

Interim Report

***Atlantic Cod Tagging Study:
North Thames Estuary***

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Summary: North Thames Cod Tagging Programme 2010

The FV Harvester was chartered between February and March 2010 as part of the FSP North Thames cod tagging programme. The aim of the programme was to investigate spatial movements of adult cod, a species known to aggregate annually between January and March (during spawning) in the North Thames and Shipwash area. In all, 233 cod were captured during the study with a mean length of 61 cm (± 10 cm) and a mean weight of 3 kg (± 1 kg). Of these, 217 were tagged externally with plastic mark-recapture tags (T-bar anchor tags), and another 14 were tagged internally with electronic data storage tags (DSTs) before being released back to the wild within close proximity of their capture position. Of the 233 cod captured, 203 were classed as adults based on maturity ogives derived from International Bottom Trawl Survey data (ICES, 2005). The cod caught were mainly mature females (61%), with just a few males readily identified (3%) and a further 36% for which the sex could not be determined.

To date (20 May 2010), 12 marked/tagged cod have been recaptured and were at liberty between 6 and 61 days (± 15 days). They had travelled between 3 and 136 km in a straight line (± 34 km). The greatest distance travelled (136 km) was by a cod at liberty for 25 days before being recaptured in the eastern English Channel by a gillnetter 3 miles off Hastings in the neighbouring ICES management area, VIId.

Introduction

Atlantic cod are distributed widely throughout the North Sea and, as do other commercial marine species (such as plaice and sole), undertake seasonal changes in their distribution as a result of migration between spawning and feeding grounds (Graham, 1948; Bedford, 1966; Daan, 1978). In general, spawning sites for cod around the British Isles are well understood, and several distinct spawning grounds are considered to be present in each ICES stock area (Jones, 1981). Genetic studies have also demonstrated subpopulation structuring of cod within the North Sea (Hutchinson *et al.*, 2003). The importance of understanding migratory movements of subpopulations within commercial stocks is becoming increasingly recognised (Hunter *et al.*, 2004; Metcalfe *et al.*, 2006), and Righton *et al.* (2007) described the spatial movements of cod in the southern North Sea (ICES Division IVc) and eastern English Channel (VIId) by re-evaluating historical mark-recapture data (1964–2006) and undertaking new electronic tagging experiments. Results from that analysis showed that adult cod tagged in IVc during the spawning season have a strong pattern of seasonal northward movement to feeding grounds in the central North Sea (the neighbouring IVb) during spring and summer. In contrast there appears to be little movement south of post-spawning IVc cod to feeding grounds in the eastern English Channel (VIId) during spring and summer.

To date, historical and recent mark-recapture studies on cod in the southern North Sea have focused heavily upon spawning aggregations to the north and south of the Thames estuary (i.e. off the coast of Lowestoft and Folkestone, respectively). There have been no mark-recapture studies specifically undertaken upon adult cod within a known coastal spawning aggregation in the north Thames estuary and Shipwash area, and the local movements of these cod have not been described. With an increasing number of international reports describing the importance of local coastal aggregations and subpopulations of cod (Hutchinson *et al.*, 2003; Righton *et al.*, 2007, 2008; Bendall *et al.*, 2009), a greater knowledge of the north Thames estuary cod spawning aggregation would likely prove valuable in further establishing

seasonal spatial movements of cod subpopulations within the southern North Sea. It was therefore proposed and agreed that a Fisheries Science Partnership study be undertaken to tag mature adult cod within the north Thames estuary during the months January–March 2010 (the spawning season) to develop an understanding of local cod movements and seasonal distribution. Local fishermen and scientists want to know how the adult cod spawning in the north Thames and Shipwash region mix with other cod subpopulations to the north and south within IVc (southern North Sea).

This is an interim report that focuses upon details of the external mark–recapture tag and internal data storage tag (DST) releases on cod during the study, together with preliminary results from tagged cod returned up to the end of May 2010. A final report in ~12 months' time will be provided when more tags are expected to have been returned.

The detailed Operations Plan (DOP) for this FSP project was finalised between Cefas and the skipper of the FV Harvester, Clive Mills, on 2 December 2010, and is reproduced in Appendix 1.

Within this FSP project the primary aims were to

- investigate the movements of adult cod in the locality of the North Thames and Shipwash area.
- tag and release adult cod (>50 cm long) within the north Thames and Shipwash area during the spawning season. In all, ~300 external plastic mark-recapture tags (T-bar anchor tags) were expected to be deployed together with ~15 electronic data storage tags (DSTs).

Methods

Field study design

The field study was designed to catch and tag ~300 mature adult cod (>50 cm long, based on maturity ogives derived from International Bottom Trawl Survey data collected between 1977 and 2005 (ICES, 2005)) with external plastic T-bar anchor tags, and ~15 DSTs. In all, 12 days at sea were split into three trips between January and March 2010 to coincide with the north Thames spawning aggregation of cod.

Areas fished were based upon years of local knowledge and experience of fishermen catching cod within the north Thames region, between west Mersea and Shipwash, within 10 miles of the coast of East Anglia (Figure.1).

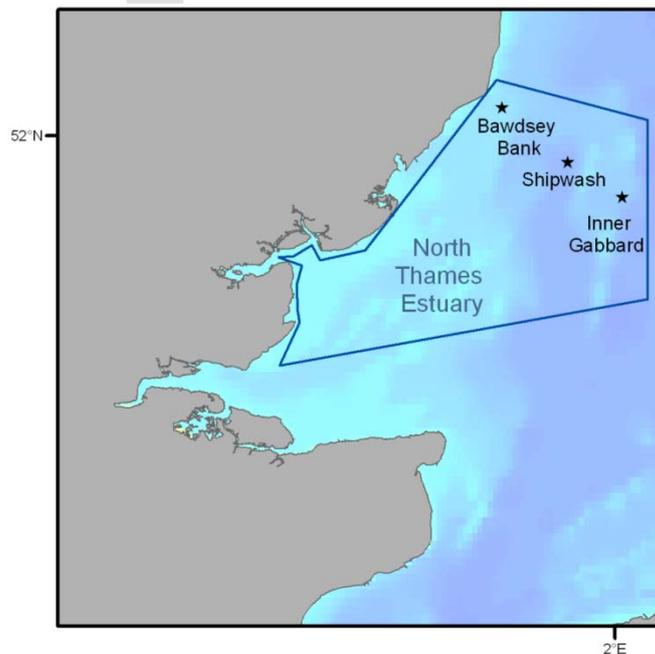


Figure 1. Map showing the area where fishing was undertaken on nearshore fishing grounds, within 10 miles of land, in the north Thames / Shipwash area.

The field study detailed in the DOP (Appendix 1.) had to be modified during the course of fishing operations owing to disruption caused by bad weather. Planned dates and sailings had to be adjusted to coincide with limited periods of good weather, and with knowledge of a lack of sufficient numbers of cod on the inshore grounds. The extreme cold weather and unusually high run-off of snow-melt and freshwater throughout January and February 2010 meant that adult cod seemed to aggregate farther offshore (~30 miles) in deeper water, with only a limited number appearing to enter estuarine waters (based on local fisheries knowledge and catch rates during this period; commercial landings data for this period will be documented in the final report and compared with previous years).

Fishing vessel, gear and activity

The FV Harvester is an under 10 m bottom trawler with a 115 kW engine. The trawl gear used throughout the field study was a 18 m (10 fm) Boris Box Trawl with 27 m (15 fm) sweeps, a 20 cm (8") mesh size entry, 10 cm (4") mesh in the wings, 120 mm meshes in the sleeve and codend, 30 cm (12") hopper discs and No.4 Bison doors.

Fishing activity per day was aimed to allow for approximately five variable short bottom tows, to ensure greatest survival and fitness of mature cod. The net was shot over the stern of the vessel and towed for 1–1½ h before being hauled slowly to the surface to avoid rupture of the swimbladder of any cod caught. The net was brought aboard, the codend emptied into 1000-l deck tanks of seawater, and manually sorted for mature cod (see Figure 2a).

