

CRUISE REPORT CEND 4-11

A survey of Irish Sea cod spawning grounds for Defra project MEMFISH

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1 Outline of the survey

1.1 Staff

Georg H. Engelhard (SIC; Cefas)

John K. Pinnegar (2IC; Cefas)

Mark Etherton (deckmaster day shift; Cefas)

Benjamin Hatton (deckmaster night shift; Cefas)

Louise Straker Cox (deputy deckmaster night shift; Cefas)

Antonio Plirú (responsible diet analysis pelagics; Cefas)

Mark Platts (responsible analysis predator–prey interactions; Cefas)

Tina Kerby (PhD student, University of East Anglia–Cefas)

Miranda Jones (PhD student, University of East Anglia–Cefas)

Serena Wright (PhD student, University of Swansea–Cefas)

Manuel Nicolaus (responsible marine litter sampling programme)

Ciara Brennan (Republic of Ireland FCO)

1.2 Duration

18 February–4 March 2011

1.3 Location

Irish Sea. Sailing from Swansea; docking in Portland.

1.4 Objectives

1. Assess the abundance and distribution of cod at known cod spawning areas in the Irish Sea through simultaneous acoustic and trawl surveys, using the Portuguese high-headline trawl (PHHT)
2. Assess the size and age composition of the spawning cod population through data on trawl catch compositions (including collection of otoliths)

3. Assess the biological characteristics of individual cod on the spawning grounds, through data on size, weight and body condition (including hepatosomatic index), and reproductive status (sex, age, maturity, gonad weight)
4. Collect biopsy samples from the ovaries of female cod to determine the reproductive status, egg size etc.
5. Collect tissue samples for genetic analysis on population structure, through fin-clipping
6. Assess the diet of cod through stomach contents analysis
7. Examine spatial overlap with potential cod egg predators, viz., sprat, herring, and squid species, including assessing the stomach contents of ~10 individuals per species per station
8. Support research on marine litter led by Thomas Maes (Cefas), by collecting data on any marine litter caught in the PHHT on standard datasheets, following established protocol (onboard responsible Manuel Nicolaus)
9. Support research on small plastics floating in the sea led by Thomas Maes (Cefas), by carrying out regular hauls using a Manta trawl, i.e. a small plankton trawl lowered from the side of the ship using the small crane, and towed close to the water surface (onboard responsible Manuel Nicolaus)

1.5 Additional objectives

10. Assess the physical characteristics of cod spawning areas
11. Tag elasmobranchs, in support of studies on their movement patterns in the Irish Sea
12. Examine diet of samples of fish species other than cod and pelagics
13. Examine cod nursery grounds
14. Collect frozen samples of anchovy and sardine

1.6 Narrative

RV *Cefas Endeavour* left the port of Swansea at 14:30 on Friday 18 February 2011 (after an induction at 9:00) to depart towards the Irish Sea. A shake down tow was carried out in the late afternoon, in the Bristol Channel near Stanley Bank, to allow the gear and EDC measuring system to be tested (it was also planned to collect fish samples from this site for Paul Rumney, Cefas, to be used for contaminants analysis; but insufficient material of three target species was caught).

Endeavour then steamed towards the western Irish Sea, where the first station was shot on Saturday morning at 10:00. From 19–27 February, a total of 74 stations (nr. 2–75) in the western Irish Sea were sampled in the same area surveyed during the 2009 and 2010 Memfish surveys. Scientists worked in two shifts nearly around the clock except between 3:00–7:00 AM. The Portuguese high-headline trawl was used, towed for 1 hour at 4 knots at pre-determined stations. Several stations in the north of this area, where the gear had been damaged in previous years, were not re-sampled, and practically no gear damage was experienced during this survey. Overall, cod were encountered in abundances that were either comparable to, or marginally higher, those observed during the 2009 and 2010 Memfish surveys in the western Irish Sea.

In the night of 27–28 February, after surveying the western study area was completed, *Endeavour* steamed over along the north tip of the Isle of Man to the eastern Irish Sea, to re-visit the sites surveyed during the 2008 and 2009 Memfish surveys (but not in 2010). The eastern Irish Sea was surveyed from 28 February–2 March (12:00) and a total of 21 stations

(nr. 76–96) were trawled here, also by PHHT. Cod were encountered at noticeably higher catch rates than in 2009. By noon on 2 March, the return voyage to Portland had to be commenced. The survey was completed on Friday 4 March at 9:00 with *Endeavour* docking in Portland.

Throughout this survey, overseen by Manuel Nicolaus, a substantial number of Manta trawl hauls were carried out to monitor marine floating debris in waters around the UK. To maximise the spatial coverage, the Manta trawl was frequently hauled simultaneously with the PHHT hauls, or during longer steams in between hauls, and moreover during the transits to and from the departure and home ports. In total, 54 Manta trawls were achieved, covering stations in the Bristol Channel, western and eastern Irish Sea, the Celtic Sea and Western English Channel.

