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Decommissioning Strategy

Scoter and Merganser Decommissioning Environmental Appraisal Report

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Non-Technical Summary

Introduction

This Environmental Appraisal report (EA) documents the environment and societal impacts assessment carried out in support of the Scoter and Merganser Decommissioning Programmes (DP). The DP documentation contains full details of Shell's plans to decommission the Scoter and Merganser offshore facilities. Some information from the DP has been repeated in this report to aid the understanding of the context for assessing the significance of potential environmental and societal impact.

The Scoter and Merganser fields are normal pressure and temperature gas condensate fields tied back to the Shearwater platform in Blocks 22/30, 23/26 and 22/25 of the central North Sea in approximately 88 m water depth. The Scoter and the Merganser fields are located approximately 230 km and 226 km respectively from the Scottish coastline and approximately 21 km and 25 km respectively from the UK/Norway median line. An overview of the field equipment and its connections with Shearwater is shown in Figure 0-1.

The Scoter field was discovered in 1989 and consists of three gas production wells, drilled in 2003 and 2006, and the Scoter manifold. Reservoir fluids are conveyed to Shearwater A via a 12 km 12-inch production pipeline that is trenched and buried with <1% of its length having <1 m cover. The Merganser field was discovered in 1995 and consists of two gas production wells, drilled between 2006 and 2007, and the Merganser manifold. Reservoir fluids are conveyed to Shearwater A via a 4 km 8-inch pipeline to the Scoter Manifold Extension Structure (SMES) and from here via the Scoter production pipeline.

Control is via an umbilical from Shearwater that is trenched and buried between Shearwater and Scoter, and is trenched and naturally backfilled between Scoter and Merganser. The umbilical provides chemical injection, hydraulic control and electrical signalling.

All seabed infrastructure for both fields lies within Block 22/30.

The drilling of the production wells at both fields did not result in discharge of oil based mud (OBM) cuttings.

Both Scoter and Merganser are normal pressure, normal temperature gas-condensate fields. Production from Scoter and merganser started in 2004 and 2006 respectively. Approval for the cessation of production (CoP) from both fields was received from Oil and Gas Authority (OGA) and production ceased in December 2020.

Summary of Planned Decommissioning Works

It is acknowledged that the decommissioning works are subject to an approved DP, but the recommendations in the DP include the following activities, on which the EA has been based:

- The Scoter manifold, Merganser manifold and the SMES will be removed and recovered to a shore yard for dismantling and recycling;
- All surface laid tie-in spools and umbilical jumpers will be removed and recovered to a shore yard for re-use, recycling or disposal ;
- Buried pipelines and umbilicals will be decommissioned *in situ;*
- Exposed pipeline stabilisation features (concrete mattresses and grout bags) will be recovered to shore for re-use, recycling or disposal;

- Electrical control cores will be retained in active use for monitoring of wells until the wells are plugged and lubricated (P&L) or plugged and made safe (P&MS), following which they will be recovered to shore for re-use, recycling or disposal;
- The Scoter umbilical will remain attached at Shearwater C and will be recovered to shore when Shearwater C is decommissioned;
- Depressions caused by activities from the drilling of the wells, production at the field and its decommissioning that are identified during post-decommissioning surveys as potentially causing a risk to other users of the sea will be made safe by use of rock cover. This may include e.g. spud cans and anchor scars;
- The seabed within the 500 m safety zone around the wells, and within a 100 m wide corridor along the pipelines, will be inspected and any debris related to oil and gas operations will be removed.;
- Following completion of the decommissioning, surveys will be conducted to demonstrate that the seabed has been left clear and safe.

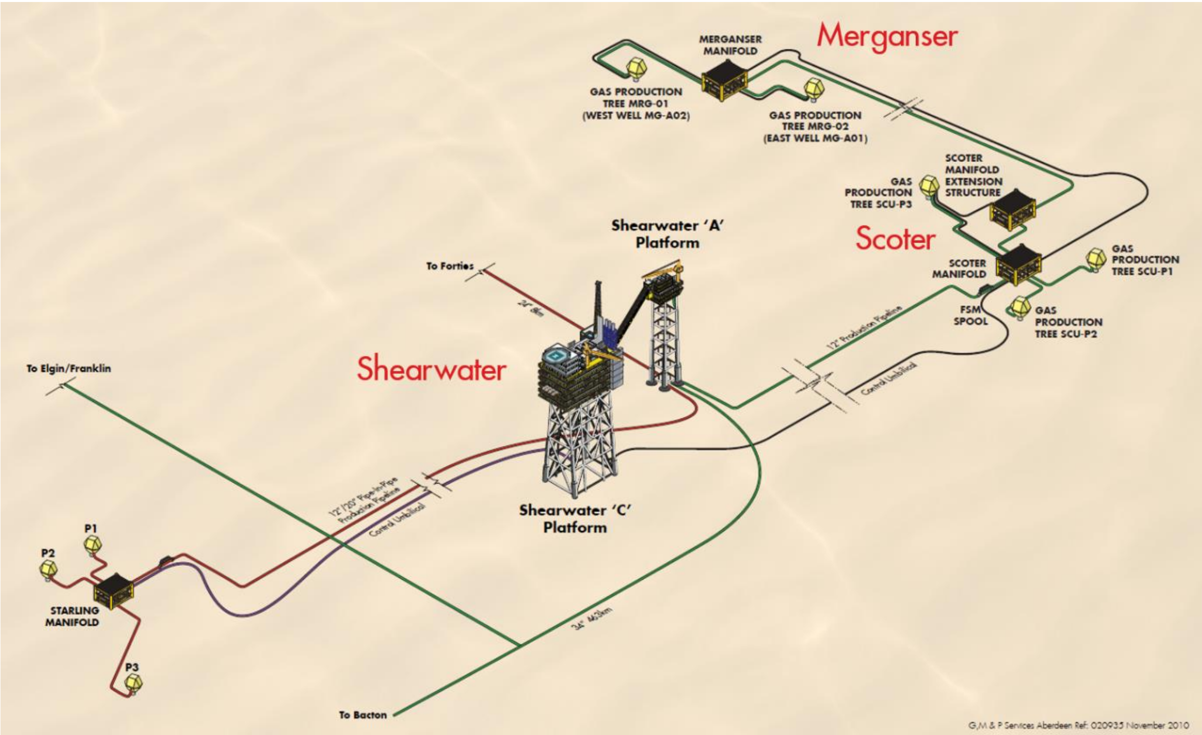

Figure 0-1 Infrastructure Overview

The Scoter production riser at Shearwater A was identified for re-use for the Arran field development, installation of which occurred in 2021. To enable re-use of the riser, certain preparatory works have been undertaken under a Preparatory Works Request that was approved by OPRED in December 2020. These activities include the following:

- Flushing of the Scoter production pipeline and manifold, the Merganser production pipeline and manifold, the SMES and production jumpers connecting each well to their respective manifold;
- Disconnection of tie-in spools to each well Christmas tree;

- Flushing of chemical cores of the Scoter and Merganser umbilicals; and
- Recovery of the Scoter riser tie-in spool and associated concrete mattresses to shore for recycling.

The Scoter riser has now been transferred to the Arran Pipelines Works Authorisation and no longer forms part of the Scoter and Merganser assets.

Between the Scoter Field and the Shearwater Platforms, the Scoter production pipeline and umbilical cross over third party pipelines (Marnock to Machar) and are protected at the crossing with a combination of flexible concrete mattresses and rock cover. At this location the Scoter pipeline and umbilical will be left in their current state while the third party pipelines remain live. When use of the third party lines ceases, the protective mattresses over the Scoter umbilical will be replaced by continuous rock berms.

The decommissioning activities will utilise a variety of vessels, with an anticipated aggregate of 109 vessel-days' service.

Environmental Baseline Summary

The seabed sediment in the area around the Scoter and Merganser fields comprise mainly fine muddy sand to sandy mud with intermittent areas additionally containing small quantities (<4%) of gravels. The sediment habitats are mainly assigned to the EUNIS biotope 'Deep circalittoral sand' and 'Circalittoral muddy sand' which, while common throughout the central North Sea (CNS), are listed as 'Endangered' on the European Red List of Habitats.

Hydrocarbon concentrations in sediments were generally low across survey areas within at least 10 km of Scoter and Merganser except where OBM-contaminated cuttings had been discharged. As no OBM was discharged during the drilling of the five production wells, hydrocarbon concentrations in sediments at Scoter and Merganser are anticipated to be at background levels. An exploration and assessment (E&A) well was drilled in 1995 using OBM which was approximately 500 m from Merganser. Any hydrocarbon contamination at Merganser, related to discharges of OBM contaminated cuttings from the E&A well, is expected to be minor on account of both the distance and subsequent biodegradation.

The closest designated area of conservation interest to the Scoter and Merganser fields is the East of Gannet and Montrose Fields Nature Conservation Marine Protected Area (NCMPA), approximately 18 km west of the Merganser manifold. This area is designated for offshore deep sea muds and ocean quahog (*Arctica islandica*) aggregations. The Fulmar Marine Conservation Zone (MCZ) is approximately 58 km south of the Scoter and Merganser manifolds and is designated for subtidal sand, subtidal mud, subtidal mixed sediments and *A. islandica*.

There is a Norwegian Particularly Valuable Area (PVA) for mackerel spawning approximately 25 km east of the Scoter manifold.

Sea pens and faunal burrows observed in the vicinity of the Scoter and Merganser fields are not considered to occur at high enough densities to constitute the Priority Marine Feature (PMF) habitat 'Sea pens and burrowing megafauna' or the Oslo/Paris Convention (OSPAR) threatened and/or declining habitat 'Sea pens and burrowing megafauna communities'.

Methane-Derived Authigenic Carbonate reefs are present at the Culzean field approximately 1.5 km north west of Merganser. These are associated with a subsurface salt diapir at Culzean and are not thought to be present at the Scoter and Merganser fields.

At least four cetacean species frequent the area, with high densities of white-beaked dolphin.

Various seabird species are found in low numbers in the area of the decommissioning activities at different seasons throughout the year, with medium densities of combined species in the summer and breeding season. Vulnerability of seabirds to oil spills is predominantly low across the area and during most of the year, but reach a level of High sensitivity in September and October.

The Scoter and Merganser fields lie within spawning grounds for a number of fish species of commercial and/or conservation importance. None of these spawn at the seabed and their populations are consequently less vulnerable to seabed disturbance.

Fishing effort is low to moderate compared with the wider CNS although, the statistics on fishing effort and weight and value of the catch from this area may in part be supressed by the presence of safety zones around oil and gas infrastructure such as Scoter and Merganser.

Stakeholder Engagement

Shell has actively engaged with key external stakeholders to inform them of our intention to decommission the Scoter and Merganser fields and discuss options for decommissioning. The extent of the engagement has been proportionate to the scale of the decommissioning works and has focussed specifically on stakeholders potentially impacted. Issues raised by stakeholders to date have been addressed throughout the EA report.

ENVID

Potential environmental and societal risks arising from the DP were determined through an Environmental Impact Identification (ENVID) workshop. The ENVID uses standard definitions for rating the magnitude of impact based on the sensitivity of the receptor and the scale and duration of the activities.

The ENVID concluded that the decommissioning of Scoter and Merganser would give rise to no impacts categorised as “major” or “moderate”. Identified risks can be mitigated using standard control measures and procedures due to the relatively small scale of the facilities to be decommissioned, the nature of the activities to be carried out and the relatively short duration of these activities.

This EA report provides a robust justification for this conclusion by presenting the science, reasoning and professional judgement that was used in drawing these conclusions at the ENVID workshop. The following summarises the key findings and mitigations planned for the DP. Further details are included in the main body of the report.

Summary of Key Findings of the EA

The assessment considered potential impacts of planned activities. Risks from unplanned activities were considered during the ENVID, included within the project risk register and risk minimisation measures developed. However, in accordance with OPRED Guidance, unplanned events are not treated within the EA.

Disturbance to Other Users of the Sea

There will be a number of vessels active at sea during the planned decommissioning activities. Vessels will be required for relatively short durations and will cause minimal interference to other users of the sea as most activity will be within the 500 m safety zones around the wells or the Shearwater A platform, from which other shipping is excluded. These activities will be for limited short durations and will be communicated through Notices to Mariners and the Kingfisher Bulletin which will allow fishing vessels to plan avoidance of these areas during periods of sea surface activity.

All vessels engaged in operations will have markings and lightings as per the International Regulations for the Prevention of Collisions at Sea (COLREGS) (International Maritime Organisation, 1972).

Navigational aids including radar, lighting and Automatic Identification Systems (AIS) will be used. A vessel Collision Risk Assessment (CRA) will be produced if required.

Post decommissioning surveys will ensure potential snagging points for fishing gear are identified and remedied.

Air Quality

Emissions to air from the vessels and equipment required for execution of the DP constitute a very minor addition to the overall emissions from routine shipping in the area and will have a negligible impact on air quality and on greenhouse gas emissions.

Discharges to Sea

The decommissioning works will require a number of aqueous phase discharges to sea.

Pipelines PL1945 and PL2345 (and associated tie-in spools)have been de-oiled with a gel slug and flushed with sea water into the Merganser reservoir via one of the wells. No discharges to sea resulted from this activity.

Umbilicals PLU1946 and PLU2346 have been flushed with seawater and interface fluids such as EGMBE and MEG. These fluids were flowed to the Shearwater topsides umbilical termination unit where they were contained in appropriate vessels and shipped to shore for disposal. Umbilical jumpers connecting manifolds to wellheads are self-sealing. These will be disconnected and recovered to shore without release of fluids to the environment.

Pipelines and umbilicals will remain filled with inhibited seawater, which will ultimately disperse into the water-column as the pipelines and umbilicals degrade.

Discharges associated with wastewaters generated on vessels are controlled by standard requirements of vessels operating in the North Sea for compliance with the International Convention for the Prevention of Pollution from Ships (MARPOL).

Seabed Disturbance

Disturbance of the seabed will occur:

- during removal of subsea infrastructure within the 500 m safety zones at Shearwater, Scoter and Merganser;
- at pipeline crossings; and
- in areas where additional rock cover is required.

It is also possible that overtrawl trials will be necessary to demonstrate a safe seabed if non-intrusive methods are found to be inconclusive. This may potentially be for example at pipeline ends, locations of extensive debris and/or extensive seabed disturbance resulting from decommissioning operations. Whereas the base case will avoid intrusive methods they cannot be ruled out and consequently overtrawl trials are considered in the EA as being the worst case.

The nature of the seabed, the habitats that it provides, and the ecological communities that it supports are found throughout the central North Sea. Even though these have been considered as being of moderate sensitivity, the area of the seabed affected is very small in the context of the overall coverage of these widespread habitats in the central North Sea. Recovery of the seabed communities following disturbance is anticipated to be around 1 – 3 years, except in the areas where rock cover is required as rock cover results in a change to the seabed from its natural type. This harder substrate will support a different community, with fewer sediment-resident animals but increased species of brittle star, star fish and crabs. Although this is a change from the natural baseline habitat, the activity will result in an increase in biodiversity in these areas.

The activity with potential for most widespread disturbance of the seabed is the overtrawl trials. Should there be a requirement for overtrawl trials, fishermen contracted to undertake them will be advised of the spawning periods for cod and sandeels, which lay their eggs at the seabed and are most vulnerable to disturbance.

Underwater Noise

There is no requirement for any activities that generate major sources of noise during the planned decommissioning. However, the activities will contribute to the general levels of anthropogenic underwater noise due to vessel engine noise and the use of cutting tools and other equipment. The activities will take place within an area of low to moderate shipping intensity and the cumulative impact of the Scoter and Merganser decommissioning programme on the baseline noise levels will be minimal.

Waste

A total of approximately 2,213 tonnes (te) of materials will be recovered to shore. Of this total weight, approximately 11% is carbon steel, 11% is stainless steel, <1% is non-ferrous metals, 75% is concrete and 2% is plastics. In addition, the manifolds are anticipated to have approximately 20 te wet weight of marine growth attached. The majority of this weight is water, which will dry out in transit to shore. Residual marine growth will be landfilled if no alternative disposal route is available.

A full inventory of materials has been compiled and the fate of all materials will be tracked through an active waste management plan using waste consignment notes, up to the point of materials re-entering the supply system following recycling or, where necessary, to the point of disposal.

Mitigation Measures

The control and mitigation measures identified in this EA are summarised in the table on the following pages. These commitments will be carried through the contracting process for contract award and will be tracked to ensure the commissioned contractors have sufficient mechanisms, processes, procedures and competent resources in place to implement the measures required. Shell's assurance procedures will monitor implementation.

Conclusion

The baseline environment in the affected area is well understood and this EA has identified environmental and societal risks associated with the planned decommissioning activities at the Scoter and Merganser fields. Well established control measures and procedures, including careful planning, can be adopted to eliminate many of the potential risks and adverse impacts to the environment or to other users of the sea. Where potential for impact during the programme is unavoidable, mitigation measures can be readily adopted to reduce impacts to the minimum.

The conclusion of the assessment indicates that with careful management, including effective management of contractors, the DP can be executed with minimal impact on the environment and minimal disturbance to other users of the sea.

MITIGATION AND CONTROL MEASURE		ASPECTS CONTROLLED
A policy of a clear seabed has been adopted. Exceptions to this are limited to the location of third party pipeline crossings.		Natural Capital and Ecosystem Services Socio-economic
The scheduling of vessels' operations and the types of vessels used will be optimised to execute the decommissioning as efficiently as possible.		Natural Capital and Ecosystem Services Emissions to Air Underwater Noise
Notification of decommissioning activities will be advertised to other users of the sea such as via publication of Notices to Mariners and Kingfisher Bulletin. Notification will include details of vessel positions, activities and timing.		Socio-economic Accidental Events (Oil Spill) Accidental Events (Dropped Object)
Disturbance of the seabed will be minimised through: • Minimising the need for excavation to remove facilities attached to the seabed (manifolds) by selecting suitable cutting tools. • Minimising the amount and type of rock cover required while also minimising risk of snagging by careful selection of rock sizes that can be overtrawled while seeking to minimise change of seabed habitat. • Adoption of non-intrusive methods for demonstrating safe seabed as the base case.		Natural Capital and Ecosystem Services Seabed Disturbance
All vessels commissioned will be subject to Shell's Group Maritime Assurance System (GMAS). This includes assurance in line with the Oil Companies International Marine Forum (OCIMF) inspection (OVIQ2) and review of the Maritime Contractor Offshore Vessel Managers Self-Assessment (OVMSA). The review includes (inter alia) consideration of reliability and maintenance standards, navigational safety, emergency preparedness and contingency planning, spill prevention and spill response, control of emissions to air and		Emissions to Air Discharges to Sea Accidental Events (Oil Spill) Waste Management

adherence to requirements of MARPOL for the discharge of sewage, control of garbage and management of ballast water. All vessels will have current Shipboard Oil Pollution Emergency Plans which are regularly reviewed by the vessels' crews.		
Discharges of chemicals during the decommissioning campaign will be permitted under the Offshore Chemicals Regulations. Discharges of residual flushing water in pipelines will be permitted under the Oil Pollution Prevention and Control Regulations. Any controls identified in the permits following risk assessment will be adopted.		Discharges to Sea
Adoption of Joint Nature Conservation Committee (JNCC) guidelines for minimising the risk of injury to marine mammals will be followed as necessary (and as agreed during permit approvals).		Underwater Noise
Materials brought to shore will be processed in accordance with the Waste Hierarchy. An Active Waste Management Plan (WMP) will describe and quantify wastes arising from the decommissioning activities, segregation and storage requirements, and identify available disposal options for each waste stream.		Waste Management
Following removal of all infrastructure, the 500 m safety zones at Scoter and Merganser, and the pipeline route will be subjected to surveys to demonstrate a clear and safe seabed and further remediation provided if required. The base case will be to use non-intrusive methods.		Socio-economic
All contractors commissioned will be subject to Shell's Contractor management and assurance procedures.		All

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1. Introduction

In accordance with the Petroleum Act 1998, the Section 29 notice holders of the Scoter and Merganser fields are applying to The Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) to obtain approval for decommissioning the Scoter and Merganser fields.

Under the Petroleum Act 1998 there is a requirement to provide an assessment of the impact of the decommissioning activities on the marine environment. In accordance with OPRED's decommissioning guidelines (BEIS, 2018), the environmental assessment shall be documented in an environmental appraisal report. The environmental appraisal report is submitted along with the Decommissioning Programme and Comparative Assessment[1] in draft form for consideration at the Public Consultation stage, and in final form when the Decommissioning Programme is submitted for approval.

The Scoter and Merganser Environmental Appraisal (EA) report has been prepared by Shell U.K. Limited (hereinafter Shell), on behalf of the Section 29 notice holders, to satisfy the regulatory requirement for environmental assessment and to inform the planning and execution of the activities required to fulfil the Scoter and Merganser Decommissioning Programmes (DP).

This EA report is intended to be read in conjunction with the DP, to which it refers for certain details although some information from the DP is repeated here, or further elaborated on, to enhance understanding of the assessment of impacts on the environment.

1.1. Location of the Scoter and Merganser Fields

The Scoter Field is located in Blocks 22/30 and 23/26 of the United Kingdom Continental Shelf (UKCS) and the Merganser Field is located in Blocks 22/25 and 22/30 in water depths ranging between c. 88 m and 95 m below lowest astronomical tide (LAT) level. Both fields are tied back to the Shearwater platform (Block 22/30) situated in the Central North Sea (CNS). The Scoter field lies approximately 230 km from the Scottish coastline and approximately 21 km from the UK/Norway median line, while the Merganser field lies approximately 226 km from the Scottish coastline and approximately 25 km from the UK/Norway median line, as shown in Figure 1-1.

1.2. Production History

Both Scoter and Merganser are normal pressure, normal temperature gas-condensate fields. Production from Scoter and Merganser started in 2004 and 2006 respectively. Following approval from the OGA, the wells were shut-in and formal Cessation of Production was taken in December 2020.

1.3. Scoter and Merganser Infrastructure

During production, reservoir fluids were conveyed from Scoter and Merganser fields to Shearwater A platform, an integrated Process, Utilities and Quarters (PUQ) platform which houses facilities for separation, conditioning, compression, metering and export of hydrocarbon fluids from Shearwater and Starling fields in addition to Scoter and Merganser. Export of gas from Shearwater is via the Shearwater Elgin Area Line (SEAL) pipeline to Bacton onshore terminal. Scoter and

[1] The process and conclusions of the Comparative Assessment are documented in an Comparative Assessment report

Merganser condensate, separated during Shearwater topsides processing, was blended into the Shearwater oil stream which is exported into the Forties Pipeline System.

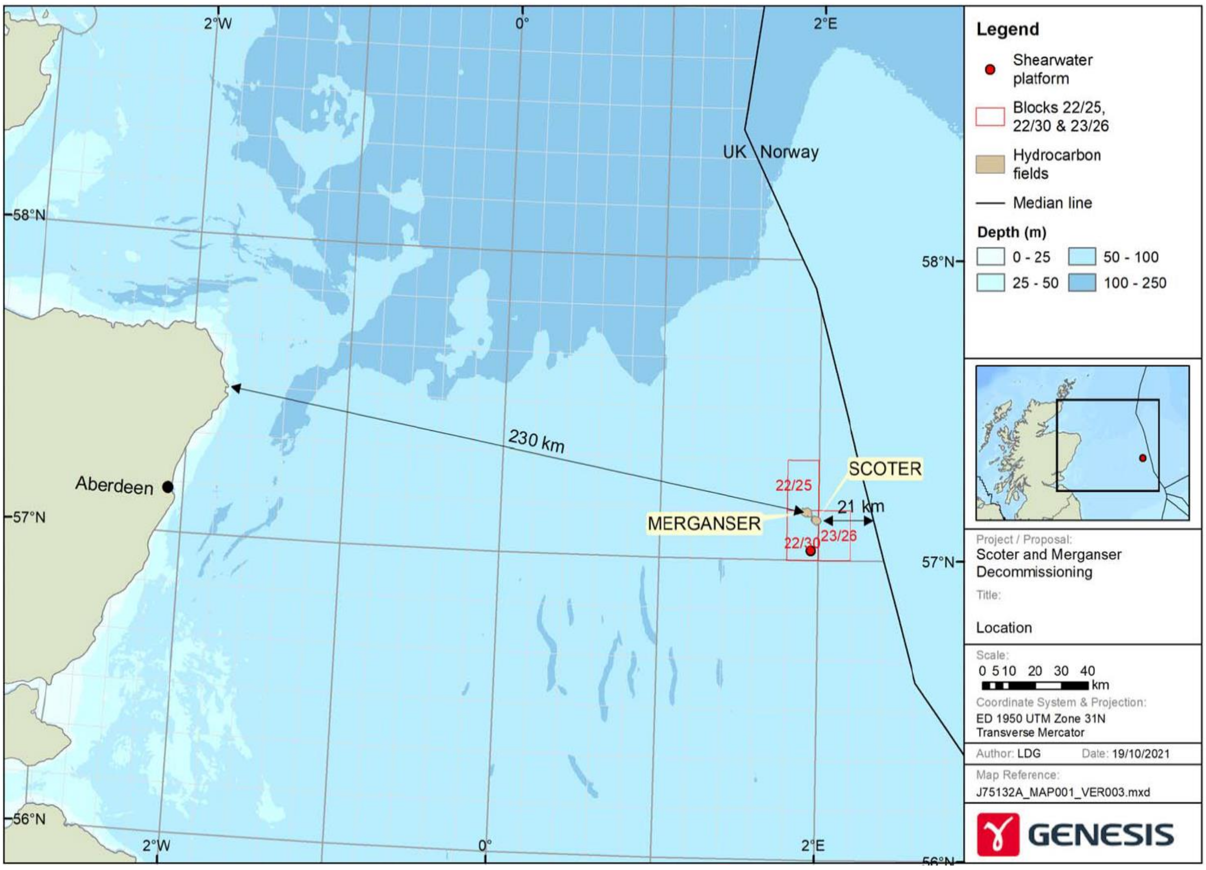

Figure 1-1 Location of Scoter and Merganser within the UKCS

A schematic of the infrastructure at both fields and their connection with Shearwater is shown in Figure 1-2. The various elements of the installation are described in the following sections.

1.3.1. Wells

There are three wells at Scoter (SCU-P1, P2 and P3) and two at Merganser (East MG-A01 and West MG-A02). All five wells were drilled after the adoption of Decision 2000/3 of the Oslo Paris Convention (OSPAR) in which, among other things, contracting parties including the UK agreed to cease the discharge of drill cuttings that could be contaminated with Organic-phase drilling fluids (OPF) such as Low Toxicity Oil Based Mud (LTOBM).

Approximately 400 te of cuttings drilled with weighted seawater or Water Based Mud (WBM) were discharged at each of the Scoter wells, and approximately 800 te for each of the Merganser wells.

Cuttings from sections of each well that were drilled with LTOBM were circulated back to the drill rig, separated from returned mud and shipped to shore for treatment and disposal.

1.3.2. Pipelines

Reservoir fluids were conveyed from the Scoter field to the Shearwater A platform by means of a 11.6 km 12 inch carbon steel production pipeline (PL1945). Reservoir fluids from the Merganser field were conveyed to the Scoter manifold by means of a 3.83 km 8 inch carbon steel production pipeline (PL2346) and from there to Shearwater A via the Scoter production pipeline.

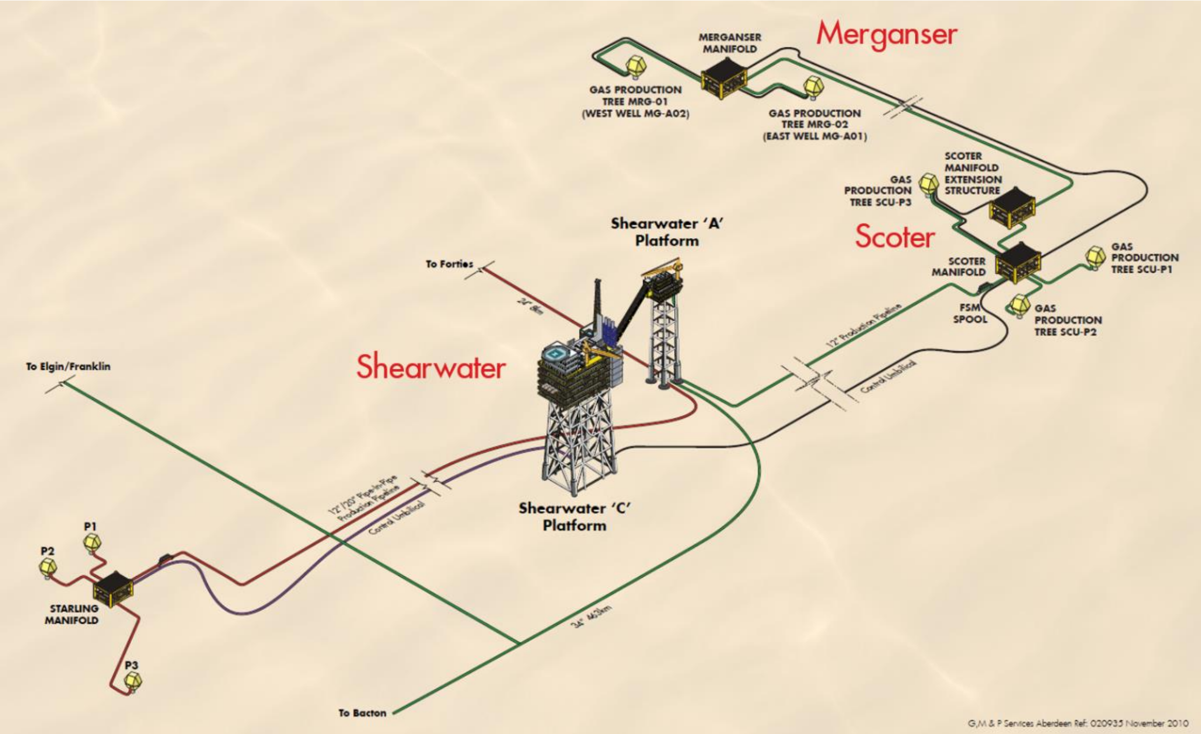

Figure 1-2 Schematic summarising infrastructure at Scoter and Merganser

1.3.3. Subsea Infrastructure

Subsea infrastructure at Scoter is summarised in Table 1-1. It consists of one manifold into which each of the three Scoter production wells was tied with Duplex connecting spools.

The Scoter manifold is fixed to the seabed with circular steel piles at each corner. A Field Signature Method (FSM) corrosion monitoring spool is installed between the Scoter manifold and the production pipeline (PL1945). The FSM is of rubber coated carbon steel and is connected to both the manifold and the production pipeline by spools of Duplex and carbon steel respectively. The production pipeline was connected to the Scoter riser at Shearwater A by means of carbon steel spool.

Table 1-1 Scoter Subsea Equipment

Equipment	Length (m)	Diameter (inch)	Weight (te)	Material	Coatings
Scoter production pipeline	11,600	12	2,174	Carbon Steel	4-layer PPF[1]
Tie-in spools (6)	323[2]	6 or 12	29[2]	Carbon Steel or Duplex	PPF

Corrosion monitoring spool	5.5	12	0.9	Carbon Steel	Rubber
Riser[3]	108	12	30	Carbon Steel	N/A
Scoter Manifold	7.3 m (W) x 9.3 m (L) x 5.6 m (H)		79	Stainless Steel, Carbon Steel, Aluminium	N/A

[1] Paint Protection Film (PPF)

[2] Total quantities

[3] The Scoter riser has been transferred to the Arran PWA and is consequently not part of the Scoter and Merganser DP

Merganser subsea infrastructure is summarised in Table 1-2. It consists of the Merganser manifold, into which both wells were tied with Super Duplex spools, and the Scoter Manifold Extension Structure (SMES), which conveyed fluids from the Merganser production pipeline (PL2346) to the Scoter manifold. The spool connecting the Merganser manifold to the Merganser production pipeline is of both Super Duplex and carbon steel. The spool connecting the Merganser production pipeline to the SMES is of carbon steel and the spool connecting the SMES to the Scoter manifold is of Super Duplex.

Table 1-2 Merganser Subsea Equipment

Equipment	Length (m)	Diameter (inch)	Weight (te)	Material	Coatings
Merganser production pipeline	3,635	8	380	Carbon Steel	4-layer PPF
Tie-in spools (5)	386[1]	6 or 8	38[1]	Carbon Steel, Duplex or Super Duplex	SPU[2]
Merganser Manifold	7.3 m (W) x 9.3 m (L) x 5.5 m (H)		77	Stainless Steel, Carbon Steel, Aluminium	N/A
Scoter Manifold Extension Structure (SMES)	6.8 m (L) x 5.3 m (W) x 4.3 m (H)		34.5	Stainless Steel, Carbon Steel, Aluminium	N/A

[1] Total quantities

[2] Syntactic Polyurethane (SPU)

Merganser tie-in spools include those which connected wellheads to the manifold, the manifold to the Merganser production pipeline, the connection between the Merganser production pipeline and the SMES and between the SMES and the Scoter manifold. Both the Merganser manifold and the SMES are fixed to the seabed with circular steel piles at each corner.

1.3.4. Umbilicals

An electro-hydraulic and chemical supply umbilical (PLU1946) runs c. 12 km from the Topsides Umbilical Termination Unit at Shearwater C to the Bullhead Umbilical Termination Assembly at the Scoter manifold, with separate jumpers to each well (237 m in total). In addition, an electric jumper (PLU4924) is laid between well SCU-P3 and the FSM (100 m).

The electro-hydraulic and chemical supply umbilical then runs c. 4 km from the Scoter manifold to the Merganser manifold (PLU2347). PLU2347 also includes chemical injection jumpers laid from the Merganser manifold to the two Merganser wells (172 m in total).

An electric jumper (PLU2896) is laid alongside the Merganser chemical injection jumpers to well MG-A01.

Chemical injection umbilical jumpers are also laid between the Scoter Manifold and well SCU-P3 and then to the SMES (PLU2386) (171 m in total).

1.3.5. Burial status of Pipelines and Umbilicals

The Scoter production pipeline is trenched and backfilled to a depth of cover exceeding 0.6 m along its full length with the exception of the transitions (from surface to below surface) at either end, and over a length of approximately 450 m where it crosses over the Marnock to Machar pipelines and umbilicals that are owned and operated by third parties.

The Merganser production pipeline is also trenched and backfilled to a depth of cover exceeding 0.6 m along its full length with the exception of the transitions and possibly at three discrete, short sections. At these three points, survey data from 2005 appears to indicate that, whereas the trench depth is >1 m, backfilling had not been successful in achieving the target depth of cover. In each case the effected length is c. 5 m (corresponding to a single data point).

The Scoter umbilical was trenched and allowed to backfill naturally along its full length with the exception of the transitions and over a length of approximately 250 m where it crosses over the Marnock to Machar lines. The depth of lowering of the umbilical was >1 m along its full length and it is anticipated that depth of cover is currently >0.6 m. This has not conclusively been established however. Survey data collected for part of the umbilical length in 2002 shortly after trenching shows the trench had not immediately settled over the umbilical. Survey data collected two weeks later for the remainder of the umbilical length showed successful infill had occurred by that time. Burial status will be clarified at the time of decommissioning and mitigated as necessary.

The Merganser umbilical was also trenched and allowed to backfill naturally. Survey data shows that depth of cover exceeds 0.6 m along the full length of the umbilical with the exception of the transitions and two discrete, short sections. Rock cover was applied to these locations but depth of cover remains <0.6 m and some supplementary cover may need to be applied at the time of decommissioning.

In-field tie-in spools, the FSM and all jumpers are surface laid and protected with concrete mattresses and/or grout bags. Pipeline crossings and transition points for production pipelines and umbilicals are protected with either concrete mattresses or rock cover.

1.3.6. Stabilisation Features

Stabilisation features were laid to support and protect pipelines, umbilicals and jumpers. These are listed by PL/PLU number in Table 2.3 and Table 2.8 of the DP. They are reiterated here in relation to their respective location.

1.3.6.1. Scoter

Within the vicinity of the Scoter wells, there are 176 concrete mattresses (4.7 te each) protecting the pipelines, umbilicals, spools and jumpers around the Scoter Manifold, SMES and Scoter wells. In addition, approximately 3,000 grout bags (25 kg each) were also used for stabilisation.

1.3.6.2. Approach to Shearwater

A further 77 mattresses were deployed to protect the Scoter production pipeline and umbilical as they approach Shearwater.

1.3.6.3. Merganser

There are 51 concrete mattresses (4.7 te each) protecting the pipelines, umbilicals, spools and jumpers around the Merganser manifold and wells. In addition, approximately 3,000 grout bags (25 kg each) were also used for stabilisation and 3,562 te of rock cover was used at Merganser pipeline and umbilical transitions.

1.3.6.4. Marnock to Machar lines crossings

The Scoter production pipeline and umbilical are protected with a combination of mattresses and rock cover where they cross over the Marnock to Machar pipeline series. The series includes an oil export line (PL1357), water injection line (PL1575) and two umbilical lines (PL1358 and PL1576). Two additional lines (gas lift PL1981 and Umbilical PLU3955) were laid later and cross over the top of the Scoter lines.

