BASELINE FISHERIES INFORMATION

October 2011
Last update August 2012

Sussex Inshore Fisheries and Conservation Authority

This is a live document and will be continually updated as new information is discovered or becomes available.

Vause, B. J and Clark, R. W. E. 2011.
Sussex Inshore Fisheries and Conservation Authority

Baseline Fisheries Information. 103pp.
First published October 2011
This report is available at www.sussex-ifca.gov.uk

The Sussex IFCA is funded by

Acknowledgements
The authors would like to acknowledge and thank the following people for their invaluable contributions; Charlie Hubbard and Mark Hayes from the Sussex IFCA Fisheries Protection Vessel 'Watchful' for sharing their vast local fisheries knowledge and Chief Fishery and Conservation Officer Tim Dapling for his continuous support.

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Appendix 1
Drew Associates, 2004. Executive summary: Research into the Economic Contribution of Sea Angling

Appendix 2
ICES statistical rectangles for the Sussex IFCA district

Bass
Dicentrarchus labrax (L.)

Species description
Bass belong to the order Perciformes which are the 'perch-like' fishes (Miller & Loates 1997). They have two dorsal fins which are of similar size, the first being spiny-rayed the second being soft-rayed, the scales are a large thick ctenoid scale which means they have a toothed margin, this reduces hydrodynamic drag during swimming and their jaws are structured such that they can protrude/extend their mouth to create a large funnel-like cavity which facilitates in hunting (Hayward & Ryland 1998). In addition they are thick bodied and streamlined, silvery in colour being slightly darker on their back and lighter on their belly and they have a dark patch on their gill covers (Hayward & Ryland 1998 & Dipper 1987). Juveniles (up to 10 cm) often have many darker spots on their sides and back (Miller & Loates 1997, Lythgoe & Lythgoe 1971).

Biology and ecology

Biological factor	
Size	Up to 1m, commonly 60cm (Hayward & Ryland 1998, Dipper 1987)
Lifespan	Over 25 years (MCS Fishonline)
Size at reproductive maturity	Males 31 - 35cm, females 40 - 45cm (Pawson 1995)
Age at reproductive maturity	Males 4 -7 years, females 5 - 8 years (Pawson 1995)
Fecundity	> 2 million eggs (Miller & Loates 1997)
Larval phase	Approximately 46 days (FishBase)
Adult mobility	Free swimming (mostly demersal) (FishBase)

Reproductive behaviour
Bass spawn in the English Channel from February until June (MCS Fishonline, Pawson 1995). Studies of bass egg abundance indicate that spawning is temperature related and that when temperatures exceed 9ºC (around about May), spawning occurs in the eastern Channel from the Isle of Wight to Beachy Head (Pawson 1995). The eggs are planktonic and hatch after a few days (Dipper 1987) and as the larvae grow they begin to aggregate and move steadily inshore (Pawson 1995). Upon reaching a specific developmental stage at around 15mm (from June onwards) they begin to respond to environmental cues and actively swim into their estuarine nursery habitats (Pawson 1995). The young bass remain in the nursery areas for 2 years, after which they overwinter in deeper water and in the larger estuaries (typically greater than 4km^2) they may return for the summer periods (Pawson 1995). Age at maturity is dependent upon size (growth appears to be temperature dependent) and sex (see table above). Once sexually mature they adopt the migratory movements of the adult fish (Pawson 1995).

Migratory behaviour
The seasonal distribution of bass has been studied using tags. The results suggest there are two distinct bass stocks in the English Channel; an eastern stock (which moves between the English Channel and the southern North Sea) and a western stock (which moves along the west coast and into Cornish waters), genetic analysis also supports this theory (Pawson 1995). A rough boundary between the two stocks has been identified as a southwest line drawn from Start Point in Devon (Pawson 1995). These tagging studies indicate that the eastern English Channel bass overwinter in the west of the English Channel (Pawson 1995). Spawning of these fish begins in spring (with the increase in water temperature) and so does their migration. Consequently it is believed that the centre of the spawning area shifts progressively east until June when spawning is complete (Pawson 1995). The spent fish then continue to move east to feeding grounds

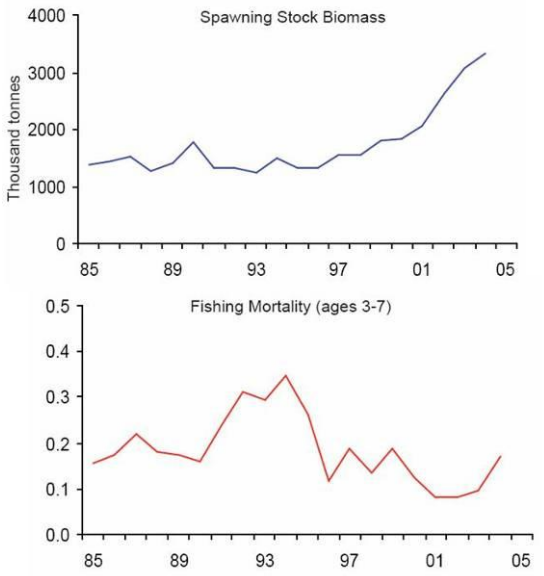
in the far eastern English Channel and southern North Sea (Pawson 1995). They remain on the feeding grounds until late autumn when the water temperature begins to decrease and then migrate south and west back to the winter pre-spawning areas in the west of the English Channel (Pawson 1995). Juvenile bass i.e. those approaching first maturity, do not perform this migration, instead they exhibit small seasonal movements generally being re-captured within 50 miles of the tagging site (Pawson 1995).

Habitat
Bass are generally regarded as a schooling fish which perform migrations together. They can be found at all depths from near the surface to below 100m and over a wide range of substrates from rocks and sand to shingle and mud (Lythgoe & Lythgoe 1971). It has been documented that they may occupy the same locality for many months including feeding territories even between tides (Lythgoe & Lythgoe 1971). Older larger bass can often be solitary and divers have reported seeing the same fish in the same locality for several months (Dipper 1987, Lythgoe & Lythgoe 1971).

Predators and prey
Bass are carnivorous predominantly feeding upon fish, crustacea and squid but will also take other cephalopods and worms (Miller & Loates 1997, Lythgoe & Lythgoe 1971). Bass are high in the marine food chain and thus have few predators but amongst these are larger bass and seabirds.

Stock status (Carleton *et. al.* 2009)
A number of recent ICES working groups, and study groups and resulting reports have focused on bass. Notably in both 2002 and 2005 there was a study group on bass and in 2005 and 2008 the Working Group on the Assessment of New MoU Species (WGNEW) has focused on bass. None the less ICES do not carry out formal routine analytical assessments of bass status which would form the basis of annual management advice.

Fig 1: Spawning stock biomass and Fishing mortality for bass (VIId)



Good length and age composition data are available for the main métier groups. Analysis of yield per recruit using UK data for 3 catch métiers provides a basis for examine how the new recruits to the fishery are exploited over time and provides a quantitative assessment of stock evolution over time. This shows that the biomass of adult seabass around the coasts of England and Wales has approximately doubled from 1985 to 2004. Within ICES division VIId (Eastern Channel) the same upward trajectory in spawning stock biomass is shown. Stock levels are now considered to be, or close to, series maxima and trends in fishing mortality are fairly level (ICES WGNEW 2008). Recruitment was good during the mid to late 1990s and the 2002 year class is also thought to be strong.

In 2003, the ICES Bass Study Group (SGBASS) carried out a stock assessment 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 over the period 1985–2002 (ICES CM 2004). However, the stock assessment did not provide information considered reliable

enough to propose biological reference points. No update has been carried out using international data, but a multi-métier, fully statistical, separable catch-at-age model was used with UK data for the period 1985–2006 covering the four Divisions IVb,c, Division VIId, Divisions VIIe, h and Divisions VIIa, f, g. (Kupschus et al., 2008). Stocks levels are considered to be at, or close to, the 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 has resulted in the current high landings and stock levels. There are some disagreements among information sources (the Solent index suggests recruitment has been stronger than the stock assessment suggests), which raises uncertainties.
The ability to do assessments has been demonstrated for this stock. However, outputs from the assessment are perhaps less clear in terms of management advice. There is a clear need to move from exploratory stock assessments to one that establishes reference points that take account of the uncertainties associated with the stock and outlined in the assessment reports. Based on the available information, this now appears possible.

The Sussex fisheries

Fishing activity

Shoals of bass start to arrive in Sussex in late spring/early summer on passage to their feeding grounds and to breed. During this migration they are often caught as a bycatch in the black bream fishery by pair trawlers; commonly in the area between Selsey Bill and Shoreham. During the summer bass are most commonly found on harder grounds e.g. the Royal Sovereign shoals off the coast of Eastbourne and on inshore seabed features e.g. wrecks and it is at this time that they are targeted by static gear, commercial anglers and recreational anglers. A small proportion of bass will also be taken in keddle nets during the summer months in the vicinity of Rye bay. From late summer to late autumn the bass are on their return migration from the feeding grounds in the east and they are commonly caught by the method of drift netting; this is most productive at night or during the day after a period of high wind activity (when water visibility is lower) and the fish are closer to the surface. In late autumn the bass gradually move west and offshore to slightly deeper water >25m and this is when they are targeted by the stern trawlers. Few bass are caught within Sussex during the winter.

Fishing methods

Fishing for bass within the Sussex IFCA district occurs on a commercial and recreational basis. Most bass are caught by commercial trawlers, commonly using the methods of stern trawling (specifically demersal otter trawls) and pair trawling. Pair trawlers specifically target bass but they are also a significant and valuable bycatch when bream are being targeted. Drift nets and rod and line are other very popular commercial methods used to target bass. Recreationally bass are targeted by angling and many charter vessels will take anglers to localities where bass are known to be present. Other fishing methods that catch bass include static nets, bottling, long-lining and spear fishing.

Pair trawl fishery

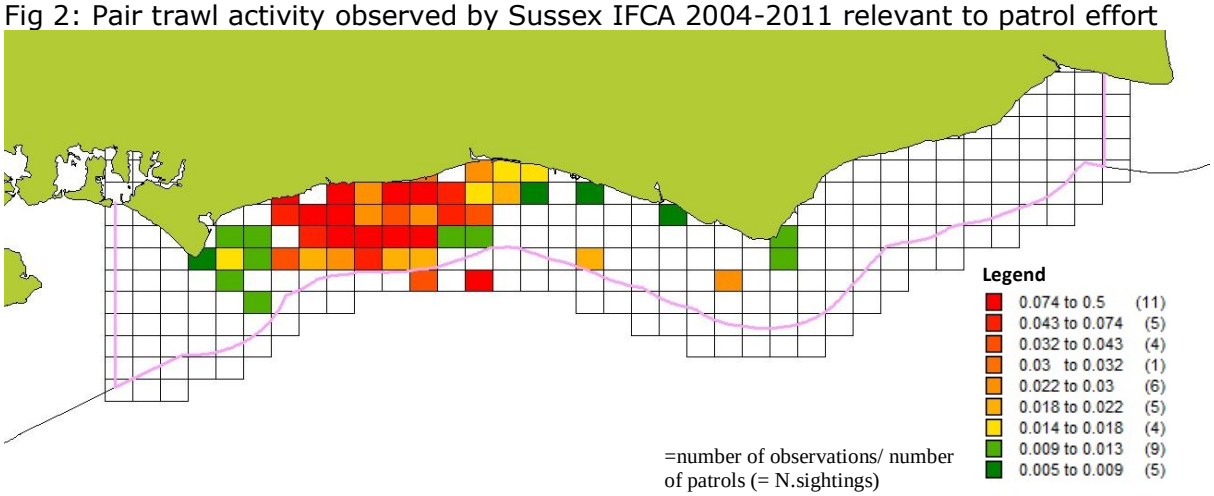
The pair trawl is made from hardwearing gear, but instead of the otter boards it is the two vessels that open the trawl. This method allows the net to be towed at a greater speed than if operated by a single boat, this means that faster moving fish can be caught. In Sussex this method is used primarily for bass and black sea bream. The net is often an adaptation of a semi-pelagic single boat trawl.

Spatial distribution of fishing activity

The activity of pair trawling within Sussex is seasonal and spatially confined; mostly occurring during spring when the black bream arrive between Selsey Bill and Shoreham-

by-Sea (Fig 2). Bass are also targeted using this method and are a high value bycatch during the black bream season.

Fig 2: Pair trawl activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 1: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
Number of vessels	216	58
Average Fishing Income (£)	57,275	156,049
Average days at sea	100	174
Average income per day (£)	569	834
Annual operating costs	40,806	127,210
Operating costs as a % of income	68%	76%
Fuel costs as a % of income	12%	16%
Operating Profit (£)	18,920	40,901
Operating Profit Margin (£)	32%	24%
Net profit margin (£)	16%	19%

Vessels in the under 10m trawl and seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total. Nationally bass account for 2% of the value of the catch composition of this segment (Curtis & Brodie 2011).
Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total. Bass is the most valuable (£ per tonnne) species caught by the ICES Area VIIb-k trawlers 10-24m segment and accounted for approximately 8% of the value of the total catch composition of this segment, this segment's average price for bass was approximately £700 per tonne higher than the UK fleet average price for bass (approx £6,600 per tonne vs £7,300 per tonne), Curtis & Brodie 2011.

Local socioeconomics

The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of bass landed by the method of pair trawling* into Sussex ports. * *includes MMO method description 'bottom pair trawl' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£27,670	£0	£27,670	£1,447	£0	£1,447	£29,117
2008	£97,157	£0	£97,157	£4,784	£0	£4,784	£101,941
2009	£60,622	£0	£60,622	£17,302	£0	£17,302	£77,924
2010	£84,016	£0	£84,016	£25,453	£0	£25,453	£109,469
Grand Total	£269,465	£0	£269,465	£48,986	£0	£48,986	£318,451

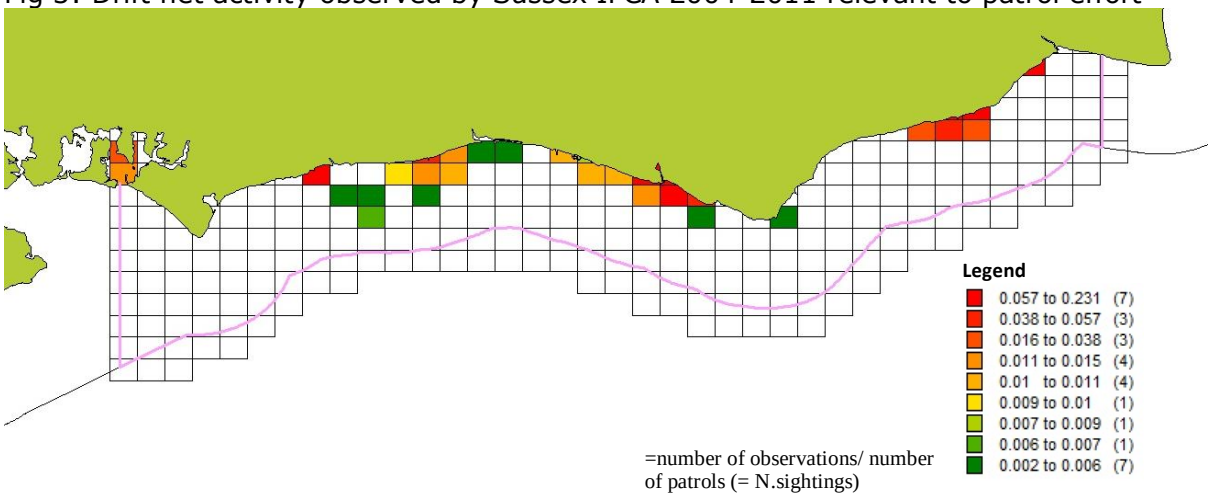
Drift net fishery

The drift net fishery has a long association with the Sussex Coast. Drift nets are rigged from a single sheet of monofilament with a depth of up to twenty feet. The float line keeps the top on the surface whilst the lead line stands the net in the water. Drift nets are shot across the tide and allowed to drift.

Spatial distribution of fishing activity

There are two distinct drift fisheries off the Sussex coast; they are a pelagic fishery, for mackerel and herring and a bass fishery. Despite the bad reputation in other parts of the world, the Sussex drift net fishery is not associated with a significant bycatch. Drift netting predominantly occurs inshore (within 3nm) along the Sussex coastline, with most activity been seen close to the ports of Littlehampton, Shoreham, Newhaven and Hastings (Fig 3).

Fig 3: Drift net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 3: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Drift and/or Fixed Nets <10m
Number of vessels	238
Average Fishing Income (£)	42,330
Average days at sea	94
Average income per day (£)	477
Annual operating costs	28,179
Operating costs as a % of income	67%
Fuel costs as a % of income	9%
Operating Profit (£)	14,151
Operating Profit Margin (£)	33%
Net profit margin (£)	25%

Vessels in the drift and/or fixed net <10m segment have an average of 2 crew members, in the UK this segment employed 438 fishermen in total. Bass accounted for only 4% of the volume of the total catch composition of this segment but 12% of the value. This segment's average price for bass was approximately £500 per tonne higher than the UK fleet average price for bass (approx £6,600 per tonne vs £7,100 per tonne) Curtis & Brodie 2011.

Local socioeconomics

The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see

appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 4: The Marine Management Organisations registration of buyers and sellers records of the total annual value of bass landed by the method of drift netting* into Sussex ports. * *includes MMO method description 'drift net' and 'unspecified gill net'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£587	£170,327	£170,914	£0	£154,290	£154,290	£325,204
2008	£1,555	£224,657	£226,213	£0	£247,132	£247,132	£473,344
2009	£3,037	£226,447	£229,484	£30	£258,929	£258,959	£488,443
2010	£10,620	£250,884	£261,505	£241	£218,170	£218,411	£479,915
Grand Total	£15,800	£872,316	£888,116	£270	£878,521	£878,791	£1,766,907

Rod and line fishery

The activity of fishing using rod and line is popular throughout the Sussex district at both a commercial level; by commercial anglers (anglers selling their catch) and by charter vessels (vessel owner operators taking recreational anglers to fish at sea). Recreational angling by private vessels and sea angling from the shore is also very popular throughout Sussex.

The main target species for fishing using rod and line in Sussex are:
Commercial anglers: bass, cod, pollack and ling
Charter vessels: bass, cod, black bream, mackerel and congor eel
Recreational angling (private vessels and angling from the shore): bass, cod, black bream, mackerel, whiting, plaice and dover sole

Recreational: Economic survey of recreational sea angling

In 2003 the Economics and Statistics Group of the Department for Environment, Food and Rural Affairs (Defra) commissioned Drew Associates to conduct a research study on the economic contribution of sea angling to the UK (Drew Associates, 2004). The executive summary of this research is attached as Appendix 2. Consumer surplus benefits from sea angling were found to be considerable; consumer surplus (mean value) on existing annual sea angling activity varied from £381 per shore angler to £886 per own boat angler. When aggregated over sea fishing trips for the whole country, the annual aggregate net benefit based on the mean consumer surplus estimates was £594 million (Drew Associates, 2004). Most anglers are male (96.7%) and had been fishing for 25.7 years on average. Anglers catch, on average, between 5 (shore anglers) and 13 (boat anglers) fish per trip and retain 32-39% of their catch (Drew Associates, 2004).

Recreational: Local socioeconomics

The population of the Sussex IFCA district is 1,804,000 (766,400 in East Sussex, 781,600 in West Sussex plus 256,000 in Brighton and Hove - all 2008 estimates). The Drew report (Drew Associates, 2004) showed 2.75% of the then population of 52 million in England and Wales were sea anglers. This equates to approximately 50,000 sea anglers in the Sussex district. In addition to the economic benefit to society from sea angling many anglers perceived a positive benefit to their health, anecdotal evidence from the Drew Associates 2004 surveys suggested that this was related to the sense of relaxation and peace of mind that angling engendered.

Commercial: Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 5: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Hooks <10m
Number of vessels	105
Average Fishing Income (£)	30,877
Average days at sea	75
Average income per day (£)	473
Annual operating costs	20,010
Operating costs as a % of income	59%
Fuel costs as a % of income	6%
Operating Profit (£)	14,191
Operating Profit Margin (£)	41%
Net profit margin (£)	31%

N.B. this segment incorporates under 10m commercial vessels using hooks by any method.

Vessels in the 'under 10m using hooks' segment have an average of 2 crew members, in the UK this segment employed 178 fishermen in total. Bass accounted for 7% of the volume of the total catch composition of this segment and 25% of the value. This segment's average price for bass was approximately £3,200 per tonne higher than the UK fleet average price for bass (approx £6,600 per tonne vs £9,800 per tonne) Curtis & Brodie 2011.

Commercial: Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 6: The Marine Management Organisations registration of buyers and sellers records of the total annual value of bass landed by the method of rod and line* into Sussex ports. * *includes MMO method description 'rod and line' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£86,633	£86,633	£0	£83,294	£83,294	£169,927
2008	£0	£56,797	£56,797	£0	£63,138	£63,138	£119,935
2009	£0	£71,926	£71,926	£0	£82,527	£82,527	£154,453
2010	£64	£86,059	£86,123	£0	£113,229	£113,229	£199,352
Grand Total	£64	£301,414	£301,478	£0	£342,189	£342,189	£643,667

Black bream/Black seabream
Spondyliosoma cantharus (L.)

Species description
Black bream have an elliptical, compressed body shape with a single dorsal fin which is spiny-rayed at the front, a tail fin which is forked and a small mouth which does not extend back to the level of the eye (Miller & Loates 1997, Lythgoe & Lythgoe 1971). The adult colouration is silver, tinged with blue and may have broken golden longitudinal lines (although this is more common in juveniles) (Miller & Loates 1997). Note, the seabreams are not related to freshwater breams.

Biology and ecology

Biological factor	
Size	Commonly 35cm (Dipper 1987). Up to 60cm (Miller & Loates 1997)
Lifespan	Approximately 15 years (FishBase)
Size at reproductive maturity	20 cm (Pawson 1995)
Age at reproductive maturity	2 - 3 years (Pawson 1995)
Fecundity	31,000 eggs in a 18.5cm female to 554,000 in a 33.5cm female (Dulcic *et. al.* 1998)
Larval phase	Demersal (stationary) egg phase followed by a 30 day planktonic larval phase (Emu Environmental Ltd. 1999)
Adult mobility	Free swimming (demersal)

Reproductive behaviour
Black bream are a member of the Sparidae family, most of which are hermaphrodites (Dulcic *et. al.* 1998); some are protandrus (mature as male and later change to be female) and some are protogynous (mature as female and later change to be male). There have been mixed reports in the past as to what type of hermaphrodite black bream are (Pawson 1995, Southern Science 1995, Emu Environmental Ltd. 1999) but the most recent research suggests they display protogynous hermaphroditism (Dulcic et. al. 1998, FishBase, MCS Fishonline). Sexual maturity is believed to take place at approximately 20cm in length (Pawson 1995) and the sex change from female to male is likely to occur between 30 and 40 cm (Pawson 1995). The larger individuals in the population are mature males and they exhibit a humped shoulder, a concave forehead and during the breeding season may appear dark silver to black with an iridescent blue-grey band between the eyes (Lythgoe & Lythgoe 1971). They are demersal spawners and exhibit very interesting breeding behaviour. Firstly, they activity seek specific types of seabed upon which to spawn. Habitats which have been identified are; open gravel areas, gravel areas adjacent to chalk reefs, gravel within sandstone reefs and gravel associated with ship's wreckage (Southern Science 1995). The common feature of these habitats is a thin layer of mobile gravel over a hard surface. The males then use their tail to remove the surface gravel layer and expose the bedrock or compacted gravel beneath, thus creating a 'nest' (Lythgoe & Lythgoe 1971, Southern Science 1995). The ideal nest size is between 1 - 2m^2 (Southern Science 1995). The females then lay their eggs in a thin layer within the nest, the eggs are sticky and they become strongly attached to the rock surface (Southern Science 1995). It is suggested that the males use their nests in intraspecific competition to attract a female (Southern Science 1995). Following this the male will fertilise the eggs and subsequently guard the nest (Pawson 1995). The juvenile bream remain in the vicinity of the nest until they are 7 - 8cm in length (Lythgoe & Lythgoe 1971). Following this they disperse slightly but continue to remain in the inshore areas for 2 - 3 years (approximately 20cm in length), when they become sexually mature and recruit to the adult stock (Pawson 1995). The hermaphroditic nature of black bream may have important consequences for the

sustained reproductive capacity of the stock (Pawson 1995). Between 1977 and 1979 the modal size of the black bream decreased from 37-38cm to 28-30cm as the bream fishery expanded (the fishing practices used to catch black bream selectively targets larger individuals); this has the potential to effect on the sex-ratio of the population and thus reproduction and repopulation (Pawson 1995).

Migratory behaviour
The adult black bream stock over winter in deep water (50-100m) west of a line from Alderney to Start Point (evidence for this comes from fisheries in the area) (Pawson 1995). As the water temperature of the English Channel increases in spring the bream migrate east and it is suggested that they follow the 9°C isotherm (Pawson 1995). They arrive in Sussex in March and inhabit the shallow inshore areas (<5m) to feed prior to reproducing. Around April they generally move to the area in between the south of the Winter Knoll and Kingmere Rocks (Southern Science 1995) (off the coast of Littlehampton). This area has been identified as a black bream breeding ground; it is 5 - 10m deep and consists of the habitats associated with black bream nesting areas (Southern Science 1995). Egg laying takes place from early May until early June (Southern Science 1995) and they remain in this area until early July. Black bream can also be found in smaller quantities throughout the district during this time (in particular around Selsey Bill and the Royal Sovereign Shoals near Eastbourne). Post spawning the bream continues to feed inshore, migrating east to the southern North Sea (Pawson 1995). In November they begin their return migration west, arriving in the western Channel in January then return offshore to the deeper waters (Pawson 1995).

Habitat
Adult black bream exhibit schooling behaviour and mostly inhabit the inshore shelf region (Miller & Loates 1997). The stock which occupy the English Channel; over winter in water depths between 50-100m, migrate inshore to breed in spring in habitats which posses a thin layer of mobile gravel over a hard surface (Southern Science 1995) and feed on inshore grounds throughout summer and autumn (Pawson 1995).

Predators and prey
Black bream predominantly feed upon seaweed and invertebrates (Miller & Loates 1997) for which they have specially adapted teeth (Lythgoe & Lythgoe 1971). In addition the stomach contents of fish which inhabit a known cuttlefish nursery ground were investigated; they found black bream to be a main predator of young cuttlefish (8 - 61mm mantle length) but not upon cuttlefish eggs (Blanc & Daguzan 1999). Male black bream stay in the close vicinity of their 'nest' until their eggs hatch. The purpose of this behaviour is believed to be guarding the eggs from predators (Pawson 1995). Likely predators on black bream eggs are the clawed crustaceans; spider crabs and brown crabs in particular which are migrating inshore through the black bream breeding sites at that time of year. Adult black bream have few predators; however a few are likely to be taken by seabirds and marine mammals.

Stock status (Carleton *et. al.* 2009)
There is no formal stock assessment in the Sussex District (or in the Channel) for Black Bream. Reference points, harvest control rules and fishery specific management objectives have not been specified.

The Sussex Fisheries
Fishing activity
Black bream are only present within the Sussex IFCA district from April to November being most prolific from April until early July. Upon arrival in the district they inhabit the shallow inshore hard ground areas to feed before breeding, it is during this time they are targeted by small inshore boats using fixed nets. The fish then move onto their breeding

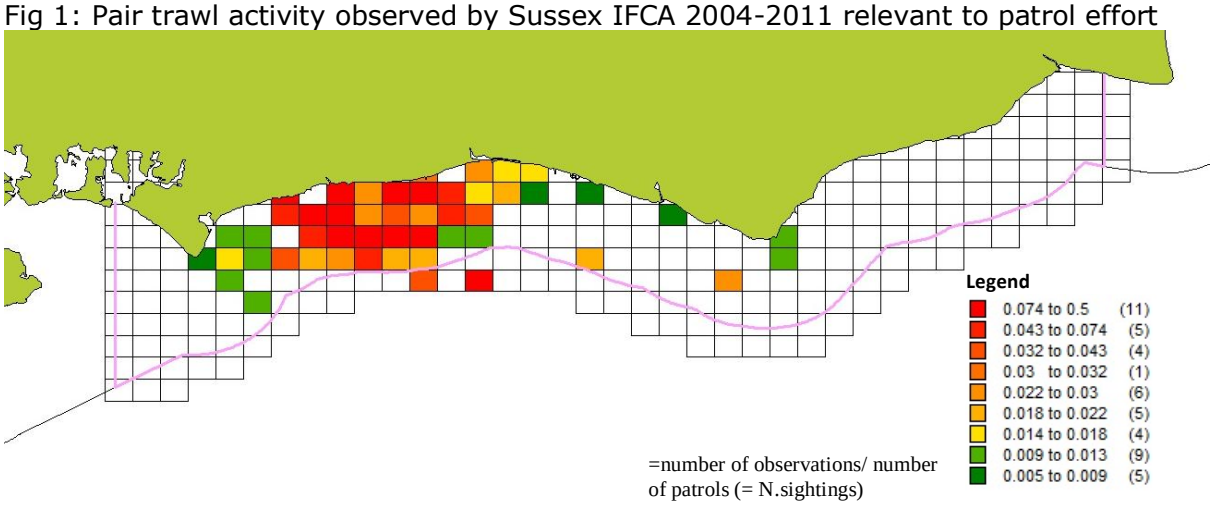
grounds where nest making, breeding and subsequent guarding of the nests occurs. During this time they are targeted by the by pair trawlers, stern trawlers and commercial and recreational anglers. The pair trawlers appear to get the best catch rates during daylight; this may be because the fish are closer to the seabed. Post breeding (early July) the majority of the fish leave the Sussex district however some are still by caught by anglers in the area until September and further offshore at the Outer Owers until November (Southern Science 1995).

Fishing methods
Fishing for black bream within the Sussex IFCA district occurs on a commercial and recreational basis. Most black bream are caught by commercial trawlers, commonly using the methods of pair trawling and stern trawling (specifically demersal otter trawls). Other commercial methods used to target black bream are static nets and rod and line. Recreationally, black bream are targeted by angling and many charter vessels will take anglers to localities where bream are known to be present. A common and valuable bycatch when targeting black bream is bass.

Pair Trawl Fishery
The pair trawl is made from hardwearing gear, but instead of the otter boards it is the two vessels that open the trawl. This method allows the net to be towed at a greater speed than if operated by a single boat, this means that faster moving fish can be caught. In Sussex this method is used primarily for bass and black sea bream. The net is often an adaptation of a semi-pelagic single boat trawl.

Spatial distribution of fishing activity
The activity of pair trawling within Sussex is seasonal and spatially confined; mostly occurring during spring when the black bream arrive between Selsey Bill and Shoreham-by-Sea (Fig 1). Bass are also targeted using this method and are a high value bycatch during the black bream season.

Fig 1: Pair trawl activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 1: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
Number of vessels	216	58
Average Fishing Income (£)	57,275	156,049
Average days at sea	100	174
Average income per day (£)	569	834
Annual operating costs	40,806	127,210
Operating costs as a % of income	68%	76%
Fuel costs as a % of income	12%	16%
Operating Profit (£)	18,920	40,901
Operating Profit Margin (£)	32%	24%
Net profit margin (£)	16%	19%

Vessels in the under 10m trawl and seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total (Curtis & Brodie 2011). Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total, black seabream accounted for approximately 4% of the volume of the total catch composition of this segment (Curtis & Brodie 2011).

Local socioeconomics

The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of black bream landed by the method of pair trawling* into Sussex ports. * *includes MMO method description 'bottom pair trawl' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£148,571	£0	£148,571	£111	£0	£111	£148,682
2008	£264,350	£0	£264,350	£752	£0	£752	£265,101
2009	£111,078	£0	£111,078	£2,122	£0	£2,122	£113,200
2010	£136,759	£0	£136,759	£1,472	£0	£1,472	£138,231
Grand Total	£660,757	£0	£660,757	£4,457	£0	£4,457	£665,214

Fixed net fishery

There are a variety of types of nets deployed off Sussex; the most common is the trammel net. The trammel is constructed of three 'sheets' of nets, the outer nets are rigged one each side of the inner mesh panel. These nets have a cork line (top line) and lead line (bottom line). The nets sit or 'swim' in 3 to 8 feet of water. The fixed net only fishes on the slowest run of the tide. Fish targeted in this manner are plaice, sole, cod

and cuttlefish. Gill nets and tangle nets are also used for targeting fish such as cod; these nets are fished in a similar manner to trammel nets but are rigged from a single sheet that sits vertically on the seabed. Nets are usually made from monofilament, although nylon is essential when catching spider crabs, due to the abrasion caused by this crab during entrapment. The fixed net vessels work various styles and combinations according to the season; gill nets for cod in the winter and trammel nets for plaice and sole in the early spring. In the spring / summer season trammel nets are set for plaice, cuttlefish and sole and gill nets for bass. In the autumn trammel nets are set for plaice and sole and gill nets set for bass and cod.

