# ICES WGNEW REPORT 2010

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# Report of the Working Group on Assessment of New MoU Species (WGNEW)

11–15 October 2010

ICES HQ, Denmark

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

**International Council for the Exploration of the Sea**
**Conseil International pour l'Exploration de la Mer**

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

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## Contents

## Executive Summary


WGNEW was established in 2005 and met in 2005 and 2007. The main task of WGNEW is to provide information on the new species of the MoU between ICES and the EC: sea bass, striped red mullet, red gurnard, tub gurnard, grey gurnard, turbot, brill, dab, flounder, lemon sole, witch flounder. Later John dory was added to this list. During the 2007 meeting it was felt that many data on these species had been collected by different institutes, but that very often, these data were not analysed, or otoliths had been collected but were not aged. WGNEW therefore applied for funding through the EC to make these essential data available, and in a few cases some small scale additional sampling was done. This year the results of a 12 month project became available. In this project, "NESPMAN Improving the knowledge of the biology and the fisheries of the new species for management" (http://ec.europa.eu/fisheries/documentation/studies/nespman /index_en.htm), all institutes represented in WGNEW participated.

During this year's meeting, the WG had the ambitious plan to provide for all species a 3- to 4-page summary, plus an Annex with a compilation of all data from the previous two reports and the NESPMAN report. This meant that by the end of the 5-day meeting the report was not yet finished.

Below, the main conclusions are summarised per species.

**Sea bass (*Dicentrarchus labrax*)**: The main countries landing sea bass are France (2/3 of the European landings) and the UK. The WG expected to be able to update the assessment of sea bass in the Channel but this could not be done because of the absence of French data for 2009. Catches at the beginning of the 1980's were around 2000 t in the North East Atlantic, but have steadily increased, reaching a peak of over 8000 t in 2006. A preliminary assessment was made for the Celtic Sea (separable VPA) on combined French and English data (area VIIe+h). The separable statistical catch at age model presented in the WGNEW2007 report was rerun. For VIIe,f, the two models gave similar increasing trends for fishing mortality (for the period 2001-2009) but differed in SSB trends. A simple catch curve was computed for the area VIIIa,b which also gave an increasing trend in F. The output from these models were considered illustrative only and the WG concluded that a workshop gathering French and English experts is necessary to conclude on the appropriate model to use.

**Striped red mullet (*Mullus surmuletus*):** Landings were around 1500 t in 1985 and have increased to around 7000 t in recent years. The majority of the landings are by France and most fish is caught in the eastern Channel. Two stock areas can be distinguished: the Bay of Biscay, and the Channel combined with the southern North Sea. Survey catches are increasing but fluctuate widely between years. Time series from market sampling are still short. Due to the continuous increase of the landings no analytical assessment has been possible yet.

**For the three gurnard species** not much more than time series of abundance and length compositions from surveys are available. The quality of landings data is generally poor since the species have usually not been well separated when landed.

**Red gurnard (*Aspitrigla cuculus*):** The species is mainly found in the Channel and on the shelf west of Brittany. Between 2001 and 2005 landings fluctuated around 5000 t. LPUE in the eastern Channel shows an upward trend. In other parts of its distribution area no trends are seen.

**Tub gurnard (*Trigla lucerna*):** Landings are 3000 to 4000 t in recent years, mainly taken in the southern North Sea (in summer) and in the eastern Channel. Survey trends indicate an increasing abundance of this species since 1985.

**Grey gurnard (*Eutrigla gurnardus*):** Only survey data are available. The species is widely distributed in the North Sea. Both in the North Sea and in Skagerrak-Kattegat abundance increases since the late 1980's. The landings, however, are decreasing in the North Sea and only 300 to 500 t in recent years. WGNEW suggests to delete this species from its ToR's.

**Turbot (*Psetta maxima*):** Turbot is mainly a by-catch in the fishery for flatfish and demersal species. For turbot many data on surveys and landings are available, but age data only exist for several short periods. Recently, the total landings have been between 4300 and 6000 t. The North Sea accounts for the major part of the landings. A preliminary analytical assessment for turbot in the North Sea is presented. It is stressed that this assessment should only be considered as indicative for trends. It indicates that fishing mortality has increased between 1975 and 2000. Since 2000, the increase has most likely stopped and fishing mortality has decreased. Possibly this is linked to effort reductions in the fishery for the species plaice and sole.

**Brill (*Scophthalmus rhombus*)**: For this species similar data are available as for turbot. Due to time constraints no assessment could be made.

**Common dab (*Limanda limanda*):** Common dab is a very common flatfish in the North Sea, where it is probably also the species with the highest discarding rate. Landings from the North Sea are around 10,000 t. Survey indices, e.g. IBTS quarter 1 surveys, indicate a gradual increase in abundance.

**Flounder (*Platichthys flesus*):** In the North Sea flounder is a by-catch in fisheries for flatfish. A considerable part of the catch is being discarded, landings are 3000 to 4000 t. Mainly data for surveys are available. Recently a market sampling programme started in The Netherlands, the main country landing flounder. The abundance of North Sea flounder in the IBTS quarter 1 survey increased between 1980 and 1990, and decreased again. Abundance was low from 1999 to 2003. In the last three years, 2008 to 2010, abundance was unusually high.

**Lemon sole (*Microstomus kitt*):** Lemon sole is a by-catch in several demersal fisheries. In the North Sea recent landings were 3500 to 4000 t. The available time series from Lpue and surveys show conflicting signals. LPUE data from UK (E&W) otter and beam trawlers off the northeast coast of England show a general decrease whereas survey abundance shows an increasing trend

**Witch flounder (*Glyptocephalus cynoglossus*)**: This species is particularly important in the Skagerrak-Kattegat area where it is a valuable by-catch in fisheries by Denmark and Sweden. An assessment was attempted but the results were too uncertain to be presented.

**John dory (*Zeus faber*):** This widespread southern species is increasing over a wide area. There are two main areas of exploitation: Celtic sea, western Channel and northern Bay of Biscay (VIIe-j & VIII a,b) and western Iberian waters (IXa). Landings, mainly by France and Spain, have increased from 1000 to 3000 t in recent years. Time series of abundance from surveys show an increase in IXa (Portuguese IBTS), VIIf-j and VIIIa,b (French EVHOE) and VII d,e (French CGFS). Four survey time series are available. All show an increase in biomass and abundance since the late 1990's up to 2007 – 2008, and a drop in 2009.

In order to decrease the workload of WGNEW slightly it is suggested to delete two species from the ToR's, grey gurnard and flounder, since there are few data for both species and the interest in fisheries for these species is very limited.

# 1 Introduction and Terms of Reference of WGNEW

WGNEW has not met since January 2007. During the 2007 meeting, WGNEW discussed the need for an EC funded project and it was felt that external funding was essential for WGNEW to make significant progress in its tasks. The main work would be to make data available from routine surveys, market sampling and discard sampling programmes, plus data on catches and effort and any further data from biological sampling or studies on stock ID. The NESPMAN project proposal was submitted for funding in 2008 but final acceptance was delayed and the final report was only made available in March 2010. Due to this delay, there was no meeting of the working group in 2009 and in 2008, the group only met by correspondence.

The group also recommended in 2007 that John dory be added on the list of species to be dealt with by the working group. The WG TOR's for its 2010 meeting were:

The **Working Group on Assessment of New MoU Species** [WGNEW] (Chaired by: Henk Heessen, Netherlands and Jean-Claude Mahé, France) will meet in ICES HQ 11–15 October 2010 to*:*

a ) consider possibilities for fish stock assessments/input to management processes/indicators of the following species: sea bass, flounder (except for the Baltic) common dab (except for the Baltic), lemon sole, brill (except for the Baltic), turbot (except for the Baltic), witch flounder, red gurnard, tub gurnard, grey gurnards, striped red mullet and John dory, through:

review of knowledge on stock structure;

existing fisheries monitoring programmes and surveys including the EU Data Collection Programme;

existing databases made available for fish stocks assessment.

b ) These results will be presented in the form of

dataseries considered indicative of stock trends/status

proposals for analytical assessments if appropriate

comments on additional data collection that would improve the assessment of stock status

c ) This will be done on the basis of data and methods prepared before the meeting.

# 2 Participants

The following persons attended the meeting :

| | |
|---|---|
| Robert Bellail | France |
| Mickael Drogou | France |
| Henk Heessen (co-chair) | Netherlands |
| Jean-Claude Mahé (co-chair) | France |
| Kelig Mahé | France |
| Kelle Moreau | Belgium |
| Kay Panten | Germany |
| Jan Jaap Poos | Netherlands |
| Francesca Vitale | Sweden |
| Sarah Walmsley (by correspondence) | UK (England) |

# 3 Background

The working group decided that the best approach for this report would to present in the main body a summary for each species highlighting the keypoints in the process of providing scientific advice. The full set of data and analysis for each species is provided in annexes. These annexes are meant to gather all the knowledge for each species and include material previously included in the former reports and also data acquired and analysed in the context of the EU funded NESPMAN project (http://ec.europa.eu/fisheries/ documentation/studies/nespman/index_en.htm ).

# 4 Sea Bass

## 4.1 General Biology

Bass *Dicentrarchus labrax* is a widely distributed species in northeast Atlantic shelf waters from southern Norway, through the North Sea, the Irish Sea, the Bay of Biscay, the Mediterranean and the Black Sea to North-west Africa. The species is at the northern limits of its range around the British Isles and southern Scandinavia (ICES 2003). It is an important commercial and recreational species and there is a large body of literature regarding its life history and migration patterns (Pawson 2008).

Bass spawn in the Bay of Biscay during January – March and in the English Channel and eastern Celtic Sea from February - May. The eggs hatch after 4-9 days and at approximately 4 - 4.5 mm long (Pickett and Pawson 1994). Larvae move steadily inshore and at around 11 - 15 mm in length, they swim into estuarine nursery habitats (Jennings and Pawson, 1992). Juveniles remain in creeks, estuaries, backwaters, and shallow bays through their first and second years, after which they migrate to overwintering areas in deeper water, returning to larger estuaries in summer. When they reach 4 or 5 years their movements become more wide-ranging and they eventually adopt the adult feeding/spawning migration patterns (Pawson *et al*., 1987). Growth is relatively slow and the species is long-lived (up to 30 years of age). At the end of their 3rd year juveniles are approximately 25 cm and at the end of their 4th year they are approximately 33 cm. Maturity is attained at around 4 - 7 years, which is around 35 cm for males and 42 cm for females (Pawson and Pickett 1996).

## 4.2 Stock ID and possible management areas

Child (1992) suggested that there may be genetic differences between immature bass from the Irish Sea and elsewhere. However, other work (Tobin, Galway University, unpublished manuscript), suggests that there is little, if any, sign of population structuring. Durand *et al.* (2001) working on adult bass suggested that the genetic differentiation between spawning grounds is very limited. Fritsch *et al.* (2007), investigating juvenile and adult bass from the Bay of Biscay, the English Channel, Ireland and Scotland reported that genetic data showed no significant population differentiation, although results suggested that Irish and Scottish populations could be separated from the Bay of Biscay and Channel.

Tagging studies in the late 1970s and early 1980s showed that adult bass moved to the south and west of the UK as the water cools during October - December (Pawson *et al*., 1987). These fish appeared to return to the same feeding area each summer, suggesting that once bass reach maturity, they either occupy well-defined (usually inshore) feeding areas or pre-spawning and spawning areas, which tend to be offshore. More recent tagging studies confirm the general adult migration pattern, but note some differences that suggest climate warming may have lengthened the duration of residence of adult bass in summer feeding areas and, at least in the North Sea, has allowed bass to spawn much further north than previously (Pawson *et al*., 2007b).

The ICES Study Group on Sea Bass (SGBASS) proposed 6 stock areas for bass (ICES 2002, 2004), based on seasonal patterns of movement and the characteristics of the seasonal fisheries taking bass. SGBASS proposed that North Sea bass be considered as a separate stock. The eastern and western Channel have resident and seasonal visiting bass and, though there is little evidence of a "biological" boundary between these stocks, SGBASS suggested that ICES Divisions VIId and VIIe are separated for assessment purposes because their respective fisheries are different. Very few bass appear to move north or south across the Hurd Deep within VIIe, which suggested to SGBASS that fish around North Brittany and the Channel Islands could be separated from UK stocks and possibly included with those in Sub-area VIII. SGBASS considered that for management the bass population around Ireland could be regarded as a discrete stock. Finally, the bass population in the Bay of Biscay appeared to be relatively self-contained, and SGBASS proposed that this should be a separate stock area.

Recent genetic and tagging studies have lead Fritsch *et al.* (2007) and Pawson *et al.* (2007), to question the need for 6 stock areas. These authors suggest that the North Sea and Bay of Biscay could remain separate, but suggest that the English Channel and Bristol Channel could be treated as a single unit, as could bass in Irish coastal waters. WGNEW recommends that these conclusions be evaluated together with all available data including further analysis of tagging-recapture data in the English Channel in relation to the definition of stock boundaries for assessment.

## 4.3 Management regulations

Under EU regulation, the MLS of bass is 36 cm total length and there is effectively a banned range for enmeshing nets of 70 - 89 mm stretched mesh in Regions 1 and 2 of Community waters. There are no direct effort or catch controls.

A variety of national restrictions are also in place that include a landings limit of 5 t/boat/week for all French and UK trawlers landing bass; the closure of 37 bass nursery areas in England and Wales; regional byelaws in Cornwall and South Wales that stipulate a MLS of 37.5 cm; and a regional byelaw in South Wales that stipulates a minimum gill net mesh size of 100 mm. In Ireland, a variety of controls effectively ban commercial fishing for bass in Irish waters.

In France, recreational fishermen only have to respect a few rules (number of fishing tackle onboard and non profit making sale of their catch) and therefore the management and the control of recreational fishery are still not rigorous. In commercial fishery and in some areas, local limitation customs apply, such as in Brittany for example long liners and hand liners voluntarily stop fishing between February and mid-March to respect the spawning season.

## 4.4 Fisheries Data

Commercial bass fisheries developed in the late 1970s and 1980s, due to the high price commanded by the species. Although bass may be the main target for some commercial fisheries, the species is more commonly caught by French and English fishermen as one of 4- 6 species that are the target of a given fishing trip. Bass are rarely exploited as the main target species throughout the whole year. Commercial bass fisheries can be split into inshore and offshore components. Inshore, small boats operate daily trips, using a variety of fishing methods (e.g. trawl, handline, longline, nets, rod and line) with relatively little activity in winter. Offshore, pre-spawning and spawning bass are targeted by French mid-water pair-trawlers and by British vessels, between November and April (ICES, 2002). Bass is also considered the most important marine recreational angling species in the UK, Ireland (Dunn *et al*., 1989, 1994), and France (Herfault *et al*, 2010). A full description of the fishery characteristics of each stock area can be found in Annex 1.

### 4.4.1 Commercial catches and discard data

A summary of bass landings by stock areas is given in Figure 4-1. Landings at the beginning of the 1980's were around 2 000 t in the North East Atlantic, but have steadily increased, reaching a peak of over 8 000 t in 2006.

French data of Seabass for the EU Data Collection Framework have been recorded but the tools to extract and exploit them are still in development.

#### 4.4.1.1 North Sea and eastern Channel (Divisions IVb,c and VIId)

Landings were relatively stable at around 500 t between 1984 and 1990. Catches rose to 1 500 t in 1994, before decreasing to 1 000 t in 1996. Catches rose again to peak at 2 500 t in 2005 t. Landings by Netherlands boats were negligible until 1998, but have increased to around 300 - 400 t annually. UK landings peaked in 1994, 1997 and 1999, whereas French landings increased from 1993.

#### 4.4.1.2 Western Channel and Western Approaches (Divisions VIIe,h)

Landings fluctuated between 260 and 520 t over the period 1984 - 1993 (except for 980 t in 1987), rose to a peak of 1440 t in 1997 and then reached approximately 1900 t in 2004 and more than 2700 t in 2006. French vessels have taken the main part of the landings - usually at least 50% - whilst English vessels landed most of the remainder. Recent landings from the Channel Islands have increased to around 150 – 200 t per annum.

#### 4.4.1.3 Irish Sea, eastern Celtic Sea, and Bristol Channel (Divisions VIIa,f&g)

Landings fluctuated between 110 and 310 t over the period 1984 - 1992, and then rose to a peak of 850 t in 1994. Landings fluctuated between 360 and 680 t, but peaked again at 840 t in 2004. The greatest component of landings is obtained from estimates of the landings of UK inshore boats obtained through the Cefas logbook scheme.

#### 4.4.1.4 Bay of Biscay (Divisions VIIIa,b &d)

Landings increased rapidly to 1550 t from 1984 to 1987, since when they fluctuated between 1 300 and 1 680 t until 1999, rising to around 2400 t in 2000 - 2001 and to more than 2500 t in 2003. In 2006 catches peaked at 2877 t. French vessels take around 90% of the annual landings. In France, VIIIa,b area represented in 2008 49% of French seabass captures. Spanish (Basque Country) bass catches from Division VIIIa,b,d have been relatively constant, averaging around 50 t annually in the period 1994 - 2002.

#### 4.4.1.5 Southern Bay of Biscay (Division VIIIc)

Between 1988 and 1998, Spain reported landings of 250 - 400 t, but landings declined to 110 t by 2002 and since that time have ranged between 114 t and 173 t Inshore catches reported by the Basque Country have averaged 9 t in the period 2000 - 2004 (range 5 - 14 t), and comprise longline (about 70% of the total landings), gillnet (15%) and purse seine (10%). In 2004, the pursein catch was 3 t.

#### 4.4.1.6 Western coast of Spain and Portugal (Division IXa)

Total landings reached a peak of 600 t in 1989, and have since fluctuated between 141 and 772 t without trend. Landings in 2006 – 2008 have been between 516 t and 772 t. The Spanish catch from this area reached a peak in 2007 (228 t), despite being at series lows in the early 2000's. The Portuguese catch peaked at over 544 t in 2007.

### 4.4.2 Commercial catch-effort data and information of fleet activity

#### 4.4.2.1 France

According to CHARM 3 Atlas of the Channel Fisheries, seabass production in value represents 31937 € in 2008. It's the 3rd most valuable species caught (source: Agrimer) in 2008 behind sole and monkfish (tuna is not included in statistics).

The market value seabass depends greatly on how its caught, giving added value to certain metiers: according to CHARM3 Atlas of the Channel Fisheries, mean price of seabass sold in the Channel (7EH+7D) by liners was 17.14 € per Kg in 2007 compared with 6.52 € per Kg for pelagic trawl.

##### 4.4.2.1.1 Fleet activity

Since 2000 Ifremer has carried out a comprehensive survey (Fisheries Information System) consisting of an exhaustive collection of annual activity calendars (*Berthou et al*, 2008). This consists of a follow up of the metiers practiced by a given vessel per month and per year (by metier, we mean the use of a gear, to target one or several species, in a given fishing area). Figure 4-2 presents the numbers of vessels targeting seabass per gear. Landings are associated. A vessel is considered targeting seabass when its annual activity calendar shows at least a "seabass metier" covering at least a month in a given year. Pelagic trawling represented in 2008 45% of captures for 59 vessels (25 pairs and 9 vessels), particularly in winter during the spawning season. Coastal liners represented 32% of captures for the rest of the year for 567 vessels.

##### 4.4.2.1.2 Effort and Lpue

France has effort data and lpue data from logbooks of bottom trawlers, pelagic trawlers, nets, longlines and handlines in 5 stock areas between 2000 and 2008 (Figure 4-3 and Figure 4-4 respectively).

In area VIIeh, fishing effort of bottom trawl and pelagic trawl has increased from 2000 to 2004-2005, then became stable. Long liners effort has increased from 2000 to 2006 then decreased. Nets effort increased until 2007 then decreased. Morizur *et al*. (2009) investigated landings, fishing effort and landings per unit of effort for bottom trawlers and pelagic pair trawlers operating in ICES sub-areas VIII and VII between 2000 and 2007. Fishing effort was assessed by using a threshold on the landings by month in order to select the most effective fishing effort as representing 75 % of the effort concerned with seabass landings. An increase of the fishing effort of pelagic trawling was detected in the English Channel area since 2005.

In VIId both bottom trawl and net gears showed an increase in days fished between 2000 and 2003, but have since declined. Effort directed in pelagic trawling increased between 2000 and 2005. A variability is then observed until 2007. (Data for 2008 are incomplete)

In general, fishing effort in VIIIa,b has increased from 2000 to 2007 for nets, long liners and hand liners, then decreased. Bottom trawl showed a constant increase in days fished between 2000 and 2008. Pelagic trawl showed an increase of effort from 2000 to 2006 (except 2004), trend is decreasing in 2007 (2008 data are incomplete).

French Lpue data are also available from logbooks of French bottom trawlers, pelagic trawlers, nets, longlines and handlines in all 5 stock areas between 2000 and 2008

The fishing effort data available is the "days fished" for bottom trawl, long lines, hand lines, nets, and the "days at sea" for pelagic trawl. No threshold was applied to each gear to calculate effort Validity of LPUE of Pelagic is questionable because of the specific management associated to this gear (limitation to 5 tons/week/vessel).

Results are presented in Figure 4-4 but the available information in the log book does not give accurate data results. Trends of LPUE presented particularly for long lines, hand lines are under estimated. Fishermen mentioned that numbers of hooks and hours fished have increased from 2000 to 2010 in 8AB and 7EH (number of hooks for long liners were multiplied by two in some area such as southern Brittany). Moreover all new technologies such as the use of automatic fishing devices cannot be taken into account.

A decrease of LPUE has been observed for most of the gear in the VIIIa,b ICES area from 2000 and in VIIe,h ICES area from more or less a long time (particularly from 2006-2007). This trend is still reported in 2010 by coastal metier (particularly long liners and hand liners). It questions the viability of some fishing companies. The only available data for 2009 is a focus on LPUE of 6 coastal liners of 7E from personal fishing presented in Figure 4-5. It shows a mean decline of 33% of their LPUE from 2007 to 2009. According to them this downward trend is still observed in 2010, but there is no explanation yet.

This trend doesn't seem to be observed in the VIId, IVbc, ICES area.

#### 4.4.2.2 UK (E&W)

The UK (E&W) has official catch and effort data for data for trawlers, pair trawlers, nets, lines and other gears in IVb,c, VIId, VIIeh, and VIIafg for 1985 - 2008 (Figure 4-6 and Figure 4-7, respectively). In addition, 'best estimates' of annual catch and effort are available from integrating official statistics with those from a voluntary log-book system for 1985 – 2006. For trawlers, effort was relatively stable in areas IVbc and VIIafg. In Area VIId, trawl effort increased to 1994 and 1995, decreased sharply in 1996, but has since increased. In area VIIeh, trawl effort has gradually increased through the time series. Effort for nets and lines is less consistent in all areas.

Individual logbook cpue data are available for logbooks that were held by the same logbook holder for ~10 years of the scheme

#### 4.4.2.3 Spain (Basque Country)

Information on bass landings and landings per unit effort made by the Spanish fleets landing into the Basque Country ports, extending from 1994 to 2004, was presented in a working document to WGNEW (Annex 3, WD2 2 Lucio *et al*., 2005). There is less detailed information from other important Spanish regions. The Basque Country data, obtained from EC log-books, skippers logbooks and *ad hoc* monitoring of the trips and landings into Basque ports, cover more than 14 commercial métiers, in four sea areas: Subarea VI; Subarea VII mainly VIIh,j); Divisions VIIIa,b,d and Division VIIIc (eastern part). Economic values per year in recent years are available for all métiers and sea areas considered together. In 1991- 1992, *ad hoc* sampling, conducted by AZTI to study the artisanal métiers in the inshore waters of the Basque Country coast (eastern Div. VIIIc and southern Div. VIIIb), produced data on bass catches, effort and length compositions for surface longline and trammel net (Puente, 1993). AZTI monitoring for bass in 1994 and 1995 did not include landings of the main fleets operating in Div. VIIIc, particularly longline and gillnet; thus total landings reported for those years in this area must be considered underestimated.

Fishing effort data are expressed in 'days fished' and are available since 1994 for Baka bottom otter trawls in Div. VIIIa,b,d, and also for other trawling métiers and for longlines and trammel nets. The best estimator of bass abundance trends (LPUE) in the period 1994 - 2004 is based on landings into the Basque port of Ondarroa by the 'baka' otter bottom trawl fleet working in Div. VIIIa,b,d. This fleet takes the largest bass catches of the Basque fleet, and its fishing effort can be quantified with accuracy through the period. However, this is currently a mixed-species fishery, in which bass is an economically important by-catch restricted to a period of the year. The effective fishing effort of this fleet was calculated as fishing days, obtained by multiplying the number of trips in Div. VIIIa,b,d by the mean number of fishing days by trip in the area, season (quarter) and year. No bass discards were observed during an observer survey in 2000, conducted by AZTI on board Baka. trawls in Sub-area VII and in Divisions VIIIa,b,d as well as in pairtrawls with VHVO nets in Divisions VIIIa,b,d and in Division VIIIc.

#### 4.4.2.4 Spain (other than BC)

Landings by Spanish vessels outside the Basque Country are available for 2000 - 2002 by sea area and gear. No associated effort data are available.

#### 4.4.2.5 Portugal

Landings by gear between 1986 and 2003 for ICES Division IXa are available.

### 4.4.3 Recreational catches

#### 4.4.3.1 France

The first national survey of recreational fishing in France (2006 to 2008) revealed that seabass was the main target species for recreational fishermen, with catches around 5000 t. According to this survey, the individual penetration rate is 2%. That means that 2% of the population aged 15 years has caught at least one seabass during the last twelve months on the Atlantic, English Channel or North Sea seaboards. The estimated number of seabass fishermen in the coastal zone is 229 000 fishers. Extrapolated to the entire France is represented 378,500 seabass fishermen. In 2009, a new study was launched to monitor seabass recreational fishing more accurately. Final results are not available yet. (Herfaut *et al.* ICES CM 2010/R: 05)

#### 4.4.3.2 UK (E&W)

The only estimates of recreational catches in UK (E&W) suggested that anglers landed 415 t and 412 t in 1987 and 1993, respectively (Dunn *et al.* 1989; Dunn and Potten 1994). This was around 57% and 37% of the composite 'best estimate' of commercial landings for the respective years. No more recent estimates are available

## 4.5 Survey data

### 4.5.1 UK

The UK has conducted pre-recruit trawl surveys in the Solent and the Thames Estuary since 1981 and 1997, respectively and has undertaken a seine net survey in the Tamar Estuary, since 1985. These surveys all ended in 2009. Additional data are available from power stations in the Thames and Severn Estuary. Abundance indices for these surveys are given in Figure 4-10. In the Solent survey, strong year classes were seen in 1989, 1995 and 1997, but in the last decade, year class strength has been more consistent, with many years classes showing a relative abundance around the series mean, rather than the large fluctuations seen at the beginning of the time series.

### 4.5.2 Netherlands

The Netherlands has data from a 3m beam trawl survey in the Westerscheldt (Figure 4-11). Between 1972 and 1990, bass catches were rare, but since 1990 abundance has increased significantly. Large peaks in abundance are seen in 1994 and 2004.

### 4.5.3 France

Index from French surveys cannot be used for seabass, because, in particularly IBTS and Evohe are not adapted for this species (only a few seabass are caught, and it cannot be representative).

## 4.6 Biological sampling

### 4.6.1 France

Good biological sampling data (length and age) are available for all métiers in VIIe (except pelagic trawls) for one year, 1989 - 90, and for all métiers by quarter in VIId,e for 1994 - 95. In addition, Figures 1-10 and 1-11 in Annex 1 show length and age data for 2000 onwards. Length structures estimates are available for VIIe,h and VIIIa,b (Figure 4-8) per gear and for all gear. Per quarter, year, gear, and by ICES area the number of sampled trips and number of measured fish are available. When a main gear was not sampled in a quarter, sampling used came from another quarter of the same year. Lack of these data is highlighted in the annex. For VIIe,h structure at age per gear and for all gear were drawn up from 2000 to 2008 with VIIe,h ALKs. The age composition for French and UK data combined is shown in Figure 4-9. Data for France and UK separately are given in Annex 1. For VIIIa,b , age compositions are available only for 2008 (quaterly) and 2009 (annual).

### 4.6.2 UK

Data on length distributions, catch numbers at length, catch numbers at age and mean weight at age are available for IVb, VIId, VIIe,h and VIIa,f,g between 1985 and 2009.

## 4.7 Biological parameters and other research

A review of bass population biology and fisheries is given by Pickett and Pawson (1994).

In 2009 the maturity of bass caught by the UK fishery was investigated (Walmsley 2010). The data indicated that for female bass, $L_{50}$ was approximately 40 cm *TL*. This contrasts with the Pawson and Picket (1996) who reported that females were not becoming ripe to spawn at lengths of <42 cm *TL*, and suggests that females may now be maturing at a smaller size than was previously reported. In addition, data suggest that the onset of maturity differs by geographic location, with females in the North Sea maturing at a larger size than those in the southeast. For males, the data indicated that $L_{50}$ was approximately 34 cm *TL*, but that there were uncertainties due to the small sample size and outliers in the data. However, it appeared that ripe and running individuals were larger than previously reported.

## 4.8 Analysis of stock trends/assessment

In 2003, SGBASS used the SURBA program with data on UK and French bass catch-at-age and fishing effort by métier groups (trawls, nets and lines) for four stock areas

(IVb,c; VIId; VIIe, h; VIIa,f&g) for which sufficient biological sampling information was available for 1985–2002 (ICES, 2004a). The assessments utilized a separable model to provide independent assessments of the status of each stock, and indicated common trends in spawning-stock biomass (SSB) within stocks, and similar recruitment patterns within and between stocks. Estimates of fishing mortality were considered to be less informative, largely because of a lack of independence between the selectivities of the fishery and that of the catch per unit of effort (cpue) indices used.

Since 2003, no new assessment has been carried out using an international data set but a multi-métier, fully statistical, separable catch-at-age model was used with UK only data for 1985-2004 (Pawson *et al.*, 2007a). This analysis covered four 'stock areas', namely Divisions IVb,c, Division VIId, Divisions VIIe,h and Divisions VIIa,f&g. 'Best estimate' catch and effort data were used, based on data integrated from official statistics and a voluntary logbook scheme. The model estimates selectivities and catchability by metier, recruitment, and numbers at age in the first year. Fishing mortality is estimated assuming constant catchability at age across years and a linear relationship between effort and F in each metier. A penalty function was included to constrain estimates of F within a realistic range, and help the model converge on a solution (otherwise there was a tendency for F to converge towards 0). This function penalises solutions according to the deviations of Fbar from the average Fbar estimated from catch curves for the same ages and period multiplied by a scaling factor. The trends in F therefore largely reflect trends in effort and the assumption of constant catchability. It should be noted that the model was designed primarily to provide selectivity patterns for exploring technical conservation measures, and not for making TAC forecasts.

The model estimated levels of $F_{(3-7)}$ for IVb and c between 0.1 and 0.2 prior to 1991, which increased rapidly to 0.5 in 1993, before remaining at lower levels of around 0.2–0.4 since 1995. A similar pattern was seen for VIId, F averaging around 0.25 in the mid-to-late 1980s, increasing sharply in 1990 and 1991 to around 0.4, then declining again in 1995 and 1996 to fluctuate around 0.2. Model estimates of F for VIIe were more constant, at around 0.2 for most of the period 1985–2004, rising to peak at 0.4 in 1997, then returning to previous lower levels in 1998. A slowly increasing trend in F estimates was seen for VIIa,f&g over the time-series, from around 0.15 to around 0.25, with some minor fluctuations including a peak at nearly 0.5 in 2000. These patterns in F were consistent with the changes in the numbers of vessels fishing for bass in the four areas.

The model indicated that bass SSB around England and Wales generally increased between 1985 and 2004, although the pattern and magnitude of the increase differed between areas. The IVb,c SSB appeared to increase slightly from about 600 to 800 t. In Division VIId, SSB was relatively stable at around 1500 t until 1998, after which it increased linearly to .3000 t in 2004. SSB in VIIe,h quadrupled, from around 500 t in 1985 to .2000 t in 2003/2004, though catches from the offshore fishery were absent from this assessment. SSB in VIIa,f&g followed a pattern similar to that in VIIe,h, rising from 600 to 800 t prior to 1993, then to around 1200 t in the years 1997–2002, after which it appeared to increase. Pawson *et al.* (2007) suggested that these SSB values and the F levels should be taken as indices rather than absolute values, and that by not including estimates of the UK recreational bass catch (around 415 t in 1987 and 1993) or of the offshore fishery in the analysis, biomass was probably underestimated.

This assessment model was re-run to include data up to 2006 and was also run using official catch and effort statistics only ('the FAD-only assessment') and the two sets of model runs were compared (Kupschus *et al.* 2008, WGNEW2008, Annex 2). The outputs from the 2006 re-run of the assessment model were in close agreement with the assessments carried out with the 1985-2004 dataset. Stocks levels were considered to be at, or close to, series maxima and trends in fishing mortality fairly level, with some peaks, throughout the time-series. Recruitment was good during the mid to late 1990s and this resulted in the high landings and stock levels observed. However, some discrepancies were noted between estimated recruitment and the index from the Solent pre-recruit survey. Comparing the original hybrid data assessment (Pawson *et al.* 2007), with the FAD-only run, in terms of stock dynamics such as recruitment and SSB there was little difference between the assessments. F levels were noisy and both assessments indicated a variable, but more or less stable level of F over the time period. It appeared that the true underlying trend in effort (not that used in the assessment) contains much less contrast than the fluctuations in the year class strength, and the assessments are therefore robust to the annually differing patterns of effort provided by the two data sources. It was not possible to analytically distinguish which of the data sources provided the more realistic assessment, because it was not possible to separate bias and variance components of the residuals (Kupschus *et al.* 2008, WGNEW2008, Annex 2). However, research was carried out during the development of the Cefas logbook scheme to ensure that it was representative of the bass fishery and the hybrid logbook data is therefore likely to be less biased than the FAD only data. Kupschus *et al.* (2008, WGNEW2008, Annex 2) concluded that from a management perspective, neither data source provides the basis for detailed annual catch projections as provided for TAC stocks.

For WGNEW2010, the assessment using official catch and effort statistics only (‘the FAD-only assessment’) model was run using data from official UK statistics only, but with data for the years 2007-2009 added (WGNEW2010 WD 1). Results of the 2010 FAD-only run are given in Working Document 1. The main conclusions of the re-run are that recent data are more variable. Improvements to catch and effort data collection in recent years in comparison with the earlier years of the time series, and possible changes in the ratio of trawlers targeting bass and those taking bass as a bycatch, have lead to a violation of the constant catchability assumption. The latest assessments suggest that relative F estimates have been stable since 1990 in western stocks, but have decreased in eastern stocks (Figure 4-12). This may be due to a decrease in trawl effort in the North Sea, since F by metier is assumed to be linearly related to effort. These boats may not catch bass, and it is not possible to distinguish if there have been different trends in effort of vessels that target bass, as opposed to those that take bass as a bycatch. The model estimates that SSB has been increasing over all stocks through the time series, but has levelled off in the westerly areas. SSB continues to increase rapidly in the North Sea, and it is almost certainly the result of a cryptic accumulation of fish in the plus group (Figure 4-13). Again, agreement between the model recruitment and the abundance indices between surveys shows some disparity in more recent years. The trends given by the model should be taken as indicative, rather than absolute values.

With regard to future assessment of bass in the four northern stock unit areas, there is clearly a great deal of data available. The UK has catch at age and catch at length data for all four stock units between 1985 and 2009, along with effort data. France has quarterly catch numbers at length, ALKs and cpue data for Area VIIe,h between 2000 and 2008. In addition, there several pre-recruit surveys series available, and data from individual logbooks. However, a major deficiency is the lack of relative abundance data for post-recruit bass, or independent estimates of selectivity and fishing mortality (e.g. from tagging).

During WGNEW 2010, available data have been explored:

#### Division VIIe,h

A exploratory separable VPA on aggregated UK and French bass catch-at-age data over the period 2000-2008 has been explored on the age range 3-12+. The reference age for unit selection was 7, corresponding to the most fished age, according to the international catch at age barplot. A Fs of 0.3 has been applied to the reference age (7), and a Ss of 0.7 has been applied to the old individuals which are still very vulnerable.

Analysis and residuals are presented in Table 4-1 and results in Figure 4-14.

These suggest that the estimate of total mortality has been increasing since 2000. This may be due to the increase of the effort in this area and is particularly well correlated with effort of French Pelagic trawl (representing the highest production of the area compared to other gears)

The model estimates that the trend for recruitment is decreasing, and biomass also from 2005. However, these trends should be used as indicative, rather than absolute values.

#### Division VIIIa,b

Because of the lack of data, particularly French ALK in this area between 2000 and 2008, no assessment can be carried out.

However, using the French length structure of all gears the growth curve has been explored. The slope of curve ln(number at length function ln(length) for individuals >40cm, per year is presented in Figure 4-15. An increase of total mortality in this area from 2000 to 2008 is observed. This could however reflect more an increase in recruitment rather than an increase in F. Again, trends should be used as indicative, rather than absolute values.

It has to be noted that for this area trends and levels of F are roughly similar to the values obtained with the FAD model while they are very different for SSB. As noted in the discussion of the FAD model, this could be due to differences in the partial recruitment e.g. a more dome vector in the FAD building cryptic biomass in the plus group while the terminal S in the separable VPA constraining the PR to a less dome shape. The difference in the two models should be further analysed.

Given the large number of stocks that the WGNEW currently considers, the WG may not have time during the course of a full meeting to hold such detailed discussions. It might be more appropriate to hold a workshop specifically aimed at bass. Such a workshop would not necessarily be a benchmark assessment, but more of an exploratory meeting gathering experts from UK and France.

## 4.9 Data requirements

In its final report, the SGBASS made recommendations on the level of sampling required to produce high quality data on which bass assessments can be based. The SGBASS2004 recommended that a biological sampling programme should produce quarterly (preferably, to avoid bias due to growth or recruitment) or half-yearly all-gear ALKs with a yearly minimum of 300 fish ages (stratified by 2 cm intervals). For some seasonal fisheries (e.g. offshore winter fishery) it may be necessary to merge data for quarters 4 and 1 (ICES 2004).

For lengths, SGBASS recommended that at least one sample of a minimum of 50 fish by commercial size category or 100 fish if unsorted in landings per month in the bass season from each of the metier groups (trawls, possibly split bottom and mid-water; lines and nets) provides a satisfactory basis for estimating catch-numbers-at-age. The length distributions should be boat-raised in proportion to the weight in each category. Clearly, each country exploiting bass in any one of the stock assessment areas should endeavour to carry out complimentary sampling that neither duplicates nor leaves important metiers unsampled.

Recreational fisheries, because of their potentially high aggregate catches, should be included in future assessments, where possible, but these (especially shore angling, where individual catches may be small) are difficult to sample and appropriate methods for obtaining essential data are under development with the French national survey (Herfault *et al.,* 2010).

Given that current sampling may not always reach the levels recommended by the Study Group, There is probably no reason to change these recommendations, as at present, sampling is not at this level.

There is a real need for relative abundance indices for post-recruit bass in all areas. Furthermore, the Solent and Thames pre-recruit surveys are now discontinued leaving no UK survey data for areas IV and VII, other than some noisy seine-net surveys for 0-group and 1-group fish in estuaries in the southwest of England. Survey data are also needed, particularly in coastal areas of the Bay of Biscay, in order to improve the biology, the dynamics and the assessment of this species. Better methods for modelling fishery cpue data would also be useful, including application of methods to identify trips where bass could have been caught (even if they were not), for example using species associations (e.g. Stephens, A. and A. MacCall, 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fish. Res. 70: 299-310).

Finally, tagging studies would be useful not only to estimate mixing rates between putative stock areas, but also to define the shape of fishery selectivity patterns and overall levels of F.

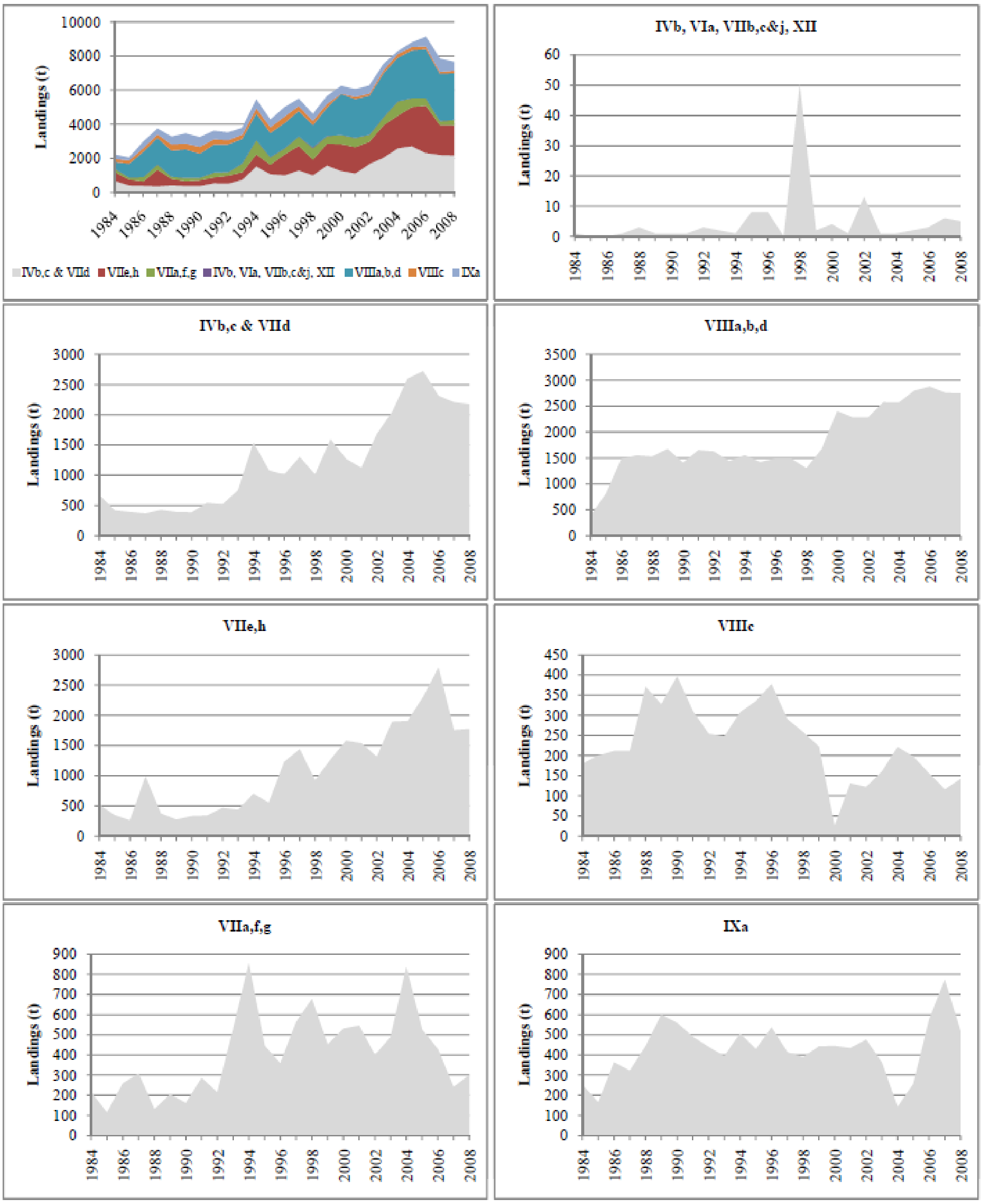


**Figure 4-1: Nominal landings (t) of bass for all stock areas, and by individual stock area. (Data for the year 2008 are provisional).**

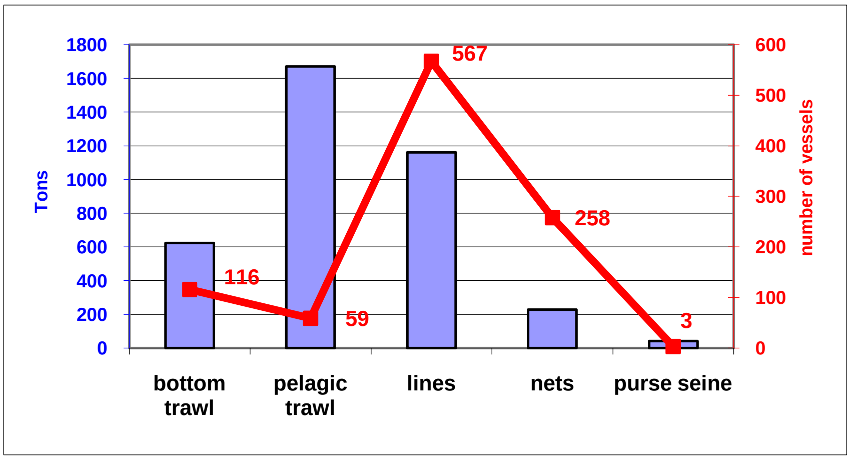


**Figure 4-2: Production per gear targeting seabass and number of vessels associated (according to the French fisheries information a vessel target sea bass when it's annual activity calendar shows at least a seabass metier during at least one month in a year)**

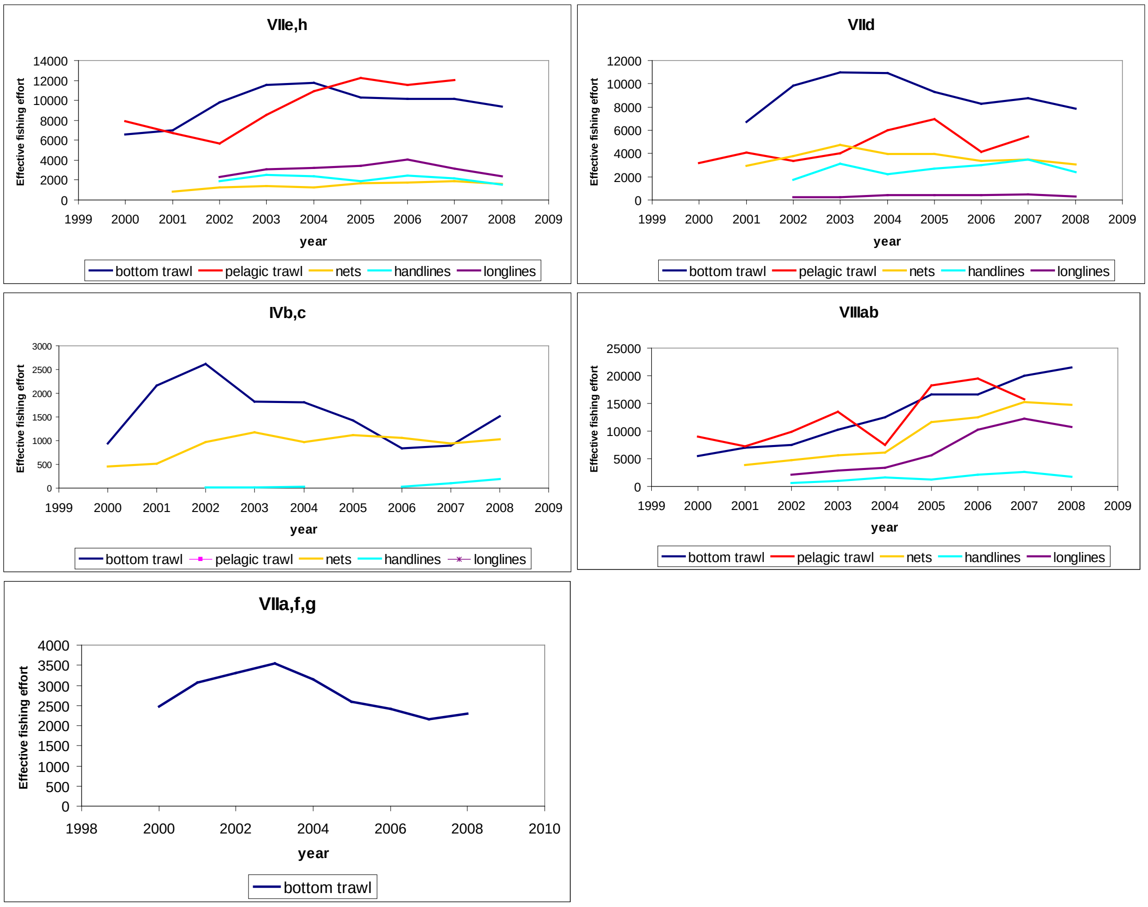


**Figure 4-3: Effective effort (days fished) from French logbooks. Data for the year 2008 are incomplete for Pelagic trawl.**

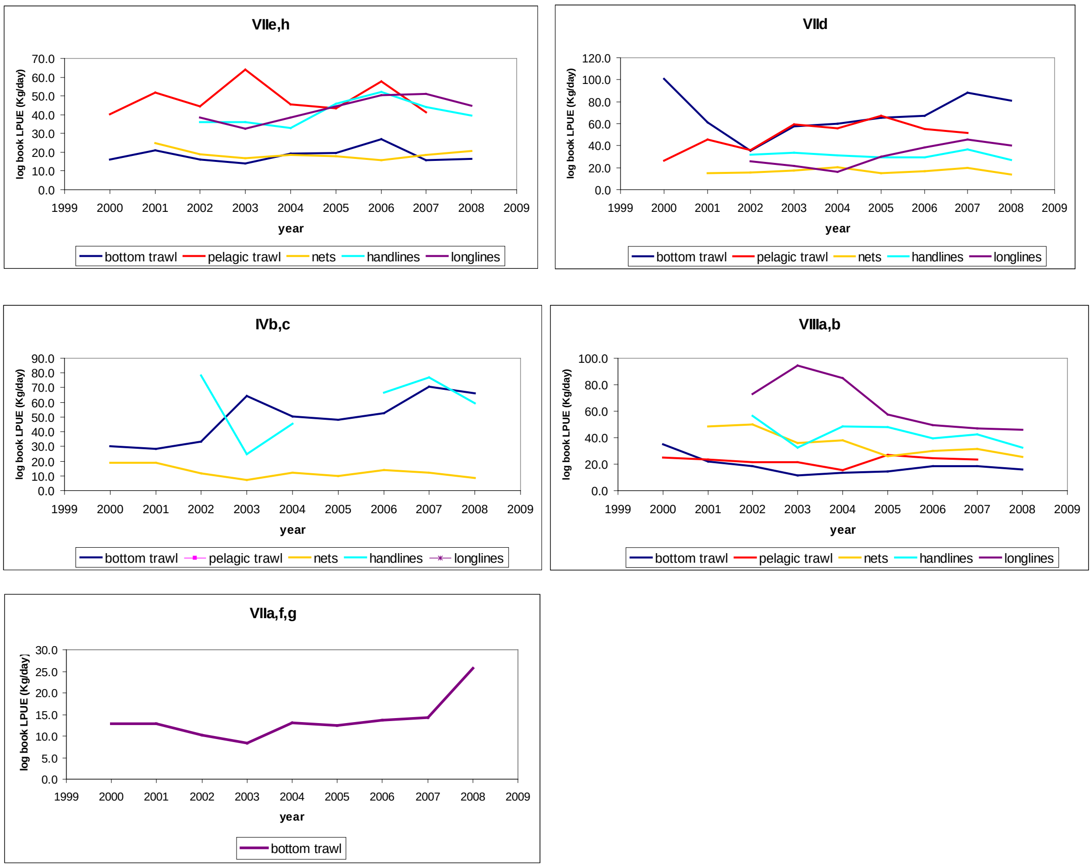


**Figure 4-4: Lpue (kg/day) from French logbooks. Data for the year 2008 are incomplete for Pelagic trawl. Trends of LPUE particularly for long lines and hand lines are under estimated. According to fishermen, numbers of hooks and hours fished increased from 2000 to 2008.**

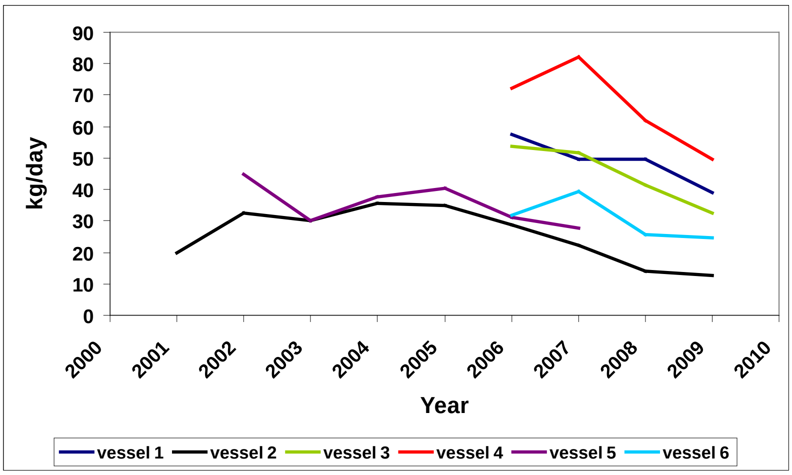


**Figure 4-5: LPUE (Kg/day) of 6 coastal liners of division VIIe from personal fishing notebook, integrating 2009.**

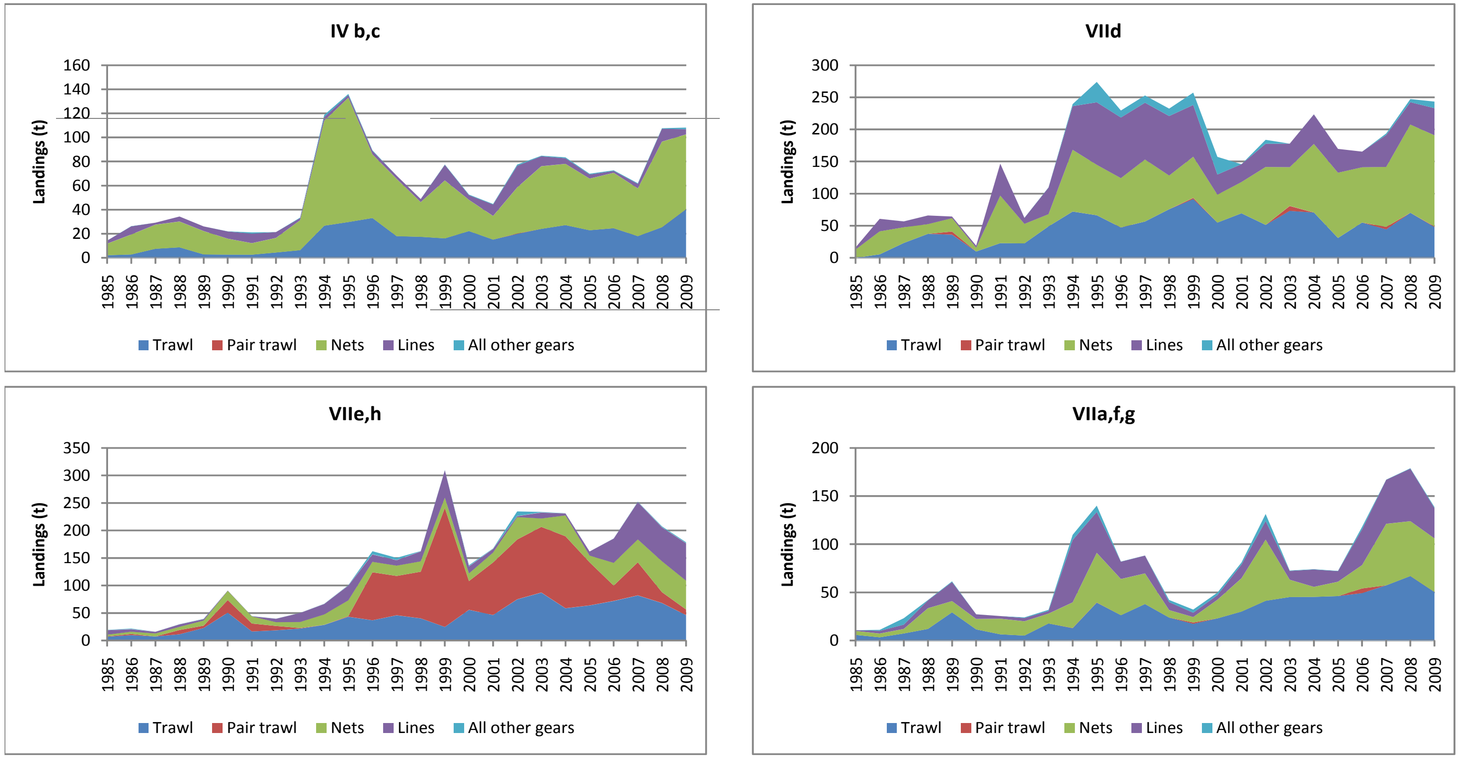


**Figure 4-6: Nominal landings (t) of bass by UK (E&W) vessels between 1985 and 2009, by gear group and stock unit. Source: FAD**

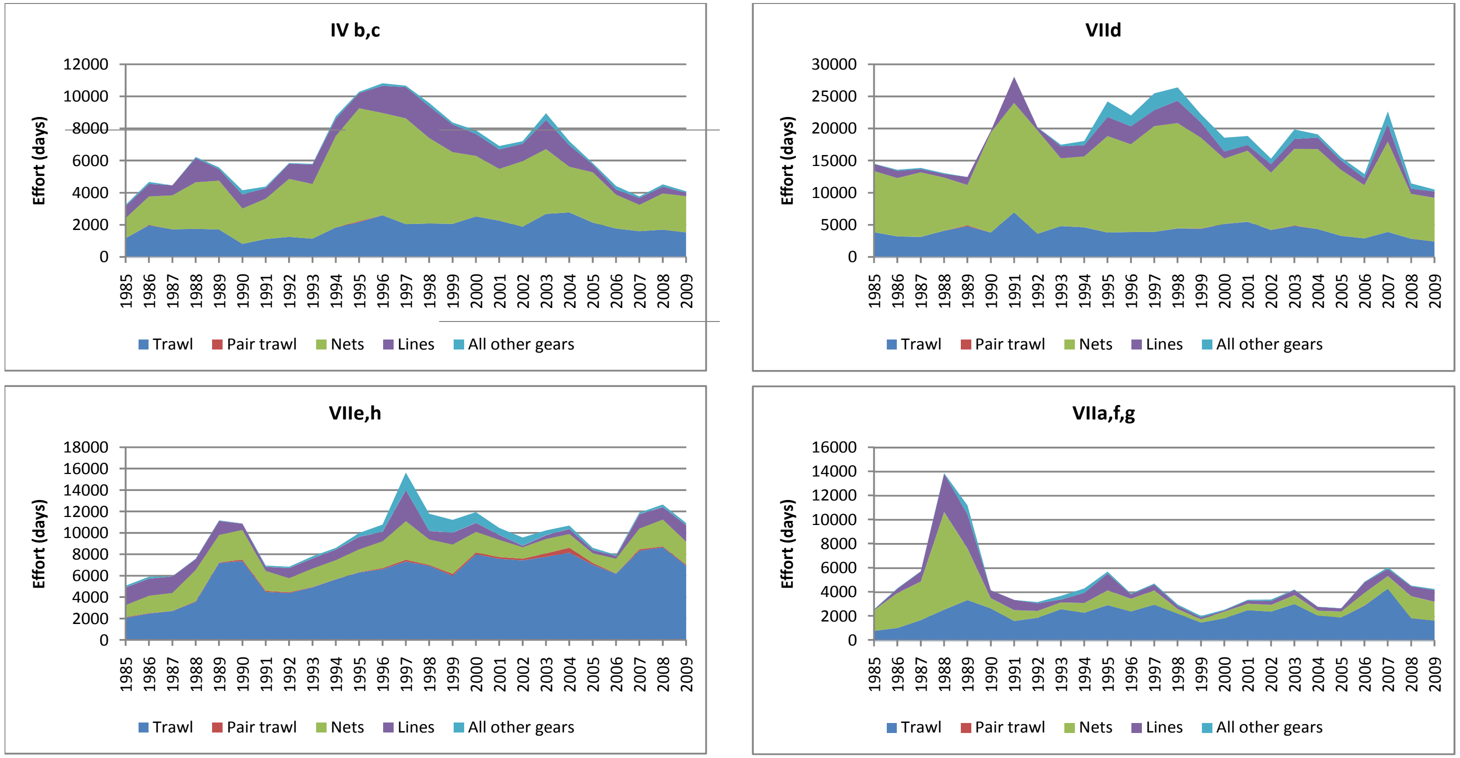


**Figure 4-7: Fishing effort (days fished) of bass by UK (E&W) vessels between 1985 and 2009, by gear group and stock unit. Source: FAD**

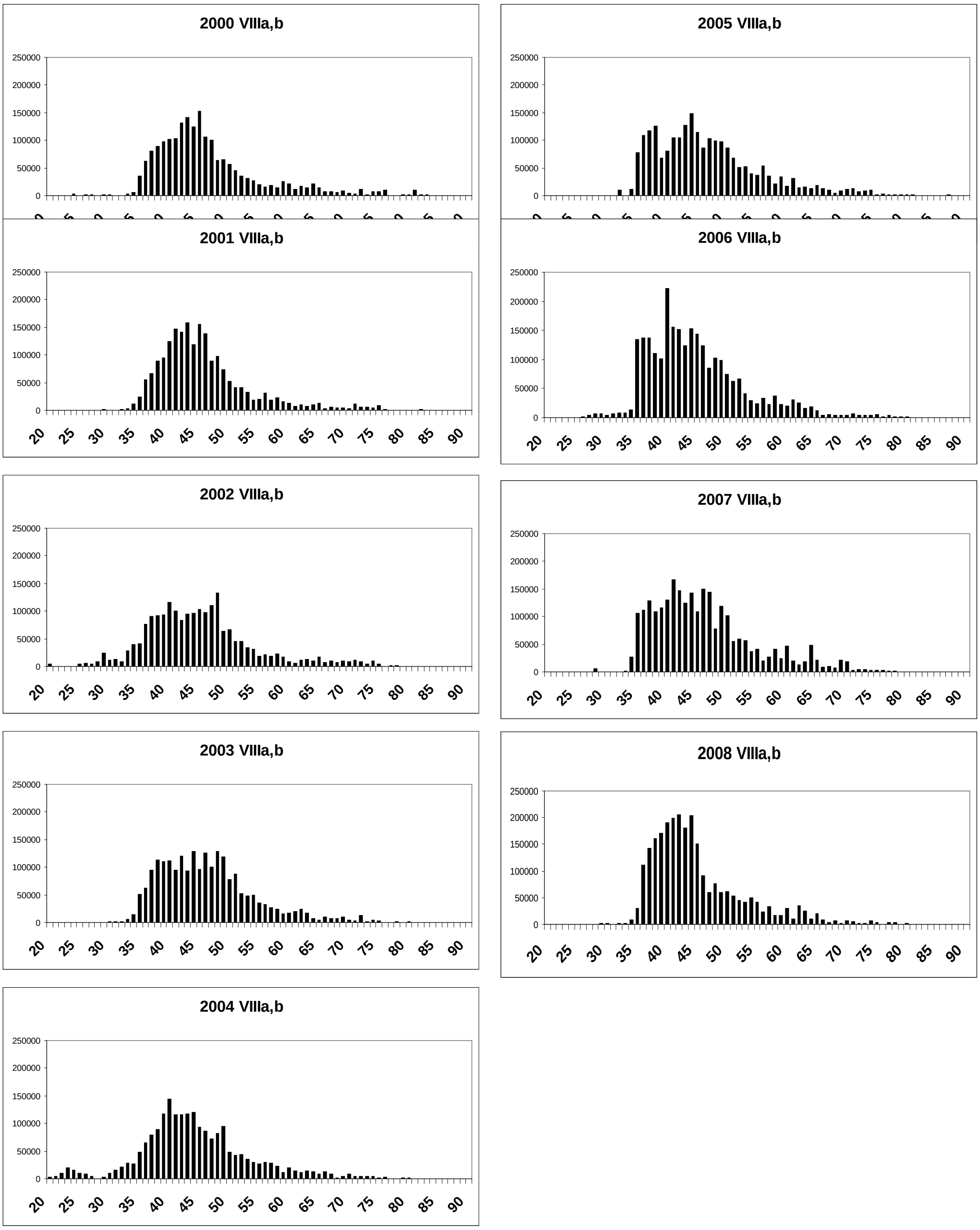


**Figure 4-8: French length structure for all gear, division VIIIa,b**

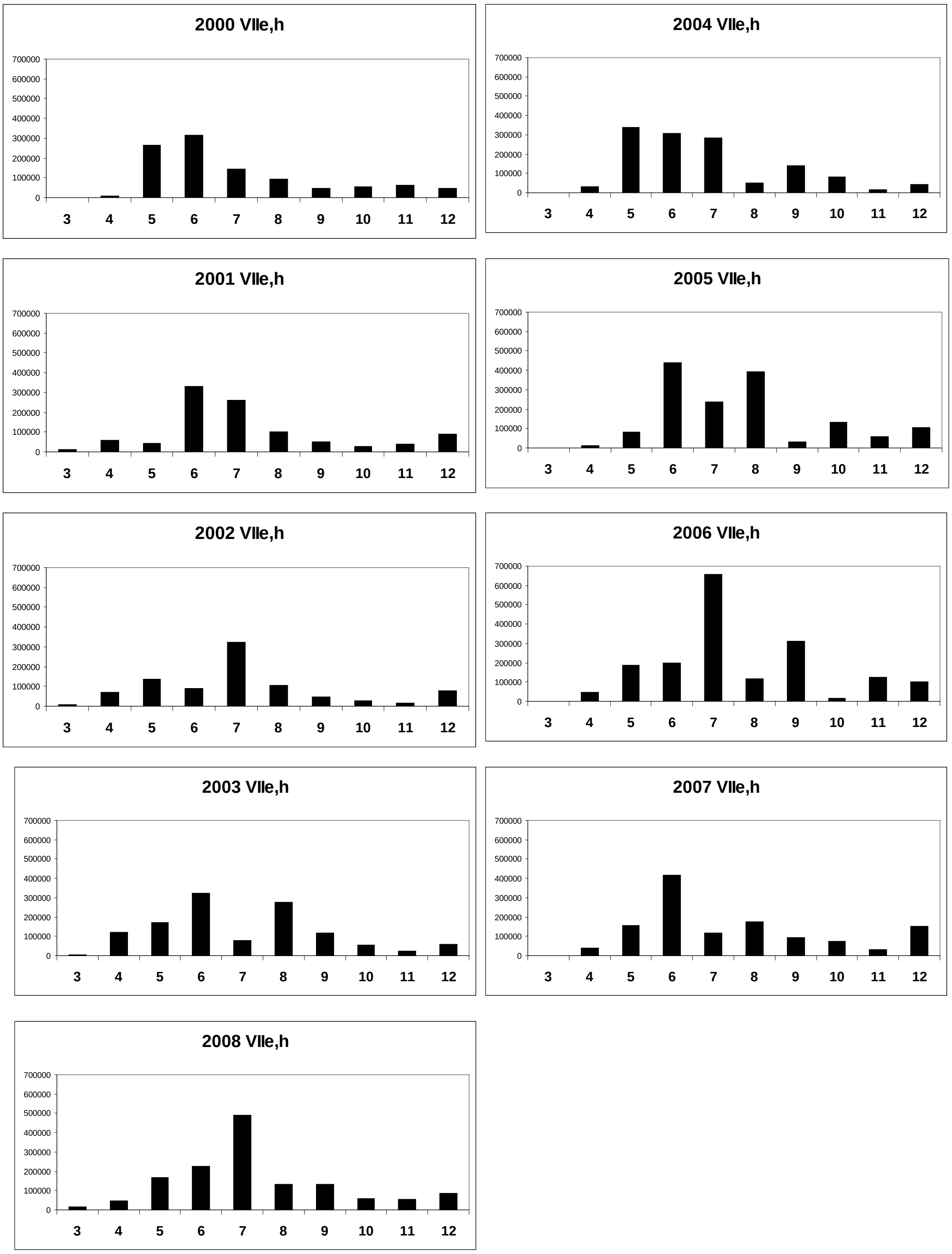


**Figure 4-9: International (UK and France) Catch at age for all gear , division VIIe,h.**

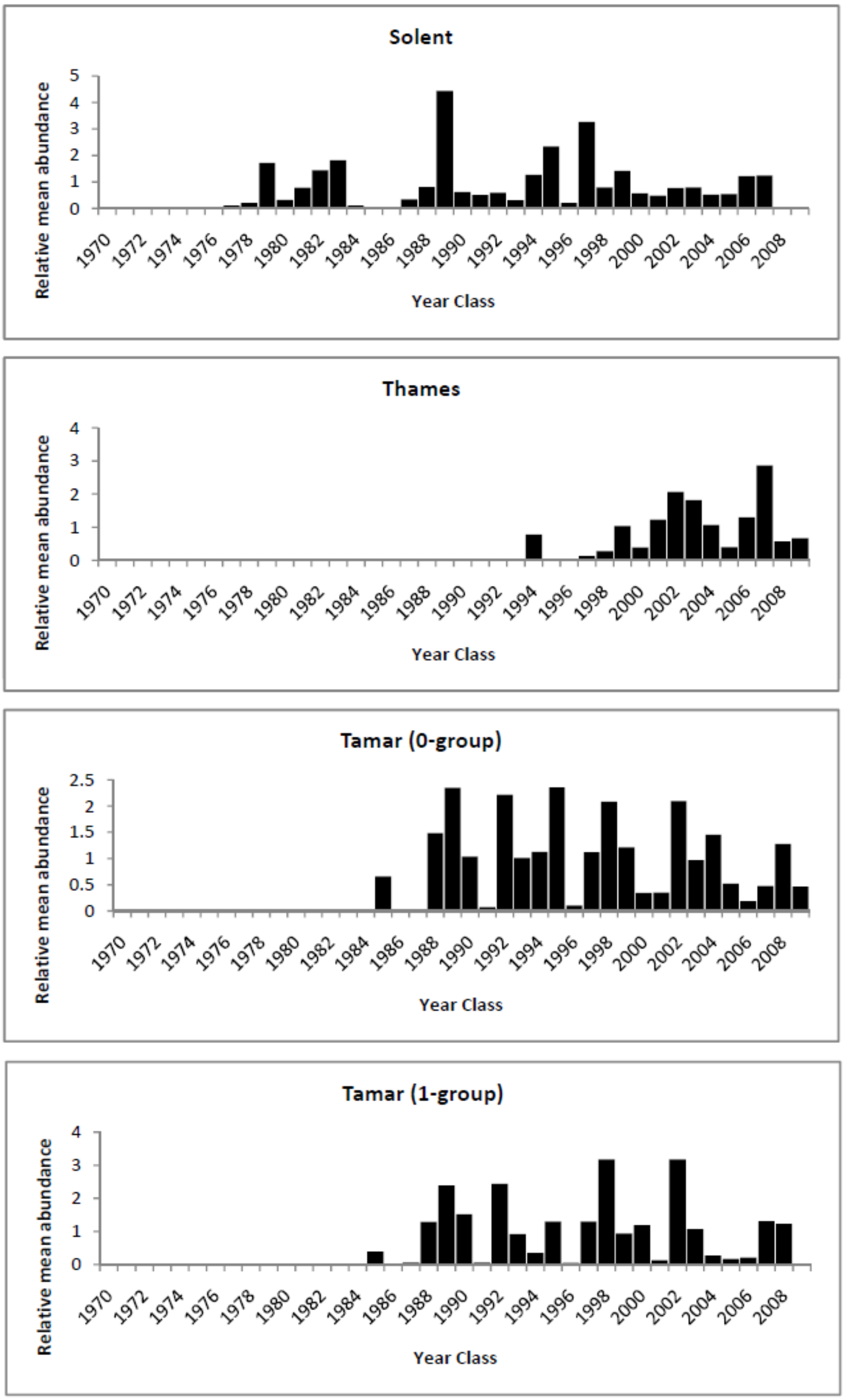


**Figure 4-10: Relative abundance of sea bass in UK (E&W) surveys**

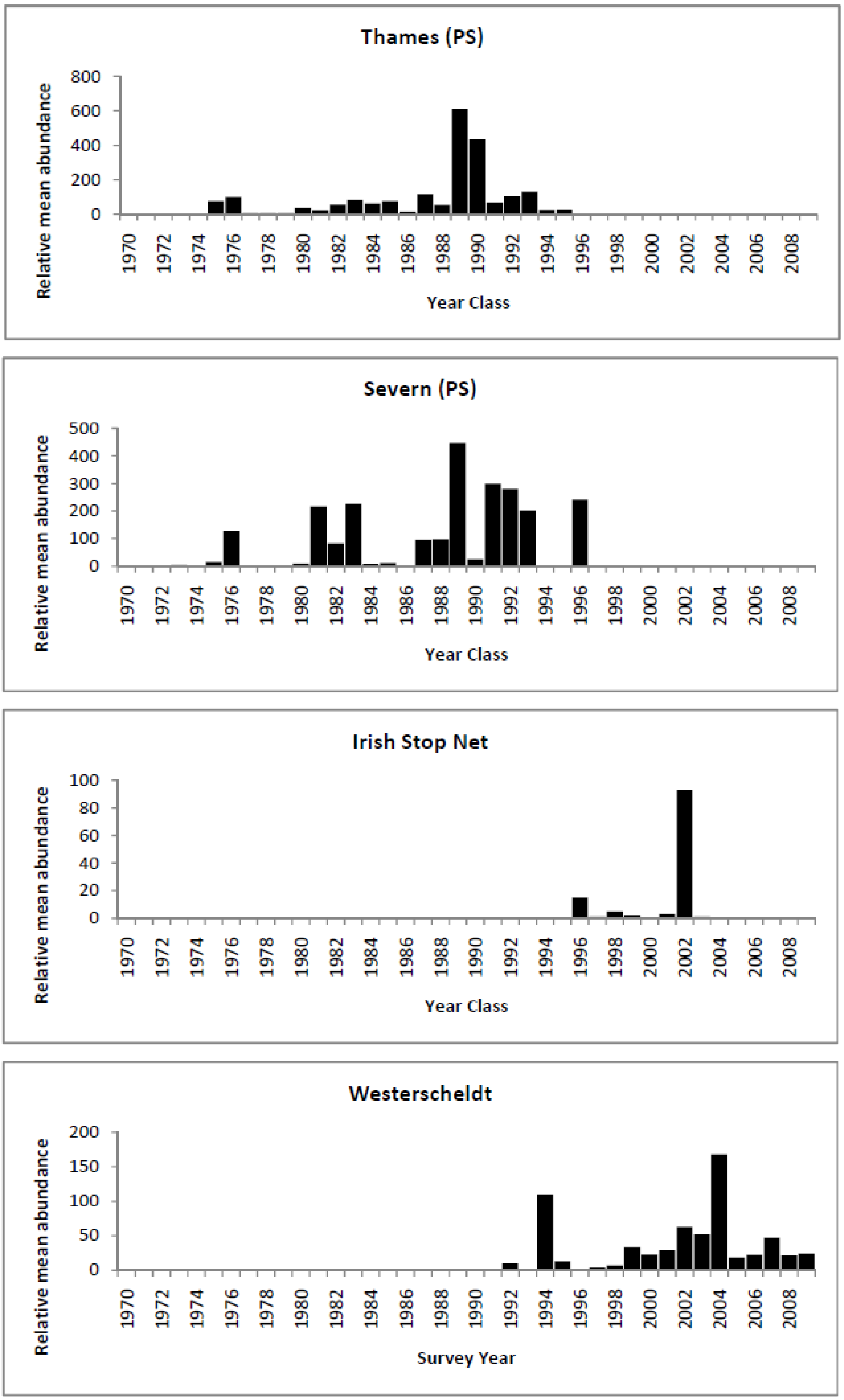


**Figure 4-11: Relative abundance of sea bass in UK (E&W), Ireland and Netherlands surveys. Thames (PS), Severn (PS) and Irish stop net survey data sets end in 1995, 1996 and 2003, respectively**

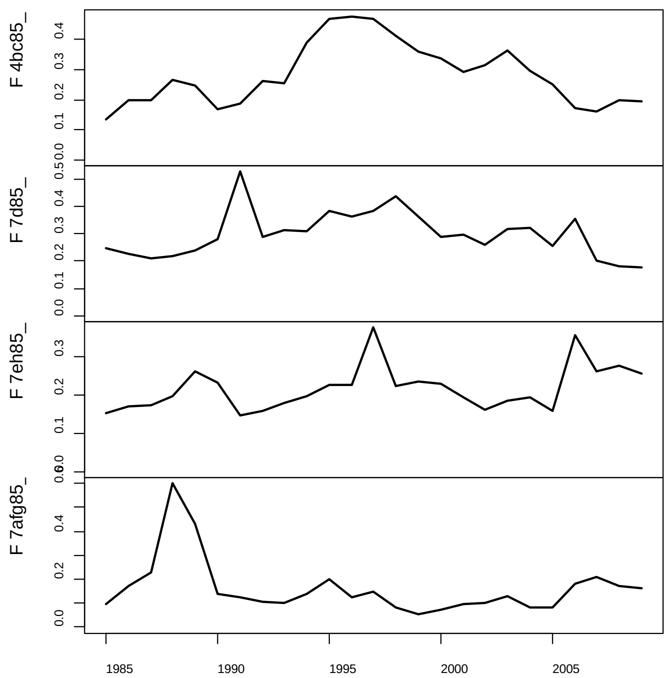


**Figure 4-12: Fishing mortality trends for bass in different areas from the FAD only model.**

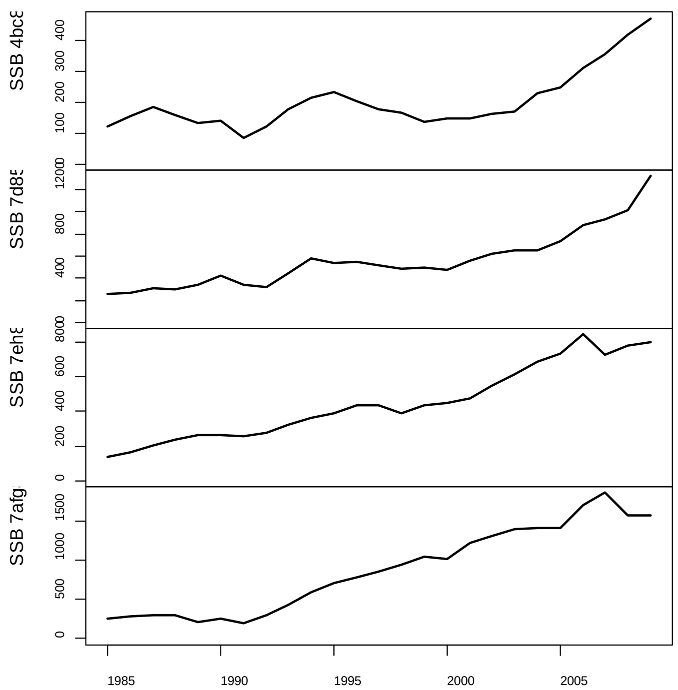


**Figure 4-13: SSB trends for bass in different areas from the FAD only model**

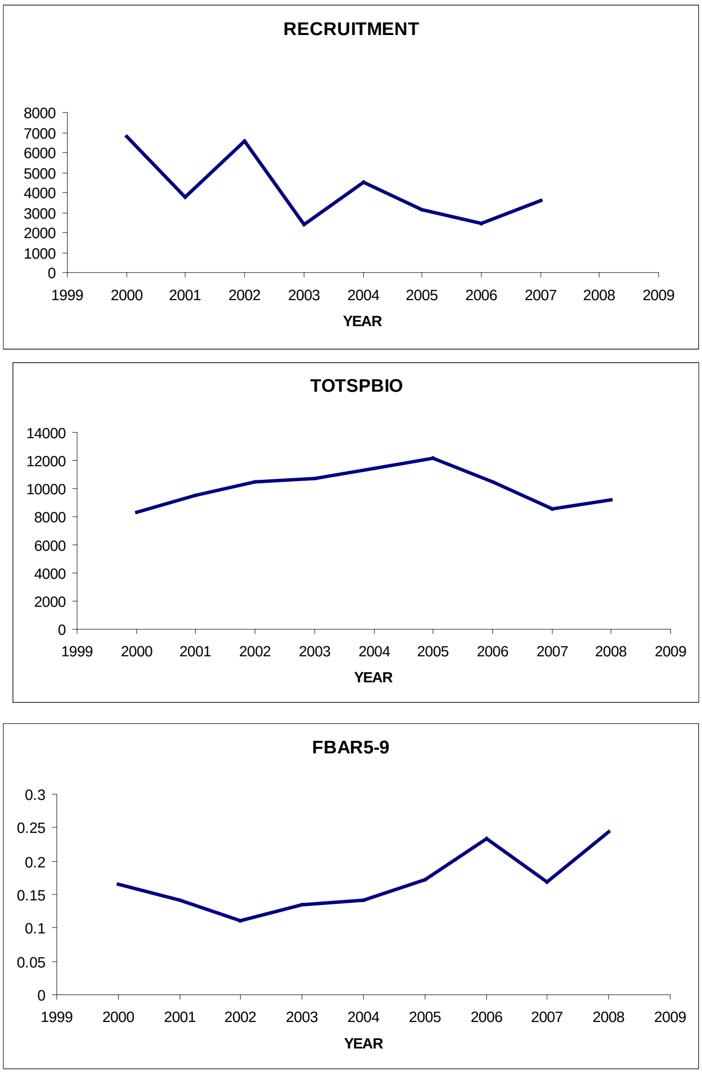


**Figure 4-14: Trends in recruitment, SSB and fishing mortality for bass in divisions VII e,h from a separable VPA model.**

**Table 4-1: Bass in divisions VII e-h - Residuals from the separable VPA**

Separable analysis from 2000 to 2008 on ages 3 to 11 with Terminal F of .300 on age 7 and Terminal S of .700.

Initial sum of squared residuals was 178.371 and final sum of squared residuals is 17.604 after 80 iterations.

Matrix of Residuals:

| Years | 2000/** | 2001/** | 2002/** | 2003/** | 2004/** | 2005/** | 2006/** | 2007/** | TOT | WTS |
|---|---|---|---|---|---|---|---|---|---|---|
| 3/ 4 | 0.028 | 1.675 | 1.318 | 1.178 | -0.386 | 0.618 | -1.532 | 0.116 | -0.002 | 0.152 |
| 4/ 5 | -0.225 | 0.358 | 0.729 | 0.17 | 0.417 | -1.039 | 0.283 | 0.165 | -0.002 | 0.297 |
| 5/ 6 | 0.229 | -0.425 | -0.124 | -0.275 | 0.275 | -0.066 | -0.235 | 0.299 | -0.002 | 0.575 |
| 6/ 7 | -0.028 | -0.341 | 0.232 | -0.212 | 0.148 | -0.231 | 0.454 | -0.16 | -0.002 | 0.584 |
| 7/ 8 | -0.204 | 0.205 | -0.065 | -0.268 | -0.746 | 0.577 | 0.902 | -0.467 | -0.002 | 0.292 |
| 8/ 9 | 0.128 | 0.081 | -0.319 | 0.027 | 0.096 | 0.09 | -0.189 | -0.026 | -0.002 | 1 |
| 9/10 | -0.271 | -0.283 | -0.529 | -0.491 | -0.604 | 0.33 | 0.812 | -0.048 | -0.002 | 0.326 |
| 10/11 | -0.085 | 0.1 | 0.079 | 0.774 | 0.02 | 0.056 | -0.951 | 0.099 | -0.002 | 0.339 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TOT | 0.004 | 0 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 | 0 | 2.245 | |
| WTS | 0.001 | 0.001 | 0.001 | 1 | 1 | 1 | 1 | 1 | | |

| Fishing Mortalities (F) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| F-values | 0.2435 | 0.2278 | 0.1787 | 0.2212 | 0.1774 | 0.1753 | 0.2352 | 0.2498 | 0.3 |

| Selection-at-age (S) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| S-val | 0.0013 | 0.0637 | 0.332 | 0.7712 | 1 | 0.9544 | 0.9154 | 0.6781 | 0.7 |

Traditional vpa Terminal populations from weighted Separable populations.

Fishing mortality residuals:

| YEAR | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | |
| 3 | 0 | 0.0031 | 0.0013 | 0.0011 | -0.0002 | 0.0003 | -0.0002 | 0 | 0 |
| 4 | -0.0071 | -0.0025 | 0.0138 | 0.0112 | 0.0059 | -0.0076 | 0.0055 | 0.0067 | -0.0009 |
| 5 | -0.0192 | -0.025 | -0.0255 | 0.0059 | 0.0322 | 0.0003 | -0.0073 | 0.0031 | 0.0218 |
| 6 | -0.0464 | -0.0737 | 0.0015 | -0.0651 | 0.0644 | 0.0285 | 0.0147 | 0.0307 | -0.058 |
| 7 | -0.0386 | -0.0605 | -0.0411 | -0.0477 | -0.0495 | 0.0616 | 0.156 | -0.0835 | 0.1426 |
| 8 | -0.0097 | 0.0025 | -0.0751 | -0.0449 | -0.0001 | 0.0913 | -0.0527 | -0.0689 | 0.0052 |
| 9 | -0.0267 | -0.0366 | -0.0116 | -0.0566 | -0.0433 | -0.0159 | 0.1225 | -0.0257 | -0.0892 |
| 10 | -0.0074 | 0.0232 | 0.0093 | 0.0959 | 0.0183 | 0.0401 | -0.06 | -0.0461 | -0.0182 |
| 11 | -0.0001 | 0.0062 | 0.0071 | 0 | -0.0266 | 0.0184 | 0.0533 | 0.1137 | -0.0798 |

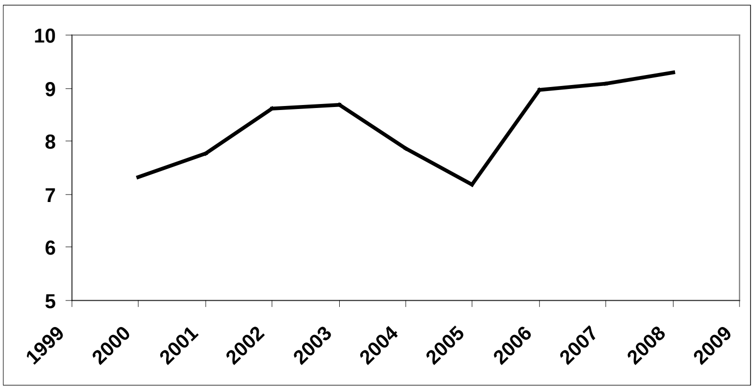


**Figure 4-15: Catch curve calculated from catch at length for all gear in division 8AB**

# 5 Striped red mullet

## 5.1 General biology

The striped red mullet (*Mullus surmuletus*), benthic fish, is found along the European coasts from South Norway and North Scotland including Faeroes, south to the Strait of Gibraltar, and also in the north part of western Africa and in the Mediterranean and Black Seas (Quéro & Vayne, 1997). It is infrequent off Norway, around Ireland, the north coasts of England and the West of Scotland (Davis & Edward, 1988; Gibson & Robb, 1997).

Analysis of British commercial landings revealed a strong concentration of this species in the central pit of western Channel during winter (Dunn, 1999). The scientific survey CGFS (Channel Ground Fish Survey), carried out every year by Ifremer in the eastern Channel since 1988, showed that the young individuals are distributed in coastal areas, while the adults have a more offshore distribution in the east part (Carpentier *et al.,* 2009).

Finally, nurseries are located in Bay of Saint-Brieuc and Falklands coasts (Morizur *et al*., 1996). The striped red mullet seems to prefer deep water and elevated temperatures (ICES, 2007b), and tolerates weak and high salinity (corresponding respectively to the habitats of the juvenile and adults) and is rarely found in the transitions zones of intermediate salinity. This species prefer sandy sediments (Carpentier *et al*., 2009). The food of striped red mullet is primarily crustaceans and molluscs.

In the English Channel, the first sexual maturity was identified to 16.2 cm for the male and 16.7 cm for the female (Mahé *et al*., 2005).

## 5.2 Management regulations

While, in France, a minimum landing size was earlier set at 16 cm, this has been removed since 2002, which has resulted in immature individuals (< 14 cm) to have recently been targeted and landed.

## 5.3 Stock ID and possible management areas

From the presence of striped red mullet in catches all year-round, Dunn (1999) suggested that a single stock exists within the English Channel, although he could not determine whether this was distinct from other more westerly stocks. He also suggested that there might be a newly established stock in the North Sea.

A study using the geometrical morphometry in the Eastern English Channel and the Bay of Biscay was carried out in 2004 and 2005. The results of this study show that there is a morphological difference between the striped red mullets of the Eastern English Channel and of the Bay of Biscay.

In 2010, in the Nespman project, a study on the shape of the otoliths used to differentiate stocks was conducted. In this work, three techniques have been applied: a Fourier, PCA and Geodesic approach. The three methods show that the population of striped red mullet can be geographically divided in three zones:

- The Bay of Biscay (North and South)
- A mixing zone composed of the Celtic Sea and the Western Channel
- A northern zone composed of the Eastern English Channel and the North Sea

Following the evolution of catches of striped red mullet in the channel per quarter and statistical rectangle, one could combine the Bay of Biscay with the Celtic Sea and the Western Channel with the Eastern Channel and the North Sea. From the movement of fishing boats throughout the year we can identify a back and forth movement of the population of red mullet from the Southern North Sea to the eastern portion of the western Channel. The Distribution of striped red mullet in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009 shows continuity between the north of the Bay of Biscay and the south of the Celtic Sea.

## 5.4 Fisheries data

According to ICES statistics (Eurostat database), for the Atlantic Ocean, the fishery was only conducted by Spain from 1950 to 1975 when France also entered the fishery. From 1950 to 1975, the fishing of the striped red mullet was carried out on Spanish coasts and in the Bay of Biscay. From 1990, the strong increase of catches is essentially due to France fisheries but also to England and the Netherlands. It could be explained by the beginning of the exploitation of striped red mullet in the English Channel and North Sea (Figure 5-1).

Currently, the main country that catches striped red mullet is France. The striped red mullet is a target species for this country and is mainly caught (> 90%) by bottom trawlers with a mesh size of 70-99 mm in the Eastern Channel and the south of the North Sea (Figure 5-1). In the Eastern English Channel and south of North Sea, the complementary gears are essentially represented by the various trawlers and in Western English Channel by various gears and gillnets. Striped red mullet catches achieved by these complementary metiers are accessory.

The trawlers concerned by striped red mullet fishery have a length and a power respectively of about 20 meters and 400 kilowatts yearly average. This has remained stable since 1991. Among this fleet, 71% of the ships which fish in the south of the North Sea fish also in the Eastern English Channel. Only 24% of ships fishing in Western English Channel frequented the Eastern English Channel. The total Basque catch of striped red mullet in the bay of Biscay by gear from 1994 till 2009 indicate that the mean contribution of these gears to total landings has remained constant during this time with an average of 91% corresponding to bottom trawl, a 8% corresponding to set nets, and the remaining 1% to purse seine and others fishing gears.

The three main areas for the exploitation of the striped red mullet are areas IV, VIId,e and VIIIa,b. For the entire zone, the French catches are the most important. Other important countries are the Netherlands and the United Kingdom with regard to the English Channel (VIId,e) and the North Sea (IV) where the catches are concentrated in the south (IVb,c). The north of the Bay of Biscay (VIIIa,b) is exploited by France and Spain. The southern part of the Bay of Biscay (VIIIc) is only exploited by Spain. Other countries with small catches are Germany, Scotland, Denmark and Ireland.

For this species, therefore for management purposes, two areas could be considered: IVc-VIId,e and VIIIa,b. This species is not discarded by French vessels. More investigations on potential discarding should be carried out in these areas for the other countries.

The analysis of the demographic structure indicates that the striped red mullet stock is dominated by recruitment (individuals of 1 year old). Two peaks of recruitment are observed in 2004 and 2007, involving a numbers significant increase of the age group 2 in 2005 and 2008, and those of the age group 3 in 2006 (Figure 5-2). These tendencies observed for numbers remain valid for the biomasses.

## 5.5 Survey data, recruit series

Since 1988, striped red mullet abundance increases in the Bay of Biscay (EVHOE survey), the Celtic sea (EVHOE survey), the eastern English Channel (CGFS survey) and the south of the North Sea (IBTS survey) (Figure 5-3). However, the increase is much significant in the eastern English Channel.

During the last decade, one can observed three good recruitment (TL from 8 cm to 15 cm) in the North with particularly in the eastern Channel: 2003, 2007 and 2009 (Figure 5-3). In the Bay of Biscay, 2001, 2003 and 2005 are the years with good recruitment.

## 5.6 Biological sampling

The Netherlands has began the age estimation since 2009 (2009, Quarter 3: N=31). The Azti institute carried out the measures of sexual maturity and length in 2009 in the Bay of Biscay.

An inventory of the French data collected from the Bay of Biscay to North Sea is given in Table 5-1. The French samplings start since 2004 in the Eastern Channel and the south of the North Sea and since 2008 in the Bay of Biscay.

A French study on the sampling optimisation (IVc; VIId) was presented. The results showed that there is a good yearly adequacy between sampling and catches (Mahé *et al.*, 2007).

## 5.7 Biological parameters and other research

Since 2004, the data (age, length, sexual maturity) are usually collected by France for the Eastern English Channel and the southern North Sea (Table 5-1). France started to collect data for VIIIa,b at the end of 2007. In 2007-2008, the striped red mullet otolith exchange should optimise the age estimation between countries (ICES, 2009).

## 5.8 Analysis of stock trends / assessment

Currently, age structured analytical stock assessment is not possible due to the too short time series of available data. Tentative assessments based on global model and surplus production model (ASPIC) did not give reliable results as the landings and the CPUE steadily increase over the period.

## 5.9 Data requirements

Regular sampling of striped red mullet catches must be continued under DCF. Sampling in the Eastern Channel and the south of the North Sea starts in 2004. The effort of sampling (700 otoliths) in the Eastern English Channel and the south of the North Sea is sufficient (ICES, 2007) but it must be continued. The effort of sampling in the North Sea (IVb and IVc), in the Western Channel, in the Celtic sea and the Bay of Biscay starts in 2009. For 2011 and 2012 a sampling year level of 500 otoliths from commercial landings and surveys is planned. An increase in sampling intensity should be considered.

Since 2009, the concurrent sampling design carried out should provide more data (length compositions) than in recent years.

The FR-CGFS survey and FR-EVHOE survey would continue to provide series of abundance indices at age. However, The FR-CGFS survey is not funded by DCF. In the same way, there is no survey in the Western Channel (VIIe) whereas the catches of the striped red mullet in this geographical area are as significant as the catches in the Celtic sea.

## 5.10 References

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Mahé K., Destombes A., Coppin F., Koubbi P., Vaz S., Leroy D. & Carpentier A., 2005. Le rouget barbet de roche *Mullus surmuletus* (L. 1758) en Manche orientale et mer du Nord, 186pp.

Quéro, J.C. & Vayne, J.J., 1997. Les poissons de mer des pêches françaises. IFREMER, Ed. Delachaux & Niestlé, 304pp.

**Table 5-1: Biological sampling in France.**

| Year | Length | | Age | | Maturity | | Individual weight | |
|---|---|---|---|---|---|---|---|---|
| | Fish number | Sample number | Fish number | Sample number | Fish number | Sample number | Fish number | Sample number |
| 1994 | 181 | 23 | - | - | - | - | - | - |
| 1995 | 246 | 32 | - | - | - | - | - | - |
| 1996 | - | - | - | - | - | - | - | - |
| 1997 | - | - | - | - | - | - | - | - |
| 1998 | - | - | - | - | - | - | - | - |
| 1999 | - | - | - | - | - | - | - | - |
| 2000 | - | - | - | - | - | - | - | - |
| 2001 | - | - | - | - | - | - | - | - |
| 2002 | 65 | 9 | - | - | - | - | - | - |
| 2003 | 147 | 17 | - | - | - | - | - | - |
| 2004 | 142 | 17 | 372 | 12 | 620 | 12 | 1401 | 12 |
| 2005 | 536 | 10 | 301 | 3 | 196 | 3 | 301 | 3 |
| 2006 | 1941 | 10 | 646 | 4 | 646 | 4 | 646 | 4 |
| 2007 | 5053 | 129 | 740 | 4 | 740 | 4 | 740 | 4 |
| 2008 | 4396 | 124 | 447 | 5 | 447 | 5 | 190 | 2 |
| 2009 | 8648 | 334 | 1221 | 11 | 1221 | 11 | 1076 | 9 |

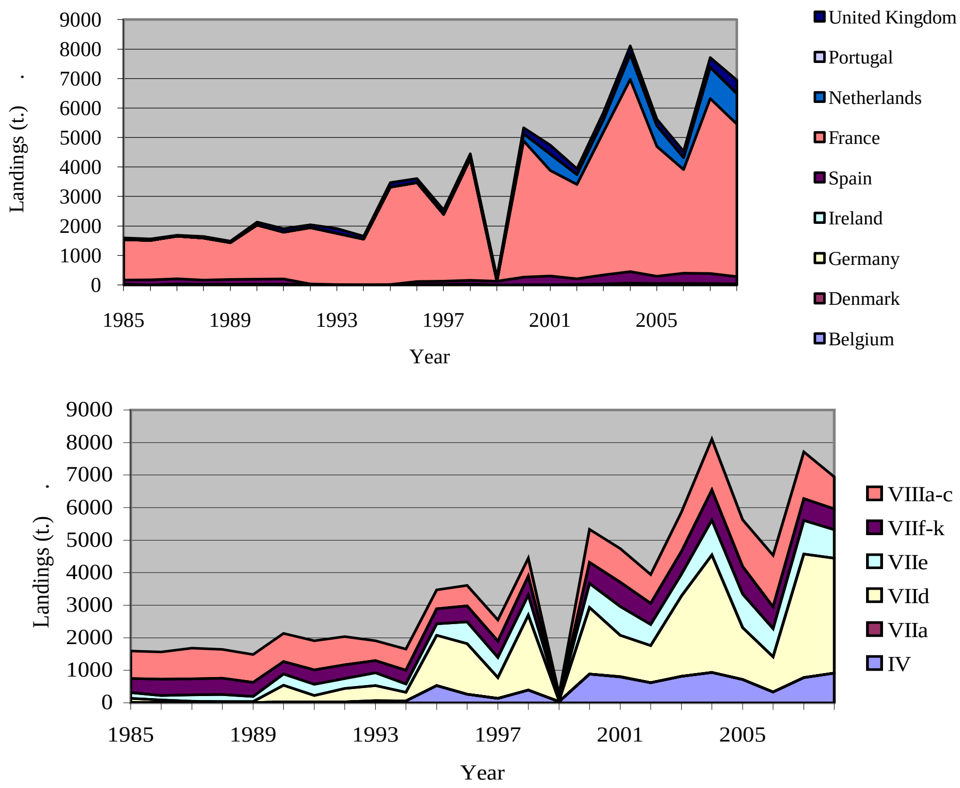



**Figure 5-1: Striped red mullet landings per ICES areas and per countries (source: ICES statistics, Eurostat, t.).**


**Figure 5-2: Demographic structure of the striped red mullet in the Eastern Channel and the south of the North Sea (G1 = age 1 etc…).**

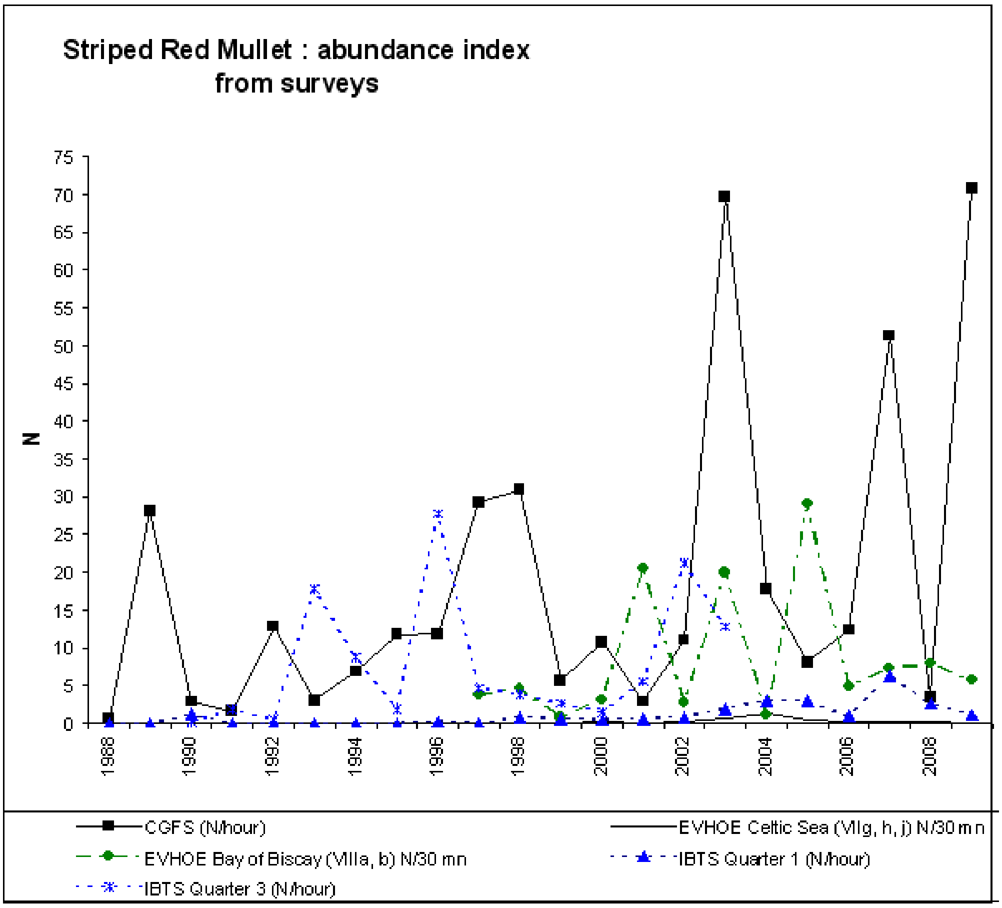



**Figure 5-3: Time series of abundance of striped red mullet base on Surveys from 1980 to 2009.**

# 6 Red gurnard

The datasets collected during the NESPMAN project funded by EU are used by the WGNEW. They are available in Annex 3.

## 6.1 General Biology

The main biological features known for this species are described in annex 3. This species is widely distributed in North-East Atlantic from South Norway and north of the British Isles to Mauritania on grounds between 20 and 250m. This benthic species is abundant in the Channel and on the shelf West of Brittany, living on gravel or coarse sand. In the Channel, the size at first maturity is ~25 cm at 3 years old.

## 6.2 Stock identity and possible assessments areas

In the English Channel, a stock structure within Divisions VIId and VIIe has not been established and Dunn (1996) recommended not to aggregate biological parameters from the two divisions.

Data available are not sufficient to state about stock identity for red gurnard from the southern North Sea and fish from English Channel and Celtic Sea, though data from IVc and VIId,e were aggregated because fish are present throughout the year in these divisions (Forest,2001).

Genetic studies have not been carried out.

## 6.3 Management regulations

At the time of the WG, there is no technical measure specifically dedicated to red gurnard or other gurnard species. The exploitation of red gurnard is submitted to the general regulation in the areas where they are caught. There is no minimum landing size set.

## 6.4 Fisheries data

Red gurnard is mainly caught by demersal trawlers in mixed fisheries, mainly in Divisions VIId-k and VIII a,b and also in Division IVc.

### 6.4.1 Historical landings

Series of EUROSTAT/ICES statistics of landings are available in Annex 3 for the period 1985 –2008 and were produced for the NESPMAN project.

They have shown in the past that species of gurnards were not always reported by species and data for Triglidae also occurred.

For UK (E+W) and Spain, landings reported by ICES Divisions are mainly available for all species of gurnards combined and not usable specifically for red gurnard.

From the official data, France is the main contributor to international landings in areas VII and VIII except VIIa in recent years. The landings in area IV have increased since 2000 mainly by UK, Netherlands and Denmark. In the period 2001 to 2005, international landings from areas IV, VIIa, VIId-k and VIII have fluctuated around 5200 t and then declined to 4650 t in 2008. French data are not available for 1999.

Examination of French logbooks data has shown that discrepancies between this source of information and the official landings are generally minor in recent years, except in 2008 in Division VIIe.

### 6.4.2 Discards

French data of gurnards for the EU Data Collection Framework have been recorded but the tools to extract and exploit them are still in development. The length compositions of observed catches are not available yet for 2007-2009.

The few observations from catches at sea from French bottom trawlers carried out under DCF in 2005 and 2006 are shown in Annex 3.

From the Dutch programme of observers at sea, the level of discarding in the beam trawl fishery appears to be very low.

### 6.4.3 Catch and effort data by sea area and country

In some countries species of gurnards are not always distinguished by species and their contribution to international landings is much smaller than those of France. Therefore only French data-sets are presented.

The data series proposed in WGNEW 2007 have been completely revised since the new French database Harmonie has come into service. Series 1999-2009 of LPUEs and total effort dedicated to gurnards by otter trawlers (OTB+OTT) are shown in Table 6-1 and Figure 6-1. Odd values are observed in 1999 and 2009 reflecting problems of quality in the datasets of these years. Therefore the observed window is reduced to the period 2000-2008.

A decreasing trend of effort is shown in the period 2003-2008 in VIIde. A similar trend has begun before, in 2002 in area VIIfgh in line with several decommissioning plans carried out in order to reduce the effort of Gadoids trawlers to manage the reduced quotas of cod. At the same time, effort in VIIIab has generally increased in that period. Over the period 2000-2008, the LPUEs have fluctuated without trend in each of the areas selected (Figure 4-1).

Other series of French effort and LPUE data using landings and effort by ICES rectangle over the period 1999-2008 have been constructed by metier in the Western Approaches (VIIe-k) and Bay of Biscay (area VIII). Effort considered is the fishing effort by metier and area. Trends of LPUE and effort are shown in Table 6-2 and Figure 6-2. The main metiers contributing to red gurnard landings are the Gadoid trawlers in Western Approaches which target mainly haddock, whiting and cod and the Benthic trawlers in the same area which target mainly monkfish, megrim and rays. The fluctuations without trend of LPUE of Gadoids trawlers in Western Approaches are rather similar to those observed in the series mentioned above. LPUE of Benthic trawlers in the same area increased to 2004 and since then levelled with fluctuations. LPUE of the other metiers described are very small. In the Western Approaches, effort of Gadoids and *Nephrops* trawlers have shown an almost continuous decline over the period in line with the adjustment to the effort regulation and restrictive quotas of cod set in this area. In the same area, effort of benthic trawlers has fluctuated without trend. In Bay of Biscay, the effort of gadoid trawlers has increased since 2003, probably indicating a shift of effort from Western Approach to Bay of Biscay. Effort of *Nephrops* and benthic trawlers have fluctuated at lower levels.

A series 1999-2008 of LPUE and effort of French otter trawler (OTB) in VIId is shown in Table 6-3 and Figure 6-3. LPUE have fluctuated between 1.2 and 2.0 kg/hour and levelled at higher values since 2005 as the fishing effort has decreased.

Over all the short series presented, only LPUE in VIId could indicate a trend of abundance increasing in recent years in that area. The other series have only shown small fluctuations without obvious trends.

## 6.5 Survey data, recruit series

Data from the IBTS surveys in the North Sea and the French EVHOE survey in the Celtic Sea and CGFS in Division VIId have been analysed during the NESPMAN project. Detailed information is given in Annex 3.

The abundance index of red gurnard from IBTS and CGFS is shown in Figure 6-4 with the 95% confidence interval.

The IBTS index is quite low but indicates an upward trend in the last decade.

The CGFS index in VIId has fluctuated in the range of the confidence interval indicating no significant trend .However some higher values have been observed in 2006 and 2008.

The FR-EVHOE index in number or in weight by 30 min as well shows a higher abundance in Celtic Sea than in Bay of Biscay (Table 6-5). In the Celtic Sea, the index has increased sharply (x2) in 2001 and has fluctuated at this high level since then. In the Bay of Biscay, the index has fluctuated in a wider range but at lower levels. The peak observed in 2008 is uncertain (Figure 6–5).

The distribution of red gurnard in the Eastern Channel during the FR-CGFS survey in October between 1988 and 2006 is shown in Figure 6-6 and indicates that higher abundance occurred in the central area along a Southwest- Northeast axis between Cotentin (FR) and Kent (UK).

The distribution of red gurnard in the Celtic Sea and the Bay of Biscay during FR-EVHOE from 1997 to 2009 is shown in Figure 6-7. Clearly the greater abundance is located offshore of Brittany in the south of Division VIIh and in the north of Division VIIIa quite in a geographical continuity with Division VIIe where the bulk of the landings comes from.

The abundance index at length from the CGFS and EVHOE surveys is shown in Figure 6-8 and Figure 6-9 respectively. In the CGFS dataset, there is no variability of mean lengths in the length distributions in which we can notice the quasi absence of 0 group (under 15 cm) in the catches, 1989 and 2002 excepted. For some years, bimodal distributions from the EVHOE survey series show clearly an abundant 0 group in the period 2001-2005. They are poorly represented in recent years.

The presence in the southern Celtic sea- northern Bay of Biscay area of younger individuals than seen in the eastern Channel may suggest an eastward migration of the species as it gets older. Data from the western Channel are lacking to improve the resolution of this pattern.

Age reading of red gurnards caught during EVHOE survey has been carried out in 2006 and routinely since 2008. Therefore abundance indeces at age are available in 2006, 2008 and 2009. They are shown in Figure 6-10 and indicate that the populations caught are mainly composed of individuals of age 1 and 2.

## 6.6 Biological sampling

There was a lack of regular sampling for red gurnard both in commercial landings and discarding to provide series of length or age compositions usable for a preliminary analytical assessment.

Since 2003, under DCF sampling programme at sea, length data have been collected, in a sporadic way during the first years by observers at sea but more intensively since 2009 when the concurrent sampling was planned. The French sampling programme by observation at sea under DCF should provide with length compositions of catches by metiers of the fishery when the tools to extract and exploit them will be developed (COST tools to adapt).

For surveys, length data were available and age compositions are now available since 2008 at least for the FR-EVHOE survey, but this survey is carried out outside the area where the bulk of landings is harvested. The abundance index per age from this survey where obtained by sampling 223 and 222 otoliths sampled during EVHOE 2008 and 2009 respectively.

Without DCF funding, it is not reasonable to get more biological data from the FR-CGFS or to envisage an extent of the survey in Division VIIe.

At the time of this WG, there are no more length composition data of landings than those shown at WGNEW 2007.

## 6.7 Biological parameters and other research

There is no update of growth parameters presented at WGNEW 2007 and available parameters from several authors are summarized in Annex 3. They vary widely.

Available length-weight relationships are also shown in Annex 3.

A maturity ogive is not available yet except an assumed knife-edge at age 3. Biological parameters collected during EVHOE survey since 2008 could provide a first estimate for the Celtic Sea.

Natural mortality has not been estimated in the areas studied at this Working Group.

## 6.8 Analyses of stock trends.

In the period 2001 to 2005, international landings from areas IV, VIIa, VIId-k and VIII have fluctuated around 5 200 t and then declined to 4 650 t in 2008. From only the French database and in the same area the landings have remained well above 4 000 t since 2001 and decreased in 2008 to 3 200 t. These datasets show a rather consistent signal from landings which show some indication of stability in recent years.

The length abundance index of the FR-CGFS surveys in VIId has fluctuated at higher values up to 1997. After the lowest value observed in 1998, indices have shown a slight increasing trend with fluctuations but confidence intervals are wide. Indices also show that 0 group (under 15 cm) are generally very scarce in the samples.

In the Celtic Sea and Bay of Biscay, length abundance indices from FR-EVHOE surveys have remained at lower values up to 2000 and then they have peaked in 2004. Indices of recruitment (age 0 set under 15 cm) have been also lower in 2008 and 2009. The stronger year classes shown in 2001, 2002 and 2004 are probably now almost fished out. The available abundance indices at age from this survey since 2006 have shown rather the same structure from year to year and therefore without signal of any stronger year class.

## 6.9 Data requirements

Regular sampling of red gurnard catches is envisaged mainly by observations at sea under DCF at least to estimate by metier and areas weight and length compositions of retained and discarded catches but the priority given to this species should be discussed taking into account its lower economical importance compared to those of valuable species harvested in the same areas which also need more data to assess.

Anyway, the concurrent sampling design carried out since 2009 should provide with more sampling data than it was in recent years.

The FR-EVHOE survey funded by DCF will continue to provide with a series of abundance indices at age. Not designed for data collection of gurnards, it provides good indicators of recruitment for red gurnard.

The FR-CGFS survey also provides abundance indices at length. Extending the studied area to VIIe and collecting length and age data of red gurnard should aid in better understanding the biology and dynamics of this species in the area.

**Table 6-1: Series of landings of red gurnard, effort and LPUE of French otter trawlers (OTB+OTT) from logbooks datasets.**

| | Landings kg | Red gurnard | | effort 000'h fished | | 1000 | LPUE | kg/h fished | |
|---|---|---|---|---|---|---|---|---|---|
| year | 7de | 7fgh | 8ab | 7de | 7fgh | 8ab | 7de | 7fgh | 8ab |
| 1999 | 3143378 | 315217 | 35275 | 810.553 | 230.328 | 48.834 | 3.9 | 1.4 | 0.7 |
| 2000 | 3026836 | 607484 | 54645 | 1130.318 | 941.991 | 356.194 | 2.7 | 0.6 | 0.2 |
| 2001 | 3356616 | 684815 | 49543 | 1067.780 | 994.438 | 302.113 | 3.1 | 0.7 | 0.2 |
| 2002 | 3813616 | 595813 | 39719 | 1219.589 | 846.449 | 321.536 | 3.1 | 0.7 | 0.1 |
| 2003 | 3507286 | 661274 | 49012 | 1391.980 | 893.467 | 426.490 | 2.5 | 0.7 | 0.1 |
| 2004 | 3248722 | 900132 | 63445 | 1297.526 | 865.703 | 497.762 | 2.5 | 1.0 | 0.1 |
| 2005 | 3624801 | 681381 | 112036 | 1085.057 | 778.914 | 768.129 | 3.3 | 0.9 | 0.1 |
| 2006 | 3452166 | 633692 | 117881 | 1069.908 | 672.443 | 680.123 | 3.2 | 0.9 | 0.2 |
| 2007 | 3352089 | 657775 | 100654 | 1002.862 | 623.124 | 716.833 | 3.3 | 1.1 | 0.1 |
| 2008 | 2254264 | 583834 | 103017 | 778.306 | 603.849 | 677.288 | 2.9 | 1.0 | 0.2 |
| 2009 | 1314597 | 336279 | 26941 | 213.796 | 106.379 | 59.186 | 6.1 | 3.2 | 0.5 |

1999 and 2009: datasets unreliable

**Table 6-2: Series of landings of red gurnard, effort and LPUE by metier of French otter trawlers (OTB+OTT) from CPR datasets.**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Red Gurnard France | | | | | | | | | | |
| Captures (t) | | | | | | | | | | |
| Metier | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
| Benthic Western Approaches | 55 | 145 | 252 | 247 | 463 | 810 | 595 | 614 | 751 | 469 |
| Gadoids Western Approaches | 2685 | 2874 | 2930 | 3222 | 2851 | 2536 | 2850 | 2667 | 2421 | 1642 |
| Nephrops Western Approaches | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| Benthic Bay of Biscay | 7 | 29 | 21 | 22 | 29 | 28 | 57 | 62 | 39 | 51 |
| "Gadoids" Bay of Biscay | 25 | 24 | 22 | 16 | 18 | 30 | 52 | 49 | 59 | 51 |
| Nephrops Bay of Biscay | 3 | 3 | 2 | 3 | 4 | 6 | 6 | 5 | 5 | 6 |
| | 2778 | 3077 | 3228 | 3511 | 3366 | 3411 | 3561 | 3397 | 3275 | 2219 |
| | | | | | | | | | | |
| Red Gurnard France | | | | | | | | | | |
| Fishing Effort | | | | | | | | | | |
| Metier | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
| Benthic Western Approaches | 260758 | 295235 | 289227 | 265173 | 311690 | 319664 | 277571 | 303860 | 327413 | 266640 |
| Gadoids Western Approaches | 603846 | 561385 | 549464 | 549402 | 532461 | 488775 | 455446 | 436125 | 394148 | 314761 |
| Nephrops Western Approaches | 198129 | 219402 | 195229 | 182732 | 199108 | 164514 | 168537 | 159230 | 118692 | 99788 |
| Benthic Bay of Biscay | 143053 | 137186 | 128085 | 132199 | 148483 | 166266 | 203183 | 173227 | 178323 | 170854 |
| "Gadoids" Bay of Biscay | 276271 | 211502 | 208556 | 184709 | 194668 | 215719 | 260360 | 291848 | 356308 | 305030 |
| Nephrops Bay of Biscay | 199384 | 171203 | 181568 | 182496 | 218913 | 238337 | 277343 | 277908 | 249244 | 230292 |
| Total | 1681441 | 1595913 | 1552129 | 1496711 | 1605323 | 1593275 | 1642440 | 1642198 | 1624128 | 1387365 |
| | | | | | | | | | | |
| Red Gurnard France | | | | | | | | | | |
| LPUE (Kg/10h) | | | | | | | | | | |
| Metier | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
| Benthic Western Approaches | 2.1 | 4.9 | 8.7 | 9.3 | 14.9 | 25.3 | 21.4 | 20.2 | 22.9 | 17.6 |
| Gadoids Western Approaches | 44.5 | 51.2 | 53.3 | 58.6 | 53.5 | 51.9 | 62.6 | 61.2 | 61.4 | 52.2 |
| Nephrops Western Approaches | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| Benthic Bay of Biscay | 0.5 | 2.1 | 1.6 | 1.7 | 2.0 | 1.7 | 2.8 | 3.6 | 2.2 | 3.0 |
| "Gadoids" Bay of Biscay | 0.9 | 1.1 | 1.1 | 0.9 | 0.9 | 1.4 | 2.0 | 1.7 | 1.7 | 1.7 |
| Nephrops Bay of Biscay | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 |

**Table 6-3: Series of landings of red gurnard, effort and LPUE of French otter trawlers (OTB) in VIId from logbooks datasets.**

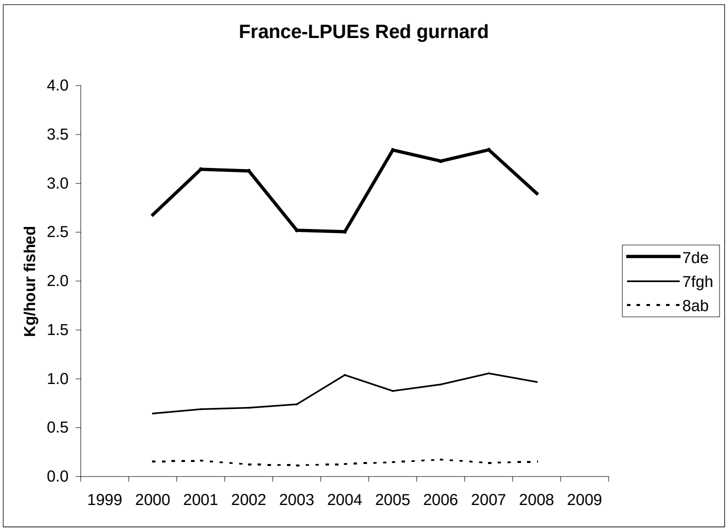
| year | Landings kg | Effort hours | LPUE Kg/hour |
|---|---|---|---|
| 1999 | 731485 | 449924 | 1.6 |
| 2000 | 653244 | 551088 | 1.2 |
| 2001 | 869054 | 485479 | 1.8 |
| 2002 | 929381 | 560053 | 1.7 |
| 2003 | 813963 | 629978 | 1.3 |
| 2004 | 800899 | 573711 | 1.4 |
| 2005 | 827994 | 441078 | 1.9 |
| 2006 | 791125 | 440473 | 1.8 |
| 2007 | 811937 | 438125 | 1.9 |
| 2008 | 698455 | 342351 | 2.0 |

**Table 6-4: The abundance index (N/h) of red gurnard from the IBTS database in North Sea and CGFS survey in Eastern Channel.**

| Year | IBTS Quarter 1 | CGFS |
|---|---|---|
| 1986 | 11.87 | 20.77 |
| 1987 | 1.17 | 19.24 |
| 1988 | 0.00 | 12.33 |
| 1989 | 0.37 | 11.87 |
| 1990 | 4.91 | 16.35 |
| 1993 | 0.00 | 10.12 |
| 1994 | 0.00 | 23.71 |
| 1995 | 0.00 | 12.89 |
| 1996 | 0.00 | 9.56 |
| 1997 | 0.06 | 18.01 |
| 1998 | 0.00 | 6 |
| 1999 | 0.00 | 7.09 |
| 2000 | 0.11 | 9.83 |
| 2001 | 0.12 | 7.17 |
| 2002 | 0.05 | 11.18 |
| 2003 | 0.24 | 12.92 |
| 2004 | 0.22 | 7.34 |
| 2005 | 0.10 | 10.9 |
| 2006 | 0.00 | 13.56 |
| 2007 | 0.23 | 10.26 |
| 2008 | 0.00 | 18.64 |
| 2009 | 0.24 | 17.24 |

**Table 6-5: The average abundance( number and weight (kg) per 30 mn) of red gurnard annually from FR-EVHOE survey in the Celtic Sea (VII,g,h,j) and in the Bay of Biscay (VIIIa,b).**

| Year | Celtic Sea (VIIg, h, j) | | Bay of Biscay (VIIIa, b) | |
|---|---|---|---|---|
| | Number/30minutes | W(kg)/30minutes | Number/30minutes | W(kg)/30minutes |
| 1997 | 23.29 | 2.24 | 5.34 | 0.43 |
| 1998 | 22.32 | 2.35 | 2.79 | 0.25 |
| 1999 | 25.22 | 2.35 | 0.9 | 0.09 |
| 2000 | 19.12 | 1.65 | 1.2 | 0.11 |
| 2001 | 39.11 | 3.03 | 8.02 | 0.7 |
| 2002 | 35.75 | 2.97 | 9.79 | 0.69 |
| 2003 | 37.62 | 2.8 | 2.61 | 0.21 |
| 2004 | 43.76 | 3.66 | 7.19 | 0.58 |
| 2005 | 38.84 | 3.39 | 6.7 | 0.57 |
| 2006 | 27.89 | 2.56 | 6.82 | 0.53 |
| 2007 | 36.41 | 3.18 | 10.59 | 0.81 |
| 2008 | 33.97 | 3.39 | 14.71 | 1.42 |
| 2009 | 38.7 | 3.82 | 6.04 | 0.53 |



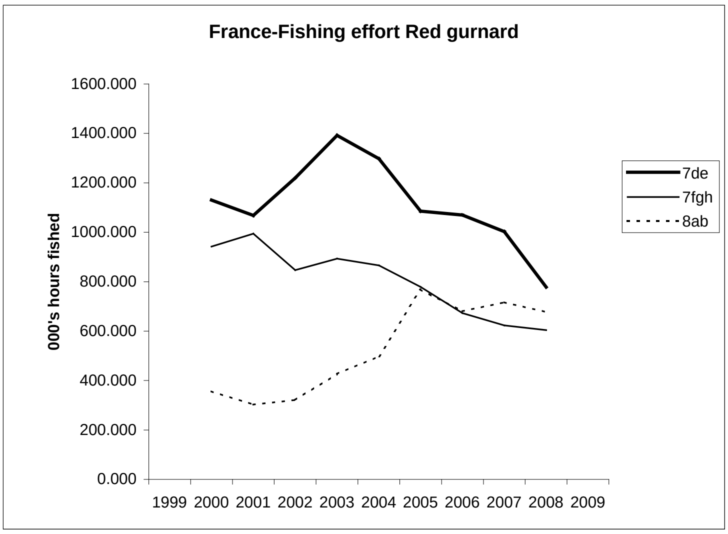
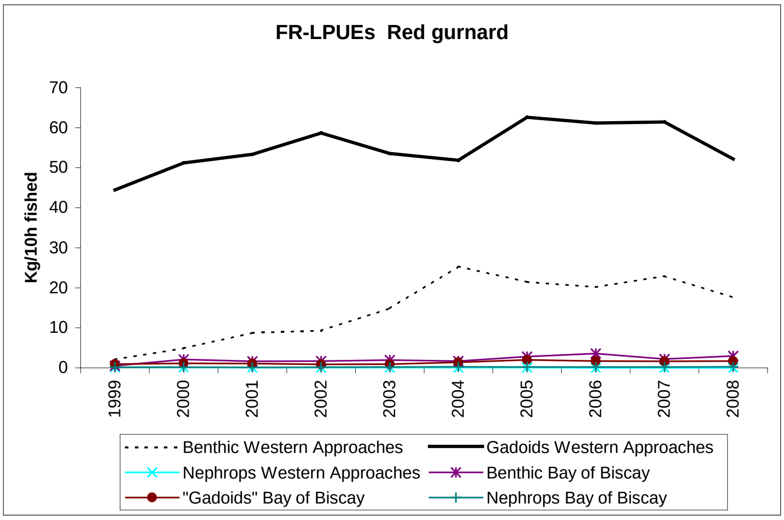




**Figure 6-1: Trends of LPUEs and French effort OTB+OTT and in VIIde, VIIfgh and VIIIab.**



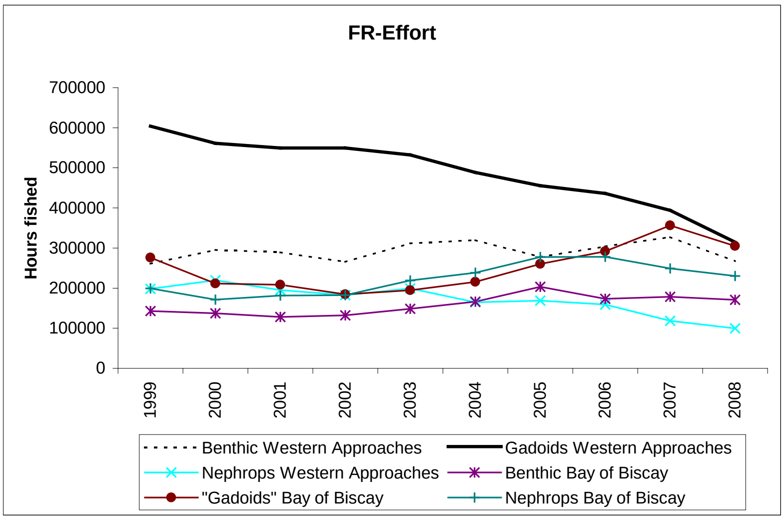




**Figure 6-2: Red Gurnard. Trends of LPUE (kg/10h) and fishing effort (hours fished) of French otter trawlers (OTB+OTT) in areas VIIe-k (Western Approaches) and VIII (Bay of Biscay**

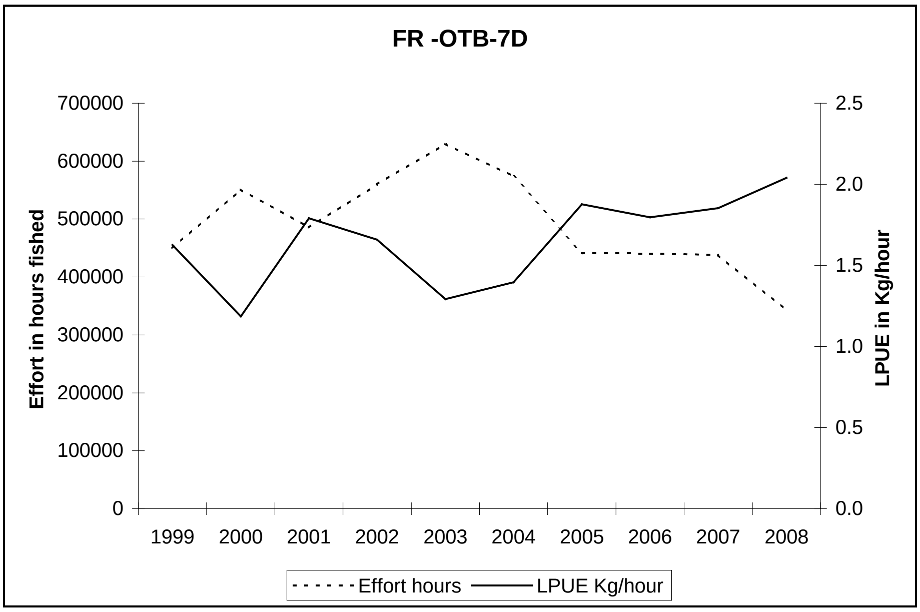



**Figure 6-3: France. Trends of LPUE and effort in VIId of otter trawlers (OTB) for years 1999-2008**

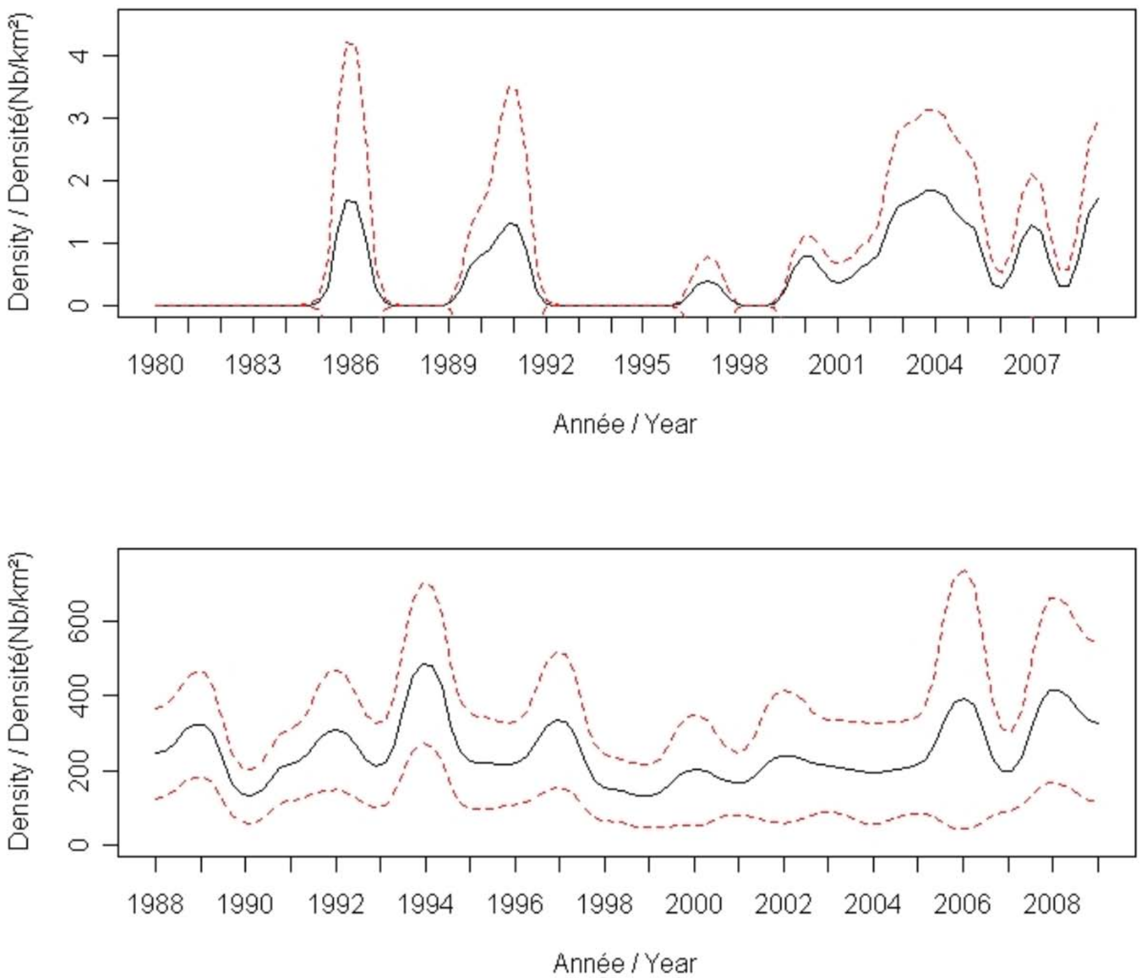



**Figure 6-4: Time series of abundance of red gurnard in the North Sea base on IBTS data (Nb/km²) from 1980 to 2009 in upper panel and in the eastern Channel base on FR-CGFS data (Nb/km²) from 1988 to 2009 in the lower panel.**

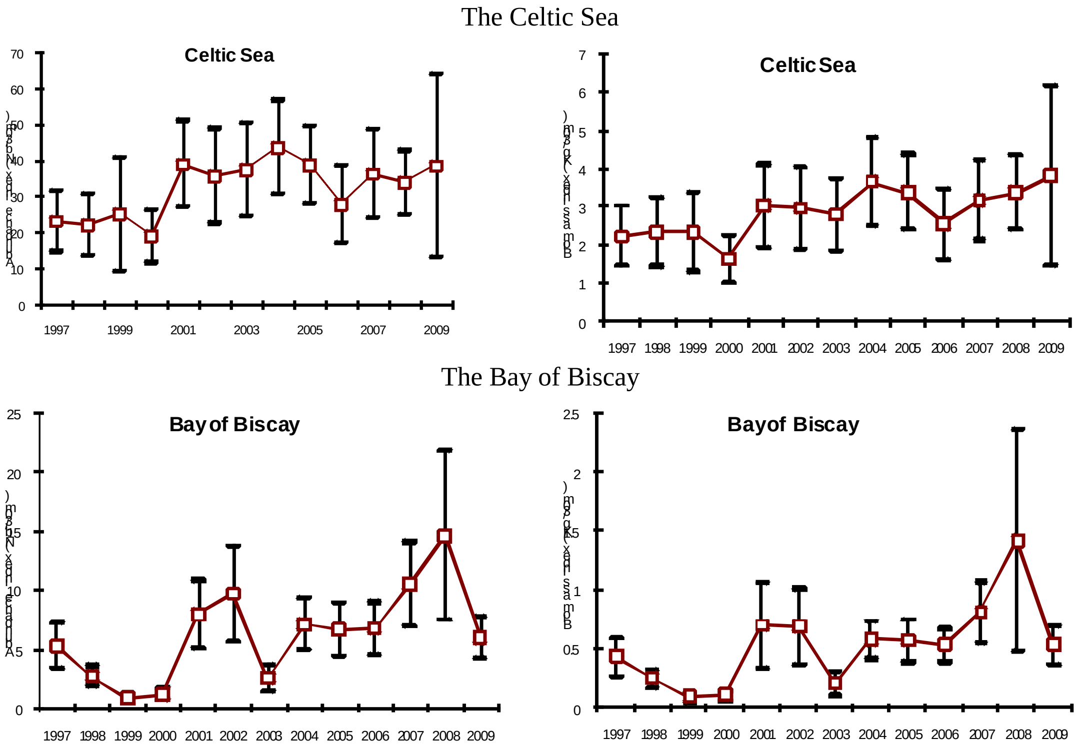
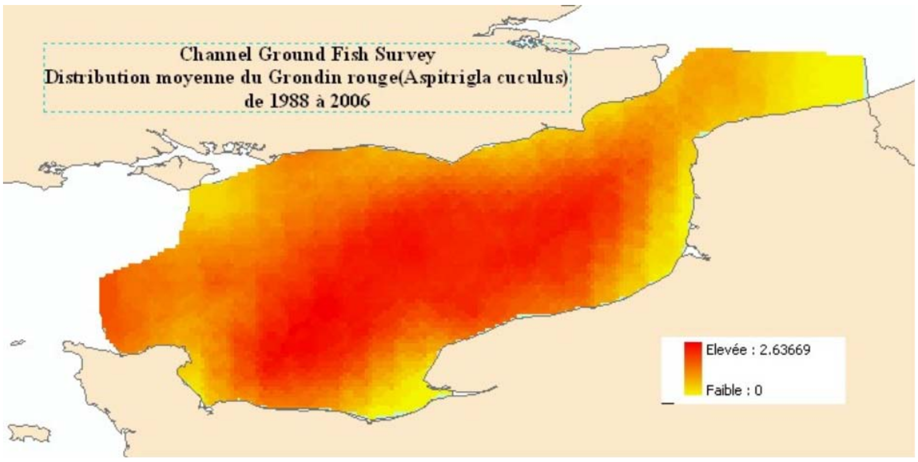



**Figure 6-5: Time series of abundance (Nb and Weight (kg)/30 min Trawl) of red gurnard in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009.**

**Figure 6-6: FR-CGFS surveys series. Geographical distribution of red gurnard in Eastern Channel in October from 1988 to 2006**



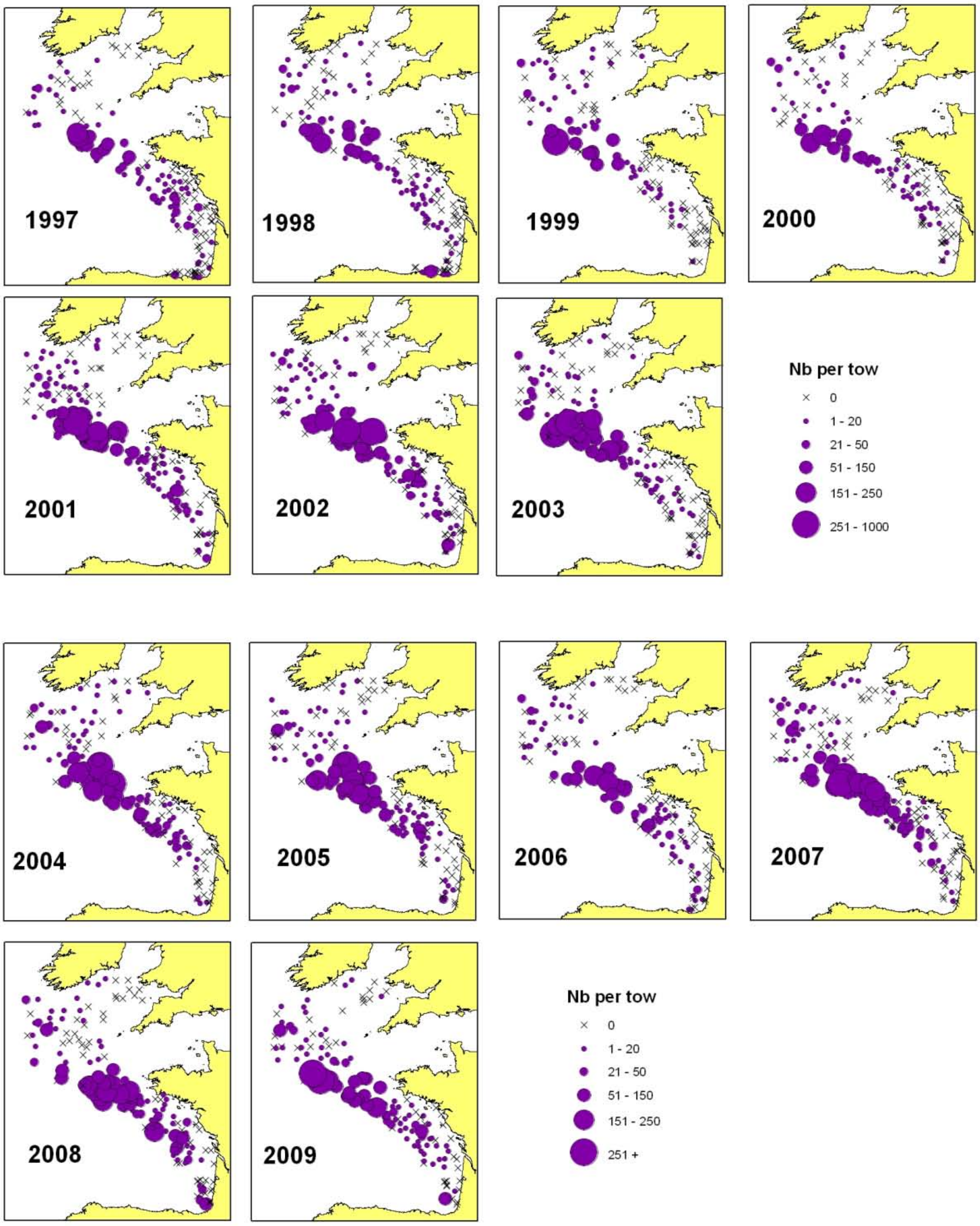



**Figure 6-7: Distribution of red gurnard in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009.**

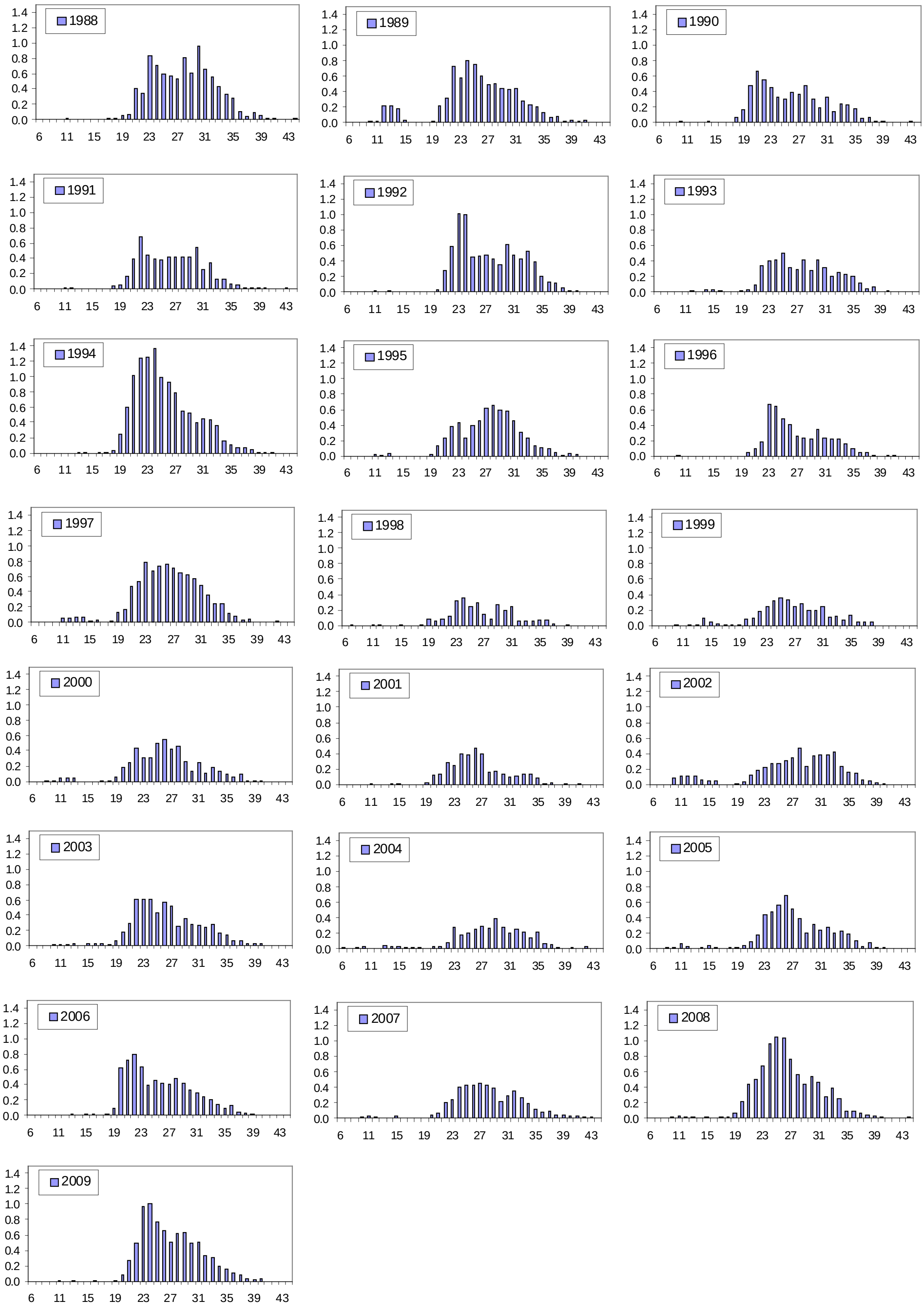



**Figure 6-8: Abundance index at length of red gurnard in Eastern Channel from FR-CGFS surveys series.**

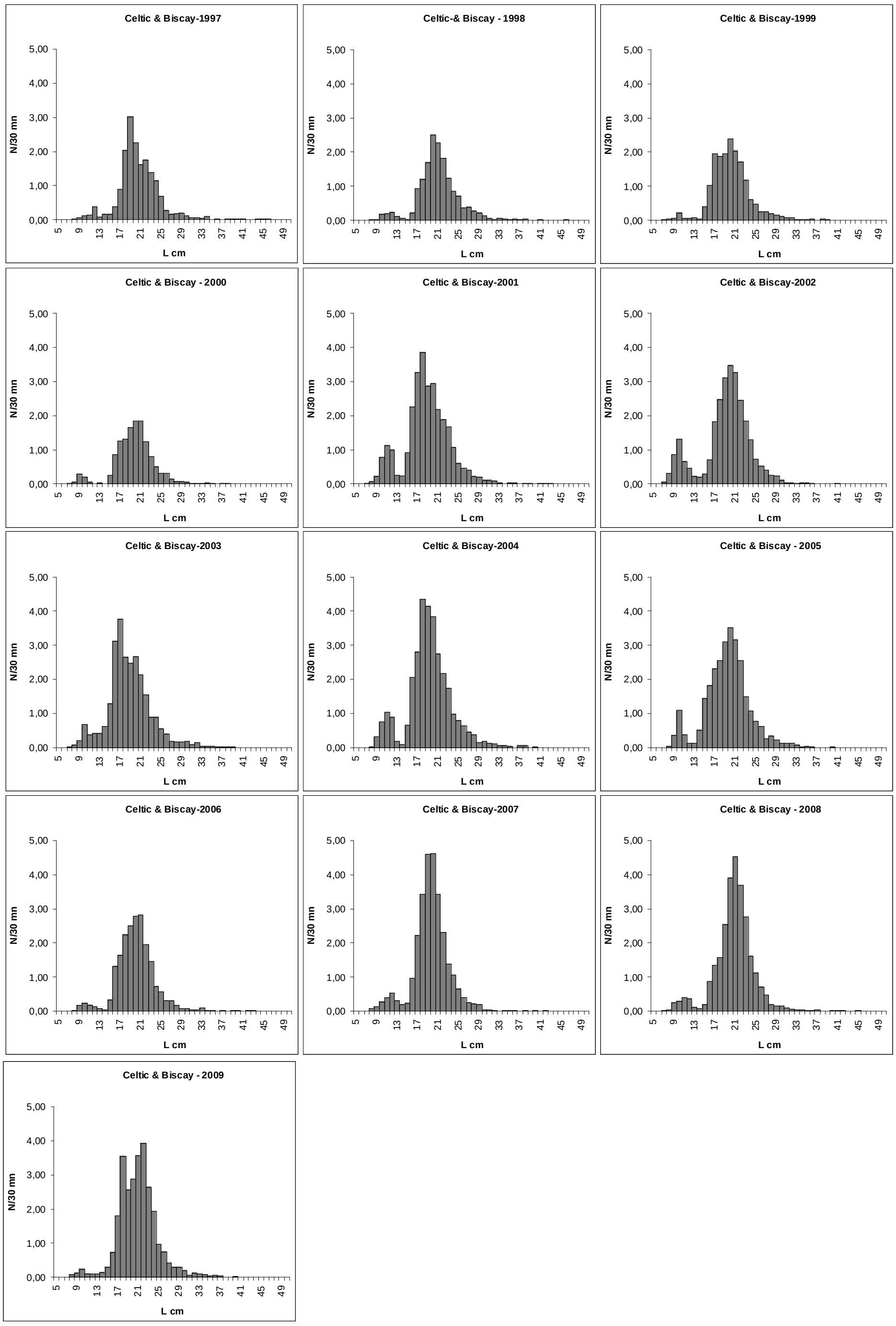



**Figure 6-9: Length abundance index of red gurnard in the combined areas of Celtic Sea and bay of Biscay from FR-EVHOE surveys series.**

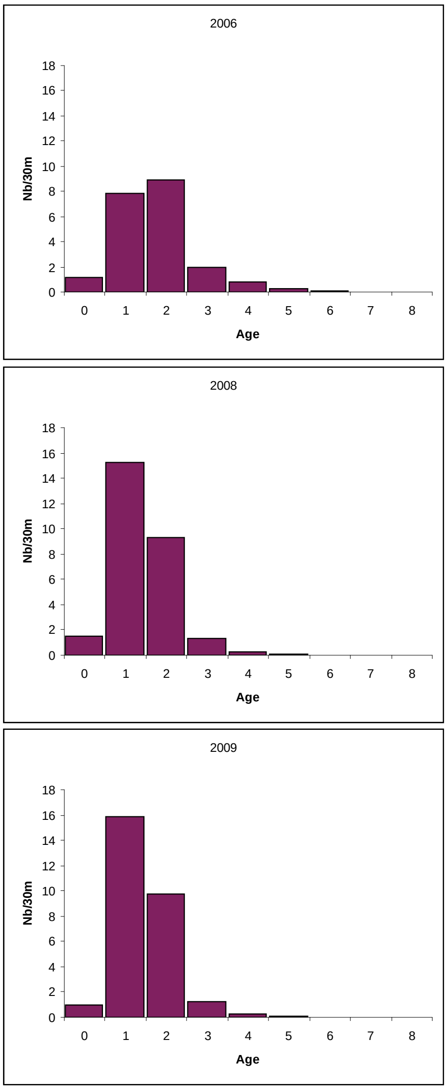



**Figure 6-10: Abundance index at age of red gurnard in the combined areas of Celtic Sea and bay of Biscay from FR-EVHOE surveys series for 2006, 2008 and 2009.**

# 7 Tub gurnard

## 7.1 General biology

Tub gurnard *Trigla lucerna* or *Chelidonichthys lucernus* is a benthic species which occurs in the Eastern Atlantic from Norway to Senegal, in Mediterranean Sea and also in South Africa (Quero, 1984).

Tub gurnard is relatively abundant in inshore waters of 20-150 m, extending in decreasing numbers to 200 m. Small specimens are frequent in shallow water from 2-20 m. It lives occasionally solitarily, more often in small schools, on mud and muddy-sand bottoms (Wheeler 1978). It lives from the shore up to 300 m and maximum concentrations are located between 50 and 150 m (Quero, 1984).

In summer, tub gurnard occurs in inshore waters on sand, muddy sand and gravel grounds. It can occur also in estuaries (Gironde). In winter, it migrates on grounds more than 80 m. Juveniles feed on a variety of small crustaceans, mainly copepods at length lesser than 15 cm, mysids, shrimps and amphipods at length less than 25 cm and also crabs for fish between 20-30 cm long. The diet of larger specimens consists mainly of small fish and some cephalopods (Quero, 1984).

Spawning takes place from December to February in Mediterranean Sea and in May-June in Celtic Sea. Younger fish migrate to coastal waters at the end of summer (Quero, 1984).

The maximum length recorded is 75 cm.

## 7.2 Stock identity and possible assessment areas

No recent studies are known of the stock ID of tub gurnard at the time of the WG. Some genetic studies have only been carried out in Mediterranean Sea.

## 7.3 Management regulations

There is no minimum landing size set. There is no technical measures specifically dedicated to tub gurnard or others species of gurnards. The exploitation of tub gurnard is submitted to the general regulation in the areas where they are harvested.

## 7.4 Fisheries data

### 7.4.1 Historical landings

It is a by-catch species in demersal fisheries. Tub gurnard is either landed for human consumption or fish could also be used for baiting traps used to harvest large crustaceans.

Gurnards are often not sorted by species when they are landed. This is reflected in the catch statistics where different species of gurnards are often reported into one generic category of "gurnards". EUROSTAT/ICES data have been compiled for the NESPMAN project and they are shown in Table 7-1. French data are still missing in 1999. Only the series from 2000 which seems more reliable from year to year has been examined. The international landings (without Spain, Germany and Ireland) are relatively constant, nearly 3000 tons except for 2007 with 4120 tons. 3 countries contributes strongly in the international landings:

The Netherlands: 47% ; 1542 t on average

France: 36% ; 1159 t on average

Belgium: 16% ; 513 t on average

Among the fishing areas, the North Sea is most significant with 52% on average (1575 t) then the eastern English Channel with 37% (1113 t).

Figure 7-1 shows the contribution of landings by country and by area.

Tub gurnard is either landed for human consumption or fish could also be used for baiting traps used to harvest large crustaceans.

From logbooks database a series 1988-2008 is available for France in Divisions IVc, VIId, VIIe, VIIf-k and VIII (Table 7-2 and Figure 7-2). The dome shape at high level of the production in the period 1989-1996 is not apparent in neighbouring Divisions IVc or VIIe. Then the high levels of landings from VIId in that period could be an effect of the misreporting of another species in that Division. Tub gurnard is mainly harvested in VIId,e and the landings from these Divisions have shown and increasing trend up to 2006-2007. The production from Division IVc is declining.

Historically, tub gurnard is mainly taken as by-catch in mixed demersal fisheries for flatfish and roundfish.

### 7.4.2 Discards

Under the DCF, National programs of sampling by observation at sea have collected some data of tub gurnard since 2003 and probably more when the concurrent sampling has been carried out in 2009.

Van Helmond & Heessen (2010) present in the NESPMAN report the discarded length compositions per fishing hour in the Dutch beam trawl fishery. They are shown in Figure 7-3. The size range of the discards is from 5 to 30 cm. Higher values of discarding were observed in 2005 and then they decline continuously, may be indicating no strong year class coming in or a change in the fishing strategy of this fleet.

At the time of the WG only the French data sets shown at WGNEW 2007 are available in Figure 7-4 and Figure 7-5.

### 7.4.3 Catch and effort data by sea area and country

A series of Landings, effort and LPUEs of French otter trawlers (OTB +OTT) based on logbooks datasets has been reconstructed for the period 1999-2009. Considering that the low effort data recorded in these 2 years, LPUEs of 1999 and 2009 are unreliable. Annual data are shown in Table 7-3 and their trends in Figure 7-6. Effort data are the effort dedicated to all gurnards species. The general declining trend of effort is in line with the decommissioning plans or the shift of effort outside the areas where the reduced quotas of cod were set or to reduce the effort of gadoids trawlers in Celtic Sea and in North Sea and Eastern Channel. LPUEs have fluctuated in IVc at higher values and slightly increased in VIId, remaining at very low values in the others areas.

Another series of French effort and LPUEs data using landings and effort by ICES rectangle over the period 1999-2008 have been constructed by metier in Western Approaches (VIIe-k) and Bay of Biscay (area VIII). Effort considered is the fishing effort by metier and area. Trends of LPUEs and effort are shown in Table 7-4 and Figure 7-7. There is a general increasing trend of the LPUE of the Gadoids trawlers in the Western Approaches. The LPUEs of the other metiers have remained at very low levels.

## 7.5 Survey data, recruit series

Several series are available in North Sea.

For the NESPMAN Project, ter Hofstede et al. (2010) analysed data from several surveys: the ICES-coordinated IBTS in 1st and 3rd quarter in the North Sea, the Dutch contribution to the Beam trawl Survey (BTS) during the 3rd quarter in the South-Western North Sea and the Dutch contribution to the Demersal young Fish Survey (DFS) during the 3rd quarter in the Wadden Sea, Coastal zone and Delta area (Heessen, 2010).

The datasets of the French survey FR-CGFS in October in Eastern channel have also been analysed (Mahé, 2010).

Tub gurnard abundance index from the IBTS Q1 are very low all along the series in the North Sea and in the Eastern English Channel. One can notice that this species is more regularly seen in the catches the last years in the North Sea. Concerning the observed abundance during the CGFS survey, the general trend is stable.

Table 7-5 shows the time series of abundance indices of tub gurnard from the IBTS quarter 1 database in North Sea and in the FR-CGFS survey in October in VIId. Both the two series indicate high abundance in 2009, particularly unusual in the IBTS series where the values are generally very small in winter. The trend of the FR-CGFS index is shown in Figure 7-8 . Higher fluctuating in the earlier years (1988-1998) the index has then had a more stable trend and has increased in 2008 and 2009.

The time series of abundance of the surveys conducted in North Sea are shown in Figure 7-9.

IBTS-1: During quarter 1 the abundance is quite low. No clear trend is to be seen, although numbers (of overwintering fish) seem to increase in the last five years of the time series.

IBTS-3: This time series is relatively short, and the first year clearly is an outlier, possibly due to a wrong identification (grey gurnard identified as tub gurnard?). Slightly higher values during the last three years.

BTS-3: Although a clear peak in abundance in the late 1980ies and early 1990ies can be seen in Figure 7-9 and a much lower level since around 1995 this is not seen at all when the time series for the two vessels that carry out the survey is shown in Figure 7-10. The abundance in the stations covered by RV Isis gradually increased since 1985, but in the stations fished by RV Tridens numbers remain at a low level.

DFS-3: the numbers caught in the Demersal Fish Survey are usually quite low. Apart from a possible minor increase in the coastal zone no clear trend can be seen.

In conclusion, tub gurnard is normally not present in the North Sea during winter, but enters the southern North Sea in spring and leaves again in the autumn. The slight increase seen in IBTS1 may indicate an increase in the numbers of tub gurnard that remain in the North Sea in winter in recent years. This is similar to striped red mullet, another species that used to enter the North Sea in spring and leave in the autumn, but that now over winters in the North Sea in increasing numbers. The most promising time series for tub gurnard seems to be from the Beam Trawl Surveys in quarter 3, and especially for the stations in the southeastern North Sea covered by RV Isis.

The abundance indices at length have been examined for all surveys during the NESPMAN Project.

In the FR-CGFS series, the length distributions were generally stretched in the range 6-60 cm and showed sometimes a bi modal structure possibly separating juveniles and adults (Figure 7-11).

IBTS-1: Fish caught were in the range of 8 to 50 cm, with no clear peaks indicating age-groups.

IBTS-3: The range is from about 12 to 50 cm, with a very clear peak at about 23 cm.

BTS-3: The range is from 5 to around 50 cm. Two very clear peaks can be seen, around 10 cm, and around 25 cm (Figure 7-12).

DFS-3: Catches seem to be limited to small fish in the range of 4 to 20 cm. In the coastal area and in the Delta area also some fish in the range of 20 to 35 cm are caught.

Overall this series, BTS-3 probably provides the most complete picture of the annual length compositions.

Indices of the BTS3 series have been split in two strata in order to get some modes indicating the recruitment at age 0 assumed to be under 16 cm long. Figure 7-14 shows that higher recruitments can be observed in years 1993, 1998 and 2003.

Heessen has also analysed the distribution of tub gurnard in the North Sea from the IBTS-Q1, IBTS-Q3, BTS-3 and 2 datasets from the Dutch series DFS-3 in 1975 and 1990. They are shown in Figure 7-15 and 7-16.

IBTS-1: The numbers of tub gurnard caught in the first quarter are very low. The highest abundance can be seen near the northwestern and southwestern boundaries of the survey area.

IBTS-3: In the third quarter the abundance is much higher. There is a tendency that adults are more abundant towards the southeastern part of the North Sea. In juveniles no pattern is to be seen.

BTS-3: In this survey a very clear pattern can be seen, especially in the adult distribution. The abundance is higher (but numbers caught are still low) along the southeastern edge of the survey area. Juveniles show the same pattern but less clearly.

DFS-3: No clear pattern in shallow waters can be seen. In some years the highest catches are made in the Wadden Sea, in other years in the coastal zone.

## 7.6 Biological sampling

Under DCF, sampling of tub gurnard has been carried out by observations at sea in Netherlands at least since 2004.

Since 2009, the French concurrent sampling program by observation at sea under DCF should provide with length compositions of catches by metier and area when the tools to extract and exploit them will be developed (COST tools to adapt).

At the moment, the main source of biological data remains the surveys conducted in North Sea, Eastern Channel. The few catches from the survey conducted in Celtic Sea and Bay of Biscay are not able to provide some usable biological data series.

## 7.7 Biological parameters

Growth parameters available are from a small southern part of Division VIIe (Bay of Douarne-nez) and have not been updated since 1985 (Baron, 1985). They are shown in Table 7-6 and Table 7-7.

## 7.8 Analyses of stock trends

Beare & al (2004), based on a long series of CPUEs (1925-2003) from FRS survey database, have suggested that in Division IVb, abundance of species having southern biogeographic affinities (tub gurnard included) have tended to raise in the last decade.

From the analysis of survey data by Heessen in North Sea and Mahe in Eastern Channel, a continuity could be considered between Division VIId and southeastern part of Division IVc. There are mainly adults (above 24 cm) both in the CGFS survey in October and the BTS-3 in 3rd quarter. Then tub gurnard is almost not present during quarter 1 in North Sea (See IBTS-1 results) suggesting they enter the Southern North Sea later in the year.

International landings both in the North Sea and the Eastern Channel show a rather synchronized increasing trend since 2000 and then a decrease both by ~25% in 2008.

The short period 2000-2008 of LPUEs of French otter trawlers in Eastern Channel have shown that LPUEs have increased with fluctuations and still remained at high value in 2008. In the same period LPUEs in Division IVc have widely fluctuated.

North Sea Beam Trawl Survey index (BTS-3) showed an increase from 1985 to 1992 and has fluctuated at a relatively high level since (Figure 7-12).

## 7.9 Data requirements

Regular sampling of tub gurnard catches must be envisaged mainly by observations at sea under DCF at least to estimate by metier and areas weight and length compositions of retained and discarded catches but the priority given to this species should be discussed taking into account its lower economical importance compared to those of valuable species harvested in the same areas which also need more data to assess.

Anyway, the concurrent sampling design carried out since 2009 should provide with more sampling data than it was in recent years.

In the medium term the survey program IBTS providing with length abundance indices in the North Sea will continue.

The FR-CGFS survey, not yet funded by DCF, also provide with abundance indices at length and is expected to continue.

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**Table 7-1: Nominal landings in tonnes of Tub gurnard from EUROSTAT/ICES database.**

North Sea (ICES region: 4)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 47 | 33 | 32 | 112 | 176 | 115 | 96 | 106 | 61 | 67 | 63 | 85 |
| Denmark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 125 | 63 | 23 | 29 | 62 | 29 | 62 | 63 | 60 | 46 | 60 | 59 | 52 | 45 | 16 | 24 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 39 | 0 | 37 | 24 | 96 | 122 | 73 | 120 | 123 | 205 | 160 | 95 | 55 | 101 | : | 206 | 134 | 203 | 99 | 83 | 110 | 94 | 89 | 76 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 1093 | 1533 | 1437 | 1202 | 1422 | 1519 | 1666 | 1875 | 1390 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |

Irish Sea (ICES region: 7a)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 80 | 41 | 24 | 73 | 42 | 80 | 56 | 22 | 64 | 51 | 22 | 15 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | : | 3 | 6 | 10 | 4 | 2 | 3 | 1 | 1 | 0 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |

Eastern Channel (ICES region: 7d)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 81 | 83 | 143 | 186 | 247 | 265 | 328 | 368 | 221 | 357 | 514 | 353 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 375 | 74 | 226 | 276 | 618 | 1343 | 916 | 1095 | 1421 | 1248 | 1145 | 780 | 427 | 544 | : | 667 | 637 | 692 | 633 | 612 | 766 | 762 | 826 | 603 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 14 | 35 | 19 | 32 | 46 | 58 | 59 | 204 | 157 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |

Western Channel (ICES region: 7e)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 3 | 0 | 0 | 5 | 6 | 8 | 19 | 12 | 23 | 28 | 32 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 76 | 12 | 150 | 114 | 87 | 94 | 207 | 180 | 173 | 120 | 126 | 185 | 179 | 185 | : | 188 | 212 | 216 | 216 | 190 | 212 | 251 | 242 | 152 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 5 | 4 | 4 | 7 | 17 | 6 | 26 | 29 | 6 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |

Celtic Sea (ICES region: 7f-k)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 20 | 24 | 27 | 34 | 24 | 27 | 25 | 42 | 19 | 32 | 38 | 47 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 17 | 23 | 25 | 35 | 23 | 18 | 35 | 41 | 33 | 34 | 28 | 52 | 62 | 68 | : | 105 | 125 | 84 | 96 | 92 | 104 | 97 | 109 | 56 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |

Bay of Biscay (ICES region: 8)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 3 | 7 | 7 | 7 | 4 | 6 | 5 | 7 | 7 | 6 | 6 | 6 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 138 | 2 | 4 | 5 | 5 | 3 | 3 | 6 | 2 | 5 | 3 | 5 | 7 | 7 | : | 36 | 24 | 28 | 45 | 51 | 50 | 56 | 58 | 21 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |

**Table 7-2: Tub gurnard. France: Landings in tonnes live weight**

Only from logbooks in series 1999-2008

| Year | IVc | VIId | VIIe | VIIf-k | VIII |
|---|---|---|---|---|---|
| 1988 | 24 | 329 | 104 | 36 | 6 |
| 1989 | 104 | 619 | 75 | 25 | 6 |
| 1990 | 121 | 1152 | 85 | 47 | 5 |
| 1991 | 87 | 987 | 185 | 38 | 4 |
| 1992 | 120 | 1095 | 180 | 42 | 7 |
| 1993 | 123 | 1421 | 173 | 35 | 4 |
| 1994 | 205 | 1248 | 114 | 35 | 6 |
| 1995 | 161 | 1145 | 125 | 30 | 6 |
| 1996 | 96 | 780 | 183 | 57 | 6 |
| 1997 | 67 | 433 | 179 | 69 | 35 |
| 1998 | 101 | 575 | 129 | 73 | 26 |
| 1999 | 50 | 514 | 157 | 46 | 3 |
| 2000 | 195 | 574 | 173 | 97 | 25 |
| 2001 | 126 | 532 | 197 | 118 | 12 |
| 2002 | 198 | 571 | 202 | 82 | 16 |
| 2003 | 92 | 561 | 211 | 96 | 25 |
| 2004 | 79 | 699 | 208 | 95 | 30 |
| 2005 | 97 | 696 | 225 | 95 | 49 |
| 2006 | 73 | 663 | 272 | 85 | 41 |
| 2007 | 75 | 809 | 254 | 100 | 43 |
| 2008 | 63 | 595 | 200 | 111 | 49 |

**Table 7-3: Series of landings, effort and LPUE of French otter trawlers (OTB+OTT) from logbooks datasets. 1999 and 2009 datasets are unreliable**

| | Landings kg | Tub gurnard | | | |
|---|---|---|---|---|---|
| year | 4c | 7d | 7e | 7f-k | 8 |
| 1999 | 44321 | 503610 | 154327 | 45349 | 2060 |
| 2000 | 187670 | 555966 | 170151 | 96561 | 11288 |
| 2001 | 121122 | 502254 | 195508 | 117915 | 7491 |
| 2002 | 194166 | 552311 | 199899 | 81019 | 9443 |
| 2003 | 89439 | 533712 | 206950 | 94462 | 20390 |
| 2004 | 75887 | 562699 | 186241 | 94371 | 23134 |
| 2005 | 93645 | 612053 | 214563 | 94437 | 32910 |
| 2006 | 68572 | 599709 | 241568 | 83152 | 33287 |
| 2007 | 70468 | 698812 | 231414 | 99896 | 37481 |
| 2008 | 61047 | 469940 | 187934 | 107785 | 38370 |
| 2009 | 84008 | 79623 | 134173 | 108386 | 59186 |

| | effort 000'h fished | | | | 1000 |
|---|---|---|---|---|---|
| year | 4c | 7d | 7e | 7f-k | 8 |
| 1999 | 82.797 | 449.924 | 360.630 | 239.714 | 49.951 |
| 2000 | 75.670 | 551.088 | 579.230 | 995.384 | 365.647 |
| 2001 | 120.872 | 485.479 | 582.301 | 1024.288 | 314.139 |
| 2002 | 92.382 | 560.053 | 659.537 | 882.582 | 334.549 |
| 2003 | 61.917 | 629.978 | 762.002 | 928.493 | 438.997 |
| 2004 | 56.931 | 573.711 | 723.815 | 885.129 | 510.374 |
| 2005 | 45.005 | 441.078 | 643.979 | 799.601 | 788.723 |
| 2006 | 22.273 | 440.473 | 629.435 | 692.168 | 692.085 |
| 2007 | 27.988 | 438.125 | 564.737 | 640.689 | 729.624 |
| 2008 | 42.574 | 342.351 | 435.955 | 626.154 | 706.469 |
| 2009 | 11.038 | 79.623 | 134.173 | 108.386 | 59.186 |

| | LPUE | kg/h fished | | | |
|---|---|---|---|---|---|
| year | 4c | 7d | 7e | 7f-k | 8 |
| 1999 | 0.5 | 1.1 | 0.4 | 0.2 | 0.0 |
| 2000 | 2.5 | 1.0 | 0.3 | 0.1 | 0.0 |
| 2001 | 1.0 | 1.0 | 0.3 | 0.1 | 0.0 |
| 2002 | 2.1 | 1.0 | 0.3 | 0.1 | 0.0 |
| 2003 | 1.4 | 0.8 | 0.3 | 0.1 | 0.0 |
| 2004 | 1.3 | 1.0 | 0.3 | 0.1 | 0.0 |
| 2005 | 2.1 | 1.4 | 0.3 | 0.1 | 0.0 |
| 2006 | 3.1 | 1.4 | 0.4 | 0.1 | 0.0 |
| 2007 | 2.5 | 1.6 | 0.4 | 0.2 | 0.1 |
| 2008 | 1.4 | 1.4 | 0.4 | 0.2 | 0.1 |
| 2009 | 7.6 | 1.0 | 1.0 | 1.0 | 1.0 |

**Table 7-4: Series of landings of tub gurnard, effort and LPUEs by metier of French otter trawlers (OTB+OTT) for CPR datasets**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Tub Gurnard France | | | | | | | | | | |
| Captures (t) | | | | | | | | | | |
| Cible | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
| Benthic Western Approaches | 8 | 33 | 31 | 35 | 53 | 52 | 42 | 47 | 47 | 47 |
| Gadoids Western Approaches | 187 | 232 | 276 | 238 | 238 | 220 | 253 | 267 | 267 | 267 |
| Nephrops Western Approaches | 2 | 3 | 3 | 2 | 4 | 4 | 4 | 2 | 2 | 2 |
| Benthic Bay of Biscay | 1 | 6 | 4 | 5 | 7 | 8 | 14 | 20 | 20 | 20 |
| "Gadoids" Bay of Biscay | 1 | 4 | 4 | 3 | 10 | 11 | 14 | 10 | 10 | 10 |
| Nephrops Bay of Biscay | 0 | 0 | 0 | 1 | 4 | 3 | 5 | 4 | 4 | 4 |
| | 199 | 278 | 318 | 284 | 316 | 298 | 332 | 350 | 350 | 350 |
| | | | | | | | | | | |
| Tub Gurnard France | | | | | | | | | | |
| Effort (hours fished) | | | | | | | | | | |
| Cible | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
| Benthic Western Approaches | 260758 | 295235 | 289227 | 265173 | 311690 | 319664 | 277571 | 303860 | 327413 | 266640 |
| Gadoids Western Approaches | 603846 | 561385 | 549464 | 549402 | 532461 | 488775 | 455446 | 436125 | 394148 | 314761 |
| Nephrops Western Approaches | 198129 | 219402 | 195229 | 182732 | 199108 | 164514 | 168537 | 159230 | 118692 | 99788 |
| Benthic Bay of Biscay | 143053 | 137186 | 128085 | 132199 | 148483 | 166266 | 203183 | 173227 | 178323 | 170854 |
| "Gadoids" Bay of Biscay | 276271 | 211502 | 208556 | 184709 | 194668 | 215719 | 260360 | 291848 | 356308 | 305030 |
| Nephrops Bay of Biscay | 199384 | 171203 | 181568 | 182496 | 218913 | 238337 | 277343 | 277908 | 249244 | 230292 |
| Total | 1681441 | 1595913 | 1552129 | 1496711 | 1605323 | 1593275 | 1642440 | 1642198 | 1624128 | 1387365 |
| | | | | | | | | | | |
| Tub Gurnard France | | | | | | | | | | |
| PUE (Kg/10h) | | | | | | | | | | |
| Cible | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
| Benthic Western Approaches | 0.3 | 1.1 | 1.1 | 1.3 | 1.7 | 1.6 | 1.5 | 1.5 | 1.6 | 1.8 |
| Gadoids Western Approaches | 3.1 | 4.1 | 5.0 | 4.3 | 4.5 | 4.5 | 5.6 | 6.1 | 7.0 | 7.6 |
| Nephrops Western Approaches | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 |
| Benthic Bay of Biscay | 0.1 | 0.4 | 0.3 | 0.4 | 0.5 | 0.5 | 0.7 | 1.2 | 0.8 | 1.1 |
| "Gadoids" Bay of Biscay | 0.0 | 0.2 | 0.2 | 0.2 | 0.5 | 0.5 | 0.5 | 0.3 | 0.6 | 0.6 |
| Nephrops Bay of Biscay | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.0 |

**Table 7-5: Abundance index (Nb/hr) of tub gurnard from International Bottom Trawl Survey (IBTS, IVb,c) and Channel Ground Fish Survey (FR-CGFS, VIId).**

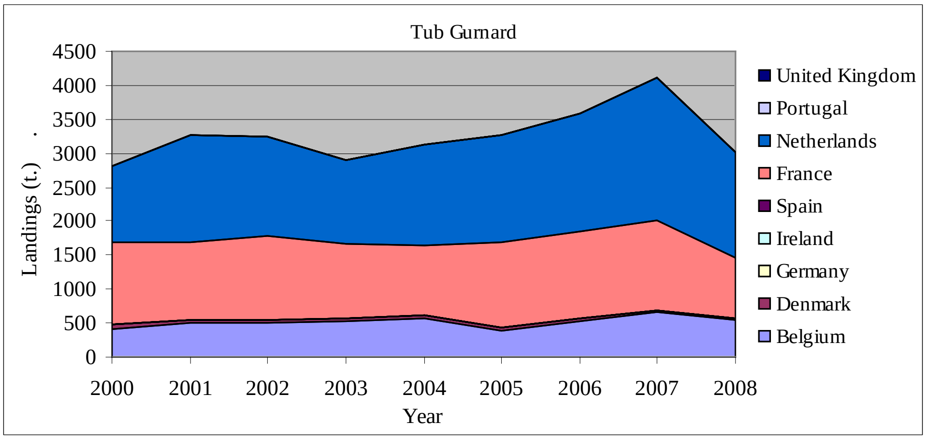
| Year | IBTS Quarter 1 | CGFS |
|---|---|---|
| 1980 | 0.00 | |
| 1981 | 0.00 | |
| 1982 | 0.00 | |
| 1983 | 0.00 | |
| 1984 | 0.00 | |
| 1985 | 1.58 | |
| 1986 | 0.00 | |
| 1987 | 0.00 | |
| 1988 | 0.00 | 0.94 |
| 1989 | 0.00 | 2.88 |
| 1990 | 0.13 | 2.52 |
| 1991 | 0.00 | 0.59 |
| 1992 | 0.00 | 3.4 |
| 1993 | 0.00 | 3.03 |
| 1994 | 0.00 | 1 |
| 1995 | 0.00 | 1.01 |
| 1996 | 0.00 | 1.09 |
| 1997 | 0.00 | 2.61 |
| 1998 | 0.10 | 1.36 |
| 1999 | 0.00 | 2.46 |
| 2000 | 0.00 | 0.84 |
| 2001 | 0.00 | 1.44 |
| 2002 | 0.00 | 2.11 |
| 2003 | 0.29 | 1.09 |
| 2004 | 0.5 | 1.72 |
| 2005 | 0.48 | 1.56 |
| 2006 | 0.00 | 1.61 |
| 2007 | 0.18 | 1.39 |
| 2008 | 0.36 | 1.64 |
| 2009 | 3.34 | 2.19 |

**Table 7-6: Tub gurnard. Growth parameters in the English Channel**

| **Authors** | **Area** | **Sex** | **Nb** | **L∝** | **K** | **$T_0$ (year)** |
|---|---|---|---|---|---|---|
| Baron (1985) | VIIe | M | 217 | 48.4 | 0.462 | -0.41 |
| | | F | 239 | 66.8 | 0.32 | -0.46 |

**Table 7-7: Tub gurnard. Length-weight relationships. W= live weight in g, L in cm**

| Authors | Area | Sex | Nb | a | b |
|---|---|---|---|---|---|
| Baron (1985) | VIIe | N | ? | 0.00431 | 3.21 |



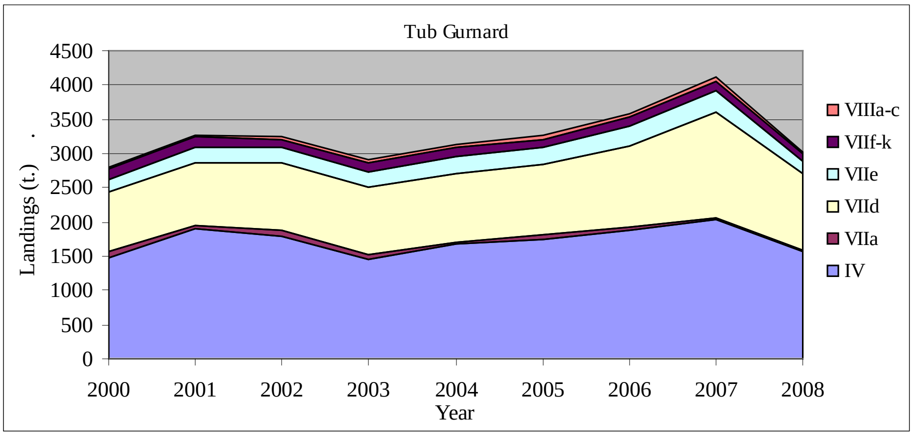




**Figure 7-1: Total international landings of Tub gurnard in the period 2000-2008 by country (upper panel) and by area (lower panel).**

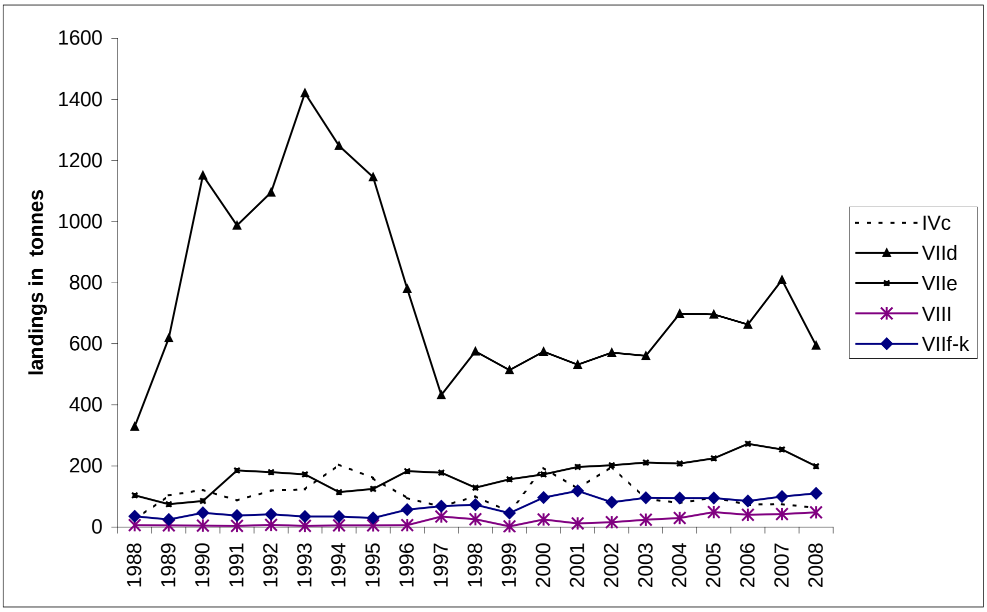



**Figure 7-2: Tub gurnard. Trends of French landings, only from logbooks since 1999**

TUB GURNARD

| length class | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|
| 0 | | | | | |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | 0.055 | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | 0.085 | | | |
| 9 | 0.056 | 0.016 | | | |
| 10 | | 0.062 | 0.148 | | |
| 11 | 0.078 | 0.094 | 0.094 | 0.248 | |
| 12 | 0.286 | 1.710 | | 0.358 | 0.026 |
| 13 | 0.662 | 2.188 | | 0.060 | 0.067 |
| 14 | 0.300 | 1.209 | 0.246 | 0.453 | 0.153 |
| 15 | 0.186 | 1.304 | | 0.446 | 0.134 |
| 16 | 0.312 | 1.823 | 0.145 | 0.253 | 0.217 |
| 17 | 0.332 | 1.443 | 0.523 | 0.742 | 0.229 |
| 18 | 0.319 | 2.041 | 0.559 | 0.586 | 0.457 |
| 19 | 0.559 | 0.716 | 1.000 | 0.556 | 0.405 |
| 20 | 0.354 | 0.303 | 1.001 | 0.571 | 0.288 |
| 21 | 0.414 | 0.340 | 0.843 | 0.467 | 0.359 |
| 22 | 0.436 | 0.262 | 1.156 | 0.586 | 0.686 |
| 23 | 0.943 | 0.519 | 0.948 | 0.933 | 0.274 |
| 24 | 0.663 | 0.793 | 1.367 | 1.517 | 1.285 |
| 25 | 0.718 | 0.501 | 1.061 | 0.727 | 0.431 |
| 26 | 0.245 | 0.137 | 0.667 | 0.384 | 0.365 |
| 27 | | 0.278 | 0.225 | 0.475 | 0.539 |
| 28 | 0.112 | 0.056 | 0.059 | 0.091 | 0.020 |
| 29 | 0.030 | 0.024 | 0.043 | 0.167 | 0.019 |
| 30 | | | 0.197 | 0.081 | 0.078 |
| 31 | | | 0.058 | | |
| 32 | | | | | 0.022 |
| 33 | | | | | 0.022 |
| 34 | | | | | |
| 35 | | | | | |
| 36 | | | | | |
| 37 | | | | | |
| 38 | | | | | |
| 39 | | | | | |
| 40 | | | | | |
| 41 | | | | | |
| 42 | | | | | |
| 43 | | | | | |
| 44 | | | | | |
| 45 | | | | | |
| 46 | | | | | |
| 47 | | | | | |
| 48 | | | | | |
| 49 | | | | | |
| 50 | | | | | |
| sum | 7.0 | 15.9 | 10.3 | 9.8 | 6.1 |

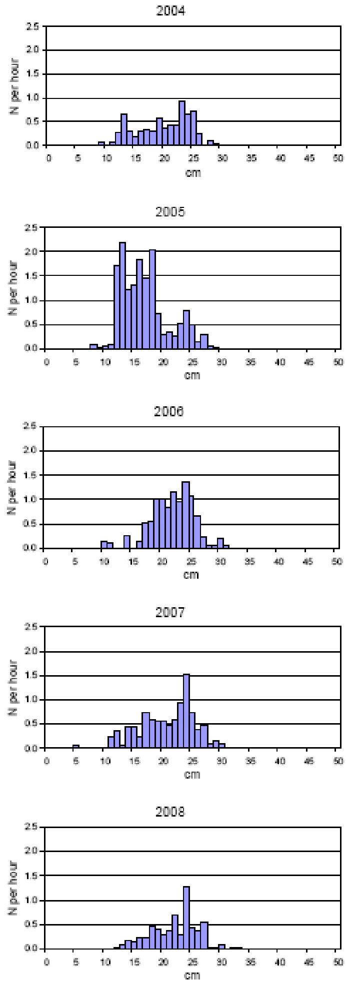



**Figure 7-3: Tub gurnard: number at length discarded per hour in the Dutch beam trawl fishery in the years 2004 to 2008 (van Helmond and Heessen, 2010).**

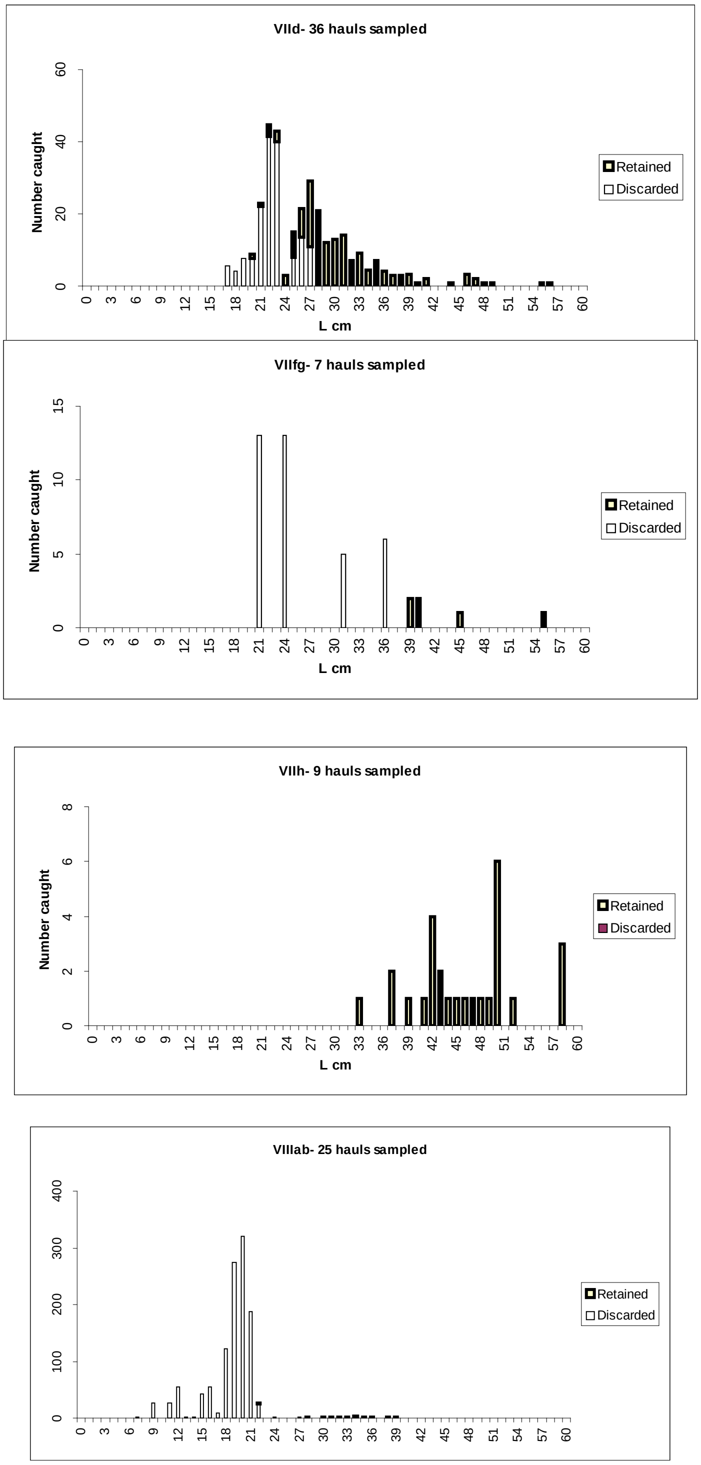



**Figure 7-4: 2005 Length composition of French catches from bottom trawl hauls sampled**

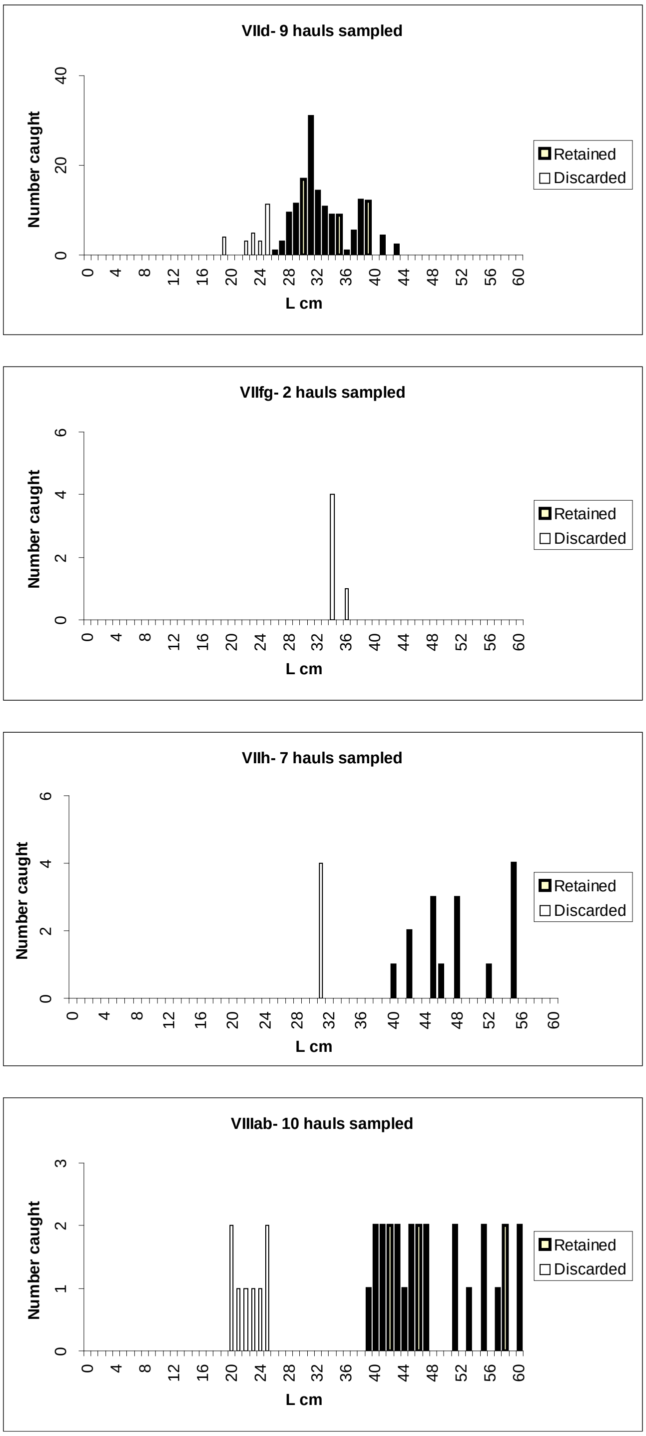
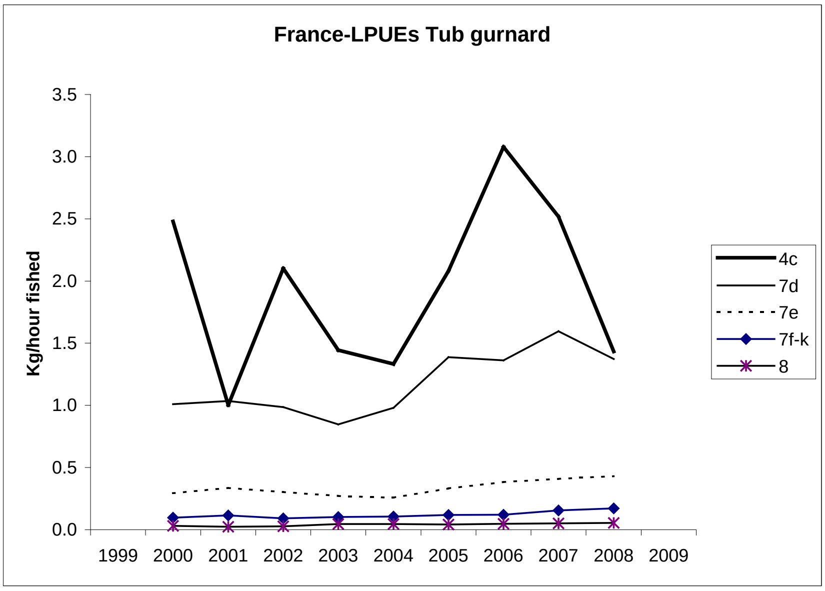



**Figure 7-5: 2006 Length composition of French catches from bottom trawl hauls sampled**



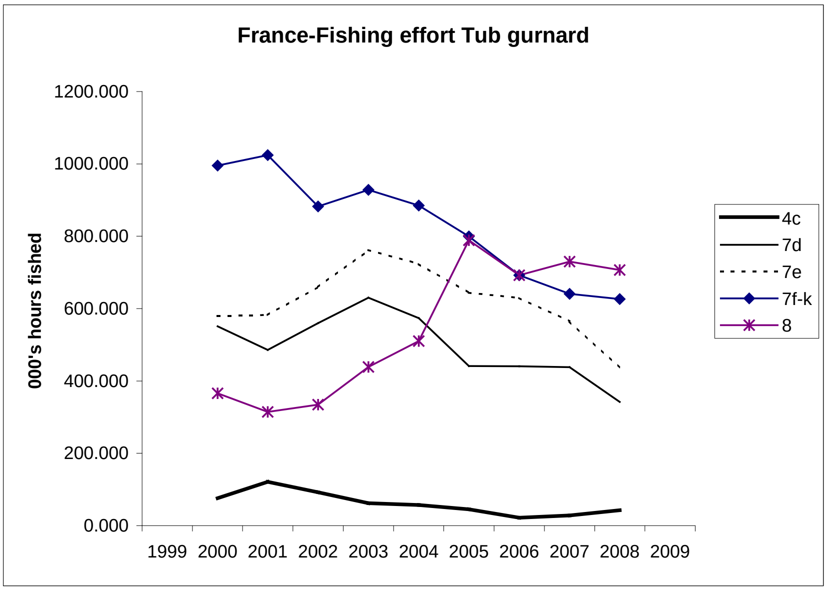
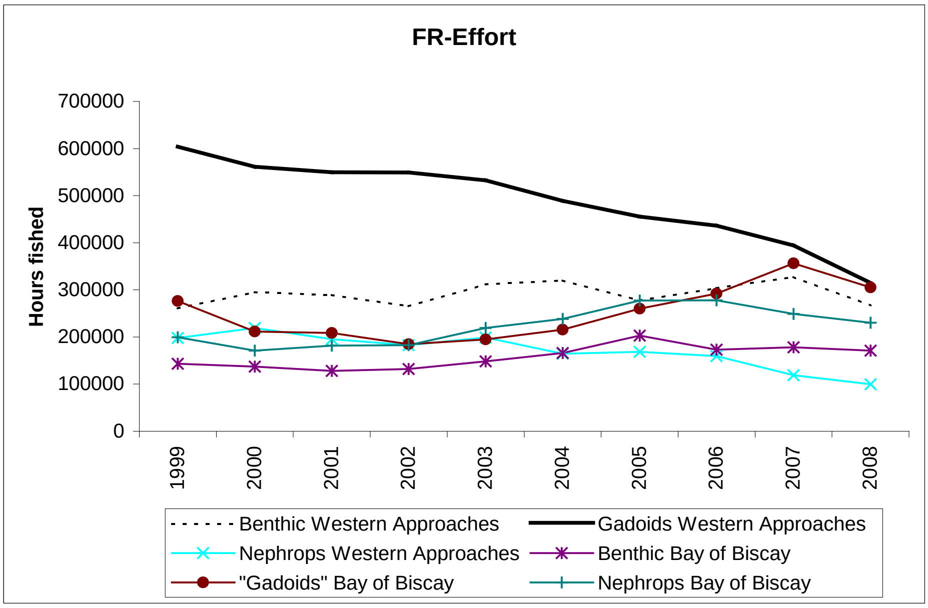




**Figure 7-6: Trends of effort and LPUEs of tub gurnard of French otter trawlers (OTB+OTT) in IVc, VIId, VIIe, VIIf-k and VIII.**



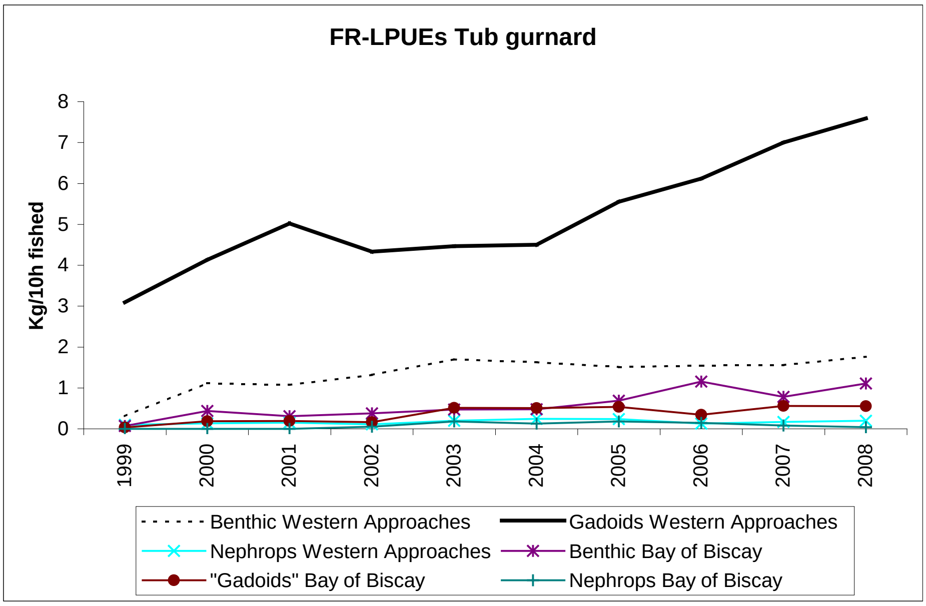




**Figure 7-7: Trends of effort and LPUEs of tub gurnard of French otter trawlers (OTB+OTT) by metier in area VIIe-k (Western Approaches) and VIII (Bay of Biscay).**

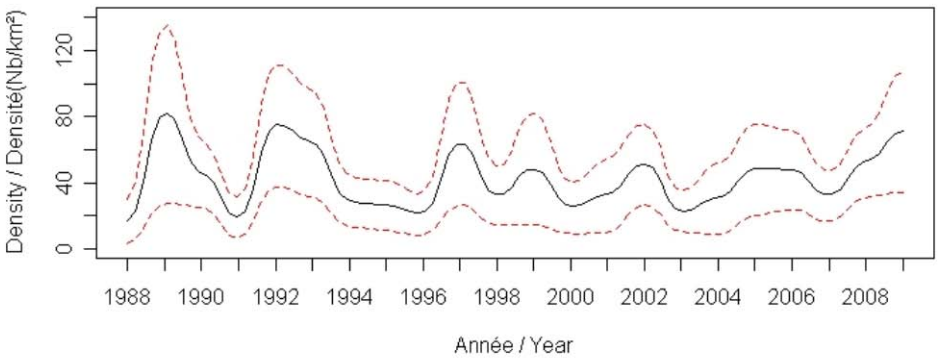



**Figure 7-8: Time series of abundance of tub gurnard in the eastern Channel from 1988 to 2009 based on FR-CGFS data (Nb/km²) from 1988 to 2009 with their 95% confidence intervals.**

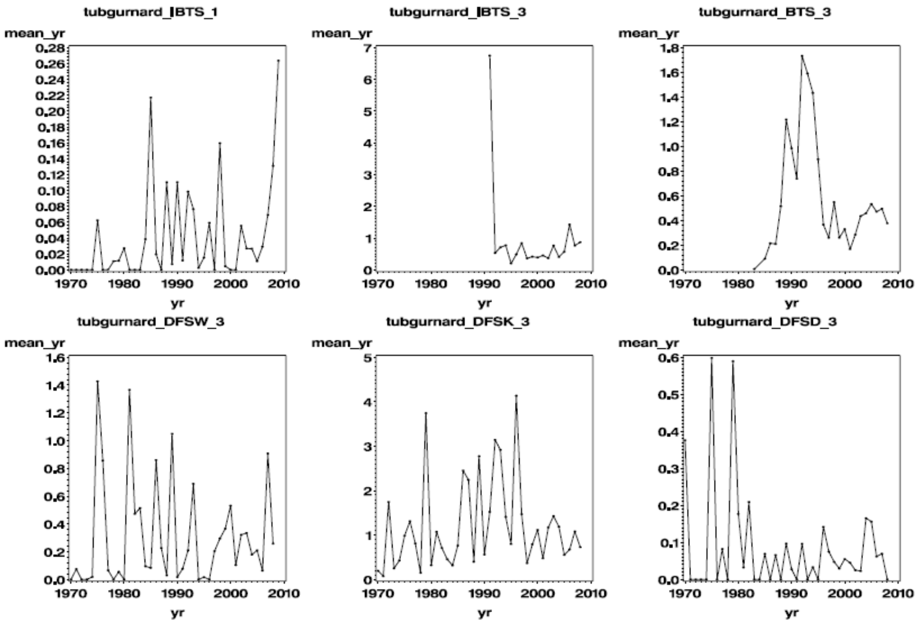



**Figure 7-9: Time series of abundance of tub gurnard by survey. Row above from left to right: IBTS-1 (1970-2009), IBTS-3 (1991-2008), BTSG3 (1985-2008); row below from left to right: DFS quarter 3 (1970-2008) Wadden Sea, Coastal Zone and Delta area (ter Hofstede *et al*. 2010).**

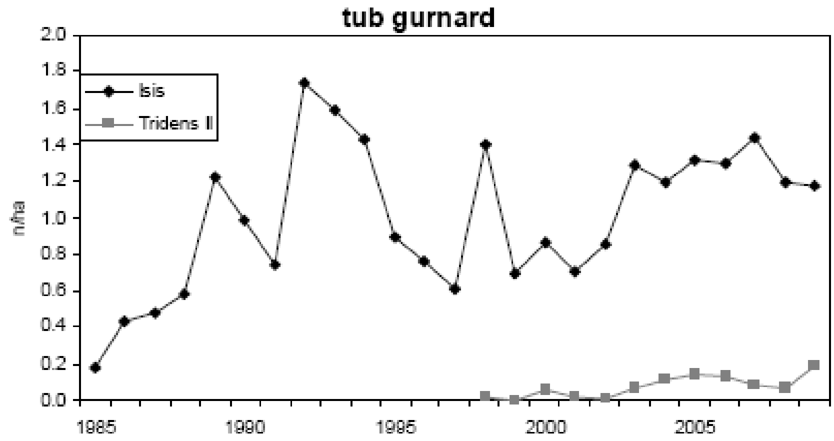



**Figure 7-10: Time series of abundance of tub gurnard in the North Sea BTS3 survey by vessel.**

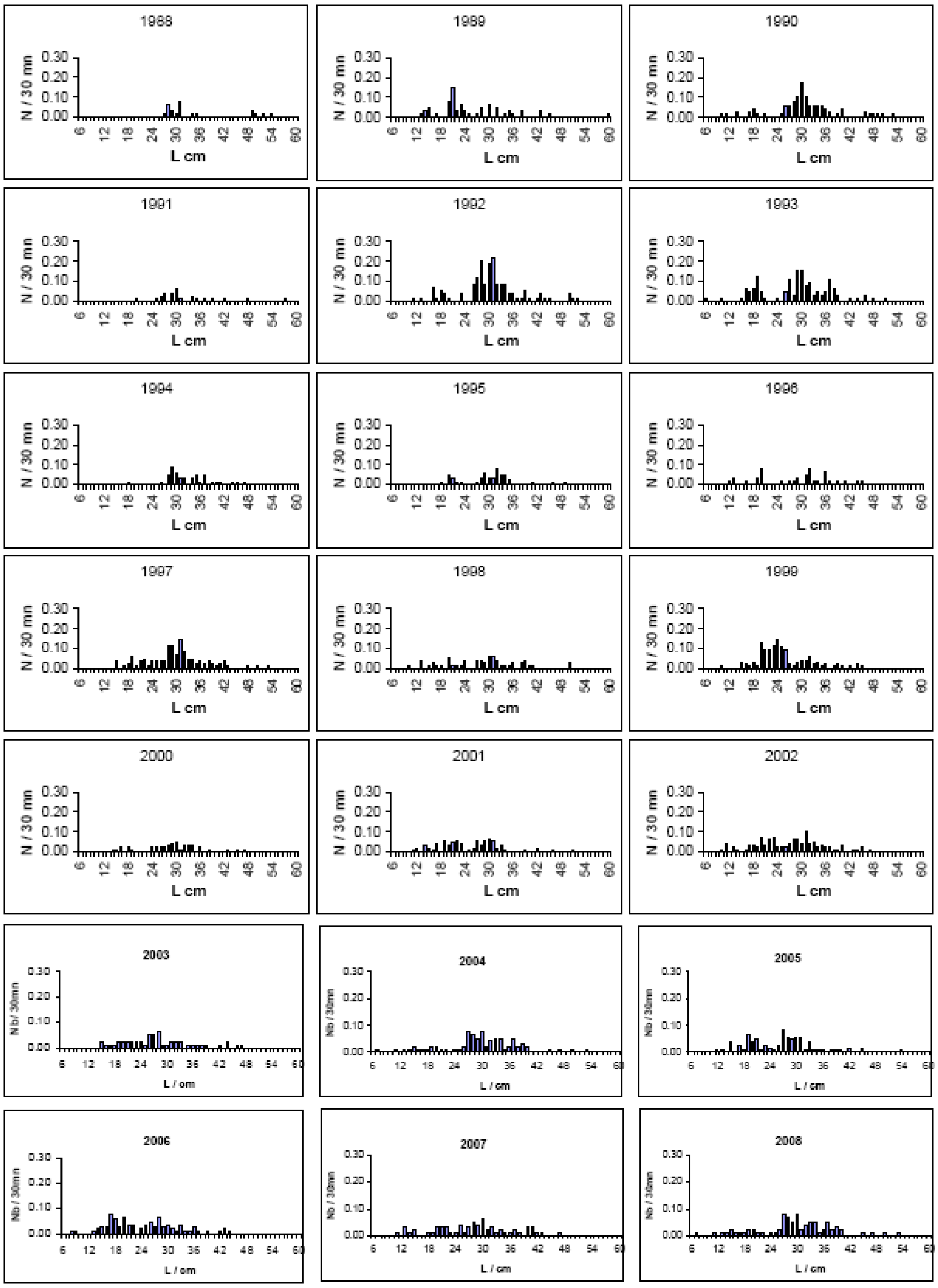


**Figure 7-11: Time series of abundance indices at length of tub gurnard from the FR-CGFS survey in VIId.**

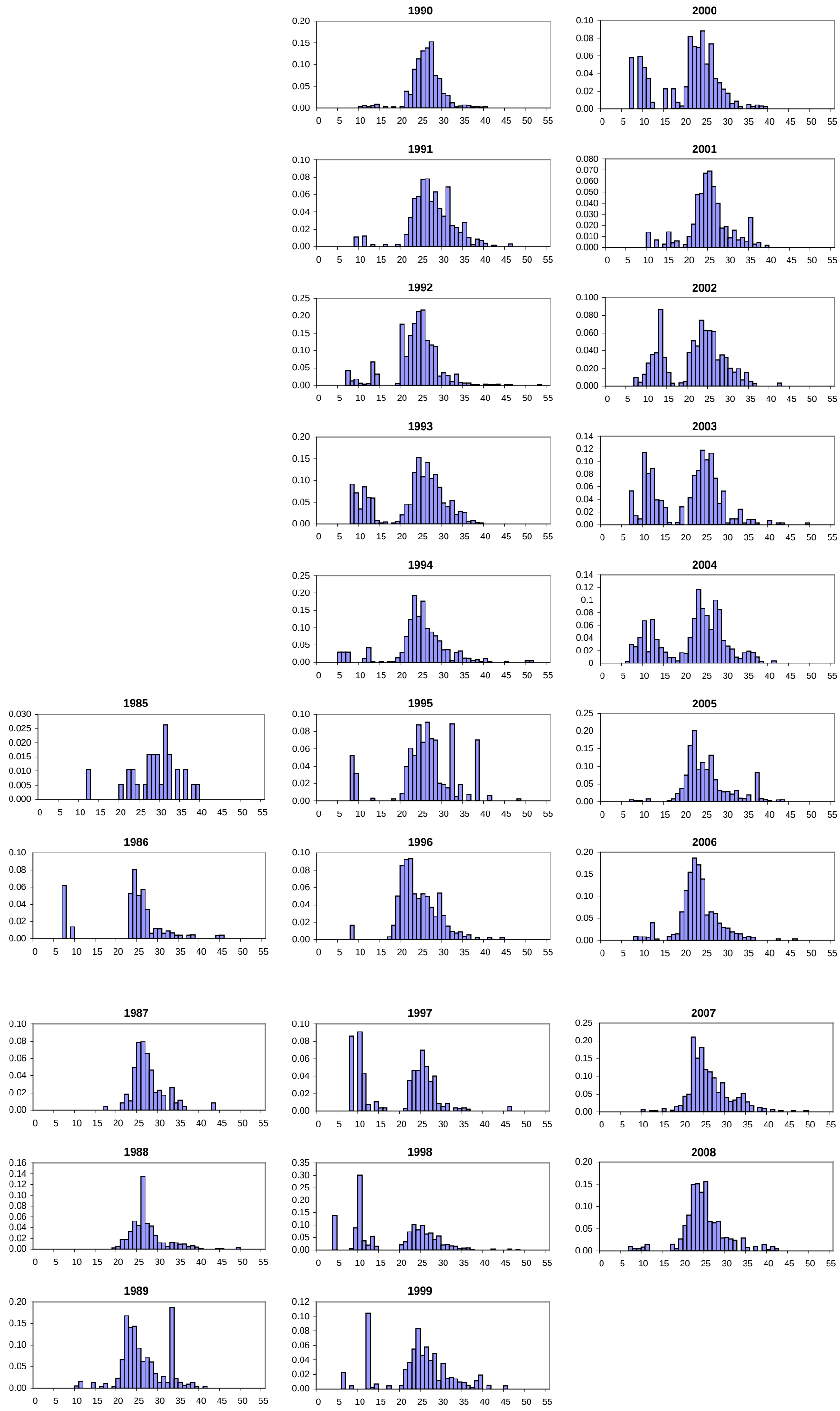



**Figure 7-12: Times series of abundance indices at length of tub gurnard from the Beam Trawl Survey (BTS-3) in the North Sea.**

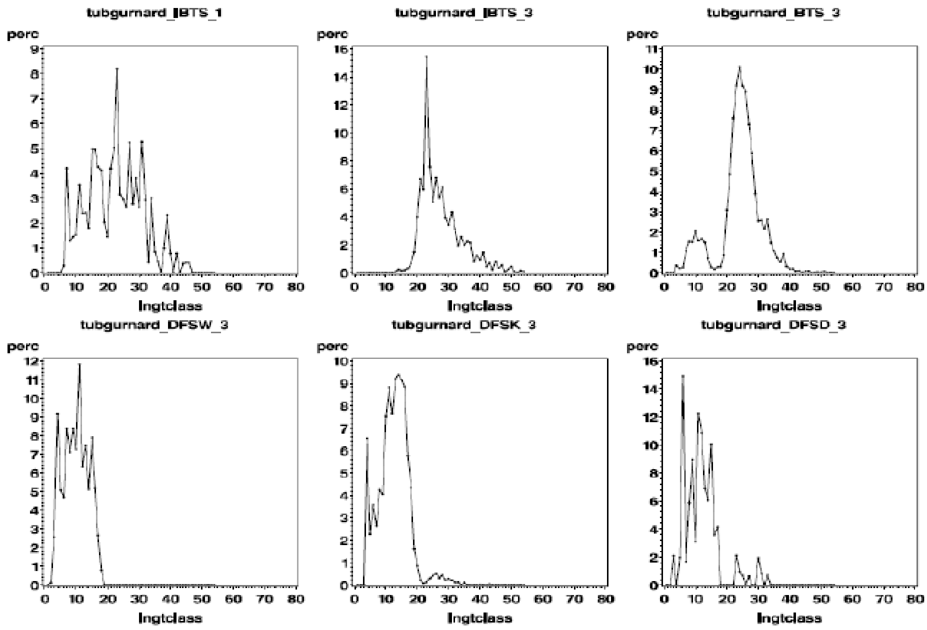



**Figure 7-13: Time series of abundance indices at length of tub gurnard by survey in the North Sea. Row above from left to right: IBTS-1 (1970-2009), IBTS-3 (1991G2008), BTS-3 (1985-2008); row below from left to right: DFS quarter 3 (1970-2008) Wadden Sea, Coastal Zone and Delta area.**

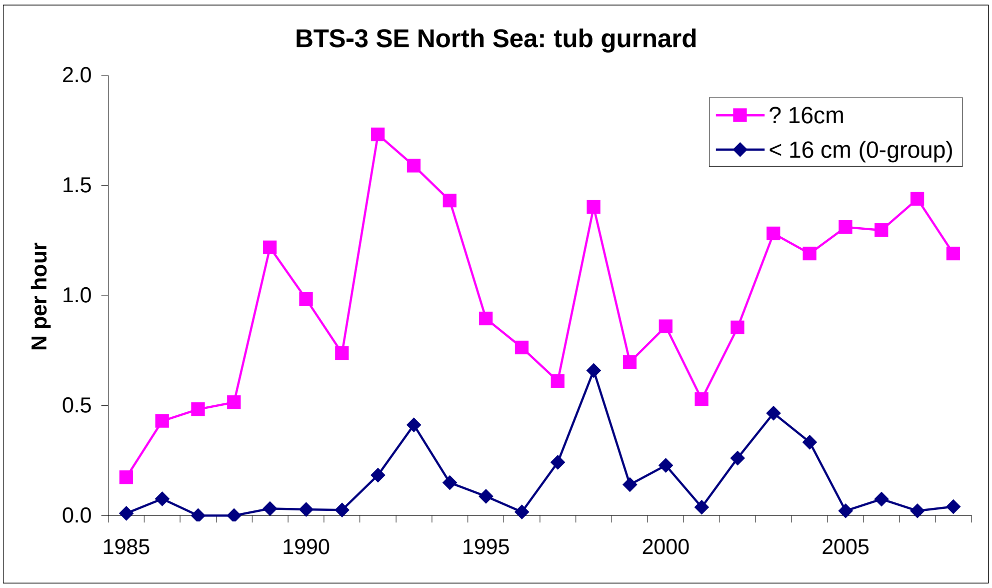



**Figure 7-14: Time series of abundance of tub gurnard in the BTS3 survey by vessel showing higher recruitments in 1993, 1998, 2003.**

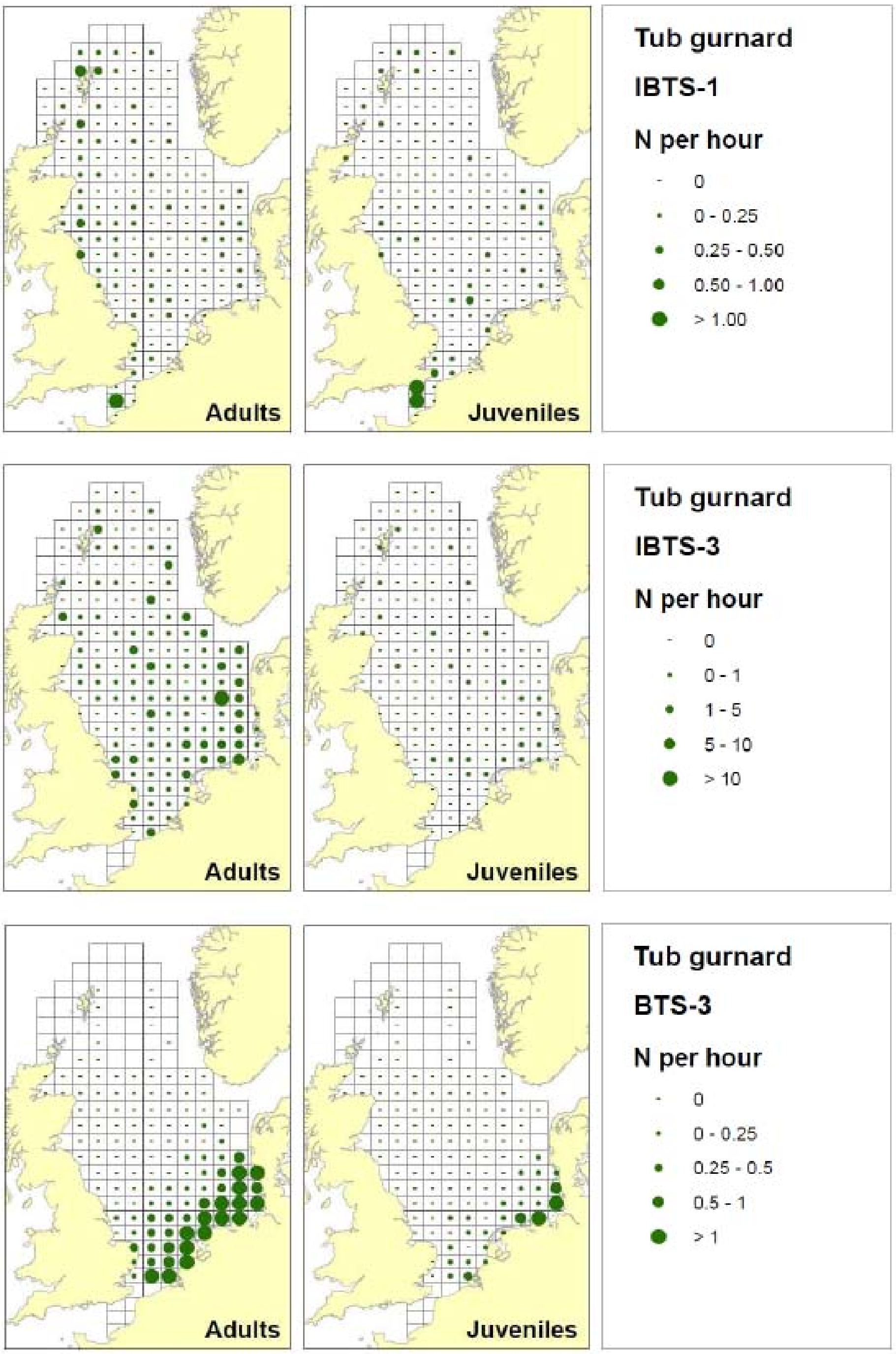



**Figure 7-15: Distribution of tub gurnard in IBTS-1 (average 1970-2009), IBTS-3 (average 1991-2008) and BTS-3 (average 1985-2008) (ter Hofstede *et al*. 2010).**

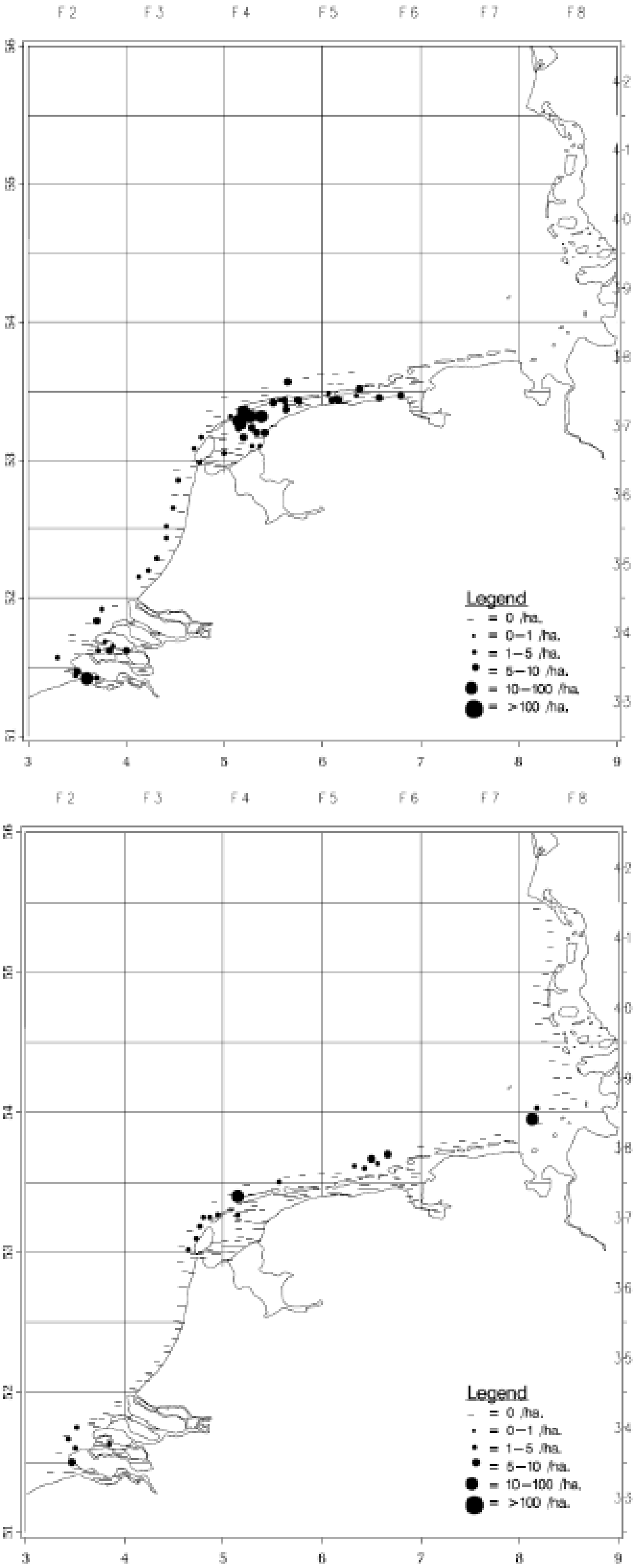



**Figure 7-16 Two examples of the distribution of tub gurnard in the DFS survey. Upper panel 1975, lower panel 1990 (ter Hofstede *et al.* 2010)**

# 8 Grey gurnard

## 8.1 General biology

Grey gurnard *Eutrigla gurnardus* occurs in the Eastern Atlantic from Iceland, Norway, southern Baltic, and North Sea to southern Morocco, Madeira. It is also found in the Mediterranean and Black Seas.

