




MORAY EAST

OFFSHORE WINDFARM

Moray East Offshore Windfarm Cod Spawning Survey Results – Technical Report

September 2024

Moray Offshore Windfarm (East) Limited

Produced by Brown and May Marine Ltd on behalf of Moray Offshore WindFarm (East) Limited	
	
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List of Abbreviations

BMM	Brown & May Marine
BOWL	Beatrice Offshore Windfarm Ltd
CPUE	Catch per unit effort
EGNOS	European Geostationary Navigation Overlay Service
ES	Environmental Statement
EU	European Union
MFV	Marine Fishing Vessel
Moray East	Moray Offshore Windfarm (East) Limited
MD	Marine Directorate
MSS	Marine Scotland Science
MD-LOT	Marine Directorate Licensing and Operations Team
OFTI	Offshore Transmission Infrastructure
PEMP	Project Environmental Monitoring Programme
TAC	Total Allowable Catch
TI	Transmission Infrastructure

Definitions

- **Moray Offshore Windfarm (East) Limited** - formerly known as Moray Offshore Renewables Limited and hereinafter referred to as Moray East.
- **The Moray East site** - the area in which the Moray East Offshore Wind Farm will be located. Section 36 Consents and associated Marine Licences to develop and operate up to three generating stations on the Moray East site were granted in March 2014. At that time the Moray East site was known as the “Eastern Development Area” and was made up of three sites known as the Telford, Stevenson and MacColl Offshore Wind Farm sites. The Section 36 Consents and Marine Licences were subsequently varied in March 2018;
- **Telford, Stevenson and MacColl wind farms** – these names refer to the three consented offshore wind farm sites located within the Moray East site;

Moray East Offshore Wind Farm Consents – are comprised of the following:

- Section 36 Consents:
 - Section 36 consent for the Telford Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Telford Offshore Wind Farm assigned to Moray East on 19 June 2018.
 - Section 36 consent for the Stevenson Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Stevenson Offshore Wind Farm assigned to Moray East on 19 June 2018.
 - Section 36 consent for the MacColl Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the MacColl Offshore Wind Farm assigned to Moray East on 19 June 2018.
- Marine Licences
 - Marine Licence for the Telford Offshore Wind Farm (as varied) – Licence Number: 04629/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on 19 July 2018.
 - Marine Licence for the Stevenson Offshore Wind Farm (as varied) – Licence Number: 04627/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on 19 July 2018.
 - Marine Licence for the MacColl Offshore Wind Farm (as varied) – Licence Number: 04628/19/0 (as varied) - consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on 19 July 2018.
- **OfTI Licences** – These licences have now been transferred to the OfTO and are comprised of the following:
 - Marine Licence for the Offshore Transmission infrastructure – Licence Number 05340/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the “OfTI Marine Licence”).

- Marine Licence for two additional distributed OSPs – Licence Number 06347/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction, operation and maintenance works and the deposit of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the “OSP Marine Licence”).

Executive Summary

This post-construction monitoring report has been prepared for Moray Offshore Windfarm (East) Limited (Moray East) as part of the Project Environmental Monitoring Programme (PEMP) required as part of their Section 36 Consents. This report describes the post-construction element of Condition 26 of the PEMP in relation to cod spawning and satisfies Condition 11 (Piling Strategy (PS)), Condition 34 (Telford & Stevenson), and Condition 33 (MacColl) of Moray East Section 36 consent conditions.

Whilst the North Sea cod (*Gadus morhua*) stock is assessed as a single unit, there is evidence of sub-stock structuring (Fox *et al.*, 2008 and ICES, 2007). Cod spawning grounds have been defined in the Moray East site (i.e. Coull *et al.*, 1998 and Ellis *et al.*, 2010); however, the degree of spawning activity currently taking place in this area is largely unknown.

The objective of this survey was to collect data to characterise the spatial and temporal distribution of spawning cod activity in and around the Moray East site. The survey methodology was designed in consultation with Marine Scotland Science (MSS) and Marine Directorate Licensing and Operations Team (MD-LOT).

The survey was conducted in two trips (Trip A and Trip B) between 12th March 2024 and 29th March 2024 coinciding with the peak cod spawning season. Eight stations were sampled during each trip. In line with the 2019 pre-construction cod survey, sampling was undertaken using a commercial rock-hopper otter trawl with a 120 mm mesh cod-end, fitted with a 40 mm blinder.

The catch from each otter trawl was emptied into the hopper, sorted into baskets by species and photographed. The length, sex and spawning condition of each cod was identified, recorded and their gonads photographed.

Over the course of the two survey trips (Trip A and Trip B), cod were caught at five of the eight stations sampled, with a maximum of three cod caught at a single station (OT35, Trip A). Of the 10 cod caught in total, nine stage III (“spawning”) cod were caught (OT36, OT39, OT38, OT27, and OT35 Trip A; OT39, Trip B), with one juvenile recorded (OT08, Trip A). Only one cod was caught during Trip B (25th March – 29th March 2024), which was of maturity stage “spawning (cessation)”.

Cod catch rates were calculated using the net sensor data outputs (swept area per tow). MSS guidance (derived from Wright *et al.*, 2006) definition of spawning areas based on Catch Per Unit Effort (CPUE) was used to determine whether significant cod spawning occurred at any of the stations surveyed. Three categories were assigned based on the values provided by MDS:

- ‘Not important’ for spawning cod (≤ 15 spawning cod/km²);
- ‘May be important’ for spawning cod (>15 to ≤ 75 spawning cod/km²); and
- ‘Spawning area’ (>75 spawning cod/km²).

The analysis of CPUE of spawning cod found no locations fell within the threshold of a cod “spawning area”. Four locations fell within the threshold of “may be important” to spawning cod in Trip A, and one in Trip B; however, it should be noted that this is based on one individual of cod of spawning status caught at three of the stations during Trip A, and one station during Trip B. All other stations fell within the “not important” for spawning cod threshold.

The results of the surveys suggest that cod spawning occurred in the survey area pre-construction and that this continues to be the case post-construction. Both surveys found cod in relatively low numbers and no sampling stations were identified as “spawning areas” based on analysis of spawning cod CPUE between the pre- and post-construction.

1 Introduction

This Post-construction Cod Survey Report has been commissioned by Moray Offshore Windfarm (East) Limited (Moray East) to inform the Project Environmental Monitoring Programme (PEMP) required as part of the Section 36 Consents for the Telford, Stevenson and MacColl Offshore Wind Farms (together the Section 36 Consents).

This report is submitted in accordance with the following Moray East Section 36 Consent Conditions:

- Section 36 Condition 26 (PEMP) in relation to cod spawning;
- Section 36 Condition 34 (Telford & Stevenson Offshore Wind Farms); and
- Section 36 Condition 33 (MacColl Offshore Wind Farm).

This report has been prepared by Brown and May Marine Ltd (BMM).

This report details the findings of the cod survey undertaken between 12th March 2024 and 29th March 2024 in the vicinity of the Moray East site.

The objectives of the cod survey were as follows:

- to collect data on the spatial and temporal distribution of spawning cod in the vicinity of the Moray East site; and
- to determine the level of spawning activity in and around the Moray East site.

The survey methodology (Moray East Cod Survey Methodology) was previously agreed with Marine Scotland Science (MSS) and Marine Directorate Licensing and Operations Team (MD-LOT) in January 2019.

The sampling area was previously agreed with MSS with the “Cod Survey Area” defined within the Moray East Section 36 Consents for the Telford, Stevenson and MacColl wind farms in regard to post construction survey requirements. Eight sampling locations were identified, and the survey was undertaken in two trips, using an otter trawl with a 40 mm blinder. All eight sampling locations were surveyed in each trip.

A Marine Directorate (MD) derogation to catch and land undersized and out of quota fish utilising specified cod end mesh sizes was granted prior to the commencement of the survey, in accordance with the terms of Section 9 of the Sea Fish Conservation Act 1967 and Article 43 of Council Regulation No. 850/98.

Following discussions with the MS Access to Fisheries teams, the EU landing obligation (i.e. discard ban) was not derogated against through allocation of scientific Total Allowable Catch (TAC). Instead, the species caught were either landed against the vessel’s quota, or discarded at sea, as required by the landing obligation. The relevant text from the MD derogation is given below:

- *All quota species subject to the landing obligation must be landed and will be recorded against the uptake of the vessels PO¹.*
- *Electronic logbooks and landing declarations are to be completed and returned as per regular voyages”..”*

A summary of the health and safety performance of the survey is provided in Appendix 1.

¹ Producers Organisation

2 Scope of Works

The scope of works for the cod spawning survey is detailed below. The sampling stations are illustrated in Figure 2-1.

The scope of the survey work included the following:

- Two Otter Trawl Survey Trips
 - Trip A: 8 tows of 30 minutes duration
 - Trip B: 8 tows of 30 minutes duration conducted at least 2 weeks after the end of trip A
- Sample Analysis - Cod
 - Number of individuals
 - Catch per Unit Effort (CPUE; number of cod/km²)
 - Length (nearest cm below)
 - Maturity analysis – Bucholtz et al. (Draft) maturity key
- Sample Analysis -By Catch
 - Number of individuals by species
 - Length by species
 - Finfish and sharks (except herring and sprat): length (nearest cm below)
 - Herring and sprat: length (nearest 0.5 cm below)
 - Rays: length and wing-width (nearest cm below)
 - Octopus and squid: mantle length (nearest cm below)
 - Scallop: shell width (mm)
 - Whelk: shell height (mm)
 - Edible crab: carapace width (mm)
 - Lobster: carapace length (mm)