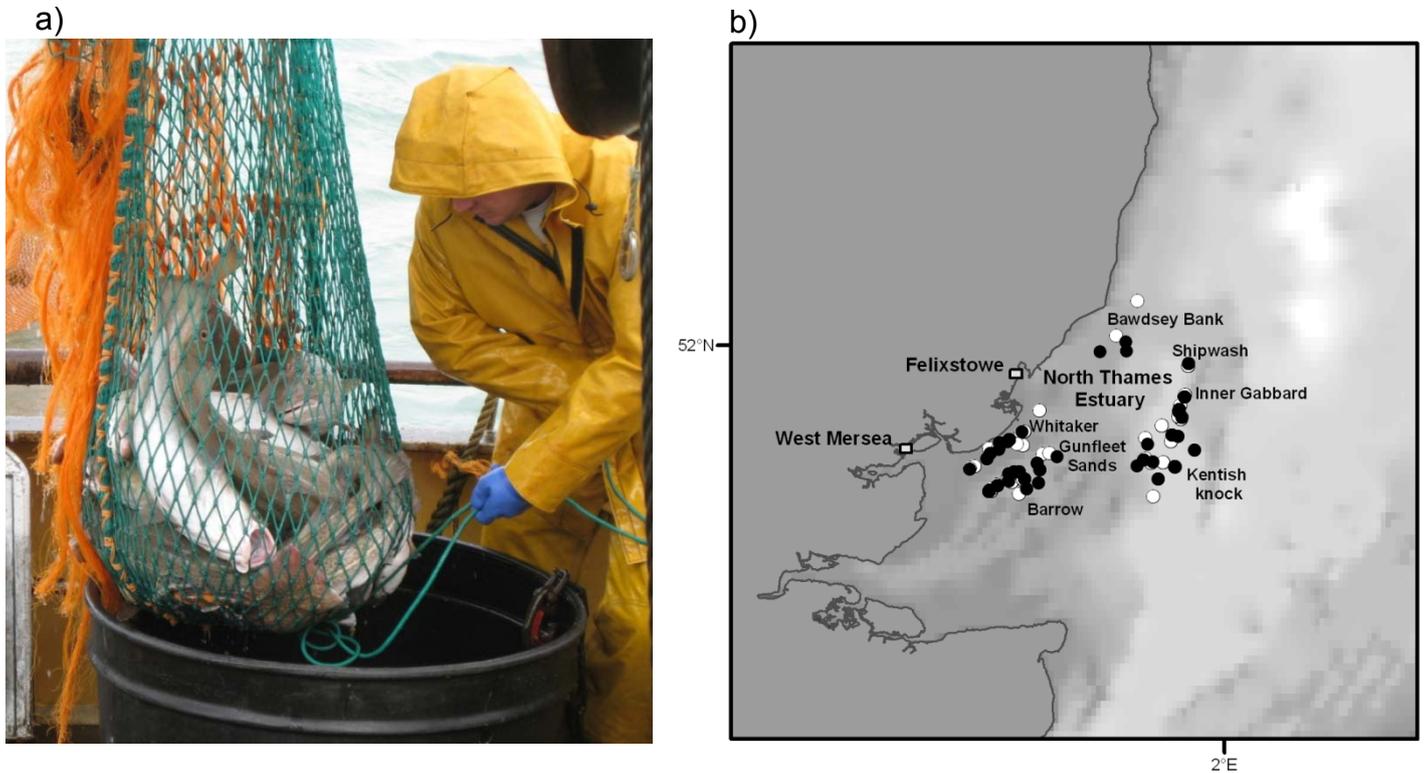


Figure 2. (a) A haul of cod about to be emptied into a deck tank for manual sorting. (b) Shoot (white circles) and haul (black circles) positions of Boris Box bottom trawl throughout the course of the 12 days.

After being hauled aboard and emptied, the net was again shot, to allow continued fishing activity while any suitable cod from the previous catch were measured (for length and weight), sexed (where possible), tagged and released. All shoot and haul positions undertaken throughout the north Thames estuary over the 12 study days are shown in Figure 2b, together with the named principal fishing ground areas.

Tagging procedure

Between February and March 2010, mature adult cod were tagged and released primarily within ICES rectangle 32 F1 of the North Thames Estuary. Cod in seemingly fit condition were placed into separate 1000-l deck tanks prior to being tagged, to assess their fitness and state of inflation of the swimbladder. All cod that were caught were found to be in very good condition, and all were suitable for subsequent release. However, despite being hauled onto the deck slowly, most cod still showed overinflation of their swimbladder, which required deflation with a hollow needle in order for the cod to retain natural buoyancy within the deck tanks. Cod suitable for tagging (length >45 cm) were measured, weighed and placed into a 'V-shaped' channel foam block which was kept wet with seawater. Then, a wet cloth was placed over the head and operculae of the fish before they were double-tagged with an external T-Bar anchor tag, as shown in Figure 3.

a)



b)



Figure 3. (a) T-bar anchor tag gun being inserted into the dorsal musculature of a mature cod. (b) Mature cod double-tagged with external T-bar anchor tags.

In addition, 14 cod were tagged with internal DSTs (Figure 4). The cod were first anaesthetized in a shallow (20 cm) bath containing 2-phenoxy-ethanol (0.5 ml l^{-1}), before being placed on the 'V-shaped' foam block with a constant flow of seawater pumped across the gills. The DST was then surgically implanted into the peritoneal cavity (details in Righton *et al.*, 2006). A spaghetti tag attached to the DST was then placed through the lateral body wall using a curved needle.

For the first 100 cod, a small fin-clip was taken from the third dorsal fin and preserved in 95% ethanol in a 5 ml Eppendorf container. Finally, all cod were placed into a recovery tank before release.

a)



b)



c)



d)



Figure 4. Data storage tag (DST) surgery. (a) Small incision being made into the peritoneal cavity of cod; (b) insertion of the DST into the peritoneal cavity; (c) insertion wound being closed by stitching with medical grade sutures; (d) wound after surgery and prior to antibiotic powder seal; note the external spaghetti tag shown to the side of the flank which is directly attached to the internally placed DST.

Reward scheme

In order to encourage the recovery of information on the recaptured tagged cod, a reward scheme was established throughout the commercial fisheries of the UK and the EU. A reward poster and T-shirt were specifically designed for the north Thames cod tagging study with the intention of raising the profile of the work within the local fishing industry and detailing the project objectives and how to return tags and fish back to the Cefas laboratory. Reward posters were distributed widely to Marine Fisheries Agency and Sea Fisheries Committees offices, and to local port offices. A copy of the poster and a picture of the T-shirt is given in Appendix 2.

Tag returns

For all tags returned with their fish, as much recapture information as possible was obtained, including the receiving port, tag number, vessel name, gear type, nationality, date, capture position (latitude and longitude), and any other relevant information.

On the return of whole or gutted tagged cod to the laboratory, the carcasses were examined to evaluate any wounding caused by the tags, the recapture length and weight were measured, and the otoliths removed for ageing. If the fish was returned whole, the sex, maturity stage, condition of liver (parasites, etc.) and stomach contents were also examined.

When all the recapture information had been processed, a reward of £6 (plus the market value of the fish if it was returned), any postage costs, a promotional T-shirt, posters and project summary were sent to the returnee with a letter of thanks. If a DST-tagged cod is returned, a reward of €100 will be paid (for tag and fish) and entry into the Cefas Annual Tag Lottery prize draw of £1000.

Analysis of fish movements for mark–recapture tag and DST recaptures

Movement parameters (derived from Jones, 1976), were calculated using the release and recapture dates and positions for each recaptured cod from mark–recapture tag returns.

Values of distance travelled in km (r), duration in days to recapture (t), bearing in degrees north θ , northward movement $r(N)$ in km ($r \cos \theta$), eastward movement $r(E)$ in km ($r \sin \theta$) and the average distance in km travelled per day (velocity (V) r/t) were calculated for each recapture as follows:

Overall bearing north (degrees),

$$\Psi = \frac{\sum_1^n \theta}{n}$$

Total eastward movement (km),

$$R(E) = \sum_1^n r(E)$$

Total northward movement (km),

$$R(N) = \sum_1^n r(N)$$

Mean velocity (km d^{-1}),

$$V = \frac{\sum_1^n v}{n}$$

Results

In all, 233 cod were captured during the study, with a mean length of 61 cm (± 10 cm) and a mean weight of 3 kg (± 1 kg). Figure 5 shows the overall length/weight frequency distribution.

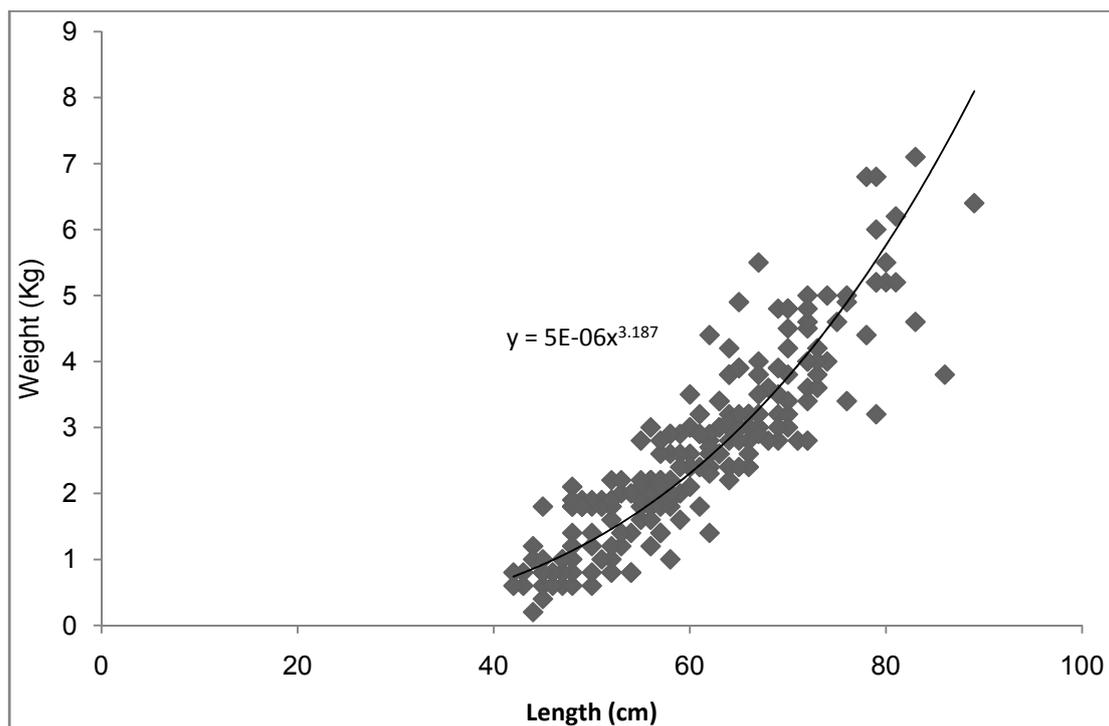


Figure 5. Length–weight frequency distribution of all 233 cod captured during the course of 12 field study days in the North Thames Estuary between February and March 2010. (Note: the broad scatter of length/weight data is probably attributable to weighing of fish on board the vessel using a Newton balance, and the variation in spawning condition)

Of the 233 cod, 203 were classed as adults (>50 cm long) based on maturity ogives derived from International Bottom Trawl Survey data (ICES, 2005). The cod caught were mainly mature females (61%), with just a few males readily identifiable (3%) and a further 36% for which the sex could not be determined (see Table 1). Unfortunately, there was little opportunity to sample the cod biologically (only two cod were so handled) as detailed in the DOP (Appendix 1), owing to the small numbers of cod caught throughout the study. Priority was therefore placed on external tag and release of all cod caught in good condition. However fin-clip samples were taken from the first 100 cod captured to allow for the possibility of future genetic studies on cod subpopulations in the southern North Sea. Other species taken as bycatch during the study are detailed in Appendix 3.