2 Preliminary results of the survey

3.1 Sampling stations

As in the 2009 and 2010 surveys, hour-long trawls using the Portuguese high-headline trawl (PHHT) were carried out to assess the abundance of cod, focussing on two areas which yielded high commercial catch rates in February 2007–2009: an area in the western Irish Sea to the west and south-west of the Isle of Man, and an area in the eastern Irish Sea to the west of Morecambe Bay and north of Wales. The western area corresponds to the sites surveyed in 2009 and 2010; the eastern study area was also sampled in 2009 but not in 2010 (owing to lost time resulting from gear damage). In total, 96 trawl hauls were carried out. Figures 1 and 2 show the stations sampled in the western and eastern Irish Sea, respectively.

Seventy-four stations (2–75) were in the western Irish Sea in relatively deep waters (Figure 1), at depths averaging 87 ± 25 m (range 34–136 m). The grounds were generally muddy or sandy, and Norway lobsters *Nephrops norvegicus* were often highly abundant. They are located in an area where *Nephrops* are fished commercially, although queen scallops *Aequipecten opercularis* are also fished nearby. Some of the shallowest of the stations in the western Irish Sea tended to be in areas with high abundance of kelp (e.g. stations 67–69).

Twenty-one stations (76–96) were in the eastern Irish Sea (Figure 2), in generally much shallower waters at depths averaging 27 ± 7 m (range 16–44 m). The grounds tended to be sandy. Most of the eastern stations are located off Morecambe Bay, where gas is exploited from the seabed, and some are near offshore wind farms. Generally, these stations yielded high abundance of flatfish.