The Scoter lines are supported by five mattresses (9 te each) and two concrete plinths (15.6 te each) for the crossings, with 28 mattresses (4.7 te each) laid over the umbilical for protection.

In addition, a total of 10,900 te of rock cover was deployed at the Marnock to Machar crossings and at locations along the Scoter production pipeline to increase depth of cover.

A schematic of the crossings and associated Scoter protection is shown in Figure 1-3.

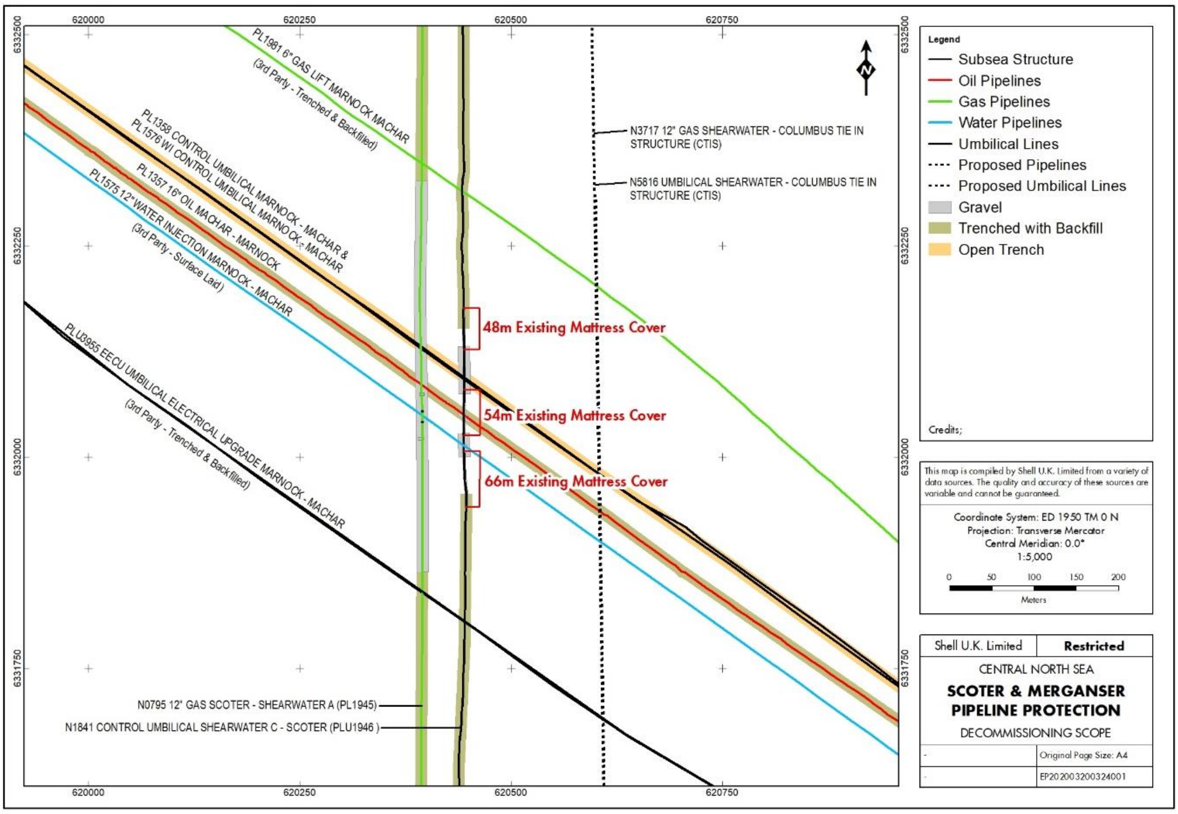

Figure 1-3 Crossings of Scoter and Marnock to Machar pipelines and umbilicals

1.4. Current Operating Status

Production at both Merganser and Scoter ceased in December 2020. All of the wells are planned to be plugged and lubricated (P&L) and then to be plugged and made safe (P&MS) by mid-2025.

1.5. Preparatory Works Undertaken

The Scoter production riser at Shearwater A was identified for re-use for the Arran field development, installation of which occurred in 2021. To enable re-use of the riser, certain preparatory works have been undertaken under a Preparatory Works Request (PWR) that was approved by OPRED in December 2020. These activities include the following:

- Flushing of the Scoter and Merganser production systems;
- Disconnection of tie-in spools to each well Christmas tree;
- Flushing of chemical cores of the Scoter and Merganser umbilicals; and
- Recovery of the Scoter riser tie-in spool and associated concrete mattresses to shore for recycling.

Prior to CoP the pipelines contained reservoir fluids of hydrocarbon gas and condensates. Umbilical cores were filled with hydraulic fluids and production chemicals including methanol, MEG/water, corrosion inhibitor and scale inhibitor.

Flushing of the Scoter and Merganser production system incorporated the following activities:

- Production jumpers for Merganser wells and for Scoter wells 1 and 3 were flushed with methanol into the production pipelines;
- The Scoter Well 2 production jumper could not be flushed in this way and was instead flushed to the well using MEG/water;
- Production pipelines were flushed with 6 line volumes of inhibited seawater from Shearwater A into the Merganser reservoir via the Merganser P1 well and;
- A 10 m^3 gel slug was propelled ahead of the flushing water to de-oil the pipelines and to act as an interface between the hydrocarbons and the flushing water.

Flushing loops were installed at the Merganser manifold to facilitate round-trip displacement of chemical injection and hydraulic control umbilical cores from and to the Topsides Umbilical Termination Unit at Shearwater C.

These preparatory works were completed in full during 2021 and the riser has been transferred to the Arran Pipelines Works Authorisation (PWA).

1.5.1. Current Contents of Pipelines and Umbilicals

Following flushing, the pipelines and umbilical cores are now left filled with inhibited seawater which may contain residual traces of hydrocarbons at very low concentrations.

Records at Shearwater during production from Scoter and Merganser indicated there was a low likelihood of any significant contamination of the pipelines with hazardous materials such as Naturally Occurring Radioactive Material (NORM), wax or mercury. The absence of such hazardous materials was confirmed by testing of spool pieces recovered as part of the preparatory works.

1.6. Outline of Residual Decommissioning Activities

The following activities remain to be undertaken and will be commissioned following approval of the DPs:

- The two manifolds and the SMES, along with all spools (including the FSM), electric jumpers, chemical supply jumpers and electro-hydraulic jumpers will be recovered to shore;
- In keeping with the conclusions of the Comparative Assessment Report, all pipelines and umbilicals that are currently trenched and buried will be decommissioned *in situ*.;
- The in-field ends of the pipelines and umbilicals will be made safe and buried;
- The Shearwater end of the Scoter pipeline is within the Shearwater A 500 m safety zone and demonstration that it has been left safe will form part of the Shearwater decommissioning works;
- The Scoter umbilical will remain connected at the Shearwater C topsides umbilical termination unit, with all cores positively isolated. The umbilical riser will be recovered to shore for recycling at the time of Shearwater C decommissioning;
- Exposed concrete mattresses and grout bags at Scoter and Merganser will be recovered and returned to shore. This will occur either during recovery of subsea equipment or

following P&MS of wells, depending on the location of the materials and on the continued need for them to provide protection;

- Mattresses on the Scoter pipeline and umbilical within the Shearwater 500 m safety zones that were not recovered as part of the Preliminary Works will be recovered at the time of Shearwater decommissioning;
- Concrete plinths and supporting mattresses at the Marnock to Machar crossings will remain underneath the Scoter pipeline and umbilical. Additional rock fill-in will be applied to the Scoter umbilical at this crossing to provide a continuous berm. This rock will be applied following removal of the existing concrete mattresses. This activity will be undertaken following the decommissioning of the Marnock to Machar lines to avoid the potential for damage to these lines while live;
- Any oil and gas industry related debris identified within the Scoter and Merganser 500 m safety zones or along a 100 m wide corridor along the pipelines will be recovered;
- Well heads, flowbases and well protecting structures will remain in place until the wells are plugged and made safe, at which time they will be recovered to shore under well decommissioning permits;
- All material recovered during the decommissioning activities will be returned to shore for re-use, processing and recycling or disposal; and
- Offshore activities will be finalised with surveys to demonstrate a clean seabed that is safe for other users of the sea, notably fishermen.

Much of the detail of how the removals works will be undertaken has not been determined at this stage and will be subject to offers received from the market. However, certain aspects including those required by regulation or regulatory guidance, will be built in to the scope of works for the decommissioning contractor. Further detail about the decommissioning activities in as much as they have been established to date, and in as much as it significantly influences the potential for environmental impact, is presented in the following subsections.

1.6.1. Subsea Infrastructure Removal

To enable removal of the manifolds and SMES, their foundation piles will be cut at least 3 m below the seabed. It is anticipated that these will be cut internally, although excavation for external cutting may be required if internal cutting proves unfeasible. Connecting spools will be cut into manageable sections and removed. All exposed mattresses and grout bags will be removed during decommissioning. The remainder, for instance at the pipeline crossings, will remain *in situ* and covered by rock.

1.6.2. Safe seabed survey and over trawl trials

Post-decommissioning surveys are required to demonstrate that the as-left condition of the seabed does not present a hazard to fishing and to confirm a clear seabed.

The default OPRED policy requirement is for clear seabed verification to be undertaken using non-intrusive means, such as side scan sonar. This will form the base case for Scoter and Merganser decommissioning. Should the survey results prove to be inconclusive, or where there are specific safety concerns such as at pipeline ends, extensive debris and/or extensive seabed disturbance resulting from decommissioning operations, there may be requirement for remediation works to be undertaken, such as overtrawling with chain mats. Overtrawl surveys as a means to locate debris and/or verify clear seabed, are likely only to be approved in cases where it is deemed necessary.

1.6.3. Post-Decommissioning Survey

An as-left environmental survey of the seabed will be undertaken. The scope of the survey will be to provide a baseline for the state of biodiversity, contamination and pipeline burial which will be used to determine the extent and frequency of any potential ongoing monitoring.

1.6.4. Onshore Dismantling

The onshore decommissioning yard will strip the materials and either process each waste type on site (if suitably authorised) or transfer them to appropriate processing facilities. Steel structures will be cut and packaged for transport to be recycled. There may be a requirement to clean parts of the recovered equipment (e.g. of marine growth, paints or residual contamination) prior to dismantling.

The port facilities and waste processing facilities to be used will be determined through competitive tender, but at the time of writing have not been selected. Aspects such as onshore transport of materials either from port to dismantling/recycling yard, or final destination of materials are consequently not currently known.

1.6.5. Timing of Decommissioning Activities

The decommissioning activities will be undertaken at various stages to accommodate interdependences with other Shell operated, or third party, developments and assets. A summary of the timings of activities is provided in Table 1-3.

Table 1-3: Indicative timing of Scoter and Merganser decommissioning activities

Campaign	Indicative Timing	Decommissioning Activities
Arran Riser Readiness	Completed	• Flushing of pipelines, including spools, jumpers and manifolds; • Disconnection of production spools at wellheads; • Disconnection and removal of Production spool at Shearwater A (SWA).
Umbilical Flushing	Completed	• Flushing of umbilical chemical cores from Shearwater C (SWC)
Wells Plug & Lubrication	*c.* 2024	• Wells Plug & Lubrication • Disconnection of jumpers
Wells Plug & Make Safe	*c.* 2025	• Wells Plug & Make Safe • Removal of well heads and associated protective structures

Subsea Infrastructure Removal	2024 - 2026	• Removal of mats, grout bags, SS equipment, spools, jumpers etc. within Scoter and Merganser 500 m zones; • DOC survey of pipelines and remediation as necessary; • Survey sweeps within Scoter & Merganser 500 m zones and remediation as required; • Post-decom environmental baseline survey.
Scoter Umbilical Crossing of Marnock-Machar	Unknown. Dependent on third party field CoP	• Remediate crossings; • Survey sweeps of crossings.
Shearwater Field Decommissioning	Unknown. Dependent on host platform CoP	• Removal of remaining mats, grout bags at the approach to Shearwater; • Cut and bury ends of Scoter production line and umbilical at the approach to Shearwater; • Removal of Scoter umbilical riser at SWC; • Clear and safe seabed surveys within SWA/SWC 500 m safety zones.

1.6.6. Vessel Usage

Indicative estimates for the required duration of different vessel types to undertake different parts of the decommissioning activities are included in Table 1-4. These include mobilisation, demobilisation and transit times and a contingency for bad weather delays. Activities for well workover, plugging and making safe are outside the scope of the DP and hence excluded from the estimates in the table.

Table 1-4: Estimated vessel use for Scoter and Merganser Decommissioning Programme

Activity	Vessel Type	Number of days
Flush and Disconnect (PWR scope)	DSV	35
Subsea Equipment Recovery	DSV	32
Well Head Recovery	DSV	20
Rock placement (contingency)	Rock Placement Vessel	5
Post-decommissioning surveys	Survey vessel	17
Total		**109**

The removal of the Scoter and Merganser subsea tie back infrastructure is a relatively small scope and provides opportunities for contractors to take a flexible approach to the timing of the activities so that they can be integrated with their other commitments in the North Sea and thereby optimise their vessel usage. Shell is seeking proposals from appropriately qualified contractors to undertake the decommissioning activities, and opportunities for optimisation may lead to a reduction from the estimates in Table 1-4.

1.7. Environmental Appraisal Process

The Petroleum Act 1998 (as amended by the Energy Act 2008) requires approval of a decommissioning programme by the Secretary of State, subject to statutory and public consultations, before the Section 29 notice holders proceed with decommissioning. The role of the Secretary of State is administered by OPRED within the Department of Business, Energy and Industrial Strategy (BEIS). OPRED has published Guidance Notes on the Decommissioning of Offshore Oil and Gas Installations and Pipelines (BEIS, 2018) which describes the processes introduced into UK regulations to implement OSPAR Decision 98/3 and the Petroleum Act 1998.

The guidance notes require a decommissioning programme to be supported by a report that documents the assessment of the potential for environmental impact to result from the decommissioning programme activities. The environmental assessment is required to be evidence based and be proportionate to the scale of activities proposed, providing a more robust level of assessment where environmental sensitivities are higher.

Environmental appraisal of the Scoter and Merganser DP is an ongoing process that has informed the development of the Scoter and Merganser Comparative Assessment (CA) and DP, and will continue to inform the delivery of the programme, including risk assessments required for the application of activity-specific permits and consents, monitoring the management of wastes and establishing the as-left environmental status of the seabed.

This EA report records the status of appraisal at the time of the submission of the draft DP for public consultation.

1.7.1. Scope of the EA Report

The scope of the EA report is determined by that of the Scoter and Merganser DP, which is limited to offshore installations, offshore pipelines and umbilicals.

The DP has been informed by the conclusions of the CA and the EA does not evaluate environmental impacts of options that were rejected through the CA process.

To inform the scope of this EA report and identify aspects requiring a higher level of assessment, an Environmental Impacts Identification (ENVID) workshop was held.

The ENVID followed a standard approach, with a multidisciplinary group applying their particular expertise to provide a high level assessment of the impacts of activities in the context of established definitions for receptor sensitivity and impact magnitude. These definitions are provided in Appendix A and the workshop output is provided in Appendix B. The output is necessarily a very succinct and compressed record of the full discussion and rationale. This EA report expands on the ENVID output, citing published data to provide justification for the conclusions reached.

The ENVID identified that none of the planned activities for the execution of the Scoter and Merganser DP would give rise to Moderate or Major impact to the environment. The potential for certain unplanned events to cause significant environmental damage was noted, although the low likelihood of such events occurring resulted in the risk of impacts from unplanned events being classified as minor or less.

All impact scenarios were consequently scoped out from requiring further impact assessment. This is not to say that execution of the DP will have no environmental impact, rather that the sensitivities of the receiving environment are well understood, the scale of the impacts of the activities are minor and that the controls for ensuring all potential impacts are minimised are identified and will be implemented.

This EA report consequently documents the rationale for the scoping conclusions reached and provides information requested by stakeholders. The report also provides a list of impact minimisation and mitigation measures that will be implemented.

1.8. Stakeholder Consultation

A CA workshop was attended by statutory consultees in October 2019 to determine the optimal decommissioning options for the Scoter and Merganser pipelines. Shell also presented and discussed the proposed scope of this EA with statutory consultees at the same event. Consultees expressed agreement with the proposed approach and scope of the EA with the following specific points raised for inclusion:

- Information should be provided on pipeline contents – both current and post-flushing;
- Interpretation of historical data on fishing intensity should recognise that the data may have been influenced by the presence of infrastructure and could therefore underestimate the potential for fishing interest in the area once that infrastructure has been removed; and
- Quantitative estimates of proposed new rock cover should be provided in the EA, including the current status of the seabed ('natural' vs rock/mattress) to be overlain.

2. Environmental Baseline

An understanding of the environment at the Scoter and Merganser fields and along the pipeline route to the Shearwater platform has been compiled to provide a basis for assessing the potential interactions of the decommissioning activities with the environment. This section has been prepared with reference to available literature including environmental survey reports from the surrounding area.

2.1. Surveys

There are no historic environmental surveys available over the Scoter and Merganser fields, however a number of environmental baseline surveys have been carried out in the near vicinity, as shown in Figure 2-1. These wider vicinity surveys, surrounding the Scoter and Merganser fields are considered to provide a robust baseline of background condition as expected at Scoter and Merganser. Analysis of contamination from analogue fields (i.e. similar number of wells, water depth and sediment) was used to predict the potential worst-case extent of contamination. The wider vicinity surveys and analogue field contamination assessment are considered to contain sufficient suitable data to inform the environmental baseline description for the Scoter and Merganser Decommissioning Project. An environmental survey specific to the decommissioning project has therefore not been commissioned.

The main surveys covering the four blocks centred around Scoter and Merganser fields, and that have been used to inform this section, are identified in Table 2-1.

Table 2-1 Surveys reports used to support baseline description.

Area	Survey Report	Reference
Arran	Pipeline Route Habitat Assessment and Environmental Baseline Survey conducted in 2015. Sample points occur along the Arran to Scoter pipeline route (to the north of the Scoter manifold) and along the Scoter-Shearwater pipeline route. Results from sample stations within Blocks 22/30 and 23/21 have been used to inform this report.	Gardline, 2015; Gardline 2016
Culzean	Pipeline route '2B' habitat assessment and environmental baseline survey undertaken in 2014. The pipeline route crosses the Merganser field. The results from four stations that are closest to the Scoter and Merganser fields are used to inform this report.	Gardline 2014a; Gardline 2014b; Gardline 2014c
Culzean	Environmental Baseline Survey undertaken for Maersk Oil in 2013 prior to development of the field. 36 stations in total with results also compared to an earlier survey from 2009 prior to drilling of an appraisal well.	Gardline, 2013a
Shearwater	Monitoring survey undertaken in 2018. Sample points lie to the east of the Scoter-Shearwater pipeline route.	Fugro, 2019
Heron and Egret	Pre-decommissioning environmental survey for the Heron Cluster undertaken in 2017. Eleven stations at Heron, and	Fugro, 2018

	four stations at Egret, Also five transects at Heron and five at Egret.	
Machar	Environmental survey within the Eastern Trough Area Project (ETAP), encompassing the Machar, Mirren, Marnock and Mungo fields, undertaken in August 2012.	Gardline, 2013b

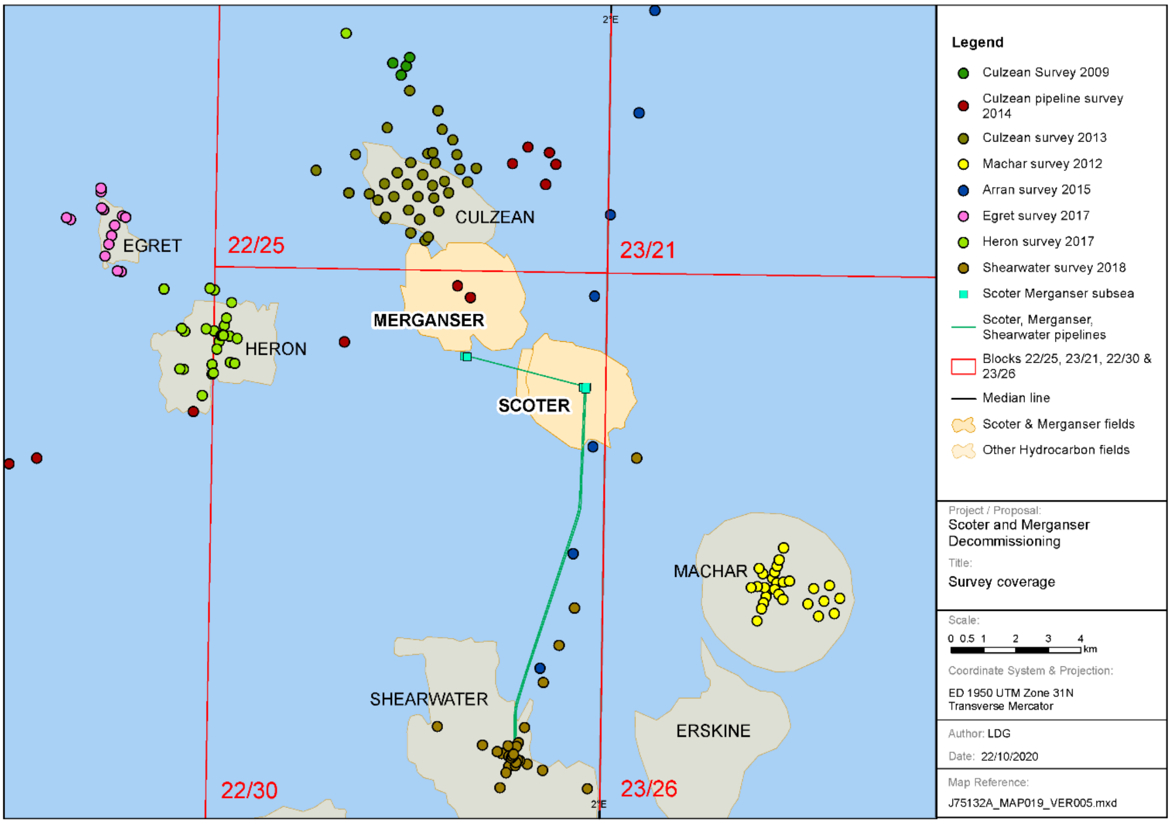

Figure 2-1 Map showing indicative location of recent surveys

2.2. Physical Environment

The type and distribution of marine life is influenced by the physical conditions of the surrounding environment, biological interactions and anthropogenic activities. These physical factors, which include, currents and tides, wave, temperature, salinity and wind also help set the design parameters for offshore facilities and influence the fate and behaviour of any emissions and discharges from an installation and the risk associated with them.

2.2.1. Meteorology

Winds at the Scoter and Merganser fields occur predominately from a south-west direction reaching speeds of > 16 m/s with an average wind speed of 8.6 m/s (Data Explorer, 2019). Although the prevailing wind direction is from the south west, winds do occur from all directions throughout the region and there is some seasonality to the directional distribution. Low pressure systems cause the strongest winds and these usually track from approximately south-west to north-east across the north-west European Continental Shelf and have central pressures in the range 950 to 1,040 millibar (mb). Any low with a central pressure below 990 mb may result in gales. There is a strong seasonal trend, with generally calmer winds during the period June to August, and the highest probability of strong winds in the period November to March. Occasional strong winds may occur in September and October due to extra-tropical storms (Shell, 2019).

At the nearby Jackdaw Project location (approximately 30 km south east of the Scoter manifold) wind speeds exceed 5.4 m/s for 75 % of the year, 8.0 m/s for 50 % of the year and 19.7 m/s for 1 % of the year at 10 m above sea level. The hourly average wind speed with an average recurrence of 100 years is 32.2 m/s at 10 m above mean sea level (Shell, 2019).

2.2.2. Temperature and Salinity

Information from the National Marine Plan interactive (NMPi) Map (Scottish Government, 2019) indicates that the annual mean surface temperature in the area is approximately 10 °C whilst the annual mean seabed temperature is approximately 7 °C.

Salinity varies with season and variations in ocean currents. The annual mean surface and seabed salinity range is approximately 34 to 35 ‰ (Scottish Government, 2019).

2.2.3. Water Masses, Currents and Tides

Water masses, local current speeds and direction influence the transport, dispersion and ultimate fate of marine discharges, nutrients, plankton and larvae (OSPAR, 2010).

Circulation in the North Sea is driven by a combination of winds, tidal forcing and freshwater inputs (DECC, 2016). The predominant regional current in the CNS originates from the vertically well-mixed coastal water and Atlantic water inflow of the Fair Isle/Dooley current, which flows around the north of the Orkney Islands and into the North Sea (BMT Cordah, 1998; North Sea Task Force, 1993).

The Scoter and Merganser fields are in an area which becomes stratified in the summer months. It is influenced by Scottish coastal water which flows clockwise around the coast of Scotland, and the Fair Isle and Dooley currents which flow from the north (DECC, 2016).

Semi-diurnal currents are relatively weak in the offshore CNS (DTI, 2001; Baxter *et al.*, 2011). Total current is a combination of 'residual' (oceanic circulation and surges) and tidal induced currents. In an area such as the CNS the oceanic circulation is small and therefore the residual current is dominated by storm surges.

The average wave height in the CNS region follows a gradient decreasing from the northern area of the Fladen/Witch Ground to the southern area of the Dogger Bank. According to the NMPi map the mean spring tidal range in the region ranges from 0.1 to 1.0 m and the annual mean significant wave height in the area ranges from 2.11 – 2.40 m (Scottish Government, 2019).

2.2.4. Bathymetry

Water depth is approximately 88 m at the Scoter and Merganser manifolds. The seabed along the Scoter-Shearwater pipeline route gently undulates with gradients of <1° (other than at the Machar-ETAP pipeline trench, where a gradient of 2° was recorded) and deepens slightly to 90 m at the Shearwater platform (Gardline, 2015; Gardline, 2016).

2.2.5. Seabed Features and Shallow Geology

The seabed in the region of the proposed decommissioning operations is generally featureless, apart from areas where subsea infrastructure and anchor scars occur (Gardline, 2014a; Gardline, 2014b; Gardline, 2015; Gardline, 2016; Fugro, 2018; Fugro, 2019).

The Scoter production pipeline and umbilical cross over two pipelines and two umbilicals as follows:

- 12" Marnock to Machar water injection pipeline
- 16" Machar to Marnock production pipeline
- Marnock to Machar control umbilicals (x2)

The Scoter production pipeline and umbilical are also crossed over by the Marnock to Machar gas lift pipeline and Marnock to Machar electrical upgrade umbilical.

The Blyth – Kvilldal North Sea Link Interconnector high voltage power cable, constructed in 2020, crosses over the Merganser production pipeline and umbilical, and passes within approximately 600 m of the Merganser manifold.

2.2.6. Cuttings Piles

The Scoter and Merganser fields were developed after the ban on discharge of OBM. WBM and cuttings were discharged at these locations, although there is little evidence from bathymetry data of any residual water-based mud cuttings piles that is distinguishable from sediment disturbed by the act of placing wellheads on the seabed.

A contaminated historic cuttings pile is present at the Shearwater A platform. It is characterised by higher proportions of fine sediments and drilling related contaminants, notably hydrocarbons and barium, which is a major component of drilling muds. Several other metals (cadmium, chromium, copper, iron, nickel, lead and zinc) were also found in higher concentrations closer to the platform. Pushcore sample analysis indicated that the contaminated cuttings layer spans from at least 120 m north-north-east, to 62 m north-north-west and 37 m south-west of the platform. It ranges from 8 cm thick (37 m south-west) to more than 31 cm thick (120 m north-north-east) (Fugro, 2017). The extent of the cuttings pile can also be inferred from bathymetry data shown in Figure 2-2. The profile of cuttings can be seen amongst the circular depressions made by drill rig footings to the north west of Shearwater A.

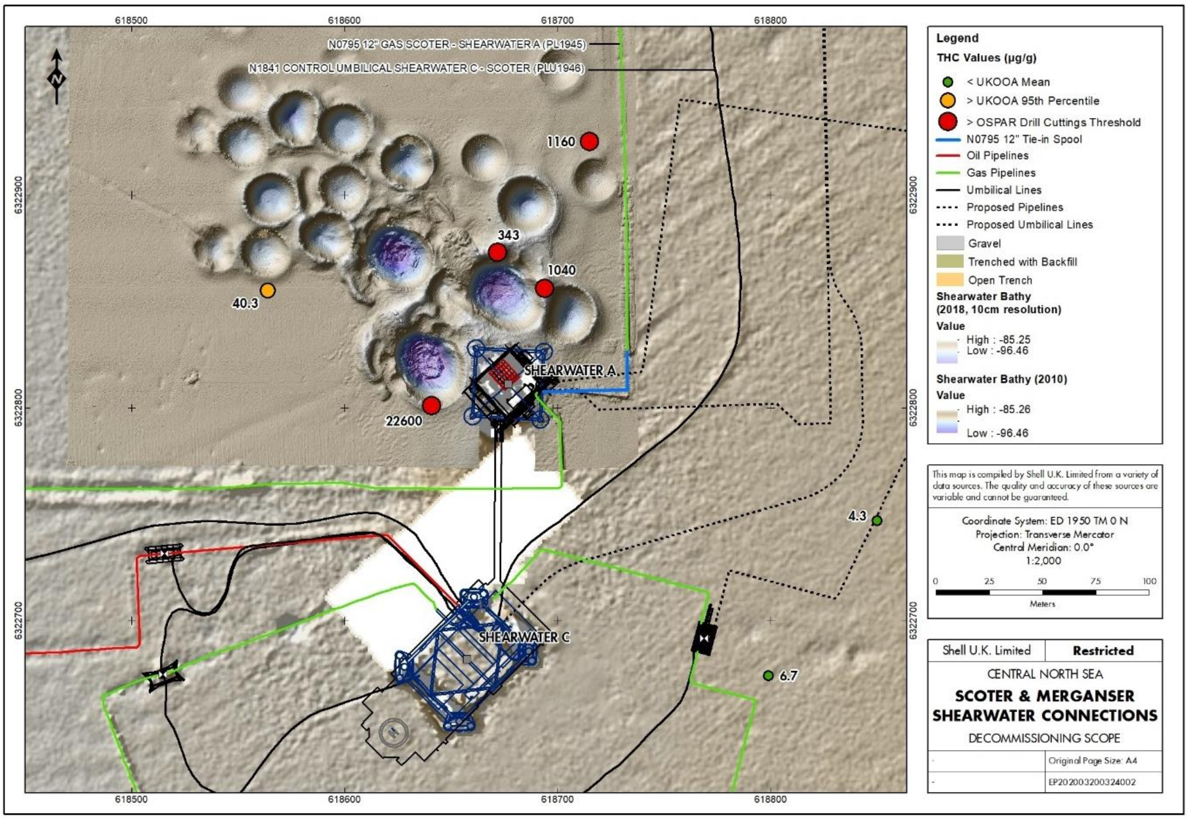

Figure 2-2 Bathymetry and infrastructure at Shearwater

The only subsea activity around Shearwater A required for execution of the Scoter and Merganser DP will be the removal of the Scoter riser tie in spool, marked in Figure 2-2, and recovery of pipeline stabilisation materials.

2.2.7. Seabed Sediments

Seabed sediments comprising mineral and organic particles occur commonly in the form of mud, sand or gravel and are dispersed by processes driven by wind, tides and density driven currents. The distribution of seabed sediments within the North Sea results from a combination of hydrographic conditions, bathymetry and sediment supply. The seabed sediment distribution in the CNS is illustrated in Figure 2-3. Sediments classified as sand and slightly gravelly sand cover approximately 80 % of the CNS (Gatliff, 1994). These sandy sediments occur over a wide range of water depths, from the shallow coastal zone down to about 110 m in the north and to below 120 m in isolated depths to the south and west. The carbonate (shell) content of the sand fraction is generally less than 10 % (Gatliff, 1994).

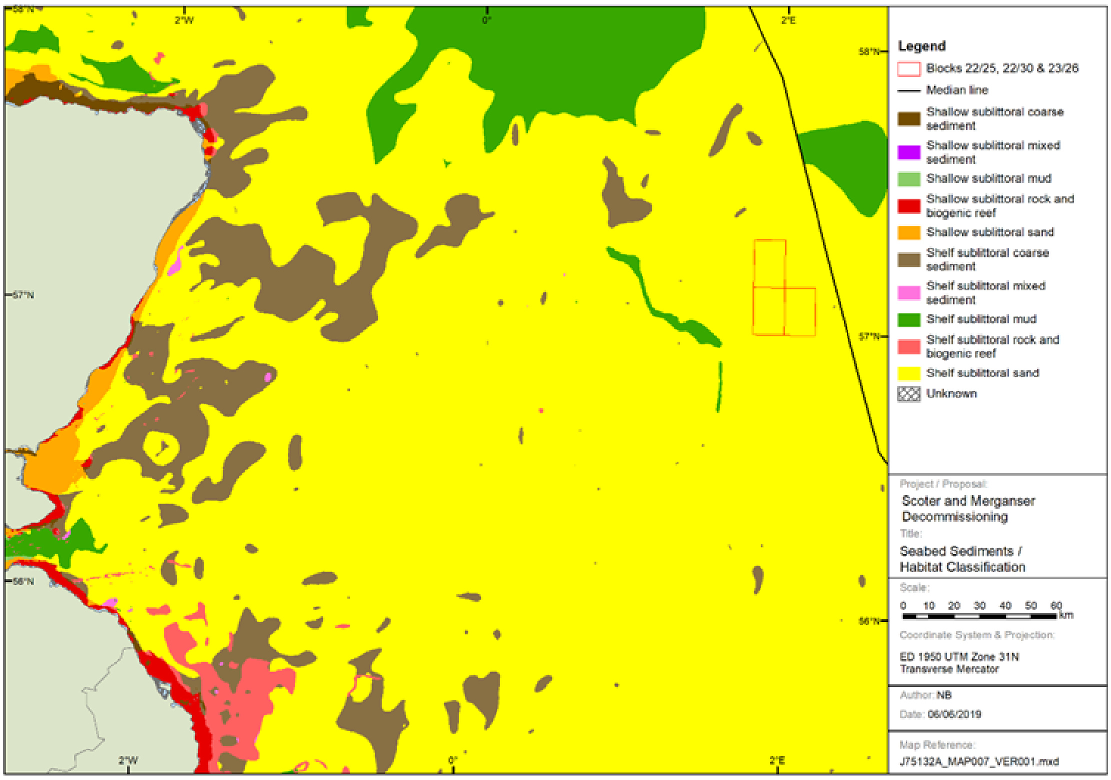

Figure 2-3 Sediment types in the CNS (EMODnet, 2019)

2.2.8. Physical Properties

Seabed sediments in the region of the proposed decommissioning operations predominantly comprise fine muddy sand to sandy mud with shell fragments, cobbles, occasional boulders and intermittent areas of outcropping clay (e.g. Gardline, 2014a; Gardline, 2014b; Gardline, 2015; Gardline, 2016; Fugro, 2019).

To the north of the Scoter and Merganser fields, and along the Scoter-Shearwater pipeline route, seabed sediments comprise a Holocene veneer of loose to very dense silty sand with occasional areas of shell and gravel (Gardline, 2015).

Arran survey stations within 10 km of Scoter were all classified as predominantly fine sand and contained between 13.3% and 16.6% fines (silt and clay) and between 0.1% and 5.5% gravel (Gardline, 2015).

The 2018 Shearwater monitoring survey showed all stations dominated by poorly sorted fine to very fine sand with 15% to 20% silt and less than 5% clay at all stations. At two stations sediments included 1% - 4% gravel content, while all other stations had <1% gravel (Fugro, 2019). Similar results were noted in the Heron cluster survey with 11.4 to 15.4 % silt at Egret, 9.03% to 18.7% silt at Heron, between 3.05% and 4.52% clay at Egret and 3.23% and 5.37% clay at Heron. By exception, one station at each of these fields had sediments with 1% - 2% gravel (Fugro, 2018).

Again, poorly sorted very fine sand was noted at the Culzean site survey which had percentage fines (<63 µm; silt and clay) ranging between 11.5% and 30.8%, with granular material (≥ 2mm) being negligible, with ≤1.6% recorded at all stations (Gardline, 2013a).

At Machar, fine material (<63 µm) ranged between 9.0% and 24.4%; gravel sized particles (>2 mm) contributed ≤1.2% at all stations (Gardline, 2013b).

2.2.9. Habitats

The Arran survey stations within 10 km of Scoter are classified as European Nature Information System (EUNIS) biotope 'Deep circalittoral sand' (A5.27) (Gardline, 2016) and the Shearwater, Heron and Egret survey areas comprised sediments classified as EUNIS biotope complex 'Circalittoral muddy sand' (A5.26) (Fugro, 2018; Fugro 2019). Both habitats are listed as 'Endangered' on the European Red List of Habitats. The muddy sand communities are vulnerable to trawling and long term disturbance has had a negative impact on benthic fauna. Other pressures and threats include pollution and climate change (EU, 2016). 'Circalittoral muddy sand' (A5.26) falls within the broad habitat Priority Marine Feature (PMF) of 'offshore subtidal sands and gravel' (Tyler-Walters *et al.,* 2016). These habitats are widespread in offshore waters and are threatened by demersal trawling and other activities that physically disturb the seabed (Tyler-Walters *et al.*, 2016).

