

**Final Report**

***Programme 15: Eastern Channel Cod***

Prepared by:

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*Cefas, Lowestoft*

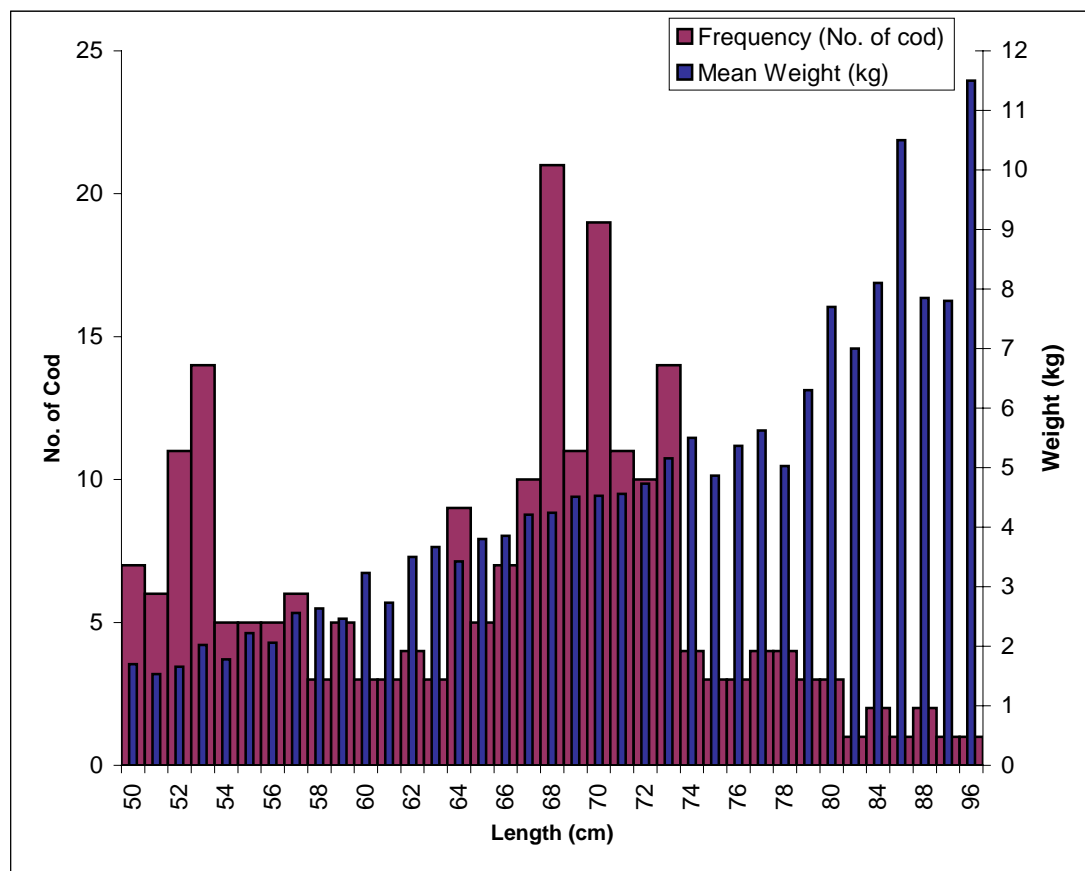


**March 2007**

## Summary: eastern Channel cod 2007.

The FV Halcyon was chartered between January and February 2007 to work off the south coast of England to carry out a series of FSP surveys on cod in the eastern Channel, with the aim of identifying important locations for spawning cod and determining post-spawning migrations. In all, 229 mature cod (>50cm) were tagged with plastic marker tags ('Howitts') and released in the vicinity of their capture. The mean length and weight of released cod was 66 cm ( $\pm 7.50$  cm) and 3.9 kg ( $\pm 1.33$  kg), respectively. Additionally, 104 cod were dissected to determine maturity etc.

*Number of conventionally tagged cod summarised by mean weight (kg) at length (cm).*



Although as much information as possible was gathered to map the fishing area (seabed type, maturity, sex, stomach contents and age) confirmation of the existence of spawning aggregations proved inconclusive at this early stage. It was not possible to determine whether the cod caught in the fishing area constituted a group composed of many distinct individuals, or simply if the cod were migrating through the area.

Of the 104 cod that were dissected, the mean length and weight were 65 cm ( $\pm 8.44$  cm) and 3.51 kg ( $\pm 1.22$  kg), respectively. 70% of the fish were 3

years of age and 80% were mature. The sex ratio was 2 females : 1 male over the entire area.

*Number of biologically sampled cod summarised by age, sex and maturity.*

Age	No. Cod	Male	Female	Immature	Mature	Mean Length	Mean Weight
2	27	10	17	18	9	49.66 ( $\pm$ 3.77)	1.46 ( $\pm$ 0.42)
3	71	24	47	2	69	70.72 ( $\pm$ 3.07)	4.26 ( $\pm$ 0.72)
4	3	2	1	0	3	78 ( $\pm$ 3.33)	5.1 ( $\pm$ 0.73)
Unkn.	3	0	3	1	2	66 ( $\pm$ 2.4)	2 ( $\pm$ 0.2)
Total	104	36	68	21	83		

## Introduction

Cod in the eastern Channel (ICES VIId) and North Sea (ICES IV) are assessed as one stock by the ICES North Sea and Skagerrak working group, resulting in restrictions and controls on landing cod as a result of the 'Cod Recovery Plan'. For some time the fishing industry of the eastern English Channel has claimed that the VIId cod stock is healthier than that in IVc because the cod population is resident, rather than migratory. They argue that the eastern English Channel cod quota should be relaxed, rather than subject to the same limitations as that of the North Sea.

In the winter of 2004 and 2005/06, Cefas undertook new electronic tagging experiments to investigate individual behaviour and migration patterns of cod in the eastern English Channel, as part of Defra's R&D programme (MF0158). Several commercial fishing vessels with Cefas personnel on board fished out of Hastings and Eastbourne and deployed 185 electronic data storage tags and conventional tags on cod.

As well as the deployment of electronic and conventional tags, this Defra-funded research project re-evaluated archived conventional tagging data collected between 1964 and the present day. Results drawn from this analysis show that small (<50 cm) cod tagged in VIId during autumn and winter often move into IVc, where they remain until capture. In contrast, cod in IVc show a clear pattern of seasonal northward movement. This provides an indication that the population of cod in VIId is not supplemented by post-spawning cod from IVc during spring and summer. Subsequently, behavioural data from recent returns of electronic data storage tags suggests that there are behavioural differences between cod in IVc and VIId that may limit the mixing of cod from these two areas during the feeding and spawning seasons (Righton *et al.*, 2007)

Major spawning areas in the eastern English Channel have not been identified or mapped to date. Such areas have been identified for the North Sea, the Irish Sea, the Celtic Sea, the Faroe Islands and the Hebrides. The likely limit of possible spawning areas has been attempted for a significant proportion of the east and south coasts of the UK, but not for the eastern English Channel (Jones, 1981).

It was agreed that this FSP project should be undertaken in winter 2006/07, to further contribute and develop to the understanding of eastern Channel cod movements and behaviour patterns.

This is an interim report that focuses primarily on details of the conventional tag releases together with biological sampling data gathered during the field programme. An Annex to this report will be provided in 12 months time, when more data will be available from recaptured tagged cod.

The Detailed Operations Plan for this FSP project was finalised between Cefas and the vessel owner on 4<sup>th</sup> December 2006 and is supplied as Appendix 8, along with the post-cruise report as Appendix 7 and a report by the skipper, Mr G. Doswell, as Appendix 10.

## **Objectives**

To contribute to in-progress studies on the population biology and migration of the VIIId cod stock.

## **Key aims**

- To undertake a conventional tagging field programme on mature cod in spawning condition
- To identify and map possible spawning aggregations of cod in the eastern English Channel
- To undertake a degree of biological sampling to complement the assessment of possible spawning aggregations.

## **Methods**

### *Survey design*

The survey was designed to allow the maximum number of mature cod (>50 cm long, based on maturity ogives derived from International Bottom Trawl Survey (ICES, 2005) data collected between 1977 and 2005) to be tagged by conventional means as well as allowing for the identification and mapping of possible spawning aggregations. In all, 12 days of sea time were intentionally split into 3 'blocks' of time over a 3-month period (December 2006 – February 2007) to coincide with the spawning season of cod.

The areas that were fished were initially based on local knowledge and experience of fishermen catching cod in a defined area between Beachy Head and Folkestone, within 10 miles of the coast. The nets were shot along transects, with the latitude and longitude of each net start and end being recorded.

The ground type along these transects was also noted, using a combination of admiralty charts and the vessel's echo sounder. During the 12 days at sea the gear was methodically fished in different locations (when possible) to allow the geographical extremities of the area to be defined by a falling, non-viable catch rate.

The survey plan as detailed in section 1 of the Detailed Operations Plan (Appendix 8) had to be modified during the project because of disruption caused by severe weather. For this reason the survey area was modified from three possibly distinct areas to one large area, and the planned dates for each of the three survey 'blocks' were adjusted to coincide with windows of opportunity.

### *Vessel and fishing gear*

The FV Halcyon (NN114) is a GRP netter, with an overall length of 9.8 m, breadth of 3.9 m, with 115 kW engine power. In total, up to 10 fleets of monofilament gill and trammel nets were fished (2 x fleets of 7 inch mesh gill nets, 4 x fleets of 6.5 inch mesh gill nets and 4 x fleets of 6 inch mesh trammel nets). The nets employed a heavily weighted footrope and a floated headrope. Each end of each net was attached to an anchor to prevent the net moving with the current, both ends being marked with a ban buoy. The nets were fished approximately 6 feet above the seabed, each net or fleet being approximately 400 yards long and soaked for 24 h.



The nets were shot by hand over the stern of the vessel, along the tidal axis to (1) reduce the amount of debris in the net and (2) to stop the net shifting and 'bunching up' (Figure 1). The net was allowed to soak for approximately 24 h, before being hauled the following day. Using a net hauler, the gear was brought aboard and manually sorted into a net bin. Depending on the forecast weather conditions and the survey plan, the net was either immediately shot or kept aboard until the vessel was steamed to a new location.

**Figure 1:** Martin Wiltshire shooting the nets away.

### *Tagging methodology.*

Before commencement of hauling the fishing gear, the tagging workstation was set up. This consisted of a clear working area of some 3 m<sup>2</sup>, with a raised bench area, measuring board, a foam block with a 'V'-shaped channel and 2 x 1 m<sup>3</sup> tanks, one for the reception of live fish and one for the subsequent recovery after tagging.

The fishing gear was hauled slowly, bringing the individual fish to the surface, in a controlled manner to avoid damage to the swimbladder. The crew then removed all living fish as quickly as possible from the gear, and placed them in the reception tank. The Cefas member of staff aboard the vessel then, in consultation with the crew, assessed each fish for its suitability for tagging. The two main criteria for determining suitability were (1) the extent of wounding or damage caused by the fishing gear (primarily to the dorsal fins and operculae of the fish, which sometimes showed signs of bleeding, bruising or even torn tissue) and (2) the level of exhaustion. Obviously the lesser the extent of these two criteria, the more suitable the fish was for tagging.

