Annex 2: Stock Annexes

Quality handbook: Plaice in Division VIId

Working Group:	ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
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GENERAL

Stock Definition

There is mixing of plaice between the North Sea and VIId both as adults and juveniles. Analysis of tagging data shows that around 40% of the juvenile plaice in VIId come from nursery grounds in the North Sea. The eastern Channel supplies very few recruits to the North Sea. There is also an adult migration between the North Sea and Channel with 20-30% of the plaice caught in the winter in VIId were from migratory North Sea fish. Separation between VIId and the western Channel (VIIe) is much clearer. VIId does not receive significant numbers of juvenile plaice from VIIe but contributes around 20% of the recruits to VIIe. Similarly, around 20% of the adult plaice spawning in VIId may have spent part of the year in VIIe but few plaice tagged in VIIe during the spawning period are recaptured in VIId. It can be concluded that there is considerable interchange of plaice from the North Sea into VIId but a much smaller interchange between VIId and VIIe. Since the exploitation patterns between the three areas are very different, it has been concluded that separate assessments should be carried out.

The management area for channel plaice is a combined one between VIId and VIIe. TACs are obtained by combining the agreed TAC from each area.

Fishery

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts. The main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st and 4th quarters and their area of activity covers almost the whole of VIId south of the 6 mile contour from the English coast. There is only light activity by this fleet between April and September. The second offshore fleet is mainly large otter trawlers from Boulogne, Dieppe and Fecamp. The target species of these vessels are cod, whiting, plaice mackerel, gurnards and cuttlefish and the fleet operates throughout VIId. The inshore trawlers and netters are mainly vessels <10m operating on a daily basis within 6 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish.

The minimum landing size for plaice is 27cm. Demersal gears permitted to catch plaice are 80mm for beam trawling and 100mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

There is widespread discarding of plaice, especially from beam trawlers. The 25 and 50% retention lengths for plaice in an 80mm beam trawl are16.4cm and 17.6cm respectively which are substantially below the MLS. Routine data on discarding is not available but comparison with the North Sea suggests that discarding levels in excess of 40% by weight are likely. Discard survival from small otter trawlers can be in excess of 50% (Millner et al., 1993). In comparison discard mortality from large beam trawlers has been found to be between less than 20% after a 2h haul and up to 40% for a one-hour tow (van Beek et al 1989).

Ecosystem Aspects

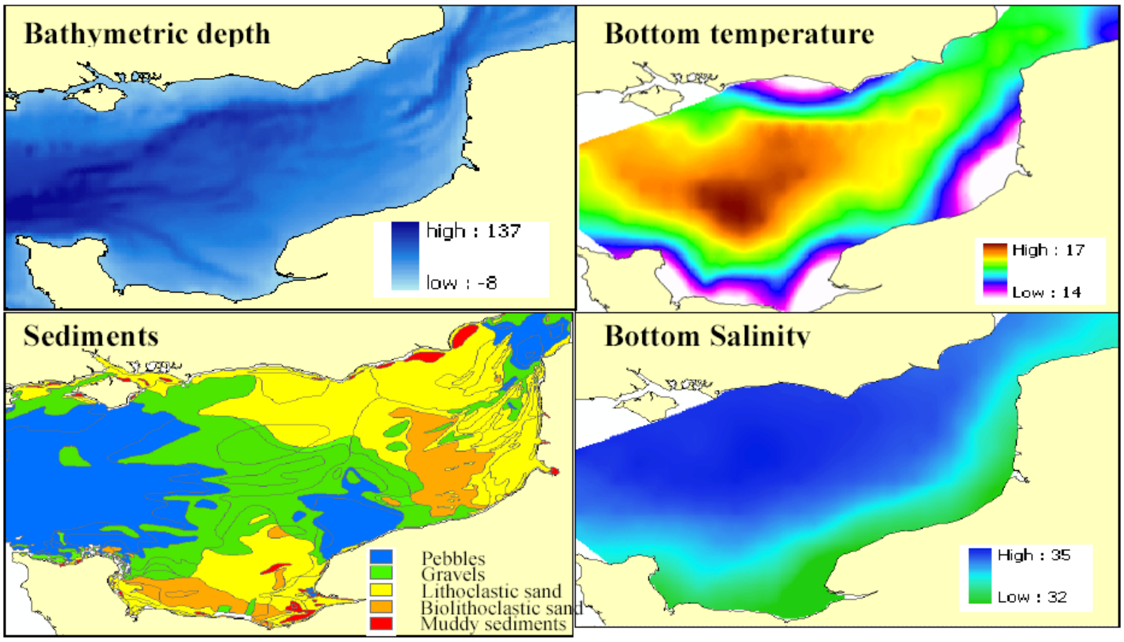


Figure 1 Eastern English Channel physical and hydrological features: Bathymetric depth and simplified sediment types representation. Survey bottom temperature and bottom salinity (averaged for 1997 to 2003) obtained by kriging. (in Vaz *et al.* 2004)

Biology : Adult plaice feed essentially on annelid polychaetes, bivalve molluscs, coelenterates, crustaceans, echinoderms, and small fish. In the English Channel, spawning occurs from December to March between 20 and 40 m. depth. At the beginning, pelagic eggs float at the surface and then progressively sink into deeper waters during development. Hatching occurs 20 (5-6°C) to 30 (2-2.5°C) days after fertilization. Larvae spend about 40 days in the plankton before migrating to the bottom and moving to coastal waters when metamorphosing (10-17 mm). The fry undergo relatively fast growth during the first year (*Carpentier et al., 2005*).

Environment: This bentho-demersal species prefers living on sand but also gravel or mud bottoms, from the coast to 200 m depth. The sepcies is found from marine to brackish waters in temperate climate (*Carpentier et al., 2005*)..

Geographical distribution : Northeast Atlantic, from northern Norway and Greenland to Morocco, including the White Sea; Mediterranean and Black Seas (*Carpentier et al., 2005*)..

Vaz et al. (2007) used a multivariate and spatial analyses to identify and locate fish, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004. Four sub-communities with varying diversity levels were identified in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Fig.2 below) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

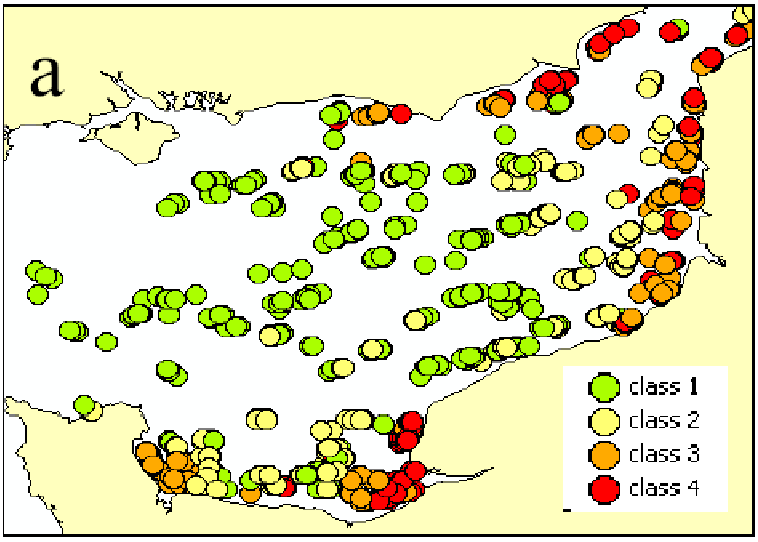


Figure 2 : Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities. (In Vaz *et al.*, 2004)

Community evolution over time : (From Vaz *et al*., 2007). The community relationship with its environment was remarkably stable over the 17 y of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect interannual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

Data

Commercial Catch

The landings are taken by three countries France (55% of combined TAC), England (29%) and Belgium (16%). Quarterly catch numbers and weights were available for a range of years depending on country; the availability is presented in the text table below. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable. In 2001 international landings covered by market sampling schemes represented the majority of the total landings.

Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books (CHECK).

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch.

France

French commercial landings in tonnes by quarter, area and gear are derived from log-books for boats over 10m and from sales declaration forms for vessels under 10m. These self declared production are then linked to the auction sales in order to have a complete and precise trip description.

The collection of discard data has begun in 2003 within the EU Regulation 1639/2001. This first year of collection will be incomplete in term of time coverage, therefore the use of these data should be investigated only from 2005.

The length measurements are done by market commercial categories and by quarter into the principal auctions of Grandcamp, Port-en-Bessin, Dieppe and Boulogne. Samplings from Grandcamp and Port-en-Bessin are used for raising catches from Cherbourg to Fecamp and samplings from Dieppe and Boulogne are used to raise the catches from Dieppe to Dunkerque

Otoliths samples are taken by quarter throughout the length range of the landed catch for quarters 1 to 3 and from the october GFS survey in quarter 4. These are aged and combined to the quarterly level and the age-length key thus obtained is used to transform the quarterly length compositions. The length not sampled during one quarter are derived from the same year close quarter.

Weight, sex and maturity at length and at age are obtained from the fish sampled for the age-length keys.

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. . No information is collected on discarding from vessels <10m. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation.

The gear group used for length measurements are beam trawl, otter trawl and net.

Separate-sex length measurements are taken from each of the gear groupings by trip. Trip length samples are combined and raised to monthly totals by port and gear group. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Otoliths samples are taken by 2cm length groups separately for each sex throughout the length range of the landed catch. These are aged and combined to the quarterly level, and include all ports, gears and months. The quarterly sex-separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

The text table below shows which country supplies which kind of data:

Country	Numbers	Weights-at-age
Belgium	1981-present	1986-present
France	1989- present	1989- present
UK	1980- present	1989- present

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock co-ordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\ple_eche or w:\ifapdata\eximport\nsskwg\ple_eche.

Biological

Natural mortality

Natural mortality was assumed constant over ages and years at 0.1 as in the North Sea.