Spatial distribution of fishing activity

The practice of fixed net fishing is the most common method used to catch fin fish within the Sussex district. Fishing used fixed nets occurs throughout the year (targeting one or more of the variety of species that this method is effective at catching) from Bognor Regis to Rye bay and most commonly within 3-4nm of the shore (fig 2).

Fig 2: Fixed net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort

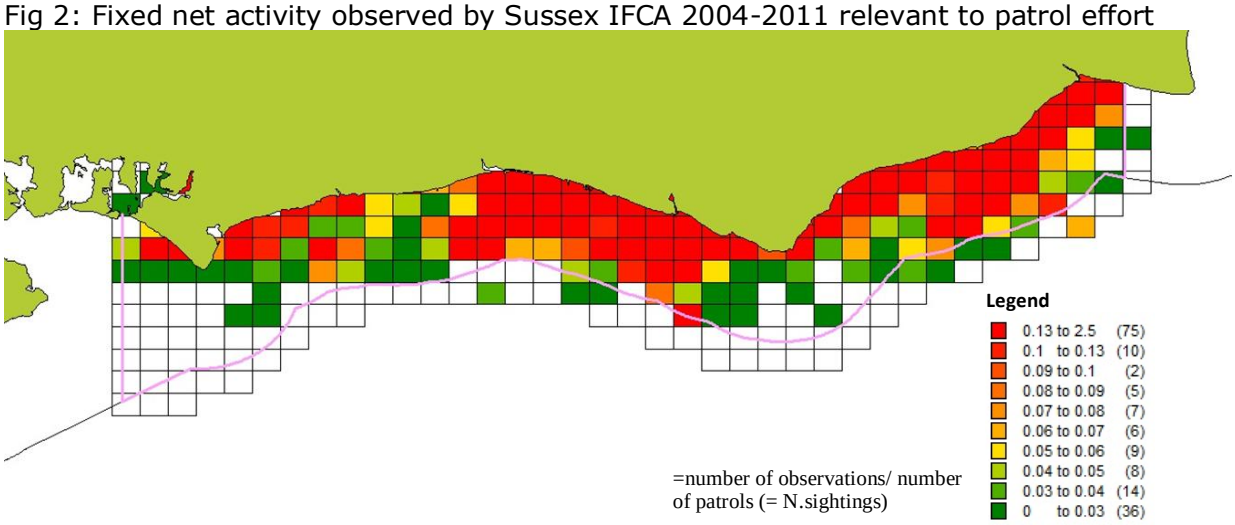


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Table 3: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Drift and/or Fixed Nets <10m
Number of vessels	238
Average Fishing Income (£)	42,330
Average days at sea	94
Average income per day (£)	477
Annual operating costs	28,179
Operating costs as a % of income	67%
Fuel costs as a % of income	9%
Operating Profit (£)	14,151
Operating Profit Margin (£)	33%

Net profit margin (£)	25%

Vessels in the under 10m drift and/or fixed net segment have an average of 2 crew members, in the UK this segment employed 438 fishermen in total (Curtis & Brodie 2011).

Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 4: The Marine Management Organisations registration of buyers and sellers records of the total annual value of black bream landed by the method of fixed nets* into Sussex ports. * *includes MMO method description 'gill net (not 52 or 53)', 'gill net (tangle)', 'gill net (trammel)' and unspecified gill net*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£2,401	£2,401	£33	£1,060	£1,093	£3,495
2008	£0	£3,232	£3,232	£5	£1,153	£1,157	£4,389
2009	£0	£2,231	£2,231	£1	£1,298	£1,299	£3,531
2010	£0	£2,818	£2,818	£1	£1,761	£1,762	£4,580
Grand Total	£0	£10,683	£10,683	£39	£5,272	£5,312	£15,994

Rod and line fishery
The activity of fishing using rod and line is popular throughout the Sussex district at both a commercial level; by commercial anglers (anglers selling their catch) and by charter vessels (vessel owner operators taking recreational anglers to fish at sea). Recreational angling by private vessels and sea angling from the shore is also very popular throughout Sussex.

The main target species for fishing using rod and line in Sussex are:
Commercial anglers: bass, cod, pollack and ling
Charter vessels: bass, cod, black bream, mackerel and congor eel
Recreational angling (private vessels and angling from the shore): bass, cod, black bream, mackerel, whiting, plaice and dover sole

Recreational: Economic survey of recreational sea angling
In 2003 the Economics and Statistics Group of the Department for Environment, Food and Rural Affairs (Defra) commissioned Drew Associates to conduct a research study on the economic contribution of sea angling to the UK (Drew Associates, 2004). The executive summary of this research is attached as Appendix 2. Consumer surplus benefits from sea angling were found to be considerable; consumer surplus (mean value) on existing annual sea angling activity varied from £381 per shore angler to £886 per own boat angler. When aggregated over sea fishing trips for the whole country, the annual aggregate net benefit based on the mean consumer surplus estimates was £594 million (Drew Associates, 2004). Most anglers are male (96.7%) and had been fishing for 25.7 years on average. Anglers catch, on average, between 5 (shore anglers) and 13 (boat anglers) fish per trip and retain 32-39% of their catch (Drew Associates, 2004).

Recreational: Local socioeconomics
The population of the Sussex IFCA district is 1,804,000 (766,400 in East Sussex, 781,600 in West Sussex plus 256,000 in Brighton and Hove - all 2008 estimates). The Drew report (Drew Associates, 2004) showed 2.75% of the then population of 52 million in England and Wales were sea anglers. This equates to approximately 50,000 sea anglers in the Sussex district. In addition to the economic benefit to society from sea angling many anglers perceived a positive benefit to their health, anecdotal evidence from the Drew Associates 2004 surveys suggested that this was related to the sense of relaxation and peace of mind that angling engendered.

Commercial: Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 5: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Hooks <10m
Number of vessels	105
Average Fishing Income (£)	30,877
Average days at sea	75
Average income per day (£)	473
Annual operating costs	20,010
Operating costs as a % of income	59%
Fuel costs as a % of income	6%
Operating Profit (£)	14,191
Operating Profit Margin (£)	41%
Net profit margin (£)	31%

N.B. this segment incorporates under 10m commercial vessels using hooks by any method.
Vessels in the 'under 10m using hooks' segment have an average of 2 crew members, in the UK this segment employed 178 fishermen in total (Curtis & Brodie 2011).

Commercial: Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 6: The Marine Management Organisations registration of buyers and sellers records of the total annual value of black bream landed by the method of rod and line* into Sussex ports. * *includes MMO method description 'rod and line' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£221	£221	£0	£14	£14	£235
2008	£0	£71	£71	£0	£43	£43	£114
2009	£0	£135	£135	£0	£1	£1	£136
2010	£54	£68	£122	£0	£1	£1	£123
Grand Total	£54	£495	£549	£0	£59	£59	£608

Brill
Scophthalmus rhombus (L.)

Species description
Brill are flatfish with an oval body outline and eyes on the 'left' side of the head. The dorsal and anal fins run the length of the body but do not join the tail fin (Hayward & Ryland 1998); in addition the finrays at the front of the dorsal fin are branched, giving a 'frilly' appearance (Hayward & Ryland 1998). Unlike turbot, brill have scales and no 'tubercles' (bony bumps) (Hayward & Ryland 1998, Miller & Loates 1997) but similarly they do have a lateral line which is strongly arched above the pectoral fin (Hayward & Ryland 1998, Miller & Loates 1997). Their colouration and markings are variable depending on the colour of the seabed (Dipper 1987) but they are commonly greyish brown with an abundance of dark and light speckles on top and white underneath (Hayward & Ryland 1998).

Biology and ecology

Biological factor	
Size	Up to 75cm (Miller & Loates 1997)
Lifespan	Approximately 6 years (FishBase)
Size at reproductive maturity	Approximately 22cm (FishBase)
Age at reproductive maturity	Approximately 1.5 years (FishBase)
Fecundity	Mean egg production >100,000 eggs per kg body weight (Hachero-Cruzado *et. al.* 2007)
Larval phase	Yes, planktonic (duration unknown)
Adult mobility	Free swimming (demersal)

Reproductive behaviour
Brill spawn from April to August in water depths of 10 - 20m (Miller & Loates 1997, Dipper 1987). Their eggs are planktonic and hatch after 14 days; following this the larvae remain in the pelagic zone until metamorphosis occurs at 20 - 35mm in length (Miller & Loates 1997). During this period the larvae will be subject to surface water currents and may have the potential to travel long distances. Following metamorphosis they adopt a demersal life style. Young brill remain in shallow waters for 1 - 2 years then move to slightly deeper depths (Dipper 1987, Lythgoe & Lythgoe 1971). Wild hybrids of turbot and brill have been identified; these individuals exhibit intermediate characteristics of both species (Miller & Loates 1997, Lythgoe & Lythgoe 1971).

Migratory behaviour
There has been little research regarding brill movements in the Sussex district. In general it is common for younger/smaller individuals to be found in the shallower waters and older /larger individuals to be found at deeper depths (Dipper 1987, Lythgoe & Lythgoe 1971), thus moving in a slight offshore direction as they mature and grow. It is likely that as adults they perform small seasonal migrations, coming into shallower inshore areas to breed. A 5 year tag and recapture study in the Kattegat showed that brill perform short migrations into deeper water in the autumn and winter and return to the same shallow water area each spring (Hachero-Cruzado *et. al.* 2007). It is likely that brill are very similar in their movements to turbot (Hachero-Cruzado *et. al.* 2007) and that if they have settled as juveniles in the district they are likely to stay within (or in the close vicinity of) the district throughout the year and thus their lifespan. It is therefore likely that the main dispersal potential of this species is during the egg and larval planktonic phase.

Habitat
Brill inhabit the inshore shelf region to depths of 70m but may also be found in brackish waters (Dipper 1987, Lythgoe & Lythgoe 1971). Very small juvenile brill may be found in rock pools on the shore, as they grow they move to inhabit the shallow inshore waters and as they get older reside further offshore at the greater depths (Dipper 1987, Lythgoe & Lythgoe 1971). Their preferred substrate type is sand but they can also be found on mud or gravel bottoms (Hayward & Ryland 1998, Dipper 1987, Lythgoe & Lythgoe 1971).

Predators and prey
Brill are carnivorous predators, mostly feeding upon other fish species (Miller & Loates 1997, Lythgoe & Lythgoe 1971). Their most common prey items are sand eels and gobies (Miller & Loates 1997, Lythgoe & Lythgoe 1971); they will also take whiting and crustaceans such as crabs and shrimps and molluscs, in particular squid (Dipper 1987, FishBase). Predators of brill include cod and sea mammals (FishBase).

Stock status (Carleton *et. al.* 2009)
Seafish conclude that there is a serious shortage of basic information for this stock due to severe deficiencies in the data (lack of updates, gaps in the time series, little data on discards and limited survey information). There are no formal stock assessments, so stock status is uncertain and it is unclear whether a rebuilding strategy is required. Reference points and harvest control rules have not been formalized.

The Sussex Fisheries
Fishing activity
Brill are present throughout the Sussex IFCA district, however the 'joint targeted' fishery which uses the large mesh static nets exploits deeper waters which are predominantly outside of 6nm and thus outside of IFCA jurisdiction; within the district brill are generally taken only as a bycatch. The joint targeted fishery for brill is from late spring until the end of summer, coincidently this is in line with their breeding season but they can be caught all year round. During the spring and summer the more settled weather allows the fishing vessels to attend offshore areas on a more regular basis and it is a good supplementary fishery to fit in with other fishing practices at that time of year. The most productive fishing is over the neap tides. Similar to turbot, brill are a very hardy fish and they are usually live upon hauling.

Fishing methods
The fishery for brill within the Sussex IFCA district is solely on a commercial basis and they are not targeted alone; they are part of a 'joint targeted' fishery for large flat bottom dwelling species which includes; turbots, rays and brills. These species are targeted using a specific type of static net commonly called a 'turbot-ray net' or a 'skate net'. This is a single walled gill net with a large mesh; the common mesh size used is between 160 - 270 mm (this is double the mesh size of a standard net used to target sole and plaice) and it is made from a more robust monofilament (this is necessary to handle these larger rougher species). The nets are left on the seabed for up to 3 days and they are mostly set in water depths 20 - 30m. They are a common bycatch for most other fishing methods, in particular beam trawls but they are also caught in standard static nets, otter trawls and scallop dredges.

Fixed net fishery
There are a variety of types of nets deployed off Sussex; the most common is the trammel net. The trammel is constructed of three 'sheets' of nets, the outer nets are rigged one each side of the inner mesh panel. These nets have a cork line (top line) and lead line (bottom line). The nets sit or 'swim' in 3 to 8 feet of water. The fixed net only

fishes on the slowest run of the tide. Fish targeted in this manner are plaice, sole, cod and cuttlefish. Gill nets and tangle nets are also used for targeting fish such as cod; these nets are fished in a similar manner to trammel nets but are rigged from a single sheet that sits vertically on the seabed. Nets are usually made from monofilament, although nylon is essential when catching spider crabs, due to the abrasion caused by this crab during entrapment. The fixed net vessels work various styles and combinations according to the season; gill nets for cod in the winter and trammel nets for plaice and sole in the early spring. In the spring / summer season trammel nets are set for plaice, cuttlefish and sole and gill nets for bass. In the autumn trammel nets are set for plaice and sole and gill nets set for bass and cod.

Spatial distribution of fishing activity

The practice of fixed net fishing is the most common method used to catch fin fish within the Sussex district. Fishing used fixed nets occurs throughout the year (targeting one or more of the variety of species that this method is effective at catching) from Bognor Regis to Rye bay and most commonly within 3-4nm of the shore (fig 1).

Fig 1: Fixed net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort

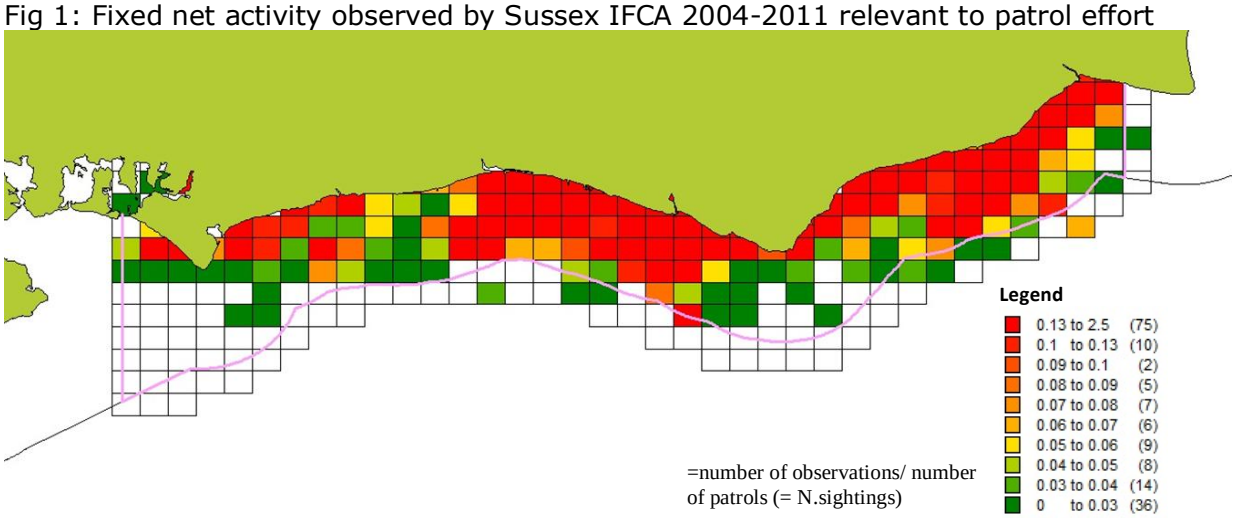

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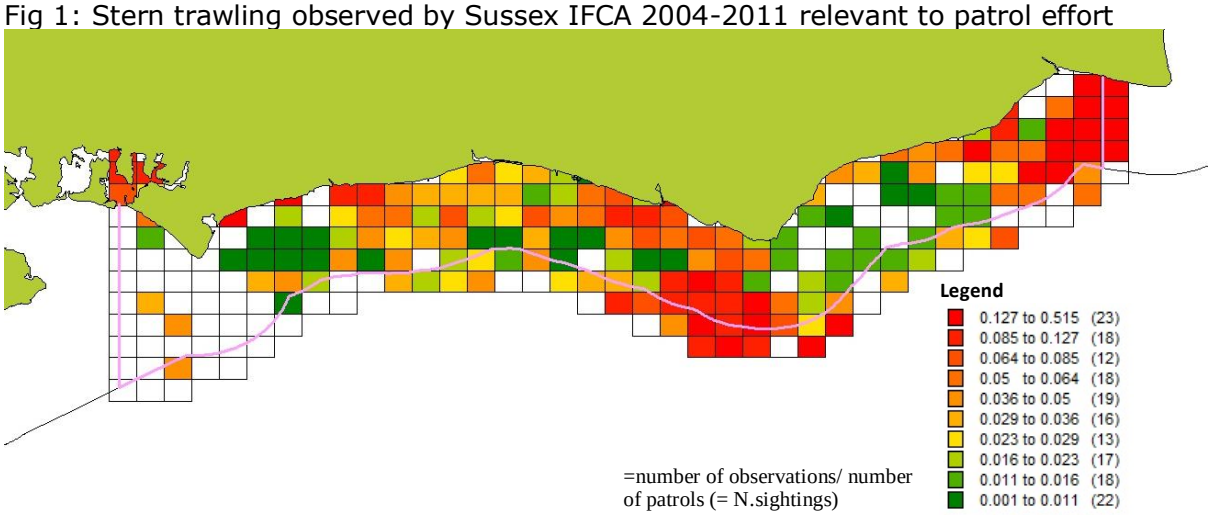
Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of brill landed by the method of fixed nets* into Sussex ports. * *includes MMO method description 'gill net (not 52 or 53)', 'gill net (tangle)', 'gill net (trammel)' and unspecified gill net*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007		£11,316	£11,316	£80	£22,556	£22,636	£33,952
2008	£83	£13,672	£13,755	£40	£23,594	£23,634	£37,389
2009		£26,033	£26,033	£32	£28,788	£28,820	£54,853
2010	£223	£32,916	£33,139	£62	£29,748	£29,809	£62,948
Grand Total	£306	£83,937	£84,243	£213	£104,686	£104,899	£189,142

Stern trawl fishery
There are two types of towed gear used off the Sussex Coast, they are: rock hopper otter trawl and small footrope otter trawl (the effort map (fig x) does not discriminate between these two types of trawls). The rock hopper otter trawl is normally used in conjunction with steel otter boards and wire bridles these trawls target cod, whiting, lemon sole, squid, cuttlefish, and bass. Larger sole, skate and dogfish are also caught. This gear can be worked on the grounds with harder substrates such as the fisheries off Dungeness, Beachy Head, Worthing and Selsey. The small footrope otter trawl uses wooden otter boards. Wire or combination wire bridles are also used but they are longer than the rock hopper rig typically 60 to 100 fathoms. The main species targeted with this method are plaice, sole, codling, cuttlefish and any other demersal species. This trawl cuts through the top layer of the soft sea bottom and the tickler chain digs the fish out. This rig is used predominantly to the east of the District due to the softer seabed. The small footrope otter trawl may be twin rigged (two nets) or triple rigged (3 nets), the nets are towed side by side and thus the effective area swept is increased.

Spatial distribution of fishing activity

Fig 1: Stern trawling observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 3: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
Number of vessels	216	58
Average Fishing Income (£)	57,275	156,049
Average days at sea	100	174
Average income per day (£)	569	834
Annual operating costs	40,806	127,210
Operating costs as a % of income	68%	76%
Fuel costs as a % of income	12%	16%
Operating Profit (£)	18,920	40,901
Operating Profit Margin (£)	32%	24%
Net profit margin (£)	16%	19%

Vessels in the under 10m demersal trawl / seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total (Curtis & Brodie 2011).

Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total (Curtis & Brodie 2011).

Local socioeconomics

The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 4: The Marine Management Organisations registration of buyers and sellers records of the total annual value of brill landed by the method of stern trawling* into Sussex ports. * *includes MMO method description 'heavy otter trawl', 'light otter trawl', 'twin otter trawl' and 'unspecified otter trawl'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£1,211	£827	£2,038	£798	£7,855	£8,653	£10,691
2008	£418	£284	£702	£1,169	£3,469	£4,638	£5,340
2009	£695	£122	£817	£792	£2,161	£2,953	£3,770
2010	£1,003	£282	£1,285	£800	£4,496	£5,296	£6,581
Grand Total	£3,326	£1,516	£4,842	£3,559	£17,981	£21,540	£26,382

Cod
Gadus morha (L.)

Species description
Cod are a typical fish shape with an elongated body however, quite uniquely they have; three dorsal fins, two anal fins, the upper jaw overhangs the lower jaw and the lower jaw possess a barbel (Hayward & Ryland 1998). The lateral line is prominently curved and whitish in colour, above this is mottled brown in colour and below is paler, almost white (Hayward & Ryland 1998). Cod often form large schools during the day (FishBase).

Biology and ecology

Biological factor	
Size	Up to 150cm (Hayward & Ryland 1998)
Lifespan	25 years (FishBase)
Size at reproductive maturity	68 - 78cm (Miller & Loates 1997)
Age at reproductive maturity	4 - 5 years (Miller & Loates 1997)
Fecundity	3,000,000 - 6,000,000 eggs (Dipper 1987)
Larval phase	Yes: 60 - 75 days (Miller & Loates 1997)
Adult mobility	Free swimming (demersal)

Reproductive behaviour
Cod spawn in the southern North Sea and eastern English Channel from January through to April, peaking in late February (Pawson 1995). The area of the Channel between Beachy Head and Dungeness has been identified as one of the U.K.'s main cod spawning areas (Pawson 1995). Cod exhibit pre-spawning courtship behaviour. This begins with a fin display and grunting by the males, the pair then move towards the surface and swim in circles with the male inverted below the female whilst spawning occurs (Miller & Loates 1997). The eggs are 1 - 2mm in size and are buoyant, thus planktonic. Hatching occurs at approximately 4mm; growth rate is temperature dependant but usually hatching occurs between 8 - 23 days (Miller & Loates 1997). The larvae then drift to nursery areas and at a size of approximately 20mm, 60 - 75 days old they become demersal. The juveniles are known as 'codling' and remain on 'rough' ground for 1.5 - 2 years. Maturity occurs at 4 - 5 years of age, 68 - 78cm in length.

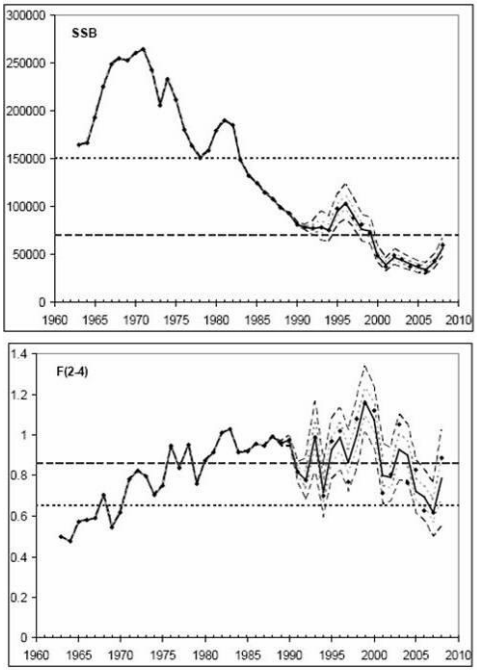
Migratory behaviour
Within the Sussex district cod begin to migrate inshore to their spawning grounds during autumn and spawning occurs during winter and spring (Pawson 1995). They then move to feeding areas, which may be associated with herring abundance (Miller & Loates 1997). A recent tagging study by CEFAS indicated that cod in ICES square VIId (which encompasses the Sussex Sea Fisheries District) do not have a consistent pattern of large seasonal movement. Some moved out of the English Channel into the North Sea but many were recaptured close to their release position (Righton *et. al.* 2007). Special electronic tags were used to monitor the fish's behaviour. The results found their distribution to be quite closely matched both seasonally and ontogenetically, indicating no obvious pattern of large redistribution of the cod in VIId (Righton *et. al.* 2007). In comparison the cod in the adjacent ICES area IVc migrate northwards and eastwards using tidal streams during spring (Righton *et. al.* 2007). It is suggested that these behavioral differences limit the mixing of cod from these two areas during feeding and spawning seasons (Righton *et. al.* 2007). In addition, it was noted that during autumn and winter the cod were a) more likely to be recaptured closer to their release position and b) there was a greater proportion of overlap between the 'juvenile' range and the 'adult' range (Righton *et. al.* 2007).

Habitat
Cod spend most of their adult life close to the sea bed and can be found from the shoreline to 600m deep (MarLIN).

Predators and prey
Cod are voracious predators feeding on a large variety of zoo benthic invertebrates and fish, including smaller cod. Most of their feeding activity takes place at dawn and dusk (FishBase). The main predators of young cod include larger cod, squid and pollock, while a common predator of larger cod are marine mammals, notably seals (FishBase).

Stock status (Carleton *et. al.* 2009)
The cod stock in Sussex, or the Eastern English Channel (VIId) is Inspite of recent increases (from a historical low in 2006), at the time of writing (based upon the 2009 advice) the spawning stock biomass remains below the limit reference point of 70,000 tonnes. Although there is an upward trajectory, it appears unlikely that fishing mortality will be restricted sufficiently in the short term to enable SSB to exceed its limit reference point before 2011.
Fishing mortality has generally declined since 2000, thanks to significantly reduced quotas. However, as quotas have reduced still further in recent years, the level of discarding has increased, meaning that there has been a slight overall increase in fishing mortality in 2008, to the point where F is now between the limit and precautionary reference points.
Recruitment to the fishery has been low since around 1998, compared to historical averages. Since then, the 2005 year class has been estimated to be one of the most abundant (amongst recent below average year classes), whereas 2008 is estimated to have been one of the lowest.

Fig 1: Spawning stock Biomas and Fishing mortality for cod in IV, VIId & IIIa.



The Sussex Fisheries
Fishing activity
Cod begin to migrate inshore into the Sussex IFCA district during autumn and move further offshore again in late winter/early spring, during this time inshore breeding occurs and catch rates are highest. Due to strict TAC quota regulations in recent years, cod is rarely a target species and is more commonly landed as a bycatch; specially in the use of fixed nets and stern trawls whose target species is most commonly flatfish. A small proportion of cod will also be taken in keddle nets in the vicinity of Rye bay, these nets are set in the evening and recovered the following morning with catches being at their best following a spell of unsettled weather. There appears to be no difference in the catch rate of cod between day and night. It is important to note that the majority of the cod caught and landed within the district are codling; between 1 to 3 years of age and thus are sexually immature.

Fishing methods
Quota permitting, cod is commercially caught by; stern trawling, pair trawling, static netting, keddle netting and angling. Cod is also caught by recreational static netters and

anglers. It is uncommon to catch cod by beam trawling and currently there is no drift netting activity targeting cod within the Sussex IFCA district.

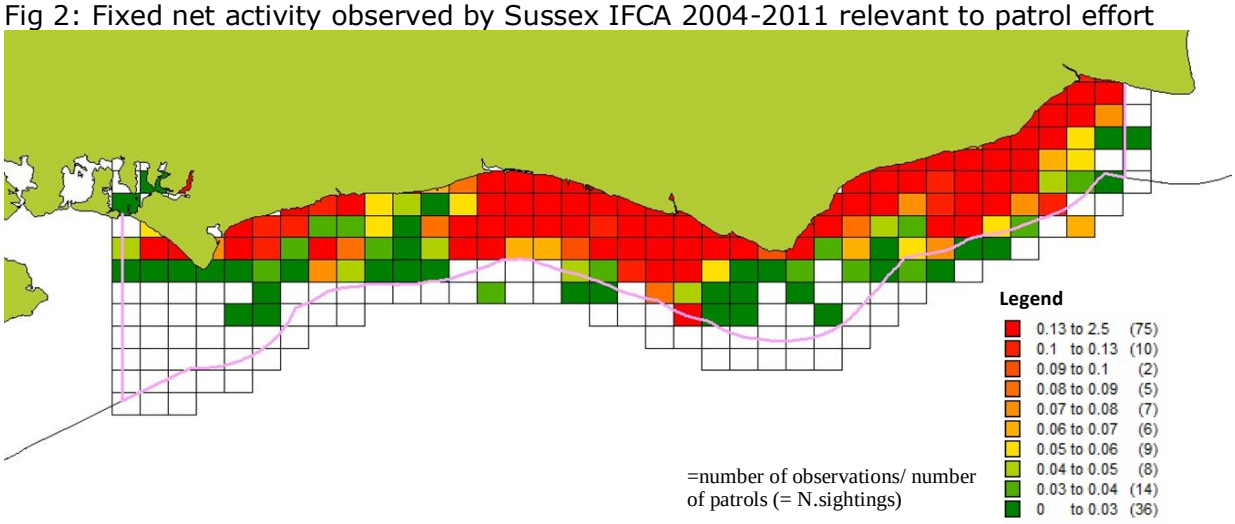
Fixed net fishery

There are a variety of types of nets deployed off Sussex; the most common is the trammel net. The trammel is constructed of three 'sheets' of nets, the outer nets are rigged one each side of the inner mesh panel. These nets have a cork line (top line) and lead line (bottom line). The nets sit or 'swim' in 3 to 8 feet of water. The fixed net only fishes on the slowest run of the tide. Fish targeted in this manner are plaice, sole, cod and cuttlefish. Gill nets and tangle nets are also used for targeting fish such as cod; these nets are fished in a similar manner to trammel nets but are rigged from a single sheet that sits vertically on the seabed. Nets are usually made from monofilament, although nylon is essential when catching spider crabs, due to the abrasion caused by this crab during entrapment. The fixed net vessels work various styles and combinations according to the season; gill nets for cod in the winter and trammel nets for plaice and sole in the early spring. In the spring / summer season trammel nets are set for plaice, cuttlefish and sole and gill nets for bass. In the autumn trammel nets are set for plaice and sole and gill nets set for bass and cod.

Spatial distribution of fishing activity

The practice of fixed net fishing is the most common method used to catch fin fish within the Sussex district. Fishing used fixed nets occurs throughout the year (targeting one or more of the variety of species that this method is effective at catching) from Bognor Regis to Rye bay and most commonly within 3-4nm of the shore (fig 2).

Fig 2: Fixed net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 1: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Drift and/or Fixed Nets <10m
Number of vessels	238
Average Fishing Income (£)	42,330
Average days at sea	94
Average income per day (£)	477
Annual operating costs	28,179
Operating costs as a % of income	67%
Fuel costs as a % of income	9%
Operating Profit (£)	14,151
Operating Profit Margin (£)	33%
Net profit margin (£)	25%

Vessels in the under 10m drift and/or fixed net segment have an average of 2 crew members, in the UK this segment employed 438 fishermen in total, cod accounted for 5% of the volume of the total catch composition of this segment and 4% of the value (Curtis & Brodie 2011).