After being visually assessed and allowed to recover from capture, the fish were measured, weighed, photographed and placed into the 'V-shaped' channel of a foam block, which held the fish securely. The foam block was kept wet with seawater and a wet cloth was then placed over the head and operculae of the fish. A conventional 'Howitt' tag was then attached to the fish, by passing a curved needle through the dorsal musculature, allowing the braided cord of the 'Howitt' tag to be pulled through and tied off. The fish was then removed from the foam block and placed in the recovery tank for visual assessment before release.

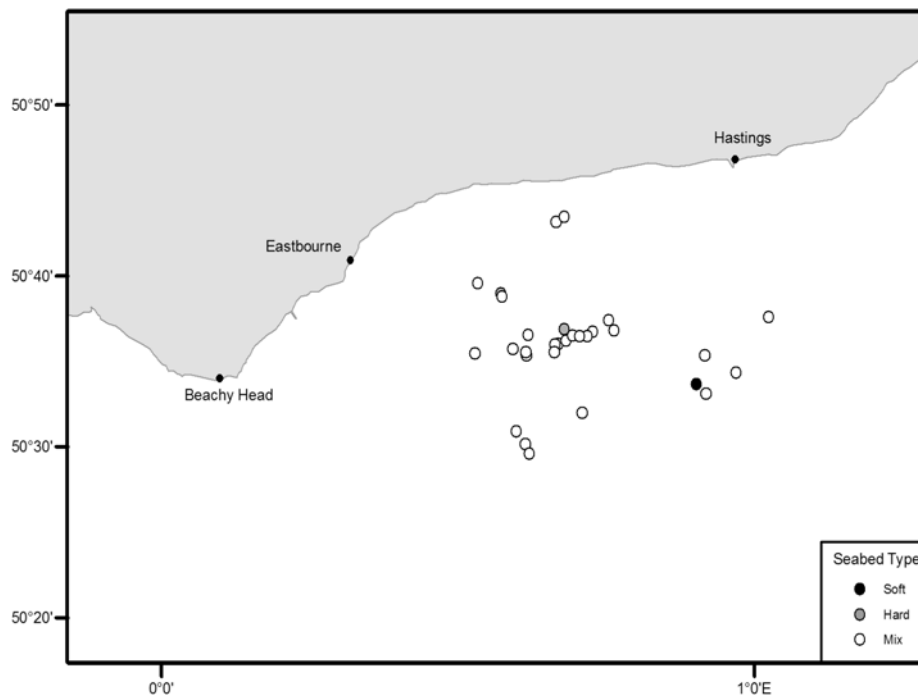
### *Biological sampling / dissected cod.*

In order to aid the identification and mapping of possible spawning aggregations of cod, some biological sampling was undertaken after the completion of each tag deployment, if time allowed. Up to ten fleets of nets were fished for each of the 12 days, and all fish >40 cm that were unable to be tagged were kept aboard and grouped by station number. Owing to time constraints, approximately two fish from each fleet of nets were then measured and weighed, their sex and maturity stage determined, otoliths removed, photographed, fin clipped and stomach contents noted.

### *Location of fishing sites*

The weather conditions experienced during the survey period greatly influenced the location of the fishing stations (Figure 2). Often inshore sites in relative close proximity to the home port had to be chosen, purely on the grounds of safety.

**Figure 2.** Location of the 30 fishing stations.



*Publicity programme.*

A reward poster was specifically designed for this FSP project, with the intention of raising the profile of the work within the fishing industry by detailing the project and how to return a tag (and fish). These posters were distributed to the offices of the local Marine Fisheries Agency and Sea Fisheries Committees in the likely areas that would experience recaptures, informing fisheries offices and the broader fishing industry of the work. A copy of the poster is attached to Appendix 9.

*Tag returns.*

For all tags returned (and the fish carrying them) as much recapture information as possible will be obtained from the captor, including the receiving port, tag number, vessel name/number, gear type, nationality, date and ground position, along with any other relevant information. If the fish are returned to the Cefas Lowestoft laboratory via the local MFA office, then MFA officers will gather the information on our behalf and forward it to Cefas, with the tag (and the fish). However, if the tag (and fish) is returned directly to Cefas by the captor, then the recapture information will be gathered directly from the fisherman.

If the whole fish and tag is returned to the Cefas Lowestoft laboratory, then the fish will be biologically sampled. The length and weight (whole and gutted) will be taken and the gut contents noted. The overall condition of the fish will be assessed, along with the condition of the tagging 'wound'. Finally the otoliths will be removed for age determination.

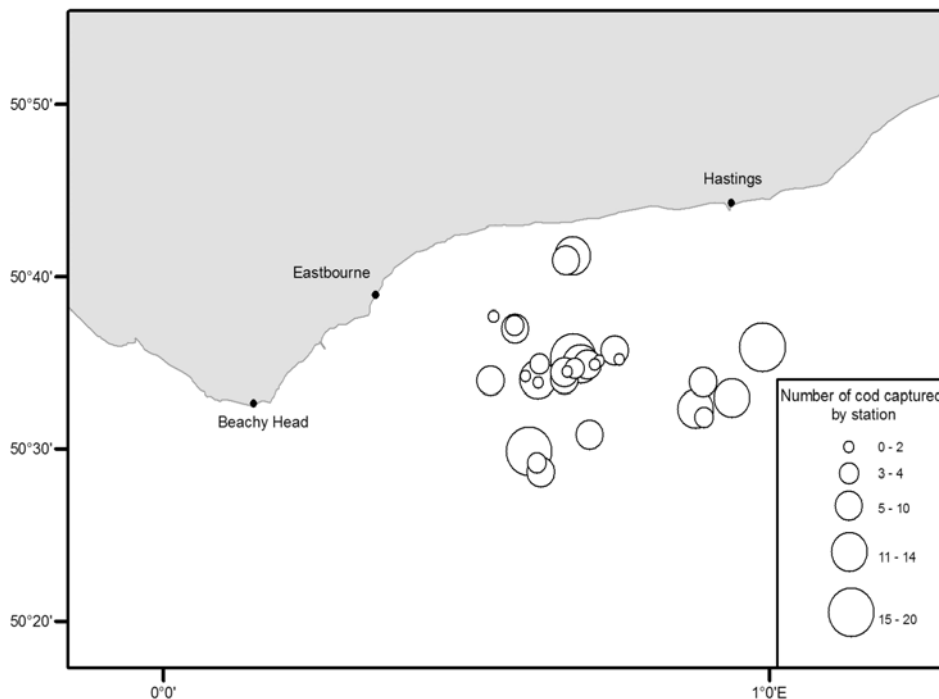
When all the recapture information details have been recorded the reward (£6 plus the market value of the fish, if returned) and postage will be paid to the captor with a letter of thanks, providing further information on the FSP project.

## Results

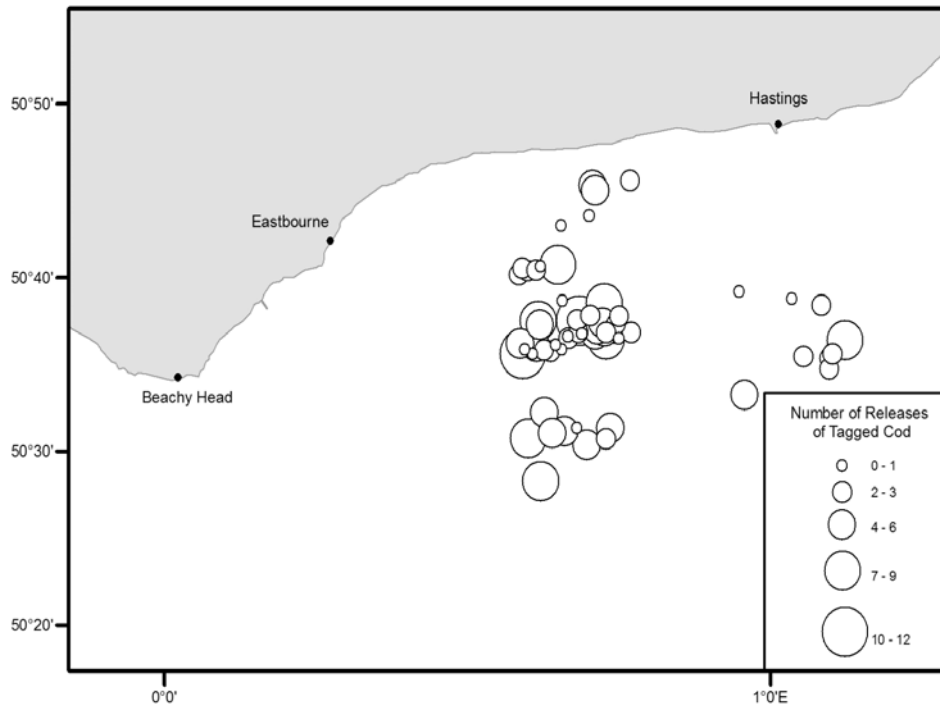
### *Conventionally tagged cod.*

In all 229 cod >50 cm long, were tagged and released with a conventional Howitt tag, over the 12 days of sampling. Figure 3 illustrates the distribution and numbers of cod caught per fishing station and Figure 4 the subsequent release positions of the tagged cod. The information recorded for each tagged cod is detailed in Appendix 1. To date (3 April 2007) 14 cod (6%) have been recaptured.

**Figure 3.** Number of captures of cod by fishing station.



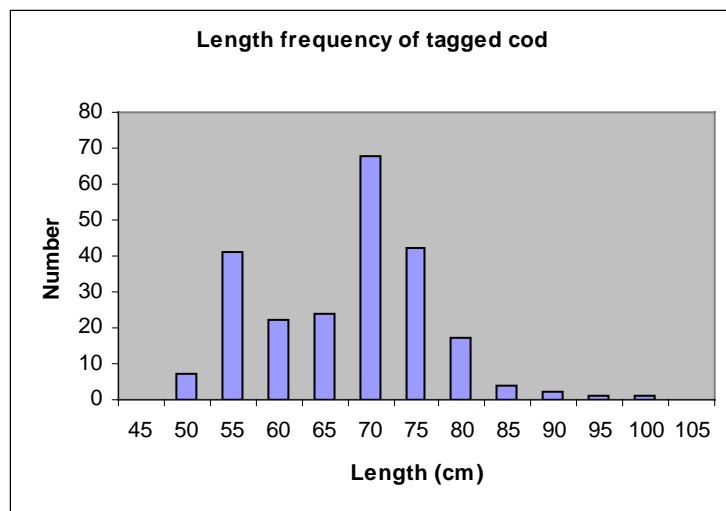
**Figure 4.** Number of tagged cod released.