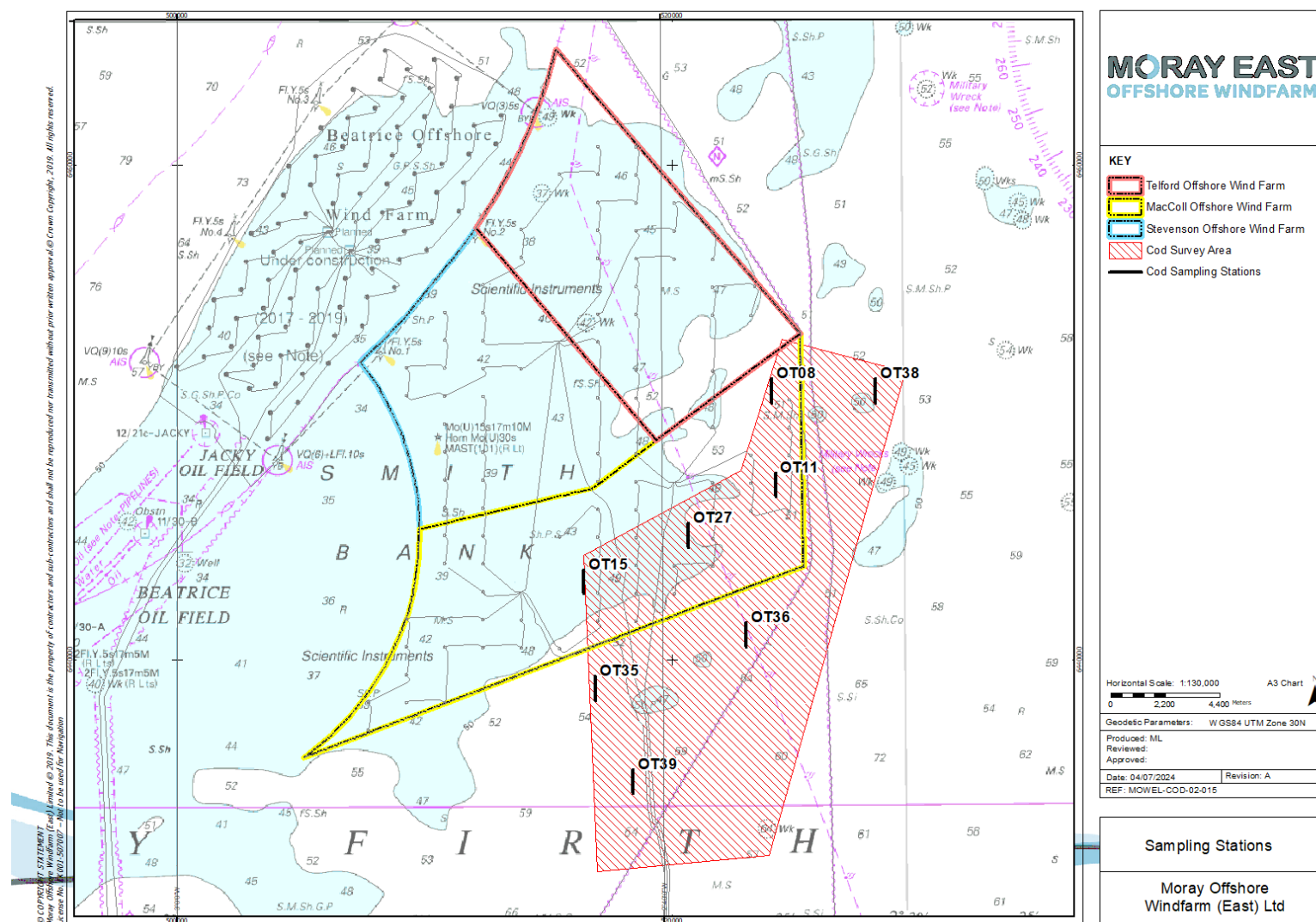


Figure 2-1: Sampling stations

3 Survey Methodology

The survey was undertaken during daylight hours between 12 March 2024 and 29 March 2024 in order to cover the peak cod spawning period in the area.

Two sampling trips were undertaken: Trip A (12th March 2024 to 15th March 2024) and Trip B (25th March 2024 to 29th March 2024). During each trip, the same eight stations were sampled.

Due to long periods of consistently poor weather, there was one station (OT35) where there was only a difference of 13 days instead of 14 days (two weeks). It was agreed with the Project that it would be preferable to obtain the data a day early in order to take advantage of a small weather window rather than risk not being able to carry it out later.

A summarised log of events is given in Appendix 2.

3.1 Survey Vessel

The vessel chartered for the survey, the fishing vessel (FV) “Reaper” (Figure 3-1), is a Wick-based commercial trawler that also carried out the post-construction cod survey for the Beatrice offshore wind farm. The specifications of the vessel are given in Table 3-1.



Figure 3-1: Survey vessel “FV Reaper”

Table 3-1: Survey vessel (FV Reaper) specifications

Survey Vessel Specifications	
Length	16.75 m
Beam	7.0 m
Draft	4.2 m
Main Engine	650HP Cat, 8 berths
GPS	2 x Furuno GP-39
Plotters	2 x Sodena, 1 x Furuno MaxSEA TIMEZERO (with wassp/3D mapping)
Sounder	1 x WASP Furuno and 1 x JRC
Net sensors	Simrad TV80 Data Logging

3.2 Survey Gear

In line with the previous cod surveys, a commercial rock-hopper otter trawl (Figure 3-2) with a 120 mm mesh cod end, fitted with a 40 mm blinder was used for sampling. The specifications of the gear used are detailed in Table 3-2.

In order to calculate the area sampled by the trawl (trawl swept area) during each tow, a receiver and data processing unit was used to receive data from net sensors monitoring and recording the trawl door and wing spread and providing information for positioning and management of the trawl net.



Figure 3-2: Otter trawl net being hauled

Table 3-2: Otter trawl specifications

Survey Equipment	
Towing Warp	180 m, 20 mm diameter, dyform
Depth: Payout Ratio	3:1

Survey Equipment	
Trawl Doors	850 kg, 2 backstrops into one attachment
Net	80 -120 mm mesh cod-end whitefish trawl with a 40 mm cod end blinder
Groundline	Rock-hopper 14" centre bobbins and 12" wing bobbins
Estimated Headline Height	2.5 m
Distance between Trawl Doors	45– 60 m
Towing Warp	180 m, 20 mm diameter, dyform
Depth: Payout Ratio	3:1

3.3 Sampling Procedures

A total of eight tows were undertaken during Trip A. These were replicated during Trip B. No stations were omitted from any of the survey trips.

The otter trawl tow tracks for Trip A and Trip B are illustrated in Figure 3-3 and Figure 3-4, respectively. The start and end times, co-ordinates, depths and durations of each otter trawl tow are given in Appendix 3.

3.3.1 Positioning and Navigation

The position of the vessel was tracked at all times using a Garmin GPS Map 276CX with a European Geostationary Navigation Overlay Service (EGNOS) differential connected to an external Garmin GA30 antenna. Sensors monitoring and recording the trawl door spread provided information for positioning and management of the trawl.

Otter trawl start times, positions and water depths were taken when the gear made contact with the seafloor and the skipper advised that the gear was settled and had reached the appropriate spread based on net sensor readings. Otter trawl end times, positions and water depths were taken when hauling of the gear commenced.

Some of the sample locations were adjusted from the 2019 positions to avoid infrastructure allowing for safe operations during the survey. These locations have been adjusted approximately 500m to the west of their previous position. The adjustment of the sample locations was agreed with MSS prior to commencement of the survey.

Given the sampling method and inherent variables of offshore surveys such as seastate, tide, wind and seabed conditions which affect net deployment times, and the time the net takes to “settle” on the seabed some variation was observed between the pre and post-construction survey tows (as shown in Figure 3-3 and Figure 3-4), however, all encompassed the planned survey line

3.3.2 Sampling

At each station, the otter trawl was deployed to the seabed. Once the skipper advised that the gear was settled, the otter trawl was towed for 30 minutes at a speed of approximately three knots.

The catch from each otter trawl was emptied into the hopper, photographed, and sorted into baskets by species. The length, sex and spawning condition of each cod was identified, recorded and their gonads photographed.

By-catch species were identified, counted, measured and either landed against the vessels quota or returned to sea, as required by the UK Landing Obligation. Sub-sampling by species was carried out at sea where necessary.

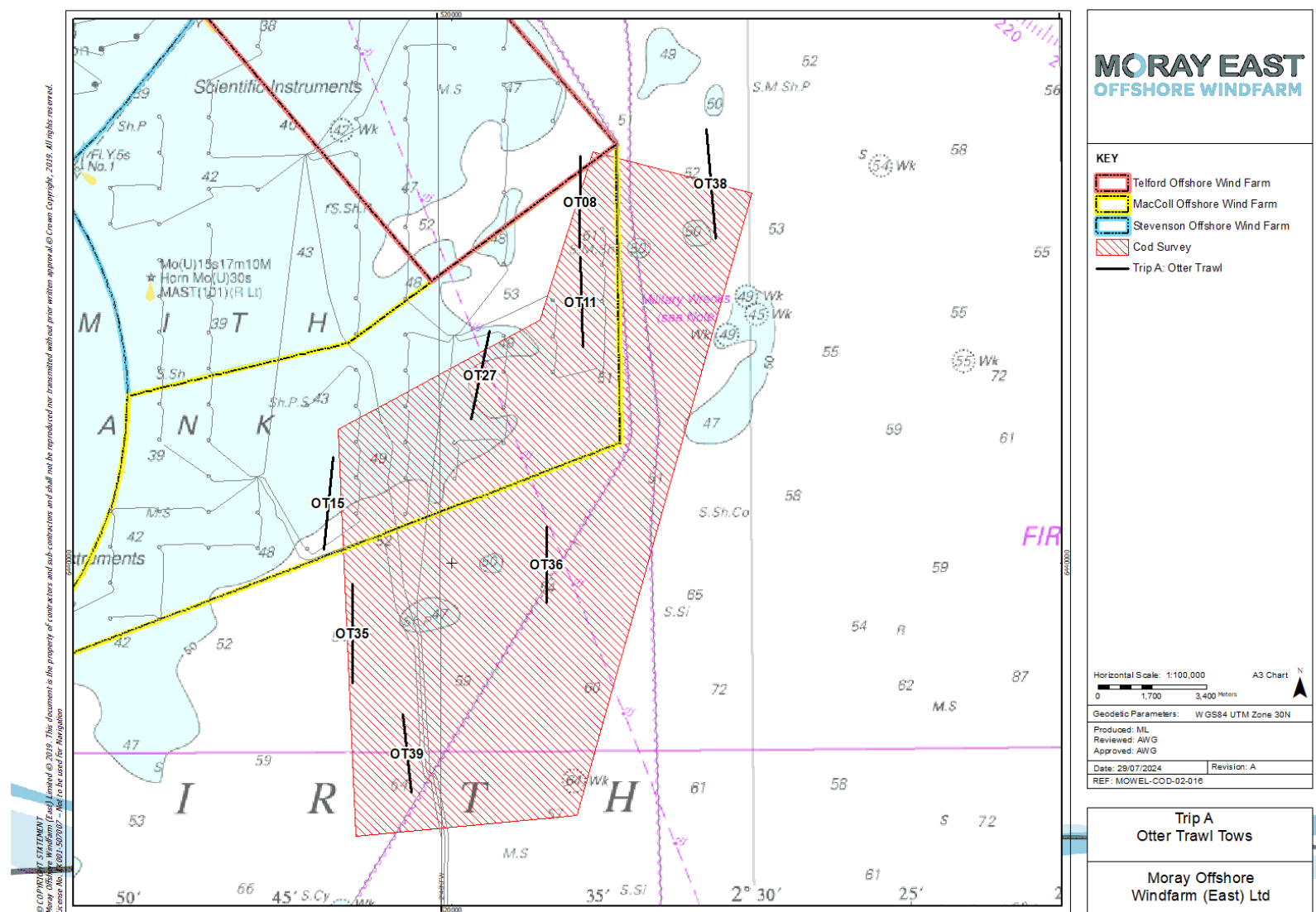
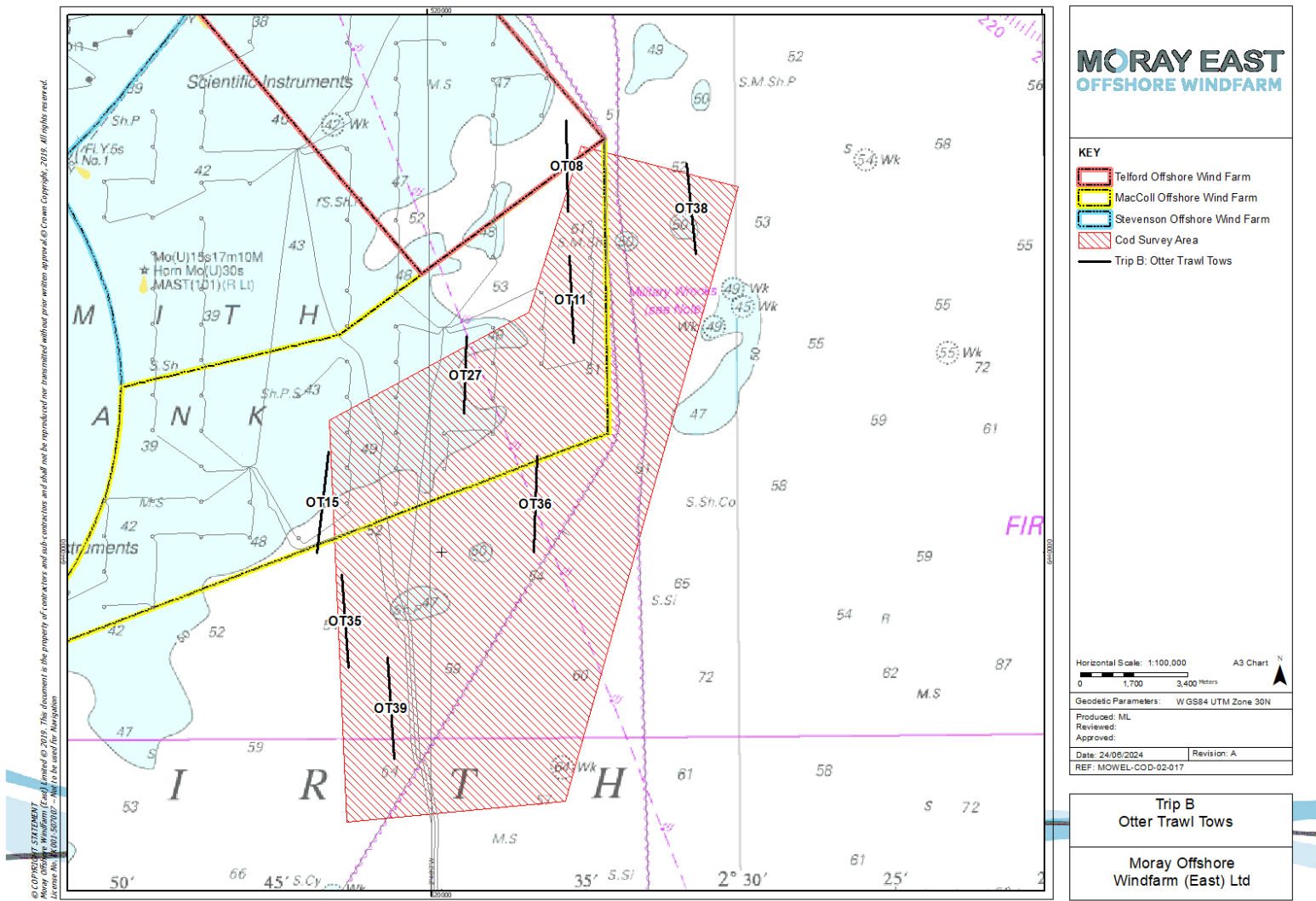