Maturity

The maturity ogive used assumes that 15% of age 2, 53% of age 3 and 96% of age 4 are mature and 100% for ages 5 and older.

Weight at age

Prior to 2001, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. From 2001, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole. The database was revised back to 1990.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the period back to 1987. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou et al, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled (Cf. Annex 1). Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

A third survey consists of the French otter trawl groundfish survey (FR GFS) in October (Annex 2). Prior to 2002, the abundance indices were calculated by splitting the survey area into five zones, calculating a separate index for each zone each zone, and then averaging to obtain the final GFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. A new procedure was developed based on raising abundance indices to the level of ICES rectangles, and then by averaging those to calculate the final abundance index. Although there are only minor differences between the two indices, the revised method was used in 2002 and subsequently.

Commercial CPUE

Three commercial fleets have been used in tuning. UK inshore trawlers, Belgian beam trawl fleet and French otter trawlers as well as three survey fleets.

The effort of the French otter trawlers is obtained by the log-books information on the duration of the fishing time weighted by the engine power (in KW) of the vessel. Only trips where sole and/or plaice have been caught is accounted for.

Other Relevant Data

None.

Historical Stock Development

Deterministic Modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning.

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1980 – last data year	2– 10+	Yes
Canum	Catch at age in numbers	1980 – last data year	2– 10+	Yes
Weca	Weight at age in the commercial catch	1980 – last data year	2– 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1980 – last data year	2– 10+	Yes - assumed to be the weight at age in the Q1 catch
Mprop	Proportion of natural mortality before spawning	1980 – last data year	2– 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980 – last data year	2– 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1980 – last data year	2– 10+	No – the same ogive for all years
Natmor	Natural mortality	1980 – last data year	2– 10+	No – set to 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	English commercial Inshore trawl	1985 – last data year	2 – 10
Tuning fleet 2	Belgian commercial Beam trawl	1981 – last data year	2-10
Tuning fleet 3	French trawlers	1989 – last data year	2 - 10
Tuning fleet 4	English BT survey	1988 – last data year	1 – 6
Tuning fleet 5	French GFS	1988 – last data year	1 - 5
Tuning fleet 6	International YFS	1987 – last data year	1 - 1

Uncertainty Analysis

Retrospective Analysis

Short-Term Projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size: Taken from XSA for age 3 and older. The number at age 2 in the last data year is estimated using RCT3. The recruitment at age 1 in the last data year is estimated using the geometric mean over a long period (1980 – last data year)

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight of the three last years

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (2-6) to the level of the last year

Intermediate year assumptions:

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

Medium-Term Projections

The segmented stock/recruitment relationship is considered not significant (ICES, 2003a). There is therefore no consistent basis to build a medium term projection.

Long-term projections, yield per recruit

Biological Reference Points

Blim = 5400 t.

Bpa = 8000 t.

Flim = 0.54

Fpa = 0.45

Other Issues

None.

References

Beek, F.A. van, Leeuwen, P.I. van and Rijnsdorp, A.D. 1989. On the survivalof plaice and sole discards in the otter trawl and beam trawl fisheries in the North Sea. ICES C.M. 1989/G:46, 17pp

Carpentier, A., Vaz, S., Martin, C. S., Coppin, F., Dauvin, J.- C., Desroy, N., Dewarumez, J.-M., Eastwood, P. D., Ernande, B., Harrop, S., Kemp, Z., Koubbi, P., Leader-Williams, N., Lefèbvre, A., Lemoine, M., Loots, C., Meaden, G. J., Ryan, N., Walkey, M., 2005. Eastern Channel Habitat Atlas for Marine Resource Management (CHARM), Atlas des Habitats des Ressources Marines de la Manche Orientale, INTERREG IIIA, 225 pp.

ICES 2003a. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 2002. ICES CM 2003/ACFM:02

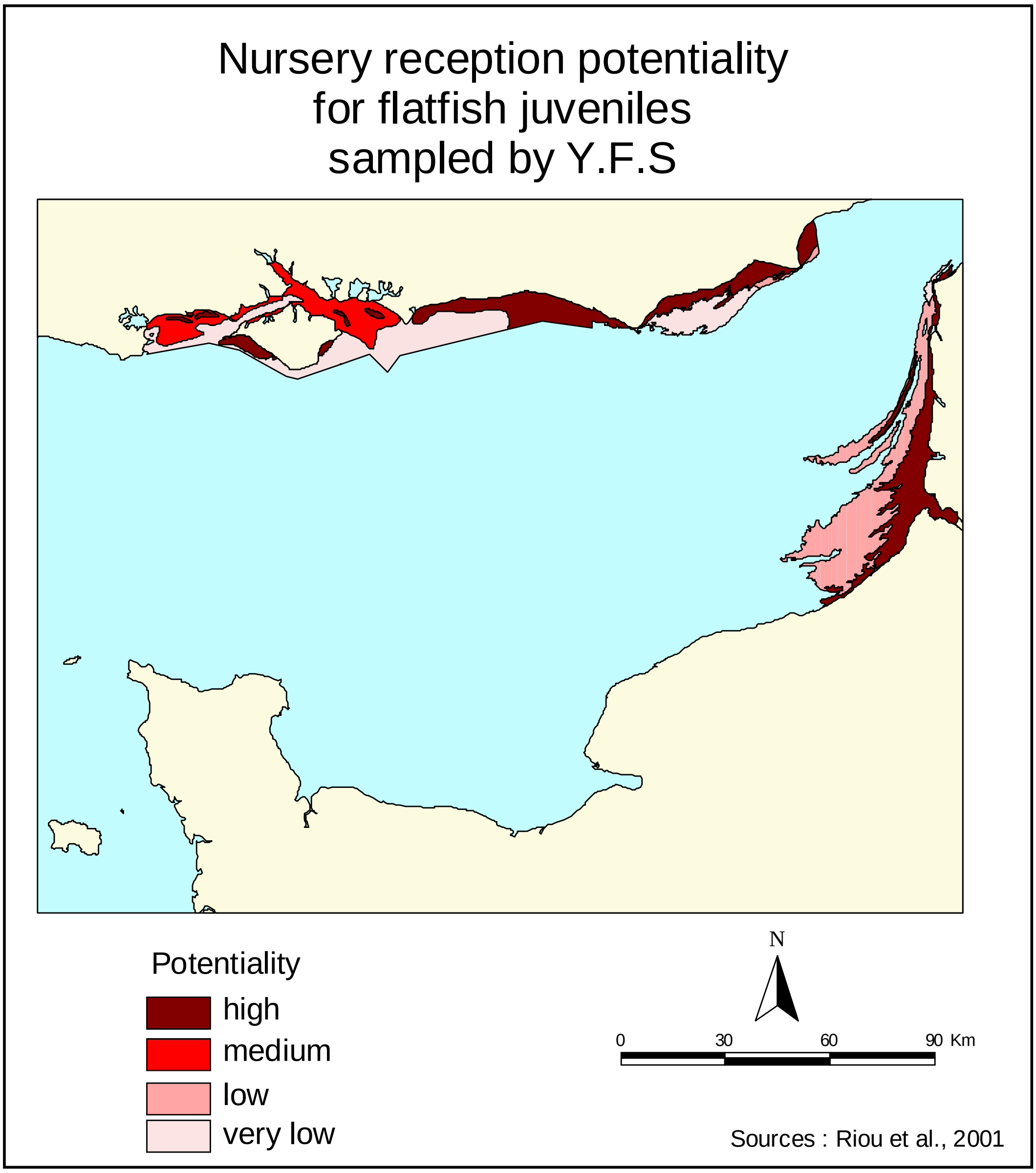
ICES 2003b. Report of the Study Group on Precautionary Reference Points For Advice on Fishery Management ICES CM 2003/ACFM:15

Millner, R.S., Whiting, C.L and Howlett, G.J. 1993. Estimation of discard mortality of plaice from small otter trawlers using tagging and cage survival studies. ICES C.M. 1993/G:24, 6pp

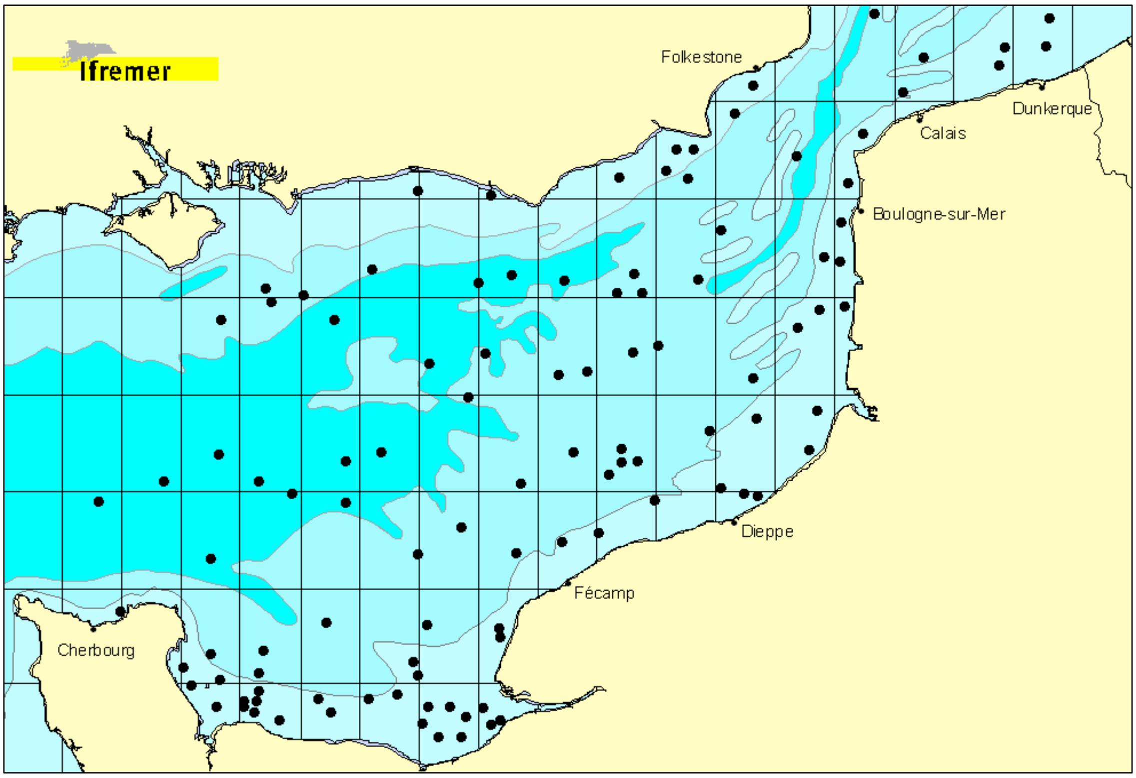
Riou et al. 2001. Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel : application of a combined method using generalized linear models and a geographic information system. Aquatic Living Resources. 14 (2001) 125-135