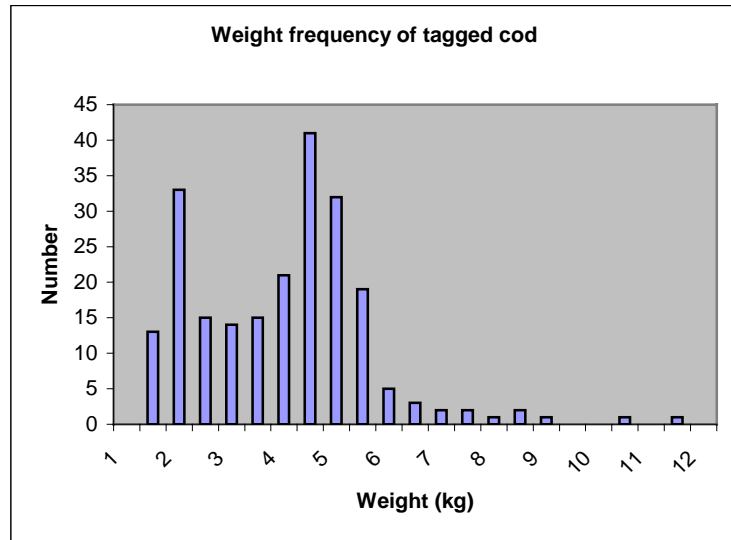
*Length and weight distributions.*

The length distributions of tagged cod (Figure 5), show that fish were most abundant between 55 cm and 75 cm long. Cod >80 cm were very uncommon (just 6 of the 229 tagged cod). The weight distributions (Figure 6), show that fish commonly weighed between 2 and 6 kg. The overall mean length and weight of tagged cod was 66 cm ( $\pm 7.50$  cm) and 3.9 kg ( $\pm 1.33$  kg), respectively.

**Figure 5.** Length frequency distribution of tagged cod.



**Figure 6.** Weight frequency distribution of tagged cod.



*Dissected / biologically sampled cod*

In all, 104 cod were dissected to aid the identification and mapping of possible spawning aggregations of cod. Details of length, weight, sex and maturity were recorded (see Appendix 2) and a fin clip taken for future use.

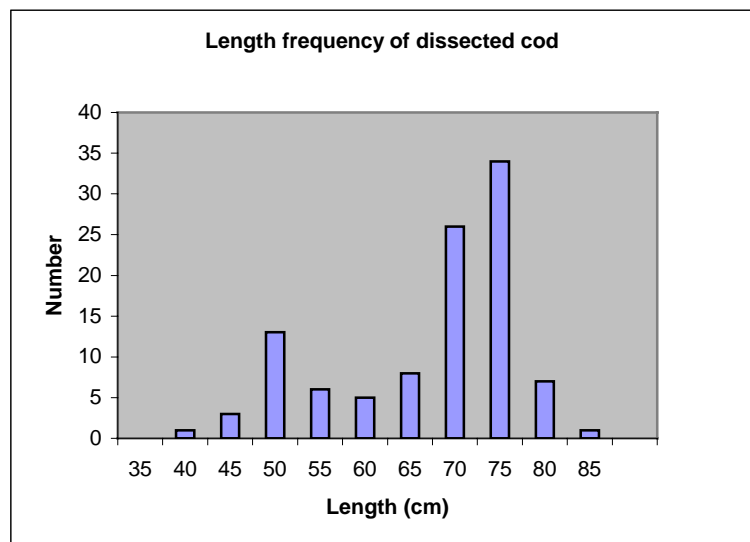
*Length, weight and age distributions of sampled cod.*

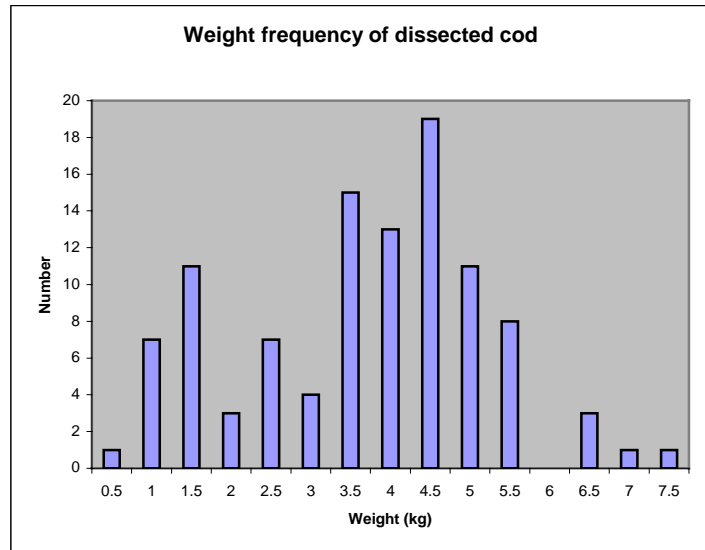
The length distributions of the dissected cod (Figure 7), show that these fish were also most abundant between 50 cm and 75 cm. Only one cod >80 cm was sampled. The weight distributions (Figure 8), show a broader spatial distribution of 1 – 5.5 kg.

The overall mean length and weight for the dissected cod was 65 cm ( $\pm$  8.44 cm) and 3.51 kg ( $\pm$  1.22 kg), respectively.

Of the 104 cod dissected, 101 were also successfully aged, with 27% aged at 2 years, 70% aged at 3 years, and the remaining 3% at 4 years.

**Figure 7.** Length frequency distribution of dissected cod.





**Figure 8.** Weight frequency distribution of dissected cod.

#### *Diet compositions.*

Of the 104 fish that were dissected, 80% of the stomach contents consisted of either a mix or single specimens of fish, crustaceans and bivalves, the remaining 20% of sampled fish having empty stomachs. The most common prey items were unidentifiable fish and crustaceans, along with the sea mouse (*Aphrodita aculeata*). In all, 22 different prey items were identified, with no obvious pattern between station location and that of stomach contents or indeed a lack of contents.

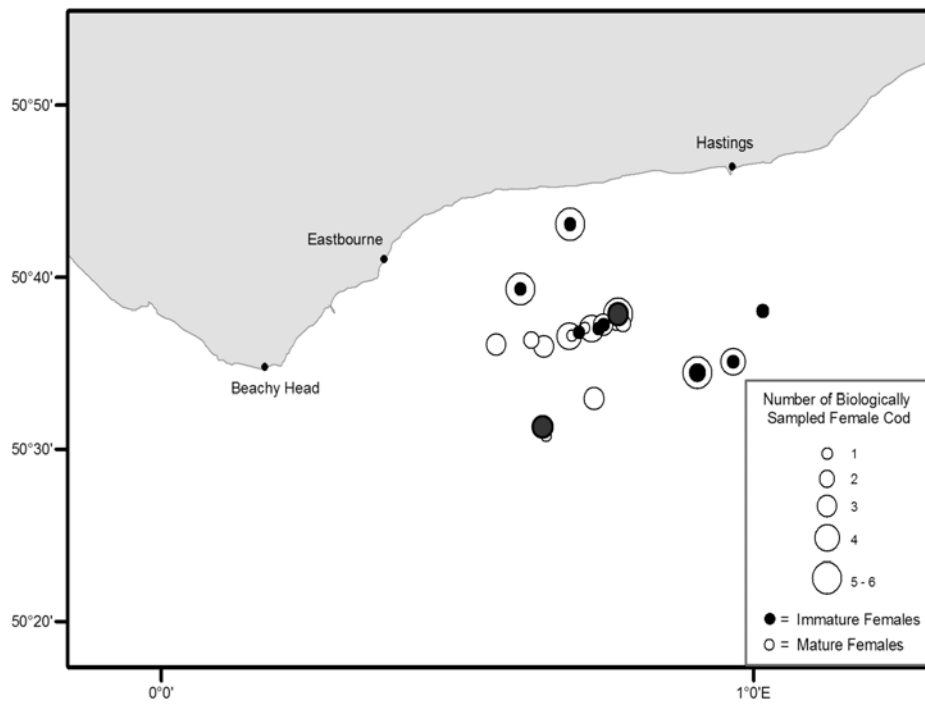
#### *Catch compositions.*

The composition of the catch is of interest because this is a targeted fishery. Appendices 3 and 4 list the species in the daily catch. During the period of the project, between 48% and 78% of the daily catch consisted of cod. On average 66.9% of the catch was cod, the remainder being made up of 18 fish species, 2 species of crustacean and one species of gastropod over the survey period. Of these, plaice, whiting, dab, pout, skate and sole were the most common.

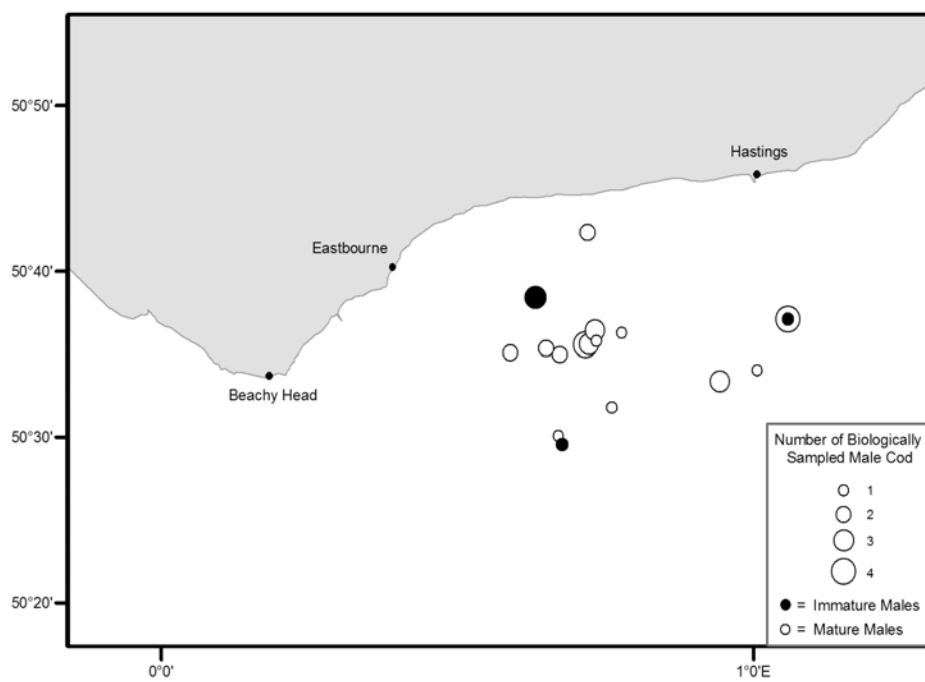
#### *Spawning aggregations.*

In all, less than 26% of the total cod catch was dissected, and 9 of the 30 capture stations are not represented by biological sampling. 65% of the 104 dissected cod were females, representing a 2 : 1 ratio of females to males overall (Appendix 6). 80% of the dissected fish were mature and 38% were immature (and <50 cm long).

**Figure 9.** Number and distribution of immature & mature female cod.



**Figure 10.** Number and distribution of immature & mature male cod.



Figures 9 and 10 show how the mature/immature fish appear to be distributed between the capture stations, with no apparent pattern of aggregation and a seemingly random distribution of males and females, both mature and immature, throughout the area surveyed.

The seabed was categorised into either soft, hard or mixed ground for each station. 90% of the stations were on mixed ground, 7% on hard ground and 3% on soft ground. There is no apparent correlation between sex, maturity and catch numbers with the different ground types.

## **Discussion**

This FSP project has successfully completed the initial phase of further investigating the behaviour and migration patterns of cod in the region, by tagging and subsequently releasing 229 cod in the eastern English Channel (ICES VIIId). Continuation of this FSP project through the recapture of tagged cod throughout 2007/08 should yield valuable information on the migrations of cod in the eastern English Channel and therefore contribute to the completed and on-going work of the possible interactions between the cod in ICES VIIId and ICES IVc.