Cod Size	Tag Type	Male	Female	Unknown	Total.No	% Male	% Female	% Unknown
<50cm (Juvenile)	Marker	1	13	16	30	3	43	54
	DST	0	0	0	0	-	-	-
	Total	1	13	16	30	3	43	54

>50cm (Adult)	Marker	4	120	63	187	2	64	34
	DST	1	9	4	14	7	64	29
	Bio sample	0	2	0	2	-	100	-
	Total	5	129	67	203	-	-	-
Total Cod	Marker	5	133	79	217	2	61	36
	DST	1	9	4	14	7	64	29
	Bio sample	0	2	0	2	0	100	0
	Total	6	144	83	233	3	61	36

Table 1. Summary details of sex and maturity class (<50 cm cod were classed as juvenile, and >50 cm cod as adult) for all cod caught within 12 field study days aboard FV Harvester between February and March 2010.

Mark-recapture tagged cod

In all 217 cod were tagged and released with external T-bar anchor tags over the 12 study days. Figure 6 illustrates the distribution and numbers of cod caught and released per bottom trawl tow with mark-recapture tags. Record details for each

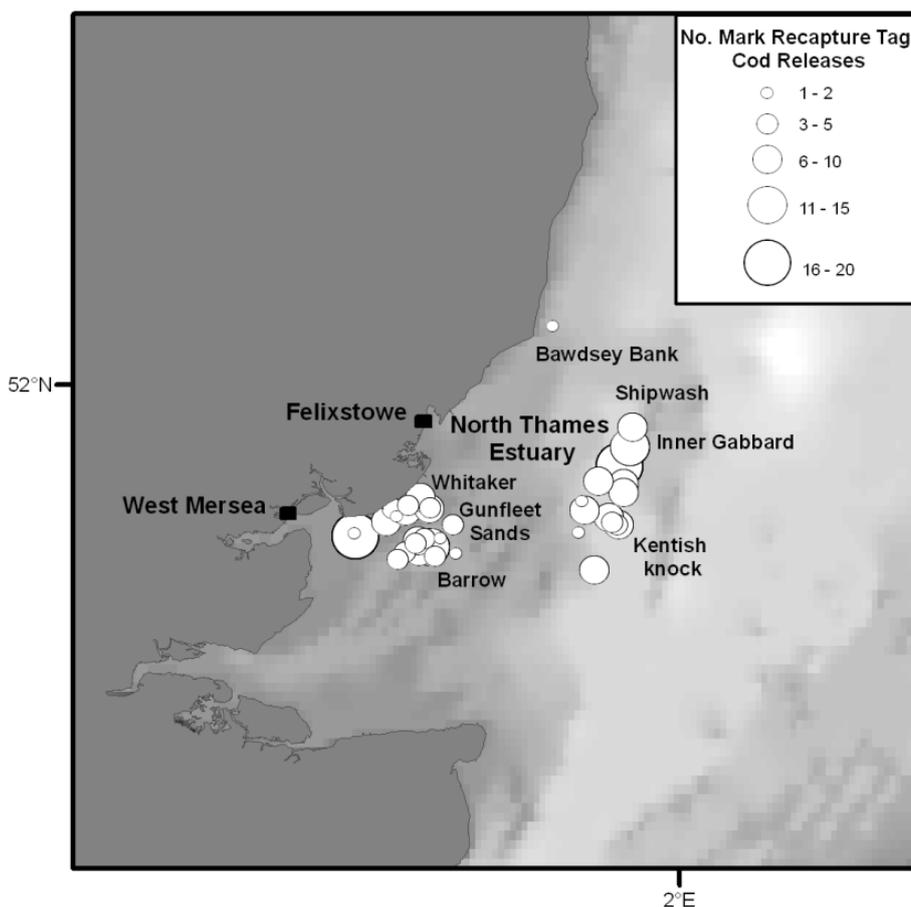


Figure 6. Map showing the number of mark-recapture tagged cod by area of release

To date (20 May 2010), 12 cod (6%) have been recaptured, and they were at liberty between 6 and 61 days (± 15 days) and travelled between 3 and 136 km (± 34 km), measured in a straight line. Full details given in Table 2.

Tag Id.1	Tag Id.2	Release Date	Recapture Date	Days at Liberty	Lr (cm)	Lc (cm)	Distance (km)	Sex & Condition	Gut Contents
E012837	E012838	21/03/2010	15/04/2010	25	67	65	136	Unknown	Fish discarded by fisherman
E012561	E012562	11/03/2010	07/04/2010	27	52	-	31	Male	Fish in freezer to process!
E012978	E012979	24/03/2010	08/04/2010	15	58	59	16	Unknown	Fish discarded by fisherman
E012565	E012567	11/03/2010	17/03/2010	6	57	58	3	Female	Fish discarded by fisherman
E012555	E012556	11/03/2010	11/04/2010	31	54	55	35	Female, spent	4 x Vertebra columns of UI fish, sea mouse
E012914	E012915	24/03/2010	30/04/2010	37	52		49	Female	Fish in Freezer to process!
E012754	E012755	23/03/2010	20/04/2010	28	62	60	32	Female, spent	Squid (possibly bait from long-line!), UI worm. Liver very pale and full of nematodes
E012873	E012874	21/03/2010	07/04/2010	17	62	60	26	Female	Fish gutted before return to lab
E012505	E012506	08/02/2010	10/04/2010	61	67	68	18	Female, spent	5 crabs (whole), sea mouse, Squid (possibly bait from long-line!), UI bivalve. Liver very pale and full of nematodes
E012856	E012857	21/03/2010	16/04/2010	26	63	62	35	Male, spent	Squid (possibly bait from long-line!), crab claw. Liver very pale and full of nematodes
E012701	E012702	23/03/2010	16/04/2010	24	67	67	31	Female	Fish gutted before returned to lab
E012659	E012660	12/03/2010	01/05/2010	50	55	-	65	Female	Fish in freezer to process!

Table 2. Details of the recaptured cod tagged and released with external T-bar anchor tags in the North Thames Estuary between February and March 2010. Lr and Lc refer to length at release and recapture respectively. Distance (km) relates to the distance between release and recapture positions, in a straight line. (-) indicates unavailable data.

The greatest distance travelled in a straight line (136 km) was by a cod at liberty for 25 days before being recaptured in the English Channel by a gillnetter 3 miles off Hastings in the neighbouring ICES management area (VIId). Figure 7 shows the release and recapture positions for the 12 mark-recapture cod returned to date, and Table 3 shows their movement parameters. Average time at liberty before recapture was 29 days (± 14 days) with an average distance of 40 km (± 34 km). Overall, the direction of cod movement away from the release site was northwards (with a bearing of 13 degrees), at least for the cod recaptured.

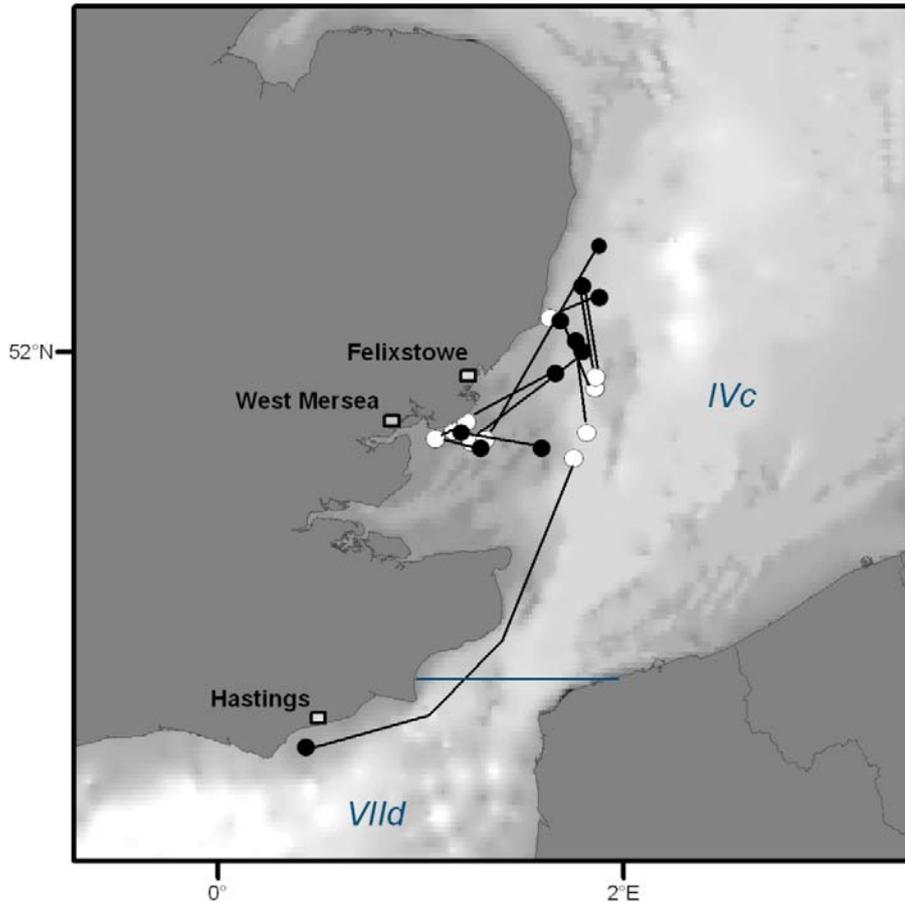


Figure 7. Release and recapture positions of 12 mark–recapture cod tagged in the North Thames Estuary between February and March 2010. White circles show the the release positions and black dots the recapture positions.