Appendix 1 – Nursery reception potentiality for flatfish used as a basis for the combination of FR and UK YFS

Potentiality surface (Km^2)	South England	Bay of Somme
High	756	575.1
Medium	484.7	0
Low	30.5	953.1
Very low	993.3	21.3
Total	2264.5	1549.5
Total (Low – Medium – High)	1271.2	1528.2



Appendix 2 – FR GFS. Sampling tows location grid



Quality Handbook ANNEX:__SAN-NSEA

Stock specific documentation of standard assessment procedures used by ICES.

Working group: North Sea Demersal Working Group

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1 Sandeel in IV

1.1.1 General

1.1.2 Stock definition

For assessment purposes, the European continental shelf was divided into four regions for sandeel assessment purposes up to 1995: Division IIIa (Skagerrak), northern North Sea, southern North Sea, and Shetland Islands and Division VIa. These divisions were based on regional differences in growth rate and evidence for a limited movement of adults between divisions (e.g. ICES CM 1977/F:7, ICES CM 1991/Assess:14.). The two North Sea divisions were revised in 1995, and it was decided to amalgamate the two stocks into a single stock unit with two fleets, one fleet in the northern North Sea and one in the southern North Sea. The Shetland sandeel stock is assessed separately. ICES assessments have used these stock definitions since 1995.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations (Proctor et al. 1998, Wright et al. 1998). Recruitment to local areas may not only be related to the local stock, as some interchange between areas situated close to each other seems to take place during the early phases of life before settlement.

Based on the distribution and simulated dispersal of larval stages, Wright et al. (1998) suggest that the North Sea stock could be split into six areas, including the Shetland as a separate population. Assessments have tentatively been made for some of these areas (Pedersen et al. 1999) and there was high correlation between the results from the study and the assessment made by the WG for the whole North Sea. Presently there are insufficient information about sandeel biology, especially about the intermixing of the early life stages between spawning aggregations, to allow for and alternative separation of the North Sea into separate population units to be assessed.

Recent studies indicate a low interchange of pre-settled sandeels between the spawning grounds identified (Christensen et al. Accepted, Christensen et al. Submitted). These results also indicate that the population structure suggested by Wright et al. (1998) need to be revised. Work is currently conducted to do this.

1.1.3 Fishery

Sandeel is taken by trawlers using small meshed trawls with mesh sizes < 16 mm. The fishery is seasonal. The geographical distribution of the sandeel fishery varies seasonally and annually, taking place mostly in the spring and summer. In the third quarter of the year the distribution of catches generally changes from a dominance of the west Dogger Bank area back to the more easterly fishing grounds.

The sandeel fishery developed during the 1970's, and landings peaked in 1998 at more than 1 million tons. Since then there have been a rapid decrease in landings, and the total landings were at a historic low level in 2005 with a small increase from 2005 to 2006. Danish and Norwegian landings in 2003 were only 44% and 17% of those in 2002.

The spatial distribution of sandeel landings is considered as a good representation of stock distribution, except for areas where severe restrictions on fishing effort is applied (i.e. the Firth of Forth, Shetland areas, and Norwegian EEZ in 2006). Up to 2002 and particularly prior to 1998, most landings of sandeels in March were taken from the eastern North Sea banks whilst sandeel landings in April-June were mainly from the west Dogger Bank. In some years a relatively large part of the sandeel landings are taken from the central and eastern North Sea along the Danish west coast. From 1991, grounds off the Scottish east coast have been targeted particularly in June. However, since 2000 the banks in the Firth of Forth area have been closed to fishing.

Large variations in the fishing pattern occurred concurrent with the decline in the total fishery and CPUE in 2003. The distribution of landings in the southern North Sea in 2003 to 2005 seemed more extensive than the typical long-term pattern in the same area. Further, grounds usually less exploited became more important for the total fishery during the same period. In 2006 there was another large change in the fishing pattern, when the fishery showed a strong concentration at the fishing grounds in the Dogger Bank area. Although this overall large variation in fishing pattern there is a general high importance for most years of the Dogger Bank area.

In the Northern North Sea, mainly NEEZ, the change in the spatial pattern was significantly different from southern part. The highest landings from a single statistical square were taken in 1995 on the Vikingbank, the most northerly fishing ground for sandeel in the North Sea. However, in 1996 landings from the Vikingbank dropped substantially, and since 1997 have been close to null. The marked reduction in landings around 2000 in NEEZ was accompanied by a marked contraction of the fishery to a small area in the southern part of NEEZ, the Vestbank area. In this area landings remained high in 2001 and 2002 due to the strong 2001 year-class. However, the 2001 year-class was only abundant in the Vestbank area, which resulted in a highly concentrated fishery and the decimation of the year-class before it reached maturity in 2003. This may have led to the collapse of the sandeel fishery in NEEZ. In the EU EEZ any contraction of the fishery has been less apparent.

The sandeel fishing season was unusual short in both 2005 and 2006, starting later and ending earlier than in previous years. The late start of the fishery was partly because the Danish fishery first opened the 1st April, in accordance with a national regulation introduced in 2005. Further, weekly data on the oil content of sandeels in the commercial landings, provided by Danish fish meal factories, indicated a late onset of sandeels feeding season in both 2005 and 2006 and that sandeels therefore became available to the fishery later than usual. Landings in the second half year of both 2005 and 2006 were on a low level compared to previous years. Only 14.000 tones were recorded in 2005 and 17.000 tones in 2006.

Regulation of the fishery is no explanation to the small fishery observed from 2003 and onwards. The TAC in force has never been restrictive in the sandeel fishery, and in 2005 (the only year when additional regulation was introduced) the fishery was first regulated in July after the main fishing season.

There was a 50% decline in the number of Danish vessels (from 200 to 98 vessels) fishing sandeels from 2004 to 2005. In 2006 the Danish fleet increased to 124 vessels participating in the sandeel fishery. The capacity of the Danish fleet participating in the North Sea sandeel fishery is not likely to increase much further, due to decommission of a substantial number of vessels during the last years. Also for the Norwegian fleet a drastic decline in number of vessels fishing sandeels has been observed in recent years.

Technical measures for the sandeel fishery include a minimum percentage of the target species at 95% for meshes < 16 mm, or a minimum of 90% target species and maximum 5% of the mixture of cod, haddock, and saithe for 16 to 31 mm meshes.

Most of the sandeel catch consists of the lesser sandeel *Ammodytes marinus*, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species (ICES WGNSSK 2004).

1.1.4 Ecosystem aspects

Due to the stationary habit of post-settled sandeels (DIFRES unpublished information, Gauld 1990), a patchy distribution of the sandeel habitat (Jensen et al. 2001, Jensen and Rolev 2004), and a limited interchange of the planktonic stages between the spawning areas (Christensen et al. Accpeted, Christensen et al. Submitted, Gauld et al. 1998) the sandeel stock in IV consist of a number of sub-populations (Wright et al. 1998). Due to a to coarse spatial aggregation level of the fisheries data that is used in the sandeel assessment and a lack of biological information for defining the limits of each of the reproductively isolated population units, it is presently not possible to make an assessment that take account of the sub-population structure of sandeels. The ICES Ad Hoc Group on Sandeels (ICES AGSAN 2007) outlined some feasible management strategies in the context of management aims and recent understanding of population biology. It will require modelling and simulation work well beyond what has been common practise for other stocks.

The catches of sandeels in area IV consist mainly of the lesser sandeel Ammodytes marinus. However, other species of sandeels is also caught. At some of the grounds in the Dogger Bank area the smooth sandeel Gymnammodytes semisquamatus can be important, and in the catches from more coastal grounds the other Ammodytes species Ammodytes tobianus can be important. The greater sandeel Hyperoplus lanceolatus appears in the catches from all grounds, but usually in insignificant numbers compared to A. marinus. The population dynamics of A. tobianus, G. semisquamatus, and H. lanceolatus are largely unknown, and so are the possible effects on these species of commercial fisheries.

The stock dynamics of sandeels is driven by a highly variable recruitment and a high natural mortality in addition to fishing. The recruitment seems more linked to environmental factors than to the size of the spawning stock biomass. This was confirmed by analyses carried out by the ICES Study Group on Recruitment Variability in North Sea Planktivorous Fish (ICES-SGRECVAP 2006). SGRECVAP considered there was a common trend in recruitment for herring, Norway pout and sandeel with significant shift in recruitment in 2001. However, it could not be assumed that the same mechanism was common for all three species. It was clear that the poor sandeel recruitment from 2002 occurred at low spawning-stock biomass. Further, although the decline in recruitment in sandeels could be linked to both the NAO index and to annual average abundance of Calannus finmarchicus in the central North Sea, it was not possible to determine the mechanisms driving recruitment in sandeels or the link between changes in the environment and sandeel population dynamics.

ACFM consider that there is a need to ensure that the sandeel stock remains high enough to provide food for a variety of predator species.