Areas of 'Circalittoral mixed sediment' (A5.44) were also recorded at Egret and Shearwater (Fugro, 2018; Fugro, 2019) and is listed as 'Vulnerable' on the European Red List of Habitats, with fisheries being the main threat (EU, 2016).

'Pontic methane seeps in infralittoral and circalittoral rock' were observed in two patches along two transects at Heron (HTR01 and HTR02) (Fugro, 2018). This biotope complex consists of hard substrate comprising methane-derived authigenic carbonate (MDAC) and relates to the Annex I and PMF habitat type 'submarine structures made by leaking gas' (Tyler-Walters *et al.*, 2016).

The Culzean pipeline route '2B' survey describes an area of approximately 2.2 km by 1.5 km where patchy higher sonar reflectivity was noted which could indicate MDAC with heights of up to 0.7 m. The route of that survey crosses the Merganser field approximately 2 km north west of the Merganser manifold. Gas bubbles were noted in the water column indicating the presence of gas seepage, which are required for MDAC structures to form (Bussmann *et al.* 1999). Bacterial mats were also present at Station CULGT5-E-EBS-001 and several other locations, indicating possible methane presence (Gardline, 2014a). Faunal diversity and abundance were higher in the areas with potential MDAC as compared to the surrounding areas. Higher densities of epifauna such as Bryozoa, Hydrozoa and Porifera, were observed, as well as higher numbers of arthropods (mostly Galatheoidea and Paguridae), brittle stars (Ophiuroidea) and fish (mostly Gadidae and *Sebastes* spp.) that could find refuge in the potential MDAC structures. This area was considered to be a possible example of the Annex I habitat 'Submarine structures made by leaking gases' (Gardline, 2014c) and was investigated further.

The area of high sonar reflectivity to the north of Merganser can be seen as darker shades in the inset section in Figure 2-4.

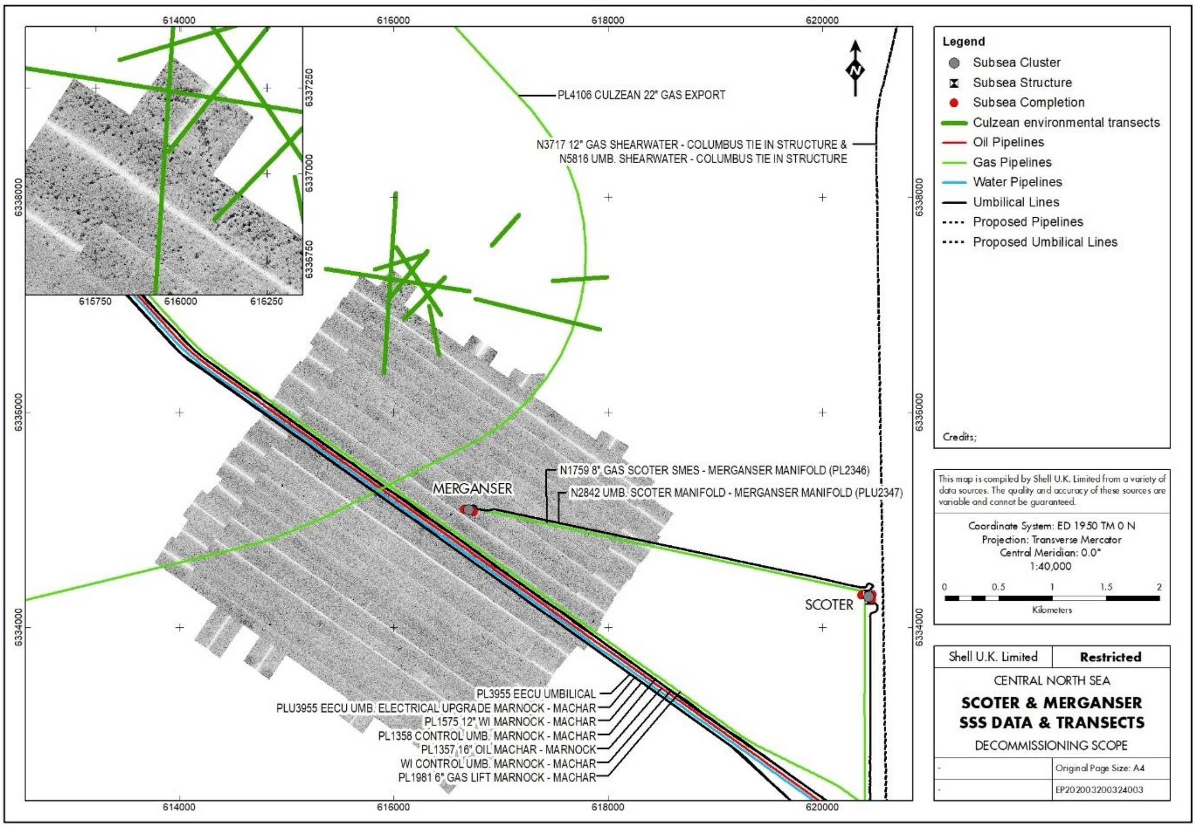

Figure 2-4 Sonar data around Merganser

Seismic data at different depths below seabed level were interpreted as showing gas, or gas chimneys, in the shallow subsurface (up to c. 200 m) below the area of MDAC. The semblance at c. 70 m below seafloor is shown in Figure 2-5, wherein the dark shading below the Culzean environmental transects represent the active area of subsurface gas. These subsurface structures cover an area of approximately 500 m radius. On this interpretation, the area of MDAC was concluded to extend to within 1.5 km from the Merganser manifold and is >4 km from the Scoter manifold.

The Culzean export pipeline was subsequently re-routed to the south of the area of MDAC (Gardline, 2014a) and it is reported that no evidence of MDAC was observed along the revised Route (Gardline, 2014a). The Culzean export pipeline was installed between the area of MDAC and the Scoter/Merganser manifolds.

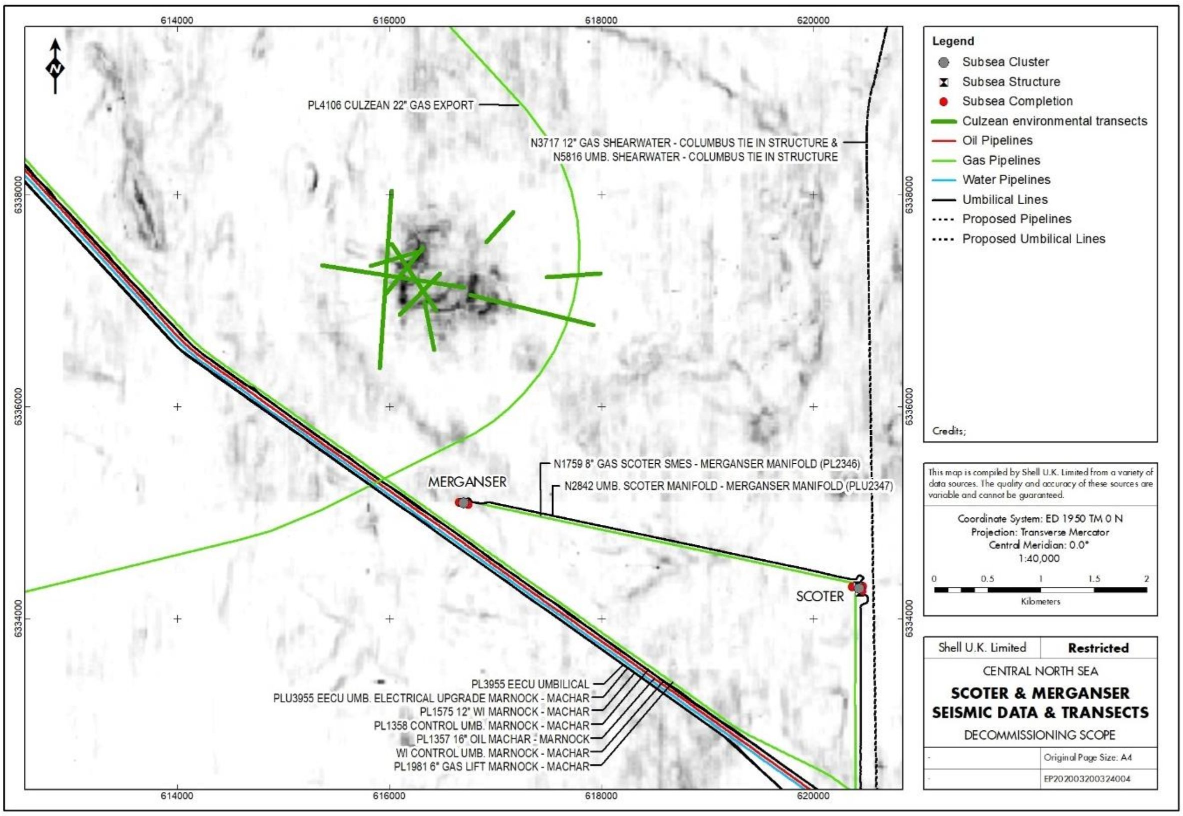

Figure 2-5 Seismic semblance at c. 70 m below seafloor

The Culzean pipeline route '2B' survey also reported the presence of seapens *Virgularia* sp. and *Pennatula phosphorea* at most of the stations, however due to the low density of seapens and low abundance of faunal tracks and/or megafauna encountered these areas are not considered to constitute the PMF and OSPAR (OSPAR, 2008) threatened and/or declining habitat 'Seapens and burrowing megafauna' (Gardline, 2014a). Similarly, at Heron and Egret, elements of the OSPAR habitat were identified (Fugro, 2018), with seapens *P. phosphorea* and *V. mirabilis* present throughout the survey area.

In summary, based on knowledge of the seabed from the various surveys within c 5 km from the proposed decommissioning works, the habitats to be expected at Scoter and Merganser include deep circalittoral sand and circalittoral muddy sand. Whereas both of these are listed as threatened by OSPAR, they are both widespread within the region surveyed. Although MDAC has been found in the area, the side scan sonar and shallow seismic survey data over Merganser suggest that MDAC is not present in the immediate vicinity of the manifold.

2.2.10. Sediment Contaminants

To provide an indication of the anticipated level of contamination of sediments in areas affected by the Scoter and Merganser decommissioning activities, concentrations of hydrocarbon contaminants and metals in sediment samples from survey stations within c. 10 km (as listed in Table 2-1) have been reviewed in the context of the following published threshold values:

- Regional background concentrations reported for the CNS by UKOOA in 2001; and

- OSPAR Coordinated Environmental Monitoring Programme Effects Range Low (ERL) concentrations (OSPAR, 2009a).

The UK Offshore Operators Association (UKOOA) commissioned a study by researchers at Heriot-Watt University to undertake a statistical analysis of data from environmental surveys of sediments in the North Sea undertaken between 1975 and 1995 (UKOOA, 2001). Data from survey stations located >5 km from any oil and gas installation were used to identify background concentrations of various hydrocarbon and metal species. Some of the chemical species exhibited distinct correlations with latitude and so separate background concentrations were established for the Southern, Central and Northern sectors of the North Sea. Those for the CNS are relevant for understanding the context of results obtained from more recent surveys within the area of Scoter and Merganser listed in Table 2-1. The range of results found at the UKOOA background sites are expressed as a mean, a median and the 95th percentile for each substance considered within the statistical study. By definition, uncontaminated sediments will exhibit concentrations either side of the background mean values, but few would be expected to have concentrations above the 95th percentile values.

OSPAR also adopted ERL values for certain hydrocarbon compounds and metals in marine sediments to represent concentrations below which ecological effects would rarely be observed (OSPAR, 2009a).

2.2.10.1. Hydrocarbons

The Arran survey (Gardline, 2016) reported mean total hydrocarbon concentrations (THC) of 6.7 μg/g with a standard deviation of 2.0 μg/g for all stations surveyed. All bar two THCs were below the UKOOA mean regional background value for the CNS (9.5 μg/g) with the exceptions being 10.9 μg/g approximately 8 km north of and 11.9 μg/g approximately 2 km south (enroute to Shearwater) of Scoter, and all were well below the CNS background 95th percentile concentration (40 μg/g). Those within Blocks 22/25, 22/30, 23/21 and 23/26 ranged between 4.7 μg/g and 11.9 μg/g.

From the location of these stations there is no obvious reason why they would be contaminated with hydrocarbons and it is likely that the levels of THC measured merely reflect the statistical spread for background sites within the CNS and are unlikely due to drilling activities at Scoter

The Heron field is produced via three wells that were drilled with OBM. THC concentrations in surface samples from push core samples of the cuttings at these wells were in the range 668 – 28,900 μg/g, while THC in sediment samples collected between 200 m and 1 km from the wells were below the 95%-ile background concentration for the CNS, within the range 7.8 – 26.8 μg/g (Fugro, 2018).

At Egret, which is produced via a single well was drilled using OBM in 1997, THC concentrations in sediment samples collected between 100 m and 500 m from the well were below the mean background level for the CNS, within the range 4.1 – 8.1 μg/g (Fugro, 2018).

The survey stations for the Arran pipeline in Block 22/30 overlap with stations surveyed as part of the Shearwater 2018 survey (Fugro, 2019) and the THC concentrations for both samples are broadly consistent.

THC levels recorded across most of the Shearwater monitoring survey area in 2018 were below the UKOOA (2001) regional mean background concentration, except at one station (SWA05, 375 m north northeast of the Shearwater A platform) where there is some influence from the dispersion of OBM-contaminated drill cuttings. This influence is also observable at 500 m even though THC levels at this station were below the CNS background mean value. A comparison of THC concentrations with previous survey data at the Shearwater field in 2010 (Fugro, 2011) and 2013 (Fugro, 2017) showed a reduction in THC concentrations for impacted stations between 2010 and 2018, as shown in Figure 2-6 (Fugro, 2019), suggesting that degradation of the hydrocarbons has taken place. THC concentrations did not exceed the CNS 95th percentile value at any of the survey stations (Fugro, 2019).

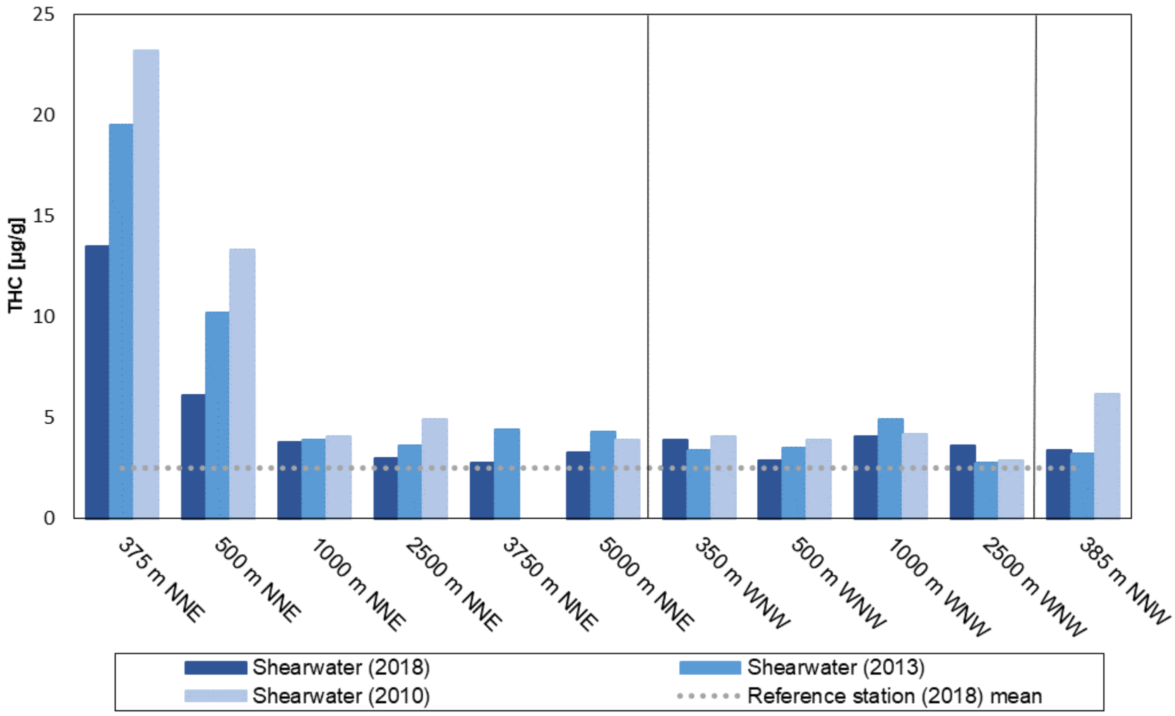

Figure 2-6 Comparison of sediment THC values in relation to distance from the Shearwater platform between 2013 and 2018 (Source: Fugro, 2019).

The Culzean field area was surveyed in 2013 prior to the field development (Gardline, 2014). Samples of sediment were collected from approximately 30 survey stations covering an area of approximately 4 km by 4 km. Sediments were largely of a uniform type and were described as poorly sorted at all stations. THC concentrations were generally low across the survey area, typically <11 µg/g, although sediments from three stations, ENV23, ENV17 and ENV30 contained elevated THC (52.2 µg/g, 136.2 µg/g and 17.5 µg/g respectively). The location of these sample stations in relation to the exploration well site can be seen in Figure 2-7.

ENV23 and ENV17 are within 500 m along the prevailing current direction of the Culzean appraisal wells 22/25a-10(Y/Z), which were drilled in 2010 and 2011. Stations equivalent to ENV17 and ENV23 were sampled during a survey in 2009 and THC in these sediments were in keeping with background concentrations, indicating that the elevated THC in 2013 resulted from discharges of drill cuttings contaminated with LTOBM from well 22/25a-10. Further analysis of component hydrocarbon constituents confirmed this conclusion (Gardline, 2013a).

ENV30 is approximately 100 m from Culzean appraisal well 22/25a-3 which was drilled in 1991. The lower level of contamination at this survey site may indicate natural attenuation has occurred over the intervening 22 years between the spud date and the 2013 survey.

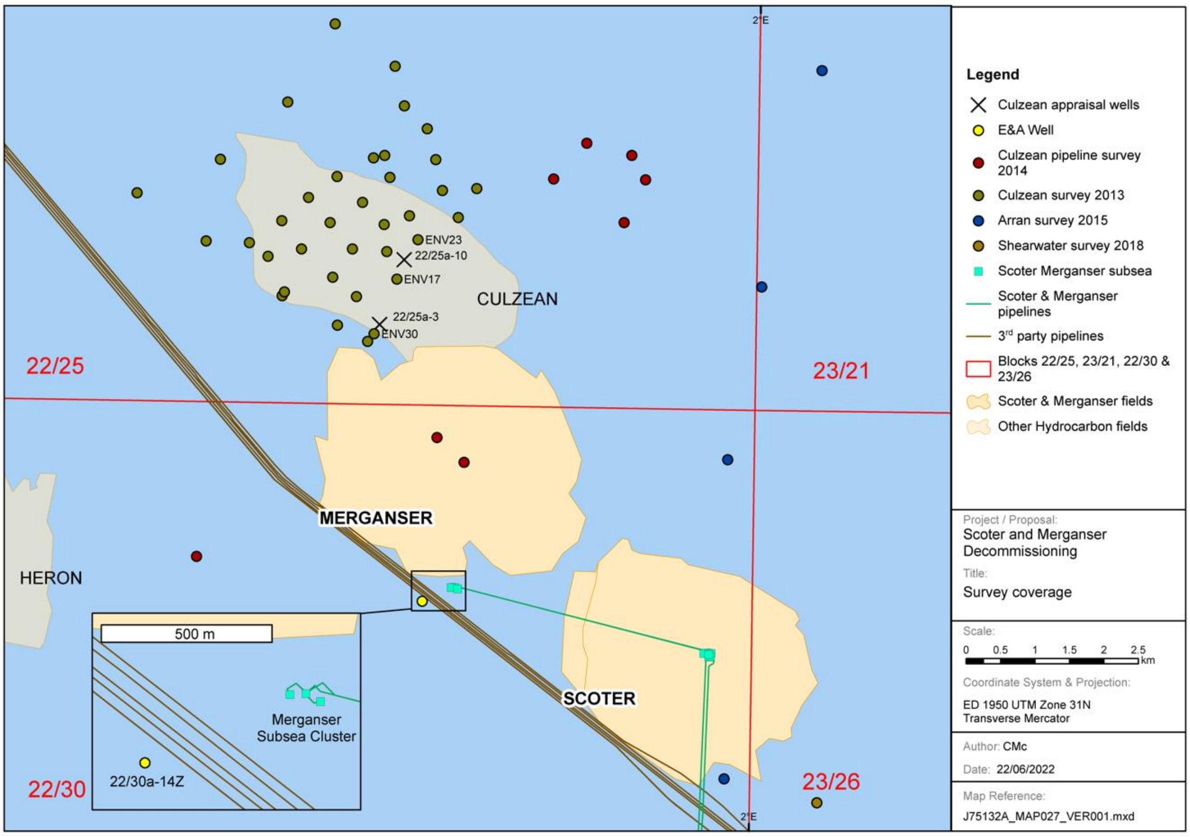

Figure 2-7 Exploration and Appraisal well locations at Culzean and Merganser

2.2.10.2. Metals

Sediments collected as part of the Arran survey at stations within Blocks 22/25, 22/30, 23/21 and 23/26 showed total barium concentrations in the range 279 – 409 µg/g, which straddle the CNS mean background concentration of 348 µg/g and are well below the CNS 95th percentile of 720 µg/g. This is consistent with these locations being outside the influence of contamination from drilling or production.

No sediments from the Arran survey in Blocks 23/21 and 23/26 had concentrations of any metals above the 95th percentile value for background sediments in the CNS. Vanadium concentrations in all samples were above the CNS mean, while all other metals were below the respective CNS mean values except for copper in one sample (out of 11) and for lead in another.

The Shearwater survey reported that sediments at all stations had concentrations of bioavailable barium above the CNS mean (178 µg/g), including the 'reference' station (202 µg/g), which lies closest to Scoter. Levels of barium increased closer to the Shearwater A platform and exceeded the CNS background 95th percentile at stations <500 m from the platform, indicating contamination from drill cuttings. There was a consistent pattern for certain metals (e.g. Zinc, Cadmium, Mercury) of elevated concentrations close to Shearwater A but little indication of contamination at stations beyond 500 m from the platform in the direction of prevailing currents.

Sediments from the Culzean survey (Gardline, 2013a) contained total barium at concentrations between the CNS background mean and 95th percentile values with the exception of stations ENV17 and ENV23 which are influenced by drill cuttings from well 22/25a-10, as seen for THC.

For all other metals in the Culzean sediments the mean concentrations were below the respective mean background CNS values and the maximum concentrations were below the respective 95th percentile values.

At Heron, concentrations of several metals (Chromium, Copper, Mercury, Lead, Zinc) were generally between the mean and the 95th percentile background values for the CNS, with concentrations at one station exceeding the 95th percentile value for most metals. At Egret, barium concentrations were between the CNS background mean and 95th percentile values. All other metals were below the respective background mean values for the CNS.

In none of the sediments from any of the surveys described were the concentrations of any contaminants above the ERL value defined by OSPAR and this is expected to be the case at Scoter and Merganser as described in the following section.

2.2.11. Anticipated Sediment Contamination at Scoter and Merganser

The results summarised in Section 2.2.10 indicate that sediments across Blocks 22/25, 22/30, 23/21 and 23/26 are uncontaminated except in the vicinity of wells, where they have been influenced by discharges of drill cuttings. This influence is particularly noticeable close to Shearwater. The extent to which it relates to Scoter and Merganser is considered in this section.

Sediments at the Scoter and Merganser decommissioning site can be expected to be consistent with the observations for the wider area and as such there may be contamination of sediments consistent with the discharge of water based muds during the drilling of the 3 wells at Scoter and the 2 wells at Merganser. An E&A well (22/30a-14Z) was drilled in 1995 using OBM approximately 500 m from Merganser (see Figure 2-7) and it is possible that the dispersion and deposition of drill cuttings from the E&A well may have resulted in elevated concentrations of contaminants at Merganser.

Survey results from two analogous fields, FRAM and Starling, both of which tie-back to Shearwater, have been used to determine the likely magnitude and extent of any contamination at Scoter and Merganser resulting from drilling. These fields are located approximately 40 km from the Scoter manifold in water depths of approximately 97 m and drilled with WBM.

The FRAM development consists of five wells drilled in 2012 and 2013, while at Starling three wells were drilled, two in 2006 and one in 2009. WBM cuttings were discharged to sea during drilling of all wells at both fields. Environmental surveys were carried out both before and after drilling, in 2006 at Starling (Gardline, 2007), in 2010 at FRAM (Gardline, 2011) and at both fields in 2015 (Fugro, 2016). Five of the stations within 1,000 m of the FRAM wells were sampled in surveys before and after drilling.

As is to be expected where discharges of WBM cuttings has occurred, the survey data showed that, at all stations within 1,000 m of the drilling, concentrations of barium increased from values consistently below the mean background level for the CNS (178 µg/g) before drilling, to values up to and exceeding the 95th percentile for background locations in the CNS (523 µg/g) after drilling. The station closest to the wells (at 250 m) had 4,130 µg/g of barium. No evidence of increased barium concentrations was observable for sediments at stations more than 2,500 m from the drill centres of either field.

The closest station to the FRAM wells also had concentrations of lead and zinc that were above the respective CNS 95th percentile background values after drilling although there was no indication of any spatial trends in these or any other metals among samples from other stations. No metals concentrations in any samples exceeded OSPAR ERLs.

THC concentrations at stations within 1,000 m from FRAM were between 8.9 μg/g and 10.1 μg/g and the closest station to Starling had THC of 11.2 μg/g. Whereas these are comparable with the CNS mean background value of 9.51 μg/g, stations at least 580 m from Starling and at least 1,600 m from FRAM had THC concentrations between 4.7 μg/g and 8.6 μg/g. It is possible that there may have been a degree of hydrocarbon contamination of sediments close to the well sites during drilling. However, this is not clear since the pre-drilling survey measured THC concentrations between 9.8 μg/g and 13.5 μg/g within 1,000 m of FRAM.

There may also be an influence from the dispersion and deposition of drill cuttings from the Merganser E&A well drilled with OBM mud in 1995. The E&A well was drilled approximately 500 m to the west southwest of where the Merganser manifold has subsequently been positioned. As seen in Figure 2-6 the influence of cuttings at Shearwater extends to at least 500 m, although this is from a significantly higher number of wells drilled and is specifically within the direction of residual currents. Settlement of OBM contaminated cuttings from the Merganser E&A well is expected to have been as a very thin film at the site of the Merganser manifold and production wells and subsequent biodegradation of hydrocarbon contamination within such a film would be expected over the intervening 25 years. Evidence of this is also seen in the Shearwater results, with residual THC concentration below the mean background level for the CNS at 500 m distance.

The conclusion drawn for Scoter and for Merganser is that little contamination is anticipated, with the exception of barium, potentially out to 2 – 3 km from each manifold and, possibly more locally, increased lead and zinc concentrations. There is potential for a low level of residual hydrocarbon contamination at the Merganser site from the drilling of the E&A well, although THC concentrations would be expected to be well below the 95%-ile value for background sediments at this distance and time, as was the case at other fields surveyed (e.g. Egret).

There are no wells near to the Scoter pipeline crossing of the Marnock to Machar pipelines and sediments in this area are anticipated to be uncontaminated, as seen across the wider area.

2.2.12. Anticipated Sediment Contamination at the Scoter Riser Spool

The Scoter riser tie in spool projects eastwards along the seabed from the eastern side of the Shearwater A platform. As Per Figure 2-2 the cuttings pile projects from the Shearwater Platform footings to the north west which is the opposite side of the platform to the tie-in spool and is perpendicular to the prevailing current direction. Nevertheless, it is likely that some contamination from discharged cuttings, or from resuspended contaminated sediments, could have settled around the riser spool which is immediately adjacent to the east side of the Shearwater Platform. THC concentrations fall rapidly in the easterly direction, from values of up to 23,400 μg/g within the cuttings pile to 4.3 μg/g 200 m away. However, no samples have been collected at intermediate locations and so the rate of decrease is not known. It is likely that sediments that have settled on the mattresses that protect the riser spool could have THC concentrations higher than the 50 μg/g level generally regarded as a threshold below which ecological impacts are unlikely to be observed (Norwegian Oil and Gas, 2016), and which is used by OSPAR to aid the interpretation of environmental impact of cuttings piles (OSPAR, 2006).

2.3. Marine Flora and Fauna

2.3.1. Plankton

Plankton are drifting organisms that inhabit the pelagic zone of a body of water and include single celled organisms such as bacteria as well as plants (phytoplankton) and animals (zooplankton). Phytoplankton are primary producers of organic matter in the marine environment and form the basis of marine ecosystem food chains. They are grazed upon by zooplankton and larger species such as fish, birds and cetaceans. Therefore, the distribution of plankton directly influences the movement and distribution of other marine species. Meroplankton includes the eggs, larvae and spores of non-planktonic species (fish, benthic invertebrates and algae).

The composition and abundance of plankton communities vary throughout the year and are influenced by several factors including depth, tidal mixing, temperature stratification, nutrient availability and the location of oceanographic fronts. Species distribution is directly influenced by temperature, salinity, water inflow and the presence of local benthic communities (Robinson, 1970; Colebrook, 1982).

Over the past 30 years, rising sea temperatures have been accompanied by a rise in the North Atlantic Oscillation index. The seasonal timing of phytoplankton and zooplankton production has altered in recent decades with some species present up to four to six weeks earlier than 20 years before. This directly affects their availability to predators such as fish (OSPAR, 2010). Seasonal stratification of the water column into layers of different temperatures has an important impact on phytoplankton abundance. A peak in phytoplankton abundance usually occurs every spring with phytoplankton communities dominated by relatively large diatoms, for example *Thalassiosiria* spp. and *Chaetoceros* spp. There may be an additional, but smaller, peak in phytoplankton numbers during the autumn with smaller dinoflagellate species, for example *Ceratium*, dominating (SAHFOS, 2001).

Zooplankton communities in the North Sea are dominated by copepods, such as *Calanus* spp. *Acartia* spp and *Metridia lucens*, occurring during the summer peak period (Nielsen and Richardson, 1989).

In the North Sea there have been extensive changes in the planktonic ecosystem in terms of plankton production, biodiversity and species distribution with the population of the previously dominant and important cold water species, *Calanus finmarchicus* has declined in biomass by 70% since the 1960s. Warmer-water species such as *Calanus helgolandicus* are moving northward to replace *C. finmarchicus* but are not numerically abundant or as nutritionally (i.e. less lipid rich) important (Edwards M, 2013).

2.3.2. Benthos

Bacteria, plants and animals living on or within the seabed sediments are collectively referred to as benthos. Species living on top of the sea floor may be sessile (e.g. sea anemone) or freely moving (e.g. starfish). Animals living within the sediment are termed infaunal (e.g. tubeworms and burrowing clams) while animals living on the surface are termed epifaunal (e.g. crabs, starfish). Semi-infaunal animals, including sea pens, lie partially buried in the sediment. The majority of marine benthic invertebrates exhibit a life cycle that includes a planktonic larval phase from which the bottom dwelling juvenile and adult phases recruit.

Benthic animals display a variety of feeding methods. Suspension and filter feeders capture particles which are suspended in the water column (e.g. sea pens) or transported by the current (e.g. mussels). Deposit feeders (e.g. sea cucumbers) ingest sediment and digest the organic material contained within it. Other benthic species can be herbivorous (e.g. sea urchins), carnivorous (e.g. crabs) or omnivorous (e.g. starfish).

Sessile infaunal species are particularly vulnerable to external influences that may alter the physical, chemical or biological characteristics of the sediment as they are unable to avoid unfavourable conditions. Each species has its own response and degree of adaptability to changes in the physical and chemical environment. Consequently, the species composition and relative abundance in a particular location provides a reflection of the immediate environment, both current and historical (Clark, 1996). Surveys of the North Sea show that the benthic fauna is characterised by water depth and seabed type, with depth mainly influencing epifauna, whilst sediment characteristics are more important for the infauna (Rees *et al.*, 2007).

The recognition that aquatic contaminants may alter sediment characteristics, together with the relative ease of obtaining quantitative samples from specific locations, has led to the widespread use of infaunal communities in monitoring the long-term impact of disturbance to the marine environment (Rees *et al.*, 1990).

Activities that result in the disruption of the seabed such as pipeline installation can affect the benthic fauna (Clark, 1996). An International Council for the Exploration of the Sea (ICES) report on the structure and dynamics of the North Sea benthos (Rees *et al.*, 2007) concluded that the ecological effects of anthropogenic influences arising from oil and gas installations and aggregate extraction were not identifiable on a large ICES block scale. They found no evidence of impacts associated with clusters of installations, rather that any variations identified were associated predominantly with natural forces. In addition, it was concluded that the benthos are sufficiently resilient to accommodate the consequences of contemporary anthropogenic influences over large scales without significant degradation.

Benthic communities in the region are generally consistent with the presence of circalittoral muddy sand and circalittoral sand habitats, which are concluded to be expected at both Scoter and Merganser.

The Culzean field site survey (Gardline, 2013a) was dominated by Polychaetes, in particular *Paramphinome jeffreysii*, *Galathowenia oculata*, *Spiophanes bombyx*, *Pholoe assimilis* and *Pseudopolydora paucibranchiata*. These abundant taxa were characteristic of the muddy sandy sediment recorded across the survey area.

The Culzean Pipeline Route 2B survey found that the faunal community was dominated by Annelida (Polychaeta), Arthropoda, Mollusca and Echinodermata (Gardline, 2016). The Arran survey also found communities at stations within 10 km of Scoter to be dominated by these same taxa (Gardline, 2014b). There were differences in communities between Arran stations to the north of Scoter and those to the south, towards Shearwater. The two most abundant taxon at stations north of Scoter were the polychaetes *Paramphinome jeffreysii* followed by *Spiophanes bombyx*. In stations to the south of Scoter *Galathowenia oculata* agg. and/or *Ophiocten affinis* were present in similar or greater abundance than *S. bombyx*, there was an absence of species such as *Eudorellopsis deformis* and increased abundance of hydrocarbon tolerant Thyasira. This is consistent with higher THC concentrations in sediments at Shearwater noted above.

The macrofaunal community was relatively homogenous across the Shearwater field. The most abundant and most dominant taxa were the polychaetes *Paramphinome jeffreysii*, *Galathowenia* and

Pholoe assimilis followed by the bivalves *Axinulus croulinensis*, *Adontorhina similis* and *Parathyasira equalis* (Fugro, 2019). The macrofaunal community was considered typical of muddy sand within the CNS.

The Machar area survey was also dominated by polychaete annelids. The most dominant species recorded across the ETAP survey area were characteristic of the fine sandy sediments in the CNS, with the polychaete *Paramphinome jeffreysii* and juvenile echinoderm Ophiura dominating the community (Gardline, 2013b).

The dominance of polychaete taxa is not unusual. Various studies by Gage (2001) show polychaetes consistently dominating soft bottom benthos from continental shelves to abyssal plains and revealed that over 50% of total macrofaunal individuals are generally composed of polychaete worms.

The most frequently observed burrowing taxa in the 'circalittoral muddy sand' biotope complex in the Heron cluster survey were the sea pens (*Virgularia mirabilis*) and (*Pennatula phosphorea*), with some tall sea pens (*Funiculina quadrangularis*) also observed. Other burrowing fauna included the Norway lobster (*Nephrops norvegicus*) and polychaete worms (Polychaeta, Phyllodocidae, Eunicidae). Frequently observed mobile taxa included sea urchins (*Gracilechinus acutus*, *Echinus esculentus*), with starfish (*Astropecten irregularis*, *Asterias rubens*), brittle stars (Ophiuroidea, *Ophiura ophiura*), hermit crabs (Paguroidea), Masked crab (*Corystes cassivelaunus*) spider crab (Inachidae), shrimp (Pandalus spp.) squat lobsters (Munida spp.) and common whelks (*Buccinum undatum*) observed less frequently.

The presence of hard substrate within the biotope complex 'circalittoral mixed sediment' provided a surface for the attachment of sessile epifaunal such as faunal turf (hydrozoa/bryozoa) and sea anemones (Actinaria, *Bolocera tuediae*) (Fugro, 2018). Juvenile ocean quahog (*Arctica islandica*) are recorded throughout the surveyed area at a rate considered to be representative of the wider region (e.g. Gardline, 2014b). Juveniles were also present in the Heron cluster and Culzean site surveys (Fugro, 2018; Gardline, 2013a) with a small number of adults noted at Shearwater and Machar (Fugro, 2019; Gardline, 2013b).

On the basis of the data from the various surveys covering the area, it is to be expected that benthic communities at Scoter and Merganser will be typical of this wider area.