Recapture movement parameters	
Total number of fish	12
Total time at liberty	347
Average time at liberty	29
Total distance (km)	476
Average distance (km)	40
Average northward movement	11
Average eastward movement	2
Bearing of movement (degrees)	13
Velocity (km d ⁻¹)	1.4

Table 3. Overall movement parameters for recaptured cod tagged with mark–recapture tags in the North Thames Estuary.

Data storage tagged cod (DSTs)

In all, 14 adult cod (>50cm) were tagged and released with DSTs over the 12 field study days. Figure 8 shows the distribution and numbers caught and released per bottom trawl with DST tags. Recorded details for each DST tagged cod are listed in Appendix 5. To date (20 May 2010), unfortunately, no cod have been recaptured with DSTs.

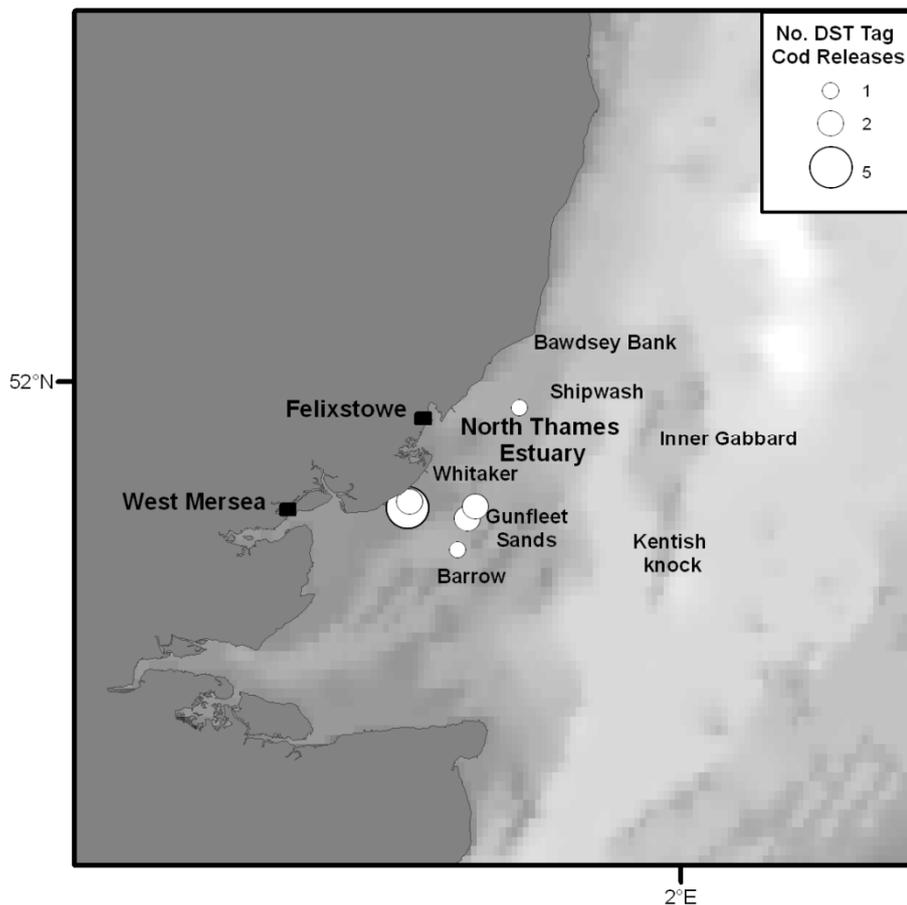


Figure 8. Map showing the number of DST tagged cod by area of release.

Discussion

This FSP cod tagging study successfully met its primary objectives with the capture and subsequent release of 217 mark-recapture tagged cod and an additional 14 adult cod tagged and released with DSTs within the North Thames Estuary and Shipwash fishing grounds. Continuation of the study through the recapture of tagged cod throughout 2010 and 2011 should yield more, valuable information on migrations of north Thames cod during spring and summer and the subsequent spawning season in February/ March 2011 and help our understanding of cod subpopulation movements in the southern North Sea (IVc).

From the preliminary results of recaptures to date, there appears to be a notable northward movement away from the North Thames Estuary release site. These results are consistent with the findings of Righton *et al.* (2007) for southern North Sea (IVc) adult cod that there tends to be a strong seasonal pattern of northward movement to feeding grounds in the central North Sea (IVb). However, to date North Thames cod have been recaptured early on in their migrations and have not yet migrated as far north as IVb. Further recaptures from this study later in the year may help to determine whether North Thames Estuary adult cod do in fact move farther north and mix with other subpopulations on feeding grounds in the central North Sea during spring and summer. In contrast, one adult cod migrated south and west more than 100 km into the neighbouring ICES management area (VIId) in the eastern English Channel, within the vicinity of other cod spawning aggregations off Hastings. Results from Righton *et al.* (2007) suggested that although there was some movement of cod across the southern North Sea and into the eastern English Channel, VIId cod stocks did not appear to be supplemented significantly by the arrival of post-spawning cod from IVc during spring and summer. Further returns will help determine whether the current single return is anomalous or whether north Thames cod mix significantly with the cod stocks in the eastern English Channel.

Overall our results show that mark–recapture data can still provide important insights into spatial distribution patterns of cod, information that is important to fisheries management. Further tag returns will help to determine the scale of North Thames cod seasonal distributions, migration rates and potential mixing with other subpopulations of cod within the North Sea.

Acknowledgements

The work was carried out in collaboration with skipper Clive Mills and the crew of FV Harvester. Their considerate help, knowledge and determination to make the study as successful as possible is sincerely appreciated by Cefas and the authors. Peter Randall is acknowledged for his manifold efforts in making the study a success; it would have been an uphill struggle without his enthusiasm and support! Peter also showed unwavering commitment to ever-changing scheduling of sea days at short notice. Tisha Martin, Gary Burt and Suzy Baldry are thanked for dealing with recaptured cod returns and sending out the rewards, and Sarah Pitcher for her data entry and QA. Finally, Stuart Hetherington, David Righton and Andy Payne are thanked for their advice and direction.

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Appendix 1. Detailed Operational Plan (DOP)

Fisheries Science Partnership: FSP 2009-2010
North Thames Cod Tagging Programme

North Thames Cod Tagging Programme 2010

Detailed Operations Plan (D.O.P)

A meeting was held in Mersey Island on 2nd December 2009 in order to discuss detailed operations plans for the North Thames Cod Tagging FSP programme. Victoria Bendall and Clive Mills were in attendance.

The main aims and objectives of the study were presented:-

Aims

- To investigate the movements of adult cod in the locality of the North Thames and Shipwash area.
- Local fishermen and scientists are interested to know how adult cod, which spawn in the north Thames and Shipwash region, mix with other cod sub-populations to the north and south within IVc (southern North Sea).

Objectives

- To tag & release adult cod (>50cm in length) within the north Thames region & Shipwash area during spawning. ~300 Conventional tags will be used, but it is hoped that around 10 electronic data storage tags can also be used.

1) Location and method of fishing activity

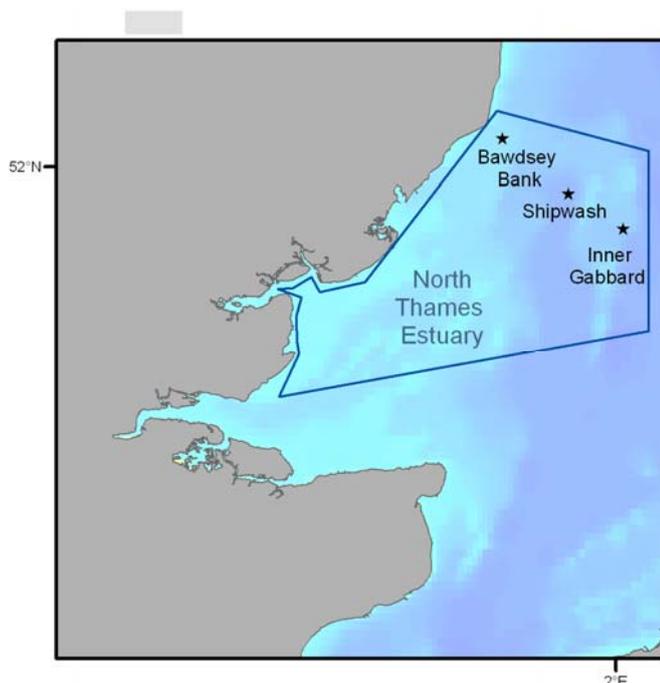


Figure 1. Map showing the area where fishing operations are to be carried out on nearshore fishing grounds, within 10 miles of land, in the North Thames / Shipwash area.

After discussions of fishing gear and methods to be used for the study the following was agreed by Clive Mills and Victoria Bendall.

An initial fishing period will be undertaken to allow the Cefas Scientist and Clive Mills aboard the Harvester, to assess the survival and catchability of cod, greater than 50cm in length. Fishing activity per day should allow for approximately five "bottom trawl" variable short tows (from 30 min to several hours) in total throughout the designated fishing area. The preferred tow duration and fishing methods will be decided upon during the initial fishing period by Clive Mills and Victoria Bendall and then used for the remainder of the study.

2) Duration and timing of fishing operations

Weather and fish permitting three 4-day trips will be conducted, with embarkation and disembarkation to the vessel on each day.