Local socioeconomics

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Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of cod landed by the method of fixed nets* into Sussex ports. * *includes MMO method description 'gill net (not 52 or 53)', 'gill net (tangle)', 'gill net (trammel)' and unspecified gill net*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007		£45,265	£45,265	£1,669	£95,613	£97,283	£142,548
2008	£74	£41,755	£41,829	£1,522	£54,434	£55,957	£97,786
2009		£58,400	£58,400	£985	£56,893	£57,879	£116,279
2010	£485	£62,948	£63,433	£530	£71,206	£71,737	£135,169
Grand Total	£559	£208,368	£208,927	£4,707	£278,147	£282,854	£491,781

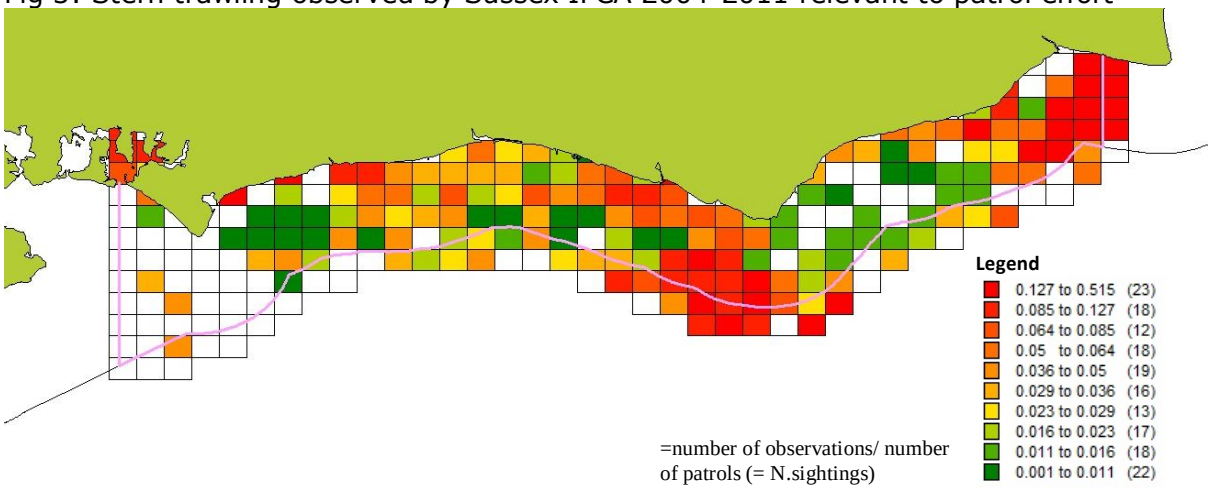
Stern trawl fishery

There are two types of towed gear used off the Sussex Coast, they are: rock hopper otter trawl and small footrope otter trawl (the effort map (fig 3) does not discriminate between these two types of trawls). The rock hopper otter trawl is normally used in conjunction with steel otter boards and wire bridles these trawls target cod, whiting, lemon sole, squid, cuttlefish, and bass. Larger sole, skate and dogfish are also caught. This gear can be worked on the grounds with harder substrates such as the fisheries off Dungeness, Beachy Head, Worthing and Selsey. The small footrope otter trawl uses

wooden otter boards. Wire or combination wire bridles are also used but they are longer than the rock hopper rig typically 60 to 100 fathoms. The main species targeted with this method are plaice, sole, codling, cuttlefish and any other demersal species. This trawl cuts through the top layer of the soft sea bottom and the tickler chain digs the fish out. This rig is used predominantly to the east of the District due to the softer seabed. The small footrope otter trawl may be twin rigged (two nets) or triple rigged (3 nets), the nets are towed side by side and thus the effective area swept is increased.

Spatial distribution of fishing activity

Fig 3: Stern trawling observed by Sussex IFCA 2004-2011 relevant to patrol effort



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Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
Number of vessels	216	58
Average Fishing Income (£)	57,275	156,049
Average days at sea	100	174
Average income per day (£)	569	834
Annual operating costs	40,806	127,210
Operating costs as a % of income	68%	76%
Fuel costs as a % of income	12%	16%
Operating Profit (£)	18,920	40,901
Operating Profit Margin (£)	32%	24%
Net profit margin (£)	16%	19%

Vessels in the under 10m demersal trawl / seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total; nationally cod accounted for 3% of the volume of the catch composition of this segment (Curtis & Brodie 2011).

Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total (Curtis & Brodie 2011).

Local socioeconomics
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Table 4: The Marine Management Organisations registration of buyers and sellers records of the total annual value of cod landed by the method of stern trawling* into Sussex ports. * *includes MMO method description 'heavy otter trawl', 'light otter trawl', 'twin otter trawl' and 'unspecified otter trawl'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£5,927	£1,293	£7,220	£15,044	£24,030	£39,074	£46,294
2008	£6,735	£301	£7,036	£17,100	£19,236	£36,336	£43,372
2009	£4,415	£77	£4,492	£10,018	£9,685	£19,703	£24,195
2010	£1,526	£737	£2,264	£11,193	£15,003	£26,196	£28,460
Grand Total	£18,604	£2,408	£21,011	£53,354	£67,955	£121,309	£142,320

Rod and line fishery
The activity of fishing using rod and line is popular throughout the Sussex district at both a commercial level; by commercial anglers (anglers selling their catch) and by charter vessels (vessel owner operators taking recreational anglers to fish at sea). Recreational angling by private vessels and sea angling from the shore is also very popular throughout Sussex.

The main target species for fishing using rod and line in Sussex are:
Commercial anglers: bass, cod, pollack and ling
Charter vessels: bass, cod, black bream, mackerel and congor eel
Recreational angling (private vessels and angling from the shore): bass, cod, black bream, mackerel, whiting, plaice and dover sole

Recreational: Economic survey of recreational sea angling
In 2003 the Economics and Statistics Group of the Department for Environment, Food and Rural Affairs (Defra) commissioned Drew Associates to conduct a research study on the economic contribution of sea angling to the UK (Drew Associates, 2004). The executive summary of this research is attached as Appendix 2. Consumer surplus benefits from sea angling were found to be considerable; consumer surplus (mean value) on existing annual sea angling activity varied from £381 per shore angler to £886 per own boat angler. When aggregated over sea fishing trips for the whole country, the annual aggregate net benefit based on the mean consumer surplus estimates was £594 million (Drew Associates, 2004). Most anglers are male (96.7%) and had been fishing for 25.7 years on average. Anglers catch, on average, between 5 (shore anglers) and 13 (boat anglers) fish per trip and retain 32-39% of their catch (Drew Associates, 2004).

Recreational: Local socioeconomics
The population of the Sussex IFCA district is 1,804,000 (766,400 in East Sussex, 781,600 in West Sussex plus 256,000 in Brighton and Hove - all 2008 estimates). The Drew report (Drew Associates, 2004) showed 2.75% of the then population of 52 million in England and Wales were sea anglers. This equates to approximately 50,000 sea anglers in the Sussex district. In addition to the economic benefit to society from sea

angling many anglers perceived a positive benefit to their health, anecdotal evidence from the Drew Associates 2004 surveys suggested that this was related to the sense of relaxation and peace of mind that angling engendered.

Commercial: Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 5: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Hooks <10m
Number of vessels	105
Average Fishing Income (£)	30,877
Average days at sea	75
Average income per day (£)	473
Annual operating costs	20,010
Operating costs as a % of income	59%
Fuel costs as a % of income	6%
Operating Profit (£)	14,191
Operating Profit Margin (£)	41%
Net profit margin (£)	31%

N.B. this segment incorporates under 10m commercial vessels using hooks by any method.
Vessels in the 'under 10m using hooks' segment have an average of 2 crew members, in the UK this segment employed 178 fishermen in total, cod accounted for 5% of the volume of the total catch composition of this segment and 3% of the value (Curtis & Brodie 2011).

Commercial: Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 6: The Marine Management Organisations registration of buyers and sellers records of the total annual value of cod landed by the method of rod and line* into Sussex ports. * *includes MMO method description 'rod and line' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£1,809	£1,809	£0	£875	£875	£2,684
2008	£0	£468	£468	£0	£755	£755	£1,223
2009	£0	£582	£582	£0	£1,262	£1,262	£1,843
2010	£0	£442	£442	£0	£211	£211	£653
Grand Total	£0	£3,301	£3,301	£0	£3,102	£3,102	£6,403

Dover Sole
Solea solea (L.)

Species description
The Dover sole is a large elliptical shaped flatfish with eyes on the right side of the body, a rounded snout and a curved mouth (Miller & Loates 1997). The dorsal and anal fin are united thus the fin runs from the eye down the whole length of the body (Miller & Loates 1997). Generally Dover sole are greyish brown in colour with some darker blotches on the upper side (Miller & Loates 1997) and white on the underside, but colour may vary depending on the substrate colour (Irving 1998).

Biology and ecology

Biological factor	
Size	70cm (Miller & Loates 1997)
Lifespan	26 years (MCS Fishonline)
Size at reproductive maturity	25 - 35cm length, the males being smaller than the females (MCS Fishonline)
Age at reproductive maturity	3 - 5 years (MCS Fishonline) with considerable inter-annual variation (Pawson 1995)
Fecundity	Fecundity is length dependant, annual potential fecundity of a 35cm fish is between 205,000 - 440,000 oocytes (Witthames *et. al.* 1995)
Larval phase	Up to 6 weeks (Pawson 1995)
Adult mobility	Free swimming (benthic)

Reproductive behaviour
Within the Sussex District the area west of Beachy Head to the Isle of Wight has been identified as Dover sole spawning ground (Pawson 1995). Spawning occurs between February and June, peaking April to May and has been related to water temperature; specifically when temperatures exceed 7ºC (Pawson 1995). The eggs hatch 2-14 days after fertilisation depending on the water temperature (commonly 8 days) when they are approximately 3mm in length and then they live in the pelagic zone for up to 6 weeks, metamorphosing and moving to bottom dwelling when they attain of a length of approximately 10m m (Miller & Loates 1997, Pawson 1995). At metamorphosis the larvae recruit to shallow inshore nursery areas, commonly estuaries, tidal inlets and shallow sandy bays, with recruitment to the spawning population occurring at 2 or 3 years old (Pawson 1995).

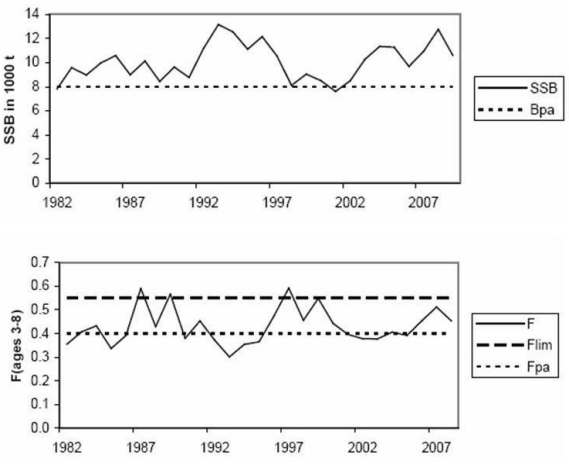
Migratory behaviour
Tagging studies have indicated that the Dover sole can undertake extensive migrations as maturing juveniles but once fully mature their movement is relatively little, only making short seasonal migrations from the deeper offshore areas to the shallower spawning grounds (Pawson 1995). Dover sole appear to use the same spawning ground year after year to which they first recruit (Pawson 1995).

Habitat
Dover sole are found on sandy and muddy substrates (Miller & Loates 1997). They are nocturnal, spending the daytime camouflaged against their soft substrate or buried with only their eyes protruding (Irving 1998).

Predators and prey
Common prey items for the Dover sole are benthic invertebrates including small crustaceans, worms, molluscs and fish (Irving 1998). The most common predators of adult soles are rays; in particular the Blond ray and Thornback ray (FishBase).

Stock status (Carleton *et. al.* 2009)
The spawning stock biomass (SSB) for sole in the Eastern Channel is currently assessed as being above the precautionary limit (B_{pa}), as identified by ICES. Indeed, SSB has been above the precautionary reference point of 8,000 tonnes since 2002. In addition to spawning stock biomas, MSC assessments also consider the level of fishing mortality (F) as a further indication of stock status. In the case of Eastern Channel Sole, fishing mortality is currently (and has been for the last 3 years) greater than the precautionary reference point for F. The amount of removals from the fishery has been greater than advised by precautionary science. In 2007 recruitment to the fishery was the weakest since the early 1980s, although the 2001, 04 and 05 year classes were strong.

Fig 1: Spawning stock Biomass and Fishing mortality for sole in VIId.



The Sussex fisheries

Fishing activity

Soles are more active during the night making them easier to catch thus, this is mostly when they are targeted by all fishing methods and higher catch rates are seen. In the Sussex district the Dover soles move inshore to breed during the spring and offshore again in late autumn, during these periods of migration the fixed net fishery is high; shooting the nets for a one day lay. Fishing with fixed nets also occurs during the summer, when the practice of 'quick shooting' is common to avoid catching large amounts of unwanted bycatch in the nets (predominantly spider crabs). The best catch rates seen from quick shooting are when low water occurs during darkness (very late night/early morning) which in Sussex coincides with neap tides. Trawling for Dover soles predominantly occurs in the summer and large quantities of plaice, a lower value species, are also taken.

Fishing methods

Fishing for Dover soles within the Sussex district predominantly occurs at a commercial level. The most common practice used is fixed netting then beam trawling and stern (otter) trawling. Smaller quantities are also taken by recreational fishers using fixed gear or rod and line.

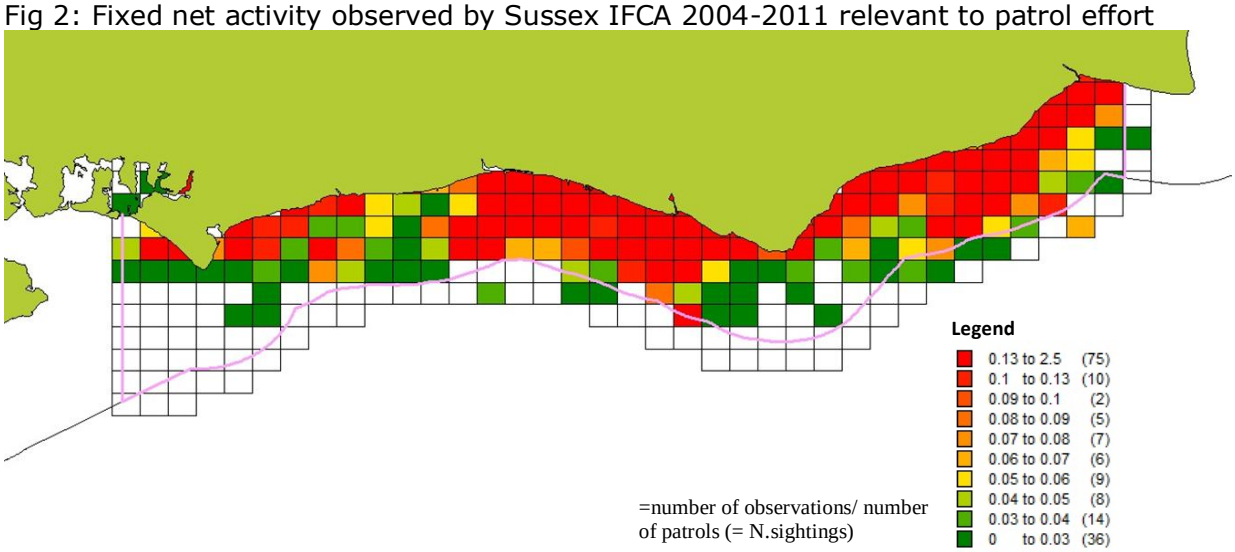
Fixed net fishery

There are a variety of types of nets deployed off Sussex; the most common is the trammel net. The trammel is constructed of three 'sheets' of nets, the outer nets are rigged one each side of the inner mesh panel. These nets have a cork line (top line) and lead line (bottom line). The nets sit or 'swim' in 3 to 8 feet of water. The fixed net only fishes on the slowest run of the tide. Fish targeted in this manner are plaice, sole, cod and cuttlefish. Gill nets and tangle nets are also used for targeting fish such as cod; these nets are fished in a similar manner to trammel nets but are rigged from a single sheet that sits vertically on the seabed. Nets are usually made from monofilament, although nylon is essential when catching spider crabs, due to the abrasion caused by this crab during entrapment. The fixed net vessels work various styles and combinations according to the season; gill nets for cod in the winter and trammel nets for plaice and

sole in the early spring. In the spring / summer season trammel nets are set for plaice, cuttlefish and sole and gill nets for bass. In the autumn trammel nets are set for plaice and sole and gill nets set for bass and cod.

Spatial distribution of fishing activity
The practice of fixed net fishing is the most common method used to catch fin fish within the Sussex district. Fishing used fixed nets occurs throughout the year (targeting one or more of the variety of species that this method is effective at catching) from Bognor Regis to Rye bay and most commonly within 3-4nm of the shore (fig 2).

Fig 2: Fixed net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 1: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Drift and/or Fixed Nets <10m
Number of vessels	238
Average Fishing Income (£)	42,330
Average days at sea	94
Average income per day (£)	477
Annual operating costs	28,179
Operating costs as a % of income	67%
Fuel costs as a % of income	9%
Operating Profit (£)	14,151
Operating Profit Margin (£)	33%
Net profit margin (£)	25%

Vessels in the under 10m drift and/or fixed net segment have an average of 2 crew members, in the UK this segment employed 438 fishermen in total. Dover sole was the

most important species to this segment in terms of value accounting for 33%, but only accounted for 10% of volume of landings (Curtis & Brodie 2011).

Local socioeconomics

The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of dover sole landed by the method of fixed nets* into Sussex ports. * *includes MMO method description 'gill net (not 52 or 53)', 'gill net (tangle)', 'gill net (trammel)' and unspecified gill net*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007		£541,770	£541,770	£20,469	£1,561,588	£1,582,057	£2,123,826
2008	£783	£361,459	£362,242	£22,211	£1,104,372	£1,126,584	£1,488,826
2009		£490,646	£490,646	£19,967	£1,614,792	£1,634,759	£2,125,406
2010	£1,874	£584,999	£586,872	£12,536	£1,360,588	£1,373,124	£1,959,996
Grand Total	£2,656	£1,978,874	£1,981,531	£75,183	£5,641,340	£5,716,523	£7,698,054

Marine Stewardship Council (MSC) certification

In September 2005 the Marine Stewardship Council certified the Dover sole trammel net fishery by the under 10m Hastings fleet as sustainable.
http://www.msc.org/track-a-fishery/certified/north-east-atlantic/hastings-fleet-dover-sole/hastings-fleet-dover-sole-fishery-1
In July 2009 the method of gill netting also achieved certification.
http://www.msc.org/track-a-fishery/certified/north-east-atlantic/Hastings-fleet-Dover-sole-trawl-and-gill-net/Hastings-fleet-Dover-sole-trawl-and-gill-net
These certifications encompass the area from Beachy Head to Dungeness to 6nm offshore.

Beam trawl fishery

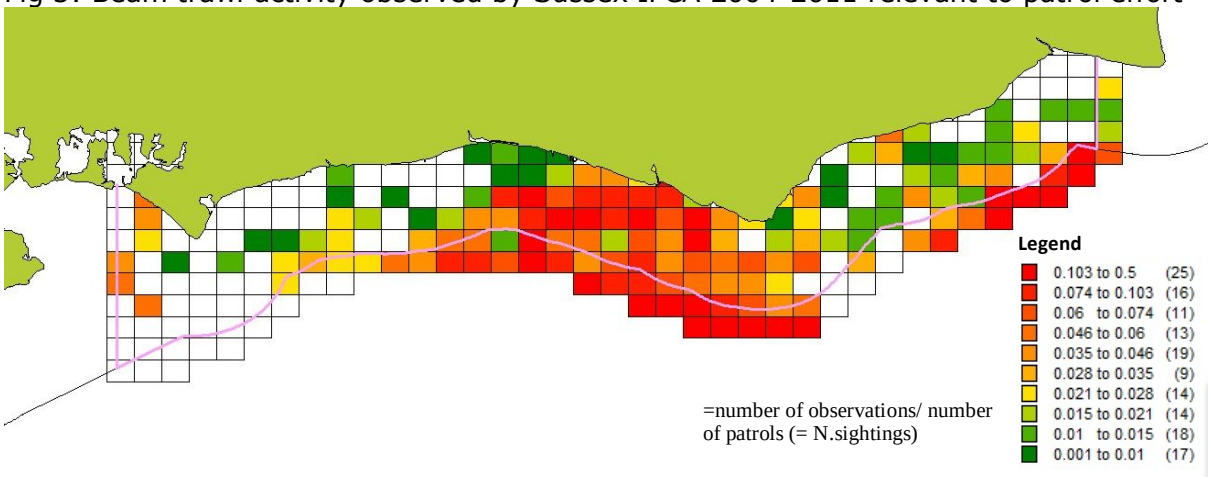
Beam trawls target mainly flatfish, including plaice, sole, turbot and brill. Other ground feeding fish such as codling, gurnard and cuttlefish may be caught. The substrate over which the gear is towed is usually sand and shingle, however slightly 'harder ground' can be worked with the aid of wheels on the beams. The addition of flip up footropes also facilitates the working of slightly harder ground. Furthermore the use of 'chain matrices' or 'stone mats' reduce the wear on the trawls.
Beam trawls are towed either astern of the vessel on the smaller boats, or, more commonly, from derricks (one from the port side and one from the starboard side) forward of amidships on the larger boats.

Spatial distribution of fishing activity

Beam trawling is an activity which is generally engaged by larger (>10m vessel length) vessels due to the engine capacity required to tow this heavy fishing gear. Due to a vessel length restriction by a Sussex IFCA byelaw, vessels >14m in length are prohibited from fishing within 6nm, thus this practice mostly occurs further offshore, however,

there is some activity within 6nm by 10-14m vessels most commonly within the vicinity of Shoreham, Newhaven and Hastings (fig 3).

Fig 3: Beam trawl activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 3: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
Number of vessels	216	58
Average Fishing Income (£)	57,275	156,049
Average days at sea	100	174
Average income per day (£)	569	834
Annual operating costs	40,806	127,210
Operating costs as a % of income	68%	76%
Fuel costs as a % of income	12%	16%
Operating Profit (£)	18,920	40,901
Operating Profit Margin (£)	32%	24%
Net profit margin (£)	16%	19%

Vessels in the under 10m demersal trawl / seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total. Nationally Dover sole account for 5% of the volume and 16% of the value of the catch composition of this segment (Curtis & Brodie 2011). This segment's average price for Dover sole was approximately £1,600 per tonne less than the UK fleet average price for Dover Sole (<£6,000 per tonne and >£7,500 per tonne respectively), Curtis & Brodie 2011.

Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total; dover sole accounted for approximately 4% of the value of catch composition by this segment (Curtis & Brodie 2011).

Local socioeconomics

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Table 4: The Marine Management Organisations registration of buyers and sellers records of the total annual value of dover sole landed by the method of beam trawling* into Sussex ports. * *includes MMO method description 'beam trawl' only*

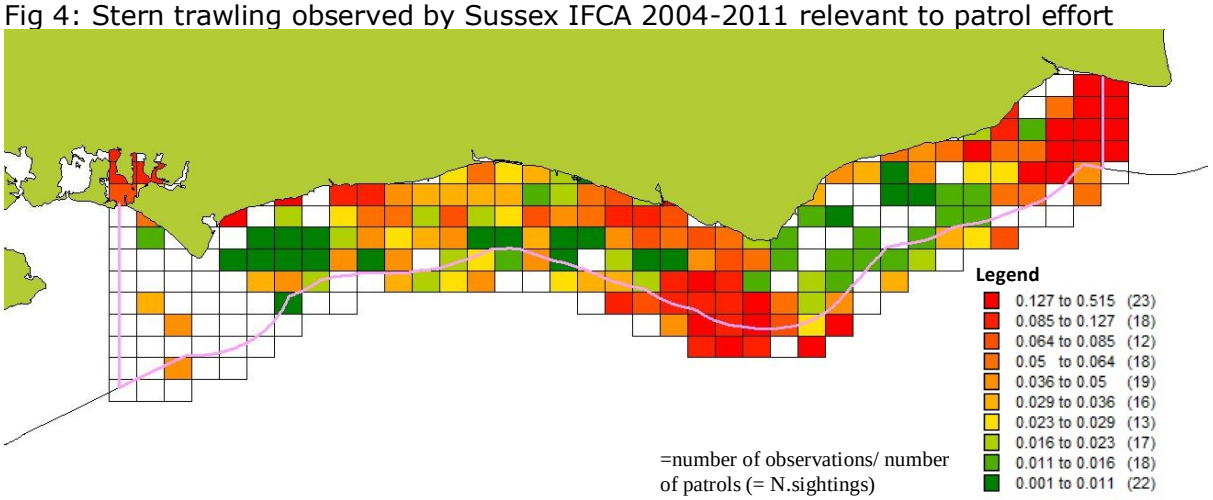
ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£184,331	£0	£184,331	£241,945	£0	£241,945	£426,276
2008	£311,421	£0	£311,421	£332,238	£0	£332,238	£643,658
2009	£225,446	£4,189	£229,635	£445,460	£5,861	£451,321	£680,956
2010	£211,368	£0	£211,368	£345,153	£35,687	£380,840	£592,209
Grand Total	£932,566	£4,189	£936,755	£1,364,796	£41,549	£1,406,345	£2,343,099

Stern trawl fishery

There are two types of towed gear used off the Sussex Coast, they are: rock hopper otter trawl and small footrope otter trawl (the effort map (fig 4) does not discriminate between these two types of trawls). The rock hopper otter trawl is normally used in conjunction with steel otter boards and wire bridles these trawls target cod, whiting, lemon sole, squid, cuttlefish, and bass. Larger sole, skate and dogfish are also caught. This gear can be worked on the grounds with harder substrates such as the fisheries off Dungeness, Beachy Head, Worthing and Selsey. The small footrope otter trawl uses wooden otter boards. Wire or combination wire bridles are also used but they are longer than the rock hopper rig typically 60 to 100 fathoms. The main species targeted with this method are plaice, sole, codling, cuttlefish and any other demersal species. This trawl cuts through the top layer of the soft sea bottom and the tickler chain digs the fish out. This rig is used predominantly to the east of the District due to the softer seabed. The small footrope otter trawl may be twin rigged (two nets) or triple rigged (3 nets), the nets are towed side by side and thus the effective area swept is increased.

Spatial distribution of fishing activity

Fig 4: Stern trawling observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

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Table 5: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

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Operating Profit Margin (£)	32%	24%
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Vessels in the under 10m demersal trawl / seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total. Nationally Dover sole account for 5% of the volume and 16% of the value of the catch composition of this segment (Curtis & Brodie 2011). This segment's average price for Dover sole was approximately £1,600 per tonne less than the UK fleet average price for Dover Sole (<£6,000 per tonne and >£7,500 per tonne respectively), Curtis & Brodie 2011. Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total; dover sole accounted for approximately 4% of the value of catch composition by this segment (Curtis & Brodie 2011).

Local socioeconomics
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Table 6: The Marine Management Organisations registration of buyers and sellers records of the total annual value of dover sole landed by the method of stern trawling* into Sussex ports. * *includes MMO method description 'heavy otter trawl', 'light otter trawl', 'twin otter trawl' and 'unspecified otter trawl'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£5,688	£22,947	£28,635	£14,072	£438,658	£452,730	£481,365
2008	£3,254	£14,754	£18,008	£18,366	£385,913	£404,278	£422,286
2009	£983	£9,853	£10,836	£20,996	£657,594	£678,590	£689,426
2010	£2,614	£5,929	£8,543	£17,319	£460,467	£477,786	£486,330
Grand Total	£12,539	£53,483	£66,022	£70,752	£1,942,633	£2,013,385	£2,079,407

Marine Stewardship Council (MSC) certification
In July 2009 the Marine Stewardship Council certified the Dover sole demersal trawl fishery by the Hastings fleet as sustainable.
http://www.msc.org/track-a-fishery/certified/north-east-atlantic/Hastings-fleet-Dover-sole-trawl-and-gill-net/Hastings-fleet-Dover-sole-trawl-and-gill-net
This certification encompasses the area from Beachy Head to Dungeness to 6nm offshore.

Rod and line fishery
The activity of fishing using rod and line is popular throughout the Sussex district at both a commercial level; by commercial anglers (anglers selling their catch) and by charter vessels (vessel owner operators taking recreational anglers to fish at sea). Recreational angling by private vessels and sea angling from the shore is also very popular throughout Sussex.

The main target species for fishing using rod and line in Sussex are:
Commercial anglers: bass, cod, pollack and ling
Charter vessels: bass, cod, black bream, mackerel and congor eel
Recreational angling (private vessels and angling from the shore): bass, cod, black bream, mackerel, whiting, plaice and dover sole

Recreational: Economic survey of recreational sea angling
In 2003 the Economics and Statistics Group of the Department for Environment, Food and Rural Affairs (Defra) commissioned Drew Associates to conduct a research study on the economic contribution of sea angling to the UK (Drew Associates, 2004). The executive summary of this research is attached as Appendix 2. Consumer surplus benefits from sea angling were found to be considerable; consumer surplus (mean value) on existing annual sea angling activity varied from £381 per shore angler to £886 per own boat angler. When aggregated over sea fishing trips for the whole country, the

annual aggregate net benefit based on the mean consumer surplus estimates was £594 million (Drew Associates, 2004). Most anglers are male (96.7%) and had been fishing for 25.7 years on average. Anglers catch, on average, between 5 (shore anglers) and 13 (boat anglers) fish per trip and retain 32-39% of their catch (Drew Associates, 2004).

Recreational: Local socioeconomics
The population of the Sussex IFCA district is 1,804,000 (766,400 in East Sussex, 781,600 in West Sussex plus 256,000 in Brighton and Hove - all 2008 estimates). The Drew report (Drew Associates, 2004) showed 2.75% of the then population of 52 million in England and Wales were sea anglers. This equates to approximately 50,000 sea anglers in the Sussex district. In addition to the economic benefit to society from sea angling many anglers perceived a positive benefit to their health, anecdotal evidence from the Drew Associates 2004 surveys suggested that this was related to the sense of relaxation and peace of mind that angling engendered.

Commercial: Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 7: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Hooks <10m
Number of vessels	105
Average Fishing Income (£)	30,877
Average days at sea	75
Average income per day (£)	473
Annual operating costs	20,010
Operating costs as a % of income	59%
Fuel costs as a % of income	6%
Operating Profit (£)	14,191
Operating Profit Margin (£)	41%
Net profit margin (£)	31%

N.B. this segment incorporates under 10m commercial vessels using hooks by any method.
Vessels in the 'under 10m using hooks' segment have an average of 2 crew members, in the UK this segment employed 178 fishermen in total, sole accounted for 1% of the volume of the total catch composition of this segment and 2% of the value (Curtis & Brodie 2011).

Commercial: Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 8: The Marine Management Organisations registration of buyers and sellers records of the total annual value of dover sole landed by the method of rod and line* into Sussex ports. * *includes MMO method description 'rod and line' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£1,072	£1,072	£0	£1,008	£1,008	£2,081
2008	£0	£940	£940	£0	£11,473	£11,473	£12,413
2009	£0	£898	£898	£0	£9,307	£9,307	£10,205
2010	£0	£82	£82	£0	£409	£409	£491
Grand Total	£0	£2,993	£2,993	£0	£22,198	£22,198	£25,190

Herring
Clupea harengus (L.)

Species description
The herring has the basic 'fish' form; one short dorsal fin, a deeply forked tail, no lateral line and a body covered in large round scales (Hayward & Ryland 1998, Dipper 1987). Herring are silver below and dark blue above and have a rounded belly unlike the sprats and shads which have a keel-like edge to their stomach (Dipper 1987). They are a pelagic, shoal forming, open-water species that perform extensive migrations and can be found all around the coast of the Britain (Hayward & Ryland 1998). Herring is an oily fish and young herring are sold in restaurants and as whitebait (Dipper 1987).

Biology and ecology

Biological factor	
Size	Up to 40cm (Hayward & Ryland 1998)
Lifespan	12 - 16 years (Miller & Loates 1997)
Size at reproductive maturity	22.9 - 26.7cm (Miller & Loates 1997)
Age at reproductive maturity	2 - 5 years (Miller & Loates 1997, Pawson 1995)
Fecundity	20,000 - 80,000 eggs for a 28cm individual (Miller & Loates 1997)
Larval phase	Yes
Adult mobility	Free swimming (pelagic)

Reproductive behaviour
The main spawning population of herring in the English Channel is referred to as the 'Downs spawners' (see Migratory behaviour below). This group moves into the eastern English Channel to spawn in late November, spawning peaks in December and continues until February (Pawson 1995, CEFAS 2009a). There are other smaller spawning groups within the Channel and captures of ripe individuals indicate these spawning in autumn, winter and spring at other sites (Pawson 1995). The female herring lay their eggs over stones or gravel substrates and the eggs remain demersal (Dipper 1987, Lythgoe & Lythgoe 1971). Hatching occurs after 7 to 49 days depending on water temperature (the warmer the water the less time hatching takes to occur) (Miller & Loates 1997). The larval fish that hatch out are long and slender resembling small sand eels (Lythgoe & Lythgoe 1971), they are pelagic and drift with the current (Dipper 1987). At approximately 5cm in length they appear 'herring shaped' and begin to gather and shoal moving inshore to shallower waters where they remain for 6-12 months (Dipper 1987, Lythgoe & Lythgoe 1971). Following this, the young herring scatter into deeper water until they are sexually mature and then they join the adult shoals (Lythgoe & Lythgoe 1971).

