Moray Offshore Renewables Limited

Proposal & Scope of Works: Herring Larval Monitoring

Brown & May Marine Ltd.

Project Title/Location	MORL Herring Larval Monitoring
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Contents

1.0 Introduction

This scope of works has been prepared by Brown and May Marine (BMM) Ltd on behalf of Moray Offshore Renewables Limited (MORL).

This proposal provides a scope of works for two deliverables in regards to herring larvae monitoring in the vicinity of the Telford and Stevenson wind farm sites of the MORL eastern development area (EDA):

1. Annual desktop review of herring larvae baseline; and
2. Herring larval monitoring survey.

The undertaking and results of the desktop study and monitoring survey will be used to meet the requirements under Section 36 consent condition number 33 for both Telford and Stevenson wind farms and conditions 11 (Piling Strategy) and 26 (Project Environmental Monitoring Programme) for the three consented wind farms as it relates to herring mitigation and monitoring These deliverables are described in detail in the following sections.

2.0 Deliverable 1: Review of existing herring larvae data

A desktop study will be undertaken to inform an annually updated report on the spatial and temporal abundance of herring larvae. The report will review and incorporate data from:

- International Herring Larval Survey (IHLS)
- Vessel Monitoring System (VMS)
- Commercial fisheries data
- Beatrice Offshore Wind Limited (BOWL) herring larval surveys
- Current literature on herring larvae life history
- Hydrodynamics of the area.

Additionally, in the Beatrice Offshore Windfarm Limited (BOWL) site herring larval surveys, back calculations from length distributions were undertaken to approximately determine peak spawning periods and herring larvae age. Traditionally, the IHLS only supply their larval distribution data in grouped length categories of <10mm and ≥10mm, which result in inaccurate estimates of age. It should be noted that the 2015 IHLS data was published by raw ungrouped individual length data and if it is possible to obtain other years data in this format, back calculations could be undertaken on the most recent IHLS datasets.

Published hatch sizes, mortality rates and growth rates would be used in back calculation analysis. This would produce estimates of larval age from larval length, and peak spawning times and abundance. Calculating larval age gives an indication of the duration of the larvae in the water column, which when used with hydrodynamic data, can give an estimate of larval drift distances.

The report would be updated on an annual basis until the pre-construction monitoring surveys detailed below is undertaken. The final report will be produced for the year preceding these surveys.

3.0 Deliverable 2: Herring pre-construction monitoring survey

3.1 Sampling Methodology

The proposed methodology for the Herring Monitoring Survey is detailed below and is based on that used for the BOWL herring larvae surveys. This was designed in consultation with Marine Scotland Science (MSS), using the IHLS standard methodology, to ensure adequate coverage of known spawning areas, and comparable data.

The pre-construction monitoring survey would be undertaken in the August and September preceding the commencement of construction within Telford and Stevenson wind farms. The work would be carried out under a dispensation to land herring and other fish larvae for scientific purposes. This will be applied for upon approval of the methodology by MSS / Marine Scotland-Licensing Operations Team (MS-LOT).

3.2 Vessels and Equipment

Following discussions with Scottish Fishermen's Federation (SFF) Services Ltd, two fishing vessels Antaries (BF27; Figure 3.1) and Pleiades (BF155; Figure 3.2), or ones similar, are proposed to undertake the herring larval surveys, working on a two week rotation. These vessels will have the appropriate certification, equipment and skippers experienced in undertaking surveys.

3.2.1 Antaries (BF27)

Fishing vessel (FV) Antaries (Figure 3.1) is a steel hulled, 16.70 m, Fraserburgh based trawler, launched in 2001 which has the required MCA certification and equipment to carry out the specified sampling program. This has passed SFF vessel audits and will undertake an IMCA audit prior to commencing the survey. Details of the vessel's specification are listed in Table 3.1 below.

Figure 3.1 FV Antaries

Table 3.1 FV Antaries Specifications

Survey Vessel Specifications	
Length	16.70 m
Beam	6.45 m
Draft	2.76m
Main engine	Caterpillar 3408-DITA-JW 363KW
GPS	2x Koden KGP-913D
Radar	JRC 5200 series (ARPA) & Koden MD3441
Plotters	Fishmaster Plotter and Trax Plotter
Sounder	Koden CVS8841
Berths	6

3.2.2 Pleiades (BF155)

FV Pleiades (Figure 3.2) is a steel hulled, 17.50 m, Fraserburgh based trawler, launched in 2009 which has the required MCA certification and equipment to carry out the specified sampling program. This has passed SFF vessel audits and will undertake an IMCA audit prior to commencing the survey. Details of the vessel's specification are listed in Table 3.2 below.