The decline in the sandeel population concurrent with a markedly change in distribution (ICES WGNSSK 2007) has increased the possibility of local depletion, of which there now is some evidence (ICES WGNSSK 2007). This may be of consequence for marine predators that are dependent on sandeels as a food source. It is presently not possible to make an assessment that takes account of the sub-population structure of sandeels (ICES AGSAN 2007).

Sandeels are important prey species for many marine predators, but the effects of variation in the size of this stock on predators are poorly known. Although the direct effects of sandeel fishing that have been identified on other species fished for human consumption, e.g. haddock and whiting are relatively small in comparison to the effects of directed fisheries for human consumption species there is still relatively scant information on the indirect effects of the sandeel fishery.

In 1999 the U.K called for a moratorium on sandeel fishing adjacent to seabird colonies along the U.K. coast and in response the EU requested advice from ICES. An ICES Study Group, was convened in 1999 to assess whether removal of sandeel by fisheries has a measurable effect on sandeel, whether establishment of closed areas and seasons for sandeel fisheries could ameliorate any effects, and to identify possible spatial and/or temporal restrictions of the fishery as specifically as possible. The ICES Advisory committees (ACFM and ACE) accepted the advice from the study group. STECF (1999) agreed with this ICES advice and the EU advised to close the fishery whilst maintaining a commercial monitoring. A 3-year closure, from 2000 to 2002, was decided. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et *al.* 2002) and has been extended until 2007, with a small increase in the effort of the monitoring fishery. There is presently no decision on weather a full commercial sandeel fishery will be reopened in the Firth of Forth area.

In general, fishing on sandeel aggregations at a distance less than 100 km from seabird colonies has been found to affect some surface feeding bird species, especially black-legged kittiwake and sandwich tern (Frederiksen et al. 2004, 2005). Recent research of effects on seabird predators due to changes in sandeel availability showed that black-legged kittiwake Rissa tridactyla in the Firth of Forth area off the Scottish east coast was related to abundance of both 1+ group, the age class targeted by the fishery, and 0 group sandeels. The same relationship was not found for six other sandeel dependent seabird species. Controlling for environmental variation (sea surface temperature, abundance of larval sandeels and size of adult sandeels), Frederiksen et al. (submitted) found that breeding productivity in the seabird colony on the Isle of May was significantly depressed by the fishery during periods of unregulated fishery for one surface-feeding seabird species (black-legged kittiwake), but not for four diving species. The mechanism by which the fishery affects the seabird however remains unclear as the fishery is not always in direct competition with the birds. The strong impact on these surface-feeding species, while no effects are documented found for diving species, could result from its inherently high sensitivity to reduced prey availability, from changes in the vertical distribution of sand lance at lower densities, or from sand lance showing avoidance behaviour to fishery vessels.

The ecosystem effects of industrial fisheries are discussed in the Report of the ICES Advisory Committee on Ecosystems, June 2003, Section 11 (ICES Cooperative Research Report No. 262).

Other ecosystem effects of the sandeel fishery are discussed in section 16.5 and in the ICES Report of the Advisory Committee on Ecosystems, June 2003, Section 11.

1.2 Data

1.2.1 Commercial catch

In the last 20 years the landings of sandeels in IV have been taken mainly by Denmark and Norway with UK/Scotland, Sweden and Faroes Isl. taken a much smaller part of total landings. In the 1950's also Germany and the Netherlands participated in this fishery, but since the start of the 1970's no landings have been recorded for these countries.

Age, length and weight at age data are available for Denmark and Norway to estimate numbers by age in the landings. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight at age for the southern North Sea are based only on Danish age compositions.

1.2.1.1 **Denmark** More details to be included in this section

Industrial species are not sorted by species before processing and it is assumed that the landings consist of one species only in the calculation of the official landings. The WG estimate of landings is based on samples for species composition taken by the Fishery Inspectors for control of the by-catch regulation. At least one sample (10-15 kg) per 1000 tons landings is taken and these samples are used to estimate average species composition by area (ICES rectangles) and month. This species/area/period key, logbook data (spatial distribution) and landings slip data (quantity) are used to derive the Danish WG estimates of landings of sandeel and by-catch of other species (further information can be found in ICES, 1994/Assess:7; Dalskov, 2002).

1.2.1.2 **Norway** Text to be inserted by Norway

For Norway and Sweden, the official landings and the WG estimated landings are the same.

1.2.1.3 **UK/Scotland** Text to be inserted by UK/Scotland

1.2.1.4 **Sweden** Text to be inserted by Sweden

The text table below shows which country supplies which kind of data:

	Data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Denmark	x	x	x		x
Norway	x	x	x		x
UK/Scotland	x				
Sweeden	x				
Farao Islands	x				

All input files are Excel spreadsheet files.

The national data sets have been imported in a database aggregated to international data by DIFRES.

The combined Danish and Norwegian age composition data and weight at age data are applied on the landings of UK, Sweeden and Farao Isl., assuming catches from these countries have the same age composition and weight at age as the Danish and Norwegian landings.

1.2.2 Biological

Historically, assessments were done separately for the Northern and Southern North Sea. In recent years, the assessment has been done for the whole North Sea, but data are still compiled separately for the two areas. The catch numbers and weight at age data for the Northern North Sea are constructed by combining Danish and Norwegian data by half-year.

The catch numbers and weight-at-age data for the northern North Sea were constructed by combining Danish and Norwegian data by half-year. Prior to 1996, the Norwegian age composition data were based on Danish ALK’s. Catch numbers and weight-at-age for the southern North Sea are based on Danish age compositions. The mean weight at age in the catch used in the assessment is the mean weights at age in the catch for the Southern and Northern North Sea weighted by catch numbers. The mean weight at age in the stock is copied from the mean weight in the catch first half-year, and an arbitrary chosen weight at 1 gram was used for the 0-group.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Values for natural mortalities are the same as used since 1989 (ICES CM 1989/Asssess:13). During the WGNSSK 2005 meeting an exploratory assessment was carried out, using the natural mortality for sandeels estimated by ICES-SGMSNS (2005). The time series of natural mortality only include up to 2003, so 2003 estimates were copied to 2004 and 2005. In contras to the fixed values of natural mortality used in previous sandeel assessments, the natural mortalities estimated by ICES-SGMSNS (2005) show large variability over years. The most significant differences between the natural mortalities of sandeels used in previous sandeel assessments and those estimated by ICES-SGMSNS (2005) are those for age-0 sandeels. The natural mortalities of age-0 sandeels estimated by ICES-SGMSNS (2005) are about twice as high than those used in previous sandeel assessments.

The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1. Recent research indicates however, that there are large regional variations in age at maturity of *Ammodytes marinus* in the North Sea (Boulcott et al. 2006). Whilst sandeels in some areas seem to spawn at age 2 or older, sandeels in other regions seem to mature and spawn at age 1. As the decision to spawn at age 1 or 2 is an annual event, it is likely that there are large regional and annual variations in the fraction of the populations of the sandeels that contribute to the spawning. The age at maturity keys used in the assessment might thus considerably underestimate the spawning biomass of sandeels in the North Sea.

The fishing fleet catches sandeels in different parts of the North Sea during the year, and the fishing pattern changes from year to year. Because sandeels, *Ammodytes marinus*, in the North Sea consist of a number of sub populations (section 1.1.1) the industrial fishery target different part of the sandeel populations during the year and between years. There seem to be significant spatial and temporal variations in emergence behaviour (e.g. Rindorf *et al*. 2000) and growth (e.g. Boulcott et al. 2006, Pedersen et al. 1999; Wright et al. 1998) of sandeels in the North Sea. Further, there are age/length dependent variations in the burrowing behaviour of sandeels (Kvist et al. 2001). The information about age compositions in the catches and the age and weight relationships thus represent average values over time and space and reflect the variability in emergence behaviour and growth. For example, weight at age of sandeels seems to vary both between years and between Danish and Norwegian catches.

1.2.3 Surveys

As no recruitment estimates (abundance of age-0 sandeels second half year) from surveys are available, recruitment estimated in the assessments are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

The need for fishery independent information on sandeel distribution and abundance has been highlighted by ICES-WGNSSK (2006 and 2007). The demand for such information has increased due to the recent years decline in the North Sea sandeel stock concurrent with large changes in distribution and in the fishing pattern.

Different survey approaches are presently investigated by European research institutes, to establish a time series of fishery independent abundance estimates for sandeels in the North Sea. This is not a trivial job, because of the unpredictable emergence behaviour of sandeels, i.e. any sampling approach must take account of that part of the population can be in the water column as well as in the sea bed (Greenstreet et al. 2006). Further, more in total 238 individual sandeel fishing grounds are identified (Jensen and Rolev 2004). The total area of the sandeel fishing constitutes 15831 km2.

Descriptions of the survey methods that are presently explored and preliminary information from these surveys are given by ICES WGNSSK (2006 and 2006) and ICES_AGSAN (2007).

1.2.4 Commercial CPUE

There is no survey time-series available for this stock. As in previous assessments effort data from the commercial fishery in the northern and southern North Sea are treated as two independent tuning fleets, separated into first and second half year.

Because of the trends in the residuals for 1-group sandeels in the first half year, the two tuning fleets in the first half year were in the final assessment from 2005 split into two time periods, i.e. before and after 1999. This change in the tuning series removed the trends in the residuals of log stock numbers, and the tendency to underestimate F and overestimate SSB was reduced. Information about the size of the trawls used by Danish vessels fishing sandeels show an increase in trawl size from 1988 to 1994 and a larger increase from 1997 to 1998. This is a clear indication of an increase in catchability of the Danish vessels fishing sandeels, due to gear technology. However based only on this information it is not possible to quantify the likely change in catchability over the years.