2.3.3. Finfish and Shellfish

At present, more than 330 fish species inhabit the shelf seas of the UKCS (DECC, 2016). Fish and shellfish species are particularly sensitive to chemical discharges and noise generated from the offshore oil and gas industry during their early life stages. The most vulnerable stages of the fish lifecycle to general disturbances such as disruption to sediments and chemical/hydrocarbon discharges are the egg and larval stages, hence recognition of spawning and nursery grounds within the area is important (Sindermann, 1994 and WWF Norway, 2005). Fish species can be categorised into pelagic and demersal finfish and shellfish, with the following characteristics:

- Pelagic species occur in shoals swimming in mid-water, typically making extensive seasonal movements or migrations between sea areas. Most pelagic species such as mackerel (*Scomber scombrus*), blue whiting (*Micromesistius poutassou*) and sprat (*Sprattus sprattus*) spawn in the water column whilst pelagic species such as herring (*Clupea harengus*) are batch demersal spawners laying their eggs in specific substrate;

- Demersal species live on or near the seabed. Typical demersal species are cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), plaice (*Pleuronectes platessa*), which spawn in the pelagic environment, whereas sandeel (*Ammodytes* spp.) spawn in sandy sediments at the sea bottom; and
- Shellfish species include demersal (bottom-dwelling) molluscs, such as mussels and scallops, and crustaceans, such as shrimps, crabs and *Nephrops* (Norway lobster).

The Scoter and Merganser fields lie within ICES rectangles 43F1 and 43F2. The pipeline route, Shearwater platform and the infrastructure to be removed lies within ICES rectangle 43F1.

Fish spawning and nursery locations in the vicinity of the decommissioning site are shown in Table 2-2 and Figure 2-8. The table and figure relate to generalised patterns of spawning and nursery areas which are dynamic features of fish life history and are rarely fixed in one location from year to year (Coull *et al.*, 1998). The information provided therefore represents the widest known distribution given present knowledge and should not be seen as a fixed, unchanging description of presence or absence of a species (Coull *et al.*, 1998; Ellis *et al.*, 2012).

Of the species identified, sandeels and cod are of particular note with regard to anthropogenic activity on the seabed. sandeel eggs are laid in sticky clumps on sandy substrates. Upon hatching, the larvae become planktonic, resulting in a potentially wide distribution and, by around 2 – 5 months after hatching they adopt a demersal habit (Rogers & Stocks, 2001).

Cod are a species known to aggregate over specific grounds to spawn where males hold small territories in a lek-like mating system (Gonzalez & Wright, 2015). This aggregative behaviour together with seasonal site fidelity can make cod, vulnerable to certain anthropogenic impacts. Cod spawning tends to be more abundant in areas of coarse sand in depths <125 m (Gonzalez and Wright, 2015). Cod eggs are known to be buoyant and will float to surface waters once released, transported miles by ocean currents before hatching (MarLIN, 2020). Their seabed vulnerability is therefore particularly in regard to spawning itself.

Sediments in the project area are predominantly fine grained (see Section 2.2.8) and mostly lack the coarser sand habitat favoured by both cod and sandeel for spawning. For example, sandeels have not been found in field samples where the silt content in the sediment is greater than 10 % (Wright *et al.*, 2000) and the occupancy and the density of sandeels in seabed habitats containing more than 4 % silt is expected to be extremely low (Holland *et al.*, 2005). Whereas the generalised patterns of spawning of these species includes the Scoter and Merganser area, it is unlikely that either cod or sandeels would favour these sediments for spawning.

Using species distribution modelling, Aires *et al.* (2014) predicted the location of aggregations of 0-group fish (fish in their first year of life) based on environmental information and catch records. They found that 0-group fish for a number of species would be present in the Scoter and Merganser area. Figure 2-9 shows the probability of juvenile (0-group) fish, for a selection of species, being present in the area at any one time.

Table 2-2 Spawning grounds and nursery areas of some commercially and ecologically important fish species in ICES rectangle 43F1.

Species	J	F	M	A	M	J	J	A	S	O	N	D	Nursery
Anglerfish[2]													
Blue whiting[1,2]													
Cod[2]	S	S*	S*	S									
Haddock[1,3]													
Hake[2,3]													
Herring[2]													
Lemon sole[1]				S	S	S	S	S	S				
Ling[2]													
Mackerel[1,2]					S*	S*	S*	S					
Nephrops[1]	S	S	S	S*	S*	S*	S	S	S	S	S	S	
Norway pout[1,3]	S	S*	S*	S									
Plaice[2]													
Sandeels[2]	S	S									S	S	
Spurdog[2]													
Whiting[2,3]													

Key	S = spawning period S* = peak spawning			
		Higher egg concentrations[1]		Nursery (all year)

Sources: Coull *et al.*, 1998[1]; Ellis *et al.*, 2012[2]; Aires *et al.*, 2014[3]

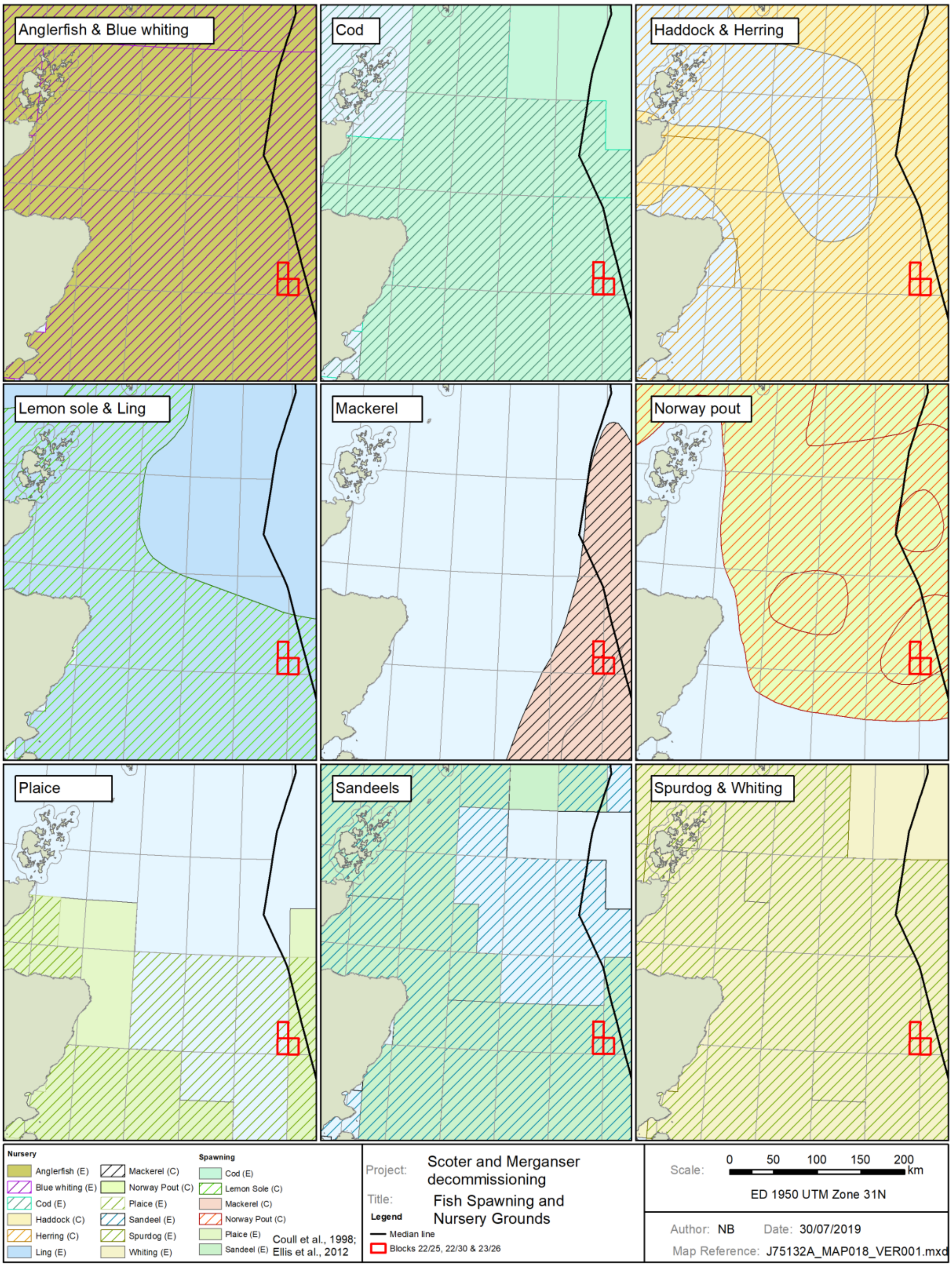

Figure 2-8 Spawning and nursery areas in the vicinity of the Scoter and Merganser fields (Coull *et al.*, 1998; Ellis *et al.*, 2012).

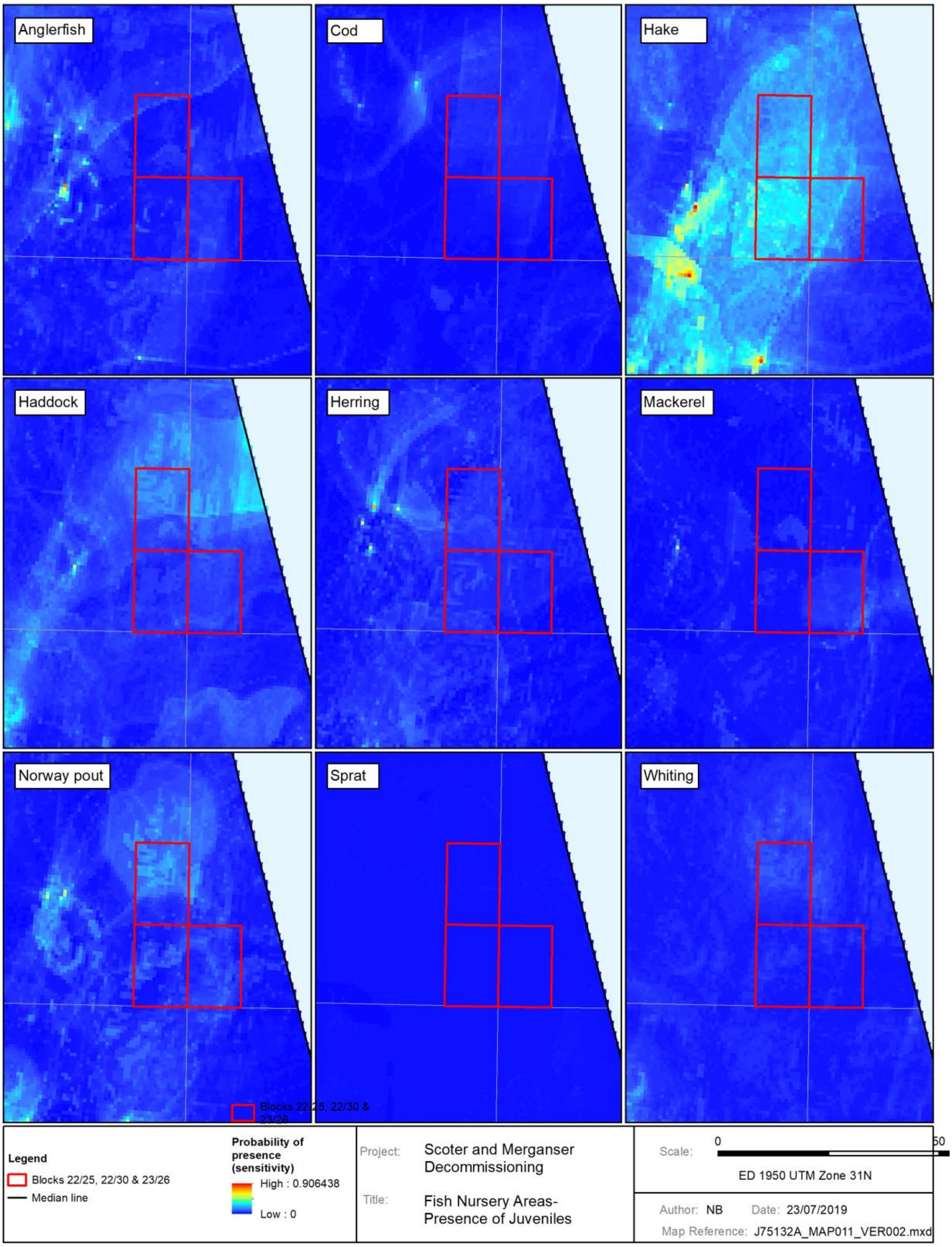

Figure 2-9 Probability of juvenile (0-group) fish occurring in the Scoter and Merganser area (Aires *et al.*, 2014).

A number of the species occurring in the area are of conservation concern:

- Anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, sandeels, spurdog and whiting are listed as Scottish PMFs (Tyler-Walters et al., 2016).
- Cod and spurdog are listed on the OSPAR list of threatened and/or declining species in the Greater North Sea (OSPAR, 2008).
- Cod and haddock are listed as 'vulnerable' on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species™ and spurdog are listed as 'endangered' in Europe (IUCN, 2019).

Other fish species which may occur in the area and which are Scottish PMFs are halibut, horse mackerel, saithe, basking shark, common skate, porbeagle shark and sandy ray (Tyler-Walters *et al.*, 2016).

Fish species recorded during environmental surveys include flatfish and hagfish (Fugro, 2019).

Marine Scotland has identified a 'period of concern' for seismic surveys between May and August within Blocks 22/25, 22/30 and 23/26, due to fish spawning (OGA, 2019a). Fish spawning areas and spawning periods, in particular, are regarded as environmental sensitivities in the context of oil and gas activities. Species that spawn on the seabed and in geographically restricted areas (for example herring) are regarded as more sensitive than others. The species identified as having spawning grounds in the Scoter and Merganser area spawn over extensive areas and are not considered to be sensitive to point-source activities such as the proposed decommissioning project.

2.3.4. Sharks, Skates and Rays

Sharks, skates and rays (elasmobranchs) have a cartilage, rather than a bony, skeleton and occur globally. Over 30 species have been recorded in Scottish waters.

Larger species such as the common skate take 15 years to reach maturity, while smaller species may mature in around six years. They are vulnerable to overfishing due to this slow growth rate and slow breeding rate which mean that depleted populations take a long time to recover. Elasmobranchs reproduce by laying eggs or bearing live young which are fully developed prior to birth or hatching. This means they are large enough to be trapped in trawl nets or dredge gear and can often be caught as bycatch before they have chance to reproduce and relatively few individuals reach breeding age. They are also vulnerable to habitat disturbance (Scottish Government, 2019).

The distribution of elasmobranchs in the UKCS is not extensively documented. According to DECC (2016) the most common species recorded in UK waters are:

<u>Sharks</u>

- Lesser spotted dogfish (*Scyliorhinus canicular*);
- Greater spotted dogfish (*Scyliorhinus stellaris*);
- Spurdog (*Squalus acanthias*);
- Tope shark (*Galeorhinus galeus*);

<u>Skates and rays</u>

- Thornback Ray (*Raja clavata*);

- Cuckoo ray (*Raja naevus*);
- Starry ray (*Amblyraja radiata*);
- Blonde ray (*Raja brachyura*);
- Small-eyed ray (*Raja microocellata*);
- Undulate ray (*Raja undulata*);
- Spotted ray (*Raja montagui*).

Sightings of common skate (*Leucoraja batis*), porbeagle (*Lamna nasus*) and basking shark (*Cetorhinus maximus*) are rare (DECC, 2016).

2.3.5. Seabirds

The UK and its surrounding seas are very important for seabirds. The extensive network of cliffs, sheltered bays, coastal wetlands and estuarine areas provide breeding and wintering grounds for nationally and internationally important bird species and assemblages (DECC, 2016). Approximately 26 species of seabird regularly breed in the UK and Ireland as do a number of other waterbird and wader species (DECC, 2016).

Predicted maximum monthly abundance of seabirds in the Scoter and Merganser fields is based on an analysis of the European Seabirds at Sea data collected over 30 years (Kober *et al.*, 2010). Continuous seabird density surface maps were generated using the spatial interpolation technique 'Poisson kriging' and fifty-seven seabird density surface maps were created to show particular species distribution in specific areas. Data from the relevant maps has been summarised for the Scoter and Merganser area in Table 2-3.

Distribution and abundance of these bird species vary seasonally and annually. Most species occur only at low densities of less than one individual per km^2.

Seabirds are generally not at risk from routine offshore oil and gas production operations. However, they may be vulnerable to pollution from less regular offshore activities such as well testing and flaring, when hydrocarbon dropout to the sea surface can occasionally occur, or from unplanned events such as accidental oil or diesel spills. There is no period of concern due to seabird sensitivity for drilling activities in Blocks 22/25, 22/30 or 23/26 (OGA, 2019a).

The vulnerability of seabirds to surface oil in the blocks and surrounding areas has been assessed according to the Seabird Oil Sensitivity Index (SOSI). The purpose of this index is to identify areas where seabirds are likely to be most sensitive to oil pollution by considering factors that make a species more or less sensitive to oil-related impacts.

The SOSI combines the seabird survey data with individual seabird species sensitivity index values. These values are based on a number of factors which are considered to contribute towards the sensitivity of seabirds to oil pollution, and include:

- habitat flexibility (the ability of a species to locate to alternative feeding grounds);
- adult survival rate;
- potential annual productivity; and
- the proportion of the biogeographical population in the UK (classified following the methods developed by Certain *et al.*, (2015).

Table 2-3 Predicted seabird density (maximum number of individuals per km²).

Species	Season	J	F	M	A	M	J	J	A	S	O	N	D
Northern fulmar	All year	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5
European storm-petrel	Breeding						<1	<1	<1	<1	<1		
Northern gannet	All year	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Great skua	Breeding					<1	<1	<1	<1				
Black-legged kittiwake	All year	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Black-headed gull	Breeding				<1	<1	<1	<1	<1				
Great black-backed gull	Winter	<1	<1	<1						<1	<1	<1	<1
Herring gull	Breeding	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Glaucous gull	Winter	<1	<1	<1							<1	<1	<1
Common guillemot	Breeding	1-5	1-5	1-5	1-5	1-5	1-5		1-5	1-5	1-5	1-5	1-5
Little auk	Winter	<1	<1	<1								<1	<1
Atlantic puffin	Breeding				1-5	1-5	1-5	1-5					
	Winter	<1	<1	<1					<1	<1	<1	<1	<1
All species	Breeding/ summer			5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10		
	Winter	1-5	1-5	1-5								1-5	1-5
Key:	Not recorded			<1		1-5		5-10		10-20		>20	

Source: Kober *et al.*, 2010

The combined seabird data and species sensitivity index values were then subsequently summed at each location to create a single measure of seabird sensitivity to oil pollution. The median sensitivity SOSI data for the area is shown in Table 2-4. For blocks with 'no data', an indirect assessment has been made (where possible) using Joint Nature Conservation Committee (JNCC) guidance (JNCC, 2018). The sensitivity of birds to surface oil pollution is shown in Figure 2-10. The sensitivity of birds to surface oil pollution in the Scoter and Merganser area is generally low throughout the year, with the exception of September and October when it is regarded as high in Block 23/26 (Webb *et al.*, 2016).

Table 2-4 Median seabird sensitivity in Block 22/30 and surrounding blocks.

Block	J	F	M	A	M	J	J	A	S	O	N	D
22/24	5	5	5	5*	5*	5	5	5	5	5*	N	5*
22/25	5	5	5	5*	5*	5	5	5	5	5*	N	5*
23/21	5	5	5*	N	5*	5	5	5	5	5*	N	5*
23/22	5	5	5*	N	5*	5	5	5	5	5*	N	5*
22/29	5	5	5	5*	5*	5	5	5	5	5*	N	5*
22/30	**5**	**5**	**5**	**5***	**5***	**5**	**5**	**5**	**5**	**5***	**N**	**5***
23/26	5	5	5*	N	5*	5	5	5	3	3*	N	5*
23/27	5	5	5*	N	5*	5	5	5	5	5*	N	5*
29/04	5*	5	5	5*	5*	5	5	5	5	5*	N	N
29/05	5*	5	5	5*	5*	5	5	5	5	5*	N	N
30/01	5*	5	5*	N	5*	5	5	5	5*	N	N	N
30/02	5	5	5*	N	5*	5	5	5	5*	N	N	5*
30/03	5	5	5*	N	5*	4	5	5	5*	N	N	5*
22/19	5	5	5	5*	5*	5	5	5	5	5*	N	5*
22/20	5	5	5*	N	5*	5	5	5	5	5*	N	5*
23/16	5	5	5*	N	5*	5	5	5	5	5*	N	5*
23/17	5	5	5*	N	5*	5	5	5	5	5*	N	5*
Key	1 extremely high		2 very high		3 high		4 medium		5 low		No data	
	* Data gaps filled, where possible, following JNCC guidance (JNCC, undated).											

Source: Webb *et al.*, 2016

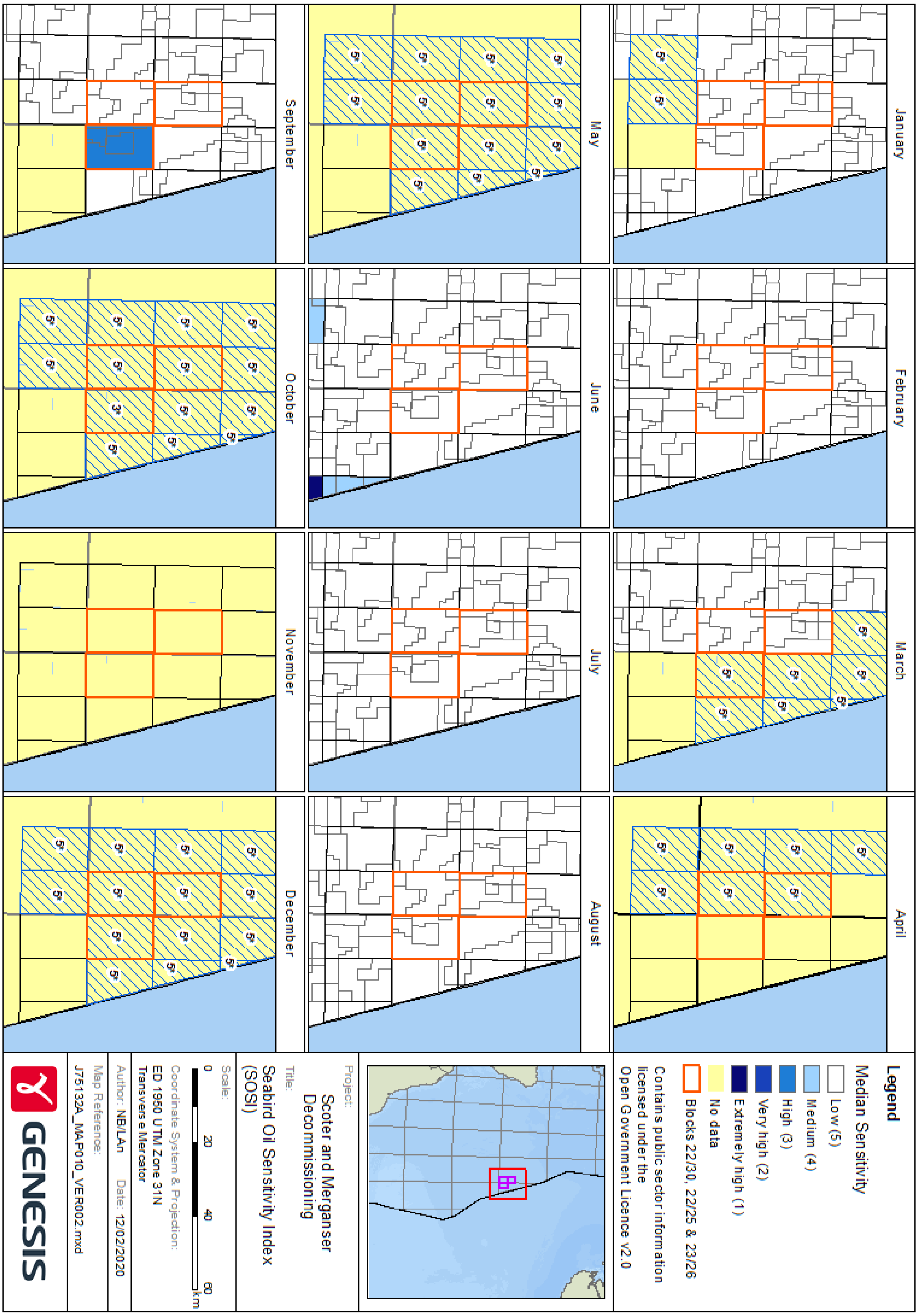

Figure 2-10 SOSI and indirect assessment for the Scoter and Merganser area (Webb *et al.*, 2016).

2.3.6. Marine Mammals

2.3.6.1. Pinnipeds

Two species of seal live and breed in UK waters: the grey seal (*Halichoerus grypus*) and the harbour (also called common) seal (*Phoca vitulina*). Both species are Annex II and PMF species. Distribution maps based on telemetry data (1991 – 2015) and count data (1988 – 2015) indicate that both grey seals and harbour seals are unlikely to occur in the vicinity of the Scoter and Merganser fields (Figure 2-11) (Russell *et al.*, 2017).

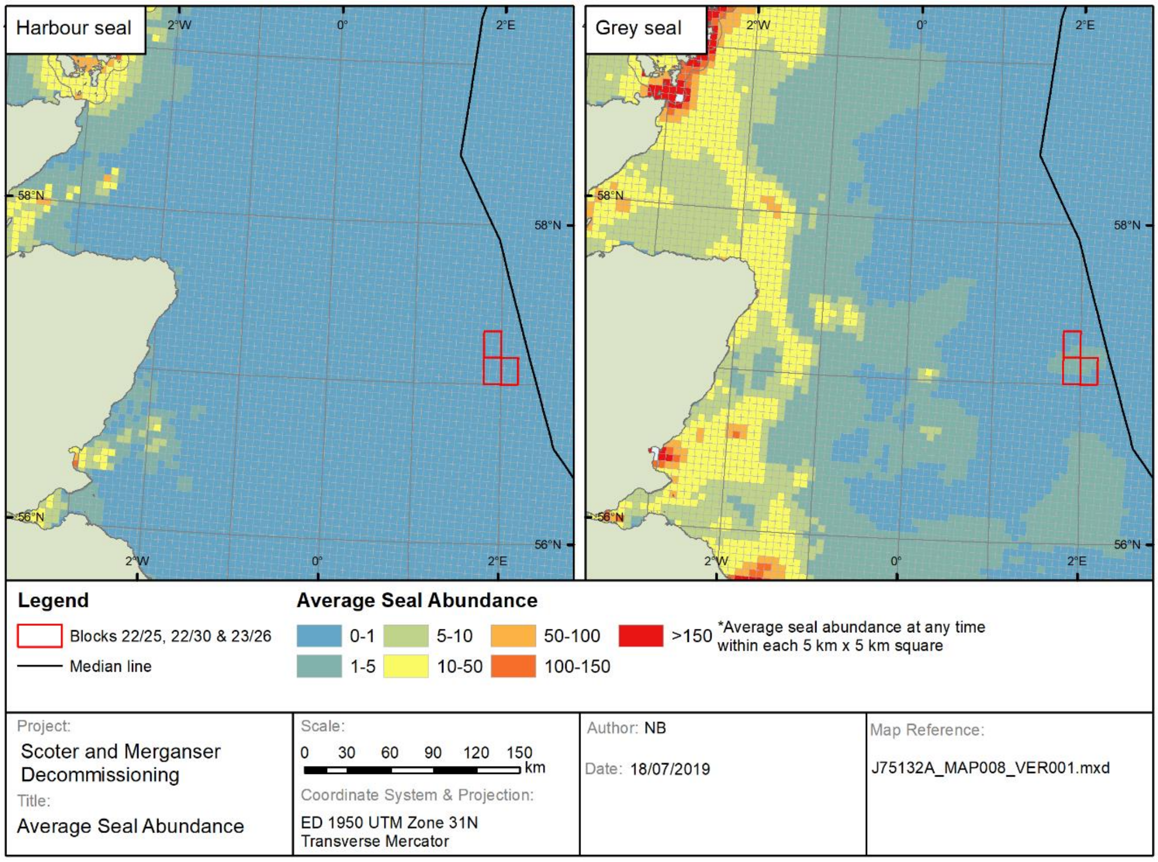

Figure 2-11 Average seal abundance in the Scoter and Merganser area (Russell *et al.*, 2017).

2.3.6.2. Cetaceans

All cetaceans are European Protected Species (EPS) and Scottish PMFs. Harbour porpoise is also an Annex II species.

Many activities associated with the offshore oil and gas industry have the potential to impact cetaceans by causing physical injury, disturbance or changes in behaviour. Activities with the potential to cause disturbance or behavioural effects include: drilling, seismic surveys, vessel movements, construction work and decommissioning (JNCC, 2008).

Cetaceans regularly recorded in the North Sea include harbour porpoise, white-beaked dolphin, minke whale, Atlantic white-sided dolphin, bottlenose dolphin (primarily in inshore waters) and killer whale (Reid *et al.*, 2003). Risso's dolphin and large baleen whales are also occasionally sighted.

Spatially and temporally, harbour porpoise, white-beaked dolphin and minke whale are the most commonly sighted cetacean species in the North Sea (Reid *et al.*, 2003).

There is no site- or block-specific data for cetacean distribution in the area of the proposed project. It is therefore necessary to rely on wider area reviews to determine cetacean presence.

The JNCC compiled an Atlas of Cetacean Distribution in Northwest European Waters (Reid *et al.*, 2003) which gives an indication of the annual distribution and abundance of cetacean species in the North Sea. Figure 2-12 shows the annual abundance and distribution of some cetacean species likely to occur in the Scoter and Merganser area. The data suggest that Atlantic white-sided dolphin, harbour porpoise, minke whale and white beaked dolphin are likely to occur in the area.Table 2-5 shows the seasonal distribution of these species in the area.

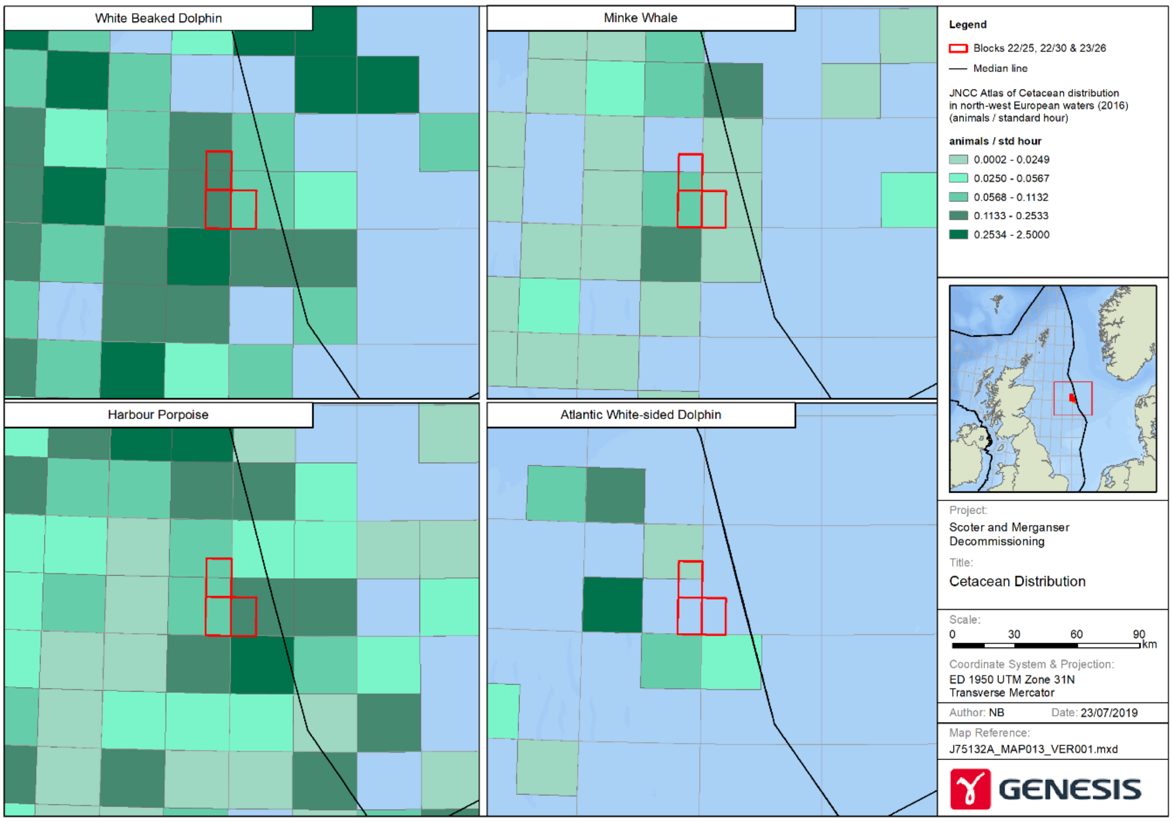

Figure 2-12 Distribution of cetacean species in the vicinity of the Scoter and Merganser fields (Reid *et al.*, 2003).

Table 2-5 Seasonal occurrence of cetaceans in the Scoter and Merganser area.

Species	J	F	M	A	M	J	J	A	S	O	N	D
Atlantic white-sided dolphin												
Harbour porpoise												
Minke whale												
White-beaked dolphin												
Key		Months in which species recorded										

Source: Reid *et al.*, 2003

A series of Small Cetaceans in European Atlantic waters and the North Sea (SCANS) surveys have been conducted to obtain an estimate of cetacean abundance in North Sea and adjacent waters in the summers of 1994, 2005 and 2016 (SCANS, SCANS-II and SCANS-III, respectively). The results of these surveys are presented in Hammond *et al.* (2002); Hammond *et al.* (2006) and Hammond *et al.*, (2017).

The Scoter and Merganser decommissioning project is located within SCANS-III survey Block "Q" as shown in Figure 2-13. Aerial survey estimates of animal abundance and densities (animals per km^2) in this survey block are provided in Table 2-6 which suggest that harbour porpoise and minke whale occur in the area.

Table 2-6 Cetacean abundance in SCANS-III survey Block Q.

Survey block	Species	Animal Abundance per survey block	Animal density (per km^2)
Q	Harbour porpoise	16,569	0.333
	Minke whale	384	0.007

Source: Hammond *et al.*, 2017

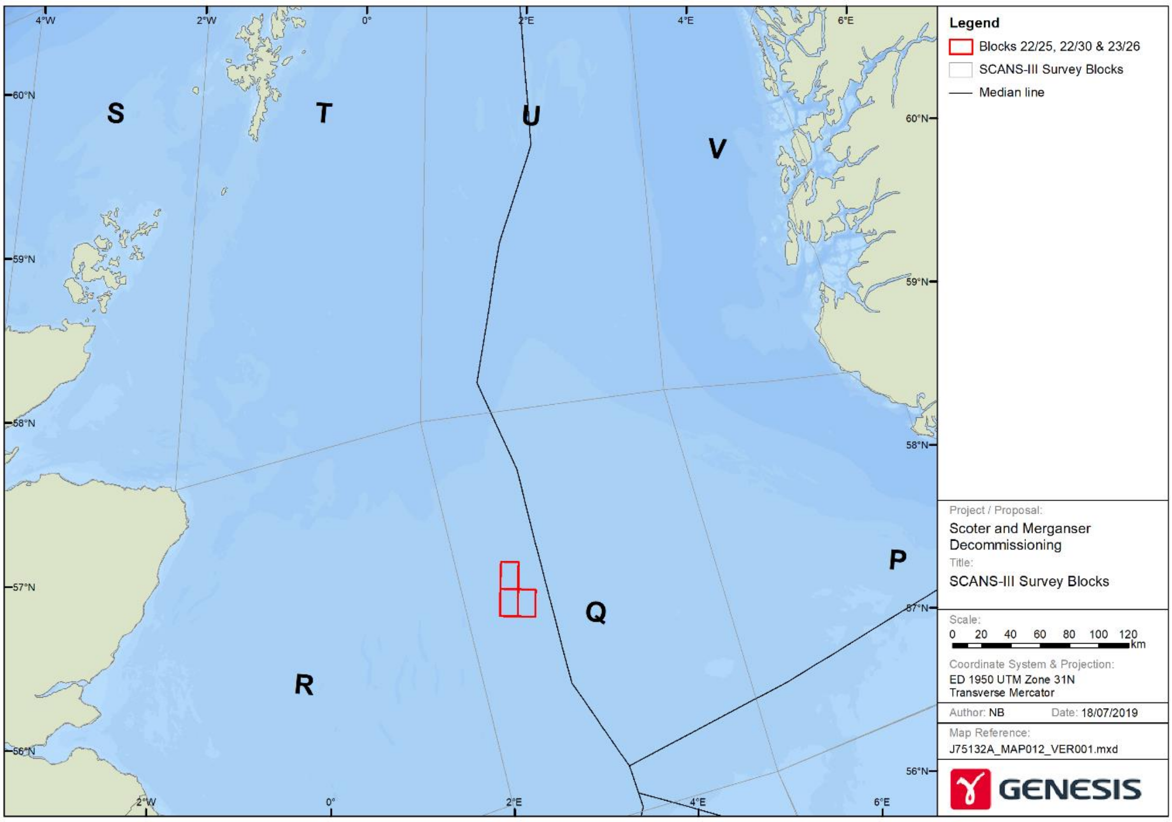

Figure 2-13 SCANS-III survey blocks in relation to the Scoter and Merganser fields (Hammond *et al.*, 2017).