The original survey plan could not be implemented because of the severe weather conditions experienced throughout, from December 2006 to February 2007. It was intended that three separate areas would be mapped to allow for the possibility that a spawning aggregation might be identified through comparing and contrasting the areas, and also through biological sampling etc. However, this did not prove possible, so the interpretation of future results may be limited accordingly. For the area that was mapped, females and males were randomly distributed, both mature and immature stages, with a sex ratio of 2 females to 1 male. Overall, 80% of the fish caught were mature and 70% were 3 years of age.

The identification and mapping of spawning aggregations of cod in the eastern English Channel proved inconclusive. An aggregation is hereby defined as "a group composed of many distinct individuals", and the biological sampling undertaken has not determined whether this fits with the area fished. This FSP project has identified an area that produces significant numbers of large, mature cod. An average of 124 kg of cod was caught per day over the survey period, i.e. approximately 28 individuals. It cannot be determined at this stage whether the area identified actually 'holds' these fish, i.e. they are aggregating, or if they are simply moving/migrating through. However, once the recapture data of the tagged fish have been collated and analysed, the early recaptures will show whether the fish were re-captured in the same area or whether they were moving away. This will go some way towards determining whether the cod were aggregating in the area that was mapped by this FSP project.

## Future work

In 12 months time (approximately), an Annex to this report will be provided, concentrating on the tag return data and if possible giving some answer to whether the fish in the area are resident or migratory.

## Acknowledgements

The work was carried out in collaboration with the skipper and crew of the FV Halcyon, Graham Doswell and Martin Wiltshire. Their help, knowledge, determination and contribution is sincerely appreciated by Cefas and the authors of this report. Kevin Sullivan is acknowledged for the time he spent at sea in less-than-pleasant conditions and we are very grateful to him. The Cefas staff involved in otolith processing, along with Louise Cox and Gary Burt for dealing with recaptured fish are also thanked. Finally, David Righton and Andy Payne are thanked for their advice and direction in the project.

## References

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Jones, B.W., 1981. Cod (*Gadus morhua*): spawning areas. Atlas of the Seas around the British Isles, section 3.06.

Righton, D., Quayle, V. A., Hetherington, S. and Burt, G. (2007). Movements and distribution of cod (*Gadus morhua* L.) in the southern North Sea and English Channel: results from conventional and electronic tagging experiments. *Journal of the Marine Biological Association, UK*, **87**, 599 - 613.

## Appendix 1. Details of conventionally tagged cod.

Seabed code: 1 - soft ground, 2 - hard ground, 3 - mixed ground

Date	Station number	Howitt tag number	Release latitude	Release longitude	Water depth	Seabed type	Release length (cm)	Release weight (kg)
06/01/2007	1	E938753	50 45 847N	0 28 382E	12	3	73	4.8
06/01/2007	1	E938754	50 45 912N	0 28 774E	12	3	69	4.5
06/01/2007	2	E938756	50 46 331N	0 29 903E	12	3	71	
06/01/2007	2	E938757	50 46 425N	0 30 245E	12	3	68	5
06/01/2007	3	E938758	50 46 600N	0 30 648E	15	3	57	
06/01/2007	3	E938759	50 46 600N	0 30 648E	15	3	70	
06/01/2007	4	E938760	50 46 404N	0 30 305E	11	3	74	
06/01/2007	4	E938761	50 46 404N	0 30 305E	11	3	84	
06/01/2007	6	E938764	50 46 439N	0 27 793E	12	3	70	
06/01/2007	6	E938763	50 46 439N	0 27 793E	12	3	72	
06/01/2007	6	E938766	50 46 439N	0 27 793E	12	3	69	
15/01/2007	7	E938765	50 46 780 N	0 30 709E	11	3	75	5.5
15/01/2007	7	E938767	50 46 780 N	0 30 709E	11	3	59	2.5
15/01/2007	7	E938769	50 46 624 N	0 30 205E	11	3	71	5
15/01/2007	7	E938768	50 46 624 N	0 30 205E	11	3	70	5.5
15/01/2007	7	E938770	50 46 590 N	0 30 124E	11	3	62	2.5
15/01/2007	7	E938771	50 46 590 N	0 30 124E	11	3	67	4
15/01/2007	7	E938773	50 46 590 N	0 30 124E	11	3	57	3
15/01/2007	7	E938772	50 46 320N	0 29 305E	11	3	63	4
15/01/2007	7	E938774	50 46 320N	0 29 305E	11	3	62	3.5
15/01/2007	7	E938775	50 46 320N	0 29 305E	11	3	70	5
15/01/2007	8	E938776	50 46 208N	0 28 927E	11	3	50	2
15/01/2007	8	E938777	50 46 208N	0 28 927E	11	3	68	5.3
15/01/2007	8	E938778	50 46 208N	0 28 927E	11	3	73	5.5
15/01/2007	8	E938779	50 46 094N	0 28 580E	11	3	65	4.7
15/01/2007	8	E938783	50 46 094N	0 28 580E	11	3	73	5.5
15/01/2007	8	E938784	50 46 094N	0 28 580E	11	3	88	7.5
15/01/2007	8	E938785	50 46 094N	0 28 580E	11	3	70	5
15/01/2007	8	E938780	50 45 894N	0 27 840E	11	3	60	4
15/01/2007	8	E938781	50 45 894N	0 27 840E	11	3	68	4.5
15/01/2007	8	E938782	50 45 894N	0 27 840E	11	3	67	4.5
15/01/2007	8	E938787	50 45 894N	0 27 840E	11	3	69	5
15/01/2007	8	E938786	50 45 894N	0 27 840E	11	3	69	5
15/01/2007	8	E938789	50 45 814N	0 27 429E	11	3	68	5
15/01/2007	8	E938791	50 45 814N	0 27 429E	11	3	68	5
15/01/2007	9	E938793	50 45 894N	0 27 840E	11	3	67	5
15/01/2007	9	E938792	50 45 894N	0 27 840E	11	3	70	5.5
15/01/2007	9	E938794	50 45 894N	0 27 840E	11	3	73	5.5
15/01/2007	9	E938790	50 45 894N	0 27 840E	11	3	74	5.5
15/01/2007	9	E938796	50 45 708N	0 27 039E	11	3	66	5
15/01/2007	9	E938797	50 45 708N	0 27 039E	11	3	69	5.5
15/01/2007	9	E938795	50 45 708N	0 27 039E	11	3	73	6
15/01/2007	9	E938788	50 45 708N	0 27 039E	11	3	67	5.5
15/01/2007	9	E938798	50 45 708N	0 27 039E	11	3	81	7
15/01/2007	9	E938799	50 45 708N	0 27 039E	11	3	68	4.5
15/01/2007	9	E938800	50 45 708N	0 27 039E	11	3	69	4.5
15/01/2007	9	E938603	50 45 708N	0 27 039E	11	3	68	3.5
16/01/2007	10	E938607	50 46 446N	0 29 970E	12	3	62	4
16/01/2007	10	E938608	50 46 446N	0 29 970E	12	3	69	4.5
16/01/2007	10	E938605	50 46 446N	0 29 970E	12	3	62	4

Date	Station number	Howitt tag number	Release latitude	Release longitude	Water depth	Seabed type	Release length (cm)	Release weight (kg)
16/01/2007	10	E938606	50 46 446N	0 29 970E	12	3	66	4.5
16/01/2007	10	E938609	50 46 302N	0 29 436E	12	3	67	4.5
16/01/2007	10	E938611	50 46 302N	0 29 436E	12	3	63	4
16/01/2007	10	E938610	50 46 302N	0 29 436E	12	3	71	4.5
16/01/2007	10	E938612	50 46 302N	0 29 436E	12	3	70	5
16/01/2007	11	E938616	50 46 166N	0 28 975E	12	3	68	4
16/01/2007	11	E938615	50 45 994N	0 28 527E	12	3	79	6
16/01/2007	11	E938614	50 45 994N	0 28 527E	12	3	68	4.5
16/01/2007	11	E938617	50 45 994N	0 28 527E	12	3	73	5
16/01/2007	11	E938618	50 45 858N	0 28 137E	12	3	73	5.5
16/01/2007	11	E938619	50 45 741N	0 27 733E	11	3	69	3.5
16/01/2007	11	E938620	50 45 741N	0 27 733E	11	3	64	4
16/01/2007	11	E938622	50 45 741N	0 27 733E	11	3	59	3.2
16/01/2007	12	E938621	50 45 922N	0.27.228E	11	3	80	7.5
23/01/2007	14	E938623	50 47 350N	0 26 882E	10	2	78	4.5
23/01/2007	14	E938624	50 47 463N	0 27 202E	10	2	78	4.5
23/01/2007	14	E938625	50 47 463N	0 27 202E	10	2	52	1.5
23/01/2007	14	E938626	50 47 463N	0 27 202E	10	2	63	3
23/01/2007	14	E938627	50 47 592N	0 27 638E	8	2	64	3
23/01/2007	14	E938628	50 47 669N	0 28 262E	8	2	54	1.7
23/01/2007	14	E938629	50 47 669N	0 28 262E	8	2	52	1.5
23/01/2007	14	E938630	50 49 330N	0 29 274E	6	3	52	1.5
23/01/2007	14	E938631	50 49 330N	0 29 274E	6	3	53	1.6
23/01/2007	13	E938632	50 49 444N	0 29 164E	6	3	53	1.6
23/01/2007	13	E938633	50 49 444N	0 29 164E	6	3	66	3
23/01/2007	13	E938634	50 49 645N	0 30 516E	8	3	53	1.6
24/01/2007	15	E938635	50 47 500N	0 27 000E	10	2	61	2.5
24/01/2007	15	E938636	50 47 500N	0 27 000E	10	2	91	7.8
24/01/2007	15	E938637	50 47 500N	0 27 000E	10	2	69	4.4
24/01/2007	15	E938638	50 47 500N	0 27 000E	10	2	55	2.2
24/01/2007	15	E938639	50 47 500N	0 27 000E	10	2	50	1.5
24/01/2007	15	E938640	50 47 500N	0 27 500E	10	2	52	1.6
24/01/2007	15	E938641	50 47 500N	0 27 500E	10	2	53	2
24/01/2007	15	E938642	50 47 500N	0 27 500E	10	2	59	2.6
24/01/2007	15	E938643	50 48 500N	0 28 200E	11	2	51	1.5
24/01/2007	15	E938644	50 48 500N	0 28 200E	11	2	53	2.4
24/01/2007	15	E938645	50 48 790N	0 29 160E	11	3	53	1.7
24/01/2007	15	E938646	50 48 790N	0 29 160E	11	3	61	2.7
24/01/2007	15	E938647	50 48 790N	0 29 160E	11	3	54	1.8
24/01/2007	15	E938648	50 48 790N	0 29 160E	11	3	60	3
24/01/2007	16	E938649	50 46 570N	0 29 200E	11	3	70	4.8
24/01/2007	16	E938650	50 46 570N	0 29 200E	11	3	68	4.2
25/01/2007	17	E938651	50 46 580N	0 29 291E	11	2	71	5
25/01/2007	17	E938652	50 46 580N	0 29 291E	11	2	72	5
25/01/2007	17	E938653	50 46 580N	0 29 291E	11	2	56	2
25/01/2007	17	E938654	50 46 580N	0 29 291E	11	2	77	5
25/01/2007	18	E938655	50 46 362N	0 27 087E	12	3	70	5
25/01/2007	18	E938656	50 46 362N	0 27 087E	12	3	73	5
25/01/2007	18	E938657	50 46 362N	0 27 087E	12	3	77	5.5
25/01/2007	18	E938658	50 46 362N	0 27 087E	12	3	77	5.5
25/01/2007	18	E938659	50 46 362N	0 27 087E	12	3	71	5
25/01/2007	18	E938660	50 46 362N	0 27 087E	12	3	70	5
25/01/2007	18	E938661	50 46 362N	0 27 087E	12	3	73	5.5