The definition of tuning fleets used in 2005 was also used in 2006. The following tuning series were from 2005 are:

Fleet 1: Northern North Sea 1983-1998 first half year

Fleet 2: Northern North Sea 1999-2006 first half year

Fleet 3: Southern North Sea 1983-1998 first half year

Fleet 4: Southern North Sea 1999-2006 first half year

Fleet 5: Northern North Sea 1983-2005 second half year

Fleet 6: Southern North Sea 1983-2005 second half year

The effort data for the southern North Sea prior to 1999 are only available for Danish vessels, but since 1999 Norwegian vessels have also provided effort data. These data for the first half year has since 2003 been included in tuning series. The effect of this on the assessment is analysed in this year’s assessment. The reason for including the Norwegian effort data for first half year for the southern North Sea into the tuning fleet is that in recent years Norwegian catches in the southern North Sea in first half year constitute a significant part of Norwegian landings in the North Sea. The tuning fleet used for the northern North Sea is a mixture of Danish and Norwegian vessels. A separation of the Danish and Norwegian fleets is presently not possible, due to the lack of Norwegian age-length keys for the period before 1996. Separate national fleets would have been preferable because this would have made procedure for the generation of the tuning series more transparent. This issue should be addressed at the next benchmark assessment.

The size distribution of the fleet has changed through time. Therefore effort standardisation is required. The assumption underlying the standardisation procedure is that CPUE is a function of sandeel abundance and vessel size. Standardised effort is calculated from standardised CPUE and total catch. CPUE is standardized to a vessel size of 200 Gross Tonnes (GR) using the relationship:

$CPUE = a * GR^{b}$ (1)

where a and b are constants and GR is vessel size in GR

The constants a and b were prior to 2003 estimated for each year by performing the regression analysis:

$Ln(C/e)=ln(a)+b*ln(GR)$ (2)

where C=catch in ton, e=effort in days spend fishing, and the rest of the parameters are as in (1).

Since 2003 the parameters in (2) have estimated using catch and effort data on single trip level, instead of average values of catch and effort for each vessel size category (see ICES 2004). The data used for the regression is logbook data for the Danish industrial fleet for the years 1984 to 2003 and first half year of 2004. General linear models were used to estimate the parameters in:

$ln(CPUE) = d_y + f_y*ln(GR)$ (3)

where y=year, GR=vessel size in GR as defined in Table 1, and the remaining factors are constants. Log transformation was required to stabilise the variance in CPUE to fit the model although it does result in a more skewed distribution of GT leading to the smaller vessels receiving a higher weight in the subsequent regression. The GLM was carried out by half year (first and second half year) and area (northern and southern North Sea) to generate estimates of effort for the fleets presently used in the assessment of sandeels in IV. Type III analysis was used to test for significance of parameters. All analyses were weighted by the number of days spend fishing, as the variation on the average catch per day fishing decreases with the number of days fished. The results of the analysis and the parameter estimates are given in Table 13.1.3.2.

The parameters estimated in (3) were used to estimate CPUE for a vessel size of 200 GR from:

$CPUE=e^{dy}*200^{fy}$ (4)

Mean CPUE of Danish and Norwegian fleets, after the Norwegian CPUE had been standardised to a vessel size of 200 GR, was estimated as a weighted mean weighted by the catches sampled used to estimate CPUE. Total standardised effort was afterwards estimated from the combined Danish and Norwegian CPUE and total international catches.

As no recruitment estimates from surveys are available, recruitment estimates are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

There is a relatively poor correlation between the tuning indices and the stock, which may be due to the fact that several sub-stocks are assessed as a single unit.

1.2.5 Other relevant data

None.

1.3 Estimation of Historical Stock Development

The Seasonal XSA (SXSA) developed by Skagen (1993) was up to 2001 used for stock assessment of sandeel in IV. Annual XSA was tried in 2002 WG where it was concluded that the two approaches gave similar results. For a standardization of methodology, it was decided to shift to XSA in 2003. In 2004 SXSA was used again for the final assessment, the reason being that data were available for the first half year of 2004 for the assessment. SXSA has been used or the final assessment since 2004. The XSA are used for comparison using the following settings:

Time series weights	none
Power model	no
Catchability independent of age	>=2
F-shrinkage S.E.	1.5 (5 years and 2 ages)
Min. standard error for pop. estimate	0.3
Prior weighting	none
Number of iterations	20
Convergence	Yes

In the SXSA weighting of estimated catchabilities (rhat) is set manually, where last years data is down weighted compared to previous years. Estimated survivors are weighted from manually entered data, where estimates of survivors are given a lower weighting in the second half of the year. This setting was chosen because the fishery inflicts the majority of the fishing mortality in the 1st half of the year and thus the signal from the fishery is considered less reliable in the second half.

During the benchmark assessment in 2004 (ICES-WGNSSK 2005) the effect of changing some of the default settings was explored. The assumption in the assessment of constant catchability for the tuning fleets over years, was analysed. Further, the effect of weighting the survivors with the inverse variance of the estimated log catchability, instead of the manual weighting, was explored. At last, the effect of down weighting last half years data in the estimation of the inverse catchability was analysed. There were no major effects on the assessment results of changing these settings, i.e. the same trends were seen in SSB, R and F. It was therefore decided to keep the default settings.

During the 2005 WG meeting the SMS model was used as a comparison to the SXSA. The SXSA and SMS explorative runs gave quite similar results for the time trend of SSB, but the absolute levels differ between model configurations. The main difference in the explorative runs is in the estimate of fishing mortality. Fs for the most recent years were estimated higher and more variable by the SMS model. All SXSA runs showed a decrease in F since 2001, while SMS estimated a step decrease in F in 2003 followed by a seep increase in 2003 and subsequently decreases in 2004 and 2005. Both SXSA and SMS assume constant catchability in the CPUE time series. In addition, SMS assumes constant catchability (or more correctly, constant exploitation pattern) for the F-model and catch data. CPUE time series are however, subset of the total international catch data and changes in the exploitation pattern will violate the assumption of constant catchability for the CPUE time series. Said in another way; if exploitation pattern changes, the assumptions for both models are violated. It is difficult to judge whether the SXSA assumption that catch data are exact, or the SMS assumption that exploitation pattern are constant, violates the assumptions most. The F values from SXSA shows a very variable exploitation pattern from year to year, and extreme F values for age 4. This indicates that there might be a considerable sampling uncertainty in the international catch at age data, which SMS might be better to handle. However, SXSA was chosen for the final assessment, because the model is the default model for this stock and SXSA does not rely on the assumption of constant exploitation pattern in catch at age data.

During the WGNSSK 2005 meeting an exploratory assessment was carried out, using the natural mortality for sandeels estimated by ICES-SGMSNS (2005, see section 1.1.2). The assessment using the natural mortalities estimated by ICES-SGMSNS (2005) showed similar trends in SSB as the assessment using the fixed natural mortalities, whereas the estimates of recruitment and F, were generally higher in assessment using the natural mortalities estimated by ICES-SGMSNS (2005). This difference was mainly due to the larger natural mortality for the 0-group sandeels used in the assessment using the natural mortalities estimated by ICES-

The low number of age groups makes the assessment highly sensitive to estimated terminal fishing mortalities for the oldest age (age 3). This in combination with an assumed constant and poorly determined proportion mature makes the SSB estimate highly uncertain.

1.4 Short-Term Projection

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Quantitative estimates of recruits (age 0) in the year of the assessment are not available at the time of the WG. Traditional deterministic forecasts are therefore not considered appropriate.

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes.

0-group CPUE is a poor predictor of recruitment (ICES-WGNSSK 2003) why traditional deterministic forecasts are not considered appropriate. However, because of the low sandeel stock WGNSSK provided indicative short term prognoses during the meetings from 2004 and on, using a range of scenarios for the recruitment and exploitation pattern.

The short term forecasts from 2004 and 2005 overestimated the SSB in 2005 and 2006 by a factor 2-3 when compared to the SSB estimated by the SXSA in 2006. This overestimation bias was addressed during the 2006 WG meeting, carrying out a short term forecast, where the start population and the F-s-at-age in the first half year of 2006 was corrected according to the bias identified in the assessment. In order to estimate potential bias in the terminal population sizes and F's, an analysis was made from the retrospective SXSA runs. A bias factor was determined for each year by dividing the terminal estimate of each retrospective run with the "true" value as estimated by this year's final assessment. The bias factor taken forwards to the short term forecast was the mean ratio over the period 2000-2005. As retrospective corrections continue to be made for several years, the bias correction factors for the most recent 1-2 years may be underestimates. Additional analyses were made to investigate the change in bias correction when comparing terminal values with "converged" values taken from retrospective runs 1 or 2 years later. This demonstrated that the bulk of the correction is made in the first year with much smaller corrections in the second year.

1.5 Medium-Term Projections

Not done

1.6 Long-Term Projections

Not done

1.7 Biological Reference Points

There is no management objective set for this stock. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

In 1998 ACFM proposed that $\mathbf{B}_{lim}$ be set at 430,000 t, the lowest observed SSB. The $\mathbf{B}_{pa}$ was estimated at 600,000 t, approximately $\mathbf{B}_{lim}$ * 1.4. This corresponds to that if SSB is estimated to be at $\mathbf{B}_{pa}$ then the probability that the true SSB is less than $\mathbf{B}_{lim}$ will be less than 5% (assuming that estimated SSB is log normal distributed with a CV of 0.2). No fishing mortality reference points are given. These reference points are based on an assessment using another tuning method than used from 2002 (see section 1.2.4).

1.8 Other Issues

Recent investigations (Greenstreet et al. 2006) showed the biomass of age 1+ sandeels increased sharply in the Firth of Forth area in the first year of the closure and remained higher in all four of the closure years analysed, than in any of the preceding three years, when the fishery was operating. Further, the biomass of 0-group sandeels in three of the four closure years exceeded the biomass present in the three years of commercial fishing. The closure appears to have coincided with a period of enhanced recruit production.