2.4. Designated Sites

The UKCS supports a wide variety of species and habitats. A key policy for conserving them is the designation and management of protected sites for nationally and/or internationally important habitats and species. Figure 2-14 shows the location of protected areas in closest proximity to the Scoter and Merganser fields.

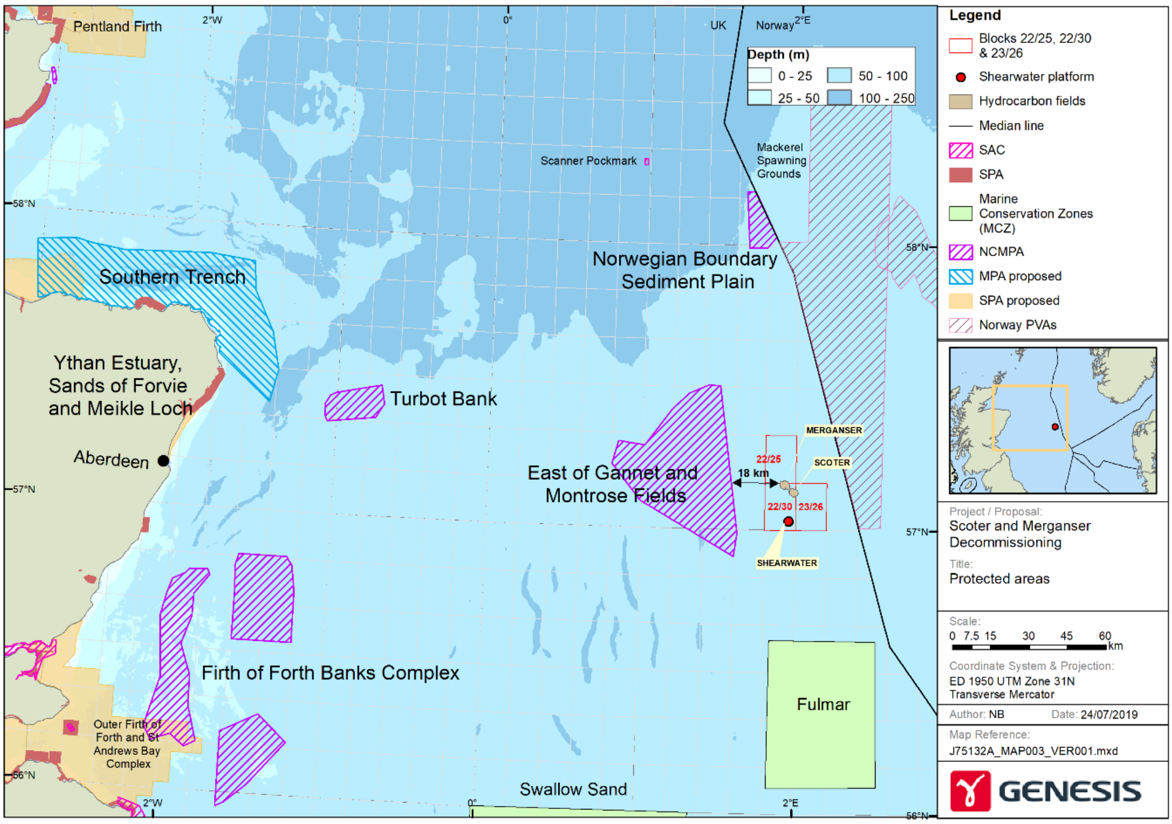

Figure 2-14 Location of the Scoter and Merganser fields in relation to areas of conservation concern (JNCC, 2019a; Norwegian Environmental Agency, 2012).

2.4.1. Offshore Conservation Areas

There are no Special Areas of Conservation (SAC) located within 40 km of the Scoter and Merganser fields. The closest sites of conservation concern (Figure 2-14) are the Fulmar Marine Conservation Zone (MCZ), the East of Gannet and Montrose Fields Nature Conservation Marine Protected Area (NCMPA) amd the Norwegian Particularly Valuable Area (PVA).

The Fulmar MCZ is approximately 58 km south of the Scoter and Merganser manifolds and is designated for subtidal sand, subtidal mud, subtidal mixed sediments and ocean quahog (*A. islandica*) (JNCC, 2019a).

The East of Gannet and Montrose Fields NCMPA is approximately 18 km west of the Merganser manifold and is designated for offshore deep sea muds and ocean quahog aggregations (JNCC, 2019a).

The Norwegian PVA is designated for its mackerel spawning grounds and is approximately 20 km east of the Scoter manifold (Norwegian Environment Agency, 2012).

2.4.2. Potentially Sensitive Habitats and Species

The potentially sensitive habitats and species identified in the vicinity of the Scoter and Merganser fields are summarised in Table 2-7. These features have either been identified as likely to be present in this part of the CNS within publicly available datasets, or have been recorded in surveys mentioned throughout this report.

Table 2-7 Summary of potential sensitive species/habitats in the Scoter and Merganser area.

Species/Habitat	Legislation	Description	Designation / Status	Likelihood of Presence at Scoter / Merganser
Submarine structures made by leaking gases	EC Habitats Directive	Submarine structures made by leaking gases	Annex I habitat	There is potential for this habitat to be present at Heron and Culzean (Fugro, 2018; Gardline, 2014a), although unlikely to be present at Scoter and Merganser.
	Marine Scotland Act	Submarine structures made by leaking gases	Scottish PMF habitat	
Ocean quahog (*A. islandica*)	OSPAR threatened and/or declining habitats and species	Ocean quahog	Threatened and/or declining species	Juvenile *A. islandica* is present in the survey areas with small numbers of adults noted at Shearwater and Machar (Fugro, 2019; Gardline, 2013b). It is likely that *A. islandica* (particularly juveniles) will be present at Scoter and Merganser.
	Marine Scotland Act	Ocean quahog	Scottish PMF low or limited mobility species	
Sea pens and burrowing megafauna	Marine Scotland Act	Sea pens and burrowing megafauna	Scottish PMF habitat	Aspects of this habitat noted in the Heron cluster survey (Fugro, 2018).
	OSPAR threatened and/or declining habitats and species	Sea pens and burrowing megafauna communities	Threatened and/or declining species	
Mud habitats in deep water	Marine Scotland Act	Burrowed mud	Scottish PMF habitat	Aspects of this habitat noted in the Heron cluster survey (Fugro, 2018).
	Nature Conservation (Scotland) Act	Mud habitats in deep water	UK Post-2010 Biodiversity Framework priority habitat	
Circalittoral sediments	European Red List of Habitats	Circalittoral muddy sand	Endangered	Circalittoral sediments were noted throughout the survey areas and likely to be present at Scoter and Merganser
		Deep circalittoral sand	Endangered	
		Circalittoral mixed sediment	Vulnerable	
	Marine Scotland Act	Offshore Subtidal Sands and Gravels	Scottish PMF habitat	
Cetaceans	EC Habitats Directive	All cetaceans	Annex II species/EPS	Atlantic white-sided dolphin, harbour porpoise, minke whale and white-beaked dolphin are likely to be present at Scoter and Merganser
	Marine (Scotland) Act	All cetaceans	Scottish PMF mobile species	

Pinnipeds	EC Habitats Directive	Grey seals/harbour seals	Annex II species/EPS	Unlikely to be present at Scoter and Merganser
	Marine (Scotland) Act	Grey seals/harbour seals	Scottish PMF mobile species	
Finfish	Marine (Scotland) Act	Anglerfish, blue whiting, cod, halibut, herring, horse mackerel, ling, mackerel, Norway pout, saithe, sandeels, whiting	Scottish PMF mobile species	Anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, sandeels and whiting are likely to be present at Scoter and Merganser. Halibut, saithe and horse mackerel may occur at Scoter and Merganser.
	OSPAR threatened and/or declining habitats and species	Cod	Threatened and/or declining species	Likely to be present at Scoter and Merganser
	IUCN Red List of Threatened Species™	Cod, haddock	Vulnerable	Likely to be present at Scoter and Merganser
Elasmobranchs	Marine (Scotland) Act	Basking shark, common skate, porbeagle shark, sandy ray, spurdog	Scottish PMF mobile species	Spurdog are likely to be present at Scoter and Merganser. Basking shark, common skate, porbeagle shark and sandy ray may occur at Scoter and Merganser.
	OSPAR threatened and/or declining habitats and species	Basking shark, common skate, porbeagle shark, spurdog, thornback ray	Threatened and/or declining species	Spurdog are likely to be present at Scoter and Merganser. Basking shark, common skate, porbeagle shark and sandy ray may occur at Scoter and Merganser.
	IUCN Red List of Threatened Species™	Blonde ray, greater spotted dogfish, small-eyed ray, thornback ray	Near threatened	May all occur at Scoter and Merganser
		Basking shark, porbeagle shark, spurdog, starry ray, tope shark	Vulnerable	Spurdog is likely to occur at Scoter and Merganser. Porbeagle shark, starry ray and tope shark may occur at Scoter and Merganser
		Sandy ray, undulate ray	Endangered	May occur at Scoter and Merganser
		Common skate	Critically endangered	May occur at Scoter and Merganser
Seabirds	EC Birds Directive	European storm petrel, common guillemot	Annex I Species	Likely to be present at Scoter and Merganser
	IUCN Red List of Threatened Species™	Black legged kittiwake, Atlantic puffin	IUCN Vulnerable	Likely to be present at Scoter and Merganser
	OSPAR threatened and/or declining	Black legged kittiwake	Threatened and/or declining species	Likely to be present at Scoter and Merganser

	habitats and species

NOTES

EC Habitats Directive: Annex I and II lists those habitats and species respectively whose conservation requires the designation of SACs.

EC Birds Directive: Annex I lists bird species which require the designation of Special Protection Areas (SPA).

IUCN Red List of Threatened Species™: is the world's most comprehensive inventory of species conservation status. Status (applicable to species occurring in the Scoter/Merganser area) is described as: Near Threatened, Vulnerable, Endangered, Critically Endangered (IUCN, 2019).

European Red List of Habitats: gives an overview of the risk posed to habitats in the European Union and adjacent areas (Gubbay *et al.*, 2016). Classification is per the IUCN Red List of Threatened Species™.

European Protected Species (EPS): are species of plants and animals, listed in the Habitats Directive, protected by law throughout the EU whose natural range includes any area in the UK.

OSPAR List of Threatened and/or Declining Species and Habitats (2008-6): Lists species and habitats in the OSPAR area which are considered to be under threat (OSPAR, 2008).

Priority Marine Features (PMF): are Scottish habitats and species considered to be conservation priorities Scotland (Tyler-Walters *et al.*, 2016).

UK Post-2010 Biodiversity Framework: sets a structure for action across the UK to address biodiversity challenges, including identifying priority habitats and species (JNCC, 2012).

2.4.3. Circalittoral Sediments

The EUNIS biotopes 'Deep circalittoral sand' (A5.27) and 'Circalittoral muddy sand' (A5.26) have been identified in the vicinity of Scoter and Merganser (Gardline, 2016; Fugro, 2018; Fugro, 2019). 'Circalittoral muddy sand' (A5.26) is also a component of the broad PMF habitat Offshore Subtidal sands and gravels (Tyler-Walters *et al.*, 2016). Although both habitats are relatively common, with a large natural range they are listed as 'Endangered' on the European Red List of Habitats, with threats from over fishing as well as pollution and climate change (EU, 2016). Areas of 'Circalittoral mixed sediment' (A5.44) were also noted (Fugro, 2018; Fugro, 2019) and are listed as 'Vulnerable' on the European Red List of Habitats.

Although threatened, circalittoral habitats tend to be more stable than infralittoral habitats, supporting a rich faunal community (JNCC, 2020) likely to recover from fishing impacts (EU, 2016).

2.4.4. Submarine Structures Made by Leaking Gases

Precipitations of various carbonate mineral phases are brought about by enrichment in pore water alkalinity. Enrichment in bicarbonate ion concentration has been attributed to anaerobic oxidation of methane and concomitant sulphate reduction process. Anaerobic oxidation of methane is believed to be performed by a consortium of methane-oxidizing archaea microbes and sulphate-reducing bacteria in the marine environment and is widely observed at locations with gas seepages and pore fluid ventings along with carbonate precipitates (Muralidhar *et al.*, 2006). The precipitates generally occur as individual slabs, thinly lithified pavements, vertical pillars, mushroom-like structures, microbial mats, dispersed crystals and micro-concretions. These carbonates are methane-derived authigenic (i.e. formed in place) carbonates. Under the EU Habitats Directive, Annex I habitat formed by MDAC is defined as '*Spectacular submarine complex structures, consisting of rocks, pavements and pillars up to 4 m high. These formations are due to the aggregation of sandstone by a carbonate* *cement resulting from microbial oxidation of gas emissions, mainly methane. The methane most likely originated from the microbial decomposition of fossil plant materials. The formations are interspersed with gas vents that intermittently release gas. These formations shelter a highly diversified ecosystem with brightly coloured species*' (JNCC, 2019b).

The occurrence and distribution of MDAC in the North Sea is poorly known (Judd, 2001; 2005). Those that have been identified have been found largely within pockmarks (seabed depressions) formed through the expulsion of shallow gas. These pockmarks are commonly found in the Fladen and Witch Grounds in the northern North Sea as well as part of the Irish Sea (JNCC 2019b). However, it is recognised that MDACs could occur in areas of natural gas seeps where the carbonates are not suitable for pockmarks (Judd, 2005).

There are two designated SACs in the UK sector of the North Sea: The Braemar Pockmarks and Scanner Pockmark. Both sites support a diverse fauna including large numbers of anemones (*Urticina feline* and *Metridium senile*) and fish species. These features also support micro-organisms known as 'chemosynthesizers' which utilise the discharged methane and its by-product, hydrogen sulphide (Judd, 2001).

Although the total extent of Annex I 'Submarine structures made by leaking gases' in UK waters is unknown, reported instances cover less than 100 km^2. The habitat is vulnerable to a number of pressures including fishing, oil and gas activity and marine pollution. Vulnerability to fishing activity is considered to be 'high' whereas vulnerability to other pressures is considered to be 'low' (JNCC, 2013).

2.4.5. Ocean Quahog

The ocean quahog (*Arctica. islandica*) is listed on the OSPAR (2008) 'List of threatened and declining habitats and species' and has subsequently been listed as a species for which Scottish marine protected areas (MPAs) and English/Welsh MCZs may be selected, under UK legislation. Areas known to host *A. islandica* are shown in Figure 2-15.

The growth rate of *A. islandica* is very slow and highly variable. Mature *A. islandica* may reach a size of up to 130 mm and individuals have been estimated to live for up to 400 years. The slow growth and maturation rates of *A. islandica*, its low fecundity and sporadic recruitment suggest vulnerability to impacts by a number of human activities. They are considered to be particularly sensitive to activities that result in physical disturbance or substratum loss, such as by beam trawling, aggregate extraction and seabed engineering projects (OSPAR, 2009b). However, they are considered tolerant of anthropogenic contamination by heavy metals and nutrients and of sediment deoxygenation (Sabatini *et al.*, 2008).

During the Culzean Pipeline Route '2B' survey, juvenile *A. islandica* were recorded at a rate considered to be representative of the wider area (Gardline, 2014b). Juveniles were also present in the Heron cluster and Culzean site surveys (Fugro, 2018; Gardline, 2013a). In the 2018 Shearwater field survey, *A. islandica* were not observed in the seabed photographs or video footage but were recovered from grab samples. Adult specimens were recovered from two stations (station SWA04 approximately 500 m south southwest of Shearwater A and station SWA23 approximately 400 m south southeast of Shearwater A) at 'abundant' level on the SACFOR scale. Juveniles were recovered from all stations at 'abundant' to 'super-abundant' densities with the exception of the reference station where they were 'common' (Fugro, 2019). One adult specimen was observed at Machar (Gardline, 2013b).

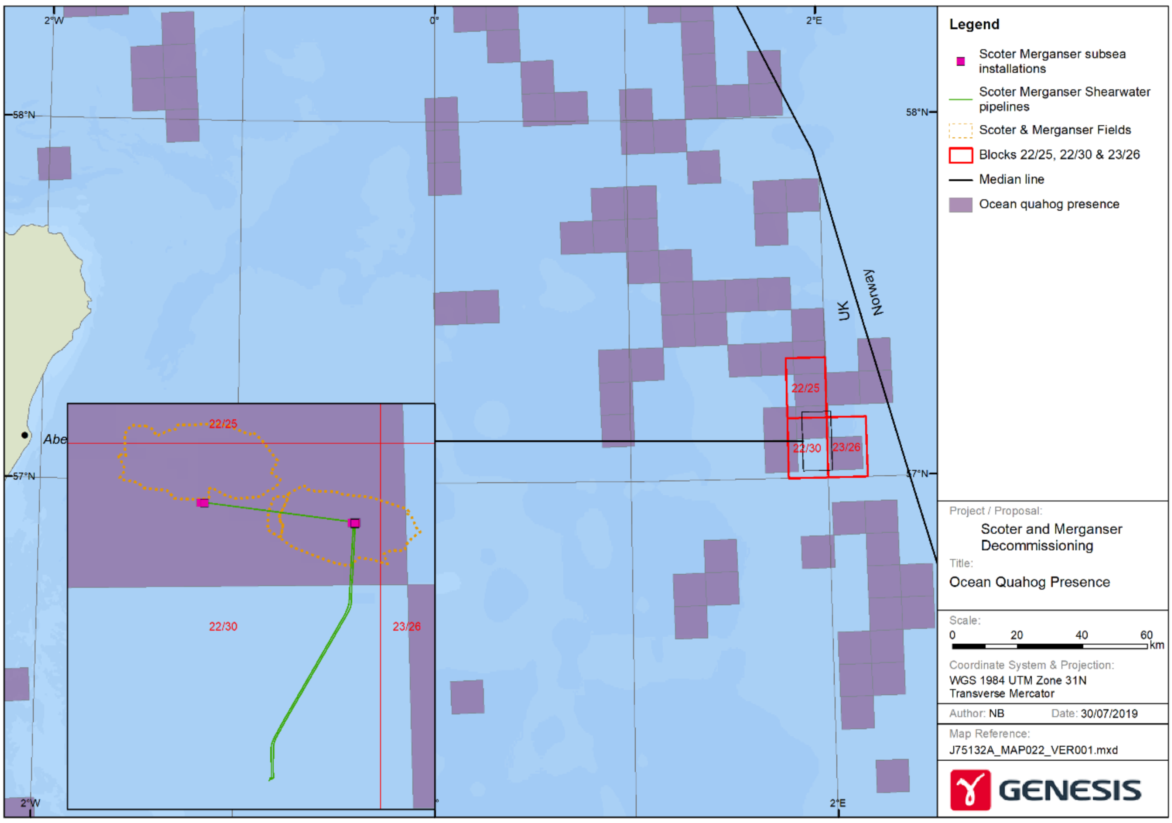

Figure 2-15 Ocean quahog presence in the vicinity of the Scoter and Merganser fields (Defra, 2010).

2.4.6. Sea Pens and Burrowing Megafauna

The PMF 'Offshore deep sea muds' provides a stable environment generally dominated by polychaete worms such as *Levinsenia gracilis*, *Heteromastus filifirmis* and *Paramphinome jeffreysii* (Lancaster *et al*., 2014). In association with this habitat is the biotope 'Sea pen and burrowing megafauna communities' which is on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR, 2008). This biotope comprises plains of fine mud, in water depths ranging from 15 m to 200 m or more, which are 'heavily bioturbated by burrowing megafauna', with 'burrows and mounds forming a prominent feature of the sediment. The burrowing megafauna may include the crustaceans *Nephrops norvegicus*, *Calocaris macandreae* or *Callianassa subterranea* (MarLIN, 2018).

Sea pens and faunal burrows observed in the vicinity of the Scoter and Merganser fields are not considered to occur at high enough densities to constitute the PMF habitat 'Sea pens and burrowing megafauna' or the OSPAR threatened and/or declining habitat 'Sea pens and burrowing megafauna communities'.

2.4.7. Summary of Seabed Sensitivity at Scoter and Merganser

Benthic communities at both Scoter and Merganser are expected to be typical of those in the wider region, generally being consistent with the presence of circalittoral muddy sand and circalittoral sand habitats. In keeping with the wider area, ocean quahog are expected to be present, ostensibly juveniles but with the possibility of adult specimens. There is a low likelihood that these areas include the PMF habitat 'Sea pens and burrowing megafauna'. Submarine Structures Made by Leaking Gases are not expected to be present.

Overall the sensitivity of the seabed has been regarded as Medium throughout the EA.

2.5. Anthropogenic Activity

2.5.1. Commercial Fisheries

ICES divides the north-east Atlantic into a number of rectangles measuring 30 nautical miles (nm) by 30 nm. Each ICES rectangle covers approximately one half of one quadrant i.e. 15 license blocks. The importance of an area to the fishing industry is assessed by measuring the fishing effort which may be defined as the number of days (time) x fleet capacity (tonnage and engine power). It should be noted that fishing activity may not be uniformly distributed over the area of the ICES rectangle.

The Scoter and Merganser fields lie within ICES rectangles 43F1 and 43F2. The pipeline route, Shearwater platform and the infrastructure to be removed lies within ICES rectangle 43F1.

Based on UK annual fishing effort for vessels >10 m the UK annual fishing effort in these ICES rectangles can be considered low. During the five year period from 2015 to 2019, the average fishing effort in rectangle 43F1 was 110 days/year[2]. ICES rectangle 43F1 represents 0.09% of total UK effort over the five year period (Scottish Government, 2021a). Figure 2-16 shows the average fishing intensity between 2015 and 2019. A more detailed breakdown of effort in days within ICES rectangle 43F1 and, more broadly, the UK total from 2015 – 2019 is given in Table 2-8.

It is noted that the value of the area for fishing could potentially be higher if fishermen were to regain access to parts of the sea currently within exclusion zones for other industries, such as oil and gas.

Table 2-8 Annual fishing effort in ICES Rectangle 43F1 (Scottish Government, 2021a).

Year	UK total effort (days)	Effort (days) 43F1	43F1 as % of UK total
2015	120,141	54.8	0.05
2016	126,226	271.7	0.22
2017	120,282	169.7	0.14
2018	118,942	24.2	0.02
2019	120,323	27.8	0.02
Average	121,183	110	0.09

[2] Note this value is based on landing values reported for ICES rectangles within which more than five UK vessels measuring 10 m were active. In those ICES rectangles where <5 vessels were active the information is considered disclosive and is therefore not available.

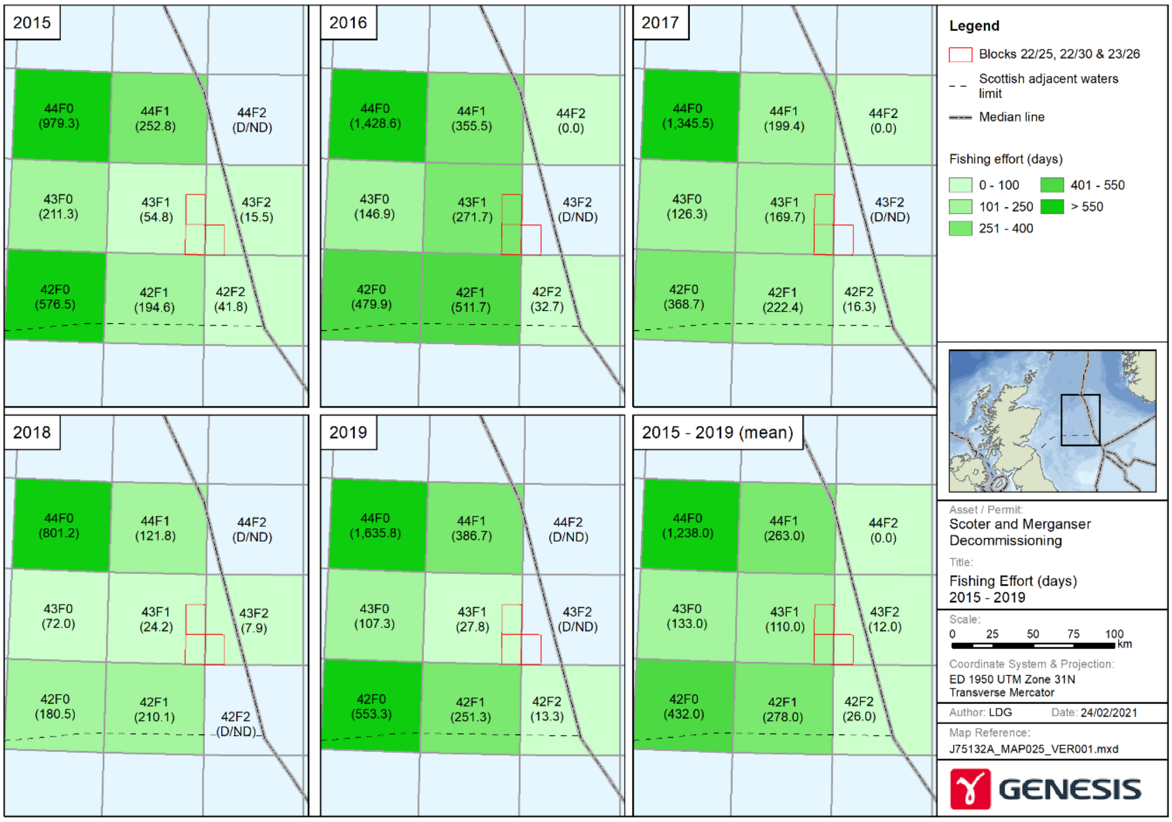

Figure 2-16 Fishing effort in the CNS over a five year period (2015 – 2019) in the vicinity of the Scoter and Merganser fields (Scottish Government, 2021a).

'Within year' fishing effort is detailed in

Table 2-9. The majority of fishing in the area takes place in May, August and September. The majority of data are disclosive and are not available (meaning that fewer than five vessels (>10 m) undertook fishing activity) and there are several months in which no fishing effort took place. Trawls were the main gear type used within ICES rectangle 43F1 between 2015 and 2019 (seine nets are also listed but all data are disclosive) (Scottish Government, 2021a).

Table 2-10 shows the annual landings between 2015 – 2019 of demersal, pelagic and shellfish species in ICES rectangle 43F1. In terms of value, landings from the area were dominated by shellfish species in 2016 and 2017, and for all over years by demersal. Landings are much lower in terms of both value and quantity in 2018. Figure 2-17 shows the five-year averages with demersal species dominating in 43F1 (both in weight and value).

Table 2-9 Within year combined fishing effort for ICES rectangle 43F1 (2015 -2019).

Year	J	F	M	A	M	J	J	A	S	O	N	D
2015	0	D	0	D	D	D	0	D	D	11	5	D
2016	D	D	20	D	59	0	D	D	149	14	0	13
2017	28	0	0	D	D	9	D	115	D	D	D	D
2018	8	D	0	0	D	D	0	D	0	D	0	D
2019	6	D	D	0	D	D	D	D	0	D	0	D
Key	Disclosive data		≤ 20 days		21-30 days		31-40 days		41-50 days		≥ 51 days	

If fewer than five vessels over 10 metres undertook fishing activity in the ICES rectangle the data is considered to be disclosive (D) and therefore not shown.

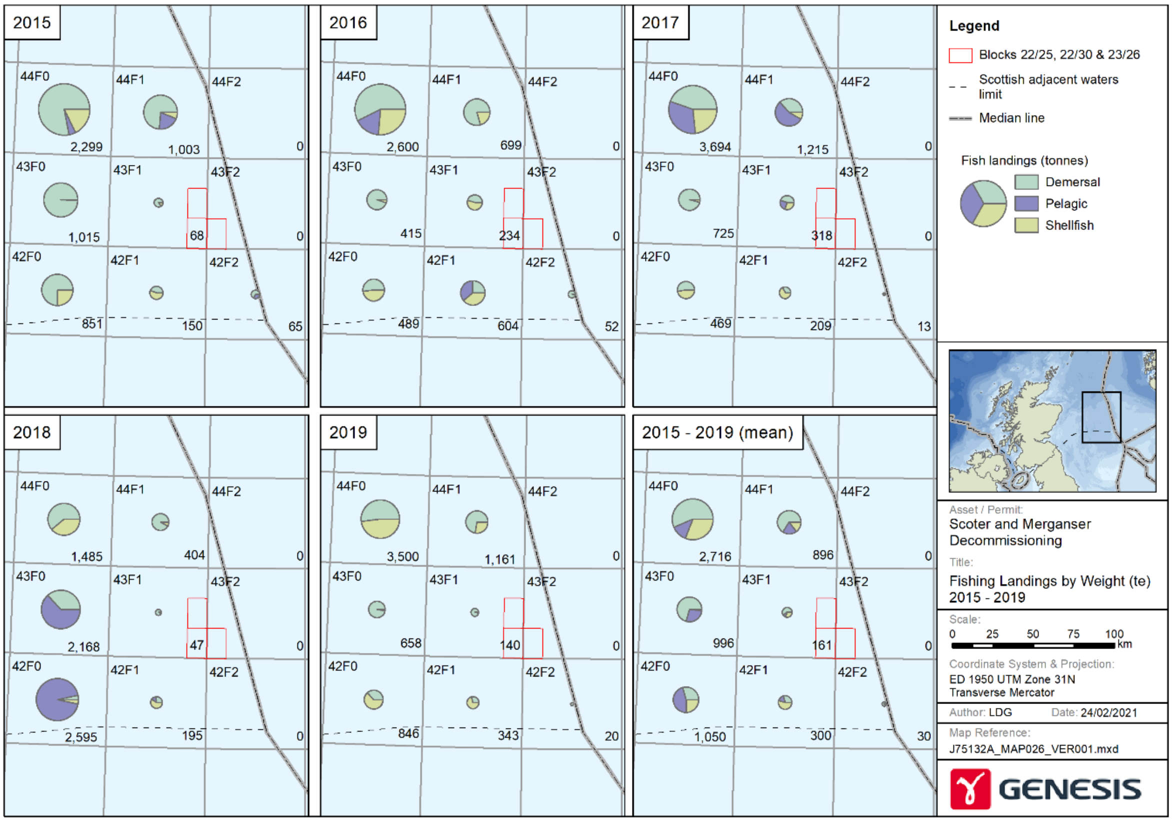

Figure 2-17 UK reported landings by quantity (te) and value (£) in the project area (2015-2019) (Scottish Government, 2021a).

Table 2-10 Fish landings from ICES rectangle 43F1.

Species type	2015		2016		2017		2018		2019	
	Value (£)	Live weight (te)	Value (£)	Live weight (te)	Value (£)	Live weight (te)	Value (£)	Live weight (te)	Value (£)	Live weight (te)
Demersal	64,849	57	136,761	106	183,878	140	56,045	43	149,129	136
Pelagic	369	0.3	967	0.6	33,760	80	90	0.1	70,736	21
Shellfish	42,065	10	528,622	127	409,710	93	21,766	3.7	18,736	4
Total	**107,284**	**68**	**666,349**	**234**	**627,348**	**317**	**77,901**	**47**	**238,601**	**161**

Source: Scottish Government, 2021a

Spatial data layers depicting fishing intensity/pressure (derived from Vessel Monitoring System (VMS)/log book fishing intensity data for vessels >15 m in length; ICES, 2019) show that low intensity fishing using bottom trawls for demersal species (2009-2016) and for *Nephrops* and crustaceans (2009-2017), occurs in the area as shown in Figure 2-18 (Scottish Government, 2021b).

Fishing intensity along the Scoter and Merganser pipelines is identified as having been less than 5 tracks for all fish gear types between 2007 and 2015 (Scottish Government NMPi).

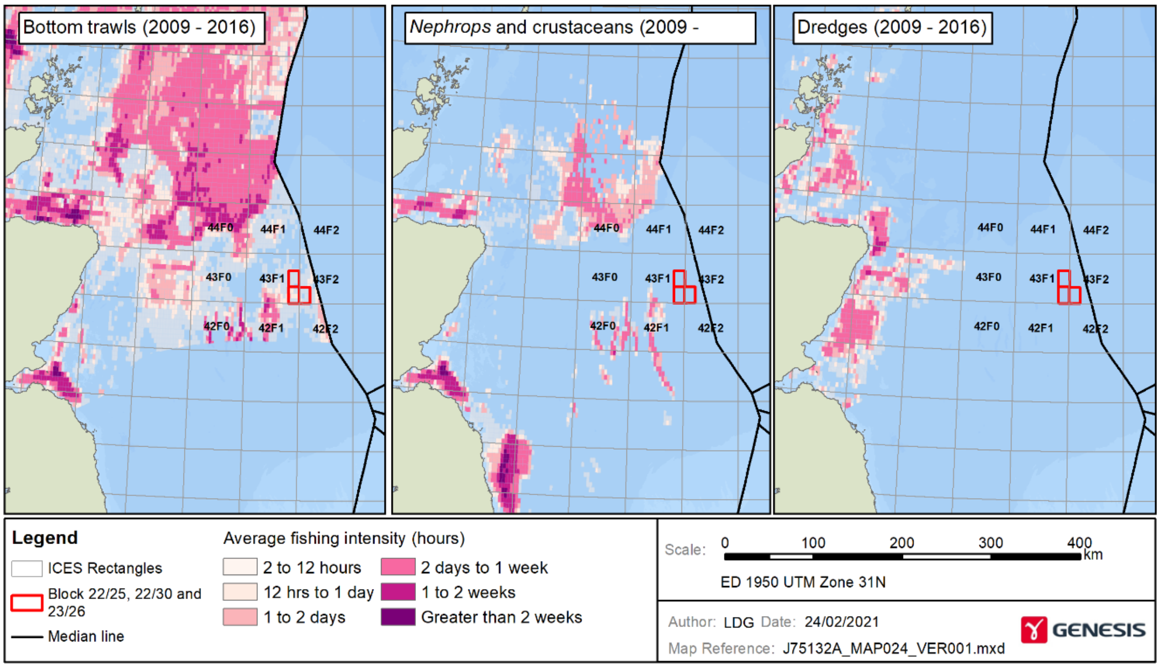

Figure 2-18 Average Fishing Intensity (hours) (Scottish Government NMPi).

2.5.2. Shipping

Shipping density in the UKCS is categorised by the OGA as very low, low, moderate, high or very high. Shipping density is considered to be low in Block 22/25, moderate in Block 22/30, and low in Block 23/26 (OGA, 2019b). Data collated by the Marine Management Organisation (MMO) also show relatively low shipping density in the area (MMO, 2016) (Figure 2-19).

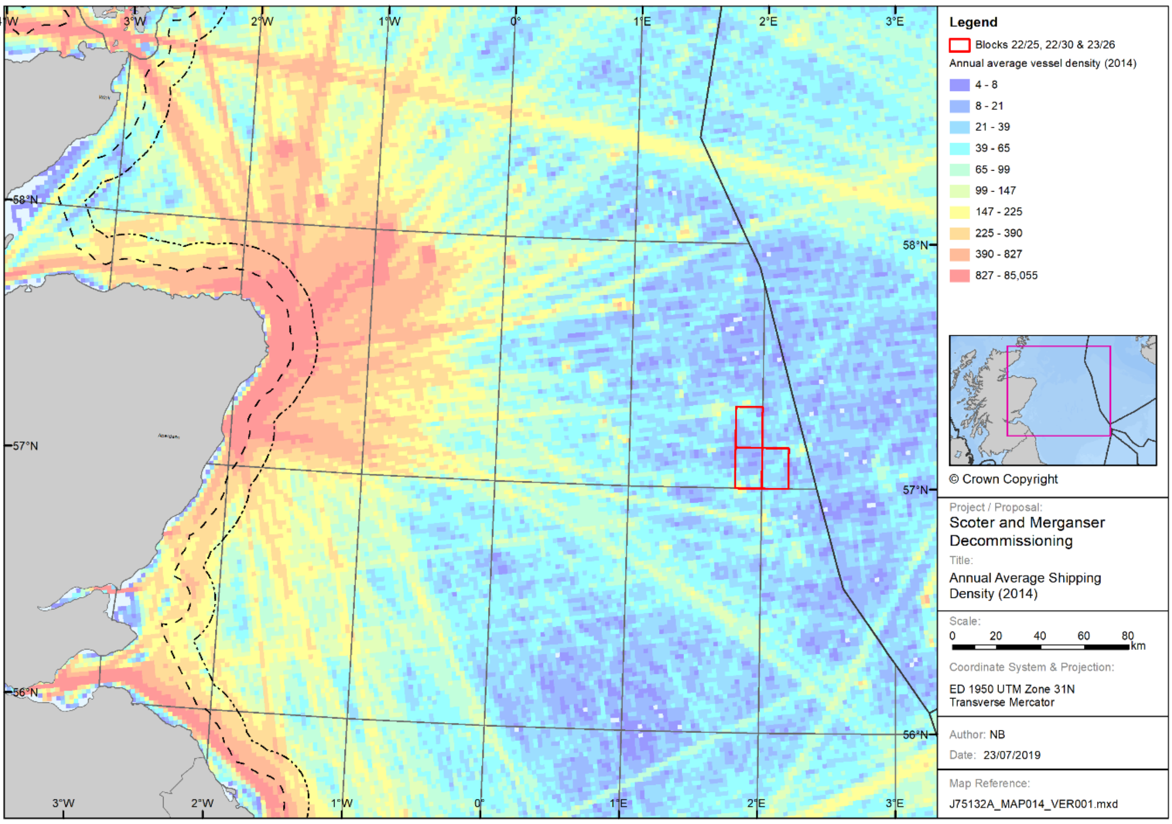

Figure 2-19 Average annual shipping density in 2014 (MMO, 2016).