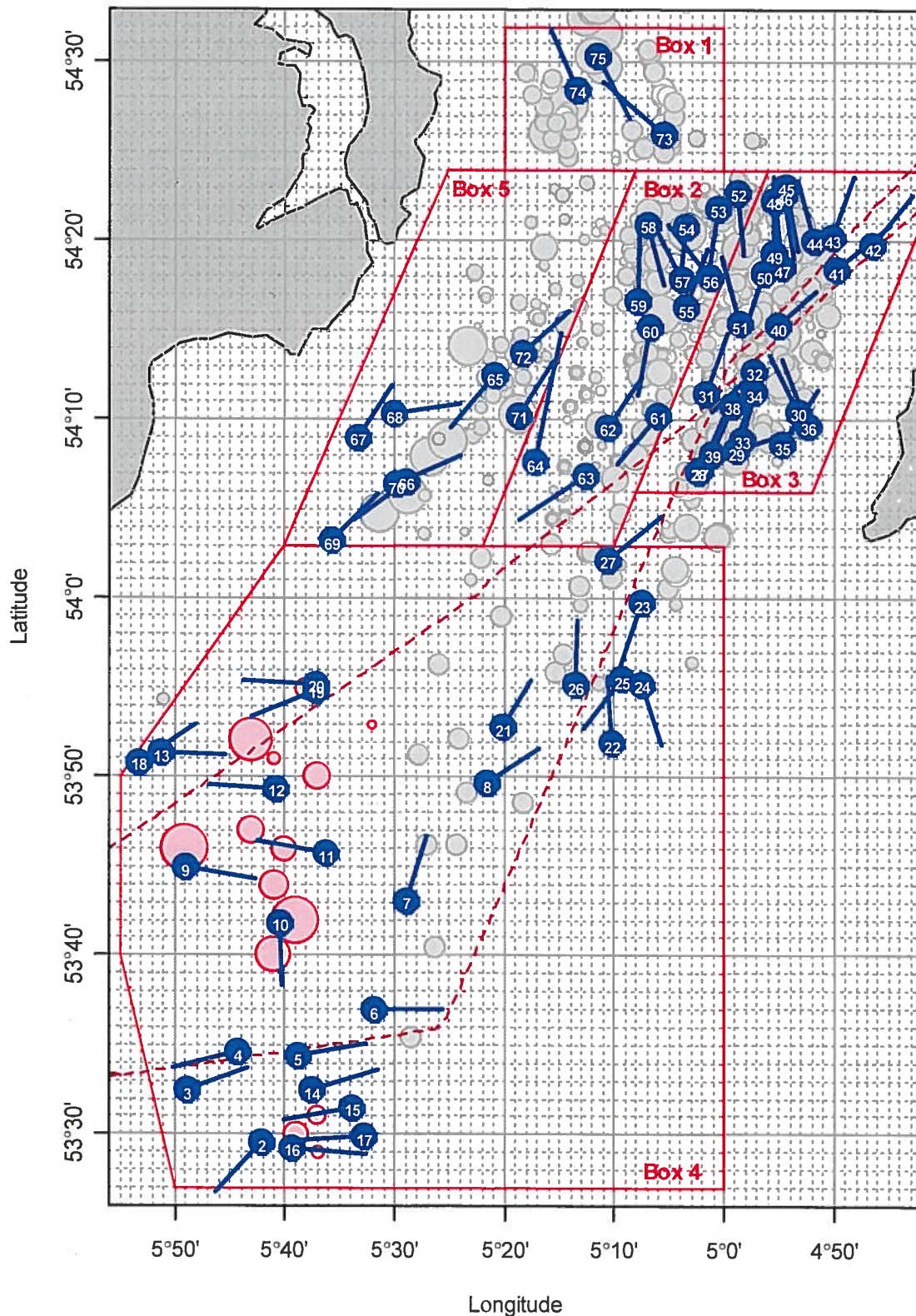


Figure 1. Stations in the western Irish Sea sampled during the 2011 Memfish survey, 19–27 February 2011. Station numbers are shown where the trawl was shot, and the lines indicate the trawl haul transects. Grey symbols indicate commercial trawlers cod cpue (February 2007–2009, averaged over fishing trips, from VMS). Five ‘survey boxes’ are indicated by red lines. Further, two underwater gas pipelines running from Scotland to Northern Ireland are indicated by brown dotted lines.

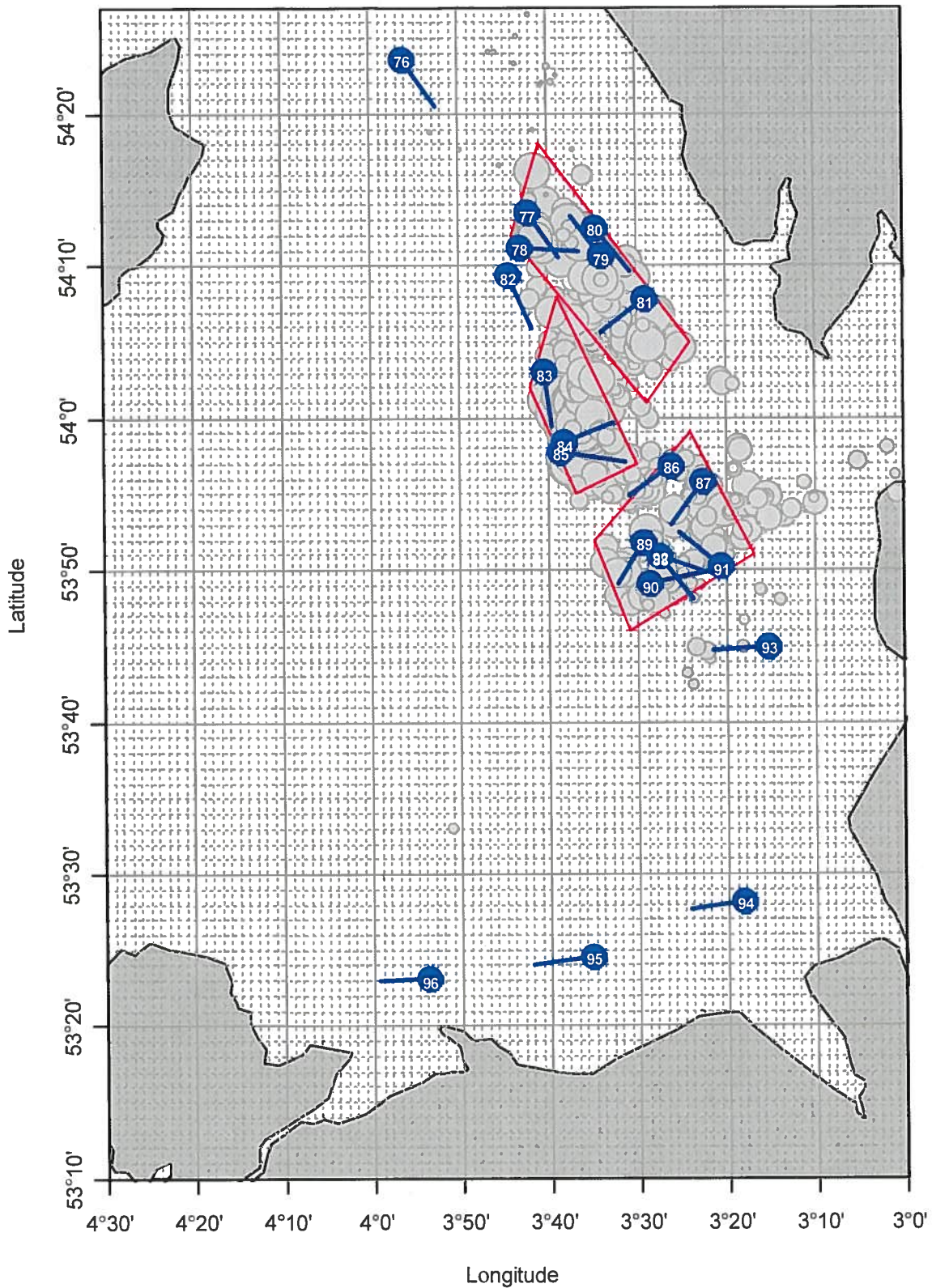


Figure 2. Stations in the eastern Irish Sea sampled during the 2011 Memfish survey, 28 February–2 March 2011. Station numbers are shown where the trawl was shot, and the lines indicate the trawl haul transects. Grey symbols indicate commercial trawlers cod cpue (February 2007–2009, averaged over fishing trips, from VMS). Three ‘survey boxes’ are indicated by red lines.

