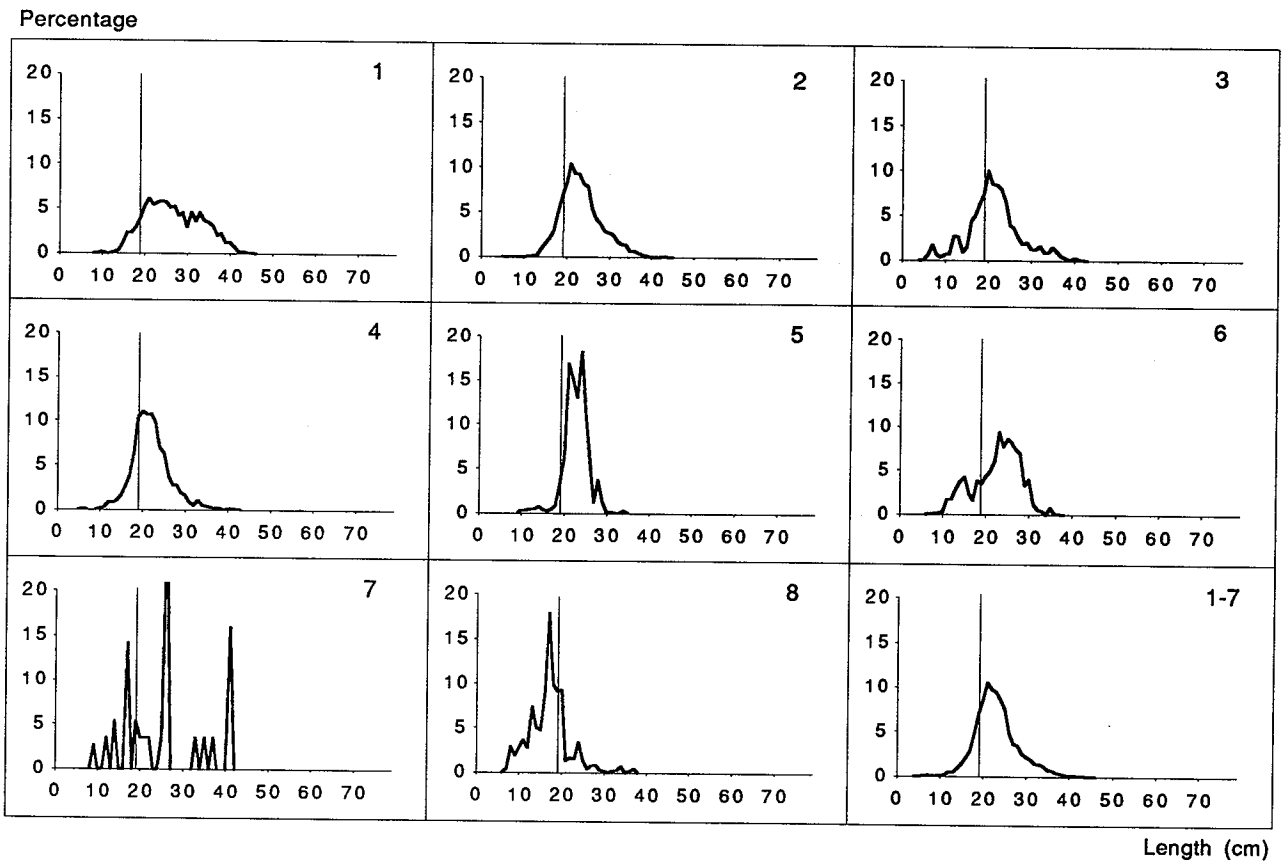
Length composition

The winter catches were in general dominated by larger specimens. Only hauls made in southern area 6 and in the Skagerrak and Kattegat (area 8) contained relatively many small (10 – 20 cm) fish.

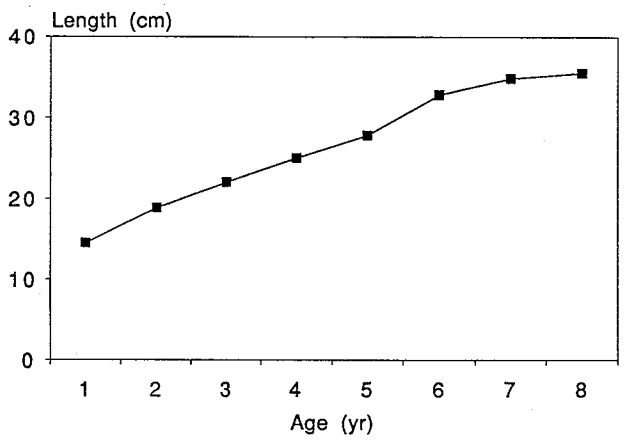
Life history

During the first half of the year, crustaceans like the brown shrimp *Crangon crangon* and small crabs are major food items in terms of weight for small (< 25 cm) North Sea grey gurnard, while stomach contents of larger specimens are dominated by a variety of fish, including whiting, sandeel, dragonet, and sole [1]. Specimens in Loch Etive (west coast of Scotland) were found to feed almost exclusively on mysids, euphausiids, and decapods [2]. Notwithstanding their physical adaptations to a demersal way of life — the lowest three spines of the pelvic fins are used to 'walk' over the substratum and to search for buried prey [3] — divers have observed gurnards swimming well off the bottom. Off Jutland, grey gurnard appeared to be a major predator on pelagic 0-group cod during June – July [1].

Individual grey gurnards have been estimated to be up to nine years old. Females grow faster and are more long-lived than males [4]. Sexual maturity is said to be attained at between two and three years of age [5], but survey data from the first half of May 1992 show that this gurnard matures from about 15 cm onwards, males at a somewhat smaller length than females. During these particular surveys, all specimens larger than 32 cm appeared to be females.



Length-frequency distribution of grey gurnard by roundfish area during winter (length split indicated).



Mean length (cm) per age group in February – March 1977 [4].

Population and exploitation

The near absence of grey gurnard in the southern North Sea during winter and the marked shift in the centre of distribution between winter and summer has been described before [6,7] and might be related to a preference for high water temperatures. Bottom temperatures in high-density areas usually range from 8 to 13°C [8].

Spawning, which in the North Sea occurs in spring and summer and, perhaps, in autumn [9], might also explain the observed seasonal movements [10]. The German Bight, where spawning is known to occur, is invaded by grey gurnards from April onwards. Emigration to northern, deeper waters commences in September and by November only a few young specimens are left [6].

After an initial post-war peak of 4000 t, the annual catches of gurnards in the North Sea (all species combined, but mainly grey gurnard) stayed well below 2000 t until the early 1980s, when yearly catches increased to almost 3000 t. Grey gurnard is a by-catch species in demersal fisheries; it is of only minor commercial interest.

References

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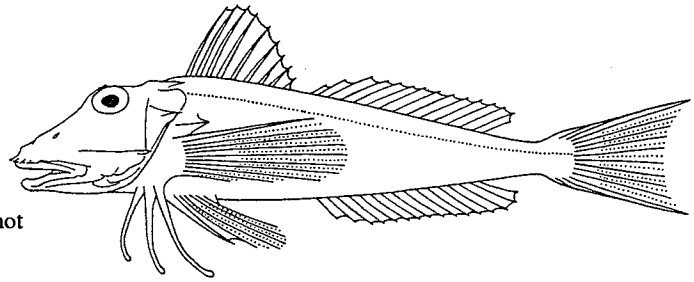
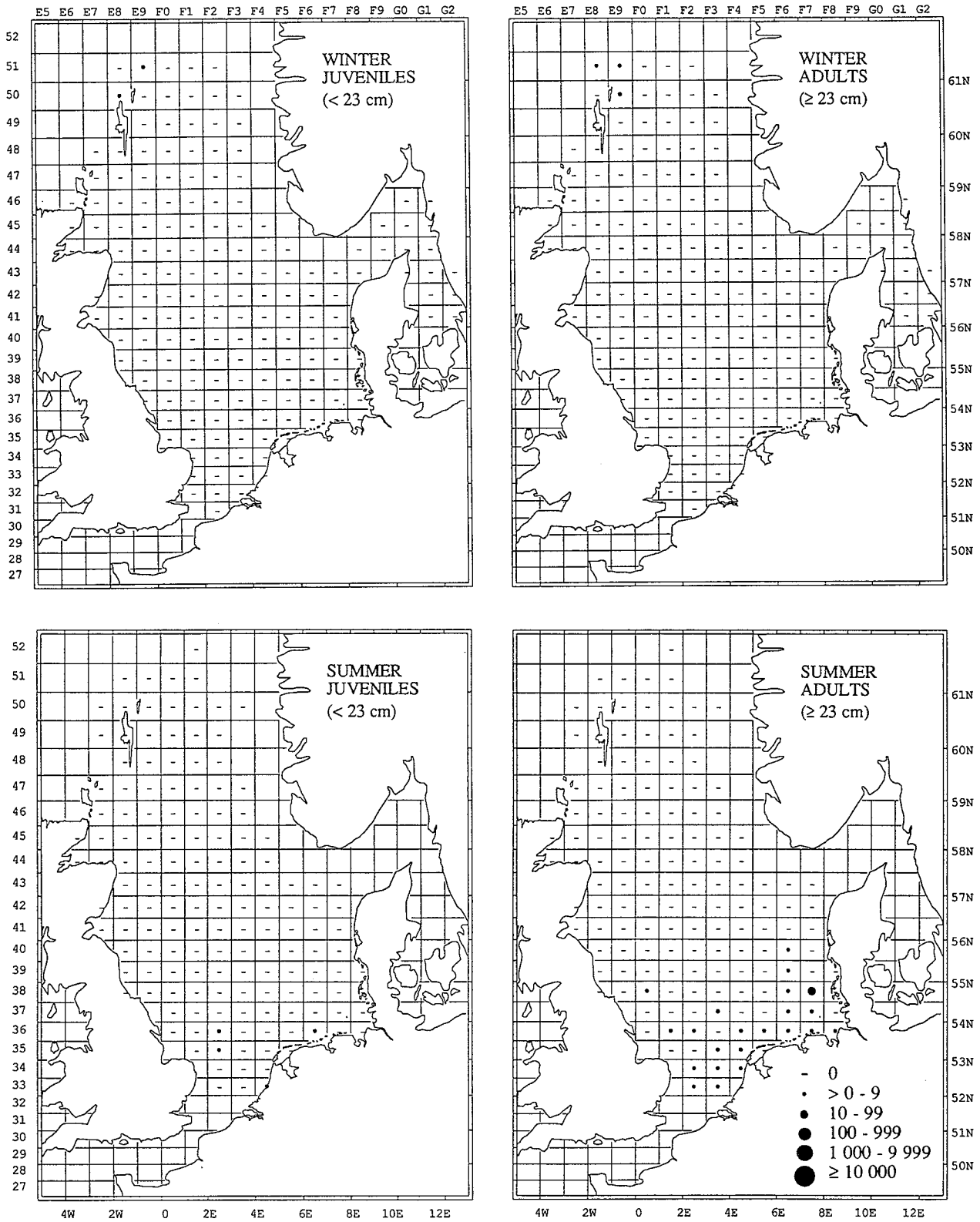
74. *Trigla lucerna*: see page 194.

74. *Trigla lucerna*
Family Triglidae



E. Tub gurnard, F. Grondin perlon, D. Seeschwalbe, DK. Rød knurhane, N. Rødknurr, NL. Rode poon, S. Fenknot



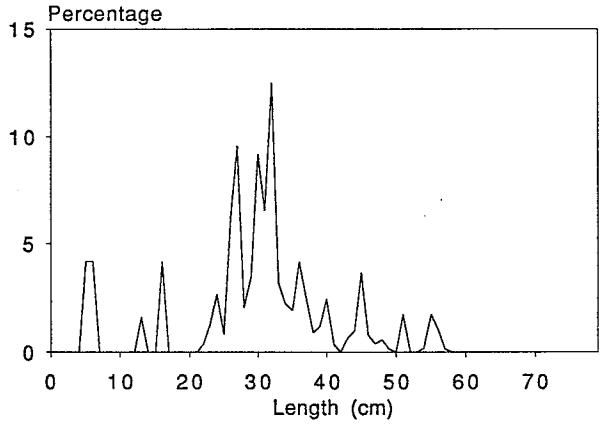
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Tub gurnard had a rather peculiar distribution. In summer surveys it was only caught in the southern North Sea whereas the few individuals taken in winter were all caught near Shetland.

Length composition

The majority of the specimens caught in summer measured between 20 and 40 cm. The small catches in winter consisted of specimens that had a length of 13 – 26 cm.



Length-frequency distribution of tub gurnard during summer.

Life history

This is the largest European gurnard. It can reach a length of 75 cm and a weight of 11 kg [1]. Fish such as gobiids, small flatfishes, and dragonets are important prey organisms. Molluscs and crustaceans are also eaten [1,2].

The eggs of tub gurnard are pelagic.

Population and exploitation

Tub gurnard is a southern species that is confined to waters of 13.5°C or more. During spring it wanders into the southern North Sea through the English Channel, sometimes as far north as the entrance to the Skagerrak [3].

It is of little economic importance in the North Sea.

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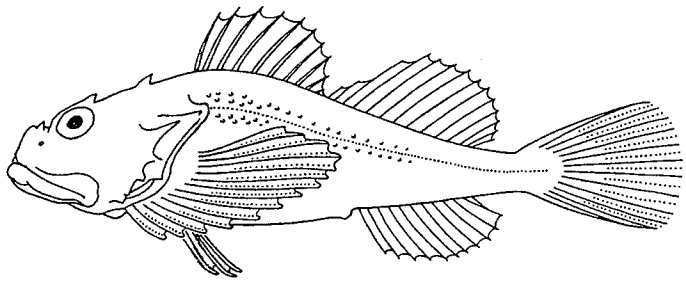
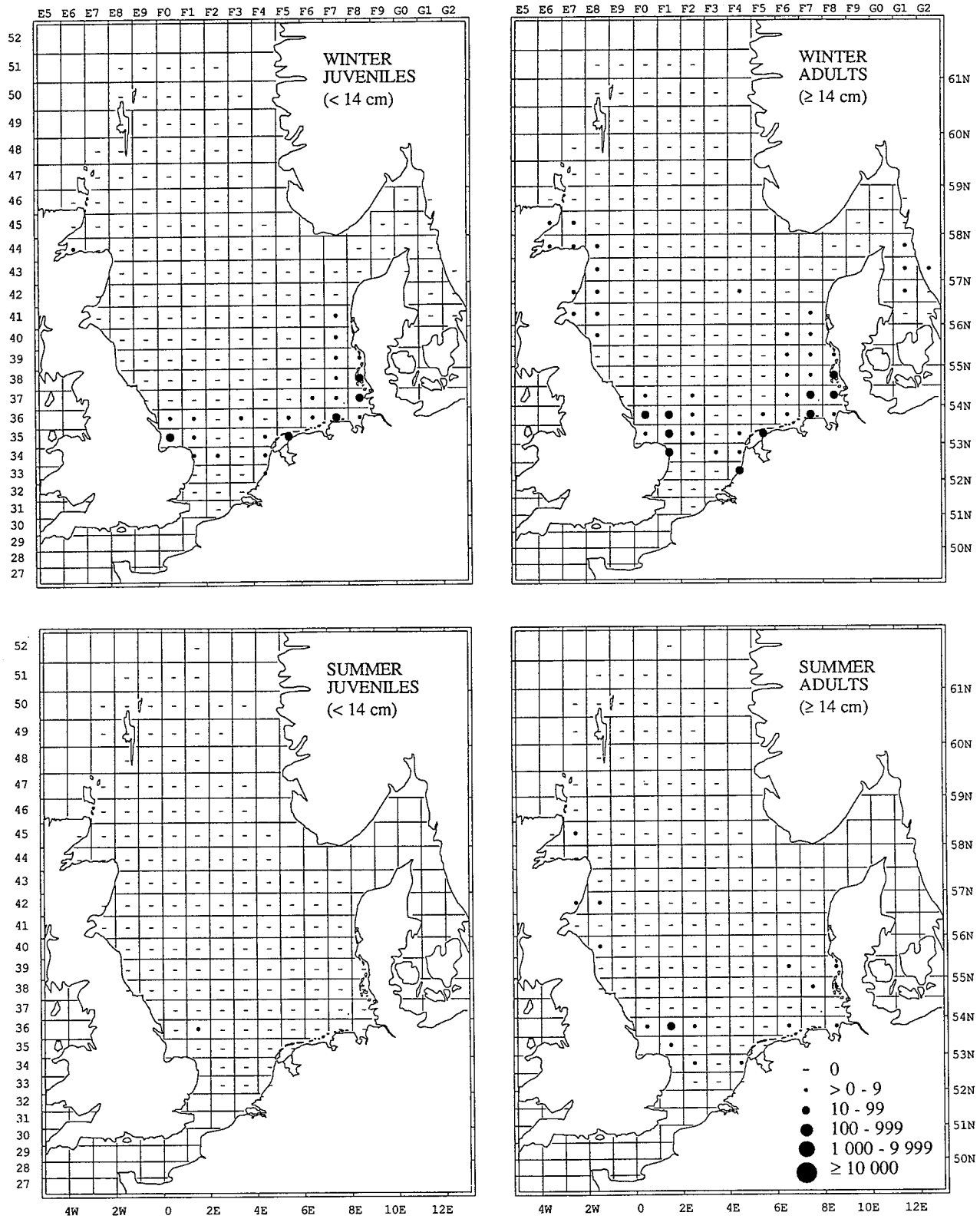
75. *Myoxocephalus scorpius*
Family Cottidae

E. Bullrout, F. Chaboisseau, D. Seeskorpion, DK. Almindelig ulk, N. Vanlig ulke, NL. Zeedonderpad, S. Rötsimpa





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

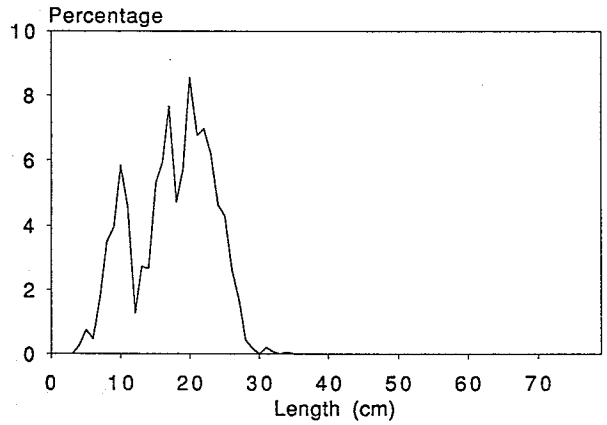
Spatial distribution

Bullrout was caught in coastal areas all over the North Sea. High-density areas were confined to southern coastal waters, but were seen only during winter. This may suggest a summer migration into shallow, coastal waters where no samples could be taken.

Bullrout is a well-known inhabitant of rocky substrata, which means that actual densities in such areas (e.g. the northeast coast of the British Isles) presumably are higher than shown by the *Atlas* data.

Length composition

The largest bullrout caught during the winter surveys measured 34 cm. The dip in the distribution at 12 cm probably represents a split between individuals in their first year of life and older fish.



Length-frequency distribution of bullrout during winter.

Life history

This spiny species, which makes a humming sound when handled, reaches an average length of 7.5 cm in its first year of life in the Baltic; it measures 12.5 cm in its second year, and reaches 20 cm in its fifth year of life. The females grow to a larger size than the males. Sexual maturity is reached when the individual is around 15 cm long and in its second year of life. North Sea bullrout may differ notably in longevity and growth rate [1].

Crustaceans like the crab *Macropipus holsatus* and the brown shrimp *Crangon crangon* dominate the diet of this benthic predator. However, it seems to be an opportunistic feeder, and bivalves and small fish (dragonets, for instance) are also eaten [3].

Divers' observations made in Newfoundland at 3 – 15 m depth revealed that the eggs are laid in individual masses on the bottom and that they are guarded very assiduously by the males: *'If a diver remains near and particularly if he touches the eggs, the sculpin bites at his fingers and hands and sometimes will hold on tenaciously even when shaken.'* [2]

Population and exploitation

Spawning takes place in winter between November and February [1]. It is not known whether the higher winter concentrations are related to spawning activities.

In the Dutch Wadden Sea, bullrout is particularly found in tidal channels on mussel beds, and seasonal fluctuations in trawl catches in this habitat may indicate dispersion, vertical migration, and changes in activity [4,5].

References

1. Lamp, F. 1966. Beiträge zur Biologie der Seeskorpione *Myoxocephalus scorpius* (L.) und *Taurulus bubalis* (Euphr.) in der Kieler Förde. Kieler Meeresforschungen 22: 98-120.
2. Ennis, G.P. 1970. Reproduction and associated behaviour in the shorthorn sculpin, *Myoxocephalus scorpius*, in Newfoundland waters. Journal of the Fisheries Research Board of Canada 27(11): 2037-2045.
3. Ebeling, E., and Alshuth, S. 1989. Food preferences and diseases of *Myoxocephalus scorpius* in the German Bight. ICES CM 1989/G: 48. 6 pp.
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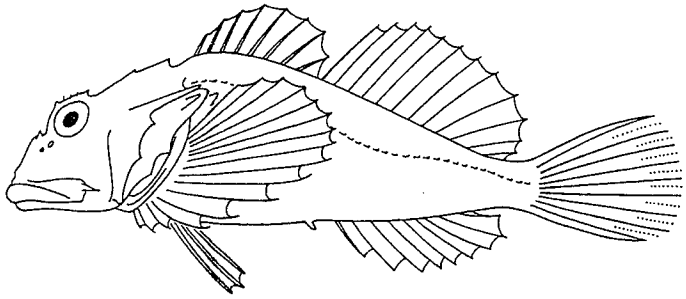
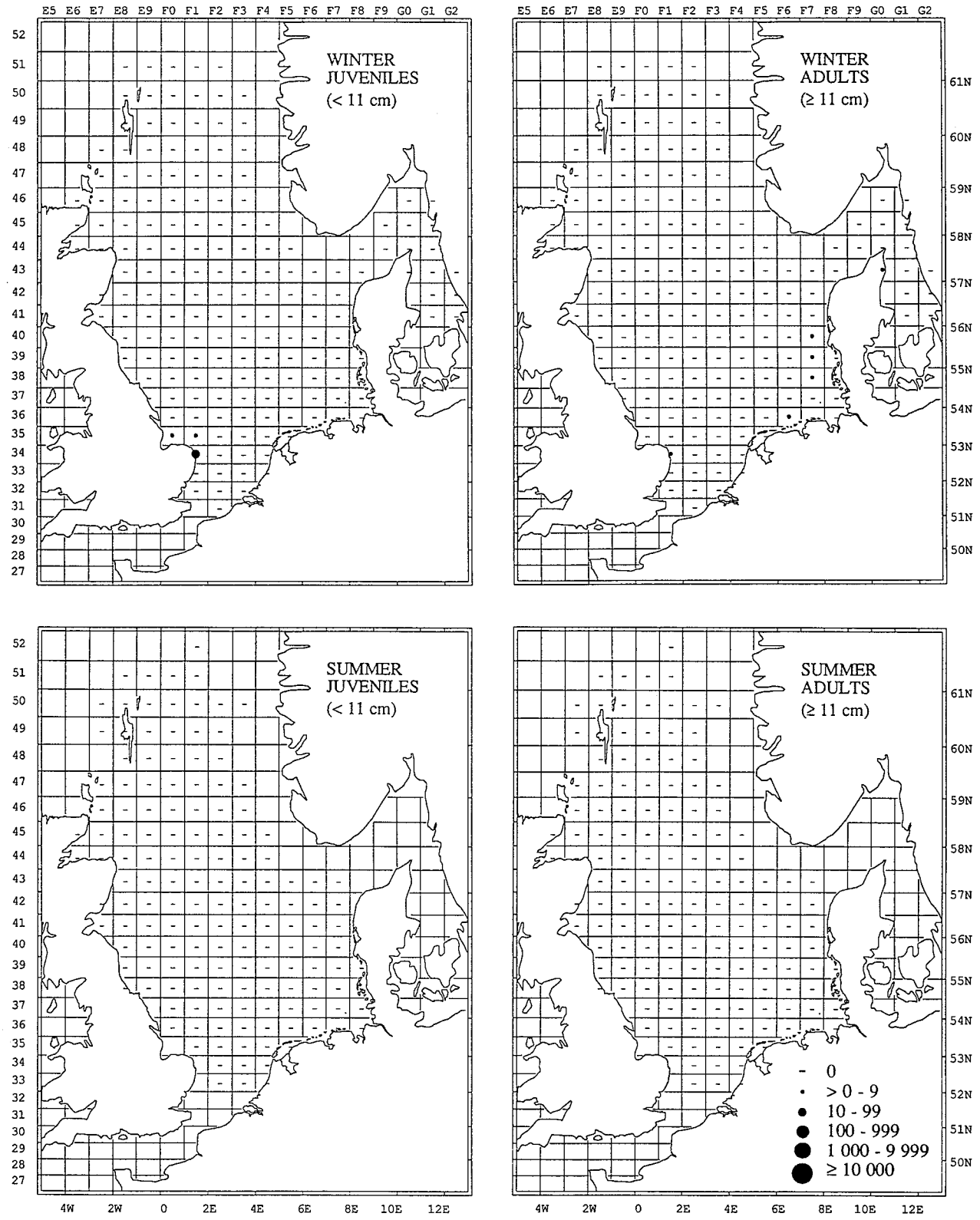
76. *Taurulus bubalis*
Family Cottidae

E. Sea scorpion, F. Chabot, D. Langstacheliger Seeskorpion, DK. Langtornet ulk, N. Dvergulke, NL. Groene zeedonderpad, S. Oxsimpa





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

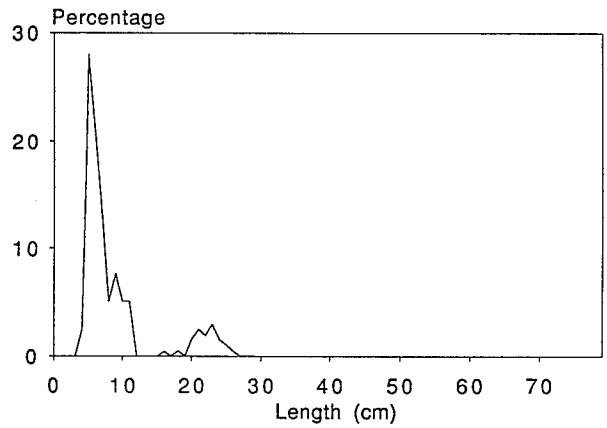
Spatial distribution

This species lives in shallow inshore waters throughout the area from the littoral zone down to 30 m, but only on a rocky substratum with algal cover [1,2]. Sea scorpion occupies the same type of habitat as its larger 'cousin', the bullrout (No. 75).

Substantial catches with the *Atlas* gears (which are poor samplers of shallow rocky substrates) were only made in rectangle 34F1 off the English coast, in waters of approximately 20 m depth. No sea scorpions were caught during summer.

Length composition

It is very likely that the larger specimens caught in the German Bight are in fact bullrout, as sea scorpion is believed to attain a maximum length of only 17.5 cm [2,3].



Length-frequency distribution of sea scorpion during winter.

Life history

Specimens from the Kieler Förde reach 10 cm during their second year of life, at the end of which they are sexually mature. Few individuals reach an age of four years [3].

Observations made in a Scottish sea loch indicate that amphipods, polychaetes, and decapods are important food organisms for sea scorpions [1].

Population and exploitation

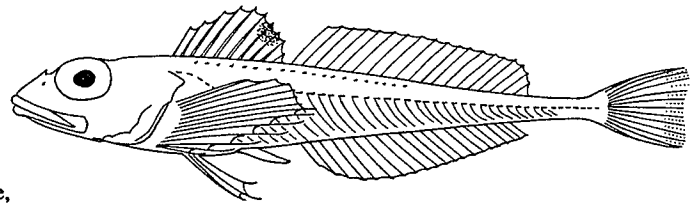
Spawning takes place from January to April, with clumps of eggs being laid amongst algae [4].

This species is of no economic importance.

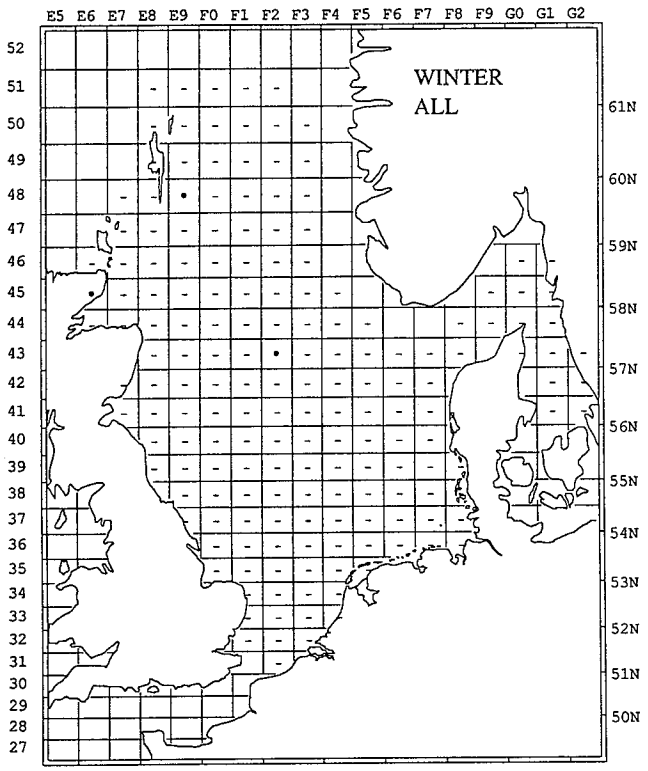
References

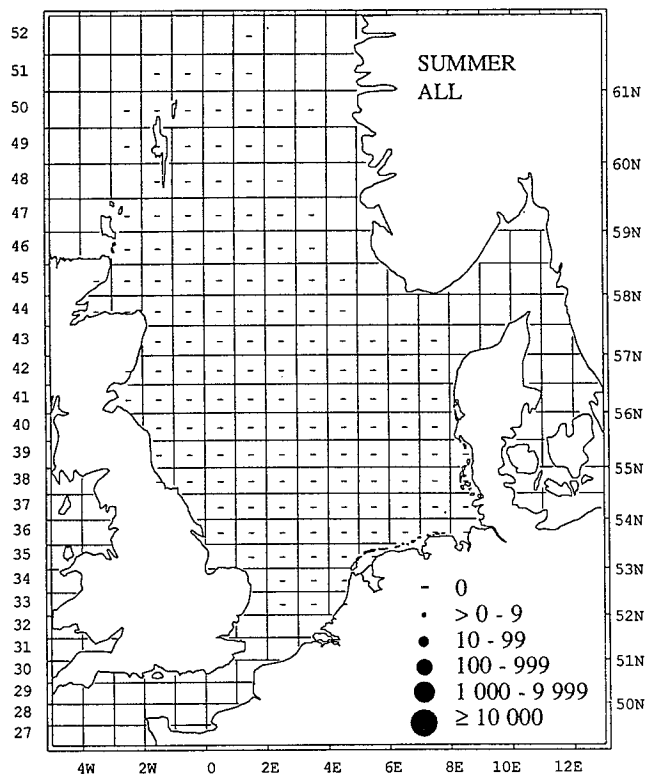
1. Kislalioglu, M., and Gibson, R.N. 1977. The feeding relationships of shallow water fishes in a Scottish sea loch. Journal of Fish Biology 11: 257-266.
2. Wheeler, A. 1978. The fishes of northern Europe. Frederick Warne, London. 380 pp.
3. Lamp, F. 1966. Beiträge zur Biologie der Seeskorpione *Myoxocephalus scorpius* (L.) und *Taurulus bubalis* (Euphr.) in der Kieler Förde. Kieler Meeresforschungen 22(1): 98-120.
4. Russell, F.S. 1976. The eggs and planktonic stages of British marine fishes. Academic Press, London. 524 pp.