Figure 3-3: Trip A tow tracks



3.3.3 Cod Maturity Analysis

The gonadal maturity key used to determine the spawning condition of the cod sampled is presented in Table 3-3. This was as provided by MSS (Bucholtz *et al.*, Draft manual). As shown, stage III cod is considered to be in spawning condition. Individuals that have recently spawned (spent) are included under stage IV.

For the purposes of this report, the presence of both stage III and stage IV cod is considered indicative of spawning activity as both stages represent sexually active adults. Examples of spawning and spent individuals are provided in Appendix 4.

Table 3-3: Cod maturity key (adapted from Bucholtz *et al.*, Draft manual)

Stage		Description of Appearance	
		Female	Male
I	Juvenile/ immature	Ovaries small but easily distinguishable posterior in body cavity, soft with smooth surface, blurred translucent, reddish-orange	Testes small, but distinguishable along air bladder. Lobules small, blurred translucent reddish-white
II	Maturing	Ovaries occupy between half and 2/3 of the body cavity, plump and firm with prominent blood vessels, opaque, orange to creamy yellow. Oocytes clearly visible and densely packed	Testes enlarged and prominent dorsal in body cavity; lobules plump and brittle; reddish-white. Empty transparent spermatoducts with prominent blood vessels; no sperm release
III	Spawning	Ovaries fill most of body cavity; very distended and soft; appear granulated orange- to reddish-grey from mixture of opaque and glassy oocytes. Lumen containing viscous fluid in excess or hydrated eggs	Testes large and prominent in body cavity. Lobules still plump, but soft; completely opaque, whitish. Spermatoducts filled with fluid, milky semen that easily flows from vent
IV	Spent	Ovaries contracted; slack with greyish cast; rich in blood vessels; dim translucent reddish-grey. Vitellogenic oocytes absent but single hydrated eggs or atretic oocytes (opaque irregular granules) may occur	Testes contracted, close to air bladder; rich in blood vessels. Lobules empty, flabby, reddish potentially with a greyish cast. Spermatoducts with signs of previous distension, often with visible remains of semen
V	Resting/Skip of spawning	Ovaries small as in stage I but with signs of previous spawning; e.g. greyish cast and somewhat uneven walls; blurred translucent, reddish-grey, but more granulated and opaque than in stage I	Testes small but with signs of previous spawning; e.g. lobules slightly larger than in stage I; spermatoducts often with a greyish cast
VI	Abnormal	Stone roe. Ovary has a thick wall, grey-whitish cast and hard parts	Testes with adipose tissue formation; affected parts undeveloped, hard and yellowish

3.3.4 Cod Analysis by CPUE

The number of cod caught at each station were multiplied up using the swept area of each tow calculated from the net sensor data following the methodology provided in Wright *et al.* (2006). This produced a CPUE value of number of cod per km² for each station. In order to identify whether or not the CPUE of spawning cod (stage III and stage IV cod) recorded was indicative of significant spawning activity, the following guidance produced by MSS (and based on Wright *et al.* (2006) findings) was applied (see Appendix 6):

- “Not important” for spawning cod (≤ 15 spawning cod/km²);
- “May be important” to spawning cod (>15 to ≤ 75 spawning cod/km²); and
- “Spawning area” (>75 spawning cod/km²).

3.3.5 Moray West Construction Activity

Moray West is an adjacent offshore wind farm that is in its construction phase and construction activities such as piling were ongoing at the time of the survey, which may have had an effect on the survey results. The dates of the installation of monopiles that were recorded during the survey periods are given below in Table 3-4.

Table 3-4: Installation dates of monopiles that occurred during the cod survey sampling trips

Sampling Trip	Monopile installation dates
Trip A	13/03/2024 (G05) 14/03/2024 (F04, M09) 15/03/2024 (K12).
Trip B	26/03/2024 (J10, K08) 28/03/2024 (H08) 29/03/2024 (H06)

4 Survey Results

4.1 Cod

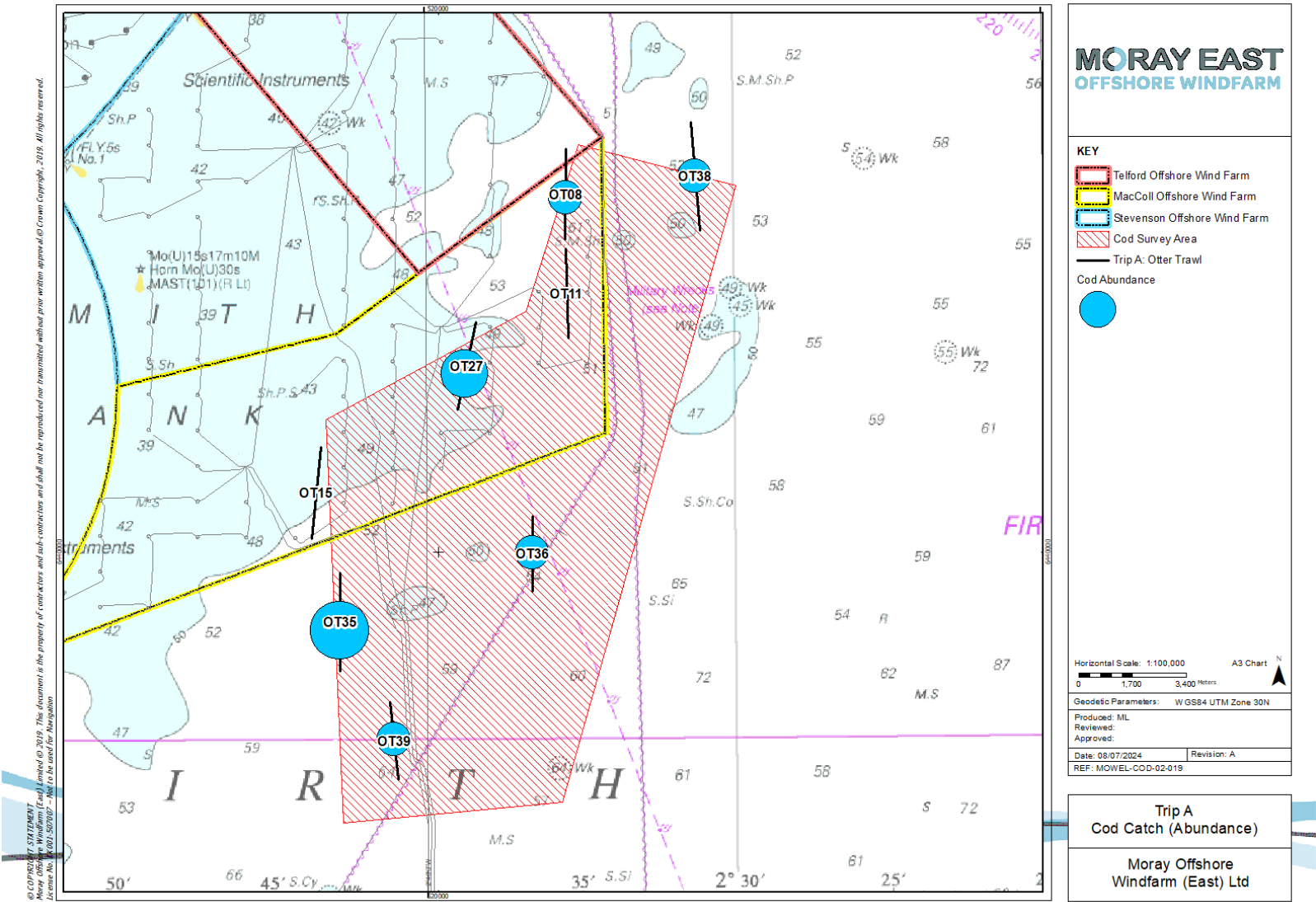
Cod were caught in small numbers during the survey with a total of 10 individuals recorded across Trip A and Trip B. Of these, one was juvenile and nine were adults. A maximum of three cod were recorded at a single station (OT35, Trip A).