In the North Sea and in Skagerrak/Kattegat, grey gurnard is an abundant demersal species. In the North Sea, the species may form dense semi-pelagic aggregations in winter to the northwest of the Dogger Bank, in summer it is more widespread. The species is less abundant in the Channel, the Celtic Sea and in the Bay of Biscay.

Spawning takes place in spring and summer. There do not seem to be clear nursery areas.

Maximum length is 50 cm. It is a bycatch species in demersal fisheries. Catches are largely discarded.

## 8.2 Stock ID and possible assessment areas

No studies are known of the stock ID of grey gurnard. There are possibly separate stocks in the North Sea and in the Skagerrak. Grey gurnard from the North Sea may also well be separated from grey gurnard in the Channel. Figure 8-1 shows that the species is almost absent from the southernmost stations of the Southern Bight. In the eastern Channel abundance of grey gurnard seems to be low compared to the North Sea (Figure 8-2). The distribution in the western Channel is not known. A higher abundance is observed in the Celtic Sea, whereas the species is almost absent from the Bay of Biscay (Figure 8-3).

## 8.3 Management regulations

There is no minimum landing size for this species and there is no TAC.

## 8.4 Fisheries data

In the past, gurnards were often not sorted by species when landed and reported into one generic category of "gurnards". In recent years the official statistics seem to improve gradually, however, also obvious that the catch statistics are incomplete for several years: some countries reporting no landings at all, other countries reporting exceptionally high landings.

Grey gurnard from the North Sea is mainly landed for human consumption purposes. North Sea landings decreased gradually before World War II. After an initial post-war peak of 4000 t, annual landings stayed well below 2000 t until the early 1980s, when annual catches increased to around 40 000 t (Figure 8-4) because of Danish landings for reduction purposes. In the same period, however, there was some misreporting as well. After a few years the Danish landings dropped again to a low level. The Netherlands did not report gurnards during the years 1984–1999. Recent international landings have been very low at around 300 to 500 t per year only.

Historically, grey gurnard is mainly taken as a by-catch in mixed demersal fisheries for flatfish and roundfish. However, the market is limited and the larger part of the catch appears to be discarded (see also Annex 5). Owing to the low commercial value of this species, landings data will usually not reflect the actual catches very well.

## 8.5 Survey data / recruit series

For the North Sea and Skagerrak/Kattegat, data are available from the International Bottom Trawl survey. The IBTS can provide information on distribution and the length composition of the catches. Grey gurnard occurs throughout the North Sea and Skagerrak/Kattegat. During winter, grey gurnards are concentrated to the northwest of the Dogger Bank at depths of 50–100 m, while densities are low off the Danish coast, in the German Bight and eastern part of the Southern Bight (Figure 8-1). The distribution pattern changes substantially in the spring, when the whole area south of 56°N becomes densely populated and the high concentrations in the central North Sea disappear until the next winter.

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 suggests a preference for higher water temperatures (Hertling, 1924; Daan *et al.* 1990).

During winter, grey gurnard occasionally form dense aggregations just above the sea bed (or even in midwater, especially during night time) which may result in extremely large catches. Within one survey, these large hauls may account for 70 percent or more of the total catch of the species. Bottom temperatures in high-density areas usually range from 8 to 13°C (Sahrhage, 1964).

Spawning occurs in spring and summer and, perhaps, in autumn (Russel, 1976), and may also explain the observed seasonal movements (Van der Land, 1990).

Numbers at length per year are shown for areas IV and IIIa (Figure 8-5 and Figure 8-6). Average length frequency distributions for these two areas are given in Figure 8-7. In Skagerrak Kattegat two modes can be seen, whereas in the North Sea the smaller fish are only found in relatively small numbers.

Time series of abundance of grey gurnard, based on catches of all length classes combined during the IBTS quarter 1 survey in the North Sea (IV) and Skagerrak Kattegat (IIIa) are presented in Figure 8.8. The time series for the North Sea shows a clear upward trend, especially since the late 1980s. The peak in 1981 is presumably caused by a single very large catch in that year, caused by one of the enormous concentrations of fish that appear in that time of year. Also in Skagerrak Kattegat an increase can be seen since the same time as in the North Sea, but since a maximum was reached in 1993, catches decreased and have fluctuated widely around the same level since then.

## 8.6 Biological sampling

Biological data for this species are scarce (see also Annex 5).

## 8.7 Population biological parameters and other research

The length distributions for the North Sea are remarkably similar from year to year and do not indicate a clear year-class signal: small individuals are never very abundant. The absence of small fish in the North Sea suggests that the IBTS survey does not adequately cover the nursery grounds.

**Available von Bertalanffy growth parameters are given in the text table below:**

| Area | $L_\infty$ (cm) | K (yr-1) | $t_0$ (yr) | Reference |
|---|---|---|---|---|
| Brittany males | 34.4 | 0.85 | 0.14 | Baron, 1985 |
| Brittany females | 38.0 | 0.77 | 0.16 | Baron, 1985 |

Sexual maturity is said to be attained at between two and three years of age (Wheeler, 1978; Baron, 1985a, 1985b), but data from the North Sea from the first half of May 1992 show that specimens from about 15 cm onwards can be mature, males at a somewhat smaller length than females (Knijn *et al.*, 1993). The same can be seen in the data for the 4th quarter of 1992. This indicates that maturity may even be reached in 1-year old fish.

## 8.8 Analysis of stock trends / assessment

Information from landings is very poor, due to poor reporting (gurnard species are not always identified in the data, and probably also misreporting has occurred) and also because the low value of the species leads to massive discarding.

The status of the stocks in areas IIIa, IV and VIId,e is not known but the time series based on catches from the IBTS survey in the North Sea and in Skagerrak-Kattegat both show an increase since the late 1980s (Figure 8-8).

## 8.9 Data requirements

For management purposes information should be available on catches and landings. The quality of landings data has been poor for this species because in the past only landings of “gurnards” were reported.

For a better understanding of this species an increase in our knowledge of biological parameters is required.

From the information presented here, it can be concluded that grey gurnard is of very limited commercial interest. It should be considered to exclude this species from the list of species dealt with by WGNEW.

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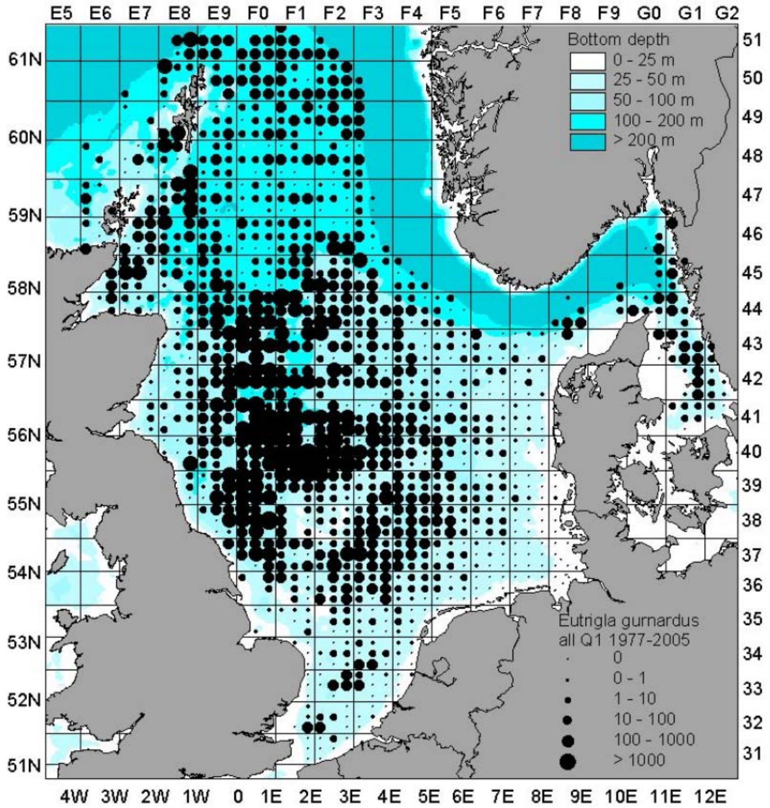


**Figure 8-1: Average annual catch (number per fishing hour for all length classes combined) for grey gurnard in the quarter 1 IBTS survey, 1977–2005 (ICES-FishMap).**

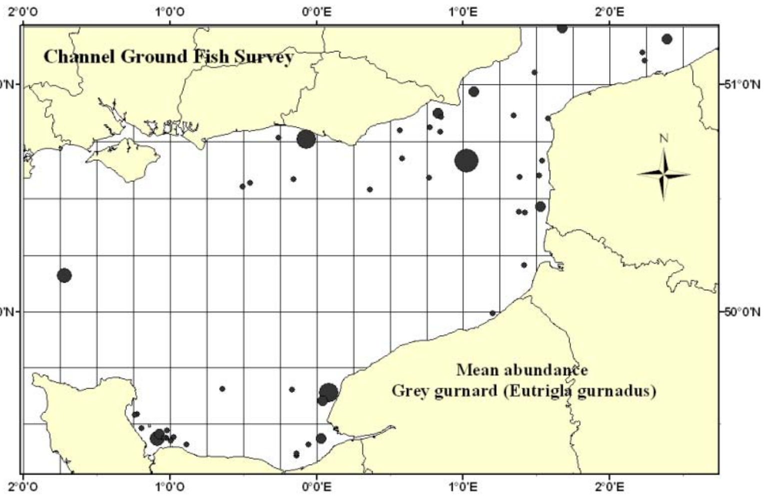


**Figure 8-2: Distribution of grey gurnard in the eastern Channel. CGFS survey 1988–2004**

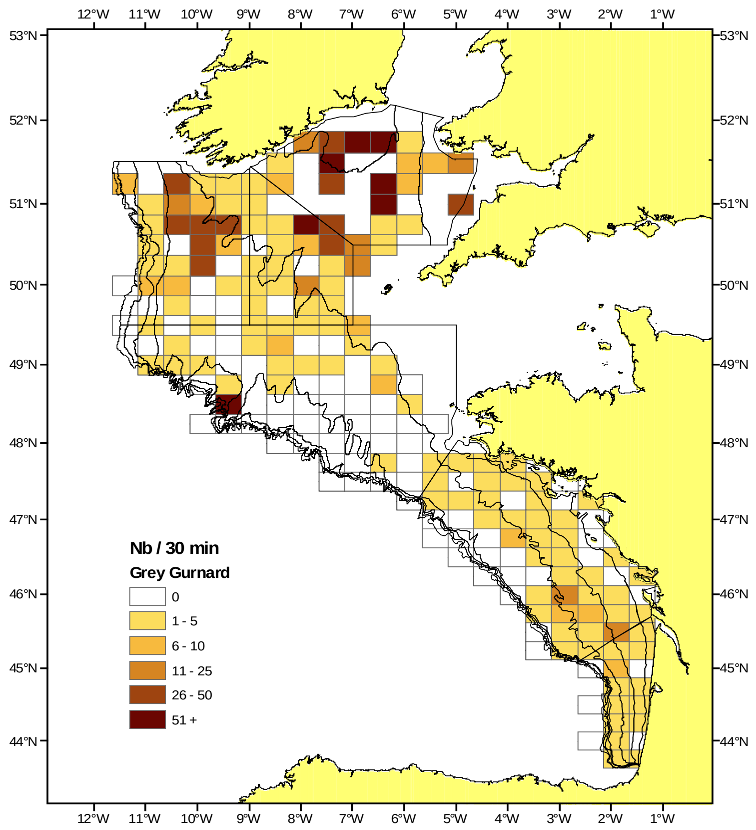


**Figure 8-3: Distribution of grey gurnard in the Celtic Sea and the Bay of Biscay. EVHOE survey, 1997–2004.**

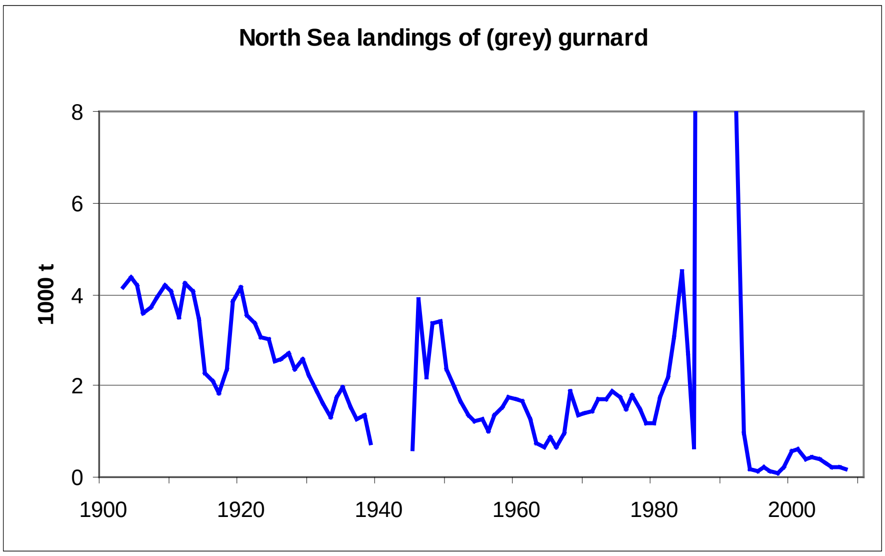


**Figure 8-4: Total international landings of gurnards from the North Sea, probably most of the landings consisted of grey gurnard. See text for further explanation.**

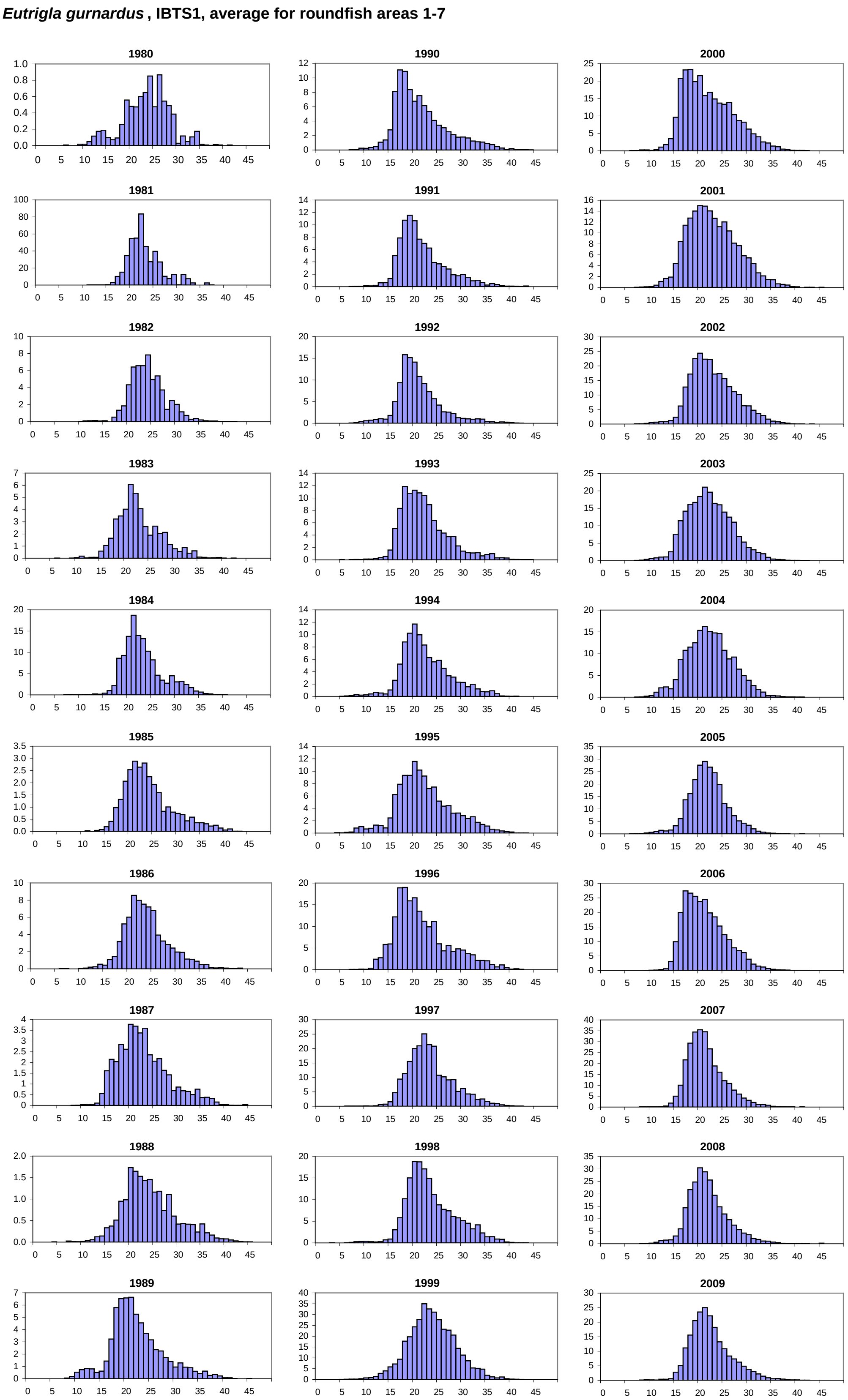


**Figure 8-5: Grey gurnard in IV: number at length during the quarter 1 IBTS survey.**

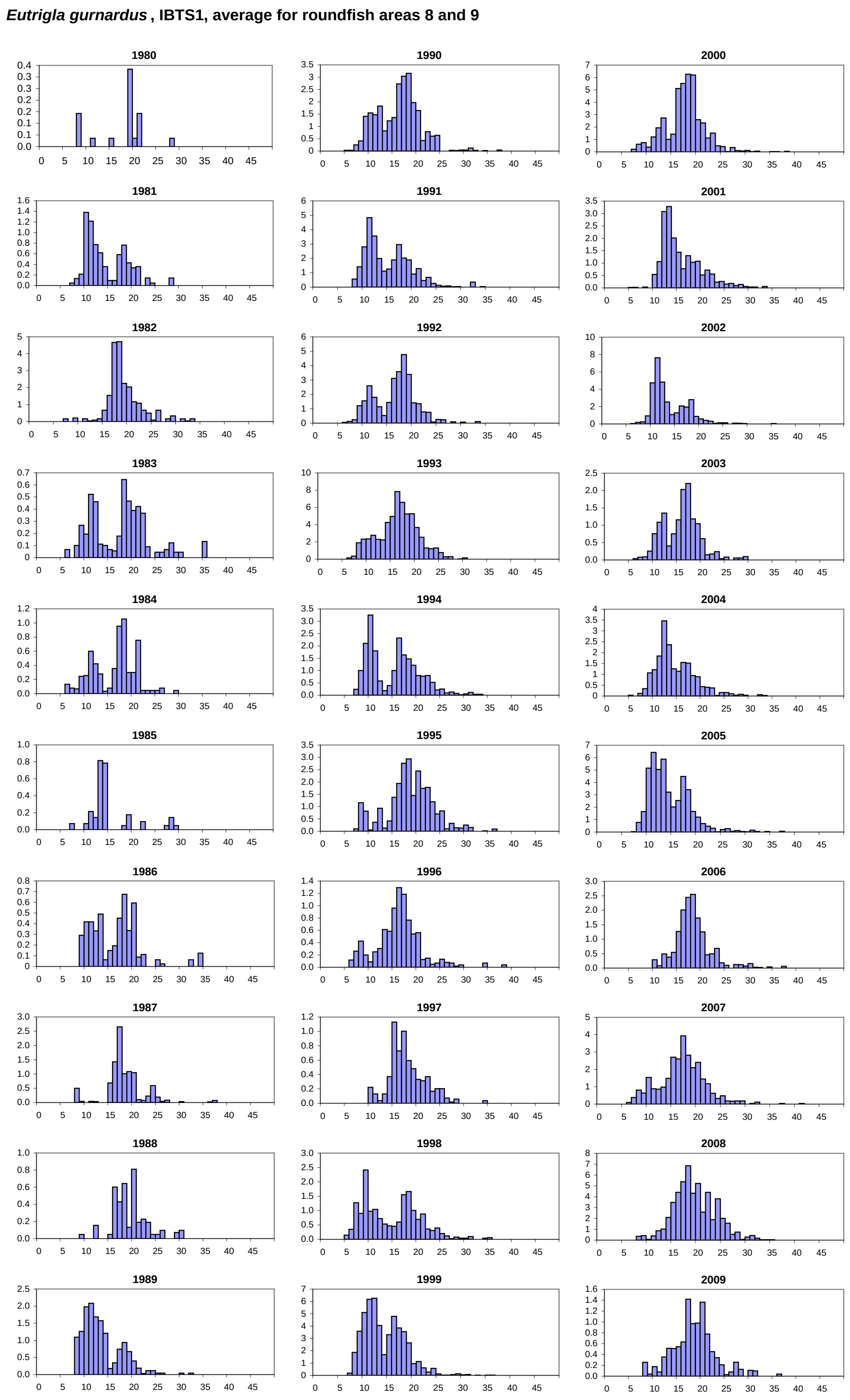


**Figure 8-6: Grey gurnard in IIIa: number at length during the quarter 1 IBTS survey.**

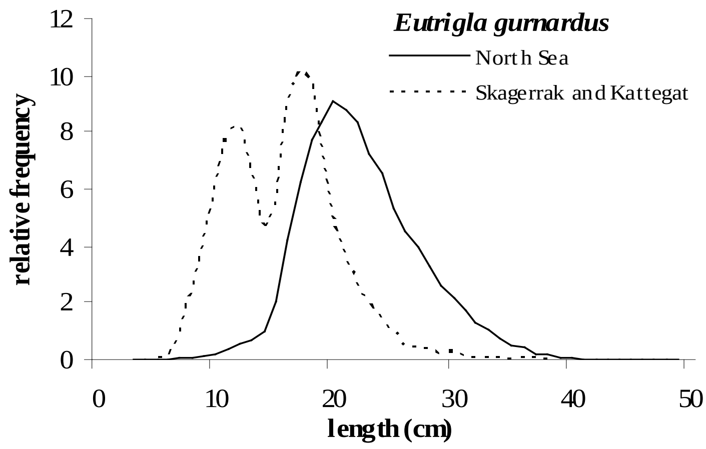


**Figure 8-7: Length frequency distribution of E. gurnardus based on the quarter 1 IBTS, 1985–2005, for the North Sea and for Skagerrak/Kattegat. (ICES-FishMap).**

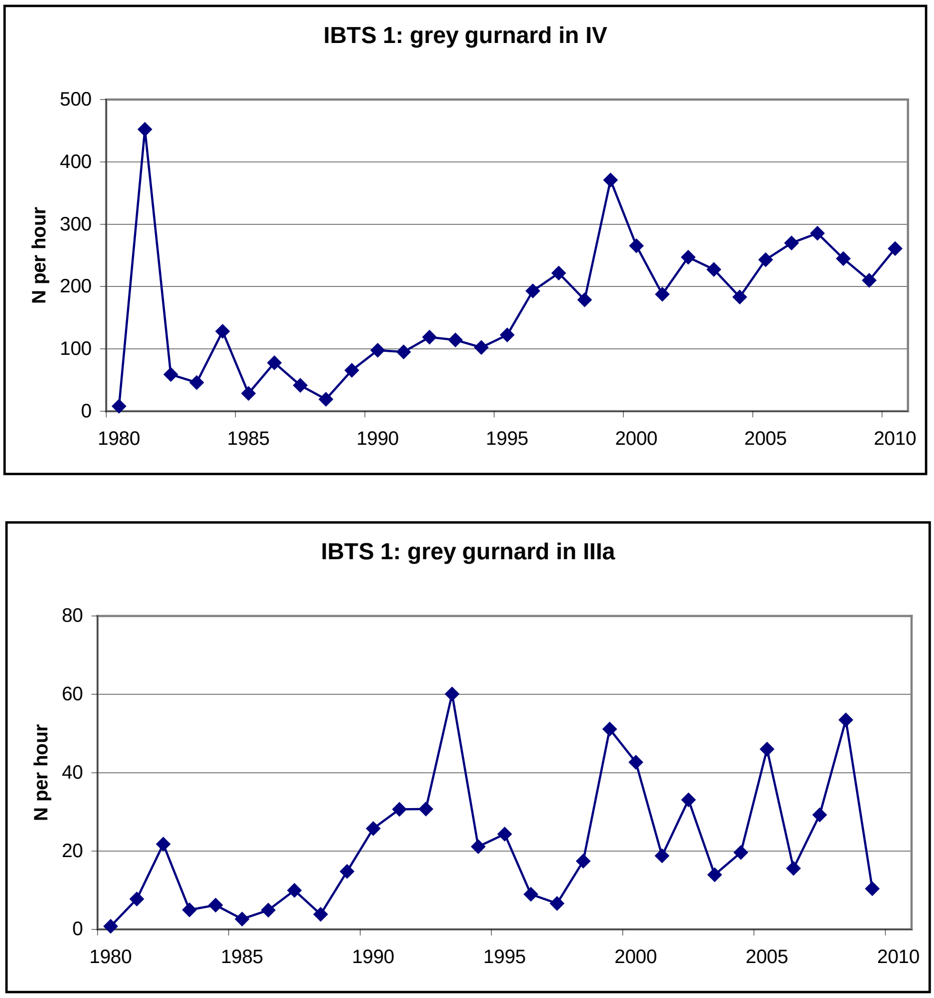


**Figure 8-8: Average catch rate (number per hour for all length classes combined) of grey gurnard in the North Sea (upper panel) and in Skagerrak and Kattegat (lower panel), based on quarter 1 IBTS.**

# 9 Brill

## 9.1 General biology

Brill is a shallow-water flatfish mainly found in areas close inshore. It prefers sandy bottoms, but can sometimes also be found on gravel and muddy grounds. Its vertical distribution ranges from 4 meters to 73 meters, although small juvenile fish are often common in sand shore pools. Mature brill are rarely observed inshore, whereas immature specimens are often caught near the coast and even in estuaries.

The distribution of brill in the North Eastern Atlantic Ocean ranges along the European coastline from 64° N (the Lofotes) down to 30° N, extending into the Mediterranean and even into the Black Sea (Nielsen, 1986). Brill is also found in the Skagerrak, the Kattegat, and small quantities in the Baltic Sea. The western limit of its distribution area is reached in southern Iceland. The distribution in the North Sea, Skagerrak and Kattegat, based on presence/absence in a number of surveys, is shown in Figure 9-1.

The feeding habits of this species closely resemble those of turbot and were extensively reviewed by de Groot (1971) and Wetsteijn (1981). The pelagic larvae feed primarily on copepod nauplii, decapod and mollusc larvae. With increasing size, this diet gradually changes from larger invertebrate prey and larvae of several fish species to small fish. Larger brill (> 40 cm) are primarily piscivorous.

## 9.2 Stock identity and possible management areas

The oldest study that could be found containing information on the genetic structure of brill was carried out by Blanquer *et al.* (1992), using allozyme electrophoresis. No genetic differentiation could be found between Atlantic and Mediterranean populations, suggesting that there are also very low levels of differentiation in brill from different areas.

In the EU funded study on 'Stock discrimination in relation to the assessment of the brill fishery' the following was concluded (Delbare and De Clerck, 1999).

"As a final conclusion, biological parameters (composition of Belgian brill landings, growth rate and reproduction characteristics) and the sequencing of the D-loop resulted in insignificant differences between brill from the different areas. Therefore, arguments favour the hypothesis that brill from the NE Atlantic might be considered to be only one population: the North-eastern Atlantic brill population. Further research on spawning areas and migration through respectively egg surveys and tagging experiments, could generate valuable information about (sub-) population structures of brill throughout its entire distribution area. Therefore it is advisable to extend the sampling area to the Mediterranean Sea and the Black Sea."

## 9.3 Management regulations

So far, no analytical assessments leading to fisheries advice have been carried out for brill by ICES. The available information is inadequate to evaluate stock trends. Therefore, the state of the stock(s) is unknown. No explicit objectives have been defined for potential stocks of this species, no precautionary reference points have been proposed, and no management plans are in place. However, for the EC-waters in Division IIa and Subarea IV, precautionary TACs have been defined for brill and turbot (combined) in the past. These TACs belong entirely to the EC-fisheries, and a historical overview is presented in Table 9-1.

**Table 9-1: Historical overview of combined TACs for brill *Scophthalmus rhombus* and turbot *Psetta maxima* in Division IIa and Subarea IV**

| YEAR | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TAC | 9000 | 9000 | 6750 | 5738 | 4877 | 4550 | 4323 | 4323 | 5263 | 5263 | 5263 |

No restriction on the minimum length for landing brill is imposed by the EC. In several geographical areas however, Minimum Landing Sizes (MLS) have been installed for brill by different authorities. The most frequently applied MLS is 30 cm (e.g., in Belgium, the Baltic, the English Sea Fisheries District Cornwall, …).

## 9.4 Fisheries data

Table 9-2 and Figure 9-2 summarise the brill landings by area as reported to ICES and the EC (Source: Eurostat database). Over the period 1973 – 2008, total landings (all areas) ranged from 1460 t to 3838 t per year, with the lowest landings in the second half of the eighties and the highest peak in the early nineties. In the last decade, the total landings of brill varied between 2000 and 3000 t. The North Sea accounts for the major part of these landings, generating 45-50% of the totals in the past ten years (up to more than 60% halfway the seventies). The English Channel is the second most important fishing grounds for brill, with mean landings percentages of 20% over the entire time-line and an increasing share of the total landings in recent years (23% of the total landings in the last decade). Fishing grounds from where the landings represent on average between 3 and 10% of the total landings over the entire time-line are IIIa, VIIa, VIIf-k, VIII and IX. Landings from other areas are negligible. Details on the history of brill landings in the North Sea, the Skagerrak, the English Channel, the Celtic Sea and the Irish Sea, and on relative contribution of different countries in the brill fisheries in these areas, can be found in Annex 5.

Length- and age-distributions of Belgian brill landings are shown in Figure 9-3 and 9-4. Numbers at length discarded per hour fishing for the Dutch beam trawl fleet fishing in the North Sea are shown in Figure 9-5 for the period 2004 to 2009. Numbers discarded are very low and only fish with a length of less than 25 cm are being discarded.

## 9.5 Survey data

Cefas conducts several annual surveys in western waters in which brill are routinely measured and biological information is retained. Four of the most important surveys are the Irish Sea (VIIa, VIIfg) beam trawl survey, the Channel (VIId) beam trawl survey, the Carhelmar (VIIe) commercial beam trawl survey and the English groundfish (IVb & c) GOV trawl survey. All fish caught are routinely measured during these surveys, and on most surveys also biological information is collected for brill. A summary of the numbers of fish measured and the numbers of biological samples (otoliths, length, weight, sex and maturity) in four Cefas survey series is given in Annex 5.

In addition, data on geopgraphical distributions, length distributions and abundance of brill is available in Cefas technical reports for the Irish Sea beam trawl survey (Parker-Humphreys, 2004a), the English Channel and southern North Sea (Parker-Humphreys, 2004b) beam trawl survey and the Young Fish Survey for the south and east coasts of (Rogers et al., 1998).

Length frequency distributions for the Dutch Beam Trawl Survey are shown in Figure 9-6.

Under the NESPMAN project, survey-data on brill were requested from different national databases for the Skagerrak (IIIa), the English Channel (VIId,e), the Irish (VIIa) and Celtic Seas (VIIf-h). Time series of abundance (over all sizes and by size-class) and length frequency distributions (annual and average) can be presented for all areas covered in this study, but the series should be further updated and analysed. Catches of brill are generally very low on surveys. These low catch numbers very often result in an underrepresentation of some year-classes (mainly the older ones), leading to a poor quality of the resulting survey abundance series and indices, and poor agreement among different surveys.

## 9.6 Biological sampling

### 9.6.1 DCF-requirements and Member States sampling intentions

Appendix VII of Commission Decision 2010/93/EU lists biological variables with species sampling specifications for all ICES areas. Table 9-3 gives an overview of what this implies for brill (sampling for fecundity is optional). Brill is classified as a Group 2 species under the DCF (internationally regulated species and major non-internationally regulated by-catch species, that don't drive the international management process and are not under EU management plans, EU recovery plans, EU long term multi-annual plans or EU action plans for conservation and management based on Council Regulation 2002/2371/EC). Group 2 species only require data on weight, sex-ratio and maturity to be collected every three years.

In Table 9-4, the sampling intensions of all Member States that inscribed sampling of biological parameters for brill in their national proposals for the period 2011-2013, were compiled, and can directly be compared to the required numbers in Table 9-3. For the North Sea and the Eastern English Channel, the joint effort of Belgium, the Netherlands and the UK leads to sufficient sampling for age, weight, sex-ratio and maturity of brill (green fields; for these parameters only 125 individuals are required under the DCF). Also for Subarea VII (excl. VIId), the minimum DCF-requirements will be met by the UK plans to collect biological information on 150 individuals in the Western English Channel and the Celtic Sea, whereas only 125 individuals should be documented in the western waters (green fields). All of the countries mentioned above plan to collect this biological information every year in the period 2011-2013 (and not on the minimum required three-year basis). France included the biological sampling of brill in the western waters in its national proposal for 2013, but gave no details on the numbers. No Member States included sampling of biological parameters for brill in the Irish Sea and the Skagerrak in their proposals.

## 9.7 Biological parameters and other research

### 9.7.1 Length

An analysis of time series of landings and data from sampling on board of commercial vessels by Belgium (Moreau, 2010) provided information on length-distributions, but not much on age-distributions, of landings and discards of brill. Table 9-5 and Figure 9- give the length-distribution of landings and discards as recorded on observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.

### 9.7.2 Age

ILVO extracted existing age-information on brill from its own database, and collected similar information from relevant NESPMAN partners and some other countries that were not involved in this project. This resulted in only very few data due to the problems of low occurrence in commercial catches and on surveys, in combination with a high commercial value, as explained above. For (some of) the areas covered in this study, only Belgium, the Netherlands and the United Kingdom currently still collect and read brill-otoliths, but the time series are fragmented and therefore of little use for assessment-purposes. An analysis of the available data is currently being prepared and will be included in the next report.

### 9.7.3 Sex-ratio, maturity and other reproductive characteristics

For brill, especially the studies of Dunn et al. (1996), Delbare & De Clerck (1999) and Boon et al. (2000) (and the references therein) are worth mentioning in this respect. Some important findings on sex-ratio and maturity of brill (mainly females) are taken over from Delbare & De Clerck (1999), and summarized in Table 9-6.

For the UK, length information from market sampling for brill is available for 1994–1996, and from 2000 onwards. Biological sampling for otoliths, weight, sex and maturity has only been carried out since 2000. A summary of the number of samples and the number of fish that were measured is given in Annex 5. The otoliths collected have not been aged.

France did collect length and age data on brill (demographic structures per metier) in the areas VIId and VIIe during the years 1994–1996. These data were collected under an EU funded project carried out by France and the UK (Dunn et al., 1996).

During the mid 1990s, Belgium took age and length samples of brill caught in the Eastern English Channel, the Celtic Sea, and the Irish Sea. The numbers measured vary between 200 and 600 individuals per year. The relative age distribution of brill in the commercial landings of the Belgian beam trawl fleet for the period 1996–1998 is presented in Figure 9-.

## 9.8 Analysis of stock trends / assessment

The data that have currently been collected by WGNEW do not allow an evaluation of stock trends for brill in the different areas.

Ulrich (2000) made an assessment of brill in the Channel fisheries using the data sampled under the EU funded project carried out by France and the UK. (Dunn *et al.*, 1996). She concluded that the Channel stock was not heavily overexploited, but that a reduction in fishing effort was required to get an increase of 10% of the observed production. The maximum annual production was found to be around 400 t.

The trend in abundance (all length classes combined) in the Dutch Beam Trawl Survey (RV Isis only) is shown in Figure 9-7. Abundance decreased from 1985 to 1992 and decreased again. No trend is obvious since 1997.

## 9.9 Data requirements

The collection of data needs to be continued by the countries that already collect these, and taken up by some others, in order to get a better understanding of the state of potential brill stocks in the Northeast Atlantic area, and to enable the evaluation of trends. Updates of survey abundance-series, discard information and CPUE-series will be analyzed and included in the next report.

In order to meet the DCF-requirements for sampling of biological parameters for brill in the Skagerrak and the Irish Sea, the following countries could be valid candidates to fill in the gaps in Table 9-4, according to their importance in brill fisheries:

- Denmark in the Skagerrak
- Belgium and the UK in the Irish Sea

**General recommendations**

- EU to upgrade brill from Group 2 to Group 1, forcing relevant Member States to collect biological information on a yearly basis
- Relevant Member States to include market sampling for turbot in their National Proposals, thus generating the required funds through the DCF

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**Table 9-2: International landings (t) of brill *Scophthalmus rhombus* over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | II | Baltic | IIIa | IIIb-d | IV | V | VI | VIIa | VIIb,c | VIId,e | VIIf-k | VIII | IX | X | XIV | TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 0 | 0 | 134 | 16 | 1002 | 20 | 26 | 124 | 48 | 90 | 165 | 309 | - | 0 | 0 | 1934 |
| 1974 | 0 | 0 | 202 | 30 | 1167 | 0 | 44 | 100 | 20 | 81 | 80 | 0 | - | 0 | 0 | 1724 |
| 1975 | 0 | 0 | 189 | 43 | 1242 | 0 | 41 | 117 | 28 | 135 | 120 | 50 | - | 0 | 0 | 1965 |
| 1976 | 0 | 0 | 227 | 50 | 1223 | 1 | 57 | 94 | 43 | 283 | 156 | 35 | - | 0 | 0 | 2169 |
| 1977 | 0 | 0 | 389 | 70 | 1447 | 0 | 63 | 121 | 35 | 319 | 241 | 261 | - | 0 | 0 | 2946 |
| 1978 | 1 | 0 | 218 | 43 | 1418 | 0 | 53 | 113 | 36 | 408 | 122 | 28 | - | 0 | 0 | 2440 |
| 1979 | 2 | 0 | 184 | 31 | 1393 | 1 | 49 | 129 | 26 | 457 | 126 | 25 | - | 0 | 0 | 2423 |
| 1980 | 0 | 0 | 82 | 26 | 1054 | 0 | 37 | 131 | 32 | 400 | 213 | 50 | - | 0 | 0 | 2025 |
| 1981 | 0 | 0 | 59 | 23 | 1226 | 0 | 31 | 105 | 30 | 484 | 452 | 55 | - | 0 | 0 | 2465 |
| 1982 | 0 | 0 | 74 | 20 | 1300 | 0 | 32 | 94 | 23 | 480 | 179 | 58 | - | 0 | 0 | 2260 |
| 1983 | 0 | 13 | 83 | 13 | 1455 | 0 | 28 | 136 | 19 | 523 | 206 | 71 | - | 0 | 0 | 2547 |
| 1984 | 0 | 12 | 97 | 13 | 333 | 0 | 39 | 147 | 18 | 526 | 179 | 96 | - | 0 | 0 | 1460 |
| 1985 | 0 | 0 | 109 | 18 | 343 | 0 | 46 | 234 | 25 | 484 | 187 | 91 | - | 0 | 0 | 1537 |
| 1986 | 0 | 19 | 106 | 20 | 262 | 0 | 27 | 245 | 46 | 445 | 224 | 134 | 10 | 0 | 0 | 1538 |
| 1987 | 0 | 15 | 103 | 17 | 260 | 0 | 30 | 251 | 22 | 483 | 226 | 155 | 24 | 0 | 0 | 1586 |
| 1988 | 0 | 10 | 101 | 10 | 336 | 0 | 27 | 248 | 16 | 447 | 206 | 199 | 28 | 0 | 0 | 1628 |
| 1989 | 0 | 10 | 97 | 10 | 460 | 0 | 28 | 121 | 12 | 423 | 185 | 214 | 36 | 0 | 0 | 1596 |
| 1990 | 0 | 12 | 127 | 13 | 923 | 0 | 17 | 138 | 10 | 535 | 229 | 188 | 54 | 0 | 0 | 2246 |
| 1991 | 0 | 17 | 99 | 17 | 1682 | 0 | 27 | 137 | 10 | 470 | 230 | 131 | 40 | 0 | 0 | 2860 |
| 1992 | 0 | 34 | 146 | 36 | 1810 | 0 | 43 | 173 | 20 | 456 | 278 | 167 | 53 | 0 | 24 | 3240 |
| 1993 | 0 | 35 | 212 | 46 | 2439 | 0 | 38 | 116 | 26 | 486 | 221 | 154 | 65 | 0 | 0 | 3838 |
| 1994 | 0 | 62 | 220 | 69 | 1916 | 0 | 28 | 130 | 25 | 485 | 269 | 137 | 49 | 1 | 0 | 3391 |
| 1995 | 0 | 101 | 151 | 106 | 1434 | 0 | 25 | 131 | 27 | 540 | 353 | 139 | 57 | 0 | 0 | 3064 |
| 1996 | 0 | 62 | 111 | 64 | 1247 | 0 | 25 | 121 | 41 | 598 | 369 | 120 | 498 | 0 | 0 | 3256 |
| 1997 | 0 | 28 | 106 | 28 | 957 | 0 | 40 | 156 | 50 | 491 | 397 | 125 | 434 | 0 | 0 | 2812 |
| 1998 | 0 | 25 | 132 | 25 | 1283 | 0 | 42 | 153 | 18 | 441 | 260 | 112 | 52 | 0 | 0 | 2543 |
| 1999 | 0 | 28 | 157 | 29 | 1280 | 0 | 30 | 130 | 18 | 227 | 183 | 17 | 62 | 0 | 0 | 2161 |
| 2000 | 0 | 33 | 142 | 34 | 1508 | 0 | 16 | 103 | 44 | 661 | 239 | 131 | 63 | 0 | 0 | 2974 |
| 2001 | 0 | 23 | 98 | 23 | 1573 | 0 | 15 | 119 | 21 | 721 | 251 | 122 | 70 | 0 | 0 | 3036 |
| 2002 | 0 | 30 | 89 | 32 | 1302 | 0 | 12 | 107 | 34 | 700 | 255 | 160 | 55 | 0 | 0 | 2776 |
| 2003 | 0 | 40 | 129 | 43 | 1346 | 0 | 36 | 131 | 33 | 744 | 249 | 155 | 45 | 0 | 0 | 2951 |
| 2004 | 0 | 48 | 156 | 51 | 1249 | 0 | 20 | 87 | 21 | 651 | 293 | 165 | 62 | 0 | 0 | 2803 |
| 2005 | 0 | 63 | 133 | 63 | 1160 | 0 | 13 | 102 | 17 | 590 | 279 | 135 | 60 | 0 | 0 | 2615 |
| 2006 | 0 | 60 | 140 | 61 | 1175 | 0 | 10 | 79 | 17 | 634 | 264 | 140 | 57 | 0 | 0 | 2637 |
| 2007 | 0 | 71 | 160 | 71 | 1239 | 0 | 6 | 77 | 20 | 730 | 244 | 139 | 37 | 0 | 0 | 2794 |
| 2008 | 0 | 107 | 181 | 106 | 1004 | 0 | 8 | 71 | 18 | 580 | 184 | 60 | 47 | 0 | 0 | 2366 |

**Table 9-3: Overview of the requirements for biological sampling of brill *Scophthalmus rhombus* under the DCF for the period 2011-2013 (EC/2010/93).**

| Species | Area/Stock | Species Group | Age N°/1000 t | Weight | Sex | Maturity |
|---|---|---|---|---|---|---|
| Brill | IIIa | G2 | 125 | T | T | T |
| Brill | IV, VIId | G2 | 125 | T | T | T |
| Brill | all areas (NE Atlantic + W Channel) | G2 | 125 | T | T | T |

**Table 9-4: Compilation of the scheduled sampling effort of Member States for biological parameters in brill *Scophthalmus rhombus* for the period 2011-2013 (source: reports RCM's 2010).**

| Species | Species Group | MS | 2011 | 2012 | 2013 | Fishing ground | Age (n° per year) | Weight (n° per year) | Sex-ratio (n° per year) | Maturity (n° per year) | Data sources |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Brill | G2 | / | | | | IIIa | | | | | |
| | | TOTAL | | | | | 0 | 0 | 0 | 0 | |
| Brill | G2 | BEL | X | X | X | IV | 25 | 25 | 25 | / | Comm. + surveys |
| Brill | G2 | UK | X | X | X | IV, VIId | 25 | 25 | 25 | 25 | Market + surveys |
| Brill | G2 | NLD | X | X | X | IV, VIId | 720 | 720 | 720 | 720 | Comm. + surveys |
| | | TOTAL | | | | | 770 | 770 | 770 | 745 | |
| Brill | G2 | UK | X | X | X | VIIe | 75 | 75 | 75 | 75 | Market + surveys |
| Brill | G2 | UK | X | X | X | VIIfgh | 75 | 75 | 75 | 75 | Market surveys |
| Brill | G2 | FRA | | | X | All areas | X | X | X | X | Commercial landings |
| | | TOTAL | | | | | > 150 | > 150 | > 150 | > 150 | |

**Table 9-5: Length-distribution of landings and discards of brill *Scophthalmus rhombus* as recorded on observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.**

| Length | Discards N° @ length | | | Subtot | Landings N° @ length | | | | | Subtot | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | VIIa | VIId | VIIf | disc | VIIa | VIId | VIIe | VIIf | VIIg | land | catch No |
| **220** | 1 | | | 1 | | | | | | | **1** |
| **230** | 4 | | | 4 | | | | | | | **4** |
| **240** | 12 | 1 | | 13 | 1 | | | | | 1 | **14** |
| **250** | 16 | | | 16 | 3 | | | | | 3 | **19** |
| **260** | 25 | | 1 | 26 | 2 | | | | | 2 | **28** |
| **270** | 26 | | 1 | 27 | 2 | | | | | 2 | **29** |
| **280** | 34 | 2 | 2 | 38 | 3 | 3 | | | | 6 | **44** |
| **290** | 32 | 1 | 2 | 35 | 18 | 9 | | | | 27 | **62** |
| **300** | 13 | | | 13 | 64 | 51 | | 5 | | 120 | **133** |
| **310** | | | | | 71 | 79 | | 5 | | 155 | **155** |
| **320** | | | | | 68 | 116 | | 12 | 1 | 197 | **197** |
| **330** | | | | | 57 | 125 | 1 | 19 | 1 | 203 | **203** |
| **340** | | | | | 54 | 133 | | 15 | 3 | 205 | **205** |
| **350** | | | | | 65 | 130 | 3 | 23 | 1 | 222 | **222** |
| **360** | 1 | | | 1 | 50 | 136 | 2 | 16 | 3 | 207 | **208** |
| **370** | | | | | 37 | 133 | | 16 | 1 | 187 | **187** |
| **380** | | | | | 48 | 111 | 2 | 19 | 2 | 182 | **182** |
| **390** | | | | | 47 | 94 | 1 | 14 | 2 | 158 | **158** |
| **400** | | | | | 52 | 80 | 2 | 15 | 5 | 154 | **154** |
| **410** | | | | | 57 | 68 | 2 | 17 | 4 | 148 | **148** |
| **420** | | | | | 39 | 81 | 1 | 20 | 4 | 145 | **145** |
| **430** | | | | | 28 | 66 | 1 | 14 | 5 | 114 | **114** |
| **440** | | | | | 32 | 55 | 2 | 14 | 5 | 108 | **108** |
| **450** | | | | | 29 | 68 | 3 | 14 | 4 | 118 | **118** |
| **460** | | 1 | | 1 | 33 | 44 | 3 | 9 | 1 | 90 | **91** |
| **470** | | | | | 27 | 46 | 4 | 10 | 4 | 91 | **91** |
| **480** | | | | | 21 | 33 | 3 | 9 | | 66 | **66** |
| **490** | | | | | 14 | 31 | 2 | 6 | 2 | 55 | **55** |
| **500** | | | | | 19 | 21 | 2 | 6 | 4 | 52 | **52** |
| **510** | | | | | 13 | 15 | 1 | 6 | 3 | 38 | **38** |
| **520** | | | | | 10 | 9 | | 5 | 2 | 26 | **26** |
| **530** | | | | | 9 | 5 | 1 | 2 | | 17 | **17** |
| **540** | | | | | 7 | 13 | | 5 | | 25 | **25** |
| **550** | | | | | 7 | 3 | 1 | | 1 | 12 | **12** |
| **560** | | | | | 1 | 2 | | 3 | 1 | 7 | **7** |
| **570** | | | | | 5 | 2 | 2 | 1 | 1 | 11 | **11** |
| **580** | | | | | 4 | 1 | | 2 | | 7 | **7** |
| **590** | | | | | 3 | | 1 | 3 | | 7 | **7** |
| **600** | | | | | 4 | 3 | | | | 7 | **7** |
| **610** | | | | | 1 | 2 | | | | 3 | **3** |
| **620** | | | | | | | 1 | | | 1 | **1** |

| Length | Discards N° @ length | | | Subtot | Landings N° @ length | | | | | Subtot | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | VIIa | VIId | VIIf | disc | VIIa | VIId | VIIe | VIIf | VIIg | land | catch No |
| **630** | | | | | | | | 1 | | 1 | **1** |
| **640** | | | | | | | | | | | |
| **650** | | | | | | | | | | | |
| **660** | | | | | | | | | | | |
| **670** | | | | | | | | | | | |
| **680** | | | | | | | | | | | |
| **690** | | | | | | | 1 | | | 1 | **1** |
| **Total No** | **164** | **5** | **6** | **178** | **1005** | **1768** | **42** | **306** | **60** | **3181** | **3359** |

**Table 9-6: Summary of reproductive characteristics of female brill *Scophthalmus rhombus* from different ICES areas (after Delbare & De Clerck, 1999).**

| | North Sea | English Channel | Celtic Sea | Irish Sea | Bay of Biscay |
|---|---|---|---|---|---|
| Proportion females (age 2 - 7 years) | 30 - 60 % | 10 -60 % | 15 - 50 % | 40 - 70 % | 30 - 65 % |
| Proportion females (age > 7 years) | 15 -100 % | 10 - 15 % | 5 - 100 % | 100% | 100% |
| Spawning period | March – June | March - April | February - May? | March – May? | February - June? |
| Length at 0% maturity | 39 cm | 46 cm | 39 cm | 37 cm | 43 cm |
| Length at full maturity | ND* | 47 cm | 49 cm | 46 cm | 47 cm |
| Age at maturity | 3 years | 4 years | 3 years | 4 years | 3 years |
| Monthly variation in condition factor | NO | NO | NO | NO | NO |

ND* : not determined

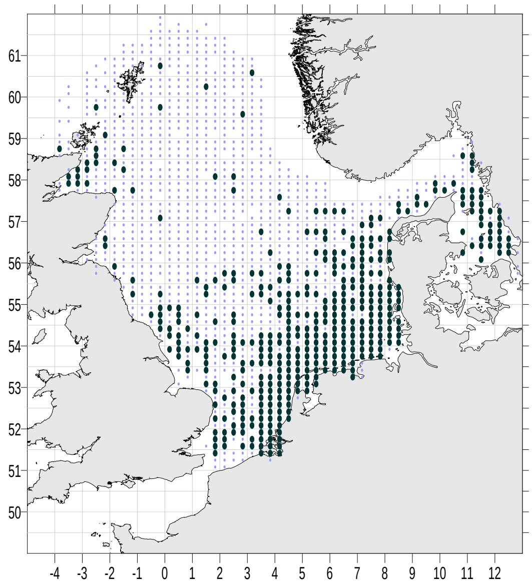


**Figure 9-1: Distribution of brill *Scopthalmus rhombus* in the North Sea and the Skagerrak (presence/absence) based on different surveys such as the IBTS and BTS surveys.**

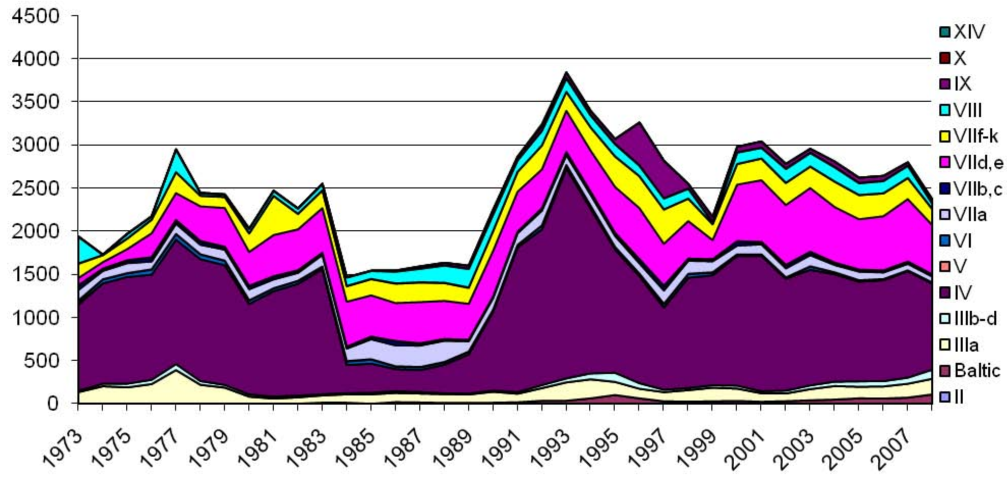


**Figure 9-2: International landings (t) of brill *Scophthalmus rhombus* in the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

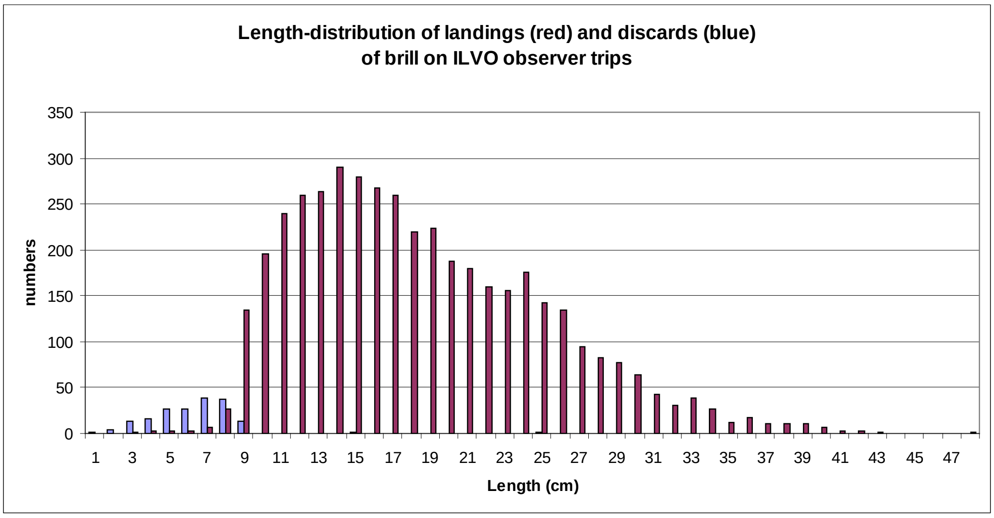


**Figure 9-3: Length-distribution of landings and discards of brill *Scophthalmus rhombus* as recorded on observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.**

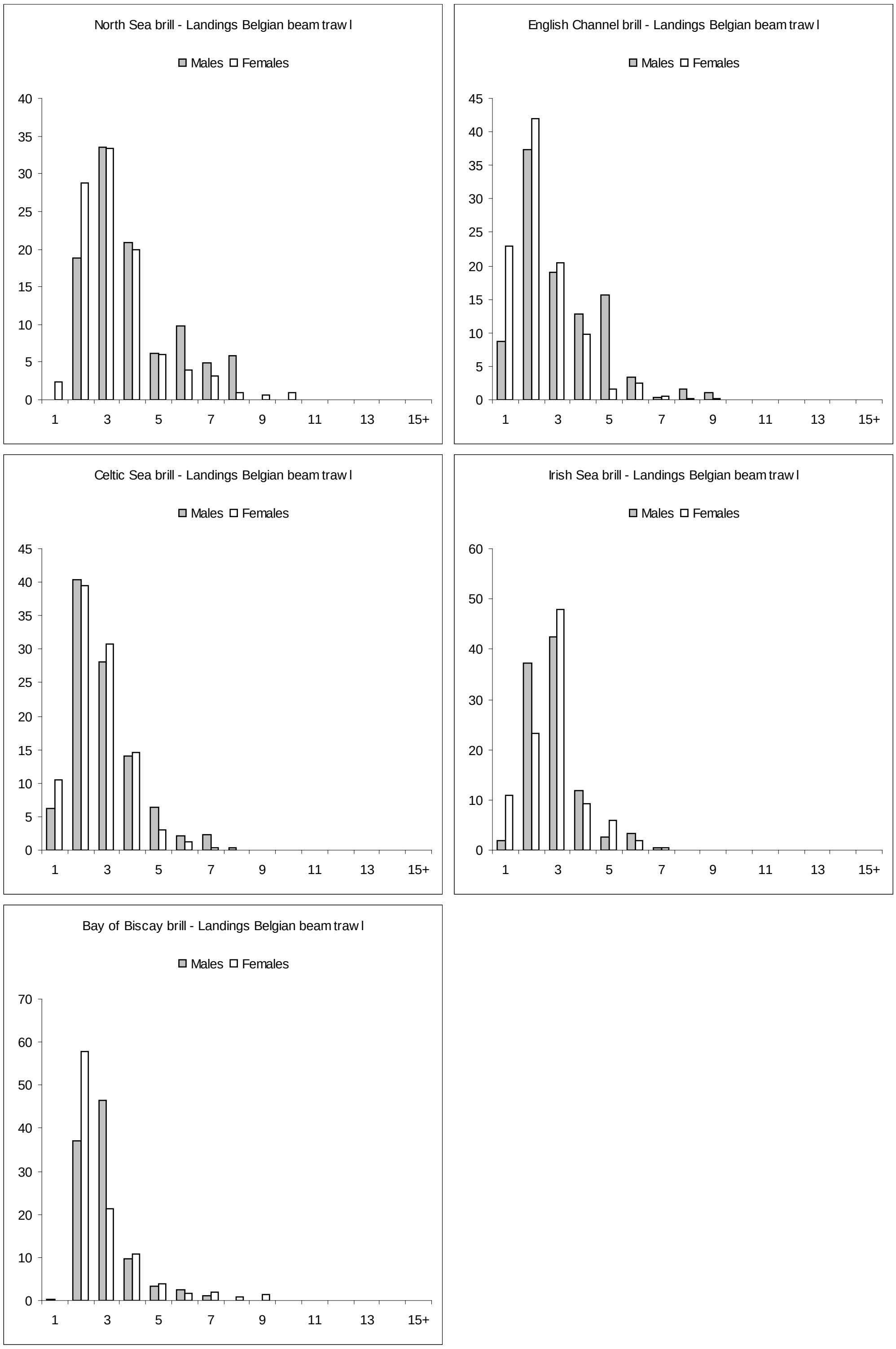


**Figure 9-4: Relative age distribution of brill *Scophthalmus rhombus* in the commercial landings of the Belgian beam trawl fleet for the period 1996–1998.**

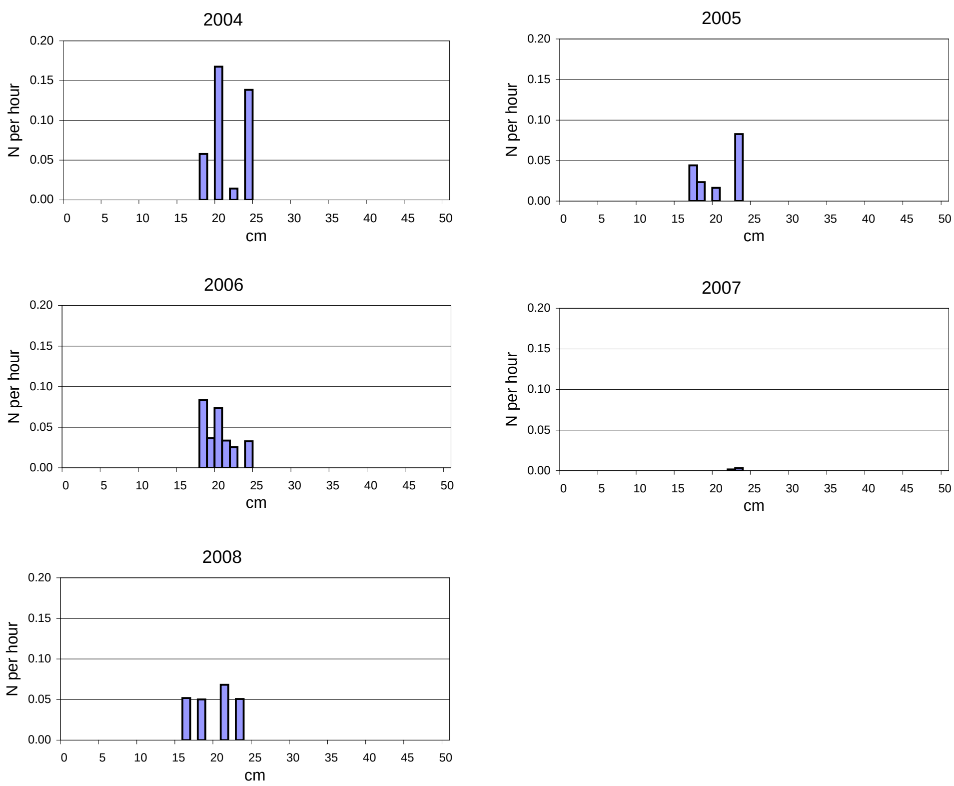


**Figure 9-5: North Sea brill: numbers per length discarded per hour fishing in the Dutch bream trawl fishery in the years 2004 to 2008 (from van Helmond & Heessen, 2010)**

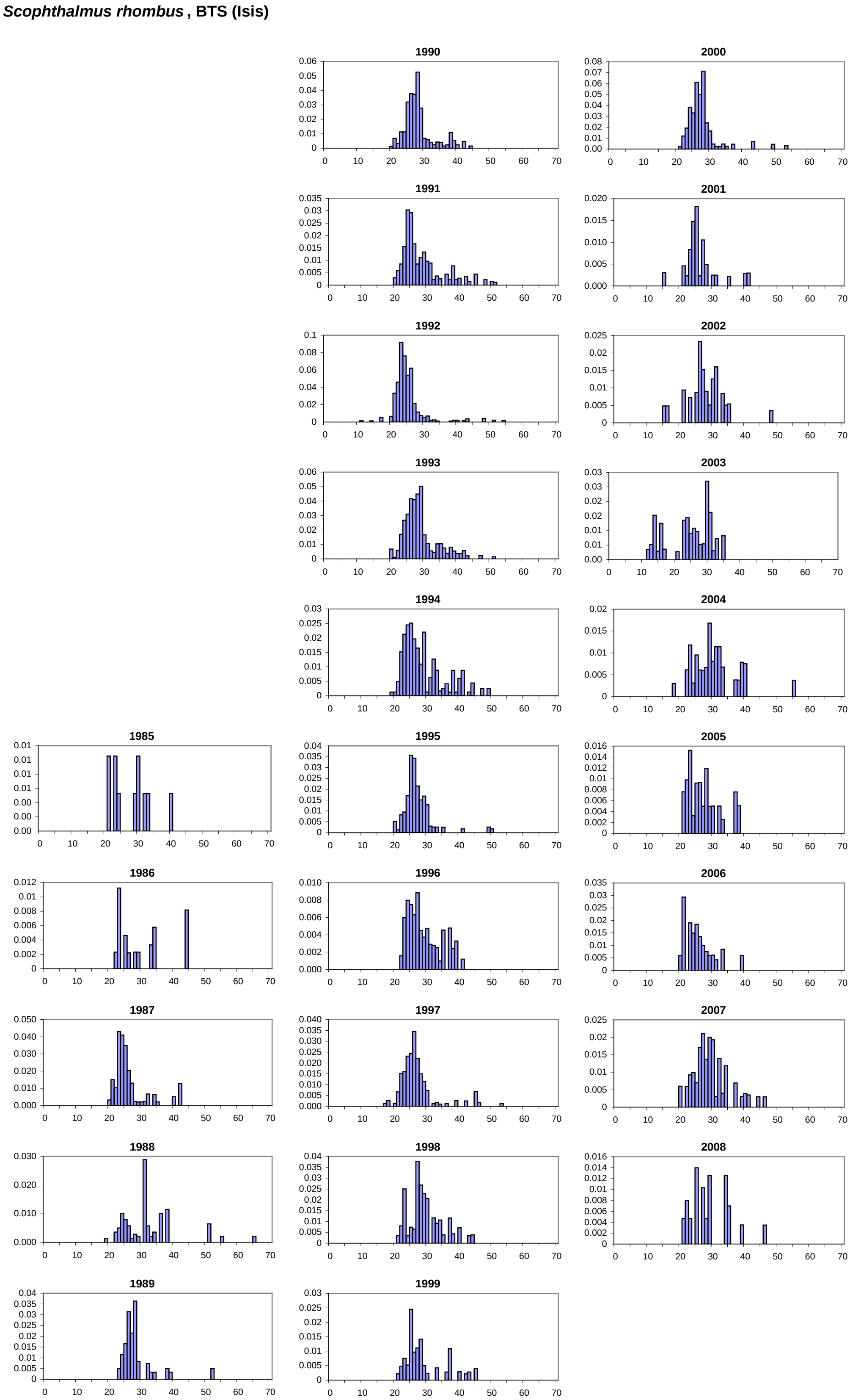


**Figure 9-6: North Sea brill *Scophthalmus rhombus*: number at length for the Dutch contribution to the North Sea Beam Trawl Survey. Only data for RV Isis are included.**

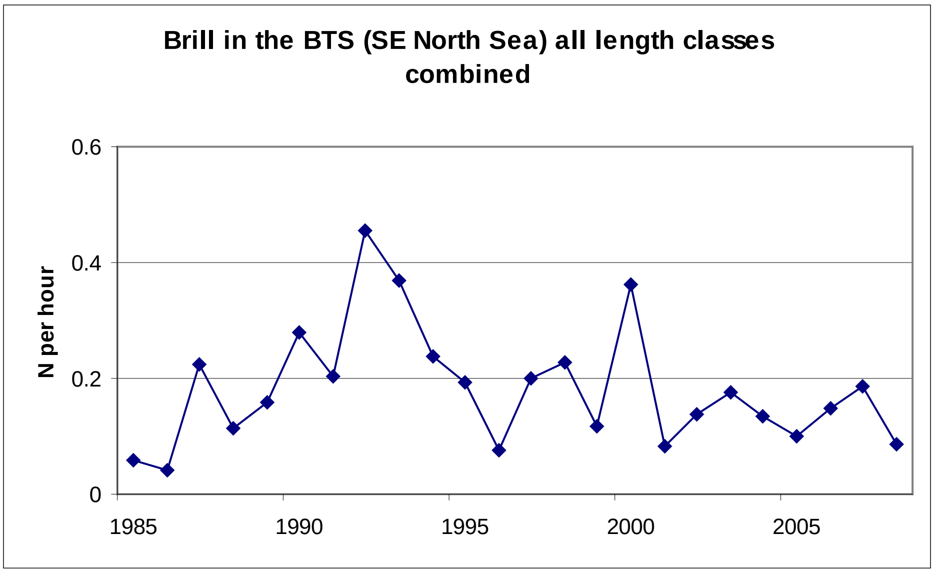


**Figure 9-7: Time series of abundance of brill *Scophthalmus rhombus* in the Dutch BTS (RV Isis only).**

# 10 Turbot

## 10.1 General biology

Turbot is distributed along the European coastline and is rarer around the Faroe Islands, Iceland and on Rockall Bank. Turbot is also found in the Skagerrak, the Kattegat, the Belt Sea and in the Baltic Sea. The distribution area also extends into the Mediterranean and Adriatic Sea. It is typically found at a depth range of 10 to 70m, on sandy, rocky or mixed bottoms. It is one of the few marine fish species that inhabits brackish waters.

Turbot is one of the fastest growing flatfish. During the juvenile phase growth rates are high, through which the turbot can reach 30 cm in three years. Like other flatfish, females grow faster than males. Young females grow from 8 to 10 cm a year. Females older than 10 years still grow 1 or 2 cm a year. In male turbot the growth is already reduced to 2 cm a year at the age of 6 years. Males older than 10 grow less than 1 cm a year.

Turbot is a typical visual feeder and feeds mainly on other bottom-living fishes, small pelagic fish and also, to a lesser extent, on larger crustaceans and bivalves. Large turbot (40 to 70 cm) feed from March till May excessive on herring and sprat (Rae & Devlin, 1972; Wetsteijn, 1981). During the other nine months 50 to 70 % of the animals were found to have empty stomachs. The diet of the juveniles has been shown to consist of copepods, shrimps, barnacle larvae and gastropod mollusc larvae (Jones, 1973).

Turbot is a rather sedentary species, but there are some indications of migratory patterns. In the North Sea, migrations from the nursery grounds in the south-eastern part to the more northern areas have been recorded, since adult turbot are more tolerant of the colder conditions in the northern areas of the North Sea where temperatures are too low for juveniles to survive. A study in the northern Baltic by Aneer and Weston (1990) also indicated that adult turbot is very stationary.

## 10.2 Stock identity and possible assessment areas

There are distinct turbot populations in the Baltic Sea and in the Irish Sea. Also, there are indications that turbot from the North Sea, the southern coast of Iceland, the western coast of Scotland and Ireland, and the Celtic Sea (including the Western Approaches - 51°N, 10°W) forms another stock, the northern Atlantic stock, which is different from the stock originating from the Bay of Biscay and the Atlantic side of southern Europe, the southern stock. Transition zones between the northern stock and the southern stock are found in the English Channel and between the northern stock and the Baltic Sea in the Kattegat and the Belt Sea. The situation of turbot stocks in the Mediterranean is still unclear, although there are indications that samples from the Aegean Sea are genetically different from those originating from other areas (Figure 10.1).

## 10.3 Management regulations

So far, no analytical assessments leading to fisheries advice have been carried out for turbot by ICES. The available information is inadequate to evaluate stock trends. No explicit objectives have been defined for potential stocks of this species, no precautionary reference points have been proposed, and no management plans are in place. However, for the EC-waters in Division IIa and Subarea IV, precautionary TACs have been defined for turbot and brill (combined) in the past. These TACs only apply to the EC-fisheries, and a historical overview is presented in Table 10-1.

**Table 10-1: Historical overview of combined TACs for turbot *Psetta maxima* and brill *Scophthalmus* rhombus in Division IIa and Subarea IV.**

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| TAC | 9000 | 9000 | 6750 | 5738 | 4877 | 4550 |
| Year | 2006 | 2007 | 2008 | 2009 | 2010 | |
| TAC | 4323 | 4323 | 5263 | 5263 | 5263 | |

There is no official EC minimum landing size. In several geographical areas however, Minimum Landing Sizes (MLS) have been installed by different authorities. The most frequently applied MLS is 30 cm (e.g., in Belgium, the Baltic, the English Sea Fisheries District Cornwall, …).

## 10.4 Fisheries data

Table 10--2 and Figure 10-2 summarize turbot landings by area as reported to ICES and the EC (Source: Eurostat database). Over the period 1973 – 2008, total landings (all areas) ranged from 3504 t to 9361 t per year, with the lowest landings halfway the eighties and the highest peak in the early nineties (Figure 10-2). In the last decade, the total landings of turbot were between 5000 and 6500 t. The North Sea (Figure 10-3 and 10-4) accounts for the major part of these landings generating around 60% of the totals in the past ten years (70-80% from the early sixties to the early seventies).

The English Channel (VIId,e) and the Celtic Sea (VIIf + VIIg-k) are the second and third most important fishing grounds for turbot, but are already much less important than the North Sea (mean landings percentages of 8% and 7% respectively over the entire time-line). The importance of these fishing grounds increased slightly to almost 9% of the total landings (for each of these two areas) in the past ten years. Fishing grounds from where the landings represent on average between 2 and 5% of the total landings over the entire time-line are IIIa, IIIb-d, VIIa, VIII and IX. Landings from other areas are negligible. Details on the history of turbot landings in the North Sea, the Skagerrak, the English Channel, the Celtic Sea and the Irish Sea, and on relative contribution of different countries in the turbot fisheries in these areas, can be found in Annex 6.

## 10.5 Survey data, recruit series

The presence or absence of turbot in the catches of the BTS and IBTS survey is summarized in Figure 10.5. Turbot is mainly caught in the southern and eastern part of the North Sea. Also catches are made in the Kattegat and on the east coast of Scotland.

There are three Dutch trawl surveys for flatfish species that catch turbot in the North Sea: Sole Net Survey (SNS), BTS Isis survey, and BTS Tridens survey (Table 10-4 to 10-6). These surveys are held in autumn, but each covers a different area of the North Sea, and different gears are used. The SNS survey covers the coastal areas in the southern Bight and the German Bight. The BTS-Isis survey covers the south-eastern part of the North Sea. The BTS-Tridens covers the central and western part of the North Sea.

For the Dutch trawl surveys, data by length and age are available. Age structured survey indices are plotted in Figure 10.6.

Cefas conducts several annual surveys in which turbot are routinely measured and biological information is retained. The most important surveys are the Irish Sea (VIIa, VIIfg) beam trawl survey, the Channel (VIId) beam trawl survey, the Carhelmar (VIIe) commercial beam trawl survey and the English groundfish (IVb & c) GOV trawl survey.

## 10.6 Biological sampling

### DCF-requirements and Member States sampling intentions

Appendix VII of Commission Decision 2010/93/EU lists biological variables with species sampling specifications for all ICES areas. Table 10.10 gives an overview of what this implies for turbot (sampling for fecundity is optional). Turbot is classified as a Group 2 species under the DCF. These are internationally regulated species and major non-internationally regulated by-catch species, that don't drive the international management process and are not under EU management plans, EU recovery plans, EU long term multi-annual plans or EU action plans for conservation and management based on Council Regulation 2002/2371/EC. Group 2 species only require data on weight, sex-ratio and maturity to be collected every three years.

In Table 10.11 the sampling intentions of all Member States that inscribed sampling of biological parameters for turbot in their national proposals, were compiled, and can directly be compared to the required numbers. For the North Sea and the Eastern English Channel, the joint effort of Belgium, Denmark, the Netherlands and the UK leads to sufficient sampling for age, weight, sex-ratio and maturity of turbot (green fields; for these parameters only 250 individuals are required under the DCF). For Subarea VII (excl. VIId) however, only the UK plans to collect biological information on 150 individuals in the Western English Channel and the Celtic Sea, whereas 250 individuals should be documented in the western waters to meet the DCF-requirements (red fields). All of the countries mentioned above plan to collect this biological information every year in the period 2011-2013 (and not on the minimum required three-year basis). No Member States included sampling of biological parameters for turbot in the Irish Sea and the Skagerrak in their proposals.

### General problems

Due to the relatively low numbers of turbot in commercial catches (per trip) and the high commercial value of this species, it is very difficult to collect data on biological variables in sufficient numbers for a meaningful analysis. Fishermen very often don't allow observers to take turbot otoliths on board of commercial vessels (even when informing them that it is possible to sample the otoliths through the operculum in this species, making it unnecessary to cut open the heads and thus not influencing the appearance of individual fish and their value to buyers in this way), set aside sampling gonads for maturity staging (although the fish are gutted on board anyhow). Buying turbot as part of the market sampling hasn't been an option for most countries either, because of the high prices. However, including the biological sampling in MS national proposals, and the subsequent generating of required funds through the DCF, should solve this problem. On surveys, catches of turbot are generally even lower than on commercial vessels. Most likely this is due to the lower trawling speeds on surveys compared to commercial vessels, making it easier for bigger fish like turbot to actively escape the nets. Turbot grows relatively fast and generally reaches a certain length faster (at younger ages) than other flatfish species in the same areas, leading to a higher proportion of bigger fish in the younger age-classes than in slower growing species such as sole Solea solea and plaice Pleuronectes platessa. This also means that it is much more difficult to obtain sufficient information on the bigger length classes for turbot. Additionally, the shorter trawl durations on surveys decrease the chance to encounter an individual turbot, which occur more scattered over a given area than other co-occurring flatfish species because of their predatory feeding behaviour (turbot is piscivorous and could be regarded as a top predator, except for the smaller larval stages).

## 10.7 Population biological parameters and other research

***Length***

Length weight relationships for males and females are given in Figure 10-9. An analysis of time series of landings and data from sampling on board of commercial vessels by Belgium (Moreau, 2010a) provided information on length-distributions, but not much on age-distributions, of landings and discards of turbot. Table 10-8 gives the length-distribution of landings and discards as recorded on observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.

***Age***

Growth parameters ($L\infty$ and K) for North Sea turbot are shown in Figure 10-10. ILVO extracted already existing age-information on turbot from its own database (Moreau, 2010b), and collected similar information from relevant project partners and some other countries that were not involved in the NESPMAN-project. This resulted in only very few data.

***Sex-ratio, maturity and other reproductive characteristics***

A couple of studies on the reproductive characters of turbot have been carried out in the past by various authors (e.g., Dunn *et al*. 1996, Ongenae & De Clerck 1998, Boon *et al*. 2000, and references therein). Some important findings on sex-ratio and maturity of turbot (mainly females) are summarized in Table 10-9 (after Moreau 2010b). Due to sampling outside the main spawning months no certain assumptions could be made on the length range during first maturation for turbot in the English Channel, Celtic and Irish Seas.

In the past, biological samples of turbot from the Danish fisheries in IIIa have been taken both from landed catches and through the national at-sea-sampling programme.

UK length information from market sampling for turbot from the Irish Sea and the English Channel is available for 1994–1996, and from 2000 onwards. Biological sampling for age, weight, sex and maturity has only been carried out since 2000 (Annex 6). The otoliths collected have not been aged.

France did collect length and age data on turbot (demographic structures per metier) in the areas VIId and VIIe during the years 1994–1996. These data were collected under an EU funded project carried out by France and the UK (Dunn *et al.*, 1996).

The Netherlands did sample North Sea turbot for age and length in 1982-1990, 1998 and from 2002 onwards. The number of length measurements varies between 3500 and 5500 per year, the number of aged fish between 400 and 2500 per year. The relative age distribution for the earliest sampling period is presented in Figure 10-7.

During the mid 1990s, Belgium took age and length samples of turbot caught in the Eastern English Channel, the Celtic Sea, the Irish Sea and the Bay of Biscay. The numbers measured vary between 200 and 600 individuals per year. The relative age distribution of turbot in the commercial landings of the Belgian beam trawl fleet for the period 1996–1997 is given in Annex 6. Since 2002, Belgium samples North Sea turbot as part of the DCR, although the sampling intensity has been rather low (<200 individuals per year).

Some biological sampling has been done in Germany for landings of turbot in the North Sea at the end of the 1970's. The age structured landings raised to the North Sea total are described by Weber (1979).

The different ageing programmes do not fully cover all years since the first observations presented in Weber (1979). The combined availability of age structured landings estimated is presented in Figure 10-8.

## 10.8 Analyses of stock trends

Dunn (1999) made an assessment of turbot in the Channel fisheries (UK and FR) by using a Pella-Tomlinson model to a cpue time series of the English beam trawlers (1984–1995). He concluded that fishing mortality has increased from 1984 to 1989 from 1 to 1.5 and decreased thereafter to 0.7 in 1995. The MSY was given by Dunn (1999) to be between 300 and 400 t, which was lower than the observed catches (550 t /year). Ulrich (2000) found a maximum sustainable production of 440 t/year.

For the North Sea, a stock assessment was developed based on the ideas presented in Aarts and Poos (2009). The available landings-at-age matrix spanning 1975-2008 is used (Table 10-7). The age range for the matrix is 1-9. The assessment incorporates the age structured survey indices for the SNS, BTS-Isis, and BTS-Tridens. In an initial run, all surveys are included, each with an age range of ages 1-7. Figure 10-11 and 10-12 show the residuals of the survey indices and landings at age.

The assessment indicates that fishing mortality has increased between 1975 and 2000 (Figure 10-13). Since 2000, the increase has most likely stopped and fishing mortality has decreased. However, the 95% confidence limits for the estimates are very wide. The fishing mortality in 2008 is estimated to be between 0.40 and 0.77. The recent decrease in fishing mortality is most likely a response to the decrease in fishing effort by the beam trawl fleet in the North Sea. This decrease has also resulted in reductions in fishing mortality in the target species for this fishery, plaice and sole. The long term management plan for these two species will probably result in further reductions in fishing effort. Under the proviso that there is no increase in targeted fishing for turbot, the fishing mortality for turbot will likely further decrease in the future. The effects on the landings of this decrease in fishing effort is difficult to predict, given that there is no yield curve analysis available.

The recruitment in the North Sea is estimated to have been high at the beginning of the timeseries (Figure 10-14). No further trends are found. Recruitment appears slightly higher in the most recent period, but that may be an effect of the changes in the MLS discussed above. The Total Stock Biomass has likely decreased since the beginning of the time series, but the 95% confidence limits are very large (up to a factor 2 between lower and upper limit (Figure 10-15). The most recent estimate in TSB (at 1 January 2008) is estimated to be between 7.6 and 15.6 thousand tonnes.

**The assessment on which these estimates are based should be carefully evaluated before management advice can be given based on this assessment**.

## 10.9 Data recommendations

The collection of data needs to be continued in order to get a better understanding of the state of turbot stocks in the Northeast Atlantic, and to enable the evaluation of trends.

In order to meet the DCF-requirements (Table 10-10) for sampling of biological parameters for turbot in the Skagerrak, the English Channel, the Celtic Sea and the Irish Sea, the following countries could be valid candidates to fill in the gaps in Table 10-11, according to their importance in turbot fisheries;

- Denmark in the Skagerrak
- France and Belgium in the English Channel
- France, Belgium and Ireland in the Celtic Sea
- Ireland and Belgium in the Irish Sea

*General recommendations*

- EU to upgrade turbot from Group 2 to Group 1, forcing relevant Member States to collect biological information on a yearly basis
- Relevant Member States to include market sampling for turbot in their National Proposals, thus generating the required funds through the DCF.

## 10.10 References

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**Table 10-2: Turbot in the North Sea. Landings of *Psetta maxima* in different areas as reported to ICES (Source: fishstat database).**

| | I | II | Baltic | IIIa | IIIb-d | IV | V | VI | VIIa | VIIb,c | VIId,e | VIIf | VIIg-k | VIII | IX | X | XII | TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 0 | 0 | - | 100 | 85 | 4212 | 1 | 70 | 135 | 19 | 188 | 57 | 136 | 0 | 94 | 0 | 0 | 5097 |
| 1974 | 0 | 0 | - | 117 | 93 | 4116 | 2 | 86 | 127 | 21 | 187 | 96 | 154 | 201 | 65 | 0 | 0 | 5265 |
| 1975 | 0 | 0 | - | 183 | 143 | 4588 | 3 | 94 | 120 | 31 | 282 | 75 | 139 | 206 | 79 | 0 | 0 | 5943 |
| 1976 | 0 | 5 | - | 383 | 120 | 4814 | 3 | 122 | 110 | 48 | 387 | 75 | 188 | 140 | 109 | 0 | 0 | 6504 |
| 1977 | 0 | 0 | - | 736 | 142 | 4484 | 3 | 131 | 114 | 35 | 438 | 58 | 242 | 1187 | 92 | 0 | 0 | 7662 |
| 1978 | 2 | 17 | - | 525 | 110 | 5034 | 1 | 100 | 113 | 25 | 618 | 74 | 211 | 126 | 74 | 0 | 0 | 7030 |
| 1979 | 0 | 8 | - | 406 | 126 | 6364 | 2 | 86 | 115 | 29 | 461 | 72 | 191 | 264 | 94 | 0 | 0 | 8218 |
| 1980 | 0 | 0 | - | 233 | 124 | 5485 | 1 | 82 | 102 | 34 | 392 | 77 | 237 | 373 | 111 | 0 | 0 | 7251 |
| 1981 | 0 | 0 | - | 207 | 160 | 4755 | 20 | 103 | 96 | 60 | 449 | 70 | 241 | 388 | 106 | 0 | 0 | 6655 |
| 1982 | 0 | 0 | - | 182 | 139 | 4453 | 0 | 174 | 92 | 80 | 381 | 70 | 224 | 166 | 210 | 0 | 0 | 6171 |
| 1983 | 0 | 2 | 50 | 209 | 110 | 4575 | 0 | 162 | 117 | 52 | 595 | 68 | 256 | 221 | 215 | 0 | 0 | 6632 |
| 1984 | 0 | 1 | 61 | 188 | 128 | 1497 | 0 | 138 | 182 | 36 | 567 | 61 | 273 | 190 | 182 | 0 | 0 | 3504 |
| 1985 | 0 | 0 | 27 | 241 | 194 | 1588 | 0 | 112 | 139 | 39 | 541 | 73 | 306 | 270 | 192 | 0 | 0 | 3722 |
| 1986 | 0 | 0 | 151 | 193 | 280 | 1453 | 0 | 102 | 177 | 56 | 444 | 99 | 351 | 342 | 256 | 0 | 0 | 3904 |
| 1987 | 0 | 0 | 192 | 161 | 353 | 1511 | 0 | 118 | 273 | 46 | 505 | 134 | 309 | 369 | 254 | 0 | 0 | 4225 |
| 1988 | 0 | 0 | 176 | 138 | 374 | 4041 | 0 | 160 | 285 | 31 | 598 | 126 | 418 | 493 | 265 | 0 | 0 | 7105 |
| 1989 | 0 | 0 | 188 | 184 | 358 | 4927 | 0 | 162 | 156 | 31 | 669 | 79 | 385 | 453 | 199 | 0 | 0 | 7791 |
| 1990 | 0 | 0 | 227 | 386 | 461 | 5750 | 0 | 103 | 129 | 45 | 652 | 54 | 398 | 354 | 184 | 0 | 0 | 8743 |
| 1991 | 0 | 0 | 257 | 276 | 527 | 6340 | 0 | 100 | 90 | 29 | 726 | 83 | 353 | 255 | 211 | 0 | 0 | 9247 |
| 1992 | 0 | 0 | 312 | 309 | 664 | 5933 | 0 | 98 | 111 | 45 | 617 | 62 | 370 | 311 | 255 | 0 | 0 | 9087 |
| 1993 | 320 | 13 | 209 | 351 | 546 | 5546 | 0 | 98 | 162 | 42 | 680 | 78 | 430 | 347 | 291 | 0 | 0 | 9113 |
| 1994 | 0 | 11 | 340 | 353 | 606 | 5244 | 1 | 96 | 134 | 33 | 583 | 130 | 421 | 1171 | 238 | 0 | 0 | 9361 |
| 1995 | 0 | 6 | 399 | 301 | 719 | 4671 | 1 | 124 | 122 | 46 | 578 | 101 | 495 | 357 | 176 | 0 | 0 | 8096 |
| 1996 | 0 | 6 | 600 | 210 | 745 | 3644 | 0 | 141 | 106 | 60 | 485 | 114 | 561 | 326 | 137 | 0 | 0 | 7135 |
| 1997 | 0 | 6 | 492 | 220 | 679 | 3382 | 0 | 128 | 148 | 51 | 357 | 112 | 545 | 214 | 265 | 0 | 3 | 6602 |

| | I | II | Baltic | IIIa | IIIb–d | IV | V | VI | VIIa | VIIb,c | VIId,e | VIIf | VIIg–k | VIII | IX | X | XII | TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 0 | 6 | 541 | 164 | 614 | 3086 | 0 | 124 | 147 | 46 | 351 | 107 | 350 | 199 | 160 | 0 | 0 | 5895 |
| 1999 | 0 | 6 | 377 | 156 | 517 | 3187 | 0 | 81 | 112 | 64 | 111 | 58 | 365 | 95 | 169 | 0 | 3 | 5301 |
| 2000 | 0 | 7 | 273 | 193 | 382 | 4025 | 1 | 48 | 106 | 89 | 439 | 80 | 448 | 230 | 104 | 0 | 0 | 6425 |
| 2001 | 0 | 7 | 160 | 238 | 278 | 4100 | 1 | 43 | 106 | 67 | 472 | 83 | 427 | 228 | 119 | 0 | 0 | 6329 |
| 2002 | 0 | 4 | 166 | 222 | 246 | 3749 | 1 | 31 | 132 | 55 | 537 | 98 | 524 | 174 | 89 | 1 | 0 | 6029 |
| 2003 | 0 | 5 | 160 | 159 | 197 | 3374 | 3 | 48 | 205 | 69 | 580 | 80 | 468 | 215 | 74 | 0 | 0 | 5637 |
| 2004 | 0 | 7 | 196 | 147 | 230 | 3317 | 1 | 52 | 100 | 101 | 592 | 94 | 513 | 205 | 78 | 0 | 0 | 5633 |
| 2005 | 0 | 7 | 281 | 127 | 299 | 3195 | 0 | 27 | 105 | 45 | 596 | 67 | 408 | 181 | 91 | 0 | 0 | 5429 |
| 2006 | 0 | 6 | 293 | 121 | 303 | 2976 | 0 | 18 | 85 | 42 | 558 | 69 | 372 | 180 | 76 | 0 | 0 | 5099 |
| 2007 | 0 | 7 | 276 | 173 | 289 | 3508 | 0 | 23 | 80 | 51 | 614 | 81 | 335 | 181 | 59 | 1 | 0 | 5678 |
| 2008 | 0 | 6 | 334 | 142 | 344 | 3005 | 0 | 14 | 53 | 48 | 518 | 67 | 265 | 116 | 59 | 0 | 0 | 4971 |

**Table 10-3: Turbot *Psetta maxima* in the North Sea. Individual weight of landed fish in quarter 2 (spawning season). Note that for the period 1981-1990 the age 10 estimates represent a plus group.**

| YEARS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10(+) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | NA | 0.73 | 1.30 | 2.02 | 2.63 | 3.35 | 3.99 | 4.41 | 4.71 | 5.19 |
| 1976 | NA | 0.73 | 1.30 | 1.96 | 2.73 | 3.29 | 4.04 | 4.58 | 4.91 | 4.97 |
| 1977 | NA | 0.73 | 1.30 | 1.95 | 2.65 | 3.45 | 3.71 | 4.53 | 5.03 | 5.28 |
| 1978 | NA | 0.73 | 1.30 | 1.93 | 2.57 | 3.35 | 4.06 | 3.85 | 5.20 | 5.25 |
| 1979 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1980 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1981 | NA | 0.90 | 0.80 | 1.48 | 2.59 | 3.23 | 5.66 | 5.17 | 6.39 | 8.40 |
| 1982 | NA | 0.59 | 1.01 | 1.80 | 2.53 | 3.33 | 4.88 | 6.20 | 6.42 | 5.95 |
| 1983 | NA | 0.61 | 1.13 | 1.99 | 2.77 | 3.38 | 3.97 | 4.72 | 3.70 | 6.65 |
| 1984 | NA | 0.66 | 1.04 | 2.07 | 2.87 | 4.25 | 4.93 | 6.02 | 5.46 | 7.77 |
| 1985 | NA | 0.59 | 1.02 | 1.83 | 2.95 | 4.46 | 5.99 | 4.83 | 6.36 | 7.19 |
| 1986 | NA | 0.91 | 1.12 | 1.98 | 3.08 | 3.48 | 7.02 | 4.12 | 7.45 | 7.40 |
| 1987 | 0.70 | 0.72 | 1.25 | 1.87 | 3.60 | 3.24 | 5.36 | 8.60 | 6.58 | 9.72 |
| 1988 | 0.70 | 1.16 | 1.65 | 2.65 | 3.31 | 5.78 | 7.24 | 4.58 | 7.00 | 12.56 |
| 1989 | NA | 0.81 | 1.48 | 2.96 | 5.30 | 5.77 | 8.26 | 8.00 | 8.31 | 8.62 |
| 1990 | 0.90 | 0.84 | 1.79 | 3.09 | 3.02 | 5.34 | 3.47 | 7.02 | 10.66 | 8.66 |
| 1991 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1992 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1993 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1994 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1995 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1996 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1997 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1998 | NA | 0.80 | 1.03 | 1.67 | 3.08 | 5.06 | 2.57 | 7.49 | NA | NA |
| 1999 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2000 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2001 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2002 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2003 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2004 | NA | 0.52 | 1.10 | 1.90 | 2.47 | 2.91 | 5.35 | 6.49 | 5.63 | 7.21 |
| 2005 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2006 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2007 | NA | 0.59 | 1.10 | 1.57 | 2.58 | 2.71 | 1.72 | 5.11 | NA | 4.65 |
| 2008 | NA | 0.65 | 1.14 | 1.44 | 2.10 | 5.16 | 6.01 | NA | 7.00 | 7.25 |
| 2009 | NA | 0.44 | 0.80 | 1.51 | 1.65 | 3.55 | 4.70 | 5.74 | 6.01 | 3.16 |

**Table 10-4: Turbot *Psetta maxima* in the North Sea. SNS survey index. Index numbers represent numbers of fish per 100 fishing hours.**

| | AGE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1970 | 53.919 | 81.176 | 24.546 | 5.436 | 1.299 | 0.549 | 0.168 | 0.030 | 0.030 | 0.070 |
| 1971 | 19.614 | 61.060 | 20.153 | 3.881 | 0.957 | 0.454 | 0.118 | 0.023 | 0.023 | 0.068 |
| 1972 | 17.932 | 63.716 | 23.035 | 5.423 | 1.057 | 0.484 | 0.104 | 0.079 | 0.039 | 0.131 |
| 1973 | 49.008 | 56.723 | 14.637 | 3.710 | 0.538 | 0.229 | 0.061 | 0.027 | 0.012 | 0.055 |
| 1974 | 91.445 | 61.564 | 14.032 | 3.341 | 0.555 | 0.289 | 0.067 | 0.037 | 0.018 | 0.063 |
| 1975 | 100.961 | 82.587 | 17.554 | 3.665 | 0.601 | 0.312 | 0.091 | 0.005 | 0.005 | 0.015 |
| 1976 | 49.880 | 54.755 | 11.343 | 2.498 | 0.384 | 0.131 | 0.067 | 0.006 | 0.000 | 0.031 |
| 1977 | 415.318 | 208.182 | 41.937 | 10.813 | 4.713 | 2.731 | 1.721 | 0.640 | 0.214 | 0.285 |
| 1978 | 38.322 | 134.257 | 43.781 | 10.013 | 2.169 | 0.980 | 0.330 | 0.066 | 0.044 | 0.133 |
| 1979 | 20.480 | 122.187 | 43.675 | 9.129 | 1.832 | 0.848 | 0.274 | 0.076 | 0.035 | 0.131 |
| 1980 | 117.129 | 71.836 | 22.152 | 5.118 | 1.059 | 0.445 | 0.138 | 0.035 | 0.027 | 0.062 |
| 1981 | 29.442 | 72.032 | 20.261 | 6.071 | 3.683 | 2.621 | 1.764 | 0.811 | 0.312 | 0.336 |
| 1982 | 88.932 | 40.048 | 7.767 | 2.118 | 0.348 | 0.138 | 0.021 | 0.025 | 0.016 | 0.031 |
| 1983 | 168.301 | 142.722 | 23.738 | 5.728 | 0.809 | 0.246 | 0.090 | 0.017 | 0.006 | 0.057 |
| 1984 | 94.616 | 80.057 | 26.305 | 6.248 | 1.211 | 0.635 | 0.250 | 0.065 | 0.058 | 0.110 |
| 1985 | 51.362 | 94.481 | 21.287 | 4.174 | 0.718 | 0.391 | 0.137 | 0.000 | 0.000 | 0.005 |
| 1986 | 23.971 | 17.256 | 5.537 | 3.605 | 1.831 | 1.167 | 0.363 | 0.116 | 0.039 | 0.117 |
| 1987 | 64.116 | 17.379 | 2.495 | 0.555 | 0.059 | 0.046 | 0.015 | 0.000 | 0.000 | 0.000 |
| 1988 | 166.951 | 103.470 | 17.632 | 4.129 | 0.573 | 0.231 | 0.096 | 0.846 | 0.421 | 6.761 |
| 1989 | 65.994 | 46.137 | 14.352 | 3.880 | 0.743 | 0.291 | 0.132 | 0.048 | 0.052 | 0.088 |
| 1990 | 241.772 | 99.383 | 18.937 | 5.152 | 1.031 | 0.248 | 0.000 | 0.071 | 0.035 | 0.035 |
| 1991 | 43.580 | 77.483 | 19.348 | 3.968 | 0.761 | 0.384 | 0.102 | 0.012 | 0.012 | 0.018 |
| 1992 | 266.424 | 111.891 | 30.347 | 7.379 | 1.122 | 0.585 | 0.281 | 0.037 | 0.030 | 0.094 |
| 1993 | 162.396 | 150.387 | 29.937 | 7.406 | 1.101 | 0.443 | 0.145 | 0.046 | 0.023 | 0.115 |
| 1994 | 100.188 | 49.915 | 19.045 | 5.215 | 1.022 | 0.596 | 0.254 | 0.064 | 0.053 | 0.093 |
| 1995 | 194.538 | 57.004 | 4.909 | 1.670 | 0.102 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | 89.867 | 76.786 | 14.828 | 3.019 | 0.550 | 0.221 | 0.063 | 0.000 | 0.000 | 0.000 |
| 1997 | 35.459 | 27.614 | 10.743 | 4.459 | 0.966 | 0.393 | 0.117 | 0.097 | 0.058 | 0.093 |
| 1998 | 57.746 | 41.561 | 9.366 | 2.061 | 0.310 | 0.186 | 0.057 | 0.015 | 0.008 | 0.023 |
| 1999 | 165.059 | 98.285 | 29.282 | 6.207 | 1.477 | 0.647 | 0.202 | 0.038 | 0.019 | 0.117 |
| 2000 | 155.615 | 38.400 | 4.323 | 1.325 | 0.112 | 0.010 | 0.010 | 0.000 | 0.000 | 0.000 |
| 2001 | 48.891 | 36.151 | 17.505 | 4.458 | 0.859 | 0.424 | 0.060 | 0.084 | 0.047 | 0.092 |
| 2002 | 133.338 | 49.316 | 13.082 | 2.848 | 0.735 | 0.439 | 0.088 | 0.015 | 0.000 | 0.046 |
| 2003 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2004 | 150.213 | 42.384 | 13.395 | 7.336 | 2.473 | 1.048 | 0.237 | 0.055 | 0.082 | 0.110 |
| 2005 | 148.462 | 86.209 | 14.937 | 3.832 | 0.583 | 0.183 | 0.058 | 0.022 | 0.015 | 0.033 |
| 2006 | 180.330 | 105.290 | 20.901 | 4.853 | 0.862 | 0.337 | 0.073 | 0.037 | 0.019 | 0.048 |
| 2007 | 80.278 | 77.989 | 25.292 | 6.340 | 1.305 | 0.424 | 0.056 | 0.061 | 0.046 | 0.059 |
| 2008 | 78.786 | 91.298 | 33.181 | 10.682 | 4.674 | 3.204 | 2.094 | 0.897 | 0.416 | 0.436 |
| 2009 | 25.791 | 24.357 | 14.252 | 4.678 | 1.053 | 0.624 | 0.292 | 0.085 | 0.093 | 0.107 |

**Table 10-5: Turbot *Psetta maxima* in the North Sea. BTS-Isis survey index. Index numbers represent numbers of fish per fishing hour.**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 0.547 | 1.104 | 0.344 | 0.105 | 0.025 | 0.011 | 0.003 | 0.001 | 0.001 | 0.002 |
| 1986 | 0.297 | 0.817 | 0.333 | 0.096 | 0.025 | 0.015 | 0.012 | 0.009 | 0.007 | 0.011 |
| 1987 | 0.362 | 0.956 | 0.350 | 0.114 | 0.029 | 0.016 | 0.006 | 0.008 | 0.004 | 0.013 |
| 1988 | 0.715 | 1.053 | 0.344 | 0.098 | 0.021 | 0.010 | 0.002 | 0.001 | 0.001 | 0.001 |
| 1989 | 0.461 | 1.240 | 0.460 | 0.118 | 0.036 | 0.023 | 0.016 | 0.010 | 0.007 | 0.011 |
| 1990 | 2.138 | 1.162 | 0.337 | 0.129 | 0.036 | 0.019 | 0.008 | 0.005 | 0.002 | 0.004 |
| 1991 | 1.387 | 1.140 | 0.439 | 0.116 | 0.035 | 0.021 | 0.012 | 0.007 | 0.004 | 0.006 |
| 1992 | 1.424 | 1.010 | 0.341 | 0.100 | 0.025 | 0.015 | 0.006 | 0.003 | 0.001 | 0.003 |
| 1993 | 1.632 | 1.248 | 0.327 | 0.092 | 0.034 | 0.022 | 0.013 | 0.006 | 0.002 | 0.003 |
| 1994 | 1.815 | 1.183 | 0.353 | 0.084 | 0.021 | 0.012 | 0.008 | 0.005 | 0.003 | 0.006 |
| 1995 | 1.667 | 0.615 | 0.195 | 0.051 | 0.015 | 0.010 | 0.005 | 0.003 | 0.001 | 0.002 |
| 1996 | 1.087 | 1.173 | 0.321 | 0.096 | 0.031 | 0.020 | 0.011 | 0.006 | 0.003 | 0.004 |
| 1997 | 0.936 | 1.006 | 0.348 | 0.101 | 0.029 | 0.016 | 0.007 | 0.002 | 0.001 | 0.002 |
| 1998 | 1.671 | 1.090 | 0.320 | 0.097 | 0.024 | 0.011 | 0.004 | 0.001 | 0.001 | 0.002 |
| 1999 | 1.430 | 0.900 | 0.279 | 0.087 | 0.021 | 0.010 | 0.003 | 0.001 | 0.001 | 0.001 |
| 2000 | 4.009 | 1.078 | 0.429 | 0.136 | 0.034 | 0.014 | 0.003 | 0.002 | 0.001 | 0.002 |
| 2001 | 1.246 | 1.017 | 0.340 | 0.105 | 0.031 | 0.017 | 0.007 | 0.002 | 0.001 | 0.002 |
| 2002 | 2.733 | 0.587 | 0.174 | 0.040 | 0.008 | 0.004 | 0.002 | 0.000 | 0.000 | 0.001 |
| 2003 | 1.387 | 0.861 | 0.260 | 0.074 | 0.015 | 0.007 | 0.002 | 0.001 | 0.001 | 0.001 |
| 2004 | 1.980 | 0.933 | 0.306 | 0.080 | 0.016 | 0.007 | 0.002 | 0.001 | 0.001 | 0.002 |
| 2005 | 1.647 | 1.179 | 0.404 | 0.101 | 0.021 | 0.010 | 0.003 | 0.001 | 0.001 | 0.001 |
| 2006 | 1.635 | 0.872 | 0.283 | 0.072 | 0.016 | 0.008 | 0.002 | 0.000 | 0.000 | 0.001 |
| 2007 | 1.263 | 1.234 | 0.494 | 0.175 | 0.041 | 0.018 | 0.005 | 0.002 | 0.002 | 0.003 |
| 2008 | 1.573 | 1.067 | 0.319 | 0.101 | 0.022 | 0.012 | 0.004 | 0.001 | 0.001 | 0.002 |
| 2009 | 0.980 | 0.686 | 0.364 | 0.132 | 0.033 | 0.016 | 0.006 | 0.002 | 0.002 | 0.003 |

**Table 10-6: Turbot *Psetta maxima* in the North Sea. BTS-Tridens survey index. Index numbers represent numbers of fish per fishing hour.**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1996 | 0.0237 | 0.1128 | 0.0633 | 0.0156 | 0.0041 | 0.0017 | 0.0005 | 0.0001 | 0.0001 | 0.000 |
| 1997 | 0.0002 | 0.0227 | 0.0545 | 0.0394 | 0.0166 | 0.0097 | 0.0035 | 0.0013 | 0.0008 | 0.001 |
| 1998 | 0.0000 | 0.0005 | 0.0247 | 0.0371 | 0.0146 | 0.0077 | 0.0020 | 0.0006 | 0.0005 | 0.001 |
| 1999 | 0.0000 | 0.0015 | 0.0230 | 0.0120 | 0.0030 | 0.0013 | 0.0006 | 0.0004 | 0.0004 | 0.000 |
| 2000 | 0.0031 | 0.0840 | 0.0610 | 0.0153 | 0.0040 | 0.0017 | 0.0004 | 0.0003 | 0.0002 | 0.000 |
| 2001 | 0.0469 | 0.0816 | 0.0651 | 0.0196 | 0.0049 | 0.0026 | 0.0008 | 0.0002 | 0.0001 | 0.000 |
| 2002 | 0.0067 | 0.0599 | 0.0441 | 0.0118 | 0.0026 | 0.0017 | 0.0004 | 0.0001 | 0.0000 | 0.000 |
| 2003 | 0.0026 | 0.0481 | 0.0520 | 0.0165 | 0.0040 | 0.0021 | 0.0011 | 0.0003 | 0.0004 | 0.000 |
| 2004 | 0.0014 | 0.0589 | 0.0757 | 0.0306 | 0.0085 | 0.0037 | 0.0014 | 0.0005 | 0.0004 | 0.001 |
| 2005 | 0.0134 | 0.1106 | 0.1345 | 0.0466 | 0.0117 | 0.0056 | 0.0017 | 0.0007 | 0.0004 | 0.001 |
| 2006 | 0.0149 | 0.0870 | 0.0496 | 0.0135 | 0.0030 | 0.0012 | 0.0004 | 0.0002 | 0.0001 | 0.000 |
| 2007 | 0.0256 | 0.1993 | 0.1008 | 0.0398 | 0.0106 | 0.0044 | 0.0012 | 0.0004 | 0.0003 | 0.001 |
| 2008 | 0.0311 | 0.1104 | 0.0365 | 0.0310 | 0.0177 | 0.0134 | 0.0086 | 0.0062 | 0.0025 | 0.003 |
| 2009 | 0.0165 | 0.2210 | 0.1469 | 0.0382 | 0.0089 | 0.0048 | 0.0017 | 0.0005 | 0.0004 | 0.001 |

**Table 10-7: Turbot *Psetta maxima* in the North Sea. Landings at age matrix derived from the different data sources. Numbers are in thousands. Age 10 is a +group**

| | age | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10+** |
| 1975 | 0.8 | 427 | 1012 | 239 | 108 | 124.2 | 90.0 | 46.9 | 41.7 | 146.2 |
| 1976 | 0.0 | 350 | 1346 | 392 | 114 | 75.9 | 57.4 | 50.2 | 38.2 | 173.8 |
| 1977 | 18.2 | 895 | 644 | 531 | 166 | 43.8 | 30.5 | 42.0 | 36.6 | 142.0 |
| 1978 | 0.0 | 1324 | 1273 | 309 | 268 | 76.0 | 37.6 | 29.0 | 20.4 | 64.7 |
| 1979 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1980 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1981 | 0.0 | 299 | 755 | 532 | 458 | 175.0 | 67.0 | 35.0 | 40.0 | 32.0 |
| 1982 | 0.0 | 169 | 1046 | 267 | 167 | 292.0 | 98.0 | 49.0 | 41.0 | 65.0 |
| 1983 | 0.0 | 402 | 673 | 479 | 110 | 113.0 | 180.0 | 91.0 | 31.0 | 81.0 |
| 1984 | 0.0 | 1296 | 1223 | 311 | 157 | 60.0 | 57.0 | 74.0 | 51.0 | 70.0 |
| 1985 | 0.0 | 795 | 2415 | 654 | 179 | 109.0 | 26.0 | 38.0 | 48.0 | 74.0 |
| 1986 | 0.0 | 371 | 1470 | 697 | 183 | 67.0 | 29.0 | 16.0 | 18.0 | 90.0 |
| 1987 | 13.0 | 648 | 546 | 676 | 158 | 52.0 | 19.0 | 5.0 | 5.0 | 60.0 |
| 1988 | 36.0 | 1084 | 897 | 178 | 176 | 90.0 | 28.0 | 42.0 | 10.0 | 25.0 |
| 1989 | 0.0 | 594 | 1037 | 315 | 139 | 73.0 | 28.0 | 22.0 | 10.0 | 29.0 |
| 1990 | 43.0 | 957 | 1032 | 305 | 160 | 73.0 | 98.0 | 58.0 | 13.0 | 39.0 |
| 1991 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1992 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1993 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1994 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1995 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1996 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1997 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1998 | 0.0 | 540 | 1158 | 476 | 97 | 39.3 | 11.3 | 10.1 | 0.9 | 8.0 |
| 1999 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2000 | 4.5 | 255 | 938 | 270 | 315 | 144.7 | 116.1 | 51.3 | 58.8 | 72.4 |
| 2001 | 0.0 | 478 | 1642 | 357 | 64 | 75.5 | 55.1 | 64.7 | 21.6 | 61.1 |
| 2002 | 0.0 | 67 | 1565 | 463 | 148 | 24.3 | 43.8 | 29.2 | 11.4 | 34.1 |
| 2003 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2004 | 458.4 | 2376 | 900 | 216 | 98 | 9.7 | 8.1 | 3.8 | 1.9 | 1.5 |
| 2005 | 363.3 | 2383 | 894 | 336 | 29 | 56.8 | 3.2 | 11.0 | 8.9 | 10.5 |
| 2006 | 960.7 | 1357 | 1072 | 236 | 85 | 20.6 | 60.9 | 12.4 | 5.8 | 24.0 |
| 2007 | 98.7 | 2907 | 671 | 413 | 65 | 38.7 | 13.0 | 10.6 | 0.0 | 5.8 |
| 2008 | 163.0 | 1402 | 921 | 284 | 219 | 67.0 | 42.1 | 2.3 | 12.6 | 15.4 |

**Table 10-8: Length-distribution of landings and discards of turbot *Psetta maxima* as recorded on Belgian observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.**

| | Discards No @ length | | | Subtot | Landings No @ length | | | | Subtot | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Length | VIIa | VIId | VIIf | disc | VIIa | VIId | VIIf | VIIg | land | catch No |
| **210** | 2 | | | 2 | | | | | | **2** |
| **220** | 3 | | | 3 | | | | | | **3** |
| **230** | 3 | | | 3 | | | | | | **3** |
| **240** | 3 | | | 3 | | | | | | **3** |
| **250** | 10 | | | 10 | | | | | | **10** |
| **260** | 10 | | | 10 | | | | | | **10** |
| **270** | 10 | | 1 | 11 | | | | | | **11** |
| **280** | 17 | | 1 | 18 | | | | | | **18** |
| **290** | 28 | 1 | 1 | 30 | | 1 | | | 1 | **31** |
| **300** | 6 | | | 6 | 73 | 12 | 1 | | 86 | **92** |
| **310** | | | | | 94 | 21 | 1 | | 116 | **116** |
| **320** | | | | | 93 | 37 | 6 | | 136 | **136** |
| **330** | | | | | 93 | 51 | 2 | | 146 | **146** |
| **340** | | | | | 76 | 96 | 4 | | 176 | **176** |
| **350** | | | | | 99 | 109 | 6 | 1 | 215 | **215** |
| **360** | | | | | 70 | 118 | 5 | 1 | 194 | **194** |
| **370** | | | | | 68 | 110 | 5 | 3 | 186 | **186** |
| **380** | | | | | 58 | 114 | 4 | 1 | 177 | **177** |
| **390** | | | | | 46 | 114 | 8 | 3 | 171 | **171** |
| **400** | | | | | 36 | 97 | 7 | 1 | 141 | **141** |
| **410** | | | | | 42 | 77 | 2 | 1 | 122 | **122** |
| **420** | | | | | 25 | 60 | 2 | 4 | 91 | **91** |
| **430** | | | | | 25 | 42 | 3 | | 70 | **70** |
| **440** | | | | | 17 | 31 | 4 | 1 | 53 | **53** |
| **450** | | | | | 16 | 28 | 8 | 4 | 56 | **56** |
| **460** | | | | | 20 | 27 | 5 | 2 | 54 | **54** |
| **470** | | | | | 22 | 28 | 1 | 2 | 53 | **53** |
| **480** | | | | | 15 | 16 | 3 | 4 | 38 | **38** |
| **490** | | | | | 12 | 15 | 3 | 1 | 31 | **31** |
| **500** | | | | | 16 | 16 | 2 | | 34 | **34** |
| **510** | | | | | 11 | 14 | 1 | 2 | 28 | **28** |
| **520** | | | | | 21 | 13 | | 1 | 35 | **35** |
| **530** | | | | | 10 | 7 | 2 | 1 | 20 | **20** |
| **540** | | | | | 6 | 10 | | | 16 | **16** |
| **550** | | | | | 8 | 7 | 2 | | 17 | **17** |
| **560** | | | | | 5 | 4 | | | 9 | **9** |
| **570** | | | | | 8 | | 2 | 1 | 11 | **11** |
| **580** | | | | | 2 | 1 | | 1 | 4 | **4** |
| **590** | | | | | 3 | | 1 | 1 | 5 | **5** |

| | Discards No @ length | | | Subtot | Landings No @ length | | | | Subtot | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Length | VIIa | VIId | VIIf | disc | VIIa | VIId | VIIf | VIIg | land | catch No |
| **600** | | | | | 2 | 1 | 1 | | 4 | **4** |
| **610** | | | | | 2 | 1 | | | 3 | **3** |
| **620** | | | | | 1 | | | | 1 | **1** |
| **630** | | | | | | | 1 | | 1 | **1** |
| **640** | | | | | 2 | | | | 2 | **2** |
| **650** | | | | | 1 | | | | 1 | **1** |
| **660** | | | | | | 1 | | | 1 | **1** |
| **680** | | | | | 1 | | | | 1 | **1** |
| **700** | | | | | 1 | | | | 1 | **1** |
| **710** | | | | | 1 | 1 | | | 2 | **2** |
| **720** | | | | | 1 | | | | 1 | **1** |
| **Total No** | **92** | **1** | **3** | **96** | **1102** | **1280** | **92** | **36** | **2510** | **2606** |

**Table 10-9: Summary of reproductive characteristics of female turbot *Psetta maxima* from different ICES areas (after Moreau, 2010b).**

| | North Sea/ Skagerrak | English Channel | Celtic Sea | Irish Sea |
|---|---|---|---|---|
| Proportion females (age 2 - 5 years) | 50 - 80 % | 30 - 50 % | 40 - 60 % | 40 - 50 % |
| Proportion females (age > 5 years) | 60 - 80 % | 10 - 100 % | 35 - 100 % | 30 - 100 % |
| Spawning period | Apr–Aug | May-Sep | Apr-Jul? | May–Aug? |
| Length at 0% maturity | 30 cm | 35 cm | 35 cm | 35 cm |
| Length at full maturity | 47 cm | ND | ND | ND |
| Age at maturity males | 3 years | 3 years | 3 years | 3 years |
| Age at maturity females | 4-5 years | 4-5 years | 4-5 years | 4-5 years |
| Monthly variation in condition factor | NO | NO | NO | NO |

ND* : not determined

**Table 10-10: Overview of the requirements for biological sampling of turbot *Psetta maxima* under the DCF for the period 2011-2013 (EC/2010/93).**

| Species | Area/Stock | Species Group | Age N°/1000 t | Weight | Sex | Maturity |
|---|---|---|---|---|---|---|
| *Psetta maxima* | IIIa | G2 | 250 | T | T | T |
| *Psetta maxima* | IV, VIId | G2 | 250 | T | T | T |
| *Psetta maxima* | all areas (NE Atlantic + W Channel) | G2 | 250 | T | T | T |

**Table 10-11: Compilation of the scheduled sampling effort of Member States for biological parameters in turbot *Psetta maxima* for the period 2011-2013 (source: reports RCM's 2010).**

| Species | Species Group | MS | 2011 | 2012 | 2013 | Fishing ground | Age (N° per year) | Weight (N° per year) | Sex-ratio (N° per year) | Maturity (N° per year) | Data sources |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Psetta maxima* | G2 | / | | | | IIIa | | | | | |
| | | TOTAL | | | | | 0 | 0 | 0 | 0 | |
| *Psetta maxima* | G2 | BEL | X | X | X | IV | 25 | 25 | 25 | / | Comm. + Surveys |
| *Psetta maxima* | G2 | DNK | X | X | X | IV, VIId | 300 | 300 | 100 | 100 | Comm. + Surveys [(a)] |
| *Psetta maxima* | G2 | NLD | X | X | X | IV, VIId | 720 | 720 | 720 | 720 | Comm. + surveys |
| *Psetta maxima* | G2 | UK | X | X | X | IV, VIId | 25 | 25 | 25 | 25 | Market + surveys |
| | | TOTAL | | | | | 1070 | 1070 | 870 | 845 | |
| *Psetta maxima* | G2 | UK | X | X | X | VIIe | 75 | 75 | 75 | 75 | Market + surveys |
| *Psetta maxima* | G2 | UK | X | X | X | VIIfgh | 75 | 75 | 75 | 75 | Market + surveys |
| | | TOTAL | | | | | 150 | 150 | 150 | 150 | |

(a) DNK: sex-ratio and maturity only on surveys

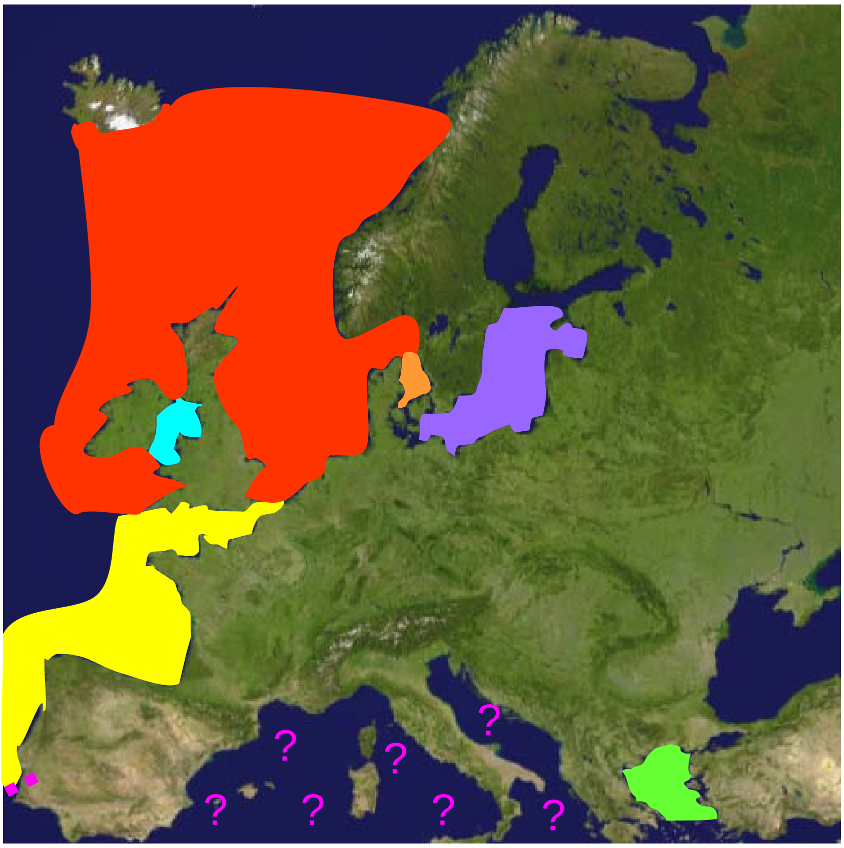


**Figure 10-1: Turbot *Psetta maxima*. Preliminary map of the population structure of turbot (From Annex 4, ICES, 2005).**

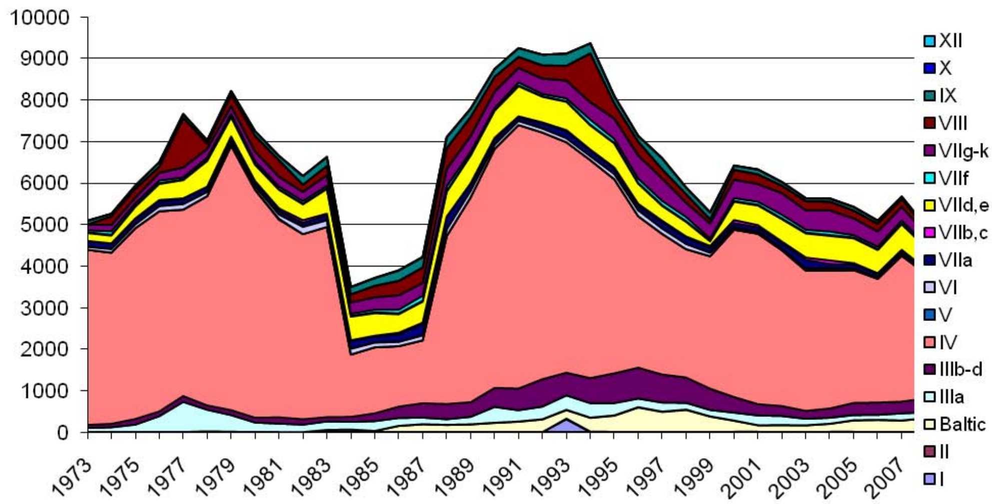


**Figure 10-2: International landings (t) of turbot *Psetta maxima* in the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

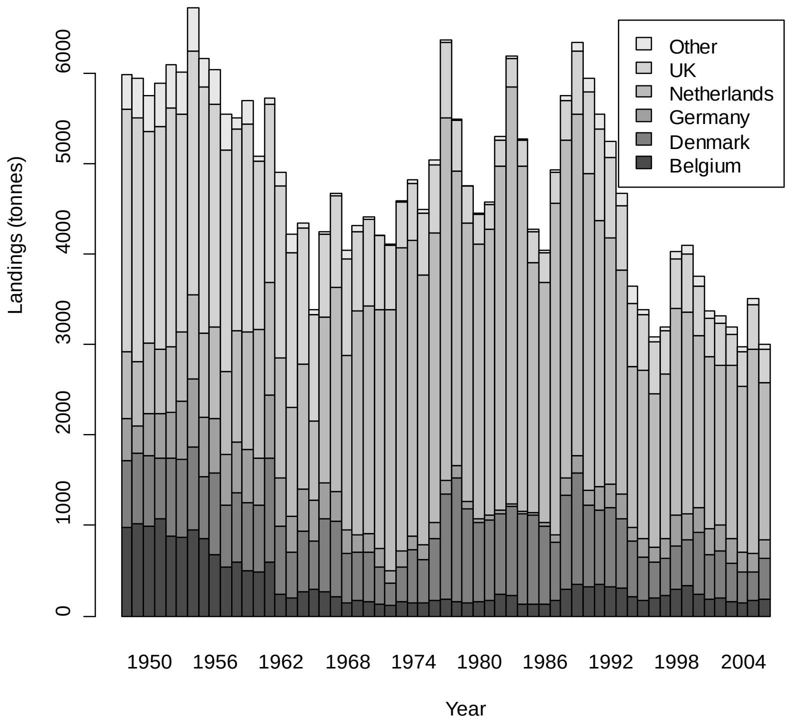


**Figure 10-3: North Sea Turbot *Psetta maxima*. Contribution of landings by country to North Sea total for the period 1950-2008.**

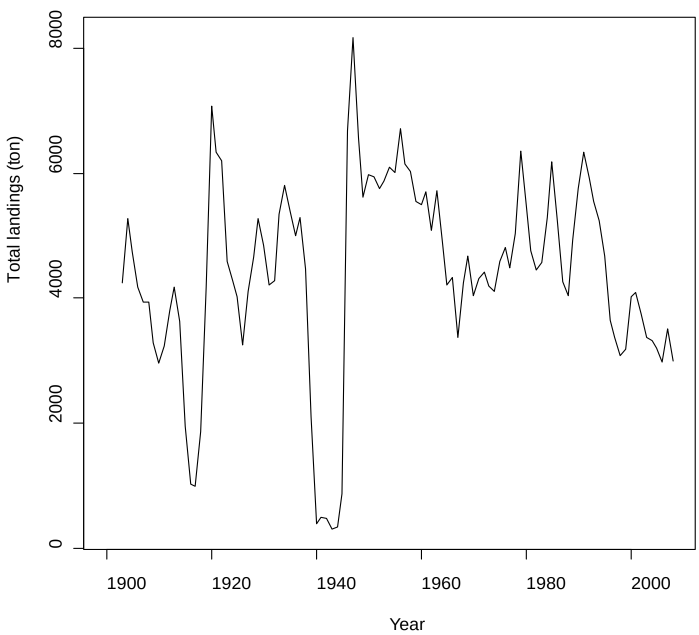


**Figure 10-4: North Sea turbot *Psetta maxima*. Total landings for turbot in the North Sea for the period 1903–2008.**

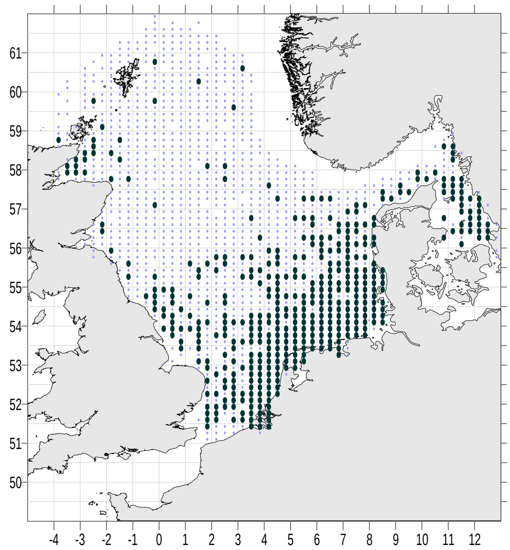

**Figure 10-5: Turbot *Psetta maxima* catches (present or absent) during the IBTS and BTS surveys.**

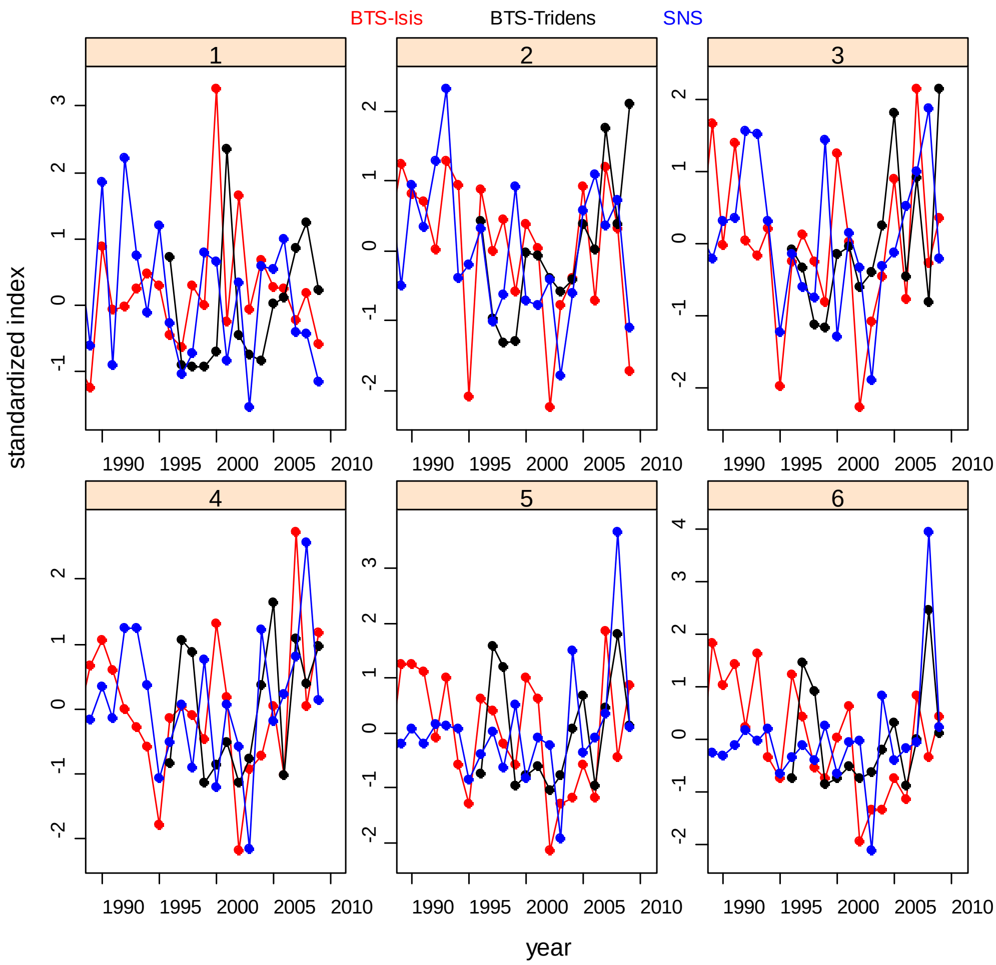


**Figure 10-6: Turbot *Psetta maxima* in the North Sea. Standardized time series for ages 1-6 of the three trawl surveys: BTS-Isis, BTS-Tridens, and SNS.**

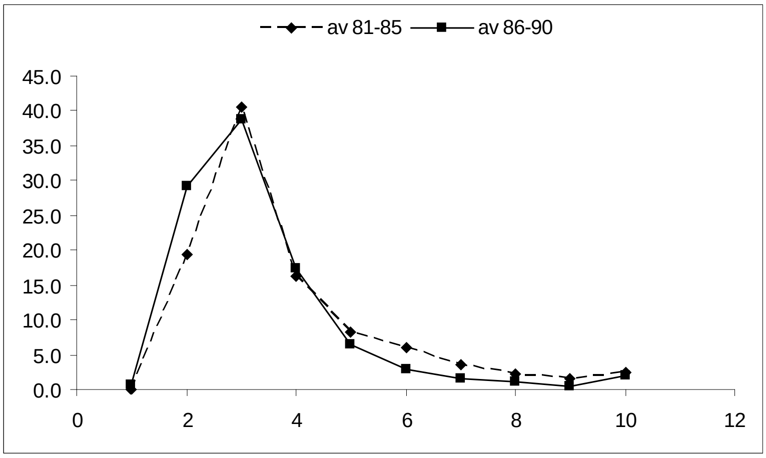


**Figure 10-7: Relative age distribution of turbot *Psetta maxima* in the commercial landings of the Dutch beam trawl fleet averaged over the periods 1981–85 and 1986–1990.**

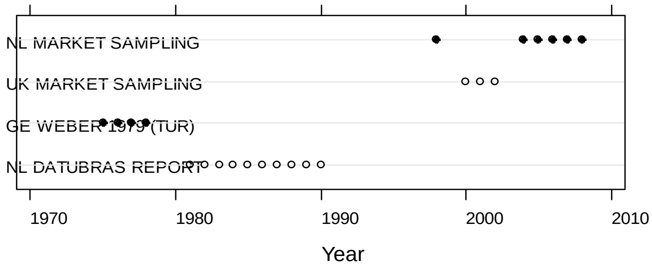


**Figure 10-8: Turbot *Psetta maxima* North Sea. Availability of market sampling data. Note that the Weber (1979) data is available for turbot only. Closed circles indicate availability of sex segregated data, open circles indicate sex separate data.**

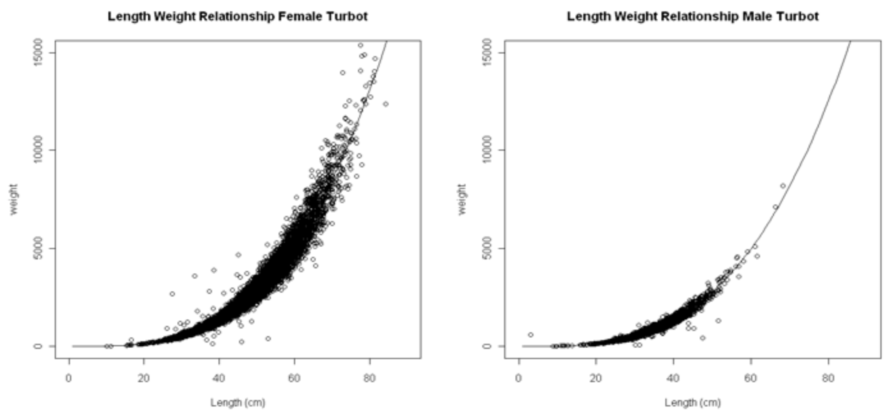


**Figure 10-9: Turbot *Psetta maxima* in the North Sea. Length-weight relationship of female and male turbot for 1984-1990, 1998, 2004-2009 and corresponding fitted power functions. Based on survey and market data. Figure taken from NESPMAN report.**

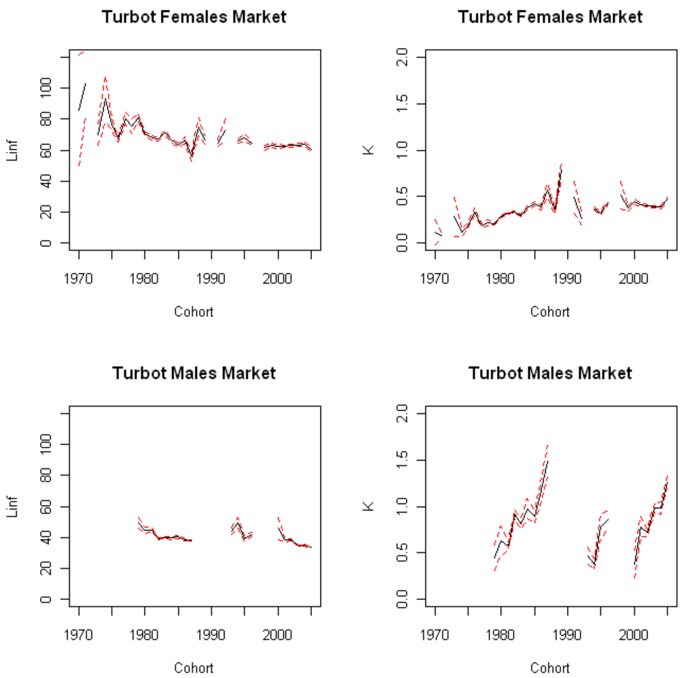


**Figure 10-10: Turbot *Psetta maxima* in the North Sea. Estimated parameters L∞ (± S.E.) and K (± S.E.) from the von Bertalanffy growth curve for the different cohorts of female (upper) and male (lower) turbot. Based on market data. Figure taken from NESPMAN report.**

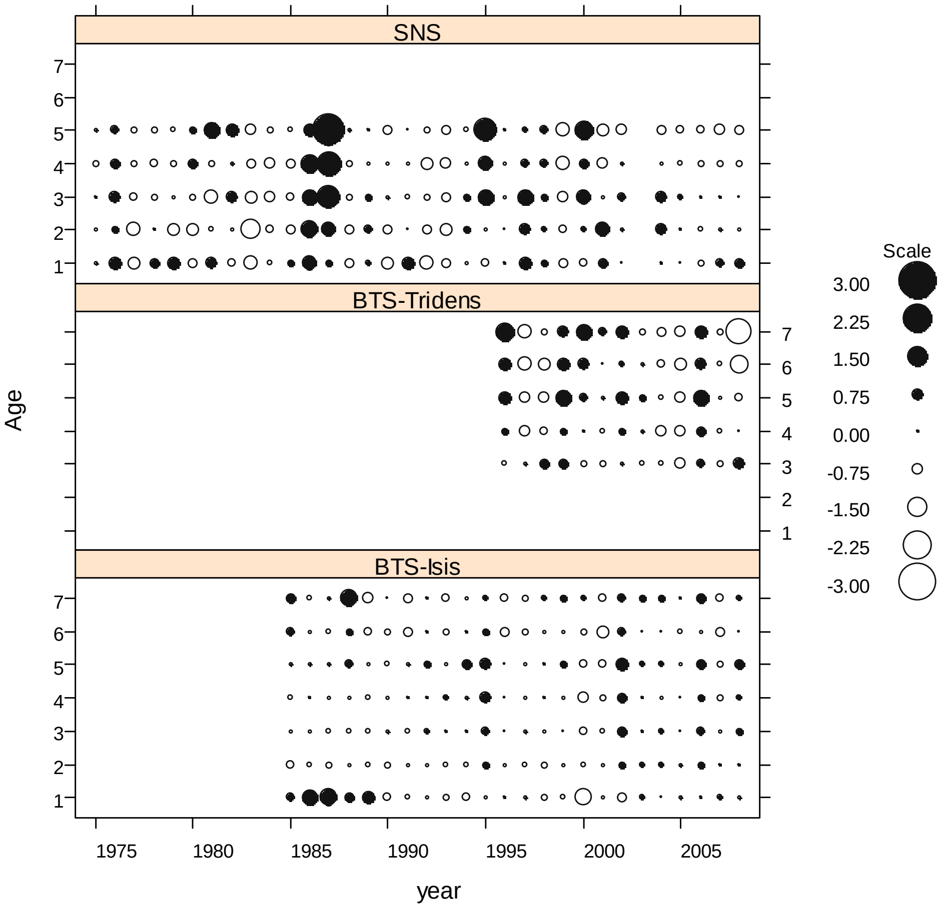


**Figure 10-11: Turbot *Psetta maxima* in the North Sea. Survey index residuals for all surveys from assessment where age selection has taken place for SNS and BTS-Tridens.**

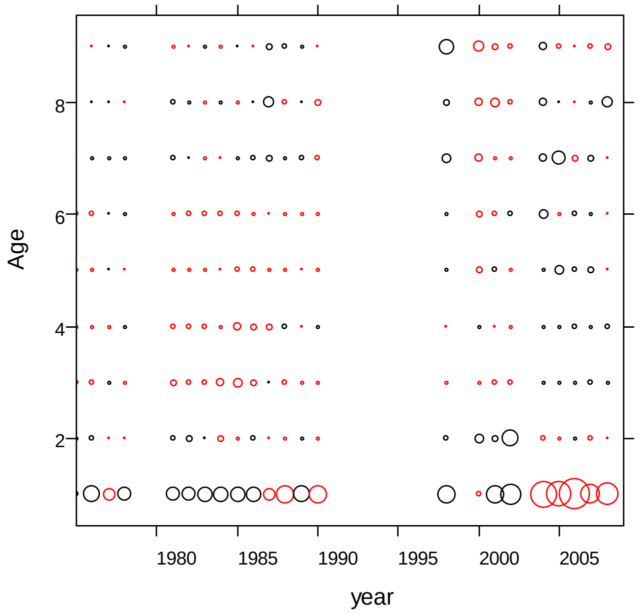


**Figure 10-12: Turbot *Psetta maxima* in the North Sea. Landings-at-age residuals from assessment where age selection has taken place for SNS and BTS-Tridens.**

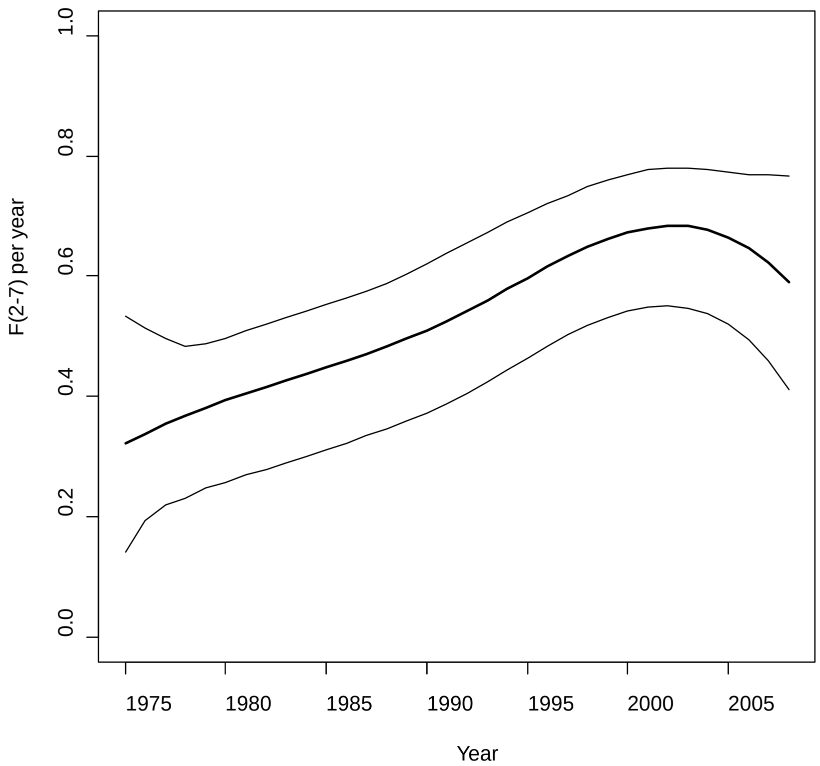


**Figure 10-13: Turbot *Psetta maxima* in the North Sea. F(2-6) estimates. Resulst are from the assessment where a limited number of ages is used for SNS and BTS-Tridens. Bold drawn line indicates model estimate. Thin lines indicate 95% confidence limits based on likelihood profile in ADMB.**

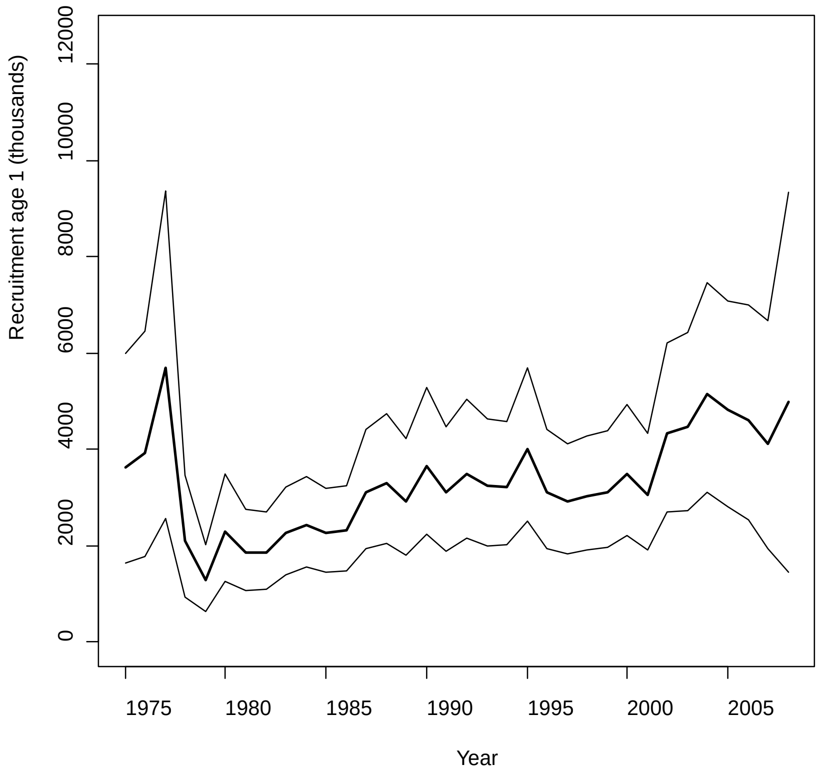


**Figure 10-14: Turbot *Psetta maxima* in the North Sea. Recruitment estimates. Resulst are from the assessment where a limited number of ages is used for SNS and BTS-Tridens. Bold drawn line indicates model estimate. Thin lines indicate 95% confidence limits based on likelihood profile in ADMB.**

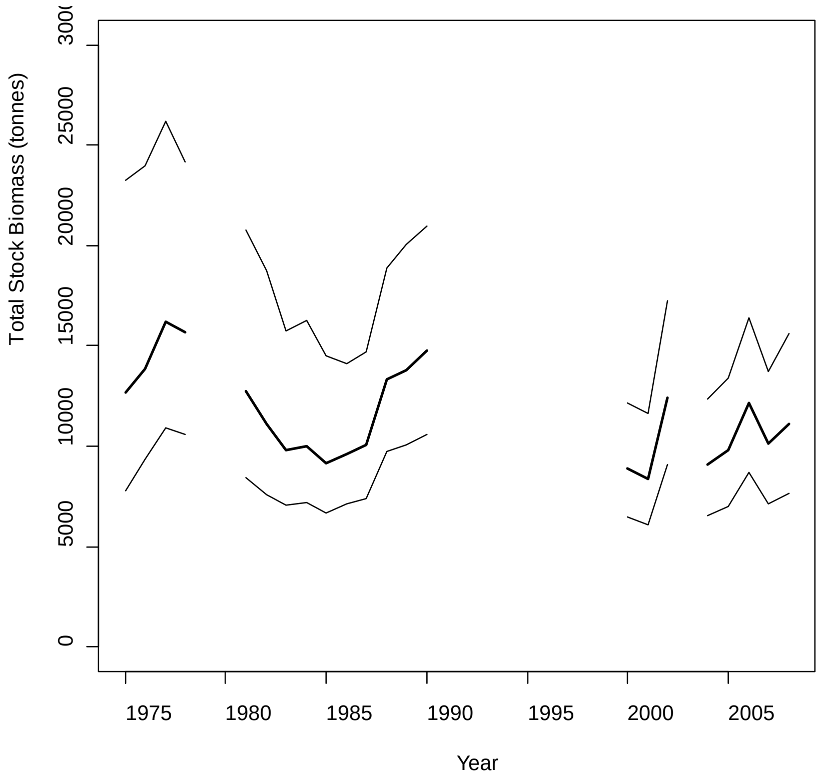


**Figure 10-15: Turbot *Psetta maxima* in the North Sea. Total Stock Biomass estimates. Results are from the assessment where a limited number of ages is used for SNS and BTS-Tridens. Bold drawn line indicates model estimate. Thin lines indicate 95% confidence limits based on likelihood profile in ADMB.**

# 11 Lemon Sole

## 11.1 General Biology

Lemon sole *Microstomus kitt* is a commercially important flatfish that is found in the shelf waters of the North Atlantic from the White Sea and Iceland southwards to the Bay of Biscay (Wheeler 1969). The basic biology of lemon sole is given in Wheeler (1969) and the life history of lemon sole in Scottish waters was reviewed by Rae (1965). Lemon sole spawn in the northwest of the North Sea in April and spawning spreads north and east as the season progresses (Rae 1965). In the western English Channel, lemon sole spawn in April and May (Jennings *et al.* 1973). Newly metamorphosed lemon sole are rare in eastern Scottish waters and few juveniles are caught in either the shallows of the east coast of Scotland, or in the English Channel. In Scottish waters lemon sole begin to mature at approximately 2 years of age. Male length at 50 % maturity is in the 3rd year at around 19 cm length and female length at 50% maturity is at around 26 cm length, or 4-5 years of age.

## 11.2 Stock ID and possible management areas

There is little information available on lemon sole stock identity. Using tagging information, Jennings *et al.* (1993) suggested that the seasonal movements of lemon sole in the western Channel were restricted and that lemon sole in this area could be considered as a separate stock. Further work on lemon sole stock identity is required.

## 11.3 Management regulations

There is currently no minimum landing size for lemon sole. In ICES Areas IIa and IV, a combined annual TAC is set for lemon sole and witch. In 2006 and 2007 this TAC was 6,175 t, in 2008 and 2009 6,793 t and in 2010 the TAC was 6,521 t.

## 11.4 Fisheries Data

Lemon sole are generally caught in mixed fisheries for flatfish by beam trawlers and otter trawlers.

### 11.4.1 Commercial catches and discard data

Total landings of lemon sole in FAO Area 27 between 1950 and 2008 are given in Figure 11-1 and landings by country are given in Figure 11-2. Between 1950 and 1970, landings ranged between 6 000 and 8 000 t and then steadily increased to a peak of 14 504 t in 1983, before declining again to 1995. Landings increased to the series maximum of 15 506 t in 2001, dropped significantly the following year to 10 389 t, but have been around 12 000 t since 2004. The majority of landings are taken by Iceland and Spain. However, Denmark, Belgium, the UK (England and Wales, E&W) and the UK (Scotland) all take over 1 000 t annually.

### 11.4.2 Commercial catch-effort data

The UK (E&W) has estimates of beam trawl and otter trawl lemon sole lpue (kg/h) in the North Sea and for the 'Westerly' area (ICES Divisions VIIe-h). In the North Sea, three areas, off the English northeast coast provide the majority of UK landings. Lpue trends for otter and beam trawlers in this area show a slight decline throughout the time series. In rectangle group 10, (the eastern Channel, ICES Division VIId), the lpue trends is generally more of an upward one for both gears (Figure 11-3).

In ICES Division VIIe, the lpue of otter trawlers in 7eW (ICES Division VIIe – west) and 7eN (VIIe – north) shows a slight decline through the time series. For all three areas in VIIe, beam trawl lpue has generally decreased since 1983, showed a small peak in 1995-1997, before becoming relatively steady for the last few years. In 2009, however, increases in both beam trawl and otter trawl gears are seen in all parts of ICES Division VIIe.

## 11.5 Survey data

#### International Bottom Trawl Survey

The Q1 IBTS index of abundance for lemon sole between 1970 and 1993 suggested that abundance was stable in the early years between 1974 and the early 1980's, but increased up to 1983. Between 1983 and 1990, abundance was considered to be stable (Heessen & Daan 1996). Since the early 1990s, abundance increased to a series high in 2002, before declining to early 1990 levels in 2006 (Figure 11-4).

#### UK (E&W)

Lemon sole abundance indices are currently available for 4 survey series - the Irish Sea/Bristol Channel (September) (VIIa, f and g) beam-trawl survey, the Channel (VIId) beam-trawl survey (July), the Carhelmar (VIIe) beam-trawl survey (October) and the English groundfish (IVb & c) GOV trawl survey (August) (Figure 11.5). In the eastern Channel, abundance has been variable with a large peak observed in 1995 and smaller peaks in 2002, 2004 and 2008. In the Carhelmar survey lemon sole abundance was initially relatively high but decreased in the early 1990's until the early 2000's. This was followed by an increase to 2004, but abundance then decreased again. However, abundance increased again in 2008 and 2009. In the Irish Sea/Bristol Channel, lemon sole abundance steadily increased from the beginning of the time series to 2003, since when it has declined. In the North Sea, lemon sole abundance has generally increased through the time series.

#### Netherlands

The Netherlands has beam trawl surveys in the southeast North Sea between 1985 and 2009 (Isis) and in the central North Sea between 1998 and 2009 (Tridens). Abundance indices for these surveys are given in Figure 11-6. In both surveys, abundance has generally increased through the series. However abundance in the central North Sea, has almost doubled since the survey began.

## 11.6 Biological sampling

Biological data from the fishery have been collected by UK (E&W), the Netherlands and Belgium

## 11.7 Biological parameters and other research

Length weight data are available from surveys and from market sampling and given in the NESPMAN report (EU 2010). Male and female length weight relationships are:

Male $Wt = 0.0054\ L^{3.205}$

Female $Wt = 0.0075\ L^{3.128}$

## 11.8 Analysis of stock trends/assessment

With regard to trends that may be indicative of stock status, information is available on catches, lpue and survey abundance for several areas. For many areas, the information shows conflicting trends.

In the North Sea, landings peaked in the mid-1980's at just over 8 000 t and have since declined. They have been relatively stable since 2001, but are the lowest of the time series. Lpue data from UK (E&W) otter and beam trawlers off the northeast coast of England (area 1 & 2 in the graph) also show a general decrease. However, survey abundance show an increasing trend (Figure 11-4).

In the eastern Channel (ICES Division VIId) since 1973, landings decreased significantly from 1151 t in 1995 to 140 t in 1999, before increasing to 471 t in 2003, but have since decreased again. However, UK (E&W) lpue data suggest an increase in both the otter trawl and beam trawl gears. The English Eastern Channel beam trawl survey abundance appears to have fluctuated greatly with no real trend since 1998.

In the western Channel, the pattern of landings is similar to that of the eastern Channel. Lpue data suggest a general decrease for beam trawl lpue and a fluctuation in the otter trawl lpue.

In the Irish Sea, landings have decreased substantially since the mid 1990s, while in the Celtic Sea and Bristol Channel they have remained relatively stable. The English Irish Sea/Bristol Channel beam trawl survey index covers both these areas and shows an increase I abundance to 2003, followed by a continual decline to 2009.

## 11.9 Data requirements

In general, there is a great deal of data already available for lemon sole. However, in order to progress this work and undertake an analytical assessment, the following data are required:

- Discussion on appropriate stock units for lemon sole assessment
- Catch at age, effort and cpue data for countries other than the UK (E&W), particularly those that contribute significantly to the total international landings. Note however that in the Data Collection Framework, the species is classified as Group II and for all species classified in Group 2, there is often time limited access to the fish in port sampling and those species are most often not sampled.
- Additional survey data. The English contribution to the Q3 IBTS in the North Sea is not used to provide abundance indices for either the North Sea plaice or sole assessments, and it may be that the use of this survey to indicate trends in lemon sole abundance is not appropriate and that other surveys that use beam trawl gears might be better suited to providing abundance indices for this species in the North Sea (e.g. the Belgian southern North Sea BTS). In addition, the English Irish Sea/Bristol Channel survey could be separated into its VIIa and VIIf&g components to provide regional survey abundances more in line with management units of other flatfish species. There may also be additional information in the English Q1 Celtic Sea survey (although this was discontinued in 2005). Also, given summary data already provided, the possibility of providing abundance indices from the French Evhoe survey could be considered.

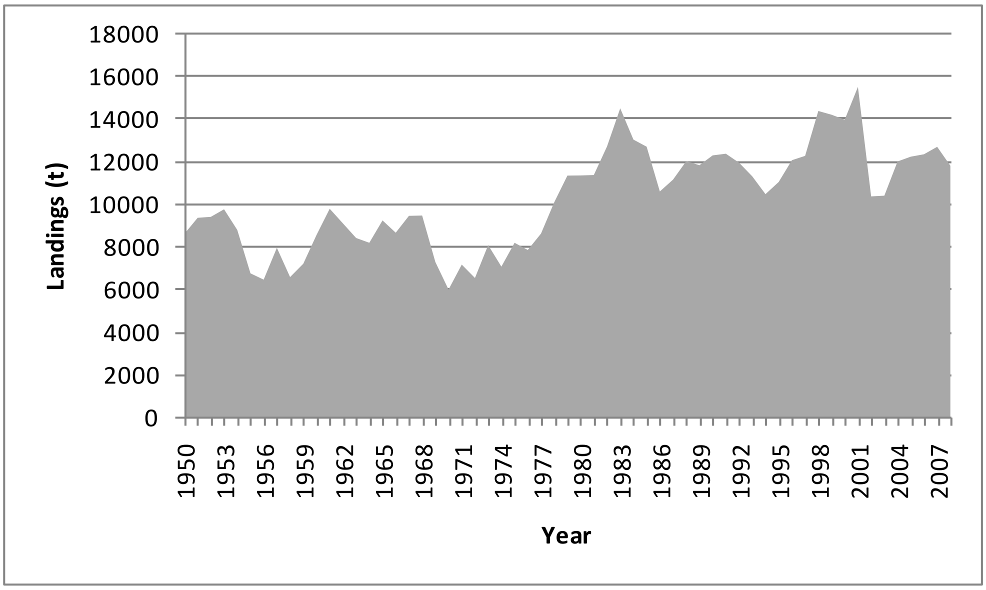


**Figure 11-1: Total international landings (t) of lemon sole for FAO Area 27, for 1950 – 2008. Source: FishStat**

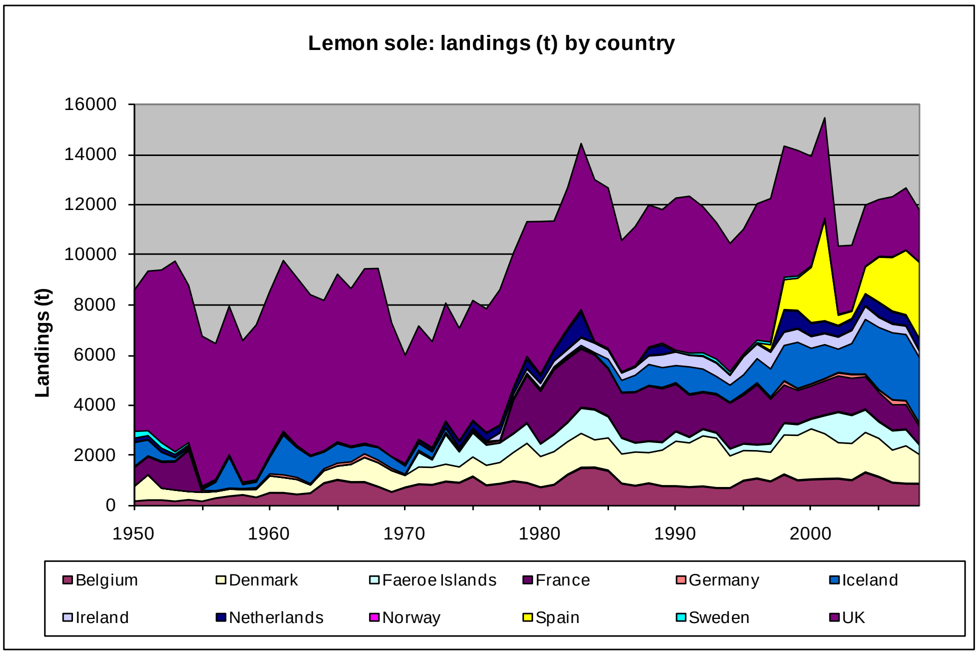


**Figure 11-2: Total international landings (t) of lemon sole for FAO Area 27, for 1950 – 2008, by country of landing. Source: FishStat**


**Figure 11-3: Lpue (kg/h) of (top panels) North Sea lemon sole in North Sea areas[1] 1, 2, 8 & 10 and (bottom panels) 'westerly' lemon sole in ICES Division VIIe West (7EW), North (7EN) and South (7ES), caught by UK (E&W) otter trawlers (OT, left panels) and beam trawlers (BT, right panels) of < 24 m length.**

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[1] NS areas : 1 &2: Western, 8 : Central, 10 : Eastern Channel

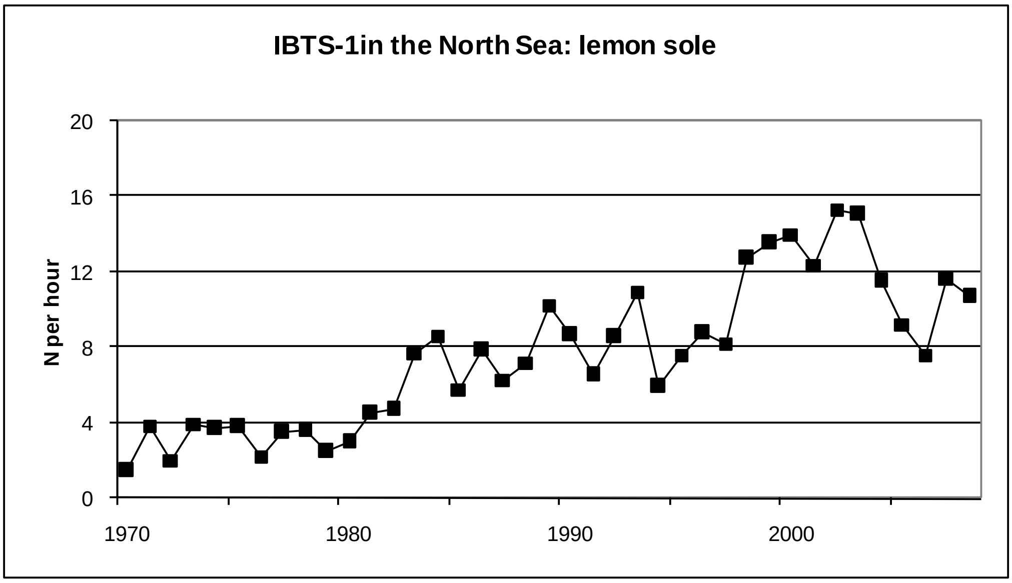


**Figure 11-4: Index of abundance (number per hour) of lemon sole caught in the Q1 International Bottom Trawl survey between 1970 and 2008.**

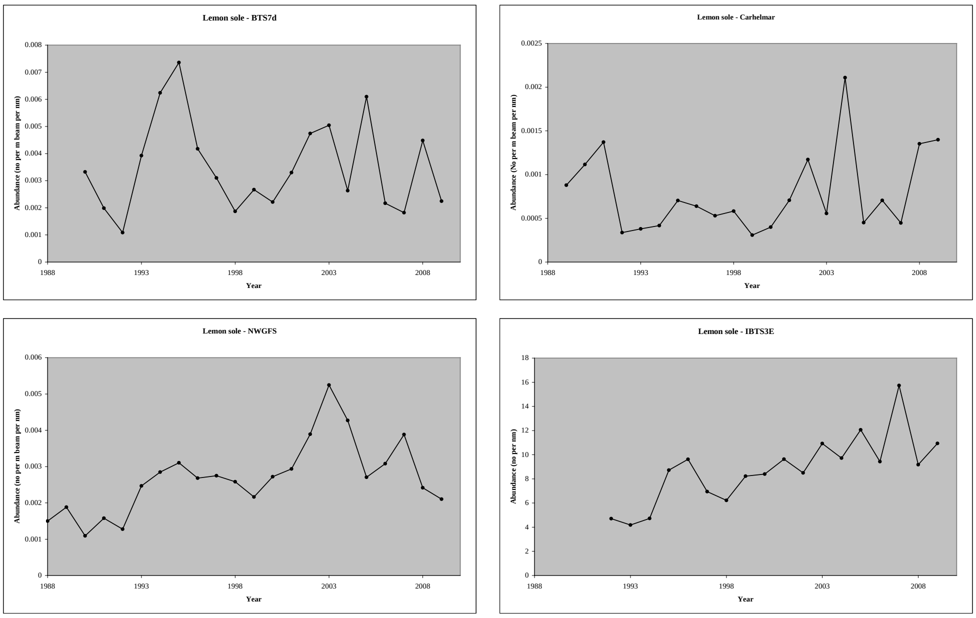


**Figure 11-5: Indices of abundance of lemon sole caught in 4 Cefas surveys: the eastern Channel Beam Trawl survey (BTS7d)(July), the western Channel (VIIe) (Carhelmar) Beam Trawl survey (October), the Irish Sea/Bristol Channel (VIIa, f, g) Beam Trawl survey (NWGFS)(September) and the 3rd Quarter North Sea IBTS Groundfish Survey (IBTS3E)(August). Abundances are given as number of fish per m beam per nm for the beam trawl surveys and as number of fish per nm for the groundfish survey.**

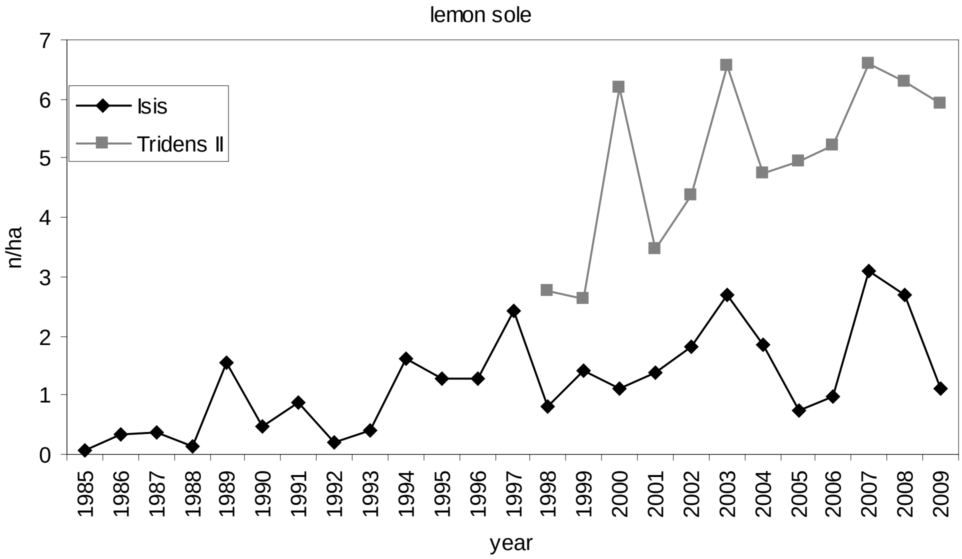


**Figure 11-6: Lemon sole abundance (number per 30 minute tow) in Dutch Beam Trawl Surveys, Isis (SE north Sea) and Tridens (Central North Sea)**

# 12 Dab

## 12.1 General biology

Dab is a widespread demersal species on the Northeast Atlantic shelf and distributed from the Bay of Biscay to Iceland and Norway; including the Barents Sea and the Baltic. Next to sandeel, it is the secondmost abundant species in the North Sea (Daan *et al*. 1990). According to ICES IBTS results and other research surveys its centre of distribution in the North Sea is located in the southern North Sea (Lozán 1988; Daan *et al.* 1990, ICES 2010 (Figure 12-1)).

With regard to growth parameters it is an intermediate species with a maximum life span of 12 years and a population doubling time of about 1.4 - 4.4 years (Froese and Pauly 2004).

Spawning, pelagic development and settlement of postlarvae all occur within the spawning ground (Bohl 1959). Settled 0-group specimens migrate to nearby nursery grounds (Bolle *et al.* 1994). Recruitment success in terms of 0-group abundance in autumn is negatively related to spring water temperature (Henderson 1998).

Regional migrations (< 200 nm distance) occur. Tagging experiments show that German Bight spawners represent a transient aggregation from the entire southern North Sea (Rijnsdorp *et al.* 1992).

Sex- and age-dependent seasonal within-area migrations between spawning grounds, nursery areas and adult feeding grounds are triggered by changes in water temperatures (Saborowski and Buchholz 1997). Spatial aggregations and habitat do not occurr, although very fine scale distribution patterns, i.e. patchiness, are present at scales < 2 km (Stelzenmüller *et al.* 2005a, 2005b).

The 0-group shows a general preference for sheltered areas, but not for particular depth or salinity zones (Riley *et al*. 1981). Correspondingly, dab appears to be 'euryhaline' and 'eurytherme' (Bohl 1959; Henderson and Holmes 1991).

Dab has proven to be a valuable indicator in ecotoxicological studies (e.g. Vethaak *et al*. 1992).

## 12.2 Stock identity and possible assessment areas;

The several spawning grounds and the wide distribution of dab indicate the presence of more than one stock. However, egg surveys to verify potential spawning grounds are available only to a limited extent.

Meristic data (Lozán 1988) corroborate the hypothesis of several stocks for dab, distinguishing significantly between populations from western British waters and the North Sea and the Baltic. Further, tagging experiments and significant meristic differences within Baltic populations led Temming et al. (1989b) to propose an individual stock around Bornholm, separated from IIIc22. However, no further scientific evidence is available.

Under the EU Data Collection Framework, 5 stock/management units have been defined (those underlined are subject to sampling under the DCF):

- II, V, VI, VII (excl. d), VIII, IX, X, XII, XIV
- <u>IIIa north</u>
- <u>IIIa south, IIIb-d</u>
- <u>IV, VIId</u>
- VIId.

## 12.3 Management regulations (TAC's, minimum landing size)

According to EU-Regulations a precautionary TAC is given in EU waters of IIa and IV together with flounder (*Plathichthys flesus*). The TAC decreased from 2002 to 2010 from about 27 000 to 18 800 t. No minimum landing size is defined.

## 12.4 Fisheries data

Dab is a by-catch species in fisheries for plaice, sole and demersal roundfish. According to ICES catch statistics, annual catch of dab in ICES Divisions III, IV, and VII has been well above 10 000 t since 1973. Apparent decreases in total catch in the 1980's and 1990's are due to unreported catches by the Netherlands, Norway and Spain (Figure 12-2 and Figure 12-3 ). The main fishery divisions are IVb, IVc, VIId and IIIa. The main fishing gear in the North Sea is the beam trawl with mesh sizes between 80 and 100mm. In the Baltic the otter trawl is used with mesh sizes >100mm.

Dab and plaice are the most discarded species in the ICES area. For the period 1960 to 1981, discards in IIIc22 were estimated for Danish and German fisheries (Temming 1983). The sampling under the DCF programme shows that in the beam trawl fishery on sole and the otter trawl fishery on plaice about 95% of the catches on dab are discarded. An example for the 2$^{nd}$ quarters in 2007, 2008 and 2009 on length-frequency distribution (LFD) and age composition in IVb is given in Figure 12-4 and Figure 12-5 for beam trawl and otter trawl, respectively. Landings on dab depend on several factors: the crew, the availability of the target species and market prices.

## 12.5 Survey data, recruit series

Important surveys that provide information on distribution, abundance and length frequency for dab are the International Bottom Trawl Survey IBTS in quarter 1 and 3 and the Beam Trawl Survey in quarter 3. Abundance indices from IBTS and BTS are shown in Figure 12-6. The abundance in IBTS Q1 increases since 1980. Length frequencies for the German BTS in the North Sea are given in Figure 12-7. In some years a recruiting year class can clearly be seen, as e.g. in 1999, 2005 and in 2008.

## 12.6 Biological sampling

For most UK surveys, biological information is collected for dab. In addition, data on length distributions, distributions and abundance is available in Cefas technical reports for the Celtic Sea (Warnes and Jones 1995), the Irish Sea (Parker-Humphreys 2004a) and the English Channel and southern North Sea (Parker-Humphreys 2004b). Length information from market sampling for this species is available for 2000 – 2003 only. Biological samples for otoliths, weight, sex and maturity are only available for 2000 – 2002.

During different flatfish surveys by the Netherlands biological samples for dab are being collected since many years. These data include information on length, weight, sex and maturity stage. Market sampling is carried out since 2002.

Germany routinely measured dab by sex during surveys. Age reading started in 1997 with BTS. Market samples for dab are not available.

From the DCF programme, length sampling and ageing information by gear and quarter are available.

## 12.7 Population biology parameters and a summary of other research

Several extended population studies provide regional age-length keys by sex, fecundity data and small scale distribution analyses for dab in the southern North Sea, the English Channel and the Bay of Biscay (Deniel 1990; Rijnsdorp *et al*. 1992; Jennings *et al.* 1999). Maturity is reached at about 2 - 3 years. Maturity data are available in terms of combined age-at-maturity and length-at-maturity information (Deniel 1990; Jennings *et al*. 1999) (Deniel and Tassel 1986).

Mortality rates for 0-group dab during winter time have been calculated for 11 time series (Iles and Beverton 1991). Temperature is considered as a mortality factor for eggs (van der Land 1991).

## 12.8 Analyses of stock trends and potential status indicators

For the North Sea survey indices indicate that the population size has increased in the long term and had a considerably high level in recent years (Figure 12-6). High abundances can be found in the southeast along the German and Dutch coast and in the centre of the North Sea in the Doggerbank area. Biomass indices are linked to the abundance indices. Length composition has been stable over the years showing a slight increase of the range of sizes in recent years. Age 1 and age 2 dab are most abundant. Female dab are more abundant than male dab.

## 12.9 Data requirements

Information on catches and landings should be made available from existing market and onboard sampling since the early 2000's. The best way to get more information about discards is the concurrent onboard sampling. More biological data such as length and sex distribution and age composition should be collected. At this moment the sampling effort is not well evaluated and this needs to be done before any recommendation can be made.

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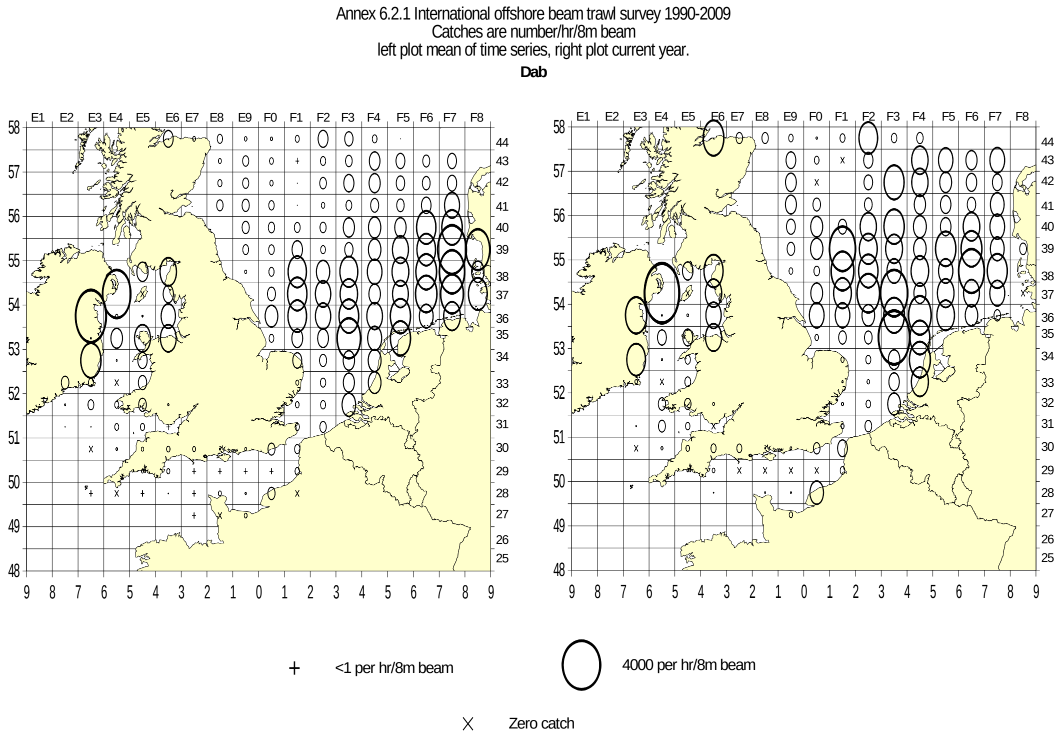


**Figure 12-1: Abundance of dab in the International offshore beam trawl survey 1990-2009. Source WGBEAM 2010 (ICES 2010)**

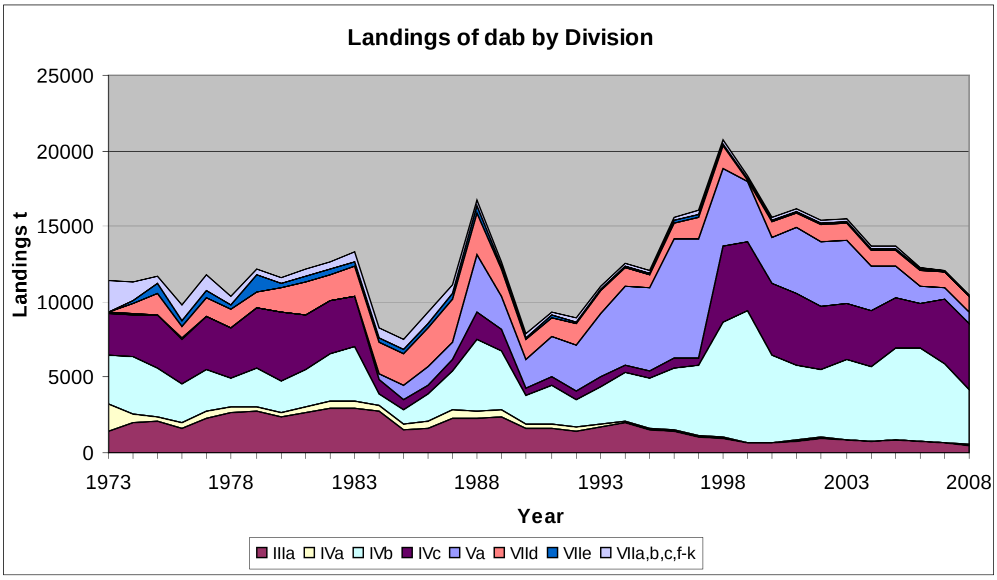


**Figure 12-2: Dab landings by ICES Division**

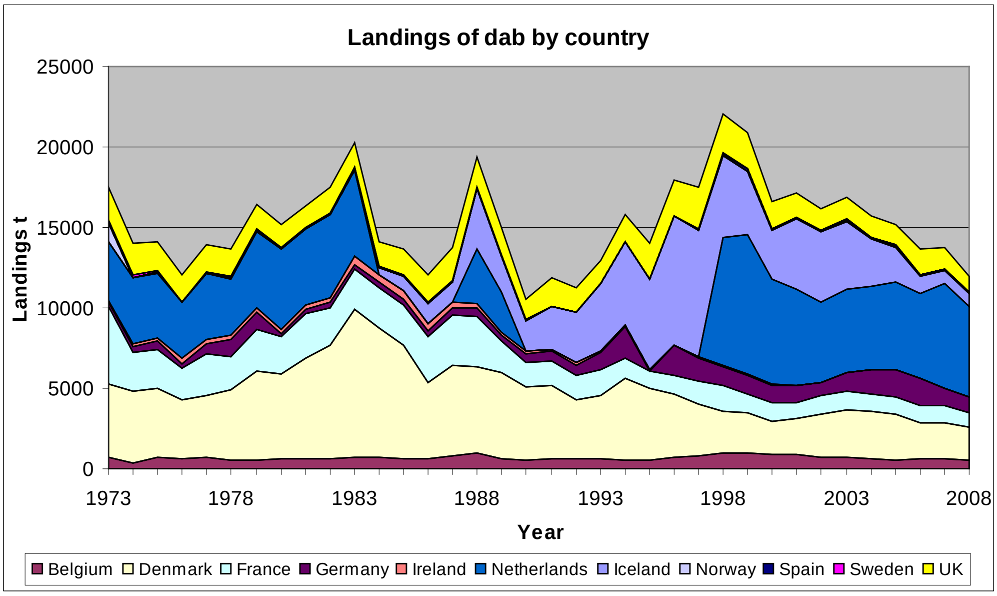


**Figure 12-3: Dab landings by country**

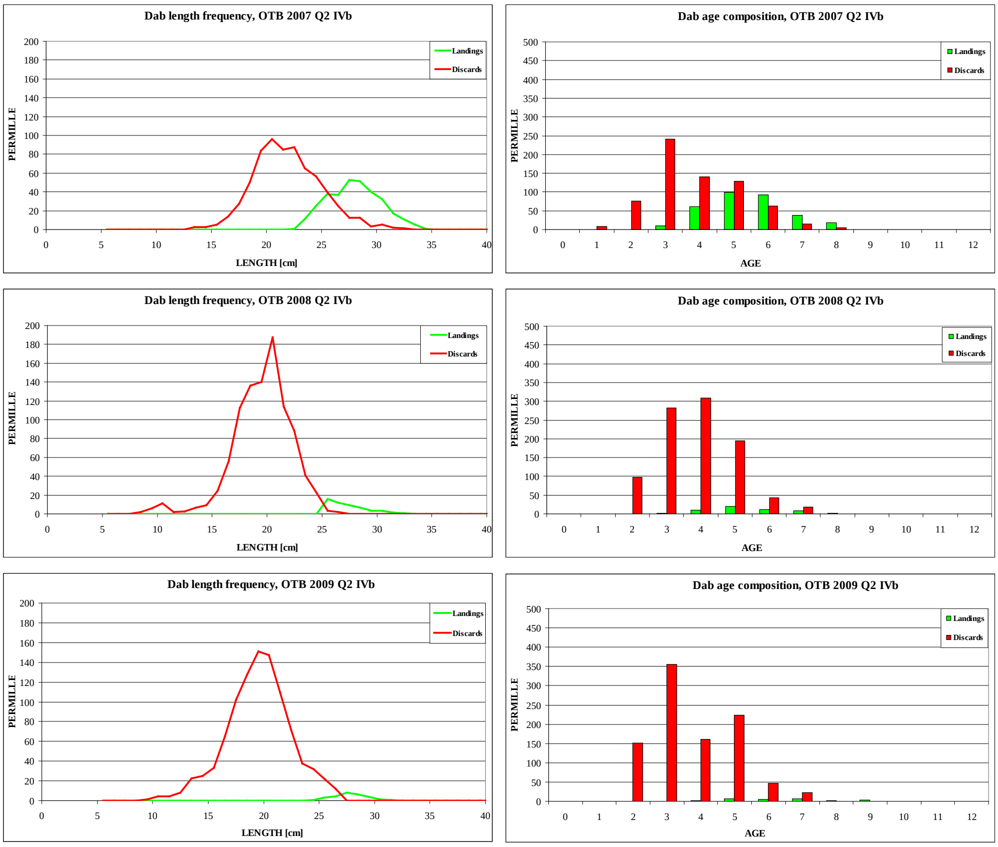


**Figure 12-4: LFD of dab catches in IVb from 2007 to 2009, Q2 by gear OTB. From German DCR program.**

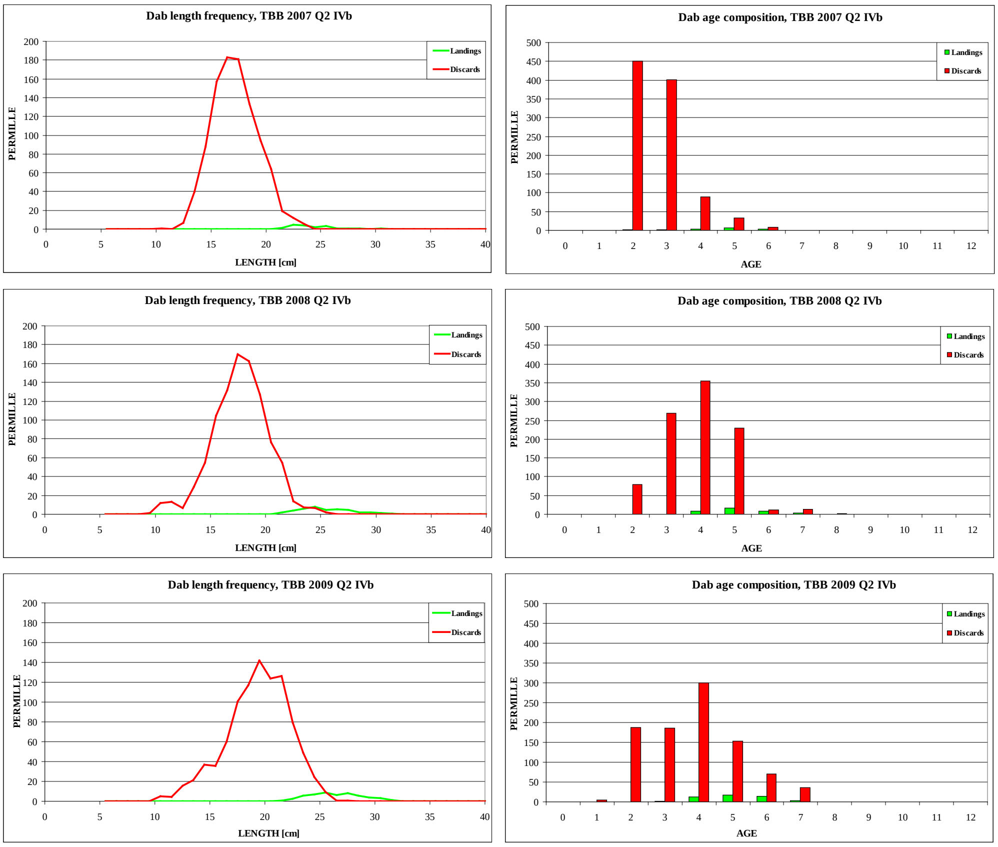


**Figure 12-5: LFD of dab catches in IVb from 2007 to 2009, Q2 by gear TBB. From German DCR program.**

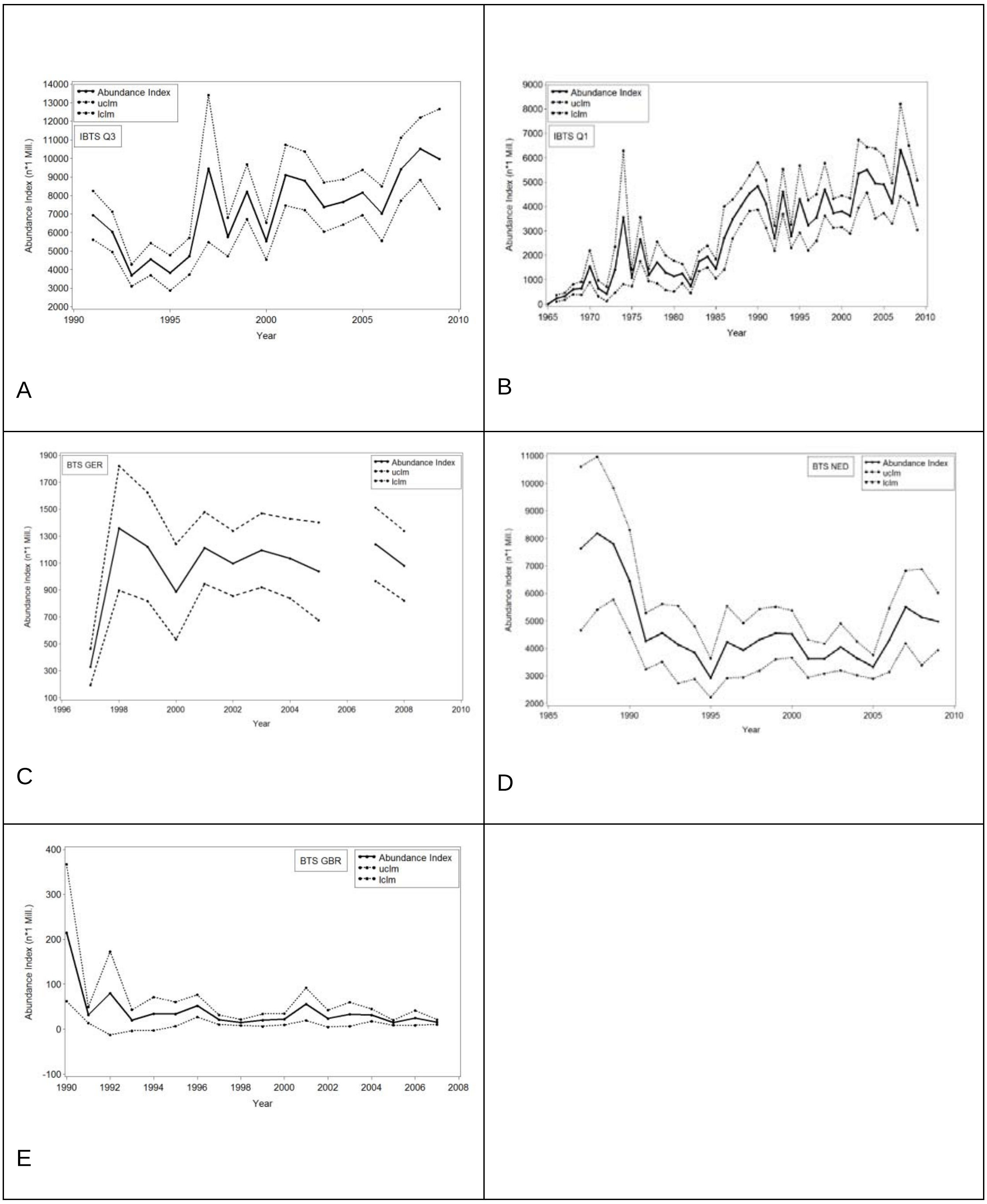


**Figure 12-6: North Sea dab: abundance indices (n*1 Mill) for IBTS Q3 (A), IBTS Q1 (B), German (C), Dutch (D) and British BTS (E). Confidence intervals (CI) were set at the 95% level of significance of the stratified mean.**

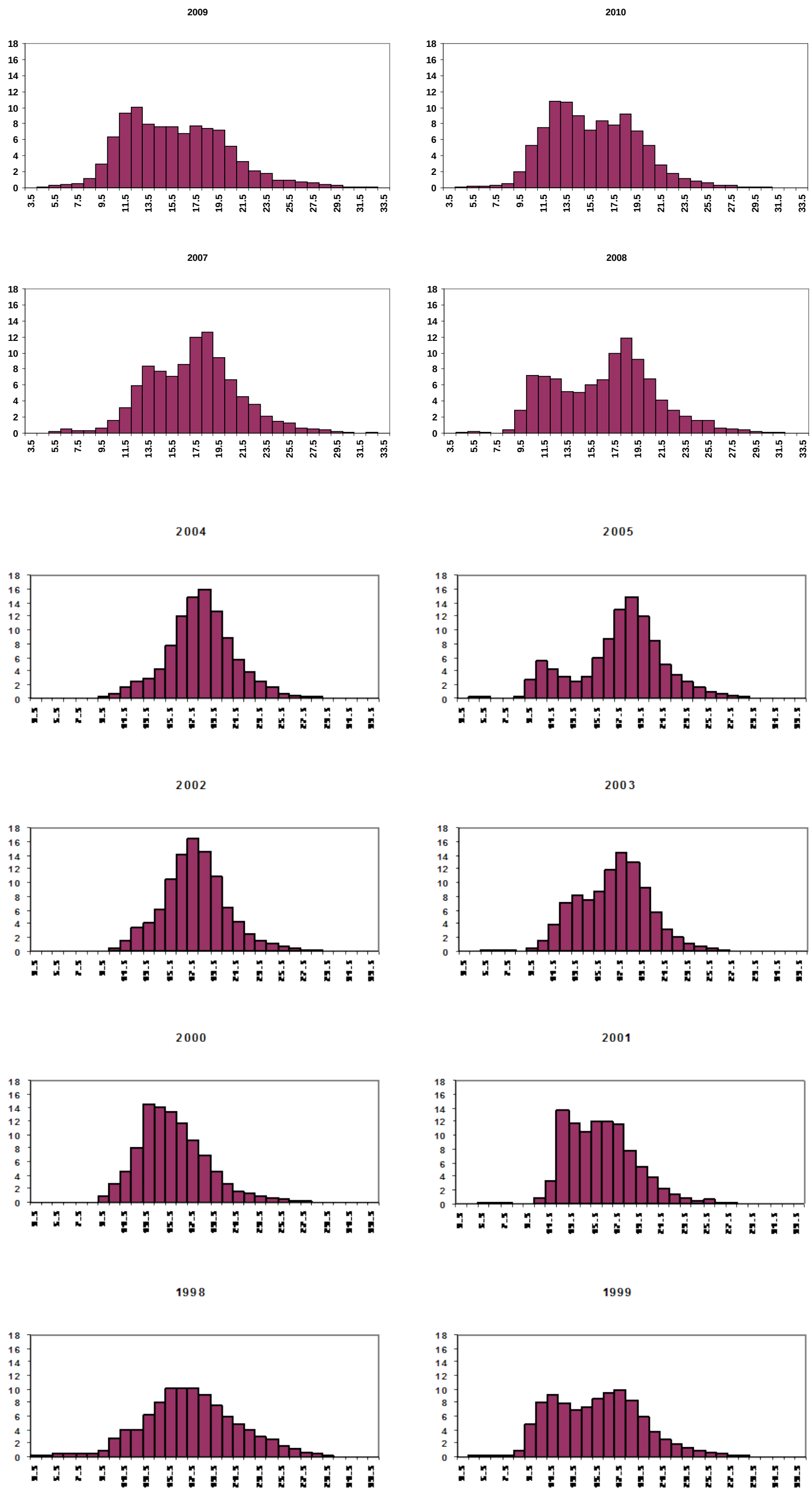


**Figure 12-7: Length-frequency distribution (LFD) of dab from the German BTS, ICES area IVb. Frequency in %.**

# 13 Flounder in IV and IIIa

## 13.1 General biology

Flounder (*Platichthys flesus*) is a euryhaline flatfish: the life cycle of each individual usually includes marine, brackish, and freshwater habitats. It has a coastal distribution in the Northeast Atlantic, ranging from the White Sea and the Baltic in the north, to the Mediterranean and Black Sea in the south (Whitehead *et al.* 1986). In the North Sea flounder is mainly found in the southeastern part and in lower abundance off the eastern UK coast (Figure 13.1) Flounder can live in low salinity water but they reproduce in water of higher salinity. In the North Sea, Skagerrak and Kattegat flounder spawn between February and April.