77. *Triglops murrayi*
Family Cottidae



E. Moustache sculpin, F. Chabot arctique,
D. Murray's Knurrfisch, DK. Knurulk, N. Nordlig knurrulke,
NL. Murray's zeedonderpad, S. Simpknot





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Five moustache sculpin were taken in four hauls in the northern North Sea. All the catches were in winter.

Moustache sculpin is the rarest of the three sculpin species (Cottidae) reported during the *Atlas* surveys.

Length composition

The length range of the specimens caught was 7 – 11 cm.

Life history

Moustache sculpin is usually caught on sandy bottoms in moderate depths (50 – 250 m). The diet consists mainly of benthic polychaetes and small crustaceans [1,2].

This species lays large (2 mm) demersal eggs in late autumn and winter [1].

Population and exploitation

Moustache sculpin is a northerly species, whose distribution extends from the northern part of the British Isles to Greenland, the White Sea, and the southern part of Spitsbergen [1].

It is of no commercial importance.

References

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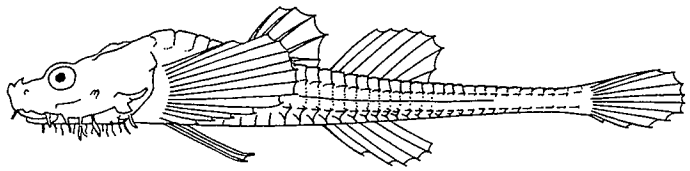
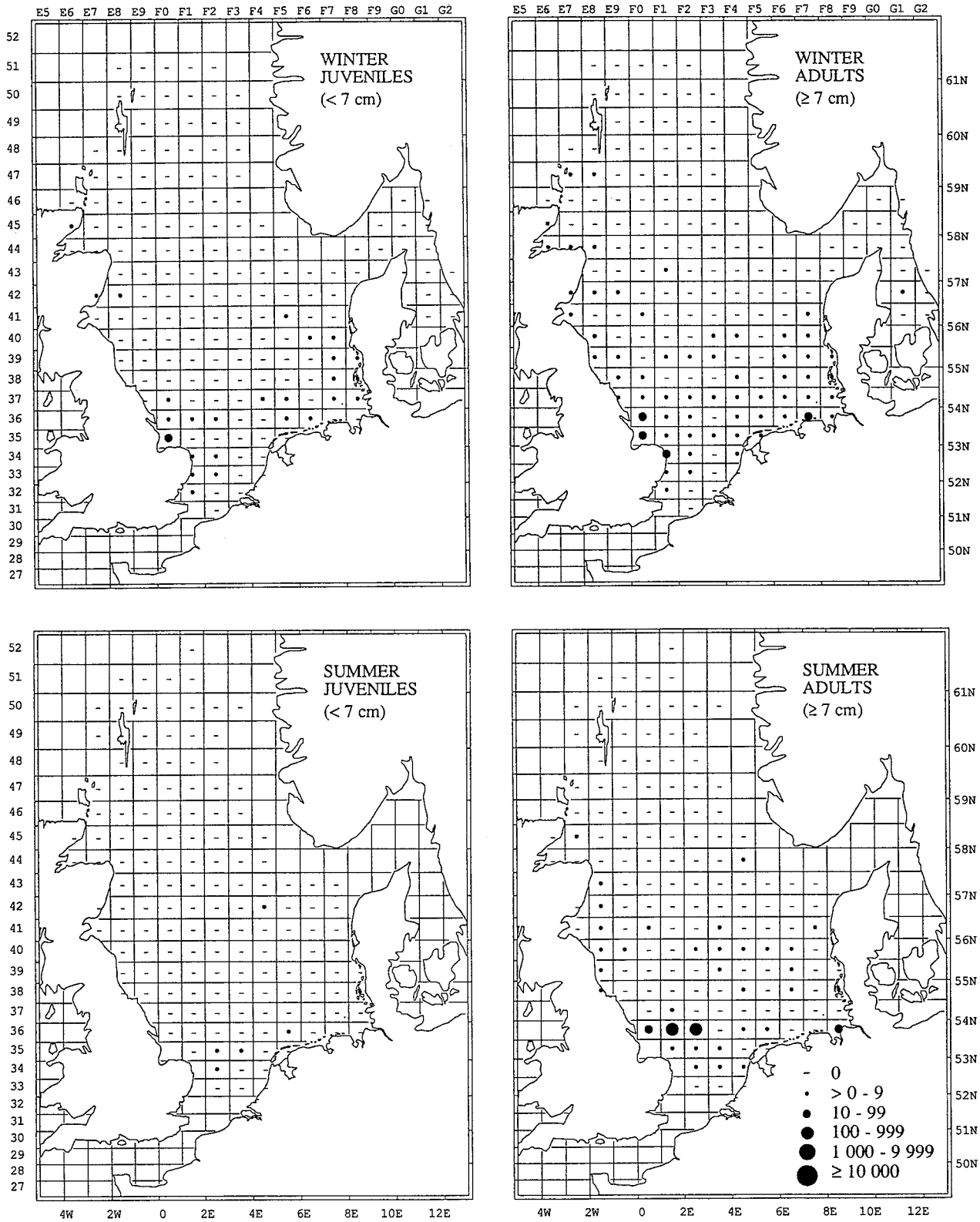
2. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.

78. *Agonus cataphractus*
Family Agonidae



E. Hooknose, F. Souris de mer, D. Steinpicker,
DK. Panserulk, N. Panserulke, NL. Harnasmannetje,
S. Skäggsimpa



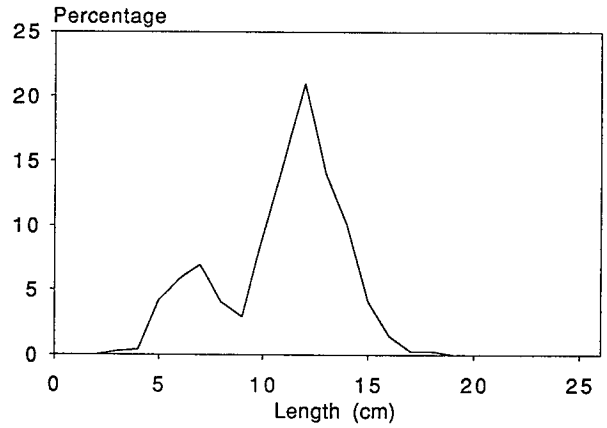
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Hooknose is very common in inshore waters, but it was also caught throughout the southern North Sea and, occasionally, in parts of the deeper central North Sea. Large catches of adults were made off the English coast in both seasons (e.g. 322 in rectangle 36F1 during a summer haul). Specimens smaller than 7 cm were less frequently caught than larger fish and appeared to be somewhat more confined to the shallower, coastal parts of the area. Hooknose, or pogge, is thought to prefer sandy bottoms [1], which may account for the fact that it was widely distributed over the southern and central North Sea, but most of the catches in the north were in coastal hauls.

Length composition

The length composition has two peaks, probably corresponding to one-year-old and older fish.



Length-frequency distribution of hooknose during winter.

Life history

Hooknose measuring 12 – 15 cm have been classified as adults [2], but no information on length-at-age or maturity has been found in the literature. The fecundity of hooknose ranges from 500 eggs in an 11 cm female to 2400 eggs in a 16 cm female [3]. Observations made near Helgoland at the turn of the century showed that clumps of eggs are attached to the stalks of large algae (*Laminaria* spp.). The incubation period is extremely long (10 – 12 months). Newly hatched pelagic larvae in this area were found mostly during February and March [4].

Hooknose from the Elbe estuary feed on the brown shrimp *Crangon crangon*, amphipods, and cumaceans. Gobiid fish are occasionally eaten [2].

Population and exploitation

It has been reported that this species migrates to deeper water in winter [5] but there is no evidence of such migration in the *Atlas* data.

Hooknose is of no economic importance.

References

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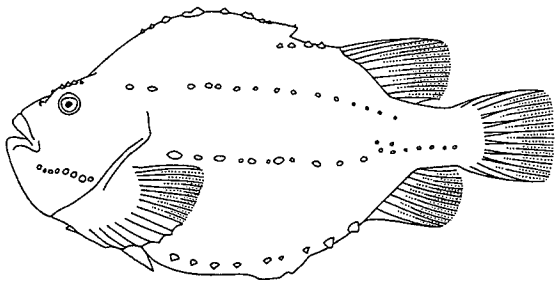
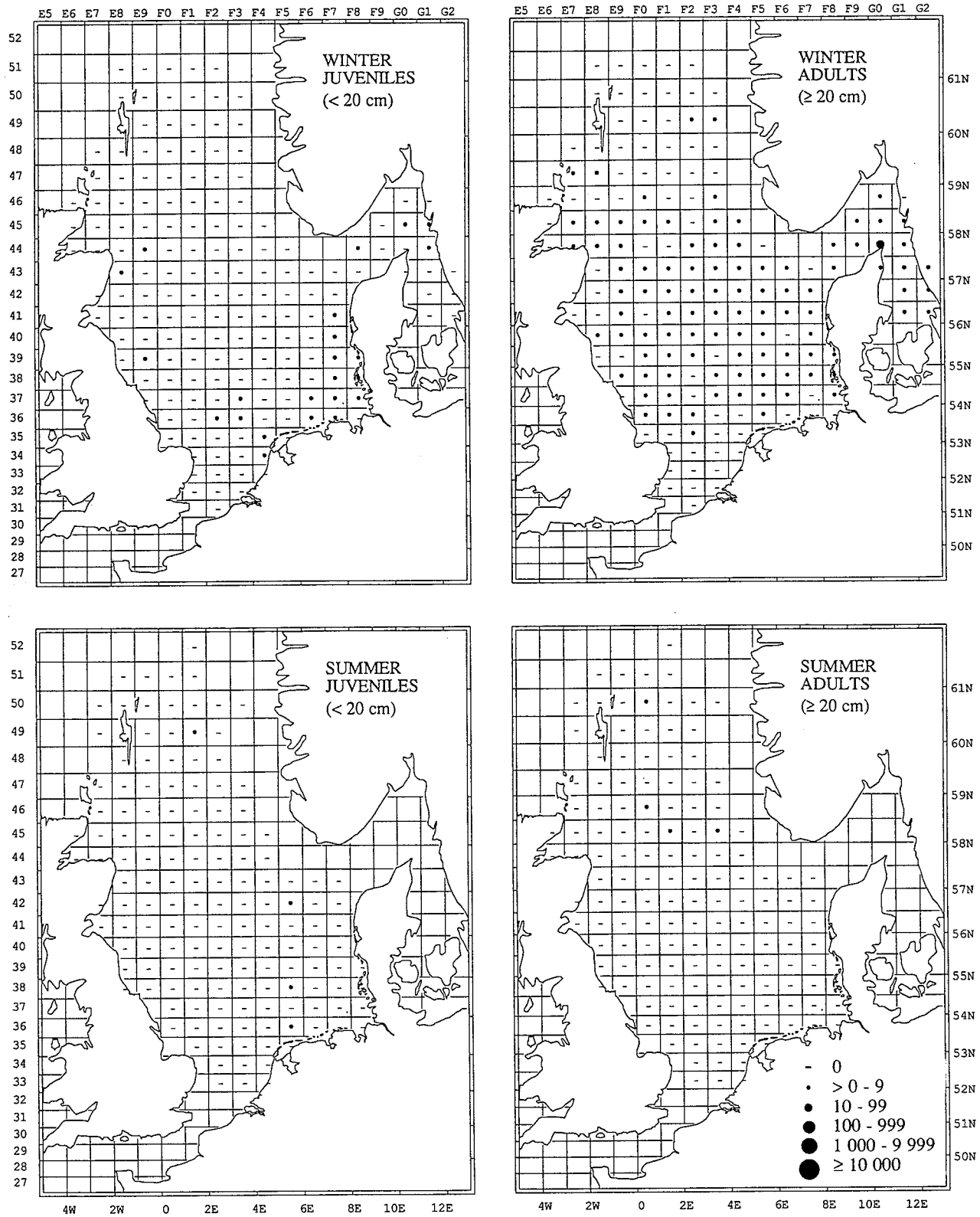
79. *Cyclopterus lumpus*
Family Cyclopteridae

E. Lumpsucker, F. Lompe, D. Seehase, DK. Stenbider,
N. Rognkjeks, NL. Snotolf, S. Sjurygg





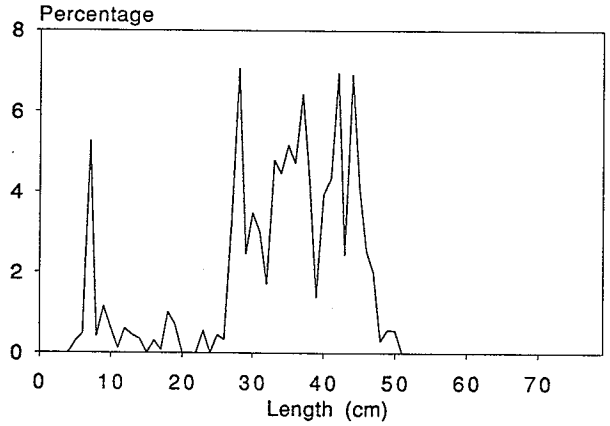
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Catches of lumpsucker during summer were small and widely distributed. In winter, however, adult lumpsucker were caught in almost every rectangle between latitudes 53° 30' N and 58° 30' N (including the Kattegat and Skagerrak) but were scarce in the northern and southern parts of the survey area. The juveniles were much less abundant and occurred mainly in shallow and/or coastal areas.

Length composition

Although there seems to be some disagreement about the age at first maturity (at three to five years of age) [1], the discontinuity in the length-frequency distribution at a length of 20 – 25 cm probably represents the separation between juvenile and adult lumpsuckers.



Length-frequency distribution of lumpsucker during winter.

Life history

This species has a different life history from most of its bottom-dwelling relatives such as sea snails (*Liparis liparis*, No. 80), spending part of its life pelagically in the open sea.

The ventral sucker, globiform body, and lack of a swim-bladder allow this species to spawn in turbulent inshore waters. The lumpsucker's neutral buoyancy proves very useful in maintaining a position in the water column when it is feeding pelagically on ctenophores and euphausiids [2].

Icelandic lumpsuckers grow to 10 cm in their second year of life; they attain 30 cm in their fourth year, and gradually they grow to a size of 50 cm in their tenth year of life. The maximum age observed is thirteen years [1].

The eggs are laid on stones and among weed beds, protected by the males which will attack even large intruders [3].

Population and exploitation

The distributional data are in line with earlier findings that adult lumpsucker migrate into shallow waters to spawn (in April in the southern Kattegat), and return to deeper waters afterwards, while larvae and juveniles spend most of their first year in rockpools and coastal, shallow waters [2,4]. However, the life cycle of the lumpsucker is not fully known. Pelagic catches of adults and juveniles have been made in both winter and summer, and it has been suggested that the lumpsucker is a pelagic or bathypelagic species which only visits the seabed to spawn [5].

Lumpsuckers are of some economic value, mainly on account of their roe which is used as a substitute for caviar.

References

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2. Davenport, J., and Thorsteinsson, V. 1990. Sucker action in the lumpsucker. Sarsia 75:33-42.
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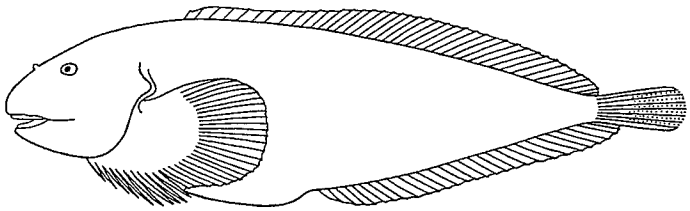
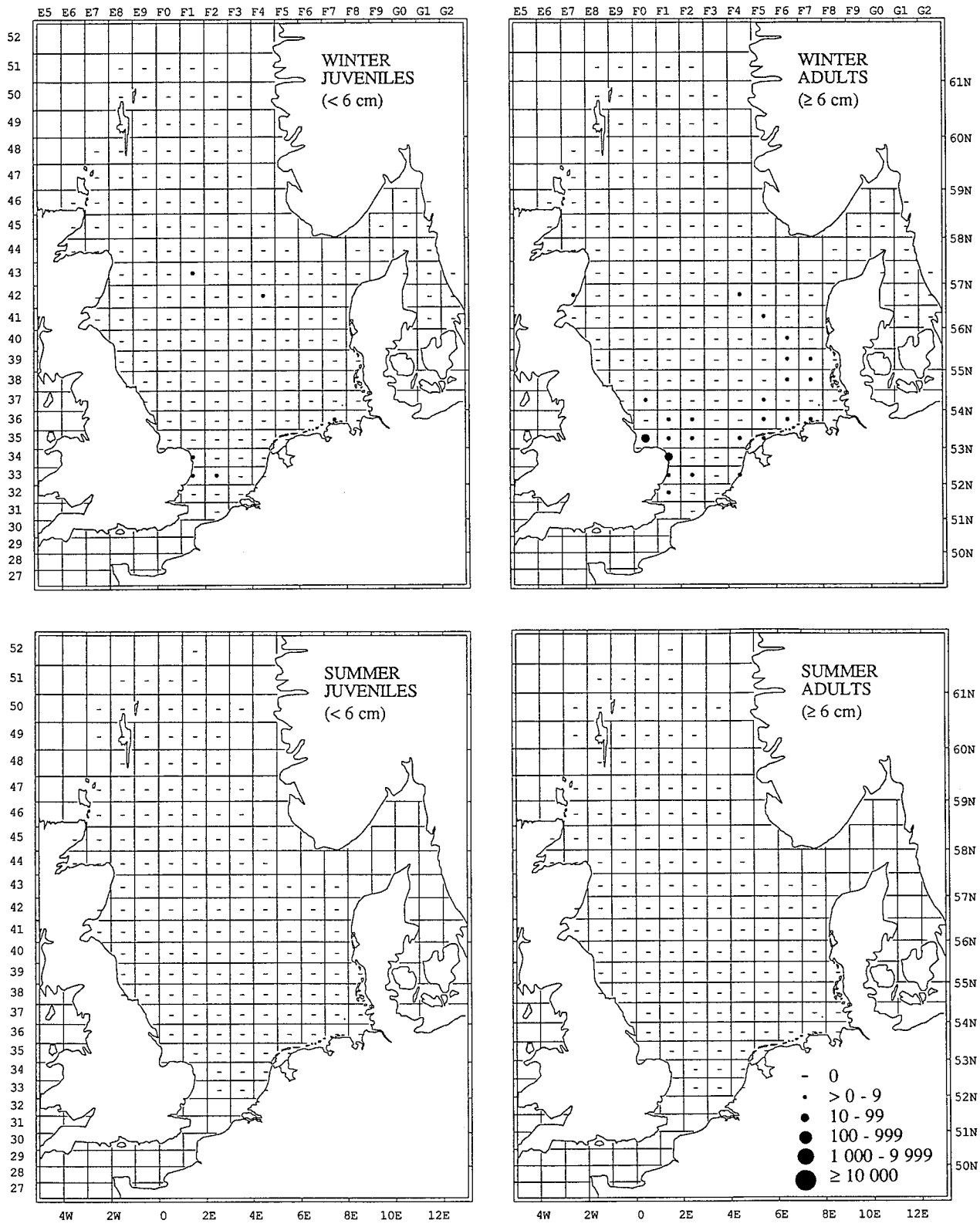
4. Bagge, O. 1967. Some preliminary results from tagging of lumpsucker (*Cyclopterus lumpus*) 1966. ICES CM 1967/F:23. 3 pp.
5. Blacker, R.W. 1983. Pelagic records of the lumpsucker. Journal of Fish Biology 23: 405-417.

80. *Liparis liparis*
Family Liparididae

E. Sea-snail, F. Limace de mer, D. Scheibenbauch,
DK. Finnebræmmet ringbug, N. Vanlig ringbuk,
NL. Slakdolf, S. Ringbuk





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

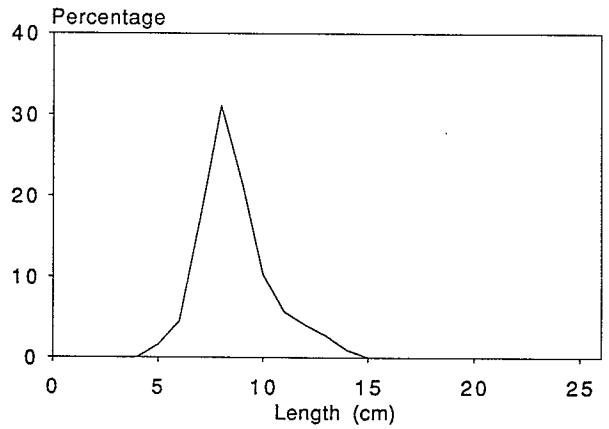
Spatial distribution

The sea-snail was caught only during the winter surveys. It was taken in very low densities off the English and continental coasts in the southern North Sea. Apart from six exceptionally rich hauls in rectangles 34F1 and 35F0 (20 – 30 m depth), no clear spatial gradation in density could be found.

N.B. Survey data on sea-snail may include data on its smaller relative, *Liparis montagui* (Montagu's sea snail).

Length composition

Individuals of 5 to 14 cm in length were caught.



Length-frequency distribution of sea-snail during winter.

Life history

Observations in aquaria reveal that the sea-snail attaches itself to a look-out point with its ventral sucker and either snaps at passing prey or chases them with short strokes of its fins [1]. Crustaceans such as *Crangon crangon* and amphipods (*Gammarus* spp.) are major components of the sea-snail's diet, but small fishes such as gobies are also eaten [1,2,3].

Population and exploitation

Sea-snail, a very common species in inshore waters, is abundant in the middle reaches of the Severn estuary during October – February. From February onward a seaward migration occurs to spawning grounds in the mouth of the Bristol Channel [2]. Winter catches in rectangles 34F1 and 35F0 may very well be examples of spawning aggregations in the southern North Sea. The demersal eggs are laid in clumps and are mostly found attached to hydroids [4]. The adult fish die after spawning when they are one year old [5]. This also explains the absence of catches in summer: the young fish are presumably too small to be caught.

This small species is of no economic importance.

References

1. Kühl, H. 1961. Nahrungsuntersuchungen an einigen Fischen im Elbe-Mündungsgebiet. Berichte der Deutschen Wissenschaftlichen Kommission für Meeresforschung 16(2): 90-104.

2. Badsha, K.S., and Sainsbury, M. 1978. Some aspects of the biology and heavy metal accumulation of the fish *Liparis liparis* in the Severn estuary. Estuarine and Coastal Marine Science 7: 381-391.

3. Quéro, J., Dunne, J., and Labastie, J. 1980. Les *Liparis liparis* (Linné, 1766) (Pisces, Scorpaeniformes, Liparidae) du canal Saint-Georges et du canal de Bristol. Distribution, abondance et remarques biologiques. Revue des Travaux de l'Institut des Pêches Maritimes 44(3): 235-243.

4. Russell, F.S. 1976. The eggs and planktonic stages of British marine fishes. Academic Press, London. 518 pp.

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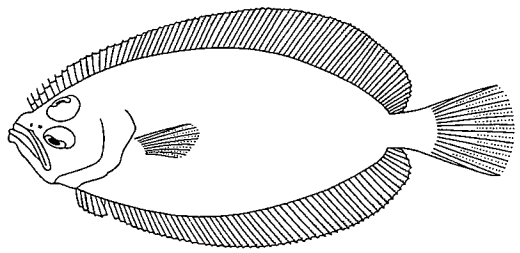
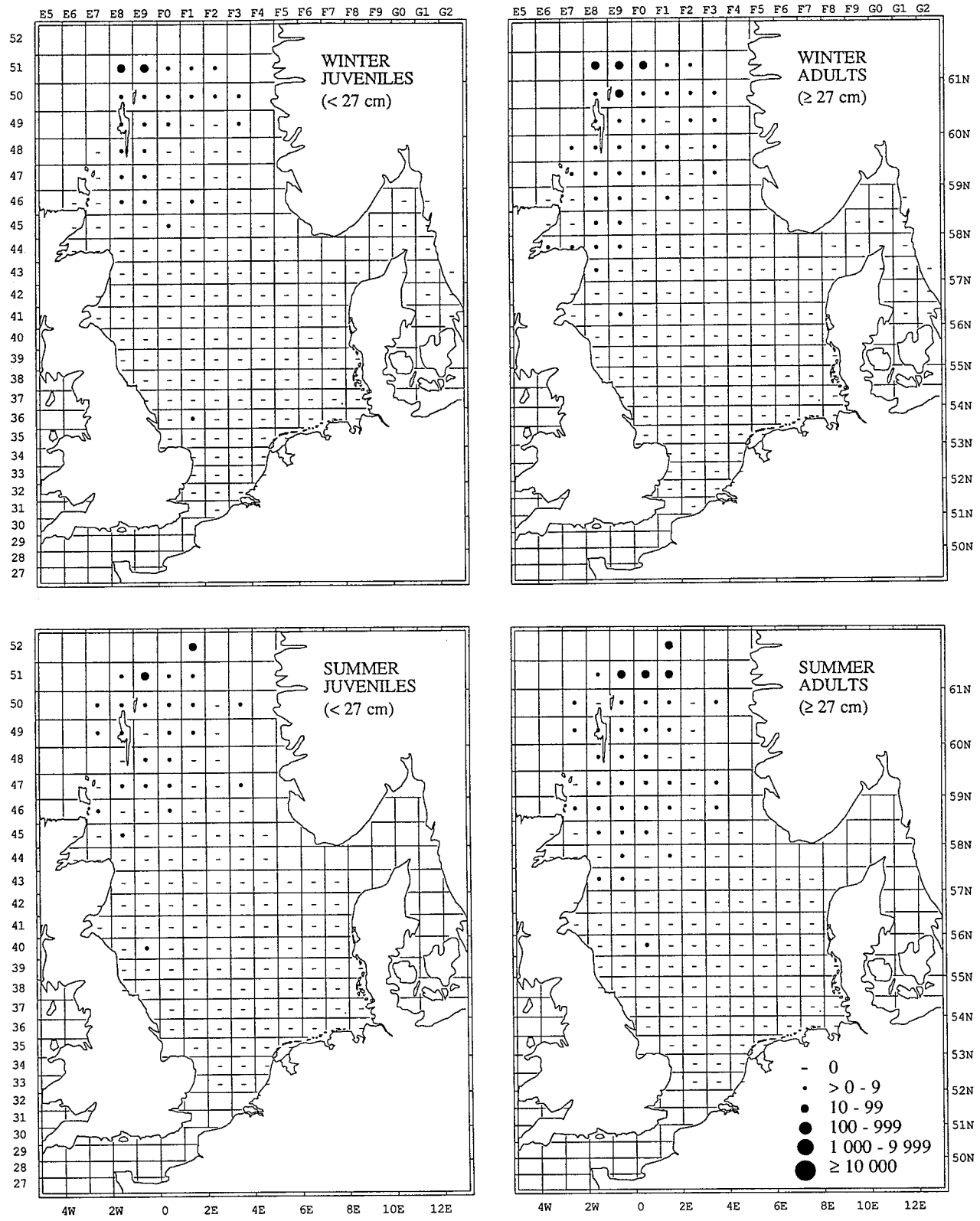
81. *Lepidorhombus whiffiagonis*
Family Scophthalmidae

E. Megrim, F. Cardine, D. Flügelbutt, DK. Glashvarre,
N. Glassvar, NL. Scharretong, S. Glasvar





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

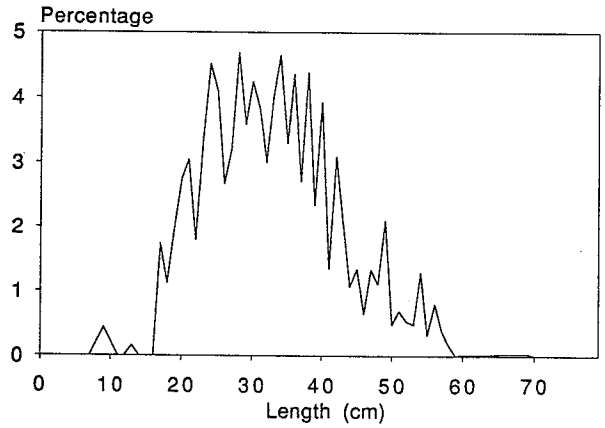
Spatial distribution

Megrim was seldom caught in waters less than 100 m deep, and only during the deepest *Atlas* hauls in the north did catches become substantial. No seasonal differences in spatial distribution could be detected.

The existence of a close relative, *Lepidorhombus boscii* (four-spotted megrim), should be mentioned, as it may occur in the deeper parts west of Shetland [1].

Length composition

A wide range of length classes of this flatfish were caught, but the majority measured between 20 and 40 cm.

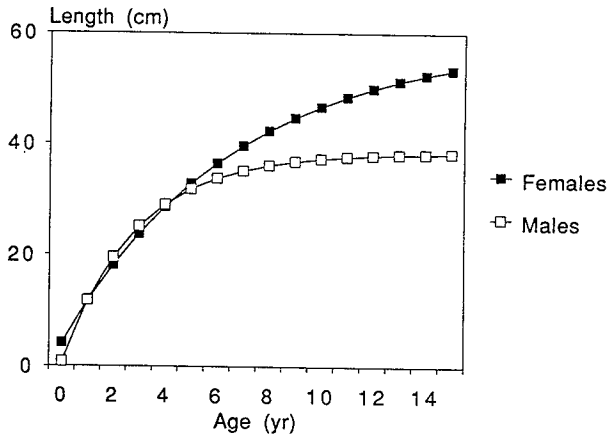


Length-frequency distribution of megrim during winter.

Life history

North Sea megrim feeds predominantly on crustaceans (*Crangon* spp., *Pandalus* spp., mysids) and, especially for the larger ones, on fish such as sandeel, Norway pout, and *Pomatoschistus* spp. The prey is probably caught just above the sea floor [2].

Females grow to a bigger size than males, as is usual in flatfish. Maturity in Celtic Sea specimens is attained at 25 – 28 cm [3].



Length-at-age of Celtic Sea megrim [3].

Population and exploitation

Gonads of megrim from the Celtic Sea are fully developed in March – April [3]. There are no separate nursery or spawning grounds recognized in the North Sea [4].