3.2 Overall catch composition in western and eastern Irish Sea

There were important differences in the general catch composition between the stations sampled in the western and eastern Irish Sea. In both areas, herring and sprat were the dominating pelagic species but whereas herring outnumbered sprat in the west, the reverse was true in the east where sprat was the most numerically abundant species overall. Norway lobster was far more abundant in the west than in the east. Various gadoid species were much more commonly found in the west, most notably haddock, Norway pout and blue whiting, although whiting was ubiquitous. In the east, a range of flatfish species were very common, especially dab, plaice, flounder and solenette.

Table 1. The most abundant fish and shellfish species in our catches in the western and eastern Irish Sea compared.

<i>Western Irish Sea (74 stations)</i>			<i>Eastern Irish Sea (21 stations)</i>		
187273	Herring	<i>Clupea harengus</i>	103007	Sprat	<i>Sprattus sprattus</i>
49254	Whiting	<i>Merlangius merlangus</i>	84543	Herring	<i>Clupea harengus</i>
42748	Sprat	<i>Sprattus sprattus</i>	20090	Dab	<i>Limanda limanda</i>
16145	Norway lobster	<i>Nephrops norvegicus</i>	18539	Whiting	<i>Merlangius merlangus</i>
9322	Dab	<i>Limanda limanda</i>	2866	Plaice	<i>Pleuronectes platessa</i>
7550	Haddock	<i>Melanogrammus aeglefinus</i>	595	Norway lobster	<i>Nephrops norvegicus</i>
5085	Norway pout	<i>Trisopterus esmarki</i>	282	Lesser sp. dogfish	<i>Scyliorhinus canicula</i>
4096	Lesser sp. dogfish	<i>Scyliorhinus canicula</i>	210	Flounder	<i>Platichthys flesus</i>
3497	Grey gurnard	<i>Eutrigla gurnardus</i>	208	Lesser weever	<i>Echiichthys vipera</i>
1861	Red gurnard	<i>Aspitrigla cuculus</i>	183	Solenette	<i>Buglossidium luteum</i>

3.3 Distribution and abundance of cod

In total, 220 Irish Sea cod were caught during this survey (and one cod during the shake-down tow in the Bristol Channel). These were distributed fairly evenly over the cod spawning ground study areas in the western and eastern Irish Sea (Figure 3). In the western Irish Sea, 168 cod were caught in 73 hauls of 1 hour duration each, i.e. at an average catch rate of 2.30 per hour. This was somewhat lower than the mean catch rates in the western Irish Sea 2009 and 2010 Memfish surveys (respectively, 3.29 and 2.50 cod per hour). However, it should be noted that some of the northernmost stations on rocky grounds, where many small juvenile cod occur, were not sampled this year owing to the extensive gear damage experienced at these sites in 2010 (and 2009).

In the eastern Irish Sea (not visited in 2010), cod catch rates were far higher than in 2009 when only 17 cod were caught in a total of 26 hauls (mean 0.65 per hour); this year 52 cod were caught in 21 hauls (mean 2.48 per hour). Whereas in 2009 cod were much less common in the eastern than western Irish Sea, in 2011 there appeared to be no appreciable difference in cod abundance between east and west.