Flounder settle at a size of 8-10 mm. The bottom-living stages appear by the end of April in brackish water near river mouths. The juveniles either stay in the brackish environment or migrate further up the rivers.

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 (Rijnsdorp & Vethaak 1989).

## 13.2 Stock identity and possible assessment areas

There is no information about stock identity and possible stock assessment areas in the North Sea, Skagerrak and Kattegat. Within the North Sea there may exist a number sub-populations.

## 13.3 Management regulations

There is no minimum landing size for this species in EC waters.

In the EC waters of IIa and IV there is a combined TAC for flounder and dab. Since 2006 this TAC was:

| | |
|---|---|
| 2006 | 17,100 t |
| 2007 | 17,100 t |
| 2008 | 18,810 t |
| 2009 | 18,810 t |
| 2010 | 18,810 t |

## 13.4 Fisheries data

In the North Sea and in Skagerrak-Kattegat flounder is mainly a by-catch in the fishery for commercially more important flatfish such as sole and plaice and in the mixed demersal fisheries. Landings by ICES Division and by country are shown in Figures 13.2 and 13.3. In the early 1970s there has probably been some misreporting from Divisions I and II. The majority of the landings are from the Baltic and from the North Sea. From Figure 13.3 it can be seen that the landings data are not complete: Poland, e.g. only started reporting flounder in recent years, whereas there is a gap in Dutch landings data from 1984 to 1997.

Since the early 1900's, annual landings form the North Sea have fluctuated between 1000 and 4000 t (Figure 13.4), without a clear pattern. Flounder is of relatively little commercial importance in the North Sea and the Kattegat, but its importance in the Baltic is considerable (Figure 13.2). In the North Sea and the Kattegat the landings data may be influenced by misreporting in years that quota for more important species are limited. The amount of misreporting however is not known. In addition, the North Sea landings may not reflect the catches very well, as the landings may be influenced by the prices and the availability of other, commercially more important, (flatfish) species.

## 13.5 Survey data, recruit series

Several surveys in the North Sea, Skagerrak and Kattegat provide information on distribution, abundance and length composition of flounder. Most relevant for flounder is probably the International Bottom Trawl Survey IBTS in quarter 1 (Figure 13.5). The Demersal Fish Survey DFS (in quarter 3&4,) carried out in the coastal continental zone and estuaries, targets 0- and 1-group of sole and plaice and nicely illustrates the importance of the shallow continental waters as a nursery for this species (Figure 13.6).

North Sea length frequency distributions for IBTS (quarter 1) and DFS (quarter 3&4) are presented in Figures 13.7 and 13.8. Only in some years a recruiting year class can clearly be seen, as e.g. in 1987 and in 1996. The catches in the Wadden Sea mainly consist of 0-group (5 to 13 cm) and 1-group (14 to 25 cm) fish.

Time series of abundance are shown in Figure 13.9. The abundance of North Sea flounder in the quarter 1 IBTS survey increased slightly between 1980 and 1990, and decreased again. Abundance was low in the years 1999 to 2003. In the most recent three years (2008 to 2010) the abundance of flounder in the North Sea was unusually high (Fig. 13.9 upper panel). In the Wadden Sea 1-group fish was slightly more abundant than 0-groups from 1980 to 1986. Since then the incoming year-class outnumbers the one year older fish. Yars with high recruitment are not always followed by years with high numbers of 1-group fish (Fig. 13.9 lower panel).

More detailed data on flounder catches during surveys may be found in ter Hofstede *et al.* (2010).

Figure 13.10 gives the trend in overall abundance (all length classes combined) for Skagerrak-Kattegat. Note that the abundance here is much higher than in the North Sea. No trend is apparent from this time series.

## 13.6 Biological sampling

Biological sampling for this species has been rather poor, at least for the North Sea area. For the UK, biological sampling for otoliths, weight, sex and maturity is only available for 2000. A summary of the number of samples available is given in WGNEW-2007. The otoliths collected have not been aged.

In 2009 the Netherlands started the collection of market samples under the DCF. In all, 3772 specimens were measured (from 51 samples) and otoliths and biological data were collected from 866 specimens (from 18 samples). For 2010 the collection of 36 length samples (60 fish each) and 18 age samples (50 fish each) is planned.

The Netherlands collect biological samples for flounder routinely during a number of flatfish surveys (DFS, SNS and BTS).

## 13.7 Population biological parameters and other research

Van Overzee (2010) analysed survey data for the Netherlands. She gives length-weight relationships for females and males based on survey data:

females: $y = 0.0242 * x^{2.78}$ males: $y = 0.0239 * x^{2.77}$

$T_0$ was set at 0 years. $L_\infty$ was estimated at 36.18 cm for females and 29.58 cm for males.

K for females was found to be 0.7234 and for males this was 1.036.

## 13.8 Analyses of stock trends / assessment

Time series that could be used to describe the state of the flounder in the North Sea would be the landings, abundance during IBTS1 surveys, and information on recruitment would be provided by DFS survey in the Wadden Sea. Landings data are not complete, and probably not always indicative of catches. The IBTS1 uses a bottom trawl which is not very well suited to catch demersal flatfishes. The BTS survey(s) are carried out in quarter 3, in a time of year in which flounder is usually distributed in more coastal, shallow and brackish waters. BTS catches are therefore not necessarily a good indicator of the stock size.

Surveys in shallow waters in the continental zone do catch juvenile flounder but it is not yet clear that the abundance of 0- and 1-group flounder are indicative of the year-class strength of older age-groups.

## 13.9 Data requirements

For flounder in the North Sea, at this moment, only the Netherlands collect biological data under the DCF. For 2010 a sampling level of 900 otoliths from commercial landings is planned. In addition data are being collected during surveys. For 2011 to 2013 the collection of biological data is foreseen for 450 fish annually, for surveys and commercial landings combined. It may be clear that sampling effort for this species is at a very low level. In order to follow the developments in the North Sea stock more closely, an increase in sampling intensity should be considered.

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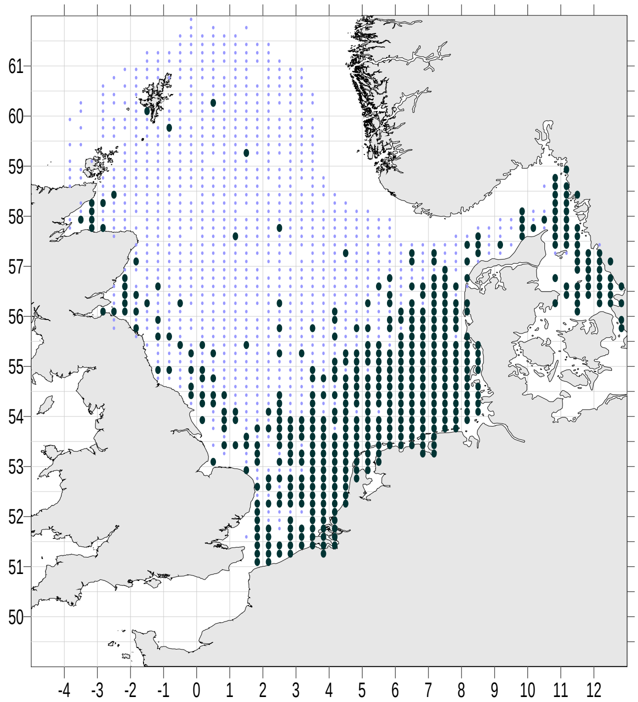



**Figure 13.1: Presence/absence data for flounder in IV and IIIa based on international data from IBTS and BTS surveys and some Dutch flatfish surveys (DFS, SNS)**

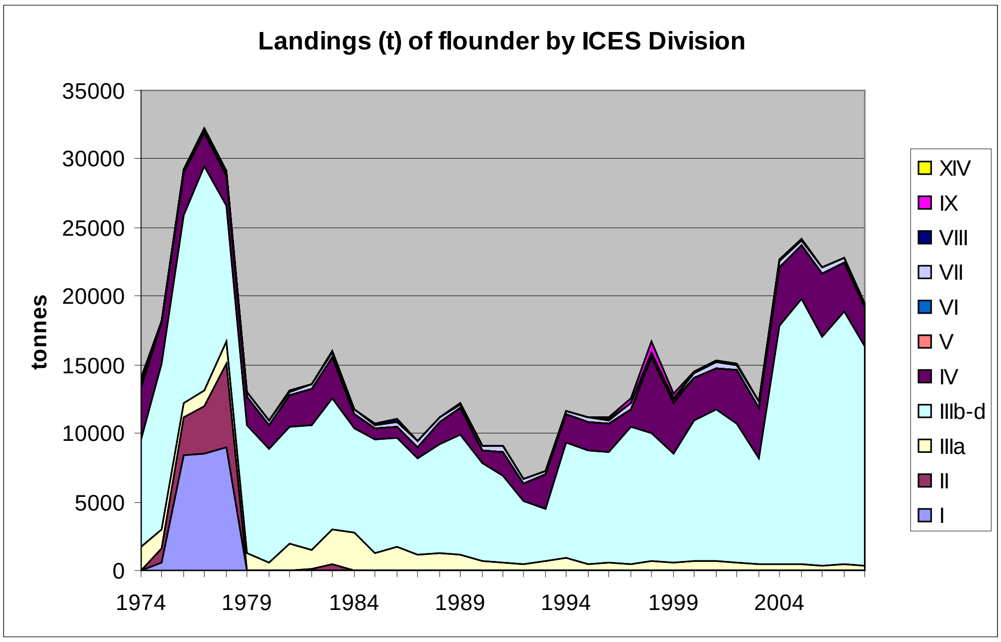



**Figure 13.2: Landings (t) of flounder by ICES Division**

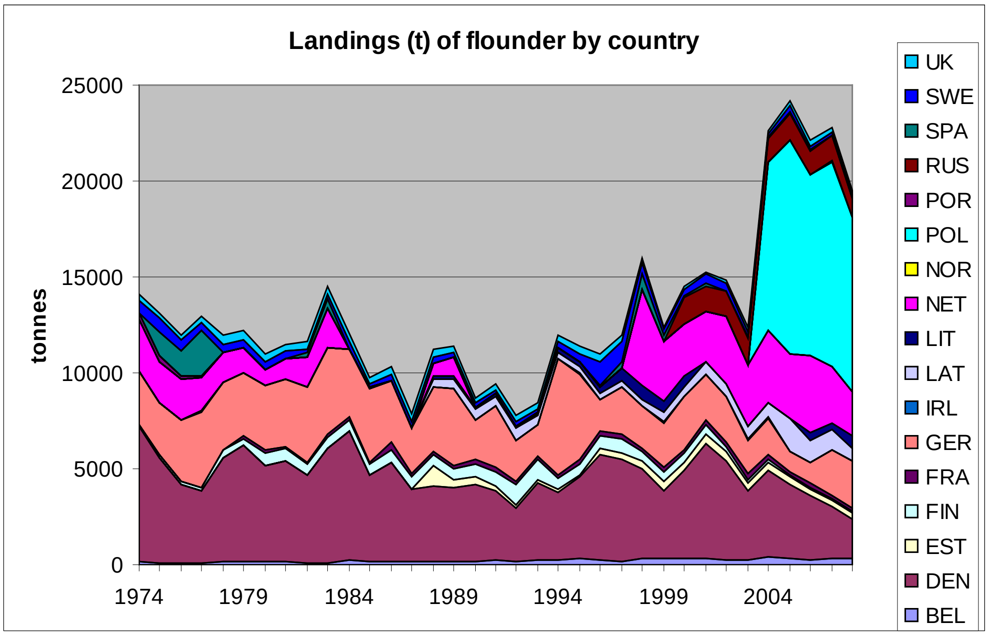



**Figure 13.3: Landings (t) of flounder by country**

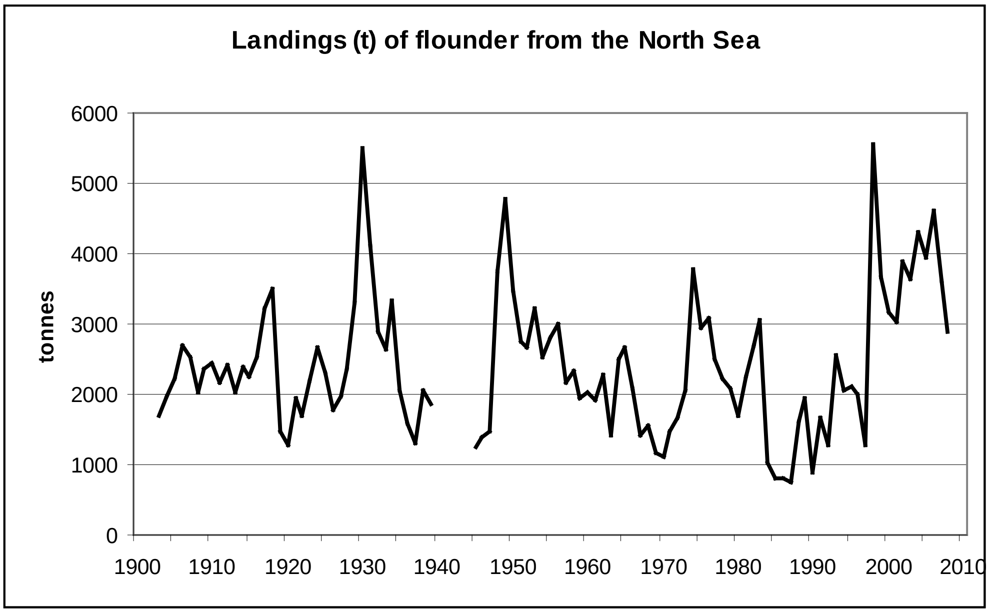



**Figure 13.4: Landings (t) of flounder from the North Sea (IV)**

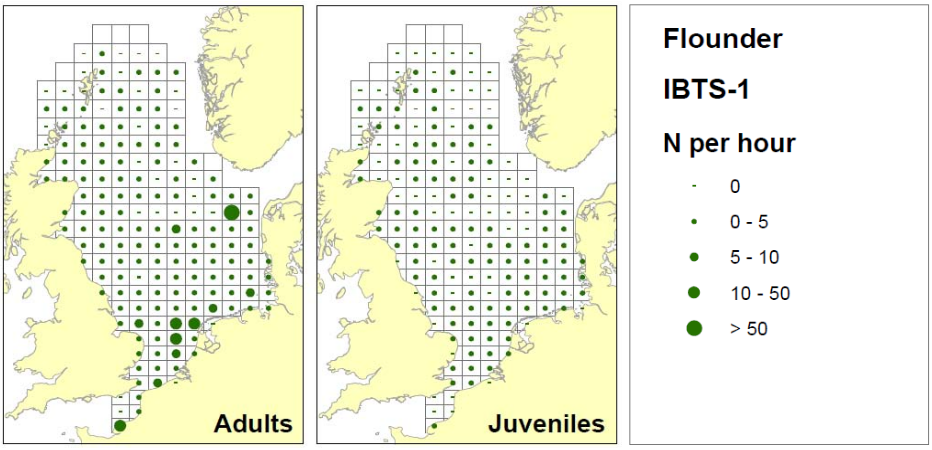



**Figure 13.5: Distribution of adults and juveniles (< 35 cm) of flounder in the IBTS quarter 1 survey based on the average for the years 1970-2009 (from ter Hofstede *et al*. 2010).**

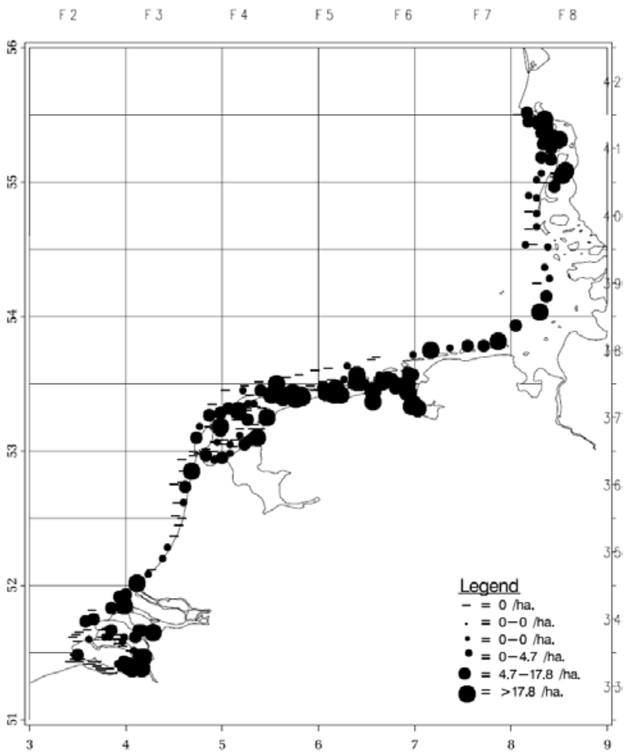



**Figure 13.6: The distribution of juvenile flounder in the coastal zone of the southeastern North Sea in the autumn of 1980. Data from the Dutch Demersal Fish Survey.**

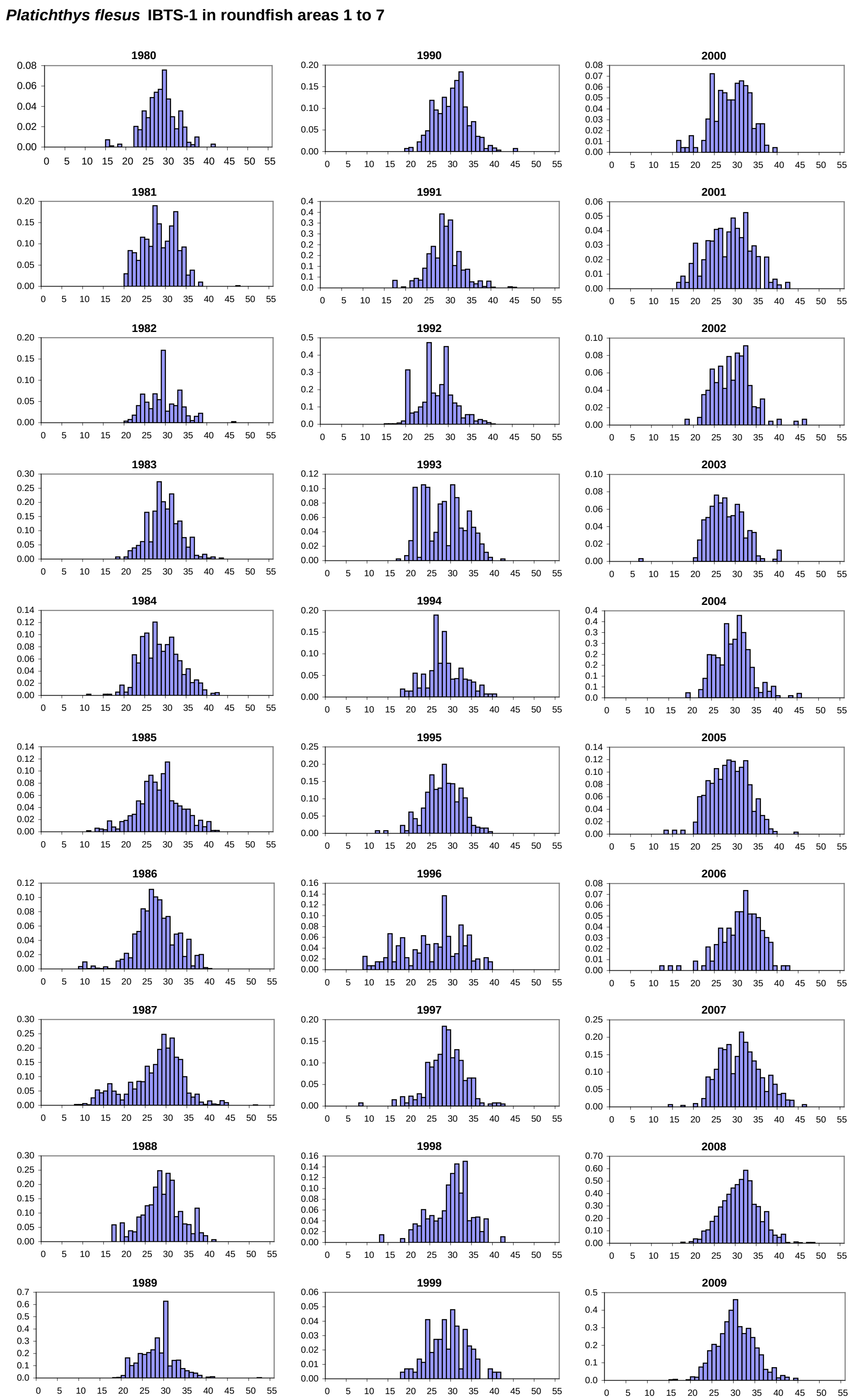



**Figure 13.7: Numbers at length for the quarter 1 IBTS survey in roundfish areas 1 to 7 (area IV) for the years 1980 to 2009. Note that the scales are different.**

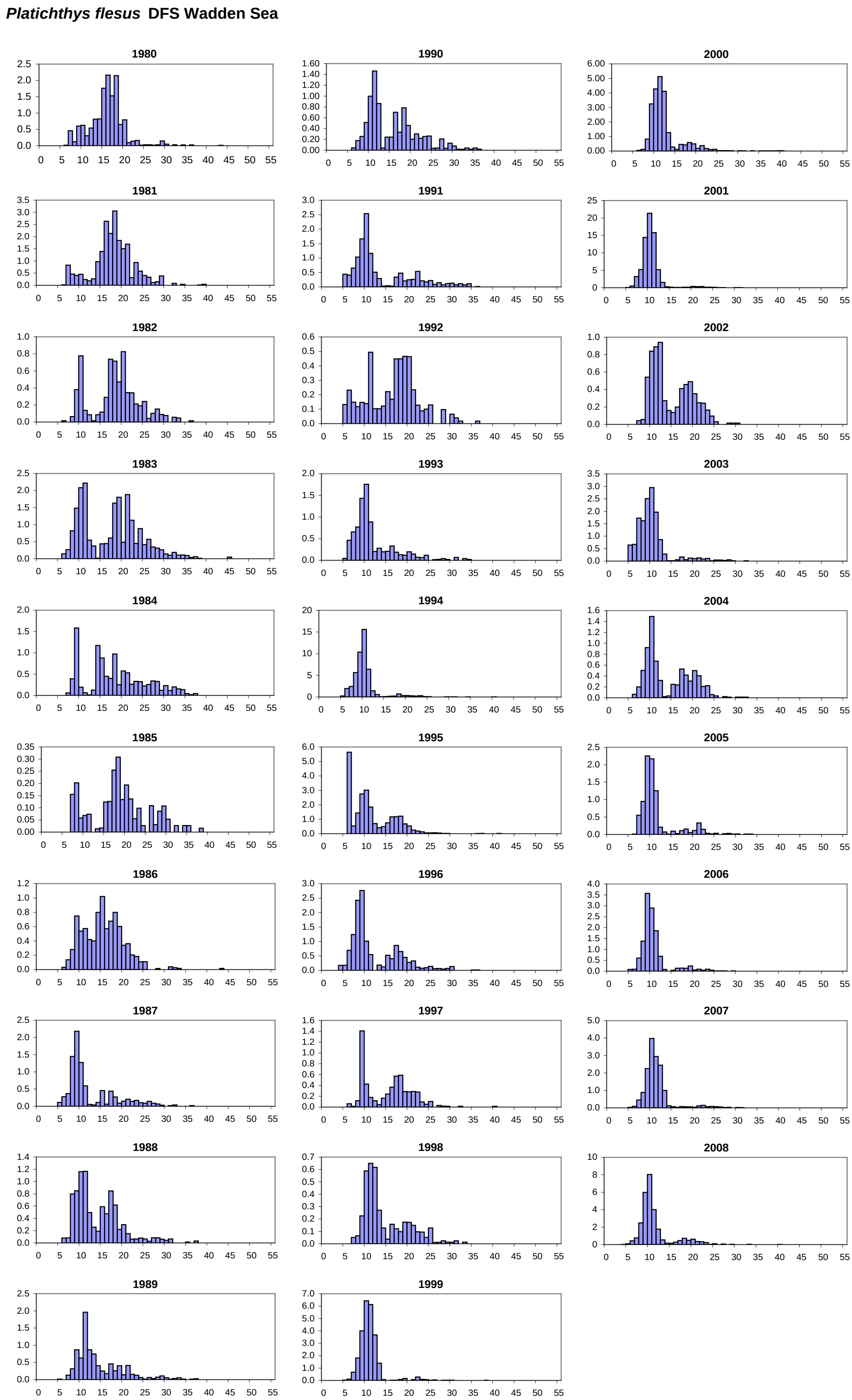
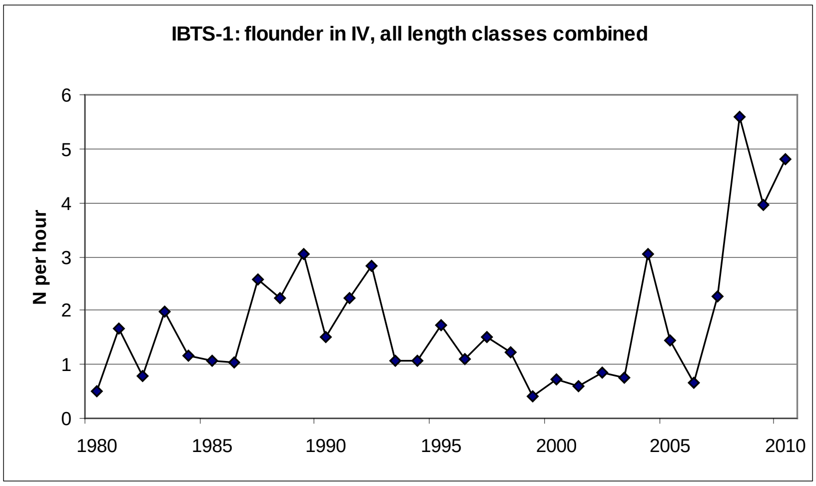



**Figure 13.8: Numbers at length for the quarters 3 to 4 DFS survey in the Dutch part of the Wadden Sea, for the years 1980 to 2008. Note that the scales are different.**



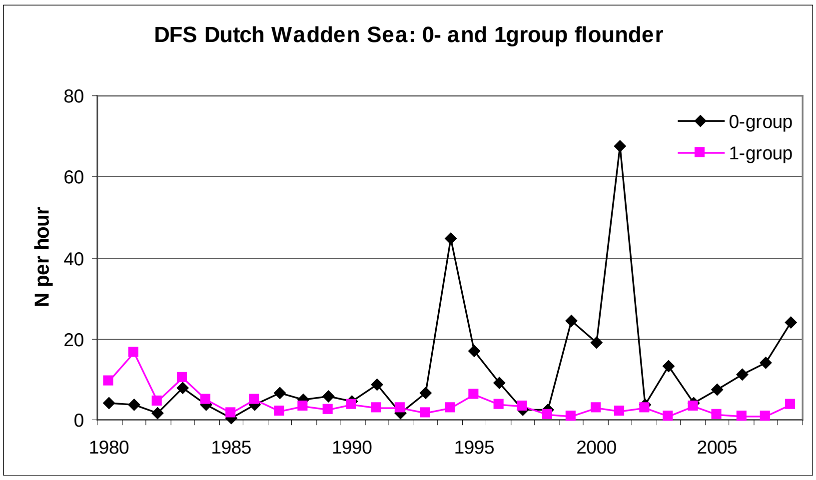




**Figure 13.9: Time series of abundance. Upper panel: IBTS quarter 1 in roundfish areas 1 to 7 (area IV), for all length classes combined. Lower panel: DFS quarter 3&4 in the Dutch Wadden Sea. Length classes 5-13 and 14-25 cm are presumed to represent age groups 0 and 1.**

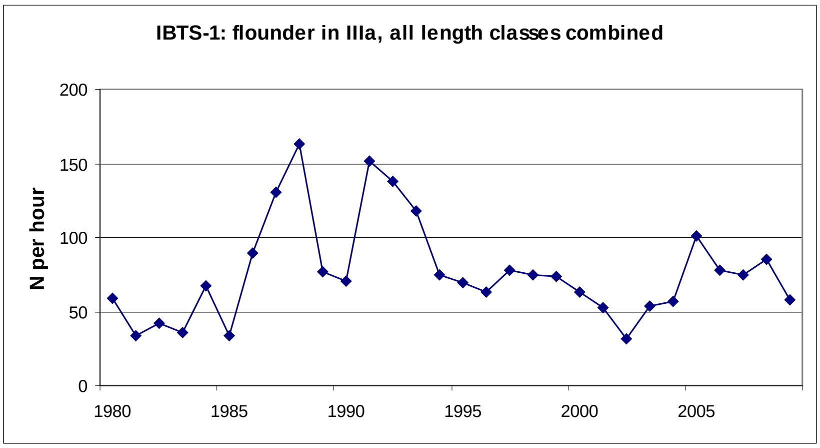



**Figure 13.10: Time series of abundance for IBTS quarter 1 in roundfish areas 8 and 9 (area IIIa), for all length classes combined.**

# 14 Witch flounder

## 14.1 General biology

Witch flounder (*Glyptocephalus cynoglossus*) is common in the northern North Sea, west of the British Isles, in Icelandic waters and along the North American east coast. Most of the more recent information published on general biology refers to investigations in the NW Atlantic. The stock in the North Sea area has not been investigated recently and most of the information refers to old studies.

This species is mainly found on soft bottoms, mostly clay, but in some cases clean sandy bottoms (Molander, 1935) and in fairly deep waters, i.e. around 100–400 m. In the North Sea, witch flounder live at depths between 100 and 200 meters primarily in the Norwegian trench and in the northern parts of the North Sea. In Skagerrak it is most common between 150 and 300 meters preferably at high salinity (3.5%) and low (6-7 ° C) temperature waters. In Kattegat, individuals are found in comparatively shallow waters (30-100 meters). When optimum hydrographical conditions prevail in large areas, such as during spring and summer, it is the availability of food that mainly influences the species distribution. The main diet consists of crustaceans, polychaets, brittle stars and fishes.

According to Molander (1935), there are probably two stocks of witch flounder, one in the Kattegat and one in the North Sea and Skagerrak. The Kattegat stock is considered stationary and no spawning migration occurs. Spawning generally takes place in October-November. For the North Sea and Skagerrak stock, the North Sea acts as both a spawning and growth area, while the Skagerrak acts primarily as a nursery/ feeding ground, but spawning can also occur here. Most of the larger individuals migrate from the Skagerrak to shallower waters in the northern North Sea during the spawning season (May-September, peak in June-July). Spawning occurs in shoals in shallow waters (70-100 m) or in mixed shoals (mature and immature individuals) in deeper waters (100-160 m).

Eggs are pelagic and hatch after 7-8 days at 5-7° C. Their larval stage is relatively long compared with other flatfish, between 4 months and one year (Bigelow and Schroeder, 1953; Evseenko and Nevinsky, 1973). The larvae are pelagic until they reach a size of approximately 4 cm, then they become demersal (Muus *et al*., 1997).

Age and size at first spawning differs between the North Sea and Skagerrak. In the North Sea witch flounder generally reach maturity at around 5-6 years, which corresponds to a length of around 39 to 50 cm (TL = total length, from the snout to the end of the tail). The Skagerrak stock generally reaches maturity at around 6 -7 years at length between 40 and 54 cm (TL).

.The growth rate seems to vary according to distribution area. In the North Sea area it seems to be higher in the Kattegat and lower in the western parts of the Skagerrak and in the Norwegian trench. Growth rate is not uniform within each area and varies with depth; it generally reduces with increased depth. The slower growth rate at greater depths may reflect the fact that they live in sub-optimal conditions. Growth also varies between the sexes. Males grow slightly slower than females (Molander, 1935) or die smaller. A specimen measuring 78 cm has been recorded from Canadian waters (Valtysson, 1998).

## 14.2 Stock identity and possible assessment areas

A first approach regarding assessment units would be to base these on the ICES Divisions/Sub-divisions associated with the fisheries. However, witch flounder is a rather stationary species and the knowledge about stock identity is little and based on old investigations. As mentioned above, Molander (1935) distinguished two stocks in IIIa and IV, one in the Kattegat and one in the North Sea and Skagerrak. However, as already reported by Molander in 1935, catches in the Kattegat are still in very inconsiderable numbers and irregular, only at scattered places at depths between 30 and 100 m.

## 14.3 Management regulations

As a typical by-catch species, witch flounder has not been subject to any TAC limitations. In 1927 a minimum landing size of 30 cm was introduced and subsequently revoked in 1943. At present the minimum landing size in Denmark and Sweden is 28 cm.

## 14.4 Fisheries data

### 14.4.1 Sweden

According to data collected by Molander (1925, 1935 and 1947) witch flounder was fished in the early 1900's mainly in the Skagerrak with seines. Landings varied widely during this period (Figure 14-1). From 1911 to 1916 landings were approximately 200 t per year in Gothenburg's fishing port. The following three years landings increased dramatically but from 1919 until 1928 the landings decreased steadily despite the increased number of seiners. In 1927 a minimum size of 30 cm for witch flounder was introduced. This was not reflected in the landings, which increased from 1928 until 1931 and then fluctuated between 800 and 1200 t up to 1939. At the beginning of the Second World War landings declined sharply and varied dramatically during the war. The increase in the early 1930's was however, according to Molander (1947), likely a result of the Swedish fisheries in the North Sea being developed, and not because of increased catches in the Skagerrak. The large landings during 1943 and 1944 were probably due to the minimum size limit of 30 cm being revoked.

The high fishing pressure from 1919 onwards is likely to have negatively impacted the stock as reflected in substantially reduced landings per trip. In comparison with today's witch flounder fishery, landings were approximately threefold as much during the first half of the 1900's, making it difficult to draw parallels to the possible consequences for today's stock. However it is known that the number of boats in the past decade is much smaller than during the years studied by Molander. Today's witch flounder fishery is also much more efficient and a small increase in the number of vessels fishing exclusively for witch flounder would probably have a big impact on the stock.

In Sweden witch flounder is mainly caught in the witch flounder directed fishery and in the Pandalus, and demersal fish fisheries (i.e. fishing after demersal and benthic species), mostly in Skagerrak (IIIa). In the first half of the 20th century, Sweden had very high landings of this species from IIIa, up to more than 1500 t annually. The fisheries where witch flounder are caught are mainly the Pandalus, and demersal fish fisheries, i.e. fishing after demersal and benthic species.

Swedish logbook data from 1991-2008 were used to classify fishing trips into their respective metiers based on gear, mesh size and/ or landing compositions. In some trips more than 30% by weight in the landings consisted of witch flounder. Therefore, in such cases, a fishery targeting this species could be defined. Landings of witch flounder from all the fisheries in Sweden increased markedly until 2000, where it remained stable until 2005 and then declined significantly to 2008. 2005 was the year when landings of witch flounder were at its peak, approximately 550 t. Landings since 2005 have fallen by more than 50% (Figure 14-2).

Spatial distribution of effort has been analysed using both logbook (1997-2008) and vessel monitoring system (VMS) data (2005-2008). Effort in 2005 had already begun declining and had returned to a similar level as in 2000 when the witch flounder fishery was on the rise. The spatial distribution of effort in 2005 was concentrated along the Norwegian, Swedish, and Danish verges of the Norwegian trench. In 2006 total Swedish effort was substantially reduced. These effort reductions were largely along the slopes in the western parts of Skagerrak. Subsequently, effort along the Norwegian border in 2007 and 2008 was non-existent. Effort in 2008 remained low, while expanding spatially, especially along the Danish border.

### 14.4.2 Denmark

The Danish witch flounder landings are taken in Skagerrak (IIIa) and in the Norwegian Deep (IVa East). At present, the majority of the landings are by-catches in mixed demersal trawl fisheries (Table 14-1), which in this connection includes both *Nephrops* trawls and trawls for demersal fish. In IIIa these are defined as trawls with a mesh size > 70 mm in the cod-end, while in the North Sea the term covers trawls with mesh sizes > 90 mm in the cod-end. Witch flounder constitutes a stable by-catch component in the Danish shrimp fishery in Skagerrak (trawls with mesh size 35-45 mm). Some of the Danish seine landings of witch come from trips targeting this species. However, the number of such trips has been declining in recent years. The other species caught in the Danish fisheries taking witch flounder are mentioned in the section on the Swedish fisheries for this species.

### 14.4.3 Scotland

In the UK fishery, witch flounder is mainly caught in IVa, IVb and VIa. At a first screening, landings data by UK vessels into Scotland display different signals depending on the gear used. However the major two fisheries catching witch flounder are light and Nephrops trawl (single and multiple) mostly fishing in the IVa. Data from light trawl show a decrease both in landings and effort but an increase in CPUE (Kg/hours) since 1999. Similarly Nephrops trawl show an increase in CPUE with landings increasing at a relatively stable level of effort (Figure 14-3). The fact that landings and effort crash within the light trawl fishery could be explained by the spate of decommissioning in the fleet and also the transfer of gear type from light trawl to Nephrops trawl by some of the vessels. A more detailed investigation taking into account engine size and number of vessels is needed.

## 14.5 Survey data, recruit series

Survey data of witch flounder are collected during the International Bottom Survey (IBTS), performed every year in the Skagerrak and the North Sea (IIIa and IV), during the first and third quarter of the year.

Furthermore a time series of Dutch Beam Trawl Survey (BTS) data (1985-2008) in IV was also available.

### 14.5.1 Witch Flounder in IIIa

The survey data used were collected during the Swedish IBTS since 1975, during the first (Q1) and third (Q3) quarters of the year in Skagerrak (IIIa). Investigation on the distribution of different length classes in the water column show that small individuals (<15cm) tend to be found together with the largest ones (>31cm) in deeper waters, while individuals of medium size (between 16 and 30cm) are found at lower depths. This pattern is shown in both quarters of the year, although shifted to shallower waters during the autumn (Q3), confirming the results from the previous study (Molander, 1925).

Time series of abundance (CPUE, number per hours) in both quarters were standardized by haul position, depth and year through general linear models. Results show a decline in both quarters during the last decade confirming the trend observed in landings. Nonetheless the spatial distribution of haul-specific CPUE averaged over 5-year time intervals, appears to be stable in both quarters during the entire time span (Figure 14-4). The abundance variations correspond to changes in individual growth. The mean length in fact decreases in periods of higher abundance showing a possible effect of fishing pressure, withdrawing larger individuals or a density dependent effect. The latter occurs as an outcome of increased stock size and thus increased competition for food, which reduces the per capita resources and consequently the growth.

However, if as reported by Molander in 1935, we are dealing with a single stock inhabiting Skagerrak and North Sea, attention must be paid before any conclusion is drawn. Overlooking the seasonal migration pattern between the two areas may lead to erroneous interpretation of the observed pattern. More knowledge about the reproductive migration and stock identification is thus needed.

### 14.5.2 Witch Flounder in IV

The abundance of witch flounder observed during the first quarter of the IBTS has been fluctuating. A “maximum” was reached around 1995, and the abundance seems to have decreased since. No pattern can be detected in the abundance time series during the third quarter of the IBTS.

In the time series of BTS quarter 3 the change in survey coverage in 1996 is reflected. Only since that year part of the distribution area of witch flounder has been included. No clear trend is visible since 1996.

Some specimens of witch flounder have incidentally been reported for the Demersal Fish Survey (DFS-Q3) but these catches are believed to stem from wrong identification of the species. Witch flounder in fact does not occur in the southern North Sea.

Thus as a time series the catches of witch flounder during the IBTS seem most promising, and especially for the IBTS-Q1 since more stations are usually fished in quarter 1, and the time series is longer.

For what concerns the length composition, both IBTS-Q1, IBTS-Q3 and BTS-Q3 catch the whole size range of witch flounder from just below 10 cm to around 50 cm. The peak in the length range in both IBTS surveys is around 35 cm, in the BTS it is around 30 cm.

Regarding the distribution, witch flounder is a species that occurs in the deeper waters of the northern North Sea. There does not seem to be a significant difference in the distribution in winter and in summer. Whereas a tendency seems to exist for adults to occur mainly in offshore waters (certainly in IBTS-Q3) the juveniles may be more abundant towards the edges of the survey area.

The third quarter Beam Trawl Survey (BTS-Q3) just covers the southern range of witch flounder. Also in these data no obvious difference exists between adult and juvenile distribution.

## 14.6 Biological sampling

Up to 2009 there have been no requests for biological advice on the exploited stocks of witch flounder and therefore no regular assessments have been carried out. Nonetheless, this species has been subject of 'ad hoc' investigations covering only shorter time periods. Therefore, long continuous time series of biological measurements have not been available so far. Witch flounder has in fact been included as a mandatory species in the EU Data Collection Framework (DCF) from 2009. Thus in agreement with the DCF and with the onset of the NESPMAN project, the regular sampling of biological data started in 2009. In Sweden samples are regularly purchased from commercial boats, randomly selected on a quarterly basis. Danish samples are stratified by landing category. Individual length, weight and maturity status are recorded and otoliths stored for age determination. Until now all samples have been taken from IIIa landings. However, since the distribution of this species is continuous from Skagerrak into the eastern part of the North Sea, the IIIa samples are assumed to also cover IVa. Biological samples have also been collected in UK but due to the lack of expertise in age reading for this species otoliths have been stored but not read yet. Those data are not available at the moment.

It is noteworthy that the age reading is not straightforward and several techniques were tried in order to find the optimal one. The best result was obtained by using a combination of two techniques, namely reading the otoliths right after the removal from the fish and if need be, grinding. Problems are also encountered in maturity stage assessment. The reproductive period is still unknown and histological investigation of gonads is planned at the Swedish Institute of Marine Research for 2011 in order to delineate the spawning season and be able to calculate accurate maturity ogives and therefore spawning stock biomass. Thus the knowledge of this species' biology is currently under improvement.

## 14.7 Population biological parameters and other research

The age determination of samples from 2009 was used for distributing the landings from the same year among different age classes. The age classes 4 and 5 were the most represented ages in the Swedish landings, during Q1 and Q2 in 2009. Younger individuals were poorly represented as well as individuals older than 8-year old. The abundance of age 4 and 5 could be a consequence of two strong consecutive year classes, i.e. 2004 and 2005. On the other hand in the Danish landings, age 4 to 8 were the most abundant in the fourth quarter of 2009.

The total size distribution, estimated taking the magnitude of the landings into account, evidenced differences between Swedish and Danish landings and between those and Danish landings from 1981 (Figure 14-5). In 2009 the mean size in Swedish landings appears to be smaller than the Danish landings in 2009, and the 1981 data indicate greater mean size in that year than in 2009. However more data would probably be needed to make any firm conclusions on whether these differences are more than 'technical', reflecting local or annual variations.

Sex distribution in IIIa is generally skewed and females are in majority (Molander, 1925). This bias is especially clear among the larger individuals, with the largest individuals being exclusively females. Also sampling of the Swedish catches in 2009 indicated a majority of females and, in IIIa, the largest individuals in the catches are normally females. Growth decreases with increasing depth and so does the number of males (Molander, 1935).The growth pattern seems to differ between sexes.

The maturity pattern observed in the Swedish samples from 2009 confirms previous studies showing that this species tend to mature quite late and at large size. On the other hand, fully mature individuals have been found all year around and thus it seems difficult to either delineate with certainty the spawning period in the studied area or confirm the findings of previous study (Molander, 1935).

## 14.8 Analyses of stock trends / assessment

Analytical assessment of the stock(s) in the North Sea area is not possible yet due to insufficient data. However the recently started collection of biological parameters and the investigation on the biology of this species laid the basis to start an assessment in the future as soon as a reasonable data time series are collected in a broader area. Preliminary growth and mortality estimates have been presented in the NESMAN report.

## 14.9 Data requirements

According to the DCF Denmark and Sweden started to collect biological data from market samples in IIIa in 2009 on a quarterly basis, resulting in the age structure estimate of landings in this area. Similarly UK collect market samples for biological parameters in area IV. For 2011-2013 all three countries will continue to collect data both from market samples and surveys. This systematic and regular data collection in both IIIa and IV will represent a valuable help in trying to delineate the population dynamic as well as the stock identity of this species. On the other hand, landings data from other countries fishing this species in the North Sea, e.g. Norway, are needed.

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**Table 14-1: Witch flounder: composition by gear (%) of total Danish landings, 2002-2009.**

| | | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Gear** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| **Skagerrak IIIa** | dem. trawls | 84.5 | 85.8 | 85.6 | 76.9 | 83.0 | 77.0 | 77.9 | 72.8 |
| | Shrimp trawl | 3.4 | 4.9 | 4.9 | 6.3 | 4.2 | 8.3 | 9.1 | 7.0 |
| | Danish seine | 11.7 | 8.9 | 9.2 | 16.7 | 12.7 | 14.5 | 13.0 | 19.8 |
| | other gear | 0.4 | 0.4 | 0.2 | 0.1 | 0.1 | 0.2 | 0.0 | 0.3 |
| | **Landings, in t** | **1366** | **1037** | **1188** | **635** | **635** | **618** | **476** | **589** |
| | **Gear** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| **North Sea IVa** | dem. trawls | 89.6 | 91.6 | 92.1 | 90.9 | 93.1 | 96.5 | 96.8 | 96.1 |
| | Shrimp trawl | 0.7 | 0.8 | 1.0 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 |
| | Danish seine | 8.3 | 6.7 | 6.4 | 7.5 | 6.7 | 2.5 | 3.1 | 3.2 |
| | other gear | 1.4 | 1.0 | 0.5 | 1.3 | 0.1 | 0.8 | 0.1 | 0.7 |
| | **Landings, in t** | **541** | **767** | **623** | **714** | **654** | **529** | **350** | **345** |

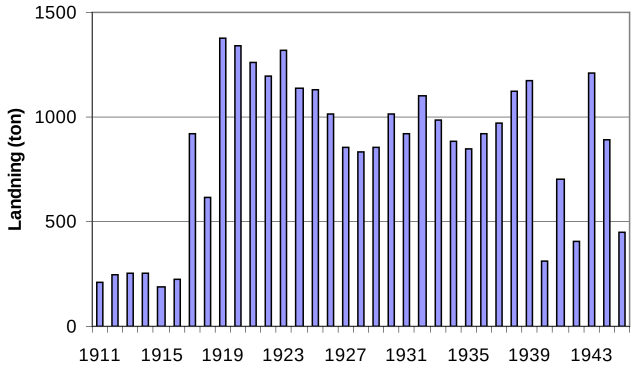


**Figure 14-1: Witch flounder: quantity landed per year in Gothenburg's fishing port 1911-1945. (Molander 1925, 1935 and 1947)**

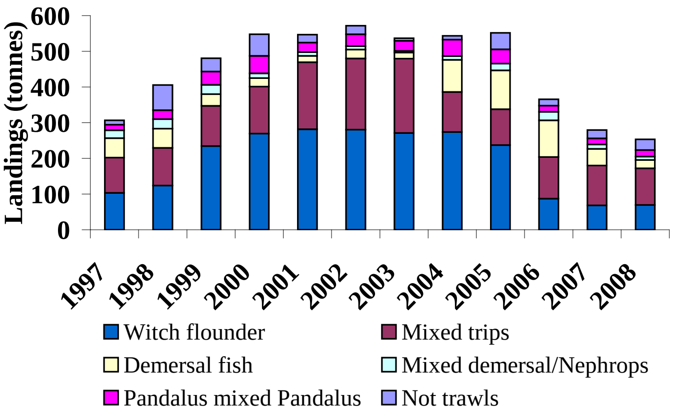


**Figure 14-2: Total landings of witch flounder within Skagerrak during 1997-2008 divided by types of fishery.**

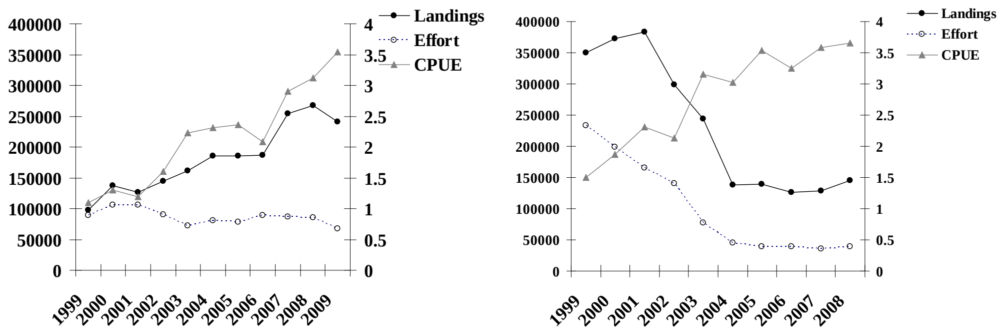


**Figure 14-3: Witch flounder: time series of landings (Kg), Effort (hours) and CPUE (Kg/h) in IVa in Nephrops (on the left) and light trawl (on the right) fisheries.**

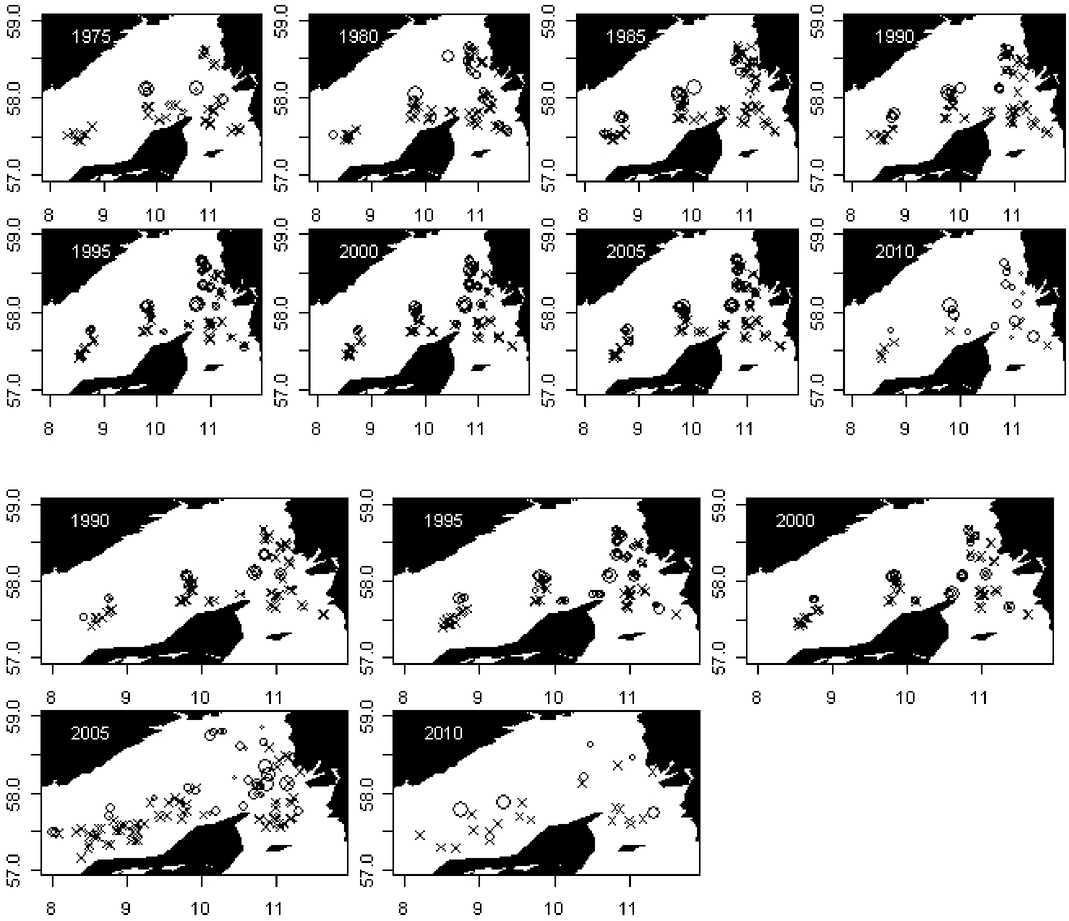


**Figure 14-4: Witch flounder: haul-specific CPUE (n/h) standardized for depth and averaged over 5 years' time intervals during the first (top) and third (bottom) quarters. Notice that 2010 is shown as single year, i.e. not pooled.**

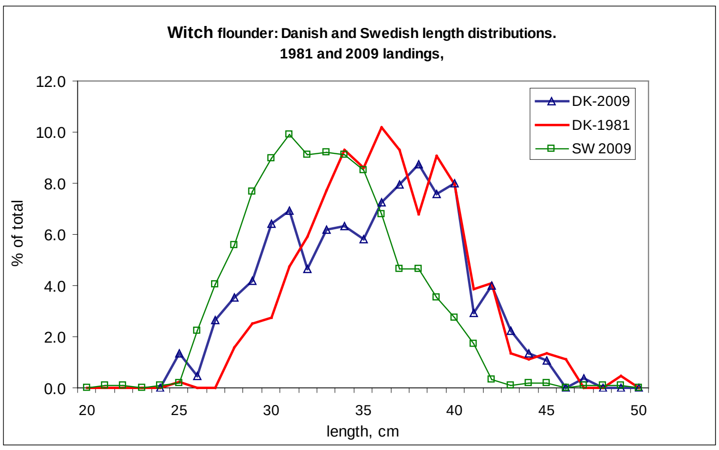


**Figure 14-5: Witch flounder: size distribution in Danish and Swedish landings in 2009 and in Danish landings in 1981**

# 15 John dory (*Zeus faber*, Linnaeus, 1758)

## 15.1 General Biology

John dory is wide spread, it is found in the East Atlantic from Norway to south of Africa as well as in the Mediterranean and Black Seas. It is also found in the western Pacific Ocean as well as in the Indian Ocean (Omnes, 2003; Quéro, 1978; Quéro & Vayne, 1997). It is a demersal species, never found in great concentrations. It is found mostly over soft and muddy areas close to rocks, in depths ranging from 20 to more than 400 meters. However 99% of catches are made between 20 and 160 meters. Reproduction takes place at the end of winter and at the start of spring in the northeastern Atlantic, earlier in the Mediterranean (Fishbase.org).

Sexual maturity varies from 23 to 29 cm for males and 29 to 37 cm for females depending on location.

Individuals of less than 8 cm feed on zooplankton mainly mysids. As they grow they progressively feed on small benthic fishes and when they grow over 14 cm they feed exclusively on benthic and demersal fishes.

Ageing through otolith reading has been investigated without success. Modal analysis of length distributions from survey data indicates that at the end of the first year, the John dory measures between 9 to 13 cm, 24 to 27 cm at the second, about 34 at the third and 40 at the end of the fourth year (Quéro, 1997). Males rarely grow larger than 50 cm while females can reach 60 cm or more.

## 15.2 Stock identity and possible assessment areas

There are no data available on possible stock separation based on genetic or morphological studies.

Data from the fishery indicate two main areas of exploitation: the Celtic sea, Western Channel and Northern Bay of Biscay (areas VIIe-j & VIII a,b) and the Western Iberian waters (area IXa). Based on average figures from 1999 to 2008, areas VII and VIIIa,b,d account for about 79% of the total catches, areas VIIIc and IX come second with 17% (Table 15-1 and Figure 15-1).

## 15.3 Management

There is no management measure in effect in the ICES area for John dory.

## 15.4 Fisheries data

Landings figures were available through the EUROSTAT/ICES database. French landings statistics are only documented since 1978. From 1978 to 1985 landings average about 850 t, they increased then to peak at 4000 t in 2003 – 2004 (Figure 15-2.). France and Spain are dominating the fishery and the bulk of the landings come from area VII (Figure 15-2).

Note that the drop in 1999 seen in the landings per area figures but not in landings per country, is due to France having submitted only a tonnage for all areas combined in 1999.

CPUE data were available for 6 French trawl metiers in the Celtic sea and the Bay of Biscay over the period 1999-2008 (Figure 15-3). All except the Nephrops fleets and the demersal trawl in the Bay of Biscay show an increasing trend over the period.

## 15.5 Survey data, recruit series

Four time series of survey indices are available covering areas IVa-c (NS-IBTS-Q1), VIIf-j and VIIIa,b (FR-EVHOE), VII d (FR-CGFS) and IXa (PT-IBTS).

All indices show an increase in biomass and abundance since the late 1990's up to 2007 – 2008, and a drop in 2009 (Figure 15-4). The recruitment index from the EVHOE survey, taken as numbers of individuals less than 16 cm, indicates four strong year classes in 1997, 2001, 2004 and 2007, the later being particularly high (Figure 15-5).

## 15.6 Biological sampling

Little biological information is available from market sampling and only since 2009. Some biological data have been collected from onboard sampling in 2009 and 2010 by France but no processing could be carried out due to software problems.

Sampling for the length distribution of landings should be put at a higher level of priority in areas VII, VIII and IX. Sampling for maturity has been carried out in 2009 on EVHOE survey and analysis should be available soon.

## 15.7 Population biological parameters and other research

Several reading techniques have been tested to read otoliths of John dory but so far, it has not been possible to estimate the age of John dory through otolith reading.

## 15.8 Analyses of stock trends /assessment

CPUE and survey indices show that the population in areas VII and VIII a,b has increased as a consequence of strong incoming year-classes. Similar increases are observed in area IXa and to a lower extent in the North Sea (area IVa-c). (Figure 15-4.).

There are no sufficient data to carry out any analytical assessment even through a surplus production model as the time series of biomass index available lacks contrast.

## 15.9 Conclusion and comments on additional data or studies needed

In the Data Collection Framework, the species is classified as Group II. It is too early to judge on the quantity and quality of data that will become available as the new concurrent sampling strategy has been implemented only in 2009. In any case it will take a minimum of 5 years before any analysis can be undertaken on fishery length distribution data. It is also to be noted that for all species classified in Group 2, the time of access to the fish in port sampling is limited and group 2 species are most often not sampled.

Survey data will therefore be of prime importance for assessing stock trends for this species.

## 15.10 References

Omnes, M.H., 2003. Le Saint-Pierre (Zeus faber) – Biologie, pêche, marché et potentiel aquacole. Editions Ifremer.

Quéro, J.C., J.J.Vayne. 1997. Les poissons de mer des pêches françaises. Delacheaux&Niestlé Ed. 170-171.

Quéro, J.C., 1978. Répartition des Zéidés (Pisces, Zéiformes) capturés dans l'Atlantique oriental entre le Cap Vert (15°N) et le cap Juby (28°N) au cours des campagnes de la « Thalassa ». Bull. Off. Natn. Pêche. Tunisie, 2(1/2), 49-61.

**Table 15-1 : Proportion of total catch of John dory per area based on the average 1999 – 2008**

| AREA | VI | VII | VIIIA,B | VIIIC+IXA | OTHER |
|---|---|---|---|---|---|
| Average catch 99-08 (t) | 633 | 20299 | 3336 | 5144 | 285 |
| % Total | 2.1% | 68.4% | 11.2% | 17.3% | 1.0% |

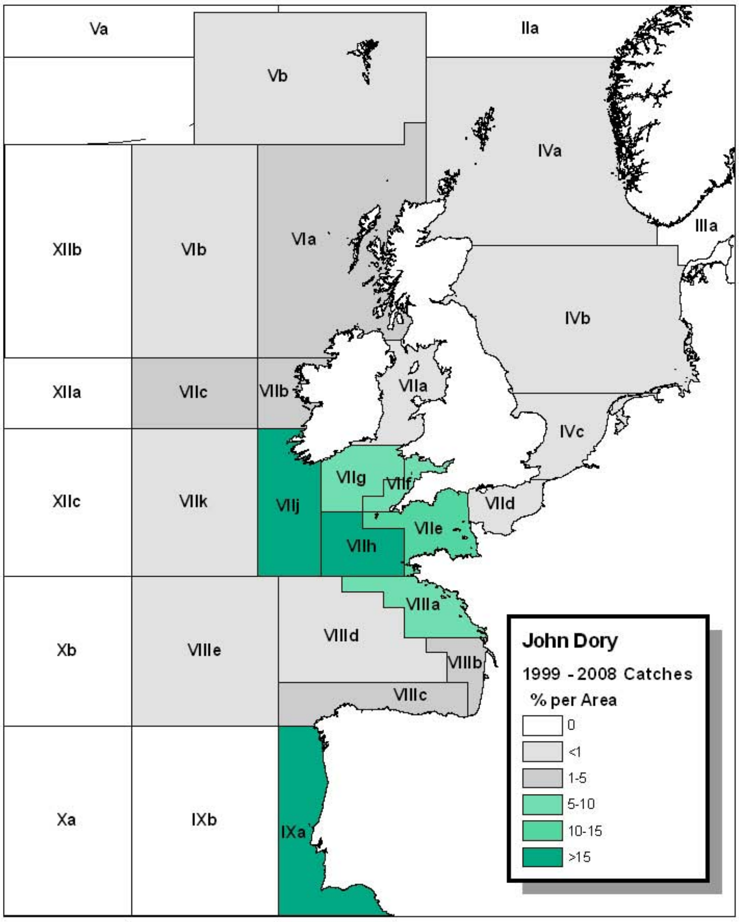


**Figure 15-1: Proportion of total catch of John dory per area based on the average 1999 – 2008**

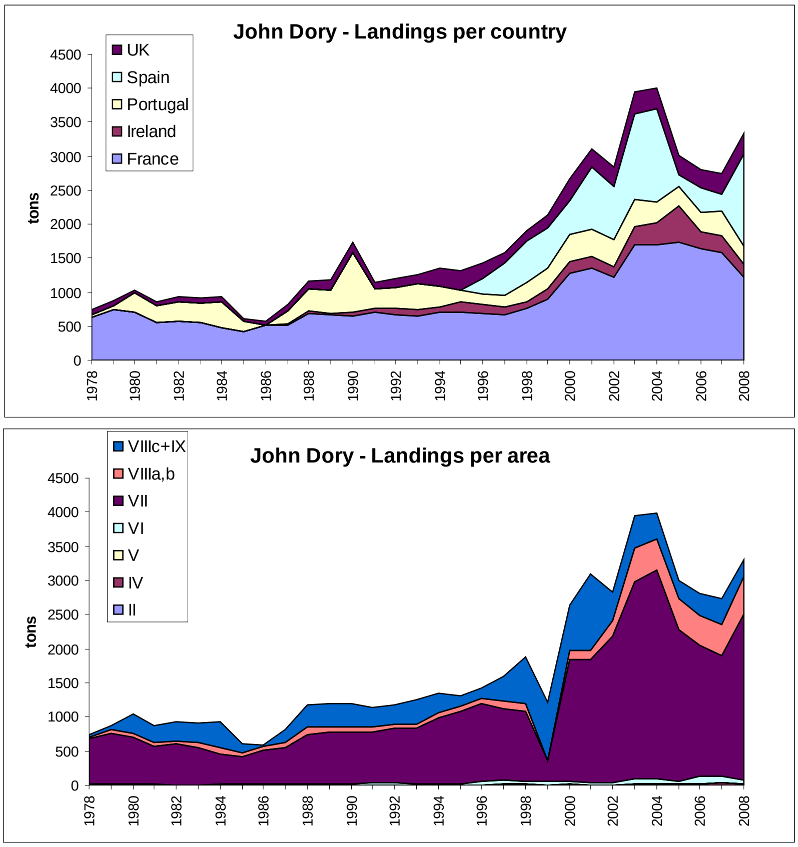


**Figure 15-2: Landings of John dory per country and area from 1978 to 2008.**

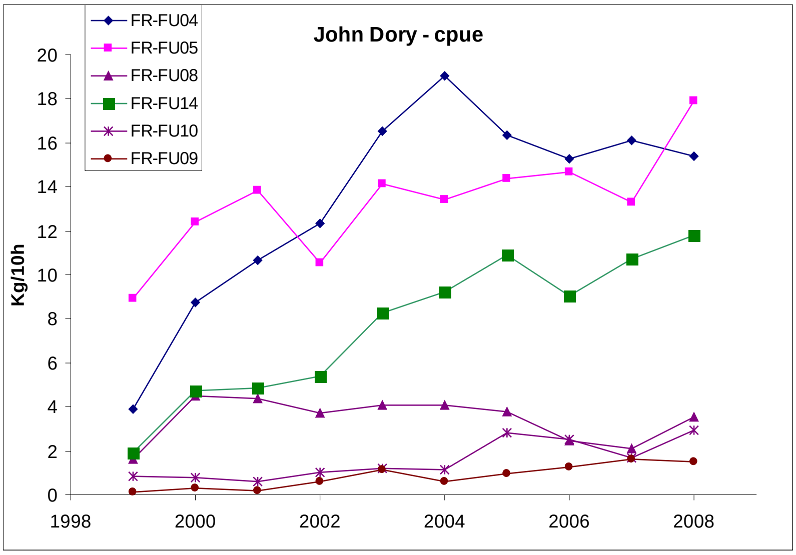


**Figure 15-3: Cpues for some French metiers from 1999 to 2008.**

Métiers :

FU04 : Benthic in the Celtic Sea

FU05 : Demersal in the Celtic Sea

FU08 : Nephrops in the Celtic Sea

FU09 : Nephrops in the Bay of Biscay

FU 10 : Demersal in the Bay of Biscay

FU 14 : Benthic in the Bay of Biscay

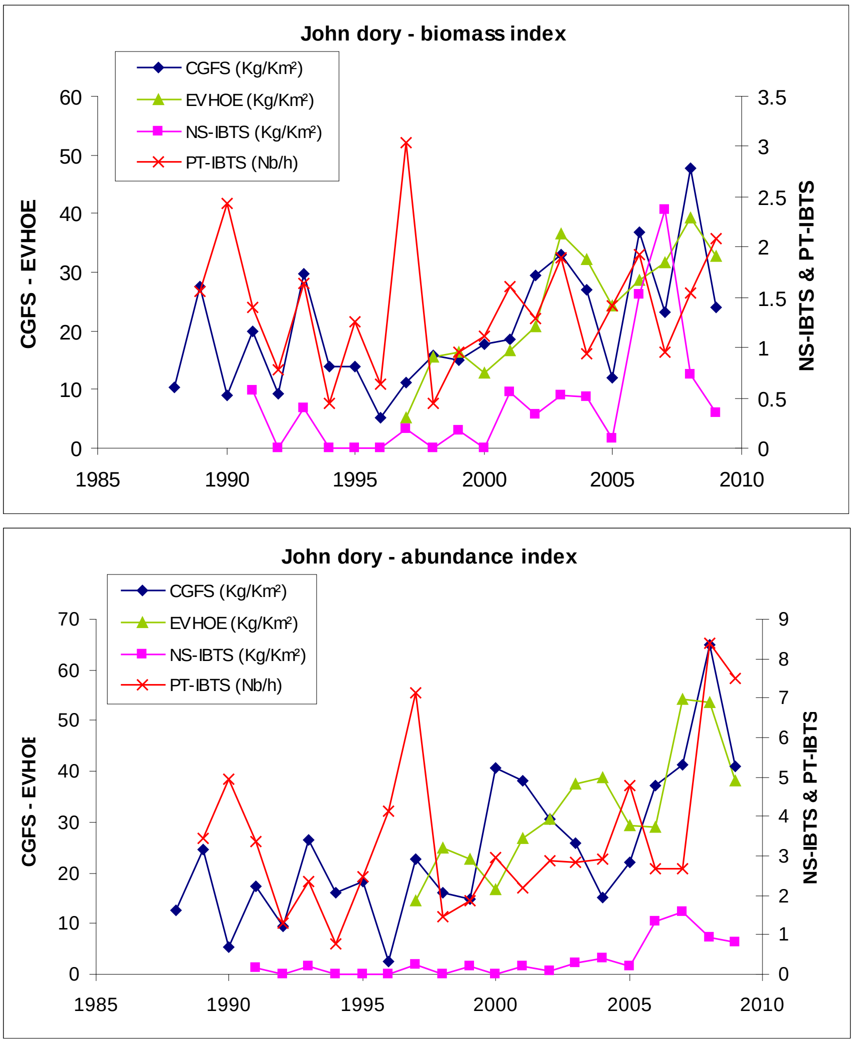


**Figure 15-4: Biomass and abundance indices of John dory from different surveys for areas IV to IX.**

Areas :

NS-IBTS : IVa-c
CGFS : VIIe
EVHOE : VIIf-j+VIIIa,b
PT-IBTS : IXa

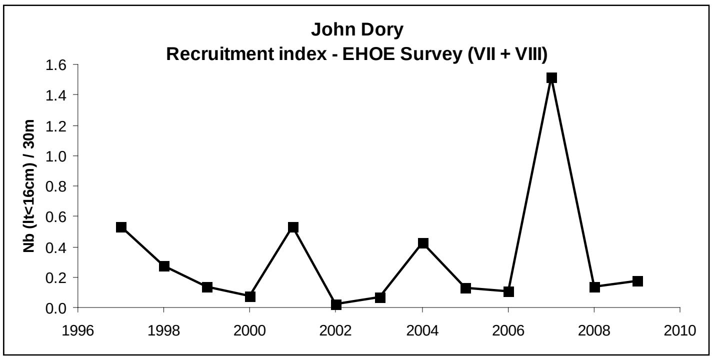


**Figure 15-5: John dory recruitment index (as number of individuals less than 16 cm) from the EVHOE survey**

# Annex 1 – Sea Bass

## General Biology

Bass *Dicentrarchus labrax* is a widely distributed species in northeast Atlantic shelf waters with a range from southern Norway, through the North Sea, the Irish Sea, the Bay of Biscay, the Mediterranean and the Black Sea to North-west Africa. The species is at the northern limits of its range around the British Isles and southern Scandinavia (ICES 2003). It is an important commercial and recreational species and there is a relatively large body of literature regarding its life history and migration patterns (Pawson 2008).

Ripe adult bass have been caught by pelagic trawling in the south of Division VIIIa and in the north of Division VIIIb in the Bay of Biscay during January - March (Morizur, unpublished data), and planktonic egg surveys (Thompson and Harrop, 1987; Jennings and Pawson, 1992) have shown that bass spawn offshore in the English Channel and eastern Celtic Sea from February to May. Spawning started in the Mid-western Channel during March, when the temperature range associated with bass egg distributions was 8.5 - 11°C, and appeared to spread east through the Channel as the surface water temperature exceeded 9°C. The eggs float in the water column, hatching 4-9 days after fertilisation and at approximately 4 - 4.5 mm long (Pickett and Pawson 1994).

Bass larvae resulting from offshore spawning move steadily inshore towards the coast as they grow and, when they reach a specific developmental stage at around 11 - 15 mm in length (at 30 - 50 days old), it is thought that they respond to an environmental cue and actively swim into estuarine nursery habitats (Jennings and Pawson, 1992). From June onwards, 0-group bass in excess of 15 mm long are found almost exclusively in creeks, estuaries, backwaters, and shallow bays all along the southeast, south, and west coasts of England and Wales, where they remain through their first and second years, after which they migrate to over-wintering areas in deeper water, returning to the larger estuaries in summer. Several studies indicate the existence of similar bass nursery areas in bays and estuaries on the French coasts of the Channel and Bay of Biscay and southern Ireland.

During the winter, juvenile bass move into deeper channels or into open water, and return in spring to the larger estuaries and shallow bays on the open coast, where they remain for the next 2-3 years. When they reach 4 or 5 years of age their movements become more wide-ranging and they eventually adopt the adult feeding/spawning migration patterns (Pawson *et al*., 1987). Growth is relatively slow and the species is long-lived (up to 30 years of age). At the end of their 3$^{rd}$ year juveniles are approximately 25 cm Total Length (TL) and at the end of their 4$^{th}$ year they are approximately 33 cm. Maturity is attained at around 4 - 7 years, which is around 35 cm for males and 42 cm for females (Pawson and Pickett 1996).

Bass are opportunistic feeders, preying on a variety of species. Larval bass primarily feed on small zooplankton, such as copepod nauplii, cladocerans and mysids, while 0-group bass eat small crustaceans such as isopods, amphipods and mysids. Larger crustaceans (such as brown shrimp and the shore crab) and small fish such as gobies, herring and sprat dominate the diet of juvenile bass. Adults feed on fish and crustaceans when they are distributed inshore and on pelagic fish such as mackerel and pilchards when they are feeding offshore (Kelley, 1987; Pickett and Pawson 1994).

Climate and the environment can significantly affect early life history (Holden and Williams 1974), which, in turn, can have implications for bass production. Reynolds *et al*. (2003) observed a positive relationship between annual seawater temperature during the development phases of eggs and larvae and the timing and (possibly) abundance of post-larval recruitment to nursery areas. In addition, early growth is related to summer temperature and survival of 0-groups through the first winter is affected by body size (and fat reserves) and water temperature (Lancaster 1991; Pawson 1992). Prolonged periods of temperatures below 5 - 6°C may lead to high levels of mortality in 0-groups. As a result, any SSB–recruit relationships may be obscured by temperature effects (Pawson *et al*., 2007a). Patterns in the recruitment time-series in the 4 UK bass stock areas indicate that England and Wales bass 'stocks' are biologically linked (Pickett *et al*. 2004) and/or that recruitment is controlled by large-scale environmental patterns.

On the south and west coasts of the UK, juvenile bass emigrate from these nursery areas at around 36 cm TL (age 3.6 years, depending on growth rate), often dispersing well outside the 'home' range, and not necessarily recruiting to their specific parent spawning stock (Pawson *et al*., 1987; Pickett *et al*., 2004). It appears that there is substantial mixing of bass at this stage throughout large parts of the populations' distribution range. After 4.7 years, or at approximate lengths of 35 cm for males and 42 cm for females, bass attain maturity (Kennedy and Fitzmaurice, 1972; Pawson and Pickett, 1996).

## Stock ID and possible management areas

Although Child (1992) suggested that there may be genetic differences between immature bass from the Irish Sea and elsewhere, other work (Tobin, Galway University, unpublished manuscript), using samples of 0-group bass from the Camel and Tamar Estuaries (SW England), the Scheldt Estuary in Belgium and two Irish samples, suggests that there is little, if any, sign of population structuring. In addition, work by Durand, Bonhomme and Morizur (2001) on adult bass captured at the main spawning grounds in VIIe, VIIf, VIIIa and VIIIb suggested that the genetic differentiation between spawning grounds is very limited, suggesting that mixing between generations is sufficient to homogenise the genetic makeup of each sub-population. Fritsch *et al.* (2007) investigated 8 microsatellite loci of juvenile and adult bass caught in the Bay of Biscay and the English Channel and of 5 loci of bass caught in Ireland and Scotland. Genetic data showed no significant population differentiation, indicting substantial gene flow. However, results suggested that Irish and Scottish populations could be separated from the Bay of Biscay and Channel, but the sample size in this case was limited.

Tagging studies around England, Wales and Ireland in the late 1970s and early 1980s showed that adult bass moved to the south and west as the water temperature decreases during October - December (Pawson *et al*., 1987). These fish appeared to return to the same feeding area each summer, and it has been proposed that, once bass reach maturity, they either occupy well-defined (usually inshore) feeding areas or pre-spawning and spawning areas, which tend to be offshore.

In 2000 and 2001, some 5000 adult bass were tagged and released inshore around the coasts of England, Wales and Ireland during summer and autumn, and on the offshore spawning grounds in winter (Pawson *et al*., 2007b). The pattern of recaptures confirmed the general migration patterns of adult bass between summer feeding areas and offshore spawning areas seen in earlier tagging studies (Pawson *et al*., 1987).

However, whereas all winter recaptures of adult bass tagged in the North Sea were reported from the offshore fishery in the western Channel during the early 1980s, no North Sea fish were reported there in the more recent study. The proportion of tagged adult bass reported from within the UK 3-mile zone between November and April of 2000–2005 was much higher than in the 1980s. Reports of local, inshore, recaptures of tagged adult bass between November and April were scarce in the 1980s (2.8%), whereas this proportion is now much higher (14.6%), with some fish being recaptured in these areas as late as February. This suggests that climate warming may have lengthened the duration of residence of adult bass in summer feeding areas and, at least in the North Sea, has allowed bass to spawn much further north than previously. This fits well with the observations that the bass population has developed both in abundance and its northwards range since the early 1990s. Also, warmer winters might be expected to enhance survival of first-year bass towards the northern edge of their distribution (Kelley 1986; Pawson and Eaton 1999).

The ICES Study Group on Sea Bass (SGBASS) proposed 6 stock areas for bass (ICES 2002, 2004), based on seasonal patterns of movement and the characteristics of the seasonal fisheries taking bass. The Study Group proposed that bass in the North Sea be considered as a separate stock. The eastern and western Channel have resident and seasonal visiting bass and, though there is little evidence of a "biological" boundary between these stocks, the SGBASS suggested that the boundary between ICES Divisions VIId and VIIe be retained for assessment purposes because the respective fisheries are different in character. Very few bass appear to move north or south across the Hurd Deep within VIIe, which suggested to SGBASS that fish around North Brittany and the Channel Islands could be separated from UK stocks and possibly included with those in Sub-area VIII. The Study Group considered that for management purposes the bass population around Ireland could be regarded as a discrete stock. Finally, the bass population in the Bay of Biscay appeared to be relatively self-contained, and the Study Group proposed that this should be treated as a separate stock area.

Recent genetic and tagging studies, have lead both Fritsch *et al.* (2007) and Pawson *et al.* (2007), to question the need for 6 stock areas. While these authors suggested that the North Sea and Bay of Biscay could be separated as stock units, they suggest that the English Channel and Bristol Channel could be treated as a single stock unit, as could bass in Irish waters.

## Management regulations

### EC

The MLS (landing, stored, sold, displayed, or offered for sale) of 36 cm total length came into force in 1990 in Regions 2 and 3 of Community waters (Council Regulation (EEC) No. 3094/86 as amended by Council Regulation (EEC) No. 4056/89), and is aimed at protecting juvenile bass that occur predominantly inshore. There is now effectively a banned range for enmeshing nets of 70 - 89 mm stretched mesh (the most selective range for bass of 30 - 36 cm) in Community waters in Regions 1 and 2 (Council Conservation Regulation 850/98; AnnexVI, Fixed gear, Regions 1 and 2).

### France

Although there are no direct effort or catch (TAC) restrictions on this fishery, a national regulation limiting bass landings by French pelagic trawlers fishing in the Channel was set up for economic reasons in 1996, when landings were limited to

2t/boat /week from 1 January to 30 April. Since 1998, this measure has been extended to all trawlers landing bass and the current limit is 5 t/boat/week.

In some areas, additional local regulations apply. In Brittany, long liners and hand liners voluntarily stop fishing between February and mid-March, which is the main spawning season.

For recreational fishing, regulations stipulate the amount of fishing tackle that is allowed onboard a vessel, and anglers are not allowed to sell their catch.

#### UK

In 1990, a package of technical measures was implemented in England and Wales, comprising a 36 cm MLS, closure of 37 key bass nursery areas (in estuaries or around the warm-water discharges from coastal power stations where juvenile bass congregate and are vulnerable to fishing) under the Bass (Specified Sea Areas) (Prohibition of Fishing) Order 1990, with amendments up to 1998), and mesh size regulations for enmeshing nets which effectively banned meshes between 70 and 89 mm (i.e. those most selective for bass of 30 - 36 cm).

In England and Wales, the Cornwall and South Wales Sea Fisheries Committees have bye-laws stipulating a 37.5 cm MLS, and the South Wales SFC also has a gill net minimum mesh size of 100 mm.

There are no bass-related local regulations in Scotland, but the weekly limit of 5 t per vessel adopted for French pair trawlers in 1996 (see below) was adopted by the UK (largely for Scottish vessels working in VIIe) in 2000 to prevent excessive landings in the winter offshore fishery.

#### Ireland

In the 1970s, Bye-law No. 577 of 1975 introduced a size limit of 38 cm, a closed time for fishing bass by net or weir, and a restriction in the taking of bass by net in certain areas. S.I. No. 128 Bass (Conservation of Stocks) Order, 1990 - increased the size limit to 40 cm TL and forbade fishing from a boat for bass or the use of nets in their capture or to have the fish on board an Irish fishing vessel. A Bass (Restriction on Sale) Order (S.I. No. 191 of 1991, renewable annually) prohibits the sale or offer for sale of bass. The Bass Fishing Conservation Bye-law (No. 673 of 1991) prohibited the taking or having in possession more than two bass in any 24-hour period, and a closed season for angling for bass between 15 May and 15 June was established in 1992. The cumulative effect of these regulations has been to ban commercial fishing for bass.

#### Spain

The 36 cm MLS for bass applies in the Spanish waters of Div. VIIIb,c and northern Div. IXa, and for the recreational fishery in the inshore waters of the Basque Country (Decreto de la Comunidad del País Vasco. 198/2000).

## Fisheries Data

### Fisheries description

Commercial fisheries for bass in NW Europe developed rapidly in the late 1970s and 1980s, due to the high price commanded by the species and despite the availability of farmed bass, wild caught bass is still a popular species. Although bass may be the main target for some commercial fisheries, the species is more commonly caught by fishermen in England and France as one of 4- 6 species that are the target of a given fishing trip. Bass are rarely exploited as the main target species throughout the whole year.

The commercial bass fisheries can be split into inshore and offshore components. In the inshore fishery, small boats operate daily trips and use a wide variety of fishing methods with relatively little activity in winter. Once bass mature, they are less available to the inshore fishery, but they have been increasingly targeted on their pre-spawning and spawning grounds by French mid-water pair-trawlers since the early 1980s and more recently by British vessels, chiefly between November and April (ICES, 2002). Catches of bass taken by rod-and-line have comprised a substantial part of the overall landings into southern Britain and Ireland for many years (Dunn *et al.*, 1989, 1994), where the bass is widely regarded as the most important marine recreational angling species. This species is also considered the most important marine recreational species in France (Herfault *et al*, 2010).

#### North Sea (IVa,b&c)

Though bass are caught by angling around Oslo and the far north of Scotland, and near warmwater discharges from power stations on the Scottish east coast, the northern limit of the commercial bass fishery is on the Yorkshire coast, where trawl-caught fish are increasingly landed into Scarborough and Whitby, and bass are also taken as a by-catch in nets set for cod and sea trout. Southwards along the English coast, small quantities of bass are taken as a by-catch in trawls and set nets and occasionally by directed angling, and are regularly caught in the southern North Sea as part of a mixed fishery in fixed and drift nets, trawls and by lines, and may be targeted in the local estuaries and around wrecks and offshore banks from May until November by both commercial fishermen and recreational anglers often using charter boats. Bass are caught in the southern North Sea by French boats using bottom trawls, and both shore and boat angling for bass has become popular and worthwhile along the Netherlands coast of the North Sea.

#### The eastern English Channel (VIId)

The inshore bass fishery on the English coast of the eastern English Channel is largely a part-time activity to the east of Selsey Bill in Sussex, prosecuted from April to November by a large fleet of beach-launched day-boats using trammel and gill nets. Both commercial and recreational rod and line fisheries, using live sandeel and sometimes pout whiting or mackerel as bait for large bass, have existed for many years off Beachy Head in Sussex and, more recently, off Brighton and Selsey on the Owers Bank and around the Nab Tower. A pair trawl fishery, mainly out of Shoreham and Newhaven, occasionally take large catches of bass. In the Solent area, much of the bass fishing is by fixed gill nets and drift-nets, long-lines and rod-and-line, and several small trawlers from Newhaven to Poole have used locally designed, high-headline bottom trawls for bass fishing. In addition, charter boats take out groups of anglers specifically to catch bass, the larger vessels going offshore as far as the Channel Isles and the numbers of such vessels has increased in recent years. Bass are taken as a by-catch by French boats using bottom trawls in the eastern Channel, and by netters and liners operating out of eastern Channel ports.

#### The western English Channel (VIIe,h)

Most of the boat fishing for bass along the English coast is with rod and line, both commercial and charter recreational angling off the estuary mouths and headlands, and there is also some fixed gill netting inshore. There is relatively little gill netting for bass in south Cornwall, though there is considerable recreational and some commercial rod and line fishing for bass all year round. The largest bass fishery in the western English Channel uses pair trawls from February until April for bass shoaling offshore prior to spawning, and involves local French boats and pair teams from ports in the Bay of Biscay that return to fish in Biscay during the rest of the year. This fishery has recently included Scottish and, occasionally, Danish mid-water pair trawling teams, and up to 5 pairs of UK mid-water trawlers have targeted bass between November and April.

Along the French coast, to the west of the Cherbourg Peninsula, artisanal boats take bass as a by-catch all year round, and also target bass using long-lines in spring and summer and trolling, as on the south coast of England. The local gill net fleet has similar characteristics to the English inshore fisheries in the western Channel, and bass are also taken as by-catch in nets directed at other species and by trawlers. Recreational boat angling for bass takes place around north Brittany.

There is a small commercial bass fishery in the many tide races and overfalls around the Channel Isles, using drifting longlines and rod and line, and trolling and gillnetting around the rocky reefs. The recreational angling fishery for bass around Jersey and Guernsey appears to have grown steadily in recent years.

#### The Celtic Sea and Bristol Channel (VIIf,g)

The main bass fishery along the north coasts of Cornwall and Devon is netting and rod and lining in summer in the estuaries and tide rips, whilst trawlers from Padstow and Bideford also take a by-catch of bass throughout the year. In late winter, spawning bass are sometimes targeted by French mid-water pair teams and by single bottom trawlers on the Trevose Head grounds. On the south Wales coast, west of Cardiff, bass are taken between May and November by various netting methods, including drift netting, though there has recently been a move towards the commercial use of rod and line. A few boats in the Tenby area still troll for bass on offshore reefs and areas of tidal overfalls. Similarly, the bass fishery in Cardigan Bay is characterised by small boats operated mainly on a part-time basis and setting gill, trammel and stake nets close inshore. Catches taken by trawlers in south Wales have increasingly included bass, which are landed mainly into Swansea and Milford Haven.

Commercial exploitation of bass in the Republic of Ireland has been prohibited since 1990. The best of the bass angling fishery extends from the west of County Wexford around the southern coast to County Clare, where bass shoal in estuary mouths, off rocky headlands and reefs and along open storm beaches.

#### Irish Sea (VIIa)

In Cardigan Bay, bass are taken by small boats setting gill, trammel and stake nets close inshore, and some have recently been landed by trawlers. Commercial rod and line fishing tends to predominate along the north-west Wales coast and, with netters and recreational anglers, target bass shoals on the broad sand banks at each end of the Menai Strait Eastwards, along the north Wales, Lancashire and Cumbrian coasts of the Irish Sea, fixed gill nets or drifted gill or trammel nets are used in summer to catch bass, and they are also caught in nets and lines set intertidally and by rod and line, both recreational and commercial. Bass are taken as a by-catch in nets or traps set for flatfish or salmon throughout the Solway Firth. Few bass are caught along the Irish coast of the Irish Sea to the north of the River Boyne.

#### Bay of Biscay (VIIIa,b)

Main metiers are Pelagic trawl, nets, bottom trawl, longline and hand line.

Bass are also taken as a by-catch in the sole gill-net fishery and by bottom trawlers, though the most important bass fishery is by pelagic pair-trawlers. Since 2001, purse seiners from South Brittany have taken around 50 t of bass per year in winter. In the south of this region, bass are taken as a by-catch in mixed demersal fisheries operated by the Basque fleet, particularly the 'baka' bottom trawl off the central western French coast (Gironde area), by high vertical opening pair bottom trawls, longlines and gill nets, and by purse-seiners targeting pelagic species. Bass are mainly caught in this fishery from September until March.

Recreational angling for bass is also popular along the French coast, particularly between the Cherbourg Peninsula and southern Brittany and is becoming increasingly important in parts of southern Norway, the Netherlands and Belgium. For the purpose of this report, the bass fisheries in North-west Europe are presented by groups of ICES divisions that encompass the major differences in patterns of bass migration and seasonality of exploitation.

### Commercial catches and discard data

A summary of bass catches is given in Table 0-1 and Figure 0-1. As can be seen, catches at the beginning of the 1980's were around 2 000 t in the North East Atlantic. However, since that time, catches have steadily increased, reaching a peak of over 8 000 t in 2006. These figures include an 'Unallocated' component of the UK fishery, which is calculated using a voluntary logbook scheme. This scheme was closed in 2007 and for 2007 – 2009, only official landings values are given for the North Sea, Eastern Channel and western Channel. French data of Seabass for the EU Data Collection Framework have been recorded but the tools to extract and exploit them are still in development.

#### IVb,c and VIId (Table 0-2)

Total international landings of bass from the southern North Sea and eastern Channel were relatively stable at around 500 t over the period 1984 – 1990. Catches then rose to 1 500 t in 1994, before decreasing to 1 000 t in 1996. Since that time however, catches have risen once more, peaking in 2005 at 2 500 t. According to national official statistics, annual landings have recently been higher for France than for England, but inclusion of estimates of the landings of English inshore boats obtained through a voluntary log-book scheme indicate that the English catch until 2000 was higher than that reported by France. Recorded bass landings by Netherlands boats have been negligible until 1998, since when they have increased to around 300 - 400 t annually. UK landings peaked in 1994, 1997 and 1999, whereas French landings increased from 1993 onwards.

#### Divisions VIIe,h

Landings of bass from the western Channel and Western Approaches fluctuated between 260 and 520 t over the period 1984 - 1993 (except for 980 t in 1987), rose to a peak of 1440 t in 1997 and then reached approximately 1900 t in 2004 and more than 2 700 t in 2006. French vessels have accounted for the main part of the annual landings - usually at least 50% - whilst English vessels landed most of the remainder. In recent years, landings from the Channel Islands have also increased to approximately 150 – 200 t per annum.

#### Divisions VIIa,f&g (Table 0-4)

Bass landings from the Irish Sea, eastern Celtic Sea, and Bristol Channel fluctuated between 110 and 310 t over the period 1984 - 1992, and then rose to a peak of 850 t in 1994. After this landings fluctuated between 360 and 680 t, but peaked again at 840 t in 2004. The greatest component of landings in this area is obtained from estimates of the landings of UK inshore boats obtained through the CEFAS logbook scheme.

#### Divisions VIa,b and VII b,c,j,k (Table 0-5)

Offshore catches of bass are occasionally reported from Subarea VI and the western divisions of Sub-area VII. Historically, France has averaged less than 0.5 t per annum for this area, but since 2005, landings have averaged around 5 t annually. Occasional large landings from this area have been reported. Spanish landings of up to 40 t were in 1998, though the provenance of these data is questionable.

#### Divisions VIIIa,b &d

Landings of bass from the Bay of Biscay increased rapidly to 1550 t from 1984 to 1987, since when they have fluctuated between 1 300 and 1 680 t until 1999, rising to around 2 400 t in 2000 - 2001 and to more than 2 500 t in 2003. In 2006 catches peaked at 2 877 t. French vessels appear to have accounted for around 90% of the annual landings. Spanish (only Basque Country) bass catches from Division VIIIa,b,d have been relatively constant, amounting to an annual average of around 50 t in the period 1994 - 2002 and mostly due to the Baka otter trawl and longline fisheries. A very regular and marked seasonality (main catches in the 4th and 1st quarters) is observed in the Basque landings throughout the period 1994 - 2004.

#### Division VIIIc (Table 0-7)

Between 1988 and 1998, Spain consistently reported landings of between 250 and 400 t of bass from the southern Bay of Biscay, Division VIIIc, but landings declined to 110 t by 2002 and since that time have ranged between 114 and 173 t Inshore catches reported by the Basque Country have amounted to an annual average of 9 t in the period 2000-2004 (range 5.14 t), and comprise longline (about 70% of the total landings), gillnet (15%) and purse seine (10%). In 2004, the purseiners catch reached 3 t.

#### Div. IXa (Table 0-8)

Total landings of bass reported from the western coast of Spain and Portugal reached a peak of 600 t in 1989, and have since fluctuated between 141 and 772 t without an apparent trend. Landings in 2006 – 2008 have been between 516 t and 772 t. The Spanish catch from this area reached a peak in 2007 (228 t), despite being at series lows in the early 2000's. The Portuguese catch peaked at over 544 t in 2007.

### Commercial catch-effort data

#### France

Nominal fishing effort data are available for French pelagic trawlers and demersal trawlers operating in VIId, VIIeh, VIIafg and VIIIab between 1984 and 1998 (Table 0-9).

According to CHARM 3 Atlas of the Channel Fisheries, seabass production in value represents €31 937 in 2008. It's the 3rd most valuable species caught (source: Agrimer) in 2008 behind sole and monkfish (tuna is not included in statistics). The market value of seabass depends greatly on how it is caught, giving added value to certain metiers: according to CHARM3 Atlas of the Channel Fisheries, mean price of seabass sold in the Channel (7EH+7D) by liners was €17.14 per Kg in 2007 compared with €6.52 per Kg for pelagic trawl.

Since 2000 Ifremer has carried out a comprehensive survey (Fisheries Information System) consisting of an exhaustive collection of annual activity calendars (Berthou *et al*, 2008). This consists of a follow up of the metiers practiced by a given vessel per month and per year (by metier, we mean the use of a gear, to target one or several species, in a given fishing area). Figure 0-2 presents the numbers of vessels targeting seabass per gear. Landings are associated. A vessel is considered targeting seabass when its annual activity calendar shows at least a "seabass metier" covering at least a month in a given year. An imbalance exists between Pelagic trawling which represented in 2008 45% of captures for 59 vessels (25 pairs and 9 vessels), particularly in winter during the spawning season and coastal liners which represented 32% of captures for the rest of the year for 567 vessels

France has effort data (Figure 0-3 and0-10: Effective effort (days fished) from French logbooks) and lpue data (Figure 0-4 and Table 0-11) from logbooks of bottom trawlers, pelagic trawlers, nets, longlines and handlines in 5 stock areas between 2000 and 2008.

In area VIIeh, fishing effort of bottom trawl and pelagic trawl has increased from 2000 to 2004-2005, then became stable. Long liners effort has increased from 2000 to 2006 then decreased. Nets effort increased until 2007 then decreased. Morizur *et al*. (2009) investigated landings, fishing effort and landings per unit of effort for bottom trawlers and pelagic pair trawlers operating in ICES sub-areas VIII and VII between 2000 and 2007. Fishing effort was assessed by using a threshold on the landings by month in order to select the most effective fishing effort as representing 75 % of the effort concerned with seabass landings. An increase of the fishing effort of pelagic trawling was detected in the English Channel area since 2005.

In VIId both bottom trawl and net gears showed an increase in days fished between 2000 and 2003, but have since declined. Effort directed in pelagic trawling increased between 2000 and 2005. Variability is then observed until 2007. (Data for 2008 are incomplete)

In general, fishing effort in VIIIa,b has increased from 2000 to 2007 for nets, long liners and hand liners, then decreased. Bottom trawl showed a constant increase in days fished between 2000 and 2008. Pelagic trawl showed an increase of effort from 2000 to 2006 (except 2004), trend is decreasing in 2007 (2008 data are incomplete).

French Lpue data are also available from logbooks of French bottom trawlers, pelagic trawlers, nets, longlines and handlines in all 5 stock areas between 2000 and 2008

The fishing effort data available is the "days fished" for bottom trawl, long lines, hand lines, nets, and the "days at sea" for pelagic trawl. No threshold was applied to each gear to calculate effort Validity of LPUE of Pelagic has to be discussed because of the specific management associated to this gear (5 tons/week/vessels). Results are presented in Figure 0-3 but the available information in the log book does not give accurate data results. Trends of LPUE presented particularly for long lines, hand lines are under estimated. Fishermen mentioned that numbers of hooks and hours fished have increased from 2000 to 2010 in 8AB and 7EH (number of hooks for long liners were multiplied by two in some area such as southern Brittany). Moreover all new technologies such as the use of automatic fishing devices cannot be taken into account.

A decrease of LPUE has been observed for most of the gear in the VIIIa,b ICES area from 2000 and in VIIe,h ICES area from more or less a long time (particularly from 2006-2007). This trend is still reported in 2010 by coastal metier (particularly long liners and hand liners). It questions the viability of some fishing companies. The only available data for 2009 is a focus on LPUE of 6 coastal liners of 7E from personal fishing presented in Figure 0-5. It shows a mean decline of 33% of their LPUE from 2007 to 2009. According to them this trend is still observed in 2010. It is not explained yet.

This trend doesn't seem to be observed in the VIId, IVbc, ICES area.

#### UK

Nominal fishing effort data are available for UK(E&W) trawlers, pair trawlers, nets, lines and other gears operating in IVb,c, VIId, VIIeh, and VIIafg between 1985 and 2008 (Table 0-12).

In addition, historically, 'best estimates' of annual catch and effort for bass were obtained by integrating official statistics derived from landings declarations and local market sales at major ports with those from a voluntary log-book system. Between 1985 and 2006, the Cefas logbook system provided daily catch records from a sample of 45 - 60 inshore fishing vessels, including charter angling boats. Estimates of total landings were obtained from the sampled catch and effort, raised to numbers of active vessels, and stratified by gear, boat-type and division, derived from an annual fleet census. Catches by gear-type, derived from each system, were compared by stock area on an annual basis between 1985 and 1995, and quarterly between 1996 and 2006, and the higher values chosen. Best estimates of landings are a composite of these figures. In mid-2007, the logbook scheme was closed, but was subsequently reopened at the beginning of 2009 calendar year. Catch and effort data for 2009 were considered to be of poor quality due to the low number of logbooks returned. Composite 'best estimate' landings are given in Table 0-13, and the composite effort data for 1985-2006 are given in Table 0-14. For trawlers, effort was relatively stable through the time series in areas IVbc and VIIafg. In Area VIId, trawl effort increased to 1994 and 1995, decreased sharply in 1996, but has since increased. In area VIIeh, trawl effort has gradually increased through the time series. Effort for nets and lines is less consistent in all areas.

Individual logbook cpue data are given in Figure 0-6 and Figure 0-8. Data presented are for those logbooks that were held by the same logbook holder for ~10 years of the scheme. In general, there are few trends in the cpue of individual logbook holders. However, some trends can be seen In Region 1 (ICES Division IVb&c), the cpue of individual rod and line gears from the mid-1990's to 2006. Tangle nets also show a general increase through the time series, possibly reflecting the increase in abundance of bass in the North Sea. In region 2 (ICES Division VIId), only 3 series of net cpues are available. All suggest low cpues in the late 1990s but increase at the start of the 2000's.

#### Ireland

Ireland has had no legal commercial bass fishery since 1990. Data on Irish recreational fisheries were presented in the SGBASS report in 2003 (ICES 2004a)

#### Spain (Basque Country)

Information on bass landings and landings per unit effort made by the Spanish fleets landing into the Basque Country ports, extending from 1994 to 2004, was presented in a working document to WGNEW (Annex 3, WD2 2 Lucio *et al*., 2005). There is less detailed information from other important Spanish regions. The Basque Country data, obtained from EC log-books, skippers logbooks and *ad hoc* monitoring of the trips and landings into Basque ports, cover more than 14 commercial métiers, in four sea areas: Subarea VI; Subarea VII mainly VIIh,j); Divisions VIIIa,b,d and Division VIIIc (eastern part). Economic values per year in recent years are available for all métiers and sea areas considered together. In 1991- 1992, *ad hoc* sampling, conducted by AZTI to study the artisanal métiers in the inshore waters of the Basque Country coast (eastern Div. VIIIc and southern Div. VIIIb), produced data on bass catches, effort and length compositions for surface longline and trammel net (Puente, 1993). AZTI monitoring for bass in 1994 and 1995 did not include landings of the main fleets operating in Div. VIIIc, particularly longline and gillnet; thus total landings reported for those years in this area must be considered underestimated.

Fishing effort data are expressed in 'days fished' and are available since 1994 for Baka bottom otter trawls in Div. VIIIa,b,d, and also for other trawling métiers and for longlines and trammel nets. The best estimator of bass abundance trends (LPUE) in the period 1994 - 2004 is based on landings into the Basque port of Ondarroa by the 'baka' otter bottom trawl fleet working in Div. VIIIa,b,d. This fleet takes the largest bass catches of the Basque fleet, and its fishing effort can be quantified with accuracy through the period. However, this is currently a mixed-species fishery, in which bass is an economically important by-catch restricted to a period of the year. The effective fishing effort of this fleet was calculated as fishing days, obtained by multiplying the number of trips in Div. VIIIa,b,d by the mean number of fishing days by trip in the area, season (quarter) and year. No bass discards were observed during an observer survey in 2000, conducted by AZTI on board Baka trawls in Sub-area VII and in Divisions VIIIa,b,d as well as in pairtrawls with VHVO nets in Divisions VIIIa,b,d and in Division VIIIc.

There is very little information on bass taken by the recreational rod and line fishery close to the Basque coast and in the rivers mouths (eastern Division VIIIc and southern Division. VIIIb), but their catches might be considered of very low importance (possibly less than 3 t per year). The main catches are taken in autumn (September to November) (L. Arregi, pers. com.), although major effort is applied in summer months (holidays season).

#### Spain (other than BC)

Statistics were provided of bass landings by Spanish vessels outside the Basque Country for 2000 - 2002 by sea area and gear. No associated effort data were available.

#### Portugal

Landings by gear between 1986 and 2003 for ICES Division IXa are given in Table 0-15.

## Recreational catches

### France

The first national survey of recreational fishing in France (2006 to 2008) revealed that seabass was the main target species for recreational fishermen, with catches around 5000 tons. According to this survey, the individual penetration rate is 2%. That means that 2% of the population aged 15 years and has catch at least a seabass during the last twelve months on the Atlantic, English Channel or North Sea seaboards. The estimated number of seabass fishermen in the coastal zone is then 229 000 fishers. Extrapolated to the entire France is represented seabass 378,500 fishermen. In 2009, a new study was launched to monitor seabass recreational fishing more accurately. Results are not available yet. (Monitoring of recreational fishing of seabass (*Dicentrarchus labrax*) in France: output from a dual methodology (telephone survey and diary). Author: Herfaut *et al.* ICES CM 2010/R: 05)

### UK (England and Wales)

Estimating the number of anglers targeting bass is difficult, but estimates made since the early 1990's have ranged from 361 000 and 435 000 anglers (Dunn and Potten 1994; Drew Associates 2003; BASS 2004). Given the paucity of information on the fishing activity of bass anglers, it is difficult to estimate the total annual recreational landings and annual fishing effort. However, socio-economic studies undertaken by the University of Portsmouth's Centre for the Economics and Management of Aquatic resources (CEMARE), estimated that in 1987 and 1993 recreational landings in England and Wales were 415 t and 412 t, respectively (Dunn *et al.* 1989; Dunn and Potten 1994). This was approximately 57% and 37% of the composite 'best estimate' of commercial landings for the respective years. No more recent estimates of recreational catches are available

### Ireland

No estimate of recreational catches is available.

### Spain (Basque Country)

A traditional, but small, recreational fishery (by rods and lines) takes place close to the coast and in the rivers mouths along the Basque coast (eastern Division VIIIc and southern Division VIIIb). No information on the catches is available, though the main catches are obtained in autumn (September to November), whilst the major effort is applied in summer (holidays season).

## Survey data

### UK

The UK has conducted pre-recruit trawl surveys in the Solent and the Thames Estuary since 1981 and 1997, respectively and has undertaken a seine net survey in the Tamar Estuary, since 1985 – 2009. In addition, historic abundance data are available from power stations where juveniles may be impinged on intake screens. Data are available in the River Thames for the year classes 1975 – 1995 and in the River Severn for the year classes 1972 – 1996. Abundance indices for UK survey series are given in Table 0-16.

In the Solent survey, strong year classes were seen in 1989, 1995 and 1997. In the last decade, year class strength has been more consistent than the early part of the time series, with many years classes showing a relative abundance around the series mean, rather than the large fluctuations seen at the beginning of the time series.

Additional pre-recruit surveys are also undertaken in the Rivers Fal and Helford, using seine and stop nets in a variety of ways. These survey data were reviewed by Bailey and Smith (2009), who concluded that the survey was able to identify particularly strong or weak year classes, but that more standardisation in the survey methods would improve the robustness of the survey.

#### Netherlands

Since 1972, 0-3 group bass have been recorded in 3m beam trawl surveys carried out in the Westerscheldt in September and October. Relative abundance is given in Table 0-17. Between 1972 and 1990, catches of bass in these surveys were rare, with catches recorded in only 6 years of that range. However, from 1990 onwards the abundance in the Westerscheldt area has increased significantly. Large peaks in survey abundance are seen in 1994 and 2004.

Figure 0-9 shows the abundance at length for each year of the survey. In 1994, abundance of 0-grouip fish (~5 cm TL) was extremely high, the highest of the time series. This year class can be tracked in 2005 and 2006, at approximately 20 cm TL, and 26 cm TL, respectively. Although 1994 was not a strong year for the Solent and Tamar surveys, which take place further west, the 1994 year class was strong in the Thames pre-recruit survey, where it was the fourth-highest of the time series. Other strong 0-group year classes can be seen in 1999, 2002, 2003 and 2004.

#### Ireland

Data are available from a stop net survey between 1996 and 2003 (Table 0-16).

#### France

Index from French surveys cannot be used for seabass, because, in particularly IBTS and Evohe are not adapted for this species (only a few seabass are caught, and it cannot be representative).

### Biological sampling

#### France

Good biological sampling data (length and age) are available for all métiers in VIIe (except pelagic trawls) for one year, 1989 - 90, and for all métiers by quarter in VIId,e for 1994 - 95. Length structures estimates are available for VIIe,h and VIIIa,b (Figure 0-10 and Figure 0-11) per gear and for all gear. Per quarter, year, gear, and by ICES area the number of sampled trips and number of measured fish are available. When a main gear was not sampled in a quarter, sampling used came from another quarter of the same year. Lack of these data are highlighted in Table 0-18. For VIIe,h structure at age per gear and for all gear were drawn up from 2000 to 2008 with VIIe,h ALKs (Figure 0-12). For VIIIa,b , ALK are available only for 2008 (quaterly) and 2009 (annual). No structure at age is also available for this division.

#### UK

Lengths of bass in commercial landings are measured from either the whole landing or samples of >50 fish from each commercial size category, against targets set by métier group (i.e. demersal trawls, gillnets, lines, and pelagic trawls). Half-yearly length distributions are raised to equivalent total landings by métier-group and stock area. In each stock area, length-stratified (all gears) scale samples of at least 150 fish are used to provide corresponding age data, stratified to ensure that ALKs contain a minimum of 5 ages per 1-cm total length class across the available length range. Where sampling is sparse (usually because of sampling difficulties with landings outside the main port market system), annual ALKs are used.

Length and age data have been used to compile 'stock' files for the period 1985-2009 that include age-length distributions and data on mean fish weight-at-age, by year. Sex ratio, maturity, growth, condition factors, and TL to FL conversion data are largely derived from biological sampling carried out between 1982 and 1990 (Pawson and Pickett, 1996), and from sampling of the UK offshore fishery in 1999 and 2002. Catch numbers at length and age for the UK fishery are given in Figure 0-13 to Figure 0-28.

### Biological parameters and other research

The life history traits of bass vary across their environmental range, with fish at the cooler, northern extremes usually exhibiting slower growth, later maturity and longer maximum life spans than those from warmer environments. Around Britain and Ireland, male bass mature at a length of 31 - 35 cm, aged 4 - 7 years, and females at 40 - 45 cm, aged 5 - 8 years, (Kennedy and Fitzmaurice, 1972; Pawson and Pickett, 1996). Data from the south part of the Bay of Biscay (Lam Hoai, 1970, Stequert, 1972) indicate that male matures at a length of 35 cm (age 4) and females at 42 cm (age 6). Off the Tunisian coast, males mature at around 24 cm, aged 2 - 3 years, and females at around 32 cm, aged 4 - 5 years.

Other aspects of the population biology of bass are presented in the following references, and include spawning areas in relation to temperature (Thompson and Harrop, 1987; Jennings and Pawson, 1992; Reynolds *et al.*, 2003); egg development (Jennings and Pawson, 1991), larval drift and recruitment to nursery areas (Jennings and Pawson, 1992; Reynolds *et al.*, 2003); development, growth and survival of 0-groups in relation to temperature (Lancaster, 1991; Reynolds *et al.*, 2003); establishement of recruits year class strength and dispersal from nursery areas (Pawson, 1992; Pickett *et al.*, 2004); development of maturity (Kennedy and Fitzmaurice, 1972; Pawson and Pickett, 1996; Masski, 1998; Pawson *et al*, 2000), migrations and movements (Pawson *et al.*, 1987). A review of bass population biology and fisheries is given by Pickett and Pawson (1994).

In 2009 the maturity of 981 bass (male = 339, female = 642) commercially-caught bass caught by the UK fishery was investigated (Walmsley 2010). Samples were obtained from fisheries in the northeast, the southeast and the southwest. All fish were weighed, measured, assigned a maturity stage and scale samples were retained for age determination. The data indicated that for all female bass sampled, L50 was approximately 40 cm TL. This contrasts with the data of Pawson and Pickett, (1996) who reported that females were not becoming ripe to spawn at lengths of <42 cm TL, and may suggest that females may be maturing at a smaller size than was previously reported. In addition, data suggest that the onset of maturity differs by geographic location, with females in the North Sea maturing at a larger size than those in the southeast. For males, the data indicated that L50 was approximately 34 cm TL, but that there were uncertainties due to the small sample size and outliers in the data. However, it appeared that gravid and running individuals were larger than previously reported.

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**Table 0-1: Nominal landings (t) of bass by stock area**

| Year | IVb,c and VIId | VIIe, h | VIIa, f, g | IVb, Via, VIIb, c & j, XII | VIIIa, b, d | VIIIc | IXa | Total |
|---|---|---|---|---|---|---|---|---|
| 1984 | 675 | 518 | 212 | 1 | 381 | 180 | 250 | 2217 |
| 1985 | 421 | 348 | 114 | <0.5 | 806 | 200 | 164 | 2053 |
| 1986 | 392 | 264 | 258 | <0.5 | 1482 | 211 | 363 | 2970 |
| 1987 | 365 | 983 | 307 | 1 | 1552 | 211 | 321 | 3740 |
| 1988 | 425 | 373 | 130 | 3 | 1528 | 370 | 444 | 3273 |
| 1989 | 391 | 274 | 203 | 1 | 1673 | 327 | 599 | 3468 |
| 1990 | 386 | 332 | 161 | 1 | 1407 | 396 | 558 | 3241 |
| 1991 | 541 | 343 | 286 | 1 | 1648 | 310 | 489 | 3618 |
| 1992 | 516 | 467 | 214 | 3 | 1624 | 254 | 439 | 3517 |
| 1993 | 751 | 436 | 526 | 2 | 1437 | 247 | 393 | 3792 |
| 1994 | 1533 | 701 | 854 | 1 | 1554 | 307 | 506 | 5456 |
| 1995 | 1079 | 551 | 445 | 8 | 1420 | 335 | 428 | 4266 |
| 1996 | 1007 | 1230 | 357 | 8 | 1488 | 377 | 536 | 5003 |
| 1997 | 1301 | 1437 | 562 | <0.5 | 1488 | 290 | 413 | 5491 |
| 1998 | 1007 | 925 | 676 | 50 | 1302 | 258 | 388 | 4606 |
| 1999 | 1594 | 1268 | 451 | 2 | 1672 | 222 | 442 | 5651 |
| 2000 | 1268 | 1577 | 530 | 4 | 2403 | 25 | 444 | 6251 |
| 2001 | 1122 | 1538 | 545 | 1 | 2282 | 131 | 434 | 6053 |
| 2002 | 1679 | 1310 | 399 | 13 | 2281 | 122 | 475 | 6279 |
| 2003 | 2047 | 1893 | 488 | 1 | 2576 | 160 | 362 | 7527 |
| 2004 | 2598 | 1906 | 835 | 1 | 2568 | 221 | 141 | 8270 |
| 2005 | 2719 | 2299 | 525 | 2 | 2800 | 197 | 256 | 8798 |
| 2006 | 2311 | 2786 | 428 | 3 | 2877 | 155 | 576 | 9136 |
| 2007 | 2207 | 1754 | 240 | 6 | 2758 | 116 | 772 | 7853 |
| 2008 | 2176 | 1774 | 301 | 5 | 2746 | 142 | 516 | 7660 |
| 2009* | 1963 | 1354 | 165 | | 2181 | | | 6015 |

*2009 data are provisional only

**Table 0-2: Nominal landings (t) of bass by country in Divisions IVb,c, and VIId, and additional UK catch according to the CEFAS logbook scheme, 1985 – 2006**

| Year | Belgium | Denmark | France[1] | Netherlands | Scotland | UK (E&W) | Unallocated[2] | Total |
|---|---|---|---|---|---|---|---|---|
| 1984 | | | 21 | | | 77 | 577 | 675 |
| 1985 | | | 175 | | | 76 | 170 | 421 |
| 1986 | | | 151 | | | 92 | 149 | 392 |
| 1987 | | | 85 | | | 86 | 194 | 365 |
| 1988 | | | 104 | 8 | | 102 | 211 | 425 |
| 1989 | | 1 | 147 | 2 | | 91 | 150 | 391 |
| 1990 | | <0.5 | 131 | | | 70 | 185 | 386 |
| 1991 | | <0.5 | 161 | | | 168 | 212 | 541 |
| 1992 | | <0.5 | 180 | | | 83 | 253 | 516 |
| 1993 | | | 262 | | | 143 | 346 | 751 |
| 1994 | | 1 | 260 | | | 357 | 915 | 1533 |
| 1995 | | 1 | 298 | | <0.5 | 413 | 367 | 1079 |
| 1996 | | 1 | 417 | 4 | <0.5 | 318 | 267 | 1007 |
| 1997 | | 1 | 290 | 1 | <0.5 | 321 | 688 | 1301 |
| 1998 | | 2 | 369 | 32 | <0.5 | 281 | 323 | 1007 |
| 1999 | | 1 | 628 | 32 | <0.5 | 335 | 598 | 1594 |
| 2000 | | | 612 | 61 | <0.5 | 217 | 378 | 1268 |
| 2001 | | | 681 | 76 | <0.5 | 205 | 160 | 1122 |
| 2002 | | | 868 | 105 | 5 | 244 | 457 | 1679 |
| 2003 | 133 | | 1197 | 169 | 2 | 269 | 277 | 2047 |
| 2004 | 119 | | 1318 | 197 | <0.5 | 307 | 657 | 2598 |
| 2005 | 149 | 1 | 1377 | 319 | 1 | 276 | 596 | 2719 |
| 2006 | 150 | 2 | 1145 | 299 | 6 | 250 | 459 | 2311 |
| 2007 | 128 | 1 | 1429 | 373 | 24 | 252 | - | 2207 |
| 2008 | 118 | | 1290 | 375 | 41 | 352 | - | 2176 |
| 2009* | | | 1611 | 352 | | 352 | | 1962 |

Source: ICES Bulletin Statistique

[1]Landings for 2000 – 2008 revised in 2010

[2]Landings estimated by the Study Group.

*2009 data are provisional only

**Table 0-3: Nominal landings (t) of bass by country in Divisions VIIe,h, and additional UK catch according to the CEFAS logbook scheme 1985 – 2006**

| Year | Belgium | Denmark | France[1] | Guernsey | Jersey | Channel Islands | Netherlands | Spain | UK (S) | UK (E&W) | Unallocated[2] | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1984 | | | 171 | 18 | 7 | | | | | 39 | 283 | 518 |
| 1985 | | | 98 | 10 | 8 | | | | | 19 | 213 | 348 |
| 1986 | | | 128 | 8 | 7 | | | | | 22 | 99 | 264 |
| 1987 | | | 744 | 8 | 6 | | | | | 16 | 209 | 983 |
| 1988 | | | 228 | 7 | 5 | | | | | 30 | 103 | 373 |
| 1989 | | 1 | 131 | 40 | 8 | | | | | 39 | 55 | 274 |
| 1990 | | | 157 | 20 | 5 | | | | | 91 | 59 | 332 |
| 1991 | | | 202 | 13 | 3 | | | | | 45 | 80 | 343 |
| 1992 | | | 337 | 26 | 10 | | | | | 40 | 54 | 467 |
| 1993 | | | 252 | 29 | 16 | | | | | 51 | 88 | 436 |
| 1994 | | | 163 | | | 49 | | | | 67 | 422 | 701 |
| 1995 | | | 269 | 59 | 10 | | | | | 101 | 112 | 551 |
| 1996 | | | 959 | | | 56 | 4 | | <0.5 | 162 | 49 | 1230 |
| 1997 | | | 774 | 57 | 17 | | | | | 150 | 439 | 1437 |
| 1998 | | | 580 | 60 | 19 | | 16 | | | 162 | 88 | 925 |
| 1999 | | | 756 | 92 | 16 | | | | <0.5 | 310 | 94 | 1268 |
| 2000 | | | 1137 | 111 | 19 | | <0.5 | 1 | | 137 | 172 | 1577 |
| 2001 | | | 1149 | 65 | 15 | | 4 | | | 167 | 138 | 1538 |
| 2002 | | | 902 | 52 | 21 | | 2 | | <0.5 | 234 | 99 | 1310 |
| 2003 | 2 | | 1258 | 59 | 25 | | 5 | | | 234 | 310 | 1893 |
| 2004 | 4 | | 1237 | 140 | 19 | | | | | 231 | 275 | 1906 |
| 2005 | 3 | | 1750 | 198 | 22 | | 8 | <0.5† | | 162 | 156 | 2299 |
| 2006 | 6 | | 2075 | 162 | 31 | | 9 | | 1 | 199 | 303 | 2786 |
| 2007 | 6 | | 1314 | 142 | 18 | | 3 | | 28 | 243 | - | 1754 |
| 2008 | 7 | | 1402 | 123 | 20 | | 5 | | | 217 | - | 1774 |
| 2009* | | | 1163 | | 12 | | | | | 179 | | 1354 |

Source: ICES Bulletin Statistique

[1]Landings for 2000 – 2008 revised in 2010

[2]Landings estimated by the Study Group

*2009 data are provisional only

**Table 0-4: Nominal landings (t) of bass by country in Divisions VIIa,f&g, and additional UK catch according to the CEFAS logbook scheme, 1985-2006**

| Year | Belgium | France[1] | Ireland | Scotland | UK (E&W) | Unallocated[2] | Total |
|---|---|---|---|---|---|---|---|
| 1984 | | 1 | | | 8 | 203 | 212 |
| 1985 | | 13 | | | 11 | 90 | 114 |
| 1986 | | 2 | | | 11 | 245 | 258 |
| 1987 | | 24 | 3 | | 23 | 257 | 307 |
| 1988 | | 7 | | | 43 | 80 | 130 |
| 1989 | | 14 | | | 62 | 127 | 203 |
| 1990 | | 14 | | | 27 | 120 | 161 |
| 1991 | | 75 | | | 27 | 184 | 286 |
| 1992 | | 43 | | | 24 | 147 | 214 |
| 1993 | | 14 | | | 32 | 480 | 526 |
| 1994 | | 9 | | | 110 | 735 | 854 |
| 1995 | | 40 | | <0.5 | 141 | 264 | 445 |
| 1996 | | 41 | | <0.5 | 82 | 234 | 357 |
| 1997 | | 31 | | <0.5 | 88 | 443 | 562 |
| 1998 | | 195 | | <0.5 | 42 | 439 | 676 |
| 1999 | | 28 | | <0.5 | 32 | 391 | 451 |
| 2000 | | 56 | | <0.5 | 50 | 424 | 530 |
| 2001 | | 54 | | | 81 | 410 | 545 |
| 2002 | | 55 | | | 131 | 213 | 399 |
| 2003 | 17 | 16 | | <0.5 | 73 | 382 | 488 |
| 2004 | 34 | 49 | | 2 | 74 | 676 | 835 |
| 2005 | 54 | 34 | | 1 | 72 | 364 | 525 |
| 2006 | 55 | 39 | | | 118 | 216 | 428 |
| 2007 | 44 | 28 | | | 168 | | 240 |
| 2008 | 63 | 58 | | | 180 | | 301 |
| 2009* | | 26 | | | 139 | | 165 |

Source: ICES Bulletin Statistique

[1]Landings for 2000 – 2008 revised in 2010

[2]Landings estimated by the Study Group

*2009 data are provisional only

**Table 0-5: Nominal landings (t) of bass by country in Divisions IVa, VIa, VIIb,c,j&k and XII**

| Year | Belgium | Denmark | France[1] | Ireland | Netherlands | Norway | Portugal | Scotland | Spain | Spain (BC)[2] | UK (E&W) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1984 | | | 1 | | | | | | | | | 1 |
| 1985 | | | <0.5 | | | | | | | | <0.5 | <0.5 |
| 1986 | | | <0.5 | | | | | | | | | <0.5 |
| 1987 | | | <0.5 | 1 | | | | | | | <0.5 | 1 |
| 1988 | | | <0.5 | | 3 | | | | | | | 3 |
| 1989 | | | 0.5 | 1 | | | | | | | | 1 |
| 1990 | | <0.5 | <0.5 | 1 | | | | | | | | 1 |
| 1991 | | <0.5 | 1 | | | | | | | | <0.5 | 1 |
| 1992 | | | 2 | | | | | | | | 1 | 3 |
| 1993 | | | 1 | | | | | | | | 1 | 2 |
| 1994 | | <0.5 | <0.5 | | | | | | | | 1 | 1 |
| 1995 | | <0.5 | <0.5 | | | | | <0.5 | | | 8 | 8 |
| 1996 | | | 0.5 | | | | 3 | <0.5 | | | 5 | 8 |
| 1997 | | <0.5 | <0.5 | | | | | | | | <0.5 | <0.5 |
| 1998 | | <0.5 | 0.5 | | | | | <0.5 | 40 | | 10 | 50 |
| 1999 | | <0.5 | 0 | | | | | <0.5 | 1 | | 1 | 2 |
| 2000 | | | 3 | | | | | <0.5 | | <0.5 | 1 | 4 |
| 2001 | | | 1 | | | | | | | <0.5 | <0.5 | 1 |
| 2002 | | | | | | | | | 1 | <0.5 | 12 | 13 |
| 2003 | | | | | | <0.5 | | <0.5 | | <0.5 | | 1 |
| 2004 | <0.5 | | | | | <0.5 | | <0.5 | | <0.5 | | 1 |
| 2005 | | <0.5 | 2 | | | <0.5 | | | | | | 2 |
| 2006 | | | 3 | | | <0.5 | | | | | | 3 |
| 2007 | | <0.5 | 6 | | | <0.5 | | | | | | 6 |
| 2008 | | | 5 | | | | | | | | | 5 |

Source: ICES Bulletin Statistique

[1]Landings for 2000 – 2008 revised in 2010

[2]Estimates for Spain (Basque Country)

**Table 0-6: Nominal landings (t) of bass by country in Division VIIIa,b&d**

| Year | Belgium | France[1] | Spain | Spain (BC)[2] | UK (E&W) | Unallocated[3] | Total |
|---|---|---|---|---|---|---|---|
| 1984 | | 381 | 0 | | 0 | | 381 |
| 1985 | | 805 | 0 | | 1 | | 806 |
| 1986 | | 1478 | 0 | | 4 | | 1482 |
| 1987 | | 1547 | 0 | | 5 | | 1552 |
| 1988 | | 1512 | 0 | | 16 | | 1528 |
| 1989 | | 1673 | 0 | | | | 1673 |
| 1990 | | 1407 | 0 | | | | 1407 |
| 1991 | | 1611 | 17 | | 20 | | 1648 |
| 1992 | | 1601 | 14 | | 9 | | 1624 |
| 1993 | | 1404 | 14 | | 19 | | 1437 |
| 1994 | | 1393 | 17 | 60 | 14 | 130 | 1554 |
| 1995 | | 1283 | 0 | 29 | 7 | 130 | 1420 |
| 1996 | | 1344 | 0 | 51 | 14 | 130 | 1488 |
| 1997 | | 1345 | 0 | 42 | 13 | 130 | 1488 |
| 1998 | | 1142 | 27 | 50 | 3 | 130 | 1302 |
| 1999 | | 1602 | 11 | 57 | 2 | | 1672 |
| 2000 | | 2295 | 50 | 58 | | | 2403 |
| 2001 | | 2238 | 2 | 42 | | | 2282 |
| 2002 | | 2216 | 15 | 50 | <0.5 | | 2281 |
| 2003 | | 2497 | 39 | 38 | 2 | | 2576 |
| 2004 | <0.5 | 2284 | 212 | 65 | 7 | | 2568 |
| 2005 | <0.5 | 2722 | 31 | 43 | 4 | | 2800 |
| 2006 | | 2707 | 168 | | 2 | | 2877 |
| 2007 | 1 | 2677 | 79 | | 1 | | 2758 |
| 2008 | | 2600 | 146 | | | | 2746 |
| 2009 | | 2181 | | | | | 2181 |

Source: ICES Bulletin Statistique

[1]Landings for 2000 – 2008 revised in 2010

[2]Estimates for Spain (Basque Country).

[3]Landings estimated by the Study Group.

*2009 data are provisional only

**Table 0-7: Nominal landings (t) of bass by country in Division VIIIc**

| Year | France | Portugal | Spain | Spain (BC)[1] | UK (E&W) | Total |
|---|---|---|---|---|---|---|
| 1984 | 0 | | 180 | | | 180 |
| 1985 | 0 | | 200 | | | 200 |
| 1986 | 5 | | 206 | | | 211 |
| 1987 | 3 | | 208 | | | 211 |
| 1988 | 12 | <0.5 | 358 | | | 370 |
| 1989 | 1 | 1 | 325 | | | 327 |
| 1990 | 1 | | 395 | | | 396 |
| 1991 | 9 | 1 | 300 | | | 310 |
| 1992 | 0 | | 254 | | | 254 |
| 1993 | 0 | <0.5 | 247 | | | 247 |
| 1994 | 0 | 1 | 306 | | | 307 |
| 1995 | 1 | <0.5 | 334 | | <0.5 | 335 |
| 1996 | 1 | <0.5 | 376 | | | 377 |
| 1997 | 0 | <0.5 | 290 | | | 290 |
| 1998 | 0 | <0.5 | 258 | | | 258 |
| 1999 | 9 | <0.5 | 221 | | | 222 |
| 2000 | 20 | | | 5 | | 25 |
| 2001 | 1 | | 122 | 8 | | 131 |
| 2002 | 1 | | 107 | 14 | | 122 |
| 2003 | 0 | | 152 | 8 | | 160 |
| 2004 | 39 | 1 | 173 | 8 | | 221 |
| 2005 | 57 | 1 | 130 | 9 | <0.5 | 197 |
| 2006 | 2 | 2 | 151 | | | 155 |
| 2007 | 1 | 1 | 114 | | | 116 |
| 2008 | | 1 | 141 | | | 142 |

Source: ICES Bulletin Statistique

[1]Estimates for Spain (Basque Country).

**Table 0-8: Nominal landings (t) of bass by country in Division IXa**

| Year | Portugal[1] | Spain | Total |
|---|---|---|---|
| 1984 | | 250 | 250 |
| 1985 | | 164 | 164 |
| 1986 | 181 | 182 | 363 |
| 1987 | 127 | 194 | 321 |
| 1988 | 351 | 93 | 444 |
| 1989 | 507 | 92 | 599 |
| 1990 | 412 | 146 | 558 |
| 1991 | 378 | 111 | 489 |
| 1992 | 345 | 94 | 439 |
| 1993 | 289 | 104 | 393 |
| 1994 | 372 | 134 | 506 |
| 1995 | 316 | 112 | 428 |
| 1996 | 378 | 158 | 536 |
| 1997 | 229 | 184 | 413 |
| 1998 | 273 | 115 | 388 |
| 1999 | 308 | 134 | 442 |
| 2000 | 361 | 83 | 444 |
| 2001 | 332 | 102 | 434 |
| 2002 | 326 | 49 | 475 |
| 2003 | 279 | 83 | 362 |
| 2004 | 66 | 75 | 141 |
| 2005 | 176 | 80 | 256 |
| 2006 | 459 | 117 | 576 |
| 2007 | 544 | 228 | 772 |
| 2008 | 405 | 111 | 516 |

[1]Revised data set 2004

**Table 0-9: Nominal fishing effort for French Pelagic trawls (hours) and Demersal Trawls (days)**

| | VIId | | VIIe,h | | VIIf,g | | VIII |
|---|---|---|---|---|---|---|---|
| Year | Pelagic | Demersal | Pelagic | Demersal | Pelagic | Demersal | Pelagic |
| 1984 | | | 1884 | | | | 5543 |
| 1985 | 2136 | | 465 | | | | 10040 |
| 1986 | 1182 | | 2086 | | | | 24317 |
| 1987 | 2302 | | 7762 | | 326 | | 20178 |
| 1988 | 1729 | | 3350 | | | | 26114 |
| 1989 | 1720 | | 2008 | | | | 26260 |
| 1990 | 2788 | | 1511 | | | | 26305 |
| 1991 | 803 | | 1487 | | 634 | | 40291 |
| 1992 | 220 | | 3133 | | 198 | | 28733 |
| 1993 | 97 | | 2964 | | 108 | | 23174 |
| 1994 | 722 | 7743 | 1899 | 4056 | | 799 | 17584 |
| 1995 | 342 | 6365 | 2040 | 4158 | 264 | 781 | 14665 |
| 1996 | 906 | 6796 | 6944 | 4357 | 392 | 647 | 16107 |
| 1997 | 1100 | 6891 | 11252 | 5889 | 55 | 1348 | 13459 |
| 1998 | 686 | 8384 | 8903 | 5085 | 2600 | 1360 | 6289 |

**Table 0-10: Effective effort (days fished) from French logbooks**

| | Bottom trawl | Pelagic trawl | Nets | Longline | Handline |
|---|---|---|---|---|---|
| IVbc | | | | | |
| 2000 | | 124 | 451 | | |
| 2001 | | 206 | 518 | | |
| 2002 | | 206 | 975 | 38 | 20 |
| 2003 | | 121 | 1175 | 100 | 17 |
| 2004 | | 93 | 974 | 114 | 28 |
| 2005 | | 76 | 1124 | 98 | |
| 2006 | | 36 | 1060 | 74 | 23 |
| 2007 | | 33 | 944 | | 100 |
| 2008 | | 32 | 1030 | | 194 |
| VIId | | | | | |
| 2000 | 3347 | 3189 | | | |
| 2001 | 6741 | 4068 | 2929 | | |
| 2002 | 9847 | 3387 | 3794 | 241 | 1723 |
| 2003 | 11002 | 4030 | 4755 | 270 | 3111 |
| 2004 | 10934 | 6003 | 3936 | 438 | 2241 |
| 2005 | 9284 | 6938 | 3948 | 416 | 2717 |
| 2006 | 8260 | 4118 | 3373 | 397 | 3010 |
| 2007 | 8768 | 5451 | 3454 | 489 | 3453 |
| 2008 | 7838 | 3122* | 3084 | 330 | 2403 |
| VIIeh | | | | | |
| 2000 | 6603 | 7887 | | | |
| 2001 | 7027 | 6747 | 822 | | |
| 2002 | 9812 | 5672 | 1279 | 2327 | 1882 |
| 2003 | 11549 | 8554 | 1416 | 3107 | 2491 |
| 2004 | 11750 | 10931 | 1285 | 3201 | 2382 |
| 2005 | 10294 | 12248 | 1701 | 3420 | 1896 |
| 2006 | 10177 | 11557 | 1767 | 4088 | 2439 |
| 2007 | 10185 | 12006 | 1899 | 3181 | 2158 |
| 2008 | 9391 | 2608* | 1598 | 2367 | 1559 |
| VIIafg | | | | | |
| 2000 | 2477 | 359 | | | |
| 2001 | 3061 | 136 | | | |
| 2002 | 3299 | 132 | | | |
| 2003 | 3539 | 32 | | | |
| 2004 | 3140 | 114 | | | |
| 2005 | 2595 | | | | 3 |
| 2006 | 2421 | 142 | | | |
| 2007 | 2151 | 35 | | | |
| 2008 | 2294 | | | | |
| VIIIab | | | | | |
| 2000 | 5553 | 8960 | | | |
| 2001 | 6944 | 7221 | 3847 | | |

| | Bottom trawl | Pelagic trawl | Nets | Longline | Handline |
|---|---|---|---|---|---|
| 2002 | 7520 | 9850 | 4741 | 2089 | 673 |
| 2003 | 10209 | 13517 | 5585 | 2880 | 1044 |
| 2004 | 12539 | 7532 | 6177 | 3363 | 1582 |
| 2005 | 16602 | 18266 | 11654 | 5589 | 1233 |
| 2006 | 16657 | 19462 | 12468 | 10201 | 2178 |
| 2007 | 19999 | 15763 | 15201 | 12278 | 2680 |
| 2008 | 21514 | 6274* | 14748 | 10775 | 1733 |

*Data incomplete for these areas in 2008

**Table 0-11: Lpue (kg/day) from French logbooks**

| | Bottom trawl | Pelagic trawl | Nets | Longline | Handline |
|---|---|---|---|---|---|
| IVbc | | | | | |
| 2000 | | 0.3 | 19.1 | | |
| 2001 | | 1.3 | 18.7 | | |
| 2002 | | 0.7 | 11.7 | 45.9 | 78.3 |
| 2003 | | 1.1 | 7.2 | 66.8 | 24.8 |
| 2004 | | 1.7 | 12.0 | 33.9 | 45.7 |
| 2005 | | 2.5 | 9.7 | 52.9 | |
| 2006 | | 1.6 | 13.8 | | 66.7 |
| 2007 | | 0.9 | 12.3 | | 77.0 |
| 2008 | | 12.0 | 8.5 | | 59.2 |
| VIId | | | | | |
| 2000 | 100.6 | 26.2 | | | |
| 2001 | 61.4 | 45.7 | 15.1 | | |
| 2002 | 35.6 | 36.0 | 15.4 | 25.7 | 31.7 |
| 2003 | 57.3 | 59.3 | 17.1 | 21.8 | 33.8 |
| 2004 | 60.3 | 55.8 | 20.2 | 16.5 | 31.0 |
| 2005 | 65.5 | 67.0 | 15.3 | 29.8 | 29.1 |
| 2006 | 67.4 | 55.5 | 16.9 | 38.6 | 29.5 |
| 2007 | 88.0 | 51.5 | 19.6 | 45.4 | 36.4 |
| 2008 | 81.2 | 53.1 | 13.5 | 40.1 | 27.2 |
| VIIeh | | | | | |
| 2000 | 16.2 | 40.3 | | | |
| 2001 | 21.1 | 51.8 | 24.7 | | |
| 2002 | 16.2 | 44.4 | 18.8 | 38.5 | 36.2 |
| 2003 | 14.0 | 64.1 | 16.9 | 32.4 | 36.0 |
| 2004 | 19.2 | 45.4 | 18.6 | 38.4 | 33.0 |
| 2005 | 19.8 | 43.4 | 17.8 | 44.6 | 45.7 |
| 2006 | 26.8 | 57.9 | 15.9 | 50.5 | 52.1 |
| 2007 | 15.9 | 41.2 | 18.6 | 51.1 | 44.2 |
| 2008 | 16.3 | 41.7 | 20.8 | 44.8 | 39.7 |
| VIIafg | | | | | |
| 2000 | 12.8 | | | | |
| 2001 | 12.8 | 9.4 | | | |
| 2002 | 10.2 | 46.5 | | | |
| 2003 | 8.4 | | | | |
| 2004 | 13.0 | 0.3 | | | |
| 2005 | 12.5 | | | | 126.7 |
| 2006 | 13.7 | 3.5 | | | |
| 2007 | 14.2 | 0.8 | | | |
| 2008 | 25.7 | | | | |
| VIIIab | | | | | |
| 2000 | 34.9 | 24.9 | | | |
| 2001 | 21.8 | 23.5 | 48.5 | | |

| | Bottom trawl | Pelagic trawl | Nets | Longline | Handline |
|---|---|---|---|---|---|
| 2002 | 18.3 | 21.3 | 49.9 | 73.0 | 56.5 |
| 2003 | 11.3 | 21.4 | 36.2 | 94.6 | 32.4 |
| 2004 | 13.4 | 15.7 | 38.0 | 84.9 | 48.3 |
| 2005 | 14.6 | 26.8 | 25.9 | 57.3 | 48.1 |
| 2006 | 18.3 | 24.4 | 29.8 | 49.4 | 39.6 |
| 2007 | 18.3 | 23.6 | 31.3 | 47.1 | 42.3 |
| 2008 | 16.2 | 28.8 | 25.6 | 46.2 | 32.6 |

**Table 0-12: Nominal fishing effort (days fished, by gear) by UK (E&W) vessels, 1985–2008. Source FAD database**

| | IVb+c | | | | | VIId | | | | | VIIe+h | | | | | VIIa+f+g | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trawls | Pair trawls | Nets | Lines | Other | Trawls | Pair trawls | Nets | Lines | Other | Trawls | Pair trawls | Nets | Lines | Other | Trawls | Pair trawls | Nets | Lines | Other |
| 1985 | 1169 | 2 | 1254 | 749 | 81 | 3889 | 1 | 9500 | 1126 | 28 | 2072 | 62 | 1128 | 1653 | 159 | 788 | 0 | 1704 | 67 | 30 |
| 1986 | 1967 | 26 | 1780 | 782 | 122 | 3227 | 2 | 9073 | 1139 | 168 | 2462 | 36 | 1642 | 1595 | 172 | 1029 | 0 | 2899 | 359 | 45 |
| 1987 | 1720 | 0 | 2121 | 626 | 0 | 3155 | 0 | 10038 | 515 | 193 | 2694 | 12 | 1692 | 1541 | 20 | 1677 | 5 | 3196 | 826 | 38 |
| 1988 | 1722 | 0 | 2904 | 1502 | 72 | 4116 | 0 | 8263 | 556 | 148 | 3552 | 64 | 2926 | 1014 | 44 | 2546 | 0 | 8096 | 3173 | 58 |
| 1989 | 1712 | 0 | 3041 | 718 | 110 | 4810 | 140 | 6270 | 1250 | 9 | 7187 | 47 | 2576 | 1314 | 45 | 3342 | 8 | 4278 | 2826 | 750 |
| 1990 | 749 | 0 | 2205 | 873 | 268 | 3833 | 0 | 15557 | 259 | 1 | 7363 | 139 | 2782 | 580 | 19 | 2648 | 2 | 851 | 649 | 12 |
| 1991 | 1016 | 0 | 2517 | 661 | 98 | 6973 | 6 | 17024 | 4057 | 38 | 4481 | 95 | 1881 | 385 | 107 | 1613 | 1 | 891 | 852 | 3 |
| 1992 | 1232 | 0 | 3617 | 947 | 42 | 3645 | 1 | 16068 | 464 | 73 | 4378 | 77 | 1324 | 943 | 117 | 1876 | 0 | 563 | 640 | 104 |
| 1993 | 1115 | 0 | 3407 | 1209 | 45 | 4842 | 1 | 10535 | 1882 | 282 | 4906 | 33 | 1736 | 950 | 190 | 2587 | 0 | 561 | 238 | 328 |
| 1994 | 1797 | 6 | 5624 | 1082 | 155 | 4651 | 0 | 11017 | 1758 | 662 | 5654 | 15 | 1793 | 985 | 150 | 2293 | 4 | 799 | 844 | 370 |
| 1995 | 2125 | 56 | 7022 | 947 | 79 | 3832 | 24 | 15000 | 2977 | 2423 | 6299 | 34 | 2142 | 1166 | 352 | 2919 | 5 | 1226 | 1382 | 173 |
| 1996 | 2556 | 0 | 6364 | 1685 | 160 | 3909 | 10 | 13633 | 2813 | 1701 | 6602 | 102 | 2514 | 887 | 669 | 2405 | 0 | 1044 | 368 | 70 |
| 1997 | 1966 | 0 | 6571 | 1943 | 91 | 3931 | 0 | 16461 | 2486 | 2639 | 7312 | 170 | 3624 | 2896 | 1621 | 2960 | 0 | 1176 | 498 | 88 |
| 1998 | 2010 | 0 | 5319 | 1971 | 208 | 4481 | 23 | 16351 | 3491 | 2072 | 6914 | 90 | 2393 | 791 | 1597 | 2226 | 3 | 367 | 274 | 113 |
| 1999 | 1997 | 0 | 4467 | 1722 | 126 | 4420 | 42 | 14116 | 2382 | 1258 | 5987 | 179 | 2749 | 1101 | 1196 | 1478 | 1 | 270 | 150 | 136 |
| 2000 | 2447 | 0 | 3779 | 1358 | 227 | 5165 | 8 | 10160 | 1120 | 2231 | 7997 | 168 | 1940 | 836 | 993 | 1835 | 0 | 552 | 99 | 66 |
| 2001 | 2203 | 2 | 3226 | 1183 | 216 | 5507 | 19 | 11051 | 876 | 1514 | 7572 | 165 | 1616 | 457 | 649 | 2510 | 0 | 529 | 268 | 69 |
| 2002 | 1829 | 0 | 4053 | 1079 | 163 | 4237 | 19 | 8900 | 1320 | 1014 | 7426 | 170 | 1080 | 149 | 828 | 2387 | 0 | 554 | 326 | 128 |
| 2003 | 2503 | 0 | 4003 | 1815 | 420 | 4861 | 81 | 11910 | 1544 | 1564 | 7759 | 333 | 1359 | 351 | 477 | 3015 | 0 | 743 | 422 | 149 |

| | IVb+c | | | | | VIId | | | | | VIIe+h | | | | | VIIa+f+g | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trawls | Pair trawls | Nets | Lines | Other | Trawls | Pair trawls | Nets | Lines | Other | Trawls | Pair trawls | Nets | Lines | Other | Trawls | Pair trawls | Nets | Lines | Other |
| 2004 | 2624 | 1 | 2818 | 1332 | 252 | 4369 | 5 | 12442 | 1795 | 511 | 8145 | 474 | 1296 | 467 | 311 | 2063 | 0 | 397 | 318 | 19 |
| 2005 | 1877 | 4 | 3090 | 482 | 93 | 3316 | 12 | 10250 | 1477 | 490 | 7014 | 171 | 923 | 309 | 189 | 1902 | 0 | 495 | 254 | 26 |
| 2006 | 1388 | 2 | 2074 | 318 | 223 | 3503 | 5 | 14848 | 2456 | 617 | 15571 | 74 | 2376 | 616 | 126 | 4573 | 19 | 923 | 586 | 45 |
| 2007 | 1604 | 2 | 1642 | 432 | 95 | 3929 | 20 | 14033 | 2717 | 1997 | 9353 | 164 | 1972 | 1331 | 145 | 2469 | 0 | 1724 | 1451 | 31 |
| 2008 | 1697 | 1 | 2262 | 247 | 140 | 2862 | 1 | 6975 | 808 | 835 | 8650 | 77 | 2524 | 1162 | 228 | 1845 | 0 | 1820 | 824 | 57 |

**Table 0-13: Best estimates of sea-bass catch (t) for UK inshore fisheries and UK and French offshore pair-trawls fished in ICES Divisions IVb, c, VIId, VIIe, h, and VIIa, f, g, 1985-2006. UK estimates are based on a 'composite' landings estimate obtained from official landings information and from a voluntary fishermen's logbook scheme. This scheme was closed in 2007**

| Year | Drift-/ gillnets | Lines | Otter trawl | Other gears | Pair trawl | Total |
|---|---|---|---|---|---|---|
| 1985 | 176 | 408 | 61 | 1 | | 646 |
| 1986 | 190 | 321 | 30 | 3 | | 544 |
| 1987 | 326 | 341 | 49 | 7 | | 723 |
| 1988 | 330 | 226 | 70 | 2 | | 628 |
| 1989 | 188 | 323 | 100 | 2 | | 613 |
| 1990 | 198 | 281 | 98 | + | | 577 |
| 1991 | 216 | 323 | 79 | 1 | | 619 |
| 1992 | 165 | 287 | 68 | 1 | | 521 |
| 1993 | 462 | 686 | 103 | 2 | | 1253 |
| 1994 | 1143 | 800 | 246 | 11 | | 2200 |
| 1995 | 525 | 449 | 220 | 40 | + | 1234 |
| 1996 | 357 | 557 | 153 | 17 | 87 | 1171 |
| 1997 | 565 | 1127 | 159 | 15 | 41 | 1907 |
| 1998 | 302 | 469 | 157 | 14 | 113 | 1055 |
| 1999 | 447 | 841 | 150 | 23 | 220 | 1681 |
| 2000 | 537 | 438 | 156 | 39 | 76 | 1246 |
| 2001 | 395 | 588 | 160 | 15 | 66 | 1224 |
| 2002 | 580 | 567 | 188 | 40 | 128 | 1503 |
| 2003 | 567 | 536 | 272 | 1 | 127 | 1503 |
| 2004 | 773 | 1099 | 207 | 1 | 131 | 2211 |
| 2005 | 448 | 898 | 197 | 2 | 78 | 1623 |
| 2006 | 569 | 810 | 198 | 22 | 33 | 1632 |

**Table 0-14: 'Composite' nominal fishing effort (days fished, by gear) by UK (England and Wales) vessels fishing for sea bass, 1985–2006. [1] trawls other than pelagic pair-trawls. Data based on data from official FAD database and on effort estimates from the voluntary fishermen's logbook scheme. This scheme was closed in 2007**

| | IVb,c | | | VIId | | | | VIIe,h | | | | VIIa,f,g | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trawls1 | Nets | Lines | Trawls1 | Nets | Lines | Pair trawl | Trawls1 | Nets | Lines | Pair trawl | Trawls1 | Nets | Lines |
| 1984 | 815 | 8960 | 2340 | 1195 | 13327 | 7683 | | 2219 | 2216 | 7419 | | 612 | 9032 | 5210 |
| 1985 | 1169 | 5663 | 4544 | 0 | 13911 | 16670 | | 2072 | 3871 | 28538 | | 788 | 11412 | 11679 |
| 1986 | 1967 | 4485 | 6928 | 2610 | 14032 | 17777 | | 2462 | 5965 | 9806 | | 1029 | 21526 | 20223 |
| 1987 | 1720 | 5622 | 5772 | 2929 | 18062 | 22386 | | 2694 | 11926 | 8637 | | 1677 | 12703 | 22213 |
| 1988 | 1722 | 11468 | 10366 | 4116 | 13662 | 17611 | | 3552 | 2846 | 13598 | | 2546 | 26743 | 21809 |
| 1989 | 1712 | 7206 | 12630 | 4810 | 10190 | 21307 | | 7187 | 3243 | 12531 | | 3342 | 11823 | 16927 |
| 1990 | 749 | 5285 | 4414 | 3678 | 13405 | 13428 | | 7363 | 302 | 4036 | | 2648 | 11038 | 17214 |
| 1991 | 1016 | 16365 | 5614 | 3963 | 19000 | 24878 | | 4481 | 358 | 4688 | | 1613 | 15717 | 23544 |
| 1992 | 1232 | 10019 | 10481 | 6751 | 16884 | 45180 | | 4378 | 213 | 16110 | | 1876 | 15839 | 23035 |
| 1993 | 1115 | 11508 | 8533 | 7762 | 25998 | 20685 | | 4906 | 67 | 9574 | | 2589 | 49321 | 21059 |
| 1994 | 1797 | 9806 | 13069 | 11290 | 24100 | 33102 | | 5654 | 578 | 11662 | | 3233 | 17914 | 22545 |
| 1995 | 2125 | 7800 | 10664 | 10695 | 13832 | 30131 | | 6299 | 13159 | 14967 | | 3784 | 23075 | 21592 |
| 1996 | 2556 | 4463 | 11144 | 3909 | 4984 | 17168 | 12 | 6602 | 4281 | 16961 | | 2405 | 38192 | 13920 |
| 1997 | 1966 | 13198 | 15097 | 3931 | 14591 | 18310 | 0 | 7312 | 18592 | 24244 | | 2960 | 17161 | 20944 |
| 1998 | 2010 | 4207 | 8187 | 4481 | 6938 | 17702 | 25 | 6914 | 3937 | 12243 | | 2226 | 24446 | 25440 |
| 1999 | 1997 | 8427 | 11523 | 4420 | 7489 | 31495 | 33 | 5987 | 763 | 10302 | 163 | 1478 | 25277 | 20553 |
| 2000 | 2447 | 10496 | 8205 | 5165 | 9557 | 8038 | 10 | 7997 | 9816 | 14762 | 114 | 1835 | 36233 | 46138 |
| 2001 | 2203 | 4382 | 6759 | 5507 | 2592 | 9361 | | 7572 | 1051 | 24470 | 137 | 2510 | 38734 | 24470 |
| 2002 | 1829 | 8212 | 11450 | 4237 | 3486 | 9225 | | 7426 | 1814 | 13534 | 159 | 2387 | 37095 | 15223 |
| 2003 | 2503 | 5826 | 6306 | 4861 | 4458 | 10159 | | 7759 | 1754 | 21151 | | 3015 | 16555 | 19797 |
| 2004 | 2624 | 12656 | 15099 | 4369 | 8115 | 25161 | | 8145 | 1754 | 21358 | 462 | 2063 | 15817 | 24653 |
| 2005 | 1877 | 10444 | 26265 | 3316 | 11698 | 25932 | | 7014 | 2945 | 17807 | 171 | 1902 | 14350 | 30627 |
| 2006 | 1388 | 12739 | 19726 | 2514 | 5091 | 33129 | 10 | 7642 | 2945 | 25338 | 621 | 3167 | 25707 | 28302 |

**Table 0-15: Portuguese landings (t) of sea bass in ICES Division IXa, by gear for 1986 - 2003**

| Year | Trawl | Artisanal | Seine | Total |
|---|---|---|---|---|
| 1986 | 5.7 | 115.9 | 59.5 | 181.1 |
| 1987 | 3.9 | 89.2 | 33.6 | 126.8 |
| 1988 | 6.9 | 293.7 | 50.4 | 351.0 |
| 1989 | 9.5 | 384.9 | 113.6 | 508.0 |
| 1990 | 4.9 | 397.5 | 9.2 | 411.6 |
| 1991 | 2.0 | 343.5 | 33.0 | 378.5 |
| 1992 | 2.7 | 313.0 | 29.5 | 345.2 |
| 1993 | 6.0 | 244.2 | 38.8 | 289.0 |
| 1994 | 4.8 | 354.6 | 13.9 | 373.3 |
| 1995 | 4.2 | 299.5 | 11.9 | 315.6 |
| 1996 | 1.4 | 345.8 | 33.8 | 381.0 |
| 1997 | 1.2 | 211.2 | 16.8 | 229.3 |
| 1998 | 0.8 | 264.5 | 7.2 | 272.6 |
| 1999 | 2.4 | 287.9 | 17.6 | 308.0 |
| 2000 | 1.6 | 345.0 | 14.7 | 361.3 |
| 2001 | 2.8 | 322.3 | 6.8 | 331.9 |
| 2002 | 1.8 | 318.3 | 5.5 | 325.6 |
| 2003 | 1.7 | 273.8 | 3.7 | 279.3 |

**Table 0-16: Relative abundance of bass by year class for surveys conducted in the UK (E&W) and Ireland**

| Country | UK (England and Wales) | | | | | | | Ireland |
|---|---|---|---|---|---|---|---|---|
| Area | East (Thames) | East (Thames) | South (Solent) x100 | South (Tamar) | South (Tamar) | West (Camel) | West (Severn) | |
| Division | IVc | IVc | VIId | VIIe | VIIe | VIIf | VIIf | VII |
| Age sampled | 0 group | 0-3 group | 2-4 group | 0-group | 1-group | 0-group | 0 group | 0 group |
| Gear | PS screens | Trawl survey | Trawl survey | Seine survey | Seine survey | Seine survey | PS screens | Seine/ Stop-net survey |
| Year Class | | | | | | | | |
| 1972 | | | | | | | 3 | |
| 1973 | | | | | | | 4 | |
| 1974 | | | | | | | 1 | |
| 1975 | 78 | | | | | | 15 | |
| 1976 | 100 | | | | | | 127 | |
| 1977 | 6 | | 12 | | | | - | |
| 1978 | 5 | | 22 | | | | - | |
| 1979 | 5 | | 172 | | | | - | |
| 1980 | 37 | | 32 | | | | 9 | |
| 1981 | 21 | | 78 | | | 2 | 216 | |
| 1982 | 56 | | 145 | | | 123 | 83 | |
| 1983 | 83 | | 181 | | | 30 | 226 | |
| 1984 | 62 | | 10 | | 0.13 | 134 | 8 | |
| 1985 | 76 | | 1 | 0.66 | 0.38 | 22 | 11 | |
| 1986 | 14 | | 5 | 0.00 | 0.01 | 1 | 3 | |
| 1987 | 116 | | 34 | 0.03 | 0.06 | 31 | 96 | |
| 1988 | 54 | | 81 | 1.48 | 1.28 | 48 | 98 | |
| 1989 | 610 | | 443 | 2.35 | 2.39 | 112 | 446 | |
| 1990 | 433 | | 63 | 1.04 | 1.52 | 89 | 25 | |
| 1991 | 64 | | 51 | 0.08 | 0.06 | 50 | 300 | |
| 1992 | 104 | | 59 | 2.22 | 2.43 | 25 | 280 | |
| 1993 | 131 | | 31 | 1.01 | 0.91 | 22 | 202 | |
| 1994 | 26 | 0.78 | 127 | 1.13 | 0.35 | 134 | - | |
| 1995 | 27 | 0.01 | 234 | 2.36 | 1.29 | - | - | |
| 1996 | † | | 21 | 0.10 | 0.05 | 119 | 242 | 15 |
| 1997 | | 0.13 | 326 | 1.12 | 1.30 | 102 | † | 1 |
| 1998 | | 0.28 | 80 | 2.08 | 3.17 | 264 | | 5 |
| 1999 | | 1.04 | 141 | 1.22 | 0.94 | 56 | | 2 |
| 2000 | | 0.39 | 57 | 0.34 | 1.18 | 133 | | 0 |
| 2001 | | 1.23 | 48 | 0.35 | 0.13 | † | | 3 |
| 2002 | | 2.06 | 77 | 2.10 | 3.18 | | | 93 |
| 2003 | | 1.81 | 79 | 0.97 | 1.07 | | | 1 |

| | | | | | |
|---|---|---|---|---|---|
| 2004 | 1.07 | 53 | 1.45 | 0.26 | ‡ |
| 2005 | 0.40 | 55 | 0.52 | 0.17 | |
| 2006 | 1.30 | 123 | 0.19 | 0.20 | |
| 2007 | 2.87 | 125 | 0.47 | 1.31 | |
| 2008 | 0.57 | | 1.28 | 1.23 | |
| 2009 | 0.67 | | 0.46 | | |

† Indicates the survey was discontinued

‡ Indicates that no additional data are available

**Table 0-17: Annual survey abundance (no per 30 min) of bass in the Netherlands Westerscheldt beam trawl survey (area IV)**

| Country | Netherlands |
|---|---|
| Area | Westerscheldt |
| Age sampled | 0-3 group |
| Year Class | |
| 1972 | 0 |
| 1973 | 0 |
| 1974 | 0 |
| 1975 | 0 |
| 1976 | 0 |
| 1977 | 0 |
| 1978 | 0 |
| 1979 | 0 |
| 1980 | 0 |
| 1981 | 0 |
| 1982 | 0 |
| 1983 | 0 |
| 1984 | 1 |
| 1985 | 0 |
| 1986 | 0 |
| 1987 | 0 |
| 1988 | 0 |
| 1989 | 0 |
| 1990 | 1 |
| 1991 | 0 |
| 1992 | 10 |
| 1993 | 1 |
| 1994 | 109 |
| 1995 | 13 |
| 1996 | 1 |
| 1997 | 4 |
| 1998 | 7 |
| 1999 | 33 |
| 2000 | 23 |
| 2001 | 29 |
| 2002 | 63 |
| 2003 | 52 |
| 2004 | 168 |
| 2005 | 18 |
| 2006 | 22 |
| 2007 | 47 |
| 2008 | 21 |
| 2009 | 24 |

**Table 0-18: French biological sampling**

| 7EH | 2000 | | | | 2001 | | | | 2002 | | | | 2003 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB sampled | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| handlines | | 4 | 23 | 12 | 41 | 29 | 26 | 3 | 16 | 15 | 24 | 22 | 18 | 20 | 27 | 9 |
| longlines | | 3 | 8 | 3 | | 1 | 1 | | | 1 | 2 | | 3 | 1 | 1 | 1 |
| nets | | 1 | 1 | | | | | 1 | | | | | | | | |
| bottom traw | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | | | |
| pelagic traw | 2 | | | | | 1 | | 1 | 2 | 1 | | | 2 | 1 | | |
| | | | | | | | | | | | | | | | | |
| NB sampled | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| handlines | | 113 | 656 | 301 | 1321 | 625 | 590 | 51 | 283 | 455 | 597 | 540 | 394 | 427 | 538 | 234 |
| longlines | | 147 | 318 | 78 | | 39 | 33 | | | 98 | 103 | | 55 | 40 | 14 | 30 |
| nets | | 56 | 16 | | | | | 5 | | | | | | | | |
| bottom traw | to be confirmed | | | | to be confirmed | | | | to be confirmed | | | | 261 | | | |
| pelagic traw | 629 | | | | 4043 | 1408 | | 887 | 413 | 267 | | | 479 | 84 | | |

| 7EH | 2004 | | | | 2005 | | | | 2006 | | | | 2007 | | | | 2008 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB sampled | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| handlines | 20 | 13 | 26 | 12 | 9 | 9 | | 4 | 6 | 18 | 7 | 9 | 5 | 7 | 6 | 4 | 3 | 5 | 6 | 5 |
| longlines | 1 | 3 | 2 | 1 | 2 | 8 | | 1 | | 2 | 5 | 2 | | 9 | 8 | 7 | 1 | 7 | 6 | |
| nets | 6 | | | | 4 | | | | 4 | | 1 | 6 | 14 | 4 | 3 | 5 | 11 | 4 | 1 | 8 |
| bottom traw | 2 | | | | 3 | | | 4 | 3 | 2 | | 2 | 5 | | | 3 | 5 | 2 | | 3 |
| pelagic traw | 2 | 2 | | 1 | 2 | | | 2 | 7 | 2 | | 1 | 4 | 1 | | | 3 | 2 | | |
| | | | | | | | | | | | | | | | | | | | | |
| NB sampled | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| handlines | 475 | 268 | 534 | 239 | 224 | 185 | | 159 | 87 | 835 | 139 | 372 | 87 | 171 | 219 | 87 | 32 | 102 | 398 | 133 |
| longlines | 23 | 141 | 67 | 1 | 64 | 290 | | 12 | | 95 | 135 | 56 | | 442 | 504 | | 6 | 274 | 335 | |
| nets | 84 | | | | 110 | | | | 122 | | 61 | 108 | 336 | 31 | 18 | 336 | 154 | 23 | 23 | 296 |
| bottom traw | 71 | | | | 215 | | | 139 | 264 | 104 | | 92 | 157 | | | 157 | 128 | 58 | | 145 |
| pelagic traw | 137 | 489 | | 129 | 273 | | | 260 | 1459 | 271 | | 498 | 917 | 270 | | 917 | 365 | 176 | | |

| 8AB | 2000 | | | | 2001 | | | | 2002 | | | | 2003 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB sampled | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| handlines | | | | | | | | | | 14 | 12 | 5 | 2 | 4 | 7 | 1 |
| longlines | 12 | 8 | 16 | 10 | 15 | 5 | 7 | 13 | 8 | 12 | 23 | 14 | 4 | 23 | 10 | 15 |
| nets | 8 | 11 | 9 | 3 | 8 | 22 | 6 | 11 | 10 | 25 | 11 | 3 | 11 | 20 | 12 | 7 |
| bottom traw | 5 | 10 | 6 | 9 | 3 | 3 | 7 | 15 | 6 | 15 | 17 | 9 | 7 | 12 | 15 | 10 |
| pelagic traw | 2 | | | | | | | | 2 | | | | 2 | 1 | | |
| | | | | | | | | | | | | | | | | |
| NB | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| handlines | | | | | | | | | | 308 | 325 | 79 | 6 | 128 | 170 | 55 |
| longlines | 317 | 87 | 326 | 255 | 498 | 175 | 222 | 161 | 125 | 180 | 348 | 385 | 120 | 422 | 267 | 394 |
| nets | 253 | 131 | 129 | 154 | 377 | 430 | 104 | 225 | 279 | 236 | 131 | 48 | 336 | 255 | 256 | 218 |
| bottom traw | 162 | 131 | 137 | 296 | 88 | 10 | 167 | 356 | 302 | 116 | 271 | 315 | 349 | 95 | 294 | 236 |
| pelagic traw | 69 | | | | | | | | 266 | | | | 182 | 17 | | |

| 8AB | 2004 | | | | 2005 | | | | 2006 | | | | 2007 | | | | 2008 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NB sampled | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| handlines | 3 | 3 | 10 | 4 | 13 | 6 | 6 | | | 9 | 7 | 9 | 2 | 4 | 7 | 7 | 2 | 7 | 3 | 3 |
| longlines | 5 | 6 | 10 | 8 | | 7 | 9 | 4 | 2 | 3 | 1 | 4 | 1 | 4 | 3 | | | 2 | 2 | 9 |
| nets | 12 | 18 | 8 | 3 | 15 | 14 | 10 | 4 | 5 | 12 | 3 | 11 | 5 | 6 | 4 | 4 | 4 | 19 | 9 | 5 |
| bottom traw | 11 | 10 | 19 | 16 | 12 | 11 | 24 | 16 | 10 | 9 | 21 | 15 | 19 | 14 | 11 | 13 | 5 | 16 | 14 | 14 |
| pelagic traw | 2 | 1 | | 1 | 3 | | | | | | | | 2 | 1 | | 5 | 11 | 7 | 10 | 28 |
| | | | | | | | | | | | | | | | | | | | | |
| NB | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| handlines | 61 | 30 | 134 | 55 | 112 | 62 | 89 | | | 139 | 197 | 423 | 96 | 122 | 233 | 199 | 89 | 79 | 102 | 125 |
| longlines | 102 | 132 | 246 | 234 | | 125 | 183 | 45 | 17 | 54 | 13 | 97 | 7 | 108 | 70 | | | 15 | 80 | 218 |
| nets | 205 | 122 | 100 | 163 | 351 | 167 | 130 | 284 | 288 | 162 | 66 | 340 | 342 | 43 | 144 | 77 | 197 | 313 | 182 | 311 |
| bottom traw | 461 | 147 | 318 | 332 | 307 | 137 | 288 | 236 | 192 | 198 | 510 | 485 | 494 | 244 | 265 | 306 | 113 | 208 | 292 | 415 |
| pelagic traw | 356 | 141 | | 140 | 274 | | | | | | | | 195 | 98 | | 206 | 1052 | 247 | 227 | 200 |

when no data available in yellow, red sampling used

8AB Q1-2006 pelagic trawl comes from Q1-2005

8AB Q2-2006 and Q3-2006 comes from Q2-2007 and Q3-2007

8AB CPEL 2007 and 2008 no data available from sale market, data comes from datas at sea

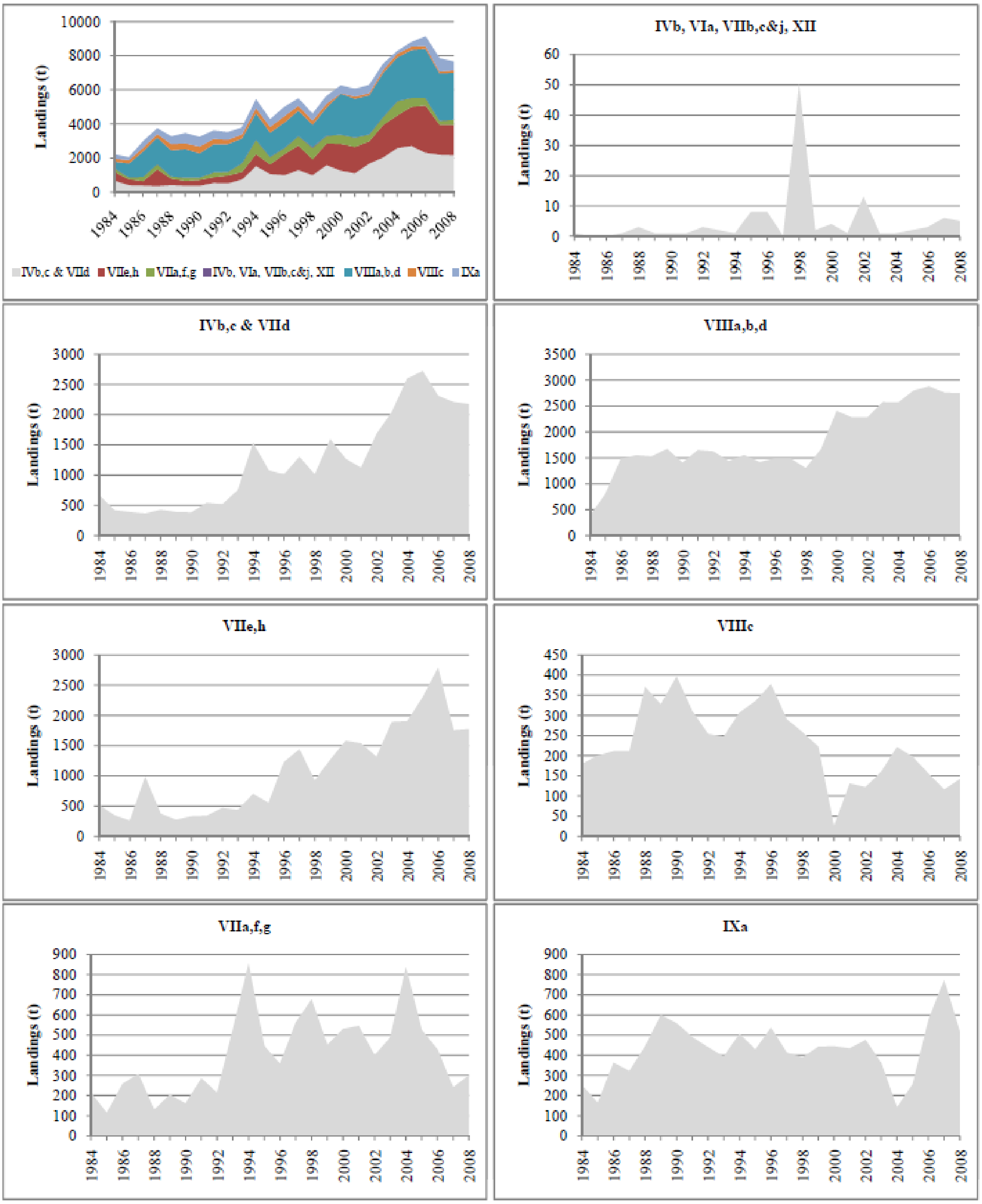



**Figure 0-1: Nominal landings (t) of bass for all stock areas, and by individual stock area**

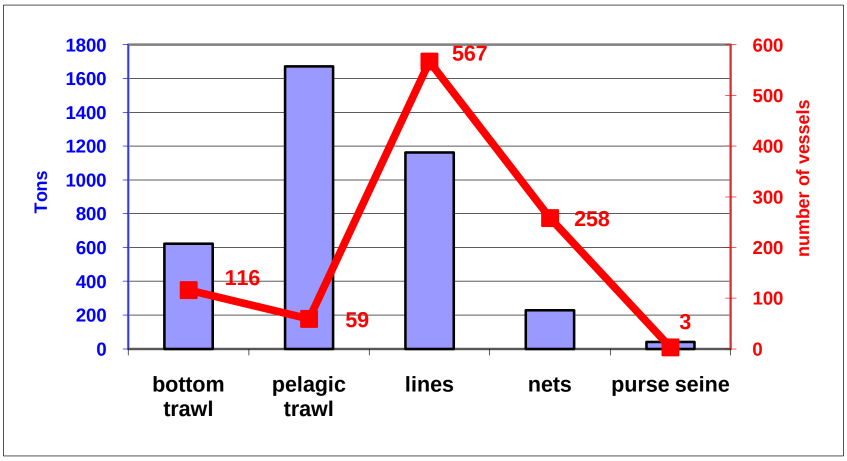



**Figure 0-2: Production per gear targeting seabass and number of vessels associated (according to the French fisheries information a vessel target sea bass when it's annual activity calendar shows at least a seabass metier during at least one month in a year)**

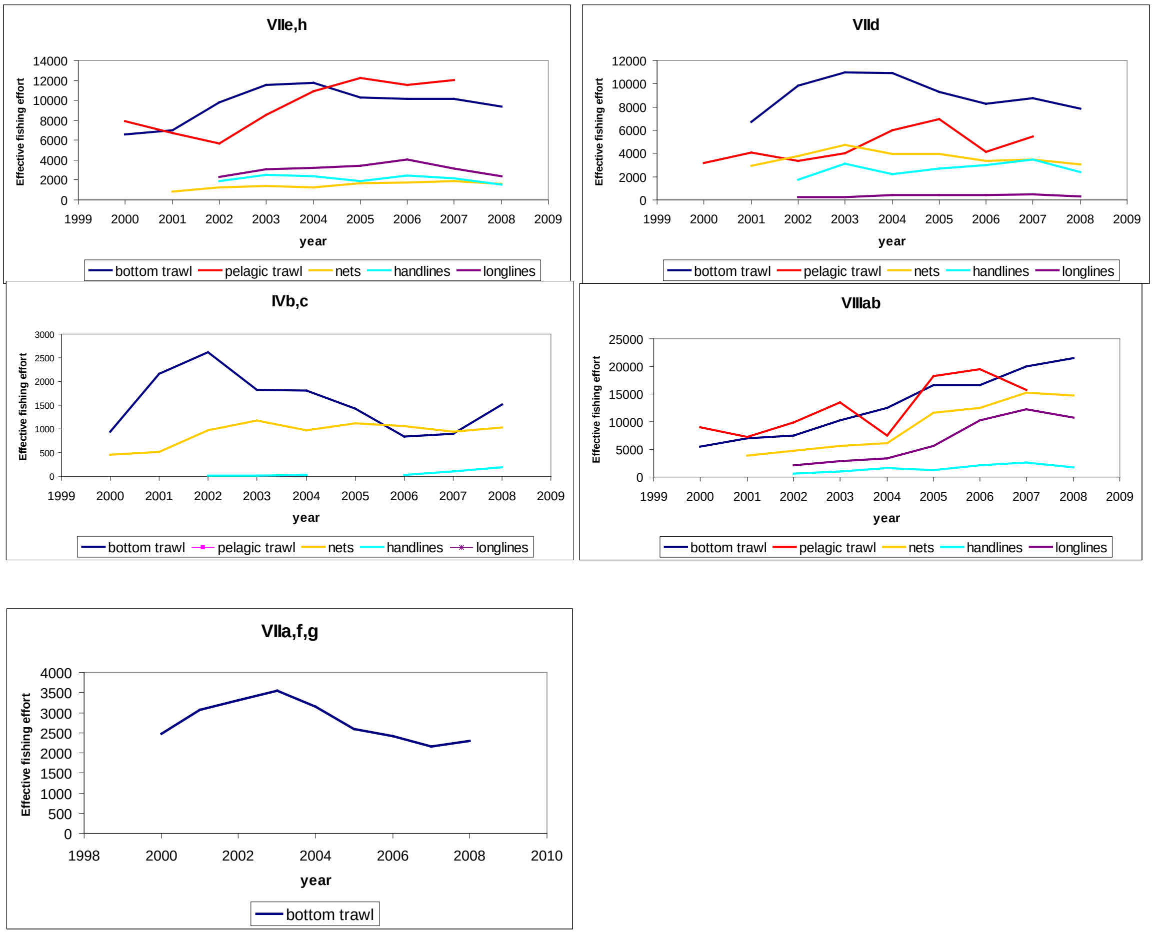



**Figure 0-3: Effective effort (days fished) from French logbooks. Data for the year 2008 are incomplete for Pelagic trawl.**

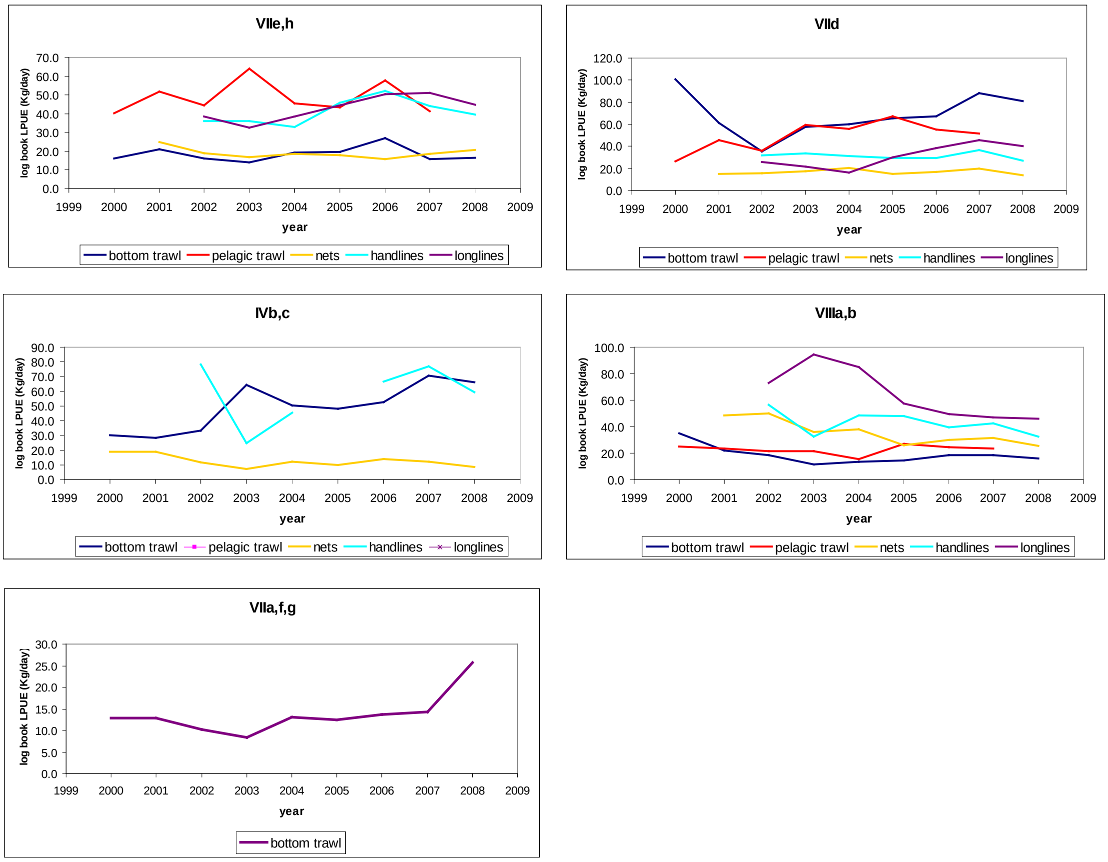



**Figure 0-4: Lpue (kg/day) from French logbooks. Data for the year 2008 are incomplete for Pelagic trawl. Trends of LPUE particularly for long lines and hand lines are under estimated. According to fishermen, numbers of hooks and hours fished increased from 2000 to 2008.**

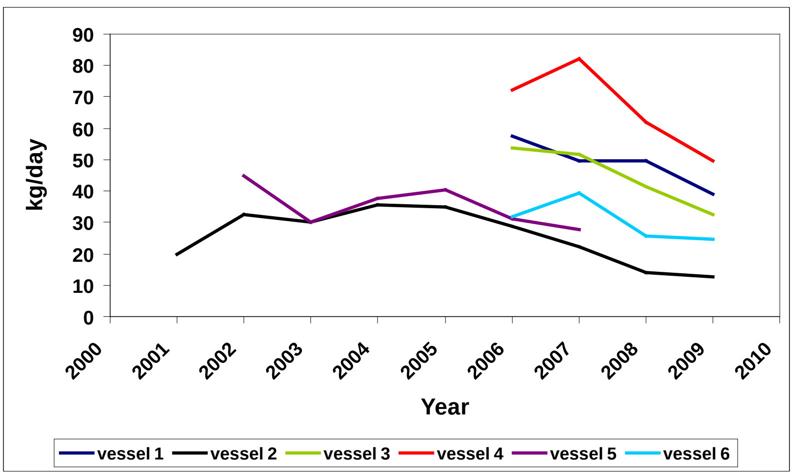



**Figure 0 -5: LPUE (Kg/day) of 6 coastal liners of division VIIe from personal fishing notebook, integrating 2009.**

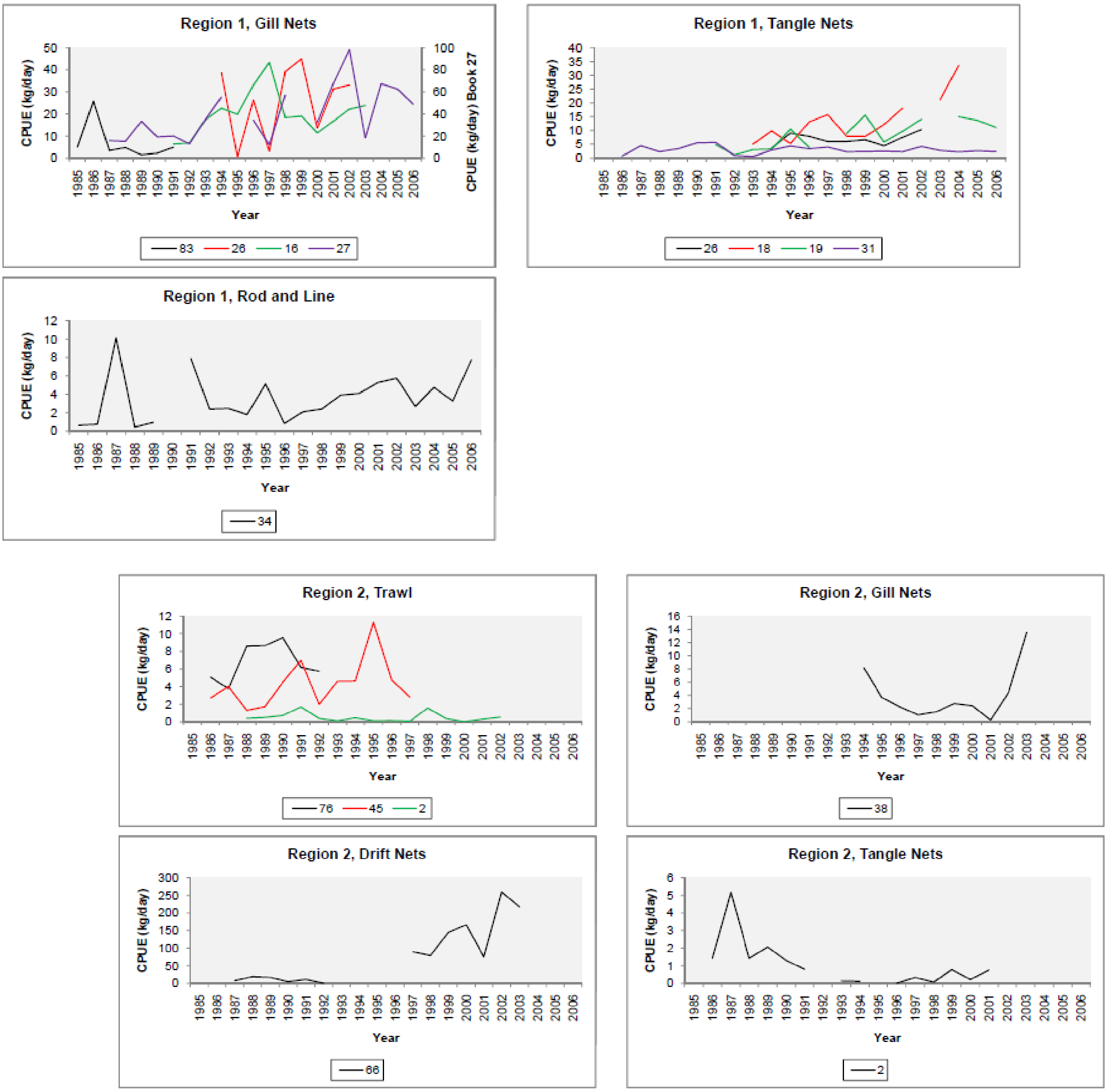



**Figure 0-6: Annual cpue (kg/day) of individual UK bass voluntary logbook holders, for Region 1 (ICES Divisions IVb & c) and Region 2 (ICES Division VII). Legend numbers relate to individual logbook number.**

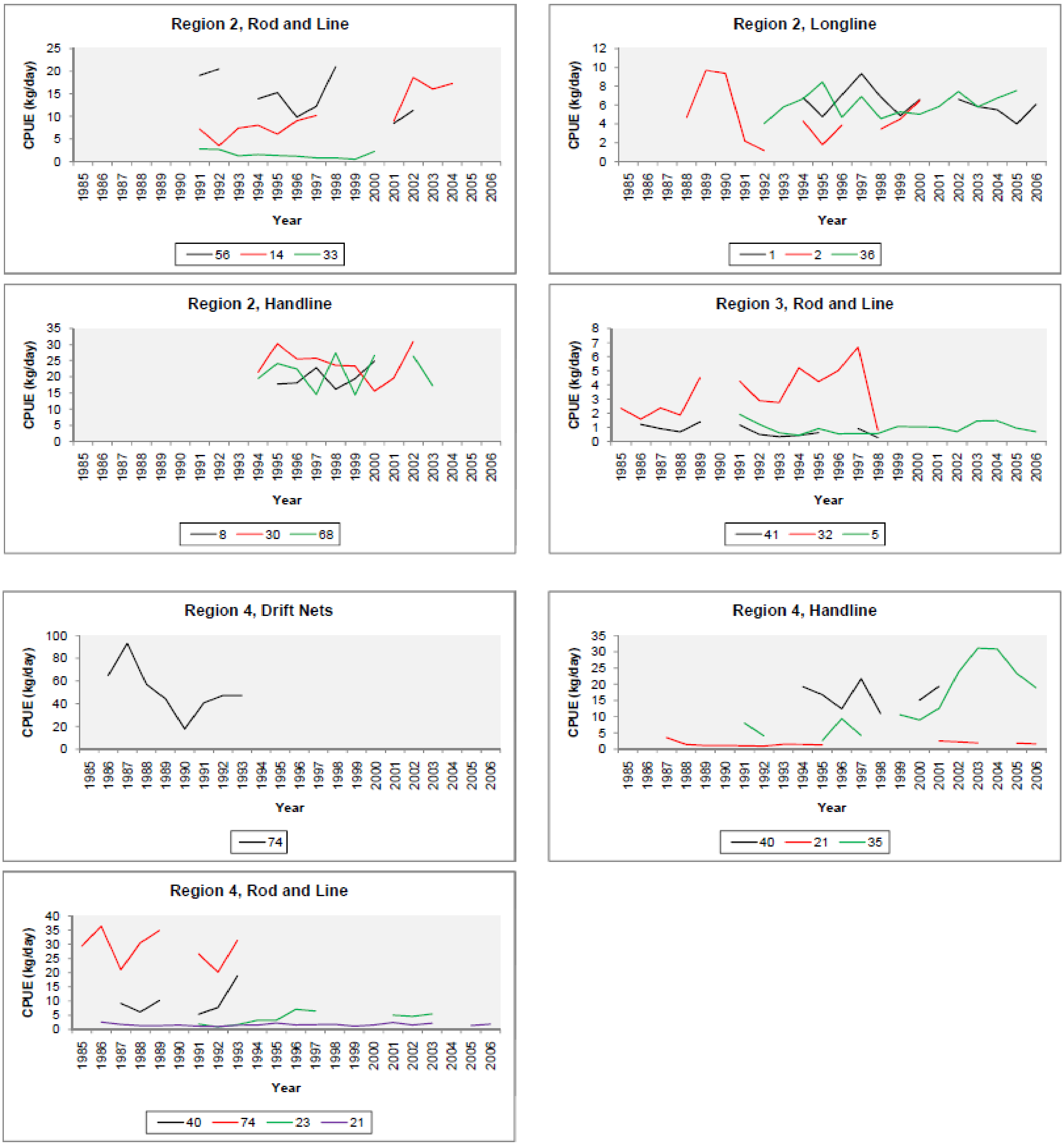



**Figure 0-7: Annual cpue (kg/day) of individual UK bass voluntary logbook holders, for Region 2 (ICES Division VIId), Region 3 (ICES Division VIIe) and Region 4 (ICES Divisions VIIf&g). Legend numbers relate to individual logbook number.**

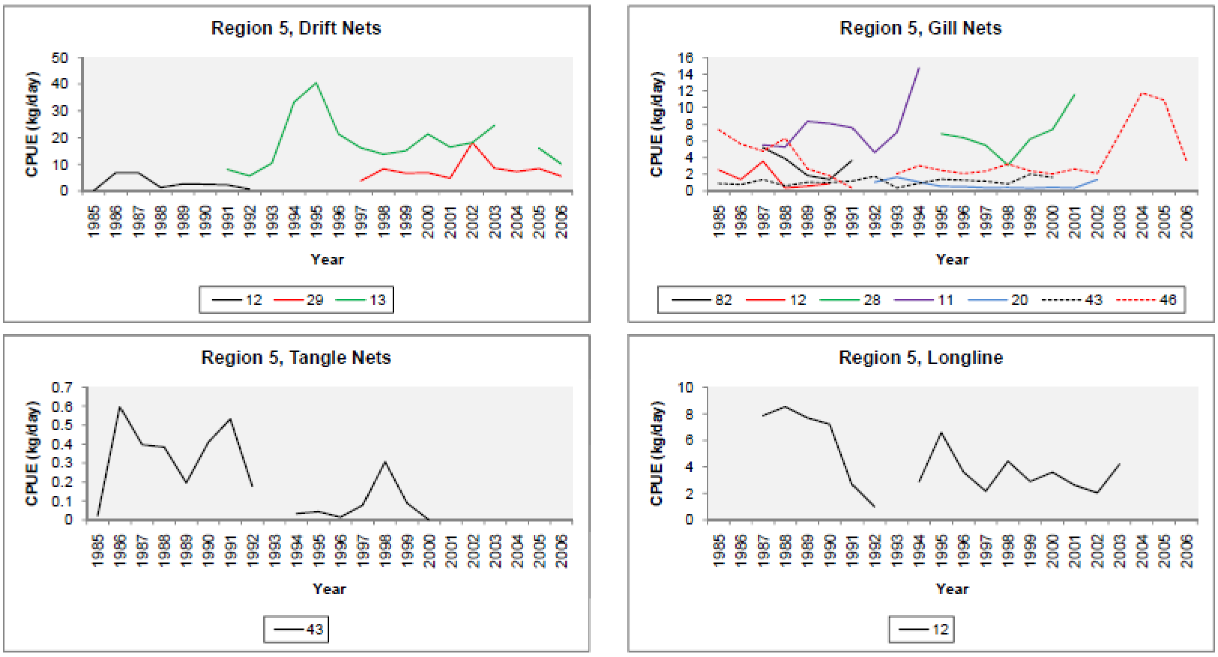



**Figure 0-8: Annual cpue (kg/day) of individual UK bass voluntary logbook holders, for Region 5 (ICES Division VIIa). Legend numbers relate to individual logbook number.**

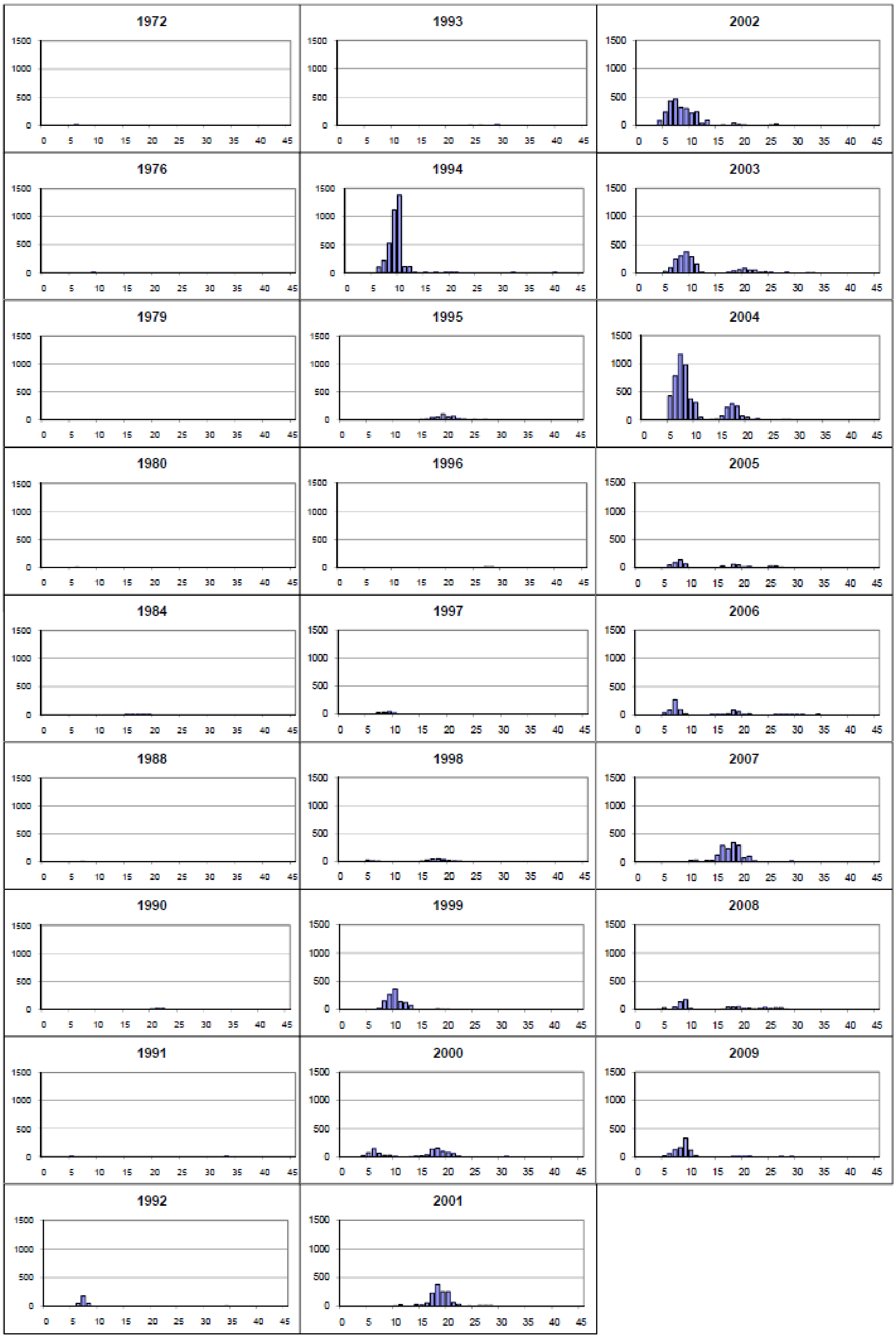



**Figure 0-9: Netherlands Westerscheldt 3 m beam trawl survey. Relative bass abundance at length, by year**

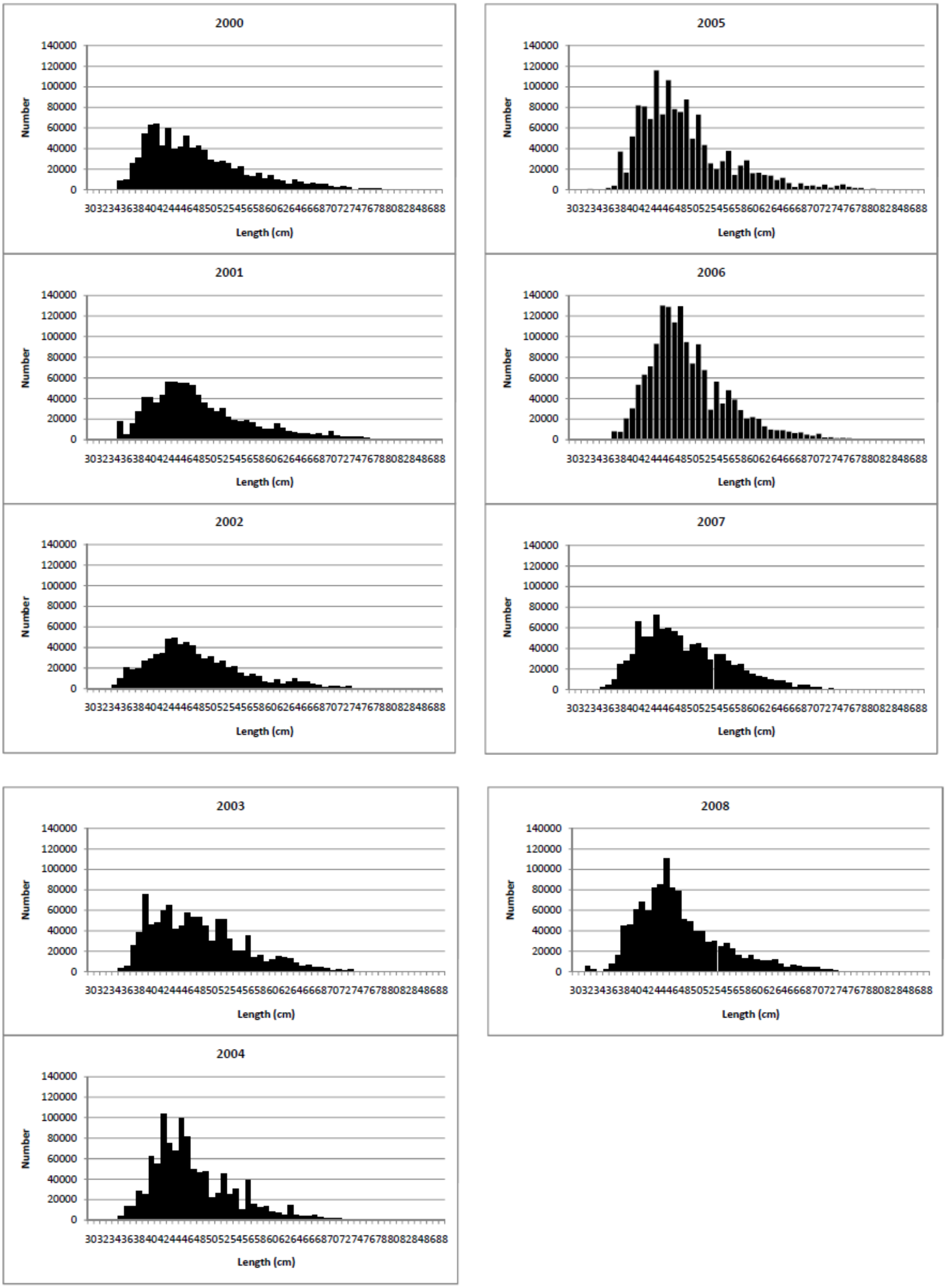



**Figure 0-10: French bass catch numbers at length for ICES Divisions VIIe,h, for bottom trawl, pelagic trawl, nets, handline and longlines combined, between 2000 and 2008.**

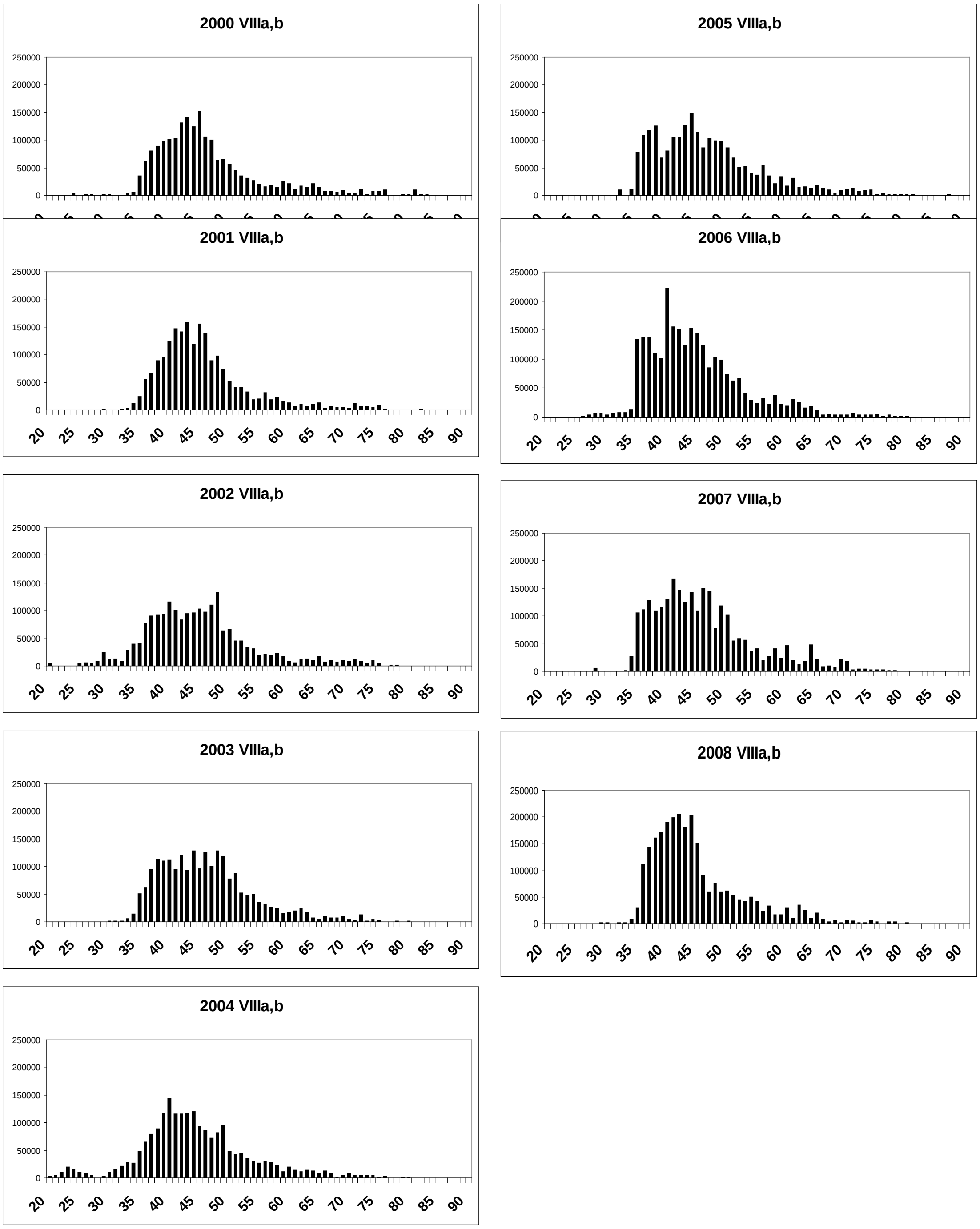



**Figure 0-11: French length structure for all gear, division VIIIa,b**

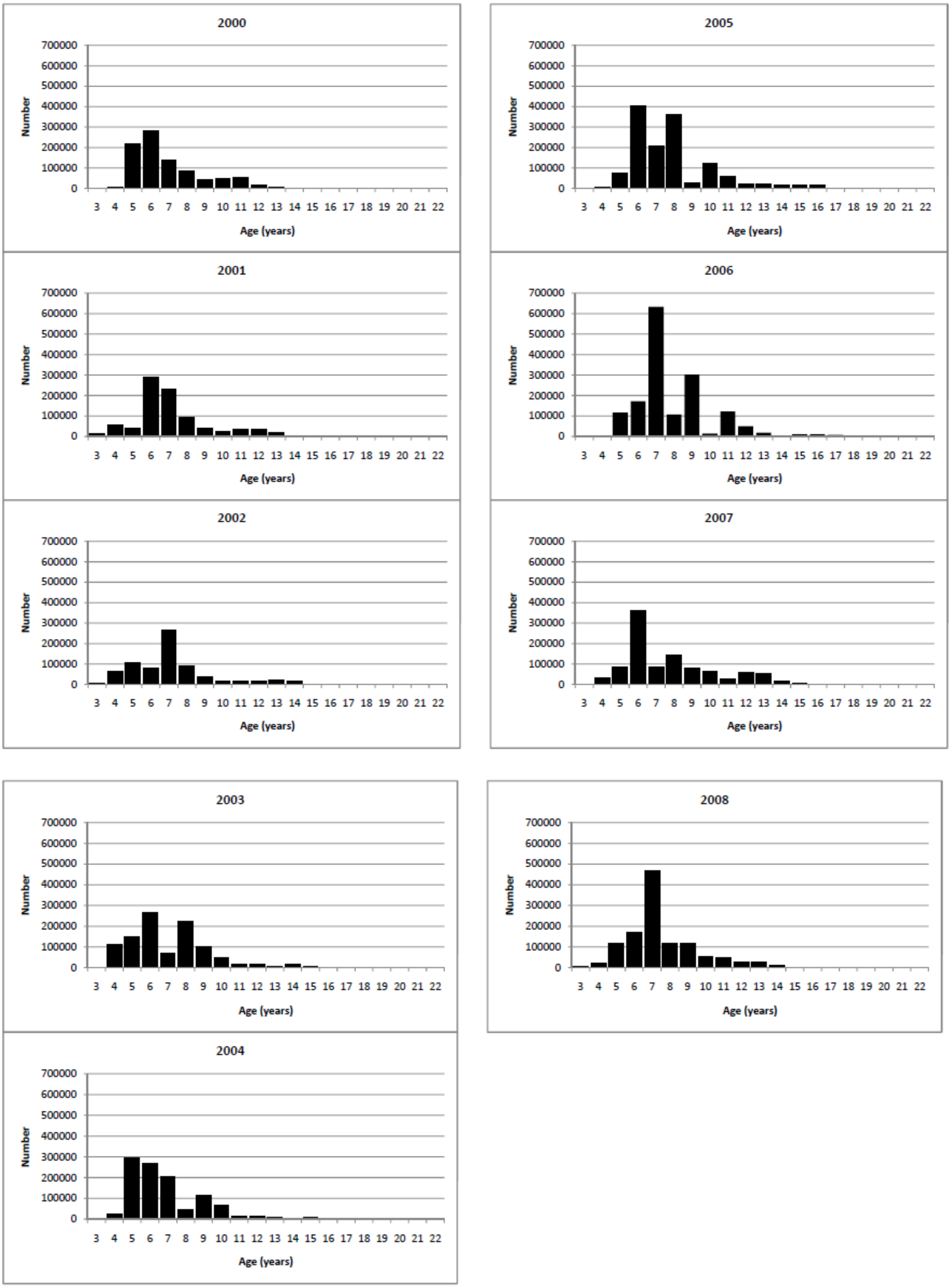



**Figure 0-12: French bass catch numbers at age for ICES Divisions VIIe,h, for bottom trawl, pelagic trawl, nets, handline and longlines combined, between 2000 and 2008.**