This flatfish, whose price has increased markedly in recent years, is of moderate economic importance. Yearly North Sea catches have fluctuated between 500 and 1000 t since 1945. Between the two World Wars annual catches peaked at nearly 2000 t.

References

1. Wheeler, A. 1978. The fishes of northern Europe. Frederick Warne, London. 380 pp.
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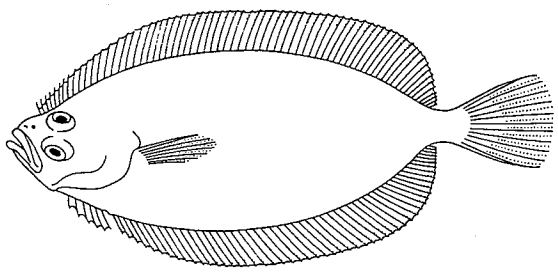
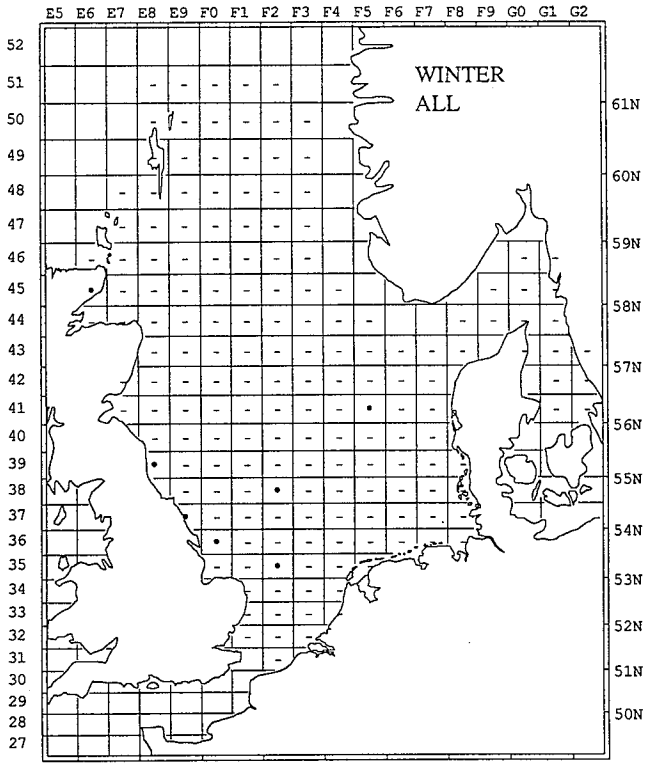
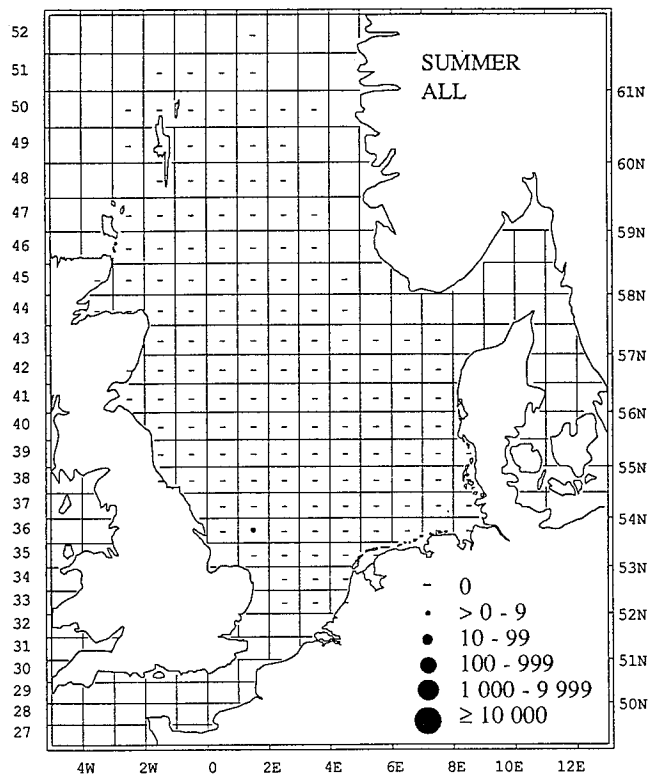
3. Aubin-Ottenheimer, G. 1987. Bilan des connaissances sur la cardine (*Lepidorhombus whiffiagonis*). Etude du stock de Mer Celtique. Revue des Travaux de l'Institut des Pêches Maritimes 49(3-4): 205-214.
4. Rae, B.B. 1970. The distribution of flatfishes in Scottish and adjacent waters. Marine Research 2: 1-39.

82. *Phrynorhombus norvegicus*
Family Scophthalmidae

E. Norwegian topknot, F. Phrynorhombe de Norvège,
D. Zwergbutt, DK. Småhvarre, N. Småvar, NL. Dwergbot,
S. Småvar







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Twenty specimens of Norwegian topknot were caught on eight occasions. These hauls were either on inshore grounds or in fairly shallow offshore waters. Because this species is small and prefers rough grounds, it may have been under-represented in the *Atlas* surveys.

Length composition

The fish were in the length range 5 – 10 cm, representing the upper half of the size band of this species; the maximum size is about 12 cm [1].

Life history

Norwegian topknot is usually caught in fairly shallow water (20 – 50 m) but has also been taken in deeper waters (170 m) [1].

There appears to be no information on age and growth rate in the *Atlas* area. This small flatfish is believed to eat polychaete worms, crustaceans, and small fishes [1].

Spawning takes place in spring and early summer off southwest Britain, and later in the north [2]. The eggs and larvae are pelagic.

Population and exploitation

The range of Norwegian topknot extends from Biscay to the north coast of Norway. It also occurs in Icelandic waters.

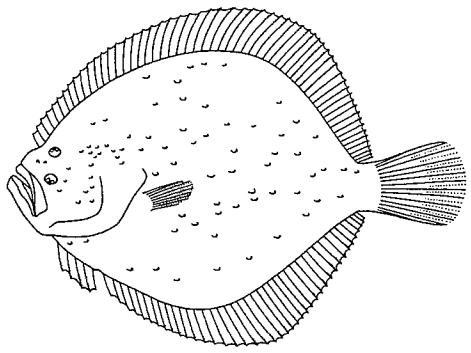
This species is of no economic importance.

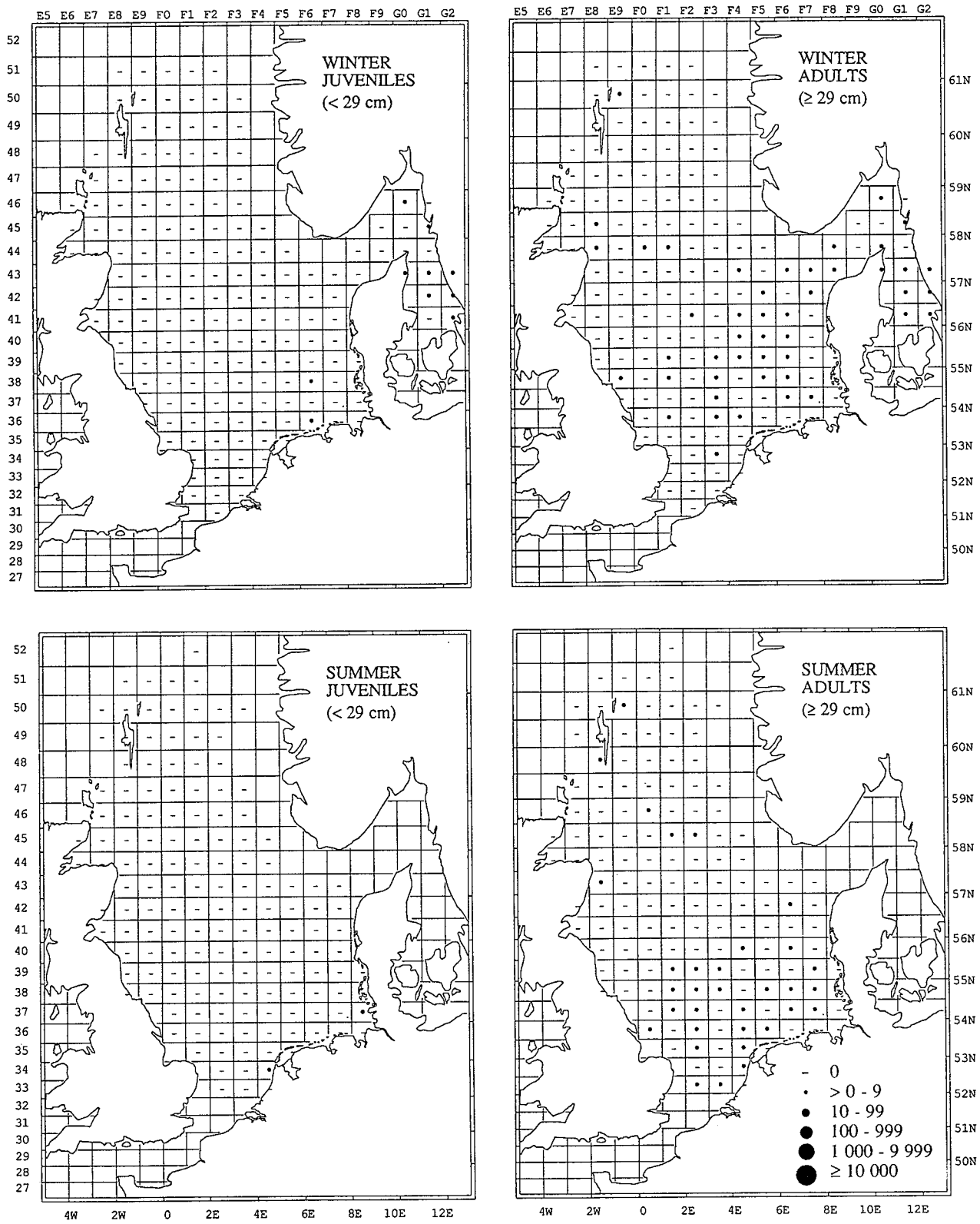
References

1. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.
2. Wheeler, A. 1969. The fishes of the British Isles and north-west Europe. Macmillan, London. 613 pp.

83. *Psetta maxima*
Family Scophthalmidae

E. Turbot, F. Turbot, D. Steinbutt, DK. Pighvarre,
N. Piggvar, NL. Tarbot, S. Piggvar





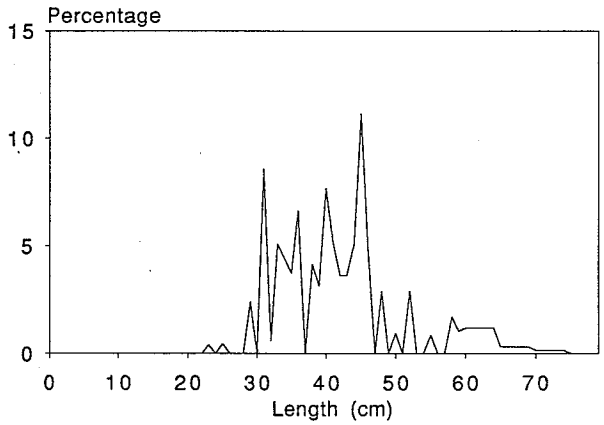
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Although it was caught on occasion as far north as Shetland, turbot's main area of occurrence was found to be to the west of Denmark and in the Skagerrak and Kattegat. Compared with the distribution in winter, the centre of occurrence during summer was situated farther south. Turbot mostly appeared in the catches as single specimens.

Length composition

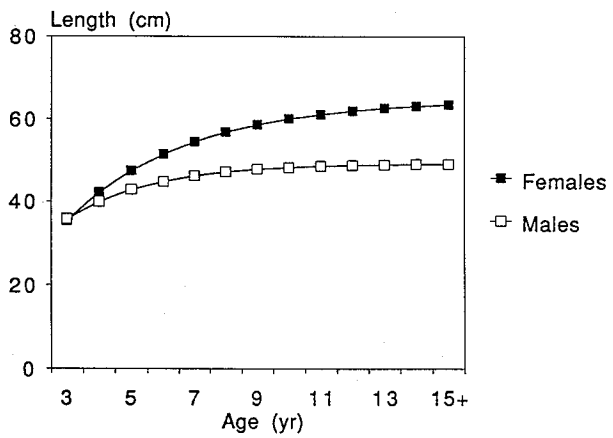
Fish 23 to 75 cm in length were caught during the surveys. This large flatfish is known to attain a length of 100 cm and a weight of 25 kg [1].



Length-frequency distribution of turbot during winter.

Life history

The turbot is a voracious predator. The young feed on a variety of benthic prey (e.g. polychaete worms, mysids), but at a length of approximately 20 cm they switch to a diet consisting almost entirely of fish. Sandeels, gobies, herring, sprat, cod, whiting, haddock, Norway pout, dab and long rough dab, dragonets, and lesser weever are only a few of the many species taken [2,3,4].



Length-at-age of turbot [5].

Females grow to a larger size than males. Fifty per cent of the four- to five-year-old females are mature [5].

The numbers of eggs produced per spawning season range from 1.0 million eggs for a 1 kg fish to 7.2 million eggs for a 7 kg fish. This is the equivalent, on average, of 1100 eggs per gram body weight [6].

Population and exploitation

Spawning takes place from May to August. Relatively important spawning grounds are Aberdeen Bank (rectangle 43E8) and, of course, Turbot Bank (rectangle 43E9) in the north [2], while major spawning concentrations in the south occur around and to the north of the Dogger Bank. Several other smaller spawning grounds are recognized throughout the area [7].

The young are dispersed to suitable nursery areas during their pelagic phase and appear in shallow, knee-deep waters between June and October. One- and two-group juveniles of up to 30 cm are mostly found in waters less than 14 m in depth, while fish of 30 – 45 cm move into waters of 21 – 50 m depth. Larger specimens are confined to even deeper waters [2,3].

Although landed in relatively small quantities (yearly catches have fluctuated around 5000 t since the turn of the century), turbot is an extremely valuable food fish, which fetches a higher unit price than almost any other fish taken from the North Sea [5]. The tasty flesh and the high price make it a promising fish for aquaculture.

References

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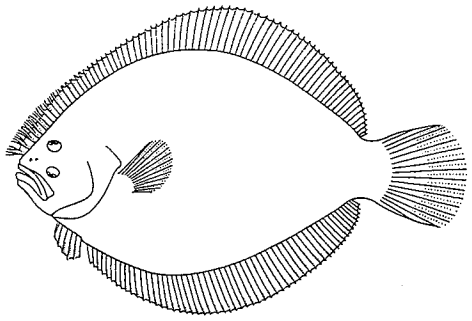
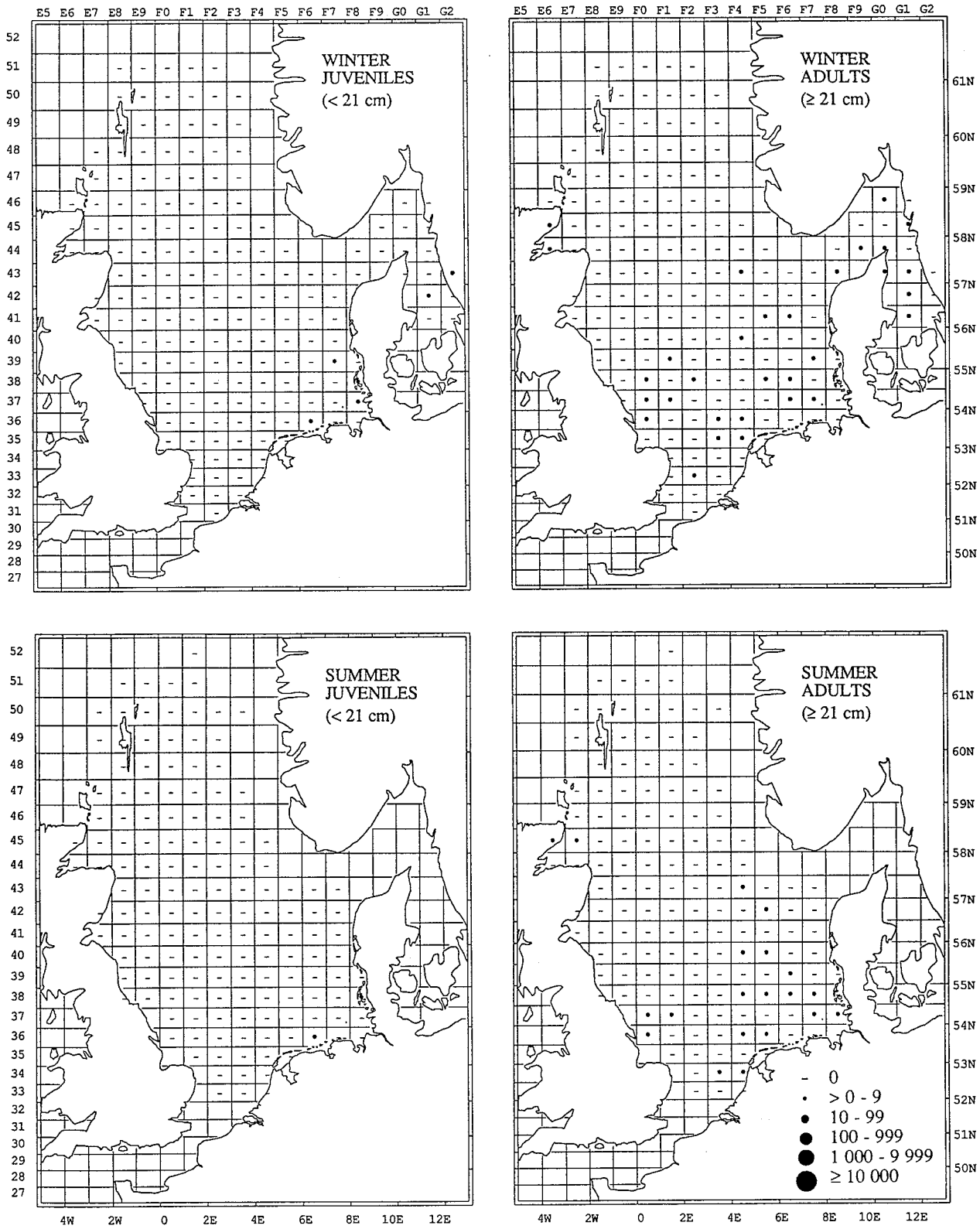
84. *Scophthalmus rhombus*
Family Scophthalmidae

E. Brill, F. Barbue, D. Glattbutt, DK. Slethvarre,
N. Slettvar, NL. Griet, S. Slätvar





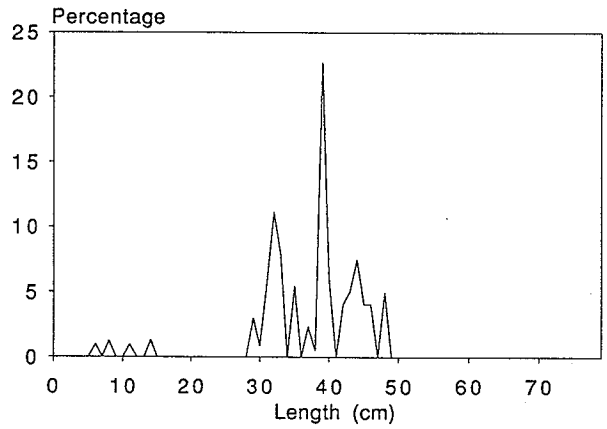
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Brill was mostly caught in the southern part of the North Sea and in the Skagerrak and Kattegat, though less regularly and in lower numbers than turbot. A few specimens were taken from northern rectangles, relatively isolated from the main concentration in the south.

Length composition

Winter hauls principally contained specimens in the range 30 to 45 cm.



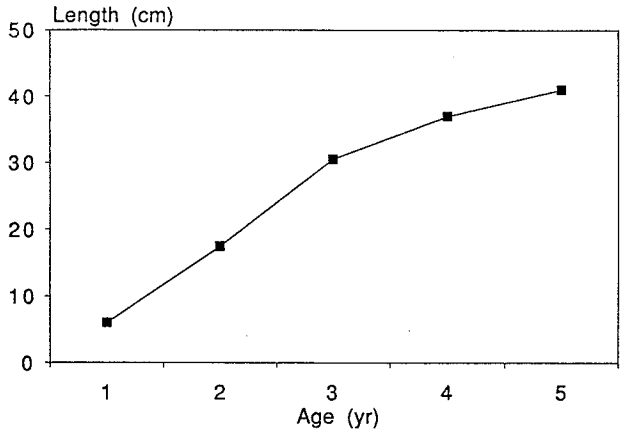
Length-frequency distribution of brill during winter.

Life history

This flatfish is very similar to the turbot (No. 83) in appearance, life style, and distribution.

Like turbot, brill is an active predator which feeds largely on fish. Gobies, sandeel, gadoids, and clupeoids are important prey for brill (> 25 cm) in the southern North Sea [1].

Length-at-age distributions calculated for southern North Sea females in the summer months of their first five years of life are given in the figure [2]. As is usual in flatfish, the females grow to a larger size than the males. Fifty per cent of the females are sexually mature at the age of three years [3].



Length-at-age of female brill [2].

Population and exploitation

The spawning period of brill overlaps with that of turbot. Newly hatched young appear in the very shallow waters along the sandy beaches of the Dutch coast in July and August. One- and two-year-old brill share this shallow strip of sea with the 0-group specimens, but most brill have moved to deeper waters by the age of three [2].

Brill is of moderate commercial importance, taken as by-catch in the fishery for sole and plaice. An average yearly catch of 1000 t was landed during the period 1960 – 1985.

References

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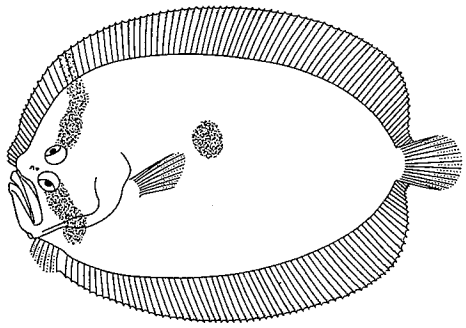
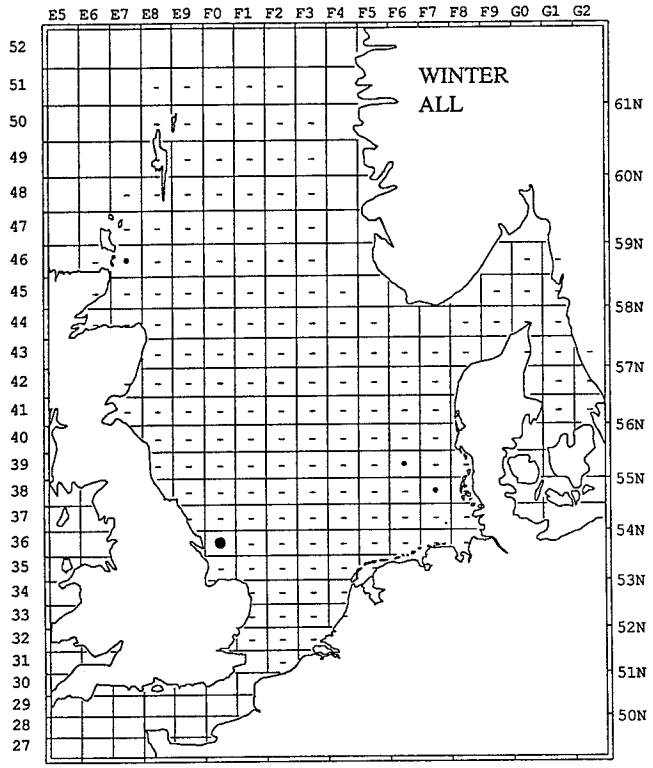
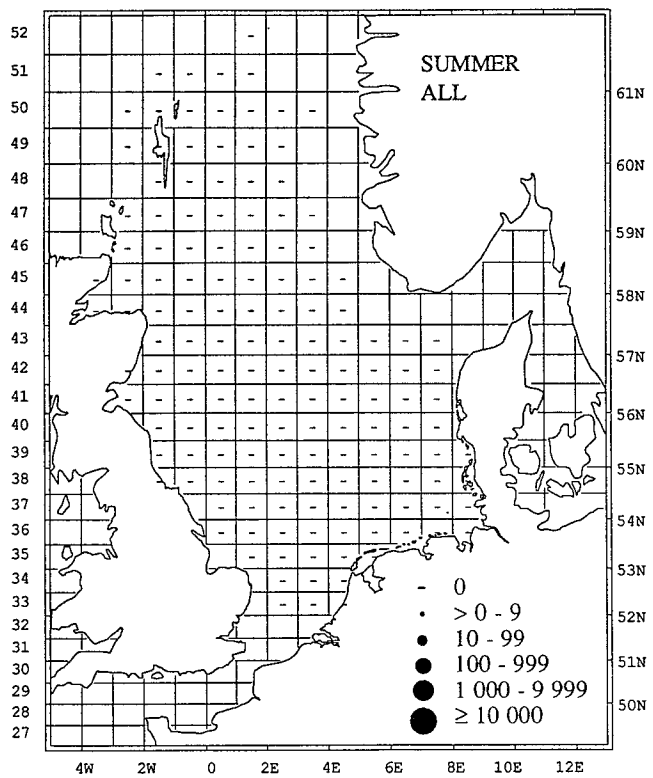
2. Lucio. P. 1986. On the methodology of length back-calculation from otoliths in flatfish with particular reference to brill: *Scophthalmus rhombus*, L. ICES CM 1986/G:52. 13 pp.
3. Lucio, P. 1988. Surplus energy allocation patterns in some fish species of the North Sea. ICES CM 1988/G:12. 11 pp.

85. *Zeugopterus punctatus*
Family Scophthalmidae

E. Topknot F. Targeur, D. Haarbutt, DK. Hårhvarre,
N. Hårvar, NL. Gevlekte griet, S. Bergvar







Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Topknot was caught only in the 1986 winter survey, when twelve specimens were taken in four hauls. Topknot occurred in both the northern and the southern parts of the area.

Topknot is believed to be a shallow-water species, usually found close inshore in depths of 1 – 40 m. Because it usually occurs on stony ground, trawl surveys may not give a good picture of its distribution.

Length composition

All the specimens were rather small (7 – 10 cm), well below the maximum size of 25 cm [1].

Life history

Topknots can sometimes be seen clinging to the surface of stones and algae. It is believed that they feed mainly on crustaceans and small fishes [1,2].

Spawning takes place in spring in the western English Channel and the eggs and larvae are pelagic [3].

Population and exploitation

The distribution extends from Biscay to the west coast of Norway.

Topknot is of no economic importance.

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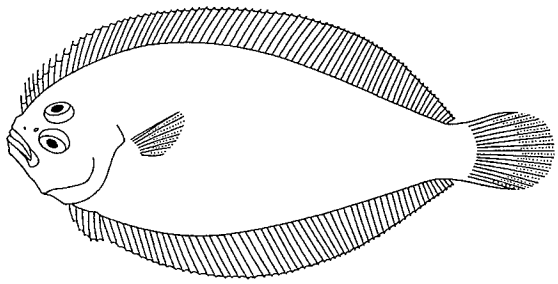
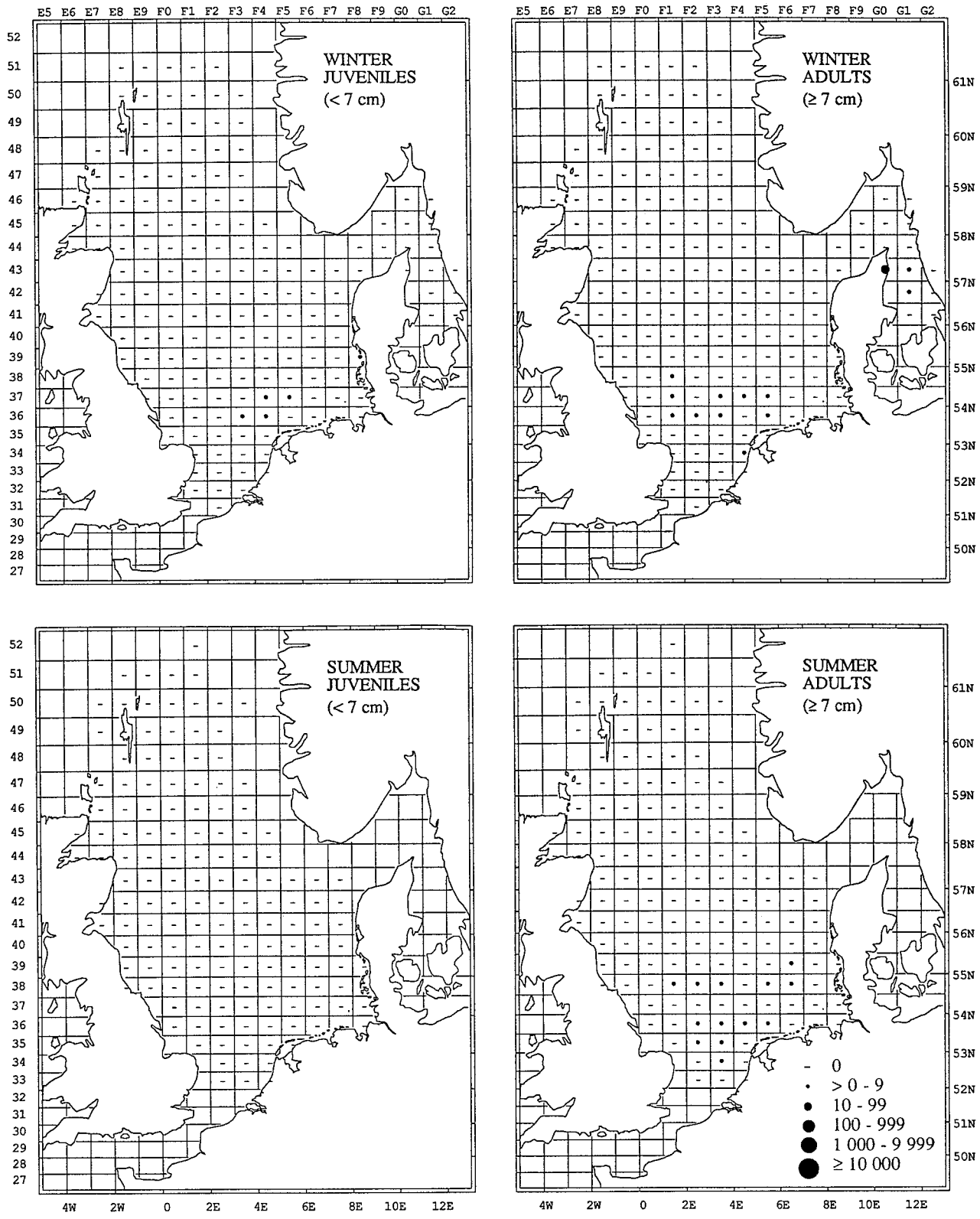
86. *Arnoglossus laterna*
Family Bothidae

E. Scaldfish, F. Arnoglosse laterne, D. Lammzunge,
DK. Tungehvarre, N. Tungevar, NL. Schurftvis, S. Tungevar





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

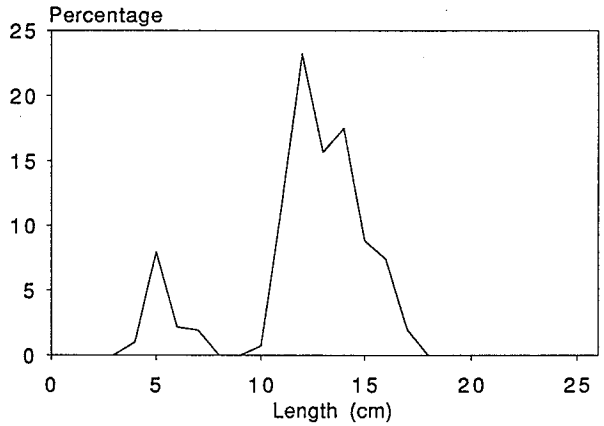
Spatial distribution

During the *Atlas* surveys scaldfish was only caught in the shallow waters of the central part of the southern North Sea and in the Kattegat. A more detailed beam-trawl survey in Dutch territorial waters showed this fish to be common everywhere, except in the northern, silty part of that area [1]. Scaldfish is regarded as rare off the Scottish east coast [2].