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Quality handbook: Stock Annex- Sole in Division VIId

Working Group:	ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
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GENERAL

Stock Definition

The sole in the eastern English Channel (VIId) are considered to be a separate stock from the larger North Sea stock to the east and the smaller geographically separate stock to the west in VIIe. There is some movement of juvenile sole from the North Sea into VIId (ICES CM 1989/G:21) and from VIId into the western Channel (VIIe) and into the North Sea. Adult sole appear to largely isolated from other regions except during the winter, when sole from the southern North Sea may enter the Channel temporarily (Pawson, 1995).

Fishery

There is a directed fishery for sole by small inshore vessels using trammel nets and trawls, who fish mainly along the English and French coasts and possibly exploit different coastal populations. Sole represents the most important species for these vessels in terms of the annual value to the fishery. The fishery for sole by these boats occurs throughout the year with small peaks in landings in spring and autumn. There is also a directed fishery by English and Belgian beam trawlers who are able to direct effort to different ICES divisions. These vessels are able to fish for sole in the winter before the fish move inshore and become accessible to the local fleets. In cold winters, sole are particularly vulnerable to the offshore beamers when they aggregate in localised areas of deeper water. Effort from the beam trawl fleet can change considerably depending on whether the fleet moves to other areas or directs effort at other species such as scallops and cuttlefish. A third fleet is made up of French offshore trawlers fishing for mixed demersal species and taking sole as a by-catch.

The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 90mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

Ecosystem Aspects

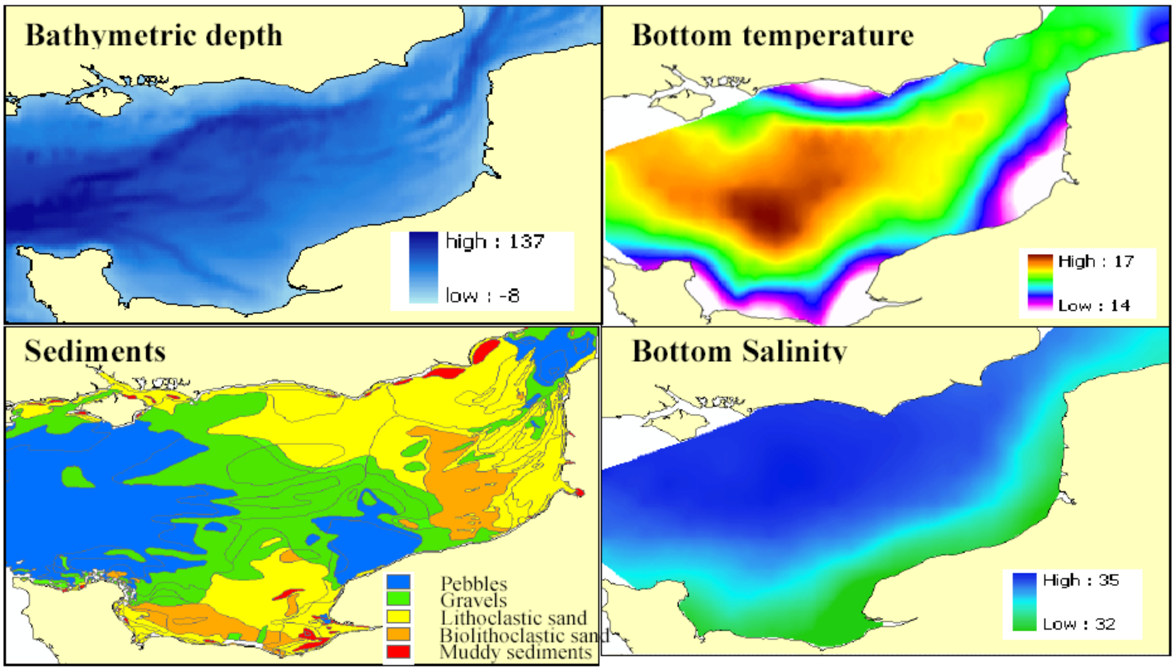


Figure 1 Eastern English Channel physical and hydrological features: Bathymetric depth and simplified sediment types representation. Survey bottom temperature and bottom salinity (averaged for 1997 to 2003) obtained by kriging. (in Vaz *et al.* 2004)

Biology: Adult sole feeds on worms, small molluscs and crustaceans. In the English Channel, reproduction occurs between February and April, mainly in the coastal areas of the Dover Strait and in large bays (Somme, Seine, Solent, Mont-Saint-Michel, Start et Lyme Bay). Pelagic eggs hatch after 5 to 11 days leading to larvae that are also pelagic and that will metamorphose into benthic fry after 1 or 2 weeks. Juveniles spend the first 2 or 3 years in coastal nurseries (bays and estuaries) where fast growth occurs (11 cm at 1 year old) before moving to deeper waters.

The spatial distribution of life stages of common sole shows a particular pattern: larvae distribution (on spanning grounds) and juvenile distributions (in nursery grounds) overlap. If larvae are found everywhere during spring, the potential habitat for stage 2 larvae is along the Flanders coast and near the Pays de Caux, to the central zone of the English Channel. Older larvae have a more coastal preference habitat, which can be explained by a retention phenomenon linked to estuaries.

Environment: A benthic species that lives on fine sand and muddy seabeds between 0 and 150 meters depth. Ranges from marine to brackish waters with temperatures between 8 and 24°C.

Geographical distribution: Eastern Atlantic, from southern Norway to Senegal, Mediterranean Sea including Sea of Marmara and Black Sea.

Vaz et al. (2007) used a multivariate and spatial analyses to identify and locate fish, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004. Four sub-communities with varying diversity levels were identified in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Fig.2 below) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

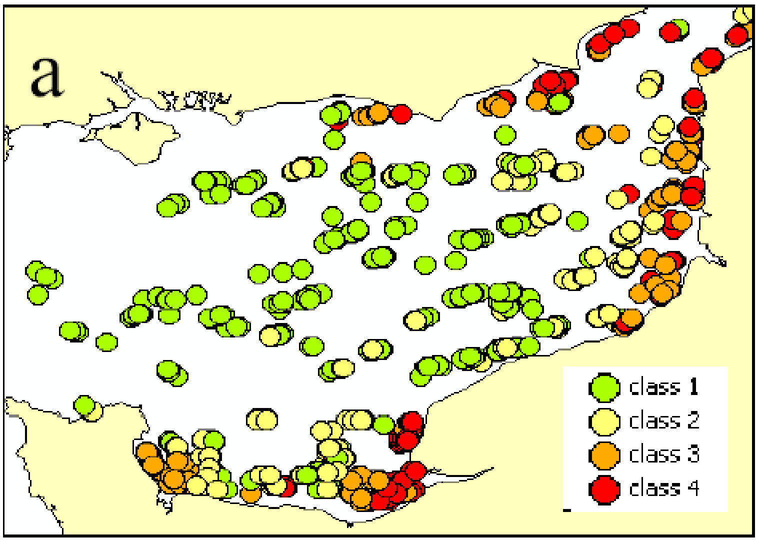


Figure 2 : Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities. (In Vaz *et al.*, 2004)

Community evolution over time : (From Vaz *et al*., 2007). The community relationship with its environment was remarkably stable over the 17 y of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect interannual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

Data

Commercial Catch

The landings are taken by three countries France (50%), Belgium (30%) and England (20%). Age sampling for the period before 1980 was poor, but between 1981 and 1984 quarterly samples were provided by both Belgium and England. Since 1985, quarterly catch and weight-at-age compositions were available from Belgium, France, and England.

Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books.

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch. Since 2004 it is part of the DCR.

France

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. .No information is collected on discarding from vessels <10m but it is known to be low. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation and is also relatively low.

Length samples are combined and raised to monthly totals by port and gear group for each stock. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Age structure from otolith samples are combined to the quarterly level, and generally include all ports, gears and months. For sole the sex ratio from the randomly collected otolih samples are used to spli the unsexed length composition into sex-separate length compositions. The quarterly ses separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions. At this stage the age compositions by gear group are combined to give total quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

Weight at age is derived from the length samples using [to be completed].

The text table below shows which country supply which kind of data:

KIND OF DATA SUPPLIED QUARTERLY					
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Belgium	x	x	x		x
England	x	x	x		x
France	x	x	x		x

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\sol_eche or w:\ifapdata\eximport\nsskwg\sol_eche.

Biological

Natural mortality

Natural mortality was assumed constant over ages and years at 0.1.

Maturity

The maturity ogive used was knife-edged with sole regarded as fully mature at age 3 and older as in the North Sea.

Weight at age

Prior to 2001 WG, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. Since the 2002 WG, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the full period back to 1981. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou et al, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%. (see Annex 1)

Commercial CPUE

Three commercial fleets have been used in tuning. The Belgian beam trawl fleet (BEL BT), the UK Beam Trawl fleet (UK BT) and a French otter trawl fleet (FR OT). The two beam trawl fleets carry out fishing directed towards sole but can switch effort between ICES areas. The UK BT CPUE data is derived from trips where landings of sole from VIId exceeded 10% of the total demersal catch by weight on a trip basis. Effort from both the BT fleets is corrected for HP. The French otter trawl fleet is description needed.

Other Relevant Data

None.

Historical Stock Development

Deterministic Modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Since 2004 - S.E. of the mean to which the estimate are shrunk = 2.000

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1982 – last data year	2 – 11+	Yes
Canum	Catch at age in numbers	1982 – last data year	2 – 11+	Yes
Weca	Weight at age in the commercial catch	1982 – last data year	2 – 11+	Yes
West	Weight at age of the spawning stock at spawning time.	19682 – last data year	2 – 11+	Yes - assumed to be the same as weight at age in the Q2 catch
Mprop	Proportion of natural mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1982 – last data year	2 – 11+	No – the same ogive for all years
Natmor	Natural mortality	1982 – last data year	2 – 11+	No – set to 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	Belgian commercial BT	1986 – last data year	2-10
Tuning fleet 2	English commercial BT	1986 – last data year	2-10
Tuning fleet 3	English BT survey	1988 – last data year	1-6
Tuning fleet 4	International YFS	1994 – last data year	1-1

Uncertainty Analysis

Retrospective Analysis

Short-Term Projection

Model used: Age structured

Software used: WGFRANSW

Initial stock size is taken from the XSA for age 3 and older and from RCT3 for age 2. The long-term geometric mean recruitment is used for age 1 in all projection years.