Fishing for cod in the north Thames / Shipwash area is best during small tides during February and March and therefore a number of suitable periods were identified in order to conduct the tagging study:-

- 1) 25th – 28th January 2010
- 2) 8th – 11th February 2010
- 3) 22nd – 25th February 2010
- 4) 8th – 11th March 2010
- 5) 15th – 18th March 2010
- 6) 23rd – 26th March 2010

Embarkation and disembarkation of the vessel will initially be from west Mersea waterfront during February and from the Deben throughout March to save on steaming time to and from designated fishing grounds.

In the event of bad weather / mechanical failure a minimum 48hr notice on 'go/no go' decision to sail will be provided by Clive Mills to Victoria Bendall.

Days at sea lost due to adverse weather conditions will be rescheduled at the earliest opportunity.

The daily fishing activities were agreed to incorporate a minimum of 2 half hour rest periods for scientists aboard the Harvester.

3) Requirements for tagging & collection of biological samples

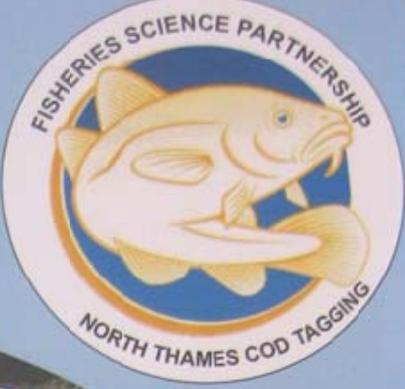
- Minimum length of 50cm will ensure that all cod tagged & sampled will be mature fish capable of spawning. Minimum length derived from maturity ogives data collected between 1977 – 2005 (International Beam Trawl Survey) which confirms 50cm in length to be consistent with average size at 50% maturity (ICES, unpublished data).
- All cod >50cm caught on spawning grounds in fit condition will be:-
 - Measured
 - Weighed
 - Sexed

- Fin-clipped
 - Photographed
 - Conventionally tagged / DST tagged
-
- Cod unsuitable for tagging will be biologically sampled as above and dissected to determine sex, maturity, stomach contents and age (by obtaining otoliths).
 - All fish at or above legal marketable size, which are not used for tagging, can be landed off-quota, subject to dispensation.
 - Clive Mills agreed to provide a safe uncluttered working space of 4 metres² on the Harvester deck for tagging procedures and equipment.
 - Crew aboard Harvester will assist Cefas scientist aboard in sorting the catch.

A publicity and tag reward scheme will be initiated by Victoria Bendall from Cefas to ensure best return rates of tags are achievable. Reward posters are to be made and distributed throughout local fisheries offices / fish markets and t-shirts are to be made up especially for the programme.

It was recognised overall that changes to the operational plan may be necessary depending upon numbers of cod caught and weather conditions.

Appendix 2a. Reward poster for north Thames cod tagging study 2010



Cash Reward*

As part of a FSP project, several hundred cod tagged with distinctive external (pink) tags have been released into the North Thames Estuary to investigate adult cod movements.



In addition scientists have also released 15 cod tagged internally with distinctive **ELECTRONIC TAGS**. Tagged cod are easy to spot, as they have bright coloured external tags.

Please return the tags and whole fish, together with the details of date and place of recapture 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

THANK YOU



* £100 cash reward for electronic tag & return of the whole fish. In addition your name will be entered into a UK cash draw for £1000.
*£6 reward(+ market value of fish if returned) & F.S.P. T-shirt for external tags.

Appendix 2b. T-shirt created for the north Thames cod tagging study 2010



Appendix 3. Additional by catch of species during the north Thames cod tagging study

Date	Capture Trawl shot Latitude	Capture Trawl shot Longitude	Capture Trawl Haul Latitude	Capture Trawl Haul Longitude	Species other than cod caught in trawl during field study
08/02/2010	52.0969	1.6927	52.0064	1.6533	lumpsucker
11/03/2010	51.73155	1.1068	51.7508	1.1658	Juvenile bass, whiting
11/03/2010	51.81220	1.2955	51.7924	1.2453	juvenile bass, bib, whiting
11/03/2010	51.80850	1.2852	51.785	1.2103	
11/03/2010	51.77830	1.2095	51.7286	1.1062	whiting, bass
12/03/2010	51.69530	1.1995	51.7218	1.2802	Thornback ray, bib, whiting
12/03/2010	51.74630	1.3832	51.7261	1.3491	
13/03/2010	51.73580	1.1219	51.7619	1.1785	Juvenile bass, adult bass, whiting.
13/03/2010	51.77460	1.1747	51.7888	1.2391	Small whiting catch
14/03/2010	51.67400	1.2786	51.6977	1.3478	Bib, dab, whiting and few juvenile bass
14/03/2010	51.85700	1.3497	51.6848	1.305	Thornback ray, juvenile bass
14/03/2010	51.78430	1.2710	51.7716	1.208	Thornback ray, juvenile bass
21/03/2010	51.83870	1.8455	51.8858	1.8603	Bib, lemon sole
21/03/2010	51.88770	1.8582	51.8034	1.8158	Thornback ray, sole, few bib
21/03/2010	51.79030	1.8124	51.7062	1.7672	Thornback ray, sole
21/03/2010	51.66820	1.7501	51.7435	1.7499	Thornback ray, Bib
21/03/2010	51.74360	1.7841	51.8588	1.8411	Thornback ray, Bib
21/03/2010	51.86900	1.8440	51.8417	1.8504	Thornback ray, Bib
23/03/2010	51.89170	1.8604	51.9589	1.8752	Lesser spotted dogfish
23/03/2010	51.95550	1.8727	51.8547	1.8385	Thornback ray, Bib, Lemon sole
23/03/2010	51.84430	1.8361	51.7338	1.8266	Thornback ray, Bib, Lemon sole, lesser spotted dogfish
23/03/2010	51.73440	1.8251	51.8002	1.8375	Thornback ray, Bib, Lemon sole, lesser spotted dogfish, LBE
23/03/2010	51.82450	1.7787	51.7485	1.7163	Thornback ray, dab, sole, whiting
23/03/2010	51.75230	1.7204	51.783	1.7313	Thornback ray, sole
23/03/2010	51.79770	1.7223	51.7347	1.6944	Thornback ray, sole
24/03/2010	51.71390	1.2403	51.6924	1.2048	Thornback ray, whiting
24/03/2010	51.70000	1.2530	51.702	1.2423	Thornback ray, whiting
24/03/2010	51.72120	1.2527	51.6821	1.1766	Thornback ray, whiting, sea bass
24/03/2010	51.68050	1.1810	51.7057	1.299	Thornback ray, whiting, R, D
24/03/2010	51.70620	1.2922	51.6789	1.1748	Thornback ray, whiting
26/03/2010	51.68610	1.1830	51.726	1.3531	Thornback ray, sole, lumpsucker, whiting
26/03/2010	51.76260	1.3618	51.7227	1.2617	Thornback ray, sole, whiting
26/03/2010	51.72020	1.2571	51.7176	1.2438	Thornback ray, whiting

Appendix 4. Summary details of mark recapture tagged cod

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
08/02/2010	E012506	E012505	67	-	MALE?	52.0064	1.6533	-	Hard	52.1035	1.6379	-	Felixstowe	Good condition but tired from tow
11/03/2010	E012511	E012512	48	1	UNK	51.7508	1.1658	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	E012513	E012514	45	0.6	UNK	51.7508	1.1658	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	E012515	E012516	47	0.6	FEMALE	51.7508	1.1658	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	E012517	E012518	47	0.8	UNK	51.7508	1.1658	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	E012519	E012520	48	0.6	UNK	51.7508	1.1658	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	E012527	E012528	50	0.8	UNK	51.7924	1.2453	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	E012531	E012532	47	0.8	UNK	51.7924	1.2453	30	Hard	51.7988	1.2599	35	Gunfleet Sands	
11/03/2010	E012534	E012536	48	0.8	UNK	51.7924	1.2453	30	Hard	51.7988	1.2599	35	Gunfleet Sands	
11/03/2010	E012539	E012542	50	0.6	UNK	51.7924	1.2453	30	Hard	51.7988	1.2599	35	Gunfleet Sands	
11/03/2010	E012543	E012544	46	0.6	UNK	51.7924	1.2453	30	Hard	51.7988	1.2599	35	Gunfleet Sands	
11/03/2010	E012549	E012550	58	1	UNK	51.7924	1.2453	30	Hard	51.7988	1.2599	35	Gunfleet Sands	
11/03/2010	E012551	E012552	47	0.8	UNK	51.7924	1.2453	30	Hard	51.7988	1.2599	35	Gunfleet Sands	
11/03/2010	E012553	E012554	44	0.2	UNK	51.7924	1.2453	30	Hard	51.7842	1.2247	40	Gunfleet Sands	
11/03/2010	E012555	E012556	54	1.4	FEMALE	51.7924	1.2453	30	Hard	51.7842	1.2247	40	Gunfleet Sands	Ovaries maturing
11/03/2010	E012557	E012558	45	0.8	UNK	51.7924	1.2453	30	Hard	51.7842	1.2247	40	Gunfleet Sands	Ovaries maturing
11/03/2010	E012559	E012560	52	1	FEMALE	51.7924	1.2453	30	Hard	51.7842	1.2247	40	Gunfleet Sands	Ovaries maturing