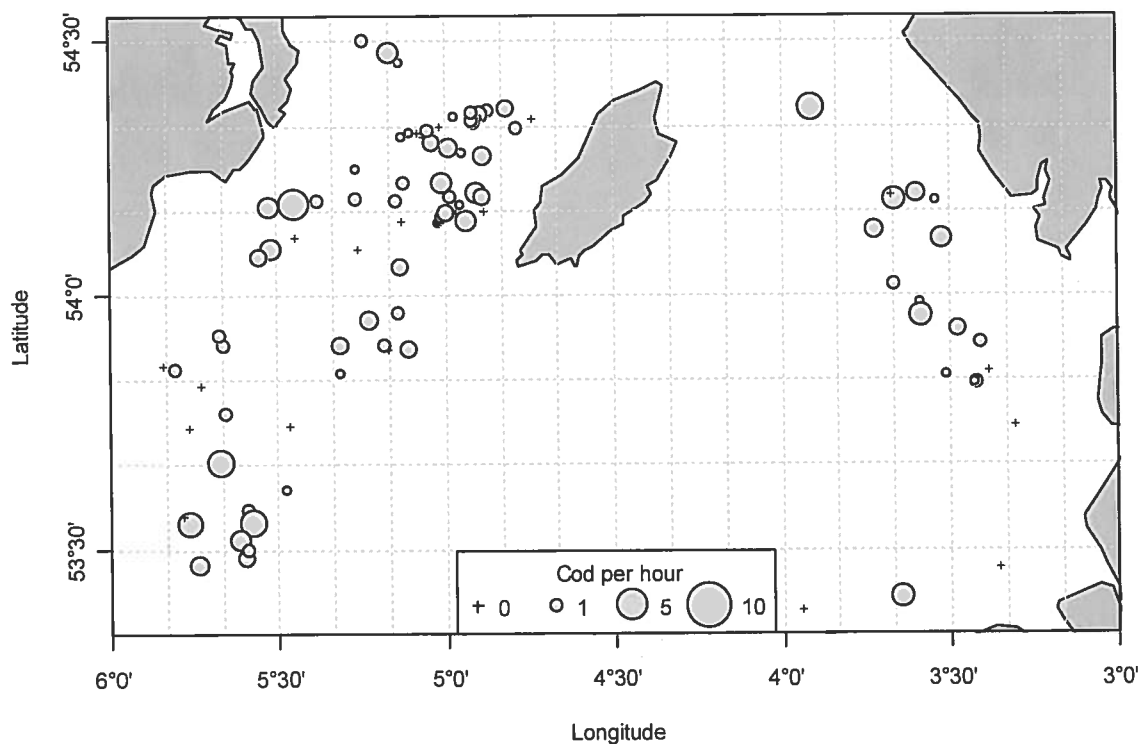


Figure 3. Distribution of cod catches in the Irish Sea. Symbol sizes indicate catch rates as number of cod per 1-hour haul (+ indicates a station where no cod were caught).

3.4 Size composition of cod on spawning grounds

In the western Irish Sea, a broad size distribution of cod was represented, including juveniles, smaller and larger mature fish. There were more large individuals present than in 2010 (Figure 4). A few very large cod were caught; the largest two individuals (both females) measured 105.5 and 99.0 cm and weighed 13.56 and 11.66 kg, respectively. Adult cod showed a peak in the length distribution around 60–75 cm, progressed from a peak around 40–60 cm in 2010.

In 2009, few medium to large adult cod had been encountered in the eastern Irish Sea and no juveniles at all had been found. In 2011, evidence was found of a wide range of sizes including juveniles and medium- to moderately large adult cod, although no cod >80 cm were found in this survey. This tentatively suggests a rejuvenated, growing young population of cod in the eastern Irish Sea.