2.5.3. Other Infrastructure

2.5.3.1. Oil and Gas Infrastructure

The Scoter and Merganser fields are located in a well-established area for oil and gas infrastructure. The closest surface infrastructure is the Culzean platform approximately 4 km north northwest of the Merganser manifold. The Shearwater and Erskine platforms lie approximately 12 km south and 13 km south southeast (respectively) of the Scoter manifold. The Scoter-Shearwater pipeline crosses, and is crossed by, pipelines and umbilicals associated with the Machar to Marnock pipeline. A new 12 inch pipeline connecting Shearwater to the Columbus and Arran fields was installed during 2020 which passes through the Scoter 500 m safety zone and approximately 150 m from the Scoter manifold. These and other structures in the vicinity are shown in Figure 2-20.

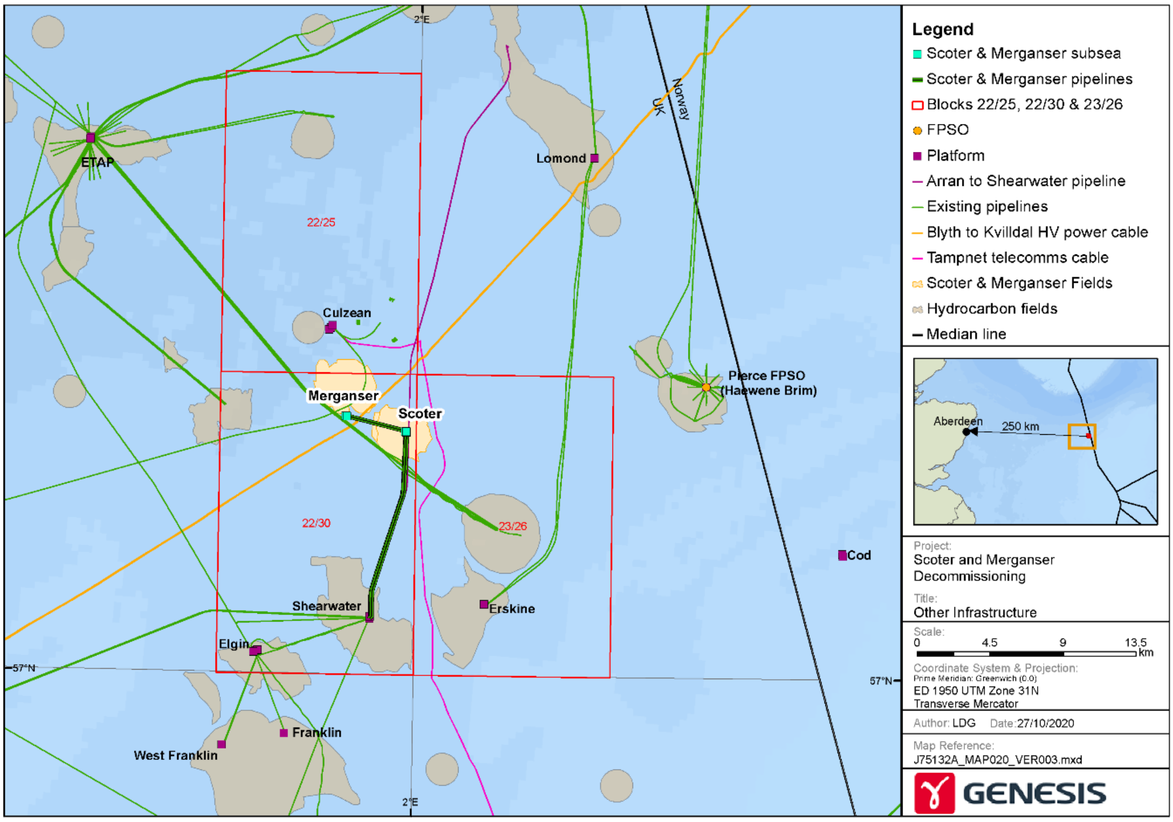

Figure 2-20 Other infrastructure in the vicinity of the Scoter and Merganser fields

2.5.3.2. Renewable Energy Developments

There are no renewable energy developments in close proximity to the Scoter and Merganser fields (Scottish Government, 2021b).

2.5.3.3. Submarine Cables

The cable awareness charts (KIS-ORCA, 2020) show two submarine cables in the vicinity of the Scoter and Merganser fields. The TAMPNET cable passes approximately 2 km to the east of Scoter *en route* to the Culzean field. The Blyth – Kvilldal North Sea Link Interconnector high voltage power cable, constructed in 2019, passes within approximately 600 m of the Merganser manifold.

2.5.3.4. Cultural Heritage

The closest wreck to the Scoter and Merganser infrastructure is approximately 6 km to the east of the pipeline route to Shearwater, just north of the Erskine platform (Scottish Government, 2021b).

2.5.3.5. Military Activities

There are no military exercise areas in the area (Scottish Government, 2021b).

3. Identification of Impacts

3.1. ENVID

Potential environmental impacts of the DP were identified through an ENVID workshop. Attendees to the workshop covered all relevant engineering disciplines and included environmental specialists, the decommissioning manager, operating installation manager and risk management consultant. The workshop was chaired by an environmental specialist with experience of multiple field development and decommissioning environmental assessments in the North Sea.

3.1.1. ENVID Approach

Shell ENVID protocol utilises a standard series of guidewords that has been adapted specifically to the consideration of activities encountered for decommissioning projects. The guidewords are used to prompt a thorough discussion about the specific aspects for the present decommissioning project from which the potential for all environmental impacts are identified and noted.

The severity of each impact is scored through a qualitative risk-based approach utilising matrices which consider the sensitivity of the receptor, the scale of the activity and magnitude of impact. For unplanned or accidental aspects, the likelihood of the event occurring is also incorporated into the overall impact evaluation. The impact ratings were determined on the basis that standard mitigation measures required to meet regulatory permitting requirements, Shell Group practices, Industry best practice and regulatory guidance were implemented. These mitigation measures are included through Section 4 of this report and have been recorded as commitments in the project Environment, Social and Health Management Plan.

The methodology used is presented in Appendix A and the outcome of the workshop is presented in Appendix B.

3.1.2. ENVID Conclusions

3.1.2.1. Planned Activities

The ENVID concluded that the planned decommissioning activities would give rise to no impacts of Major significance.

All planned activities were determined to have minor, slight or no impact on the environment or other users of the sea.

3.1.2.2. Unplanned Events

The DP includes no activities that have High risk to the environment.

Certain scenarios for the accidental loss of fuel from vessels were considered in the ENVID and had risk ratings of Minor or Negligible.

3.2. Impact Assessment Scoping

The output of the ENVID has been used as a scoping tool to identify any aspects for which further environmental impact assessment would be informative and proportionate.

All Minor impacts and risks, or lower, were scoped out from requiring further environmental impact assessment on the grounds that the magnitude of impact does not warrant more quantitative or semi-quantitative study, and that the control measures identified are well established and accepted as means of minimising impacts.

Consequently, due to the particular characteristics of the Scoter and Merganser decommissioning, no aspects or impacts have been scoped for more detailed assessment.

The scoping conclusions were presented to statutory consultees and feedback received as described in Section 1.8.

4. Environmental Assessment

The evaluation of impacts during the ENVID workshop relied on the expert knowledge of the attendees, based on their understanding of the issues and of relevant published sources of information.

For many aspects considered in the ENVID, the type of activity, mechanism of impact, scale and duration of impact are such that the conclusion reached is clear and can be made with a high degree of confidence. For some other aspects, it is recognised that the ENVID output could be overly concise and may not adequately capture the full justification for the conclusions reached. Further detail is provided in this section in support of the ENVID conclusions for these aspects.

The information is organised under standard headings of receptors or sources of impact, rather than the activity nodes used for the ENVID process. The headings used are:

- Natural Capital and Ecosystem Services (NCES)
- Emissions to Air
- Discharges to Sea
- Seabed disturbance
- Underwater Sound
- Socio-economic Effects
- Designated Sites, Protected & Endangered Species

OPRED guidance for decommissioning specifically excludes the expectation for issues of waste management and accidental events to be captured within the EA report. Potential environmental impacts related to these aspects are assessed and actively managed by Shell through standard systems and processes such as waste management planning, Oil Pollution Emergency Planning (OPEP) etc. but, in keeping with OPRED guidance, assessment of these environmental impacts has not been included in the EA.

4.1. Natural Capital and Ecosystem Services

The ENVID identified a number of activities that have the potential to affect the productivity of the area either in terms of fishing activity or in terms of ecological abundance. These were due to:

- The physical presence of vessels and obstacles;
- Changes to the seabed substrate type following disturbance of the seabed; and
- Return of the area around the manifolds for fishing.

Natural capital will also be expended through use of hydrocarbon resource for fuel and quarried material for rock cover.

4.1.1. Physical presence of vessels

Most of the vessel activity will be within the 500 m safety zones of the Scoter and Merganser wells and the Shearwater A platform. As such, their presence will be unlikely to cause an impact on other users of the sea. However, certain activities will be outwith the 500 m safety zone including areas of the pipeline crossings needing additional rock cover. These activities have the potential to cause a short term interruption of fishing activities but are expected to have negligible impact on fishing productivity as a whole due to their short duration and very limited extent.

4.1.2. Disturbance of the seabed

The disturbance of the seabed is assessed under Section 4.2.

4.1.3. Scoter and Merganser safety zones

Following decommissioning, the 500 m safety zones around the Scoter and Merganser wells will remain in place until the wells have been P&MS. After P&MS the safety zones will no longer exist and the area will be once more available for fishing. This will offset any lost fishing productivity due to rock cover laid during decommissioning.

4.1.4. Materials use

The two natural resources to be consumed in the decommissioning activities will be fuel and rock. While both of these resources are finite, and incur a financial cost, they are extensively abundant and their use in the decommissioning works will not impact their availability.

4.1.5. Controls for the Management of Impacts to NCES

The following mitigation measures, safeguards and controls are proposed to minimise the potential for the Scoter and Merganser decommissioning to erode natural capital and interrupt ecosystem services.

MITIGATION MEASURES, SAFEGUARDS AND CONTROLS

- Adoption of a clear seabed policy*;
- Optimisation of vessel use to minimise disturbance to other users of the sea;
- Minimise disturbance to the seabed (see Section 4.2.8).

*Except at pipeline crossings and transition points, where burial is not feasible.

The appraisal of impacts on NCES due to the decommissioning activities supports the conclusion that impacts will be minimal, and constrained to a level that is as low as reasonably and safely practical by adoption of the control measures specified.

4.2. Seabed Disturbance

The following activities will cause disturbance of the seabed:

- Removal of subsea infrastructure; and
- Laying additional rock cover.

It is also possible that overtrawl trials may be required to confirm the seabed is left safe for other users of the sea. Whereas the base case will be to use non-intrusive survey methods, in accordance with OPRED's policy requirement, at the time of writing this EA there have been no precedents whereby a clear seabed certificate has been awarded solely on the basis of non-intrusive survey methods. The EA has therefore included consideration of the impacts from overtrawl trials as a worst case.

Some of these activities would cause temporary impacts, while others (such as rock cover) would result in lasting localised effects. These are discussed below in the following subsections.

The seabed at Scoter and Merganser is described in Section 2.2 as comprising sediment types that are generally typical of the wider CNS area, though supporting habitats identified as 'endangered' by OSPAR, and with sensitive marine features (e.g. *A. islandica*) present.

There will be no disturbance of the seabed in the area of MDAC described in Section 2.2.9.

4.2.1. Seabed Recovery

Following disturbance of soft habitats during removal of subsea infrastructure, it is anticipated that the affected seabed would be recolonised by benthic fauna typical of the area. This will occur as a result of natural settlement by larvae and plankton and through the migration of motile animals from adjacent undisturbed benthic communities (Dernie *et al.*, 2003; Hiddink *et al.*, 2017).

The six Arran survey stations were classified as fine sand and contained 13.3. and 16.6 % fines (silt and clay), between 0.1 and 5.5 % gravel (Gardline, 2015) and were classified as EUNIS biotope 'Deep circalittoral sand' (A5.27) (Gardline, 2016). The Shearwater survey stations were dominated by poorly sorted fine to very fine sand with 15 to 20 % silt with most of the stations having <1 % gravel apart from SWA02 and SWA20 with 3.23 and 1.19 % gravel respectively (Fugro, 2019). The Shearwater monitoring survey area comprised fine sediments of muddy sand with shell fragments classified as EUNIS biotope complex 'Circalittoral muddy sand' (A5.26) (Fugro, 2019).

Recovery times for soft sediment faunal communities are difficult to predict, although studies have attempted to quantify timescales. From studies of the impact of dredging on seabed habitats, de Groot (1979, 1986) reported recovery of sandy sediments following within approximately 3 years. Benthic communities are observed to recover at rates similar to physical restoration (Kraus and Carter, 2018). An area of benthos that has been disturbed will initially be recolonised by opportunistic species. These consist of large populations of organisms that have a high development rate, such as small sedentary tube dwelling deposit feeders. Eventually the area is invaded by a variety of species that have a slower recruitment and growth rate which results in a decline in the population density but increase in diversity. Early colonisers are eventually replaced by more mature communities creating stable climax communities (Rosenberg *et al.*, 2002).

The Minerals Management Service (MMS) (1999) quotes various sources and reports that recolonisation takes 1-3 years in areas of strong currents but up to 5-10 years in areas of low current velocity. A later study (Kraus and Carter, 2018) corroborates the finding that restoration is fastest in high energy environments with high sediment supply and slowest in lower energy environments further from terrestrial sediment inputs. It compiles 12 case studies of subsea power cables that were surveyed at varying intervals after installation. In shallow inner continental shelf waters up to 30 m (not including sensitive nearshore habitats such as seagrass beds) recovery could be seen within a year but in deeper outer continental shelf – continental slope environments (approximately 80 to >130 m water depth) characterised by mud or sandy mud, full recovery could take more than 15 years. Longer recovery times are also reported for sands and gravels where an initial recovery phase in the first 12 months is followed by a period of several years before pre-extraction population structure is attained (MMS, 1999). Communities on gravel may be more sensitive because they generally have a larger proportion of longer living species with lower reproduction rates that take longer to recover (Hiddink *et al.*, 2017). Fine sediments such as sands, as found at the pipeline location, tend to recover much more quickly than the biologically controlled communities which characterise coarse deposits.

The rate of recovery has also been found to be fastest in unconsolidated deposits such as muds and sand; these are colonised by opportunistic species that are well adapted to rapid recolonisation and growth following episodic mortality. In contrast, more consolidated and coarser deposits are colonised by a wide variety of slow growing 'equilibrium' species that may take several years for recolonisation following disturbance. In general, a period of 2-3 years has been commonly recorded for restoration of species composition and benthic biomass in sands and gravels that are exploited by the marine aggregates industry in the U.K (Hitchcock *et al.*, 1998; Newell *et al.*, 1998).

Figure 4-1 has been proposed by Newell *et al* (1998) to show typical succession of benthic communities following heavy disturbance and indicating likely recovery times for benthic communities in estuarine muds, sands and reef areas based on their research and data reviews.

Recovery of the benthic communities also depends on the spatial and temporal scale of the disturbance. In their metaanalysis of the impacts of trawl gear on benthic communities, Hiddink *et al.*, 2017 found that more frequently trawled areas take longer to recover and that proximity to less impacted areas, from which individuals can migrate, also speeds up the recovery process. Given the short duration and small areas of seabed impacted by decommissioning operations, recovery can be expected to occur more quickly than it does in the case of wider ranging and longer term disturbance.

At Scoter and Merganser, the substrate is of circalittoral muddy sand or circalittoral sand, for which the available information indicates an ecological recovery period of between 1 and 3 years could be expected for natural habitats disturbed during the decommissioning activities.

Placement of rock over previously uncovered seabed would lead to permanent habitat change, as discussed in Section 4.2.3.

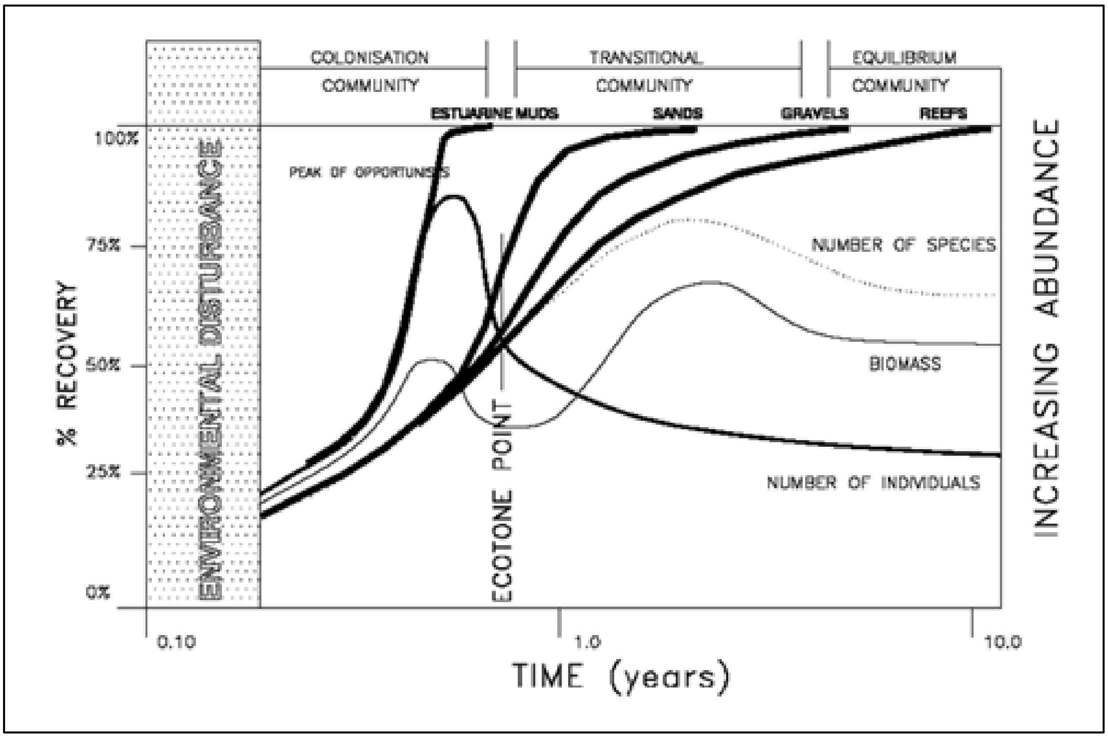

Figure 4-1 Schematic time series diagram showing a colonisation succession in a marine environment (from Newell *et al.,* 1998).

4.2.2. Removal of subsea infrastructure

4.2.2.1. Manifolds

Some localised disturbance of sediments will occur as a result of the removal of the Scoter and Merganser manifolds and the SMES. These are each fixed with steel piles at each corner of the structure. Piles are planned to be cut internally and some sediment will be disturbed over a small area as the upper, cut section of the piles are pulled out, and the structure itself is removed from the seabed. The combined seabed footprint of the three structures is 172 m^2.

As a worst case, if all piles needed external cutting, a total volume of approximately 4,700 m^3 of material could need to be excavated to enable access for the cutting tool, with a combined footprint of approximately 1,300 m^2.

The sediments will disperse due to the action of currents before resettling over the nearby surrounding seabed, with the potential to cause some burial of benthic fauna.

For internal cutting of the steel piles, impact from resettling sediments is anticipated to be within 1 m of the footprint of the structure at worst. This would present a total impacted area of 272 m^2.

Impacts from the removal of the manifolds will be localised and of small effect.

Following removal, the re-exposed sediments within the footprint of the structures will be readily recolonised

4.2.2.2. Stabilisation Features

A total of approximately 330 exposed concrete mattresses and approximately 6,000 grout bags will be removed from the Merganser field, Scoter field, pipeline crossings and at the approaches to Shearwater A and Shearwater C platforms. Mattresses are 3 m by 6 m and, as a realistic worst case, it is assumed that disturbance will extend to within 1 m surrounding each mattress. Removal of the mattresses will cause disturbance to approximately 9,900 m^2 of seabed resulting in a short-lived small scale effect on biota in the immediate vicinity. Removal of the grout bags may add approximately 10% to the area disturbed. The removals will cause disturbance and possible mortality of fauna that have colonised these features during field operation. Their removal will re-expose the natural substrate beneath them which will be quickly recolonised by the surrounding benthic communities.

4.2.2.3. Remediation of Pipeline Ends

Following disconnection, the exposed sections of pipelines and umbilicals (i.e. surface laid and transitions) will be buried to a minimum depth of 0.6 m. This may typically be undertaken with a mass flow excavator, with a trenching corridor width of 2 m. Remediation of a total of eight ends (four for the umbilical and two each for the Scoter and the Merganser production pipelines) will result in the disturbance of approximately 1,600 m^2 of seabed in total.

Mass flow excavation fluidises the sediment around the pipeline causing it to sink below the seabed, with the majority of the disturbed sediment remaining within the trenching corridor. There will nevertheless be suspension of some sediment during this operation, which will disperse before resettling over the nearby surrounding seabed. Impacts to marine fauna will be localised and of short duration.

4.2.2.4. Jumpers and Connection Spools

Surface laid connection spools (714 m in total) and umbilical jumpers (680 m in total) at both fields are protected by the mattresses and grout bags considered in Section 4.2.2.2. Seabed disturbance from their removal is not double accounted for here.

4.2.2.5. Scoter Riser Tie-in Spool

The riser spool was protected by 19 concrete mattresses which have now been recovered to expose the spool prior to its removal. It is anticipated that sediments will have settled on the mattresses, some of which could include contamination from the Shearwater drill cuttings pile. Any contaminated sediment that was resuspended during recovery of the mattresses will have resettled, following dispersion, in the surrounding area. This had the potential to cause a minor, short term increase in contaminant levels in the water column. It is unlikely that this will have lead to increased contamination levels in surrounding sediments since these will have been subjected to the same inputs as the sediments deposited on the spool mattresses. Resuspension may also lead to increased biodegradation of any hydrocarbon contaminants.

4.2.2.6. Wellhead structures

Each wellhead structure will be internally cut and removed following P&MS. Wellhead structures are 4 m by 4 m and, as a realistic worst case, it is assumed that disturbance will extend to within 1 m surrounding each wellhead structure. Removal will consequently disturb approximately 36 m^2 of seabed area, or 180 m^2 in total.

4.2.3. Rock Cover

Rock cover has previously been laid at pipeline crossing points and along some sections of the export pipeline to increase burial depth. These will remain in place and may need to be added to to ensure long term protection against snagging, depending on the outcome of post-decommissioning surveys and subsequent consultations. Areas where additional rock cover will or may be required include:

- At the Marnock to Machar pipeline crossings, rock will be placed over the Scoter umbilical to provide a continuous berm;
- At the upstream termination points of the export pipelines and umbilicals existing concrete mattresses will be recovered and new rock cover will be laid at the pipeline ends following burial ; and
- Along some additional sections of the export pipeline, though this is likely to be very limited, if any.

Depending on the mobility of sediments at any location where rock cover may be required, relatively coarse rock material may be needed to provide effective long-term cover. Coarse rock cover can increase the risk of trawl gear snagging, to avoid which it may be necessary to profile the coarser rock with smaller material, increasing the overall area impacted.

Where rock cover is applied to previously unaltered seabed it causes a significant and permanent change to the substrate which in turn alters the habitat and ecology, creating preferential areas for benthic organisms that live on hard substrates at the expense of the native, soft substrate ecosystem. This can result in artificially increased local diversity of habitat and fauna.

Addition of new rock cover to areas of existing rock cover, or areas that were previously covered by concrete mattresses, does not alter the habitat type, though may cause morbidity of fauna that has colonised the artificial materials over the field operating period. This practice generally increases the overall footprint of the previously affected area.

Areas of rock cover required for the DP will not be fully known until after analysis of the post-decommissioning survey but is expected to be limited to localised points or stretches that, combined, would represent an insignificant proportion of a widespread region of fairly uniform seabed habitat. An estimate of the quantities that may be deployed, and the seabed footprint they would cover is provided below. The scale of the activity will be optimised to leave a seabed that is safe for other marine users, notably fisheries, while minimising the amount of rock used.

Where rock cover is required, the rock mass will be carefully placed over the designated areas of the pipelines and seabed by Remotely Operated Vehicle (ROV) and/or a controlled fall pipe, equipped with cameras, profilers, pipe tracker and other sensors as required. This will control the profile of the rock covering, thus ensuring rock is only placed within the planned footprint with minimal spread over adjacent sediment, minimising seabed disturbance.

At the pipeline crossings, mattresses over the umbilical will be removed and rock cover will be applied to fill in the gaps between sections already covered by rock, to create a single continuous berm. The rock cover will be 5.3 m wide, based on an umbilical diameter of 0.117 m, depth of cover of 0.6 m, a 1:3 profile and 1 m wide flat top. The infill areas are currently protected by concrete mattresses over a combined length of 168 m. Rock will therefore be placed over 890 m^2. The mattresses are 3 m wide, so 504 m^2 of this rock would cover the area already disturbed by the presence and removal of mattresses and the remaining 386 m^2 would cover what is currently natural habitat. A total of *c.* 540 m^3 (*c.* 1,400 te) of rock would therefore be needed.

At the pipeline and umbilical transitions (from above to below surface), spot rock cover may be provided to make the cut ends safe. There are two such points at Merganser and four at Scoter. If employed, each will typically require approximately 10 te of rock (*c.* 3.85 m^3), and cover *c.* 16 m^2 of seabed, much of which will cover sediment previously trenched or covered by concrete mattresses. At the time of Shearwater decommissioning the pipeline and umbilical ends may also be protected in this way.

In total up to 986 m^2 (504 + 386 + 6 * 16) of seabed may be covered by approximately 1,460 te of rock.

4.2.4. Anchor Scars and Spud Cans

There is no evidence from bathymetry survey data to indicate any significant depressions (natural or man-made) at either field and, consequently, there is no anticipated requirement for the use of rock cover to reprofile the seabed topography to make it safe for fishermen.

Seabed surveys will be undertaken following removal of subsea infrastructure to determine whether any depressions could pose a risk of snagging. A FishSAFE span is defined as a span >10 m long and >0.8 m high which presents a snagging risk to fishing gear such that the location of the span should be included on the FishSAFE system. It is anticipated that this will form the basis for agreement between BEIS and SFF on whether additional assurance measures are required to support issue of a safe seabed certificate.

If the clear seabed surveys find that depressions within the 500 m safety zone (such as anchor scars or spud cans) present a risk to trawl gear, attempts will first be made to smooth out the profile of these features with dragged chain matts. If this approach does not adequately reduce the risk of future snagging, rock cover will be applied to make the seabed safe. Where feasible, any such rock cover will infill the depressions to a level approximately 0.5 m below the surrounding seabed level.

This will allow subsequent natural infill with fine sediments over time, thereby recreating a more natural habitat than if rock were filled to seabed level.

As noted in Section 4.2.3, rock cover has a lasting impact on the habitat and ecology of the seabed where it is laid. Should any rock cover be required for reprofiling, the affected area would be of very limited extent and the severity of the impact assessed to be slight.

4.2.5. Overtrawl trials

Following recovery of subsea infrastructure and debris the seabed will be subjected to debris sweeps and surveys to confirm that the seabed is clear and safe for fishing. Surveys may include video, side scan sonar or similar.

If the survey results identify areas where there are specific safety concerns, such as at pipeline ends and/or extensive seabed disturbance resulting from decommissioning operations, it may be necessary to supplement the surveys with overtrawl trials to demonstrate the seabed is left in a safe state. This is typically undertaken by fishermen firstly using chain mats and, if this shows no adverse issues it is followed by trawls using standard bottom towed fishing gear.

The relatively small scale of the Scoter and Merganser facilities are not expected to have attracted significant debris over the field life. The decommissioning works are not expected to give rise to extensive seabed disturbance resulting in severe changes in topography. The need for overtrawls is consequently of low likelihood. Should there be a requirement for overtrawl trials, the sweep plan to be used will be optimised to target the minimum area deemed at risk by the non-intrusive survey methods.

As a worst case, if the entire 500 m safety zone at one of the fields was to be overtrawled this would result in a total area of 2.6 km^2 being impacted, when allowing for vessel turning circles and for trawling in both a north-south and an east-west direction. If both safety zones required overtrawling this total would be doubled.

Disturbance of the seabed is also inherent in ongoing seabed fishing activities and temporary disturbance to the seabed sediments will occur during these operations. Collie *et al.* (2000) examined impacts on benthic communities from bottom towed fishing gear and concluded that, in general, sandy sediment communities were able to recover rapidly, although this was dependent upon the spatial scale of the impact. It was estimated that recovery from a small scale impact, such as a fishing trawl, could occur within about 100 days.

Use of chain mats would result in greater sediment disturbance than fishing gear and the recovery time may therefore be longer. Whereas it is not possible to quantify the magnitude of the impact resulting from chain mat overtrawls, the impact is qualitatively considered to be of Minor significance when taking consideration of the relatively low sensitivity of the seabed habitat and the spatial extent and duration of impact.

Scoter and Merganser, with finer sandy sediments, are not thought to be preferential spawning ground for sandeel or cod and so impacts to these potentially vulnerable species is not expected to be significant. Even so, should overtrawl trials be required fishermen contracted to undertake these will be informed of the spawning times of these species (January – April for cod, November – February for sandeels), though no formal constraints on the timing of the trials is considered to be necessary.

4.2.6. Impact of Seabed Habitat Disturbance

A summary of the area of seabed that could be disturbed by the decommissioning activities is presented in Table 4-1. The total areas disturbed for each activity has been separated into areas that are currently covered by existing infrastructure and that which is currently uncovered and assumed to be natural habitat. For example, rock cover may be placed over 504 m^2 of seabed that is currently covered by mattresses, which will be removed. Rock cover may also be placed over 482 m^2 of seabed that is currently exposed and assumed to be natural habitat. In combination rock cover may be deployed over 986 m^2 as part of the decommissioning works. The table does not record the extent of any existing rock cover that will remain *in situ*.

Table 4-1: Areas of seabed disturbed according to activity

	Area of disturbance		
Activity causing disturbance	**Seabed Currently Covered (m^2)**	**Natural Habitat (m^2)**	**Total (m^2)**
Rock Cover	504	482	986
Stabilisation features removal[1] (assumes 330 mattresses removed)	5,940	4,950	10,890
Subsea equipment removal[1] (includes manifolds, SMES and five well heads)	252	196	448
Overtrawl (Base case is for zero coverage, areas given for worst case)	6,192	5,193,808	5,200,000

Note 1: Area of natural habitat disturbance assumed to be due to resettlement of suspended sediment up to 1 m around the structures.

Approximately 482 m^2 of currently natural seabed habitat could be permanently altered due to coverage with rock.

Assuming no overtrawl trials are required, a total of approximately 5,146 m^2 of currently natural seabed habitat could be temporarily impacted by coverage of resettled sediments that have been suspended due to the lifting of subsea equipment and mattresses.

Approximately 6,192 m^2 of seabed currently covered by equipment and mattresses will be uncovered. These combined 11,338 m^2 of seabed are expected to recover to a near natural state within a short period.

The area that will remain under rock cover (986 m^2) is significantly less than the area that will be exposed by removal of materials currently covering the seabed (*c.* 6,192 m^2). Following recovery of these areas, this will give rise to a net increase in habitat.

The impacted area equivalent to approximately 1.2 hectares constitutes a very small proportion of the much wider area of the same habitat type spreading at least between the Scoter and merganser fields south to Shearwater. Coupled with the temporary duration of impact, and with the short term recovery for the vast majority of the seabed affected, the severity of impact, assessed as Low at the scoping stage of the EA, is confirmed as an appropriate assessment.

Should overtrawl trials be required, a total area of up to 2.6 km^2 could be disturbed for each 500 m safety zone, with recovery anticipated to be between 1 and 3 years. As stated in Section 4.2.5, this activity is considered to present an impact of Minor significance.

4.2.7. Impacts to Sensitive Species and Habitats

Sensitive sediment habitats, listed as endangered by OSPAR, are noted to be prevalent in nearby surveys. As noted above, the areas of sediment that will be disturbed by the decommissioning activities are currently overlain with equipment. Removal of the equipment will result in a short term disturbance, after which the habitats will be able to become restored to their natural state.

Small areas where rock cover is required may impact on *A. islandica*. Surveys discussed in Section 2.1 identified juvenile *A. islandica* at densities considered to be representative of the wider region. A small number of adult *A. islandica* were noted at Shearwater and Machar (see Section 2.3.2) and it is therefore plausible that some adults could be at locations that require rock cover.

Whereas some disturbance or smothering of *A. islandica* individuals may occur during decommissioning of Scoter and Merganser, this will have minimal effect of the local population due to the very limited areas over which the seabed will be disturbed.

The Annex I habitat 'Submarine structures made by leaking gases' with MDAC was identified approximately 2 km from the Merganser manifold and the decommissioning activities are therefore not considered to have any impact on this habitat.

4.2.8. Controls for the Management of Impacts to Seabed Disturbance

The following mitigation measures, safeguards and controls are proposed to minimise the disturbance of the seabed from the Scoter and Merganser decommissioning.

MITIGATION MEASURES, SAFEGUARDS AND CONTROLS

- Preference for internal cutting of piles to minimise excavation;
- The extent of rock cover to be deployed will be minimised while ensuring the seabed is left safe for other users of the sea;
- Preference for non-intrusive methods for demonstration of safe seabed.

The appraisal of the disturbance of the seabed due to the decommissioning activities supports the conclusion that impacts will be minor, and that adoption of the control measures specified will ensure disturbance will be as low as reasonably and safely practical.

4.3. Emissions to Air

The decommissioning activities will give rise to emissions of a range of gaseous combustion products including carbon dioxide (CO_2), sulphur dioxide (SO_2), and oxides of nitrogen (NOx) as well as trace quantities of unburned hydrocarbons, including methane (CH_4), and others collectively classed as volatile organic carbons (VOC). Emissions of SO_2, NOx, CH_4 and VOC reduce air quality locally, including through contributing to low level ozone concentrations. Emissions of SO_2 and NOx lead to formation of respective acids, contributing to acid rain on a regional scale. Emissions of CO_2 and CH_4 both contribute to global greenhouse gas (GHG) emissions, and ultimately to climate change.

Offshore emissions to air will be due to vessels' propulsion, their onboard services demand, and from driving of pigging, flushing, cutting and lifting equipment.

As noted in Section 2.5.2, vessel density in the area around the Shearwater platform was categorised as Moderate in 2016 by the OGA and as Low at the Scoter and Merganser fields.

The DP is estimated to require in the order of 109 vessel days in total, with these segregated into distinct campaigns for the preparatory works, subsea equipment recovery and post-decommissioning surveys occurring at separate times. For each campaign the vessels required will make a small incremental addition to the shipping baseline density in the area. During the flushing and disconnection works, the majority of vessel activity was split between the Shearwater platforms and the Scoter and Merganser fields. For the subsequent removals works, vessel activity will be focussed on the fields alone.

Emissions of SO_2, NOx and VOC will contribute to reduced air quality in the vicinity of the vessels' locations. The activities will be of localised extent, of relatively short duration and will take place a significant distance (*c.* 100 km) from the nearest coastline. In general, prevailing metocean conditions would be expected to lead to the rapid dispersion and dilution of the emissions resulting in localised and short term impacts on air quality, typical of general shipping.

Contribution to global GHG emissions is independent of the location of emissions. Experience to date has shown that even for very substantive field-wide decommissioning programmes (e.g. Murchison, CNR International 2013), the principal atmospheric emissions by mass of CO_2 associated with the DP is very small (<1%) relative to the total annual CO_2 emissions from operational and production related emissions on the UKCS. For smaller scale decommissioning programmes, more similar to that for Scoter and Merganser, GHG emissions are substantially smaller, with estimates of 0.08 – 0.2 % contribution to annual UKCS domestic shipping commonly reported for the duration of the programme (e.g. Ettrick & Blackbird, Nexen 2016; Janice, James & Affleck, Maersk 2016; Atlantic & Cromarty, BG 2016; Annabel & Audrey, Centrica 2017). In all precedent decommissioning projects referenced, the impact of emissions to air was assessed to be low. This is also valid for the Scoter Merganser decommissioning. Fuel usage rates for different vessel types undertaking different activities (in port, in transit, in operation and on stand by for bad weather) are provided by the Institute of Petroleum (2000) and have been applied to the anticipated vessel usage for these decommissioning activities presented in Table 1-4 to derive a total fuel usage of 1,674 te. This is anticipated to give rise to approximately 5,500 te of CO_2e based on EEMS emissions factors for vessel engines (EEMS, 2008) and Global Warming Potential (GWP) values for methane and nitrous oxide published by the Intergovernmental Panel on Climate Change (IPCC, 2007). This represents <0.1% of total UK shipping emissions for 2018 (5.9 MteCO_2e) reported by BEIS (2020).