Date	Station number	Howitt tag number	Release latitude	Release longitude	Water depth	Seabed type	Release length (cm)	Release weight (kg)
26/01/2007	19	E938662	50 47 000N	0 30 100E	10	3	53	2
26/01/2007	19	E938663	50 47 000N	0 30 100E	10	3	61	3
26/01/2007	19	E938664	50 47 000N	0 30 100E	10	3	57	3
26/01/2007	19	E938665	50 47 000N	0 30 100E	10	3	67	4.1
26/01/2007	19	E938666	50 47 000N	0 30 100E	10	3	56	2.2
26/01/2007	19	E938667	50 46 500N	0 30 500 E	10	3	50	2
26/01/2007	19	E938668	50 46 500N	0 30 500 E	10	3	71	5
26/01/2007	19	E938669	50 46 500N	0 30 500 E	10	3	51	1.5
26/01/2007	19	E938670	50 46 500N	0 30 500 E	10	3	68	3.7
26/01/2007	19	E938671	50 46 500N	0 30 500 E	10	3	65	3.2
26/01/2007	19	E938672	50 46 500N	0 30 500 E	10	3	52	1.7
26/01/2007	19	E938673	50 46 500N	0 30 500 E	10	3	72	4.9
26/01/2007	19	E938674	50 46 500N	0 30 500 E	10	3	64	4
26/01/2007	19	E938675	50 46 571N	0 29 291E	10	3	53	2
26/01/2007	19	E938676	50 46 571N	0 29 291E	10	3	58	2.8
26/01/2007	19	E938677	50 46 571N	0 29 291E	10	3	52	1.6
26/01/2007	20	E938678	50 46 571N	0 29 291E	11	3	68	3.7
26/01/2007	20	E938679	50 46 571N	0 29 291E	11	3	72	5
26/01/2007	20	E938680	50 46 571N	0 29 291E	11	3	78	5.5
26/01/2007	20	E938681	50 46 571N	0 29 291E	11	3	70	5
26/01/2007	20	E938682	50 46 571N	0 29 291E	11	3	59	2
26/01/2007	20	E938683	50 46 571N	0 29 291E	11	3	68	4.5
26/01/2007	20	E938684	50 46 571N	0 29 291E	11	3	51	1.6
26/01/2007	20	E938685	50 46 571N	0 29 291E	11	3	78	5.6
27/01/2007	21	E938686	50 46 071N	0 29 660E	10.5	3	58	2.6
27/01/2007	21	E938687	50 46 246N	0 30 333E	10.5	3	80	6.6
27/01/2007	21	E938688	50 46 246N	0 30 333E	10.5	3	66	3.1
27/01/2007	21	E938689	50 46 246N	0 30 333E	10.5	3	70	4.1
27/01/2007	21	E938690	50 46 313N	0 30 784E	10.5	3	69	3.8
27/01/2007	21	E938691	50 46 473N	0 31 220E	10.5	3	64	4
27/01/2007	21	E938692	50 46 473N	0 31 220E	10.5	3	80	9
27/01/2007	21	E938693	50 46 473N	0 31 220E	10.5	3	88	8.2
27/01/2007	21	E938694	50 46 473N	0 31 220E	10.5	3	79	6.5
27/01/2007	22	E938695	50 43 968N	0 27 952E	10.5	3	60	2.7
27/01/2007	22	E938696	50 43 968N	0 27 952E	10.5	3	55	2.2
27/01/2007	22	E938697	50 43 968N	0 27 952E	10.5	3	57	2.3
27/01/2007	22	E938698	50 44 055N	0 28 420E	10.5	3	53	2.3
27/01/2007	22	E938699	50 44 055N	0 28 420E	15	3	71	4.5
27/01/2007	22	E938700	50 44 055N	0 28 420E	15	3	76	5.4
27/01/2007	22	E939001	50 44 055N	0 28 420E	15	3	64	2.6
27/01/2007	22	E939002	50 44 055N	0 28 420E	15	3	56	2.1
27/01/2007	22	E939003	50 44 055N	0 28 420E	15	3	54	1.9
27/01/2007	22	E939004	50 44 133N	0 28 789E	15	3	68	3.7
27/01/2007	22	E939005	50 44 133N	0 28 789E	15	3	70	4.4
27/01/2007	22	E939006	50 44 133N	0 28 789E	15	3	56	1.8
27/01/2007	22	E939007	50 44 133N	0 28 789E	15	3	67	3.2
27/01/2007	22	E939008	50 44 215N	0 29 217E	15	3	65	3.6
27/01/2007	22	E939009	50 44 215N	0 29 217E	15	3	76	5.2
27/01/2007	22	E939010	50 44 215N	0 29 217E	15	3	56	2.2
27/01/2007	22	E939011	50 44 215N	0 29 217E	15	3	68	3.4
27/01/2007	22	E939012	50 44 215N	0 29 217E	15	3	52	1.6
27/01/2007	22	E939013	50 44 318N	0 29 677E	15	3	73	4.2
27/01/2007	22	E939014	50 44 421N	0 30 087E	15	3	71	3.4
30/01/2007	23	E939015	50 47 064N	0 36 890E	12.5to15	3	70	2

Date	Station number	Howitt tag number	Release latitude	Release longitude	Water depth	Seabed type	Release length (cm)	Release weight (kg)
30/01/2007	23	E939016	50 47 064N	0 36 890E	13.5	3	53	3.7
30/01/2007	23	E939017	50 47 064N	0 36 890E	13.5	3	72	4.3
30/01/2007	23	E939018	50 47 064N	0 36 890E	13.5	3	72	4.8
30/01/2007	23	E939019	50 47 064N	0 36 890E	13.5	3	52	1.9
30/01/2007	23	E939020	50 47 064N	0 36 890E	13.5	3	53	2
30/01/2007	23	E939021	50 47 064N	0 36 890E	13.5	3	50	1.5
30/01/2007	23	E939022	50 47 064N	0 36 890E	13.5	3	52	1.7
30/01/2007	23	E939023	50 47 064N	0 36 890E	13.5	3	72	5
30/01/2007	23	E939024	50 47 064N	0 36 890E	13.5	3	51	1.6
30/01/2007	23	E939025	50 47 064N	0 36 890E	13.5	3	55	1.5
30/01/2007	23	E939026	50 47 064N	0 36 890E	13.5	3	58	2.5
30/01/2007	23	E939027	50 47 064N	0 34 942E	13.5	1	65	3.3
30/01/2007	23	E939028	50 47 064N	0 34 942E	13.5	1	64	3.2
30/01/2007	23	E939029	50 47 064N	0 34 942E	13.5	1	57	2.2
30/01/2007	23	E939030	50 47 064N	0 34 942E	13.5	1	66	3
30/01/2007	24	E939031	50 46 290N	0 38 056E	14	1	54	2
30/01/2007	24	E939032	50 46 290N	0 38 056E	14	1	53	1.7
30/01/2007	24	E939033	50 46 290N	0 38 056E	14	1	53	2.1
30/01/2007	24	E939034	50 46 290N	0 38 056E	14	1	72	4.1
30/01/2007	24	E939035	50 46 290N	0 38 056E	14	1	68	3.8
30/01/2007	24	E939036	50 46 290N	0 38 056E	14	1	68	3.7
30/01/2007	24	E939037	50 45 506N	0 35 584E	14	1	68	4.2
30/01/2007	24	E939038	50 45 506N	0 35 584E	14	1	75	4.3
30/01/2007	24	E939039	50 45 506N	0 35 584E	14	1	71	4.1
30/01/2007	24	E939040	50 45 506N	0 35 584E	14	1	71	4.4
30/01/2007	24	E939041	50 45 506N	0 35 584E	14	1	70	4.1
30/01/2007	24	E939042	50 45 506N	0 35 584E	14	1	64	3.7
31/01/2007	25	E939043	50 47 600N	0 38 000E	13	3	70	4.2
31/01/2007	25	E939044	50 47 600N	0 38 000E	13	3	55	1.8
31/01/2007	25	E939045	50 47 600N	0 38 000E	13	3	51	1.5
31/01/2007	25	E939046	50 47 600N	0 38 000E	13	3	67	4.2
31/01/2007	25	E939047	50 47 600N	0 38 000E	13	3	84	8.1
31/01/2007	25	E939048	50 47 600N	0 38 000E	13	3	73	4.2
31/01/2007	25	E939049	50 47 600N	0 38 000E	13	3	74	6
31/01/2007	26	E939050	50 46 500N	0 38 500E	13	3	64	3.2
31/01/2007	26	E939051	50 46 500N	0 38 500E	13	3	67	3.2
31/01/2007	26	E939052	50 46 500N	0 38 500E	13	3	50	2
31/01/2007	26	E939053	50 46 500N	0 38 500E	13	3	69	4.4
01/02/2007	27	E939054	50 46 928N	0 38 991E	20	3	64	3.1
01/02/2007	27	E939055	50 46 928N	0 38 991E	20	3	50	1.4
01/02/2007	27	E939056	50 46 928N	0 38 991E	20	3	53	1.6
01/02/2007	27	E939057	50 46 928N	0 38 991E	20	3	73	4.3
01/02/2007	28	E939058	50 46 928N	0 38 991E	20	3	70	4.2
01/02/2007	28	E939059	50 46 464N	0 37 562E	20	3	96	11.5
01/02/2007	28	E939060	50 46 464N	0 37 562E	20	3	72	4.5
01/02/2007	28	E939061	50 46 613N	0 38 597E	20	3	74	5
01/02/2007	28	E939062	50 46 613N	0 38 597E	20	3	52	1.9
01/02/2007	28	E939063	50 46 613N	0 38 597E	20	3	67	3.9
01/02/2007	28	E939064	50 46 613N	0 38 597E	20	3	68	4.2
01/02/2007	28	E939065	50 46 613N	0 38 597E	20	3	66	4.3
01/02/2007	28	E939066	50 46 613N	0 38 597E	20	3	72	5
01/02/2007	28	E939067	50 46 613N	0 38 597E	20	3	68	4.2
01/02/2007	28	E939068	50 44 177N	0 30 767E	15	3	52	1.7
01/02/2007	28	E939069	50 44 177N	0 30 767E	15	3	57	2.3