Since 2004 initial stock size for age 2 was taken from XSA.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight over the last three years

Weight at age in the catch: Average weight over the three last years

Exploitation pattern: Average of the three last years, scaled to the level of Fbar (3-8) in the last year

Intermediate year assumptions: F status quo

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

Medium-Term Projections

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

Long-Term Projections, yield per recruit

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

Biological Reference Points

Biological reference points

Bpa	Fpa	Flim
8000 t	0.4	0.55

Other Issues

None.

References

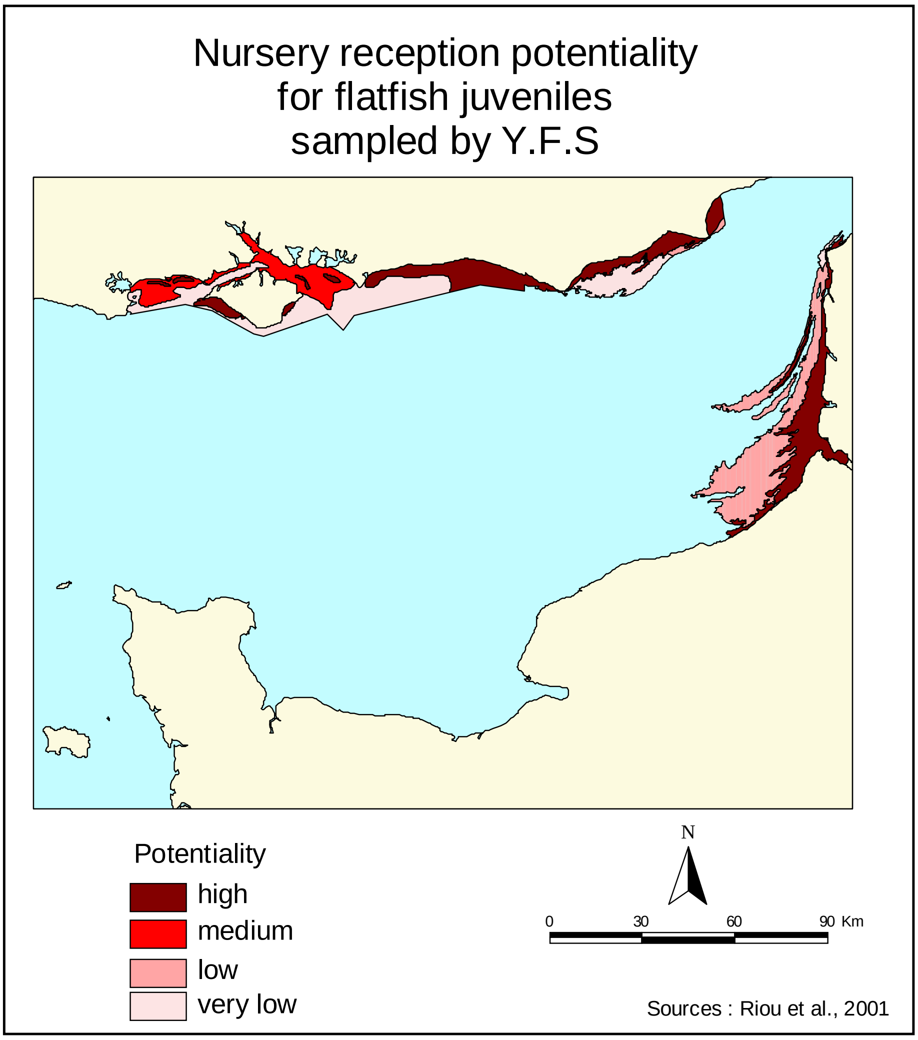
CEFAS 1999. PA software users guide. The Centre for Environment, Fisheries and Aquaculture Science, CEFAS, Lowestoft, United Kingdom, 22 April 1999.

Riou et al. 2001. Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel : application of a combined method using generalized linear models and a geographic information system. Aquatic Living Resources. 14 (2001) 125-135.

Vas et al. 2007, Modelling Fish Habitat Suitability in the Eastern English Channel. Application to community habitat level. ICES CM 2004/ P:26

Appendix 1 – Nursery reception potentiality for flatfish used as a basis for the combination of FR and UK YFS

Potentiality surface (Km2)	South England	Bay of Somme
High	756	575.1
Medium	484.7	0
Low	30.5	953.1
Very low	993.3	21.3
Total	2264.5	1549.5
Total (Low – Medium – High)	1271.2	1528.2



Quality Handbook Annex: WGNSSK: IV & VIId Whiting

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Whiting in Division IV
Working Group:	Assessment of Demersal Stocks in the North Sea and Skagerrak
Date:	16 September 2004
Last updated:	08 May 2007

A. General

A.1. Stock definition

Whiting is known to occur exclusively in some localised areas, but for the most part it is caught as part of a mixed fishery operating throughout the entire year. Adult whiting are widespread in the North Sea, while high numbers of immature fish occur off the Scottish coast, in the German Bight and along the coast of the Netherlands.

Tagging experiments, and the use of a number of fish parasites as markers, have shown that the whiting found to the north and south of the Dogger Bank form two virtually separate populations (Hislop & MacKenzie, 1976). It is also possible that the whiting in the northern North Sea may contain 'inshore' and 'offshore' populations.

A.2. Fishery

A.3. Ecosystem aspects

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate three major sources of mortality. For ages two and above, the primary source of mortality is the fishery, followed by predation by seals, which increases with fish age. For ages 0–1, though more notable on 0–group, there is evidence for cannibalism. This is corroborated by Bromley *et al.* (1997), who postulate that multiple spawings over a protracted period may provide continued resources for earlier spawned 0–group whiting.

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate that, as a predator, whiting tend to feed on (in order of importance): whiting, sprat, Norway pout, sandeel and haddock.

B. Data

B.1. Commercial catch

For North Sea catches, human consumption landings data and age compositions were provided by Scotland, the Netherlands, England, and France. Discard data were provided by Scotland and used to estimate total international discards. Other discard estimates do exist (Section 1.11.4, 2002 WG), but were not made available to Working Group data collators. Since 1991 the age composition of the Danish industrial by-catch has been directly sampled, whereas it was calculated from research vessel survey data during the period 1985–1990. Norway provides age composition data for its industrial by-catch.

For eastern Channel catches, age composition data were supplied by England and France. No estimates of discards are available for whiting in the Eastern Channel, although given the relatively low numbers in the Channel catch compared to that in the North Sea, this is not considered to be a major omission. There is a small industrial fishery in this area.

B.2. Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

Natural mortality values are rounded averages of estimates produced by previous key runs of the North Sea MSVPA (see Section 1.3.1.3 of the 1999 WG report: ICES CM 2000/ACFM:7). The values used in both the assessment and the forecast are:

AGE	1	2	3	4	5	6	7	8+
Natural Mortality	0.95	0.45	0.35	0.30	0.25	0.25	0.20	0.20

The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981-1985. The maturity ogive used in both the assessment and forecast is:

AGE	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1.00	1.00	1.00	1.00	1.00	1.00

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to zero.

B.3. Surveys

The Scottish Groundfish Survey (SCOGFS) is carried out in August each year, and covers depths of roughly 35m to 200m in the North Sea to the north of the Dogger Bank. It samples at most one survey station per statistical rectangle. In 1998 the coverage of this survey was extended into the central North Sea, but the index available to the Working Group has been modified so as to cover a consistent area throughout the time-series.

In 1998 FRS (Aberdeen) introduced a new survey vessel; it was considered at the time that no evidence existed to say the new vessel had different catch abilities to the old vessel (Zuur *et al.*, 1999). This is now generally considered not to be the case. In line with other roundfish stock assessments we present the Scottish groundfish survey as two separate series.

The English Groundfish Survey (ENGGFS) is carried out in August each year, and samples at most one station per rectangle. It covers depths of roughly 35 m to 200 m in the whole of the North Sea basin.

In 1991 the English groundfish survey changed fishing gear from the Granton trawl to the GOV trawl. For this reason the English groundfish survey is treated as two independent series.

The time-series of the survey indices of whiting supplied by the French Channel Groundfish Survey (FRAGFS) was revised in 2002. In 2001, the Eastern Channel was split into five zones. Abundance indices were first calculated for each zone, and then averaged to obtain the final FRAGFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. In 2002, it was thought more appropriate first to raise abundance indices to the level of ICES rectangles, and then to average those to calculate the final abundance index. Previous to the 2002 WG, only the hauls in which whiting were caught were used to derive abundance indices. This procedure biased estimates, and therefore, the indices supplied from 2002 are calculated on the basis of all hauls.

The first quarter International Bottom Trawl Survey (IBTS Q1) is undertaken in February and March of each year, and covers depths of roughly 35m to 200m in the whole of the North Sea basin. It uses a higher density of survey stations than either the SCOGFS or the ENGGFS, with several hauls per statistical rectangle.

B.4. Commercial cpue

Effort data are available for two Scottish commercial fleets: seiners (SCOSEI) and light trawlers (SCOLTR). Non-mandatory reporting of fishing effort for these fleets means that they cannot be viewed as strictly reliable for use for catch-at-age tuning.

Effort data are available for two French commercial fleets: otter trawl (FRATRO) and beam trawl (FRATRB). The same comment on non-mandatory reporting of fishing effort applies to these fleets.

B.5. Other relevant data

None.

C. Historical Stock Development

N/A for the time being.

D. Short-term Projection

N/A for the time being.