Migratory behaviour
The herring *Clupea harengus* is a widely distributed species with many distinct breeding stocks or populations (Dipper 1987). The time and locations of spawning varies with population and over 50 spawning grounds have been identified in the North Sea alone (Lythgoe & Lythgoe 1971). A distinct spawning population referred to as the 'Downs spawners' has been identified as the main spawning stock in the English Channel (Pawson 1995). The adult population of Downs spawners spend the summer months feeding in the central North Sea, they make an annual southerly migration in autumn appearing in the eastern English Channel in mid November (Pawson 1995, CEFAS 2009a). Since the 1970's this distinct population have been identified as spawning from Côte d'Opale near Dunkerque to Cap d'Antifer near Le Havre on the French coast, post-spawning they return to the central North Sea (Pawson 1995). Winter plankton surveys in the eastern English Channel show the larvae shifting south and east as they grow and

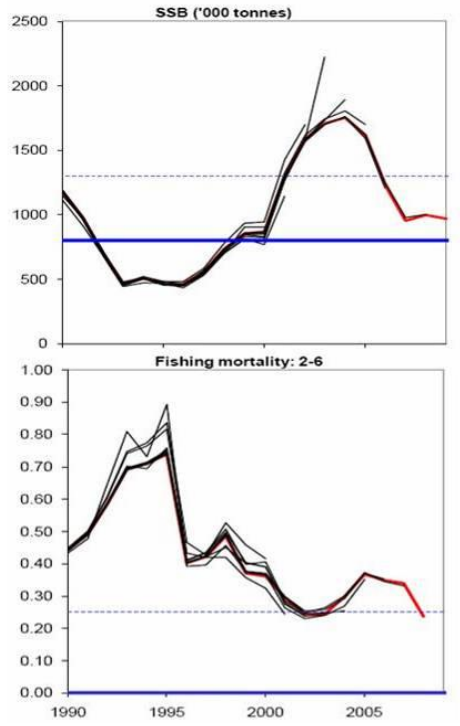
in April the post-larval herring are found inshore from Boulogne to Dieppe (Pawson 1995) and/or on nursery grounds in the eastern North Sea (CEFAS 2009a). In addition there are nursery grounds along the German and Danish coasts which the young Downs spawned herring may share (Pawson 1995). At the age of 1 year it is likely the Downs spawned herring move offshore to feed in the central North Sea, reaching maturity at 2-3 years old (Pawson 1995). Once sexual maturity is attained they join the adult stock and begin to participate in the annual southerly migration each autumn back to the eastern English Channel for spawning (Pawson 1995). The movements of larvae hatching from the smaller spawning population in the English Channel are poorly understood (Pawson 1995).
Herring also exhibit some diurnal vertical migrations, being closer to the seabed during the day and moving towards the surface at night for feeding (during this time there is some dispersion of the shoal) (Miller & Loates 1997).

Habitat
Herring are pelagic open water fish which; form large shoals, can be found to depths of 250m (Dipper 1987) and exhibit some diurnal vertical migrations (Miller & Loates 1997). Schools of young herring (<1 year) can be found closer inshore and in estuaries (Dipper 1987, Pawson 1995).

Predators and prey
Adult herring feed by eyesight on zooplankton (mostly copepods and euphausians), pteropods (floating molluscs) and sand eel larvae (Dipper 1987). Common predators of adult herring include sea birds, dolphins and larger fish species and haddock have been identified as a major predator on herring eggs (Dipper 1987, Lythgoe & Lythgoe 1971).

Stock status (Carleton *et. al.* 2009)
At the time of the most recent assessment (2009) the herring spawning stock biomass was estimated 1.0 million tones, well below the precautionary reference point of 1.3 million tones. However SSB is expected in increase slightly in both 2010 and 2011. Recent efforts have been made to reduce fishing mortality, but in spite of this F remains above the precautionary reference point, in spite of substantial reductions in TAC since 2005. This is largely the result of very poor recent recruitment. There is still no clear explanation for recent poor recruitment.

Fig 1: Spawning stock Biomas and Fishing mortality for Herring (IV, IIIa, VIId)



The Sussex Fisheries
Fishing activity
The fishing season for herring in the Sussex IFCA district is short. It begins in late October when the herring arrive to spawn. At this time they are in peak condition. Catches of herring in the district begin to dwindle in December. The herring are most commonly targeted by drift netters at dawn and dusk when the fish are in the mid-water region. A small proportion will also be taken in

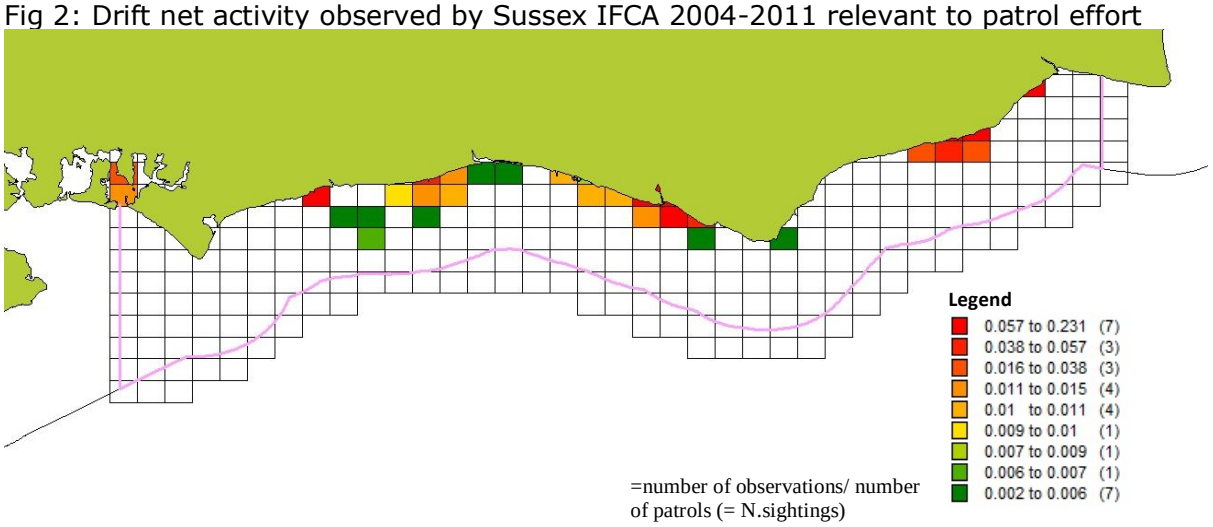
keddle nets in the vicinity of Rye bay, these nets are set in the evening and recovered the following morning.

Fishing methods
Fishing for herring within Sussex IFCA district only occurs at a commercial level. The most common practice used is drift netting and small quantities are taken using keddle nets.

Drift net fishery
The drift net fishery has a long association with the Sussex Coast. Drift nets are rigged from a single sheet of monofilament with a depth of up to twenty feet. The float line keeps the top on the surface whilst the lead line stands the net in the water. Drift nets are shot across the tide and allowed to drift.

Spatial distribution of fishing activity
There are two distinct drift fisheries off the Sussex coast; they are a pelagic fishery, for mackerel and herring and a bass fishery. Despite the bad reputation in other parts of the world, the Sussex drift net fishery is not associated with a significant bycatch. Drift netting predominantly occurs inshore (within 3nm) along the Sussex coastline, with most activity been seen close to the ports of Littlehampton, Shoreham, Newhaven and Hastings (Fig 2).

Fig 2: Drift net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



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Seafish Segment	Drift and/or Fixed Nets <10m
Number of vessels	238
Average Fishing Income (£)	42,330
Average days at sea	94
Average income per day (£)	477
Annual operating costs	28,179
Operating costs as a % of income	67%
Fuel costs as a % of income	9%
Operating Profit (£)	14,151
Operating Profit Margin (£)	33%
Net profit margin (£)	25%

Vessels in the drift and/or fixed net <10m segment have an average of 2 crew members, in the UK this segment employed 438 fishermen in total (Curtis & Brodie 2011).

Local socioeconomics

The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of herring landed by the method of drift netting* into Sussex ports. * *includes MMO method description 'drift net' and 'unspecified gill net'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£107	£107	£0	£2,409	£2,409	£2,516
2008	£0	£216	£216	£0	£3,678	£3,678	£3,894
2009	£0	£301	£301	£0	£11,729	£11,729	£12,030
2010	£0	£186	£186	£1	£3,868	£3,869	£4,055
Grand Total	£0	£810	£810	£1	£21,684	£21,684	£22,494

Marine Stewardship Council (MSC) certification

In September 2005 the Marine Stewardship Council certified the Herring drift net fishery by the under 10m Hastings fleet as sustainable.
http://www.msc.org/track-a-fishery/certified/north-east-atlantic/hastings-fleet-pelagic-herring-and-mackerel/hastings-fleet-pelagic-fishery
This certification encompass the area from Beachy Head to Dungeness to 6nm offshore.

Mackerel
Scomber scombrus (L.)

Species description
Mackerel have a long streamlined body which is rounded in section, with a row of characteristic bony scales along the lateral line (Hayward & Ryland 1998, Dipper 1987). There are two well separated dorsal fins and a single anal fin, small finlets extend from the second dorsal fin and anal fin to the tail, the tail is deeply forked (Hayward & Ryland 1998, Dipper 1987). Mackerel are iridescent blue-green on top crossed by narrow black curving bands, silvery on the flanks and white below (Hayward & Ryland 1998).

Biology and ecology

Biological factor	
Size	Up to 50cm (Hayward & Ryland 1998)
Lifespan	20 years (Miller & Loates 1997)
Size at reproductive maturity	30cm (Miller & Loates 1997)
Age at reproductive maturity	2 years (Miller & Loates 1997)
Fecundity	90,000 eggs per spawning (Miller & Loates 1997)
Larval phase	Approx 60 days [15]
Adult mobility	Free swimming (pelagic)

Reproductive behaviour
Mackerel spawn in the summer peaking in June (Miller & Loates 1997, Pawson 1995) however there is little evidence to suggest this occurs within Sussex (Pawson 1995, Bolster 1971). During spawning the eggs and sperm are released into the sea with the females laying up to 90,000 eggs per spawning (Miller & Loates 1997). Hatching occurs after 2-6 days when they are 3-4mm long and metamorphosis occurs by 21mm (Miller & Loates 1997). The egg and larval phase are planktonic (Miller & Loates 1997). Juvenile mackerel live inshore until they are sexually mature, then move offshore to join the major schools (Miller & Loates 1997). Larval and juvenile mackerel surveys do not indicate the presence of young mackerel within the Sussex district (Pawson 1995). Due to their prolonged breeding season members of one year class are very variable in size; on average a 1 year old mackerel will be 24cm in length with sexual maturity occurring in their second year when they are around 30cm (Lythgoe & Lythgoe 1971).

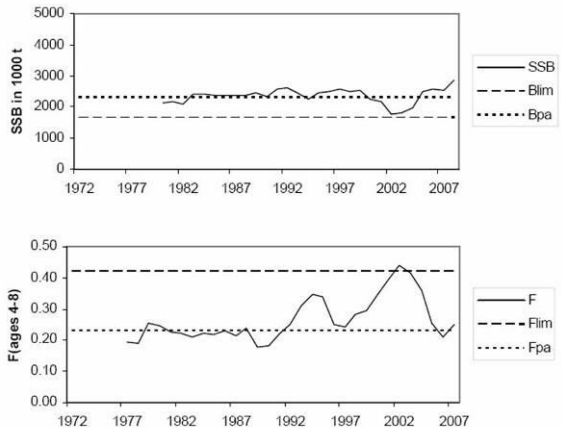
Migratory behaviour
The North East Atlantic mackerel are defined and managed as one stock (CEFAS 2009b), however they have 2 or 3 distinct spawning regions; the North Sea (which may be divided into north-eastern and central-southern) and along the continental shelf/Celtic Sea; it is currently debatable whether mixing between these groups occurs (Pawson 1995, Bolster 1971). Tagging studies of the continental shelf/Celtic Sea stock at Cornwall in the 1960's indicated an active migration of these fish during the spring and autumn; some travelling northwards and some eastwards through the English Channel. The ones which travelled eastwards were re-captured east of Brighton and along the French coast, it is thought that they were travelling to the southern North Sea to spawn in the early summer and then returning (Bolster 1971). To summarize the research suggests that the mackerel found within the SSFD are part of the continental shelf/Celtic sea stock travelling to and from the southern North Sea and due to their prolonged breeding season individuals may be travelling in opposite directions along the coastline depending on whether they are 'coming 'or 'going' (Bolster 1971).

Habitat
Mackerel are very fast swimmers and are constantly on the move; it is necessary for mackerel to have a constant water flow through their gills for respiration (Lythgoe & Lythgoe 1971). They are pelagic and form large shoals (Hayward & Ryland 1998); spending the summer inshore closer to the surface and the winter offshore, closer to the seabed (Dipper 1987, Miller & Loates 1997).

Predators and prey
Mackerel can filter plankton through their gills (Dipper 1987) and predate upon shallow inshore crustaceans and small fish (Miller & Loates 1997). Post spawning mackerel are voracious predators feeding upon schools of sprat, herring and sand eels; it is at this time they are easier to catch by rod and line (Dipper 1987). In the winter mackerel inhabit deeper waters and have a reduced feeding rate (Dipper 1987). Mackerel are an important food supply for larger fish including members of the tuna family and sharks and dolphins (Dipper 1987).

Stock status (Carleton *et. al.* 2009)
The spawning stock biomass for mackerel is above the precautionary reference point, following a 40% increase since 2002. This has been helped by recruitment from a well above average 2002 year class followed by average year classes up to 2005. This good recruitment has helped SSB to increase in spite of fishing mortality being slightly above the precautionary reference point in recent years, as continues to be the case.

Fig 1: Spawning stock Biomas and Fishing mortality for NEA mackerel (combined S, W & NS)



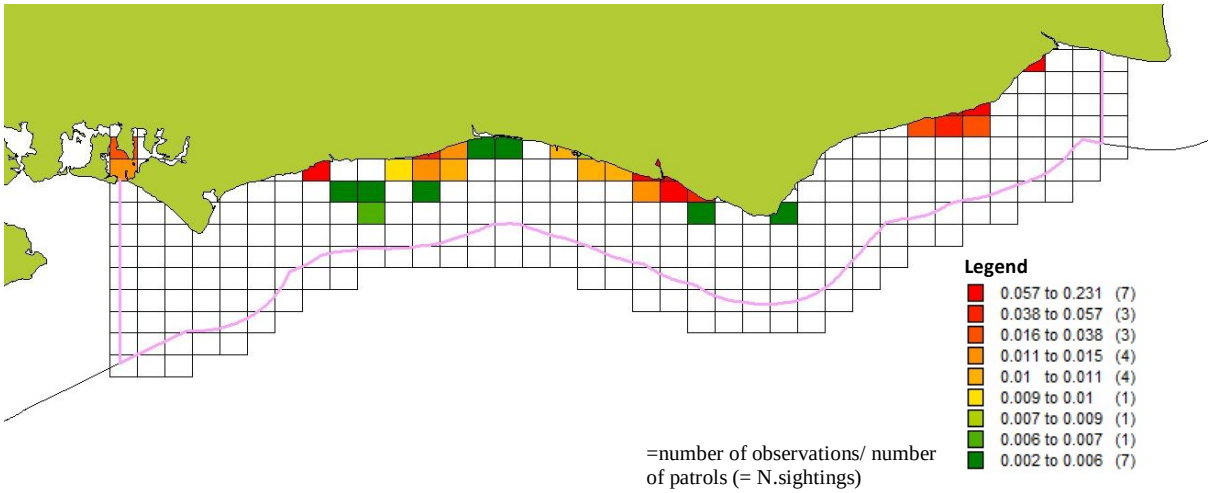
The Sussex Fisheries
Fishing activity
Mackerel are a migratory species and are present within the Sussex IFCA district from late spring until early autumn. Mackerel are most commonly caught commercially at dawn and dusk by drift netters and commercial anglers. A small proportion will also be taken in keddle nets in the vicinity of Rye bay, these nets are set in the evening and recovered the following morning. Mackerel are mainly targeted for human consumption for which the larger individuals are preferred, as there are quota restrictions on mackerel this has the potential to cause 'high-grading' whereby the smaller, less marketable fish are discarded (CEFAS 2009b). Mackerel are also commonly targeted by recreational anglers from the shore and at sea.

Fishing methods
There are commercial and recreational fisheries for mackerel within the Sussex IFCA district. The most common commercial practice used to specifically target mackerel is drift netting, mackerel is also semi-targeted in the mixed demersal trawl fisheries. Smaller quantities are taken as a bycatch in pair trawling and they are targeted by keddle netters and charter anglers. Mackerel are also a popular target of the recreational anglers.

Drift net fishery
The drift net fishery has a long association with the Sussex Coast. Drift nets are rigged from a single sheet of monofilament with a depth of up to twenty feet. The float line

keeps the top on the surface whilst the lead line stands the net in the water. Drift nets are shot across the tide and allowed to drift.

Spatial distribution of fishing activity
There are two distinct drift fisheries off the Sussex coast; they are a pelagic fishery, for mackerel and herring and a bass fishery. Despite the bad reputation in other parts of the world, the Sussex drift net fishery is not associated with a significant bycatch.
Drift netting predominantly occurs inshore (within 3nm) along the Sussex coastline, with most activity been seen close to the ports of Littlehampton, Shoreham, Newhaven and Hastings (Fig 1).
Fig 1: Drift net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 1: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Drift and/or Fixed Nets <10m
Number of vessels	238
Average Fishing Income (£)	42,330
Average days at sea	94
Average income per day (£)	477
Annual operating costs	28,179
Operating costs as a % of income	67%
Fuel costs as a % of income	9%
Operating Profit (£)	14,151
Operating Profit Margin (£)	33%
Net profit margin (£)	25%

Vessels in the drift and/or fixed net <10m segment have an average of 2 crew members, in the UK this segment employed 438 fishermen in total (Curtis & Brodie 2011).

Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of mackerel landed by the method of drift netting* into Sussex ports. * *includes MMO method description 'drift net' and 'unspecified gill net'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£4,144	£4,144	£0	£16,354	£16,354	£20,497
2008	£0	£2,962	£2,962	£0	£19,060	£19,060	£22,022
2009	£0	£1,776	£1,776	£0	£30,770	£30,770	£32,547
2010	£0	£4,879	£4,879	£0	£24,507	£24,507	£29,386
Grand Total	£0	£13,761	£13,761	£0	£90,691	£90,691	£104,452

Marine Stewardship Council (MSC) certification
In September 2005 the Marine Stewardship Council certified the Mackerel drift net fishery by the under 10m Hastings fleet as sustainable.
http://www.msc.org/track-a-fishery/certified/north-east-atlantic/hastings-fleet-pelagic-herring-and-mackerel/hastings-fleet-pelagic-fishery
This certification encompasses the area from Beachy Head to Dungeness to 6nm offshore.

Rod and line fishery
The activity of fishing using rod and line is popular throughout the Sussex district at both a commercial level; by commercial anglers (anglers selling their catch) and by charter vessels (vessel owner operators taking recreational anglers to fish at sea). Recreational angling by private vessels and sea angling from the shore is also very popular throughout Sussex.

The main target species for fishing using rod and line in Sussex are:
Commercial anglers: bass, cod, pollack and ling
Charter vessels: bass, cod, black bream, mackerel and congor eel
Recreational angling (private vessels and angling from the shore): bass, cod, black bream, mackerel, whiting, plaice and dover sole

Recreational: Economic survey of recreational sea angling
In 2003 the Economics and Statistics Group of the Department for Environment, Food and Rural Affairs (Defra) commissioned Drew Associates to conduct a research study on the economic contribution of sea angling to the UK (Drew Associates, 2004). The executive summary of this research is attached as Appendix 2. Consumer surplus benefits from sea angling were found to be considerable; consumer surplus (mean value) on existing annual sea angling activity varied from £381 per shore angler to £886 per own boat angler. When aggregated over sea fishing trips for the whole country, the

annual aggregate net benefit based on the mean consumer surplus estimates was £594 million (Drew Associates, 2004). Most anglers are male (96.7%) and had been fishing for 25.7 years on average. Anglers catch, on average, between 5 (shore anglers) and 13 (boat anglers) fish per trip and retain 32-39% of their catch (Drew Associates, 2004).

Recreational: Local socioeconomics
The population of the Sussex IFCA district is 1,804,000 (766,400 in East Sussex, 781,600 in West Sussex plus 256,000 in Brighton and Hove - all 2008 estimates). The Drew report (Drew Associates, 2004) showed 2.75% of the then population of 52 million in England and Wales were sea anglers. This equates to approximately 50,000 sea anglers in the Sussex district. In addition to the economic benefit to society from sea angling many anglers perceived a positive benefit to their health, anecdotal evidence from the Drew Associates 2004 surveys suggested that this was related to the sense of relaxation and peace of mind that angling engendered.

Commercial: Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 3: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Hooks <10m
Number of vessels	105
Average Fishing Income (£)	30,877
Average days at sea	75
Average income per day (£)	473
Annual operating costs	20,010
Operating costs as a % of income	59%
Fuel costs as a % of income	6%
Operating Profit (£)	14,191
Operating Profit Margin (£)	41%
Net profit margin (£)	31%

N.B. this segment incorporates under 10m commercial vessels using hooks by any method.
Vessels in the 'under 10m using hooks' segment have an average of 2 crew members, in the UK this segment employed 178 fishermen in total, mackerel accounted for 31% of the volume of the total catch composition of this segment but just 13% of the value (Curtis & Brodie 2011).

Commercial: Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 4: The Marine Management Organisations registration of buyers and sellers records of the total annual value of mackerel landed by the method of rod and line* into Sussex ports. * *includes MMO method description 'rod and line' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£1,205	£1,205	£0	£686	£686	£1,890
2008	£0	£85	£85	£0	£780	£780	£864
2009	£0	£543	£543	£0	£3,197	£3,197	£3,739
2010	£0	£1,024	£1,024	£0	£1,538	£1,538	£2,562
Grand Total	£0	£2,856	£2,856	£0	£6,200	£6,200	£9,056

Plaice
Pleuronectes platessa (L.)

Species description
The plaice is a flatfish with eyes on the right side of the body and a pointed snout/mouth. The head is less than 0.25 of the total fish length (Hayward & Ryland 1998) and has line of 4 to 7 bony warts between the eyes extending to the lateral line (Lythgoe & Lythgoe 1971). The upper side is dark brown with distinct orange blotches and the underside is pearly white (Hayward & Ryland 1998). To some degree plaice can adapt their colour to match their substrate (Irving 1998), thus increasing camouflage.

Biology and ecology

Biological factor	
Size	50cm (Hayward & Ryland 1998), rarely up to 90cm (Lythgoe & Lythgoe 1971)
Lifespan	20 years (Bagenal 1973)
Size at reproductive maturity	Males 25cm, females 32cm (Pawson 1995)
Age at reproductive maturity	3 years (Pawson 1995)
Fecundity	From 16,000 eggs in a 22cm female to 345,000 eggs in a 61.5cm female (Miller & Loates 1997)
Larval phase	60 - 120 days (Pawson 1995)
Adult mobility	Free swimming (benthic)

Reproductive behaviour
Plaice spawn from December until March, peaking in January and February (Pawson 1995) in well defined spawning grounds that are 20-40m deep (Pawson 1995, Dipper 1987). Spawning occurs above the seabed with the female across the upper side of the male (Miller & Loates 1997). At the time of spawning the eggs are approximately 2mm in size, are yellow and have no oil globule (Miller & Loates 1997). Hatching occurs at approximately 7mm; growth to this size takes between 12-21 days depending on the water temperature, 10 to 5°C respectively (i.e. growth and thus hatching is faster in warmer water) (Miller & Loates 1997). At approximately 40 days old the left eye shifts round to the right side of the body (Miller & Loates 1997), metamorphosis is complete at 60-120 days depending on the water temperature (Pawson 1995) and the fish takes on the typical flatfish form. By this time the juvenile plaice will have drifted inshore to an appropriate shallow nursery ground, sunk to the bottom, adopted the benthic environment and be approximately 3cm in length (Lythgoe & Lythgoe 1971, Pawson 1995). Juvenile plaice spend up to 2 years on the nursery grounds before joining the adult stock (Pawson 1995).

Migratory behaviour
A tagging study of adult plaice has indicated that there are three groups of plaice present in the English Channel; resident plaice in the west English Channel, resident plaice in the east English Channel and migratory North Sea plaice which enter the English Channel in the autumn, spawn and rapidly leave (Pawson 1995). There is very little traversing between the English Channel/North Sea plaice and the Irish Sea plaice (Pawson 1995). Interestingly however, hydrographic studies indicate that juvenile plaice do not recruit to nursery grounds near to the area they were spawned, instead showing an eastwards movement (Pawson 1995). This can be explained as the eggs/larvae have a period of several weeks in the water column before they settle to the benthic environment during which they are subject to an easterly moving current system (Pawson 1995). These hydrographic studies suggest that plaice spawned in the western English Channel recruit to nursery grounds in the eastern English Channel, whilst plaice spawned in the eastern English Channel, recruit to nursery grounds in the southern North Sea (Pawson 1995). Tagging of juvenile plaice on these nursery grounds found that over one third of the adult plaice in the eastern English Channel came from nursery

grounds in the North Sea, whilst the western English Channel received 34% of its recruits from the eastern English Channel and 53% from the North Sea (Pawson 1995).

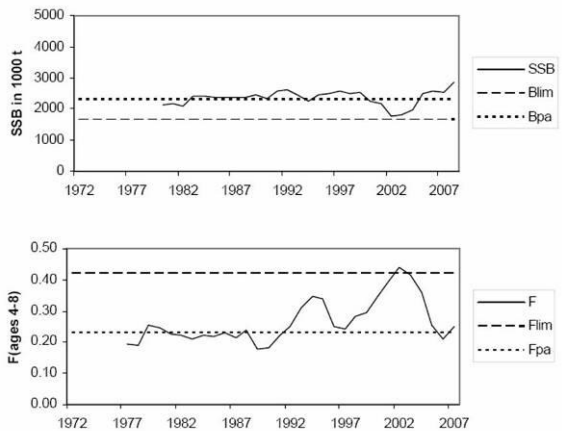
Studies by CEFAS (CEFAS a) have shown that plaice adopt 'selective tidal stream transport'; this is where the fish leaves the bottom at slack water and swim down tide i.e. with the current, and return to the seabed when the tide turns. Maturing fish select the tidal stream flowing towards the spawning ground and spent fish use the opposing tidal stream to return to the feeding grounds. This behaviour is very energy efficient.

Habitat
Adult plaice can be found on sandy or muddy substrates to over 100m deep (Lythgoe & Lythgoe 1971), whilst the juveniles are found predominantly in inshore shallower waters (Miller & Loates 1997). Plaice often increase their camouflage on the seabed by flapping their fins to cover their body with a fine layer of bottom sediment, often only leaving the eyes protruding (Lythgoe & Lythgoe 1971).

Predators and prey
Plaice most commonly feed upon bivalves including; cockles, razor shells, and small scallops (Lythgoe & Lythgoe 1971), they also predate upon some polychaetes and crustaceans and larger plaice may even take small fish. Plaice have 'cutting' teeth on the 'under side' of the jaw which they use to bite off soft protruding parts of the bivalve e.g. the siphons, whilst further back in the throat region they have crushing teeth used for crushing e.g. the shells (Lythgoe & Lythgoe 1971). Predators of the plaice include anglerfish, weever fish, gurnards, cod, conger eels, rays, seals and dolphins (FishBase).

Stock status (Carleton *et. al.* 2009)
Absolute measures of stock status – in terms of both spawning stock biomass and fishing mortality – are not available for Plaice in VIId. Only relative measures of both SSB and F are available. An exploratory assessment suggests that the spawning stock biomass has declined through the last 15 years and the current level of SSB is low.

Fig 1: Spawning stock Biomas and Fishing mortality for NEA mackerel (combined S, W & NS)



The Sussex Fisheries
Fishing activity
There are no defined seasonal or daily movements of plaice which play a role in the fishery; however, it is common for flatfish to be more active at night. Plaice are predominantly taken as a valuable bycatch in the sole fishery thus the activities of the sole fishery play a large role in the activities of the plaice fishery. The trawlers targeting sole will often fish for 24+ hours; the sole are mostly caught during the hours of darkness but fishing continues during the day as plaice are still caught. Plaice appear to be in their best condition and have the greatest meat yield during autumn and winter.

Fishing methods
Fishing for plaice within Sussex IFCA district predominantly occurs at a commercial level. The most common practices used are fixed gear, beam trawling and stern (otter) trawling. Small quantities are also taken by recreational fishers using fixed gear or rod and line.

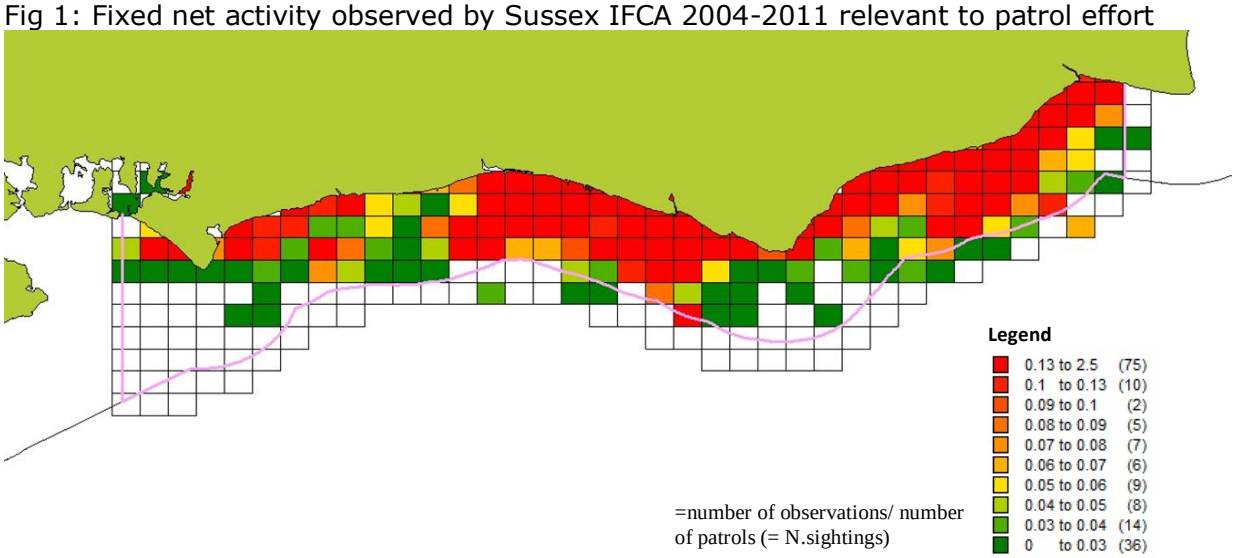
Fixed net fishery

There are a variety of types of nets deployed off Sussex; the most common is the trammel net. The trammel is constructed of three 'sheets' of nets, the outer nets are rigged one each side of the inner mesh panel. These nets have a cork line (top line) and lead line (bottom line). The nets sit or 'swim' in 3 to 8 feet of water. The fixed net only fishes on the slowest run of the tide. Fish targeted in this manner are plaice, sole, cod and cuttlefish. Gill nets and tangle nets are also used for targeting fish such as cod; these nets are fished in a similar manner to trammel nets but are rigged from a single sheet that sits vertically on the seabed. Nets are usually made from monofilament, although nylon is essential when catching spider crabs, due to the abrasion caused by this crab during entrapment. The fixed net vessels work various styles and combinations according to the season; gill nets for cod in the winter and trammel nets for plaice and sole in the early spring. In the spring / summer season trammel nets are set for plaice, cuttlefish and sole and gill nets for bass. In the autumn trammel nets are set for plaice and sole and gill nets set for bass and cod.