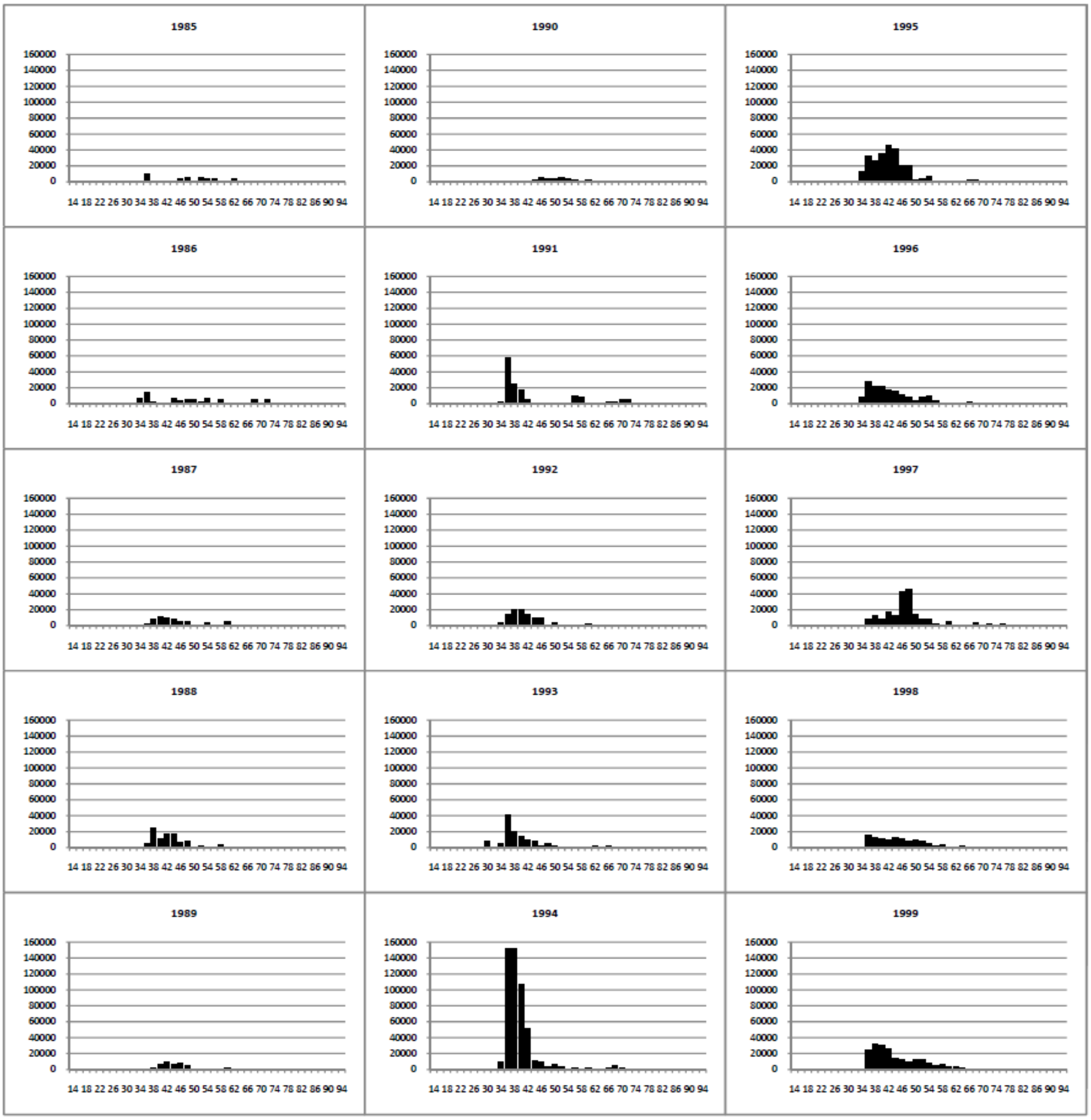



**Figure 0-13: UK (E&W) bass catch numbers at length (cm) for ICES Divisions IVb&c for all gear groups combined, between 1985 and 2009.**

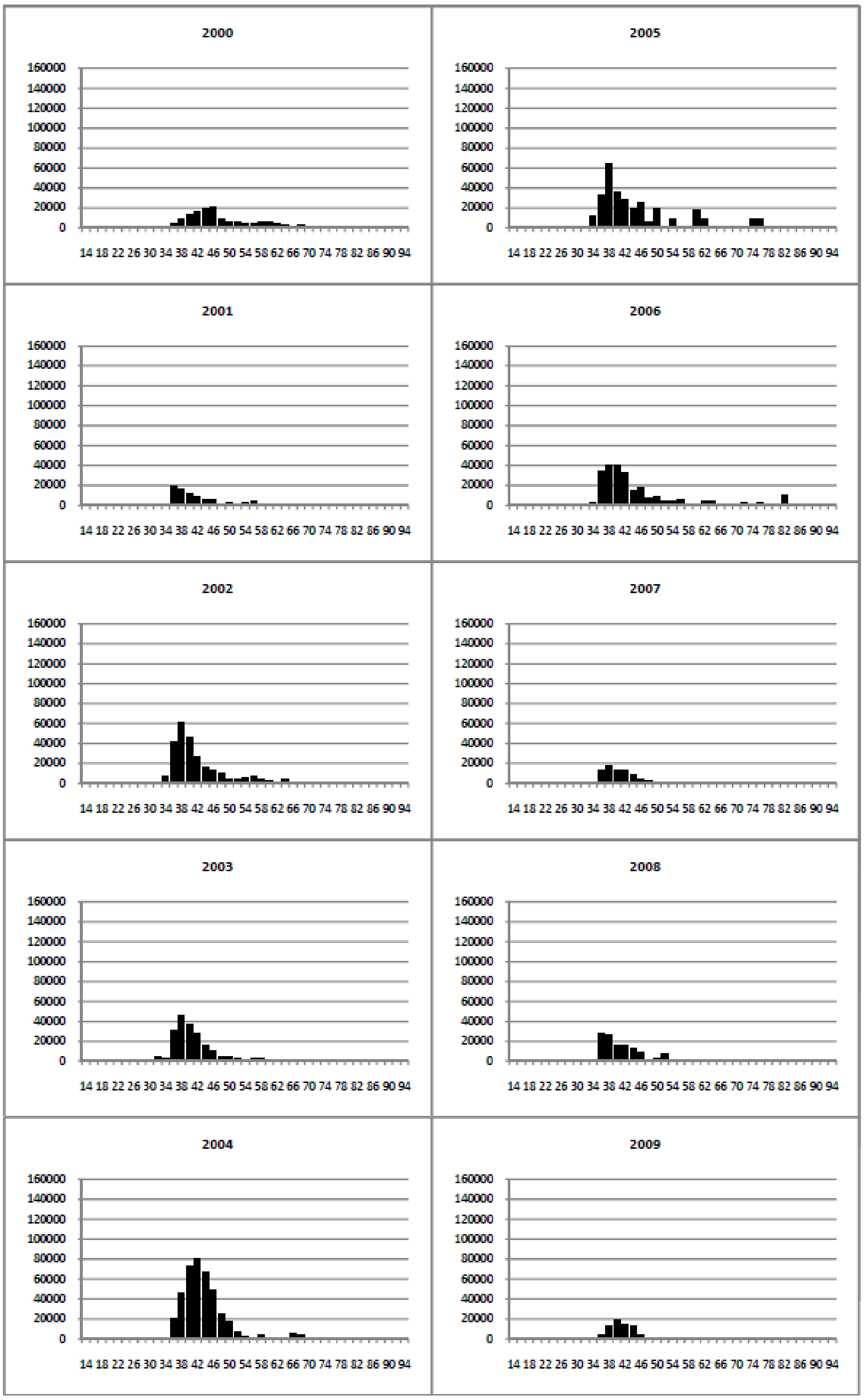



**Figure 0-14: UK (E&W) bass catch numbers at length (cm) for ICES Divisions IVb&c for all gear groups combined, between 1985 and 2009.**

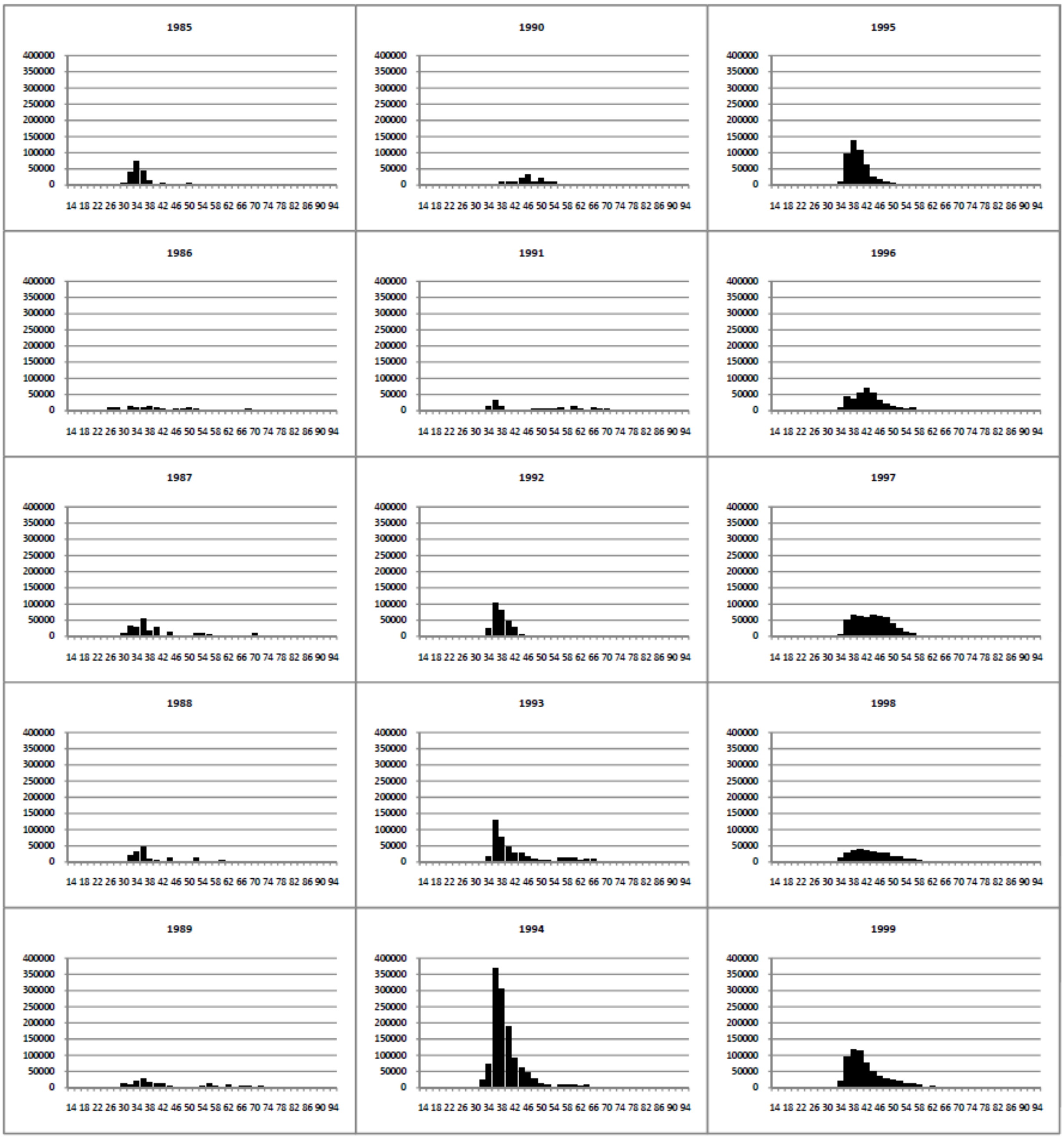



**Figure 0-15: UK (E&W) bass catch numbers at length (cm) for ICES Division VIId for all gear groups combined, between 1985 and 1999.**

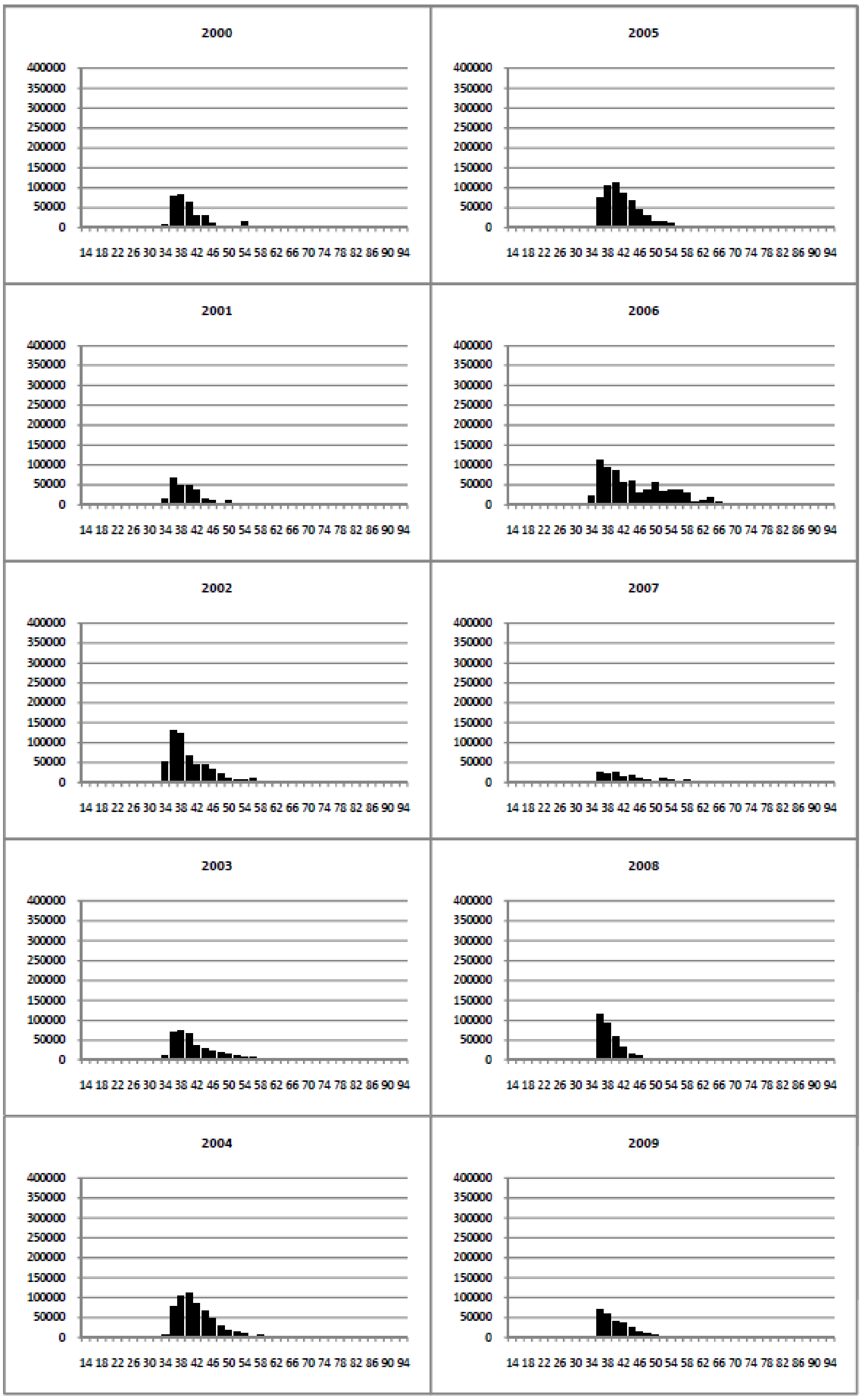



**Figure 0-16: Continued: UK (E&W) bass catch numbers at length (cm) for ICES Division VIId for all gear groups combined, between 2000 and 2009.**

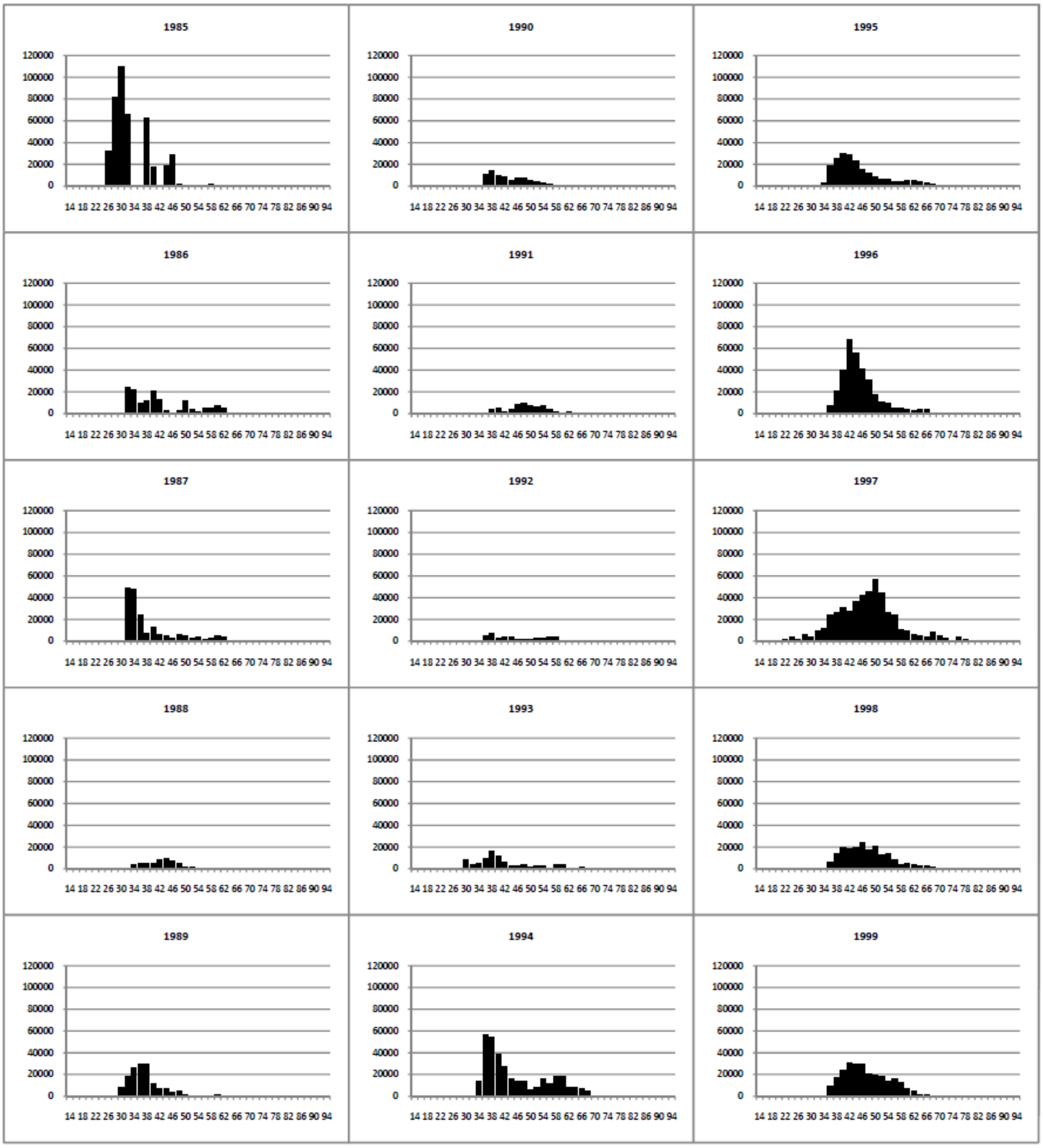



**Figure 0-17: UK (E&W) bass catch numbers at length (cm) for ICES Divisions VIIe,h for all gear groups combined, between 1985 and 1999.**

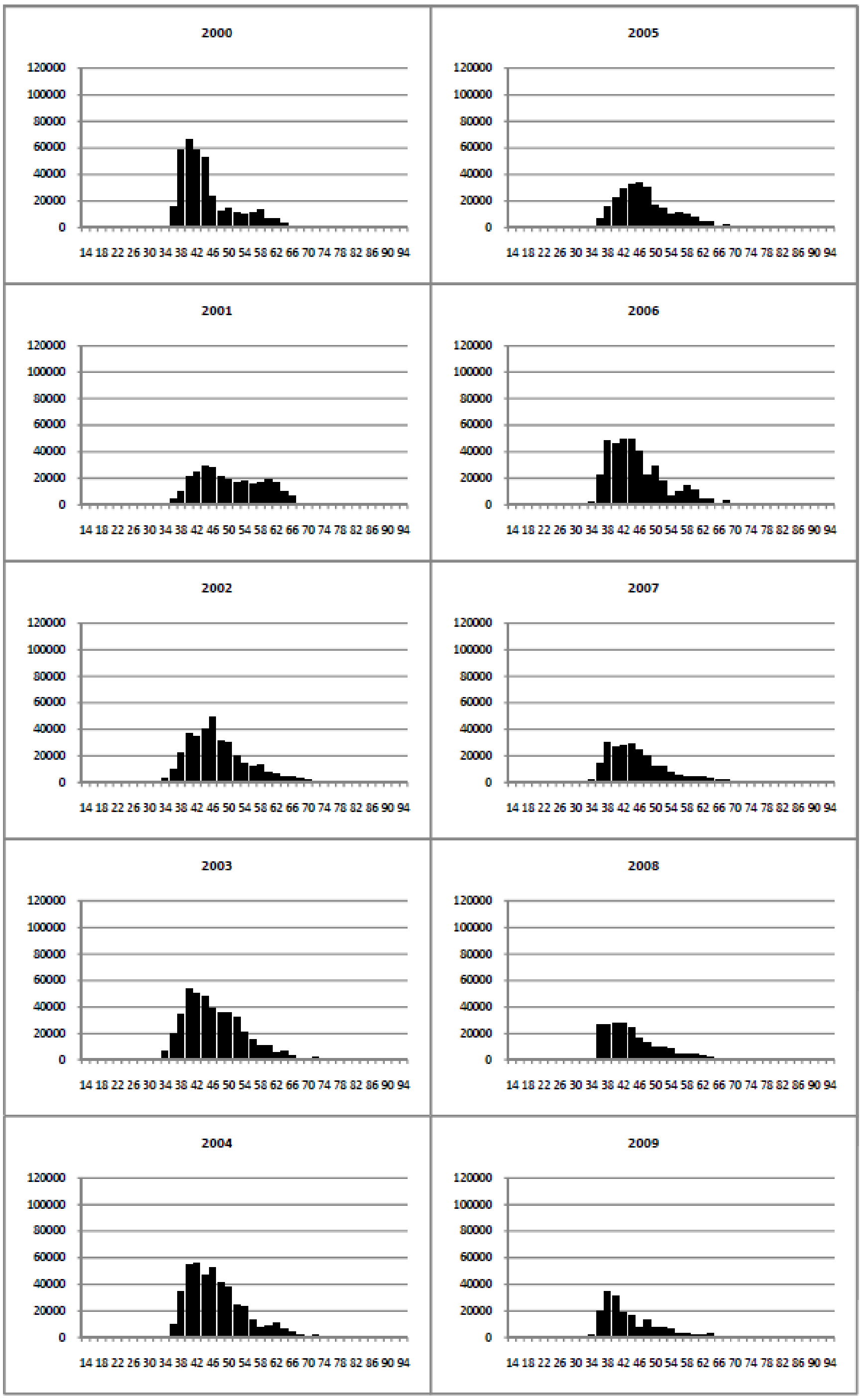



**Figure 0-18: UK (E&W) bass catch numbers at length (cm) for ICES Divisions VIIe,h for all gear groups combined, between 2000 and 2009.**

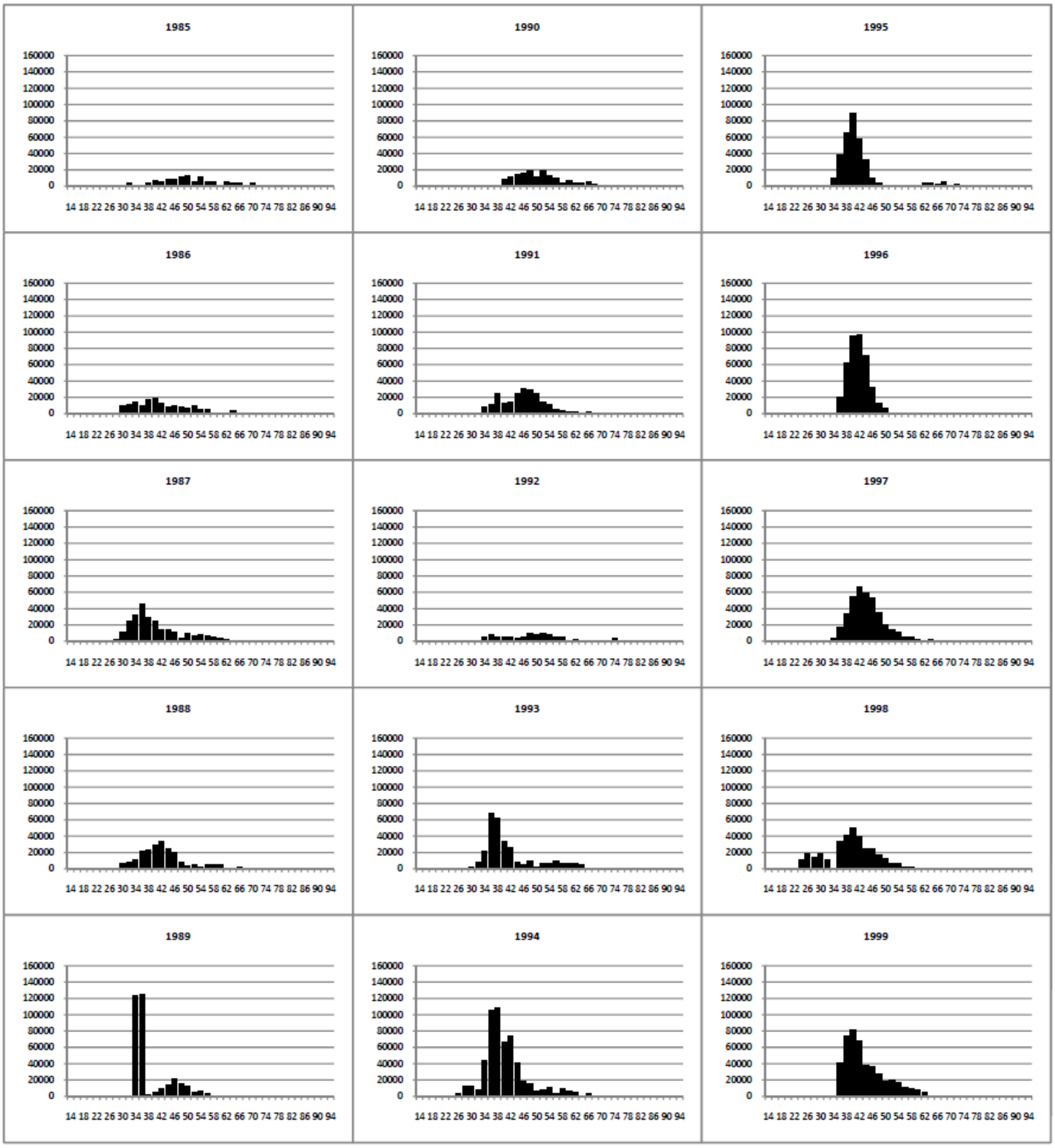



**Figure 0-19: UK (E&W) bass catch numbers at length for ICES Divisions VIIa,f &g for all gear groups combined, between 1985 and 1999.**

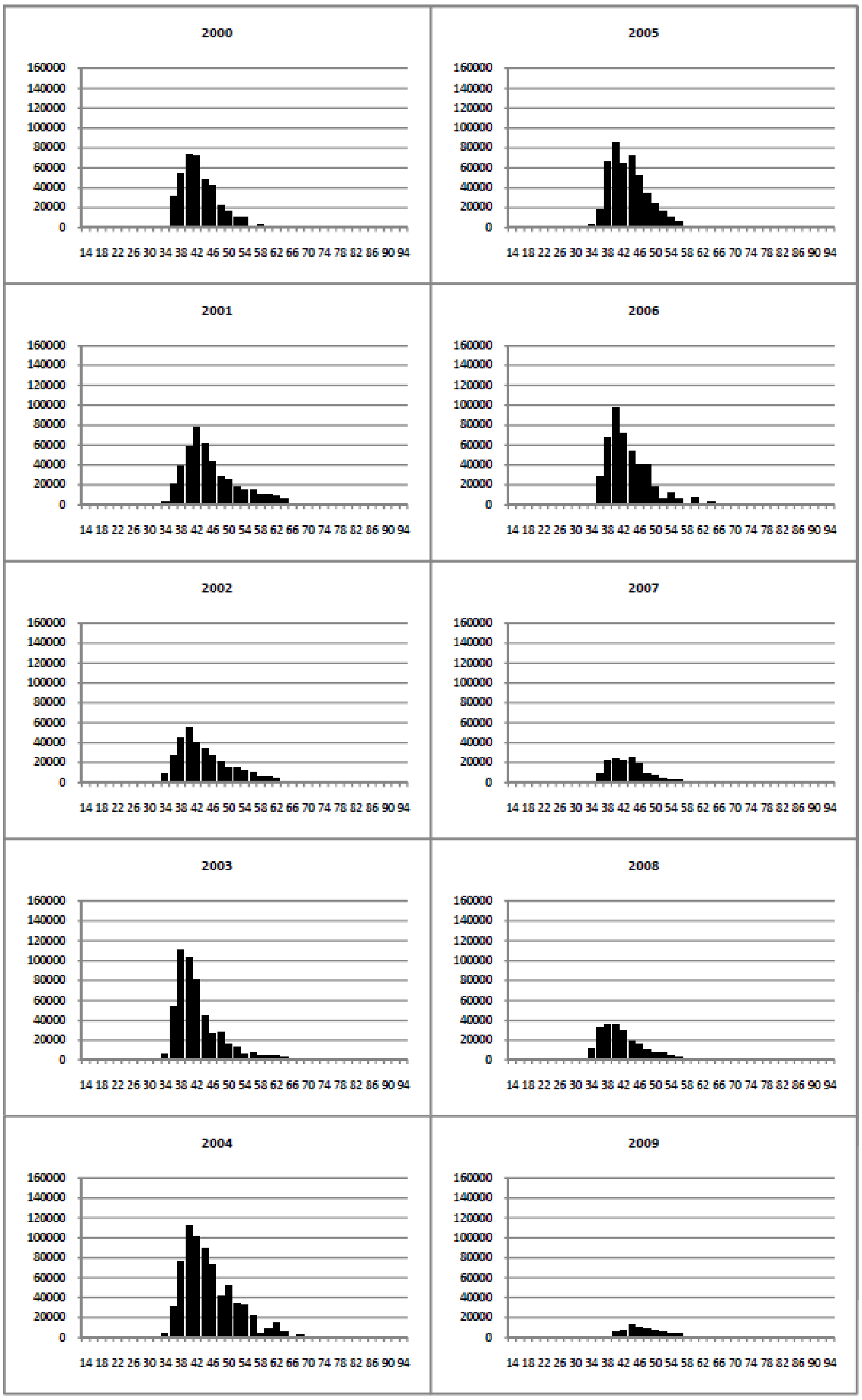



**Figure 0-20: UK (E&W) bass catch numbers at length for ICES Divisions VIIa,f &g for all gear groups combined, between 2000 and 2009.**

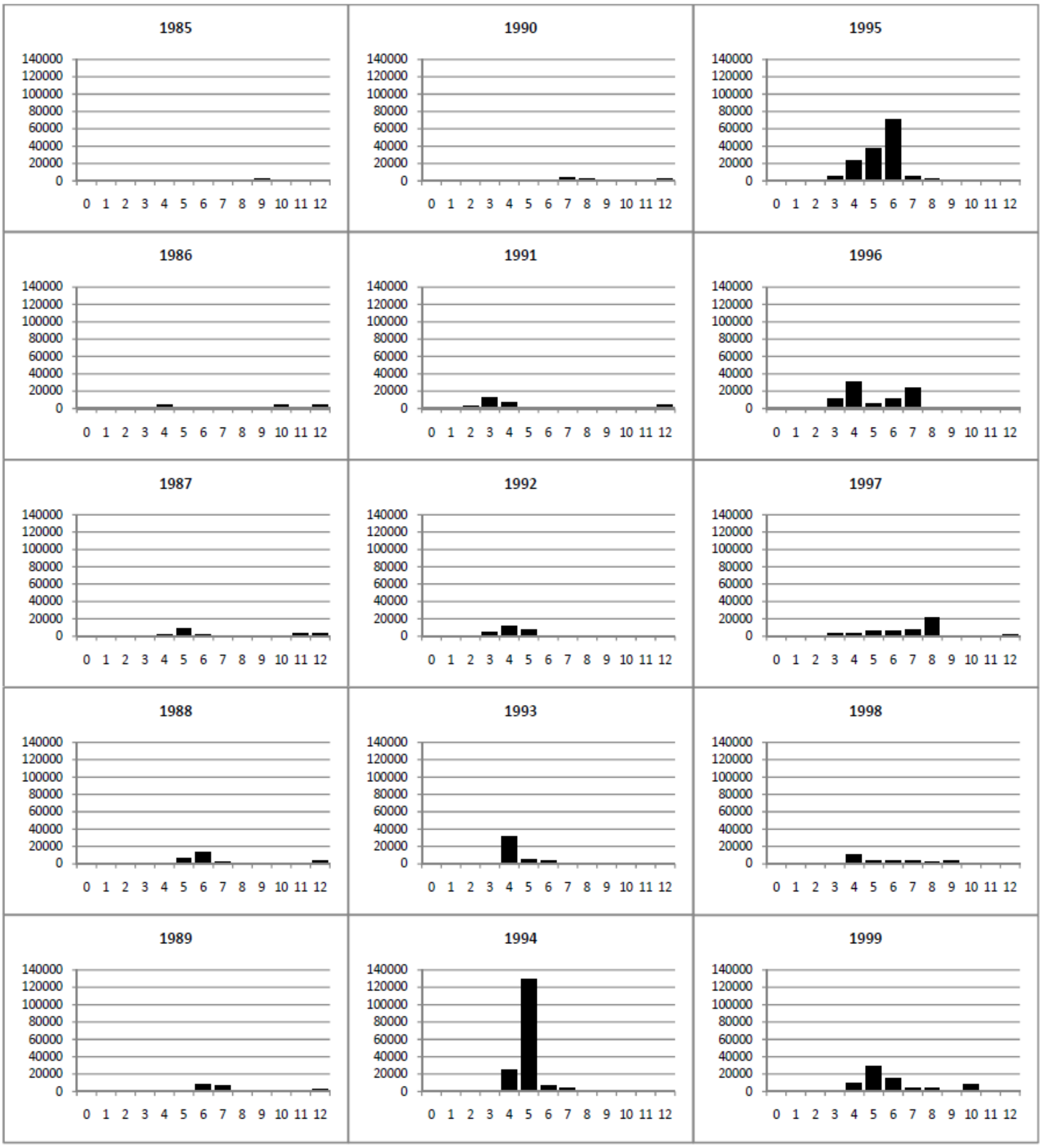



**Figure 0-21: UK (E&W) bass catch numbers at age for ICES Divisions IVb & c for all gear groups combined, between 1985 and 1999.**

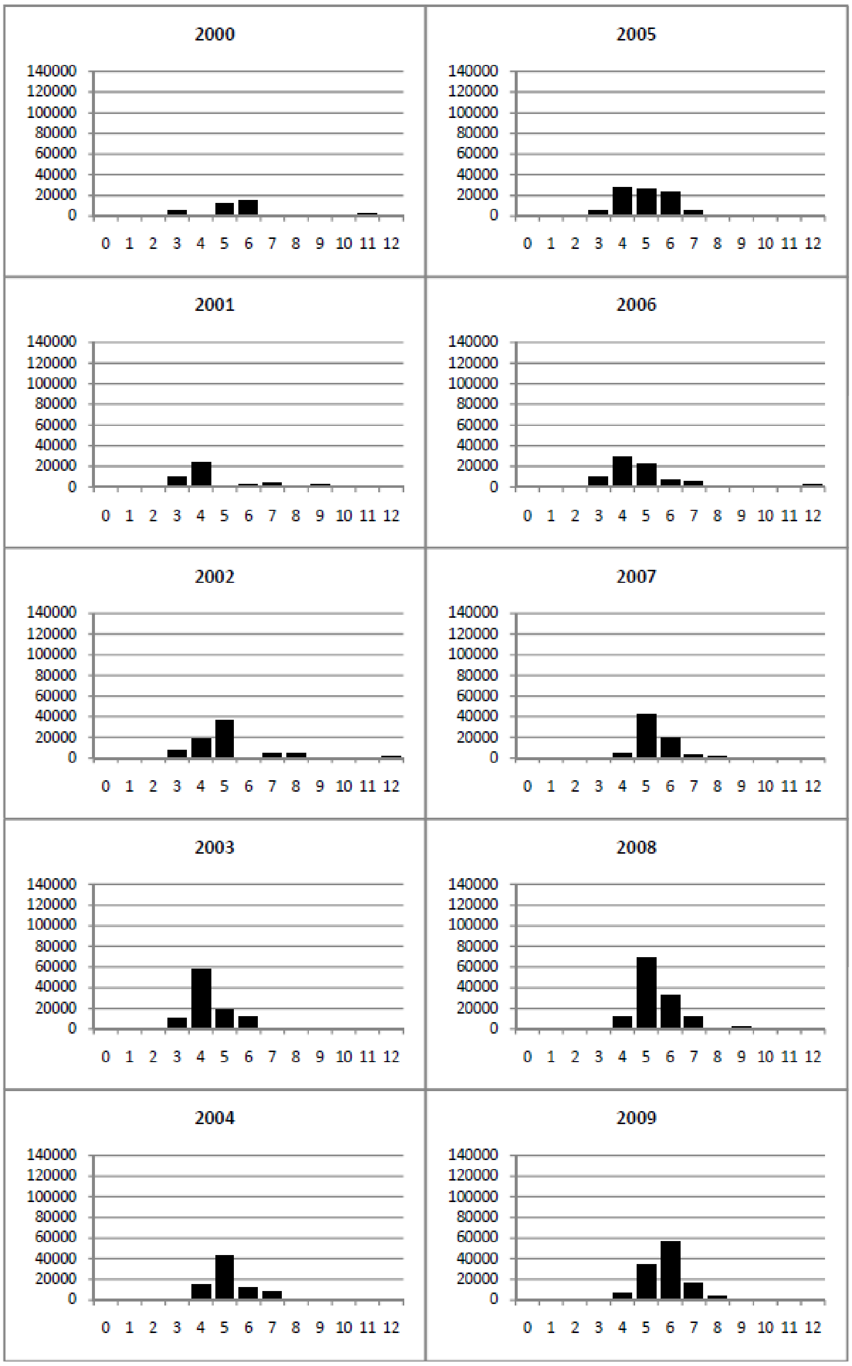



**Figure 0-22: UK (E&W) bass catch numbers at age for ICES Divisions IVb & c for all gear groups combined, between 2000 and 2009.**

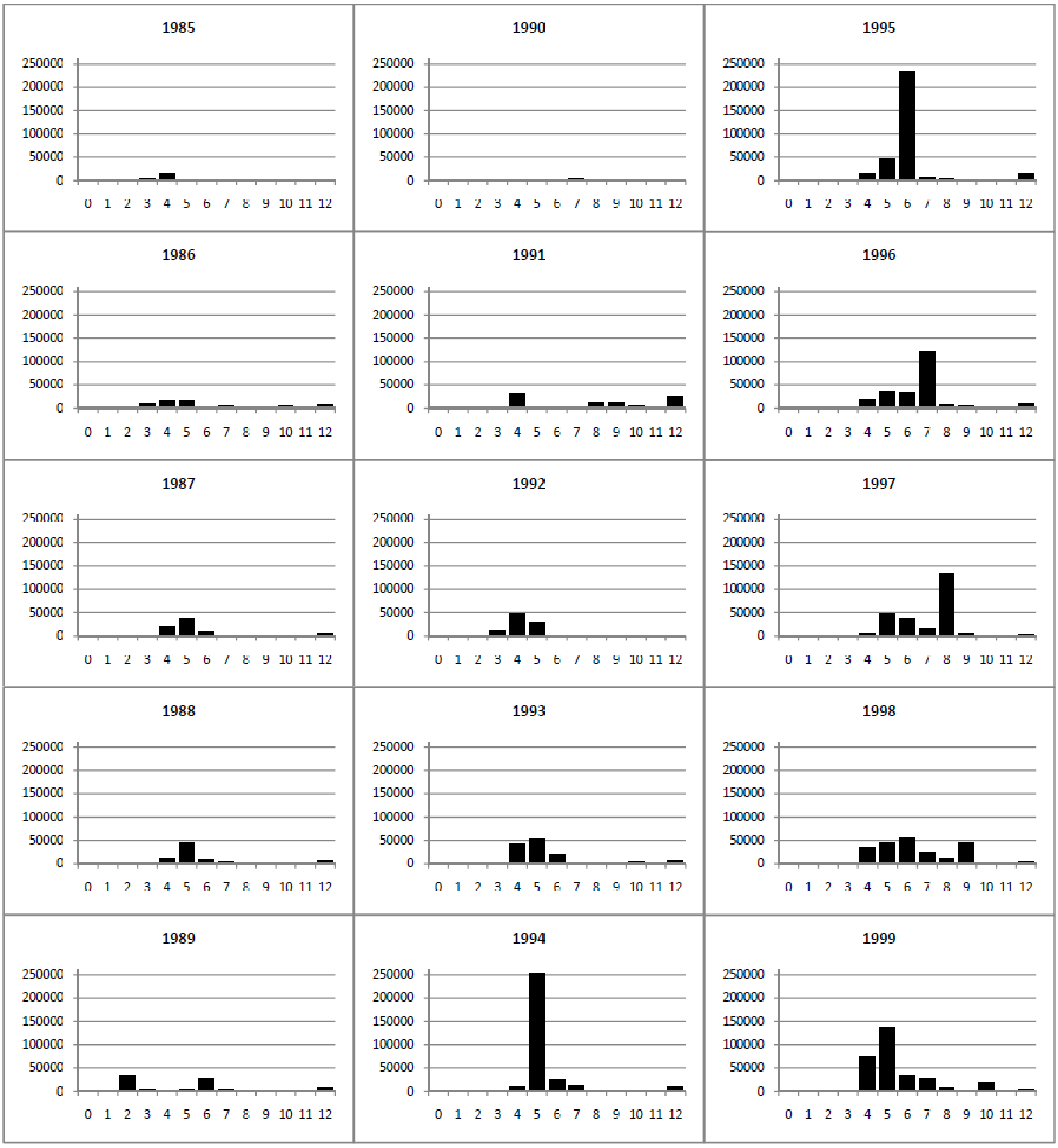



**Figure 0-23: UK (E&W) bass catch numbers at age for ICES Division VIId for all gear groups combined, between 1985 and 1999.**

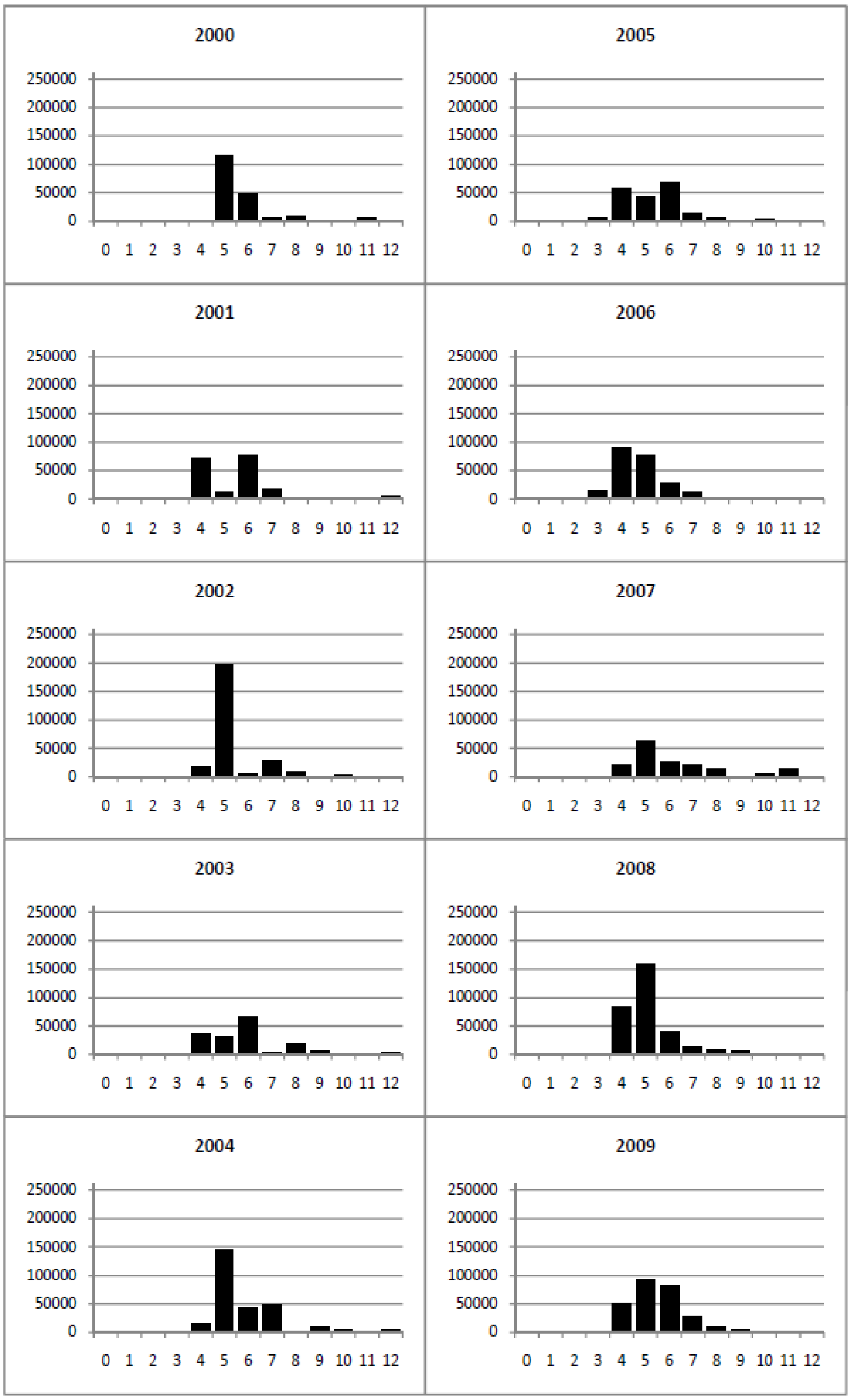



**Figure 0-24: UK (E&W) bass catch numbers at age for ICES Division VIId for all gear groups combined, between 2000 and 2009.**

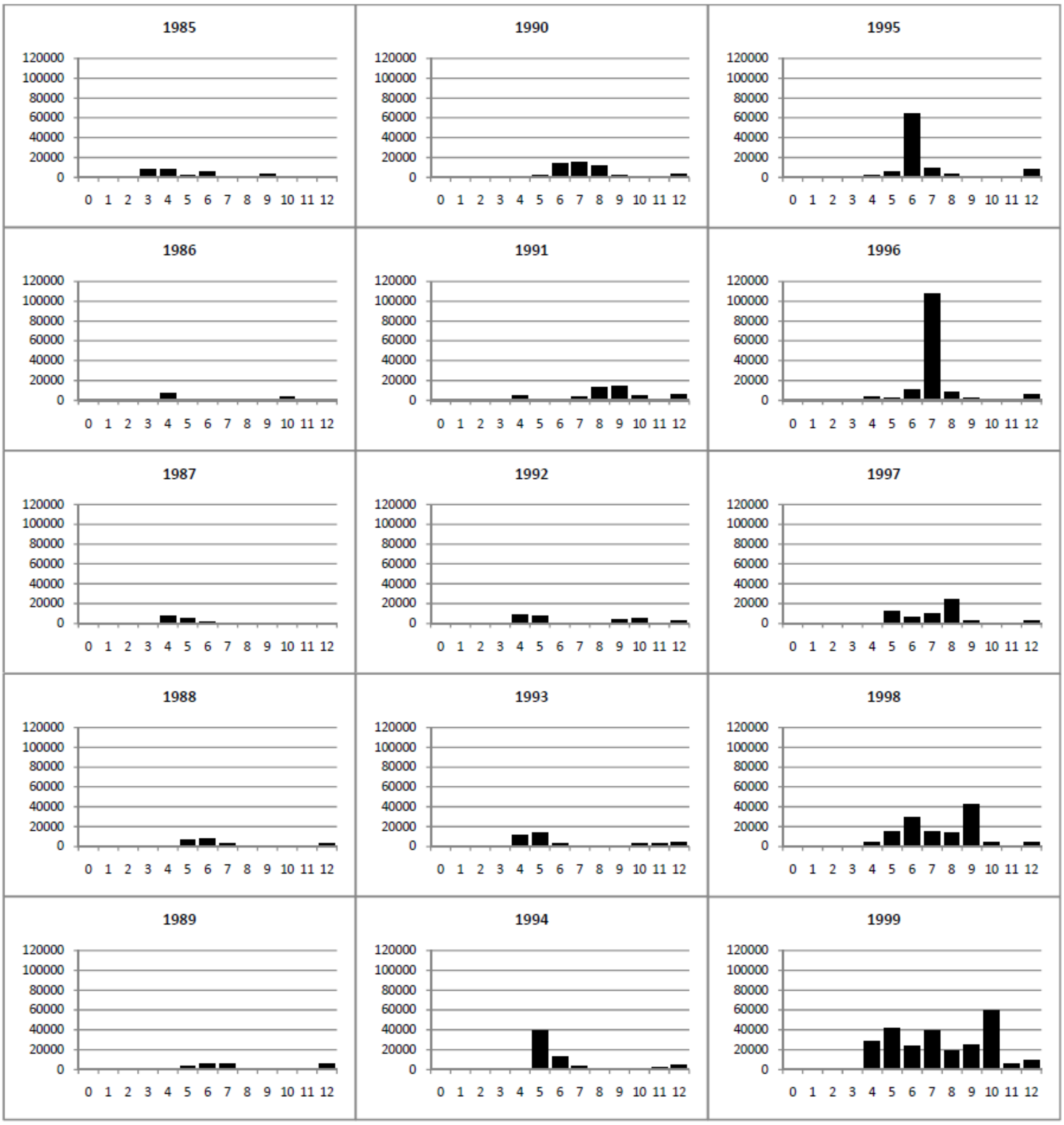



**Figure 0-25: UK (E&W) bass catch numbers at age for ICES Divisions VIIe,h for all gear groups combined, between 1985 and 1999.**

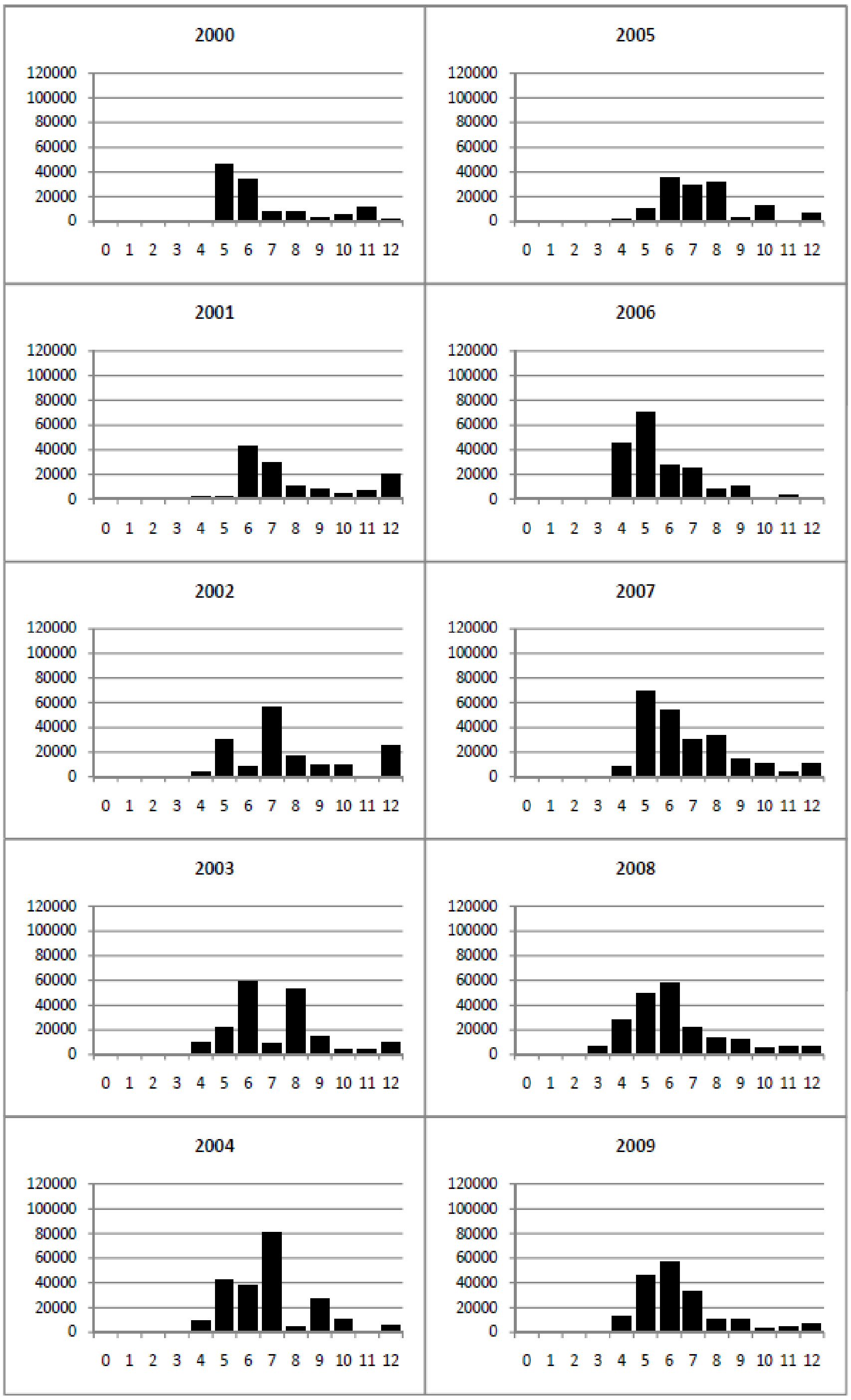



**Figure 0-26: UK (E&W) bass catch numbers at age for ICES Divisions VIIe,h for all gear groups combined, between 2000 and 2009.**

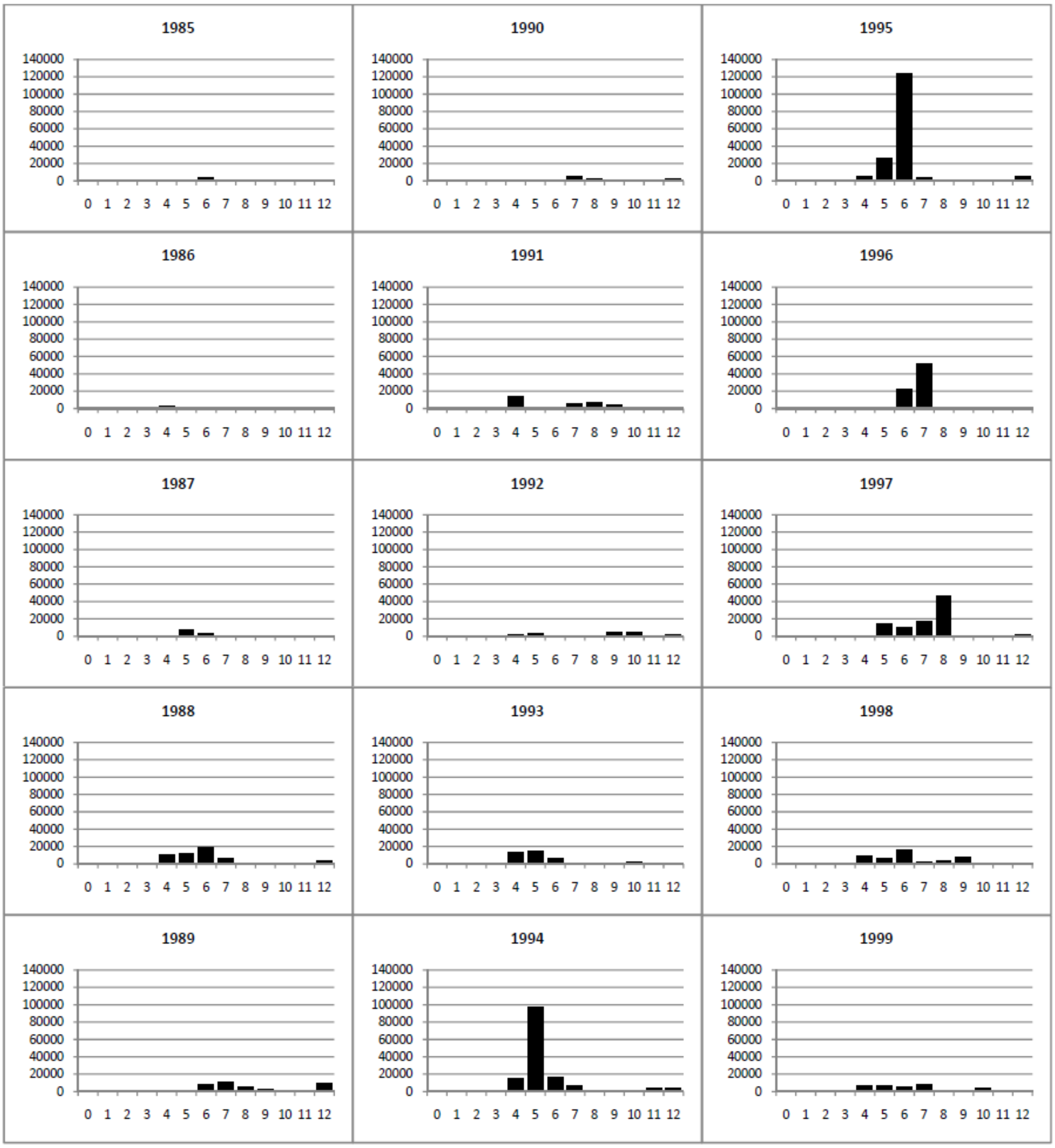



**Figure 0-27: UK (E&W) bass catch numbers at age for ICES Divisions VIIa,f &g for all gear groups combined, between 1985 and 1999.**

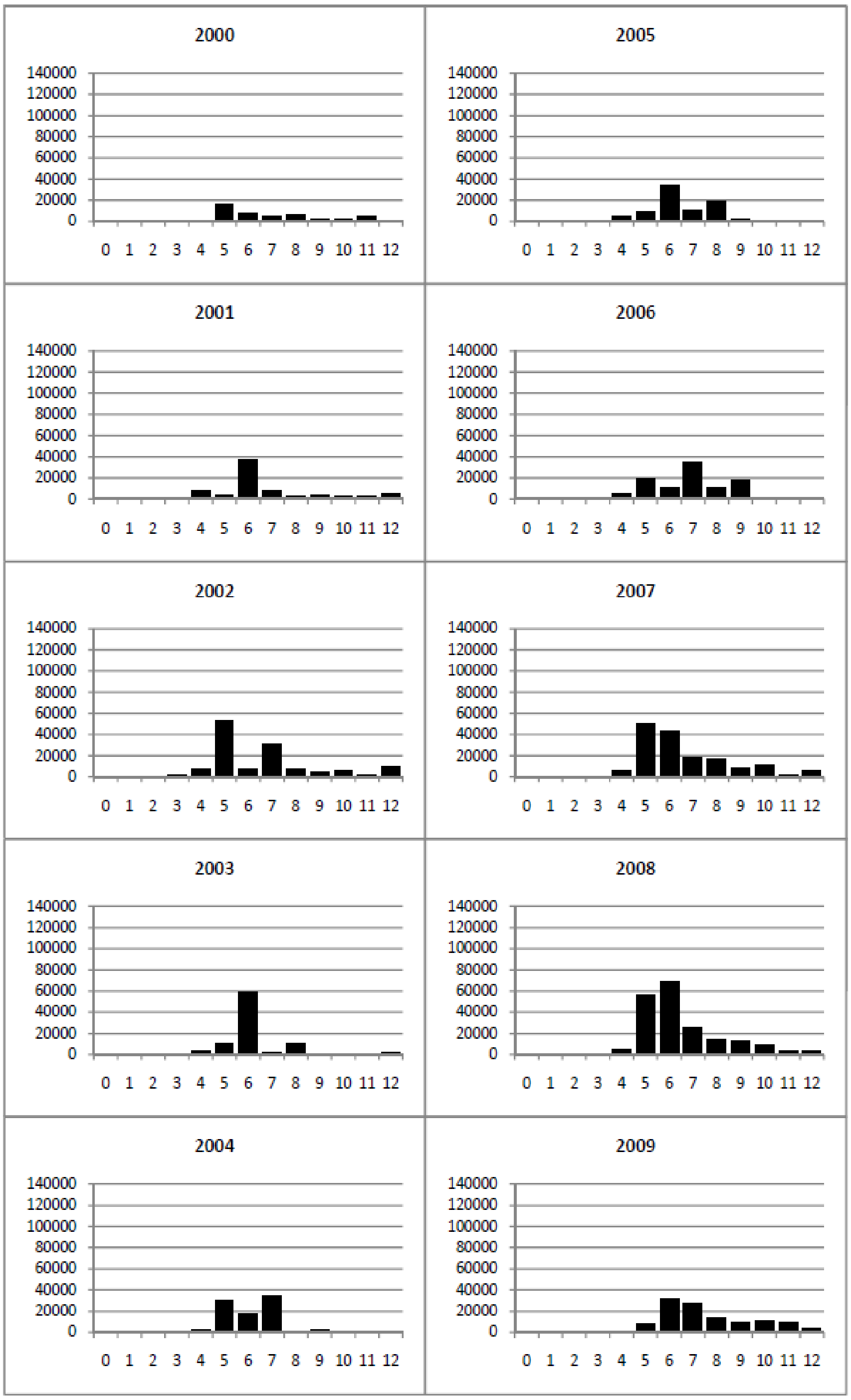



**Figure 0-28: UK (E&W) bass catch numbers at age for ICES Divisions VIIa,f &g for all gear groups combined, between 2000 and 2009.**

# Annex 2 – Striped red mullet

## General biology

The striped red mullet (*Mullus surmuletus*) is characterized by a high and short head with two long barbs under the chin. The mouth does not reach the edge of the eye, under which there are two big scales (suborbitaries scale). The colouring of the back and the sides goes from red to scarlet. Three horizontal yellow bands (strips) are visible along the lower flanks.

The striped red mullet is found along the European coasts from South Norway (Wheeler, 1978) and North Scotland (Gordon, 1981) including Faeroes (Blacker, 1977), south to the Strait of Gibraltar, and also in the north part of western Africa and in the Mediterranean and Black Seas (Fage, 1909; Quéro 1984; Hureau, 1986; Bauchot, 1987; Quéro & Vayne, 1997). It is infrequent off Norway, around Ireland, the north coasts of England and the West of Scotland (Pethon, 1979; Minchin & Molloy, 1980; Davis & Edward, 1988; Gibson & Robb, 1997).

Analysis of British commercial landings revealed a strong concentration of this species in the central pit of western Channel during winter (Dunn, 1999; Delpech & Coppin, 2001). The scientific survey CGFS (Channel Ground Fish Survey), carried out every year by Ifremer in the eastern Channel since 1988, showed that the young individuals are distributed in coastal areas, while the adults have a more offshore distribution in the east part (Carpentier & Coppin, 1999; Delpech & Coppin, 2001). Finally, nurseries are located in Bay of Saint-Brieuc and Falklands coasts (Morizur *et al*., 1996).

The striped red mullet is a benthic fish. It seems to prefer deep water and elevated temperatures, and tolerates weak and high salinity (corresponding respectively to the habitats of the juvenile and adults) and is rarely found in the transitions zones of intermediate salinity. This species prefer sandy sediments (Carpentier *et al.,* 2009).

In October, in the CGFS survey, older individuals were found in the same areas as the younger ones, but their distribution spreading further offshore (Figure 1.1 and figure 1.2). The spatial distribution of red mullet in the North Sea was strongly related with warm waters (ICES, 2007b).

In the English Channel, the first sexual maturity was identified to 16.2 for the male and 16.7 cm for the female (Mahé *et al*., 2005).

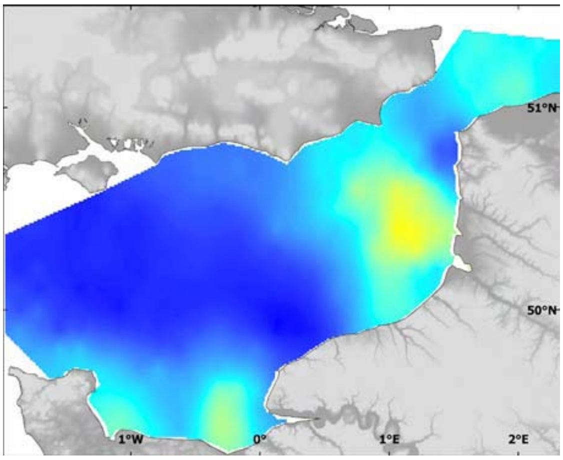



**Figure 1.1: Mean abundance in October (CGFS, 1988 -2006) of striped red mullet (<1 year old) (Carpentier et al., 2009).**

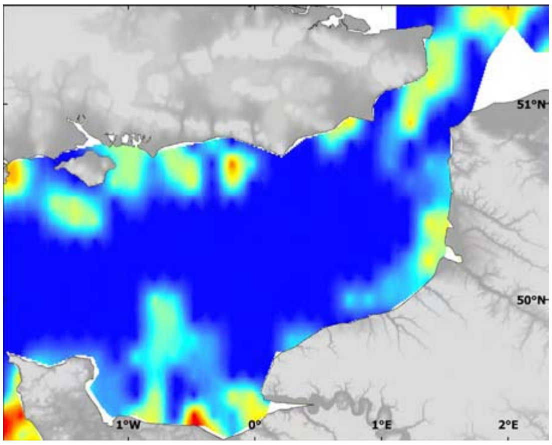



**Figure 1.2: Mean abundance in October (CGFS, 1988 -2006) of striped red mullet (<1 year old) (Carpentier et al., 2009).**

Previous studies in the Northeast Atlantic Ocean show that, for a given age, the female is heavier and longer than the male (Desbrosses, 1935; Bougis, 1952; Hashem, 1973; Gharbi & Ktari, 1979; Andaloro & Giarritta, 1985, N'Da, 1992; Reñones et al, 1995). The same phenomenon was observed in the eastern Channel and North Sea (Mahé *et al*, 2005). The food of striped red mullet is primarily crustaceans and molluscs.

## Management regulations

While, in France, a minimum landing size was earlier fixed at 16 cm, that has been removed since 2002, which has resulted in immature individuals (< 14 cm) to have recently been targeted and landed.

## Stock ID and possible management areas

For stock assessment and management, it is necessary to identify the different stocks that occur in the distribution area of a certain species. Stock structure is often investigated using morphometrics, morphologics, genetics, or some combination of the above.

From the presence of striped red mullet in catches all year-round, Dunn (1999) suggested that a single stock exists within the English Channel, although he could not determine whether this was distinct from other more westerly stocks. He also suggested that there might be a newly established stock in the North Sea.

A study using the geometrical morphometry in the Eastern English Channel and the Bay of Biscay was carried out in 2004 and 2005 and presented at the WGNEW 2007 meeting (Mahé et al., 2007).

The fish for this morphometric study come from the groundfish surveys EVHOE from the Bay of Biscay and CGFS in the Eastern English Channel (Figure 1.3). All the photographs were not retained for the analysis. The criteria of rejection of the photographs are as follows:

- measurements impossible to take because of fuzzy photographs or weak luminosity not compensable by the analysis of image,
- fish badly positioned, twisted, dissected, or mouth large open,
- missing scale into horizontal and vertical or illegible,
- dorsal or anal fins evil positioned for the take a image.

185 images out of 244 were retained bus answering the quality standards for the analysis of image and the numerical analysis (Figure 1.3). 128 fish come from campaigns CGFS and 57 of campaigns EVHOE for the years 2001 to 2003.

| Groundfish Surveys | Year | number of individuals photographed | Number of individuals retained |
|---|---|---|---|
| CGFS | 2001 | 41 | 17 |
| | 2002 | 55 | 50 |
| | 2003 | 74 | 61 |
| EVHOE | 2002 | 16 | 0 |
| | 2003 | 58 | 57 |
| | Total | 244 | 185 |

**Figure 1.3: Number of fish retained for this study.**

The striped red mullet is characterized by the presence of: two dorsal fins, an anal fin, a pair of pelvic fins and a pair of pectoral fins. These characteristics allow to identify 10 apex located on the outline of the animal. The points composing this reinforcement were given starting from the publication of Strauss and Fuiman (1984) adapted to the needs for this study on the striped red mullet (Figure 1.4).

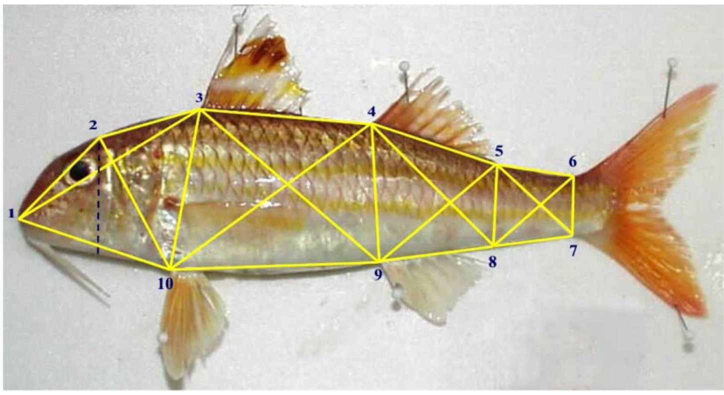



**Figure 1.4: Geometrical Morphometry according to model TRUSS (Strauss & Bookstein, 1982) applied to a striped red mullet with the presence of 10 homologous points.**

The 21 distances taken out of 185 fish were the subject of multivariate analyses in order to study if there are morphometric differences between:

- the sectors Eastern English Channel and the Bay of Biscay,
- sexes,

These parameters were used as explanatory variables.

The multivariate statistical analyses carried out are ordinations. These analyses allow to combine information of several tables. In this study, two tables were used:

- a principal data file which is the whole of measurements by segment for each individual, each box of the table is a measurement in mm; the variables (distance between homologous points) have each one a normal distribution as show it the kurtose and the coefficient of asymmetry and were thus not transformed.
- a set of explanatory variables, nominal (scientific countryside, sex).

The PCA (Principal Components Analysis) is an analysis of indirect gradient based on a model of linear answer (Leps & Smilauer, 1999; ter Braak & Smilauer, 1998). The analysis carried out is based on two measures of covariance between the variables (here distances between the homologous points). That makes it possible to find out which segments of the body vary in the same manner. The explanatory variables don't intervene in ordination but are superimposed a posteriori on those to allow an indirect interpretation of the principal data file (Legendre & Legendre, 1998).

In the literature (Strauss & Bookstein, 1982; Strauss & Fuiman, 1984), the allometric analyses and the ACP show that these distances are related to the overall length of the individuals. This strong correlation prevents from studying the morphometric differences precisely. Thus, Redundancy Partial Analyses (RDA) were carried out. In a partial analysis, it is sometimes necessary to extract the variation explained by an explanatory data file to analyze the remaining variance. Variance explained by covariable (i.e. the variable the effect must be withdrawn), here the total length, is extracted before RDA is made (Leps & Smilauer, 1999). This covariable, the total length, has an important effect which masks other informations. That is why it has been extracted to observe the influence of other explanatory variables.

The RDA is an extension of the multiple regressions to the modelling of the multivariate data (Legendre & Legendre, 1998). This technique takes into account simultaneously the linear relation between the principal data file and the explanatory variables. It is a forced version of the ACP in the sense that the ordination axes are forced to be linear combinations of the explanatory variables (Maddy & Brew, 1995). In this analysis, it is necessary to test and extract the explanatory variables influencing the principal data file. The RDA was used in combination with tests of permutation of Monte Carlo to explore the multilinear relations between the morphometry and the explanatory variables.

In these tests, the distribution of reference is simulated by repeated permutations of the observations. Thus, the explanatory variables are mixed and assigned in a random way with the principal data file. A test F is calculated on the initial data and is compared with those obtained on the permuted data. If the variable tested is significant, it is added to the model and the associated variance is withdrawn from the procedure. The variables of interests are added successively to the model according to a decreasing order of contribution and significativity by a procedure of ascending selection step by step (Stepwise Forward Selection).

185 fish were retained for this study including 42 immature, 81 females and 62 males (Figure 1.5). The number of individuals studied during the Groundfish Surveys 2001 is weaker than the other years and the females in greater number. Numbers sampled used by scientific countryside and according to the stage of sexual maturity and the sex.

| Groundfish Surveys | Juveniles | Females | Males | Total |
|---|---|---|---|---|
| CGFS2001 | 2 | 14 | 1 | 17 |
| CGFS2002 | 0 | 20 | 30 | 50 |
| CGFS2003 | 16 | 28 | 17 | 61 |
| EVHOE2003 | 24 | 19 | 14 | 57 |
| Total | 42 | 81 | 62 | 185 |

**Figure 1.5: Numbers sampled used by Groundfish Surveys and according to the stage of sexual maturity and the sex.**

The Principal Components Analysis on the morphometry (Figure 1.6) indicates that the first principal component (first axis) is related to the total lengths. This component accounts for 97% of the total information of the points group showing that there is a very strong correlation between the various distances between the homologous points and the body size, the body weight being also related to the individuals' size. The index K also is very correlated with the size but is a little shifted axis 1. The additional variable concerning the Eastern English Channel shows that there are differences between fish of the Bay of Biscay and those of the Eastern English Channel but this difference is marked little by this analysis.

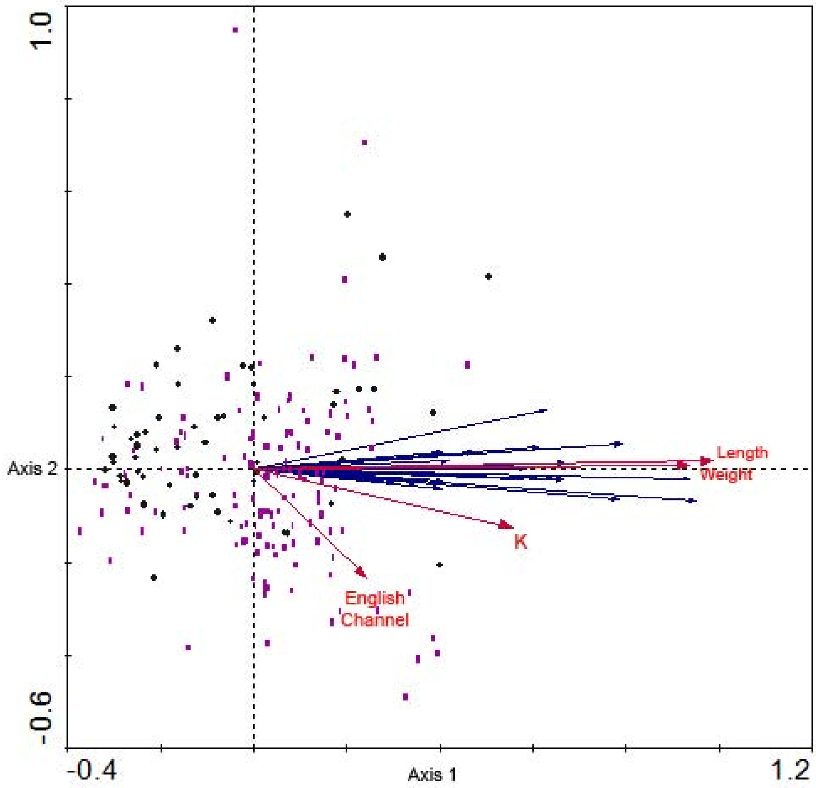



**Figure 1.6: Principal Components Analyze on the morphometry of the striped red mullets of Eastern English Channel (square purple) and of the Bay of Biscay (black rounds) integrating the different distances between the homologous points (blue arrows) and the additional explanatory variables (red arrows).**

The too strong correlations with the fish size mask the real morphological differences between sexes and geographical sectors. A partial RDA was thus carried out (Figure 1.7). This analysis separates fish from the Bay of Biscay (EVHOE) of those of the Eastern English Channel (CGFS) as indicate it the vector "Channel" and those of the different groundfish surveys or the distribution of fish (points) according to their source. However, for the Eastern English Channel, the fish of 2001 are very clearly separated from those of 2002 and 2003.

The size and the orientation of the vectors concerning the sex show that there is a light sexual dimorphism related to morphology but that the morphological difference is clearer when one compares mature individuals compared to immature individuals.

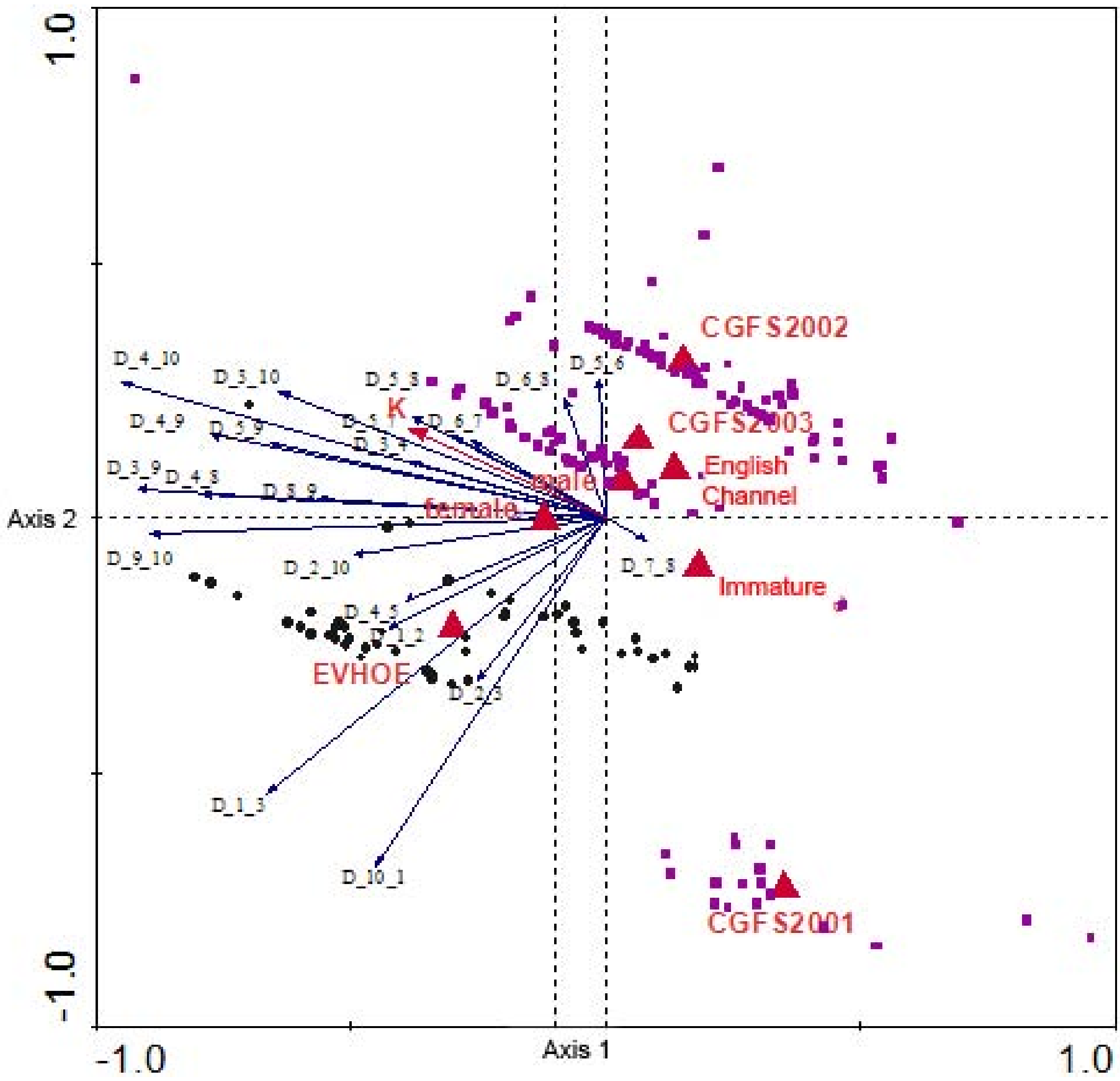



**Figure 1.7: RDA on the morphometry of the striped red mullets of Eastern English Channel (square purple) and of the Bay of Biscay (black rounds) integrating the different distances between the homologous points (blue arrows) and the additional explanatory variables (red arrows).**

The morphometric differences between the sectors seem to be related to morphological differences at head and dorsal 2 level (Figure 1.8) as indicated by the vectors of the low left quarter of RDA.

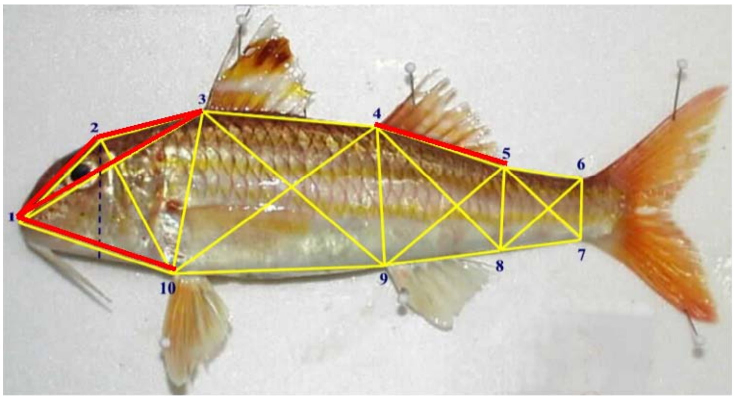



**Figure 1.8: Segments (red) showing of the morphological differences between the striped red mullets of Eastern English Channel and the Bay of Biscay.**

The vectors around the negative part of axis 1 and the quarter high left of RDA (Figure 1.7) correspond to the segments of the body on the level of the trunk, with the area delimited with the back by the end of the dorsal fins 2 and anal and with the height of the caudal part. RDA indicates that these measurements would be influenced slightly by the sex, more particularly for the females. The influence of the sex seems limited because the females are not pregnant and the morphology of the abdomen not influenced by the volume occupied by the gonads. At the reproduction season, one would find certainly differences related to the sexual condition.

The results of this study show that **there is a morphological difference between the striped red mullets of the Eastern English Channel and of the Bay of Biscay**.

Moreover, according to these first results these studies should be supplemented by genetics or morphologics studies for the identification of the stocks. En 2010, in the Nespman project, a study on the shape of the otoliths can be used to differentiate stocks of the same species.

For this study, Otoliths were collected, by IFREMER, during research vessel surveys and from the market, primarily during 2009. In all cases, the *sagitta* otoliths were used and cleaned beforehand. The otoliths are burned before ageing (ICES, 2007).

Before burning, images of whole otoliths were made for processing using both transmitted and reflected light with fixed light direction, angle and intensity. Each otolith was digitised and interpreted with the TNPC software dedicated by IFREMER.

A total of 800 otoliths and 1600 images (reflected and transmitted light) were planned and achieved for this project. For the samples, a database was created comprising all information required for the project: fish information (case study, capture date, fish length) and otolith information (estimated age).

In this work, three techniques have been applied: a Fourier, PCA and Geodesic approach. For more details on these methods see Nasredinne *et al*. (2009). Images of whole otoliths have been acquired for processing using both transmitted and reflected light. From 800 otoliths coming from six different parts of the distribution area of striped red mullet (Figure 1.9), we will consider five different image datasets in this analysis:

Dataset 1: 600 otoliths sampled from six different areas (100 otoliths per area):

- NS: North Sea (IVab) 2009

- EEC08: Eastern Channel (VIId) 2008
- WEC: Western Channel (VIIe) 2009
- CS: Celtic Sea (VIIh) 2009
- NBB: North Bay of Biscay (VIIIa) 2009
- SBB: South Bay of Biscay (VIIIb) 2009

Dataset 2: 600 otoliths with the 100 Eastern English Channel otoliths from year 2007 instead of 2008:

- EEC07: Eastern English Channel (VIId) 2007

Dataset 3: 700 otoliths: the 600 otoliths of dataset 1 with the 100 otoliths EEC07 in addition.

Dataset 4: 200 otoliths, those from the Eastern Channel over the two consecutive years 2007 and 2008:

- EEC07: Eastern Channel (VIId) 2007
- EEC08: Eastern Channel (VIId) 2008

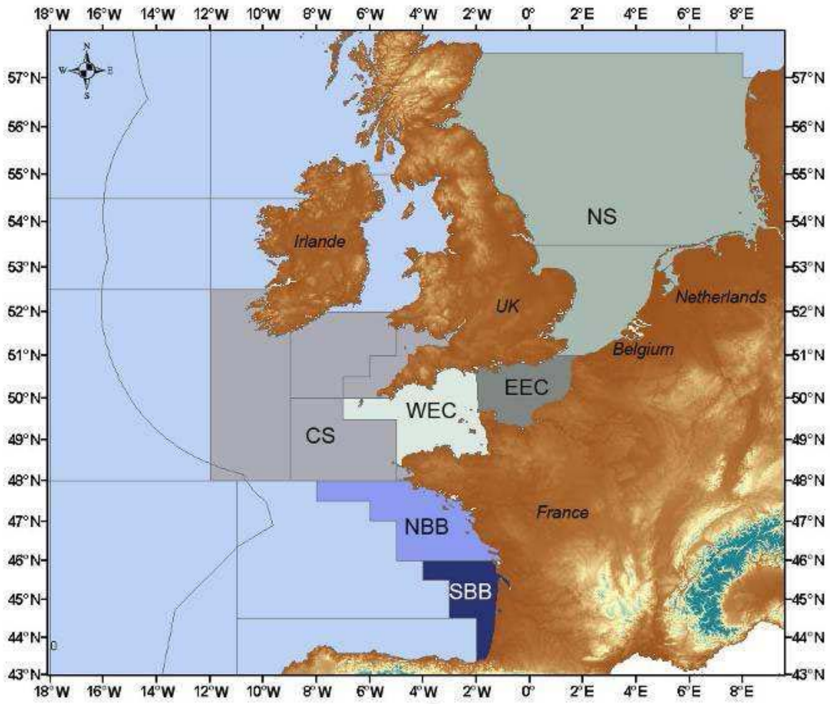



**Figure 1.9: The parts of the distribution area of striped red mullet involved in this study.**

Dataset 5: 200 otoliths from the North Sea (IVab) from the same year 2009 randomly divided in 2 classes:

- NS09a: North Sea (IVab) 2009 a
- NS09b: North Sea (IVab) 2009 b

These datasets illustrate two different types of applications of otolith shape classification: stock discrimination (datasets 1, 2 and 3) and year discrimination (datasets 4 and

5). Both issues are quite hard for current state of the art computer vision techniques because the external shapes of otoliths exhibit very few differences.

For the year discrimination issue, the test is carried out on dataset 4 and dataset 5 separately. As dataset 5 is composed of randomized classes, the classification performances on this dataset should be close to those of a theoretical random classifier (i.e. 50%). The difference in performances between dataset 4 and dataset 5 gives an idea of the validity of the results.

Otolith outlines were extracted using the Matlab image processing toolbox. To extract the otolith outline, a mixed image is built in order to integrate information available in both transmitted and reflected imaging modalities (Figure 1.10). This mixed image is a mean between the transmitted light image and the negative of the reflected light image.

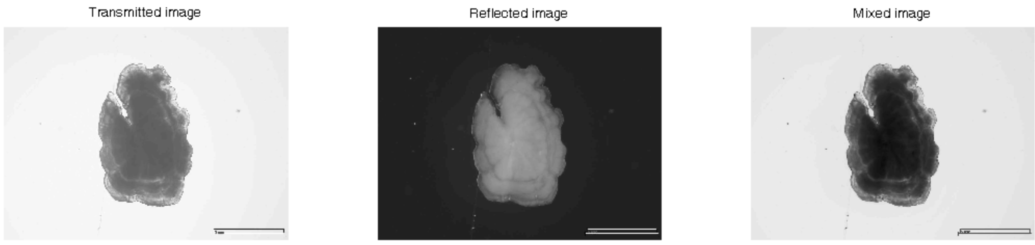



**Figure** Error! No text of specified style in document..**9: Transmitted light (left), reflected light (middle) and resulting mixed image (right).**

Then the contours are detected as maximum of the image gradient, approximated using a Sobel filtering. The resulting contours are filtered and some basic operations such as erosion and dilatation are applied so that the remaining contour corresponds to the edge of the otolith. A normalization procedure is then applied to these raw contours to be invariant in translation, rotation and scaling, so that the normalized shape is the result of the fish history, independently of acquisition settings. The translation invariance is obtained simply by subtracting the coordinates of the center of mass to the coordinates of all points, so that the shape is centred on the origin. Scale invariance is also simply obtained by dividing each point of the contour in polar coordinates by the mean radius.

The most difficult part of the normalization step is rotation normalization. A simple way to do that would be to normalize in rotation according to the main axis of the shape (i.e. the axis defined by the two farthest points of the shape) but here this axis does not correspond to a meaningful biological feature. Instead, we automatically detect the point corresponding to the center of excisura major. We then align each shape in rotation using the axis that passes through this point and the center of mass of the otolith contour. As a result, the normalized shape is independent of acquisition settings and can be used for stock identification (Figure 1.11).

From the normalized external shape of the otolith, we compare three approaches (Fourier, PCA and Geodesic) to estimate the distance between the shapes of the two selected stocks: North Sea (NS) and Eastern English Channel (EEC07). Each stock is represented by 100 otolith images. The discriminative power of each distance estimation method is evaluated using its own distance matrix as input for a k-nearest neighbours classifier tested with the "leave one out" heuristic (Figure 1.12). Experimentally, we have set k to 4 for all classification tests.

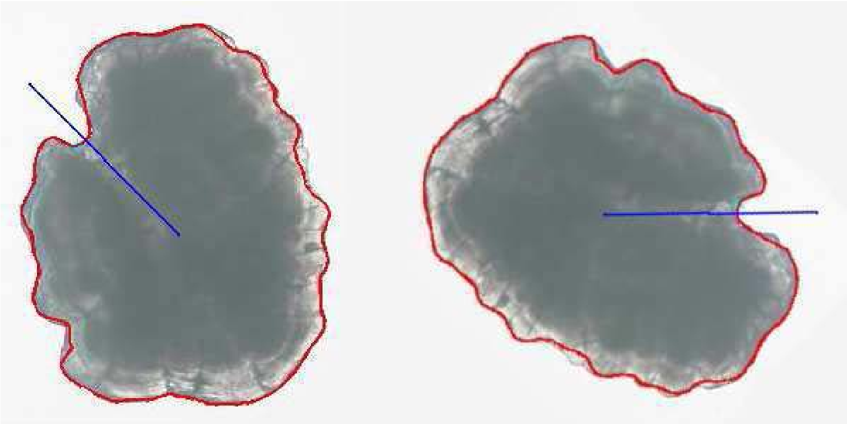


**Figure 1.11: Otolith contour extraction and normalization. Left: contour before normalization, right: contour after rotation normalization. Red: contour, Blue: main axis passing through the contour center and the excisura major center.**

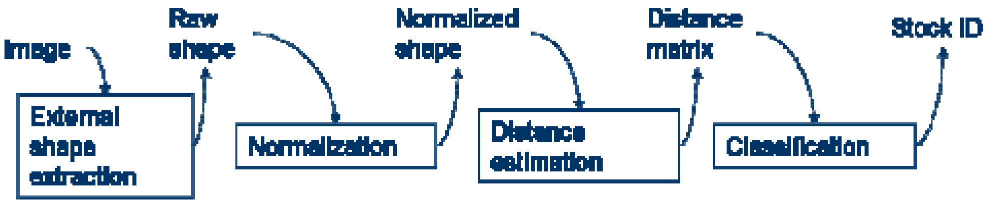



**Figure 1.12: Proposed classification scheme for primary test.**

The results of this preliminary test (Table 1.1) were obtained using a preliminary version of the outline extraction algorithm. Moreover, this test was carried out on the two stocks available at this time and the two stocks are from neighbouring geographical zones which represents a challenging task. In addition, samples of the two stocks are from different years (2007 for EEC07 and 2009 for NS). However, the results are quite good and better than the theoretical results of a random classifier (50% for 2 classes).

**Table 1-1: Mean percentage of correct classification per method on two selected striped red mullet stocks: North Sea (IVab) and Eastern Channel (VIId).**

| Method | % classification rate |
|---|---|
| Geodesic | 64.0 % |
| Fourier | 71.5 % |
| PCA | 71.0 % |

### Fourier approach

Regarding the year discrimination issue (Table 1-2), the mean classification rate on dataset 4 (56%) is too close to the theoretical mean classification rate of a random classifier (50% for 2 classes). The results on dataset 5 (43%) shows that try to discriminate random samples from the same stock and the same year with Fourier approach can lead to results slightly far away from the theoretical mean classification rate of a random classifier. Thus the results on dataset 4 do not show any differences between years and so the classical Fourier approach fails on this specific year discrimination issue. Regarding geographical zones discrimination issue, the classes in Table 1-3 and Table 1-4 are ordered according to the position of their corresponding geographical zone, from north (NS) to south (SBB), thus neighbour classes are also neighbour geographical zones. Fourier approach reaches 19.7% of mean correct classification on dataset 1 (Table 1-3). This score is better than a random classifier that would theoretically reach 16.7% (for 6 classes).

| Dataset 4 - Eastern English Channel | | |
|---|---|---|
| | Actual Class | |
| Estimated Class | 2007 | 2008 |
| 2007 | 54 | 42 |
| 2008 | 46 | 58 |
| mean rate: 56% | | |

| Dataset 5 - North Sea | | |
|---|---|---|
| | Actual Class | |
| Estimated Class | 2009a | 2009b |
| 2009a | 43 | 57 |
| 2009b | 57 | 43 |
| mean rate: 43% | | |

**Table 1-2: Confusion matrix and mean correct classification rate (in %) for the Fourier approach on dataset 4 (left) and dataset 5 (right).**

| Dataset 1 | | | | | | |
|---|---|---|---|---|---|---|
| Estimated Class | Actual Class | | | | | |
| | NS | EEC08 | WEC | CS | NBB | SBB |
| NS | 18 | 20 | 11 | 18 | 18 | 12 |
| EEC08 | 21 | 28 | 25 | 17 | 6 | 14 |
| WEC | 8 | 19 | 12 | 16 | 7 | 14 |
| CS | 21 | 12 | 18 | 13 | 11 | 14 |
| NBB | 16 | 9 | 14 | 16 | 23 | 22 |
| SBB | 16 | 12 | 20 | 20 | 35 | 24 |

**Table 1.-3: Confusion matrix (in %) for the Fourier approach on dataset 1. Mean correct classification rate: 19.7%.**

| Dataset 3 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Estimated Class | Actual Class | | | | | | |
| | NS | EEC07 | EEC08 | WEC | CS | NBB | SBB |
| NS | 15 | 10 | 22 | 7 | 18 | 13 | 11 |
| EEC07 | 15 | 19 | 12 | 23 | 14 | 11 | 11 |
| EEC08 | 17 | 16 | 24 | 18 | 17 | 7 | 11 |
| WEC | 6 | 17 | 14 | 7 | 14 | 5 | 11 |
| CS | 20 | 14 | 8 | 17 | 7 | 12 | 11 |
| NBB | 16 | 14 | 8 | 12 | 15 | 20 | 22 |
| SBB | 11 | 10 | 12 | 16 | 15 | 32 | 23 |

**Table 1-4: Confusion matrix (in %) for the Fourier approach on dataset 3. Mean correct classification rate: 16.4%.**

#### PCA approach

Regarding the year discrimination issue (Table 1-5), the mean classification rate on dataset 4 (60%) is higher than the mean classification rate on the random dataset 5 (49.5%). This shows that the otolith morphology varies over two consecutive years and that this difference in shape is higher than between two arbitrary groups of the same year and same stock.

Regarding the stock discrimination issue, PCA approach reaches 25% of correct classification on dataset 1 (Table 1-6). This score is better than a random classifier that would theoretically reach 16.7% (for 6 classes).

**Table 1-5: Confusion matrix and mean correct classification rate (in %) for the PCA approach on dataset 4 (left) and dataset 5 (right).**

| Dataset 4 - Eastern English Channel | | |
|---|---|---|
| | Actual Class | |
| Estimated Class | 2007 | 2008 |
| 2007 | 58 | 38 |
| 2008 | 42 | 62 |
| mean rate: 60% | | |

| Dataset 5 - North Sea | | |
|---|---|---|
| | Actual Class | |
| Estimated Class | 2009a | 2009b |
| 2009a | 46 | 47 |
| 2009b | 54 | 53 |
| mean rate: 49.5% | | |

**Table 1.-6: Confusion matrix (in %) for the PCA approach on dataset 1. Mean correct classification rate: 25%.**

| Dataset 1 | | | | | | |
|---|---|---|---|---|---|---|
| Estimated Class | Actual Class | | | | | |
| | NS | EEC08 | WEC | CS | NBB | SBB |
| NS | 29 | 13 | 15 | 19 | 10 | 12 |
| EEC08 | 18 | 31 | 16 | 21 | 10 | 10 |
| WEC | 14 | 13 | 26 | 11 | 21 | 18 |
| CS | 17 | 21 | 15 | 20 | 11 | 12 |
| NBB | 15 | 11 | 12 | 13 | 21 | 25 |
| SBB | 7 | 11 | 16 | 16 | 27 | 23 |

**Table 1-7: Confusion matrix (in %) for the PCA approach on dataset 3. Mean correct classification rate: 19%.**

| Dataset 3 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Estimated Class | Actual Class | | | | | | |
| | NS | EEC07 | EEC08 | WEC | CS | NBB | SBB |
| NS | 20 | 10 | 11 | 17 | 14 | 8 | 7 |
| EEC07 | 16 | 15 | 17 | 8 | 14 | 16 | 14 |
| EEC08 | 12 | 15 | 24 | 14 | 16 | 8 | 7 |
| WEC | 12 | 16 | 14 | 22 | 14 | 16 | 13 |
| CS | 19 | 12 | 16 | 14 | 15 | 11 | 9 |
| NBB | 13 | 19 | 9 | 10 | 14 | 15 | 28 |
| SBB | 8 | 13 | 9 | 15 | 13 | 26 | 22 |

#### Geodesic approach

Regarding the year discrimination issue (Table 1-8), the mean classification rate on dataset 4 (60.5%) is higher than the mean classification rate on the random dataset 5 (49.5%). This shows that the otolith morphology varies over two consecutive years and that this difference in shape is higher than between two arbitrary groups of the same year and same stock. Regarding the stock discrimination issue (Table 1-8, Table 1-10), the Geodesic approach reaches 30% of correct classification on dataset 1. This score is better than a random classifier that would theoretically reach 16.7% (for 6 classes). When comparing results on dataset 1 (Table 1-8) with the results on dataset 2 (Table 1-9), we can see that the mean correct classification rate falls from 30% to 26.2% when replacing otoliths of the Eastern Channel of the year 2008 by otoliths of the year 2007. Moreover, the correct classification for the EEC class drops from 44% (with EEC08) to 35% (with EEC07).

**Table 1-8: Confusion matrix and mean correct classification rate (in %) for the Geodesic approach on dataset 4 (left) and dataset 5 (right).**

| Dataset 4 - Eastern English Channel | | |
|---|---|---|
| | Actual Class | |
| Estimated Class | 2007 | 2008 |
| 2007 | 64 | 43 |
| 2008 | 36 | 57 |
| mean rate: 60.5% | | |

| Dataset 5 - North Sea | | |
|---|---|---|
| | Actual Class | |
| Estimated Class | 2009a | 2009b |
| 2009a | 54 | 55 |
| 2009b | 46 | 45 |
| mean rate: 49.5% | | |

**Table 1-8: Confusion matrix (in %) for the Geodesic approach on dataset 1. Mean correct classification rate: 30%.**

| Dataset 1 | | | | | | |
|---|---|---|---|---|---|---|
| Estimated Class | Actual Class | | | | | |
| | NS | EEC08 | WEC | CS | NBB | SBB |
| NS | 15 | 20 | 11 | 8 | 5 | 11 |
| EEC08 | 28 | 44 | 17 | 23 | 5 | 5 |
| WEC | 9 | 9 | 22 | 11 | 7 | 9 |
| CS | 24 | 15 | 24 | 32 | 15 | 13 |
| NBB | 10 | 5 | 16 | 13 | 27 | 22 |
| SBB | 14 | 7 | 10 | 13 | 41 | 40 |

**Table 1-9: Confusion matrix (in %) for the Geodesic approach on dataset 2. Mean correct classification rate: 26.2%.**

| Dataset 2 | | | | | | |
|---|---|---|---|---|---|---|
| Estimated Class | Actual Class | | | | | |
| | NS | EEC07 | WEC | CS | NBB | SBB |
| NS | 28 | 15 | 21 | 12 | 12 | 22 |
| EEC07 | 32 | 35 | 28 | 20 | 15 | 29 |
| WEC | 8 | 18 | 18 | 4 | 10 | 10 |
| CS | 8 | 13 | 12 | 25 | 20 | 14 |
| NBB | 13 | 11 | 12 | 35 | 35 | 9 |
| SBB | 11 | 8 | 9 | 4 | 8 | 16 |

**Table 1-10: Confusion matrix (in %) for the Geodesic approach on dataset 3. Mean correct classification rate: 24.9%.**

| Dataset 3 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Estimated Class | Actual Class | | | | | | |
| | NS | EEC07 | EEC08 | WEC | CS | NBB | SBB |
| NS | 10 | 13 | 16 | 8 | 7 | 2 | 10 |
| EEC07 | 23 | 32 | 22 | 27 | 28 | 19 | 13 |
| EEC08 | 23 | 15 | 36 | 13 | 17 | 6 | 5 |
| WEC | 5 | 3 | 5 | 15 | 9 | 4 | 7 |
| CS | 18 | 13 | 13 | 16 | 24 | 10 | 11 |
| NBB | 9 | 13 | 3 | 12 | 6 | 23 | 20 |
| SBB | 12 | 11 | 5 | 9 | 9 | 36 | 34 |

Performances of the three approaches are compared in Table 1-12. On both dataset 1 and dataset 2, the Geodesic approach exhibits the highest performance followed by the PCA approach and at last by the Fourier approach.

**Table 1.-11: Comparison of the mean correct classification rate (in %) obtained by the three approaches on dataset 1, 3 and 4.**

| | dataset 1 | dataset 3 | dataset 4 |
|---|---|---|---|
| Fourier | 19.7 | 16.4 | 56 |
| PCA | 25 | 19 | 60 |
| Geodesic | 30 | 24.9 | 60.5 |

Regarding the year discrimination issue(Table 1-2, Table 1-6, Table 1-9), the Fourier approach fails while the PCA and Geodesic approach exhibit some differences. These analyses shows that the otolith morphology varies over two consecutive years and that this difference in shape is higher than between two arbitrary groups of the same year and the same stock.

Regarding the stock discrimination issue on dataset 1 (Table 1-3, Table 1-7, Table 1-10)), the three methods show that the population of striped red mullet can be geographically divided in three zones:

· **The Bay of Biscay (North and South)**

· **A mixing zone composed of the Celtic Sea and the Western Channel**

· **A northern zone composed of the Eastern English Channel and the North Sea**

To further test the “three zones” hypothesis, the classification process has been tested on the same otoliths as those of dataset 1 but with the otoliths rearranged into the three classes corresponding to the three zones (Table 1-13). The mean correct classification rate of 55.2% clearly confirms the “three zones” hypothesis.

**Table 1-12 Classification results (in %) on dataset 1 with Geodesic approach when the otoliths are grouped in three classes according to their zones. Mean correct classification: 55.2%.**

| Dataset 1 (with otoliths grouped in class by zones) | | | |
|---|---|---|---|
| Estimated Class | Actual Class | | |
| | Northern zone | Mixing zone | Bay of Biscay |
| Northern zone | 54 | 29 | 14.5 |
| Mixing zone | 28 | 46 | 20 |
| Bay of Biscay | 18 | 25 | 65.5 |

Following the evolution of catches of striped red mullet in the channel per quarter and statistical rectangle (Figure 1.13; Mahé *et al*., 2005), one could combine the bay of Biscay with the Celtic Sea and the Western Channel with the Eastern Channel and the North Sea. From the movement of fishing boats throughout the year we can identify a back and forth movement of the population of red mullet from the Southern North Sea to the eastern portion of the western Channel. The Distribution of striped red mullet in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009 showed a continuity between the north of the bay of Biscay and the south of the Celtic Sea.

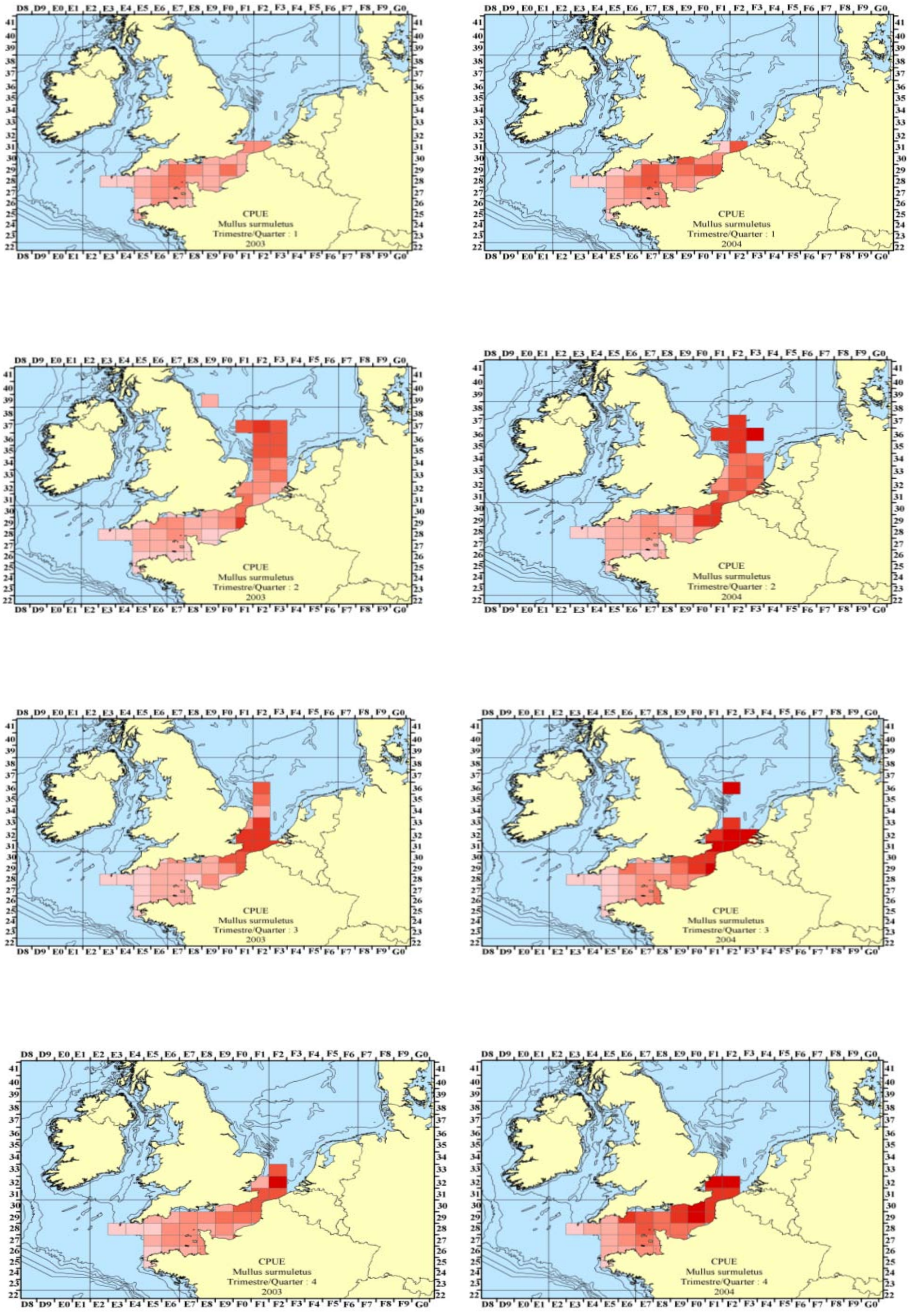



**Figure 1.10: Movement of the striped red mullet in the Channel with the catches by rectangle statistics and quarter.**

### Fisheries data

According to ICES statistics (Eurostat database), for the Atlantic Ocean, the fishery was only conducted by Spain from 1950 to 1975 when France also entered the fishery. From 1950 to 1975, the fishing of the striped red mullet was carried out on Spanish coasts and in the Bay of Biscay. From 1990, the strong increase of catches is essentially due to France fisheries but also to England and the Netherlands. It could be explained by the beginning of the exploitation of striped red mullet in the English Channel and North Sea.

Currently, the main country that catches striped red mullet is France (Table 1-14). The striped red mullet is a target species for this country and is mainly caught (> 90%) by bottom trawlers with a mesh size of 70-99 mm in the Eastern Channel and the south of the North Sea (Figure 1.14). In the Eastern English Channel and south of North Sea, the complementary gears are essentially represented by the various trawlers and in Western English Channel by various gears and gillnets. Striped red mullet catches achieved by these complementary metiers are accessory.

The trawlers concerned by striped red mullet fishery have a length and a power respectively of about 20 meters and 400 kilowatts yearly average. These sizes are steady during the time among this fleet, 71% of the ships which fish in the south of the North Sea fish also in the Eastern English Channel. Only 24% of ships fishing in Western English Channel frequented the Eastern English Channel. These are the ships whose maritime district is adjacent of the 2 zones (Cherbourg). They are completed by some units of the district of Boulogne-sur-mer frequenting the three sectors (3% of the fleet).

A summary of the total Basque catch of striped red mullet in the Bay of Biscay by gear from 1994 till 2009 is presented in Figure 1.15. The mean contribution of these gears to total landings has remained constant during the period of our study with an average of 91% corresponding to bottom trawl, a 8% corresponding to set nets, and the remaining 1% to purse seine and others fishing gears.

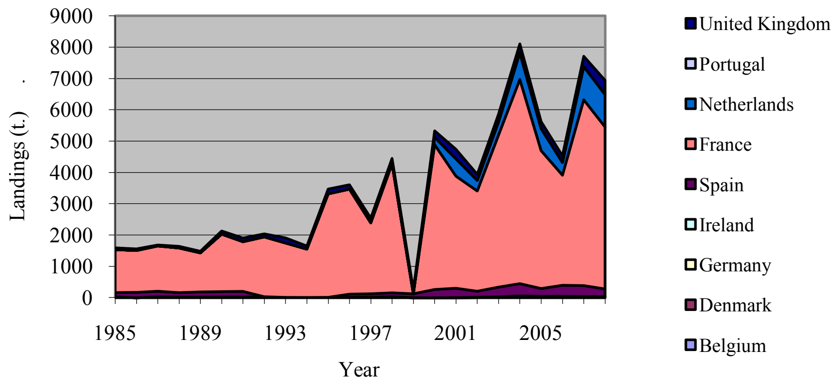
For this species, therefore for management purposes, two areas could be considered: IVc-VIId,e and VIIIa,b.

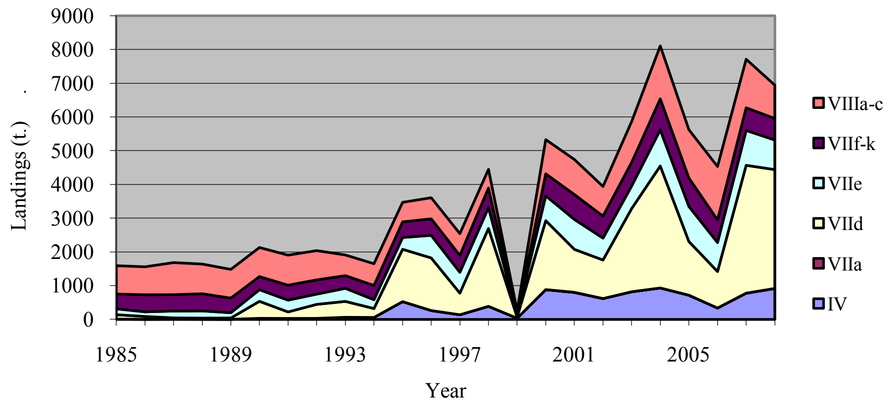
For the entire zone, the French catches are the most important. Other important countries are the Netherlands and the United Kingdom with regard to the English Channel (VIId,e) and the North Sea (IV) where the catches are concentrated in the south (IVb,c). The north of the Bay of Biscay (VIIIa,b) is exploited by France and Spain. The southern part of the Bay of Biscay (VIIIc) is only exploited by Spain. Other countries with small catches are Germany, Scotland, Denmark and Ireland. For this species, therefore, three areas should be considered: IV, VIId,e, and VIIIa,b.

This species is targeted by the French fishermen but this species has not been traditionally considered a target species for the Basque bottom otter trawl fleet, this situation has changed with the entry into force of the new DCF (2008/949/EC). According to appendix IV of the DCF, the Basque otter bottom fleet is split in three different metiers, one of them targeting cephalopods and demersal species, with striped red mullet as one of the most important species (Iriondo et al., 2008).

Moreover, this species is not discarded by French vessels. More investigations on potential discarding should be carried out in these areas for the other countries.

**Table 1-13: Striped red mullet landings per ICES areas and per countries (source: ICES statistics, Eurostat, t.).**



**North Sea (ICES region: 4)**

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 10 | 9 | 9 | 2 | 2 | 4 |
| Denmark | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 2 | 5 | 12 | 13 | 24 | 16 | 20 | 6 | 4 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 7 | 4 | 5 | 4 | 3 | 33 | 23 | 27 | 60 | 54 | 521 | 254 | 125 | 368 | : | 611 | 372 | 312 | 506 | 519 | 324 | 116 | 507 | 474 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 229 | 382 | 235 | 230 | 344 | 314 | 173 | 241 | 397 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | 2 | 1 | 1 | 2 | 2 | 0 | 3 | 3 | 3 | 4 | 6 | 8 | 13 | 20 | 33 | 40 | 41 | 59 | 62 | 37 | 55 | 28 | 22 | 40 |

**Irish Sea (ICES region: 7a)**

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 3 | 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |

Eastern Channel (ICES region:7d)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 6 | 13 | 5 | 6 | 9 | 10 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 128 | 80 | 35 | 31 | 34 | 491 | 185 | 404 | 456 | 254 | 1495 | 1531 | 606 | 2230 | : | 1979 | 1045 | 1034 | 2244 | 3099 | 1272 | 914 | 2968 | 2776 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 127 | 86 | 162 | 451 | 288 | 121 | 674 | 464 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | 2 | 2 | 3 | 2 | 3 | 13 | 8 | 11 | 15 | 10 | 57 | 28 | 35 | 77 | 37 | 53 | 101 | 23 | 53 | 53 | 26 | 41 | 139 | 273 |

**Western Channel (ICES region:7e)**

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 1 | 8 | 8 | 17 | 23 | 8 |
| Denmark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 123 | 92 | 177 | 164 | 111 | 258 | 261 | 253 | 327 | 211 | 274 | 578 | 525 | 560 | : | 630 | 711 | 528 | 546 | 860 | 795 | 586 | 699 | 555 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 39 | 16 | 29 | 58 | 102 | 113 | 147 | 173 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | 53 | 46 | 26 | 49 | 46 | 86 | 88 | 51 | 60 | 51 | 75 | 92 | 92 | 60 | 63 | 106 | 137 | 105 | 94 | 144 | 134 | 142 | 165 | 141 |

**Celtic Sea (ICES region: 7f-k)**

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 29 | 0 | 31 | 21 | 21 | 18 | 11 | 13 | 9 | 9 | 13 | 14 | 18 | 23 | : | : | : | 5 | 1 | 3 | 4 | 2 | 2 | 4 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | 8 | 12 | 19 | 3 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 406 | 506 | 454 | 488 | 413 | 363 | 420 | 390 | 364 | 413 | 451 | 476 | 482 | 549 | : | 651 | 719 | 640 | 685 | 916 | 840 | 670 | 670 | 633 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 20 | 7 | 15 | 2 | 0 | : | 0 | 1 |

**Bay of Biscay (ICES region:8)**

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 1 | 3 | 4 | 2 | 2 | 4 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | 135 | 171 | 175 | 141 | 165 | 170 | 180 | 0 | 0 | 0 | 0 | 100 | 108 | 125 | 123 | 262 | 298 | 191 | 307 | 391 | 248 | 349 | 344 | 247 |
| France | 708 | 655 | 775 | 739 | 686 | 691 | 696 | 837 | 529 | 612 | 564 | 515 | 528 | 421 | : | 753 | 734 | 688 | 879 | 1128 | 1172 | 1231 | 1091 | 737 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| United Kingdom | 0 | 2 | 1 | 0 | 0 | 0 | 15 | 29 | 83 | 33 | 14 | 10 | 10 | 8 | 2 | 0 | 0 | 0 | 22 | 46 | 6 | 0 | 0 | 0 |


**Figure 1.11: French catches by gear for the IVb, Ivc (A), the VIId (B) and VIIe ( C )**

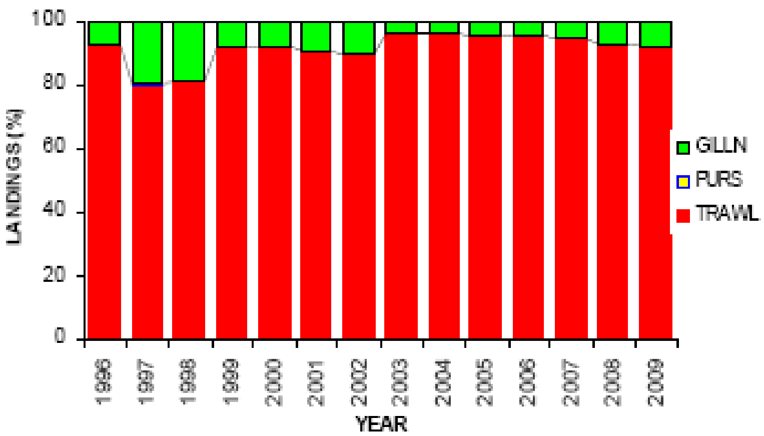



**Figure 1.12: Striped red mullet Basque landings proportions by year and gear in the bay of Biscay.**

The analysis of the demographic structure indicates that the striped red mullet stock is dominated by recruitment (individuals of 1 year old). Two peaks of recruitment are observed in 2004 and 2007, involving a numbers significant increase of the age group 2 in 2005 and 2008, and those of the age group 3 in 2006 (Figure 1.16). These tendencies observed for numbers remain valid for the biomasses.


| Catches (IVc & VIId ; kg) | | | | | |
|---|---|---|---|---|---|
| | **Year** | | | | |
| **Age** | **2004** | **2005** | **2006** | **2007** | **2008** |
| **1** | 3212809.08 | 2120791.5 | 315855.6 | 2806648.4 | 95078.9 |
| **2** | 334743.15 | 515187.5 | 241795.7 | 248474.6 | 1096189.8 |
| **3** | 209376.17 | 95905.23 | 223410.4 | 164885.2 | 211365.4 |
| **4** | 26946.85 | 26370.08 | 22809.3 | 29826.5 | 76530.5 |
| **5+** | 60317.66 | 101922.82 | 15071.6 | 15616.4 | 67967.4 |

| Mean Weight (kg) | | | | | |
|---|---|---|---|---|---|
| | **Year** | | | | |
| **Age** | 2004 | 2005 | 2006 | 2007 | 2008 |
| 1 | **0.090** | **0.105** | **0.146** | **0.107** | **0.096** |
| 2 | **0.222** | **0.172** | **0.188** | **0.313** | **0.139** |
| 3 | **0.270** | **0.300** | **0.241** | **0.422** | **0.226** |
| 4 | **0.434** | **0.383** | **0.379** | **0.446** | **0.326** |
| 5+ | **0.660** | **0.419** | **0.350** | **0.677** | **0.410** |

| Numbers | | | | | |
|---|---|---|---|---|---|
| | **Year** | | | | |
| **Age** | 2004 | 2005 | 2006 | 2007 | 2008 |
| 1 | **35428082** | **20152558** | **2153665** | **26117316** | **985379** |
| 2 | **1501860** | **2979339** | **1283604** | **793125** | **7830983** |
| 3 | **773003** | **319353** | **924622** | **390184** | **934687** |
| 4 | **61954** | **68707** | **60032** | **66854** | **234098** |
| 5+ | **91269** | **242819** | **43007** | **23050** | **165644** |

**Figure 1.13: Demographic structure of the striped red mullet in the Eastern Channel and the south of the North sea.**

The fishery is characterised by a strong seasonality, with increased catches during the second half of the year (Figure 1.17).

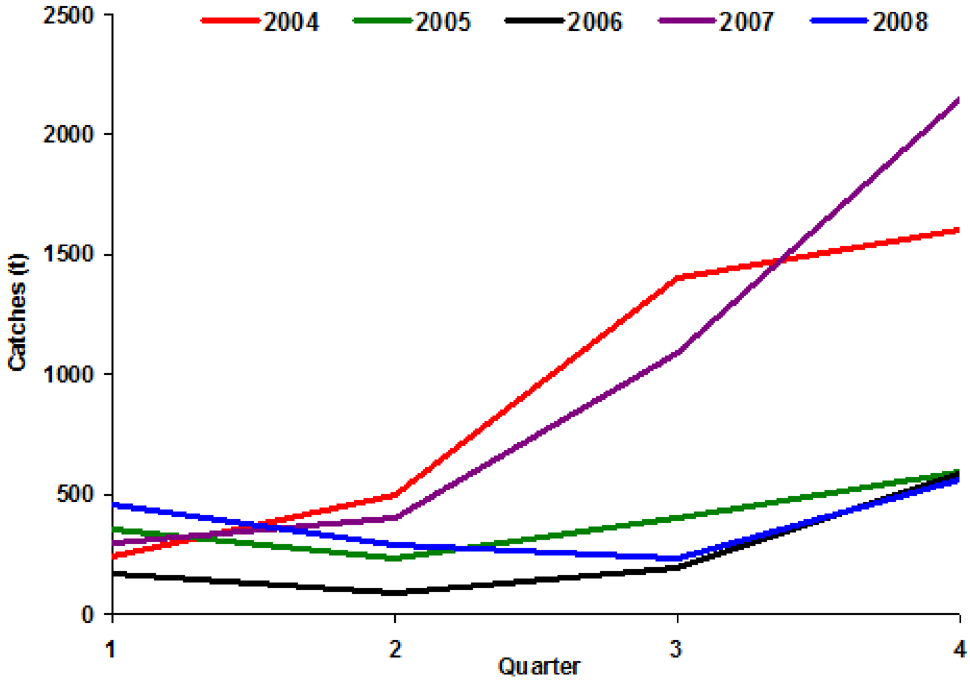



**Figure 1.14: Quarterly evolution of the striped red mullet catches (ICES areas IVc and VIId).**

## Survey data, recruit series

Since 1988, striped red mullet abundance increases in the Bay of Biscay (EVHOE survey), the Celtic sea (EVHOE survey), the eastern English Channel (CGFS survey) and the south of the North Sea (IBTS survey) (Figure 1.18). However, the increase is much significant in the eastern English Channel.

During the last decade, one can observed three good recruitment (TL from 8 cm to 15 cm) in the North with particularly in the eastern Channel: 2003, 2007 and 2009 (Table 1-15). In the bay of Biscay, 2001, 2003 and 2005 are the years with good recruitment.

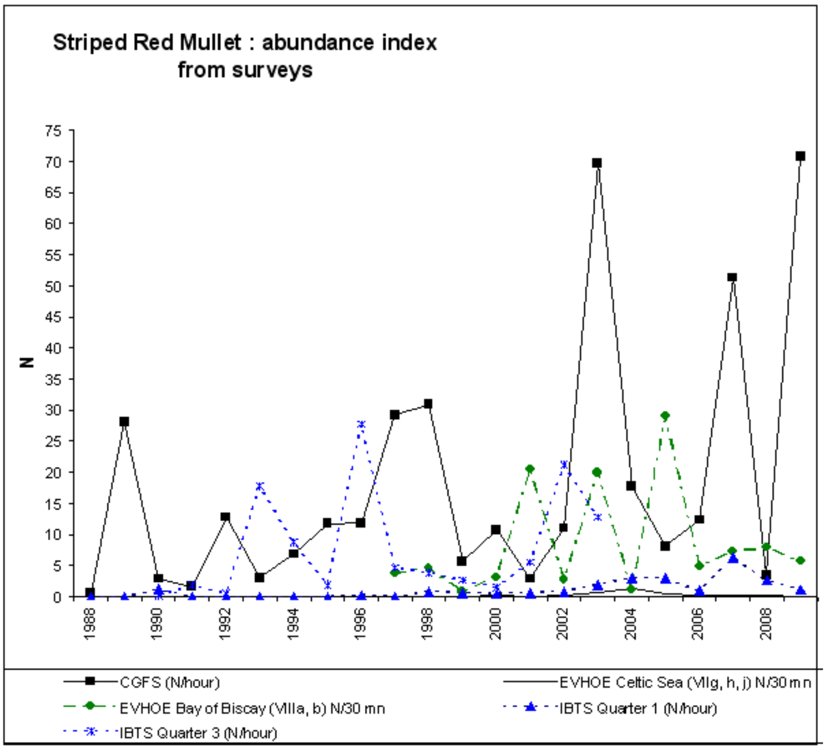
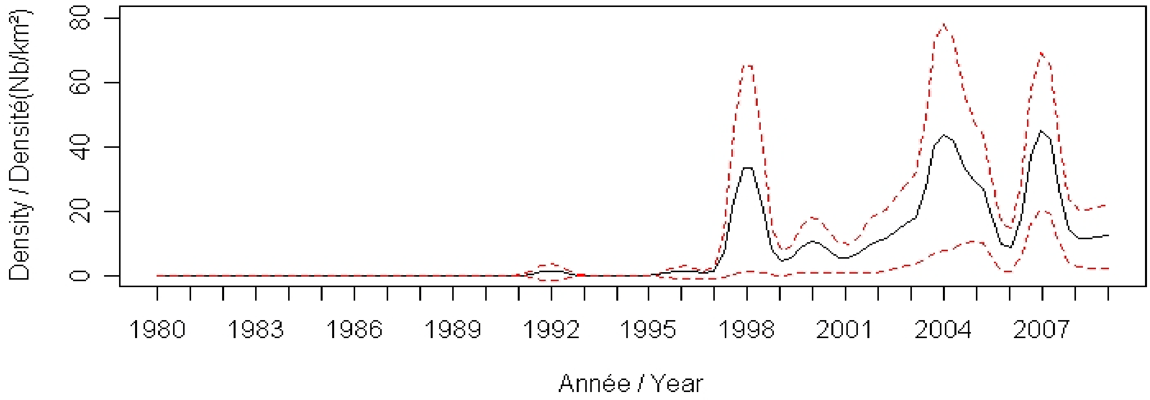



**Figure 1.15: Time series of abundance of striped red mullet base on Surveys from 1980 to 2009.**

**Table 1-14 The abundance index (Nb/hr) for International Bottom Trawl Survey (IBTS, IVb,c) and Channel Ground Fish Survey (FR-CGFS, VIId).**

| Year | IBTS Quarter 1 | IBTS Quarter 3 | CGFS |
|---|---|---|---|
| 1988 | 0.00 | | 0.72 |
| 1989 | 0.00 | | 28.14 |
| 1990 | 1.18 | | 2.93 |
| 1991 | 0.00 | 0.14 | 1.62 |
| 1992 | 0.00 | 1.88 | 12.8 |
| 1993 | 0.00 | 0.56 | 3.07 |
| 1994 | 0.00 | 17.81 | 6.86 |
| 1995 | 0.00 | 8.75 | 11.78 |
| 1996 | 0.29 | 1.88 | 11.84 |
| 1997 | 0.00 | 27.71 | 29.19 |
| 1998 | 0.77 | 4.66 | 30.92 |
| 1999 | 0.63 | 3.82 | 5.7 |
| 2000 | 0.46 | 2.69 | 10.7 |
| 2001 | 0.64 | 1.50 | 2.92 |
| 2002 | 0.89 | 5.54 | 11.04 |
| 2003 | 1.95 | 21.20 | 69.73 |
| 2004 | 3.04 | 12.79 | 17.69 |
| 2005 | 2.97 | | 8.1 |
| 2006 | 0.97 | | 12.34 |
| 2007 | 6.26 | | 51.3 |
| 2008 | 2.68 | | 3.45 |
| 2009 | 1.14 | | 70.75 |

**North Sea IBTS data, Quarter 1**




**Eastern Channel**

**1.16: Time series of abundance of striped red mullet in the North Sea base on IBTS data (Nb/km²) from 1980 to 2009 and in the eastern Channel base on FR-CGFS data (Nb/km²) from 1988 to 2009.**

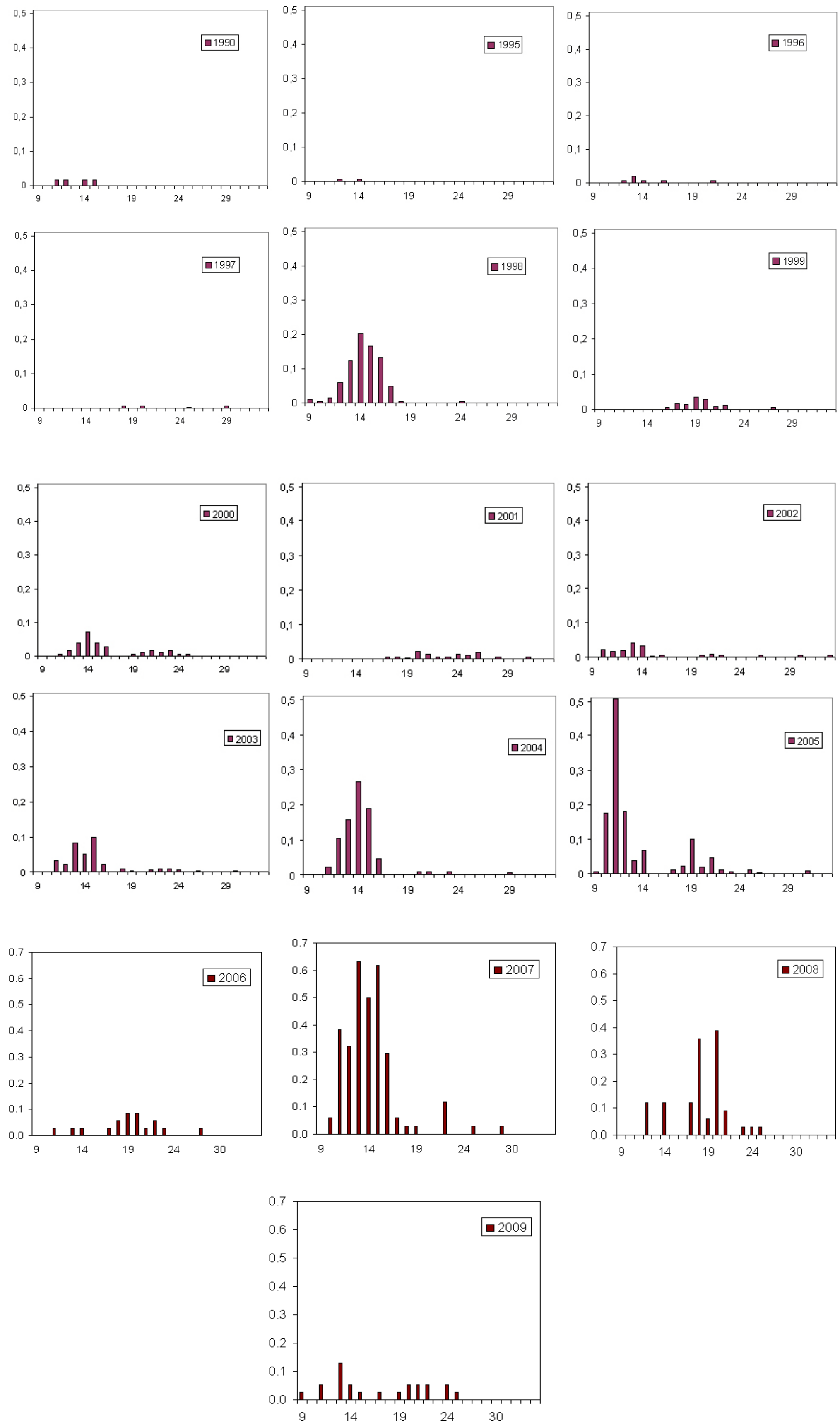
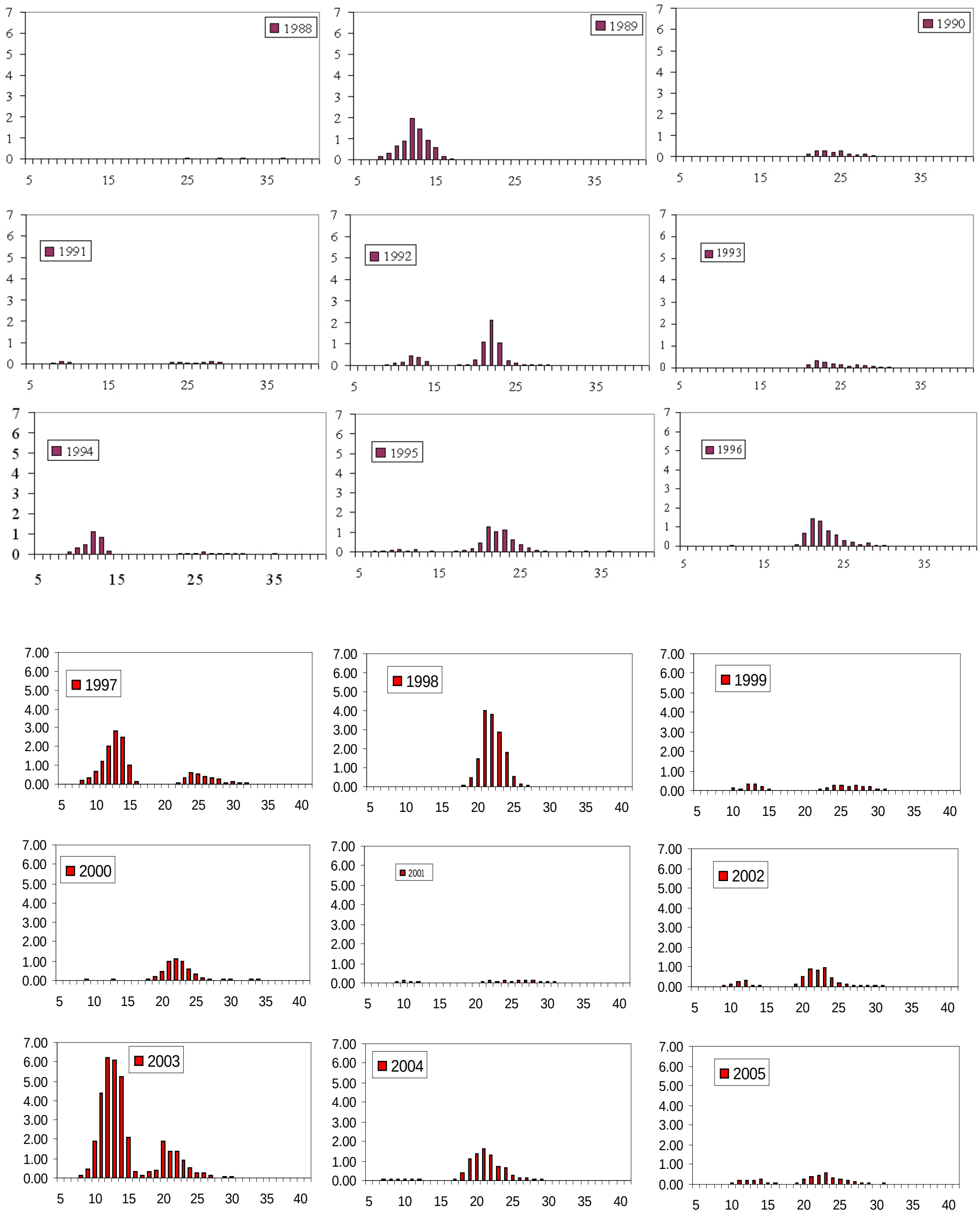



**Figure 1.17: Abundance indices (Nb/30 min Trawl) of striped red mullet per size class (Length, cm.) during IBTS (Q1, all countries) from 1990 to 2009.**


1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

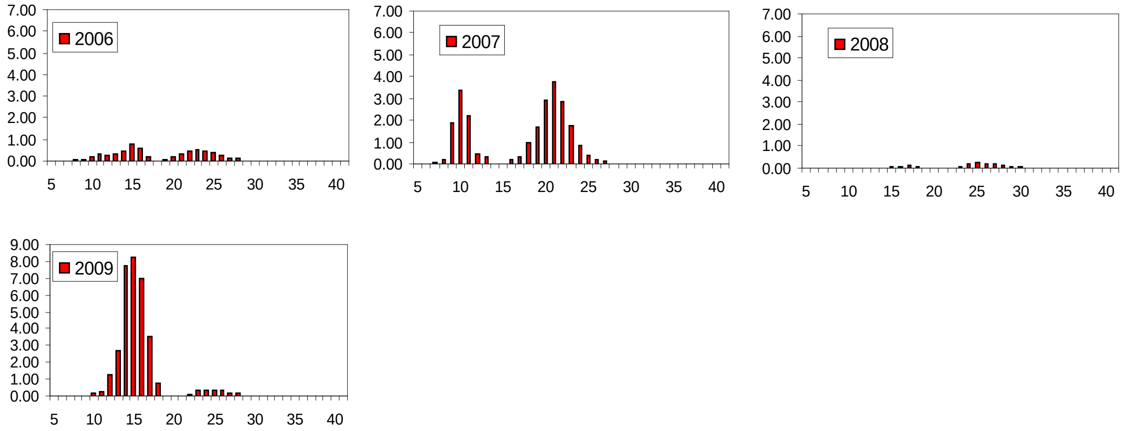


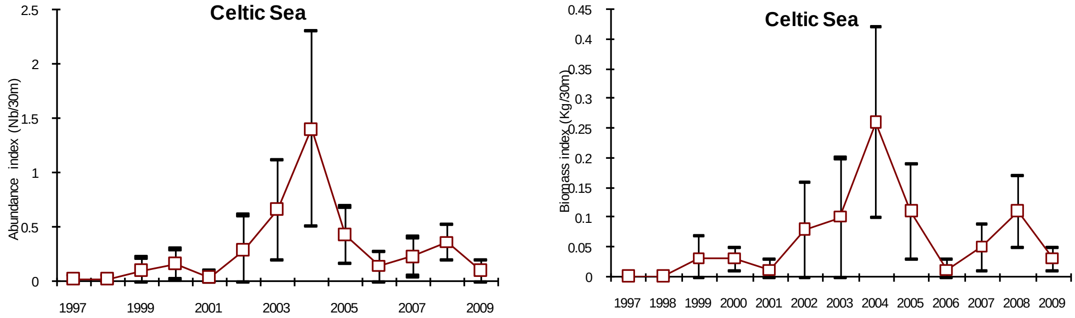

**Figure 1.18: Abundance indices (Nb/30 min Trawl) of striped red mullet per size class (Length, cm.) during FR-CGFS from 1988 to 2009.**

**Table 1-15: The average abundance (number and weight (kg) per 30 minutes) of striped red mullet annually for FR-EVHOE survey in the Celtic sea (VIIg, h, j) and in the Bay of Biscay (VIIIa,b).**

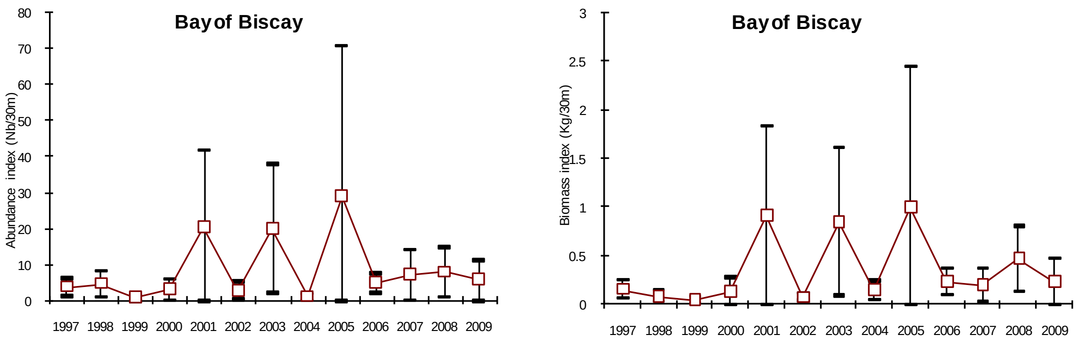
| Year | Celtic Sea (VIIg, h, j) | | Bay of Biscay (VIIIa, b) | |
|---|---|---|---|---|
| | Number/30minutes | W(kg)/30minutes | Number/30minutes | W(kg)/30minutes |
| 1997 | 0,02 | 0,00 | 3,77 | 0,16 |
| 1998 | 0,02 | 0,00 | 4,68 | 0,09 |
| 1999 | 0,10 | 0,03 | 0,81 | 0,05 |
| 2000 | 0,16 | 0,03 | 3,13 | 0,14 |
| 2001 | 0,04 | 0,01 | 20,48 | 0,91 |
| 2002 | 0,29 | 0,08 | 2,85 | 0,08 |
| 2003 | 0,66 | 0,10 | 20,02 | 0,85 |
| 2004 | 1,40 | 0,26 | 1,16 | 0,15 |
| 2005 | 0,43 | 0,11 | 29,08 | 1,00 |
| 2006 | 0,14 | 0,01 | 4,89 | 0,24 |
| 2007 | 0,23 | 0,05 | 7,32 | 0,20 |
| 2008 | 0,36 | 0,11 | 7,95 | 0,47 |
| 2009 | 0,10 | 0,03 | 5,73 | 0,74 |

**Figure 1.19: Time series of abundance (Nb and Weight(kg)/30 min Trawl) of striped red mullet in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009.**

The Celtic Sea




The Bay of Biscay



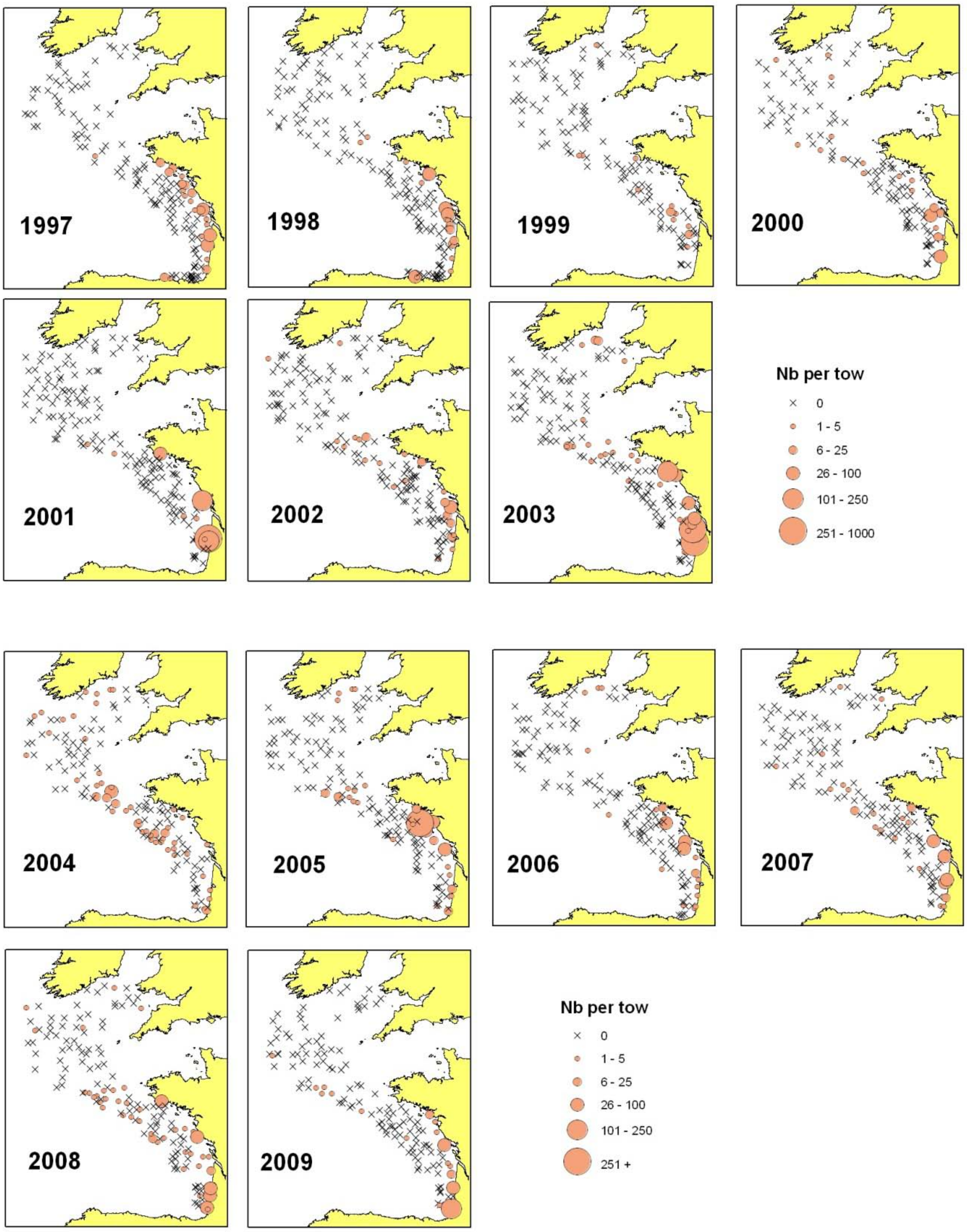



**Figure 1.20: Distribution of striped red mullet in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009.**

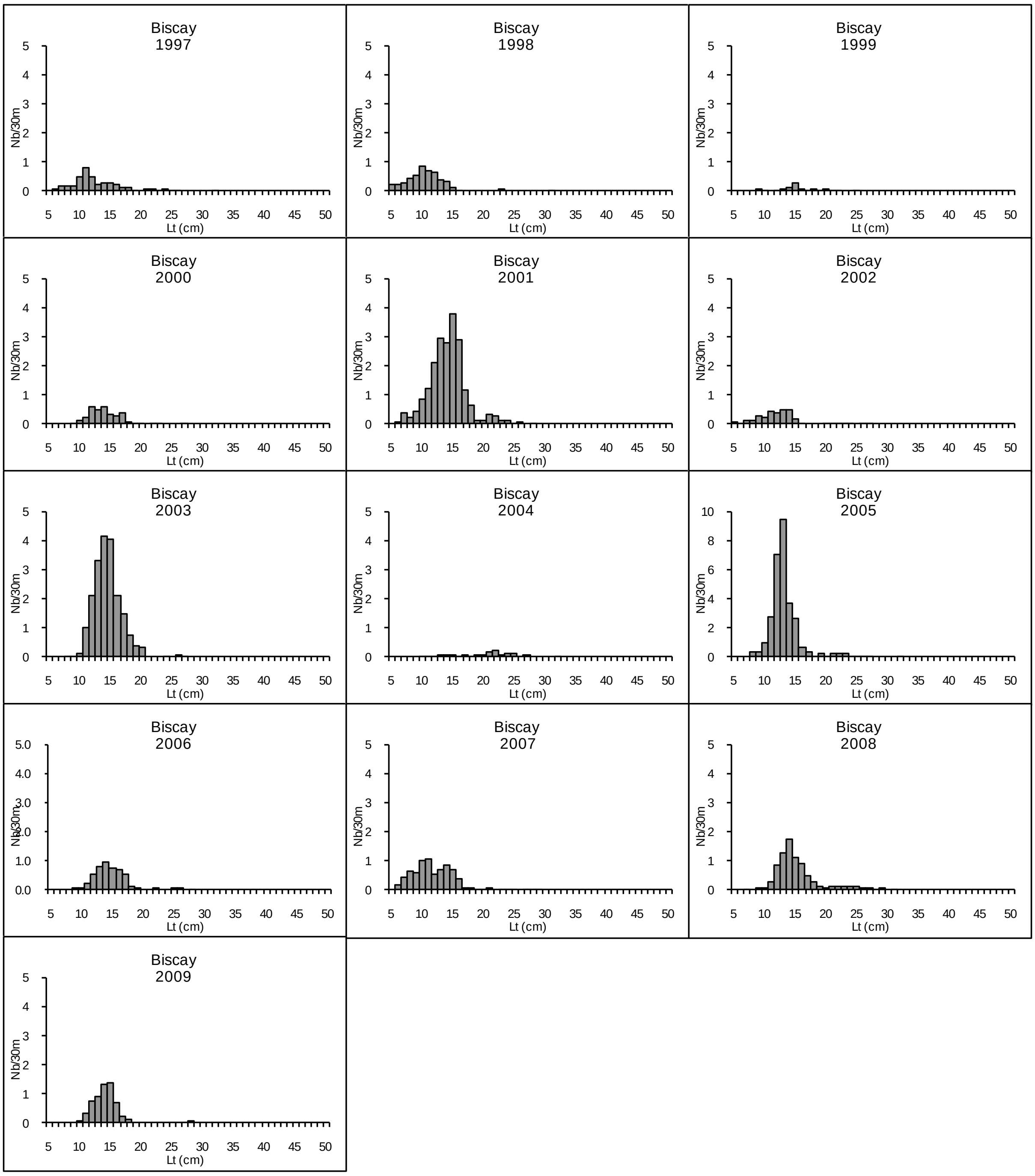



**Figure 1.21: Abundance indices (Nb/30 min Trawl) of striped red mullet per size class (Length, cm.) during FR-EVHOE (Bay of Biscay) from 1997 to 2009.**

### UK Surveys

Although all fish caught are routinely measured during Cefas surveys, biological information is not collected for striped red mullet. A summary of the numbers of fish measured in four Cefas survey series and the abundance (number per 30 minute tow) is given in Table 5.4.2 for the Irish Sea (VIIa,f,g) beam-trawl survey, the Channel (VIId) beam-trawl survey, the Carhelmar (VIIe) commercial beam-trawl survey and the English groundfish (IVb,c) GOV trawl survey. As can be seen, striped red mullet are generally uncommon in these surveys.

**Table 1-16: The average abundance (number caught per 30 minute tow) of striped red mullet annually for Cefas: Channel Beam Trawl Survey (VIId), English GroundFish Survey (EGFS, IVb & c), Carhelmar (VIIe), Irish Sea Beam Trawl Survey (VIIa, f, & g).**

| Year | Channel Beam Trawl Survey | English GroundFish Survey | Carhelmar | Irish Sea Beam Trawl survey |
|---|---|---|---|---|
| 1988 | - | - | - | 0,00 |
| 1989 | 0,52 | - | 1,48 | 0,10 |
| 1990 | 0,12 | - | 0,55 | 0,06 |
| 1991 | 0,04 | 0,57 | 0,47 | 0,01 |
| 1992 | 0,03 | 0,58 | 0,45 | 0,01 |
| 1993 | 0,11 | 0,01 | 0,70 | 0,02 |
| 1994 | 0,00 | 0,05 | 0,48 | 0,02 |
| 1995 | 0,02 | 7,76 | 0,86 | 0,06 |
| 1996 | 0,07 | 0,84 | 0,92 | 0,07 |
| 1997 | 0,01 | 0,19 | 0,80 | 0,11 |
| 1998 | 0,07 | 0,25 | 0,47 | 0,01 |
| 1999 | 0,09 | 0,23 | 2,14 | 0,22 |
| 2000 | 0,09 | 0,21 | 0,97 | 0,19 |
| 2001 | 0,05 | 1,37 | 1,99 | 0,16 |
| 2002 | 0,05 | 0,74 | 0,11 | 0,03 |
| 2003 | 0,17 | 0,55 | 3,72 | 0,39 |
| 2004 | 0,21 | 1,81 | 0,62 | 0,34 |
| 2005 | 0,02 | 0,58 | 1,32 | 0,54 |
| 2006 | 0,05 | 0,53 | 3,67 | 0,72 |
| 2007 | 0,15 | 3,83 | 1,04 | 0,21 |
| 2008 | 0,08 | 0,94 | 0,48 | 0,09 |
| 2009 | 0,21 | 0,29 | 0,28 | 0,05 |

## Biological sampling

The Netherlands has began the age estimation since 2009 (2009, Quarter 3: N=31). The Azti institute carried out the measures of sexual maturity and length in 2009 in the Bay of Biscay.

An inventory of the French data collected from the Bay of Biscay to North Sea is given in Table 1-18. The French samplings start since 2004 in the Eastern Channel and the south of the North Sea and since 2008 in the Bay of Biscay.

A French study on the sampling optimisation (IVc; VIId) was presented. The results showed that there is a good yearly adequacy between sampling and catches (Mahé *et al.*, 2007).

**Table 1-17: Biological sampling in France.**

| Year | Length | | Age | | Maturity | | Individual weight | |
|---|---|---|---|---|---|---|---|---|
| | Fish number | Sample number | Fish number | Sample number | Fish number | Sample number | Fish number | Sample number |
| 1985 | - | - | - | - | - | - | - | - |
| 1986 | - | - | - | - | - | - | - | - |
| 1987 | - | - | - | - | - | - | - | - |
| 1988 | - | - | - | - | - | - | - | - |
| 1989 | - | - | - | - | - | - | - | - |
| 1990 | - | - | - | - | - | - | - | - |
| 1991 | - | - | - | - | - | - | - | - |
| 1992 | - | - | - | - | - | - | - | - |
| 1993 | - | - | - | - | - | - | - | - |
| 1994 | 181 | 23 | - | - | - | - | - | - |
| 1995 | 246 | 32 | - | - | - | - | - | - |
| 1996 | - | - | - | - | - | - | - | - |
| 1997 | - | - | - | - | - | - | - | - |
| 1998 | - | - | - | - | - | - | - | - |
| 1999 | - | - | - | - | - | - | - | - |
| 2000 | - | - | - | - | - | - | - | - |
| 2001 | - | - | - | - | - | - | - | - |
| 2002 | 65 | 9 | - | - | - | - | - | - |
| 2003 | 147 | 17 | - | - | - | - | - | - |
| 2004 | 142 | 17 | 372 | 12 | 620 | 12 | 1401 | 12 |
| 2005 | 536 | 10 | 301 | 3 | 196 | 3 | 301 | 3 |
| 2006 | 1941 | 10 | 646 | 4 | 646 | 4 | 646 | 4 |
| 2007 | 5053 | 129 | 740 | 4 | 740 | 4 | 740 | 4 |
| 2008 | 4396 | 124 | 447 | 5 | 447 | 5 | 190 | 2 |
| 2009 | 8648 | 334 | 1221 | 11 | 1221 | 11 | 1076 | 9 |

The number of biological sampling in France increased strongly in 2009 with the Nespman project.

## Biological parameters and other research

### Length-weight relationships

Since 2003, the data are usually collected by France for the Eastern English Channel and the southern North Sea. France started to collect data for VIIIa,b at the end of 2007.

Some red mullet samples by the AZTI institute from the Bay of Biscay (VIIIabd & VIIIC) have been purchased and analysed during the Nespman project. Significant sex ratio differences have been observed. In Divisions VIIIabd males are more abundant, with 63 % of the total analysed individuals. However, around the Iberian Peninsula (Division VIIIc), females are more abundant, with 71.6 % of the total analysed fishes. Figure 1.25 and Figure 1.26 show the weight/length relationship, combined for both sexes, by ICES Divisions (VIIIabd & VIIIc).

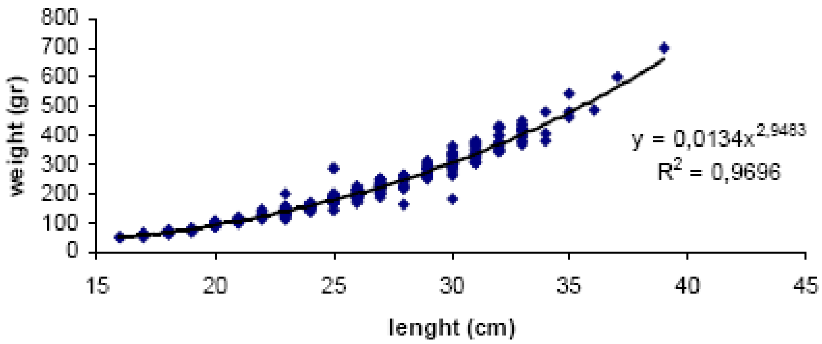



**Figure 1.22: Striped red mullet weight/length relationship in Divisions VIIIabd (for sexes combined).**

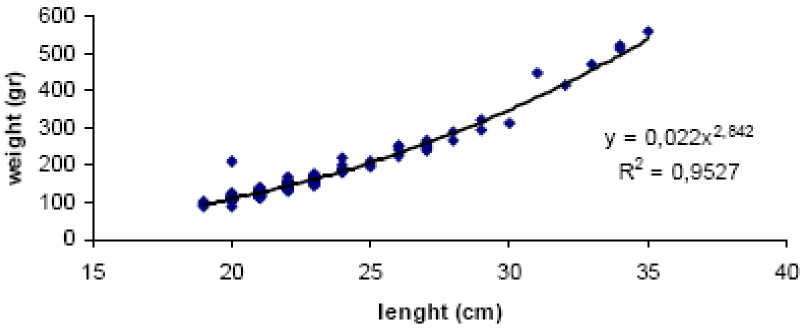



**Figure 1.23: Striped red mullet weight/length relationship in Divisions VIIIc (for sexes combined)**

### Age structure and growth

The methods were presented in the report of the 2005 WGNEW. Since 2004, data are collected by France for the Eastern Channel and the southern North Sea. France started to collect data for VIIIa,b at the end of 2006.

In 2007-2008, the striped red mullet otolith exchange should optimise the age estimation between countries (ICES, 2009).

### Comparison between scales and otoliths

The data are presented in the report of 2005 WGNEW (ICES, 2005).

### Maturity identification

Since 2004, France collects data for the Eastern English Channel and the southern North Sea. Table 1.19, Table 1.20, Table 1.21 and Table 1.22 show the maturity ogives for striped red mullet in the Eastern Channel and the south of the North Sea in 2004, 2006, 2007 and 2008. Table 1.23 shows the maturity ogives for striped red mullet in the Bay of Biscay in 2008.

**Table 1-18: Striped red mullet maturity ogive in 2004 to the Eastern English Channel and the south of the North Sea.**

| Age Group | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| % Mature | 54,17 | 65,47 | 100 | 100 | 100 |

**Table 1-19: Striped red mullet maturity ogive in 2006 to the Eastern English Channel and the south of the North Sea.**

| Age Group | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| % Mature | 10,53 | 98,67 | 97,32 | 99,41 | 100,00 | 100,00 | 100,00 |

**Table 1-20: Striped red mullet maturity ogive in 2007 to the Eastern English Channel and the south of the North Sea.**

| Age Group | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| % Mature | 35,48 | 91,8 | 97,32 | 98,59 | 100 | 100 |

**Table 1-21: Striped red mullet maturity ogive in 2008 to the Eastern English Channel and the south of the North Sea.**

| Age Group | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| % Mature | 42,33 | 65,78 | 91,89 | 95,31 | 100 | 100 |

**Table 1-22: Striped red mullet maturity ogive in 2008 to Bay of Biscay.**

| Age Group | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| % Mature | 15,61 | 46,47 | 67,32 | 100 | 100 | 100 |

Figure 1.27 and Figure 1.28 show the maturity ogives in the length for striped red mullet in the Bay of Biscay during the Nespman project. It is difficult to separate these maturity ogives by sexes, so combined ogives are presented below. Around Iberian Peninsula (VIIIc) mature at 21.2 cm, and in South Bay of Biscay a bit earlier, at 19.9 cm.

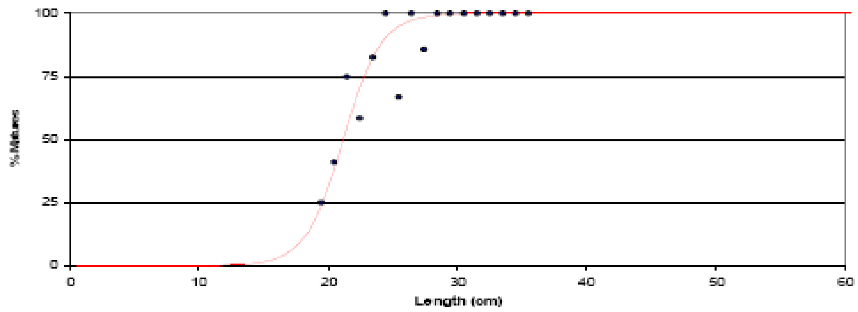



**Figure 1.24: Striped red mullet maturity ogive in Division VIIIc, for both sexes combined.**

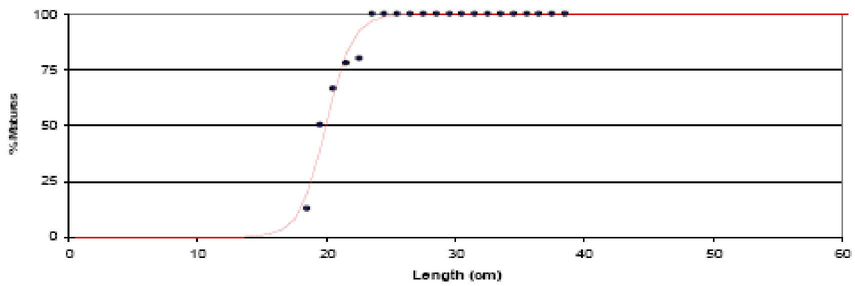



**Figure 1.25: Striped red mullet maturity ogive in Divisions VIIIabd, for both sexes combined**

## Analysis of stock trends / assessment

Catch curve analysis is used to estimate total mortality by observing the regular decline in individuals (Ogle, 2010). The natural log of catch versus age of the striped red mullet per year from 2004 to 2008 showed strong fluctuations of mortality between years (Figure 1.29 and Figure 1.30). The very strong fluctuations of recruitment do not use this method which strongly influences the mortality estimation (Z).

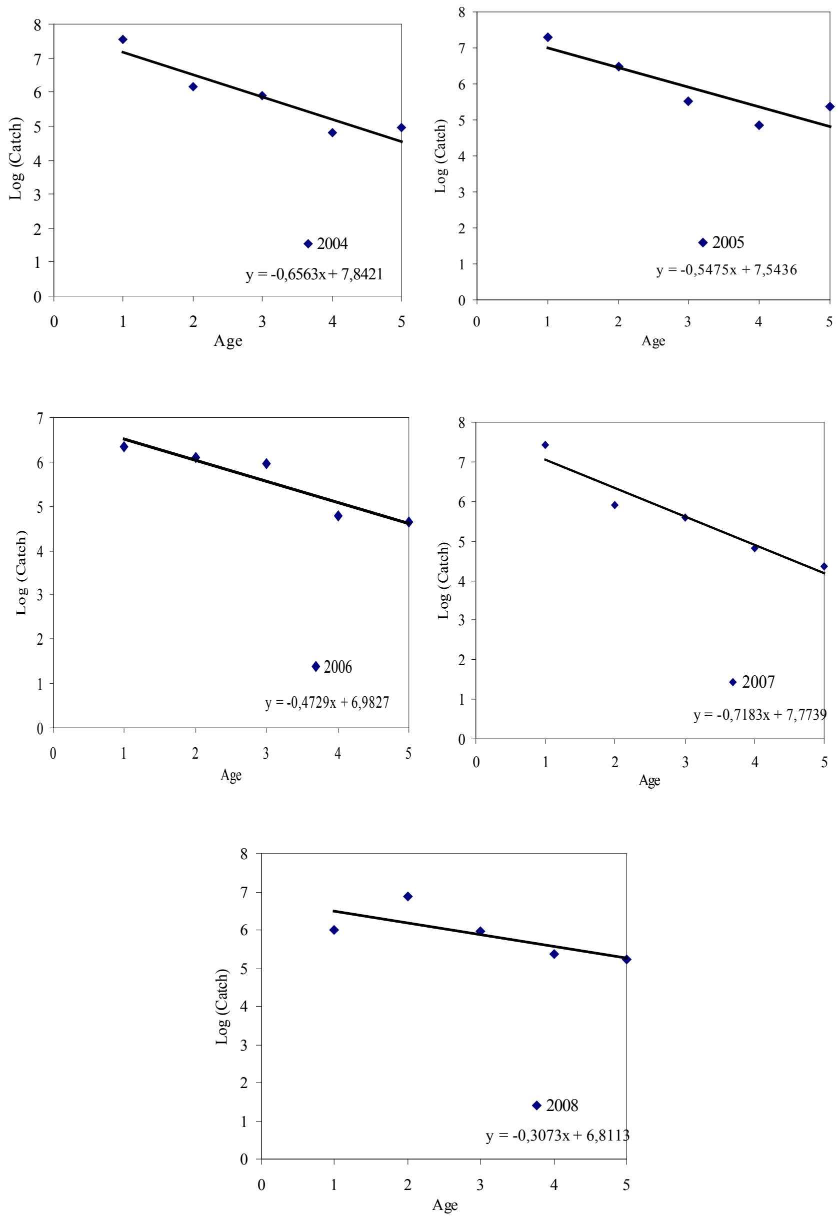



**Figure 1.26: The natural log of catch versus age of the striped red mullet per year from 2004 to 2008.**

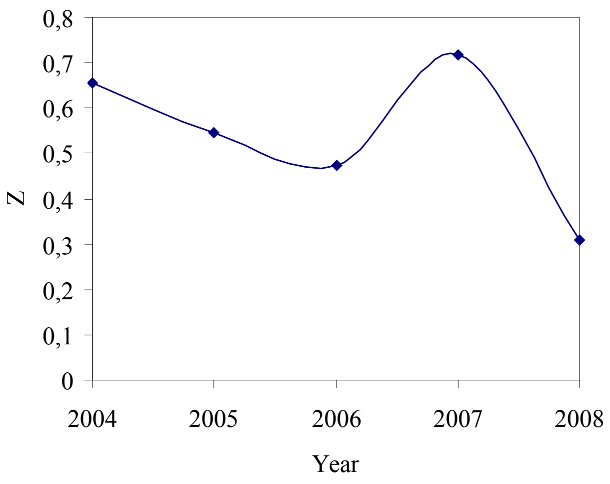



**Figure 1.27: Mortality of striped red mullet from 2004 to 2008.**

| | Tot Catches (t) | Tot Catches (Nb) | Effort |
|---|---|---|---|
| 1990 | 29,991 | 101781 | 0,07 |
| 1991 | 76,5 | 1363868 | 0,26 |
| 1992 | 73,412 | 549618 | 0,33 |
| 1993 | 80,43 | 1124682 | 0,28 |
| 1994 | 103,06 | 1353690 | 0,35 |
| 1995 | 83,752 | 832061 | 0,30 |
| 1996 | 113,745 | 5272265 | 0,38 |
| 1997 | 108,916 | 4608143 | 0,46 |
| 1998 | 98,776 | 1938931 | 0,36 |
| 1999 | 113,226 | 6793893 | 0,38 |
| 2000 | 962,571 | 2544529 | 0,41 |
| 2001 | 2272,957 | 6715013 | 0,59 |
| 2002 | 1504,588 | 3829517 | 1,02 |
| 2003 | 1225,4938 | 3458015 | 0,94 |
| 2004 | 2524,896 | 7101782 | 0,71 |
| 2005 | 3738,659 | 12580360 | 0,78 |
| 2006 | 1579,047 | 14655800 | 1,09 |
| 2007 | 1036,041 | 3724138 | 0,79 |
| 2008 | 3936,959 | 8478372 | 0,62 |
| 2009 | 1533,255 | 6454167 | 0,73 |

**Figure 1.28: French total catches (tonnes and number) and Effort of the striped red mullet in the Eastern Channel and the North Sea.**

Currently, age structured analytical stock assessment is not possible due to the too short time series of available data. Tentative assessments based on global model and surplus production model (ASPIC) did not give reliable results as the landings and the CPUE steadily increase over the period (Figure 1.32 and Figure 1.33).

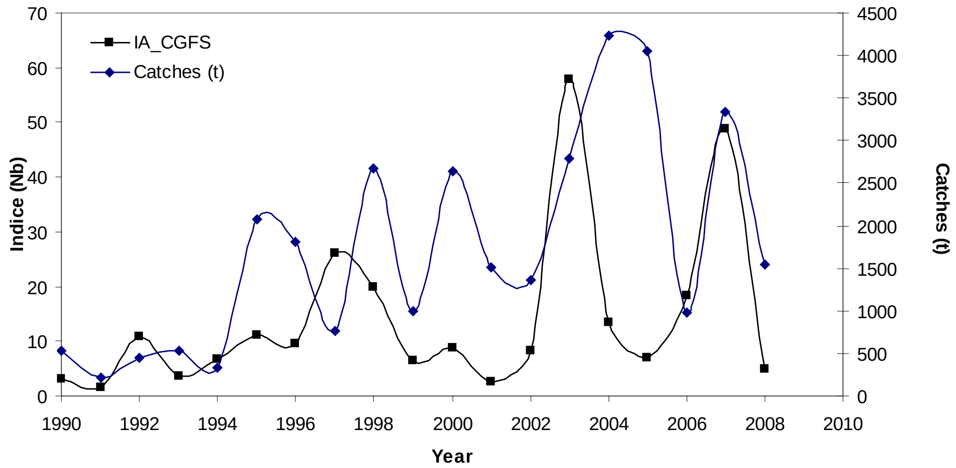



**Figure 1.29: Times series of internationals Catches in the Eastern Channel and the south of the North sea (VIId, IVa) and abundance indices of CGFS (Nb/30min) of the striped red mullet.**

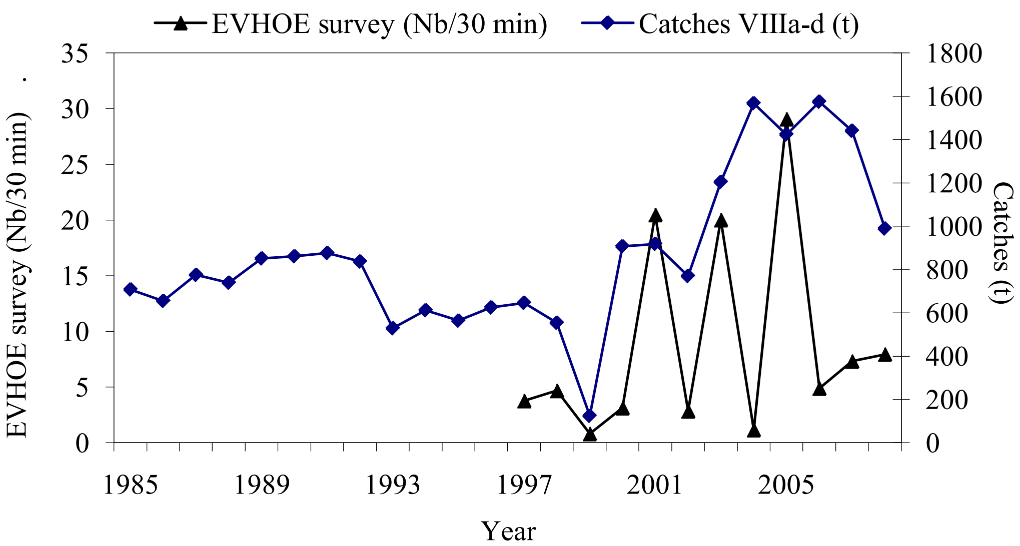



**Figure 1.30: Times series of internationals Catches in the bay of Biscay (VIIIa_d; t) and abundance indices of EVHOE in the bay of Biscay (Nb/30min) of the striped red mullet.**

## Data requirements

Regular sampling of striped red mullet catches must be continued under DCF. Sampling in the Eastern Channel and the south of the North Sea starts in 2004. The effort of sampling (700 otoliths) in the Eastern English Channel and the south of the North Sea is sufficient (ICES, 2007) but it must be continued. The effort of sampling in the North Sea (IVb and IVc), in the Western Channel, in the Celtic sea and the Bay of Biscay starts in 2009. For 2011 and 2012 a sampling year level of 500 otoliths from commercial landings and surveys is planned. An increase in sampling intensity should be considered.

Since 2009, the concurrent sampling design carried out should provide with more sampling data (length compositions) than it was in recent years.

The FR-CGFS survey and FR-EVHOE survey would continue to provide with a series of abundance indices at age. However, The FR-CGFS survey is not funded by DCF. In the same way, there is not survey in the Western Channel (VIIe) whereas the catches of the striped red mullet in this geographical area are as significant as the catches in the Celtic sea.

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# Annex 3 - Red gurnard

## 1.1 General biology

Red gurnard (*Aspitrigla cuculus* or *Chelidonichthys cuculus*) is widely distributed in North-East Atlantic from South Norway and north of the British Isles to Mauritania (Quéro 1984). Hureau (1986) indicates that this species is scarce in the North Sea. This species is also present in the Mediterranean Sea and off Western Africa to the latitude of the Canaries Islands.

This benthic species occurs on grounds between 20m and 250m. As with other species of gurnards, red gurnards are able to make audible sounds to help schooling during the spawning period (Wheeler, 1969). In the western Channel (VIIe), concentrations occur close to the Central Deep, limited to 90m depth (Theret, 1983).

Surveys results and commercial fisheries data have shown that the species occurs from the southern North Sea to the Celtic Sea (Anon, 1993). October CGFS French surveys carried out since 1988 have confirmed that in Division VIId, red gurnards mainly occur in the central area (Carpentier and Coppin, 2000). This species is considered common in autumn as it was present in around 50% of the hauls. It is not found in bays and estuaries (Dauvin, 1988) and also when salinity is below 34°/00. Adults are found mainly in the south of Division VIId, off Normandy (Delcour, 1996; Carpentier *et al.*, 1997 and 2000). This species is usually fished on gravel or coarse sand.

On the other hand, results of French IBTS surveys in North Sea have shown that this species is scarce, with a few fish caught on rocky grounds offshore Scotland (Verin & Dufour, 1999).

Théret (1983) has suggested a spawning area in Division VIIe, between Ouessant Island and the Isle of Wight.

Observations on maturity stages showed that maturity started in December and spawning season could start at the end of February and end in June. Quéro (1984) and Hureau (1986) indicated that summer should be the spawning season. Studying all species of gurnards in the Bay of Douarnenez (west of Britany), Baron (1985) indicated that the spawning season is long (6 month) and set a mean birthday at the 1st of March for red gurnard by analogy with grey gurnard but with a poor sample of red gurnards. The same author has provided some data on the size at first maturity (L50 = 27 cm for males and 28,4 cm for females). The mean size at first maturity could be set at 25 cm in a range of 26-29cm at 3 years old (Forest, 2001).

There have been no studies of migration by tagging.

## 1.2 Stock identity and possible assessment areas

In the English Channel, a stock structure within Divisions VIId and VIIe has not been established and Dunn (1996) recommended not to aggregate biological parameters from the two divisions.

Data available are not sufficient to state about stock identity for red gurnard from the southern North Sea and fish from English Channel and Celtic Sea, though data from IVc and VIId,e were aggregated because fish are present all through the year in these divisions (Forest, 2001).

## 1.3 Management regulations

At the time of the WG, there are no technical measures specifically dedicated to red gurnard or other gurnard species. The exploitation of red gurnard is submitted to the general regulation in the areas where they are caught. There is no MLS.

## 1.4 Fisheries data

### 1.4.1 Historical landings

Available EUROSTAT/ICES statistics have shown that species of gurnards are not always discriminated and data for Triglidae also occurred.

For UK (E+W) and Spain, landings reported by ICES Divisions are mainly available for all species of gurnards combined and not usable specifically for red gurnard.

Figure 1.1 and Table 1-1 show the landings by country and area specific to red gurnard. The series starts in 1985 and shows a lack of French data in 1999. In Division VIIa, landings have fluctuated at less than 100 t. France seemed the main contributor to international landings except in area VIII, but Spanish data were not available. The bulk of landings seemed to come from Divisions VIId,e at around 4 000 t. Landings in VIIf-k levelled at around 500 t. In VIII, landings fluctuated around 200 t since the beginning of 1990s. France is the main contributor to international landings in all areas described except in VIIa. In recent years, the official landings from the main areas where red gurnard is harvested (VIId to k) have shown a continuous decreasing trend from 2003-2004 to levels recorded in years before, that means a decrease of around 50%.

Based on the French database available from the fish markets network, the main species of gurnards landed in France are red gurnard and tub gurnard. The series 1999-2008 shown in Figure 1.2: Seasonal landings of gurnards in France from fishmarkets network. has been revised and updated. The drop observed previously in 2003 in the dataset used at WGNEW 2007 was due to data recorded in duplicate in the database during the period 1999-2002. The seasonal pattern is quite regular from year to year either for red gurnard and for tub gurnard. The average landings of red gurnard over the series is around 4 900 t. Two higher values are observed in 2002 and 2005 and then the landings of red gurnard tend to decrease to less than 4 000 t in 2008.

*The Working Group decided not to use the Official statistics available at ICES. The series by country to be used by the Working Group should be aggregated and checked during the inter session by the co-ordinator for this species.*

A series 1988-2008 based on logbooks is also available for France in Divisions IVc, VIId, VIIe and VIIf-k and Sub-area VIII using a data series published in Forest (2001) and recent data from 1999 (Table 1-2, Figure 1.3). The series 1999-2008 has been updated in 2010. The main area where red gurnard is caught is VIId+VIIe+VIIf-k. Datasets are rather consistent to those given by EUROSTAT/ICES database except a larger discrepancy in VIIe in 2008 not explained yet, but which seems unrealistic. Detailed data from the Celtic Sea have shown that landings are mainly provided by Division VIIh. The contribution of Division IVc has been generally marginal. In Division VIId, landings have fluctuated around 1,200 t in the period 1989-96, declined to 665 t in 2000, and remained below 1,000 t since then. Over the time series, there is in VIIe a general trend of increase with fluctuations except the odd drop in 2008. In VIIf-k, the landings have also increased since 2000 and have generally fluctuated around 700 t since then. In Sub-area VIII the production has become marginal in the period between 1999-2004 and then increased to levels observed in the years before.

In the main area where red gurnard is harvested (IVc+VIId-k), the landings have remained well above 4 000 t since 2001 and decreased in 2008.

### 1.4.2 Discards

In France, several metiers contribute to discarding in the western Channel (Morizur *et al.*, 1996).

- Gillnet with small meshes set in inshore waters and targeting crayfish, monkfish, sole and hake,
- Gillnet with large meshes targeting crabs have shown discarding of small amounts of red gurnard in winter,
- Red gurnard from coastal otter trawlers is more discarded in the western part of the area than in the eastern part where gurnards are used for baiting crabs pots,
- Offshore otter trawlers have been discarding around 50% of red gurnard catches when they fished in the north of VIIe, on the Smalls grounds and Bristol Channel (VIIf,g).

Figure 1.6 and Figure 1.7 summarized the observations of catches at sea from French bottom trawlers carried out under DCF in 2005 and 2006. Except in VIId&e, red gurnards are almost all discarded. One can note that in VIIe 2006, only one haul has been sampled and the discarded part of the catch has probably not been measured. French data of gurnards for the EU Data Collection Framework have been recorded but the tools to extract and exploit them are still in development. Then length compositions of catches observed are not available yet for 2007-2009.

### 1.4.3 Catch and effort data by sea area and country

Because in other countries species of gurnards are not always distinguished by species and their contribution to international landings is very small, only French datasets are presented.

The most important French fishery is in the Eastern Channel where the market is well established for gurnards. The main metier is offshore otter trawl (single trawl) and target species are gadoids, mackerel, plaice and gurnards. In the 1990s, this metier landed around 80% of international landings of red gurnard from Division VIIe. Boulogne sur mer, Port en Bessin and Cherbourg still are the main fish markets (Forest, 2001). In recent years, following the decrease of the quotas for cod and whiting and the extending area of red mullet and squid to the North Sea, the group of targeted species has changed and is now composed of red mullet, squid, lemon sole and red gurnard, species with commercial value.

In the 1990s in Division VIIe, the main metier was also offshore otter trawl targeting red gurnard, mainly landing in Port en Bessin, Cherbourg and harbours of North Britany.

Using French logbooks, in 2003, 99% of red gurnard landings were by single otter trawlers in VIId-e. In the same year, 85% of landings in VIIa,f-j were by single otter trawlers and 14% by twin trawlers. Landings from Division VIIk have always been very low.

Dunn (1996) indicated that catches of gurnards (mixed species) in Division VIIe mainly came from otter trawlers and partially by beam trawlers in UK (E+W). In VIId, gurnards were harvested by otter trawlers. A part of the production was directly sold to potters for baiting and might be not recorded. It was also mentioned that red gurnard was poorly represented.

Quarterly LPUEs in kg/h from French trawlers and CPUEs from French surveys by ICES rectangle have provided seasonal distribution and abundance indices for red gurnard (Anon, 1993). Mean seasonal variations over the series 1988-92 showed that red gurnard is abundant in spring in the English Channel but, in summer and autumn, fish seemed to migrate outside or became inaccessible for the fleet. The results are shown in Figure 1.5.

Information from other countries was not available at the time of the Working Group meeting.

Series available:

The series proposed in WGNEW 2007 has been fully revised following the putting into service of the new French database Harmonie. Series 1999-2009 of LPUEs and total effort dedicated to gurnards by otter trawlers (OTB+OTT) are shown in Figure 1.6 and Table 1-3. Odd values are observed in 1999 and 2009 reflecting problems of quality in the datasets of these years. Then the observed window is reduced to the period 2000-2008.

A decreasing trend of effort is shown in the periode 2003-2008 in VIIde. A similar trend has begun before, in 2002 in area VIIfgh in line with several decommissioning plans carried out in order to reduce the effort of Gadoids trawlers to manage the reduced quotas of cod set. On the opposite, effort in VIIIab has generally increased in that period. Over the period 2000-2008, the LPUEs have fluctuated without trend in each of the areas selected.

Others series of French effort and LPUEs data using landings and effort by ICES rectangle over the period 1999-2008 have been constructed by metier in Western Approaches (VIIe-k) and Bay of Biscay (area VIII). Effort considered is the fishing effort by metier and area. Trends of LPUEs and effort are shown in Table 1-4 and Figure 1.7. The main metiers contributing to red gurnard landings are the Gadoid trawlers in Western Approaches which target mainly haddock, whiting and cod and the Benthic trawlers in the same area which target mainly monkfish, megrim and rays. The fluctuations without trend of LPUEs of Gadoids trawlers in Western Approaches are rather similar to those observed in the series mentioned above. LPUE of Benthic trawlers in the same area increased to 2004 and since then levelled with fluctuations. LPUEs of the other metiers described are very small. In Western Approaches, effort of Gadoids and *Nephrops* trawlers in Western Approach has shown an almost continuous declining over the period in line with the adjustment to the effort regulation and restrictive quotas of cod set in this area. In the same area, effort of benthic trawlers has fluctuated without trend. In Bay of Biscay, the effort of gadoid trawlers has increased since 2003, probably indicating a shift of effort from Western Approach to Bay of Biscay.Effort of *Nephrops* and benthic trawlers have fluctuated at lower levels.

A series 1999-2008 of LPUEs and effort of French otter trawler (OTB) in VIId is shown in Figure 1.8 and Table 1-5. Up to 2004 the LPUEs have fluctuated between 3 and 4 kg/hour and since then they have tended to increase as the fishing effort has decreased.

Over all the series presented, only LPUEs in VIId could indicate a trend of abundance increasing in recent years in that area. The other series have only shown small fluctuations without trend.

### 1.4.4 Survey data, recruit series

Multi-annual surveys have been carried out by several countries and could provide some series of abundance index. The UK Western Channel Grounfish Surveys (UK-WCGFS) are operated in VIIe-h and in the north of VIIIa during 1st quarter. International Bottom Trawl Surveys (IBTS) cover the North Sea also in 1st quarter. French Channel Groundfish Surveys (FR-CGFS) cover Division VIId and French "Evaluation Halieutique à l'Ouest de l'Europe" (FR-EVHOE) survey cover the Bay of Biscay and the Celtic Sea out to 11°W respectively during the 4th quarter. None of them is especially designed to target gurnards, but data available could provide long series of abundance indices and at least total or stratified by area length distributions. Series from the UK-WGCFS discontinued in 2005 are not available yet.

Table 1-6 and Table 1-7 show the series of abundance index of red gurnard from IBTS database and results of the CGFS survey. Figure 1.9 and Figure 1.10 shows their trends and their 95% confidence interval.

The IBTS index produces very small values of index and the small trend to increase in the last decade as some higher values in 1986 and 1991 are rather uncertain.

The CGFS index in VIId has fluctuated in the range of the confidence interval indicating no significant trend. However some higher values have been observed in 2006 and 2008.

The FR-EVHOE index in number or in weight by 30 mn as well show a higher abundance in Celtic Sea than in Bay of Biscay. In Celtic Sea, the index have increased sharply (x2) in 2001 and have fluctuated at this high level since then. In the Bay of Biscay, the index has fluctuated in a wider range but at low levels. The peak observed in 2008 is uncertain.

The distribution of red gurnard in the Eastern Channel during the FR-CGFS survey in October between 1988 to 2006 is shown in Stock Annex and indicates that higher abundance occurred in the central area along a Southwest- Northeast axis between Cotentin (FR) and Kent (UK).

The distribution of red gurnard in the Celtic Sea and the Bay of Biscay during FR-EVHOE from 1997 to 2009 is shown in Stock Annex. Clearly the greater abundance is located offshore Brittany in the South of Division VIIh and in the North of Division VIIIa quite in a geographical continuity with Division VIIe where the bulk of landings are harvested by the fishery.

The abundance index at length of red gurnard from the CGFS and EVHOE surveys are shown in Figure 1.12 and Figure 1.13 respectively. In CGFS dataset, there is no variability of mean lengths in the length distributions in which we can notice the quasi absence of 0 group (under 15 cm) in the catches, 1989 and 2002 excepted. For some years, bimodal distributions from the EVHOE survey series show clearly the abundance 0 group. Relatively abundant in the period 2001-2005, they are poorly represented in recent years.

Age reading of red gurnards caught during EVHOE survey has been carried out in 2006 and routinely since 2008. Therefore abundance index at age are available in 2006, 2008 and 2009. They are shown in

Figure 1.14 and indicate that the populations caught are mainly composed of individuals of age 1 and 2.

## 1.5 Biological sampling

There was a lack of regular sampling data for red gurnard both in commercial landings and discarding to provide series of length or age compositions usable for a preliminary analytical assessment.

Since 2003, under DCF sampling program at sea, length data have been collected, in a sporadic way during the first years by observers at sea but more intensively since 2009 when the concurrent sampling was planned. The French sampling program by observation at sea under DCF should provide with length compositions of catches by metiers of the fishery when the tools to extract and exploit them will be developed (COST tools to adapt).

In surveys series, length data were available and age compositions are now available since 2008 at least for the FR-EVHOE survey which is partly funded by DCF but this survey is carried out outside the area where the bulk of landings is harvested. The abundance index per age from this survey where obtained by sampling 223 and 222 otoliths sampled during EVHOE 2008 and 2009 respectively.

Without DCF funding, it is not reasonable to get more biological data from the FR-CGFS or to envisage an extent of the survey in Division VIIe.

At the time of this WG, there is no more length compositions of landings than those shown at WGNEW 2007

## 1.6 Biological parameters and other research

There is no updating of growth parameters presented at WGNEW 2007 and available parameters from several authors are summarized in Table 1-8. They vary considerably. Maximum length are lower for males.

Available length-weight relationships are shown in Table 1-9. There is no updating.

A maturity ogive is not available except an assumed knife-edge at age 3. Biological parmeters collected during EVHOE survey since 2008 could provide a first estimate in Celtic Sea.

Natural mortality has not been estimated in the areas studied at this Working Group.

A total of 696 otoliths from EVHOE (the Bay of Biscay and the Celtic Sea) and IBTS (the North Sea) surveys were interpreted. A summary of aged otoliths is shown below:

| Surveys | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| EVHOE | 236 | | 222 | 222 |
| IBTS | | 16 | | |

Average sizes (cm) at the ages by sex (F: female; I: unspecified and M: male) from EVHOE 2006, 2008 and 2009 (the Bay of Biscay and the Celtic Sea):

| Age | F | I | M |
|---|---|---|---|
| 0 | 15,50 | 11,44 | |
| 1 | 19,05 | 16,70 | 18,86 |
| 2 | 24,24 | 18,75 | 22,98 |
| 3 | 29,46 | | 25,69 |
| 4 | 31,86 | | 28,36 |
| 5 | 34,08 | | 33,20 |

The cumulated age length key from 4th quarter FR-EVHOE survey 2006, 2008 and 2009 (the Bay of Biscay and the Celtic Sea) is shown in Table 1-10: Cumulated age-length Key of red gurnard from the FR-EVHOE survey 2006, 2008 and 2009..

## 1.7 Analyses of stock trends.

In recent years, the official landings recorded from the main areas where red gurnard is harvested (VIId to k) have shown a continuous decreasing trend from 2003-2004 (~2800t) to levels recorded in years before (table 6.1) at around 1350 t in 2008.

From only the French database and in the same area the landings have remained well above 4000 t since 2001 and could decrease in 2008 to 3200 t (Table 1-2).

These datasets show once again the discrepancy between them and that they are not adequate to get some signal from landings.

From length abundance indices of the FR-CGFS surveys, the indices in VIId have fluctuated at higher values up to 1997. After the lowest value observed in 1998, indices have shown a slight increasing trend with fluctuations but confidence intervals are wide. Indices also show that 0 group (under 15 cm) are generally very scarce in the samples.

In Celtic Sea and Bay of Biscay, length abundance indices from FR-EVHOE surveys have remained at lower values up to 2000 and then they have peaked in 2004. Indices of recruitment (age 0 set under 15 cm) have been also lower in 2008 and 2009. The better year classes shown in 2001, 2002 and 2004 are probably now almost fished out. The available abundance indices at age from this survey in 2006, 2008 and 2009 have shown rather the same structure from year to year and therefore without signal of any stronger year class.

## 1.8 Data requirements

High discrepancies found in the datasets available between the official landings data and other databases show that data from commercial exploitation of red gurnard are not of sufficient quality to provide an adequate signal on red gurnard exploitation.

Regular sampling of red gurnard catches must be carried out by observations at sea under DCF at least to estimate by metier and area weight and length compositions of retained and discarded catches but the priority given to this species should be discussed taking into account its lower economical importance compared to those of other valuable species harvested in the same areas.

Anyway, the concurrent sampling design carried out since 2009 should provide more data than in recent years.

The FR-EVHOE survey funded by DCF would continue to provide with a series of abundance indices at age.

The FR-CGFS survey, not funded by DCF also provides abundance indices at length. Extending the studied area to VIIe and collecting otoliths could be promising.

There are uncertainties in landings data for several countries and red gurnard has been landed mixed with other species of gurnards in UK (E+W) and Spain. Discarding data in recent years have shown that except in VIId,e most of the catch is discarded.

There is a lack of updated biological parameters.

Last year, a pragmatic approach led to propose a management area for Divisions IVc, VIId-h. The preliminary analysis of the survey data available this year which has shown opposite trends in recent years could lead to disconnect the Eastern Channel (VIId) and the Celtic sea (7f-h) populations but the data 1998-2000 have shown a lower level of population in both areas. In Division VIIe, there are no survey data available yet to provide a trend of the population in the area where the bulk of landings have been harvested.