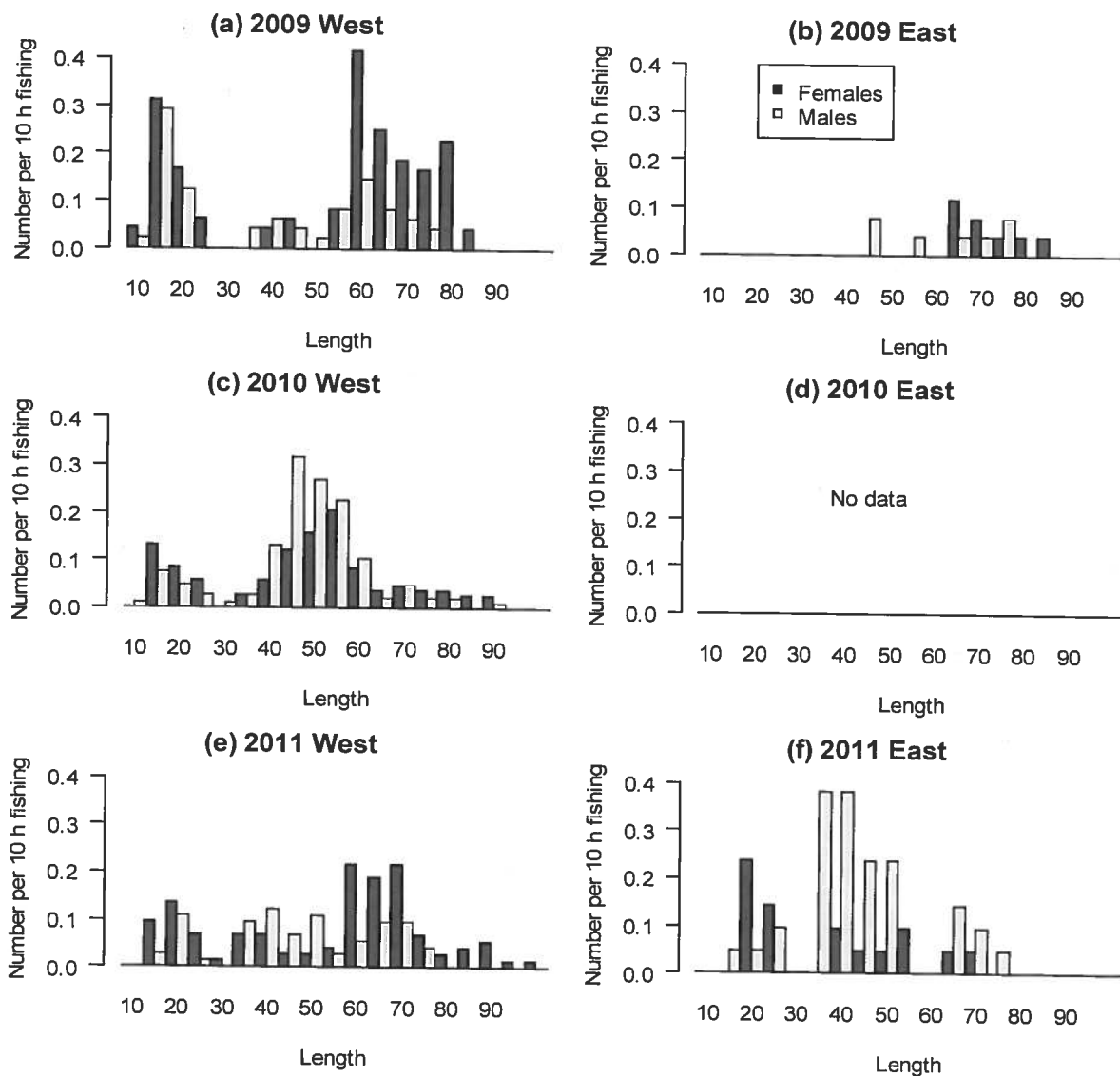


Figure 4. Length distributions of female (*black bars*) and male cod (*grey bars*) observed in the western (*left*) and eastern (*right*) Irish Sea during the Memfish surveys 2009 (a, b), 2010 (c, d), and 2011 (e, f).

3.5 Sex ratio of cod

There were local differences in the sex ratio of cod as encountered during the Memfish surveys, for (near-)adult individuals (here defined as >30cm long). In the east, far more male than female (near-)adult cod were found – notably, several catches contained groups of 4–7, only male, cod (80% male, 20% female cod). By contrast in the west, more female than male (near-)adult cod were caught (61% female, 39% male). The sex ratio in the west was similar to that in 2009 when females also clearly predominated here (72%), but quite different from the intervening year when females were less often caught than males (42% only).

Amongst juvenile (<30 cm) cod, females also predominated, in both western and eastern Irish Sea (67% in both regions).

Table 2. Numbers of female and male cod (and some unsexed individuals) smaller and larger than 30 cm, caught in the 2009–2011 surveys, and sex ratios expressed as % females and % males of the total numbers of known-sex cod. Figures shown separately for the western and eastern Irish Sea. The 2011 survey is highlighted in bold type.

<i>Area</i>	<i>Size</i>	<i>Year</i>	<i>Females</i>	<i>Males</i>	<i>Unsexed</i>	<i>% Females</i>	<i>% Males</i>
West	<30 cm	2009	28	21	0	57%	43%
		2010	29	17	1	63%	37%
		2011	22	11	3	67%	33%
	>30 cm	2009	71	28	0	72%	28%
		2010	93	128	1	42%	58%
		2011	80	52	0	61%	39%
East	<30 cm	2009	0	0	2	—	—
		2011	8	4	0	67%	33%
	>30 cm	2009	8	7	0	53%	47%
		2011	8	32	0	20%	80%

3.6 Maturity and reproductive characteristics of cod

In the 2011 survey, maturity stages were determined for 118 female and 99 male cod (Figure 5). As in previous years, all cod <30 cm were immature, and all cod >60 cm were mature. Maturity in females tended to be in a further advanced stage than in both earlier surveys, in spite of almost the same timing of the survey within the year and a very cold winter preceding. The proportion of females in the more advanced maturity stages (i.e. hyaline, running and/or spent) was 27%; this was 10% in 2009 and 14% in 2010. Conversely, maturity in males was less advanced than in 2010 but more than in 2009; the proportion of males in the advanced maturity stages (running and spent) was 21% (18% in 2009 and 33% in 2010). Two spent males were observed (none in both earlier years).