Spatial distribution of fishing activity

The practice of fixed net fishing is the most common method used to catch fin fish within the Sussex district. Fishing used fixed nets occurs throughout the year (targeting one or more of the variety of species that this method is effective at catching) from Bognor Regis to Rye bay and most commonly within 3-4nm of the shore (fig 1).

Fig 1: Fixed net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

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Table 1: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Drift and/or Fixed Nets <10m
Number of vessels	238
Average Fishing Income (£)	42,330
Average days at sea	94
Average income per day (£)	477
Annual operating costs	28,179
Operating costs as a % of income	67%
Fuel costs as a % of income	9%
Operating Profit (£)	14,151
Operating Profit Margin (£)	33%
Net profit margin (£)	25%

Vessels in the under 10m drift and/or fixed net segment have an average of 2 crew members, in the UK this segment employed 438 fishermen in total (Curtis & Brodie 2011).

Local socioeconomics

The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of plaice landed by the method of fixed nets* into Sussex ports. * *includes MMO method description 'gill net (not 52 or 53)', 'gill net (tangle)', 'gill net (trammel)' and unspecified gill net*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007		£29,107	£29,107	£3,395	£147,639	£151,034	£180,141
2008	£370	£34,050	£34,419	£4,028	£121,481	£125,509	£159,928
2009		£35,042	£35,042	£1,044	£150,790	£151,833	£186,876
2010	£351	£52,567	£52,918	£2,757	£138,167	£140,924	£193,841
Grand Total	£721	£150,766	£151,486	£11,224	£558,076	£569,300	£720,786

Beam trawl fishery

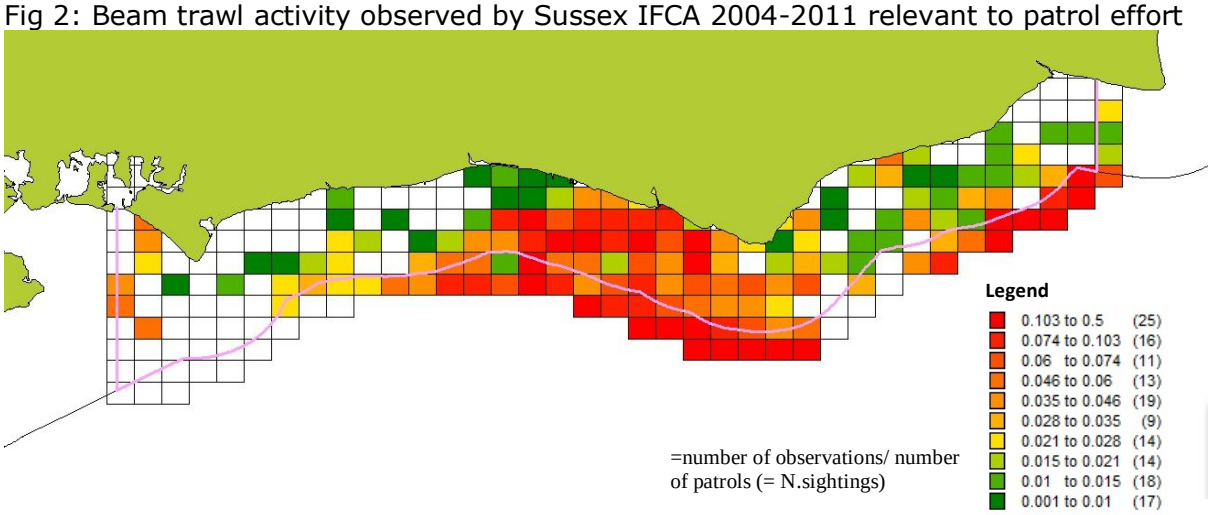
Beam trawls target mainly flatfish, including plaice, sole, turbot and brill. Other ground feeding fish such as codling, gurnard and cuttlefish may be caught. The substrate over which the gear is towed is usually sand and shingle, however slightly 'harder ground' can be worked with the aid of wheels on the beams. The addition of flip up footropes also facilitates the working of slightly harder ground. Furthermore the use of 'chain matrices' or 'stone mats' reduce the wear on the trawls.

Beam trawls are towed either astern of the vessel on the smaller boats, or, more commonly, from derricks (one from the port side and one from the starboard side) forward of amidships on the larger boats.

Spatial distribution of fishing activity

Beam trawling is an activity which is generally engaged by larger (>10m vessel length) vessels due to the engine capacity required to tow this heavy fishing gear. Due to a vessel length restriction by a Sussex IFCA byelaw, vessels >14m in length are prohibited from fishing within 6nm, thus this practice mostly occurs further offshore, however, there is some activity within 6nm by 10-14m vessels most commonly within the vicinity of Shoreham, Newhaven and Hastings (fig 2).

Fig 2: Beam trawl activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 3: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
Number of vessels	216	58
Average Fishing Income (£)	57,275	156,049
Average days at sea	100	174
Average income per day (£)	569	834
Annual operating costs	40,806	127,210
Operating costs as a % of income	68%	76%
Fuel costs as a % of income	12%	16%
Operating Profit (£)	18,920	40,901
Operating Profit Margin (£)	32%	24%
Net profit margin (£)	16%	19%

Vessels in the under 10m demersal trawl / seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total. Nationally plaice accounted for 5% of the volume but only 2% of the value of the catch composition of this segment (Curtis & Brodie 2011).

Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total (Curtis & Brodie 2011).

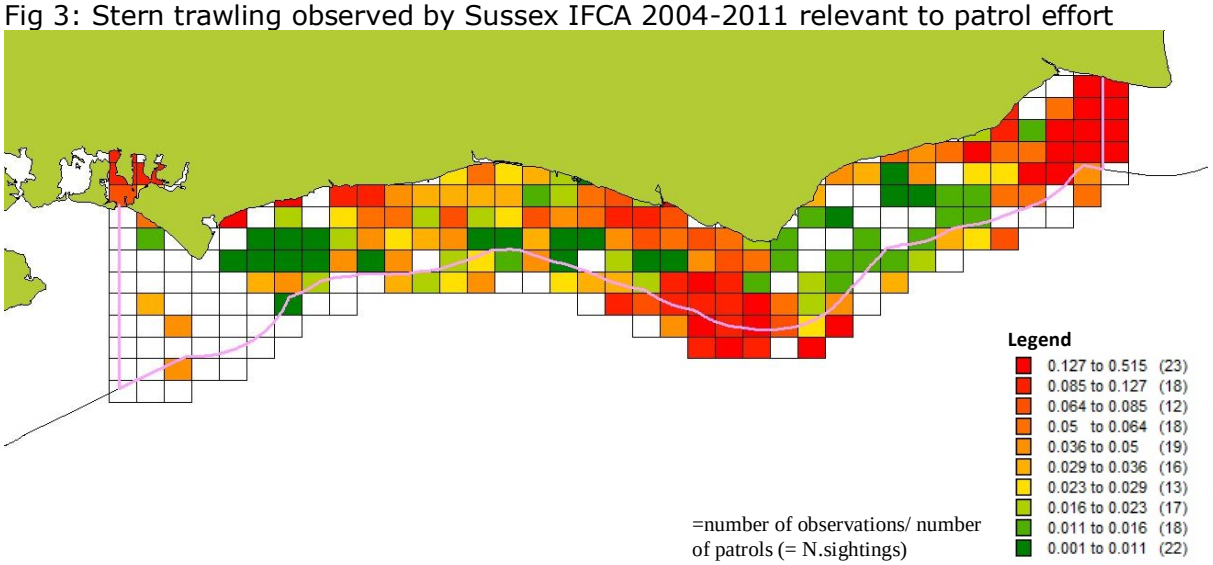
Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 4: The Marine Management Organisations registration of buyers and sellers records of the total annual value of plaice landed by the method of beam trawling* into Sussex ports. * *includes MMO method description 'beam trawl' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£66,207		£66,207	£92,633		£92,633	£158,840
2008	£103,650		£103,650	£113,991		£113,991	£217,641
2009	£77,338	£697	£78,035	£104,110	£577	£104,687	£182,722
2010	£77,201		£77,201	£113,343	£8,141	£121,484	£198,685
Grand Total	£324,396	£697	£325,093	£424,077	£8,718	£432,796	£757,889

Stern trawl fishery
There are two types of towed gear used off the Sussex Coast, they are: rock hopper otter trawl and small footrope otter trawl (the effort map (fig 3) does not discriminate between these two types of trawls). The rock hopper otter trawl is normally used in conjunction with steel otter boards and wire bridles these trawls target cod, whiting, lemon sole, squid, cuttlefish, and bass. Larger sole, skate and dogfish are also caught. This gear can be worked on the grounds with harder substrates such as the fisheries off Dungeness, Beachy Head, Worthing and Selsey. The small footrope otter trawl uses wooden otter boards. Wire or combination wire bridles are also used but they are longer than the rock hopper rig typically 60 to 100 fathoms. The main species targeted with this method are plaice, sole, codling, cuttlefish and any other demersal species. This trawl cuts through the top layer of the soft sea bottom and the tickler chain digs the fish out. This rig is used predominantly to the east of the District due to the softer seabed. The small footrope otter trawl may be twin rigged (two nets) or triple rigged (3 nets), the nets are towed side by side and thus the effective area swept is increased.

Fig 3: Stern trawling observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 5: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
Number of vessels	216	58
Average Fishing Income (£)	57,275	156,049
Average days at sea	100	174
Average income per day (£)	569	834
Annual operating costs	40,806	127,210
Operating costs as a % of income	68%	76%
Fuel costs as a % of income	12%	16%
Operating Profit (£)	18,920	40,901
Operating Profit Margin (£)	32%	24%
Net profit margin (£)	16%	19%

Vessels in the under 10m demersal trawl / seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total. Nationally plaice accounted for 5% of the volume but only 2% of the value of the catch composition of this segment (Curtis & Brodie 2011).

Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total (Curtis & Brodie 2011).

Local socioeconomics

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appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 6: The Marine Management Organisations registration of buyers and sellers records of the total annual value of plaice landed by the method of stern trawling* into Sussex ports. * *includes MMO method description 'heavy otter trawl', 'light otter trawl', 'twin otter trawl' and 'unspecified otter trawl'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£17,308	£4,397	£21,705	£14,429	£118,772	£133,201	£154,906
2008	£10,879	£3,734	£14,613	£17,667	£129,103	£146,770	£161,384
2009	£7,106	£2,319	£9,425	£18,234	£123,391	£141,625	£151,049
2010	£16,238	£3,104	£19,343	£15,266	£60,785	£76,051	£95,393
Grand Total	£51,532	£13,554	£65,085	£65,596	£432,051	£497,647	£562,732

Rod and line fishery

The activity of fishing using rod and line is popular throughout the Sussex district at both a commercial level; by commercial anglers (anglers selling their catch) and by charter vessels (vessel owner operators taking recreational anglers to fish at sea). Recreational angling by private vessels and sea angling from the shore is also very popular throughout Sussex.

The main target species for fishing using rod and line in Sussex are:
Commercial anglers: bass, cod, pollack and ling
Charter vessels: bass, cod, black bream, mackerel and congor eel
Recreational angling (private vessels and angling from the shore): bass, cod, black bream, mackerel, whiting, plaice and dover sole

Recreational: Economic survey of recreational sea angling

In 2003 the Economics and Statistics Group of the Department for Environment, Food and Rural Affairs (Defra) commissioned Drew Associates to conduct a research study on the economic contribution of sea angling to the UK (Drew Associates, 2004). The executive summary of this research is attached as Appendix 2. Consumer surplus benefits from sea angling were found to be considerable; consumer surplus (mean value) on existing annual sea angling activity varied from £381 per shore angler to £886 per own boat angler. When aggregated over sea fishing trips for the whole country, the annual aggregate net benefit based on the mean consumer surplus estimates was £594 million (Drew Associates, 2004). Most anglers are male (96.7%) and had been fishing for 25.7 years on average. Anglers catch, on average, between 5 (shore anglers) and 13 (boat anglers) fish per trip and retain 32-39% of their catch (Drew Associates, 2004).

Recreational: Local socioeconomics

The population of the Sussex IFCA district is 1,804,000 (766,400 in East Sussex, 781,600 in West Sussex plus 256,000 in Brighton and Hove - all 2008 estimates). The Drew report (Drew Associates, 2004) showed 2.75% of the then population of 52 million in England and Wales were sea anglers. This equates to approximately 50,000 sea anglers in the Sussex district. In addition to the economic benefit to society from sea angling many anglers perceived a positive benefit to their health, anecdotal evidence from the Drew Associates 2004 surveys suggested that this was related to the sense of relaxation and peace of mind that angling engendered.

Commercial: Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 7: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Hooks <10m
Number of vessels	105
Average Fishing Income (£)	30,877
Average days at sea	75
Average income per day (£)	473
Annual operating costs	20,010
Operating costs as a % of income	59%
Fuel costs as a % of income	6%
Operating Profit (£)	14,191
Operating Profit Margin (£)	41%
Net profit margin (£)	31%

N.B. this segment incorporates under 10m commercial vessels using hooks by any method.
Vessels in the 'under 10m using hooks' segment have an average of 2 crew members, in the UK this segment employed 178 fishermen in total (Curtis & Brodie 2011).

Commercial: Local Socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 8: The Marine Management Organisations registration of buyers and sellers records of the total annual value of plaice landed by the method of rod and line* into Sussex ports. * *includes MMO method description 'rod and line' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007		£116	£116	£0	£27	£27	£143
2008		£92	£92	£0	£322	£322	£414
2009		£110	£110	£0	£312	£312	£422
2010	£6	£12	£18	£0	£92	£92	£110
Grand Total	£6	£330	£336	£0	£752	£752	£1,089

Red mullet
Mullus surmuletus (L.)

Species description
Red mullet belong to the Mullidae family which are commonly known as the 'goat fish'. Despite the name they are not closely related to the grey mullet which is also found in UK waters. They have a moderately elongated body, with a steep snout and are easily recognized by their two long chemosensory barbels that protrude from the chin (Miller & Loates 1997). They have two dorsal fins which are spaced well apart and large fragile scales (Miller & Loates 1997, Lythgoe & Lythgoe 1971). Their colouration varies with depth, emotion and time of day but generally they are reddish to pink with three yellow strips along their sides (Miller & Loates 1997, Lythgoe & Lythgoe 1971).

Biology and ecology

Biological factor	
Size	Up to 40cm (Miller & Loates 1997)
Lifespan	10 years (FishBase)
Size at reproductive maturity	15 - 20cm (FishBase, MCS Fishonline)
Age at reproductive maturity	2 - 2.5 years (FishBase, MCS Fishonline)
Fecundity	Unknown
Larval phase	Yes, eggs & larvae planktonic (duration unknown)
Adult mobility	Free swimming (demersal)

Reproductive behaviour
Red mullet breed form May until July (Miller & Loates 1997, MCS Fishonline). The female deposits her eggs over the seabed in depths of 10-55m (Lythgoe & Lythgoe 1971), the larvae hatch out of the eggs at a size of 2.8mm (Miller & Loates 1997) and both the egg and larval phase are planktonic (FishBase). The young red mullet live in the open water; they are silvery blue in colour which provides camouflage and they drift with the plankton until they are 5cm in length (Lythgoe & Lythgoe 1971, Dipper 1987). Following this they take up their bottom dwelling existence (Lythgoe & Lythgoe 1971, Dipper 1987).

Migratory behaviour
There has been little research regarding the movements of red mullet in the Sussex district. In general it is common for younger/smaller individuals to be found in the shallower waters and older/larger individuals to be found at deeper depths (Lythgoe & Lythgoe 1971) and it is likely that as adults they perform seasonal migrations, coming into shallower inshore areas to breed. Research conducted off the coast of Crete revealed; small individuals in the shallow water during all seasons, a migration of individuals reaching sexual maturity into deeper water, a higher abundance of larger individuals in the deeper water and a change in distribution in spring with the larger individuals moving inshore and spawning (Machias *et. al.* 1998). In addition the study reported that red mullet do not exhibit 'homing behaviour' and suggested instead that the separation between the immature and mature individuals is bathymetric rather than geographical (Machias *et. al.* 1998).

Habitat
Red mullet inhabit the inshore area and can be found on a range of seabed types including sand, mud and coarse gravel (Miller & Loates 1997, Lythgoe & Lythgoe 1971). The young can be found in waters as shallow as 1m browsing on algae covered rocks whilst the adults can be found from 3 - 90m (Lythgoe & Lythgoe 1971). Red mullet may

be found singularly or in groups of up 50 individuals (especially as juveniles) (Lythgoe & Lythgoe 1971).

Predators and prey
Red mullet use their specially adapted barbels to locate their prey. Their barbels are chemosensory and as they move along the seabed they probe them into the sediment in search of food (Miller & Loates 1997). Once a prey item has been located they energetically dig and can excavate a hole as deep as themselves (Lythgoe & Lythgoe 1971, Dipper 1987). Common prey items are benthic invertebrates including; shrimps, amphipods, polychaetes, small crabs and bivalves (FishBase). Once individuals grow greater than 17cm in length fish becomes an important contribution to their diet (Labropoulou *et. al.* 1997). Small wrasse and seabream often follow shoals of feeding red mullet picking up any food which is thrown up in their feeding process (Lythgoe & Lythgoe 1971, Dipper 1987). Common predators of red mullet include weever fish and rays (FishBase).

Stock status (Carleton *et. al.* 2009)
There is no formal stock assessment in the Sussex District (or in the Channel) for Red Mullet. Reference points, harvest control rules and fishery specific management objectives have not been specified.

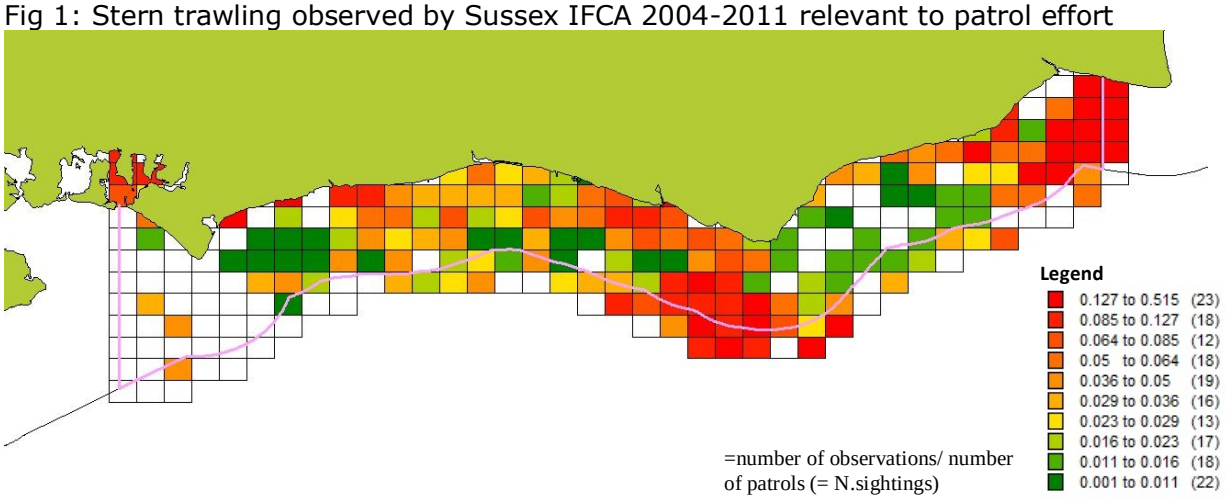
The Sussex fisheries
Fishing activity
Red mullet are mostly caught between the months of April and November. Offshore of the Sussex IFCA district they are most commonly targeted as part of a joint fishery by otter trawlers from the port of Newhaven. There appears to be no difference in catchability at day or night. Red mullet are a very soft fish with delicate flesh and scales; they usually suffer damage during capture and are mostly dead upon hauling. Following the increasing quota restrictions on other more traditional species in the late 1980's species like red mullet, (along with bass, black bream, cuttlefish and squid) have attracted more interest.

Fishing methods
The fishery for red mullet with the Sussex IFCA district is on a commercial basis only. Within the district they are not directly targeted, instead being taken as a small bycatch in small-mesh static nets, otter trawls and beam trawls. Outside of the district in the deeper water they are part of a 'joint targeted' fishery that uses otter trawls to catch the small demersal deeper water species which include; squid, red mullet, lemon soles and angler (monk) fish. Squid are usually the more abundant species in this activity but per kilo red mullet are more valuable. Offshore there is also a fly-seine fishery for squid and red mullet, however this is predominantly at activity of the Dutch vessels and it is not landed into the UK.

Stern trawl fishery
There are two types of towed gear used off the Sussex Coast, they are: rock hopper otter trawl and small footrope otter trawl (the effort map (fig 1) does not discriminate between these two types of trawls). The rock hopper otter trawl is normally used in conjunction with steel otter boards and wire bridles these trawls target cod, whiting, lemon sole, squid, cuttlefish, and bass. Larger sole, skate and dogfish are also caught. This gear can be worked on the grounds with harder substrates such as the fisheries off Dungeness, Beachy Head, Worthing and Selsey. The small footrope otter trawl uses wooden otter boards. Wire or combination wire bridles are also used but they are longer than the rock hopper rig typically 60 to 100 fathoms. The main species targeted with this method are plaice, sole, codling, cuttlefish and any other demersal species. This trawl

cuts through the top layer of the soft sea bottom and the tickler chain digs the fish out. This rig is used predominantly to the east of the District due to the softer seabed. The small footrope otter trawl may be twin rigged (two nets) or triple rigged (3 nets), the nets are towed side by side and thus the effective area swept is increased.

Fig 1: Stern trawling observed by Sussex IFCA 2004-2011 relevant to patrol effort



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Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
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Net profit margin (£)	16%	19%

Vessels in the under 10m demersal trawl / seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total (Curtis & Brodie 2011).

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Local socioeconomics

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Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of red mullet landed by the method of stern trawling* into Sussex ports. * *includes MMO method description 'heavy otter trawl', 'light otter trawl', 'twin otter trawl' and 'unspecified otter trawl'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£17,397	£386	£17,783	£8,708	£7,460	£16,168	£33,951
2008	£5,932	£243	£6,175	£8,695	£3,359	£12,053	£18,228
2009	£3,133	£49	£3,182	£3,859	£1,463	£5,322	£8,505
2010	£3,011	£23	£3,035	£3,321	£1,247	£4,569	£7,603
Grand Total	£29,473	£702	£30,174	£24,583	£13,529	£38,113	£68,287

Turbot

***Psetta maxima* (L.)**

previously known as ***Scophthalmus maximus* (L.)**

Species description

Turbots are flatfish with a circular body outline and eyes on the 'left' side of the head. The dorsal and anal fins run the length of the body but do not join the tail fin (Hayward & Ryland 1998). Turbot have no scales but they do have prominent 'tubercles', bony bumps that are scattered irregularly on their upper side (Hayward & Ryland 1998, Miller & Loates 1997). Their lateral line is strongly arched above the pectoral fin (Hayward & Ryland 1998, Miller & Loates 1997) and their colouration and markings are variable depending on the colour of the seabed (Lythgoe & Lythgoe 1971); commonly they are greyish brown with an abundance of dark and light speckles on top and white underneath (Hayward & Ryland 1998).

Biology and ecology

Biological factor	
Size	Up to 90 cm (Miller & Loates 1997)
Lifespan	Up to 25 years (Deniel 1990)
Size at reproductive maturity	Males 30 cm, females 35 - 45cm (Miller & Loates 1997)
Age at reproductive maturity	3 - 5 years (FishBase)
Fecundity	10 - 15 million eggs (Miller & Loates 1997, Dipper 1987)
Larval phase	Yes, planktonic phase 4 - 6 months (Miller & Loates 1997)
Adult mobility	Free swimming (demersal)

Reproductive behaviour

Turbot breed from April until August, laying their eggs predominantly on gravel bottom at depths >10m (Miller & Loates 1997, Lythgoe & Lythgoe 1971, FishBase). The eggs are planktonic and hatch after 7 - 9 days; following this the larval remain in the pelagic zone for 4 - 6 months Lythgoe & Lythgoe 1971, Dipper 1987, FishBase). During this period the larvae will be subject to surface water currents and with such a long planktonic phase they have the potential to travel long distances. Metamorphosis occurs at approximately 25mm after which they adopt their demersal life style (Miller & Loates 1997, Lythgoe & Lythgoe 1971). Wild hybrids of turbot and brill have been identified; these individuals exhibit intermediate characteristics of both species (Miller & Loates 1997).

Migratory behaviour

There has been little research regarding turbot movements in the Sussex district. In general it is common for younger/smaller individuals to be found in the shallower waters and older /larger individuals to be found at deeper depths (Lythgoe & Lythgoe 1971), thus moving in a slight offshore direction as they mature and grow. It is likely that as adults they perform small seasonal migrations, coming into shallower inshore areas to breed, but if they have settled as juveniles in the district they are likely to stay within (or in the vicinity of) the district throughout the year and thus their lifespan. Tagging studies conducted in Sweden suggest that turbot move into breeding areas (which are shallower) during spring and summer to spawn and then return back to deeper waters in the autumn (Støttrup *et. al.* 2002, Bergstad & Folkvord 1997, Fisjeriverket). During the spawning period all re-captures were made within a small area, the furthest distance between release and re-capture being 35km (Støttrup *et. al.* 2002, Bergstad & Folkvord 1997, Fisjeriverket). This study also suggested that the turbot showed breeding area fidelity; the tagged individuals returned to the same area to breed the following year (Støttrup *et. al.* 2002, Bergstad & Folkvord 1997, Fisjeriverket). The mean distance

between release and recapture one year later was 7.6 km with 95% of all recaptures being made within a 30 km radius (the longest recorded displacement was 90 km) (Støttrup *et. al.* 2002, Bergstad & Folkvord 1997, Fisjeriverket). Similar studies monitoring the movements of hatchery reared turbot that were released into the wild support the theory that adult turbot do not make large scale migrations (Dipper 1987, Deniel 1990) . A study in the Kattegat revealed that after one year the migration of cultured one year old turbot was less than 10km; they continued to remain close to the shore for the first 2 years then moved offshore (Dipper 1987), as would be expected as they mature. A study in Norway found that after 3 years the tagged fish were recaptured within a 50km radius of the release locations (Deniel 1990). It is therefore likely that the main dispersal potential of this species is during the 4-6 month planktonic larval phase.

Habitat
Turbot inhabit the inshore shelf region to depths of 80m but may also be found in brackish waters (Miller & Loates 1997, Lythgoe & Lythgoe 1971). Their preferred substrate type is sand or gravel but they can also be found in upon shelly and muddy seabeds (Lythgoe & Lythgoe 1971).

Predators and prey
Turbot are carnivorous predators, mostly feeding upon other fish species (Miller & Loates 1997, Lythgoe & Lythgoe 1971). Their most common prey items are sprats and sand eels (Miller & Loates 1997); they will also take herring, whiting, gobies, other flatfish, dragonets, crustaceans and molluscs (Dipper 1987). Predators of turbot include large cod (for young turbot) and sea mammals (FishBase).

Stock status (Carleton *et. al.* 2009)
Seafish conclude that there is a serious shortage of basic information for this stock due to severe deficiencies in the data (lack of updates, gaps in the time series, little data on discards and limited survey information). There are no formal stock assessments, so stock status is uncertain and it is unclear whether a rebuilding strategy is required. Reference points and harvest control rules have not been formalized.

The Sussex fisheries
Fishing activity
Turbot are present in small quantities throughout the district, however the 'joint targeted' fishery which uses the large mesh static nets exploits deeper waters which are predominantly outside of 6nm and thus outside of the Sussex IFCA district; within the district turbot are generally taken only as a bycatch. The joint targeted fishery for turbot is from late spring until the end of summer, coincidently this is in line with their breeding season but they can be caught all year round. During the spring and summer the more settled weather allows the fishing vessels to attend offshore areas on a more regular basis and it is a good supplementary fishery to other fishing practices at that time of year. The most productive fishing is over the neap tides. Turbot are a very hardy fish and they are usually live upon hauling. It is common to 'bleed' a turbot; this is the practise of cutting a 'V' shape out of the base of the tail and prevents the white underside of the fish discolouring. Turbot are less common than most commercially exploited species within the district but as they are a valuable fish to catch because they are a large fish, commonly 10 - 30lbs and the price per kilo is high.

Fishing methods
The fishery for turbot within the Sussex IFCA district is mostly on a commercial basis and they are not targeted alone; they are part of a 'joint targeted' fishery for large flat bottom dwelling species which includes; turbots, rays and brills. These species are targeted using a specific type of static net commonly called a 'turbot-ray net' or a 'skate net'. This is a single walled gill net with a large mesh; the common mesh size used is

between 160 - 270 mm (this is double the mesh size of a standard net used to target sole and plaice) and it is made from a more robust monofilament (this is necessary to handle these larger rougher species). The nets are left on the seabed for up to 3 days and they are mostly set in water depths of 20 - 30m. Turbot are a common bycatch for most other fishing methods, in particular beam trawls but they are also caught in standard static nets, otter trawls and scallop dredges.

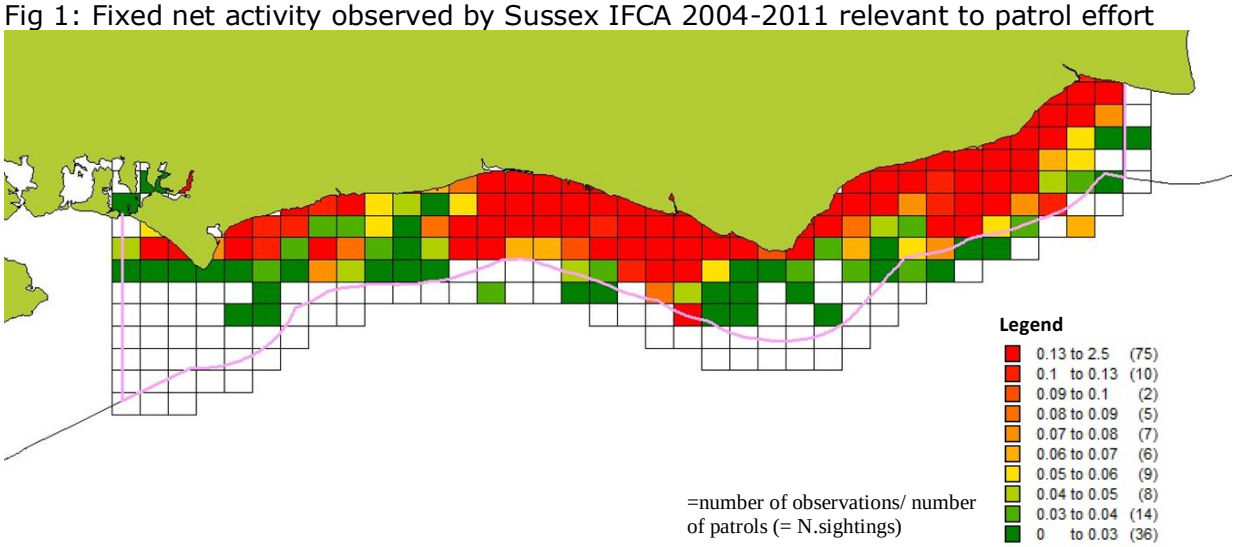
Fixed net fishery

There are a variety of types of nets deployed off Sussex; the most common is the trammel net. The trammel is constructed of three 'sheets' of nets, the outer nets are rigged one each side of the inner mesh panel. These nets have a cork line (top line) and lead line (bottom line). The nets sit or 'swim' in 3 to 8 feet of water. The fixed net only fishes on the slowest run of the tide. Fish targeted in this manner are plaice, sole, cod and cuttlefish. Gill nets and tangle nets are also used for targeting fish such as cod; these nets are fished in a similar manner to trammel nets but are rigged from a singlesheet that sits vertically on the seabed. Nets are usually made from monofilament, although nylon is essential when catching spider crabs, due to the abrasion caused by this crab during entrapment. The fixed net vessels work various styles and combinations according to the season; gill nets for cod in the winter and trammel nets for plaice and sole in the early spring. In the spring / summer season trammel nets are set for plaice, cuttlefish and sole and gill nets for bass. In the autumn trammel nets are set for plaice and sole and gill nets set for bass and cod.