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**Table 1-1: Nominal landings from EUROSTAT/ICES databases.**

North Sea (ICES region: 4)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 35 | 0 | 74 | 61 | 107 | 59 | 19 | 11 | 19 | 19 | 15 | 17 | 10 | 11 | 10 | 16 | 26 | 31 | 41 | 83 | 29 | 13 | 7 | 13 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 21 | 2 | 2 | 2 | 3 | 15 | 10 | 8 | 0 | 27 | 40 | 68 | 48 | 0 | 60 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 50 | 40 | 77 | 68 | 111 | 136 | 65 | 58 | 81 | 75 | 71 | 75 | 48 | 70 | : | 54 | 111 | 43 | 39 | 27 | 26 | 13 | 19 | 15 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 45 | 166 | 53 | 43 | 52 | 51 | 63 | 44 | 36 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 7 | 24 | 25 | 30 | 28 | 32 | 42 | 23 | 6 | 0 | 0 | 4 | 150 | 217 | 253 | 221 | 95 | 76 | 107 | 84 |

Irish Sea (ICES region: 7a)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 32 | 0 | 20 | 13 | 9 | 12 | 5 | 12 | 15 | 16 | 15 | 26 | 21 | 21 | 38 | 33 | 26 | 23 | 24 | 8 | 5 | 10 | 7 | 5 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 49 | 36 | 30 | 15 | 13 | 14 | 50 | 23 | 10 | 8 | 4 | 5 | 5 | 2 | : | 6 | 15 | 12 | 2 | 0 | 2 | 0 | 0 | 0 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 2 | 2 | 4 | 3 | 2 | 2 | 3 | 2 | 2 | 0 | 0 | 0 | 3 | 5 | 12 | 11 | 0 | 0 | : | : |

Eastern Channel (ICES region:7d)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 56 | 0 | 61 | 75 | 88 | 70 | 71 | 93 | 64 | 68 | 65 | 80 | 67 | 85 | 95 | 94 | 106 | 104 | 161 | 131 | 68 | 155 | 187 | 218 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 1384 | 1226 | 977 | 1171 | 1214 | 1574 | 1292 | 1376 | 1143 | 1132 | 1239 | 1424 | 1178 | 1000 | : | 800 | 1119 | 1183 | 1043 | 1005 | 1039 | 898 | 971 | 894 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 11 | 2 | 6 | 14 | 16 | 17 | 37 | 64 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 32 | 55 |

Western Channel (ICES region:7e)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 27 | 0 | 14 | 27 | 22 | 8 | 3 | 11 | 4 | 5 | 7 | 5 | 7 | 10 | 0 | 1 | 5 | 7 | 23 | 46 | 24 | 73 | 62 | 60 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 1122 | 2290 | 2237 | 1990 | 1642 | 1199 | 2112 | 2106 | 2194 | 2189 | 2199 | 2269 | 2614 | 2303 | : | 2499 | 2575 | 2968 | 2728 | 2436 | 2951 | 2714 | 2603 | 2382 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 3 | 0 |

Celtic Sea (ICES region:7f-k

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 29 | 0 | 31 | 21 | 21 | 18 | 11 | 13 | 9 | 9 | 13 | 14 | 17 | 19 | 11 | 9 | 12 | 15 | 26 | 47 | 16 | 26 | 33 | 36 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | 8 | 12 | 19 | 3 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 406 | 506 | 454 | 488 | 413 | 363 | 420 | 390 | 364 | 413 | 451 | 476 | 482 | 549 | : | 651 | 719 | 640 | 685 | 916 | 840 | 670 | 670 | 633 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 20 | 7 | 15 | 2 | 0 | : | 0 | 1 |

Bay of Biscay (ICES region:8)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 2 | 1 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 211 | 241 | 332 | 274 | 236 | 206 | 189 | 190 | 153 | 224 | 165 | 174 | 176 | 191 | : | 143 | 141 | 152 | 166 | 169 | 202 | 218 | 202 | 92 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | 0 |
| United Kingdom | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 3 | : | : | : |

* Only from logbooks in series 1999-2008

| Year | IVc | VIId | VIIe | VIIf-k | VIII |
|---|---|---|---|---|---|
| 1988 | 57 | 720 | 1848 | 480 | 206 |
| 1989 | 124 | 1166 | 1615 | 423 | 193 |
| 1990 | 136 | 1394 | 1347 | 442 | 208 |
| 1991 | 70 | 1295 | 2073 | 524 | 192 |
| 1992 | 56 | 1358 | 1748 | 395 | 210 |
| 1993 | 82 | 1132 | 1690 | 363 | 159 |
| 1994 | 76 | 1122 | 1561 | 386 | 217 |
| 1995 | 71 | 1235 | 1580 | 444 | 169 |
| 1996 | 76 | 1417 | 1625 | 470 | 181 |
| 1997 | 49 | 944 | 2303 | 474 | 177 |
| 1998 | 49 | 1047 | 2284 | 506 | 162 |
| 1999 | **46** | **741** | **2429** | **325** | **58** |
| 2000 | **50** | **665** | **2391** | **626** | **82** |
| 2001 | **108** | **894** | **2505** | **696** | **66** |
| 2002 | **40** | **950** | **2907** | **605** | **79** |
| 2003 | **34** | **843** | **2728** | **669** | **72** |
| 2004 | **26** | **853** | **2517** | **915** | **87** |
| 2005 | **25** | **866** | **2861** | **690** | **163** |
| 2006 | **21** | **865** | **2748** | **647** | **185** |
| 2007 | 14 | 1009 | 2627 | 664 | 170 |
| 2008 | 36 | 966 | 1661 | 592 | 166 |

**updated in bold**

**Table 1-2: France: landings of red gurnard in t live weight.**

| | Landings kg | Red gurnard | | effort 000'h fished | | 1000 | LPUE | kg/h fished | |
|---|---|---|---|---|---|---|---|---|---|
| year | 7de | 7fgh | 8ab | 7de | 7fgh | 8ab | 7de | 7fgh | 8ab |
| 1999 | 3143378 | 315217 | 35275 | 810.553 | 230.328 | 48.834 | 3.9 | 1.4 | 0.7 |
| 2000 | 3026836 | 607484 | 54645 | 1130.318 | 941.991 | 356.194 | 2.7 | 0.6 | 0.2 |
| 2001 | 3356616 | 684815 | 49543 | 1067.780 | 994.438 | 302.113 | 3.1 | 0.7 | 0.2 |
| 2002 | 3813616 | 595813 | 39719 | 1219.589 | 846.449 | 321.536 | 3.1 | 0.7 | 0.1 |
| 2003 | 3507286 | 661274 | 49012 | 1391.980 | 893.467 | 426.490 | 2.5 | 0.7 | 0.1 |
| 2004 | 3248722 | 900132 | 63445 | 1297.526 | 865.703 | 497.762 | 2.5 | 1.0 | 0.1 |
| 2005 | 3624801 | 681381 | 112036 | 1085.057 | 778.914 | 768.129 | 3.3 | 0.9 | 0.1 |
| 2006 | 3452166 | 633692 | 117881 | 1069.908 | 672.443 | 680.123 | 3.2 | 0.9 | 0.2 |
| 2007 | 3352089 | 657775 | 100654 | 1002.862 | 623.124 | 716.833 | 3.3 | 1.1 | 0.1 |
| 2008 | 2254264 | 583834 | 103017 | 778.306 | 603.849 | 677.288 | 2.9 | 1.0 | 0.2 |
| 2009 | 1314597 | 336279 | 26941 | 213.796 | 106.379 | 59.186 | 6.1 | 3.2 | 0.5 |

1999 and 2009: datasets unreliable

**Table 1-3: Series of landings of red gurnard, effort and LPUE of French otter trawlers (OTB+OTT) from logbooks datasets.**

Red Gurnard France
Captures (t)

| Metier | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| Benthic Western Approaches | 55 | 145 | 252 | 247 | 463 | 810 | 595 | 614 | 751 | 469 |
| Gadoids Western Approaches | 2685 | 2874 | 2930 | 3222 | 2851 | 2536 | 2850 | 2667 | 2421 | 1642 |
| Nephrops Western Approaches | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| Benthic Bay of Biscay | 7 | 29 | 21 | 22 | 29 | 28 | 57 | 62 | 39 | 51 |
| "Gadoids" Bay of Biscay | 25 | 24 | 22 | 16 | 18 | 30 | 52 | 49 | 59 | 51 |
| Nephrops Bay of Biscay | 3 | 3 | 2 | 3 | 4 | 6 | 6 | 5 | 5 | 6 |
| | 2778 | 3077 | 3228 | 3511 | 3366 | 3411 | 3561 | 3397 | 3275 | 2219 |

Red Gurnard France
Fishing Effort

| Metier | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| Benthic Western Approaches | 260758 | 295235 | 289227 | 265173 | 311690 | 319664 | 277571 | 303860 | 327413 | 266640 |
| Gadoids Western Approaches | 603846 | 561385 | 549464 | 549402 | 532461 | 488775 | 455446 | 436125 | 394148 | 314761 |
| Nephrops Western Approaches | 198129 | 219402 | 195229 | 182732 | 199108 | 164514 | 168537 | 159230 | 118692 | 99788 |
| Benthic Bay of Biscay | 143053 | 137186 | 128085 | 132199 | 148483 | 166266 | 203183 | 173227 | 178323 | 170854 |
| "Gadoids" Bay of Biscay | 276271 | 211502 | 208556 | 184709 | 194668 | 215719 | 260360 | 291848 | 356308 | 305030 |
| Nephrops Bay of Biscay | 199384 | 171203 | 181568 | 182496 | 218913 | 238337 | 277343 | 277908 | 249244 | 230292 |
| Total | 1681441 | 1595913 | 1552129 | 1496711 | 1605323 | 1593275 | 1642440 | 1642198 | 1624128 | 1387365 |

Red Gurnard France
LPUE (Kg/10h)

| Metier | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| Benthic Western Approaches | 2.1 | 4.9 | 8.7 | 9.3 | 14.9 | 25.3 | 21.4 | 20.2 | 22.9 | 17.6 |
| Gadoids Western Approaches | 44.5 | 51.2 | 53.3 | 58.6 | 53.5 | 51.9 | 62.6 | 61.2 | 61.4 | 52.2 |
| Nephrops Western Approaches | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| Benthic Bay of Biscay | 0.5 | 2.1 | 1.6 | 1.7 | 2.0 | 1.7 | 2.8 | 3.6 | 2.2 | 3.0 |
| "Gadoids" Bay of Biscay | 0.9 | 1.1 | 1.1 | 0.9 | 0.9 | 1.4 | 2.0 | 1.7 | 1.7 | 1.7 |
| Nephrops Bay of Biscay | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 |

**Table 1-4: Series of landings of red gurnard, effort and LPUE by metier of French otter trawlers (OTB+OTT) from CPR datasets.**

| year | Landings kg | Effort hours | LPUE Kg/hour |
|---|---|---|---|
| 1999 | 731485 | 449924 | 1.6 |
| 2000 | 653244 | 551088 | 1.2 |
| 2001 | 869054 | 485479 | 1.8 |
| 2002 | 929381 | 560053 | 1.7 |
| 2003 | 813963 | 629978 | 1.3 |
| 2004 | 800899 | 573711 | 1.4 |
| 2005 | 827994 | 441078 | 1.9 |
| 2006 | 791125 | 440473 | 1.8 |
| 2007 | 811937 | 438125 | 1.9 |
| 2008 | 698455 | 342351 | 2.0 |

**Table 1-5: Series of landings of red gurnard, effort and LPUE of French otter trawlers (OTB) in VIId from logbooks datasets.**

| Year | IBTS Quarter 1 | CGFS |
|---|---|---|
| 1986 | 11.87 | 20.77 |
| 1987 | 1.17 | 19.24 |
| 1988 | 0.00 | 12.33 |
| 1989 | 0.37 | 11.87 |
| 1990 | 4.91 | 16.35 |
| 1993 | 0.00 | 10.12 |
| 1994 | 0.00 | 23.71 |
| 1995 | 0.00 | 12.89 |
| 1996 | 0.00 | 9.56 |
| 1997 | 0.06 | 18.01 |
| 1998 | 0.00 | 6 |
| 1999 | 0.00 | 7.09 |
| 2000 | 0.11 | 9.83 |
| 2001 | 0.12 | 7.17 |
| 2002 | 0.05 | 11.18 |
| 2003 | 0.24 | 12.92 |
| 2004 | 0.22 | 7.34 |
| 2005 | 0.10 | 10.9 |
| 2006 | 0.00 | 13.56 |
| 2007 | 0.23 | 10.26 |
| 2008 | 0.00 | 18.64 |
| 2009 | 0.24 | 17.24 |

**Table 1-6: The abundance index (N/h) of red gurnard from the IBTS database in North Sea and CGFS survey in Eastern Channel.**

| Year | Celtic Sea (VIIg, h, j) | | Bay of Biscay (VIIIa, b) | |
|---|---|---|---|---|
| | Number/30minutes | W(kg)/30minutes | Number/30minutes | W(kg)/30minutes |
| 1997 | 23.29 | 2.24 | 5.34 | 0.43 |
| 1998 | 22.32 | 2.35 | 2.79 | 0.25 |
| 1999 | 25.22 | 2.35 | 0.9 | 0.09 |
| 2000 | 19.12 | 1.65 | 1.2 | 0.11 |
| 2001 | 39.11 | 3.03 | 8.02 | 0.7 |
| 2002 | 35.75 | 2.97 | 9.79 | 0.69 |
| 2003 | 37.62 | 2.8 | 2.61 | 0.21 |
| 2004 | 43.76 | 3.66 | 7.19 | 0.58 |
| 2005 | 38.84 | 3.39 | 6.7 | 0.57 |
| 2006 | 27.89 | 2.56 | 6.82 | 0.53 |
| 2007 | 36.41 | 3.18 | 10.59 | 0.81 |
| 2008 | 33.97 | 3.39 | 14.71 | 1.42 |
| 2009 | 38.7 | 3.82 | 6.04 | 0.53 |

**Table 1-7: The average abundance( number and weight (kg) per 30 mn) of red gurnard annually from FR-EVHOE survey in the Celtic Sea (VII,g,h,j) and in the Bay of Biscay (VIIIa,b).**

| Authors | Area | Sex | Nb | $L_\infty$ | K ($y^{-1}$) | $t_0$ (years) |
|---|---|---|---|---|---|---|
| Baron (1983) | Manche + mer du Nord | M | 118 | 37,1 | 0,51 | -0,08 |
| | | F | 232 | 41,7 | 0,46 | -0,05 |
| Dunn *et al.* (1996) | VIId | M | 213 | 35.75 | 0,232 | -3,37 |
| | VIId | F | 531 | 41,05 | 0,248 | -2,57 |
| | VIIe | F | 147 | NS | 0,137 | -2,09 |
| Carpentier 1995 | VIId | M+F | 187 | 36,75 | 0,597 | 0,180 |
| Id 1996 | | | 94 | 37,97 | 0,622 | 0,149 |
| Id 1997 | | | 90 | 36,67 | 0,645 | 0,185 |
| Id 1998 | | | 107 | 36,18 | 0,613 | 0,048 |
| Id 1999 | | | 122 | 36,02 | 0,511 | -0,277 |
| Mean 1995-2000 | | | 704 | 36,34 | 0,543 | -0,17 |

**Table 1-8: Growth parameters of red gurnard in the English Channel**

| Author | Area | Month | Sex | Number | a | b |
|---|---|---|---|---|---|---|
| Théret, 1983 | English Channel | september | M | 31 | $1.13.10^{-3}$ | 3.3854 |
| | | | F | 80 | $4.50.10^{-3}$ | 3.14027 |
| | | november | M | 33 | $3.65.10^{-3}$ | 3.16261 |
| | | | F | 33 | $2.94.10^{-3}$ | 3.20117 |
| | | décember | M | 55 | $1.51.10^{-3}$ | 3.32967 |
| | | | F | 144 | $1.05.10^{-3}$ | 3.38984 |
| | | january | M | 112 | $0.98.10^{-3}$ | 3.39763 |
| | | | F | 120 | $2.19.10^{-3}$ | 3.25648 |
| | | february | M | 31 | $0.73.10^{-3}$ | 3.44558 |
| | | | F | 82 | $0.88.10^{-3}$ | 3.41197 |
| Dorel, 1986 | idem | | M + F | 593 | $5.61.10^{-3}$ | 3.16882 |

**Table 1-9: Length-weight relationships available for red gurnard in English (W = aLb, W live weight in g and L in cm).**

| Length | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 8 | 5 | | | | | | |
| 9 | 12 | | | | | | |
| 10 | 8 | | | | | | |
| 11 | 10 | | | | | | |
| 12 | 10 | | | | | | |
| 13 | 14 | 1 | | | | | |
| 14 | 10 | 5 | | | | | |
| 15 | 2 | 15 | | | | | |
| 16 | 1 | 22 | 2 | | | | |
| 17 | 1 | 28 | 2 | | | | |
| 18 | | 37 | 3 | | | | |
| 19 | | 32 | 6 | | | | |
| 20 | | 30 | 10 | | | | |
| 21 | | 22 | 18 | 2 | | | |
| 22 | | 9 | 25 | 1 | | | |
| 23 | | 5 | 25 | 5 | | | |
| 24 | | 1 | 25 | 6 | 1 | 1 | |
| 25 | | 3 | 16 | 5 | 4 | | |
| 26 | | | 9 | 14 | 5 | | |
| 27 | | | 13 | 8 | 6 | 1 | |
| 28 | | 1 | 6 | 10 | 8 | 2 | |
| 29 | | | 5 | 8 | 2 | 3 | |
| 30 | | | 1 | 5 | 6 | 1 | |
| 31 | | | 2 | 6 | 7 | 4 | |
| 32 | | | 2 | 5 | 1 | 1 | |
| 33 | | | 2 | 6 | 4 | | |
| 34 | | | | 5 | 3 | 2 | |
| 35 | | | | 3 | 2 | 2 | |
| 36 | | | | 2 | 1 | 3 | |
| 37 | | | | | 1 | 2 | |
| 38 | | | | | 3 | 2 | |
| 39 | | | | | | 1 | |
| 40 | | | | | 2 | 2 | |
| 41 | | | | 1 | 1 | 1 | |
| 42 | | | | | | 1 | 1 |
| 44 | | | | | | | 1 |
| 45 | | | | | | 1 | |

**Table 1-10: Cumulated age-length Key of red gurnard from the FR-EVHOE survey 2006, 2008 and 2009.**

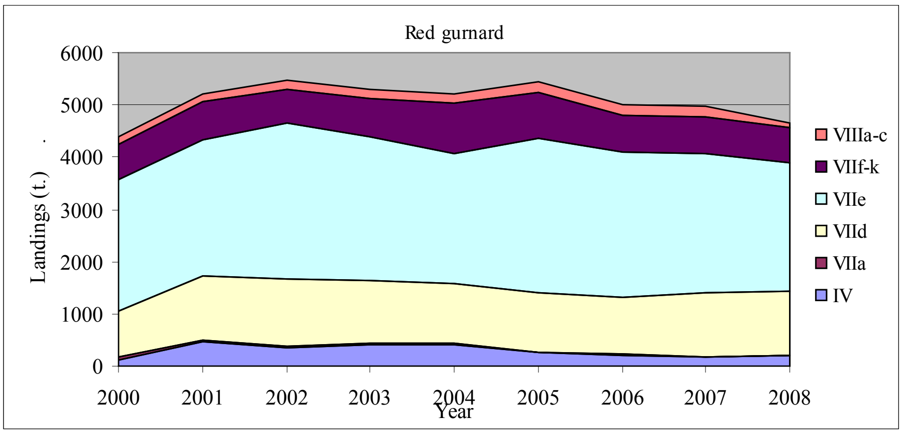



**Figure 1.1: EUROSTAT/ ICES database of red gurnard. Contribution of landings by countries and areas.**

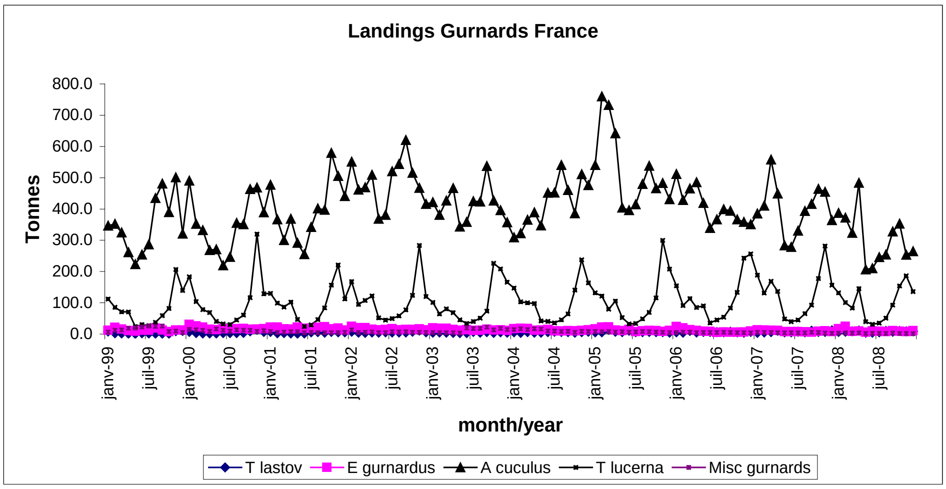



**Figure 1.2: Seasonal landings of gurnards in France from fishmarkets network.**

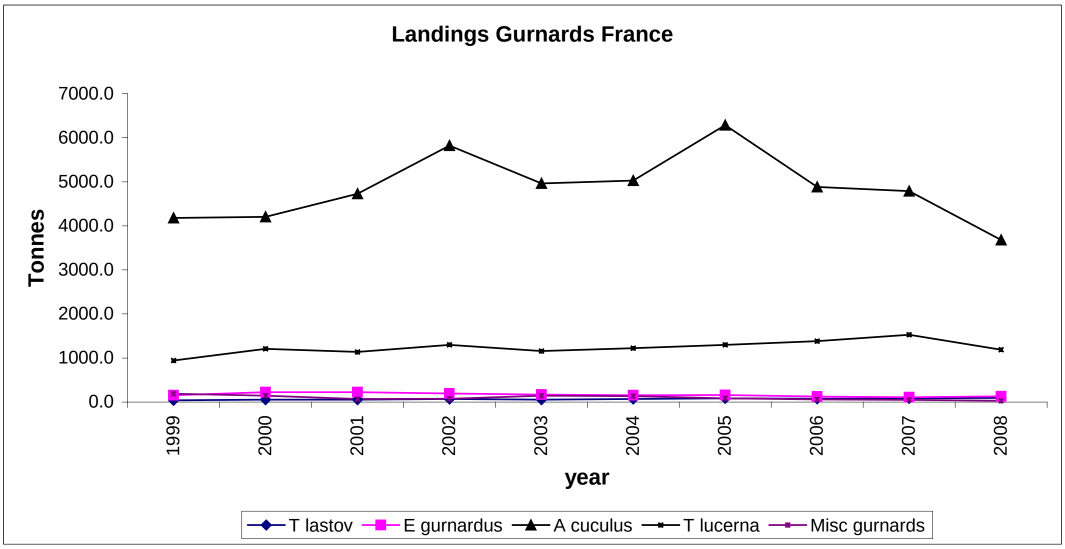



**Figure 1.3:** Annual landings of gurnards in France from fishmarkets network.

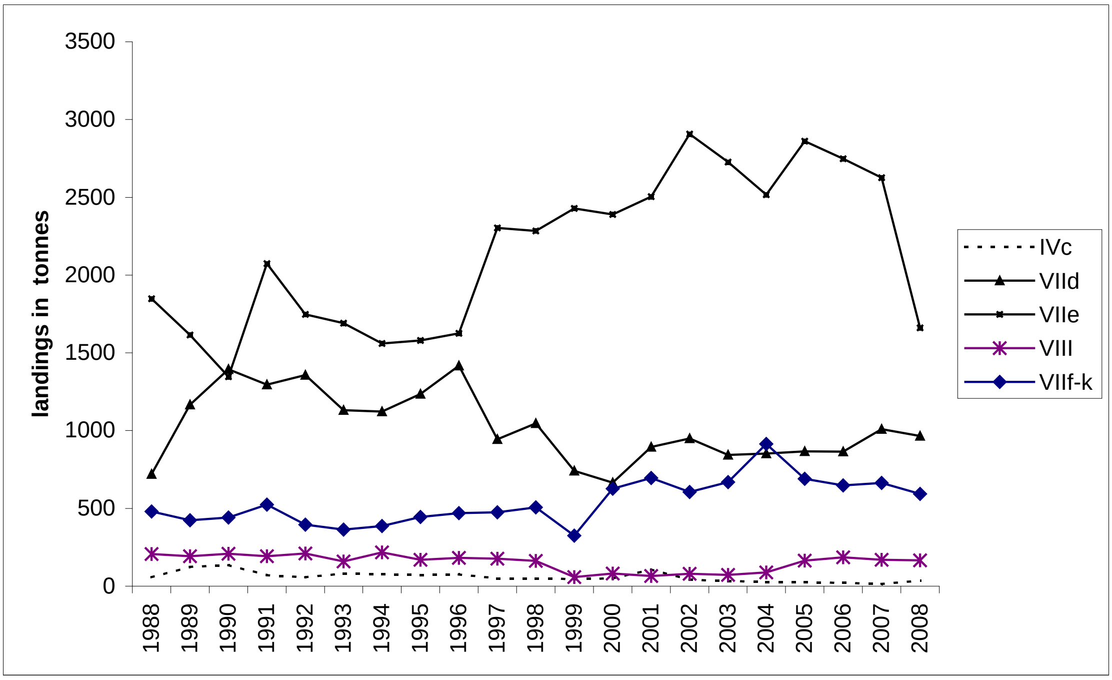



**Figure 1.4: France: Trends of French landings of red gurnard. Only from logbooks since 1999. In 2008 landings from VIIe have dropped by 35%, not observed in official landings from EUROSTAT/ICES dataset.**

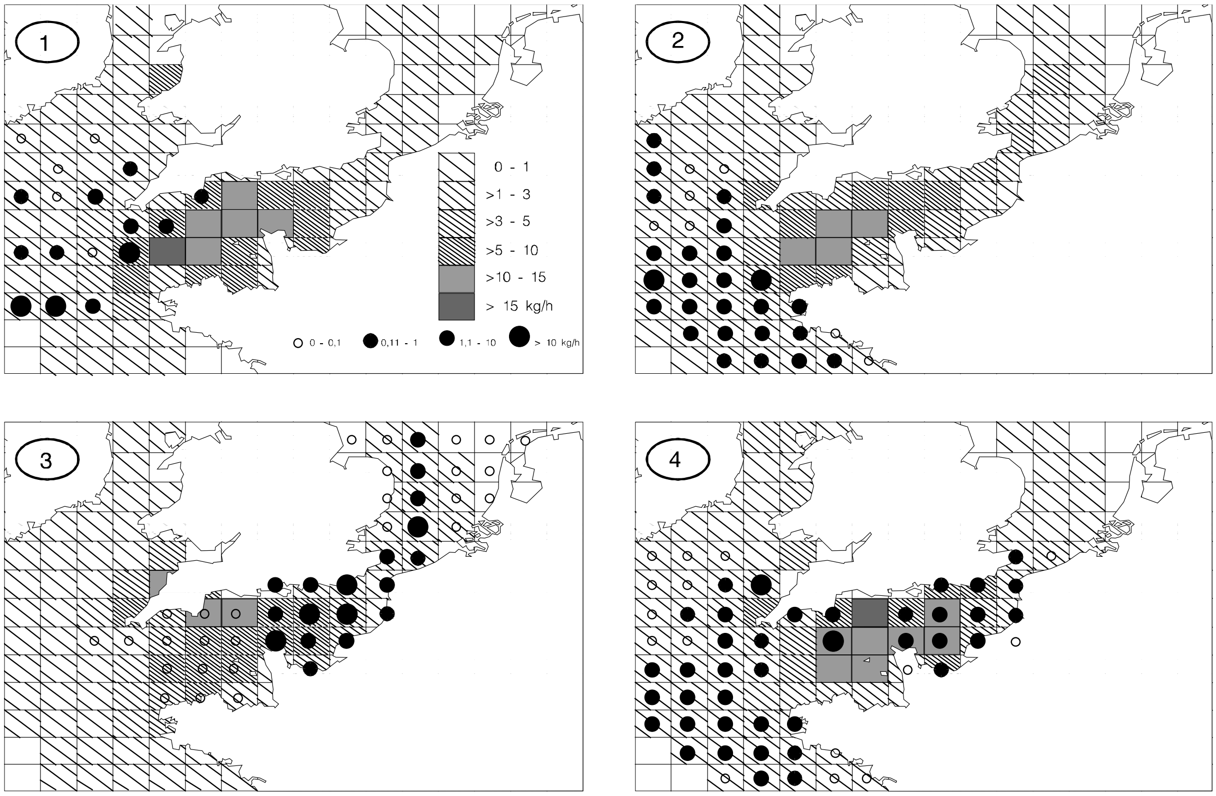



**Figure 1.5: Quarterly landings of red gurnard in English Channel and neighbouring areas in the period 1988-1992. CPUE in Kg/h from surveys are given as superimposed circles.**

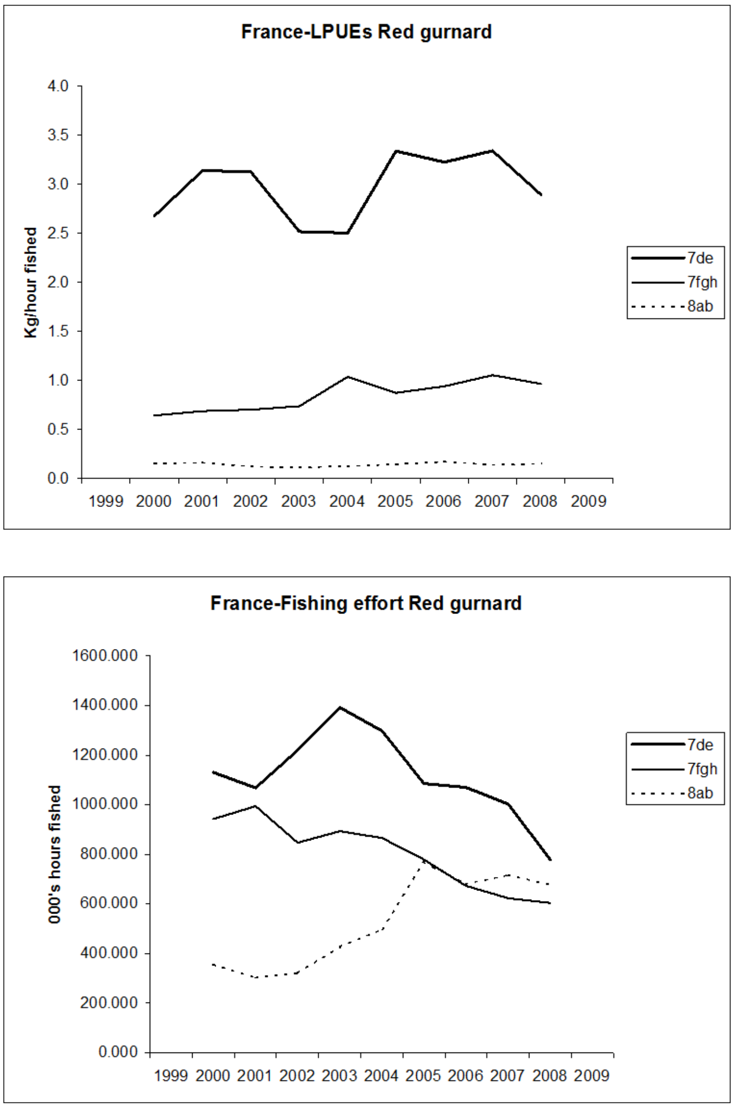
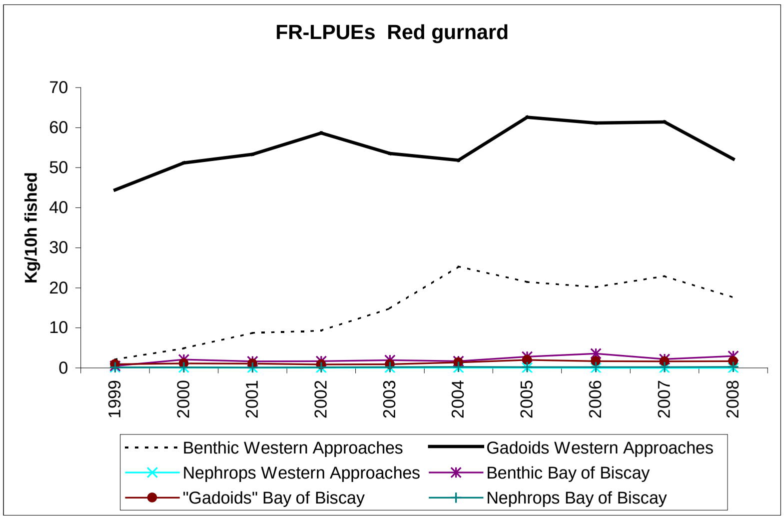



**Figure 1.6:** Trends of LPUEs and French effort OTB+OTT and in VIIde, VIIfgh and VIIIab. Unreliable data 1999 and 2009 in red.



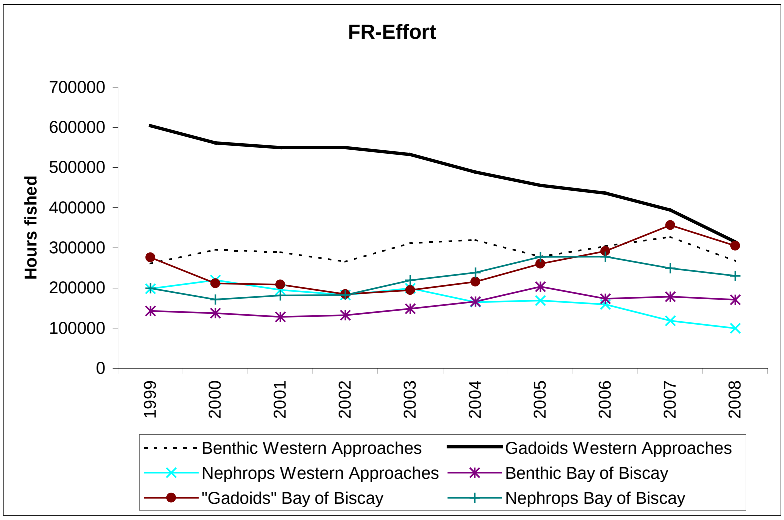




**Figure 1.7: Red Gurnard. Trends of LPUE (kg/h) and fishing effort (hours fished) of French otter trawlers (OTB+OTT) in areas VIIe-k (Western Approaches) and VIII (Bay** of Biscay).

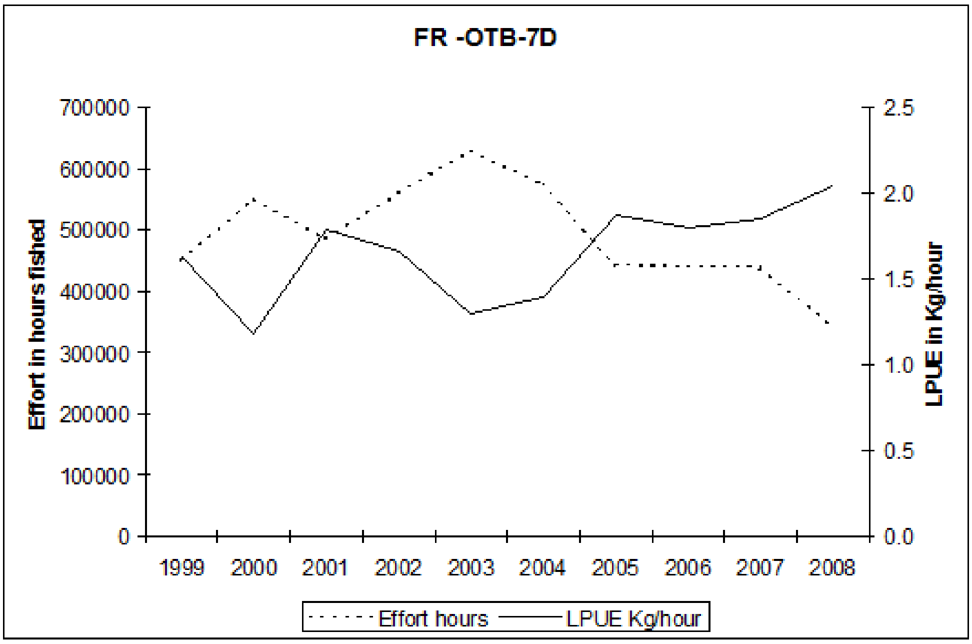



**Figure 1.8: France. Trends of LPUE and effort in VIId of otter trawlers (OTB) for years 1999-2008**

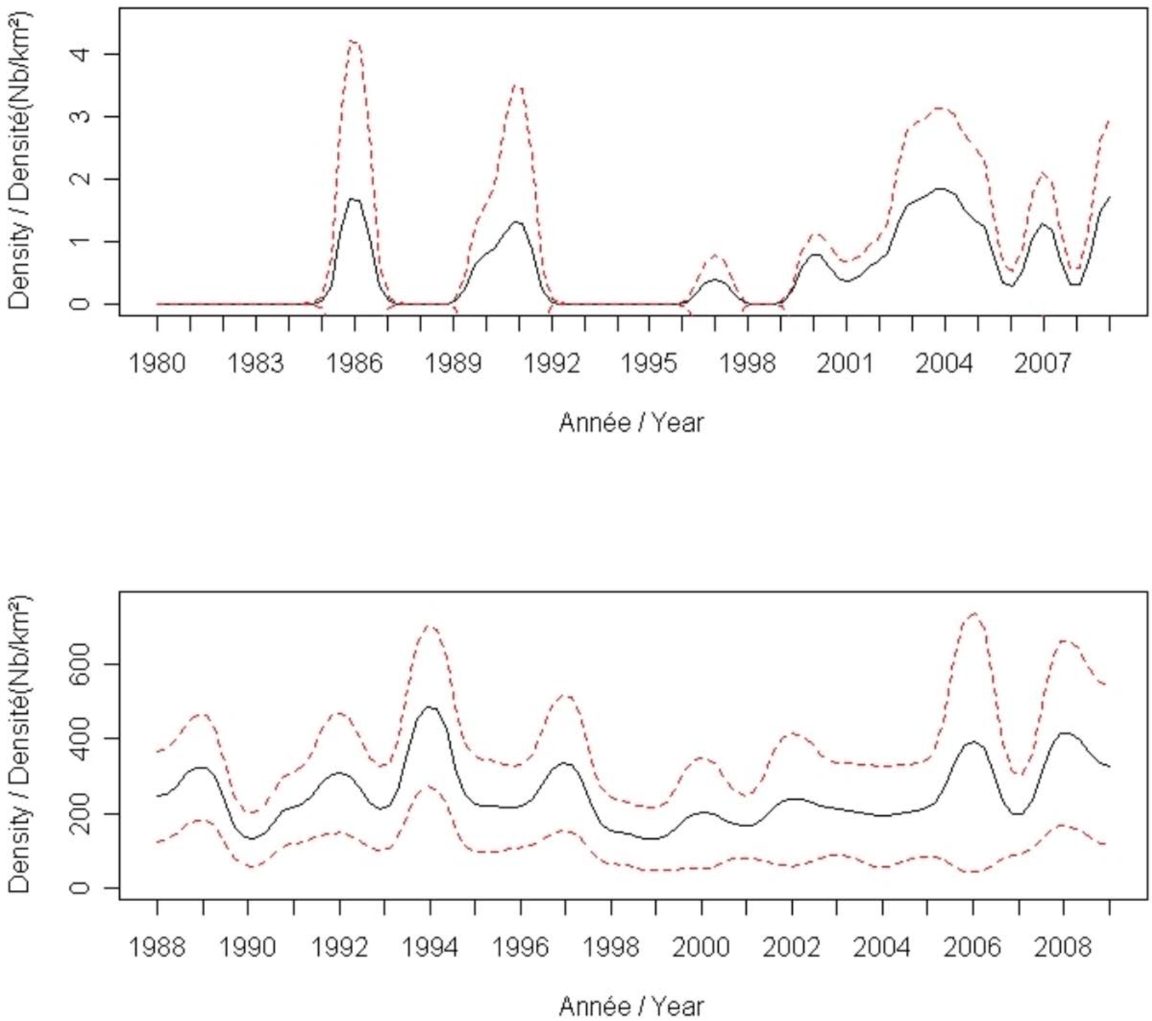



**Figure 1.9: Time series of abundance of red gurnard in the North Sea base on IBTS data (Nb/km²) from 1980 to 2009 in upper panel and in the eastern Channel base on FR-CGFS data (Nb/km²) from 1988 to 2009 in the lower panel.**

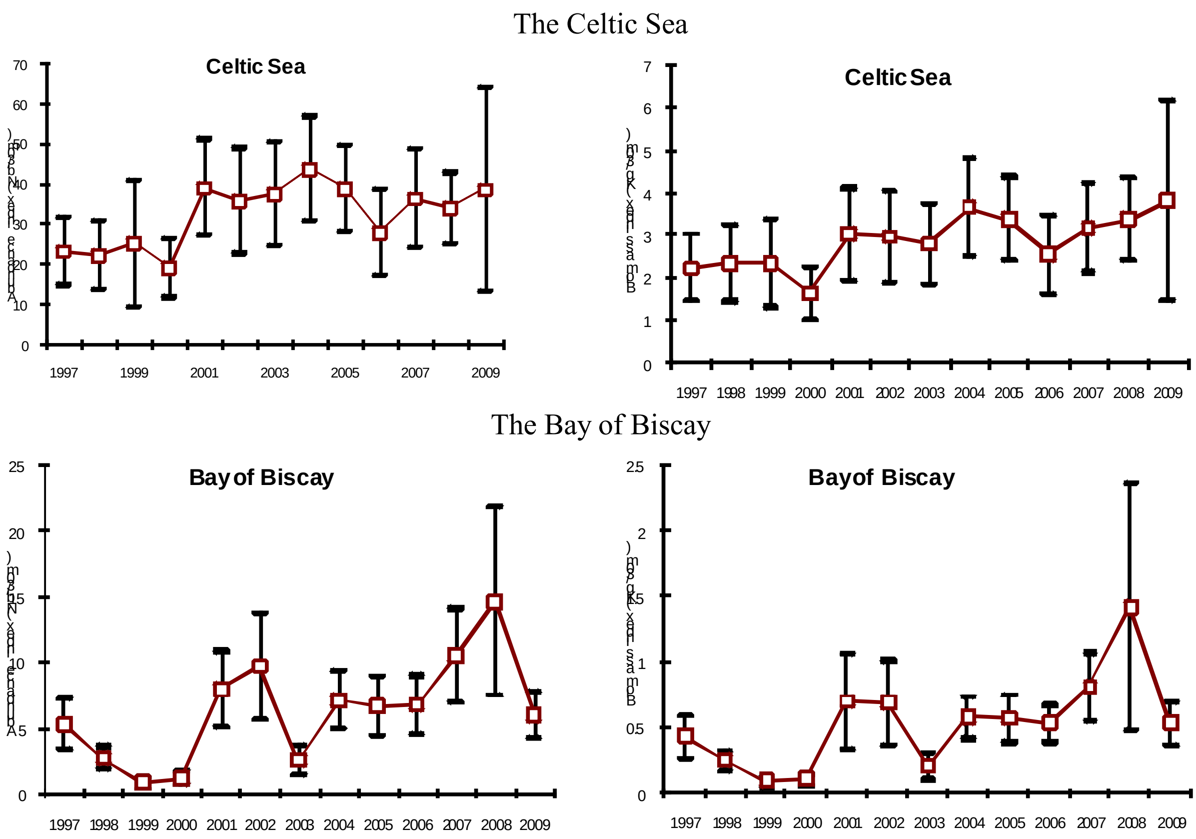



**Figure 1.10: Time series of abundance (Nb and Weight (kg)/30 min Trawl) of red gurnard in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009.**

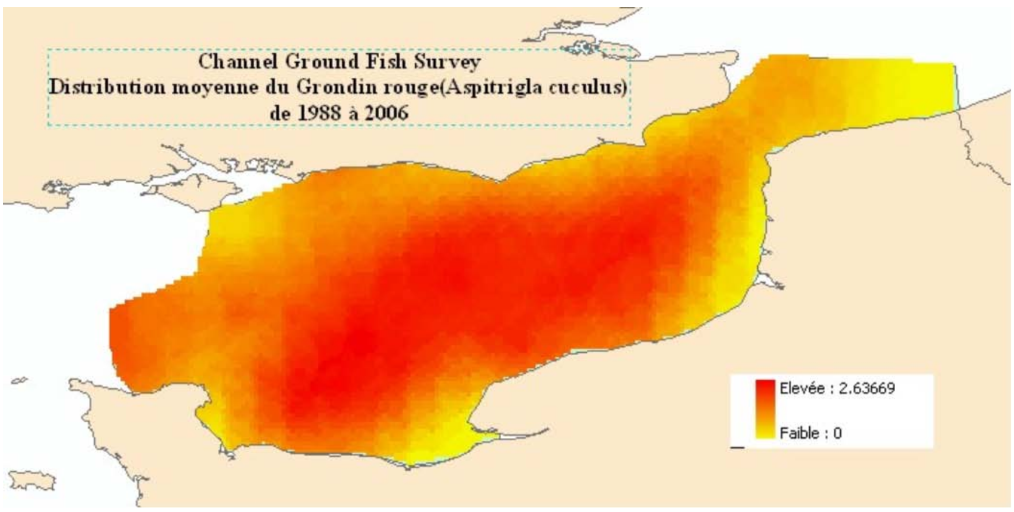



**Figure 1.11: FR-CGFS surveys series. Geographical distribution of red gurnard in Eastern Channel in October from 1988 to 2006**

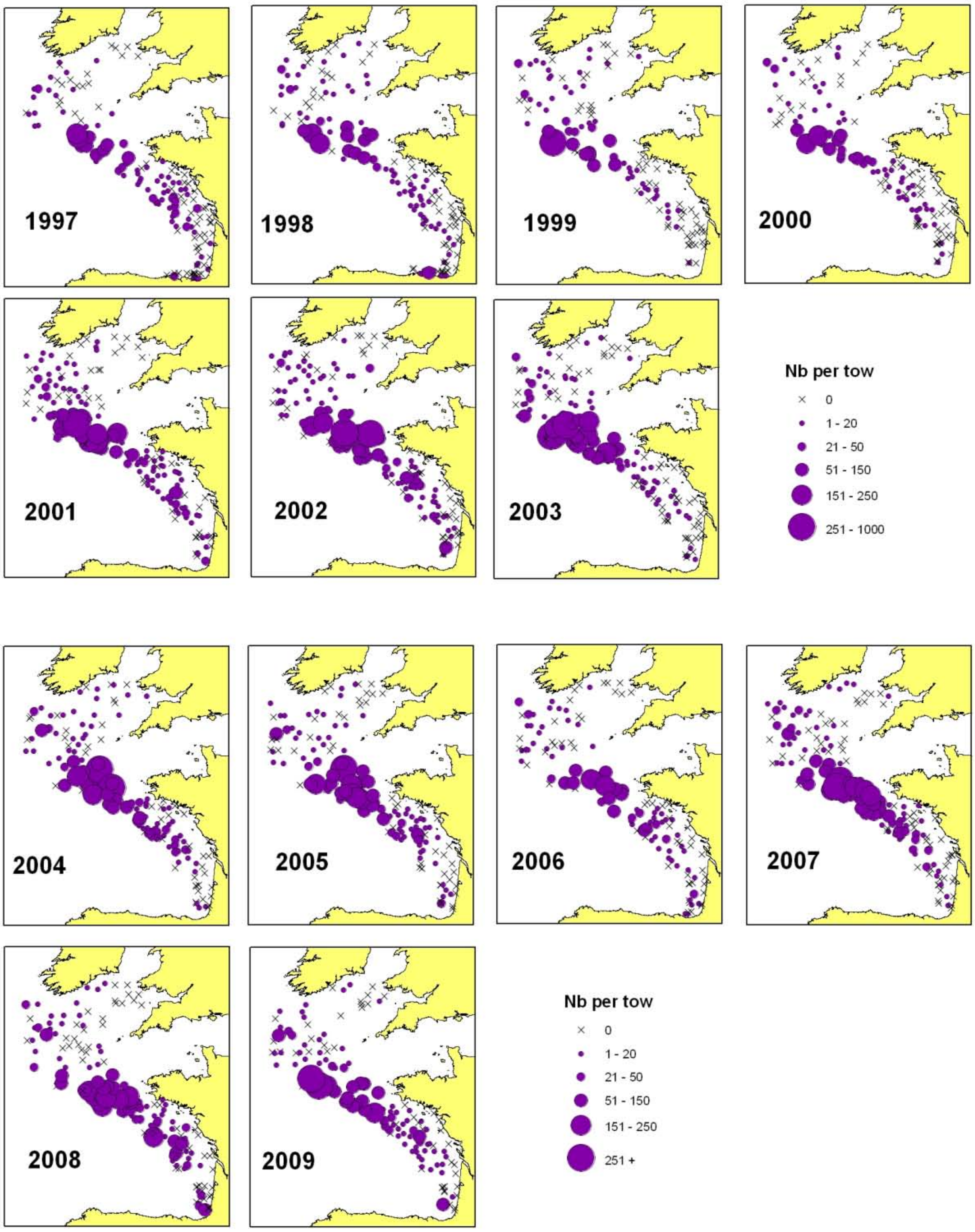



**Figure 1.12: Distribution of red gurnard in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009.**

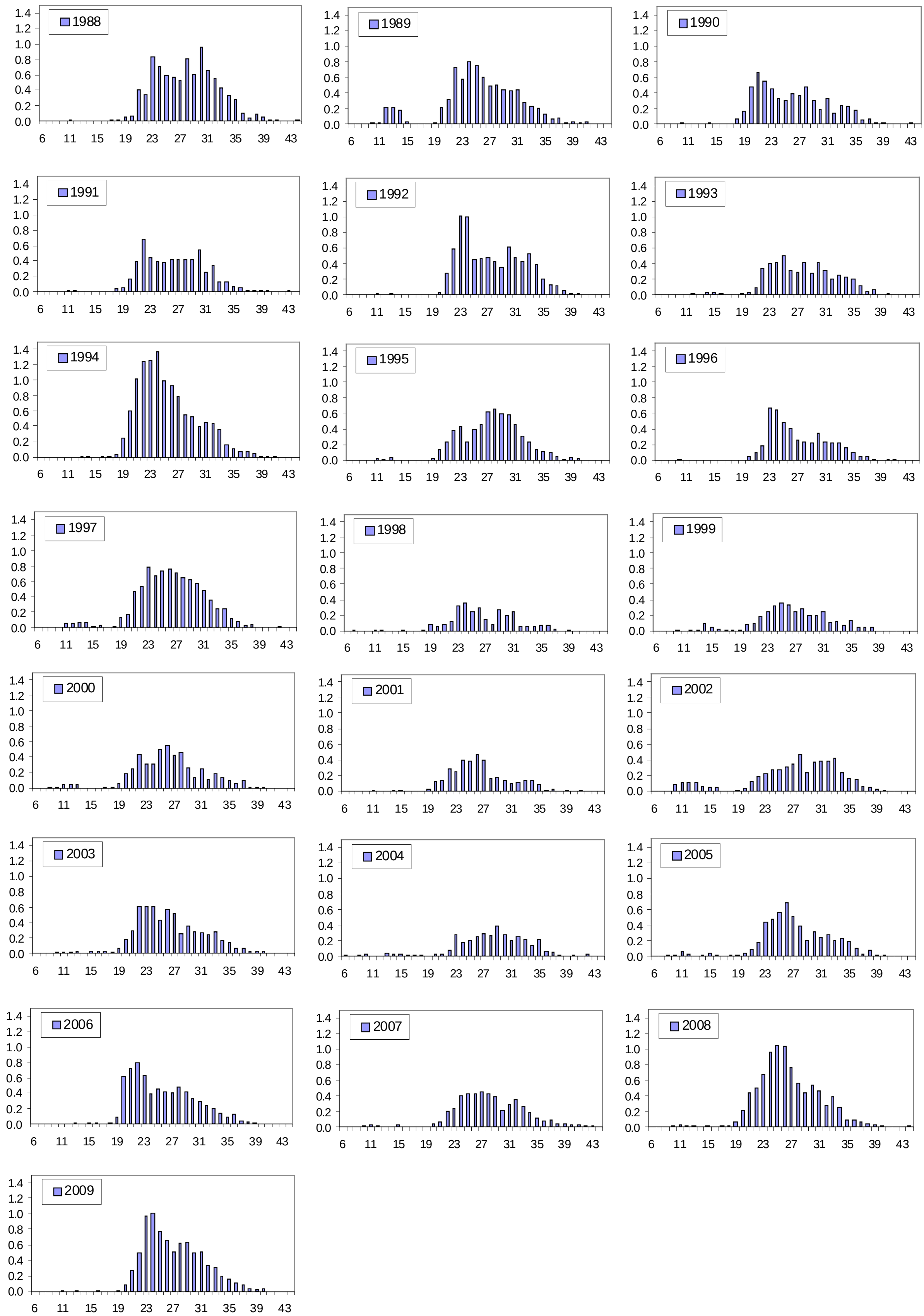



**Figure 1.13: Abundance index at length of red gurnard in Eastern Channel from FR-CGFS surveys series.**

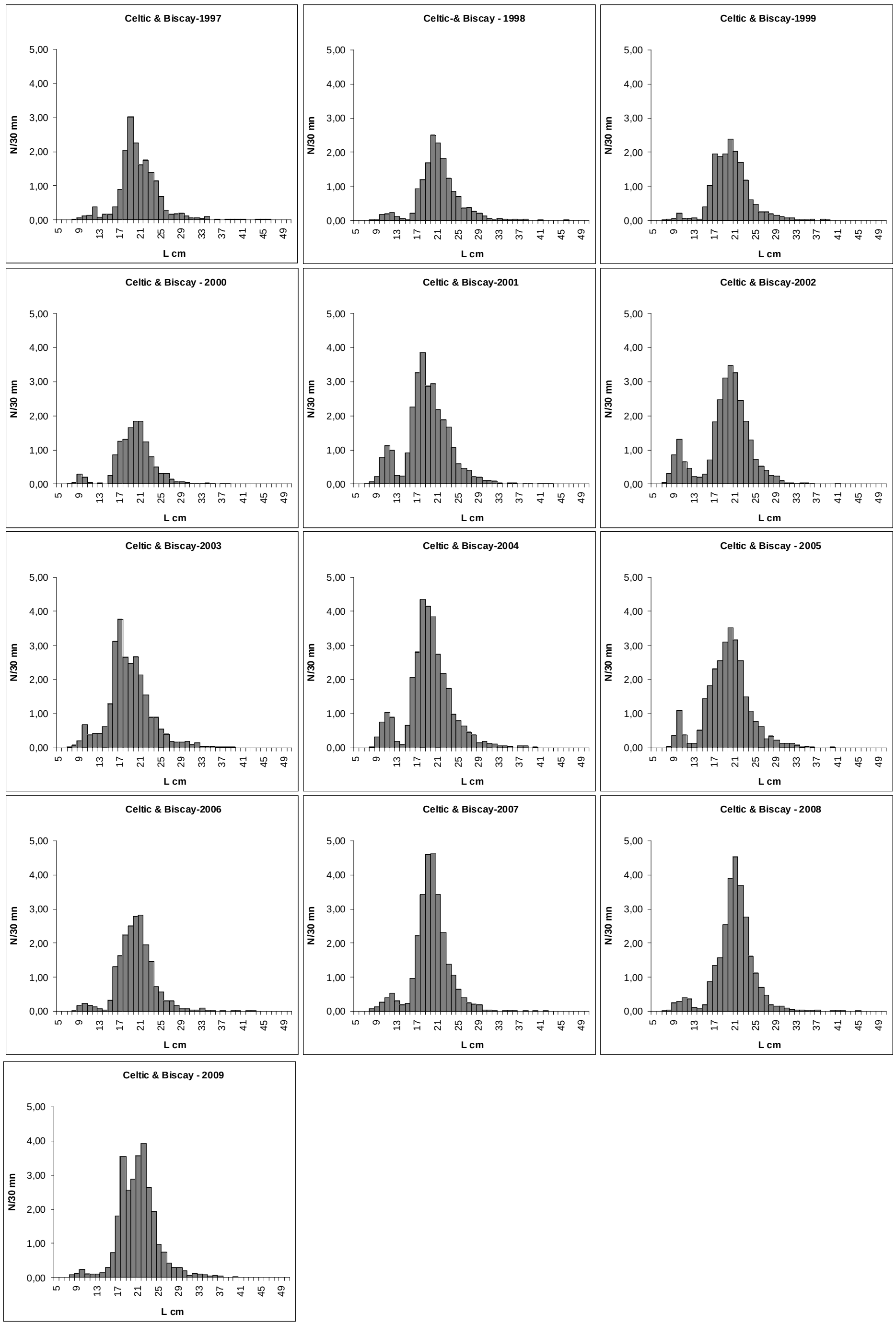



**Figure 1.14: Length abundance index of red gurnard in the combined areas of Celtic Sea and bay of Biscay from FR-EVHOE surveys series.**

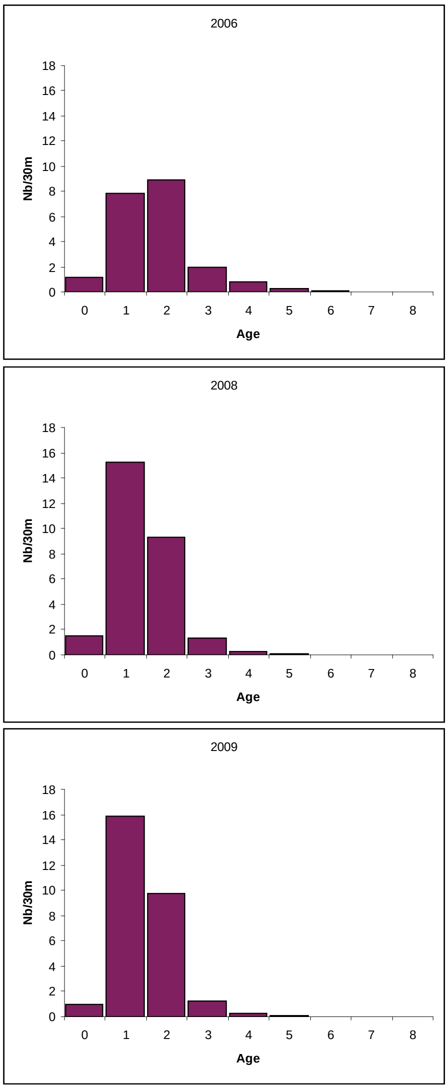



**Figure 1.15: Ab**undance index at age of red gurnard in the combined areas of Celtic Sea and bay of Biscay from FR-EVHOE surveys series for 2006, 2008 and 2009.

# Annex 4 - Grey gurnard

## 1.1 General biology [1])

Grey gurnard *Eutrigla gurnardus* occurs in the Eastern Atlantic from Iceland, Norway, southern Baltic, and North Sea to southern Morocco, Madeira. It is also found in the Mediterranean and Black Seas.

In the North Sea and in Skagerrak/Kattegat, grey gurnard is an abundant demersal species. In the North Sea, the species may form dense semi-pelagic aggregations in winter to the northwest of the Dogger Bank, in summer it is more widespread. The species is less abundant in the Channel, the Celtic Sea and in the Bay of Biscay.

Grey gurnard is most common on sandy bottoms, but also on mud, shell and rocky bottoms (Wheeler, 1978). Juveniles feed on a variety of small crustaceans. The diet of older specimens consists mainly of larger crustaceans and small fish. Spawning takes place in spring and summer. There do not seem to be clear nursery areas.

The maximum length is 50 cm.

It is a bycatch species in demersal fisheries. Catches are largely discarded.

## 1.2 Stock ID and possible assessment areas

No studies are known of the stock ID of grey gurnard. Based on IBTS survey data Heessen and Daan (1996) suggested that there may be three sub-populations in the North Sea and Skagerrak/Kattegat: one to north-west of the Dogger Bank, one around Shetland and one in the Skagerrak/Kattegat. A more recent distribution map (based on quarter 1 IBTS data for the period 1977–2005) suggests that there is indeed an area with low abundance between the North Sea and the Skagerrak, but that a more or less continuous distribution exists between the central and north-western North Sea. Grey gurnard from the North Sea may well be separated from grey gurnard in the Channel. Figure 1.1 shows that the species is almost absent from the southernmost stations of the Southern Bight. In the eastern Channel abundance of grey gurnard seems to be low compared to the North Sea (Figure 1.2). The distribution in the western Channel is not known. A higher abundance is observed in the Celtic Sea, whereas the species is almost absent from the Bay of Biscay (Figure 1.3).

## 1.3 Management regulations

There is no minimum landing size for this species and there is no TAC.

## 1.4 Fisheries data

Gurnards were often not sorted by species when landed. This is reflected in the catch statistics where different species of gurnards were often reported into one generic category of "gurnards". Only some countries sometimes report landings of "grey gurnard" (see Table 1-1. Total international landings of grey gurnard from the whole ICES area as reported to FAO for the years 1975–2008 for landings data for 1975 - 2008). From this table it is also obvious that the catch statistics are incomplete for several years: some countries reporting no landings at all, other countries reporting exceptionally high landings.

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[1]) Most of the text is copied from the text on grey gurnard in ICES-FishMap (2005)

Grey gurnard from the North Sea is mainly landed for human consumption purposes. North Sea landings decreased gradually before World War II. After an initial post-war peak of 4000 t, annual landings stayed well below 2000 t until the early 1980s, when annual catches increased to around 40 000 t (Figure 1.4) because of Danish landings for reduction purposes. In the same period, however, there was some misreporting as well. The Netherlands did not report gurnards during the years 1984–1999. Recent international landings have been very low at around 300 to 500 t per year only.

Historically, grey gurnard is mainly taken as a by-catch in mixed demersal fisheries for flatfish and roundfish. However, the market is limited and the larger part of the catch appears to be discarded. Data for French discard sampling in 2005 and 2006 in different ICES areas are shown in Figure 1.5 and Figure 1.6. Information on discarding in the Dutch beam trawl fleet is shown in Figure 1.7. Owing to the low commercial value of this species, landings data will usually not reflect the actual catches very well.

## 1.5 Survey data / recruit series

For the North Sea and Skagerrak/Kattegat, data are available from the International Bottom Trawl survey. The IBTS can provide information on distribution and the length composition of the catches.

Grey gurnard occurs throughout the North Sea and Skagerrak/Kattegat. During winter, grey gurnards are concentrated to the northwest of the Dogger Bank at depths of 50–100 m, while densities are low off the Danish coast, in the German Bight and eastern part of the Southern Bight (Figure 1.1). The distribution pattern changes substantially in the spring, when the whole area south of 56°N becomes densely populated and the high concentrations in the central North Sea disappear until the next winter. Many gurnards are also caught in the northernmost part of the area throughout the year.

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 suggests a preference for higher water temperatures (Hertling, 1924; Daan *et al.* 1990).

During winter, grey gurnard occasionally form dense aggregations just above the sea bed (or even in midwater, especially during night time) which may result in extremely large catches. Within one survey, these large hauls may account for 70 percent or more of the total catch of the species. Bottom temperatures in high-density areas usually range from 8 to 13°C (Sahrhage, 1964).

Patterns in distribution of the small and large fish are similar in space and time (Knijn *et al.*, 1993).

Spawning occurs in spring and summer and, perhaps, in autumn (Russel, 1976), and may also explain the observed seasonal movements (Van der Land, 1990). For instance, the German Bight is invaded from April onwards by fish that apparently spawn there. Emigration to northern, deeper waters commences in September and by November only a few young specimens are left (Hertling, 1924).

Length frequency distributions per year are shown for areas IV and IIIa (Figure 1.9 and Figure 1.10). Average length frequency distributions for these two areas are given in Figure 1.11. In Skagerrak Kattegat two modes can be seen, whereas in the North Sea the smaller fish are only found in relatively small numbers.

Time series of abundance of grey gurnard, based on catches of all length classes combined during the IBTS quarter 1 survey in the North Sea (IV) and Skagerrak Kattegat (IIIa) are presented in Figure 1.12. The time series for the North Sea shows a clear upward trend, especially since the late 1980s. The peak in 1981 is presumably caused by a single very large catch in that year, caused by one of the enormous concentrations of fish that appear in that time of year. Also in Skagerrak Kattegat an increase can be seen since the same time as in the North Sea, but since a maximum was reached in 1993, catches decreased and have fluctuated widely around the same level since then.

## 1.6 Biological sampling

Biological data for this species are scarce. In the early 1990s some countries collected otoliths and information on maturity stages during the quarterly IBTS surveys and Table 1-3 provide an age-length key for females and for males based on sampling by CEFAS in the 4th quarter of 1992. For the same fish, Table 1-4 and Table 1-5 provide information on maturity-at-length.

## 1.7 Population biological parameters and other research

The maximum size reported by different authors ranges from 45 (Wheeler, 1978) to 50 cm (N.Daan pers. comm.). In the North Sea, specimens > 45 cm are rarely caught.

The winter catches in the North Sea are dominated by larger specimens, with a maximum abundance at 19–22 cm. In Skagerrak-Kattegat, the length frequency distribution has two clear peaks at 11–12 cm and at 16–18 cm, while larger fish are clearly absent (Figure 1.10). There are no reliable data on the age composition.

The length distributions are remarkably similar from year to year and do not indicate a clear year-class signal: small individuals are never very abundant. The absence of small fish in the North Sea suggests that the IBTS survey does not adequately cover the nursery grounds. It is possible that juveniles concentrate on rough bottoms, which have usually to be avoided to minimise damage to the fishing gear, or that they remain pelagic (ICES-FishMap).

Average length of 1-year-olds was 13-14 cm and of 2-year-olds 19–20 cm in samples collected during the first quarter of 1977–1978. Highest age reported was nine years. The average length of 8-year-old fish has been estimated at 35 cm (Damm, 1987) and 32 cm (MacDonald *et al.,* 1994). Females grow faster and live longer than males (Damm, 1987). This is supported by a survey in May 1992, where all specimens larger than 32 cm were females (Knijn *et al.,* 1993).

**Available von Bertalanffy growth parameters are given in the text table below:**

| Area | $L_\infty$ (cm) | K (yr-1) | $t_0$ (yr) | Reference |
|---|---|---|---|---|
| Brittany males | 34.4 | 0.85 | 0.14 | Baron, 1985 |
| Brittany females | 38.0 | 0.77 | 0.16 | Baron, 1985 |

Sexual maturity is said to be attained at between two and three years of age (Wheeler, 1978; Baron, 1985a, 1985b), but data from the North Sea from the first half of May 1992 show that specimens from about 15 cm onwards can be mature, males at a somewhat smaller length than females (Knijn *et al.,* 1993). The same can be seen in the data for the 4th quarter of 1992 presented in Table 1-4 andTable 1-5. This indicates that maturity may even be reached in 1-year old fish.

Studies in the Baie de Douarnenez (Brittany) have shown that the length at which 50% of males and females were mature were 29.4 and 31.2 cm, respectively (Baron, 1985a, 1985b). These values seem very high compared to the North Sea.

The spawning period is from April to August (Wheeler, 1978). Off the English north-east coast eggs are found from May to August (Harding and Nichols, 1987). The pelagic eggs are 1.3–1.5 mm in diameter, and the larvae hatch at a length of 3–4 mm (Russell, 1976).

Seasonal distribution maps indicate a marked seasonal northwest-southeast migration pattern that is rather unusual. The population is concentrated in the central western North Sea during winter and spreads into the south eastern part during spring to spawn. In the Kattegat and the northern North Sea, such shifts appear to be absent. The withdrawal from the colder coastal waters may reflect the southerly origin of the species (ICES-FishMap).

The lower three rays of the pectoral fins of gurnards are separate and well supplied with sense organs. They are used to 'walking' over the substratum and locating prey buried in the sea bed (Wheeler, 1978). Small crustaceans, such as the brown shrimp *Crangon crangon* and small crabs are major food items in terms of weight for small (< 25 cm) individuals, while stomach contents of larger specimens are dominated by a variety of fish species (De Gee and Kikkert, 1993). The fish component of the diet largely consists of juveniles (0- and 1-group) of commercially exploited species such as cod, whiting, sandeel and sole. Off Jutland, grey gurnard appeared to be a major predator on pelagic 0-group cod during June–July (De Gee and Kikkert, 1993). Specimens in Loch Etive (west coast of Scotland) were found to feed almost exclusively on mysids, euphausiids, and decapod crustaceans (Gordon, 1981). Due to their piscivorous behaviour, grey gurnard appears to play an important role in the ecosystem.

## 1.8 Analysis of stock trends / assessment

The information from landings is very poor, due to poor reporting (gurnard species are not always identified in the data, and probably also misreporting has occurred) and also because the low value of the species leads to massive discarding.

The status of the stocks in areas IIIa, IV and VIId,e is not known. Most informative are probably the time series based on the catches from the IBTS survey in the North Sea and in Skagerrak-Kattegat. Especially in the North Sea these show a marked increase since the late 1980s (Figure 1.12).

## 1.9 Data requirements

For management purposes information should be available on catches and on landings. The quality of landings data has been poor for this species because in the past only landings of "gurnards" were reported.

Little is known of the biological parameters of grey gurnard.

From the information presented here, it can be concluded that grey gurnard is of very limited commercial interest. It should be considered to exclude this species from the list of species dealt with by WGNEW.

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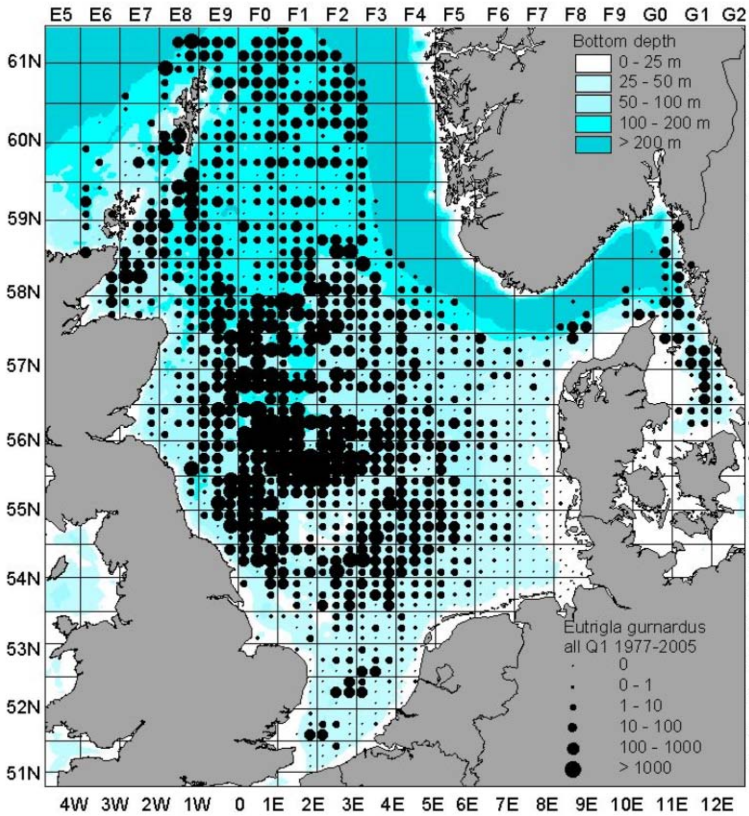



**Figure 1.1: Average annual catch (number per fishing hour for all length classes combined) for grey gurnard in the quarter 1 IBTS survey, 1977–2005 (ICES-FishMap).**

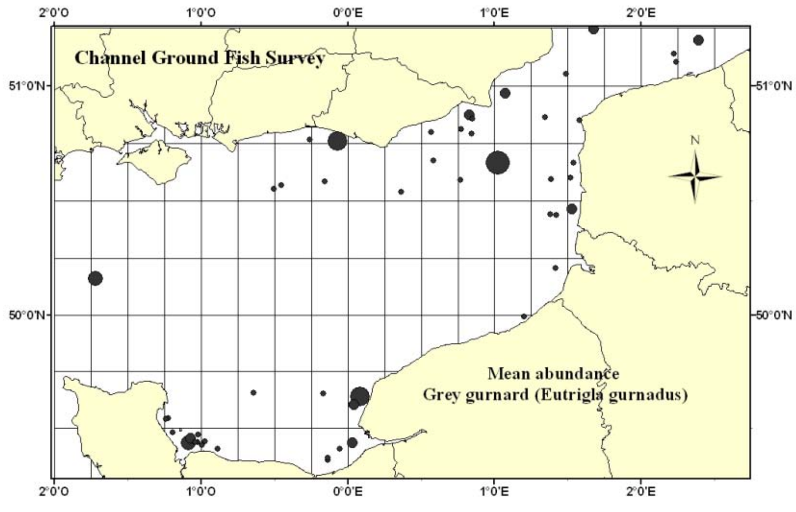



**Figure 1.2: Distribution of grey gurnard in the eastern Channel. CGFS survey 1988–2004**

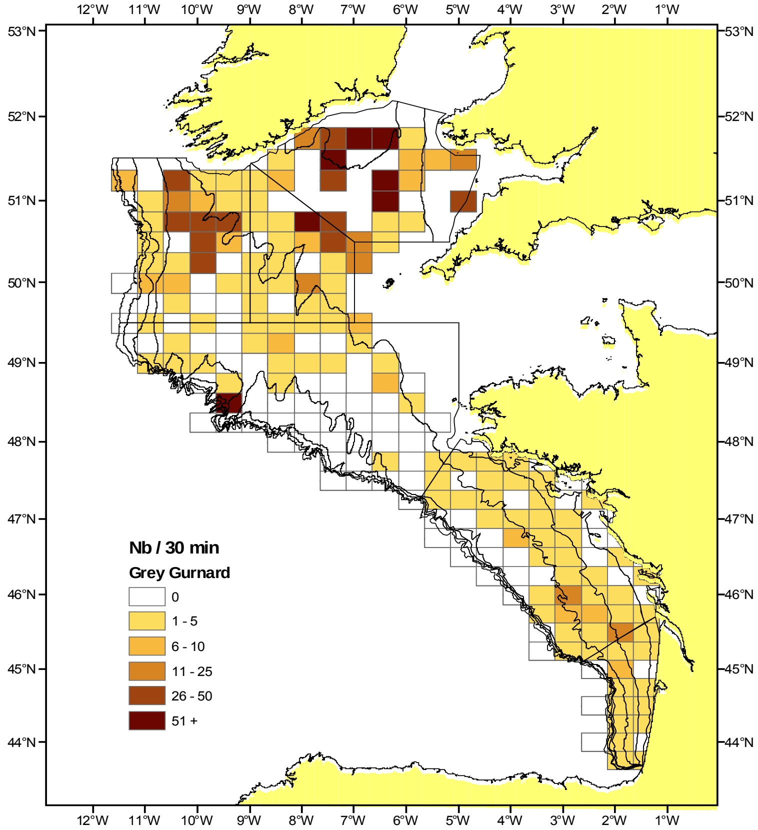



**Figure 1.3: Distribution of grey gurnard in the Celtic Sea and the Bay of Biscay. EVHOE survey, 1997–2004.**

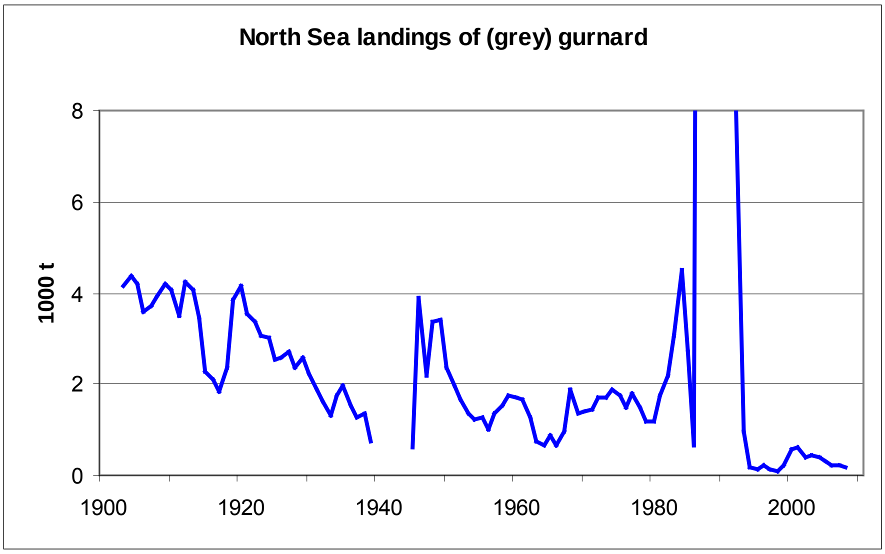



**Figure 1.4: Total international landings of gurnards from the North Sea, probably most of the landings consisted of grey gurnard. See text for further explanation.**

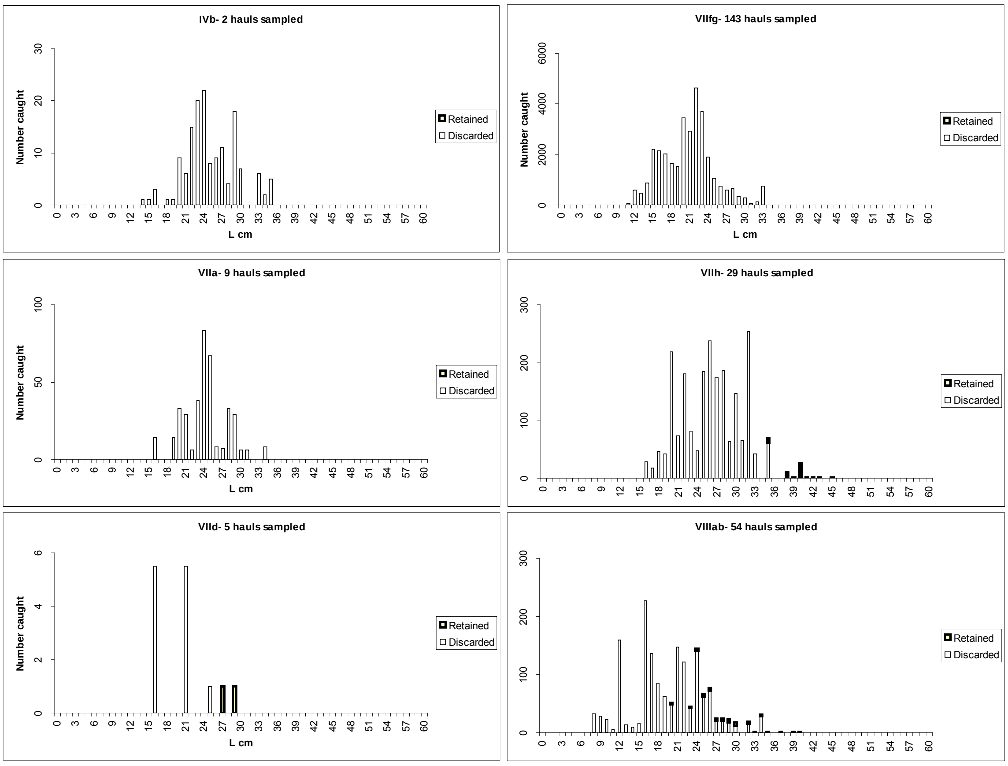



**Figure 1.5: Length composition of French catches of grey gurnard in 2005.**

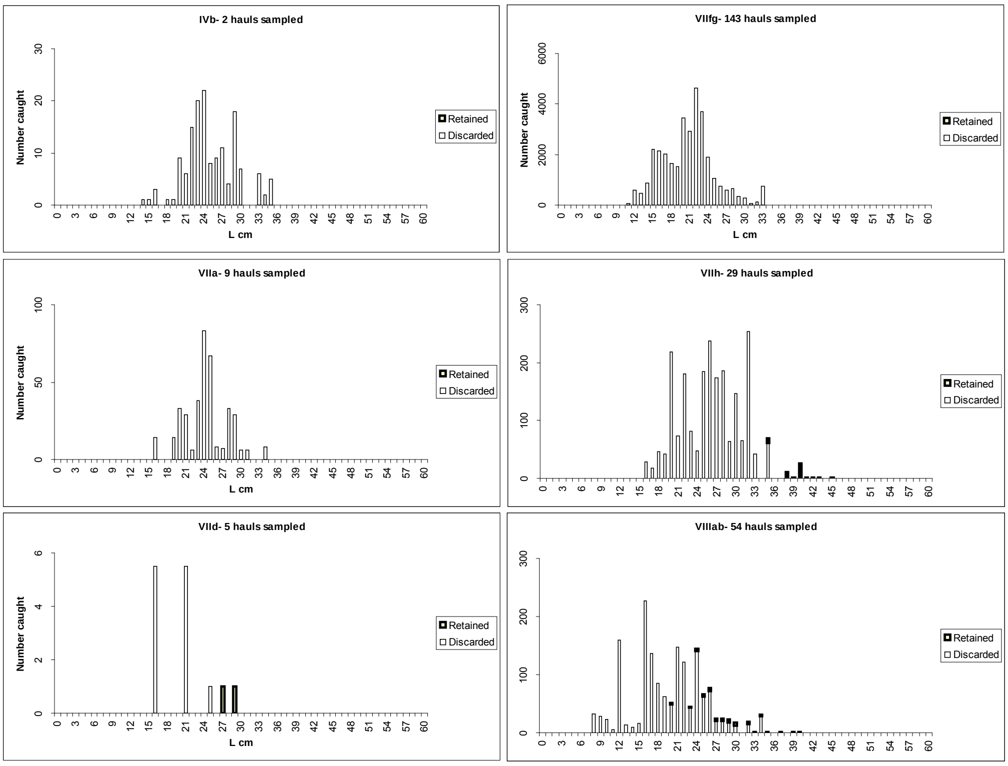



**Figure 1.6: Length composition of French catches of grey gurnard in 2006.**

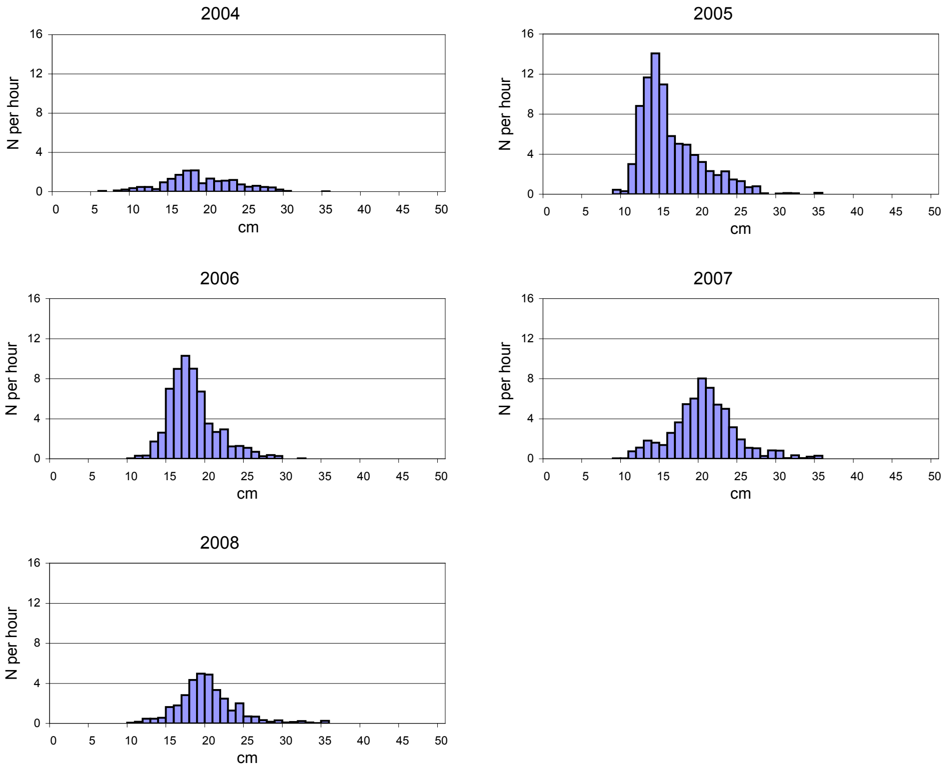
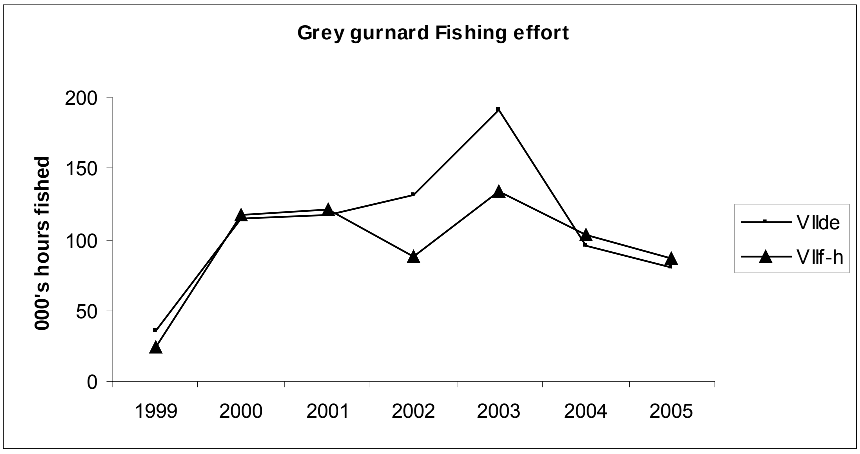



**Figure 1.7: Grey gurnard: number at length discarded per fishing hour by the Dutch beam trawl fishery in the years 2004 to 2008.**



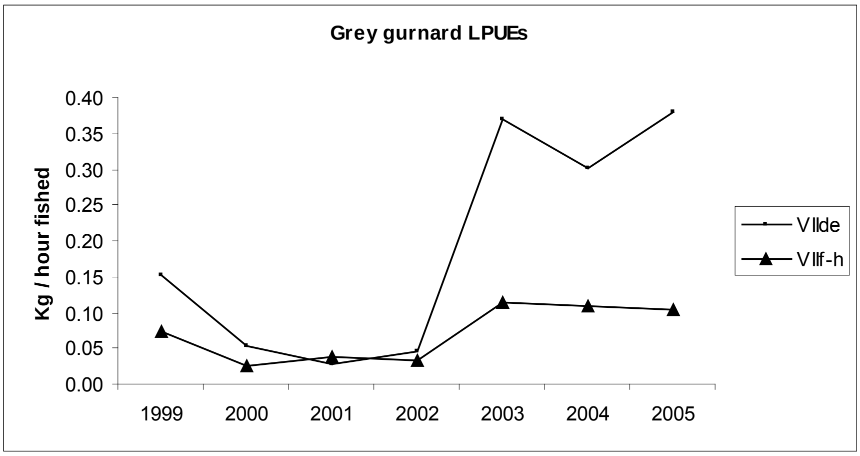




**Figure 1.8: Effort and landings per unit of effort for French single otter trawlers for areas VIId,e and VIIf–h for the years 1999 to 2005.**

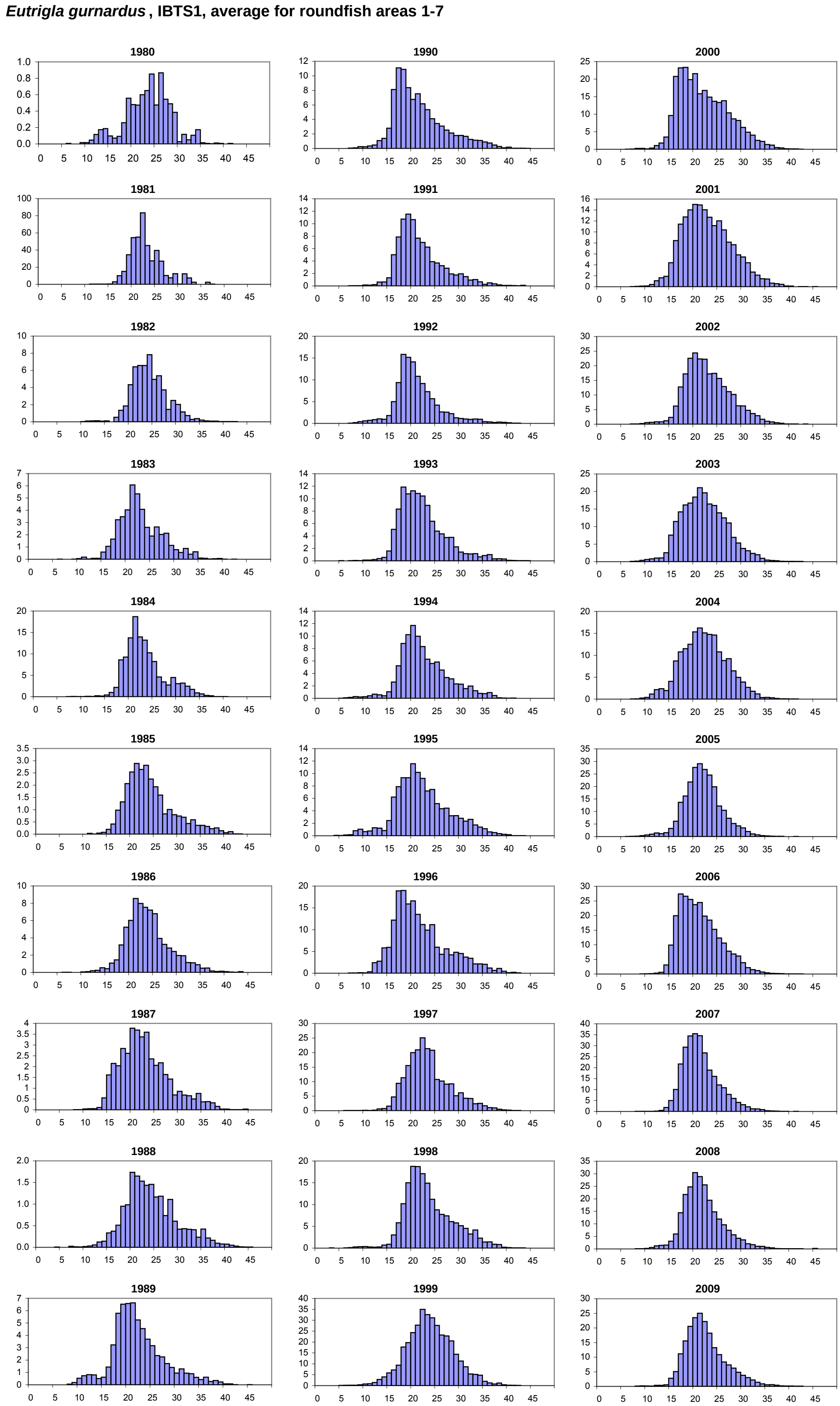



**Figure 1.9: Grey gurnard in IV: number at length during the quarter 1 IBTS survey.**

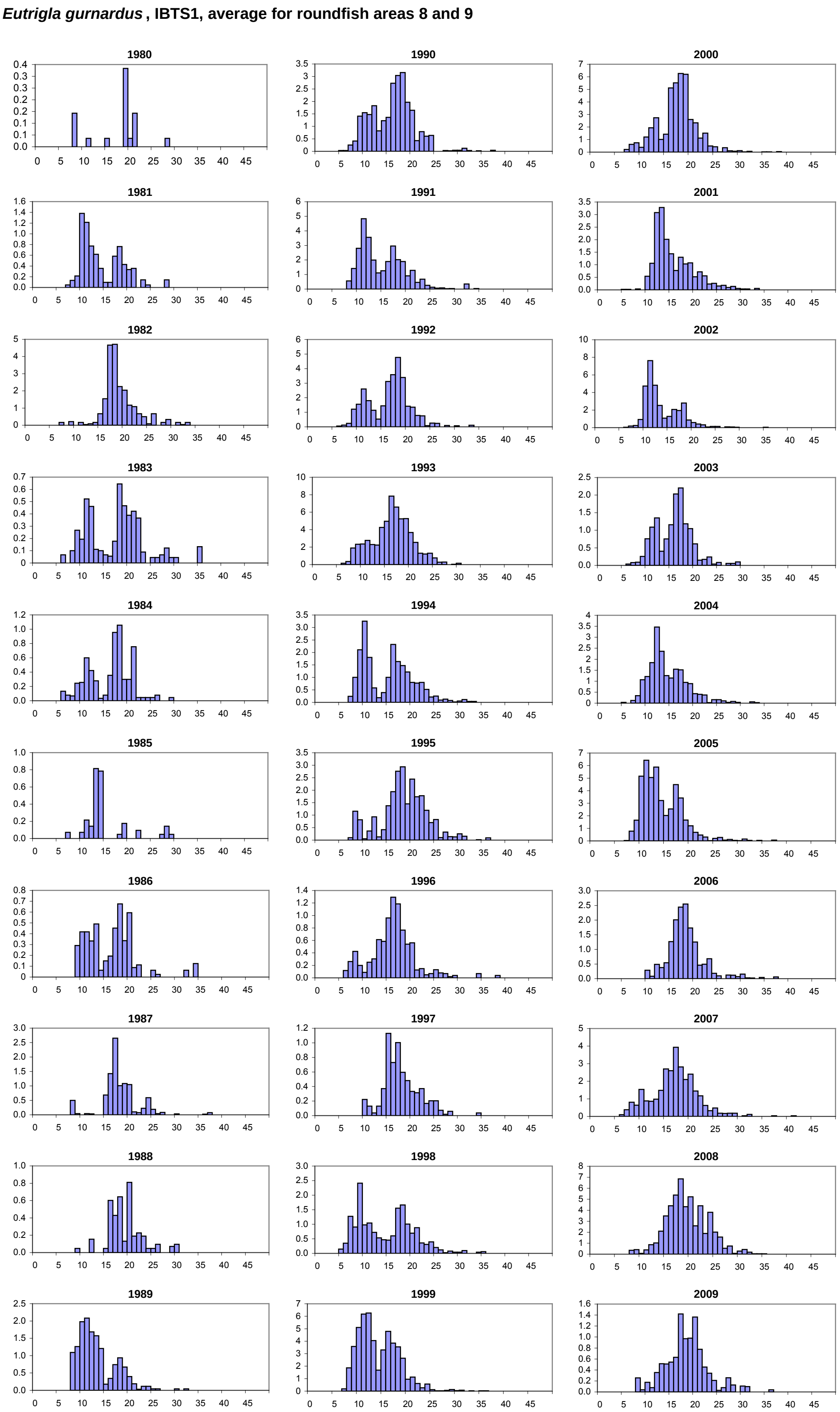



**Figure 1.10: Grey gurnard in IIIa: number at length during the quarter 1 IBTS survey.**

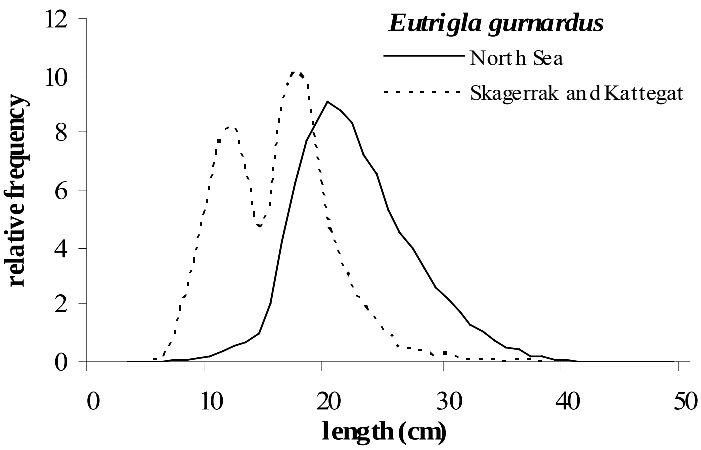
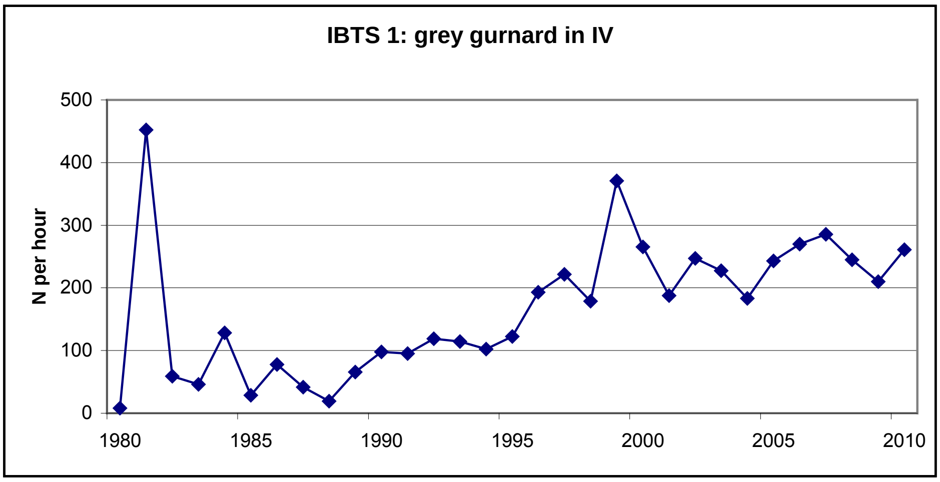



**Figure 1.11: Length frequency distribution of *E. gurnardus* based on the quarter 1 IBTS, 1985–2005 in the North Sea and in Skagerrak/Kattegat. (ICES-FishMap).**



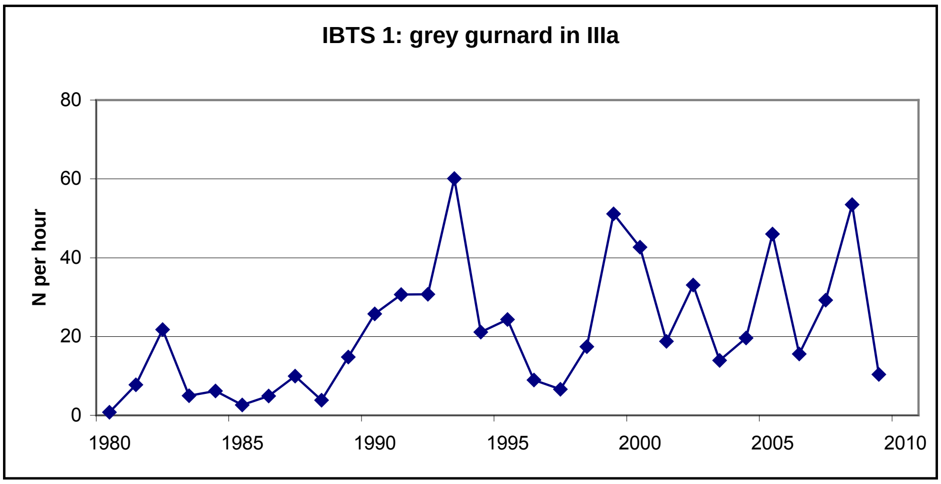




**Figure 1.12: Average catch rate (number per hour for all length classes combined) of grey gurnard in the North Sea (upper panel) and in Skagerrak and Kattegat (lower panel), based on quarter 1 IBTS.**

**Table 1-1: Total international landings of grey gurnard from the whole ICES area as reported to FAO for the years 1975–2008.**

| Country | Bel | Den | Faer | Fra | Icl | Irl | Net | Nor | Por | Russ | Swe | UK E&W | UK Sc | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | . | 14 | 0 | 0 | 14 |
| 1976 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | . | 69 | 0 | 0 | 69 |
| 1977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | . | 37 | 0 | 0 | 37 |
| 1978 | 0 | 0 | 0 | 222 | 0 | 0 | 0 | 0 | 0 | . | 54 | 0 | 0 | 276 |
| 1979 | 0 | 0 | 0 | 1,118 | 0 | 0 | 0 | 0 | 0 | . | 49 | 0 | 0 | 1,167 |
| 1980 | 0 | 0 | 0 | 1,172 | 0 | 0 | 0 | 0 | 0 | . | 38 | 0 | 0 | 1,210 |
| 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | . | 46 | 0 | 0 | 46 |
| 1982 | 0 | 360 | 0 | 895 | 0 | 0 | 0 | 0 | 0 | . | 43 | 0 | 0 | 1,298 |
| 1983 | 0 | 1,067 | 0 | 852 | 0 | 0 | 0 | 0 | 0 | . | 8 | 0 | 0 | 1,927 |
| 1984 | 0 | 4,041 | 0 | 400 | 0 | 0 | 0 | 0 | 0 | . | 7 | 0 | 0 | 4,450 |
| 1985 | 137 | 2,358 | 0 | 373 | 0 | 0 | 0 | 0 | 0 | . | 9 | 0 | 0 | 2,879 |
| 1986 | 0 | 314 | 0 | 638 | 0 | 0 | 0 | 0 | 0 | . | 10 | 0 | 0 | 962 |
| 1987 | 115 | 46,598 | 0 | 432 | 0 | 0 | 0 | 0 | 0 | . | 6 | 0 | 0 | 47,151 |
| 1988 | 116 | 38,237 | 0 | 655 | 0 | 0 | 0 | 0 | 0 | . | 3 | 43 | 0 | 39,054 |
| 1989 | 119 | 26,739 | 0 | 841 | 0 | 0 | 0 | 0 | 0 | . | 5 | . | 0 | 27,704 |
| 1990 | 110 | 22,076 | 0 | 704 | 0 | 16 | 0 | 0 | 0 | . | 3 | . | 0 | 22,909 |
| 1991 | 93 | 14,539 | 0 | 443 | 0 | 15 | 0 | 0 | 0 | . | 5 | . | 4 | 15,099 |
| 1992 | 118 | 8,136 | 0 | 259 | 0 | 17 | 0 | 0 | 0 | 0 | 10 | . | 10 | 8,550 |
| 1993 | 126 | 840 | 0 | 240 | 0 | 10 | 0 | 0 | <0.5 | 0 | 9 | . | 25 | 1,250 |
| 1994 | 79 | 99 | 0 | 194 | 0 | 0 | 0 | 0 | <0.5 | 0 | 12 | . | 24 | 408 |
| 1995 | 58 | 73 | 0 | 204 | 0 | 0 | 0 | 0 | <0.5 | 0 | 6 | . | 21 | 362 |
| 1996 | 122 | 70 | 0 | 220 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | . | 56 | 473 |
| 1997 | 64 | 36 | 0 | 217 | <0.5 | 0 | 0 | 0 | 0 | 0 | 5 | . | 59 | 381 |
| 1998 | 50 | 56 | 0 | 159 | <0.5 | 38 | 0 | 0 | 0 | 0 | 8 | . | 0 | 311 |
| 1999 | 48 | 86 | 0 | . | 0 | 0 | 0 | 0 | 0 | 0 | 132 | . | 0 | 266 |
| 2000 | 51 | 96 | 0 | 224 | 0 | 0 | 459 | 0 | 0 | 26,081 | 5 | . | 0 | 26,916 |

| Country | Bel | Den | Faer | Fra | Icl | Irl | Net | Nor | Por | Russ | Swe | UK E&W | UK Sc | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 32 | 289 | 0 | 216 | 0 | 0 | 295 | <0.5 | 0 | 3,155 | 4 | . | 46 | 4,037 |
| 2002 | 64 | 64 | 1 | 179 | 0 | 0 | 286 | 0 | 0 | 60 | 2 | . | 41 | 697 |
| 2003 | 38 | 92 | 0 | 159 | 0 | 0 | 320 | <0.5 | 0 | 263 | 7 | . | 26 | 905 |
| 2004 | 41 | 83 | 0 | 132 | 0 | 0 | 304 | <0.5 | <0.5 | 1,401 | 5 | . | 23 | 1,989 |
| 2005 | 39 | 73 | 0 | 124 | 0 | 0 | 246 | 0 | 0 | 2,456 | 9 | . | 22 | 2,969 |
| 2006 | 25 | 67 | <0.5 | 103 | 0 | 0 | 165 | 2 | 0 | 138 | 2 | . | 27 | 529 |
| 2007 | 20 | 38 | 12 | 97 | 0 | 0 | 166 | 5 | 4 | 0 | 3 | . | 54 | 399 |
| 2008 | 19 | 48 | 15 | 11 | 1 | 0 | 123 | 5 | 8 | 0 | 8 | . | 79 | 317 |

**Table 1-2: Age-length key for female grey gurnard from the North Sea (1992, quarter 4). Data provided by CEFAS.**

| FEMALES | AGE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LENGTH (MM) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | GRAND TOTAL |
| 110 | 1 | | | | | | | | | | | 1 |
| 120 | 1 | | | | | | | | | | | 1 |
| 130 | 1 | | | | | | | | | | | 1 |
| 150 | | 5 | | | | | | | | | | 5 |
| 160 | | 6 | 2 | | | | | | | | | 8 |
| 170 | | 4 | 4 | | | | | | | | | 8 |
| 180 | | 2 | 4 | | 1 | | | | | | | 7 |
| 190 | | 3 | 3 | 1 | 1 | | | | | | | 8 |
| 200 | | 1 | 5 | | | | | | | | | 6 |
| 210 | | | 1 | 4 | | | | | | | | 5 |
| 220 | | | 3 | 4 | 1 | | | | | | | 8 |
| 230 | | | 1 | 2 | 2 | 1 | | | | | | 6 |
| 240 | | | | 1 | 3 | | | | | | | 4 |
| 250 | | | | 3 | 2 | 1 | 1 | | | | | 7 |
| 260 | | | | 2 | 2 | 2 | | 1 | | | | 7 |
| 270 | | | | 1 | 3 | 3 | 1 | | | | | 8 |
| 280 | | | | | 3 | 1 | 1 | 1 | | | 1 | 7 |
| 290 | | | | | 4 | 1 | 1 | 1 | | | | 7 |
| 300 | | | | | 2 | 1 | | | 1 | | | 4 |
| 310 | | | | | 1 | | 2 | 1 | | | | 4 |
| 320 | | | | | 1 | | | 1 | 2 | | 1 | 5 |
| 330 | | | | | 1 | | | 3 | 2 | | | 6 |
| 340 | | | | | 1 | 1 | | 2 | | 1 | | 5 |
| 350 | | | | | | 1 | | | | 2 | | 3 |
| 360 | | | | | 1 | | | | 1 | | 1 | 3 |
| 370 | | | | | | | 1 | | 1 | | | 2 |
| 380 | | | | | | 2 | | 1 | | 1 | | 4 |
| 390 | | | | | | | 2 | 1 | | 1 | 1 | 5 |
| 400 | | | | | | | | | | | | 0 |
| 410 | | | | | | | | | | | | 0 |
| 420 | | | | | | | | | | | 2 | 2 |
| 430 | | | | | | | | | | | 1 | 1 |
| 440 | | | | | | | | | | | | 0 |
| 450 | | | | | | | | | | | | 0 |
| 460 | | | | | | | | | | | 1 | 1 |
| Grand Total | 3 | 21 | 23 | 18 | 29 | 14 | 9 | 12 | 7 | 5 | 8 | 149 |

**Table 1-3: Age-length key for male grey gurnard from the North Sea (1992, quarter 4). Data provided by CEFAS.**

**Males**

| | Age | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length (mm) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | Grand Total |
| 140 | 1 | | | | | | | | | | | 1 |
| 150 | | 3 | | | | | | | | | | 3 |
| 160 | | 1 | 1 | | | | | | | | | 2 |
| 170 | | 4 | | | | | | | | | | 4 |
| 180 | | 2 | 5 | 1 | | | | | | | | 8 |
| 190 | | 1 | 3 | 1 | 1 | | | | | | | 6 |
| 200 | | 1 | 5 | | | | | | | | | 6 |
| 210 | | | 4 | 3 | 1 | | | | | | | 8 |
| 220 | | | 1 | 4 | | | | | | | | 5 |
| 230 | | | 1 | 3 | 3 | | | | | | | 7 |
| 240 | | | 1 | 2 | | 1 | | | | | | 4 |
| 250 | | | 1 | | 1 | 1 | 1 | | 1 | 1 | | 6 |
| 260 | | | | | 2 | 2 | 1 | | | | | 5 |
| 270 | | | | | 1 | | | | | 1 | 1 | 3 |
| 280 | | | | | 2 | 2 | | | | | 2 | 6 |
| 290 | | | | | | 1 | 1 | 1 | | | 2 | 5 |
| 300 | | | | 1 | 1 | 1 | 1 | | 1 | | | 5 |
| 310 | | | | | 1 | | 1 | | | | | 2 |
| 320 | | | | | 1 | 1 | | | | 1 | | 3 |
| 330 | | | | | 1 | | | | 2 | | | 3 |
| 340 | | | | | | 1 | | | 1 | | | 2 |
| 350 | | | | | | | 1 | 1 | | | | 2 |
| 360 | | | | | | | 1 | | | | | 1 |
| 370 | | | | | | | | | | 1 | 1 | 2 |
| 380 | | | | | | | 1 | | | 1 | | 2 |
| 390 | | | | | | | | | | | 1 | 1 |
| 400 | | | | | | | | | | | 2 | 2 |
| 410 | | | | | | | | | | | 1 | 1 |
| Grand Total | 1 | 12 | 22 | 15 | 15 | 10 | 8 | 2 | 5 | 5 | 10 | 105 |

**Table 1-4: Maturity data for female grey gurnard from the North Sea (1992, quarter 4). Data provided by CEFAS.**

FEMALES

| LENGTH | IMMATURE | MATURING | MATURE | SPENT | GRAND TOTAL |
|---|---|---|---|---|---|
| 110 | 1 | | | | 1 |
| 120 | 1 | | | | 1 |
| 130 | 1 | | | | 1 |
| 150 | 5 | | | | 5 |
| 160 | 5 | 2 | | 1 | 8 |
| 170 | 8 | | | | 8 |
| 180 | 5 | 1 | | 1 | 7 |
| 190 | 6 | 1 | | 1 | 8 |
| 200 | 4 | 1 | | 1 | 6 |
| 210 | 2 | 3 | | | 5 |
| 220 | 3 | 4 | | 1 | 8 |
| 230 | 2 | 1 | | 3 | 6 |
| 240 | 1 | 1 | | 2 | 4 |
| 250 | 2 | 3 | | 2 | 7 |
| 260 | 1 | 3 | | 3 | 7 |
| 270 | 2 | 3 | | 3 | 8 |
| 280 | | 3 | | 4 | 7 |
| 290 | 1 | 4 | | 2 | 7 |
| 300 | | 2 | | 2 | 4 |
| 310 | | 2 | | 2 | 4 |
| 320 | | 3 | | 2 | 5 |
| 330 | | 5 | | 1 | 6 |
| 340 | | 2 | | 3 | 5 |
| 350 | | 3 | | | 3 |
| 360 | | 1 | | 2 | 3 |
| 370 | | 2 | | | 2 |
| 380 | | 3 | | 1 | 4 |
| 390 | | 2 | 1 | 2 | 5 |
| 420 | | 1 | | 1 | 2 |
| 430 | | 1 | | | 1 |
| 460 | | | | 1 | 1 |
| Grand Total | 50 | 57 | 1 | 41 | 149 |

**Table 1-5: Maturity data for male grey gurnard from the North Sea (1992, quarter 4). Data provided by CEFAS.**

**Males**

| Length | Immature | Maturing | Mature | Spent | Grand Total |
|---|---|---|---|---|---|
| 140 | 1 | | | | 1 |
| 150 | 3 | | | | 3 |
| 160 | 2 | | | | 2 |
| 170 | | 4 | | | 4 |
| 180 | 6 | 1 | | 1 | 8 |
| 190 | 4 | 1 | | 1 | 6 |
| 200 | 3 | 3 | | | 6 |
| 210 | 6 | 2 | | | 8 |
| 220 | 3 | 1 | | 1 | 5 |
| 230 | 1 | 2 | | 4 | 7 |
| 240 | 1 | 1 | | 2 | 4 |
| 250 | 1 | 2 | | 3 | 6 |
| 260 | 1 | 1 | 1 | 2 | 5 |
| 270 | | 3 | | | 3 |
| 280 | 1 | 3 | | 2 | 6 |
| 290 | | 1 | | 4 | 5 |
| 300 | 1 | 2 | | 2 | 5 |
| 310 | | 1 | | 1 | 2 |
| 320 | 1 | 2 | | | 3 |
| 330 | | | | 3 | 3 |
| 340 | | 2 | | | 2 |
| 350 | | 2 | | | 2 |
| 360 | | 1 | | | 1 |
| 370 | | | | 2 | 2 |
| 380 | | | | 2 | 2 |
| 390 | | 1 | | | 1 |
| 400 | | 2 | | | 2 |
| 410 | | 1 | | | 1 |
| Grand Total | 35 | 39 | 1 | 30 | 105 |

# Annex 3 - Red gurnard

## 1.1 General biology

Red gurnard (*Aspitrigla cuculus* or *Chelidonichthys cuculus*) is widely distributed in North-East Atlantic from South Norway and north of the British Isles to Mauritania (Quéro 1984). Hureau (1986) indicates that this species is scarce in the North Sea. This species is also present in the Mediterranean Sea and off Western Africa to the latitude of the Canaries Islands.

This benthic species occurs on grounds between 20m and 250m. As with other species of gurnards, red gurnards are able to make audible sounds to help schooling during the spawning period (Wheeler, 1969). In the western Channel (VIIe), concentrations occur close to the Central Deep, limited to 90m depth (Theret, 1983).

Surveys results and commercial fisheries data have shown that the species occurs from the southern North Sea to the Celtic Sea (Anon, 1993). October CGFS French surveys carried out since 1988 have confirmed that in Division VIId, red gurnards mainly occur in the central area (Carpentier and Coppin, 2000). This species is considered common in autumn as it was present in around 50% of the hauls. It is not found in bays and estuaries (Dauvin, 1988) and also when salinity is below 34°/00. Adults are found mainly in the south of Division VIId, off Normandy (Delcour, 1996; Carpentier *et al.*, 1997 and 2000). This species is usually fished on gravel or coarse sand.

On the other hand, results of French IBTS surveys in North Sea have shown that this species is scarce, with a few fish caught on rocky grounds offshore Scotland (Verin & Dufour, 1999).

Théret (1983) has suggested a spawning area in Division VIIe, between Ouessant Island and the Isle of Wight.

Observations on maturity stages showed that maturity started in December and spawning season could start at the end of February and end in June. Quéro (1984) and Hureau (1986) indicated that summer should be the spawning season. Studying all species of gurnards in the Bay of Douarnenez (west of Britany), Baron (1985) indicated that the spawning season is long (6 month) and set a mean birthday at the 1st of March for red gurnard by analogy with grey gurnard but with a poor sample of red gurnards. The same author has provided some data on the size at first maturity (L50 = 27 cm for males and 28,4 cm for females). The mean size at first maturity could be set at 25 cm in a range of 26-29cm at 3 years old (Forest, 2001).

There have been no studies of migration by tagging.

## 1.2 Stock identity and possible assessment areas

In the English Channel, a stock structure within Divisions VIId and VIIe has not been established and Dunn (1996) recommended not to aggregate biological parameters from the two divisions.

Data available are not sufficient to state about stock identity for red gurnard from the southern North Sea and fish from English Channel and Celtic Sea, though data from IVc and VIId,e were aggregated because fish are present all through the year in these divisions (Forest, 2001).

## 1.3 Management regulations

At the time of the WG, there are no technical measures specifically dedicated to red gurnard or other gurnard species. The exploitation of red gurnard is submitted to the general regulation in the areas where they are caught. There is no MLS.

## 1.4 Fisheries data

### 1.4.1 Historical landings

Available EUROSTAT/ICES statistics have shown that species of gurnards are not always discriminated and data for Triglidae also occurred.

For UK (E+W) and Spain, landings reported by ICES Divisions are mainly available for all species of gurnards combined and not usable specifically for red gurnard.

Figure 1.1 and Table 1-1 show the landings by country and area specific to red gurnard. The series starts in 1985 and shows a lack of French data in 1999. In Division VIIa, landings have fluctuated at less than 100 t. France seemed the main contributor to international landings except in area VIII, but Spanish data were not available. The bulk of landings seemed to come from Divisions VIId,e at around 4 000 t. Landings in VIIf-k levelled at around 500 t. In VIII, landings fluctuated around 200 t since the beginning of 1990s. France is the main contributor to international landings in all areas described except in VIIa. In recent years, the official landings from the main areas where red gurnard is harvested (VIId to k) have shown a continuous decreasing trend from 2003-2004 to levels recorded in years before, that means a decrease of around 50%.

Based on the French database available from the fish markets network, the main species of gurnards landed in France are red gurnard and tub gurnard. The series 1999-2008 shown in Figure 1.2: Seasonal landings of gurnards in France from fishmarkets network. has been revised and updated. The drop observed previously in 2003 in the dataset used at WGNEW 2007 was due to data recorded in duplicate in the database during the period 1999-2002. The seasonal pattern is quite regular from year to year either for red gurnard and for tub gurnard. The average landings of red gurnard over the series is around 4 900 t. Two higher values are observed in 2002 and 2005 and then the landings of red gurnard tend to decrease to less than 4 000 t in 2008.

*The Working Group decided not to use the Official statistics available at ICES. The series by country to be used by the Working Group should be aggregated and checked during the inter session by the co-ordinator for this species.*

A series 1988-2008 based on logbooks is also available for France in Divisions IVc, VIId, VIIe and VIIf-k and Sub-area VIII using a data series published in Forest (2001) and recent data from 1999 (Table 1-2, Figure 1.3). The series 1999-2008 has been updated in 2010. The main area where red gurnard is caught is VIId+VIIe+VIIf-k. Datasets are rather consistent to those given by EUROSTAT/ICES database except a larger discrepancy in VIIe in 2008 not explained yet, but which seems unrealistic. Detailed data from the Celtic Sea have shown that landings are mainly provided by Division VIIh. The contribution of Division IVc has been generally marginal. In Division VIId, landings have fluctuated around 1,200 t in the period 1989-96, declined to 665 t in 2000, and remained below 1,000 t since then. Over the time series, there is in VIIe a general trend of increase with fluctuations except the odd drop in 2008. In VIIf-k, the landings have also increased since 2000 and have generally fluctuated around 700 t since then. In Sub-area VIII the production has become marginal in the period between 1999-2004 and then increased to levels observed in the years before.

In the main area where red gurnard is harvested (IVc+VIId-k), the landings have remained well above 4 000 t since 2001 and decreased in 2008.

### 1.4.2 Discards

In France, several metiers contribute to discarding in the western Channel (Morizur *et al.*, 1996).

- Gillnet with small meshes set in inshore waters and targeting crayfish, monkfish, sole and hake,
- Gillnet with large meshes targeting crabs have shown discarding of small amounts of red gurnard in winter,
- Red gurnard from coastal otter trawlers is more discarded in the western part of the area than in the eastern part where gurnards are used for baiting crabs pots,
- Offshore otter trawlers have been discarding around 50% of red gurnard catches when they fished in the north of VIIe, on the Smalls grounds and Bristol Channel (VIIf,g).

Figure 1.6 and Figure 1.7 summarized the observations of catches at sea from French bottom trawlers carried out under DCF in 2005 and 2006. Except in VIId&e, red gurnards are almost all discarded. One can note that in VIIe 2006, only one haul has been sampled and the discarded part of the catch has probably not been measured. French data of gurnards for the EU Data Collection Framework have been recorded but the tools to extract and exploit them are still in development. Then length compositions of catches observed are not available yet for 2007-2009.

### 1.4.3 Catch and effort data by sea area and country

Because in other countries species of gurnards are not always distinguished by species and their contribution to international landings is very small, only French datasets are presented.

The most important French fishery is in the Eastern Channel where the market is well established for gurnards. The main metier is offshore otter trawl (single trawl) and target species are gadoids, mackerel, plaice and gurnards. In the 1990s, this metier landed around 80% of international landings of red gurnard from Division VIIe. Boulogne sur mer, Port en Bessin and Cherbourg still are the main fish markets (Forest, 2001). In recent years, following the decrease of the quotas for cod and whiting and the extending area of red mullet and squid to the North Sea, the group of targeted species has changed and is now composed of red mullet, squid, lemon sole and red gurnard, species with commercial value.

In the 1990s in Division VIIe, the main metier was also offshore otter trawl targeting red gurnard, mainly landing in Port en Bessin, Cherbourg and harbours of North Britany.

Using French logbooks, in 2003, 99% of red gurnard landings were by single otter trawlers in VIId-e. In the same year, 85% of landings in VIIa,f-j were by single otter trawlers and 14% by twin trawlers. Landings from Division VIIk have always been very low.

Dunn (1996) indicated that catches of gurnards (mixed species) in Division VIIe mainly came from otter trawlers and partially by beam trawlers in UK (E+W). In VIId, gurnards were harvested by otter trawlers. A part of the production was directly sold to potters for baiting and might be not recorded. It was also mentioned that red gurnard was poorly represented.

Quarterly LPUEs in kg/h from French trawlers and CPUEs from French surveys by ICES rectangle have provided seasonal distribution and abundance indices for red gurnard (Anon, 1993). Mean seasonal variations over the series 1988-92 showed that red gurnard is abundant in spring in the English Channel but, in summer and autumn, fish seemed to migrate outside or became inaccessible for the fleet. The results are shown in Figure 1.5.

Information from other countries was not available at the time of the Working Group meeting.

Series available:

The series proposed in WGNEW 2007 has been fully revised following the putting into service of the new French database Harmonie. Series 1999-2009 of LPUEs and total effort dedicated to gurnards by otter trawlers (OTB+OTT) are shown in Figure 1.6 and Table 1-3. Odd values are observed in 1999 and 2009 reflecting problems of quality in the datasets of these years. Then the observed window is reduced to the period 2000-2008.

A decreasing trend of effort is shown in the periode 2003-2008 in VIIde. A similar trend has begun before, in 2002 in area VIIfgh in line with several decommissioning plans carried out in order to reduce the effort of Gadoids trawlers to manage the reduced quotas of cod set. On the opposite, effort in VIIIab has generally increased in that period. Over the period 2000-2008, the LPUEs have fluctuated without trend in each of the areas selected.

Others series of French effort and LPUEs data using landings and effort by ICES rectangle over the period 1999-2008 have been constructed by metier in Western Approaches (VIIe-k) and Bay of Biscay (area VIII). Effort considered is the fishing effort by metier and area. Trends of LPUEs and effort are shown in Table 1-4 and Figure 1.7. The main metiers contributing to red gurnard landings are the Gadoid trawlers in Western Approaches which target mainly haddock, whiting and cod and the Benthic trawlers in the same area which target mainly monkfish, megrim and rays. The fluctuations without trend of LPUEs of Gadoids trawlers in Western Approaches are rather similar to those observed in the series mentioned above. LPUE of Benthic trawlers in the same area increased to 2004 and since then levelled with fluctuations. LPUEs of the other metiers described are very small. In Western Approaches, effort of Gadoids and *Nephrops* trawlers in Western Approach has shown an almost continuous declining over the period in line with the adjustment to the effort regulation and restrictive quotas of cod set in this area. In the same area, effort of benthic trawlers has fluctuated without trend. In Bay of Biscay, the effort of gadoid trawlers has increased since 2003, probably indicating a shift of effort from Western Approach to Bay of Biscay.Effort of *Nephrops* and benthic trawlers have fluctuated at lower levels.

A series 1999-2008 of LPUEs and effort of French otter trawler (OTB) in VIId is shown in Figure 1.8 and Table 1-5. Up to 2004 the LPUEs have fluctuated between 3 and 4 kg/hour and since then they have tended to increase as the fishing effort has decreased.

Over all the series presented, only LPUEs in VIId could indicate a trend of abundance increasing in recent years in that area. The other series have only shown small fluctuations without trend.

### 1.4.4 Survey data, recruit series

Multi-annual surveys have been carried out by several countries and could provide some series of abundance index. The UK Western Channel Grounfish Surveys (UK-WCGFS) are operated in VIIe-h and in the north of VIIIa during 1st quarter. International Bottom Trawl Surveys (IBTS) cover the North Sea also in 1st quarter. French Channel Groundfish Surveys (FR-CGFS) cover Division VIId and French "Evaluation Halieutique à l'Ouest de l'Europe" (FR-EVHOE) survey cover the Bay of Biscay and the Celtic Sea out to 11°W respectively during the 4th quarter. None of them is especially designed to target gurnards, but data available could provide long series of abundance indices and at least total or stratified by area length distributions. Series from the UK-WGCFS discontinued in 2005 are not available yet.

Table 1-6 and Table 1-7 show the series of abundance index of red gurnard from IBTS database and results of the CGFS survey. Figure 1.9 and Figure 1.10 shows their trends and their 95% confidence interval.

The IBTS index produces very small values of index and the small trend to increase in the last decade as some higher values in 1986 and 1991 are rather uncertain.

The CGFS index in VIId has fluctuated in the range of the confidence interval indicating no significant trend. However some higher values have been observed in 2006 and 2008.

The FR-EVHOE index in number or in weight by 30 mn as well show a higher abundance in Celtic Sea than in Bay of Biscay. In Celtic Sea, the index have increased sharply (x2) in 2001 and have fluctuated at this high level since then. In the Bay of Biscay, the index has fluctuated in a wider range but at low levels. The peak observed in 2008 is uncertain.

The distribution of red gurnard in the Eastern Channel during the FR-CGFS survey in October between 1988 to 2006 is shown in Stock Annex and indicates that higher abundance occurred in the central area along a Southwest- Northeast axis between Cotentin (FR) and Kent (UK).

The distribution of red gurnard in the Celtic Sea and the Bay of Biscay during FR-EVHOE from 1997 to 2009 is shown in Stock Annex. Clearly the greater abundance is located offshore Brittany in the South of Division VIIh and in the North of Division VIIIa quite in a geographical continuity with Division VIIe where the bulk of landings are harvested by the fishery.

The abundance index at length of red gurnard from the CGFS and EVHOE surveys are shown in Figure 1.12 and Figure 1.13 respectively. In CGFS dataset, there is no variability of mean lengths in the length distributions in which we can notice the quasi absence of 0 group (under 15 cm) in the catches, 1989 and 2002 excepted. For some years, bimodal distributions from the EVHOE survey series show clearly the abundance 0 group. Relatively abundant in the period 2001-2005, they are poorly represented in recent years.

Age reading of red gurnards caught during EVHOE survey has been carried out in 2006 and routinely since 2008. Therefore abundance index at age are available in 2006, 2008 and 2009. They are shown in

Figure 1.14 and indicate that the populations caught are mainly composed of individuals of age 1 and 2.

## 1.5 Biological sampling

There was a lack of regular sampling data for red gurnard both in commercial landings and discarding to provide series of length or age compositions usable for a preliminary analytical assessment.

Since 2003, under DCF sampling program at sea, length data have been collected, in a sporadic way during the first years by observers at sea but more intensively since 2009 when the concurrent sampling was planned. The French sampling program by observation at sea under DCF should provide with length compositions of catches by metiers of the fishery when the tools to extract and exploit them will be developed (COST tools to adapt).

In surveys series, length data were available and age compositions are now available since 2008 at least for the FR-EVHOE survey which is partly funded by DCF but this survey is carried out outside the area where the bulk of landings is harvested. The abundance index per age from this survey where obtained by sampling 223 and 222 otoliths sampled during EVHOE 2008 and 2009 respectively.

Without DCF funding, it is not reasonable to get more biological data from the FR-CGFS or to envisage an extent of the survey in Division VIIe.

At the time of this WG, there is no more length compositions of landings than those shown at WGNEW 2007

## 1.6 Biological parameters and other research

There is no updating of growth parameters presented at WGNEW 2007 and available parameters from several authors are summarized in Table 1-8. They vary considerably. Maximum length are lower for males.

Available length-weight relationships are shown in Table 1-9. There is no updating.

A maturity ogive is not available except an assumed knife-edge at age 3. Biological parmeters collected during EVHOE survey since 2008 could provide a first estimate in Celtic Sea.

Natural mortality has not been estimated in the areas studied at this Working Group.

A total of 696 otoliths from EVHOE (the Bay of Biscay and the Celtic Sea) and IBTS (the North Sea) surveys were interpreted. A summary of aged otoliths is shown below:

| Surveys | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| EVHOE | 236 | | 222 | 222 |
| IBTS | | 16 | | |

Average sizes (cm) at the ages by sex (F: female; I: unspecified and M: male) from EVHOE 2006, 2008 and 2009 (the Bay of Biscay and the Celtic Sea):

| Age | F | I | M |
|---|---|---|---|
| 0 | 15,50 | 11,44 | |
| 1 | 19,05 | 16,70 | 18,86 |
| 2 | 24,24 | 18,75 | 22,98 |
| 3 | 29,46 | | 25,69 |
| 4 | 31,86 | | 28,36 |
| 5 | 34,08 | | 33,20 |

The cumulated age length key from 4th quarter FR-EVHOE survey 2006, 2008 and 2009 (the Bay of Biscay and the Celtic Sea) is shown in Table 1-10: Cumulated age-length Key of red gurnard from the FR-EVHOE survey 2006, 2008 and 2009..

## 1.7 Analyses of stock trends.

In recent years, the official landings recorded from the main areas where red gurnard is harvested (VIId to k) have shown a continuous decreasing trend from 2003-2004 (~2800t) to levels recorded in years before (table 6.1) at around 1350 t in 2008.

From only the French database and in the same area the landings have remained well above 4000 t since 2001 and could decrease in 2008 to 3200 t (Table 1-2).

These datasets show once again the discrepancy between them and that they are not adequate to get some signal from landings.

From length abundance indices of the FR-CGFS surveys, the indices in VIId have fluctuated at higher values up to 1997. After the lowest value observed in 1998, indices have shown a slight increasing trend with fluctuations but confidence intervals are wide. Indices also show that 0 group (under 15 cm) are generally very scarce in the samples.

In Celtic Sea and Bay of Biscay, length abundance indices from FR-EVHOE surveys have remained at lower values up to 2000 and then they have peaked in 2004. Indices of recruitment (age 0 set under 15 cm) have been also lower in 2008 and 2009. The better year classes shown in 2001, 2002 and 2004 are probably now almost fished out. The available abundance indices at age from this survey in 2006, 2008 and 2009 have shown rather the same structure from year to year and therefore without signal of any stronger year class.

## 1.8 Data requirements

High discrepancies found in the datasets available between the official landings data and other databases show that data from commercial exploitation of red gurnard are not of sufficient quality to provide an adequate signal on red gurnard exploitation.

Regular sampling of red gurnard catches must be carried out by observations at sea under DCF at least to estimate by metier and area weight and length compositions of retained and discarded catches but the priority given to this species should be discussed taking into account its lower economical importance compared to those of other valuable species harvested in the same areas.

Anyway, the concurrent sampling design carried out since 2009 should provide more data than in recent years.

The FR-EVHOE survey funded by DCF would continue to provide with a series of abundance indices at age.

The FR-CGFS survey, not funded by DCF also provides abundance indices at length. Extending the studied area to VIIe and collecting otoliths could be promising.

There are uncertainties in landings data for several countries and red gurnard has been landed mixed with other species of gurnards in UK (E+W) and Spain. Discarding data in recent years have shown that except in VIId,e most of the catch is discarded.

There is a lack of updated biological parameters.

Last year, a pragmatic approach led to propose a management area for Divisions IVc, VIId-h. The preliminary analysis of the survey data available this year which has shown opposite trends in recent years could lead to disconnect the Eastern Channel (VIId) and the Celtic sea (7f-h) populations but the data 1998-2000 have shown a lower level of population in both areas. In Division VIIe, there are no survey data available yet to provide a trend of the population in the area where the bulk of landings have been harvested.

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**Table 1-1: Nominal landings from EUROSTAT/ICES databases.**

North Sea (ICES region: 4)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 35 | 0 | 74 | 61 | 107 | 59 | 19 | 11 | 19 | 19 | 15 | 17 | 10 | 11 | 10 | 16 | 26 | 31 | 41 | 83 | 29 | 13 | 7 | 13 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 21 | 2 | 2 | 2 | 3 | 15 | 10 | 8 | 0 | 27 | 40 | 68 | 48 | 0 | 60 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 50 | 40 | 77 | 68 | 111 | 136 | 65 | 58 | 81 | 75 | 71 | 75 | 48 | 70 | : | 54 | 111 | 43 | 39 | 27 | 26 | 13 | 19 | 15 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 45 | 166 | 53 | 43 | 52 | 51 | 63 | 44 | 36 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 7 | 24 | 25 | 30 | 28 | 32 | 42 | 23 | 6 | 0 | 0 | 4 | 150 | 217 | 253 | 221 | 95 | 76 | 107 | 84 |

Irish Sea (ICES region: 7a)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 32 | 0 | 20 | 13 | 9 | 12 | 5 | 12 | 15 | 16 | 15 | 26 | 21 | 21 | 38 | 33 | 26 | 23 | 24 | 8 | 5 | 10 | 7 | 5 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 49 | 36 | 30 | 15 | 13 | 14 | 50 | 23 | 10 | 8 | 4 | 5 | 5 | 2 | : | 6 | 15 | 12 | 2 | 0 | 2 | 0 | 0 | 0 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 2 | 2 | 4 | 3 | 2 | 2 | 3 | 2 | 2 | 0 | 0 | 0 | 3 | 5 | 12 | 11 | 0 | 0 | : | : |

Eastern Channel (ICES region:7d)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 56 | 0 | 61 | 75 | 88 | 70 | 71 | 93 | 64 | 68 | 65 | 80 | 67 | 85 | 95 | 94 | 106 | 104 | 161 | 131 | 68 | 155 | 187 | 218 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 1384 | 1226 | 977 | 1171 | 1214 | 1574 | 1292 | 1376 | 1143 | 1132 | 1239 | 1424 | 1178 | 1000 | : | 800 | 1119 | 1183 | 1043 | 1005 | 1039 | 898 | 971 | 894 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 11 | 2 | 6 | 14 | 16 | 17 | 37 | 64 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 32 | 55 |

Western Channel (ICES region:7e)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 27 | 0 | 14 | 27 | 22 | 8 | 3 | 11 | 4 | 5 | 7 | 5 | 7 | 10 | 0 | 1 | 5 | 7 | 23 | 46 | 24 | 73 | 62 | 60 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 1122 | 2290 | 2237 | 1990 | 1642 | 1199 | 2112 | 2106 | 2194 | 2189 | 2199 | 2269 | 2614 | 2303 | : | 2499 | 2575 | 2968 | 2728 | 2436 | 2951 | 2714 | 2603 | 2382 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 3 | 0 |

Celtic Sea (ICES region:7f-k

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 29 | 0 | 31 | 21 | 21 | 18 | 11 | 13 | 9 | 9 | 13 | 14 | 17 | 19 | 11 | 9 | 12 | 15 | 26 | 47 | 16 | 26 | 33 | 36 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | 8 | 12 | 19 | 3 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 406 | 506 | 454 | 488 | 413 | 363 | 420 | 390 | 364 | 413 | 451 | 476 | 482 | 549 | : | 651 | 719 | 640 | 685 | 916 | 840 | 670 | 670 | 633 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | : | : | : | : | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 20 | 7 | 15 | 2 | 0 | : | 0 | 1 |

Bay of Biscay (ICES region:8)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 2 | 1 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 211 | 241 | 332 | 274 | 236 | 206 | 189 | 190 | 153 | 224 | 165 | 174 | 176 | 191 | : | 143 | 141 | 152 | 166 | 169 | 202 | 218 | 202 | 92 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | 0 |
| United Kingdom | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 3 | : | : | : |

* Only from logbooks in series 1999-2008

| Year | IVc | VIId | VIIe | VIIf-k | VIII |
|---|---|---|---|---|---|
| 1988 | 57 | 720 | 1848 | 480 | 206 |
| 1989 | 124 | 1166 | 1615 | 423 | 193 |
| 1990 | 136 | 1394 | 1347 | 442 | 208 |
| 1991 | 70 | 1295 | 2073 | 524 | 192 |
| 1992 | 56 | 1358 | 1748 | 395 | 210 |
| 1993 | 82 | 1132 | 1690 | 363 | 159 |
| 1994 | 76 | 1122 | 1561 | 386 | 217 |
| 1995 | 71 | 1235 | 1580 | 444 | 169 |
| 1996 | 76 | 1417 | 1625 | 470 | 181 |
| 1997 | 49 | 944 | 2303 | 474 | 177 |
| 1998 | 49 | 1047 | 2284 | 506 | 162 |
| 1999 | **46** | **741** | **2429** | **325** | **58** |
| 2000 | **50** | **665** | **2391** | **626** | **82** |
| 2001 | **108** | **894** | **2505** | **696** | **66** |
| 2002 | **40** | **950** | **2907** | **605** | **79** |
| 2003 | **34** | **843** | **2728** | **669** | **72** |
| 2004 | **26** | **853** | **2517** | **915** | **87** |
| 2005 | **25** | **866** | **2861** | **690** | **163** |
| 2006 | **21** | **865** | **2748** | **647** | **185** |
| 2007 | 14 | 1009 | 2627 | 664 | 170 |
| 2008 | 36 | 966 | 1661 | 592 | 166 |

**updated in bold**

**Table 1-2: France: landings of red gurnard in t live weight.**

| | Landings kg | Red gurnard | | effort 000'h fished | | 1000 | LPUE | kg/h fished | |
|---|---|---|---|---|---|---|---|---|---|
| year | 7de | 7fgh | 8ab | 7de | 7fgh | 8ab | 7de | 7fgh | 8ab |
| 1999 | 3143378 | 315217 | 35275 | 810.553 | 230.328 | 48.834 | 3.9 | 1.4 | 0.7 |
| 2000 | 3026836 | 607484 | 54645 | 1130.318 | 941.991 | 356.194 | 2.7 | 0.6 | 0.2 |
| 2001 | 3356616 | 684815 | 49543 | 1067.780 | 994.438 | 302.113 | 3.1 | 0.7 | 0.2 |
| 2002 | 3813616 | 595813 | 39719 | 1219.589 | 846.449 | 321.536 | 3.1 | 0.7 | 0.1 |
| 2003 | 3507286 | 661274 | 49012 | 1391.980 | 893.467 | 426.490 | 2.5 | 0.7 | 0.1 |
| 2004 | 3248722 | 900132 | 63445 | 1297.526 | 865.703 | 497.762 | 2.5 | 1.0 | 0.1 |
| 2005 | 3624801 | 681381 | 112036 | 1085.057 | 778.914 | 768.129 | 3.3 | 0.9 | 0.1 |
| 2006 | 3452166 | 633692 | 117881 | 1069.908 | 672.443 | 680.123 | 3.2 | 0.9 | 0.2 |
| 2007 | 3352089 | 657775 | 100654 | 1002.862 | 623.124 | 716.833 | 3.3 | 1.1 | 0.1 |
| 2008 | 2254264 | 583834 | 103017 | 778.306 | 603.849 | 677.288 | 2.9 | 1.0 | 0.2 |
| 2009 | 1314597 | 336279 | 26941 | 213.796 | 106.379 | 59.186 | 6.1 | 3.2 | 0.5 |

1999 and 2009: datasets unreliable

**Table 1-3: Series of landings of red gurnard, effort and LPUE of French otter trawlers (OTB+OTT) from logbooks datasets.**

Red Gurnard France
Captures (t)

| Metier | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| Benthic Western Approaches | 55 | 145 | 252 | 247 | 463 | 810 | 595 | 614 | 751 | 469 |
| Gadoids Western Approaches | 2685 | 2874 | 2930 | 3222 | 2851 | 2536 | 2850 | 2667 | 2421 | 1642 |
| Nephrops Western Approaches | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| Benthic Bay of Biscay | 7 | 29 | 21 | 22 | 29 | 28 | 57 | 62 | 39 | 51 |
| "Gadoids" Bay of Biscay | 25 | 24 | 22 | 16 | 18 | 30 | 52 | 49 | 59 | 51 |
| Nephrops Bay of Biscay | 3 | 3 | 2 | 3 | 4 | 6 | 6 | 5 | 5 | 6 |
| | 2778 | 3077 | 3228 | 3511 | 3366 | 3411 | 3561 | 3397 | 3275 | 2219 |

Red Gurnard France
Fishing Effort

| Metier | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| Benthic Western Approaches | 260758 | 295235 | 289227 | 265173 | 311690 | 319664 | 277571 | 303860 | 327413 | 266640 |
| Gadoids Western Approaches | 603846 | 561385 | 549464 | 549402 | 532461 | 488775 | 455446 | 436125 | 394148 | 314761 |
| Nephrops Western Approaches | 198129 | 219402 | 195229 | 182732 | 199108 | 164514 | 168537 | 159230 | 118692 | 99788 |
| Benthic Bay of Biscay | 143053 | 137186 | 128085 | 132199 | 148483 | 166266 | 203183 | 173227 | 178323 | 170854 |
| "Gadoids" Bay of Biscay | 276271 | 211502 | 208556 | 184709 | 194668 | 215719 | 260360 | 291848 | 356308 | 305030 |
| Nephrops Bay of Biscay | 199384 | 171203 | 181568 | 182496 | 218913 | 238337 | 277343 | 277908 | 249244 | 230292 |
| Total | 1681441 | 1595913 | 1552129 | 1496711 | 1605323 | 1593275 | 1642440 | 1642198 | 1624128 | 1387365 |

Red Gurnard France
LPUE (Kg/10h)

| Metier | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| Benthic Western Approaches | 2.1 | 4.9 | 8.7 | 9.3 | 14.9 | 25.3 | 21.4 | 20.2 | 22.9 | 17.6 |
| Gadoids Western Approaches | 44.5 | 51.2 | 53.3 | 58.6 | 53.5 | 51.9 | 62.6 | 61.2 | 61.4 | 52.2 |
| Nephrops Western Approaches | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| Benthic Bay of Biscay | 0.5 | 2.1 | 1.6 | 1.7 | 2.0 | 1.7 | 2.8 | 3.6 | 2.2 | 3.0 |
| "Gadoids" Bay of Biscay | 0.9 | 1.1 | 1.1 | 0.9 | 0.9 | 1.4 | 2.0 | 1.7 | 1.7 | 1.7 |
| Nephrops Bay of Biscay | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 |

**Table 1-4: Series of landings of red gurnard, effort and LPUE by metier of French otter trawlers (OTB+OTT) from CPR datasets.**

| year | Landings kg | Effort hours | LPUE Kg/hour |
|---|---|---|---|
| 1999 | 731485 | 449924 | 1.6 |
| 2000 | 653244 | 551088 | 1.2 |
| 2001 | 869054 | 485479 | 1.8 |
| 2002 | 929381 | 560053 | 1.7 |
| 2003 | 813963 | 629978 | 1.3 |
| 2004 | 800899 | 573711 | 1.4 |
| 2005 | 827994 | 441078 | 1.9 |
| 2006 | 791125 | 440473 | 1.8 |
| 2007 | 811937 | 438125 | 1.9 |
| 2008 | 698455 | 342351 | 2.0 |

**Table 1-5: Series of landings of red gurnard, effort and LPUE of French otter trawlers (OTB) in VIId from logbooks datasets.**

| Year | IBTS Quarter 1 | CGFS |
|---|---|---|
| 1986 | 11.87 | 20.77 |
| 1987 | 1.17 | 19.24 |
| 1988 | 0.00 | 12.33 |
| 1989 | 0.37 | 11.87 |
| 1990 | 4.91 | 16.35 |
| 1993 | 0.00 | 10.12 |
| 1994 | 0.00 | 23.71 |
| 1995 | 0.00 | 12.89 |
| 1996 | 0.00 | 9.56 |
| 1997 | 0.06 | 18.01 |
| 1998 | 0.00 | 6 |
| 1999 | 0.00 | 7.09 |
| 2000 | 0.11 | 9.83 |
| 2001 | 0.12 | 7.17 |
| 2002 | 0.05 | 11.18 |
| 2003 | 0.24 | 12.92 |
| 2004 | 0.22 | 7.34 |
| 2005 | 0.10 | 10.9 |
| 2006 | 0.00 | 13.56 |
| 2007 | 0.23 | 10.26 |
| 2008 | 0.00 | 18.64 |
| 2009 | 0.24 | 17.24 |

**Table 1-6: The abundance index (N/h) of red gurnard from the IBTS database in North Sea and CGFS survey in Eastern Channel.**

| Year | Celtic Sea (VIIg, h, j) | | Bay of Biscay (VIIIa, b) | |
|---|---|---|---|---|
| | Number/30minutes | W(kg)/30minutes | Number/30minutes | W(kg)/30minutes |
| 1997 | 23.29 | 2.24 | 5.34 | 0.43 |
| 1998 | 22.32 | 2.35 | 2.79 | 0.25 |
| 1999 | 25.22 | 2.35 | 0.9 | 0.09 |
| 2000 | 19.12 | 1.65 | 1.2 | 0.11 |
| 2001 | 39.11 | 3.03 | 8.02 | 0.7 |
| 2002 | 35.75 | 2.97 | 9.79 | 0.69 |
| 2003 | 37.62 | 2.8 | 2.61 | 0.21 |
| 2004 | 43.76 | 3.66 | 7.19 | 0.58 |
| 2005 | 38.84 | 3.39 | 6.7 | 0.57 |
| 2006 | 27.89 | 2.56 | 6.82 | 0.53 |
| 2007 | 36.41 | 3.18 | 10.59 | 0.81 |
| 2008 | 33.97 | 3.39 | 14.71 | 1.42 |
| 2009 | 38.7 | 3.82 | 6.04 | 0.53 |

**Table 1-7: The average abundance( number and weight (kg) per 30 mn) of red gurnard annually from FR-EVHOE survey in the Celtic Sea (VII,g,h,j) and in the Bay of Biscay (VIIIa,b).**

| Authors | Area | Sex | Nb | $L_\infty$ | K ($y^{-1}$) | $t_0$ (years) |
|---|---|---|---|---|---|---|
| Baron (1983) | Manche + mer du Nord | M | 118 | 37,1 | 0,51 | -0,08 |
| | | F | 232 | 41,7 | 0,46 | -0,05 |
| Dunn *et al.* (1996) | VIId | M | 213 | 35.75 | 0,232 | -3,37 |
| | VIId | F | 531 | 41,05 | 0,248 | -2,57 |
| | VIIe | F | 147 | NS | 0,137 | -2,09 |
| Carpentier 1995 | VIId | M+F | 187 | 36,75 | 0,597 | 0,180 |
| Id 1996 | | | 94 | 37,97 | 0,622 | 0,149 |
| Id 1997 | | | 90 | 36,67 | 0,645 | 0,185 |
| Id 1998 | | | 107 | 36,18 | 0,613 | 0,048 |
| Id 1999 | | | 122 | 36,02 | 0,511 | -0,277 |
| Mean 1995-2000 | | | 704 | 36,34 | 0,543 | -0,17 |

**Table 1-8: Growth parameters of red gurnard in the English Channel**

| Author | Area | Month | Sex | Number | a | b |
|---|---|---|---|---|---|---|
| Théret, 1983 | English Channel | september | M | 31 | $1.13.10^{-3}$ | 3.3854 |
| | | | F | 80 | $4.50.10^{-3}$ | 3.14027 |
| | | november | M | 33 | $3.65.10^{-3}$ | 3.16261 |
| | | | F | 33 | $2.94.10^{-3}$ | 3.20117 |
| | | décember | M | 55 | $1.51.10^{-3}$ | 3.32967 |
| | | | F | 144 | $1.05.10^{-3}$ | 3.38984 |
| | | january | M | 112 | $0.98.10^{-3}$ | 3.39763 |
| | | | F | 120 | $2.19.10^{-3}$ | 3.25648 |
| | | february | M | 31 | $0.73.10^{-3}$ | 3.44558 |
| | | | F | 82 | $0.88.10^{-3}$ | 3.41197 |
| Dorel, 1986 | idem | | M + F | 593 | $5.61.10^{-3}$ | 3.16882 |

**Table 1-9: Length-weight relationships available for red gurnard in English (W = aLb, W live weight in g and L in cm).**

| Length | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 8 | 5 | | | | | | |
| 9 | 12 | | | | | | |
| 10 | 8 | | | | | | |
| 11 | 10 | | | | | | |
| 12 | 10 | | | | | | |
| 13 | 14 | 1 | | | | | |
| 14 | 10 | 5 | | | | | |
| 15 | 2 | 15 | | | | | |
| 16 | 1 | 22 | 2 | | | | |
| 17 | 1 | 28 | 2 | | | | |
| 18 | | 37 | 3 | | | | |
| 19 | | 32 | 6 | | | | |
| 20 | | 30 | 10 | | | | |
| 21 | | 22 | 18 | 2 | | | |
| 22 | | 9 | 25 | 1 | | | |
| 23 | | 5 | 25 | 5 | | | |
| 24 | | 1 | 25 | 6 | 1 | 1 | |
| 25 | | 3 | 16 | 5 | 4 | | |
| 26 | | | 9 | 14 | 5 | | |
| 27 | | | 13 | 8 | 6 | 1 | |
| 28 | | 1 | 6 | 10 | 8 | 2 | |
| 29 | | | 5 | 8 | 2 | 3 | |
| 30 | | | 1 | 5 | 6 | 1 | |
| 31 | | | 2 | 6 | 7 | 4 | |
| 32 | | | 2 | 5 | 1 | 1 | |
| 33 | | | 2 | 6 | 4 | | |
| 34 | | | | 5 | 3 | 2 | |
| 35 | | | | 3 | 2 | 2 | |
| 36 | | | | 2 | 1 | 3 | |
| 37 | | | | | 1 | 2 | |
| 38 | | | | | 3 | 2 | |
| 39 | | | | | | 1 | |
| 40 | | | | | 2 | 2 | |
| 41 | | | | 1 | 1 | 1 | |
| 42 | | | | | | 1 | 1 |
| 44 | | | | | | | 1 |
| 45 | | | | | | 1 | |

**Table 1-10: Cumulated age-length Key of red gurnard from the FR-EVHOE survey 2006, 2008 and 2009.**

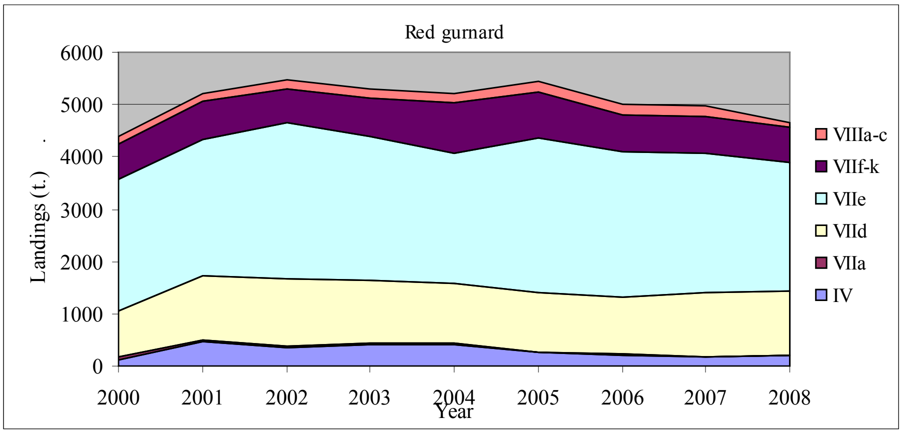



**Figure 1.1: EUROSTAT/ ICES database of red gurnard. Contribution of landings by countries and areas.**

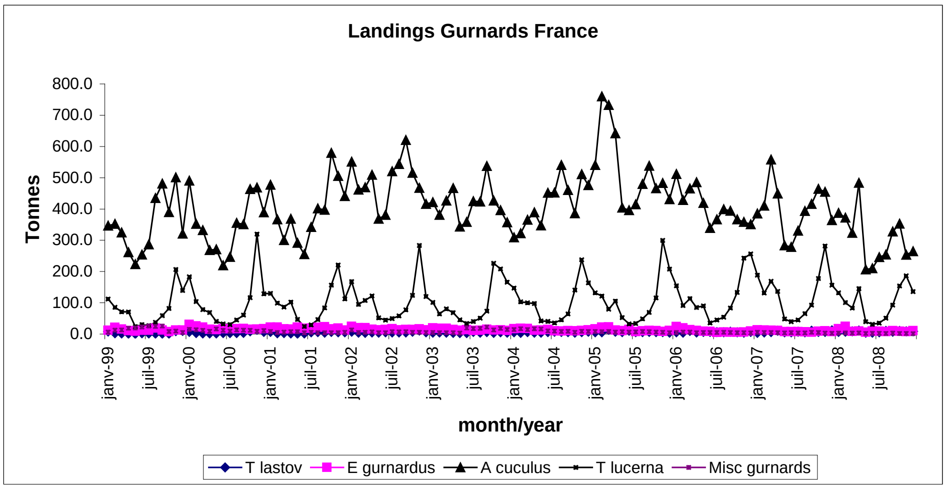



**Figure 1.2: Seasonal landings of gurnards in France from fishmarkets network.**

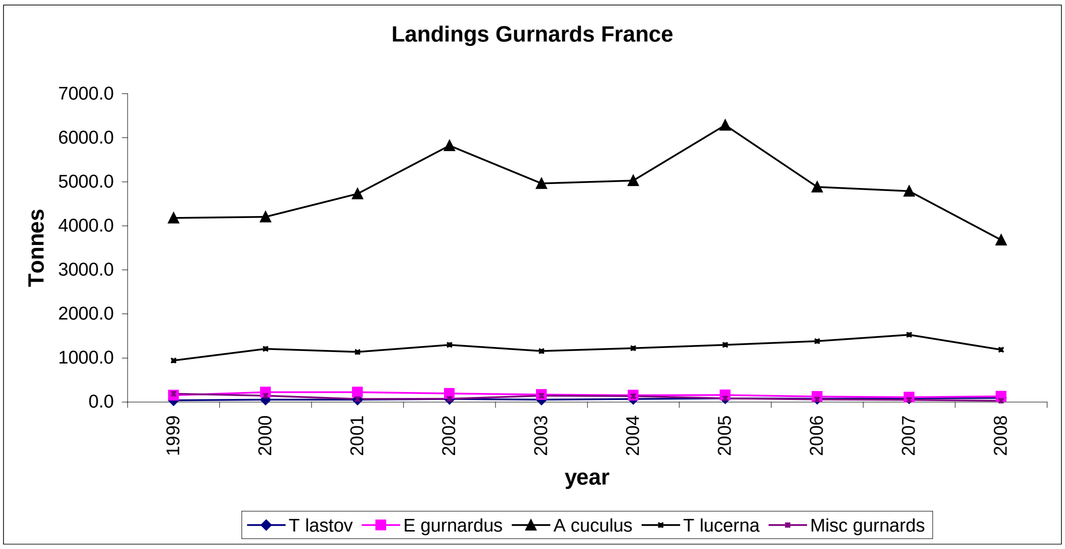



**Figure 1.3:** Annual landings of gurnards in France from fishmarkets network.

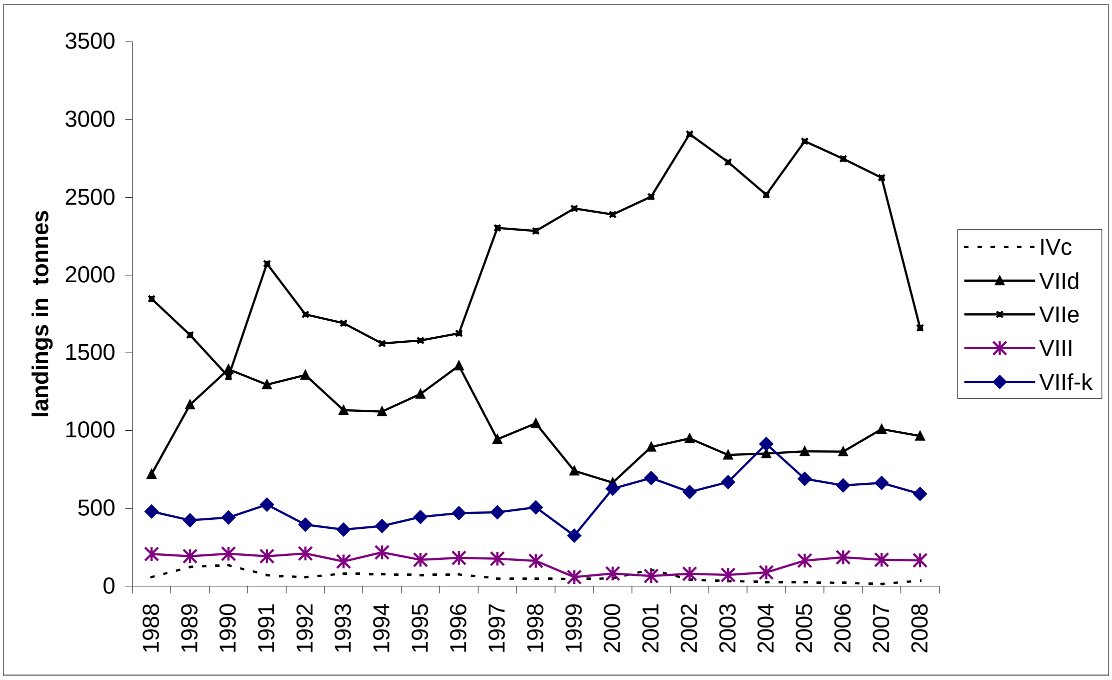



**Figure 1.4: France: Trends of French landings of red gurnard. Only from logbooks since 1999. In 2008 landings from VIIe have dropped by 35%, not observed in official landings from EURO-STAT/ICES dataset.**

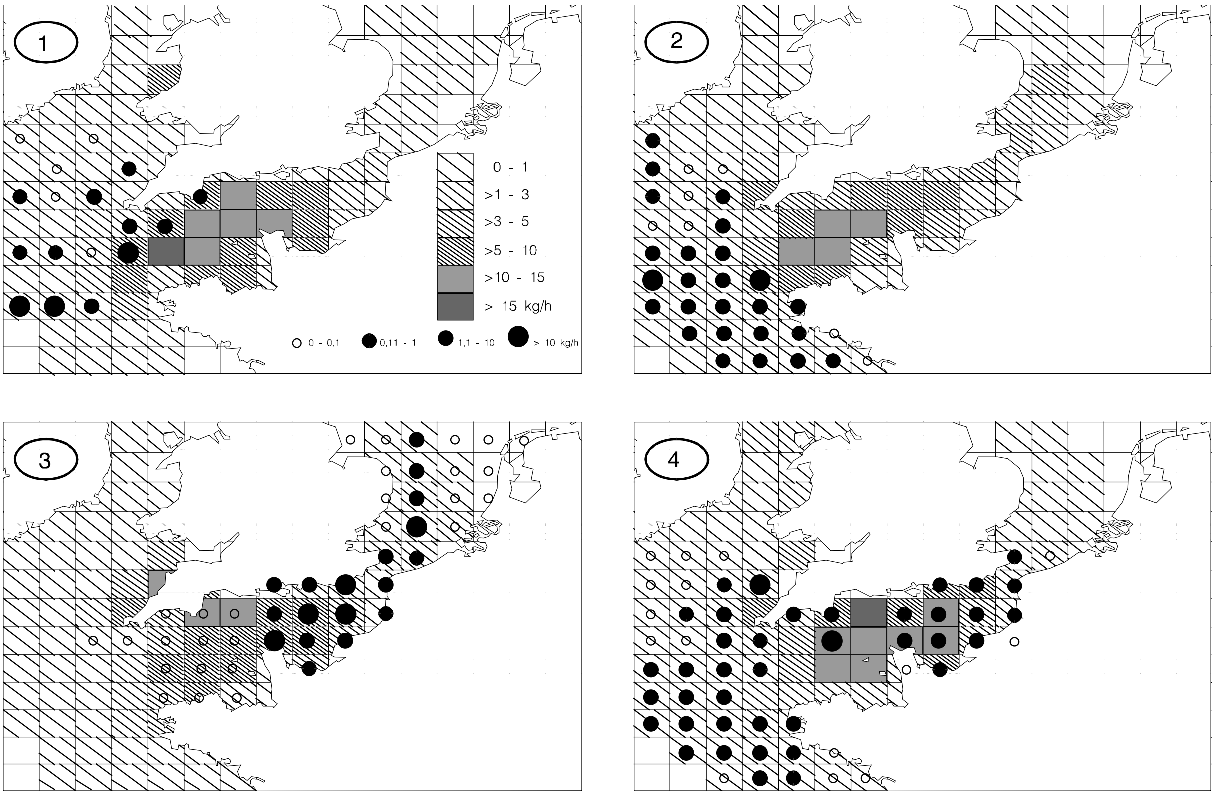



**Figure 1.5: Quarterly landings of red gurnard in English Channel and neighbouring areas in the period 1988-1992. CPUE in Kg/h from surveys are given as superimposed circles.**

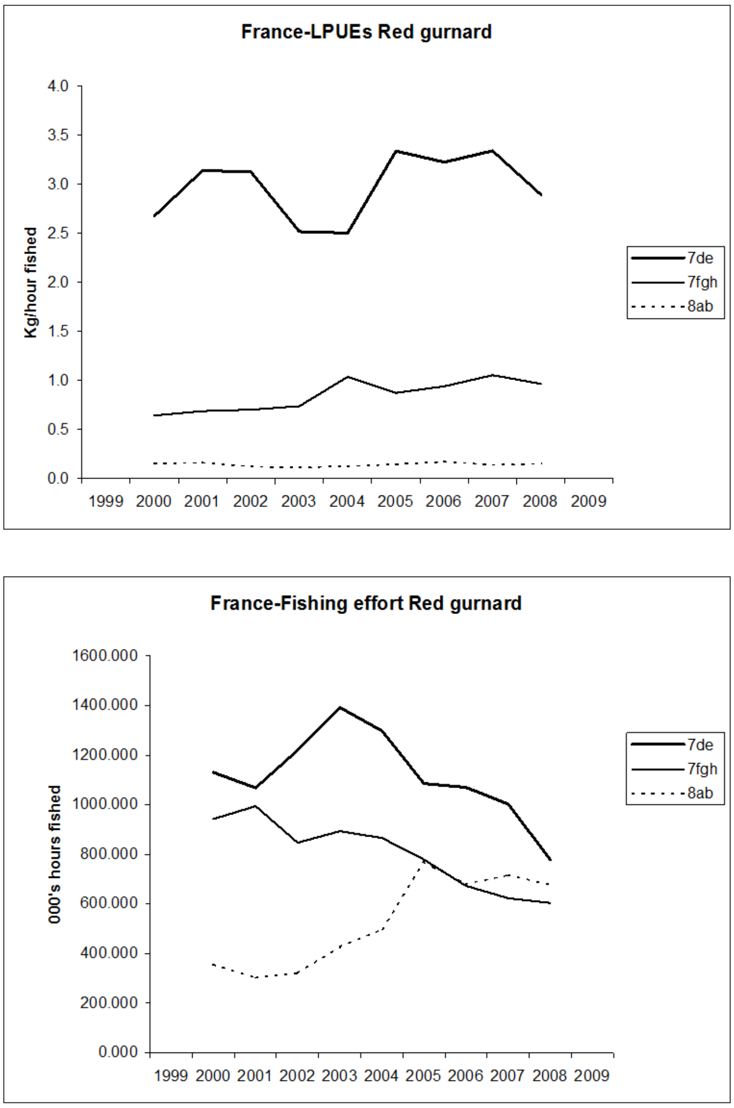
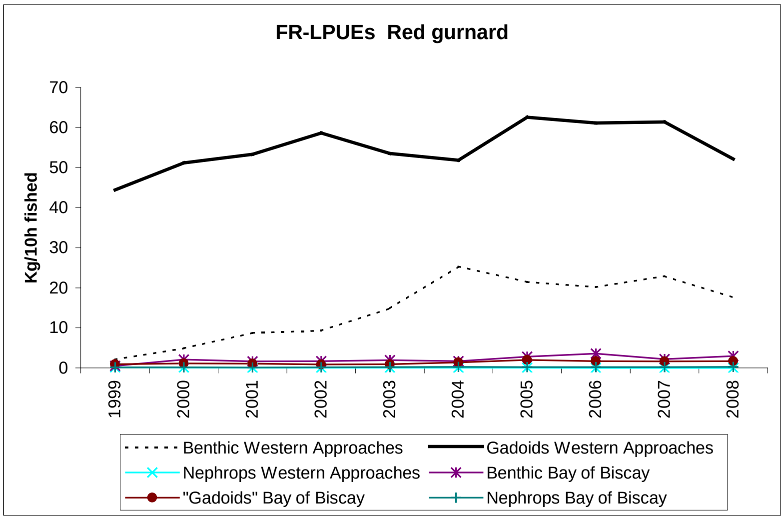



**Figure 1.6:** Trends of LPUEs and French effort OTB+OTT and in VIIde, VIIfgh and VIIIab. Unreliable data 1999 and 2009 in red.



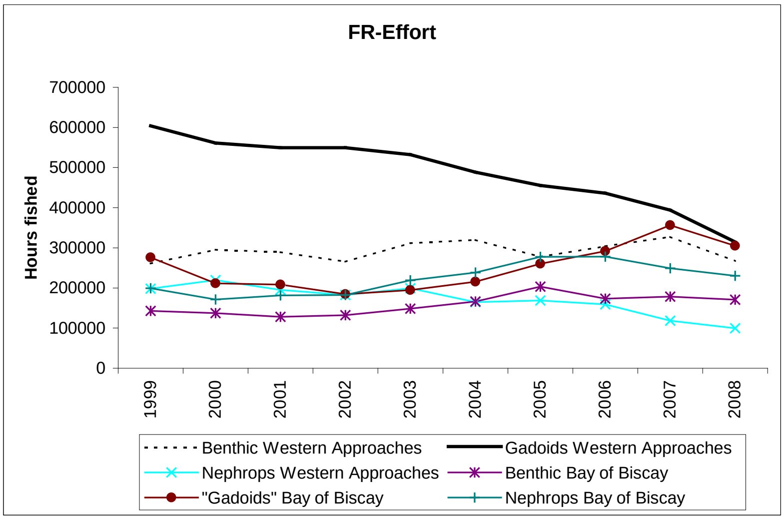




**Figure 1.7: Red Gurnard. Trends of LPUE (kg/h) and fishing effort (hours fished) of French otter trawlers (OTB+OTT) in areas VIIe-k (Western Approaches) and VIII (Bay** of Biscay).

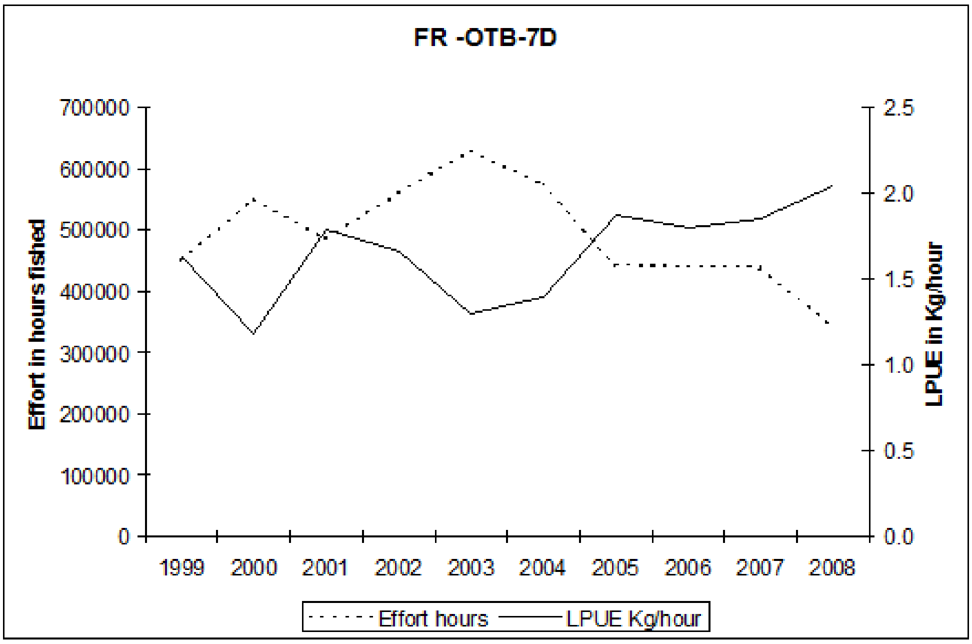



**Figure 1.8: France. Trends of LPUE and effort in VIId of otter trawlers (OTB) for years 1999-2008**

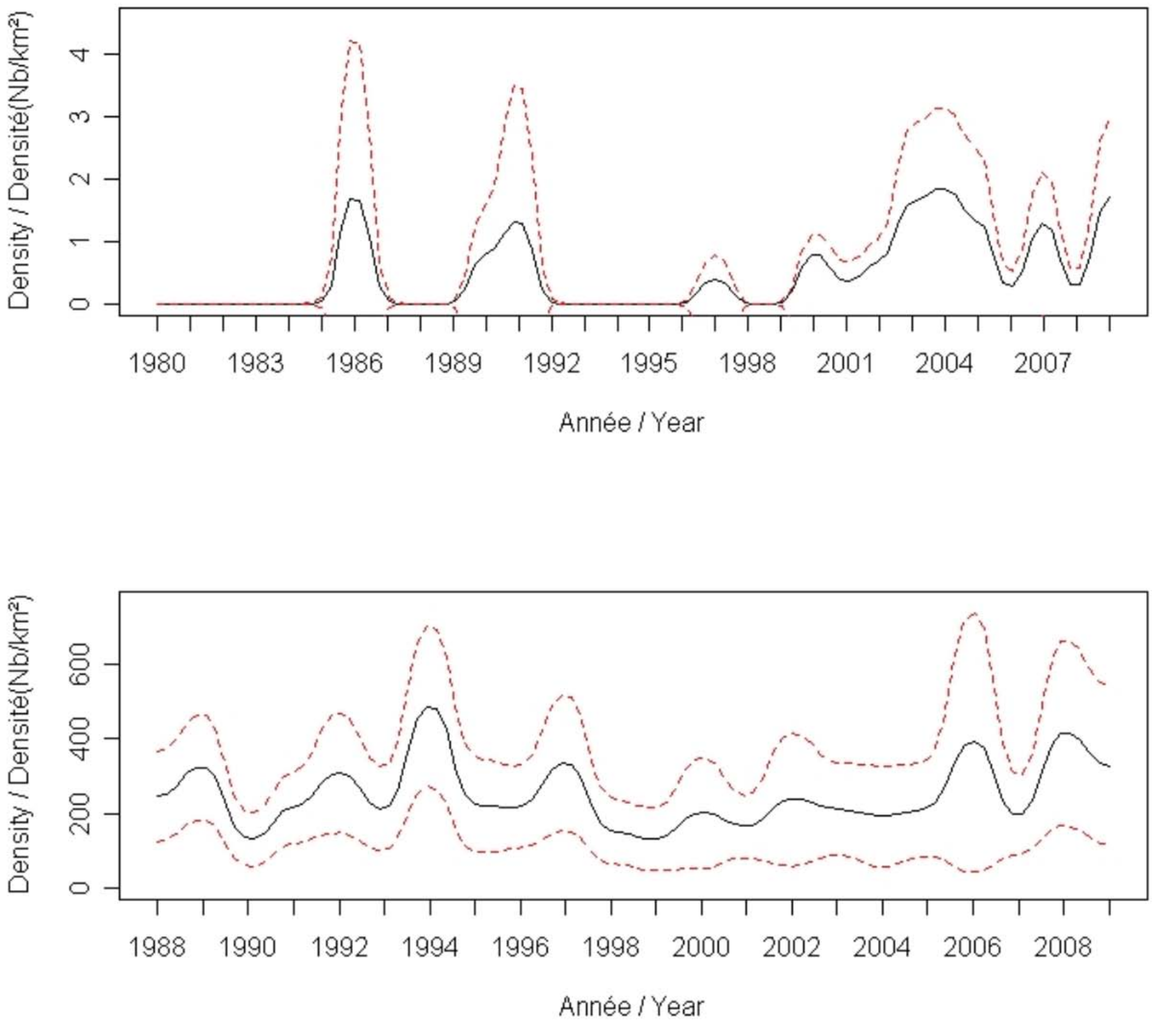



**Figure 1.9: Time series of abundance of red gurnard in the North Sea base on IBTS data (Nb/km²) from 1980 to 2009 in upper panel and in the eastern Channel base on FR-CGFS data (Nb/km²) from 1988 to 2009 in the lower panel.**

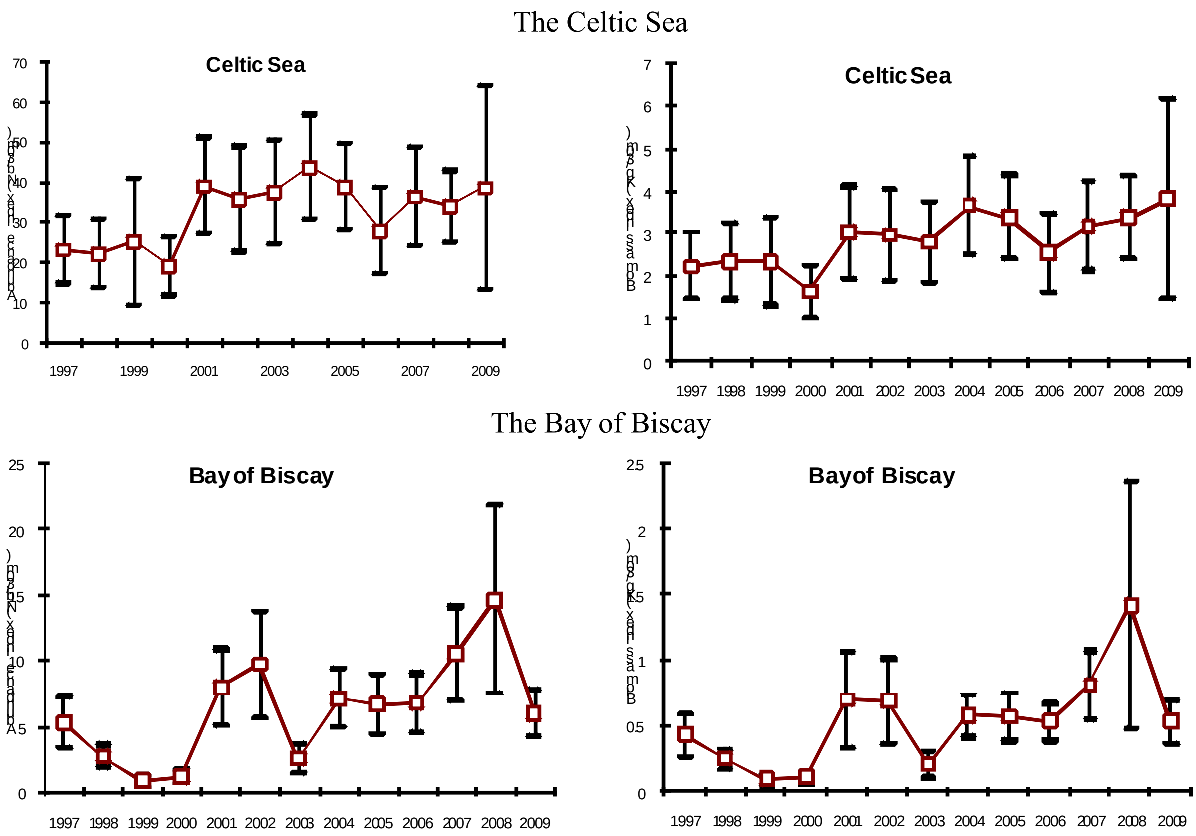



**Figure 1.10: Time series of abundance (Nb and Weight (kg)/30 min Trawl) of red gurnard in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009.**

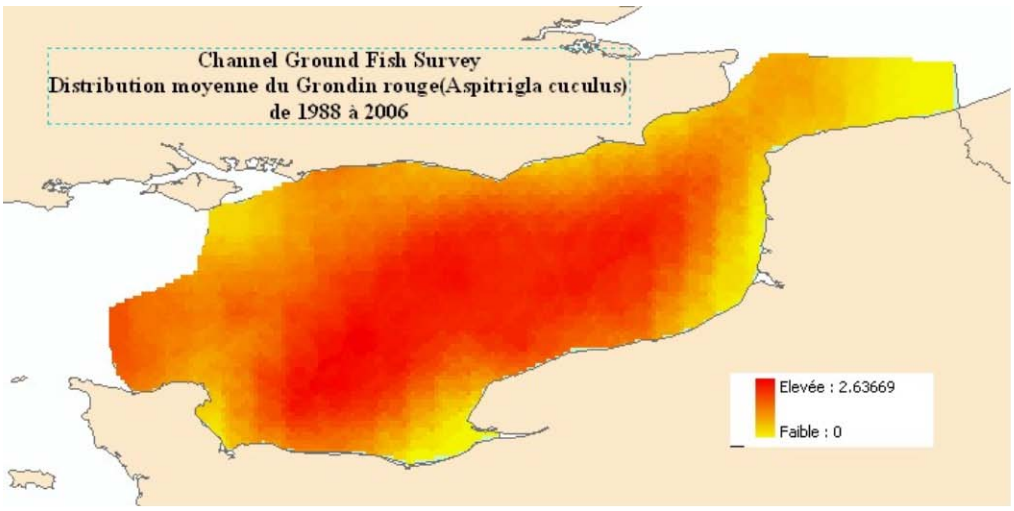



**Figure 1.11: FR-CGFS surveys series. Geographical distribution of red gurnard in Eastern Channel in October from 1988 to 2006**

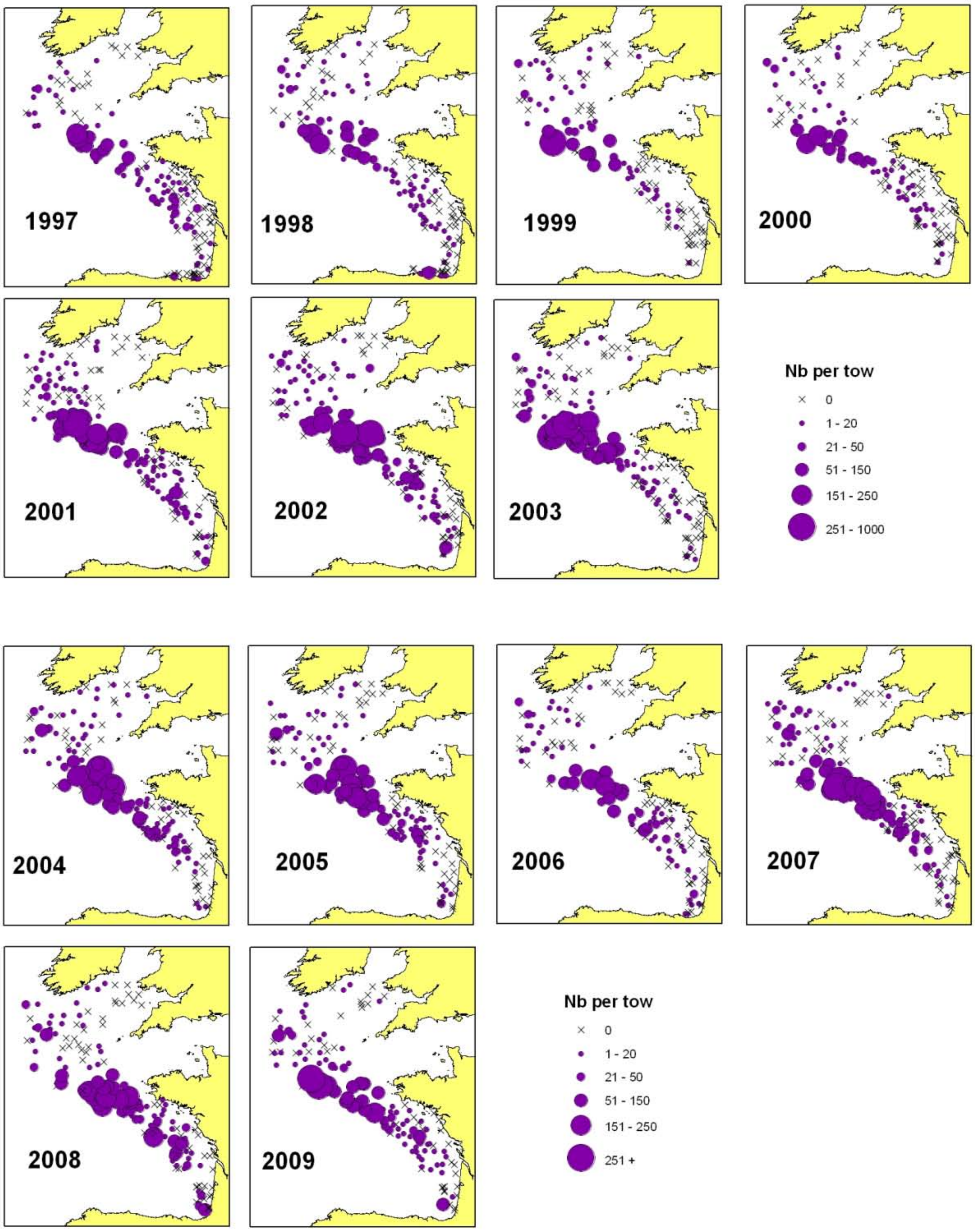



**Figure 1.12: Distribution of red gurnard in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009.**

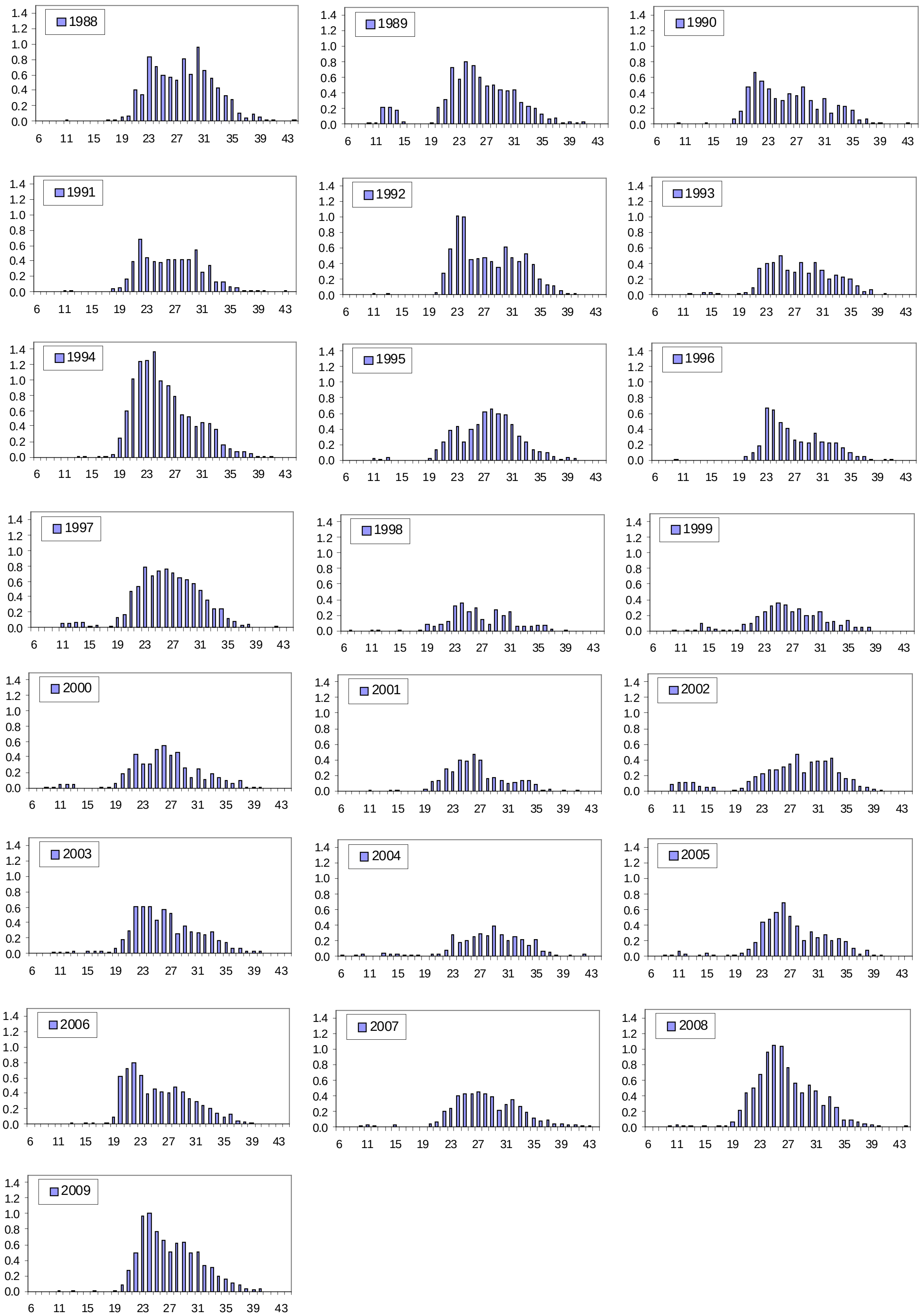



**Figure 1.13: Abundance index at length of red gurnard in Eastern Channel from FR-CGFS surveys series.**

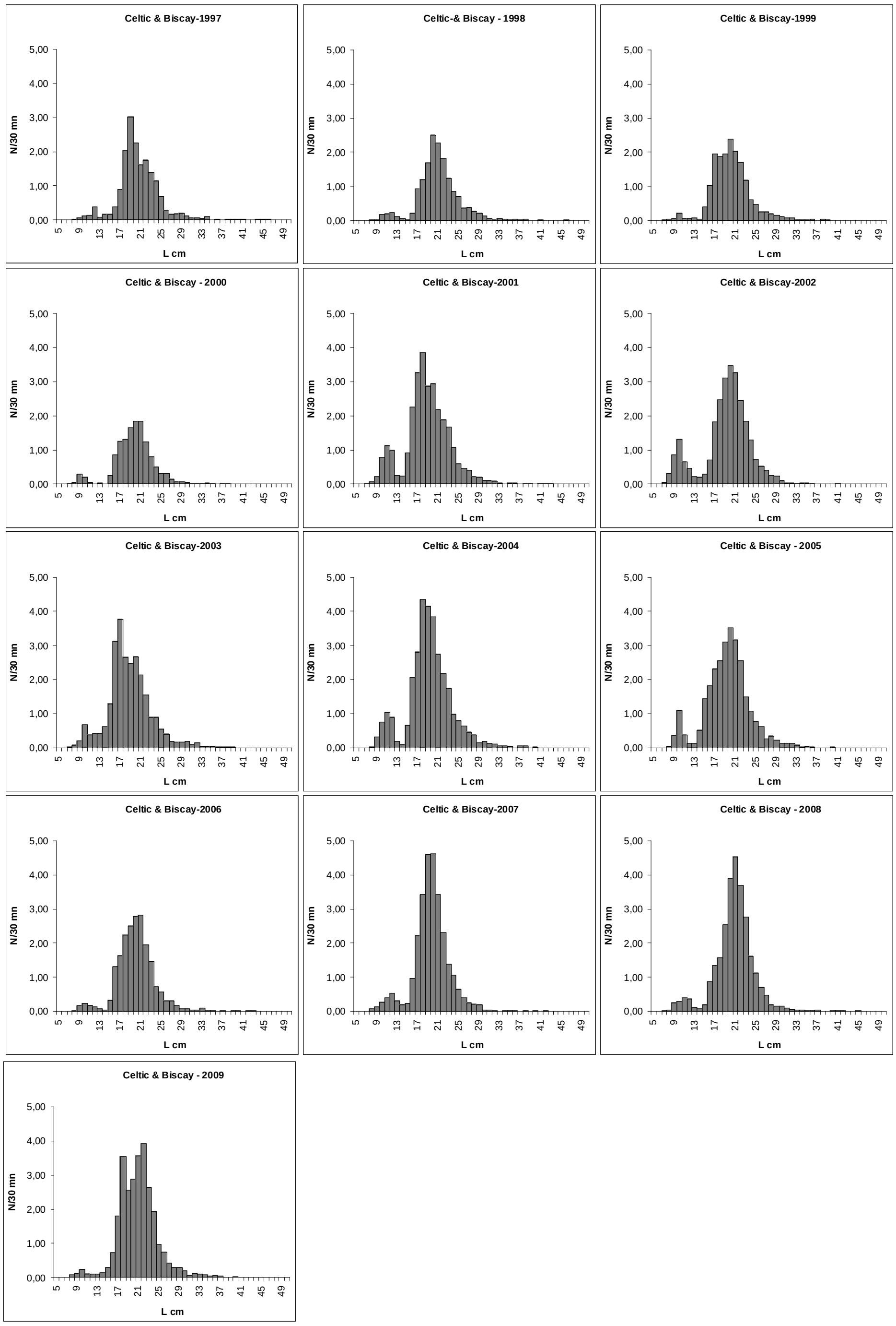



**Figure 1.14: Length abundance index of red gurnard in the combined areas of Celtic Sea and bay of Biscay from FR-EVHOE surveys series.**

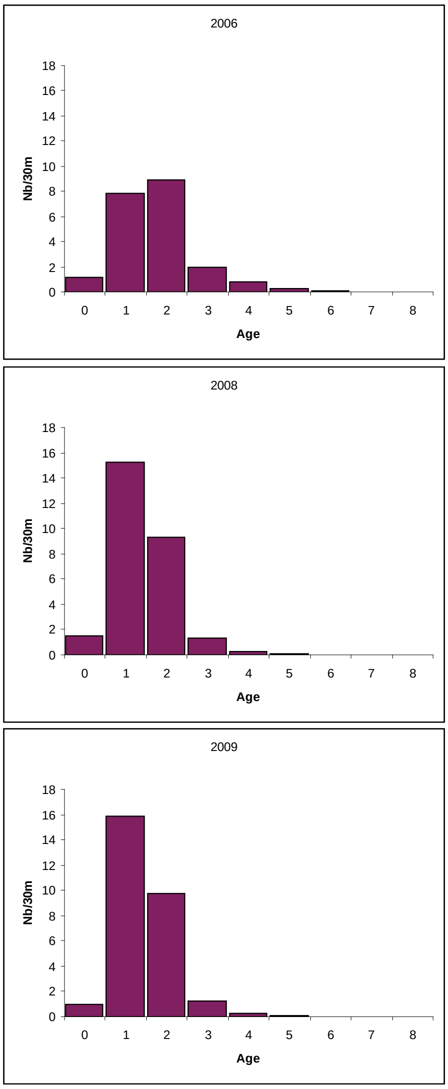



**Figure 1.15: Ab**undance index at age of red gurnard in the combined areas of Celtic Sea and bay of Biscay from FR-EVHOE surveys series for 2006, 2008 and 2009.

# Annex 4 - Grey gurnard

## 1.1 General biology [1])

Grey gurnard *Eutrigla gurnardus* occurs in the Eastern Atlantic from Iceland, Norway, southern Baltic, and North Sea to southern Morocco, Madeira. It is also found in the Mediterranean and Black Seas.

In the North Sea and in Skagerrak/Kattegat, grey gurnard is an abundant demersal species. In the North Sea, the species may form dense semi-pelagic aggregations in winter to the northwest of the Dogger Bank, in summer it is more widespread. The species is less abundant in the Channel, the Celtic Sea and in the Bay of Biscay.

Grey gurnard is most common on sandy bottoms, but also on mud, shell and rocky bottoms (Wheeler, 1978). Juveniles feed on a variety of small crustaceans. The diet of older specimens consists mainly of larger crustaceans and small fish. Spawning takes place in spring and summer. There do not seem to be clear nursery areas.

The maximum length is 50 cm.

It is a bycatch species in demersal fisheries. Catches are largely discarded.

## 1.2 Stock ID and possible assessment areas

No studies are known of the stock ID of grey gurnard. Based on IBTS survey data Heessen and Daan (1996) suggested that there may be three sub-populations in the North Sea and Skagerrak/Kattegat: one to north-west of the Dogger Bank, one around Shetland and one in the Skagerrak/Kattegat. A more recent distribution map (based on quarter 1 IBTS data for the period 1977–2005) suggests that there is indeed an area with low abundance between the North Sea and the Skagerrak, but that a more or less continuous distribution exists between the central and north-western North Sea. Grey gurnard from the North Sea may well be separated from grey gurnard in the Channel. Figure 1.1 shows that the species is almost absent from the southernmost stations of the Southern Bight. In the eastern Channel abundance of grey gurnard seems to be low compared to the North Sea (Figure 1.2). The distribution in the western Channel is not known. A higher abundance is observed in the Celtic Sea, whereas the species is almost absent from the Bay of Biscay (Figure 1.3).

## 1.3 Management regulations

There is no minimum landing size for this species and there is no TAC.

## 1.4 Fisheries data

Gurnards were often not sorted by species when landed. This is reflected in the catch statistics where different species of gurnards were often reported into one generic category of “gurnards”. Only some countries sometimes report landings of “grey gurnard” (see Table 1-1. Total international landings of grey gurnard from the whole ICES area as reported to FAO for the years 1975–2008 for landings data for 1975 - 2008). From this table it is also obvious that the catch statistics are incomplete for several years: some countries reporting no landings at all, other countries reporting exceptionally high landings.

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[1]) Most of the text is copied from the text on grey gurnard in ICES-FishMap (2005)

Grey gurnard from the North Sea is mainly landed for human consumption purposes. North Sea landings decreased gradually before World War II. After an initial post-war peak of 4000 t, annual landings stayed well below 2000 t until the early 1980s, when annual catches increased to around 40 000 t (Figure 1.4) because of Danish landings for reduction purposes. In the same period, however, there was some misreporting as well. The Netherlands did not report gurnards during the years 1984–1999. Recent international landings have been very low at around 300 to 500 t per year only.

Historically, grey gurnard is mainly taken as a by-catch in mixed demersal fisheries for flatfish and roundfish. However, the market is limited and the larger part of the catch appears to be discarded. Data for French discard sampling in 2005 and 2006 in different ICES areas are shown in Figure 1.5 and Figure 1.6. Information on discarding in the Dutch beam trawl fleet is shown in Figure 1.7. Owing to the low commercial value of this species, landings data will usually not reflect the actual catches very well.

## 1.5 Survey data / recruit series

For the North Sea and Skagerrak/Kattegat, data are available from the International Bottom Trawl survey. The IBTS can provide information on distribution and the length composition of the catches.

Grey gurnard occurs throughout the North Sea and Skagerrak/Kattegat. During winter, grey gurnards are concentrated to the northwest of the Dogger Bank at depths of 50–100 m, while densities are low off the Danish coast, in the German Bight and eastern part of the Southern Bight (Figure 1.1). The distribution pattern changes substantially in the spring, when the whole area south of 56°N becomes densely populated and the high concentrations in the central North Sea disappear until the next winter. Many gurnards are also caught in the northernmost part of the area throughout the year.

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 suggests a preference for higher water temperatures (Hertling, 1924; Daan *et al.* 1990).

During winter, grey gurnard occasionally form dense aggregations just above the sea bed (or even in midwater, especially during night time) which may result in extremely large catches. Within one survey, these large hauls may account for 70 percent or more of the total catch of the species. Bottom temperatures in high-density areas usually range from 8 to 13°C (Sahrhage, 1964).

Patterns in distribution of the small and large fish are similar in space and time (Knijn *et al.*, 1993).

Spawning occurs in spring and summer and, perhaps, in autumn (Russel, 1976), and may also explain the observed seasonal movements (Van der Land, 1990). For instance, the German Bight is invaded from April onwards by fish that apparently spawn there. Emigration to northern, deeper waters commences in September and by November only a few young specimens are left (Hertling, 1924).

Length frequency distributions per year are shown for areas IV and IIIa (Figure 1.9 and Figure 1.10). Average length frequency distributions for these two areas are given in Figure 1.11. In Skagerrak Kattegat two modes can be seen, whereas in the North Sea the smaller fish are only found in relatively small numbers.

Time series of abundance of grey gurnard, based on catches of all length classes combined during the IBTS quarter 1 survey in the North Sea (IV) and Skagerrak Kattegat (IIIa) are presented in Figure 1.12. The time series for the North Sea shows a clear upward trend, especially since the late 1980s. The peak in 1981 is presumably caused by a single very large catch in that year, caused by one of the enormous concentrations of fish that appear in that time of year. Also in Skagerrak Kattegat an increase can be seen since the same time as in the North Sea, but since a maximum was reached in 1993, catches decreased and have fluctuated widely around the same level since then.

## 1.6 Biological sampling

Biological data for this species are scarce. In the early 1990s some countries collected otoliths and information on maturity stages during the quarterly IBTS surveys and Table 1-3 provide an age-length key for females and for males based on sampling by CEFAS in the 4th quarter of 1992. For the same fish, Table 1-4 and Table 1-5 provide information on maturity-at-length.

## 1.7 Population biological parameters and other research

The maximum size reported by different authors ranges from 45 (Wheeler, 1978) to 50 cm (N.Daan pers. comm.). In the North Sea, specimens > 45 cm are rarely caught.

The winter catches in the North Sea are dominated by larger specimens, with a maximum abundance at 19–22 cm. In Skagerrak-Kattegat, the length frequency distribution has two clear peaks at 11–12 cm and at 16–18 cm, while larger fish are clearly absent (Figure 1.10). There are no reliable data on the age composition.

The length distributions are remarkably similar from year to year and do not indicate a clear year-class signal: small individuals are never very abundant. The absence of small fish in the North Sea suggests that the IBTS survey does not adequately cover the nursery grounds. It is possible that juveniles concentrate on rough bottoms, which have usually to be avoided to minimise damage to the fishing gear, or that they remain pelagic (ICES-FishMap).

Average length of 1-year-olds was 13-14 cm and of 2-year-olds 19–20 cm in samples collected during the first quarter of 1977–1978. Highest age reported was nine years. The average length of 8-year-old fish has been estimated at 35 cm (Damm, 1987) and 32 cm (MacDonald *et al.,* 1994). Females grow faster and live longer than males (Damm, 1987). This is supported by a survey in May 1992, where all specimens larger than 32 cm were females (Knijn *et al.,* 1993).

**Available von Bertalanffy growth parameters are given in the text table below:**

| Area | $L_\infty$ (cm) | K (yr-1) | $t_0$ (yr) | Reference |
|---|---|---|---|---|
| Brittany males | 34.4 | 0.85 | 0.14 | Baron, 1985 |
| Brittany females | 38.0 | 0.77 | 0.16 | Baron, 1985 |

Sexual maturity is said to be attained at between two and three years of age (Wheeler, 1978; Baron, 1985a, 1985b), but data from the North Sea from the first half of May 1992 show that specimens from about 15 cm onwards can be mature, males at a somewhat smaller length than females (Knijn *et al.,* 1993). The same can be seen in the data for the 4th quarter of 1992 presented in Table 1-4 andTable 1-5. This indicates that maturity may even be reached in 1-year old fish.

Studies in the Baie de Douarnenez (Brittany) have shown that the length at which 50% of males and females were mature were 29.4 and 31.2 cm, respectively (Baron, 1985a, 1985b). These values seem very high compared to the North Sea.

The spawning period is from April to August (Wheeler, 1978). Off the English north-east coast eggs are found from May to August (Harding and Nichols, 1987). The pelagic eggs are 1.3–1.5 mm in diameter, and the larvae hatch at a length of 3–4 mm (Russell, 1976).

Seasonal distribution maps indicate a marked seasonal northwest-southeast migration pattern that is rather unusual. The population is concentrated in the central western North Sea during winter and spreads into the south eastern part during spring to spawn. In the Kattegat and the northern North Sea, such shifts appear to be absent. The withdrawal from the colder coastal waters may reflect the southerly origin of the species (ICES-FishMap).

The lower three rays of the pectoral fins of gurnards are separate and well supplied with sense organs. They are used to 'walking' over the substratum and locating prey buried in the sea bed (Wheeler, 1978). Small crustaceans, such as the brown shrimp *Crangon crangon* and small crabs are major food items in terms of weight for small (< 25 cm) individuals, while stomach contents of larger specimens are dominated by a variety of fish species (De Gee and Kikkert, 1993). The fish component of the diet largely consists of juveniles (0- and 1-group) of commercially exploited species such as cod, whiting, sandeel and sole. Off Jutland, grey gurnard appeared to be a major predator on pelagic 0-group cod during June–July (De Gee and Kikkert, 1993). Specimens in Loch Etive (west coast of Scotland) were found to feed almost exclusively on mysids, euphausiids, and decapod crustaceans (Gordon, 1981). Due to their piscivorous behaviour, grey gurnard appears to play an important role in the ecosystem.

## 1.8 Analysis of stock trends / assessment

The information from landings is very poor, due to poor reporting (gurnard species are not always identified in the data, and probably also misreporting has occurred) and also because the low value of the species leads to massive discarding.

The status of the stocks in areas IIIa, IV and VIId,e is not known. Most informative are probably the time series based on the catches from the IBTS survey in the North Sea and in Skagerrak-Kattegat. Especially in the North Sea these show a marked increase since the late 1980s (Figure 1.12).

## 1.9 Data requirements

For management purposes information should be available on catches and on landings. The quality of landings data has been poor for this species because in the past only landings of "gurnards" were reported.

Little is known of the biological parameters of grey gurnard.

From the information presented here, it can be concluded that grey gurnard is of very limited commercial interest. It should be considered to exclude this species from the list of species dealt with by WGNEW.