Date	Station number	Howitt tag number	Release latitude	Release longitude	Water depth	Seabed type	Release length (cm)	Release weight (kg)
01/02/2007	28	E939070	50 44 177N	0 30 767E	15	3	73	5.2
02/02/2007	29	E939071	50 44 000N	0 30 100E	27	3	50	1.5
02/02/2007	29	E939072	50 44 000N	0 30 100E	27	3	75	4.8
02/02/2007	29	E939073	50 44 000N	0 30 100E	27	3	66	4.1
02/02/2007	29	E939074	50 44 000N	0 30 100E	27	3	51	1.5
02/02/2007	29	E939075	50 44 000N	0 30 100E	27	3	85	10.5
02/02/2007	29	E939076	50 44 000N	0 30 100E	27	3	70	4.2
02/02/2007	29	E939077	50 44 000N	0 30 100E	27	3	77	6.5
02/02/2007	29	E939078	50 44 000N	0 30 100E	27	3	79	6.4
02/02/2007	30	E939079	50 44 000N	0 30 100E	27	3	59	2
02/02/2007	30	E939080	50 43 100N	0 28 600E	27	3	73	6
02/02/2007	30	E939081	50 43 100N	0 28 600E	27	3	76	5.5
02/02/2007	30	E939082	50 43 100N	0 28 600E	27	3	68	4.5
02/02/2007	30	E939083	50 43 100N	0 28 600E	27	3	71	4.7
02/02/2007	30	E939084	50 43 100N	0 28 600E	27	3	70	4
02/02/2007	30	E939085	50 43 100N	0 28 600E	27	3	54	1.5
02/02/2007	30	E939086	50 43 100N	0 28 600E	27	3	65	4.2
02/02/2007	30	E939087	50 43 100N	0 28 600E	27	3	55	3.4

## Appendix 2. Biologically sampled cod

Date	Capture station	Length (cm)	Weight (kg)	Sex	Maturity stage	Otolith age	Stomach contents
06/01/2007	1	73	4	F	M	3	1 x bass,
06/01/2007	1	73	3.9	M	R	3	1 x velvet crab,
06/01/2007	1	69	3.6	F	M	3	1 x corystes , 1 x sea mouse
06/01/2007	1	69	3	F	M	3	1 x dragonet
06/01/2007	1	67	6.4	M	M	3	Empty
06/01/2007	2	66	2.9	F	M	3	1 x sea mouse , 1 x whiting, 1 x velvet crab
06/01/2007	2	73	4.1	M	M	4	1 x spider crab, 1 x UI fish, 1 x velvet crab
06/01/2007	2	68	3.1	M	M	3	E
06/01/2007	2	69	3.2	M	M	3	1 x velvet crab , 1 x sea mouse
06/01/2007	3	71	3.6	F	M	3	1 x UI fish, 1 x poggie , 2 x velvet crab
06/01/2007	3	70	3.2	F	M	3	UI fish
06/01/2007	4	74	3.5	F	M	3	Empty
06/01/2007	4	67	3.4	M	M	3	Empty
06/01/2007	4	69	2.7	F	M		2 x codling, 1 x UI fish
06/01/2007	4	65	2.1	F	I		Empty
06/01/2007	4	64	2.4	F	M		Empty
06/01/2007	5	53	1	F	I	2	2 x Hermit crab, 1 x slipper limit
06/01/2007	6	76	4.5	M	M	3	Empty
06/01/2007	6	66	2.3	F	I	3	1 X UI flat fish, 1 x velvet crab
15/01/2007	7	74	4.5	F	M	3	UI fish crab
15/01/2007	7	74	4.2	F	M	3	Herring
15/01/2007	7	58	2.5	F	I	2	Aphrodita, crab
15/01/2007	7	54	2.2	F	I	2	Empty
15/01/2007	7	51	1.5	F	I	2	Crab, UI fish
15/01/2007	7	65	3.5	F	M	3	UI fish
15/01/2007	7	68	3.5	F	M	3	Herring, UI fish
15/01/2007	7	78	5	F	M	4	Whiting, crab
15/01/2007	8	68	3.7	F	M	3	Aphrodita, crab
16/01/2007	10	77	5.4	F	M	3	UI fish
16/01/2007	10	75	5.4	F	M	3	UI crab
16/01/2007	10	71	4.6	F	M	3	Aphrodita, pout
16/01/2007	10	75	4.6	F	M	3	Swimming crab, whiting
16/01/2007	11	70	3.5	M	M	3	Empty
16/01/2007	11	72	5.4	F	M	3	Aphrodita, pout
16/01/2007	11	77	6.5	F	M	3	Brown crab
16/01/2007	11	74	4.9	M	M	3	Empty
16/01/2007	11	78	5.5	F	M	3	Crab, ui fish
16/01/2007	11	80	6.8	M	M	3	Aphrodita, corystes
16/01/2007	11	73	5	M	M	3	Empty
16/01/2007	11	69	4.2	F	M	3	Velvet crab, aphrodita
16/01/2007	12	68	4.5	F	M	3	Aphrodita
16/01/2007	12	72	4.8	M	M	3	Aphrodita, corystes
16/01/2007	12	74	4.8	F	M	3	UI fish
16/01/2007	12	73	5.1	M	M	3	UI fish
23/01/2007	14	83	6.2	M	M	4	Whiting
23/01/2007	14	71	4.5	M	M	3	Swimming crab, ui fish
23/01/2007	14	72	4.6	F	M	3	Herring, anenome, razor
23/01/2007	14	66	3.6	F	M	3	Velvet crab
23/01/2007	14	70	4.5	F	M	3	Velvet crab, UI crust
23/01/2007	14	64	3.4	F	I	3	Swimming crab, cdt one stone
23/01/2007	14	73	5.5	F	M	3	Empty

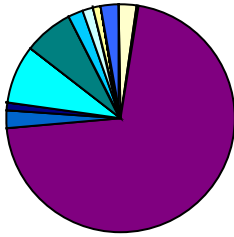
Date	Capture station	Length (cm)	Weight (kg)	Sex	Maturity stage	Otolith age	Stomach contents
23/01/2007	14	70	3.8	F	M	3	Swimming crab, prawn
23/01/2007	13	69	4.1	F	M	3	Brown crab, swimming crab, whiting
23/01/2007	13	73	4.2	F	M	3	UI crust, velvet crab
23/01/2007	13	70	3.6	F	M	3	Razor, ui fish
23/01/2007	13	49	1.3	F	M	2	Hermit
23/01/2007	13	55	1.7	F	I	2	UI fish
23/01/2007	13	49	1.4	F	M	2	UI fish
23/01/2007	13	49	1.5	M	I	2	Swimming crab
23/01/2007	13	46	1	M	I	2	Swimming crab
23/01/2007	13	49	1.1	M	I	2	Brown crab, swimming crab
26/01/2007	20	64	3.1	F	H	3	Empty
26/01/2007	20	64	3.3	F	M	3	Aphrodita, square crab, prawn
26/01/2007	20	74	4.5	M	M	3	Crab
26/01/2007	20	59	4	F	M	3	UI invert
26/01/2007	19	73	3.2	M	M	3	Empty
26/01/2007	19	74	4.5	M	M	3	Velvet crab
26/01/2007	19	71	4.7	M	M	3	Velvet crab
26/01/2007	20	64	3.5	M	M	3	Velvet crab
30/01/2007	24	78	7.5	F	M	3	Corystes
30/01/2007	24	46	1.5	F	M	2	Aphrodita, hermit
30/01/2007	23	50	1.5	M	I	2	Aphrodita, crab
30/01/2007	23	73	4.2	M	M	3	Dab
30/01/2007	23	75	5.3	M	M	3	Empty
30/01/2007	23	67	3.7	F	M	3	Aphrodita, crab, ui fish
30/01/2007	23	47	1.5	F	I	2	Shrimp, crab
30/01/2007	23	43	1	M	M	2	Anenome
30/01/2007	23	41	0.7	M	M	2	UI crust
30/01/2007	24	49	1	F	I	2	Empty
30/01/2007	24	71	4	M	M	3	Crab
30/01/2007	24	63	3.2	F	M	3	Crab, UI fish
30/01/2007	24	72	5	F	H	3	Empty
30/01/2007	24	72	4.2	F	M	3	Crab
30/01/2007	24	48	1.5	M	M	2	Crab
30/01/2007	24	47	1.2	F	I	2	Empty
30/01/2007	24	69	4	F	M	3	UI fish
30/01/2007	24	40	0.5	M	M	2	UI fish
30/01/2007	24	58	2.5	F	I	2	UI fish
01/02/2007	28	71	4.6	F	M	3	UI fish
01/02/2007	28	59	2.6	F	M	2	Empty
01/02/2007	28	51	1.6	M	I	2	Gobie
01/02/2007	28	71	4.3	M	M	3	UI fish
01/02/2007	28	69	3.4	F	M	3	Aphrodita, UI fish, poggie
01/02/2007	28	69	4.5	F	M	3	Empty
01/02/2007	27	71	4.1	M	M	3	Empty
01/02/2007	27	50	1.1	F	I	2	Large clawed crab
01/02/2007	27	51	1.6	F	I	2	Velvet crab
01/02/2007	27	44	1	F	I	2	Crab, hermit
02/02/2007	29	72	4.3	M	M	3	Swimming crab
02/02/2007	29	57	2.5	F	M	2	Sandeel
02/02/2007	29	74	5.2	F	M	3	Swimming crabs
02/02/2007	29	69	3.8	F	M	3	Crab
02/02/2007	30	69	4.1	F	M	3	Herring, limpet
02/02/2007	30	47	1	M	I	2	Aphrodita

### Appendix 3. Catch composition

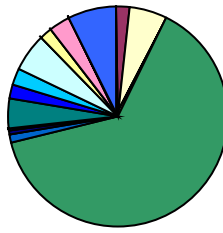
Species / Date	Quantity (kg)												Total
	06/01/2007	15/01/2007	16/01/2007	23/01/2007	24/01/2007	25/01/2007	26/01/2007	27/01/2007	30/01/2007	31/01/2007	01/02/2007	02/02/2007	
Bait fish		0.5		0.9		0.5	2			0.5	0.9	0.3	5.6
Bass		7.15	3.5	0	0	0	8.2	3.2	0	0	0	0	22.1
Brill	2.3	20.45	1.1	0	1.1	2.4	0.4	3.35	0.65	1	0	2.2	35.0
Claws	0.2	0.25	1	0.25	1	0.25		0.4	0.5		1	3	7.9
Cod (excl releases)	61.7												61.7
Cod (inc releases)		239.4	189.7	73.1	93.7	88.5	130.6	154.05	128.4	83.7	91.75	91.05	1364.0
Cod roe	2	4.75	8	1.8	1.5	3.5	5.25	2.5	2.25	5	1.25	1.2	39.0
Crabs											3.75		3.8
Dabs	1	2.5	1	0.5	1	0.15	0.3	0.6	4	2.75	3		16.8
Herring		0.1			0.25								0.4
Huss ungutted		2	0.5	0.5		1	2	4.75		0.8	4.5	4.5	20.6
Huss gutted	7.5												7.5
Lemon Sole			0.4										0.4
Lobsters					0.55		0.8				3.2		4.6
Plaice	6.15	15.55	5.15	0.7	8.1	2.5	1.65	5.75	27.75	20.5	11.65	2.3	107.8
Pollock	0	8	7.5	0	0	0	0	0	0	0	0	0	15.5
Pout	2	9.75	4	1.5	5.5	0.7	3.5	0.75	2	1	1.75	1.75	34.2
Skate	1.3	22.25	2.25	0	0	14	6.45	12.5	0	3.6	1.5	0	63.9
Smooth hound	0	0	0	0	0	0	105	15	2.5	0	5.5	0	128.0
Sole	1	5.73	0.45	9.98	4.4	0.79	0.85	0.35	2.65	0.54	1.09	0	27.8
Spur dog								4			18	14.5	36.5
Tope	0	12.5	0	0	0	0	0	0	0	0	36.5	0	49.0
Turbot									4.75				4.8
Whelks					0.25								0.3
Whiting	2.25	27.75	18.75	6.75	12.5	0.75	8.75	10.25	18.9	11.75	4.85	2.1	125.4
Wrasse							1						1.0