Gender identification was possible in all 10 of the cod caught. Of these, the majority were male, with two females caught.

There was evidence of spawning in all individuals of the adult cod caught (one stage III (“spawning”) female, seven stage III (“spawning”) males and one stage III (“spawning (cessation)”) male. The stage III female was caught at station OT38 during Trip A. Stage III males were caught at OT36, OT39, OT27 (two individuals), and OT35 (three individuals) during Trip A. The stage III (“spawning (cessation)”) male was the only cod caught during Trip B, at station OT39.

The abundance (number of individuals caught) by station is illustrated in Figure 4-1 and Figure 4-2 for Trip A and Trip B, respectively. Cod were found in six out of the eight stations sampled during Trip A and only in one out of the eight stations sampled during Trip B.

There was no clear pattern to indicate whether piling activities at the adjacent Moray West offshore wind farm had an effect on the presence or absence of cod given that piling occurred during both sampling trips.



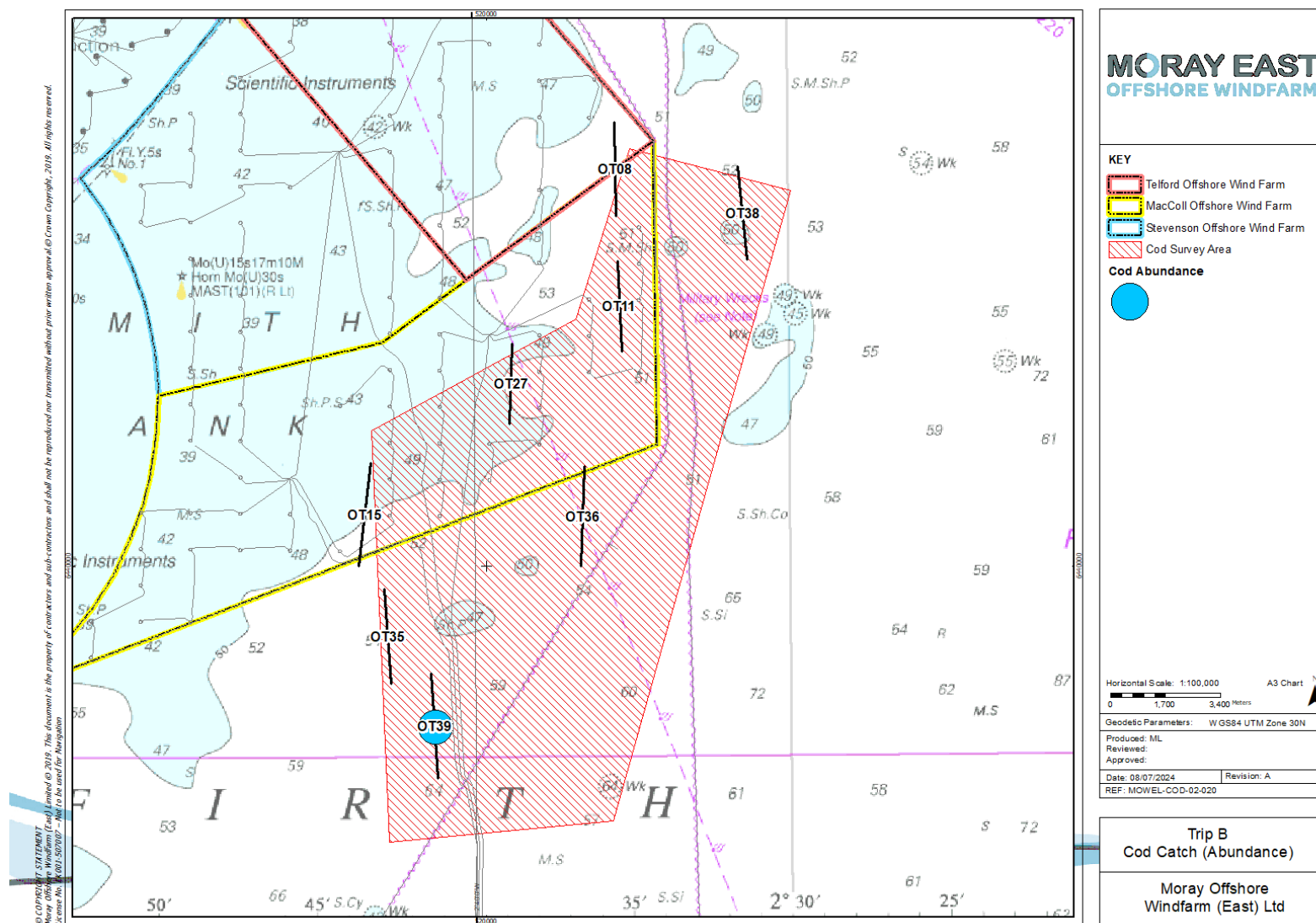


Figure 4-2: Number of cod caught in Trip B

4.1.1 Trip A

The number of cod caught by station during Trip A together with the length, sex and maturity stage of each individual is shown in Table 4-1. Eight individuals with spawning status (stage III cod “spawning”) were caught. Figure 4-3 and Figure 4-4 illustrate cod abundance during trip A by spawning status (spawning/not spawning) and maturity stages (I to IV) respectively.

Table 4-1: Number of cod, sex and maturity stage by sampling station for Trip A

Stations	Length (cm)	Sex	Maturity stage	Total no. individuals	Total no. spawning cod
OT36	47.5	M	Spawning (III)	1	1
OT39	73	M	Spawning (III)	1	1
OT08	26	F	Juvenile (I)	1	0
OT38	36	F	Spawning (III)	1	1
OT27	36	M	Spawning (III)	2	2
	41	M	Spawning (III)		
OT35	45	M	Spawning (III)	3	3
	39	M	Spawning (III)		
	55	M	Spawning (III)		
Grand Total				9	8