No evidence was found that densities increase going into shallow waters, and this suggests that the *Atlas* data mirror the scaldfish's distribution fairly realistically.

Length composition

The smaller size group of 4 – 7 cm individuals was observed during winter surveys only and presumably represents one-year-old fish.



Length-frequency distribution of scaldfish during winter.

Life history

The length distribution indicates that the catches may be a mixture of young (probably one-year-old) fish in the length range 4 – 6 cm, and older fish. However, the limited available information in the literature suggests that scaldfish grows slowly, taking up to thirteen years to reach a length of 14 cm [3], and the smaller size group caught may be made up of several age classes. Maturity is attained at 6 – 7 cm.

This small bothid flatfish is known to feed on mysids and amphipods, decapod crustaceans (crangonid and pandalid shrimps in particular), polychaete worms, and small fish such as gobiids [3].

Population and exploitation

Little is known about scaldfish life history other than that eggs in the southern North Sea have been found in May – June [4].

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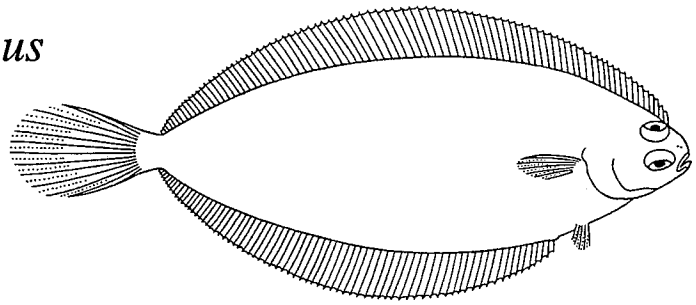
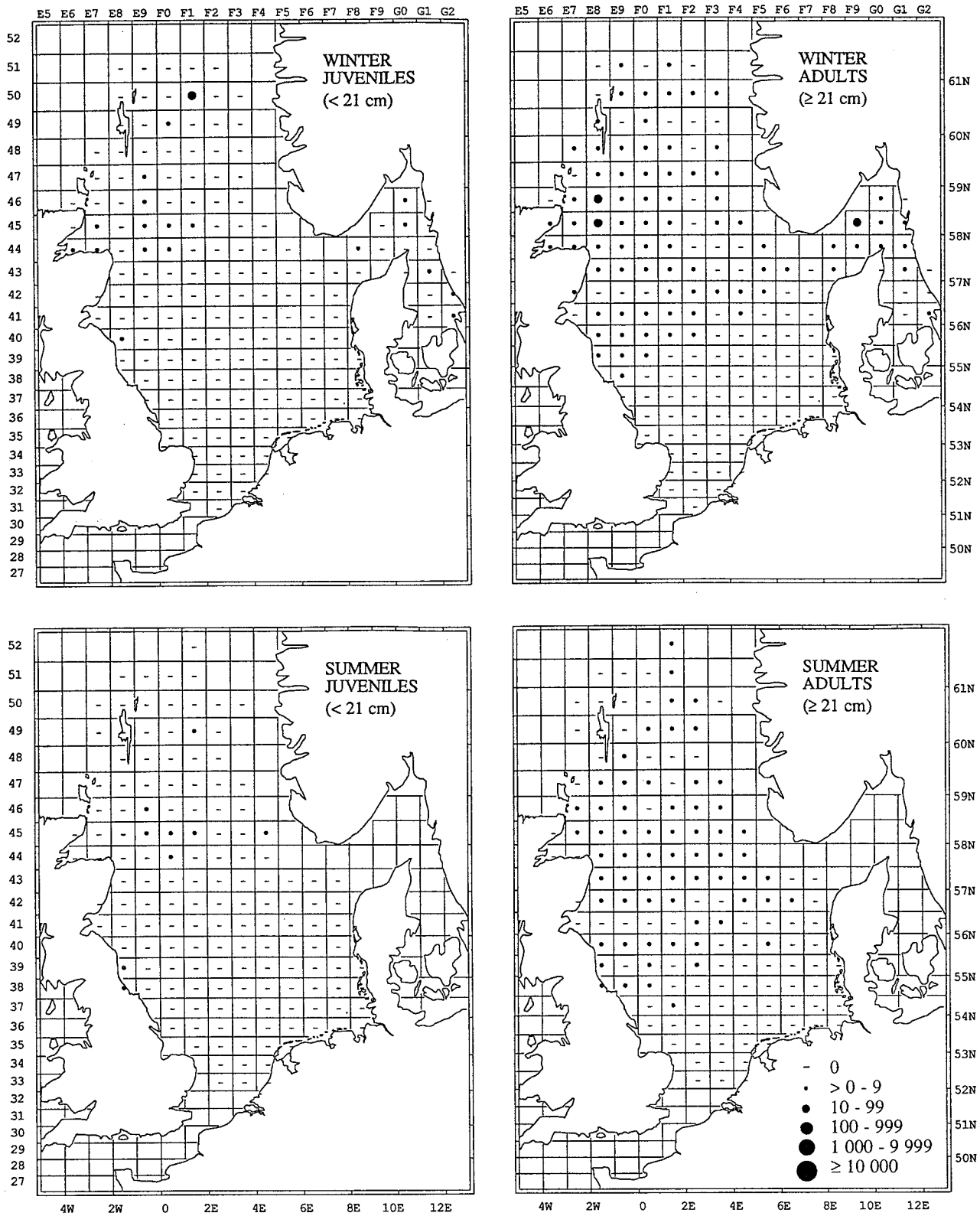
87. *Glyptocephalus cynoglossus*
Family Pleuronectidae

E. Witch, F. Plie cynoglosse, D. Rotzunge,
DK. Skærising, N. Smørflyndre, NL. Witje, S. Rödtunga





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

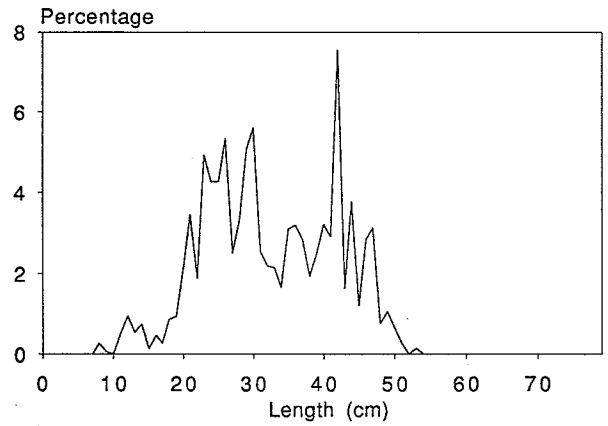
Spatial distribution

Modest numbers of witch were caught throughout the northern, deeper parts of the area. Notwithstanding its presence in a few more southern rectangles during summer, witch can be said to be generally absent from the shallow areas south of the Dogger Bank. This flatfish is abundant in the Norwegian Deep [1].

The smaller fish were mostly caught in the northern North Sea and in the Skagerrak and Kattegat during winter.

Length composition

A bimodal length distribution with peaks at around 25 and 40 cm has been observed before [2] and probably corresponds with animals of approximately 3 – 5 and 8 – 10 years old [4].



Length-frequency distribution of witch during winter.

Life history

Studies on the stomach contents of witches from the North Sea and bordering waters suggest that it mainly feeds on polychaete worms and crustaceans (amphipods, cumaceans, decapods, mysids). Highly mobile or pelagic prey are not usually eaten [3,4].

In common with other flatfishes, witch has pelagic eggs and larvae. However, it descends to the bottom at a considerably greater size than the other species, and can still be caught in pelagic trawls at a length of 5 – 6 cm [5]. Witch is said to have a preference for muddy bottoms [3].

Population and exploitation

Spawning in the Irish Sea takes place in late March, April, and May [6], but some months later in the North Sea [7]. It is interesting to note that although witch appears to be more or less restricted to the northern half of the North Sea, eggs have been found in the southeastern North Sea between January and June [8].

This flatfish is of moderate economic importance. Post-war catches in the North Sea have never again reached the level of the interwar years (2500 t), although during the early 1980s yearly catches rose from 1000 to 2000 t.

References

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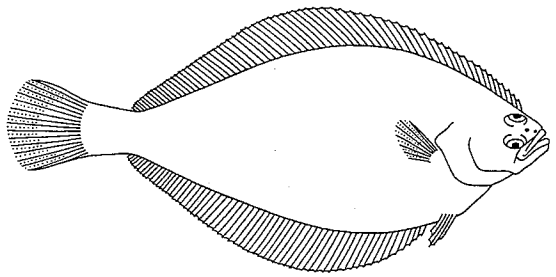
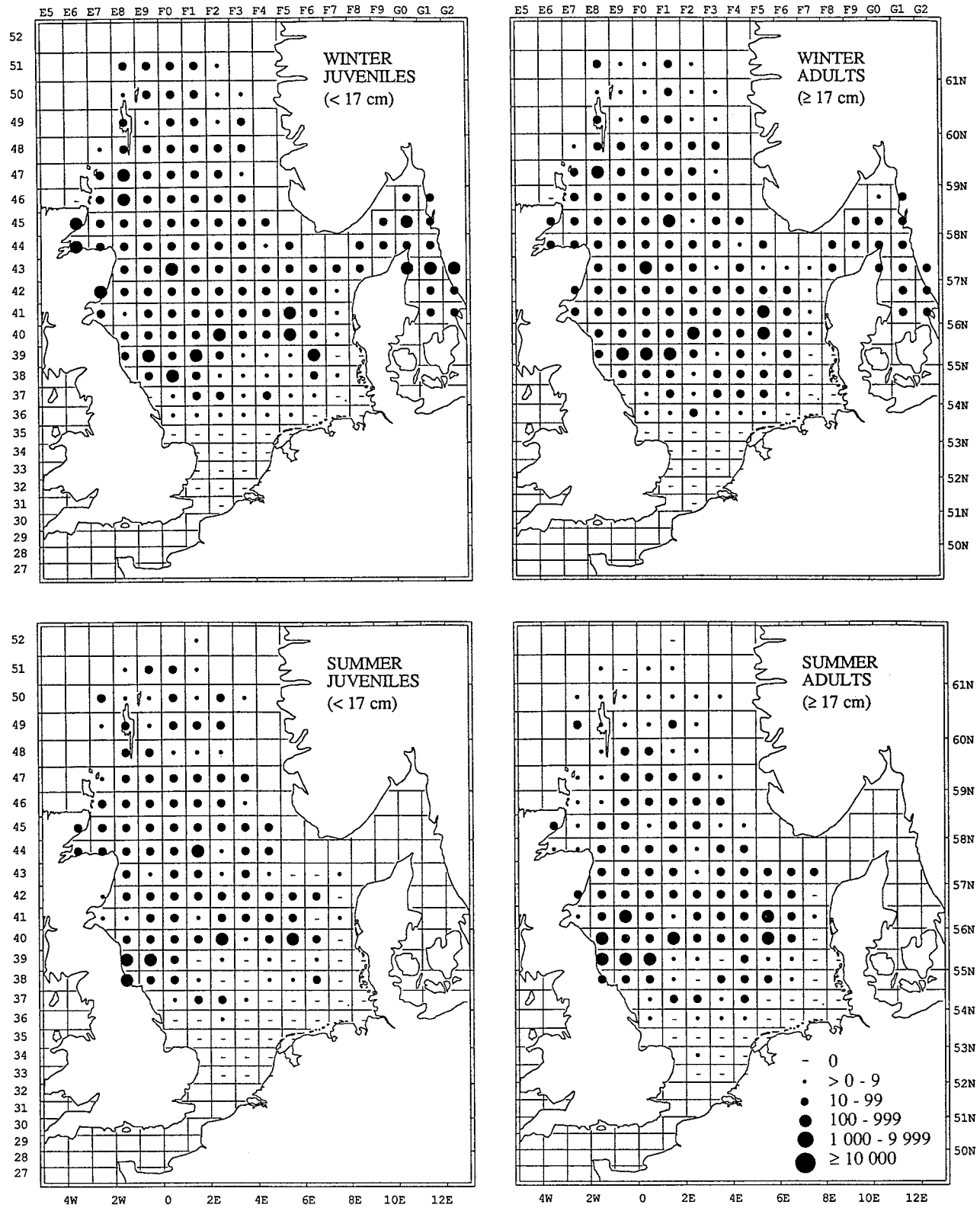
88. *Hippoglossoides platessoides*
Family Pleuronectidae

E. Long rough dab, F. Balai, D. Doggerscharbe,
DK. Håising, N. Gapeflyndre, NL. Lange schar, S. Lerskädda





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Long rough dab is the most abundant flatfish in the northern part of the survey area [1]. It was virtually absent from hauls made in the Southern and German Bights.

Local areas of relatively high densities were found all over the central and northern part of the North Sea and in the Skagerrak and Kattegat. With the possible exception of a concentration of adult specimens in the central part of the North Sea during summer, no evident patterns in distribution could be detected.

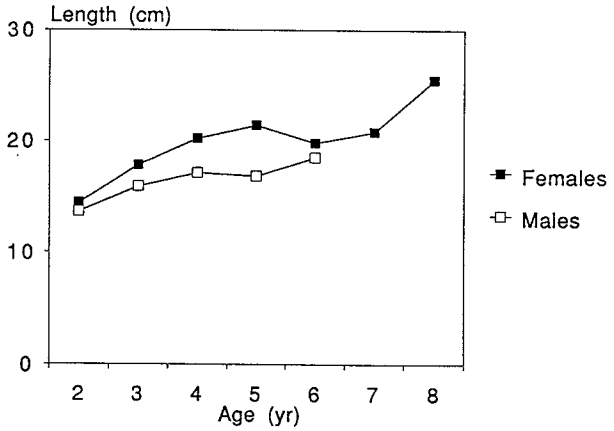
Length composition

Long rough dab caught during the winter surveys measured on average 15 cm. The smaller size classes formed the major part of the catches in northern and central areas 1, 2, and 3. The dominance of the smaller fish was even more prominent in the Skagerrak and Kattegat (area 8).

Life history

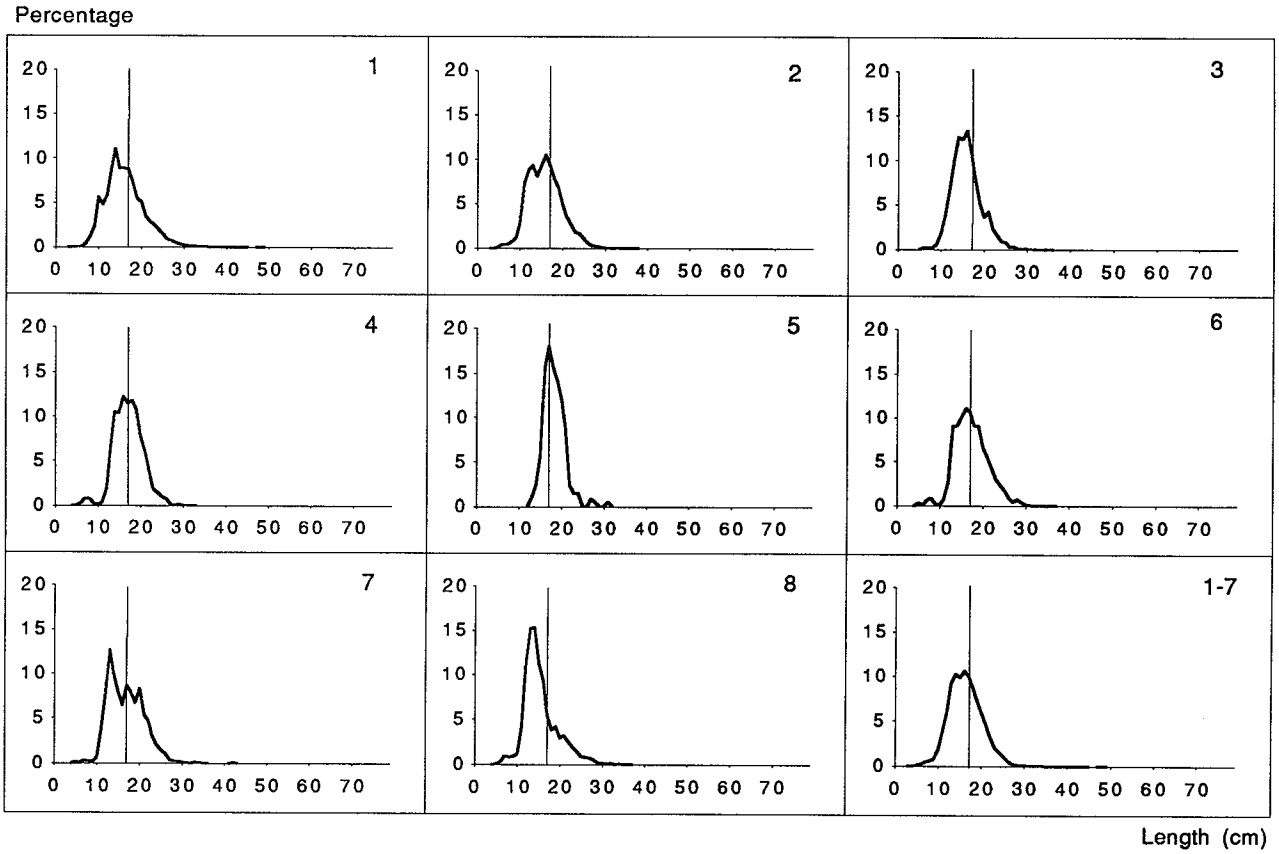
Long rough dab from the west of Scotland produce approximately 1300 eggs per gram body weight (80,000 to 100,000 eggs for a 21 cm individual) [6].

A growth curve for specimens from the central North Sea is given below. Ages of up to six years are quite common in the central North Sea, but long rough dab caught in the German Bight, at the species' southern margin of occurrence, are seldom more than two years old [7]. Fifty per cent of the fish have matured at the age of three and it is likely that all long rough dab of seven years and older are mature [8].



Mean length-at-age (cm) of specimens caught in the central North Sea during February 1978 and 1979 [7].

Important prey items for the planktonic larvae in the northern North Sea are the copepod *Calanus finmarchicus* and to a lesser extent appendicularians [3]. For larger (3 – 17 cm) long rough dab from the Fladen Ground polychaete worms are the most important prey. They also feed on bivalves, ophiuroids, and amphipods (9). Sandeel, gobies, dragonet, gurnard, and long rough dab itself are common prey for many of the adult long rough dab in the Clyde Sea area (west of Scotland) [10].



Length-frequency distribution of long rough dab by roundfish area during winter (length split indicated).

Population and exploitation

Eggs or larvae have been found in the southern and northern border of its range [3,4] and spawning is expected to occur in any area where the long rough dab lives [5]. Absence of any clear large-scale movements of mature fish confirm this expectation. Eggs were found in the southern North Sea between January and March [4], and both eggs and larvae were observed off the north-eastern English coast during February and September [2].

No statistics are available for this economically unimportant flatfish. A larger North American subspecies is commercially exploited.

References

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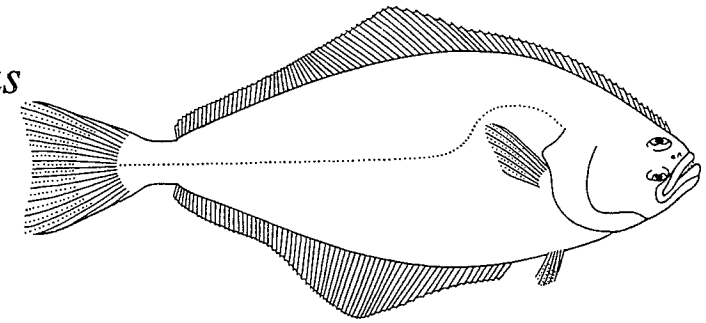
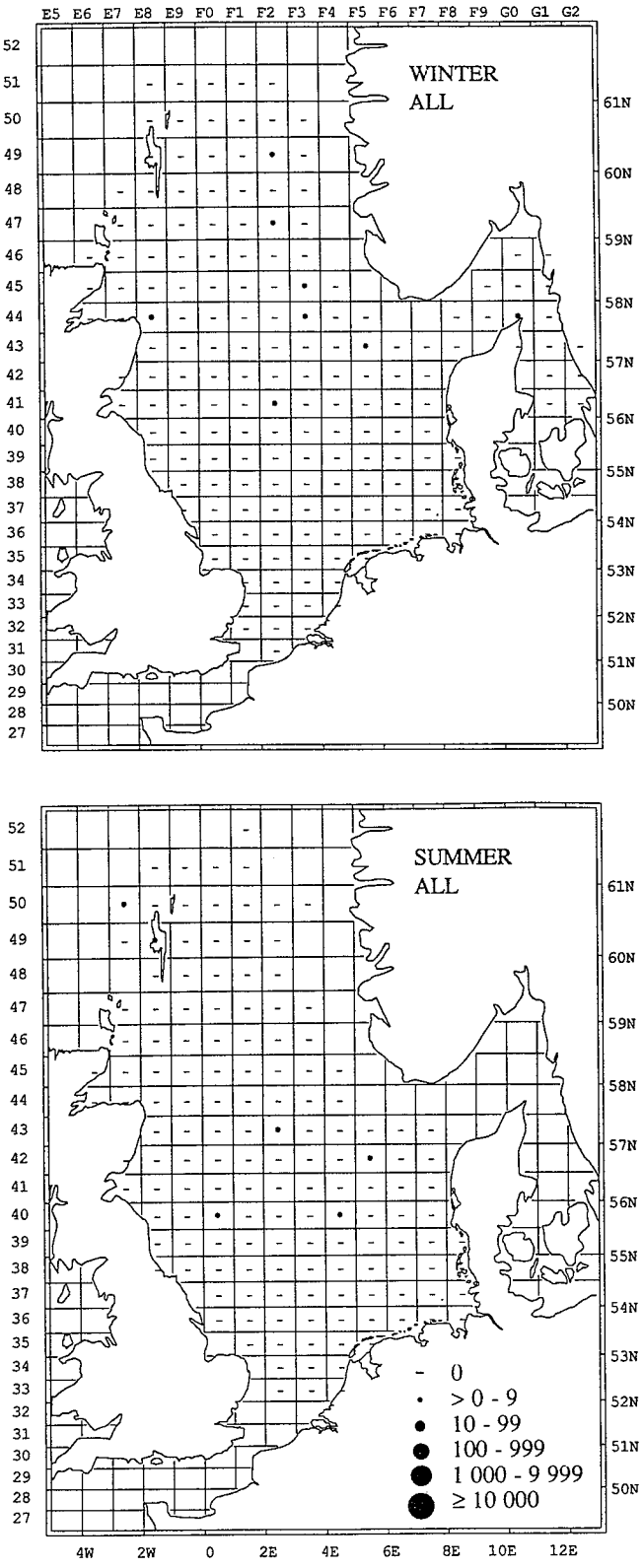
89. *Hippoglossus hippoglossus*: see page 226.

89. *Hippoglossus hippoglossus*
Family Pleuronectidae



E. Halibut, F. Flétan, D. Weißer Heilbutt,
DK. Helleflynder, N. Kveite, NL. Heilbot, S. Hälleflundra



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

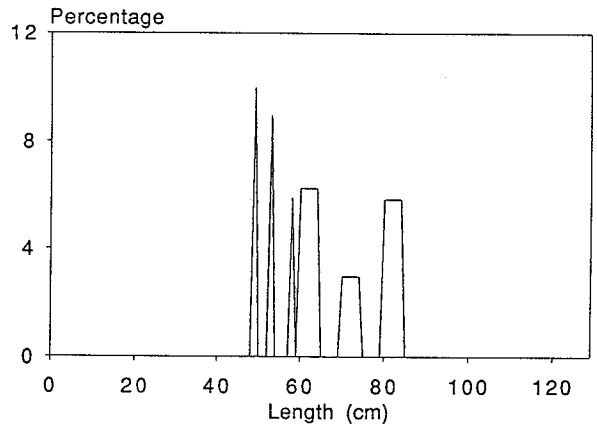
Spatial distribution

Catches of halibut in the *Atlas* area were very meagre; none was caught south of 55°30'N.

Length composition

The size distribution is very irregular due to the low catches.

A 250 cm (114 kg) specimen, caught by a commercial vessel to the north of the Great Fisher Bank in May 1992, was described as 'enormous', although in earlier days, before the heavy overfishing of the North Sea, halibut could attain four metres or more [1,2]. During the *Atlas* surveys, neither large (> 85 cm) nor small (< 50 cm) halibut were caught.



Length-frequency distribution of halibut during winter.

Life history

Halibut has a large potential for egg production. Depending on body size, females are able to produce 0.5 – 7 million eggs per spawning season [3].

Female halibut from the Faroes reach 40 cm when they are three years old; they measure 80 cm at the age of seven years, and are 200 cm when they are eighteen years old. The males, which grow more slowly than the females, mature at 4.5 years or 55 cm length, while the females mature at the age of seven years (or 110 – 115 cm) [4].

Examination of stomach contents of North Sea halibut confirms findings from other areas that the larger specimens feed almost entirely on fish. Remains of whiting, haddock, and poor cod were found in stomachs of 31 – 90 cm specimens, which had also fed on hermit crab, *Eupagurus bernardus*. Crustaceans and, to a lesser extent, cephalopods, are important food as well, especially for the smaller halibut [5].

Population and exploitation

Spawning occurs from December to March in northern Norwegian waters at depths of 300 – 700 m, and it is likely that the slope areas of the continental shelf are used as spawning grounds too. The pelagic eggs gradually move upwards in the water column [6].

Nursery areas are found in coastal areas 20 – 60 m deep with a sandy bottom, and one of the authors has caught young halibut with a rod and line in a Faroese harbour. It is not until they are 4 – 5 years old that juvenile halibut leave their Norwegian nurseries. Emigration from the Norwegian nursery areas is directed to shallow as well as deep waters and to various destinations, including the North Sea, Greenland, and Iceland [6].

This extremely valuable food fish has been so massively overexploited that it is now of minor economic importance in the North Sea; after the Second World War yearly catches peaked at almost 4000 t, but decreased to a level well below 500 t in the 1980s. In the Skagerrak, close to the Norwegian coast, there is a small fishery in December and January, which is directed at spawning aggregations at depths of 300 – 400 m.

Halibut has considerable potential for aquaculture.

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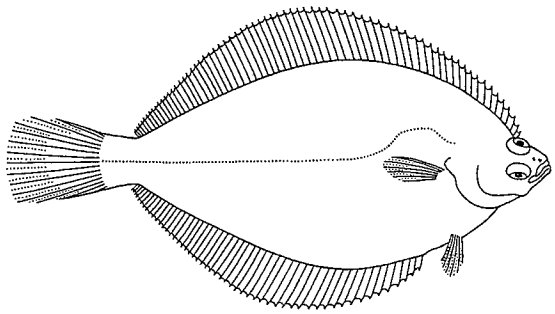
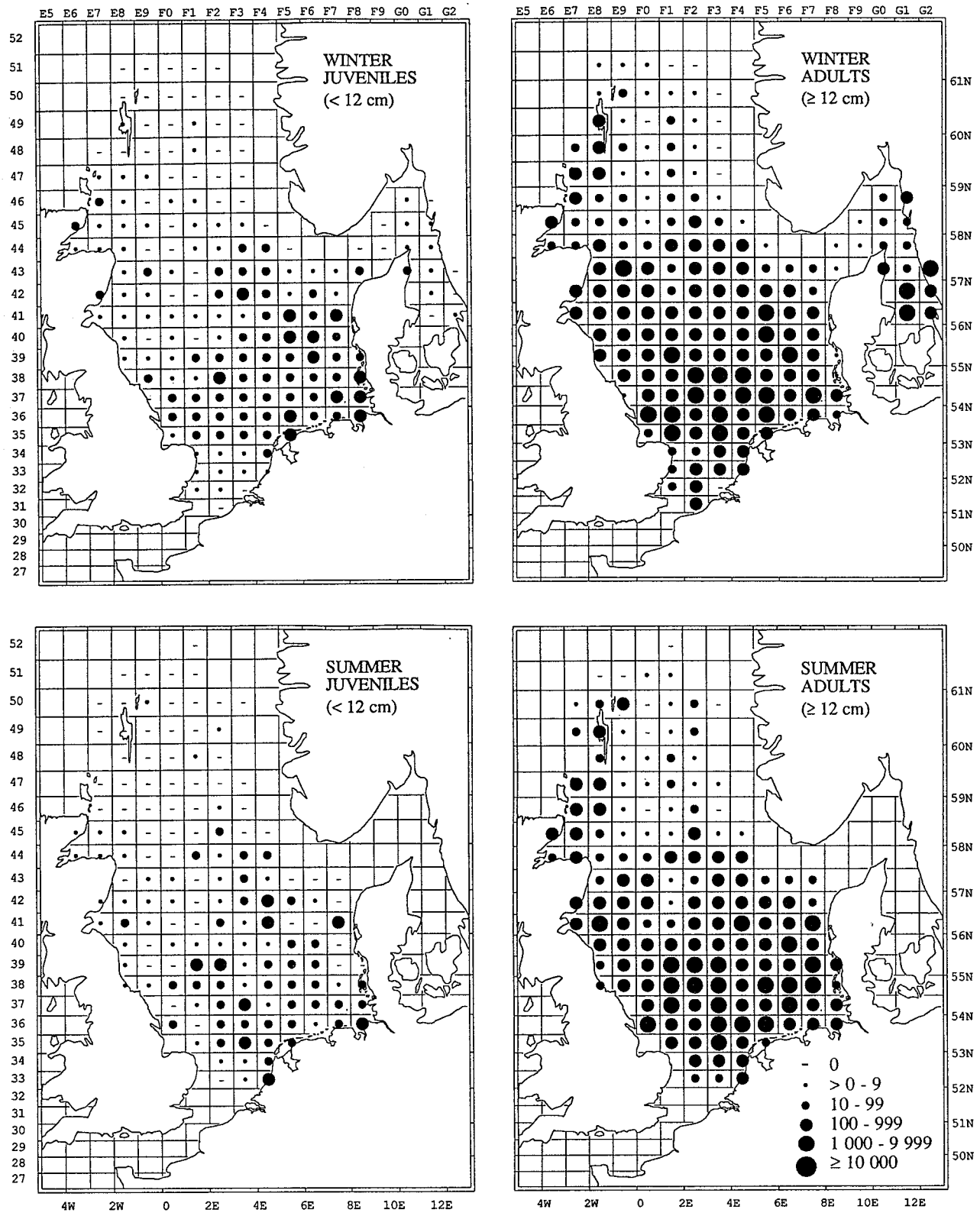
90. *Limanda limanda*
Family Pleuronectidae

E. Dab, F. Limande, D. Kliesche, DK. Ising,
N. Sandflyndre, NL. Schar, S. Sandskädda





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Dab might be described as the flatfish equivalent of whiting (No. 38), on the basis of its high abundance and widespread distribution in the North Sea. It was caught from the extreme north to the extreme south. Differences in densities made it possible to distinguish three regions in the survey area:

a. the sparsely populated, deeper areas in the far north;
b. the western part of the southern and central North Sea, where adults, but not juveniles, were caught very frequently;
c. the eastern part of the southern and central North Sea, where both adults and juveniles occurred in high densities.