Spatial distribution of fishing activity

The practice of fixed net fishing is the most common method used to catch fin fish within the Sussex district. Fishing used fixed nets occurs throughout the year (targeting one or more of the variety of species that this method is effective at catching) from Bognor Regis to Rye bay and most commonly within 3-4nm of the shore (fig 1).

Fig 1: Fixed net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

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Table 1: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Drift and/or Fixed Nets <10m
Number of vessels	238
Average Fishing Income (£)	42,330
Average days at sea	94
Average income per day (£)	477
Annual operating costs	28,179
Operating costs as a % of income	67%
Fuel costs as a % of income	9%
Operating Profit (£)	14,151
Operating Profit Margin (£)	33%
Net profit margin (£)	25%

Vessels in the under 10m drift and/or fixed net segment have an average of 2 crew members, in the UK this segment employed 438 fishermen in total, turbot accounted for 4% of the catch composition value of this segment (Curtis & Brodie 2011).

Local socioeconomics

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Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of turbot landed by the method of fixed nets* into Sussex ports. * *includes MMO method description 'gill net (not 52 or 53)', 'gill net (tangle)', 'gill net (trammel)' and unspecified gill net*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007		£10,689	£10,689	£1,569	£36,378	£37,948	£48,636
2008	£108	£19,601	£19,709	£840	£51,059	£51,899	£71,608
2009		£24,400	£24,400	£328	£62,883	£63,210	£87,611
2010	£189	£31,781	£31,970	£747	£57,560	£58,307	£90,277
Grand Total	£297	£86,471	£86,768	£3,484	£207,880	£211,364	£298,132

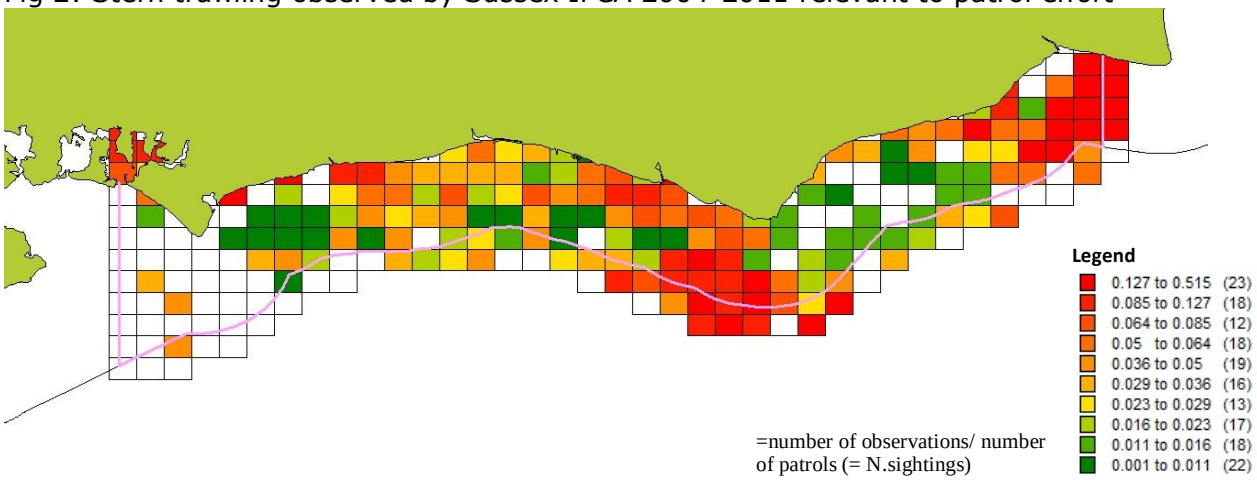
Stern trawl fishery

There are two types of towed gear used off the Sussex Coast, they are: rock hopper otter trawl and small footrope otter trawl (the effort map (fig 2) does not discriminate between these two types of trawls). The rock hopper otter trawl is normally used in conjunction with steel otter boards and wire bridles these trawls target cod, whiting, lemon sole, squid, cuttlefish, and bass. Larger sole, skate and dogfish are also caught. This gear can be worked on the grounds with harder substrates such as the fisheries off Dungeness, Beachy Head, Worthing and Selsey. The small footrope otter trawl uses wooden otter boards. Wire or combination wire bridles are also used but they are longer

than the rock hopper rig typically 60 to 100 fathoms. The main species targeted with this method are plaice, sole, codling, cuttlefish and any other demersal species. This trawl cuts through the top layer of the soft sea bottom and the tickler chain digs the fish out. This rig is used predominantly to the east of the District due to the softer seabed. The small footrope otter trawl may be twin rigged (two nets) or triple rigged (3 nets), the nets are towed side by side and thus the effective area swept is increased.

Spatial distribution of fishing activity

Fig 2: Stern trawling observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

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Table 3: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
Number of vessels	216	58
Average Fishing Income (£)	57,275	156,049
Average days at sea	100	174
Average income per day (£)	569	834
Annual operating costs	40,806	127,210
Operating costs as a % of income	68%	76%
Fuel costs as a % of income	12%	16%
Operating Profit (£)	18,920	40,901
Operating Profit Margin (£)	32%	24%
Net profit margin (£)	16%	19%

Vessels in the under 10m demersal trawl / seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total (Curtis & Brodie 2011).

Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total (Curtis & Brodie 2011).

Local socioeconomics

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Table 4: The Marine Management Organisations registration of buyers and sellers records of the total annual value of turbot landed by the method of stern trawling* into Sussex ports. * *includes MMO method description 'heavy otter trawl', 'light otter trawl', 'twin otter trawl' and 'unspecified otter trawl'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£2,359	£441	£2,800	£3,369	£16,848	£20,216	£23,016
2008	£1,503	£597	£2,101	£4,237	£15,824	£20,061	£22,162
2009	£1,904	£231	£2,135	£3,327	£15,295	£18,622	£20,756
2010	£1,815	£746	£2,561	£2,685	£16,552	£19,238	£21,798
Grand Total	£7,581	£2,015	£9,596	£13,618	£64,519	£78,137	£87,732

Brown / Edible crab
Cancer pagurus (L.)

Species description
Cancer pagurus is known locally in Sussex as the brown crab, it has an oval shaped body with a distinctive 'piecrust' edge. It is reddish-brown in color with black tipped pincers.

Biology and ecology

Biological factor	
Size	Up to 250mm carapace width (Hayward & Ryland 1998)
Lifespan	20 years (Hayward *et. al.* 1996)
Size at reproductive maturity	Male 110mm, female 115mm (MarLIN)
Age at reproductive maturity	10 years (MarLIN, Marine Ecological Surveys Ltd.)
Fecundity	>1,000,000 eggs (MarLIN)
Larval phase	60 - 90 days (Pawson 1995)
Adult mobility	Crawls (benthic)

Reproductive behaviour
The sex of a brown crab can be determined by the shape of the abdomen; the males being narrow and the females being broad and rounded for carrying eggs. The females move inshore in late spring to moult and shortly afterwards mating by copulation occurs (Brown & Bennett 1980). The females store the sperm, then in late summer they move offshore again and use the stored sperm to fertilise their eggs in the winter (Hayward *et. al.* 1996). The females carry their eggs under their abdomen; this is commonly known as being 'berried'. Berried females rarely feed or move, instead they lay in pits dug in the sediment or under rocks and thus are less likely to be caught in a baited pot (MarLIN). Around late spring/early summer (6 - 9 months after copulation) the larvae are released into the water column (Thompson et. al. 1995). The larvae remain in the plankton for 2 months and then settle as juveniles in the intertidal zone in late summer/early autumn (Bennett 1995) . They remain in the intertidal zone until they reach a carapace width of 60 - 70mm (which takes about 3 years) then they migrate to subtidal areas (MarLIN). Growth rate varies with age, gender and water depth from 1 - 10mm increase in carapace width per year (MarLIN). Generally growth rate decreases with age, is higher in deeper waters and males grow faster than females (Brown & Bennett 1980). The majority of the south coast of England has been identified as brown crab nursery ground (Pawson 1995).

Migratory behaviour
A brown crab can travel 2 - 3km per day and may perform migrations of up to 200 nautical miles (Pawson 1995). Suture tags (which persist through moulting) were used to study the movements of brown crabs and the results infer that they perform a 'one-way' migration (Pawson 1995). The females in the English Channel were found to move west or southwest with no indication of a return movement (Pawson 1995). The research suggests that this westerly movement of the females may be contranatent (i.e. against the prevailing current), thus ensuring that their progeny drift back towards their own nursery grounds (Pawson 1995). The males make shorter less directed movements (Pawson 1995). There are no records of brown crabs moving into the English Channel from the North Sea (Pawson 1995).

Habitat
The brown crab frequents a variety of habitats depending during its life cycle from sublittoral rocky shores as a juvenile to depths of 200m as an adult (Hayward *et. al.*

1996, Pawson 1995). Some research suggests that there may be sex segregation with habitat, suggesting that mature males are caught predominantly on rocky substrates whilst females are more abundant on sand and gravel (Pawson 1995). Commonly adults of both sexes can be found sheltering under boulders.

Predators and prey
The brown crab is a scavenger for carrion and an active predator which hunts a variety of crustaceans and molluscs including the green shore crab, the broad clawed porcelain crab, the long clawed porcelain crab, the hairy crab, the squat lobster, the dog whelk, the winkle, razor shells, the blue mussel, the common cockle and the oyster and it will also eat smaller members of their own species (conspecifics) (MarLIN, Lawton 1989). Motile prey may be taken (Lawton 1989). The brown crab is mainly nocturnal, research suggests this is to reduce its risk of predation from cod and seals (Skajaa *et. al.* 1998).

Stock status (Carleton *et. al.* 2009)
According to CEFAS, recent records show landings of brown crab are generally being maintained or even increasing. However, there are signs that the quantity of crabs caught-per-init-effort is falling in some areas, but it is not yet clear if this is indicative of a decline in stock abundance or a local fishery effect. It is not currently possible to state whether a rebuilding plan is required. According to the report to the ICES Crab Working Group (WGCRAB 2007) the landings in the Eastern Channel Stock management unit have declined, but with no discernible trend in LPUE.

The Sussex Fisheries
Fishing activity
The main fisheries for lobsters and brown crab within the Sussex district are based at the fishing stations of Selsey and Eastbourne. Brown crab can be caught all year round but the highest catch rates are seen March - April and October - December. During these months meat quality is at its best. Market prices/demand peaks in the run up to Christmas. Lower catch rates and poorer meat qualities are seen from June until September. During the months of June and July the catch is predominantly hens (females), at this time the females are presumed to be migrating inshore locally to moult and breed. Similar to lobsters, brown crabs are more active during the hours of darkness, feeding more and thus are more likely to be attracted to bait in a pot during the night. Out of season many lobster/crab fishermen also fish for whelks and consequently during the winter it is fairly common for such fishermen to move their parlour pots further offshore and haul them less frequently (once or twice a week) whilst working whelk gear too.
Within Sussex brown crabs are most commonly transported and sold live. Several fisherman within the Sussex district use 'store-pots', these are a large cage-like devices left on the sea-bed in which they store the crabs and lobsters for up to two weeks until they have a desirable quantity for their respective markets. Brown crabs have a notoriously strong and persistent claw grip. To prevent damage to adjacent crabs and handlers some fishermen immobilise their claws by the method of 'kiving', this is the process of cutting the tendon which controls the claw.

Fishing methods
The fishery for brown crab is solely commercial within the Sussex IFCA district and is intertwined with the lobster fishery. Brown crab is often not the main target species, instead it is often considered as a valuable bycatch from the lobster fishery. Traditionally inkwell pots were used to catch brown crab and are considered the best gear type to catch and retain them, however, parlour pots are better for lobsters and as the brown crab and lobster fisheries have converged most commercial fishermen use only parlour pots. Typically parlour and inkwell pots are worked in strings of 20 to 60 pots, with a spacing of 12 to 16 fathoms in between each pot. They are laid for 1 to 2 days, being

hauled, emptied, re-baited and shot in succession. Common bait used for these pots is horse mackerel, scad, dogfish, gurnard and skate chog (the head, torso and tail remnants from skate winging). In static nets brown crabs are often an undesirable bycatch, they become tangled up and are difficult to remove intact thus they are often broken up into 'back and claws' or destroyed and discarded. There is a market for the 'back and claws' product but per kilo the price is much less than for whole crab. They are also occasionally caught in scallop dredges. Brown crab is commonly used as bait in whelk pots and many lobster/crab fishermen retain some brown crab for this purpose, either to whelk fish themselves or sell as a bait product.

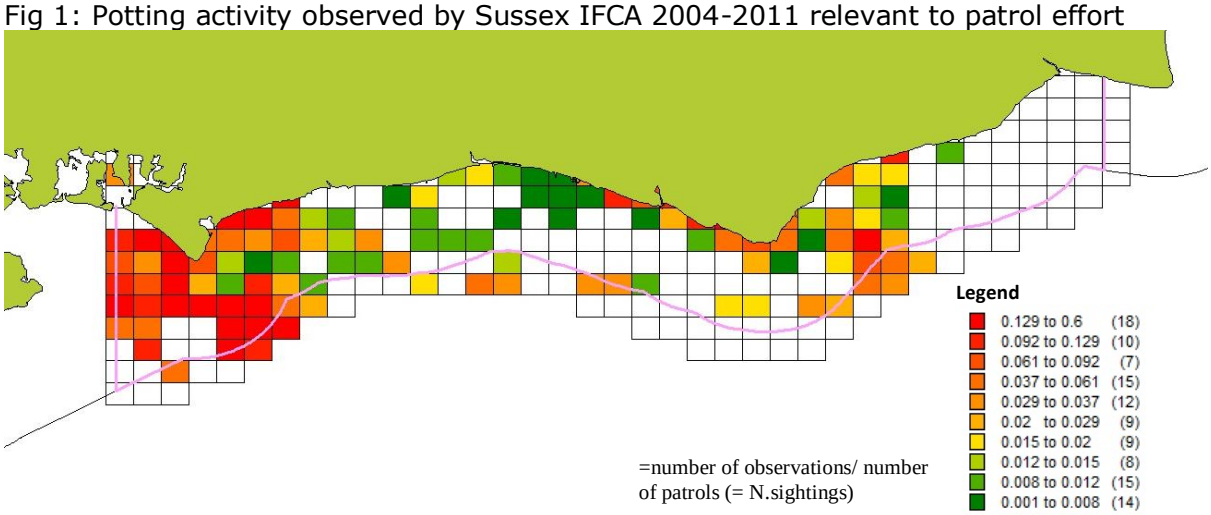
Pot fishery

Lobsters and brown crabs are targeted in pots. The Parlour pot is the most common method for targeting lobster within the District; these are fished in strings of up to twenty pots by the larger vessels and singularly by the smaller open boats. Inkwell pots are usually deployed for brown crab, which inshore are mostly to be found in the west of the District. A small number of boats set prawn pots to supply small local markets.

Spatial distribution of fishing activity

Potting for lobster and brown and brown crab predominantly occurs in the vicinity of Selsey Bill and to a lesser extent around Beachy Head (fig 1).

Fig 1: Potting activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



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Seafish Segment	Pots and Traps <10m	Pots and Traps 10-12m	Pots and Traps >12m
Number of vessels	991	177	83
Average Fishing Income (£)	44,248	93,707	248,017
Average days at sea	113	167	179
Average income per day (£)	474	602	1,252
Annual operating costs	28,566	60,819	222,009
Operating costs as a % of income	61%	64%	77%
Fuel costs as a % of income	12%	9%	14%
Operating Profit (£)	18,297	34,225	68,049
Operating Profit Margin (£)	39%	36%	23%
Net profit margin (£)	28%	24%	19%

Vessels in the under 10m pot and trap segment in 2009 had an average of 2 crew members and employed 1,635 fishermen in the UK (Curtis & Brodie 2011). Brown crab accounted for 35% of the volume of landings, more than any other species caught by this segment but only 17% of value (Curtis & Brodie 2011).

Vessels in the 10m – 12m using pots and traps segment in 2009 had an average of 3 crew members and employed 513 fishermen (Curtis & Brodie 2011). Brown crabs accounted for 42% of the volume of landings, more than any other species caught by this segment and 24% of value (Curtis & Brodie 2011).
Vessels in the over 12m pots and traps segment had an average of 5 crew members and employed 376 fishermen in 2009 (Curtis & Brodie 2011). Brown crab was the most important species to this segment in terms of both value; 63% and volume; 70% (Curtis & Brodie 2011).

Local socioeconomics
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Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of brown crab landed by the method of potting* into Sussex ports. * *includes MMO method description 'other or mixed pots', 'parlour pots' and 'top opening pots'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£29,655	£45,638	£75,293	£129,406	£3,141	£132,547	£207,840
2008	£19,153	£12,802	£31,955	£166,836	£1,431	£168,267	£200,222
2009	£48,146	£19,054	£67,200	£153,280	£27,856	£181,136	£248,336
2010	£50,009	£38,595	£88,605	£133,631	£42,834	£176,465	£265,070
Grand Total	£146,964	£116,089	£263,052	£583,153	£75,263	£658,415	£921,467

Common cuttlefish
Sepia officinalis (L.)

Species description
The common cuttlefish is a highly evolved mollusc with large eyes, tough jaws, 8 arms, 2 retractable tentacles and an internal cuttlebone (Hayward *et. al.* 1996). The body is flattened and oval in shape, with lateral fins running the entire length of the body (Hayward *et. al.* 1996). The cuttlebone is made of calcium carbonate and is used to control the animals' buoyancy. The cuttlefish is capable of changing colour and texture very rapidly; this may be used in sexual or competitive behaviour or to camouflage.

Biology and ecology

Biological factor	
Size	40cm length (Hayward *et. al.* 1996)
Lifespan	Approx. 18 - 24 months (Pawson 1995, Laptikhovsky *et. al.* 2003)
Size at reproductive maturity	13cm mantle length (Pawson 1995)
Age at reproductive maturity	Approx. 18 months (Pawson 1995)
Fecundity	1000 - 3000 eggs (Laptikhovsky *et. al.* 2003)
Larval phase	No
Adult mobility	Free swimming (mid-water to demersal)

Reproductive and migratory behaviour
The sexes of the common cuttlefish are separate with the males having a specialized left ventral (hectocotylized) arm used to transfer sperm packages to the female (Hayward *et. al.* 1996). During the winter the common cuttlefish inhabits the central western English Channel and moves inshore to breed during spring and summer (Pawson 1995). Spawning is gregarious with eggs being laid between February and May (peaking mid-April to mid-May) (Pawson 1995). The common cuttlefish eggs are similar in size and appearance to black grapes with a small nipple and can be found attached to a range of substrates from algae, sessile animals and man-made objects e.g. mooring lines or fishing pots, most commonly on sandy bottoms (Irving 1998, Pawson 1995). The eggs hatch after 80 - 90 days (however this is temperature dependant) and the juveniles remain close inshore burrowing in the sand during the day and emerging to feed at night (Pawson 1995). Tagging studies suggest the juveniles begin to move offshore in October when they are 6cm in mantle length (Pawson 1995). The cuttlefish become sexually mature during their second winter and return to inshore areas in their second spring/summer to breed but not necessarily to their original nursery area (Pawson 1995). Once mating and egg laying has occurred the cuttlefish die. It is unknown whether the cuttlefish in the Channel are members of one stock or whether they are separate breeding stocks which overwinter in the same region (Pawson 1995).
The common cuttlefish has two modes of movement. Normal swimming is achieved using a wave action of the lateral fins or for fast movement i.e. an escape response, jet propulsion is used by actively pumping water into the mantle cavity and expelling it through a short funnel (Hayward *et. al.* 1996).

Habitat
Cuttlefish can be found from the shallow sub-littoral to offshore as deep as 250m, most commonly around sand or mud substrates (Hayward *et. al.* 1996).

Predators and prey
The common cuttlefish is a highly adapted predator and escape artist. As a predator it is capable of camouflaging itself with its background and has two retractable tentacles with suckers grouped on the terminal pads which it can rapidly shoot out to seize prey. Their primary prey is crustaceans; juveniles commonly feeding on shrimps and adults commonly feeding on crabs (Hayward *et. al.* 1996, MarineBio 1998). Apart from being able to quickly change colour and become camouflaged another predator avoidance attribute is the 'ink sac' from which they can expel a dark fluid inhibiting the vision of the predator thus assisting in escape (it is also thought to be a mild narcotic) (Pechenik 1996). The main predators of the juvenile common cuttlefish are bass, wrasse, brill and eels (Blanc & Daguzan 1999), predators of adults are more limited but include members of the shark family and angler (monk) fish (MarineBio 1998).

Stock status (Carleton *et. al.* 2009)
There is no formal stock assessment, and limited management in the Sussex cuttlefish fishery. Although there is licensing and reporting requirements, there is no TAC, no minimum landing size and few directly applicable gear restrictions. There are EU technical measures related to towed and fixed net fishing for this species, this includes restrictions on mesh size ranges and on the catch percentage applicable to the use of a single mesh size range. In addition, the Fishing Instrument byelaw states that fishing is only permissible if it is conducted by a method which is specified in the byelaw. There is no restriction on the number of cuttlefish pots which can be used when targeting the species with static gear.
There are particular issues with regard to this species, such as potting activity generally occurring in inshore areas during the breeding season, and the need for alternative measures to prevent the females from laying eggs on the traps, and these being damaged (thus affecting recruitment to the fishery in the long term) as traps are hauled and emptied.

The Sussex Fisheries
Fishing activity
The start of the cuttlefish season is temperature dependent, when the water is 13 - 14°C (around May), they come into the district to breed. Breeding is so energy expensive that once this has occurred they die and thus the fishery for the adults begins to dwindle around July. From July to August small quantities of cuttlefish are still caught in beam trawlers as a bycatch, some are adults but most are 2 - 3 month old juveniles. The cuttlefish breeding areas and therefore the fishery are in distinct regions; they are inshore commonly 4 - 15m deep, from Fairlight to Beachy Head and from Brighton to the Solent (including the region of Chichester harbour).
There is very little bycatch in the cuttlefish fishery. Firstly the cuttlefish trap is designed to utilise the cuttlefish's behaviour and it is rare to find any other species in the trap. Secondly, cuttlefish are voracious predators and thus nothing appears to move in the water column with them so there is little bycatch when the methods of static nets and otter trawls are used to target them. There appears to be no difference in catchability between day and night. It is common for the cuttlefish to exhibit their escape response upon handling and storage thus; the catch, the fishermen and the fishing vessels are often coated in a layer of black ink.
Due to the fishing activity utilising the cuttlefishes breeding behaviour it is common for the females to lay her eggs on trap and subsequently they are damaged. In 2006 the Sussex Sea Fisheries Committee investigated the feasibility of laying artificial substrates as receptors for cuttlefish eggs; the artificial substrate used was similar to a string of cuttlefish traps but without the traps i.e. just the backline, weights and floats. The cuttlefish did use the alternative egg receptors provided in addition to the trap lines. The

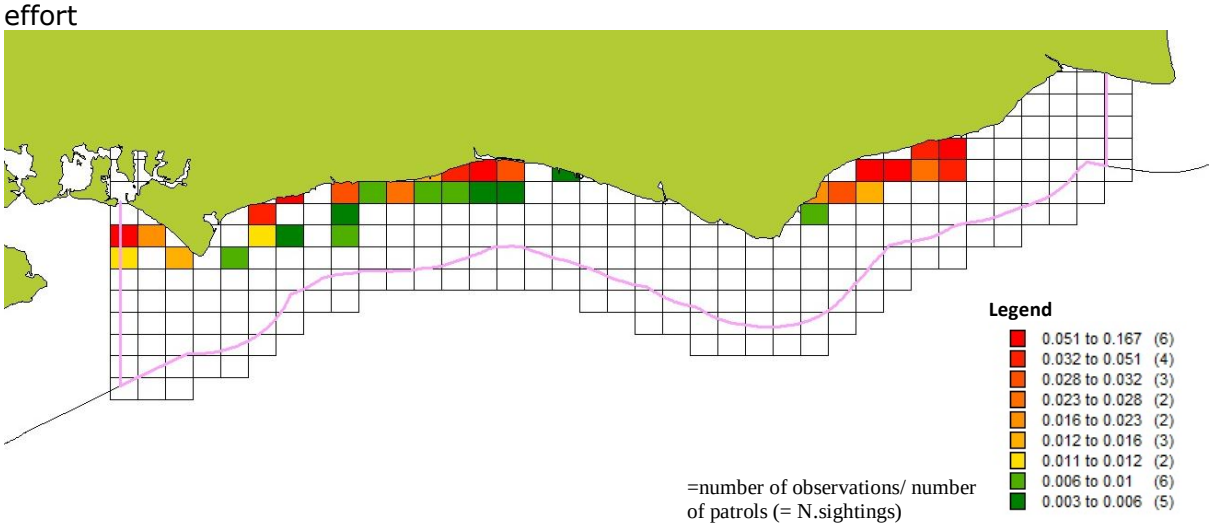
study recommended that further techniques should be developed in the form of 'removable receptors' which could be placed on the actual traps and once covered in eggs be removed and returned to the sea (Clark 2006).

Fishing methods
Within the Sussex IFCA district the fishery for cuttlefish is only on a commercial basis and three fishing methods are employed; cuttlefish traps are most commonly used of which there are two designs, static nets usually trammel nets with a mesh size of 120 – 160mm mesh and otter trawls, specifically rock hoppers. In addition cuttlefish are caught as a bycatch in beam trawls and otter trawls with light foot ropes.

Cuttletrap fishery
There are two designs of cuttletraps used in Sussex; one is a metre square steel frame with a nylon net covering, the other is a smaller round trap (also known as a 'French style' trap). Both types have a feathered finger entrance designed for the cuttlefish to be able to enter but not exit and a trap door for emptying and baiting. The traps are worked in strings of 10 - 20 (depending upon the size of the vessel) with a spacing of around 50ft in between each trap; it is common practice to haul the traps every 2 days. Instead of food a white ceramic tile or a female is used as 'bait' as it is their breeding season and this attracts the males and thus other females into the trap. On each haul the catch is emptied, the female is replaced and the gear is shot again in succession. It is common to see cuttlefish traps on fishing quays, this is because the fishing season is short and the gear would get damaged if it was left at sea thus at the end of the season they are brought ashore. Unfortunately these traps often have the progeny (eggs) attached.

Spatial distribution of fishing activity
The activity of cuttlefish trapping occurs very close inshore usually within 1-2nm mostly from Selsey Bill to Brighton and between Eastbourne and Hastings (fig 1).

Fig 1: Cuttlefish trapping activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



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Vessels in the over 12m pots and traps segment had an average of 5 crew members and employed 376 fishermen in 2009 (Curtis & Brodie 2011).

Local socioeconomics
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Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of cuttlefish landed by the method of cuttle trapping* into Sussex ports. * *includes MMO method description 'cuttle trap' and 'other or mixed pots'*

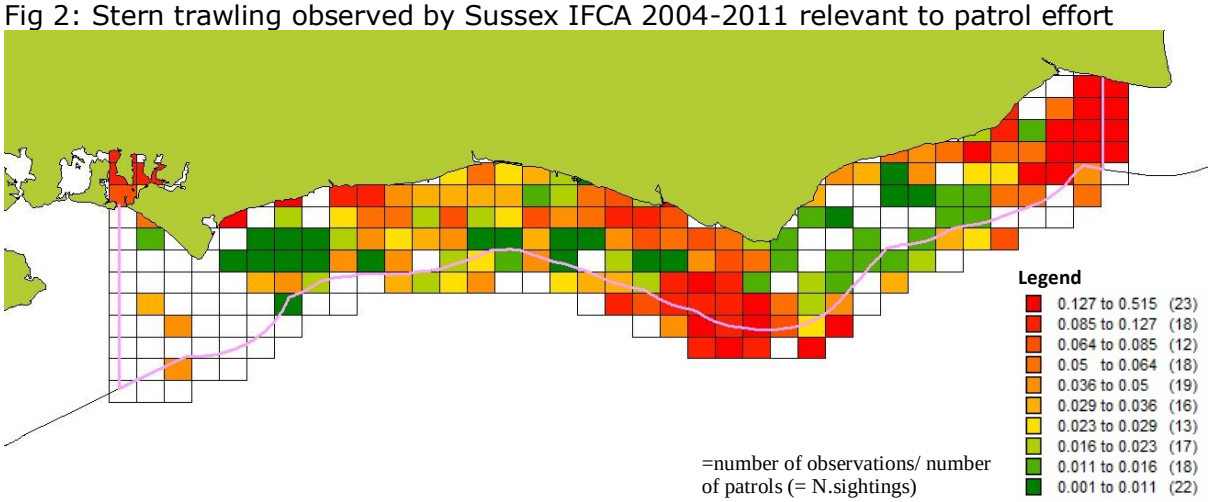
ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£1,175	£126,010	£127,186	£0	£84,503	£84,503	£211,689
2008	£459	£43,015	£43,474	£0	£18,190	£18,190	£61,665
2009	£348	£39,281	£39,629	£0	£3,264	£3,264	£42,893
2010	£1,221	£173,135	£174,356	£0	£73,935	£73,935	£248,291
Grand Total	£3,203	£381,441	£384,645	£0	£179,893	£179,893	£564,537

Stern trawl fishery
There are two types of towed gear used off the Sussex Coast, they are: rock hopper otter trawl and small footrope otter trawl (the effort map (fig 2) does not discriminate

between these two types of trawls). The rock hopper otter trawl is normally used in conjunction with steel otter boards and wire bridles these trawls target cod, whiting, lemon sole, squid, cuttlefish, and bass. Larger sole, skate and dogfish are also caught. This gear can be worked on the grounds with harder substrates such as the fisheries off Dungeness, Beachy Head, Worthing and Selsey. The small footrope otter trawl uses wooden otter boards. Wire or combination wire bridles are also used but they are longer than the rock hopper rig typically 60 to 100 fathoms. The main species targeted with this method are plaice, sole, codling, cuttlefish and any other demersal species. This trawl cuts through the top layer of the soft sea bottom and the tickler chain digs the fish out. This rig is used predominantly to the east of the District due to the softer seabed. The small footrope otter trawl may be twin rigged (two nets) or triple rigged (3 nets), the nets are towed side by side and thus the effective area swept is increased.

Spatial distribution of fishing activity

Fig 2: Stern trawling observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 3: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Demersal Trawl / Seine <10m	ICES Area VIIb-k Trawlers 10-24m
Number of vessels	216	58
Average Fishing Income (£)	57,275	156,049
Average days at sea	100	174
Average income per day (£)	569	834
Annual operating costs	40,806	127,210
Operating costs as a % of income	68%	76%
Fuel costs as a % of income	12%	16%
Operating Profit (£)	18,920	40,901
Operating Profit Margin (£)	32%	24%
Net profit margin (£)	16%	19%

Vessels in the under 10m demersal trawl / seine segment have an average of 2 crew members, in the UK this segment employed 506 fishermen in total (Curtis & Brodie 2011).

Vessels in the ICES Area VIIb-k trawlers 10-24m segment had 3 crew members and the segment employed 183 fishermen in total, cuttlefish accounted for 4% of the volume of the catch composition of this segment (Curtis & Brodie 2011).