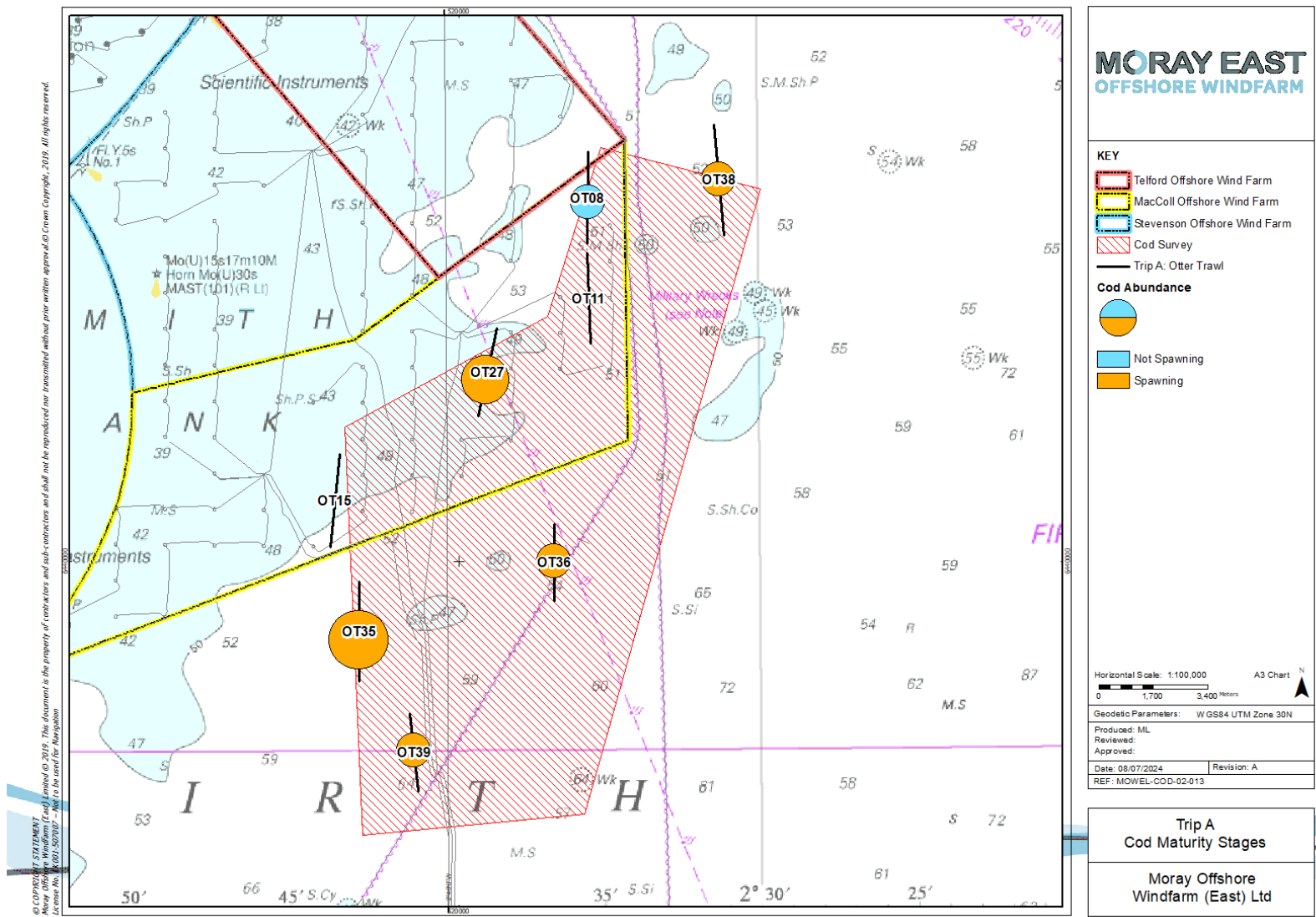


Figure 4-3: Cod spawning status (spawning/not spawning) in Trip A

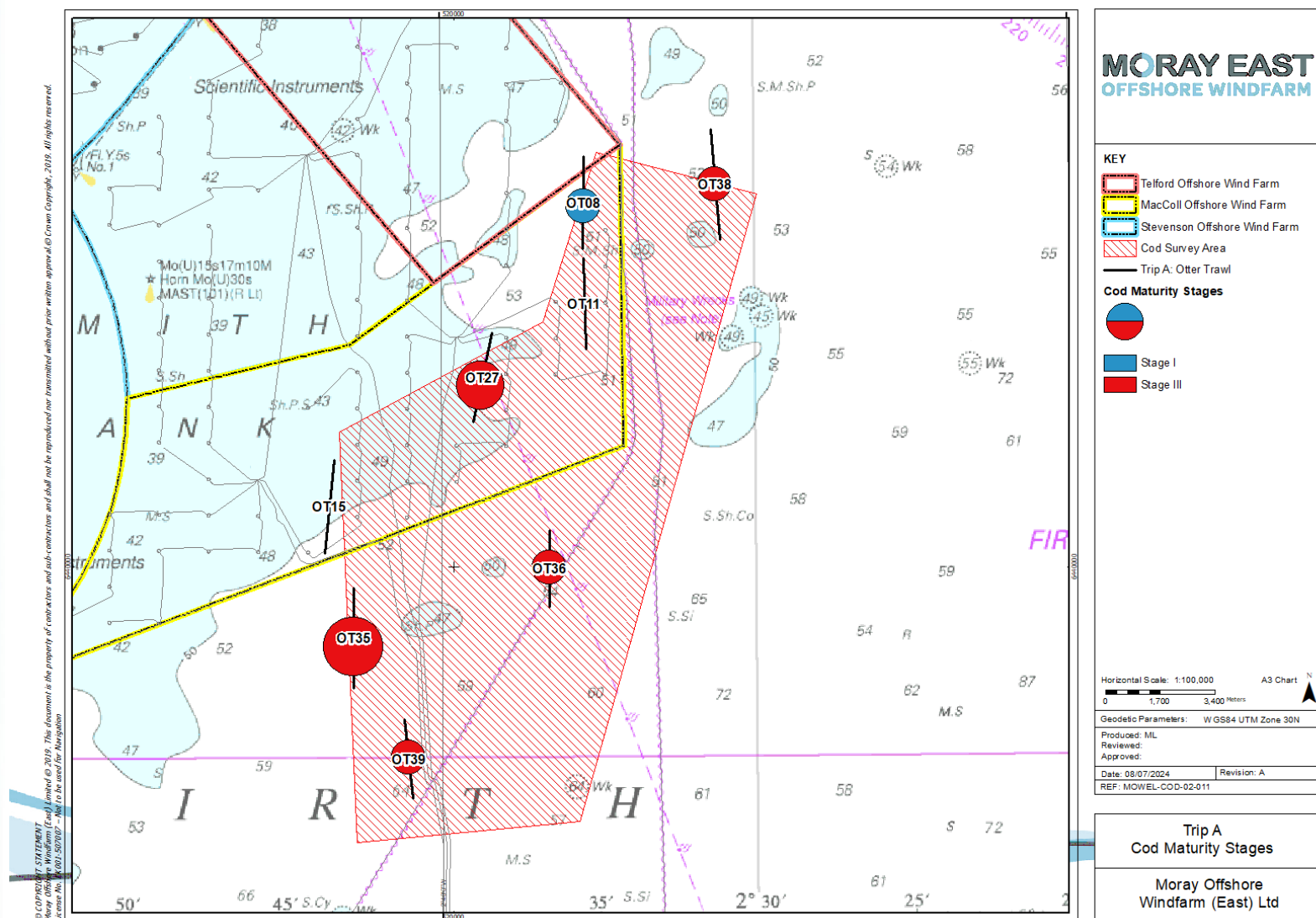


Figure 4-4: Cod maturity stages (II-III) in Trip A

4.1.2 Trip B

The number of cod caught by station during Trip B together with the length, sex and maturity stage of each individual is shown in Table 4-2. Only one cod was caught during Trip B. The individual was of spawning cessation status. The spatial distribution of cod abundance during trip B by spawning state (spawning/not spawning) is given in Figure 4-5 and by maturity stage (I to IV) in Figure 4-6.

Table 4-2: Number of cod, sex and maturity stage by sampling station for trip B

Station	Length (cm)	Sex	Maturity stage	Total no. individuals	Total no. spawning cod
OT39	47	M	Spawning cessation (III)	1	1
Grand Total				1	1

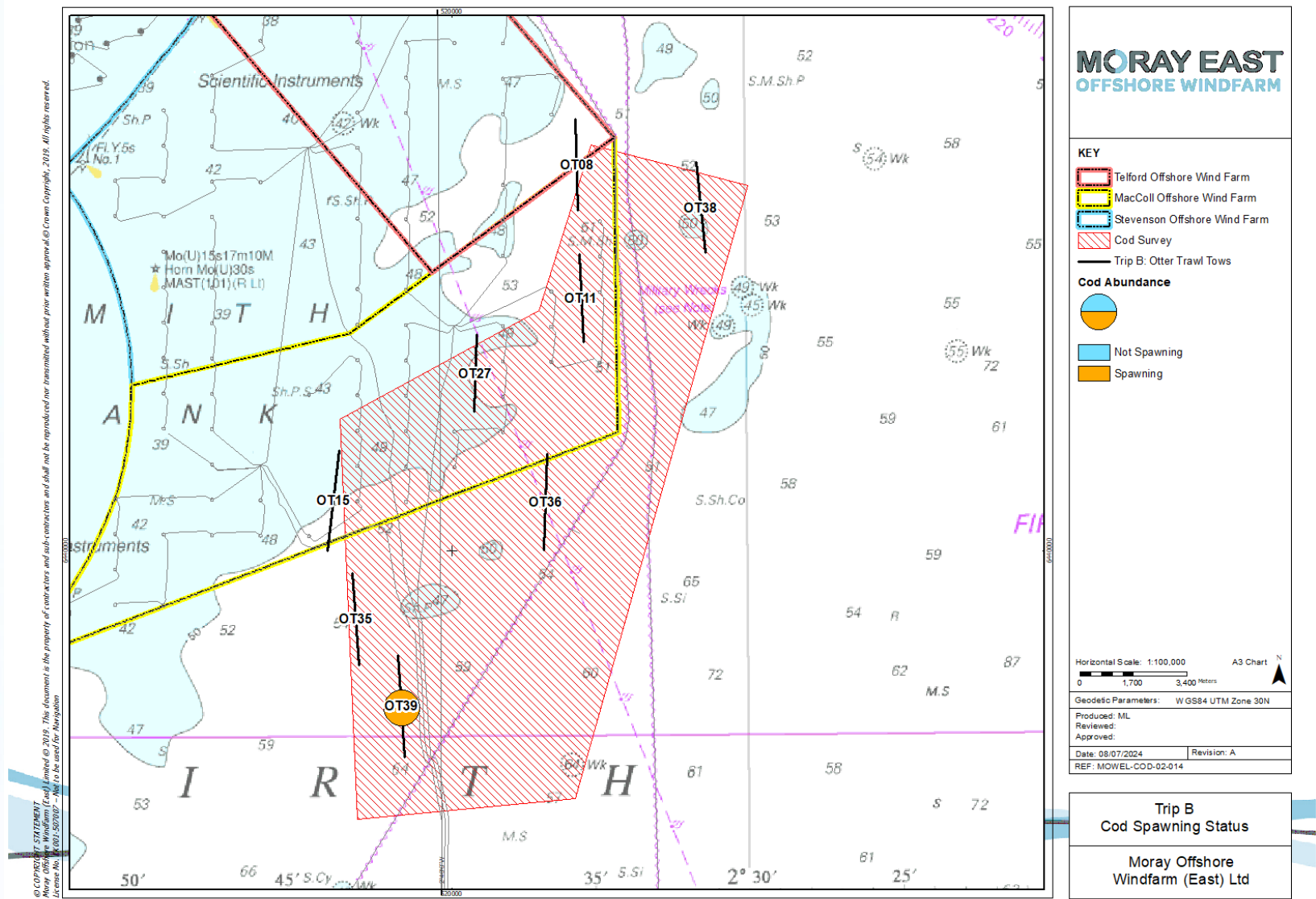


Figure 4-5: Cod spawning status (spawning/not spawning) for Trip B

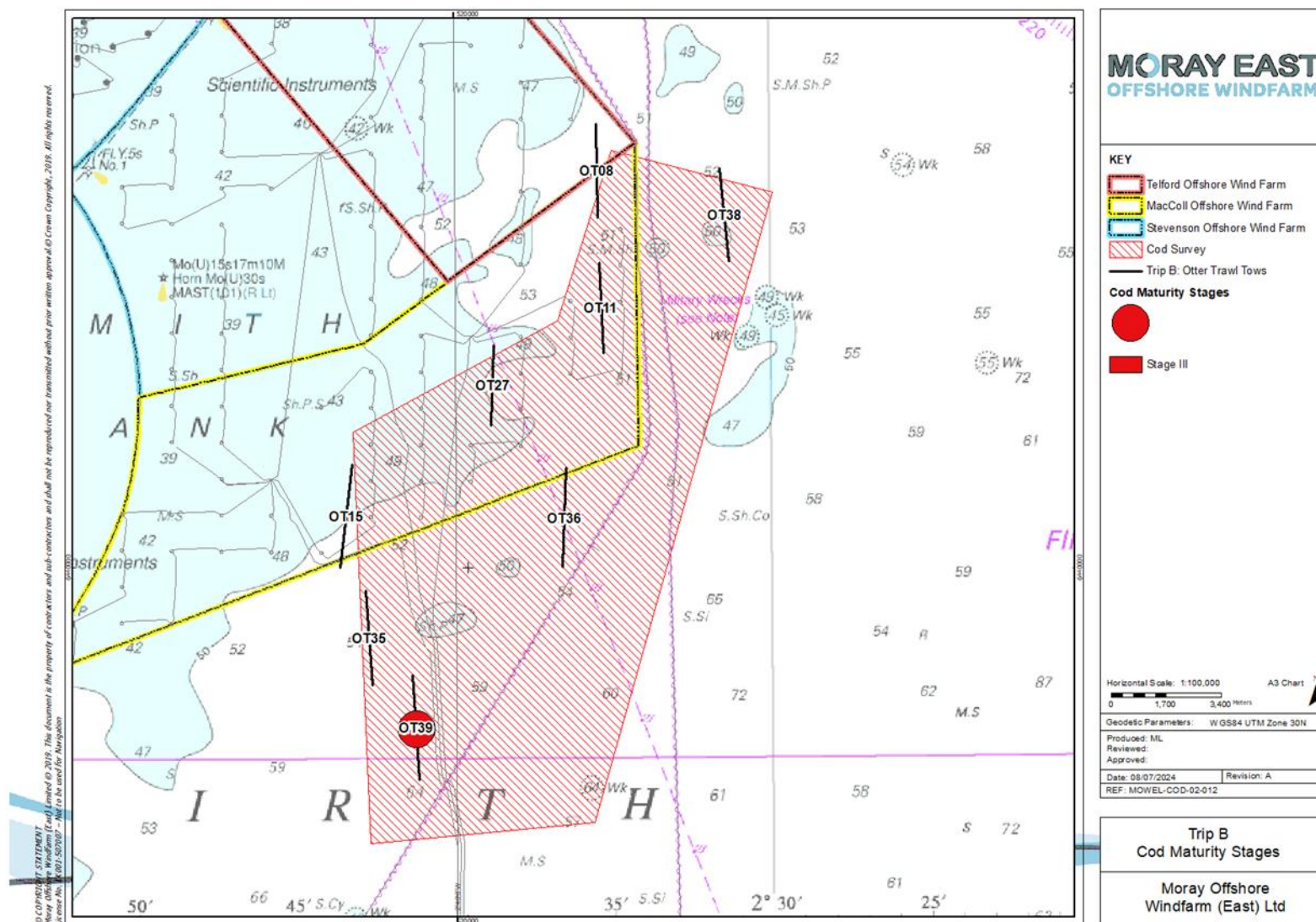


Figure 4-6: Cod maturity stages (III) in Trip B

4.2 Cod spawning activity analysis

The survey stations have been categorised, in line with MSS guidance on defining cod spawning areas based on cod CPUE (individuals of spawning cod/km²), as shown in Table 4-3.