### 1.10 References (not necessarily all mentioned in the text)


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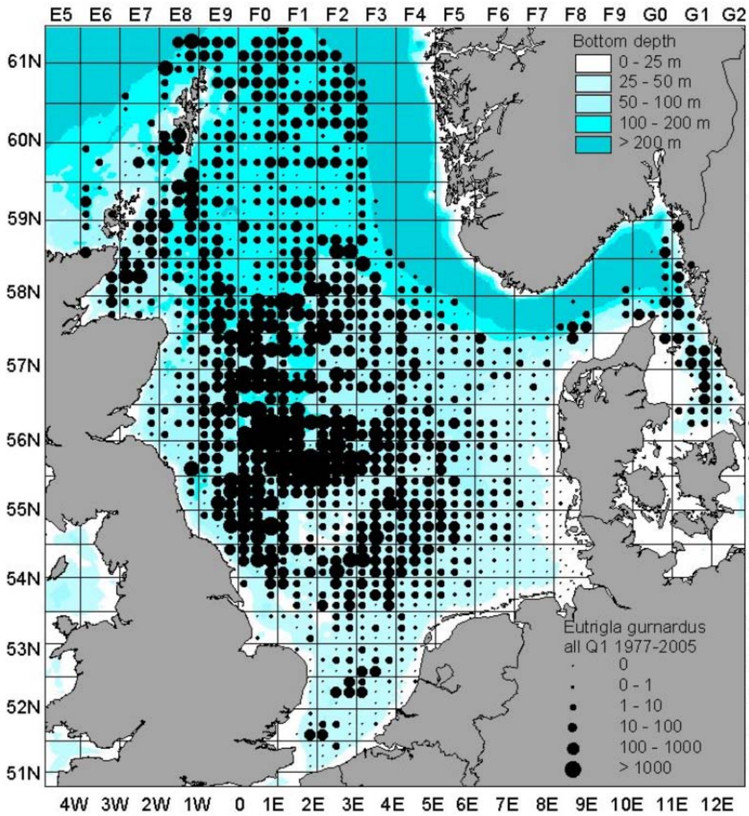



**Figure 1.1: Average annual catch (number per fishing hour for all length classes combined) for grey gurnard in the quarter 1 IBTS survey, 1977–2005 (ICES-FishMap).**

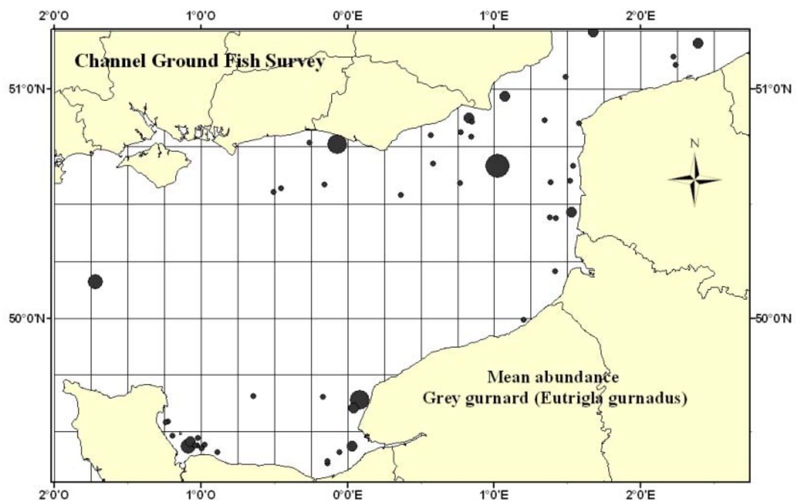



**Figure 1.2: Distribution of grey gurnard in the eastern Channel. CGFS survey 1988–2004**

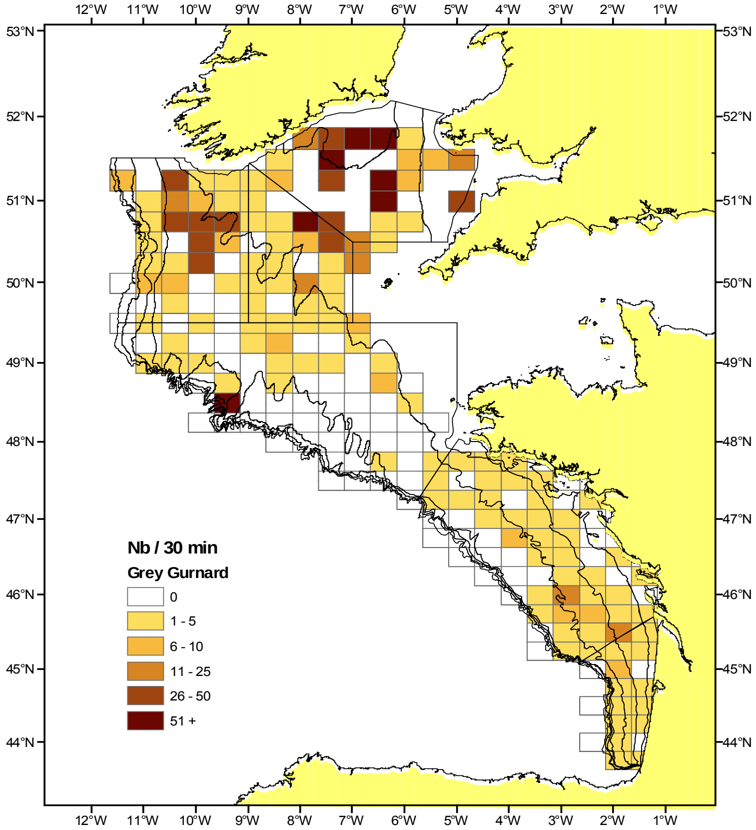



**Figure 1.3: Distribution of grey gurnard in the Celtic Sea and the Bay of Biscay. EVHOE survey, 1997–2004.**

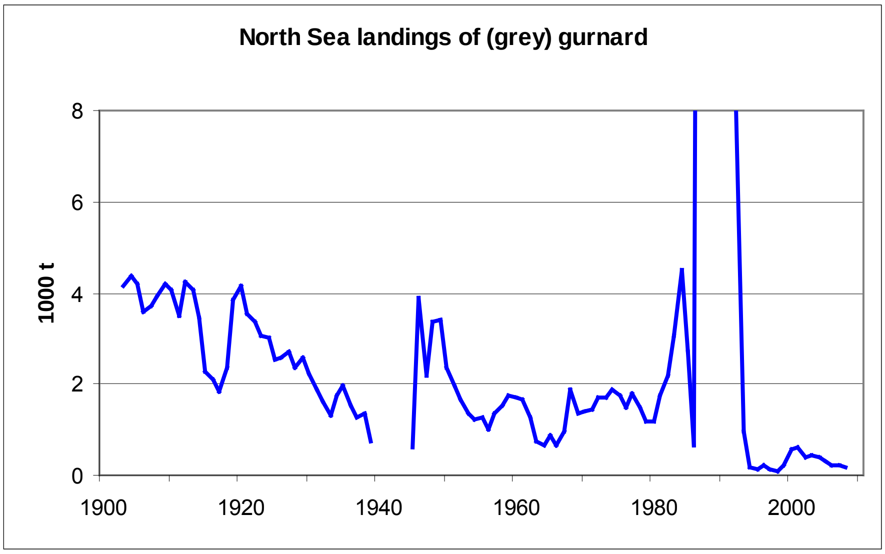



**Figure 1.4: Total international landings of gurnards from the North Sea, probably most of the landings consisted of grey gurnard. See text for further explanation.**

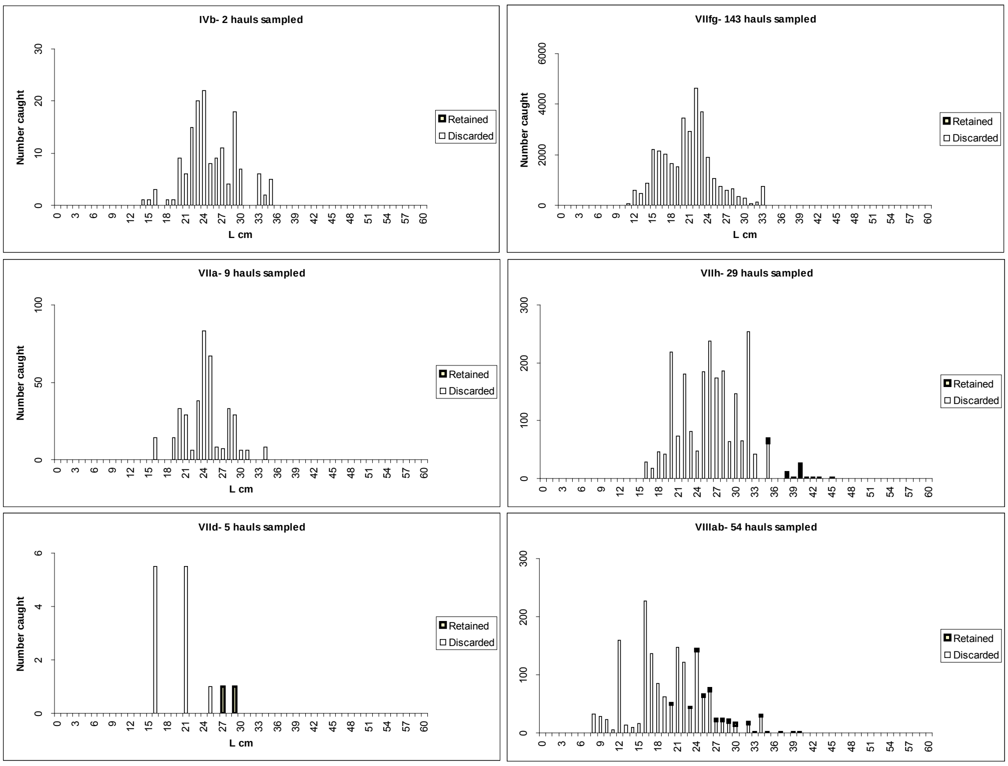



**Figure 1.5: Length composition of French catches of grey gurnard in 2005.**

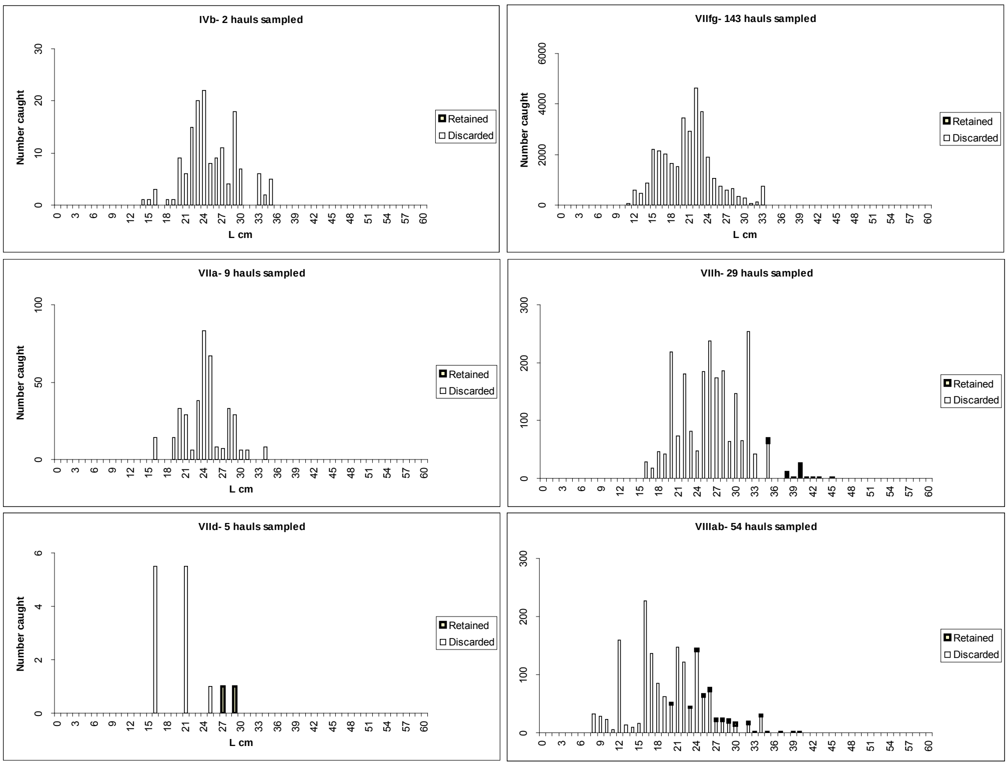



**Figure 1.6: Length composition of French catches of grey gurnard in 2006.**

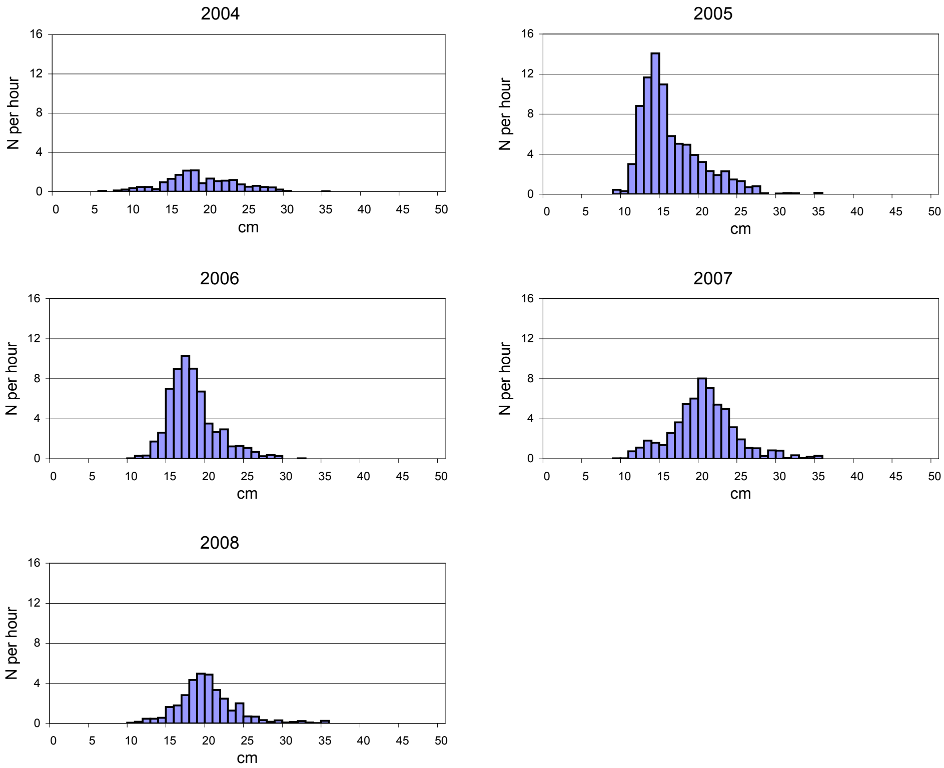
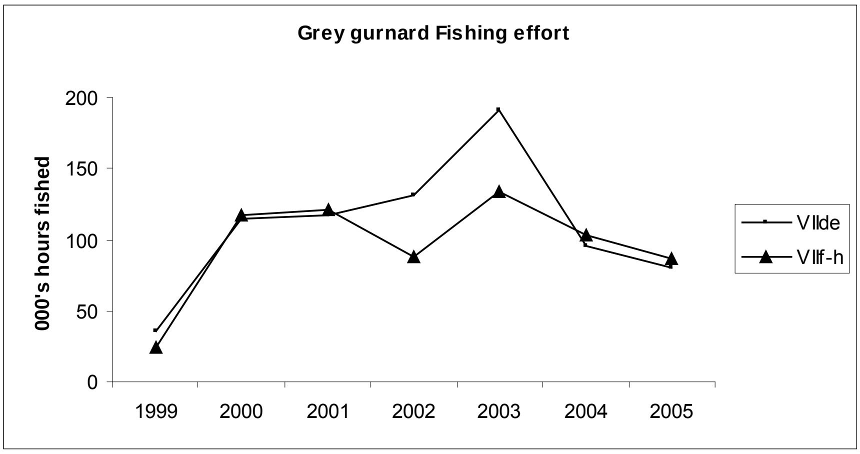



**Figure 1.7: Grey gurnard: number at length discarded per fishing hour by the Dutch beam trawl fishery in the years 2004 to 2008.**



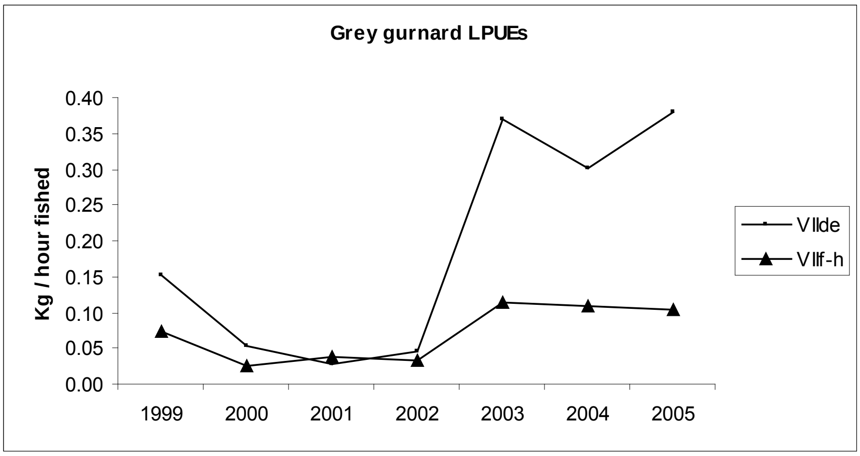




**Figure 1.8: Effort and landings per unit of effort for French single otter trawlers for areas VIId,e and VIIf–h for the years 1999 to 2005.**

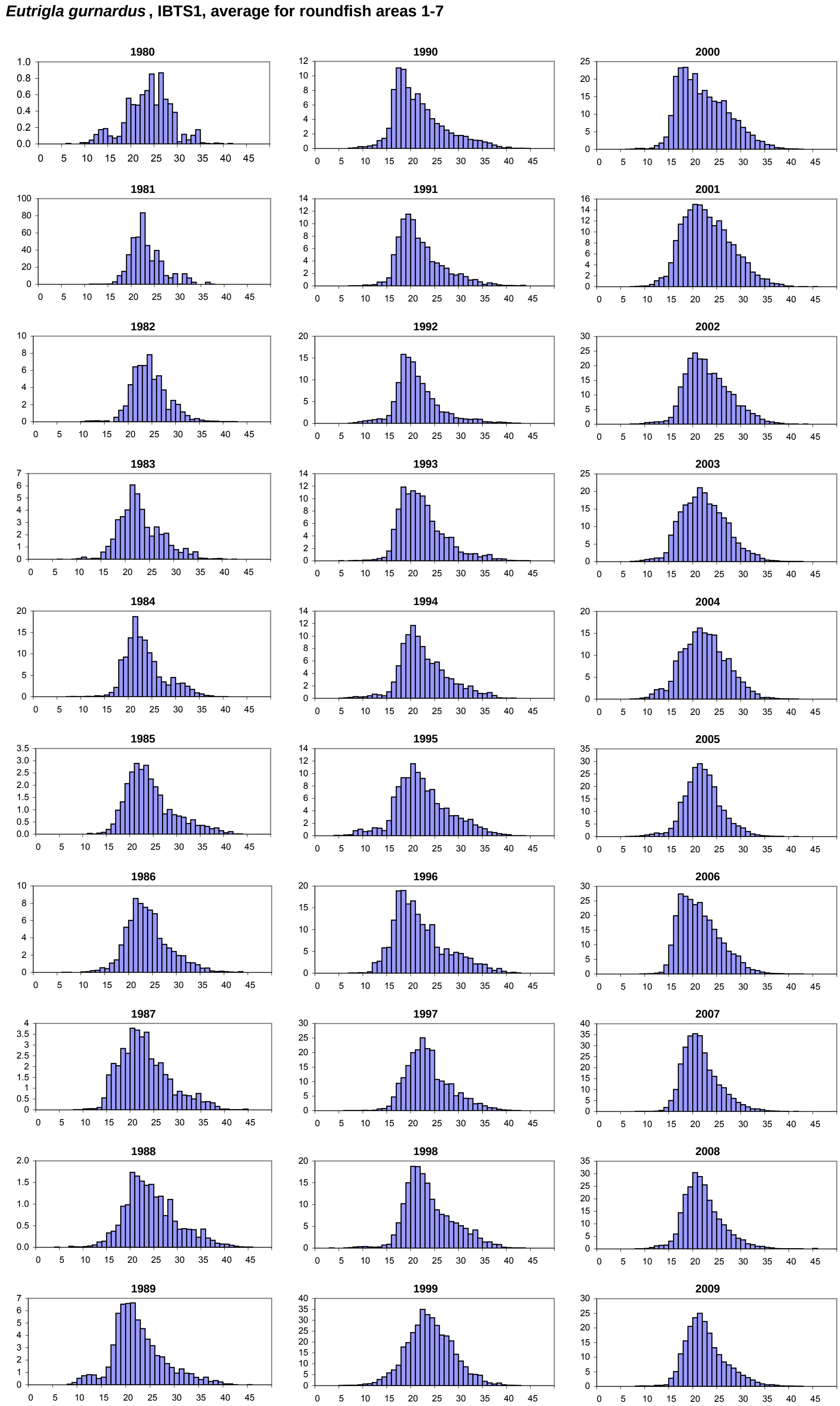



**Figure 1.9: Grey gurnard in IV: number at length during the quarter 1 IBTS survey.**

***Eutrigla gurnardus*** **, IBTS1, average for roundfish areas 8 and 9**

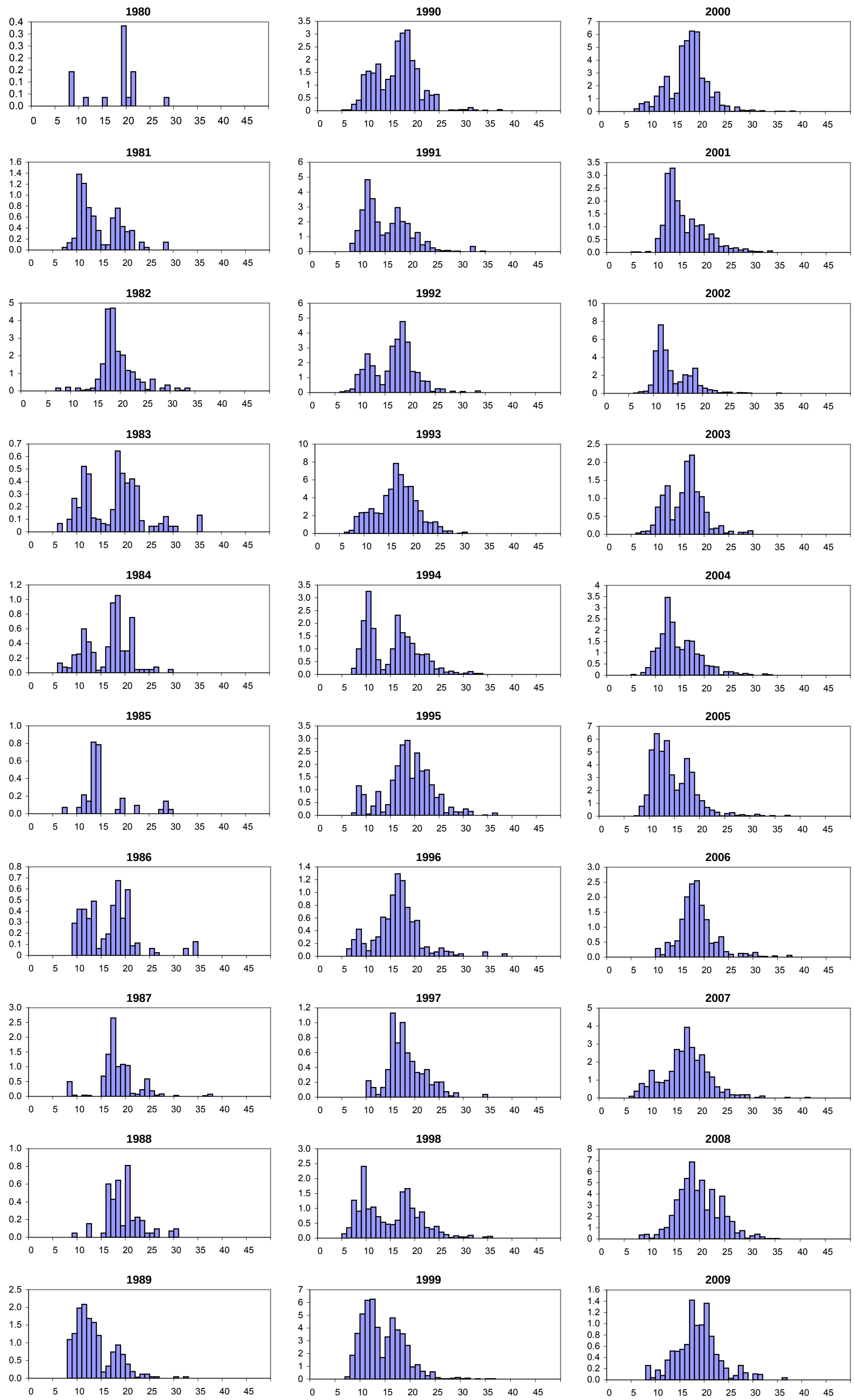



**Figure 1.10: Grey gurnard in IIIa: number at length during the quarter 1 IBTS survey.**

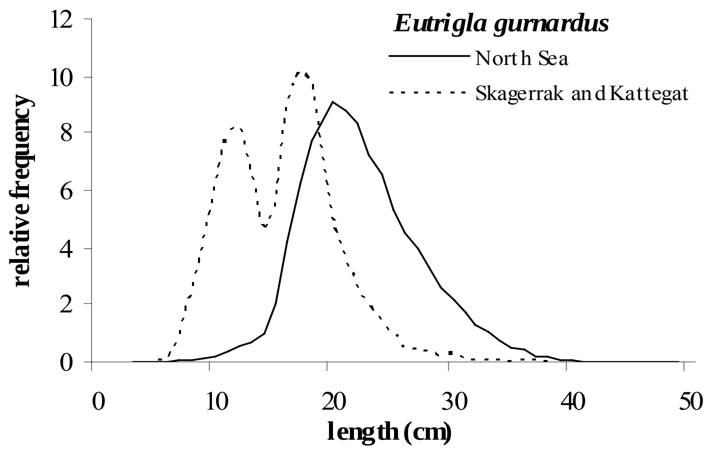
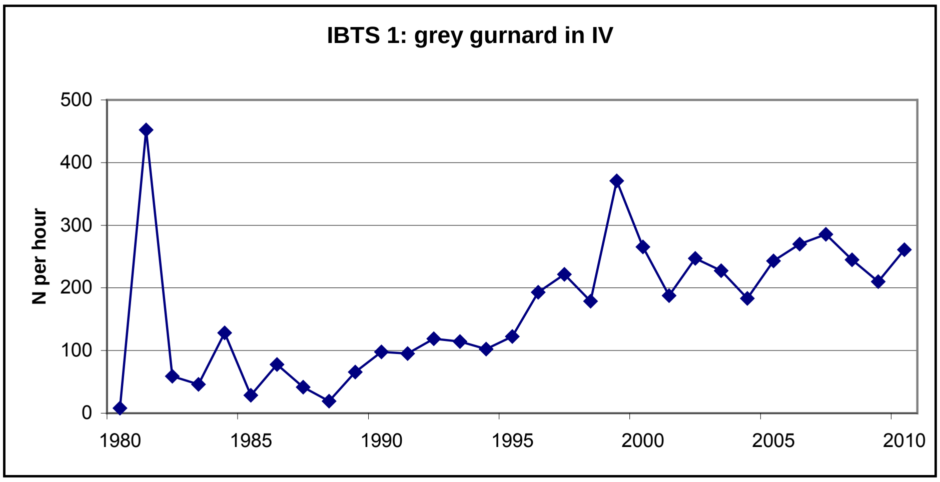



**Figure 1.11: Length frequency distribution of *E. gurnardus* based on the quarter 1 IBTS, 1985–2005 in the North Sea and in Skagerrak/Kattegat. (ICES-FishMap).**



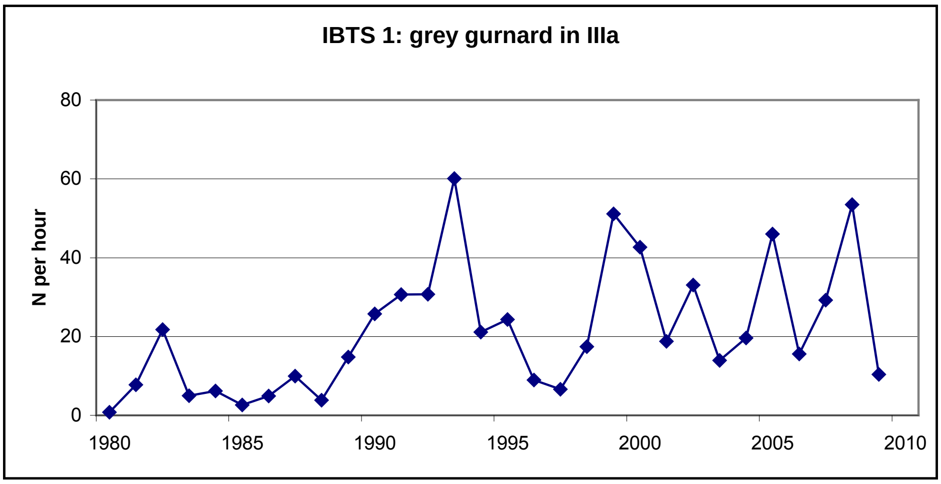




**Figure 1.12: Average catch rate (number per hour for all length classes combined) of grey gurnard in the North Sea (upper panel) and in Skagerrak and Kattegat (lower panel), based on quarter 1 IBTS.**

**Table 1-1: Total international landings of grey gurnard from the whole ICES area as reported to FAO for the years 1975–2008.**

| Country | Bel | Den | Faer | Fra | Icl | Irl | Net | Nor | Por | Russ | Swe | UK E&W | UK Sc | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | . | 14 | 0 | 0 | 14 |
| 1976 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | . | 69 | 0 | 0 | 69 |
| 1977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | . | 37 | 0 | 0 | 37 |
| 1978 | 0 | 0 | 0 | 222 | 0 | 0 | 0 | 0 | 0 | . | 54 | 0 | 0 | 276 |
| 1979 | 0 | 0 | 0 | 1,118 | 0 | 0 | 0 | 0 | 0 | . | 49 | 0 | 0 | 1,167 |
| 1980 | 0 | 0 | 0 | 1,172 | 0 | 0 | 0 | 0 | 0 | . | 38 | 0 | 0 | 1,210 |
| 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | . | 46 | 0 | 0 | 46 |
| 1982 | 0 | 360 | 0 | 895 | 0 | 0 | 0 | 0 | 0 | . | 43 | 0 | 0 | 1,298 |
| 1983 | 0 | 1,067 | 0 | 852 | 0 | 0 | 0 | 0 | 0 | . | 8 | 0 | 0 | 1,927 |
| 1984 | 0 | 4,041 | 0 | 400 | 0 | 0 | 0 | 0 | 0 | . | 7 | 0 | 0 | 4,450 |
| 1985 | 137 | 2,358 | 0 | 373 | 0 | 0 | 0 | 0 | 0 | . | 9 | 0 | 0 | 2,879 |
| 1986 | 0 | 314 | 0 | 638 | 0 | 0 | 0 | 0 | 0 | . | 10 | 0 | 0 | 962 |
| 1987 | 115 | 46,598 | 0 | 432 | 0 | 0 | 0 | 0 | 0 | . | 6 | 0 | 0 | 47,151 |
| 1988 | 116 | 38,237 | 0 | 655 | 0 | 0 | 0 | 0 | 0 | . | 3 | 43 | 0 | 39,054 |
| 1989 | 119 | 26,739 | 0 | 841 | 0 | 0 | 0 | 0 | 0 | . | 5 | . | 0 | 27,704 |
| 1990 | 110 | 22,076 | 0 | 704 | 0 | 16 | 0 | 0 | 0 | . | 3 | . | 0 | 22,909 |
| 1991 | 93 | 14,539 | 0 | 443 | 0 | 15 | 0 | 0 | 0 | . | 5 | . | 4 | 15,099 |
| 1992 | 118 | 8,136 | 0 | 259 | 0 | 17 | 0 | 0 | 0 | 0 | 10 | . | 10 | 8,550 |
| 1993 | 126 | 840 | 0 | 240 | 0 | 10 | 0 | 0 | <0.5 | 0 | 9 | . | 25 | 1,250 |
| 1994 | 79 | 99 | 0 | 194 | 0 | 0 | 0 | 0 | <0.5 | 0 | 12 | . | 24 | 408 |
| 1995 | 58 | 73 | 0 | 204 | 0 | 0 | 0 | 0 | <0.5 | 0 | 6 | . | 21 | 362 |
| 1996 | 122 | 70 | 0 | 220 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | . | 56 | 473 |
| 1997 | 64 | 36 | 0 | 217 | <0.5 | 0 | 0 | 0 | 0 | 0 | 5 | . | 59 | 381 |
| 1998 | 50 | 56 | 0 | 159 | <0.5 | 38 | 0 | 0 | 0 | 0 | 8 | . | 0 | 311 |
| 1999 | 48 | 86 | 0 | . | 0 | 0 | 0 | 0 | 0 | 0 | 132 | . | 0 | 266 |
| 2000 | 51 | 96 | 0 | 224 | 0 | 0 | 459 | 0 | 0 | 26,081 | 5 | . | 0 | 26,916 |

| Country | Bel | Den | Faer | Fra | Icl | Irl | Net | Nor | Por | Russ | Swe | UK E&W | UK Sc | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 32 | 289 | 0 | 216 | 0 | 0 | 295 | <0.5 | 0 | 3,155 | 4 | . | 46 | 4,037 |
| 2002 | 64 | 64 | 1 | 179 | 0 | 0 | 286 | 0 | 0 | 60 | 2 | . | 41 | 697 |
| 2003 | 38 | 92 | 0 | 159 | 0 | 0 | 320 | <0.5 | 0 | 263 | 7 | . | 26 | 905 |
| 2004 | 41 | 83 | 0 | 132 | 0 | 0 | 304 | <0.5 | <0.5 | 1,401 | 5 | . | 23 | 1,989 |
| 2005 | 39 | 73 | 0 | 124 | 0 | 0 | 246 | 0 | 0 | 2,456 | 9 | . | 22 | 2,969 |
| 2006 | 25 | 67 | <0.5 | 103 | 0 | 0 | 165 | 2 | 0 | 138 | 2 | . | 27 | 529 |
| 2007 | 20 | 38 | 12 | 97 | 0 | 0 | 166 | 5 | 4 | 0 | 3 | . | 54 | 399 |
| 2008 | 19 | 48 | 15 | 11 | 1 | 0 | 123 | 5 | 8 | 0 | 8 | . | 79 | 317 |

**Table 1-2: Age-length key for female grey gurnard from the North Sea (1992, quarter 4). Data provided by CEFAS.**

| Females | Age | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length (mm) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | Grand Total |
| 110 | 1 | | | | | | | | | | | 1 |
| 120 | 1 | | | | | | | | | | | 1 |
| 130 | 1 | | | | | | | | | | | 1 |
| 150 | | 5 | | | | | | | | | | 5 |
| 160 | | 6 | 2 | | | | | | | | | 8 |
| 170 | | 4 | 4 | | | | | | | | | 8 |
| 180 | | 2 | 4 | | 1 | | | | | | | 7 |
| 190 | | 3 | 3 | 1 | 1 | | | | | | | 8 |
| 200 | | 1 | 5 | | | | | | | | | 6 |
| 210 | | | 1 | 4 | | | | | | | | 5 |
| 220 | | | 3 | 4 | 1 | | | | | | | 8 |
| 230 | | | 1 | 2 | 2 | 1 | | | | | | 6 |
| 240 | | | | 1 | 3 | | | | | | | 4 |
| 250 | | | | 3 | 2 | 1 | 1 | | | | | 7 |
| 260 | | | | 2 | 2 | 2 | | 1 | | | | 7 |
| 270 | | | | 1 | 3 | 3 | 1 | | | | | 8 |
| 280 | | | | | 3 | 1 | 1 | 1 | | | 1 | 7 |
| 290 | | | | | 4 | 1 | 1 | 1 | | | | 7 |
| 300 | | | | | 2 | 1 | | | 1 | | | 4 |
| 310 | | | | | 1 | | 2 | 1 | | | | 4 |
| 320 | | | | | 1 | | | 1 | 2 | | 1 | 5 |
| 330 | | | | | 1 | | | 3 | 2 | | | 6 |
| 340 | | | | | 1 | 1 | | 2 | | 1 | | 5 |
| 350 | | | | | | 1 | | | | 2 | | 3 |
| 360 | | | | | 1 | | | | 1 | | 1 | 3 |
| 370 | | | | | | | 1 | | 1 | | | 2 |
| 380 | | | | | | 2 | | 1 | | 1 | | 4 |
| 390 | | | | | | | 2 | 1 | | 1 | 1 | 5 |
| 400 | | | | | | | | | | | | 0 |
| 410 | | | | | | | | | | | | 0 |
| 420 | | | | | | | | | | | 2 | 2 |
| 430 | | | | | | | | | | | 1 | 1 |
| 440 | | | | | | | | | | | | 0 |
| 450 | | | | | | | | | | | | 0 |
| 460 | | | | | | | | | | | 1 | 1 |
| Grand Total | 3 | 21 | 23 | 18 | 29 | 14 | 9 | 12 | 7 | 5 | 8 | 149 |

**Table 1-3: Age-length key for male grey gurnard from the North Sea (1992, quarter 4). Data provided by CEFAS.**

**Males**

| | Age | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length (mm) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | Grand Total |
| 140 | 1 | | | | | | | | | | | 1 |
| 150 | | 3 | | | | | | | | | | 3 |
| 160 | | 1 | 1 | | | | | | | | | 2 |
| 170 | | 4 | | | | | | | | | | 4 |
| 180 | | 2 | 5 | 1 | | | | | | | | 8 |
| 190 | | 1 | 3 | 1 | 1 | | | | | | | 6 |
| 200 | | 1 | 5 | | | | | | | | | 6 |
| 210 | | | 4 | 3 | 1 | | | | | | | 8 |
| 220 | | | 1 | 4 | | | | | | | | 5 |
| 230 | | | 1 | 3 | 3 | | | | | | | 7 |
| 240 | | | 1 | 2 | | 1 | | | | | | 4 |
| 250 | | | 1 | | 1 | 1 | 1 | | 1 | 1 | | 6 |
| 260 | | | | | 2 | 2 | 1 | | | | | 5 |
| 270 | | | | | 1 | | | | | 1 | 1 | 3 |
| 280 | | | | | 2 | 2 | | | | | 2 | 6 |
| 290 | | | | | | 1 | 1 | 1 | | | 2 | 5 |
| 300 | | | | 1 | 1 | 1 | 1 | | 1 | | | 5 |
| 310 | | | | | 1 | | 1 | | | | | 2 |
| 320 | | | | | 1 | 1 | | | | 1 | | 3 |
| 330 | | | | | 1 | | | | 2 | | | 3 |
| 340 | | | | | | 1 | | | 1 | | | 2 |
| 350 | | | | | | | 1 | 1 | | | | 2 |
| 360 | | | | | | | 1 | | | | | 1 |
| 370 | | | | | | | | | | 1 | 1 | 2 |
| 380 | | | | | | | 1 | | | 1 | | 2 |
| 390 | | | | | | | | | | | 1 | 1 |
| 400 | | | | | | | | | | | 2 | 2 |
| 410 | | | | | | | | | | | 1 | 1 |
| Grand Total | 1 | 12 | 22 | 15 | 15 | 10 | 8 | 2 | 5 | 5 | 10 | 105 |

**Table 1-4: Maturity data for female grey gurnard from the North Sea (1992, quarter 4). Data provided by CEFAS.**

FEMALES

| LENGTH | IMMATURE | MATURING | MATURE | SPENT | GRAND TOTAL |
|---|---|---|---|---|---|
| 110 | 1 | | | | 1 |
| 120 | 1 | | | | 1 |
| 130 | 1 | | | | 1 |
| 150 | 5 | | | | 5 |
| 160 | 5 | 2 | | 1 | 8 |
| 170 | 8 | | | | 8 |
| 180 | 5 | 1 | | 1 | 7 |
| 190 | 6 | 1 | | 1 | 8 |
| 200 | 4 | 1 | | 1 | 6 |
| 210 | 2 | 3 | | | 5 |
| 220 | 3 | 4 | | 1 | 8 |
| 230 | 2 | 1 | | 3 | 6 |
| 240 | 1 | 1 | | 2 | 4 |
| 250 | 2 | 3 | | 2 | 7 |
| 260 | 1 | 3 | | 3 | 7 |
| 270 | 2 | 3 | | 3 | 8 |
| 280 | | 3 | | 4 | 7 |
| 290 | 1 | 4 | | 2 | 7 |
| 300 | | 2 | | 2 | 4 |
| 310 | | 2 | | 2 | 4 |
| 320 | | 3 | | 2 | 5 |
| 330 | | 5 | | 1 | 6 |
| 340 | | 2 | | 3 | 5 |
| 350 | | 3 | | | 3 |
| 360 | | 1 | | 2 | 3 |
| 370 | | 2 | | | 2 |
| 380 | | 3 | | 1 | 4 |
| 390 | | 2 | 1 | 2 | 5 |
| 420 | | 1 | | 1 | 2 |
| 430 | | 1 | | | 1 |
| 460 | | | | 1 | 1 |
| Grand Total | 50 | 57 | 1 | 41 | 149 |

**Table 1-5: Maturity data for male grey gurnard from the North Sea (1992, quarter 4). Data provided by CEFAS.**

**Males**

| Length | Immature | Maturing | Mature | Spent | Grand Total |
|---|---|---|---|---|---|
| 140 | 1 | | | | 1 |
| 150 | 3 | | | | 3 |
| 160 | 2 | | | | 2 |
| 170 | | 4 | | | 4 |
| 180 | 6 | 1 | | 1 | 8 |
| 190 | 4 | 1 | | 1 | 6 |
| 200 | 3 | 3 | | | 6 |
| 210 | 6 | 2 | | | 8 |
| 220 | 3 | 1 | | 1 | 5 |
| 230 | 1 | 2 | | 4 | 7 |
| 240 | 1 | 1 | | 2 | 4 |
| 250 | 1 | 2 | | 3 | 6 |
| 260 | 1 | 1 | 1 | 2 | 5 |
| 270 | | 3 | | | 3 |
| 280 | 1 | 3 | | 2 | 6 |
| 290 | | 1 | | 4 | 5 |
| 300 | 1 | 2 | | 2 | 5 |
| 310 | | 1 | | 1 | 2 |
| 320 | 1 | 2 | | | 3 |
| 330 | | | | 3 | 3 |
| 340 | | 2 | | | 2 |
| 350 | | 2 | | | 2 |
| 360 | | 1 | | | 1 |
| 370 | | | | 2 | 2 |
| 380 | | | | 2 | 2 |
| 390 | | 1 | | | 1 |
| 400 | | 2 | | | 2 |
| 410 | | 1 | | | 1 |
| Grand Total | 35 | 39 | 1 | 30 | 105 |

# Annex 5 - Brill

## 1.1 General biology

The description of the general biology of brill *Scophthalmus rhombus* is largely based on the report 'Stock discrimination in relation to the assessment of the brill fishery' by Delbare and De Clerck (1999).

Brill is a shallow-water flatfish mainly found in areas close inshore. It prefers sandy bottoms, but can sometimes also be found on gravel and muddy grounds (while the eyed side of brill is often coloured olive green with dark and light spots, they are able to change colour of this side, matching the bottom they rest on). Its vertical distribution ranges from 4 meters to 73 meters, although small juvenile fish are often common in sand shore pools. Mature brill are rarely observed inshore, whereas immature specimens are often caught near the coast and even in estuaries.

The distribution of brill in the North Eastern Atlantic Ocean ranges along the European coastline from 64° N (the Lofotes) down to 30° N (northwest Morocco), extending into the Mediterranean and even into the Black Sea (rare in the latter, extreme eastern locations around 42°E) (Nielsen, 1986). Brill is also found in the Skagerrak, the Kattegat, and small quantities in the Baltic Sea. The western limit of its distribution area is reached in southern Iceland (around 25°W).

The feeding habits of this species closely resemble those of turbot and were extensively reviewed by de Groot (1971) and Wetsteijn (1981). The pelagic larvae feed primarily on copepod nauplii (mainly, but not entirely on Temora sp.), decapod and mollusc larvae. This diet is maintained until a total length of 10 cm is reached and complemented with larger prey organisms, e.g. polychaets, amphipods, mysids, and larvae of several fish species (e.g. Mugilidae). For brill within the size range 10–20 cm, the most important food items are sand gobies *Pomatoschistus mniutus*, dragonets *Callionymus* sp. and other small benthic fishes, with a smal proportion of mysids, crabs and shrimps. In this immature stage, the diet changes gradually. In the size range 20–40 cm brill feeds mainly on sandeels (Ammodytidae) and sand gobies. In southern areas the diet is complemented with anchovy *Engraulis encrasicolus* and solenette *Buglossidium luteum*. Crabs are almost the sole invertebrates eaten. With increasing length, the dominant species on its menu changes from sandeels for the size range 30–50 cm to gadoids for the size range > 50 cm, e.g. whiting Merlangius merlangus and cod *Gadus morhua*. Larger brill (41–85 cm) are primarily piscivorous with their diet consisting of gadoids (e.g. poor-cod *Trisopterus minutus,* bib T. luscus, whiting and haddock *Melanogrammus aeglefinus*) and to a lesser extent of sandeels, clupeoids (e.g. sprat *Sprattus sprattus*) and flatfish. Occasionally invertebrates such as squid and shrimps are eaten. Wetsteijn (1981) however did not find haddock, plaice *Pleuronectes platessa* or sole Solea solea in the stomachs of brill, which could be explained by a variable diet according to seasonal and geographical patterns.

## 1.2 Stock identity and possible management areas

The oldest study that could be found containing information on the genetic structure of brill was carried out by Blanquer *et al*. (1992), using allozyme electrophoresis of the brill-specific cestode parasite *Bothriocephalus barbatus* (because of the constant arms race between parasites and their hosts, parasite phylogeography can be expected to reflect host phylogeography). No genetic differentiation could be found between Atlantic and Mediterranean populations of *B. barbatus,* suggesting that there are also very low levels of differentiation in brill from different areas. However, newer techniques involving the use of more variable genetic markers instead of proteins (allozymes) are expected to shed a new light on the differentiation between different potential brill populations.

In the EU funded study on 'Stock discrimination in relation to the assessment of the brill fishery' the following was concluded (Delbare and De Clerck, 1999).

"Field surveys revealed that brill was widely distributed, but at low densities throughout the south-eastern part of the Atlantic, mainly along the continental coastlines. Aggregations of brill were found in the North Sea in the area of the Wadden Sea and the German Bight, in the Irish Sea in the Cardigan Bay and the Carmathen Bay, and in the English Channel in the vicinity of the Hurd Deep.

The genetic research carried out in this study revealed a high variation in the sequenced part of the D-loop. Furthermore, only a weak geographical differentiation in the D-loop sequence of brill throughout its distribution area in the North-eastern Atlantic was observed. This was in agreement with the results obtained from the biological parameters, as the composition of commercial Belgian brill landings, growth rate and reproduction characteristics. However, there is an indication that the North-eastern Atlantic brill can be separated into two groups: a first group of brill occupying the Bay of Biscay, the English Channel, the Celtic Sea and the Irish Sea, and a second group in the North Sea, Skagerrak and Kattegat. The first group can further be split up into two subgroups: English Channel-Celtic Sea and Irish Sea-Bay of Biscay.

As a final conclusion, biological parameters (composition of Belgian brill landings, growth rate and reproduction characteristics) and the sequencing of the D-loop resulted in insignificant differences between brill from the different areas. Therefore, arguments favour the hypothesis that brill from the NE Atlantic might be considered to be only one population: the North-eastern Atlantic brill population. Further research on spawning areas and migration through respectively egg surveys and tagging experiments, could generate valuable information about (sub-)population structures of brill throughout its entire distribution area. Therefore it is advisable to extend the sampling area to the Mediterranean Sea and the Black Sea."

In 2009 a new genetic study of brill (PhD-research Sara Vandamme) was initiated by ILVO-Fisheries and the University of Leuven, investigating the phylogeography of brill all over its distribution area (around Europe from the Baltic to the Black Sea) and the connectivity between (sub)-populations or potential management units (based on the adult population components). Because separate analyses of mitochondrial DNA (generally only maternally inherited but very useful in phylogeographic studies because of the large uncoding regions that lack important selective pressures, and their high mutation rates) and nuclear DNA (biparentally inherited) can lead to conflicting results, this study combines both nuclear (microsatellites) and mitochondrial markers (whereas Delbare & De Clerck, 1999, only used mitochondrial DNA). Comparative analyses of nuclear and organelle genetic markers may help delineate evolutionarily significant units or management units, although population differentiation estimates from multiple genomes can also conflict. In this study, brill from the North Sea, English Channel, Celtic Sea, Irish Sea, Gulf of Biscay, Baltic Sea, Mediterranean Sea and Black Sea are analysed. Generally, sufficient numbers of samples (min. 50 per area) have been collected for all areas (except for the Black Sea where brill is a very rare species), adding to the strength of the results obtained. Genetic variation in brill was found to be of mean to high levels, but the analyses have only just started and the results are still preliminary. Differentiation between potential biological populations and/or management units, and the levels of connectivity between these units, will be characterized in the next step of this research.

General conclusions: The use of both nuclear and mitochondrial DNA as tools to unravel the genetic structure of brill over its entire distribution area, and the levels of connectivity between different subareas, is expected to generate more detail and certainty than the studies by Blanquer *et al*. (1992) and Delbare & De Clerck (1999). Combining the results of this genetic study with variation in biological parameters will provide an important potential basis for population delineation and therefore of potential management units. However, also further research on brill spawning areas (egg surveys), and of migration of adult (tagging experiments) and especially immature brill (tagging experiments and genetic analysis of the immature population components) could still generate valuable information about (sub-)population structure of brill throughout its entire distribution area.

## 1.3 Management regulations

So far, no analytical assessments leading to fisheries advice have been carried out for brill by ICES. The available information is inadequate to evaluate stock trends. Therefore, the state of the stock(s) is unknown. Also STECF has no access to any stock assessment information. No explicit objectives have been defined for potential stocks of this species, no precautionary reference points have been proposed, and no management plans are in place. However, for the EC-waters in Division IIa and Subarea IV, precautionary Total Allowable Catches have been defined for brill and turbot (combined) in the past. These TACs belong entirely to the EC-fisheries, and a historical overview is presented in Table 1-1.

**Table 1-1: Historical overview of combined TACs for brill Scophthalmus rhombus and turbot Psetta maxima in Division IIa and Subarea IV**

| YEAR | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TAC | 9000 | 9000 | 6750 | 5738 | 4877 | 4550 | 4323 | 4323 | 5263 | 5263 | 5263 |

No restriction on the minimum length for landing brill is imposed by the EC. In several geographical areas however, Minimum Landing Sizes (MLS) have been installed for brill by different authorities. The most frequently applied MLS is 30 cm (e.g., in Belgium, the Baltic, the English Sea Fisheries District Cornwall, …).

## 1.4 Fisheries data

### Landings in all areas

Table 1-2 summarizes the brill landings by area as reported to ICES and the EC (Source: Eurostat database). Over the period 1973 – 2008, total landings (all areas) ranged from 1460 t to 3838 t per year, with the lowest landings in the second half of the eighties and the highest peak in the early nineties. In the last decade, the total landings of brill varied between 2000 and 3000 t. The North Sea accounts for the major part of these landings (Figure 1.1), generating 45-50% of the totals in the past ten years (up to more than 60% halfway the seventies). The English Channel is the second most important fishing grounds for brill, with a mean landings percentages of 20% over the entire time-line and an increasing share of the total landings in recent years (23% of the total landings in the last decade). Fishing grounds from where the landings represent on average between 3 and 10% of the total landings over the entire time-line are IIIa, VIIa, VIIf-k, VIII and IX. Landings from other areas are negligible.

#### Landings in the North Sea (IV)

International landing series from the Skagerrak were composed for brill (source: Eurostat database) and can be consulted in Table 1-3 and Figure 1.2. Over the period 1973-2008, these landings ranged from 260 t to 2439 t per year (but, for 1984-1987 no data from the Netherlands were uploaded in Eurostat). The Netherlands landed on average 66% of the North Sea brill. Other countries contributing to the total landings were –in descending order of importance – Belgium (average 14%), UK (average 9%), Denmark (average 7%), Germany (average 3%) and France (average 1%). Norway only appears in the landing statistics from 1991 onwards (average 0,5%), while Ireland and Sweden only landed negligible quantities of North Sea brill in 1979 and 1992 respectively.

#### Landings in the Skagerrak (IIIa)

International landing series from the Skagerrak were updated for brill (compared to Moreau, 2010a; source: Eurostat database) and can be consulted in Table 1-4 and Figure 1.3. Over the period 1973-2008, these landings ranged from 59 t to 389 t per year. Denmark landed on average 83% of the Skagerrak brill. Other countries contributing to the total landings were - in descending order of importance – Sweden, Norway, the Netherlands (mainly because of a peak in the second half of the seventies), Germany and Belgium.

#### Landings in the English Channel (VIId,e)

International landing series from the English Channel were composed for brill (compared to Moreau, 2010a; source: Eurostat database) and can be consulted in Table 1-5 and Figure 1.4. In the period 1973-2008, these landings ranged from 81 t to 894 t per year, but if we leave out 1974 and 1999 (no French brill landings from VIIde in Eurostat for these years) total landings were always above 137 t. France and the UK have always been the main contributors to the brill landings from the English Channel (41% and 37% respectively, over the entire time-line), with Belgium in third place (21%). In the past decade, mainly the Belgian landings became relatively bigger, leading to a shift in the proportions towards 36% for France, 36% for the UK and 28% for Belgium over this period. The Netherlands, Ireland and Denmark landed negligible quantities.

#### Landings in the Celtic Sea (VIIf-h)

International landing series from the Celtic Sea were composed for brill (compared to Moreau, 2010a; source: Eurostat database) and can be consulted in Table 1-6 and Figure 1.5. Between 1973 and 2008, these landings ranged from 35 t to 269 t per year. However, two very different periods can be distinguished within this time range, with average annual landings of 83 t from 1973 to 1984, and 195 t from 1985 to 2008 (mainly due to an increasing interest from the UK). Recently, also Irish and Belgian brill landings became more important. In the past decade, the main countries contributing to brill landings from the Celtic Sea were - in descending order of importance – France (33%), Belgium (30%), the UK (23%) and Ireland (14%). Negligible quantities have been landed by the Netherlands in some years.

#### Landings in the Irish Sea (VIIa)

International landing series from the Irish Sea were composed for brill (compared to Moreau, 2010a; source: Eurostat database) and can be consulted in Table 1-7 and Figure 1.6. Over the period 1973-2008, these landings ranged from 71 t to 254 t per year (with average landings of 101 t over the past ten years). Historically, the UK accounted for the biggest share of brill landings in the Irish Sea (53% of the total landings over the entire time-line), with Ireland and Belgium in second and third places (22% and 21% respectively over this period). Other countries contributing to the total landings were - in descending order of importance – France, the Netherlands and Poland.

### 1.4.1 Fishery descriptions

### 1.4.2 Fisheries in Belgium

Brill is mainly caught in mid-class (301–900 Hp) and large (> 900 Hp) beam trawlers. These vessels are mostly flatfish directed (particularly towards plaice and sole, together with the associated by-catch species such as turbot, brill, dab, lemon sole, anglerfish and some roundfish), and usually operate in the central and southern North Sea (ICES Sub-areas IVb and IVc), the English Channel (VIId,e), the Irish Sea (VIIa), the Celtic Sea (VIIf,g) and the inner part of the Bay of Biscay (VIIIa,b). Brill is mainly caught in the southern North Sea and the English Channel. Landings from the Bay of Biscay are negligible. The average effort and the average landings of brill for the Belgian beam trawl fleet for the period 1996-2005 is presented in Figure 1.7.

### 1.4.3 Fisheries in France

Bottom trawlers and netters are the main métiers in France. They account for more than 70% of the brill landings from ICES areas VII and VIII. Brill is not targeted, but can be an important by-catch during some seasons and in some fisheries (monkfish nets or sole nets).

Netters using tangle nets or trammel nets with large mesh target monkfish, crayfish, rays and brill (mainly in spring). They also land turbot during summer. Each boat can have between 5 and 50 km of nets at sea. Most boats make daily trips and the immersion time of the nets is usually 3 days. In the 1990s about 100 vessels fished in the western Channel and about 30 vessels fished north to the Seine Bay in area VIId.

The métiers in the English Channel catching brill are described in Guitton et al., 2003.

In the 1990s, discarding practices in bottom trawling and netting fisheries were studied during the whole year (Morizur et al., 1996). Discarding was low in netting and mainly occurred when the immersion time was too long (e.g. due to bad weather).

### 1.4.4 Fisheries in the Netherlands

Brill is caught as part of the by-catch in the beam trawl fishery for plaice and sole. Probably only the very small brill specimens will be discarded. Discard data have been collected during recent years and an overview of discards can be made.

### 1.4.5 Fisheries in Spain

The Basque fleet operating in areas VI, VII and VIII, and targeting mainly hake, megrim and monkfish have a wide range of bycatch species such as sea bass, brill, turbot, gurnards and mullets. Long liners account for the major part of the turbot landings. The origin of the brill landings in the Basque fleet are presented in Figure 1.8.

### 1.4.6 Fisheries in the UK

The majority of landings are in Divisions VIId, e and f and are landed into the UK. Data by gear group are available.

### 1.5 Survey data

Cefas conducts several annual surveys in western waters in which brill are routinely measured and biological information is retained. Four of the most important surveys are the Irish Sea (VIIa, VIIfg) beam trawl survey, the Channel (VIId) beam trawl survey, the Carhelmar (VIIe) commercial beam trawl survey and the English groundfish (IVb & c) GOV trawl survey. All fish caught are routinely measured during these surveys, and on most surveys also biological information is collected for brill. A summary of the numbers of fish measured and the numbers of biological samples (otoliths, length, weight, sex and maturity) in four Cefas survey series is given in Table 1-8 and Table 1-9 , respectively.

In addition, data on length distributions, distributions and abundance of brill is available in Cefas technical reports for the Irish Sea beam trawl survey (Parker-Humphreys, 2004a), the English Channel and southern North Sea (Parker-Humphreys, 2004b) beam trawl survey and the Young Fish Survey for the south and east coasts of (Rogers *et al*., 1998).

Under the NESPMAN project, survey-data on brill were requested from different national databases for the Skagerrak (IIIa), the English Channel (VIId,e), the Irish (VIIa) and Celtic Seas (VIIf-h). Time series of abundance (over all sizes and by size-class) and length frequency distributions (annual and average) can be presented for all areas covered in this study, but the series should be updated and analysed. Catches of brill are generally very low on surveys however. A relatively low trawling speed allows bigger fish like brill to actively escape the nets more easily than smaller fish can. Also the generally short trawl durations on bottom trawl surveys add to a decrease in the chance to encounter an individual brill. Their piscivorous habits classify them as predators, that typically are distributed over an area more scattered than other species that target food resources that are more widely available. Unfortunately, these low catch numbers very often result in an underrepresentation of some year-classes (mainly the older ones), leading to a poor quality of the resulting survey abundance series and indices, and poor agreement among different surveys.

## 1.6 Biological sampling

#### 1.6.1 DCF-requirements and Member States sampling intentions

Appendix VII of Commission Decision 2010/93/EU lists biological variables with species sampling specifications for all ICES areas. Table 1-10 gives an overview of what this implies for brill (sampling for fecundity is optional). Brill is classified as a Group 2 species under the DCF (internationally regulated species and major non-internationally regulated by-catch species, that don't drive the international management process and are not under EU management plans, EU recovery plans, EU long term multi-annual plans or EU action plans for conservation and management based on Council Regulation 2002/2371/EC). Group 2 species only require data on weight, sex-ratio and maturity to be collected every three years.

In Table 1-11, the sampling intensions of all Member States that inscribed sampling of biological parameters for brill in their national proposals, were compiled, and can directly be compared to the required numbers in Table 1-10. For the North Sea and the Eastern English Channel, the joint effort of Belgium, the Netherlands and the UK leads to sufficient sampling for age, weight, sex-ratio and maturity of turbot (green fields; for these parameters only 125 individuals are required under the DCF). Also for Subarea VII (excl. VIId), the minimum DCF-requirements will be met by the UK plans to collect biological information on 150 individuals in the Western English

Channel and the Celtic Sea, whereas only 125 individuals should be documented in the western waters (green fields). All of the countries mentioned above plan to collect this biological information every year in the period 2011-2013 (and not on the minimum required three-year basis). France included the biological sampling of brill in the western waters in its national proposal for 2013, but gave no details on the numbers. No Member States included sampling of biological parameters for brill in the Irish Sea and the Skagerrak in their proposals.

### 1.6.2 General problems

Due to the relatively low numbers of brill in commercial catches (per trip) and the high commercial value of this species, it is very difficult to collect data on biological variables in sufficient numbers for a meaningful analysis. Fishermen very often don't allow observers to take brill otoliths on board of commercial vessels (even when informing them that it is possible to sample the otoliths through the operculum in this species, making it unnecessary to cut open the heads and thus not influencing the appearance of individual fish and their value to buyers in this way), set aside sampling gonads for maturity staging (although the fish are gutted on board anyhow). Buying brill as part of the market sampling hasn't been an option for most countries either, because of the high prices. However, including the biological sampling in MS national proposals, and the subsequent generating of required funds through the DCF, should solve this problem. On surveys, catches of brill are generally even lower than on commercial vessels. Most likely this is due to the lower trawling speeds on surveys compared to commercial vessels, making it easier for bigger fish like brill to actively escape the nets. Brill grows relatively fast and generally reaches a certain length faster (at younger ages) than other flatfish species in the same areas, leading to a higher proportion of bigger fish in the younger age-classes than in slower growing species such as sole Solea solea and plaice *Pleuronectes platessa*. This also means that it is much more difficult to obtain sufficient information on the bigger length classes for brill. Additionally, the shorter trawl durations on surveys decrease the chance to encounter an individual brill, that occur more scattered over a given area than other co-occurring flatfish species because of their predatory feeding behaviour (brill is piscivorous and could be regarded as a top predator, except for the smaller larval stages).

## 1.7 Biological parameters and other research

### 1.7.1 Length

An analysis of time series of landings and data from sampling on board of commercial vessels by Belgium (Moreau, 2010a) provided information on length-distributions, but not much on age-distributions, of landings and discards of brill. Table 1-12 and Figure 1.9 give the length-distribution of landings and discards as recorded on observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.

### 1.7.2 Age

ILVO extracted existing age-information on brill from its own database, and collected similar information from relevant project partners and some other countries that were not involved in the NESPMAN-project. This resulted in only very few data due to the problems of low occurrence in commercial catches and on surveys, in combination with a high commercial value, as explained above. For (some of) the areas covered in this study, only Belgium, the Netherlands and the United Kingdom currently still collect and read brill-otoliths, but the time series are fragmented and therefore of little use for assessment-purposes. An analysis of the available data is currently being prepared and will be included in the next report.

The last brill otolith exchange took place in 2005. A small-scale exchange comprising mainly the North Sea countries (but open to other participants) was recommended by PGCCBDS 2009, and will be carried out in 2010. ILVO, Belgium, will act as coordinator for the exchange. Depending on the results of this otolith exchange (overall agreement among readers, CV's), an age reading workshop might be recommended afterwards.

### 1.7.3 Sex-ratio, maturity and other reproductive characteristics

For brill, especially the studies of Dunn *et al*. (1996), Delbare & De Clerck (1999) and Boon *et al.* (2000) (and the references therein) are worth mentioning in this respect. Some important findings on sex-ratio and maturity of brill (mainly females) are taken over from Delbare & De Clerck (1999), and summarized in Table 1-13.

At present, the databases of ILVO and the relevant NESPMAN partners don't contain additional series of maturity-data for brill that could add to this knowledge and could already be used for assessment-purposes. Since no biological sampling for brill was scheduled under the NESPMAN contract, additional maturity information was not gathered in this project. Since the maturity stage is an important biological parameter to be used in the calculation of maturity ogives (and therefore of Spawning Stock Biomass), for the definition of the spawning season of a species, for the monitoring of long-term changes in the spawning cycle, and for many other research needs regarding the biology of fish, it is important to continue studying the maturation of species for which management advice is requested and analytical assessments are to be developed, such as brill. This species also emerged as a species deserving a maturity staging workshop from the review of the species list of Appendix VII of the DCF against the details of previously held workshops by PGCCDBS (2010), and is therefore included in the workshop that will be organized on turbot (WKMSTB – Workshop on Maturity Staging of turbot and brill – Ijmuiden, 2012).

### 1.7.4 Historical biological sampling

For the UK, length information from market sampling for brill is available for 1994–1996, and from 2000 onwards. Biological sampling for otoliths, weight, sex and maturity has only been carried out since 2000. A summary of the number of samples and the number of fish that were measured is given in Table 1-14. Table 1-15 lists the numbers of samples and numbers of fish for which biological data were collected. The otoliths collected have not been aged.

France did collect length and age data on brill (demographic structures per metier) in the areas VIId and VIIe during the years 1994–1996. These data were collected under an EU funded project carried out by France and the UK (Dunn *et al*., 1996).

During the mid 1990s, Belgium took age and length samples of brill caught in the Eastern English Channel, the Celtic Sea, and the Irish Sea. The numbers measured vary between 200 and 600 individuals per year. The relative age distribution of brill in the commercial landings of the Belgian beam trawl fleet for the period 1996–1998 is presented in Figure 1.10.

### 1.7.5 Maturation or discarding? (after Moreau, 2010b)

Does a Minimum Landing Size of 30 cm (as installed for brill by different authorities, but not regulated on a European scale) make biological sense for this species? To answer this question we refer to Table 1-16, and work out an example for brill in the North Sea.

In all areas covered in this project, not a single female brill was found that measured less than 37 cm and already reached sexual maturity. The first individuals mature at 37 cm, while all are mature only at lengths from 46-49 cm. In other words, when a MLS of 30 cm is implemented, all landed females measuring 30 to 37 cm are sexually immature and didn't have the chance to reproduce themselves. Given the fact that males generally mature at shorter lengths in related species (mature at the same age as females, but grow slower), the impact of a too small MLS is higher on females. Based on the results of Delbare & De Clerck (1999), and taking the length at 0% maturity as a criterion, a MLS of 40 cm would make much more sense in a biological way. In the English Channel and the Gulf of Biscay (where brill grow faster and generally mature at greater lengths), MLS's should be even higher. Table 1-16 gives the mean discard percentages of brill per area in 2007-2008, as documented in the Belgian observer programme. Discard percentages range from 0 – 7 %, which are values that are sufficiently low to be considered acceptable under the current legislations. So it seems justified to state that the MLS of 30 cm doesn't raise big problems for brill from a discard perspective. Increasing the MLS to a higher length, which makes sense from the maturity viewpoint, would quickly lead to higher discard percentages (e.g., put the MLS at 40 cm in Table 1-16 and compare the numbers of fish that should be discarded now with the ones when a MLS of 30 cm was retained), that cannot be lowered using the technical adaptations that are currently used and tested in bottom trawl fisheries. In this context, the survival of discarded brill should be documented.

## 1.8 Analysis of stock trends / assessment

The data that have currently been collected by WGNEW don't allow an evaluation of stock trends for brill in the different areas.

Ulrich (2000) made an assessment of brill in the Channel fisheries using the data sampled under the EU funded project carried out by France and the UK. (Dunn *et al.*, 1996). She concluded that the Channel stock was not heavily overexploited, but that a reduction in fishing effort was required to get an increase of 10% of the observed production. The maximum annual production was found to be around 400 t.

## 1.9 Data requirements

The collection of data needs to be continued in order to get a better understanding of the state of potential brill stocks in the Northeast Atlantic area, and to enable the evaluation of trends. Updates of survey abundance-series, discard information and CPUE-series will be analyzed and included in the next report.

In order to meet the DCF-requirements for sampling of biological parameters for brill in the Skagerrak and the Irish Sea, the following countries could be valid candidates to fill in the gaps in Table 1-10, according to their importance in turbot fisheries:

- Denmark in the Skagerrak
- Belgium and the UK in the Irish Sea

**General recommendations**

- EU to upgrade brill from Group 2 to Group 1, forcing relevant Member States to collect biological information on a yearly basis
- Relevant Member States to include market sampling for turbot in their National Proposals, thus generating the required funds through the DCF

## 1.10 References


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**Table 1-2: International landings (t) of brill *Scophthalmus rhombus* over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | II | Baltic | IIIa | IIIb-d | IV | V | VI | VIIa | VIIb,c | VIId,e | VIIf-k | VIII | IX | X | XIV | TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 0 | 0 | 134 | 16 | 1002 | 20 | 26 | 124 | 48 | 90 | 165 | 309 | - | 0 | 0 | 1934 |
| 1974 | 0 | 0 | 202 | 30 | 1167 | 0 | 44 | 100 | 20 | 81 | 80 | 0 | - | 0 | 0 | 1724 |
| 1975 | 0 | 0 | 189 | 43 | 1242 | 0 | 41 | 117 | 28 | 135 | 120 | 50 | - | 0 | 0 | 1965 |
| 1976 | 0 | 0 | 227 | 50 | 1223 | 1 | 57 | 94 | 43 | 283 | 156 | 35 | - | 0 | 0 | 2169 |
| 1977 | 0 | 0 | 389 | 70 | 1447 | 0 | 63 | 121 | 35 | 319 | 241 | 261 | - | 0 | 0 | 2946 |
| 1978 | 1 | 0 | 218 | 43 | 1418 | 0 | 53 | 113 | 36 | 408 | 122 | 28 | - | 0 | 0 | 2440 |
| 1979 | 2 | 0 | 184 | 31 | 1393 | 1 | 49 | 129 | 26 | 457 | 126 | 25 | - | 0 | 0 | 2423 |
| 1980 | 0 | 0 | 82 | 26 | 1054 | 0 | 37 | 131 | 32 | 400 | 213 | 50 | - | 0 | 0 | 2025 |
| 1981 | 0 | 0 | 59 | 23 | 1226 | 0 | 31 | 105 | 30 | 484 | 452 | 55 | - | 0 | 0 | 2465 |
| 1982 | 0 | 0 | 74 | 20 | 1300 | 0 | 32 | 94 | 23 | 480 | 179 | 58 | - | 0 | 0 | 2260 |
| 1983 | 0 | 13 | 83 | 13 | 1455 | 0 | 28 | 136 | 19 | 523 | 206 | 71 | - | 0 | 0 | 2547 |
| 1984 | 0 | 12 | 97 | 13 | 333 | 0 | 39 | 147 | 18 | 526 | 179 | 96 | - | 0 | 0 | 1460 |
| 1985 | 0 | 0 | 109 | 18 | 343 | 0 | 46 | 234 | 25 | 484 | 187 | 91 | - | 0 | 0 | 1537 |
| 1986 | 0 | 19 | 106 | 20 | 262 | 0 | 27 | 245 | 46 | 445 | 224 | 134 | 10 | 0 | 0 | 1538 |
| 1987 | 0 | 15 | 103 | 17 | 260 | 0 | 30 | 251 | 22 | 483 | 226 | 155 | 24 | 0 | 0 | 1586 |
| 1988 | 0 | 10 | 101 | 10 | 336 | 0 | 27 | 248 | 16 | 447 | 206 | 199 | 28 | 0 | 0 | 1628 |
| 1989 | 0 | 10 | 97 | 10 | 460 | 0 | 28 | 121 | 12 | 423 | 185 | 214 | 36 | 0 | 0 | 1596 |
| 1990 | 0 | 12 | 127 | 13 | 923 | 0 | 17 | 138 | 10 | 535 | 229 | 188 | 54 | 0 | 0 | 2246 |
| 1991 | 0 | 17 | 99 | 17 | 1682 | 0 | 27 | 137 | 10 | 470 | 230 | 131 | 40 | 0 | 0 | 2860 |
| 1992 | 0 | 34 | 146 | 36 | 1810 | 0 | 43 | 173 | 20 | 456 | 278 | 167 | 53 | 0 | 24 | 3240 |
| 1993 | 0 | 35 | 212 | 46 | 2439 | 0 | 38 | 116 | 26 | 486 | 221 | 154 | 65 | 0 | 0 | 3838 |
| 1994 | 0 | 62 | 220 | 69 | 1916 | 0 | 28 | 130 | 25 | 485 | 269 | 137 | 49 | 1 | 0 | 3391 |
| 1995 | 0 | 101 | 151 | 106 | 1434 | 0 | 25 | 131 | 27 | 540 | 353 | 139 | 57 | 0 | 0 | 3064 |
| 1996 | 0 | 62 | 111 | 64 | 1247 | 0 | 25 | 121 | 41 | 598 | 369 | 120 | 498 | 0 | 0 | 3256 |
| 1997 | 0 | 28 | 106 | 28 | 957 | 0 | 40 | 156 | 50 | 491 | 397 | 125 | 434 | 0 | 0 | 2812 |
| 1998 | 0 | 25 | 132 | 25 | 1283 | 0 | 42 | 153 | 18 | 441 | 260 | 112 | 52 | 0 | 0 | 2543 |
| 1999 | 0 | 28 | 157 | 29 | 1280 | 0 | 30 | 130 | 18 | 227 | 183 | 17 | 62 | 0 | 0 | 2161 |
| 2000 | 0 | 33 | 142 | 34 | 1508 | 0 | 16 | 103 | 44 | 661 | 239 | 131 | 63 | 0 | 0 | 2974 |
| 2001 | 0 | 23 | 98 | 23 | 1573 | 0 | 15 | 119 | 21 | 721 | 251 | 122 | 70 | 0 | 0 | 3036 |
| 2002 | 0 | 30 | 89 | 32 | 1302 | 0 | 12 | 107 | 34 | 700 | 255 | 160 | 55 | 0 | 0 | 2776 |
| 2003 | 0 | 40 | 129 | 43 | 1346 | 0 | 36 | 131 | 33 | 744 | 249 | 155 | 45 | 0 | 0 | 2951 |
| 2004 | 0 | 48 | 156 | 51 | 1249 | 0 | 20 | 87 | 21 | 651 | 293 | 165 | 62 | 0 | 0 | 2803 |
| 2005 | 0 | 63 | 133 | 63 | 1160 | 0 | 13 | 102 | 17 | 590 | 279 | 135 | 60 | 0 | 0 | 2615 |
| 2006 | 0 | 60 | 140 | 61 | 1175 | 0 | 10 | 79 | 17 | 634 | 264 | 140 | 57 | 0 | 0 | 2637 |
| 2007 | 0 | 71 | 160 | 71 | 1239 | 0 | 6 | 77 | 20 | 730 | 244 | 139 | 37 | 0 | 0 | 2794 |
| 2008 | 0 | 107 | 181 | 106 | 1004 | 0 | 8 | 71 | 18 | 580 | 184 | 60 | 47 | 0 | 0 | 2366 |

**Table 1-3: International landings (t) of brill *Scophthalmus rhombus* in the North Sea (IV) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | DNK | GER | IRL | FRA | NLD | SWE | UK | NOR | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| **1973** | 185 | 55 | 13 | 0 | 0 | 710 | 0 | 39 | 0 | **1002** |
| **1974** | 135 | 68 | 15 | 0 | 0 | 905 | 0 | 44 | 0 | **1167** |
| **1975** | 164 | 76 | 20 | 0 | 13 | 925 | 0 | 44 | 0 | **1242** |
| **1976** | 148 | 65 | 15 | 0 | 10 | 940 | 0 | 45 | 0 | **1223** |
| **1977** | 166 | 88 | 37 | 0 | 17 | 1,079 | 0 | 60 | 0 | **1447** |
| **1978** | 175 | 123 | 43 | 0 | 26 | 967 | 0 | 84 | 0 | **1418** |
| **1979** | 188 | 154 | 27 | 3 | 10 | 908 | 0 | 103 | 0 | **1393** |
| **1980** | 129 | 104 | 21 | 0 | 8 | 747 | 0 | 45 | 0 | **1054** |
| **1981** | 148 | 66 | 8 | 0 | 5 | 957 | 0 | 42 | 0 | **1226** |
| **1982** | 182 | 53 | 6 | 0 | 11 | 1,007 | 0 | 41 | 0 | **1300** |
| **1983** | 182 | 62 | 7 | 0 | 23 | 1,153 | 0 | 28 | 0 | **1455** |
| **1984** | 190 | 73 | 11 | 0 | 30 | : (-) | 0 | 29 | 0 | **333** |
| **1985** | 187 | 71 | 4 | 0 | 35 | : (-) | 0 | 46 | 0 | **343** |
| **1986** | 131 | 76 | 5 | 0 | 4 | : (-) | 0 | 46 | 0 | **262** |
| **1987** | 140 | 50 | 5 | 0 | 17 | : (-) | 0 | 48 | 0 | **260** |
| **1988** | 102 | 33 | 10 | 0 | 18 | 121 | 0 | 52 | 0 | **336** |
| **1989** | 112 | 43 | 15 | 0 | 9 | 223 | 0 | 58 | 0 | **460** |
| **1990** | 168 | 139 | 30 | 0 | 24 | 480 | 0 | 82 | 0 | **923** |
| **1991** | 205 | 145 | 38 | 0 | 28 | 1,111 | 0 | 147 | 8 | **1682** |
| **1992** | 203 | 77 | 59 | 0 | 34 | 1,196 | 1 | 218 | 22 | **1810** |
| **1993** | 291 | 118 | 63 | 0 | 38 | 1,647 | 0 | 268 | 14 | **2439** |
| **1994** | 208 | 109 | 90 | 0 | 28 | 1,235 | 0 | 235 | 11 | **1916** |
| **1995** | 194 | 55 | 67 | 0 | 24 | 943 | 0 | 145 | 6 | **1434** |
| **1996** | 206 | 64 | 47 | 0 | 15 | 732 | 0 | 175 | 8 | **1247** |
| **1997** | 129 | 38 | 48 | 0 | 1 | 590 | 0 | 135 | 16 | **957** |
| **1998** | 160 | 58 | 58 | 0 | 11 | 808 | 0 | 172 | 16 | **1283** |
| **1999** | 161 | 91 | 51 | 0 | 0 | 805 | 0 | 156 | 16 | **1280** |
| **2000** | 167 | 93 | 77 | 0 | 16 | 998 | 0 | 141 | 16 | **1508** |
| **2001** | 182 | 67 | 66 | 0 | 12 | 1,075 | 0 | 158 | 13 | **1573** |
| **2002** | 145 | 52 | 58 | 0 | 10 | 907 | 0 | 120 | 10 | **1302** |
| **2003** | 145 | 57 | 70 | 0 | 9 | 934 | 0 | 119 | 12 | **1346** |
| **2004** | 140 | 77 | 66 | 0 | 7 | 772 | 0 | 168 | 19 | **1249** |
| **2005** | 120 | 89 | 62 | 0 | 7 | 716 | 0 | 138 | 28 | **1160** |
| **2006** | 105 | 75 | 55 | 0 | 9 | 765 | 0 | 154 | 12 | **1175** |
| **2007** | 110 | 52 | 47 | 0 | 12 | 854 | 0 | 156 | 9 | **1240** |
| **2008** | 117 | 86 | 42 | 0 | 5 | 650 | 0 | 93 | 11 | **1004** |

**Table 1-4: International landings (t) of brill *Scophthalmus rhombus* in the Skagerrak (IIIa) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | DNK | GER | NLD | SWE | NOR | TOT |
|---|---|---|---|---|---|---|---|
| **1973** | 0 | 131 | 3 | 0 | 0 | 0 | **134** |
| **1974** | 0 | 200 | 2 | 0 | 0 | 0 | **202** |
| **1975** | 0 | 167 | 2 | 1 | 19 | 0 | **189** |
| **1976** | 1 | 185 | 3 | 26 | 12 | 0 | **227** |
| **1977** | 1 | 276 | 1 | 99 | 12 | 0 | **389** |
| **1978** | 0 | 178 | 2 | 27 | 11 | 0 | **218** |
| **1979** | 0 | 156 | 0 | 17 | 11 | 0 | **184** |
| **1980** | 2 | 69 | 0 | 1 | 10 | 0 | **82** |
| **1981** | 0 | 54 | 0 | 0 | 5 | 0 | **59** |
| **1982** | 1 | 64 | 0 | 1 | 8 | 0 | **74** |
| **1983** | 0 | 73 | 0 | 3 | 7 | 0 | **83** |
| **1984** | 0 | 89 | 0 | 0 | 8 | 0 | **97** |
| **1985** | 0 | 100 | 0 | 0 | 9 | 0 | **109** |
| **1986** | 0 | 94 | 0 | 0 | 12 | 0 | **106** |
| **1987** | 0 | 93 | 0 | 0 | 10 | 0 | **103** |
| **1988** | 0 | 91 | 0 | 0 | 10 | 0 | **101** |
| **1989** | 0 | 88 | 0 | 0 | 9 | 0 | **97** |
| **1990** | 1 | 116 | 0 | 0 | 10 | 0 | **127** |
| **1991** | 1 | 81 | 0 | 0 | 10 | 7 | **99** |
| **1992** | 1 | 123 | 0 | 0 | 15 | 7 | **146** |
| **1993** | 2 | 184 | 0 | 0 | 16 | 10 | **212** |
| **1994** | 0 | 191 | 0 | 0 | 17 | 12 | **220** |
| **1995** | 0 | 124 | 1 | 0 | 13 | 13 | **151** |
| **1996** | 0 | 94 | 0 | 0 | 5 | 12 | **111** |
| **1997** | 0 | 83 | 1 | 0 | 11 | 11 | **106** |
| **1998** | 0 | 108 | 1 | 0 | 13 | 10 | **132** |
| **1999** | 0 | 126 | 1 | 0 | 17 | 13 | **157** |
| **2000** | 0 | 112 | 2 | 0 | 16 | 12 | **142** |
| **2001** | 0 | 73 | 0 | 0 | 12 | 13 | **98** |
| **2002** | 0 | 66 | 0 | 0 | 11 | 12 | **89** |
| **2003** | 0 | 99 | 1 | 1 | 16 | 12 | **129** |
| **2004** | 0 | 119 | 1 | 4 | 17 | 15 | **156** |
| **2005** | 0 | 101 | 0 | 3 | 13 | 16 | **133** |
| **2006** | 0 | 105 | 1 | 3 | 14 | 16 | **139** |
| **2007** | 0 | 119 | 1 | 3 | 22 | 15 | **160** |
| **2008** | 0 | 138 | 2 | 1 | 28 | 13 | **182** |

**Table 1-5: International landings (t) of brill *Scophthalmus rhombus* in the English Channel (VIIde) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | DNK | IRL | FRA | NLD | UK | TOTAL |
|---|---|---|---|---|---|---|---|
| 1973 | 20 | 0 | 0 | 130 | 0 | 70 | 220 |
| 1974 | 25 | 0 | 0 | 0 | 0 | 56 | 81 |
| 1975 | 24 | 0 | 0 | 55 | 0 | 58 | 137 |
| 1976 | 41 | 0 | 0 | 170 | 0 | 74 | 285 |
| 1977 | 45 | 0 | 0 | 197 | 0 | 81 | 323 |
| 1978 | 58 | 3 | 0 | 227 | 0 | 123 | 411 |
| 1979 | 55 | 0 | 0 | 262 | 0 | 142 | 459 |
| 1980 | 64 | 2 | 3 | 213 | 0 | 120 | 402 |
| 1981 | 83 | 0 | 0 | 271 | 0 | 136 | 490 |
| 1982 | 105 | 0 | 0 | 225 | 1 | 156 | 487 |
| 1983 | 107 | 0 | 0 | 234 | 1 | 184 | 526 |
| 1984 | 114 | 0 | 0 | 226 | 0 | 191 | 531 |
| 1985 | 103 | 0 | 0 | 213 | 0 | 213 | 529 |
| 1986 | 123 | 0 | 0 | 183 | 0 | 183 | 489 |
| 1987 | 131 | 0 | 0 | 216 | 0 | 216 | 563 |
| 1988 | 121 | 0 | 0 | 202 | 0 | 202 | 525 |
| 1989 | 97 | 0 | 0 | 213 | 0 | 213 | 523 |
| 1990 | 104 | 0 | 0 | 249 | 0 | 249 | 602 |
| 1991 | 84 | 0 | 0 | 249 | 0 | 249 | 582 |
| 1992 | 86 | 0 | 0 | 223 | 0 | 223 | 532 |
| 1993 | 80 | 0 | 0 | 256 | 0 | 256 | 592 |
| 1994 | 91 | 0 | 0 | 227 | 0 | 227 | 545 |
| 1995 | 95 | 0 | 1 | 248 | 0 | 248 | 592 |
| 1996 | 107 | 0 | 0 | 240 | 0 | 240 | 587 |
| 1997 | 109 | 0 | 1 | 185 | 0 | 185 | 480 |
| 1998 | 74 | 0 | 0 | 196 | 2 | 198 | 470 |
| 1999 | 97 | 0 | 0 | 0 | 3 | 3 | 103 |
| 2000 | 166 | 0 | 1 | 260 | 4 | 264 | 695 |
| 2001 | 217 | 0 | 0 | 256 | 2 | 258 | 733 |
| 2002 | 213 | 0 | 0 | 268 | 1 | 269 | 751 |
| 2003 | 231 | 0 | 1 | 287 | 1 | 288 | 808 |
| 2004 | 180 | 0 | 1 | 259 | 3 | 262 | 705 |
| 2005 | 153 | 0 | 0 | 267 | 2 | 269 | 691 |
| 2006 | 203 | 0 | 0 | 281 | 3 | 284 | 771 |
| 2007 | 242 | 0 | 0 | 325 | 1 | 326 | 894 |
| 2008 | 177 | 0 | 0 | 225 | 2 | 227 | 631 |

**Table 1-6: International landings (t) of brill *Scophthalmus rhombus* in the Celtic Sea (VIIf-h) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | IRL | FRA | NLD | UK | TOT |
|---|---|---|---|---|---|---|
| 1973 | 20 | 0 | 0 | 0 | 15 | 35 |
| 1974 | 21 | 0 | 0 | 0 | 14 | 35 |
| 1975 | 23 | 0 | 4 | 0 | 17 | 44 |
| 1976 | 32 | 0 | 46 | 0 | 14 | 92 |
| 1977 | 95 | 0 | 127 | 0 | 13 | 235 |
| 1978 | 17 | 0 | 26 | 0 | 16 | 59 |
| 1979 | 18 | 1 | 35 | 0 | 20 | 74 |
| 1980 | 43 | 0 | 87 | 0 | 25 | 155 |
| 1981 | 17 | 0 | 14 | 0 | 29 | 60 |
| 1982 | 22 | 0 | 19 | 0 | 26 | 67 |
| 1983 | 35 | 0 | 22 | 2 | 25 | 84 |
| 1984 | 20 | 0 | 10 | 0 | 28 | 58 |
| 1985 | 33 | 0 | 54 | 0 | 29 | 116 |
| 1986 | 40 | 0 | 56 | 0 | 34 | 130 |
| 1987 | 34 | 3 | 62 | 0 | 82 | 181 |
| 1988 | 33 | 4 | 68 | 0 | 66 | 171 |
| 1989 | 35 | 7 | 59 | 0 | 38 | 139 |
| 1990 | 21 | 13 | 48 | 0 | 70 | 152 |
| 1991 | 24 | 15 | 52 | 0 | 68 | 159 |
| 1992 | 15 | 26 | 61 | 0 | 53 | 155 |
| 1993 | 14 | 11 | 59 | 0 | 59 | 143 |
| 1994 | 23 | 7 | 56 | 0 | 123 | 209 |
| 1995 | 26 | 9 | 47 | 0 | 187 | 269 |
| 1996 | 30 | 8 | 57 | 1 | 149 | 245 |
| 1997 | 21 | 20 | 59 | 0 | 156 | 256 |
| 1998 | 27 | 17 | 56 | 0 | 82 | 182 |
| 1999 | 64 | 20 | 0 | 0 | 54 | 138 |
| 2000 | 55 | 22 | 78 | 0 | 56 | 211 |
| 2001 | 52 | 28 | 86 | 0 | 74 | 240 |
| 2002 | 53 | 24 | 81 | 0 | 78 | 236 |
| 2003 | 75 | 34 | 77 | 0 | 51 | 237 |
| 2004 | 78 | 47 | 85 | 0 | 48 | 258 |
| 2005 | 74 | 46 | 83 | 0 | 36 | 239 |
| 2006 | 66 | 38 | 88 | 0 | 37 | 229 |
| 2007 | 70 | 26 | 84 | 0 | 41 | 221 |
| 2008 | 59 | 21 | 54 | 0 | 31 | 165 |

**Table 1-7: International landings (t) of brill *Scophthalmus rhombus* in the Irish Sea (VIIa) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | IRL | FRA | NLD | POL | UK | TOT |
|---|---|---|---|---|---|---|---|
| 1973 | 24 | 20 | 10 | 2 | 0 | 78 | 134 |
| 1974 | 22 | 21 | 0 | 4 | 0 | 53 | 100 |
| 1975 | 23 | 20 | 0 | 6 | 0 | 68 | 117 |
| 1976 | 11 | 22 | 1 | 4 | 0 | 56 | 94 |
| 1977 | 17 | 21 | 2 | 7 | 0 | 74 | 121 |
| 1978 | 14 | 25 | 5 | 6 | 0 | 63 | 113 |
| 1979 | 20 | 31 | 8 | 5 | 0 | 77 | 141 |
| 1980 | 15 | 28 | 4 | 9 | 0 | 81 | 137 |
| 1981 | 13 | 33 | 5 | 3 | 0 | 54 | 108 |
| 1982 | 10 | 35 | 2 | 1 | 0 | 49 | 97 |
| 1983 | 35 | 40 | 2 | 2 | 0 | 60 | 139 |
| 1984 | 20 | 49 | 3 | 0 | 0 | 78 | 150 |
| 1985 | 31 | 58 | 4 | 0 | 0 | 147 | 240 |
| 1986 | 41 | 55 | 4 | 0 | 0 | 148 | 248 |
| 1987 | 39 | 51 | 4 | 0 | 0 | 160 | 254 |
| 1988 | 18 | 143 | 3 | 0 | 0 | 84 | 248 |
| 1989 | 13 | 29 | 2 | 0 | 0 | 80 | 124 |
| 1990 | 31 | 24 | 2 | 0 | 0 | 84 | 141 |
| 1991 | 21 | 25 | 3 | 0 | 0 | 94 | 143 |
| 1992 | 27 | 50 | 3 | 0 | 0 | 96 | 176 |
| 1993 | 11 | 21 | 2 | 0 | 0 | 85 | 119 |
| 1994 | 31 | 26 | 1 | 0 | 0 | 75 | 133 |
| 1995 | 28 | 29 | 1 | 0 | 0 | 76 | 134 |
| 1996 | 34 | 17 | 1 | 4 | 4 | 68 | 128 |
| 1997 | 48 | 34 | 0 | 7 | 7 | 67 | 163 |
| 1998 | 40 | 32 | 0 | 2 | 2 | 79 | 155 |
| 1999 | 41 | 19 | 0 | 1 | 1 | 72 | 134 |
| 2000 | 30 | 31 | 1 | 3 | 3 | 41 | 109 |
| 2001 | 43 | 28 | 0 | 0 | 0 | 48 | 119 |
| 2002 | 43 | 15 | 0 | 0 | 0 | 49 | 107 |
| 2003 | 36 | 20 | 0 | 0 | 0 | 75 | 131 |
| 2004 | 31 | 15 | 0 | 0 | 0 | 41 | 87 |
| 2005 | 55 | 13 | 1 | 0 | 0 | 33 | 102 |
| 2006 | 35 | 12 | 0 | 0 | 0 | 32 | 79 |
| 2007 | 32 | 12 | 0 | 0 | 0 | 33 | 77 |
| 2008 | 26 | 9 | 0 | 0 | 0 | 36 | 71 |

**Table 1-8: The number of brill *Scophthalmus rhombus* measured each year for four Cefas survey series in the period 1988-2005.**

| | Irish Sea Autumn | Irish Sea Spring | Carhelmar | Channel | North Sea |
|---|---|---|---|---|---|
| 1988 | 12 | | | | |
| 1989 | 22 | | 14 | 23 | |
| 1990 | 45 | | 9 | 47 | |
| 1991 | 6 | | 15 | 17 | 2 |
| 1992 | 52 | | 14 | 18 | 3 |
| 1993 | 65 | 37 | 11 | 19 | |
| 1994 | 35 | 36 | 10 | 27 | 3 |
| 1995 | 41 | 31 | 9 | 36 | |
| 1996 | 46 | 14 | 16 | 36 | 1 |
| 1997 | 39 | 23 | 13 | 25 | 1 |
| 1998 | 31 | 16 | 21 | 23 | |
| 1999 | 29 | 23 | 21 | 25 | 1 |
| 2000 | 44 | | 19 | 29 | |
| 2001 | 28 | | 20 | 29 | 3 |
| 2002 | 29 | | | 31 | 2 |
| 2003 | 41 | | 17 | 25 | 3 |
| 2004 | 31 | | | 25 | 1 |
| 2005 | 29 | | | 16 | |
| Total | 625 | 180 | 209 | 451 | 20 |

**Table 1-9: The number of brill *Scophthalmus rhombus* for which biological data (otoliths, weight, sex and maturity) have been collected from four Cefas survey series in the period 1988-2005.**

| | Irish Sea Autumn | Irish Sea Spring | Carhelmar | Channel | North Sea |
|---|---|---|---|---|---|
| 1994 | 21 | | 9 | 4 | |
| 1995 | 40 | 31 | 9 | 31 | |
| 1996 | 45 | 8 | 15 | 32 | |
| 1997 | 39 | 22 | 12 | | |
| 1998 | 30 | 14 | | | |
| 1999 | 29 | | | | |
| 2000 | 44 | | | | |
| 2001 | 26 | | 20 | 28 | |
| 2002 | 19 | | 9 | 27 | |
| 2003 | 36 | | 4 | | 2 |
| 2004 | | | | 7 | 1 |
| 2005 | 24 | | | 8 | |
| Total | 353 | 75 | 78 | 137 | 3 |

**Table 1-10: Overview of the requirements for biological sampling of brill *Scophthalmus rhombus* under the DCF for the period 2011-2013 (EC/2010/93).**

| Species | Area/Stock | Species Group | Age N°/1000 t | Weight | Sex | Maturity |
|---|---|---|---|---|---|---|
| Brill | IIIa | G2 | 125 | T | T | T |
| Brill | IV, VIId | G2 | 125 | T | T | T |
| Brill | all areas (NE Atlantic + W Channel) | G2 | 125 | T | T | T |

**Table 1-11: Compilation of the scheduled sampling effort of Member States for biological parameters in brill *Scophthalmus rhombus* for the period 2011-2013 (source: reports RCM's 2010).**

| Species | Species Group | MS | 2011 | 2012 | 2013 | Fishing ground | Age (n° per year) | Weight (n° per year) | Sex-ratio (n° per year) | Maturity (n° per year) | Data sources |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Brill | G2 | / | | | | IIIa | | | | | |
| | | TOTAL | | | | | 0 | 0 | 0 | 0 | |
| Brill | G2 | BEL | X | X | X | IV | 25 | 25 | 25 | / | Comm. + surveys |
| Brill | G2 | UK | X | X | X | IV, VIId | 25 | 25 | 25 | 25 | Market + surveys |
| Brill | G2 | NLD | X | X | X | IV, VIId | 720 | 720 | 720 | 720 | Comm. + surveys |
| | | TOTAL | | | | | 770 | 770 | 770 | 745 | |
| Brill | G2 | UK | X | X | X | VIIe | 75 | 75 | 75 | 75 | Market + surveys |
| Brill | G2 | UK | X | X | X | VIIfgh | 75 | 75 | 75 | 75 | Market surveys |
| Brill | G2 | FRA | | | X | All areas | X | X | X | X | Commercial landings |
| | | TOTAL | | | | | > 150 | > 150 | > 150 | > 150 | |

**Table 1-12: Length-distribution of landings and discards of brill *Scophthalmus rhombus* as recorded on observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.**

| **Length** | **Discards** | | | | **Landings** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N° @ length** | | | **Subtot** | **N° @ length** | | | | | **Subtot** | **Total** |
| | **VIIa** | **VIId** | **VIIf** | **disc** | **VIIa** | **VIId** | **VIIe** | **VIIf** | **VIIg** | **land** | **catch No** |
| **220** | 1 | | | 1 | | | | | | | **1** |
| **230** | 4 | | | 4 | | | | | | | **4** |
| **240** | 12 | 1 | | 13 | 1 | | | | | 1 | **14** |
| **250** | 16 | | | 16 | 3 | | | | | 3 | **19** |
| **260** | 25 | | 1 | 26 | 2 | | | | | 2 | **28** |
| **270** | 26 | | 1 | 27 | 2 | | | | | 2 | **29** |
| **280** | 34 | 2 | 2 | 38 | 3 | 3 | | | | 6 | **44** |
| **290** | 32 | 1 | 2 | 35 | 18 | 9 | | | | 27 | **62** |
| **300** | 13 | | | 13 | 64 | 51 | | 5 | | 120 | **133** |
| **310** | | | | | 71 | 79 | | 5 | | 155 | **155** |
| **320** | | | | | 68 | 116 | | 12 | 1 | 197 | **197** |
| **330** | | | | | 57 | 125 | 1 | 19 | 1 | 203 | **203** |
| **340** | | | | | 54 | 133 | | 15 | 3 | 205 | **205** |
| **350** | | | | | 65 | 130 | 3 | 23 | 1 | 222 | **222** |
| **360** | 1 | | | 1 | 50 | 136 | 2 | 16 | 3 | 207 | **208** |
| **370** | | | | | 37 | 133 | | 16 | 1 | 187 | **187** |
| **380** | | | | | 48 | 111 | 2 | 19 | 2 | 182 | **182** |
| **390** | | | | | 47 | 94 | 1 | 14 | 2 | 158 | **158** |
| **400** | | | | | 52 | 80 | 2 | 15 | 5 | 154 | **154** |
| **410** | | | | | 57 | 68 | 2 | 17 | 4 | 148 | **148** |
| **420** | | | | | 39 | 81 | 1 | 20 | 4 | 145 | **145** |
| **430** | | | | | 28 | 66 | 1 | 14 | 5 | 114 | **114** |
| **440** | | | | | 32 | 55 | 2 | 14 | 5 | 108 | **108** |
| **450** | | | | | 29 | 68 | 3 | 14 | 4 | 118 | **118** |
| **460** | | 1 | | 1 | 33 | 44 | 3 | 9 | 1 | 90 | **91** |
| **470** | | | | | 27 | 46 | 4 | 10 | 4 | 91 | **91** |
| **480** | | | | | 21 | 33 | 3 | 9 | | 66 | **66** |
| **490** | | | | | 14 | 31 | 2 | 6 | 2 | 55 | **55** |
| **500** | | | | | 19 | 21 | 2 | 6 | 4 | 52 | **52** |
| **510** | | | | | 13 | 15 | 1 | 6 | 3 | 38 | **38** |
| **520** | | | | | 10 | 9 | | 5 | 2 | 26 | **26** |
| **530** | | | | | 9 | 5 | 1 | 2 | | 17 | **17** |
| **540** | | | | | 7 | 13 | | 5 | | 25 | **25** |
| **550** | | | | | 7 | 3 | 1 | | 1 | 12 | **12** |
| **560** | | | | | 1 | 2 | | 3 | 1 | 7 | **7** |
| **570** | | | | | 5 | 2 | 2 | 1 | 1 | 11 | **11** |
| **580** | | | | | 4 | 1 | | 2 | | 7 | **7** |
| **590** | | | | | 3 | | 1 | 3 | | 7 | **7** |
| **600** | | | | | 4 | 3 | | | | 7 | **7** |
| **610** | | | | | 1 | 2 | | | | 3 | **3** |
| **620** | | | | | | | 1 | | | 1 | **1** |

| Length | Discards<br>N° @ length<br>VIIa | <br><br>VIId | <br><br>VIIf | <br>Subtot<br>disc | Landings<br>N° @ length<br>VIIa | <br><br>VIId | <br><br>VIIe | <br><br>VIIf | <br><br>VIIg | <br>Subtot<br>land | <br>Total<br>catch No |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **630** | | | | | | | | 1 | | 1 | **1** |
| **640** | | | | | | | | | | | |
| **650** | | | | | | | | | | | |
| **660** | | | | | | | | | | | |
| **670** | | | | | | | | | | | |
| **680** | | | | | | | | | | | |
| **690** | | | | | | | 1 | | | 1 | **1** |
| **Total No** | **164** | **5** | **6** | **178** | **1005** | **1768** | **42** | **306** | **60** | **3181** | **3359** |

**Table 1-13: Summary of reproductive characteristics of female brill *Scophthalmus rhombus* from different ICES areas (after Delbare & De Clerck, 1999).**

| | North Sea | English Channel | Celtic Sea | Irish Sea | Bay of Biscay |
|---|---|---|---|---|---|
| Proportion females (age 2 - 7 years) | 30 - 60 % | 10 -60 % | 15 - 50 % | 40 - 70 % | 30 - 65 % |
| Proportion females (age > 7 years) | 15 -100 % | 10 - 15 % | 5 - 100 % | 100% | 100% |
| Spawning period | March – June | March - April | February - May? | March – May? | February - June? |
| Length at 0% maturity | 39 cm | 46 cm | 39 cm | 37 cm | 43 cm |
| Length at full maturity | ND* | 47 cm | 49 cm | 46 cm | 47 cm |
| Age at maturity | 3 years | 4 years | 3 years | 4 years | 3 years |
| Monthly variation in condition factor | NO | NO | NO | NO | NO |

ND* : not determined

**Table 1-14: Number of brill *Scophthalmus rhombus* measured during the Cefas biological sampling programme.**

| | No of fish | No of Samples |
|---|---|---|
| 1994 | 1778 | 55 |
| 1995 | 1446 | 84 |
| 1996 | 422 | 10 |
| 1997 | | |
| 1998 | | |
| 1999 | | |
| 2000 | 3550 | 179 |
| 2001 | 3450 | 117 |
| 2002 | 2044 | 66 |
| 2003 | 53 | 4 |
| 2004 | 256 | 8 |
| Total | 12999 | 523 |

**Table 1-15. Number of brill *Scophthalmus rhombus* for which biological information has been collected by the Cefas biological sampling programme.**

| | No of fish | No of Samples |
|---|---|---|
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | | |
| 1999 | | |
| 2000 | 996 | 134 |
| 2001 | 1151 | 143 |
| 2002 | 796 | 103 |
| 2003 | 37 | 6 |
| 2004 | | |
| 2005 | | |
| Total | 2980 | 386 |

**Table 1-16: Mean discard percentages of brill *Scophthalmus rhombus* in the Belgian observer program over the years 2007-2008.**

| Area | Mesh size | # Trips | Discard percentage |
|---|---|---|---|
| VIId | 80-89 | 11 | 0.36 |
| VIIe | 80-89 | 1 | 0 |
| VIIfgh | 80-89 | 8 | 1.52 |
| VIIa | 80-89 | 6 | 7.88 |
| Mean | | | 2.44 |

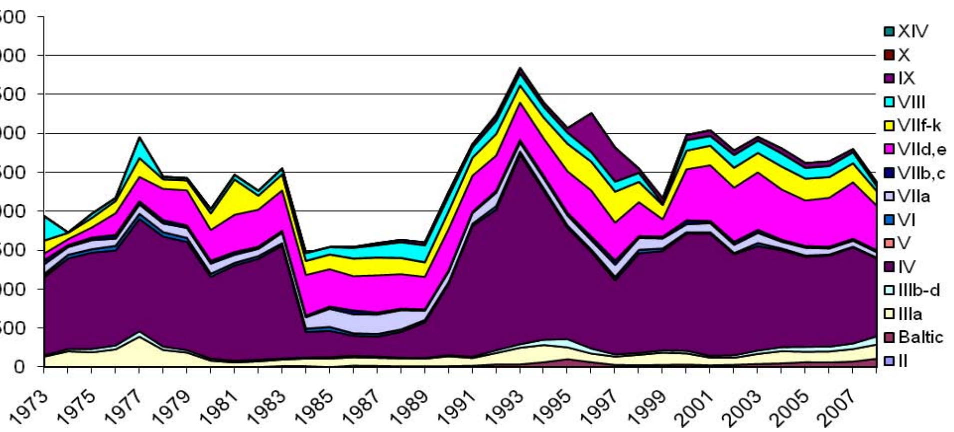


**Figure 1.1: International landings (t) of brill *Scophthalmus rhombus* in the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

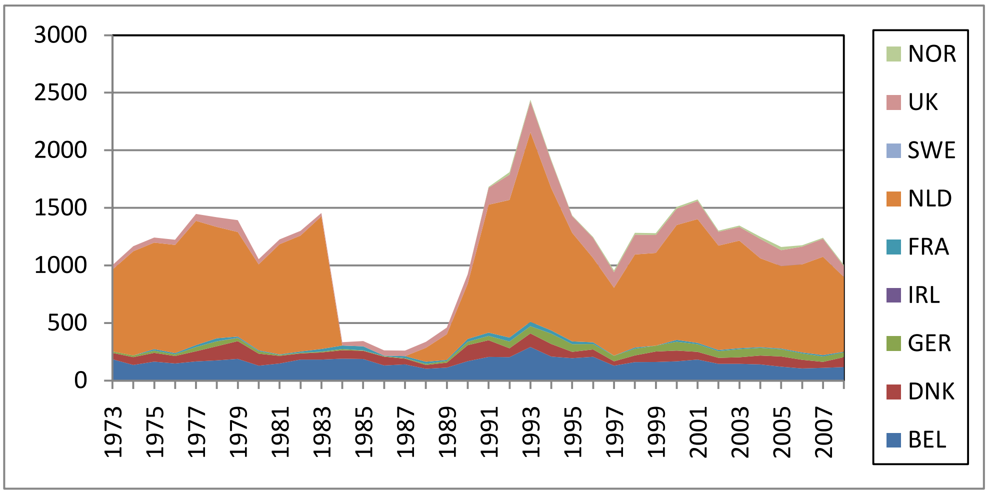


**Figure 1.2: Composition of landings (t) of brill Scophthalmus rhombus in the North Sea (IV) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

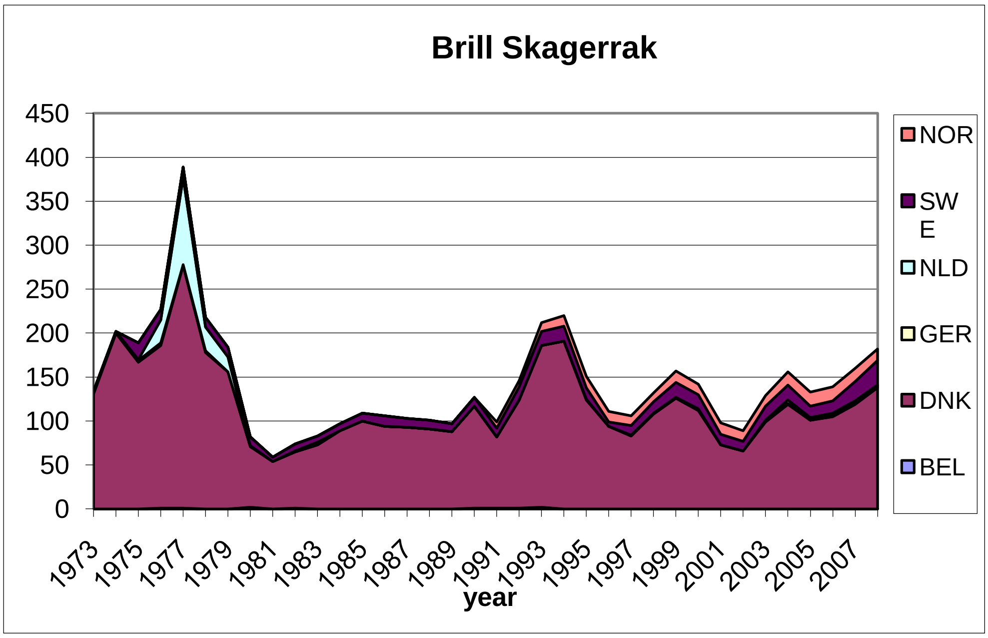


**Figure 1.3: Composition of landings (t) of brill *Scophthalmus rhombus* in the Skagerrak (IIIa) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

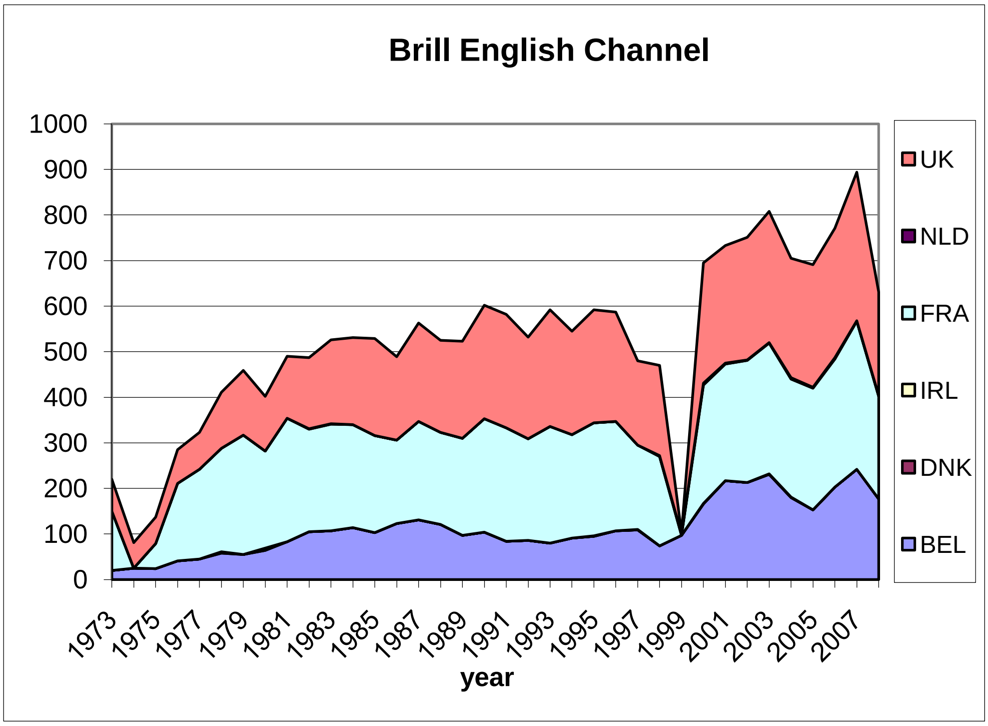


**Figure 1.4: Composition of landings (t) of brill *Scophthalmus rhombus* in the English Channel (VIIde) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

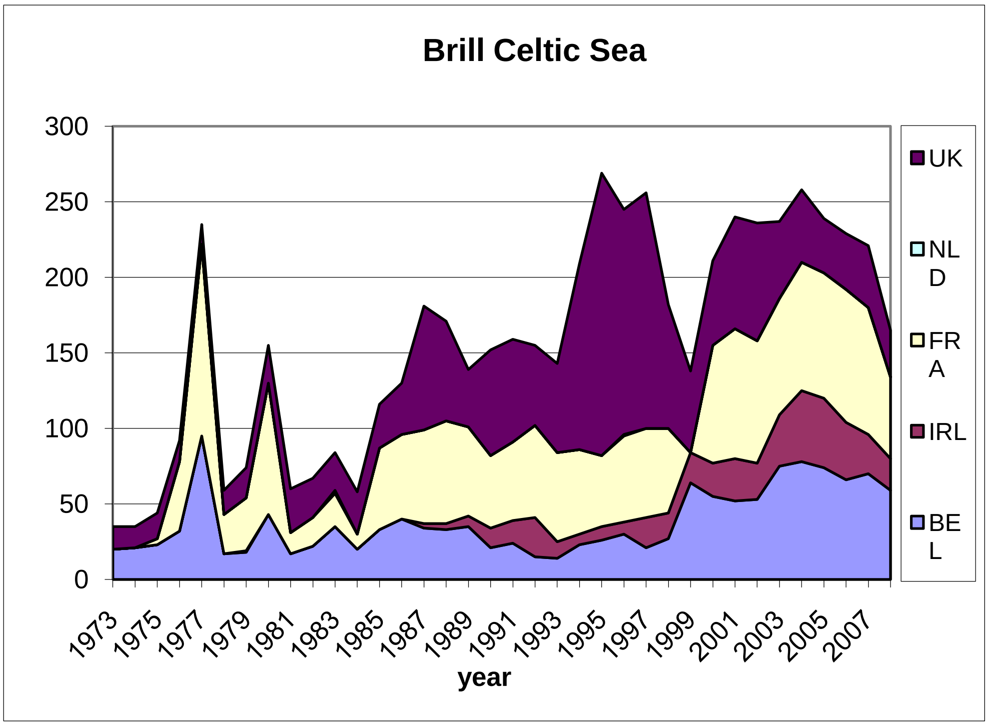


**Figure 1.5: Composition of landings (t) of brill *Scophthalmus rhombus* in the Celtic Sea (VIIf-h) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

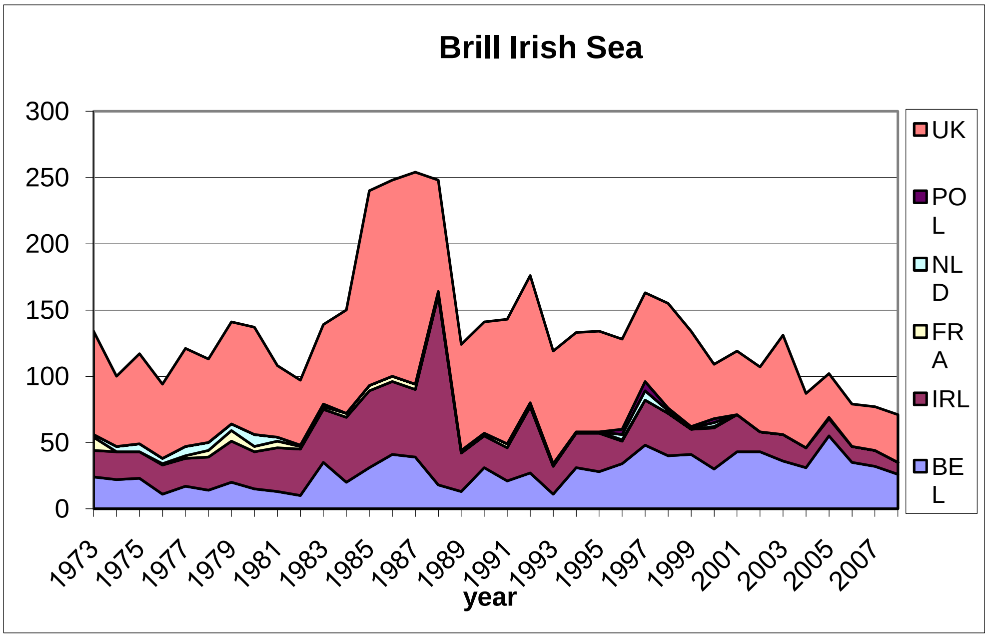


**Figure 1.6: Composition of landings (t) of brill *Scophthalmus rhombus* in the Irish Sea (VIIa) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

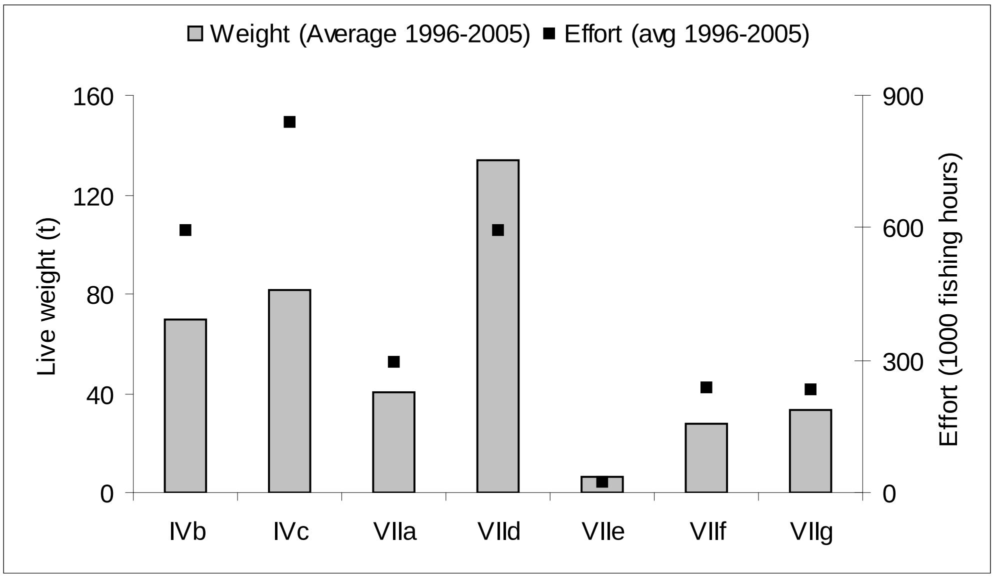


**Figure 1.7: Average effort and average landings of brill for the Belgian beam trawl fleet for the period 1996–2005.**

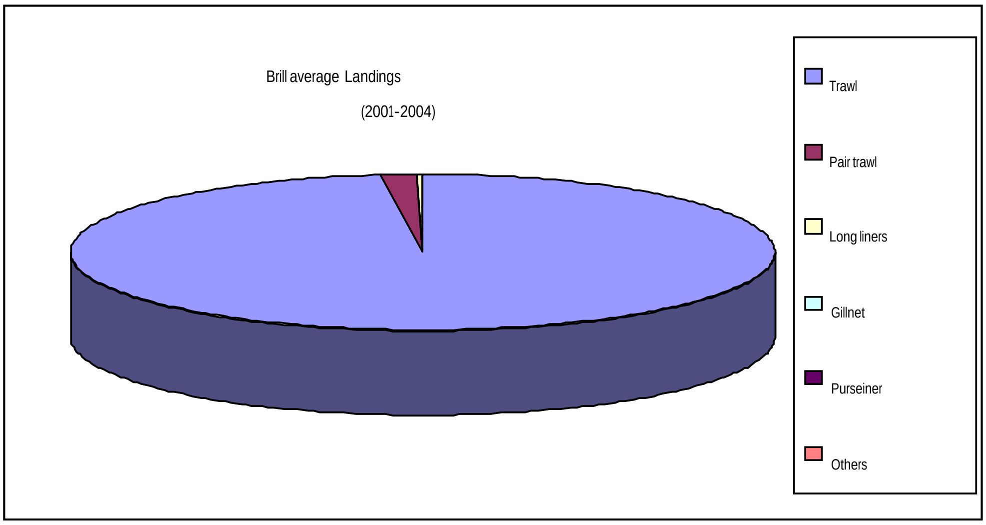


**Figure 1.8: Origin of the brill *Scophthalmus rhombus* landings in the Basque fleet (Spain). Almost all brill is caught by the "baka" otter trawl fleet.**

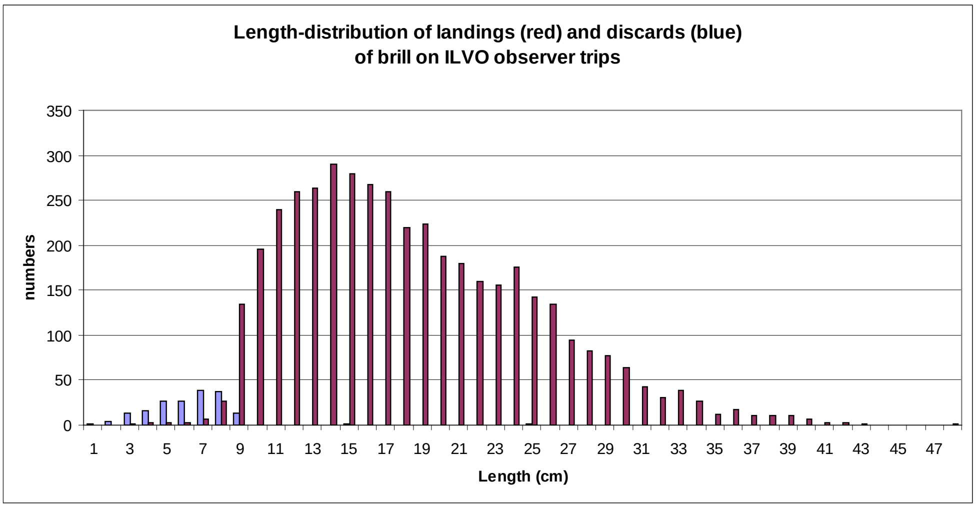


**Figure 1.9: Length-distribution of landings and discards of brill as recorded on observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.**

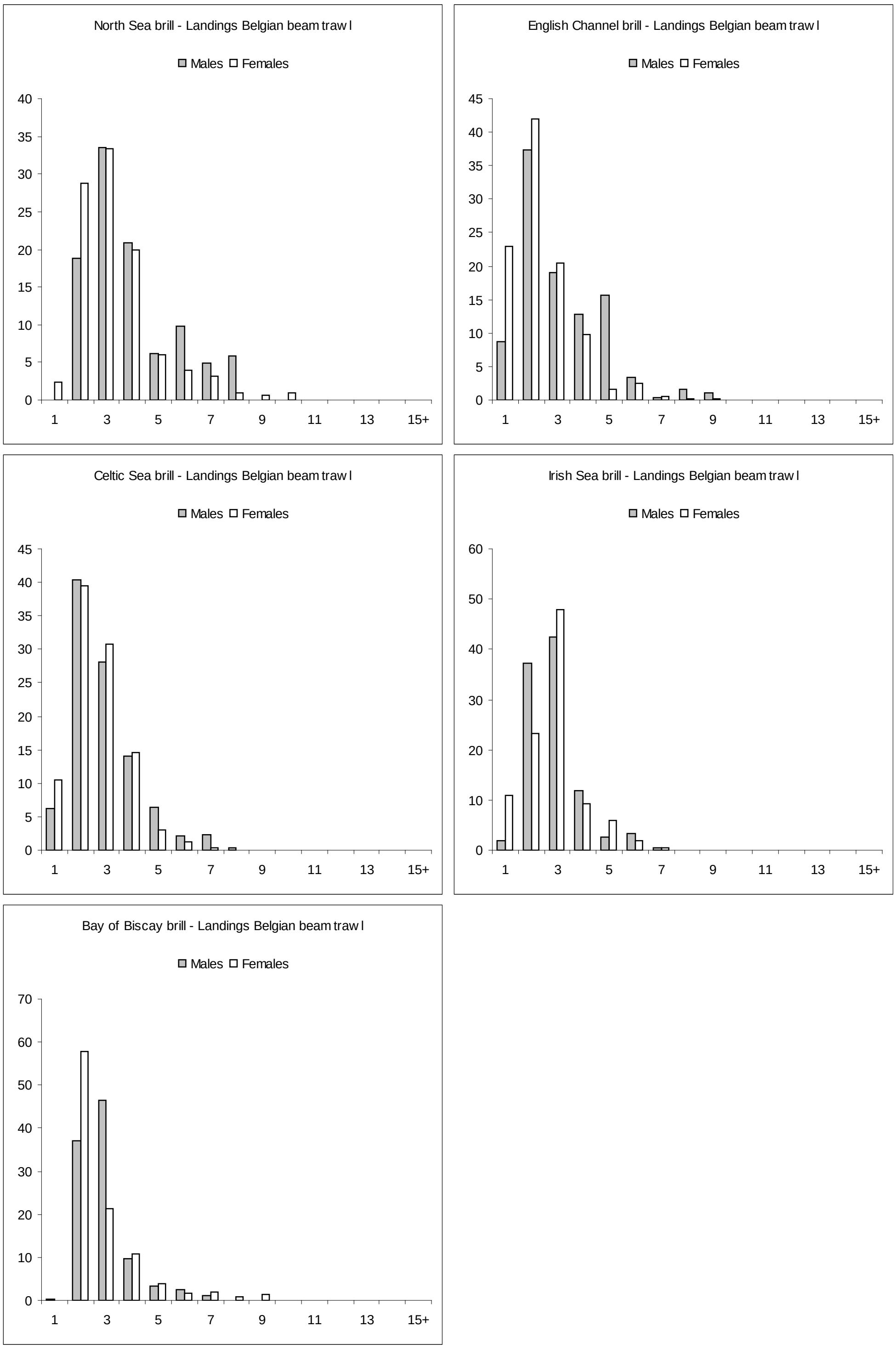


**Figure 1.10: Relative age distribution of brill *Scophthalmus rhombus* in the commercial landings of the Belgian beam trawl fleet for the period 1996–1998.**

# Annex 6 –Turbot

## 6.1 General biology

The description of the general biology of turbot *Psetta maxima* is largely based on Annex 4 of the 2005 Report of the Working Group on Environmental Interactions of Mariculture (ICES, 2005).

Turbot is distributed throughout the Northeast Atlantic Ocean along the European coastline (from the arctic circle at 70°N to Morocco at 30°N) and is rarer around the Faroe Islands, Iceland (western extreme around 23°W) and on Rockall Bank. Turbot is also found in the Skagerrak, the Kattegat, the Belt Sea and the Baltic Sea, but is very scarce in the Gulf of Bothnia north of the Åland archipelago, where salinity levels are below 5 psu. The distribution area also extends into the Mediterranean Sea. The subspecies *P. maxima maeotica* inhabits the Black Sea (to 42°E). It is typically found at a depth range of 10 to 70m. Turbot lives on sandy, rocky or mixed bottoms and is one of the few marine fish species that also inhabits brackish waters. Spawning only occurs in marine waters (pelagic eggs), where it is a batch spawner (Murua and Saborido-Rey, 2003). The spawning season generally ranges from April to August.

Turbot is one of the fastest growing flatfish. Only halibut *Hippoglossus hippoglossus* grows faster. During the juvenile phase growth rates are high, turbot can reach 30 cm in three years. Females grow faster than males. During the first years of life females grow from 8 to 10 cm a year. Females older than 10 years still grow 1 or 2 cm a year. In male turbot the growth is already reduced to 2 cm a year at the age of 6 years. Males older than 10 grow less than 1 cm a year. The difference in length between the sexes increases from 3 cm in 3-year-old turbot to 9 cm in 10-year-old turbot. The maximum growth rates are obtained in 3, 4 and 5-year-old turbot during the summer (May till October). In these months growth can reach between 2 and 2,6 cm per month. This high rate is comparable with the growth in artificial circumstances. In nature the ultimate growth rate (on year basis) is lower due to the slowing-down of metabolism during winter.

Turbot is a typical visual feeder and feeds mainly on other bottom-living fishes (common gadoids, sandeels, gobies, sole *Solea solea*, dab *Limanda limanda*, dragonets *Callionymus sp.*, sea breams and boarfish *Capros aper*), small pelagic fish (e.g. sprat *Sprattus sprattus*, sardine *Sardinus pilchardus*) and also, to a lesser extent, on larger crustaceans and bivalves. Large turbot (40 to 70 cm) feed excessive on herring and sprat from March till May (Rae & Devlin, 1972; Wetsteijn, 1981), to build up enough reserve for the subsequent spawning season. During the other nine months 50 to 70 % of the animals were found to have empty stomachs. This percentage is much higher than for most other flatfish species. However, a complete time of fasting, which is characteristic in the life cycle of lemon sole *Microstomus kitt* is not observed in turbot (Rae & Devlin, 1972). The diet of the juveniles has been shown to consist of copepods, shrimps, barnacle larvae and gastropod mollusc larvae (Jones, 1973).

In general, turbot is a rather sedentary species, but there are some indications of migratory patterns. For example in the North Sea, migrations from the nursery grounds in the south-eastern part to more northerly areas have been recorded, since adult turbot are more tolerant of the colder conditions in the northern areas of the North Sea where temperatures are too low for juveniles to survive. A study in the northern Baltic by Aneer and Weston (1990) also indicated that adult turbot might be considered to be very stationary. In this project a large number of turbot were tagged and released. The average distance between first capture and recapture appeared to be very short: only 6 km. Furthermore, more than 90% of the recaptured turbot were caught less than 20 km away from the point of first capture.

## 6.2 Stock identity and possible management areas

Turbot has been subject to a substantially larger amount of differentiation studies than its close relative brill. Firstly, allozyme analysis of the turbot specific cestode parasite *Bothriocephalus gregarius* (Blanquer *et al.*, 1992) revealed significant differences between the Mediterranean and Atlantic regions (because of the constant arms race between parasites and their hosts, parasite phylogeography can be expected to reflect host phylogeography). However, other studies using turbot specific allozyme loci and hemoglobine showed little differentiation between turbot from different areas within its geographical range. Also most studies using DNA for stock delineation refer to little genetic differentiation in turbot. Although much more genetic studies have been carried out in turbot compared to brill, the results are still too few and mostly based on insufficient numbers of individuals to generate a clear picture of the distribution of potentially different turbot stocks. Also indications for the existence of several transit- and 'hybrid'-zones still require confirmation by analyzing larger samples, and multiple markers. Annex 4 of the 2005 Report of the Working Group on Environmental Interactions of Mariculture (ICES, 2005) summarized these findings as follows:

*Compiling all data from different studies, it becomes clear that there are distinct turbot populations in the Baltic Sea and in the Irish Sea. Furthermore there are indications that turbot from the North Sea, the southern coast of Iceland, the western coast of Scotland and Ireland, and the Celtic Sea (including the Western Approaches - 51°N, 10°W) forms another stock, the northern Atlantic stock, which is different from the stock originating from the Bay of Biscay and the Atlantic side of southern Europe, the southern Atlantic stock. Transition zones between the northern stock and the southern stock are found in the English Channel and between the northern stock and the Baltic Sea in Kattegat and the Belt Sea. The situation of turbot stocks in the Mediterranean is still unclear, although there are indications that samples from the Aegean Sea are genetically different from those originating from other areas (Figure 6-1).*

Additionally, the status of Black Sea turbot (subspecies that represents a separate stock, or maybe even a distinct species?) and its relation to eastern Mediterranean turbot remains to be investigated genetically.

To enlarge the number of analyzed individuals, use multiple genetic markers, combine previous small scale studies, and include the Black Sea in the phylogeographical research on turbot, ILVO-Fisheries and the University of Leuven initiated a new large-scale genetic study of turbot in 2009 (PhD-research Sara Vandamme), that will generate much stronger results. The main objectives of this study are to define separate biological populations and management units (around Europe from the Baltic to the Black Sea) and describe the connectivity between (sub)-populations or potential management units (based on the adult population components). Because separate analyses of mitochondrial DNA (generally only maternally inherited but very useful in phylogeographic studies because of the large uncoding regions that lack important selective pressures, and their high mutation rates) and nuclear DNA (biparentally inherited) can lead to conflicting results, this study combines both nuclear (microsatellites) and mitochondrial markers. Comparative analyses of nuclear and organelle genetic markers may help delineate evolutionarily significant units or management units, although population differentiation estimates from multiple genomes can also conflict. In this study, mainly turbot from the North Sea, English Channel, Celtic Sea, Irish Sea, Gulf of Biscay, Baltic Sea, Mediterranean Sea and Black Sea are being analysed. Although turbot is a species for which it is generally difficult to collect sufficient numbers of samples (min. 50 per area), this collection went well. Preliminary results indicate that turbot has a typical genetic profile for marine fishes, with high genetic diversity and low but clear differentiation between populations. The spatial structure thereby reflects a historical geographical break between Baltic, Atlantic, Mediterranean and Black Seas, and a more recent differentiation within the Atlantic cluster. Before final results can be presented, the number of sampling sites and individuals will be further increased, the historical population structure will be analyzed in greater detail, it will be established whether the observed genetic patterns are also stable in time, correlations between genetic data, biological traits and environmental parameters will be established, and adaptive variation will be described using gene-linked microsatellites.

## 6.3 Management regulations

So far, no analytical assessments leading to fisheries advice have been carried out for turbot by ICES. The available information is inadequate to evaluate stock trends. Therefore, the state of the stock(s) is unknown. Also STECF has no access to any stock assessment information. No explicit objectives have been defined for potential stocks of this species, no precautionary reference points have been proposed, and no management plans are in place. However, for the EC-waters in Division IIa and Subarea IV, precautionary Total Allowable Catches have been defined for turbot and brill (combined) in the past. These TACs belong entirely to the EC-fisheries, and a historical overview is presented in Table 6-1.

**Table 6-1. Historical overview of combined TACs for turbot *Psetta maxima* and brill *Scophthalmus* rhombus in Division IIa and Subarea IV.**

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TAC | 9000 | 9000 | 6750 | 5738 | 4877 | 4550 | 4323 | 4323 | 5263 | 5263 | 5263 |

No restriction on the minimum length for landing turbot is imposed by the EC. In several geographical areas however, Minimum Landing Sizes (MLS) have been installed for turbot by different authorities. The most frequently applied MLS is 30 cm (e.g., in Belgium, the Baltic, the English Sea Fisheries District Cornwall, …).

## 6.4 Fisheries data

### Landings

Table 6-2 summarizes the turbot landings by area as reported to ICES and the EC (Source: Eurostat database). Over the period 1973 – 2008, total landings (all areas) ranged from 3504 t to 9361 t per year, with the lowest landings halfway the eighties and the highest peak in the early nineties. In the last decade, the total landings of turbot were between 5000 and 6500 t. The North Sea accounts for the major part of these landings (Figure 6-2), generating around 60% of the totals in the past ten years (70-80% from the early sixties to the early seventies). The English Channel (VIId,e) and the Celtic Sea (VIIf + VIIg-k) are the second and third most important fishing grounds for turbot, but are already much less important than the North Sea (mean landings percentages of 8% and 7% respectively over the entire time-line). The importance of these fishing grounds increased slightly to almost 9% of the total landings (for each of these two areas) in the past ten years. Fishing grounds from where the landings represent on average between 2 and 5% of the total landings over the entire time-line are IIIa, IIIb-d, VIIa, VIII and IX. Landings from other areas are negligible.

### Landings in the North Sea (IV)

The landings in the North Sea peaked in 1979 and 1991 at slightly more than 6000 t. In 2008 they were at 3000 t (Table 6-3 and Figure 6-3). Data are incomplete for the Netherlands, the main country landing turbot from this area, and for Norway.

### Landings in the Skagerrak (IIIa)

International landing series from the Skagerrak were updated for turbot (compared to Moreau, 2010a; source: Eurostat database) and can be consulted in Table 6-4 and Figure 6-4. Over the period 1973-2008, these landings ranged from 100 t to 736 t per year (but never exceeded 238 t in the past ten years). Denmark landed on average 82% of the Skagerrak turbot. Other countries contributing to the total landings were - in descending order of importance - the Netherlands (mainly because of a peak in the second half of the seventies), Sweden, Norway, Belgium, Germany and the UK.

#### Landings in the English Channel (VIId,e)

International landing series from the English Channel were composed for turbot (compared to Moreau, 2010a; source: Eurostat database) and can be consulted in Table 6-5 and Figure 6-5. In the period 1973-2008, these landings ranged from 58 t to 726 t per year, but if we leave out 1973 and 1999 (no French turbot landings from VIIde in Eurostat for these years) total landings were always above 187 t. France has always been the main contributor to the turbot landings from the English Channel (65% over the entire time-line), with the UK and Belgium in second and third places (25% and 10% respectively). In the past decade, mainly the Belgian landings became relatively bigger, leading to landings percentages of 57% for France, 27 for the UK and 15% for Belgium over this period. Ireland, Denmark and the Netherlands landed negligible quantities.

#### Landings in the Celtic Sea (VIIf-h)

International landing series from the Celtic Sea were composed for turbot (compared to Moreau, 2010a; source: Eurostat database) and can be consulted in Table 6-6 and Figure 6-6. In the period 1973-1984, these landings ranged from 57 t to 96 t per year, but dramatically increased to a range from 213 t to 528 t in the period 1985-2008 (mainly due to increasing interest from France and the UK). Recently, also Irish and Belgian landings became more important. In the past decade, the main countries contributing to turbot landings from the Celtic Sea were - in descending order of importance – the UK (31%), France (31%), Belgium (20%) and Ireland (17%). Negligible quantities are landed by Spain, Denmark and the Netherlands.

#### Landings in the Irish Sea (VIIa)

International landing series from the Irish Sea were composed for turbot (compared to Moreau, 2010a; source: Eurostat database) and can be consulted in Table 6-7 and Figure 6-7. Over the period 1973-2008, these landings ranged from 52 t to 258 t per year (with average landings of 108 t over the past ten years). Historically, the UK and Ireland accounted for the biggest share of turbot landings in the Irish Sea (each ca 38% of the total landings), with an increasing importance of UK landings in the past ten years (47%). Irish landings decreased substantially in recent years (only 19% over the last decade), whereas the Belgian fisheries gained importance (32% of the landings in the last decade). Other countries contributing to the total landings were - in descending order of importance – France and the Netherlands. Denmark landed 55 t of Irish Sea turbot in 1984.

### Fishery descriptions

#### Fisheries in Belgium

Turbot is mainly caught in mid-class (301–900 Hp) and large (> 900 Hp) beam trawlers. These vessels are mostly flatfish directed (particularly towards plaice and sole, together with the associated bycatch species such as turbot, brill, dab, lemon sole, anglerfish and some roundfish), and usually operate in the central and southern North Sea (ICES Sub-areas IVb and IVc), the English Channel (VIId,e), the Irish Sea

(VIIa), the Celtic Sea (VIIf,g) and the inner part of the Bay of Biscay (VIIIa,b). The average effort and the average landings of turbot for the Belgian beam trawl fleet for the period 1996–2005 is presented in Figure 6-8.

#### Fisheries in Denmark

Except for some gillnet fisheries in the North Sea mainly targeting cod and turbot, turbot is taken only as bycatch in Danish fisheries. In the North Sea, where most of the Danish landings of turbot are taken, the gillnet fishery accounts for almost half of the landings (2004 and 2005 figures, see Figures 6-9a & b respectively). In the Skagerrak the main gears are beam trawls and Nephrops trawls.

#### Fisheries in France

Bottom trawlers and netters are the main métiers catching turbot in France. They account for more than 70% of the turbot landings from ICES areas VII and VIII. The species is targeted by beam trawlers and some large mesh netters in area VII. In area VIII, turbot is not targeted, but can be an important by-catch in the sole net fishery and in bottom trawl fisheries.

Beam trawlers from Dunkerque (27 meters long) operate in area IVc and VIId. Smaller boats (14 meters long) from Cherbourg target turbot in area VIId during some seasons. These vessels also catch dab.

Netters using tangle nets or trammel nets with large meshes target monkfish, crayfish, rays and brill (mainly in spring). They also land turbot during summer. Each boat can have between 5 km and 50 km of nets at sea. Most boats make daily trips and the immersion time of the nets is usually 3 days. In the 1990s about 100 vessels fished in the Western Channel and about 30 vessels fished north to the Seine bay in area VIId.

The métiers in the English Channel that catch turbot are described in Guitton *et al.*, 2003.

In the 1990s, discarding practices in bottom trawling and netting fisheries were studied during the whole year (Morizur *et al.*, 1996). Discarding of turbot was low in netting and mainly occurred when the immersion time was too long (e.g. due to bad weather).

#### Fisheries in the Netherlands

Turbot, brill, lemon sole, dab and flounder are caught as part of the by-catch in the beam trawl fishery for plaice and sole, with turbot by far the most important species. For turbot, brill and lemon sole probably only very small specimens are discarded. Discard data have been collected during recent years and an overview of discards can be made.

#### Fisheries in Spain

The Basque fleet operating in areas VI, VII and VIII, and targeting mainly hake, megrim and monkfish have a wide range of bycatch species such as sea bass, brill, turbot, gurnards and mullets. Long liners account for the major part of the turbot landings.

#### Fisheries in the UK

The majority of landings are in Divisions IVb and VIIf and are landed into the UK. Data by gear group are available.

## 6.5 Survey data

Cefas conducts several annual surveys in which turbot are routinely measured or biological information is retained. Four of the most important surveys are the Irish Sea (VIIa, VIIfg) beam trawl survey, the Channel (VIId) beam trawl survey, the Carhelmar (VIIe) commercial beam trawl survey and the English groundfish (IVb & c) GOV trawl survey. All fish caught are routinely measured during Cefas surveys, and for most surveys, biological information is collected for turbot. A summary of the numbers of fish measured and the numbers of biological samples (otoliths, length, weight, sex and maturity) in four Cefas survey series is given in Tables 6-8 and 6-9, respectively.

In addition, data on length distributions, distributions and abundance of turbot is available in Cefas technical reports for the Irish Sea beam trawl survey (Parker-Humphreys, 2004a), the English Channel and southern North Sea (Parker-Humphreys, 2004b) beam trawl survey and the Young Fish Survey for the south and east coasts (Rogers *et al.*, 1998).

Under the NESPMAN project, survey-data on turbot were requested from different national databases for the Skagerrak (IIIa), the English Channel (VIId,e), the Irish (VIIa) and Celtic Seas (VIIf-h). Time series of abundance (over all sizes and by size-class) and length frequency distributions (annual and average) can be presented for all areas covered in this study, but the series should be updated. Catches of turbot are generally very low on surveys however. A relatively low trawling speed allows bigger fish like turbot to actively escape the nets more easily than smaller fish can. Also the generally short trawl durations on bottom trawl surveys add to a decrease in the chance to encounter an individual turbot. Their piscivorous habits classify them as predators, that typically are distributed over an area more scattered than other species that target food resources that are more widely available. Unfortunately, these low catch numbers very often result in an underrepresentation of some year-classes (mainly the older ones), leading to a poor quality of the resulting survey abundance series and indices, and poor agreement among different surveys.

## 6.6 Biological sampling

#### DCF-requirements and Member States sampling intentions

Appendix VII of Commission Decision 2010/93/EU lists biological variables with species sampling specifications for all ICES areas. Table 6-10 gives an overview of what this implies for turbot (sampling for fecundity is optional). Turbot is classified as a Group 2 species under the DCF. These are internationally regulated species and major non-internationally regulated by-catch species, that don't drive the international management process and are not under EU management plans, EU recovery plans, EU long term multi-annual plans or EU action plans for conservation and management based on Council Regulation 2002/2371/EC. Group 2 species only require data on weight, sex-ratio and maturity to be collected every three years.

In Table 6-11, the sampling intensions of all Member States that inscribed sampling of biological parameters for turbot in their national proposals, were compiled, and can directly be compared to the required numbers in Table 6-10. For the North Sea and the Eastern English Channel, the joint effort of Belgium, Denmark, the Netherlands and the UK leads to sufficient sampling for age, weight, sex-ratio and maturity of turbot (green fields; for these parameters only 250 individuals are required under the DCF). For Subarea VII (excl. VIId) however, only the UK plans to collect biological information on 150 individuals in the Western English Channel and the Celtic Sea, whereas 250 individuals should be documented in the western waters to meet the DCF-requirements (red fields). All of the countries mentioned above plan to collect this biological information every year in the period 2011-2013 (and not on the minimum required three-year basis). No Member States included sampling of biological parameters for turbot in the Irish Sea and the Skagerrak in their proposals.

#### General problems

Due to the relatively low numbers of turbot in commercial catches (per trip) and the high commercial value of this species, it is very difficult to collect data on biological variables in sufficient numbers for a meaningful analysis. Fishermen very often don't allow observers to take turbot otoliths on board of commercial vessels (even when informing them that it is possible to sample the otoliths through the operculum in this species, making it unnecessary to cut open the heads and thus not influencing the appearance of individual fish and their value to buyers in this way), set aside sampling gonads for maturity staging (although the fish are gutted on board anyhow). Buying turbot as part of the market sampling hasn't been an option for most countries either, because of the high prices. However, including the biological sampling in MS national proposals, and the subsequent generating of required funds through the DCF, should solve this problem. On surveys, catches of turbot are generally even lower than on commercial vessels. Most likely this is due to the lower trawling speeds on surveys compared to commercial vessels, making it easier for bigger fish like turbot to actively escape the nets. Turbot grows relatively fast and generally reaches a certain length faster (at younger ages) than other flatfish species in the same areas, leading to a higher proportion of bigger fish in the younger age-classes than in slower growing species such as sole *Solea solea* and plaice *Pleuronectes platessa*. This also means that it is much more difficult to obtain sufficient information on the bigger length classes for turbot. Additionally, the shorter trawl durations on surveys decrease the chance to encounter an individual turbot, that occur more scattered over a given area than other co-occurring flatfish species because of their predatory feeding behaviour (turbot is piscivorous and could be regarded as a top predator, except for the smaller larval stages).

## 6.7 Biological parameters and other research

#### Length

An analysis of time series of landings and data from sampling on board of commercial vessels by Belgium (Moreau, 2010a) provided information on length-distributions, but not much on age-distributions, of landings and discards of turbot. Table 6-12 and Figure 6-10 give the length-distribution of landings and discards as recorded on observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.

#### Age

ILVO extracted already existing age-information on turbot from its own database (Moreau, 2010b), and collected similar information from relevant project partners and some other countries that were not involved in the NESPMAN-project. This resulted in only very few data due to the problems of low occurrence in commercial catches and on surveys, in combination with a high commercial value, as explained above. For (some of) the areas covered in this study, only Belgium, Germany, the Netherlands and the United Kingdom currently still collect and read turbot-otoliths, but the time series are often fragmented and therefore of little use for assessment-purposes (but see the progress that has been made in North Sea turbot).

The PGCCDBS meeting in Valetta, Malta, March 2007 (ICES 2007a), identified turbot as a species requiring an ageing workshop to evaluate and improve the age interpretation based on stained slides of the otoliths. One of the main difficulties in reading turbot-otoliths is the interpretation of the first annual ring, causing uncertainty among readers in national laboratories, and in the first turbot-otolith exchange that was organized in 2004. The WKART (Workshop on Age Reading of Turbot, 2008) could build on the results of this exchange and was the first ageing workshop for turbot. In this workshop two sets of otoliths were analysed, one from North Sea and one from the Baltic, but the same problem is likely to arise also in the age determination of turbot from other areas in the NE Atlantic. Because validated otoliths or agreed reference collections did not exist, the final debate on whether or not the first ring is indeed the first annual ring is still ongoing. The workshop therefore dedicated its effort to conclude to a common interpretation of this particular first ring and thus improve the agreement among readers. Also a manual on the preparation of turbot otoliths has been compiled, and documented with a reference set of annotated images (that should be used as an international approved set). This document can be used as a guideline and can form the template for discussion when refining the interpretation of the growth pattern and for identifying gaps and opportunities concerning the current knowledge of the age estimation of turbot. The overall agreement rate of the North Sea sample (N=110, besides this there was also a Baltic sample) was 82.8%. The range of agreement with the modal age was 70.5–91.1%. The results for this first turbot age reading workshop were evaluated by the participants as positive. For the North Sea area, expert readers should be able to reach an agreement of more than 90%. This indicates that the age estimation of turbot can be highly precise when the agreed interpretation is used, and applied on sufficient samples of good quality. Nevertheless, among the final recommendations of WKART some aspects illustrating the need for further research still remained: 1) compare different methods for the preparation of otoliths to determine a standard international procedure, 4) build a collection of otoliths that documents the edge growth, and 6) compile certified otoliths to determine the status of the first ring. A new turbot-otolith exchange was proposed by WKART (2008) for the Baltic, and approved by ICES PGCCDBS 2010 for the North Sea, the Baltic Sea and the Black Sea. ILVO, Belgium, will act as a coordinator for this exchange that will be carried out in 2012. Meanwhile, for the North Sea, Skagerrak, English Channel, Celtic and Irish Seas, ILVO started collecting more turbot-otoliths through increasing the Belgian sampling-effort for this species and engaging in regional coordination contracts with other European Member States regarding the sampling and reading of turbot otoliths within the framework of the RCM NS-EA (Regional Coordination Meeting for the North Sea and the Eastern Arctic) and the RCM NA (Regional Coordination Meeting for the North Atlantic). Under these contracts, other Member States can send the otoliths they collected to ILVO for reading.

#### Sex-ratio, maturity and other reproductive characteristics

A couple of studies on the reproductive characters of turbot have been carried out in the past by various authors (e.g., Dunn *et* al. 1996, Ongenae & De Clerck 1998, Boon *et al*. 2000, and references therein). Some important findings on sex-ratio and maturity of turbot (mainly females) are summarized in Table 6-13 (after Moreau 2010b). Due to sampling outside the main spawning months (fisheries scientists and observers are often dependent on seasonal fisheries for data collection) no certain assumptions could be made on the length range during first maturation for turbot in the English Channel, Celtic and Irish Seas.

After checking the databases of ILVO and the relevant NESPMAN partners, it proved impossible to find series of maturity-data for turbot that could add to this knowledge and could already be used for assessment-purposes (Moreau, 2010b). Since no biological sampling for turbot was scheduled under the NESPMAN contract, additional maturity information was not gathered in that project. However, the maturity stage is an important biological parameter to be used in the calculation of maturity ogives (and therefore of Spawning Stock Biomass), for the definition of the spawning season of a species, for the monitoring of long-term changes in the spawning cycle, and for many other research needs regarding the biology of fish, illustrating the need for reliable maturity staging abilities. Also judging from WKMSSPDF (2010), a workshop on maturity staging for other commercial flatfish species (including turbot and brill) might be useful. However, the lemon sole staging during WKMSSPDF shows that having the expertise in staging one species of flatfish can be adequate to stage other species of flatfish. After reviewing the species list of Appendix VII of the DCF against the details of previously held workshops, PGCCDBS (2010) considered that there is sufficient need and interest to organize a maturity staging workshop on turbot, as national maturity scales exist for this species but no maturity staging workshop has previously been held. As this is a Group 2 species in the DCF and there are constraints on the number of workshops that should be held in 2011, the workshop is proposed for 2012 and will take place in Ijmuiden (WKMSTB – Workshop on Maturity Staging of turbot and brill). This timing will also allow for sufficient opportunities to organize the collection of suitable fresh samples. The workshop will focus on the following issues: agree on a common maturity scale for turbot across laboratories comprising a comparison of existing scales and standardization of maturity determination criteria, reduce sources of error on maturity determination validating macroscopic staging, establish correspondence between old and new scales to convert time series, and propose optimal sampling strategy to estimate accurate maturity ogives.

#### Historical biological sampling

In the past, biological samples of turbot from the Danish fisheries in IIIa have been taken both from landed catches and through the national at-sea-sampling programme.

UK length information from market sampling for turbot from the Irish Sea and the English Channel is available for 1994–1996, and from 2000 onwards. Biological sampling for age, weight, sex and maturity has only been carried out since 2000. A summary of the number of samples available is given in Tables 6-14 and 10.7.4. The otoliths collected have not been aged.

France did collect length and age data on turbot (demographic structures per metier) in the areas VIId and VIIe during the years 1994–1996. These data were collected under an EU funded project carried out by France and the UK (Dunn *et al.*, 1996).

During the mid 1990s, Belgium took age and length samples of turbot caught in the Eastern English Channel, the Celtic Sea, the Irish Sea and the Bay of Biscay. The numbers measured vary between 200 and 600 individuals per year. The relative age distribution of turbot in the commercial landings of the Belgian beam trawl fleet for the period 1996–1997 is presented in Figure 6-11.

#### Maturation or discarding?

Because of the similarities in life-history, turbot faces the same MLS versus maturity paradox as brill. A Minimum Landing Size of 30 cm (as independently installed by various authorities) leads to the landing of many immature individuals, while increasing the MLS to higher lengths leads to higher discarding percentages.

Examples can be detailed out for turbot as it was done for North Sea brill elsewhere in this report.

## 6.8 Analysis of stock trends / assessment

Dunn (1999) made an assessment of turbot in the Channel fisheries (UK and FR) by using a Pella-Tomlinson model to a cpue time series of the English beam trawlers (1984–1995). They concluded that fishing mortality has increased from 1984 to 1989 from 1 to 1.5 and decreased thereafter to 0.7 in 1995. The MSY was given by Dunn (1999) to be between 300 and 400 t, which was lower than the observed catches (550 t /year). Ulrich (2000) found a maximum sustainable production of 440 t/year.

Given the highly fragmented and incomplete time series of age data, the poor quality of survey abundance series and indices (low catch numbers quickly result in underrepresentation of certain year-classes – mainly for the older ones) and the poor agreement among these survey series, no progress could be made in the development of assessments for these species in the Skagerrak, the English Channel and the Celtic and Irish Seas.

## 6.9 Data requirements

The collection of data needs to be continued in order to get a better understanding of the state of potential turbot stocks in the Northeast Atlantic area, and to enable the evaluation of trends. Updates of survey abundance-series, discard information and CPUE-series will be analyzed and included in the next report.

In order to meet the DCF-requirements for sampling of biological parameters for turbot in the Skagerrak, the English Channel, the Celtic Sea and the Irish Sea, the following countries could be valid candidates to fill in the gaps in Table 6-11, according to their importance in turbot fisheries:

- Denmark in the Skagerrak
- France and Belgium in the English Channel
- France, Belgium and Ireland in the Celtic Sea
- Ireland and Belgium in the Irish Sea

#### General recommendations

- EU to upgrade turbot from Group 2 to Group 1, forcing relevant Member States to collect biological information on a yearly basis
- Relevant Member States to include market sampling for turbot in their National Proposals, thus generating the required funds through the DCF

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**Table 6-2: International landings (t) of turbot *Psetta maxima* over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | I | II | Baltic | IIIa | IIIb-d | IV | V | VI | VIIa | VIIb,c | VIId,e | VIIf | VIIg-k | VIII | IX | X | XII | TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 0 | 0 | - | 100 | 85 | 4212 | 1 | 70 | 135 | 19 | 188 | 57 | 136 | 0 | 94 | 0 | 0 | 5097 |
| 1974 | 0 | 0 | - | 117 | 93 | 4116 | 2 | 86 | 127 | 21 | 187 | 96 | 154 | 201 | 65 | 0 | 0 | 5265 |
| 1975 | 0 | 0 | - | 183 | 143 | 4588 | 3 | 94 | 120 | 31 | 282 | 75 | 139 | 206 | 79 | 0 | 0 | 5943 |
| 1976 | 0 | 5 | - | 383 | 120 | 4814 | 3 | 122 | 110 | 48 | 387 | 75 | 188 | 140 | 109 | 0 | 0 | 6504 |
| 1977 | 0 | 0 | - | 736 | 142 | 4484 | 3 | 131 | 114 | 35 | 438 | 58 | 242 | 1187 | 92 | 0 | 0 | 7662 |
| 1978 | 2 | 17 | - | 525 | 110 | 5034 | 1 | 100 | 113 | 25 | 618 | 74 | 211 | 126 | 74 | 0 | 0 | 7030 |
| 1979 | 0 | 8 | - | 406 | 126 | 6364 | 2 | 86 | 115 | 29 | 461 | 72 | 191 | 264 | 94 | 0 | 0 | 8218 |
| 1980 | 0 | 0 | - | 233 | 124 | 5485 | 1 | 82 | 102 | 34 | 392 | 77 | 237 | 373 | 111 | 0 | 0 | 7251 |
| 1981 | 0 | 0 | - | 207 | 160 | 4755 | 20 | 103 | 96 | 60 | 449 | 70 | 241 | 388 | 106 | 0 | 0 | 6655 |
| 1982 | 0 | 0 | - | 182 | 139 | 4453 | 0 | 174 | 92 | 80 | 381 | 70 | 224 | 166 | 210 | 0 | 0 | 6171 |
| 1983 | 0 | 2 | 50 | 209 | 110 | 4575 | 0 | 162 | 117 | 52 | 595 | 68 | 256 | 221 | 215 | 0 | 0 | 6632 |
| 1984 | 0 | 1 | 61 | 188 | 128 | 1497 | 0 | 138 | 182 | 36 | 567 | 61 | 273 | 190 | 182 | 0 | 0 | 3504 |
| 1985 | 0 | 0 | 27 | 241 | 194 | 1588 | 0 | 112 | 139 | 39 | 541 | 73 | 306 | 270 | 192 | 0 | 0 | 3722 |
| 1986 | 0 | 0 | 151 | 193 | 280 | 1453 | 0 | 102 | 177 | 56 | 444 | 99 | 351 | 342 | 256 | 0 | 0 | 3904 |
| 1987 | 0 | 0 | 192 | 161 | 353 | 1511 | 0 | 118 | 273 | 46 | 505 | 134 | 309 | 369 | 254 | 0 | 0 | 4225 |
| 1988 | 0 | 0 | 176 | 138 | 374 | 4041 | 0 | 160 | 285 | 31 | 598 | 126 | 418 | 493 | 265 | 0 | 0 | 7105 |
| 1989 | 0 | 0 | 188 | 184 | 358 | 4927 | 0 | 162 | 156 | 31 | 669 | 79 | 385 | 453 | 199 | 0 | 0 | 7791 |
| 1990 | 0 | 0 | 227 | 386 | 461 | 5750 | 0 | 103 | 129 | 45 | 652 | 54 | 398 | 354 | 184 | 0 | 0 | 8743 |
| 1991 | 0 | 0 | 257 | 276 | 527 | 6340 | 0 | 100 | 90 | 29 | 726 | 83 | 353 | 255 | 211 | 0 | 0 | 9247 |
| 1992 | 0 | 0 | 312 | 309 | 664 | 5933 | 0 | 98 | 111 | 45 | 617 | 62 | 370 | 311 | 255 | 0 | 0 | 9087 |
| 1993 | 320 | 13 | 209 | 351 | 546 | 5546 | 0 | 98 | 162 | 42 | 680 | 78 | 430 | 347 | 291 | 0 | 0 | 9113 |
| 1994 | 0 | 11 | 340 | 353 | 606 | 5244 | 1 | 96 | 134 | 33 | 583 | 130 | 421 | 1171 | 238 | 0 | 0 | 9361 |
| 1995 | 0 | 6 | 399 | 301 | 719 | 4671 | 1 | 124 | 122 | 46 | 578 | 101 | 495 | 357 | 176 | 0 | 0 | 8096 |
| 1996 | 0 | 6 | 600 | 210 | 745 | 3644 | 0 | 141 | 106 | 60 | 485 | 114 | 561 | 326 | 137 | 0 | 0 | 7135 |
| 1997 | 0 | 6 | 492 | 220 | 679 | 3382 | 0 | 128 | 148 | 51 | 357 | 112 | 545 | 214 | 265 | 0 | 3 | 6602 |

| | I | II | Baltic | IIIa | IIIb-d | IV | V | VI | VIIa | VIIb,c | VIId,e | VIIf | VIIg-k | VIII | IX | X | XII | TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 0 | 6 | 541 | 164 | 614 | 3086 | 0 | 124 | 147 | 46 | 351 | 107 | 350 | 199 | 160 | 0 | 0 | 5895 |
| 1999 | 0 | 6 | 377 | 156 | 517 | 3187 | 0 | 81 | 112 | 64 | 111 | 58 | 365 | 95 | 169 | 0 | 3 | 5301 |
| 2000 | 0 | 7 | 273 | 193 | 382 | 4025 | 1 | 48 | 106 | 89 | 439 | 80 | 448 | 230 | 104 | 0 | 0 | 6425 |
| 2001 | 0 | 7 | 160 | 238 | 278 | 4100 | 1 | 43 | 106 | 67 | 472 | 83 | 427 | 228 | 119 | 0 | 0 | 6329 |
| 2002 | 0 | 4 | 166 | 222 | 246 | 3749 | 1 | 31 | 132 | 55 | 537 | 98 | 524 | 174 | 89 | 1 | 0 | 6029 |
| 2003 | 0 | 5 | 160 | 159 | 197 | 3374 | 3 | 48 | 205 | 69 | 580 | 80 | 468 | 215 | 74 | 0 | 0 | 5637 |
| 2004 | 0 | 7 | 196 | 147 | 230 | 3317 | 1 | 52 | 100 | 101 | 592 | 94 | 513 | 205 | 78 | 0 | 0 | 5633 |
| 2005 | 0 | 7 | 281 | 127 | 299 | 3195 | 0 | 27 | 105 | 45 | 596 | 67 | 408 | 181 | 91 | 0 | 0 | 5429 |
| 2006 | 0 | 6 | 293 | 121 | 303 | 2976 | 0 | 18 | 85 | 42 | 558 | 69 | 372 | 180 | 76 | 0 | 0 | 5099 |
| 2007 | 0 | 7 | 276 | 173 | 289 | 3508 | 0 | 23 | 80 | 51 | 614 | 81 | 335 | 181 | 59 | 1 | 0 | 5678 |
| 2008 | 0 | 6 | 334 | 142 | 344 | 3005 | 0 | 14 | 53 | 48 | 518 | 67 | 265 | 116 | 59 | 0 | 0 | 4971 |

**Table 6-3: International landings (t) of turbot *Psetta maxima* in the North Sea (IV) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | DEN | FRA | GER | NLD | NOR | UK | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 1973 | 135 | - | 50 | 194 | 2,638 | - | 824 | 3841 |
| 1974 | 113 | 247 | 12 | 135 | 2,885 | - | 717 | 4109 |
| 1975 | 158 | 387 | 21 | 169 | 3,349 | - | 503 | 4587 |
| 1976 | 146 | 588 | 38 | 156 | 3,253 | - | 631 | 4812 |
| 1977 | 145 | 474 | 37 | 172 | 2,973 | - | 683 | 4484 |
| 1978 | 170 | 693 | 50 | 173 | 3,196 | - | 752 | 5034 |
| 1979 | 187 | 1,164 | 22 | 151 | 3,999 | - | 838 | 6361 |
| 1980 | 162 | 1,360 | 17 | 146 | 3,241 | - | 559 | 5485 |
| 1981 | 142 | 1,044 | 6 | 86 | 3,073 | - | 404 | 4755 |
| 1982 | 153 | 880 | 14 | 42 | 3,029 | - | 335 | 4453 |
| 1983 | 174 | 893 | 24 | 44 | 3,163 | - | 277 | 4575 |
| 1984 | 242 | 886 | 40 | 46 | - | - | 282 | 1496 |
| 1985 | 222 | 983 | 37 | 34 | - | - | 312 | 1588 |
| 1986 | 133 | 997 | 5 | 31 | - | - | 287 | 1453 |
| 1987 | 130 | 988 | 21 | 27 | - | - | 345 | 1511 |
| 1988 | 129 | 858 | 24 | 41 | 2,660 | - | 328 | 4040 |
| 1989 | 176 | 637 | 30 | 85 | 3,666 | - | 333 | 4927 |
| 1990 | 292 | 1,046 | 52 | 184 | 3,732 | - | 437 | 5743 |
| 1991 | 350 | 1,233 | 64 | 186 | 3,780 | 30 | 688 | 6331 |
| 1992 | 317 | 907 | 81 | 163 | 3,495 | 65 | 902 | 5930 |
| 1993 | 355 | 817 | 123 | 252 | 2,939 | 47 | 1013 | 5546 |
| 1994 | 330 | 862 | 141 | 263 | 2,724 | 42 | 882 | 5244 |
| 1995 | 315 | 761 | 108 | 275 | 2,476 | 33 | 703 | 4671 |
| 1996 | 210 | 618 | 160 | 157 | 1,776 | 36 | 687 | 3644 |
| 1997 | 169 | 479 | 1 | 215 | 1,854 | 45 | 619 | 3382 |
| 1998 | 198 | 392 | 22 | 164 | 1,695 | 33 | 582 | 3086 |
| 1999 | 224 | 411 | . | 224 | 1,808 | 32 | 488 | 3187 |
| 2000 | 302 | 469 | 21 | 349 | 2,280 | 55 | 549 | 4025 |
| 2001 | 333 | 506 | 17 | 297 | 2,226 | 79 | 642 | 4100 |
| 2002 | 243 | 677 | 15 | 280 | 1,898 | 85 | 551 | 3749 |
| 2003 | 192 | 486 | 18 | 289 | 1,893 | 65 | 431 | 3374 |
| 2004 | 207 | 518 | 15 | 278 | 1,762 | 74 | 463 | 3317 |
| 2005 | 159 | 429 | 18 | 274 | 1,903 | 65 | 347 | 3195 |
| 2006 | 146 | 338 | 22 | 221 | 1,828 | 40 | 381 | 2976 |
| 2007 | 173 | 310 | 32 | 203 | 2,263 | 43 | 485 | 3509 |
| 2008 | 182 | 457 | 21 | 199 | 1,744 | 32 | 370 | 3005 |

**Table 6-4: International landings (t) of turbot *Psetta maxima* in the Skagerrak (IIIa) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | DNK | GER | NLD | SWE | UK | NOR | TOT |
|---|---|---|---|---|---|---|---|---|
| 1973 | 0 | 98 | 2 | 0 | 0 | 0 | 0 | 100 |
| 1974 | 0 | 116 | 1 | 0 | 0 | 0 | 0 | 117 |
| 1975 | 0 | 167 | 2 | 7 | 7 | 0 | 0 | 183 |
| 1976 | 7 | 178 | 2 | 190 | 6 | 0 | 0 | 383 |
| 1977 | 7 | 331 | 4 | 389 | 5 | 0 | 0 | 736 |
| 1978 | 2 | 327 | 4 | 186 | 6 | 0 | 0 | 525 |
| 1979 | 8 | 307 | 0 | 87 | 4 | 0 | 0 | 406 |
| 1980 | 7 | 205 | 0 | 14 | 6 | 1 | 0 | 233 |
| 1981 | 2 | 183 | 0 | 12 | 8 | 2 | 0 | 207 |
| 1982 | 1 | 164 | 0 | 9 | 7 | 1 | 0 | 182 |
| 1983 | 4 | 171 | 0 | 24 | 10 | 0 | 0 | 209 |
| 1984 | 0 | 176 | 0 | 0 | 12 | 0 | 0 | 188 |
| 1985 | 1 | 224 | 0 | 0 | 16 | 0 | 0 | 241 |
| 1986 | 2 | 180 | 0 | 0 | 11 | 0 | 0 | 193 |
| 1987 | 5 | 147 | 0 | 0 | 9 | 0 | 0 | 161 |
| 1988 | 2 | 115 | 0 | 11 | 10 | 0 | 0 | 138 |
| 1989 | 2 | 173 | 0 | 0 | 9 | 0 | 0 | 184 |
| 1990 | 5 | 363 | 0 | 0 | 18 | 0 | 0 | 386 |
| 1991 | 4 | 244 | 0 | 0 | 21 | 0 | 7 | 276 |
| 1992 | 4 | 278 | 0 | 0 | 19 | 0 | 8 | 309 |
| 1993 | 3 | 336 | 2 | 0 | 0 | 0 | 10 | 351 |
| 1994 | 2 | 313 | 1 | 0 | 22 | 0 | 15 | 353 |
| 1995 | 4 | 268 | 1 | 0 | 11 | 0 | 17 | 301 |
| 1996 | 0 | 185 | 1 | 0 | 11 | 0 | 13 | 210 |
| 1997 | 0 | 200 | 0 | 0 | 11 | 0 | 9 | 220 |
| 1998 | 0 | 148 | 1 | 0 | 8 | 0 | 7 | 164 |
| 1999 | 0 | 139 | 1 | 0 | 6 | 0 | 10 | 156 |
| 2000 | 0 | 180 | 1 | 0 | 6 | 0 | 6 | 193 |
| 2001 | 0 | 227 | 0 | 0 | 3 | 0 | 8 | 238 |
| 2002 | 0 | 205 | 1 | 0 | 5 | 0 | 11 | 222 |
| 2003 | 0 | 128 | 0 | 13 | 4 | 0 | 14 | 159 |
| 2004 | 0 | 119 | 0 | 14 | 7 | 0 | 7 | 147 |
| 2005 | 0 | 108 | 0 | 7 | 6 | 0 | 6 | 127 |
| 2006 | 0 | 95 | 1 | 8 | 9 | 0 | 8 | 121 |
| 2007 | 0 | 138 | 1 | 15 | 12 | 0 | 7 | 173 |
| 2008 | 0 | 121 | 1 | 4 | 11 | 0 | 6 | 143 |

**Table 6-5: International landings (t) of turbot *Psetta maxima* in the English Channel (VIIde) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | DNK | IRL | FRA | NLD | UK | TOT |
|---|---|---|---|---|---|---|---|
| **1973** | 8 | 0 | 0 | 0 | 0 | 50 | **58** |
| **1974** | 12 | 0 | 0 | 122 | 1 | 52 | **187** |
| **1975** | 8 | 0 | 0 | 217 | 0 | 59 | **284** |
| **1976** | 14 | 0 | 0 | 288 | 0 | 86 | **388** |
| **1977** | 15 | 1 | 0 | 331 | 0 | 91 | **438** |
| **1978** | 16 | 60 | 0 | 405 | 0 | 137 | **618** |
| **1979** | 19 | 1 | 0 | 316 | 0 | 125 | **461** |
| **1980** | 18 | 1 | 1 | 269 | 0 | 103 | **392** |
| **1981** | 28 | 0 | 0 | 325 | 0 | 97 | **450** |
| **1982** | 31 | 0 | 0 | 234 | 2 | 123 | **390** |
| **1983** | 37 | 0 | 0 | 397 | 0 | 175 | **609** |
| **1984** | 43 | 0 | 0 | 381 | 0 | 151 | **575** |
| **1985** | 31 | 0 | 0 | 372 | 0 | 144 | **547** |
| **1986** | 35 | 0 | 0 | 289 | 0 | 128 | **452** |
| **1987** | 37 | 0 | 0 | 356 | 0 | 118 | **511** |
| **1988** | 46 | 0 | 0 | 421 | 0 | 131 | **598** |
| **1989** | 49 | 0 | 0 | 517 | 0 | 104 | **670** |
| **1990** | 65 | 0 | 0 | 452 | 0 | 136 | **653** |
| **1991** | 74 | 0 | 0 | 567 | 0 | 85 | **726** |
| **1992** | 60 | 0 | 0 | 445 | 0 | 114 | **619** |
| **1993** | 50 | 0 | 0 | 493 | 0 | 139 | **682** |
| **1994** | 55 | 0 | 0 | 361 | 0 | 170 | **586** |
| **1995** | 54 | 1 | 1 | 356 | 0 | 174 | **585** |
| **1996** | 45 | 0 | 0 | 269 | 0 | 176 | **490** |
| **1997** | 40 | 0 | 0 | 195 | 0 | 127 | **362** |
| **1998** | 22 | 0 | 0 | 234 | 0 | 98 | **354** |
| **1999** | 40 | 0 | 0 | 0 | 2 | 73 | **115** |
| **2000** | 54 | 1 | 1 | 274 | 4 | 112 | **445** |
| **2001** | 62 | 0 | 0 | 265 | 12 | 142 | **481** |
| **2002** | 72 | 0 | 0 | 303 | 1 | 167 | **543** |
| **2003** | 95 | 1 | 1 | 354 | 2 | 136 | **588** |
| **2004** | 76 | 2 | 2 | 363 | 2 | 163 | **606** |
| **2005** | 64 | 1 | 1 | 390 | 5 | 154 | **614** |
| **2006** | 100 | 0 | 0 | 338 | 3 | 125 | **566** |
| **2007** | 125 | 0 | 0 | 347 | 1 | 144 | **617** |
| **2008** | 98 | 0 | 0 | 255 | 3 | 164 | **520** |

**Table 6-6: International landings (t) of turbot *Psetta maxima* in the Celtic Sea (VIIf-h) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | DNK | IRL | ESP | FRA | NLD | UK | TOT |
|---|---|---|---|---|---|---|---|---|
| 1973 | 19 | 0 | 0 | 0 | 0 | 0 | 38 | 57 |
| 1974 | 22 | 0 | 0 | 0 | 52 | 0 | 22 | 96 |
| 1975 | 21 | 0 | 0 | 0 | 27 | 0 | 27 | 75 |
| 1976 | 9 | 0 | 0 | 0 | 47 | 0 | 19 | 75 |
| 1977 | 6 | 0 | 0 | 0 | 33 | 0 | 19 | 58 |
| 1978 | 6 | 0 | 0 | 0 | 41 | 0 | 27 | 74 |
| 1979 | 8 | 0 | 0 | 0 | 38 | 0 | 41 | 87 |
| 1980 | 16 | 0 | 0 | 0 | 32 | 0 | 29 | 77 |
| 1981 | 15 | 0 | 0 | 0 | 27 | 0 | 28 | 70 |
| 1982 | 13 | 0 | 0 | 0 | 26 | 0 | 31 | 70 |
| 1983 | 23 | 0 | 0 | 0 | 16 | 2 | 27 | 68 |
| 1984 | 15 | 0 | 0 | 0 | 8 | 0 | 38 | 61 |
| 1985 | 27 | 0 | 0 | 0 | 192 | 0 | 40 | 259 |
| 1986 | 32 | 4 | 0 | 0 | 207 | 0 | 55 | 298 |
| 1987 | 22 | 0 | 5 | 0 | 177 | 0 | 144 | 348 |
| 1988 | 26 | 35 | 6 | 0 | 187 | 0 | 190 | 444 |
| 1989 | 32 | 7 | 6 | 0 | 203 | 0 | 71 | 319 |
| 1990 | 20 | 8 | 25 | 0 | 196 | 0 | 66 | 315 |
| 1991 | 38 | 24 | 18 | 0 | 145 | 0 | 65 | 290 |
| 1992 | 15 | 10 | 26 | 0 | 126 | 0 | 98 | 275 |
| 1993 | 14 | 16 | 41 | 0 | 113 | 0 | 165 | 349 |
| 1994 | 21 | 0 | 20 | 0 | 87 | 0 | 288 | 416 |
| 1995 | 22 | 5 | 19 | 0 | 116 | 0 | 237 | 399 |
| 1996 | 19 | 0 | 16 | 2 | 153 | 1 | 210 | 401 |
| 1997 | 18 | 0 | 20 | 3 | 151 | 0 | 228 | 420 |
| 1998 | 19 | 0 | 18 | 2 | 110 | 1 | 142 | 292 |
| 1999 | 55 | 0 | 44 | 2 | 0 | 0 | 112 | 213 |
| 2000 | 69 | 0 | 54 | 1 | 166 | 0 | 106 | 396 |
| 2001 | 69 | 0 | 53 | 0 | 175 | 0 | 97 | 394 |
| 2002 | 71 | 0 | 65 | 1 | 147 | 0 | 244 | 528 |
| 2003 | 106 | 0 | 89 | 5 | 125 | 0 | 121 | 446 |
| 2004 | 94 | 0 | 99 | 0 | 148 | 0 | 120 | 461 |
| 2005 | 82 | 0 | 82 | 5 | 117 | 0 | 100 | 386 |
| 2006 | 82 | 0 | 70 | 1 | 109 | 0 | 95 | 357 |
| 2007 | 72 | 0 | 50 | 1 | 106 | 0 | 89 | 318 |
| 2008 | 53 | 0 | 51 | 1 | 72 | 0 | 89 | 266 |

**Table 6-7: International landings (t) of turbot *Psetta maxima* in the Irish Sea (VIIf-h) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

| | BEL | DNK | IRL | FRA | NLD | UK | TOT |
|---|---|---|---|---|---|---|---|
| 1973 | 14 | 0 | 33 | 0 | 2 | 76 | 125 |
| 1974 | 15 | 0 | 32 | 7 | 3 | 70 | 127 |
| 1975 | 13 | 0 | 27 | 11 | 6 | 63 | 120 |
| 1976 | 8 | 0 | 45 | 3 | 6 | 48 | 110 |
| 1977 | 6 | 0 | 36 | 27 | 2 | 43 | 114 |
| 1978 | 8 | 0 | 50 | 18 | 2 | 35 | 113 |
| 1979 | 5 | 0 | 57 | 17 | 4 | 33 | 116 |
| 1980 | 4 | 0 | 60 | 6 | 5 | 27 | 102 |
| 1981 | 7 | 0 | 57 | 7 | 4 | 21 | 96 |
| 1982 | 8 | 0 | 55 | 3 | 4 | 23 | 93 |
| 1983 | 30 | 0 | 58 | 2 | 2 | 25 | 117 |
| 1984 | 10 | 77 | 67 | 5 | 0 | 32 | 191 |
| 1985 | 23 | 0 | 62 | 8 | 0 | 47 | 140 |
| 1986 | 33 | 0 | 88 | 10 | 0 | 46 | 177 |
| 1987 | 37 | 0 | 136 | 6 | 0 | 94 | 273 |
| 1988 | 16 | 0 | 182 | 6 | 0 | 81 | 285 |
| 1989 | 10 | 0 | 68 | 3 | 0 | 75 | 156 |
| 1990 | 20 | 0 | 47 | 6 | 0 | 57 | 130 |
| 1991 | 12 | 0 | 25 | 5 | 0 | 49 | 91 |
| 1992 | 16 | 0 | 43 | 5 | 0 | 48 | 112 |
| 1993 | 13 | 0 | 52 | 3 | 0 | 95 | 163 |
| 1994 | 25 | 0 | 55 | 2 | 0 | 52 | 134 |
| 1995 | 24 | 0 | 58 | 2 | 0 | 38 | 122 |
| 1996 | 27 | 0 | 38 | 2 | 3 | 37 | 107 |
| 1997 | 32 | 0 | 69 | 1 | 8 | 39 | 149 |
| 1998 | 31 | 0 | 59 | 1 | 3 | 53 | 147 |
| 1999 | 30 | 0 | 22 | 0 | 2 | 58 | 112 |
| 2000 | 22 | 0 | 33 | 3 | 3 | 45 | 106 |
| 2001 | 35 | 0 | 19 | 0 | 0 | 52 | 106 |
| 2002 | 50 | 0 | 21 | 0 | 0 | 61 | 132 |
| 2003 | 43 | 0 | 31 | 1 | 0 | 133 | 208 |
| 2004 | 28 | 0 | 22 | 0 | 0 | 50 | 100 |
| 2005 | 54 | 0 | 16 | 3 | 0 | 32 | 105 |
| 2006 | 35 | 0 | 19 | 1 | 0 | 30 | 85 |
| 2007 | 31 | 0 | 17 | 1 | 0 | 31 | 80 |
| 2008 | 19 | 0 | 10 | 0 | 0 | 23 | 52 |

**Table 6-8: The number of turbot Psetta maxima measured each year for five Cefas survey series.**

| | Irish Sea Autumn | Irish Sea Spring | Carhelmar | Channel | North Sea |
|---|---|---|---|---|---|
| 1988 | 5 | | | | |
| 1989 | 23 | | 3 | 14 | |
| 1990 | 11 | | 2 | 13 | |
| 1991 | 9 | | 2 | 10 | 11 |
| 1992 | 20 | | 1 | 15 | 4 |
| 1993 | 19 | 5 | 3 | 8 | 2 |
| 1994 | 23 | 5 | 2 | 10 | 7 |
| 1995 | 28 | 3 | 3 | 14 | |
| 1996 | 19 | 3 | 3 | 8 | 3 |
| 1997 | 8 | 9 | 3 | 6 | 3 |
| 1998 | 16 | 5 | 2 | 4 | 4 |
| 1999 | 39 | 3 | 4 | 12 | 6 |
| 2000 | 27 | | 4 | 16 | 1 |
| 2001 | 16 | | 6 | 9 | 9 |
| 2002 | 31 | | | 8 | 6 |
| 2003 | 23 | | 4 | 22 | 4 |
| 2004 | 20 | | | 15 | 6 |
| 2005 | 27 | | | 24 | 15 |
| Total | 364 | 33 | 42 | 208 | 81 |

**Table 6-9: The number of turbot Psetta maxima for which biological data (otoliths, weight, sex and maturity) have been collected from five Cefas survey series.**

| | Irish Sea Autumn | Irish Sea Spring | Carhelmar | Channel | North Sea |
|---|---|---|---|---|---|
| 1994 | 18 | | 1 | 3 | |
| 1995 | 28 | 3 | 3 | 10 | |
| 1996 | 19 | 3 | 3 | 7 | |
| 1997 | 8 | 9 | 3 | | |
| 1998 | 15 | 5 | | 4 | |
| 1999 | 39 | | | | |
| 2000 | 26 | | | | |
| 2001 | 15 | | 6 | 9 | |
| 2002 | 28 | | 2 | 8 | |
| 2003 | 40 | | 6 | | 4 |
| 2004 | | | | 2 | 6 |
| 2005 | 14 | | | 21 | 14 |
| Total | 250 | 20 | 24 | 64 | 24 |

**Table 6-10: Overview of the requirements for biological sampling of turbot *Psetta maxima* under the DCF for the period 2011-2013 (EC/2010/93).**

| Species | Area/Stock | Species Group | Age N°/1000 t | Weight | Sex | Maturity |
|---|---|---|---|---|---|---|
| *Psetta maxima* | IIIa | G2 | 250 | T | T | T |
| *Psetta maxima* | IV, VIId | G2 | 250 | T | T | T |
| *Psetta maxima* | all areas (NE Atlantic + W Channel) | G2 | 250 | T | T | T |

**Table 6-11: Compilation of the scheduled sampling effort of Member States for biological parameters in turbot *Psetta maxima* for the period 2011-2013 (source: reports RCM's 2010).**

| Species | Species Group | MS | 2011 | 2012 | 2013 | Fishing ground | Age (n° per year) | Weight (n° per year) | Sex-ratio (n° per year) | Maturity (n° per year) | Data sources |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Psetta maxima* | G2 | / | | | | IIIa | | | | | |
| | | **TOTAL** | | | | | **0** | **0** | **0** | **0** | |
| *Psetta maxima* | G2 | **BEL** | X | X | X | IV | 25 | 25 | 25 | / | Comm. + Surveys |
| *Psetta maxima* | G2 | **DNK** | X | X | X | IV, VIId | 300 | 300 | 100 | 100 | Comm. + Surveys [(a)] |
| *Psetta maxima* | G2 | **NLD** | X | X | X | IV, VIId | 720 | 720 | 720 | 720 | Comm. + surveys |
| *Psetta maxima* | G2 | **UK** | X | X | X | IV, VIId | 25 | 25 | 25 | 25 | Market + surveys |
| | | **TOTAL** | | | | | **1070** | **1070** | **870** | **845** | |
| *Psetta maxima* | G2 | UK | X | X | X | VIIe | 75 | 75 | 75 | 75 | Market + surveys |
| *Psetta maxima* | G2 | UK | X | X | X | VIIfgh | 75 | 75 | 75 | 75 | Market + surveys |
| | | **TOTAL** | | | | | **150** | **150** | **150** | **150** | |

(a) DNK: sex-ratio and maturity only on surveys

**Table 6-12: Length-distribution of landings and discards of turbot *Psetta maxima* as recorded on Belgian observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.**

| | Discards | | | | Landings | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No @ length | | | Subtot | No @ length | | | | Subtot | Total |
| Length | VIIa | VIId | VIIf | disc | VIIa | VIId | VIIf | VIIg | land | catch No |
| **210** | 2 | | | 2 | | | | | | **2** |
| **220** | 3 | | | 3 | | | | | | **3** |
| **230** | 3 | | | 3 | | | | | | **3** |
| **240** | 3 | | | 3 | | | | | | **3** |
| **250** | 10 | | | 10 | | | | | | **10** |
| **260** | 10 | | | 10 | | | | | | **10** |
| **270** | 10 | | 1 | 11 | | | | | | **11** |
| **280** | 17 | | 1 | 18 | | | | | | **18** |
| **290** | 28 | 1 | 1 | 30 | | 1 | | | 1 | **31** |
| **300** | 6 | | | 6 | 73 | 12 | 1 | | 86 | **92** |
| **310** | | | | | 94 | 21 | 1 | | 116 | **116** |
| **320** | | | | | 93 | 37 | 6 | | 136 | **136** |
| **330** | | | | | 93 | 51 | 2 | | 146 | **146** |
| **340** | | | | | 76 | 96 | 4 | | 176 | **176** |
| **350** | | | | | 99 | 109 | 6 | 1 | 215 | **215** |
| **360** | | | | | 70 | 118 | 5 | 1 | 194 | **194** |
| **370** | | | | | 68 | 110 | 5 | 3 | 186 | **186** |
| **380** | | | | | 58 | 114 | 4 | 1 | 177 | **177** |
| **390** | | | | | 46 | 114 | 8 | 3 | 171 | **171** |
| **400** | | | | | 36 | 97 | 7 | 1 | 141 | **141** |
| **410** | | | | | 42 | 77 | 2 | 1 | 122 | **122** |
| **420** | | | | | 25 | 60 | 2 | 4 | 91 | **91** |
| **430** | | | | | 25 | 42 | 3 | | 70 | **70** |
| **440** | | | | | 17 | 31 | 4 | 1 | 53 | **53** |
| **450** | | | | | 16 | 28 | 8 | 4 | 56 | **56** |
| **460** | | | | | 20 | 27 | 5 | 2 | 54 | **54** |
| **470** | | | | | 22 | 28 | 1 | 2 | 53 | **53** |
| **480** | | | | | 15 | 16 | 3 | 4 | 38 | **38** |
| **490** | | | | | 12 | 15 | 3 | 1 | 31 | **31** |
| **500** | | | | | 16 | 16 | 2 | | 34 | **34** |
| **510** | | | | | 11 | 14 | 1 | 2 | 28 | **28** |
| **520** | | | | | 21 | 13 | | 1 | 35 | **35** |
| **530** | | | | | 10 | 7 | 2 | 1 | 20 | **20** |
| **540** | | | | | 6 | 10 | | | 16 | **16** |
| **550** | | | | | 8 | 7 | 2 | | 17 | **17** |
| **560** | | | | | 5 | 4 | | | 9 | **9** |
| **570** | | | | | 8 | | 2 | 1 | 11 | **11** |
| **580** | | | | | 2 | 1 | | 1 | 4 | **4** |
| **590** | | | | | 3 | | 1 | 1 | 5 | **5** |

| Length | Discards No @ length VIIa | VIId | VIIf | Subtot disc | Landings No @ length VIIa | VIId | VIIf | VIIg | Subtot land | Total catch No |
|---|---|---|---|---|---|---|---|---|---|---|
| **600** | | | | | 2 | 1 | 1 | | 4 | **4** |
| **610** | | | | | 2 | 1 | | | 3 | **3** |
| **620** | | | | | 1 | | | | 1 | **1** |
| **630** | | | | | | | 1 | | 1 | **1** |
| **640** | | | | | 2 | | | | 2 | **2** |
| **650** | | | | | 1 | | | | 1 | **1** |
| **660** | | | | | | 1 | | | 1 | **1** |
| **680** | | | | | 1 | | | | 1 | **1** |
| **700** | | | | | 1 | | | | 1 | **1** |
| **710** | | | | | 1 | 1 | | | 2 | **2** |
| **720** | | | | | 1 | | | | 1 | **1** |
| **Total No** | **92** | **1** | **3** | **96** | **1102** | **1280** | **92** | **36** | **2510** | **2606** |

**Table 6-13: Summary of reproductive characteristics of female turbot *Psetta maxima* from different ICES areas (after Moreau, 2010b).**

| | North Sea/ Skagerrak | English Channel | Celtic Sea | Irish Sea |
|---|---|---|---|---|
| Proportion females (age 2 - 5 years) | 50 - 80 % | 30 - 50 % | 40 - 60 % | 40 - 50 % |
| Proportion females (age > 5 years) | 60 - 80 % | 10 - 100 % | 35 - 100 % | 30 - 100 % |
| Spawning period | Apr–Aug | May-Sep | Apr-Jul? | May–Aug? |
| Length at 0% maturity | 30 cm | 35 cm | 35 cm | 35 cm |
| Length at full maturity | 47 cm | ND | ND | ND |
| Age at maturity males | 3 years | 3 years | 3 years | 3 years |
| Age at maturity females | 4-5 years | 4-5 years | 4-5 years | 4-5 years |
| Monthly variation in condition factor | NO | NO | NO | NO |

ND* : not determined

**Table 6-14: Number of turbot Psetta maxima measured during the Cefas biological sampling programme.**

| | No of fish | No of Samples |
|---|---|---|
| 1994 | 1128 | 55 |
| 1995 | 821 | 69 |
| 1996 | 222 | 10 |
| 1997 | | |
| 1998 | | |
| 1999 | | |
| 2000 | 4231 | 113 |
| 2001 | 6336 | 112 |
| 2002 | 3813 | 66 |
| 2003 | 1 | 1 |
| 2004 | | |
| Total | 16552 | 426 |

**Table 6-15: Number of turbot Psetta maxima for which biological information has been collected by the Cefas biological sampling programme.**

| | No of fish | No of Samples |
|---|---|---|
| 1995 | 2 | 1 |
| 1996 | | |
| 1997 | | |
| 1998 | | |
| 1999 | | |
| 2000 | 1017 | 121 |
| 2001 | 1087 | 137 |
| 2002 | 748 | 103 |
| 2003 | 13 | 5 |
| 2004 | | |
| 2005 | | |
| Total | 2867 | 367 |

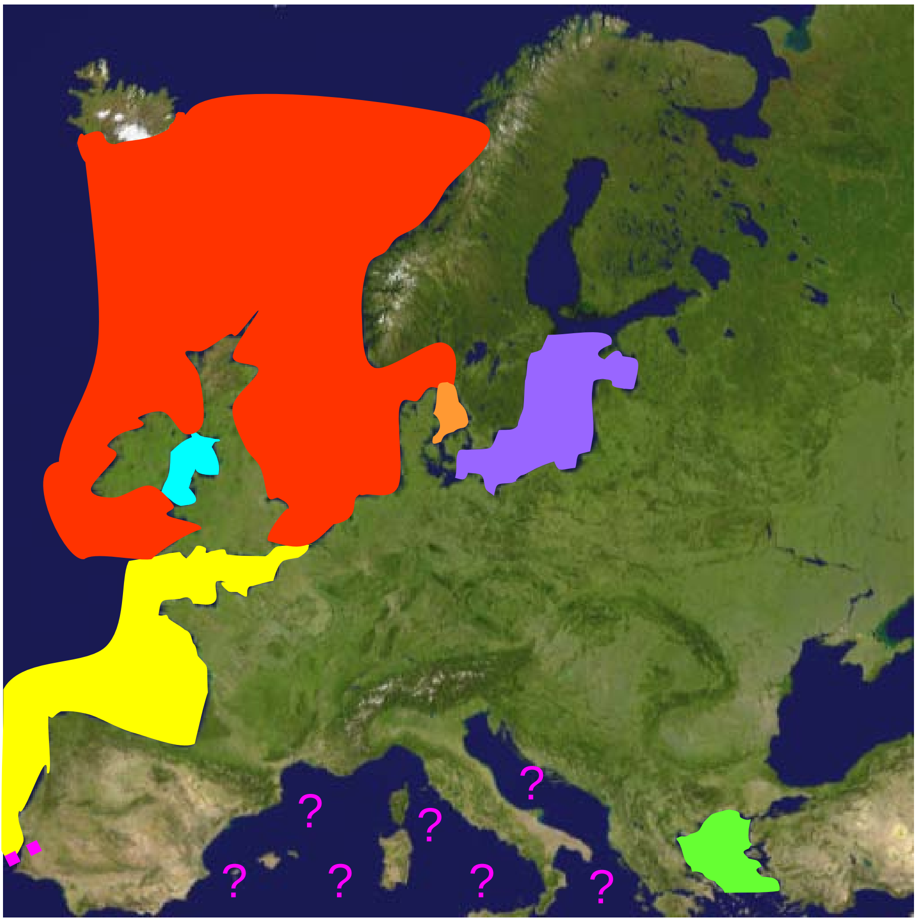



**Figure 6-1: Preliminary map of the population structure of turbot *Psetta maxima* (From Annex 4, ICES, 2005).**

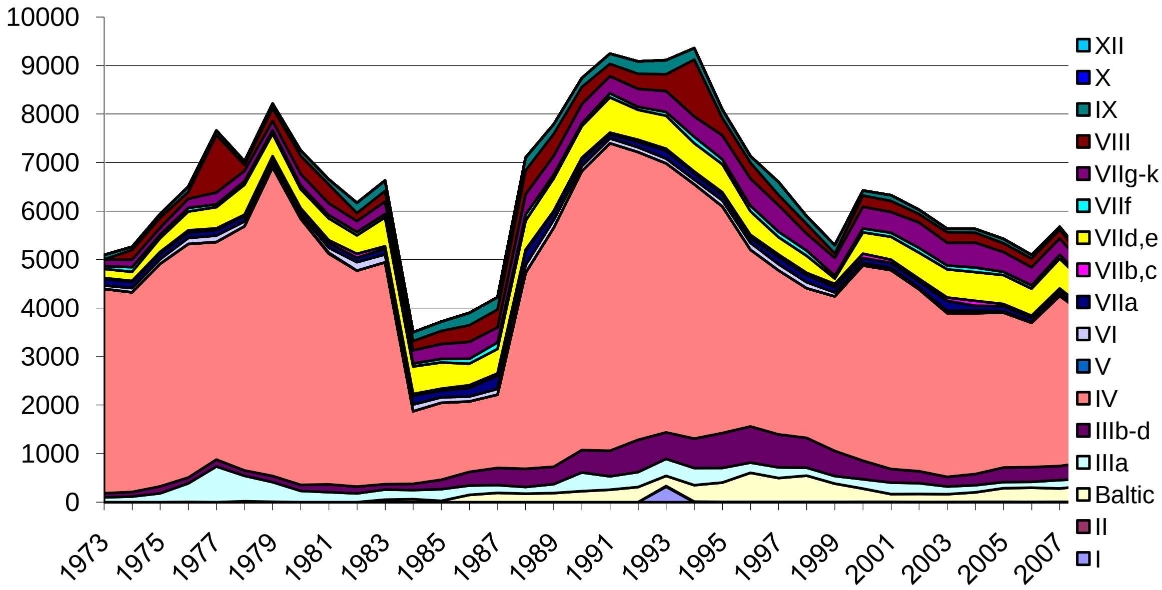



**Figure 6-2: International landings (t) of turbot *Psetta maxima* in the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

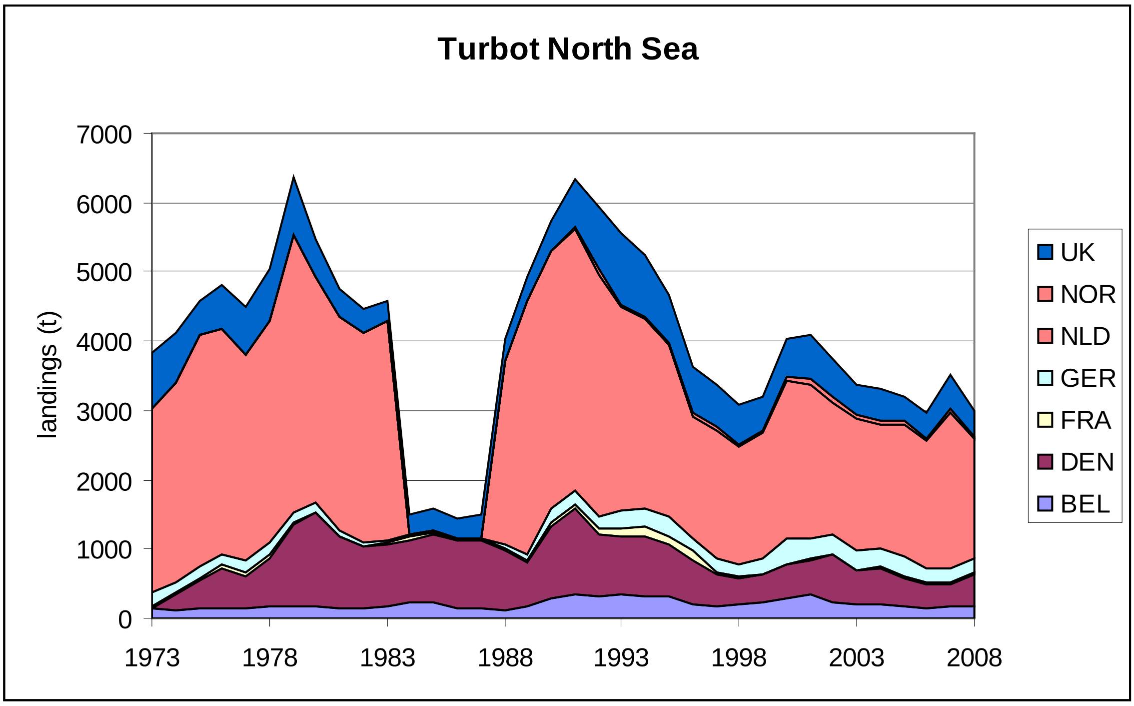



**Figure 6-3: Composition of landings (t) of turbot *Psetta maxima* in the North Sea (IV) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

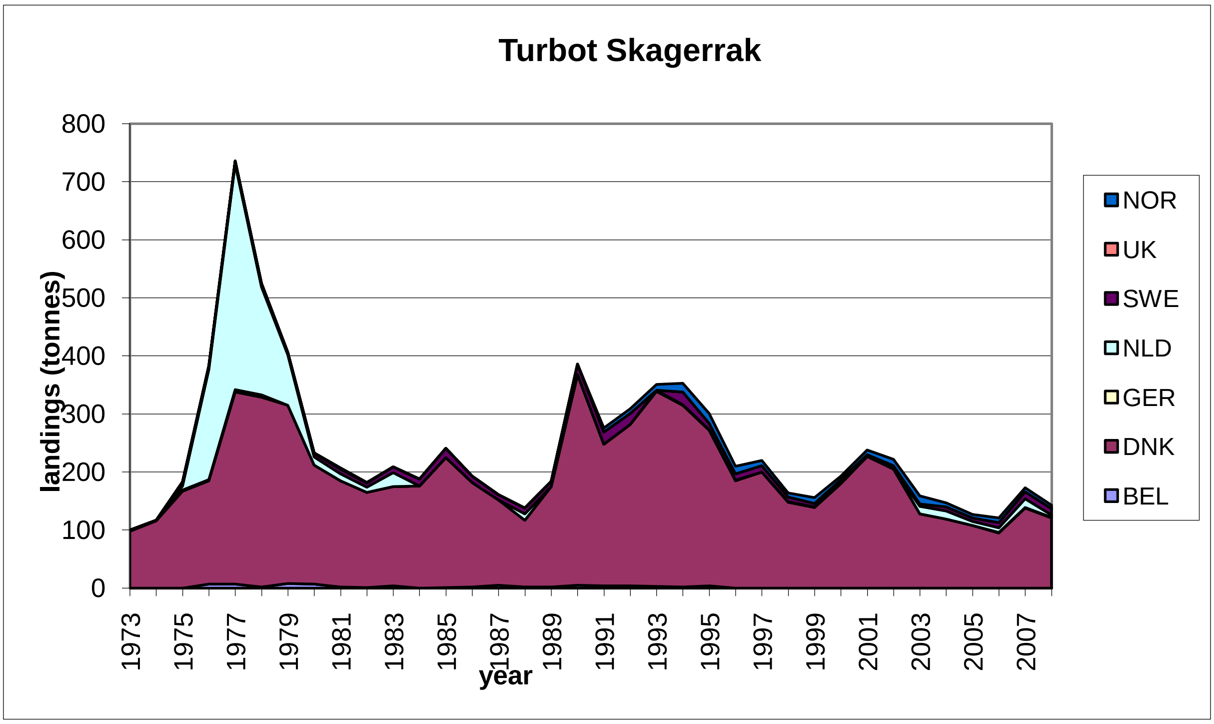



**Figure 6-4: Composition of landings (t) of turbot *Psetta maxima* in the Skagerrak (IIIa) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

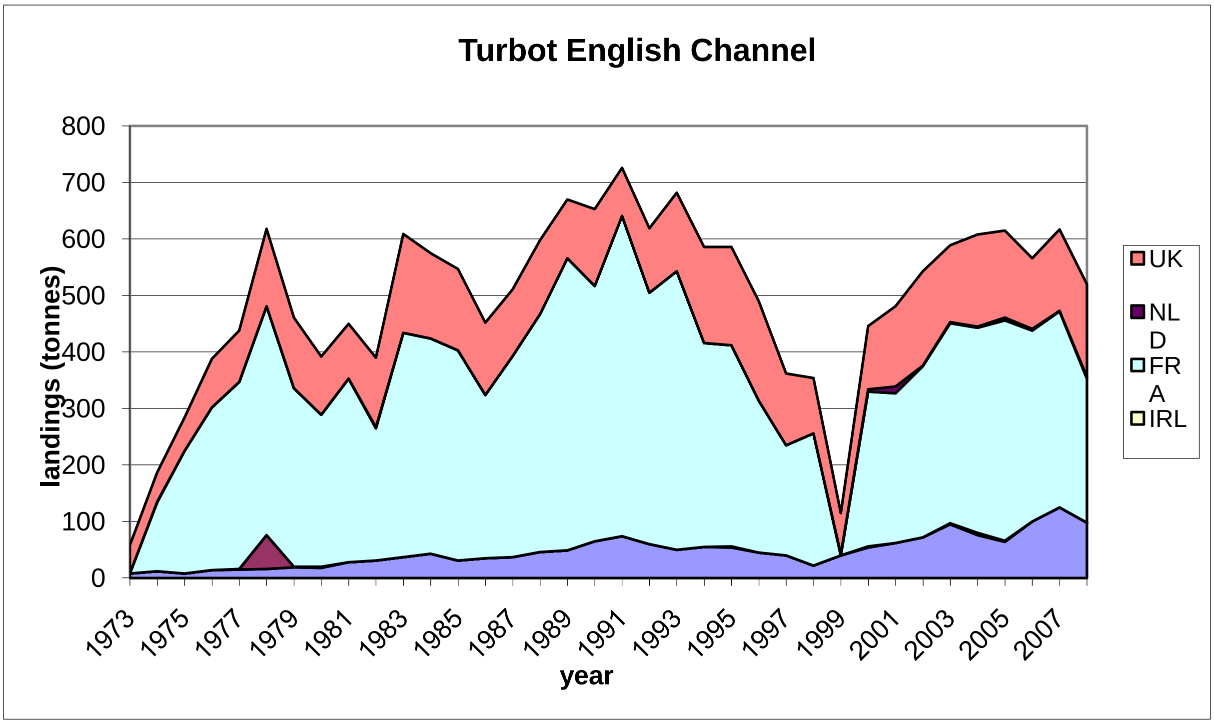



**Figure 6-5: Composition of landings (t) of turbot *Psetta maxima* in the English Channel (VIIde) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

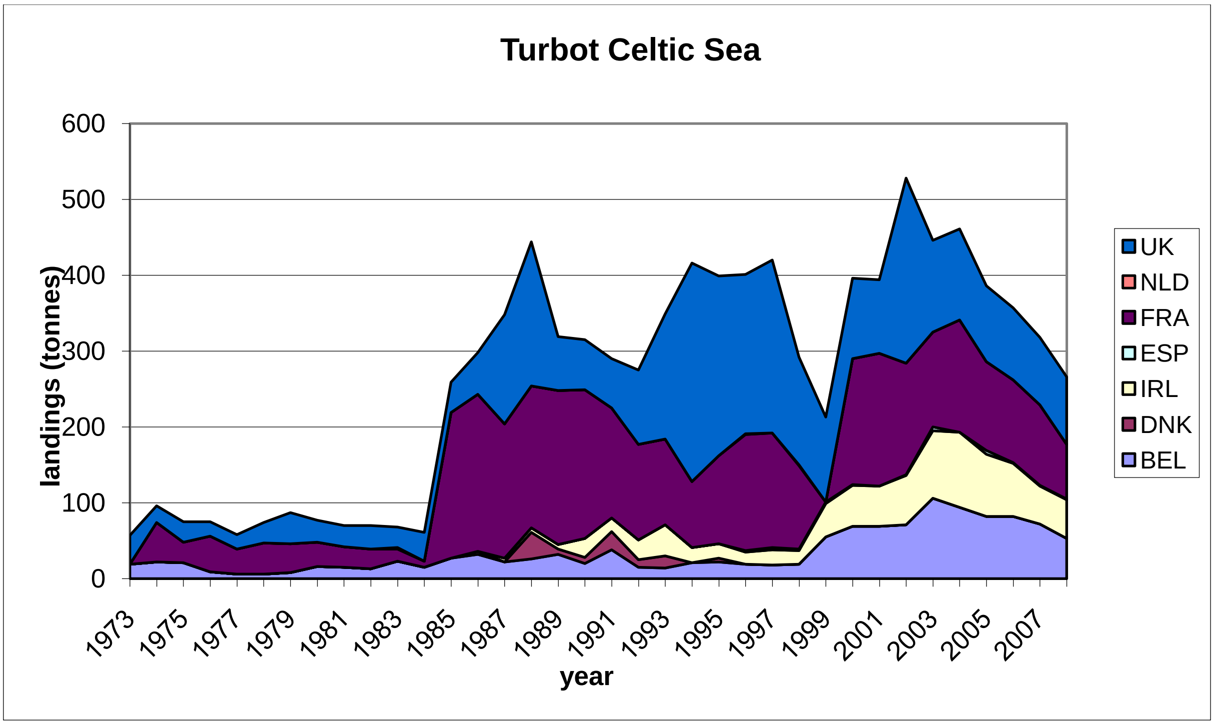



**Figure 6-6: Composition of landings (t) of turbot *Psetta maxima* in the Celtic Sea (VIIf-h) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

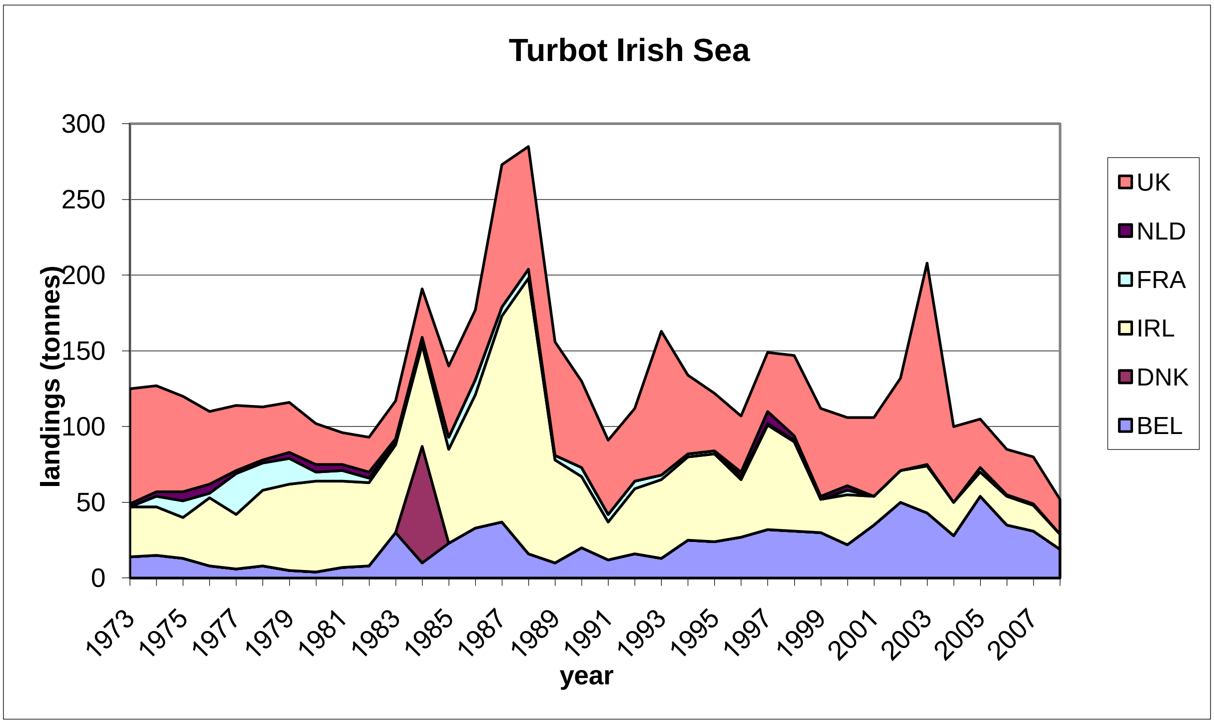



**Figure 6-7: Composition of landings (t) of turbot *Psetta maxima* in the Irish Sea (VIIa) over the period 1973-2008 as reported to the EC and ICES (source: Eurostat database).**

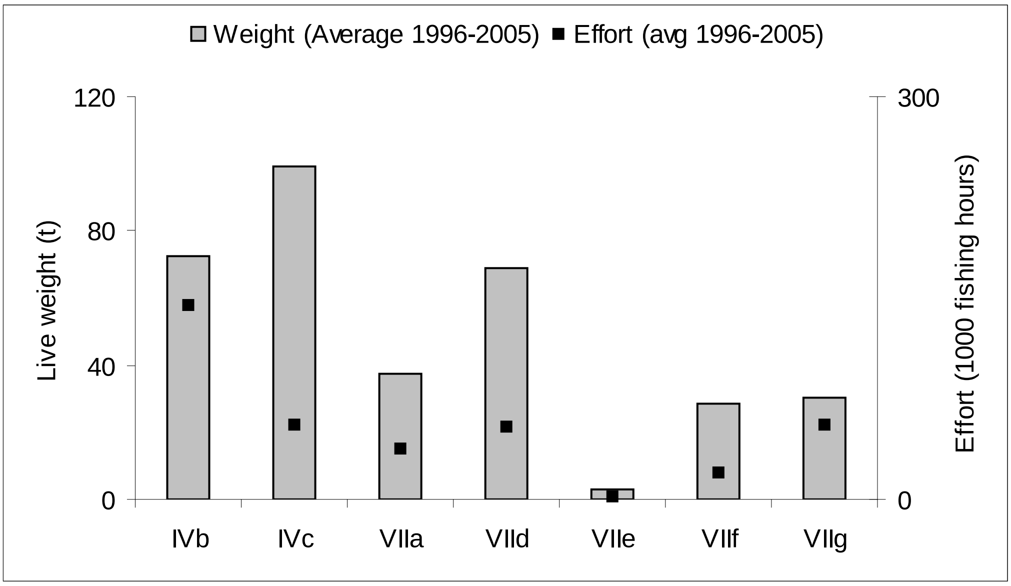



**Figure 6-8: Average effort and average landings of turbot *Psetta maxima* for the Belgian beam trawl fleet for the period 1996–2005.**

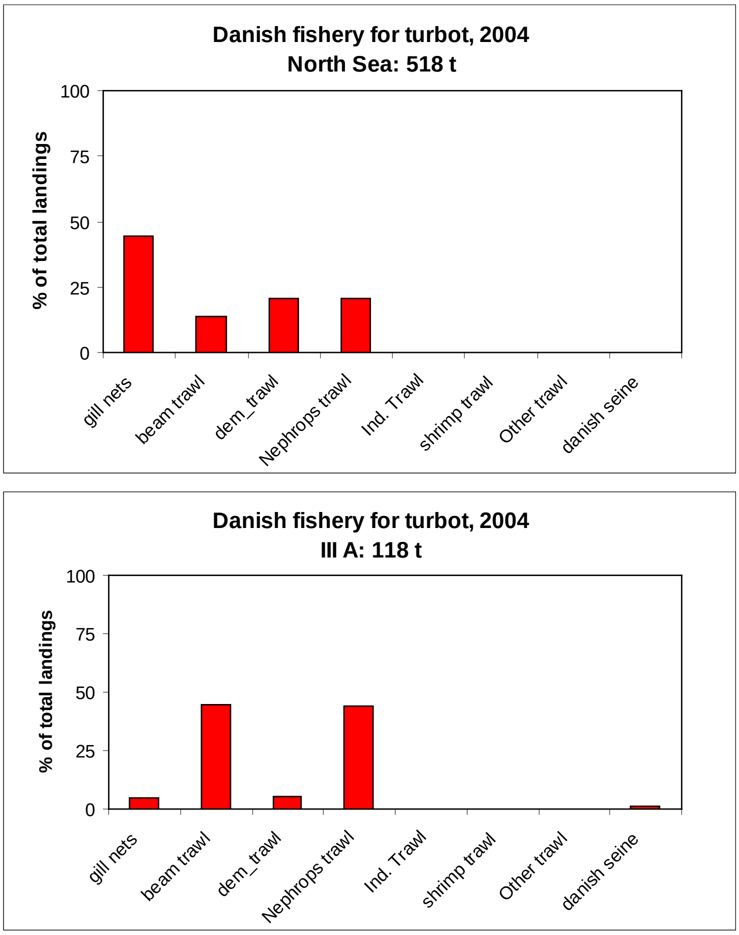
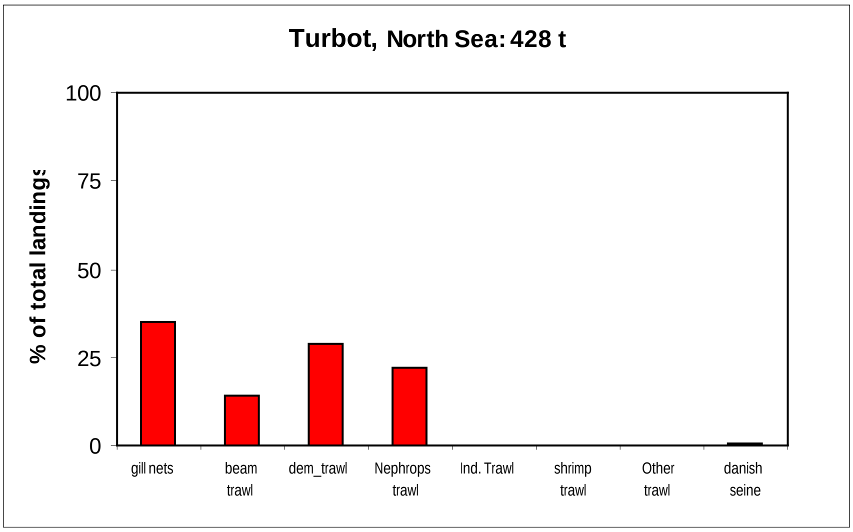



**Figure 6-9a: Total Danish landings (2004) of turbot *Psetta maxima* in the North Sea and IIIa by fishery.**



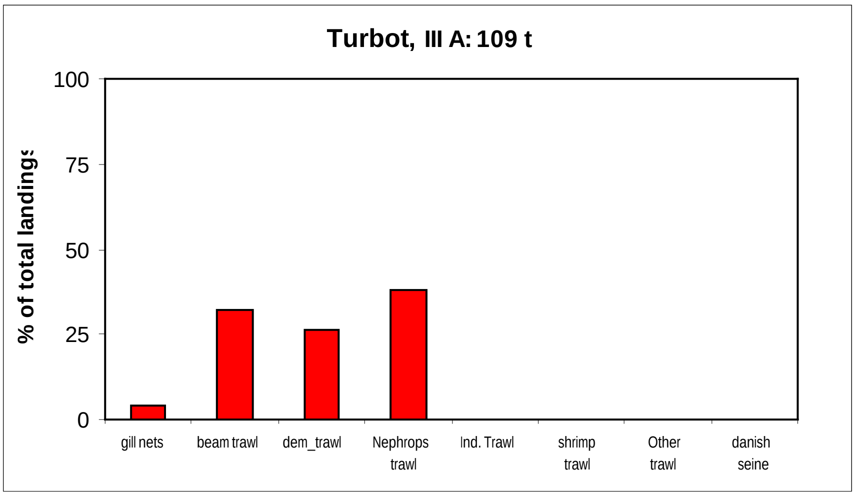




**Figure 6-9b: Total Danish landings (2005) of turbot *Psetta maxima* in the North Sea and IIIa by fishery.**

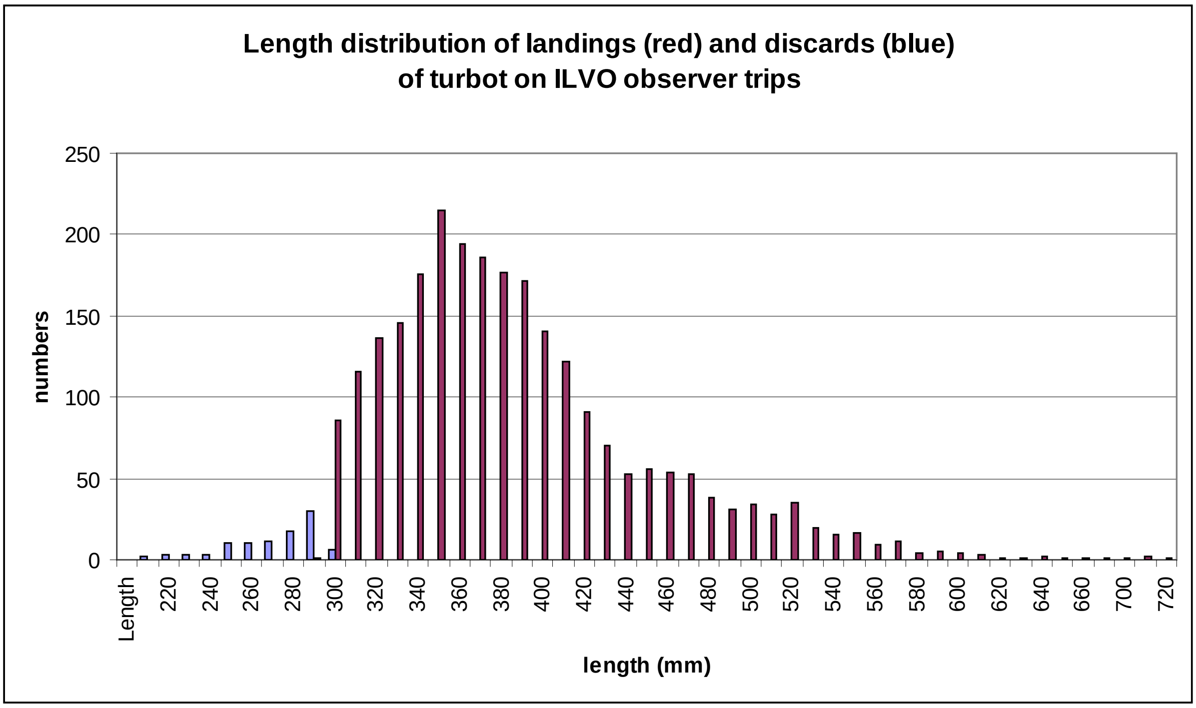



**Figure 6-10: Length-distribution of landings and discards of turbot *Psetta maxima* as recorded on Belgian observer trips in the Irish Sea, the Celtic Sea (only VIIf and VIIg) and the English Channel by ILVO during 2007-2008.**

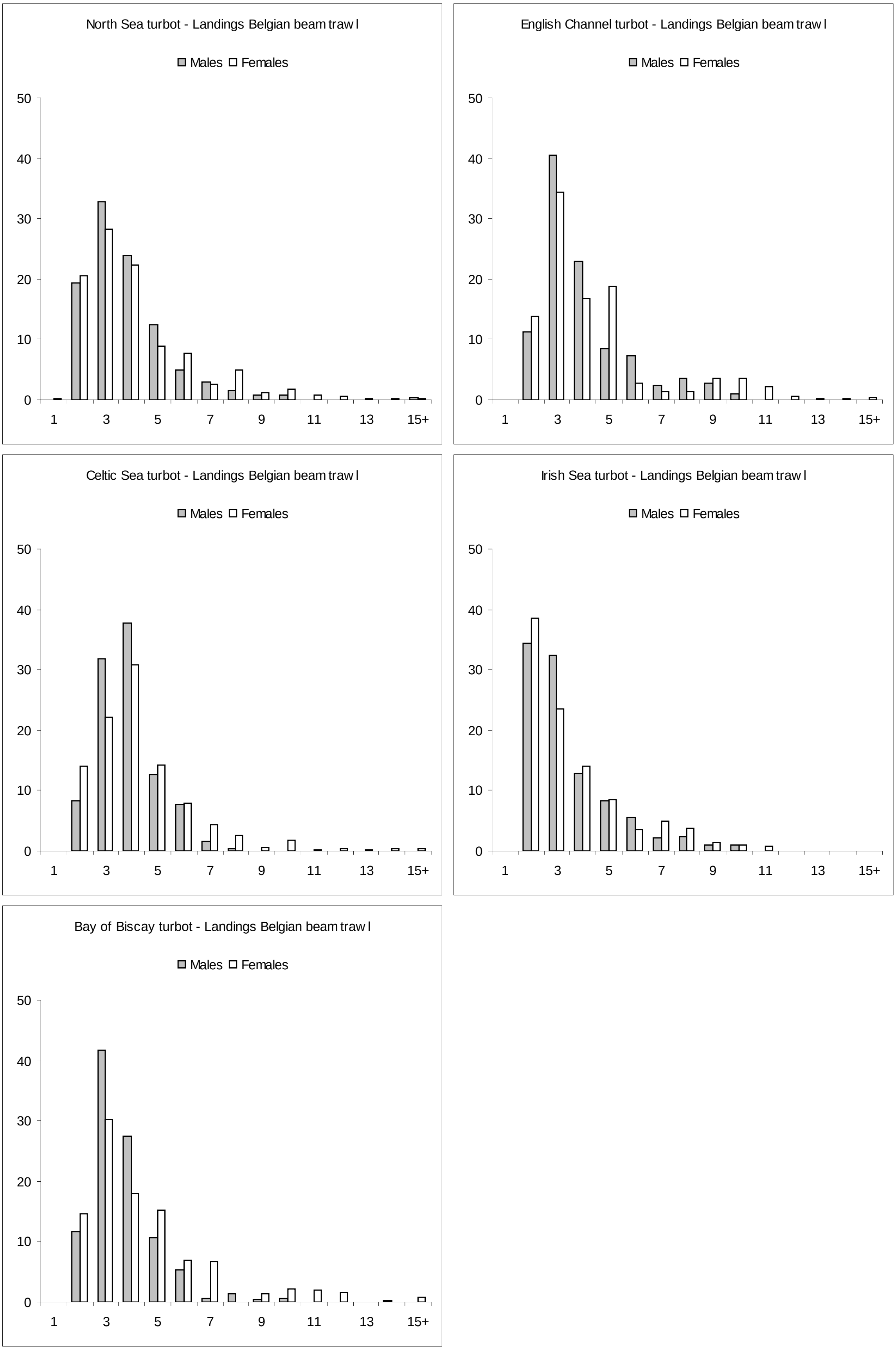



**Figure 6-11: Relative age distribution of turbot *Psetta maxima* in the commercial landings of the Belgian beam trawl fleet for the period 1996–1998.**

# Annex 7 – Lemon sole

## 1.1 General Biology

Lemon sole *Microstomus kitt* is a commercially important flatfish that is found in the shelf waters of the North Atlantic from the White Sea and Iceland southwards to the Bay of Biscay Wheeler (1969). They are common in the North Sea and Channel but are absent in the Baltic (Pawson, 1995). The basic biology of lemon sole is relatively well known and a summary of lemon sole life history is given in Wheeler (1969). The life history of lemon sole in Scottish waters was reviewed by Rae (1965).