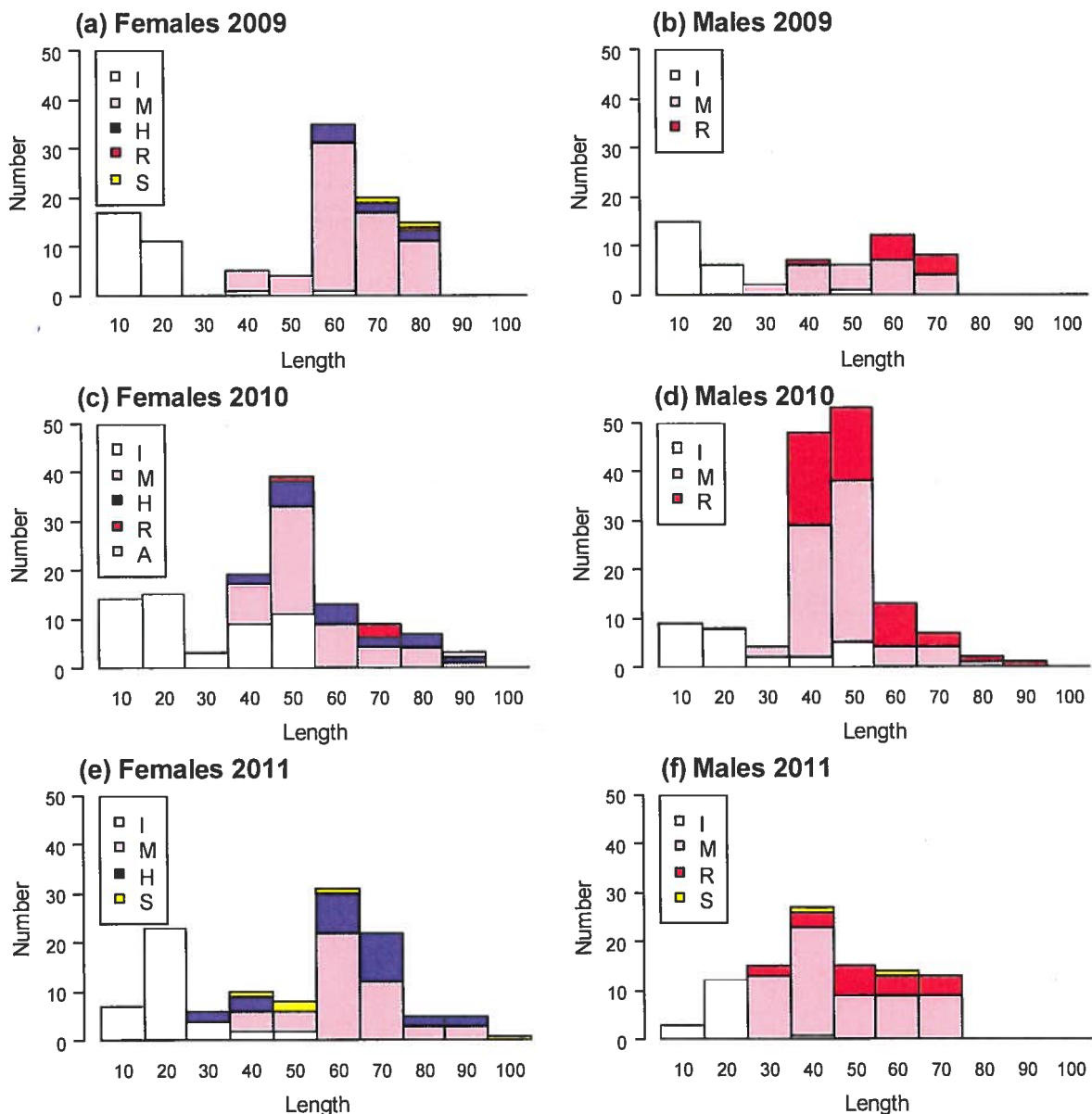


Figure 5. Maturity stages by 10-cm length groups of Irish Sea cod, for females (*left*) and males (*right*) caught during the surveys of 2009 (a, b), 2010 (c, d) and 2011 (e, f). I immature; M maturing; H hyaline (females only); R running; S spent; A atretic.