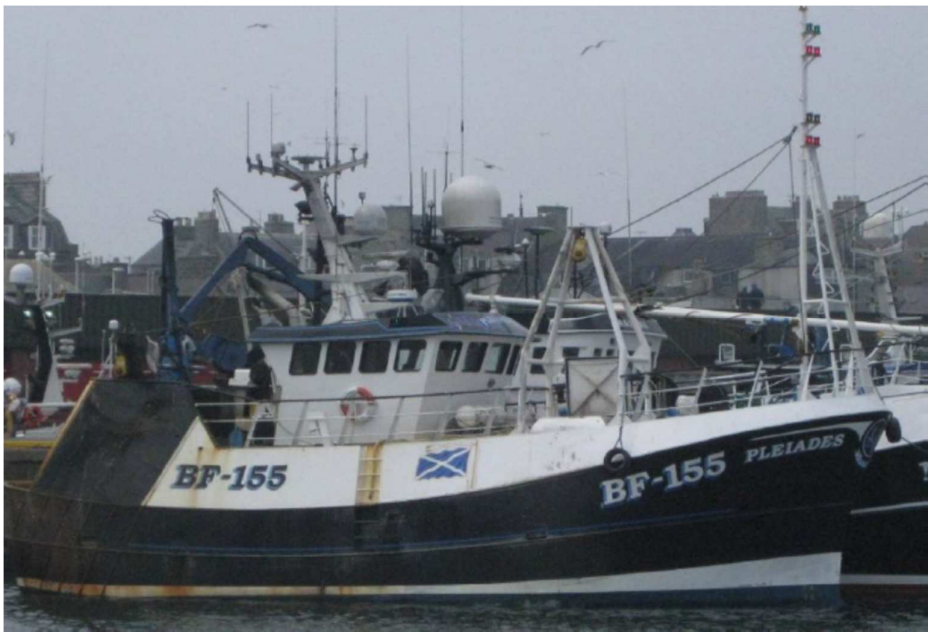

Figure 3.2 FV Pleiades

Table 3.2 FV Pleiades specifications

Survey Vessel Specifications	
Length	17.50 m
Beam	6.65 m
Draft	3.07 m
Main engine	Caterpillar 3408-480HP
GPS	Furuno SC50
Radar	Furuno Navnet Vx2 (ARPA & Ais modules); Furuno Navnet Vx2
Plotters	Fishmaster Plotter and Trax Plotter
Sounder	JRc-JFC 130
Berths	8

3.3 Sampling Gears

The specifications of the Gulf VII plankton sampler proposed for the herring larval survey are given below in Table 3.3. The proposed model is shown in Figure 3.3.

Table 3.3 Gulf VII specifications

Gulf VII Plankton Sampler Specifications	
Frame size	50 cm frame with tail fin
Nose cone	20 cm
Scripps type depressor	20 kg bronze
Drogue	1 standard form
Net	270 micron
Cod ends	Screw fit type
Flow meter	General oceanics mechanical flowmeters (internal and external)
Deployment cable	9 mm 6x36 IWRC galv rho 1960 grade MBL:5.76t
CTD probe	SAIV- A/S SD204
Transducer Control Box	PAM 35-10
Dunker	PAM 3 MF 3910
Beacon	1019D

Figure 3.3 Gulf VII high speed plankton sampler

3.4 Sampling Procedure

Accepting weather constraints, the objective will be for herring larval sampling to be carried out during eight separate trips of four days duration, the first commencing early August and continuing until late September. A consistent sampling pattern will be undertaken with the stations being sampled in the same order each week.

The proposed sampling pattern is given in **Error! Reference source not found.**. There are 20 proposed sampling locations encompassed within the 90 dB_{ht} ranges modelled for herring and cross referenced with previous IHLS results and the area defined by Coull *et al.* (1998)[1] as herring spawning grounds in the Moray Firth. This follows the sampling pattern used in the BOWL herring larval surveys and is in line with the rationale for a grid of evenly spaced stations which is considered to be the best approach for mapping the distribution of fish eggs and larvae.

[1] Coull K. A., Johnstone R., and Rogers S.I. (1998). Fisheries Sensitivity Maps in British Waters. UKOOA Ltd.