## Appendix 4. Percentage of catch composition per day.

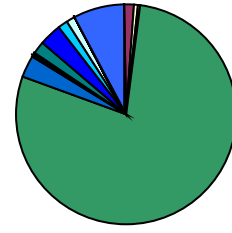
6th January 2007



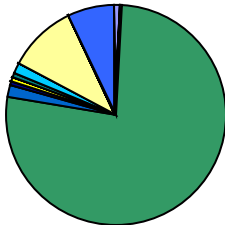
15th January 2007



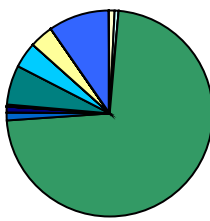
16th January 2007



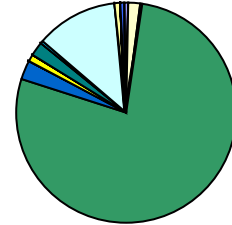
23rd January 2007



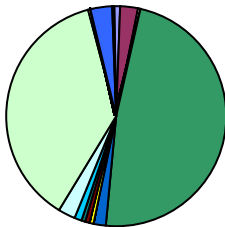
24th January 2007



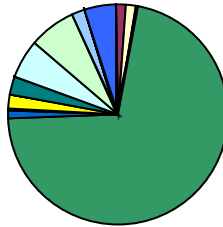
25th January 2007



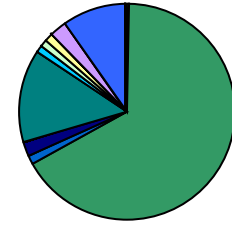
26th January 2007



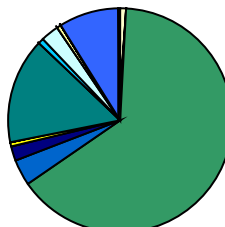
27th January 2007



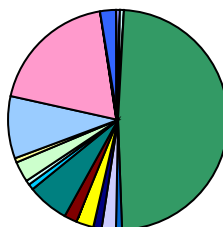
30th January 2007



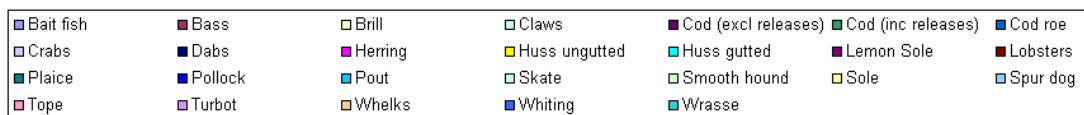
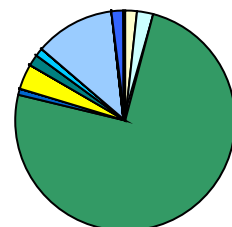
31st January 2007



1st February 2007



2nd February 2007



## Appendix 5. Fishing station details

Date	Station number	Latitude begin	Longitude begin	Latitude end	Longitude end	Depth	Seabed type	Weather conditions
6-Jan-2007	1	50 45 80N	0 27 84E	50 45 91N	0 28 77E	12	3	S/SW 3/4
6-Jan-2007	2	50 46 19N	0 29 11E	50 46 29N	0 29 39E	12	3	S/SW 3/4
6-Jan-2007	3	50 46 70N	0 31 04E	50 46 60N	0 30 65E	15	3	S/SW 3/4
6-Jan-2007	4	50 46 60N	0 30 51E	50 46 50N	0 30 18E	12	3	SW 3
6-Jan-2007	5	50 46 48N	0 30 03E	50 46 39N	0 39 78E	11	3	SW 3
6-Jan-2007	6	50 46 30N	0 29 42E	50 46 44N	0 27 79E	12	3	SW 3
15-Jan-2007	7	50 46 93N	0 31 13E	50 46 46N	0 29 70E	11	3	SW4
15-Jan-2007	8	50 46 44N	0 29 67E	50 45 89N	0 27 84E	11	3	SW4
15-Jan-2007	9	50 45 88N	0 27 79E	50 45 70N	0 27 04E	11	3	SW4
16-Jan-2007	10	50 46 46N	0 29 97E	50 46 30N	0 29 43E	12	3	S/SW7 Very rough
16-Jan-2007	11	50 46 16N	0 28 97E	50 45 74N	0 27 73E	11	3	S/SW7 Very rough
16-Jan-2007	12	50 45 92N	0 27 22E	50 45 69N	0 26 98E	12	3	S/SW7 Very rough
23-Jan-2007	13	50 47 22N	0 26 45E	50 47 67N	0 28 26E	9	2	NE8/9 Very rough
23-Jan-2007	14	50 49 13N	0 28 41E	50 49 64N	0 30 51E	7	3	NE8/9 Very rough
24-Jan-2007	15	50 49 28N	0 28 71E	50 49 72N	0 30 54E	10	3	N/E4/5 Snow
24-Jan-2007	16	50 47 39N	0 25 42E	50 48 06N	0 28 51E	11	3	N/E4/5 Snow
25-Jan-2007	17	50 46 30N	0 27 08E	50 47 04N	0 28 96E	11	3	NE6/8 Rough
25-Jan-2007	18	50 47 14N	0 26 05E	50 47 68N	0 28 05E	12	3	NE6/8 Rough
26-Jan-2007	19	50 46 57N	0 29 29E	50 47 04N	0 31 41E	10	2	N/W 3/4 Moderate to rough
26-Jan-2007	20	50 45 67N	0 25 64E	50 46 45N	0 28 49E	11	3	N/W 3/4 Moderate to rough
27-Jan-2007	21	50 45 98N	0 29 00E	50 46 62N	0 31 38E	10.5	3	N/W4/5
27-Jan-2007	22	50 43 93N	0 27 80E	50 44 47N	0 30 23E	15	3	N/W4/5
30-Jan-2007	23	50 47 55N	0 37 85E	50 46 78N	0 35 53E	13.5	3	N/W4/5
30-Jan-2007	24	50 45 68N	0 35 15E	50 46 44N	0 37 72E	14	1	N/W4/5
31-Jan-2007	25	50 46 41N	0 35 34E	50 47 23N	0 37 88E	13	3	W 4/5
31-Jan-2007	26	50 45 49N	0 35 59E	50 46 25N	0 37 98E	13	3	W 4/5
1-Feb-2007	27	50 43 66N	0 28 24E	50 44 13N	0 29 92E	20	3	W 4/5
1-Feb-2007	28	50 46 01N	0 36 75E	50 46 77N	0 39 29E	15	3	W 4/5
2-Feb-2007	29	50 44 61N	0 30 47E	50 45 21N	0 32 73E	27	3	Slight to moderate
2-Feb-2007	30	5043 44N	0 28 46E	50 44 14N	0 30 92E	27	3	Slight to moderate

**Appendix 6. Numbers of males and females per station.**

Capture station	Sex		Total
	Female	Male	
1	3	2	5
2	1	3	4
3	2	0	2
4	4	1	5
5	1	0	1
6	1	1	2
7	8	0	8
8	1	0	1
10	4	0	4
11	4	4	8
12	2	2	4
13	6	3	9
14	6	2	8
19	0	3	3
20	3	2	5
23	2	5	7
24	9	3	12
27	3	1	4
28	4	2	6
29	3	1	4
30	1	1	2
<b>Total</b>	<b>68</b>	<b>36</b>	<b>104</b>

## **Appendix 7**

**CENTRE FOR ENVIRONMENT, FISHERIES AND AQUACULTURE  
SCIENCE, LOWESTFOT LABORATORY, LOWESTOFT, SUFFOLK  
NR33 0HT.**

**Report:** FSP - eastern Channel cod.

**Prepared by:** Kevin Sullivan.

**Staff:** Kevin Sullivan / Stuart Hetherington.

**Duration:** 12 days between between 5<sup>th</sup> January 07 to 2<sup>nd</sup> February 07.

**Location:** Fishing from Sovereign Harbour in ICES area V11d, block 03.

### **Aims:**

To undertake a conventional tagging field programme on mature cod in spawning condition.

To identify and map possible spawning aggregations of cod in the eastern English Channel.

To undertake a degree of biological sampling to complement the assessment of possible spawning aggregations.

### **Narrative**

05/01/07. Cefas staff loaded the fieldwork equipment and travelled to Eastbourne and met with the Skipper, Mr Graham Doswell, to discuss the Detailed Operation Plan and logistics for the following day.

06/01/07. On arrival at Sovereign harbour, introductions to the skipper, Mr Graham Doswell and crewman Martin Wiltshire took place. The scientific equipment was loaded aboard the FV Halcyon, following a brief discussion of the protocols for the trip. The vessel then sailed to commence hauling of anchor nets set the previous day, by the skipper and crew.

Stuart Hetherington gave guidance on the protocol to be adapted for the remainder of the trip by Kevin Sullivan, the skipper and crewman. It should be noted that at this point the weather, although workable, was far from ideal. Reasonable results were achieved with a number of fish being successfully tagged and released, as well as a number of retained cod being biologically sampled as planned. Whilst the FV Halcyon returned to port, the weather worsened and a joint decision was made to wait for an improvement in the weather conditions, before continuing with the remainder of the trip.

The Cefas staff returned to Lowestoft with Stuart Hetherington leaving the cruise at this point to continue electronic tagging in the western English Channel.

13/01/07. Kevin Sullivan returned to Eastbourne.

14/01/07. Kevin Sullivan with skipper & crew sailed on the FV Halcyon and reset the nets for the commencement of tagging the following day at Pevensey Shoals.

15/01/07. The weather conditions were very poor, but judged safe by the skipper. As predicted by Graham Doswell the nets had fished well " fish tend to move inshore in bad weather and offshore as weather calms". 36 cod were tagged and released from 10 fleets of nets. The fleets of nets were hauled and then re-shot in new positions, with fish releases being away from the set nets. The conditions were not suitable for working on deck on the return journey to the harbour. A number of retained cod were sampled at the quayside, but failing light brought the work to a close.

16/01/07. Sailed and continued as the previous day. Weather S/SW 7. A further 17 fish tagged in very difficult conditions. The FV Halcyon returned to port, with the weather forcing an end to this block of the survey.

23/01/07. Recommenced the 'cruise', with five full days achieved with better weather during the last 2 days. A good working partnership was achieved during this time.

A small weather window prompted a call from Graham Doswell (skipper) to restart the project on 30/01/07. Fishing continued as before with the exception of damage to one net on hauling, which was replaced the following day. The sea time of this FSP project finished on 02/02/07.

## **Results**

Conventional tagging targets were achieved and exceeded.

Fin clips and otoliths collected for DNA and age processing.

Some very useful data collected throughout the entire survey and a very useful fisheries partnership developed in this area with the local fishermen.

Data entered electronically and forwarded to Stuart Hetherington for later analysis and inclusion into the interim report.