E. Medium-Term Projections

N/A for the time being.

F. Yield and Biomass per Recruit / Long-Term Projections

N/A for the time being.

G. Biological Reference Points

The precautionary fishing mortality and biomass reference points agreed by the EU and Norway, (unchanged since 1999), are as follows:

Blim=225 000t; Bpa=315 000t; Flim=0.90; Fpa=0.65.

H. Other Issues

References

Bromley, P. J., Watson, T., and Hislop, J. R. G. (1997). Diel feeding patterns and the development of food webs in pelagic 0-group cod (*Gadus morhua* L.), *haddock (Melanogrammus aeglefinus* L.), whiting (*Merlangius merlangus* L.), saithe (*Pollachius virens* L.), and Norway pout (*Trisopterus esmarkii* Nilsson) in the northern North Sea. *Ices Journal of Marine Science* **54:** 846–853.

Hislop, J. R. G & MacKenzie, K. (1976). Population studies of the whiting (*Merlangius merlangus* L.) of the northern North Sea. *Journal du Conseil International pour l'Exploration de laMer*. **37:** 98–111.

Table 12.2.13 Whiting in IV and VIId. Complete available tuning series.

SCOSEI_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	325246	14994	29308	43711	15390	1058	1409	201	36	0
1979	316419	90750	41092	28124	14745	6084	677	156	3	0
1980	297227	27032	73704	37658	11915	9368	2556	260	229	27
1981	289672	8727	22244	25048	10552	2402	2084	374	41	4
1982	297730	3721	7032	26194	13117	2713	539	277	81	5
1983	333168	11565	14957	21690	34199	9831	2155	407	158	16
1984	388035	4923	24016	20670	14986	21269	4715	960	87	50
1985	381647	20068	20263	19696	8956	4796	8013	1363	334	18
1986	425017	139498	48705	34509	11341	2624	1098	1771	216	7
1987	418536	13793	52715	38939	18440	3638	1097	298	348	16
1988	377132	2502	28446	44869	12631	4072	679	64	21	17
1989	355735	6879	15704	41407	23710	4769	1323	112	43	11
1990	252732	14230	124636	27694	29921	14768	721	207	23	0
1991	336675	11952	44964	63414	10436	8730	1743	195	94	0
1992	300217	16614	19452	21217	27962	2805	1958	565	32	3
1993	268413	9564	31623	26013	12458	14446	899	332	153	8
1994	264738	9236	21452	22571	11778	5531	5612	204	116	15
1995	204545	8288	22153	30007	9019	3875	1373	1270	86	15
1996	177092	5732	26021	21430	10506	3483	1031	296	289	28
1997	166817	6628	8974	16231	9922	4445	575	110	62	37
1998	150361	3711	4695	6806	6840	3670	1417	244	13	2
1999	93796	13384	13750	7009	6068	3462	1684	409	77	3
2000	69505	5176	11208	6458	2112	1972	836	298	90	7
2001	36135	607	6352	5592	1715	486	353	146	66	11
2002	21830	1017	3349	7716	2182	363	140	79	23	6
2003	15371	388	1089	2514	2980	1046	256	30	17	5
2004	15663	282	689	1912	2003	1711	456	108	16	4
2005	16149	1131	1889	994	1638	1852	1035	362	41	1
2006	13539	25	435	874	695	966	960	433	99	18

SCOLTR_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	236944	8785	19910	30722	14473	956	1612	635	72	6
1979	287494	171147	42910	23155	17996	4058	377	286	57	5
1980	333197	20806	58382	38436	9525	9430	1864	144	145	3
1981	251504	6576	19069	21550	9706	1777	1455	310	9	1
1982	250870	5214	8197	26681	12945	3334	647	339	74	16
1983	244349	37496	17926	12535	19234	6124	1217	183	141	26
1984	240775	38267	16048	10784	6307	9019	2371	479	13	30
1985	267393	28761	9368	7617	3086	1333	2901	443	173	14
1986	279727	8138	8572	9578	4109	767	425	609	52	2
1987	351131	18761	25933	16161	5954	1183	388	116	129	4
1988	391988	2398	15779	22526	5128	1641	207	31	15	6
1989	405883	20319	10052	21390	10837	2394	448	33	54	2
1990	371493	3677	35322	7665	8960	3423	160	40	5	0
1991	408056	8727	11908	22146	3192	2906	629	50	41	0
1992	473955	17581	14551	11823	15418	1500	1160	304	13	0
1993	447064	16439	20513	14386	6591	10105	574	204	97	24
1994	480400	4133	15771	13005	6454	2710	2997	172	84	14
1995	442010	9248	15887	19322	6262	2983	1092	1132	89	3
1996	445995	6662	12461	13523	9223	3012	861	282	243	9
1997	479449	2557	6768	15603	9464	4535	628	181	52	31
1998	427868	5096	5350	8058	9507	4312	1729	276	58	12
1999	329750	26519	20672	9295	6706	4080	2051	487	41	7
2000	280938	8385	16220	9287	3788	2621	1470	602	79	7
2001	245489	1303	11409	10419	3287	745	431	247	66	27
2002	184099	980	4653	11067	3686	818	221	180	60	13
2003	98721	871	1639	3986	5136	2080	286	73	59	7
2004	63953	224	1088	2225	2463	2168	669	123	18	15
2005	54905	954	2414	1236	1448	1901	831	251	26	2
2006	51456	66	495	1487	990	1055	1067	604	105	6

Table 12.2.13 (cont'd) Whiting in IV and VIId. Complete available tuning series.

FRATRO_IV units = individuals

year	effort	0	1	2	3	4	5	6	7	8
1986	56099	19	1542	1892	7146	3783	600	158	39	2
1987	71765	12	2508	4985	1271	5713	413	258	92	70
1988	84052	0	2537	8982	3223	704	1321	123	55	1
1989	88397	27	2958	3740	5629	1654	209	280	47	11
1990	71750	38	3210	6170	3781	2456	365	29	44	2
1991	67836	323	4465	6084	2864	1412	777	85	6	3
1992	51340	355	3427	6498	1940	635	358	96	5	0
1993	62553	938	3950	4586	4307	877	290	68	40	6
1994	51241	87	7006	3298	1191	612	108	11	8	1
1995	57823	263	6331	6125	2674	544	99	19	0	2
1996	50163	577	5523	4743	3214	890	156	8	12	0
1997	48904	267	1961	4677	3929	1020	221	18	3	0
1998	38103	567	4893	1959	533	161	68	36	0	2
1999	-9	51	7652	2886	1453	960	500	133	46	31
2000	30082	129	7367	8191	2453	1056	737	455	345	95
2001	50846	3357	10767	15476	6923	3227	1701	638	345	128
2002	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9
2003	52609	625	9277	16880	7857	5528	1701	188	19	23
2004	21074	0	938	367	919	946	743	256	36	4
2005	23683	0	1037	1665	386	178	149	103	52	14
2006	19100	4.918	4402.199	2229.464	373.059	37.178	183.608	226.409	0.27	-9

FRATRB_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	69739	1153	10312	14789	8544	807	1091	227	34	4
1979	89974	698	12272	14379	10884	3789	394	315	45	14
1980	63577	90	5388	11298	4605	4051	1004	78	71	10
1981	76517	144	6591	13139	8196	2090	1644	314	16	10
1982	78523	173	1643	16561	11241	3948	1035	539	119	14
1983	69720	500	4407	8188	16698	5541	1061	228	126	19
1984	76149	317	4281	7465	4576	5999	1596	308	32	26
1985	25915	315	3653	2942	1225	566	599	117	12	4
1986	28611	891	3830	3991	1202	369	94	160	22	1
1987	28692	431	4823	3667	2152	497	166	48	46	3
1988	25208	150	2718	4815	1125	530	100	31	3	4
1989	25184	448	2064	4351	1877	314	106	10	4	1
1990	21758	164	3794	2124	2010	620	55	13	1	0
1991	19840	292	2224	3829	819	657	138	15	3	0
1992	15656	365	1598	1686	2204	248	195	44	3	0
1993	19076	173	1225	2633	1141	1233	97	37	14	4
1994	17315	108	1806	1721	1466	413	430	29	8	1
1995	17794	114	1023	3304	1537	1163	240	212	14	7
1996	18883	21	655	1594	1438	482	199	38	30	10
1997	15574	40	357	1407	1139	606	86	16	10	2
1998	14949	32	126	317	326	192	63	8	2	1
1999	-9	96	490	489	684	452	239	59	14	1
2000	11747	47	1148	2968	1205	320	298	124	54	5
2001	6771	298	649	528	150	36	36	14	6	2

FRATRO_7D units = individuals

year	effort	1	2	3	4	5	6	7
1986	257794	2587	2250	7741	4463	804	198	19
1987	188236	1955	5050	907	4606	331	218	54
1988	215422	2233	7957	2552	537	1193	127	61
1989	320383	2578	3916	6006	1490	216	343	50
1990	257120	2492	5240	3363	2168	251	30	51
1991	294594	4009	8177	3985	2625	1474	155	11
1992	285718	5733	10924	3241	882	587	171	3
1993	283999	3158	6543	8607	1677	442	124	79
1994	286019	13932	7980	3269	1776	444	40	21
1995	268151	6301	8450	5261	1217	264	63	8
1996	274495	6140	6466	5465	1623	324	47	14
1997	282216	3320	8144	6608	1974	451	59	8
1998	291360	9921	6863	2385	781	265	105	15
1999	-9	-9	-9	-9	-9	-9	-9	-9
2000	215553	7096	7026	1734	1724	1375	877	675
2001	163848	89	6101	10124	3976	2563	2303	1040
2002	192589	985	1922	6247	6476	2270	461	463
2003	296717	155	6896	5489	5551	2397	312	65
2004	89127	1831	706	2312	2945	2611	902	109
2005	108369	5813	3730	793	813	720	510	262
2006	78600	2864	1912	457	133	800	1013	0