The distribution pattern did not change significantly by season.

Length composition

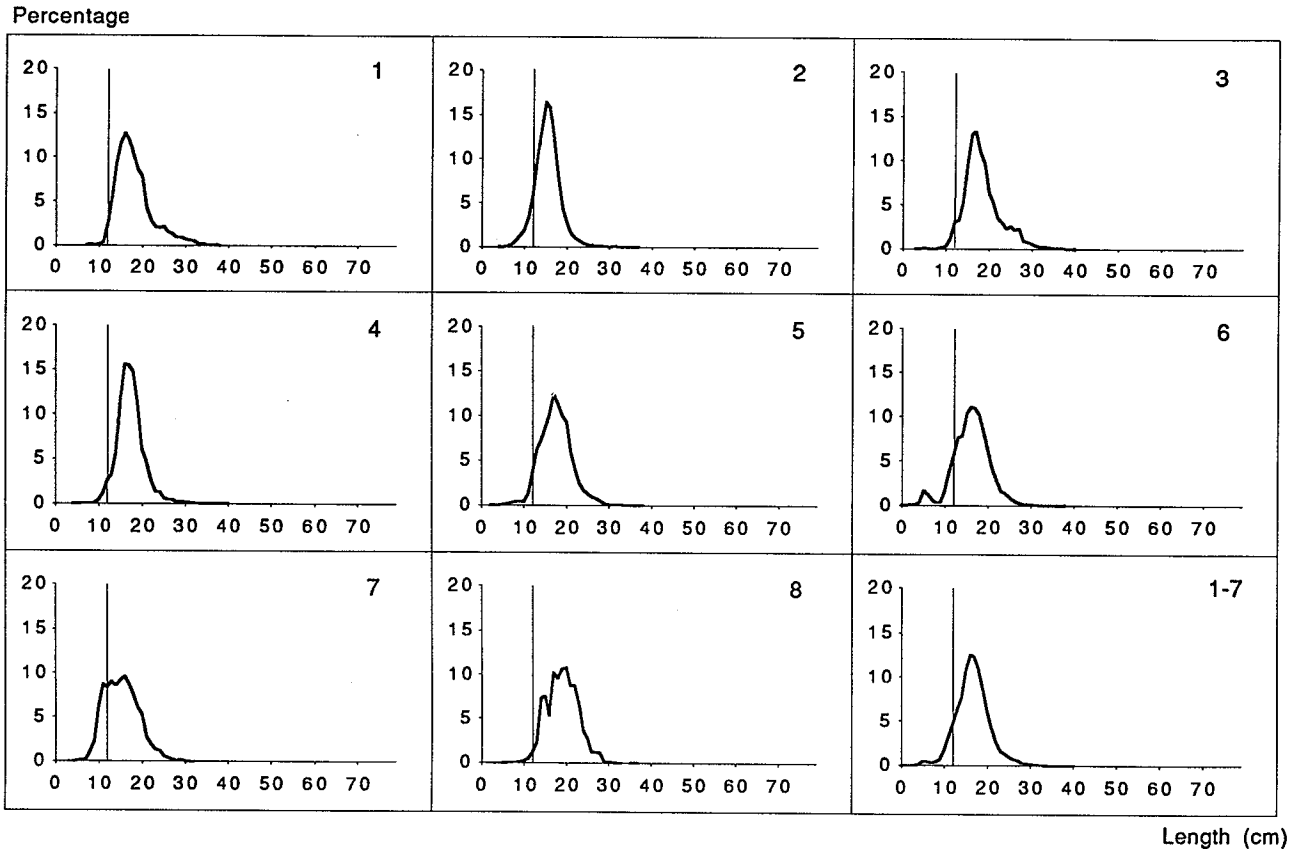
Most of the fish caught during the winter surveys measured between 10 and 20 cm. Relatively many small (< 10 cm) specimens were caught in southeastern area 6.

Life history

Dab is a very fecund flatfish species. A 20.5 cm female sheds 214,000 to 246,000 eggs during the spawning season, equivalent to around 3300 eggs per gram body weight [1].

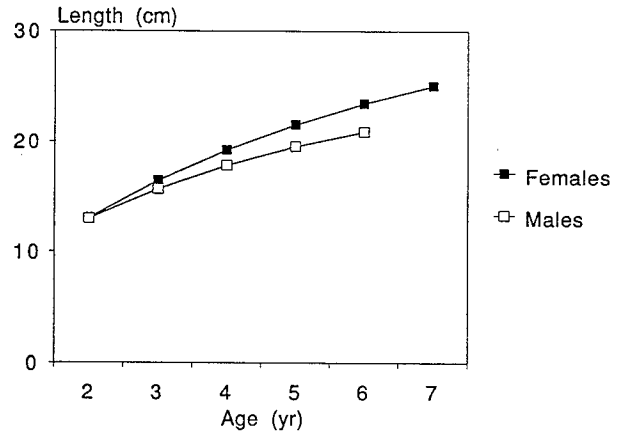
During autumn, both planktonic larvae (6 – 20 mm) and the newly metamorphosed young (12 – 20 mm) which have assumed a demersal way of life, can be caught [2]. The larvae feed on organisms like copepods, diatoms, protozoa, larval molluscs, and *Oikopleura* spp. [3]. The diet of later stages of dab is also highly variable. Cumaceans, amphipods, and brittle stars (*Ophiura albida*) are important prey for dab in the southern North Sea. Sedentary polychaete worms, such as *Pectinaria koreni*, however, constitute the main part of the food in coastal areas, whereas brittle stars are more important in deeper areas [4]. Food diversity, ingestion rate, and body condition of dab in the German Bight are at their maximum levels during summer and are low in spring during the spawning season [5].

Dab, which, like other flatfish species, is able to bury itself in sandy bottoms, differs in growth rate by area. The greatest differences in growth are those between populations in the German Bight and off the Scottish coast. Fish off Scotland grow relatively rapidly during their first years of life and slow down when they become older, whereas the opposite is true of those caught in the German Bight. The growth curves below illustrate that there are sexual differences in growth rate as well [6].

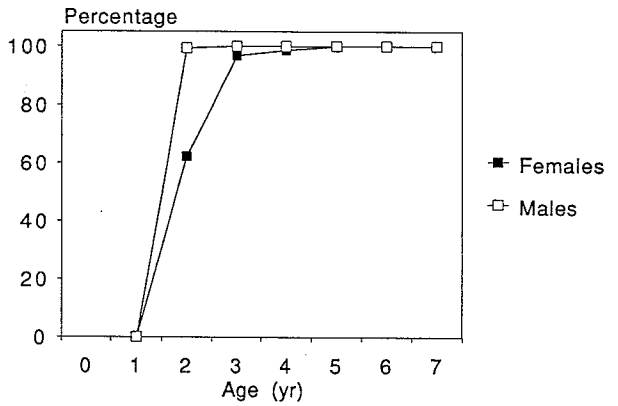


Length-frequency distribution of dab by roundfish area during winter (length split indicated).

Compared with other flatfish, dab mature at an early age [1].



Average growth of North Sea dab in the first half of 1984 and 1986 [6].



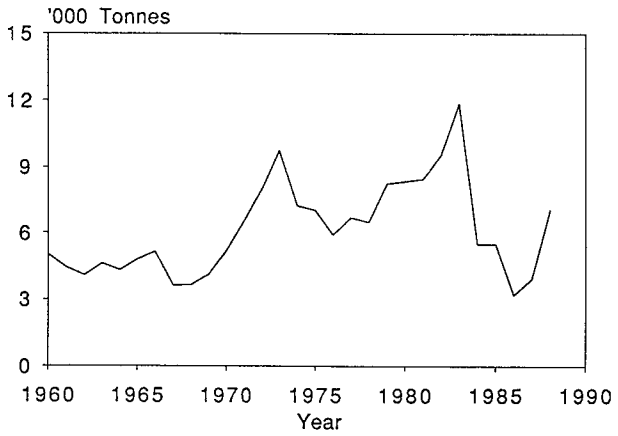
Percentage of mature dab per age group (adapted from Table 19 in [1]).

Population and exploitation

Dab spawn throughout the North Sea, but local concentrations of eggs occur in an offshore strip along the continental coasts, and off Flamborough Head. Spawning in the southern North Sea occurs from January until June, and until August or September in more northerly regions [1,7,8].

Demersal 0-group dab appear in coastal nurseries (10 – 20 m deep) during autumn. They gradually move into deeper waters as they grow, and those measuring over 11 cm are to be found mainly in waters deeper than 20 m [2]. Specimens of about 20 cm are known to cover distances of up to 150 nautical miles within 86 days. Some movements of the mature fish have a seasonal character and may be related to spawning or feeding [9,10].

Annual North Sea dab landings rose from 5000 t in 1960 to 12,000 t in the mid-1980s. Landings of more than 10,000 t per year were made at the beginning of this century, and just after the Second World War. It is difficult to interpret the fluctuations in annual landings, because dab is merely caught as by-catch during fishing for more valuable species, and landings are heavily dependent on the profits made from the target species. Over 90% of the catches are considered too small for human consumption and are discarded at sea.



Annual North Sea landings since 1960.

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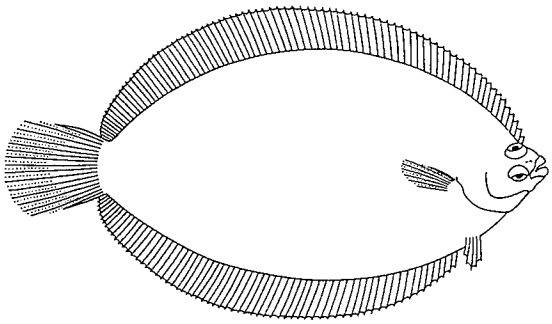
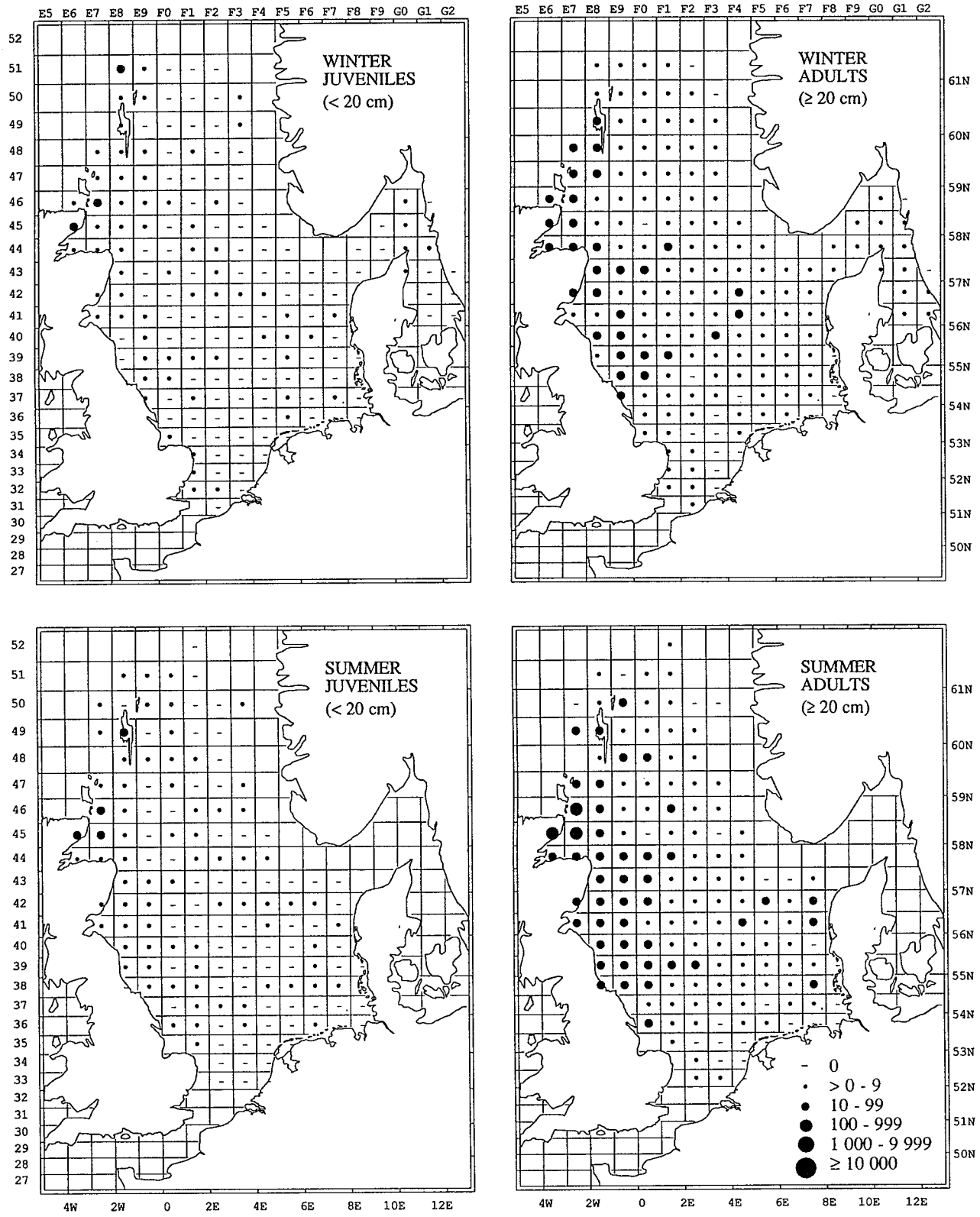
91. *Microstomus kitt*: see page 232.

91. *Microstomus kitt*
Family Pleuronectidae

E. Lemon sole, F. Limande sole, D. Limande,
DK. Rødtunge, N. Lomre, NL. Tongschar, S. Bergtunga





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

The centre of distribution of lemon sole, which, despite its name does not belong to the sole family, is situated in Scottish, Orkney, and Shetland waters. Mature lemon sole occurred in small numbers throughout most of the remainder of the survey area, but they were not caught in southeastern coastal waters. Smaller lemon sole were caught in relatively high numbers only in the Moray Firth. Except for a somewhat higher density in the Moray Firth during summer, no seasonal differences were detected.

Length composition

The length composition of the winter catches differed by area. The most distinct difference is that between the areas off the Scottish east and north coasts (areas 1 and 3), where fish of about 20 cm dominated the catches, and the adjacent central part of the North Sea (area 2), where the majority of the catches was made up of fish of 30 cm or more.

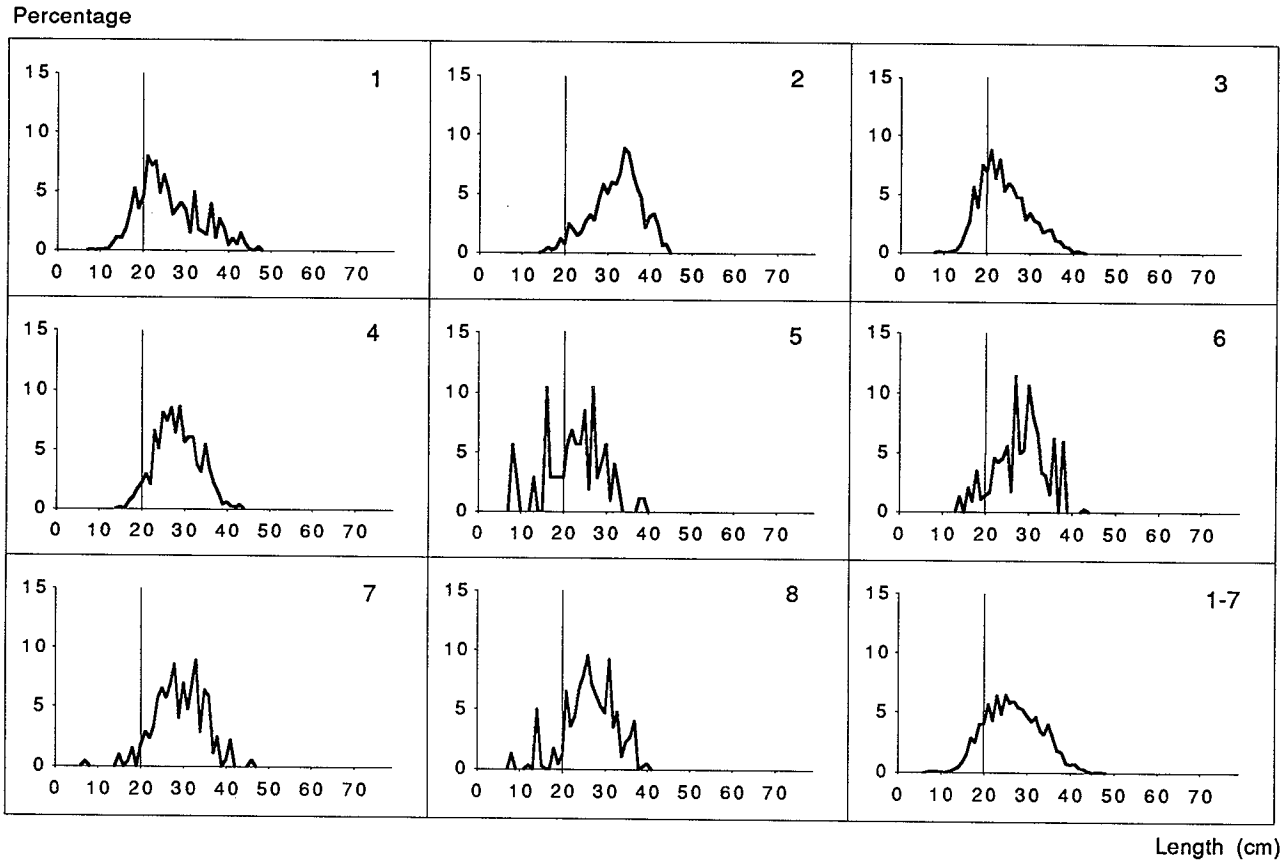
Life history

It is estimated that a female lemon sole produces 470 eggs per gram body weight during the spawning season. This is the equivalent of about 100,000 eggs for a 30 cm fish [1].

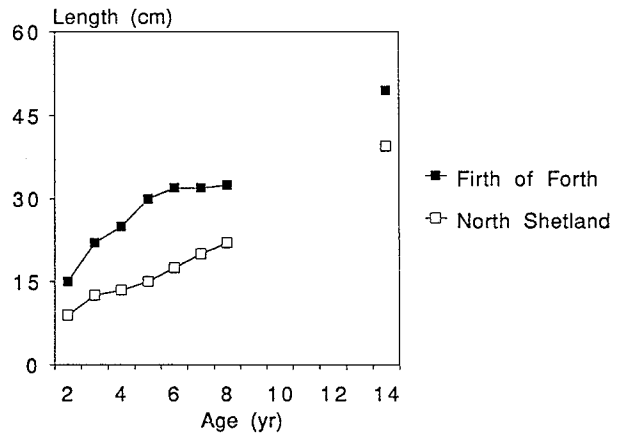
The pelagic eggs hatch in five to eight days at temperatures of 8 to 17°C [2]. The emerging larvae measure 5 mm. They adopt a demersal way of life after metamorphosis, when they are 2.5 cm long [2].

Growth shows considerable geographic variance. Lemon sole from the Firth of Forth grow rapidly, while those north of Shetland grow slowly. Sexual maturity is reached at the age of three for the males. Most of the female lemon sole reach sexual maturity at five years of age (3).

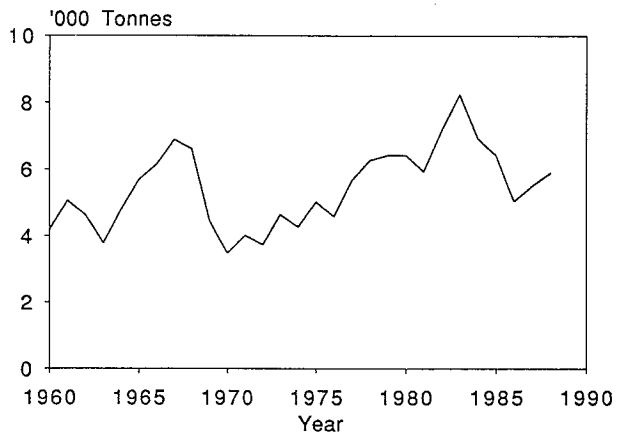
The diet of this flatfish is dominated by both errant and sessile polychaete worms, but regionally, crustaceans (e.g. eupagurids, amphipods, decapod larvae), molluscs (chitons, small gastropods), echinoderms (small ophiuroids), and coelenterates (anemones and hydroids) may be of importance as well [3,4].



Length-frequency distribution of lemon sole by roundfish area during winter (length split indicated).



Mean length-at-age of lemon sole from an area of fast growth (Firth of Forth) and an area of slow growth (Shetland). Data derived from Figure 7 in [3].



Total North Sea landings since 1960.

Population and exploitation

It is assumed that the lemon sole spawns wherever it is found, but spawning is heaviest in places where it is caught in large numbers [3]. Eggs and larvae have also been reported from two Norwegian fjords near Bergen, but the eggs were evenly distributed over the fjords and no centres of spawning could be detected [5].

Spawning in the main area of occurrence, off the Scottish east coast, begins in May and ends in October [3].

The species as a whole probably does not undertake extensive migrations, in spite of the single tagged specimen that travelled from the Firth of Forth to the Hebrides [3]. However, seasonal movements over shorter distances occur more frequently and may be related to spawning. An example of such a short-distance migration is that of concentrations of commercially exploited lemon sole that move from the entrance of the southern Moray Firth towards the Fair Isle vicinity [3].

The lemon sole is of moderate importance as a food-fish [6] and is generally not the object of any directed fishery. No clear symptoms of overfishing could be detected in 1965 [3].

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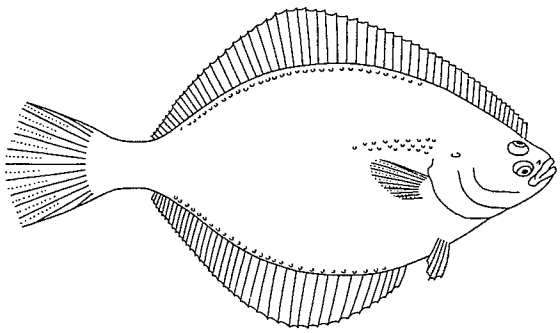
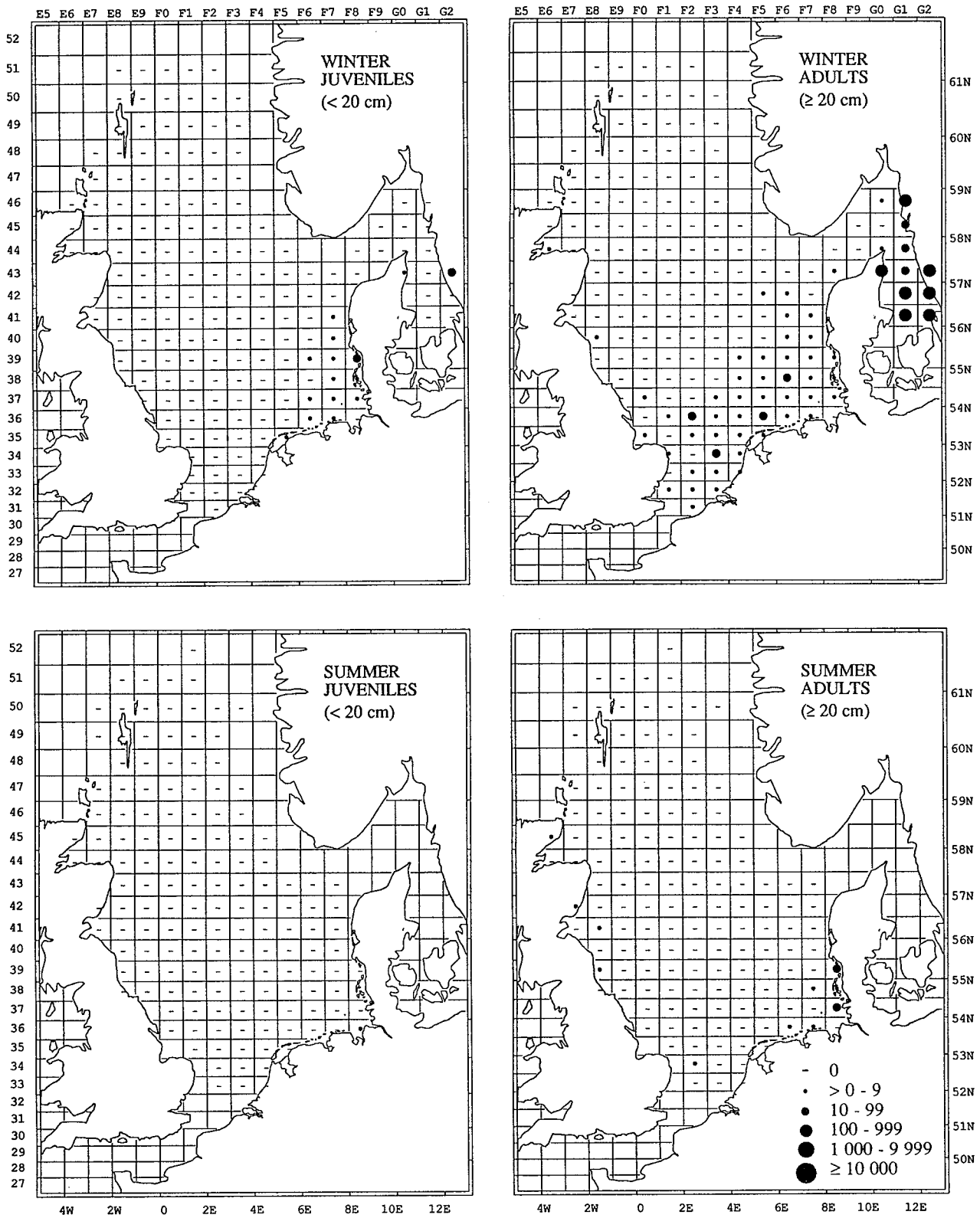
92. *Platichthys flesus*: see page 236.

92. *Platichthys flesus*
Family Pleuronectidae

E. Flounder, F. Flet, D. Flunder, DK. Skrubbe,
N. Skrubbe, NL. Bot, S. Skrubbskädda





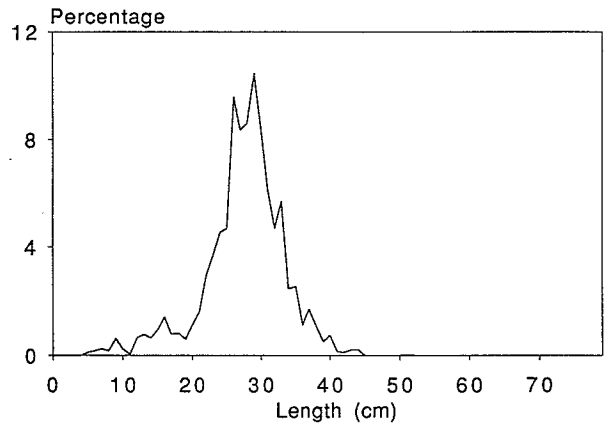
Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

During the winter surveys, flounder was caught in the Southern and German Bights and, in particularly high numbers, in the Kattegat. Flounder had migrated out of reach of the survey gears into shallow waters by summer.

Length composition

The complete length range of flounder was caught during winter.



Length-frequency distribution of flounder during winter.

Life history

The flounder is an outstanding example of a euryhaline species: the life cycle of each individual usually includes marine, brackish, and freshwater habitats.

This flatfish, which is able to bury itself several centimetres deep into the sand, feeds on a wide variety of small invertebrates (mainly polychaete worms, shellfish, and crustaceans), but locally the diet may include small fish species like smelt and gobies [1].

One- to six-year-old specimens caught in Dutch waters during the third quarter of the year are on average 11, 20, 25, 29, 31, and 34 cm long [2]. The females mature at an age of three to four years [3].

Population and exploitation

During autumn, both mature and immature flounder withdraw from the inshore and estuarine feeding areas. The immatures migrate into coastal areas, where they spend the winter. The adults move further offshore to the 25 – 40 m deep spawning grounds, the most important of which are situated along the coasts of Belgium, the Netherlands, Germany, and Denmark. An area of potential importance for spawning is the eastern part of the English Channel, while small areas off the English and Scottish coasts are probably of minor significance [1].

The eggs are found pelagically off the continental coasts mostly in February [4], and the pelagic larvae enter the western Wadden Sea during April – May [5]. Apart from estuarine and shallow nurseries such as the Wadden Sea, small flounder (< 25 cm) can also commonly be found in fresh water as long as there are no major barriers obstructing movement to and from the sea [6].

Since the turn of the century, annual North Sea catches have fluctuated between 1000 and 4000 t. Flounder is of relatively little commercial importance in the North Sea and the Kattegat, but its importance in the Baltic is considerable.

This fish is frequently used as a local indicator for chemical pollutants in estuarine and coastal areas [6].