Trial runs will be undertaken with the Gulf VII to ensure the gear and equipment is working effectively. The vessel will steam along the proposed tow to ensure there are no seabed anomalies that could pose a risk to the Gulf VII plankton sampler. The standard towing speed will be 5 knots, directed into the tide, in a double oblique pattern (V shaped) from the sea surface to within a least 5 m of the seabed (target 3 m). The deployment and hauling will be continuous, aiming to have 10 m of the water column measured for a minimum of 1.5 minutes.

Where waters are relatively shallow, a double oblique pattern (W shaped) would be undertaken to ensure adequate coverage of the station, with a minimum sampling duration of 15 minutes.

Sample stations have been selected to avoid areas in proximity to known seabed obstacles. The locations have also been mapped against previous IHLS stations in the survey area.

In addition to the vessels' GPS systems, two Garmin GPSMap278 GPS's with an EGNOS differential would be used to record the vessels steaming tracks and the sampling tracks when the Gulf VII is actually sampling in the water. The tow start times and positions will be taken at the point and time at which the Gulf VII makes contact with sea surface and out-hauling commences. Similarly, the sample end times and positions will be taken at the point and time at which the Gulf VII returns to the surface after either an oblique or a double oblique tow.

For each station, information will be logged on the station number, position, date and time, haul duration, flowmeter revolutions, bottom and sampler depth, water bottom temperature and vessel direction of tow.

Note that depending on BOWLs construction programme and associated safety and exclusion zones, sampling of stations within the BOWL site may not be possible.