Local socioeconomics
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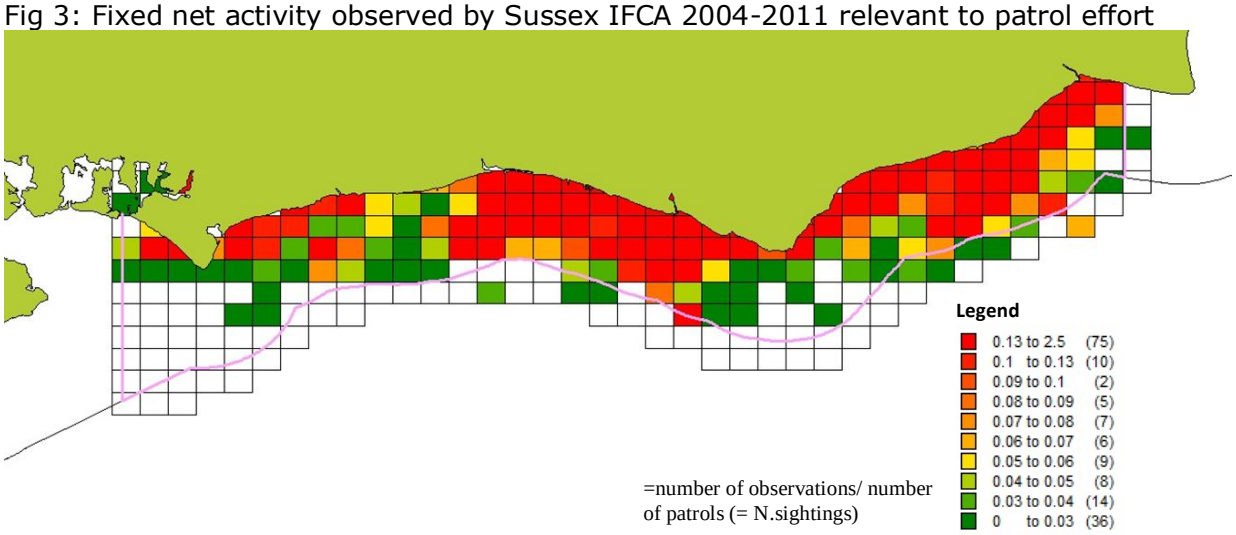
Table 4: The Marine Management Organisations registration of buyers and sellers records of the total annual value of cuttlefish landed by the method of stern trawling* into Sussex ports. * *includes MMO method description 'heavy otter trawl', 'light otter trawl', 'twin otter trawl' and 'unspecified otter trawl'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£16,603	£10,150	£26,753	£2,564	£14,502	£17,066	£43,819
2008	£5,301	£3,240	£8,542	£2,965	£13,094	£16,058	£24,600
2009	£2,227	£298	£2,524	£2,254	£15,561	£17,815	£20,340
2010	£23,073	£175	£23,248	£4,396	£29,038	£33,434	£56,682
Grand Total	£47,204	£13,863	£61,067	£12,178	£72,195	£84,374	£145,441

Fixed net fishery
There are a variety of types of nets deployed off Sussex; the most common is the trammel net. The trammel is constructed of three 'sheets' of nets, the outer nets are rigged one each side of the inner mesh panel. These nets have a cork line (top line) and lead line (bottom line). The nets sit or 'swim' in 3 to 8 feet of water. The fixed net only fishes on the slowest run of the tide. Fish targeted in this manner are plaice, sole, cod and cuttlefish. Gill nets and tangle nets are also used for targeting fish such as cod; these nets are fished in a similar manner to trammel nets but are rigged from a single sheet that sits vertically on the seabed. Nets are usually made from monofilament, although nylon is essential when catching spider crabs, due to the abrasion caused by this crab during entrapment. The fixed net vessels work various styles and combinations according to the season; gill nets for cod in the winter and trammel nets for plaice and sole in the early spring. In the spring / summer season trammel nets are set for plaice, cuttlefish and sole and gill nets for bass. In the autumn trammel nets are set for plaice and sole and gill nets set for bass and cod.

Spatial distribution of fishing activity
Fishing used fixed nets occurs throughout the year (targeting one or more of the variety of species that this method is effective at catching) from Bognor Regis to Rye bay and most commonly within 3-4nm of the shore (fig 3).

Fig 3: Fixed net activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet

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Table 5: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Drift and/or Fixed Nets <10m
Number of vessels	238
Average Fishing Income (£)	42,330
Average days at sea	94
Average income per day (£)	477
Annual operating costs	28,179
Operating costs as a % of income	67%
Fuel costs as a % of income	9%
Operating Profit (£)	14,151
Operating Profit Margin (£)	33%
Net profit margin (£)	25%

Vessels in the under 10m drift and/or fixed net segment have an average of 2 crew members, in the UK this segment employed 438 fishermen in total. Cuttlefish accounted for 4% of the volume of the catch composition of this segment (Curtis & Brodie 2011).

Local socioeconomics

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Table 6: The Marine Management Organisations registration of buyers and sellers records of the total annual value of cuttlefish landed by the method of fixed nets* into Sussex ports. * *includes MMO method description 'gill net (not 52 or 53)', 'gill net (tangle)', 'gill net (trammel)' and unspecified gill net*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£82,461	£82,461	£1,331	£123,694	£125,026	£207,487
2008	£0	£144,821	£144,821	£1,891	£152,827	£154,719	£299,540
2009	£0	£122,646	£122,646	£266	£116,678	£116,944	£239,590
2010	£0	£138,055	£138,055	£1,375	£99,552	£100,927	£238,981
Grand Total	£0	£487,983	£487,983	£4,863	£492,752	£497,615	£985,598

European lobster
Homarus gammarus (L.)

Species description
The European lobster is dark blue in colour with off-white markings and bright red antennae. It has two front claws that are different in shape, the right-hand claw being larger with blunt serrations used for crushing, the left-hand claw being more slender with sharper serrations used for cutting. It is a solitary animal and can be quite aggressive (Hayward *et. al.* 1996).

Biology and ecology

Biological factor	
Size	Up to 1 metre in length (Hayward *et. al.* 1996)
Lifespan	15 - 20 years (Hayward *et. al.* 1996)
Size at reproductive maturity	Females 25cm (Irving 1998)
Age at reproductive maturity	Females 7 years (Irving 1998)
Fecundity	Up to 30,000 eggs (Brusca & Brusca 2003)
Larval phase	3 weeks (Pawson 1995)
Adult mobility	Crawls (benthic)

Reproductive behaviour
The sex of the European lobster can be determined by the first pair of pleopods; in males they are hard/'boney' being modified for copulation (Hayward *et. al.* 1996) in the females they are soft/'feathery'. Lobsters breed once per year in the summer and newly berried females begin to appear from September to December (Pawson 1995). The females carry their eggs for 9 months in clumps attached to the pleopods which then hatch as planktonic larvae in spring and early summer (Hayward *et. al.* 1996). The larvae are pelagic for 3 weeks and undergo 3 moults before settling on the seabed (Pawson 1995). It is rare to see young lobsters, one theory is because they burrow in the soft sediments (Hayward *et. al.* 1996) another is that they inhabit rocky inshore ground (Pawson 1995).

Migratory behaviour
Lobsters have well developed walking legs and are also capable of swimming short distances; this is done by quickly flexing the abdomen which projects the lobster backwards. Capture and release studies of adult lobsters have been conducted around the English coast, including Selsey. Tags which were designed to persist through moulting were used and most lobsters were re-captured within 1 - 2 years (Pawson 1995). The results indicated that lobsters do not undertake regular migrations like many other decapods, instead they make small movements; this may be due to local competition for food or to change habitat which is necessary as their size increases (Pawson 1995). Thus the main dispersal potential of this species is likely to be during the planktonic larval phase.

Habitat
Adult lobsters live in holes in rocks or excavate soft material from beneath boulders to create deep tunnels (Hayward *et. al.* 1996). They can also be found inhabiting artificial habitats e.g. crevices in shipwrecks. Lobsters are most commonly present from the lower shore to a depth of 60m (Hayward & Ryland 1998) with individuals on offshore grounds generally being less abundant but larger (and thus more fecund) (Pawson 1995).

Predators and prey
It is commonly believed that the sheltering and nocturnal behaviour of the lobster is a predator avoidance tactic (Van der Meeren 2005). To support this research shows that

juvenile lobsters released on open sandy grounds suffer higher predation compared to those released on rocky shelter-providing ground (Van der Meeren 2005). Juvenile lobsters are preyed upon by a large variety of fish and crustaceans including; cod, wrasse, eels, flatfish, brown crabs, shore crabs and larger lobsters (Van der Meeren 2005). Adult lobsters are one of the largest marine invertebrates and are an unlikely prey item for most marine organisms because of their sheltering and nocturnal behaviour and their deterrent claws. Interestingly, research suggests that the size of the lobster's claws is disproportionate to the size of their prey and that rather than being adapted for foraging or predator defence, they may be more related to intra-specific competition for shelter, food and mates and as a warning indicator of power (Parker 1974).
Juvenile lobsters predate upon annelids, echinoderms and small molluscs (Van der Meeren 2005). The diet of an adult lobster is extended to include smaller lobsters, crabs and larger molluscs. The feeding rate of a lobster decreases with decreasing water temperature in conjunction with their metabolic rate slowing down.

Stock status (Carleton *et. al.* 2009)
No formal assessment of stock status is done. However, based on previous assessments and monitoring of catch records CEFAS concludes that the majority of lobster in the UK coastal waters are in a satisfactory state, with catch rates that are stable or increasing, and with no sign of imminent decline in the recruitment of young lobster into the stock. Local anecdotal evidence supports the claim that stocks are in reasonable shape.

The Sussex fishery
Fishing activity
The main fisheries for lobsters and brown crab within the Sussex IFCA district are based at the fishing stations of Selsey and Eastbourne. There is an all year round fishery for lobsters, however they are mostly targeted from spring to autumn. As the water temperature increases so does their metabolic rate, this increases their feeding rate and the attraction to the baited pots, thus it is during the warmer water months that higher catch rates are seen. Lobsters are nocturnal and it is during the night time they predominantly feed and thus find their way into pots and nets. Lobsters are sometimes caught with a soft shell, this occurs when they have just moulted and are generally unmarketable. Usually fishermen just return these individuals to the sea. Out of season, during the winter and into spring many parlour pot fishermen turn to whelking.

Dead and/or damaged lobsters are found in the pots; this has been attributed to fighting as lobsters are territorial and aggressive (and cannibalistic). It is usually the bigger individual that wins. A baited pot attracts all sizes of lobsters many of which are under the minimum legal size and must be returned to the sea. Small lobsters which are caught and discarded suffer in numerous ways; they may be damaged by larger lobsters whilst in the pot, they may be damaged during the hauling and sorting process and when they are returned to the sea they are vulnerable whilst in search for a new territory/habitat. To try and reduce this Sussex Sea Fisheries Committee and now the Sussex IFCA, provide 'lobster escape hatches' to the local fishing fleets. The hatch is a plastic square which is of the appropriate dimension to allow undersize lobsters to escape and is laced into the side of the parlour pot. This scheme reduces the number of undersize lobsters retained in the pots (thus reduces the mortality on this portion of the population) and it reduces the time it takes the fishermen to sort their catch (Clark 2007).

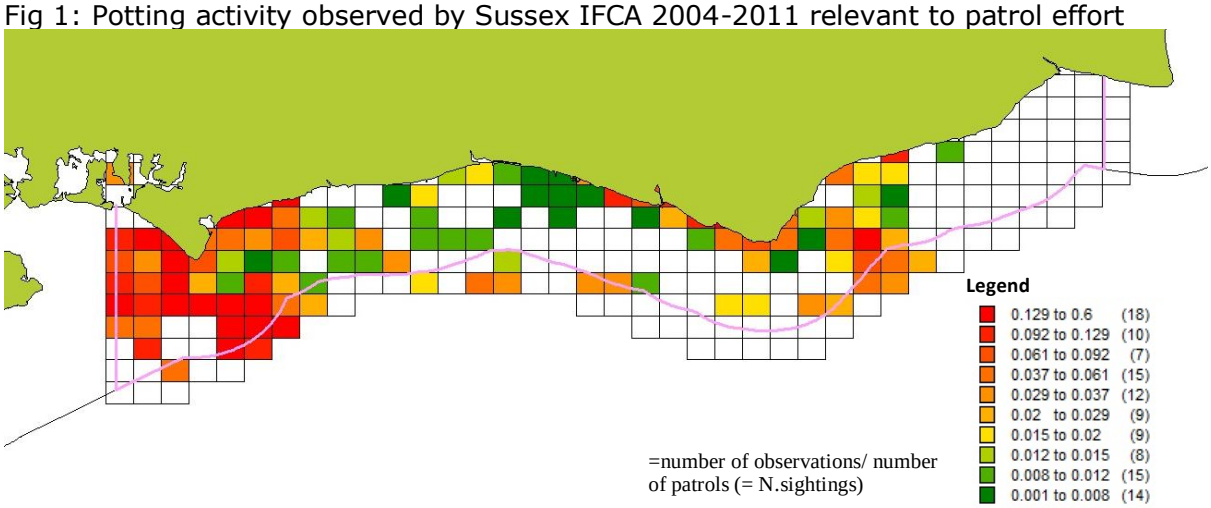
In static nets, lobsters are a particularly significant bycatch in the autumn when nets are often shot close inshore; this does not occur during the summer months (1st May – 30th September) due to the Sussex IFCA fixed engine byelaw.

Within the Sussex IFCA district lobsters are most commonly transported and sold live and so to prevent fighting and damage occurring their claws are immobilised using elastic bands. Several fisherman within the district use 'store-pots', these are a large cage-like devises left on the sea-bed in which they empty their the crabs and lobsters into and can store them for up to two weeks until they have a desirable quantity for their respective markets. The best market prices for lobsters and brown crabs are during the run up to Christmas when the festive demand is high.

Fishing methods
Within Sussex IFCA district lobsters are caught on a commercial and recreational basis. Predominantly they are caught commercially with parlour pots which are especially designed to retain lobsters. Lobsters are also a common bycatch in inkwell pots (mostly used to target brown crab and spider crab) however, these are less desirable as lobsters will quite easily escape through the entrance hole once the bait is used or becomes less desirable. Common bait used to attract lobsters is horse mackerel, scad, dogfish, gurnard and skate chog (the head, torso and tail remnants from skate winging). Typically parlour pots are worked in strings of 20 to 60 pots, with a spacing of 12 to 16 fathoms in between each pot. They are laid for 1 to 2 days, being hauled, emptied, re-baited and shot in succession. A common and valuable bycatch in parlour pots is brown crab. Lobsters are a valuable bycatch for static netters and are occasionally caught in trawls. Recreationally lobsters are taken by divers and snorkelers.

Pot fishery
Lobsters and crabs are targeted in pots. The Parlour pot is the most common method for targeting lobster within the District; these are fished in strings of up to twenty pots by the larger vessels and singularly by the smaller open boats. Inkwell pots are usually deployed for brown crab, which inshore are mostly to be found in the west of the District. A small number of boats set prawn pots to supply small local markets.

Spatial distribution of fishing activity
Potting for lobster and brown and brown crab predominantly occurs in the vicinity of Selsey Bill and to a lesser extent around Beachy Head (fig 1).
Fig 1: Potting activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



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Net profit margin (£)	28%	24%	19%

Vessels in the under 10m pot and trap segment in 2009 had an average of 2 crew members and employed 1,635 fishermen in the UK (Curtis & Brodie 2011). Lobster was the most important species to this segment in terms of value, accounting for 37% however lobsters only accounted for 9% of the volume of landings, in 2009 the average first sale value of this species was over £10,000 per tonne which makes it one of the highest value (£ per tonne) species in the UK. In contrast whelks accounted for 29% of the volume of landings but only 7% of the value.
Vessels in the 10m – 12m using pots and traps segment in 2009 had an average of 3 crew members and employed 513 fishermen (Curtis & Brodie 2011). Lobsters accounted for 5% of the volume of landings and 25% of value (Curtis & Brodie 2011).
Vessels in the over 12m pots and traps segment had an average of 5 crew members and employed 376 fishermen in 2009 (Curtis & Brodie 2011). Lobsters accounted for only 3% of the volume of landings but 20% of value (Curtis & Brodie 2011).

Local socioeconomics
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Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of lobsters landed by the method of potting* into Sussex ports. * *includes MMO method description 'other or mixed pots', 'parlour pots' and 'top opening pots'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£125,240	£355,816	£481,056	£42,977	£37,074	£80,051	£561,107
2008	£80,510	£149,149	£229,659	£54,096	£7,286	£61,382	£291,040
2009	£82,317	£251,222	£333,539	£67,634	£24,812	£92,446	£425,985
2010	£76,262	£341,362	£417,624	£64,591	£48,931	£113,522	£531,145
Grand Total	£364,328	£1,097,550	£1,461,878	£229,298	£118,102	£347,400	£1,809,278

Native/Flat/Common Oyster
Ostrea edulis (L.)

Species description
Ostrea edulis has an oval or pear-shaped shell with a rough, scaly surface which is off-white in colour (Hayward & Ryland 1998). The lower left valve is concave and fixed to the substratum, the right valve is flat and sits inside the left (MarLIN). The only commercial fishery for the native oyster in the Sussex IFCA district is in Chichester harbour. It is likely that the individuals found here are part of the larger Solent population which exists in our neighbouring Southern IFCA district.

Biology and ecology

Biological factor	
Size	Up to 100mm diameter (Hayward *et. al.* 1996)
Lifespan	10 years (max. 15 years) (MarLIN). The majority in a population is between 2 - 6 years old (Richardson *et. al.* 1993).
Size at reproductive maturity	Females 50mm shell length (MarLIN), males unknown
Age at reproductive maturity	3 years (MarLIN)
Fecundity	Up to 2,000,000 eggs from a large individual (MarLIN)
Larval phase	11 - 30 days (MarLIN)
Adult mobility	None: permanently attached

Reproductive behaviour
Oysters are protandrous alternating hermaphrodites; they start off as males producing sperm then switch to egg producing females then back to males and so on (MarLIN). They breed between May and August (Hayward *et. al.* 1996), this is in part temperature dependent with spawning peaking during the full moon periods (MarLIN). The eggs produced during the female stage are held in the gills and mantle cavity. The eggs are fertilized by sperm drawn in by the inhalant water flow used for feeding and respiration. The fertilized eggs are retained for 7-10 days whilst development to the veliger stage occurs (MarLIN). Following this there is a free swimming larval period with settlement taking place after 11-30 days (MarLIN). Growth is quite rapid for the first 1.5 years; it then remains constant at approximately 20 grams per year for five years, subsequently slowing down (MarLIN). Highest growth rates are seen between April and October (MarLIN).

Migratory behaviour
Adult native oysters are permanently attached to the substrate. The dispersal potential of this species is at the spawning stage (larval settling time 11-30 days (MarLIN)). The individuals in Chichester harbour are considered to be part of the wider Solent population thus interbreeding and cross settlement between Sussex and Southern IFCA districts is highly likely.

Habitat
Ostrea edulis is associated with highly productive estuarine and shallow coastal water habitats (MarLIN), up to depths of 80m (Hayward & Ryland 1998). They can be found on firm seabed's of mud, rock, muddy sand, muddy gravel with shells and hard silt (MarLIN). One of the most suitable settlement substrates (also known as 'cultch') for oyster larvae is natural oyster shells (*SCORE*). In exploited areas cultch can be created in the form waste shells and ropes.

Predators, prey and competitors
The native oyster feeds by the process known as filter feeding; pumping water through a filter in the gill chamber to remove suspended organic particles which are subsequently

ingested. They are preyed upon by a variety of species including starfish, the sting winkle/rough tingle (*Ocenebra erinacea*) and American oyster drill (*Urosalpinx cinerea*) which was accidentally introduced to the British Isles and feeds almost entirely on oyster spat (MarLIN). In addition the oyster faces serious competition from the slipper limpet (*Crepidula fornicata*) another introduced species from the U.S. The slipper limpet can occur in very high densities and competes with the native oyster for space and food whilst depositing pseudo faeces which forms 'mussel mud', this changes the substrate and hinders oyster settlement (MarLIN).

Stock status (Carleton *et. al.* 2009)
No formal stock assessment is currently available for the oyster population in Chichester harbour – or indeed elsewhere in the Sussex district. Some studies have been done on the regulated fishery in the Solent (Walker & Burnett 2008) which is believed to be all part of the same stock. These assessments have not been reviewed however it is likely that these will have to be undertaken routinely, and be directly applicable to the Chichester Harbour population – unless these becomes part of a wider Solent management unit.
Throughout much of the UK and in Europe generally the native oyster is in a severely depleted state in the wild and is on the OSPAR List of threatened and/or declining species and habitats, OSPAR agreement 2008-6 (Haelters & Kerckhof 2009). In order to address and potentially to reverse this situation *Ostrea edulis* was designated in the UK Biodiversity Action (BRIG 2007, *UKBAP*). There is a considerable body of data on the biology, ecology and distribution of *O. edulis* to inform restoration projects and restoration efforts and associated studies elsewhere have shown the potential for success of native oyster stock regeneration, especially in disease-free areas.

Chichester Harbour Oyster Partnership Initiative (CHOPI)
In 2010, the declining productivity of the Chichester Harbour oyster fishery instigated the formation of the Chichester Harbour Oyster Partnership Initiative (CHOPI), members include: the local oysters fishers, Chichester Harbour Conservancy (CHC) , Natural England (NE), Southern IFCA and the Sussex IFCA and is further supported by scientists from Southampton National Oceanographic Centre (NOC) and CEFAS, Lowestoft and the Environmental Health teams of Chichester District Council and Havant Borough Council. In November 2010, 2.3 tonnes of large native oysters were re-re-laid at 3 sites within Chichester Harbour, now known as the '2010/2011 broodstock sites', to boost recruitment potential and hopefully kick-start wider repopulation of the Harbour. The group is currently exploring a range of intervention measures (e.g. creation of broodstock sites and nursery sites) and regulatory management options which could ensure the future viability of the stock and sustainability of the fishery through the development a management plan.

The Sussex fishery
Fishing activity
There is only a small oyster fishery within the Sussex IFCA district; it exists within the confines of Chichester Harbour and is seasonal and diurnal. There are several reasons for this. Firstly Chichester Harbour is where oysters predominantly occur, secondly there is a local byelaw preventing oyster dredging in other areas of the district, thirdly there are seasonal restrictions to protect the oysters during their breeding season and finally there is a diurnal restriction to prevent night fishing. In addition to the public fishery there is currently a disputed claim to a small private fishery.

There are several other matters regarding the Chichester oyster fishery which should be considered. Firstly the location, Chichester harbour is of national and international importance for landscape and nature conservation and has a long list of protection

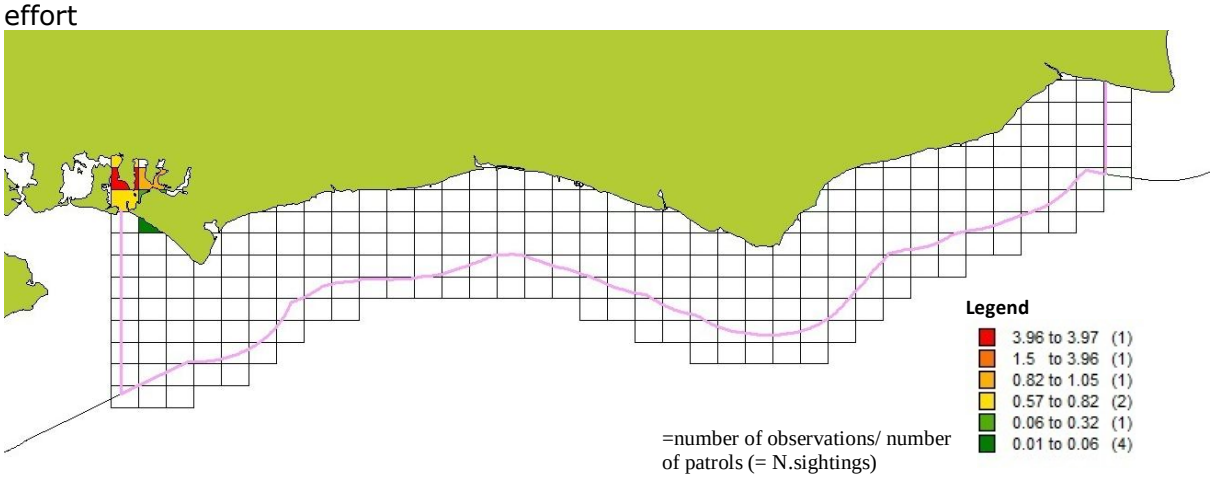
designations. These include; Amenity Area (Chichester Harbour Conservancy Act 1971), Special Area of Conservation (EU Habitats Directive), Ramsar (International Convention of Wetlands of International Importance), Special Protection Area (EU), Area of Outstanding Natural Beauty, a Site of Special Scientific Interest and several local nature reserves (the latter three being accredited by Natural England). Secondly, there are several directives relevant to all UK oyster fisheries which are designed to protect the health of the stocks and ensure that shellfish are safe for human consumption. These include the EU fish and shellfish health regime, Shellfish Hygiene Directive and monitoring for marine biotoxins.

Fishing methods
The oyster fishery in the Sussex IFCA district is solely commercial using specially designed dredges. The dredges used within the district are locally known as the Chichester Harbour oyster dredge and the Solent oyster dredge; they are similar in design but the Solent dredge is slightly heavier. Commonly two dredges are used, each on a single warp being hauled and shot at 10 minute intervals

Oyster dredge fishery
Oyster dredges have a fixed flat bar across the forward section of the dredge. This bar digs the oysters out of the seabed; they are then collected in a bag behind the bar. Oyster dredging in Sussex is typically associated with fishing vessels less than 10m. One or two oyster dredges are typically towed from the stern of the vessel. There is limited commercial bycatch associated with this fishery, though clams are also sometimes caught.

Spatial distribution of fishing activity
In the Sussex District oyster dredging is exclusively conducted inside Chichester Harbour (fig 1).

Fig 1: Oyster dredging activity observed by Sussex IFCA 2004-2011 relevant to patrol effort



Economic survey of the UK fishing fleet
The *2009 Economic Survey of the UK Fishing Fleet* (Curtis & Brodie 2011) provides a detailed insight into the financial and operational performance of the UK fishing fleet during 2009.

Table 1: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Other mobile gear <10m
Number of vessels	94
Average Fishing Income (£)	51,658
Average days at sea	71
Average income per day (£)	1,038
Annual operating costs	data not available
Operating costs as a % of income	data not available
Fuel costs as a % of income	data not available
Operating Profit (£)	data not available
Operating Profit Margin (£)	data not available
Net profit margin (£)	data not available

Vessels in the under 10m other mobile gear segment have an average of 2 crew members in the UK in 2009 and employed 180 fishermen in total (Curtis & Brodie 2011). The native oyster accounted for 2% of the value of the catch composition of this segment (Curtis & Brodie 2011).

Local socioeconomics

The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of native oyster landed by the method of oyster dredging* into Sussex ports. * *includes MMO method description 'unspecified dredge'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£0	£0	£0	£3,529	£30,613	£34,142	£34,142
2008	£0	£0	£0	£3,696	£11,041	£14,737	£14,737
2009	£0	£0	£0	£4,281	£13,050	£17,331	£17,331
2010	£0	£0	£0		£4,345	£4,345	£4,345
Grand Total	£0	£0	£0	£11,506	£59,049	£70,555	£70,555

Great Scallop
Pecten maximus (L.)

Species description
The great scallop, *Pecten maximus* is a bivalve mollusc (it has a shell consisting of two valves). The lower right valve is convex and off-white in colour whilst the upper left valve is flat and reddish-brown. It is has many common names including the great scallop, the king scallop, the giant scallop, escallop and Coquille St. Jacques.

Biology and ecology

Biological factor	
Size	Most <150mm shell width (Hayward *et. al.* 1996) but up to 210mm shell width (Mason 1983)
Lifespan	20 years (Hayward *et. al.* 1996, MarLIN)
Size at reproductive maturity	Minimum 60mm (MarLIN)
Age at reproductive maturity	Full maturity 3 - 5 years (MarLIN)
Fecundity	15 - 21 million oocytes per emission for a 3 years old (Le Pennec *et. al.* 2003)
Larval phase	11 - 30 days (MarLIN)
Adult mobility	Limited swimming mobility (benthic)

Reproductive behaviour
The great scallop is a hermaphrodite, fertilization is external and either sperm or eggs may be exuded first (Mason 1983). Temporal gonad studies indicate there may be a bi-modal spawning pattern with partial spawning in the spring (April or May) and then further spawning in the autumn (late August) (Mason 1983), however some studies have hypothesized that a part of the decrease in gonad contents in the autumn may be attributed to re-absorption. Following fertilisation a planktotrophic veliger larva develops, this stage is free living and subject to water transport. Within 30 days the veliger will settle from the water column and attach by the form of byssal thread to a suitable substrate. Young scallops generally remain attached until they are between 4 - 13 mm in length (Fish & Fish 1996). Then detaching and settling on the seabed.

Migratory behaviour
The great scallop is capable of 'swimming' and 'jumping' however research indicates that these movements are small and localised (Hartnoll 1967) and that this behaviour is generally exhibited as an escape reaction. Swimming is achieved by rapidly 'clapping' the valves and expelling the water on either side of the dorsal hinge so that the scallop moves with the curved edge of the shell foremost (Thomas & Gruffydd 1971). Jumping is achieved through the gradual relaxation of the adductor muscle followed by the rapid opening and closing of valves, which jumps the scallop hinge forward (Thomas & Gruffydd 1971). It is generally believed that adult scallops do not migrate and they will only move if disturbed, instead they rely on larval dispersal for distribution and consequently are affected by local hydrographic regimes. Estimates of how far the larvae may travel range from 10 - 40km (MarLIN). It is therefore possible that recruitment to one scallop bed may actually be supported by another scallop bed some distance away; it is also possible that a scallop bed may be self-sustaining, depending on the hydrographics (there is scientific evidence for both scenarios) (Brand 1991, MarLIN).

Habitat
The great scallop is found offshore to a depth of 100m (Hayward & Ryland 1998), normally on a seabed of fine sand and gravel where it lies recessed in slight hollows.

Recessing is achieved through a series of powerful adductions (valve closures) where water is ejected from the mantle cavity and lifts the shell at an angle to the seabed so that subsequent water jets blow a hollow into the sediment (Brand 1991). The great scallop has an aggregated distribution within their geographic range which is most likely due to the hydrography as they are dispersed as larvae and the availability of suitable settlement substrate. Major fishing grounds are generally widely separated, so much so, that respective environmental conditions produce marked differences in population parameters (Brand 1991).

Predators and prey
The great scallop feeds by filter feeding; pumping water through a filter in the gill chamber to remove particulate organic matter and phytoplankton (MarLIN). Predators of the great scallop include a range of starfish, commonly *Asterias rubens*, large crabs and cephalopods. Scallops posses primitive 'eyes' and on detection of a change in light caused by a shadow or a movement a scallop may swim, re-orientate itself or close its shell in response (Wilkens 1991). Research also suggests they may 'smell/taste' danger. Experimental contact with different starfish species elicited distinct, energy adaptive types of response; full swimming response was initiated only by extracts of *Asterias rubens* and *Astropecten irregularis* which prey on molluscs, while limited jumping or valve-closing responses were induced by non-predatory starfish (Thomas & Gruffydd 1971).

Stock status (Carleton *et. al.* 2009)
There is no stock assessment carried out on scallops. Local anecdotal evidence suggests that stock and fishing mortality are stable, however there is no absolute or routine measure of this, and there is certainly no awareness of where stocks are relative to reference points. It is therefore unclear whether or not a rebuilding program is necessary (probably unlikely but stronger evidence base needed). As a result there is no clearly defined harvest control rule, stating what management actions will be taken based on routine monitoring and it cannot therefore be stated that exploitation rates would be reduced in event of decline in stock status.

The Sussex fishery
Fishing activity
The scallop fishery within the Sussex IFCA district is predominantly east of Brighton. No scallop dredging occurs within 3 nautical miles of the shoreline nor during their spawning period which makes it a winter and spring fishery, this is because of local Sussex IFCA byelaws. The best price for scallops is obtained when the gonad/roe is in good condition; typically this is better in the winter fishing months. Fishing activity for scallops occurs equally during daylight and night time.

Fishing methods
The scallop fishery in the Sussex IFCA district is solely commercial using a specific dredge type; the 'spring-loaded Newhaven dredge', this is the only type of dredge permitted within the district. It was originally designed in Newhaven but is now used throughout the British Isles. Typically the inshore trawlers within the district alternate between beam trawling, otter trawling and scallop dredging depending on the time of year and economics. The duration of a scallop fishing trip will typically be between one day and one week depending on the size and storage capacity of the individual vessel. Under chilled conditions scallops can stay alive for a week. At present there are no established SCUBA diving activities that target scallops commercially within the Sussex IFCA district.

Scallop Dredge Fishery

A Newhaven type scallop dredge is the only scallop dredge permitted for use in the Sussex District. It consists of a steel frame to which a 'belly' of heavy steel rings is connected; the back of the dredge is made of trawl mesh and lightly constructed steel rings. Forward are the high tensile spring-loaded teeth, these teeth make contact with the seabed and rake the scallops into the dredge.