The CPUE of spawning cod (cod in maturity stage III and IV) recorded during Trip A and Trip B was not indicative of the presence of a cod “spawning area” (>75 spawning cod/km²). The MSS spawning area category of “may be important” to spawning cod (>15 to ≤75 spawning cod/km²) was recorded for four locations; OT36, OT39, OT38, and OT27 in Trip A (29.5, 29.4, 19.5, and 63.2 spawning cod/km² respectively), and OT39 (19.4 spawning cod/km²) in Trip B. It should be noted, however, that this is based on one individual of cod of spawning status caught at stations OT36, OT39 and OT38, two caught at OT27, and three caught at OT35 during Trip A. Similarly, only one individual cod of spawning status was caught during Trip B at station OT39. Cod spawning status is illustrated by station in Figure 4-7 for Trip A. Stations that fall within the category “spawning area” are highlighted in red. Stations that fall within the category “may be important” are highlighted in orange. As only one spawning cod was caught in Trip B, this chart has been omitted.

Table 4-3: Number of spawning cod per km² with spawning status assigned for each station during both trips

Trip	Station	No. spawning cod (maturity stage III and IV) per km ²	Spawning status based on MSS guidance
A	OT36	29.5	May be important
A	OT39	29.4	May be important
A	OT38	19.5	May be important
A	OT08	0	Not important
A	OT11	0	Not important
A	OT27	50.1	May be important
A	OT15	0	Not important
A	OT35	63.2	May be important
B	OT36	0	Not important
B	OT39	19.4	May be important
B	OT38	0	Not important
B	OT08	0	Not important
B	OT11	0	Not important
B	OT27	0	Not important
B	OT15	0	Not important
B	OT36	0	Not important

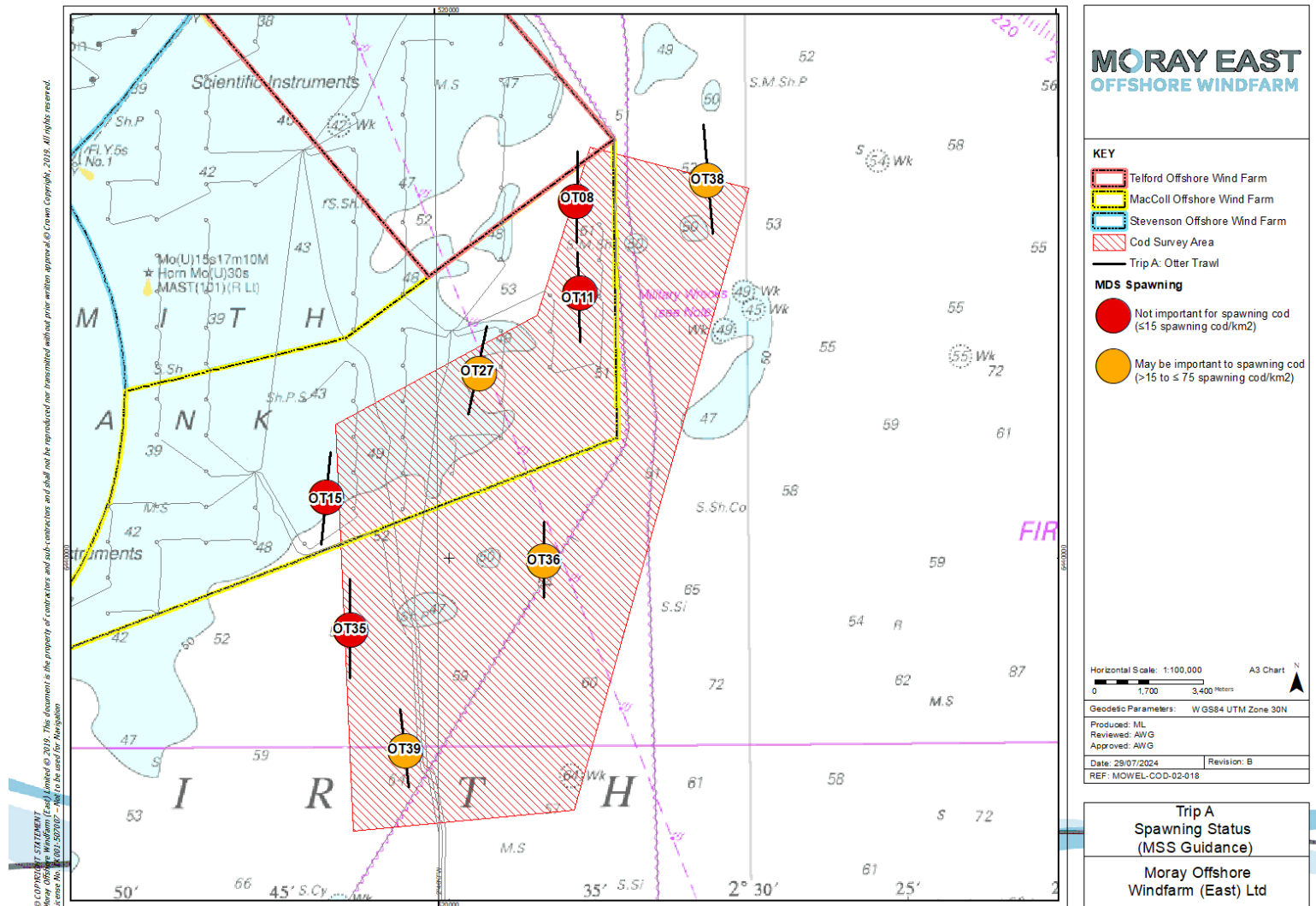


Figure 4-7: Trip A cod spawning status derived from CPUE (no. cod/km²) by station

4.3 By-catch

The fish and invertebrate by-catch were recorded in the survey. The fish by-catch is outlined in Table 4-4 and Table 4-5, for Trip A and Trip B respectively.

Haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*), sprat (*Sprattus sprattus*), herring (*Clupea harengus*), mackerel (*Scomber scombrus*), and grey gurnard (*Eutrigla gurnardus*) were the principal by-catch species found during the survey.

Haddock was the most abundant species in both survey trips (16,612 individuals) accounting for 83.9 % of the total fish by-catch. The highest abundances for haddock were recorded in Trip 1 (8,662 individuals) with 7,950 individuals recorded in Trip 2. Haddock and whiting are gadoids, with a similar morphology and life history to cod. The presence of high numbers of these species in the catch indicates the effectiveness of the gear used in the survey.

The majority of the remaining by-catch species of fish and commercial shellfish species were recorded in relatively low numbers (<1,000 individuals per trip). The invertebrate by-catch is given in Appendix 5, section A5.1.

Table 4-4: Number of fish (by-catch species) caught during Trip A

Species		Trip A
Common Name	Scientific Name	Total No. of individuals Caught
Haddock	<i>Melanogrammus aeglefinus</i>	8,662
Whiting	<i>Merlangius merlangus</i>	992
Sprat	<i>Sprattus sprattus</i>	133
Herring	<i>Clupea harengus</i>	105
Poor cod	<i>Trisopterus minutus</i>	98
Mackerel	<i>Scomber scombrus</i>	88
Grey gurnard	<i>Eutrigla gurnardus</i>	86
Dab	<i>Limanda limanda</i>	56
Plaice	<i>Pleuronectes platessa</i>	30
Pout	<i>Trisopterus luscus</i>	27
Long rough dab	<i>Hippoglossoides platessoides</i>	8
Argentine	<i>Argentina sphyraena</i>	2
Lesser Spotted Dogfish	<i>Scyliorhinus canicula</i>	2
Lemon sole	<i>Microstomus kitt</i>	1
Total No. of Individuals		10,299

Table 4-5: Number of fish (by-catch species) caught during Trip B

Species		Trip B
Common Name	Scientific Name	Total No. of individuals Caught
Haddock	<i>Melanogrammus aeglefinus</i>	7,950
Whiting	<i>Merlangius merlangus</i>	972
Mackerel	<i>Scomber scombrus</i>	278
Grey gurnard	<i>Eutrigla gurnardus</i>	123
Sprat	<i>Sprattus sprattus</i>	109
Dab	<i>Limanda limanda</i>	34
Plaice	<i>Pleuronectes platessa</i>	25
Herring	<i>Clupea harengus</i>	9

Species		Trip B
Common Name	Scientific Name	Total No. of individuals Caught
Long rough dab	<i>Hippoglossoides platessoides</i>	3
Sandeel	<i>Ammodytes</i>	3
Sole	<i>Solea solea</i>	3
John Dory	<i>Zeus faber</i>	1
Lemon sole	<i>Microstomus kitt</i>	1
Lesser Spotted Dogfish	<i>Scyliorhinus canicula</i>	1
Total No. of Individuals		9,512

5 Comparison with the Pre-Construction Cod Surveys

While two pre-construction surveys have been carried out for the Moray East project in 2013 and 2019, a comparison has only been carried out between the 2019 pre-construction and post-construction surveys due to the difference in sampling methodology in 2013 (i.e. number of sampling stations, use of a 20mm blinder supplied by MSS). A summary of the 2013 methodology and results however is given in section 5.1.

An overview of the comparison of results from the 2019 pre-construction and post-construction surveys is given in Table 5-1.

Cod were caught in low numbers during both the pre-construction and post-construction surveys, with a maximum of 12 cod caught in a single survey trip (Trip 1, pre-construction). Overall, cod numbers were higher in the 2019 pre-construction survey (22 individuals compared to 10 individuals post-construction). To some extent this is a result of the comparatively high number of juvenile/immature fish that were caught pre-construction (19 immature/juvenile fish pre-construction compared to one juvenile post-construction).

It should be noted that while the pre-construction and post-construction survey dates of Trip 2 were comparable, post-construction Trip 1 was undertaken over one week later in the year than pre-construction Trip 1, as a result of extensive periods of poor weather. There was also no clear pattern to indicate whether piling activities at the adjacent Moray West offshore wind farm had an effect on the presence or absence of cod given that the numbers of cod caught in Trip 1 post-construction was equivalent to the numbers recorded in each of the pre-construction sampling trips.

Table 5-1 Comparison between 2019 and 2024 cod survey results

Item	2019		2024	
	Trip 1	Trip 2	Trip 1	Trip 2
Survey dates	01/03/2019 - 04/03/2019	21/03/2019 – 26/03/2019	12/03/2024 – 15/03/2024	25/03/2024 – 29/03/2024
Number of stations where cod were caught / total number of stations sampled	6/8	6/8	6/8	1/8
Total number of cod individuals	12	10	9	1
Immature/Juvenile Cod (Stage I)	9	10	1	0
Spawning Cod (Stage III)	2	0	8	1
Stations classified as spawning areas under MSS guidance	0	0	0	0

5.1 MORL 2013 Pre-construction Survey

The 2013 pre-construction cod survey was carried out in two trips between 17th February and 19th March 2013 (Trip A from 17th February to 26th February and Trip B from 10th March to 19th March). Sampling was undertaken using a commercial rock-hopper otter trawl with a 120 mm mesh cod end, fitted with a 20 mm blinder (provided by MSS). 56 tows of 30 minutes duration were undertaken within and adjacent to the Moray Offshore Renewables Limited (MORL) Round 3 Area to cover areas of the cod spawning grounds defined by Coull et al (1998) where noise levels at which cod may exhibit strong avoidance reactions during the construction phase may occur (90dBht). Two tows of 60 minutes duration were also carried out at the request of MSS to determine whether larger cod were out-swimming the net in the 30 minute tows.