References

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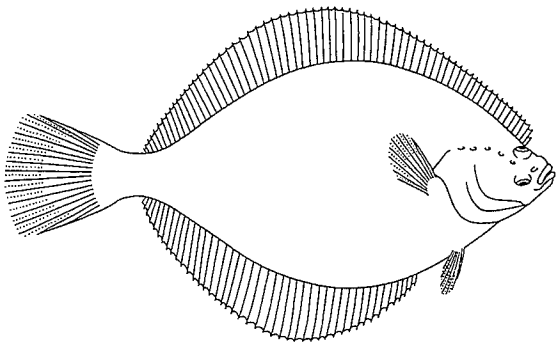
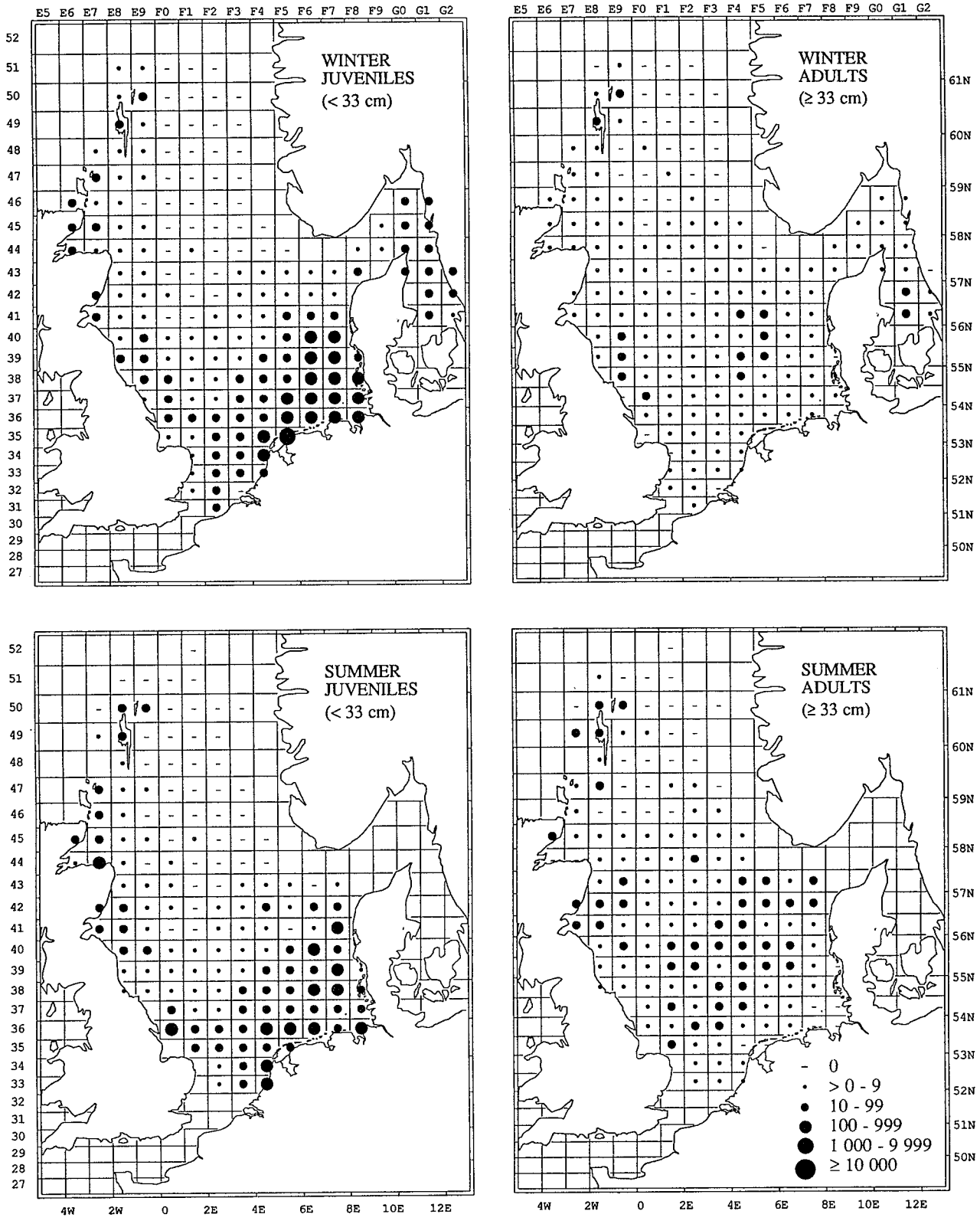
93. *Pleuronectes platessa*
Family Pleuronectidae

E. Plaice, F. Plie, D. Scholle, DK. Rødspætte,
N. Rødspette, NL. Schol, S. Rödspätta





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Juvenile specimens of plaice, an abundant flatfish, were concentrated in the Southern and German Bights, along the east coast of Britain, and in the Skagerrak and Kattegat. They occurred in low densities in the central part of the North Sea, and were virtually absent from the northeastern part. The distribution pattern was similar during both seasons.

Adult plaice were caught in much lower numbers than the juveniles. Densities of adults did not vary much over the area during winter, but during the summer surveys areas of relatively high (central North Sea) and low density (the continental coast) could be readily observed.

Length composition

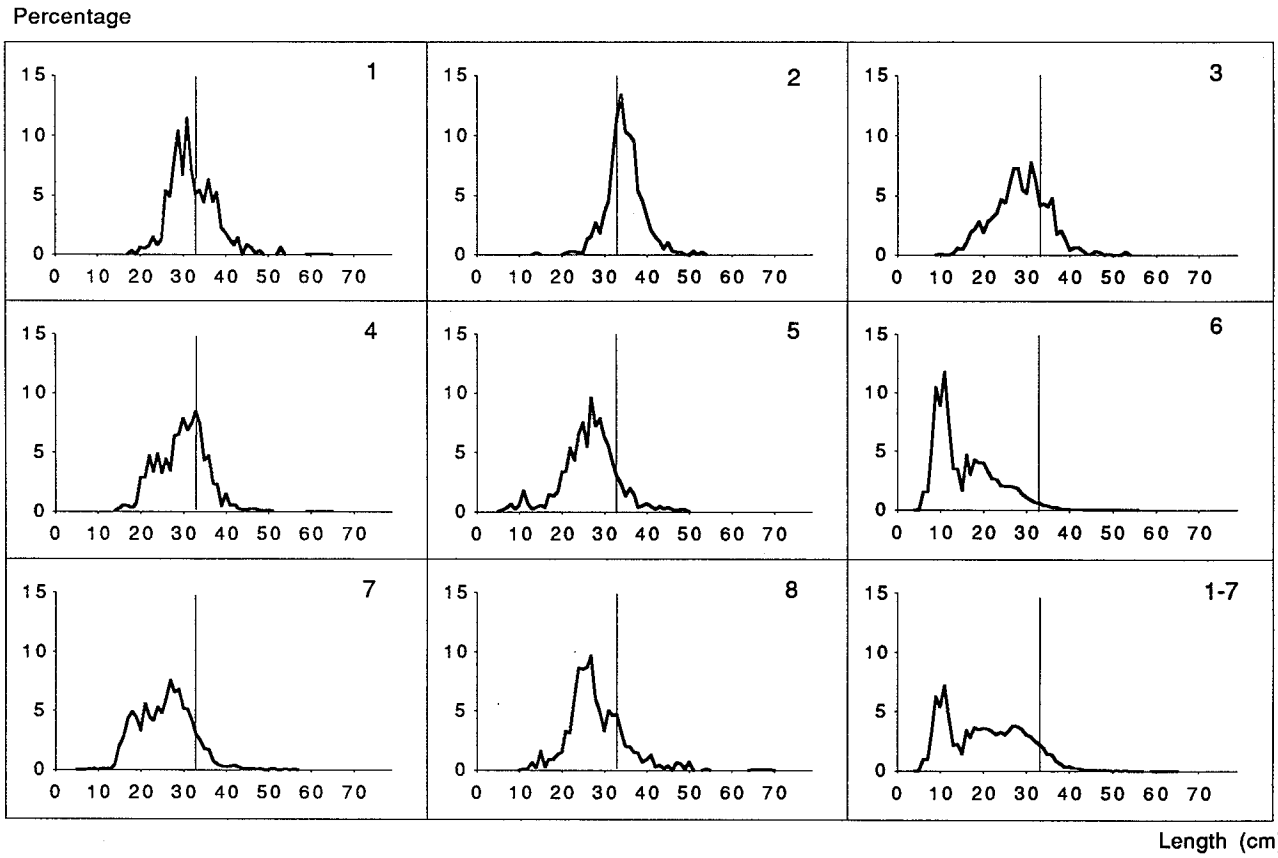
The length-frequency distributions clearly illustrate that winter catches in the southeastern area (area 6) were dominated by smaller (about 10 cm) plaice, whereas those over 30 cm in size dominated the winter catches in the central, offshore area (area 2). In the other areas catches consisted mainly of intermediate-sized plaice.

Life history

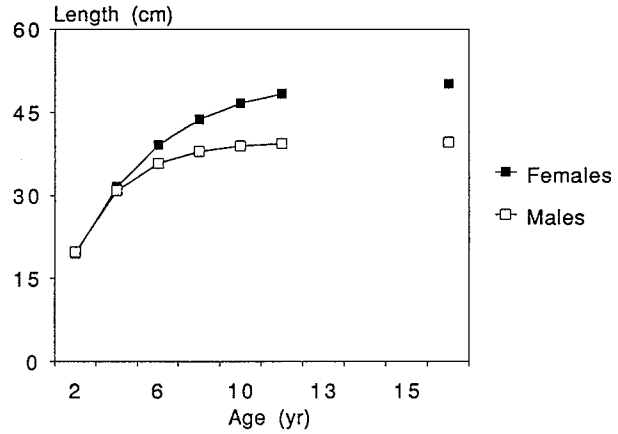
The number of eggs that a 35 cm female produces may vary from 60,000 to 100,000, corresponding to about 265 eggs per gram body weight. Fecundity has shown remarkable changes in relation to stock abundance [1]. Duration of the planktonic egg and larval stages of plaice (three to four months) is long compared with that of, for instance, sole (about one month). This results in long exposure to residual currents, and the young plaice may settle in areas far away from the spawning area. Settling on the bottom happens only after complete metamorphosis, i.e. when the left eye has shifted to the right side at a length of 13 – 14 mm [2].

The staple diet of plaice larvae in the Southern Bight consists of appendicularians such as *Oikopleura dioica* and *Fritillaria borealis*, but several stages of copepods, algae, and bivalve post-larvae also form part of the diet [3]. Polychaete worms, especially sessile *Pectinaria koreni*, are one of the most important food groups for larger plaice. Important as well are crustacean prey (amphipods, mysids), bivalve molluscs such as *Abra* spp., *Mya* spp. and *Venus* spp., and, depending on depth, brittle stars (*Ophiura* spp.) [4]. Plaice are typical daylight feeders. The adults do not feed during the spawning period [4,5].

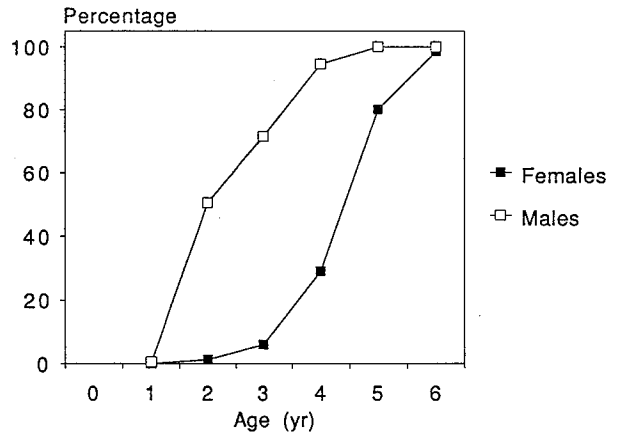
Male plaice become sexually mature at two or three years of age; females mature at an older age, when they are four or five years old. In general, plaice from northern areas mature at an older age and larger size than plaice from the south [5]. Time series have shown that the percentage of mature four-year-old females changed from 20% in the mid-1960s to 70% during the early 1980s, coinciding with a substantial increase in growth rate during the first four years of life [6,7]. Hence, the figures below only serve to give a general impression of maturity and growth.



Length-frequency distribution of plaice by roundfish area during winter (length split indicated).



Mean length in cm per age group in 1985. Data from A. Rijnsdorp, RIVO.



Percentage of mature fish per age group [5].

Plaice make selective use of tidal currents in various stages of their life. Metamorphosing larvae enter estuarine nursery areas on the flood tide [8]; juvenile plaice in the Wadden Sea move with the flood tide onto sandy flats to feed and move back to the surrounding channels on the ebb tide [9]. Adult plaice are also known to make use of tidal stream transport during their seasonal migrations between spawning and feeding grounds; they move downstream with the tide in mid-water, and stay on the bottom during the opposing tide, showing little or no movement [10].

Population and exploitation

Spawning grounds are recognized over most of the shallower parts of the southern North Sea and off the east coast of Britain from Flamborough Head to the Moray Firth. Centres of high egg production are the eastern English Channel and the Southern Bight, while egg production around the Dogger Bank and in the German Bight is more diffuse [11,12]. The peak in spawning shifts from early January in the eastern part of the English Channel to mid-February in the German Bight and Flamborough area. Part of the North Sea plaice population spawns in the English Channel and returns to its feeding grounds in the North Sea afterwards. Progeny of this group enters the North Sea by passive drift [13].

Coastal and inshore stretches along the North Sea coasts of Britain and the continent are essential as nursery areas, but the Wadden Sea is considered to be the most important one [14]. One-year-old plaice show a strictly coastal distribution but the older age groups gradually disperse further offshore, away from the nursery areas [5].

Annual North Sea plaice catches rose from 90,000 in the 1960s to 170,000 t in the late 1980s. During this rise, doubling of fishing mortality was offset by an increasing level of recruitment, and this has resulted in a remarkably stable spawning stock biomass since the late 1960s, when the strong 1963 year class matured [7]. In 1991, fishing mortality was at a historically high level, but the spawning stock biomass was still above the biologically acceptable level of 300,000 t (15). In fact, the ratio between landings and spawning stock biomass is low compared with the ratio observed in other species (e.g. cod, No. 36).

To improve the pattern of exploitation and to increase the sustainable yield, trawling has been temporarily prohibited in a part of the southeastern North Sea where catches usually contain a high proportion of undersized fish. The effects of this 'plaice box', most of which is in roundfish area 6, have still to be evaluated.

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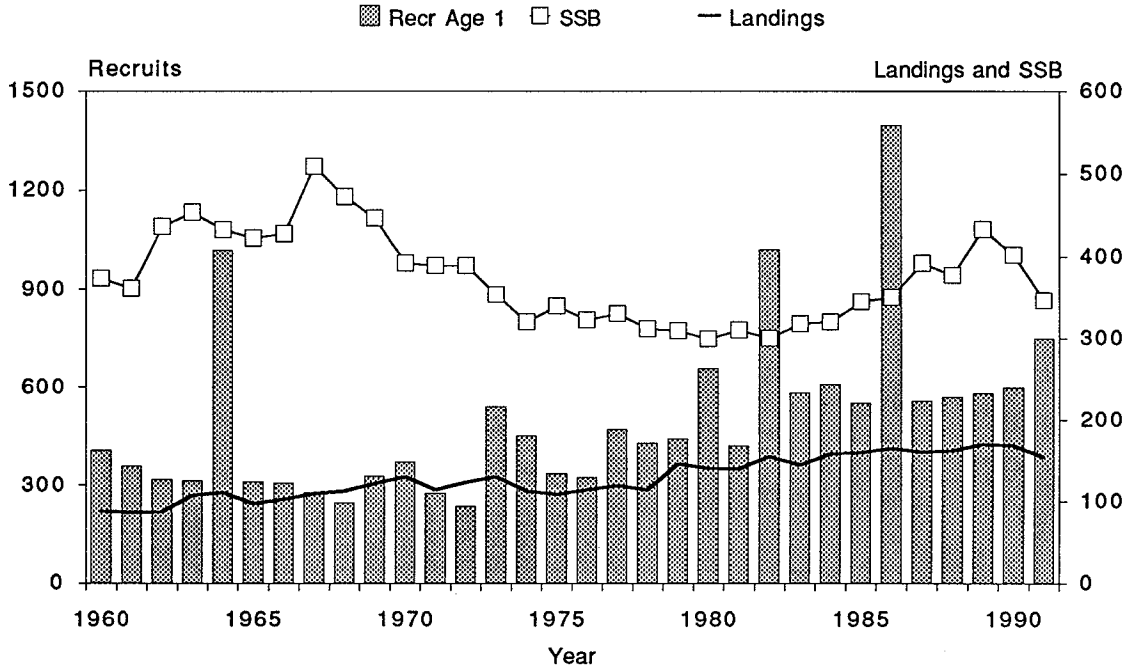
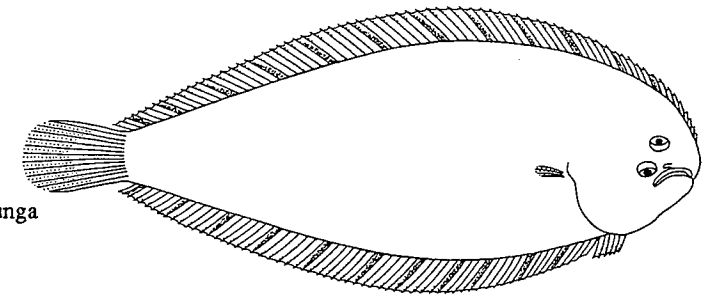
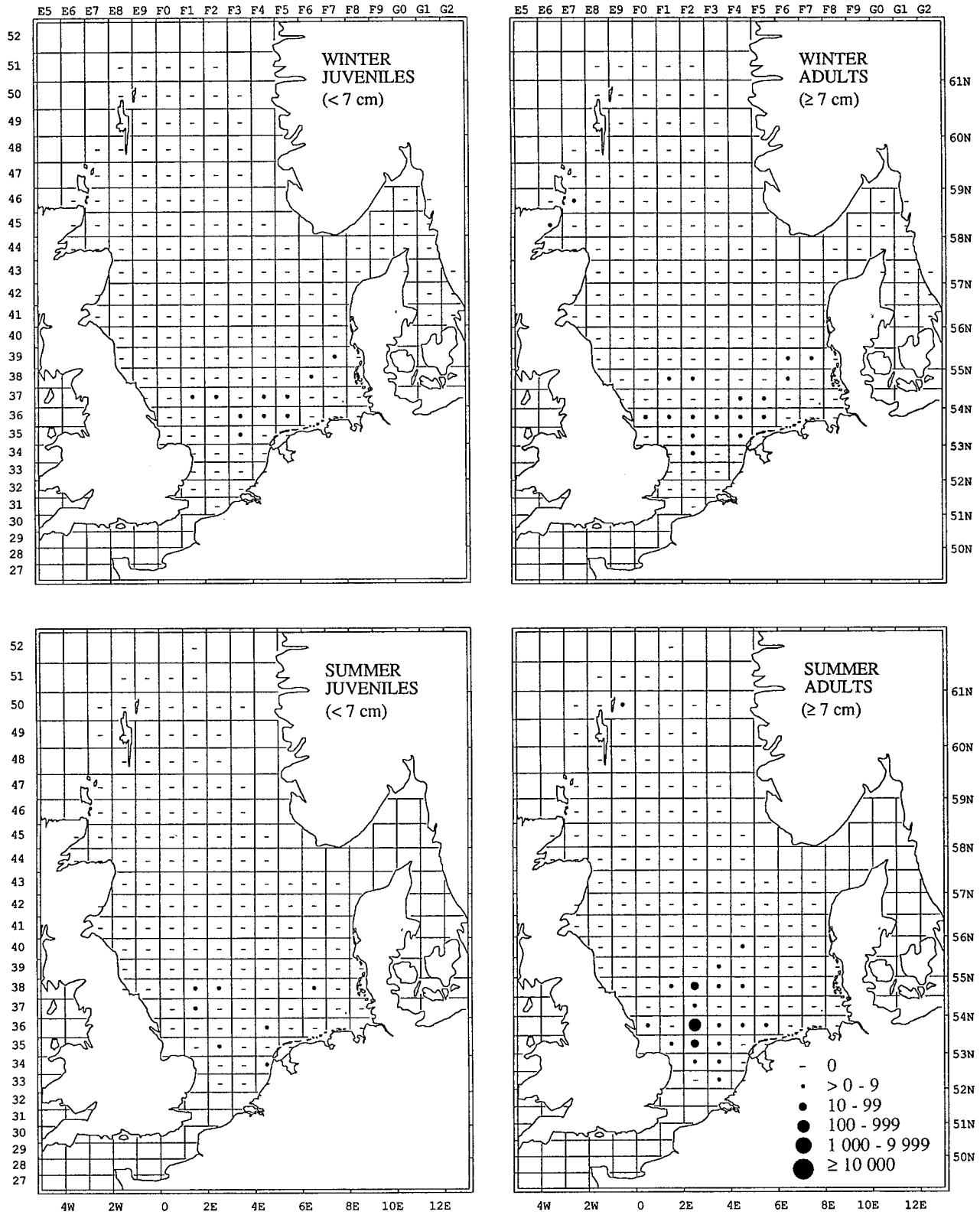


Total North Sea landings of plaice, spawning stock biomass, and recruitment of one-year-olds to the stock since 1960.

94. *Buglossidium luteum*
Family Soleidae

E. Solenette, F. Sole jaune, D. Zwergzunge,
DK. Glastunge, N. Glasstunge, NL. Dwergtong, S. Småtunga





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

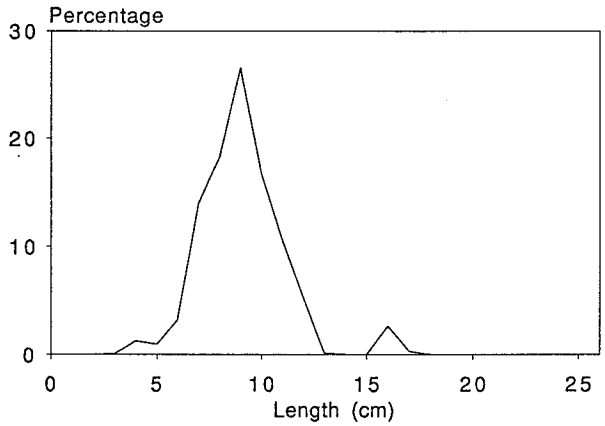
Spatial distribution

This small sole occurred throughout the southern North Sea and was caught a few times off the Scottish north coast during winter. Off Scotland, solenette is known to be confined to coastal waters [1].

The high density in rectangle 36F2 during summer has its origin in a single huge catch which contained nine hundred specimens in the length range 8 – 10 cm.

Length composition

The presence of 16, 17, and 18 cm individuals is noteworthy because various sources state that solenette attains a maximum length of only 13 – 14 cm [2,3].



Length-frequency distribution of solenette during winter.

Life history

Solenette from the Solway Firth (in between the English and Scottish west coast) attain an average length of 6 cm in their second year of life; they grow to 10 cm in their sixth year and measure 13 cm at the age of ten. Females grow to a larger size than the males but both sexes mature when they are three years of age. The oldest fish examined was in its eleventh year [3].

Solway Firth solenette is an opportunistic predator that feeds on a wide variety of organisms including copepods, cumaceans, small amphipods, polychaete worms, and soft-shelled juvenile bivalve molluscs. In addition, juvenile shrimp and fish (e.g. *Crangon crangon*, plaice, and sole) are heavily preyed upon, when and where they are abundant [2].

Population and exploitation

Although this species is not known to undertake extensive migrations, the large catch in rectangle 36F2 during summer might have been a gathering of late spawners, as spawning in this area normally takes place between April and August [4].

Solenette is of no economic importance.

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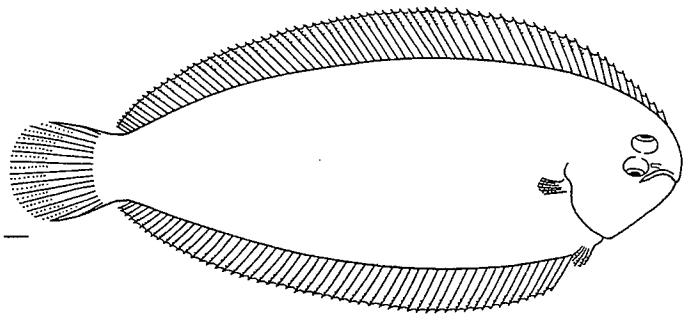
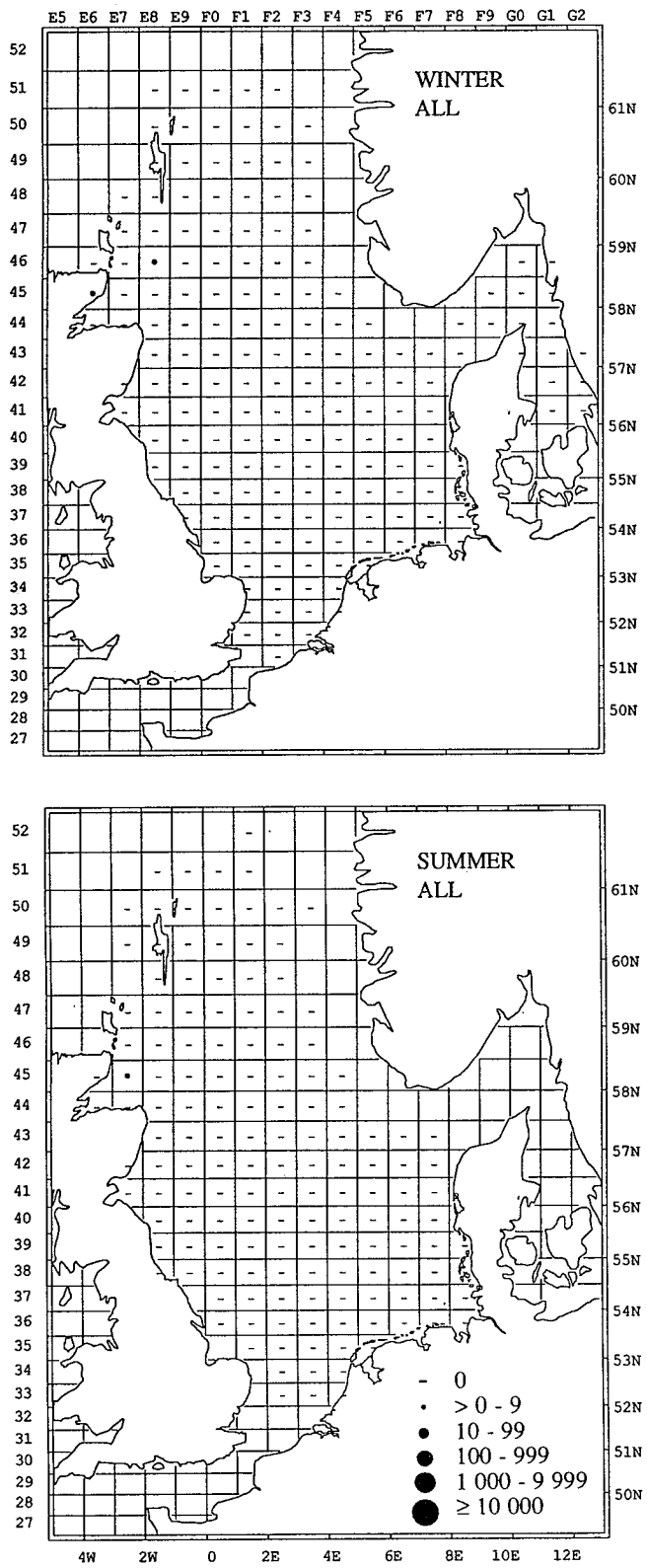
95. *Microchirus variegatus*
Family Soleidae

E. Thickback sole, F. Sole perdrix,
D. Gestreifte Seezunge, DK. —, N. —, NL. Dikrugtong, S. —





Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution
The small numbers of thickback sole caught were restricted to the northwestern North Sea.

Length composition
The few specimens caught measured between 9 and 20 cm.

Life history
Thickback sole are usually found in depths of 18 – 400 m [1], but in Scottish waters, most of the recorded catches prior to 1968 were made at depths of 100 – 150 m. Thickback sole seems to prefer sandy bottoms [2]. Its main distribution is to the west and south of the *Atlas* area.

Thickback sole may reach a length of 33 cm [1]. Polychaete worms, eupagurids, amphipods, small gastropods, small lamellibranchs, and ophiuroids have been found in its stomach [2].

Population and exploitation
Within the *Atlas* area no spawning has been recorded. Thickback sole do, however, spawn in the English Channel from April to May [3]. The eggs, larvae, and early juveniles are pelagic, but the latter stage moves deeper down as it develops. Juvenile thickbacks seek the bottom from 12 mm onwards [1].

Owing to its rarity the thickback sole is of no commercial importance in the North Sea.

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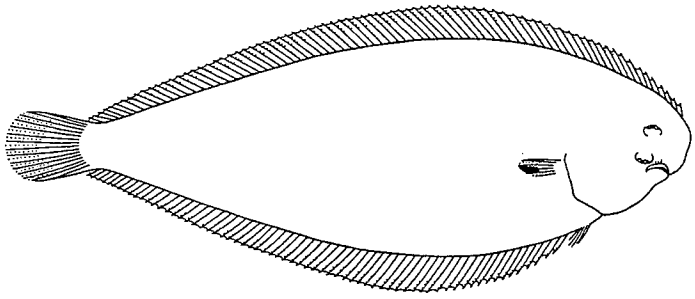
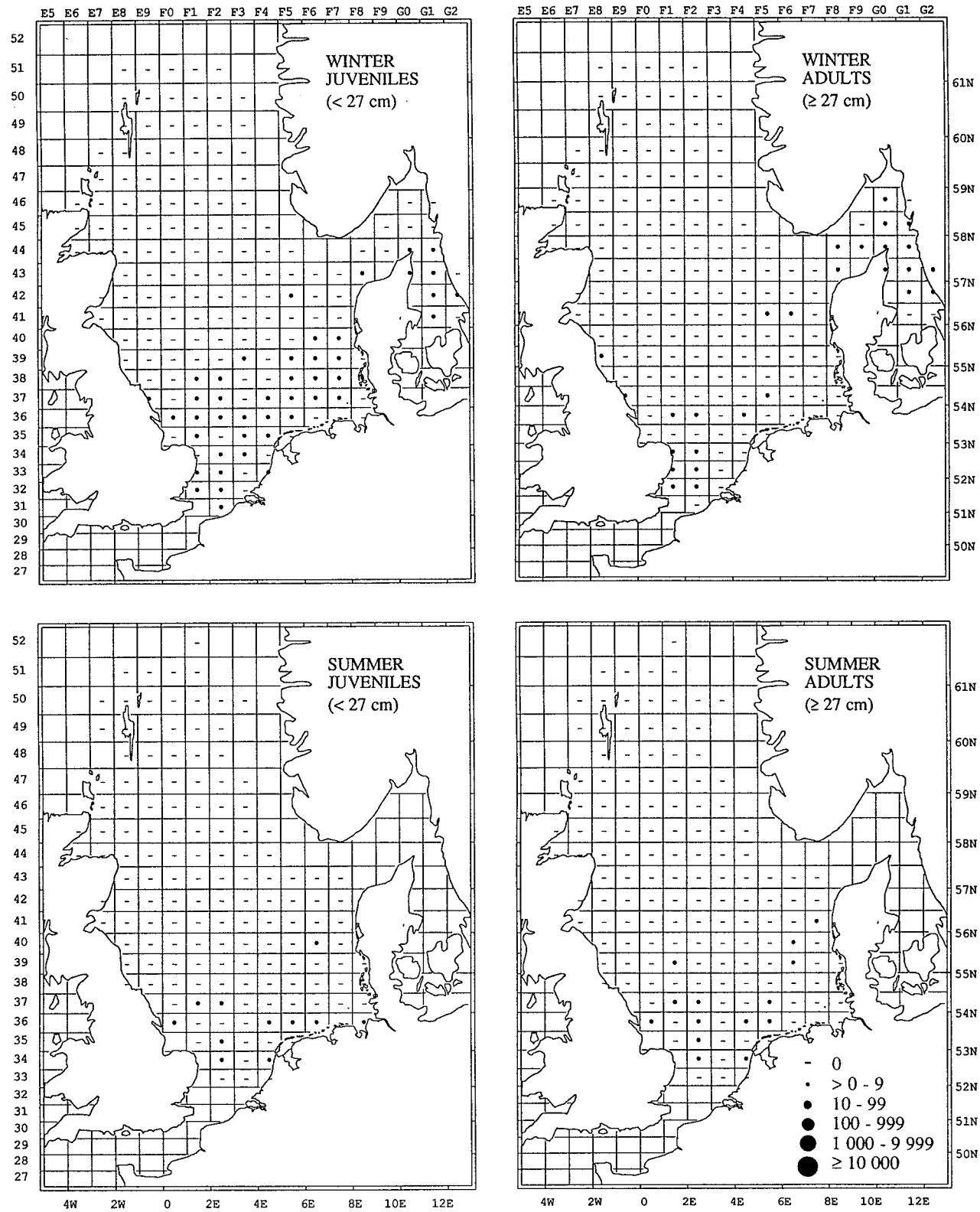
96. *Solea vulgaris*
Family Soleidae

E. Sole, F. Sole commune, D. Seezunge, DK. Tunge,
N. Tunge, NL. Tong, S. Äkta tunga





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

Sole, a valuable food fish, which in the North Sea is at its northern limit of distribution [1], was caught in low numbers in the southern part of the North Sea, in the Skagerrak, and in the Kattegat. Immature sole was caught less frequently during summer than during winter.