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
11/03/2010	E012561	E012562	52	0.8	MALE?	51.785	1.2103	30	Hard	51.7552	1.163	25	Gunfleet Sands	
11/03/2010	E012563	E012564	57	1.4	FEMALE	51.785	1.2103	30	Hard	51.7552	1.163	25	Gunfleet Sands	Ovaries maturing
11/03/2010	E012565	E012567	57	1.4	FEMALE	51.785	1.2103	30	Hard	51.7552	1.163	25	Gunfleet Sands	Ovaries maturing
11/03/2010	E012569	E012570	51	1	FEMALE	51.785	1.2103	30	Hard	51.7552	1.163	25	Gunfleet Sands	Ovaries maturing
11/03/2010	E012571	E012572	45	0.4	FEMALE	51.785	1.2103	30	Hard	51.7552	1.163	25	Gunfleet Sands	Ovaries maturing
11/03/2010	E012573	E012574	66	2.4	FEMALE	51.785	1.2103	30	Hard	51.7552	1.163	25	Gunfleet Sands	Ovaries maturing
11/03/2010	E012575	E012576	48	1.4	FEMALE	51.785	1.2103	30	Hard	51.7552	1.163	25	Gunfleet Sands	Ovaries maturing
11/03/2010	E012577	E012578	46	0.8	FEMALE	51.7286	1.1062	30	Hard	51.7345	1.0723	30	Gunfleet Sands	Ovaries maturing
11/03/2010	E012580	E012581	43	0.8	UNK	51.7286	1.1062	30	Hard	51.7345	1.0723	30	Gunfleet Sands	
12/03/2010	E012582	E012583	53	1.2	MALE?	51.7218	1.2802	40 - 50	Hard	51.7251	1.2705	40	Whitaker	Not running
12/03/2010	E012584	E012586	55	1.6	FEMALE	51.7218	1.2802	40 - 50	Hard	51.7251	1.2705	40	Whitaker	Ovaries maturing
12/03/2010	E012587	E012588	56	1.8	FEMALE	51.7218	1.2802	40 - 50	Hard	51.7251	1.2705	40	Whitaker	Ovaries maturing
12/03/2010	E012589	E012590	53	1.4	FEMALE	51.7218	1.2802	40 - 50	Hard	51.7251	1.2705	40	Whitaker	Ovaries maturing
12/03/2010	E012591	E012592	58	2	FEMALE	51.7218	1.2802	40 - 50	Hard	51.7251	1.2705	40	Whitaker	Ovaries maturing
12/03/2010	E012657	E012658	59	1.6	UNK	51.7409	1.343	71 - 72	Hard	51.7267	1.318	35	Whitaker	
12/03/2010	E012659	E012660	55	1.8	FEMALE	51.7409	1.343	71 - 72	Hard	51.7267	1.318	35	Whitaker	
13/03/2010	E012661	E012662	47	1	FEMALE	51.7619	1.1785	25	Stone	51.7778	1.1803	26	Runch	Ovaries maturing
13/03/2010	E012663	E012664	42	0.8	FEMALE	51.7619	1.1785	25	Stone	51.7778	1.1803	26	Runch	Ovaries maturing
13/03/2010	E012665	E012666	52	1.2	FEMALE	51.7619	1.1785	25	Stone	51.7778	1.1803	26	Runch	Ovaries maturing
13/03/2010	E012667	E012668	46	0.8	FEMALE	51.7619	1.1785	25	Stone	51.7778	1.1803	26	Runch	Ovaries maturing
13/03/2010	E012670	E012669	45	0.8	FEMALE	51.7888	1.2391	25 - 33	Stone	51.7789	1.2857	45	Runch	Ovaries maturing
13/03/2010	E012671	E012672	52	1.8	FEMALE	51.7888	1.2391	25 - 33	Stone	51.7789	1.2857	45	Runch	Ovaries maturing, lots of sea lice attached
13/03/2010	E012674	E012675	56	1.8	MALE?	51.7888	1.2391	25 - 33	Stone	51.7789	1.2857	45	Runch	Lots of sea lice attached
13/03/2010	E012676	E012677	43	0.6	MALE?	51.7888	1.2391	25 - 33	Stone	51.7789	1.2857	45	Runch	Fishing hook in mouth removed

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
13/03/2010	E012678	E012679	50	1.2	FEMALE	51.7888	1.2391	25 - 33	Stone	51.7789	1.2857	45	Runch	Ovaries maturing
13/03/2010	E012680	E012682	44	1.2	FEMALE	51.7888	1.2391	25 - 33	Stone	51.7789	1.2857	45	Runch	Ovaries maturing
13/03/2010	E012683	E012684	44	1	FEMALE	51.7703	1.8958	47 - 49	Stone	51.7792	1.2864	20	Runch	Ovaries maturing
13/03/2010	E012687	E012686	42	0.6	FEMALE	51.7703	1.8958	47 - 49	Stone	51.7792	1.2864	20	Runch	Ovaries maturing
13/03/2010	E012688	E012689	47	1	FEMALE	51.7703	1.8958	47 - 49	Stone	51.7792	1.2864	20	Runch	Ovaries maturing
13/03/2010	E012690	E012691	45	1	FEMALE	51.7703	1.8958	47 - 49	Stone	51.7792	1.2864	20	Runch	Ovaries maturing
14/03/2010	E012695	E012696	61	2.4	FEMALE	51.6977	1.3478	55 - 56	Stone	51.6998	1.3619	60	Barrow	Possibly spent?
14/03/2010	E012697	E012698	59	2	FEMALE	51.6977	1.3478	55 - 56	Stone	51.6998	1.3619	60	Barrow	Possibly spent?
14/03/2010	E012699	E012700	79	5.2	FEMALE	51.6848	1.305	55 - 56	Stone	51.6937	1.3023	50	Barrow	Possibly spent?
14/03/2010	E012801	E012802	56	2.2	FEMALE	51.6848	1.305	55 - 56	Stone	51.6937	1.3023	50	Barrow	Final stages of spawning
14/03/2010	E012803	E012804	60	3	FEMALE	51.6848	1.305	55 - 56	Stone	51.6937	1.3023	50	Barrow	Final stages of spawning
14/03/2010	E012809	E012810	56	1.6	FEMALE	51.7716	1.208	30 - 38	Stone	51.7661	1.192	30	Gunfleet Sands	Possibly spent?
21/03/2010	E012601	E012602	62	2.4	FEMALE	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012603	E012604	52	1.8	FEMALE	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012605	E012622	60	2.4	FEMALE	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012607	E012608	57	1.8	FEMALE	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012611	E012612	64	2.8	FEMALE	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012613	E012615	69	3.2	FEMALE	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012617	E012618	72	3.4	FEMALE	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012619	E012621	69	2.8	-	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012623	E012624	68	2.8	FEMALE?	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	Spent? Lice
21/03/2010	E012625	E012627	71	2.8	FEMALE?	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
21/03/2010	E012628	E012629	70	3.2	FEMALE?	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012631	E012632	50	1.4	-	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012635	E012637	78	4.4	-	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012638	E012639	66	2.8	-	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012640	E012641	62	2.6	-	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	
21/03/2010	E012643	E012644	60	2.6	FEMALE?	51.8858	1.8603	77 - 80	Stone	51.8541	1.8281	148	Inner Gabbard	Spent?
21/03/2010	E012646	E012648	64	2.4	-	51.8034	1.8158	84 - 140	Stone	51.7623	1.7983	135	Near Knock	
21/03/2010	E012649	E012650	66	3.2	-	51.8034	1.8158	84 - 140	Stone	51.7623	1.7983	135	Near Knock	
21/03/2010	E012813	E012814	58	1.8	-	51.8034	1.8158	84 - 140	Stone	51.7623	1.7983	135	Near Knock	
21/03/2010	E012815	E012816	64	2.2	-	51.8034	1.8158	84 - 140	Stone	51.7623	1.7983	135	Near Knock	
21/03/2010	E012817	E012818	72	3.6	-	51.8034	1.8158	84 - 140	Stone	51.7623	1.7983	135	Near Knock	
21/03/2010	E012820	E012821	58	2.2	-	51.8034	1.8158	84 - 140	Stone	51.7623	1.7983	135	Near Knock	
21/03/2010	E012822	E012823	61	2.4	-	51.8034	1.8158	84 - 140	Stone	51.7623	1.7983	135	Near Knock	
21/03/2010	E012824	E012825	65	2.8	FEMALE?	51.8034	1.8158	84 - 140	Stone	51.7623	1.7983	135	Near Knock	Spent?
21/03/2010	E012826	E012827	67	3	-	51.8034	1.8158	84 - 140	Stone	51.7623	1.7983	135	Near Knock	
21/03/2010	E012828	E012829	66	3.2	-	51.7062	1.7672	120 - 140	Stone	51.6688	1.7548	111	Near Knock	
21/03/2010	E012830	E012831	73	3.6	-	51.7062	1.7672	120 - 140	Stone	51.6688	1.7548	111	Near Knock	
21/03/2010	E012832	E012833	66	2.6	FEMALE?	51.7062	1.7672	120 - 140	Stone	51.6688	1.7548	111	Near Knock	Spent?
21/03/2010	E012835	E012836	62	2.4	FEMALE?	51.7062	1.7672	120 - 140	Stone	51.6688	1.7548	111	Near Knock	Spent?
21/03/2010	E012837	E012838	67	3	-	51.7062	1.7672	120 - 140	Stone	51.6688	1.7548	111	Near Knock	
21/03/2010	E012840	E012841	64	2.4	-	51.7062	1.7672	120 - 140	Stone	51.6688	1.7548	111	Near Knock	
21/03/2010	E012842	E012843	70	3	FEMALE?	51.7062	1.7672	120 - 140	Stone	51.6688	1.7548	111	Near Knock	Spent?
21/03/2010	E012844	E012845	80	5.2	FEMALE?	51.7435	1.7499	112 - 117	Stone	51.7543	1.8068	135	Kentish Knock	Spent?
21/03/2010	E012846	E012847	64	3.2	-	51.7435	1.7499	112 - 117	Stone	51.7543	1.8068	135	Kentish Knock	