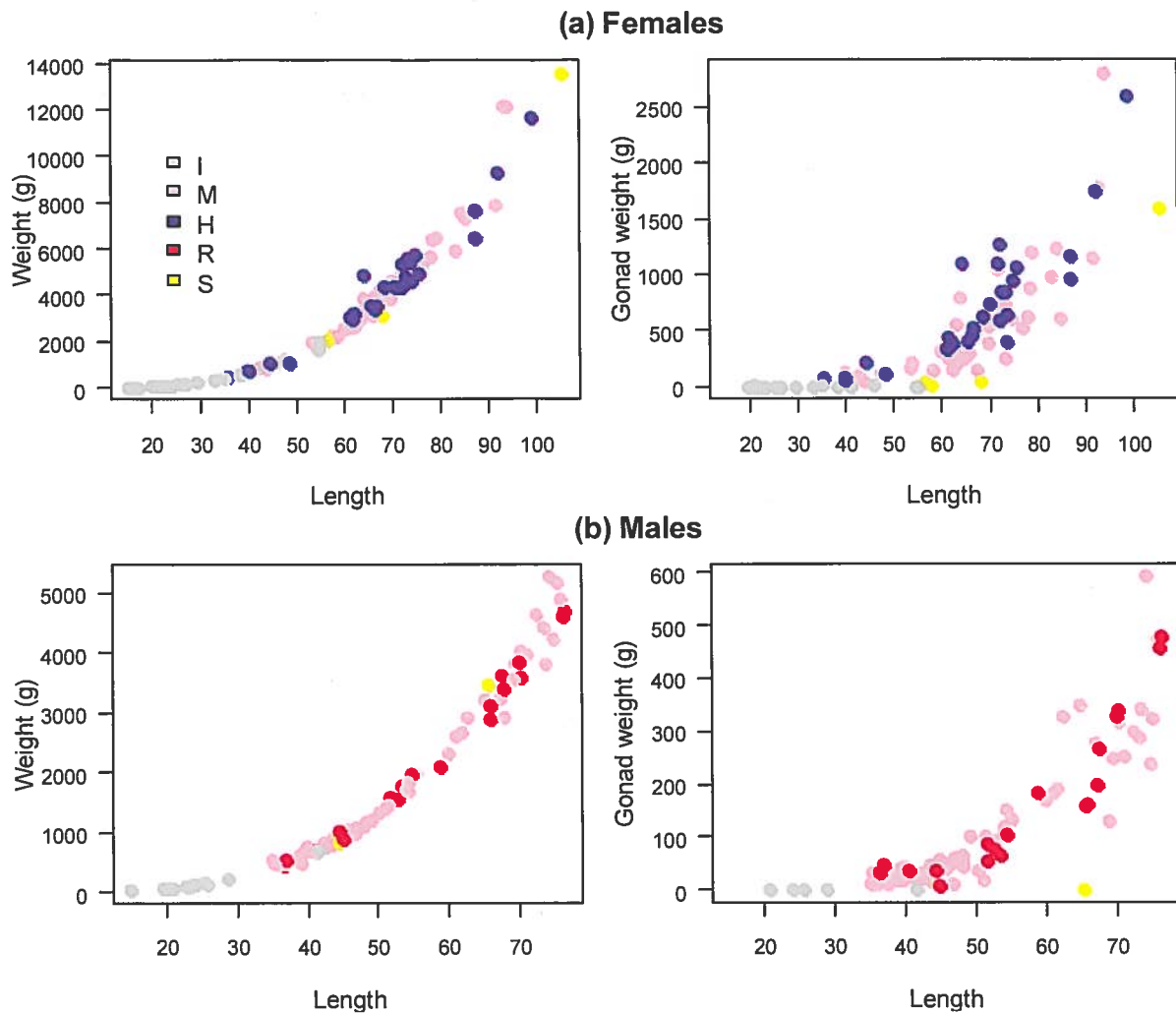


Figure 6. Length–weight relationships (*left panels*) and length–gonad weight relationships (*right panels*) of (a) female and (b) male cod caught in the 2011 survey. For each individual fish, the colour of the symbol indicates its maturity stage (see legend: I immature; M maturing; H hyaline [females only]; R running; S spent).

Length–weight and length–gonad relationships for the 2011 Memfish survey are shown in Figure 6, for female and male cod. These figures show a steady length–weight relationship, and also illustrate that gonadal investment remains quite limited for cod up to 50 cm length. Above that length, however, cod invest heavily in gonadal development. The highest ovary weights recorded were 2804 g and 2602 g, above the highest ovary weights recorded in 2009 (2529 g) and 2010 (2084 g).

3.7 Length–weight relationships

The length–weight relationships for cod sampled during the 2009, 2010 and 2011 Memfish surveys are shown in Figure 6. The relationships were highly similar during the initial two years, but during the current year tended to be slightly lower, indicating a slight decrease in the average body condition of cod at a given length.

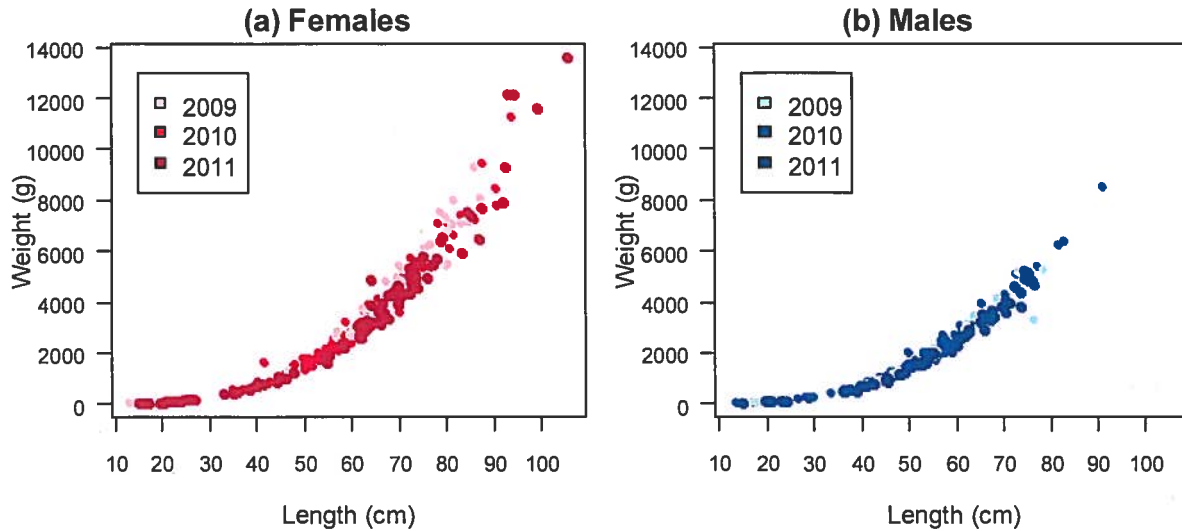


Figure 7. Length–weight relationships of (a) female and (b) male cod during the 2009, 2010 and 2011 Memfish surveys, shown for the western Irish Sea only.

3 Appendix 1

Renewed search for the elusive Irish Sea cod (a diary of an SIC)