Sole is generally considered to be a noctural feeder, spending the day buried in finely sedimented bottoms [2,3]. This behaviour must have greatly affected catch rates of the surveys, which mainly took place during daytime.

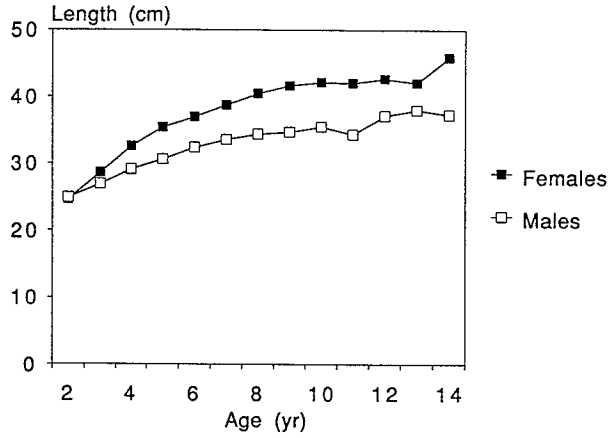
Length composition

The length distribution in southeastern area 6 shows a catch that was dominated by the smallest length classes (< 15 cm). The remaining part of the winter catches consisted of sole that measured between 20 and 35 cm.

Life history

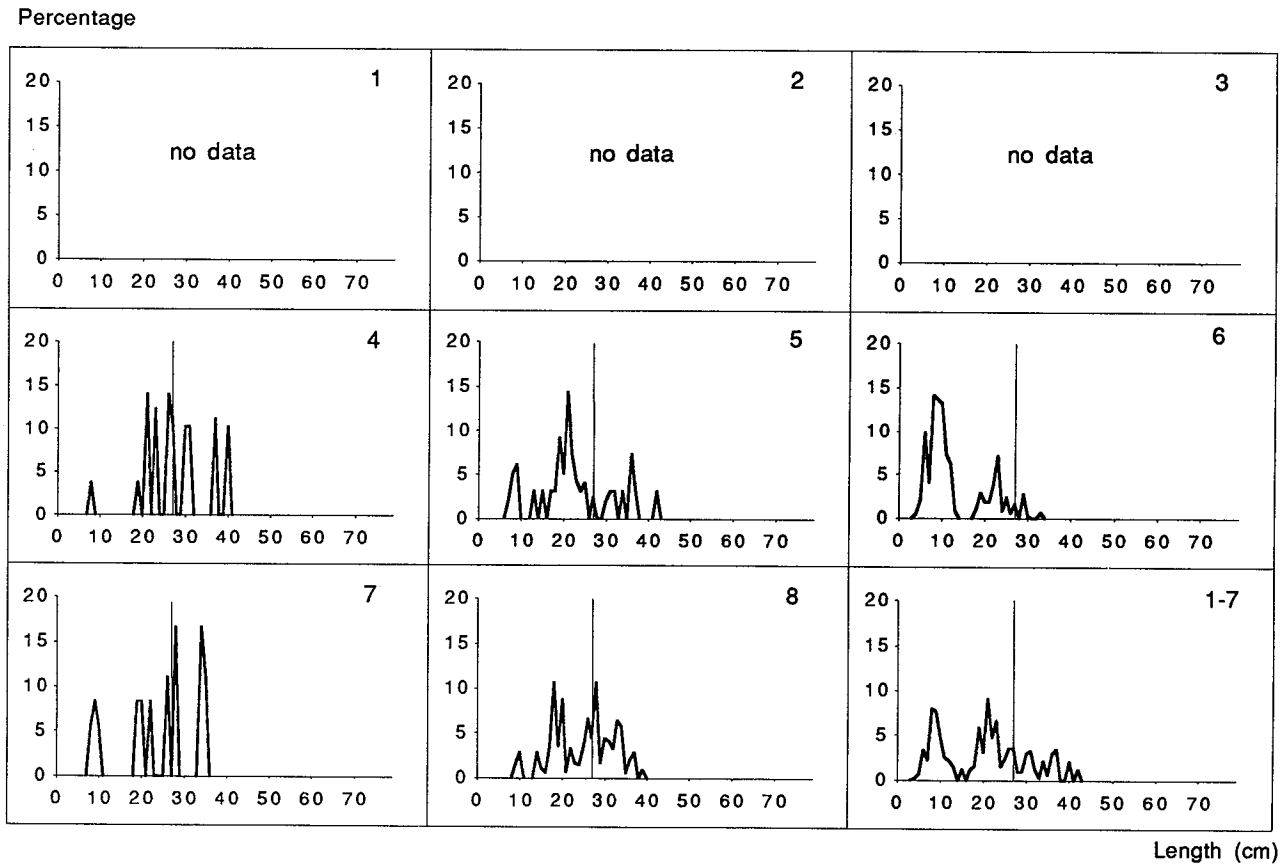
It is estimated that a North Sea female produces between 700 and 800 eggs per gram body weight, which corresponds to about 350,000 eggs for a 35 cm fish [4].

The pelagic larvae, 2.5 to 4 mm long at hatching, feed on copepods and fish larvae [5]. Juvenile and adult sole from the Dutch Wadden Sea feed mainly on polychaete worms *Arenicola marina*, *Lanice* spp. and *Nereis* spp. [6]. Juveniles on their nursery grounds in a French bay prey on amphipods, young opisthobranchs, and again polychaetes. Siphons of various bivalve molluscs are eaten as well [3].

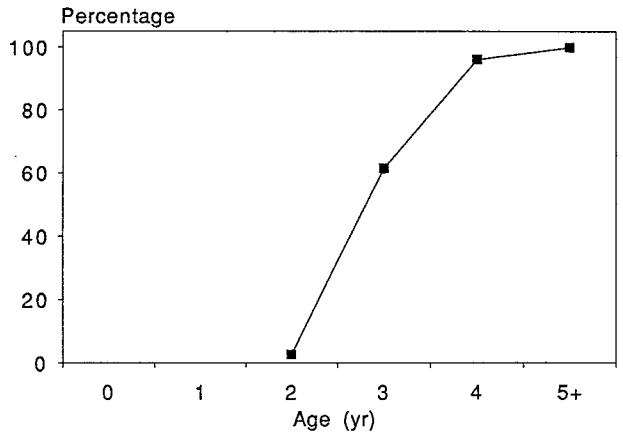


Mean length (cm) per age group in the second quarter of 1986 [7].

It is suggested that an increase in food availability led to an increase in growth rate for all age groups during the 1960s. Four-year-old specimens measured only 28.5 cm in the second quarter of 1957, whereas those of the same age in 1971 measured 32 cm [7]. Growth rate remained at this higher level throughout the 1970s and 1980s [8]. In contrast to growth, the proportion of mature fish at age varied considerably over time, but without a clear trend [9].



Length-frequency distribution of sole by area during winter (length split indicated).



Percentage of mature females per age group (averages during 1980 – 1988, adapted from [9]).

Population and exploitation

The sole is a southern species, and its distribution in the North Sea is confined to areas with relatively high bottom temperatures. Seasonal movements are probably temperature-induced because they are directed offshore into deeper, warmer waters during winter and inshore in March – May. During these movements, which are generally made at night, sole appears to make use of selective tidal transport ([10], see also plaice, No. 93). Sole may suffer high mortalities during extremely cold winters [11]. Under such circumstances dense concentrations are formed in deeper, warmer waters like the Silver Pit (rectangles 35F0 and 36F0). This area actually owes its name to the valuable catches of sole made there during cold winters [12].

Peak spawning occurs in April – May, in coastal areas within the 30 m depth contour. Major centres of spawning in the southern North Sea are the Belgian coast, the Thames estuary, the Norfolk Banks, the area off Texel, and the German Bight [1,5]. The pelagic larvae develop into demersal sole in a relatively short time, approximately one month. Consequently, passive transport of the larvae by the currents occurs over short distances only and it is likely that local abundance of 0-group sole mirrors the spawning success of local spawning groups [13].

Nurseries are situated in shallow waters all along the continental and English coasts at 5 to 10 m depth. Their relative importance to the total North Sea sole stock may vary from year to year, but the nurseries in estuarine areas are always of minor importance [13].

North Sea landings increased during the second half of the century until the very strong 1963 year class, responsible for the big stock in 1966, lost its importance to the fisheries [14]. Since then, exploitation of the North Sea sole stock has risen to the level of overfishing. Estimated landings in 1990 are at the highest level ever, and the 1991 spawning stock biomass, which consists mainly of fish hatched in 1987, was close to the 'safe' level of 40,000 t [15].

Other peculiarities to be seen in the figure below are an increase in both spawning stock biomass and catches after recruitment to the stock of the strong 1958 and 1963 year classes, followed by a sharp decline after the extremely severe winter of 1963 [9].

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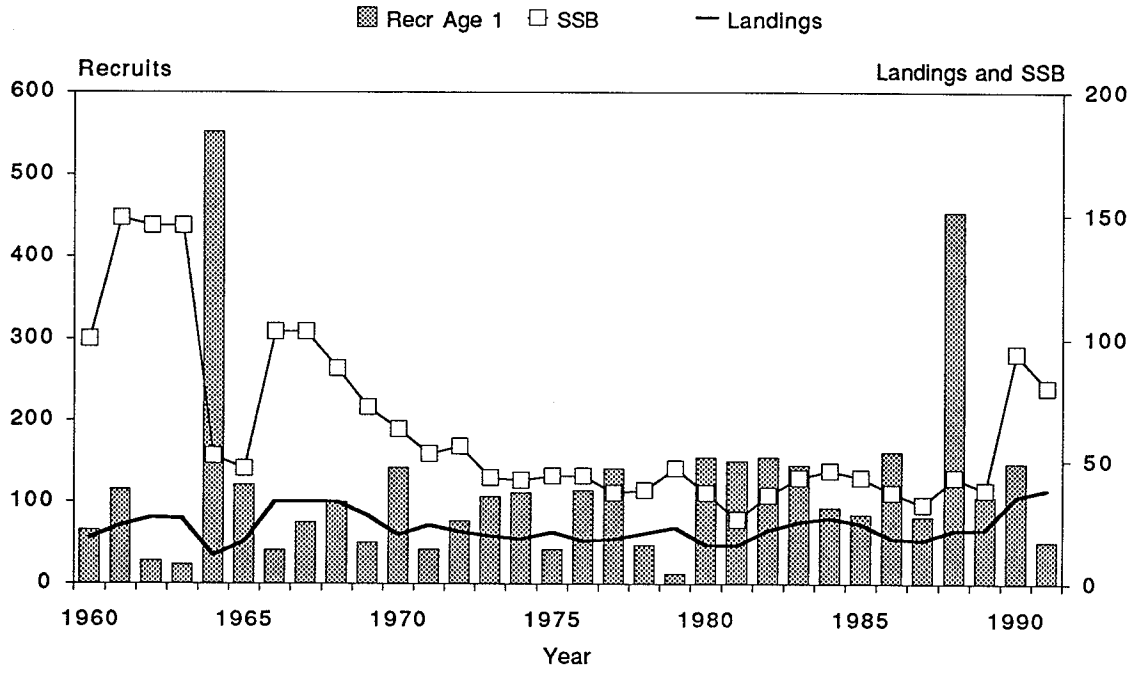
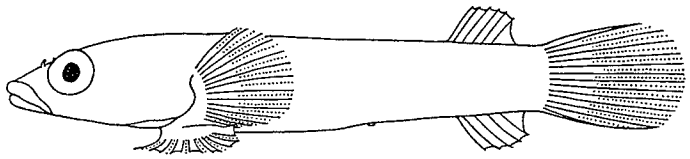
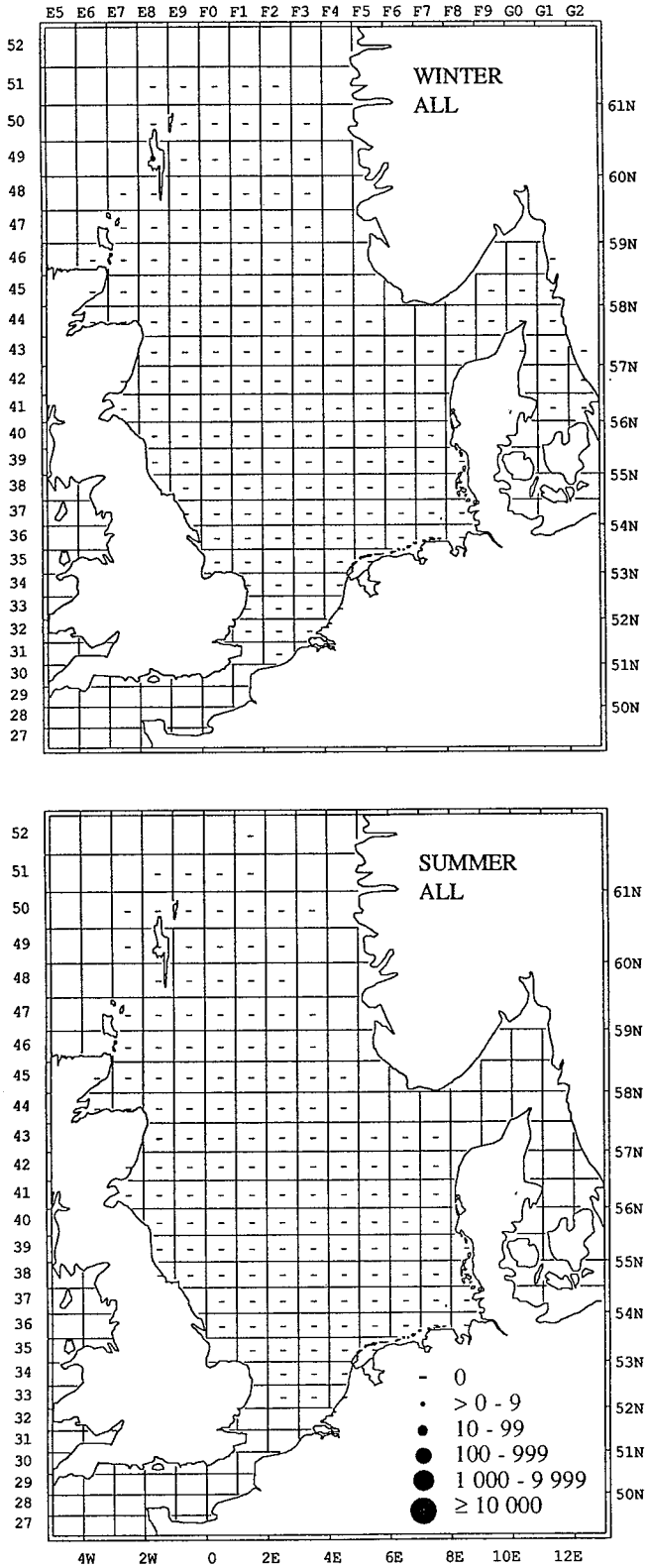


Total North Sea landings, spawning stock biomass, and recruitment of one-year-old sole to the stock [9] since 1960.

97. *Diplecogaster bimaculata*
Family Gobiesocidae



E. Two-spotted clingfish, F. Lepadogaster à deux taches, D. Zweifleckige Haftgrundel, DK. —, N. Dobbeltsuger, NL. Zuignapvis, S. Tvåfläckig dubbelsugare



Total catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

This small, brightly coloured fish was caught west of Shetland during the 1987 *Atlas* winter survey. The small size of two-spotted clingfish, its preference for shallow coastal water [1], and its ability to attach itself to stones or shells by means of a sucking disc on the ventral side of the body indicate that the trawl surveys are likely to provide unreliable information on this species' distribution and abundance.

Another three species of clingfish are known from northern European waters [1].

Length composition

The single fish caught had a length of 3 cm. Two-spotted clingfish may grow to 4 cm in length [1].

Life history

Clingfish spawn in summer [2]. The golden yellow eggs of 1.6 mm diameter are laid in empty bivalve shells or under stones. The eggs are guarded by the adult fish [3].

Casual observation indicates that the diet includes small crustaceans [3].

Population and exploitation

The North Sea distribution of two-spotted clingfish is said to be restricted to northern coastal waters, although it has been caught in the southern part of the Dogger Bank [4].

Its very small size makes this fish of no commercial interest.

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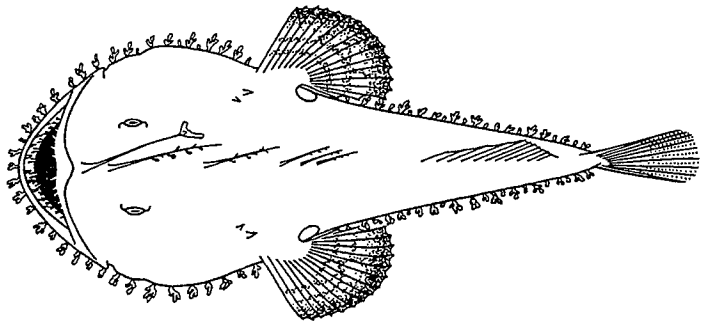
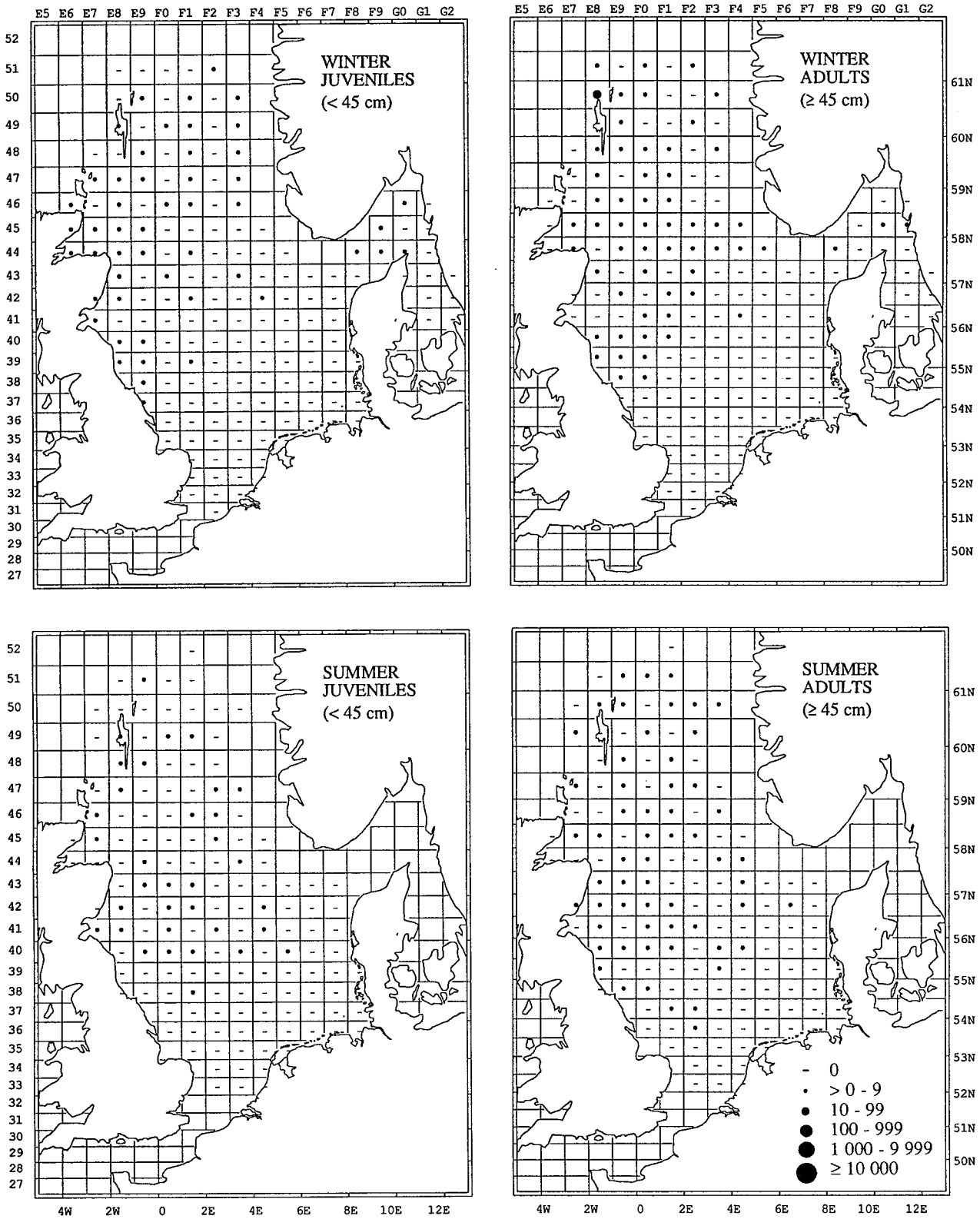
98. *Lophius piscatorius*
Family Lophiidae

E. Angler/Monkfish, F. Baudroie commune, D. Seeteufel, DK. Havtaske, N. Breiflabb, NL. Zeeduivel, S. Marulk





Average annual catch rates (numbers per hour fishing) in the years 1985 — 1987.

Spatial distribution

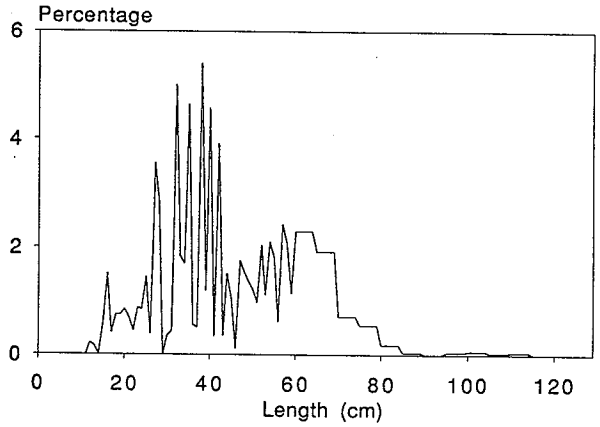
Although it was caught in somewhat shallower, southern regions during summer, the angler generally occurred throughout the deeper parts (> 50 m) of the *Atlas* area. Densities were low and as a rule no more than one or two specimens were caught per haul.

The area of occurrence of juvenile anglers off the Scottish coast appeared to be more patchy during summer than during winter.

A related species, *Lophius budegassa* (black-bellied angler) also occurs west of the British Isles and, probably, in the northern North Sea.

Length composition

The angler can reach a length of 200 cm, but specimens bigger than 120 cm are rare, as demonstrated by the survey catches. The majority of the catches consisted of fish of 50 to 70 cm in size, but smaller size groups (10 – 30 cm, 30 – 50 cm) may be distinguished as well.



Length-frequency distribution of angler during winter.

Life history

The angler's eggs are shed in ribbon-like gelatinous sheets that may be several metres long and 30 cm wide [2,3]. The pelagic larvae have beautiful elongated rays and become demersal at a length of at least 64 mm [3]

A one-year-old angler from the Irish Sea is on average 20 cm long; it measures almost 80 cm at the age of six [4]. Growth studies make use of seasonal zones in the illicium [5]. This illicium, or lure, is a modified dorsal fin-ray, whose fleshy top serves as a bait to attract prey within reach of the gigantic mouth, while the angler itself lies quietly and perfectly camouflaged on the bottom [6].

The angler is an opportunistic feeder, whose diet largely consists of demersal roundfish species and benthic crustaceans (e.g. *Nephrops norvegicus*), but sandeel, herring, flatfish, and cephalopods are also eaten [7].

As shown by the the low densities in the survey area, anglers live a solitary life. They are very poor swimmers and use their pelvic and pectoral fins for 'walking' on the bottom [6].

Population and exploitation

Spawning probably takes place from February to August, mainly between March and June [2,3], and is said to occur over deep waters offshore [1]. Unfortunately, no recent data on spawning in the *Atlas* area are available. It has been suggested that the pelagic egg ribbons and a prolonged pelagic stage of nine months secure a wide distribution of the species, which in its adult phase appears to be relatively immobile [3].

The angler is of considerable economic importance. Until recently it was just a valuable by-catch but there is now a directed trawl fishery for this species along the edge of the continental shelf north and west of the British Isles. From 1900 to 1985 total North Sea catches fluctuated between 1,000 and 5,000 t per year.

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7. Appendix

This appendix describes the procedure adopted to combine catches of 'A' species (see also Chapter 4) made with dissimilar trawls during the summer months of the years 1985–1987.

The data on spatial distributions available for the summer period were provided by Dutch, Scottish, and English surveys. The Dutch research vessels used a GOV trawl and surveyed mostly the southern and central North Sea, Scotland used a 48-ft Aberdeen trawl and worked in the northern and central North Sea, and England used a 78-ft Granton trawl and covered the whole North Sea. As the GOV was agreed to be the standard trawl, factors were required to adjust the catches made with the Aberdeen and Granton trawls. This procedure was limited to the 'A' species because only these are abundant enough to enable calculations to be made. As explained already in Chapter 4, the gears were regarded as having an equal catching efficiency for the less abundant 'B' and 'C' species.

Fish distributions are reported in this *Atlas* for juvenile and adult fish. For the 'A' species they were determined by a length split at the length at which females are 50 percent mature (L_{50}): below the given length all fish are considered immature; at the given length and above all fish are considered mature. Table I contains the 'A' species, the length split, and the source on which the length split is based.

The extent of each year's survey area common to the Netherlands/ England and England/ Scotland was determined (see Figure I). The average catch as number per hour was calculated for each species/ maturity/ area/ country/ year. From these catch rates factors were calculated to adjust Aberdeen- and Granton-trawl catches to 'GOV catches' (Table II, Figure II). For some species, notably Norway pout and the pelagic species, high between-year variations in the catch rate factors were observed. To overcome this, the median value was selected. Excepted from this procedure were sprat and Norway pout since juvenile fish were rarely caught and the median value of adult fish was used. The catches were adjusted by these factors.

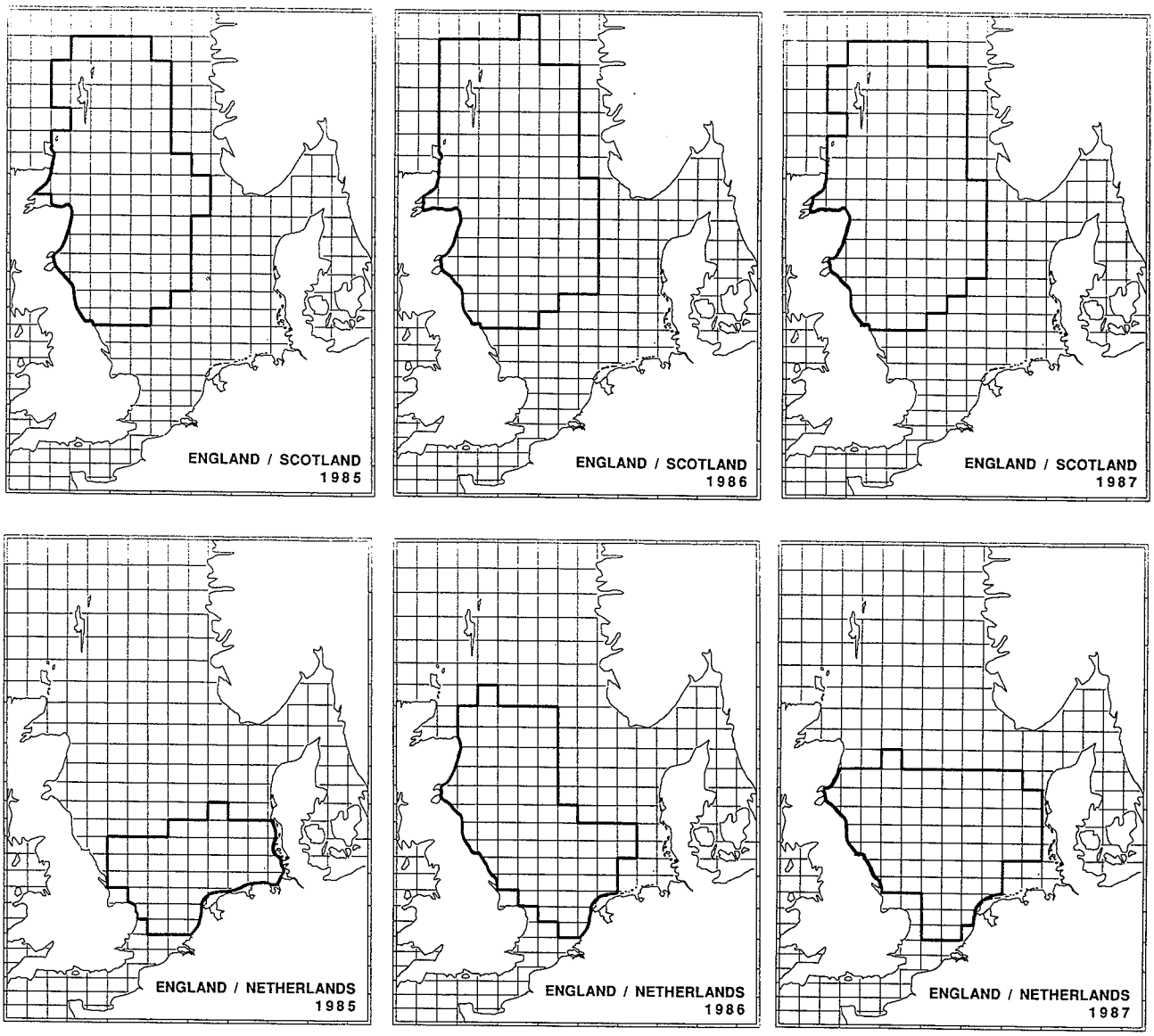
Comparison of the calculated factors gives some information on how the catchabilities of the fishes may differ between gears and species. For example the numbers of juvenile starry ray (*Raja radiata*) caught with the Granton trawl had to be multiplied by 0.40 to derive the equivalent number if a GOV trawl had been used. In the case of herring the numbers caught with the Granton trawl had to be multiplied by 4.48.