Cod were recorded in 35 out of 58 stations, with a maximum of nine individuals caught at a single station (OT38, Trip B). In general terms, cod were found in very low numbers with a total of 73 individuals being caught during the survey (Trip A + Trip B). A total of 23 spawning cod were caught in the survey, 12 in Trip A and 11 in Trip B.

5.2 BOWL Pre-and Post-construction Surveys

The Beatrice Offshore Wind Limited (BOWL) pre-construction cod spawning survey was undertaken between 20th February and 13th March 2014 and the post-construction survey was undertaken between 1st March and 29th March 2021. A total of 42 tows of 30 minutes duration were completed at 21 stations in two sampling trips.

Sampling was undertaken using a commercial rock-hopper otter trawl with a 120 mm mesh cod end, however it should be noted that in the pre-construction survey a 20 mm blinder (provided by MSS) was used and for the post-construction a 40mm blinder was used.

Cod were caught in relatively low numbers during both the pre-construction and post-construction surveys, with a maximum of 70 cod caught in a single survey trip (Trip 2, pre-construction). Overall, cod numbers were higher in the pre-construction survey (131 individuals compared to 30 individuals post-construction). There was a comparatively higher number of juvenile/immature fish that were caught pre-construction (77 immature/juvenile fish) compared to seven post-construction. This may have been affected by the difference in blinder mesh size (20mm pre-construction and 40mm post-construction).

Only a few stations were identified as “spawning areas” during the surveys based on analysis of spawning cod CPUE (a maximum of four in pre-construction Trip 2) and these were not consistent across trips within the same survey nor between the pre- and post-construction surveys.

6 Conclusion

Data on the spatial and temporal distribution of cod in the vicinity of the Moray East site was collected over the course of two survey trips in March 2024.

Cod were caught at six of the eight stations sampled in Trip A and at one station in Trip B. In both trips, cod were caught in very low numbers in comparison to other gadoids recorded as by-catch during the survey (e.g. haddock and whiting). In total, only one juvenile and nine adult cod were caught during the survey. Of these, eight cod caught were considered to be of “spawning status” (stage III), and one considered to be of “spawning cessation status” (stage III).

The analysis of CPUE of spawning cod found no locations fell within the threshold of a cod “spawning area” as defined by MSS. Four locations fell within the threshold of “may be important” to spawning cod in Trip A, and one in Trip B; however, it should be noted that this is based on one individual of cod of spawning status caught at three of the stations during Trip A, and one station during Trip B. All other stations fell within the “not important” for spawning cod threshold.

The pre- and post-construction surveys have provided high resolution information on cod spawning in the central Moray Firth. No clear pattern with regard to spawning locations is apparent from the survey results and no sampling stations were identified as “spawning areas” based on analysis of spawning cod CPUE between the pre- and post-construction. The results of the surveys suggest that cod spawning occurred in the survey area pre-construction and that this continues to be the case post-construction. Both surveys however found cod in relatively low numbers.

Cod surveys have also been undertaken for the Beatrice offshore wind farm within the Moray Firth following a similar methodology (BOWL, 2015 and BOWL, 2021). This data could allow some comparisons to be made with this report’s data, with scope to provide a broader overview of cod spawning activity in the Moray Firth. It should be noted however, that there were some differences in methodology regarding sampling station number, locations and net blinder size.

7 References

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APPENDIX 1: HEALTH AND SAFETY

A1.1 Personnel

Brown and May Marine (BMM) staff followed the standard health and safety protocol outline in the BMM Project Health & Safety Plan & Risk Assessment (HSE) and Moray East permit to work documents.

All BMM staff have completed a sea survival course approved by STCW. All crew and BMM staff have valid medical certificates (ENG1).

A1.2 Vessel induction

Before boarding, the survey team were shown how to safely board and disembark the vessel. Prior to departure, the skipper briefed surveyors on the whereabouts of the safety equipment, including the life raft, emergency flares and fire extinguishers, and the location of the emergency muster point. The safe deck areas, man-overboard procedures and emergency alarms were also discussed. The survey team was warned about the possible hazards, such as slippery decks and obstructions whilst aboard. Surveyors were briefed about trawling operations and the need to keep clear of all winches when operational. All hazards were assessed prior to the survey in the BMM health and safety risk assessment.

A1.3 Daily safety checks

The condition of the life jackets, PLB's, and life raft were inspected prior to departure. Daily checks were undertaken in the survey team working areas, including the deck and the wheelhouse, to ensure these areas were clear of hazards such as clutter and obstructions.

A1.4 Post trip survey review

Upon completion of the survey a "post trip survey review" was completed. For the summary see Table A1.0-1 and Table A1.0-2 below.

Table A1.0-1: Post trip survey review (part 1)

Project: Moray East Post-construction Cod Survey 2024	
Vessel	Reaper WK 83
Skipper	Donald Anderson
Dates at Sea	12/03/2024 - 29/03/2024
Survey Area	Moray Firth
Total Time at Sea	Two x one week sampling trips
Surveyor Supervisors	Alex Winrow-Giffin, Zoe Lawrence
Surveyors:	Shawn Taylor-Michel, Rhys Kibble, Morgan Lord

Table A1.0-2: Post trip survey review (part 2)

Review	Comments	Actions
Did vessel comply with pre trip safety audits?	Yes (CMID audit undertaken prior to survey and required items closed out)	N/A
Skipper and crew attitude to safety?	Good –correct PPE worn	N/A
Vessel machinery failures?	None	N/A
Safety Equipment failures?	None	N/A
Accidents?	None	N/A
Injuries?	None	N/A

APPENDIX 2: LOG OF EVENTS

A summarised log of events is given below in Table A2.0-1 for the survey.

Table A2.0-1: Summarised log of events

Wednesday	13 March 2024	Trip A
TBT held where HSE briefing and vessel induction was reviewed ahead of weather window for the next day.		
Thursday	14 March 2024	Trip A
Vessel left Fraserburgh Harbour at 04:00.		
TBT held at 06:30. Agreed to steam over station locations before deploying net.		
Arrived at first survey location at 07:00.		
Steamed first survey location (OT38) at 08:00.		
OT38 completed at 08:30. Sample processing conducted while steaming to next location.		
OT08 station trawl started.		
OT08 completed at 11:00. Sample processing conducted while steaming to next location.		
OT11 started at 12:30.		
OT11 completed at 13:00. Sample processing conducted while steaming to next location.		
OT27 started at 14:30.		
OT27 completed at 15:00. Sample processing conducted while steaming to next location.		
OT15 started at 16:00. Aborted 20 minutes in as approaching wreck / obstruction.		
OT15 restarted at 16:50.		
OT15 completed at 17:20. Sample processing conducted while steaming to shelter area.		
Sample processing completed at 18:30.		
19:00 arrived at shelter area for evening.		
Friday	15 March 2024	Trip A
Vessel steamed to survey location OT35 from shelter area.		
TBT held at 07:00.		
OT35 started at 07:30.		
OT35 completed at 08:00. Sample processing conducted while steaming to Fraserburgh Harbour. Trip A complete.		
Arrived at Fraserburgh Harbour at 12:30.		
Monday	25 March 2024	Trip B
TBT held at 08:00.		
Departed Fraserburgh Harbour to transit to site at 09:20.		
OT36 started at 14:00. Tow halted due to issue with net.		
OT36 completed at 15:00.		
OT39 started at 16:50.		
OT39 completed at 17:40. Sample processing conducted while steaming to Fraserburgh Harbour.		
Arrived in Fraserburgh Harbour at 21:40.		

Discussed plans for following day based on forecast at 22:00.		
Tuesday	26 March 2024	Trip B
TBT held at 09:00. On standby in port due to weather.		
Crew carried out visual inspection of net at 10:00. No damage observed.		
Discussed plans for following day based on forecast at 17:00.		
Wednesday	27 March 2024	Trip B
TBT held at 09:00. On standby in port due to weather.		
Discussed plans for following day based on forecast at 17:00.		
Thursday	28 March 2024	Trip B
TBT held at 09:00. On standby in port due to weather.		
Discussed plans for following day based on forecast at 17:00.		
Friday	29 March 2024	Trip B
TBT held at 06:50. Steamed to site.		
OT39 started at 07:00.		
OT39 completed at 07:30. Sample processing conducted while steaming to next location.		
OT35 started at 08:40.		
OT35 completed at 09:10. Sample processing conducted while steaming to next location.		
OT15 started at 10:30.		
OT15 completed at 11:00. Sample processing conducted while steaming to next location.		
OT27 started at 12:10.		
OT27 completed at 12:40. Sample processing conducted while steaming to next location.		
OT11 started at 13:40.		
OT11 completed at 14:10. Sample processing conducted while steaming to next location.		
OT08 started at 14:55.		
OT08 completed at 15:25. Sample processing conducted while steaming to next location.		
OT38 started at 16:15.		
OT38 completed at 16:45. Sample processing conducted while steaming to Fraserburgh Harbour. Trip B completed.		
Arrived in Fraserburgh Harbour at 22:10.		

APPENDIX 3: TIME AND COORDINATES

The date, times, coordinates and depth for each station is given below in Table A3.0-1 for Trip A and in Table A3.0-2 for Trip B.