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
21/03/2010	E012848	E012849	75	4.6	-	51.7435	1.7499	112 - 117	Stone	51.7543	1.8068	135	Kentish Knock	
21/03/2010	E012851	E012852	56	2.2	-	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012853	E012855	62	2.4	FEMALE?	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012856	E012857	63	2.6	MALE	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012858	E012859	73	3.8	FEMALE?	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012860	E012861	67	3	FEMALE?	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012863	E012864	68	3.6	FEMALE?	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012865	E012866	65	3	FEMALE?	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012867	E012868	79	3.2	FEMALE?	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012869	E012870	76	5	FEMALE?	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012871	E012872	63	3.4	FEMALE?	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	
21/03/2010	E012873	E012874	62	2.6	FEMALE?	51.8588	1.8411	106 - 124	Stone	51.8885	1.8586	78	Inner Gabbard	Spent?
21/03/2010	E012875	E012876	58	2.6	FEMALE?	51.8417	1.8504	70 - 97	Stone	51.8278	1.7667	140	Inner Gabbard	Spent?
21/03/2010	E012877	E012878	81	5.2	FEMALE?	51.8417	1.8504	70 - 97	Stone	51.8278	1.7667	140	Inner Gabbard	Spent?
21/03/2010	E012879	E012880	64	4.2	FEMALE?	51.8417	1.8504	70 - 97	Stone	51.8278	1.7667	140	Inner Gabbard	Spent?
21/03/2010	E012881	E012882	67	3.2	-	51.8417	1.8504	70 - 97	Stone	51.8278	1.7667	140	Inner Gabbard	
21/03/2010	E012883	E012884	62	2.4	FEMALE?	51.8417	1.8504	70 - 97	Stone	51.8278	1.7667	140	Inner Gabbard	Spent?
21/03/2010	E012885	E012886	55	2.8	FEMALE?	51.8417	1.8504	70 - 97	Stone	51.8278	1.7667	140	Inner Gabbard	Spent?
23/03/2010	E012887	E012888	66	3.2	FEMALE?	51.9589	1.8752	75 - 115	Stone	51.9233	1.865	85	Inner Gabbard	Spent?
23/03/2010	E012889	E012890	69	3.5	FEMALE?	51.9589	1.8752	75 - 115	Stone	51.9233	1.865	85	Inner Gabbard	Spent?

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
23/03/2010	E012891	E012892	57	2.2		51.9589	1.8752	75 - 115	Stone	51.9233	1.865	85	Inner Gabbard	
23/03/2010	E012893	E012894	67	5.5	FEMALE?	51.9589	1.8752	75 - 115	Stone	51.9233	1.865	85	Inner Gabbard	Spent?
23/03/2010	E012895	E012896	83	7.1	FEMALE?	51.9589	1.8752	75 - 115	Stone	51.9233	1.865	85	Inner Gabbard	Spent?
23/03/2010	E012897	E012898	60	3	FEMALE?	51.9589	1.8752	75 - 115	Stone	51.9233	1.865	85	Inner Gabbard	Spent?
23/03/2010	E012899	E012900	56	2.2	FEMALE?	51.9589	1.8752	75 - 115	Stone	51.9233	1.865	85	Inner Gabbard	Spent?
23/03/2010	E012701	E012702	67	3.8	FEMALE?	51.9589	1.8752	75 - 115	Stone	51.9233	1.865	85	Inner Gabbard	Spent?
23/03/2010	E012703	E012704	74	5	FEMALE?	51.8547	1.8385	110	Stone	51.8227	1.8394	95	Inner Gabbard	Spent?
23/03/2010	E012705	E012706	79	5.2		51.8547	1.8385	110	Stone	51.8227	1.8394	95	Inner Gabbard	
23/03/2010	E012708	E012709	66	3		51.8547	1.8385	110	Stone	51.8227	1.8394	95	Inner Gabbard	
23/03/2010	E012710	E012711	65	3.9	FEMALE?	51.8547	1.8385	110	Stone	51.8227	1.8394	95	Inner Gabbard	Spent?
23/03/2010	E012712	E012713	67	3.5		51.8547	1.8385	110	Stone	51.8227	1.8394	95	Inner Gabbard	
23/03/2010	E012714	E012715	86	3.8	FEMALE?	51.8547	1.8385	110	Stone	51.8227	1.8394	95	Inner Gabbard	Spent?
23/03/2010	E012716	E012717	60	3.5	FEMALE?	51.8547	1.8385	110	Stone	51.8227	1.8394	95	Inner Gabbard	Spent?
23/03/2010	E012718	E012719	63	3		51.8547	1.8385	110	Stone	51.8227	1.8394	95	Inner Gabbard	
23/03/2010	E012720	E012721	66	3.2		51.8547	1.8385	110	Stone	51.8227	1.8394	95	Inner Gabbard	
23/03/2010	E012722	E012723	72	4.5	FEMALE?	51.8547	1.8385	110	Stone	51.8075	1.8401	98	Inner Gabbard	Spent?
23/03/2010	E012724	E012725	53	2		51.8547	1.8385	110	Stone	51.8075	1.8401	98	Inner Gabbard	
23/03/2010	E012726	E012728	58	2.9	FEMALE?	51.8547	1.8385	110	Stone	51.8075	1.8401	98	Inner Gabbard	Spent?
23/03/2010	E012729	E012730	70	3.8	FEMALE?	51.8547	1.8385	110	Stone	51.8075	1.8401	98	Inner Gabbard	Spent?
23/03/2010	E012731	E012732	64	3.8	FEMALE?	51.8547	1.8385	110	Stone	51.8075	1.8401	98	Inner Gabbard	Spent?

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
23/03/2010	E012733	E012734	64	3.8	FEMALE?	51.8547	1.8385	110	Stone	51.8075	1.8401	98	Inner Gabbard	Spent?
23/03/2010	E012735	E012736	61	3.2		51.7338	1.8266	94 - 127	Stone	51.7492	1.8245	130	Inner Gabbard	
23/03/2010	E012737	E012738	65	3.9	FEMALE?	51.7338	1.8266	94 - 127	Stone	51.7492	1.8245	130	Inner Gabbard	Spent?
23/03/2010	E012739	E012740	69	4.8	FEMALE?	51.7338	1.8266	94 - 127	Stone	51.7492	1.8245	130	Inner Gabbard	Spent?
23/03/2010	E012741	E012742	72	5	FEMALE?	51.7338	1.8266	94 - 127	Stone	51.7492	1.8245	130	Inner Gabbard	Spent?
23/03/2010	E012743	E012744	70	4.5	FEMALE?	51.7338	1.8266	94 - 127	Stone	51.7492	1.8245	130	Inner Gabbard	Spent?
23/03/2010	E012745	E012746	72	4.6	FEMALE?	51.7338	1.8266	94 - 127	Stone	51.7492	1.8245	130	Inner Gabbard	Spent?
23/03/2010	E012747	E012748	62	4.4		51.7338	1.8266	94 - 127	Stone	51.7492	1.8245	130	Inner Gabbard	
23/03/2010	E012749	E012751	65	4.9	FEMALE?	51.7338	1.8266	94 - 127	Stone	51.7492	1.8245	130	Inner Gabbard	Spent?
23/03/2010	E012752	E012753	67	3	FEMALE?	51.7338	1.8266	94 - 127	Stone	51.7492	1.8245	130	Inner Gabbard	Spent?
23/03/2010	E012754	E012755	62	2.8		51.8002	1.8375	110 - 130	Stone	51.7492	1.821	141	Inner Gabbard	
23/03/2010	E012756	E012757	59	2.6		51.8002	1.8375	110 - 130	Stone	51.7492	1.821	141	Inner Gabbard	
23/03/2010	E012758	E012759	70	3.4		51.8002	1.8375	110 - 130	Stone	51.7492	1.821	141	Inner Gabbard	
23/03/2010	E012760	E012761	89	6.4	FEMALE?	51.7485	1.7163	105 - 156	Stone	51.7751	1.7291	106	Inner Gabbard	Spent?
23/03/2010	E012762	E012763	81	6.2	FEMALE?	51.7485	1.7163	105 - 156	Stone	51.7751	1.7291	106	Inner Gabbard	Spent?
23/03/2010	E012764	E012765	80	5.5	FEMALE?	51.7485	1.7163	105 - 156	Stone	51.7751	1.7291	106	Inner Gabbard	Spent?
23/03/2010	E012766	E012767	69	3.9	FEMALE?	51.7485	1.7163	105 - 156	Stone	51.7751	1.7291	106	Inner Gabbard	Spent?
23/03/2010	E012768	E012769	59	2.9	FEMALE?	51.7485	1.7163	105 - 156	Stone	51.7751	1.7291	106	Inner Gabbard	Spent?
23/03/2010	E012770	E012771	65	3		51.7485	1.7163	105 - 156	Stone	51.7751	1.7291	106	Inner Gabbard	Spent?
23/03/2010	E012772	E012773	63	3	FEMALE?	51.7485	1.7163	105 - 156	Stone	51.7751	1.7291	106	Inner Gabbard	Spent?