Appendix Table I. Values of L_{50} for the 'A' species used to split their length compositions into juvenile and adult fish.

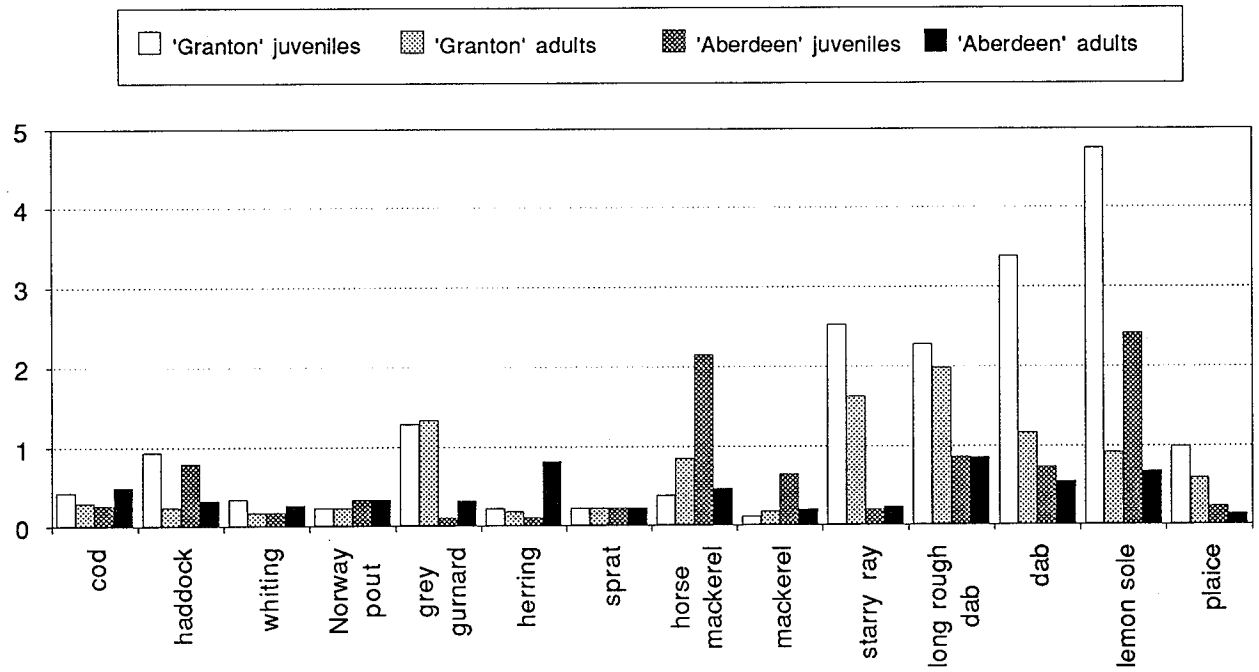
Species	L_{50}	Source
Starry ray	47	H. Sparholt, personal communication
Herring	24	IYFS, Herring Working Group information
Sprat	10	IYFS
Cod	70	IYFS
Haddock	30	IYFS
Norway pout	13	IYFS
Whiting	20	IYFS
Grey gurnard	19	EGFS
Horse mackerel	24	Dutch data
Mackerel	30	Dutch data
Long rough dab	17	EGFS
Dab	12	Dutch data
Lemon sole	20	EGFS
Plaice	33	Flatfish Working Group information
Sole	27	Flatfish Working Group information

Appendix Table II. Factors by which the catches of the Granton trawl (EGFS) and Aberdeen 48-ft trawl (SGFS) were multiplied to derive 'GOV catches'. See text for further explanation.

Species	EGFS Juveniles	EGFS Adults	SGFS Juveniles	SGFS Adults
Starry ray	0.40	0.61	5.03	4.32
Herring	4.48	5.42	9.57	1.22
Sprat	4.44	4.44	4.44	4.44
Cod	2.30	3.33	3.81	2.01
Haddock	1.07	4.17	1.27	3.05
Norway pout	4.32	4.32	2.94	2.94
Whiting	2.90	5.52	5.66	3.77
Grey gurnard	0.78	0.75	9.23	3.11
Horse mackerel	2.58	1.18	0.46	2.11
Mackerel	8.74	5.68	1.54	5.04
Long rough dab	0.44	0.50	1.16	1.17
Dab	0.30	0.85	1.35	1.81
Lemon sole	0.21	1.09	0.41	1.47
Plaice	1.00	1.66	4.30	7.18
Sole	0.23	0.54	1.00	1.00



Appendix Figure I. Overlap in areas covered by England and Scotland, and England and the Netherlands, during the summer surveys in the years 1985–1987.



Appendix Figure II . Differences in catchability when different trawls are used. Catchability equals 1 if a GOV trawl is used.

8. Glossary

Although many of the terms used in the *Atlas* are widely used in biological and fishery biological fields of research and thus do not need further explanation — for instance, an overview of the terminology is given in the *Encyclopedia of marine sciences* [1] — there are a number of expressions in this publication that require more specific definition in order to preclude misunderstanding. Some of the definitions below were directly taken from the *Encyclopedia of marine sciences* or from *Key to the fishes of northern Europe* [2].

1. Baretta-Bekker, J.G., Duursma, E.K., and Kuipers, B.R. (eds). 1992. Encyclopedia of marine sciences. Springer-Verlag, Berlin. 311 pp.
2. Wheeler, A. 1978. Key to the fishes of northern Europe. Frederick Warne, London. 380 pp.

* * *

Adult (mature) fish: fish that have reached sexual maturity.

Age group (cohort): a group of fish of the same age. By convention, fish are called 0-group in their year of birth, 1-group in their second year of life, and so on. See also **year class.**

Anadromous: migrating from saline waters to spawn in fresh water, as opposed to **catadromous**. The Atlantic salmon is a classic example.

Anguilliform: with an eel-like shape. The scientific name for eel is *Anguilla anguilla.*

Bathypelagic: living pelagically over great depths.

Beam trawl: a type of bottom trawl, mainly used for flatfish and shrimps. The horizontal opening of the net is provided by a beam, which may be 12 m long or more. Fish on the bottom are disturbed by 'tickler chains' fixed in front of the groundrope and then enter the net.

Benthic: bottom-living. Typical benthic organisms are sea urchins and sea stars. Although it is possible that some fish species may be truly benthic, it is usual to describe fish which spend most of their time on or close to the seabed as **demersal**. By contrast, **pelagic** species spend most of their time somewhere in the water column off the bottom.

Benthopelagic: living on the bottom and up to 200 to 300 m above the bottom in deep water.

By-catch: species in the catch which are not the main target of the fishery. Often the by-catch species are non-commercial and are rejected as **discards**. However, valuable species such as halibut and anglerfish are usually taken as by-catch, rather than in a directed fishery.

Catadromous: migrating from fresh water to spawn in the sea, as opposed to **anadromous**. The eel is a good example.

Catch: strictly speaking, this term refers to the total quantity of fish taken by the fishery. However, in most cases a proportion of the catch is rejected at sea (**discards**). The fish which are brought ashore constitute the **landings**, which are sometimes described as **nominal catches.**

Catchability: the degree to which fish are vulnerable to the fishing gear. The catchability of a species, or different size classes of the same species, can vary enormously depending on which gear is used. Thus pelagic species such as mackerel have a low catchability in bottom trawls and flatfishes have a very low catchability in trawls fished in mid-water. It is clear, therefore, that although the *Atlas* surveys were undertaken with a more or less standard fishing gear, the catches of the various species are by no means 'standard'.

Demersal: living on or close to the seabed. See **benthic.**

Discards: fish which are returned to the sea after capture. Fish may be discarded for several reasons; they may be of non-marketable species, they may be below the minimum legal landing size, current prices may be considered too low, or the quota for a particular species may have been exceeded. Discarding may take place on a very large scale, particularly when an abundant **year class** starts to enter the catchable part of the stock.

EGFS: English Groundfish Survey.

Elasmobranchs: fish with cartilaginous skeletons, such as sharks and rays. Fish with bony skeletons are called **teleosts.**

Euryhaline: capable of living in waters of widely ranging salinity.

Fecundity: the total number of eggs spawned by a female during a single spawning season. The eggs may be laid singly or in masses and released all at once (**synchronous spawning**) or in several batches (**serial spawning**). In this *Atlas*, frequent reference is made to the number of eggs produced per gram female body weight. This parameter, which facilitates comparison within and between species, is the **relative fecundity.**

Fertilization: in fishes, fertilization is usually external, the eggs and sperm (milt) being shed into the water. In some groups, however, fertilization is internal. Male sharks and rays, for example, have specialized copulatory organs (claspers) to facilitate the introduction of sperm.

Fishing mortality: deaths caused by fishing.

Growth: unlike mammals, fish continue to grow throughout their lives. However, in temperate regions such as the North Sea, growth is most rapid during the warmer months of the year and slows down or stops during the winter.

IBTS: International Bottom Trawl Survey.

ICES: International Council for the Exploration of the Sea.

Industrial fishery: a fishery which catches fish in bulk for reduction to fish meal and fish oil. The industrial fishery is usually targeted at small, short-lived species such as sandeels and Norway pout, which are considered unsuitable for human consumption. However, large quantities of herring are taken by the industrial fishery.

Isobath: a line on a chart connecting points of equal water depth.

IYFS: International Young Fish Survey.

Juvenile (immature) fish: fish that have not reached sexual maturity.

Landings: fish which are brought ashore. See **catch**.

Larva: stage of life between hatching from the egg and metamorphosis.

L_{50}: length at which 50% of the individuals sampled in that length class are sexually maturing/mature. The onset of maturity will occur over a range of sizes for any species.

Metamorphosis: process during which the larva acquires characteristics such as scales, and adult body proportions.

Mortality (mortality rate): a measure of the rates at which fish in a given stock die during a given time period. Fisheries biologists usually make a distinction between **natural mortality** and **fishing mortality**.

Natural mortality: deaths due to natural causes, such as disease and predation.

Nektonic: moving independently of the current. See **planktonic**.

Nominal catches: see **catch**.

Nursery (nursery area): an area which provides a favourable environment (food, shelter) for young fish.

Oviparous: egg-laying.

Ovoviviparous: form of reproduction whereby the eggs develop and hatch within the mother's oviduct, following internal fertilization, and are expelled as larvae.

Pelagic: living mostly off the bottom. See **benthic**.

Planktonic: floating in the water column. The movements of planktonic organisms are almost entirely dictated by the prevailing currents. By contrast, **nektonic** organisms can move independently of the current.

Purse seine: a fishing method whereby entire shoals of fish (usually pelagic species) are encircled by a sheet of netting, the bottom of which is then drawn together to form a bag or 'purse'.

Recruitment: 1) the number of young produced by a given stock each year, or 2) the numbers of new fish which are added to the catchable portion of the stock resulting from growth or migration of smaller fish.

Relative fecundity: see **fecundity**.

RIVO: Netherlands Institute for Fisheries Research.

Serial spawning: release of eggs in several batches. See **fecundity**.

SGFS: Scottish Groundfish Survey.

Spawning stock biomass: see **stock**.

SSB: Spawning Stock Biomass. See **stock**.

Stock: a part of a fish population, usually with a particular migratory pattern, specific spawning grounds, and subject to a distinct fishery. **Total stock** refers to both juveniles and adults, either in numbers or by weight, while **spawning stock (biomass)** refers to the numbers (weights) of individuals which are old enough to reproduce.

Synchronous spawning: release of eggs at one time. See **fecundity**.

Teleosts: fish with bony skeletons. See **elasmobranchs**.

Viviparous: form of reproduction whereby the young develop within the mother and are nourished by her via a placenta.

VPA: Virtual Population Analysis. See page 3.

Year class: a group of fish born in the same year. Thus 1-group fish sampled in 1985, 2-group fish sampled in 1986, and 3-group fish sampled in 1987 are all members of the 1984 year class. See also **age group**.

9. Index of fish names

9.1 Scientific names

Name	Number
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Anarhichas lupus	63
Anguilla anguilla	27
Argentina silus	25
Argentina sphyraena	25
Argentina spp.	25
Arnoglossus laterna	86
Aspitrigla cuculus	72
Belone belone	29
Brosme brosme	45
Buglossidium luteum	94
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Callionymus lyra	62
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Callionymus reticulatus	62
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Hippoglossoides platessoides	88
Hippoglossus hippoglossus	89
Hyperoplus immaculatus	57
Hyperoplus lanceolatus	57
Lampetra fluviatilis	1
Lepidorhombus whiffiagonis	81
Lepidorhombus boscii	81
Limanda limanda	90
Liparis liparis	80
Liza aurata	69
Liza ramada	69
Lophius budegassa	98
Lophius piscatorius	98
Lumpenus lampretaeformis	65
Lycodes vahli	66
Maurolicus muelleri	23
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Merlangius merlangus	38
Merluccius merluccius	34
Microchirus variegatus	95
Micromesistius poutassou	39
Microstomus kitt	91
Molva dipterygia	49
Molva molva	50
Mugilidae	69
Mullus surmuletus	55
Myoxocephalus scorpius	75
Myxine glutinosa	2
Nerophis lumbriciformis	31
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Petromyzon marinus	1
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Pholis gunnellus	64
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Pollachius pollachius	40
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Raja naevus	14
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Sardina pilchardus	20
Scomber scombrus	60
Scomberesox saurus	30
Scophthalmus rhombus	84
Scyliorhinus canicula	4
Scyliorhinus stellaris	5
Sebastes marinus	71
Sebastes viviparus	71
Solea vulgaris	96
Spondyliosoma cantharus	56
Sprattus sprattus	21
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Name	Number
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Taurulus bubalis	76
Trachinus draco	59
Trachurus trachurus	54
Trigla lucerna	74
Triglops murrayi	77
Trisopterus esmarki	42
Trisopterus luscus	43
Trisopterus minutus	44
Zeugopterus punctatus	85
Zeus faber	52
Zoarces viviparus	67

9.2 English

Name	Number
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Anchovy	22
Angler	98
Argentines	25
Bass	53
Bib	43
Black sea-bream	56
Black-bellied angler	98
Black-mouthed dogfish	3
Blue ling	49
Blue whiting	39
Bluemouth	70
Brill	84
Brown trout	24
Bullrout	75
Catfish	63
Cod	36
Common dragonet	62
Common sandeel	57
Common skate	10
Conger	28
Corbin's sandeel	57
Cuckoo ray	14
Dab	90
Deep-snouted pipefish	31
Dragonet	62
Eel	27
Eelpout	67
Five-bearded rockling	46
Flounder	92
Four-bearded rockling	51
Garfish	29
Gobies	61
Golden mullet	69
Great pipefish	31
Greater argentine	25
Greater sandeel	57
Greater sandeels	57
Greater weever	59
Grey gurnard	73
Grey mullets	69
Gunnel	64
Haddock	37
Hagfish	2
Hake	34
Halibut	89
Herring	19
Hooknose	78
Horse mackerel	54
John Dory	52
Lampern	1
Lamprey	1
Lampreys	1
Lemon sole	91
Lesser argentine	25
Lesser sandeels	57
Lesser weever	58
Lesser-spotted dogfish	4
Ling	50
Long-nosed skate	11
Long rough dab	88

Name	Number
Lozano's goby	61
Lumpsucker	79
Mackerel	60
Megrim	81
Monkfish	98
Moustache sculpin	77
Nilsson's pipefish	31
Northern rockling	47
Norway haddock	71
Norway pout	42
Norwegian topknot	82
Nursehound	5
Pearlfish	68
Pearlsides	23
Pilchard	20
Pipefishes	31
Plaice	93
Pogge	78
Pollack	40
Poor cod	44
Rabbit fish	17
Raitt's sandeel	57
Red gurnard	72
Red mullet	55
Redfish	71
Reticulated dragonet	62
Roker	15
Roundnose grenadier	33
Saithe	41
Sand goby	61
Sandeels	57
Sandy ray	12
Sardine	20
Saurey pike	30
Scad	54
Scaldfish	86
Sea scorpion	76
Sea trout	24
Sea-snail	80
Seahorse	31
Shagreen ray	13
Silvery pout	35
Skipper	30
Smelt	26
Smooth sandeel	57
Snake blenny	65
Snake pipefish	31
Sole	96
Solenette	94
Spiny dogfish	8
Spotted dragonet	62
Spotted ray	16
Sprat	21
Spurdog	8
Starry ray	9
Straight-nosed pipefish	31
Thick-lipped mullet	69
Thickback sole	95
Thin-lipped mullet	69
Three-bearded rockling	48
Three-spined stickleback	32

Name	Number	Name	Number
Tope	6	Two-spotted clingfish	97
Topknot	85	Vahl's eelpout	66
Trout	24	Velvet-belly	7
Tub gurnard	74	Whiting	38
Turbot	83	Witch	87
Tusk	45	Wolffish	63
Twaite shad	18	Worm pipefish	31

9.3 French

Name	Number
Aiguillat commun	8
Alose fallax	18
Alose vraie	18
Anchois	22
Anguille	27
Arnoglosse laterne	86
Aurin	68
Balai	88
Balaou	30
Bar	53
Barbue	84
Baudroie commune	98
Brosme	45
Callionyme	62
Cardine	81
Chaboisseau	75
Chabot	76
Chabot arctique	77
Chien espagnol	3
Chimère commune	17
Chinchard	54
Congre	28
Dorade grise	56
Eglefin	37
Eperlan	26
Epinoche	32
Equilles	57
Flet	92
Flétan	89
Gadicule	35
Gobies	61
Gonelle	64
Grand tacaud	43
Grande argentine	25
Grande roussette	4
Grande vive	59
Grenadier à nez rond	33
Grondin gris	73
Grondin perlon	74
Grondin pin	72
Hareng	19
Lamproie de rivière	1
Lamproie marine	1
Lançons	57
Lepadogaster à deux taches	97
Lieu jaune	40
Lieu noir	41
Limace de mer	80
Limande	90
Limande sole	91
Lingue bleue	49
Lingue franche	50
Lompe	79
Loquette	67
Loup	63
Lumpenus lampretaeformis	65
Lycodes vahli	66
Maquereau commun	60
Maurolicus muelleri	23
Merlan	38
Merlan bleu	39
Merlu	34
Morue	36
Motelle à cinq barbillons	46
Motelle à quatre barbillons	51
Motelle commune	48
Motelle nordique	47
Mulets	69
Myxine	2
Orphie	29
Petit sébaste	71
Petit tacaud	44
Petite argentine	25
Petite roussette	5
Petite vive	58
Phrynorhombe de Norvège	82
Plie	93
Plie cynoglosse	87
Pocheteau gris	10
Pocheteau noir	11
Raie bouclée	15
Raie chardon	13
Raie circulaire	12
Raie douce	16
Raie fleurie	14
Raie radiée	9
Requin hâ	6
Rouget barbet	55
Sagre commun	7
Saint Pierre	52
Sardine	20
Sébaste chèvre	70
Sole commune	96
Sole jaune	94
Sole perdrix	95
Souris de mer	78
Sprat	21
Syngnathes	31
Tacaud norvégien	42
Targeur	85
Truite de mer	24
Turbot	83

9.4 German

Name	Number
Aalmutter	67
Bandfisch	65
Blauer Wittling	39
Blauleng	49
Blaumäulchen	70
Butterfisch	64
Chagrin Roche	13
Doggerscharbe	88
Dornhai	8
Dreibärtelige Seequappe	48
Dreistacheliger Stichling	32
Finte	18
Fleckhai	3
Flußaal	27
Flußneunauge	1
Flunder	92
Flügelbutt	81
Franzosendorsch	43
Fünfbärtelige Seequappe	46
Gefleckter Roche	16
Gestreifte Seezunge	95
Gestreifter Katfisch	63
Glasauge	25
Glattbutt	84
Glattroche	10
Goldlachs	25
Grauer Knurrhahn	73
Großgefleckter Katzenhai	5
Grundel	61
Haarbutt	85
Hering	19
Heringsköning	52
Hornhecht	29
Hundshai	6
Inger	2
Kabeljau	36
Kleingefleckter Katzenhai	4
Kliesche	90
Kuckucksroche	14
Küstenrotbarsch	71
Lachshering	23
Lammzunge	86
Langstacheliger Seeskorpion	76
Leierfisch	62
Leng	50
Limande	91
Lumb	45
Maifisch	18
Makrele	60
Makrelenhecht	30
Meeraal	28
Meeräschen	69
Meerbarbe	55
Meerforelle	24
Meerneunauge	1
Murray's Knurrfisch	77
Nagelroche	15
Perlfisch	68
Petermännchen	59
Pollack	40
Roter Knurrhahn	72
Rotzunge	87
Rundnasengrenadier	33
Sandaale	57
Sandroche	12
Sardelle	22
Sardine	20
Scheibenbauch	80
Schellfisch	37
Scholle	93
Schwarzer Dornhai	7
Seehase	79
Seehecht	34
Seelachs	41
Seenadeln	31
Seeratte	17
Seeschwalbe	74
Seeskorpion	75
Seeteufel	98
Seezunge	96
Silberdorsch	35
Spitzschnauziger Roche	11
Sprott	21
Steinbutt	83
Steinpicker	78
Sternroche	9
Stint	26
Stintdorsch	42
Stöcker	54
Streifenbrasse	56
Vahls Wolfsfisch	66
Vielbärtelige Seequappe	51
Vierbärtelige Seequappe	47
Viperqueise	58
Weißer Heilbutt	89
Wittling	38
Wolfsbarsch	53
Zweifleckige Haftgrundel	97
Zwergbutt	82
Zwergdorsch	44
Zwergzunge	94

9.5 Danish

Name	Number
Almindelig ulk	75
Ansjos	22
Bars	53
Blåhvilling	39
Blåkæften	70
Brisling	21
Brosme	45
Byrkelange	49
Ciliata septentrionalis	47
Diplecogaster bimaculata	97
Echiodon drummondi	68
Femtrådet havkvabbe	46
Finnebræmmet ringbug	80
Firetrådet havkvabbe	51
Fjæsing	59
Flodlampret	1
Fløjfisk	62
Glashvarre	81
Glastunge	94
Glyse	44
Grå knurhane	73
Gråhaj	6
Guldlaks	25
Gøgerokke	13
Havkat	63
Havlampret	1
Havmus	17
Havrude	56
Havtaske	98
Havål	28
Helleflynder	89
Hestemakrel	54
Hornfisk	29
Hvilling	38
Håising	88
Hårhvarre	85
Ising	90
Knurhane	72
Knurulk	77
Kuller	37
Kulmule	34
Kutling	61
Laksesild	23
Lange	50
Langtornet ulk	76
Lille fjæsing	58
Lille rødfisk	71
Lubbe	40
Majsild	18
Makrel	60
Makrelgedde	30

Name	Number
Microchirus variegatus	95
Mulle	55
Multe	69
Panserulk	78
Pighaj	8
Pighvarre	83
Pletrokke	14
Plovjerns rokke	11
Ringhaj	3
Rød knurhane	74
Rødspætte	93
Rødtunge	91
Sandrokke	12
Sankt Petersfisk	52
Sardin	20
Sej	41
Sild	19
Skade	10
Skolæst	33
Skrubbe	92
Skægtorsk	43
Skærising	87
Slethvarre	84
Slimål	2
Smelt	26
Småhvarre	82
Småplettet rødhaj	4
Sorthaj	7
Spidshalet langebarn	65
Spærling	42
Stavsild	18
Stenbider	79
Storplettet rokke	16
Storplettet rødhaj	5
Strømsild	25
Sølvtorsk	35
Sømrokke	15
Tangspræl	64
Tangål	31
Tobis	57
Torsk	36
Trepigget hundestejle	32
Tretrådet havkvabbe	48
Tunge	96
Tungehvarre	86
Tærbe	9
Vahl's ålebrosme	66
Ål	27
Ålekvabbe	67
Ørred	24

9.6 Norwegian

Name	Number
Ansjos	22
Aure	24
Blåkjeft	70
Blålange	49
Breiflabb	98
Brisling	21
Brosme	45
Dobbeltsuger	97
Dvergfjesing	58
Dvergulke	76
Elveniøye	1
Femtrådet tangbrosme	46
Firetrådet tangbrosme	51
Fjesing	59
Flekkskate	16
Fløyfisk	62
Gapeflyndre	88
Glasstunge	94
Glassvar	81
Gråhai	6
Gråsteinbit	63
Havkaruss	56
Havmus	17
Havniøye	1
Havåbor	53
Havål	28
Horngjel	29
Hvitting	38
Hyse	37
Hågjel	3
Hårvar	85
Kloskate	9
Knurr	73
Kolmule	39
Krøkle	26
Kutlingfisker	61
Kveite	89
Laksesild	23
Lange	50
Langhalet langebarn	65
Lomre	91
Lusuer	71
Lyr	40
Lysing	34
Maisild	18
Makrell	60
Makrellgjedde	30
Microchirus variegatus	95
Mulle	55
Multefisker	69
Nebbskate	13
Nordlig knurrulke	77
Nordlig tangbrosme	47
Nålefisker	31
Panserulke	78
Pigghå	8
Piggskate	15
Piggvar	83
Raja naevus	14
Rognkjeks	79
Rødknurr	74
Rødspette	93
Sandflyndre	90
Sandskate	12
Sankt Petersfisk	52
Sardin	20
Sei	41
Sild	19
Skjeggtorsk	43
Skolest	33
Skrubbe	92
Slettvar	84
Slimål	2
Småflekket rødhai	4
Småvar	82
Smørflyndre	87
Snyltefisk	68
Spisskate	11
Stamsild	18
Storflekket rødhai	5
Storskate	10
Strømsild	25
Svarthå	7
Sypike	44
Sølvtorsk	35
Taggmakrell	54
Tangsprell	64
Tobis	57
Torsk	36
Trepigget stingsild	32
Tretrådet tangbrosme	48
Tunge	96
Tungevar	86
Tverrstripet knurr	72
Vanlig ringbuk	80
Vanlig ulke	75
Vanlig ålebrosme	66
Vassild	25
Ål	27
Ålebrosme	66
Ålekvabbe	67
Øyepål	42

9.7 Dutch

Name	Number
Aal	27
Ansjovis	22
Blauwe leng	49
Blauwe wijting	39
Blauwkeeltje	70
Bot	92
Botervis	64
Congeraal	28
Dikrugtong	95
Doornhaai	8
Draakvis	17
Driedoornige stekelbaars	32
Driedradige meun	48
Dwergbolk	44
Dwergbot	82
Dwergtong	94
Elft	18
Engelse poon	72
Fint	18
Forel	24
Geep	29
Gevlekte griet	85
Gevlekte rog	16
Grauwe poon	73
Grenadiervis	33
Griet	84
Groene zeedonderpad	76
Grondels	61
Grootoogrog	14
Grote pieterman	59
Grote zilversmelt	25
Harders	69
Haring	19
Harnasmannetje	78
Heek	34
Heilbot	89
Hondshaai	4
Horsmakreel	54
IJslandse bandvis	65
Kabeljauw	36
Kathaai	5
Kever	42
Kleine pieterman	58
Kleine roodbaars	71
Kleine zilversmelt	25
Koolvis	41
Lange schar	88
Leng	50
Lichtend sprotje	23
Lom	45
Makreel	60
Makreelgeep	30
Mul	55
Murray's zeedonderpad	77
Noorse meun	47
Paling	27
Parelvis	68
Pelser	20
Pitvis	62
Pollak	40
Puitaal	67
Rivierprik	1
Rode poon	74
Ruwe haai	6
Sardien	20
Schar	90
Scharretong	81
Schelvis	37
Scherpsnuit	11
Schol	93
Schurftvis	86
Segrijnrog	13
Slakdolf	80
Slijmprik	2
Snotolf	79
Spiering	26
Sprot	21
Steenbolk	43
Stekelrog	15
Sterrog	9
Tarbot	83
Tong	96
Tongschar	91
Vierdradige meun	51
Vijfdradige meun	46
Vleet	10
Wijting	38
Witje	87
Wolfsvis	66
Zandrog	12
Zandspieringen	57
Zeebaars	53
Zeedonderpad	75
Zeeduivel	98
Zeekarper	56
Zeenaalden	31
Zeeprik	1
Zeewolf	63
Zilverkabeljauw	35
Zonnevis	52
Zuignapvis	97
Zwartbekhondshaai	3
Zwarte doornhaai	7

9.8 Swedish

Name	Number
Ansjovis	22
Äkta tunga	96
Bergtunga	91
Bergvar	85
Birkelånga	49
Bleka	40
Blåkäft	70
Blåkäxa	7
Blåvitling	39
Ciliata septentrionalis	47
Echiodon drummondi	68
Femtömmad skärlånga	46
Fenknot	74
Fjärsing	59
Flodnejonöga	1
Fyrtömmad skärlånga	51
Glasvar	81
Glyskolja	44
Gobiidae	61
Gökrocka	13
Gråhaj	6
Gråsej	41
Guldlax	25
Havsabborre	53
Havskatt	63
Havsmus	17
Havsnejonöga	1
Havsruda	56
Havsål	28
Hälleflundra	89
Horngädda	29
Hågäl	3
Kantnålar	31
Klorocka	9
Knaggrocka	15
Knot	73
Kolja	37
Kummel	34
Laxsill	23
Lerskädda	88
Lubb	45
Långa	50
Majfisk	18
Makrill	60
Makrillgädda	30
Marulk	98
Microchirus variegatus	95
Mindre fjärsing	58
Mindre kungsfisk	71
Mullus	55
Multar	69

Name	Number
Nordlig silvertorsk	35
Nors	26
Oxsimpa	76
Öring	24
Pigghaj	8
Piggvar	83
Pirål	2
Plogjärnsrocka	11
Raja circularis	12
Raja montagui	16
Raja naevus	14
Ringbuk	80
Rödknot	72
Rödspätta	93
Rödtunga	87
Rötsimpa	75
Sandskädda	90
Sanktpersfisk	52
Sardin	20
Scyliorhinus stellaris	5
Sill	19
Silverfisk	25
Simpknot	77
Sjökock	62
Sjurygg	79
Skarpsill	21
Skäggsimpa	78
Skäggtorsk	43
Skoläst	33
Skrubbskädda	92
Slätrocka	10
Slätvar	84
Småfläkkig rödhaj	4
Småtunga	94
Småvar	82
Spetsstjärtat långebarn	65
Staksill	18
Storspigg	32
Taggmakrill	54
Tejstefisk	64
Tobisar	57
Torsk	36
Tretömmad skärlånga	48
Tungevar	86
Tvåfläckig dubbelsugare	97
Vahls ålbrosme	66
Vitling	38
Vitlinglyra	42
Ål	27
Ålkusa	67