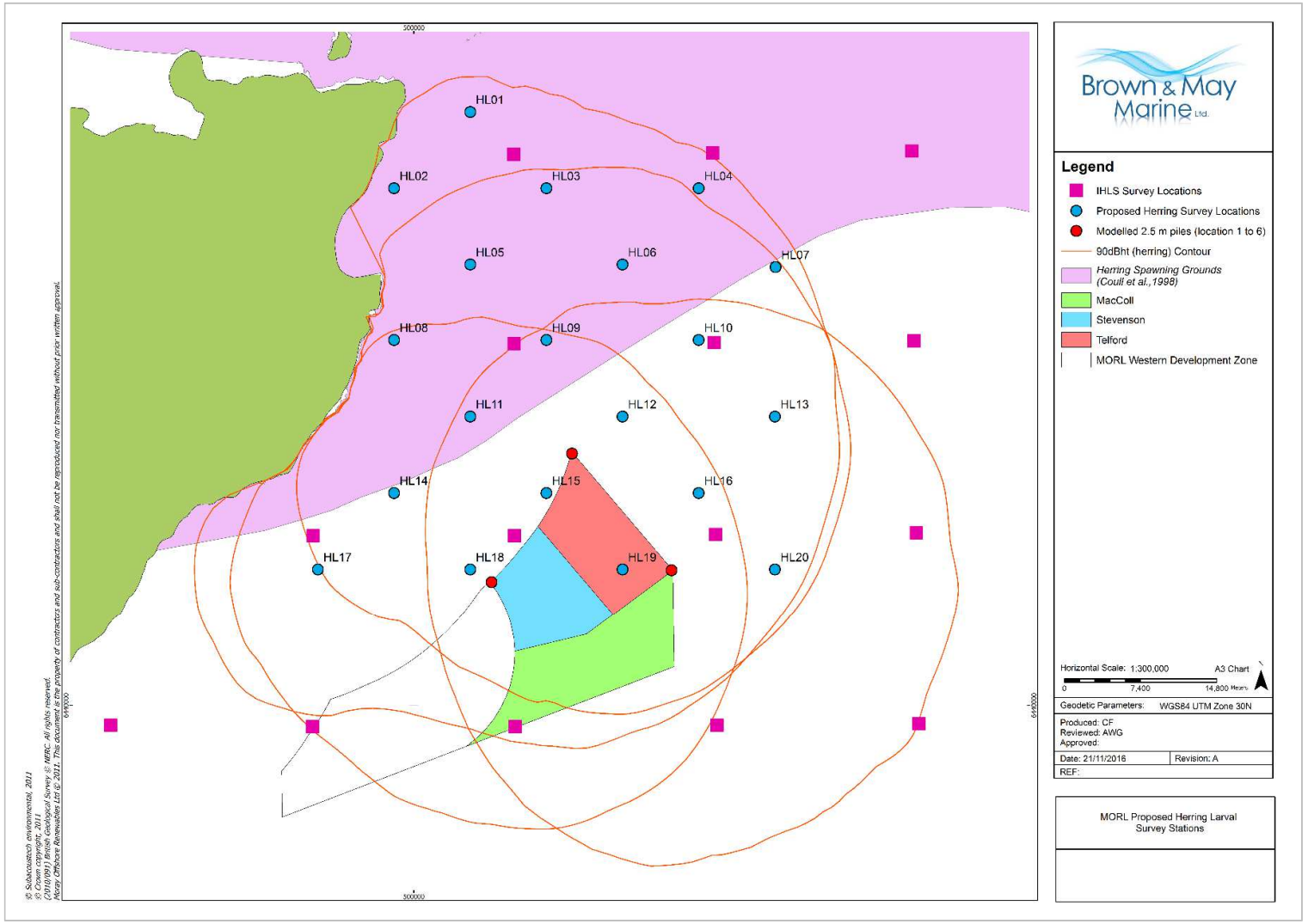

Figure 3.4 Proposed sampling locations, showing IHLS stations and spawning grounds defined by Coull *et al*. (1998)

3.5 Analysis

3.5.1 Sample analysis and preservation

After hauling the Gulf VII, the sampler will be set on deck with the nose raised to ensure that no part of the sample is running out from the net basket back into the net. A bucket will be placed underneath the cod end. The cod-end with the initial catch will be removed. A second cod-end will be fitted and the net will then be very gently washed with sea water. This will enable surveyors to very gently tease out any larvae in the net to ensure the entire sample is collected before removing the cod end.

The sample will then be retrieved from the cod-ends and transferred to screw top plastic jars. The samples will be preserved in 4% borax buffered formalin solution in seawater. The plankton volume will not exceed 20% of the pot volume. Additional pots will be used if required.

The pots will be lidded, sealed with electrical tape and labelled with hazard labels prior to storage in a cool, dark area on the vessel. Samples will be transferred on shore at the end of each week. Samples will be regularly transported to the laboratory during the survey campaign.

The larvae will be analysed by experienced specialists. Samples will be drained and sorted under a low powered microscope. Any fish larvae, post-larvae and juveniles present will be removed, measured (total length, mm) and speciated using appropriate keys and literature (e.g. Russell, 1976[2]). Large samples of herring larvae will be sub-sampled in line with IHLS methodology. In addition, 10% of the samples will be reanalysed for quality assurance purposes.

For each station, information will be logged on the station number, position, date and time, haul duration, flowmeter revolutions, bottom and sampler depth, water bottom temperature and vessel direction of tow.

3.5.2 Results analysis and comparison with IHLS data

A summary of bycatch larvae and eggs will be produced for each survey trip and total herring larvae abundance data will be produced for each station per survey trip. Herring larvae will also be categorised by size to separate out the early larval stages and to identify key spawning periods.

As the flow of water filtered by the net will be recorded by the flowmeters, the number of larvae below a square metre of sea surface at each station will be calculated using the Smith & Richardson (1977)[3] formula, following the IHLS reporting methodology. Depth profiles will be produced for each station and survey trip and water bottom temperature spatially plotted.

Herring larvae <10 mm are categorised as newly hatched and considered to more accurately reflect proximity to active spawning grounds. Abundance data for herring larvae <10 mm will be produced for each station per survey trip to provide a temporal and spatial indication of high intensity spawning periods within the survey area.

Abundance data of <10 mm herring larvae from the survey will be compared to results from the IHLS surveys undertaken in the last two weeks of September. The same dates and size category will be used to allow comparison of numbers at each station from recent surveys (2011-2015) on a year by year basis and in comparison to the 5 year average. This will give an indication of the relative spawning intensity within the survey area compared to previous years for the last two weeks in September.

[2] Russell, F.S. (1976). The eggs and planktonic stages of British marine fishes, Academic Press, London

[3] Smith, P.E. & Richardson, S.L. (1977). Standard technique for pelagic fish egg and larval survey. FAO Fisheries Technical Paper No. 175, 100 pp. FAO, Rome

It should be noted that the 2016 IHLS data will not be available until the production of the ICES report in May 2017.