Off the Sussex coast between 4 and 14 dredges aside are used and some of the smaller vessels tow dredges astern working the dredges across the transom of the vessel. The ability of vessels to keep dredges on the seabed is effected by weather and tide. Heavy bars increase the seabed keeping ability. But smaller vessels are heavily restricted to the weather that they can work. There is limited commercial bycatch associated with this fishing method but there can be significant non commercial discards.

Spatial distribution of fishing activity

Scallop dredging is an activity which is generally engaged by larger (>10m vessel length) vessels due to the engine capacity required to tow this heavy fishing gear. Due to a vessel length restriction by a Sussex IFCA byelaw, vessels >14m in length are prohibited from fishing within 6nm and a further byelaw prohibits scallop dredging by any vessel within 3nm of the shore line, thus this practice mostly occurs further offshore, however, there is some activity within the 3 to 6nm by 10-14m vessels most commonly within the vicinity of Beachy Head and Rye (fig 1).

Fig 1: Scallop dredging observed by Sussex IFCA 2004-2011 relevant to patrol effort

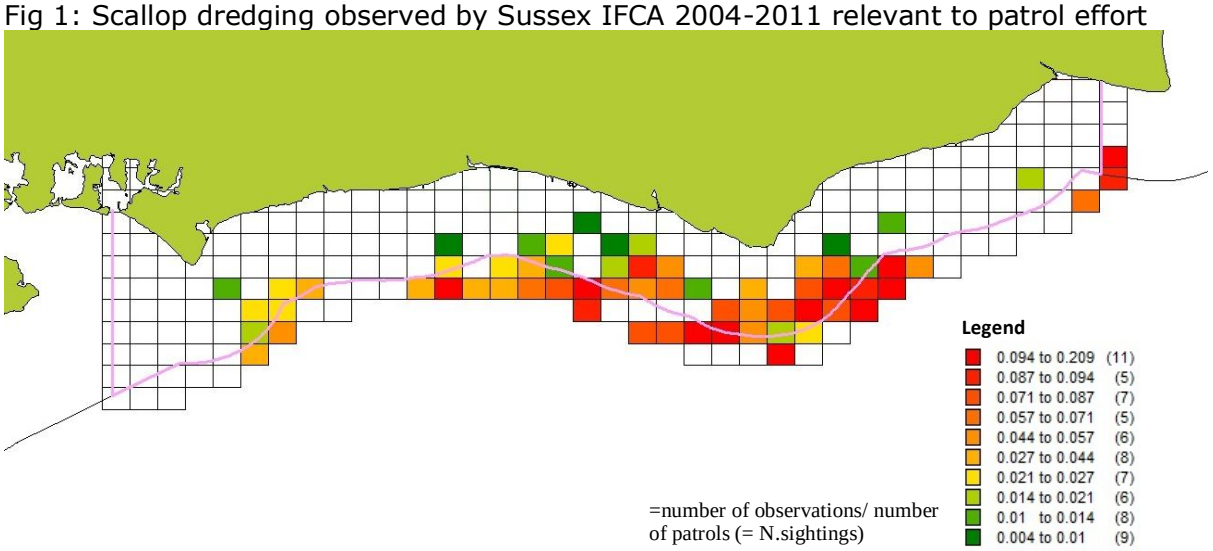


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Table 1: Average financial and operational performance values per UK fishing vessel by Seafish segment (Seafish fleet segmentation groups together vessels of comparable characteristics so that it is easier to make sense of the fleet overall. Each segment of vessels has criteria that define which vessels are included, Curtis & Brodie 2011).

Seafish Segment	Other mobile gear <10m	ICES Area VII Scallop Dredge
Number of vessels	94	54
Average Fishing Income (£)	51,658	434,402
Average days at sea	71	177
Average income per day (£)	1,038	2,078
Annual operating costs	data not available	349,133
Operating costs as a % of income	data not available	79%
Fuel costs as a % of income	data not available	13%
Operating Profit (£)	data not available	95,271
Operating Profit Margin (£)	data not available	21%
Net profit margin (£)	data not available	15%

Vessels in the under 10m other mobile gear segment have an average of 2 crew members in the UK in 2009 and employed 180 fishermen in total (Curtis & Brodie 2011). The great scallop was the most important species to this segment in terms of both value; 53% and volume; 49%. This segment's average price for great scallop was well above the UK fleet average price for this species; approximately £2,800 per tonne versus £1,600 per tonne respectively (Curtis & Brodie 2011).
Vessels in the ICES Area VII scallop dredge segment have an average of 4 crew members in the UK in 2009 and employed 217 fishermen; the average vessel length of this segment was 19m (Curtis & Brodie 2011). As one would expect, the great scallop dominates the catch in this sector accounting for 88% of the volume and 91% of the value (Curtis & Brodie 2011).

Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of great scallops landed by the method of scallop dredging* into Sussex ports. * *includes MMO method description 'unspecified dredge' only*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£678,075	£66,029	£744,104	£239,799	£176,340	£416,139	£1,160,243
2008	£603,099	£92,323	£695,422	£400,500	£173,596	£574,096	£1,269,518
2009	£373,191	£8,316	£381,507	£822,472	£97,408	£919,880	£1,301,387
2010	£673,297	£6,392	£679,690	£1,236,564	£75,508	£1,312,072	£1,991,762
Grand Total	£2,327,662	£173,060	£2,500,723	£2,699,335	£522,852	£3,222,187	£5,722,910

Common Whelk
Buccinum undatum (L.)

Species description
The common whelk *Buccinum undatum* is a relatively large gastropod mollusc with a tall spired shell. The body of the animal is yellowish white, flecked with black and it is a popular sea food in countries around the Southern North Sea. It is common on all British coasts.

Biology and ecology

Biological factor	
Size	Up to 110mm shell length x 68mm shell width (Hayward & Ryland 1998)
Lifespan	10 years (Hancock 1967)
Size at reproductive maturity	60mm shell height for 50% maturity; 90mm shell height for 100% maturity (estimate for males from a Worthing fishing ground*). In the vicinity of Whitstable individuals spawn from 50mm in shell height (Hancock 1967).
Age at reproductive maturity	In the vicinity of Whitstable individuals spawn from 2-3 years of age (Hancock 1967). The age of reproductive maturity has not been confirmed for the Sussex district but could possibly as late as 7 years old*.
Fecundity	Up to 2,000 capsules (Irving 1998). Each capsule may contain up to 3,000 eggs (Hancock 1967) but an average of only 13-14 individuals hatches from each capsule (Hancock 1967).
Larval phase	Within the egg capsule, no planktonic phase
Adult mobility	Limited crawler: up to 20cm per min* (benthic)

* personal communication 02/12/08 Dr. Peter Walker, CEFAS, Lowestoft, England. There is currently an on-going study by CEFAS and Sussex SFC/Sussex IFCA as part of the Fisheries Science Partnership (FSP) programme investigating the biology and populations of whelks in Sussex (Lawler & Vause 2009).

Reproductive behaviour
The sexes of the common whelk are separate and reproduction occurs by internal fertilization in late autumn (Hancock 1967). Once mating has occurred the females often gather in a group and lay their eggs together (Hancock 1967). Spawning in many creatures is triggered by an increase in temperature however, the trigger for the whelk is believed to be a temperature decrease; when the water falls below 9ºC, thus the females begin to lay their eggs around the month of November (Hancock 1967), this may continue until April (pers. comms. Dr. Peter Walker.). The females lay their eggs in lens-shaped capsules which are stuck together in a sponge-like mass, commonly known as a 'sea wash ball' (Irving 1998). Up to 2,000 capsules may be laid by a female (Irving 1998) and estimates vary on how many eggs each capsule contains from up to 1,000 (Irving 1998) to up to 3,000 eggs (Hancock 1967). Only a small proportion of the eggs will develop, on average 13 to 14 individuals will hatch from each capsule, the remainder being used as a food source by the developing embryo's (Hancock 1967). The juveniles hatch from the egg cluster as a fully formed whelk mostly during February and March and immediately take to the benthic environment (Hancock 1967), there is no planktonic stage, and thus dispersal potential of this species is very low.

Migratory behaviour
There is no evidence to suggest that adult whelks perform any significant migrations and it is likely that their total movement is very limited (Hancock 1967). The adults are incapable of travelling long distances and there is no larval planktonic phase in their life

cycle; these two factors significantly limit their potential dispersal. Thus, it is very likely that the whelks in the Sussex IFCA district will spend their entire life-span in a local area within the district.

Habitat
This species of whelk can occasionally be found at the low water mark on spring tides but it is much more common in the sublittoral zone to the continental shelf edge (as deep as 1200m) (Hayward & Ryland 1998). They live on a wide variety of hard and soft substrates including; rock, cobbles, gravel, coarse sand and muddy sand. On the softer sediments they spend some of their time burrowed in the surface layers of the seabed with only their siphon protruding (Hancock 1967).

Predators and prey
Whelks are carnivorous predators and scavengers often using scent to locate food and can travel in search of food for several hundred metres (Marine Ecological Surveys Ltd.). They commonly feed on tube-dwelling polychaetes such as *Lanice conchilega*, bivalves (commonly cockles) and carrion (Hancock 1967, Hayward *et. al.* 1996). Research shows that whelks attack cockles by using their foot to asphyxiate the cockle or by using the lip of its own shell to push the shell valves apart (Hancock 1967, Scolding *et. al.* 2007). The whole process of opening and eating a cockle can take less than 1 hour (Hancock 1967); unlike some similar species the common whelk cannot drill into the shell of its prey as it lacks a pedal boring organ (Hayward *et. al.* 1996). Laboratory experiments on the diet of whelks revealed the maximum feeding rate; of 2 cockles per whelk per week; to occur during the spring, incidentally this is when maximum growth occurs (Hancock 1960). These experiments also showed oysters not to be a food of preference (Hancock 1960). Adult whelks are a prey item for a range of species including cod, dogfish, crabs (Hancock 1967), rays, flatfish and starfish. Predators of whelk eggs include sea urchins and starfish. It should be noted here that the empty shells of whelks are often inhabited by hermit crabs and such shells are an integral part of a hermit crabs life (note, hermit crabs are not a predator of the whelk).

Stock status
No formal stock assessment currently available (Carleton *et. al.* 2009).

Current whelk research
Fisheries Science Partnership 2009/2010: The main objectives of this project were to investigate the population structure of whelks within the inshore static-gear fishery of both the Selsey and Eastbourne areas of the eastern English Channel; to trial a mark–recapture experiment in both areas to ascertain the potential of the methodology to determine the exploitation rate and the population size (Lawler & Vause 2009); and to design and initiate a monthly maturity sampling programme to determine the size at sexual maturity and the seasonality of the reproductive cycle (in progress). This research will be extended nationally during 2012 in the DEFRA Science and Research Project MF0231: Determination of the size at maturity of the whelk *Buccinum undatum* in English waters.
http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=2&ProjectID=17916

The Sussex fishery
The long life-span and lack of population mobility i.e. absence of planktonic larval phase and limited mobility of the adults, makes the common whelk vulnerable; should over-fishing occur the population is likely to take a long time to recover.

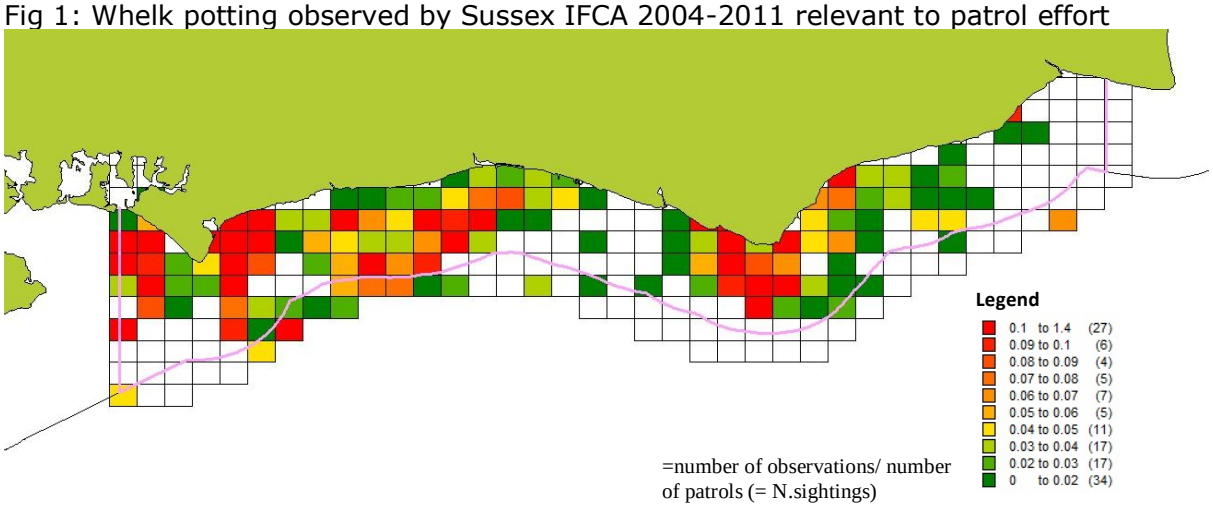
Fishing activity
Whelks are fished all year round generally on 'softer' ground; the extensive gravel deposits found in the eastern channel provide the ideal substratum. The highest catch rates of whelks are seen between February and April; this coincides with when the whelks are most actively feeding (Hancock 1967). In the autumn lower catch rates are seen, this is probably due to two factors; there will be increased disturbance of the pots on the sea bed due to the poorer weather conditions and at this time the whelks are breeding and thus feeding activity is likely to decrease.

Fishing methods
Fishing for whelks within the Sussex district only occurs at a commercial level. When whelks are the target species whelk pots are used, a very small portion is also taken as bycatch in fixed gear.

Whelk pot fishery
The most common whelks pots used in Sussex are reclaimed 25l plastic containers that are weighted at one end with concrete. The pots are shot in strings in a similar fashion to lobster pots. Whelks are attracted into the pot by the scent of bait; the most common bait used in Sussex is dogfish, brown crab and spider crab. It is common for the pots to be left at sea permanently and hauled on a 1 to 3 day basis. If the pots are left for several days and the bait is used up catches decrease.

Spatial distribution of fishing activity
Within Sussex whelk potting is most common within 3-4nm of the shore from Selsey Bill to Brighton and from Beach Head to Hastings (fig 1)

Fig 1: Whelk potting observed by Sussex IFCA 2004-2011 relevant to patrol effort



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Seafish Segment	Pots and Traps <10m	Pots and Traps 10-12m	Pots and Traps >12m
Number of vessels	991	177	83
Average Fishing Income (£)	44,248	93,707	248,017
Average days at sea	113	167	179
Average income per day (£)	474	602	1,252
Annual operating costs	28,566	60,819	222,009
Operating costs as a % of income	61%	64%	77%
Fuel costs as a % of income	12%	9%	14%
Operating Profit (£)	18,297	34,225	68,049
Operating Profit Margin (£)	39%	36%	23%
Net profit margin (£)	28%	24%	19%

Vessels in the under 10m pot and trap segment in 2009 had an average of 2 crew members and employed 1,635 fishermen in the UK (Curtis & Brodie 2011). Whelks accounted for 29% of the volume of landings, the second highest (after brown crab) caught by this segment but only 7% of value (Curtis & Brodie 2011).
Vessels in the 10m – 12m using pots and traps segment in 2009 had an average of 3 crew members and employed 513 fishermen (Curtis & Brodie 2011). Whelks accounted for 33% of the volume of landings, the second highest (after brown crab) caught by this segment, but only 9% of value (Curtis & Brodie 2011).
Vessels in the over 12m pots and traps segment had an average of 5 crew members and employed 376 fishermen in 2009 (Curtis & Brodie 2011). Whelks accounted for only 24% of the volume of landings and 11% of value (Curtis & Brodie 2011).

Local socioeconomics
The Registration of Buyers and Sellers (RBS) Scheme has been fully operational in England since 2005 under *The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 (England),* this scheme is managed by the Marine Management Organisation (MMO). The legislation requires that all buyers and sellers of first sale fish are registered and that all auction sites of first sale fish are designated. One of the purposes of the RBS Scheme is to improve the monitoring and control of landings of fish. The RBS scheme uses the ICES rectangle spatial denominations (see appendix 1) and the information recorded includes; length group (vessels over 10m or under 10m (U10m)), fishing gear type, species, weight and value.

Table 2: The Marine Management Organisations registration of buyers and sellers records of the total annual value of whelks landed by the method of relevant static methods, mostly whelk potting* into Sussex ports. * *includes MMO method description 'gill net (not 52 or 53)', 'gill net (tangle)', 'gill net (trammel)', 'other or mixed pots', 'top opening pots', ' unspecified gill net' and 'whelk pots'*

ICES rectangle	30E9			30F0			Grand Total
Vessel length	Over 10m	U10m	Total	Over 10m	U10m	Total	
2007	£356,769	£622,506	£979,275	£302,933	£263,875	£566,808	£1,546,083
2008	£235,688	£475,870	£711,558	£145,296	£325,851	£471,147	£1,182,705
2009	£126,510	£597,067	£723,577	£39,168	£107,796	£146,964	£870,541
2010	£214,565	£722,881	£937,446	£95,079	£230,275	£325,355	£1,262,801
Grand Total	£933,532	£2,418,324	£3,351,856	£582,476	£927,798	£1,510,274	£4,862,129

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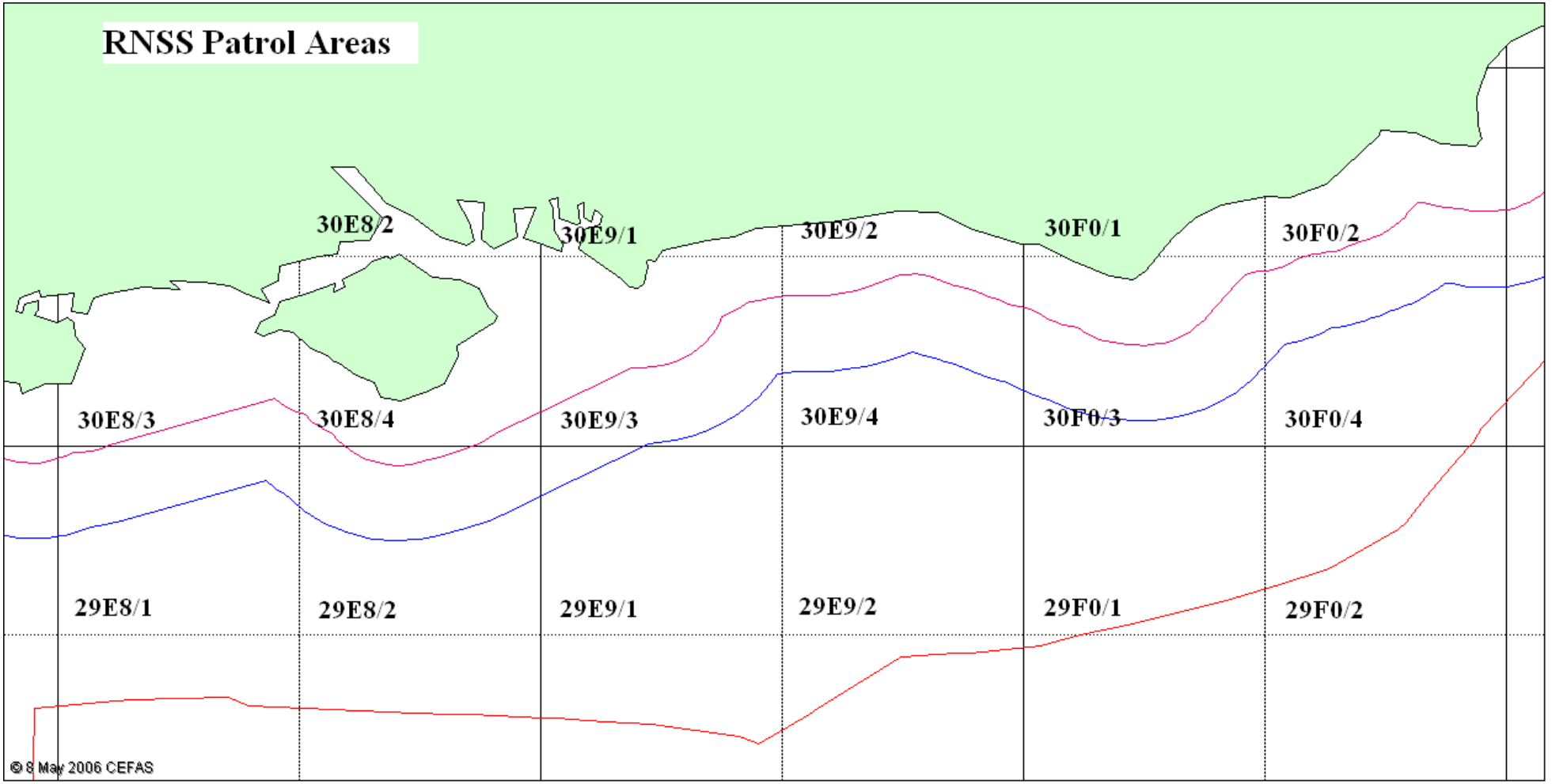
Appendix 1: ICES statistical rectangles for the Sussex IFCA district



Appendix 2

EXECUTIVE SUMMARY

Background

Existing information about the economic characterises of sea angling in England and Wales is sparse. This study was established to provide more detailed economic information on sea anglers and sea angling in England and Wales. Specifically it was set up principally to identify the important local centres for sea angling, its economic contribution both nationally and more locally, and the value of the experience to anglers.

Methods

Information was obtained from a number of surveys, the main ones being:

- Household Omnibus survey, in order to estimate the number of people engaged in sea angling in England and Wales (10,200 households interviewed);
- Angler survey, in order to understand better their activities; the utility associated with the activity and their expenditure patterns (900 anglers surveyed, partly face-to-face and partly by postal survey of members of angling clubs); and
- Business survey of suppliers to sea anglers in order to estimate the impacts on employment and incomes from anglers' expenditure (130 businesses surveyed).

We also took four contrasting case study locations – Weymouth, Whitby, Hastings and Anglesey – in order to estimate the impact of sea anglers' expenditures on the local economies. The business surveys were concentrated in these areas.

Location, participation and activity

Sea angling is practised all around the coast of England and Wales. The wide ranging geological makeup of the coastline with its rivers, estuaries and sheltered ports, along with the differing seas and currents provides a huge and diverse range of options for sea anglers. The south western and western shores are affected by the warm Gulf Stream, whilst the English Channel to the south and the cooler North Sea on the eastern coast, all have the potential to provide a large number of species for the sea angler to catch. These are ideal elements, whether sea angling be carried out from charter boat, own boat or from beach or rocky shore.

The household survey indicated that 1.1m households contain at least one member who had been sea angling in the past year. Participation is greatest in the northeast of England, south of England, and Wales. 54% of sea anglers fish mainly from the shore, 23% from private boast and 22% from charter boats. The mean number of days angling per household per year was 11.3 days but 24% indicated that they fished on only one day in the last year. Some dedicated people fish most days. Shore anglers fished more often (13.6 days) than charter boat anglers(4.96 days) or own boat anglers(12.41 days).

Participation is spread across all social classes with 6% of AB households having a fishing member as compared with 5% in C1C2 and 4% in DE. AB households fish less (9.1 days per year) and use boats more (only 41% are shore anglers) as compared with DE where 59% are shore anglers but they fish on average 15.7 days per year.

We obtained more detailed information on the activities of sea anglers from face-to-face and postal surveys. It is important to note that face-to-face interviews are biased toward the more active angler because their chance of being interviewed is higher. In these interviews, shore anglers fished for 65 days per year on average, charter boat anglers for 31 days, and own boat anglers for 47 days. In the aggregation of economic data we accounted for different activity levels by converting all data to a per day basis.

Most anglers are male (96.7%) and had been fishing for 25.7 years on average. 55% of anglers had incomes in the £10,000-£30,000 range. but 17% had incomes exceeding £40,000. Anglers catch, on average, between 5 (shore anglers) and 13 (boat anglers) fish per trip and retain 32-39% of their catch. Most anglers had observed a trend decline in the number of fish caught and their size. This was more marked over a 15-year period but there was still a decline over the last five years.

Fifteen percent of respondents had been sea angling outside England and Wales in the last year. Anecdotal evidence from the surveys indicated a growth in sea angling tourism by UK nationals (to the Channel islands, Ireland, USA, Africa) where fishing opportunities were better. At the margin there was some substitution of this for domestic sea angling but we were unable to quantify the scale of this trend. There was also evidence of a growth in sea angling as a corporate 'leisure' activity.

Value of the experience to anglers

The great majority of those interviewed perceived a positive benefit to their health from sea angling. Anecdotal evidence from the surveys suggested that this was related to the sense of relaxation and peace of mind that angling engendered.

Consumer surplus benefits from sea angling were found to be considerable. Consumer surplus (mean value) on existing annual sea angling activity varied from £381 per shore angler to £886 per own boat angler. When aggregated over sea fishing trips for the whole country the annual aggregate net benefit based on the mean consumer surplus estimates was £594 million.

The consumer surplus per angling day was found to be between £68 and £105 using the travel cost method (TCM). The basic TCM estimated an average consumer surplus of £26 per day per shore angler, £42 per day per charter boat angler, and £104 per day per own boat angler. An annual aggregate value can be obtained by multiplying each day consumer surplus value by their respective numbers of households and by the respective number of sea angling days (13.62; 4.96; 12.41) of these households from the Omnibus survey described in Section 3. This

produces an aggregate consumer surplus value of £216 million for shore anglers; £50 million for charter boat anglers; and £336 million for own boat anglers; that is: £602 million in total.

The total value of the angling experience can be measured by summing the actual expenditures per day and the estimates of surplus[1]. *Using the full range of estimates*, we derived a total value for the angling experience of between £600m and £1,300m per year (see Table below right hand column).

Total value of sea angling

	Expenditure per day angling mean (£/day)	Surplus (range of estimates) (£/day)	Total value (£/day)	Number of house-holds (m)	Days angling (mean per household per year)	Total value (£m)
Shore	21.6	5.7-35.5	27-57	0.61	13.62	224-473
Charter boat	67.7	18.4-90.9	86-159	0.24	4.96	102-189
Own boat	87.9	14.3-108.7	102-197	0.26	12.41	329-635

The choice experiments (CE) estimated the values associated with changes in the diversity and quality of the angling experience. The results indicated positive benefits from an improvement in the angling experience (as measured by fish size and diversity), but benefits from increasing the numbers caught were less clear-cut. All types of angler were wiling to pay more for larger fish (£0.22 per 1% increase in size) and for greater diversity in the catch (£11.38 to catch different species from those usually caught). However, only shore anglers were willing to pay for more fish (£0.81 per extra fish caught). Boat anglers had a negative valuation for more fish.

It may be that the skill of boat owners to find stocks (especially those using more powerful charter boats) has reduced the impacts of any loss of total stocks. The satisfaction of boat users is now more concentrated on fish size and ability to target species. Shore anglers have limited options for responding to reduce stocks and the CE results suggest that marginal utility for catch is positive and that an improvement in fish stocks would deliver benefits to this group.

The economic contribution of recreational sea angling in England and Wales

The total expenditure by anglers resident in England and Wales was estimated as £538m per year from 12.7m angler days of activity (see Table below). Around half of the expenditure (52%) was by own boat anglers and reflects the importance of capital expenditures on boats and

[1] We assume that the market value of any fish retained is embedded within the surplus estimate.

equipment. Shore anglers were the next most important group (37% of the total expenditure). In terms of first round impacts on the spending translates into 18,889 jobs and £71m in suppliers' income. Multiplier effects were not measured.

National level impacts of sea angler expenditures

	No of house-holds (m)	Days angling (mean per household per year)	Expenditure per household per year (£, mean)	Aggregate expenditure per year (£m)	Employment supported (FTE)*	Income generated (£m)*
Shore	0.61	13.62	295	178	5,652	19.1
Charter boat	0.24	4.96	336	82	3,092	9.0
Own boat	0.26	12.41	1,091	278	10,145	43.3
Total	**1.10**	**30.99**	**1,722**	**538**	**18,889**	**71.4**

Note *first round impacts only

Angling expenditure by visitors (travelling more than 50 miles from home) was £192m (35% of the total). It emphasises the fact that residents not travelling far from home undertake most sea angling. It compares with a total tourism expenditure by UK residents in England and Wales of £22,331m (UKTS, 2002). Angling spending by visitors was just under 1% of total tourism spending.

Conclusions on the contribution of sea angling to the national economy have to be made with care. Cessation of the activity would not result in the loss of 18,890 jobs. Expenditure would be displaced into other directions with corresponding benefits to employment and income. Similarly any comparison of the economic characteristics of sea angling with those of commercial fishing is potentially open to misinterpretation. They represent quite different types of economic activity (a consumer activity by sea anglers, and a natural resource harvesting activity combined with processing, by commercial fishing).

Case studies and local economic impacts

The four case studies illustrated different evolutions of sea angling over time and different contributions of sea angling to local economies. The main factors explaining differences between locations and change over time have been the reliability of obtaining a satisfactory catch and the range of facilities available to support angling. Weymouth was the most competitive location, and angling generated 119 first round jobs. Much of the spend was by local residents, and the contribution on the context of the whole local economy is significant but small. With knock-on effects, it might reach 0.6% of the total 25,900 workforce in the district (Gray, 2003). General tourism is clearly much more important to Weymouth since 38% of employees are employed in distribution, hotels and restaurants.

Whitby and Hastings have been more severely affected by a lack of catch with corresponding negative effects for sea angling and expenditures. Angling on Anglesey supports 46 jobs. Visiting anglers and charter boat operations making an important contribution.

To some extent anglers had adapted as best they can to reduction in stocks by selecting different locations, with own boat and charter anglers using their mobility and skills to search more widely for available stocks. There is a trend towards more powerful, better equipped, charter boats in order to increase the available fishing area and provide a more professional service. Lack of fish was clearly having a negative impact on utility and expenditure in some locations, whereas in others (e.g. Weymouth) this was less obvious.

Side effects of sea angling

Sea angling is now enjoyed across a wide spectrum of social classes throughout the country. Participation rates are highest in the southwest, southeast, northeast and Wales. A broad mix of social classes now pursues sea angling. Participation rates are slightly higher in the AB class (5.6% of households) and C1C2 (5.4%) than DE (4.0%). This compares with 1970 when 40% of sea anglers were skilled manual (C2). Boat activity is higher amongst the AB classes.

Key trends in the sector

The identification of trends through comparison of this study with others is not straightforward because of the different survey methods used. Our survey indicated a population of 1.11m households with at least one sea angler, i.e. an adult population of at least 1.11m. The evidence suggests a stabilisation and possible increase in the sea angling population since the early 1990's.

Activity levels appear to have stabilised in the last decade. In 1970 sea anglers fished on average 36 times a year. This fell to 12 times in 1992 (Dunn and Potten, 1994) and our mean was 11.3. However, there is some variation between types of angling with shore anglers most active (13.62 days per year) and charter boat anglers least active (4.96 days per year).

Seventy-one percent of anglers perceived a decrease in numbers caught over the last 5 years, and 62% a decrease in fish size. To some extent anglers have adapted to changing conditions by switching locations, travelling further and using more powerful boats to extend their search.

Future prospects for the sector

Future prospects for the sector depend mainly on demand, fish stocks and facilities. There appears to be a stable or possibly increasing demand for sea angling with higher income groups being more prominent. Projection of the current trends indicates an increasing use of private and charter boats. There is some evidence of increasing corporate involvement in charter boat angling.

Growth in the sector in England and Wales may be inhibited by lack of fish or poor fish quality. At a national level it is not clear to what extent activity is being constrained by available stocks. The value placed on additional fish caught was negative for boat anglers but positive for shore anglers. This indicates that an increase in the numbers caught would provide benefits only to shore anglers. In some regions all types of angling are limited by low stocks.

In some port locations growth in boat angling is limited by port size and facilities. Yachting is the main competitor for port space over much of the south and west coats. There does not appear to be any real physical limit on shore angling but these anglers are the most vulnerable to any deterioration in fish numbers.

Overall, the prospects appear reasonably stable, but with considerable regional variation, and vulnerability to an increased switching of activity to locations outside England and Wales.