In Scottish waters, lemon sole spawn in the northwest of the North Sea in April and spawning spreads north and east as the season progresses (Rae 1965). Newly metamorphosed lemon sole are rare in eastern Scottish waters and few juveniles are caught in the shallows of the east coast of Scotland. However, ichthyoplankton surveys conducted to the west of Ireland and Scotland in May and June 2002 showed that lemon sole were abundant in species-rich larval assemblages on offshore banks and the shelf edge (Dransfield *et al*., 2009).

In the western English Channel, lemon sole spawn in April and May (Jennings *et al.* 1973, and again few juveniles are found in shallow waters. Jennings et al. (1973) postulated that juveniles metamorphose and develop in areas where the seabed is rocky, or over patches of sand a gravel that are inaccessible to beam and otter trawlers. In the English Channel, investigations of habitat association for plaice, sole and lemon sole indicated that distribution was restricted to a few sites and that lemon soles appeared to prefer sandy and gravely strata, living deeper and at a higher salinity and lower temperature than plaice or sole (Hinz *et al*., 2006).

Off the Norwegian coast, results of otter trawl surveys showed that although lemon sole were present in most survey stations, the distribution of small individuals was restricted to distinct geographical areas in more offshore stations (Albert *et al.* 1998)

In Scotland lemon sole begin to mature at approximately 2 years of age. Male length at 50 % maturity is in the 3$^{rd}$ year and at around 19 cm length and female length at 50% maturity is at around 26 cm length, or 4-5 years of age.

Both Rae (1956) and Jennings *et al.* (1973), suggested that lemon sole do not undergo extensive migrations

## 1.2 Stock ID and possible management areas

There is little information available on lemon sole stock identity. However, using tagging information, Jennings *et al.* (1993) suggested that the seasonal movements of lemon sole in the western Channel were restricted and that lemon sole in this area could be considered as a separate stock. Further work on lemon sole stock identity is required.

## 1.3 Management regulations

### EC

There is currently no minimum landing size for lemon sole. In ICES Areas IIa and IV, a combined annual TAC is set for lemon sole and witch.

## 1.4 Fisheries Data

Lemon sole are generally caught in mixed fisheries for flatfish by beam trawlers and otter trawlers.

### 1.4.1 Commercial catches and discard data

Total landings of lemon sole in FAO Area 27 between 1950 and 2008 are given in Figure 1.1. Total international landings (t) of lemon sole for FAO Area 27, for 1950 – 2008. Source: FishStatBetween 1950 and 1970, landings ranged between 6 000 and 8 000 t. From 1971, landings steadily increased to a peak in 1983 of 14 504 t, before declining again to 1995. Landings increased to the series maximum of 15 506 t in 2001, dropped significantly the following year to 10 389 t, but have been around 12 000 t since 2004.

Total landings of lemon sole within the ICES area, by country between 1973 and 2008 are given in Table 1-1. The majority of landings are taken by Iceland and Spain. However, Denmark, Belgium, the UK (England and Wales, E&W) and the UK (Scotland) all take over 1 000 t annually.

Landings, by ICES Division, are given in Table 1-2 and Table 1-3, and plotted in Figure 1.2. Approximately 60% of landings are made from areas I-VI, in which most landings are from Areas IV and Va, The remaining landings are from Areas VII-XIV, with the majority from Area IXa.

#### UK (E&W)

Landings of lemon sole by UK (E&W) vessels are available by ICES Division (Table 1-4), and by gear. Lemon sole are caught by UK (E&W) vessels in mixed trawl fisheries, using beam trawl and otter trawl gears. Landings have decreased from 3 849 t in 1985 to 981 t in 2008.

#### UK (Scotland)

Landings by the UK Scottish fleet of lemon sole into Scotland from the North Sea and west coast for 1980 – 2005 are given in Table 1-5. Most of these catches are from Divisions IVa and IVb (northern and central North Sea) by light trawl, demersal pair trawl and seine. Lemon sole is mainly caught as a by-catch in the mixed demersal trawl fishery.

#### Denmark

The majority of the Danish landings of lemon sole come from the North Sea, with the remainder from the IIIa (Skagerrak and Kattegat) and the North eastern part of the North Sea (Norwegian Deep). It is taken as by-catch, mainly in (mixed) demersal trawl fisheries. In the North Sea, more than 80 % of lemon sole landings are taken in fisheries using demersal trawls (mesh size > 100 mm), whereas the main gear in Division IIIa is the *Nephrops* trawl (100 mm > mesh size > 70 mm), (Figure 1.4 and Figure 1.4, respectively).

### 1.4.2 Commercial catch-effort data

#### UK (E&W)

The UK (E&W) has estimates of lpue (kg/h) of lemon sole in the North Sea and for the 'Westerly' area. For the North Sea, lpue is processed in a series of 10 rectangle groups (Figure 1.5), and beam trawlers and otter trawlers are processed separately. For the

'Westerly' area, ICES Division VIIe is split into 3 areas (North, West and South), Divisions VIIg and VIIh are both split 2 areas (East and West), and Division VIIj is split into 2 areas (North and South) (Figure 1.5).

Full results (by rectangle group) are given in Table 1.6 for the North Sea, and are plotted for rectangle groups 1, 2 8 and 10 (from which the majority of the lemon sole catch is landed), in Figure 1.6. For the 'Westerly' stock, full results are given in Table 1-7 and are plotted for areas within ICES Division VIIe (from which the majority of the lemon sole catch is landed), in Figure 1.6.

In the North Sea, trends in the otter trawl lpue for rectangle groups 1, 2 and 8 were similar, showing a slight decline throughout the time series. These three rectangle areas cover much of ICES Division IVb, in which landings have also decreased during the same time. In rectangle group 10 however, which covers the eastern Channel (ICES Division VIId), the lpue trends is more of an upward one. For beam trawlers, lpue is generally less than that of otter trawlers. In 2009, an increase in both the beam trawl and otter trawl gears is seen for area 10, along with small increases in the lpue of otter trawlers in areas 2 and 8.

In the 'Westerly' area, the lpue of otter trawlers is generally higher than that of beam trawlers in all rectangle group areas. For otter trawlers, in 7eW (ICES Division VIIe – west) and 7eN (ICES Division VIIe – north) the lpue trend is similar, showing an overall decline through the time series. For all three rectangle groups, beam trawl lpue values have generally decreased since 1983, showed a small peak in 1995-1997, before becoming relatively steady for the last few years. In 2009, however, increases in both beam trawl and otter trawl gears is seen in all parts of ICES Division VIIe.

## 1.5 Survey data

International Bottom trawl surveys

Heessen and Daan reviewed the data of the International Bottom Trawl Survey in the North Sea between 1970 and 1993 (Heessen & Daan 1996). During the time period investigated, juvenile lemon sole were generally caught along the UK east coast, especially the north east coast. Larger lemon sole were more widespread, but again, the highest abundance was in the western parts of the North Sea. An index of abundance for lemon sole between 1970 and 1993 suggested that abundance was stable in the early years between 1974 and the early 1980's, but increased up to 1983. Between 1983 and 1990, abundance was considered to be stable. However, during the early years of the IBTS survey, not all areas of the North Sea were sampled Heessen & Daan (2006).

Additional information on lemon sole survey abundance is available from WGBEAM 2010 (ICES 2010). Figure 1.7 shows the combined abundance of lemon sole between 1990 and 2009, along with survey abundances in 2009. As can be seen, abundance of lemon sole is highest off the north east coast of England and in the central North Sea.

#### UK (E&W)

The UK (E&W) conducts several annual surveys in which lemon sole are routinely measured or biological information is retained. Four of the most important surveys are the Irish Sea/Bristol Channel (September) (VIIa, f and g) beam-trawl survey, the Channel (VIId) beam-trawl survey (July), Carhelmar (VIIe) commercial beam-trawl survey (October) and the English groundfish (IVb and c) GOV trawl survey (August).

A full review of the survey distributions of lemon sole abundance from 4 UK surveys is given in the final report of the EU NESPMAN project (EU 2010), where annual abundance by station information is given. A time series of survey abundances is given in Figure 1.8. For lemon sole in the eastern Channel, abundance has been variable with a large peak observed in 1995 and smaller peaks in 2002, 2004 and 2008. In the Carhelmar survey lemon sole abundance was initially relatively high but decreased in the early 1990's until the early 2000's. There then followed by an increase to 2004, but abundance then decreased again. However, abundance increased again in 2008 and 2009. In the Irish Sea/Bristol Channel, lemon sole abundance steadily increased from the beginning of the time series to 2003, since when it has declined. In the North Sea, lemon sole abundance has generally increased through the time series. Mean length of lemon sole in these surveys is given in Table 1-8.

It should be noted that the North Sea groundfish survey is not used to provide abundance indices for either the North Sea plaice or sole assessments, and it may be that the use of this survey to indicate trends in lemon sole abundance is not appropriate. Surveys that use beam trawl gears might be better suited to providing abundance indices for this species in the North Sea. With regard to the Irish Sea, additional work could be carried out to separate the Irish Sea (VIIa) and Bristol Channel (VIIf & g) components.

Cefas also undertakes Young Fish Surveys along various parts of the east and south coast of England. Abundance and length distribution information for lemon sole between 1981 and 1997 can be found in Rogers *et al*. (1998). In general, limited numbers of juveniles were found in the Outer Thames estuary and in the Wash, but were rare elsewhere. Data since that that time have not been analysed

#### France

France has data on the number and abundance of lemon sole caught during its EVHOE surveys. A composite picture of lemon sole abundance for 1997 – 2004 is given in Figure 1.9. Lemon sole are most abundant in the north eastern Celtic Sea, off the northwest coast of Cornwall and off the southern coast of Ireland.

#### Germany

Germany has length data for lemon sole caught between 1985 and 2005 from its IBTS (Table 1-9). In addition, biological data such as otoliths, sex and maturity are available for 708 individuals caught in the IBTS between 2003 and 2005. However, these individuals have not been aged.

#### Netherlands

The Netherlands has beam trawl surveys in the southeast North Sea between 1985 and 2009 (Isis) and in the central North Sea between 1998 and 2009. Abundance indices for these surveys are given in Figure 1.10. In both surveys, abundance has generally increased through the series. However abundance in the central North Sea, has almost doubled since the survey began.

## 1.6 Biological sampling

#### UK (E&W)

The UK routinely collects biological data for lemon sole as part of its DCF requirement. Since 2005, otoliths have been aged, allowing estimates of catch numbers at length and catch numbers at age to be estimated. The UK (E&W) routinely process biological data in two 'stock units', namely the North Sea and Eastern Channel (ICES

Area IV and Division VIId), and 'Westerly' (ICES Divisions VIIe-h). Time series of catch numbers at length and catch numbers at age for North Sea lemon sole are given in Figure 1.11 and Figure 1.12, respectively. Similar numbers at length and age are given for 'Westerly' lemon sole in Figure 1.13 and Figure 1.14. Mean length of landings for these two 'stock units' are given in Table 1-10.

#### The Netherlands

IMARES has been collecting length, age and sex data for lemon sole since 2003, as part of its market sampling programme. A summary of available results (2003-2005) is given in Figure 1.15 and Figure 1.16.

#### Belgium

Length data for lemon sole are collected from the Belgium beam trawl fleet during market sampling surveys. Length distributions for 2002-2006 are given in Table 7-11.

## 1.7 Biological parameters and other research

#### Netherlands

Length weight data are available from surveys and from market sampling and given in the NESPMAN report (EU 2010). Male and female length weight relationships are given as:

Male $Wt = 0.0054\ L^{3.205}$

Female $Wt = 0.0075\ L^{3.128}$

## 1.8 References

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**Table 1-1. Total international landings (t) of lemon sole by country for 1973 – 2008. Source: FishStat**

| Year | Belgium | Denmark | Faeroe Is | France | Germany | Guernsey | Iceland | Ireland | IoM | Jersey | Neth | Norway | Portugal | Spain | Sweden | UK (E&W+NI) | UK (E&W) | UK (NI) | UK (S) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 971 | 692 | 1193 | 0 | 76 | 0 | 175 | 0 | 0 | 0 | 217 | 16 | 0 | 0 | 71 | 0 | 2715 | 0 | 1987 | 8113 |
| 1974 | 923 | 630 | 607 | 0 | 61 | 0 | 84 | 0 | 0 | 0 | 270 | 0 | 0 | 0 | 50 | 0 | 2293 | 0 | 2189 | 7107 |
| 1975 | 1171 | 784 | 972 | 0 | 85 | 2 | 67 | 0 | 0 | 0 | 300 | 0 | 0 | 0 | 63 | 0 | 2674 | 0 | 2103 | 8221 |
| 1976 | 819 | 800 | 815 | 0 | 73 | 1 | 63 | 4 | 0 | 0 | 330 | 0 | 0 | 0 | 50 | 0 | 2895 | 0 | 2035 | 7885 |
| 1977 | 883 | 850 | 787 | 0 | 81 | 0 | 11 | 291 | 0 | 0 | 303 | 0 | 0 | 0 | 51 | 0 | 2812 | 0 | 2580 | 8649 |
| 1978 | 989 | 1151 | 747 | 1323 | 56 | 0 | 24 | 160 | 0 | 0 | 245 | 0 | 0 | 0 | 59 | 0 | 2801 | 0 | 2554 | 10109 |
| 1979 | 916 | 1592 | 799 | 1905 | 42 | 1 | 47 | 169 | 0 | 0 | 400 | 0 | 0 | 0 | 114 | 0 | 2935 | 0 | 2441 | 11361 |
| 1980 | 741 | 1233 | 502 | 2098 | 49 | 0 | 63 | 203 | 0 | 0 | 303 | 0 | 0 | 0 | 89 | 0 | 3426 | 0 | 2661 | 11368 |
| 1981 | 843 | 1330 | 683 | 2584 | 39 | 0 | 77 | 230 | 0 | 0 | 415 | 0 | 0 | 0 | 76 | 0 | 2855 | 0 | 2255 | 11387 |
| 1982 | 1246 | 1328 | 761 | 2539 | 52 | 1 | 86 | 239 | 9 | 0 | 769 | 0 | 0 | 0 | 80 | 0 | 3434 | 3 | 2175 | 12722 |
| 1983 | 1523 | 1387 | 1015 | 2352 | 28 | 1 | 112 | 304 | 24 | 0 | 1021 | 0 | 0 | 0 | 114 | 0 | 3740 | 4 | 2879 | 14504 |
| 1984 | 1532 | 1117 | 1209 | 2176 | 22 | 1 | 73 | 379 | 6 | 0 | na | 0 | 0 | 0 | 67 | 0 | 3714 | 4 | 2743 | 13043 |
| 1985 | 1411 | 1317 | 852 | 1891 | 26 | 1 | 367 | 370 | 4 | 0 | na | 0 | 0 | 0 | 68 | 0 | 3847 | 8 | 2549 | 12711 |
| 1986 | 891 | 1185 | 636 | 1801 | 16 | 0 | 488 | 298 | 7 | 0 | na | 0 | 0 | 0 | 57 | 0 | 3025 | 10 | 2205 | 10619 |
| 1987 | 803 | 1354 | 360 | 2016 | 14 | 0 | 675 | 321 | 6 | 0 | na | 0 | 0 | 0 | 69 | 0 | 3009 | 4 | 2542 | 11173 |
| 1988 | 901 | 1230 | 451 | 2204 | 14 | 0 | 855 | 340 | 3 | 0 | 307 | 0 | 0 | 0 | 57 | 0 | 3075 | 22 | 2575 | 12034 |
| 1989 | 788 | 1447 | 303 | 2145 | 40 | 0 | 804 | 511 | 4 | 0 | 397 | 0 | 0 | 0 | 77 | 2831 | 0 | 0 | 2499 | 11846 |
| 1990 | 786 | 1807 | 383 | 1882 | 49 | 0 | 702 | 545 | 4 | 0 | na | 0 | 0 | 0 | 78 | 3149 | 0 | 0 | 2920 | 12305 |
| 1991 | 748 | 1779 | 219 | 1676 | 41 | 0 | 1095 | 461 | 8 | 0 | na | 12 | 0 | 0 | 89 | 2965 | 0 | 0 | 3290 | 12383 |
| 1992 | 777 | 2032 | 261 | 1455 | 30 | 0 | 915 | 505 | 7 | 0 | na | 30 | 0 | 0 | 125 | 3175 | 0 | 0 | 2650 | 11962 |
| 1993 | 711 | 2008 | 201 | 1514 | 41 | 0 | 697 | 531 | 2 | 0 | na | 31 | 0 | 0 | 146 | 2812 | 0 | 0 | 2631 | 11325 |

| Year | Belgium | Denmark | Faeroe Is | France | Germany | Guernsey | Iceland | Ireland | IoM | Jersey | Neth | Norway | Portugal | Spain | Sweden | UK (E&W+NI) | UK (E&W) | UK (NI) | UK (S) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | 710 | 1289 | 276 | 1828 | 29 | 0 | 692 | 390 | 3 | 0 | na | 33 | 0 | 0 | 127 | 2529 | 0 | 0 | 2588 | 10494 |
| 1995 | 1007 | 1208 | 265 | 1944 | 72 | 0 | 741 | 723 | 2 | 1 | na | 30 | 0 | 0 | 96 | 3077 | 0 | 0 | 1896 | 11062 |
| 1996 | 1095 | 1108 | 236 | 2396 | 68 | 0 | 984 | 581 | 4 | 0 | na | 46 | 0 | 0 | 117 | 3492 | 0 | 0 | 1953 | 12080 |
| 1997 | 976 | 1172 | 332 | 1782 | 78 | 0 | 1135 | 668 | 0 | 0 | na | 63 | 0 | 235 | 121 | 3603 | 0 | 0 | 2117 | 12282 |
| 1998 | 1256 | 1591 | 464 | 1522 | 152 | 0 | 1432 | 528 | 4 | 1 | 838 | 59 | 0 | 1197 | 106 | 2865 | 0 | 0 | 2365 | 14380 |
| 1999 | 1021 | 1812 | 433 | 1349 | 69 | 0 | 1860 | 531 | 3 | 1 | 681 | 59 | 0 | 1282 | 95 | 2202 | 0 | 0 | 2808 | 14206 |
| 2000 | 1057 | 2037 | 389 | 1308 | 74 | 0 | 1438 | 469 | 3 | 3 | 492 | 59 | 0 | 2207 | 71 | 2030 | 0 | 0 | 2337 | 13974 |
| 2001 | 1076 | 1821 | 728 | 1374 | 78 | 0 | 1371 | 440 | 1 | 1 | 456 | 53 | 0 | 4040 | 61 | 2049 | 0 | 0 | 1957 | 15506 |
| 2002 | 1089 | 1446 | 1221 | 1442 | 120 | 0 | 950 | 482 | 0 | 1 | 402 | 61 | 0 | 408 | 48 | 1683 | 0 | 0 | 1036 | 10389 |
| 2003 | 1025 | 1477 | 1131 | 1470 | 142 | 0 | 1245 | 520 | 0 | 0 | 399 | 75 | 3 | 286 | 39 | 1636 | 0 | 0 | 968 | 10416 |
| 2004 | 1339 | 1610 | 908 | 1309 | 86 | 0 | 2210 | 519 | 0 | 0 | 438 | 60 | 0 | 1071 | 34 | 1606 | 0 | 0 | 831 | 12021 |
| 2005 | 1158 | 1550 | 661 | 1170 | 91 | 0 | 2509 | 400 | 0 | 0 | 551 | 54 | 0 | 1796 | 41 | 1480 | 0 | 0 | 784 | 12245 |
| 2006 | 926 | 1309 | 778 | 1028 | 191 | 0 | 2693 | 342 | 0 | 0 | 452 | 67 | 2 | 2141 | 34 | 1282 | 0 | 0 | 1112 | 12357 |
| 2007 | 888 | 1519 | 648 | 992 | 148 | 0 | 2661 | 336 | 0 | 0 | 384 | 63 | 0 | 2569 | 24 | 1297 | 0 | 0 | 1177 | 12706 |
| 2008 | 884 | 1169 | 380 | 729 | 127 | 0 | 2635 | 252 | 0 | 0 | 440 | 59 | 0 | 3054 | 19 | 985 | 0 | 0 | 1090 | 11823 |

**Table** 1.**-2. Total international landings (t) of lemon sole for ICES Areas I - VI for 1973 – 2008. Source: FishStat**

| | Area 27 | Area 27 Sub-area 22 | Area 27 Sub-area 23 | I | II a | II b | IIIa | IIIb, c | III d | IV | IVa | IVa+ b | IVa, b+IIIa | IVb | IVc | Va | Vb | Vb 1 | Vb 2 | VI a | VI b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 214 | 0 | 0 | 0 | 829 | 478 | 71 | 3051 | 210 | 475 | 0 | 1673 | 36 | 211 | 1 |
| 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 183 | 0 | 0 | 0 | 781 | 447 | 50 | 2816 | 183 | 332 | 0 | 1227 | 20 | 255 | 0 |
| 1975 | 0 | 0 | 0 | 0 | 0 | 0 | 317 | 0 | 0 | 11 | 797 | 521 | 0 | 3353 | 347 | 326 | 0 | 1421 | 23 | 269 | 0 |
| 1976 | 3 | 0 | 0 | 3 | 0 | 2 | 361 | 0 | 0 | 0 | 872 | 516 | 0 | 3171 | 271 | 202 | 0 | 1209 | 36 | 369 | 3 |
| 1977 | 0 | 0 | 0 | 0 | 0 | 0 | 627 | 0 | 0 | 0 | 1122 | 321 | 0 | 3920 | 298 | 38 | 191 | 693 | 118 | 484 | 2 |
| 1978 | 0 | 0 | 0 | 0 | 0 | 0 | 705 | 4 | 0 | 517 | 1015 | 0 | 0 | 4044 | 532 | 31 | 35 | 721 | 37 | 442 | 3 |
| 1979 | 0 | 0 | 0 | 0 | 1 | 0 | 833 | 12 | 0 | 876 | 1036 | 0 | 0 | 4087 | 429 | 54 | 10 | 798 | 2 | 379 | 0 |
| 1980 | 0 | 0 | 0 | 0 | 0 | 0 | 722 | 12 | 0 | 599 | 1059 | 2 | 0 | 4487 | 277 | 79 | 0 | 471 | 21 | 346 | 2 |
| 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 793 | 15 | 0 | 605 | 837 | 1 | 0 | 3973 | 517 | 99 | 0 | 650 | 21 | 317 | 0 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 0 | 735 | 11 | 0 | 670 | 821 | 3 | 0 | 4662 | 1012 | 98 | 0 | 717 | 36 | 240 | 1 |
| 1983 | 0 | 16 | 0 | 0 | 0 | 0 | 759 | 0 | 0 | 735 | 1198 | 4 | 0 | 5436 | 884 | 119 | 0 | 971 | 44 | 284 | 1 |
| 1984 | 0 | 25 | 0 | 0 | 1 | 0 | 595 | 0 | 0 | 567 | 1171 | 3 | 0 | 4553 | 636 | 80 | 0 | 1155 | 54 | 356 | 2 |

| | Area 27 | Area 27 Sub-area 22 | Area 27 Sub-area 23 | I | IIa | IIb | IIIa | IIIb, c | IIId | IV | IVa | IVa+b | IVa, b+IIIa | IVb | IVc | Va | Vb | Vb1 | Vb2 | VIa | VIb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 0 | 0 | 0 | 0 | 0 | 0 | 793 | 33 | 0 | 555 | 971 | 4 | 0 | 4458 | 447 | 380 | 0 | 789 | 61 | 257 | 19 |
| 1986 | 0 | 31 | 1 | 0 | 1 | 0 | 639 | 0 | 0 | 157 | 938 | 1 | 0 | 3695 | 256 | 496 | 0 | 576 | 60 | 214 | 15 |
| 1987 | 0 | 34 | 1 | 0 | 0 | 0 | 669 | 0 | 0 | 19 | 1177 | 1 | 0 | 3932 | 387 | 680 | 0 | 348 | 12 | 329 | 23 |
| 1988 | 0 | 21 | 1 | 0 | 0 | 0 | 642 | 0 | 0 | 3 | 1221 | 1 | 0 | 4228 | 445 | 860 | 0 | 436 | 15 | 398 | 19 |
| 1989 | 0 | 9 | 0 | 0 | 0 | 0 | 693 | 0 | 0 | 2 | 1067 | 2 | 0 | 4565 | 331 | 810 | 0 | 287 | 14 | 469 | 12 |
| 1990 | 0 | 18 | 0 | 41 | 0 | 0 | 872 | 0 | 0 | 4 | 1251 | 4 | 0 | 4581 | 350 | 704 | 15 | 337 | 5 | 491 | 54 |
| 1991 | 0 | 36 | 3 | 0 | 0 | 0 | 734 | 0 | 1 | 2 | 1264 | 6 | 0 | 4951 | 395 | 1098 | 6 | 207 | 12 | 426 | 52 |
| 1992 | 0 | 83 | 7 | 0 | 0 | 0 | 952 | 0 | 0 | 0 | 1194 | 5 | 0 | 4622 | 305 | 919 | 5 | 258 | 3 | 384 | 19 |
| 1993 | 0 | 55 | 6 | 0 | 5 | 0 | 1156 | 2 | 1 | 0 | 1312 | 3 | 0 | 4146 | 378 | 701 | 13 | 191 | 18 | 462 | 7 |
| 1994 | 0 | 38 | 4 | 0 | 6 | 2 | 803 | 0 | 0 | 0 | 1183 | 0 | 0 | 3482 | 597 | 692 | 35 | 176 | 104 | 462 | 9 |
| 1995 | 0 | 41 | 6 | 0 | 3 | 0 | 714 | 1 | 2 | 0 | 886 | 0 | 0 | 3077 | 749 | 741 | 7 | 262 | 3 | 566 | 8 |
| 1996 | 0 | 41 | 9 | 0 | 4 | 0 | 635 | 0 | 15 | 0 | 864 | 0 | 0 | 2976 | 897 | 984 | 10 | 231 | 5 | 499 | 11 |
| 1997 | 0 | 40 | 7 | 5 | 7 | 0 | 768 | 0 | 0 | 0 | 790 | 0 | 0 | 3536 | 401 | 1135 | 8 | 328 | 4 | 432 | 11 |

| | Area 27 | Area 27 Sub-area 22 | Area 27 Sub-area 23 | I | IIa | IIb | IIIa | IIIb,c | IIId | IV | IVa | IVa+b | IVa,b+IIIa | IVb | IVc | Va | Vb | Vb1 | Vb2 | VIa | VIb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 0 | 49 | 5 | 12 | 2 | 0 | 868 | 0 | 0 | 0 | 923 | 0 | 0 | 4909 | 634 | 1432 | 8 | 455 | 8 | 357 | 57 |
| 1999 | 1349 | 63 | 5 | 11 | 2 | 0 | 844 | 0 | 0 | 0 | 1032 | 0 | 0 | 4969 | 315 | 1864 | 6 | 432 | 0 | 276 | 125 |
| 2000 | 389 | 36 | 3 | 22 | 5 | 0 | 803 | 1 | 0 | 0 | 1158 | 0 | 0 | 4368 | 454 | 1438 | 15 | 0 | 0 | 202 | 131 |
| 2001 | 5 | 24 | 5 | 10 | 2 | 0 | 584 | 0 | 1 | 0 | 1054 | 0 | 0 | 3750 | 585 | 1371 | 19 | 726 | 2 | 188 | 98 |
| 2002 | 0 | 16 | 4 | 19 | 5 | 0 | 522 | 0 | 0 | 0 | 585 | 0 | 0 | 2737 | 505 | 950 | 36 | 1216 | 4 | 152 | 34 |
| 2003 | 0 | 17 | 1 | 13 | 24 | 0 | 541 | 0 | 0 | 0 | 621 | 0 | 0 | 2569 | 508 | 1245 | 26 | 1126 | 5 | 125 | 46 |
| 2004 | 0 | 0 | 0 | 13 | 17 | 0 | 607 | 27 | 0 | 0 | 492 | 0 | 0 | 2661 | 390 | 2210 | 20 | 904 | 3 | 97 | 18 |
| 2005 | 0 | 0 | 0 | 10 | 16 | 0 | 674 | 27 | 0 | 0 | 619 | 0 | 0 | 2519 | 306 | 2509 | 20 | 658 | 2 | 40 | 21 |
| 2006 | 0 | 0 | 0 | 14 | 24 | 0 | 417 | 20 | 0 | 0 | 850 | 0 | 0 | 2583 | 194 | 2693 | 8 | 777 | 1 | 39 | 18 |
| 2007 | 0 | 0 | 0 | 6 | 15 | 0 | 432 | 9 | 0 | 0 | 808 | 0 | 0 | 2933 | 151 | 2661 | 0 | 650 | 0 | 33 | 9 |
| 2008 | 0 | 0 | 0 | 7 | 14 | 0 | 276 | 5 | 0 | 0 | 784 | 0 | 0 | 2403 | 279 | 2635 | 0 | 379 | 2 | 24 | 74 |

**Table 1-3. Total international landings (t) of lemon sole for ICES Areas VII – XIV for 1973 – 2008. Source: FishStat**

| | VIIa | VIIb | VIIb+c | VIIc | VIId | VIId+e | VIIe | VIIf | VIIg | VIIg-k | VIIh | VIIj | VIIk | VIII | VIIIa | VIIIb | VIIIc | VIIId | IX | IXa | XIV | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 54 | 0 | 0 | 0 | 0 | 451 | 0 | 198 | 0 | 160 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8113 |
| 1974 | 66 | 0 | 1 | 0 | 0 | 351 | 0 | 265 | 0 | 130 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7107 |
| 1975 | 57 | 0 | 1 | 0 | 33 | 0 | 356 | 284 | 0 | 105 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8221 |
| 1976 | 51 | 0 | 0 | 0 | 42 | 0 | 499 | 159 | 0 | 114 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7885 |
| 1977 | 79 | 0 | 16 | 0 | 36 | 1 | 447 | 99 | 0 | 156 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8649 |
| 1978 | 116 | 18 | 6 | 3 | 139 | 2 | 737 | 244 | 321 | 113 | 304 | 6 | 0 | 1 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 10109 |
| 1979 | 143 | 10 | 7 | 1 | 260 | 0 | 1201 | 427 | 512 | 107 | 108 | 0 | 0 | 0 | 68 | 0 | 0 | 0 | 0 | 0 | 0 | 11361 |
| 1980 | 146 | 82 | 4 | 1 | 152 | 0 | 1165 | 515 | 714 | 197 | 143 | 88 | 0 | 1 | 83 | 0 | 0 | 0 | 0 | 0 | 0 | 11368 |
| 1981 | 196 | 0 | 32 | 0 | 290 | 0 | 979 | 465 | 0 | 1540 | 0 | 0 | 0 | 57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11387 |
| 1982 | 195 | 0 | 31 | 0 | 584 | 0 | 1180 | 417 | 0 | 1245 | 0 | 0 | 0 | 64 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12722 |
| 1983 | 278 | 0 | 29 | 0 | 491 | 0 | 1583 | 426 | 0 | 1132 | 0 | 0 | 0 | 2 | 112 | 0 | 0 | 0 | 0 | 0 | 0 | 14504 |
| 1984 | 313 | 0 | 31 | 0 | 586 | 0 | 1342 | 328 | 0 | 1102 | 0 | 0 | 0 | 0 | 143 | 0 | 0 | 0 | 0 | 0 | 0 | 13043 |
| 1985 | 348 | 18 | 13 | 12 | 347 | 0 | 1480 | 310 | 632 | 313 | 338 | 44 | 5 | 2 | 81 | 0 | 0 | 1 | 0 | 0 | 0 | 12711 |
| 1986 | 333 | 15 | 15 | 65 | 251 | 0 | 1162 | 398 | 578 | 292 | 333 | 26 | 2 | 1 | 66 | 1 | 0 | 1 | 0 | 0 | 0 | 10619 |
| 1987 | 314 | 54 | 0 | 34 | 310 | 0 | 1153 | 423 | 578 | 55 | 428 | 117 | 1 | 1 | 92 | 0 | 0 | 1 | 0 | 0 | 0 | 11173 |
| 1988 | 274 | 41 | 0 | 36 | 258 | 0 | 1149 | 534 | 607 | 63 | 531 | 147 | 1 | 2 | 100 | 0 | 0 | 1 | 0 | 0 | 0 | 12034 |
| 1989 | 325 | 46 | 0 | 26 | 364 | 0 | 1015 | 406 | 664 | 68 | 427 | 162 | 0 | 4 | 75 | 0 | 0 | 3 | 0 | 0 | 0 | 11846 |
| 1990 | 213 | 54 | 0 | 11 | 423 | 0 | 1139 | 309 | 530 | 51 | 483 | 281 | 1 | 6 | 73 | 0 | 0 | 4 | 0 | 0 | 0 | 12305 |
| 1991 | 199 | 45 | 0 | 21 | 428 | 0 | 1184 | 334 | 355 | 26 | 309 | 220 | 0 | 1 | 64 | 1 | 0 | 3 | 0 | 0 | 0 | 12383 |
| 1992 | 206 | 41 | 0 | 12 | 364 | 0 | 1241 | 343 | 447 | 36 | 231 | 241 | 0 | 1 | 42 | 0 | 0 | 1 | 0 | 0 | 0 | 11962 |
| 1993 | 173 | 48 | 0 | 8 | 422 | 0 | 884 | 346 | 538 | 49 | 204 | 157 | 0 | 2 | 37 | 0 | 0 | 1 | 0 | 0 | 0 | 11325 |
| 1994 | 163 | 46 | 0 | 7 | 695 | 0 | 712 | 349 | 451 | 45 | 278 | 109 | 0 | 1 | 44 | 0 | 0 | 1 | 0 | 0 | 0 | 10494 |

| | VIIa | VIIb | VIIb+c | VIIc | VIId | VIId+e | VIIe | VIIf | VIIg | VIIg-k | VIIh | VIIj | VIIk | VIII | VIIIa | VIIIb | VIIIc | VIIId | IX | IXa | XIV | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 177 | 84 | 0 | 9 | 877 | 0 | 1272 | 378 | 439 | 100 | 304 | 302 | 2 | 7 | 44 | 0 | 0 | 1 | 0 | 0 | 0 | 11062 |
| 1996 | 174 | 61 | 0 | 4 | 1151 | 0 | 1756 | 414 | 432 | 109 | 425 | 281 | 7 | 9 | 74 | 1 | 0 | 1 | 0 | 0 | 0 | 12080 |
| 1997 | 178 | 41 | 0 | 7 | 563 | 0 | 1878 | 553 | 410 | 130 | 436 | 298 | 2 | 2 | 76 | 0 | 0 | 1 | 0 | 235 | 0 | 12282 |
| 1998 | 155 | 45 | 0 | 13 | 346 | 0 | 1135 | 588 | 446 | 118 | 310 | 277 | 5 | 6 | 69 | 1 | 15 | 1 | 0 | 1131 | 0 | 14380 |
| 1999 | 111 | 43 | 0 | 5 | 140 | 0 | 515 | 265 | 355 | 0 | 69 | 203 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 1202 | 0 | 14206 |
| 2000 | 85 | 106 | 0 | 59 | 388 | 0 | 691 | 454 | 630 | 0 | 226 | 257 | 4 | 5 | 38 | 6 | 2 | 1 | 0 | 1997 | 0 | 13974 |
| 2001 | 134 | 83 | 0 | 55 | 483 | 0 | 820 | 463 | 652 | 0 | 231 | 250 | 3 | 5 | 36 | 4 | 1 | 0 | 0 | 3862 | 0 | 15506 |
| 2002 | 148 | 72 | 0 | 28 | 474 | 0 | 871 | 541 | 670 | 0 | 269 | 453 | 5 | 21 | 37 | 6 | 0 | 1 | 0 | 8 | 0 | 10389 |
| 2003 | 166 | 57 | 0 | 58 | 471 | 0 | 891 | 428 | 715 | 0 | 253 | 328 | 5 | 0 | 125 | 0 | 0 | 1 | 3 | 48 | 0 | 10416 |
| 2004 | 97 | 36 | 18 | 0 | 424 | 0 | 983 | 643 | 693 | 0 | 276 | 211 | 1 | 0 | 104 | 3 | 0 | 2 | 0 | 1071 | 0 | 12021 |
| 2005 | 63 | 51 | 11 | 0 | 350 | 0 | 960 | 606 | 552 | 0 | 279 | 97 | 1 | 0 | 48 | 1 | 0 | 2 | 0 | 1793 | 0 | 12245 |
| 2006 | 37 | 41 | 13 | 0 | 246 | 0 | 884 | 330 | 526 | 0 | 323 | 101 | 0 | 0 | 74 | 0 | 0 | 3 | 0 | 2140 | 0 | 12357 |
| 2007 | 37 | 34 | 8 | 0 | 164 | 0 | 803 | 375 | 486 | 0 | 309 | 134 | 1 | 0 | 71 | 1 | 0 | 6 | 0 | 2569 | 0 | 12706 |
| 2008 | 19 | 36 | 76 | 0 | 234 | 0 | 633 | 318 | 376 | 0 | 226 | 216 | 7 | 0 | 34 | 0 | 0 | 2 | 0 | 2764 | 0 | 11823 |

**Table 1-4. Total UK (E&W) landings (t) of lemon sole, by ICES Area for 1985 – 2008. Source: FAD**

| | IIa | IIIa | IVa | IVb | IVc | Va | Vb | Vc | VIa | VIb | VIIa | VIIb | VIIc | VIId | VIIe | VIIf | VIIg | VIIh | VIIj | VIIk | VIIIa | VIIIb | VIIId | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 0 | 0 | 64 | 2192 | 66 | 0 | 0 | 0 | 2 | 3 | 21 | 0 | 0 | 66 | 1208 | 86 | 27 | 101 | 12 | 0 | 0 | 0 | 0 | 3849 |
| 1986 | 0 | 0 | 22 | 1731 | 30 | 0 | 0 | 0 | 3 | 3 | 24 | 1 | 0 | 41 | 934 | 97 | 22 | 108 | 7 | 0 | 0 | 0 | 0 | 3024 |
| 1987 | 0 | 0 | 26 | 1767 | 47 | 0 | 0 | 0 | 9 | 3 | 32 | 5 | 0 | 44 | 809 | 133 | 15 | 115 | 6 | 0 | 0 | 0 | 0 | 3011 |
| 1988 | 0 | 0 | 21 | 1795 | 73 | 0 | 0 | 0 | 29 | 3 | 36 | 0 | 0 | 29 | 803 | 118 | 16 | 140 | 2 | 0 | 0 | 0 | 0 | 3065 |
| 1989 | 0 | 0 | 31 | 1791 | 37 | 0 | 0 | 0 | 16 | 1 | 41 | 0 | 0 | 44 | 701 | 61 | 8 | 70 | 0 | 0 | 0 | 0 | 0 | 2801 |
| 1990 | 0 | 0 | 39 | 1803 | 47 | 0 | 0 | 0 | 7 | 2 | 21 | 0 | 0 | 82 | 858 | 62 | 12 | 193 | 0 | 0 | 0 | 0 | 0 | 3128 |
| 1991 | 0 | 0 | 28 | 1646 | 51 | 0 | 0 | 0 | 3 | 0 | 23 | 0 | 0 | 73 | 910 | 94 | 13 | 98 | 2 | 0 | 0 | 0 | 0 | 2942 |
| 1992 | 0 | 0 | 47 | 1690 | 39 | 0 | 0 | 0 | 3 | 0 | 38 | 0 | 0 | 119 | 1005 | 101 | 30 | 77 | 4 | 0 | 0 | 0 | 0 | 3155 |
| 1993 | 0 | 0 | 42 | 1690 | 24 | 3 | 0 | 4 | 2 | 0 | 34 | 0 | 0 | 67 | 703 | 105 | 34 | 85 | 5 | 0 | 0 | 0 | 0 | 2801 |
| 1994 | 0 | 0 | 41 | 1454 | 35 | 5 | 0 | 0 | 6 | 29 | 0 | 1 | 0 | 93 | 538 | 105 | 27 | 155 | 6 | 0 | 0 | 0 | 0 | 2496 |
| 1995 | 0 | 0 | 40 | 1329 | 84 | 0 | 0 | 0 | 15 | 0 | 23 | 2 | 0 | 150 | 1070 | 133 | 24 | 138 | 32 | 1 | 0 | 0 | 0 | 3042 |
| 1996 | 0 | 0 | 40 | 1197 | 76 | 3 | 0 | 0 | 2 | 0 | 13 | 6 | 0 | 209 | 1495 | 122 | 25 | 166 | 80 | 2 | 0 | 1 | 0 | 3437 |
| 1997 | 0 | 0 | 44 | 1362 | 47 | 1 | 0 | 0 | 2 | 0 | 24 | 0 | 2 | 110 | 1572 | 158 | 25 | 161 | 55 | 0 | 0 | 0 | 0 | 3564 |
| 1998 | 0 | 0 | 37 | 1304 | 88 | 1 | 0 | 0 | 2 | 9 | 19 | 9 | 7 | 91 | 885 | 151 | 24 | 107 | 77 | 1 | 0 | 0 | 0 | 2814 |
| 1999 | 0 | 0 | 40 | 1155 | 53 | 1 | 0 | 0 | 2 | 0 | 11 | 16 | 5 | 89 | 514 | 121 | 34 | 67 | 55 | 1 | 0 | 0 | 0 | 2164 |
| 2000 | 0 | 0 | 41 | 990 | 26 | 0 | 0 | 0 | 0 | 9 | 10 | 5 | 0 | 122 | 535 | 131 | 27 | 59 | 51 | 0 | 0 | 0 | 0 | 2009 |
| 2001 | 0 | 0 | 31 | 831 | 22 | 1 | 0 | 0 | 0 | 0 | 12 | 14 | 3 | 186 | 620 | 125 | 30 | 52 | 62 | 0 | 0 | 0 | 0 | 1989 |
| 2002 | 0 | 0 | 15 | 566 | 10 | 3 | 0 | 0 | 1 | 0 | 8 | 3 | 1 | 116 | 665 | 124 | 16 | 60 | 34 | 0 | 0 | 0 | 0 | 1622 |
| 2003 | 0 | 0 | 7 | 521 | 11 | 0 | 0 | 0 | 3 | 4 | 21 | 3 | 5 | 112 | 656 | 118 | 23 | 54 | 60 | 0 | 0 | 0 | 0 | 1597 |
| 2004 | 0 | 0 | 2 | 425 | 8 | 0 | 0 | 0 | 3 | 0 | 9 | 0 | 108 | 754 | 112 | 0 | 28 | 61 | 73 | 1 | 0 | 0 | 0 | 1584 |
| 2005 | 0 | 0 | 2 | 425 | 7 | 0 | 0 | 0 | 1 | 0 | 6 | 11 | 1 | 71 | 718 | 103 | 20 | 81 | 26 | 0 | 0 | 0 | 0 | 1471 |
| 2006 | 0 | 0 | 3 | 348 | 4 | 0 | 0 | 0 | 1 | 0 | 2 | 8 | 0 | 48 | 652 | 82 | 17 | 73 | 39 | 0 | 0 | 0 | 0 | 1277 |

| | IIa | IIIa | IVa | IVb | IVc | Va | Vb | Vc | VIa | VIb | VIIa | VIIb | VIIc | VIId | VIIe | VIIf | VIIg | VIIh | VIIj | VIIk | VIIIa | VIIIb | VIIId | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2007 | 0 | 0 | 1 | 452 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 21 | 580 | 87 | 20 | 72 | 51 | 0 | 0 | 0 | 0 | 1291 |
| 2008 | 0 | 1 | 145 | 172 | 2 | 0 | 0 | 0 | 0 | 1 | 5 | 2 | 0 | 43 | 457 | 65 | 8 | 58 | 22 | 0 | 0 | 0 | 0 | 981 |

**Table 1-5. Annual landings (t) of lemon sole by Scottish vessels into Scotland by ICES Division. Source: FRS FMD database.**

| Year | IIa | IIb | IIIa | IVa | IVb | IVc | Vb1 | Vb2 | VIa | VIb | VIIa | VIIb | VIIc | VIId | VIIe | VIIf | VIIg | VIIj | VIIk | XII | XIVa | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1980 | 0 | 0 | 0 | 870 | 1288 | 0 | 2 | + | 199 | + | 5 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2365 |
| 1981 | 0 | 0 | 0 | 676 | 1132 | 0 | 0 | + | 192 | + | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2004 |
| 1982 | 0 | 0 | 0 | 671 | 1119 | 0 | 0 | + | 137 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1931 |
| 1983 | 0 | 0 | 0 | 964 | 1431 | 0 | 0 | 0 | 154 | + | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2551 |
| 1984 | 0 | 0 | 0 | 939 | 1296 | 0 | 0 | 0 | 189 | 2 | 12 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2438 |
| 1985 | 0 | 0 | 0 | 784 | 1330 | + | + | 0 | 128 | 15 | 5 | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2262 |
| 1986 | 0 | 0 | 0 | 842 | 1134 | 0 | + | 0 | 132 | 9 | 2 | 0 | + | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 2120 |
| 1987 | 0 | 0 | 0 | 1049 | 1167 | 0 | + | 0 | 211 | 14 | 9 | + | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2451 |
| 1988 | + | 0 | 0 | 1108 | 1108 | 0 | + | + | 222 | 15 | 7 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2460 |
| 1989 | 0 | 0 | 0 | 947 | 1171 | 0 | + | 0 | 260 | 11 | 3 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2392 |
| 1990 | + | 0 | 0 | 1096 | 1310 | 3 | 15 | + | 293 | 50 | 5 | 1 | + | 0 | 0 | 0 | + | 1 | + | 0 | 0 | 2776 |
| 1991 | 0 | 0 | 0 | 1122 | 1658 | 0 | 5 | 0 | 277 | 50 | 6 | 2 | + | 0 | 0 | 0 | + | 1 | + | 0 | 0 | 3121 |
| 1992 | 0 | 0 | 0 | 996 | 1220 | 0 | 5 | 1 | 225 | 17 | 3 | 1 | 0 | + | 0 | 0 | + | 0 | + | + | 0 | 2467 |
| 1993 | + | 0 | 0 | 1112 | 958 | + | 4 | 0 | 287 | 6 | 5 | 1 | 0 | 2 | 0 | 0 | + | 0 | 0 | 0 | 0 | 2373 |
| 1994 | 0 | 0 | 0 | 1006 | 1003 | 0 | 34 | 0 | 322 | 7 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2375 |
| 1995 | + | 0 | 0 | 737 | 667 | 0 | 7 | + | 284 | 8 | 5 | 1 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1709 |
| 1996 | + | + | 0 | 758 | 694 | + | 6 | + | 282 | 8 | 1 | + | + | + | + | 0 | + | 0 | 0 | 0 | 0 | 1751 |
| 1997 | 1 | 0 | 0 | 676 | 940 | + | 7 | + | 173 | 10 | 2 | + | + | 2 | + | + | 0 | 0 | 0 | 0 | 0 | 1810 |
| 1998 | + | 0 | 0 | 792 | 1074 | + | 7 | 0 | 148 | 14 | 1 | + | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2037 |
| 1999 | + | 0 | 0 | 897 | 1387 | + | 5 | + | 134 | 51 | 2 | + | + | + | 0 | 0 | + | 0 | 0 | 0 | 0 | 2477 |
| 2000 | + | 0 | 0 | 985 | 952 | 0 | 13 | 1 | 99 | 50 | 1 | + | 0 | 0 | + | 0 | 0 | 0 | 0 | + | 0 | 2101 |
| 2001 | + | 0 | + | 803 | 758 | 0 | 16 | 1 | 115 | 29 | 1 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 1722 |

| Year | IIa | IIb | IIIa | IVa | IVb | IVc | Vb1 | Vb2 | VIa | VIb | VIIa | VIIb | VIIc | VIId | VIIe | VIIf | VIIg | VIIj | VIIk | XII | XIVa | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | + | 0 | 0 | 416 | 326 | + | 27 | 2 | 75 | 11 | 2 | 0 | 0 | 0 | 0 | + | + | 0 | 0 | 0 | 0 | 859 |
| 2003 | + | 0 | 0 | 374 | 309 | + | 22 | 1 | 59 | 14 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 786 |
| 2004 | 0 | 0 | 0 | 323 | 252 | + | 17 | + | 38 | 7 | 6 | + | + | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 644 |
| 2005 | 0 | 0 | 0 | 553 | 259 | + | 15 | + | 11 | 1 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 841 |
| Total | 2 | + | + | 21495 | 25943 | 4 | 207 | 7 | 4646 | 399 | 103 | 8 | 1 | 5 | + | + | 1 | 1 | 1 | + | + | 52824 |

**Table 1-6. Lpue (kg/h) of lemon sole caught in the North Sea and eastern Channel by UK (E&W) otter trawlers and beam trawlers between 1983 and 2009, by rectangle group**

| | Rectangle group 1 | | Rectangle group 2 | | Rectangle group 3 | | Rectangle group 4 | | Rectangle group 5 | | Rectangle group 6 | | Rectangle group 7 | | Rectangle group 8 | | Rectangle group 9 | | Rectangle group 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Otter trawl | Beam trawl | Otter trawl | Beam trawl | Otter trawl | Beam trawl | Otter trawl | Beam trawl | Otter trawl | Beam trawl | Otter trawl | Beam trawl | Otter trawl | Beam trawl | Otter trawl | Beam trawl | Otter trawl | Beam trawl | Otter trawl | Beam trawl |
| Year | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) |
| 1983 | 2.45 | 0 | 3.49 | 0 | 0.41 | 0.46 | 1.56 | 2.81 | 0.05 | 0 | 12.44 | 0 | 1.41 | 0 | 1.32 | 4.46 | 0.64 | 0 | 2.54 | 5.11 |
| 1984 | 4.2 | 8.23 | 6.4 | 5.7 | 1.27 | 1 | 2.2 | 1.88 | 4.65 | 0.95 | 14.34 | 7.63 | 1.72 | 0 | 2.25 | 2.63 | 1.09 | 5.89 | 2.15 | 2.63 |
| 1985 | 5.84 | 3.12 | 5.43 | 4.58 | 1.06 | 0.6 | 1.32 | 1.27 | 0 | 0 | 9.13 | 6.97 | 3.22 | 2.21 | 2.79 | 2.35 | 0.91 | 1.19 | 2.27 | 1.63 |
| 1986 | 3.82 | 3.9 | 3.75 | 2.48 | 0.39 | 0.26 | 0.75 | 0.69 | 1.35 | 0 | 10.82 | 3.9 | 1.86 | 1.94 | 2.18 | 1.96 | 0.67 | 1.15 | 0.54 | 0.85 |
| 1987 | 3.83 | 3.98 | 4.14 | 4.28 | 0.41 | 0.74 | 0.93 | 0.75 | 1.25 | 3.7 | 5.27 | 4.34 | 1.94 | 1.47 | 3.17 | 2.77 | 1.1 | 0.7 | 0.49 | 0.67 |
| 1988 | 4.51 | 2.69 | 4.38 | 1.38 | 0.39 | 0.56 | 1.13 | 0.69 | 0.67 | 1.91 | 5.68 | 5.47 | 1.63 | 0.68 | 3.88 | 2.33 | 0.48 | 0.76 | 1.02 | 0.69 |
| 1989 | 3.98 | 2.65 | 3.6 | 1.05 | 0.44 | 0.77 | 0.31 | 0.58 | 0 | 0.02 | 6.91 | 2.62 | 1.97 | 1.13 | 3.78 | 1.9 | 1.6 | 1.64 | 0.97 | 0.79 |
| 1990 | 3.75 | 3.67 | 4.09 | 1.37 | 0.59 | 1.15 | 1.11 | 0.11 | 0.34 | 1.29 | 5.23 | 1.45 | 2.88 | 1.35 | 3.77 | 2.09 | 3.01 | 0.94 | 1.37 | 0.66 |
| 1991 | 3.2 | 3.1 | 3.45 | 2.13 | 0.57 | 0.29 | 1.13 | 0.53 | 0.68 | 0.1 | 4.95 | 1.37 | 2.49 | 1.07 | 4.63 | 1.5 | 0.99 | 0.89 | 1.5 | 0.71 |

| | Rectangle group 1 | | Rectangle group 2 | | Rectangle group 3 | | Rectangle group 4 | | Rectangle group 5 | | Rectangle group 6 | | Rectangle group 7 | | Rectangle group 8 | | Rectangle group 9 | | Rectangle group 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1992 | 3.14 | 4.07 | 3.25 | 4.4 | 0.54 | 0.66 | 0.55 | 0.63 | 5.09 | 1.88 | 2.87 | 3.41 | 2.5 | 1.75 | 3.64 | 2.11 | 5.01 | 1.85 | 1.58 | 0.92 |
| 1993 | 2.87 | 4.73 | 3.11 | 3.3 | 0.25 | 0.66 | 0.61 | 0.7 | 0.46 | 0 | 3.18 | 1.72 | 2.49 | 1.83 | 3.38 | 2.06 | 2.74 | 1.59 | 0.4 | 0.91 |
| 1994 | 3.5 | 4.93 | 2.27 | 3.55 | 0.22 | 0.34 | 0.88 | 0.75 | 1.92 | 0 | 4.48 | 7.98 | 3.3 | 1.91 | 5.48 | 1.82 | 0.57 | 1.84 | 1.26 | 0.8 |
| 1995 | 4.8 | 5.89 | 3.39 | 2.03 | 0.56 | 0.68 | 1.16 | 1.53 | 0.42 | 0.58 | 6.22 | 27.82 | 3.08 | 1.26 | 5.33 | 0.93 | 1.08 | 1.23 | 2.6 | 1.78 |
| 1996 | 5.26 | 4.72 | 4.04 | 2.86 | 0.77 | 1.07 | 2.52 | 1.29 | 1.06 | 1.49 | 5.46 | 0 | 3.95 | 1.52 | 4.3 | 1.08 | 0.39 | 1.53 | 4.5 | 1.34 |
| 1997 | 5.26 | 5.35 | 4.48 | 2.81 | 0.6 | 0.58 | 1.48 | 1.1 | 0 | 0 | 5.13 | 6.52 | 3.91 | 1.81 | 7.32 | 1.97 | 2.47 | 0.92 | 0.91 | 0.96 |
| 1998 | 4.26 | 6.57 | 4.3 | 4.57 | 0.57 | 2.11 | 1.21 | 3.66 | 1.05 | 0 | 4.59 | 2.95 | 4.98 | 2.02 | 5.23 | 1.1 | 1.55 | 1.17 | 1 | 0.94 |
| 1999 | 4.9 | 8.84 | 3.73 | 4.33 | 0.21 | 0.9 | 1.51 | 2.57 | 1.52 | 0.12 | 3.69 | 2.93 | 4.38 | 1.66 | 3.91 | 0.85 | 0.68 | 0.97 | 1.22 | 1.52 |
| 2000 | 3.75 | 4.76 | 2.81 | 0.29 | 0.61 | 0.43 | 0.9 | 1.2 | 0.21 | 0 | 6.02 | 0 | 6.38 | 1.64 | 3.88 | 1.33 | 0.55 | 0.79 | 4.46 | 2.66 |
| 2001 | 3.41 | 9.5 | 2.96 | 0.91 | 0.59 | 0.54 | 1.97 | 2.55 | 0 | 0 | 8 | 0 | 8.4 | 1.53 | 4.29 | 1.36 | 0.51 | 0.62 | 1.41 | 3.53 |
| 2002 | 2.98 | 1.34 | 2.55 | 0.32 | 0.56 | 0.13 | 4.47 | 0.87 | 1.56 | 0 | 2.68 | 3.36 | 4.5 | 1.05 | 2.39 | 0.68 | 0.94 | 0.65 | 1.59 | 1.91 |
| 2003 | 3.64 | 1.28 | 2.8 | 0.79 | 0.78 | 0.05 | 2.29 | 0.19 | 0 | 0 | 0.87 | 0 | 2.05 | 0 | 3.65 | 1.64 | 4.98 | 0 | 4.76 | 2.16 |
| 2004 | 4.45 | 1.21 | 3.36 | 0.27 | 1.86 | 0.01 | 0.91 | 0.03 | 0 | 0 | 0.63 | 0 | 8.38 | 0 | 3.19 | 1.16 | 10.9 | 0 | 1.89 | 1.94 |

| | Rectangle group 1 | | Rectangle group 2 | | Rectangle group 3 | | Rectangle group 4 | | Rectangle group 5 | | Rectangle group 6 | | Rectangle group 7 | | Rectangle group 8 | | Rectangle group 9 | | Rectangle group 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | 3 | 3.48 | 2.37 | 0.25 | 0.21 | 0.07 | 0.51 | 3.01 | 0 | 0 | 0.15 | 0 | 18.06 | 0 | 2.08 | 0.74 | 0 | 0 | 13.04 | 1.88 |
| 2006 | 2.17 | 6 | 1.7 | 0.24 | 0.1 | 0.96 | 0.6 | 0.46 | 0 | 0 | 0.59 | 0 | 21.33 | 0 | 3.69 | 1.72 | 0.6 | 0 | 6.51 | 1.27 |
| 2007 | 1.99 | 0 | 2.49 | 0.1 | 0.06 | 0.06 | 0.35 | 0.01 | 0 | 0.3 | 0.74 | 0 | 14.37 | 0 | 2.31 | 1.4 | 2.26 | 0 | 3.26 | 0.57 |
| 2008 | 2.31 | 0 | 1.45 | 0 | 0.04 | 0.06 | 0.04 | 0.87 | 0.16 | 0 | 1.4 | 0 | 10.29 | 0 | 0.95 | 0 | 0.26 | 0 | 4.96 | 1.1 |
| 2009 | 1.93 | 0 | 1.64 | 0 | 0.11 | 0.11 | 0.14 | 0.78 | 0 | 0 | 2.47 | 0 | 5.37 | 0 | 1.41 | 0 | 0 | 0 | 9.56 | 2.24 |

**Table 1-7. Lpue (kg/h) of 'westerly' lemon sole, caught by UK (E&W) otter trawlers and beam trawlers between 1983 and 2009, by ICES Division (7e, 7f, 7g and 7h). Some ICES Divisions have been further separated into North (N), South (S), East (E) or West (W).**

| | Rect Group 7eW | | Rect Group 7eN | | Rect Group 7eS | | Rect Group 7f | | Rect Group 7gE | | Rect Group 7gW | | Rect Group 7hE | | Rect Group 7hW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Otter | Beam | Otter | Beam | Otter | Beam | Otter | Beam | Otter | Beam | Otter | Beam | Otter | Beam | Otter | Beam |
| | trawl | trawl | trawl | trawl | trawl | trawl | trawl | trawl | trawl | trawl | trawl | trawl | trawl | trawl | trawl | trawl |
| Year | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) | (kg/hr) |
| 1983 | 9.6 | 4.02 | 7.76 | 2.29 | 6.1 | 3.03 | 1.16 | 3.68 | 0.66 | 3.43 | 0 | 4.21 | 4.88 | 2.28 | 4.63 | 4.39 |
| 1984 | 7.24 | 4.01 | 9.06 | 2.3 | 3.68 | 2.62 | 1.75 | 2.89 | 0.53 | 3.26 | 0 | 5.52 | 3.35 | 2.88 | 3.16 | 2.54 |
| 1985 | 7.64 | 3.83 | 9.55 | 2.41 | 0.46 | 2.44 | 1.25 | 2.49 | 0.51 | 2.56 | 0.74 | 4.17 | 9.75 | 3.39 | 0.12 | 2.59 |
| 1986 | 6.36 | 3.75 | 5.92 | 1.64 | 12.59 | 1.7 | 1.01 | 2.54 | 0.35 | 2.37 | 1.18 | 3.32 | 3.91 | 3.48 | 0 | 3.19 |
| 1987 | 5.22 | 3.55 | 3.67 | 1.24 | 7.02 | 1.41 | 1 | 2.1 | 0.34 | 1.17 | 0.29 | 1.64 | 3.08 | 2.7 | 2.09 | 1.95 |
| 1988 | 4.51 | 3.25 | 3.62 | 1.3 | 3.13 | 1.45 | 0.9 | 3.12 | 0.32 | 2.71 | 0.13 | 2.34 | 2.33 | 2.85 | 0 | 1.87 |
| 1989 | 3.49 | 1.8 | 5.42 | 1.24 | 2.76 | 1.31 | 1 | 1.46 | 0.38 | 1.35 | 0.25 | 0.2 | 2.87 | 1.28 | 0 | 1.15 |
| 1990 | 3.69 | 1.59 | 4 | 1.18 | 0.97 | 1.03 | 1.02 | 0.84 | 0.29 | 0.48 | 0.21 | 1.72 | 1.46 | 0.65 | 0 | 0.56 |
| 1991 | 4.25 | 1.32 | 7.17 | 1.1 | 1.82 | 1.1 | 0.81 | 1.09 | 0.29 | 0.6 | 0.23 | 0.64 | 1.45 | 0.67 | 0.27 | 0.23 |
| 1992 | 4.68 | 1.9 | 7.42 | 1.04 | 4.87 | 1.15 | 1.17 | 2.03 | 0.2 | 1.54 | 0.43 | 1.16 | 1.82 | 1.33 | 0.12 | 1.03 |
| 1993 | 3.37 | 1.47 | 4.84 | 0.89 | 1.05 | 0.81 | 0.96 | 1.7 | 0.14 | 1.35 | 0 | 0.85 | 0.57 | 1.36 | 0 | 1.18 |
| 1994 | 2.45 | 1.96 | 3.41 | 0.87 | 0.16 | 0.89 | 0.78 | 2.25 | 0.35 | 2.06 | 0.3 | 1.95 | 1.1 | 2.17 | 0 | 1.09 |
| 1995 | 4.26 | 2.36 | 6.61 | 1.53 | 0.87 | 1.44 | 1.05 | 2.36 | 0.49 | 1.53 | 1.48 | 0.82 | 2.54 | 1.63 | 0.88 | 1.31 |
| 1996 | 7.07 | 2.46 | 9.35 | 1.62 | 0.03 | 1.21 | 1.57 | 2.11 | 1.32 | 0.99 | 0.81 | 0.65 | 2.37 | 1.86 | 0.52 | 1.08 |
| 1997 | 7.76 | 2.51 | 8.59 | 1.47 | 0.49 | 1.42 | 1.53 | 2.47 | 0.58 | 1.46 | 0.08 | 0.62 | 2.77 | 1.72 | 2.11 | 0.98 |
| 1998 | 3.89 | 2.17 | 5.19 | 1.13 | 0.2 | 0.93 | 1.42 | 2.15 | 0.68 | 1.51 | 0.28 | 0.93 | 0.8 | 1.43 | 1.06 | 0.72 |
| 1999 | 2.69 | 1.6 | 2.44 | 0.77 | 0.83 | 0.62 | 1.76 | 1.95 | 0.44 | 1.22 | 0.2 | 0.57 | 3.23 | 1.07 | 0.26 | 0.75 |
| 2000 | 2.06 | 1.41 | 3.31 | 1.07 | 4.31 | 0.71 | 0.61 | 2.27 | 0.43 | 1.28 | 0.23 | 0.7 | 1.46 | 0.91 | 0.08 | 0.51 |

| | Rect Group 7eW | | Rect Group 7eN | | Rect Group 7eS | | Rect Group 7f | | Rect Group 7gE | | Rect Group 7gW | | Rect Group 7hE | | Rect Group 7hW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 2.53 | 1.64 | 3.3 | 0.99 | 3.06 | 1.03 | 0.84 | 2.19 | 0.28 | 1.19 | 0.49 | 1.09 | 2.4 | 0.93 | 0.01 | 0.52 |
| 2002 | 1.93 | 1.98 | 5.46 | 1.22 | 1.66 | 0.84 | 0.84 | 2.48 | 0.24 | 1.56 | 0.25 | 1.24 | 2.29 | 1.06 | 0.04 | 0.54 |
| 2003 | 2.46 | 1.7 | 4.67 | 1.27 | 3.09 | 0.76 | 0.93 | 2.2 | 2.57 | 1.36 | 0.4 | 0.29 | 4.27 | 0.86 | 0.55 | 0.42 |
| 2004 | 3.07 | 1.83 | 5.94 | 1.24 | 2.04 | 0.67 | 0.52 | 2.76 | 0.57 | 1.54 | 0.23 | 0.57 | 2.78 | 1.05 | 0.79 | 0.43 |
| 2005 | 4.72 | 1.67 | 5.41 | 0.99 | 10.44 | 0.77 | 0.68 | 2.81 | 0.19 | 2.29 | 0.74 | 0.29 | 3.64 | 1.18 | 0.27 | 0.48 |
| 2006 | 4.83 | 1.58 | 3.9 | 0.84 | 11.16 | 0.58 | 0.59 | 1.84 | 0.08 | 2.48 | 0.74 | 0.93 | 2.15 | 1.32 | 0.45 | 0.66 |
| 2007 | 3.51 | 1.86 | 4.66 | 0.79 | 0.41 | 0.58 | 0.42 | 3.48 | 0.31 | 2.26 | 1.62 | 0.3 | 2.37 | 1.28 | 0.56 | 0.82 |
| 2008 | 2.9 | 1.4 | 3.52 | 0.76 | 1.09 | 0.61 | 0.5 | 2.9 | 0.29 | 1.51 | 1.15 | 0 | 0 | 1.1 | 0.32 | 0.74 |
| 2009 | 3.84 | 1.67 | 10.26 | 1.45 | 6.67 | 0.86 | 0.34 | 3.02 | 0.19 | 1.33 | 1.39 | 0.06 | 21.45 | 1 | 0.37 | 0.57 |

**Table 1-8. Mean length (cm) of lemon sole caught in the North Sea and eastern Channel (ICES Area IV and Division VIId), and in the 'Westerly' (ICES Divisions VIIe-k) stock units, between 1983 and 2008, by UK(E&W) vessels. For the North Sea, no samples were available for 1983, 1984, 1986, 1987 and 1992-1997**

| Year | BTS7d | Carhelmar | NWGFS | IBTS3E |
|---|---|---|---|---|
| 1988 | | | 0.0015 | |
| 1989 | | 0.0009 | 0.0019 | |
| 1990 | 0.0033 | 0.0011 | 0.0011 | |
| 1991 | 0.002 | 0.0014 | 0.0016 | |
| 1992 | 0.0011 | 0.0003 | 0.0013 | 4.71 |
| 1993 | 0.0039 | 0.0004 | 0.0025 | 4.18 |
| 1994 | 0.0062 | 0.0004 | 0.0028 | 4.72 |
| 1995 | 0.0074 | 0.0007 | 0.0031 | 8.72 |
| 1996 | 0.0042 | 0.0006 | 0.0027 | 9.63 |
| 1997 | 0.0031 | 0.0005 | 0.0027 | 6.94 |
| 1998 | 0.0019 | 0.0006 | 0.0026 | 6.22 |
| 1999 | 0.0027 | 0.0003 | 0.0022 | 8.23 |
| 2000 | 0.0022 | 0.0004 | 0.0027 | 8.4 |
| 2001 | 0.0033 | 0.0007 | 0.0029 | 9.63 |
| 2002 | 0.0047 | 0.0012 | 0.0039 | 8.5 |
| 2003 | 0.005 | 0.0006 | 0.0052 | 10.92 |
| 2004 | 0.0026 | 0.0021 | 0.0043 | 9.72 |
| 2005 | 0.0061 | 0.0005 | 0.0027 | 12.06 |
| 2006 | 0.0022 | 0.0007 | 0.0031 | 9.43 |
| 2007 | 0.0018 | 0.0004 | 0.0039 | 15.73 |
| 2008 | 0.0045 | 0.0014 | 0.0024 | 9.18 |
| 2009 | 0.0022 | 0.0014 | 0.0021 | 10.93 |

**Table 1-9. Summary of the data available for lemon sole from German surveys**

| Survey data | IBTS coverage | Length measurements (number) | Age | Discard and bycatch data | Landings by German vessels* |
|---|---|---|---|---|---|
| Time series 1959-2005 | 20 % | Time series 1985-2005 | 708 specimens 2003-2005<br><br>additionally sex, maturity | DCP | |

**Table 1-10. Mean length (cm) of lemon sole caught in the North Sea and eastern Channel (ICES Area IV and Division VIId), and in the 'Westerly' (ICES Divisions VIIe-k) stock units, between 1983 and 2008, by UK (E&W) vessels. For the North Sea, no samples were available for 1983, 1984, 1986, 1987 and 1992-1997**

| | North Sea | Westerly |
|---|---|---|
| 1983 | | 32.4 |
| 1984 | | 31.7 |
| 1985 | 31.9 | 31.1 |
| 1986 | | 31.9 |
| 1987 | | 31.5 |
| 1988 | 32.5 | 31.5 |
| 1989 | 33.9 | 32.7 |
| 1990 | 29.9 | 30.3 |
| 1991 | 28.3 | 30.8 |
| 1992 | | 32.2 |
| 1993 | | 31.3 |
| 1994 | | 30.9 |
| 1995 | | 30 |
| 1996 | | 30.8 |
| 1997 | | 31 |
| 1998 | 28 | 30.6 |
| 1999 | 27.8 | 31.7 |
| 2000 | 28.2 | 30.1 |
| 2001 | 28.5 | 29.5 |
| 2002 | 28.2 | 29.7 |
| 2003 | 27.9 | 29.3 |
| 2004 | 26.9 | 28.3 |
| 2005 | 26.6 | 28.5 |
| 2006 | 27.3 | 27.7 |
| 2007 | 26.9 | 29 |
| 2008 | 27.5 | 27.6 |

**Table 1-11. Length distribution (numbers of fish) of North Sea lemon sole landed by the Belgian Beam trawl fleet between 2002 and 2006**

| Length (cm) | 2002 | 2003 | 2004 | 2005 | 2006* |
|---|---|---|---|---|---|
| 23 | 118479 | 15465 | 7765 | 0 | 6572 |
| 24 | 196837 | 86251 | 39839 | 13971 | 30761 |
| 25 | 172449 | 139816 | 132078 | 90809 | 55685 |
| 26 | 216172 | 125310 | 194740 | 146692 | 84751 |
| 27 | 286078 | 149473 | 244512 | 266439 | 134561 |
| 28 | 188983 | 153008 | 230543 | 207560 | 169554 |
| 29 | 192929 | 151481 | 207672 | 227513 | 151599 |
| 30 | 137152 | 150053 | 159948 | 187096 | 149745 |
| 31 | 111544 | 95987 | 157147 | 154651 | 143311 |
| 32 | 96511 | 113839 | 135863 | 82322 | 162118 |
| 33 | 82274 | 86703 | 142404 | 68112 | 121703 |
| 34 | 55587 | 59873 | 85845 | 73038 | 89015 |
| 35 | 40938 | 27524 | 69162 | 31498 | 42559 |
| 36 | 25397 | 12715 | 40923 | 26525 | 36213 |
| 37 | 18741 | 7974 | 26482 | 16578 | 16513 |
| 38 | 10865 | 8410 | 11637 | 8289 | 9792 |
| 39 | 6971 | 8597 | 2023 | 8289 | 3487 |
| 40 | 6174 | 7934 | 1674 | 0 | 2981 |
| 41 | 387 | 2898 | 1153 | 1658 | 595 |
| 42 | 1582 | 5217 | 285 | 1658 | 0 |
| 43 | 1041 | 2898 | 0 | 0 | 276 |
| 44 | 0 | 1739 | 0 | 0 | 276 |
| 45 | 836 | 0 | 0 | 0 | 0 |
| 46 | 316 | 0 | 0 | 0 | 0 |
| 47 | 316 | 0 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 |
| 49 | 0 | 0 | 0 | 0 | 0 |
| 50 | 0 | 0 | 0 | 0 | 0 |
| Total number | 1968559 | 1413166 | 1891696 | 1612697 | 1412064 |
| Total weight (kg) | 541519 | 451935 | 580389 | 539265 | 502857 |

* data for 2006 are preliminary

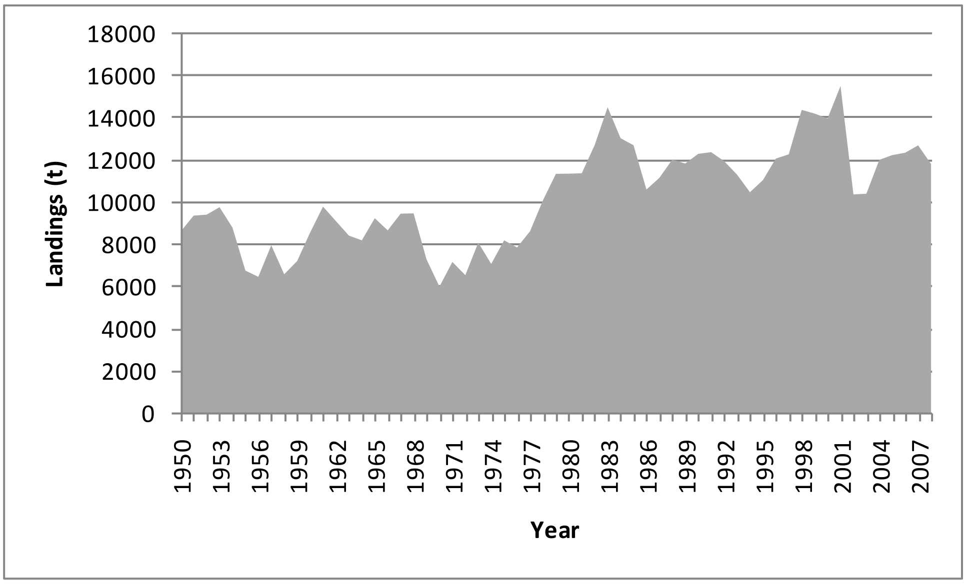


**Figure 1.1. Total international landings (t) of lemon sole for FAO Area 27, for 1950 – 2008. Source: FishStat**

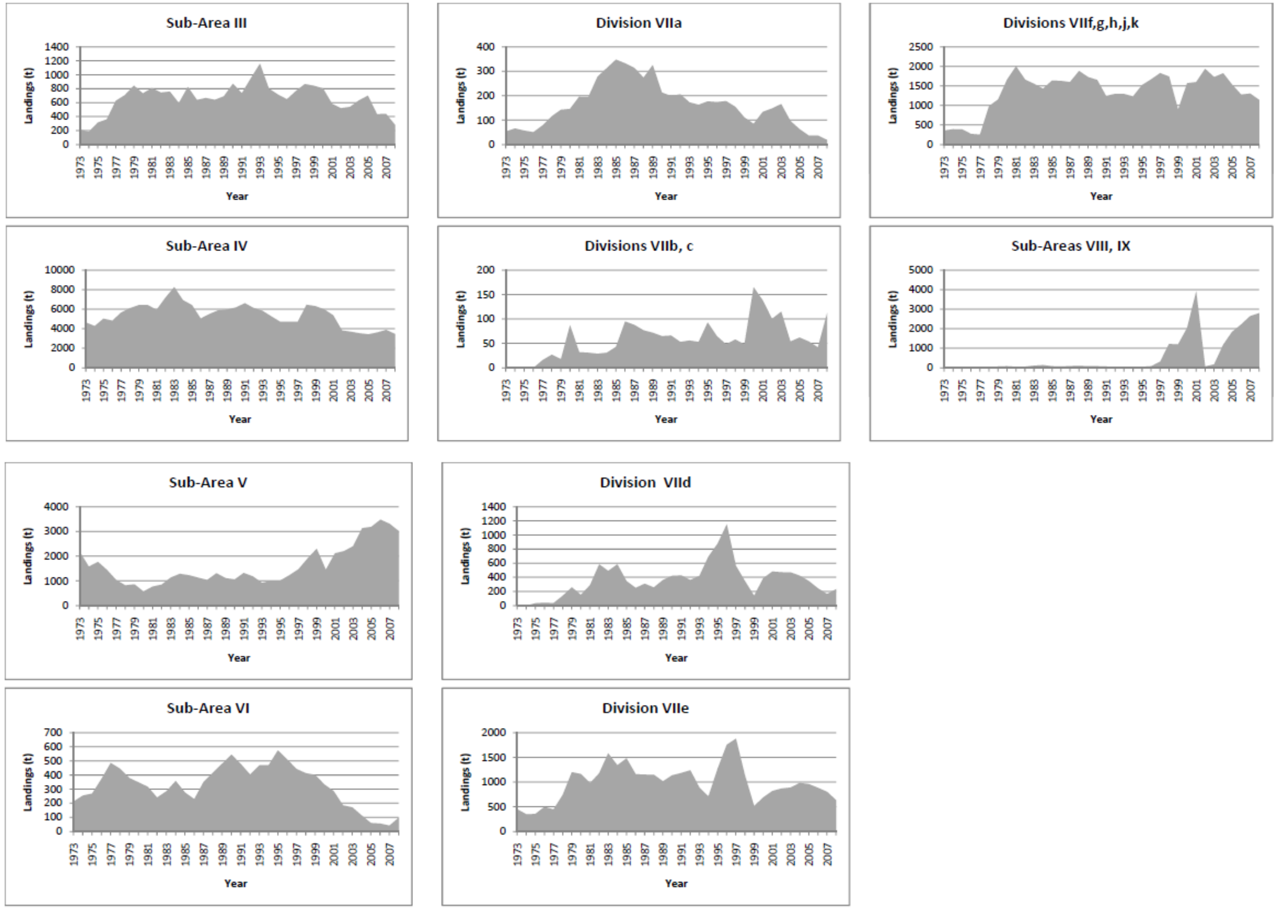


**Figure 1.2. Total international landings (t) of lemon sole by ICES area, for 1973-2008. Source : FishStat.**

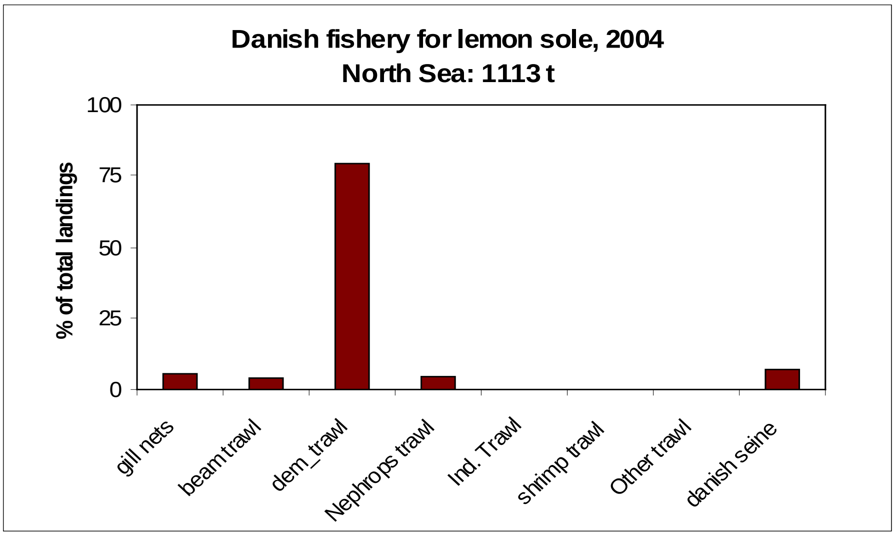


**Figure 1.3. Landings of lemon sole from the North Sea by the Danish fleet, by gear type.**

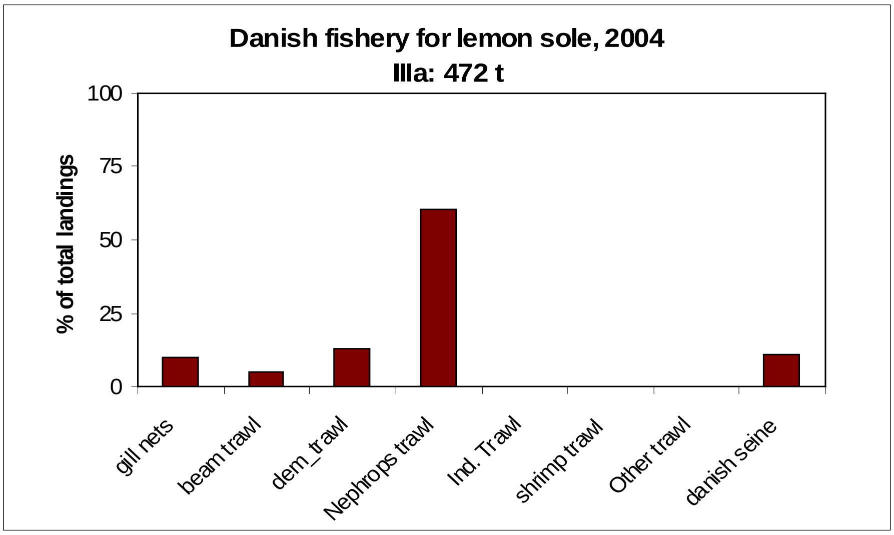


**Figure 1.4. Landings of lemon sole from Division IIIa Sea by the Danish fleet, by gear type.**

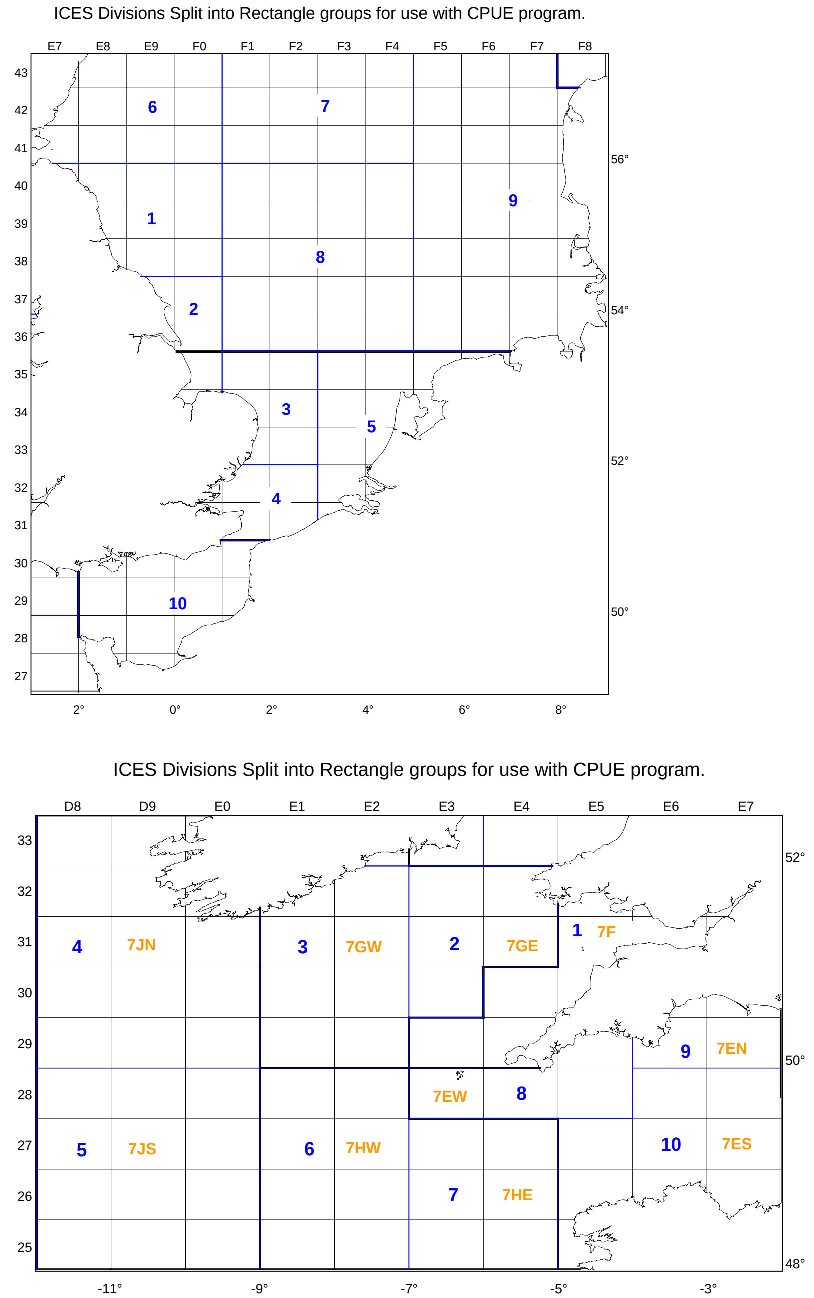


**Figure 1.5. North Sea (top panel) and 'Westerly' (bottom panel) rectangle groups, used for processing lemon sole lpue.**


**Figure 1.6. Lpue (kg/h) of (top panels) North Sea lemon sole in North Sea roundfish areas 1, 2, 8 & 10 and (bottom panels) 'westerly' lemon sole in ICES Division VIIe West (7EW), North (7EN) and South (7ES), caught by UK (E&W) otter trawlers (OT, left panels) and beam trawlers (BT, right panels) of < 24 m length.**

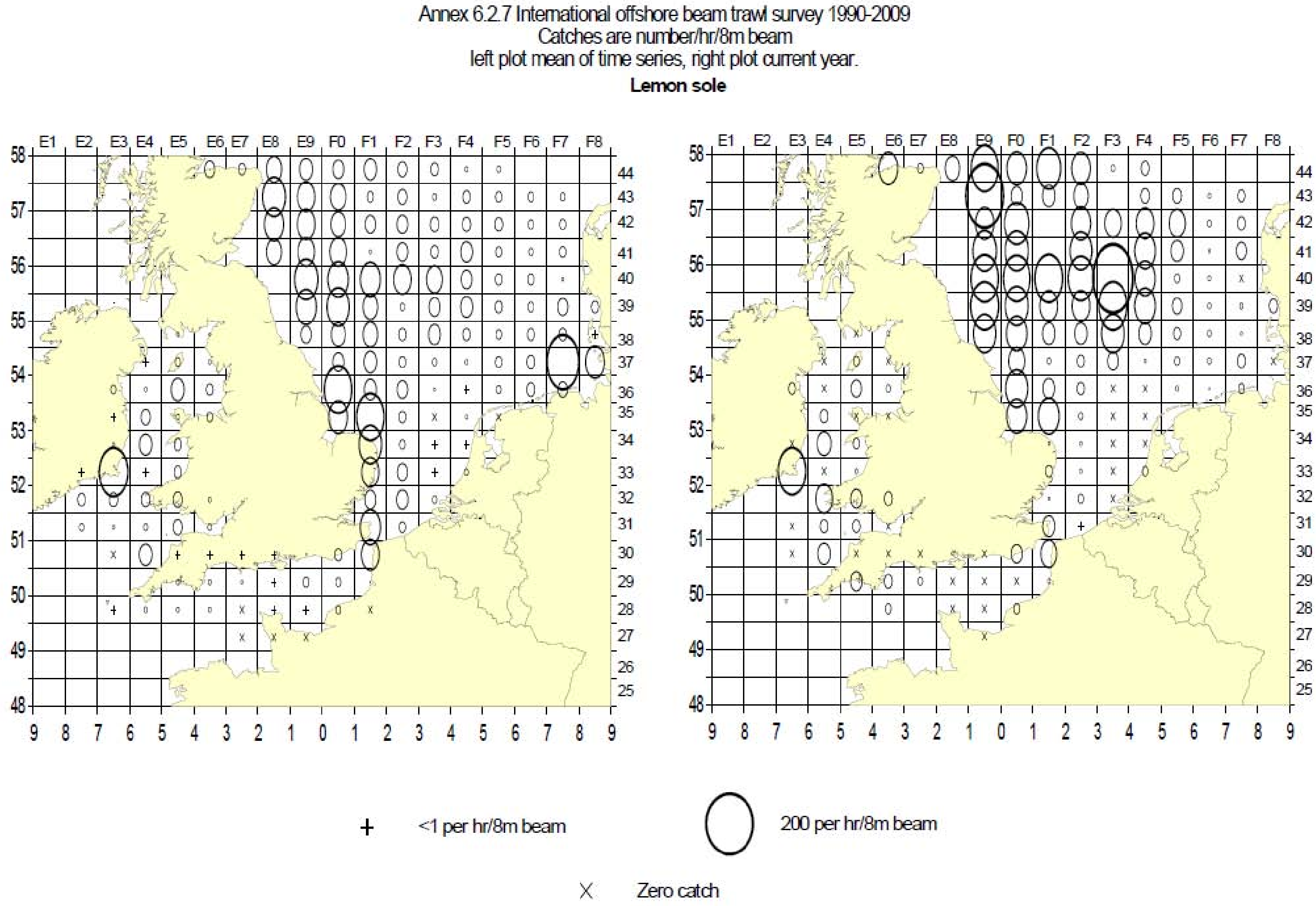


**Figure 1.7 Abundance of lemon sole in the International offshore beam trawl survey 1990-2009. Source WGBEAM 2010 (ICES 2010)**

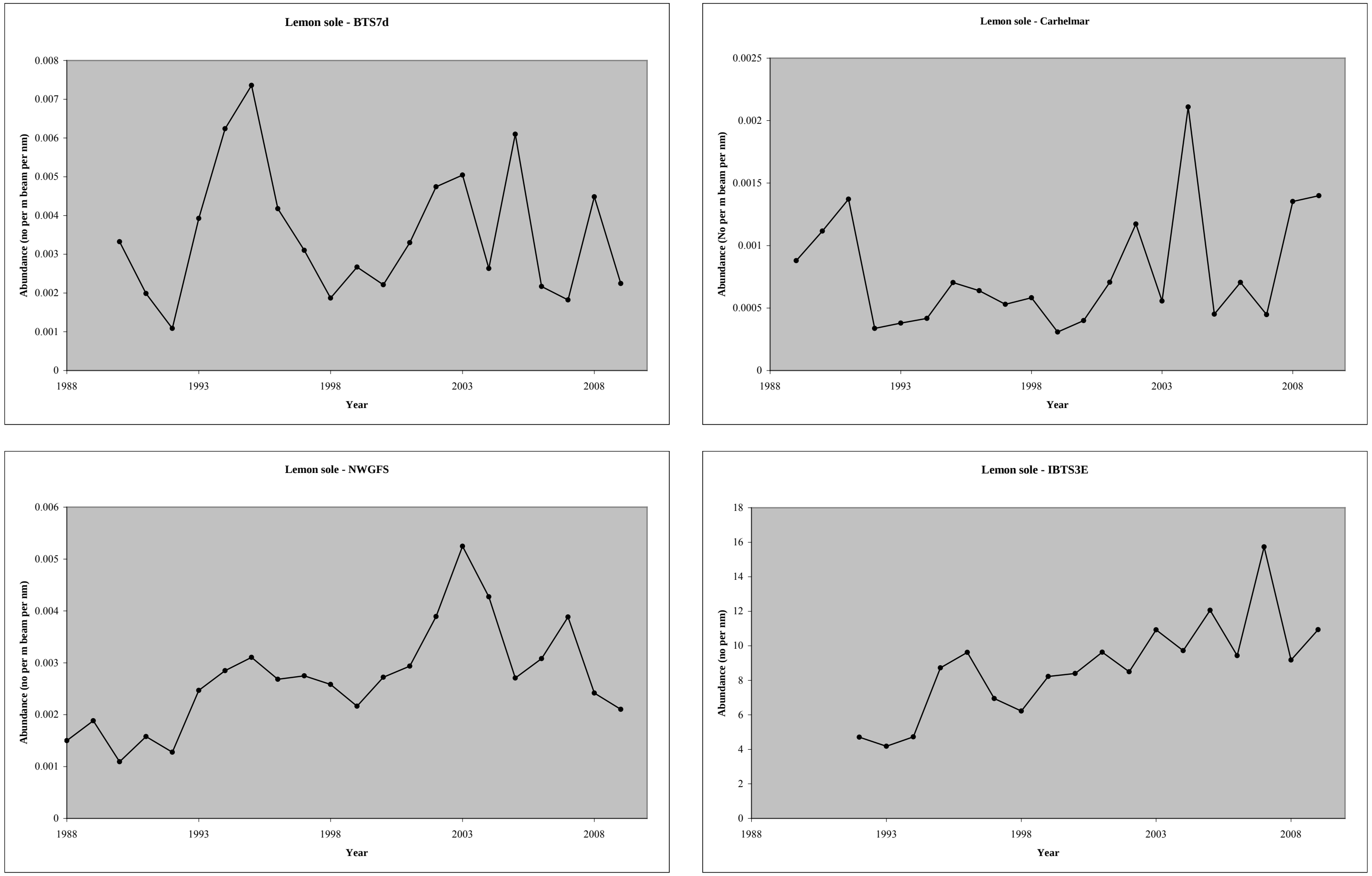


**Figure 1.8. Indices of abundance of lemon sole caught in 4 Cefas surveys: the eastern Channel Beam Trawl survey (BTS7d)(July), the western Channel (VIIe) (Carhelmar) Beam Trawl survey (October), the Irish Sea/Bristol Channel (VIIa, f, g) Beam Trawl survey (NWGFS)(September) and the 3rd Quarter North Sea IBTS Groundfish Survey (IBTS3E)(August). Abundances are given as number of fish per m beam per nm for the beam trawl surveys and as number of fish per nm for the groundfish survey.**

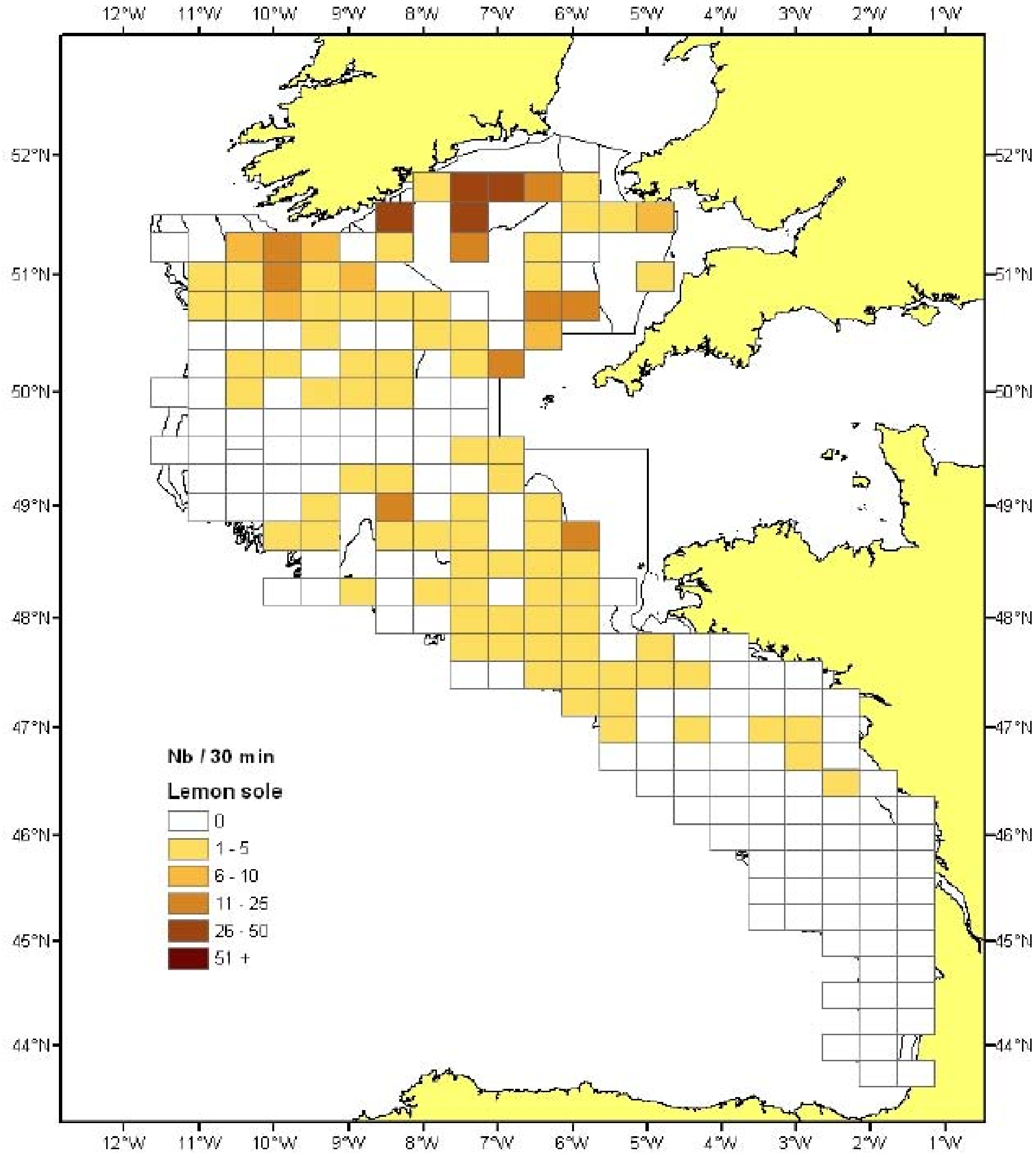


**Figure 1.9. Average abundance (number of fish per 30 minute tow) of lemon sole caught in the French EVHOE surveys 1997–2004.**

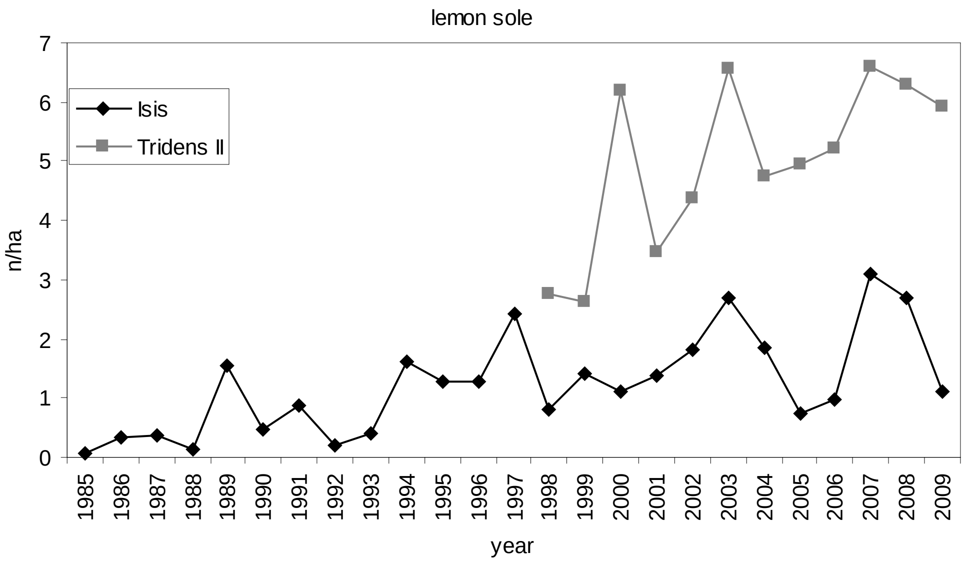


**Figure 1.10. Lemon sole abundance (number per 30 minute tow) in Dutch Beam Trawl Surveys, Isis (SE north Sea) and Tridens (Central North Sea)**

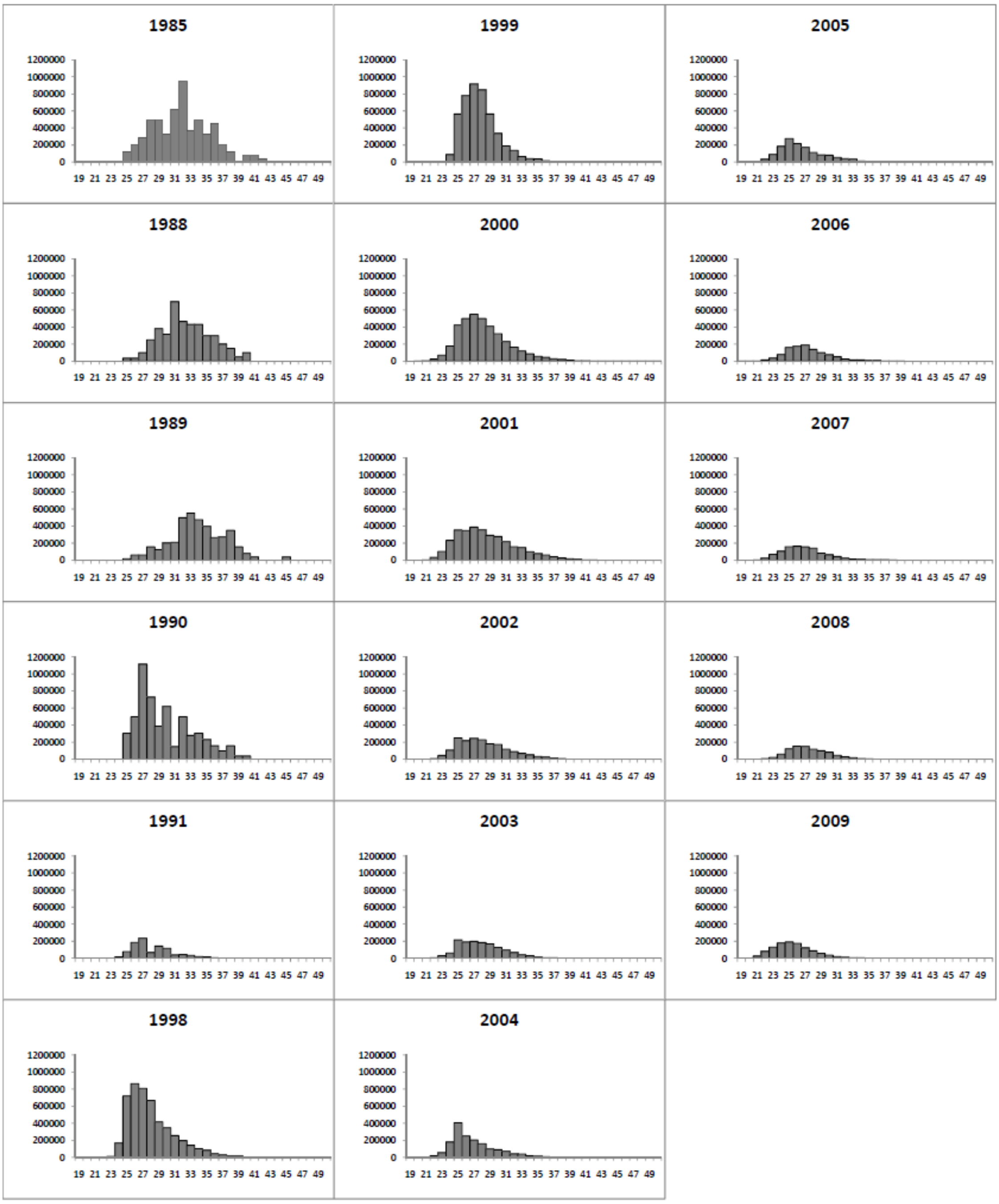


**Figure 1.11. Catch numbers at length (cm) for lemon sole landed by UK (E&W) vessels into ICES Area IV and Division VIId, between 1985 and 2009. For some years, no market sample lengths were available**

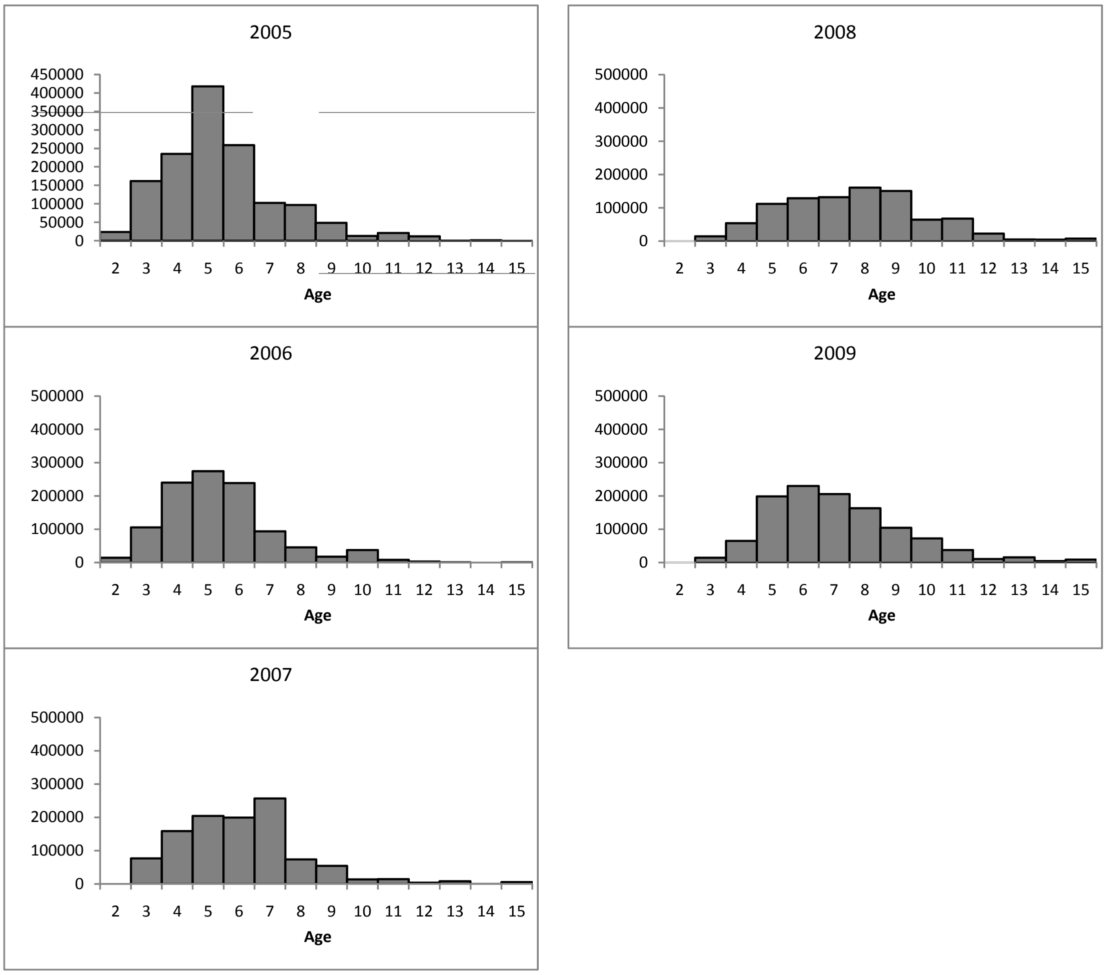


**Figure 1.12. Catch numbers at age for lemon sole landed by UK (E&W) vessels in Area IV and Division VIId, between 2005 and 2009**

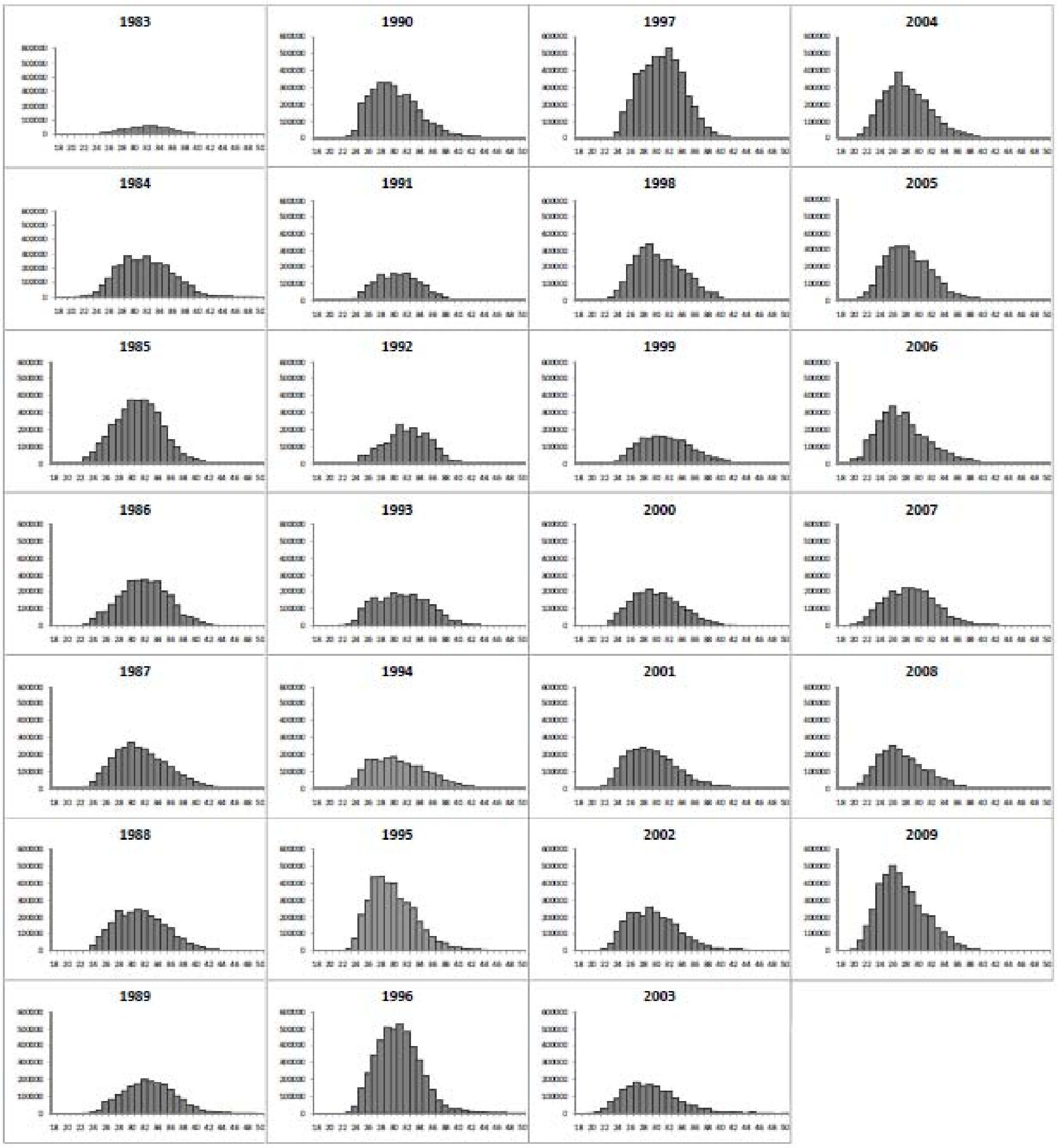


**Figure 1.13. Catch numbers at length (cm) for lemon sole landed by UK (E&W) vessels into ICES Divisions VIIe-h, between 1982 and 2009**

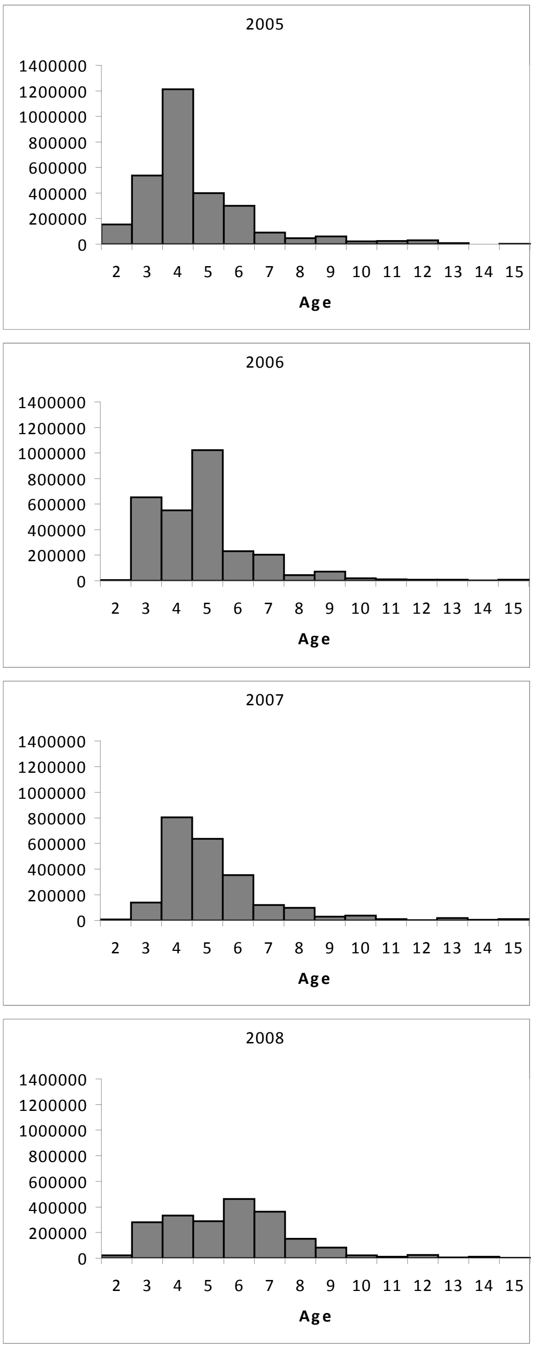


**Figure1.14. Catch numbers at age for lemon sole landed in Divisions VIIe-h, by UK (E&W) vessels, between 2005 and 2009**

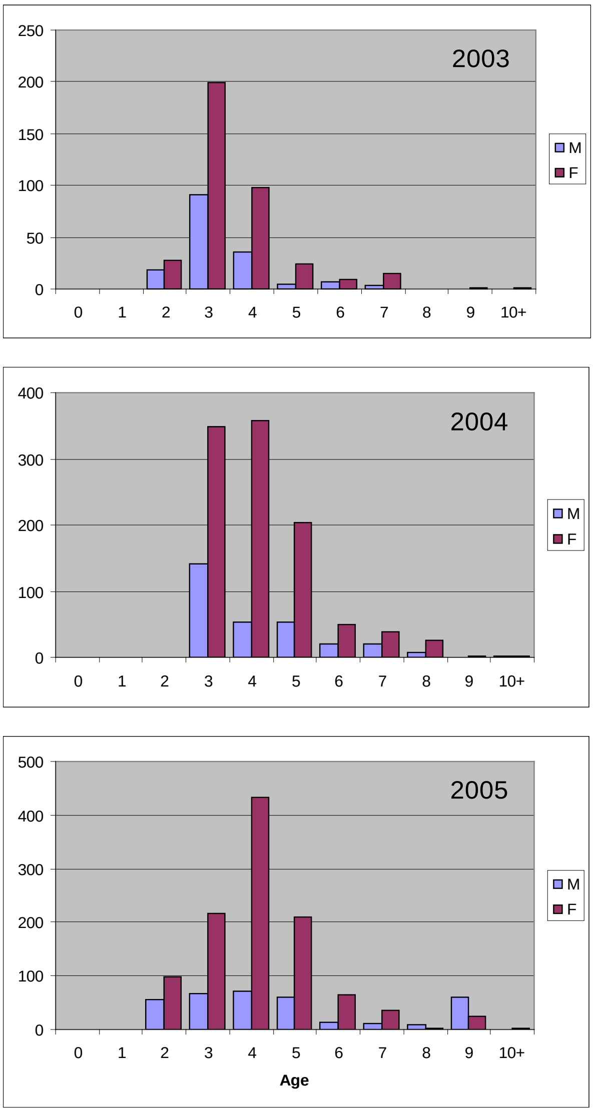


**Figure 1.15. Summary of raised Dutch market sampling data of lemon sole 2003 – 2005. Numbers (x1000) landed by age and by sex.**

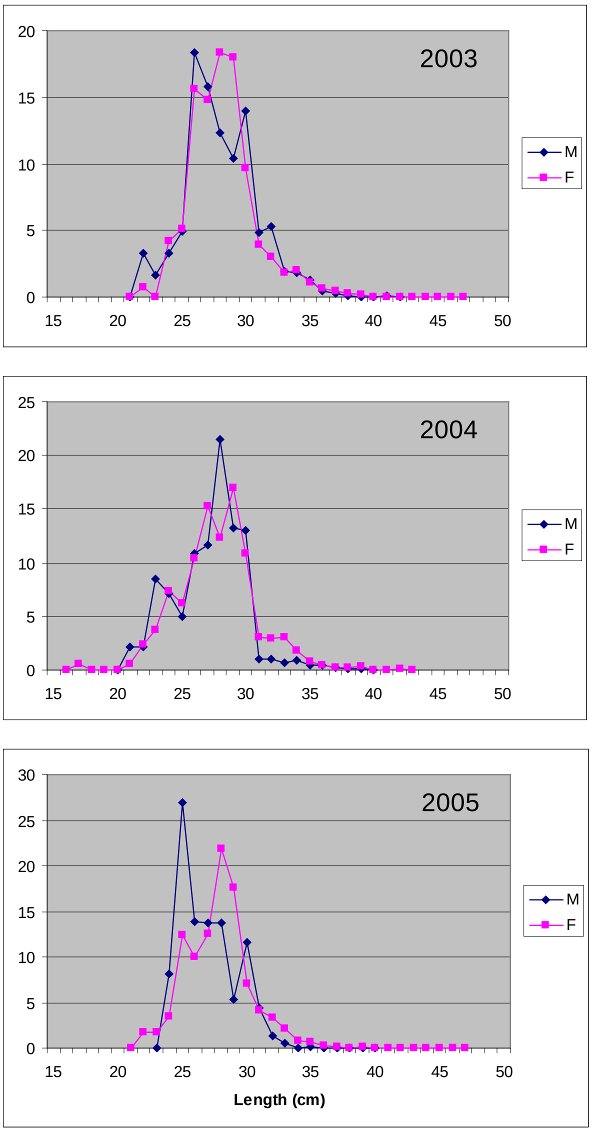


**Figure 1.16. Summary of raised Dutch market sampling data of lemon sole 2003 – 2005. Percentage landed by length and by sex.**

# Annex 8 - Dab (Limanda limanda)

## 1.1 General biology

Dab is a widespread demersal species on the Northeast Atlantic shelf and distributed from the Bay of Biscay to Iceland and Norway; including the Barents Sea and the Baltic. Next to sandeel, it is the second most abundant species in the North Sea (Daan et al. 1990). According to ICES IBTS results and research surveys its centre of distribution in the North Sea is located in the Southern North Sea (Lozán 1988; Daan *et al.* 1990, ICES 2010 (Figure 8-1)).

With regard to growth parameters it is an intermediate species with a maximum life span of 12 years and a population doubling time of about 1.4 - 4.4 years (Froese and Pauly 2004).

Spawning, pelagic development and settlement of postlarvae all occur within the spawning ground (Bohl 1959). Settled 0-group specimens migrate to nearby nursery grounds (Bolle *et al.* 1994). Recruitment success in terms of 0-group abundance in autumn is negatively related to spring water temperature (Henderson 1998).

Regional migrations (< 200 nm distance) occur. Tagging experiments show that German Bight spawners represent a transient aggregation from the entire southern North Sea (Rijnsdorp *et al.* 1992).

Sex- and age-dependent seasonal within-area migrations between spawning grounds, nursery areas and adult feeding grounds are triggered by changes of water temperatures (Saborowski and Buchholz 1997). Spatial aggregations and habitat do not occur, although very fine scale distribution patterns, i.e. patchiness, are present at scales < 2 km (Stelzenmüller *et al.* 2005a, 2005b).

The 0-group shows a general preference for sheltered areas, but not for particular depth or salinity zones (Riley et al. 1981). Correspondingly, dab appears to be 'euyhaline' and 'eurytherme' (Bohl 1959; Henderson and Holmes 1991).

Dab has proven to be a valuable indicator in ecotoxicological studies (only one reference, e.g. Vethaak *et al*. 1992).

## 1.2 Stock identity and possible assessment areas;

The several spawning grounds and the wide distribution of dab indicate the presence of more than one stock (Table 8-1). However, egg surveys are available to only a limited extent to verify potential spawning grounds.

Meristic data (Lozán 1988) corroborate the hypothesis of several stocks for dab, distinguishing significantly between populations from western British waters and the North Sea and the Baltic. Further, tagging experiments and significant meristic differences within Baltic populations led Temming *et al*. (1989b) to propose an individual stock around Bornholm, separated from IIIc22. However, no further scientific evidence is available.

Under the EU Data Collection Framework, 5 stocks/management units have been defined (those underlined are subject to sampling under the DCF):

- II, V, VI, VII (excl. d), VIII, IX, X, XII, XIV
- IIIa north
- IIIa south, IIIb-d

- IV, VIId
- VIId.

## 1.3 Management regulations (TAC's, minimum landing size)

No analytical assessments have been carried out for dab. According to EU-Regulations a precautionary TAC is given in EU waters of IIa and IV together with flounder (*Plathichthys flesus*). The TAC decreases from 2002 to 2010 from about 27 000 to 18 800 t (Table 8-2). Furthermore, no minimum landing size is defined.

## 1.4 Fisheries data

### 1.4.1 Landings

According to ICES catch statistics, annual catch of dab in ICES Divisions III, IV, and VII has been well above 10,000 t since 1973. Apparent decreases in total catch are due to unreported catches by the Netherlands, Norway and Spain (Table 8-3, Table 8-4, Figure 8-2, Figure 8-3). Total landings of dab in detail for Belgium, Denmark, France, Germany, Iceland, The Netherlands and United Kingdom by ICES Division are given in Tables 8-5 to 8-11.

### 1.4.2 Description of fishing fleets

#### Belgium

Flatfish fisheries with beam trawls is the major métier for dab landings. About equal amounts are yielded in the vessel categories >221kW and <=221kW.

#### Denmark

Historically, a directed dab fishery was carried out in the Danish Wadden Sea which ceased in the early 1950's, and the dab fishermen's association dissolved in 1957 (Holm, 2005). Dab maintained further important catches in the Kattegat and Belt Sea area in the 1930s, yielding about 4000 t annually (Poulsen, 1933).

Recent landings are yielded as by-catch from mixed fisheries with otter trawls and seiners.

#### Germany

The fleet structure with regard to dab landings is different between fisheries in the North Sea and in the Baltic in terms of vessel power and gear type.

In the North Sea, dab is mainly landed in the métier beam trawl with 80-99 mm mesh size as the main fleet segment. In 2008, 96 t out of 112 t total landings from this métier were obtained from the vessel category > 221kW (300 Hp). In turn, 15 t were landed from the vessel category <=221kW.

In the Baltic, landings are mainly derived from the cod fisheries with otter trawls with 110-119 mm mesh size as the main fleet segment. In 2008, 399 t were landed from vessel category <=221kW, whereas only 1 t was landed from vessel category >221kW.

#### The Netherlands

For the Dutch seafood industry, flatfish product exports are an essential and integral part of its economic development. Flatfish products are supplied to retail sales, catering and bulk accounts from the main species plaice, sole and dab.

Landings are only reported from the North Sea. Dab is part of the by-catch in the beam trawl fishery for plaice and sole. The main métier is beam trawling with 80-99 mm mesh.

Discard data have been collected during recent years. Only the bigger specimens of dab are landed, and most of the catch will usually be discarded. The portion retained depends on the availability of the main target species and on the prices in the market. Market sampling is carried out since 2002.

#### United Kingdom

Dab is a by-catch in beam trawl fisheries for flatfish, both for sole and plaice (80-99 mm mesh size) and for plaice only (> 99 mm mesh size), and in mixed fisheries/Nephrops fisheries with otter trawls.

About 95 % of dab landings are in the vessel power category > 221 kW.

## 1.5 Survey data, discards, recruit series

### 1.5.1 Surveys

The beam trawl survey (BTS) is conducted in the North Sea under participation from England, Belgium, Germany, France and the Netherlands, and is coordinated by the ICES Working Group on beam trawl surveys (WGBEAM). The BTS is accomplished each year from July to September and has been carried out since 1985 in the southeastern North Sea. In 1996, it was further extended northward. Trawl speed is set at 4 knots over the ground; nominal haul duration is 30 minutes. Sampling strategy for age, sex and maturity differs between the countries.

Analyses were restricted to the German, British and Dutch BTS.

The German survey started in 1991, covering areas off the Jutlands coast. The year 2006 is missing in the German series as a result of technical failures. A light beam trawl is used with a width of 7.2m and five tickler chains attached without modification. Since 1992 the cod-end mesh size is 40 mm.

The Dutch offshore beam trawl survey started in 1985 using an 8 m steel beam trawl. Mesh size in the cod-end is 40 mm. The British beam trawl survey for the eastern English Channel has been carried out since 1989 using a commercially rigged 4m steel beam trawl. Mesh size in the cod-end is 40 mm.

The international bottom trawl survey (IBTS) is conducted in the North Sea and Skagerrak/Kattegat. It is coordinated by the ICES Working Group on International Bottom Trawl Surveys (WGIBTS), formerly known as the International Young Fish Survey Working Group (WGIYFS).

The IBTS is conducted each year in quarter 1-4. Analysis were carried out for the first (Q1) and the third quarter (Q3) of the year.

IBTS methodology was harmonized in 1983, when all participating nations started using the GOV 36/47 as recommended standard gear. The average horizontal net opening of the GOV is 20 m with a 20 mm mesh cod-end. The vertical opening is of approximately 5 m.

Standard fishing speed is 4 knots measured as trawl speed over the ground. Each haul lasts 30 minutes. The IBTS is conducted in the entire North Sea within the 200-m depth contour, including the Skagerrak and Kattegat. Usually each rectangle is fished by vessels of two different countries, so that at least two hauls are obtained per rectangle.

Abundance indices from IBTS and BTS are shown in Figure 8-4. The abundance in IBTS Q1 increases since 1980. Length frequencies for the German BTS in the North Sea are given in Figure 8-5. In some years a recruiting year class can clearly be seen, as e.g. in 1999, 2005 and in 2008. Figure 8-6 provides similar data for French surveys in quarter 4 in VIId,e.

### 1.5.2 Discards and discard mortality

Dab and plaice are the most discarded species in the ICES area. For the period 1960 to 1981, discards in IIIc22 were estimated for Danish and German fisheries (Temming 1983). The sampling under the DCF programme shows that in the beam trawl fishery on sole and the otter trawl fishery on plaice about 95% of the catches on dab were discarded. An example for the 2$^{nd}$ quarters in 2007, 2008 and 2009 on length-frequency distribution (LFD) and age composition in IVb are given in Figure 8-7 and 8-8 for beam trawl and otter trawl, respectively. Landings on dab are depends on the crew and the availability of the target species.

In the 1990's, the Northeast Atlantic flatfish beam-trawl fishery was assessed among the 20 most discarding fisheries world-wide (Alverson *et al*. 1994). Recent estimates still indicate heavy dab discards from beam-trawl fishery, amounting to 60 to 70 % of the total catch (Borges et al. 2005).

Berghahn *et al.* (1992) provide discard mortality data for a number of bycatch species taken by shrimp vessels in the North Sea. Survival of flatfish is noted to depend strongly on the species and the size of specimens, as well as the catch processing conditions. A series of experiments on dab survival resulted in discard mortalities ranging from 0% to 67%, with an average mortality of 32.6% for fish collected after "sieving" and 11.9% for dab collected from the catch before "sieving" (Table 8-13). Additional data on the mortality of fish taken in shrimp fisheries in the Wadden Sea is available (Table 8-14).

### 1.5.3 Recruit series

Recruitment series are only available from analytical assessments (Temming 1983).

## 1.6 Biological sampling

All fish caught are routinely measured during surveys. For the UK, for most surveys, biological information is collected for dab. In addition, data on length distributions, distributions and abundance is available in Cefas technical reports for the Celtic Sea (Warnes and Jones 1995), the Irish Sea (Parker-Humphreys 2004a) and the English Channel and southern North Sea (Parker-Humphreys 2004b).

Length information from market sampling for this species is available for 2000 – 2003 only. Biological samples for otoliths, weight, sex and maturity are only available for 2000 – 2002.

Germany routinely measured dab by sex during surveys. Age reading started in 1997 with BTS. Market samples for dab are not available.

From the DCF programme, length sampling and ageing information by gear and quarter are available.

### 1.6.1 Population biology parameters and a summary of other research

Several extended population studies provide regional age-length keys by sex, fecundity data and small scale distribution analyses for dab in the southern North Sea, the English Channel and the Bay of Biscay (Deniel 1990; Rijnsdorp et al. 1992; Jennings *et al.* 1999). Maturity is reached at about 2 - 3 years. Maturity data are available in terms of combined age-at-maturity and length-at-maturity information (Deniel 1990; Jennings *et al*. 1999) (Deniel and Tassel 1986).

Mortality rates for 0-group dab during winter time have been calculated for 11 time series (Iles and Beverton 1991). Temperature is considered as a mortality factor for eggs (van der Land 1991).

## 1.7 Analyses of stock trends and potential status indicators

For the North Sea the population size has increased in the long term and had a considerably high level in recent years. High abundances can be found in the southeast along the German and Dutch coast and in the centre of the North Sea in the Doggerbank area. Biomass indices are linked to the abundance indices. Length composition is stabile over the years, with a slight increase in recent years. Age 1 and age 2 dab are most abundant. Age frequency decreases with increasing age. Female dab are more abundant than male dab.

In the Baltic Sea dab population increased in abundance and biomass over the last years. High abundances can be found for the western Baltic Sea, while abundance gets very low in the east. Biomass indices are linked to the abundance indices. In recent years a slight increase in mean length can be found. In the western Baltic Sea dab population has a lower mean length than in easterly parts.

Analysis of length-frequency distributions (LFDs) for the period 1998-2008 for which a consistent catch record is available reveals considerable differences between ICES areas IVb and VIId,e. In IVb with high dab catches (Table 8-4), LFDs are truncated to lengths < 30 cm (Figure 8-5). This is consistent with catch LFDs for area IVb (Figure 8-7, 8-8). Specimens < 22 cm are usually discarded. With a given length-at-maturity of 21.6 cm (Deniel and Tassel 1986), the catch comprises immature as well as mature specimens.

On average, in IVb 1 to 2 length groups can be discerned likely to represent different age groups present in the stock. In turn, in VIId,e where in particular in VIIe catches are low and declining, a diverse structure of the LFDs is evident (Figure 8-6). On average, 3 to 4 length groups are present. Specimens older than 3 years (app. length > 28 cm) are present in the stock.

The rationale, that fisheries as documented by the catch record and structure of the LFDs are linked is further corroborated by the relatively flat LFDs for 1998 and 1999 in IVb, corresponding to years with highest reported catches since 1973 (Table 8-4).

## 1.8 Data requirements

For the management information on catches and landings should be available. The best way to get more information about discard is the concurrent onboard sampling. More biological data such as length and sex distribution and age composition should be collected. At this moment the sampling effort is at low level. The intensity in sampling has to increase in surveys (see also Table 8-15)

The precautionary TAC should be separated from flounder.

## 1.9 References

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**Table 8-1. Dab spawning grounds, nurseries and affiliated populations**

| Spawning Ground (ref) | Nursery Ground (ref) | Adult population (ref) | Remarks (ref) |
|---|---|---|---|
| | Kattegat (8) | | Referring to ICES IIIa |
| | Bridgwater Bay (1) | Bristol Channel (1) | Referring to ICES VII f |
| Off Flamborough Head (2), Dogger Bank (4,5) | | Humber-The Wash - Doggerbank (?) | Adult population delineated by means of survey results in (3). Ref. to ICES IV b |
| Central German Bight (5) | E Coastal zone & Wadden Sea | German Bight-Doggerbank-Southern Bight | Referring to ICES IV b According to findings from Campos et al. (1994) spawning grounds in the German Bight and the Southern Bight are not separated |
| Southern Bight (5) Eastern Channel (5) | SE Coastal zone of Southern Bight (6) Eastern Channel (7) | | Referring to ICES IV c |
| | Western Scottish waters (9) | | Referring to ICES VI a |
| | | Western Channel (10) | |

**1- Henderson and Holmes (1991),**

**2 - Harding and Nicholls (1987),**

**3- Rijnsdorp *et al.* (1992),**

**4 - van der Land (1991),**

**5 - Bohl (1959),**

**6 - Bolle *et al.* (1994),**

**7 - Amara *et al.* (2001)**

**8 - Pihl (1989),**

**9 - Steele and Edwards (1970), Edwards and Steele (1968),**

**10 - Ortega-Salas (1979), Ph.D. thesis 1981**

**Table 8-2. Precationary TAC on dab and flounder in EU waters of IIa and IV**

| | TAC |
|---|---|
| 2002 | 27060 |
| 2003 | 23001 |
| 2004 | 19551 |
| 2005 | 18000 |
| 2006 | 17100 |
| 2007 | 17100 |
| 2008 | 18810 |
| 2009 | 18810 |
| 2010 | 18810 |

**Table 8-3 Data on dab landings (in t) by country from ICES Sub-areas III, IV, and VII as obtained from ICES catch statistics (- : missing data, . = fishing ceased)**

| Year | Belgium | Denmark | France | Germany | Ireland | Iceland | Netherlands | Norway | Spain | Sweden | UK | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 738 | 4554 | 4790 | 235 | 131 | 3 | 3641 | 1179 | - | 136 | 968 | 16372 |
| 1974 | 375 | 4465 | 2387 | 342 | 235 | 4 | 4105 | - | - | 123 | 921 | 12953 |
| 1975 | 672 | 4320 | 2441 | 514 | 198 | 5 | 4041 | - | - | 123 | 925 | 13234 |
| 1976 | 588 | 3712 | 1991 | 247 | 294 | 8 | 3497 | - | - | - | 880 | 11209 |
| 1977 | 728 | 3828 | 2543 | 626 | 270 | 8 | 4144 | - | - | 85 | 911 | 13135 |
| 1978 | 580 | 4362 | 1987 | 1108 | 253 | 34 | 3526 | - | - | 80 | 974 | 12870 |
| 1979 | 538 | 5551 | 2544 | 1130 | 239 | 32 | 4743 | - | - | 92 | 846 | 15683 |
| 1980 | 604 | 5247 | 2372 | 208 | 194 | 5 | 5029 | - | - | 112 | 673 | 14439 |
| 1981 | 651 | 6220 | 2734 | 287 | 274 | <0.5 | 4737 | - | - | 105 | 625 | 15633 |
| 1982 | 581 | 7106 | 2333 | 348 | 291 | <0.5 | 5138 | - | - | 83 | 632 | 16512 |
| 1983 | 703 | 9166 | 2507 | 343 | 460 | 24 | 5380 | - | - | 142 | 574 | 19275 |
| 1984 | 756 | 8024 | 2512 | 318 | 475 | 446 | - | - | - | 92 | 641 | 12818 |
| 1985 | 645 | 7033 | 2459 | 383 | 510 | 948 | - | - | - | 73 | 646 | 11749 |
| 1986 | 620 | 4722 | 2870 | 324 | 485 | 1254 | - | - | - | 71 | 660 | 9752 |
| 1987 | 793 | 5597 | 3172 | 456 | 381 | 1184 | - | - | - | 78 | 713 | 11190 |
| 1988 | 951 | 5423 | 3090 | 504 | 261 | 3776 | 3419 | - | - | 98 | 740 | 14486 |
| 1989 | 596 | 5368 | 1954 | 405 | 152 | 2236 | 2521 | - | - | 51 | 483 | 11530 |
| 1990 | 534 | 4561 | 1514 | 501 | 231 | 1897 | - | - | - | 54 | 448 | 7843 |
| 1991 | 611 | 4602 | 1454 | 672 | 101 | 2632 | - | - | - | 59 | 683 | 8182 |
| 1992 | 602 | 3677 | 1514 | 627 | 230 | 3045 | - | - | - | 46 | 592 | 7288 |
| 1993 | 665 | 3878 | 1575 | 1103 | 79 | 4222 | - | - | - | 38 | 684 | 8022 |
| 1994 | 570 | 5066 | 1254 | 1944 | 90 | 5159 | - | - | - | 38 | 905 | 9867 |
| 1995 | 558 | 4484 | 1062 | - | 95 | 5558 | - | - | - | 59 | 1414 | 7672 |
| 1996 | 689 | 3952 | 1120 | 1880 | 76 | 7954 | - | - | - | 39 | 1441 | 9197 |
| 1997 | 790 | 3211 | 1446 | 1384 | 112 | 7891 | - | - | <0.5 | 47 | 1511 | 8501 |
| 1998 | 961 | 2646 | 1576 | 1129 | 109 | 5061 | 7984 | - | 130 | 33 | 1353 | 15921 |
| 1999 | 981 | 2512 | 1194 | 1105 | 66 | 3981 | 8661 | - | 129 | 17 | 1026 | 15691 |
| 2000 | 865 | 2113 | 1106 | 1125 | 39 | 3015 | 6544 | 50 | 29 | 9 | 899 | 12779 |
| 2001 | 849 | 2300 | 965 | 1075 | 34 | 4373 | 5968 | 54 | 24 | 15 | 827 | 12111 |
| 2002 | 752 | 2648 | 1195 | 762 | 32 | 4358 | 4955 | 54 | 70 | 10 | 674 | 11152 |
| 2003 | 682 | 3004 | 1115 | 1152 | 40 | 4213 | 5138 | 91 | 58 | 5 | 771 | 12056 |
| 2004 | 592 | 2945 | 1065 | 1537 | 55 | 2953 | 5162 | 56 | 45 | 5 | 708 | 12170 |
| 2005 | 558 | 2824 | 1109 | 1640 | 9 | 2116 | 5478 | 131 | 36 | 5 | 823 | 12613 |
| 2006 | 604 | 2264 | 1077 | 1698 | 6 | 1081 | 5210 | 125 | 15 | 7 | 863 | 11869 |
| 2007 | 626 | 2196 | 1098 | 1106 | 1 | 810 | 6472 | 121 | . | 11 | 714 | 12345 |
| 2008 | 561 | 2024 | 941 | 927 | - | 798 | 5638 | 63 | 2 | 14 | 579 | 10749 |

**Table 8-4 Dab landings (in t) by area according to ICES catch statistics. Apparent reductions in catches 1990-1997 in IV b,c due to unreported catches.**

**(- : missing data, . = fishing ceased). VII d,e separated to reveal different trends by area**

| Year | IIIa | IVa | IVb | IVc | Va | VIId | VIIe | VIId,e | VIIa,b,c ,f-k |
|---|---|---|---|---|---|---|---|---|---|
| 1973 | 1449 | 1812 | 3241 | 2705 | 132 | - | - | 2157 | 2051 |
| 1974 | 2003 | 591 | 3743 | 2812 | 76 | 658 | 223 | 1118 | 1225 |
| 1975 | 2049 | 345 | 3197 | 3488 | 56 | 1386 | 710 | 2096 | 491 |
| 1976 | 1583 | 370 | 2641 | 2906 | 63 | 772 | 437 | 1209 | 996 |
| 1977 | 2318 | 443 | 2715 | 3544 | 9 | 1280 | 419 | 1703 | 1072 |
| 1978 | 2630 | 373 | 1931 | 3304 | 34 | 1270 | 272 | 1554 | 534 |
| 1979 | 2716 | 322 | 2567 | 3988 | 32 | 1031 | 1148 | 2180 | 382 |
| 1980 | 2333 | 301 | 2153 | 4527 | 5 | 1573 | 337 | 1916 | 415 |
| 1981 | 2679 | 333 | 2526 | 3627 | <0.5 | 2107 | 407 | 2514 | 510 |
| 1982 | 2902 | 506 | 3175 | 3528 | <0.5 | 1657 | 405 | 2062 | 459 |
| 1983 | 2906 | 507 | 3660 | 3270 | 25 | 2003 | 310 | 2313 | 619 |
| 1984 | 2769 | 395 | 727 | 922 | 447 | 2074 | 313 | 2387 | 576 |
| 1985 | 1545 | 388 | 898 | 681 | 949 | 2117 | 281 | 2398 | 685 |
| 1986 | 1608 | 448 | 1804 | 598 | 1254 | 2512 | 337 | 2849 | 770 |
| 1987 | 2258 | 621 | 2552 | 730 | 1186 | 2850 | 347 | 3197 | 589 |
| 1988 | 2254 | 527 | 4737 | 1797 | 3777 | 2802 | 440 | 3242 | 395 |
| 1989 | 2346 | 526 | 3889 | 1397 | 2237 | 1747 | 233 | 1980 | 262 |
| 1990 | 1574 | 281 | 1947 | 462 | 1897 | 1302 | 149 | 1451 | 258 |
| 1991 | 1609 | 291 | 2545 | 606 | 2636 | 1272 | 145 | 1417 | 251 |
| 1992 | 1454 | 276 | 1799 | 572 | 3046 | 1408 | 118 | 1526 | 268 |
| 1993 | 1723 | 194 | 2470 | 645 | 4222 | 1454 | 92 | 1546 | 191 |
| 1994 | 1963 | 149 | 3246 | 466 | 5159 | 1243 | 115 | 1358 | 166 |
| 1995 | 1530 | 98 | 3361 | 406 | 5557 | 813 | 101 | 914 | 195 |
| 1996 | 1409 | 121 | 4071 | 642 | 7954 | 1051 | 112 | 1163 | 191 |
| 1997 | 1015 | 82 | 4660 | 517 | 7891 | 1450 | 182 | 1632 | 258 |
| 1998 | 963 | 47 | 7639 | 5073 | 5061 | 1535 | 144 | 1679 | 228 |
| 1999 | 675 | 25 | 8671 | 4580 | 3981 | 131 | 67 | 198 | 193 |
| 2000 | 660 | 39 | 5788 | 4768 | 3015 | 1045 | 90 | 1135 | 200 |
| 2001 | 766 | 42 | 5027 | 4730 | 4373 | 915 | 83 | 998 | 192 |
| 2002 | 979 | 29 | 4517 | 4132 | 4358 | 1123 | 80 | 1203 | 142 |
| 2003 | 869 | 32 | 5259 | 3717 | 4213 | 1153 | 85 | 1238 | 143 |
| 2004 | 782 | 14 | 4944 | 3650 | 2953 | 1078 | 92 | 1170 | 177 |
| 2005 | 841 | 15 | 6041 | 3346 | 2117 | 1056 | 93 | 1149 | 156 |
| 2006 | 725 | 13 | 6157 | 3019 | 1081 | 1081 | 113 | 1194 | 117 |
| 2007 | 694 | 10 | 5154 | 4268 | 810 | 1037 | 51 | 1088 | 83 |
| 2008 | 522 | 13 | 3673 | 4343 | 798 | 970 | 64 | 1034 | 81 |

**Table 8-5 Total landings (t) of dab by Belgian vessels by ICES Division**

| | IVb | IVc | VIIa | VIId | VIIe | VIIf | VIIg-k | Total |
|---|---|---|---|---|---|---|---|---|
| 1973 | 322 | 356 | 12 | - | - | 14 | 16 | 720 |
| 1974 | 246 | 35 | 11 | - | - | 45 | 17 | 354 |
| 1975 | 250 | 349 | 15 | 15 | 1 | 33 | 8 | 671 |
| 1976 | 198 | 291 | 12 | 9 | 6 | 25 | 30 | 571 |
| 1977 | 185 | 467 | 10 | 17 | <0.5 | 15 | 23 | 717 |
| 1978 | 146 | 374 | 8 | 19 | <0.5 | 17 | 12 | 576 |
| 1979 | 177 | 307 | 10 | 17 | - | 14 | 10 | 535 |
| 1980 | 155 | 363 | 13 | 20 | 3 | 28 | 18 | 600 |
| 1981 | 214 | 328 | 14 | 45 | 2 | 22 | 26 | 651 |
| 1982 | 231 | 229 | 10 | 54 | 4 | 30 | 22 | 580 |
| 1983 | 297 | 242 | 18 | 64 | 8 | 44 | 24 | 697 |
| 1984 | 262 | 339 | 12 | 85 | 2 | 25 | 28 | 753 |
| 1985 | 313 | 195 | 11 | 65 | 5 | 29 | 23 | 641 |
| 1986 | 215 | 229 | 27 | 74 | 6 | 38 | 25 | 614 |
| 1987 | 269 | 241 | 43 | 135 | 4 | 54 | 20 | 766 |
| 1988 | 368 | 329 | 21 | 145 | 7 | 55 | 11 | 936 |
| 1989 | 255 | 188 | 13 | 70 | 4 | 44 | 15 | 589 |
| 1990 | 237 | 177 | 15 | 53 | 1 | 30 | 15 | 528 |
| 1991 | 242 | 249 | 10 | 61 | 4 | 29 | 6 | 601 |
| 1992 | 180 | 284 | 20 | 80 | 3 | 11 | 13 | 591 |
| 1993 | 222 | 326 | 11 | 67 | 3 | 12 | 17 | 658 |
| 1994 | 177 | 220 | 27 | 103 | 5 | 16 | 11 | 559 |
| 1995 | 225 | 185 | 40 | 77 | 1 | 15 | 10 | 553 |
| 1996 | 256 | 271 | 43 | 90 | - | 14 | 12 | 686 |
| 1997 | 317 | 190 | 74 | 151 | 1 | 28 | 23 | 784 |
| 1998 | 352 | 405 | 44 | 93 | 2 | 40 | 21 | 957 |
| 1999 | 358 | 444 | 42 | 84 | - | 24 | - | 952 |
| 2000 | 264 | 419 | 43 | 100 | - | 19 | - | 845 |
| 2001 | 228 | 347 | 74 | 152 | 2 | 29 | - | 832 |
| 2002 | 273 | 243 | 46 | 152 | 1 | 28 | - | 743 |
| 2003 | 188 | 208 | 43 | 198 | 1 | 28 | - | 666 |
| 2004 | 205 | 177 | 32 | 120 | 1 | 44 | - | 579 |
| 2005 | 243 | 129 | 34 | 105 | 1 | 32 | - | 544 |
| 2006 | 244 | 125 | 33 | 160 | 3 | 16 | - | 581 |
| 2007 | 238 | 198 | 8 | 147 | 2 | 20 | - | 613 |
| 2008 | 119 | 253 | 6 | 147 | 2 | 13 | - | 540 |

**Table 8-6. Total landings (t) of dab by Danish vessels by ICES Division**

| | IIIa | IIIb | IIIc | IIId | IVa | IVb | Total |
|---|---|---|---|---|---|---|---|
| 1973 | 1449 | | 1145- | 61 | | 1899- | 4554 |
| 1974 | 2003 | | 1240- | 54 | 110 | 1058 | 4465 |
| 1975 | 1959 | | 1339- | 78 | 16 | 928 | 4320 |
| 1976 | 1493 | | 1304- | 63 | 29 | 820 | 3709 |
| 1977 | 2105 | | 942- | 34 | 34 | 709 | 3824 |
| 1978 | 2515 | | 982- | 54 | | 799- | 4350 |
| 1979 | 2616 | | 1516- | 52 | | 1366- | 5550 |
| 1980 | 2218 | | 1625- | 22 | | 1376- | 5241 |
| 1981 | 2574 | | 1644- | 34 | | 1968- | 6220 |
| 1982 | 2823 | | 1875- | 52 | | 2356- | 7106 |
| 1983 | 2759 | 9 | 1926 | 44 | | 4428- | 9166 |
| 1984 | 2695 | - | 1823 | 68 | | 3438- | 8024 |
| 1985 | 1486 | | 1951- | 61 | | 3535- | 7033 |
| 1986 | 1551 | 26 | 1655 | 90 | 5 | 1029 | 4356 |
| 1987 | 2182 | 33 | 1709 | 98 | 16 | 1516 | 5554 |
| 1988 | 2150 | 26 | 1847 | 76 | 8 | 1298 | 5405 |
| 1989 | 2302 | 16 | 1723 | 47 | 5 | 1248 | 5341 |
| 1990 | 1535 | 22 | 1827 | 74 | 4 | 1077 | 4539 |
| 1991 | 1556 | 57 | 1733 | 96 | 6 | 1135 | 4583 |
| 1992 | 1412 | 78 | 1406 | 82 | 7 | 689 | 3674 |
| 1993 | 1656 | 65 | 1059 | 82 | 10 | 1001 | 3873 |
| 1994 | 1917 | 60 | 1619 | 163 | 8 | 1266 | 5033 |
| 1995 | 1482 | 49 | 1510 | 137 | 6 | 1292 | 4476 |
| 1996 | 1387 | 37 | 917 | 127 | 4 | 1439 | 3911 |
| 1997 | 990 | 32 | 730 | 60 | 7 | 1357 | 3176 |
| 1998 | 942 | 26 | 569 | 85 | 5 | 986 | 2613 |
| 1999 | 661 | 26 | 665 | 59 | 4 | 1072 | 2487 |
| 2000 | 647 | 23 | 612 | 46 | 7 | 718 | 2053 |
| 2001 | 751 | 42 | 588 | 78 | 16 | 748 | 2223 |
| 2002 | 968 | 20 | 491 | 43 | 12 | 1091 | 2625 |
| 2003 | 674 | 19 | 559 | 172 | 23 | 1553 | 3000 |
| 2004 | 637 | 34 | 953 | 185 | 9 | 1114 | 2932 |
| 2005 | 738 | 34 | 747 | 177 | 10 | 1099 | 2805 |
| 2006 | 566 | 36 | 531 | 182 | 7 | 905 | 2227 |
| 2007 | 547 | 40 | 860 | 115 | 5 | 616 | 2183 |
| 2008 | 475 | 36 | 757 | 86 | 6 | 642 | 2002 |

**Table 8-7. Total landings (t) of dab by French vessels by ICES Division**

| | IVb | IVc | VIId | VIIe | VIIf | VIIg | VIIh | VIIIa | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1973 | 763 | - | - | - | 85 | - | - | - | 848 |
| 1974 | 48 | 262 | 658 | 223 | - | - | - | - | 1191 |
| 1975 | 83 | 335 | 1277 | 522 | 21 | - | - | - | 2238 |
| 1976 | 46 | 253 | 636 | 240 | 23 | 279 | 230 | 99 | 1806 |
| 1977 | 36 | 332 | 1081 | 271 | 170 | 312 | 93 | 110 | 2405 |
| 1978 | 96 | 412 | 1087 | 117 | 33 | 110 | 51 | 71 | 1977 |
| 1979 | 116 | 513 | 881 | 946 | 6 | 52 | 2 | 20 | 2536 |
| 1980 | 78 | 560 | 1521 | 106 | 7 | 46 | 2 | 22 | 2342 |
| 1981 | 67 | 377 | 2001 | 159 | 4 | - | - | - | 2608 |
| 1982 | 27 | 564 | 1529 | 151 | 37 | - | - | - | 2308 |
| 1983 | 20 | 466 | 1858 | 70 | 2 | - | - | 32 | 2448 |
| 1984 | 10 | 471 | 1909 | 59 | 2 | - | - | 14 | 2465 |
| 1985 | 15 | 381 | 1962 | 50 | - | 14 | 3 | 10 | 2435 |
| 1986 | 4 | 278 | 2359 | 55 | 1 | 15 | 4 | 49 | 2765 |
| 1987 | 9 | 415 | 2607 | 92 | 1 | 8 | 5 | 16 | 3153 |
| 1988 | 11 | 326 | 2580 | 120 | 4 | 5 | 2 | 22 | 3070 |
| 1989 | 14 | 205 | 1630 | 41 | 1 | 23 | 2 | 25 | 1941 |
| 1990 | 17 | 192 | 1201 | 25 | 1 | 26 | 2 | 33 | 1497 |
| 1991 | 10 | 246 | 1109 | 29 | 4 | 13 | 1 | 32 | 1444 |
| 1992 | 3 | 213 | 1216 | 15 | 7 | 29 | 1 | 23 | 1507 |
| 1993 | 4 | 231 | 1303 | 9 | 4 | 11 | 2 | 11 | 1575 |
| 1994 | - | 133 | 1082 | 15 | 6 | 7 | - | 11 | 1254 |
| 1995 | - | 155 | 697 | 17 | 4 | 6 | 6 | 8 | 893 |
| 1996 | - | 177 | 914 | 9 | 2 | 3 | - | 12 | 1117 |
| 1997 | 2 | 122 | 1234 | 67 | 8 | 2 | - | 10 | 1445 |
| 1998 | 3 | 123 | 1387 | 54 | 3 | - | - | 6 | 1576 |
| 1999 | . | . | . | . | . | . | . | . | 0 |
| 2000 | 2 | 122 | 900 | 21 | 5 | 12 | 5 | 14 | 1081 |
| 2001 | 5 | 201 | 718 | 13 | 2 | 2 | - | 7 | 948 |
| 2002 | 6 | 222 | 934 | 17 | 3 | 3 | - | 8 | 1193 |
| 2003 | 5 | 149 | 908 | 19 | 2 | - | 2 | 27 | 1112 |
| 2004 | 4 | 117 | 896 | 11 | 4 | 7 | 8 | 10 | 1057 |
| 2005 | 4 | 117 | 900 | 33 | 11 | 5 | 6 | 18 | 1094 |
| 2006 | 33 | 96 | 888 | 23 | 2 | 10 | 6 | 11 | 1069 |
| 2007 | 26 | 168 | 834 | 15 | 2 | 7 | 5 | 30 | 1087 |
| 2008 | 18 | 142 | 720 | 9 | 2 | 6 | 3 | 30 | 930 |

**Table 8-8. Total landings (t) of dab by German vessels by ICES Division**

| | IIIa | IIIc | IVa | IVb | IVc | Total |
|---|---|---|---|---|---|---|
| 1973 | 0 | 133 | 0 | 41 | 0 | 174 |
| 1974 | 0 | 136 | 0 | 59 | 0 | 195 |
| 1975 | 0 | 145 | 1 | 44 | 0 | 190 |
| 1976 | 0 | 130 | 2 | 50 | 0 | 182 |
| 1977 | 0 | 115 | 0 | 70 | 0 | 185 |
| 1978 | 0 | 180 | 3 | 59 | 2 | 244 |
| 1979 | 0 | 158 | 1 | 77 | 9 | 245 |
| 1980 | 0 | 124 | 1 | 23 | 0 | 148 |
| 1981 | 0 | 203 | 2 | 29 | 0 | 234 |
| 1982 | 0 | 248 | 1 | 40 | 1 | 290 |
| 1983 | 0 | 266 | 1 | 48 | 0 | 315 |
| 1984 | 0 | 225 | 0 | 35 | 0 | 260 |
| 1985 | 0 | 260 | 0 | 24 | 0 | 284 |
| 1986 | 0 | 241 | 0 | 34 | 0 | 275 |
| 1987 | 0 | 327 | 0 | 36 | 0 | 363 |
| 1988 | 0 | 348 | 0 | 50 | 22 | 420 |
| 1989 | 0 | 268 | 0 | 117 | 0 | 385 |
| 1990 | 0 | 260 | 0 | 162 | 0 | 422 |
| 1991 | 1 | 366 | 0 | 290 | 0 | 657 |
| 1992 | 0 | 407 | 0 | 218 | 0 | 625 |
| 1993 | 28 | 563 | 0 | 464 | 29 | 1084 |
| 1994 | 2 | 1190 | 1 | 591 | 34 | 1818 |
| 1995 | - | - | - | - | - | - |
| 1996 | 4 | 1008 | 0 | 622 | 96 | 1730 |
| 1997 | 3 | 413 | 0 | 830 | 115 | 1361 |
| 1998 | 2 | 322 | 0 | 692 | 104 | 1120 |
| 1999 | 2 | 339 | 1 | 702 | 55 | 1099 |
| 2000 | 6 | 212 | 1 | 562 | 329 | 1110 |
| 2001 | 1 | 191 | 2 | 586 | 290 | 1070 |
| 2002 | 2 | 173 | 0 | 502 | 80 | 757 |
| 2003 | 4 | 493 | 0 | 559 | 83 | 1139 |
| 2004 | 3 | 746 | 0 | 669 | 98 | 1516 |
| 2005 | 5 | 475 | 0 | 1005 | 100 | 1585 |
| 2006 | 20 | 494 | 0 | 1028 | 121 | 1663 |
| 2007 | 9 | 552 | 1 | 482 | 43 | 1087 |
| 2008 | 12 | 507 | 0 | 358 | 17 | 894 |

**Table 8-9. Total landings (t) of dab by Icelandic vessels by ICES Division**

| | Va |
|---|---|
| 1973 | 3 |
| 1974 | 4 |
| 1975 | 5 |
| 1976 | 8 |
| 1977 | 8 |
| 1978 | 34 |
| 1979 | 32 |
| 1980 | 5 |
| 1981 | <0.5 |
| 1982 | <0.5 |
| 1983 | 24 |
| 1984 | 446 |
| 1985 | 948 |
| 1986 | 1254 |
| 1987 | 1184 |
| 1988 | 3776 |
| 1989 | 2236 |
| 1990 | 1897 |
| 1991 | 2632 |
| 1992 | 3045 |
| 1993 | 4222 |
| 1994 | 5159 |
| 1995 | 5557 |
| 1996 | 7954 |
| 1997 | 7891 |
| 1998 | 5061 |
| 1999 | 3981 |
| 2000 | 3015 |
| 2001 | 4373 |
| 2002 | 4358 |
| 2003 | 4213 |
| 2004 | 2953 |
| 2005 | 2116 |
| 2006 | 1081 |
| 2007 | 810 |
| 2008 | 798 |

**Table 8-10. Total landings (t) of dab by Dutch vessels by ICES Division**

| | IIIa | IVb | IVc | VIId | Total |
|---|---|---|---|---|---|
| 1973 | - | 1343 | 2293 | - | 3636 |
| 1974 | - | 1637 | 2463 | - | 4100 |
| 1975 | 2 | 1292 | 2737 | - | 4031 |
| 1976 | 80 | 1087 | 2311 | - | 3478 |
| 1977 | 142 | 1283 | 2674 | - | 4099 |
| 1978 | 39 | 1088 | 2380 | - | 3507 |
| 1979 | 15 | 1651 | 3073 | - | 4739 |
| 1980 | 3 | 1495 | 3527 | - | 5025 |
| 1981 | 5 | 1878 | 2851 | - | 4734 |
| 1982 | 22 | 2454 | 2657 | 1 | 5134 |
| 1983 | 34 | 2831 | 2486 | - | 5351 |
| 1984 | - | - | - | - | 0 |
| 1985 | - | - | - | - | 0 |
| 1986 | - | - | - | - | 0 |
| 1987 | - | - | - | - | 0 |
| 1988 | 15 | 2318 | 1048 | - | 3381 |
| 1989 | - | 1569 | 940 | - | 2509 |
| 1990 | - | - | - | - | 0 |
| 1991 | - | - | - | - | 0 |
| 1992 | - | - | - | - | 0 |
| 1993 | - | - | - | - | 0 |
| 1994 | - | - | - | - | 0 |
| 1995 | - | - | - | - | 0 |
| 1996 | - | - | - | - | 0 |
| 1997 | - | - | - | - | 0 |
| 1998 | - | 3609 | 4362 | 4 | 7975 |
| 1999 | - | 4629 | 4020 | 2 | 8651 |
| 2000 | - | 2713 | 3810 | 9 | 6532 |
| 2001 | - | 2098 | 3788 | 3 | 5889 |
| 2002 | - | 1411 | 3540 | 4 | 4955 |
| 2003 | 173 | 1730 | 3224 | 10 | 5137 |
| 2004 | 138 | 1796 | 3192 | 35 | 5161 |
| 2005 | 95 | 2462 | 2889 | 31 | 5477 |
| 2006 | 117 | 2541 | 2526 | - | 5184 |
| 2007 | 126 | 2502 | 3809 | 33 | 6470 |
| 2008 | 26 | 1658 | 3883 | 68 | 5635 |

**Table 8-11. Total landings (t) of dab by UK vessels by ICES Division**

| | IVa | IVb | IVc | VIa | VIIa | VIId | VIIe | VIIf | VIIg | VIIh | VIIj | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 521 | 772 | 56 | 71 | 62 | - | - | 40 | - | - | - | 1522 |
| 1974 | 480 | 695 | 52 | 125 | 60 | - | - | 29 | - | - | - | 1441 |
| 1975 | 325 | 600 | 67 | 149 | 59 | 94 | 187 | 32 | - | - | - | 1513 |
| 1976 | 328 | 440 | 48 | 150 | 64 | 127 | 191 | 26 | - | - | - | 1374 |
| 1977 | 404 | 432 | 71 | 164 | 82 | 182 | 148 | 28 | - | - | - | 1511 |
| 1978 | 360 | 542 | 136 | 137 | 77 | 164 | 155 | 29 | - | - | - | 1600 |
| 1979 | 320 | 545 | 86 | 170 | 73 | 133 | 202 | 29 | - | - | - | 1558 |
| 1980 | 298 | 402 | 77 | 187 | 94 | 32 | 226 | 36 | - | - | - | 1352 |
| 1981 | 328 | 338 | 71 | 133 | 56 | 61 | 246 | 48 | - | - | - | 1281 |
| 1982 | 502 | 423 | 77 | 184 | 38 | 73 | 250 | 35 | - | - | - | 1582 |
| 1983 | 494 | 464 | 76 | 160 | 27 | 81 | 232 | 37 | - | - | - | 1571 |
| 1984 | 388 | 420 | 112 | 159 | 22 | 80 | 252 | 42 | - | - | - | 1475 |
| 1985 | 379 | 546 | 104 | 167 | 53 | 90 | 226 | 63 | - | - | - | 1628 |
| 1986 | 435 | 522 | 79 | 175 | 51 | 79 | 274 | 43 | - | - | - | 1658 |
| 1987 | 591 | 722 | 60 | 197 | 71 | 108 | 251 | 55 | 7 | 12 | - | 2074 |
| 1988 | 469 | 692 | 60 | 128 | 54 | 77 | 313 | 44 | 4 | 18 | 5 | 1864 |
| 1989 | 505 | 686 | 41 | 167 | 50 | 47 | 188 | 19 | 3 | 2 | 3 | 1711 |
| 1990 | 270 | 454 | 75 | 174 | 53 | 48 | 123 | 9 | 2 | 1 | . | 1209 |
| 1991 | 283 | 868 | 97 | 151 | 88 | 102 | 112 | 19 | 3 | 19 | 1 | 1743 |
| 1992 | 268 | 709 | 66 | 128 | 55 | 111 | 98 | 16 | 3 | 9 | 1 | 1464 |
| 1993 | 184 | 779 | 46 | 93 | 51 | 83 | 79 | 20 | 3 | 5 | . | 1343 |
| 1994 | 140 | 1212 | 38 | 83 | 50 | 57 | 95 | 10 | 3 | 3 | 2 | 1693 |
| 1995 | 91 | 1844 | 34 | 42 | 46 | 37 | 83 | 7 | 1 | 1 | 8 | 2194 |
| 1996 | 117 | 1754 | 43 | 47 | 63 | 47 | 103 | 10 | 2 | 2 | 2 | 2190 |
| 1997 | 75 | 2154 | 35 | 29 | 59 | 65 | 114 | 12 | 4 | 2 | 9 | 2558 |
| 1998 | 42 | 1997 | 34 | 26 | 37 | 51 | 88 | 9 | 2 | 6 | 42 | 2334 |
| 1999 | 18 | 1910 | 29 | 21 | 40 | 45 | 67 | 7 | 2 | 1 | 26 | 2166 |
| 2000 | 25 | 1481 | 18 | 8 | 22 | 36 | 69 | 21 | 2 | 2 | . | 1684 |
| 2001 | 24 | 1318 | 20 | 9 | 14 | 42 | 67 | 10 | 1 | 1 | . | 1506 |
| 2002 | 17 | 1183 | 12 | 6 | 8 | 33 | 62 | 6 | 2 | . | 3 | 1332 |
| 2003 | 8 | 1147 | 23 | 10 | 12 | 37 | 65 | 6 | 4 | . | 19 | 1331 |
| 2004 | 4 | 1103 | 23 | 2 | 9 | 27 | 80 | 6 | 4 | 1 | 9 | 1268 |
| 2005 | 3 | 1098 | 57 | 6 | 16 | 20 | 59 | 5 | 1 | . | 2 | 1267 |
| 2006 | 1 | 1312 | 64 | 1 | 11 | 30 | 65 | 7 | 2 | . | 1 | 1494 |
| 2007 | 0 | 1174 | 17 | <0.5 | 15 | 20 | 34 | 10 | 2 | . | . | 1272 |
| 2008 | 0 | 821 | 23 | . | 17 | 25 | 53 | 7 | 5 | . | . | 951 |

**Table 8-12. Survey information by ICES division**

**Offshore surveys with regional focus, coastal surveys delimited depth range and coastal affiliation, inshore surveys cover estuaries and shallow water systems such as the Wadden Sea. ICES IBTS not included (refers to IV a - c)**

| ICES area | Number of surveys and affiliation to habitats (offshore/coastal/inshore) | Period | Specified area | Specifics | Source |
|---|---|---|---|---|---|
| III | | | | | |
| IV a | 1 (1 / 0 / 0) | 1975 - present | | | ISH |
| IV b | 4 (2 / 1 / (1)) | 1966(1974)-present | (Wadden Sea) | | Cefas / ISH |
| IV c | 2 (1 / {1} / 0) | {1982-2001} | | | Cefas / {ISH} |
| VI a | | | | | |
| VII a | 1 | | | | Cefas |
| VII b | | | | | |
| VII d | 1 | | | | Cefas |
| VII e | 1 | | | | Cefas |
| VII f | 2 (1 / 1* / 0) | 1981-1991* (present) | Bristol Channel* | *Sampled from power plant cooling water filter | (* Henderson and Holmes 1991), Cefas |
| VII g | 1 | | | | Cefas |
| VII h | | | | | |
| VIII a | | | | | |
| VIII b | | | | | |

**Table 8-13. Dab mortality from shrimp fishery bycatch. A = after sieving out; B = results of controls with samples collected from the catch before sieving; TL = total length; Catch = total catch in one codend; $N_b$ = number in the beginning; $N_e$ = number at the end of the experiment. Source: Berghahn *et al*. (1992). Sieving refers to an onboard sorting system for shrimp.**

| Date | | TL Range (cm) | Catch (kg) | Water Temperature (celcius) | Duration of Experiments (d) | $N_b$ | $N_e$ | Mortality (%) |
|---|---|---|---|---|---|---|---|---|
| 5/23/88 | A | 10.5–21 | 100 | 12–13.4 | 5.5 | 63 | 46 | 27 |
| | B | 12–22 | | | | 26 | 23 | 12 |
| 8/2/88 | B | 14.5–24 | 50 | 17.2–17.4 | 5.5 | 40 | 31 | 23 |
| 8/8/88 | A | 12–20.5 | 70 | 18.0–18.8 | 5.5 | 6 | 2 | 67 |
| 8/15/88 | A | 9.5–20 | 70 | 17.6 | 5.0 | 13 | 8 | 38 |
| 5/15/89 | A | 12.5–20 | 110 | 12.0–14.0 | 6.0 | 19 | 17 | 11 |
| 5/21/89 | B | 10.5–23.5 | | | | 20 | 20 | 0 |
| | A | 12–27 | 55 | 15.0–15.2 | 6.0 | 81 | 54 | 33 |
| 5/28/89 | B | 12–26 | | | | 45 | 40 | 11 |
| | A | 10.5–25 | 150 | 15.7–14.4 | 5.5 | 31 | 23 | 26 |
| 7/49/89 | B | 11.5–25.5 | | | | 11 | 10 | 9 |
| 7/25/89 | B | 20–20.5 | 75 | 15.0–16.0 | 5.0 | 2 | 2 | 0 |
| 5/10/90 | A | 20.5–26 | 125 | 17.2–17.5 | 5.5 | 5 | 4 | 20 |
| | A | 7–19.5 | 40 | 16.0 | 5.0 | 33 | 17 | 48 |
| 5/16/90 | B | 11–16 | | | | 2 | 2 | 0 |
| 7/20/91 | A | 7.5–25 | 15 | 14.0–13.6 | 4.0 | 40 | 23 | 43 |
| | B | 12.5–25 | 50 | 16.7–17.5 | 5.0 | 12 | 12 | 0 |
| Average | | | | A | | 291 | 196 | 32.6 |
| | | | | B | | 159 | 140 | 11.9 |

**Table 8-14. Mortality of selected fish species in the bycatch of the shrimp fishery in the Wadden Sea after five days of maintenance (Berghahn 1990).**

| Species | Number of Trials | Total Catch One Codend kg | Water Temp. C | Number of Specimens | Total Length cm | Mortality % |
|---|---|---|---|---|---|---|
| Dab | 4 | 55–125 | 14.4–17.5 | 133 | 10–27 | 10–35 |
| Sculpin | 7 | 70–150 | 14.4–18.8 | 52 | 10–20 | 0 |
| Hooknose | 6 | 70–150 | 12.0–18.8 | 134 | 7–16 | 0.0–13 |
| Eelpout | 4 | 70–100 | 12.0–17.6 | 45 | 13–20 | 0.0–17 |

**Table 8-15. Market sampling of new MOU species under the DCR (based on the 2004 technical reports from Belgium, Denmark, Finland, France, Germany, Ireland, the Netherlands, Spain, Sweden and the UK)**

| Species | Area | Length required | Length achieved | Age required | Age achieved |
|---|---|---|---|---|---|
| Limanda limanda | IV, VIId | 1772 | 3056 | 0 | 300 |

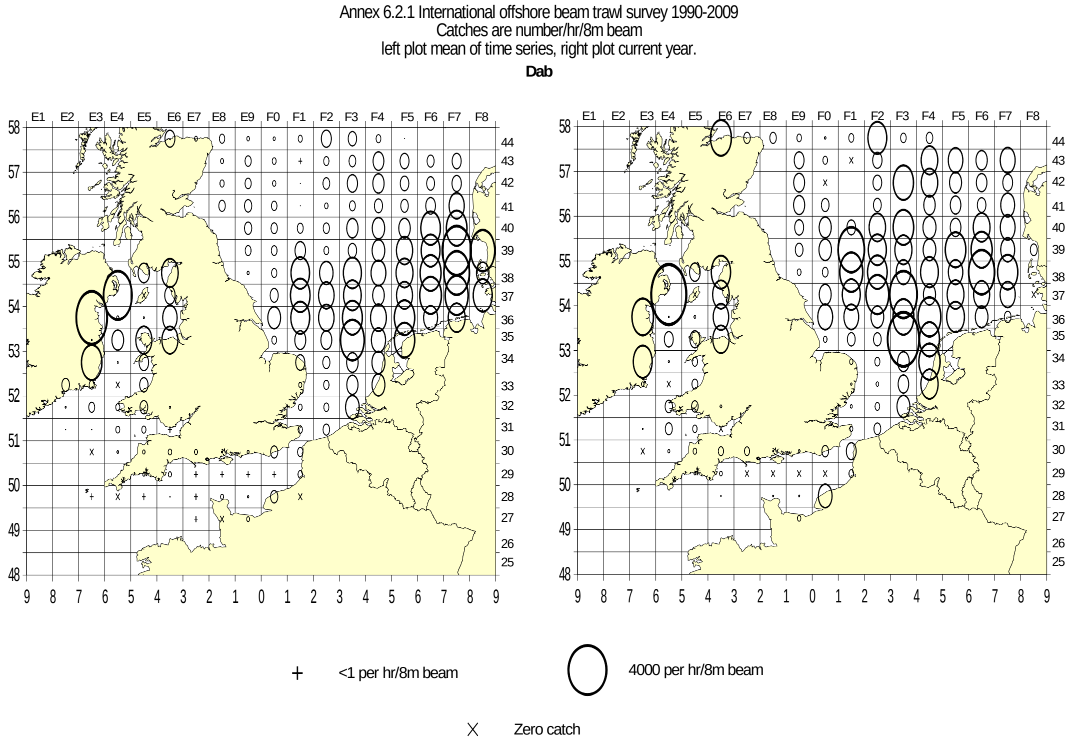


**Fig. 8-1. Abundance of dab in the International offshore beam trawl survey 1990-2009. Source WGBEAM 2010 (ICES 2010)**

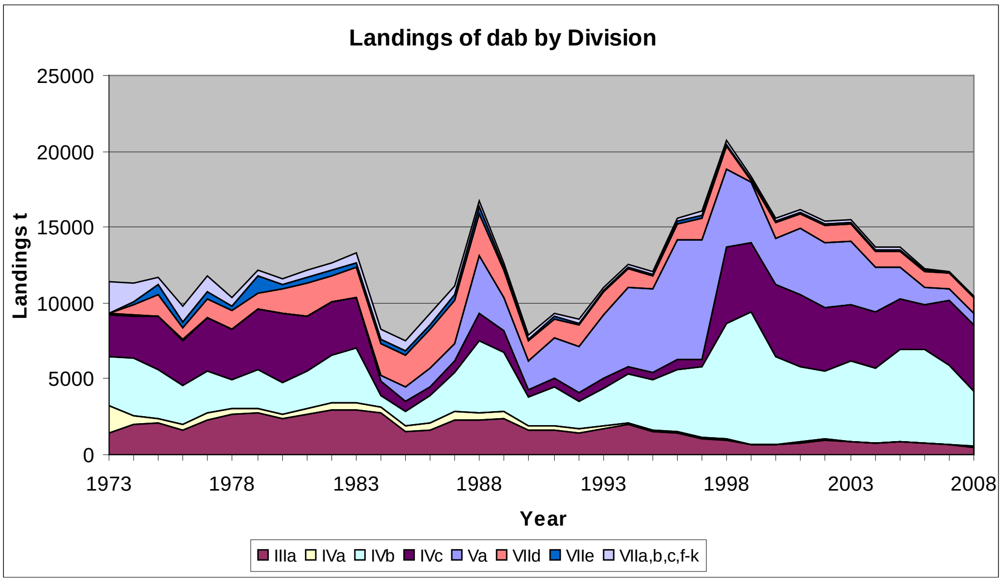


**Figure 8-2. Dab landings by ICES Division**

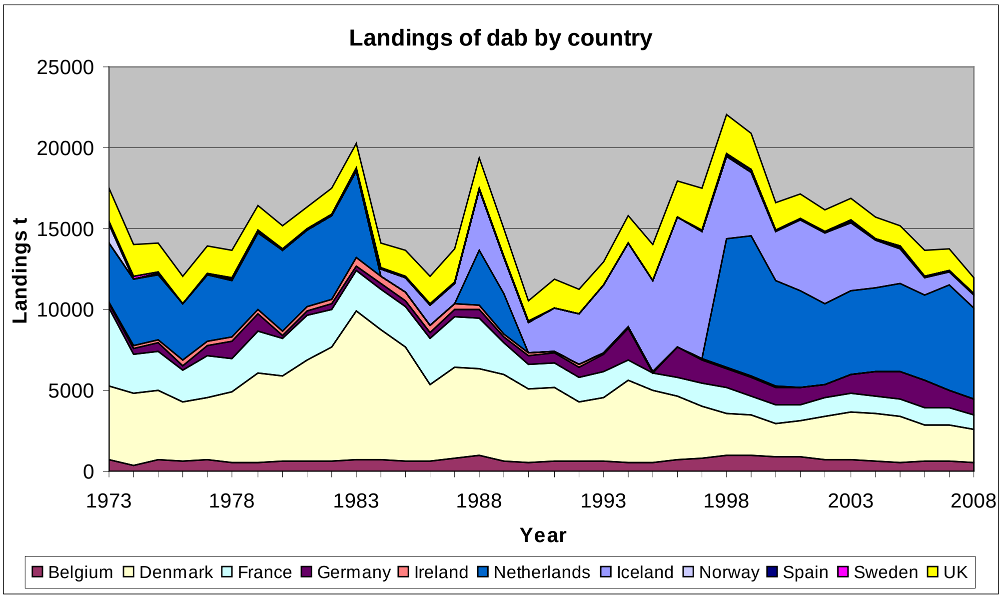


**Figure 8-3. Dab landings by country**

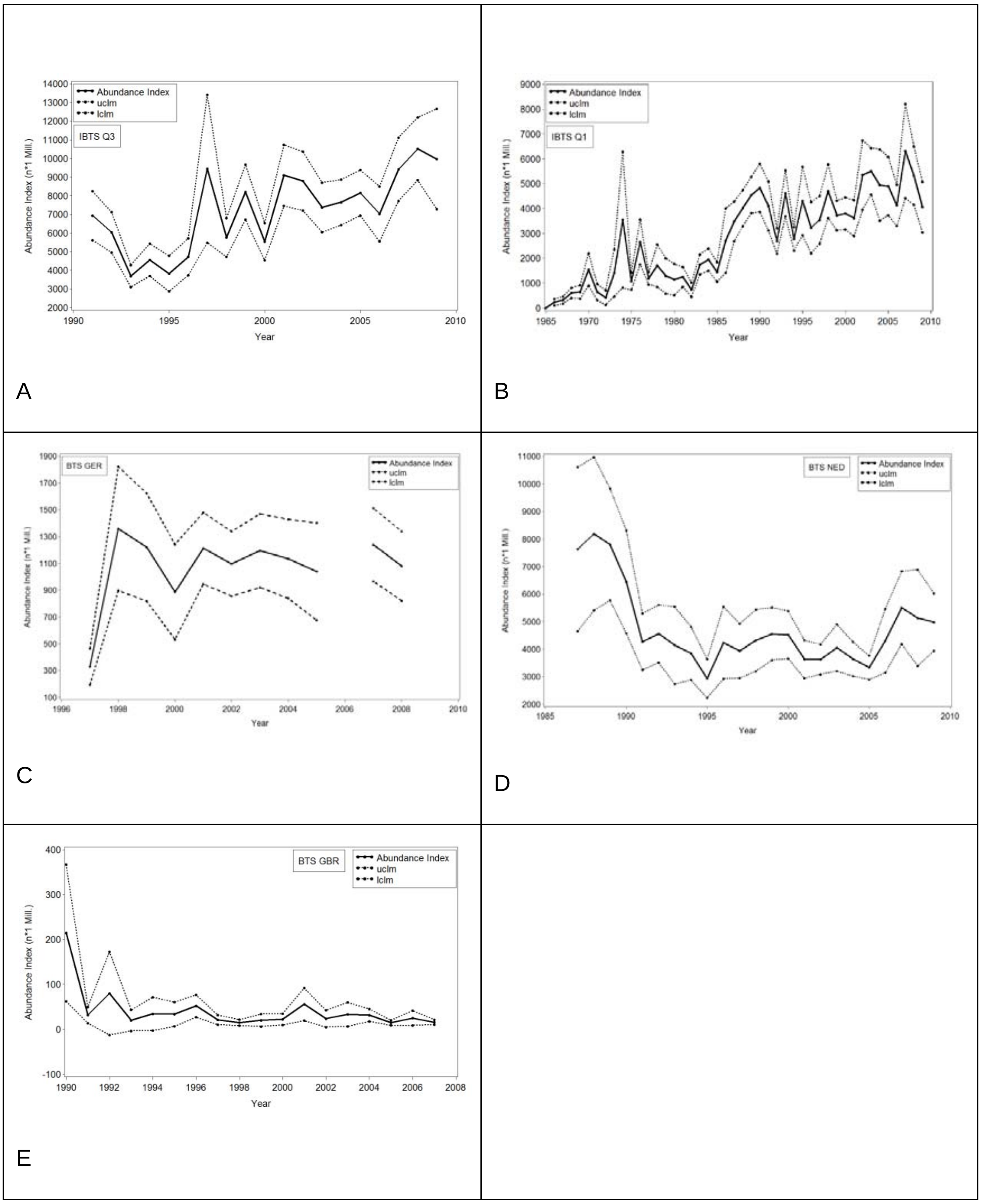


**Figure 8-4. North Sea dab abundance indices (n*1 Mill) for IBTS Q3 (A), IBTS Q1 (B), German (C), Dutch (D) and British BTS (E). Confidence intervals (CI) were set at the 95% level of significance of the stratified mean.**

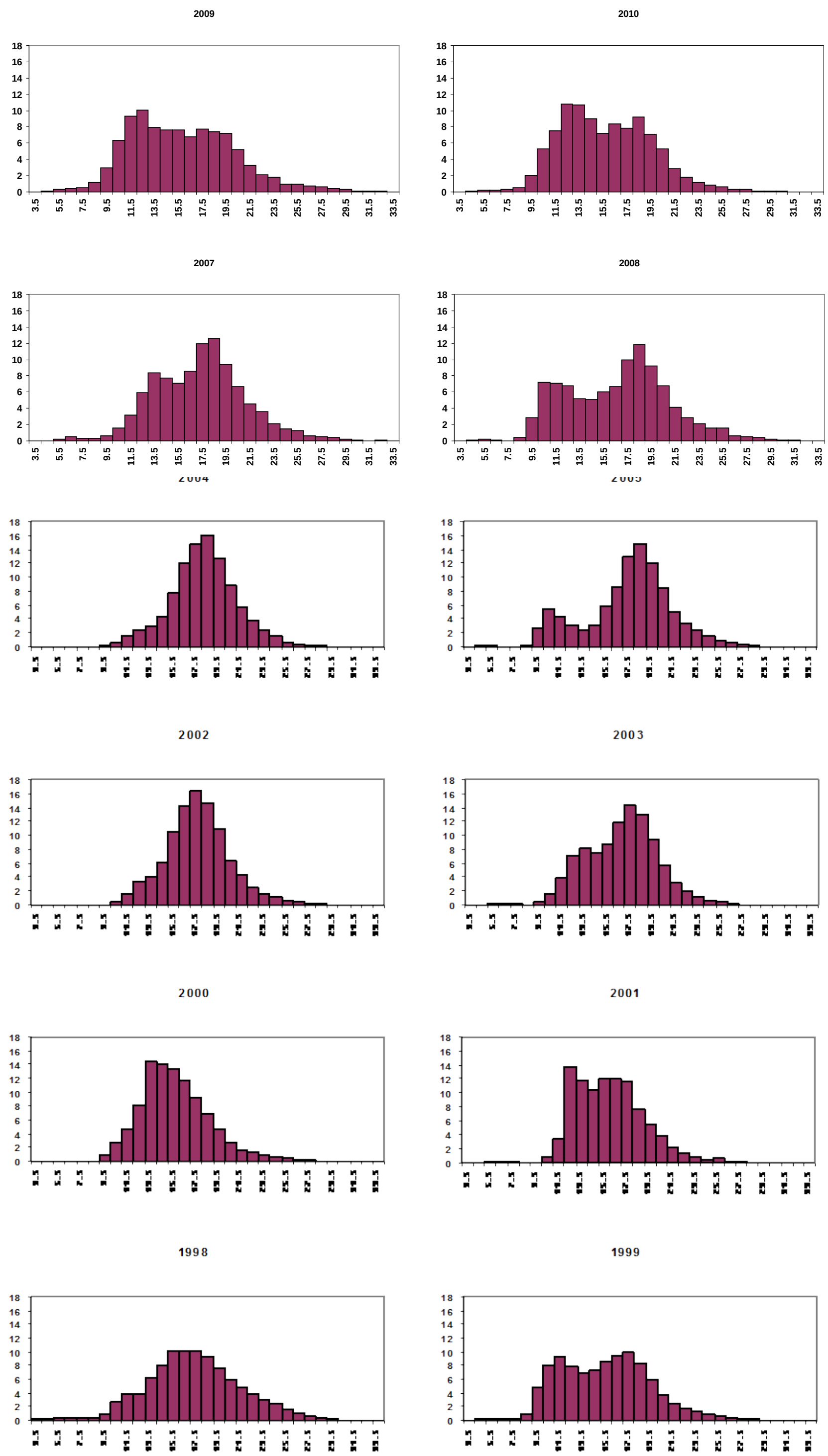


**Figure 8-5. Length-frequency distribution (LFD) of dab from the German BTS, ICES area IVb. Frequency in %.**

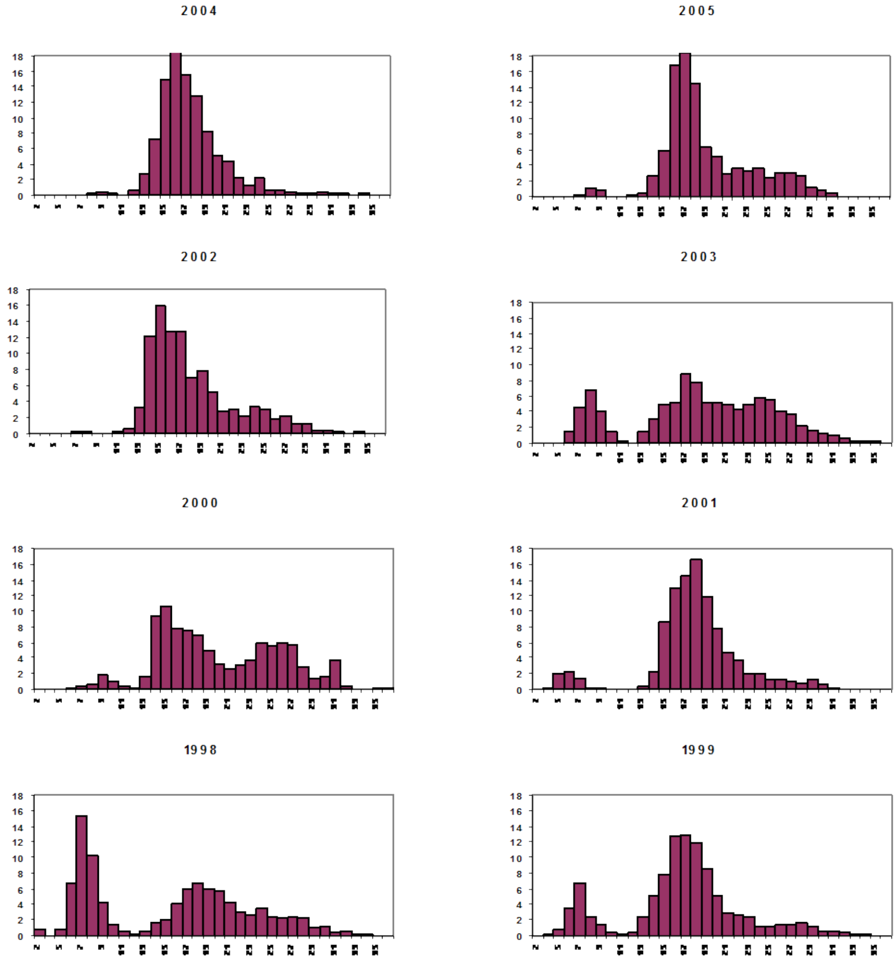


**Figure 8-6. LFD from the French Q4 survey, ICES area VII d,e. Frequency in %.**

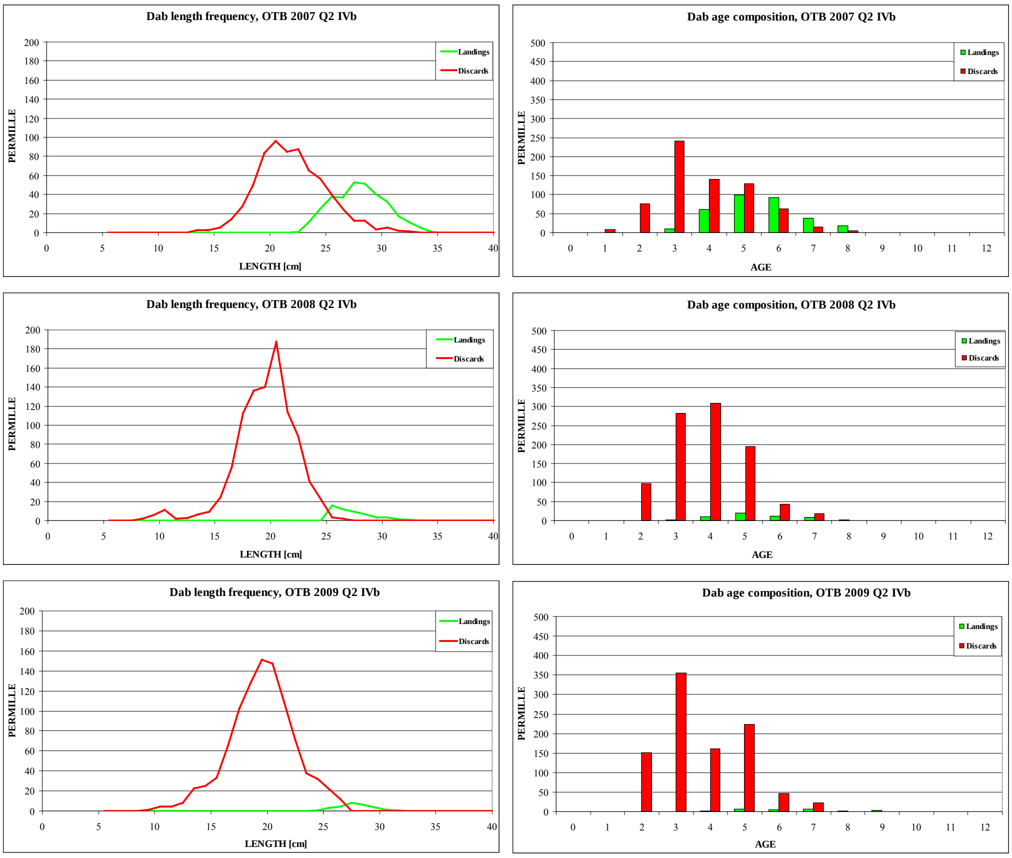


**Figure 8-7. LFD of catches from 2007 to 2009, Q2 by gear OTB. From German DCR program.**

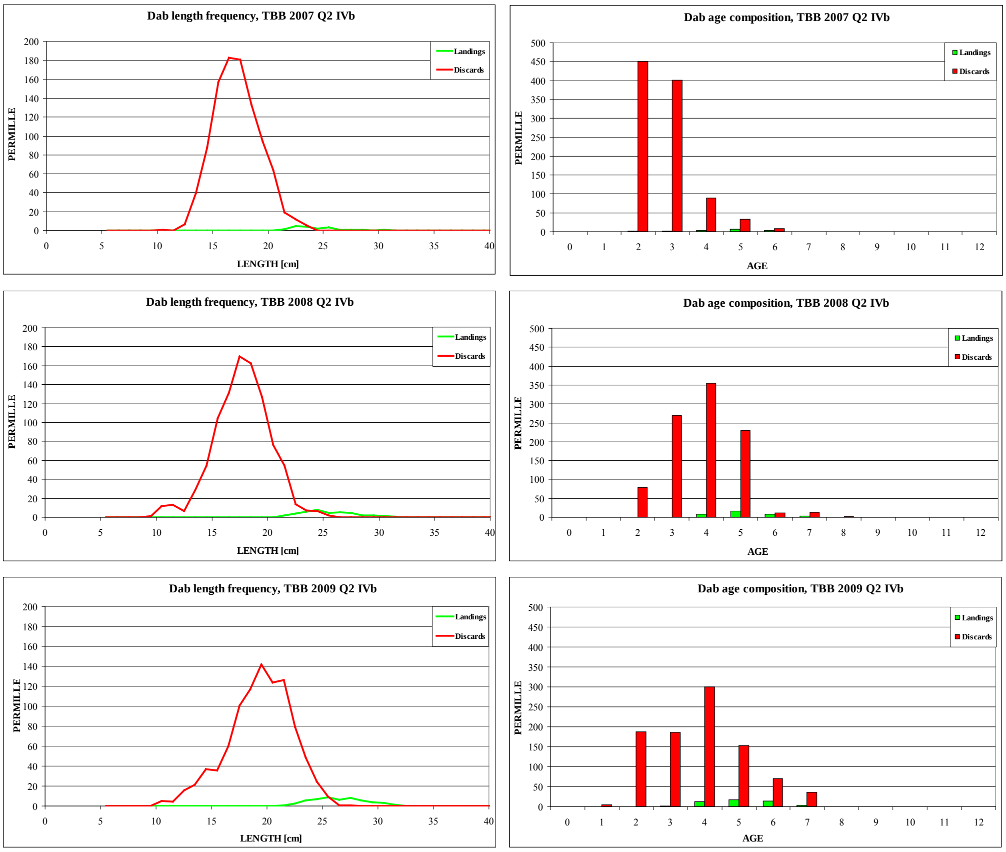


**Figure 8-8. LFD of catches from 2007 to 2009, Q2 by gear TBB. From German DCR program.**

# Annex 9 – Flounder in IV and IIIa

## 1.1 General biology

Flounder (*Platichthys flesus*) is a euryhaline flatfish: the life cycle of each individual usually includes marine, brackish, and freshwater habitats. It has a coastal distribution in the Northeast Atlantic, ranging from the White Sea and the Baltic in the north, to the Mediterranean and Black Sea in the south (Whitehead *et al.* 1986). Flounder can live in low salinity water but they reproduce in water of higher salinity. In the North Sea, Skagerrak and Kattegat flounder spawn between February and April. In the Baltic, spawning is later, further to the east and to the north.

Flounder settle at a size of 8-10 mm. The bottom-living stages appear by the end of April in brackish water near river mouths. The juveniles either stay in the brackish environment or migrate further up the rivers.

Flounder is a good example of a fish species that shows increasing growth in length and especially in weight with increasing salinity. Growth also increases with temperature and, in a laboratory experiment, 0- group flounder from the North Sea had an optimum growth at a temperature of 20 °C. Males reach a smaller size than females and are more numerous in the younger age classes.

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 (Van Leeuwen & Vethaak, 1988). Females mature at an age of 3 to 4 years.

Flounder 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 (Rijnsdorp & Vethaak 1989). The most intensive feeding occurs in the summer, while food is sparse in the winter. Investigations from the Kiel Bay and Gdansk Bay suggest that they do not feed during spawning.

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 (Rijnsdorp & Vethaak 1989). The pelagic eggs are found off the continental coasts mostly in February (Van der Land 1991). The pelagic larvae enter the western Wadden Sea during April – May (Van der Veer & Groenewold 1987). 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 (Vethaak 1992).

## 1.2 Stock identity and possible assessment areas

There is no information about stock identity and possible stock assessment areas in the North Sea, Skagerrak and Kattegat. Flounder is mainly found in the southeastern North Sea, in the Skagerrak and in the Kattegat (Figure 9-1)

## 1.3 Management regulations

There is no minimum landing size for this species in EC waters.

In the EC waters of IIa and IV there is a combined TAC for flounder and dab. Since 2006 this TAC was:

| | |
|---|---|
| 2006 | 17,100 t |
| 2007 | 17,100 t |
| 2008 | 18,810 t |
| 2009 | 18,810 t |
| 2010 | 18,810 t |

## 1.4 Fisheries data

Landings by ICES Division and by country are shown in Table 9-1 and 9-2 and in Figures 9-2 and 13.3. In the early 1970s there has probably been some misreporting from Divisions I and II. The majority of the landings are from the Baltic and from the North Sea. From Figure 9-3 it can be seen that the landings data are not complete: Poland, e.g. only started reporting flounder in recent years, whereas there is a gap in Dutch landings data from 1984 to 1997.

Since the early 1900’s, annual landings form the North Sea have fluctuated between 1000 and 4000 t (Figure 9-4), without a clear pattern. Flounder is of relatively little commercial importance in the North Sea and the Kattegat, but its importance in the Baltic is considerable (Figure 9-2). In the North Sea and the Kattegat the landings data may be influenced by misreporting in years that quota for more important species are limited. The amount of misreporting however is not known. In addition, the North Sea landings may not reflect the catches very well, as the landings may be influenced by the prices and the availability of other, commercially more important, (flatfish) species.

Data on discards by the Dutch beam trawl fleet are shown in Figure 9-5. The impression is that discarding varies considerably, depending on availability of the main target species and market prices.

## 1.5 Survey data, recruit series

Several surveys in the North Sea, Skagerrak and Kattegat provide information on distribution, abundance and length composition of flounder. Most relevant for flounder is probably the International Bottom Trawl Survey IBTS in quarter 1 (Figure 9-6). The surveys in quarter 3 (IBTS and BTS) are in a time of year that flounder are more concentrated in coastal waters (Figure 9-6). The Demersal Fish Survey DFS (in quarter 3&4,) carried out in the coastal zone and estuaries, targets 0- and 1-group of sole and plaice and nicely illustrates the importance of the shallow continental waters as a nursery for this species (Figure 9-7).

North Sea length frequency distributions for IBTS (quarter 1) and DFS (quarter 3&4) are presented in Figures 9-8 and 9-9. Only in some years a recruiting year class can clearly be seen, as e.g. in 1987 and in 1996. The catches in the Wadden Sea mainly consist of 0-group (5 to 13 cm) and 1-group (14 to 25 cm) fish. Average length frequency distributions for different North Sea surveys are shown in Figure 9-10.

Time series of abundance are shown in Figure 9-11. The abundance of North Sea flounder in the quarter 1 IBTS survey increased slightly between 1980 and 1990, and decreased again. Abundance was low in the years 1999 to 2003. In the most recent three years (2008 to 2010) the abundance of flounder in the North Sea was unusually high (Fig. 13.11 upper panel). In the Wadden Sea 1-group fish was slightly more abundant than 0-groups from 1980 to 1986. Since then the incoming year-class outnumbers the one year older fish. Yars with high recruitment are not always followed by years with high numbers of 1-group fish (Fig. 13.11 lower panel). More detailed data on flounder catches during surveys may be found in ter Hofstede *et al.* (2010).

Some additional information for flounder in the Skagerrak and Kattegat is presented in Figures 9-12 and 9-13. Figure 9-12 shows the numbers at length for the quarter 1 IBTS in the years 1980 to 2009, while Figure 9-13 gives the trend in overall abundance (all length classes combined). Note that the abundance here is much higher than in the North Sea. No trend is apparent from this time series.

## 1.6 Biological sampling

Length information from UK market sampling for this species is available for 2000 – 2001 only. Biological sampling for otoliths, weight, sex and maturity is only available for 2000. A summary of the number of samples available is given in WGNEW-2007. The otoliths collected have not been aged.

In 2009 the Netherlands started the collection of market samples under the DCF. In all, 3772 specimens were measured (from 51 samples) and otoliths and biological data were collected from 866 specimens (from 18 samples). For 2010 the collection of 36 length samples (60 fish each) and 18 age samples (50 fish each) is planned.

The Netherlands collect biological samples for flounder routinely during a number of flatfish surveys (DFS, SNS and BTS).

## 1.7 Population biological parameters and other research

Van Overzee (2010) analysed survey data for the Netherlands. She gives length-weight relationships for females and males based on survey data:

females: $y = 0.0242 * x^{2.78}$ males: $y = 0.0239 * x^{2.77}$

$T_0$ was set at 0 years. $L_\infty$ was estimated at 36.18 cm for females and 29.58 cm for males.

K for females was found to be 0.7234 and for males this was 1.036.

## 1.8 Analyses of stock trends / assessment

Time series that could be used to describe the state of the flounder in the North Sea would be the landings, abundance during IBTS1 surveys, and information on recruitment would be provided by DFS survey in the Wadden Sea. Landings data are not complete, and probably not always indicative of catches. The IBTS1 uses a bottom trawl which is not very well suited to catch demersal flatfishes. The BTS survey(s) are carried out in quarter 3, in a time of year in which flounder is usually distributed in more coastal, shallow and brackish waters. BTS catches are therefore not necessarily a good indicator of the stock size.

Surveys in shallow waters in the continental zone do catch juvenile flounder but it is not yet clear that the abundance of 0- and 1-group flounder are indicative of the year-class strength of older age-groups.

The abundance of North Sea flounder in the quarter 1 IBTS is shown in Figure 9-11 for the period 1980-2010. This graph suggests an increase in abundance from 1977 to a maximum in the late 1980s, followed by a gradual decrease. In the three most recent years abundance was exceptionally high.

## 1.9 Data requirements

For flounder in the North Sea, at this moment, only the Netherlands collect biological data under the DCF. For 2010 a sampling level of 900 otoliths from commercial landings is planned. In addition data are being collected during surveys. For 2011 to 2013 the collection of biological data is foreseen for 450 fish annually, for surveys and commercial landings combined. It may be clear that sampling effort for this species is at a very low level. In order to follow the developments in the North Sea stock more closely, an increase in sampling intensity should be considered.

## 1.10 References

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Hofstede, R. ter, H.J.L. Heessen and I. de Boois 2010. Analysis of survey data. In: Heessen, H.J.L. 2010. Final Report NESPMAN. Improving the knowledge of the biology and the fisheries of the new species for amanagement. http://ec.europa.eu/fisheries/documentation/studies/nespman/index_en.htm , IMARES Report C089/10, p 9-36.

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Vethaak, D. 1992. Diseases of flounder (*Platichthys flesus* L.) in the Dutch Wadden Sea, and their relation to stress factors. Netherlands Journal of Sea Research 29(1-3): 257-272.