K. SULLIVAN.  
8<sup>th</sup> March 2007

## **Appendix 8.**

Fisheries Science Partnership: FSP (2006-7)  
Eastern Channel cod.

### **Detailed operations plan.**

#### **1. Identification of the locations of spawning aggregations of cod in the eastern English Channel.**

The following locations are based on Mr Doswell's past experience and are to be fished with the intention to identify and map spawning aggregations of cod.

- Beachy Head overfalls.
- East of the Royal Sovereign bank.
- Pevensey shoals / West Hards.

These locations are subject to change (after consultation) if circumstances dictate, but ideally they would remain unchanged. Beachy Head will best be fished in slack tides.

As the tidal state and weather conditions will vary on a daily basis, it will be the Skipper, Mr Doswell, who ultimately decides which of the 3 locations are fished during each of the 12 days. An equal amount of fishing effort must be applied to each of the 3 locations.

#### **2. Duration & timings of the fishing operations.**

The following dates are provisional, to be confirmed no later than the 5<sup>th</sup> December 06. The standby dates have been built in to accommodate days lost at sea to severe weather or mechanical failure. The dates are;

Block 1: 12<sup>th</sup> – 15<sup>th</sup> December 2006. Standby 3<sup>rd</sup> – 6<sup>th</sup> January 2007.

Block 2: 16<sup>th</sup> – 19<sup>th</sup> January 2007. Standby 28<sup>th</sup> – 31<sup>st</sup> January 2007.

Block 3: 6<sup>th</sup> – 9<sup>th</sup> February 2007. Standby 13<sup>th</sup> – 16<sup>th</sup> February 2007.

#### **2. Mapping of the spawning aggregations.**

The mapping of the spawning aggregation in each location, must not be detrimental to the number of cod caught, as the other aim of undertaking a conventional tagging exercise is of equal importance.

For each of the 3 locations Mr G. Doswell will initially fish the gear in the manner that will typically achieve the maximum catch, from each location. This will be based on Mr Doswell's past experience of fishing the above-mentioned locations. From this point onwards, the gear will be situated and fished in a northerly, easterly, southerly and westerly location, from the initial

location until the catch reduces by 50%, in each case. This will determine the inner extremities of the aggregations.

It is expected that the weather and proceeding season will effect the location of the aggregations on a regular basis and that they may readily shift location as the survey proceeds.

The nature of the habitat (hard/ soft ground) of the aggregation will be identified using the vessels echo sounder.

#### **4. Fishing activity.**

Initially the fishing gear must be as stated in the ITT. A combination of monofilament gill nets and trammel nets, with an equal number of each type of net fished. Ideally 10 nets in total will be fished (5 gill nets & 5 trammel nets), with each net being approximately 400 yards in length.

This initial fishing period will allow the Cefas Scientist on board the vessel, along with Mr Doswell, to assess the survival and catchability of cod, greater than 50 cm in length, for each gear type. The preferred gear is then to be used for the remainder of the survey, with a minimum of 10 nets (each of 400 yards long) to be fished per day.

A mixture of soak times are to be used (i.e. overnight & over tide).

#### **5. Collection of data and biological samples.**

A minimum length of 50cm will ensure that all cod tagged & sampled will be mature fish capable of spawning. This minimum length has been derived from maturity ogives data collected between 1977 and 2005 (International Bottom Trawl Survey) which confirms 50cm in length to be consistent with mean size at 50% maturity (ICES, unpubl. data).

All fish > 50cm, caught in the location of an aggregation will be;

- Measured
- Weighed
- Sexed
- Photographed
- Conventionally tagged

A minimum of 60 individuals are to be tagged, where possible, in each aggregation identified. Any cod (> 50cm) which are unsuitable for tagging, will be sampled as follows:

- Measured
- Weighed
- Sexed
- Maturity stage
- Otolithed
- Photographed
- Fin-clipped
- Stomach contents

All fish at or above legal marketable size, which are not tagged, can be landed off-quota, subject to dispensation.

## **6. Organisational and logistical requirements.**

- 6.1. The crew aboard the FV Halcyon will be required to assist in sorting the catch as required by the Cefas scientist aboard the vessel.
- 6.2. The daily fishing activities must allow for a minimum of 2 x 0.5 hour rest periods for the scientist aboard the vessel.
- 6.3. Embarkation & disembarkation points for the vessel will be the West quay of Sovereign harbour, Eastbourne.
- 6.4. 48 hours notice will be provided by Mr Doswell to Mr Hetherington on a 'go / no-go' decision for each survey block of 4 days.
- 6.5. If a day(s) at sea is lost due to adverse weather conditions &/or mechanical failure then the following procedure must be applied.
  - 6.5.1. The day(s) should be 'rolled on' to the next survey block  
or
  - 6.5.2. rescheduled for later in the same month at the earliest possible convenience, if
    - its in the month of February,
    - the accumulation of days is impractical for a 'roll on',
    - an entire survey block of 4 days is lost.
- 6.6. Cefas is to seek a dispensation to cover all possibilities that could hinder the FSP survey, i.e. closure of the fishery.
- 6.7. The vessel will provide a safe working deck area of four square metres, which will be uncluttered and well lit under all sea conditions.

## Appendix 9

### Fisheries Science Partnership

- eastern Channel cod



### Reward\*

As part of a FSP project, several hundred cod tagged with distinctive external (orange) tags have been released into the eastern English Channel.  
**It is essential that we recover as many as possible.**



**\*£6 reward (plus the market value of the fish, if returned) and any postage incurred**

**We thank you for your help and co-operation**

Please return the tag and ideally the whole fish, together with the details of time and place of capture to:  
Centre for Environment, Fisheries & Aquaculture Science (Cefas),  
Pakefield Road, Lowestoft,  
Suffolk NR33 0HT UK  
Tel: +44 (0) 1502 524526  
[www.cefas.co.uk/fishtagreturns](http://www.cefas.co.uk/fishtagreturns)



## **Appendix 10**

### **Skipper's report for the FSP project – eastern Channel cod.**

**Vessel:** Halcyon NN 114. 10 mtr Netter.

**Skipper:** Graham Doswell.

**Deck Hand:** Martin Wiltshire.

**Cefas staff:** Stuart Hetherington / Kevin Sullivan.

#### *Narrative:*

A preliminary meeting was held between Stuart and I at the Eastbourne Fishermen's Club to discuss the details and structure of an operations plan for the FSP project, eastern Channel cod. Later, onboard Halcyon we discussed the layout of the tanks, equipment and the safest position for the scientists to work on deck.

The operations plan called for 1 block of 4 days fishing in each month of December 06, January 07 and February 07, with the option of rolling over lost days. The weather experienced in December 06 was very unsettled with near continuous gales. Although we managed 10 days fishing, most were in horrendous conditions that would have been neither safe nor suitable for the FSP work. Therefore we were not able to put to sea for the FSP project during December 06.

The nets were shot away in the morning of 5<sup>th</sup> January 07 in the area around Pevensey Shoals and down to the West Hards. This location was chosen due to the poor weather at the time and the forecasted gales, for later the following day. Later that day I met up with Stuart and Kevin to finalise details, nets, safety issues, time of sailing, etc.

We left the quay at 0730 the following morning (6<sup>th</sup> January 07) with Stuart and Kevin aboard and started working the gear at around 0845 in a stiff southerly breeze. The weather gradually deteriorated throughout the day to such an extent that the scientists were unable to continue working. We hauled the last fleet aboard and returned to the harbour. Considering the ground swell that was left in the water from the previous day's gale and that some of the nets had driven up, some good fish were caught, tagged and successfully released.

The weather continued in the same vein for the following week with storm force winds keeping the local fleet tied up. We had hoped to shoot the gear away on the 13<sup>th</sup> January 2007, but again the sea was too rough, so we decided to leave it until the following day. Again we headed for Pevensey Shoals to Bexhill /Galley Hill area, where we would be in the lee of Beachy Head for the tagging work the next day.

We sailed from Sovereign Harbour at 0730 on 15<sup>th</sup> January 2007, in a westerly 7 to 8. Good fishing in all fleets led to our best days tagging, with 36 good fish released. We moved position within the area and shot the nets back. The next morning the wind had opened up to S/SW force 7, a very difficult day for all aboard the Halcyon, especially Kevin who still managed to tag and release 17 cod. We returned to the harbour with the nets on deck. Kevin returned to Lowestoft.

We returned to Pevensey Shoals/ West Hards area on the 22<sup>nd</sup> January 2007 for the final days fishing on 23<sup>rd</sup> January 2007, to complete the first block of 4 days.

We moved to the next fishing area, West Shingle Bank/ East Sovereign Shoals and redeployed the nets. We fished for a further 4 days in that general area, the weather conditions were difficult but improved for the last couple of days (26<sup>th</sup> – 27<sup>th</sup> January 07) with good numbers of fish tagged and released. Kevin returned to Lowestoft, Martin and I continued fishing, making the most of the break in the gales.

On Monday 29<sup>th</sup> January 07, Stuart and I discussed the option of bringing forward the final 4 days fishing to the east of the Shingle Bank, off Hastings Old Town, while the weather was still holding. Stuart gave us the go-ahead so we moved 8 miles east from our position at that time and Kevin travelled down for a start on the 30<sup>th</sup> January 07.

By the end of the 31<sup>st</sup> January 07, it looked as if we may fall short on numbers of fish tagged and returned for the final block. I decided to move some of the effort back to the west, this proved to be the right move with poor results from the east on the 1<sup>st</sup> February 2007. The last days fishing was with all the nets back at the west side of the Shingle Bank with good results overall.

#### *Comments on the report.*

I have read the report prepared by Stuart Hetherington, Victoria Quayle and Kevin Sullivan and found it to be an accurate account of the FSP project we have undertaken. The report states that major spawning areas for cod have not been identified or mapped, to date, in the eastern English Channel. I feel that the unprecedented severity of the weather during the winter of 2006/07 made the task impossible. Clearly defining aggregations of spawning cod may be possible during “normal winters” with lower sea temperatures and longer settled spells of cold weather.

#### *General comments.*

It is my opinion that sea temperature has always had a marked effect on the success of our local seasonal fisheries, none more so than on the cod which are caught between mid September and mid April during a ‘normal cold winter’. The autumn/winter of 2006-2007 proved to be the worst spell of

continuous storms and gales I can remember, with unusually high sea temperatures throughout. These high temperatures appear to have delayed the cod moving inshore. The minimum recorded winter sea temperature at the Pevensey Bay weather buoy was 8 degrees C, in February 2007, compared to a constant 5 degrees in February 2006 and a minimum of 4 degrees C, in March 2006.

In my experience the movement of mature cod (September to April) in the eastern English Channel tends to be from north to south in direction and often onto the harder ground as the weather settles and the water clears (vice versa during gales). Rather than confined aggregations of spawning cod, the mature and hyaline fish appear to be well distributed throughout the area. This was backed up from anecdotal evidence from other fishermen working 25 miles to the west of us during the period we were tagging.

In years of 'normal' water temperatures, we often land 10% by weight of cod roe to gutted landed weight of cod during January. By the end of January and into February a high proportion of the mature fish have watery roes and seem to disappear within a few days.

G. Doswell  
8<sup>th</sup> May 2007.