4.3.1. Controls for the Management of Impacts from Atmospheric Emissions

The following mitigation measures, safeguards and controls are proposed to minimise the emissions to air associated with the Scoter and Merganser decommissioning.

MITIGATION MEASURES, SAFEGUARDS AND CONTROLS

- All vessels employed for the decommissioning will meet the requirements of Shell's Group Marine Assurance System (GMAS)[1]; and
- The scheduling of vessels' operations and types of vessels used will be optimised to execute the decommissioning as efficiently as possible.

Note 1: Shell's GMAS adopts and expands on the Oil Companies International Marine Forum (OCIMF) vessel inspection (OVIQ2) and review of the Maritime Contractor Offshore Vessel Managers Self-Assessment (OVMSA). The review includes (*inter alia*) consideration of reliability and maintenance standards, navigational safety, emergency preparedness and contingency planning and compliance with the International Convention for the Prevention of Pollution from Ships (MARPOL) and International Maritime Organization (IMO) standards for sewage discharge, garbage management, ballast water management and emissions controls.

Shell is adopting a flexible approach to the timing of the removal works to allow decommissioning contractors the opportunity to maximise efficient utilisation of vessels. Shell is also investigating the potential to bundle the decommissioning of Scoter and Merganser with that of other assets to achieve additional vessel efficiencies. These measures have the potential to further minimise the emissions resulting from the decommissioning activities.

The appraisal of the atmospheric emissions from the decommissioning activities supports the conclusion that emissions will have a minor impact, while adoption of the control measures specified will ensure emissions are kept as low as reasonably practical.

4.4. Discharges to Sea

The DP activities will result in a small number of minor sources of planned discharges to sea. These are:

- Vessels' sanitary drainage;
- Vessels' ballast water;
- Abrasive cutting compounds;
- Inhibited seawater and residual hydrocarbons and chemicals within spools, manifolds and risers; and
- Inhibited seawater and residual hydrocarbons and chemicals following ultimate degradation of the pipelines.

4.4.1. Flushing operations

Prior to disconnection, the subsea equipment, pipelines and umbilical cores were flushed as described in Section 1.5.

The flushing operations gave rise to no discharges to sea.

Following completion of the flushing works, the subsea equipment, pipelines and umbilicals now remain filled with inhibited seawater. Discharges of these fluids are covered in Section 4.4.4 and Section 4.4.5.

4.4.2. Vessels' discharges

Discharges of vessels' sanitary waters and ballast water are subject to specific requirements under MARPOL (Annex IV) and the International Convention on the Control and Management of Ship's Ballast Water and Sediments. These minimise the potential impact on the water column from shipping activities. All vessels contracted for the DP activities will comply with these requirements, confirmation of which forms part of Shell's GMAS (see Section 4.3.1).

4.4.3. Abrasive cutting compounds

Cutting of the manifold piles will involve the release of ground garnet (a natural mineral) used as an abrasive agent, and of metal shavings inside the cylindrical steel pile. When the piles are removed some of this material may be released into the water column along with sediments. The piles will be cut 3 m below seabed level and so the majority of cutting shavings etc. will remain below seabed and become buried by sediment as the residual hole collapses.

Connection spools may be cut into sections for recovery. This is most likely to be achieved with hydraulic shears, though there is a possibility that abrasive cutting techniques could be used resulting in discharges of abrasive agent and metal shavings.

The discharges will result in suspended solids in the water column which will eventually settle out. Suspended solids have the potential to cause physical stress to organisms within the water column.

The activities, and any associated impact, will be short lived and localised.

4.4.4. Discharge from spools, manifolds and risers

At the time of their disconnection as part of the preliminary works, production spools connecting manifolds to wells contained methanol which was released to the water column under licence under the Offshore Chemicals Regulations (2002) (as amended). Methanol is listed by the OSPAR commission as a substance considered to Pose Little or No Risk (PLONOR) to the environment, and consequently no impact is anticipated due to this release.

Disconnection of the Scoter production riser spool resulted in the contents of the spool and riser to be released to sea. This discharge consisted of inhibited seawater containing whatever traces of oil remained following flushing. This discharge was licensed under the Offshore Petroleum Activities (Oil Pollution prevention and Control) Regulations (2005) having been assessed to have negligible environmental impact.

All other subsea equipment, pipelines and umbilicals are currently filled with inhibited seawater.

When the remaining in-field subsea equipment is recovered (including manifolds, SMES, etc), their contents will be discharged to the water column resulting in <0.5 kg of oil discharged at each field.

These discharges are expected to have negligible impact on the water column as determined for the riser and riser spool, above.

4.4.5. Future discharge from pipelines

All pipelines will remain buried following decommissioning *in situ*. Following recovery of the subsea infrastructure the in-field ends of the pipelines will be open to the environment and the pipeline contents will be free to migrate through the covering sediment/rock and comingle with the ambient seawater. This is likely to be a slow process as there is no active impetus to drive release of the pipeline contents.

At some point in the future the steel will degrade and the protective coatings will crack. At this point the residual contents of the pipelines will slowly be released into the sediments, through which there will be migration to the water column.

Whereas the concentration of oil in the seawater that is left in the pipelines will be unknown, from Shell's previous experience flushing gas/condensate and/or oil pipelines for decommissioning, low residual hydrocarbon content (< 20 mg/l) has historically been achieved with three or less line flushes. The Scoter and Merganser pipelines will be flushed with twice this volume.

As a worst case, if it is assumed that the residual concentration of hydrocarbons is 100 mg/l, there would be a total of 96 kg of hydrocarbons within the total length of the pipelines.

The eventual discharge is expected to have negligible impact on the sediments or water column. This is ostensibly because releases are likely to be gradual and intermittent over a very long timeframe, and because the hydrocarbon content of the water will be low and the inhibitors originally dosed will have reacted as intended and there would be little if any trace of the active compounds still present.

4.4.6. Controls for the Management of Impacts from Discharges to Sea

The following mitigation measures, safeguards and controls are proposed to minimise the impact of discharges to sea associated with the Scoter and Merganser decommissioning.

MITIGATION MEASURES, SAFEGUARDS AND CONTROLS

- All vessels employed for the decommissioning will meet the requirements of Shell's Group Marine Assurance System (GMAS)[1]; and
- Adoption of any controls identified following risk assessment under the Offshore Chemicals Regulations and/or Oil Pollution Prevention and Control Regulations.

Note 1: Shell's GMAS adopts and expands on the Oil Companies International Marine Forum (OCIMF) inspection (OVIQ2) and review of the Maritime Contractor Offshore Vessel Managers Self-Assessment (OVMSA). The review includes (*inter alia*) consideration of reliability and maintenance standards, navigational safety, emergency preparedness and contingency planning, and compliance with MARPOL and IMO standards for sewage discharge, garbage management, ballast water management and emissions controls.

The appraisal of the discharges from the decommissioning activities supports the conclusion that these will have a minimal impact, while adoption of the control measures specified will ensure discharges are kept as low as reasonably practical.

4.5. Underwater Noise

Ambient noise in the ocean is background sound generated by natural (e.g. wind, waves, tectonic activity, rain and marine organisms) and human (e.g. background shipping traffic and onshore and offshore construction) sources (e.g. Hildebrand, 2009; Richardson *et al.*, 1995). The characteristics of the sound produced, in terms of the amplitude, range of frequencies and temporal features, varies with the type of activity and equipment.

Marine fauna use sound for navigation, communication and prey detection (see e.g. reviews in NMFS, 2016; Southall *et al.*, 2007; Richardson *et al.*, 1995). Therefore, the introduction of anthropogenic underwater sound has the potential to impact on marine animals if it interferes with the animal's ability to use, receive and distinguish different sounds (see e.g. OSPAR, 2009c). Particularly loud sound can disturb marine animals, triggering avoidance response or, in extreme cases, has the potential to cause temporary, or even permanent, auditory threshold shifts (TTS and PTS respectively). In fish, the effects of "excessive" sound include avoidance reactions and changes in shoaling behaviour. Avoidance of an area may interfere with feeding or reproduction or cause stress-induced reduction in growth and reproductive output (Slabbekoorn *et al.*, 2010).

As reported in Section 2.3.3, a range of fish species use the area for nursery and/or spawning grounds at different times of the year including anglerfish, blue whiting, cod, haddock, hake, herring, lemon sole, ling, mackerel, Nephrops, Norway pout, plaice, sandeels, spotted ray, spurdog and whiting (Coull *et al.*, 1998; Ellis *et al.*, 2012). Harbour porpoise, white-beaked dolphin, minke whale and Atlantic white-sided dolphin are among the marine mammals that have been observed or identified as likely to be present in the Scoter and Merganser area.

The Conservation of Offshore Marine Habitats and Species Regulations 2017 make it an offence to injure or disturb EPS, the list of which includes many marine mammals. The Regulation defines 'injury' as a permanent threshold shift and 'disturbance' as the likelihood of impairing their ability to survive, to breed or reproduce, or to rear or nurture their young, or migrate. It also includes a likelihood of significantly affecting the local distribution or abundance of the species.

The potential for injury or disturbance depends on the amplitude and frequencies of the sound source, the sensitivity of a receptor animal to sounds of the source frequencies, as well as the distance and propagation of sound between the source and the receptor. This section of the report considers the sources of underwater noise associated with the Scoter and Merganser decommissioning activities, the sensitivity of the receptors in the vicinity of those activities and the potential for disturbance and injury due to underwater noise.

4.5.1. Sources of Underwater Noise

Decommissioning will give rise to sources of noise related to:

- Vessels of various types;
- Cutting tools;
- Placement of rock cover; and
- Seabed surveys.

The noise associated with these sources are discussed below.

No high energy noise sources such as the use of explosives, piling or deep sediment penetration seismic equipment will be required for the Scoter and Merganser decommissioning.

4.5.1.1. Vessels

The Scoter and Merganser decommissioning will mobilise a variety of vessels (e.g. DSVs, ROV support vessels, survey vessels etc.) that are typical of routine oil and gas industry operations, some of which will use dynamic positioning systems to maintain and adjust their position when working.

The primary sources of sound from vessels are propellers, propulsion and other machinery (Ross, 1976; Wales and Heitmeyer., 2002), with an estimated 85% of vessel noise resulting from propeller cavitations (Barlow and Gentry 2004), which are particularly prominent for dynamic positioning systems.

In general, vessel sound is continuous and results from narrowband tonal sounds at specific frequencies as well as broadband sounds. Acoustic energy is strongest at frequencies below 1 kHz and is the dominant noise source in deeper water between 20 – 500 Hz (Ulrick 1983). Acoustic broadband source levels typically increase with increasing vessel size, with smaller vessels (<50 m) having a source root mean square (rms) sound pressure level (SPL) of 160-175 dB re 1 μPa at 1 m, medium size vessels (50-100 m) 165-180 dB re 1μPa at 1 m and large vessels (> 100 m) 180-190 dB re 1 μPa at 1 m (Richardson *et al.*, 1995), although sound levels depend on the operating status of the vessel and can vary considerably in time.

Kyhn *et al.*, (2014) identified noise generation from various activities of a drillship (the *Stena Forth*) equipped with six dynamic positioning thrusters and determined that the dynamic positioning control system generated noise at around 100 dB re 1 μPa (rms) at frequencies between 20 – 35 kHz.

4.5.1.2. Underwater Cutting

Underwater cutting will be required to cut the manifold piles and to cut connection spools into sections for lifting.

Mechanical methods of cutting underwater structures use hard cutting tools that produce a sawing or machining action. Examples include hydraulic shears, diamond wire and abrasive water jet cutters. Any or all of these may be employed at Scoter and Merganser.

A recent paper reported that the noise from underwater diamond wire cutting, during the severance of a 0.76 m (30 inch) diameter conductor at a platform in the North Sea, was barely discernible above background noise levels including the noise of associated vessel presence (Pangerc *et al.*, 2016). The cutting noise, an increase of 4 – 15 dB above background levels, was more discernible at higher frequencies, i.e. >5 kHz, than at low frequencies, and was identifiable in recordings made 800 m from source. Anthony *et al.* (2009) present a review of published underwater noise measurements for various types of diver-operated tools. Several of these are underwater cutting tools, including a high-pressure water jet lance, chainsaw, grinder and oxy-arc cutter. Reported source sound pressure levels were 148 – 170.5 dB re 1µPa (it was not indicated whether these are rms or zero-peak). It is possible that larger ROV operated cutting tools could generate louder sound levels but no published data are available.

4.5.1.3. Rock Cover

Rock cover is likely to be required at the pipeline ends and pipeline crossings. It is also possible that additional rock cover may be required should post-decommissioning surveys identify that the depth of cover of the trenched and buried pipelines and umbilicals need to be increased. Rock cover is applied from a vessel via a downpipe which extends close to the seabed for accurate positioning of the rock.

Nedwell and Edwards (2004) reported the sound from a fall pipe vessel *Rollingstone*. The vessel used dynamic positioning and was powered by two main pitch propellers, two bow thrusters and two Azimuth thrusters. It was concluded that the sound levels were dominated by the vessel and not the rock placement activities.

4.5.1.4. Acoustic Surveying Equipment

Surveys will be undertaken to establish the baseline post-decommissioning state of the pipelines and umbilicals left *in situ* and for demonstrating a clear and safe seabed.

Shell routinely carries out surveys and inspections of all their pipelines within the UKCS on a rolling basis. These surveys employ a combination of acoustic surveying devices, including side-scan sonar (SSS) and multibeam echo sounders (MBES) to generate images of the seabed, and sub-bottom profilers (SBP) to determine the burial depth of the pipelines. A subset of these will also be used to inform the demonstration of clear and safe seabed. All of these instruments use electromagnetic sources rather than air guns. The surveys required for the Scoter and Merganser decommissioning will be similar to those routinely undertaken and are anticipated to use the same equipment type.

SSS devices use an acoustic beam to generate an accurate image of a narrow area of seabed to either side of the instrument by measuring the amplitude of back-scattered return signals. The instrument can either be towed behind a ship at a specified depth or mounted on to a ROV. Source levels of side-scan sonars are typically in the range of 200 – 230 dB re 1 µPa-m, although available information and measurements is limited. In order to provide higher resolution imaging of the seabed the frequencies used by side-scan sonar systems are relatively high (100 – 600 kHz).

MBES use multiple transducers to send out a swath of sound covering a large, fan-shaped area of the seabed either side of the vessel track. The width of individual beams transmitted by a multi-beam echosounder are typically in the range of 0.5° – 2°. The swath width is typically in the order of two to four times the water depth, but can be up to ten times the water depth in high-performance systems (Danson, 2005). Maximum peak source levels for the most powerful, deep-water systems are 236 – 238 dB re 1 μPa-m. Similar to side-scan sonar devices, the frequencies used by multi-beam echosounders are relatively high (100 – 500 kHz).

Sub-bottom profiling is used to determine the stratification of soils beneath the sea floor. Various types of SBP instrument may be used depending on the required resolution and seabed penetration (King, 2013; Danson, 2005). For pipeline burial depth surveys a Pinger type SBP provides adequate penetration at high resolution. Typical SBP Pingers used by Shell have a zero to peak SPL of 220 dB re 1 μPa-m, and a rms SPL of 217 dB re 1 μPa-m, with the sound energy generated being at a peak frequency of 3 kHz. The pulse length is approximately 50 ms and the pulse interval 0.2 s, giving a pulse frequency of 4 Hz i.e. 4 pulses will be transmitted every second. Based on the rms SPL and the pulse length, the sub-bottom profiler is estimated to have a single pulse SEL of 204 dB re 1 μPa^2s-m, and a source SEL over a 1 second exposure of 210 dB re 1 μPa^2s-m. The majority of sound energy from SBPs is directed vertically downwards and the pulse duration is short.

4.5.2. Sensitivity of Receptors to Underwater Noise

4.5.2.1. Marine Mammals

Different marine mammal species are sensitive to sounds over different frequency ranges. Audiograms, showing the hearing thresholds over a broad frequency spectrum are presented in Figure 4-2 for a selection of mammals known or likely to occur in the area of the Scoter and Merganser decommissioning activities. Audiograms for a selection of fish species are presented in Figure 4-3. The curve for each species represents the lowest amplitude of sound audible to that species at the sound frequency identified on the *x*-axis. Both figures also include indicative source profiles from a merchant vessel, pipelay barge and a dredger.

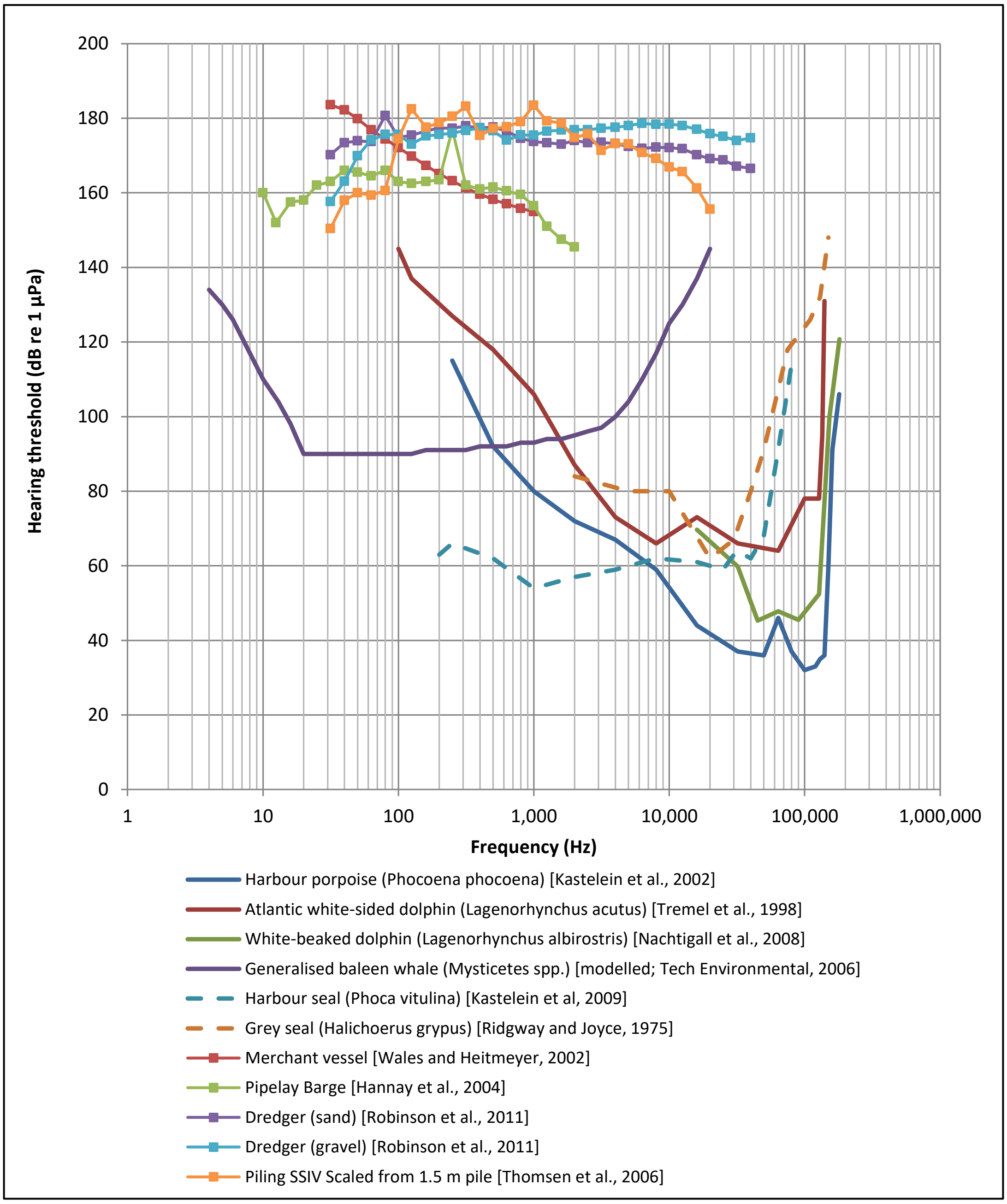

Figure 4-2: Marine mammal audiograms for species occurring in the DP area.

Baleen whales (including the minke whale) are low-frequency hearing cetaceans; the white-beaked dolphin is representative of high-frequency hearing cetaceans; and the harbour porpoise is representative of very high-frequency hearing cetacean species.

The figure indicates that noise from vessels covers frequency ranges that are audible to all marine mammals and that the source noise levels are above the hearing thresholds. It is also evident from Figure 4-2 that noise from SSS and MBES (>100 kHz) is outside the main hearing range of all marine species, as acknowledged by JNCC (2017). SBP pingers, with a peak source frequency of around 3 kHz are within the audible range of many marine mammal species.

The accepted method (Marine Scotland, 2014) for determining whether activities cause injury to marine mammals is based on the potential to cause a permanent elevation of the hearing threshold (i.e. a degree of loss of hearing). Southall *et al.* (2019) established thresholds for the onset of a PTS for four groups of marine mammals (Phocid pinnipeds and three groups of cetaceans: those with low-, high- and very high-frequency hearing). Thresholds were determined for two metrics, peak SPL and M-weighted SEL, which captured different aspects of a sound field. Peak SPL is a measure of the loudest instantaneous sound likely to be generated during an activity. SEL is a measure of the total energy in a sound pulse over a period of time. To apply the SEL thresholds, the SEL is calculated over a 24 hour period and is weighted according to marine mammal hearing sensitivities. Thresholds for the onset of PTS from peak SPL range between 202 and 230 dB re 1 µPa (NMFS, 2016).

4.5.2.2. Fish

There is limited data available on hearing frequencies for fish species, but those included in Figure 4-3 cover either the species found in the area of DP activities or are representative of most of those species.

The frequency ranges of some of the noise sources identified with the Scoter and Merganser decommissioning activities overlap with the audible ranges of fish, and the source noise levels exceed the hearing thresholds at these frequencies.

Fish are mobile animals that would be expected to be able to move away from a noise source that had the potential to cause them harm. If fish are disturbed by a noise, evidence suggests they will return to an area once it has ceased (Slabbekoorn *et al.*, 2010).

Turnpenny and Nedwell (1994) reviewed published observations of injury to fish eggs and larvae from high-energy sounds. The results of the studies were variable, but no injury effects were observed beyond approximately 10 m of the source or at levels below an SPL of 220 dB re 1 µPa.

Experiments exposing caged fish of various species to mid-frequency (2.8 – 3.5 kHz) sonar at a received SPL of 210 dB re 1µPa rms found evidence of temporary hearing damage in fish with hearing sensitivity in the frequency range generated by the source but not those with lower frequency hearing. Hearing damage recovered within 24 hours and no evidence of pathology or mortality was found (Halvorsen *et al.*, 2012).

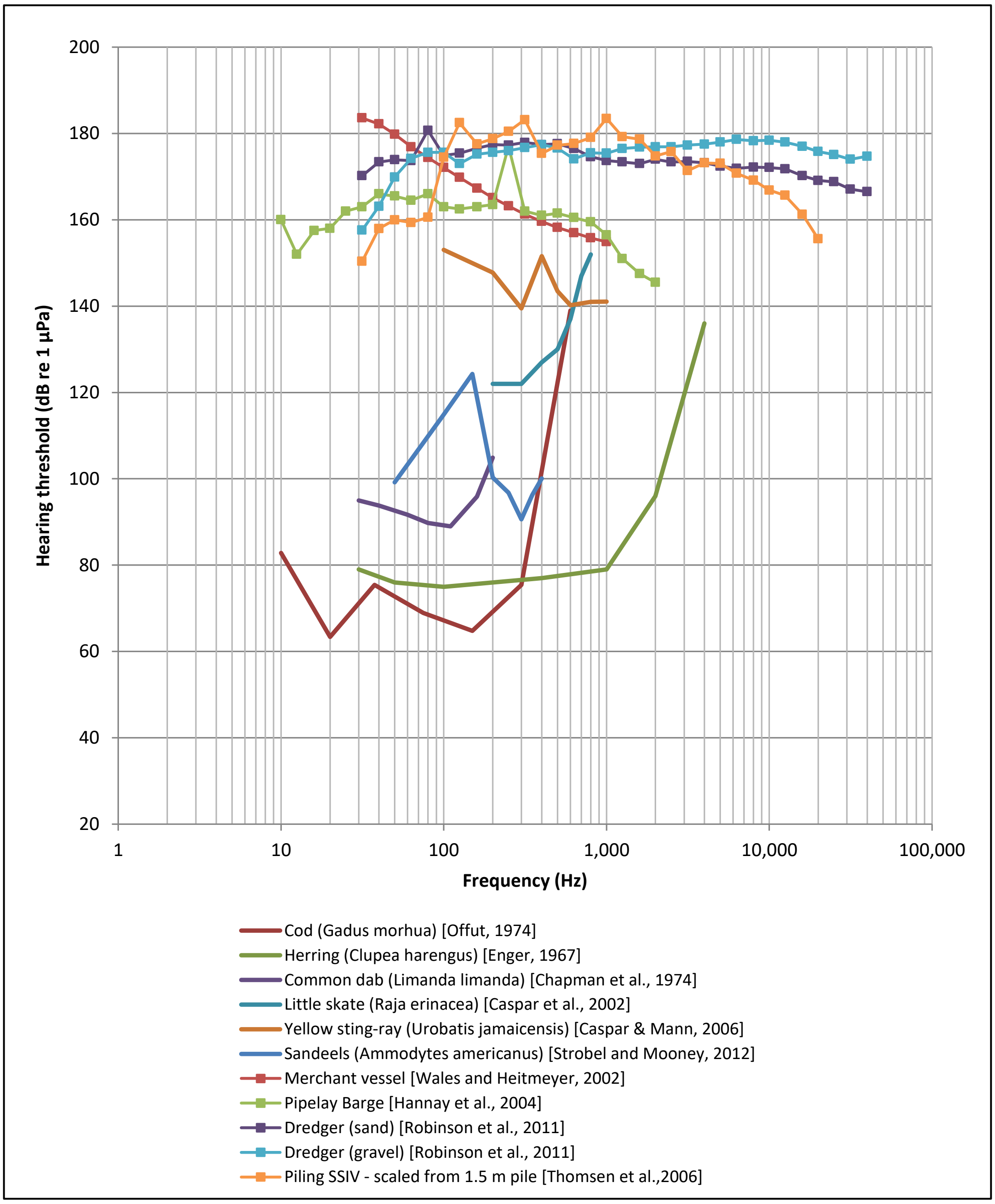

Figure 4-3: Relevant fish audiograms and representative sound sources from the DP.

Unpublished work by the Norwegian Defence Research Establishment (Jørgensen *et al.*, 2005; presented in Kvaldsheim and Sevaldsen, 2005) exposed larval and juvenile fish to simulated sonar signals at 1.5 kHz, 4 kHz and 6.5 kHz to investigate potential effects on survival, development and behaviour. The fish species used were herring, Atlantic cod, saithe and spotted wolfish (*Anarhichas minor*). Received sound levels ranged from 150 – 189 dB re 1 µPa. The only effects on fish behaviour were some startle or panic movements by herring for sounds at 1.5 kHz and there were no long-term effects on behaviour, growth or survival. There was no damage to internal organs and no mortality apart from in two groups of herring (out of over 40 tests) at received sound levels of 189 dB, for which there was a post-exposure mortality of 20% to 30%. Herring can detect higher frequencies than are detected by the other species in the study.

Popper *et al.* (2014) have defined criteria for injury to fish based on a review of impacts to fish, fish eggs, and larvae from various high-energy sources. The most sensitive species are those with a swim bladder that is also used for hearing, for which Popper *et al.* (2014) determined a threshold for mortality, or potential mortal injury, of a peak SPL of 207 dB re 1 μPa.

4.5.3. Potential for Impacts from Underwater Noise

4.5.3.1. Potential for Impacts from Vessel Noise

The DP will require in the order of 109 vessel days to complete, which will split between three distinct periods for flush & disconnection (completed in 2021), infrastructure recovery and post-decommissioning surveys. This will make a small, temporary addition to the background vessel density around the Scoter and Merganser wells. JNCC considers that temporary vessel traffic is unlikely to cause more than trivial disturbance to marine mammals (JNCC, 2010). The increase in underwater sound from vessels mobilised for the Scoter and Merganser decommissioning will therefore be slight and the impact on the environment minor.

4.5.3.2. Underwater Cutting

There is no published information on the response of marine mammals or fish to sound generated by underwater cutting. However, reported source levels are low compared with those generated by vessels (see Section 4.5.1) and any noise generated from cutting operations is not likely to cause significant disturbance to marine fauna. This is consistent with JNCC guidance which states that non-explosive cutting technology produces relatively little noise (JNCC, 2008).

4.5.3.3. Placement of Rock Cover

Where rock cover is required it will be placed on the seabed using a down pipe or similar low-noise method. No noise source levels have been reported for rock cover, but the only available information suggests that levels are lower than that generated by the vessel used. Furthermore, given the short duration of individual rock cover activities, there is only likely to be a low impact on marine mammals or fish associated with the noise generated (JNCC, 2008).

4.5.3.4. Acoustic Surveying Equipment

A review of the impact of acoustic surveying techniques on marine fauna in the Antarctic concluded that acoustic instruments such as SSS and many echo sounders are of sufficiently low power and high frequency as to pose only a minor risk to the environment. This concurs with a review by Richardson *et al.*, (1995), which found no obvious response to pingers, echo sounders and other pulsed sound at higher frequencies unless the received levels were very high.

The high frequency sound produced by SSS and MBES in relatively shallow waters (<200 m) is outside the hearing range of marine mammals and attenuates rapidly. The risk of injury or disturbance from operation of this type of equipment is considered negligible and no mitigation is required (JNCC, 2017).

Little information is available on the potential effects of SSS and echo sounders on fish (Popper, 2008 and ICES, 2005), but since the sound generated by SSS and MBES are outside the hearing threshold of fish, no effect would be anticipated.

Sound generated be SBP pingers is within the audible range of most marine mammals and sound source levels are at or around the peak SPL threshold for the onset of PTS in some marine mammal species. This raises the potential for disturbance and/or injury.

SBP surveys undertaken in relation to licences issued under the Petroleum Act 1998 (and the Energy Act 2008) require consent under the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001. Applications require consideration of the potential impact of noise from the SBP on the marine environment and such assessments are frequently informed by noise modelling studies. Shell frequently undertakes pipeline surveys using acoustic equipment for its assets throughout the North Sea.

Most recently, an assessment in support of application for consents for a survey using SBP pingers for pipeline inspection in autumn 2020 identified:

- Sound levels would not exceed thresholds for the onset of PTS for high-frequency hearing cetaceans and pinnipeds;
- Sound levels would decrease to below thresholds for the onset of PTS within:
    - 190 m for very high-frequency hearing cetaceans; and
    - 50 m for low-frequency hearing cetaceans;
- Behavioural responses to the sound may be exhibited by all cetacean groups and pinnipeds up to 1.8 km from the source; and
- Sound levels would decrease below the threshold for injury or potential mortality to fish, including eggs and larvae, within a maximum of 30 m from the source.

Guidelines for minimising the risk of potential impacts of sound (JNCC, 2017) include the following measures relevant for surveys of this nature:

- A qualified Marine Mammal Observer (MMO) will be aboard the vessel during the entire survey, who will be following JNCC (2017) guidelines for minimising the risk of injury to marine mammals from geophysical surveys. When the MMO observation period is ongoing, the designated MMO will not be required to undertake any other duties on the vessel.
- The designated MMO will detect marine mammals within a 500 m mitigation zone. If any cetaceans are observed within 500 m from the source array, then the start of the seismic sources will be delayed for at least 20 minutes following last sighting.
- The designated MMO will carry out a 30-minute pre-data acquisition survey of the mitigation zone and, if an animal is detected, the soft-start of the seismic sources will be delayed until their passage, or the transit of the vessel, results in the marine mammals being more than 500 metres away from the source i.e. out with the 500 m mitigation zone.
- A soft-start activation of the SBP will be employed, whereby the source power will be incrementally increased over period of at least 20 minutes. This will allow any marine mammals to move away from the sound source and reduce the likelihood of exposing the animal to sounds that could potentially cause injury. A soft start will be employed whenever the SBP is used.
- If the SBP has been inactive for a period of 10 minutes or longer, the designated MMO will perform a visual inspection of the 500 m mitigation zone. If a mammal is detected within the 500 m mitigation zone, the restart of the survey will be delayed for at least 20 minutes following last sighting.

The study, in keeping with Shell's general experience of such surveys, concluded that, with the implementation of mitigation measures established by JNCC, they will not have a significant impact on marine fauna.

4.5.4. Controls for the Management of Impacts from Underwater Noise

Cetaceans and fish are present in the part of the CNS around the Scoter and Merganser fields and these receptors have been identified to be sensitive to underwater noise. Disturbance of these receptors from noise resulting from the proposed decommissioning activities is expected to be low, and the likelihood of injury from underwater noise is negligible.

The following mitigation measures, safeguards and controls are proposed to minimise the impact of underwater noise associated with the Scoter and Merganser decommissioning.

MITIGATION MEASURES, SAFEGUARDS AND CONTROLS

- The scheduling of vessels' operations and types of vessels used will be optimised to execute the decommissioning as efficiently as possible.
- JNCC guidelines for minimising the risk of injury to marine mammals will be followed in as much as they relate to the use of SBP for geophysical surveys should this technique be required.

4.6. Waste Management of Recovered Materials

The DP identifies a total of 2,213 te of materials will be removed from the seabed. This includes 506 te of steel, 4 te non-ferrous metals, 1,651 te of concrete and grout, and 53 te of plastics.

All these materials will be brought to shore and disposed of through Shell's waste management contractors who will apply the waste hierarchy to identify the optimal treatment, use and/or disposal mechanisms for each waste stream. It is anticipated that steel and other metals will be recycled while concrete and grout will be repurposed. Plastics may need to be disposed of to landfill, although other options further up the hierarchy will be investigated on a case by case basis.

During the flushing and cleaning of the pipelines liquid wastes were generated that were injected into the Merganser reservoir via the Merganser P1 well.

Waste fluids (chemicals, solvents and seawater) were also generated from the cleaning of umbilical cores. These were captured at Shearwater and brought to shore for treatment as appropriate.

It is likely that some marine growth will be removed with the manifolds. This has been approximately estimated to be 20 te wet weight.

Given the nature of the recovered materials, the use of established waste handling processes and with an emphasis on reuse and recycling, there is little risk of environmental impact from waste. OPRED guidance for Environmental Appraisal reports excludes consideration of waste management and no further consideration is provided here.

4.7. Fate of Materials Left *in situ*

Pipelines and umbilicals will be decommissioned *in situ* and the ultimate fate of metals and plastic coatings is discussed below.

The external corrosion of coated pipelines is normally restricted to those localised areas where there are defects or damage in the coating, or where the coating has become disbonded from the pipe. Disbondment of the coating may be the result of damage during installation, impacts from trawl boards and dropped objects, abrasion, etc. Corrosion can be expected to be almost negligible in areas where the coating integrity is intact. Pipeline corrosion is therefore expected in most cases to occur as localised pits, which will eventually result in random perforations throughout the pipeline length.

Structural degradation of the Scoter and Merganser pipelines will be a long-term process caused by corrosion and the eventual collapse of the structures under their own weight and that of the overlying sediments. Oxidised metal components released during this process could potentially become bio-available to benthic fauna in the immediate vicinity. Pathways for these components from the pipelines to the receptors would be via the interstitial spaces in seabed sediments and the water column, or via water flow through overlying rock placement.

Degradation of the plastic coating into soluble compounds will be extremely slow and release into the water column will consequently be highly diffuse and is unlikely to result in any adverse impacts. Physical breakdown of the coating (cracking/flaking) will be enhanced by the degradation of the pipeline steel, but the resulting fragments would be expected to remain buried.

Significant quantities of hazardous materials such as wax and heavy metals are not anticipated to be present in the Scoter and Merganser pipelines following flushing (see Section 1.5.1). Any trace quantities of contaminants present will either remain buried in perpetuity or may be released into the sediments, and subsequently into the water column as the pipeline collapses.

4.8. Socio-economic Effects

The socio-economic effects considered in the ENVID related to potential for impacts on the fishing industry through the following mechanisms:

- Restriction of activity;
- Loss of productivity; and
- Risk of snagging.

4.8.1. Restriction of activity

Most of the decommissioning activity will take place within the Scoter, Merganser and Shearwater 500 m safety zones and will therefore not impede fishing, with some low density activity required at the pipeline crossings and for post-decommissioning surveys.

4.8.2. Loss of productivity

Areas of rock cover will have lower potential to support commercial fish species resulting in a minor negative impact. Conversely, decommissioning will result in the re-opening of the Scoter and Merganser 500 m safety zones to fishing, resulting in a minor positive impact. Overall this is expected to result in a small net increase in fishing productivity.

4.8.3. Risk of snagging

The decommissioning will result in a clear seabed, with only the buried pipelines and umbilicals remaining *in situ*. These will be buried to a depth of at least 0.6 m with natural fill enhanced as necessary with additional rock cover. The area traversed by the pipeline has a dynamic seabed which could have the potential for uncovering sections of the buried lines in the future. Shell will remain responsible for maintaining the safe status of the pipeline, and future remedial action will be informed by surveys of pipeline depth. Remediation planning will include liaison with SFF, Marine Scotland and OPRED and will balance risk of snagging with a desire to maintain the seabed in as natural a state as possible.