**Table 9-1: Landings (t) of flounder by country**

| | BEL | DEN | EST | FIN | FRA | GER | IRL | LAT | LIT | NET | NOR | POL | POR | RUS | SPA | SWE | UK | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1974 | 126 | 7097 | 0 | 55 | 0 | 2818 | 0 | 0 | 0 | 2677 | 0 | 0 | 358 | 0 | 0 | 639 | 327 | 14097 |
| 1975 | 76 | 5484 | 0 | 181 | 0 | 2663 | 0 | 0 | 0 | 2199 | 0 | 0 | 286 | 0 | 1279 | 662 | 264 | 13094 |
| 1976 | 97 | 4044 | 0 | 200 | 0 | 3240 | 0 | 0 | 0 | 2089 | 0 | 0 | 177 | 0 | 1270 | 594 | 262 | 11973 |
| 1977 | 111 | 3719 | 0 | 203 | 0 | 3916 | 51 | 0 | 0 | 1773 | 0 | 0 | 47 | 0 | 2358 | 474 | 330 | 12982 |
| 1978 | 124 | 5434 | 0 | 390 | 68 | 3471 | 0 | 0 | 0 | 1549 | 0 | 0 | 8 | 0 | 54 | 410 | 437 | 11945 |
| 1979 | 131 | 6063 | 0 | 399 | 151 | 3265 | <0.5 | 0 | 0 | 1273 | 0 | 0 | 0 | 0 | 0 | 415 | 495 | 12192 |
| 1980 | 191 | 5002 | 0 | 622 | 140 | 3379 | 0 | 0 | 0 | 813 | 0 | 0 | 0 | 0 | 0 | 430 | 422 | 10999 |
| 1981 | 164 | 5268 | 0 | 648 | 98 | 3456 | 0 | 0 | 0 | 1072 | 0 | 0 | 0 | 0 | 41 | 374 | 344 | 11465 |
| 1982 | 111 | 4521 | 0 | 620 | 77 | 3932 | 0 | 0 | 0 | 1599 | 0 | 0 | 0 | 0 | 166 | 218 | 400 | 11644 |
| 1983 | 88 | 5949 | 0 | 609 | 159 | 4511 | 0 | 0 | 0 | 2063 | 0 | 0 | 0 | 0 | 437 | 305 | 386 | 14507 |
| 1984 | 274 | 6670 | 0 | 613 | 122 | 3587 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 400 | 359 | 12029 |
| 1985 | 166 | 4475 | 0 | 607 | 120 | 3852 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 213 | 312 | 9747 |
| 1986 | 158 | 5190 | 0 | 667 | 389 | 3205 | 13 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 314 | 354 | 10292 |
| 1987 | 134 | 3787 | 0 | 673 | 136 | 2408 | 15 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 258 | 427 | 7848 |
| 1988 | 164 | 3950 | 1062 | 592 | 144 | 3327 | 29 | 383 | 179 | 682 | 0 | 0 | 0 | 0 | 0 | 315 | 366 | 11193 |
| 1989 | 202 | 3810 | 424 | 593 | 145 | 3974 | 14 | 513 | 200 | 918 | 0 | 0 | 0 | 0 | 0 | 298 | 294 | 11385 |
| 1990 | 155 | 4035 | 368 | 724 | 225 | 2039 | 29 | 505 | 156 | 1 | 0 | 0 | 0 | 0 | 0 | 239 | 231 | 8707 |
| 1991 | 272 | 3612 | 236 | 740 | 240 | 3172 | 17 | 466 | 141 | 16 | 0 | 0 | 0 | 0 | 0 | 203 | 329 | 9444 |
| 1992 | 170 | 2799 | 164 | 1072 | 178 | 2056 | 17 | 691 | 9 | 31 | 0 | 0 | 0 | 0 | 0 | 269 | 310 | 7766 |
| 1993 | 213 | 4031 | 165 | 1092 | 139 | 1630 | 17 | 501 | 120 | 35 | 0 | 0 | 0 | 0 | 0 | 210 | 276 | 8429 |
| 1994 | 223 | 3585 | 162 | 564 | 175 | 6018 | 19 | 329 | 262 | 0 | 0 | 0 | 0 | 0 | 0 | 275 | 383 | 11995 |
| 1995 | 348 | 4235 | 102 | 575 | 209 | 4488 | 24 | 362 | 194 | 0 | 0 | 0 | 0 | 0 | 0 | 459 | 388 | 11384 |
| 1996 | 278 | 5469 | 297 | 715 | 238 | 1637 | 13 | 294 | 330 | 0 | 0 | 0 | 0 | 0 | 74 | 1262 | 357 | 10964 |
| 1997 | 146 | 5378 | 333 | 702 | 223 | 2449 | 13 | 367 | 624 | 0 | 0 | 0 | 0 | 0 | 319 | 1073 | 379 | 12006 |
| 1998 | 307 | 4725 | 355 | 555 | 163 | 2159 | 13 | 364 | 736 | 4942 | 0 | 0 | 0 | 0 | 873 | 526 | 293 | 16011 |
| 1999 | 363 | 3528 | 416 | 558 | 204 | 2347 | 13 | 509 | 571 | 3159 | 0 | 0 | 0 | 0 | 323 | 274 | 149 | 12414 |
| 2000 | 322 | 4604 | 419 | 449 | 221 | 2782 | 12 | 418 | 618 | 2658 | 5 | 0 | 0 | 1392 | 88 | 341 | 201 | 14530 |
| 2001 | 316 | 6026 | 482 | 500 | 243 | 2349 | 18 | 613 | 0 | 2621 | 4 | 0 | 0 | 1351 | 139 | 467 | 148 | 15277 |
| 2002 | 230 | 5143 | 515 | 228 | 287 | 2385 | 19 | 599 | 0 | 3530 | 3 | 0 | 6 | 1314 | 21 | 357 | 172 | 14809 |
| 2003 | 262 | 3562 | 442 | 193 | 285 | 1737 | 43 | 673 | 0 | 3172 | 9 | 0 | 30 | 1402 | 37 | 270 | 258 | 12375 |
| 2004 | 410 | 4525 | 406 | 118 | 285 | 1914 | 41 | 769 | 0 | 3723 | 18 | 8739 | 17 | 1277 | 31 | 211 | 156 | 22640 |
| 2005 | 295 | 3852 | 403 | 104 | 214 | 1025 | 5 | 1713 | 0 | 3364 | 38 | 11135 | 16 | 1400 | 79 | 310 | 191 | 24144 |
| 2006 | 227 | 3372 | 352 | 97 | 241 | 1018 | 7 | 1163 | 376 | 4021 | 39 | 9427 | 14 | 1237 | 41 | 181 | 344 | 22157 |
| 2007 | 343 | 2650 | 335 | 96 | 185 | 2350 | 5 | 1056 | 361 | 2927 | 11 | 10693 | 13 | 1328 | 19 | 193 | 237 | 22802 |
| 2008 | 345 | 2047 | 324 | 84 | 111 | 2515 | 2 | 651 | 665 | 2233 | 4 | 9111 | 9 | 980 | 13 | 225 | 166 | 19485 |

**Table 9-2: Landings (t) of flounder by ICES division**

| Year | ICES Division | | | | | | | | | | | Grand |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | IIIa | IIIb-d | IV | V | VI | VII | VIII | IX | XIV | TOTAL |
| 1974 | 18 | 0 | 1658 | 7906 | 3790 | 0 | 35 | 227 | 0 | 358 | 0 | 14081 |
| 1975 | 579 | 986 | 1467 | 12069 | 2939 | 5 | 31 | 149 | 0 | 0 | 0 | 18225 |
| 1976 | 8393 | 2735 | 1099 | 13691 | 3079 | 1 | 40 | 176 | 0 | 0 | 64 | 29278 |
| 1977 | 8524 | 3473 | 1119 | 16317 | 2505 | 0 | 55 | 218 | 0 | 1 | 0 | 32212 |
| 1978 | 9025 | 6060 | 1648 | 9892 | 2211 | 5 | 44 | 232 | 45 | 0 | 0 | 29162 |
| 1979 | 0 | 0 | 1319 | 9230 | 2077 | 3 | 41 | 343 | 6 | 0 | 0 | 13019 |
| 1980 | 0 | 0 | 561 | 8329 | 1698 | 3 | 19 | 326 | 22 | 0 | 0 | 10958 |
| 1981 | 0 | 0 | 1905 | 8625 | 2248 | 0 | 11 | 267 | 14 | 0 | 0 | 13070 |
| 1982 | 0 | 166 | 1311 | 9104 | 2689 | 0 | 17 | 299 | 3 | 0 | 0 | 13589 |
| 1983 | 0 | 437 | 2512 | 9550 | 3069 | 14 | 11 | 350 | 24 | 0 | 0 | 15967 |
| 1984 | 0 | 0 | 2746 | 7637 | 1030 | 0 | 18 | 306 | 18 | 0 | 0 | 11755 |
| 1985 | 0 | 0 | 1305 | 8252 | 793 | 0 | 19 | 280 | 12 | 0 | 0 | 10661 |
| 1986 | 0 | 0 | 1751 | 7901 | 814 | 0 | 10 | 330 | 295 | 0 | 0 | 11101 |
| 1987 | 0 | 0 | 1169 | 7037 | 754 | 0 | 10 | 417 | 31 | 0 | 0 | 9418 |
| 1988 | 0 | 0 | 1313 | 7900 | 1598 | 0 | 13 | 391 | 3 | 0 | 0 | 11218 |
| 1989 | 0 | 0 | 1129 | 8733 | 1951 | 0 | 18 | 296 | 26 | 0 | 0 | 12153 |
| 1990 | 0 | 0 | 708 | 7138 | 881 | 0 | 9 | 327 | 24 | 0 | 0 | 9087 |
| 1991 | 0 | 0 | 624 | 6321 | 1659 | 0 | 3 | 432 | 17 | 0 | 0 | 9056 |
| 1992 | 0 | 0 | 507 | 4541 | 1276 | 0 | 6 | 365 | 12 | 0 | 0 | 6707 |
| 1993 | 0 | 0 | 743 | 3732 | 2545 | 0 | 5 | 239 | 10 | 0 | 0 | 7274 |
| 1994 | 0 | 0 | 943 | 8377 | 2063 | 0 | 13 | 257 | 22 | 0 | 0 | 11675 |
| 1995 | 0 | 0 | 498 | 8228 | 2125 | 0 | 4 | 285 | 23 | 0 | 0 | 11163 |
| 1996 | 0 | 0 | 542 | 8130 | 2005 | 0 | 7 | 311 | 43 | 73 | 0 | 11111 |
| 1997 | 0 | 0 | 437 | 9994 | 1290 | 0 | 14 | 423 | 42 | 313 | 0 | 12513 |
| 1998 | 0 | 0 | 725 | 9235 | 5560 | 0 | 9 | 282 | 64 | 832 | 0 | 16707 |
| 1999 | 0 | 0 | 588 | 7963 | 3672 | 198 | 0 | 148 | 4 | 318 | 0 | 12891 |
| 2000 | 0 | 0 | 656 | 10235 | 3165 | 0 | 4 | 320 | 55 | 79 | 0 | 14514 |
| 2001 | 0 | 0 | 705 | 11026 | 3022 | 12 | 2 | 378 | 40 | 129 | 0 | 15314 |
| 2002 | 13 | 0 | 524 | 10153 | 3890 | 0 | 0 | 401 | 38 | 16 | 0 | 15035 |
| 2003 | 0 | 0 | 473 | 7712 | 3637 | 0 | 1 | 482 | 38 | 32 | 0 | 12375 |
| 2004 | 0 | 0 | 478 | 17381 | 4294 | 0 | 0 | 404 | 37 | 45 | 0 | 22639 |
| 2005 | 0 | 0 | 482 | 19283 | 3946 | 0 | 0 | 315 | 30 | 79 | 0 | 24135 |
| 2006 | 0 | 0 | 393 | 16678 | 4614 | 0 | 0 | 390 | 35 | 41 | 0 | 22151 |
| 2007 | 0 | 0 | 445 | 18405 | 3622 | 0 | 0 | 280 | 20 | 27 | 0 | 22799 |
| 2008 | 0 | 0 | 346 | 15988 | 2895 | 0 | 0 | 230 | 7 | 16 | 0 | 19482 |

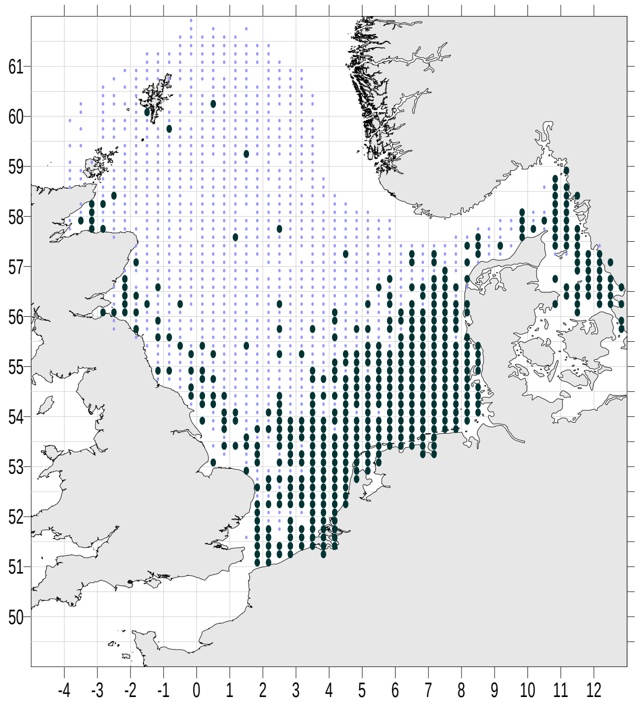



**Figure 9.1: Presence/absence data for flounder in IV and IIIa based on international data from IBTS and BTS surveys and some Dutch flatfish surveys (DFS, SNS)**

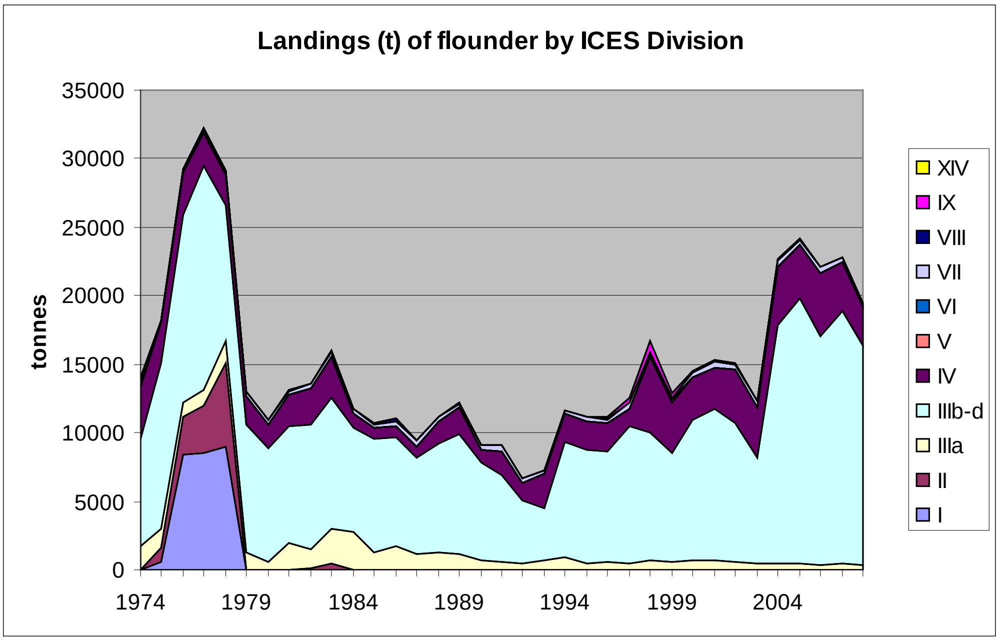



**Figure 9.2: Landings (t) of flounder by ICES Division**

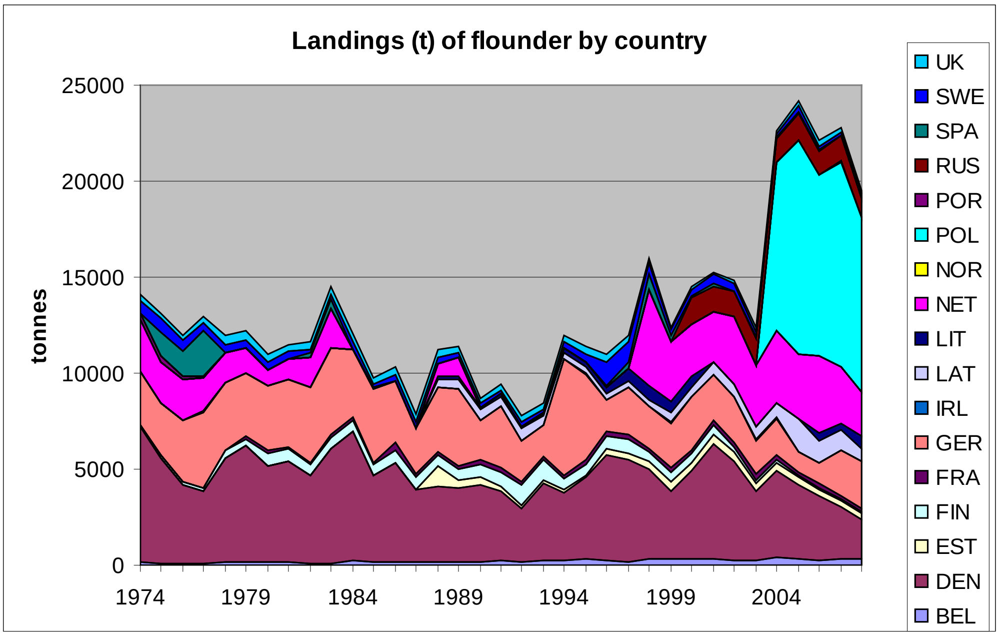



**Figure 9.3: Landings (t) of flounder by country**

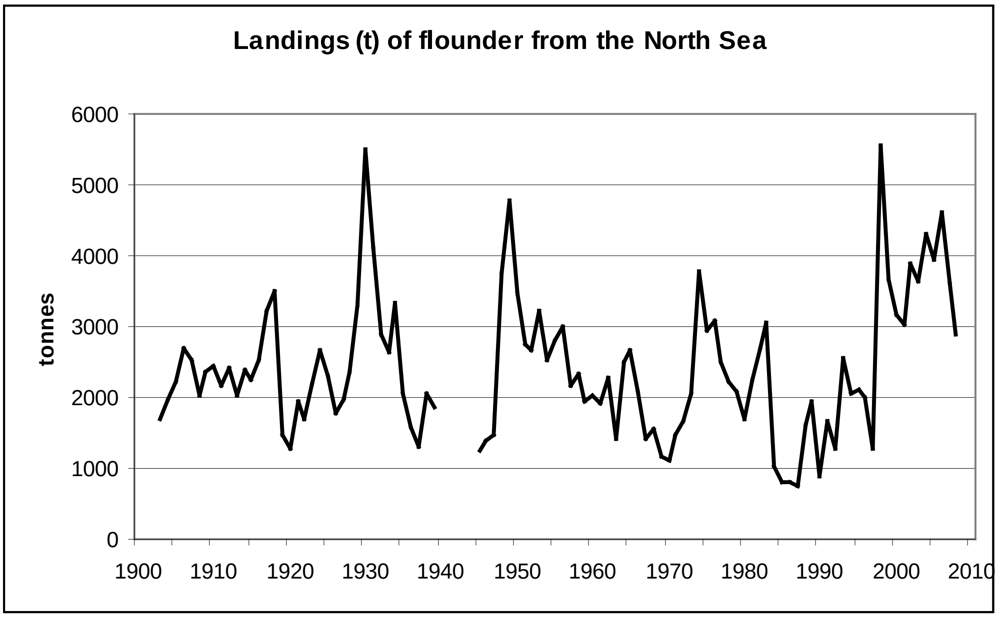



**Figure 9.4: Landings (t) of flounder from the North Sea (IV)**

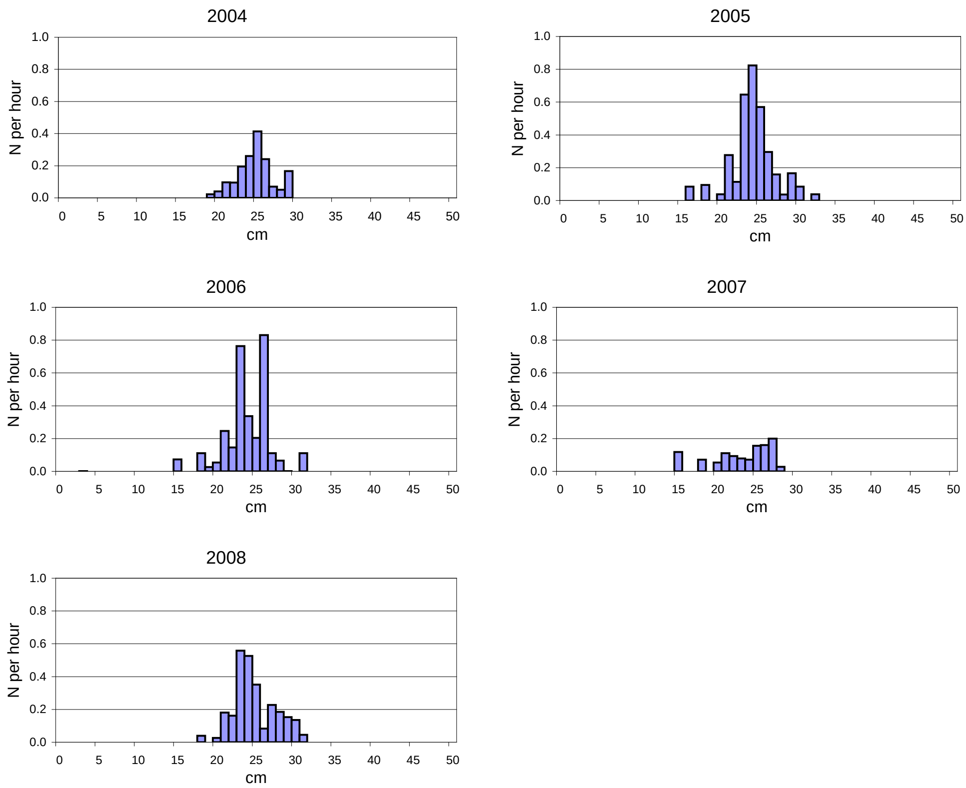



**Figure 9.5: Flounder: number at length discarded per fishing hour in the Dutch beam trawl fishery in the years 2004 to 2008 (from van Helmond & Heessen, 2010)**

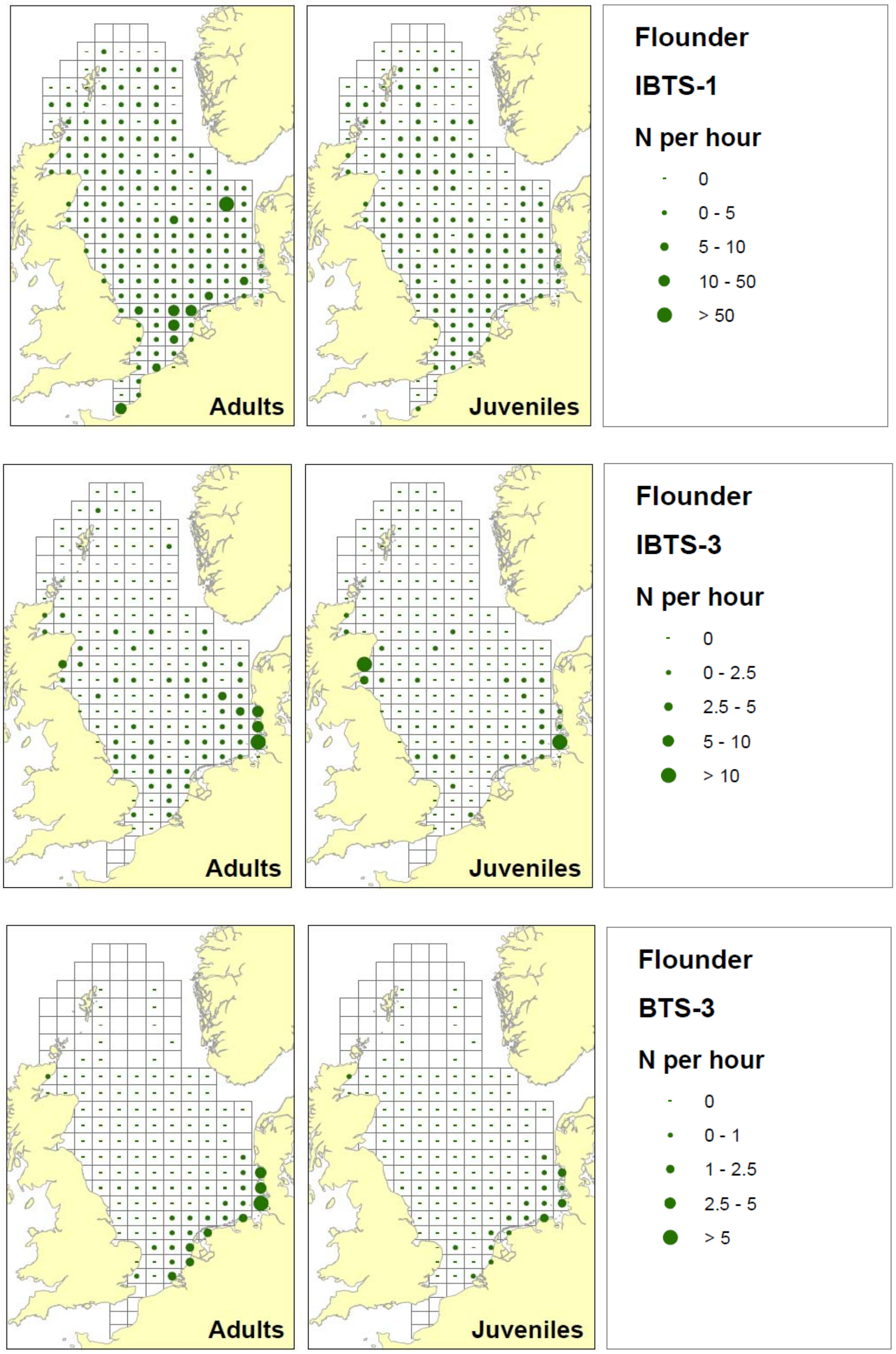



**Figure 9.6: Distribution of adults and juveniles (< 35 cm) of flounder in the IBTS survey (quarter 1 and quarter 3) based on the average for the years 1970-2009, and in the Dutch BTS survey (1985-2008) (from ter Hofstede *et al*. 2010).**

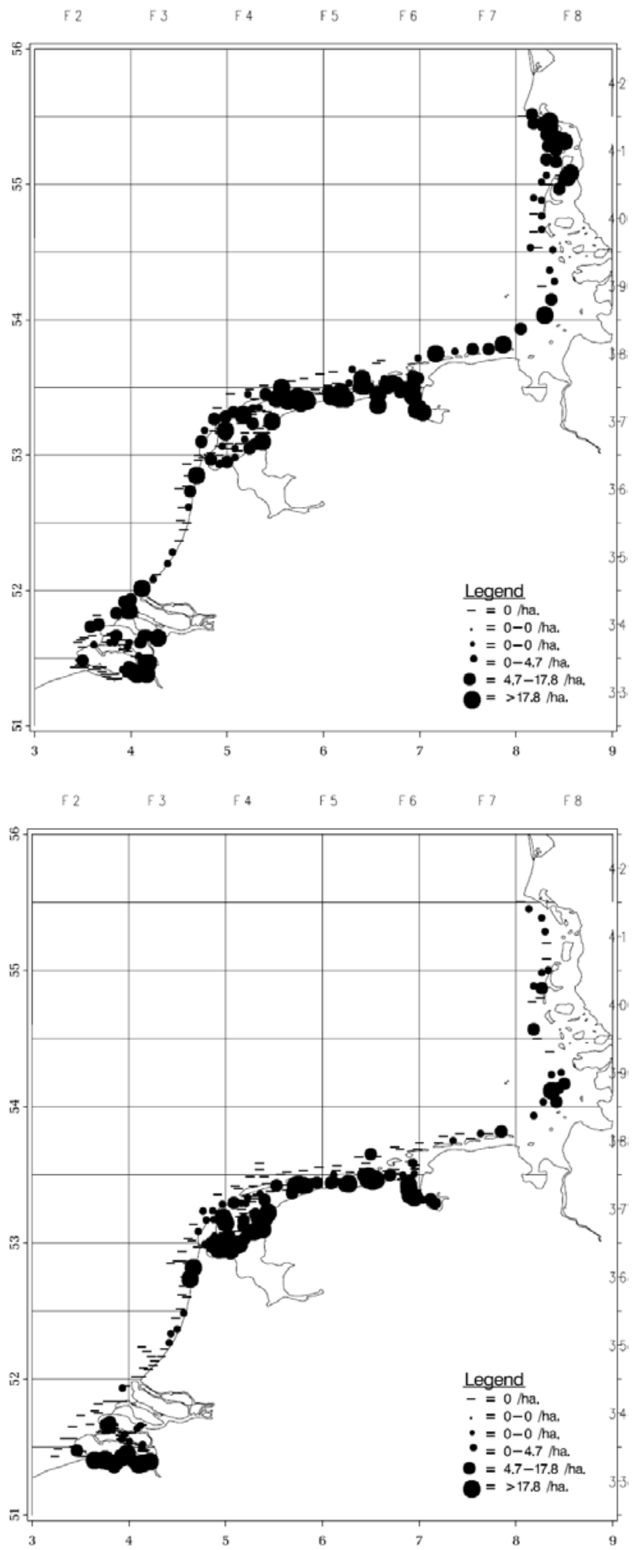



**Figure 9.7: The distribution of juvenile flounder in the coastal zone of the southeastern North Sea in the autumn of 1980 and in 2007 (lower panel). Data from the Dutch Demersal Fish Survey.**

***Platichthys flesus*** **IBTS-1 in roundfish areas 1 to 7**

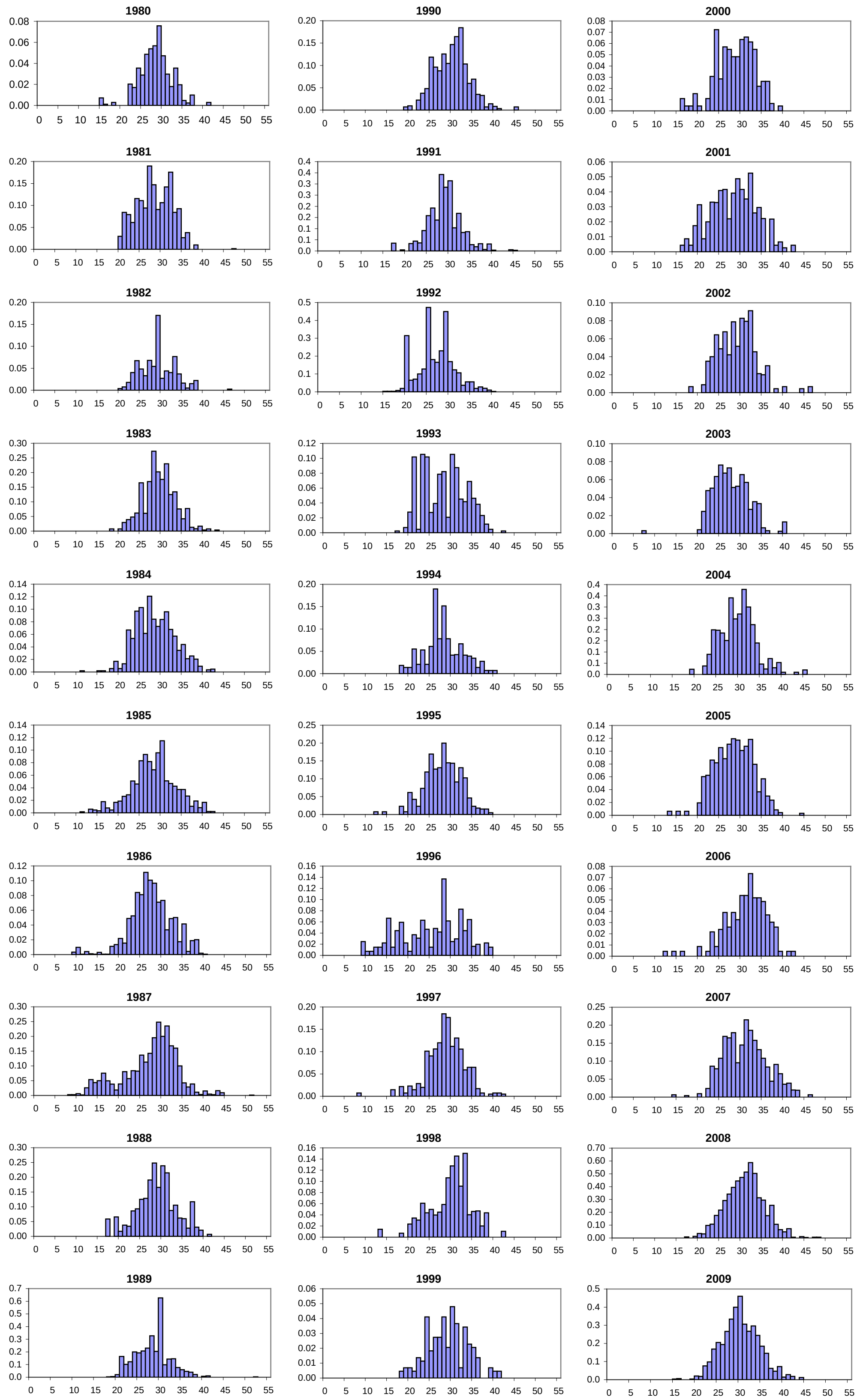



**Figure 9.8: Numbers at length for the quarter 1 IBTS survey in roundfish areas 1 to 7 (area IV) for the years 1980 to 2009. Note that the scales are different.**

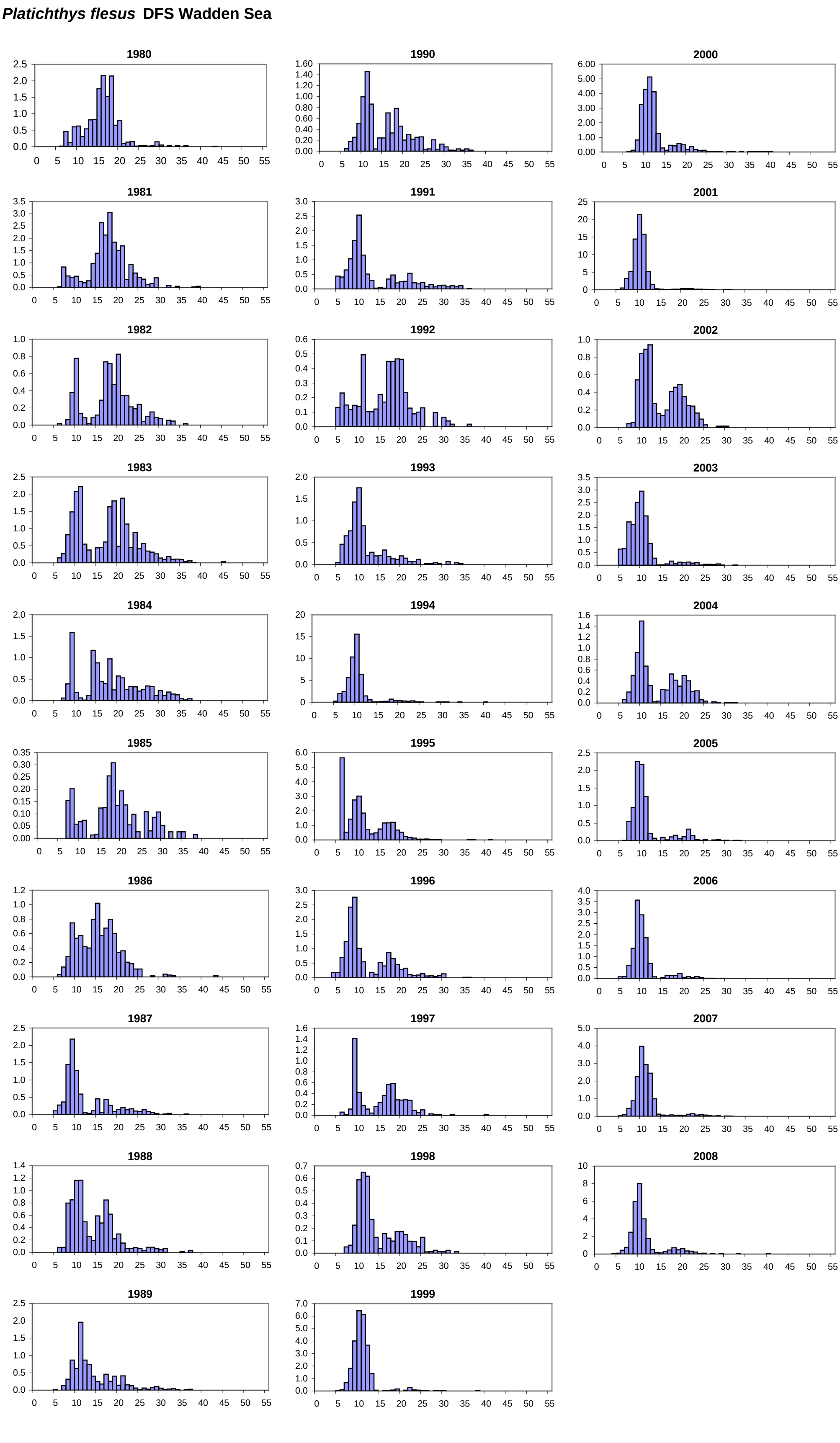



**Figure 9.9: Numbers at length for the quarters 3 to 4 DFS survey in the Dutch part of the Wadden Sea, for the years 1980 to 2008. Note that the scales are different.**

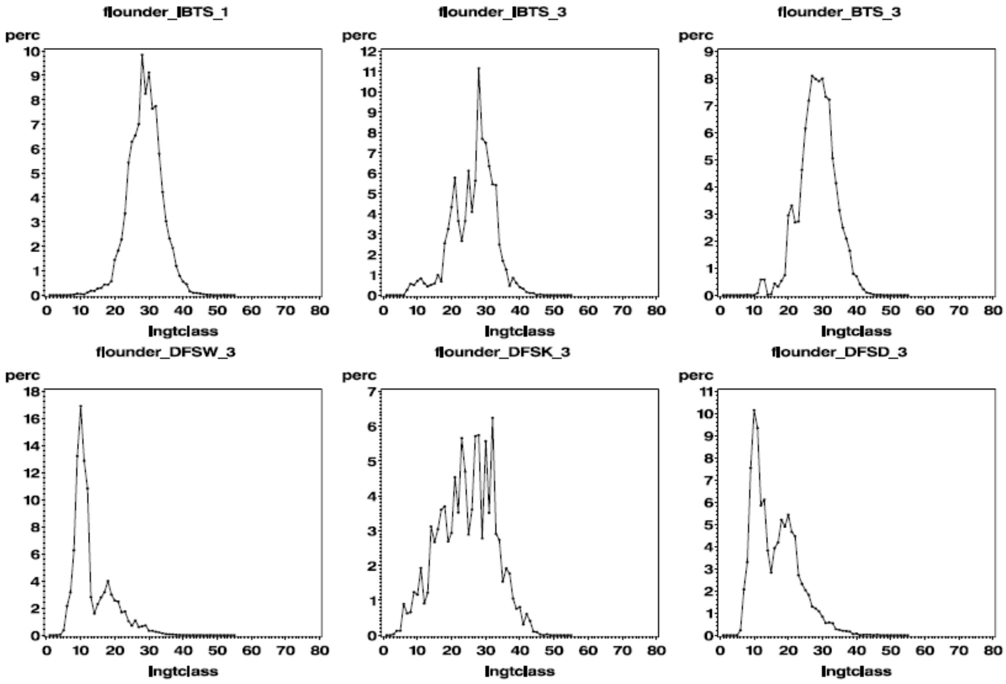
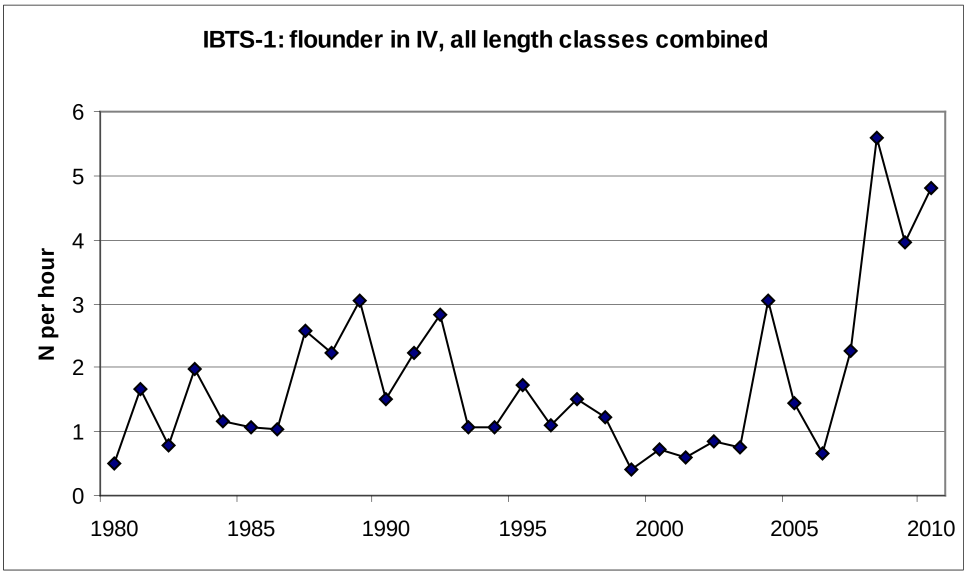



**Figure 9.10: Length frequency distributions (in percentage) of flounder in different surveys. Upper panels from left to right: IBTS-1 (1970-2009), IBTS-3 (1991-2008), BTS-3 Dutch contribution (1985-2008). Lower panels: DFS quarter 3 & 4 (1970-2008) Wadden Sea, Dutch coastal zone, south-western Delta.**



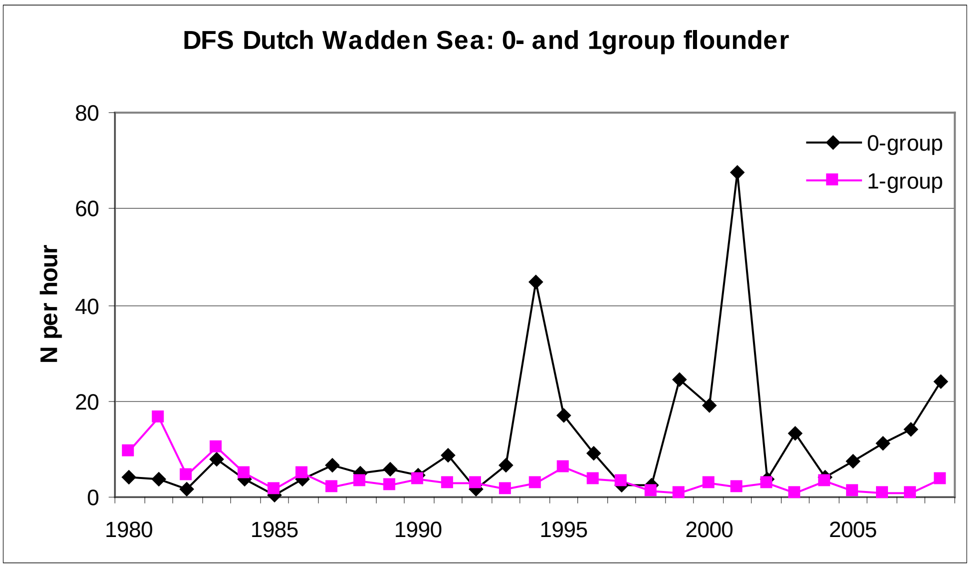




**Figure 9.11: Time series of abundance. Upper panel: IBTS quarter 1 in roundfish areas 1 to 7 (area IV), for all length classes combined. Lower panel: DFS quarter 3&4 in the Dutch Wadden Sea. Length classes 5-13 and 14-25 cm are presumed to represent age groups 0 and 1.**

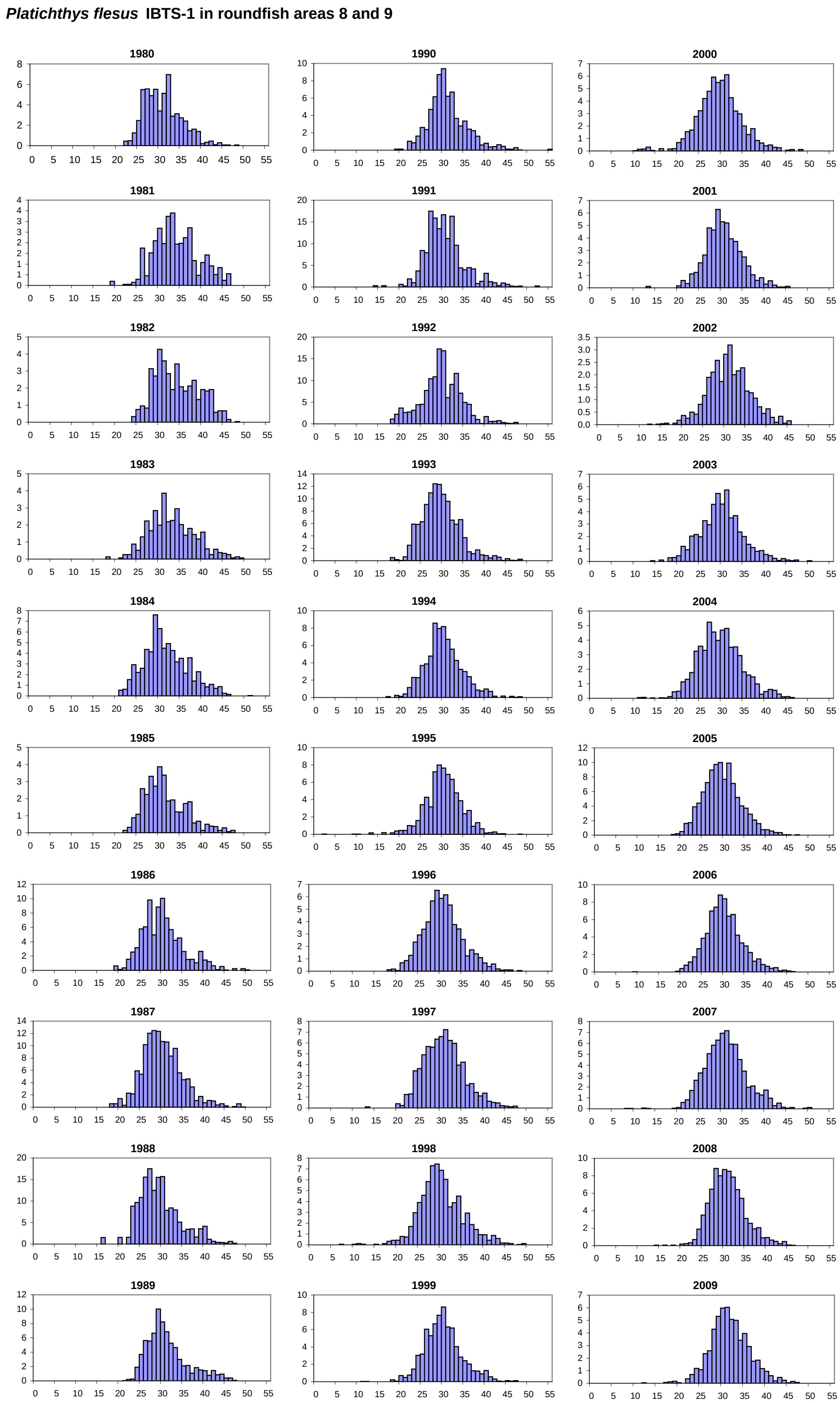



**Figure 9.12: Numbers at length for the quarter 1 IBTS survey in roundfish areas 8 and 9 (area IIIa) for the years 1980 to 2009. Note that the scales are different.**

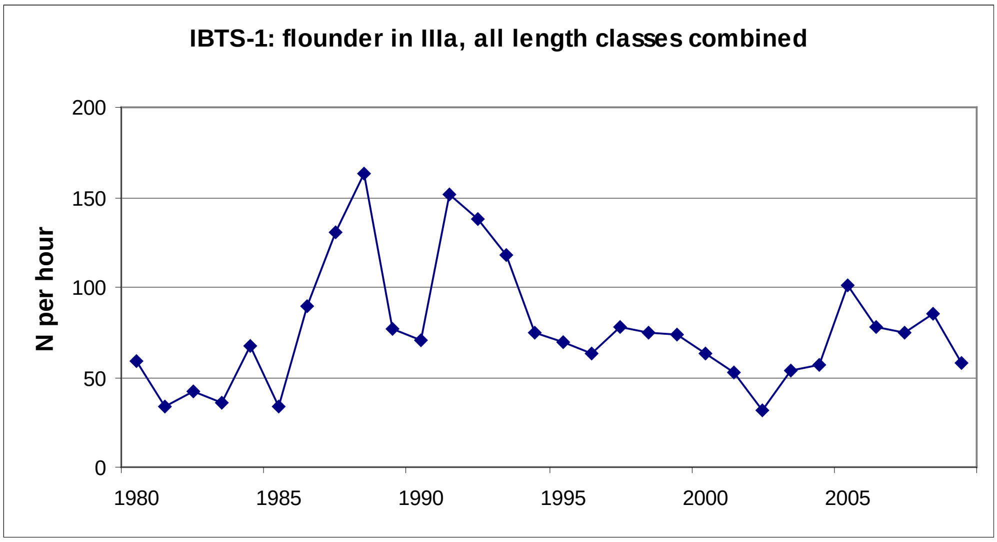



**Figure 9.13: Time series of abundance for IBTS quarter 1 in roundfish areas 8 and 9 (area IIIa),**

## Annex 10 - Witch Flounder in IIIa and IV

### 1.1 General biology

Witch flounder (*Glyptocephalus cynoglossus*) is common in the northern North Sea, west of the British Isles and along the North American east coast. Most of the more recent information published on general biology refers to investigations in the NW Atlantic. On the contrary, the stock in the North Sea has not been intensively investigated and most of the information refers to old studies.

This species is mainly found on soft bottoms, mostly clay, but in some cases clean sandy bottoms (Molander, 1935) and in fairly deep waters, i.e. around 100–400 m. In the North Sea, witch flounder live at depths between 100 and 200 meters primarily in the Norwegian trench and in the northern parts of the North Sea. In Swedish waters they occur in Skagerrak's and Kattegat's deeper parts, most commonly between 150 and 300 meters in Skagerrak and in relatively shallower waters in Kattegat (30-100 meters). It is caught at different depths throughout the year and appear to follow fluctuations in temperature and salinity (Molander, 1935). In autumn, when temperatures rise in deeper waters (100-300 m) witch flounder move to shallower areas (50-150 m), only to return to deeper waters again in late winter/ spring (Molander, 1925). They prefer high salinity (3.5%) and a low (6-7 ° C) uniform temperature. When optimum hydrographical conditions prevail in large areas, such as during spring and summer, it is the availability of food that mainly influences the species distribution. The main diet consists of crustaceans, polychaetes, brittle stars and fishes. According to Molander (1935), there are probably two stocks of witch flounder, one in the Kattegat and one in the North Sea and Skagerrak. The Kattegat stock is considered stationary and no spawning migration occurs. Here spawning generally takes place in October-November. As for the North Sea and Skagerrak stock, the North Sea acts as both a spawning and growth area, while the Skagerrak acts primarily as a nursery/ feeding ground, but spawning can also occur here. Most of the larger individuals migrate from the Skagerrak to shallower waters in the northern North Sea during the spawning season (May-September with peak in June-July). Spawning occurs in shoals in shallow waters (70-100 m) or in mixed shoals (mature and immature individuals) in deeper waters (100-160 m). Age and size at first spawning differs between the North Sea and Skagerrak. In the North Sea witch flounder generally reach maturity at around 5-6 years, which corresponds to a length of around 39 to 50 cm (TL = total length, from the snout to the end of the tail). The Skagerrak stock generally reaches maturity at around 6 -7 years at length between 40 and 54 cm (TL).

Eggs are pelagic and hatch after 7-8 days at 5-7 ° C. Their larval stage is relatively long compared with other flat fish, between 4 months and one year (Bigelow and Schroeder, 1953; Evseenko and Nevinsky, 1973). The larvae are pelagic until they reach a size of approximately 4 cm, then they become demersal (Muus *et al.*, 1997). They can reach a maximum length of approximately 60 cm and weigh up to 2.5 kg (Muus *et al.*, 1997).

The growth rate varies in different parts of the ocean. It is highest in the Kattegat and slowest in the western parts of the Skagerrak and in the Norwegian trench. Growth rate is not uniform within each area and varies with depth; it generally reduces with increased depth. The slower growth rate at greater depths may reflect the fact that they live in sub-optimal conditions. Growth also varies between the sexes. Males grow slightly slower than females (Molander, 1935) or die smaller. They can reach a maximum length of approximately 60 cm and weigh up to 2.5 kg (Muus *et al.*, 1997).

## 1.2 Stock identity and possible assessment areas

A first approach regarding assessment units would be to base these on the ICES Divisions/Sub-divisions associated with the fisheries. However, witch flounder is a rather stationary species and the knowledge about stock identity is little and based on old investigations (Molander 1935). As mentioned above Molander (1935) distinguished 2 stocks in IIIa and IV, one in the Kattegat and one in the North Sea and Skagerrak. However, as already reported by Molander in 1935, catches in the Kattegat are still in very inconsiderable numbers and irregular, only at scattered places at depth between 30 and 100 meters.

## 1.3 Management regulations

As a typical by-catch species, witch flounder has not been subject to any TAC limitations. In 1927 a minimum landing size of 30 cm was introduced and subsequently revoked in 1943. At present Swedish landings are regulated by a minimum landing size of 28 cm.

## 1.4 Fisheries data

### 1.4.1 The witch flounder fishery in the first half of the 1900s

According to data collected by Molander (1925, 1935 and 1947) witch flounder was fished in the early 1900s mainly in the Skagerrak with seines. Landings varied widely during this period. From 1911 to 1916 landings were approximately 200 tonnes per year in Gothenburg’s fishing port. The following three years landings increased dramatically (Figure 10-1). In 1919 1380 tonnes were landed, compared to today's landings of approximately 250 tonnes per year. From 1919 until 1928 the landings decreased steadily despite the fact that the number seiners during the same period rose from 91 in 1919 to 440 in 1931. The average catch per trip in May decreased between 1919 and 1931 from 2 tonnes to 0.3 tonnes (Figure 10-2). Also in April during the same period catch per trip decreased.

In 1927 a minimum size of 30 cm for witch flounder was introduced. This was not reflected in the landings, which increased from 1928 until 1931 and then fluctuate between 800 and 1200 tonnes up to 1939. At the beginning of the Second World War landings declined sharply and varied dramatically during the war. The increase in the early 1930s was however, according to Molander (1947), likely a result of the Swedish fisheries in the North Sea being developed, and not because of increased catches in the Skagerrak. The large landings during 1943 and 1944 were probably due to the minimum size limit of 30 cm being revoked.

In conclusion, the high fishing pressure from 1919 onwards is likely to have negatively impacted the stock as reflected in substantially reduced landings per trip. In comparison with today's witch flounder fishery, landings were approximately threefold as much during the first half of the 1900's, making it difficult to draw parallels to the possible consequences for today’s stock. However it is known that the number of boats in 2000’s is much smaller than during the years studied by Molander. In 2008 only 20 vessels were active in the witch flounder directed fishery. Today’s witch flounder fishery is also much more efficient and a small increase in the number of vessels fishing exclusively for witch flounder would probably have a big impact on the stock.

### 1.4.2 Denmark

The Danish witch flounder landings are taken in Skagerrak (IIIa) and in the Norwegian Deep (IVa East). At present, the majority of the landings are by-catches in mixed demersal trawl fisheries (Figure 10-3 and Table 10-1).

Notice that in this connection 'demersal trawl' includes both Nephrops trawls and trawls for demersal fish. In IIIa these are defined as trawls with a mesh size > 70 mm in the cod-end, while in the North Sea the term covers trawls with mesh sizes > 90 mm in the cod-end. Witch flounder constitutes a stable by-catch component in the Danish shrimp fishery in Skagerrak (trawls with mesh size 35-45 mm). Some of the Danish seine landings of witch come from trips targeting this species. However, the number of such trips has been declining in recent years. The other species caught in the Danish fisheries taking witch flounder are mentioned in the following section on the Swedish fisheries for this species.

### 1.4.3 Sweden

The fisheries where witch flounder are caught, apart from the witch flounder directed fishery, are mainly the *Pandalus*, and demersal fish fisheries, i.e. fishing after demersal and benthic species. Here the fisheries were classified into metiers; the combination of a given fishing gear, targeting a species or species group in a given area (Mesnil and Shepherd, 1990; Laurec *et al.*, 1991; Salas and Gaertner, 2004)). Logbook data from 1991-2008 were used to classify fishing trips into their respective metiers based on gear, mesh size and/ or landing compositions (Figure 4). Notice that fishing trips classified as mixed trips are trips that have performed hauls that have taken place in two of more different metiers.

The definition of the fisheries is problematic because the Swedish demersal fisheries on the west coast are largely among the fisheries that do not focus on a single target species. A tow containing 30% witch flounder may actually be considered as by-catch if the rest of the catch is, for example, cod, and this being the real target species. At the same time, a haul that is meant to capture witch flounder accidentally captures significant amounts of other species and is thus classified in the demersal fish fisheries.

Throughout the study period (1997-2008) approximately 98% of witch flounder landings occurred in the Skagerrak. Landings of witch flounder from all the fisheries in Sweden increased markedly until 2000, where it remained stable until 2005 and then declined significantly to 2008 (Figure 10-5). 2005 was the year when landings of witch flounder were at its peak, approximately 550 tonnes. Landings since 2005 have fallen by more than 50%.

Directed fishery

Of the total landings of witch flounder in 2008, roughly 27% (70 tonnes) came from the witch flounder directed fishery (Figure 10-6). During the mid 2000's when the directed fishery was at its peak the percent was much greater, 50%. The percent from the mixed trips metier has increased in the last three years and now accounts for approximately 40%. Therefore fishing after witch flounder has become a more mixed fishery in the last years compared with what it was in the beginning of the 2000's. From 1997 to 2001 landings increased 178 tonnes and then decreased markedly to 2008, where 70 tonnes were landed.

*Fishing patterns*

Spatial distribution of effort has been analysed using both logbook and vessel monitoring system (VMS) data. VMS data were used to provide a highly temporal and spatial distribution of fishing effort within the witch flounder directed fishery. Although VMS data is independent of fishers' declarations and provides far greater spatial resolution than what can be obtained from logbooks, it is only available from 2005 to 2008 and for vessels greater than 15 metres. Therefore logbook data was also used to spatial analyse effort on a greater time scale. Logbook data for all years 1997 to 2008 were used to analyse fishing effort within ICES rectangles.

Effort in 2005 had already begun declining and had returned to a similar level as in 2000 when the witch flounder fishery was on the rise (Figure 10-7). The spatial distribution of effort in 2005 was concentrated along the Norwegian, Swedish, and Danish verges of the Norwegian trench. In 2006 total effort was greatly reduced which resulted in a large reduction of effort along the Norwegian and Danish verges. Subsequently, effort along the Norwegian border in 2007 and 2008 was non-existent. Effort in 2008 remained low, while expanding spatially, especially along the Danish border.

Approximately 90 percent of witch flounder landings are taken around the Norwegian trench in the four ICES rectangles 45F9, 46F9, 45G0 and 46G0 (Figure 10-8). The fishing pattern has changed in the area during the investigated years. In 1997 effort was mainly concentrated in ICES rectangle 46G0. In 2004 landings became increasingly distributed over the area and were of similar magnitude in all 4 rectangles. The pattern in 2008 reverted back to a similar state as observed in 1997. Total landings have decreased by approximately 50% and what remained was largely concentrated to ICES rectangles 46G0 and 45G0.

Fishing effort, is reported as energy consumption (kWh), and based on both trawl time (hours) and engine size (kW). Between 1997 and 2001 effort increased in the Skagerrak from 1.5 million kWh to just over 4 million kWh (Figure 10-9). Landings and effort followed a similar pattern, with the exception of 2002, when the effort fell by over 700 000 kWh, but the landings were on the same level as the year before. In 2006 landings and effort declined drastically and have remained low for the past few years.

In Figure 10-10 is shown the progression of landings and effort in the individual ICES rectangles where witch flounder is mainly fished.

In 45G0 landings and effort increased gradually up to and including 2005 (Fig.10a). In 2006, the two decreased and were at a similar level as observed in the beginning of the study period. In 46G0 (Fig.10b) landings and effort increased between 1998 and 2000. From 2000 to 2001 effort increased but the landing remained at the same level as in 2000. From 2001 onwards, both the landing and effort decreased. In 2004 the effort and landing were back to the same level as 1998. In 45F9 (Fig. 10c) landings and effort increased from 1998 to 2003. Between 2003 and 2004, effort increased but landing declined slightly. Since 2005 landings and effort have declined significantly. In 46F9 (Fig.10d) no significant fisheries were conducted until 2000 and they rose sharply until 2002. Between 2002 and 2003 landings were constant while effort increased. In 2004, both effort and landings, were at their peak and have since declined markedly, returning to similar levels as observed in 1997.

In conclusion it is noted that effort and landings increased in all rectangles during the early 2000's and have since returned to levels equally low or lower than what was observed in the beginning of the study period. From 2000 to 2001, the CPUE in 46G0 declined, and since then landings and effort have declined steadily. This corresponds with effort and landings increasing in all other rectangles, suggesting that the reduction in CPUE in the 46G0 may have led to a spatial expansion of fishing effort.

*By-catch in the witch flounder directed fishery*

Approximately 40% of the total landings in the witch flounder directed fishery consist of species other than witch flounder. Most of the landed by-catch is saithe, cod and monkfish (Figure 10-11 and 12 left). The proportion of saithe increased substantially, from almost 13 tonnes in 2001 to approximately 65 tonnes in 2004, and has since return to similar levels as observed in 1997. Since 2002, landings of cod in the witch flounder directed fishery have decreased from approximately 70 tonnes in 2002 to around 10 tonnes in 2006. This is probably due to the cod quota being reduced, not because of reduced landings. Landings of monkfish increased steadily from approximately 9 tonnes in 1997 to 30 tonnes to 2004, but have since declined, returning to a similar level as in 1997. Haddock, Norway lobster, ling, hake, plaice and shrimps are also landed, but in smaller quantities.

Also landed are by-catches of cartilaginous fishes (Figure 10-12 right). Skates are not separated into individual species in the landings data and therefore it is unknown which species are landed. Unlike skates, sharks are classified to species level and within the witch flounder directed fishery dogfish is landed exclusively. Landings of both skates and dogfish in the directed fishery increased markedly from 2000 but have since returned to similar levels as observed in the end of the 1990's.

*Discard in the witch flounder fishery*

Data on discard were collected from three trips in the Skagerrak (in May 2003 and June 2005) with a total of 18 trawls in the directed witch flounder fishery. The amount of data is not sufficient to make a quantitative analysis of the discards of various species. Instead a semi-quantitative analysis was performed on the number of fishing hauls where the species have been listed (Table 10-2). The species that occurred as discard in most trawls are blue whiting (*Micromesistius poutassou*), fourbeard rockling (*Enchelyopus cimbrius*), rabbit fish (*Chimaera monstrosa*), starry ray (*Amblyraja radiata*), and cod (*Gadus morhua*). On two of the trips, however, the cod quota had been fulfilled, which led to cod of legal size, which would normally have been landed, being included in the discard portion of the landing.

*Witch flounder as by-catch in other fisheries*

Witch flounder is caught as by-catch in all fisheries where bottom trawling is used, ie. Shrimp, Norway lobster and fishing for demersal/benthic fish. Total landings of witch flounder in the non-target fisheries in 2008 were around 190 tonnes (Figure 10-13). Of these landings, 102 tonnes were within the mixed trips metier, 21 tonnes were within the shrimp fishery, about 33 tonnes in the demersal fish fishery, which was equivalent to 40%, 8% and 12% of the total witch flounder landings.

As for the mixed trips metier, some of the hauls within trips may have been classified within the witch flounder fishery and some, for example, within the *Pandalus* fishery, and have therefore ended up in the mixed trips metier. This is more than likely why there are such high levels of witch flounder in landings. Since the mixed trips metier landed the largest amount of by-catch of witch flounder it has been studied more closely. *Pandalus* landings within the mixed hauls metier accounted for around 50% in 1999 and declined steadily until 2006 when it started increasing again. Although landings of witch flounder in the directed fishery reached its peak in 2001, by-catch of witch flounder in the mixed hauls metier continued to increase until 2005. This could be a result of landings per unit effort beginning to decline, resulting in more fishers switching to a mixture of *Pandalus* and witch flounder hauls within trips.

### 1.4.4 Scotland

In the UK fishery, witch flounder is mainly caught in IVa, IVb and VIa. At a first screening, landings data by UK vessels into Scotland display different signals depending on the gear used. However the major two fisheries catching witch flounder are light and nephrops trawl (single and multiple) mostly fishing in the IVa. Data from nephrops trawl show an increase in CPUE (Kg/hours) with landings increasing at a relatively stable level of effort (Figure 10-14 left). Similarly light trawl show increase in CPUE albeit a decrease both in landings and effort but an since 1999 (Figure 10-14 right) The fact that landings and effort crash within the light trawl fishery could be explained by the spate of decommissioning in the fleet and also the transfer of gear type from light trawl to Nephrops trawl by some of the vessels. A more detailed investigation taking into account engine size and number of vessels is needed.

## 1.5 Survey data, recruit series

Survey data of witch flounder are collected during the International Bottom Survey (IBTS), performed every year in the North Sea (IIIa and IV), during the first and third quarter of the year. Furthermore a time series of Beam Trawl Survey (BTS) data (1985-2008) in IV was also available.

### 1.5.1 Witch Flounder in IIIa

The survey data used in this study were collected during the Swedish International Bottom Trawl Survey (IBTS) since 1972, during the first (Q1) and third (Q3) quarter of the year. Previous studies showed that witch flounder are caught at different depths throughout the year and appear to follow fluctuations in temperature and salinity (Molander, 1935). In autumn, when temperatures rise in deeper waters (100-300 m) witch flounder move to shallower areas (50-150 m), only to return to deeper waters again in late winter/ spring (Molander,1925). Unfortunately, the majority of the tows during the Swedish IBTS are taken at depths between 26 -165 meters and 205-265 with sporadic ones outside these ranges. Therefore, the survey does not fully cover the whole natural range of this species. A first screening analysis investigated the distribution of different length classes at different depths. Individual data have been divided in four length classes and the depth at which they were caught was averaged within each length class (Figure 10-15). Results show that small individuals (<15cm) tend to be found together with the largest ones (>31cm) in deeper water, while individuals of medium size (between 16 and 30cm) are found at lower depths. This pattern is shown in both quarters of the year, although shifted at shallower waters during the autumn (Q3), confirming the previous study.

The second step was to explore the possible variation in the Catch per Unit of Effort (CPUE) in different depth strata. The CPUE was calculated as number of individuals caught per hour divided by the number of hauls performed at a certain depth stratum in a certain year, in order to scale the effect of the unequal number of hauls between years. The results from the first quarter surveys show an increase in CPUE with depth as well as an increase during the period 1998 - 2003 when the stock started to decrease again, at all depth strata (Figure 10-16). The spatial distribution of haul-specific CPUEs, reconstructed, averaging over 5 years time intervals, appears to be stable in both quarters during the entire time span (Figure 10-17).

Interestingly, the Q1 trend corresponds with a decrease in average length during the same period, investigated through a general linear model (GLM), with normal distribution (Figure 10-18). In the model, length was the dependent and year the independent variable, while depth and quarter were used as covariate, in order to scale their possible effects. Furthermore a regression between CPUE and average length shows that there is a significant inverse relationship between the two variables (Figure 10-19).During the same period an increase in effort and therefore in landings occurred (see Section 1.4). The observed trend could, therefore, be interpreted as either a result of fishing pressure, withdrawing larger individuals, or a consequence of a density dependent effect. The latter would occur as an outcome of increased stock size and thus increased competition for food, which reduces the per capita resources and consequently growth.

However, if as reported by Molander in 1935, we are dealing with a single stock inhabiting Skagerrak and North Sea, attention must be paid before any conclusion is drawn. Overlooking the seasonal migration pattern between the two areas may lead to erroneous interpretation of the observed pattern. More knowledge about the reproductive migration and stock identification is thus needed.

### 1.5.1 Witch Flounder in IV

The abundance of witch flounder observed during the first quarter of the IBTS has been fluctuating (Figure 10-20). A "maximum" was reached around 1995, and the abundance seems to have decreased since. No pattern can be detected in the abundance time series during the third quarter of the IBTS.

In the time series of BTS quarter 3 the change in survey coverage in 1996 is reflected. Only since that year part of the distribution area of witch flounder has been included. No clear trend is visible since 1996.Some specimens of witch flounder have incidentally been reported for the Demersal Fish Survey (DFS-Q3) but these catches are believed to stem from wrong identification of the species. Witch flounder in fact does not occur in the southern North Sea.

Thus as a time series the catches of witch flounder during the IBTS seem most promising, and especially for the IBTS-1 since more stations are usually fished in quarter 1, and the time series is longer.

For what it concerns the length composition, both IBTS-Q1, IBTS-Q3 and BTS-Q3 catch the whole size range of witch flounder from just below 10 cm to around 50 cm. The peak in the length range in both IBTS surveys is around 35 cm, in the BTS it is around 30 cm (Figure 10-21).

Regarding the distribution witch flounder is a species that occurs in the deeper waters of the northern North Sea. There does not seem to be a significant difference in the distribution in winter and in summer. Whereas a tendency seems to exist for adults to occur mainly in offshore waters (certainly in IBTS-Q3) the juveniles may be more abundant towards the edges of the survey area (Figure 10-22). The third quarter Beam Trawl Survey (BTS-Q3) just covers the southern range of witch flounder. Also in these data no obvious difference exists between adult and juvenile distribution.

## 1.6 Biological sampling

Up to 2009 there have been no requests for biological advice on the exploited stocks of witch flounder and therefore no regular assessments have been carried out. However, this species has been subject of 'ad hoc' investigations covering only shorter time periods. Therefore, long continuous time series of biological measurements have not been available so far. From 2009 witch flounder has been included as a mandatory species in the EU Data Collection Framework (DCF). Thus in agreement with the DCF and with the onset of the NESPMAN project the regular sampling of biological data started in 2009.

In Sweden samples have been purchased from commercial boats, randomly selected on a quarterly basis in 2009. Due to low fishing activity the third quarter was not sampled. In 2010, the collection of those samples encountered many problems therefore only a small sample in June was taken and not yet analyzed. Individual length, weight and maturity status are recorded and otoliths stored for age determination.

In Denmark, a regular sampling of the landings begun in the 4th quarter of 2009 in the ports of Skagen and Hirtshals. Samples, obtained from by-catch landings both from shrimp fisheries and mixed demersal trawl fisheries, have been stratified according to the three size categories of the landings. All fish are measured and individual weights recorded. Otoliths have been collected from all samples, although not all otoliths have been read yet. Further samples have been collected, but these have not yet been analysed. Until now all samples have been taken from IIIa landings. However, since the distribution of this species seems to be continuous from Skagerrak into the eastern part of the North Sea, the IIIa samples are assumed to also cover IVa.

Biological samples have been also collected in UK but due to the lack of expertise in age reading of this species, otoliths have been stored but not read yet. Those data are not available at the moment.

However, witch flounder otoliths are difficult to read. Several techniques were tried by Swedish technicians in order to find the optimal one, including grinding the otolith whole, sectioning with or without staining, burning and breaking as well as reading the otolith whole and wet, straight after removal from the fish.

The best result was obtained by using a combination of two techniques, namely reading the otoliths right after the removal from the fish and if need be, grinding. The core of the otolith is asymmetrical (as in all flatfish) and the rings are clearer on the otolith with the central nucleus. The core of this otolith is relatively thick and the first ring is sometimes hard to discern and therefore one will in some cases have to grind the otolith for the ring to come through. This inner ring has also been verified by collecting witch flounder of the 0-group and comparing the distance from nucleus to edge/first ring (Figure 10-23). A further attempt consisted in soaking dry whole otoliths in saline solution 0,9%. This method gave satisfying results, providing an easier handling of samples when personnel skilled in age reading are not at disposal.

The maturity assessment is also problematic (see section 1.7.2). The reproductive period is uncertain (see section 1.7.2) and histological investigation of gonads is planned at the Swedish Institute of Marine Research for 2011 in order to delineate the spawning season and be able to calculate accurate maturity ogives and spawning stock biomass. Thus the knowledge about the biology of this species is currently under improvement.

## 1.7 Population biological parameters and other research

### 1.7.1 Sex Ratio

Gender distribution in the witch flounder population is generally skewed and females are in majority. This bias is especially clear among the larger individuals, with the largest individuals being exclusively female. In percentage, there is the least number of females in the eastern part of the Skagerrak and the northern North Sea. Growth decreases with increasing depth and so does the number of males (Molander, 1935).

The population consists of 65% females. Gender distribution is between 0.4 and 0.6 for each sex in the length classes 23cm to 33cm and afterwards becomes skewed to consist of an increasingly large proportion of females, which dominate totally from 39 cm and upwards. Molander (1935) concluded that males grow slower than females and that the number of males decreases with increasing depth, which can result in the largest individuals being exclusively female.

A comparison between Molander's 1925 study and the data collected by Sweden during 2009 was performed. A clear division in gender distribution was evident in both studies. Molander (1925) found that most witch flounder are females (68% of 445 individuals) and that the females dominated completely from 50cm and greater, with the largest individual being 51cm. In the 2009 sample females dominated completely from 35 cm in all quarters with the largest sex determined individual being 49 cm (Figure 10-24). However, these two studies are not entirely comparable. Molanders (1925) sex distribution is based on individuals caught in the Skagerrak and Kattegat during two years, 1922 and 1923, and during the months of April, May and August. In addition, Molander (1925) measured SL (standard length, from snout to the posterior end of the last vertebra, i.e. excluding the length of the caudal fin), where as TL (total length) was used in the 2009.

### 1.7.2 Maturity

The individuals from 2009 sample were divided by maturity stage according to an 8-point macroscopical scale, where stages 1 and 2 are immature and the remaining stages are mature (stage 3-6), spent (stage 7) or resting (stage 8). Among 1192 individuals a male in the first quarter and a female in the second quarter were spawning (stage 5) while a single female was found in the spent stage in quarter 2. Few resting individuals were found in all quarters. However the assessment of resting individuals is uncertain as this stage is easily confoundable with stage 2 and furthermore its duration is unknown. Around 80% of individuals in all quarters were immature, i.e. maturity stages 1 and 2. Based on the observed pattern Maturity ogives (i.e. proportion of mature individuals within age classes) relative to 2009 are shown in Figure 10-25. The maturity pattern confirms the old studies showing that this species tend to mature quite late and at large size. On the other hand it seems difficult to delineate with certainty the spawning period in the studied area and corroborate (or contradict) the findings of previous study (Molander, 1935).

### 1.7.3 Age distribution

All samples collected from the landings during 2009 were thus aged and results were used to explore the age composition of landings. The catch numbers at age were estimated. Age classes 4 and 5 were the most represented ages in the Swedish landings, during Q1 and Q2 in 2009 (Figure 10-26). This pattern could be a consequence of two strong consecutive year classes, i.e. 2004 and 2005. On the other hand in the Danish landings age 4 to 8 are the most abundant in the fourth quarter (Table 10-3).

### 1.7.4 Growth

*Analyses of length and weight data.*

The total size distribution has been estimated taking the magnitude of the landings (by size category in the case of Danish samples) into account. The size distribution for

2009 is shown in Figure 10-27. In the same figure also the size distribution in Danish landings in 1981 is shown. In Figure 10-28 Swedish and Danish data are combined and compared to the Danish landings in 1981.

Notice the difference between the 3 data sets. In 2009 the mean size in Swedish landings appears to be smaller than the Danish landings in 2009, and the 1981 data indicate greater mean size in that year than in 2009 (Table 10-4). In fact, statistically the three means are significantly different (t-test), but more data would probably be needed to make any firm conclusions on whether these differences are more than 'technical', reflecting local or annual variations.

*The length weight relationship.*

Based on the Danish data, the parameters of the length-weight relationship were estimated (Figure 10-29 and Table 10-5). Notice, the similarity of the estimates based on 2009 data with the estimates from the 1981 data. These parameters are also expected to vary according the for instance the maturity condition of the fish.

## 1.8 Analyses of stock trends / assessment

The analytical assessment of this species is not possible due to lack of data. However the recently started collection of biological parameters and the investigation on the biology of this species laid the basis to start an assessment in the future as soon as a reasonable data time series are collected in a broader area.

## 1.9 Data requirements

According to the DCF Denmark and Sweden started to collect biological data from market samples in IIIa in 2009 on a quarter bases, resulting in age structure estimate of landings in this area. Similarly UK collect market samples for biological parameters in area IV. For 2011-2013 all three countries will continue to collect data both from market samples and surveys. This systematic and regular data collection in both IIIa and IV will represent a valuable help in trying to delineate the population dynamic as well as the stock identity of this species. Landings data from other countries fishing this species in North Sea, e.g. Spain, need to be enquired.

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**Table 10-1: Composition by gear (%) of total Danish landings of witch flounder, 2002-2009.**

| | | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Gear** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| | dem. trawls | 84.5 | 85.8 | 85.6 | 76.9 | 83.0 | 77.0 | 77.9 | 72.8 |
| **Skagerrak** | Shrimp trawl | 3.4 | 4.9 | 4.9 | 6.3 | 4.2 | 8.3 | 9.1 | 7.0 |
| **IIIa** | Danish seine | 11.7 | 8.9 | 9.2 | 16.7 | 12.7 | 14.5 | 13.0 | 19.8 |
| | other gear | 0.4 | 0.4 | 0.2 | 0.1 | 0.1 | 0.2 | 0.0 | 0.3 |
| | **Landings, in t** | **1366** | **1037** | **1188** | **635** | **635** | **618** | **476** | **589** |
| | **Gear** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| | dem. trawls | 89.6 | 91.6 | 92.1 | 90.9 | 93.1 | 96.5 | 96.8 | 96.1 |
| **North Sea** | Shrimp trawl | 0.7 | 0.8 | 1.0 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 |
| **IVa** | Danish seine | 8.3 | 6.7 | 6.4 | 7.5 | 6.7 | 2.5 | 3.1 | 3.2 |
| | other gear | 1.4 | 1.0 | 0.5 | 1.3 | 0.1 | 0.8 | 0.1 | 0.7 |
| | **Landings, in t** | **541** | **767** | **623** | **714** | **654** | **529** | **350** | **345** |

**Table 10-2. Number of hauls (tot=18) where each species has been recorded either as discard or by-catch hauls in the witch flounder direct fishery**

| Species | Discard | | | By-catch | | |
|---|---|---|---|---|---|---|
| | 1-5 hauls | 6-15 hauls | 16-18 hauls | 1-5 hauls | 6-15 hauls | 16-18 hauls |
| *Amblyraja radiata* | | | x | | | |
| *Anarhichas lupus* | | | | x | | |
| *Argentina silus* | | x | | | | |
| *Argentina sphyraena* | x | | | | | |
| *Brosme brosme* | | | | x | | |
| *Callionymus lyra* | x | | | | | |
| *Chimaera monstrosa* | | | x | | | |
| *Coryphaenoides rupestris* | | x | | | | |
| *Crayfish* | | x | | | | x |
| *Cyclopterus lumpus* | x | | | | | |
| *Dipturus linteus* | x | | | x | | |
| *Dipturus oxyrinchus* | | | | x | | |
| *Enchelyopus cimbrius* | | | x | | | |
| *Etmopterus spinax* | | x | | | | |
| *Gadiculus argenteus* | x | | | | | |
| *Gadus morhua* | | | x | x | | |
| *Hippoglossoides platessoides* | | x | | | | |
| *Hippoglossus hippoglossus* | | | | x | | |
| *Limanda limanda* | x | | | | | |
| *Loligo ssp* | x | | | x | x | |
| *Lophius piscatorius* | x | | | | x | |
| *Lumpenus lampretaeformis* | x | | | | | |
| *Lycodes gracilis* | | | | | | |
| *Melanogrammus aeglefinus* | | x | | | x | |
| *Merluccius merluccius* | | x | | | x | |
| *Micromesistius poutassou* | | | x | | | |
| *Microstomus kitt* | x | | | x | | |
| *Molva molva* | x | | | | x | |
| *Myxine glutinosa* | x | | | | | |
| *Pleuronectes platessa* | | x | | | x | |
| *Pollachius virens* | x | | | | x | |
| *Sebastes norvegicus* | x | | | | | |
| *Sebastes viviparus* | x | | | | | |
| *Squalus acanthias* | | | | x | | |
| *Trisopterus esmarkii* | x | | | | | |
| *Trisopterus minutus* | x | | | | | |

**Table 10-3. Catch in numbers by age group in Danish landings 4th quarter, 2009.**

| Age group | C(a) |
|---|---|
| 1 | 0 |
| 2 | 20440 |
| 3 | 292967 |
| 4 | 660879 |
| 5 | 558681 |
| 6 | 558681 |
| 7 | 579121 |
| 8 | 170330 |
| 9 | 61319 |
| 10 | 68132 |
| >10 | 20440 |

**Table 10-4. Mean lengths in Danish landings.**

| | S 2009 | DK 2009 | DK 1981 |
|---|---|---|---|
| Mean length, cm | 33.0 | 35.3 | 36.3 |
| St. dev. | 3.797 | 4.643 | 4.003 |
| N in sample | 989 | 409 | 441 |

**Table 10-5. Parameters for the length-weight relationship of witch flounder based data collected in 1981 and in 2009.**

| | | 1981 | 2009 |
|---|---|---|---|
| allometric | a | 0.000003 | 0.0000016 |
| | b | 3.2457 | 3.41 |
| isometric | q | 0.000007 | 0.0000069 |

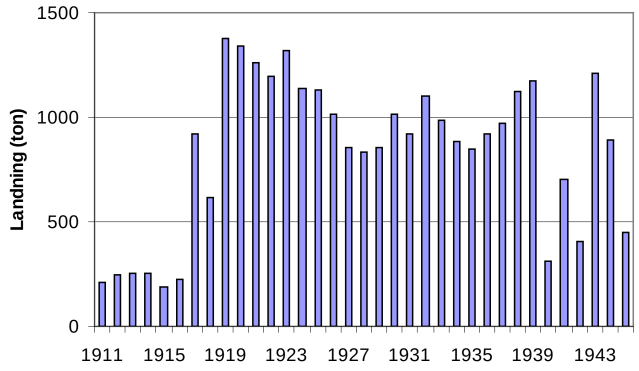



**Figure 10-1. Quantity of witch flounder landed per year in Gothenburg's fishing port 1911-1945. (Molander 1925, 1935 and 1947)**

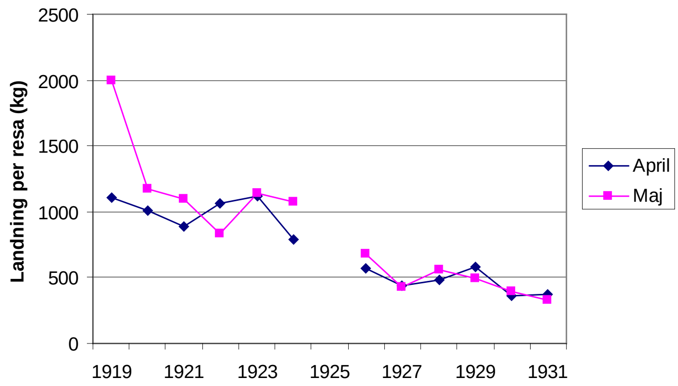



**Figure 10-2. Average amount of witch flounder landed per trip in April and May 1919-1931. Data for 1925 are missing. (Molander 1935)**

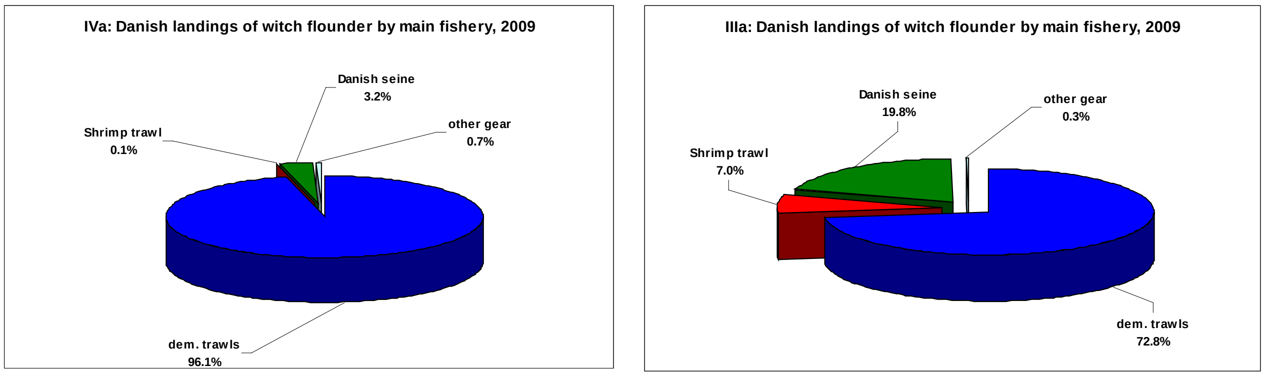



**Figure 10-3. Danish landings of witch flounder by gear type/fishery in 2009.**

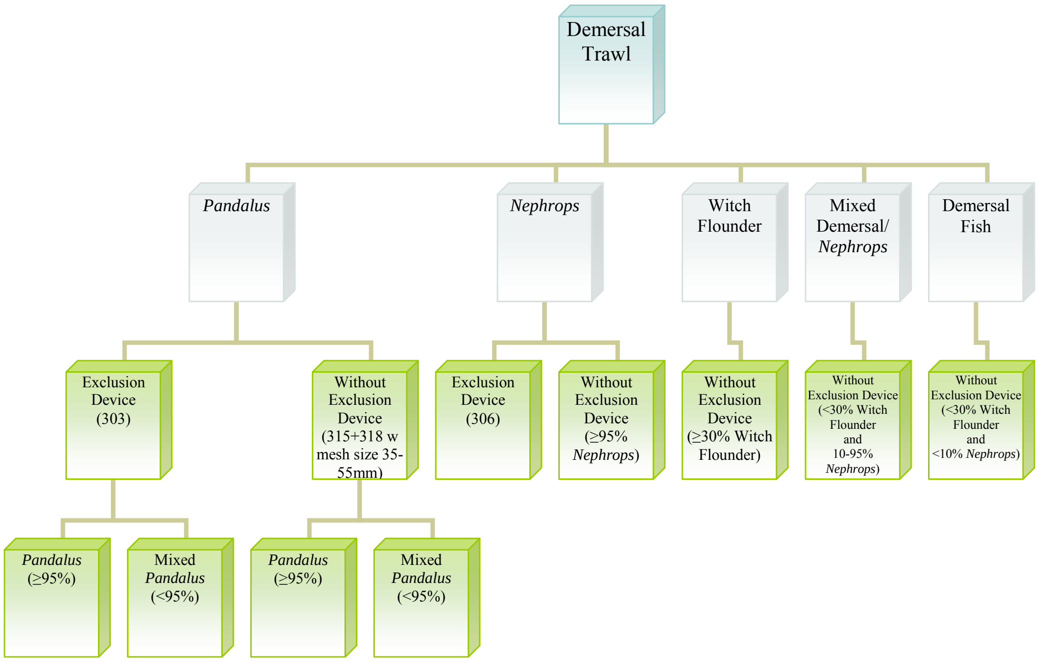



**Figure 10-4. Demersal fisheries' classification pyramid**

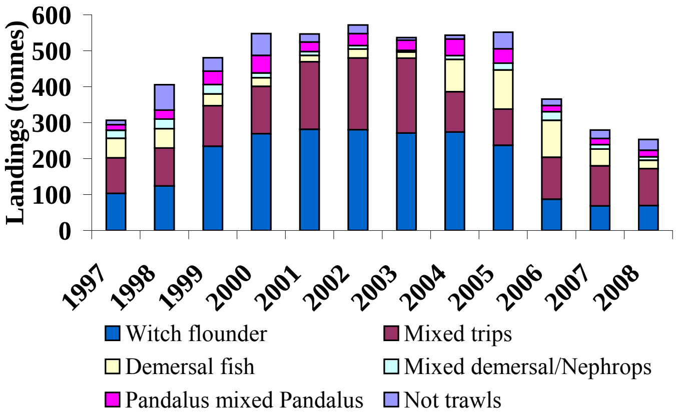



**Figure 10-5. Total landings of witch flounder within Skagerrak during 1997-2008 divided by types of fishery.**

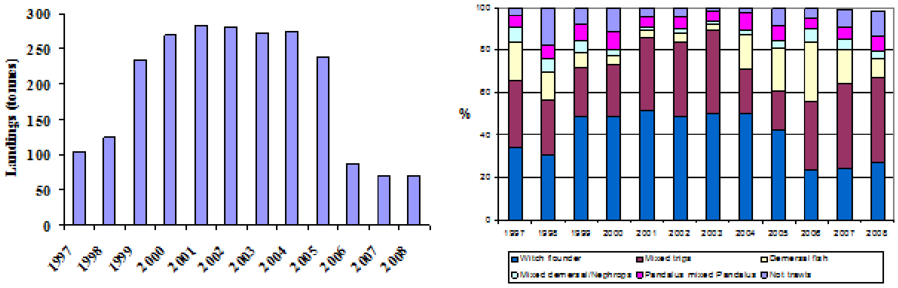



**Figure 10-6 Landings (t) within the witch flounder directed fishery and contribution per métier in the period 1997-2008.**

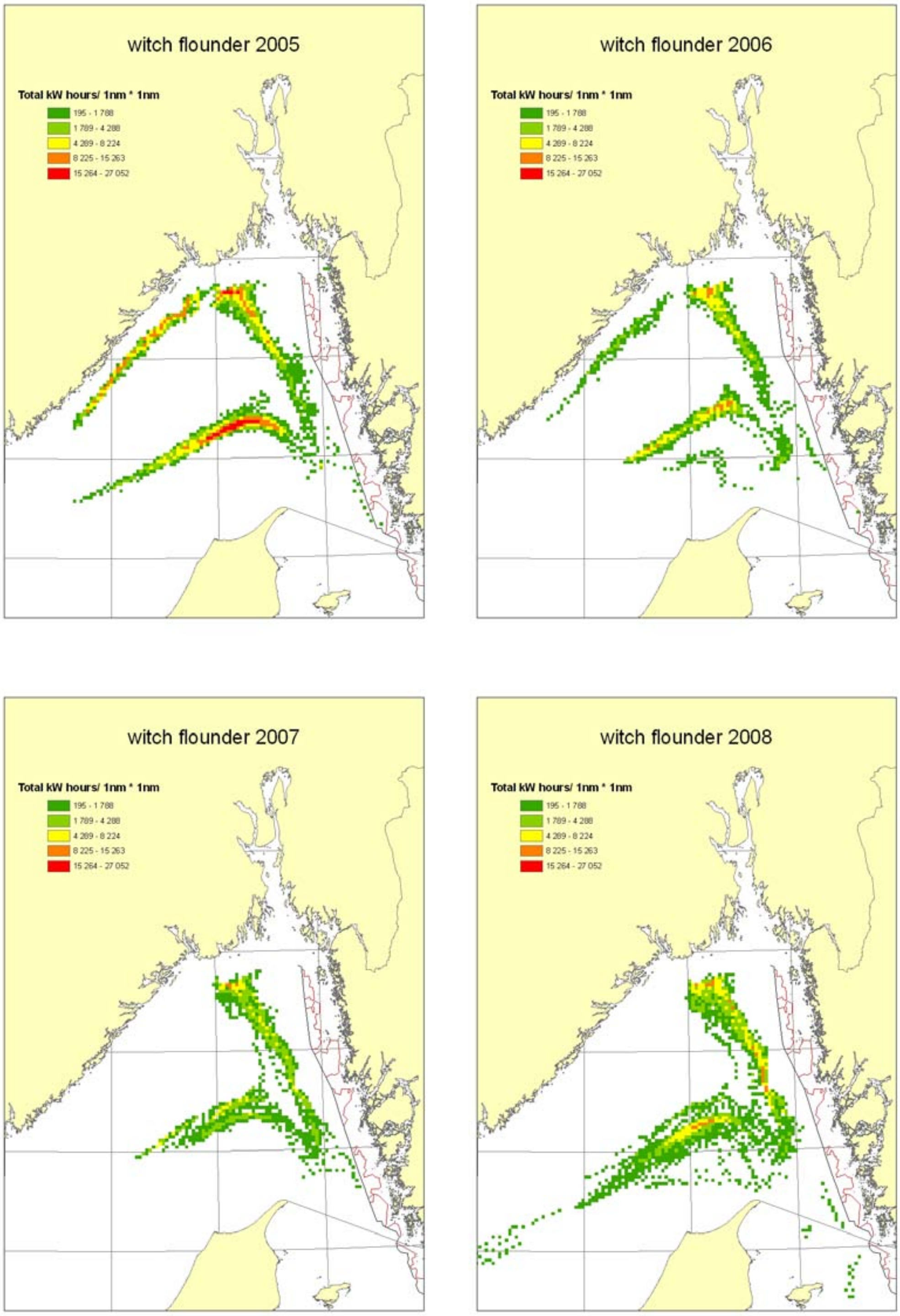



**Figure 10-7. Spatial distribution of effort within the directed fishery for witch flounder in the years 2005 – 2008.**

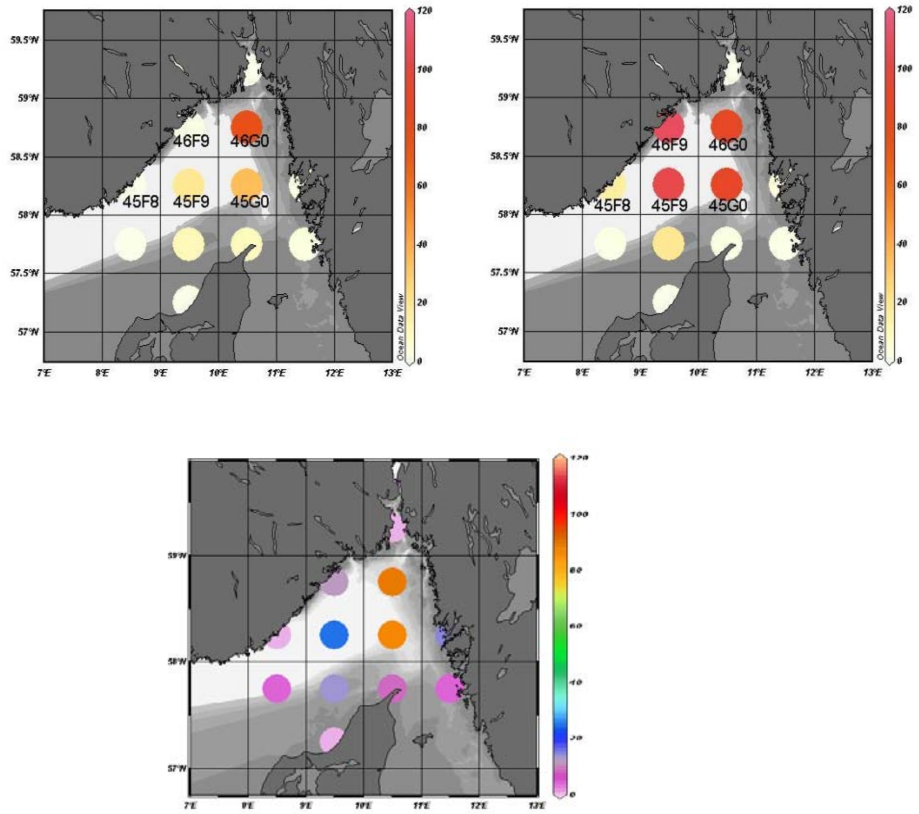



**Figure 10-8. Landings (t) of witch flounder per ICES rectangle in 1997, 2004 and 2008, respectively. N.B. the 2008 colour scheme differs from 1997 and 2004**

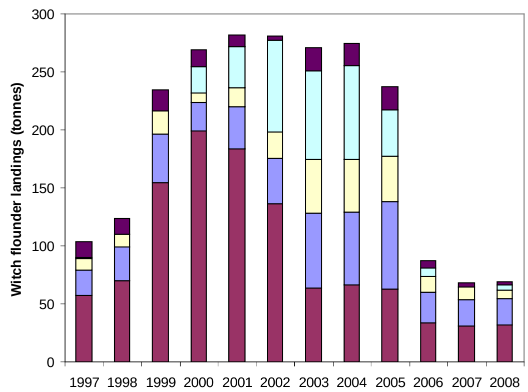



**Figure 10-9. Landings and effort from the 4 ices rectangles where witch flounder is prominently fished.**

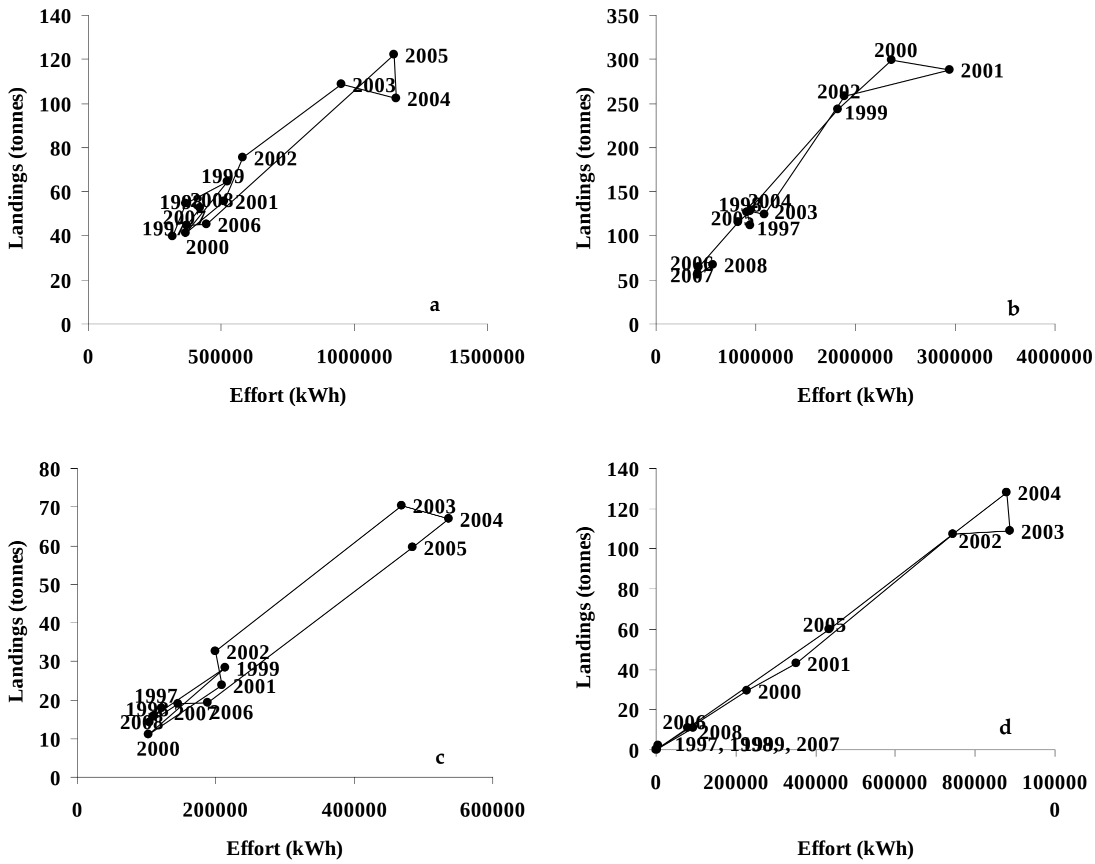



**Figure 10-10. Changes in landings of witch flounder and effort from 1997 to 2008 in four ICES-rectangles a) 45G0, b) 46G0, c) 45F9, d) 46F9 where witch flounder is fished most. Note that scales are different.**

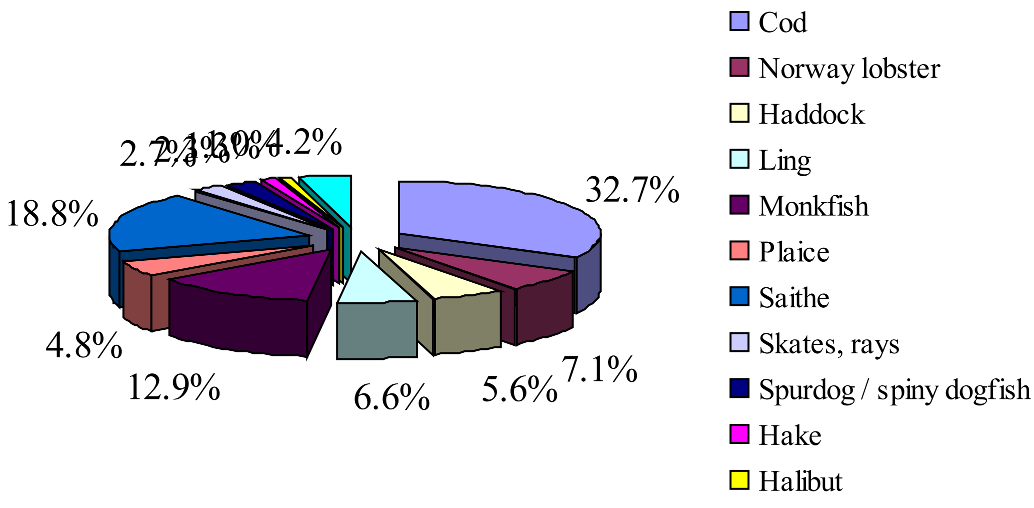



**Figure 10-11. Mean percent of by-catch species within landings from the witch flounder directed fishery 1997 to 2008.**

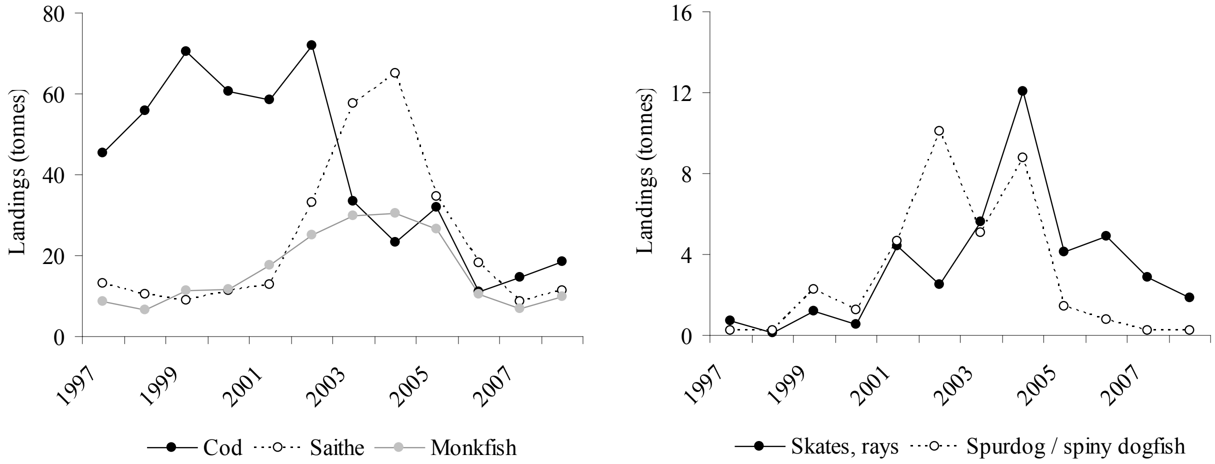



**Figure 10-12. Landed by-catch for a selection of species of teleosts and elasmobranchs.**

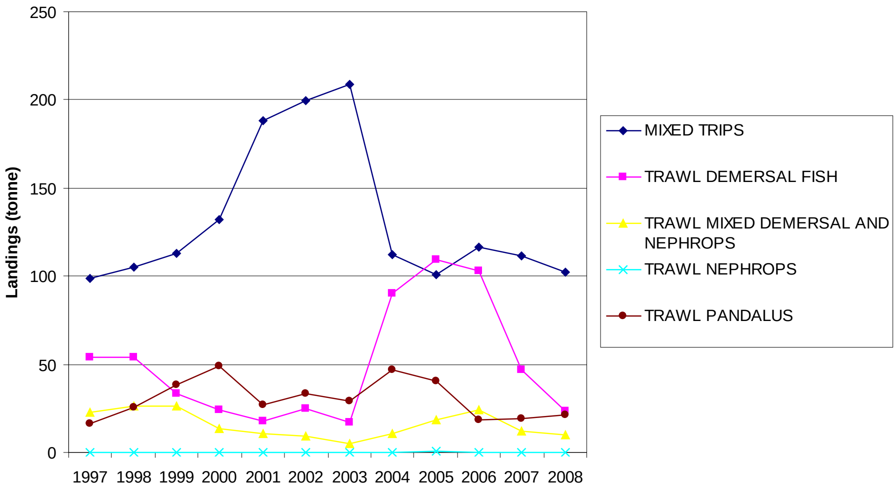



**Figure 10-13. Landings of witch flounder from fisheries other than the witch flounder directed fishery.**

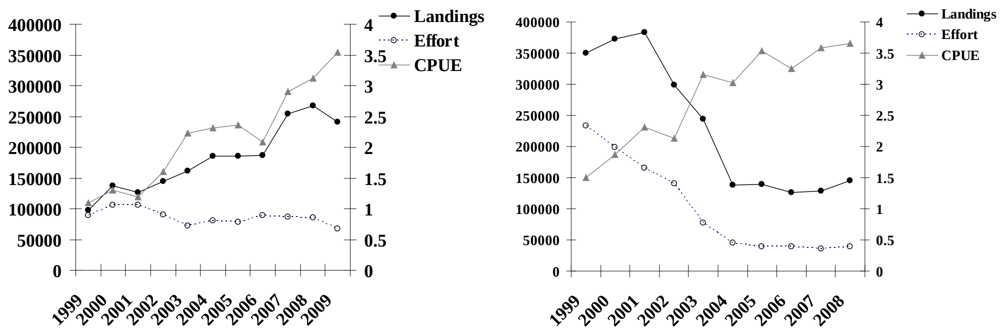



**Figure 10-14. Time series of landing (Kg), Effort (hours) and CPUE (Kg/h) in IVa in Nephrops (on the left) and light trawl (on the right) fisheries.**

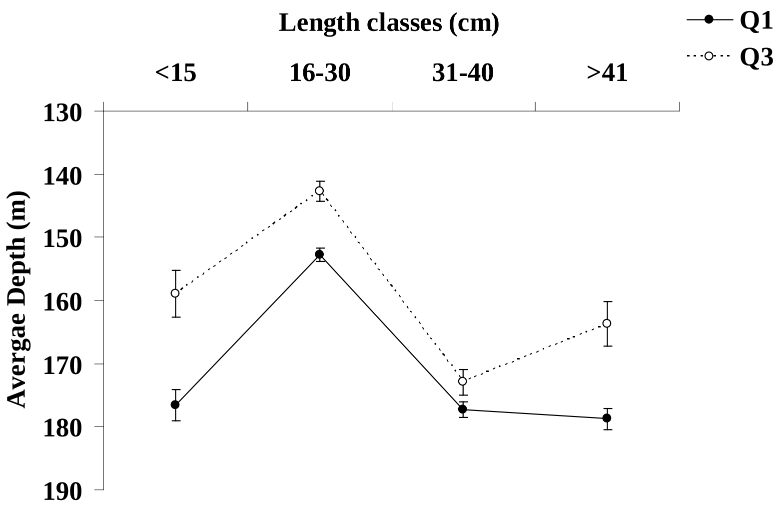



**Figure 10-15. Occurrence of different length classes at different depths. Bars represent standard errors.**

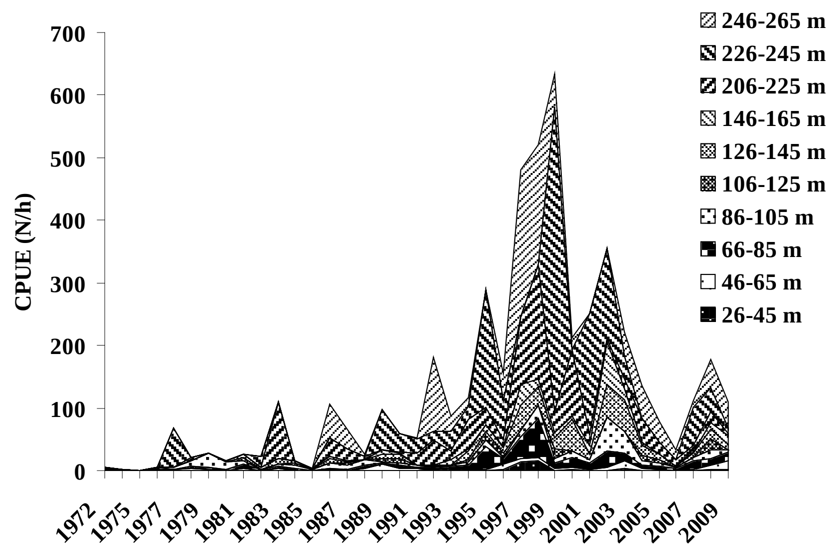



**Figure 10-16. Time series of CPUE at different depth strata in quarter 1.**

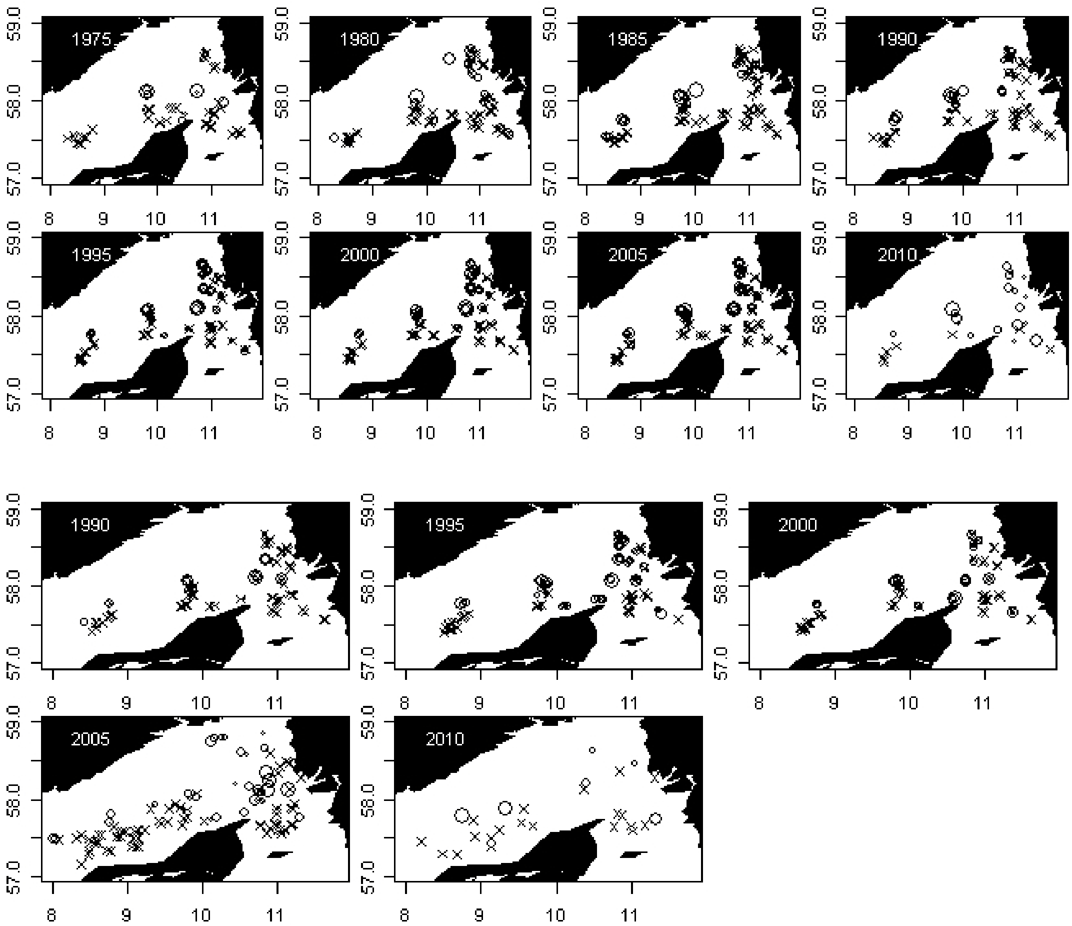



**Figure 10-17. Haul-specific CPUE (n/h) standardized for depth and averaged over 5 years' time intervals during the first (top) and third (bottom) quarters. Notice that 2010 is shown as single year, i.e. not pooled.**

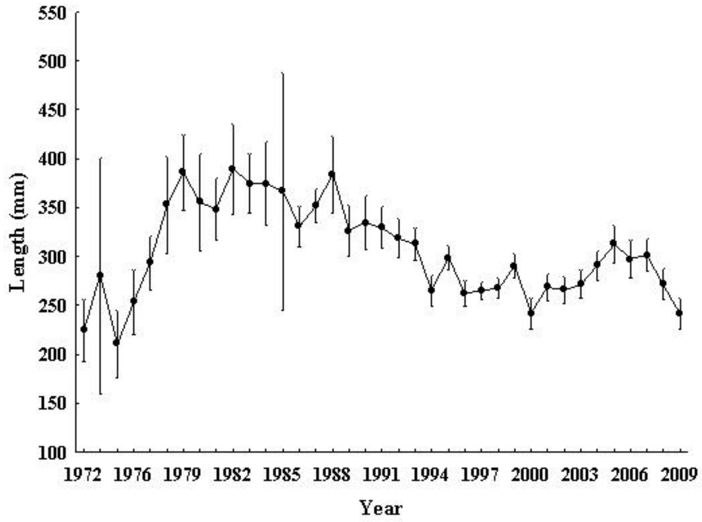



**Figure 10-18. Time series of average length distribution. Vertical bars denote 0.95 confidence intervals.**

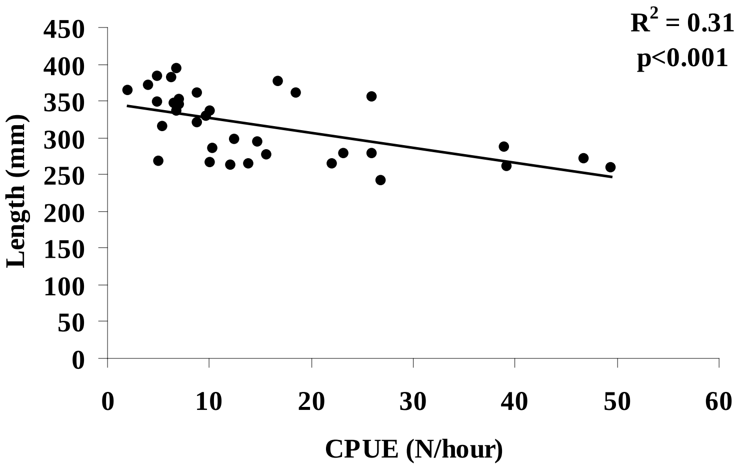



**Figure 10-19. Regression between yearly CPUE and average length.**

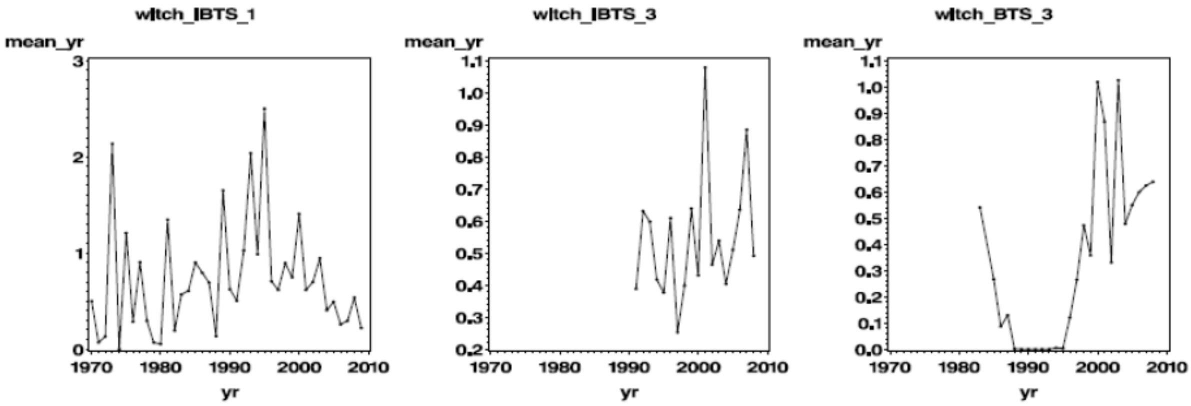



**Figure 10-20. Time series of abundance of witch flounder by survey. From left to right: IBTS-Q1 (1970-2009), IBTS-Q3 (1991-2008), BTS-Q3 (1985-2008).**

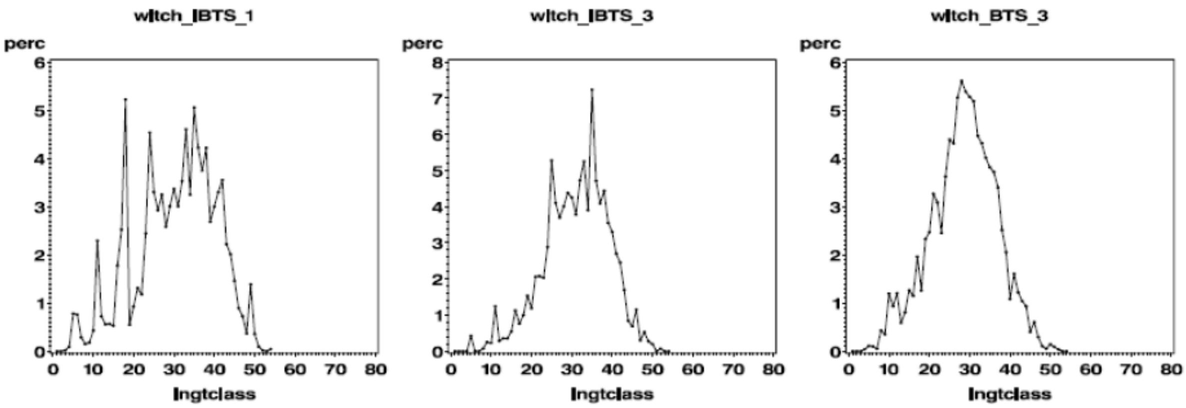



**Figure 10-21. Length frequency distribution of witch flounder by survey. From left to right: IBTS-Q1 (1970-2009), IBTS-Q3 (1991-2008), BTS-Q3 (1985-2008).**

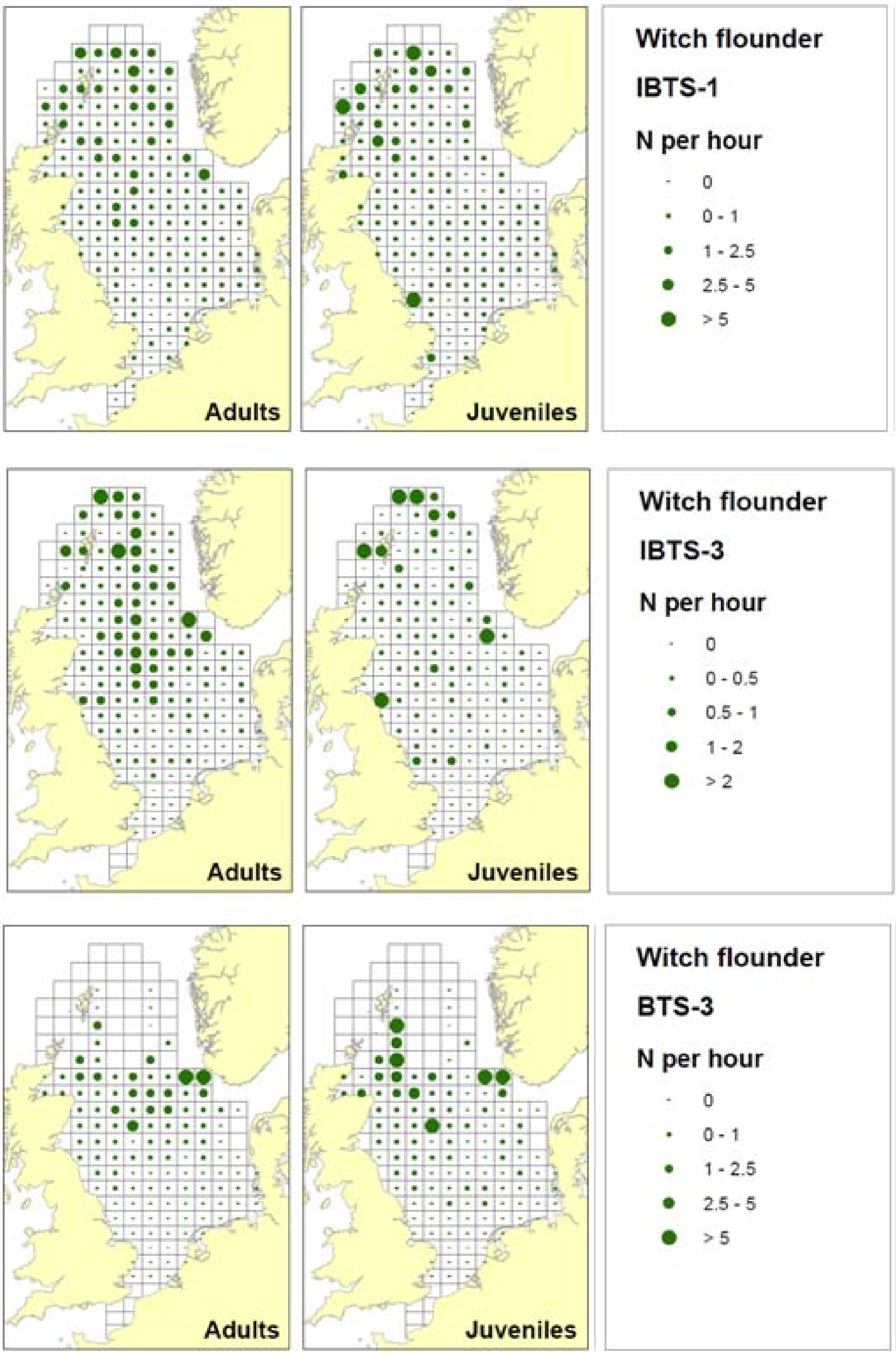



**Figure 10-22. Distribution of witch flounder in IBTS-Q1 (average 1970-2009), IBTS-Q3 (average 1991-2008) and BTS-Q3 (average 1985-2008).**

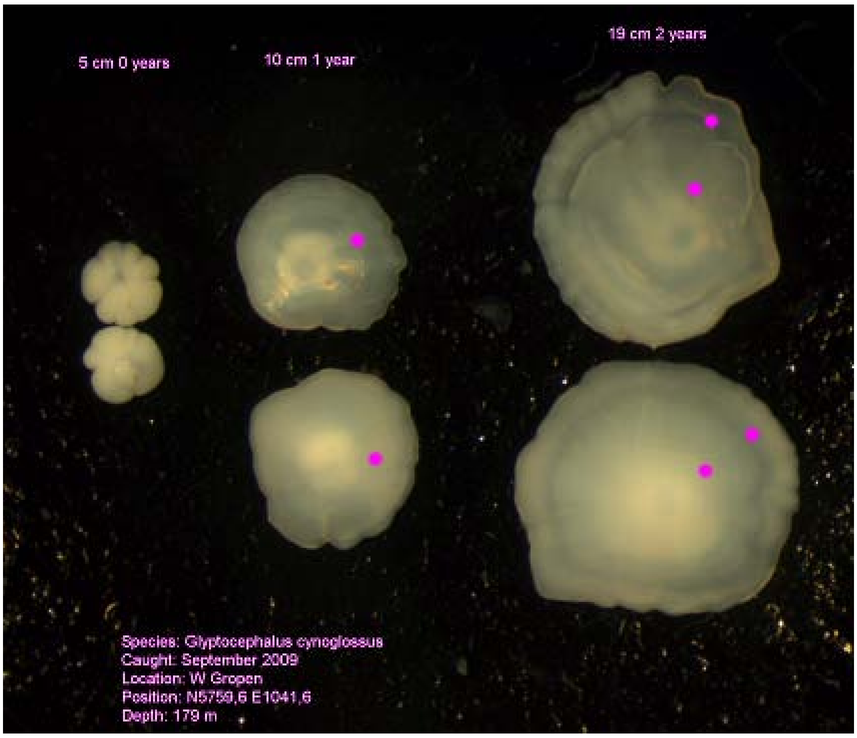



**Figure 10-23. Picture showing the identification of rings in three age groups.**

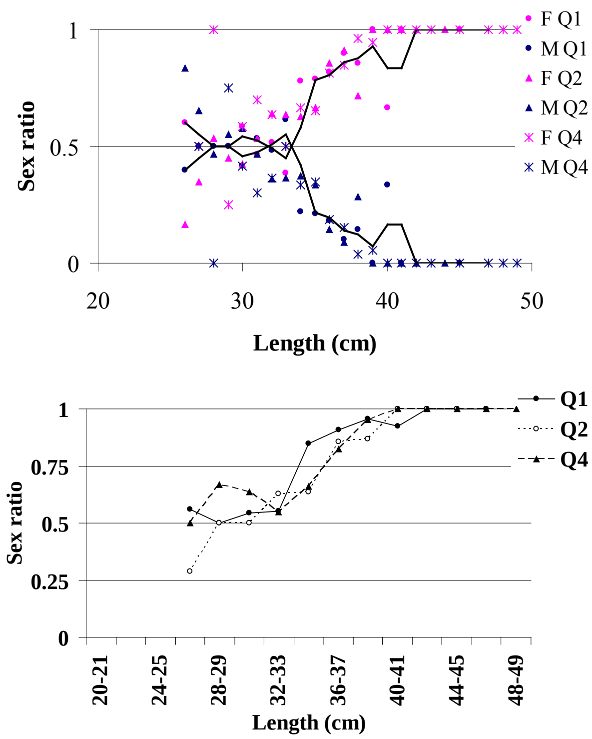



**Figure 10-24. Length distribution divided by sex (top) and sex ratio (bottom) in the 2009 sample**

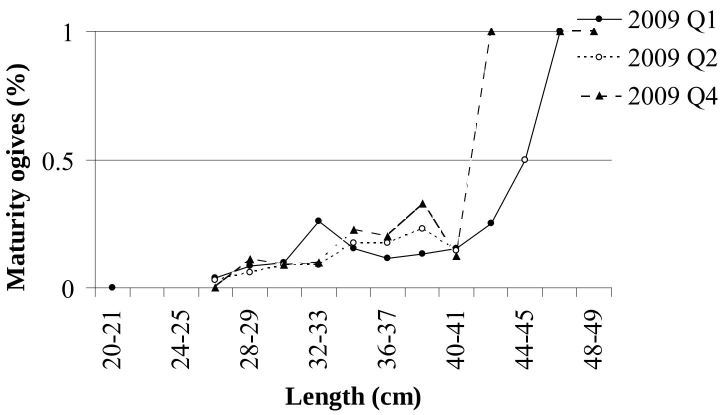



Figure 10-25. Maturity ogives estimated in the Swedish sample from 2009.

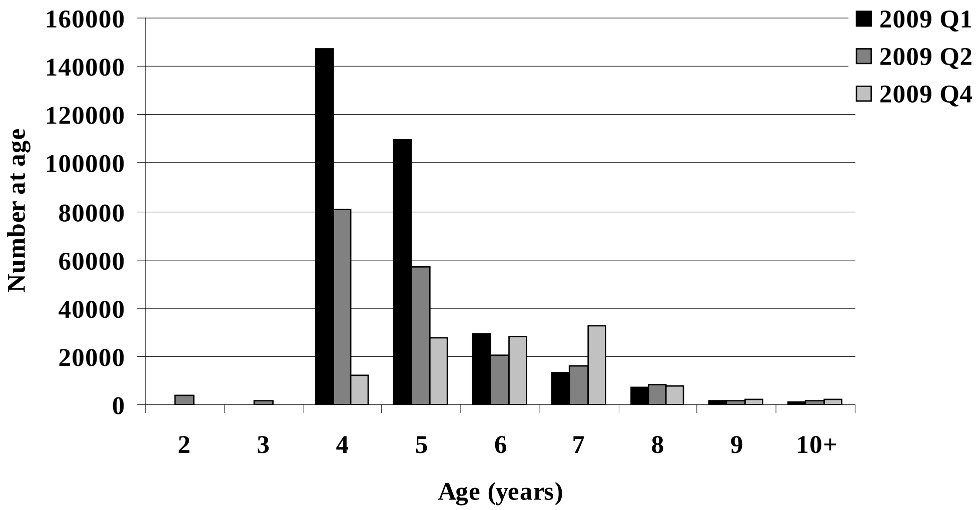



Figure 10-26. Catch in number in Swedish landings from 2009

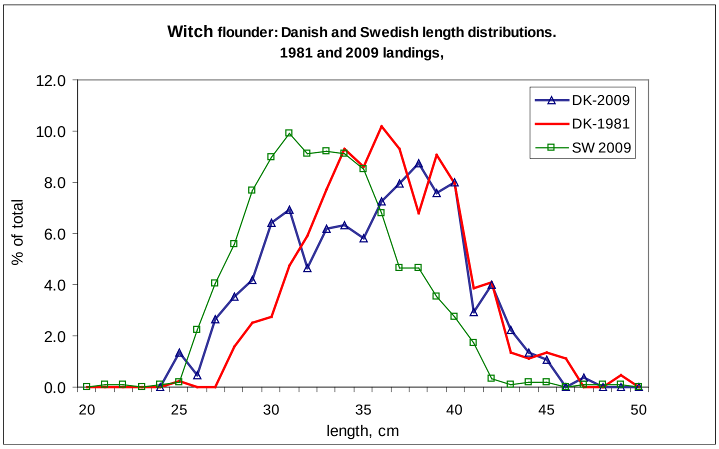



Figure 10-27. Size distribution of the landings of witch flounder in Danish and Swedish landings in 2009 and in Danish landings in 1981

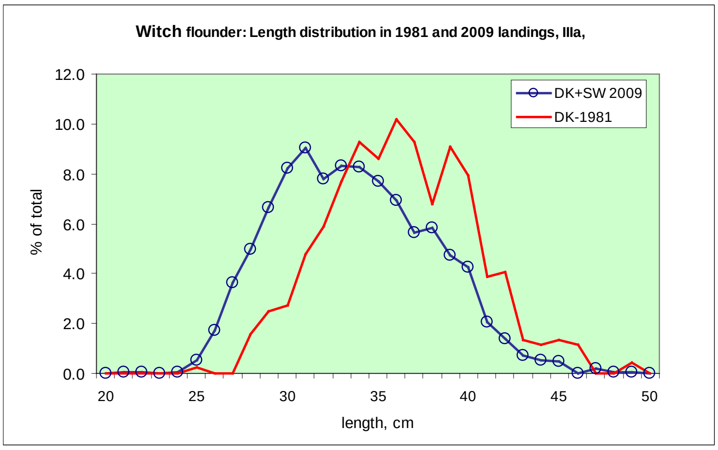



**Figure 10-28. The length distribution of witch flounder in 2009 for Danish and Swedish landings combined, compared with the Danish landings in 1981.**

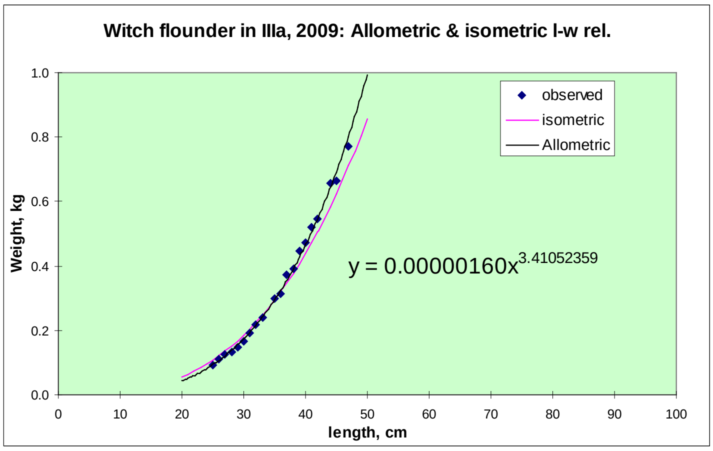



**Figure 10-29. Length-weight relationship for witch flounder.**

# Annex 11 – John dory (*Zeus faber*, Linnaeus, 1758)

## 1.1 General Biology

John dory is wide spread, it is found in the East Atlantic from Norway to south of Africa as well as in the Mediterranean and Black Seas. It is also found in the western Pacific Ocean as well as in the Indian Ocean (Omnes, 2003; Quéro, 1978; Quéro & Vayne, 1997). It is a demersal species, never found in great concentrations. It is found mostly over soft and muddy areas close to rocks, in depths ranging from 20 to more than 400 meters. However 99% of catches are made between 20 and 160 meters. Reproduction takes place at the end of winter and at the start of spring in the north eastern Atlantic, earlier in the Mediterranean (Fishbase.org).

Sexual maturity varies from 23 to 29 cm for males and 29 to 37 cm for females depending on location.

Individuals of less than 8cm feed on zooplankton mainly mysids. As they grow they progressively feed on small benthic fishes and when they grow over 14 cm they feed exclusively on benthic and demersal fishes.

Ageing through otolith reading has been investigated without success. Modal analysis of length distributions from survey data indicates that at the end of the first year, John dory measure between 9 to 13 cm, 24 to 27 cm at the second, about 34 at the third and 40 at the end of the forth year (Quéro, 1997). Males rarely grow larger than 50 cm while females can reach 60 cm or more.

## 1.2 Stock identity and possible assessment areas

There are no data available on possible stock separation based on genetic or morphological studies.

Data from the fishery indicate two main areas of exploitation: the Celtic sea, Western Channel and Northern Bay of Biscay (areas VIIe-j & VIII a,b) and the Western Iberian waters (area IXa). Based on average figures from 1999 to 2008, areas VII and VIIIa,b,d account for about 79% of the total catches, areas VIIIc and IX come second with 17% (Figure 1.1).

## 1.3 Management

There is no management measure in effect in the ICES area for John dory.

## 1.4 Fisheries data

Landings figures were available through the EUROSTAT/ICES database. French landings statistics are only documented since 1978. From 1978 to 1985 landings average about 850 t, they increased then to peak at 4000 t in 2003 – 2004 (Figure 1.2). France and Spain are dominating the fishery. Note that the drop in 1999 seen in the landings per area figures but not in landings per country is due to France having submitted only a tonnage for all areas combined in 1999.

The relative proportion of landings per major area computed from an average over the years 1999 – 2008 indicates that the bulk of the fishery takes place in the Celtic sea (Table 1.1). Detailed landings by country and area are given in Table 1.2.

CPUE data were available for 6 French trawl metiers in the Celtic sea and the Bay of Biscay over the period 1999-2008 (Figure 1.3). All except the *Nephrops* fleets and the demersal trawl in the Bay of Biscay show an increasing trend over the period.

## 1.5 Survey data, recruit series

Four time series of survey indices are available covering areas IVa-c (NS-IBTS-Q1), VIIf-j and VIIIa,b (FR-EVHOE), VII d (FR-CGFS) and IXa (PT-IBTS).

All indices show an increase in biomass and abundance since the late 1990's up to 2007 – 2008, and a drop in 2009 (Figure 1.4 and 1.5). Recruitment indices from the EVHOE survey, taken as numbers of individuals less than 16 cm, indicate four strong year classes in 1997, 2001, 2004 and 2007, the later being particularly high (Figure 1.6).

Length distributions from the CGFS survey and the EVHOE survey are given in Figure 1.7 and Figure 1.8. Modes in the length distribution are generally well tracked, especially in the EVHOE survey. Density is lower in the CGFS area and larger fish are proportionally not so abundant. This is probably related to movements of older fish to deeper areas (Quéro & Vayne, 1997).

Distribution maps from the EVHOE survey do not show any particular pattern of species distribution (Figure 1.9).

## 1.6 Biological sampling

Few biological data are available from market sampling. Some biological data have been collected from onboard sampling in 2009 and 2010 by France but no processing could be carried due to software problems.

Sampling for length distribution of landings should be put at a higher level of priority in areas VII, VIII and IX. Sampling for maturity has been carried out in 2009 during the EVHOE survey and analysis should be available soon.

## 1.7 Population biological parameters and other research

### Ageing

Several reading techniques have been tested to read otoliths of John dory:

- whole otolith
- burning
- staining
- sectioning
- polishing.

Images of the results of these treatments are shown in Figure 1.10.

Age estimation was carried out, starting from a sample of 256 fishes from the EVHOE survey. Even if it is possible to identify a growth diagram from some otoliths (Figure 1.11), most of the otoliths are not interpretable.

Also, when the TNPC software was used, the analysis of distances between rings and of the greyscale along the radial, did not permit to identify reproducible marks among otoliths.

So far, it has not been possible to estimate the age of John dory.

## 1.8 Analyses of stock trends /assessment

CPUEs and survey indices show that the population in areas VII and VIII a,b has increased as a consequence of strong incoming year-classes. Similar increases are observed in area IXa and to a lower extent in the North Sea (area IVa-c) (Figure 1.3, Figure 1.4, Figure 1.5, Figure 1.6).

There are no sufficient data to carry out any analytical assessment even through a surplus production model as the time series of biomass index available lacks contrast.

## 1.9 Conclusion and comments on additional data or studies needed

In the Data Collection Framework, the species is classified as Group II. It is too early to judge on the quantity and quality of data that will be made available as the new concurrent sampling strategy has been implemented only in 2009. In any case it will take a minimum of 5 years before any analysis can be undertaken on fishery length distribution data. It is also to be noted that for all species classified in Group 2, the time of access to the fish in port sampling is limited and group 2 species are most often not sampled.

Survey data will therefore be of prime importance for assessing stock trends for this species.

## 1.10 References

Omnes, M.H., 2003. Le Saint-Pierre (Zeus faber) – Biologie, pêche, marché et potentiel aquacole. Editions Ifremer.

Quéro, J.C., J.J.Vayne. 1997. Les poissons de mer des pêches françaises. Delacheaux&Niestlé Ed. 170-171.

Quéro, J.C., 1978. Répartition des Zéidés (Pisces, Zéiformes) capturés dans l'Atlantique oriental entre le Cap Vert (15°N) et le cap Juby (28°N) au cours des campagnes de la « Thalassa ». Bull. Off. Natn. Pêche. Tunisie, 2(1/2), 49-61.

**Table 1.1 - Proportion of total catch of John dory per area based on the average 1999 – 2008**

| Area | VI | VII | VIIIa,b | VIIIc+IXa | other |
|---|---|---|---|---|---|
| Average catch 99-08 (t) | 633 | 20299 | 3336 | 5144 | 285 |
| % Total | 2.1% | 68.4% | 11.2% | 17.3% | 1.0% |

**Table 1.1 – Landings of John dory per area**

## North Sea (ICES IV)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | : | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | 0 | 0 | 0.32 | 1 | 1 | 0 | 0 | 1 | 1 | 3 | 2 | 0 | 9 | 4 | 4 | 8 | 5 | 3 | 10 | 12 | 8 | 21 | 28 | 18 |

## Irish Sea (ICES VIIa)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | 0 | 0 | 6 | 9 | 11 | 3 | 6 | 5 | 14 | 15 | 11 | 9 | 11 | 8 | 12 | 17 | 12 | 6 | 14 | 8 | 7 | 7 | 3 | 3 |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| France | 3 | 5 | 4 | 5 | 3 | 3 | 3 | 4 | 4 | 3 | 2 | 1 | 0 | 2 | : | 8 | 3 | 5 | 3 | 4 | 8 | 4 | 2 | 2 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | 0 | 0 | 1 | 2 | 2 | 1 | 1 | 3 | 4 | 4 | 4 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 4 | 5 | 25 | 5 | 1 | 2 |

## Eastern Channel (ICES VIId)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | : |
| France | 25 | 26 | 23 | 33 | 34 | 26 | 20 | 20 | 21 | 31 | 24 | 16 | 12 | 19 | : | 18 | 21 | 29 | 41 | 25 | 28 | 27 | 31 | 9 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | 0 | 1 | 3 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 4 | 3 | 1 | 2 | 1 | 2 | 4 |

## Western Channel (ICES VIIe)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | : | : |
| France | 108 | 132 | 123 | 151 | 199 | 186 | 236 | 218 | 204 | 233 | 255 | 207 | 189 | 207 | : | 322 | 318 | 334 | 428 | 378 | 414 | 422 | 411 | 361 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | 26 | 35 | 70 | 90 | 114 | 106 | 55 | 84 | 101 | 163 | 140 | 86 | 48 | 68 | 73 | 120 | 106 | 119 | 124 | 66 | 90 | 106 | 88 | 108 |

## Celtic Sea (ICES VIIf-k)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | 0 | 0 | 9 | 14 | 19 | 33 | 34 | 51 | 65 | 58 | 118 | 99 | 88 | 79 | 108 | 113 | 104 | 117 | 194 | 241 | 277 | 190 | 168 | 152 |
| Spain | : | : | : | : | : | : | : | : | : | : | : | 143 | 179 | 119 | 15 | 199 | 154 | 694 | 951 | 1057 | 100 | 150 | : | : |
| France | 221 | 275 | 261 | 379 | 341 | 338 | 356 | 365 | 357 | 356 | 356 | 393 | 371 | 408 | : | 735 | 841 | 642 | 890 | 943 | 841 | 760 | 691 | 574 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| United Kingdom | 9 | 16 | 24 | 25 | 19 | 33 | 12 | 31 | 27 | 87 | 137 | 123 | 95 | 52 | 77 | 122 | 125 | 130 | 120 | 150 | 116 | 101 | 108 | 133 |

## Bay of Biscay (ICES VIII)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denmark | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | 15 | 76 | 97 | 65 | 76 | 81 | 62 | 208 | 235 | 59 | 145 | 112 | 360 |
| France | 52 | 60 | 81 | 99 | 69 | 88 | 62 | 46 | 48 | 67 | 71 | 52 | 82 | 115 | : | 123 | 124 | 178 | 295 | 284 | 382 | 334 | 365 | 222 |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | 0 | 0 | 0 | 2 | 4 | 4 | 6 | 2 | 4 | 4 | 2 | 3 | 4 | 8 | 3 | 3 | 1 | 0 | 3 | 1 | 0 | 1 | 1 | 1 |
| United Kingdom | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

## Iberian waters (ICES VIIIc + IX)

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Denmark | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Germany | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Ireland | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Spain | : | : | : | : | : | : | : | : | : | : | : | : | 185 | 410 | 566 | 288 | 731 | 39 | 92 | 80 | 16 | 30 | 28 | 27 |
| France | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | 1 | : | : | 1 | : |
| Netherlands | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Portugal | 139 | 7 | 193 | 323 | 342 | 325 | 291 | 299 | 361 | 292 | 150 | 150 | 170 | 276 | 282 | 382 | 397 | 387 | 382 | 292 | 254 | 281 | 355 | 231 |
| United Kingdom | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |

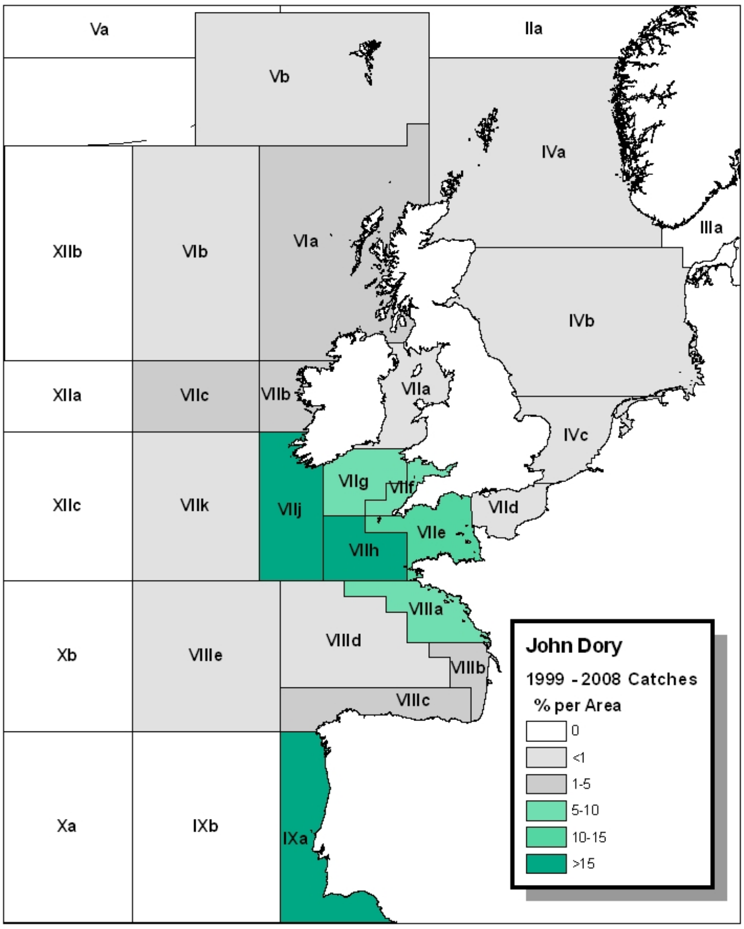
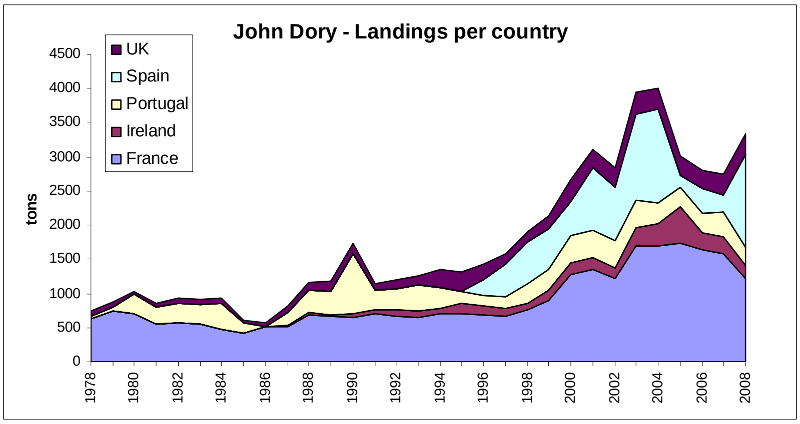



**Figure 1.1 - Proportion of total catch of John dory per area based on the average 1999 – 2008**



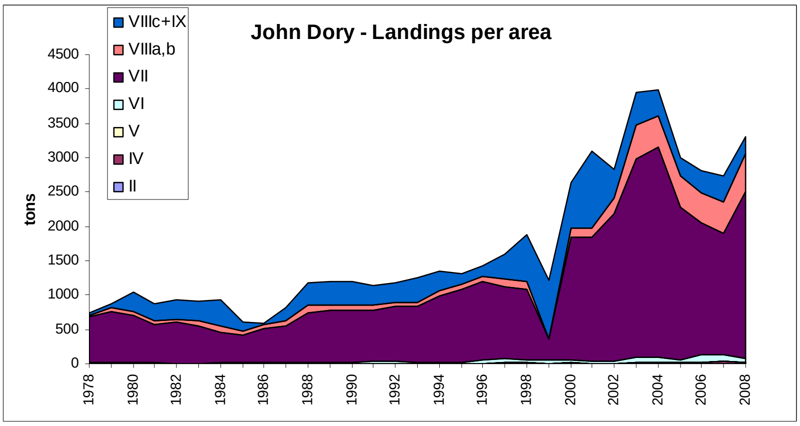




**Figure Figure1.1. - Landings of John dory per country and area from 1978 to 2008.**

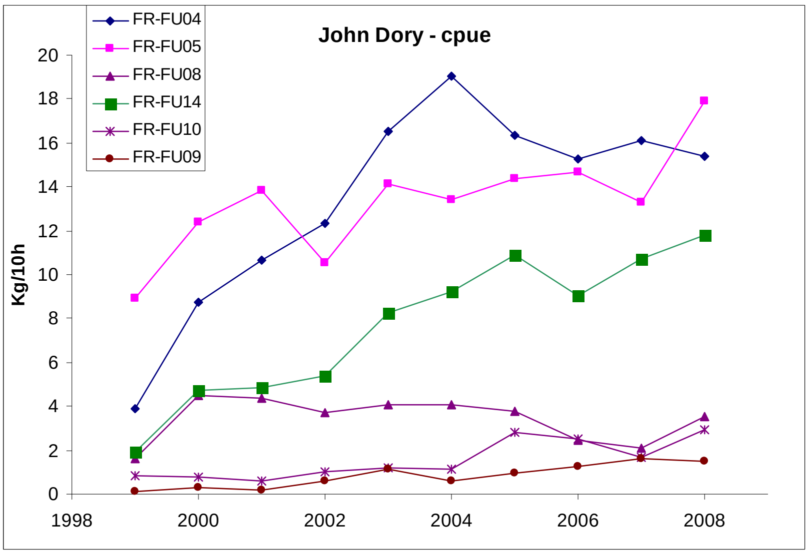



**Figure Figure 1.2 – Cpues for some French metiers from 1999 to 2008.**

Métiers:
FU04: Benthic in the Celtic Sea
FU05: Demersal in the Celtic Sea
FU08: Nephrops in the Celtic Sea
FU09: Nephrops in the Bay of Biscay
FU 10: Demersal in the Bay of Biscay
FU 14: Benthic in the Bay of Biscay

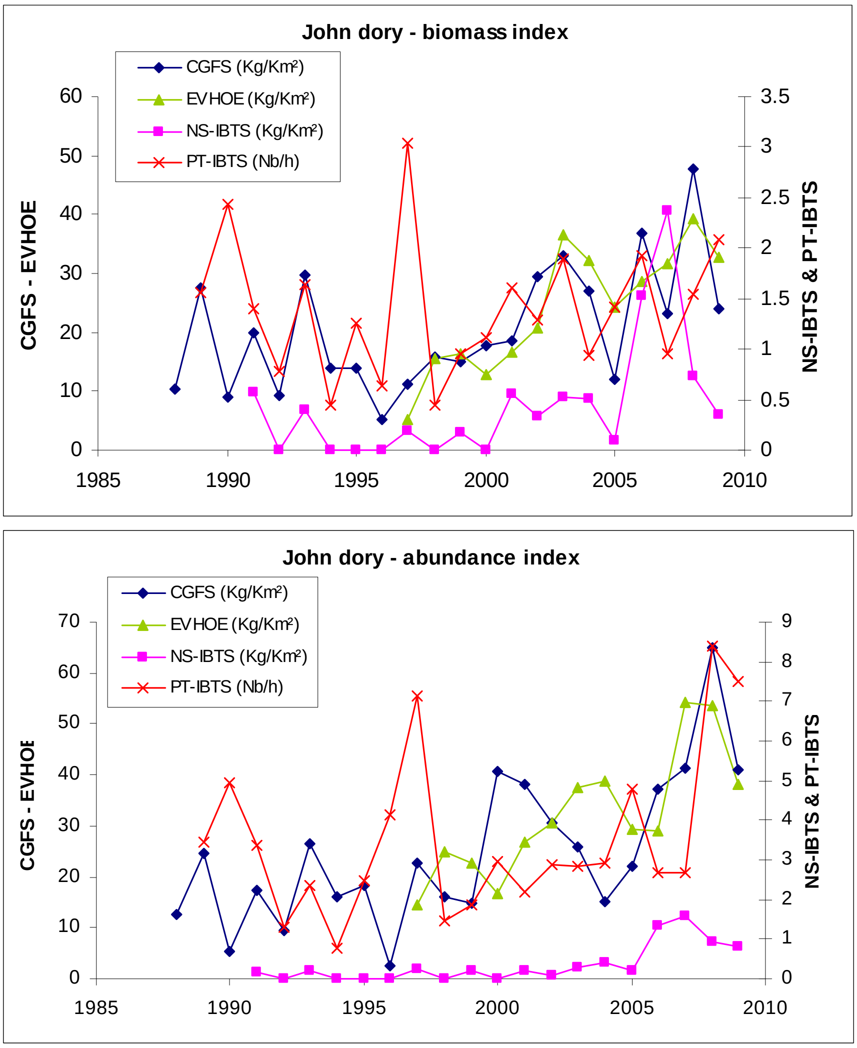



**Figure 1.4– Biomass and abundance indices of John dory from different surveys for areas IV to IX.**

Areas:

NS-IBTS: IVa-c
CGFS: VIIe
EVHOE: VIIf-j+VIIIa,b
PT-IBTS: IXa

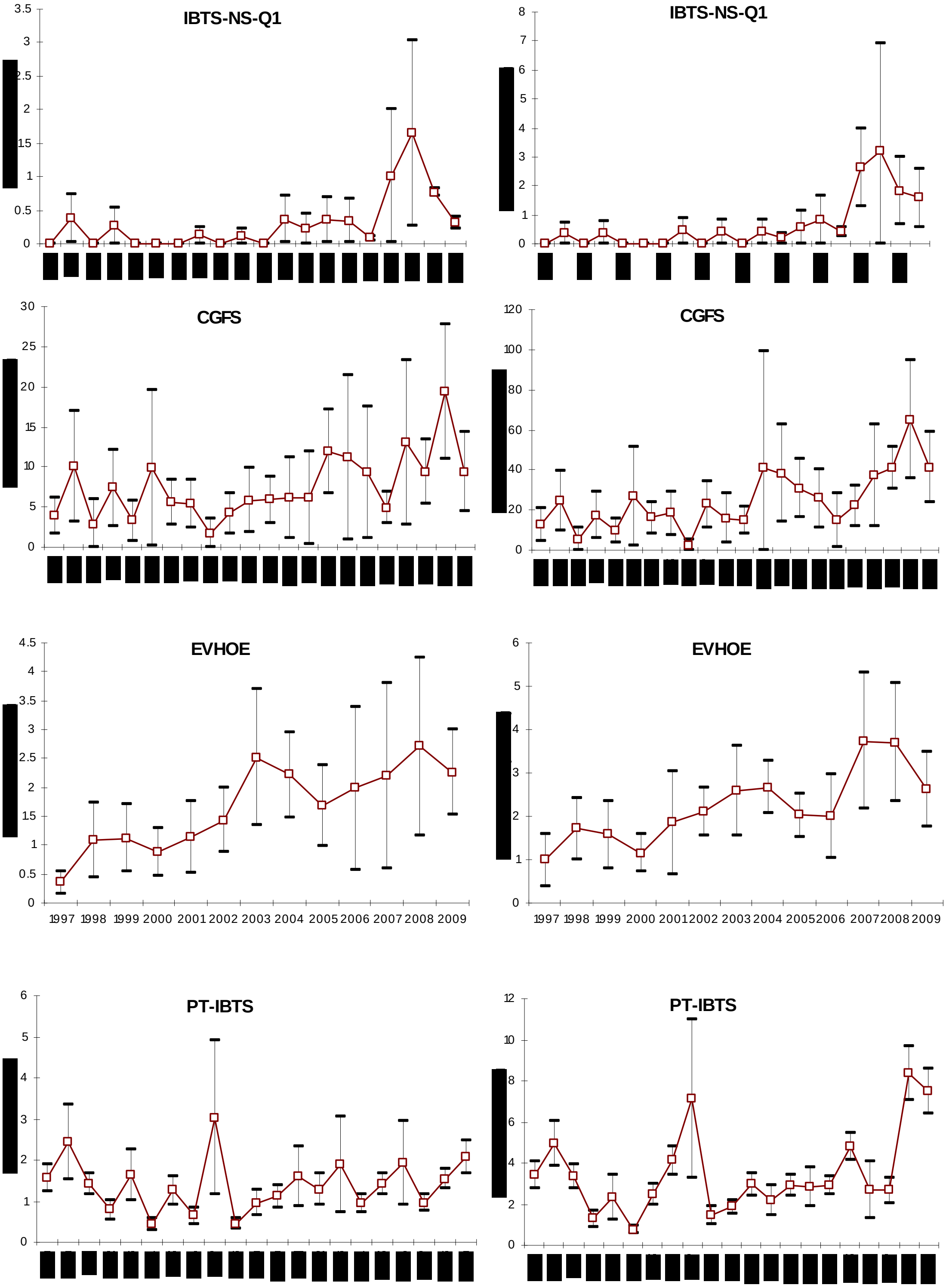



**Figure 1.3– Biomass and abundance indices of John dory from different surveys for areas IV to IX.**

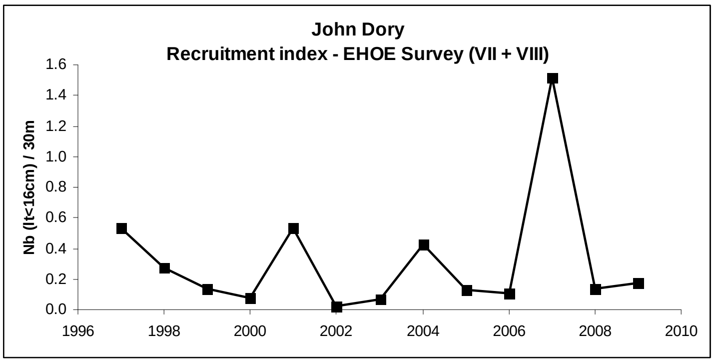



**Figure 1.6 – John dory recruitment index (as number of individuals less than 16 cm) from the EVHOE survey**

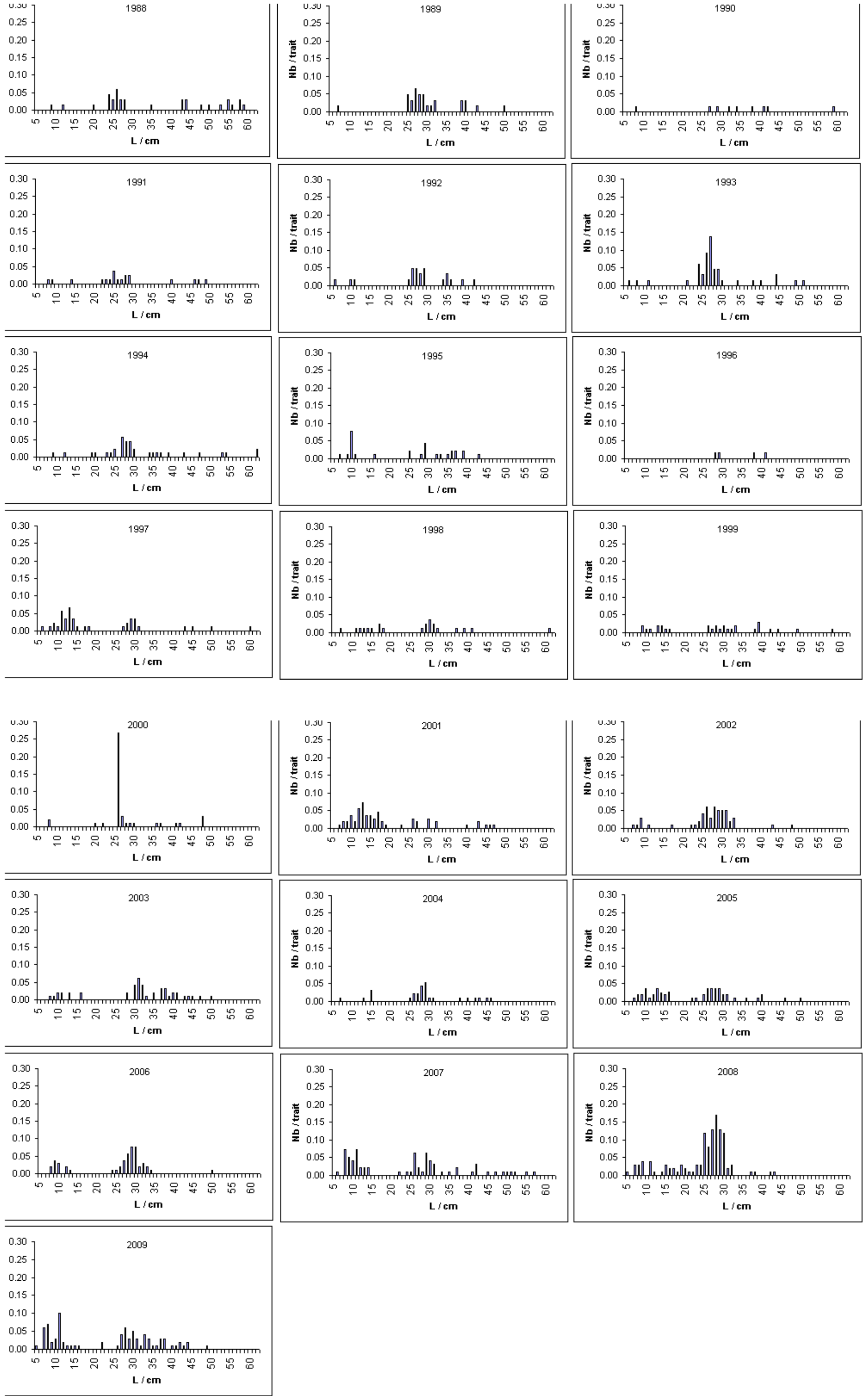



**Figure 1.7 - Length abundance indices of John dory from FR-CGFS surveys in VIId**

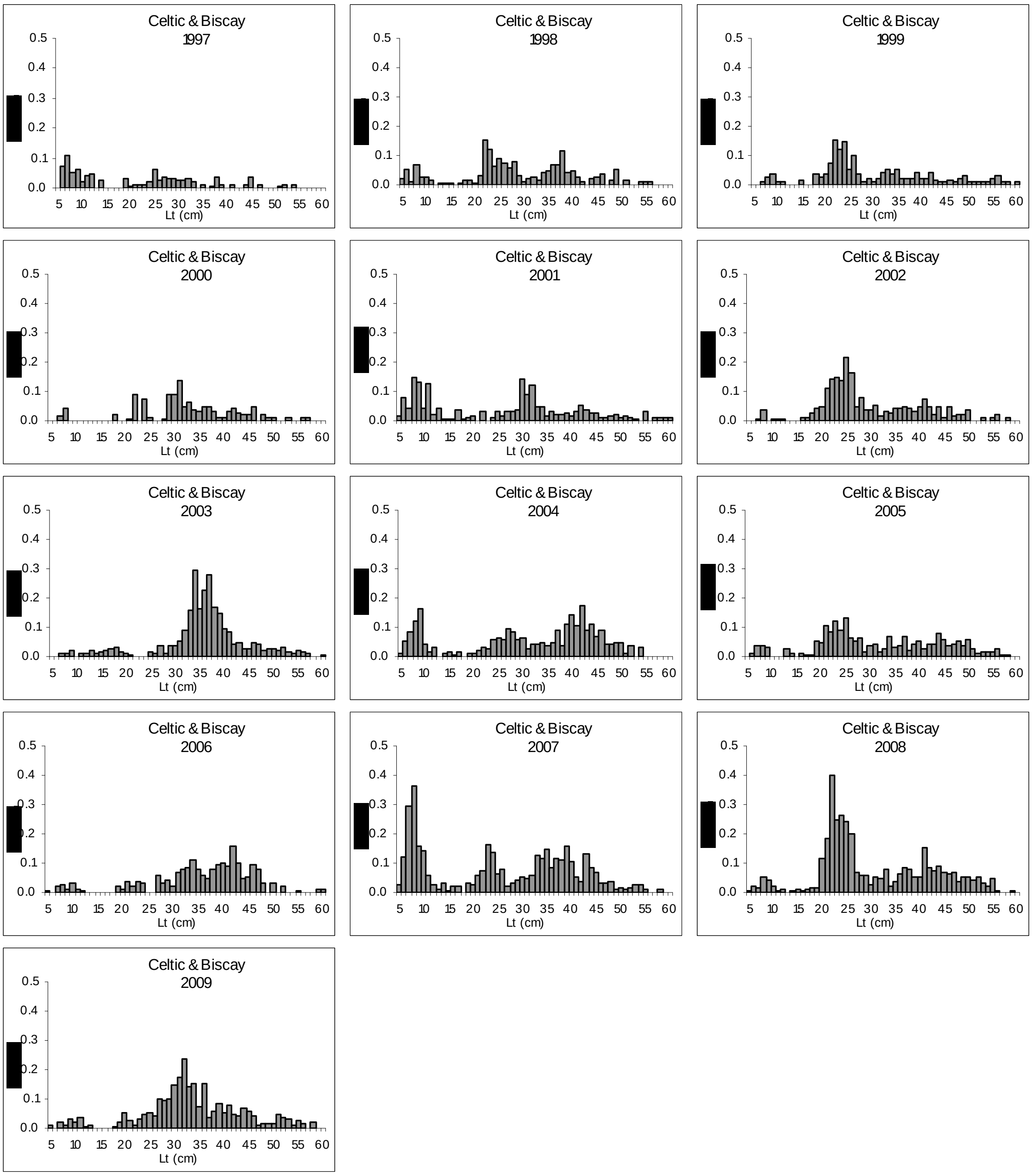



**Figure 1.4 - Length abundance index of John dory in Celtic Sea and Bay of Biscay from FR-EVHOE surveys series.**

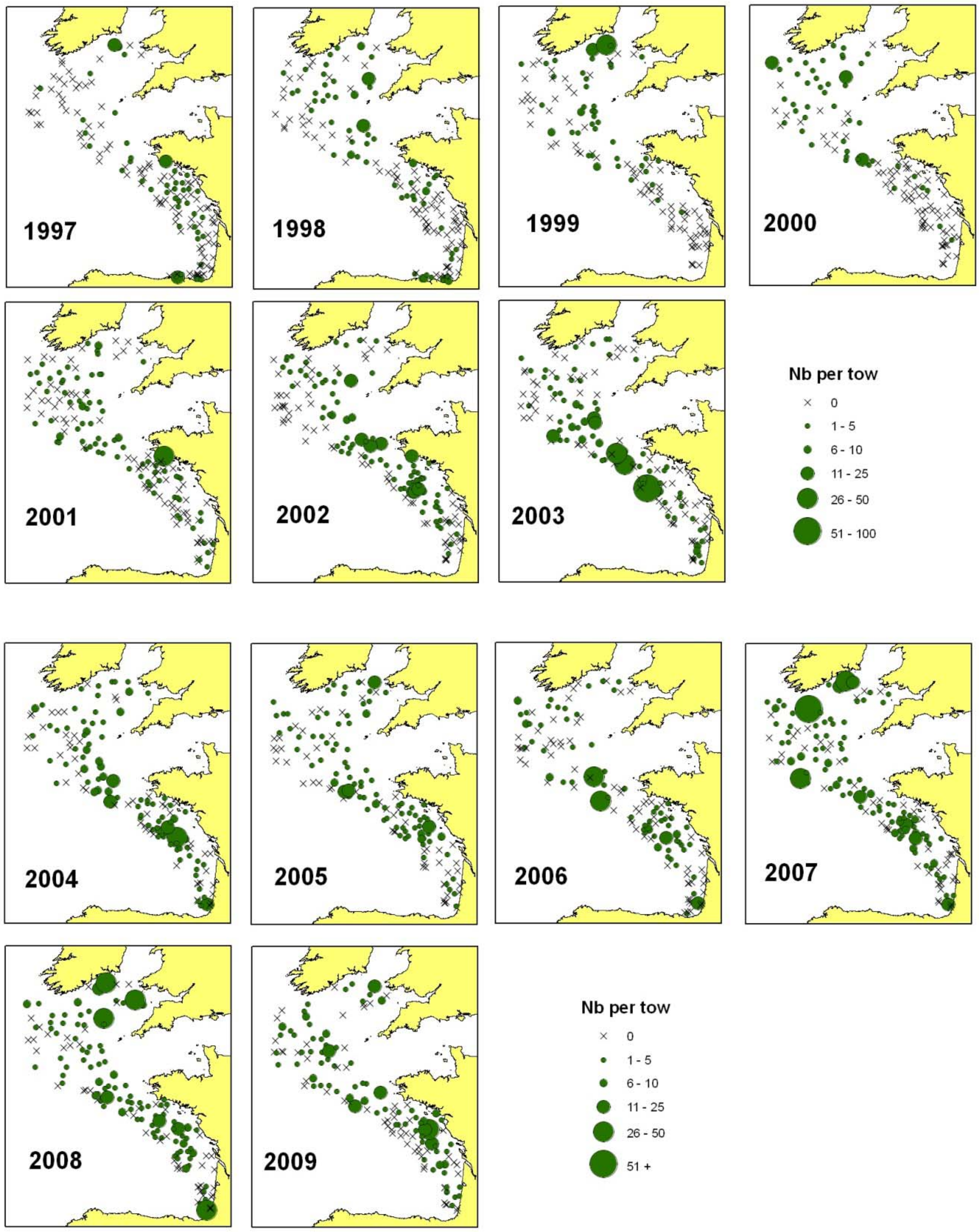



**Figure 1.5 - Distribution of John dory in the Celtic Sea and in the Bay of Biscay during FR-EVHOE from 1997 to 2009.**

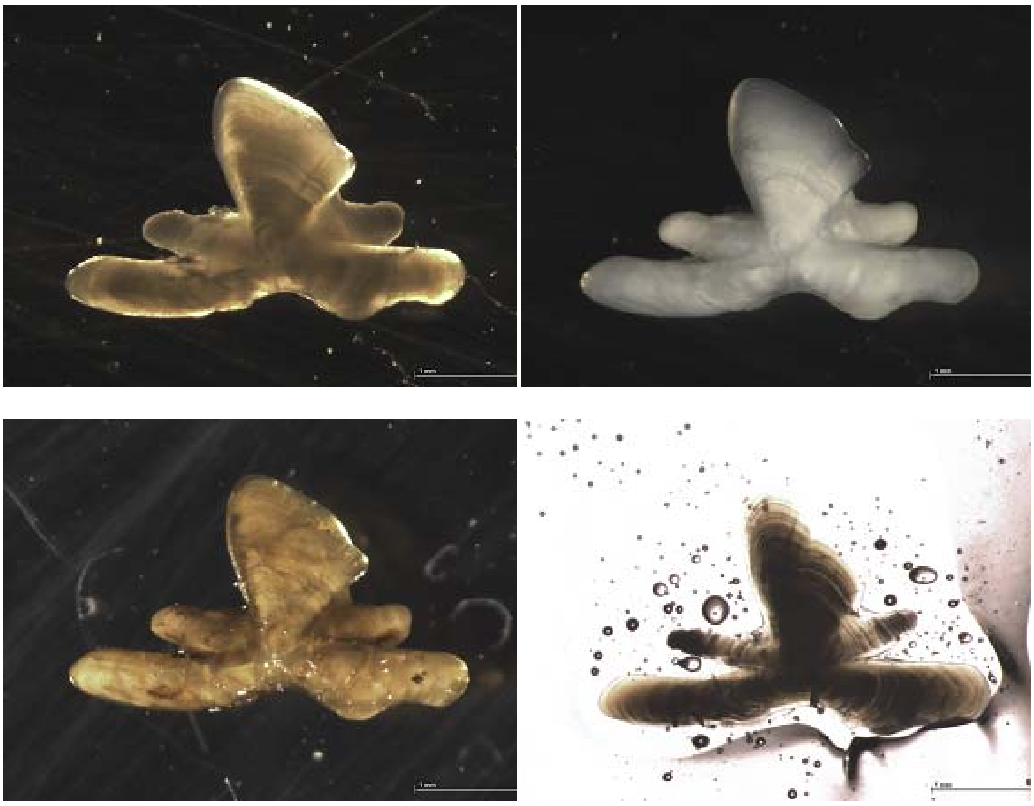


**Figure 1.6– Otoliths of John dory: transmitted light, reflected light, burnt otolith and polished otolith**

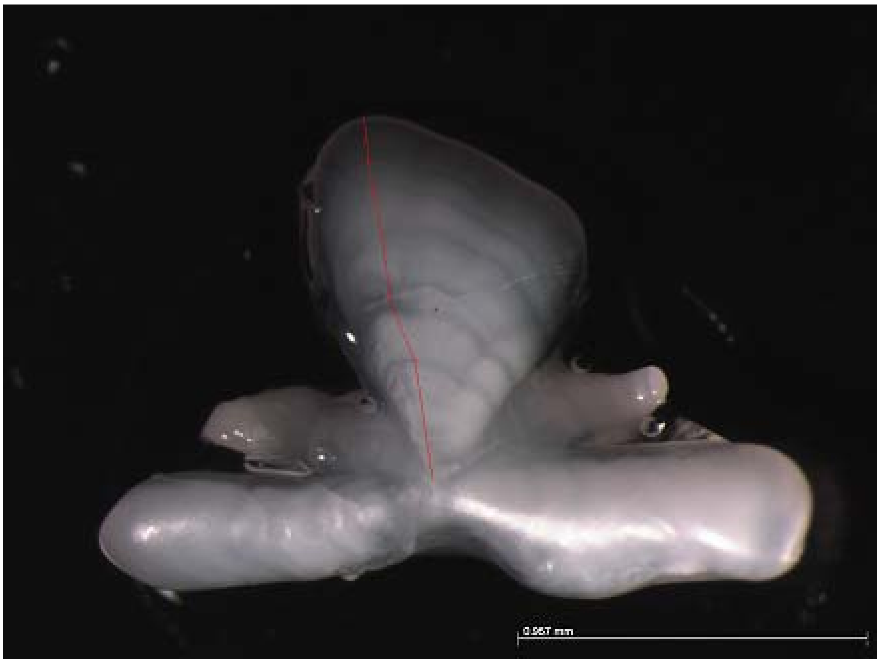


**Figure 1.7– Otolith of John dory (50 cm) with easily identifiable rings.**

## Annex 12 – Working Documents

### WD1

# Working Document: The UK bass fishery, re-run of FAD-only assessment model

By S. Kupschus

CEFAS, Lowestoft

### Background

In 2007, Pawson *et al.* (2007) published a multi-métier, fully statistical, separable catch-at-age model using UK-only bass data for the period 1985-2004. This analysis covered the four 'stock areas' previously proposed, namely Divisions IVb,c, Division VIId, Divisions VIIe, h and Divisions VIIa, f, g. The data used was a 'best estimate' of the catch and effort of the bass fishery, based on data integrated from official statistics and a voluntary bass logbook scheme. These integrated data were regarded as being a more realistic reflection of the fishery.

In 2008, Kupschus *et al.* (2008) re-ran the original model with additional data (2005-2006). The model was also run using official catch and effort statistics only, to compare with the outputs of the 'best estimate' (hybrid) model.

For WGNEW 2010, the FAD-only model was re-run, including data for 2007-2009. Unfortunately, the original assessment model of Pawson *et al.* (2007) could not be re-run, as the Cefas voluntary logbook scheme was closed in 2007 and 2008 and although data were available for 2009, catch and effort estimates were not considered robust enough. All model settings were retained, and the model simply run with the additional data. A full description of the model structure can be found in Pawson *et al.* (2007) and Kupschus *et al.* (2008)

### Results and discussion

The catch residuals plotted on the original scale (Figure 1-4) indicate a lot of noise and some consistent patterns (year, cohort effects) in the age information, as has always been the case but worrisome is the fact that recent information seems now to be much more variable. There are a number of potential causes for this. FAD data is now much better recorded for trawls so that CPUE / catches are probably more realistic now, but are inconsistent with the historic reporting rate so violate the constant catchability assumption

The assessments were never designed to determine absolute levels in the stock, but rather to get a handle on trends in the stock and to produce useful selectivity patterns. In fact the shape of selectivity patterns (the relative differences between the gears) were partly used to assess the quality of the assessments. In general the selectivities between gears appear to be less significant now than they were before, least affected by this is the North Sea, most the Celtic Sea. As length/age information has always come from FAD, it is either the sampling levels between gears or a general reduction in sampling that may have caused this.

Relative F-estimates appear variable but stable since 1990 in western stocks, but show a decline in eastern stocks since about 1995. Because of the direct link with effort, this may well be associated with the general decline in trawl effort due to cod recovery measures in the North Sea and eastern channel. However, these are not the boats catching bass, but the boats are not distinguishable on FAD. This may at least in part also explain the exponential increase in SSB predicted by the model for the eastern stocks.

SSB has been increasing in all of the stocks over the period, but the increases have leveled off in the western stocks, whilst continuing to increase rapidly in the eastern stocks. Whilst there is little doubt that bass are still expanding into the NS with recent reports of the being found in Norway, it seems unlikely that this is one contiguous fully mixed stock. The local nature of much of the bass fishery in the NS would suggest that the model is insufficiently constrained and allows a large accumulation of SSB in the unmonitored plus group (except for the lines métier) aided by the forced reduction in F due to the apparent decline in bass trawl effort (see above).

Recruitment indices still show very good agreement between stocks and the independent observed index calculated from the Solent survey until about 2002. Since then stocks appear to have at least on the relative scale to historic recruitments developed independent identities. Some of the patterns are still similar, North and Celtic Sea show recruitment diminishing since 2003 fading away to very little. Channel stocks, particularly the west appears to have had record recruitments for the last 4 years. The Solent index instead indicates that recruitment has been around median levels. The last two years of the survey index are provisional as they have only been assessed at less than three ages. Similarly, the final value for recruitment for each of the stocks is very tenuous, as it is based on small numbers of fish for which the selectivity is assessed to be very low. (Small number times small number, same level of precision). The index was originally seen as a good indication that the assessments were providing useful information. The fact that this is deteriorating should suggest that the assessments are at the least increasingly uncertain and that even at the relative level should probably only be used in conjunction with other evidence.

In short, it is still possible to say quite a lot about the past even when using the FAD only data. Saying much about the present is more difficult as we have had a change in the reporting. With further refinement of the FAD database it may in future be possible to get a better handle on the boats that target bass and those that land bass as a by catch. These could then be treated as separate fleets and would not cause the same potential for bias in the assessment. The uncertainty of the older ages is not necessarily new, in the sense there has always been a migration issue (at the older ages) that these assessments have ignored however at least in the eastern stocks this effects is now making it difficult to even discern the trends in abundance so that it is difficult to even say if the stocks are increasing or not. Recent residual patterns show increases in uncertainty and for forecasts this is the most important information, so it is definitely not possible to provide any short-term forecast even if the assessments could be taken on an absolute level.

## References

Kupschus, S., Smith, M. T., Walmsley, S. A. (2008) Annex 2: Working Document. An update of the UK bass assessments 2007. Report of the Working Group on the Assessment of New MoU Species (WGNEW). By Correspondence, ICES CM 2008/ACOM:25. 77 pp.

Pawson, M. G., Kupschus, S. and Pickett, G. D., 2007a. The status of sea bass (*Dicentrarchus labrax*) stocks around England and Wales, derived using a separable catch-at-age model, and implications for fisheries management. *ICES Journal of Marine Science* 64, 346–356.

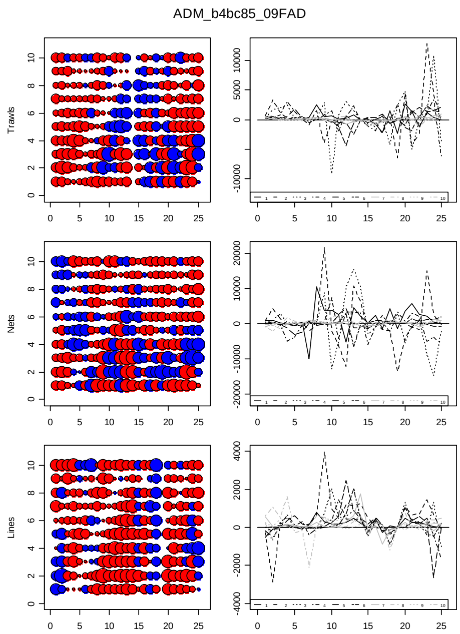



Fig. 1: Residual Plots by fleet North Sea

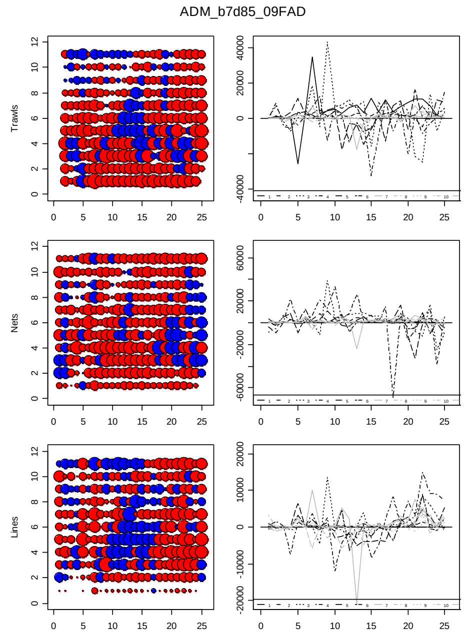



Fig. 2: Residual Plots by fleet Eastern Channel

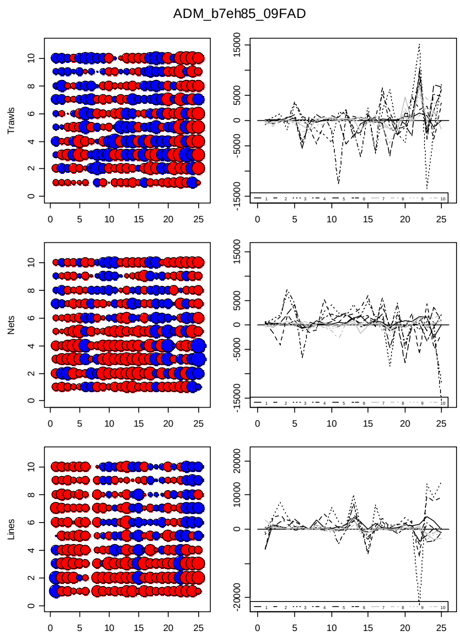



Fig. 3: Residual Plots by fleet Western Channel

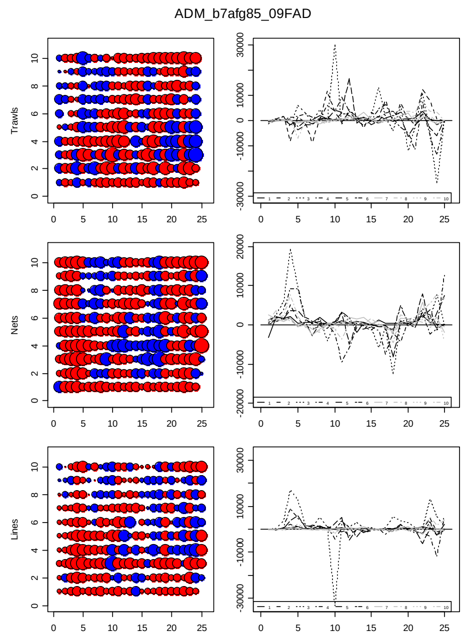



Fig. 4: Residual Plots by fleet Celtic Sea

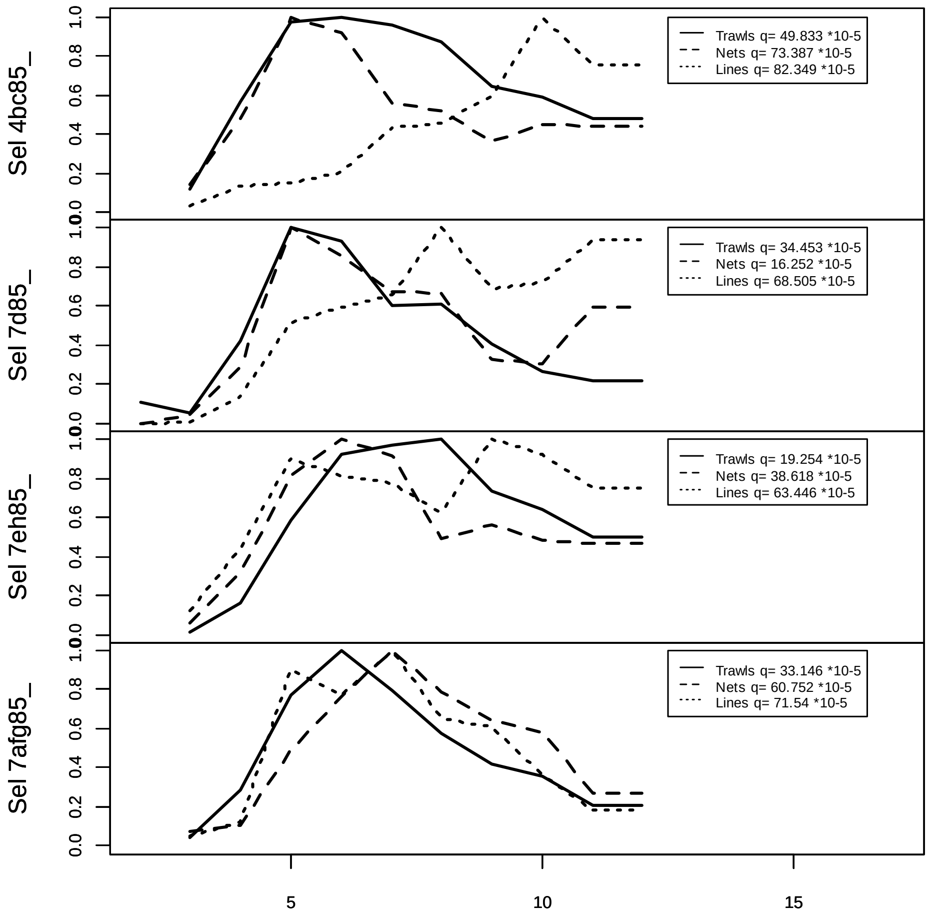



**Figure 5 Selectivities by fleet and stock noting the greater similarities between gears in the western versus the eastern stocks**

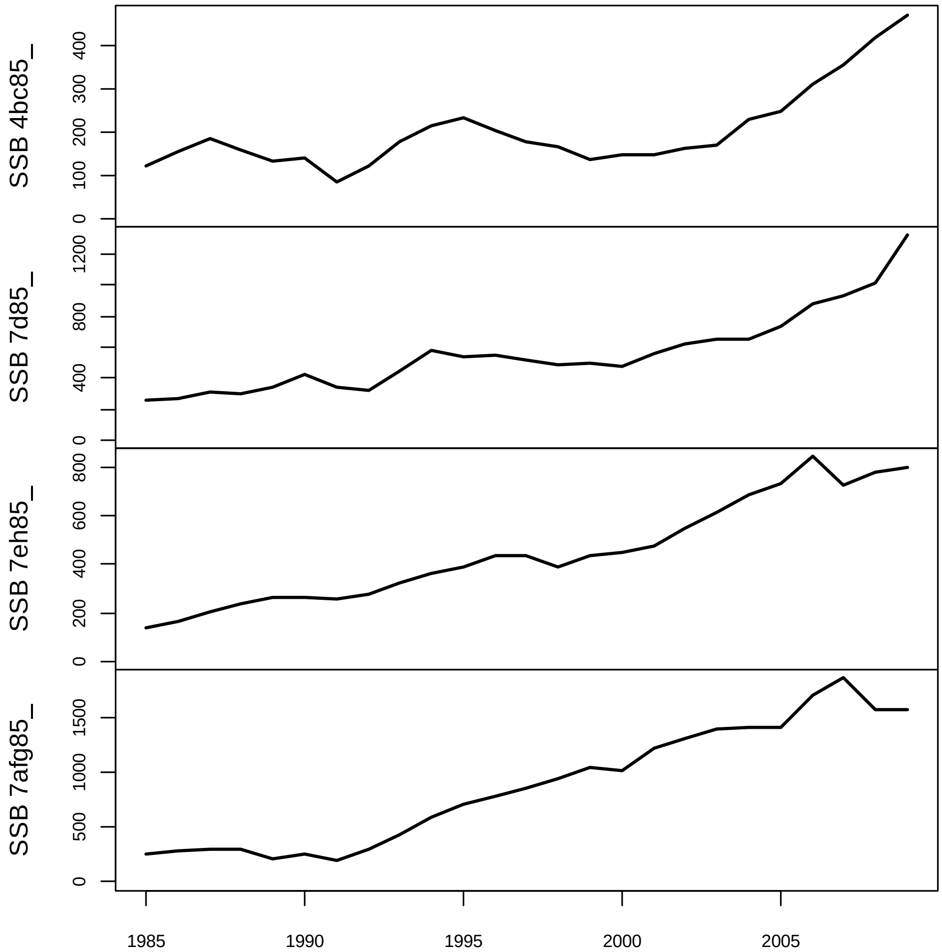



**Figure 6 SSB estimates by stock, noting the exponential increase in the eastern stocks**

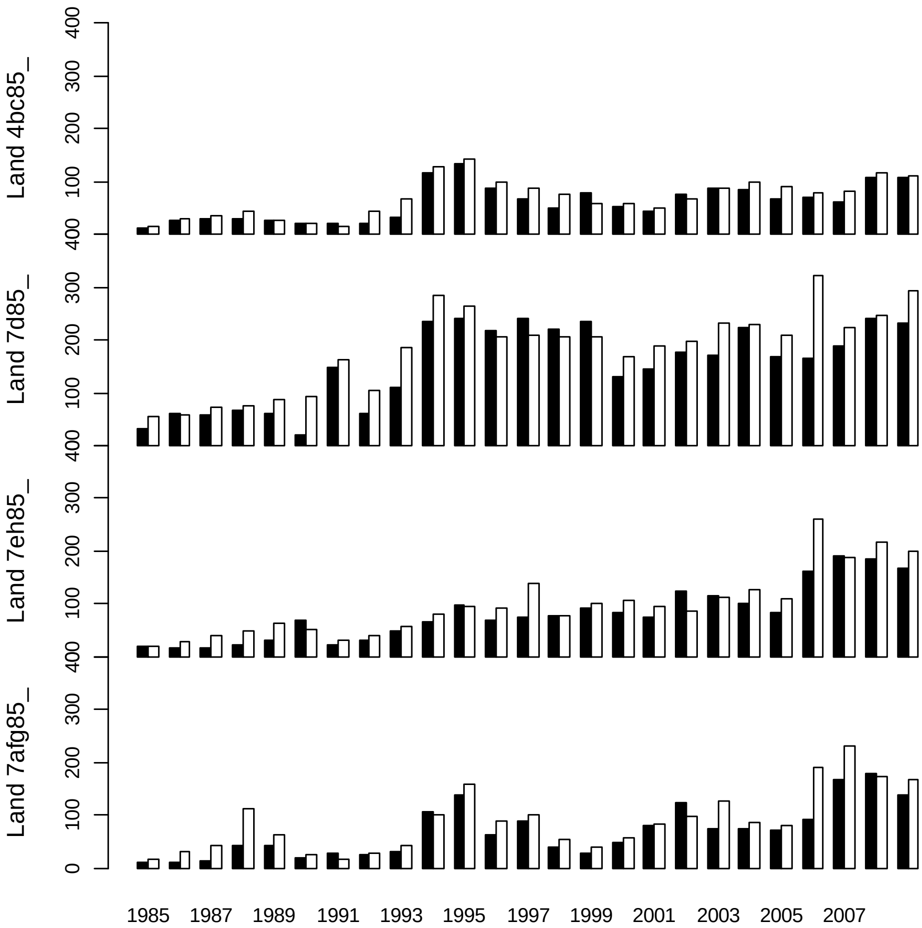



**Figure 7 Observed (black) and Predicted (white) landings by stock indicating recent increases in the landings in the western stocks with more stable landings in the eastern stocks.**

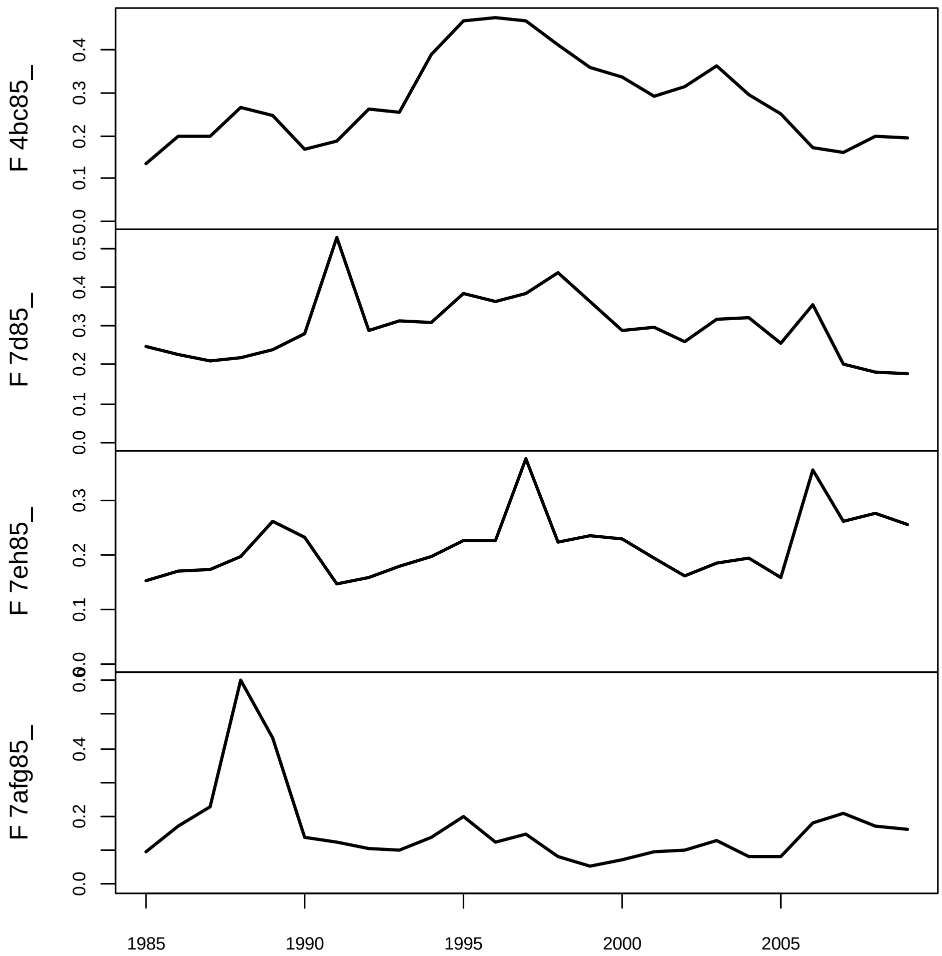



**Figure 8: Fishing mortality trends for the four stocks. Note that F trends are linearly tied to the effort in the different métiers weighted by the catchabilities of the three fleets.**

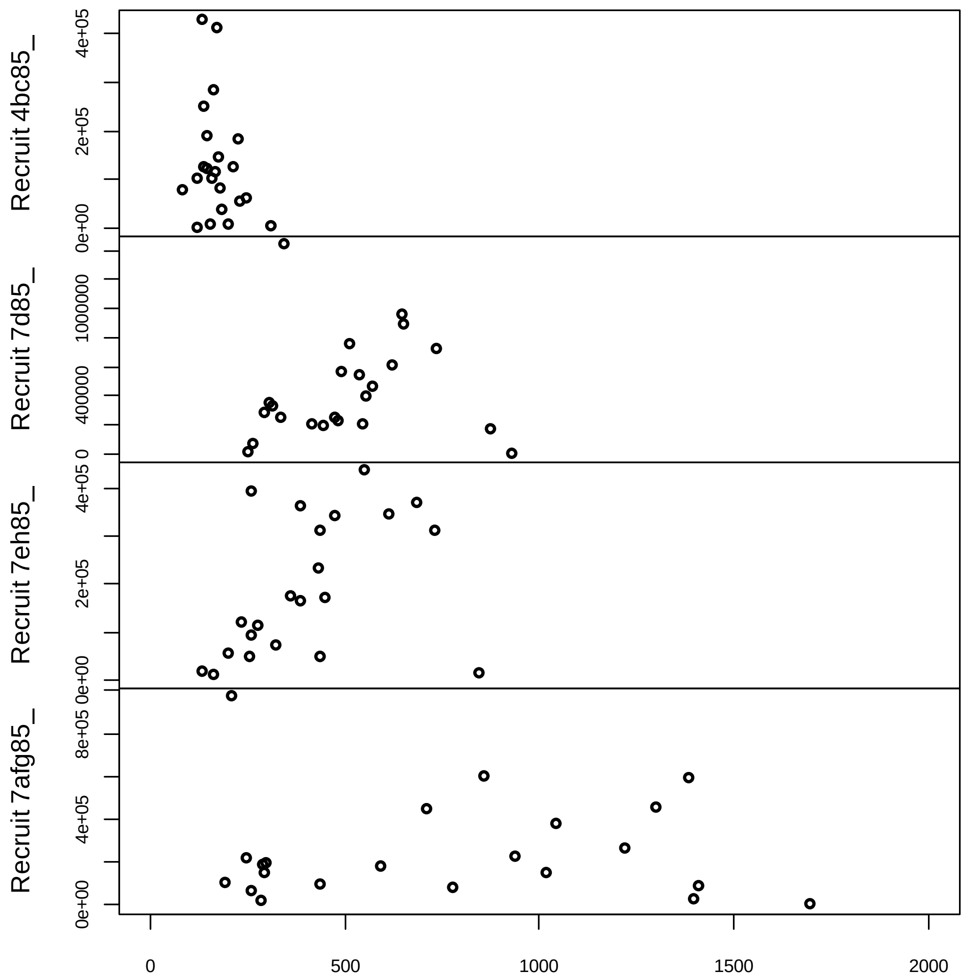



**Figure 9 Potential stock recruit plots for the four stocks. Channel stocks and possibly the Celtic Sea stock appear to show a linear relationship, but we only have a single increasing trend over time in SSB so this may well be a recruit stock relationship.**

## Annex 13: List of participants

| Name | Address | Phone/Fax | Email |
|---|---|---|---|
| Robert Bellail | IFREMER Lorient Station<br>8, rue François Toullec<br>56100 Lorient<br>France | Phone +33 2 97 87 3819<br>Fax +33 2 97 87 3836 | robert.bellail@ifremer.fr |
| Mickael Drogou | IFREMER Brest<br>BP70<br>29270 Plouzané<br>France | Phone +33 2 98 22 4374<br>Fax +33 2 98 22 | Mickael.Drogou@ifremer.fr |
| Henk Heessen<br>Chair | IMARES<br>P.O. Box 68<br>NL-1970 AB IJmuiden<br>Netherlands | Phone +31 (0)317-487089 | henk.heessen@wur.nl |
| Jean-Claude Mahé<br>Chair | IFREMER Lorient Station<br>8, rue François Toullec<br>56100 Lorient<br>France | Phone +33 (0)2 97 87 38 18<br>Fax +33 (0)2 97 87 38 36 | jean.claude.mahe@ifremer.fr |
| Kelig Mahé | IFREMER Boulogne-sur-Mer Centre<br>P.O. Box 699<br>62321 Boulogne Cédex<br>France | Phone +33 321 995602<br>Fax +33 321 995601 | Kelig.Mahe@ifremer.fr |
| Kelle Moreau | Institute for Agricultural and Fisheries Research (ILVO)<br>Ankerstraat 1<br>8400 Oostende<br>Belgium | Phone +32 59 569830<br>Fax +32 59 330629 | kelle.moreau@ilvo.vlaanderen.be |
| Kay Panten | Johann Heinrich von Thünen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries Institute for Sea Fisheries<br>Palmaille 9<br>D-22767 Hamburg<br>Germany | Phone +49 4038 905 108<br>Fax +49 4038 905 263 | kay.panten@vti.bund.de |
| Jan Jaap Poos | IMARES<br>P.O. Box 68<br>NL-1970 AB IJmuiden<br>Netherlands | Phone +31 317 487 189<br>Fax +31 317 480 900 | Janjaap.Poos@wur.nl |
| Francesca Vitale | Swedish Board of Fisheries Institute of Marine Research, Lysekil<br>P.O. Box 4<br>SE-453 21 Lysekil<br>Sweden | Phone +46 523 18792 | francesca.vitale@fiskeriverket.se |
| Sarah Walmsley<br>(by correspondance) | Cefas<br>Lowestoft Laboratory<br>Lowestoft<br>Suffolk NR33 0HT<br>United Kingdom | Phone +44(0)1502527790<br>Fax : +44(0)1502513865 | s.walmsley@cefas.co.uk |

## Annex 14: WGNEW terms of reference for the next meeting

The Working Group on Assessment of New MoU Species [WGNEW] (Chaired by Jan Jaap Poos, Netherlands) will meet in ICES HQ xx–xx Month 2012 to:

a ) consider possibilities for fish stock assessments/input to management processes/indicators of the following species: sea bass, common dab (except for the Baltic), lemon sole, brill (except for the Baltic), turbot (except for the Baltic), witch flounder, red gurnard, tub gurnard, striped red mullet and John dory, through:
   - i ) review of knowledge on stock structure;
   - ii ) existing fisheries monitoring programmes and surveys including the EU Data Collection Programme;
   - iii ) existing databases made available for fish stocks assessment.

b ) These results will be presented in the form of
   - iv ) dataseries considered indicative of stock trends/status
   - v ) proposals for analytical assessments if appropriate
   - vi ) comments on additional data collection that would improve the assessment of stock status

c ) This will be done on the basis of data and methods prepared before the meeting.

Material and data relevant for the meeting must be available to the group no later than 14 days prior to the starting date.

WGNEW will report by xx month 2012 to ACOM and SSGSUE.

### Supporting Information

| | |
|---|---|
| **Priority:** | High. The new MoU lists these species as new and extra species for which EC and NEAFC want advice on their management. |
| **Scientific Justification and relation to Action Plan** | The MoU between the EC and ICES lists a number of new species for which the EC wants routine advice from ICES regarding management of the fishery on them.<br>This WG is regarded to deal with the issues for the fish species mentioned. |
| **Resource Requirements:** | No specific resource requirements, beyond the need for members to prepare for and participate in the meeting. |
| **Participants:** | 10–15 |
| **Secretariat Facilities:** | Production of report |
| **Financial:** | |
| **Linkages to Advisory Committees:** | WGNEW reports to ACOM |
| **Linkages to other Committees or Groups:** | SSGSUE |
| **Linkages to other Organisations:** | |

## Annex 15: Recommendations

We suggest that each Expert Group collate and list their recommendations (if any) in a separate annex to the report. It has not always been clear to whom recommendations are addressed. Most often, we have seen that recommendations are addressed to:

- Another Expert Group under the Advisory or the Science Programme;
- The ICES Data Centre;
- Generally addressed to ICES;
- One or more members of the Expert Group itself.

| Recommendation | For follow up by: |
|---|---|
| 1. WGNEW recommends that a workshop is organised to discuss the data available for a bass assessment and discuss an assessment method that can provide population and exploitation dynamics | ACOM |
| 2. WGNEW recommends a rolling scheme for future meetings, in order to better focus on a limited number of species each year. A proposal could be:<br>Year 1: sea bass, red gurnard, grey gurnard, brill, turbot, dab<br>Year 2: striped red mullet, tub gurnard, lemon sole, flounder, witch flounder, John dory | ACOM |
| 3. WGNEW uses distribution maps, length frequency distributions and abundance time series based on surveys for which data are stored in the Datras database (e.g. IBTS and BTS surveys in the North Sea and in Skagerrak/Kattegat). WGNEW recommends that the ICES Data Centre provides updates of these data for the NEW species annually. Ideally the information should consist of:<br>• a distribution map per year, all length classes combined<br>• an overall index of abundance (all length classes combined) per area per year;<br>• length distributions by area and year;<br>• numbers-at-length by area and year.<br>These indices should be calculated as other IBTS indices: 1) average per ICES rectangle, 2) then average per roundfish area, 3) then average over total North Sea. | ICES Data Centre |

After submission of the report, the ICES Secretariat will follow up on the recommendations, which will also include communication of proposed terms of reference to other ICES Expert Group Chairs. The "Action" column is optional, but in some cases, it would be helpful for ICES if you would specify to whom the recommendation is addressed.