3.5.3 Back calculation of larval age, spawning date and intensity

Back calculation of larval age enables a more accurate reflection of proximity to active spawning grounds. As newly hatched herring larvae passively drift in the water column, smaller, younger larvae will therefore be closer to active spawning grounds, and larger, older larvae will have had longer time to disperse from the active spawning grounds. The following analysis is therefore proposed:

- Ages of herring larvae, in days, will be calculated using published values of growth rates and hatch sizes. Minimum ages will be based on the larger hatch size and faster growth rate, while maximum age will be based on the reverse.
- Mean estimated ages (in days) for sampled herring larvae on each day of sampling will be calculated and estimated hatch dates for each larvae length will then be determined.
- Estimated larvae ages will also be applied to hydrodynamic data to determine possible drift distances.
- Spawning intensity will be estimated using published growth and mortality rates to back-calculate an estimate of the mean spawning stock at the time of hatching for each hatch-date.

3.6 Reporting

3.6.1 Daily Reporting

Daily progress reports (DPRs) would be communicated to BMM by 1000 hrs the following morning, and issued to MORL by 1200 hrs, detailing the work completed, the observed weather conditions, any health and safety issues (including accidents/emergencies) and the forecast for the following day. A daily summary of the number of days spent at sea and in port will also be provided.

3.6.2 Technical Report

A technical survey report, including GIS mapping, will be produced following the completion of the herring larvae survey and subsequent laboratory analysis. The report will summarise all aspects of the survey and results analysis and interpretation. The report will include the following sections:

- Executive Summary
- Introduction
- Background
- Scope of Works
- Survey Methodology
- Herring Larval Results and Analysis
- Conclusion
- References
- Appendices

Formatting and report layout will be agreed with MORL in advance of production of reports and will be in line with MORL quality systems. The technical report will be issued to MORL within one month of receipt of larval data analysis.

4.0 Health, Safety and Environment

BMM have set a series of objectives with aims of allowing continual improvement of HSE within their operations.

4.1 HSE Documentation

4.1.1 Subcontractor assessment

Following BMM policy and procedures, the subcontractor's operational procedures will be reviewed by BMM's MD and survey H&S manager. The vessel and crew's certification are reviewed and signed off and if an external audit is not required a BMM vessel audit is carried out by BMM personnel.

The vessels will have the required MCA certification and equipment to carry out the specified survey operations.

4.1.2 Risk assessment

BMM survey risk assessments are produced by a team consisting of an external H&S contractor, BMM's internal survey H&S manager, BMM's senior surveyors, surveyors and BMM's MD.

They are reviewed prior to each survey and there is a formal minuted annual review meeting.

The vessels' risk assessments are produced by the vessel's skipper and crew. The skipper and crew are trained and competent personnel with extensive experience, and the required certificates for offshore survey operations.

4.1.3 Monitoring

Daily "toolbox talks" will be attended by all personnel on board the vessel every morning before survey operations commence.

Daily progress report meetings will be attended by all crew on board the vessel after gear removal operations, at which time the skipper will fill in, or call in to BMM, the daily progress report (DPR). All H&S observations will be recorded in the DPR.

A daily phone call will be made from the surveyor on board the survey vessel to the BMM DPA by 1000 hrs.

4.1.4 Review

A "Post Offshore Survey Safety and Environmental Review" sheet is completed at the end of each gear removal in order to summarise and review all aspects of the operation, including any HS&E incidents, equipment failures and examples of good practise.

Health & Safety goals are monitored and reviewed in line with BMM's Strategic Health & Safety Objectives. These are reviewed at each management review meeting. H&S issues, including surveys, is an agenda item in all weekly BMM team meetings

4.2 Accident and Incident Reporting

All significant accidents, incidents or near misses (including environmental) are to be reported to the BMM Designated Person Ashore (DPA)/Emergency contact and MORL's HSE Manager within 30 minutes of the situation being made safe.

All other accidents, incidents or near misses (including environmental) are to be reported to BMM and MORL within 1 day, through the DPR.

4.3 Pollution

All employees and contractors are responsible for ensuring their activities both onshore and offshore have minimal impact on the environment.

Nothing man-made shall be put into the sea at all, unless it presents an immediate danger to the vessel or personnel. This includes cigarette ends, plastic cups etc. All man-made waste must be collected and disposed of appropriately once returned to shore.

5.0 ISO Accreditation

Brown & May Marine Ltd. utilises an ISO 9001: 2008, ISO 14001: 2004 and OHSAS 18001: 2007 certified quality management system (certificate number: 11957). This certificate is valid until 22nd July 2017. The certification was issued by ISOQAR Ltd., Alcumus Certification and successfully passed a surveillance audit (26th -27th January 2016).