4.9. Transboundary Impacts

The removal activities will take place at least 25 km from the UK/Norway median line. At this distance there is negligible likelihood of transboundary impacts on air quality or on seabed habitats (such as the PVA for mackerel spawning) given the scale of the proposed activities.

4.10. Cumulative Impacts

There are no other known developments within 10 km of Scoter and Merganser.

Developments at Shearwater include the Arran Field tie in and start up, and ongoing drilling campaigns. These will add to the vessel traffic in the Shearwater area. All Shearwater vessel activity is coordinated, with simultaneous operations plans developed where appropriate. The contribution of decommissioning vessels to the in combination vessel activity at Shearwater is minor, but will add to the overall underwater noise levels for the short duration of decommissioning operations undertaken at Shearwater.

5. Conclusions

This EA confirms that the DP can be executed with minimal impact on the environment. The baseline environment in the affected area is well understood, the potential for impact from the decommissioning activities are known and Shell procedures include robust, well established control measures to reduce the potential for impacts to develop and mitigation of those that are unavoidable.

The development of the decommissioning programme for the Scoter and Merganser fields has been informed by ongoing appraisal of the environmental impacts and risks posed by options under consideration. The environmental appraisal has been based on an understanding of the baseline environment established from multiple web-based sources and seabed surveys. Comparative Assessment established that the most appropriate decommissioning option for the pipelines and umbilicals was for them to be decommissioned *in situ* below the seabed.

Comprehensive identification of potential impacts from the proposed DP was achieved through ENVID, the output of which was used to scope the requirements for further detailed impact assessment.

The ENVID identified no planned activities that would give rise to impacts of either Moderate or High significance rating. No unplanned events were identified that would have a High or Moderate risk of environmental impact.

Activity-specific mitigation measures will be planned and managed to avoid adverse environmental and social impacts and, where avoidance is not possible, ensure potential impacts are minimised to a level that is as low as reasonably practicable. This includes management of contractors commissioned to carry out the decommissioning activities, and monitoring and auditing contractor performance during the execution of the work. Agreed mitigation controls, regulatory requirements, as well as Shell's standard requirements, will be included as terms and conditions in the contract and the measures to be adopted. Monitoring measures required to ensure compliance will form part of the contractors' decommissioning plans and procedures to be approved by Shell prior to mobilisation. Shell will carry out pre-mobilisation audits to assure that effective planning and operational procedures are in place and that all vessels comply with International Maritime Organisation requirements, including MARPOL requirements with regard to emissions, discharges, waste management and collision avoidance.

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Appendix A: ENVID Methodology

Impacts Identification and Aspects

Firstly, potential impacts were identified using the environmental aspects listed in Table A-1, and Social Performance aspects listed in Table A-2. Each environmental impact was assessed for significance to determine those impacts which require active management.

Table A-1: Environmental Aspects used for ENVID

No.	Environmental Aspect	Definitions/Comments
Emissions to air		
1	Gaseous emissions	The emission of hazardous gases (such as but not limited to CO_2, NOx, SOx, CO, SO_2, H_2S, CH_4) resulting from flaring off, venting, heating, leaks, transport, etc. Comment: this concerns both continuous emissions (flares, vents, heating installations, losses through leaks), discontinuous emissions (well tests, depressurising installations), leaks of HCFCs from cooling installations and emissions arising from accidental fires and explosions.
Discharges to water		
2	Fluids and other materials into water	The controlled discharge to surface water of production water, household waste water, decontamination water, drainage water at well points, (contaminated) rainwater and discharge to sewer as part of normal operations. The discharge of oil, chemicals and other materials as a result of incidents including for example vessel collision and dropped objects. Comment: this concerns both discharges offshore and to surface waters onshore.
Effects on land including groundwater		
3	Fluids into soil	The controlled or uncontrolled discharge of liquids such as rainwater, oil and condensate into the soil (soil and groundwater). Includes discharges and spills arising as a result of accidental events e.g. fire and explosion. Comment: the surface water can also become contaminated as a result of infiltration and runoff.
4	Waste materials	All materials that the holder disposes of, with the intention of permanent removal. Waste includes hazardous waste, operational waste, office waste, domestic waste, clinical waste, WEEE, batteries and small volumes of chemical waste. Important waste materials are drilling fluid / drilling dust, production water, waste water, contaminated soil and waste contaminated with mercury and LSA.

No.	Environmental Aspect	Definitions/Comments
5	Disruption to the soil and subsoil	1) Disruption to the subsoil resulting from product extraction with the possible consequence being earth tremors and subsidence. 2) Disruption to soil layers as a result of drilling, pile driving and seismic shot holes with the possible consequence being the lowering of the water table, seepage, etc.
Extraction and consumption of resources		
6	Raw materials, additives and materials	The use of (depletable or regulated) raw materials additives and materials for operational purposes. Comment: including chemicals; excluding water.
7	Water consumption	The operational and incidental consumption of water for instance for combating emergencies (killing wells, fighting fires), cooling, rinsing, cleaning activities, catering, making shot holes. Comment: this concerns seawater, fresh surface water, groundwater and mains water.
8	Energy consumption	The use of energy carriers such as natural gas, diesel oil, petrol, kerosene, electricity for operating installations, transport and (office) buildings.
9	Usage of space	The temporary or permanent use of space that has an influence on the flora, fauna and the appearance of the landscape. Also includes physical presence in the context of other stakeholders including fishing vessels and other shipping movements. Examples: installations, pipelines, buildings, transport, survey operations.
10	Product extraction	The extraction of oil, gas, condensate and sulphur (as depletable resources). Comment: subsidence and earth tremors as effects of this are included in a separate environmental aspect (no. 16).
Others		
11	Radiation (heat and ionising)	Disruption to the surroundings resulting from heat radiation and ionising radiation from natural and unnatural sources. Example of heat radiation: flaring during production activities and well testing. Example of ionising radiation: the settling of LSA in sludge and parts of an installation (and as a result in materials and equipment), and radiation emitted by measuring equipment (drilling tools, x-ray equipment).
12	Noise and vibrations	Disruption to the surroundings as a result of operational and incidental noise and vibration resulting from operational activities.

No.	Environmental Aspect	Definitions/Comments
		Examples: seismic vibration vehicles and explosives, pile driving activities, drilling activities, etc.
13	Smell / odour	Disruption to the surroundings resulting from operational activities. Examples: ammonia, H_2S, combustion gases, hydrocarbons
14	Light	Disruption to the surroundings (mainly at night) by light radiated from locations and operational activities. Examples: drilling rigs, offshore platforms and seismic vehicles.
15	Dust	Disruption to the surroundings from dust particles such as those created by construction and abandoning activities and during the execution of sandblasting and painting activities. Examples: grit, asbestos, blown sand.
16	Materials to subsurface/disturbance to the soil or subsoil	The intended or unintended introduction of liquids and gases in deep layers of the earth, including associated earth tremors and subsidence. For instance: the injecting of production water into layers of the earth intended for it: the undesired leaking into formations of drilling fluid and possibly the future injection of CO_2.
17	Aesthetics	Disruption to local residents and visitors to an area. Examples: landscape and visual effects.
18*	Biodiversity	Disruption to flora, fauna and ecosystems both onshore and offshore including seabed disturbance. Examples: effects on local, national and internationally important ecological interests including protected habitats and species.

Table A-2: Social Performance Aspects

No.	Social Aspect	Definitions / Comments
1	Adverse social impacts on communities	Changes to the livelihoods or social wellbeing of communities brought about by the project (perceived or actual). Examples include: loss of livelihood resources (e.g. farming, industry) due to land take or resource pollution or disturbance (e.g. fisheries); compensation for changes in income; protection of valuable/endangered natural resources or monuments/cultural heritage; threats to safety or security of community; accidents and major site risks crime; prostitution; demands on social services;
2	Stakeholder involvement (lack of)	Barriers to stakeholder involvement in the project planning, construction and/or operational phases. Examples include: changes in power relations, community decision making structures and skills, high or unrealistic expectations, personal conflict, perceived health, social or environmental impacts; governance issues influencing ability to participate
3	Conflicting use of resources	Extent to which the project results in conflicting/competing use for resources. Examples include: High prices paid for local commodities, use of local labour and talent, use of local accommodation, transportation and infrastructure; use of natural resources e.g. water, land.
4	Social Cohesion	Changes in the social cohesion of communities from establishment of operational activities in the area. Examples include: voluntary or involuntary resettlement brought about by the development, fragmentation of communities and families and/or in or out migration for employment brought about by the project; tensions between local and non-local workforces due to engagement of foreign workforce or erosion of traditional values/cultures or social networks
5	Revenue distribution	Economic changes to the local economy brought about by the project. Examples include: revenue distribution and inequality, peaks and troughs of employment patterns due to cycle nature of EP activities, wider impact of activities on local economy, such as inflationary effects, socio-economic imbalances; accessibility of employment opportunities, corruption.
6	Vulnerable/indigenous groups	Direct or indirect impact on indigenous or vulnerable groups Examples include: marginalised or unrepresented people, unskilled people not able to secure a job in oil industry because skills are not required, local inflation caused by presence of the project, loss of access to informal land users due to project, human rights.
7	Health	Extent to which project influences the health of the community. Examples include: decline in health due to introduction of communicable diseases and/or pollution; demands on health services; HIV/AIDS

No.	Social Aspect	Definitions / Comments
8	Local content (lack of)	Extent to which local content is integrated into the project: Examples: Supply chain management/contracting, local purchasing, employment and labour, pre-qualification; special training requirements.
9	Temporary (constructional) impacts	Temporary changes brought about by the constructional phase of the project: Changes in make up of population, large workforces, employment (direct/indirect, multiplier effects); foreign workers, disturbance impacts (e.g. traffic; noise etc), archaeological sites or artefacts, cultural and sacred sites, communities (schools etc)
10	Exit and post-construction strategy	Extent to which project has considered exit and post-construction strategy Examples include: 'boom-bust; local or regional recession after construction project; retention of improved infrastructure (who owns it/maintains it?); long term sustainability

Assessment of Impact Significance

The significance of environmental impacts was assessed in terms of:

- Magnitude based on the size, extent and duration of the impact;
- The sensitivity of the receiving receptors; and
- The likelihood of an unplanned event occurring.

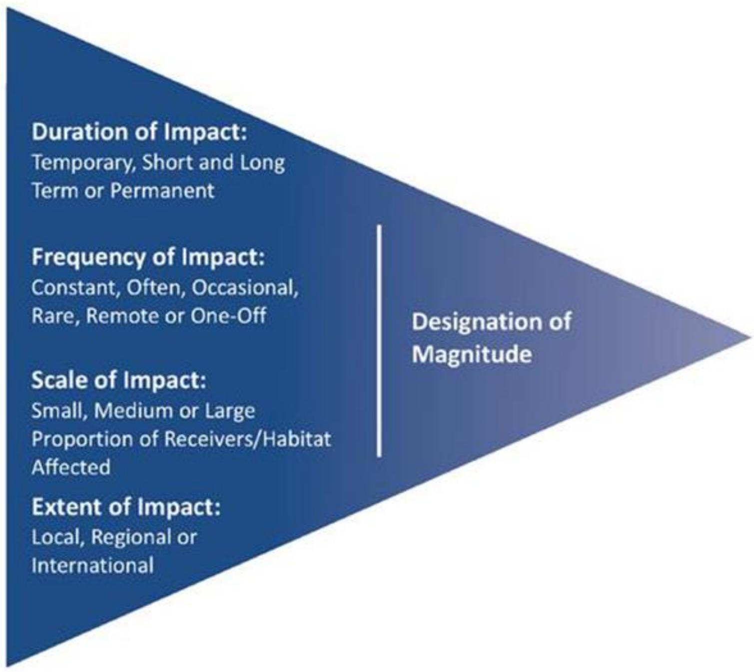

Figure A-1: Magnitude definition

Magnitude

Levels of magnitude of environmental impacts are outlined in Table A-3. The magnitude of an impact or predicted change takes into account the following:

- Nature of the impact and its reversibility;
- Duration and frequency of an impact;
- Extent of the change; and
- Potential for cumulative impacts.

The impact magnitude is defined differently according to the type of impact. For readily quantifiable impacts, such as noise or plume extent, numerical values can be used whereas for other topics (e.g. ecology) a more qualitative definition may be necessary. These criteria capture high level definitions, and according to the nature of a project some additional factors could be included. Other more suitable definitions can be added according to the project being pursued but they must be equivalent.

Table A-3: Magnitude Definitions

DEFINITION	ENVIRONMENTAL IMPACT
No effect	▪ No environmental damage or effects
Slight effect	▪ Slight environmental damage contained within the premises. Example: Small spill in process area or tank farm area that readily evaporates. ▪ Effects unlikely to be discernible or measurable ▪ No contribution to transboundary or cumulative effects ▪ Short-term or localised decrease in the availability or quality of a resource, not effecting usage.
Minor effect	▪ Minor environmental damage, but no lasting effects ▪ Change in habitats or species which can be seen and measured but is at same scale as natural variability. ▪ Unlikely to contribute to trans-boundary or cumulative effects. ▪ Short-term or localised decrease in the availability or quality of a resource, likely to be noticed by users
Moderate effect	▪ Environmental damage that will persist or require cleaning up. ▪ Widespread change in habitats or species beyond natural variability ▪ Observed off-site effects or damage, e.g. fish kill or damaged vegetation. ▪ Groundwater contamination – localised, or decrease in the short-term (1-2 years) availability or quality of a resource affecting usage ▪ Local or regional stakeholders' concerns leading to complaints ▪ Minor transboundary and cumulative effects
Major effect	▪ Severe environmental damage that will require extensive measures to restore beneficial uses of the environment. ▪ Widespread degradation to the quality or availability of habitats and/or wildlife requiring significant long-term restoration effort. ▪ Major oil spill over a wide area leading to campaigns and major stakeholders' concerns

DEFINITION	ENVIRONMENTAL IMPACT
	▪ Transboundary effects or major contribution to cumulative effects ▪ Mid-term (2-5 y) decrease in the availability or quality of a resource affecting usage ▪ National Stakeholders' concern leading to campaigns affecting Company's reputation
Massive effect* (to be used only for unplanned events)	▪ Persistent severe environmental damage that will lead to loss of use or loss of natural resources over a wide area. ▪ Widespread long-term degradation to the quality or availability of habitats that cannot be readily rectified. ▪ Major impact on the conservation objectives of internationally/nationally protected sites. ▪ Major trans-boundary or cumulative effects. ▪ Long-term (>5 y) decrease in the availability or quality of a resource affecting usage ▪ International public concern

Receptor Sensitivity

Receptors were categorised into different groups, such as:

- Atmosphere;
- Water (Marine, Estuarine, river or groundwater);
- Habitat or species;
- Soil or seabed; and
- Community (e.g. public, commercial).

Receptor sensitivity criteria were based on the following key factors:

- **Importance of the receptor at local, national or international level**: for instance, a receptor will be of high importance at international level if it is categorised as a designated protected area (such as Ramsar site or SAC). Areas that may potentially contain e.g. Annex I Habitats are of medium importance if their presence/extent has not yet been confirmed.
- **Sensitivity/vulnerability of a receptor and its ability to recovery**: for instance, certain species could adapt to changes easily or recover from an impact within a short period of time. Thus, as part of the receptor sensitivity criteria (Table A-4), experts considered immediate or long term recovery of a receptor from identified impacts.

- **Sensitivity of the receptor to certain impacts**: for instance, , vessel emissions will potentially cause air quality impacts and do not affect other receptors such as seabed.

Table A-4: Receptor Sensitivity

LEVEL	SENSITIVITY	DEFINITION
A	Low	Receptor with low value or importance attached to them, e.g. habitat or species which is abundant and not of conservation significance. Immediate recovery and easily adaptable to changes.
B	Medium	Receptor of importance e.g. recognised as an area/species of potential conservation significance for example, Annex I Habitats and Annex II species. Recovery likely within 1-2 years following cessation of activities, or localised medium-term degradation with recovery in 2-5 years.
C	High	Receptor of key importance e.g. recognised as an area/species of potential conservation significance with development restrictions for example SACs, MPAs. Recovery not expected for an extended period (>5 years following cessation of activity) or that cannot be readily rectified.

Evaluation of Significance

Planned Events

The magnitude of the impact and sensitivity of receptor was then combined to determine the impact significance as shown in Table A-5. Mitigation measures were then identified to reduce the impact. The residual impact following mitigation was then determined.

Table A-5: Evaluation of significance planned events

		SENSITIVITY		
		A - Low	B - Medium	C - High
MAGNITUDE	0 – No effect	No effect	No effect	No effect
	1 – Slight effect	Slight	Slight	Minor
	2 – Minor effect	Minor	Minor	Moderate
	3 – Moderate effect	Minor	Moderate	Major
	4 – Major effect	Moderate	Major	Major

Unplanned Events

For unplanned events, the likelihood of such an event occurring was also considered. For example, based on magnitude and sensitivity alone, a hydrocarbon spill associated with a total loss of fuel inventory could be classed as having major impact significance; however, the likelihood of such an event occurring is very low. Thus unplanned events were also assessed in terms of environmental risk.

As with planned activities, the potential impacts of unplanned events were identified and their magnitude and the sensitivity of the environment defined and combined in order to determine the impact significance. The significance of the impact was then combined with the likelihood of the event occurring (Table A-6), in order to determine its overall environmental risk as summarised in Table A-7.

Mitigation measures were then identified to reduce the risk of such an event occurring in order to determine residual risk.

Table A-6: Likelihood Criteria

LIKELIHOOD	DEFINITION
A	- Never heard of in the industry - Extremely remote - <10^{-5} per year - Has never occurred within the industry or similar industry but theoretically possible
B	- Heard of in the industry - Remote - 10^{-5} – 10^{-3} per year - Similar event has occurred somewhere in the industry or similar industry but not likely to occur with current practices and procedures
C	- Has happened in the Organisation or more than once per year in the industry – Unlikely - 10^{-3} – 10^{-2} per year - Event could occur within lifetime of similar facilities. Has occurred at similar facilities.
D	- Has happened at the location or more than once per year in the Organisation – Possible - 10^{-2} – 10^{-1} per year - Could occur within the lifetime of the development
E	- Has happened more than once per year at the location – Likely - 10^{-1} - >1 per year - Event likely to occur more than once at the facility.

Table A-7: Evaluation of significance unplanned events

		LIKELIHOOD				
		A	B	C	D	E
IMPACT SIGNIFICANCE	No effect	No effect				
	Slight	Negligible	Negligible	Minor	Minor	Minor
	Minor	Negligible	Minor	Minor	Moderate	Moderate
	Moderate	Minor	Minor	Moderate	Moderate	Major
	Major	Moderate	Moderate	Moderate	Major	Major
	Massive	Major	Major	Massive	Massive	Massive

Appendix B: ENVID Output

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	EXISTING MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED
Vessel Use					
Gaseous emissions	Offshore vessel, helicopter	Fuel combustion emissions (CO_2, CO, SOx, NOx, etc.) from vessels including construction vessel, ROV support vessels/dive support vessels, supply vessels, rock placement vessel, survey vessels, Emergency Response and Rescue/Guard Vessel (ERRV), helicopter etc. UK and EU Air Quality Standards not exceeded.	Shell's Group Marine Assurance System (GMAS) is mandatory for all vessels engaged in Shell related activities. This includes environmental assurance including for emissions (e.g. maintenance of combustion equipment) Optismised schedules	A1 Slight	N/A
Physical Presence	Vessel activity. Depending on scheduling, a guard vessel could be put in place during work scope.	Potential restriction on navigation and fishing operations. No planned anchoring requirements.	Minimise use of vessels, through efficient journey planning. Notify other sea users - e.g. Kingfisher, Scottish Fishermen's Association (SFF) etc. Ongoing collaboration with SFF. All vessels engaged in the project operations will have markings and lightings as per the International Regulations for the Prevention of Collisions at Sea (COLREGS) (International Maritime Organisation, 1972). Navigational aids including radar, lighting and Automatic Identification Systems (AIS) will be used. A vessel Collision Risk Assessment (CRA) will be produced if required.	A1 Slight	N/A
Disruption to the soil and subsoil	Lay down of anchors and associated anchor chains on the seabed (HLV) and the spud cans associated with HDJU.	N/A. No jack-up is anticipated for decommissioning. No anchoring of vessels used for decommissioning is anticipated.		N/A	N/A
Disruption to the soil and subsoil	Impact of anchor depressions/scars and spudcan depressions on other sea users.	N/A. No jack-up is anticipated for decommissioning. No anchoring of vessels used for decommissioning is anticipated.		N/A	N/A

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	EXISTING MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED
Fluids and other materials into water	Discharge of sewage from vessels used during decommissioning activities; grey and black water macerated to <6 mm prior to discharge and discharge of food waste to sea.	Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Minimise use of vessels through efficient journey planning and use of relevant vessels for each activity. Prior to contract award Shell will apply GMAS to review all vessels. This covers (inter alia) Environmental performance, emissions, discharges, equipment maintenance, compliance with MARPOL and IMO environmental requirements Including conditions for sewage and garbage management	A1 Slight	N/A
Fluids and other materials into water	Ballast water (important if the vessels were to be brought from the outside of the North Sea)	Water quality in immediate vicinity of discharge may be reduced, but effects are usually minimised by rapid dilution in receiving body of water and non-continuous discharge. Possible introduction of invasive species depending on vessel routes if IMO requirements are not followed.	Prior to contract award Shell will apply GMAS to review all vessels. This covers (inter alia) Environmental performance, emissions, discharges, equipment maintenance, compliance with MARPOL and IMO environmental requirements Including conditions for ballast water management	A1 Slight	N/A
Fluids and other materials into water	Biofouling (important if the vessels were to be brought from the outside of the North Sea)	Bioinvasions as a result of biofouling (accumulation of organisms including plants, algae, or animals such as barnacles) on vessels.	Prior to contract award Shell will apply GMAS to review all vessels. This covers (inter alia) Environmental performance, emissions, discharges, equipment maintenance, compliance with MARPOL and IMO environmental requirements Including conditions for management of biofouling	N/A	B2B Minor
Noise	Vessels using Dynamic Positioning (DP).	Vessels will use DP which has the potential to cause disturbance to marine mammals and fish in the form of temporary displacement from the area. Marine mammals and fish are expected to return once the vessels have left the area. Shipping intensity is considered low/moderate in the area.	Minimise use of vessels, through efficient journey planning.	B1 Slight	N/A

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	EXISTING MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED
Light	Vessel lighting	Possible impact on birds and birds migration, however given the short duration of activities, low number of vessels anticipated and the proximity to the platform and surrounding infrastructure the lights associated with vessels is not expected to have an impact on bird migrations.	Minimise use of vessels, through efficient journey planning.	A0 No Effect	N/A
Waste	Vessel waste (solid, vessel operations waste)	General vessel waste returned to shore and treated in line with the waste hierarchy.	Minimise use of vessels through efficient journey planning and use of relevant vessels for each activity. Prior to contract award Shell will apply GMAS to review all vessels. This covers (*inter alia*) Environmental performance, emissions, discharges, equipment maintenance, compliance with MARPOL and IMO environmental requirements Including conditions for garbage management	A0 No Effect	N/A
Energy Consumption	Fuel use by vessels and helicopters.	Use of a finite resource.	Minimise use of vessels, through efficient journey planning.	A0 No Effect	N/A
Unplanned event	Loss of fuel during bunkering of equipment. No requirement for bunkering operations with the other vessels.	Diesel release could significantly impact on fauna in the area e.g. plankton, fish, marine mammals and birds.	Use of appropriate controls to prevent overboards s pillings eg. Bunding, spill kits etc. Up to 100's of litres	N/A	A2C Minor
Unplanned event	Loss of fuel inventory due to vessel collision or fire.	Diesel release could significantly impact on fauna in the area e.g. plankton, fish, marine mammals and birds.	Vessel Assurance Inspection. Pre-hire vessel audit shall be used to establish nature of fire fighting systems. Emergency response plans in place including vessel Shipboard Oil Pollution Emergency Plans (SOPEPs). SIMOPs (simultaneous operations) will be managed through bridging documents and communications.	N/A	A3A Negligible
Flush and Disconnect					
Gaseous emissions	Flushing spread	Fuel combustion emissions (CO_2, CO, SOx, NOx, etc.) from DSV / Flushing UK and EU Air Quality Standards not exceeded. 3/4 weeks intense activity.	Optimise flushing goals and procedures to limit excessive use of fuel / emissions / waste generation	A1 Slight	N/A

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	EXISTING MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED
Physical Presence	n/a - covered under Vessel node			N/A	N/A
Disruption to the soil and subsoil	Localised seabed disturbance for subsea disconnections.	Localised seabed disturbance resulting in some lethal/sub-lethal effects on benthic and epibenthic fauna. Possible smothering of some organisms following settlement of re-suspended particles. Rate of recovery dependent on type of seabed and species present. Area of impact is very small and out with any designated areas. Sensitivity is based on having no site specific survey data.		B1 Slight	N/A
Fluids and other materials into water	Discharge of low concentration OIW and flushing fluids during flushing and later disconnections.	Potential toxic contaminant effects to organisms in water column and seabed sediments.	Discharges permited under OPPC and OCR regs.	A1 Slight	N/A
Noise	n/a - covered under Vessel node				
Light	n/a - covered under Vessel node				
Waste	Flushing pigs, umbilical chemicals, shipped to shore, scoter riser tie in spool and associated mats.	Onshore energy use and emissions / discharges from waste processing and potential landfill	Optimise flushing goals and procedures to limit excessive use of fuel / emissions / waste generation, opportunity of re-use of mats. Spool recycling.	B1 Slight	N/A
Energy Consumption	Operation of flushing spread	Use of a finite resource.	Optimise flushing goals and procedures to limit excessive use of fuel / emissions / waste generation	A1 Slight	N/A
Unplanned event	Spill of chemicals/ slops	Potential toxic contaminant effects to organisms in water column and seabed sediments.	Use of appropriate controls to prevent overboards spillings eg. Bunding, spill kits etc. Up to 10's of litres	N/A	A1C Minor
Radiation (heat and ionising)	Possible recovery of NORM or pyrophoric scale with spools.	Landfill of hazardous material	Check all recovered equipment. Treat and disposal by licensed waste disposal contractor	N/A	B1B Negligible

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	EXISTING MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED
Recovery of Subsea Equipment					
Disruption to the soil and subsoil	Potential jetting and excavation to access manifold piles.	Should internal cutting of the manifold piles not be technically feasible there will be disturbance to the seabed associated with excavation of material to allow access to the manifold piles below the seabed. Increased suspended solids in the water column and dilution and dispersion before settling on seabed.	A suitable tool will be selected for the cutting to ensure that impacts are minimised. Procedures will be in place for the activity.	B1 Slight	N/A
Disruption to the soil and subsoil	excavation of spool, pipeline and umbilical ends to achieve required depth of burial.	Localised seabed disturbance resulting in some lethal/sub-lethal effects on benthic and epibenthic fauna. Possible smothering of some organisms following settlement of re-suspended particles. Rate of recovery dependent on type of seabed and species present. Area of impact is small and out with any designated areas.	Minimise seabed disturbance	B1 Slight	N/A
Disruption to the soil and subsoil	Use of rock cover to fill pipeline ends / depressions left on the seabed.	<u>Environmental impacts</u>: Introduction of hard substrate to a sandy habitat, could cause small localised changes to the ecosystem in area impacted.	Alternatives to rock for infill have been previously considered and rejected - e.g. use of sand due to poor / dispersed settlement	B1 Slight	N/A
Disruption to the soil and subsoil	Use of rock cover to fill depressions left on the seabed.	<u>Socio-economic impacts</u>: Potential depressions following recovery of subsea equipment (should seabed be excavated prior to cutting). Could impact on fishing activity.	Overtrawl trials within 500m zone will identify any areas requiring remediation.	B1 Slight	N/A
Fluids and other materials into water	Increased suspended solids in the water column from cuttings activities (shavings). Garnet in cutting medium. Release of residual fluids in pipelines and subsea equipment.	Increased suspended solids due to metal shavings from cutting pipelines. Garnet is inert.	Discharges permitted under OPPC.	A1 Slight	N/A
Fluids and other materials into water	Marine Growth discharge	Marine growth may fall off structure into sea and onto the vessels during transit. It will be naturally dispersed in the marine environment. Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water.		A0 No Effect	N/A
Noise	Underwater noise from cutting activities	Abrasive water jet cutting or diamond wire cutting, could have potential impact on fish and marine mammals in the area.	Under JNNC guidance acknowledges that noise from cutting has negligible impact	A0 No Effect	N/A

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	EXISTING MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED
Returning access to fishing area	Removal of 500 m safety zone	Fishing vessels gain access to an area that they have previously been excluded from.	Benefit		
Onshore/yard activities	Gaseous emissions	Fuel combustion emissions (CO_2, CO, SO_x, NO_x, etc.) from lorries and cuttings tools and recycling operations. Positive impact of recycling steel given that recycling of steel results in less CO_2 emissions than production of new steel).	Benefit		
Onshore/yard activities	Noise and vibrations	Lorries transporting the recovered infrastructure. Noise associated with the yard activities. 50m spools approx. 500t	Use of permitted yards	B0 No Effect	N/A
Onshore/yard activities	Odour	Marine growth	Licensed yards with odour management plan.	B1 Slight	N/A
Onshore/yard activities	Waste materials: 1. waste fluids 2. Steel 3. Supporting structures 4.Plastics	Minimal waste to go to landfill.	Application of waste hierarchy. Recycling of steel, concrete, grout where-ever feasible.	B1 Slight	N/A
Onshore/yard activities	Hazardous waste.	Potential for NORM /scale	Detection, recovery and treatment by a licensed waste contractor.	B1 Slight	N/A
Unplanned event	Dropped object during operations: objects such as manifolds, spools/jumpers	Environmental impacts: Seabed disturbance.	Negligible damage as well is plugged prior to any recovery of equipment.	N/A	B1B Negligible
Unplanned event	Dropped object during operations: objects such as manifolds, spools/jumpers	Socio-economic: potential exclusion of fishing activity from a small area if object cannot be recovered.	Items would be recovered. Hold 500m zone cover until made safe.	N/A	N/A
Decommissioning of pipelines and umbilicals *in situ*					
Usage of Space	N/A			N/A	N/A
Disruption to the soil and subsoil	Potential spot rock where insufficient depth of cover.	Habitat change.	Results of overtrawl trial and depth of cover survey will be discussed OPRED /SSF to determine extent of rock cover required.	B1 Slight	N/A
Fluids and other materials into water	release of low concentration OIW following corrosion of pipelines		Flushing to minimise residual oil content.	A0 No Effect	N/A

ASPECT	PROJECT ACTIVITY / SOURCE OF IMPACT	POTENTIAL IMPACTS / OBSERVATIONS	EXISTING MITIGATION MEASURES, SAFEGUARDS AND CONTROLS	IMPACT SIGNIFICANCE	ENVIRONMENTAL RISK - UNPLANNED
Materials to seabed	Plastic coatings, steel/copper of pipelines and umbilicals left below seabed	It is expected to be benign and unlikely to deteriorate as it will be buried within the seabed sediment.	Post-decommissioning (legacy) monitoring of pipelines to ensure continued depth of burial is adequate	B1 Slight	N/A
Use of resources	Steel not recycled	Use of finite resources. Steel components are not limited although the energy (and emissions) associated with mining, transport and processing of awe is.		B0 No Effect	N/A
Decommissioning of stabilisation features					
Disruption to the soil and subsoil	Recovery of mattresses and grout bags.	Some localised seabed disturbance at mattress locations resulting in possible smothering of some organisms following settlement of re-suspended particles. Recovery dependent on type of seabed and species present. Area of impact is relatively small and out with any designated areas. Impacted species are generally considered to be widespread throughout the area.	Optimise work procedures.	B1 Slight	N/A
Usage of space	Mattresses, rock cover and grout bags left on the seabed (not feasible to be removed).	Potential snagging hazard. Non-natural, hard substrate Remove snagging hazard by additional rock cover.	Any requirement will be discussed with OPRED /SSF to determine extent of rock cover required.	B1 Slight	N/A
Onshore activities	Waste - disposal of recovered grout bags and mattresses (potentially they might be repurposed)	Disposal to landfill - finite resource.	Apply waste hierarchy.	B1 Slight	N/A
Overtrawl Trial and Debris Clearance Survey					
Disruption to the soil and subsoil	Debris clearance surveys (chain mats) and overtrawl trials at 500 m exclusion zone. Area impacted will extend outside the 500 m zone to allow for turning of fishing vessel (and gear).	Seabed disturbance, increased suspended sediment, impact on benthic species, their disturbance and loss.	Explore opportunities to use non-intrusive survey methods to demonstrate safe and clear seabed.	B2 Minor	N/A

ABBREVIATIONS

AIS	Automatic Identification Systems
BEIS	Department for Business, Energy and Industrial Strategy
CA	(Scoter and Merganser) Comparative Assessment
CH_4	Methane
CNS	Central North Sea
CoP	Cessation of Production
CO_2	Carbon Dioxide
COLREGS	International Regulations for the Prevention of Collisions at Sea
CRA	Collision Risk Assessment
D	Disclosive
dB	Decibel
dB re 1 μPa	Decibels relative to one micro-Pascal
dB re 1 μPa^2s-m	Decibels relative to one micro-Pascal referred to one meter from source
dB re 1 μPa^2s-m	Decibels relative to one micro-Pascal square second
dB re 1 μPa^2s-m	Decibels relative to one micro-Pascal square second referred to one meter from source
DECC	Department of Energy and Climate Change
DP	(Scoter and Merganser) Decommissioning Programmes
DSV	Dive Support Vessel
EA	(Scoter and Merganser) Environmental Appraisal
E&A	Exploration and Appraisal
EC	European Commission
EGMBE	EthyleneGlycol MonoButylEther
ENVID	ENVironmental Impact iDentification
EPS	European Protected Species
ERL	Effects Range Low
ETAP	East Trough Area Project
EUNIS	European Nature Information System
FSM	Field Signature Method
GHG	Greenhouse Gases
GMAS	(Shell's) Global Marine Assurance System

H	Height
Hz	Hertz
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
kg	Kilograms
kHz	Kilo Hertz
km	Kilometres
L	Length
LAT	Lowest Astronomical Tide
LTOBM	Low Toxicity OBM
m	Metres
MARPOL	International Convention for the Prevention of Pollution from Ships
mb	Millibar
MBES	Multi Beam Echo Sounder
MCZ	Marine Conservation Zone
MDAC	Methane Derived Authigenic Carbonate
MEG	MonoEthylene Glycol
mm	Millimetre
MMO	Marine Management Organisation
MMS	Minerals Management Service
MPA	Marine Protected Area
N/A	Not Applicable
NCES	Natural Capital and Ecosystem Services
NCMPA	Nature Conservation MPA
nm	Nautical Miles
NMPi	National Marine Plan interactive
NO_x	Nitrogen Oxides
NORM	Naturally Occurring Radioactive Material
OBM	Oil Based Mud
OCIMF	Oil Companies International Marine Forum

OGA	Oil and Gas Authority
OiW	Oil in Water
OPEP	Oil Pollution Emergency Plan
OPF	Organic-Phase Drilling Fluid
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo/Paris Convention
OVIQ	OCIMF Vessel Inspection Questionnaire
OVMSA	Offshore Vessel Managers Self Assessment
PL	Prefix for OGA pipeline numbering system
P&L	Plug and Lubricate
PMF	Priority Marine Features
P&MS	Plug and Make Safe
PPF	Paint Protection Film
ppm	Parts Per Million
PTS	Permanent Threshold Shift
PUQ	Production, Utilities and Quarters
PVA	Particularly Valuable Area
PWR	Preparatory Works Request
rms	Root Mean Square
ROV	Remotely Operated Vessel
SAC	Special Area of Conservation
SBP	Sub Bottom Profiler
SCANS	Small Cetacean Abundance in the North Sea
SEAL	Shearwater Elgin Area Line
SEL	Sound Exposure Level
SFF	Scottish Fishermen's Federation
SMES	Scoter Manifold Extension Structure
SOPEP	Shipboard Oil Pollution Emergency Plan
SOSI	Seabird Oil Sensitivity Index
SO_2	Sulphur Dioxide
spp.	Non-determined species
SPA	Special Protection Area

SPL	Sound Pressure Level
SPU	Syntactic PolyUrethane
SSS	Side Scan Sonar
te	tonnes
THC	Total Hydrocarbon
TTS	Temporary Threshold Shift
UKCS	UK Continental Shelf
UKOOA	UK Offshore Operators Association
VMS	Vessel Monitoring System
VOC	Volatile Organic Compounds
W	Width
WBM	Water Based Mud
WMP	Waste Management Plan
µg	Microgram
µm	Micrometer
µPa	Micro Pascal
°C	Degrees Celsius
‰	Per thousand
%	Percent
g	gram
km^2	Square kilometre
£	Pounds Sterling
c.	Circa (approximately)