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
23/03/2010	E012774	E012775	67	2.9		51.7485	1.7163	105 - 156	Stone	51.7751	1.7291	106	Inner Gabbard	
23/03/2010	E012776	E012777	78	6.8		51.783	1.7313	105	Stone	51.7933	1.7206	95	Inner Gabbard	
23/03/2010	E012778	E012779	79	6.8		51.783	1.7313	105	Stone	51.7933	1.7206	95	Inner Gabbard	
23/03/2010	E012780	E012781	69	3.9		51.7347	1.6944	76 - 95	Stone	51.7361	1.7117	93	Inner Gabbard	
23/03/2010	E012782	E012783	67	4		51.7347	1.6944	76 - 95	Stone	51.7361	1.7117	93	Inner Gabbard	
24/03/2010	E012784	E012785	49	1.8		51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	
24/03/2010	E012786	E012787	63	3	FEMALE?	51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	Spent?
24/03/2010	E012788	E012789	60	2.1	FEMALE?	51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	Spent?
24/03/2010	E012790	E012791	61	2.9	FEMALE?	51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	Spent?
24/03/2010	E012792	E012793	67	3.2	FEMALE?	51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	Spent?
24/03/2010	E012794	E012795	62	2.9	FEMALE?	51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	Spent?
24/03/2010	E012796	E012797	55	2	FEMALE?	51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	Spent?
24/03/2010	E012798	E012799	51	1.8		51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	
24/03/2010	E012800	E012901	52	1.9		51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	
24/03/2010	E012902	E012903	64	3	FEMALE?	51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	Spent?
24/03/2010	E012904	E012905	57	2.2	FEMALE?	51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	Spent?
24/03/2010	E012906	E012907	48	2.1		51.6924	1.2048	39 - 53	Stone	51.7103	1.2881	66	East Swin	Spent?
24/03/2010	E012908	E012909	51	1.9	FEMALE?	51.702	1.2423	39 - 53	Stone	51.7203	1.2515	48	East Swin	Spent?
24/03/2010	E012910	E012911	63	3.4	FEMALE?	51.702	1.2423	39 - 53	Stone	51.7203	1.2515	48	East Swin	Spent?
24/03/2010	E012912	E012913	48	1.8	FEMALE?	51.702	1.2423	39 - 53	Stone	51.7203	1.2515	48	East Swin	Spent?
24/03/2010	E012914	E012915	52	2.2	FEMALE?	51.702	1.2423	39 - 53	Stone	51.7203	1.2515	48	East Swin	Spent?
24/03/2010	E012916	E012917	57	2.6	FEMALE?	51.702	1.2423	39 - 53	Stone	51.7203	1.2515	48	East Swin	Spent?
24/03/2010	E012918	E012919	51	1.8	FEMALE?	51.702	1.2423	39 - 53	Stone	51.7203	1.2515	48	East Swin	Spent?
24/03/2010	E012920	E012921	67	3.8	FEMALE?	51.6821	1.1766	36 - 47	Stone	51.6875	1.1951	37	East Swin	Spent?
24/03/2010	E012922	E012923	45	1.8		51.6821	1.1766	36 - 47	Stone	51.6875	1.1951	37	East Swin	
24/03/2010	E012924	E012925	56	2.2	FEMALE?	51.6821	1.1766	36 - 47	Stone	51.6875	1.1951	37	East Swin	

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
24/03/2010	E012926	E012927	55	1.9	FEMALE?	51.6821	1.1766	36 - 47	Stone	51.6875	1.1951	37	East Swin	
24/03/2010	E012928	E012929	64	3.1	FEMALE?	51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	Spent?
24/03/2010	E012930	E012931	65	3.9		51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	
24/03/2010	E012932	E012933	65	3	FEMALE?	51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	Spent?
24/03/2010	E012934	E012935	72	4	FEMALE?	51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	Spent?
24/03/2010	E012936	E012937	56	3	FEMALE?	51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	Spent?
24/03/2010	E012938	E012939	55	2.2		51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	
24/03/2010	E012940	E012941	52	1.9	FEMALE?	51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	Spent?
24/03/2010	E012942	E012943	57	2		51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	
24/03/2010	E012944	E012945	48	1.2		51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	
24/03/2010	E012946	E012947	55	2.1		51.7057	1.299	41 - 58	Stone	51.7017	1.2557	59	East Swin	
24/03/2010	E012948	E012949	63	2.6	FEMALE?	51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012951	E012952	60	2.4	FEMALE?	51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012954	E012955	48	1.8		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012956	E012957	62	2.7		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012958	E012959	61	2.9		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012960	E012961	59	2.4		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012962	E012963	57	2.2		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012976	E012977	65	3		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012978	E012979	58	2.2		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012980	E012981	58	2.9		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012982	E012983	52	1.9		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012985	E012986	58	1.9		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012987	E012988	58	2		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	
24/03/2010	E012989	E012990	49	1.9	FEMALE?	51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	Spent?
24/03/2010	E012991	E012992	50	1.8	FEMALE?	51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	Spent?
24/03/2010	E012993	E012994	48	1.9	FEMALE?	51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	Spent?
24/03/2010	E012995	E012996	56	2		51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	

Date	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (feet)	Release Area	Comments
24/03/2010	E012997	E012998	74	4	FEMALE?	51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	Spent?
24/03/2010	E012999	E013000	57	2.1	FEMALE?	51.6789	1.1748	49 - 55	Stone	51.7292	1.0741	19	East Swin	Spent?
26/03/2010	E013101	E013102	76	4.9	FEMALE?	51.726	1.3531	42 - 75	Stone	51.749	1.353	54	Whitaker Spit	Spent?
26/03/2010	E013103	E013104	70	4.2	FEMALE?	51.726	1.3531	42 - 75	Stone	51.749	1.353	54	Whitaker Spit	Spent?
26/03/2010	E013105	E013106	53	2.2		51.726	1.3531	42 - 75	Stone	51.749	1.353	54	Whitaker Spit	
26/03/2010	E013107	E013108	62	2.3		51.726	1.3531	42 - 75	Stone	51.749	1.353	54	Whitaker Spit	
26/03/2010	E013109	E013110	70	4.8	FEMALE?	51.726	1.3531	42 - 75	Stone	51.749	1.353	54	Whitaker Spit	Spent?
26/03/2010	E013111	E013112	73	4.2	FEMALE?	51.7227	1.2617	45 - 46	Stone	51.7161	1.2464	46	Whitaker Spit	Spent?
26/03/2010	E013113	E013114	70	4.8	FEMALE?	51.7227	1.2617	45 - 46	Stone	51.7161	1.2464	46	Whitaker Spit	Spent?
26/03/2010	E013115	E013116	73	4	FEMALE?	51.7227	1.2617	45 - 46	Stone	51.7161	1.2464	46	Whitaker Spit	Spent?
26/03/2010	E013117	E013118	57	2.8	FEMALE?	51.7227	1.2617	45 - 46	Stone	51.7161	1.2464	46	Whitaker Spit	Spent?
26/03/2010	E013119	E013120	65	3.2	FEMALE?	51.7176	1.2438	47 - 55	Stone	51.7009	1.2147	38	Whitaker Spit	Spent?
26/03/2010	E013121	E013122	50	1.9	FEMALE?	51.7176	1.2438	47 - 55	Stone	51.7009	1.2147	38	Whitaker Spit	
26/03/2010	E013123	E013124	49	1.8	FEMALE?	51.7176	1.2438	47 - 55	Stone	51.7009	1.2147	38	Whitaker Spit	
26/03/2010	E013125	E013126	72	4.8	FEMALE?	51.7176	1.2438	47 - 55	Stone	51.7009	1.2147	38	Whitaker Spit	Spent?
26/03/2010	E013127	E013128	49	1.8	FEMALE?	51.7176	1.2438	47 - 55	Stone	51.7009	1.2147	38	Whitaker Spit	

Appendix 5. Summary details of DST tagged cod

Date	DST Id	Tag Id.1	Tag Id.2	Length (cm)	Weight (Kg)	Sex	Capture Latitude	Capture Longitude	Capture depth (ft)	Ground type	Release Latitude	Release Longitude	Release Depth (ft)	Release Area	Comments
11/03/2010	1418	E012509	E012510	52	1.6	UNK	51.7508	1.1658	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	1413	E012521	E012522	52	0.8	UNK	51.7924	1.2453	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	1416	E012523	E012524	54	0.8	UNK	51.7924	1.2453	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	1412	E012525	E012526	56	1.2	FEMALE	51.7924	1.2453	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	1421	E012537	E012538	54	0.8	UNK	51.7924	1.2453	30	Hard	51.7739	1.2189	30	Gunfleet Sands	
11/03/2010	1414	E012545	E012546	69	3	FEMALE	51.8099	1.2904	38	Hard	51.7842	1.2247		Gunfleet Sands	
11/03/2010	1411	E012547	E012548	61	1.8	FEMALE	51.8099	1.2904	38	Hard	51.7842	1.2247		Gunfleet Sands	
12/03/2010	1420	E012594	E012593	62	1.4	MALE?	51.7409	1.343	52 - 54	Hard	51.7757	1.4127	50	Gunfleet Sands	Not running
12/03/2010	1410	E012599	E012596	76	3.4	FEMALE	51.7409	1.343	52 - 54	Hard	51.7757	1.4127	50	Gunfleet Sands	Eggs running
12/03/2010	1409	E012651	E012652	65	2.4	FEMALE	51.7558	1.4116	60 - 80	Hard	51.7544	1.3903	77	Gunfleet Sands	
12/03/2010	1406	E012655	E012656	72	2.8	FEMALE	51.7558	1.4116	60 - 80	Hard	51.7544	1.3903	77	Gunfleet Sands	Eggs running
14/03/2010	1415	E012693	E012694	83	4.6	FEMALE	51.6977	1.3478	55 - 56	Stone	51.6998	1.3619	60	Barrow	Possibly spent?
14/03/2010	1417	E012805	E012806	79	6	FEMALE	51.9872	1.6554	74 - 77	Sand	51.0012	1.6394	61	Shipwash	Possibly spent?
14/03/2010	1419	E012807	E012808	72	4	FEMALE	51.9852	1.5634	50 - 60	Sand	51.9537	1.5385	50	Bawdsey Bank	Possibly spent?