Table A3.0-1: Start and end times, coordinates and duration of each otter trawl - Trip A

Station	Date	Otter Trawl Start (UTM30N)				Otter Trawl End (UTM30N)				Duration (mm:ss)
		Time (GMT)	Latitude	Longitude	Depth (m)	Time (GMT)	Latitude	Longitude	Depth (m)	
OT36	12/03/2024	15:22:21	58 06.6687'N	002 36.5718'W	57.79	15:52:38	56 05.3696N	002 36.5876'W	58.34	30:17.0
OT39	12/03/2024	16:44:41	58 03.4925'N	002 41.2115'W	63.28	17:14:15	58 02.1976N	002 40.9574'W	66.02	29:34.0
OT38	14/03/2024	08:08:23	58 11.5355'N	002 31.0861'W	51.57	08:41:08	58 13.4329	002 31.3605'W	52.67	32:45.0
OT08	14/03/2024	10:22:09	58 11.3975'N	002 35.4655'W	52.85	10:52:19	58 12.9102	002 35.4409'W	52.67	30:10.0
OT11	14/03/2024	12:47:20	58 09.7171'N	002 35.3859'W	54.50	13:17:00	58 11.2102	002 35.4517'W	54.32	29:40.0
OT27	14/03/2024	14:23:00	58 08.4958'N	002 38.9759'W	31.46	14:54:26	58 09.9641	002 38.4168'W	53.04	31:26.0
OT15	14/03/2024	16:50:00	58 07.8730'N	002 43.4084'W	49.93	17:21:34	58 06.3115	002 43.7255'W	52.67	31:34.0
OT35	15/03/2024	07:24:00	58 05.7148'N	002 42.8079'W	54.13	07:55:06	58 04.0751N	002 42.8138'W	56.14	31:06.0

Table A3.0-2: Start and end times, coordinates and duration of each otter trawl - Trip B

Station	Date	Otter Trawl Start (UTM30N)				Otter Trawl End (UTM30N)				Duration (mm:ss)
		Time (GMT)	Latitude	Longitude	Depth (m)	Time (GMT)	Latitude	Longitude	Depth (m)	
OT36	25/03/2024	15:12:16	58 06.6262'N	002 36.6262'W	56.33	15:42:37	58 07.7240'N	002 36.4990'W	57.06	30:21.0
OT39	29/03/2024	07:02:16	58 02.5056'N	002 41.1914'W	64.37	07:32:47	58 04.2049'N	002'41.3775'W	60.17	30:31.0
OT38	29/03/2024	16:12:12	58 12.7194'N	002 31.5884'W	53.58	16:42:30	58 11.1433'N	002'31.3256'W	53.77	30:18.0
OT08	29/03/2024	14:54:03	58 11.8987'N	002 35.4648'W	55.78	15:24:00	58 13.4920'N	002'35.5105'W	56.33	29:57.0
OT11	29/03/2024	13:39:10	58 09.0409'N	002 35.3077'W	54.32	14:09:40	58 11.1598'N	002'25.4076'W	53.95	30:30.0
OT27	29/03/2024	12:09:54	58 08.4391'N	002 38.6670'W	51.02	12:39:44	58 09.7918'N	002'38.7805'W	51.57	29:50.0
OT15	29/03/2024	10:31:24	58 07.7915'N	002 43.2746'W	49.93	11:01:42	58 06.0302'N	002'43.6850'W	54.13	30:18.0
OT35	29/03/2024	08:40:15	58 05.6834'N	002 42.8626'W	54.50	09:10:30	58 04.0861'N	002'42.6646'W	57.97	30:15.0

APPENDIX 4: EXAMPLES OF COD MATURITY STAGES

A4.1 Trip A

A4.1.1 Stage I – Juvenile



Figure A4.0-1: Juvenile (stage I) female 26 cm caught at OT08

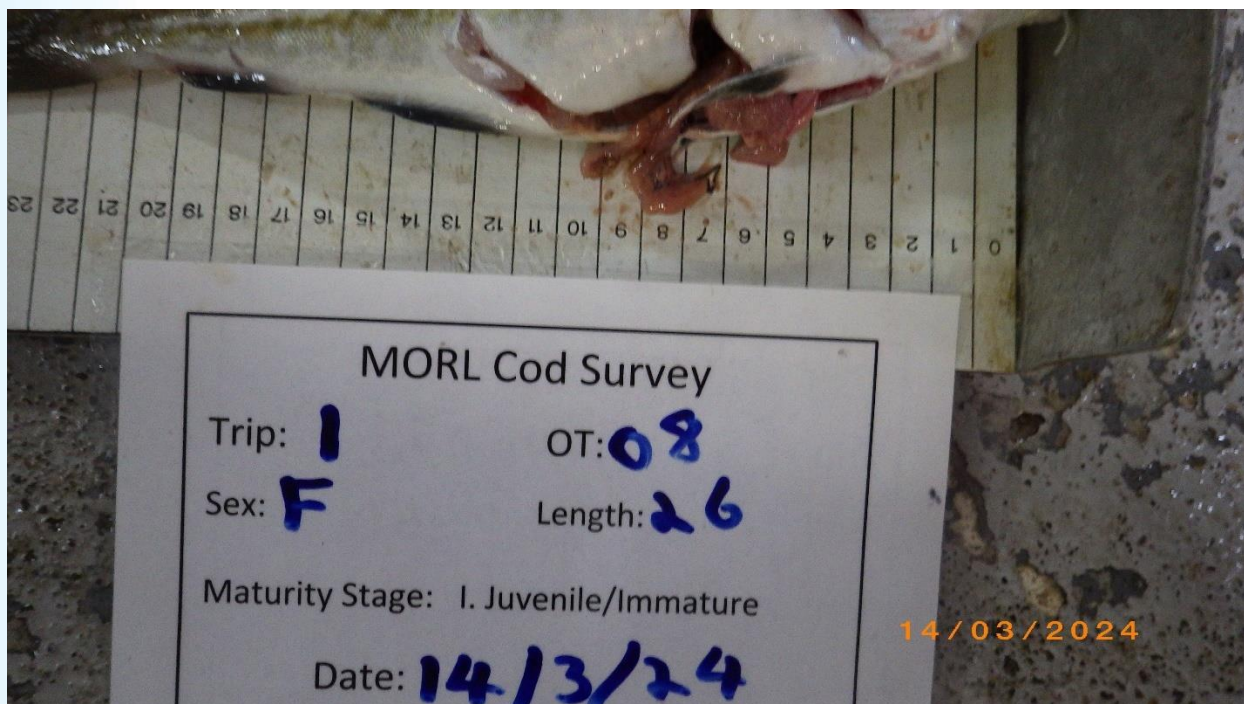


Figure A4.0-2: Juvenile (stage I) female gonads

A4.1.3 Stage III – Spawning



Figure A4.0-3: Spawning (stage III) female 38cm caught at OT38



Figure A4.0-4: Spawning (stage III) female gonads

A4.2 Trip B

A4.2.1 Stage III – Spawning (cessation)



Figure A4.0-5: Spawning cessation (stage III) male 47 cm caught at OT39



Figure A4.0-6: Spawning cessation (stage III) male gonads

APPENDIX 5: BY-CATCH

A5.1 Invertebrate by-catch

The mobile and sessile invertebrate species recorded during the cod survey are given in Table A5.0-1. Please note that the number recorded for anemone (Actiniaria) and hornwrack (*Flustra foliacea*) is a record of the number of stations where presence was recorded for those species.

Table A5.0-1: Mobile and sessile invertebrate species recorded by abundance or presence by survey trip

Mobile and sessile species	Abundance	
Species	Trip A	Trip B
Squid (<i>Loligo</i> sp.)	110	210
Hornwrack (<i>Flustra foliacea</i>)*	5	1
Anemone (Actiniaria)*	1	
Edible urchin (<i>Echinus esculentus</i>)	1	

*Number of stations present

APPENDIX 6: MSS GUIDANCE FOR DEFINING COD SPAWNING

Defining cod spawning areas based on CPUE (pers.com A. Kafas (MSS) 7th April 2014):

Wright *et al.* (2006) used a variety of approaches to define general areas of cod spawning, including the number of spawning cod caught per hour by MRV Scotia in the GOV². The threshold for defining spawning areas in that paper was CPUE values > 2 spawning cod per hour, although > 10 spawning cod per hour provides a more definitive evidence of spawning. The average swept area (wing spread x distance travelled) of 1,330 hauls conducted on Scotia during Q1 and Q4 west coast surveys, 2000-2011 was estimated to be 66039.14 m², for a 30 minute tow. The following averages were used to standardise the gear raising factors: Headline height = 5 m and wing spread = 20 m. On average then the GOV covers 0.132 km² in 1 hour. So for the GOV, 2 running cod per hour is approximately equal to 15 spawning cod per km² swept (i.e. $2 \times (1/0.132)$) and 10 running cod per hour is approximately equal to 75 spawning cod per km² swept. Three other trawl surveys targeted at cod in early spring caught mature cod in 55 out of 207 stations. Of these 55 stations with mature cod, 25 contained spawning cod ranging from 5 - 360 spawning cod per km² swept. Of the 25 spawning cod stations, 16 had >15 spawning cod per km² swept with only 2 stations > 75 spawning cod per km² swept.

So, as a guideline the presence of >15 spawning cod per km² should give some concern that the area may be important to spawning cod. Whereas >75 spawning cod per km² swept should provide a clear indication of a spawning area. It should also be noted that spawning cod generally represent a small percentage of the mature cod in a haul (on average 9%) and so we would expect that swept area estimates of mature cod numbers would be higher than this but the presence of spawning (running cod) gives the clearest indication of a spawning site.

² Grande ouverture vertical (GOV) trawl; a high-headline bottom trawl.

APPENDIX 7: TOW DATA AND COD ABUNDANCE CALCULATIONS

Table A7.0-1: Trip A Tow data and cod abundance data used to calculate no. of spawning cod per km²

Station	Date	Tow Duration (hr)	Av. Headline Height (m)	Av. Wing Spread (m)	Swept Distance (km)	Swept Area (km ²)	No. Cod	No. Spawning Cod	No. Cod/km ²	No. Spawning Cod/km ²	Spawning Status
OT36	12/03/2024	0.50	4.48	14.17	2.40	0.03	1	1	29.45	29.45	M
OT39	12/03/2024	0.49	4.50	13.76	2.47	0.03	1	1	29.38	29.38	M
OT38	14/03/2024	0.55	4.07	14.77	3.48	0.05	1	1	19.48	19.48	M
OT08	14/03/2024	0.50	4.08	14.30	2.89	0.04	1	0	24.17	0.00	L
OT11	14/03/2024	0.49	4.18	14.53	2.82	0.04	0	0	0.00	0.00	L
OT27	14/03/2024	0.52	4.16	14.08	2.84	0.04	2	2	50.08	50.08	M
OT15	14/03/2024	0.53	4.18	14.13	2.93	0.04	0	0	0.00	0.00	L
OT35	15/03/2024	0.52	4.25	15.19	3.13	0.05	3	3	63.15	63.15	M

Table A7.0-2: Trip B Tow data and cod abundance data used to calculate no. of spawning cod per km²

Station	Date	Tow Duration (hr)	Av. Headline Height (m)	Av. Wing Spread (m)	Swept Distance (km)	Swept Area (km ²)	No. Cod	No. Spawning Cod	No. Cod/km ²	No. Spawning Cod/km ²	Spawning Status
OT36	25/03/2024	0.51	4.35	16.33	3.07	0.05	0	0	0.00	0.00	L
OT39	29/03/2024	0.51	4.40	15.78	3.26	0.05	1	1	19.44	19.44	M
OT38	29/03/2024	0.51	4.15	15.79	2.90	0.05	0	0	0.00	0.00	L
OT08	29/03/2024	0.50	4.32	15.77	2.91	0.05	0	0	0.00	0.00	L
OT11	29/03/2024	0.51	4.16	16.24	2.79	0.05	0	0	0.00	0.00	L
OT27	29/03/2024	0.50	4.24	15.13	2.47	0.04	0	0	0.00	0.00	L
OT15	29/03/2024	0.51	4.13	15.47	3.43	0.05	0	0	0.00	0.00	L
OT35	29/03/2024	0.50	4.35	15.11	2.95	0.04	0	0	0.00	0.00	L



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